Final
SWMU B-3 BIOREACTOR
OPERATION AND MAINTENANCE MANUAL

DEPARTMENT OF THE ARMY • UNITED STATES OF AMERICA

1775

Prepared For:

Camp Stanley Storage Activity
Boerne, Texas

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TABLE OF CONTENTS

APPENDICES

Appendix A	TCEQ Authorization Letters
Appendix B	Product Information Recovery Well Pumps and SymCom PumpSaver
Appendix C	Product Information Price Pump Co. XT150 Centrifugal Pump and Baldor Pump Motor
Appendix D	Product Information Krystil Klear Filtration Model 88 Bag Filter
Appendix E	Product Information FullJet Standard Type G Spray Nozzles
Appendix F	Automation System Design
Appendix G	Product Information GPI TM150, Endress+Hauser Prowhirl 72F, FT420 Flow Computer
Appendix H	Product Information Magnetrol Liquid Level Switch model T21 and Displacer Type, Endress+Hauser FMU40 Ultrasonic Meter, In-Situ LevelTroll 500, and Endress+Hauser WaterPilot FMX167
Appendix I	SCADA Control Components
Appendix J	Product Information Westbay Manual
Appendix K	Field Monitoring Forms

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

btoc	below top of casing
BTS	Bioreactor Trench Sump
CC	Cow Creek Formation
CSSA	Camp Stanley Storage Activity
DO	Dissolved oxygen
DOC	Dissolved organic carbon
ft	Feet
GAC	Granular activated carbon
gpm	Gallons per minute
HDPE	High density polyethylene
HOA	Hand off automatic
Hp	Horsepower
HSP	Health and Safety Plan
MPMW	Multi port monitoring well
MSL	Mean sea level
MW	Monitoring well
NTP	Notice to proceed
O&M	Operation and Maintenance
ORP	Oxidation reduction potential
Parsons	Parsons Infrastructure and Technology
PCE	Perchloroethene
PLC	Programmable Logic Controller
psi	Pounds per square inch
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RTU	Remote Telemetry Unit
SCADA	Supervisory Control and Data Acquisition
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TOC	Total organic carbon
toc	top of casing
TCE	Trichlorethene
VOC	Volatile organic compound
VC	Vinyl Chloride

SECTION 1
INTRODUCTION

This Operations and Maintenance (O&M) Plan documents the necessary activities to be performed during operation and maintenance of the Solid Waste Management (SWMU) B-3 bioreactor and injection system installed at Camp Stanley Storage Activity (CSSA) in Boerne, Texas.

The purpose of this O&M Plan is to describe the procedures to be followed during normal operation of the system. This plan provides a detailed description of the injection system, including specifications of system components, data to be collected during normal system operations, system maintenance procedures, and general site maintenance to facilitate effective system operations. This plan furthermore provides CSSA with a set of procedures for monitoring the equipment used for operating the SWMU B-3 bioreactor as well as monitoring the bioreactor effectiveness at reducing the concentrations of volatile organic compounds (VOCs) in the aquifer underlying SWMU B-3.

Section 2 provides a description of the pilot study remedial (bioreactor) system in operation at the site, including a detailed description of the system components. Section 3 describes the system operation and monitoring requirements, Section 4 presents the system maintenance activities to be performed, and Section 5 discusses reporting requirements. The Texas Commission on Environmental Quality (TCEQ) Authorization Letter(s) for the underground injection of VOC-impacted groundwater is included in Appendix A. Product manuals and literature of system components are included in Appendix B through J. Field data forms to be used during O&M activities are included in Appendix K.

1.1 HEALTH AND SAFETY

CSSA and Parsons Infrastructure and Technology (Parsons) are committed to performing the O&M activities at the B-3 site in a safe manner. A Health and Safety Plan (HSP) has been prepared that addresses worker safety during performance of the O&M activities at the site. The HSP identifies potential safety hazards associated with the O&M work activities and describes safety procedures that must be implemented to ensure that the work can be completed without incident. A copy of the HSP is maintained at CSSA.

All personnel performing O&M activities at the site must read the HSP to become familiar with the potential work hazards and the safety procedures to be followed. After familiarizing themselves with the HSP, all employees must sign the HSP Acknowledgement Form maintained at CSSA. The procedures presented in the HSP must be followed by Parsons Employees and subcontractors at all times while on CSSA. The HSP will be updated as needed to address new site work hazards or incorporate work tasks as they are identified.

1.2 SITE DESCRIPTION

CSSA is located in northwestern Bexar County about 19 miles northwest of San Antonio, Texas. The installation consists of 4,004 acres immediately east of State Highway 3351 and approximately one-half mile from Interstate Highway 10. Additional background information regarding CSSA is located in CSSA's Environmental Encyclopedia (**Volume 1-1, Background Information Report**).

SWMU B-3 was a landfill area thought to have been used primarily for garbage disposal and trash burning from the 1950's through the 1980s. The trench areas were reportedly closed in 1990-1991. In 1991, chlorinated hydrocarbons were detected in groundwater from Well CS-16, approximately 500 feet north-northwest of SWMU B-3. The VOC concentrations, which were above drinking water standards, prompted several investigations aimed at identifying possible source areas that could be contributing to the contamination. SWMU B-3, along with nearby SWMU O-1 (oxidation pond), was identified as potential sources of groundwater contamination within the inner cantonment.

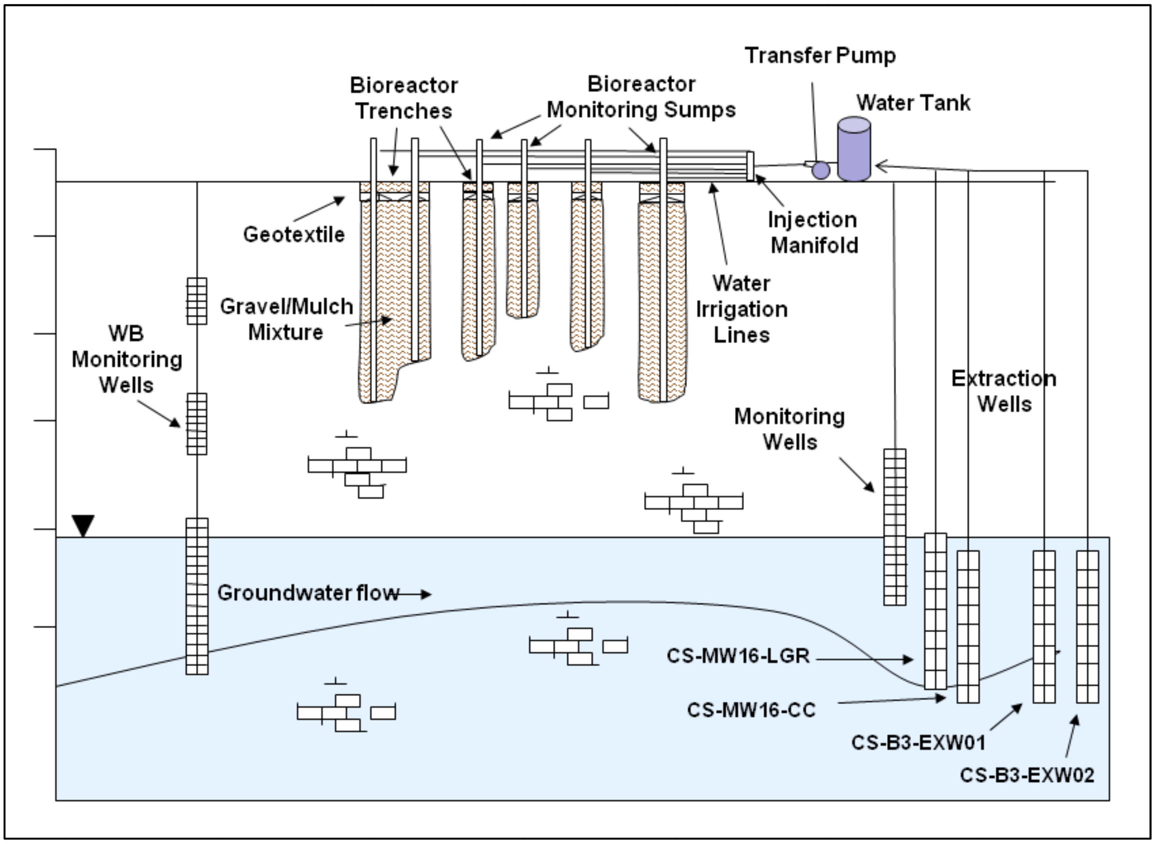
As part of the Resource Conservation and Recovery Act (RCRA) Administrative Consent Order, a pilot study using a bioreactor was conceptualized, designed, and constructed at SWMU B-3. The bioreactor is designed to remediate the affected groundwater and unsaturated zone underlying SWMU B-3. The design included excavation, removal, and offsite disposal of affected soil, debris, and waste contained within six trenches. The waste is believed to be a likely source of contaminants impacting the underlying fractured limestone (bedrock) and groundwater.

Based on the general design of the bioreactor, a request for a Class V Aquifer Remediation Injection Well was submitted to the Industrial and Hazardous Waste Permits Section of the Waste Permits Division at the TCEQ in May 2006. The permit application was approved July 20, 2006 and TCEQ Authorization Number 5X2600431; WWC 12002216; CN602728206/RN104431655 was assigned to the SWMU B-3 injection system. An amendment to CSSA's Class V Aquifer Remediation Injection permit was authorized by TCEQ letter dated June 25, 2007 for use of a sixth trench at SWMU B-3. TCEQ amended the permit reporting schedule by letter dated July 31, 2008 and an additional amendment to the reporting schedule has been requested by CSSA letter dated August 29, 2011. A copy of the Class V Aquifer Remediation Injection Well permit authorization letter and correspondence related to amendments are presented in Appendix A.

SECTION 2
SYSTEM DESCRIPTION

The general concept (see Figure 2.1) of the bioreactor is to pump extracted groundwater from recovery wells CS-MW16-LGR, CS-MW16-CC, and B3-EXW01 through B3-EXW04 to a 5,000-gallon storage tank; this water is then pumped into the bioreactor. Level switches within the storage tank are set to communicate directly with the extraction wells to maintain an available water supply in the tank for subsequent injection into bioreactor trenches. A transfer pump pumps water from the storage tank to the network of pipes buried approximately 1.5 ft below a gravel surface which overlies the SWMU B-3 gravel/mulch-filled trenches. Water from the storage tank is sprayed into the gravel/bark mulch mixture in each trench through downward-pointing discharge nozzles located at 10-foot centers along 1.5-inch flexible high density polyethylene (HDPE) pipe. The use of these nozzles allows a more even distribution of injected water along the trench.

Figure 2.1 General Components of the Bioreactor



To prevent the bioreactor from overfilling, a level switch is installed in monitoring sump 1-1 (Trench 1 - sump 1) which will shut down the transfer pump in the event that the water level in trench 1 reaches the high-level shut-off. The level switch high-level shut-off is set at approximately one foot below trench 1 capacity. Sump 1-1 is located in the north-west corner of trench 1. Additional transducers may be added to a sump in the remaining trenches to provide simultaneous monitoring locations to assess subsurface water levels within the bioreactor.

Water is pumped into selected trenches to saturate a portion of the gravel/tree mulch mixture backfill. The bioreactor capability to reduce contaminants (associated with extracted groundwater from CS-MW16-LGR, CS-MW16-CC, B3-EXW01, B3-EXW02, B3-EXW03 and B3-EXW04 as well as contaminants in the subsurface beneath the bioreactor) is assessed through periodic sampling of groundwater monitoring wells, trench sumps, piezometers and multi-port monitoring wells (MPMWs) located in and around SWMU B-3.

2.1 BIOREACTOR CONSTRUCTION

The details associated with the construction of the bioreactor are provided in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007).

2.2 MAJOR EQUIPMENT

Equipment was installed to provide control of water flow from the two CS-MW16 wells, and extraction wells B3-EXW01 through B3-EXW04. The process diagram depicting the equipment and the controls regulating the flow of water through the system is shown in Figure 2.2.

2.2.1 Extraction Wells

As shown in Figure 2.2, there are six wells within and surrounding SWMU B-3 which supply water to the bioreactor. Wells CS-MW16-LGR and CS-MW16-CC were initially used to supply water to the bioreactor upon start-up in 2007. In 2009 B3-EXW01 was installed about 30 feet to the south of trench 6. In late 2010 well B3-EXW02 was added to the south of the bioreactor approximately 600 feet, near SWMU O-1. In 2011 wells B3-EXW03 and B3-EXW04 were installed to the west of the bioreactor and will be plumbed into the bioreactor system in 2012.

2.2.2 Recovery Well Pumps

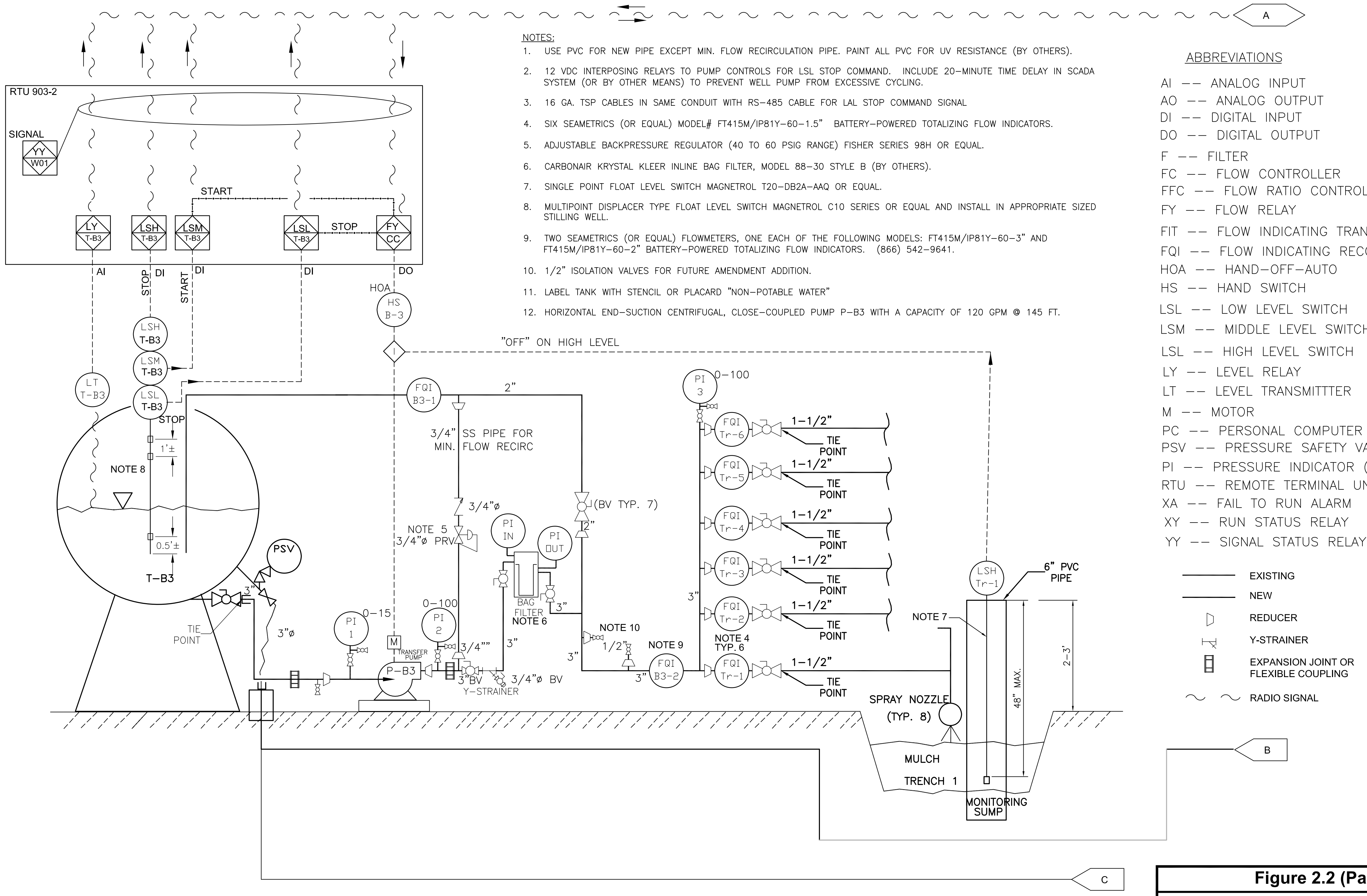
Extraction wells CS-MW16-LGR and CS-MW16-CC utilize submersible pumps installed in 2002. A 1-inch diameter flex-pipe line was installed in each of these wells to facilitate water level probe access. A 5-horsepower (hp) pump was installed in B3-EXW01 in 2009. In 2010 a 5-hp pump was also installed in B3-EXW02 and plumbed into the bioreactor system. In 2011 two additional extraction wells were installed (B3-EXW03 and B3-EXW04) to provide additional water to the bioreactor however these wells have yet to be plumbed into the system. These new extraction wells also include a 5-hp pump to extract and transmit groundwater to the bioreactor. These pumps supply recovered groundwater to a 5,000 gallon storage tank, which is ultimately injected into the bioreactor trenches. Transducers were installed in all 6 extraction wells to transmit water level data to the Supervisory Control & Data Acquisition (SCADA) system. These values control the pump cycling in order to keep the 5,000 gallon storage tank full but not overflowing and provide pump protection (automatic shut off) when water levels drop to 10-20 feet above the pump.

Additional pump protection was added to wells B3-EXW01 through B3-EXW04 with the installation of a SymCom PumpSaver 235P motor protection devices. The sensing devices monitor the amperage being used by the pump motor. After an initial calibration by the Operator, if the PumpSaver detects and undercurrent condition (user settable between 10 and 30 percent) or an overcurrent condition of more than 25 percent, the well pump is disabled for a specified time period. This protects the motor from running dry (undercurrent) or pumping too hard (overcurrent). The use of these devices requires that they be calibrated by the Operator using the methods outlined in the product brochure included in Appendix B.

Pump details, including operations and maintenance instructions and parts listing are also provided in Appendix B.

2.2.3 System Transfer Pump

An end suction centrifugal pump manufactured by Price® Pump Co. was installed to transfer water from the storage tank through the bioreactor injection manifold and ultimately into the trenches. The transfer pump cycles on/off automatically depending on the water level detected in the bioreactor and the water level in the storage tank. The pump is connected to the storage tank with a 2-inch suction hose and schedule 80 polyvinyl chloride (PVC) line that is bolted to the concrete pad constructed adjacent to the storage tank. A 1.5-inch line installed from the pump to the bag filter and then from the bag filter to the 3-inch header connects the pump to the distribution system. Since portions of the line between the storage tank and the distribution line are above ground, precautions are taken to prevent line damage during freezing weather conditions. Additional information about the pump is provided in Appendix C.



NOTES:

1. USE PVC FOR NEW PIPE EXCEPT MIN. FLOW RECIRCULATION PIPE. PAINT ALL PVC FOR UV RESISTANCE (BY OTHERS).
2. 12 VDC INTERPOSING RELAYS TO PUMP CONTROLS FOR LSL STOP COMMAND. INCLUDE 20-MINUTE TIME DELAY IN SCADA SYSTEM (OR BY OTHER MEANS) TO PREVENT WELL PUMP FROM EXCESSIVE CYCLING.
3. 16 GA. TSP CABLES IN SAME CONDUIT WITH RS-485 CABLE FOR LAL STOP COMMAND SIGNAL
4. SIX SEAMETRICS (OR EQUAL) MODEL# FT415M/IP81Y-60-1.5" BATTERY-POWERED TOTALIZING FLOW INDICATORS.
5. ADJUSTABLE BACKPRESSURE REGULATOR (40 TO 60 PSIG RANGE) FISHER SERIES 98H OR EQUAL.
6. CARBONAIR KRYSTAL KLEER INLINE BAG FILTER, MODEL 88-30 STYLE B (BY OTHERS).
7. SINGLE POINT FLOAT LEVEL SWITCH MAGNETROL T20-DB2A-AAQ OR EQUAL.
8. MULTIPOINT DISPLACER TYPE FLOAT LEVEL SWITCH MAGNETROL C10 SERIES OR EQUAL AND INSTALL IN APPROPRIATE SIZED STILLING WELL.
9. TWO SEAMETRICS (OR EQUAL) FLOWMETERS, ONE EACH OF THE FOLLOWING MODELS: FT415M/IP81Y-60-3" AND FT415M/IP81Y-60-2" BATTERY-POWERED TOTALIZING FLOW INDICATORS. (866) 542-9641.
10. 1/2" ISOLATION VALVES FOR FUTURE AMENDMENT ADDITION.
11. LABEL TANK WITH STENCIL OR PLACARD "NON-POTABLE WATER"
12. HORIZONTAL END-SUCTION CENTRIFUGAL, CLOSE-COUPLED PUMP P-B3 WITH A CAPACITY OF 120 GPM @ 145 FT.

ABBREVIATIONS

AI -- ANALOG INPUT
AO -- ANALOG OUTPUT
DI -- DIGITAL INPUT
DO -- DIGITAL OUTPUT
F -- FILTER
FC -- FLOW CONTROLLER
FFC -- FLOW RATIO CONTROLLER
FY -- FLOW RELAY
FIT -- FLOW INDICATING TRANSMITTER
FQI -- FLOW INDICATING RECORDER
HOA -- HAND-OFF-AUTO
HS -- HAND SWITCH
LSL -- LOW LEVEL SWITCH
LSM -- MIDDLE LEVEL SWITCH
LSL -- HIGH LEVEL SWITCH
LY -- LEVEL RELAY
LT -- LEVEL TRANSMITTTER
M -- MOTOR
PC -- PERSONAL COMPUTER
PSV -- PRESSURE SAFETY VALVE
PI -- PRESSURE INDICATOR (GAGE)
RTU -- REMOTE TERMINAL UNIT
XA -- FAIL TO RUN ALARM
XY -- RUN STATUS RELAY
YY -- SIGNAL STATUS RELAY

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Figure 2.2 (Page 1 of 2)

Bioreactor Pumping System
Process Diagram

CSSA SWMU B3

PARSONS

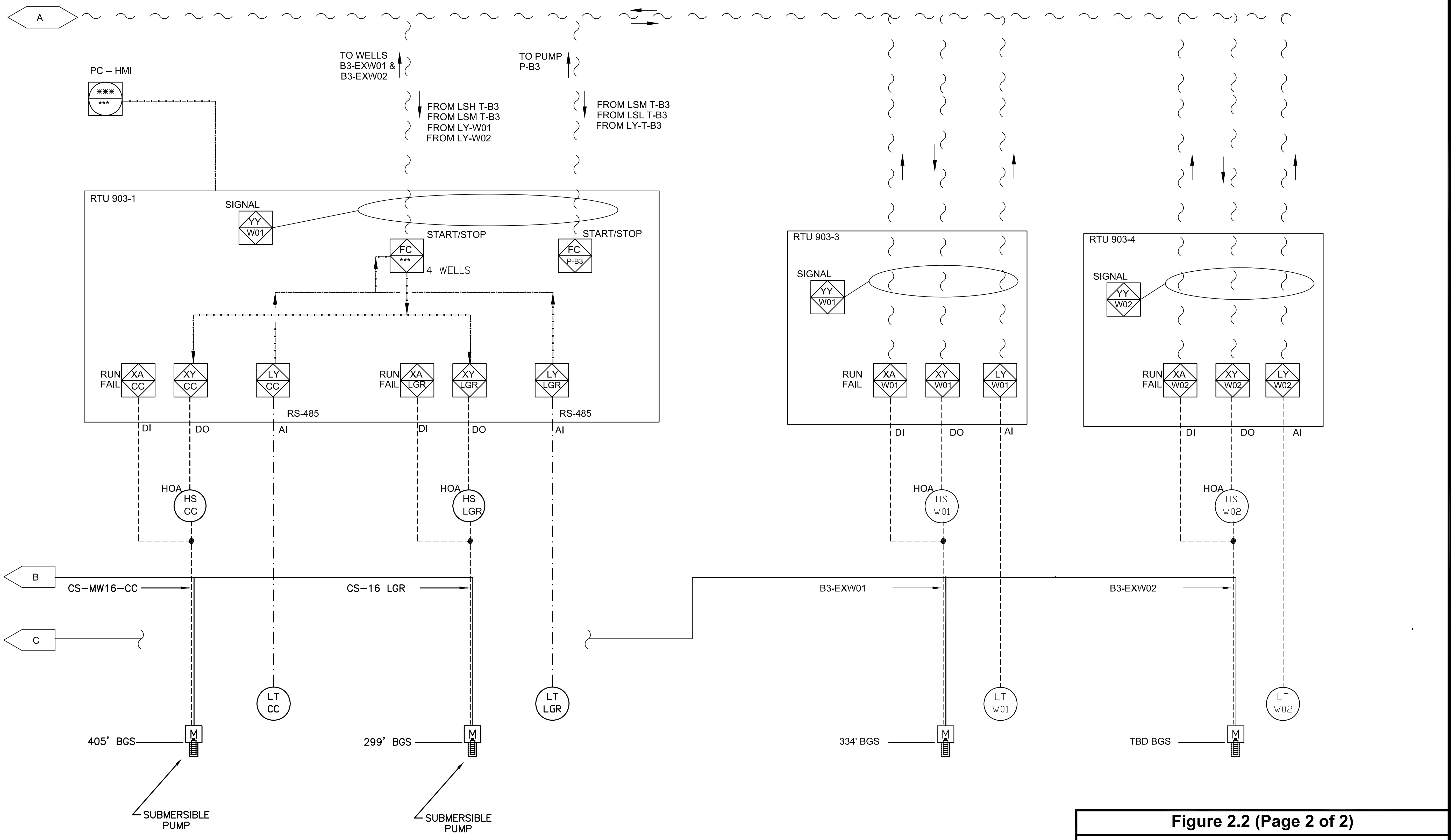

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Figure 2.2 (Page 2 of 2)

Bioreactor Pumping System
Process Diagram

CSSA SWMU B3

PARSONS

2.2.4 Storage Tank

A 5000-gallon former transport tanker was placed on the north side of the bioreactor and secured. The former transport tank serves as temporary storage of ground water from the extraction wells and is the on demand water supply to the bioreactor. Monthly inspections are conducted to examine the condition of the tank and any deficiencies are noted in the field logbook.

2.2.5 Bag Filter System

The water sprayer discharge openings in the bioreactor trenches are small (0.063-inch orifice for 1.7 gallons per minute (gpm) spray nozzles and a 0.094-inch orifice for 2.5 gpm spray nozzles); therefore, it is necessary to remove as much sediment from the injection water as possible to reduce the potential for clogging the spray heads. As shown in Figure 2.2, the bag filter equipment is installed downstream of the transfer pump before the distribution manifold. The bag filter equipment, manufactured by Krystil Klear Filtration® consists of a single chamber with a coarse mesh basket and a bag filter fitted inside the mesh basket. Bag filter replacement should follow the schedule recommended by the manufacturer, or more frequently as determined by the difference in bag filter pressures entering and leaving the filter canister. Additional information about the bag filter equipment is provided in Appendix D.

2.2.6 Eductor for Incorporation of Additive

An eductor system may be included down stream of the bag filter for future use if it is deemed necessary to inject additional additive into the bioreactor. A container of oil or similar microbial enhancement amendment can be placed near the eductor and an intake pipe will be placed in the container to inject the specified dosage. The additive is drawn into the flow system via the eductor as water passes through the piping which then uniformly distributes the additive with injected groundwater.

2.3 TRENCH AND INJECTION PIPING LAYOUT

The details associated with excavation trenches are provided in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007). There are six trenches within SWMU B-3 potentially utilized for injection of extracted groundwater. The injection piping from the transfer piping is constructed of 1.5-inch HDPE piping with pressure type fittings. Brass injection nozzles are located at 10 foot intervals in each trench with orifice openings of 0.063-inch for 1.7 gpm spray nozzles, and a 0.094-inch orifice for 2.5 gpm spray nozzles. Nozzle specifications are provided in Appendix E.

2.4 INSTRUMENTS AND CONTROL

The Bioreactor has been automated to operate with minimal supervision since it was first installed. In March 2010, the Bioreactor automation system was upgraded to provide additional controls and provide connectivity to the CSSA Supervisory Control and Data Acquisition (SCADA) system. The system uses four Remote Telemetry Units (RTU) to control the operation of the Bioreactor System. The RTUs are located at the

GAC Shack, the Bioreactor Tank, and extraction wells B3-EXW01 through B3-EXW04. The RTUs use wireless radios (900 MHz) to communicate commands, status, and data between the Bioreactor components. Ultimately, the data is wireless transferred (VHF radio) back to the SCADA system for viewing at the SCADA workstations located in Buildings 1, 36, 38, and 606. The Bioreactor can be operated from either the control screen located in the GAC Shack or SCADA workstation by an operator with the proper credentials.

The main RTU (903-1) is located inside the GAC Shack, and serves as the hub for the Bioreactor controls. It communicates directly with the slave RTUs at the Bioreactor Tank (RTU 903-2), -B3-EXW01 (RTU 903-3), B3-EXW02 (RTU 903-4), and soon to be installed at B3-EXW03 (RTU-5) and EXW04 (RTU-6) to control the operation of Bioreactor. In addition, the GAC Shack RTU communicates directly with SCADA system to transmit data and receive commands. The 903-1 RTU features touch screen controls to operate the Bioreactor system. The 903-1 RTU also controls the MW16 wells and the GAC Shack treatment system.

Slave RTU 903-2 communicates directly with Master RTU 903-1, and controls the functions at the Storage Tank and Transfer Pump. The storage tank is equipped with high, medium, and low level switches which dictate when the wells are activated to fill the tank. The level switches in the tank also control the operation of the transfer pump to convey water from the tank to the trenches. The tank is also equipped with an ultrasonic level meter to monitor the level of water in the tank. The purpose of the ultrasonic meter is to provide an accurate reading of the water level in the tank and to serve as a redundant control in the event if the mechanical switches fail. RTU 903-2 also monitors the high level switch located in Trench 1 (Monitoring Sump 1-1). When the switch indicates that Trench 1 is full to capacity, the production and transfer of water to the trenches ceases until the water level recedes as indicated by the switch.

Slave RTU 903-3 communicates directly with Master RTU 903-1, and controls the operation of extraction well B3-EXW01. This location is equipped with pump controls, pressure transducer, and a water flowmeter. Based on commands given by the Master RTU 903-1, this RTU operates the well pump and communicates the groundwater level and flowrate back to the Master RTU 903-1.

Slave RTU 903-4 communicates directly with Master RTU 903-1, and controls the operation of extraction well B3-EXW02. This location is equipped with pump controls, pressure transducer, and a water flowmeter. Based on commands given by the Master RTU 903-1, this RTU operates the well pump and communicates the groundwater level and flowrate back to the Master RTU 903-1. RTU’s 5 and 6 are expected to operate similar to RTU 903-4.

Each major component in the system is equipped with a motor control panel that features **“HAND-OFF-AUTO”** (HOA) switches. For the system to be automated, it is necessary that the individual motor control panels at wells CS-MW16-LGR, CS-MW16-CC, B3-EXW01, B3-EXW02, B3-EX0W3, B3-EXW04 and the Transfer Pump are switched to **“AUTO”**. The control equipment for each of these pumps are located at their respective locations.

Product information for controllers and instruments are provided in Appendix F.

2.4.1 Pressure Gauges and Flow Meters

As required by TCEQ, the monitoring and reporting of flow volumes discharged into the subsurface is and must be reported in the scheduled (semi-annual) UIC authorization reports. Instruments to monitor line pressures and volume of injection water are provided for the B-3 Bioreactor System. Pressure gauges are located at various locations between the storage tank and the main header as shown in the design drawings in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007.). In addition, flow meters are installed to provide injection volumes in each of the six trenches, as well as extraction volumes from the extraction wells. A K factor of 98.0 is used for flow meters installed on 1.5" lines, and a K factor of 25.4 is used for flow meters installed on 3" lines. The injection manifold containing the six trench injection lines are equipped with FT415 SeaMetrics flow meters to obtain discrete volumes injected into each trench as well a flow readings.

Extraction wells B3-EXW01 and B3-EXW02 are equipped with an Endress+Hauser Prowirl 72F flowmeter with SCADA connectivity. B3-EXW03 and B3-EXW04 are expected to be equipped with the Endress+Hauser Prowirl 72F flowmeter with SCADA connectivity. Wells CS-MW16-LGR and CS-MS16–CC are equipped with GPI TM150 flowmeters that do not offer SCADA connectivity, and therefore require manual readings.

Product information for the various flow meters is provided in Appendix G**.**

2.4.2 Liquid Level Switches and Meters

Multiple sets of water level indicators are required for the automation system to operate effectively. One set is installed within the storage tank and is comprised of three Magnetrol, model C10, liquid level switches. These switches indicate high, medium, and low levels within the storage tank. Another liquid level meter (Endress+Hauser FMU40) is also installed to provide instantaneous level measurements from within the tank.

One model T20, Magnetrol liquid level switch is installed in Sump 1-1, to communicate the water level within the trench to the control system which, in turn, controls the transfer pump.

Each well is equipped with a pressure transducer to monitor the groundwater level in the borehole. Wells CS-MS16-LGR and CS-MS16–CC are both equipped with In-Situ LevelTroll 500 devices. Extraction wells B3-EXW01 and B3-EXW02 are equipped with an Endress+Hauser WaterPilot FMX167. Additionally, B3-EXW03 and B3-EXW04 are expected to be equipped with the Endress+Hauser WaterPilot FMX167.

Product information for the liquid level switches and level transducers are provided in Appendix H.

2.4.3 SCADA Controls

The SCADA controls are made up of a myriad of components from various manufacturers. The individual components are consolidated into single enclosures to comprise an RTU. In general, the RTUs feature General Electric VersaMax Programmable Logic Controllers (PLC), Weidmuller 900 MHz radios, and Red Lion protocol converters.

Product information for the SCADA controls is provided in Appendix I.

2.5 SYSTEM UPDATES

Several system updates are currently in the planning stages and are expected to be incorporated at SWMU B-3 that will significantly change bioreactor O&M activities. The first of which is construction of a building on the north east side of the bioreactor that will house system controls, storage tanks, the transfer pump, and bag filter. The repositioning of the injection equipment in this new building will require the rerouting of water lines from extraction wells and utilities, and moving SCADA controls. Two 10,000-gallon tanks will be installed in series in the new building and will replace the 6,000-gallon trailer mounted tank currently in use.

Secondly, two new extraction wells will be incorporated into the system. These two wells, CS-B3-EXW03 and CS-B3-EXW04, were drilled, cased, and pumps were installed in May and June, 2011. The area around these wells may be subject to periodic flooding. Therefore surface completions will be constructed with the addition of fill material around these wells to build up the area around the wells and provide an elevated base to construct the pump control box and minimize the potential for flood damage. Extraction lines will be buried and run to the injection control building. Connecting power to these wells will require the addition of a power pole nearby.

Third, the bioreactor trenches will be recharged with deciduous tree mulch and 5/8 inch-sized gravel. The addition of mulch and gravel is anticipated fill the trenches completely, such that SWMU B-3 will be a level surface with no visible signs of the individual trenches. New injection lines will be installed approximately 18 inches below the surface and covered with new geotextile fabric. Additionally, sumps currently installed will be extended so they will rise above ground surface once the trenches are filled and will also extend above the level of the berm located on the west side of the bioreactor. The extension of the sumps will require the repositioning of the float switch located in sump T1-1 and the associated power lines and communication wiring.

These updates are expected to begin following the submission of this document. New equipment product information and specifications, updated system design plans and changes to normal operation procedures, maintenance, and monitoring will be documented once bioreactor modifications are completed.

SECTION 3
SYSTEM OPERATION AND MONITORING

3.1 SITE ACCESS

Camp Stanley is an active military installation. Security regulations mandate that the base be informed about any operation that are to take place inside the installation borders. Visitors and subcontractors need to contact the base 48 hours in advance with personal information to obtain entrance permit. Entry to the post occurs through the main gate situated in the south-west corner of the post, on FM 3351. Access related issues are coordinated through the CSSA Environmental Office.

3.2 NORMAL OPERATION PROCEDURES

During normal operation, the system will be pumping groundwater from six wells, CS-MW16-LGR, CS-MW16-CC, B3-EXW01 through B3-EXW04. The extracted groundwater is pumped into the storage tank which is then pumped through a bag filter to remove suspended solids that could cause fouling of the spray nozzles and ultimately into trenches filled with deciduous tree mulch/gravel mixture. The following sections outline the steps in the operation of the bioreactor. The intent of operating and controlling the groundwater recovery system (CS-MW16 and B3-EXW wells) and the bioreactor transfer pumping system (5,000 gallon storage tank) is to maximize the throughput of water to the bioreactor.

3.2.1 Pumping water from Extraction Wells to Storage Tank

Submersible pumps in wells CS-MW16-CC, CS-MW16-LGR, -B3-EXW01 through B3-EXW04 are expected to pump water at a combined, sustainable flow rate ranging between 50 gpm and 200 gpm to the 5,000-gallon storage tank. The estimated ranges of flowrates are highly variable and are dependent upon the condition of the aquifer. A 70 gpm rate is an estimated average rate that may fluctuate depending on which wells are currently operational and aquifer groundwater availability. To ensure the pump will not run dry, each well is equipped with a pressure transducer that is set to signal deactivation of the pump if the water level gets too low during the drawdown phase. The pressure transducers also signal the pump when the water level is high enough for pumping to resume after the recovery phase. The different scenarios controlling the operation of the well pumps (water levels in recovery well and 5,000 gallon storage tank) are identified in Table 3.1.

In addition to the RTU controllers for the extraction wells, there is a separate RTU controller connected to level switches located in the 5,000-gallon storage tank. There is an HOA switch at each pump that should be kept in the automatic mode where both the well transducer and the storage tank level switches control the activation of the pump.

Table 3.1 Scenarios Dictating Activation of the Submersible Pumps at Groundwater Supply Wells

Water Level in Well	Water Level in 5000-gallon Storage Tank	Activation of All or One Extraction Well Based on Water Levels in Well and Storage Tank
1. During drawdown phase and above the low level turn-off depth.	Below the high level turn-off.	**<u>On</u>**
2. During drawdown phase and above the low level turn-off depth.	At the high level turn-off.	Off
3. During recovery phase and above the low level turn-off depth, but also below the high level restart.	Below the high level turn-off.	Off
4. During recovery phase and above the low level turnoff depth.	At the high level turn-off.	Off
5. High level is attained (*i.e.*, completion of recovery phase)	Below the high level turn-off.	**<u>On</u>**
6. High level is attained (*i.e.*, completion of recovery phase)	At the high level turn-off.	Off

Note: Controllers are switches that start or stop operations under certain conditions.

Generally, the controllers associated with the recovery wells will allow recovery well pumps to operate when there is sufficient water in the wells and sufficient volume capacity in the 5,000 gallon storage tank.

3.2.2 Pumping Water from Storage Tank to the Bioreactor

Extracted water stored in the storage tank is pumped to the bioreactor with an end-suction centrifugal transfer pump located between the storage tank and the bioreactor trench manifold. The operation of the transfer pump is controlled by level switches in the storage tank as well as a level switches in bioreactor trench sump 1-1 in Trench 1. This sump is located in the deepest bioreactor trench and should provide a representative water level elevation of the saturated conditions across the base of the bioreactor in Trenches 1 through 6. There is an HOA switch at the transfer pump that should be kept in the automatic mode so that both the sump water level switch and the storage tank level switches control the activation of the transfer pump. The different scenarios controlling the operation of the transfer pump are identified in Table 3.2.

Table 3.2 Scenarios Dictating Activation/Deactivation of the Transfer Pump

Water Level in Bioreactor Sump	Water Level in 5000-Gallon Storage Tank	Response of Transfer Pump Based on Signal from a Sump or a Tank Level Switch
1. Below the high level turn-off switch and water level rising in Trench 1 with transfer pump operating.	Above the low level turn-off.	Continues operating
2. Below the high level turn-off switch and water level rising in Trench 1 with transfer pump operating.	Water level reaches the low level turn-off.	Turns off
3. Below the high level turn-off switch and water level dropping in Trench 1 with transfer pump off.	Water level rising in tank and reaches the medium-level turn-on (switch set just below the high level switch).	Turns on
4. Pump has been off and water level recedes below the sump level switch.	Water level at high-level switch.	Turns on
5. Pump has been on and water rises to the sump level switch.	Water level above low-level turn-off switch.	Turns off

Generally, the controllers at the 5,000 gallon storage tank will operate the transfer pump when there is sufficient volume of water in the 5,000 gallon storage tank and sufficient volume capacity within trench 1.

3.3 SCADA OPERATION PROCEDURES

3.3.1 General Operating Principle

As of March 2010, the Bioreactor components have been incorporated into the SCADA system. Simply stated, the process logic to operate the supply/extraction wells and transfer pump are automated to deliver groundwater to the Bioreactor infiltration trenches. Safeguards have also been included to prevent the extraction wells and transfer pump from running dry, or preventing the Bioreactor Storage Tank and infiltration trenches from overflowing. All systems include “manual override” operation by setting the **“HAND-OFF-AUTO”** (HOA) switches at each motor control panel to **“HAND”**. For the system to operate under automatic control, the HOA switches at the following locations all need to be switched to the **“AUTO”** position:

- CS-MW16-LGR;
- CS-MW16-CC;

- B3-EXW01 through B3-EXW04; and
- Bioreactor Transfer Pump.

Several criteria must be met for the wells to operate and provide water to the Bioreactor tank:

1. The water level in Trench 1 must be below the mechanical float trigger point installed in Sump 1-1. If the mechanical float in this well is active, the trenches are filled to capacity and therefore no more groundwater will be introduced until the trench water levels recede below the Sump 1-1 mechanical float setpoint.
2. The operation of the transfer pump and supply wells are interlocked with the capacity of the storage tank. The storage tank is equipped with a triple-point (**HIGH-MEDIUM-LOW**) mechanical float with redundant level measurement from an ultrasonic level meter.
   a. The **HIGH** float setpoint is used to turn off the supply wells (Table 3.1). If the water level in the tank is below the **HIGH** float setpoint and the trenches are not full (see item 1) the supply wells will run, assuming the groundwater level has recovered to its’ minimum start depth.
   b. The **LOW** float setpoint is used to turn off the transfer pump. This setpoint prevents the transfer pump from running dry (Table 3.2).
   c. The **MEDIUM** float setpoint is used to turn on the transfer pump once the tank has been re-filled by the supply wells to above two-thirds capacity (Table 3.2). The transfer pump will continue to run until the water level decreases to the **LOW** float switch. The **MEDIUM** float setpoint is also used to re-start the wells once the tank level drops below two-thirds capacity.
3. Each well is equipped with a pressure transducer to monitor the water level within the borehole and prevents the well pump from running dry, and also dictates the amount of water level recovery that must occur before the well can be re-started. The **START** and **STOP** setpoints for each well is definable by the Operator via the SCADA interface. Even if the Bioreactor tank controls (**HIGH** float) are calling for the well operation, the well will not actuate if the recovery phase is not complete.

Bioreactor automation process is all controlled locally at the site from the GAC Shack RTU. As previously described, the GAC Shack RTU communicates wireless between the groundwater wells and the Bioreactor tank. Because the automation logic is housed locally at the site, the Bioreactor system does not depend upon interface between the SCADA Master PLC, Server, or Operator Workstations.

Assuming that the motor control HOA switches are in the **“AUTO”** position, the Bioreactor system can be manipulated either locally at the GAC Shack, or remotely from any of the SCADA workstations (B1, B36, B38, or B606). The following are descriptions on how to interface with the Bioreactor SCADA Controls.

3.3.2 Local SCADA Control from GAC Shack

The operational programming functions reside in the local PLC located at the GAC Shack RTU. Most functions are internal and have been programmed by the SCADA integrator, Systems Control & Instrumentation (SCI, 210-661-9901). However, limited operational functionality resides with the Bioreactor Operator and includes:

- ***OFF/AUTO Pump Status*** (CS-MW16-LGR, CS-MW16-CC, B3-EXW01, B3-EXW02, B3-EXW03, B3-EXW04 and Transfer Pump);
- ***Water Level Operational Setpoints*** (CS-MW16-LGR, CS-MW16-CC, B3-EXW01 through B3-EXW04).

The GAC Shack RTU includes a touchscreen user interface to review the status of the Bioreactor system, and allow the Operator to make changes. Current Operators authorized to manipulate the RTU view screen are:

- ***SCI:*** Richard Fincke;
- ***Parsons:*** Julie Bouch, Samantha Elliott, and Scott Pearson.

To add additional users to the system, the user will need to contact Richard Fincke (210-661-9901) for technical support.

To operate the Bioreactor system in **"Automatic"** mode, the Operator will need to ensure that the HOA switches at the selected motor control panels (four groundwater supply wells and transfer pump) are set to **"AUTO"**. It is important to note that not all wells are required to operate Bioreactor in **"Automatic"** mode. As few as one groundwater extraction well could be run and allowed to gravity feed into the trenches if so desired. However, for this discussion all wells and transfer pump will be assumed to be needed for operation.

The GAC Shack RTU viewscreen provides a series of five menus to observe and control the function of the Bioreactor. Figure 3.1 depicts the process logic used to navigate through the menus. The menus are described below. Text within a box indicate that button can be pressed on the viewscreen.

3.3.2.1 CSSA LOGIN SCREEN

The Login Screen allows the user to gain access to the operational submenus. The initial login user name is typically their First Name with a password that is the last four digits of their cell phone number. The SCI system integrator will be responsible for setting up new users on the system. Once a user has correctly submitted their user name and password, they have the option to continue to the ***CSSA BIOREACTOR SCREEN*** or ***LOG OFF***.

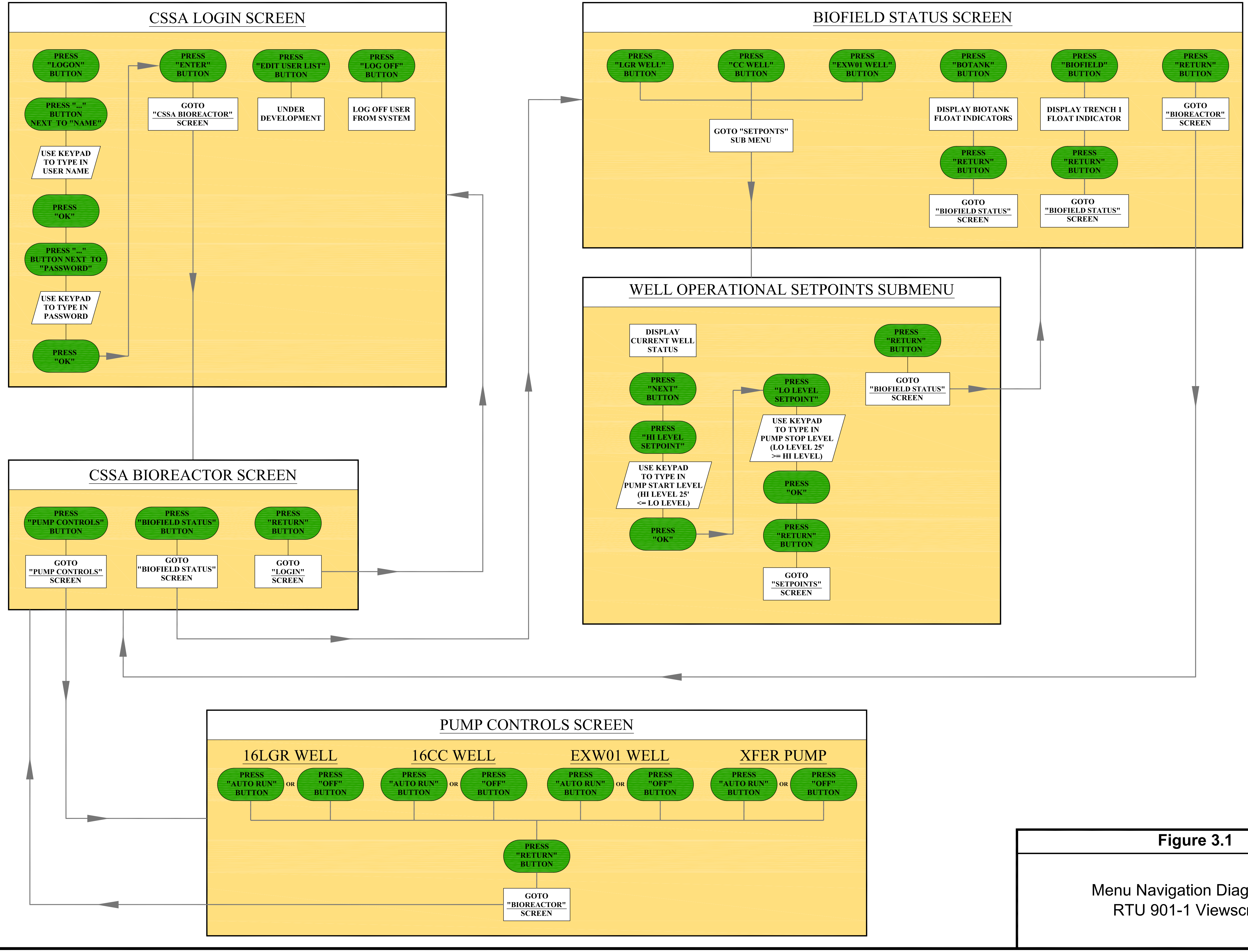


Figure 3.1

Menu Navigation Diagram for
RTU 901-1 Viewscreen

746545 B3 SCADA CONTROL CHART.DWG 4/1/10

3.3.2.2 CSSA BIOREACTOR SCREEN

This is the top level menu on the viewscreen controls. This allows the user to either navigate to the ***PUMP CONTROLS SCREEN***, ***BIOFIELD STATUS SCREEN***, or press ***RETURN*** to redirect to the ***LOGIN SCREEN***.

3.3.2.3 PUMP CONTROLS SCREEN

This screen allows the user to toggle the status of each pump associated with the Bioreactor. Each pump may be selected to either be in the ***AUTO RUN*** position or ***OFF*** position. Pressing the toggle for each pump will result in a change of color on the viewscreen toggle switch. For each pump, the toggle position displayed in the color "**RED**" indicates the current setting for that pump. For the setting to have any effect, it is imperative that the **HOA** switch for that pump is in the "**AUTO"** position. The pumps will actuate when all the level setpoint criteria are met as outlined in Section 3.3.1.

Once the pump controls are in their desired state, press the ***RETURN*** button to redirect back to the ***CSSA BIOREACTOR SCREEN***.

3.3.2.4 BIOFIELD STATUS SCREEN

This viewscreen displays the status for each component of the Bioreactor system. From this screen the user can access the ***WELL OPERATIONAL*** ***SETPOINTS SUBMENU*** (described below), or view the status of ***BIOTANK*** or ***BIOFIELD*** (Sump 1-1) Float switches (HIGH or LOW level indicators). Press the ***RETURN*** button to redirect back to the ***CSSA BIOREACTOR SCREEN***.

3.3.2.5 WELL OPERATIONAL SETPOINTS SUBMENU

This submenu is accessed from the ***BIOFIELD STATUS SCREEN*** and is used to display the current status of each groundwater supply well. For each given well, the current water level and water temperature (if available) is displayed. If the well has attained its low level setpoint and is in the recovery phase, the "Low Level" indicator will illuminate in the color "**RED**". Pressing the ***NEXT*** button will give the user access to change the ***START*** and ***STOP*** point for a given well. These user inputs are important because they can affect the operation of the pump. The numbers inputted here represent a specific groundwater level in that well as measured from Below Top of Casing (BTOC).

- ***STOP***: The corresponding water level in the well at which the well pump will be turned off. It is imperative that the ***STOP*** water level be at a depth above the well pump to prevent it from running dry. These depths need to be less than the following:
  - CS-MW16-LGR ***STOP*** < 290 feet BTOC;
  - CS-MW16-CC ***STOP*** < 390 feet BTOC;
  - B3-EXW01 ***STOP*** < 330 feet BTOC;
  - B3-EXW02 ***STOP*** < 325 feet BTOC;
  - B3-EXW03 ***STOP*** < TBD feet BTOC

  - B3-EXW04 ***STOP*** < TBD feet BTOC
- ***START***: The corresponding water level in the well at which the well pump will turn on. It is imperative that the ***START*** water level be at a depth at least 25 feet less than the ***STOP*** position and at no time should the ***START*** depth be greater than the ***STOP*** depth. The Operator should have working knowledge of the current static water level of the aquifers. If a ***START*** level is set at a depth less than the static water level, the pump will never run. In general, these depths need to follow the general guidelines:
  - ***START*** must be greater than STATIC Water Level (measured by Operator)
  - ***START*** must be at least 25 feet less than the ***STOP*** value;
  - STATIC < ***START*** < (***STOP***-25);
  - CS-MW16-LGR Example:
    - Measured Static Water Level = 235 feet BTOC
    - ***START*** = 265 feet BTOC
    - ***STOP*** = 290 feet BTOC

Once the operational setpoints are established for each well, the Operator can press the Return button to redirect back to the ***CSSA BIOFIELD STATUS SCREEN***.

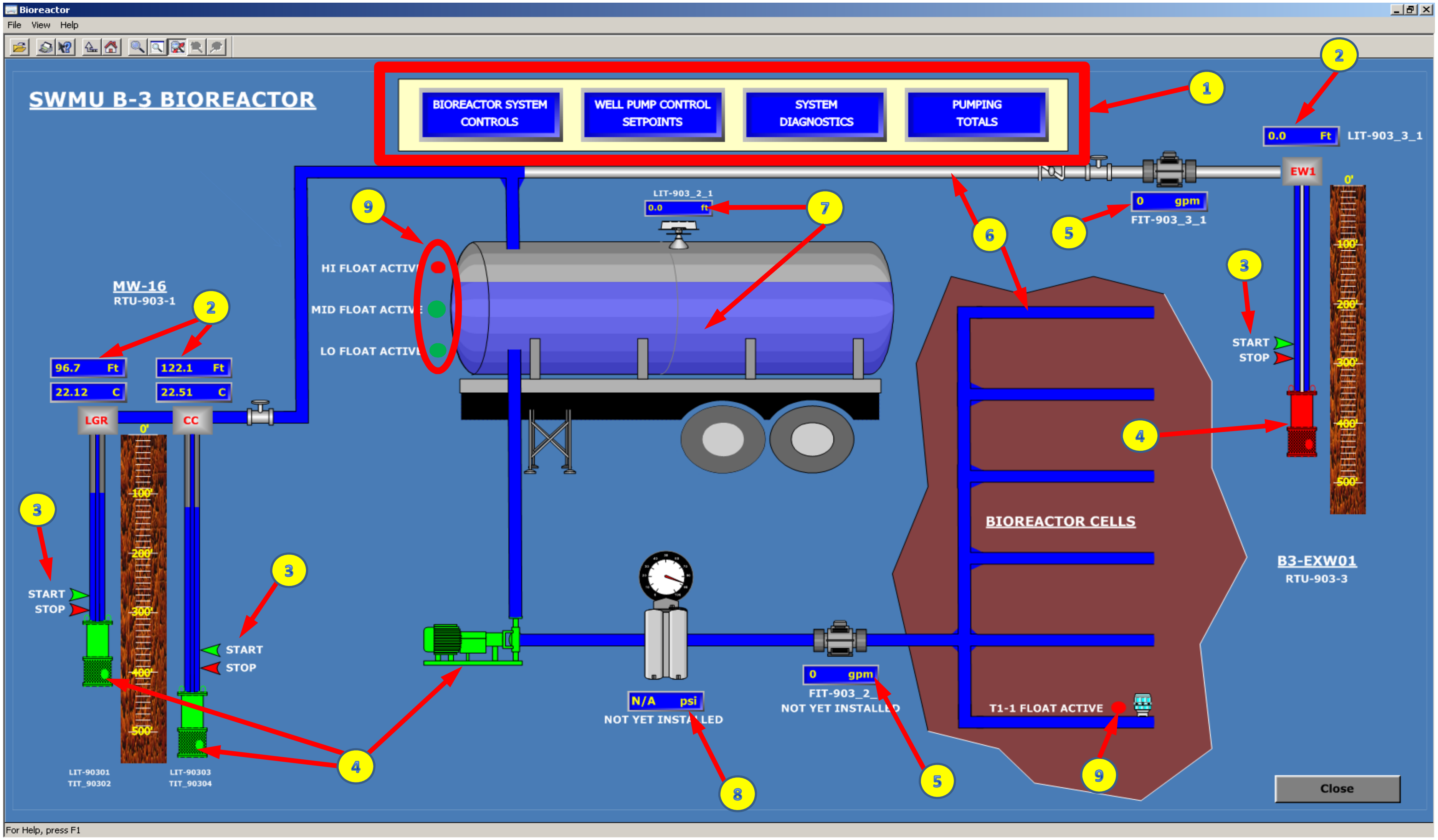
3.3.3 Remote SCADA Control from Workstations

The Operator can also display the Bioreactor status and access controls from any of the SCADA workstations at CSSA (B1, B36, B38, and B606). The Operator must have login and password credentials already established by the SCADA integrator (SCI). The BIOREACTOR screen is accessed from the left column of the ***MAIN MENU***. Real-time data from the Bioreactor is updated on the workstation approximately every three minutes due to the polling cycle of the VHF radio communications. Feedback on commands issued to the Bioreactor from a workstation may take as long as five minutes to indicate on the workstation screen because of the established VHF radio polling cycle.

3.3.3.1 MAIN BIOREACTOR SCREEN

Figure 3.2 is a screen capture from the SCADA workstation. The ***BIOREACTOR*** screen displays the physical layout of the current wellfield, storage tank, transfer pump, and infiltration trenches. The ***BIOREACTOR*** screen provides access to control menus as well as graphically displaying information about the system. Key features of the ***BIOREACTOR*** screen are enumerated on Figure 3.2 as listed below:

Figure 3.2
Bioreactor Monitoring Screen on CSSA SCADA



① Links to related Bioreactor Screens

② Moniitoring Well Water Level and/or Water Temperature

③ Well Pump Start/Stop Level Indicators

④ Pump Status (Green = Running, Red = Stop)

⑤ Water Flow Rate Indicator

⑥ Water Transmission Through Pipe (Blue = Water Flowing, White = No Water Flow)

⑦ Storage Tank Status (Measured Water Column Height and Visual Indicator)

⑧ Bag Filter Differential Pressure Meter (Optional Item not yet Installed)

⑨ Float Switch Status (Green = Water Level >Switch Depth, Red = Water Level < Swtich Depth)

1 ***Submenu Bar:*** Each button navigates to one of four Submenus.

2 ***Well Transducer***: Provides water level and/or water temperature from each Bioreactor supply well. The current water level of the well is graphically shown in the wellbore.

3 ***START/STOP Indicators***: Displays the current ***START*** and ***STOP*** setpoints for each well. The water level in the borehole is graphically approximate to the currently established ***START/STOP*** setpoints.

4 ***Pump Status Indicator***: When a pump is running it is displayed in the color "**GREEN**". When a pump is off it is displayed in the color "**RED**".

5 ***Water Flowmeter***: The current flowrate is displayed from B3-EXW01. In the future, other wells and the Transfer Pump will have a similar functionality.

6 ***Water Flow Indication***: When water is being transmitted through pipe segments in the system, empty pipes turn the color "**BLUE**" to indicate water flow.

7 ***Storage Tank***: The status is of water storage tank is displayed. The height of the water in the tank as measured by the ultrasonic level meter is displayed at the top of the tank. Additionally, the tank is graphically filled in the color "**BLUE**" to a level proportional to the current level of the tanks capacity.

8 ***Differential Pressure***: In the future, the differential pressure across the Bag Filtration Unit will be displayed.

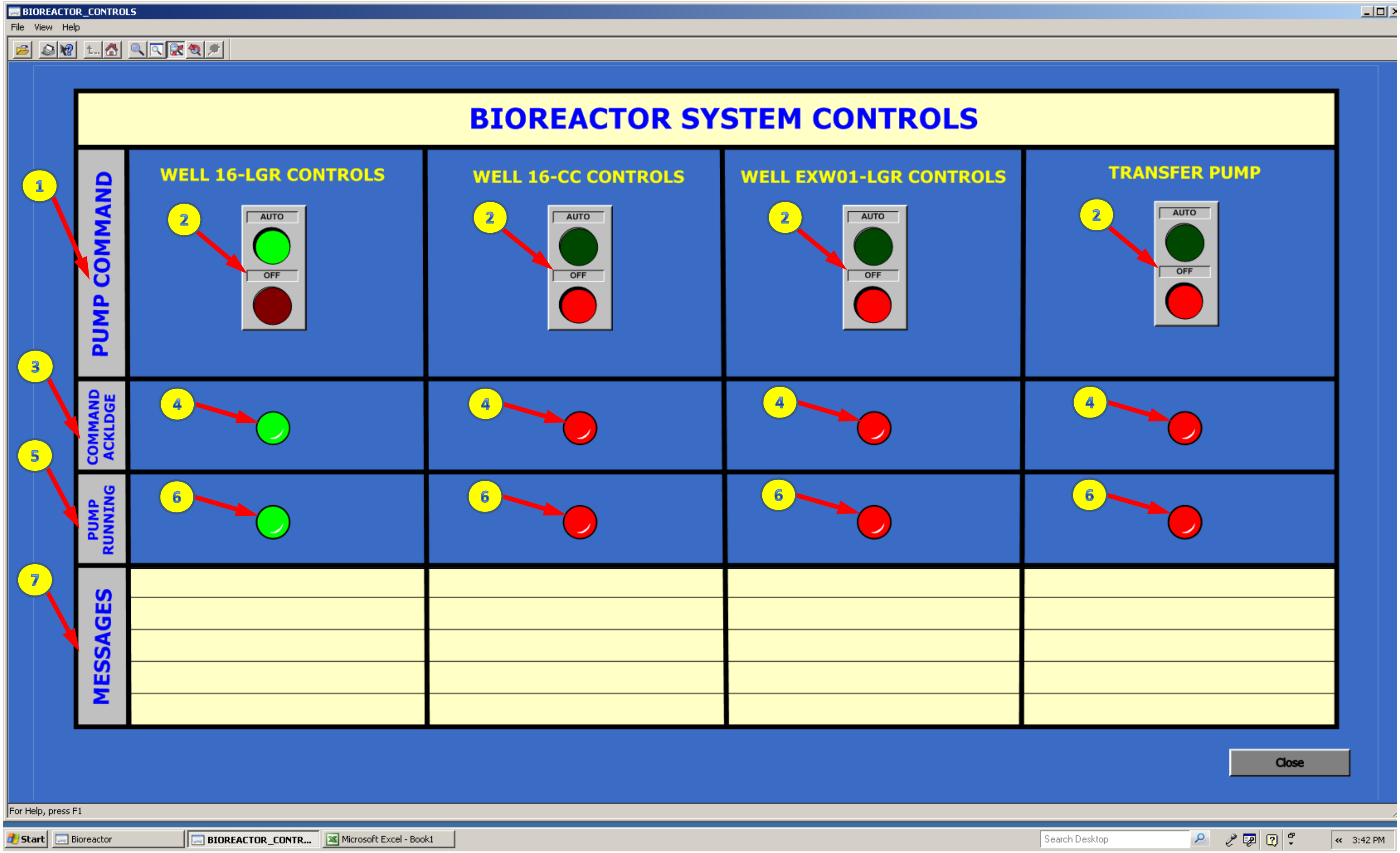
9 ***Float Switch Indicators***: The status of the mechanical float meters in the storage tank and Sump 1-1 are graphically displayed. If a switch is activated by the current level of the water, it is displayed in the color "**GREEN**". If the switch is not activated by the water level, the color is "**RED**".

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

3.3.3.2 BIOREACTOR SYSTEM CONTROLS SCREEN

This interactive screen is accessed from the Submenu bar, and allows the Operator to control the operation of the water supply pumps and transfer pump (Figure 3.3). The functionality of this screen is very similar to the ***PUMP CONTROLS SCREEN*** (Section 3.3.2.3) at the GAC Shack RTU viewscreen. For each well, the control, status, and available messages are presented on this screen. Once again, for these functions to take effect, it is imperative that the **HOA** switch at each motor control panel is set to **"AUTO"**. Key features of the ***BIOREACTOR SYSTEM CONTROLS*** screen are enumerated on Figure 3.3 as listed below:

Figure 3.3
Bioreactor System Controls Screen on CSSA SCADA



① Pump Control (Auto or Off)
② Pump Control Toggles (Green = Auto, Red = Off)
③ Command Acknowledge Indicators (Green = RTU under Run Command, Red = RTU under Stop Con
④ Command Acknowledge Indicators (Green = RTU under Run Command, Red = RTU under Stop Con
⑤ Pump Status
⑥ Pump Running Indicator (Green = Runnning, Red = Stop)
⑦ System Messages and Alarms

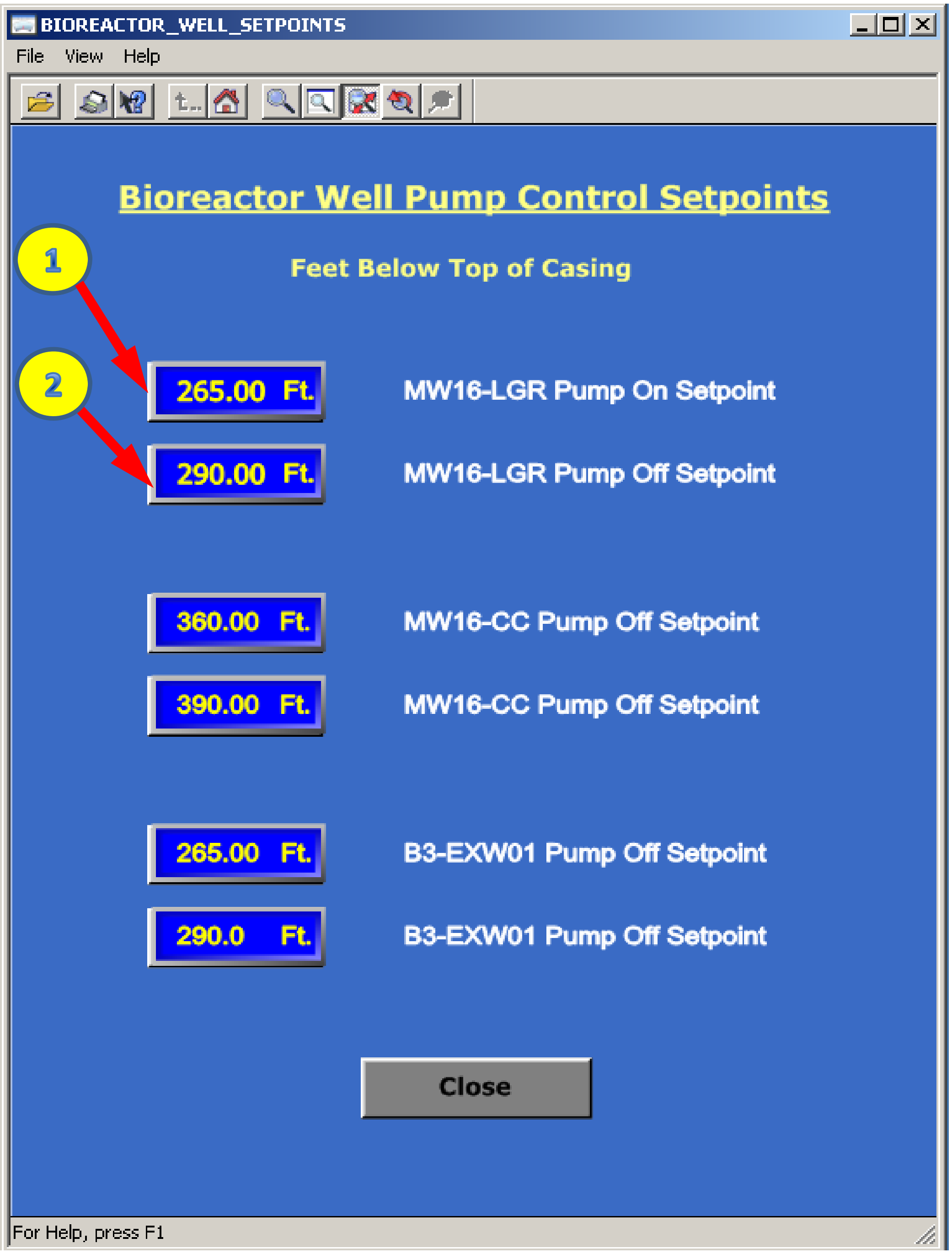
1. ***Pump Command***: This row displays the current pump command status for each well or transfer pump.
2. ***AUTO/OFF Toggle Switch***: This screen allows the user to toggle the status of each pump associated with the Bioreactor. Each pump may be selected to either be in the **"AUTO"** position (indicated in the color "**GREEN**" or "**OFF**" position (indicated in the color "**RED**"). Using the mouse to the toggle the switch for each pump will result in a change of color. For the setting to have any effect, it is imperative that the **HOA** switch for that pump is in the "**AUTO"** position. The pumps will actuate when all the level setpoint criteria are met as outlined in Section 3.3.1.
3. ***Command Acknowledge***: This row confirms that the Pump Command has been received by the GAC Shack RTU. If a pump is toggled to **"AUTO"**, a receipt of this command result in a change of color from "**RED**" to "**GREEN**", indicating that system is ready to pump if the float switch criteria given in section 3.3.1 is met.
4. ***Command Acknowledge Indicators***: These indicators will illuminate "**GREEN**" when a pump is switched to "**AUTO**". The indicators remain "**RED**" if the GAC Shack RTU has not received a command to switch the pumps to "**AUTO**". If a pump is switched to "**AUTO**" and the indicator does not turn "**GREEN**" within six minutes, this indicates that there is a problem at the GAC Shack RTU.
5. ***Pump Running***: This row of indicators display whether a pump is currently running.
6. ***Pump Running Indicators***: If the indicator is the color "**RED**", the pump is not running. If the indicator is the color "**GREEN**" the pump is the color "**GREEN**". If the Pump Running Indicator is "**RED**" and pump is set to **"AUTO"** and Command Acknowledged Indicator is "**GREEN**", this means that either the well has achieved at ***STOP*** water level, or the Bioreactor Tank is full.
7. ***Messages***: Status messages for each pump will display in this section. Messages may include "Low Level", "Loss of Power", or Pump Fail".

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

3.3.3.3 WELL PUMP CONTROL SETPOINTS SCREEN

This interactive screen is accessed from the Submenu bar, and allows the Operator to transmit operational well setpoints for the water supply wells (Figure 3.9). The functionality of this screen is very similar to the ***WELL OPERATIONAL SETPOINTS SUBMENU*** at the GAC Shack RTU viewscreen. From this screen the Operator can program the ***START/STOP*** water levels for each water supply well:

Figure 3.4
Well Pump Control Setpoints Screen on CSSA SCADA



Bioreactor Well Pump Control Setpoints

Feet Below Top of Casing

265.00 Ft.	MW16-LGR Pump On Setpoint
290.00 Ft.	MW16-LGR Pump Off Setpoint
360.00 Ft.	MW16-CC Pump Off Setpoint
390.00 Ft.	MW16-CC Pump Off Setpoint
265.00 Ft.	B3-EXW01 Pump Off Setpoint
290.0 Ft.	B3-EXW01 Pump Off Setpoint

① Required Water Level in Well to Start Pump (Feet Below Top of Casing)

② Low Water Level Cut-off to Stop Pump (Feet Below Top of Casing)

1 **START**: The corresponding water level in the well at which the well pump will turn on. It is imperative that the ***START*** water level be at a depth at least 25 less than the ***STOP*** position, and at no time should the ***START*** depth be greater than the ***STOP*** depth. The Operator should have working knowledge of the current static water level of the aquifers. If a ***START*** level is set at a depth less than the static water level, the pump will never run. In general, these depths need to follow the general guidelines:

a. ***START*** must be greater than STATIC Water Level (measured by Operator)

b. ***START*** must be at least 25 less than the ***STOP*** value;

c. STATIC < ***START*** < (***STOP***-25);

d. CS-MW16-LGR Example:

i.	Measured Static Water Level =	235 feet BTOC
ii.	***START*** =	265 feet BTOC
iii.	***STOP*** =	290 feet BTOC

2 ***STOP***: The corresponding water level in the well at which the well pump will be turned off. It is imperative that the ***STOP*** water level be at a depth above the well pump to prevent it from running dry. These depths need to be less than the following:

a.	CS-MW16-LGR	***STOP*** < 290 feet BTOC;
b.	CS-MW16-CC	***STOP*** < 390 feet BTOC;
c.	B3-EXW01	***STOP*** < 330 feet BTOC;
d.	B3-EXW02	***STOP*** < 325 feet BTOC;
e.	B3-EXW03	***STOP*** < TBD feet BTOC;
f.	B3-EXW04	***STOP*** < TBD feet BTOC.

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

3.3.3.4 SYSTEM DIAGNOSITCS SCREEN

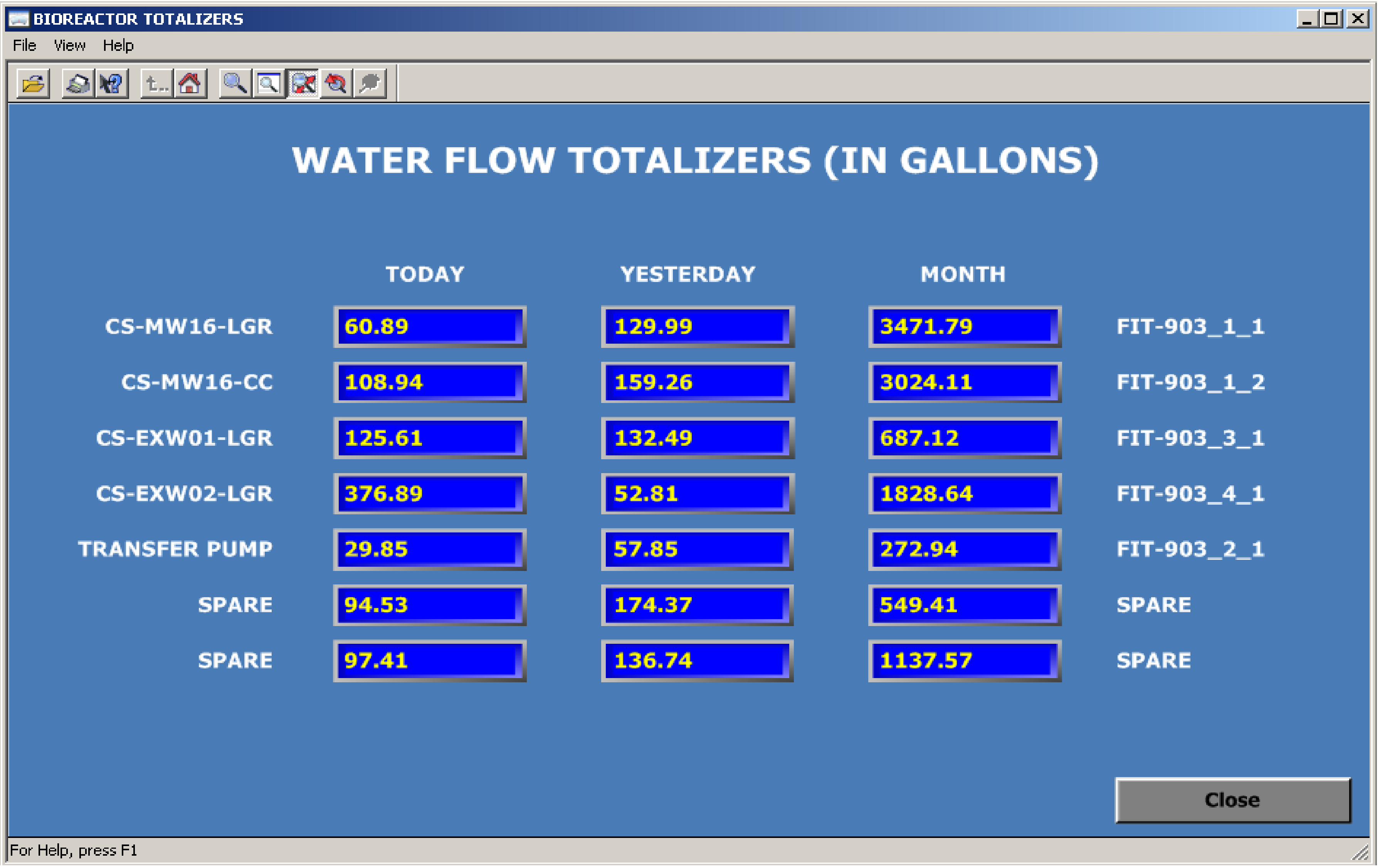
This screen is currently under development. Information useful for the SCADA integrator will be displayed here.

3.3.3.5 PUMPING TOTALS SCREEN

This static screen is accessed from the Submenu bar, and allows the Operator to view statistics about the volume of water pumped at the Bioreactor system (Figure 3.5). The screen displays the current (TODAY), YESTERDAY, and MONTH totals pumped at the Bioreactor. The screen is configured to display multiple flowmeter statistics planned for future expansions. However, currently pumping volumes from B3-EXW01 are currently available.

Pressing the CLOSE button will return you to the Bioreactor Main Screen.

Figure 3.5
Bioreactor Flowmeter Totals on CSSA SCADA



WATER FLOW TOTALIZERS (IN GALLONS)

	TODAY	YESTERDAY	MONTH	
CS-MW16-LGR	60.89	129.99	3471.79	FIT-903_1_1
CS-MW16-CC	108.94	159.26	3024.11	FIT-903_1_2
CS-EXW01-LGR	125.61	132.49	687.12	FIT-903_3_1
CS-EXW02-LGR	376.89	52.81	1828.64	FIT-903_4_1
TRANSFER PUMP	29.85	57.85	272.94	FIT-903_2_1
SPARE	94.53	174.37	549.41	SPARE
SPARE	97.41	136.74	1137.57	SPARE

3.4 LOCKOUT/TAGOUT

When the system is being shut down to perform any electrical or piping service it is necessary to follow the lockout/tagout procedure to prevent potential injuries, prevent exposure to contaminated materials, and reduce the potential for spillage of contaminated groundwater. Maintenance and repair activities requiring lockout/tagout procedures include work on the RTUs, submersible pumps, pressure transducers, storage tank, and bag filter system. Each time a lockout/tagout becomes necessary, the authorized person shall log the activity to be performed, the name of the person carrying out the activity, the date, and the time in the Logout/Tagout Log form included in Appendix J; after completing the maintenance activity the authorized person shall proceed to file the filled out tag used during the activities in the Lockout/Tagout folder, to be preserved as a safety record.

Phase I – Locking, Blocking or Releasing Energy:

- The authorized person notifies all affected people on site that a lockout/tagout procedure is ready to begin.
- The authorized person will turn off the power to the system and lockout the power switch.
- The authorized person releases or restrains all stored energy (*i.e.* venting residual pressure in the filter, or closing the valve upstream of the section of piping affected to isolate it before performing the necessary work)
- All locks and tags are checked for defects. If any are found, the lock or tag is discarded and replaced.
- The authorized person places a personalized lock or tag on the energy isolating device.
- The authorized person tries to start the system to ensure that it has been isolated from its energy source. The system is then de-energized again after this test. If the work to be performed is of an electrical nature, it will be necessary to test the affected components with a volt-meter to ensure that they are not energized.
- The system is now ready for service or maintenance.

Phase II – Returning the System to Normal Operation:

- The authorized person checks the system to be certain no tools have been left behind.
- All safety guards are checked to be certain that they have been replaced properly, if applicable.
- All affected people on site are notified that the system is about to go back into normal operation.
- The authorized person performs a secondary check of the area to ensure that no one is exposed to danger.

- ♦ The authorized person removes the lock and/or tag from the energy isolating device and restores energy to the system.

3.5 SYSTEM MONITORING

System operation monitoring will be performed to measure the effectiveness of the groundwater recovery and treatment processes and to assess performance and maintenance requirements for the system components. Periodic monitoring and sampling will also be implemented to assess the effectiveness of the bioreactor to treat the contaminants in the groundwater being pumped to the trench, and treat the contaminants present in the materials surrounding and underlying the excavation trenches.

Data to be collected monthly (12 months per year) for compliance with UIC requirements of the groundwater recovery and bioreactor operations include:

- water elevation measurements;
- injection volumes;
- system pressure readings; and
- contaminant concentrations from the injection water, active trench sumps, and the upper most saturated zone (Westbay LGR-03B zones) at four multi-point monitoring wells including:
  - ✓ Volatile Organic Compounds (VOCs - PCE, TCE, *cis*-1,2-DCE, *trans*-1-2 DCE, and VC),
  - ✓ Total Dissolve Solids (TDS),
  - ✓ and pH;

However, it is anticipated that TCEQ will authorize a reduction of monitoring data collection with the contaminant concentrations of samples collected from active trench sumps, and the upper most saturated zone at four multi-point monitoring wells scheduled for semi-annual sampling events. The contaminant concentration of injection water is anticipated to be reduced from monthly monitoring to quarterly monitoring.

Performance monitoring measurements for monthly, quarterly and semi-annual efforts may include water quality measurements, a minimal analytical suite, a full analytical suite, and additional analyses (dissolved hydrogen, and DNA).

Water Quality Analyses: conducted monthly at all trench sumps with saturated thicknesses exceeding 1 foot, UGR wells quarterly monitored.

- Temperature
- Specific Conductivity
- Oxidation Reduction Potential (ORP)
- Dissolved Oxygen (DO)
- pH

Minimal Analytical Suite: collected from active trench sumps and uppermost saturated zone of 4 MPMWs (LGR-03B zone) during the monthly events (8 per year), and collected from peripheral shallow UGR wells, and 23 MPMW zones excluding the LGR-03B zone during the quarterly events (4 per year).

- VOCs
- TDS
- Ferrous Iron, Manganese
- Methane, Ethane, Ethene
- Carbon Dioxide
- Total Metals (Arsenic)

<u>Full Analytical Suite:</u> collected from active trench sumps, uppermost saturated zone of 4 MPMWs (LGR-03B zone), four extraction wells, and four monitoring wells during the semi-annual events (2 per year).

- VOCs
- TDS
- Ferrous Iron, Manganese
- Methane, Ethane, Ethene
- Carbon Dioxide
- Total Metals (Arsenic)
- Dissolved Organic Carbon (DOC)
- Total Organic Carbon (TOC)
- Anions (Sulfate and Chloride)
- Sulfide

<u>Additional Analyses:</u> collected from one sump per active trench, one extraction well (CS-MW16-LGR), and one monitoring/extraction well during the semi-annual events (2 per year), precipitation data is downloaded from a CSSA weather station quarterly.

- Dissolved Hydrogen
- Dehalococcides populations, including vcrA reductase, TCE reductase, BAV1 – Q
- Total rainfall

The methods for collecting the data listed above and the end use of the data are described in the following sections.

3.5.1 Monitoring of Treatment within the Bioreactor

To evaluate the contaminant concentrations of bioreactor injection water (the water in the storage tank); a water sample is collected from a sampling port located prior to the injection nozzles at the trench injection line manifold. In addition, water samples are collected from the bioreactor sumps monthly in accordance with this O&M plan's monitoring schedule. Water levels and water quality measurements will be recorded weekly for all sufficiently saturated (greater than 1 foot saturated thickness) bioreactor sumps. Transducers may be installed in at least one sump per trench to measure simultaneous fluctuating water levels in the bioreactor. A summary of the monitoring (both performance and regulatory monitoring) and sample collection schedule is presented in Table 3.3. Additional details such as proper sample collection methods are provided in the CSSA Sampling and Analysis Plan and associated amendments (Parsons, December 2005) which include additional details associated with the test methods such as container type(s) and preservative(s).

3.5.2 Monitoring the Treatment of Zones Underlying the Bioreactor

Four Multi-Port Monitoring Wells (MPMW) or Westbay® wells were installed around B-3 to monitor the groundwater infiltrating through the underlying formations at SWMU B-3. The multi-port wells allow discrete samples from distinct hydrostratigraphic zones be collected from a single location. A representative sample can be collected from up to nine, discrete monitoring zones. These zones are sealed at the top and bottom with permanent well packers to evaluate migration patterns of treated groundwater moving away from the bioreactor to the underlying aquifer. Locations of the four MPMW wells are shown in Figure 3.6. A summary of the discrete intervals and the sample port depths relative to the top of casing (TOC) is provided in Table 3.4. A cross section (Figure 3.7) depicts the location of each sample port relative to elevation and within the subsurface. Water levels are determined in each zone by lowering a pressure probe that locks into the selected zone sample port. The probe is connected to a data logger at the surface which records zone pressures. Pressures are converted to water levels via the following formula:

$$Water\ Level = \frac{D-(P-A)}{0.4335}$$

Where D = depth of sample port below reference point
P = pressure of zone
A = Atm pressure at well head

A summary of the monitoring and samples to be collected is presented in Table 3.6. Appendix J provides a copy of the Westbay® monitoring well operations and repair manual.

3.5.3 Monitoring of Surrounding Monitor Wells

In addition to monitoring water levels and collecting samples from the MPMWs, samples are collected from four monitoring wells and all intervals of the four MPMWs that surround the site on a semi-annual basis. The locations of these four wells and the MPMW's are shown in Figure 3.8. Additional piezometers set in the Upper Glen Rose formation are installed for monitoring bioreactor influence in the shallow portions of the vadose zone. Water levels will be collected on a quarterly basis. Figure 3.9 shows a topographical survey of the bioreactor and the trench sump locations. The list of monitoring wells is identified in Table 3.5.

3.5.4 Monitoring the Upper Glen Rose

Nine shallow (less than 45 foot) piezometers installed in the Upper Glen Rose (UGR) formation around the bioreactor provide sample locations to monitor the lateral influence from bioreactor activities. Water samples from these piezometers will be collected semi-annually. Field parameter information will be collected during the semi-annual sampling events to determine if the reaction zone created by the bioreactor is expanding, contracting, or remaining stable. The piezometers are labeled B3-MW26-UGR through B3-MW34-UGR.

Table 3.3
Class V Aquifer Remediation Injection Well Permit #5X2600431
Sampling and Monitoring Schedule for the B3 Bioreactor Pilot Study
Boerne, Texas

	Sampling or Monitoring Location	**Parameter(s)**	**Sampling Frequency**	**Reporting Frequency**
Current Regulatory Req.	Flow meters (6) for each trench on downstream side of the header and one flow meter on the upstream side of the header	Injection volume	Monthly (record)	Semi-Annual
	Pressure gages (4) on both sides of the transfer pump, at the bag filter and on the header	Pressure on the transfer pump	Monthly (record)	Semi-Annual
	Sampling port (1) on the upstream side of the distribution header	- pH (field) and TDS (lab) - VOCs (a)	Monthly	Semi-Annual
	Trench sumps (7) (b)	- pH, water level (field) and TDS (lab) - VOCs (a)	Quarterly	Semi-Annual
	MPMWs (4 – LGR-03B zone) (b)	- TDS (lab) - VOCs (a)	Quarterly	Semi-Annual
Proposed Regulatory Req.	Flow meters (6) for each trench on downstream side of the header and one flow meter on the upstream side of the header	Injection volume	Monthly (record)	Annual
	Pressure gages (4) on both sides of the transfer pump, at the bag filter and on the header	Pressure on the transfer pump	Monthly (record)	Annual
	Sampling port (1) on the upstream side of the distribution header	- pH (field) and TDS (lab) - VOCs (a)	Quarterly	Annual
	Trench sumps (7) (b)	- pH, water level (field) and TDS (lab) - VOCs (a)	Semi-Annual	Annual
Performance sampling	Trench sumps (7) (b) MPMWs (4 – LGR-03B zone)	- MEE + CO2 - Ferrous Iron - Manganese - Metals (As)	Semi-Annual	Annual
	Trench sumps (7) (b) MPMWs (4 – LGR-03B zone) Extraction Wells (4) Monitoring Wells (4)	- MEE + CO2 - Ferrous Iron - Manganese - Metals (As) - Total organic carbon (TOC) - Dissolved organic carbon (DOC) - Sulfide - Anions (sulfate and chloride)	Semi-Annual	Annual
	Trench sumps (3), one per active trench Monitoring wells (CS-MW16-LGR and TBD)	- Dehalococcoides populations (DNA) - Dissolved Hydrogen	Semi-Annual	Annual
	MPMWs (23 – *excluding* LGR-03B zone) UGR wells (9)	- VOCs (a) - TDS (lab) - MEE + CO2 - Ferrous Iron - Manganese - Metals (As)	Semi-Annual	Annual

	Sampling or Monitoring Location	Parameter(s)		Sampling Frequency	Reporting Frequency
Performance monitoring	Trench sumps (7) (b)	- Temperature - Specific Conductivity	- Dissolved Oxygen (DO) - Oxidation Reduction Potential (ORP)	Quarterly	Annual
	UGR wells (9)	- Water Level - Temperature - Specific Conductivity	- pH - Dissolved Oxygen (DO) - Oxidation Reduction Potential (ORP)	Semi-Annually	Annual

Notes: (a) Standard list of VOCs tested at CSSA

(b) Bioreactor trench sumps (BTS) include: Trench 1 – 1-1, 1-2 and 1-3; Trench 2 – 2-1 and 2-2; Trench 3 – 3-1 and 3-2; Trench 4 – 4-1; Trench 5 – 5-1 and 5-2; Trench 6 – 6-1 and 6-2. Samples are collected from all trench sumps which includes the injection of CS-MW16-CC and -LGR, and B3-EXW-01 through -04 groundwater.
Multi-port monitoring wells (MPMW) include: CS-WB05 (9 sampling ports), CS-WB06 (6 sampling ports), CS-WB07 (6 sampling ports) and CS-WB08 (6 sampling ports).
Surrounding monitor wells include: CS-MW1-LGR, CS-B3-MW01-LGR, CS-MW2-LGR (as needed) and CS-D-LGR.
Surrounding extraction wells include: CS-MW16-LGR, CS-MW16-CC, B3-EXW-01, through B3-EXW-04.
Surrounding UGR wells include: B3-MW26-UGR through B3-MW34-UGR.

Table 3.4
List of Multi-Port Monitoring Wells

Well	Elevation (a) (Top of Casing)	Zone	Interval (Ft. BTOC)	Elevation (Ft MSL)		Sampling Port (b) (Ft BTOC)	
				Top of Interval	Base of Interval	Primary	Secondary
CS-WB05	1242.93	LGR-01	32 - 109	1210.93	1133.93	99	
		LGR-02	114 - 192	1128.93	1050.93	182	
		LGR-03	197 - 272	1045.93	970.93	216	262
		LGR-04A	277 - 286	965.93	956.93	277	
		LGR-04B	291 - 342	951.93	900.93	329	
		BS-01	347 - 390	895.93	852.93	362	
		CC-01	395 - 444	847.93	798.93	432	
		CC-02	449 - 482	793.93	760.93	460	
CS-WB06	1235.20	UGR-01	12 - 30	1223.20	1205.20	20	
		LGR-01	35 - 103	1200.20	1132.20	93	
		LGR-02	108 - 184	1127.20	1051.20	174	
		LGR-03	189 - 270	1046.20	965.20	207	260
		LGR-04	275 - 335.5	960.20	899.70	320	
CS-WB07	1235.13	UGR-01	9 - 24	1226.13	1211.13	14	
		LGR-01	29 - 100	1206.13	1135.13	90	
		LGR-02	105 -185	1130.13	1050.13	175	
		LGR-03	190 - 267	1045.13	968.13	208	257
		LGR-04	272 - 336.75	963.13	898.38	318	
CS-WB08	1253.26	UGR-01	12 - 48	1241.26	1205.26	38	
		LGR-01	53 - 125	1200.26	1128.26	115	
		LGR-02	130 - 203	1123.26	1050.26	193	
		LGR-03	208 - 283	1045.26	970.26	228	273
		LGR-04	288 - 357.5	965.26	895.76	341	

Notes:
BTOC - Below Top of Casing
(a) Top of Casing (TOC) elevations surveyed by Baker and Associates located in San Antonio, Texas.
(b) For each well there is one zone where both the upper (primary) and lower (secondary) portions are monitored.

Table 3.5
List of Surrounding Monitoring Wells

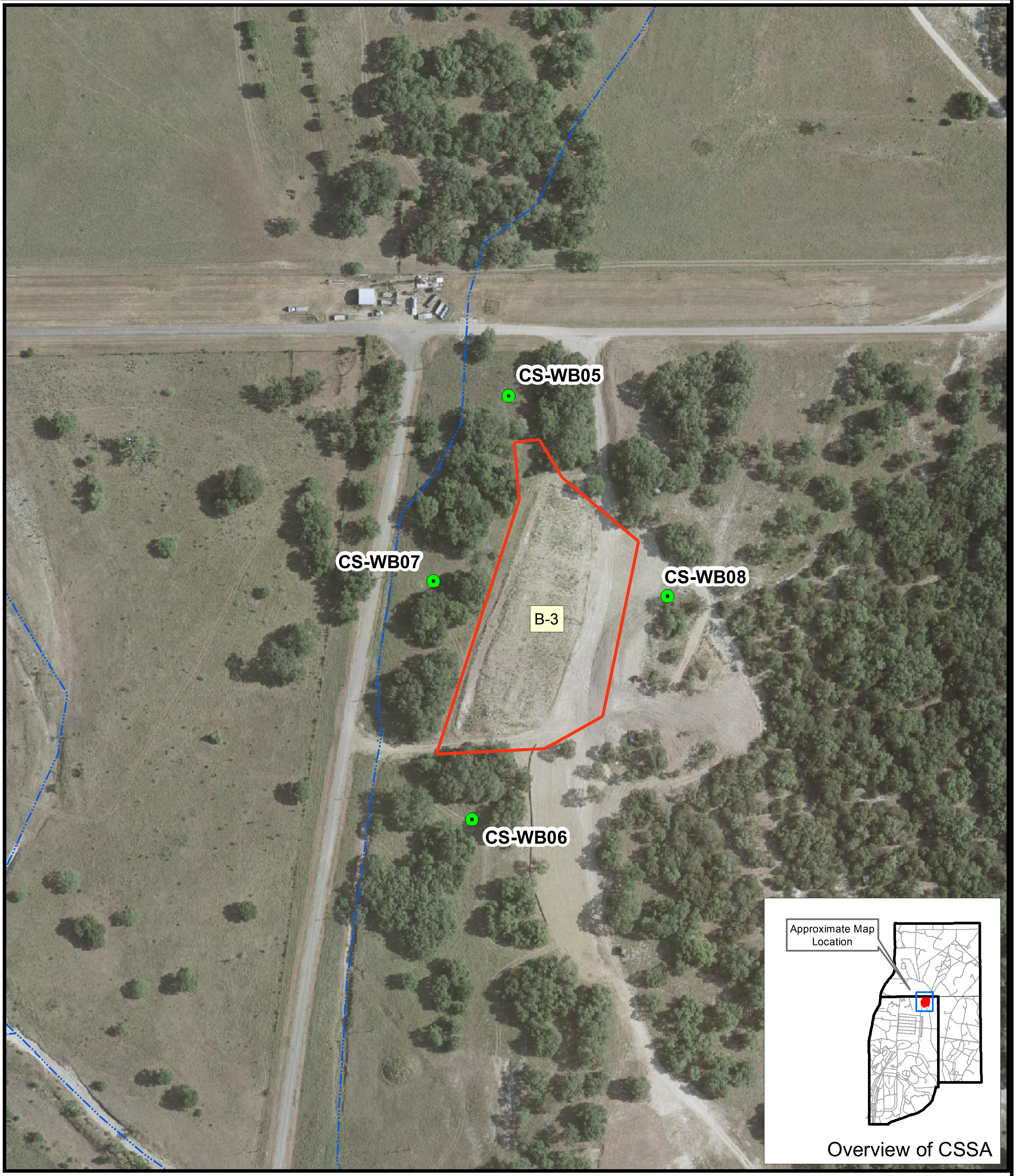
Well ID	TOC Elev. (Ft MSL)	Screen Interval Depth below TOC (Ft bgs)	Pump Depth (Ft bgs)	Pump Elevation (Ft MSL)	Depth to LGR/BS Contact (Ft bgs)	Planned Performance Monitoring Frequency
CS-MW1-LGR	1220.73	288 – 313	300	920.73	319	Semi-Annually
CS-MW2-LGR	1237.08	318 – 343	330	907.08	347	Semi-Annually
CS-MW-D-LGR	1257.27	296 – 321	283	974.27		Semi-Annually
CS-B3-MW01	1242.84	277 - 287	284	958.84		Semi-Annually

bgs = below ground surface

MSL = mean sea level

Table 3.6
B-3 O&M Monitoring Schedule

	Recurrence Interval	Activity
Performance Requirement	Quarterly	Trench Sumps and MPMWs Water Level Measurements
	Semi-Annually	Trench Sumps, Uppermost Interval (LGR 03B) of WB-05 thru WB-08 Performance Sampling (metals only)
	Semi- Annually	Trench Sumps, MPMWs, and Surrounding Wells Performance Sampling
Proposed Regulatory Requirement	Monthly	Headers and Flow Meter Measurements
	Monthly	Transfer Pump and Filter Pressure Readings
	Quarterly	Sampling Port Monitoring (pH, TDS, VOCs)
	Semi-Annually	Trench Sumps Sampling (ph, TDS, VOCs)
	Semi-Annually	Uppermost Saturated Interval (LGR 03B) MPMWs Sampling (TDS, VOCs)



Aerial Photo Date: 2003

Creeks (Dashed where intermittent)
🟥 SWMU Boundary
● Westbay Wells

Figure 3.6

SWMU B-3
MPMW Location
Camp Stanley Storage Activity

PARSONS

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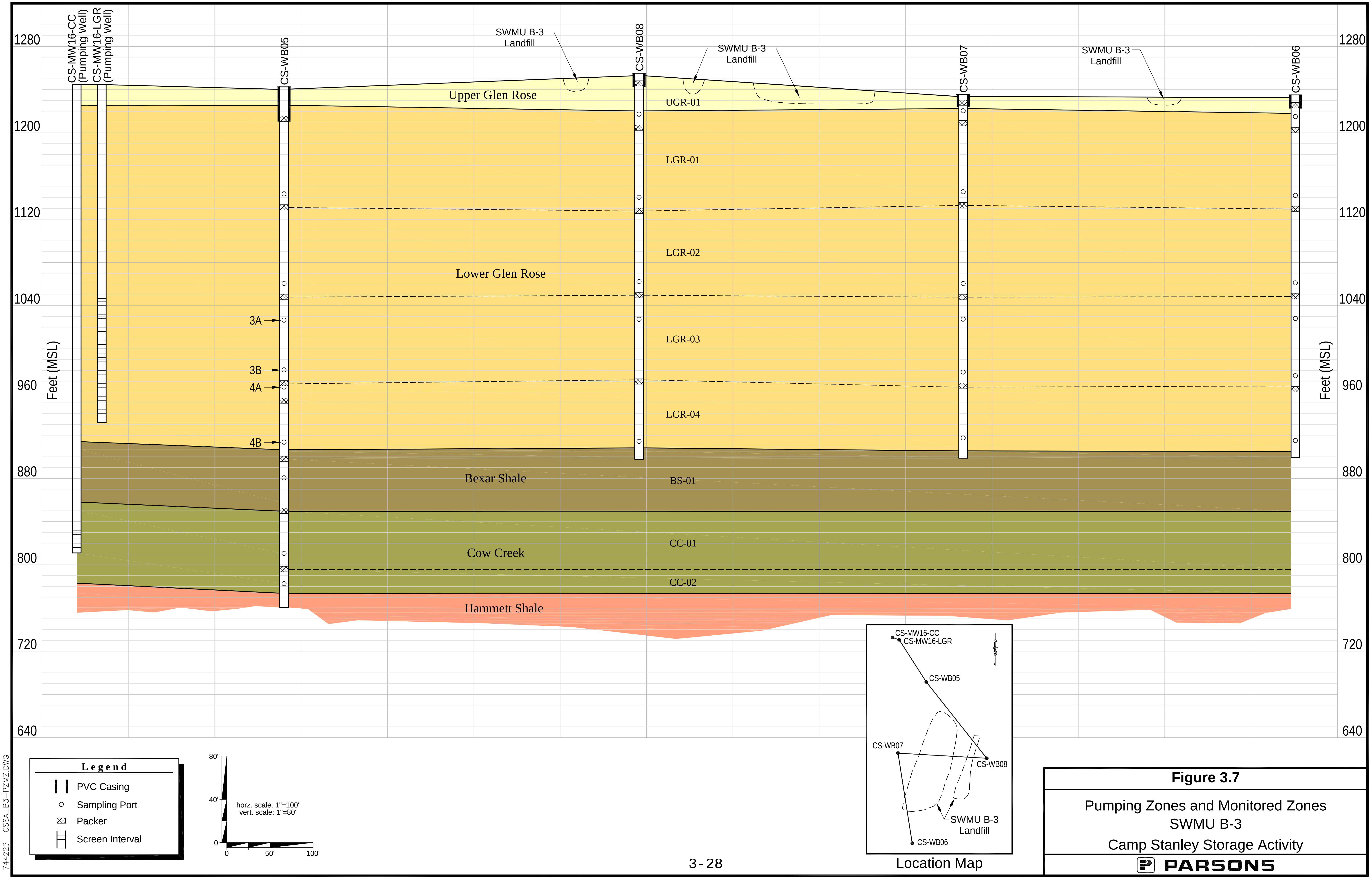
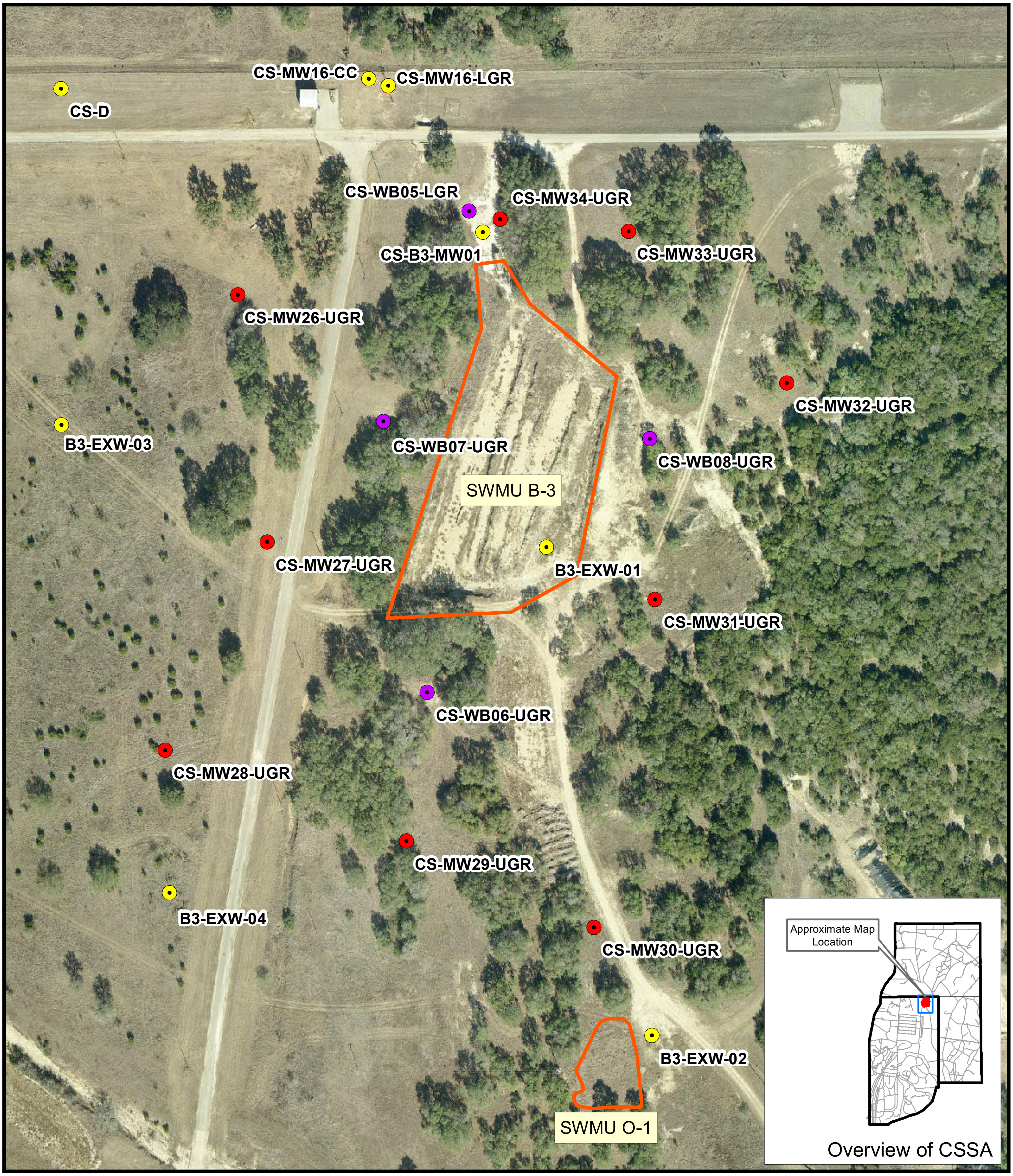


Figure 3.7

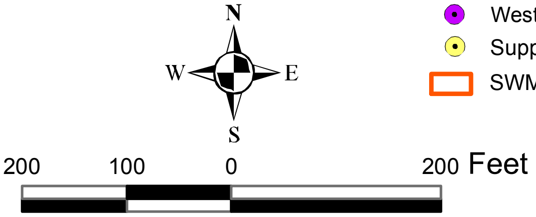
Pumping Zones and Monitored Zones
SWMU B-3

Camp Stanley Storage Activity

PARSONS



Aerial Photo Date: 2009

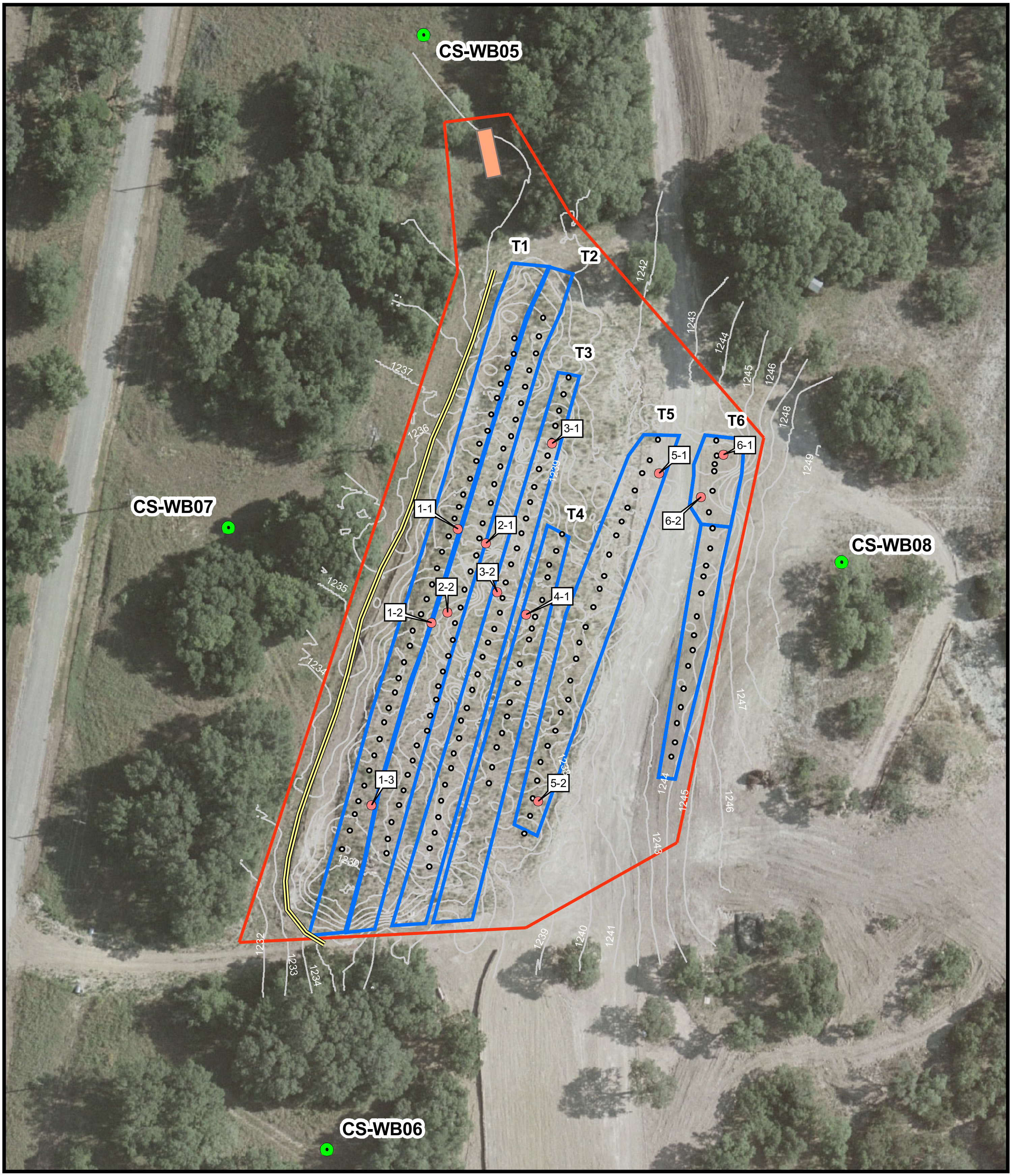


- ● UGR Monitoring Well Location
- ● Westbay Multi-port Well
- ● Supply/Monitoring Well
- ▭ SWMU Boundary

Figure 3.8

SWMU B-3
Monitoring Locations
Camp Stanley Storage Activity

PARSONS



○ Irrigation Nozzles

● Bioreactor Trench Sumps

● Westbay Wells

B3 Boundary

Elevation Contours (1' interval)

Berm Location

Tank

Former Trench Locations

Figure 3.9

B-3 Site Survey Map
Camp Stanley Storage Activity

PARSONS

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SECTION 4
SYSTEM MAINTENANCE

4.1 BIOREACTOR INSPECTION

The bioreactor will be inspected daily to determine if the components are operating properly. Future plans call for the possible installation of equipment to monitor the equipment remotely. Items to include in the inspection include the following:

- Condition of all visible piping;
- Condition of berms identifying any erosional features that may be indicative of surface drainage not being collected in the bioreactor;
- Readings will be collected from pressure gages, flow meters and water levels in the bioreactor sumps weekly;
- Conditions of the storage tank;
- Replacement of bag filter, as necessary.

A System Operation and Monitoring logbook will be maintained documenting all maintenance activities associated with bioreactor system operations, as well as, documenting monthly system inspections.

4.2 MAINTENANCE

To reduce the potential for unexpected equipment shutdown, a maintenance schedule will be incorporated based on the required maintenance specified by the equipment manufacturers.

4.2.1 Bag Filter Replacement

The filters in the bag filtration system must be replaced when they become plugged with particulates. The filters will be replaced when the pressure drop across the filter increases and negatively impacts the capacity of the transfer pump due to high head loss within the treatment system. To prevent the pressure drop across the filter from exceeding safe levels, the filters will be changed if the pressure drop is determined to be 12 pounds per square inch (psi) or greater during a weekly site visit. Spare filters will be stored in the GAC building at CSSA Outfall 002. The procedure for replacing the filter follows:

1. Turn off the system and initiate lockout/tagout procedures in Subsection 3.2.3.
2. Close the ball valve before and after the filter system to isolate the filter from further flow.
3. Carefully bleed off residual pressure inside the filter vessel by slowly opening the vent on the top of the vessel. Think Safety!
4. Loosen the retaining lugs and remove the lid from the top of the vessel.
5. Replace used filters with new ones and place used filters in 55-gal container.

6. Realign the vessel lid and tighten the retaining lugs.
7. Open the ball valves before and after the filter system.
8. Turn the recovery system back on.
9. Check the filter vessel for leaks.

Replacement of the bag filters will be documented on the System Operation and Maintenance Form (Appendix K) to reflect the replacement date of the filters, new filter sizes, and condition of the old filters.

4.2.2 Recovery Pump Maintenance

Pump maintenance will be performed to maintain optimum pump operation, maximize pump life, and to repair pump problems. During the pump maintenance events, each pump will be removed from its well, inspected for wear and damage, and any necessary/recommended repairs made to ensure optimal performance. Pump maintenance may be performed when determined necessary based on pump performance, such as diminishing groundwater yield. Additionally, any time a recovery well will be idled for periods greater than 1 month, the pump in that well will either be operated for at least two hours each month or removed from the well. This is done to prevent accumulation of calcium or iron precipitation on the idle pump components which may foul the pump and/or shorten the pump life.

During the pump maintenance, worn or malfunctioning components will be repaired or replaced. Two spare groundwater pumps are stored in the treatment compound to minimize system down time during such maintenance events. In the event that a pump malfunctions, it will be pulled for service and repaired, as necessary, and a spare pump will be installed in its place. The faulty pump will become a spare after it is repaired.

In the event that a pump must be removed from a well, the following procedures requiring a two-man crew will be followed:

1. Turn off power and initiate lockout/tagout procedures per Subsection 3.3.
2. Disconnect the pipe coupling in the discharge pipe within the well box.
3. Loosen the bolts in the well seal on top of the recovery well so the discharge pipe easily moves through the opening in the seal.
4. Lift the pump from the well by hand until the first flush-thread pipe connection is observed in the discharge pipe.
5. One crew member will secure the discharge pipe below the pipe joint using a pipe wrench while the other crew member loosens and removes the top section of pipe.
6. Care must be taken to secure and manage the electrical cables and steel support cables that attach to the pressure transducer and the pump. These wires/cables should be secured to the discharge pipe by plastic cable ties which must be cut and removed to manage the wiring and cable. CAUTION: The transducer cable includes an internal vented tube. Careful handling of this cable is necessary to prevent pinching or kinking of the cable which may damage and obstruct the vent tube.

7. Continue to remove sections of the pipe while managing the wires and cables, until the last section of pipe is brought to the surface. Carefully lay the pump and pipe next to the well without allowing dirt to plug the pump head.
8. Make necessary repairs to pump or transducer.
9. Carefully reinsert the pump in the well.
10. Reinstall the pump assembly in the well by reversing the removal instructions. New cable ties should be used to re-secure the transducer and pump lead wires to the discharge pipe as it reinserted into the well. CAUTION: Carefully insert the pump and piping assembly into the well without pinching or kinking the transducer cable which could block the internal vent tube.
11. Turn the system back on.

4.3 SPILL PREVENTION AND CONTAINMENT PLAN

To reduce the potential for offsite drainage from the site, the following guidelines will be incorporated:

1. Construction of a berm along the western side of the site to help retain water in the bioreactor;
2. Maintain a stand of vegetation along the west side of Trench 1 to reduce the potential for the development of erosional features along the west side of the site;
3. Precautions, such as storm water diversion berms, will be taken to prevent overfilling of the bioreactor with stormwater runoff; and
4. Level controller located in trench 1 monitoring sump 1 which will cease injection of water upon reaching high level.

4.4 SITE MAINTENANCE

During each visit, the following activities will take place:

- The site will be inspected to ensure no obstructions are present that could impact normal operation.
- The area around the treatment area and bioreactor will be inspected. Ensure that access to the compound is clear of tree branches and debris.
- Buried water and electrical lines will be inspected to ensure that the lines are still properly covered, and that no apparent leaks are present.

See the System Operation and Monitoring Form in Appendix K for a list of necessary activities to perform during each site visit.

SECTION 5
REPORTING REQUIREMENTS

Since the bioreactor design called for the discharge of affected water from all extraction wells into the subsurface via a buried water distribution system, it was necessary to apply for a Class V Aquifer Remediation Injection Well Permit through the Industrial and Hazardous Waste Permits Section of the Waste Permits Division at the TCEQ. The permit application was accepted on July 20, 2006 and the following TCEQ Authorization Number was assigned to the SWMU B-3 injection system: No. 5X2600431; WWC 12002216; CN602728206/RN104431655. A copy of the authorization letter and subsequent revisions of the authorization letter indicating modifications to the injection permit are presented in Appendix A.

As stated in the letter, there are four requirements that must be met as set by the Remediation Division and the UIC rules provided by 30 Texas Administrative Code (TAC) Chapter 331.

Requirement 1. All injection wells are to be constructed to meet the standards provided in 30 TAC 331.132 and completed well logs or construction diagrams submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 upon completion. Since a subsurface water distribution system instead of an injection well was proposed and accepted in the permit application, this requirement is not applicable to the B3 bioreactor.

Requirement 2. Operational and status changes shall be reported to and approved by the UIC Permits Team. Any changes to the operation of the B3 bioreactor not presented in a monitoring report can be provided to the UIC Permits Team via a letter.

Requirement 3. Closure (plugging) of injection wells, points and/or trenches shall comply with the standards provided in 30 TAC 331.133. Closure reports including plugging reports and injection well monitoring data (injection volumes, pressures and results) shall be submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 within 60 days of completion of injection or plugging activities. If closure activities do proceed in the future for SWMU B-3, then the most suitable option for closure of the trenches, and the recommended option will be presented to the UIC Permits Team. The volume of water (cumulative) as well as the chemical data results will be presented in each monitoring report submitted to the UIC Permits Team. Additional discussion on the chemical data monitoring is presented in Requirement 4.

Requirement 4. Injection volumes, pressures, and concentrations of contaminants (including selected VOCs, pH and total dissolved solids) in the injected groundwater shall be sampled monthly basis anticipated to be reduced to quarterly bases at the point of re-injection (prior to fluids being released into the trenches) and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a semi-annual basis anticipated to be reduced to an annual basis. The concentration of contaminants in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled monthly anticipated to be reduced to quarterly bases and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a semi-annual basis anticipated to be reduced to an annual basis. The monitoring and sampling program is presented in Section 4. The sampling and monitoring program will adhere to Requirement 4.

Table 5.1 outlines the monitoring and reporting activities scheduled during months 31 through 43 of the O&M period.

Table 5.1
B-3 O&M Activities Outline Months 55 – 68

	Month	Monday	Tuesday	Wednesday	Thursday	Friday	**Week**	**Reporting**
Quarter 19	November, 2011 Month 55		1	2	3	4	237	
		7	8	9	10	11	238	
		14	15	16	17	18	238	
		21	22	23	24	25	240	
		28	29	30			241	
	December, 2011 Month 56				1	2		
		5	6	7	8	9	242	
		12	13	14	15	16	243	
		19	20	21	22	23	244	
		26	27	28	29	30	245	
	January, 2012 Month 57	2	3	4	5	6	246	
		9	10	11	12	13	247	
		16	17	18	19	20	248	
		23	24	25	26	27	249	
		30	31				250	
Quarter 20	February, 2012 Month 58			1	2	3		
		6	7	8	9	10	251	
		13	14	15	16	17	252	
		20	21	22	23	24	253	
		27	28	29			254	
	March, 2012 Month 59				1	2		
		5	6	7	8	9	**255**	
		12	13	14	15	16	256	
		19	20	21	22	23	257	
		26	27	28	29	30	258	
	April, 2012 Month 60	2	3	4	5	6	259	
		9	10	11	12	13	260	
		16	17	18	19	20	261	
		23	24	25	26	27	262	
		30					263	
Quarter 21	May, 2012 Month 61		1	2	3	4		
		7	8	9	10	11	264	
		14	15	16	17	18	265	
		21	22	23	24	25	266	
		28	29	30	31		**267**	B3 UIC Bi-Annual Report
	June, 2012 Month 62					1		
		4	5	6	7	8	268	
		11	12	13	14	15	269	Quarter 20 - Annual Performance Report
		18	19	20	21	22	270	
		25	26	27	28	29	271	
	July, 2012 Month 63	2	3	4	5	6	272	
		9	10	11	12	13	273	
		16	17	18	19	20	274	
		23	24	25	26	27	275	
		30	31				276	
Quarter 22	August, 2012 Month 64			1	2	3		
		6	7	8	9	10	277	
		13	14	15	16	17	278	
		20	21	22	23	24	279	
		27	28	29	30	31	280	
	September, 2012 Month 65	1	2	3	4	5	281	
		8	9	10	11	12	282	
		15	16	17	18	19	**283**	
		22	23	24	25	26	284	
		29	30				285	
	October, 2012 Month 66			1	2	3		
		6	7	8	9	10	286	
		13	14	15	16	17	287	
		20	21	22	23	24	288	
		27	28	29	30	31	289	
Quarter 23 (partial)	November, 2012 Month 67	3	4	5	6	7	290	
		10	11	12	13	14	291	
		17	18	19	20	21	292	
		24	25	26	27	28	293	B3 UIC Bi-Annual Report
	December 2012	1	2	3	4	5	294	
		8	9	10	11	12	295	

🟩 Monthly Sampling and UIC Sampling
🟨 Semi-Annual Sampling
🟧 Semi-Annual UIC Report submittal
🟦 Annual Performance Report

Appendix A
TCEQ Authorization Letter

July 20, 2006 Transmittal

Kathleen Hartnett White, *Chairman*
Larry R. Soward, *Commissioner*
Glenn Shankle, *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

July 20, 2006

Mr. Jason Shirley
Installation Manager
U.S. Army, Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Re: Authorization and Registration of Class V Aquifer Remediation Injection Wells
TCEQ Authorization No. 5X2600431; WWC 12002216; CN602728206/RN104431655
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Dear Mr. Shirley:

The Underground Injection Control (UIC) staff has completed review of the inventory/authorization form dated May 30, 2006 from Parsons requesting approval for the injection of groundwater into five infiltration galleries filled with gravel, wood chips and vegetable oil as part of the remediation process at the above site. Our consideration for this proposed project for injection has included coordination with the commission's Remediation Division. Based on our review, approval is hereby given for construction and operation of the injection wells according to the submitted plans and specifications.

In order to maintain authorization by rule for the injection operations, the project must meet all requirements set by the Remediation Division and the UIC rules provided by 30 TAC Chapter 331. Requirements for the injection include:

1. All injection wells are to be constructed to meet the standards provided in 30 TAC §331.132 and completed well logs or construction diagrams submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 upon completion;

2. Operational and status changes shall be reported to and approved by the UIC Permits Team;

3. Closure (plugging) of injection wells, points and/or trenches shall comply with standards provided in 30 TAC §331.133. Closure reports including plugging reports and injection well monitoring data (injection volumes, pressures, and results) shall be submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 within 60 days of completion of injection or plugging activities; and

P.O. Box 13087 • Austin, Texas 78711-3087 • 512/239-1000 • Internet address: www.tceq.state.tx.us

4. Injection volumes, pressures, and concentrations of contaminants (including pH and total dissolved solids) in the injected groundwater shall be sampled bimonthly at the point of reinjection (prior to fluids being released into the trenches) and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a monthly basis. The concentration of contaminates in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled monthly and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a quarterly basis. The concentrations of the contaminants shall not exceed those limits listed in 40 CFR §261.24 Toxicity characteristic table 1 that would deem them hazardous by concentration.

If you have any questions regarding this matter, please contact me at (512) 239-6075. If you will be corresponding by mail, please use mail code MC-130.

Sincerely,

Bryan S. Smith

Bryan Smith, P.G., Engineering Specialist
Industrial and Hazardous Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality

BSS/ff

cc: ✓Mr. Brian Vanderglas, Parsons, Austin

June 25, 2007 Transmittal

Kathleen Hartnett White, *Chairman*
Larry R. Soward, *Commissioner*
H. S. Buddy Garcia, *Commissioner*
Glenn Shankle, *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

June 25, 2007

Mr. Jason Shirley
Installation Manager
U.S. Army, Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Re: Amendment to Authorization of Class V Aquifer Remediation Injection Wells
TCEQ Authorization No. 5X2600431; WWC12033366; CN602728206/RN104431655
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Dear Mr. Shirley:

The Underground Injection Control (UIC) staff has completed review of the modification request dated November 29, 2006 requesting approval for the addition of one infiltration galleries filled with gravel, wood chips and vegetable oil as part of the remediation process at the above site. Our consideration for this proposed project for injection has included coordination with the commission's Remediation Division. Based on our review, approval is hereby given for construction and operation of the injection wells according to the submitted plans and specifications.

In order to maintain authorization by rule for the injection operations, the project must meet all requirements set by the Remediation Division and the UIC rules provided by 30 Texas Administrative Code (TAC) Chapter 331. Requirements for the injection include:

1. All injection wells are to be constructed to meet the standards provided in 30 TAC Section (§)331.132 and completed well logs or construction diagrams submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 upon completion;

2. Operational and status changes shall be reported to and approved by the UIC Permits Team;

3. Closure (plugging) of injection wells, points and/or trenches shall comply with standards provided in 30 TAC §331.133. Closure reports including plugging reports and injection well monitoring data (injection volumes, pressures, and results) shall be submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 within 60 days of completion of injection or plugging activities; and

P.O. Box 13087 • Austin, Texas 78711-3087 • 512-239-1000 • Internet address: www.tceq.state.tx.us

4. Injection volumes, pressures, and concentrations of contaminants (including pH and total dissolved solids) in the injected groundwater shall be sampled bimonthly at the point of reinjection (prior to fluids being released into the trenches) and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a monthly basis. The concentration of contaminates in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled monthly and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on a quarterly basis. The concentrations of the contaminants shall not exceed those limits listed in 40 CFR §261.24 Toxicity characteristic table 1 that would deem them hazardous by concentration.

If you have any questions regarding this matter, please contact me at (512) 239-6075. If you will be corresponding by mail, please use mail code MC-130.

Sincerely,

Bryan Smith, P.G., Engineering Specialist
Industrial and Hazardous Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality

BSS/ff

cc: Mr. Brian Vanderglas, Parsons, Austin

April 24, 2008 Transmittal

DEPARTMENT OF THE ARMY
CAMP STANLEY STORAGE ACTIVITY, MCAPP
25800 RALPH FAIR ROAD, BOERNE, TX 78015-4800

April 24, 2008

U-117-08

Mr. Bryan Smith
Texas Commission on Environmental Quality
Industrial and Hazardous Waste Permits Section
P.O. Box 13087 (MC-130)
Austin, TX 78711-3087

Subject: Request for Reduction of Data Collection and Reporting Requirements for the Pilot Study Class V Aquifer Remediation Injection Wells at Camp Stanley Storage Activity, Boerne, Texas, TCEQ Authorization No. 5X2600431; WWC12002216; CN602728206/RN104431655

Dear Mr. Smith:

The Camp Stanley Storage Activity (CSSA), McAlester Army Ammunition Plant, Joint Munitions Command, Army Materiel Command, U.S. Army, is submitting this request to seek authorization to reduce the data collection requirements for the subject Class V Aquifer Remediation Injection Wells as discussed during your recent visit in December 2007. The injection activities are performed at the on-post Solid Waste Management Unit (SWMU) B-3 site as pilot study activities which include the injection of recovered groundwater into mulch/gravel- filled bioreactor trenches.

CSSA's current data collection and reporting requirements as specified by the subject Texas Commission on Environmental Quality (TCEQ) Underground Injection Control (UIC) permit for the SWMU B-3 Bioreactor Pilot Study includes:

- **Bimonthly** - Injection volumes, pressures, and concentrations of contaminants (including pH and total dissolved solids) in the injected groundwater sampled bimonthly at the point of re-injection (prior to fluids being released into the trenches) and submitted to the TCEQ on a monthly basis.

- **Monthly** - The concentrations of contaminants in the trench bioreactor monitoring sumps and the surrounding monitoring wells sampled monthly and submitted to the TCEQ on a quarterly basis.

CSSA is requesting authorization for the reduction of data collection and reporting for the subject UIC permit based on the results of the data collected through ten months of operations at SWMU B-3 bioreactor pilot study. These data indicate that concentrations of contaminants in the injected groundwater continue to be well below the limits specified in 40 CFR §261.24 Toxicity Characteristics Table 1. In addition, this UIC well is near the middle of the 4,000-acre installation, approximately a mile from the nearest off-post boundaries. Therefore, CSSA proposes that bimonthly sampling requirements move to monthly sampling and the monthly sampling requirements move to quarterly. Additionally, CSSA requests all monthly and quarterly collected data be reported semi-annually to the TCEQ (see attached table 1 for a summary of current and proposed monitoring and reporting schedule).

If you have any questions regarding the information contained in this letter, please feel free to contact Glare Sanchez, CSSA Environmental Program Manager, at (210) 698-5208 or Ken Rice, Parsons, at (512) 719-6050.

Sincerely,

Jason Shirley

Jason D. Shirley
Installation Manager

Attachments

cc: Glare Sanchez, CSSA Environmental Program Manager
Greg Lyssy, USEPA Region 6
Robert Bowersock, USACE
Julie Burdey, Parsons
Ken Rice, Parsons
Brian Vanderglas, Parsons
File: 745493.03000

Table 1

Class V Aquifer Remediation Injection Well Permit #5X2600431
Sampling and Monitoring Schedule for the B3 Bioreactor Pilot Study
CSSA - Boerne, Texas

Table 1
Class V Aquifer Remediation Injection Well Permit #5X2600431
Sampling and Monitoring Schedule for the B3 Bioreactor Pilot Study
CSSA - Boerne, Texas

	Sampling or Monitoring Location	Parameter(s)	Sampling Frequency	Reporting Frequency
Current Regulatory Req.	Flow meters (6) for each trench on downstream side of the header and one flow meter on the upstream side of the header	Injection volume	Twice per month (record)	Monthly
	Pressure gages (4) on both sides of the transfer pump, at the bag filter and on the header	Pressure on the transfer pump	Twice per month (record)	Monthly
	Sampling port (1) on the upstream side of the distribution header	- pH (field) and TDS (lab) - VOCs (b)	Twice per month	Monthly
	Trench sumps (5) (b)	- pH (field) and TDS (lab) - VOCs (b)	Monthly	Quarterly
	MPMWs (4) (c)	- pH (field) and TDS (lab) - VOCs (b)	Quarterly	Quarterly
Proposed Regulatory Req.	Flow meters (6) for each trench on downstream side of the header and one flow meter on the upstream side of the header	Injection volume	Monthly (record)	Semi-Annual
	Pressure gages (4) on both sides of the transfer pump, at the bag filter and on the header	Pressure on the transfer pump	Monthly (record)	Semi-Annual
	Sampling port (1) on the upstream side of the distribution header	- pH (field) and TDS (lab) - VOCs (a)	Monthly	Semi-Annual
	Trench sumps (5) (b)	- pH (field) and TDS (lab) - VOCs (a)	Quarterly	Semi-Annual
	MPMWs (4) (c)	- pH (field) and TDS (lab) - VOCs (a)	Quarterly	Semi-Annual

Notes:

(a) Standard list of VOCs tested at CSSA

(b) Bioreactor trench sumps (BTS) include: Trench 1 - 1-1, 1-2 and 1-3; Trench 2 - 2-1 and 2-2; Trench 3 - 3-1 and 3-2; Trench 4 - 4-1; Trench 5 - 5-1 and 5-2; Trench 6 - 6-1 and 6-2. Samples are collected from all trench sumps which includes the injection of CS-MW16 groundwater.

(c) Multi-port monitoring wells (MPMW) include: CS-WB05 (9 sampling ports), CS-WB06 (6 sampling ports), CS-WB07 (6 sampling ports) and CS-WB08 (6 sampling ports). MPMW will be sampled quarterly and include only Zone LGR-03B for each MPMW. Surrounding monitor wells includes: CS-MW1-LGR, CS-B3-MW01-LGR, CS-D-LGR, CS-MW16-LGR and CS-MW16-CC.

July 31, 2008 Transmittal

Buddy Garcia, *Chairman*
Larry R. Soward, *Commissioner*
Bryan W. Shaw, Ph.D., *Commissioner*
Mark R. Vickery, P.G., *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

July 31, 2008

Mr. Jason Shirley
Installation Manager
U.S. Army, Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Re: Amendment to Authorization of Class V Aquifer Remediation Injection Wells
TCEQ Authorization No. 5X2600431; Tracking No. 12331253-1
CN602728206/RN104431655
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Dear Mr. Shirley:

The Underground Injection Control (UIC) staff has completed review of the modification request dated April 24, 2008 requesting approval to change the data collection and reporting requirements for the above authorization. The following change has been made to the above Class V authorization.

Injection volumes, pressures, and concentrations of contaminants (including pH and total dissolved solids) in the injected groundwater shall be sampled monthly at the point of reinjection (prior to fluids being released into the trenches) and submitted to the UIC Permits Team, Industrial & Hazardous Waste Permits Section, at mail code MC-130 on a biannual basis. The concentration of contaminates in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled quartely and submitted to the UIC Permits Team, Industrial & Hazardous Waste Permits Section, at mail code MC-130 on a biannual basis. The concentrations of the contaminants shall not exceed those limits listed in 40 CFR §261.24 Toxicity characteristic table 1 that would deem them hazardous by concentration.

If you have any questions regarding this matter, please contact me at (512) 239-6075. If you will be corresponding by mail, please use mail code MC-130.

Sincerely,

Bryan Smith, P.G., Engineering Specialist
Industrial & Hazardous Waste Permits Section
Waste Permits Division

BSS/fp

cc: Mr. Brian Vanderglas, Parsons, Austin

P.O. Box 13087 • Austin, Texas 78711-3087 • 512-239-1000 • Internet address: www.tceq.state.tx.us

Appendix B

Product Information

Recovery Well Pumps and SynCom PumpSaver

CS-MW16-LGR PUMP SPECIFICATIONS

GOULDS PUMPS

4" Submersible Pumps

Installation and Operation Instructions

Table of Contents

Owner's Information

Pump Model #: ____________________

Pump Serial #: ____________________

Motor Model #: ____________________

Motor Serial #: ____________________

Dealer: ____________________

Dealer Telephone: ____________________

Purchase Date: ____________________

Installation Date: ____________________

Volts: ____________________

Amps: ____________________

Goulds Pumps

ITT Industries

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

⚠ This is a SAFETY ALERT SYMBOL. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠ DANGER Warns of hazards that WILL cause serious personal injury, death or major property damage.

⚠ WARNING Warns of hazards that CAN cause serious personal injury, death or major property damage.

⚠ CAUTION Warns of hazards that CAN cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

Important notice: Read safety instructions before proceeding with any wiring

⚠ WARNING All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in electrical shock, fire hazard, personal injury or death, damaged equipment, provide unsatisfactory performance, and may void manufacturer's warranty.

⚠ WARNING Standard units are not designed for use in swimming pools, open bodies of water, hazardous liquids, or where flammable gases exist. Well must be vented per local codes.

Only pumps specifically Listed for Class 1, Division 1 are allowable in hazardous liquids and where flammable gases may exist. *See specific pump catalog bulletins or pump nameplate for all agency Listings.*

⚠ WARNING Disconnect and lockout electrical power before installing or servicing any electrical equipment. Many pumps are equipped with automatic thermal overload protection which may allow an overheated pump to restart unexpectedly.

⚠ CAUTION All three phase (3Ø) controls for submersible pumps must provide Class 10, quick-trip, overload protection.

⚠ WARNING Do not lift, carry or hang pump by the electrical cables. Damage to the Electrical Cables can cause shock, burns or death.

⚠ WARNING Use only stranded copper wire to pump/motor and ground. The ground wire must be at least as large as the power supply wires. Wires should be color coded for ease of maintenance and troubleshooting.

⚠ DANGER Install wire and ground according to the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes.

⚠ WARNING Install an all leg disconnect switch where required by code.

⚠ WARNING The electrical supply voltage and phase must match all equipment requirements. Incorrect voltage or phase can cause fire, motor and control damage, and voids the warranty.

⚠ WARNING All splices must be waterproof. If using splice kits follow manufacturer's instructions.

⚠ WARNING Select the correct type and NEMA grade junction box for the application and location. The junction box must insure dry, safe wiring connections.

⚠ WARNING Failure to permanently ground the pump, motor and controls before connecting to power can cause shock, burns or death.

⚠ WARNING 4" motors ≥ 2 HP require a minimum flow rate of .25 ft/sec. or 7.62 cm/sec. past the motor for proper motor cooling. The following are the minimum flows in GPM per well diameter required for cooling: 1.2 GPM/4", 7 GPM/5", 13 GPM/6", 20 GPM/7", 30 GPM/8" or 50 GPM in a 10" well. Pumps ≥ 2 HP installed in large tanks should be installed in a flow inducer sleeve to create the needed cooling flow or velocity past the motor.

⚠ CAUTION This pump has been evaluated for use with Water Only.

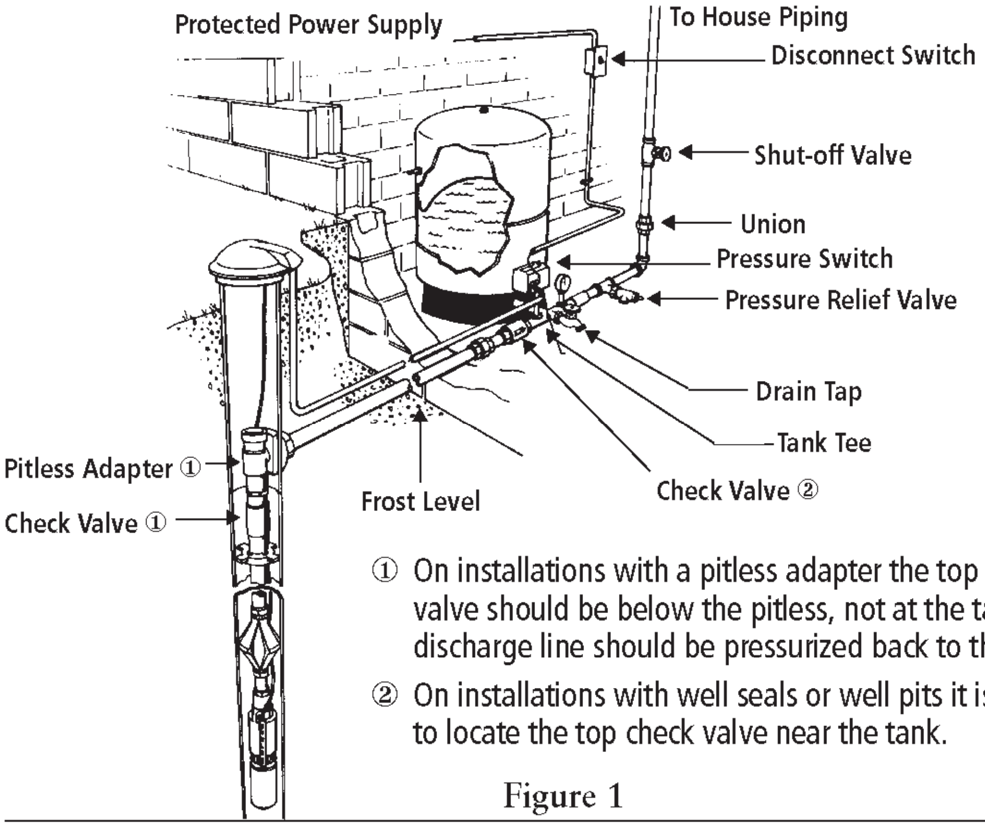
INSTALLATION CHECK LIST

- Enter the pump and motor information and other requested data on the front of this manual.
- Inspect all components for shipping damage, report damage to the distributor immediately.
- Verify that motor HP and pump HP match.
- Match power supply voltage and phase to motor and control specifications.
- Select a dry, shaded location in which to mount the controls.
- Make all underwater and underground splices with waterproof splice connections.
- Hold the pump at the discharge head when installing threaded pipe or an adapter fitting as most pumps have left hand threads which will be loosened if you hold the pump anyplace except the discharge head.
- Check all plumbing connections to insure they are tight and sealed with Teflon tape.
- Verify that the pipe pressure rating is higher than pump shut-off pressure.
- Install a pressure relief valve on any system capable of creating over 75 PSI.
- Locate the pressure switch within 4' of the pressure tank to prevent switch chatter.
- Adjust tank pre-charge to 2 PSI below the system cut-in pressure setting, ex. 28 on a 30/50 system.
- Set the pump 10' above the well bottom to keep above sediment and debris.
- Insure that main power is disconnected, turned OFF, before wiring any components.
- Wiring should be performed only by qualified technicians.
- Wiring and Grounding must be in compliance with national and local codes.
- Restrict the flow with a ball or globe valve, 1/3 open, before starting pump for first time.
- Open a faucet or discharge valve on start-up to keep dirty water from entering the tank.
- Turn main breaker or disconnect ON.
- Run through several on/off cycles to verify proper switch operation.
- Check amps and enter the data on the front of this manual.
- Leave the manual with the owner or at the job site.

1.0 TYPICAL INSTALLATIONS

CAPTIVE AIR TANK INSTALLATION

NOTICE: TANK PRE-CHARGE PRESSURE CHANGES MUST BE MADE USING THE AIR VALVE ON TOP OF THE TANK.



① On installations with a pitless adapter the top check valve should be below the pitless, not at the tank, as the discharge line should be pressurized back to the pitless.

② On installations with well seals or well pits it is allowable to locate the top check valve near the tank.

Figure 1

GALVANIZED TANK INSTALLATION

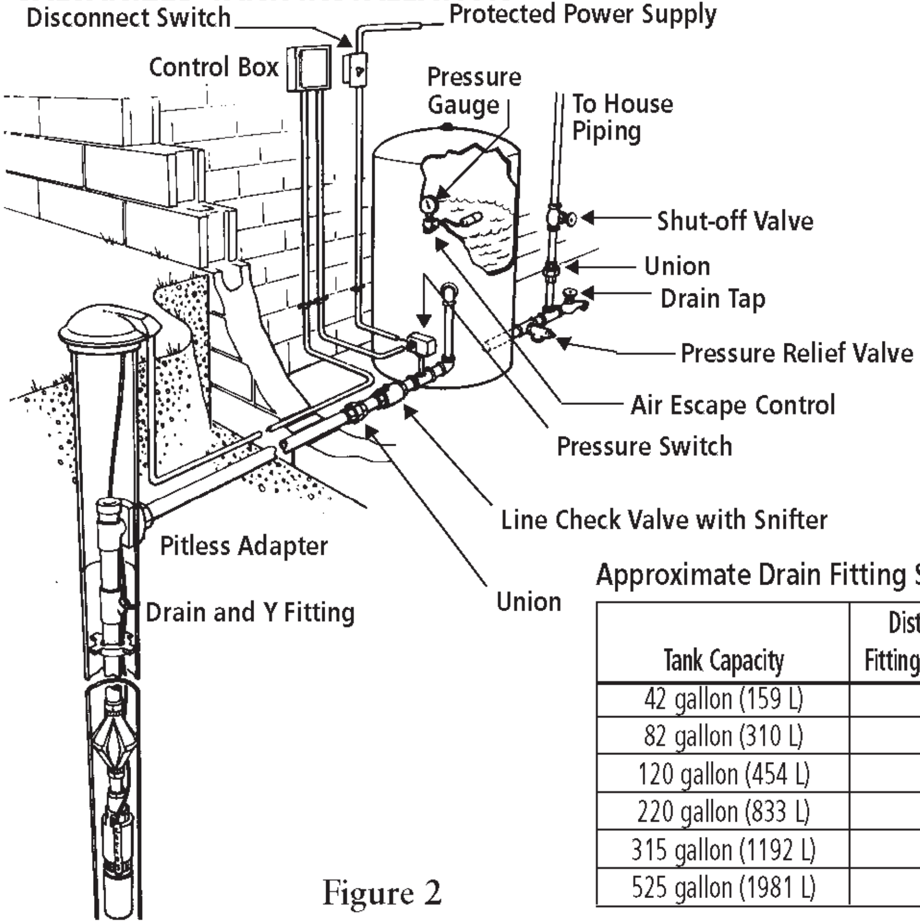


Figure 2

Approximate Drain Fitting Setting

Tank Capacity	Distance Drain and "Y" Fitting Below the Line Check
42 gallon (159 L)	7 feet (2.1m)
82 gallon (310 L)	10 feet (3m)
120 gallon (454 L)	15 feet (4.6m)
220 gallon (833 L)	15 feet (4.6m)
315 gallon (1192 L)	20 feet (6.1m)
525 gallon (1981 L)	20 feet (6.1m)

2.0 PIPING

Notice: Most 4" submersibles have left-hand discharge head threads, hold the pump only at the "discharge head" when installing fittings or threaded pipe.

2.1 General

The pump discharge piping should be sized for efficient pump operation. Use the Friction Loss Tables to calculate total dynamic head using different pipe sizes. As a rule of thumb, use 1" for up to 10 gpm, 1¼" for up to 30 gpm, 1½" for up to 45 gpm, and 2" for up to 80 gpm. In the case of long pipe runs it is best to increase pipe size.

Some pumps are capable of very high discharge pressures, please select pipe accordingly. Consult with your pipe supplier to determine the best type of pipe for each installation.

2.2 Pressure Tank, Pressure Switch and Pressure Relief Valve

Select an area in which the ambient temperature is always above 34° F (1° C) in which to install the tank, pressure switch, and pressure relief valve. The tank should be located in an area where a leak will not damage property.

The pressure switch should be located at the tank cross tee and never more than 4' from the tank. Locating the switch more than 4' from the tank will cause switch chatter.

There should be no valves, filters, or high loss fittings between the switch and the tank(s) as switch chatter may result. As an example, a 1¼" spring check valve has friction loss equal to 12' of pipe, placing the valve between the pressure switch and the pressure tank is the same as moving the pressure switch 12' away from the tank. It will create switch chatter.

On multiple tank installations the switch should be as close to the center of the tanks as possible. Multiple tank installations should have a manifold pipe at least 1½ times the size of the supply pipe from the pump. This will reduce the Friction Head in the manifold and reduce the possibility of switch chatter.

The cut-in setting on a 30 - 50 pressure switch is 30 psi. Cut-in is the lower of the pressure settings.

Pressure relief valves are required on any system that is capable of producing 100 psi or 230' TDH. If in an area where a water leak or blow-off may damage property connect a drain line to the pressure relief valve. Run it to a suitable drain or an area where the water will not damage property.

2.3 Adjusting Tank Pre-Charge

Insure that the tank is empty of water. Use a high quality pressure gauge to check the tank pre-charge pressure. The pressure should be 2 psi below the pump cut-in pressure. As an example, a 30-50 psi system would use a tank pre-charge of 28 psi.

2.4 Discharge Pipe

Note: Most discharge heads are threaded into the casing with left-hand threads. Hold the pump only at the discharge head when installing fittings. Failure to hold the discharge head will loosen it and pump damage will result on start-up.

If your pipe requires an adapter we strongly recommend using stainless steel. Galvanized fittings or pipe should never be connected directly to a stainless steel discharge head as galvanic corrosion may occur. Plastic or brass pumps can use any material for this connection. Barb type connectors should always be double clamped.

The pump discharge head has a loop for attaching a safety cable. The use of a safety cable is at the discretion of the installer.

2.5 Installing Pump in Well

If you are using a torque arrestor, install it per the manufacturer's installation instructions. Consult the seller for information on torque arrestors and for installation instructions.

Connect the discharge pipe to the discharge head or adapter you previously installed. Barb style connectors should always be double clamped. Install the pump into the well using a pitless adapter or similar device at the wellhead. Consult the fitting manufacturer or pitless supplier for specific installation instructions.

Using waterproof electrical tape, fasten the wires to the drop pipe at 10' intervals. Make sure that the tape does not loosen as it will block the pump suction if it falls down the well. Pump suppliers also sell clip-on style wire connectors that attach to the drop pipe.

2.6 Special Piping For Galvanized Tank Systems

When using a galvanized tank you should install an AV11 Drain & Y fitting in the well and a check valve with snifter valve at the tank. This will add air to the tank on each pump start and prevent water logging the tank. Use an AA4 Air Escape on the tank to allow excess air to escape. The distance between the AV11 and check valve with snifter valve determines the amount of air introduced on each cycle. See the table for recommended settings. *See Figure 2 in Sec 1.0.*

Gaseous wells should use galvanized tanks with AA4 air escapes to vent off excess air and prevent "spurting" at the faucets.

Methane and other explosive or dangerous gases require special water treatment for safe removal. Consult a water treatment specialist to address these issues.

Installations with top feeding wells should use flow sleeves on the pump.

2.7 Check Valves

Our pumps use four different style check valves. We recommend check valves as they prevent back-spinning the pump and motor which will cause premature bearing wear. Check valves also prevent water hammer and upthrust damage. Check valves should be installed every 200' – 250' in the vertical discharge pipe.

The following information is for customers who wish to disable a check valve for a drain back system, these systems should use other means to prevent water hammer and upthrust damage:

- **Built-in stainless steel valves** have a flat which is easily drilled through using an electric drill and a ¼" or ⅜" drill bit to disable the valve.
- **Poppet style check valves which are threaded in from the top** of the discharge head can be easily removed using a ½" nut driver or deep socket. The hex hub is visible and accessible from the top.
- **Internal Flomatic™ design plastic poppet style valves** must be removed from inside which requires pump disassembly.

- **Built-in plastic poppet style valves with a stem through the top** may be removed from discharge head by pulling on the stem with pliers.

3.0 WIRE SIZING, SPLICING and POWER SUPPLY

Always follow the National Electric Code (N.E.C.), Canadian Electrical Code, and any state, provincial, or local codes.
We suggest using only copper wire. Size wire from the charts found in the Technical Data section of this manual, in the Franklin Electric AIM manual, or an N.E.C. (National Electric Code) code book. If discrepancies exist the N.E.C. book takes precedence over a manufacturer's recommendations.

3.1 Splicing Wire to Motor Leads

When the drop cable must be spliced or connected to the motor lead it is necessary that the splice be watertight. The splice can be done with heat shrink kits or waterproof tape.

A. Heat Shrink Splice Instructions
To use a typical heat shrink kit: strip ½" from the motor wires and drop cable wires, it is best to stagger the splices. Place the heat shrink tubes on the wires. Place the crimps on the wires and crimp the ends. Slide the heat shrink tubes over the crimps and heat from the center outward. The sealant and adhesive will ooze out the ends when the tube shrinks. The tube, crimps, sealant, and adhesive create a very strong, watertight seal.

B. Taped Splice Instructions

A) Strip individual conductor of insulation only as far as necessary to provide room for a stake type connector. Tubular connectors of the staked type are preferred. If connector O.D. is not as large as cable insulation, build-up with rubber electrical tape.

B) Tape individual joints with rubber electrical tape, using two layers; the first extending two inches beyond each end of the conductor insulation end, the second layer two inches beyond the ends of the first layer. Wrap tightly, eliminating air spaces as much as possible.

C) Tape over the rubber electrical tape with #33 Scotch electrical tape, or equivalent, using two layers as in step "B" and making each layer overlap the end of the preceding layer by at least two inches.

In the case of a cable with three conductors encased in a single outer sheath, tape individual conductors as described, staggering joints.

Total thickness of tape should be no less than the thickness of the conductor insulation.

4.0 WIRING THE CONTROLS and SWITCH

4.1 Mounting the Motor Control Box

Single phase 3-wire control boxes meet U.L. requirements for Type 3R enclosures. They are suitable for vertical mounting in indoor and outdoor locations. They will operate at temperatures between 14°F (-10°C) and 122°F (50°C). Select a shaded, dry place to mount the box. Insure that there is enough clearance for the cover to be removed.

4.2 Verify Voltage and Turn Supply Power Off

Insure that your motor voltage and power supply voltage are the same.

Place the circuit breaker or disconnect switch in the OFF position to prevent accidentally starting the pump before you are ready.

Three-phase starter coils are very voltage sensitive; always verify actual supply voltage with a voltmeter.

High or low voltage, greater than ±10%, will damage motors and controls and is not covered under warranty.

4.3 Connecting Motor Leads to Motor Control Box, Pressure Switch or Starter

Caution Do not power the unit or run the pump until all electrical and plumbing connections are completed. Verify that the disconnect or breaker is OFF before connecting the pressure switch line leads to the power supply. Follow all local and national codes. Use a disconnect where required by code.

A. Three-Wire Single Phase Motor
Connect the color coded motor leads to the motor control box terminals - Y (yellow), R (red), and B (black); and the Green or bare wire to the green ground screw.

Connect wires between the Load terminals on the pressure switch and control box terminals L1 and L2. Run a ground wire between the switch ground and the control box ground. *See Figure 4 or 5.*

B. Two-Wire Single Phase Motor
Connect the black motor leads to the Load terminals on the pressure switch and the green or bare ground wire to the green ground screw. *See Figure 3.*

C. Three phase motors
Connect the motor leads to T1, T2, and T3 on the 3 phase starter. Connect the ground wire to the ground screw in the starter box. Follow starter manufacturers instructions for connecting pressure switch or *see Figure 6.*

4.4 Connect To Power Supply

Complete the wiring by making the connection from the single phase pressure switch Line terminals to the circuit breaker panel or disconnect where used.

Three phase - make the connections between L1, L2, L3, and ground on the starter to the disconnect switch and then to the circuit breaker panel.

Three phase installations must be checked for motor rotation and phase unbalance. To reverse motor rotation, switch (reverse) any two leads. See the instructions for checking three phase unbalance in section 4.6. Failure to check phase unbalance can cause premature motor failure and nuisance overload tripping. If using a generator, see Technical Data for generators.

4.5 Three Phase Overload Protection

Use only Class 10, quick-trip overload protection on three-phase submersible motors. Furnas Class 14 NEMA starters with ESP100 overloads and Class 16 starters equipped with "K" overload heaters or ESP100 overloads will provide adequate protection.

The Franklin Electric Application Manual lists several acceptable starter/overload combinations. Call the FE hotline at 800-348-2420 or the pump manufacturer's Customer Service group for selection assistance.

Note - If replacing an above ground motor with a submersible, verify that the overloads provide Class 10 protection, most above ground motors have Class 20 overloads. Use of Class 20 overloads on submersible motors will not protect the motors and voids the warranty.

4.6 Three Phase Power Unbalance

A full three phase supply consisting of three individual transformers or one three phase transformer is recommended. "Open" delta or wye connections using only two transformers can be used, but are more likely to cause poor performance, overload tripping or early motor failure due to current unbalance.

Check the current in each of the three motor leads and calculate the current unbalance as explained below.

If the current unbalance is 2% or less, leave the leads as connected.

If the current unbalance is more than 2%, current readings should be checked on each leg using each of the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.

To calculate percent of current unbalance:

A. Add the three line amp values together.
B. Divide the sum by three, yielding average current.
C. Pick the amp value which is furthest from the average current (either high or low).
D. Determine the difference between this amp value (furthest from average) and the average.
E. Divide the difference by the average.
Multiply the result by 100 to determine percent of unbalance.

	Hookup 1			Hookup 2			Hookup 3		
Starter Terminals	L1	L2	L3	L1	L2	L3	L1	L2	L3
Motor Leads	R	B	Y	Y	R	B	B	Y	R
	T3	T1	T2	T2	T3	T1	T1	T2	T3

Example:

T3-R = 51 amps	T2-Y = 50 amps	T1-B = 50 amps
T1-B = 46 amps	T3-R = 48 amps	T2-Y = 49 amps
T2-Y = 53 amps	T1-B = 52 amps	T3-R = 51 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷ 3 = 50 amps	÷ 3 = 50 amps	÷ 3 = 50 amps
— 46 = 4 amps	— 48 = 2 amps	— 49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%

Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source.

Contact your local power company to resolve the imbalance.

5.0 STARTING THE PUMP

5.1 Throttle the Discharge Before Starting Pump

Install a ball valve in the discharge line and set it ⅓ open before operating the pump in an open discharge manner. This will protect the pump from upthrust damage and also prevent over pumping the well and reduce turbidity. Keep the valve partially closed until the water runs clear.

5.2 Throttling A High Static Level Well To Prevent Upthrust

Any well with a high static water level may allow the pump to operate off the curve to the right or outside the "Recommended Range" shown on the pump curve. We recommend using a "Dole" flow restrictor or throttling with a ball valve to prevent upthrust damage to the pump and motor. The maximum flow must be restricted to be within the pumps recommended operating range. If you use a ball valve, set it, remove the handle, tape the handle to the pipe, and tag the valve with a note saying, "Do not open this valve or pump may be damaged". The easiest way to "set" the flow is to fill a 5 gallon bucket and time how long it takes to produce 5 gallons. Calculate the flow in gpm based on this value. As the water level drops in the well the flow will be reduced due to increased head and the valve will not interfere with performance.

5.3 Start the Pump

Partially open a valve (faucet) in the system and turn the breaker to the ON position.

Check all fittings for leaks.

Close the valve when the water clears and allow the pressure to build. If properly adjusted the switch should turn the pump off at the preset pressure. Open a few faucets and allow the pump to run through a few cycles. Check switch operation and verify that pressure settings are correct.

Recheck all fittings for leaks.

6.0 PAPERWORK and IOM

Please give this filled-in IOM and your business card to the owner.
A sticker with your name and phone number on the tank or control box is a great sales tool for future business!

SINGLE PHASE – 60 HZ MOTOR SPECIFICATIONS

Type	Goulds Motor #/ Control Box	Franklin Motor Model Prefix	HP	Volts	Hz	S.F.	Amps	S.F. Amps	Ohms M=Main S=Start	Inverse Time Breaker	Dual Ele. Time Del. Fuse
4" 2W	S04932/ NR	2445040	½	115	60	1.60	10.0	12.0	1.0 – 1.3	30	20
	S04942/ NR	2445050	½	230	60	1.60	5.0	6.0	4.2 – 5.2	15	10
	S05942/ NR	2445070	¾	230	60	1.50	6.8	8.0	3.0 – 3.6	20	15
	S06942/ NR	2445081	1	230	60	1.40	8.2	9.8	2.2 – 2.7	25	20
	S07942/ NR	2445091	1½	230	60	1.30	10.6	13.1	1.5 – 1.9	30	20
4" 3W	S04930/ 00043	2145044	½	115	60	1.60	Y=10.0 B=10.0 R=0.0	Y=12.0 B=12.0 R=0.0	M = 1.0 – 1.3 S = 4.1 – 5.1	30	20
	S04940/ 00044	2145054	½	230	60	1.60	Y=5.0 B=5.0 R=0.0	Y=6.0 B=6.0 R=0.0	M = 4.2 – 5.2 S = 16.7 – 20.5	15	10
	S05940/ 00054	2145074	¾	230	60	1.50	Y=6.8 B=6.8 R=0.0	Y=8.0 B=8.0 R=0.0	M = 3.0 – 3.6 S = 10.7 – 13.1	20	15
	S06940/ 00064	2145081	1	230	60	1.40	Y=8.2 B=8.2 R=0.0	Y=9.8 B=9.8 R=0.0	M = 2.2 – 2.7 S = 9.9 – 12.1	25	20
4" 3W with RunCap	S07940/ 00074	2243001	1½	230	60	1.30	Y=10.0 B=9.9 R=1.3	Y=11.5 B=11.0 R=1.3	M = 1.5 – 2.3 S = 8.0 – 9.7	30	20
	S08940/ 00084	2243011	2	230	60	1.25	Y=10.0 B=9.3 R=2.6	Y=13.2 B=11.9 R=2.6	M = 1.6 – 2.3 S = 5.8 – 7.2	25	20
	S09940/ 00094 ①	2243027	3	230	60	1.15	Y=14.0 B=11.2 R=6.1	Y=17.0 B=12.6 R=6.0	M = 1.0 – 1.5 S = 4.0 – 4.9	40	30
	S10940/ 00104 ②	2243037	5	230	60	1.15	Y=23.0 B=15.9 R=11.0	Y=27.5 B=19.1 R=10.8	M = 0.68 – 1.0 S = 1.8 – 2.2	60	45

M = Main Winding – Black to Yellow, S = Start Winding – Red to Yellow
Y = Yellow lead – line amps, B = Black lead – main winding amps,
R = Red lead, start or auxiliary winding amps

① Control Boxes date coded 02C and older have 35MFD capacitors and the current values
will be Y14.0 @ FL and Y17.0 @ SF Load.
B12.2 B14.5
R4.7 R4.5

② Control boxes date coded 01M and older have 60MFD run capacitors and the current values on
a 4" motor will be Y23.0 @ FL and Y27.5 @ SF Load.
B19.1 B23.2
R8.0 R7.8

THREE PHASE – 60 HZ MOTOR SPECIFICATIONS

Type	Goulds Model #	Franklin Motor Model Prefix					Rated Input		Maximum (S.F. Load)		Line to Line	Locked Rotor	KVA	Inverse Time Breaker	Dual Ele. Time Del. Fuse
			HP	Volts	Hz	S.F.	Amps	Watts	Amps	Watts	Res.	Amps	Code		
4" 3450 RPM	S04978	234501	½	200	60	1.6	2.8	585	3.4	860	6.6-8.4	17.5	N	15	5
	S04970	234511	½	230	60	1.6	2.4	585	2.9	860	9.5-10.9	15.2	N	15	5
	S04975	234521	½	460	60	1.6	1.2	585	1.5	860	38.4-44.1	7.6	N	15	3
	S05978	234502	¾	200	60	1.5	3.6	810	4.4	1150	4.6-5.9	23.1	M	15	8
	S05970	234512	¾	230	60	1.5	3.1	810	3.8	1150	6.8-7.8	20.1	M	15	6
	S05975	234522	¾	460	60	1.5	1.6	810	1.9	1150	27.2-30.9	10.7	M	15	3
	S06978	234503	1	200	60	1.4	4.5	1070	5.4	1440	3.8-4.5	30.9	M	15	10
	S06970	234513	1	230	60	1.4	3.9	1070	4.7	1440	4.9-5.6	26.9	M	15	8
	S06975	234523	1	460	60	1.4	2.0	1070	2.4	1440	19.9-23.0	13.5	M	15	4
	S07978	234504	1½	200	60	1.3	5.8	1460	6.8	1890	2.5-3.0	38.2	K	15	10
	S07970	234514	1½	230	60	1.3	4.5	1460	5.9	1890	3.2-4.0	33.2	K	15	10
	S07975	234524	1½	460	60	1.3	2.5	1460	3.1	1890	13.0-16.0	16.6	K	15	5
	S07979	234534	1½	575	60	1.3	2.0	1460	2.4	1890	20.3-25.0	13.3	K	15	4
	S08978	234305	2	200	60	1.25	7.7	2150	9.3	2700	1.8-2.4	53.6	L	20	15
	S08970	234315	2	230	60	1.25	6.7	2150	8.1	2700	2.3-3.0	46.6	L	20	15
	S08975	234325	2	460	60	1.25	3.4	2150	4.1	2700	9.2-12.0	23.3	L	15	8
	S08979	234335	2	575	60	1.25	2.7	2150	3.2	2700	14.6-18.7	18.6	L	15	5
	S09978	234306	3	200	60	1.15	10.9	2980	12.5	3420	1.3-1.7	71.2	K	30	20
	S09970	234316	3	230	60	1.15	9.5	2980	10.9	3420	1.8-2.2	61.9	K	25	20
	S09975	234326	3	460	60	1.15	4.8	2980	5.5	3420	7.2-8.8	31	K	15	10
	S09979	234336	3	575	60	1.15	3.8	2980	4.4	3420	11.4-13.9	25	K	15	8
	S10978	234307	5	200	60	1.15	18.3	5050	20.5	5810	.74-.91	122	K	50	35
	S10970	234317	5	230	60	1.15	15.9	5050	17.8	5810	1.0-1.2	106	K	40	30
	S10975	234327	5	460	60	1.15	8.0	5050	8.9	5810	4.0-4.7	53.2	K	20	15
	S10979	234337	5	575	60	1.15	6.4	5050	7.1	5810	6.4-7.8	42.6	K	20	15
	S119784	234308	7½	200	60	1.15	26.5	7360	30.5	8450	.46-.57	188	K	70	50
	S119704	234318	7½	230	60	1.15	23.0	7360	26.4	8450	.61-.75	164	K	60	45
	S119754	234328	7½	460	60	1.15	11.5	7360	13.2	8450	2.5-3.1	81.9	K	30	25
	S119794	234338	7½	575	60	1.15	9.2	7360	10.6	8450	4.0-5.0	65.5	K	25	20
	S129724	234329	10	460	60	1.15	17.0	10,000	18.5	11400	1.8-2.3	116	L	45	30
	S119794	234339	10	575	60	1.15	13.6	10,000	14.8	11400	2.8-3.5	92.8	L	35	25

FURNAS STARTERS AND HEATERS

Motor Size	HP	Volts	FURNAS Class 16		Class 14	Inverse Time Breaker	Dual Ele. Time Del. Fuse
			Order Number	Heaters	Order Number		
4" 3Ø	½	200	16AD	K29	CSBD	15	5
		230	16AG	K28	CSBA	15	5
		460	16AH	K21	CSBC	15	5
	¾	200	16AD	K33	CSBD	15	8
		230	16AG	K31	CSBA	15	6
		460	16AH	K22	CSBC	15	3
	1	200	16AD	K37	CSDD	15	10
		230	16AG	K34	CSDA	15	8
		460	16AH	K26	CSBC	15	4
	1½	200	16AD	K41	CSDD	15	10
		230	16AG	K37	CSDA	15	10
		460	16AH	K28	CSDC	15	5
		575	16AE	K26	CSBE	15	4
	2	200	16AD	K49	CSDD	20	15
		230	16AG	K43	CSDA	20	15

NOTE: The Class 16 starter chart shows the order number for matched coil and load voltage, i.e. a 230 volt power supply with a 230 volt coil. To use a different coil voltage select the same size starter with a different coil.

Nomenclature: Ex. **16 B H;**
16 = Class 16 DP Starter
B = Starter **size**, sizes are A, B, C, D, E, F, G, H. Size determined by Full Load Amps and Locked Rotor Amps.

Motor Size	HP	Volts	FURNAS Class 16		Class 14	Inverse Time Breaker	Dual Ele. Time Del. Fuse
			Order Number	Heaters	Order Number		
4" 3Ø	2	460	16AH	K32	CSDC	15	8
		575	16AE	K29	CSDE	15	5
	3	200	16AD	K54	CSED	30	20
		230	16AG	K52	CSEA	25	20
		460	16AH	K37	CSDC	15	10
		575	16AE	K33	CSDE	15	8
	5	200	16AD	K61	DSFD	50	35
		230	16AG	K60	DSFA	40	30
		460	16AH	K49	CSDC	20	15
		575	16AE	K41	CSDE	20	15
	7½	200	16CD	K69	DSFD	70	50
		230	16BG	K64	DSFA	60	45
		460	16AH	K54	DSEC	30	25
		575	16AE	K52	DSEE	25	20
	10	460	16AH	K60	DSEC	45	30
		575	16AE	K57	DSEE	35	25

H = coil voltage. Voltages are: D = 200 V, E = 575 V, F = 115 V, G = 230 V, H = 460 V.

The Class 14 starter nomenclature can be found in your Jet & Submersible Price Book.

Technical Data

MOTOR INSULATION RESISTANCE READINGS

Normal Ohm/Megohm readings, ALL motors, between all leads and ground

⚠CAUTION To perform insulation resistance test, open breaker and disconnect all leads from QD control box or pressure switch. Connect one ohmmeter lead to any motor lead and one to metal drop pipe or a good ground. **R x 100K Scale**

Condition of Motor and Leads	OHM Value	Megohm Value
New motor, without power cable	20,000,000 (or more)	20.0
Used motor, which can be reinstalled in well	10,000,000 (or more)	10.0
Motor in well – Readings are power cable plus motor		
New motor	2,000,000 (or more)	2.0
Motor in reasonably good condition	500,000 to 2,000,000	0.5 – 2.0
Motor which may be damaged or have damaged power cable *Do not pull motor for these reasons*	20,000 to 500,000	0.02 – 0.5
Motor definitely damaged or with damaged power cable *Pull motor and repair*	10,000 to 20,000	0.01 – 0.02
Failed motor or power cable *Pull motor and repair*	Less than 10,000	0 – 0.01

Generator Operation

- For externally regulated generator kilovolt amperes (KVA) ratings see Table 1. Electrical voltage, frequency, phase and ampacity, MUST match that shown on the motor nameplate, or pump control box.

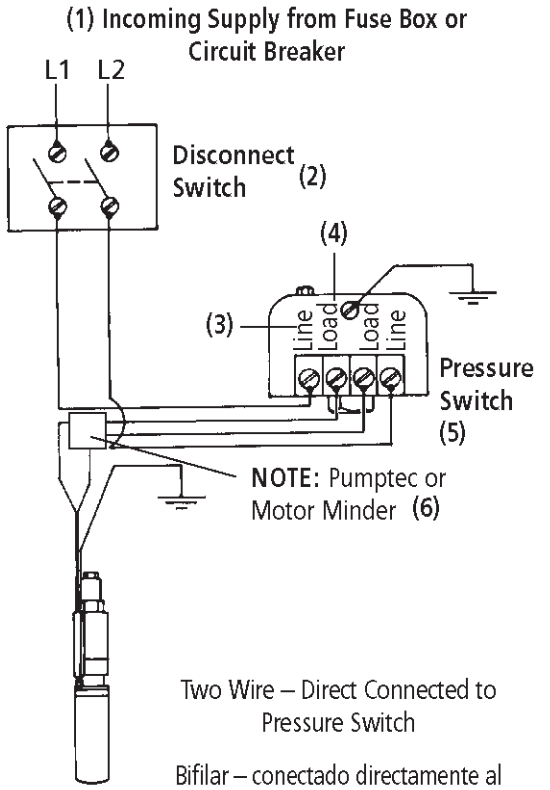
FAILURE TO USE A MANUAL OR AUTOMATIC TRANSFER SWITCH WHEN GENERATOR IS USED AS STANDBY OR BACKUP CAN CAUSE SHOCK, BURNS OR DEATH.

Min. Generator Rating	**Pump Motor Horsepower ①**							
	⅓	½	¾	1	1½	2	3	5
KVA	1.9	2.5	3.8	5.0	6.3	9.4	12.5	18.8
KW	1.5	2.0	3.0	4.0	5.0	7.5	10.0	15.0

① **NOTE:** For two-wire motors, minimum generator ratings 50% higher than shown are necessary.

NOTICE: FOLLOW THE GENERATOR MANUFACTURER'S INSTRUCTIONS CAREFULLY.

Courtesy of Franklin Electric Company

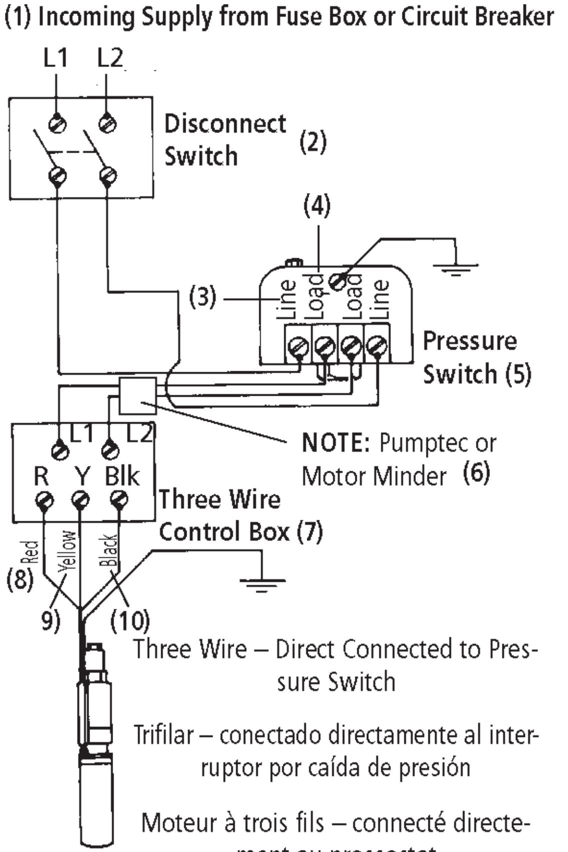


Two Wire – Direct Connected to Pressure Switch

Bifilar – conectado directamente al interruptor por caída de presión

Moteur à deux fils – connecté directement au pressostat

Figure (Figura) 3



Three Wire – Direct Connected to Pressure Switch

Trifilar – conectado directamente al interruptor por caída de presión

Moteur à trois fils – connecté directement au prossostat

Figure (Figura) 4

1.Suministro de entrada de la caja de fusibles o del cortacircuitos

2.Interruptor de desconexión

3.Línea

4. Carga

5. Interruptor por caída de presión

6. NOTA: Pumptec o Motor Minder

7. Caja de control trifilar

8. Rojo

9. Amarillo

10. Negro

1.Courant d'entrée provenant de la boîte à fusibles ou du disjoncteur

2.Sectionneur

3. Ligne

4. Charge

5. Pressostat

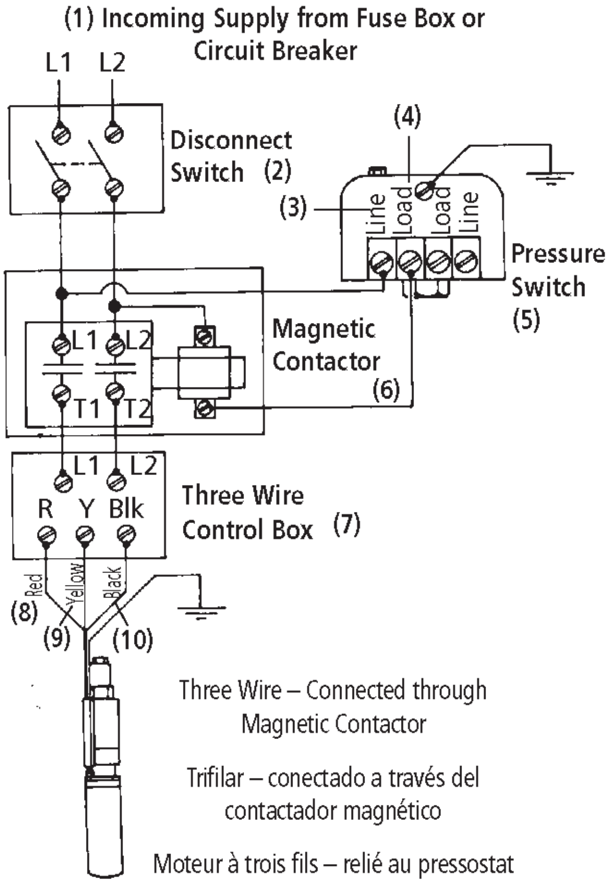
6. Protection Pumptec ou Motor Minder

7. Boîte de commande à trois fils

8. Rouge

9. Jaune

10. Noir

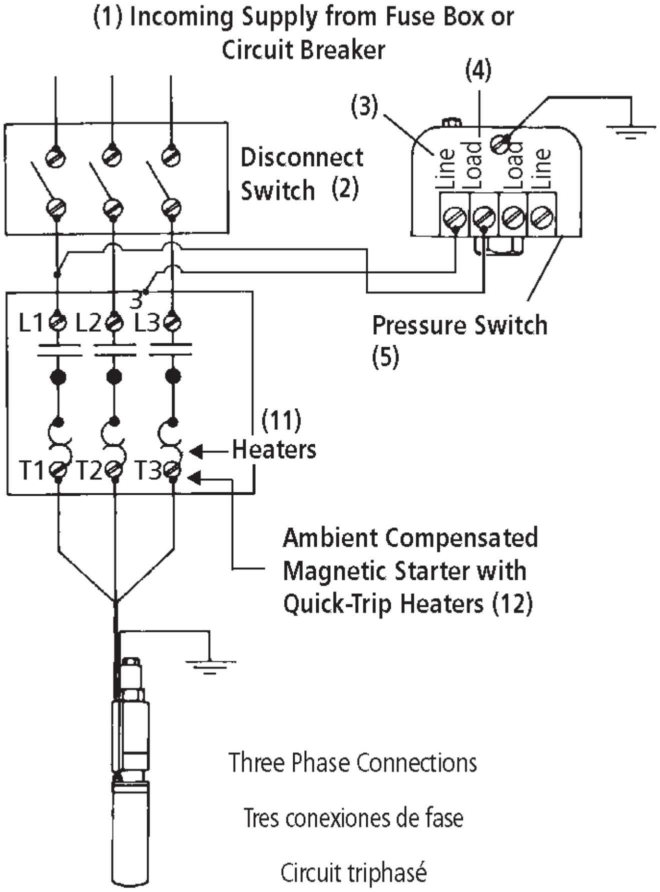


Three Wire – Connected through Magnetic Contactor

Trifilar – conectado a través del contactador magnético

Moteur à trois fils – relié au pressostat par un contacteur magnétique

Figure (Figura) 5



Three Phase Connections

Tres conexiones de fase

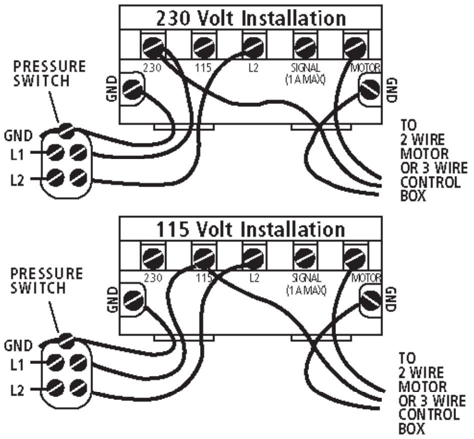
Circuit triphasé

Figure (Figura) 6

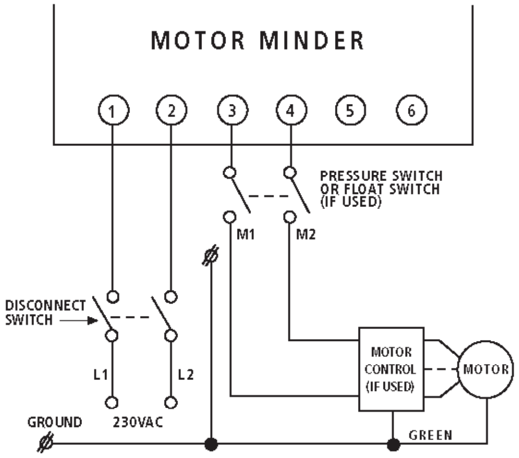
1. Suministro de entrada de la caja de fusibles o del cortacircuitos
2. Interruptor de desconexión
3. Línea
4. Carga
5. Interruptor por caída de presión
6. Contactador magnético
7. Caja de control trifilar
8. Rojo
9. Amarillo
10. Negro
11. Calentadores
12. Arrancador magnético con compensación ambiental con calentadores de disparo rápido

1. Courant d'entrée provenant de la boîte à fusibles ou du disjoncteur
2. Sectionneur
3. Ligne
4. Charge
5. Pressostat
6. Contacteur magnétique
7. Boîte de commande à trois fils
8. Rouge
9. Jaune
10. Noir
11. Dispositifs de protection contre la surcharge (DPS)
12. Démarreur magnétique compensé (température ambiante) avec DPS à déclenchement rapide

PUMPTEC WIRING



MOTOR MINDER WIRING



SINGLE PHASE MOTOR MAXIMUM CABLE LENGTH (motor to service entrance) (2)

Motor Rating		Copper Wire Size (1)								
Volts	HP	14	12	10	8	6	4	2	0	00
115	1/3	130	210	340	540	840	1300	1960	2910	3540
	1/2	100	160	250	390	620	960	1460	2160	2630
230	1/3	550	880	1390	2190	3400	5250	7960	11770	
	1/2	400	650	1020	1610	2510	3880	5880	8720	
	3/4	300	480	760	1200	1870	2890	4370	6470	7870
	1	250	400	630	990	1540	2380	3610	5360	6520
	1.5	190	310	480	770	1200	1870	2850	4280	5240
	2	150	250	390	620	970	1530	2360	3620	4480
	3	120*	190	300	470	750	1190	1850	2890	3610
	5	0	0	180*	280	450	710	1110	1740	2170
	7.5	0	0	0	200*	310	490	750	1140	1410
	10	0	0	0	0	250*	390	600	930	1160
	15	0	0	0	0	170*	270*	430	660	820

(1) This table is based on copper wire. If aluminum wire is used it must be two sizes larger.
Example: When the table calls for #12 copper wire you would use #10 aluminum wire.

(2) Single phase control boxes may be connected at any point of the total cable length.

THREE PHASE MOTOR MAXIMUM CABLE LENGTH (motor to service entrance) (3)

Motor Rating		Copper Wire Size (1)										
Volts	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**	**0**	**00**	**000**	**0000**
200 V 60 Hz	.5	710	1140	1800	2840	4420						
	.75	510	810	1280	2030	3160						
	1	430	690	1080	1710	2670	4140					
	1.5	310	500	790	1260	1960	3050					
	2	240	390	610	970	1520	2360	3610	5420			
	3	180	290	470	740	1160	1810	2760	4130			
	5	110*	170	280	440	690	1080	1660	2490	3050	3670	4440
	7.5	0	0	200	310	490	770	1180	1770	2170	2600	3150
	10	0	0	0	230*	370	570	880	1330	1640	1970	2390
230 V 60 Hz	.5	930	1490	2350	3700	5760	8910					
	.75	670	1080	1700	2580	4190	6490	9860				
	1	560	910	1430	2260	3520	5460	8290				
	1.5	420	670	1060	1670	2610	4050	6160	9170			
	2	320	510	810	1280	2010	3130	4770	7170	8780		
	3	240	390	620	990	1540	2400	3660	5470	6690	8020	9680
	5	140*	230	370	590	920	1430	2190	3290	4030	4850	5870
	7.5	0	160*	260	420	650	1020	1560	2340	2870	3440	4160
	10	0	0	190*	310	490	760	1170	1760	2160	2610	3160
460 V 60 Hz	.5	3770	6020	9460								
	.75	2730	4350	6850								
	1	2300	3670	5770	9070							
	1.5	1700	2710	4270	6730							
	2	1300	2070	3270	5150	8050						
	3	1000	1600	2520	3970	6200						
	5	590	950	1500	2360	3700	5750					
	7.5	420	680	1070	1690	2640	4100	6260				
	10	310	500	790	1250	1960	3050	4680	7050			
575 V 60 Hz	.5	5900	9410									
	.75	4270	6810									
	1	3630	5800	9120								
	1.5	2620	4180	6580								
	2	2030	3250	5110	8060							
	3	1580	2530	3980	6270							
	5	920	1480	2330	3680	5750						
	7.5	660	1060	1680	2650	4150						
	10	490	780	1240	1950	3060	4770					

(3) The portion of the total cable which is between the service entrance and a three phase motor starter should not exceed 25% of the total maximum length to assure reliable starter operation.

Lengths marked * meet the U.S. National Electrical Code ampacity only for individual conductor 75°C cable. Only the lengths without * meet the code for jacketed 75°C cable. Local code requirements may vary.

Troubleshooting

DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE. FAILURE TO DO SO CAN CAUSE SHOCK, BURNS OR DEATH.

Symptom	Probable Cause	Recommended Action
PUMP MOTOR NOT RUNNING	1. Motor thermal protector tripped a. Incorrect control box b. Incorrect or faulty electrical connections c. Faulty thermal protector d. Low voltage e. Ambient temperature of control box/starter too high f. Pump bound by foreign matter g. Inadequate submergence	1. Allow motor to cool, thermal protector will automatically reset a – e. Have a qualified electrician inspect and repair, as required f. Pull pump, clean, adjust set depth as required g. Confirm adequate unit submergence in pumpage
	2. Open circuit breaker or blown fuse	2. Have a qualified electrician inspect and repair, as required
	3. Power source inadequate for load	3. Check supply or generator capacity
	4. Power cable insulation damage 5. Faulty power cable splice	4 – 5. Have a qualified electrician inspect and repair, as required
LITTLE OR NO LIQUID DELIVERED BY PUMP	1. Faulty or incorrectly installed check valve	1. Inspect check valve, repair as required
	2. Pump air bound	2. Successively start and stop pump until flow is delivered
	3. Lift too high for pump	3. Review unit performance, check with dealer
	4. Pump bound by foreign matter	4. Pull pump, clean, adjust set depth as required
	5. Pump not fully submerged	5. Check well recovery, lower pump if possible
	6. Well contains excessive amounts of air or gases	6. If successive starts and stops does not remedy, well contains excessive air or gases
	7. Excessive pump wear	7. Pull pump and repair as required
	8. Incorrect motor rotation – three phase only.	8. Reverse any two motor electrical leads

Declaration of Conformity

We at,
Goulds Pumps/ITT Industries
1 Goulds Drive
Auburn, NY 13021
Declare that the following products: GS, GSZ, LS, LSZ, SB, SBZ
Comply with Machine Directive 98/37/EC. This equipment is intended to be incorporated with machinery covered by this directive, but must not be put into service until the machinery into which it is to be incorporated has been declared in conformity with the actual provisions of the directive.

Declaración de Conformidad

Nosotros en
Goulds Pumps/ITT Industries
1 Goulds Drive
Auburn, NY 13021
Declaramos que los siguientes productos: GS, GSZ, LS, LSZ, SB, SBZ
cumplen con las Directivas para Maquinarias 98/37/EC. Este equipo ha sido diseñado para ser incorporado a la maquinaria cubierta por esta directiva pero no debe ponerse en funcionamiento hasta que se declare que la maquinaria en la que será incorporado cumple con las disposiciones reales de la directiva.

Déclaration de Conformité

Nous, à
Goulds Pumps, ITT Industries
1 Goulds Drive
Auburn, NY, U.S.A. 13021,
déclarons que les produits GS, GSZ, LS, LSZ, SB et SBZ
sont conformes à la directive 98/37/CE (législation relative aux machines). Ils sont destinés à être intégrés dans la machinerie faisant l'objet de ladite directive, mais ne doivent pas être mis en service tant que la machinerie en question ne sera pas déclarée conforme aux stipulations de la directive.

Manager of Engineering

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.

(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.

(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

GARANTÍA LIMITADA DE GOULDS PUMPS

Esta garantía es aplicable a todas las bombas para sistemas de agua fabricadas por Goulds Pumps.

Toda parte o partes que resulten defectuosas dentro del período de garantía serán reemplazadas sin cargo para el comerciante durante dicho período de garantía. Tal período de garantía se extiende por doce (12) meses a partir de la fecha de instalación, o dieciocho (18) meses a partir de la fecha de fabricación, cualquiera se cumpla primero.

Todo comerciante que considere que existe lugar a un reclamo de garantía deberá ponerse en contacto con el distribuidor autorizado de Goulds Pumps del cual adquiriera la bomba, y ofrecer información detallada con respecto al reclamo. El distribuidor está autorizado a liquidar todos los reclamos por garantía a través del Departamento de Servicios a Clientes de Goulds Pumps.

La presente garantía excluye:

(a) La mano de obra, el transporte y los costos relacionados en los que incurra el comerciante;
(b) los costos de reinstalación del equipo reparado;
(c) los costos de reinstalación del equipo reemplazado;
(d) daños emergentes de cualquier naturaleza; y
(e) el reembolso de cualquier pérdida causada por la interrupción del servicio.

A los fines de esta garantía, los términos "Distribuidor", "Comerciante" y "Cliente" se definen como sigue:

(1) "Distribuidor" es aquel individuo, sociedad, corporación, asociación u otra entidad jurídica que opera entre Goulds Pumps y el comerciante para la compra, consignación o contratos de venta de las bombas en cuestión.

(2) "Comerciante" es todo individuo, sociedad, corporación, asociación u otra entidad jurídica que realiza negocios de venta o alquiler-venta (leasing) de bombas a clientes.

(3) "Cliente" es toda entidad que compra o que adquiere bajo la modalidad de leasing las bombas en cuestión de un comerciante. El término "cliente" puede significar un individuo, una sociedad, una corporación, una sociedad de responsabilidad limitada, una asociación o cualquier otra entidad jurídica con actividades en cualquier tipo de negocios.

LA PRESENTE GARANTÍA SE EXTIENDE AL COMERCIANTE ÚNICAMENTE

GARANTIE LIMITÉE DE GOULDS PUMPS

La présente garantie s'applique à chaque pompe de système d'alimentation en eau fabriquée par Goulds Pumps.

Toute pièce se révélant défectueuse sera remplacée sans frais pour le détaillant durant la période de garantie suivante expirant la première : douze (12) mois à compter de la date d'installation ou dix-huit (18) mois à partir de la date de fabrication.

Le détaillant qui, aux termes de la présente garantie, désire effectuer une demande de règlement doit s'adresser au distributeur Goulds Pumps agréé chez lequel la pompe a été achetée et fournir tous les détails à l'appui de sa demande. Le distributeur est autorisé à régler toute demande par le biais du service à la clientèle de Goulds Pumps.

La garantie ne couvre pas :

a) les frais de main-d'œuvre ou de transport ni les frais connexes encourus par le détaillant ;
b) les frais de réinstallation de l'équipement réparé ; c) les frais de réinstallation de l'équipement de remplacement ;
d) les dommages indirects de quelque nature que ce soit ; e) ni les pertes découlant de la panne.

Aux fins de la garantie, les termes ci-dessous sont définis comme suit :

1) « Distributeur » signifie une personne, une société de personnes, une société de capitaux, une association ou autre entité juridique servant d'intermédiaire entre Goulds Pumps et le détaillant pour les achats, les consignations ou les contrats de vente des pompes en question.

2) « Détaillant » veut dire une personne, une société de personnes, une société de capitaux, une association ou autre entité juridique dont les activités commerciales sont la vente ou la location de pompes à des clients.

3) « Client » signifie une entité qui achète ou loue les pompes en question chez un détaillant. Le « client » peut être une personne, une société de personnes, une société de capitaux, une société à responsabilité limitée, une association ou autre entité juridique se livrant à quelque activité que ce soit.

LA PRÉSENTE GARANTIE SE RAPPORTE AU DÉTAILLANT SEULEMENT.

GOULDS PUMPS

Goulds Pumps

ITT Industries

ITT

Residential Water Systems

Goulds Pumps

33GS, 40GS, 55GS, 60GS, 75GS, 80GS

REPAIR PARTS

60 Hz High Capacity 4" Submersible pumps

GOULDS PUMPS

Goulds Pumps is a brand of ITT Residential and
Commercial Water.

www.goulds.com

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GOULDS PUMPS
Residential Water Systems

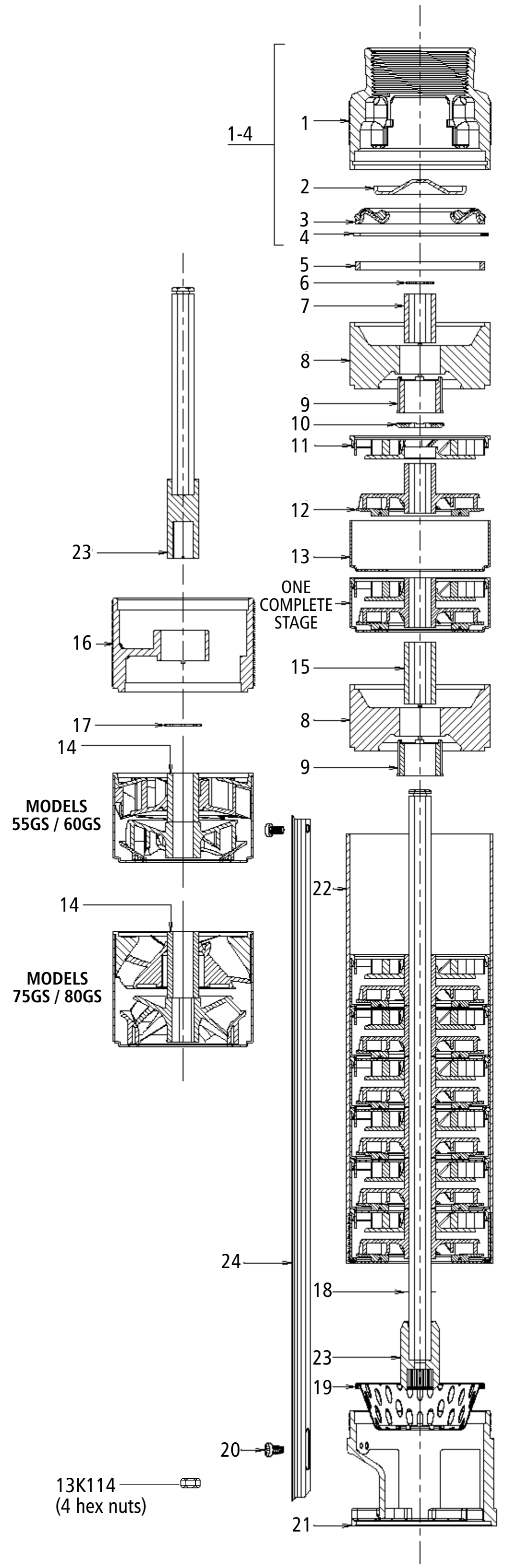
Item No.	Description			Current 4-TEP Models					
			HP	33GS	40GS	55GS	60GS	75GS	80GS
	Number of stages		1	6	—	—	—	—	—
			1½	8	5	5	4	—	—
			2	10	6	7	5	—	—
			3	14	8	9	7	7	5
			5	22 ①	14	15 ①	11 ①	11	9
			7½	34 ②	21 ①	22 ②	17 ①	16	14
			10	44 ②	—	29 ②	—	21 ②	—
1 - 4	Discharge head assembly			7K2841	7K2841	7K2841	7K2841	7K2841	7K2841
2	Check valve poppet			7K1366	7K1366	7K1366	7K1366	7K1366	7K1366
3	Check valve seal and seat assembly			7K2123	7K2123	7K2123	7K2123	7K2123	7K2123
4	Check valve retaining ring			7K1364	7K1364	7K1364	7K1364	7K1364	7K1364
5	Adapter ring			7K1597	7K1597	7K1597	7K1597	7K1597	7K1597
6	Shaft retaining ring			7K817	7K817	7K817	7K817	7K817	7K817
7	Upper Shaft sleeve			7K1571	7K1571	7K1571	7K1571	7K1571	7K1571
8	Bearing spider (upper & some int.) ①			7K1593	7K1593	7K1593	7K1593	—	—
9	Bearing ① ②			7K2756	7K2756	7K2756	7K2756	7K2756	7K2756
10	Upthrust washer			7K1575	7K1575	7K1575	7K1575	7K1575	7K1575
11	Diffuser			7K1590	7K1590	7K1591	7K1591	7K1592	7K1592
12	Impeller			7K1739	7K1587	7K1779	7K1588	7K1787	7K1589
13	Bowl			7K1584	7K1584	7K1585	7K1585	7K1586	7K1586
14	Diffuser shaft sleeve			—	—	7K1571	7K1571	7K1573	7K1573
15	Intermediate shaft sleeve ①			7K1572	7K1572	7K1572	7K1572	—	—
16	Intermediate bearing spider ②			7K2246	—	7K2246	—	7K2246	—
17	Lower shaft retaining ring ②			7K1629	—	7K1629	—	7K1629	—
18	Shim			7K1574	7K1574	7K1574	7K1574	7K1574	7K1574
19	Stainless steel strainer			7K1370	7K1370	7K1370	7K1370	7K1370	7K1370
20	Cable guard screws			13K91	13K91	13K91	13K91	13K91	13K91
21	Motor adapter			7K1363	7K1363	7K1363	7K1363	7K1363	7K1363
22	Casings		1	7K2082	—	—	—	—	—
			1½	7K2912	7K2912	7K2923	7K2675	—	—
			2	7K2888	7K2716	7K2721	7K2923	—	—
			3	7K2022	7K2912	7K2327	7K2340	7K2733	7K1636
			5	7K2913	7K2022	7K2924	7K2931	7K2936	7K2939
		Upper	7½	7K2328	7K2916	7K2332	7K2932	7K2937	7K2940
		Lower	7½	7K2983		7K2335			
		Upper	10	7K2984	—	7K2331	—	7K2333	—
		Lower	10	7K2011		7K2925		7K2938	
23	Shaft and coupling assemblies		1	7K1605	—	—	—	—	—
			1½	7K1606	7K1610	7K1662	7K1661	—	—
			2	7K1768	7K1605	7K1663	7K1662	—	—
			3	7K1631	7K1606	7K1784	7K1663	7K1631	7K1648
			5	7K1769	7K1631	7K1785	7K1664	7K1689	7K1649
		Upper	7½	7K2269	7K1611	7K2262	7K1665	7K1871	7K1650
		Lower	7½	7K2303		7K2301			
		Upper	10	7K2275	—	7K2276	—	7K2277	—
		Lower	10	7K2311		7K2310		7K2309	
24	Cable guards		1	7K2763	—	—	—	—	—
			1½	7K1891	7K2228	7K2233	7K2229	—	—
			2	7K1414	7K2763	7K2677	7K2233	—	—
			3	7K2906	7K1891	7K1923	7K2677	7K2777	7K2900
			5	7K1635	7K2906	7K2851	7K1423	7K2762	7K1927
			7½	7K1721	7K2908	7K2758	7K2761	7K2764	7K2773
			10	7K2679	—	7K2759	—	7K2765	—

① Indicates model with one intermediate bearing spider.

② Indicates model with split cases and shafts.

ITT

GOULDS PUMPS
Residential Water Systems



ITT

Residential Water Systems

GOULDS PUMPS

R33-80GS August, 2006

Engineered for life

ITT

Residential Water Systems

Goulds Pumps

33GS, 40GS, 55GS, 60GS, 75GS, 80GS

60 Hz High Capacity
4" Submersible Pumps

GOULDS PUMPS

Goulds Pumps is a brand of ITT
Residential and Commercial Water.

www.goulds.com

Engineered for life

FEATURES

- **Powered for Continuous Operation:** All ratings are within the working limits of the motor as recommended by the motor manufacturer. Pump can be operated continuously without damage to the motor.
- **Field Serviceable:** Units have left hand threads and are field serviceable with common tools and readily available repair parts.
- **Sand Handling Design:** Our face clearance, floating impeller stack has proven itself for over 40 years as a superior sand handling, durable pump design.
- **FDA Compliant Non-Metallic Parts:** Impellers, diffusers and bearing spiders are constructed of glass filled engineered composites. They are corrosion resistant and non-toxic.
- **Discharge Head/Check Valve:** Cast 303 stainless steel for strength and durability. Two cast-in safety line loops for installer convenience. The built-in check valve is constructed of stainless steel and FDA compliant BUNA rubber for abrasion resistance and quiet operation.
- **Motor Adapter:** Cast 303 stainless steel for rigid, accurate alignment of pump and motor. Easy access to motor mounting nuts using standard open end wrench.
- **Stainless Steel Casing:** Polished stainless steel is strong and corrosion resistant.
- **Hex Shaft Design:** Six sided shafts for positive impeller drive.
- **Engineered Polymer Bearings:** The proprietary, engineered polymer bearing material is strong and resistant to abrasion and wear. The upper bearing is mounted in a durable engineered composite bearing spider for excellent abrasion resistance.

WATER END DATA

Series	Model	Required H.P.	Stages	Water End Length (in)	Water End Wt (lbs)
33GS	33GS10	1	6	14.2	8
	33GS15	1.5	8	16.6	9
	33GS20	2	10	19.1	10
	33GS30	3	14	24	13
	33GS50	5	22	35.2	19
	33GS75	7.5	34	50.6	27
	33GS100	10	44	62.8	33
40GS	40GS15	1.5	5	12.9	8
	40GS20	2	6	14.2	8
	40GS30	3	8	16.6	9
	40GS50	5	14	24.0	13
	40GS75	7.5	21	34.0	18
55GS	55GS15	1.5	5	17.1	10
	55GS20	2	7	21.2	12
	55GS30	3	9	25.3	15
	55GS50	5	15	39.1	22
	55GS75	7.5	22	54.1	32
	55GS100	10	29	98.4	39
60GS	60GS15	1.5	4	15.0	8
	60GS20	2	5	17.1	9
	60GS30	3	7	21.2	10
	60GS50	5	11	30.9	14
	60GS75	7.5	17	43.2	19
75GS	75GS30	3	7	24.1	14
	75GS50	5	11	34.8	19
	75GS75	7.5	16	48.2	27
	75GS100	10	21	63.8	35
80GS	80GS30	3	5	21.4	10
	80GS50	5	9	29.4	13
	80GS75	7.5	14	42.8	24

NOMENCLATURE

See price book for complete order numbers.

33 GS 20 4 1 2 (C)

GPM at Best Efficiency — 33, 40, 55, 60, 75, 80

GS Pump Series

Horsepower Code
15 = 1½
20 = 2
30 = 3
50 = 5
75 = 7½
100 = 10

4 = 4" Motor

Phase
1 = 1 Phase 3 Wire
2 = 1 Phase 2 Wire
3 = 3 Phase 3 Wire

Voltage
1 = 115 V
2 = 230 V
3 = 380 V
4 = 460 V
7 = 575 V

Blank = w/ F.E. Motor
C = CentriPro Motor

SPECIFICATIONS

Model	Flow Range GPM	Horse-power Range	Best Efficiency GPM	Discharge Connection	Minimum Well Size	Rotation①
33GS	10 – 50	1 – 10	33	2"	4"	CCW
40GS	20 – 65	1½ – 7½	40	2"	4"	CCW
55GS	20 – 80	1½ – 10	55	2"	4"	CCW
60GS	40 – 80	1½ – 7½	60	2"	4"	CCW
75GS	40 – 100	3 – 10	75	2"	4"	CCW
80GS	50 – 120	3 – 7½	80	2"	4"	CCW

① Rotation is counterclockwise when observed from pump discharge end.

"GS" SERIES MATERIALS OF CONSTRUCTION

Part Name	Material
Discharge Head	AISI 303 SS
Check Valve Poppet	AISI 304 SS
Check Valve Seal	BUNA, FDA compliant
Check Valve Seat	AISI 304 SS
Check Valve Retaining Ring	AISI 302 SS
Bearing Spider – Upper	Glass Filled Engineered Composite
Bearing	Proprietary Engineered Polymer
Klipring	AISI 301 SS
Diffuser	Lexan®
Impeller	Noryl®
Bowl	AISI 304 SS
Intermediate Sleeve*	AISI 304 SS, Powder Metal
Intermediate Shaft Coupling*	AISI 304 SS, Powder Metal
Intermediate Bearing Spider*	Glass Filled Engineered Composite
Intermediate Bearing Spider*	AISI 303 SS
Shim	AISI 304 SS
Screws – Cable Guard	AISI 304 SS
Motor Adapter	AISI 303 SS
Casing	AISI 304 SS
Shaft	
Coupling	AISI 304 SS, Powder Metal
Cable Guard	AISI 304 SS
Suction Screen	AISI 304 SS

*See repair parts for where used.

AGENCY LISTINGS

All factory assembled, complete pump/motor assemblies are UL778 and CSA listed. All pumps and motors comply with ANSI/NSF 61-1992. Motors are UL778 recognized.

Canadian Standards Association

Underwriters Laboratories

ANSI/NSF 61 - Drinking Water System Components 4P49

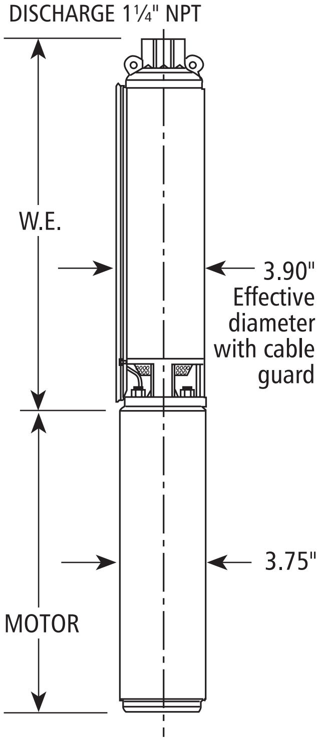
Goulds Pumps is ISO 9001 Registered.

CENTRIPRO 4" SINGLE-PHASE MOTORS

Order No.	Type	HP	Volts	Length (in)	Weight (lb)
M10422	2 Wire PSC	1	230	13.3	24.5
M15422		1.5	230	14.9	28.9
M10412	3 Wire	1	230	11.7	23.1
M15412		1.5	230	13.6	27.4

FRANKLIN ELECTRIC 4" SINGLE-PHASE MOTORS

Order No.	Type	HP	Volts	Length (in)	Weight (lb)
S06942	2 Wire SP	1	230	11.8	24
S07942		1.5	230	15.1	31
S06940	3 Wire	1	230	11.8	24
S07940		1.5	230	13.6	28
S08940		2	230	15.1	33
S09940		3	230	19.1	41
S09940HT		3	230	22.2	55
S10940		5	230	28.2	70



FRANKLIN ELECTRIC 4" THREE-PHASE MOTORS

Order No.	HP	Volts	Length (in)	Weight (lb)
S06978	1	200	11.8	24
S06970		230		
S06975		460		
S07978	1.5	200	11.8	24
S07970		230		
S07975		460		
S07979		575		
S08978	2	200	13.6	28
S08970		230		
S08975		460		
S08979		575		
S09978	3	200	16.1	35
S09970		230		
S09975		460		
S09979		575		
S09978HT	3 High Thrust	200	19.2	42
S09970HT		230		
S09975HT		460		
S09979HT		575		
S10978	5	200	22.2	55
S10970		230		
S10975		460		
S10979		575		
S119784	7.5	200	28.2	70
S119704		230		
S119754		460		
S129724	10	460	30.5	75

NEMA MOTOR

- Corrosion resistant stainless steel construction.
- Built-in surge arrestor is provided on single phase motors through 5 HP.
- Stainless steel splined shaft.
- Hermetically sealed windings.
- Replaceable motor lead assembly.
- UL 778 recognized.
- NEMA mounting dimensions.
- Control box is required with 3 wire single phase units.
- Three phase units require a magnetic starter with three leg protection. Magnetic starter and heaters must be ordered separately.

Model 33GS

SELECTION CHART

Horsepower Range 1 – 3, Recommended Range 10 – 50 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																										
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	520	560	600
33GS10	1	0		48	45	41	36	30	22	11																			
		20	44	39	34	28	19																						
		30	39	33	27	17																							
		40	32	25	15																								
		50	24	14																									
		60	12																										
Shut-off PSI			67	58	50	41	32	24	15	6																			
33GS15	1½	0		50	48	46	43	40	37	32	26	19																	
		20	48	45	43	39	35	31	24	17																			
		30	45	42	39	35	30	23	15																				
		40	42	38	34	29	22	14																					
		50	38	33	28	21	12																						
		60	33	27	20	11																							
Shut-off PSI			95	86	78	69	60	52	43	34	26	17																	
33GS20	2	0			49	48	46	44	41	38	35	32	28	22															
		20	49	47	45	43	40	38	34	31	26	21	14																
		30	47	45	42	40	37	34	30	25	20	13																	
		40	44	42	40	37	33	29	24	19	11																		
		50	42	39	36	33	29	24	18																				
		60	39	36	32	28	23	16																					
Shut-off PSI			121	112	103	95	86	77	69	60	51	43	34	26															
33GS30	3	0				49	48	46	45	43	41	40	38	35	33	31	28	24	20	15									
		20	50	49	47	46	44	43	41	39	37	35	32	30	27	23	19	13											
		30	49	47	46	44	42	41	39	37	34	32	29	26	22	18	12												
		40	47	45	44	42	40	38	36	34	32	29	25	22	17	11													
		50	45	44	42	40	38	36	34	31	28	25	21	16															
		60	43	42	40	38	36	33	31	28	24	20	15																
Shut-off PSI			170	161	152	144	135	126	118	109	100	92	83	74	66	57	48	40	31	23									

Horsepower Range 5-10, Recommended Range 10 – 50 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																										
			50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350
33GS50	5	0		50	48	46	44	41	38	35	31	27	20	11															
		20	50	48	46	44	41	38	35	32	27	21	11																
		30	49	47	45	43	40	37	34	30	25	17																	
		40	48	46	44	41	39	36	32	27	21	12																	
		50	47	45	43	40	37	34	30	25	18																		
		60	46	44	42	39	36	32	28	22	13																		
Shut-off PSI			264	242	220	199	177	156	134	112	91	69	47	26															
33GS75	7½	0				50	48	47	46	44	42	40	38	36	33	31	27	23	19	14									
		20			50	49	47	46	44	42	41	38	36	34	31	28	24	19	14										
		30		50	49	48	46	45	43	42	40	37	35	32	29	26	22	17	12										
		40		50	49	47	46	44	43	41	39	36	34	31	28	24	20	15											
		50		49	48	47	45	43	42	40	38	35	33	30	26	22	17	12											
		60	50	49	47	46	44	43	41	39	37	34	31	28	24	20	15												
Shut-off PSI			415	393	371	350	328	306	285	263	241	220	198	176	155	133	111	90	68	47									
33GS100	10	0							49	48	46	45	43	42	41	40	39	38	36	34	31	28	25	22	18	13			
		20						50	48	46	45	43	42	41	40	39	38	36	34	31	29	25	22	18	14				
		30						49	47	45	44	43	42	41	40	38	37	35	33	30	27	24	20	16	12				
		40					50	48	46	45	44	43	42	40	39	38	36	34	32	29	26	22	18	14					
		50					49	47	45	44	43	42	41	40	39	37	35	33	30	27	24	20	16	12					
		60				50	48	46	45	44	43	42	41	39	38	36	34	32	29	26	22	19	14						
Shut-off PSI			551	529	508	486	464	443	421	399	378	356	334	313	291	269	248	226	205	183	161	140	118	96	75	53			

Model 40GS

SELECTION CHART

Horsepower Range 1½ – 7½, Recommended Range 20 – 65 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																									
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	440	480	520	560	600	640
40GS15	1½	0		65	59	53	46	35																				
		20	58	51	43	31																						
		30	50	41	28																							
		40	40	25																								
		50	22																									
		60																										
Shut-off PSI			57	49	40	31	23	14																				
40GS20	2	0			63	58	53	47	38	25																		
		20	61	57	51	44	35																					
		30	56	50	43	33																						
		40	49	42	31																							
		50	40	29																								
		60	26																									
Shut-off PSI			71	62	53	45	36	27	19	10																		
40GS30	3	0				63	59	56	51	47	41	33	20															
		20	65	62	58	54	50	45	38	32	30																	
		30	61	58	54	49	44	37	28																			
		40	57	53	48	43	36	26																				
		50	52	48	42	35	24																					
		60	47	41	33	21																						
Shut-off PSI			97	88	80	71	62	54	45	36	28	19	10															
40GS50	5	0						65	64	62	60	58	56	53	51	48	45	42	38	33	26							
		20				65	63	61	59	57	55	52	50	47	44	41	36	31	23									
		30			64	63	61	59	57	54	52	50	47	44	40	36	30	21										
		40		64	62	60	58	56	54	52	49	46	43	39	35	29	20											
		50	64	62	60	58	56	54	51	49	46	43	39	34	28													
		60	62	60	58	56	53	51	48	45	42	38	33	26														
Shut-off PSI			178	169	161	152	143	135	126	117	109	100	91	83	74	65	57	48	39	31	22							
40GS75	7½	0										65	64	63	62	61	60	59	57	56	54	53	49	44	38	30		
		20								65	64	63	62	61	59	58	57	55	54	52	50	48	43	37	28			
		30							65	64	63	62	61	59	58	57	55	53	52	50	48	45	40	32	22			
		40						65	64	63	62	60	59	58	56	55	53	51	49	47	45	42	36	27				
		50					65	64	62	61	60	59	58	56	55	53	51	50	47	45	42	39	31	20				
		60			65	64	63	62	61	60	59	57	56	54	53	51	49	47	44	41	38	35	25					
Shut-off PSI			271	263	254	245	237	228	219	211	202	194	185	176	168	159	150	142	133	124	116	107	90	72	55	38		

Model 55GS

SELECTION CHART

Horsepower Range 1½ – 5, Recommended Range 20 – 80 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																								
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500
55GS15	1½	0	78	71	64	54	42	24																			
		20	61	51	37																						
		30	49	35																							
		40	32																								
		50																									
		60																									
Shut-off PSI			52	43	35	26	17	9																			
55GS20	2	0		76	71	65	58	50	41	28																	
		20	69	63	56	48	37	24																			
		30	62	55	46	35	21																				
		40	54	45	34																						
		50	43	32																							
		60	29																								
Shut-off PSI			76	67	58	50	41	32	24	15																	
55GS30	3	0		80	76	72	68	63	58	52	44	35															
		20	75	71	67	62	56	49	42	32																	
		30	70	66	61	55	48	40	30																		
		40	65	60	54	47	39	28																			
		50	59	53	46	37	26																				
		60	52	45	36	25																					
Shut-off PSI			102	94	85	76	68	59	50	42	33	24															
55GS50	5	0				80	78	76	73	71	68	65	62	58	55	50	46	40	34	27							
		20		80	77	75	73	70	67	64	61	57	53	49	44	39	32	25									
		30	79	77	75	72	70	67	64	60	57	53	48	43	38	31	24										
		40	77	74	72	69	66	63	60	56	52	47	42	37	30	23											
		50	74	71	69	66	63	59	55	51	47	42	36	29	22												
		60	71	68	65	62	59	55	51	46	41	35	28	20													
Shut-off PSI			178	169	161	152	143	135	126	117	109	100	91	83	74	65	57	48	39	31							

Horsepower Range 7½ – 10, Recommended Range 20 – 80 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																								
			20	60	100	140	180	220	260	300	340	380	420	460	500	540	580	620	660	700	740	780	820	860	900	940	980
55GS75	7½	0			79	76	73	70	66	62	58	52	46	39	31	22											
		20		78	76	73	69	66	61	57	52	45	38	30	20												
		30	80	77	74	71	67	63	59	54	48	41	33	24													
		40	78	75	72	69	65	61	56	51	44	37	28														
		50	76	73	70	67	63	58	53	47	40	32	23														
		60	75	72	68	64	60	55	50	43	36	27															
Shut-off PSI			261	243	226	209	191	174	157	139	122	105	88	70	53	36											
55GS100	10	0			80	78	76	75	73	71	68	66	63	60	56	51	47	41	35	28							
		20		80	78	76	74	73	70	68	65	62	59	55	51	46	40	33	26								
		30		79	77	75	73	71	69	67	64	61	57	53	48	42	36	29	22								
		40	79	78	76	74	72	70	68	65	62	59	55	50	45	39	32	25									
		50	78	77	75	73	71	69	66	63	60	56	52	47	42	35	28	21									
		60	77	76	74	72	70	67	65	61	58	54	49	44	38	31	24										
Shut-off PSI			353	336	319	301	284	267	250	232	215	198	180	163	146	128	111	94	76	59							

Model 60GS

SELECTION CHART

Horsepower Range 1½ – 7½, Recommended Range 40 – 80 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																							
			20	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**320**	**340**	**360**	**380**	**400**	**420**	**440**	**460**	**480**
60GS15	1½	**0**		75	64	51																				
		20	60	47																						
		30	44																							
		40																								
		50																								
		60																								
Shut-off PSI			45	36	28	19																				
60GS20	2	**0**			73	63	52																			
		20	70	60	48																					
		30	58	46																						
		40	44																							
		50																								
		60																								
Shut-off PSI			58	50	41	32	24	15	6																	
60GS30	3	**0**				77	70	62	54	45																
		20		74	67	59	51	42																		
		30	73	66	58	50	40																			
		40	65	57	48																					
		50	56	47																						
		60	45																							
Shut-off PSI			86	77	68	60	51	42	34	25																
60GS50	5	**0**							75	70	65	60	55	49	43											
		20					73	69	64	59	53	47	41													
		30				73	68	63	58	52	47	40														
		40		76	72	67	62	57	52	46	39															
		50	76	71	66	62	56	51	45	38																
		60	70	66	61	55	50	44																		
Shut-off PSI			140	131	123	114	105	97	88	79	71	62	53	45	36											
60GS75	7½	**0**											78	75	72	69	66	62	59	55	51	47	42			
		20								80	77	74	71	68	65	61	58	54	50	46	41					
		30							80	77	74	71	68	64	61	57	53	49	45	40						
		40						79	76	73	70	67	64	60	56	52	48	44	40							
		50					79	76	73	70	67	63	60	56	52	48	43									
		60				78	76	73	69	66	63	59	55	51	47	43										
Shut-off PSI			224	215	207	198	189	181	172	163	155	146	137	129	120	111	103	94	85	77	68	59	51			

Model 75GS

SELECTION CHART

Horsepower Range 3 – 10, Recommended Range 40 – 100 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																									
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520
75GS30	3	0					80	67	52																			
		20			77	63	47																					
		30		75	61	45																						
		40	73	58	42																							
		50	56	39																								
		60	37																									
Shut-off PSI			77	69	60	51	43	34	25																			
75GS50	5	0							90	83	75	65	55	44														
		20						80	72	62	51	41																
		30					79	70	60	50																		
		40				78	69	59	48																			
		50			77	67	57	47																				
		60		75	66	55	45																					
Shut-off PSI				120	111	102	94	85	76	68	59	50	42	33														
75GS75	7½	0													80	75	68	61	54	47	40							
		20											79	73	66	59	52	45										
		30										78	72	65	58	51	44											
		40									77	71	64	57	50	43												
		50								76	70	63	56	49	42													
		60							75	69	62	55	48	41														
Shut-off PSI									146	137	129	120	111	103	94	85	77	68	59	51	42							
75GS100	10	0												100	97	95	92	88	85	81	76	72	67	62	56	51	45	40
		20										99	96	94	91	87	84	79	75	70	65	60	55	49	44			
		30									99	96	94	91	87	83	79	74	69	64	59	54	48	43				
		40								98	96	93	90	86	82	78	74	69	64	58	53	48	42					
		50							98	95	92	89	86	82	77	73	68	63	57	52	47	41						
		60					100	97	95	92	89	85	81	77	72	67	62	57	51	46	40							
Shut-off PSI			272	263	254	246	237	228	220	211	202	194	185	176	168	159	150	142	133	124	116	107	98	90	81	72	64	55

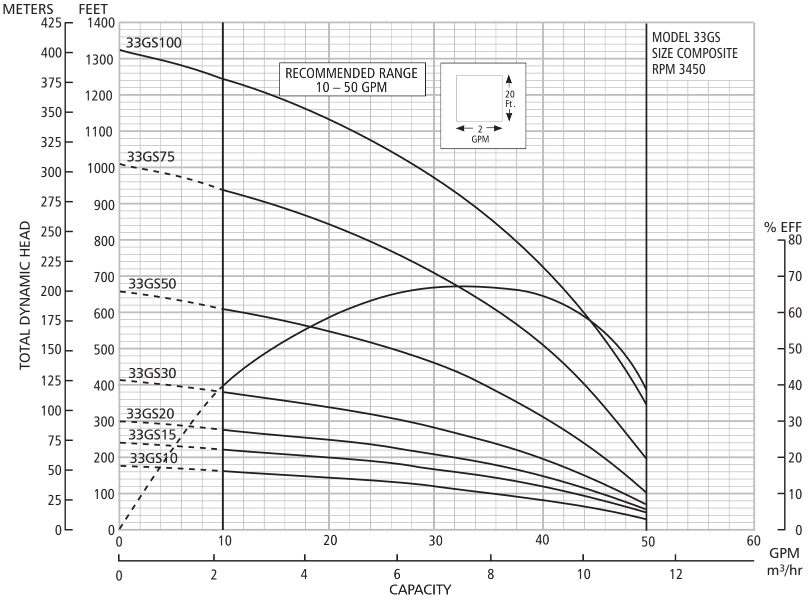
Model 80GS

SELECTION CHART

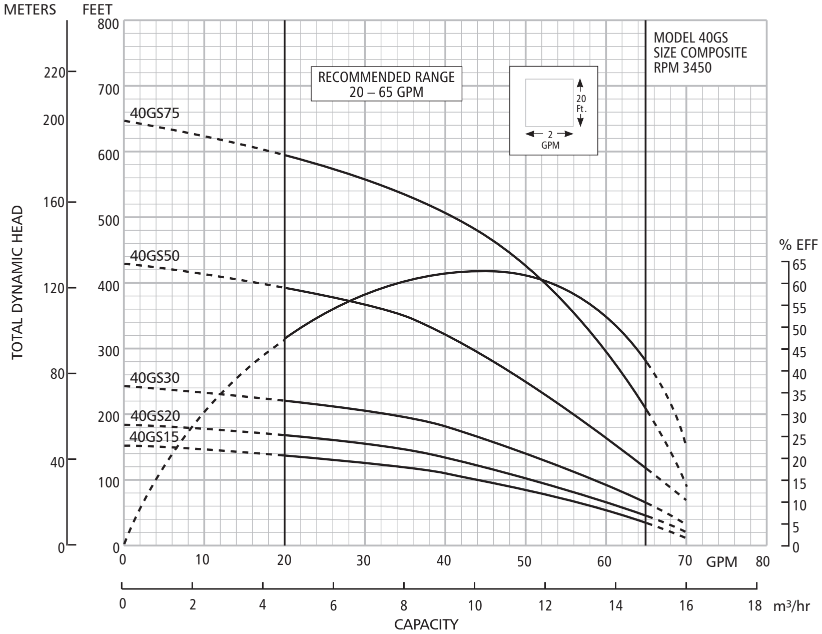
Horsepower Range 3 – 7½, Recommended Range 50 – 120 GPM, 60 Hz, 3450 RPM

Pump Model	HP	PSI	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																							
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480
80GS30	3	0		114	100	82	63																			
		20	94	77	57																					
		30	74	53																						
		40	50																							
		50																								
		60																								
Shut-off PSI			55	46	38	29	20																			
80GS50	5	0				115	106	98	89	79	68	55														
		20	120	112	104	95	86	75	64	51																
		30	111	102	94	84	74	62																		
		40	101	92	83	72	60																			
		50	91	81	70	58																				
		60	79	69	56																					
Shut-off PSI			107	98	90	81	72	64	55	46	38	29														
80GS75	7½	0						118	113	107	101	95	89	82	75	68	60									
		20			122	117	111	105	100	93	87	80	73	66												
		30		121	116	110	105	99	92	86	79	72	65													
		40	120	115	109	104	98	91	85	78	71	63														
		50	114	109	103	97	90	84	77	70	62															
		60	108	102	96	89	83	76	69	61																
Shut-off PSI			171	162	153	145	136	127	119	110	101	93	84	75	67	58	49									

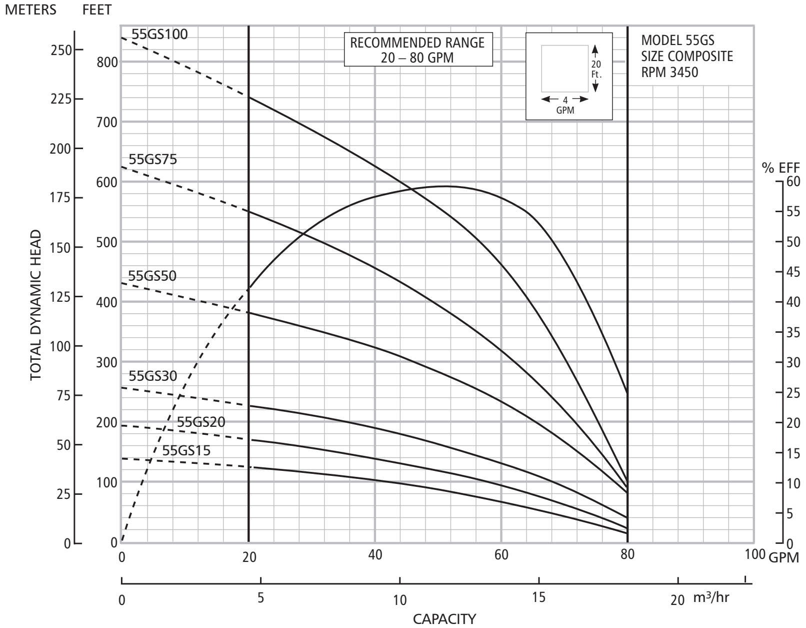
Model 33GS



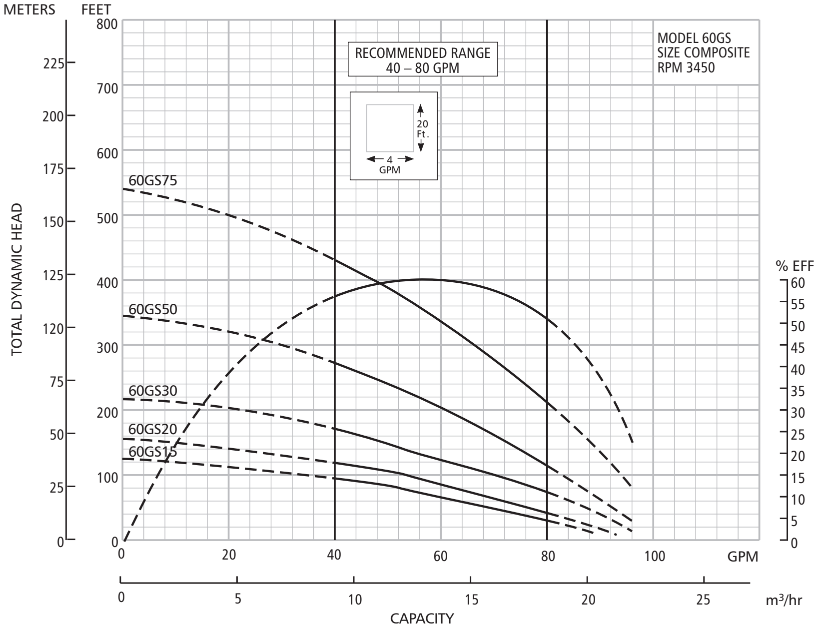
Model 40GS



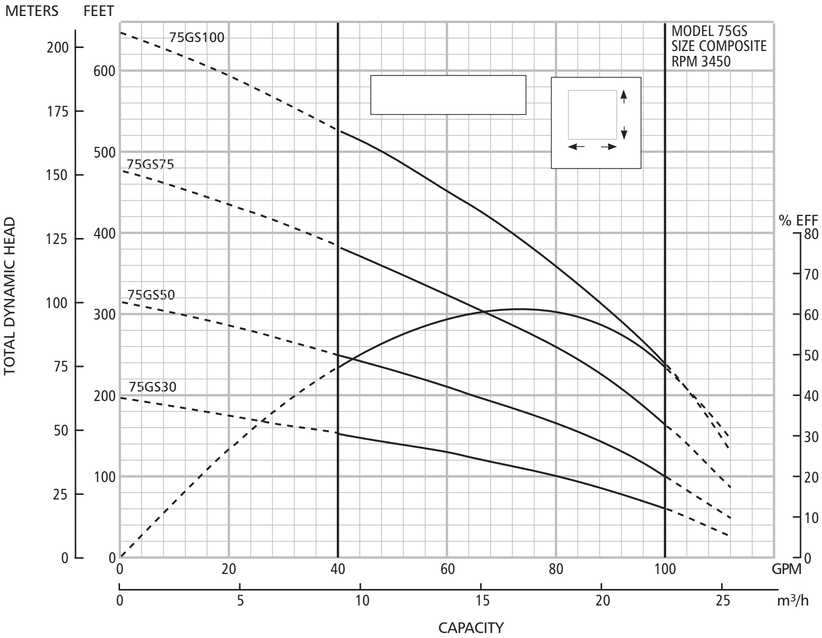
Model 55GS



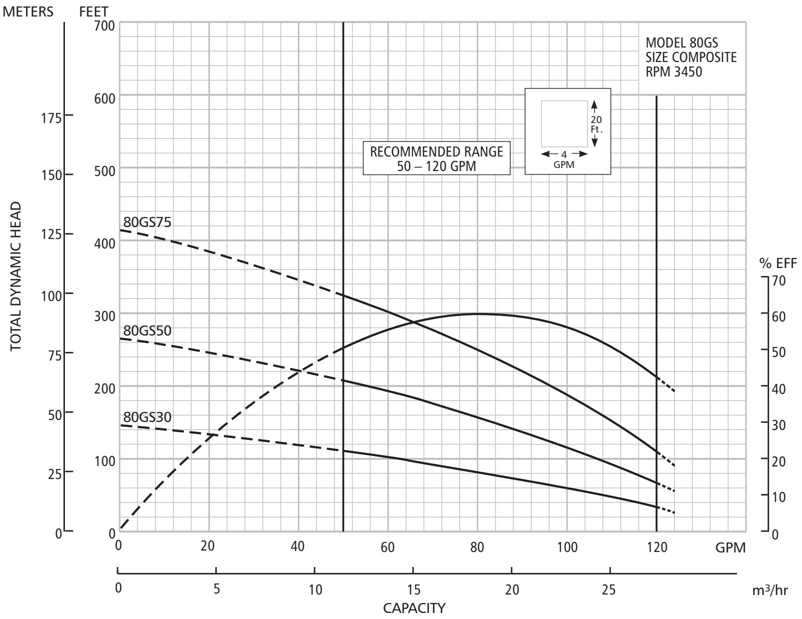
Model 60GS



Model 75GS



Model 80GS



ITT

Residential Water Systems

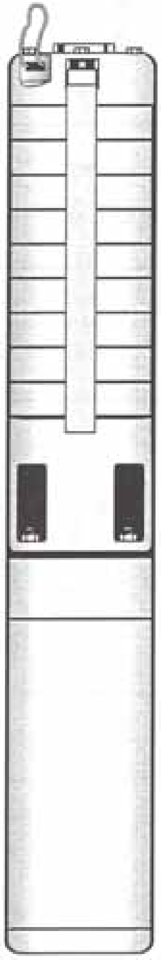
GOULDS PUMPS

B33-80GS July, 2006

Engineered for life

CS-MW16-CC PUMP SPECIFICATIONS

GRUNDFOS



Kits List

4" Submersibles

Contents

Kits List

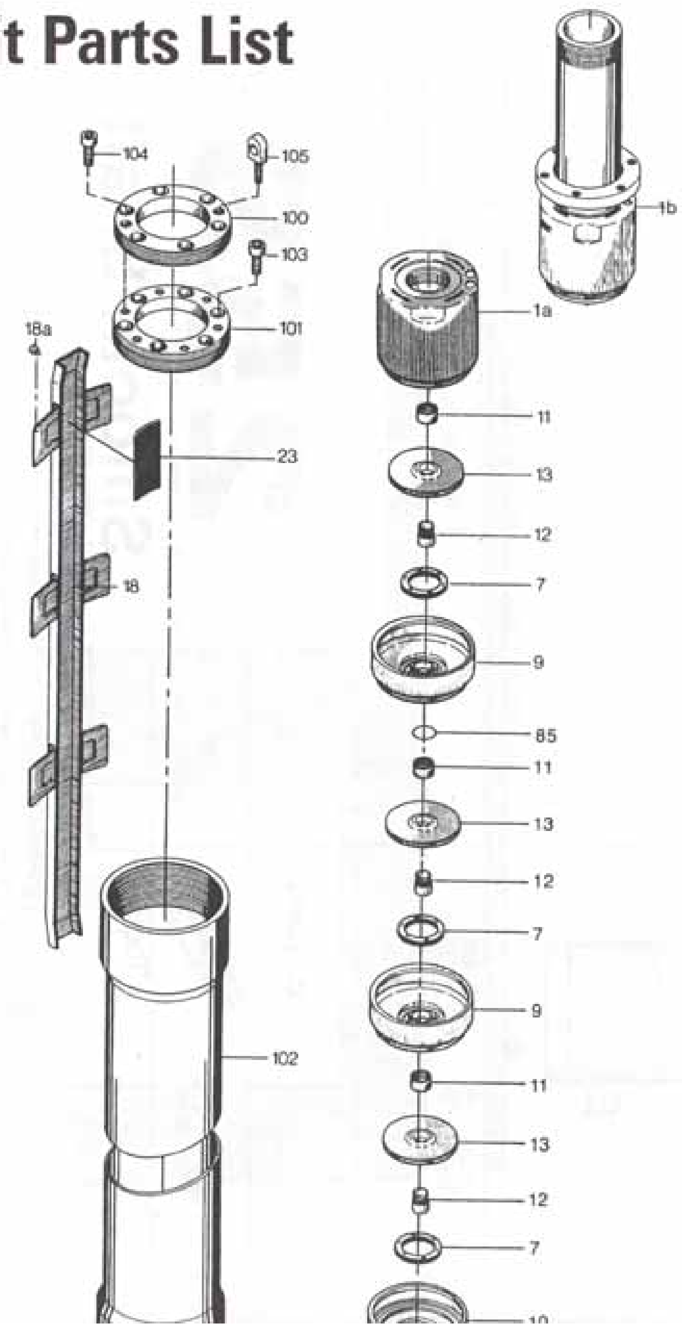
Tools

25S

Smooth Shaft

LSP-KL-0055 (Rev. 5/95)

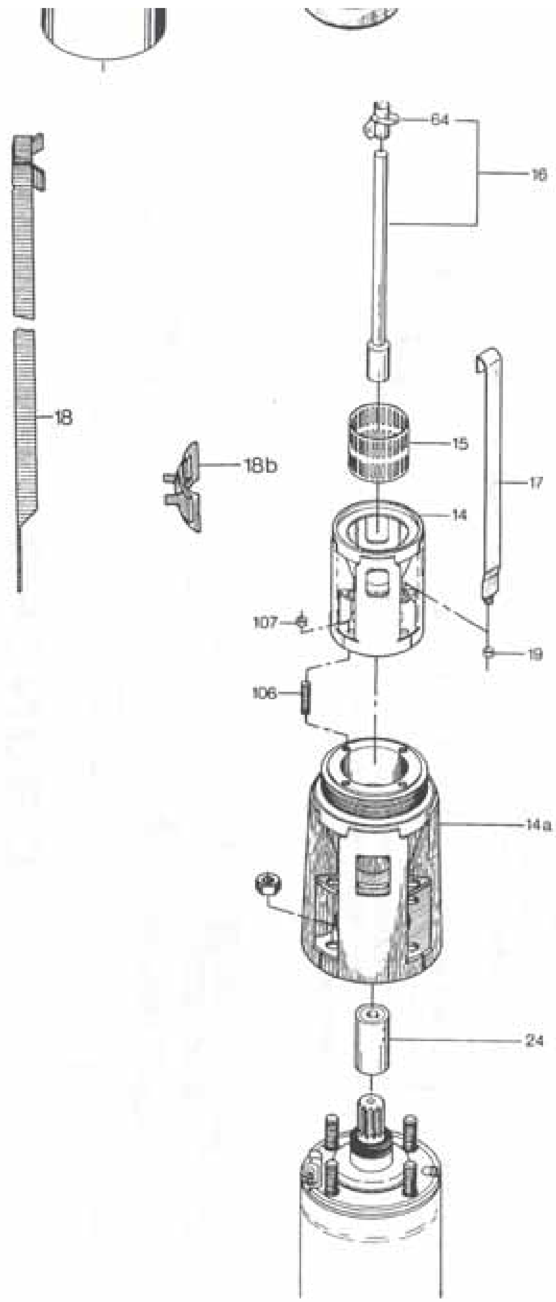
Kit Parts List



25S SMOOTH SHAFT

GRUNDFOS
"Leaders in Pump Technology"

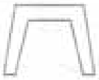
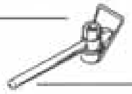
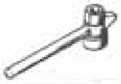
POS.	DESCRIPTION	QTY	PART #	KIT
	INLET/DISCHARGE KIT			***INLET/DISCHARGE KIT*** ***Part No. 05003Z***
1a	H/P TOP PIECE W/CHECK VALVE	1	105015	
14	4"X6" INLET	1	115038	
10	CHAMBER LOWER INT	1	095004	
15	STRAINER	1	090017	
	INLET/DISCHARGE SLEEVE KIT			***INLET/DISCHARGE KIT*** 52 STAGES 6" ***Pn. 05004Z***
1b	DISCHARGE W /PIPE	1	105020	
10	CHAMBER LOWER INT.	1	095004	
14a	INLET W/ CONN. PIECE 6"	1	115031	
14	INLET 4"	1	115023	
15	STRAINER	1	090017	
	BEARING KIT			***BEARING KIT*** 39 STAGES ***Pn. 08006Z*** 52 STAGES ***Pn. 08008Z***
85	UPTHRUST WASHER	3	100090	
7	SEAL RINGS (NBR)	SEE KIT	095006	
	IMPELLER KIT			***IMPELLER KIT*** 39 STAGES ***Pn. 05008Z*** 52 STAGES ***Pn. 05009Z***
13	IMPELLER	SEE KIT	055002	
19	NUT FOR STRAP	4	ID7187	
12	SPLIT CONE	SEE KIT	090012	
11	SPLIT CONE NUT	SEE KIT	095515	
	NUT KIT 6"	1	UB9001	
	CHAMBER KIT			***CHAMBER KIT*** 39 STAGES ***Pn. 05013Z*** 52 STAGES ***Pn. 05014Z***
9	INT. CHAMBERS	SEE KIT	055005	
19	NUT FOR STRAP	4	ID7187	
10	CHAMBER LOWER INT	1	095004	
	NUT KIT 6"	1	UB9001	
	25S75-39DS STRAP KIT			***STRAP KIT*** ***Part No. 08072Z***
17	STRAP	4	099039	
19	NUT FOR STRAP	4	ID7187	
18	CABLE GUARD	1	109339	
18b	CABLE GUARD CLIP	1	080509	
	25S100-52DS STRAP KIT			***STRAP KIT*** ***Part No.08075Z***
17	STRAP	4	119026	
19	NUT FOR STRAP	4	ID7187	
102	SLEEVE	1	108752	
100	TIGHT FLANGE COUNTER	1	110080	
101	TIGHT FLANGE	1	110081	
105	EYE BOLT	1	ID7389	
103/104	ALLEN SCREW	12	ID1368	
18a	CHEESE HD SCREW	6	ID1393	
18	CABLE GUARD	1	109052	



	SHAFT KIT			*SHAFT KIT*
16	25S75-39 SHAFT	1	106439	*Part No. 08044Z*
16	25S100-52DS SHAFT	1	106052	*Part No. 08046Z*
*	NUT KIT	1	UB9011	
24	COUPLING	1	795939	

Special Tool Kits

(Tools not generally available from normal sources)

Part Number	Description	
96022539	**Tool Kit: 5S-75S Model Pumps**	
ID1204	Tool Kit Includes: ALLEN WRENCH 6mm	
SV0006/ SV0007 SV0008 SV0009 SV0011	SHAFT SPACER 39.3mm SHAFT SPACER 38mm SHAFT SPACER 39mm SHAFT SPACER 41mm SHAFT SPACER 77mm	
SV0231 SV00211 SV00261	SHAFT SPACER 76mm SHAFT SPACER 77.5mm SHAFT SPACER 42.5mm	
SV0049	MOUNTING PLATE 4" & 6" MOTORS	
SV0054 SV0055	BOX/OPEN END WRENCH 19mm BOX/OPEN END WRENCH 13mm	
SV0074 SV0183	BOLT FOR SHAFT M8X65mm BOLT FOR SHAFT M8X110mm	
SV0114 SV0115	SHAFT HEIGHT GAUGE 4" MOTOR SHAFT HEIGHT GAUGE 6" MOTOR	
SV0182	SPLIT CONE NUT WRENCH 5S-25S	
SV0187 SV0217	SPLIT CONE NUT WRENCH 40S SPLIT CONE NUT WRENCH 60S-75S	
SV0226	SHAFT SPACER 43mm (SPLINE SHAFT MODELS)	
SV0280	SHAFT BEARING DRIVER KIT	
SV0288	SPECIAL KEY FOR SLEEVE MODELS	
SV0853	STRAP WRENCH	

* All tools may be purchased separately

96022537	TORQUE WRENCH KIT: 5S - 225S MODEL PUMPS (Kit includes three torque wrenches with fittings, range: 4Nm-200Nm)	

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GRUNDFOS
GROUNDWATER SERVICE MANUAL

Motors
4-6-8-10"

CONTENTS

BE > THINK > INNOVATE >

GRUNDFOS

4 Inch (Two Wire) Motors - *Control Box Not Required*

SINGLE PHASE

HP	Kw	Voltage	Service Factor	AMPERAGE Full Load*	AMPERAGE Service Factor	AMPERAGE Locked Rotor	Eff. %	Power Factor	Line-to-Line Resistance	KVA Code	Max. Thrust	Nameplate Number	GRUNDFOS MATERIAL NO.
1/3	.25	230	1.75	2.6	4.6	25.7	59	0.77	6.8-8.2	S	900	79952101	96465614
1/2	.37	115	1.60	7.5	12	55	62	0.76	1.1-1.3	R	900	79922102	96465574
		230	1.60	3.8	6	34.5	62	0.76	5.2-6.3	R	900	79952102	96465616
3/4	.55	230	1.50	5.6	8.4	40.5	62	0.75	3.2-3.8	N	900	79952103	96465618
1	.75	230	1.40	7.0	9.8	48.4	63	0.82	2.5-3.1	M	900	79952104	96465620
1 1/2	1.1	230	1.30	10.1	13.1	62	64	0.85	1.9-2.3	L	900	79952105	96465622

4 Inch (Three Wire) Motors

SINGLE PHASE

HP	Kw	Voltage	Service Factor	AMPERAGE Full Load*	AMPERAGE Service Factor	AMPERAGE Locked Rotor	Eff. %	Power Factor	Line-to-Line Resistance Black-Yellow	Line-to-Line Resistance Red-Yellow	KVA Code	Max. Thrust	Nameplate Number	GRUNDFOS MATERIAL NO.
1/3	.25	115	1.75	5.1	9	29	59	0.77	1.55-1.9	2.4-3	M	900	79423101	96465571
		230	1.75	2.6	4.6	14	59	0.77	6.8-8.3	17.3-21.1	L	900	79453101	96465603
1/2	.37	115	1.60	7.5	12	42.5	61	0.76	.9-1.1	1.9-2.35	L	900	79423102	96023039
		230	1.60	3.8	6	21.5	62	0.76	4.7-5.7	15.8-19.6	L	900	79453102	96465606
3/4	.55	230	1.50	5.6	8.4	31.4	62	0.75	3.2-3.9	14-17.2	L	900	79453103	96465608
1	.75	230	1.40	7.0	9.8	37	63	0.82	2.6-3.1	10.3-12.5	K	900	79453104	96465610
1 1/2	1.1	230	1.30	8.9	11.6	45.9	69	0.89	1.9-2.3	7.8-9.6	H	900	79453105	96465612
2	1.5	230	1.25	10.6	13.2	57	72	0.86	1.5-1.8	3.4-4.1	G	1500	79454506	96449947
3	2.2	230	1.15	14.8	17	77	74	0.93	1.2-1.4	2.45-3	F	1500	79454507	96449948
5	3.7	230	1.15	23.9	27.5	110	77	0.92	.65-.85	2.1-2.6	F	1500	79454509	96449949

4 Inch Motors

THREE PHASE

HP	Kw	Voltage	Service Factor	AMPERAGE Full Load*	AMPERAGE Service Factor	AMPERAGE Locked Rotor	Eff. %	Power Factor	Line-to-Line Resistance	KVA Code	Max. Thrust	Nameplate Number	GRUNDFOS MATERIAL NO.
1/2	.37	208	1.60	2.2	3.5	24.5	70	0.87	2.24	N	900	79322002	96465633
		230	1.60	2.0	3.15	15.7	69	0.72	8.1	N	900	79302002	96465624
		460	1.60	1.0	1.6	7.85	69	0.72	6.92	N	900	79362002	96465638
3/4	.55	208	1.50	3.4	5.1	24.5	69	0.7	4.6	N	900	79322003	96465634
		230	1.50	3.1	4.6	22.3	69	0.7	5.7	N	900	79302003	96465626
		460	1.50	1.5	2.3	11.2	69	0.7	23.2	N	900	79362003	96465639
1	.75	208	1.40	4.3	6	30	71	0.73	3.72	M	900	79322004	96465635
		230	1.40	3.9	5.4	27	71	0.73	4.7	M	900	79302004	96465627
		460	1.40	1.9	2.7	13.5	71	0.73	19	M	900	79362004	96465650
1 1/2	1.1	208	1.30	6.2	8.1	44.6	75	0.72	2.68	M	900	79322005	96465636
		230	1.30	5.6	7.3	40.3	75	0.72	3.12	M	900	79302005	96465629
		460	1.30	2.8	3.7	20.1	75	0.72	15.9	K	900	79362005	96465651
		575	1.30	2.2	2.9	16.1	75	0.72	25.2	K	900	79392005	–
2	1.5	208	1.25	7.7	9.6	53	77	0.75	1.9	L	900	79322006	96465637
		230	1.25	7.0	8.7	48	76	0.75	3	J	900	79302006	96465630
		460	1.25	3.5	4.4	24	76	0.75	12.1	J	900	79362006	96465652
		575	1.25	2.8	3.5	19.2	76	0.75	18.8	J	900	79392006	–
3	2.2	208	1.00	10.8	10.8	–	89	0.84	2.12	–	1500	79324507	96405806
		208/230	1.15	10.6	12.2	56	77	0.75	2.2	H	1500	79304507	96405801
		460	1.15	5.3	6.1	28	77	0.75	9	H	1500	79354507	96405810
		575	1.15	4.2	4.8	22	77	0.75	13	H	1500	79395507	–
5	3.7	208	1.15	18.1	20.8	–	80	0.82	1.2	–	1500	79324509	96405807
		208/230	1.15	17.2	19.8	108	80	0.82	1.2	H	1500	79304509	96405802
		440/460	1.15	8.6	9.9	54	80	0.82	5	H	1500	79354509	96405811
		575	1.15	6.9	7.9	54	80	0.82	7.3	H	1500	79394509	–
7 1/2	5.5	208/230	1.15	21.7	25	130	81	0.82	0.84	H	1500	79305511	96405805
		440/460	1.15	11.1	12.8	67	81	0.82	3.24	J	1500	79355511	96405814
		575	1.15	9.2	10.6	53	81	0.82	5.2	J	1500	79395511	–
10	7.5	440/460	1.15	15.7	18	90	81	0.80	1.16	H	1500	79355512	96440318
		575	1.15	12.5	14.4	72	81	0.80	1.84	H	1500	79395512	–

*This is a calculated value.

			FUSE(5)					OVERLOADS			
HP	Kw	Voltage	Fast Acting	Time Delay	Circuit Breaker	NEMA Starter Size	IEC Starter Size	Cutler Hammer (1)	Allen Bradley (2)	General Electric (3)	Siemens (4)

4 Inch (Two Wire) Motors - *Control Box Not Required*

SINGLE PHASE

1/3	.25	230	8	5	10	–	–	–	–	–	–
1/2	.37	115	25	15	20	–	–	–	–	–	–
		230	15	7	10	–	–	–	–	–	–
3/4	.55	230	20	10	15	–	–	–	–	–	–
1	.75	230	25	12	20	–	–	–	–	–	–
1 1/2	1.1	230	30	20	25	–	–	–	–	–	–

4 Inch (Three Wire) Motors

SINGLE PHASE

1/3	.25	115	15	9	15	–	–	–	–	–	–
		230	8	5	10	–	–	–	–	–	–
1/2	.37	115	25	15	20	–	–	–	–	–	–
		230	15	7	10	–	–	–	–	–	–
3/4	.55	230	20	10	15	–	–	–	–	–	–
1	.75	230	25	12	20	–	–	–	–	–	–
1 1/2	1.1	230	30	20	25	–	–	–	–	–	–
2	1.5	230	35	20	30	–	–	–	–	–	–
3	2.2	230	45	30	40	–	–	–	–	–	–
5	3.7	230	70	45	60	–	–	–	–	–	–

4 Inch Motors

THREE PHASE

1/2	.37	208	7	4	10	00	A	H2106B-3	J12	255A	K26
		230	6	3	10	00	A	H2106B-3	J11	232A	K24
		460	3	2	10	00	A	104	J4	193A	K21
3/4	.55	208	10	6	10	00	A	108	J17	420A	K32
		230	9	5	10	00	A	107	J16	380A	K29
		460	5	3	10	00	A	105	J8	174A	K21
1	.75	208	15	8	15	00	A	108	J19	510A	K34
		230	15	7	10	00	A	108	J18	463A	K33
		460	6	3	10	00	A	105	J10	232A	K23
1 1/2	1.1	208	20	15	20	00	A	109	J23	750A	K41
		230	20	10	15	00	A	109	J22	680A	K39
		460	9	5	10	00	A	107	J15	343A	K28
		575	7	4	10	00	A	106	J12	255A	K26
2	1.5	208	25	15	20	0	B	110	J25	910A	K43
		230	20	15	20	0	B	109	J24	825A	K43
		460	10	6	10	00	A	108	J17	420A	K32
		575	8	5	10	00	A	107	J15	343A	K28
3	2.2	208	40	25	35	0	C	111	J30	147B	K56
		208/230	35	20	30	0	C	110	J28	122B	K53
		460	20	9	15	0	A	109	J21	618A	K37
		575	15	7	10	0	A	108	J19	510A	K34
5	3.7	208	60	35	45	1	D	112	J34	220B	K61
		208/230	50	30	45	1	D	112	J33	199B	K60
		440/460	30	15	25	0	B	110	J26	100B	K50
		575	25	15	20	0	A	109	J24	825A	K43
7 1/2	5.5	208/230	65	40	60	1	E	112	J36	265B	K64
		440/460	35	20	30	1	C	111	J29	135B	K54
		575	30	20	25	1	B	110	J27	111B	K50
10	7.5	440/460	50	30	40	1	D	112	J32	181B	K60
		575	40	25	35	1	C	111	J30	147B	K56

Notes:

(1) These overloads are for both NEMA and IEC Freedom series starters by EATON Cutler-Hammer. The complete part number is H2_B-3. This information was collected from EATON Cutler-Hammer catalog number CA08102001E.

(2) These overload heater coils are for the Allen Bradley Bulletin 509 Starter. This information was collected from the Allen Bradley catalog number A115-CA001A-EN-P.

(3) These overloads are designed for use with GE NEMA starters. Complete part numbers are CR123L____. For use with GE CR124 single element overloads. This information was collected from page 1-107 of the Control Catalog, Rev. 07/03.

(4) These overloads are designed for Siemens NEMA Overload Relays. This information was collected from page 8/151 of the 2006 Siemens Industrial Control Catalog.

(5) The Fuses and Circuit Breakers were calculated from the NEC table 430.52.

Starters and overloads should always be sized by a licensed electrician that is familiar with local codes and standards. The overloads for submersible motors should be Class 10 Quick trip ambient compensated.

HP	Kw	Voltage	Service Factor	AMPERAGE			Eff %	Power Factor	Line-to-Line Resistance		KVA Code	Max. Thrust	Nameplate Number	GRUNDFOS MATERIAL NO.
				Calculated Full Load	Service Factor	Locked Rotor			Black-Yellow	Red-Yellow				

6 Inch (Three Wire) Motors

THREE PHASE

7 1/2	5.5	208/230	1.15	23.9/23.9	27.5/27.5	118.3/132	80.5	0.76	0.56		H	1500	78305511	96405781
		440/460	1.15	11.5	13.2/13.2	56.8/59.4	80.5	0.76	2.4		G	1500	78355511	96405794
		575	1.15	9.2	10.6	48	80.5	0.76	4.07		H	1500	78395511	–
10	7.5	208/230	1.15	31.7/30.9	36.5/35.5	153.3/170.4	82.5	0.79	0.41		H	1500	78305512	96405782
		440/460	1.15	15.1/14.8	17.4/17	74.8/78.2	82	0.79	1.8		G	1500	78355512	96405795
		575	1.15	11.8	13.6	63	82	0.79	3.1		G	1500	78395512	–
15	11	208/230	1.15	47/43.9	54/50.5	232.2/252.5	82.5	0.82	0.25		H	7000	78305514	96405783
		440/460	1.15	22.2/21.3	25.5/24.5	109.7/115.2	82.5	0.82	1.16		G	7000	78355514	96405796
		575	1.15	17.0	19.6	92	82.5	0.82	1.9		G	7000	78395514	–
20	15	208/230	1.15	60.9/58.7	70/67.5	329/364.5	84	0.81	0.2		J	7000	78305516	96405784
		440/460	1.15	29.1/28.7	33.5/33	164.2/171.6	84	0.82	0.8		H	7000	78355516	96405797
		575	1.15	23.0	26.4	137	84	0.82	1.32		H	7000	78395516	–
25	18.5	208/230	1.15	76.5/74.3	88/85.5	431.2/470.3	84.5	0.80	0.156		J	7000	78305517	96405785
		440/460	1.15	36.5/35.7	42/41	210/217.3	84.5	0.80	0.62		H	7000	78355517	96405798
		575	1.15	28.7	33	175	84.5	0.80	1.04		H	7000	78395517	–
30	22	208/230	1.15	87.8/84.3	101/97	464.6/514.1	85	0.83	0.13		H	7000	78305518	96405786
		440/460	1.15	41.7/40.4	48/46.5	225.6/237.2	85	0.83	0.55		G	7000	78355518	96405799
		575	1.15	32.2	37	189	84.5	0.83	0.92		G	7000	78395518	–
40	30	440/460	1.15	57.8/55.7	66.5/64	305.9/320	64	0.82	0.39		H	7000	78355520	96405800

*This is a calculated value.

6 Inch (Three Wire) Motors

THREE PHASE

HP	Kw	Voltage	FUSE(5)		Circuit Breaker	NEMA Starter Size	IEC Starter Size	OVERLOADS			
			Fast Acting	Time Delay				Cutler Hammer (1)	Allen Bradley (2)	General Electric (3)	Siemens (4)
7 ½	5.5	208/230	70	45	60	1	E	113	J36	293B	K64
		440/460	35	20	30	1	C	111	J29	135B	K55
		575	30	18	30	1	B	110	J27	111B	K50
10	7.5	208/230	90	60	80	2	F	114	J39	352B	K70
		440/460	45	30	40	1	D	112	J32	181B	K58
		575	35	20	30	1	C	111	J29	147B	K55
15	11	208/230	150	90	125	2	H	116	J42	593B	K75
		440/460	70	40	60	2	E	113	J35	265B	K63
		575	50	30	50	2	D	112	J33	199B	K60
20	15	208/230	200	110	150	3	J	117	J44	710B	K77
		440/460	90	50	80	2	F	114	J38	352B	K69
		575	70	40	60	2	E	113	J36	265B	K64
25	18.5	208/230	225	150	200	3	K	–	J70	950B	K85
		440/460	110	65	100	2	G	115	J39	464B	K72
		575	90	50	80	2	F	114	J38	352B	K69
30	22	208/230	300	150	225	3	L	–	J71	107C	K87
		440/460	125	75	110	3	H	–	J42	464B	K72
		575	100	55	80	3	G	–	J39	352B	K70
40	30	440/460	175	100	150	3	J	–	J44	710B	K77

Notes:

(1) These overloads are for both NEMA and IEC Freedom series starters by EATON Cutler-Hammer. The complete part number is H2_B-3. This information was collected from EATON Cutler-Hammer catalog number CA08102001E.

(2) These overload heater coils are for the Allen Bradley Bulletin 509 Starter. This information was collected from the Allen Bradley catalog number A115-CA001A-EN-P.

(3) These overloads ae designed for use with GE NEMA starters. Complete part numbers are CR123L____. For use with GE CR124 single element overloads. This information was collected from page 1-107 of the Control Catalog, Rev. 07/03.

(4) These overloads are designed for Siemens NEMA Overload Relays. This information was collected from page 8/151 of the 2006 Siemens Industrial Control Catalog.

(5) The Fuses and Circuit Breakers were calculated from the NEC table 430.52.

Starters and Overloads should always be sized by a licensed electrician that is familiar with local codes and standards. The Overloads for submersible motors should be Class 10 Quick trip ambient compensated.

				AMPERAGE									
HP	Kw	Voltage	Service Factor	Full Load*	Service Factor	Locked Rotor	Eff %	Power Factor	Line-to-Line Resistance	KVA Code	Max. Thrust	Nameplate Number	**GRUNDFOS MATERIAL NO.**

4 Inch Industrial Motors

THREE PHASE

3	2.2	230	1.15	9.9	11.4	–	78	0.81	2.08	J	1500	79305807	96415732
		460	1.15	5.0	5.7	–	78	0.81	8.00	J	1500	79355807	96415734
		575	1.15	4.0	4.55	–	78	0.81	12.00	J	1500	79395807	96415736
5	3.7	230	1.15	15.7	18	–	80.5	0.82	1.12	K	1500	79305809	96415733
		460	1.15	7.9	9.05	–	80.5	0.83	4.20	K	1500	79355809	96415735
		575	1.15	6.5	7.5	–	80.5	0.83	6.40	K	1500	79395809	96415737

6 Inch (Three Wire) Industrial Motors

THREE PHASE

7 1/2	5.5	230	1.15	23.9	27.5	457.25	77.5	0.82	0.477	K	4400	78305311	96415738
		460	1.15	12.0	13.8	81.42	78	0.82	1.833	K	4400	78195811	96415744
10	7.5	230	1.15	30.4	35	206.5	81.5	0.86	0.393	J	4400	78305312	96415739
		460	1.15	15.3	17.6	103.84	81.5	0.86	1.493	K	4400	78195812	96415745
15	11	230	1.15	44.3	51	244.8	82.5	0.86	0.27	G	4400	78305314	96415740
		460	1.15	22.2	25.5	122.4	82	0.86	1.067	H	4400	78195814	96415746
20	15	230	1.15	60.4	69.5	403.1	84	0.86	0.17	J	4400	78305316	96415741
		460	1.15	30.0	34.5	200.1	83.5	0.86	0.657	K	4400	96415747	96415747
25	18.5	230	1.15	72.2	83	473.1	84.5	0.86	0.143	J	4400	78305317	96415742
		460	1.15	36.1	41.5	236.55	84.5	0.86	0.553	J	4400	78195817	96415748
30	22	230	1.15	86.5	99.5	557.2	84	0.86	0.116	H	4400	78305318	96415743
		460	1.15	43.5	50	280	84	0.86	0.483	J	4400	78195818	96415749

*This is a calculated value.

HP	Kw	Voltage	FUSE(5)		Circuit Breaker	NEMA Starter Size	IEC Starter Size	OVERLOADS			
			Fast Acting	Time Delay				Cutler Hammer Overload (1)	Allen Bradley (2)	General Electric (3)	Siemens (4)

4 Inch Motors Industrial Motors

THREE PHASE

3	2.2	230	30	17	25	0	C	110	J28	122B	K52
		460	15	9	15	0	C	109	J21	618A	K37
		575	12	7	10	0	A	108	J18	463A	K33
5	3.7	230	50	30	40	1	D	112	J32	181B	K60
		460	25	15	20	1	D	110	J25	910A	K49
		575	20	11	20	0	B	109	J23	750A	K42

6 Inch (Three Wire) Industrial Motors

THREE PHASE

$7\ ^{1}/_{2}$	5.5	230	75	45	60	1	E	114	J36	293B	K64
		460	40	25	30	1	C	111	J30	147B	K55
10	7.5	230	100	60	80	2	F	114	J38	352B	K70
		460	50	30	40	1	D	112	J32	181B	K60
15	11	230	140	80	125	2	H	116	J42	520B	K76
		460	65	40	60	2	E	113	J35	265B	K64
20	15	230	200	110	150	3	J	117	J44	710B	K77
		460	90	60	80	2	F	114	J38	352B	K69
25	18.5	230	225	150	200	3	K	117	J46	866B	K83
		460	110	70	90	2	G	115	J40	464B	K72
30	22	230	275	150	225	3	L	-	J71	107C	K87
		460	130	80	125	3	H	-	J41	520B	K75

Notes:

(1) These overloads are for both NEMA and IEC Freedom series starters by EATON Cutler-Hammer. The complete part number is H2_B-3. This information was collected from EATON Cutler-Hammer catalog number CA08102001E.

(2) These overload heater coils are for the Allen Bradley Bulletin 509 Starter. This information was collected from the Allen Bradley catalog number A115-CA001A-EN-P.

(3) These overloads ae designed for use with GE NEMA starters. Complete part numbers are CR123L____. For use with GE CR124 single element overloads. This information was collected from page 1-107 of the Control Catalog, Rev. 07/03.

(4) These overloads are designed for Siemens NEMA Overload Relays. This information was collected from page 8/151 of the 2006 Siemens Industrial Control Catalog.

(5) The Fuses and Circuit Breakers were calculated from the NEC table 430.52.

Starters and Overloads should always be sized by a licensed electrician that is familiar with local codes and standards. The Overloads for submersible motors should be Class 10 Quick trip ambient compensated.

				AMPERAGE									
HP	Kw	Voltage	Service Factor	Full Load	Service Factor	Locked Rotor	Eff %	Power Factor	Line-to-Line Resistance	KVA Code	Max. Thrust	Nameplate Number	GRUNDFOS MATERIAL NO.

6 Inch (460V) Motors

THREE PHASE

50	37	460	1.15	68.7	79	470	84	0.83	0.378	G	13000	96476890	96023200

8 Inch (460V) Motors

THREE PHASE

40	30	460	1.15	55.7	64	380	83	0.85	0.35	K	13000	96530180	96023204
50	37	460	1.15	67.8	78	550	84	0.85	0.25	J	13000	96530182	96023205
60	45	460	1.15	80.4	92.5	640	86	0.85	0.18	K	13000	96476891	96023206
75	55	460	1.15	97.4	112	580	86	0.86	0.15	J	13000	96476892	96023207
100	75	460	1.15	130.4	150	570	87	0.86	0.13	J	13000	96476893	96023208
125	92	460	1.15	160.0	184	600	87	0.87	0.09	J	13000	96476894	96023209
150	110	460	1.15	191.3	220	580	86	0.87	0.08	J	13000	96511375	96023210

10 Inch (460V) Motors

THREE PHASE

100	75	460	1.15	133.9	154	570	87	0.84	0.092	J	13000	–	96023211
125	92	460	1.15	165.2	190	550	87	0.83	0.7	J	13000	96540300	96023212
150	110	460	1.15	194.8	224	580	88	0.84	0.055	J	13000	96540301	96023213
175	132	460	1.15	230.4	265	570	88	0.85	0.045	J	13000	96521619	96023214
200	147	460	1.15	265.2	305	620	87	0.82	0.04	K	13000	96540302	96023215
250	190	460	1.15	352.2	405	610	87	0.79	0.033	K	13000	96463669	96023217

*This is a calculated value.

			FUSE					OVERLOADS			
HP	**Kw**	**Voltage**	**Standard**	**Time Delay**	**Circuit Breaker**	**NEMA Size**	**IEC Size**	**Cutler Hammer (1)**	**Allen Bradley (2)**	**General Electric (3)**	**Siemens (4)**

6 Inch (460V) Motors

THREE PHASE

50	37	460	225	125	175	3	N	117	J46	866B	K83

8 Inch (460V) Motors

THREE PHASE

40	30	460	175	100	150	3	N	117	J43	710B	K76
50	37	460	225	125	175	3	–	117	J46	866B	K83
60	45	460	250	150	200	4	–	105	J70	950B	K86
75	55	460	300	175	250	4	–	105	J72	107C	K88
100	75	460	400	225	350	4	–	106	J75	155C	K92
125	92	460	500	300	400	5	–	107	J14	100B	K94
150	110	460	600	350	500	5	–	107	J16	111B	K96

10 Inch (460V) Motors

THREE PHASE

100	75	460	400	250	350	4	–	106	J75	155C	K92
125	92	460	500	300	400	5	–	107	J15	100B	K96
150	110	460	600	350	500	5	–	107	J17	122B	–
175	132	460	700	400	600	5	–	108	J18	135B	–
200	147	460	800	500	700	5	–	108	J20	165B	–
250	190	460	1100	600	1000	6	–	107	J14	–	–

Notes:

(1) These overloads are for both NEMA and IEC Freedom series starters by EATON Cutler-Hammer. The complete part number is H2___B-3. This information was collected from EATON Cutler-Hammer catalog number CA08102001E.

(2) These overload heater coils are for the Allen Bradley Bullitin 509 Starter. This information was collected from the Allen Bradley catalog number A115-CA001A-EN-P.

(3) These overloads are designed for use with GE NEMA starters. Complete part numbers are CR123L_ _ _ _. For use with GE CR124 single element overloads. This information was collected from page 1-107 of the Control Catalog Rev. 07/03.

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(5) The Fuses and Circuit Breakers were calculated from the NEC table 430.52.

Starters and Overloads should always be sized by a licensed electrician that is familiar with local codes and standards.
The Overloads for submersible motors should be Class 10 Quick trip Ambient compensated.

Generator Sizing

HP	Kw	KVA
1/3	1.5	1.9
1/2	2	2.5
3/4	3	3.8
1	4	4.8
1 1/2	5.9	7
2	7	9
3	10	12
5	15	18.75
7 1/2	25	33
10	35	31.5
15	49	60
20	66	81
25	82	102
30	96	116
40	125	153
50	138	162
60	163	192
75	200	233
100	269	320
125	382	461
150	456	543
175	546	642
200	606	740
250	776	982

Notes:
These values were calculated by using the following formulas:

Single Phase: (3 X FLA)V X PF/1000

Three phase through 100 HP:
(3 X FLA) V X PF X1.73/1000

Three phase 125 and above:
(3.5 X FLA) V X PF X1.73/1000

This is a guide. The generator manufacturer should be asked to assist in sizing all generators.

Transformer Capacity

Required for Three-Phase Motors

Submersible Three- Phase Motor HP Rating	Total Effective KVA Required *	Smallest KVA Rating — Each Transformer	
		Open WYE or DELTA 2 Transformers	WYE or DELTA 3 Transformers
1.5	3 **	2	1
2	4 **	2	1.5
3	5 **	3	2
5	7.5 **	5	3
7.5	10 **	7.5	5
10	15 **	10	5
15	20 **	15	7.5
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
175	200	115	70
200	230	130	75

* Pump motor KVA requirements only -- does not include allowances for other loads
** This is also the KVA required for single phase motors

Motor Cooling

(refer to page 12 of the Troubleshooting section of this Service Manual)

Total Resistance of Drop Cable

(refer to page 16 of the Troubleshooting section of this Service Manual)

Motor Service to Entrance

SINGLE PHASE 60 HZ

Motor Rating		Copper Wire Size												
VOLTS	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**	**0**	**00**	**000**	**0000**	**250**	**300**
115	1/3	130	210	340	540	840	1300	1960	2910					
	1/2	100	160	250	390	620	960	1460	2160					
230	1/3	550	880	1390	2190	3400	5250	7960						
	1/2	400	650	1020	1610	2510	3880	5880						
	3/4	300	480	760	1200	1870	2890	4370	6470					
	1	250	400	630	990	1540	2380	3610	5360	6520				
	1 1/2	190	310	480	770	1200	1870	2850	4280	5240				
	2	150	250	390	620	970	1530	2360	3620	4480				
	3	120	190	300	470	750	1190	1850	2890	3610				
	5			180	280	450	710	1110	1740	2170				
	7 1/2				200	310	490	750	1140	1410				
	10					250	390	600	930	1160				

THREE PHASE 60 HZ

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
208	1 1/2	310	500	790	1260									
	2	240	390	610	970	1520								
	3	180	290	470	740	1160	1810							
	5		170	280	440	690	1080	1660						
	7 1/2			200	310	490	770	1180	1770					
	10				230	370	570	880	1330	1640				
	15					250	390	600	910	1110	1340			
	20						300	460	700	860	1050	1270		
	25							370	570	700	840	1030	1170	
	30							310	470	580	700	850	970	1110
230	1 1/2	360	580	920	1450									
	2	280	450	700	1110	1740								
	3	210	340	540	860	1340	2080							
	5		200	320	510	800	1240	1900						
	7 1/2			230	360	570	890	1350	2030					
	10				270	420	660	1010	1520	1870				
	15					290	450	690	1040	1280	1540			
	20						350	530	810	990	1200	1450		
	25						280	430	650	800	970	1170	1340	
	30							350	540	660	800	970	1110	1270
460	1 1/2	1700												
	2	1300	2070											
	3	1000	1600	2520										
	5	590	950	1500	2360									
	7 1/2	420	680	1070	1690	2640								
	10	310	500	790	1250	1960	3050							
	15			540	850	1340	2090	3200						
	20			410	650	1030	1610	2470	3730					
	25				530	830	1300	1990	3010	3700				
	30				430	680	1070	1640	2490	3060	3700			
	40						790	1210	1830	2250	2710	3290		
	50						640	980	1480	1810	2190	2650	3010	
	60							830	1250	1540	1850	2240	2540	2890
	75								1030	1260	1520	1850	2100	2400
	100									940	1130	1380	1560	1790
	125											1080	1220	1390
	150												1050	1190
	200												1080	1300
	250													1080
575	1 1/2	2620												
	2	2030												
	3	1580	2530											
	5	920	1480	2330										
	7 1/2	660	1060	1680	2650									
	10	490	780	1240	1950									
	15		530	850	1340	2090								
	20			650	1030	1610	2520							
	25			520	830	1300	2030	3110						
	30				680	1070	1670	2560	3880					
	40					790	1240	1900	2860	3510				
	50						1000	1540	2310	2840	3420			
	60						850	1300	1960	2400	2890	3500		
	75							1060	1600	1970	2380	2890	3290	
	100								1190	1460	1770	2150	2440	2790

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

Please Note:

For Franklin motor specifications, refer to Franklin's Submersible Motor Application • Installation • Maintenance • Manual

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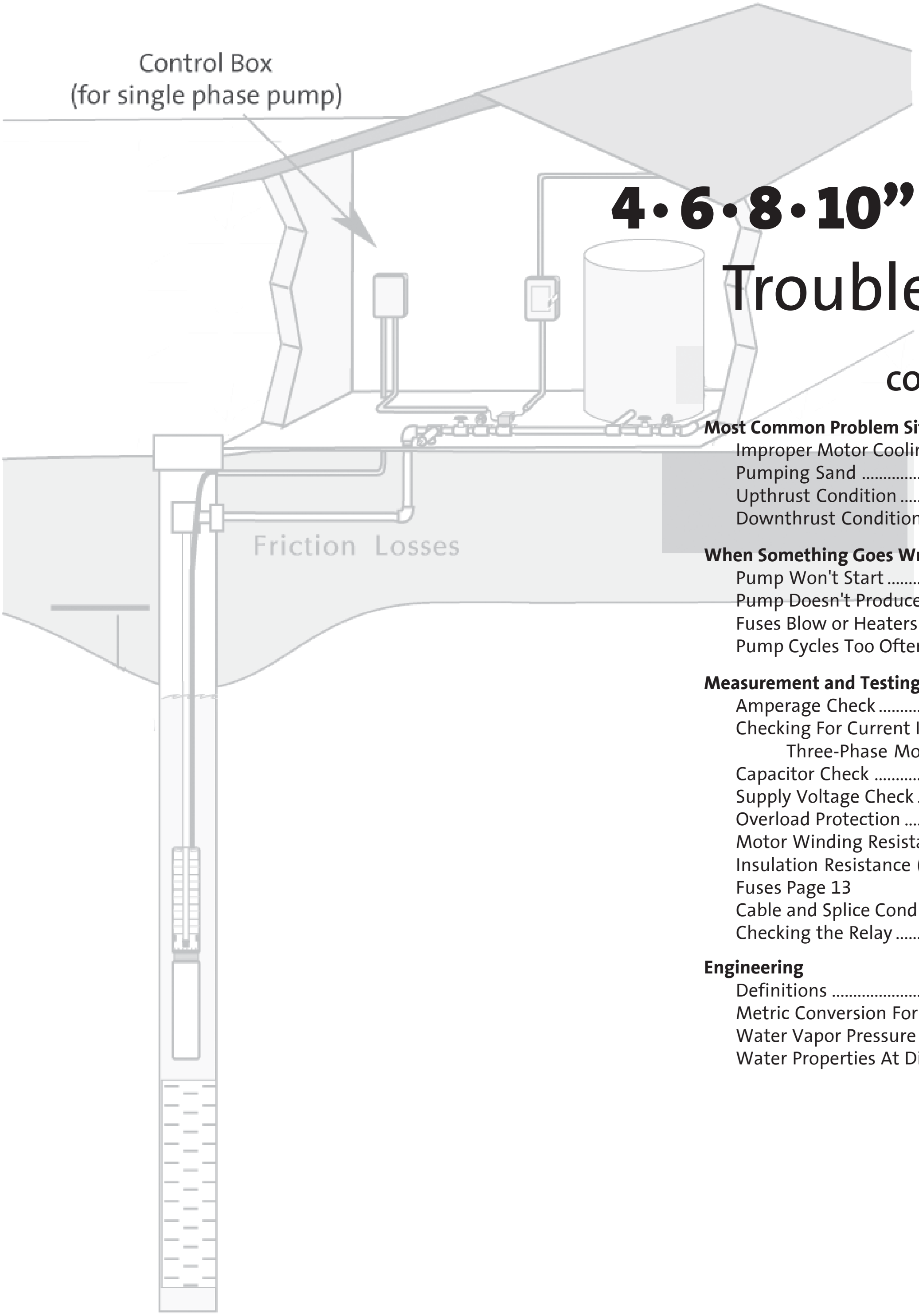
GROUNDWATER SERVICE MANUAL



4•6•8•10" Submersibles
Troubleshooting

CONTENTS

Most Common Problem Situations

When Something Goes Wrong . . .

Measurement and Testing

Engineering

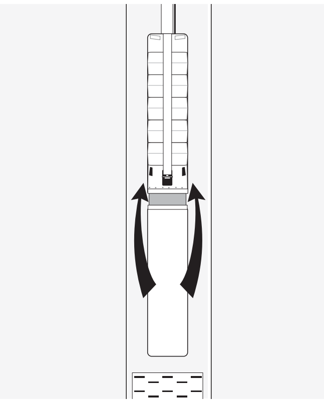
BE > THINK > INNOVATE >

GRUNDFOS®

Most Common Problem Situations

Poor Motor Cooling*

A submersible pump motor is cooled by the flow of water past its outer housing as the pump is pumping. The water must flow past the motor at a certain velocity for proper cooling to take place, and the minimum velocity needed is different for each diameter motor.



Correct screen position for proper cooling

MINIMUM VELOCITY OF WATER PAST MOTOR*

4" diameter motor	.25 feet per second
6" diameter motor	.5 feet per second
8" diameter motor	.5 feet per second
10" diameter motor	.5 feet per second

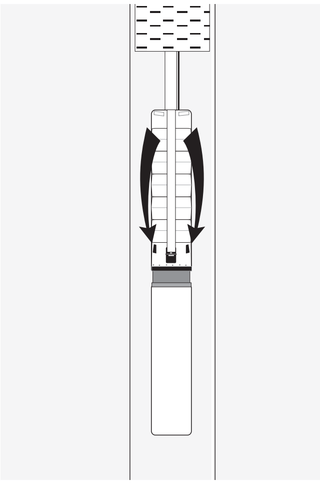
To determine whether water is flowing past the motor at a high enough velocity, note where the motor diameter and outside sleeve or casing diameter intersect on the following chart. The Gallons Per Minute scale indicates the **minimum flow required** to keep the motor properly cooled.

MINIMUM FLOW REQUIREMENTS FOR SUBMERSIBLE MOTORS*

WELL CASING OR FLOW INDUCER SLEEVE (internal diameter in inches)	**4" motor**	**6" motor**	**8" motor**	**10" motor**
4 inches	1.2 GPM	--	--	--
5	7	--	--	--
6	13	10	--	--
7	21	28	--	--
8	30	45	10	--
10	--	85	55	30
12	--	140	110	85
14	--	198	180	145
16	--	275	255	220
18	--	--	--	305

MOTOR DIAMETER

MINIMUM FLOW (GPM)
(to ensure proper motor cooling)



Cascading water from screen does not flow past motor

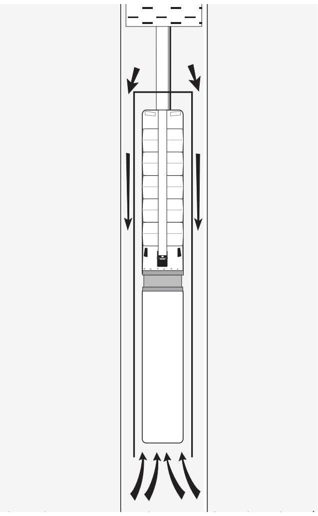
Insufficient cooling can sometimes result when:

(1) The screen is located above or at the pump, so that the water cascades down into the pump's suction intake without first flowing past the motor.

(2) The casing diameter is so large that the water is drawn into the pump's suction intake from the side without first flowing past the motor.

These problems can be solved by fitting the pump and motor into a **Flow Inducer Sleeve.** This sleeve attaches to the pump and forces water to pass around it and enter the pump's suction intake from below the motor.

If the diameter of the well's casing is too small for a sleeve inducer, a rigid tube (usually 1/4" inside diameter) can be tapped into the discharge piping above the pump (but below any check valves) with the other end positioned below the motor and pointing upwards.



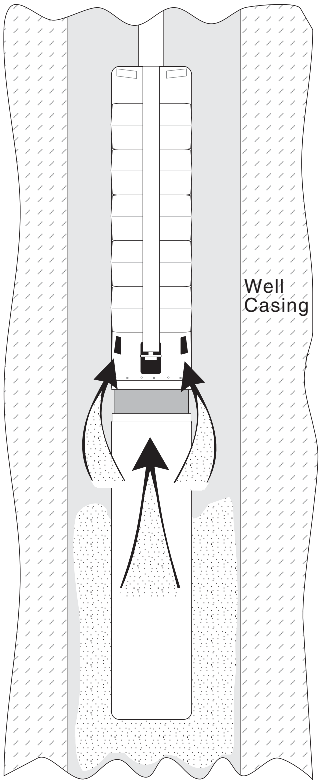
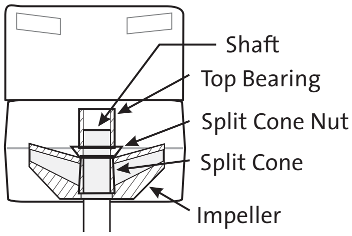
Flow Inducer Sleeve forces water past motor

***Grundfos motors have a more effective internal cooling design; therefore, a cooling sleeve is not required in water up to 30° C (86° F). However, all motors will have a longer life with a cooling sleeve installed.**

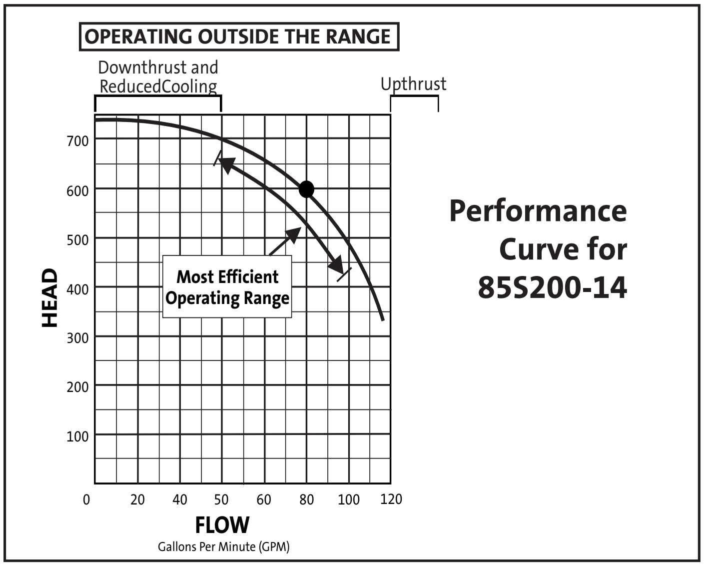
Pumping Sand

All submersible water pumps are designed with the idea they will be used to pump clean, clear water. Some design changes can be made to enable them to better handle situations that don't meet this ideal, but only to a limited degree.

No situation shortens the life of submersible pump more than pumping silt or **SAND**.

Effect On Pump	Will Be First Noticed By...	Design Changes To Deal With The Problem
SAND works its way into all moving parts of the pump, grinding bearings, impellers, and all other components as they spin against each other.  	Reduced flow (GPM) and head, since the perfect fit of the impellers and other components will be slowly worn away and the pump will become less and less efficient.  At some point, the pump's performance will become so poor it becomes quite apparent that something is seriously wrong. If the pump is pulled out of the well and the impellers and other moving components are examined, **uniform** wear (not random pitting, which might indicate that pump may have been cavitating) can be seen on virtually every moving part.	There is no way to eliminate all pump damage due to pumping sand. The effects can only be minimized. Since sand tends to be carried along with flow rates greater than 5-8 feet per second (water velocity), an enlarged drop pipe can reduce the water velocity and thereby reduce the chance sand can enter the pump. Of course, if the water velocity drops below the chart on the previous page, motor cooling may become a problem.

Upthrust Condition

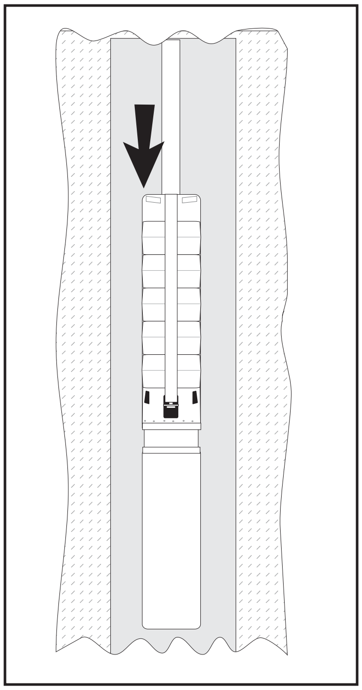


Pumps are designed with the expectation that the correct size pump will be used in the right situation. An 80 gallon per minute pump which can produce about 600 feet of head (at the same time it delivers 80 GPM) is designed so that if it is used in this situation, the pump will operate at its best efficiency **and** all its components will have a long life. The perfomance curve to the right shows the most efficient operating range for this type of pump.

If the pump is not operated within this range, problems can occur.

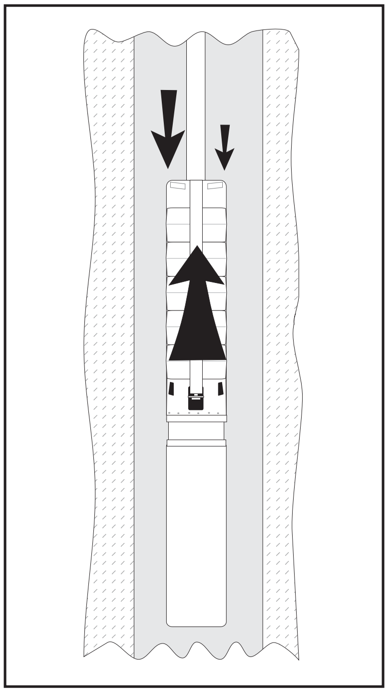
One such problem can occur when a pump is installed and run in a situation in which it will produce far GREATER flow (GPM) than it was designed for. **In other words, the pump is oversized for what is really needed.** When such a pump is started, the initial thrust (upward water surge) generated by the spinning impellers is so much GREATER than the downward thrust it is expecting to overcome (such as the force of the different water pressure, the weight of the impellers and shaft, etc.), that the entire stack of impellers within the pump is lifted upwards **(UPTHRUST).** Pumps are manufactured with bearings designed to handle intermittent upward water surges up to a certain degree. If the actual flow is much greater than this, an upthrust condition exists. The force of this **UPTHRUST** will first put pressure on the motor's thrust bearing. If and when this bearing wears out, the pump's components will begin to absorb the upthrust as they grind against each other. Upthrust is especially damaging when the pump is started and the drop pipe is empty -- causing a great upthrust of water since no head is present. Check valves in the drop pipe will prevent this from occuring.

BEFORE
pump starts pumping



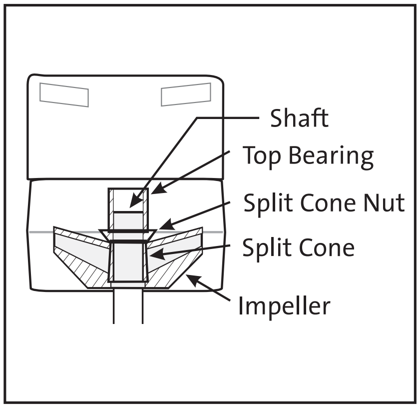
Weight of water and impellers pushes down

AFTER
pump starts pumping



Initial surge of water thrusts impellers upwards

DAMAGE CAUSED



Once the motor's thrust bearing is worn, the pump components begin wearing

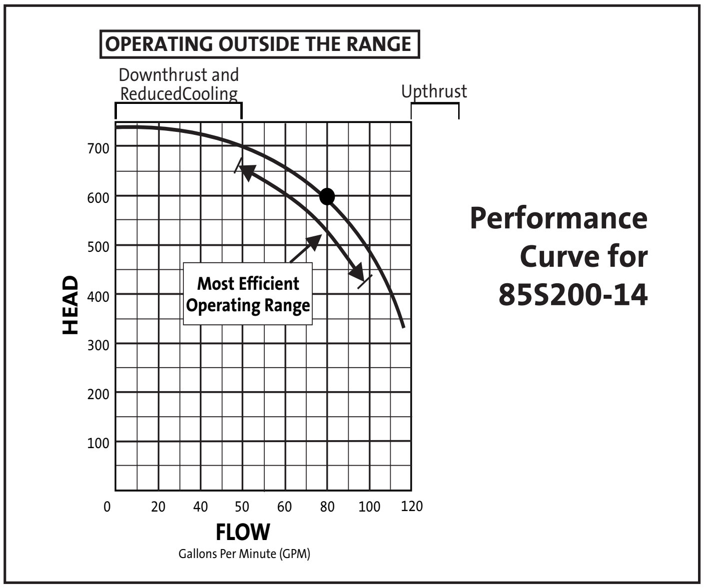
Usually, the **UPTHRUST** condition lasts for only a few seconds until the water pressure above the impellers acts as a counterforce to press the impeller stack down onto the motor shaft. Sometimes, however, if the pump is producing far more flow than for which it was designed, the upthrust condition can continue until the pump is stopped.

Downthrust Condition

Pumps are designed with the expectation that the correct size pump will be used in the right situation. An 80 gallon per minute pump which can produce about 600 feet of head (at the same time it delivers 80 GPM) is designed so that if it is used in this situation, the pump will operate at its best efficiency **and** all its components will have a long life. The perfomance curve at right shows the most efficient operating range for this type of pump.

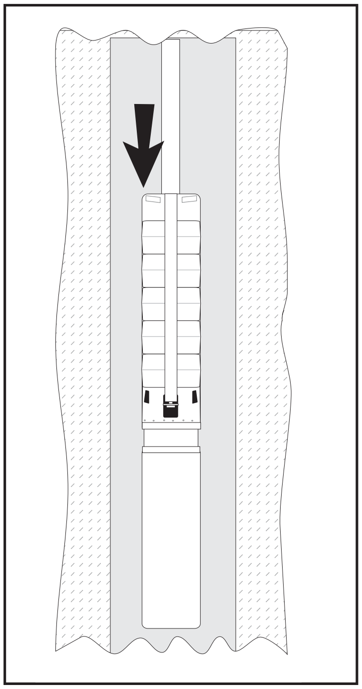
If the pump is not operated in this range, problems can occur.

One such problem can occur when a pump is installed and run in a situation in which it will produce HEAD in the range of shut-off pressure (left part of the curve, as shown above). Although the pump is designed to operate over the full curve, if it does not produce enough flow the weight of the shaft and the pressure of the water in the drop pipe is not counterbalanced, causing possible wear to the bearings in the pump and motor. **This can occur if a valve has been closed down so far that the flow is greatly restricted or when the pump is pumping water faster than the well can refill itself.**



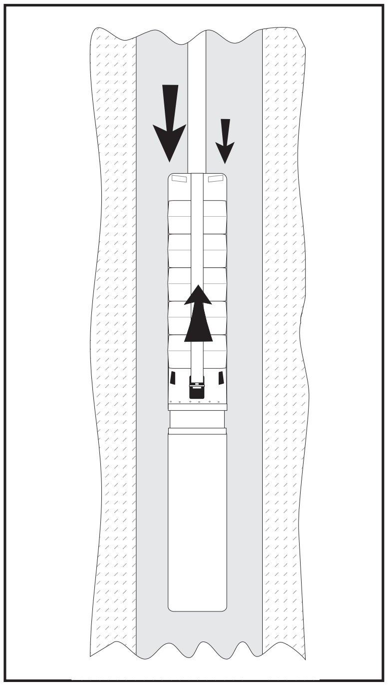
In addition to causing possible bearing damage, operating the pump in a downthrust condition is an inefficient use of energy and may not allow for proper motor cooling (see page 2).

BEFORE
pump starts pumping



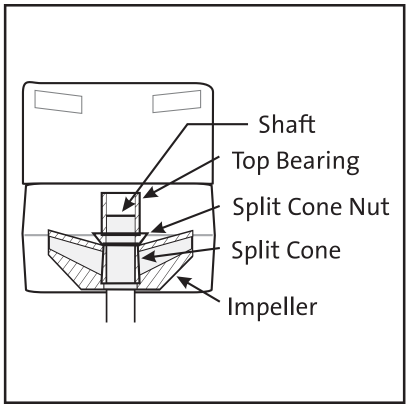
Weight of water and impellers pushes down

AFTER
pump starts pumping



Impellers can produce so much pressure they can grind down against each other

DAMAGE CAUSED



After motor's thrust bearing has worn out, pump components begin to show equal wear from grinding

The best way to check for motor bearing damage is with a shaft height gauge. Refer to the Dismantling & Reassembly section of this manual for complete instructions.

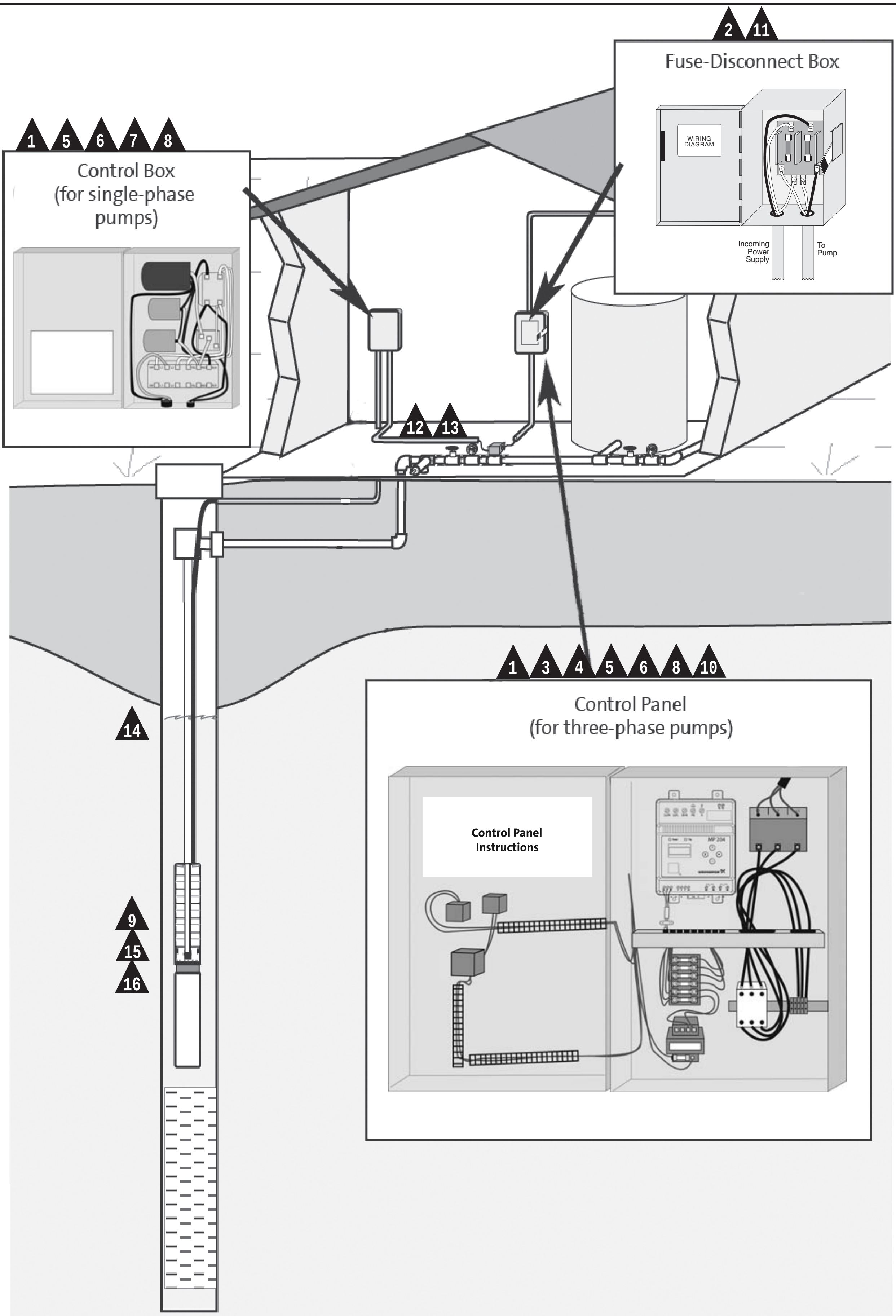
When Something Goes Wrong. . .

Pump Won't Start

Possible Cause	Check This By . . .	Correct This By . . .	
Low or no power at the motor	Check for voltage at the control box or panel. See page 11 for instructions.	If there is no voltage at the control panel, check the feeder panel for tripped circuits and reset those circuits.	1
Fuses are blown or the circuit breakers have tripped.	Turn off the power and remove the fuses. Check for continuity with an ohmmeter as shown on page 13.	Replace the blown fuses or reset the circuit breaker. If the new fuses blow or the circuit breaker trips, the electrical installation, motor, and wires must be checked for defects.	2
(3-phase motors only) **Motor starter overloads are burned or have tripped**	Check for voltage on the line and load side of the starter. Check the amp draw and make sure the heater is sized correctly.	Replace any burned heaters or reset. Inspect the starter for other damage. If the breaker trips again, check the supply voltage. Ensure that heaters are sized correctly and the trip setting is appropriately adjusted.	3
(3-phase motors only) **Starter does not energize**	Energize the control circuit and check for voltage at the holding coil.	If there is no voltage, check the control circuit fuses. If there is voltage, check the holding coil for weak connections. Ensure that the holding coil is designed to operate with the available control voltage. Replace the coil if defects are found.	4
Defective controls	Check all safety and pressure switches for defects. Inspect the contacts in control devices.	Replace worn or defective parts or controls.	5
Motor or cable is defective	Turn off the power and disconnect the motor leads from the control box. Measure the lead-to-lead resistance of the drop cable with an ohmmeter (set to R x 1). Measure the lead-to-ground values with a megohmmeter (set to R x 100K). See pages 12 and 13. Compare these measurements to the rated values for your motor.	If an open or grounded winding is found, pull the pump from the well and recheck the measurements with the lead separated from the motor. Repair or replace the motor or cable.	6
(1-phase motors only) **Defective capacitor**	Turn off the power and discharge the capacitor by shorting the leads together. Check it with an analog ohmmeter (set to R x 100K). See page 11 or use an audible capacitor tester.	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and slowly drift back to infinity (∞). Replace the capacitor if it is defective.	7
Defective pressure switch or the tubing to it is plugged.	Watch the pressure gauges as the pressure switch operates. Remove the tubing and blow through it.	Replace as neccessary.	8
The pump is mechanically bound or stuck	Turn off the power, pull the pump, and manually rotate the pump shaft. Also check the motor shaft rotation, the shaft height, and the motor's amp draw (to see if it indicates a locked rotor).	If the pump shaft doesn't rotate, remove the pump and examine it. If necessary, dismantle it and check the impellers for obstruction. Check for motor corrosion.	9

Pump Does Not Produce Enough Flow (GPM)

Possible Cause	Check This By . . .	Correct This By . . .	
Shaft is turning in the wrong direction.	Check to make sure the electrical connections in the control panel are correct.	Turn off the power. Correct the wiring. For single phase motors, check the wiring diagram on the motor. For three phase motors, simply switch any two power leads.	10
Pump is operating at the wrong speed (too slow)	Check for low voltage (as shown on page 11) and phase imbalance (as shown on page 10)	Replace defective parts or contact power company, as applicable.	11
Check valve is stuck (or installed backwards)	Pull the pump and reove the check valve.	Re-install or replace.	12
Parts in the pump are worn **or** **Impellers, Inlet Strainer, or Well Screen is clogged**	Install a pressure gauge, start the pump, and gradually close the discharge valve. Read the pressure at shutoff. (Do not allow the pump to operate for an extended period at shutoff).	Convert the PSI you read on the gauge to Feet of Head by: **PSI x 2.31 ft** Add to this number the number of feet (vertically) from the gauge down to the water's pumping level. Refer to the pump curve for the model you are working with to determine the shutoff head expected for that model. If those figures and yours do not match, remove the pump and inspect impellers, chambers, etc., for clogging.	13
The water level in the well may be too low to supply the flow desired **or** **Collapsed well**	Using a depth gauge, check the drawdown in the well while the pump is operating.	If the pumping water level (including drawdown) is not **AT LEAST 3 FEET** above the pump's inlet strainer, either: 1. Lower the pump further down the well. 2. Throttle back the discharge valve to decrease the flow, thereby reducing drawdown.	14
Broken shaft or coupling	Pull pump and inspect	Replace as necessary.	15
There are leaks in the fittings or piping	Pull the pump out of the well.	The suction pipe, valves, and fittings must be made tight. Repair any leaks and retighten all loose fittings.	16


2
11
Fuse-Disconnect Box
WIRING DIAGRAM
Incoming Power Supply
To Pump
1
5
6
7
8
Control Box (for single-phase pumps)
12
13
1
3
4
5
6
8
10
Control Panel (for three-phase pumps)
Control Panel Instructions
MP 204
14
9
15
16

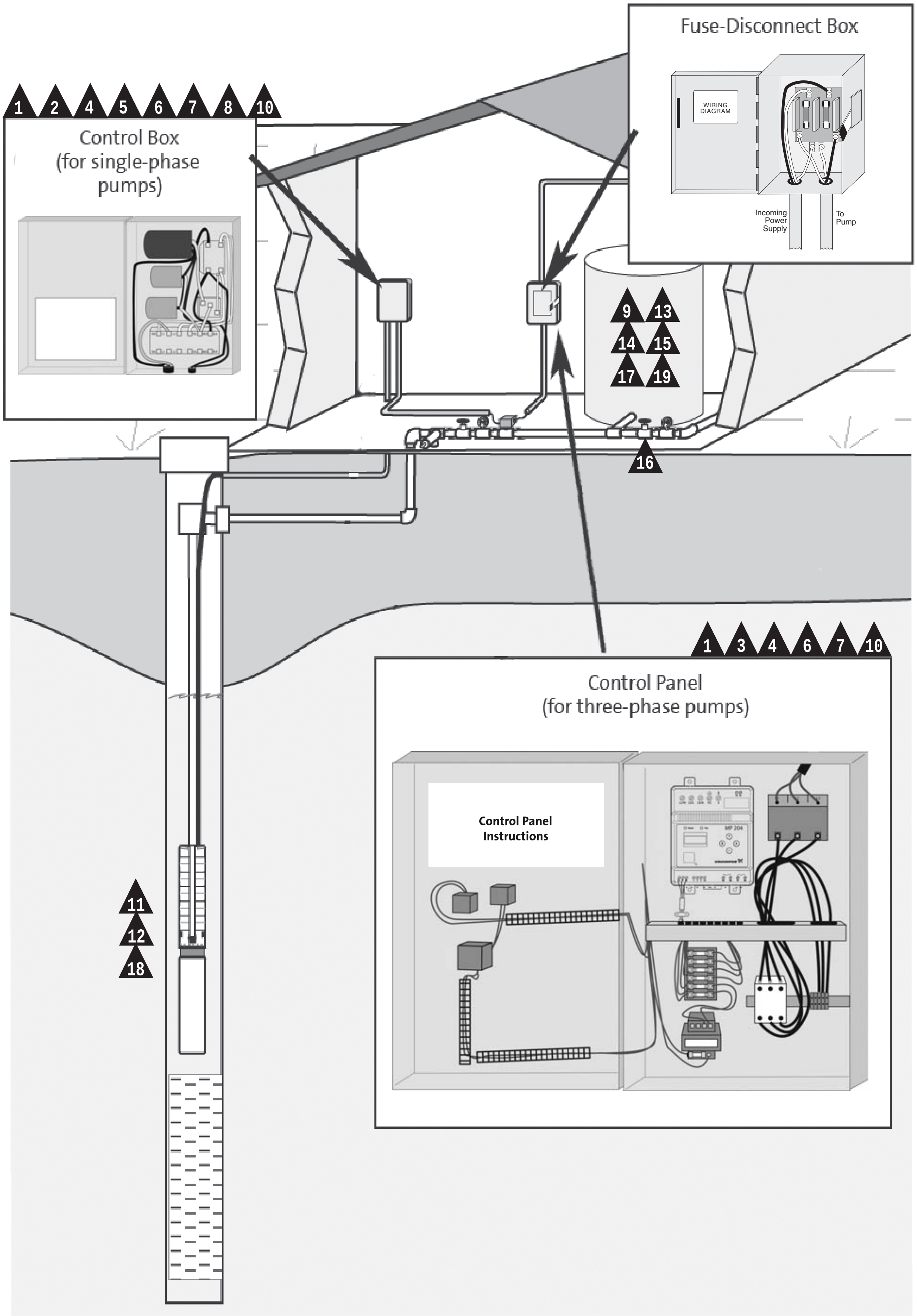
When Something Goes Wrong. . .

Fuses Blow or Heaters Trip

Possible Cause	Check This By . . .	Correct This By . . .	
Improper voltage	Check the voltage at the control box or panel. See page 11 for instructions.	If voltage varies by more than 10% (+ or -), contact the power company.	1
	If the incoming voltage is + or -10%, check the wire size and then measure the distance between the pump motor and the pump control panel.	Rewire with correct gauge. Undersized wire and a great distance between the control panel and the pump motor increases resistance and decreases the voltage by the time it reaches the pump motor.	
The starter overload is set too low.	Cycle the pump and measure the amperage. See page 10 for instructions.	Increase the heater size (use a slo-bio) or adjust the trip setting. Do not, however, exceed the recommended rating.	2
(3-phase motors only) **Current is imbalanced.**	Check the current draw on each lead to the motor. See page 11 for instructions.	The current imbalance must be within 5% of each other. If they are not, check the wiring and the power supply.	3
The wiring or connections are faulty.	Check to make sure the wiring is correct and there are no loose terminals.	Tighten any loose terminals and replace any damaged wire.	4
(1-phase motors only) **Capacitor is defective**	Turn off the power and discharge the capacitor. Check start and run capacitors with an ohmmeter (set at R x 100K). See page 11 for instructions.	When the meter is connected to the capacitor, the needle should jump towards 0 (zero) ohms and then slowly drift back to infinity (∞). Replace the capacitor if it is defective.	5
Fuse, heater, or starter are the wrong size	Check the fuses and heaters against the motor manufacturer's specification charts.	Replace as necessary.	6
The control box location is too hot	Touch the box with your bare hand during the hottest part of the day -- you should be able to keep your hand on it without burning.	Shade, ventilate, or move the control box so its environment does not exceed 120°F.	7
(1-phase motors only) **Wrong control box**	Check requirements for the motor against the control box specifications.	Replace as necessary.	8
Defective pressure switch	Watch gauges as pressure switch operates.	Replace as necessary.	9
The motor is shorted or grounded.	Turn off the power and disconnect the wiring. Measure the lead-to-lead resistance with an ohmmeter (set to R x1). Measure the lead-to-ground resistance (set to R x100K). Compare these measurements to the rated values for your motor.	If you find an open or grounded winding, remove the motor and recheck the leads. If OK, check the leads for continuity and for bad splice.	10
Poor motor cooling	Find the internal diameter of the well casing (or sleeve, if used) on the chart on page 2 and check for proper cooling.	Increase the pump flow (GPM) so proper cooling is possible (see chart on page 2) or pull the pump out of the well and add a sleeve with a smaller internal diameter *(see chart on page 2).*	11
Bad motor thrust bearing	Measure for high amps as explained on page 10.	If amps are too high, pull the pump and replace the motor.	

Pump Cycles Too Often

Possible Cause	Check This By . . .	Correct This By . . .	
The pressure switch is defective or is not properly adjusted.	Check the pressure setting on the switch. Check the voltage across closed contacts.	Adjust the pressure switch with a screwdriver or replace it if defective.	13
The tank is too small	Check the tank size and amount of air in the tank. The tank size should be about 10 gallons for each GPM needed (16 GPM = 160 gal.). At the pump cut-in pressure, the tank should be about 2/3 filled with air.	Replace the tank with one that is the correct size.	14
There is insufficient air charging of the tank or piping is leaking.	Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soapy water. Check the air-to-water ratio in the tank.	Repair as necessary.	15
Plugged snifter valve or bleed orifice (causing pressure tank to be water-logged)	Examine them for dirt or erosion.	Repair or replace as necessary.	16
Leak in the pressure tank or piping.	Check the setting and operation of the level control.	Readjust the level control setting (according to the manufacturer's instructions) or replace it if defective.	17
The level control is defective or is not properly set.	Check the yield of the well (determined by the well-test) against the pump's performance curve.	Reduce the flow by throttling back the valve. or Change the pump.	18
Pump is oversized for the application. It is outpumping the yield of the well and pumping itself dry.	Refer to the tank's operating and installation instructions and make sure it is installed correctly.	Repair or replace as needed.	19

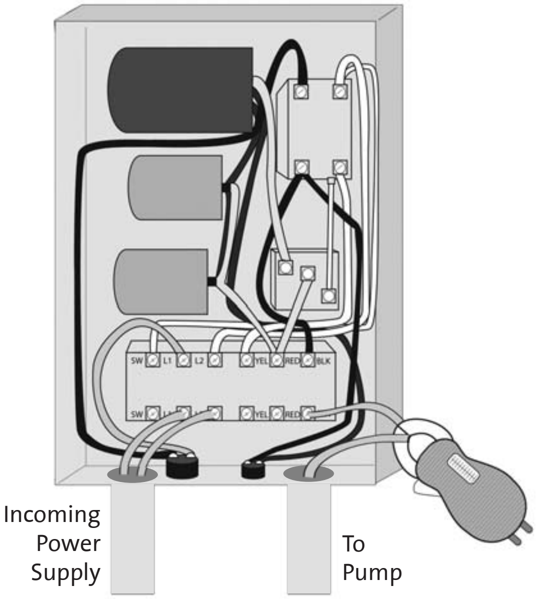

1 2 4 5 6 7 8 10
Control Box
(for single-phase pumps)
Fuse-Disconnect Box
WIRING DIAGRAM
Incoming Power Supply
To Pump
9 13
14 15
17 19
16
1 3 4 6 7 10
Control Panel
(for three-phase pumps)
Control Panel Instructions
MP 204
11
12
18

Amperage Check

To check the electrical current (measured in amperes, or "amps") use an ammeter.

Instructions

1. Make sure the pump is running
2. Set the rotary scale on the front of the ammeter to the highest scale.
3. Open the control box and place the jaws of the ammeter around the wire to be measured.
4. Slowly rotate the scale on the ammeter back towards 0 (zero) until an exact reading is shown.
5. Record the measurement
6. Repeat for the other wires.



Evaluation

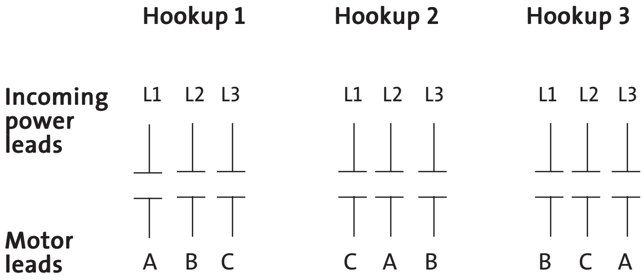
If the amp draw exceeds the service factor amps for the pump (as listed in the Motors section of the Service Manual), then:

- The motor starter may have burned contacts
- The terminals in the starter or terminal box may be loose
- There may be a winding defect. Check the winding and insulation resistance (see pages 12 and 13)
- The motor windings may be shorted or grounded
- The pump may be damaged in some way and may be causing a motor overload.
- A voltage supply or current imbalance (3-phase only) may exist. Follow the steps below to determine if this is true.
- The insulation on the drop cable may be torn, exposing the cable.

Current Imbalance On Three-Phase Motors

If the motor is connected to three-phase power, the balance of those three phases can be checked in the following way:

1. Measure the amperage of each wire as instructed above and record these figures.
2. Add together the total amperage measured by the three wires.
3. Divide this number by three to get the **average** amperage reading for the three wires.
4. Check over your numbers and determine which wire has the greatest difference from the average.
5. Take that number and subtract it from the average to determine the amount of **difference**.
6. Divide the **difference** by the **average**.
7. Multiply this number by 100 to obtain the percent of current imbalance for that particular hookup.
8. Turn **POWER OFF**
9. Repeat these steps for the other two possible hookup installations so that each motor lead is connected to a different power lead than it was before.



(where A, B, and C represent each motor lead or each set of leads joined together to make a single motor lead)

Example:

Hookup 1	Hookup 2	Hookup 3
A = 51 amps	C = 50 amps	B = 50 amps
B = 46 amps	A = 49 amps	C = 48 amps
C = 53 amps	B = 51 amps	A = 52 amps
Total = 150	Total = 150	Total = 150
150/3 = 50	150/3 = 50	150/3 = 50
- 46 = 4	- 49 = 1	- 48 = 2
4/50 = .08 or 8 %	1/50 = .02 or 2 %	2/50 = .04 or 4 %

Evaluation

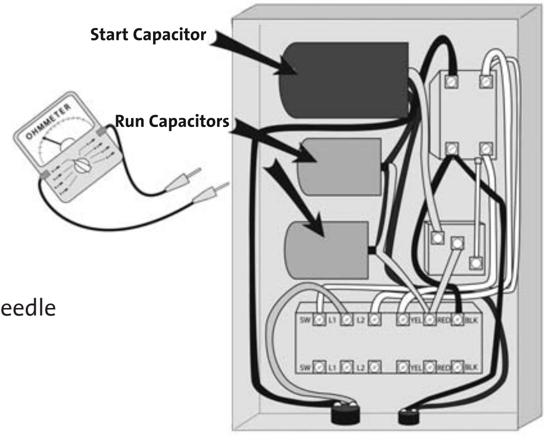
If the the current imbalance is greater than 5% on all three hookups, then:

- If the largest difference in amps is consistently drawn from the same power lead (L1, L2, or L3 above), contact the power company. Your voltage should be balanced to within + or - 5%.
- If the largest difference in amps is consistently drawn from the same motor lead (A, B, or C above), there is likely a problem with the motor. Check the items listed under "Evaluation" near the top of this page.

If the current imbalance exceeds 5% one or two of the legs, use the hookup that has the least difference and check the motor for some of the other problems listed under "Evaluation" near the top of this page.

Capacitor Check

To check the condition of any capacitor on single phase motors, use an ohmmeter.



Instructions:

1. Turn the **POWER OFF**.
2. Disconnect the capacitor from the power source.
3. Discharge the capacitor by touching its leads together.
4. Set the scale selector on the ohmmeter to R x 100K.
5. Connect the leads of the ohmmeter to the black and orange wires of the capacitor.
6. Watch the ohmmeter scale.
7. Disconnect one lead from the capacitor for approximately 30 seconds. The needle should return to the last reading taken.

Evaluation

If the capacitor is OK, the needle should swing towards zero and then float back towards infinity (∞). If the needle drops and remains at zero, the capacitor is probably shorted. If the needle remains at a high value, there is an open circuit.

CAUTION: This test may indicate a good capacitor even though it may have lost some capacitance, making the motors run noisy or draw high amps. To safeguard against this, the capacitor can be checked with a capacitor meter.

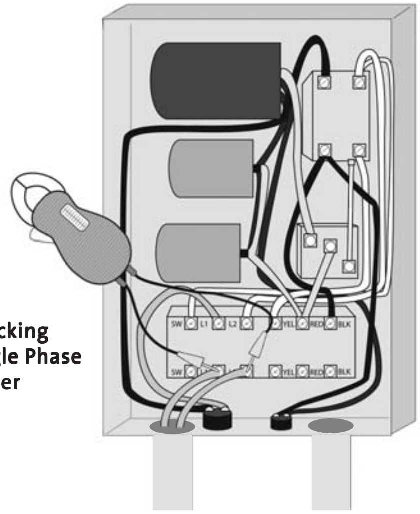
Supply Voltage Check

To check the supply voltage, use a voltmeter (or amprobe) with the power on.

Instructions

1. Set the voltmeter to the highest scale
2. Remove the cover of the control box...BE CAREFUL -- POWER IS STILL BEING SUPPLIED TO THE CIRCUIT. Do not touch the voltmeter leads together while they are in contact with the power lines.
3. Touch the ends of the voltmeter leads as follows:

Single Phase Motors
Touch one voltmeter lead to each of the lines supplying power to the control (L_1 and L_2 , or L_1 and N for 115V circuits). →



Checking Single Phase Power

Three Phase Motors
Touch a voltmeter lead to the following:

- Power leads L_1 and L_2
- Power leads L_2 and L_3
- Power leads L_3 and L_1

These tests should give a reading of full line voltage.

- Two fuses
- Two contact points
- Two heaters

Evaluation

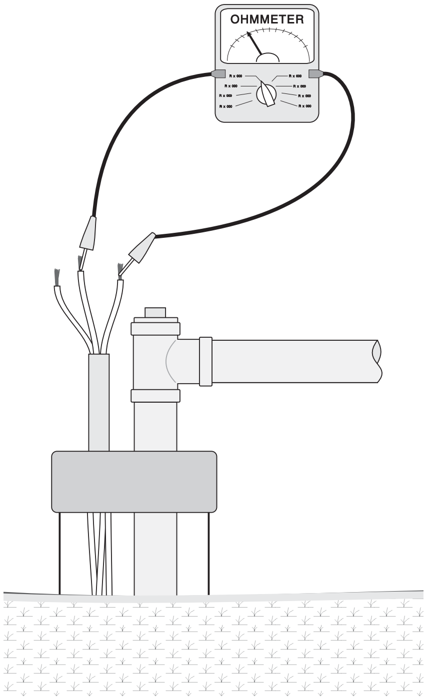
When the motor is under load, the voltage should be -10% and +6% of the nameplate voltage. Any variation larger than this can cause damage to the motor windings and should be noticeable as a high amp problem.

If The Motor Nameplate Reads . . .	Then the minimum and maximum voltage should be . . .	
	Minimum	Maximum
115V (single phase)	105 volts	121 volts
208V (single or three phase)	188 "	220 "
230V " "	210 "	243 "
460V (three phase)	414 "	487 "
575V " "	518 "	609 "

Any variations larger than these may indicate a poor electrical supply. The motor should not be operated under these conditions. Contact your power supplier to correct the problem or change the motor to one requiring the voltage you are receiving.

Motor Winding Resistance (lead-to-lead)

To check the electrical condition of the drop cable, splice, and motor windings, a resistance check with an ohmmeter is required.



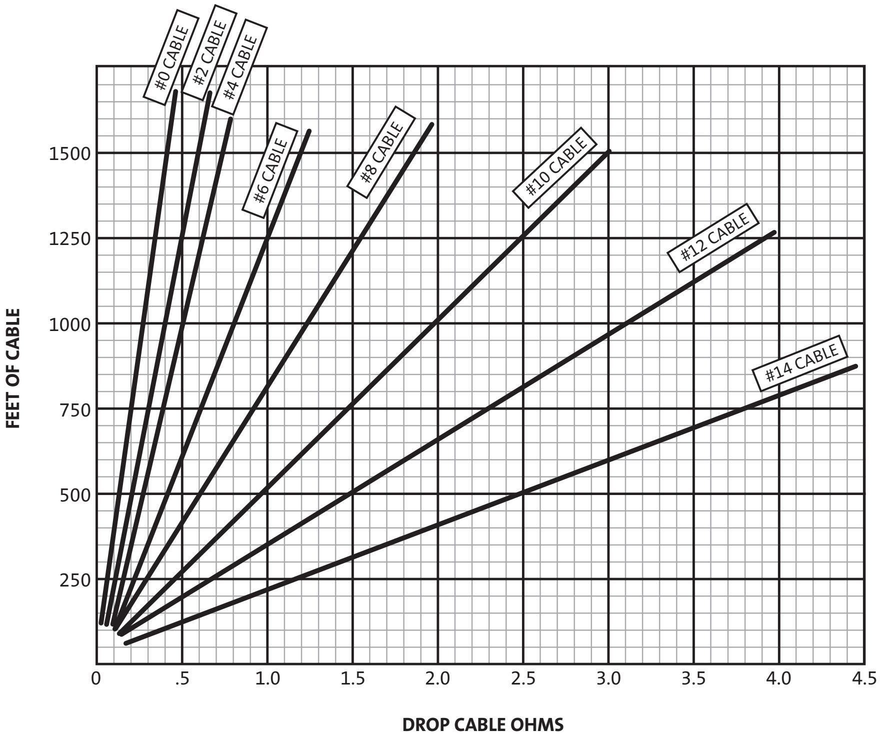
Instructions:

1. Turn the **POWER OFF**.
2. Disconnect all electrical leads to the drop cable.
3. Set the scale selector on the ohmmeter to R x 1 (if you expect ohm values under 10) or R x 10 (for ohm values over 10).
4. Touch the leads of the ohmmeter to two motor leads:
   Single Phase Motors
   Touching the leads of the ohmmeter to the black and yellow leads will measure the main winding's resistance for Franklin and Grundfos 402 motors. The red and yellow leads will be the start winding's resistance.
   Three Phase Motors
   Touching the leads of the ohmmeter to any two black leads will measure that winding's resistance. Repeat for all three possible lead combinations.
5. Watch the ohmmeter scale and record this figure. Subtract the ohm resistance for the drop cable (chart below) from the number. Compare the remaining figure with the one shown in the Motors section of this manual.

If:	**Then:**
Ohm values are normal	Motor windings are okay
One ohm value is less than normal	That motor winding may be starting to short
One ohm value is greater than normal	That winding may be starting to open
Some ohm values are greater than normal (>25%) and some are less than normal (± 25%)	The leads may be connected incorrectly, or have a break in the insulating jacket

If ohm readings are not normal and you want to verify the problem is not with the splice or drop cable, remove the lead from the motor and check the resistances from pin to pin directly at the motor. If the motor checks out okay, the fault is in the lead or splice (see page 14).

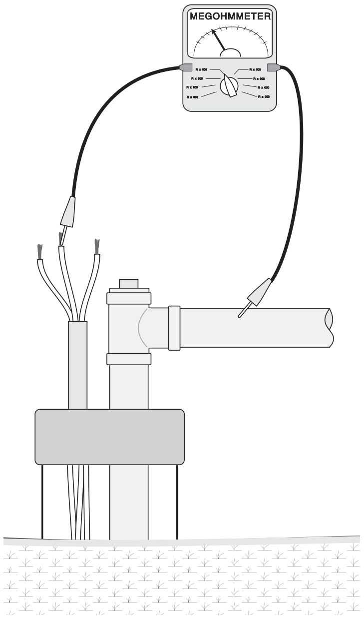
Total Resistance of Drop Cable *(from control box to motor and back)*



The values shown are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher for each foot of cable of the same size.

Copper ÷ .61 = Aluminum

Insulation Resistance (lead-to-ground)



To check the insulation resistance of the drop cable, splice, and motor leads, a megohmmeter is required.

Instructions:

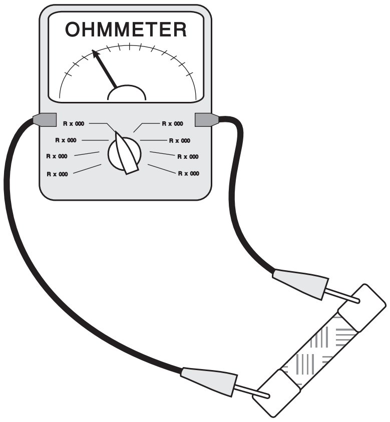
1. Turn the **POWER OFF**.
2. Disconnect all electrical leads to the drop cable.
3. Set the scale selector on the megohmmeter to R x 100, touch its leads together, and adjust the indicator to zero.
4. Touch the leads of the megohmmeter to each of the motor leads and to ground (i.e. L_1 to ground; L_2 to ground, etc.). The well casing, if made of steel, makes an excellent ground.
5. Watch the megohmmeter scale and compare this figure with the chart below.

Evaluation: In general, any ohm value above 1,000,000 ohms indicates everything is OK. The following table gives more specifics.

OHM VALUE	MEGAohm VALUE	THIS INDICATES THAT ...
		If The Motor HAS NOT Yet Been Installed:
2,000,000 (or more)	2.0	It is a new motor
1,000,000 (or more)	1.0	It is a used motor than can be used again (insulation OK)
		If The Motor HAS Been Installed: *(means that ohm readings will be for the drop cable plus the motor)*
500,000 - 1,000,000	0.5 - 1.0	The motor is in reasonably good condition
20,000 - 500,000	.02 - 0.5	The motor may have been damaged by lightning or has damaged leads.
10,000 - 20,000	.01 - .02	The motor has certainly been damaged or has damaged leads. The pump should be pulled and repairs made to the motor leads or replace the motor completely. The motor may still operate, but probably not for long.
less than 10,000	0 - .01	The motor has failed or the motor lead insulation has been completely destroyed. The pump must be pulled and the motor lead (drop cable) repaired or the entire motor replaced. **The motor will not run in this condition.**

Fuses

To check the condition of electrical fuses, an ohmmeter is required.



Instructions:

1. Turn the **POWER OFF** at the main disconnect or power source.
2. Remove the fuse.
3. Set the scale selector on the ohmmeter to R x 1.
4. Touch each lead of the ohmmeter to one end of the fuse.

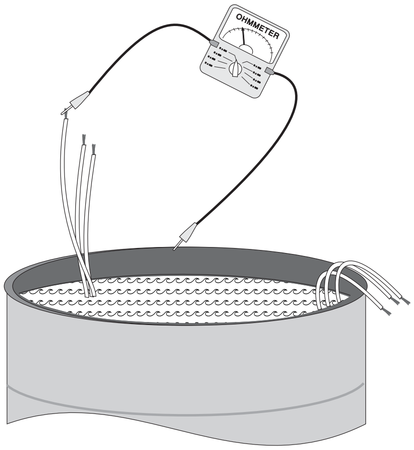
Evaluation:

A good fuse should have zero (0) ohm reading. If the ohm value is near or past infinity, the fuse must be replaced.

Measurement and Testing

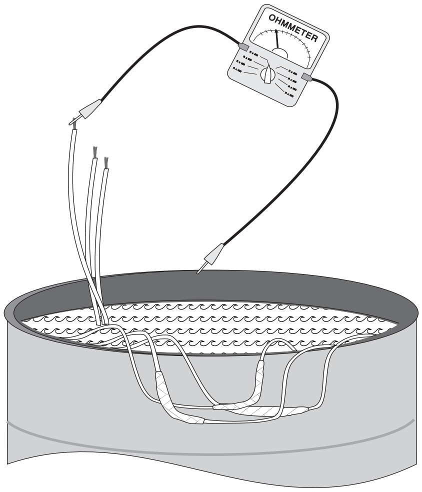
Cable and Splice Condition

To check the electrical condition of the cable and splice insulation, a megohmmeter is required.



Instructions:

1. Turn the **POWER OFF.**
2. Remove the cable from the motor and electrical supply.
3. Submerge the cable in a steel barrel of water. Make sure both ends stay out of the water. Salt may be added to increase the conductance of the water.
4. Set the megohmmeter to R x 100K. Zero-adjust the ohmmeter by touching its two leads together.
5. Touch one megohmmeter lead to the steel barrel and other to a bare cable lead.
6. If the megohmmeter drifts towards zero (0), either that lead or the splice for that lead has a leak (fault). To find out if it is the splice:



   a. Raise the splice for that lead out of the water.
   b. Repeat step 5.
   c. If the megohmmeter drifts towards infinity, the fault is in the splice.
   d. If the megohmmeter drifts towards zero (0), the fault is somewhere else in that lead. Gradually pull the rest of that cable lead out of the water until the megohmmeter drifts towards infinity. When it does, the leak is at that point in the cable lead.

7. Repeat for each of the motor leads.

Evaluation:

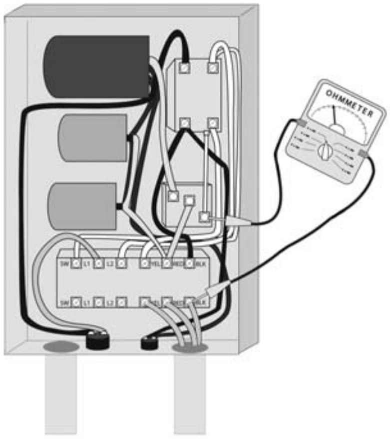
Any faulty leads should be replaced using waterproof electrical tape.

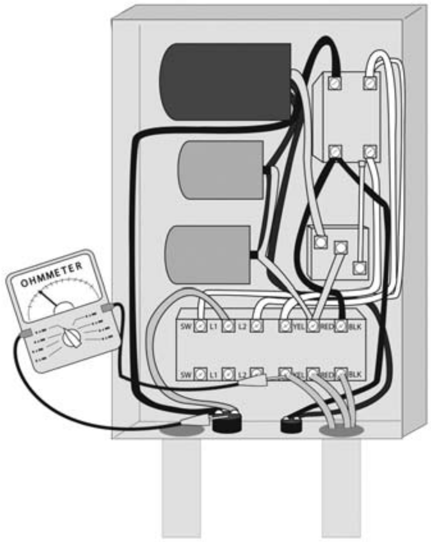
Checking the Relay

(SINGLE-PHASE CONTROL BOXES ONLY)

To check the electrical condition of the relays on single phase control boxes, an ohmmeter is required.

Specific instructions for checking the relay differ from control box to control box. Refer to the inside cover of your control box.





Overload Protection

To check the electrical condition of the thermal overloads, an ohmmeter is required.

Instructions:

1. Turn the **POWER OFF**.
2. Set the scale selector on the ohmmeter to R x 1.
3. Touch one of the ohmmeter leads to an overload protector and one to terminal 1, then terminal 3. Repeat for each overload protector.

Evaluation:

If the ohm values are 0.5 ohms or less, the overload protectors should still be functional. If not, they should be replaced.

Definitions

NET POSITIVE SUCTION HEAD (two types)

Before a centrifugal water pump can operate, the water must enter the pump under a certain minimum amount of pressure. For submersible pumps, this minimum is easily reached, since the pump is submerged in water and both the atmospheric pressure (14.7 psi) and the pressure of the water in the well are present. The amount of pressure (expressed in feet of head) required for a given pump to operate is known as its Net Positive Suction Head **Required**.

This number is determined by extensive testing of the pump by the manufacturer. These requirements are normally shown in graphical form (an **NPSH curve**) for a pump at every flow (GPM) within the flow range for which the pump is designed**.** As a pump's flow (GPM) increases, the NPSHR needed to continue that flow (without cavitating) also increases.

The amount of pressure (expressed in feet of head) that is actually available to a pump is known as its Net Positive Suction Head **Available**. Since the NPSH **Available** to the pump is almost always greater than the NPSH **Required** (for submersible pumps, that is), they are usually not a cause for any concern when sizing a pump or troubleshooting.

> *For submersible pumps, NPSH Required should not be confused with Total Dynamic Head, which is the amount of head the pump must produce to deliver water at the desired flow rate (GPM) in a given situation.* ***Total Dynamic Head*** *(or TDH, as it is sometimes called) is explained below.*

TOTAL DYNAMIC HEAD

When selecting (or "sizing") a pump, two questions must be answered:

1. How much flow is needed ?
   (expressed in Gallons Per Minute)
2. How much head must the pump produce ?
   (known as ***Total Dynamic Head****)*

To determine the Total Dynamic Head the pump must produce, 5 pieces of information are needed:

Ⓐ **STATIC WATER LEVEL**

+

Ⓑ **DRAWDOWN**
(as the pump is pumping)

+

Ⓒ **TANK ELEVATION**

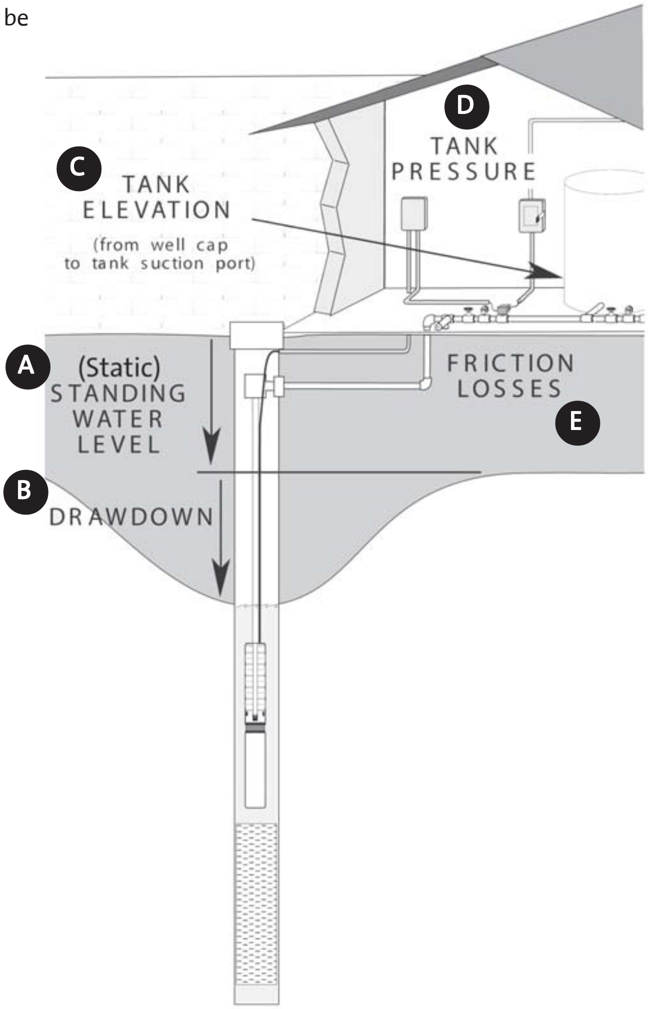
+

Ⓓ **TANK PRESSURE**
(multiply by 2.31 to
convert psi to feet of head)

+

Ⓔ **FRICTION LOSSES**

THE TOTAL
OF THESE 5 NUMBERS IS
THE AMOUNT OF HEAD
THE PUMP MUST PRODUCE



AFFINITY LAWS

The mathematical relationships which permit the head, capacity, brake horsepower (BHP), and NPSH of centrifugal pumps to be predicted based on small changes in impeller diameter size or shaft speed (RPM) changes. These relationships are:

For diameter changes at a constant RPM:

$$\frac{D_1}{D_2} = \frac{GPM_1}{GPM_2}$$

Flow changes in direct proportion to the ratio of the diameter change.

$$\left(\frac{D_1}{D_2}\right)^2 = \frac{H_1}{H_2}$$

Head changes to the square ratio of the ratio of the diameter change.

$$\left(\frac{D_1}{D_2}\right)^3 = \frac{BHP_1}{BHP_2}$$

BHP changes to the cube of the ratio of the diameter change

For RPM changes:

$$\frac{RPM_1}{RPM_2} = \frac{GPM_1}{GPM_2}$$

$$\left(\frac{RPM_1}{RPM_2}\right)^2 = \frac{NPSH_1}{NPSH_2}$$

$$\left.\begin{aligned} \left(\frac{RPM_1}{RPM_2}\right)^2 &= \frac{H_1}{H_2} \\ \left(\frac{RPM_1}{RPM_2}\right)^3 &= \frac{BHP_1}{BHP_2} \end{aligned}\right\}$$

Head is affected by the square of the ratio of RPM change
and
BHP is affected by the cube of the ratio of the RPM change

Conversion Formulas

HEAD
(in feet)

$$= \frac{\text{Pressure (PSI) x 2.31}}{\text{Specific Gravity (for water, 1.0 at ambient temperatures)}}$$

PRESSURE
(PSI)

$$= \frac{\text{HEAD (in ft) x Specific Gravity (for water, 1.0 at ambient temperatures)}}{2.31}$$

ATMOSPHERIC PRESSURE
Pressure of the Atmosphere Pushing Down (at sea level)

$$= \text{14.7 PSI} = \text{34 feet of HEAD}$$

BRAKE HORSEPOWER
Horsepower Delivered to the Pump Shaft

$$= \frac{\text{GPM x HEAD x Specific Gravity (for water, 1.0 at ambient temps)}}{\text{3960 x Efficiency Of Pump}}$$

PUMP EFFICIENCY
Of The Pump

$$= \frac{\text{GPM x HEAD x Specific Gravity}}{\text{3960 x Brake Horsepower}}$$

FOOT POUNDS = Newton Meters (or Nm) x .7376

DEGREES FARENHEIT = (Degrees Celsius x 9/5) + 32

Water Vapor Pressure and Specific Gravity

°F	°C	Specific Gravity (1 at 60°F)	Weight (Lbs per cubic foot)	Vapor Pressure (PSIA)	Vapor Pressure (in feet)
32	0	1.002	62.42	0.0885	0.204
40	4.4	1.001	62.42	0.1217	0.281
45	7.2	1.001	62.40	0.1475	0.340
50	10.0	1.001	62.38	0.1781	0.411
55	12.8	1.000	62.34	0.2563	0.591
60	15.6	1.000	62.34	0.2563	0.591
65	18.3	.999	62.31	0.3056	0.839
70	21.1	.999	62.27	0.3631	0.839
75	23.9	.998	62.24	0.4298	0.994
80	26.7	.998	62.19	0.5069	1.172
85	29.4	.997	62.16	0.5959	1.379
90	32.2	.996	62.11	0.6982	1.617
95	35.0	.995	62.06	0.8153	1.890
100	37.8	.994	62.00	0.9492	2.203
110	43.3	.992	61.84	1.275	2.965
120	48.9	.990	61.73	1.692	3.943
130	54.4	.987	61.54	2.223	5.196
140	60.0	.985	61.39	2.889	6.766
150	65.6	.982	61.20	3.718	8.735
160	71.1	.979	61.01	4.741	11.172
170	76.7	.975	60.79	5.992	14.178
180	82.2	.972	60.57	7.510	17.825
190	87.8	.968	60.35	9.339	22.257
200	93.3	.964	60.13	11.526	27.584
212 (boiling point)	100.0	.959	59.81	14.696	35.353
220	104.4	.956	59.63	17.186	41.343
240	115.6	.948	59.10	24.97	60.77
260	126.7	.939	58.51	35.43	87.05
280	137.8	.929	58.00	49.20	122.18
300	148.9	.919	57.31	67.01	168.22
320	160.0	.909	56.66	89.66	227.55
340	171.1	.898	55.96	89.66	227.55
360	182.2	.886	55.22	153.04	398.49
380	193.3	.874	54.47	195.77	516.75
400	204.4	.860	53.65	247.31	663.42
420	215.6	.847	52.80	308.83	841.17
440	226.7	.833	51.92	381.59	1056.8
460	237.8	.818	51.02	466.9	1317.8
480	248.9	.802	50.00	566.1	1628.4
500	260.0	.786	49.02	680.8	1998.2

Water Properties at Different Altitudes

ALTITUDE		BAROMETER READING		ATMOS. PRESSURE		Boiling Point Of Water F°
Feet	Meters	IN. HG.	MM. HG	PSIA	Feet of Water	
-1000	-304.8	31.0	788	15.2	35.2	213.8
-500	-152.4	30.5	775	15.0	34.6	212.9
0	**0.0**	**29.9**	**760**	**14.7**	**33.9**	**212.0**
+500	+152.4	29.4	747	14.4	33.3	211.1
+1000	304.8	28.9	734	14.2	32.8	210.2
1500	457.2	28.3	719	13.9	32.1	209.3
2000	609.6	27.8	706	13.7	31.5	208.4
2500	762.0	27.3	694	13.4	31.0	207.4
3000	914.4	26.8	681	13.2	30.4	206.5
3500	1066.8	26.3	668	12.9	29.8	205.6
4000	1219.2	25.8	655	12.7	29.2	204.7
4500	1371.6	25.4	645	12.4	28.8	203.8
5000	1524.0	24.9	633	12.2	28.2	202.9
5500	1676.4	24.4	620	12.0	27.6	201.9
6000	1828.8	24.0	610	11.8	27.2	201.0
6500	1981.2	23.5	597	11.5	26.7	200.1
7000	2133.6	23.1	587	11.3	26.2	199.2
7500	2286.0	22.7	577	11.1	25.7	198.3
8000	2438.4	22.2	564	10.9	25.2	197.4
8500	2590.8	21.8	554	10.7	24.7	196.5
9000	2743.2	21.4	544	10.5	24.3	195.5
9500	2895.6	21.0	533	10.3	23.8	194.6
10000	3048.0	20.6	523	10.1	23.4	193.7
15000	4572.0	16.9	429	8.3	19.2	184.0

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PART 1: INTRODUCTION

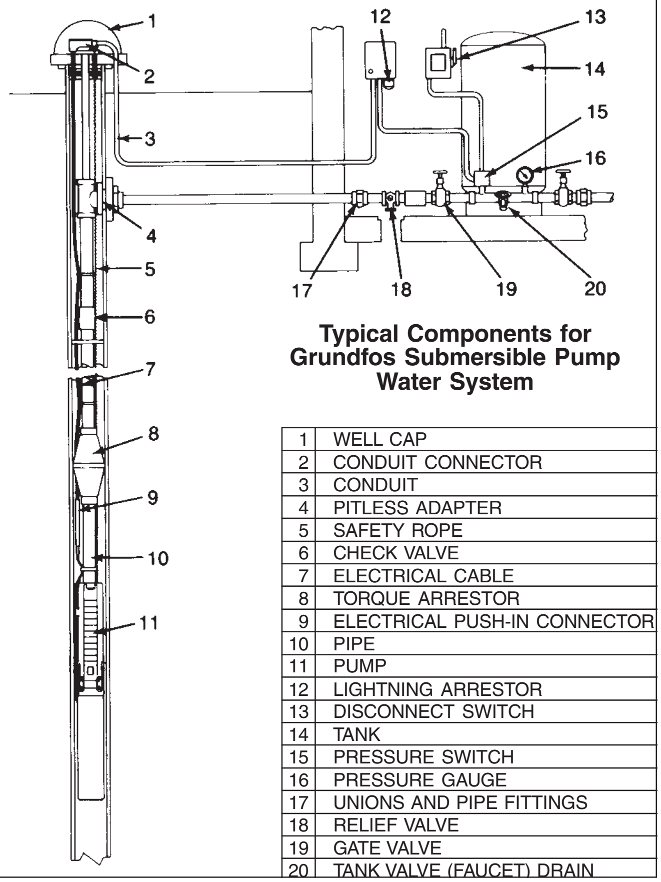
General

This section will provide the technical information needed to properly select GRUNDFOS groundwater products. The information applies primarily to domestic groundwater systems using 4-inch wells with submersible or jet pumps, pressure tanks, and accessories. It is important to be familiar with typical system components and their basic hydraulic principles to ensure a better understanding of the more technical information found later in this section.

Prior to selecting the pump, the basic system requirements must be determined. System capacity and system pressure must be calculated and friction losses determined to ensure proper system performance. These calculations are covered in detail in **Part 1.** In **Part 2**, information is provided on proper cable selection. Also provided in **Part 3** are miscellaneous technical data and formulas commonly used in the selection of domestic groundwater systems.

Typical System Components

Domestic groundwater systems are made up of a pump, storage tank, and accessories to operate the system automatically. Pumps are generally of the submersible or jet variety and include the pump and motor as a unit. Refer to Figure 8-A for the components found in a typical automatic groundwater pumping system.



Typical Components for Grundfos Submersible Pump Water System

1	WELL CAP
2	CONDUIT CONNECTOR
3	CONDUIT
4	PITLESS ADAPTER
5	SAFETY ROPE
6	CHECK VALVE
7	ELECTRICAL CABLE
8	TORQUE ARRESTOR
9	ELECTRICAL PUSH-IN CONNECTOR
10	PIPE
11	PUMP
12	LIGHTNING ARRESTOR
13	DISCONNECT SWITCH
14	TANK
15	PRESSURE SWITCH
16	PRESSURE GAUGE
17	UNIONS AND PIPE FITTINGS
18	RELIEF VALVE
19	GATE VALVE
20	TANK VALVE (FAUCET) DRAIN

FIGURE 8-A
Components found in a typical automatic groundwater pumping system including a submersible pump, pressure tank, and pressure control accessories.

In a ***closed, automatic water system*** a pressure tank is used to store water and maintain system pressure between specified limits (such as 30 to 50 psi). As the water level in the tank rises, tank air is compressed in the upper part of the tank until the upper pressure limit is reached (i.e., 50 psi). At this “cut-out” point a pressure switch opens the electrical circuit to the motor and the pump stops.

The compressed air in the tank acts like a spring pushing down on the water to create system pressure. When a valve is opened in the water system, the air pressure in the upper part of the tank forces the water to flow out of the tank and into the system. As the water is drawn from the tank, the air occupies a larger space and the pressure drops until the lower limit is reached (i.e., 30 psi). At this “cut-in” point the pressure switch closes the electrical circuit to the motor and the pump starts. A cycle is thereby completed.

In an ***open, automatic water system*** the pump is used to fill a large, elevated storage tank which utilizes gravity to maintain system pressure. Tank level controls are used to cycle the pump to maintain water levels within prescribed limits.

Refer to the following illustrations for schematic layouts of typical domestic groundwater systems and components: Figure 8-B (Submersible Pump - Closed System), Figure 8-C (Submersible Pump - Open System), Figure 8-D (Shallow Well Jet Pump), and Figure 8-E (Deep Well Jet Pump).

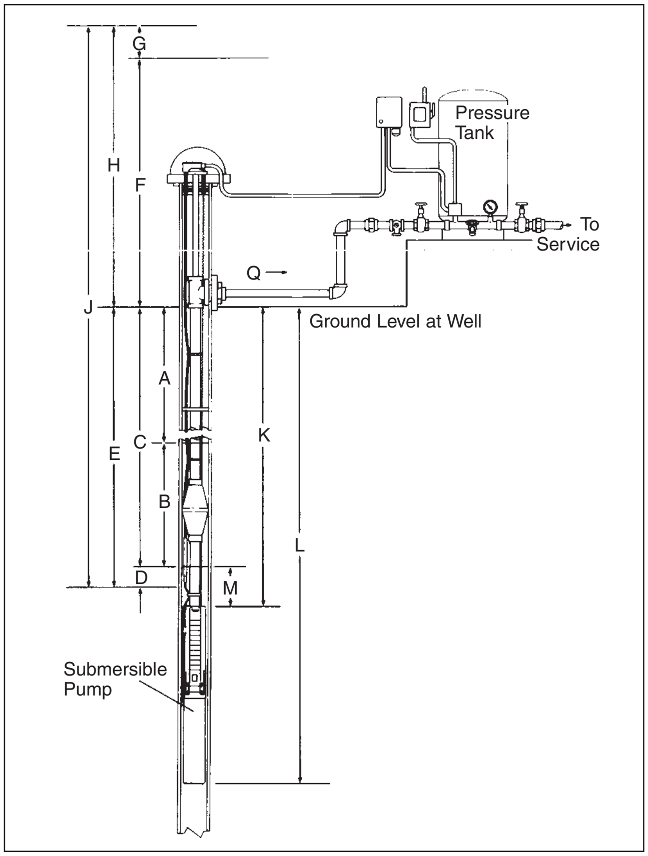


FIGURE 8-B
Figure 8-B illustrates a schematic layout of a CLOSED goundwater pumping system using a submersible pump and pressure tank set for automatic operation. A pressure switch controls the cycling of the pump.

Closed Groundwater System with Submersible Pump

- **A. STATIC WATER LEVEL (in feet):** vertical distance from the top of the well to the standing water level or water table.
- **B. DRAWDOWN (in feet):** reduction in the water level during pumping (varies with well yield and pump capacity).
- **C. PUMPING WATER LEVEL or LIFT (in feet):** C = A + B.
- **D. FRICTION LOSSES in the WELL (in feet):** friction losses caused by the drop pipe and fittings between the pump and the top of the well.
- **E. TOTAL LIFT in the WELL (in feet):** E = A + B + D.
- **F. STATIC DISCHARGE HEAD (in feet):** for PRESSURE TANK SYSTEMS it is the elevation rise in feet of the pressure tank, discharge nozzles, etc., above the top of the well plus the pressure (in feet) required at that level.
- **G. FRICTION LOSSES in the DISCHARGE SYSTEM (in feet):** friction losses caused by piping, valves, and fittings between the top of the well and the point of discharge.
- **H. TOTAL DISCHARGE HEAD (in feet):** H = F + G.
- **J. TOTAL PUMPING HEAD (in feet):** J = E + H.
- **K. SETTING OF PUMP (in feet):** vertical distance from the top of the well to the top of the pump.
- **L. OVERALL LENGTH (in feet):** vertical distance from the top of the well to the bottom of the pump.
- **M. SUBMERGENCE (in feet):** M = K - C.
- **Q. CAPACITY (in gpm or gph):** rate of pumping.

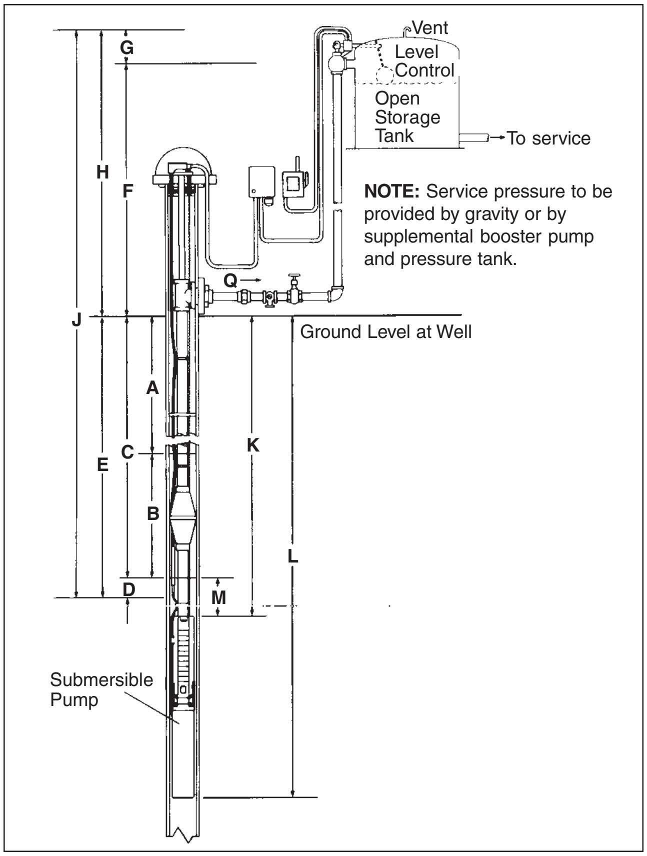


FIGURE 8-C
Figure 8-C illustrates a schematic layout of an OPEN groundwater pumping system using a submersible pump and an elevated storage tank set for automatic operation. A level control on the storage tank controls the cycling of the pump.

Open Groundwater System with Submersible Pump

- **A. STATIC WATER LEVEL (in feet):** vertical distance from the top of the well to the standing water level or water table.
- **B. DRAWDOWN (in feet):** reduction in the water level during pumping (varies with well yield and pump capacity).
- **C. PUMPING WATER LEVEL or LIFT (in feet):** C = A + B.
- **D. FRICTION LOSSES in the WELL (in feet):** friction losses caused by the drop pipe and fittings between the pump and the top of the well.
- **E. TOTAL LIFT in the WELL (in feet):** E = A + B + D.
- **F. STATIC DISCHARGE HEAD (in feet):** for OPEN DISCHARGE SYSTEMS it is the elevation of the highest water level above the top of the well.
- **G. FRICTION LOSSES in the DISCHARGE SYSTEM (in feet):** friction losses caused by piping, valves, and fittings between the top of the well and the point of discharge.
- **H. TOTAL DISCHARGE HEAD (in feet):** H = F + G.
- **J. TOTAL PUMPING HEAD (in feet):** J = E + H.
- **K. SETTING OF PUMP (in feet):** vertical distance from the top of the well to the top of the pump.
- **L. OVERALL LENGTH (in feet):** vertical distance from the top of the well to the bottom of the pump.
- **M. SUBMERGENCE (in feet):** M = K - C.
- **Q. CAPACITY (in gpm or gph):** rate of pumping.

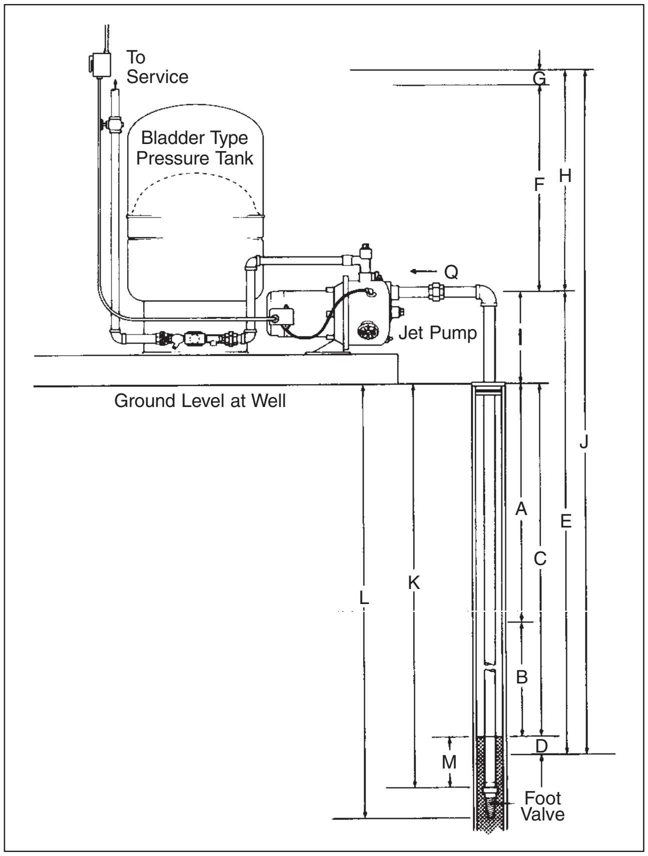


FIGURE 8-D
Figure 8-D illustrates a schematic layout of a SHALLOW WELL groundwater pumping system using a shallow well JET PUMP designed for setting to 25 feet. The pressure tank is set for automatic operation with a pressure switch controlling the cycling of the pump.

CLOSED GROUNDWATER SYSTEM WITH SHALLOW WELL JET PUMP

A. Statics Water Level (in feet): vertical distance from the top of the well to the standing water level or water table.

B. Drawdown (in feet): reduction in the water level during pumping (varies with well yield and pump capacity).

C. Pumping Water Level or Lift (in feet): C = A + B.

D. Friction Losses in the Suction System (in feet): friction losses caused by suction piping between the pump and foot valve.

E. Total Suction Lift (in feet): E = A + B + D + I.

F. Static Discharge Head (in feet): for *Pressure Tanks Systems* it is the elevation rise in feet of the pressure tank, discharge nozzles, etc., above the pump plus the pressure (in feet) discharge nozzles, etc., above the pump plus the pressure (in feet) required at that level. For *Open Discharge Systems* it is the elevation in feet of the highest water level above the pump.

G. Friction Losses in the Discharge System (in feet): friction losses caused by piping, valves, and fittings between the top of the well and the point of discharge.

H. Total Discharge Head (in feet): H = F + G.

I. Elevation of the Pump above the Top of the Well (in feet).

J. Total Pumping Head (in feet): J = E + H.

K. Setting of the Foot Valve or Strainer (in feet): vertical distance from the top of the well to the top of the foot valve or strainer.

L. Overall Length (in feet): vertical distance from the top of the well to the bottom of the foot valve or strainer.

M. Submergence (in feet): M = K - C.

Q. Capacity (in gpm or gph): rate of pumping.

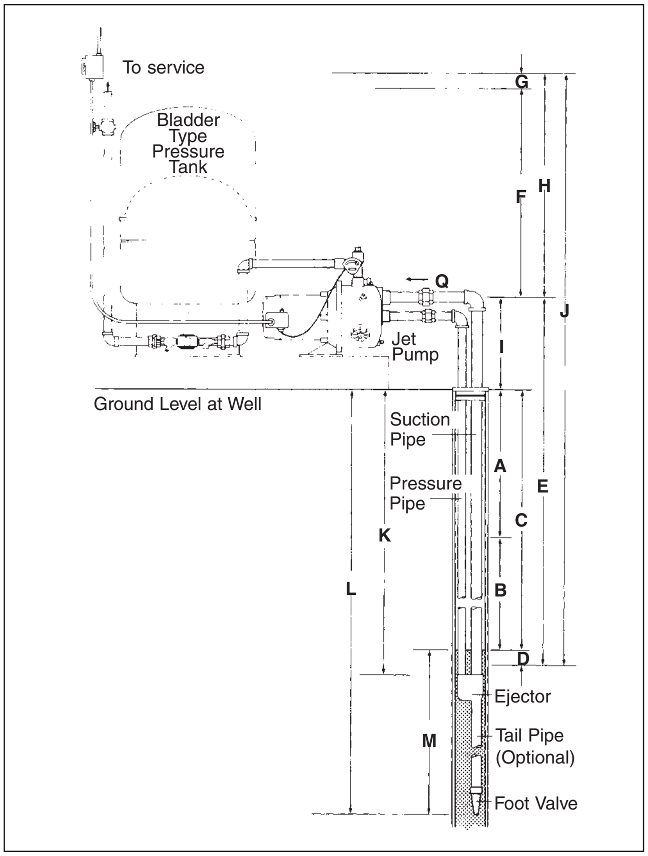


FIGURE 8-E
Figure 8-E illustrates a schematic layout of an DEEP WELL groundwater pumping system using a deep well JET PUMP designed for settings to 100 feet. The pressure tank is set for automatic operation with a pressure switch controlling the cycling of the pump.

CLOSED GROUNDWATER SYSTEM WITH SHALLOW WELL JET PUMP

A. Static Water Level (in feet): vertical distance from the top of the well to the standing water level or water table.

B. Drawdown (in feet): reduction in the water level during pumping (varies with well yield and pump capacity).

C. Pumping Water Level or Lift (in feet): C = A + B.

D. Friction Losses in the Suction System (in feet): friction losses caused by suction piping between the pump and foot valve.

E. Total Suction Lift (in feet): E = A + B + D + I.

F. Static Discharge Head (in feet): for PRESSURE TANK SYSTEMS it is the elevation rise in feet of the pressure tank, discharge nozzles, etc., above the pump plus the pressure (in feet) discharge nozzles, etc., above the pump plus the pressure (in feet) required at that level. For OPEN DISCHARGE SYSTEMS it is the elevation in feet of the highest water level above the pump.

G. Friction Losses in the Discharge System (in feet): friction losses caused by piping, valves, and fittings between the top of the well and the point of discharge.

H. Total Discharge Head (in feet): H = F + G.

I. Elevation of the Pump above the Top of the Well (in feet).

J. Total Pumping Head (in feet): J = E + H.

K. Setting of the Foot Valve or Strainer (in feet): vertical distance from the top of the well to the top of the foot valve or strainer.

L. Overall Length (in feet): vertical distance from the top of the well to the bottom of the foot valve or strainer.

M. Submergence (in feet): M=K–C. The ejector should be set as close to the bottom of its maximum depth rating as the well will permit.

Q. Capacity (in gpm or gph): rate of pumping.

Head and Pressure

Head and pressure are related in a very simple and direct manner. Since water has known weight, we know that a 231 foot long, one-inch square pipe holds 100 pounds of water. At the bottom of the one-inch square pipe we refer to the pressure as 100 pounds per square inch (psi). For any diameter pipe 231 feet high, the pressure will always be 100 psi at the bottom. Refer to Figure 8-F.

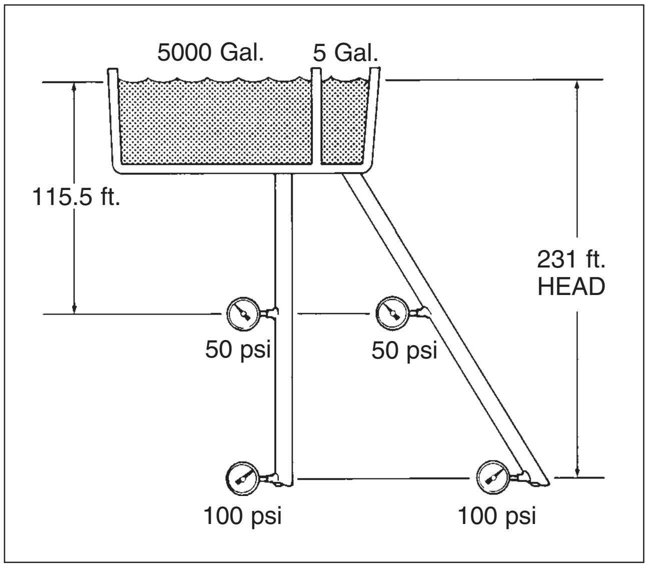


FIGURE 8-F
Figure 8-F illustrates the relationship between head and pressure.

Head is usually expressed in feet and refers to the height, or elevation, of the column of water. In Figure 8-F we see that a column of water 231 feet high creates a pressure reading of 100 psi. That same column of water is referred to as having 231 feet of **head**. Thus, for water, 231 feet of head is equivalent to 100 psi. Or, 2.31 feet of head equals 1 psi.

It should be noted that head and pressure readings for non-flowing water depend on the elevation of the water and not on the volume of water nor the size or length of piping.

Flow and Friction Loss

Flow is measured as the volume of water moved over a given length of time. This is generally referred to as gallons per minute (gpm) for larger flows and gallons per hour (gph) for smaller flows. When water moves through a pipe, it must overcome resistance to flow caused by friction as it moves along the walls of the pipe as well as resistance caused by its own turbulence. Added together, these losses are referred to as **friction losses** and may significantly reduce system pressure.

Figure 8-G illustrates the relationship of flow and friction loss. For any flow through a level pipe the gauge pressure at the pipe inlet will be greater than the gauge pressure at the pipe outlet. The difference is attributed to friction losses caused by the pipe itself and by fittings.

In general, friction losses occur or are increased under the following conditions:

1. Friction losses result from flow through any size or length of pipe (Figure 8-G).
2. Friction losses increase as the flow rate increases or as the pipe size decreases (if the flow rate doubles for a given pipe size, friction losses quadruple, Figure 8-G).
3. Friction losses increase with the addition of valves and fittings to the system (Figure 8-G).

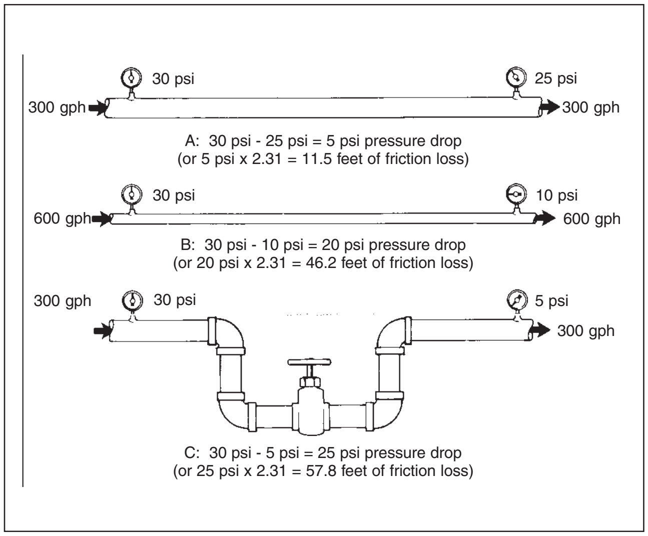


FIGURE 8-G
As shown in these illustrations friction losses increase with additional flow

Power is required to push water to a higher elevation, to increase outlet pressure, to increase flow rates, and to overcome friction losses. Good system design and common sense indicate that friction losses should be minimized whenever possible. The costs of larger pumps, bigger motors, and increased power consumption to overcome friction losses must be balanced against the increased cost of larger, but more efficient, system piping. In either case, unnecessary valves and fittings should be eliminated wherever possible.

Submersible Pumps vs. Jet Pumps

Submersible and jet pumps are both used in domestic groundwater systems. When high flow rates and pressure settings are required at high operating efficiencies, submersible pumps are generally preferred. Submersible pumps have the advantage of performing well both in shallow well applications as well as at depths to 2,000 feet. An extensive range of submersible pump models is also available allowing a precise match to exact system requirements.

Convertible jet pumps are sometimes an economical alternative to submersibles, especially in shallow well installations of 25 feet or less. The pumps are less expensive, installation is simplified, and they are easily converted for deep well installations down to 100 feet (Figure 8-H).

In “weak” well applications where the pump lowers the water level in the well faster than the well can replenish itself, a deep well jet pump with a tail pipe is particularly effective when flow requirements are relatively small. By adding 35 feet of tail pipe below the jet assembly with the foot valve attached to the bottom, it will not be possible to pull the well down and allow air to enter the system. Pump delivery remains at 100% of the rated capacity down to the level of the jet assembly. If the water level falls below that point, flow decreases in proportion to the drawdown as shown in Figure 8-I. When pump delivery equals well inflow, the water level remains constant until the pump shuts off. At 33.9 feet of drawdown the pump will no longer deliver water but the foot valve will remain fully submerged.

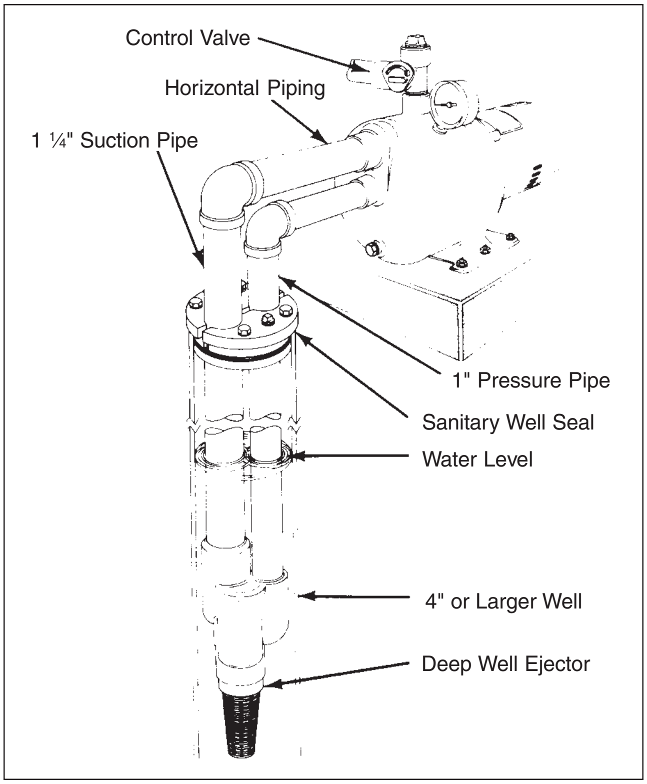


FIGURE 8-H
Figure 8-H illustrates a convertible jet pump set for deep well use (to 100 feet).

Final Pump Selection

Final pump selection will depend upon specific application requirements and cost considerations. Regardless of the pump type, system flow and head requirements (discussed in detail in Part 2) must be determined prior to actual pump selection.

Flow requirement will be determined by the size of the house or farm (including the number of bathrooms, outlets and appliances), the size of family, and the number of farm animals, if applicable.

Total Pumping Head must be calculated to ensure that the pump selected will meet all head or discharge pressure requirements. Total pumping head is the combination of the total suction lift (or lift in well), plus the pump discharge head (consisting of the elevation from the pumping water level to pressure tank plus pressure tank discharge pressure), plus all system friction losses.

Total Dynamic Head is equivalent to total pumping head plus velocity head. In most residential systems, velocity head is negligible. Because of this, the velocity head term has been left out of future examples and formulas. From the information gathered on flow and head requirements, a specific submersible or jet pump may be selected and an appropriately sized pressure tank ordered.

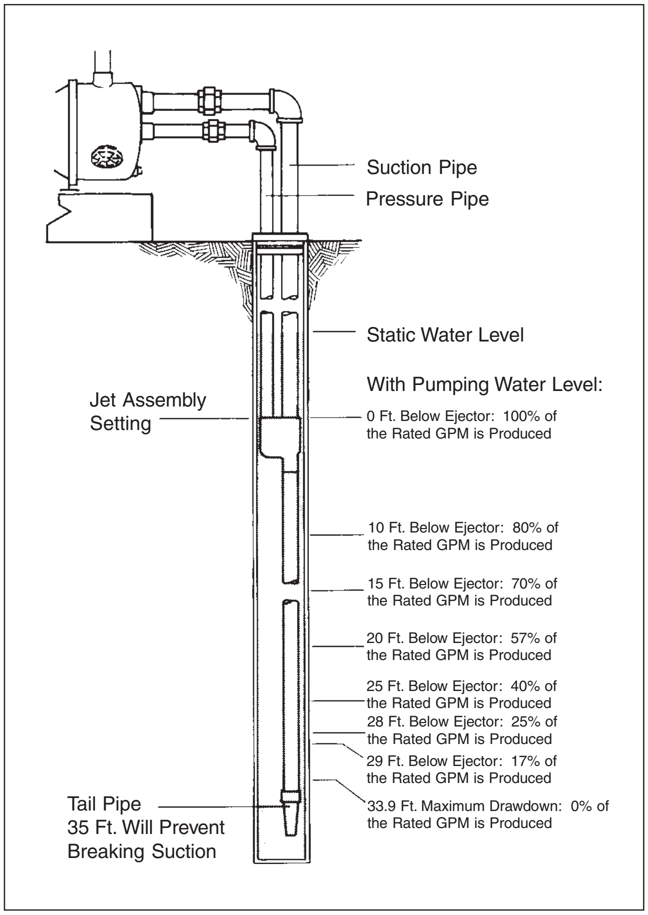


FIGURE 8-I
Figure 8-I illustrates the use of a tail pipe on a deep well convertible jet pump to compensate for weak well conditions.

PART 2: CABLE SELECTION

Submersible Pump Cable Selection Charts (60 Hz)

CABLE LENGTH SELECTION TABLES

The following table (Table 8-Q(2)) lists the recommended copper cable sizes and various cable lengths for submersible pump motors. Proper wire size will ensure that adequate voltage will be supplied to the motor.

This table complies with the 1978 edition of the National Electric Table 310-16, Column 2 for 75°C wire. The ampacities (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To assure adequate starting torque, the maximum cable lengths are calculated to maintain 95% of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power usage.

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

CALCULATING MIXED CABLE SIZES

In a submersible pump installation any combination of cable sizes may be used as long as the total percentage length of the individual cables does not exceed 100%. Mixed cable sizes are most often encountered when a pump is being replaced with a larger horsepower model and part of the old cable will be left in place.

In the following example, a 2 HP, 230 volt, 1 phase pump is being installed to replace a smaller model. The 115 feet of buried #12 cable located between the service entrance and the well head will be used in the replacement installation. The well driller must be able to calculate the required size of cable in the well to connect the new motor at a setting of 270 feet.

Cable Size Calculation:
Step 1–Check Table 8-Q(2) to see if the 115 feet of existing #12 cable is large enough to provide current to the larger 2 HP replacement pump. The table tells us that #12 cable is adequate for a maximum length of 250 feet.

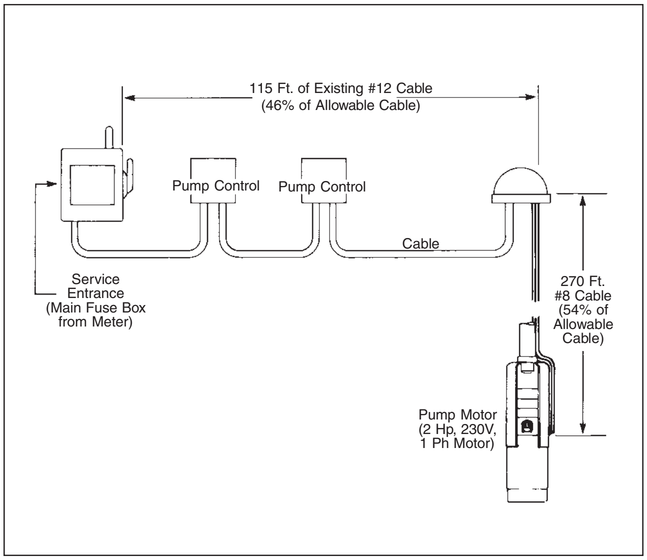


FIGURE 8-Q(1)
Example of Mixed Cable Installation

Step 2–Since 250 feet is the maximum allowable cable length for the #12 cable, calculate the percent used by the 115-foot run. (115 ft. ÷ 250 ft. = 46%)

Step 3–With 46% of the total allowable cable used between the service entrance and the well head, 54% remains for use in the well (100% - 46% = 54%). Therefore, the 270 feet of cable required in the well can utilize only 54% of the total feet allowed in the table.

Step 4–From Table 8-Q(2) determine the proper size cable required for the 2 HP pump set at 270 feet. (Remember, you are limited to 54% of the length listed in the table.) A check of #10 cable at 2 HP indicates that only 210 feet of this cable could be used (390 ft. x 54% = 210 ft.). Since this is less than the 270 required, the next larger size should be tried. For #8 cable, 54% of 620 feet = 335 feet. ***The #8 cable is suitable for use in the well at a pump setting of 270 feet.***

See Chart 8-Q(2) next page.

MAXIMUM MOTOR CABLE LENGTH

(Motor Service to Entrance)

TABLE 8-Q(2)
Single Phase 60Hz

Motor Rating		Copper Wire Size												
Volts	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**	**0**	**00**	**000**	**0000**	**250**	**300**
115	1/3	130	210	340	540	840	1300	1960	2910					
	1/2	100	160	250	390	620	960	1460	2160					
230	1/3	550	880	1390	2190	3400	5250	7960						
	1/2	400	650	1020	1610	2510	3880	5880						
	3/4	300	480	760	1200	1870	2890	4370	6470					
	1	250	400	630	990	1540	2380	3610	5360	6520				
	1½	190	310	480	770	1200	1870	2850	4280	5240				
	2	150	250	390	620	970	1530	2360	3620	4480				
	3	120	190	300	470	750	1190	1850	2890	3610				
	5			180	280	450	710	1110	1740	2170				
	7½				200	310	490	750	1140	1410				
	10					250	390	600	930	1160				

Three Phase 60Hz

Volts	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**	**0**	**00**	**000**	**0000**	**250**	**300**
208	1½	310	500	790	1260									
	2	240	390	610	970	1520								
	3	180	290	470	740	1160	1810							
	5		170	280	440	690	1080	1660						
	7½			200	310	490	770	1180	1770					
	10				230	370	570	880	1330	1640				
	15					250	390	600	910	1110	1340			
	20						300	460	700	860	1050	1270		
	25							370	570	700	840	1030	1170	
	30							310	470	580	700	850	970	1110
230	1½	360	580	920	1450									
	2	280	450	700	1110	1740								
	3	210	340	540	860	1340	2080							
	5		200	320	510	800	1240	1900						
	7½			230	360	570	890	1350	2030					
	10				270	420	660	1010	1520	1870				
	15					290	450	690	1040	1280	1540			
	20						350	530	810	990	1200	1450		
	25						280	430	650	800	970	1170	1340	
	30							350	540	660	800	970	1110	1270
460	1½	1700												
	2	1300	2070											
	3	1000	1600	2520										
	5	590	950	1500	2360									
	7½	420	680	1070	1690	2640								
	10	310	500	790	1250	1960	3050							
	15			540	850	1340	2090	3200						
	20			410	650	1030	1610	2470	3730					
	25				530	830	1300	1990	3010	3700				
	30				430	680	1070	1640	2490	3060	3700			
	40						790	1210	1830	2250	2710	3290		
	50						640	980	1480	1810	2190	2650	3010	
	60							830	1250	1540	1850	2240	2540	2890
	75								1030	1260	1520	1850	2100	2400
	100									940	1130	1380	1560	1790
	125											1080	1220	1390
	150												1050	1190
	200												1080	1300
	250													1080
575	1½	2620												
	2	2030												
	3	1580	2530											
	5	920	1480	2330										
	7½	660	1060	1680	2650									
	10	490	780	1240	1950									
	15		530	850	1340	2090								
	20			650	1030	1610	2520							
	25			520	830	1300	2030	3110						
	30				680	1070	1670	2560	3880					
	40					790	1240	1900	2860	3510				
	50						1000	1540	2310	2840	3420			
	60						850	1300	1960	2400	2890	3500		
	75							1060	1600	1970	2380	2890	3290	

CAUTION: Use of wire size smaller than listed will void warranty.

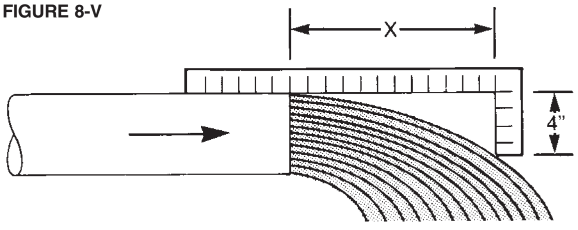
Notes:
1. If aluminum conductor is used, multiply lengths by 0.5 Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

Calculating Discharge Rate by Using The Horizontal Open Discharge Method

The most reliable method of measuring flow is to use a flow meter. When a flow meter is not available, however, it is possible to estimate the discharge capacity by constructing an "L" shaped measuring stick similar to that shown in Figure 8-V. With the water flowing from the pipe, place the long end of the "L" on top of the pipe. Position the "L" so that the end of the short 4-inch side just touches the stream of water as the stream slants downward. Note the horizontal distance "X" from this point to the open end of the discharge pipe. With the value "X" and and the nominal inside diameter of the pipe, use Table 8-X to find the discharge rate in gallons per minute.

EXAMPLE: Horizontal distance "X" is measured to be 12 inches. The size of the pipe Is known to be 1½" (nominal diameter). Find 12 inches in the left hand column of the chart and move across to the 1½" pipe size column. Table 8-X indicates that the discharge rate is 40.0 gallons per minute.

FIGURE 8-V



Calculating Low Capacity Outlets: A simple procedure for measuring low capacity outlets such as small pump outlets, hose spigots, and faucets is to record the amount of time it takes to fill a container of known size.

EXAMPLE: Select a container of known size such as a 5-gallon paint bucket. With a watch, measure, in seconds, the amount of time it takes to fill the bucket. If it takes 30 seconds to fill a 5-gallon bucket, Table 8-W indicates that the flow is 10.0 gallons per minute. To obtain gallons per hour (gph) multiply 10.0 x 60 to obtain 600 gph.

TABLE 8-W

Discharge Rate in Gallons Per Minute (GPM) for Low Capacity Systems

Capacity of Container (Gallons)	Time (in seconds) to Fill Container							
	10	15	20	30	45	60	90	120
	Discharge Rate in Gallons Per Minute (GPM)							
1	6.0	4.0	3.0	2.0	1.3	1.0	.7	.5
3	18.0	12.0	9.0	6.0	4.0	3.0	2.0	1.5
5	30.0	20.0	15.0	10.0	6.7	5.0	3.3	2.5
10	60.0	40.0	30.0	20.0	13.3	10.0	6.7	5.0

NOTE: Multiply gallons per minute (GPM) by 60 to obtain gallons per hour (GPH).

Calculating Distance to Water Level

Install ⅛" or ¼" pipe or tubing into the well so that the end of the tubing extends 10 to 20 feet below the lowest possible pumping water level. Be sure that all joints in the tubing are airtight. As the tubing is lowered into the well measure its length. Record the measurement.

TABLE 8-X

Discharge Rate in Gallons Per Minute (GPM) for Large Capacity Systems

Horiz. Dist. (X) Inches	Nominal Pipe Size (in Inches)									
	1	1 ¼"	1 ½"	2"	2 ½"	3"	4"	5"	6"	8"
	Discharge Rate in Gallons Per Minute (GPM)									
4	5.7	9.8	13.3	22.0	31	48	83			
5	7.1	12.2	16.6	27.5	39	61	104	163		
6	8.5	14.7	20.0	33.0	47	73	125	195	285	
7	10.0	17.1	23.2	38.5	55	85	146	228	334	380
8	11.3	19.6	26.5	44.0	62	97	166	260	380	665
9	12.8	22.0	29.8	49.5	70	110	187	293	430	750
10	14.2	24.5	33.2	55.5	78	122	208	326	476	830
11	15.6	27.0	36.5	60.5	86	134	229	360	525	915
12	17.0	29.0	40.0	66.0	94	146	250	390	570	1000
13	18.5	31.5	43.0	71.5	102	158	270	425	620	1080
14	20.0	34.0	46.5	77.0	109	170	292	456	670	1160
15	21.3	36.3	50.0	82.5	117	183	312	490	710	1250
16	22.7	39.0	53.0	88.0	125	196	334	520	760	1330
17		41.5	56.5	93.0	133	207	355	550	810	1410
18			60.0	99.0	144	220	375	590	860	1500
19				100.0	148	232	395	620	910	1580
20					156	244	415	650	950	1660
21						256	435	685	1000	1750

Once the tubing is fixed in a stationary position at the top of the well, connect an air line and pressure gauge. With a tire pump or other air supply, pump air into the line until the pressure gauge reaches a point where it doesn't read any higher. Record the pressure gauge reading at this point.

Figure 8-Y illustrates a typical method for measuring distance to water level:

X = Distance to water level (in feet). This figure to be determined.

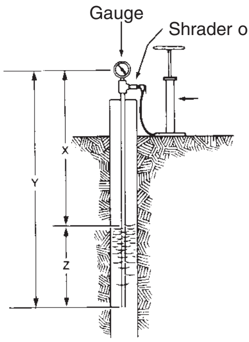
Y = Total length of air line (in feet).

Z = Length of submerged air line. This value is obtained from the pressure gauge reading which reads in pounds per square inch (psi). Multiply the pressure gauge reading by 2.31 to obtain the length of the submerged air line in feet.

Distance to water level (X) = (Y) - (Z)
= The total length of the air line (Y) minus the length of the submerged portion of the air line (Z).

Figure 8-Y

Calculating the distance to water level.



Example:
Assume that the air line is 100 feet long and the pressure gauge reads 8 psi. Calculate the distance to water level (X).

8 psi x 2.31 = 18.5 feet

(X) = 100 feet (Y) - 18.5 feet (Z)

= 81.5 feet = distance to water level

FORMULAS

TEMPERATURE CONVERSIONS:

$$\text{Degrees } \mathbf{C} = \frac{5}{9} \text{ x (Degrees F - 32)}$$

$$\text{Degrees } \mathbf{F} = \left(\frac{9}{5} \text{ x Degrees C}\right) + 32$$

Area of a Circle:

$\text{Area} = \pi r^2$

Circumference of a Circle:

$\text{Circumference} = 2 \pi r$

r = radius

$\pi = 3.14$

Volume of a Tank or Cistern:

3.14 x (radius of tank)^2 x (ht. of tank) x 7.48 = Gallons
Radius and height of tank measured in feet
7.48 = number of gallons per cubic foot of water

WORK, POWER, AND EFFICIENCY:

The amount of work required to lift 1 pound to a height of 1 foot is defined as 1 ft.-lb. To lift 100 pounds to a height of 60 feet is 100 pounds x 60 feet = 6,000 ft-lbs. This amount of energy remains the same whether it takes one minute or one hour to lift the weight. The rate of working, however, is referred to as **power** and was 6,000 ft-lbs. per minute in the first case and 100 foot pounds per minute in the second case.

Power can be represented either mechanically or electrically. **Mechanical power** is measured in horsepower (HP). One HP is the theoretical power required to raise 33,000 pounds to a height of one foot in one minute, or:

1 HP = 33,000 ft.-lb./minute
= 550 ft.-lb./second

Electrical power is measured in watts(w) or kilowatts(kw), and:

1,000 w = 1 kw = 1.34 hp, or
1 HP = 745 w = 0.746 kw

WATER HORSEPOWER (WHP):

Water horsepower is the power required to raise water at a specified rate against a specified head, assuming 100% efficiency.

$$\frac{\text{WHP = GPM x Total Pumping Head}}{3{,}960}$$

BRAKE HORSEPOWER (BHP):

Brake horsepower is based on test data and can be either the horsepower developed at the motor shaft (motor output) or that absorbed at the pump shaft (pump input).

$$\text{Pump BHP} = \frac{\text{WHP x 100}}{\text{Pump Efficiency (\%)}}$$

$$= \frac{\text{GPM x Total Pumping Head x 100}}{\text{3,960 x Pump Efficiency (\%)}}$$

$$\text{Motor BHP} = \frac{\text{Power input x Motor Efficiency (\%)}}{100}$$

$$= \frac{\text{1.34 x kw input x Motor Efficiency (\%)}}{100}$$

PUMP EFFICIENCY:

Pumps and motors, like all machines, are not 100% efficient. Not all of the energy supplied to them is converted into useful work. Pump efficiency is the ratio of power output to power input, or:

$$\text{Efficiency (\%)} = \frac{\text{Power Output x 100}}{\text{Power Input}}$$

$$\text{Pump Eff. (\%)} = \frac{\text{WHP x 100}}{\text{Pump BHP (Input)}}$$

$$= \frac{\text{GPM x Total Pumping Head x 100}}{\text{3960 x Pump BHP (Input)}}$$

$$\text{Motor Eff. (\%)} = \frac{\text{Motor BHP (Output) x 100}}{\text{1.34 x kw input}}$$

$$\text{Plant Eff. (\%)} = \frac{\text{GPM x Total Pumping Head x 100}}{\text{5,300 x kw Input}}$$

ELECTRIC POWER (AC):

E = Electrical pressure (volts). Similar to hydraulic head.

I = Electrical current (amps). Similar to rate of flow.

W = Electrical power (watts) = E x I x PF

kw = Kilowatt (1,000 watts)

kw-hr. = Kilowatt-hour = 1,000 watts for one hour

Apparent Power = E x I = volt-amperes

PF = Power Factor = Useful Power ÷ Apparent Power

Power Calculations for Single-Phase Power
W (Watts) = E x I x PF
NOTE: When measuring single-phase power use a single-phase wattmeter.

Input HP to motor = W ÷ 746 = 1.34 x kw

Power Calculations for Three-Phase Power
W (Watts) = 1.73 x E x I x PF
Where: E = effective (RMS) voltage between phases
I = average current in each phase
NOTE: When measuring three-phase power use either (1) three-phase wattmeter, (2) single-phase wattmeters, or the power company's revolving disc wattmeter.

When calculating power with a revolving disc wattmeter use the following formulas:

$$\text{kw input} = \frac{\text{K x R x 3.60}}{t}$$

$$\text{Input HP (to motor)} = \frac{\text{K x R x 3,600}}{\text{746 x t}}$$

$$= \frac{\text{K x R x 4.83}}{t}$$

FORMULAS

$$\text{Motor BHP (output)} = \frac{\text{Input HP x Motor Eff.(\%)}}{100}$$

Where K = Meter constant = watts per revolution of revolving disc (value of K is marked on the meter nameplate or on the revolving disc). Where current transformers are used, multiply meter constant by current transformer ratio.

R = Number of disc revolutions counted.
t = Time in seconds for R revolutions.

CALCULATING OPERATING COSTS OF PUMPS:
Costs in Cents per 1,000 Gallons:

$$\text{Cost (¢)} = \frac{\text{kw Input x r x 1,000}}{\text{GPH}}$$

Cost in Cents per Acre-Inch

$$\text{Cost (¢)} = \frac{\text{kw Input x r x 452.6}}{\text{GPM}}$$

Where: r = cost of power in cents per kw-hr.

FRICTION LOSS TABLES

Friction Loss Table – SCH 40 STEEL PIPE

(Friction Loss in Feet of Head Per 100 Feet of Pipe)

		1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
GPM	GPH	ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
2	120	4.8								
3	180	10	2.5							
4	240	17.1	4.2							
5	300	25.8	6.3	1.9						
6	360	36.5	8.9	2.7						
7	420	48.7	11.8	3.6						
8	480	62.7	15	4.5						
9	540	78.3	18.8	5.7						
10	600	95.9	23	6.9	1.8					
12	720		32.6	9.6	2.5	1.2				
14	840		43.5	12.8	3.3	1.5				
16	960		56.3	16.5	4.2	2				
20	1,200		86.1	25.1	6.3	2.9				
25	1,500			38.7	9.6	4.5	1.3			
30	1,800			54.6	13.6	6.3	1.8			
35	2,100			73.3	18.2	8.4	2.4			
40	2,400			95	23.5	10.8	3.1	1.3		
45	2,700				29.4	13.5	3.9	1.6		
50	3,000				36	16.4	4.7	1.9		
60	3,600				51	23.2	6.6	2.7		
70	4,200				68.8	31.3	8.9	3.6	1.2	
80	4,800				89.2	40.5	11.4	4.6	1.6	
90	5,400					51	14.2	5.8	2	
100	6,000					62.2	17.4	7.1	2.4	
120	7,200						24.7	10.1	3.4	
140	8,400						33.2	13.5	4.5	1.2
160	9,600						43	17.5	5.8	1.5
200	12,000						66.3	27	8.9	2.3
260	15,600							45	14.8	3.7
300	18,000							59.6	19.5	4.9

Friction Loss Table – SCH 40 PVC

(Friction Loss in Feet of Head Per 100 Feet of Pipe)

		1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
GPM	GPH	ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
2	120	4.1								
3	180	8.7	2.2							
4	240	14.8	3.7							
5	300	22.2	5.7	1.8						
6	360	31.2	8	2.5						
7	420	41.5	10.6	3.3						
8	480	53	13.5	4.2						
9	540	66	16.8	5.2						
10	600	80.5	20.4	6.3	1.7					
12	720		28.6	8.9	2.3	1.1				
14	840		38	11.8	3.1	1.4				
16	960		48.6	15.1	4	1.9				
20	1,200		60.5	22.8	6	2.8				
25	1,500			38.7	9.1	4.3	1.3			
30	1,800				12.7	6	1.8			
35	2,100				16.9	8	2.4			
40	2,400				21.6	10.2	3	1.1		
45	2,700				28	12.5	3.8	1.4		
50	3,000					15.4	4.6	1.7		
60	3,600					21.6	6.4	2.3		
70	4,200					28.7	8.5	3	1.2	
80	4,800					36.8	10.9	3.8	1.4	
90	5,400					45.7	13.6	4.8	1.8	
100	6,000					56.6	16.5	5.7	2.2	
120	7,200						23.1	8	3	
140	8,400						30.6	10.5	4	1.1
160	9,600						39.3	13.4	5	1.4
200	12,000						66.3	20.1	7.6	2.1
260	15,600							32.4	12.2	3.4
300	18,000							42.1	15.8	4.4

Friction Loss Table – VALVES and FITTINGS

(Friction Loss in Equivalent Number of Feet of Straight Pipe)

TYPE OF FITTING AND APPLICATION	PIPE AND FITTING	NOMINAL SIZE OF FITTING AND PIPE						
		1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"
		EQUIVALENT LENGTH OF PIPE(IN FEET)						
Insert Coupling	Plastic	3	3	3	3	3	3	3
Threaded Adapter (Plastic to Thread)	Plastic	3	3	3	3	3	3	3
90° Standard Elbow	Steel	2	2	3	4	4	5	6
	Plastic	2	2	3	4	4	5	6
Standard Tee (Flow Through Run)	Steel	1	2	2	3	3	4	4
	Plastic	1	2	2	3	3	4	4
Standard Tee (Flow Through Side)	Steel	4	5	6	7	8	11	13
	Plastic	4	5	6	7	8	11	13
Gate Valve[1]	Steel	1	1	1	1	2	2	2
Swing Check Valve[1]	Steel	5	7	9	12	13	17	21

NOTES:

Based on schedule 40 steel and plastic fittings.

Figures given are friction losses in terms of Equivalent Lenghts of straight pipe.

① Friction loss figures are for screwed valves and are based on equivalent lengths of steel pipe.

CONVERSION TABLES

UNITS OF FLOW

CONVERT TO ➧ CONVERT FROM ⬇	U.S. GALLONS PER MINUTE	MILLION U.S. GALLONS PER DAY	CUBIC FEET PER SECOND	CUBIC METERS PER HOUR	LITERS PER SECOND
	MULTIPLY BY:				
(1) U.S. GALLON PER MINUTE	1	0.001440	0.00223	0.2271	0.0631
(1) MILLION U.S. GALLONS PER DAY	694.5	1	1.547	157.7	43.8
(1) CUBIC FOOT PER SECOND	448.83	0.646	1	101.9	28.32
(1) CUBIC METER PER HOUR	4.403	0.00634	0.00982	1	0.2778
(1) LITER PER SECOND	15.85	0.0228	0.0353	3.60	1

UNITS OF PRESSURE AND HEAD

CONVERT TO ➧ CONVERT FROM ⬇	LBS. PER SQUARE INCH	FEET OF WATER ①	METERS OF WATER ①	INCHES OF MERCURY ②	ATMOSPHERES	KILOGRAMS PER SQUARE CM
	MULTIPLY BY:					
(1) LB. PER SQUARE INCH	1	2.31	0.704	2.04	0.0680	0.0703
(1) FOOT OF WATER ①	0.433	1	0.305	0.881	0.02945	0.0304
(1) METER OF WATER ①	1.42	3.28	1	2.89	0.0966	.1
(1) INCH OF MERCURY ②	0.491	1.135	0.346	1	0.0334	0.0345
(1) ATMOSPHERE (at Sea Level)	14.70	33.96	10.35	29.92	1	1.033
(1) KILOGRAM PER SQUARE CM	14.22	32.9	10	28.96	0.968	1

NOTES: ① Equivalent units are based on density of fresh water at 68°F.
② Equivalent units are based on density of mercury at 32°F.
Each 1,000 feet of ascent decreases pressure about ½ pound per square inch.

UNITS OF VOLUME AND WEIGHT

CONVERT TO ➧ CONVERT FROM ⬇	U.S. GALLONS	IMPERIAL GALLONS	CUBIC INCHES	CUBIC FEET	ACRE FEET	POUNDS ③	CUBIC METERS	LITERS
(1) U.S. GALLON	1	0.833	231	0.1337	$3.07x10^{-6}$	8.34	0.003785	3.785
(1) IMPERIAL GALLON	1.201	1	277.4	0.1605	$3.69x10^{-6}$	10.01	0.004546	4.546
(1) CUBIC INCH	0.00433	0.00360	1	0.000579	—	0.0361	$1.64x10^{-5}$	0.0164
(1) CUBIC FOOT	7.48	6.23	1728	1	$2.30x10^{-5}$	62.4	0.02832	28.32
(1) ACRE FOOT	325,850	271,335	—	43,560	1	$2.7x10^{6}$	1233.5	$1.23x10^{6}$
(1) POUND ③	0.120	0.0998	27.7	0.0160	$3.68x10^{-7}$	1	$4.54x10^{-4}$	0.454
(1) CUBIC METER	264.2	220	61,024	35.315	$8.11x10^{-4}$	2202	1	1000
(1) LITER	0.2642	0.220	61.024	0.0353	$8.11x10^{-7}$	2.202	0.001	1

NOTES: ③ Weight equivalent basis water at 60°F.

UNITS OF LENGTH

(1) Inch = 0.0833 Ft. = 0.0278 Yd. = 25.4 mm = 2.54 cm
(1) Ft. = 12 Inches = 0.333 Yd. = 30.48 cm = 0.3048 Meter
(1) Yard = 36 Inches = 3 Ft. = 91.44 cm = 0.9144 Meters

(1) Mile = 5280 Ft. = 1760 Yds. = 1.61 km = 1609 Meters
(1) Meter = 3.281 Ft. = 39.37 In. = 0.000621 Miles = 0.001 km
(1) Kilometer = 1000 m = 1093.61 Yds. = 0.62137 Miles = 3281 Ft.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

L-SP-PG-001	2/06
PRINTED IN USA	

Subject to alterations.

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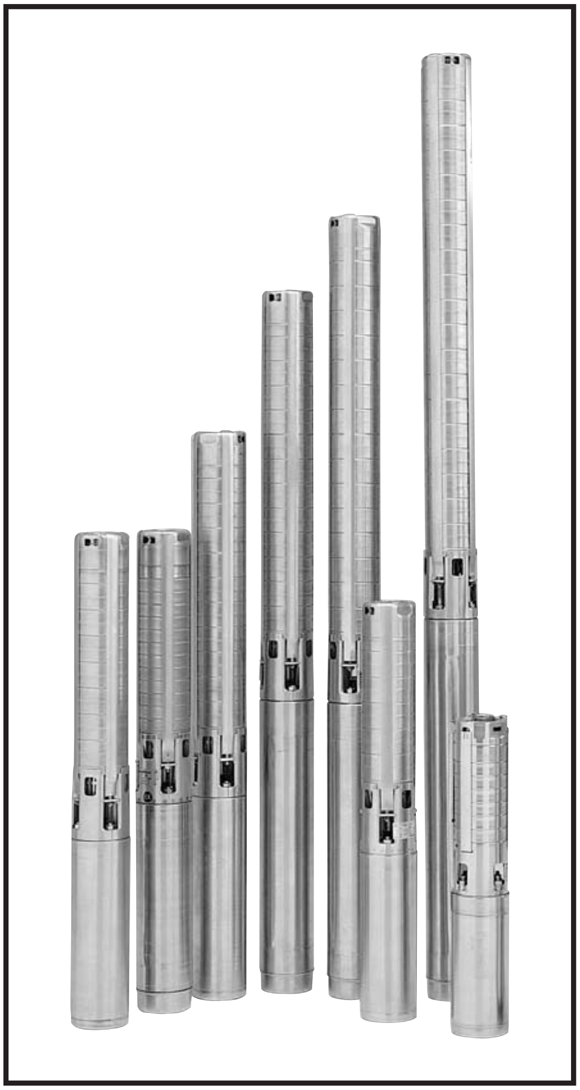
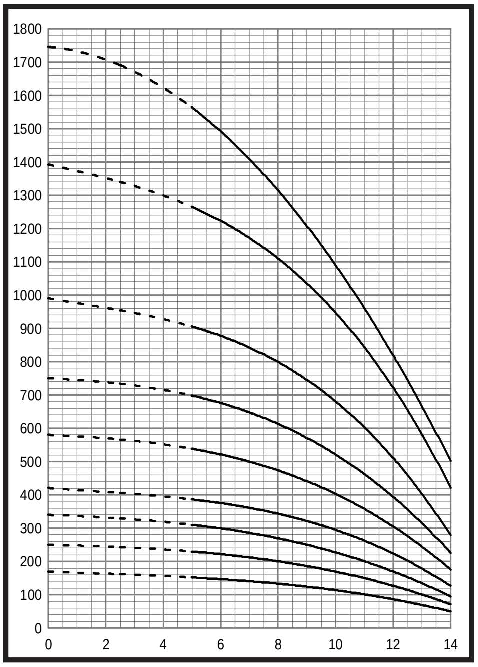
GRUNDFOS®

Easy Selection Chart
Performance Curves and Technical Data
4-Inch Submersible Pumps





Performance Curves

Materials of Construction

Grundfos Stainless Steel Submersible Pumps

4" Submersible
Easy Selection Charts.

SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)
40 GPM
FLOW RANGE
(24 TO 55 GPM)
DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET
PUMP OUTLET
2" NPT

10 GPM
FLOW RANGE
(5 TO 14 GPM)
SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)
DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET
PUMP OUTLET
1 1/4" NPT

See 10S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

5 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE

(1.2 TO 7 GPM)

PUMP OUTLET
1 " NPT

DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																											
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
5S03-9	**1/3**	0				7.1	6.7	6.2	5.8	5.3	4.8	4.3	3.2	2.1													
		20		7.0	6.6	6.1	5.7	5.2	4.6	4.0	2.8	1.6															
		30		6.5	6.0	5.6	5.1	4.6	3.8	2.9	1.5																
		40	6.7	6.0	5.5	5.1	4.4	3.8	2.4																		
		50	6.2	5.5	4.9	4.4	3.4	2.5	1.3																		
		60	5.6	4.9	4.2	3.5	1.9																				
SHUT-OFF PSI:			102	94	85	76	68	59	50	42	33	24	16	7													
5S05-13	**1/2**	0						7.1	6.8	6.4	6.1	5.8	5.5	5.2	4.8	4.5	3.9	2.3									
		20			7.3	7.0	6.7	6.3	6.0	5.7	5.4	5.1	4.7	4.3	3.7	3.1	2.0										
		30		7.2	6.9	6.6	6.3	6.0	5.7	5.4	5.0	4.7	4.2	3.7	2.8	2.0											
		40	7.2	6.9	6.6	6.3	5.9	5.6	5.3	5.0	4.6	4.2	3.5	2.8	1.6												
		50	6.8	6.5	6.2	5.9	5.6	5.3	4.9	4.6	4.0	3.5	2.6	1.6													
		60	6.5	6.2	5.8	5.5	5.2	4.9	4.5	4.0	3.3	2.6	1.3														
SHUT-OFF PSI:			152	143	134	126	117	108	100	91	82	74	65	56	48	39	30	13									
5S07-18	**3/4**	0								7.1	6.9	6.7	6.4	6.2	6.0	5.8	5.6	5.1	4.2	2.7							
		20						7.1	6.8	6.6	6.4	6.2	5.9	5.7	5.5	5.3	5.0	4.5	3.2								
		30					7.0	6.8	6.6	6.3	6.1	5.9	5.7	5.5	5.2	5.0	4.7	4.0	2.5								
		40			7.2	7.0	6.8	6.5	6.3	6.1	5.9	5.6	5.4	5.2	4.9	4.7	4.4	3.5	1.5								
		50		7.2	7.0	6.7	6.5	6.3	6.1	5.8	5.6	5.4	5.1	4.9	4.6	4.3	3.9	2.9									
		60	7.1	6.9	6.7	6.5	6.2	6.0	5.8	5.6	5.3	5.1	4.9	4.6	4.3	3.9	3.4	2.1									
SHUT-OFF PSI:			213	204	195	187	178	169	161	152	143	135	126	117	109	100	91	74	48	22							
5S10-22	**1**	0										7.1	6.9	6.7	6.6	6.4	6.2	5.8	5.3	4.7	3.8	1.7					
		20								7.1	6.9	6.7	6.5	6.3	6.1	6.0	5.8	5.4	4.8	4.0	2.8						
		30							7.0	6.8	6.7	6.5	6.3	6.1	5.9	5.7	5.6	5.2	4.6	3.6	2.1						
		40						7.0	6.8	6.6	6.5	6.3	6.1	5.9	5.7	5.5	5.4	5.0	4.3	3.1	1.3						
		50				7.2	7.0	6.8	6.6	6.4	6.2	6.1	5.9	5.7	5.5	5.3	5.1	4.7	3.9	2.5							
		60			7.1	6.9	6.8	6.6	6.4	6.2	6.0	6.0	5.7	5.5	5.3	5.1	4.9	4.4	3.5	1.7							
SHUT-OFF PSI:					245	237	228	219	211	202	194	185	176	168	159	150	142	124	98	72	46	12					
5S15-26	**1 1/2**	0												7.1	7.0	6.8	6.7	6.4	5.9	5.4	4.9	4.1	2.1				
		20										7.1	6.9	6.8	6.6	6.5	6.3	6.0	5.5	5.1	4.5	3.4					
		30									7.1	6.9	6.7	6.6	6.4	6.3	6.1	5.8	5.4	4.8	4.2	2.9					
		40								7.0	6.9	6.7	6.6	6.4	6.3	6.1	6.0	5.6	5.2	4.6	5.6	2.4					
		50							7.0	6.9	6.7	6.5	6.4	6.2	6.1	5.9	5.8	5.5	5.0	4.4	3.6	1.7					
		60						7.0	6.8	6.7	6.5	6.4	6.2	6.1	5.9	5.8	5.6	5.3	4.8	4.1	3.1						
SHUT-OFF PSI:								269	260	252	243	234	226	217	208	200	191	174	148	122	96	61	18				
5S15-31	**1 1/2**	0														7.1	7.0	6.7	6.3	5.9	5.5	6.7	4.1	2.6			
		20												7.1	6.9	6.8	6.7	6.4	6.0	5.6	5.2	4.6	3.5	1.6			
		30											7.0	6.9	6.8	6.6	6.5	6.2	5.9	5.5	5.1	4.4	3.2	0.9			
		40										7.0	6.9	6.8	6.6	6.5	6.4	6.1	5.7	5.3	4.9	4.2	2.8				
		50								7.1	7.0	6.9	6.7	6.6	6.5	6.3	6.2	6.0	5.6	5.2	4.7	4.0	2.3				
		60							7.1	7.0	6.8	6.7	6.6	6.5	6.3	6.2	6.1	5.8	5.4	5.0	4.5	3.7	1.7				
SHUT-OFF PSI:									320	311	303	294	285	277	268	259	251	233	207	181	155	121	77	34			

See 5S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

7S EASY SELECTION CHART

7 GPM

SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE
(3 TO 10 GPM)

PUMP OUTLET
1 " NPT

			DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
7S03-8	**1/3**	20	10.0	9.5	8.7	8.0	7.2	6.4	5.0	3.7	1.8																
		30	9.3	8.7	7.9	7.1	6.1	5.1	2.6																		
		40	8.5	7.8	7.0	6.1	4.5	2.9	1.5																		
		50	7.6	6.9	5.8	4.7	2.3																				
		60	6.7	5.8	3.9	2.0																					
SHUT-OFF PSI:			86	77	69	60	52	43	34	26	17	8															
7S05-11	**1/2**	0					9.9	9.5	8.9	8.4	7.8	7.3	6.7	6.0	5.0	4.0											
		20			9.8	9.3	8.8	8.2	7.7	7.1	6.5	5.8	4.7	3.5	1.8												
		30	10.1	9.7	9.2	8.7	8.1	7.6	7.0	6.4	5.6	4.7	2.9														
		40	9.6	9.2	8.6	8.1	7.5	6.9	6.2	5.6	4.3	3.0	1.5														
		50	9.1	8.5	8.0	7.4	6.8	6.2	5.3	4.3	2.2																
		60	8.4	7.9	7.3	6.8	6.0	5.3	3.8	2.3																	
SHUT-OFF PSI:			122	113	105	96	87	79	70	61	53	44	35	27	18	10											
7S07-15	**3/4**	0						10.2	9.9	9.5	9.2	8.8	8.4	8.0	7.6	7.1	6.7	5.6	2.9								
		20				10.1	9.8	9.4	9.0	8.6	8.2	7.8	7.4	7.0	6.5	6.1	5.4	3.6									
		30			10.0	9.7	9.4	9.0	8.6	8.2	7.8	7.4	6.9	6.5	5.9	5.4	4.5	1.8									
		40		10.0	9.7	9.3	8.9	8.5	8.1	7.7	7.3	6.9	6.4	5.9	5.2	4.5	3.2	1.0									
		50	9.9	9.6	9.2	8.9	8.5	8.1	7.6	7.2	6.8	6.4	5.8	5.2	4.2	3.2	1.6										
		60	9.5	9.2	8.8	8.4	8.0	7.6	7.2	6.7	6.2	5.7	4.9	4.2	2.8	1.4											
SHUT-OFF PSI:			170	101	153	144	135	127	118	110	101	92	84	75	66	58	49	32	6								
7S10-19	**1**	0								10.1	9.8	9.6	9.3	9.0	8.7	8.4	8.0	7.4	6.4	4.8							
		20						10.0	9.8	9.5	9.2	8.9	8.6	8.3	7.9	7.6	7.3	6.6	5.3	2.8							
		30					10.0	9.7	9.5	9.2	8.9	8.5	8.2	7.9	7.6	7.3	6.9	6.2	4.6	1.4							
		40				10.0	9.7	9.4	9.1	8.8	8.5	8.2	7.8	7.5	7.2	6.9	6.5	5.6	3.7								
		50		10.2	9.9	9.7	9.4	9.1	8.8	8.4	8.1	7.8	7.5	7.2	6.8	6.5	6.0	5.0	2.4								
		60	10.1	9.9	9.6	9.3	9.0	8.7	8.4	8.1	7.8	7.4	7.1	6.8	6.4	6.0	5.5	4.2									
SHUT-OFF PSI:			218	209	200	192	183	174	166	157	148	140	131	123	114	105	97	79	53	27							
7S15-26	**1 1/2**	0											10.1	9.9	9.7	9.5	9.3	8.8	8.1	7.4	6.7	5.5					
		20									10.0	9.8	9.6	9.4	9.2	9.0	8.8	8.3	7.6	6.9	6.1	4.4					
		30								10.0	9.8	9.6	9.4	9.2	9.0	8.7	8.5	8.0	7.3	6.6	5.7	3.7					
		40						10.1	10.0	9.8	9.6	9.4	9.1	8.9	8.7	8.5	8.2	7.8	7.1	6.3	5.2	2.9					
		50					10.1	9.9	9.7	9.6	9.3	9.1	8.9	8.7	8.4	8.2	8.0	7.5	6.8	5.9	4.7	1.9					
		60				10.1	9.9	9.7	9.5	9.3	9.1	8.9	8.6	8.4	8.2	7.9	7.7	7.2	6.5	5.5	4.1						
SHUT-OFF PSI:						274	265	257	248	239	231	222	213	205	196	187	179	161	135	110	84	49					
7S20-32	**2**	0	0										10.6	10.5	10.4	10.4	10.3	10.1	9.6	9.1	8.4	7.3	5.7				
		20	46.2								10.5	10.5	10.4	10.3	10.3	10.2	10.0	9.8	9.2	8.6	7.8	6.6	4.8				
		30	69.3							10.5	10.5	10.4	10.3	10.2	10.1	10.0	9.9	9.6	9.0	8.3	7.5	6.2	4.3				
		40	92.4						10.5	10.5	10.4	10.3	10.2	10.1	10.0	9.9	9.7	9.4	8.8	8.0	7.2	5.8	3.9				
		50	116						10.5	10.4	10.3	10.2	10.1	10.0	9.8	9.7	9.5	9.1	8.5	7.7	6.8	5.4	3.3				
		60	139					10.5	10.4	10.3	10.2	10.1	10.0	9.8	9.7	9.5	9.3	8.9	8.2	7.4	6.4	5.0					
SHUT-OFF PSI:							343	334	326	317	308	300	291	282	274	265	256	239	213	187	161	126	83				

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

10 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE

(5 TO 14 GPM)

PUMP OUTLET
1 1/4" NPT

			DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
10S03-6	**1/3**	20	14.0	13.2	12.4	10.6	8.9	5.3																			
		30	13.2	11.8	10.4	8.4																					
		40	11.9	10.1	8.3																						
		50	9.8	7.5																							
		60	7.7	3.9																							
SHUT-OFF PSI:			64	55	47	38	29	21	12	3																	
10S05-9	**1/2**	0				14.1	13.4	12.4	11.4	10.4	9.5	8.3	6.6	3.5													
		20		13.9	13.1	12.1	11.1	10.1	9.2	7.9	5.8	2.0															
		30	13.8	13.0	12.0	11.0	10.0	9.0	7.6	5.3	1.2																
		40	12.8	11.8	10.8	9.8	8.8	7.3	4.8																		
		50	11.7	10.7	9.7	8.6	7.0	4.3																			
		60	10.5	9.5	8.4	6.7	3.7																				
SHUT-OFF PSI:			100	92	83	74	66	57	48	40	31	23	14	5													
10S07-12	**3/4**	0					14.3	13.8	13.2	12.5	11.7	11.0	10.2	9.5	8.7	7.6	6.0										
		20			14.2	13.6	12.9	12.2	11.5	10.7	10.0	9.3	8.4	7.2	5.4	2.6											
		30		14.1	13.5	12.9	12.1	11.4	10.6	9.9	9.2	8.2	7.0	5.0	2.0												
		40	14.0	13.4	12.8	12.0	11.3	10.5	9.8	9.0	8.1	6.7	4.7	1.4													
		50	13.3	12.6	11.9	11.1	10.4	9.7	8.9	7.9	6.5	4.2															
		60	12.5	11.8	11.0	10.3	9.6	8.8	7.7	6.2	3.8																
SHUT-OFF PSI:			137	129	120	111	103	94	85	77	68	59	51	42	33	25	16										
10S10-15	**1**	0							14.1	13.6	13.1	12.5	11.9	11.3	10.7	10.1	9.6	8.2	3.8								
		20					13.9	13.5	12.9	12.3	11.7	11.1	10.5	10.0	9.4	8.7	7.9	5.2									
		30				13.9	13.4	12.8	12.2	11.6	11.0	10.5	9.9	9.3	8.6	7.7	6.6	2.6									
		40		14.2	13.8	13.3	12.7	12.1	11.5	10.9	10.4	9.8	9.2	8.5	7.6	6.3	4.6										
		50	14.1	13.7	13.2	12.6	12.1	11.4	10.9	10.3	9.7	9.1	8.3	7.4	6.1	4.3	1.7										
		60	13.6	13.1	12.6	12.0	11.4	10.8	10.2	9.6	9.0	8.2	7.2	5.9	3.9												
SHUT-OFF PSI:			174	165	157	148	139	131	122	113	105	96	87	79	70	61	53	35	10								
10S15-21	**1 1/2**	0									14.2	13.9	13.6	13.3	12.9	12.5	12.0	11.2	9.9	8.5	6.3						
		20							14.1	13.9	13.5	13.1	12.7	12.3	11.9	11.5	11.0	10.2	8.9	6.9	2.9						
		30						14.1	13.8	13.5	13.1	12.7	12.3	11.8	11.4	11.0	10.5	9.7	8.3	5.7							
		40					14.1	13.8	13.4	13.0	12.6	12.2	11.8	11.3	10.9	10.5	10.1	9.2	7.5	4.1							
		50				14.0	13.7	13.3	13.0	12.5	12.1	11.7	11.3	10.8	10.4	10.0	9.6	8.7	6.5	2.0							
		60		14.2	14.0	13.6	13.3	12.9	12.5	12.1	11.6	11.2	10.8	10.4	9.9	9.5	9.1	8.0	5.1								
SHUT-OFF PSI:				237	229	220	211	203	194	185	177	168	159	151	142	133	125	107	81	55	29						
10S20-27	**2**	0												14.1	13.9	13.7	13.4	12.8	11.8	10.8	9.8	8.3	4.7				
		20										14.1	13.8	13.6	13.3	13.0	12.7	12.0	11.0	10.0	9.0	7.1	1.5				
		30									14.0	13.8	13.5	13.3	12.9	12.6	12.3	11.6	10.6	9.7	8.6	6.2					
		40							14.2	14.0	13.8	13.5	13.2	12.9	12.6	12.2	11.9	11.2	10.3	9.3	8.1	5.2					
		50						14.2	14.0	13.7	13.5	13.2	12.8	12.5	12.2	11.9	11.5	10.9	9.9	8.9	7.4	3.8					
		60					14.1	13.9	13.7	13.4	13.1	12.8	12.5	12.1	11.8	11.5	11.1	10.5	9.5	8.4	6.6	2.1					
SHUT-OFF PSI:							285	276	268	259	250	242	233	224	216	207	198	181	155	129	103	68	25				
10S30-34	**3**	0																13.8	13.2	12.5	11.9	10.9	9.6	7.9	4.8		
		20														13.9	13.7	13.3	12.7	12.0	11.3	10.3	8.9	6.7	2.7		
		30													13.9	13.7	13.5	13.1	12.4	11.7	11.0	10.0	8.5	6.0	1.3		
		40											14.0	13.8	13.7	13.5	13.3	12.8	12.2	11.5	10.8	9.7	8.0	5.1			
		50										14.0	13.8	13.6	13.4	13.2	13.0	12.6	11.9	11.2	10.5	9.4	7.5	4.2			
		60										13.8	13.6	13.4	13.2	13.0	12.8	12.3	11.6	10.9	10.2	9.0	6.9	3.1			
SHUT-OFF PSI:												332	324	315	306	298	289	272	246	220	194	159	116	73	29		

See 10S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

16S EASY SELECTION CHART

16 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE

(10 TO 20 GPM)

PUMP OUTLET
1 1/4 " NPT

DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET

PUMP MODEL	HP	PSI	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
16S05-5	**1/2**	20	20.3	18.2	14.1	10.0	5.0																				
		30	17.3	14.4	8.0	1.6																					
		40	12.7	8.0	4.0																						
		50	6.5																								
		60	2.9																								
SHUT-OFF PSI:			58	49	40	32	23	14																			
16S07-8	**3/4**	0					20.5	19.2	17.5	15.8	12.8	9.8	5.2														
		20			20.1	18.8	16.9	15.2	11.8	8.5	4.3																
		30	21.2	19.9	18.4	16.9	14.3	11.8	7.5	3.2	1.6																
		40	19.7	18.3	16.3	14.3	10.8	7.2	3.6																		
		50	17.9	16.3	13.5	10.7	6.2	1.7																			
		60	15.7	13.5	9.6	5.8	2.9																				
SHUT-OFF PSI:			97	88	80	71	62	54	45	36	28	19	10														
16S10-10	**1**	0						20.8	19.8	18.8	17.3	15.9	13.7	11.4	8.0	4.7											
		20				20.5	19.4	18.3	16.8	15.3	12.9	10.5	7.0	3.5	1.8												
		30			20.3	19.3	18.1	16.8	14.8	12.8	9.8	6.7	3.3														
		40		20.2	19.1	18.0	16.4	14.8	12.2	9.6	5.9	2.3															
		50	20.0	19.0	17.7	16.3	14.2	12.0	8.8	5.6	2.8																
		60	18.8	17.6	15.8	14.1	11.3	8.6	4.8																		
SHUT-OFF PSI:			123	115	106	97	89	80	71	63	54	45	37	28	19	11											
16S15-14	**1 1/2**	0								21.0	20.3	19.6	18.8	18.0	16.9	15.8	14.3	10.7	3.3								
		20							20.1	19.3	18.5	17.7	16.6	15.4	13.8	12.2	10.0	5.1									
		30					20.7	20.0	19.2	18.4	17.4	16.5	15.1	13.7	11.8	9.8	7.3	2.4									
		40				20.6	19.8	19.1	18.3	17.4	16.0	15.0	13.3	11.6	9.3	7.0	4.3										
		50			20.4	19.8	18.9	18.2	17.2	16.1	14.7	13.2	11.2	9.1	6.5	3.9	2.0										
		60		20.3	19.6	18.8	18.0	17.1	15.8	14.5	12.8	11.0	8.6	6.3	3.4												
SHUT-OFF PSI:				167	158	149	141	132	123	115	106	97	89	80	71	63	54	37	28								
16S20-18	**2**	0										21.2	20.6	20.0	19.5	18.9	18.2	16.7	13.5	8.8	2.7						
		20									20.4	19.8	19.3	18.7	18.0	17.3	16.4	14.3	10.0	4.2							
		30								20.3	19.8	19.2	18.6	17.9	17.2	16.3	15.3	12.8	7.9	1.9							
		40							20.3	19.7	19.1	18.5	17.8	17.1	16.1	15.2	13.9	11.1	5.7								
		50						20.2	19.6	19.0	18.3	17.7	16.8	16.0	14.9	13.8	12.3	9.2	3.2								
		60					20.1	19.5	18.9	18.3	17.5	16.8	15.8	14.8	13.5	12.3	10.6	7.0									
SHUT-OFF PSI:							194	186	177	168	160	151	142	134	125	116	108	90	65	39	13						
16S30-24	**3**	0																19.6	18.3	16.5	14.2	9.8	2.1				
		20													20.3	19.9	19.5	18.6	17.0	14.8	11.8	6.5					
		30												20.3	19.8	19.4	19.0	18.0	16.3	13.7	10.4	4.7					
		40											20.2	19.8	19.3	18.9	18.4	17.3	15.3	12.5	8.9	2.8					
		50										20.2	19.8	19.3	18.8	18.3	17.8	16.7	14.3	11.3	7.3						
		60									20.1	19.7	19.2	18.8	18.3	17.8	17.2	15.8	13.3	9.8	5.5						
SHUT-OFF PSI:											239	230	221	213	204	195	187	169	143	117	91	57	13				
16S50-38	**5**	0																			21.5	20.4	18.7	16.5	13.4	8.9	2.1
		20																			20.9	19.6	17.7	15.2	11.5	6.1	
		30																		21.4	20.5	19.2	17.2	14.5	10.5	4.5	
		40																		21.1	20.2	18.8	16.7	13.7	9.3	2.7	
		50																	21.6	20.7	19.8	18.4	16.1	12.8	8.0	0.8	
		60																	21.3	20.4	19.4	17.9	15.4	11.9	6.6		
SHUT-OFF PSI:																			314	288	262	227	184	141	98	54	11

See 16S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

25 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE

(18 TO 32 GPM)

PUMP OUTLET
1 1/2" NPT

DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET

PUMP MODEL	HP	PSI	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
25S05-3	**1/2**	20	18.6	6.5	3.3																						
		30	10.5																								
		40																									
		50																									
		60																									
SHUT-OFF PSI:			31	22	13	5																					
25S07-5	**3/4**	0			34.5	29.8	23.9	18.1																			
		20	32.9	28.6	21.8	15.1	7.5																				
		30	27.1	22.5	12.3	2.0																					
		40	19.5	11.8	5.8																						
		50	10.1																								
		60	4.1																								
SHUT-OFF PSI:			57	48	39	31	22	13																			
25S10-7	**1**	0					31.3	28.5	24.3	20.2	12.7	5.1															
		20		33.2	30.3	27.6	22.9	18.3	10.4	2.5	1.3																
		30	33.0	29.9	26.5	23.1	13.0	9.6	4.8																		
		40	29.4	26.6	21.3	16.2	8.2																				
		50	25.3	21.5	14.3	7.0	3.5																				
		60	19.7	13.9	7.0																						
SHUT-OFF PSI:			83	74	65	57	48	39	31	22	13	5															
25S15-9	**1 1/2**	0						32.2	30.0	27.9	24.8	21.6	16.3	10.8													
		20					31.5	29.3	27.2	23.7	20.3	14.5	8.8	4.4													
		30				31.3	29.1	26.4	23.7	18.9	14.2	7.8	1.5														
		40		30.8	28.6	26.3	22.6	18.8	12.8	6.8	3.4																
		50	30.6	28.4	25.5	22.5	17.4	12.3	6.2																		
		60	27.8	25.5	21.3	17.2	11.0	4.8	2.4																		
SHUT-OFF PSI:			109	100	91	83	74	65	57	48	39	31	22	13													
25S20-11	**2**	0						33.1	31.1	29.3	27.6	25.1	22.5	18.5	14.5	9.3											
		20					32.5	30.6	28.8	27.0	24.3	21.5	17.3	13.0	7.8	2.5											
		30				32.0	30.3	28.7	26.4	24.2	20.6	16.9	12.0	7.0	3.5												
		40			31.8	30.1	28.2	26.3	23.3	20.4	15.9	11.4	6.3														
		50		31.5	29.8	28.1	25.7	23.3	19.4	15.6	10.4	5.3	2.7														
		60	31.3	29.6	27.6	25.6	22.4	19.3	14.5	9.8	4.9																
SHUT-OFF PSI:			135	126	118	109	100	92	83	74	66	57	48	40	31	23											
25S30-15	**3**	0										32.3	31.0	29.8	28.4	27.1	25.2	20.7									
		20								31.8	30.6	29.3	28.0	26.6	24.6	22.7	19.8	13.5									
		30						33.0	31.7	30.4	29.2	27.8	26.2	24.5	22.1	19.7	16.4	9.3									
		40					32.8	31.5	30.3	29.0	27.5	26.0	24.0	21.9	19.0	16.1	12.4	4.9									
		50				32.6	31.3	30.0	28.7	27.4	25.7	23.8	21.3	18.8	15.3	12.0	8.2	2.2									
		60			32.4	31.1	29.8	28.6	27.0	25.5	23.3	21.2	18.1	15.0	11.3	7.6	3.8										
SHUT-OFF PSI:					170	161	152	144	135	126	118	109	100	92	83	74	66	48									
25S50-26	**5**	0																32.5	30.3	28.0	25.3	19.9	10.2				
		20															32.3	30.8	28.6	25.9	22.5	15.8	5.0				
		30														32.1	31.3	29.9	27.7	24.7	20.8	13.5	2.5				
		40													32.0	31.3	30.5	29.1	26.7	23.3	18.9	11.0					
		50											32.7	31.8	31.2	30.4	29.7	28.2	25.5	21.8	16.8	8.5					
		60										32.5	31.8	31.0	30.3	29.6	28.8	27.3	24.3	20.0	14.6	5.8					
SHUT-OFF PSI:												253	245	236	227	219	210	193	167	141	115	80	37				

See 25S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

40S EASY SELECTION CHART

40 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE

(24 TO 55 GPM)

PUMP OUTLET
2 " NPT

				DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
PUMP MODEL	**HP**	**PSI**		**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
40S10-3	**1**	20	46.2	33.0																								
		30	69.3																									
		40	92.4																									
		50	116																									
		60	139																									
SHUT-OFF PSI:			0	28	19	11	2																					
40S15-5	**1 1/2**	0	0				52.0	41.0	24.0																			
		20	46.2	57.0	50.0	37.0	18.0																					
		30	69.3	48.0	34.0	15.0																						
		40	92.4	31.0	11.0																							
		50	116	7.0																								
		60	139																									
SHUT-OFF PSI:			0	52	44	35	26	18	9																			
40S20-7	**2**	0	0					54.0	49.0	40.0	29.0	15.0																
		20	46.2			53.0	46.0	37.0	25.0	10.0																		
		30	69.3		52.0	45.0	35.0	23.0	8.0																			
		40	92.4	51.0	44.0	33.0	21.0	5.0																				
		50	116	42.0	32.0	18.0	2.0																					
		60	139	30.0	16.0																							
SHUT-OFF PSI:			0	77	68	59	51	42	33	25	16	7																
40S30-9	**3**	0	0							53.0	47.0	41.0	32.0	22.0														
		20	46.2					51.0	45.0	38.0	29.0	19.0																
		30	69.3				50.0	44.0	37.0	28.0	17.0																	
		40	92.4		54.0	50.0	43.0	35.0	26.0	15.0																		
		50	116	54.0	49.0	42.0	34.0	24.0	13.0																			
		60	139	48.0	41.0	33.0	23.0	11.0																				
SHUT-OFF PSI:			0	102	94	85	76	68	59	50	42	33	24	16	7													
40S50-12	**5**	0	0									53.0	49.0	44.0	39.0	32.0	25.0	16.0										
		20	46.2							52.0	48.0	43.0	37.0	30.0	22.0	13.0												
		30	69.3						51.0	47.0	42.0	36.0	29.0	21.0	12.0													
		40	92.4					51.0	46.0	41.0	35.0	28.0	20.0	11.0														
		50	116			54.0	50.0	45.0	40.0	34.0	26.0	18.0	9.0															
		60	139		53.0	49.0	45.0	39.0	33.0	25.0	17.0	8.0																
SHUT-OFF PSI:			0		130	122	113	104	96	87	78	70	61	52	44	35	26	18										
40S50-15	**5**	0	0											52.0	49.0	46.0	42.0	37.0	26.0									
		20	46.2									51.0	48.0	45.0	40.0	35.0	30.0	24.0										
		30	69.3								51.0	48.0	44.0	40.0	35.0	29.0	23.0	16.0										
		40	92.4							51.0	47.0	43.0	39.0	34.0	28.0	21.0	14.0											
		50	116						50.0	47.0	43.0	38.0	33.0	27.0	20.0	13.0												
		60	139					50.0	46.0	42.0	37.0	32.0	26.0	19.0	12.0													
SHUT-OFF PSI:			0					141	132	124	115	107	98	89	81	72	63	55	37	11								
40S75-21	**7 1/2**	0	0																49.0	41.0	29.0	15.0						
		20	46.2													53.0	51.0	48.0	43.0	32.0	19.0							
		30	69.3												52.0	50.0	48.0	45.0	39.0	27.0	13.0							
		40	92.4											52.0	50.0	48.0	45.0	42.0	35.0	22.0	6.0							
		50	116										52.0	50.0	47.0	44.0	41.0	38.0	30.0	16.0								
		60	139									51.0	49.0	47.0	44.0	41.0	38.0	34.0	25.0	10.0								
SHUT-OFF PSI:			0									181	172	163	155	146	137	129	111	85	59	33						
40S75-25	**7 1/2**	0	0																	51.0	45.0	37.0	23.0					
		20	46.2																52.0	47.0	39.0	29.0	14.0					
		30	69.3															54.0	50.0	44.0	35.0	25.0						
		40	92.4														54.0	52.0	48.0	41.0	32.0	21.0						
		50	116													53.0	52.0	50.0	45.0	38.0	28.0							
		60	139												53.0	51.0	49.0	47.0	43.0	34.0	24.0							
SHUT-OFF PSI:			0												203	194	186	177	160	134	108	82	47					
***40S100-30** **40S100-30**	**10**	0	0																		53.0	49.0	41.0	27.0				
		20	46.2																	54.0	50.0	44.0	35.0	20.0				
		30	69.3																	52.0	48.0	42.0	32.0	16.0				
		40	92.4																	51.0	46.0	39.0	28.0	12.0				
		50	116																	49.0	43.0	36.0	25.0	8.0				
		60	139																52.0	47.0	41.0	33.0	21.0					
SHUT-OFF PSI:																			222	196	170	144	110	66	23			

*** 6" Motor**

See 40S performance curves for higher head models.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

60 GPM

SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE
(40 TO 75 GPM)

PUMP OUTLET
2 " NPT

			DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
60S20-4	**2**	20	72.3	64.5	38.6	12.7	6.3																				
		30	58.6	44.9	22.4																						
		40	30.4																								
		50	17.9																								
		60																									
SHUT-OFF PSI:			46	37	29	20	11	3																			
60S30-5	**3**	0				74.8	66.8	58.8	34.3																		
		20	77.8	72.9	63.8	54.8	27.4																				
		30	76.0	64.3	47.3	30.0	15.0																				
		40	60.4	49.9	25.0																						
		50	40.4	19.4	9.8																						
		60	22.0																								
SHUT-OFF PSI:			60	51	42	34	25	16	8																		
60S50-7	**5**	0					77.5	73.8	68.4	63.1	52.2	41.3															
		20			76.3	72.4	66.6	61.1	48.3	35.8	17.9																
		30		76.0	71.3	66.5	57.8	49.2	24.6																		
		40	75.1	71.0	64.6	58.2	43.8	29.4	14.8																		
		50	69.7	64.6	54.8	44.9	22.5																				
		60	62.3	55.3	38.7	22.0	11.0																				
SHUT-OFF PSI:			88	80	71	62	54	45	36	28	19	10															
60S50-9	**5**	0							74.8	71.7	67.3	63.0	55.6	48.2	32.8	17.3											
		20					73.8	70.5	65.9	61.3	53.0	44.8	27.5	10.2	5.1												
		30			76.5	73.5	69.6	65.7	59.4	53.2	40.7	28.1	14.0														
		40		76.2	72.8	69.3	64.3	59.4	50.3	41.0	20.5																
		50	75.5	72.5	68.3	64.2	57.3	50.4	36.3	22.2	11.1																
		60	71.7	68.1	62.7	57.3	47.1	36.8	18.4																		
SHUT-OFF PSI:			115	106	98	89	81	72	63	55	46	37	29	20	11	3											
***60S75-13**	**7 1/2**	0									77.3	75.4	73.1	70.7	67.8	64.8	60.7	50.0	21.5								
		20							76.8	74.8	72.3	69.9	66.8	63.8	59.3	55.0	47.9	28.9									
		30						76.6	74.3	72.1	69.3	66.6	62.8	59.2	53.3	47.7	38.2	14.3									
		40					76.2	74.1	71.6	69.1	65.8	62.7	57.9	53.3	45.6	37.9	25.0	6.0									
		50				75.9	73.6	71.3	68.4	65.6	61.7	57.7	51.6	45.4	35.0	24.7	12.3										
		60			75.5	73.3	70.8	68.2	64.8	61.4	56.3	51.3	43.1	34.8	20.8	6.8											
SHUT-OFF PSI:					152	143	134	126	117	108	100	91	82	74	65	56	48	30	4								
***60S100-18**	**10**	0													76.5	75.0	73.3	69.8	63.1	52.6	35.8						
		20											76.1	74.6	72.8	71.2	69.2	64.7	55.8	40.0	14.2						
		30										75.9	74.3	72.7	70.8	68.9	66.7	61.6	50.9	31.5							
		40									75.7	74.1	72.3	70.6	68.5	66.5	63.9	58.0	45.0	20.7							
		50								75.4	73.8	72.1	70.2	68.3	66.0	63.7	60.7	53.6	37.5	10.0							
		60							75.2	73.6	71.8	70.0	67.8	65.8	63.1	60.5	56.8	48.2	28.3								
SHUT-OFF PSI:									186	177	169	160	152	143	134	126	117	100	74	46	22						

*** 6" Motor**
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

75S EASY SELECTION CHART

75 GPM

SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE
(45 TO 95 GPM)

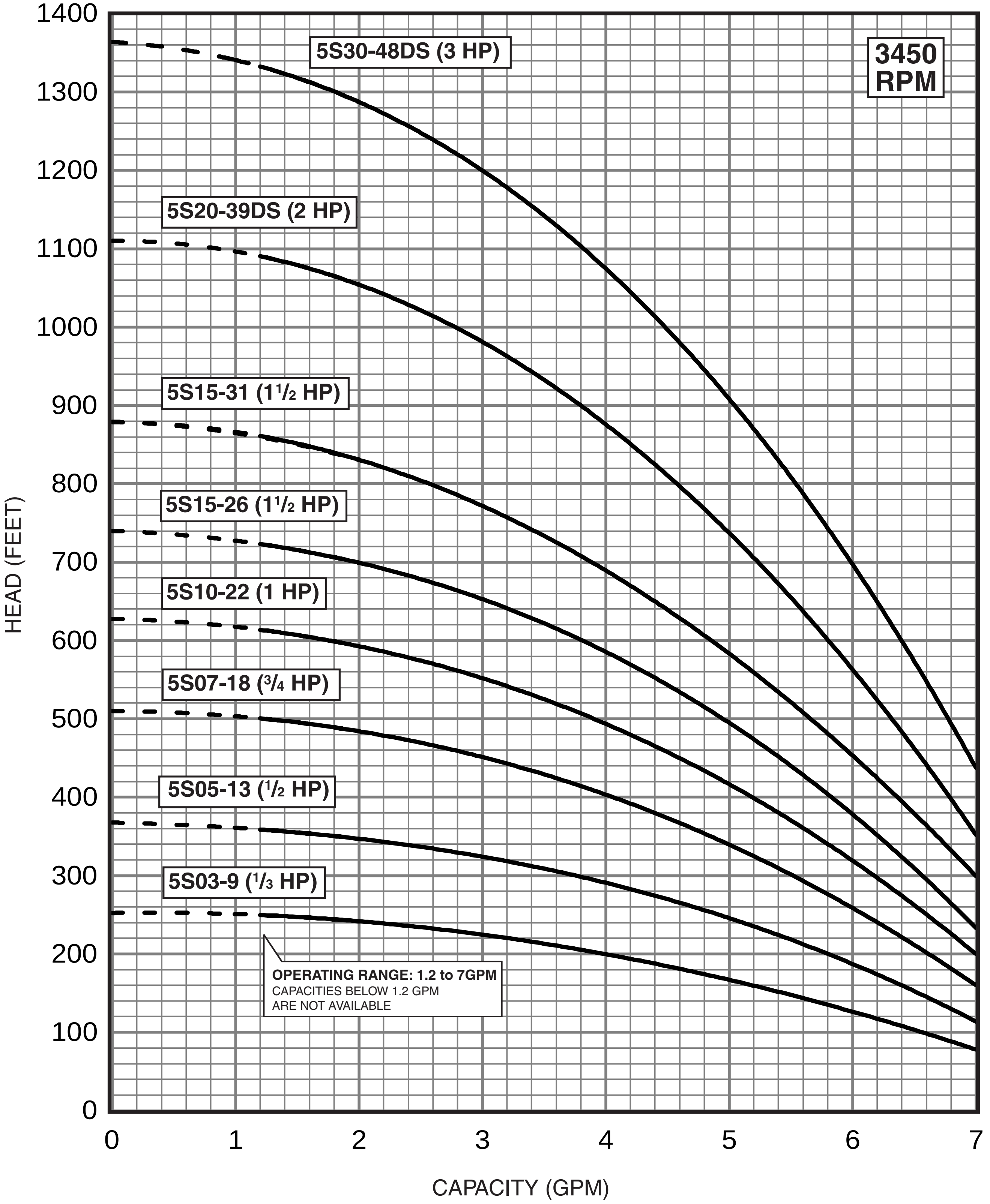
PUMP OUTLET
2" NPT

			DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
PUMP MODEL	**HP**	**PSI**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**340**	**400**	**460**	**520**	**600**	**700**	**800**	**900**	**1000**	**1100**
75S20-3	**2**	20	69.6	45.8	22.9																						
		30	36.2																								
		40	12.4																								
		50																									
		60																									
SHUT-OFF PSI:			32	23	14	6																					
75S30-5	**3**	0			89.8	90.2	78.8	67.6																			
		20	96.3	86.8	74.8	62.9	31.5																				
		30	85.8	74.2	51.8	29.5	14.8																				
		40	70.2	57.1	28.6																						
		50	35.3																								
		60	24.2																								
SHUT-OFF PSI:			58	49	41	32	23	15																			
75S50-8	**5**	0						93.3	86.5	79.6	72.0	64.5	46.9	29.4													
		20			97.4	91.3	84.7	77.5	69.4	61.3	40.3	19.4	9.8														
		30		96.9	90.1	83.3	76.3	69.3	56.3	43.1	21.6																
		40	95.5	89.1	82.3	75.4	66.5	57.5	28.8																		
		50	88.0	81.2	73.9	66.7	51.2	35.8	17.9																		
		60	80.2	73.3	63.2	53.0	26.5																				
SHUT-OFF PSI:			98	90	81	72	64	55	46	38	29	20	12	3													
***75S75-11**	**7 1/2**	0								97.8	93.3	88.8	84.3	79.8	75.1	70.4	63.7	43.4									
		20						96.5	92.0	87.4	82.9	78.3	73.5	68.8	61.4	54.0	38.8	11.8									
		30					95.7	91.3	86.8	82.2	77.6	73.1	67.3	61.4	50.3	39.3	19.7										
		40				95.2	90.6	86.0	81.5	77.0	72.0	67.0	58.9	50.8	33.5	16.3	8.2										
		50			94.3	89.9	85.3	80.8	76.2	71.6	65.3	59.0	46.6	34.2	17.1												
		60	97.9	93.8	89.2	84.6	80.1	75.6	70.3	65.2	56.1	47.0	23.5														
SHUT-OFF PSI:			151	142	133	125	116	107	99	90	81	73	64	55	47	38	29	12									
***75S100-15**	**10**	0											96.7	93.4	90.0	86.5	83.2	76.3	64.7	40.9							
		20									95.7	92.4	88.9	85.5	82.1	78.7	75.2	67.4	49.3	12.5							
		30								95.3	91.8	88.4	85.0	81.5	78.2	74.8	70.9	61.6	37.1								
		40						98.0	94.7	91.3	87.8	84.4	81.0	77.7	74.1	70.6	66.0	54.0	19.9								
		50					97.3	94.3	90.8	87.3	83.9	80.5	77.1	73.7	69.7	65.8	59.8	43.5									
		60				97.0	93.7	90.3	86.8	83.3	80.0	76.6	73.0	69.3	64.5	59.6	51.5	21.7									
SHUT-OFF PSI:						178	170	161	152	144	135	126	118	109	100	92	83	66	40	14							

*** 6" Motor** Performance is the same at Best Efficiency Point only, consult factory for actual performance.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

PERFORMANCE CURVES 5 GPM MODEL 5S

FLOW RANGE: 1.2 - 7 GPM **OUTLET SIZE: 1" NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

DIMENSIONS AND WEIGHTS

			MOTOR	DISCH.	DIMENSIONS IN INCHES					APPROX.
MODEL NO.	FIG.	HP	SIZE	SIZE	A	B	C	D	E	SHIP WT.
5S03-9	A	1/3	4"	1" NPT	22.3	8.8	13.5	3.8	3.9	27
5S05-13	A	1/2	4"	1" NPT	26.4	9.5	16.9	3.8	3.9	31
5S07-18	A	3/4	4"	1" NPT	31.7	10.7	21.0	3.8	3.9	34
5S10-22	A	1	4"	1" NPT	36.1	11.8	24.3	3.8	3.9	42
5S15-26	A	1 1/2	4"	1" NPT	41.2	13.6	27.6	3.8	3.9	46
5S15-31	A	1 1/2	4"	1" NPT	47.1	13.6	33.5	3.8	3.9	58
5S20-39DS	A	2	4"	1" NPT	55.2	15.1	40.1	3.8	3.9	65
5S30-48DS	A	3	4"	1" NPT	70.0	20.6	45.8	3.8	3.9	90

NOTES: All models suitable for use in 4" wells.
Weights include pump end with motor in lbs.

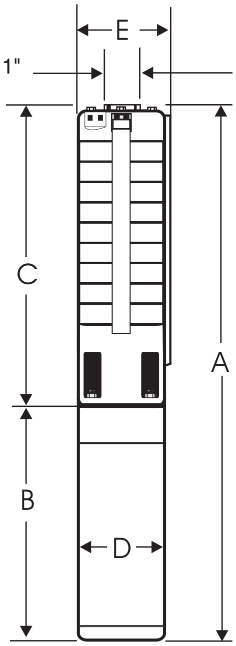


Fig. A

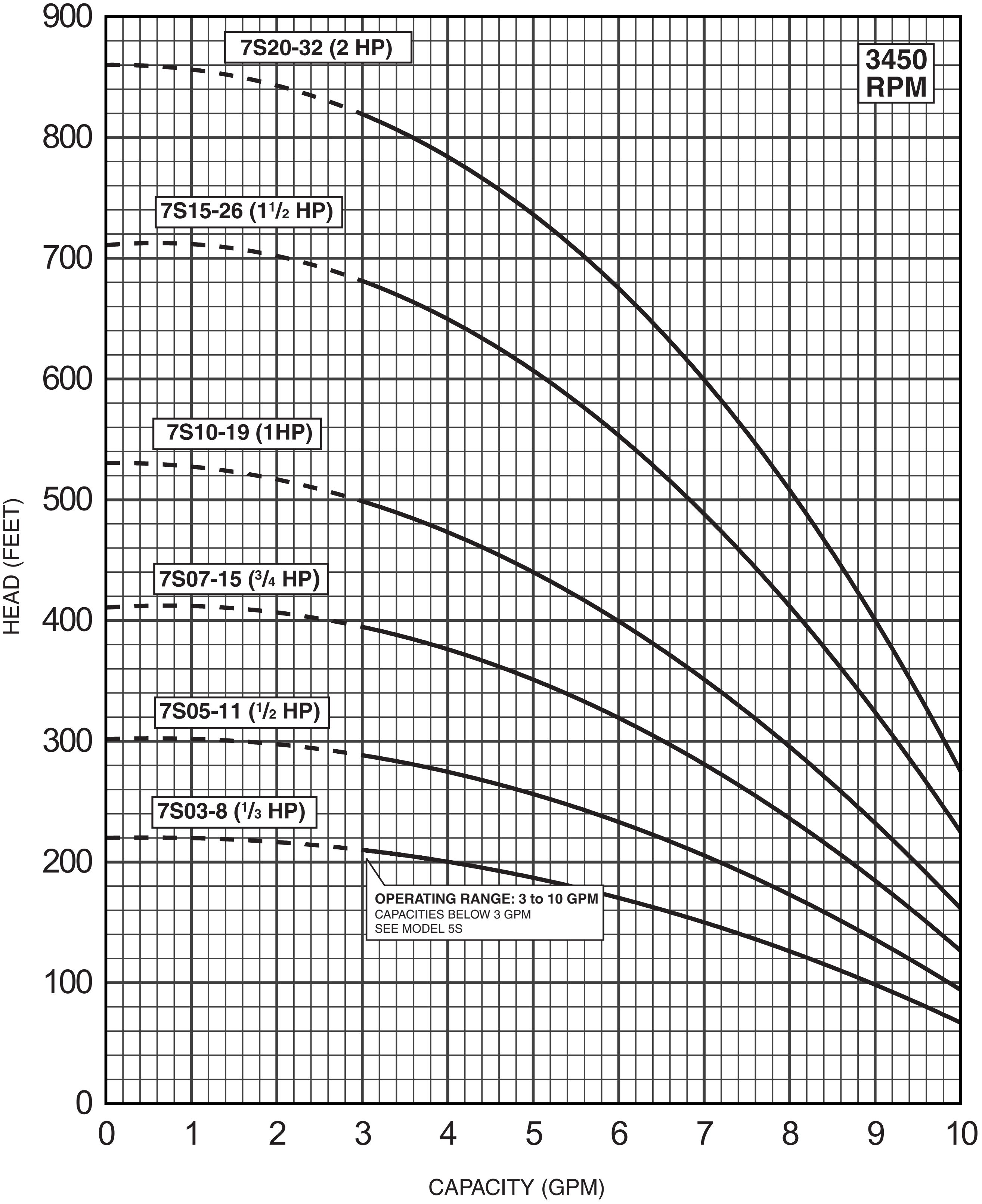
MATERIALS OF CONSTRUCTION

COMPONENT	SPLINED SHAFT (9-26 Stgs.)	CYLINDRICAL SHAFT (31-48 Stgs.)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel
Pump Shaft	304 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	316 Stainless Steel
Coupling	329/420/431 Stainless Steel	329/420/431 Stainless Steel
Check Valve Seat	NBR/304 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR/304 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/PBT (Valox®)	NBR/PPS (Ryton®)
Intermediate Bearings	NBR	304 Stainless Steel
Shaft Washer	Not Required	LCP (Vectra®)
Split Cone	Not Required	304 Stainless Steel
Split Cone Nut	Not Required	316 Stainless Steel

NOTES: Specifications subject to change without notice.
Valox® is a registered trademark of General Electric Co.
Vectra® is a registered trademark of Hoechast Calanese Corporation.
Ryton® is a registered trademark of Phillips 66.

PERFORMANCE CURVES 7 GPM MODEL 7S

FLOW RANGE: 3 -10 GPM **OUTLET SIZE: 1" NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
7S03-8	A	1/3	4"	1" NPT	21.5	8.8	12.7	3.8	3.9	27
7S05-11	A	1/2	4"	1" NPT	24.7	9.5	15.2	3.8	3.9	30
7S07-15	A	3/4	4"	1" NPT	29.2	10.7	18.5	3.8	3.9	33
7S10-19	A	1	4"	1" NPT	33.6	11.8	21.8	3.8	3.9	36
7S15-26	A	1 1/2	4"	1" NPT	41.2	13.6	27.6	3.8	3.9	46
7S20-32	A	2	4"	1" NPT	48.5	14.0	34.5	3.8	3.9	59

NOTES: All models suitable for use in 4" wells.
Weights include pump end with motor in lbs.

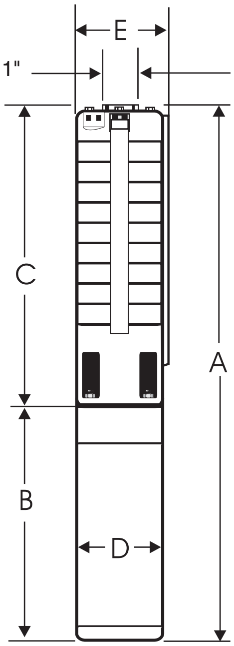


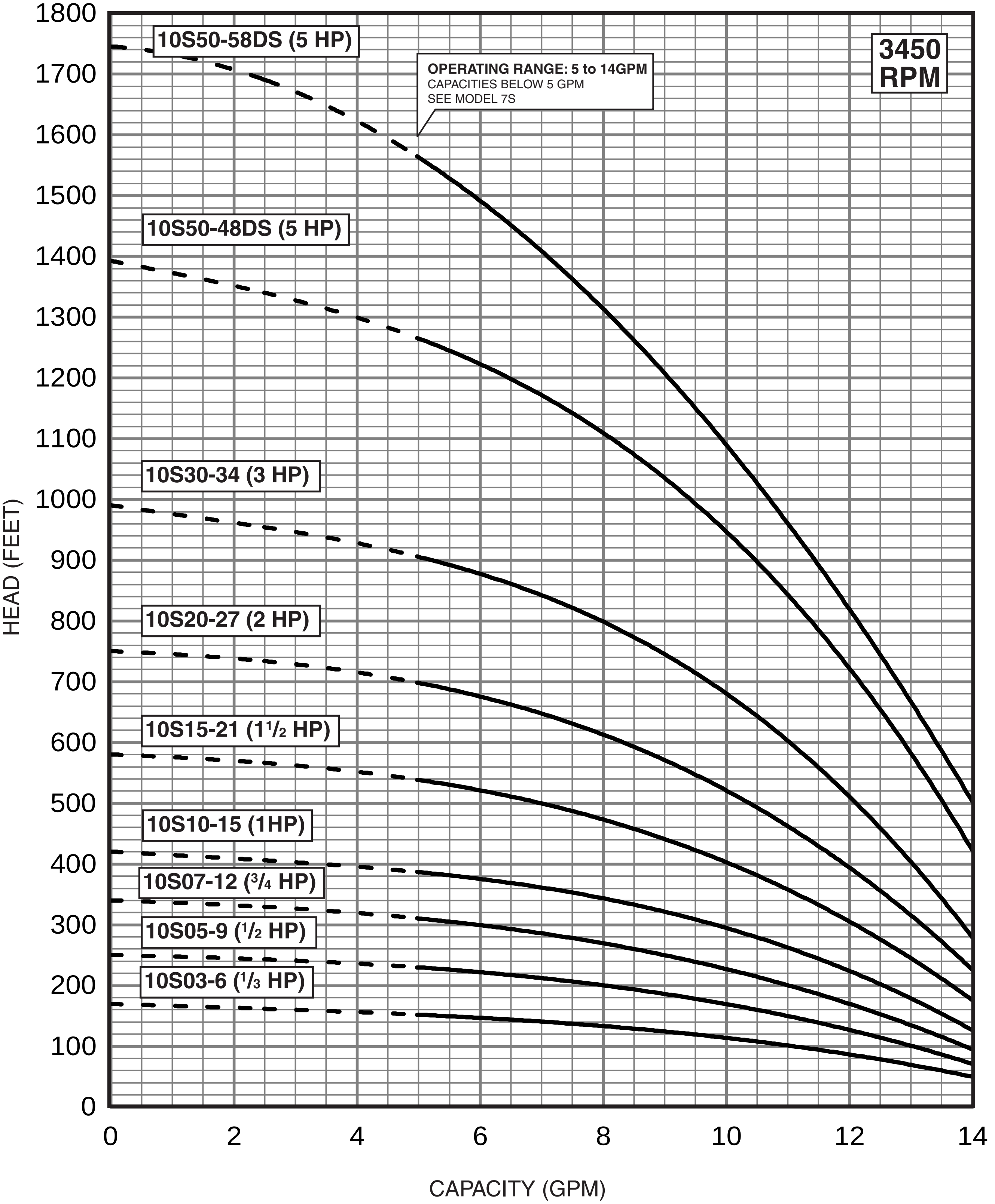
Fig. A

MATERIALS OF CONSTRUCTION

COMPONENT	SPLINE SHAFT
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	304 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Coupling	316/431 Stainless Steel
Check Valve Seat	NBR/304 Stainless Steel
Top Bearing	NBR
Impeller Seal Ring	NBR/PBT (Valox ®)
Intermediate Bearings	NBR

NOTES: Specifications subject to change without notice.
Valox® is a registered trademark of General Electric Co.

FLOW RANGE: 5 -14 GPM **OUTLET SIZE: 1¼ " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
10S03-6	A	1/3	4"	1 1/4" NPT	19.9	8.8	11.1	3.8	3.9	26
10S05-9	A	1/2	4"	1 1/4" NPT	23.0	9.5	13.5	3.8	3.9	29
10S07-12	A	3/4	4"	1 1/4" NPT	26.7	10.7	16.0	3.8	3.9	32
10S10-15	A	1	4"	1 1/4" NPT	30.3	11.8	18.5	3.8	3.9	34
10S15-21	A	1 1/2	4"	1 1/4" NPT	37.1	13.6	23.5	3.8	3.9	44
10S20-27	A	2	4"	1 1/4" NPT	43.5	15.1	28.4	3.8	3.9	49
10S30-34	A	3	4"	1 1/4" NPT	54.7	20.6	34.1	3.8	3.9	83
10S50-48DS	A	5	4"	1 1/4" NPT	71.3	23.6	47.7	3.8	3.9	115
10S50-58DS*	B	5	4"	1 1/4" MPT	88.2	23.6	64.5	3.8	4.3	142

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Built into sleeve 1$^{1}/_{4}$" MPT discharge, 5" min. well dia.

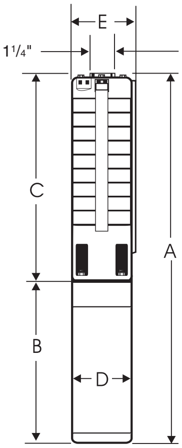


Fig. A

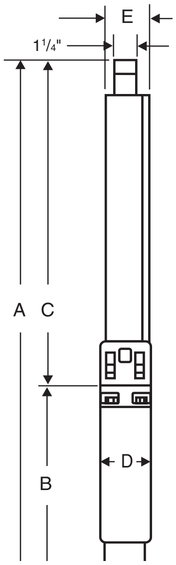


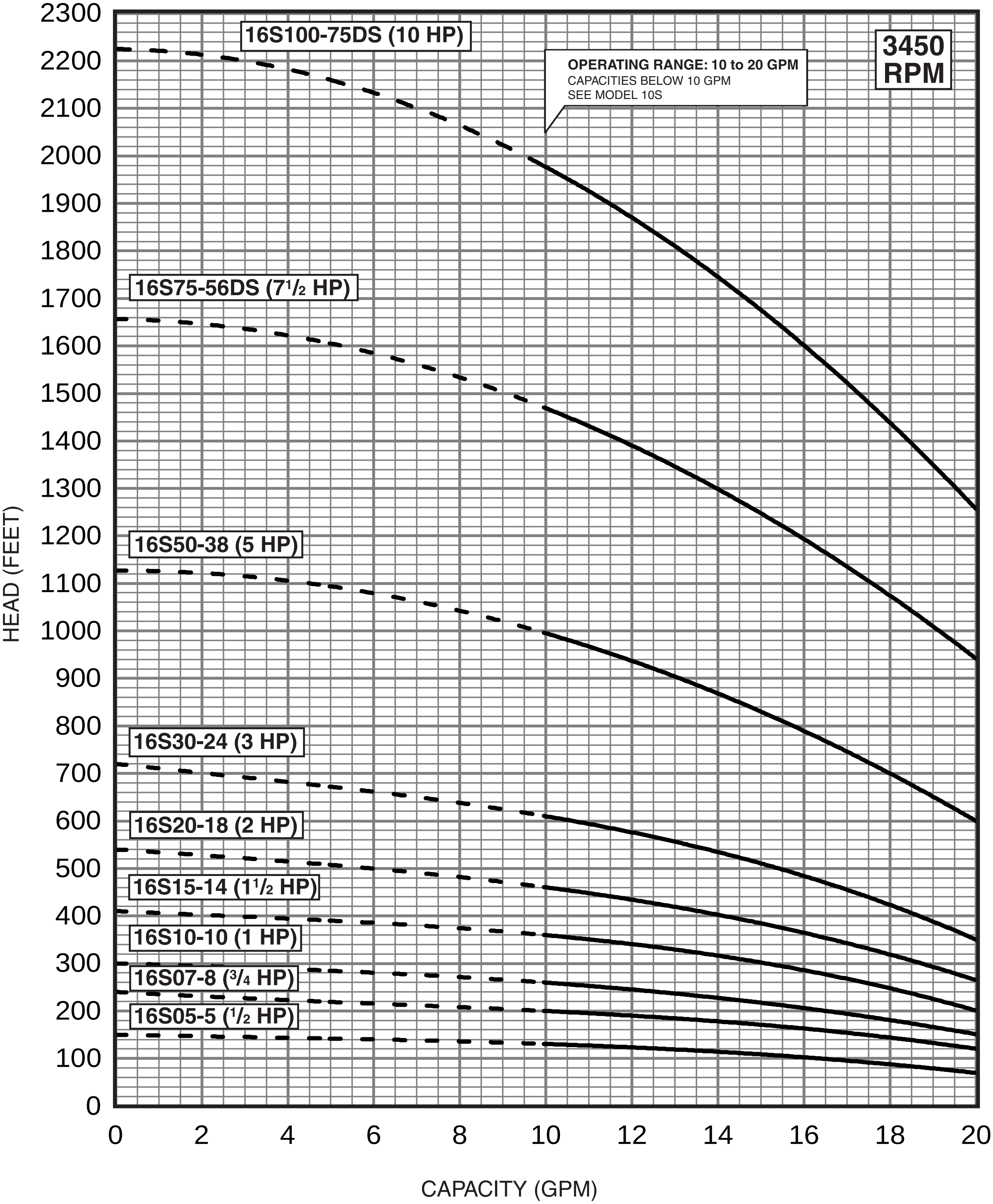
Fig. B

MATERIALS OF CONSTRUCTION

COMPONENT	SPLINED SHAFT (6-27 Stgs.)	CYLINDRICAL SHAFT (34-48 Stgs.)	DEEP SET (58 Stgs.)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Pump Shaft	304 Stainless Steel	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel	316/431 Stainless Steel	316/431 Stainless Steel
Check Valve Seat	NBR/304 Stainless Steel	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/PBT (Valox®)	NBR/PPS (Ryton®)	NBR/PPS (Ryton®)
Intermediate Bearings	NBR	304 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	Not Required	LCP (Vectra®)	LCP (Vectra®)
Split Cone	Not Required	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	Not Required	316 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	Not Required	Zincless Bronze*

NOTES: Specifications subject to change without notice.
Valox® is a registered trademark of General Electric Co.
Vectra® is a registered trademark of Hoechast Calanese Corporation.
Ryton® is a registered trademark of Phillips 66.
*** Stainless Steel option available.**

FLOW RANGE: 10 -20 GPM **OUTLET SIZE: 1$^1/_4$ " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, .5 -5 HP/3450 RPM.
6" MOTOR STANDARD,7.5 -10HP/3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

MODEL 16S 16 GPM TECHNICAL DATA

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
16S05-5	A	1/2	4"	1 1/4" NPT	19.7	9.5	10.2	3.8	3.9	27
16S07-8	A	3/4	4"	1 1/4" NPT	23.4	10.7	12.7	3.8	3.9	29
16S10-10	A	1	4"	1 1/4" NPT	26.2	11.8	14.4	3.8	3.9	32
16S15-14	A	1 1/2	4"	1 1/4" NPT	32.8	15.1	17.7	3.8	3.9	36
16S20-18	A	2	4"	1 1/4" NPT	36.0	15.1	20.9	3.8	3.9	40
16S30-24	A	3	4"	1 1/4" NPT	46.5	20.6	25.9	3.8	3.9	64
16S50-38	A	5	4"	1 1/4" NPT	61.1	23.6	37.5	3.8	3.9	94
16S75-56DS*	B	7 1/2	6"	1 1/4" MPT	93.0	24.2	68.8	5.4	4.6	220
16S100-75DS*	B	10	6"	1 1/4" MPT	109.9	25.4	84.5	5.4	4.6	245

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs..
* Built into sleeve 1¼" MPT discharge, 6" min. well dia.

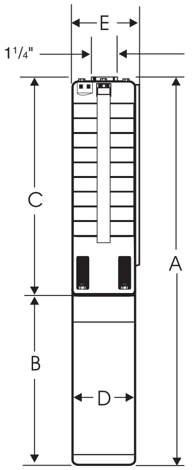


Fig. A

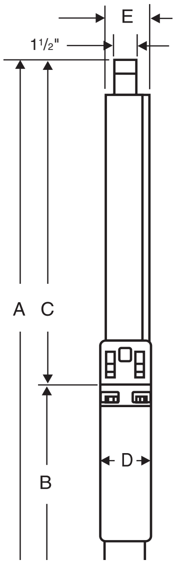


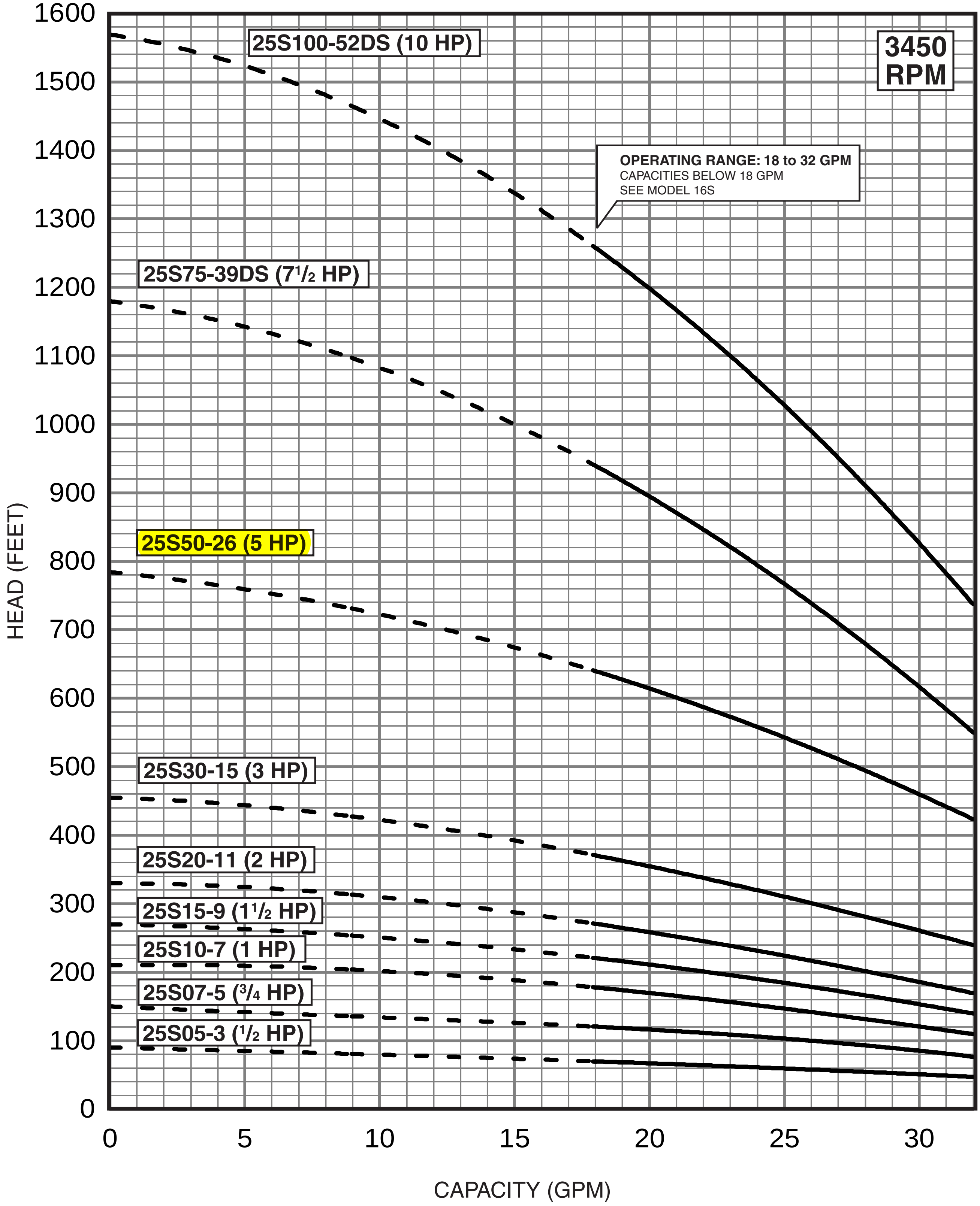
Fig. B

MATERIALS OF CONSTRUCTION

COMPONENT	SPLINED SHAFT (5-24 Stgs.)	CYLINDRICAL SHAFT (38 Stgs.)	DEEP SET (56-75 Stgs)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Pump Shaft	304 Stainless Steel	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel	316/431 Stainless Steel	329/416 Stainless Steel**
Check Valve Seat	NBR/304 Stainless Steel	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/PBT (Valox®)	NBR/PPS (Ryton®)	NBR/PPS (Ryton®)
Intermediate Bearings	NBR	304 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	Not Required	LCP (Vectra®)	LCP (Vectra®)
Split Cone	Not Required	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	Not Required	316 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	Not Required	304 Stainless Steel
Coupling Key	Not Required	Not Required	302/304 Stainless Steel**

NOTES: Specifications are subject to change without notice.
Valox® is a registered trademark of General Electric Co.
Vectra® is a registered trademark of Hoechast Calanese Corporation.
Ryton® is a registered trademark of Phillips 66.
***Stainless Steel option available.**
** If using 4" non-standard motors, refer to 329/420/431 Stainless Steel for coupling.
A coupling key is not required.

FLOW RANGE: 18 -32 GPM **OUTLET SIZE: 1½ " NPT** **NOMINAL DIA. 4"**



OPERATING RANGE: 18 to 32 GPM
CAPACITIES BELOW 18 GPM
SEE MODEL 16S

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, .5 -5 HP/3450 RPM.
6" MOTOR STANDARD,7.5 -10HP/3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

MODEL 25S

25 GPM

TECHNICAL DATA

DIMENSIONS AND WEIGHTS

			MOTOR	DISCH.	DIMENSIONS IN INCHES					APPROX.
MODEL NO.	FIG.	HP	SIZE	SIZE	A	B	C	D	E	SHIP WT.
25S05-3	A	1/2	4"	1 1/2" NPT	18.1	9.5	8.6	3.8	3.9	26
25S07-5	A	3/4	4"	1 1/2" NPT	20.9	10.7	10.2	3.8	3.9	28
25S10-7	A	1	4"	1 1/2" NPT	23.7	11.8	11.9	3.8	3.9	29
25S15-9	A	1 1/2	4"	1 1/2" NPT	27.1	13.6	13.5	3.8	3.9	34
25S20-11	A	2	4"	1 1/2" NPT	30.3	15.1	15.2	3.8	3.9	37
25S30-15	A	3	4"	1 1/2" NPT	39.1	20.6	18.5	3.8	3.9	59
25S50-26	A	5	4"	1 1/2" NPT	51.2	23.6	27.6	3.8	3.9	76
25S75-39DS	A	7 1/2	6"	1 1/2" NPT	66.8	24.2	42.6	5.4	4.6	168
25S100-52DS*	B	10	6"	1 1/2" MPT	90.9	25.4	65.5	5.4	5.4	226

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Built into sleeve 1½" MPT discharge, 6" min. well dia.

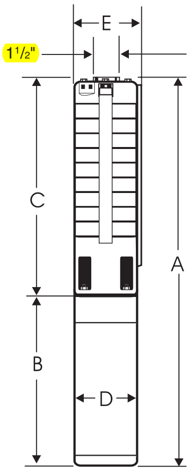


Fig. A

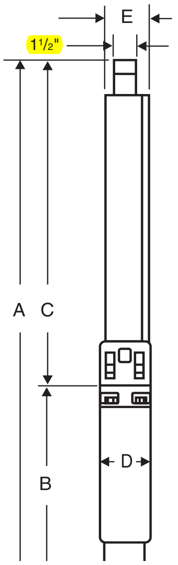


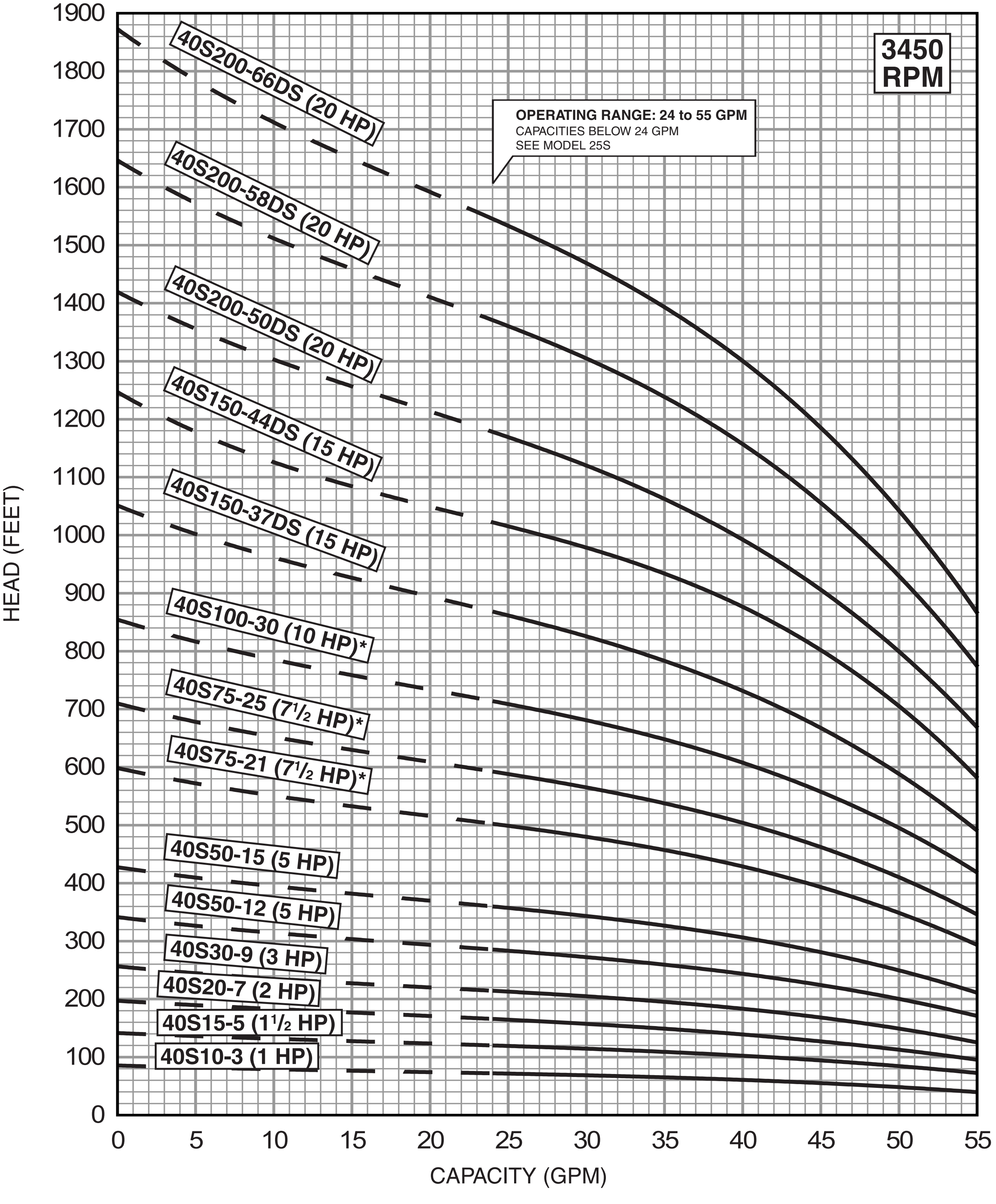
Fig. B

MATERIALS OF CONSTRUCTION

COMPONENT	SPLINED SHAFT (3-26 Stgs.)	CYLINDRICAL SHAFT (39 Stgs.)	DEEP SET (52 Stgs)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Pump Shaft	304 Stainless Steel	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel	316/431 Stainless Steel	329/416 Stainless Steel**
Check Valve Seat	NBR/304 Stainless Steel	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/PBT (Valox®)	NBR/PPS (Ryton®)	NBR/PPS (Ryton®)
Intermediate Bearings	NBR	304 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	Not Required	LCP (Vectra®)	LCP (Vectra®)
Split Cone	Not Required	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	Not Required	316 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	Not Required	304 Stainless Steel
Coupling Key	Not Required	Not Required	302/304 Stainless Steel**

NOTES: Specifications are subject to change without notice.
Valox® is a registered trademark of General Electric Co.
Vectra® is a registered trademark of Hoechast Calanese Corporation.
Ryton® is a registered trademark of Phillips 66.
***Stainless Steel option available.**
** If using 4" non-standard motors, refer to 329/420/431 Stainless Steel for coupling.
A coupling key is not required.

FLOW RANGE: 24 - 55 GPM **OUTLET SIZE: 2 " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 1-10 HP/3450 RPM.
6" MOTOR STANDARD,15-20 HP/3450 RPM.
* Also available with 6" motor.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 5 feet.

MODEL 40S 40 GPM TECHNICAL DATA

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES					APPROX. SHIP WT.
					A	B	C	D	E	
40S10-3	A	1	4"	2" NPT	24.6	11.8	12.8	3.8	3.9	32
40S15-5	A	1 1/2	4"	2" NPT	29.7	13.6	16.1	3.8	3.9	37
40S20-7	A	2	4"	2" NPT	34.5	15.1	19.4	3.8	3.9	41
40S30-9	A	3	4"	2" NPT	43.3	20.6	22.7	3.8	3.9	65
40S50-12	A	5	4"	2" NPT	51.3	23.6	27.7	3.8	3.9	78
40S50-15	A	5	4"	2" NPT	56.2	23.6	32.6	3.8	3.9	84
40S75-21*	A	7 1/2	4"	2" NPT	74.6	29.6	45.0	3.8	3.9	120
40S75-25*	A	7 1/2	4"	2" NPT	81.2	29.6	51.6	3.8	3.9	124
40S100-30*	A	10	4"	2" NPT	103.7	43.9	59.8	3.8	3.9	181
40S150-37DS	A	15	6"	2" NPT	99.5	28.0	71.5	5.4	5.4	244
40S150-44DS	A	15	6"	2" NPT	111.0	28.0	83.0	5.4	5.4	340
40S200-50DS**	B	20	6"	2" MPT	136.0	30.6	105.4	5.4	5.5	319
40S200-58DS**	B	20	6"	2" MPT	149.2	30.6	118.6	5.4	5.5	334
40S200-66DS**	B	20	6"	2" MPT	162.4	30.6	131.8	5.4	5.5	394

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Also available with 6" motor.
** Built into sleeve 2" MPT discharge, 6" min. well dia.

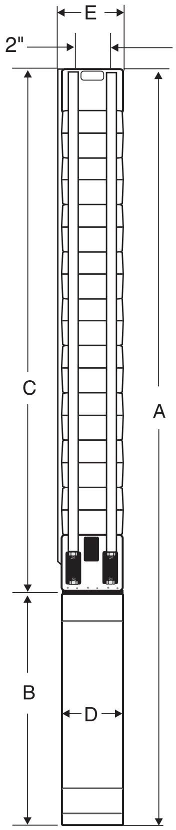


Fig. A

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (3-44 Stgs.)	DEEP SET (50-66 Stgs.)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel
Pump Shaft	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel **	329/ 416 Stainless Steel
Check Valve Seat	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Intermediate Bearings	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	LCP (Vectra®)	LCP (Vectra®)
Split Cone	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	304 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	304 Stainless Steel

NOTES: Specifications are subject to change without notice.
Vectra® is a registered trademark of Hoechast Calanese Corporation.
***Stainless Steel option available.**

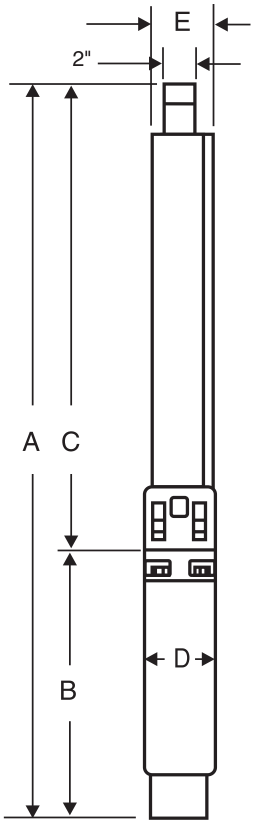
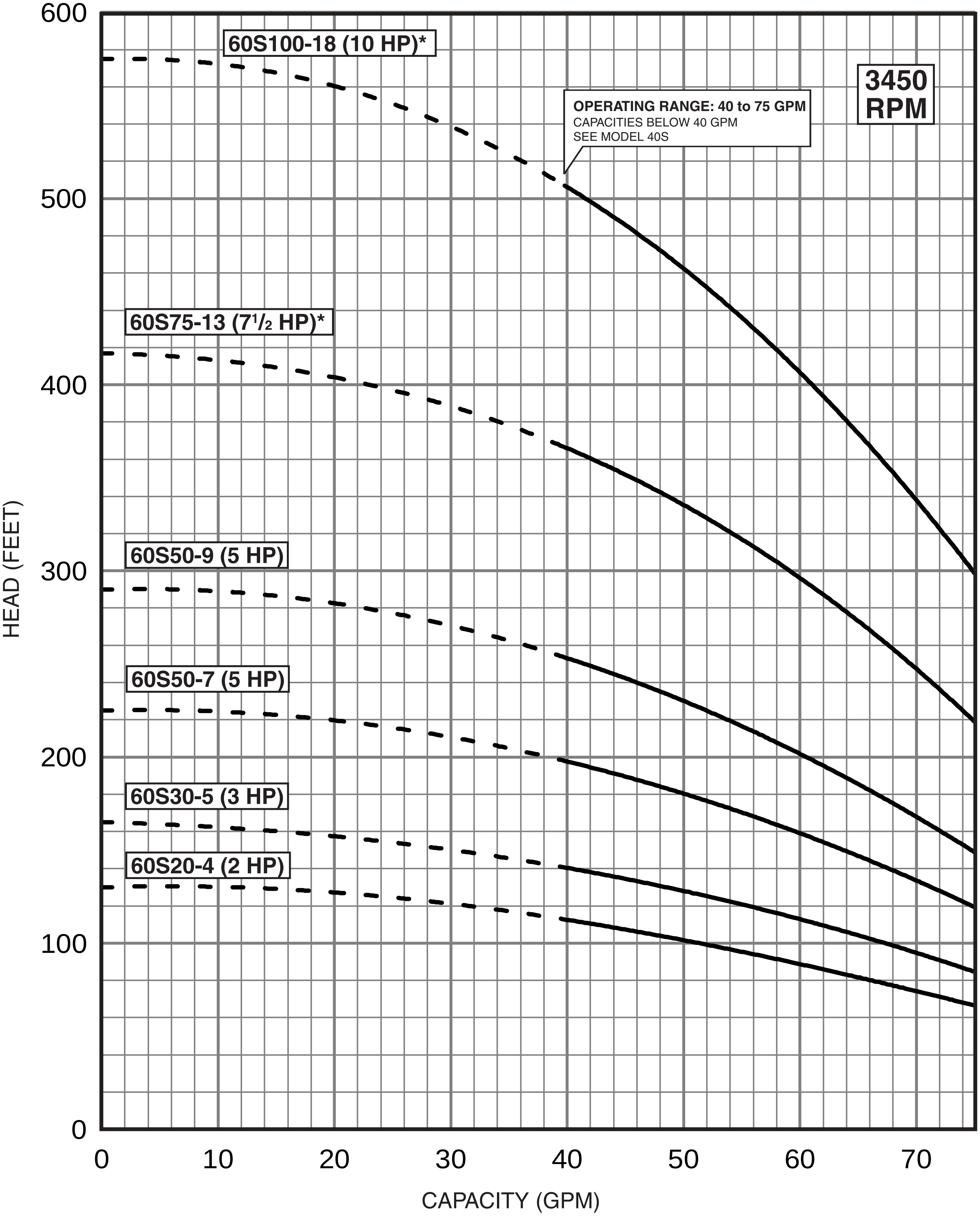


Fig. B

FLOW RANGE: 40 -75 GPM **OUTLET SIZE: 2 " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 3450 RPM.
* Also available with 6" motor.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 5 feet.

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
60S20-4	A	2	4"	2" NPT	32.6	15.1	17.5	3.8	3.9	39
60S30-5	A	3	4"	2" NPT	40.7	20.6	20.1	3.8	3.9	64
60S50-7	A	5	4"	2" NPT	48.8	23.6	25.2	3.8	3.9	75
60S50-9	A	5	4"	2" NPT	53.9	23.6	30.3	3.8	3.9	80
60S75-13*	A	7 1/2	4"	2" NPT	70.1	29.6	40.5	3.8	3.9	105
60S100-18*	A	10	4"	2" NPT	97.3	43.9	53.4	3.8	3.9	160

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs..
* Also available with 6" motor.

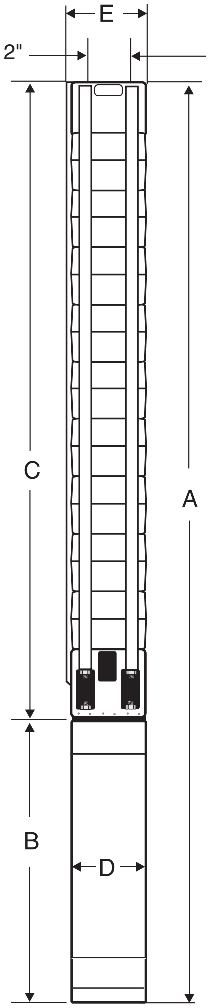


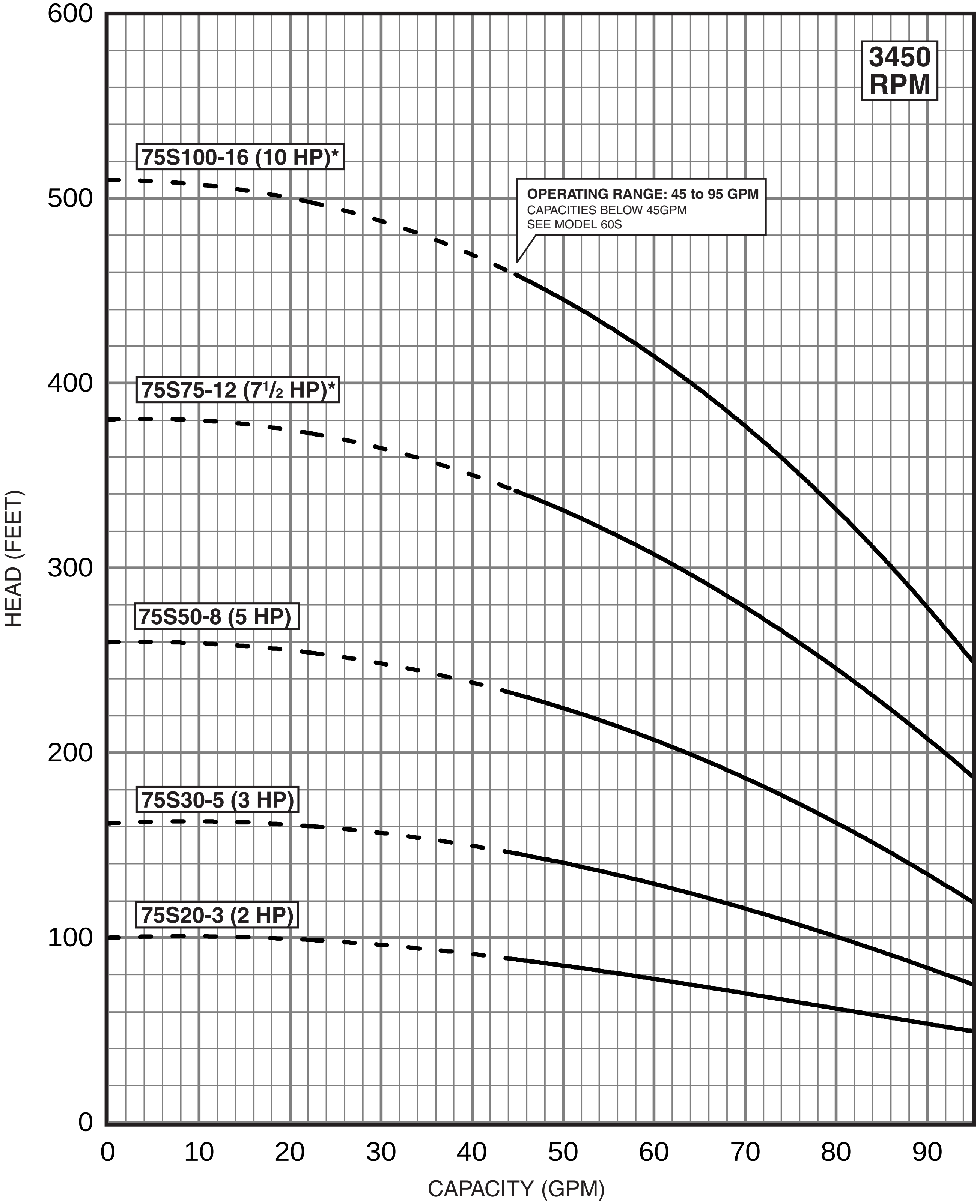
Fig. A

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (4-18 Stgs.)
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	431 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Coupling	316/431 Stainless Steel**
Check Valve Seat	NBR/316 Stainless Steel
Top Bearing	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/316 Stainless Steel
Intermediate Bearings	NBR/316 Stainless Steel
Shaft Washer	LCP (Vectra®)
Split Cone	304 Stainless Steel
Split Cone Nut	304 Stainless Steel

NOTES: Specifications are subject to change without notice.
Vectra® is a registered trademark of Hoechast Calanese Corporation.

FLOW RANGE: 45 - 95 GPM **OUTLET SIZE: 2" NPT** **NOMINAL DIA.: 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD,2-10 Hp 3450 RPM.
* Also available with 6" motor, performance is the same only at Best Effeciency point.
Consult factory for actual performance.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 5 feet.

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES					APPROX. SHIP WT.
					A	B	C	D	E	
75S20-3	A	2	4"	2" NPT	30.0	15.1	14.9	3.8	3.9	38
75S30-5	A	3	4"	2" NPT	40.7	20.6	20.1	3.8	3.9	64
75S50-8	A	5	4"	2" NPT	51.4	23.6	27.8	3.8	3.9	78
75S75-12*	A	7 1/2	4"	2" NPT	67.5	29.6	37.9	3.8	3.9	100
75S100-16*	A	10	4"	2" NPT	92.1	43.9	48.2	3.8	3.9	155

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Also available with 6" motor, performance is the same only at Best Efficiency point. Consult factory for actual performance.

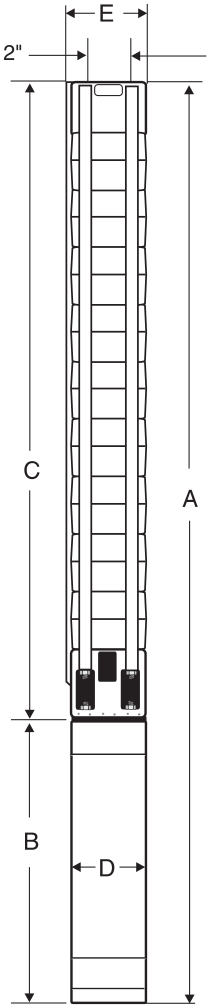


Fig. A

MATERIALS OF CONSTRUCTION

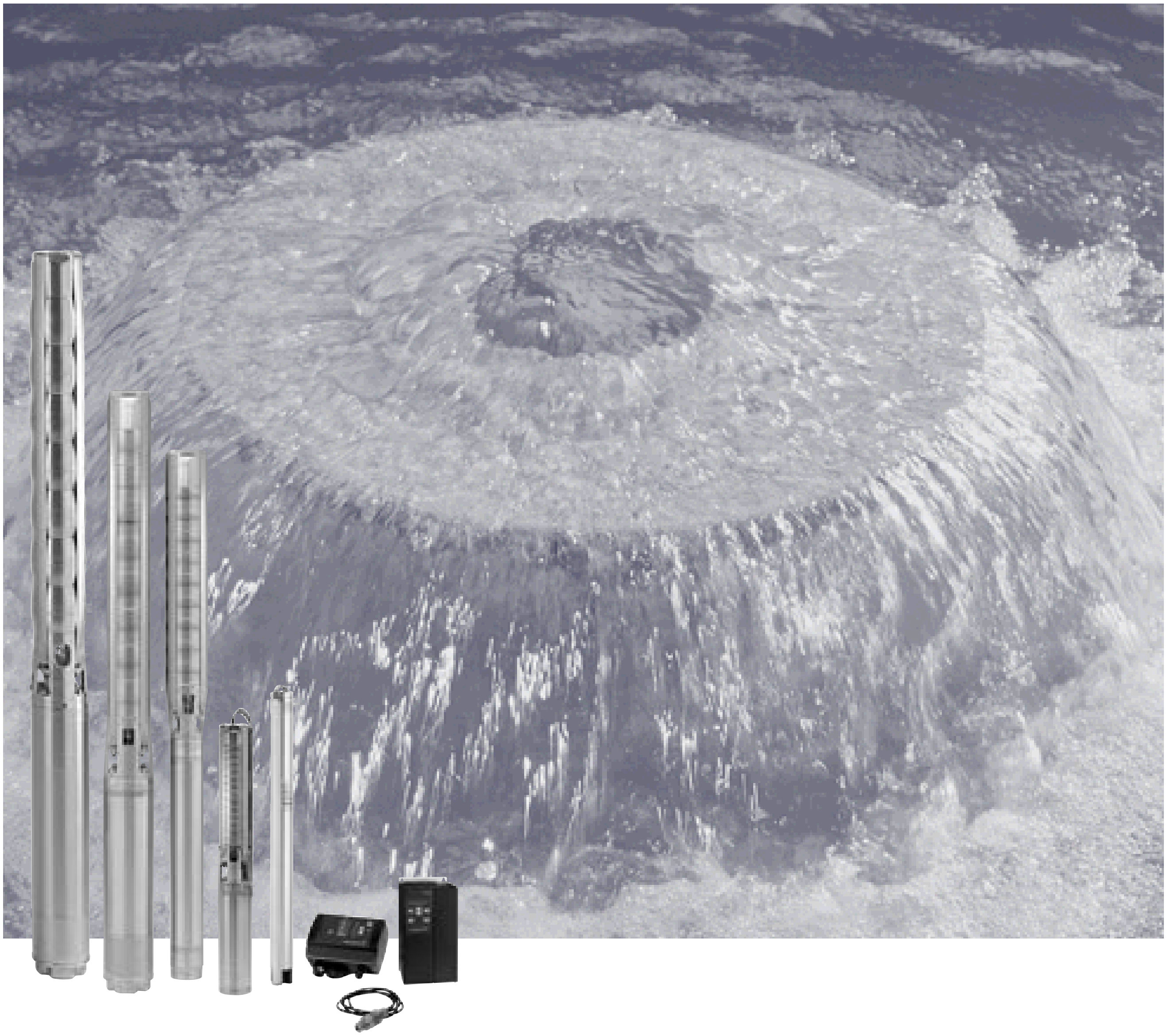
COMPONENT	CYLINDRICAL SHAFT (3-16 Stgs.)
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	431 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Coupling	316/431 Stainless Steel**
Check Valve Seat	NBR/316 Stainless Steel
Top Bearing	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/316 Stainless Steel
Intermediate Bearings	NBR/316 Stainless Steel
Shaft Washer	LCP (Vectra®)
Split Cone	304 Stainless Steel
Split Cone Nut	304 Stainless Steel

NOTES: Specifications are subject to change without notice.
Vectra® is a registered trademark of Hoechast Calanese Corporation.

GRUNDFOS **PRODUCT GUIDE**

SQ, SQE, SP

Stainless steel submersible pumps and accessories
60 Hz



BE > THINK > INNOVATE >

GRUNDFOS®

Mission

- to successfully develop, produce, and sell high quality pumps and pumping systems worldwide, contributing to a better quality of life and healthier environment

Bjerringbro, Denmark

Fresno, California

Olathe, Kansas

Monterrey, Mexico

Allentown, Pennsylvania

Oakville, Ontario

- One of the 3 largest pump companies in the world with over 11,000 employees worldwide
- World headquarters in Denmark
- North American headquarters in Kansas City - Manufacturing in Fresno, California
- 60 companies in 40 countries
- More than 10 million pumps produced annually worldwide
- North American companies operating in USA, Canada and Mexico
- Continuous reinvestment in growth and development enables the company to **BE** responsible, **THINK** ahead, and **INNOVATE**

Submittal Data Sheet

Company name: __________
Prepared by: __________
Phone number: ( ) -
Fax number: ( ) -
Date: _____ Page 1 of: _____
Quote number: __________

Client Information

Project title:	Client name:
Reference number:	Client number:
Client contact:	Client phone no: ( ) -

Location Information

For:	Unit:		
Site:	Service:		
Address:	City:	State:	Zip Code:

Technical Data

Flow (GPM)
Head (Ft)
Motor
Max Fluid Temp
Min Fluid Temp
Max Working Pressure
Min Required Inlet Pressure
Connection Type and Size

Motor Information

HP:
Phase:
Voltage:
Enclosure:

Pump Information

Model Information from Type Key and Codes:
Quantity Required: Example: SP 150S
Minimum required flow: NPSH required at duty point:

Product Guide additional information pages

Materials page number: Performance curve page number:
Technical data page number: Motor data page number:

Custom-built pump information (optional):

Additional Information

TABLE OF CONTENTS

STAINLESS STEEL CONSTRUCTION

Grundfos submersibles feature rugged and durable stainless steel construction for all vital pump components. Impellers, diffusers, shafts, vanes, cable guards, couplings...even the nuts and bolts are stainless steel. Grundfos' 4-inch pump systems include the stainless steel pump, motor, and control box and are delivered ready to install.

Computer-aided design and manufacturing techniques ensure that each *pump* is built to exacting tolerance and performs to industry-leading standards. Grundfos state-of-the-art production equipment includes extensive use of robotics and advanced quality assurance procedures. You can rely on quality Grundfos' groundwater products for outstanding pump performance and best value.

SUBMERSIBLES

4-INCH and LARGER WELLS
The 4-inch submersibles line covers all flow requirements from 1.2 to 95 gpm and heads to 2000 feet. This broad range ensures proper pump selection for all domestic groundwater system applications.

6, 8, & 10-INCH and LARGER WELLS
For high flow requirements, this submersible line includes 6, 8, and 10-inch models for flows up to 1,400 gpm and heads to 2100 feet.

Grundfos offers 18 models of submersible pumps designed for domestic and industrial applications with flow rates from five to 1,400 gpm. Horsepower range extends from 1/3 hp to 250 hp. These pumps are marketed through more than 300 distributors and nearly 2,000 dealers nationwide.

THE STAINLESS STEEL ADVANTAGE

TOP PUMP PERFORMANCE
Grundfos pumps are built to work hard with every component designed for maximum hydraulic efficiency. With the inherently smooth surfaces of fabricated stainless steel, peak performance is maintained over many years of service.

RELIABLE OPERATION
Highly advanced design and manufacturing techniques minimize the number of moving parts. This, plus Grundfos' use of rugged stainless steel construction, make GRUNDFOS groundwater pumps the toughest, most reliable pumps on the market. With Grundfos you can rely on getting the water you need, when you need it.

LONG PUMP LIFE
Stainless steel is the best available material to resist wear and corrosion in water system applications. Compare Grundfos' stainless steel construction to the best the other manufactures have to offer. Grundfos stainless steel pumps are designed to operate efficiently and effectively for a long, long time.

SQ/SQE SUBMERSIBLE PUMPS

3-Inch SQ/SQE Submersible Well Pumps
3-Inch and Larger Wells

SQ/SQE pumps are suitable for both continuous and intermittent operation for a variety of applications:

- Domestic water supply
- Small waterworks
- Irrigation
- Tank applications

SQ, SQE pumps offer the following features:

- Dry-Run protection
- High efficiency pump and motor
- Protection against up-thrust
- Soft-start
- Over-voltage and under-voltage protection
- Overload protection
- Over-temperature protection
- High starting torque

Additionally, the SQE pumps offer:

- Constant pressure control
- Variable speed
- Electronic control and communication

The SQ and SQE pump models incorporate an innovative motor design. With the use of permanent-magnet technology within the motor, the SQ/SQE pumps deliver unmatched performance. By combining permanent-magnet motors and Grundfos's own micro frequency converter, we are now able to control and communicate with the pump in ways never before possible. A few of the features that come out of this combination are Constant Pressure Control, Soft-Start, and integrated Dry-Run protection. These are just a few of the many features that the SQ/SQE pumps can offer.

The SQ pump models operate at a constant speed much like today's conventional pumps. The difference between it and traditional pumps is you get all the benefits of an electronically controlled permanent-magnet motor that cannot be accomplished with a conventional induction motor. The SQ pumps are available for single phase power. They use a simple 2-wire design making installation easy.

The SQE uses the Grundfos "Smart Motor". Like the SQ model, we still use the high efficiency permanent magnet motor, but we give this motor the ability to communicate. The "Smart Motor" communicates via the CU301 status box through the power leads. It is not necessary to run any additional wires down the well. By being able to communicate with the pump you can have Constant Pressure Control and the ability to change the pump performance while the pump is installed in the well. Like the SQ motor, this is also a 2-wire motor designed for single-phase operation.

TYPE KEYS

SP Example 10 S 05 - 9

Rated gallons per minute	10
Material of construction	S
Horsepower	05
Number of pump stages	9

SQ/SQE Example 10 SQ E 05 - 160

Rated gallons per minute	10
Basic version (without communication)	SQ
Electronic communication	E
Horsepower	05
Total Dynamic Head in (ft) at rated flow	160

SP4”

4-Inch Stainless Steel Submersible Pumps

(US) Installation and operating instructions

WATER QUALITY
DRINKING WATER
SYSTEM COMPONENTS
ANSI/NSF 61
65 GM
30°C/86°F
PUMP END ONLY

Please leave these instructions with the pump for future reference.

SAFETY WARNING

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

NOTICE: This product is designes for pumping water only. Third party agency evalustions are based on pumping water only.

Pre-Installation Checklist

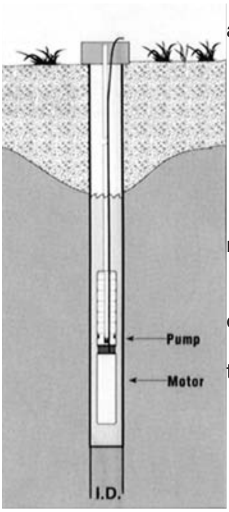
1. Well Preparation

If the pump is to be installed in a new well then the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the GRUNDFOS submersibles make it resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil.

2. Make Sure You Have The Right Pump

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.



3. Pumped Fluid Requirements

CAUTION: Submersible well pumps are designed for pumping clear, cold water; free of air or gases. Decreased pump performance and life expectancy can occur if the water is not cold, clear or contains air or gasses. Water temperature should not exceed 102°F.

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well. The bottom of the motor should never be installed lower than the top of the screen or within five feet of the well bottom.

Ensure that the requirement for minimum flow past the motor is met, as shown in the table below:

Minimum Water Flow Requirements for Submersible Pump Motors

MINIMUM DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. GPM FLOW PASSING THE MOTOR
4-Inch	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES: For proper motor cooling, a flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor. The minimum water velocity past 4" motors is 0.25 feet per second.

PRE-INSTALLATION CHECKLIST

4. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight. There are a number of cable splicing kits available today – epoxy filled, rubber-sealed and so on. Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable.

Examine the motor cable and drop cable carefully for damage. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation. Insert a properly sized Sta-kon-type connector on each pair of leads, again making sure that colors are matched. Using Sta-kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon. The putty should overlap on the insulation of the wire. Use a good quality tape such as ***#33 Scotch Waterproof*** or ***Plymouth Rubber Company Slipknot Grey***. Wrap each wire and joint tightly for a distance of about 2-1/2 inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal.

INSTALLATION PROCEDURES

1. Attach the Pump to the Motor

When attaching the pump to the motor we recommend the pump be bolted down in a cross pattern around the four bolts. Starting from the back (opposite the cable opening) and using a cross pattern, tighten the motor bolts to 13.5 ft-lbs, using progressive tightening until torque is met. (See figure 1 for example).

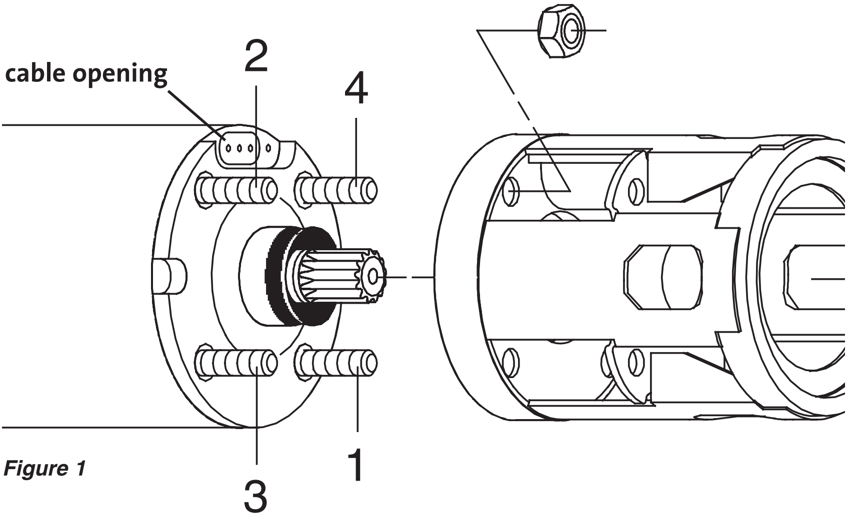


Figure 1

INSTALLATION PROCEDURES

2. Attach the Pump to the Pipe

A back-up wrench should be used when riser pipe is attached to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. Under no circumstances grip the body of the pump, cable guard or motor. When tightened down, the threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump. After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump. When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only. It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles. The manufacturer or representative should be contacted to ensure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that points are fastened, we recommend the use of a torque arrestor when using plastic pipe.

3. Lower the Pump Into the Well

Make sure the electrical cables are not cut or damaged in any way when the pump is being lowered in the well. Do not use the power cables to support the weight of the pump.

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade utilizing a locally approved well seal or pitless adaptor unit. We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

The drop cable should be secured to the riser pipe at approximately every 10 ft/3 m to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

Figure 2

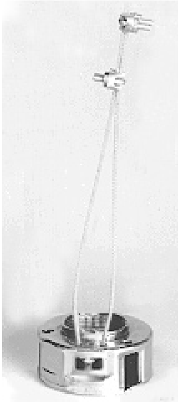


Figure 3

IMPORTANT: *Plastic pipe tends to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave three to four inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable. (See Figures 2 & 3.)*

Check Valves: A check valve should always be installed at the surface of the well and one at a maximum of 25 feet above static water level. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

4. Electrical Connections

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor electrical data can be found on page 6. If voltage variations are larger than ± 10%, do not operate the pump. Single-phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor. The type of wire used between the pump control boxes should be approved for submersible pump application. The conductor insulation should be type RW, RUW, TW or equivalent.

A high-voltage surge arrestor should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrestor should be installed on the supply (line) side of the control box or starter (See Figure 4a & 4b). The arrestor must be grounded in accordance with the National Electric Code and local governing regulations.

PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY.
The control box shall be permanently grounded in accordance with the National Electric Code and local governing codes or regulations. The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size. Ground wire should be as short a distance as possible and securely fastened to a true grounding point. True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first, then to the terminal in the control box.

Single Phase Hookup

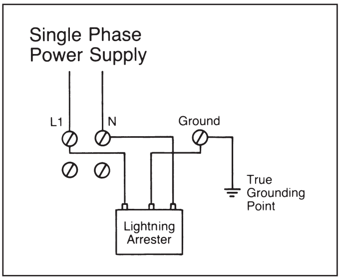


Figure 4a

Three Phase Hookup

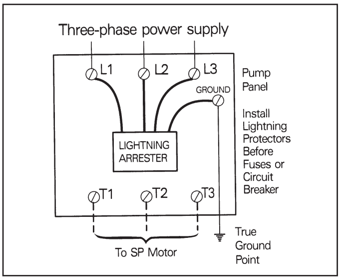
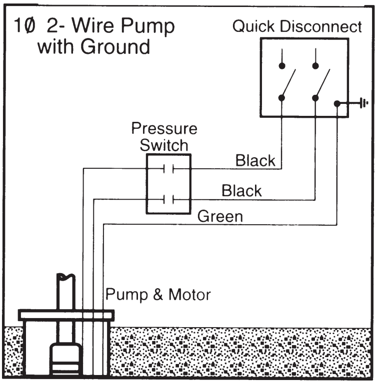


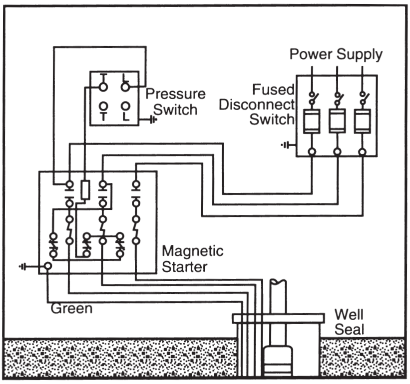
Figure 4b

INSTALLATION PROCEDURES

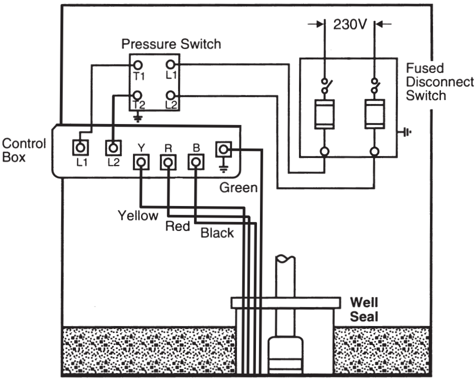
Single-Phase 2-Wire Wiring Diagram for Submersible Motors



Three-Phase Wiring Diagram for Submersible Motors



Single-Phase 3-Wire Control Box for Submersible Motors



4. Starting the Pump for the First Time

A. Attach a temporary horizontal length of pipe to the riser pipe.
B. Install a gate valve and another short length of pipe to the temporary pipe.
C. Adjust the gate valve one-third of the way open.
D. Verify that the electrical connections are in accordance with the wiring diagram.
E. After proper rotation has been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.
F. Slowly open the valve in small increments as the water clears until the valve is all the way open. The pump should not be stopped until the water runs clear.
G. If the water is clean and clear when the pump is first started, the valve should still be opened until it is all the way open.

MOTOR INFORMATION

Grundfos motors specifications

1- Phase motors

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance ( )		KVA code	Nameplate no.
				SF	Start	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
4-inch, single phase, 2-wire motors (control box not required)												
1/3	1	230	1.75	4.6	25.7	59	77	900	6.8-8.2		S	79952101
1/2	1	115	1.60	12.0	55	62	76	900	1.1-1.3		R	79922102
1/2	1	230	1.60	6.0	34.5	62	76	900	5.2-6.3		R	79952102
3/4	1	230	1.50	8.4	40.5	62	75	900	3.2-3.8		N	79952103
1	1	230	1.40	9.8	48.4	63	82	900	2.5-3.1		M	79952104
1 1/2	1	230	1.30	13.1	62	64	85	900	1.9-2.3		L	79952105
4-inch, single phase, 3-wire motors												
1/3	1	115	1.75	9.0	29	59	77	900	1.55-1.9	2.4-3	M	79423101
1/3	1	230	1.75	4.6	14	59	77	900	6.8-8.3	17.3-21.1	L	79453101
1/2	1	115	1.60	12.0	42.5	61	76	900	0.9-1.1	1.9-2.35	L	79423102
1/2	1	230	1.60	6.0	21.5	62	76	900	4.7-5.7	15.8-19.6	L	79453102
3/4	1	230	1.50	8.4	31.4	62	75	900	3.2-3.9	14-17.2	L	79453103
1	1	230	1.40	9.8	37	63	82	900	2.6-3.1	10.3-12.5	K	79453104
1.5	1	230	1.30	11.6	45.9	69	89	900	1.9-2.3	7.8-9.6	H	79453105
2	1	230	1.25	13.2	57	72	86	1500	1.5-1.8	3.4-4.1	G	79454506
3	1	230	1.15	17.0	77	74	93	1500	1.2-1.4	2.45-3	F	79454507
5	1	230	1.15	27.5	110	77	92	1500	0.65-0.85	2.1-2.6	F	79454509

3-Phase motors

HP	Ph	Volt	Service factor	Amperage		Full load		Max. thrust (lbs)	Line-to-Line resistance ( )		KVA code	Nameplate no.
				SF	Start.	Eff. (%)	Pwr fact.		Blk-Yel	Red-Yel		
4-inch, three phase, 3-wire motors												
1 1/2	3	230	1.30	7.3	40.3	75	72	900	3.9		K	79302005
		460	1.30	3.7	20.1	75	72	900	15.9		K	79362005
		575	1.30	2.9	16.1	75	72	900	25.2		K	79392005
3	3	230	1.25	8.7	48	76	75	900	3.0		J	79302006
		460	1.25	4.4	24	76	75	900	12.1		J	79362006
		575	1.25	3.5	19.2	76	75	900	18.8		J	79392006
3	3	230	1.15	12.2	56	77	75	900	2.2		H	79302006
		460	1.15	6.1	28	77	75	900	9.0		H	79362007
		575	1.15	4.8	22	77	75	900	13.0		H	79395507
5	3	208/230	1.15	18.6/17.4	108	80	82	1500	1.2		H	79304509
		440/460	1.15	8.65/8.65	54	80	82	1500	5.0		H	79354509
		575	1.15	7.9	54	80	82	1500	7.3		H	79394509
7 1/2	3	208/230	1.15	27.0/25.0	130	81	82	1500	0.84		H	79305511
		440/460	1.15	12.8/12.6	67	81	82	1500	3.24		J	79355511
		575	1.15	10.6	53	81	82	1500	5.2		J	79395511
10	3	440/460	1.15	18.0/18.6	90	81	80	1500	1.16		H	79355512
		575	1.15	14.4	72	81	80	1500	1.84		H	79395512

*All Grundfos 4" motors have a ground (green wire)

GRUNDFOS Control Box SA-SPM5

RATING		GRUNDFOS MOTOR MODEL	GRUNDFOS CONTROL BOX	GRUNDFOS STANDARD #'s	GRUNDFOS RUN CAP/DELUXE #'s
HP	VOLT				
1/3	115	MS402B	SA-SPM5	91126150	–
1/3	230	MS402B	SA-SPM5	91126151	–
1/2	115	MS402B	SA-SPM5	91126152	–
1/2	230	MS402B	SA-SPM5	91126153	–
3/4	230	MS402B	SA-SPM5	91126154	–
1	230	MS402B	SA-SPM5	91126155	91126211
1.5	230	MS402B	SA-SPM5	91126212	91126213
2	230	MS4000	SA-SPM5	91126214	91126215
3	230	MS4000	SA-SPM5	91126216	91126217
5	230	MS4000	SA-SPM5	91126218	91126219

MOTOR INFORMATION

The key to long submersible motor life is good cooling. Most submersible pumps rely on moving heat away from the motor by forced convection. The ambient/produced fluid is typically drawn by the motor in the course of pumping to accomplish this task. Submersible motors used in the water supply industry are typically designed to operate at full load in water up to 30°C (86°F), provided the flow velocity can be maintained at a minimum of 0.5 feet per second (fps).

Required Cooling Flow and Velocity

AWWA specifications state the maximum motor diameter and the minimum inside diameter of the well shall be in such relationship that under any operating condition the water velocity past the motor shall not exceed 12 fps (3.7 m/s) nor be less than 0.5 fps (0.15 m/s). The AWWA specification are principally applicable to motors 6-inch and larger, as most 4-inch motor designs are based on a minimum cooling flow velocity of 0.25 fps (0.08 m/s) at rated ambient temperature. Table 8 relates flow, casing and motor size requirements to accomplish minimum cooling velocity.

Table 8: Minimum Submersible Cooling Flow Requirements

Casing/Sleeve I.D. (inches)	4" Motor (0.25 fps)	6" Motor (0.5 fps)
	(gpm)	
4	1.2	–
5	7.0	–
6	13	9
7	20	25
8	30	45
10	50	90
12	80	140
14	110	200
16	150	280
18	–	380

Notes:
1. Minor irregularities associated with motor shape and diameter variations between manufactures are not accounted for in the table.
2. At the velocity specified in the table the temperature differential between the motor surface and ambient water will range from 5° - 15°C (10-30°F).

Some submersible motor manufactures require no cooling fluid flow past the motor, when the produced fluid temperature is 20°C (68°F) or less. Cooling by free convection in such cases, is only permitted in the vertical position and is contingent on no adverse operating conditions present such as; poor power, high stop/start frequency, presence of incrustating deposits on the motor surface, etc. Detramental operating conditions are difficult to identify or predict, and for this reason, the minimum cooling flow should be provided whenever possible - regardless of the ambient fluid temperature.

Typical Motor Jacket/Shroud Configurations.

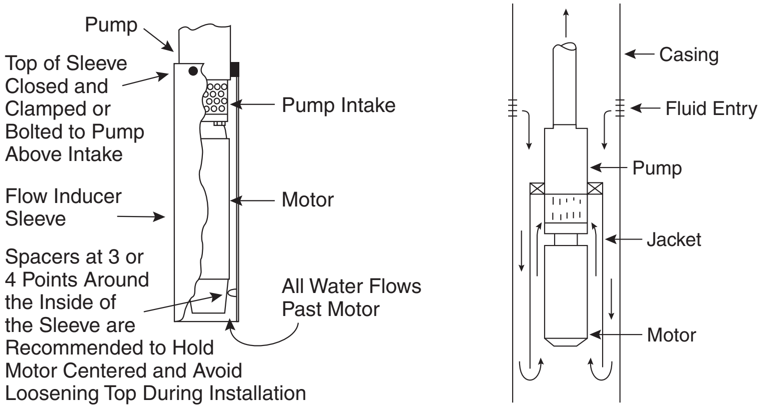
The motor shroud is generally of the next nominal diameter of standard pipe larger than the motor or the pump, depending on the shroud configuration used. The tubular/pipe material can be plastic or thin walled steel (corrosion resistant materials preferred). The cap/top must accommodate power cable without damage and provide a snug fit, so that only a very small amount of fluid can be pulled through the top of the shroud. The fit should not be completely water tight as ventilation is often required to allow escape of the air or gas that might accumulate. The shroud body should be stabilized to prevent rotation and maintain the motor centered within the shroud. The shroud length should extend to a length of 1-2 times the shroud diameter beyond the bottom of the motor when possible. Shrouds are typically attached immediately above the pump intake or at the pump/column correction.

A typical motor sleeve/shroud selection example is sited below and illustrated in Figure 8:

If a well feeds water from above the pump, has a casing/chamber too small to allow a motor jacket/sleeve on the pump, and does not have adequate level and flow to allow raising the pump above the inflow, it is difficult to properly cool the motor. When possible, the casing depth should be increased to allow flow to come from below the motor. If this is not practical, adequate flow past the motor can usually be attained by employing a motor jacket with a stringer pipe or by using a jet tube.

Figure 8: Typical Motor Jacket Installation Scenarios

Typical Flow Inducer Sleeve Cutaway View



MOTOR INFORMATION

Single-Phase 60 Hz

MOTOR RATING		COPPER WIRE SIZE (AWG)								
VOLTS	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**	**0**	**00**
115	1/3	130	210	340	540	840	1300	1960	2910	
	1/2	100	160	250	390	620	960	1460	2160	
230	1/3	550	880	1390	2190	3400	5250	7960		
	1/2	400	650	1020	1610	2510	3880	5880		
	3/4	300	480	760	1200	1870	2890	4370	6470	
	1	250	400	630	990	1540	2380	3610	5360	6520
	1-1/2	190	310	480	770	1200	1870	2850	4280	5240
	2	150	250	390	620	970	1530	2360	3620	4480
	3	120	190	300	470	750	1190	1850	2890	3610
	5	180	280	450	710	1110	1740	2170		

Three-Phase 60 Hz

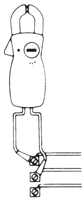
MOTOR RATIN		COPPER WIRE SIZE (AWG)						
VOLTS	**HP**	**14**	**12**	**10**	**8**	**6**	**4**	**2**
208	1-1/2	310	500	790	1260			
	2	240	390	610	970	1520		
	3	180	290	470	740	1160	1810	
		5170	280	4690	1080			1660
230	1-1/2	360	580	920	1450			
	2	280	450	700	1110	1740		
	3	210	340	540	860	1340	2080	
	5		200	320	510	800	1240	1900
460	1-1/2	1700						
	2	1300	2070					
	3	1000	1600	2520				
	5	590	950	1500	2360			
575	1-1/2	2620						
	2	2030						
	3	1580	2530					
	5	920	1480	2330				

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

TROUBLESHOOTING

SUPPLY VOLTAGE



How to Measure

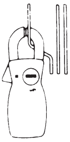
By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter. On single-phase units, measure between line and neutral.

What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

CURRENT MEASUREMENT



How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box. See page 6, for motor amp draw information.

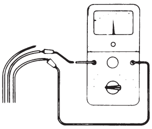
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA), check for the following:

1. Loose terminals in control box or possible cable defect. Check winding and insulation resistances.
2. Too high or low supply voltage.
3. Motor windings are shorted.
4. Pump is damaged causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.

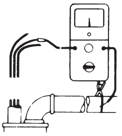
Zero-adjust the meter and measure the resistance between leads. Record the values. Motor resistance values can be found on page 6.

What it Means

If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motor may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values on page 6.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohm or mega ohmmeter, set the scale selector to Rx 100K and zero-adjust the meter. Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
2,000,000 (or more)	2.0	**Motor not yet installed:** New Motor.
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
500,000 - 1,000,000	0.5 - 1.0	**Motor in well** (Ohm readings are for drop cable plus motor): A motor in reasonably good condition.
20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

TROUBLESHOOTING

Pump Won't Start

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
No power at the motor	Check for voltage at the control box or panel.	If there is no voltage at the control panel, check the feeder panel for tripped circuits and reset those circuits.
Fuses are blown or the circuit breakers have tripped	Turn off the power and remove the fuses. Check for continuity with an ohmmeter.	Replace the blown fuses or reset the circuit breaker. If the new fuses blow or the circuit breaker trips, the electrical installation, motor, and wires must be check for defects.
(3-phase motors only) **Motor starter overloads are burned or have tripped**	Check for voltage on the line and load side of the starter. Check the amp draw and make sure the heater is sized correctly.	Replace any burned heaters or reset. Inspect the starter for other damage. If the heater trips again, check the supply voltage. Ensure that heaters are sized correctly and the trip setting is appropriately adjusted.
(3-phase motors only) **Starter does not energize**	Energize the control circuit and check for voltage at the holding coil.	If there is no voltage, check the control circuit fuses. If there is voltage, check the holding coil for weak connections. Ensure that the holding coil is designed to operate with the available control voltage. Replace the coil if defects are found.
Defective controls	Check all safety and pressure switches for defects. Inspect the contacts in control devices.	Replace worn or defective parts or controls.
Motor or cable is defective	Turn off the power and disconnect the motor leads from the control box. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K).	If an open or grounded winding is found, remove the motor from the well and recheck the measurements with the lead separated from the motor. Repair or replace the motor or cable.
(1-phase motors only) **Defective capacitor**	Turn off the power and discharge the capacitor by shorting the leads together. Check it with an analog ohmmeter (set to R x 100k).	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and slowly drift back to infinity (Ą). Replace capacitor if it is defective.
Defective pressure switch or the tubing to it is plugged	Watch the pressure gauges as the pressure switch operates. Remove the tubing and blow through it.	Replace as necessary.
The pump is mechanically bound or stuck	Turn off the power and manually rotate the pump shaft. Also check the motor shaft rotation, the shaft height, and the motor's amp draw (to see if it indicates a locked rotor).	If the pump shaft doesn't rotate, remove the pump and examine it. If necessary, dismantle it and check the impellers and seal for obstruction. Check for motor corrosion.

Pump Does Not Produce Enough Flow (GPM)

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
(3-phase motors only) **Shaft is turning in the wrong direction**	Check to make sure the electrical connections in the control panel are correct.	Correct the wiring. For single phase motors, check the wiring diagram on the motor. For three phase motors, simply switch any two power leads.
Pump is operating at the wrong speed (too slow)	Check for low voltage and phase imbalance.	Replace defective parts or contact power company, as applicable.
Check valve is stuck (or installed backwards)	Remove the check valve.	Re-install or replace.
Parts or fittings in the pump are worn **– or –** **Impellers or Inlet Strainer is clogged**	Install a pressure gauge near the discharge port, start the pump, and gradually close the discharge valve. Read the pressure at shutoff. (Do not allow the pump to operate for an extended period at shutoff.)	Convert the PSI you read on the gauge to Feet of Head by: **PSI x 2.31 ft/PSI = ______ ft.** **Specific Gravity** Add to this number the number of feet (vertically) from the gauge down to the water's pumping level. Refer to the pump curve for the model you are working with to determine the shutoff head you should expect for that model. If that head is close to the figure you came up with (above), the pump is probably OK. If not, remove the pump and inspect impellers, chambers, etc.
The water level in the well may be too low to supply the flow desired **– or –** **Collapsed well**	Check the drawdown in the well while the pump is operating.	If the pumping water level (including drawdown) is not **AT LEAST 3 FEET** above the pump's inlet strainer, either: 1. Lower the pump further down the well. 2. Throttle back the discharge valve to decrease the flow, thereby reuding drawdown.
Broken shaft or coupling	Pull pump and inspect.	Replace as necessary.
There are leaks in the fittings or piping	Pull the pump out of the well.	The suction pipe, valves, and fittings must be made tight. Repair any leaks and retighten all loose fittings.

Fuses Blow or Heaters Trip

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
Improper voltage	Check the voltage at the control box or panel.	If the voltage varies by more than 10% (+ or -), contact the power company.
	If the incoming voltage is OK, check the wire size and the distance between the pump motor and the pump control panel.	Rewire with correct gauge. Undersized wire and a great distance between the control panel and the pump motor increases resistance and decreases the voltage by the time it reaches the pump motor.
The starter overloads are set too low	Cycle the pump and measure the amperage.	Increase the heater size or adjust the trip setting. Do not, however, exceed the recommended rating.
(3-phase motors only) **The three-phase current is imbalanced**	Check the current draw on each lead to the motor.	The current draw on each lead must be within 5% of each other (+ or -). If they are not, check the wiring.
The wiring or connections are faulty	Check to make sure the wiring is correct and there are no loose terminals.	Tighten any loose terminals and replace any damaged wire.
(1-phase motors only) **Capacitor is defective**	Turn off the power and discharge the capacitor. Check the capacitor with an ohmmeter (set at R x 100k). See page 15 for instructions.	When the meter is connected to the capacitor, the needle should jump toward 0 (zero) ohms and then slowly drift back to infinity (¥). Replace capacitor if it is defective.
Fuse, heater, or starter are the wrong size	Check the fuses and heaters against the motor manufacturer's specification charts.	Replace as necessary.
The control box location is too hot	Touch the box with your bare hand during the hottest part of the day – you should be able to keep your hand on it without burning.	Shade, ventilate, or move the control box so its environment does not exceed 120°F.
(1-phase motors only) **Wrong control box**	Check requirements for the motor against the control box specifications.	Replace as necessary.
Defective pressure switch	Watch gauges as pressure switch operates.	Replace as necessary.
The motor is shorted or grounded.	Turn off the power and disconnect the wiring. Measure the lead-to-lead resistance with an ohmmeter (set to R x 1). Measure the lead-to-ground values with an ohmmeter (set to R x 100K) or a megaohmmeter. Compare these measurements to the rated values for your motor.	If you find an open or grounded winding, remove the motor and recheck the leads. If OK, check the leads for continuity and for bad splice.
Poor motor cooling	Find the internal diameter of the well casing (or sleeve, if used). For proper cooling, the flow of water **must not be less than the GPM shown across the bottom scale on page __.**	Throttle up the pump flow (GPM) so proper cooling is possible. – or – Pull the pump out of the well and add a sleeve with a smaller internal diameter.

Pump Cycles Too Often

POSSIBLE CAUSE	CHECK THIS BY...	CORRECT THIS BY...
The pressure switch is defective or is not properly adjusted	Check the pressure setting on the switch. Check the voltage across closed contacts.	Readjust the pressure switch or replace it if defective.
The tank is too small	Check the tank size and amount of air in the tank. The tank volume should be approximately 10 gallons for each Gallon-Per-Minute of pump capacity. At the pump cut-in pressure, the tank should be about 2/3 filled with air.	Replace the tank with one that is the correct size.
There is insufficient air charging of the tank or piping is leaking	Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soapy water. Check the air-to-water ratio in the tank.	Repair as necessary.
Plugged snifter valve or bleed orifice (causing pressure tank to be waterlogged)	Examine them for dirt or erosion.	Repair or replace as necessary.
Leak in the pressure tank or piping	Apply soapy water to pipes and tank, then watch for bubbles, indicating leaks.	Repair or replace as necessary.
The level control is defective or is not properly set	Check the setting and operation of the level control.	Readjust the level control setting (according to the manufacturer's instructions) or replace it if defective.
Pump is oversized for the application. It is outpumping the yield of the well and pumping itself dry.	Check the yield of the well (determined by the well-test) against the pump's performance curve.	Reduce the flow by throttling back the valve. – or – Change the pump.

LIMITED WARRANTY

Products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

MANUFACTURER WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE. EXCEPT AS EXPRESSLY HEREIN PROVIDED THE GOODS ARE SOLD "AS IS", THE ENTIRE RISK AS TO QUALITY AND FITNESS FOR A PARTICULAR PURPOSE, AND PERFORMANCE OF THE GOODS IS WITH THE BUYER, AND SHOULD THE GOODS PROVE DEFECTIVE FOLLOWING THEIR PURCHASE, THE BUYER AND NOT THE MANUFACTURER, DISTRIBUTOR, OR RETAILER ASSUMES THE ENTIRE RISK OF ALL NECESSARY SERVICING OR REPAIR.

Some jurisdictions do not allow the exclusion or limitation of implied warranties of merchantability and fitness for a particular purpose, of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last or require you to pay certain expenses as set forth above. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

BE > THINK > INNOVATE >

Being responsible is our foundation
Thinking ahead makes it possible
Innovation is the essence

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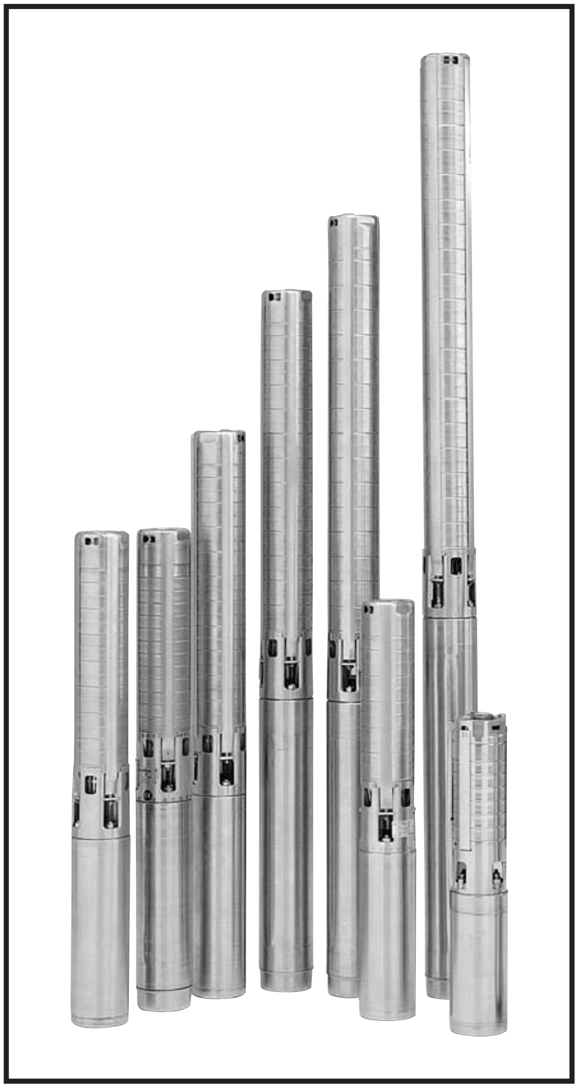
L-SP-TL-048 Rev. 2/06(US)

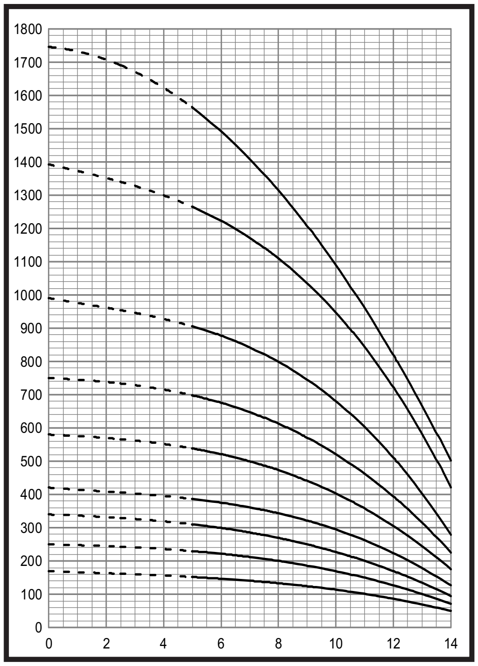
GRUNDFOS®

CS-EXW01 AND CS-EXW02 PUMP SPECIFICATIONS

Easy Selection Chart
Performance Curves and Technical Data

4-Inch Submersible Pumps





Performance Curves

Materials of Construction

Grundfos Stainless Steel Submersible Pumps

4" Submersible

Easy Selection Charts.

SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)

40 GPM
FLOW RANGE
(24 TO 55 GPM)
DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET
PUMP OUTLET
2" NPT

SELECTION CHARTS
(Ratings are in GALLONS PER MINUTE-GPM)

10 GPM
FLOW RANGE
(5 TO 14 GPM)
DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET
PUMP OUTLET
1 1/4" NPT

See 10S performance curves for higher head models.
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

40S EASY SELECTION CHART

40 GPM

SELECTION CHARTS

(Ratings are in GALLONS PER MINUTE-GPM)

FLOW RANGE

(24 TO 55 GPM)

PUMP OUTLET
2 " NPT

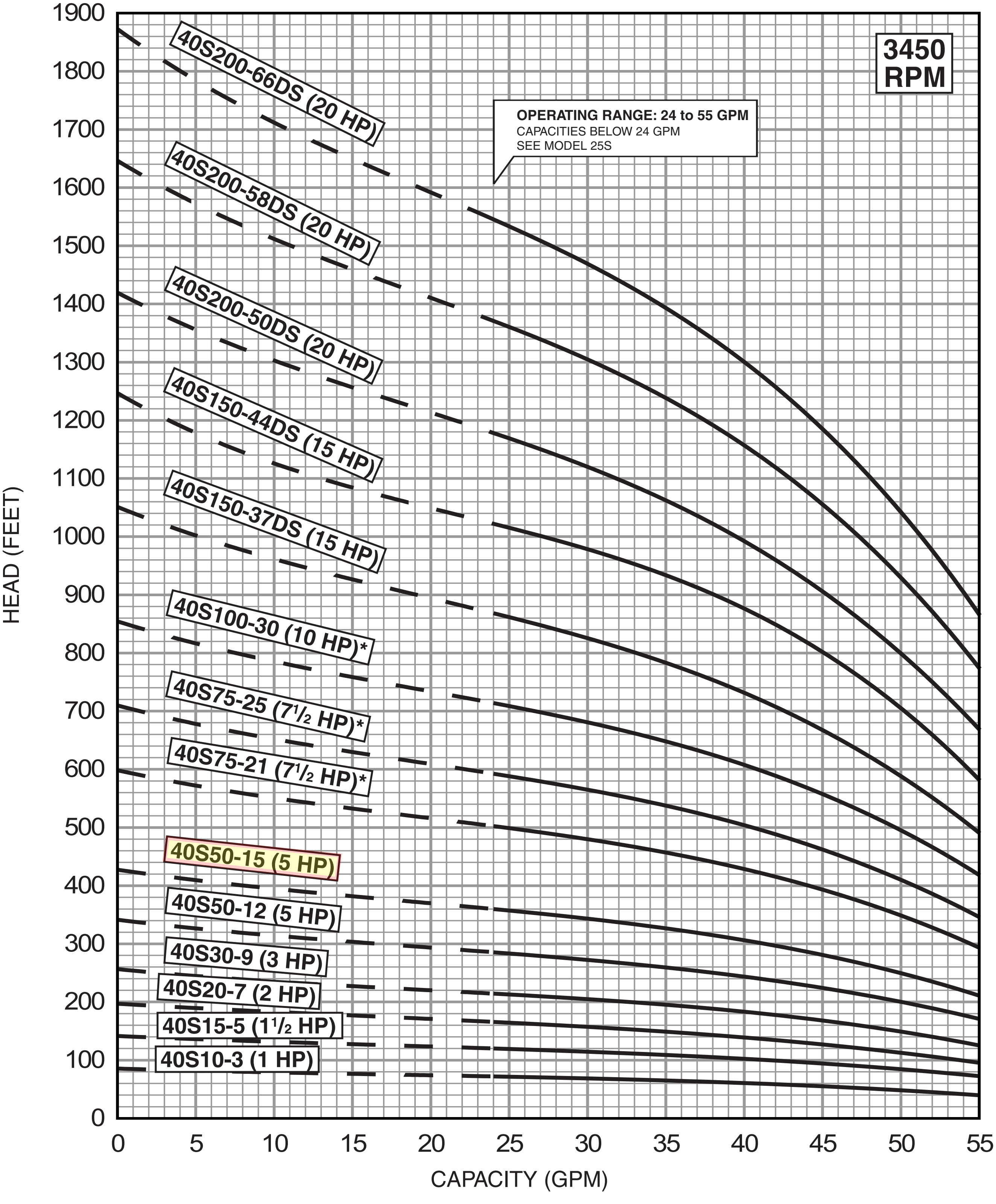
DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																												
PUMP MODEL	HP	PSI		20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
40S10-3	1	20	46.2	33.0																								
		30	69.3																									
		40	92.4																									
		50	116																									
		60	139																									
SHUT-OFF PSI:			0	28	19	11	2																					
40S15-5	1 1/2	0	0				52.0	41.0	24.0																			
		20	46.2	57.0	50.0	37.0	18.0																					
		30	69.3	48.0	34.0	15.0																						
		40	92.4	31.0	11.0																							
		50	116	7.0																								
		60	139																									
SHUT-OFF PSI:			0	52	44	35	26	18	9																			
40S20-7	2	0	0					54.0	49.0	40.0	29.0	15.0																
		20	46.2			53.0	46.0	37.0	25.0	10.0																		
		30	69.3		52.0	45.0	35.0	23.0	8.0																			
		40	92.4	51.0	44.0	33.0	21.0	5.0																				
		50	116	42.0	32.0	18.0	2.0																					
		60	139	30.0	16.0																							
SHUT-OFF PSI:			0	77	68	59	51	42	33	25	16	7																
40S30-9	3	0	0							53.0	47.0	41.0	32.0	22.0														
		20	46.2					51.0	45.0	38.0	29.0	19.0																
		30	69.3				50.0	44.0	37.0	28.0	17.0																	
		40	92.4		54.0	50.0	43.0	35.0	26.0	15.0																		
		50	116	54.0	49.0	42.0	34.0	24.0	13.0																			
		60	139	48.0	41.0	33.0	23.0	11.0																				
SHUT-OFF PSI:			0	102	94	85	76	68	59	50	42	33	24	16	7													
40S50-12	5	0	0									53.0	49.0	44.0	39.0	32.0	25.0	16.0										
		20	46.2							52.0	48.0	43.0	37.0	30.0	22.0	13.0												
		30	69.3						51.0	47.0	42.0	36.0	29.0	21.0	12.0													
		40	92.4					51.0	46.0	41.0	35.0	28.0	20.0	11.0														
		50	116			54.0	50.0	45.0	40.0	34.0	26.0	18.0	9.0															
		60	139		53.0	49.0	45.0	39.0	33.0	25.0	17.0	8.0																
SHUT-OFF PSI:			0		130	122	113	104	96	87	78	70	61	52	44	35	26	18										
40S50-15	5	0	0											52.0	49.0	46.0	42.0	37.0	26.0									
		20	46.2									51.0	48.0	45.0	40.0	35.0	30.0	24.0										
		30	69.3								51.0	48.0	44.0	40.0	35.0	29.0	23.0	16.0										
		40	92.4							51.0	47.0	43.0	39.0	34.0	28.0	21.0	14.0											
		50	116						50.0	47.0	43.0	38.0	33.0	27.0	20.0	13.0												
		60	139					50.0	46.0	42.0	37.0	32.0	26.0	19.0	12.0													
SHUT-OFF PSI:			0					141	132	124	115	107	98	89	81	72	63	55	37	11								
40S75-21	7 1/2	0	0																49.0	41.0	29.0	15.0						
		20	46.2													53.0	51.0	48.0	43.0	32.0	19.0							
		30	69.3												52.0	50.0	48.0	45.0	39.0	27.0	13.0							
		40	92.4											52.0	50.0	48.0	45.0	42.0	35.0	22.0	6.0							
		50	116										52.0	50.0	47.0	44.0	41.0	38.0	30.0	16.0								
		60	139									51.0	49.0	47.0	44.0	41.0	38.0	34.0	25.0	10.0								
SHUT-OFF PSI:			0									181	172	163	155	146	137	129	111	85	59	33						
40S75-25	7 1/2	0	0																	51.0	45.0	37.0	23.0					
		20	46.2																52.0	47.0	39.0	29.0	14.0					
		30	69.3															54.0	50.0	44.0	35.0	25.0						
		40	92.4														54.0	52.0	48.0	41.0	32.0	21.0						
		50	116													53.0	52.0	50.0	45.0	38.0	28.0							
		60	139												53.0	51.0	49.0	47.0	43.0	34.0	24.0							
SHUT-OFF PSI:			0												203	194	186	177	160	134	108	82	47					
***40S100-30** **40S100-30**	10	0	0																		53.0	49.0	41.0	27.0				
		20	46.2																	54.0	50.0	44.0	35.0	20.0				
		30	69.3																	52.0	48.0	42.0	32.0	16.0				
		40	92.4																	51.0	46.0	39.0	28.0	12.0				
		50	116																	49.0	43.0	36.0	25.0	8.0				
		60	139																52.0	47.0	41.0	33.0	21.0					
SHUT-OFF PSI:																			222	196	170	144	110	66	23			

*** 6" Motor**

See 40S performance curves for higher head models.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

FLOW RANGE: 24 - 55 GPM **OUTLET SIZE: 2 " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 1-10 HP/3450 RPM.
6" MOTOR STANDARD,15-20 HP/3450 RPM.
* Also available with 6" motor.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 5 feet.

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES					APPROX. SHIP WT.
					A	B	C	D	E	
40S10-3	A	1	4"	2" NPT	24.6	11.8	12.8	3.8	3.9	32
40S15-5	A	1 1/2	4"	2" NPT	29.7	13.6	16.1	3.8	3.9	37
40S20-7	A	2	4"	2" NPT	34.5	15.1	19.4	3.8	3.9	41
40S30-9	A	3	4"	2" NPT	43.3	20.6	22.7	3.8	3.9	65
40S50-12	A	5	4"	2" NPT	51.3	23.6	27.7	3.8	3.9	78
40S50-15	A	5	4"	2" NPT	56.2	23.6	32.6	3.8	3.9	84
40S75-21*	A	7 1/2	4"	2" NPT	74.6	29.6	45.0	3.8	3.9	120
40S75-25*	A	7 1/2	4"	2" NPT	81.2	29.6	51.6	3.8	3.9	124
40S100-30*	A	10	4"	2" NPT	103.7	43.9	59.8	3.8	3.9	181
40S150-37DS	A	15	6"	2" NPT	99.5	28.0	71.5	5.4	5.4	244
40S150-44DS	A	15	6"	2" NPT	111.0	28.0	83.0	5.4	5.4	340
40S200-50DS**	B	20	6"	2" MPT	136.0	30.6	105.4	5.4	5.5	319
40S200-58DS**	B	20	6"	2" MPT	149.2	30.6	118.6	5.4	5.5	334
40S200-66DS**	B	20	6"	2" MPT	162.4	30.6	131.8	5.4	5.5	394

NOTES: All models suitable for use in 4" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Also available with 6" motor.
** Built into sleeve 2" MPT discharge, 6" min. well dia.

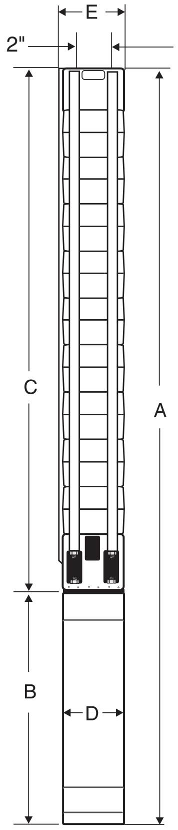


Fig. A

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (3-44 Stgs.)	DEEP SET (50-66 Stgs.)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel
Pump Shaft	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	304 Stainless Steel
Coupling	316/431 Stainless Steel **	329/ 416 Stainless Steel
Check Valve Seat	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Intermediate Bearings	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	LCP (Vectra®)	LCP (Vectra®)
Split Cone	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	304 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	304 Stainless Steel

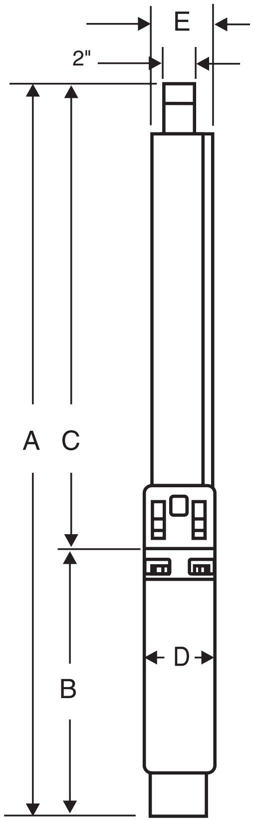


Fig. B

NOTES: Specifications are subject to change without notice.
Vectra® is a registered trademark of Hoechast Calanese Corporation.
***Stainless Steel option available.**

SYMCOM PUMPSAVER SPECIFICATIONS

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...your electronic control & protection specialists

SINGLE-PHASE
PUMPSAVER CATALOG

PumpSaver® Plus
ELECTRONIC PUMP
CONTROL & PROTECTION

Having issues with your SymCom product?
Call our **Technical Support Team** with your questions.

800-843-8848
technicalsupport@symcom.com

To Our Customers:

Many times, issues with a product are the result of an incorrect setting. By calling us, SymCom's Technical Support Team, the issue can be eliminated. With our experienced staff, we can go over the settings with you to ensure that everything is set correctly. We are well versed in all products and applications for SymCom products. Chances are, we have run into your issue before.

The best way to fix an issue is to have you at the unit when you call, that way, we can make sure that all issues are fixed the first time. In the event that we determine your unit is not functioning properly, we will issue you a return material authorization (RMA) number to send the unit in for evaluation. If the unit is determined to be faulty and covered under warranty, we will replace the unit at no charge to you. No need to contact your distributor for a replacement. A new unit will be sent to you directly if it is covered under warranty.

So call our friendly support staff today for any and all of your questions regarding your SymCom products.

Best Regards,

SymCom Technical Support Team

Note: The use of flow restrictors, unusually high head pressures, or low water conditions at the time of calibration may interfere with the detection of dead-head and dry-well conditions.

5 - 15hp, 230VAC - Model 235P

SymCom's Model 235P PumpSaver®Plus is designed to protect 5-15 hp, 230V, single-phase pumps from dry-well, dead-head, jammed impeller and overvoltage and undervoltage conditions.

A calibration adjustment allows the Model 235P to be calibrated to your specific pumping applications, thereby reducing the possibility of false or nuisance tripping. A unique microcontroller-based voltage and current-sensing circuit constantly monitors the incoming power for fluctuations causing overcurrent and undercurrent. When an abnormality, such as loss of suction is detected, the PumpSaver®Plus deactivates its output relay and directly disconnects the pump motor.

The PumpSaver®Plus communicates with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays parameters including calibration points, trip points, run time and last faults. An IR Kit-12 (12" fiber optic kit) allows the Informer to access these parameters even when the PumpSaver®Plus is enclosed in a control box. This is valuable for troubleshooting the pump while it is running.

An external current transformer is required for operation (sold separately).

Size	Current	CT*
5 - 7½ HP	27.5 - 42.1	50:5
10 HP	51	75:5
15 HP	75	100:5

NOTE: The PumpSaver®Plus models have a sensitivity adjustment for the dry-well trip point. After calibration is done, you can adjust the sensitivity for the dry-well/dead-head trip point from 70-90% of the full load. This makes the unit even more adaptable to varying pumping applications. If you have a very low producing well, you increase the sensitivity closer to the 90% mark, or if you have a very heavy producing well, you would decrease the sensitivity around the 70% mark.

Specifications

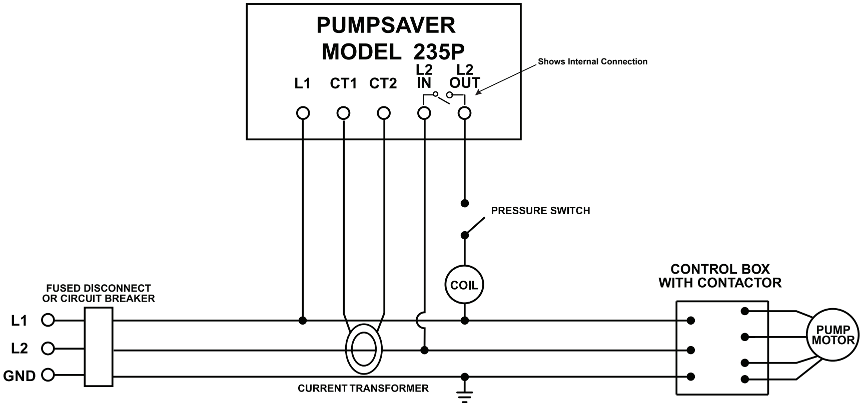
Functional Specifications	
Adjustments/Settings	
Overcurrent	125% of calibration point
Underload (dry-well)	Adjustable (70 to 90% of calibrated run power)
Overvoltage	265VAC
Undervoltage	190VAC
Number of restarts allowed in a 60-sec. period (rapid-cycling)	4
Trip Delay Times	
Overcurrent	5 seconds
Dry-well	4 seconds
Restart Delay Times	
Over/undervoltage	2 seconds
All other faults	Manual, 2-225 Minutes
Input Characteristics	
Supply Voltage	230VAC
Load Range	5 – 15 hp
Frequency	50/60Hz (Note: 50Hz will increase all delay timers by 20%)
Output Characteristics	
Output Contact Rating-SPST	A300, 720VA@240VAC (10 amps max.)
General Characteristics	
Operating Temperature	-40° to 55° C (-40° to 131° F)
Maximum Input Power	5 W
Wire Gauge	Solid or Stranded 10 - 22AWG
Terminal Torque	13 in.-lbs.
Standards Passed	
Electrostatic Discharge (ESD)	IEC 61000-4-2, Level 2, 4kV contact, 6kV air
Surge Immunity	IEC 61000-4-5, Level 4, 4kV line-to-line and line-to-ground
Safety Marks	
cUL Listed	UL508, C22.2 No. 14
Dimensions	5.26” W x 2.93” H x 2.90” D
Weight	14 oz.
Mounting Methods	#8 screws

For a typical wiring diagram see page 35.
For installation instructions see page 36.
For product dimensions see page 54.

How to order:

235P* (5 - 15hp, 230VAC)

* current transformer sold separately



Model 235P

Size	Current	CT*
5 - 7½ HP	27.5 - 42.1	50:5
10 HP	51	75:5
15 HP	75	100:5

* external current transformers sold separately

PUMPSAVER®PLUS
INSTALLATION INSTRUCTIONS

The PumpSaver®Plus INSIDERs fit inside 1/3 – 3hp, 230V Franklin™, Pentek®, Grundfos®or CentriPro™ control boxes. PumpSavers are designed to protect single-phase pumps from dry-well, dead-head, rapid-cycling, jammed impeller, and over/undervoltage conditions. Typical applications include residential waterwells, commercial waterwells, irrigation wells, and golf course and other sprinkler systems.

CONNECTIONS

(INSIDERs)

Refer to specific connection instructions depending on the particular control box being used:

Grundfos® control box	- page 28
Pentek® control box	– page 31
Franklin™ control box	– page 32
CentriPro™ control box	– page 33

(111P / 233P / 235P)

NOTE: Use in conjunction with UL listed or recognized thermal or solid-state overload relays only.

1 Mount the PumpSaver®Plus Model 111P / 233P / 235P in a convenient location in or near the pump control box. If the location is wet or dusy, a NEMA 3R, 4 or 12 enclosure should be used.
2. Refer to Typical Wiring Diagram for 111P / 233P / 235P on pages 34 and 35.

NOTE: For Model 235P, one line from the fused disconnect must pass through the current transformer.

The Model 235P will NOT function without an external CT (sold separately).

NOTE: If the Model 235P immediately trips out upon completion of the calibration process, the current transformer may be installed incorrectly. Switch the CT1 and CT2 connections at the unit, then repeat the calibration process.

CALIBRATION / RESTART DELAY

(INSIDERs)

1. Turn RESTART DELAY/CALIBRATION to the CAL position and close the box cover.
2. Apply power to the system. The pump should run for approximately 10 seconds and then shut off—this indicates the INSIDER has calibrated.
3. Remove power from the system. Open the control box and set the appropriate dry-well recovery time with the RESTART DELAY / CALIBRATION knob.
4. Shut the control box and re-apply power to the system.

(111P / 233P / 235P)

NOTE: The Model 111P / 233P / 235P should be calibrated during normal pumping conditions.

1. Turn the RESTART DELAY/CALIBRATION knob fully counter-clockwise to the CAL. position.
2. Apply power- the pump will run for approximately 10 seconds then shut off.
3. Set the RESTART DELAY/CALIBRATION knob to the desired restart delay (dry-well recovery time) - the pump will turn on.

CALIBRATING WHILE PUMPING

The Model 111P / 233P / 235P can also be calibrated while the pump is running. Turn the RESTART DELAY/CALIBRATION knob to CAL. while pumping. Wait for the pump to turn off (approximately 10 seconds), then adjust the RESTART DELAY/CALIBRATION knob to the desired setting.

MANUAL RESET MODE (111P / 233P / 235P only)

Set the RESTART DELAY/CALIBRATION knob to RESET for manual reset mode. If the 111P / 233P / 235P trips off due to a voltage or load problem, the RESTART DELAY/CALIBRATION knob must be rotated out of the RESET position to restart the pump, and then can be placed back in the RESET position for subsequent manual reset mode.

NOTE: Any restart delay can be bypassed by rotating the RESTART DELAY/CALIBRATION knob to the RESET position and back to the desired restart delay setting.

NOTE: The restart delay can be changed at any time. The next trip will follow the new restart delay setting.

OPERATION

The PumpSaver®Plus units monitor pump loads in amps and kilowatts. When the current (amps) exceeds approximately 125% of calibrated current, or power (kW) drops below the adjustable underload trip point, the PumpSaver®Plus units —after the trip delay—will turn off the pump. The PumpSaver®Plus units will automatically restart the pump after the selected restart delay time (unless in the manual reset mode).
The calibration is stored in permanent memory. The PumpSaver®Plus does not need to be recalibrated if power is lost.

SENSITIVITY

The PumpSaver®Plus units have an adjustment knob to set the underload trip sensitivity. Setting SENSITIVITY to the middle position (straight up) is equivalent to SymCom's standard underload trip level. Adjust the SENSITIVITY knob to increase/decrease underload sensitivity up to approximately ±10% of the standard trip. It may be necessary to increase the sensitivity if the PumpSaver®Plus does not trip on dry-run or dead-head or it is known that the water level in the well is very low relative to the pumps capabilities.

WARNING: Decreasing the SENSITIVITY may compromise the PumpSaver's ability to detect dry-run and/or dead-head conditions.

RUN HOURS

The PumpSaver®Plus units record pump run hours. Run hours can be displayed by a PumpSaver®Plus Informer. Run hours can be reset on the PumpSaver®Plus units.—please read the instruction fully before performing the procedure.
NOTE: Turn the SENSITIVITY knob <u>completely</u> to the left (counter-clockwise) or <u>completely</u> to the right (clockwise) when directed.

WARNING: ENSURE POWER IS APPLIED TO THE **INSIDERs** IN A SAFE MANNER WHEN PERFORMING THE FOLLOWING PROCEDURE.

To Reset Run Hours:

1. Remove power to the PumpSaver®Plus.
2. Set the RESTART DELAY/CALIBRATION knob to RESET and the SENSITIVITY knob to th middle (12:00) position.
3. Apply power to the PumpSaver®Plus—the CAL. LIGHT will turn on.
4. Turn the SENSITIVITY knob to the right—the CAL. LIGHT will turn off and the RUN LIGHT will turn on.
5. Turn the SENSITIVITY knob to the left—both lights will turn on.
6. Turn the SENSITIVITY knob to the right.
7. After 10 seconds, the CAL. and RUN LIGHTS will blink twice indicating the run hours have successfully been reset.

RAPID CYCLING

Rapid cycling is defined as more than 4 restarts in a 60-second period. The PumpSaver®Plus is capable of detecting a rapid-cycle condition whether a control device, such as a pressure switch, is installed before* or after it. Upon detecting either form of rapid cycling, the PumpSaver®Plus will lock-out, preventing damage to the pump. To reset the PumpSaver®Plus, remove and re-apply power.

RAPID CYCLING (Line Side / Upstream)

Rapid cycling of the line side of the PumpSaver®Plus may be caused by several naturally occurring conditions which are indistinguishable from true rapid cycling. For this reason, once tripped, Symcom's protection will wait 30 minutes and restart. If any restart is successful (pump runs for more than I minute), the rapid cycle counter will reset to zero. If the PumpSaver®Plus encounters rapid cycle 4 times without a successful restart, the PumpSaver®Plus will lock-out and require a manual reset. To reset the PumpSaver®Plus, remove and re-apply power.

*Protection against rapid cycling of a control device installed before the PumpSaver®Plus is disabled by default. Read the following instructions fully before performing the procedure to enable this feature.

NOTE: Turn the SENSITIVITY knob completely to the left (counter-clockwise) or completely to the right (clockwise) when directed.

To Enable Rapid-Cycle Protection when a Control Device is Installed BEFORE the PumpSaver®Plus: (to disable, follow the same procedure)

1. Remove power to the PumpSaver®Plus.
2. Set the RESTART DELAY/ CALIBRATION knob to RESET and the SENSITIVITY knob to the middle (12:00) position.
3. Apply power to the PumpSaver®Plus —the CAL. LIGHT will turn on.
4. Turn the SENSITIVITY knob to the right—the CAL. LIGHT will turn off, RUN LIGHT will turn on.
5. Turn the SENSITIVITY knob to the left—both lights will turn on.
6. Turn the SENSITIVITY knob right—left—right—left—right.
7. After 2 seconds, the CAL. and RUN LIGHTS will blink once indicating line side rapid-cycle protection has been enabled.

RAPID CYCLING (Load Side / Downstream)
Load side rapid cycling of the pump will immediately result in a manual lock-out. The pump will not restart automatically. To reset the PumpSaver®Plus, remove and re-apply power.

Note: Protection against rapid cycling of a control device installed after the PumpSaver®Plus is always enabled. Disabling line side detection will not disable load side detection.

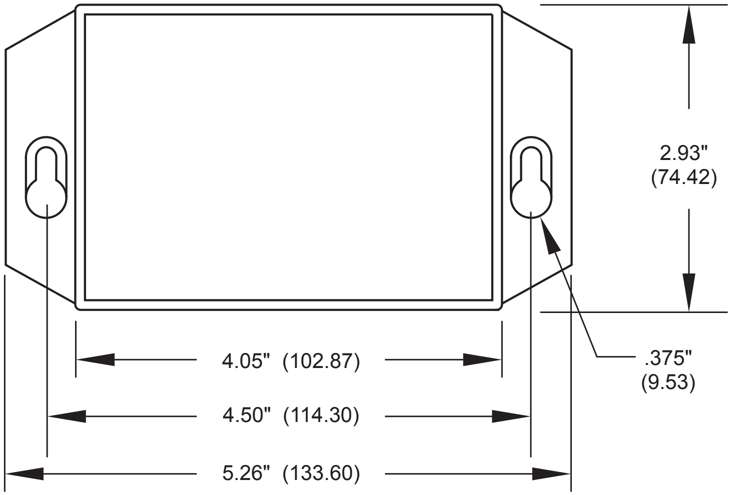
USING AN INFORMER

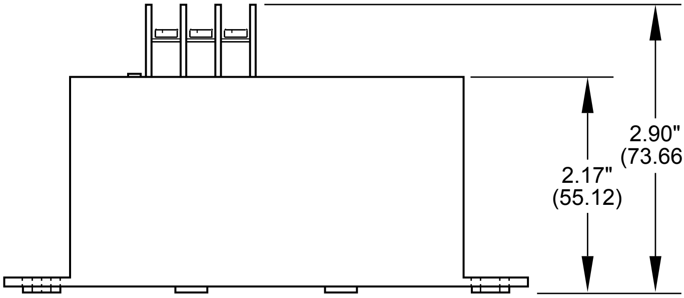
The PumpSaver®Plus units are equipped with an infrared LED that will communicate to a SymCom Informer—a hand-held, battery operated, diagnostic tool. An Informer IR Kit is required for the PumpSaver®Plus Insider units to communicate to the Informer. The Informer will display the model number; run time; pump starts; restart delay setting; restart delay timer; real-time voltage, current and power; dry-well and overload trip points; calibration voltage; last 20 faults; voltage, current, power and run time for the last 20 faults; highest/lowest voltage and current since calibration; and the CT size if applicable. The Informer can be used on any single-phase PumpSaver®Plus equipped with an infrared LED transmitter—Models 111-Insider-P; 231-Insider-P; 232-Insider; 111P; 233P; 234-P; 235P and 236-P.

INFORMER TROUBLESHOOTING GUIDE

The Informer does not activate when the ON button is pressed.	Battery Polarity Reversed - Verify the + and – terminals on the battery match the markings inside the battery compartment.
	Low Battery - Replace the battery.
The COMM STATUS light is off and all display values remain at zero.	Weak Signal – Ensure the Informer is aimed directly at the PumpSaver’s infrared LED and is within the operating distance.
	PumpSaver®Plus not transmitting - Verify the PumpSaver®Plus is energized and the green RUN light is illuminated.
	Sunlight - Verify the sun is not shining directly onto the Informer’s infrared receiver.
The COMM STATUS light is blinking.	Weak Signal – Ensure the Informer is aimed directly at the PumpSaver’s infrared LED and is within the operating distance. OR If using an older Informer (version 1.xx or earlier) with a PumpSaver®Plus, this is a normal condition.
The displayed values fluctuate radically.	Weak Signal – Ensure the Informer is aimed directly at the PumpSaver’s infrared LED and is within the operating distance.
The Informer displays values even after communication is lost.	This Is Normal - The Informer holds the last values it received before communication was lost. (until the auto shut off)

111P / 233P / 235P - DIMENSIONS





Voltage/Current/Power Monitors - Overload Relays

SymCom's 777 family of products are UL listed as Electronic Overload Relays. The KW/HP units are also power monitors that can calculate a Power reading for use with many software solutions.

Communication & I/O Modules

Units that are used for converting the information coming from a 777 family or 601 family product to Modbus, Devicenet, 4-20mA or Profibus signal to be sent over a network.

Remote Monitors

SymCom's remote monitors are used in conjunction with the 777 and 601 families to display real-time voltages and currents. Fault codes are listed on an easy to read display. Using a remote monitor will also help by making it safer for employees to gather real-time information without having to open the electrical panel.

Solutions Software

Used to monitor, log information, control and change configurations and setpoints on the 777 and 601 family of products.

Voltage Monitors, single-phase & 3-phase

Used to monitor incoming line voltages for High or Low voltage, Reverse-phase, Unbalanced voltage and Single-Phased voltages.

Current Monitors, single-phase & 3-phase

Used to monitor current levels in a motor for High or Low current, Unbalanced current and Single-Phased currents.

Alternating Relays

Unit will alternate between two pumps so they will have equal running time, thus not wearing one pump out prematurely.

Intrinsically-Safe Relays

Units designed to be used in hazardous applications where explosive materials are present.

Pump Controllers

Used to control from 2 to 4 pumps in multiple pump applications. Has the ability to be used in pump-up or pump-down configurations. Different models have multiple uses. SymCom also provides Intrinsically- Safe pump controllers.

Load Sensors

Can be used as proof relays to detect tool wear, feed rates and loss of prime on pumps by detecting current levels. Many different configurations can be used for differing uses.

Auxiliary Products

TIMERS - On-delay timer that starts its timer when power is applied. Output contact is energized when the timing is complete, anywhere from 6 seconds to 10 minutes or 0.5 to 12 seconds.
CURRENT TRANSFORMERS - Donut or foot mounted CT used for transmitting current signal from the main conductors to the SymCom units where required.

For warranty information,
please see **Terms and Conditions** at
www.symcom.com

www.SymCom.com
...your electronic control & protection specialists

2880 North Plaza Drive, Rapid City, SD 57702
(800) 843-8848 • (605) 348-5580 • fax: (605) 348-5685
customerservice@symcom.com • technicalsupport@symcom.com

Appendix C

Product Information

Price ® Pump Co. XT150 Centrifugal Pump and Baldor Pump Motor

PRICE XT150 CENTRIFUGAL PUMP

General Terms Of Sale For Products

1. GENERAL

A. Seller's price is based on these sales terms and conditions. This contract shall represent the final, complete and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained or waived by parol evidence, any Terms and Conditions contained in Buyer's purchase order or request for quotation, any course of dealings between the parties, Seller's performance or delivery, or in any other way. The Terms and Conditions of this contract may only be modified or waived in a written document signed by an Officer of Seller. These terms are intended to cover all activity of Seller and Buyer hereunder, including sales and use of products, parts and work and all related matters (references to products include parts and references to work include construction, installation and start-up). Any reference by Seller to Buyer's specifications and similar requirements are only to describe the products and work covered hereby and no warranties or other terms therein shall have any force of effect. Any information provided by Seller, including but not limited to suggestions as to specific equipment does not imply any guarantee of specific suitability and/or material compatibility in a particular application since many factors outside the control of Seller may affect the suitability of products in a particular application. Catalogs, circulars and similar pamphlets of the Seller are issued for general information purposes only and shall not be deemed to modify the provisions hereof.

B. The agreement formed hereby and the language herein shall be construed and enforced under the Uniform Commercial Code as in effect in the State of California on the date hereof.

2. TAXES

Any sales, use or other similar type taxes imposed on this sale or on this transaction are not included in the price. Such taxes shall be billed separately to the Buyer. Seller will accept a valid exemption certificate from the Buyer if applicable; however, if an exemption certificate previously accepted is not recognized by the governmental taxing authority involved and the Seller is required to pay the tax covered by such exemption certificate. Buyer agrees to promptly reimburse Seller for the taxes paid.

3. PERFORMANCE, INSPECTION AND ACCEPTANCE

A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after arrival at point of delivery. Products not covered by the foregoing and all work shall be finally inspected and accepted with thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer (including claims for shortages) excepting only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clauses hereof must be asserted in writing by Buyer within said thirty (30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty- (30) day period for each partial performance. There shall be no revocation of acceptance. Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.

B. Seller shall not be responsible for non-performance or for delays in performance occasioned by any causes beyond Seller's reasonable control, including, but not limited to, labor difficulties, delays of vendors or carriers, fires, governmental actions, or shortages of material, components, labor, or manufacturing facilities. Any delays so occasioned shall affect a corresponding extension of Seller's performance dates, which are, in any event, understood to be approximate. In no event shall Buyer be entitled to incidental or consequential damages for late performance or for a failure to perform. Seller reserves the right to make partial shipments and to ship products, parts or work which may be completed prior to the scheduled performance date.

C. In the event that Seller has agreed to mount motors, turbines, gears, or other products which are not manufactured by Seller and which are not an integral part of Seller's manufactured product, and a delay in the delivery of such products to Seller occurs that will cause a delay in Seller's performance date, Seller reserves the right to ship its product upon completion of manufacture and to refund an equitable portion of the amount originally included in the purchase price for mounting without incurring liability for non-performance.

D. Seller reserves to itself the right to change its specifications, drawings and standards if such changes will not impair the performance of its products, and parts, and further that such products, and parts, will meet any of Buyer's specifications and other specific product requirements which are a part of this agreement.

E. The manufacture and inspection of products and parts shall be to Seller's Engineering and Quality Assurance standards plus such other inspections, tests of documentation as are specifically agreed to by Seller. Requirements for any additional inspection, tests, documentation, or Buyer witness of manufacture, test, and/or inspection shall be subject to additional charges.

4. TITLE AND RISK OF LOSS

Title and risk of loss shall pass to buyer upon delivery of products at the designated Ex Works place (Incoterms 1990) unless other wise agreed by the parties.

5. EROSION AND CORROSION

It is specifically understood that products and parts sold hereunder are not warranted for operation with erosive or corrosive fluids. No product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore.

6. WARRANTY AND LIMITATION OF LIABILITY

A.Seller warrants only that its product and parts, when shipped, will be free from defects in materials and workmanship. With respect to products and parts not manufactured by Seller, Seller's only obligation shall be to assign to Buyer, to the extent possible, whatever warranty Seller requires from the manufacturer. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within one (1) year after initial start-up or eighteen (18) months after shipment, whichever first occurs, and all claims for defective work must be made in writing immediately upon discovery and in any event, within one (1) year of completion thereof by Seller.

Defective items must be held for Seller's inspection and returned to the original f.o.b. point upon request.

THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED, WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. ANY PRODUCT (S) SOLD HEREUNDER WHICH IS NOT MANUFACTURED BY SELLER IS NOT WARRANTED BY SELLER and shall be covered only by the express warranty, if any, of the manufacturer thereof.

C. Upon Buyer's submission of a claim as provided above and its substantiation, Seller shall at its option either (i) repair or replace its product, part or work at the original place of delivery, or (ii) refund an equitable portion of the purchase price.

D. THE FOREGOING IS SELLER'S ONLY OBLIGATION AND BUYER'S EXCLUSIVE REMEDY FOR BREACH OF WARRANTY AND, EXCEPT FOR GROSS NEGLIGENCE, WILLFUL MISCONDUCT, AND REMEDIES PERMITTED UNDER THE PERFORMANCE, INSPECTION AND ACCEPTANCE AND THE PATENTS CLAUSES HEREOF, THE FOREGOING IS BUYER EXCLUSIVE REMEDY AGAINST SELLER FOR ALL CLAIMS ARISING HEREUNDER OR RELATING HERETO WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT. TORT (INCLUDING NEGLIGENCE) OR OTHER THEORIES. BUYER'S FAILURE TO SUBMIT A CLAIM AS PROVIDED ABOVE SHALL SPECIFICALLY WAIVE ALL CLAIMS FOR DAMAGES OR OTHER RELIEF, INCLUDING BUT NOT LIMITED TO CLAIMS BASED ON LATENT DEFECTS. IN NO EVENT SHALL BUYER BE ENTITLED TO INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, NOR FOR DAMAGES FOR LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK OR PRODUCTION STOPPAGE, IMPAIRMENT OF OTHER GOODS, INCREASED EXPENSES OF OPERATION, OR THE COST OF PURCHASING REPLACEMENT POWER OR OTHER SERVICES BECAUSE OF SERVICE INTERRUPTIONS. FURTHERMORE, IN NO EVENT SHALL SELLER'S TOTAL LIABILITY FOR DAMAGES OF BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS OR PARTS MANUFACTURED BY SELLER AND UPON WHICH SUCH LIABILITY IS BASED. ANY ACTION ARISING HEREUNDER RELATED HERETO, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHER THEORIES, MUST BE COMMENCED WITHIN ONE (1) YEAR AFTER THE CAUSE OF ACTION ACCRUES OR IT SHALL BE BARRED.

7. PURCHASER'S REPRESENTATIONS & WARRANTIES

Purchaser represents and warranties that the products(s) covered by this contract shall not be used in or in connection with a nuclear facility or application. The parties agree that this representation and warranty is material and is being relied on by seller. This provision may be modified in a separate writing signed by an officer of PPC.

8. PATENTS

Seller agrees to assume the defense of any suit for infringement of any patents brought against Buyer to the extent of such suit charges infringement of an apparatus or product claim by Seller's product in and of itself, provided (i) said product is built entirely to Seller's design, (ii) Buyer notifies Seller in writing of the filing of such suit within ten (10) days after the service of process thereof, and (iii) Seller is given complete control of the defense of such suit, including the right to defend, settle and make changes in the product for the purpose of avoiding infringement of any process or method claims, unless infringement of such claims is the result of following specific instruction furnished by Seller.

9. EXTENT OF SUPPLY

Only products as listed in Seller's proposal are included in this agreement. It must not be assumed that Seller has included anything beyond same.

10. MANUFACTURING SOURCES

To maintain delivery schedules, Seller reservplants on a world-wide basis.

11. TERMS OF PAYMENT

Net 30 days from date of invoice.

Effective: January 1, 1999

Price® Pump Company

Type XT/XL

Installation, Operating and Maintenance Manual

<u>Caution:</u>
Before installing, repairing or performing maintenance on this pump, read these instructions completely.

If pump has been used to pump hazardous materials be certain that all materials have been removed prior to working on the pump.

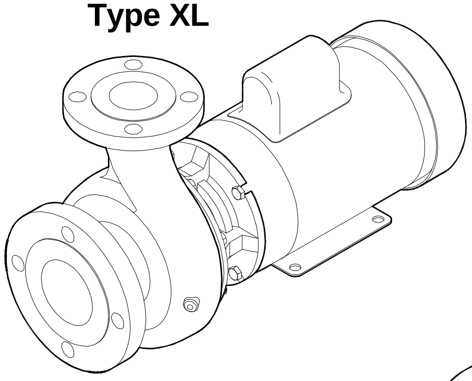
Warning!!
Ground motor before connection to electrical power supply!! Failure to ground motor can cause severe or fatal electrical shock hazard!!

Do not ground to gas supply line!!

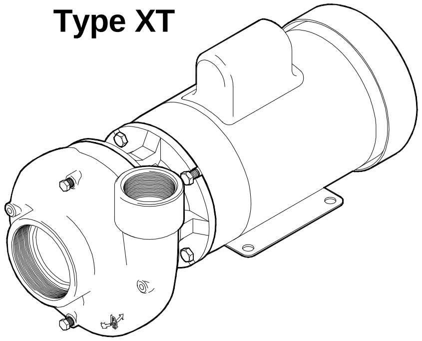
Match voltage to nameplate voltage on motor. Incorrect voltage can cause fire or seriously damage motor, voiding warranty.

Before disassembling be certain all liquid is removed from the pump.

Type XL



Type XT



Close Coupled Motor Pumps

These pumps require no special care in mounting, although it is suggested that they be firmly bolted to a level surface. Adequate air movement over motor will help prevent overloads.

Power Frame Mounted Pumps

These pumps must be mounted on a rigid steel base that will not warp or flex. Each pump must be mounted such that **the pump shaft centerline is on center with the driver shaft centerline.** Pad and/or shims will be required on either pump, driver or both. The two shafts should not touch each other and the distance between them depends on the coupling used to connect them. **Misalignment will cause bearing failure and void warranty. Pumps are rough aligned at the factory but must be realigned after shipment and installation.** Pulley driven pump must have pulleys inline and good belt tightness practices followed.

Direction of Rotation

Note: Motor shaft rotation is viewed from the suction end of pump. A rotational arrow is shown on the front of the pump volute casing. Incorrect rotation can cause pump damage, failure or reduced performance, voiding warranty. It is best to check rotation by momentarily energizing or jogging the motor prior to filling pump with liquid.

Warning! Do not operate pump without liquid for more than a few seconds, as damage will result to mechanical seal.

PLUMBING

All piping should be supported independently of the pump. Piping should not exert any stress on the pump connections.

Suction Piping Horizontal Pumps

Suction line must provide adequate suction pressure and smooth liquid flow for proper pump operation. Air entrapment in the suction line because of leaks or improper design may cause the pump to lose prime and fail. This pump is not self-priming, therefore the suction must be flooded at start up. Also, the suction line must provide sufficient pressure and smooth flow to pump inlet to prevent pump cavitation. A length of straight pipe a minimum of 5 times the pump inlet diameter and preferably 10 times the diameter should be installed in the suction line where it enters the pump. Elbows, fittings or valves installed close to the suction can disrupt liquid flow and cause malfunction. Suction lines must be at least the same size as the pump inlet or larger if possible.

CENTRIF U

School of Pumpology

Visit Our Web Site
www.pricepump.com

- * Check out The Centrifugal Pump University and take the Interactive Pump Test.
- * Find technical information for all Price Pump models.
- * Locate a local distributor at www.pumpnet.com
- * Printable I&O Manuals in PDF Format.

Parts List Type XT/XL Cont.

	All Models	
H2.	T.9 Teflon® Single Seal/Seat (opt)	0123
	Seat Pin T.9 (not shown)	0890
H3.	T.21 Double Seal/Seat (opt)	Specify P/N
	Double Seal Plate (2 rqd)	0309
	Plate Gasket, Teflon® (2 rqd)	0505
	Plate Bolts (6 rqd)	0977
H4.	Seal Quench (opt):	
	Buna Lip Seal	0756
	Viton® Lip Seal	0757
	Teflon® Lip Seal	0758
	Lip Seal Plate	0309-2
	Plate Gasket, Teflon®	0505
	Plate Bolts (3 rqd)	0977
H5.	T.9 Teflon® Double Seal/Seat (opt)	0670
	Double Seal Plate (2 rqd)	0309-1
	Plate Gasket, Teflon® (2 rqd)	0505
	Plate Bolts (6 rqd)	0977
	Seat Pin T.9 (2 rqd not shown)	0890

	All Models	
J.	Impeller Lockdown	0978
K.	Lockdown Gasket, Teflon®	0245
L.	Motor Bolts	
	All Bronze pumps (4 rqd)	0587
	Stainless Steel pumps (4 rqd)	0593
	AI & CIBF pumps (4 rqd) and	0593
	order Washers (4 rqd)	1137
M.	Sleeve Gasket, Teflon®	0245
N.	Impeller Shaft Key	0135
P1.	JM Motor	Specify P/N
P3.	Air Motor	Specify P/N
P4.	Power Frame	5480

Price Pump Co. recommends against using foot valves in the suction line to maintain liquid in the pump when it’s not operating. If foot valves are used due to suction lift conditions they must be properly maintained to avoid leaks resulting from wear or fouling. Suction piping must be designed to prevent air from being trapped in high spots in the piping. This condition may cause the pump to vapor lock as the air bubble moves into the pump.

Discharge Piping

For flow and discharge head control it is advisable to install a valve (globe, ball, or other adjustable and non-leak type) in the discharge line close to the pump. The valve may be closed during system repairs to prevent backflow. By installing a check valve in the discharge line backflow can also be prevented during maintenance or during periods of pump stoppage.

OPERATION

Priming-

All centrifugal pumps must be filled with liquid prior to start up. For the pump illustrated in this manual completely fill the volute and suction lines prior to operation. It is suggested that during initial start up the discharge valve be closed and then opened as the motor develops full rpm’s. If pump does not build up pressure as motor speed increases, shut down and make sure that liquid flow into pump is not restricted (see “Troubleshooting”).

Note: A centrifugal pump’s flow and head (pressure) will vary with the amount of resistance (friction and flow restrictions) in the discharge line. As a valve on the discharge line opens the flow and motor amp draw will increase and head will drop. As a valve on the discharge is closed the flow and amp draw will decrease and the head will increase. If resistance in the discharge line is not sufficient the pump will operate at a condition of maximum (or "choked") flow, also sometimes called "end of performance curve." Maximum horsepower is required to operate at this point and motor overload may result. If excessive amp draw and motor overload is recurring, reduce the system flow by installing a valve on the discharge line and restricting flow. Alternatively, reduce pump head by trimming impeller to a smaller diameter. Consult local Price Pump dealer for assistance.

TROUBLESHOOTING

1. Pump fails to build pressure:
Check for:
- a. Pump not primed.
- b. Incorrect rotation.
- c. Driver speed too low.
- d. Suction line restricted.
- e. Driver failure.
- f. Plugged or damaged impeller.
- g. Pump or impeller undersized.
- h. Pump cavitation.
- i. Improper impeller clearance.

2. Pump fails to provide enough flow.
Check for:
- a. System resistance too high.
- b. Pump undersized.
- c. Pump not primed.
- d. Driver speed too low.
- e. Poor suction conditions.
- f. Improper impeller clearance.

3. Excessive noise or vibration during operation.
Check for:
- a. Motor bearing failing.
- b. Pump cavitating.
- c. Improper impeller clearance.

4. Leaking mechanical seal.
Check for:
- a. Improper assembly.
- b. Worn or cracked seal faces.
- c. Abrasive material in fluid.
- d. Liquid flashing at seal faces (fluid temperature too high).
- e. Seal pressure rating too low for the service.
- f. Chemical attack of seal parts.
- g. Seal operated dry or with a liquid having poor lubricating properties.

5. Pump gradually loses pressure and head.
Check for:
- a. Increasing temperature causing cavitation or liquid vaporization.
- b. Driver failure.
- c. Suction lift too high.
- d. Air entering suction line.

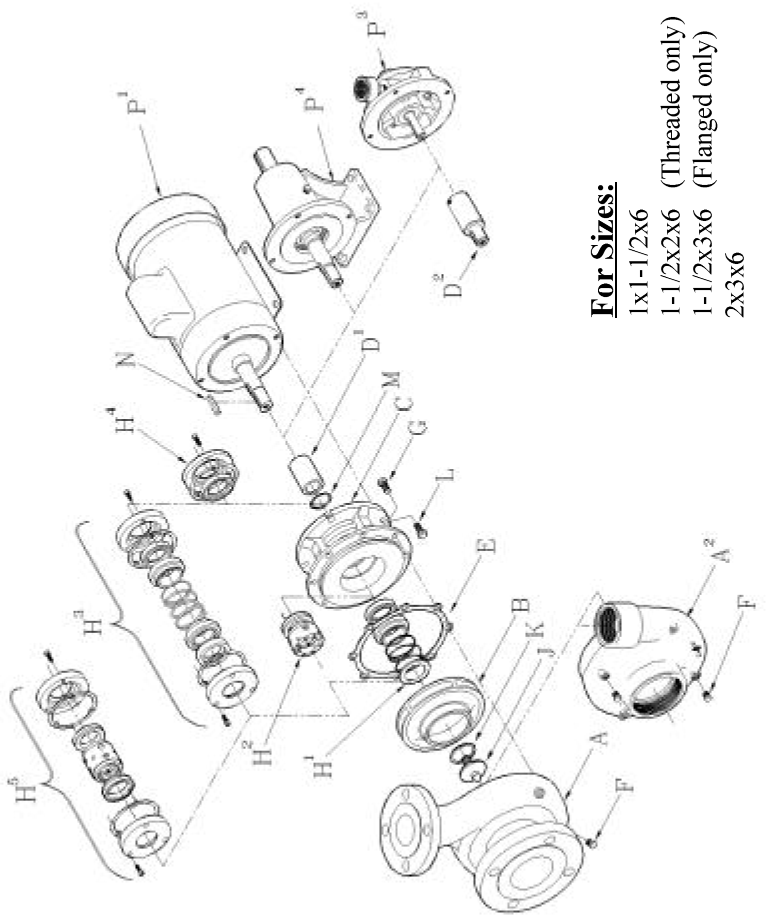
6. Motor/pump overheating.
Check for:
- a. Excessive flow and amp draw (Throttle discharge).
- b. Low voltage or frequency.
- c. Flow too low with resulting heat rise.
- d. Bearing failure.
- e. System temperature too high.

Parts List Type XT/XL

		AI Threaded	**BF Threaded**	**AB Threaded**	**SS Threaded**	**SS Flanged**
A.	Volute					
	XT/XL 100	2601	2601	2603	2629	2605
	XT/XL 150	2607	2607	2609	2626	2611
	XT/XL200	2613	2613	2615	2627	2617
B.	Impeller Specify diameter					
	XT/XL100	2602-dia	2604-dia	2604-dia	2606-dia	2606-dia
	XT/XL150	2608-dia	2610-dia	2610-dia	2612-dia	2612-dia
	XT/XL200	2614-dia	2616-dia	2616-dia	2618-dia	2618-dia
	Note: For Dbl seal add DS (Sample: 2614DS-dia)					
C.	Bracket (std)	0131	0131	0132	0979	0979
	Double Seal	0131-1	0131-1	N/A	0979-1	0979-1
	Single Flush	0131-2	0131-2	0132-2	0979-2	0979-2
	Quench	0131-3	0131-3	N/A	0979-3	0979-3
	Internal Flush	0131-4	0131-4	N/A	0979-4	0979-4
D1.	Shaft Sleeve	0127	0126	0126	0127	0127
D2.	Stub Shaft 5/8" ID	0329-1	0329-1	0329-1	0329-1	0329-1
D3.	Stub Shaft 7/8" ID	0328-1	0328-1	0328-1	0328-1	0328-1
E.	Volute Gasket	0124	0124	0124	0301	0301
F.	Pipe Plug	0557	0557	0558	0559	0559
G.	Volute Bolts	0583	0583	0587	0724	0724
H1.	T.21 Seal/Seat	0121	0121	0121	0122	0122

Continued on next page

Type XT/XL Parts List



For Sizes:
1x1-1/2x6
1-1/2x2x6 (Threaded only)
1-1/2x3x6 (Flanged only)
2x3x6

AI = All Iron
BF = Bronze Fitted
AB = All Bronze
SS = Stainless Steel

TYPE XT/XL MAINTENANCE AND REPAIR

DISASSEMBLY

1. Disconnect power source from motor.

2. Disconnect electrical connections, tagging wires carefully to preserve correct rotation. Loosen pump base.

3. Remove pump and motor assembly to repair area. Observe position of all parts prior to disassembly.
   (Note: volute may be left in piping.)

4. Remove 8 volute bolts and remove volute from pump.

5. Remove impeller. Remove impeller lockdown by turning CCW. Slide impeller off of the shaft. Save shaft key.

6. Remove seal head from the shaft. On type 9 seal, loosen set screws and slide seal from shaft. On type 21, remove seal by sliding it off of the shaft.
7. Remove the four motor bolts and remove bracket from motor.

8. Remove seal seat from bracket. Use wooden or plastic dowel to tap the seat from the bracket. Diagram A

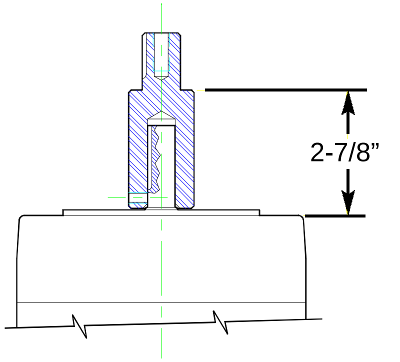
9. Remove shaft or shaft sleeve. Heat shaft sleeve to approximately 300°F and use a bearing puller to remove the sleeve.

REASSEMBLY

1. Clean seal cavity of the bracket thoroughly.

2. Thoroughly clean pump shaft. Assure that the shaft is not grooved and that there is no evidence of pitting or fretting. Polish the shaft with extra fine emery cloth and clean the keyway.

3a. On 56C motors, (stub shaft pumps only), ensure all debris and burrs are removed from the motor shaft. Align halfdog setscrew with motor keyway while sliding stub shaft over the motor shaft. Set height (diagram A). Tighten all set screws.



Reassembly Instructions continued on next page →

3b. On JM style motors, apply Loctite RC/609 to inside diameter of shaft sleeve. Install shaft sleeve onto motor shaft making sure that the groove for the Teflon® sleeve gasket is facing the pump end. Clean excess Loctite from shaft. Be sure sleeve is seated against motor shaft shoulder.

4. For Type 21, 8, and 9 seals: Place the bracket on a firm surface with the seat cavity (pump end) up. Then place a small amount of vegetable oil on the seat cup or "O" ring seat. Place the seat in the seal cavity with the polished face up toward the pump end. Evenly push seat into seat cavity with fingers, then then gently tap seat into place with a wooden dowel or plastic rod (2" outside diameter). To help ensure the seat is not damaged, place the cardboard disk supplied with the seal under the end of the dowel to prevent damaging the seat face.

5. Place bracket on motor (aligning the base if applicable). Secure bracket to motor with four motor bolts and washers.

6. Install seal head assembly:

   For Type 21:

   a. Lubricate shaft and elastomer with vegetable oil.

   b. Install rotary seal head onto pump shaft and slide toward seat using a twisting motion until carbon face touches seal seat.

   c. For 145JM through 215JM frame pumps, install new sleeve gasket into shaft sleeve. For 254JM through 256JM, install new gasket into hub of impeller.

   d. Install seal spring and retainer over shaft sleeve.

   e. Install impeller onto motor shaft being careful to align keyway of impeller with keyway in motor shaft. Push impeller on until impeller bottoms out on shaft sleeve. Install key in keyway.

   f. Install impeller lockdown gasket and impeller lockdown. Tighten securely.

   For Type 8 or Type 9:

   a. Do not remove metal clips from seal head assembly. Place seal on shaft sleeve sliding gently past shoulder.

   b. Slide seal head toward seat until carbon face contacts ceramic seat. Tighten seal head setscrews to shaft sleeve using short arm allen wrench supplied with seal or repair kit. Remove clips in seal head and discard.

   c. For 145JM through 215JM frame pumps, install new sleeve gasket into shaft sleeve. for 254JM through 256JM, install new gasket into hub of impeller.

   d. Install impeller onto motor shaft, being careful to align keyway of impeller with keyway in motor shaft. Push impeller on until impeller bottoms out on shaft sleeve. Install key in keyway.

   e. Install impeller lockdown gasket and impeller lockdown. Tighten securely.

7. Install new volute gasket. Ensure that all of the mating surfaces of the gasket joint are cleaned to bare metal.
8. Install volute and secure with 8 bolts and tighten evenly.

9. Rotate pump shaft by hand to ensure impeller does not rub against volute.

10. Return pump to installation, reconnect electric connections.

11. Start pump momentarily to observe shaft rotation. If rotation corresponds to the rotation arrow on the pump, it may be put into service. If rotation is incorrect, switch any two leads on 3-phase motors to change rotation. Check wiring diagram of motor for single phase rotation correction.

12. Remove top pipe plug (if applicable) from the front of volute and prime pump thoroughly, making sure all air is purged. Turn shaft one revolution and then refill. Replace the pipe plug.

13. Start pump allowing adequate time to purge all air from system. Observe any gauges, flow meters, etc., to see if pump performs properly.

(Xtxlparts.doc) rev A

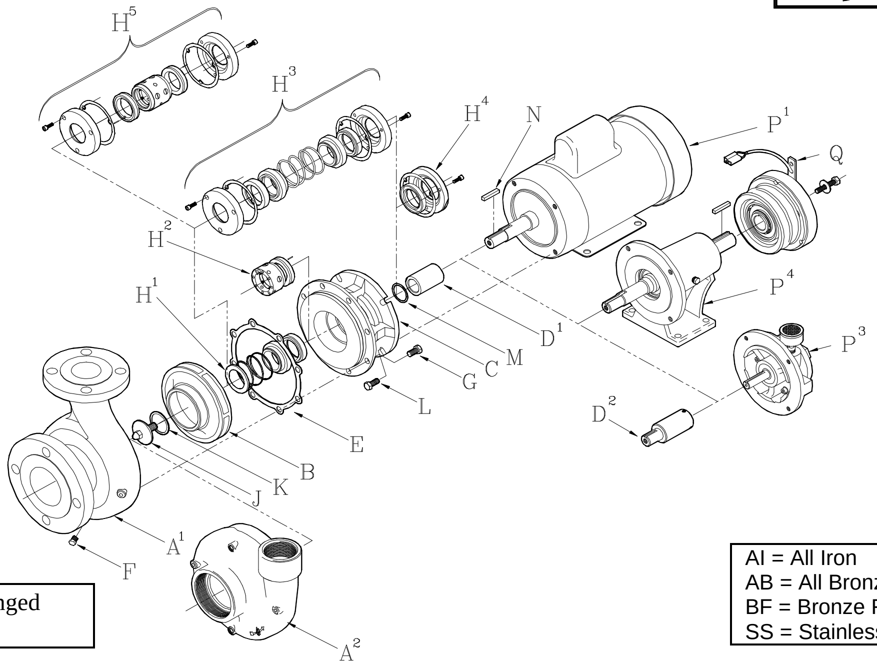
PRICE PUMP CO.

XT/XL PARTS LIST

Effective: May 17, 2001

For Sizes:

1 x 1½- 6
1½x 2 - 6 **(Threaded Only)**
1½x 3 - 6 **(Flanged Only)**
2 x 3 - 6



AI = All Iron
AB = All Bronze
BF = Bronze Fitted
SS = Stainless Steel

Note: Pumps available in Threaded or Flanged Connections as noted below

		AI Threaded	BF Threaded	AB Threaded	SS Threaded	SS Flanged
A.	Volute					
	1 x 1-1/2 - 6 (XT100 Threaded, XL100 Flanged)	2601	2601	2603	2629	2605
	1-1/2 x 2 - 6 (XT150 Threaded)	2607	2607	2609	2626	
	1/2 x 3 - 6 (XL150 Flanged)					2611
	2 x 3 - 6 (XT200 Threaded, XL200 Flanged)	2613	2613	2615	2627	2617
B.	Impeller Specify diameter **					
	1 x 1-1/2 - 6 (XT100 Threaded, XL100 Flanged)	2602-dia	2604-dia	2604-dia	2606-dia	2606-dia
	1-1/2 x 2 - 6 (XT150 Threaded)	2608-dia	2610-dia	2610-dia	2612-dia	
	1-1/2 x 3 - 6 (XL150 Flanged)					2612-dia
	2 x 3 - 6 (XT200 Threaded, XL200 Flanged)	2614-dia	2616-dia	2616-dia	2618-dia	2618-dia
	Note: For Dbl seal add DS (Sample: 2614**DS**-dia)					
C.	Bracket (std)	0131	0131	0132	0979	0979
	Double Seal	0131-1	0131-1	N/A	0979-1	0979-1
	Single Flush	0131-2	0131-2	0132-2	0979-2	0979-2
	Quench	0131-3	0131-3	N/A	0979-3	0979-3
	Internal Flush	0131-4	0131-4	N/A	0979-4	0979-4
	Bracket for 213/215 JM	3405	3405	N/A	3388	3388
	O-ring	3405-0	3405-0	N/A	N/A	N/A
	Double Seal	2405-1	3405-1	N/A	3388-1	3388-1
	Single Flush	3405-2	3405-2	N/A	3388-2	3388-2
	Quench	3405-3	3405-3	N/A	3388-3	3388-3
	Internal Flush	3405-4	3405-4	N/A	3388-4	3388-4
	Internal Flush w/ Quench	3405-5	3405-5	N/A	3388-5	3388-5
D^1.	Shaft Sleeve (for std JM motor)	0127	0126	0126	0127	0127
D^2.	Stub Shaft 5/8” ID (56C) opt	0329-1	0329-1	0329-1	0329-1	0329-1
D^3.	Stub Shaft 7/8” ID (143TC/145TC/182C/184C) option (Not Shown)	0328-1	0328-1	0328-1	0328-1	0328-1
E.	Volute Gasket	0124 (Syn Fiber)	0124 (Syn Fiber)	0124 (Syn Fiber)	0301 (PTFE)	0301 (PTFE)
F.	Pipe Plug (2 rqd Threaded, 1 rqd Flanged)	0557	0557	0558	0559	0559
G.	Volute Bolts (8 rqd)	0583	0583	0587	0724	0724
H^1.	T.21 Single Seal/Seat	0121 (std B*)	0121 (std B*)	0121 (std B*)	0122 (std V*)	0122 (std V*)

B* = Buna

V* = Fluorocarbon

**For Double Seal Impellers (add “DS”to Impeller P/N For Example: 2602DS)

Continued on Back…

Price® Pump Company

21775 8th Street East ◆ P.O. Box Q ◆ Sonoma, CA 95476-0329 ◆ (707) 938-8441 ◆ Fax (707) 938-0764

XT/XL PARTS LIST

Effective: May 17, 2001
Continued

		All Models
H^2.	T.9 PTFE Single Seal/Seat (opt)	0123
	Seat Pin T.9 (not shown)	0890
H^3.	T.21 Double Seal/Seat (opt)	Specify P/N
	Double Seal Plate (2 rqd)	0309
	Plate Gasket, PTFE (2 rqd)	0505
	Plate Bolts (6 rqd)	0977
H^4.	Seal Quench (opt):	
	Buna Lip Seal	0756
	Fluorocarbon Lip Seal	0757
	PTFE Lip Seal	0758
	Lip Seal Plate	0309-2
	Plate Gasket, PTFE	0505
	Plate Bolts (3 rqd)	0977
H^5.	T.9 PTFE Double Seal/Seat (opt)	0670
	Double Seal Plate (2 rqd)	0309-1
	Plate Gasket, PTFE (2 rqd)	0505
	Plate Bolts (6 rqd)	0977
	Seat Pin T.9 (2 rqd not shown)	0890
J.	Impeller Lockdown	0978
K.	Lockdown Gasket, PTFE	0245

		All Models
L.	Motor Bolts	
	All Bronze pumps (4 rqd)	0587
	Stainless Steel pumps (4 rqd)	0593
	AI & BF pumps (4 rqd) and	0593
	order Washers (4 rqd)	1137
	Motor Bolts for 3405 & 3388 brackets	
	All Bronze pumps	N/A
	Stainless Steel pumps (4req)	1189
	AI & BF pumps (4 req) and	1189
	order Washers (4 req)	1199
M.	Sleeve Gasket, PTFE	0245
N.	Impeller Shaft Key	0135
P^1.	JM Motor	Specify P/N
P^2.	‘C’ Face Motor (not shown)	Specify P/N
	Base Plate (not shown)	0199
P^3.	Air Motor	Specify P/N
P^4.	Power Frame	5480
Q.	12 Volt Clutch (opt)	1983
	Key for Clutch (2 ea)	0136
	Lockbolt for Clutch	0567
	Lockbolt Washer for Clutch	0564

XL/XT Repair Parts Kits

All Iron	P/N 0659	Syn. Fiber Gasket - SS Shaft Sleeve - Sleeve Gasket - Loctite - Imp. Lockdown Gasket
CIBF	P/N 0658	Syn. Fiber Gasket - BR Shaft Sleeve - Sleeve Gasket - Loctite - Imp. Lockdown Gasket
SS	P/N 1019	PTFE Gasket - SS Shaft Sleeve - Sleeve Gasket - Loctite - Imp. Lockdown Gasket

Note: Seal/seat must be ordered in addition to repair kit.

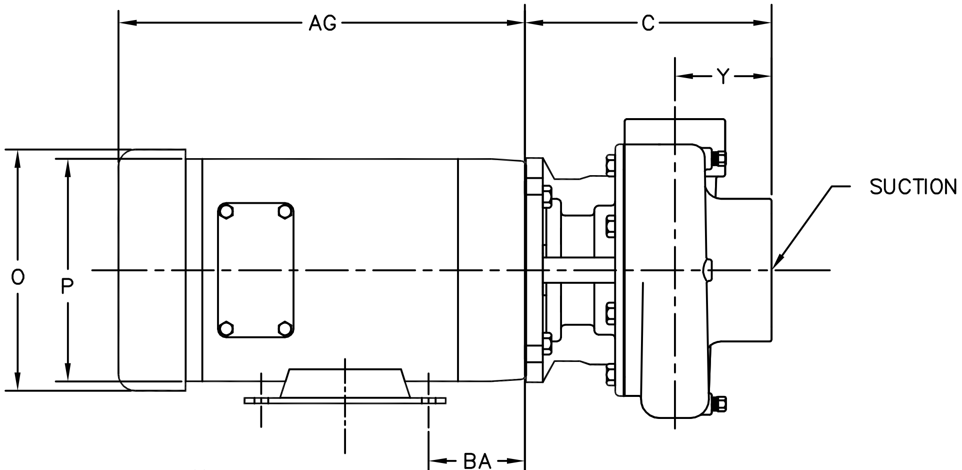
Options: 1½” T.21 & T.9 Single & Double.

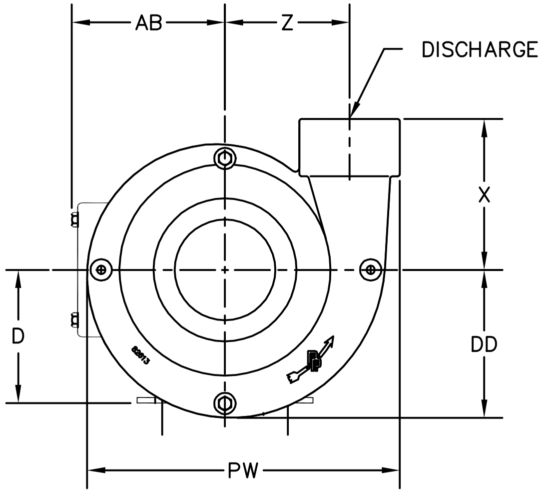
DESCRIPTION	REF. NO.	DATE	REV.
XTCIJM CLOSE COUPLED MOTOR PUMP ASSEMBLY	0-XTCIJM	1/28/93	C

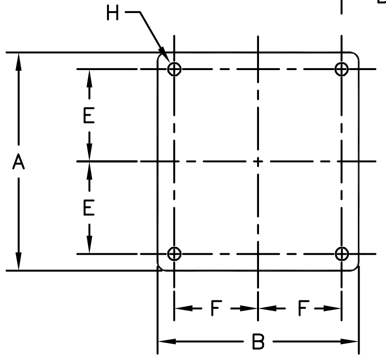
PRICE PUMP CO.

FACTORY FAX TRANSMITTAL DRAWING

#1 Pump Way P.O. Box Q
Sonoma, CA 95476 (707) 938-8441
707-FAX 938-0764







	PUMP END DIMENSIONS						PIPE THREAD – NPT	
MODEL	C	DD	PW	X	Y	Z	DISCHARGE	SUCTION
XT 1x1½ x6	6 5/8	4"	8 3/8	4"	2 3/8	3 1/2	1" x 11 ½	1½ x 11 ½
XT 1½ x2x6	7 9/16	4 1/8	8 3/4	4 1/4	3 1/4	3 5/8	1½ x 11 ½	2" x 11 ½
XT 2x3x6	7 5/16	4 7/16	9 5/16	4 1/2	2 7/8	3 3/4	2" x 11 ½	3" x 8

NOTES
ALL DIMENSIONS ARE ROUNDED TO THE NEAREST 1/8 INCH.

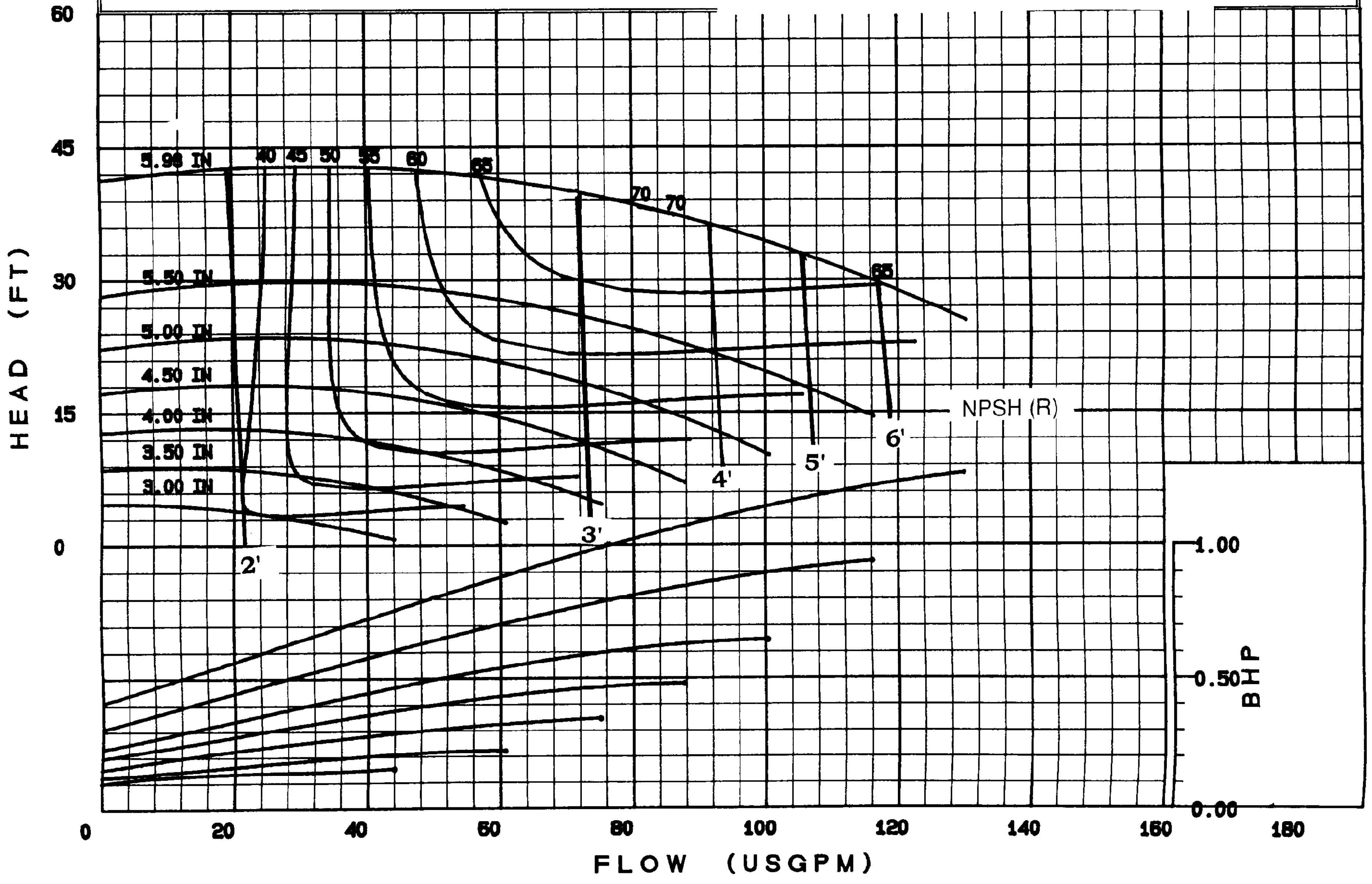
			JM MOTOR END DIMENSIONS									ODP		TEFC & EXP. PRF	
HP	RPM	FRM	A	B	D	E	F	H	BA	O	P	AB	AG	AB	AG
1 1/2	3600	143JM	6-1/2	5-15/16	3-1/2	2-3/4	2	11/32	2-7/8	6-7/8	6-5/8	5-1/4	8-3/4	6-3/4	11-1/4
2	3600	145JM					2-1/2								
3	3600	145JM													
5	3600	182JM	8-1/2	6-1/2	4-1/2	3-3/4	2-1/4	13/32	3-1/2	8-7/16	7-7/8	5-7/8	11-1/8	7-3/8	14-3/4
7 1/2	3600	184JM					2-3/4								
10	3600	213 (W/ 184 FACE)	9-1/2	8	5-1/4	4-1/4	3-1/2	13/32	3-1/8	10-1/16	9-9/16	N/A		7-3/8	14-7/16
15	3600	213 (W/ 184 FACE)													

NOTE: MOTOR DIMENSIONS WILL VARY BY MODEL AND MAKE. DIMENSIONS ARE TO BE USED FOR REFERENCE ONLY.

60 Hz

PRICE PUMP CO.
SONOMA, CALIFORNIA
Ph. (707) 938-8441 Fax (707) 938-0764

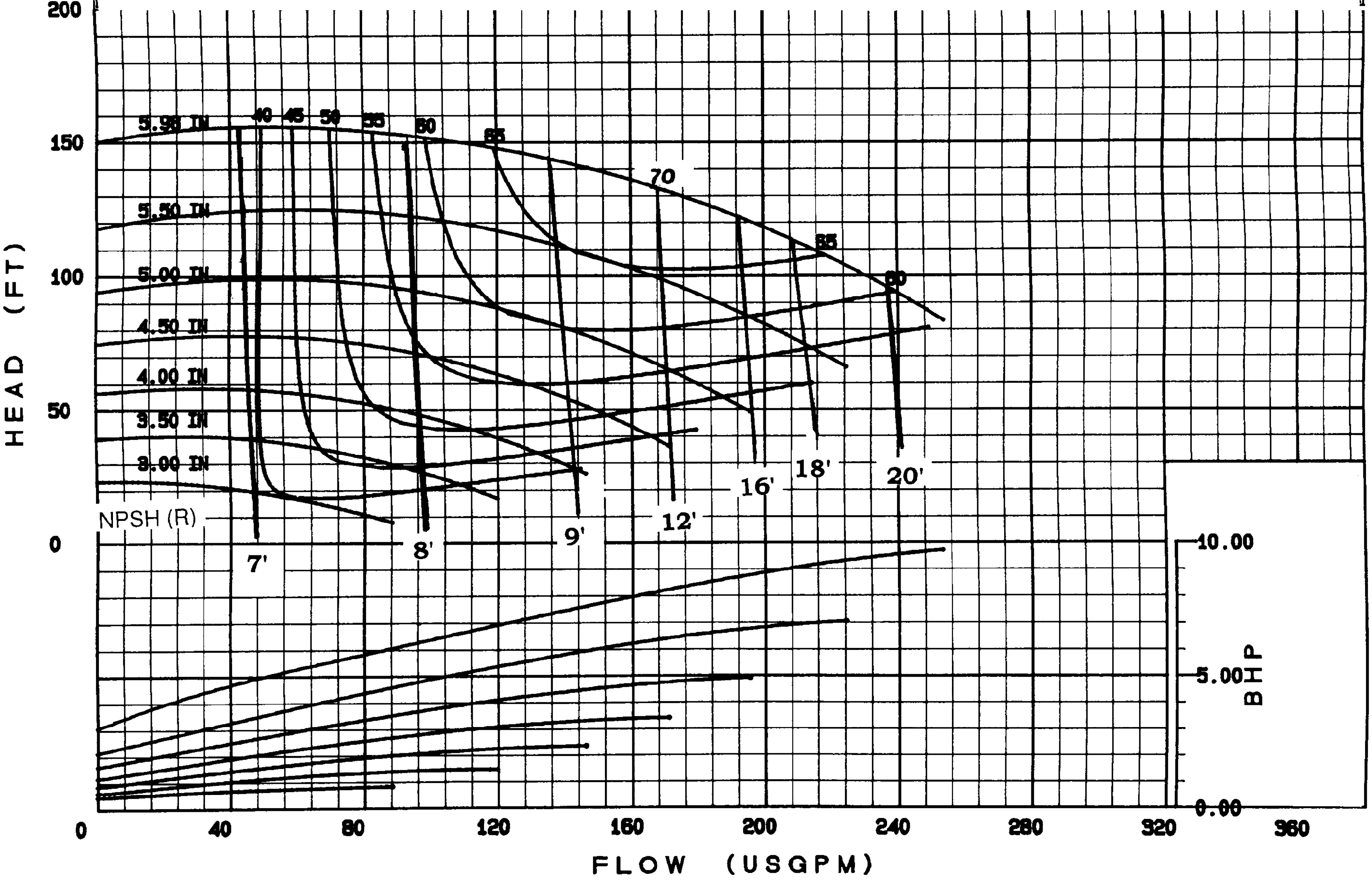
CURVE NUMBER: X000033-57-1 MODEL: XL/XT150 SIZE: *1-1/2x3x6 **1-1/2x2x6 RPM: 1750
IMPELLER DIA: VARIOUS MIN. IMPELLER DIA: 3.00" MAX. IMPELLER DIA: 5.98" MAX. SOLIDS: .19"
CUSTOMER: CUSTOMER'S P.O.:
TEST DATE: 8/01/94 VERIFIED: 5/24/01 REMARKS: *XL150=FLANGED PORTS **XT150=THREADED PORTS



60 Hz

PRICE PUMP CO.
SONOMA, CALIFORNIA
Ph. (707) 938-8441 Fax (707) 938-0764

CURVE NUMBER: X000031-55-1 MODEL: XL/XT150 SIZE: *1-1/2x3x6 **1-1/2x2x6 RPM: 3500
IMPELLER DIA: VARIOUS MIN. IMPELLER DIA: 3.00" MAX. IMPELLER DIA: 5.98" MAX. SOLIDS: .19"
CUSTOMER: CUSTOMER'S P.O.:
TEST DATE: 8/01/94 VERIFIED: 5/24/01 REMARKS: *XL150=FLANGED PORTS **XT150=THREADED PORTS



BALDOR PUMP MOTOR

BALDOR

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JMWDM3711T Go

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General Information

- Overview
- Specifications
- Performance Data
- Parts List
- Dimensional Dwg
- Connection Diag
- Product Literature

More Information

- Locate Distributor
- Baldor Sales Offices

Return to List

AC Motors | Pump |

Specifications: JMWDM3711T

Catalog Number:	JMWDM3711T
Specification Number:	37H883T968
Horsepower:	10
Voltage:	208-230/460
Hertz:	60
Phase:	3
Full Load Amps:	26.2-23.8/11.9
Usable at 208 Volts:	N/A
RPM:	3450
Frame Size:	215JM
Service Factor:	1.15
Rating:	40C AMB-CONT
Locked Rotor Code:	H
NEMA Design Code:	B
Insulation Class:	F
Full Load Efficiency:	87.5
Power Factor:	90
Enclosure:	TEFC
Baldor Type:	3730M
DE Bearing:	6309
ODE Bearing:	6206
Electrical Specification Number:	37WGT968
Mechanical Specification Number:	37H883
Base:	RG
Mounting:	F1

* For certified information, contact your local Baldor office.

Performance Data: JMWDM3711T

Product Nameplate Data :					
Rated Output	10 HP	Hertz	60	NEMA Nom. Eff.	87.5
Volts	208-230/460	Phase	3	Power Factor	90
Full Load Amps	26.2-23.8/11.9	NEMA Design Code	B	Service Factor	1.15
Speed	3450	LR KVA Code	H	Rating - Duty	40C AMB-CONT

(Typical performance - Not guaranteed values)

General Characterstics at 460 V, 60 Hz, 10 HP			
Full Load Torque	15.1 LB-FT	Starting Current	87.2 Amps
Start Configuration	DOL	No-Load Current	3.5 Amps
Break Down Torque	57.2 LB-FT	Line-line Resistance @ 25° C	1.04 Ohms
Pull-Up Torque	29.5 LB-FT	Temperature Rise, C @ FL (in deg)	65
Locked-Roter Torque	34.2 LB-FT	Temp. Rise @ S.F. Load (in deg)	76

Load Characteristics at 460 V, 60 Hz , 10 HP							
% of Rated Load	25	50	75	100	125	150	S.F.
Power Factor	67	82	88	90	91	91	91
Efficiency	75.6	84.2	87.3	87.8	87.4	86.2	87.6
Speed (rpm)	3570	3546	3521	3493	3462	3427	3474
Line Amperes	4.76	6.87	9.33	11.9	14.7	17.7	13.6

* For certified information, contact your local Baldor office.

JMWDM3711T Replacement Parts List

Print Page | Close Window

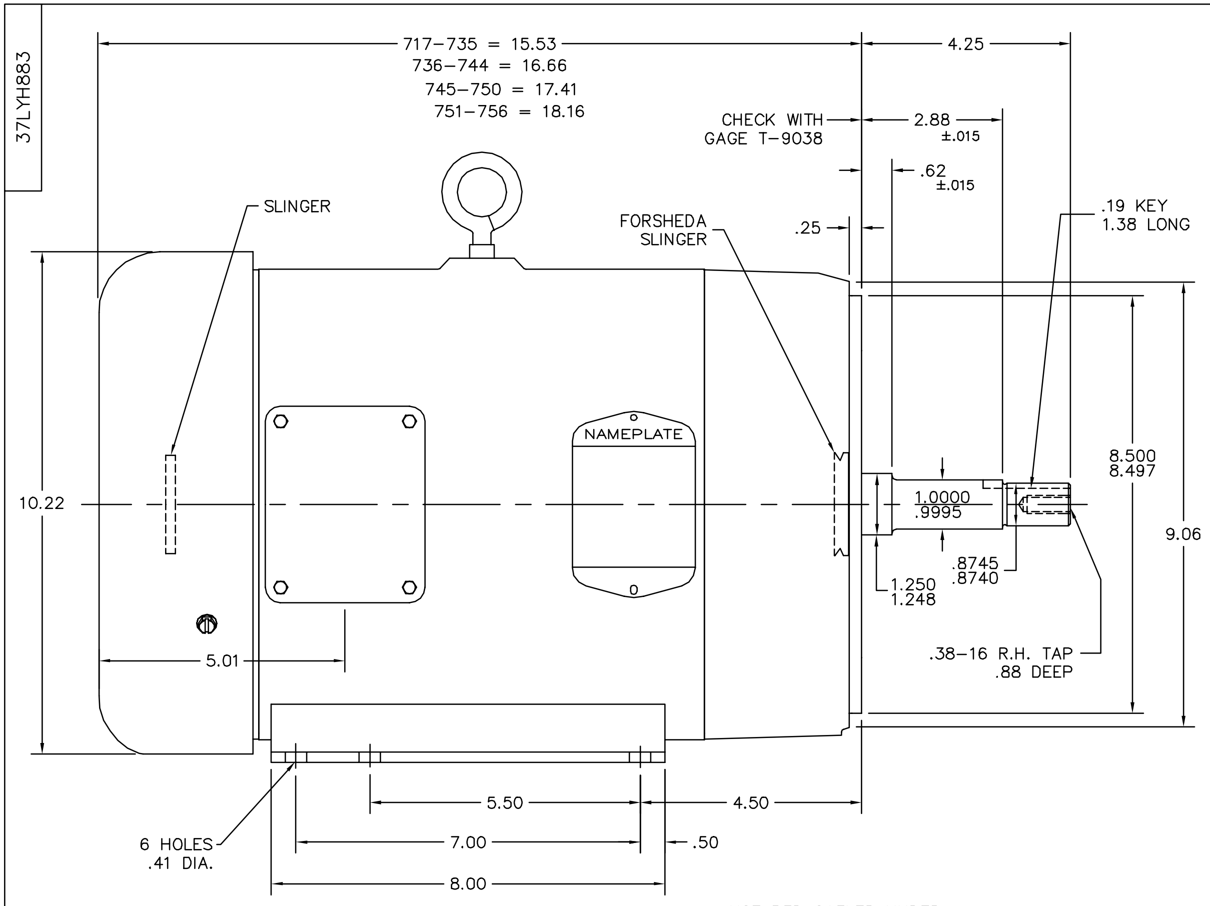
Catalog Number	JMWDM3711T
Specification Number	37H883T968
Description	10HP,3450RPM,3PH,60HZ,215,JM,3730M,TEFC
Plant	BALDOR FT SMITH/REC WHSE #5

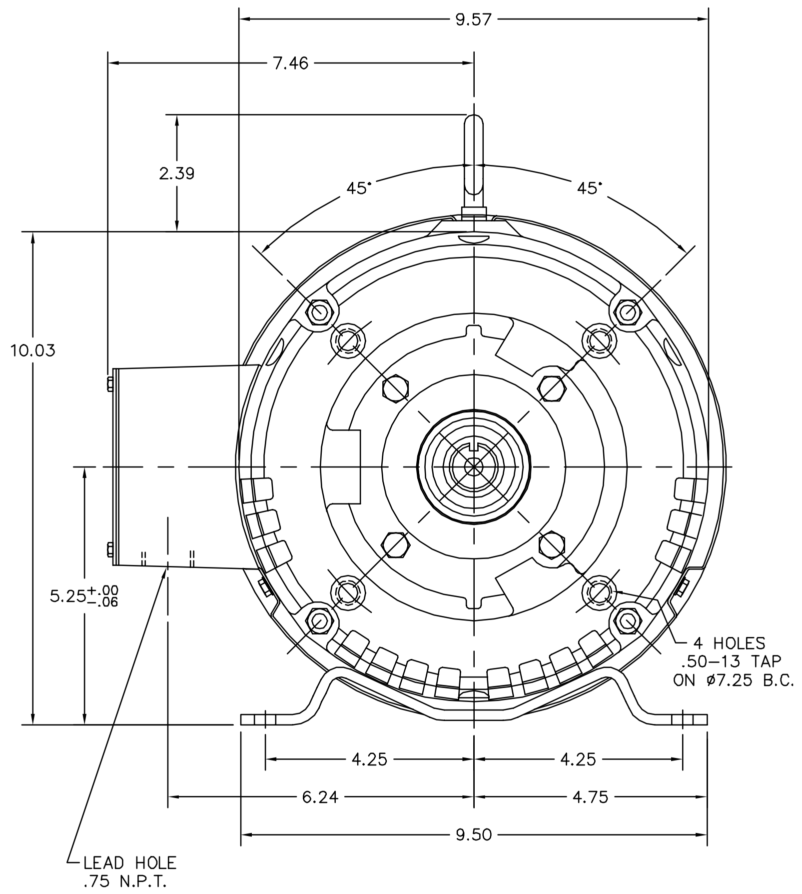
Replacement Parts

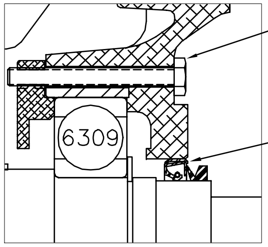
Material Number	Description	Qty.	List Price	Units
37FN3002A01	EXT FAN, PLASTIC	1	$ 24.00	EA
37CB1001A01W	WHITE EPOXY CONDUIT BOX, MACH	1	$ 45.00	EA
37CB1001W	37CB1001 W/WHITE EPOXY	1	$ 45.00	EA
37GS1016A01	NEOPRENE KOBX GASKET W/LIP (WHITE)	1	*CALL	EA
37EP3101A94MW	FRONT TEFC L&M 206 BRG W/O GRSR (WHITE)	1	$ 120.00	EA
37EP3101A94DW	FRONT TEFC L&M 206 BRG W/O GRSR	1	$ 149.00	EA
37EP3401T08MW	FACE MT EP, ENCL, 213TC-215TC, W/WHITE E	1	$ 108.00	EA
37EP3401T08DW	DRILLED EP W/WHITE EPOXY	1	$ 109.00	EA
07FH4011	WASHDOWN IEC FH W/AUTOPHORETIC PRIMER	1	$ 17.00	EA
36CB4518	36 LIPPED CB LID AUTOPHORETIC	1	$ 3.00	EA
37GS3010	1/16"WHITE LID GASKET	1	$ 2.00	EA
HA3104S14	THRUBOLT 12.125LG SS	4	$ 12.00	EA

* Please contact your **nearest Baldor Sales Office** to obtain price on these items.

37LYH883







USE RED SAELER UNDER RETAINER SCREW HEADS BEFORE INSTALLING

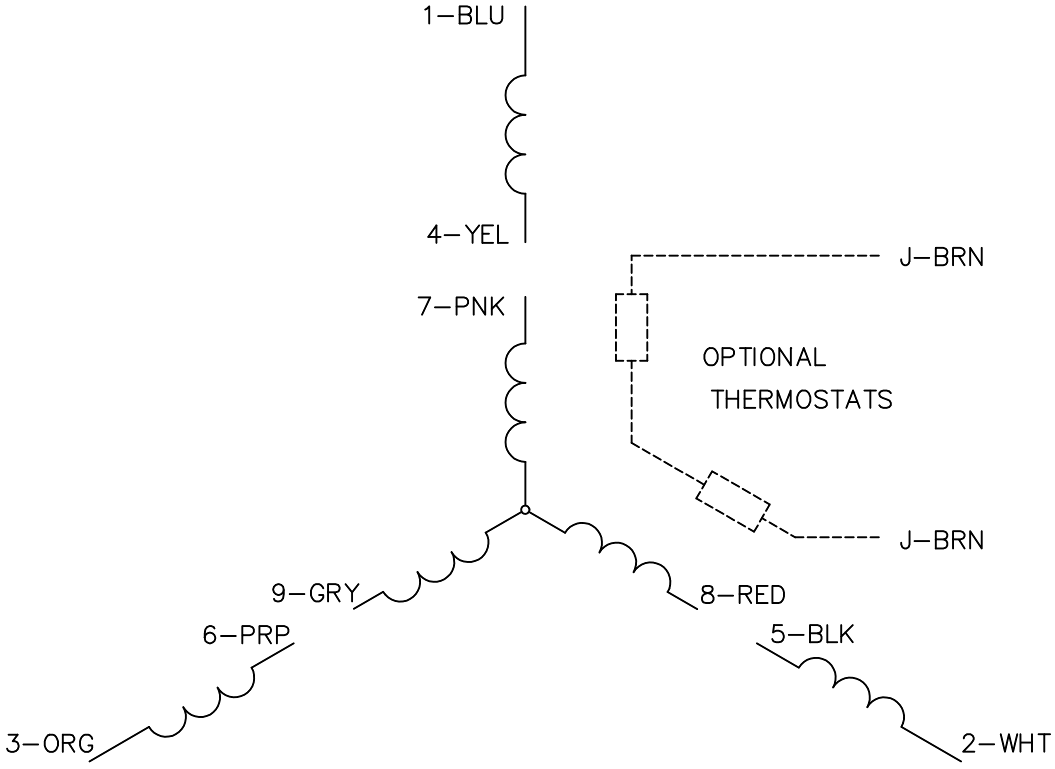
APPLY COAT OF RED SEALER TO HOUSING BEFORE PRESSING SEAL IN.

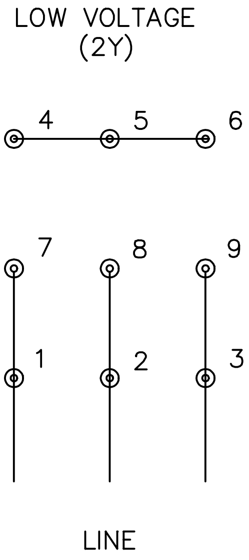
SEAL DETAIL

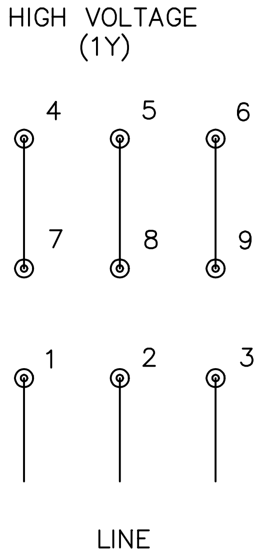
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

REV. DESC: CORRECT GRAPHICS FOR SLINGER ON FR.END PER BOM			BALDOR ELECTRIC Co.
REV. LTR: A	VERSION: 01	TDR: 000000402212	
FILE: \AAA\00093\192	REVISED: 10:45:29 07/13/2006	BY: ENODIDO	HOR 213–5JM TEFC 37M WD
MTL: –			

37LYH883







NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			
REV. LTR: E	BY: JLP	REVISED: 01/19/99 10:15	TDR: 0171435
CD0005		FILE: AAA00005140	MDL: –
		MTL: –	

BALDOR ELECTRIC Co.

3PH, DV, 9 LEADS

CD0005

Appendix D

Product Information

Krystil Klear Filtration ® Model 88 Bag Filter

Model 88 Single Liquid Bag Housing

Features and Options	Housing Operation	Vessel Construction
Specifications	Build a Part Number	Schematics and Dimensions

Krystil Klear's model 88 Single Series of Liquid Bag Housings offer two depths, a 15" and a 30" housing depending upon the needed surface area and volume of fluid to be filtered.

Contact a Sales Representative About this Product

FEATURES

- **Carbon, 304, or 316 stainless steel material**
- **150 PSI pressure rating**
- **Low pressure drop**
- **Quick swing closure with eye nuts**
- **Viton seals - lid & basket**
- **Differential, drain, and vent ports**
- **Adjustable support legs**
- **316 stainless steel strainer basket**
- **2-part epoxy finish on carbon vessels**

Our 88 series effectively removes dirt, pipe scale, and other contaminants from process liquids such as water, chemical, and petroleum products. Quality construction and design assure protection for all down-stream equipment.

SPECIFICATIONS

Housing lid has a 3-bolt swing closure with a vent port. Connections are (__) inch (NPT) (FLG) with a (side inlet and bottom outlet)(side inlet and side outlet)(side inlet and 90 degree bottom outlet). Housing is supplied with two differential pressure ports to measure the differential pressure across the filter bag. A two-part epoxy finish is applied on the carbon steel vessels to maximize the life of the housing; stainless steel vessels are supplied with a satin finish. Basket material is constructed of 316 stainless steel with 9/64" perforations to act as a strainer or to accept a #1 or #2 size liquid bag. Basket seals onto a Viton o-ring in the basket support. Adjustable tripod leg assembly is supplied with housing. Vessels are rated at a 150 pounds per square inch design.

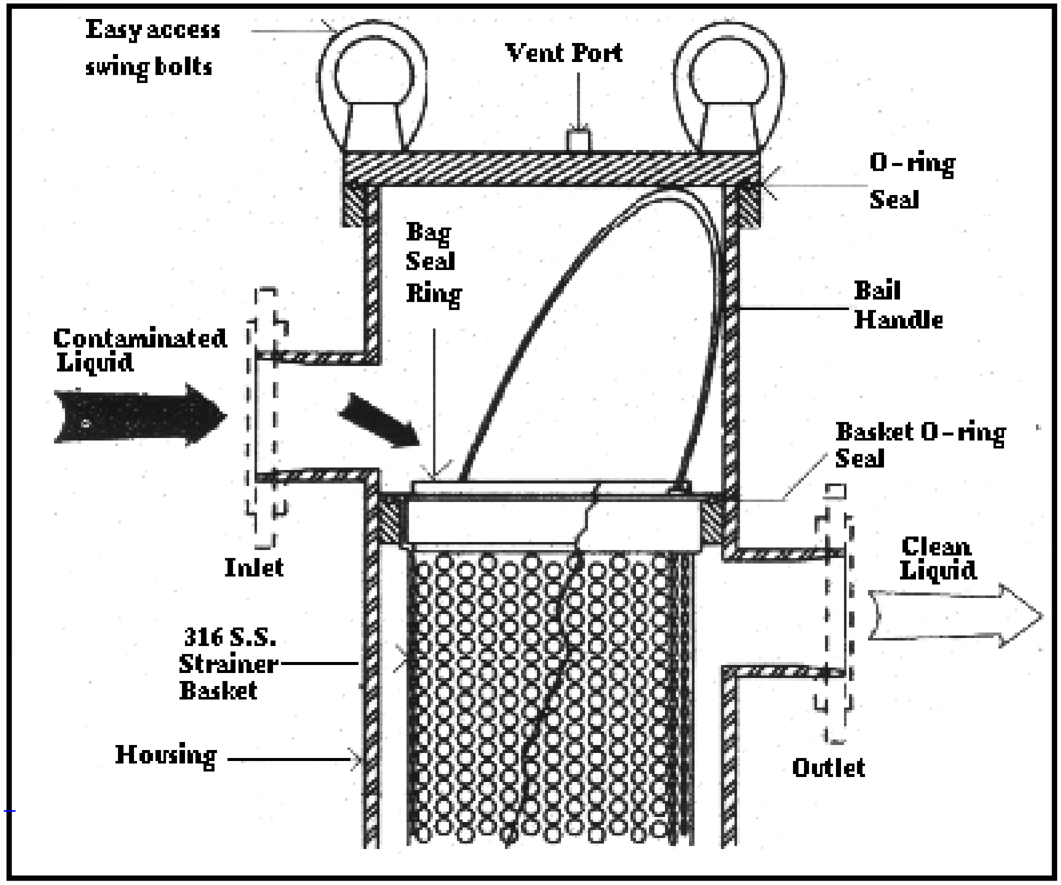
Contact a Sales Representative
About this Product

Basket Data for Model 88 with flow rates to 220 gpm

Depth Nominal (inches)	Diameter (inches)	Surface Area (sq. ft.)	Volume (cu. in.)
15	6.7	2.3	500
30	6.7	4.4	1000

Housing Operation Diagram

Unfiltered liquid enters the housing above the filter bag or strainer basket; flows down into the housing; and continues through the element. Solids are trapped inside the filter bag or strainer and easily removed when the housing is serviced. Our standard o-ring seal between the basket and the housing ensures a postive seal to prevent bypass.



Contact a Sales Representative About this Product

Basket Data for Model 88 with flow rates to 220 gpm

Depth Nominal (inches)	Diameter (inches)	Surface Area (sq. ft.)	Volume (cu. in.)
15	6.7	2.3	500
30	6.7	4.4	1000

VESSEL CONSTRUCTION

Our model 88 single vessels are designed for operating up to 150 PSI at 300 degrees Fahrenheit. The housing design provides a large sump area at the bottom of the basket for particulate accumulation. This design utilizes the filter more efficiently and prolongs the element life.

The **316 S.S. basket** seals onto a viton o-ring to eliminate particulate bypass between the basket and seat. Optional **mesh-lined strainer baskets** and **o-rings** are available. Please refer to their individual brochures in our liquid catalog.

Contact a Sales Representative
About this Product

A **vent** in the housing lid and a **drain port** in the housing speed evacuation and filling. **Gauge ports** are located on the body of the housing to install gauges for monitoring the differential pressure across the bag. Permanently piped housings are opened with simple tools without disturbing the piping. **Swing bolts** with eye-nuts allow easy opening and closing of the swing-lid. No need to remove any hardware.

As a standard finish, all vessels are blast cleaned and painted inside and out with a **2-part epoxy**. Stainless steel vessels are supplied with a satin finish.

Dimensions

All dimensions are approximate...

88-15

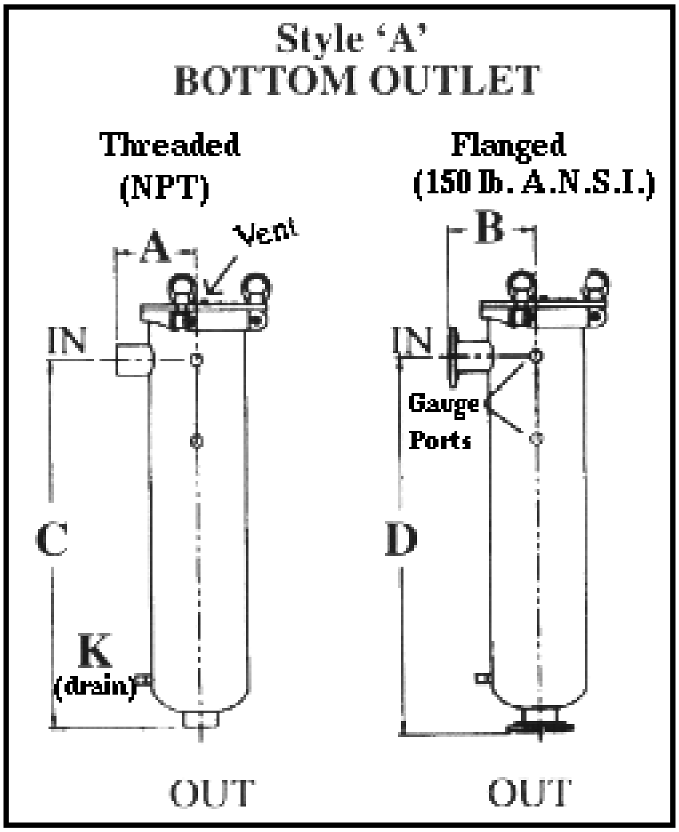
Pipe Size	A	B	C	D	E	F	G	H	I	J	K	wt.
2	5.3	6.7	24.7	25.9	7.0	24.7	26.2	3.4	25.7	2.3	1	105-125# skid wt.
3	5.4	7.1	24.7	26.5	7.0	24.7	26.5	5.0	26.3	3.1		
4	5.4	7.1	24.7	26.6	7.0	24.7	29.1	6.3	26.9	3.8		

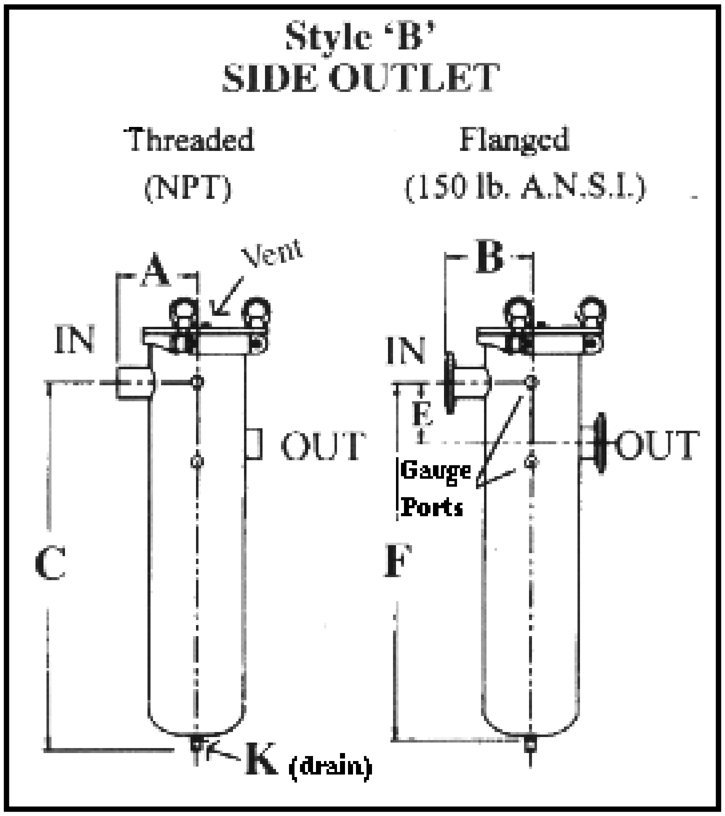
Contact a Sales Representative
About this Product

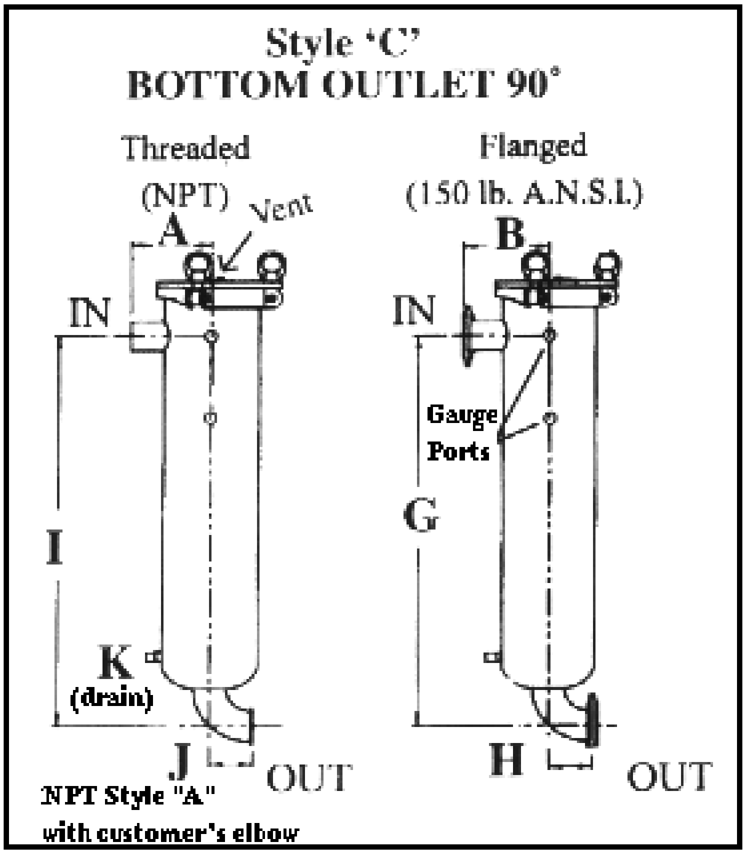
88-30

Pipe Size	A	B	C	D	E	F	G	H	I	J	K	wt.
2	5.3	6.7	36.2	37.4	7.0	36.2	37.7	3.4	37.2	2.3	1	125-145# skid wt.
3	5.4	7.1	36.2	38.0	7.0	36.2	39.2	5.0	38.7	3.1		
4	5.4	7.1	36.2	38.1	7.0	36.2	40.6	6.3	38.9	3.8		

Adjustable support legs have 12" bolt circle and a 16" height adjustment.


Style 'A'
BOTTOM OUTLET
Threaded
(NPT)
Flanged
(150 lb. A.N.S.I.)
A
Vent
B
IN
IN
Gauge
Ports
C
D
K
(drain)
OUT
OUT


Style 'B'
SIDE OUTLET
Threaded
(NPT)
Flanged
(150 lb. A.N.S.I.)
A
Vent
IN
OUT
C
K (drain)
B
IN
E
OUT
Gauge
Ports
F


Style 'C'
BOTTOM OUTLET 90°
Threaded
(NPT)
Vent
A
IN
I
K
(drain)
J
OUT
NPT Style "A"
with customer's elbow
Flanged
(150 lb. A.N.S.I.)
B
IN
Gauge
Ports
G
H
OUT

Appendix E

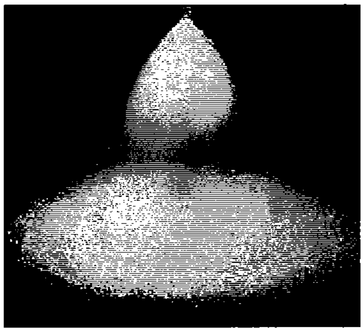
Product Information

FullJet ® Standard Type G Spray Nozzles

Spraying Systems Co.® **INDUSTRIAL SPRAY PRODUCTS** **Request a FREE Printed Copy!**
Home **Experts in Spray Technology** **Catalog 70 US** **1.800.95.SPRAY or** click here

Catalog 70 US Section B B3

B3 - FullJet® Spray Nozzles, Standard Spray



Features and Benefits

- Solid cone-shaped spray pattern with round impact area.
- Uniform distribution over a wide range of flow rates and pressures.
- Medium- to large-sized drops.
- Unique vane design with large flow passages provides superior control and uniform distribution.
- Removable caps and vanes for easy inspection and cleaning on most models.
- Removable vane has location marks for proper positioning after cleaning.
- Set screws in some models secure the vane in the nozzle to prevent dislocation caused by vibration.
- Polypropylene material option offers exceptional chemical and corrosion resistance and resists caking and buildup.
- Wall-mounted options for installation on room exterior, vessel or pipeline.
- For installations with space limitations, right-angle mounting options allow for mounting at a 90° angle.

G

Removable cap and vane
1/8" to 1/2" NPT or BSPT (F)

GG

Removable cap and vane
1/8" to 1/2" NPT or BSPT (M)

H

One-piece body
3/4" to 1" NPT or BSPT (F)

H

Removable vane/cast body
1-1/4" to 8" NPT or BSPT (F)

H

Removable vane/Polypropylene
1-1/2" to 2" NPT or BSPT (F)
Maximum temperature rating is
150°F (66°C)

HF

Removable vane/cast body
4" to 10" flange connection

HH

One-piece body
1/8" to 1" NPT or BSPT (M)

GD

Wall-mounted
Removable cap and vane
1/8" to 1/2" NPT or BSPT (F)

Catalog 70 US Section B B5

B5 - FullJet® Spray Nozzles, Standard Spray

Performance Data

*At the stated pressure in psi.

Inlet Conn. (in.)	Nozzle Type									Capacity Size	Orifice Dia. Nom. (in.)	Max. Free Passage Dia. (in.)	Capacity (gallons per minute)*										Spray Angle (°)*		
	Standard Type				Wall Mounted			Angle																	
	G	GG	H	HH	GD	HD	GGD	GA	GGA				5	7	10	20	30	40	60	80	100	150	7	20	80
1/8	•	•		•	•		•			1	.031	.025	.07	.08	.10	.14	.17	.19	.23	.26	.29	.35	–	58	53
	•	•		•						1.5	.047	.025	.11	.13	.15	.21	.25	.28	.34	.39	.43	.52	52	65	59
	•	•		•	•		•	•	•	2	.047	.040	.15	.17	.20	.28	.33	.38	.46	.52	.58	.70	43	50	46
	•	•		•	•		•	•	•	3	.063	.040	.22	.25	.30	.41	.50	.57	.68	.78	.87	1.0	52	65	59
	•	•		•	•		•	•	•	3.5	.063	.050	.25	.30	.35	.48	.58	.66	.80	.91	1.0	1.2	43	50	46
								•	•	3.9	.078	.040	.28	.33	.39	.54	.65	.74	.89	1.0	1.1	1.4	77	84	79
	•	•		•	•		•	•	•	5	.078	.050	.36	.42	.50	.69	.83	.95	1.1	1.3	1.4	1.7	52	65	59
								•	•	6.1	.094	.050	.44	.52	.61	.84	1.0	1.2	1.4	1.6	1.8	2.1	69	74	68
1/4	•	•		•	•		•	•	•	6.5	.094	.063	.47	.55	.65	.89	1.1	1.2	1.5	1.7	1.9	2.3	45	50	46
	•	•		•	•		•	•	•	10	.109	.063	.73	.85	1.0	1.4	1.7	1.9	2.3	2.6	2.9	3.5	58	67	61
								•	•	12.5	.125	.063	.91	1.1	1.3	1.7	2.1	2.4	2.9	3.3	3.6	4.3	69	74	68
3/8	•	•		•	•		•	•	•	9.5	.109	.094	.69	.81	.95	1.3	1.6	1.8	2.2	2.5	2.7	3.3	45	50	46
	•	•		•	•		•	•	•	15	.141	.094	1.1	1.3	1.5	2.1	2.5	2.8	3.4	3.9	4.3	5.2	64	67	61
								•	•	20	.156	.109	1.5	1.7	2.0	2.8	3.3	3.8	4.6	5.2	5.8	7.0	76	80	73
	•	•		•				•	•	22	.188	.109	1.6	1.9	2.2	3.0	3.6	4.2	5.0	5.7	6.3	7.6	87	90	82
1/2	•	•			•		•	•	•	16	.141	.125	1.2	1.4	1.6	2.2	2.7	3.0	3.6	4.2	4.6	5.6	48	50	46
	•	•		•	•		•	•	•	25	.188	.125	1.8	2.1	2.5	3.4	4.1	4.7	5.7	6.5	7.2	8.7	64	67	61
	•	•						•	•	32	.203	.141	2.3	2.7	3.2	4.4	5.3	6.1	7.3	8.3	9.2	11.1	72	75	68
	•	•		•				•	•	40	.250	.141	2.9	3.4	4.0	5.5	6.6	7.6	9.1	10.4	11.5	13.9	88	91	83
								•	•	50	.266	.156	3.6	4.2	5.0	6.9	8.3	9.5	11.4	13.0	14.4	17.4	91	94	86
3/4			•	•		•				2.5	.188	.172	2.1	2.5	2.9	4.1	4.9	5.6	6.7	7.7	8.5	10.2	48	50	46
			•	•		•				4.0	.250	.172	3.4	4.0	4.7	6.5	7.8	8.9	10.7	12.3	13.6	16.4	67	70	63
			•	•		•				7.0	.375	.203	6.0	7.0	8.2	11.3	13.7	15.6	18.8	21	24	29	89	92	84
1			•	•		•				4.2	.234	.219	3.6	4.2	4.9	6.8	8.2	9.4	11.3	12.9	14.3	17.2	48	50	46
			•	•		•				7.0	.328	.219	6.0	7.0	8.2	11.3	13.7	15.6	18.8	21	24	29	67	68	62
			•	•						8.0	.375	.219	6.9	8.0	9.4	13.0	15.6	17.8	21	25	27	33	72	81	82
			•	•						10	.469	.219	8.6	10.0	11.8	16.2	19.5	22	27	31	34	41	78	90	94
			•	•						12	.469	.250	10.3	12.0	14.1	19.4	23	27	32	37	41	49	89	92	84

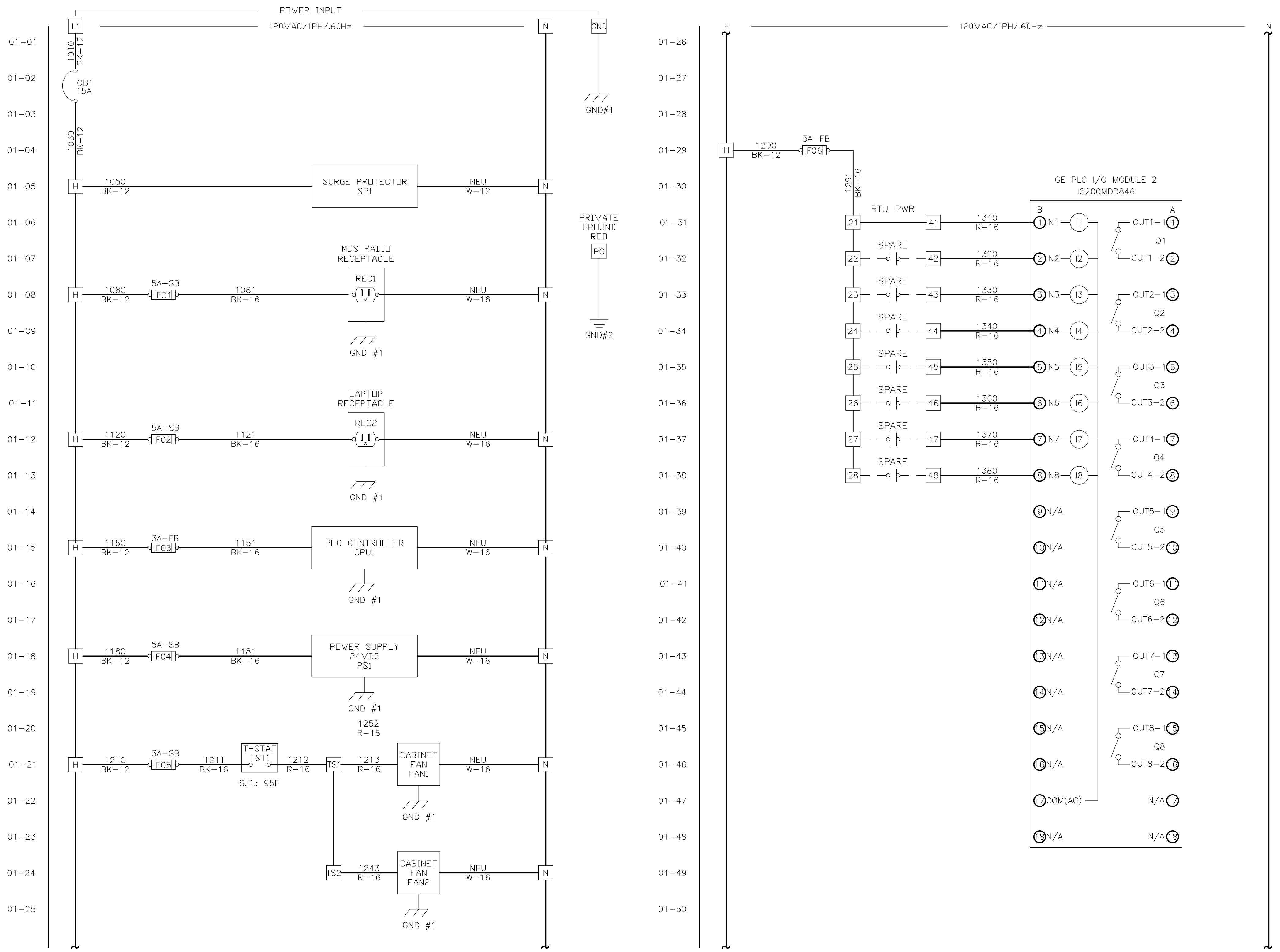
Maximum Free Passage Diameter is the maximum diameter as listed of foreign matter that can pass through the nozzle without clogging.

Appendix F

Product Information

SWMU B-3 Instrument Controls

RTU 903-1: GAC SHACK, CS-MW16-LGR, CS-MW16-CC, AND WEATHER STATION



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
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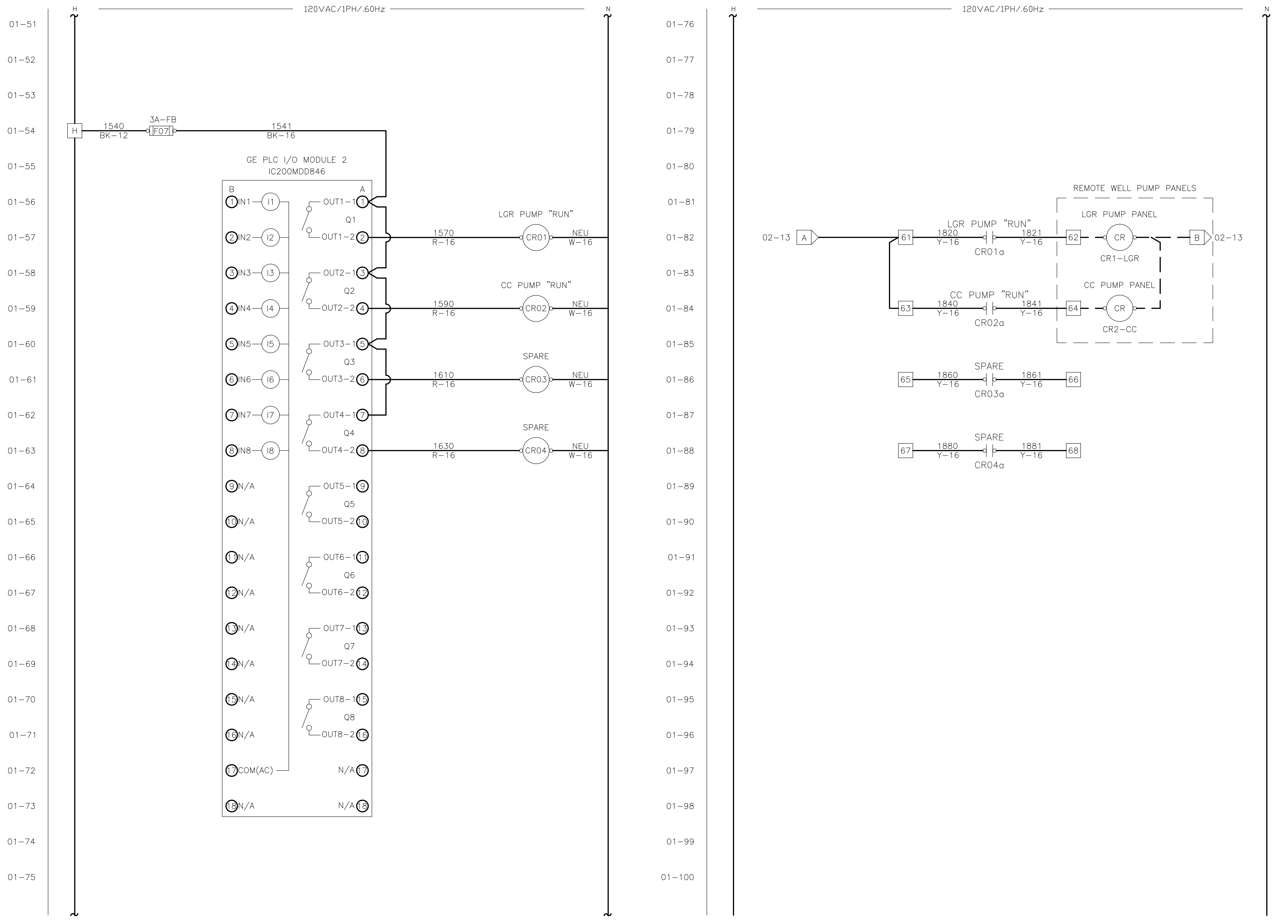
DWG. NO.	3079
SH	1
OF	12



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND

COLOR SIZE

Y-18

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LINE-TO-LINE
WIRING DIAGRAM

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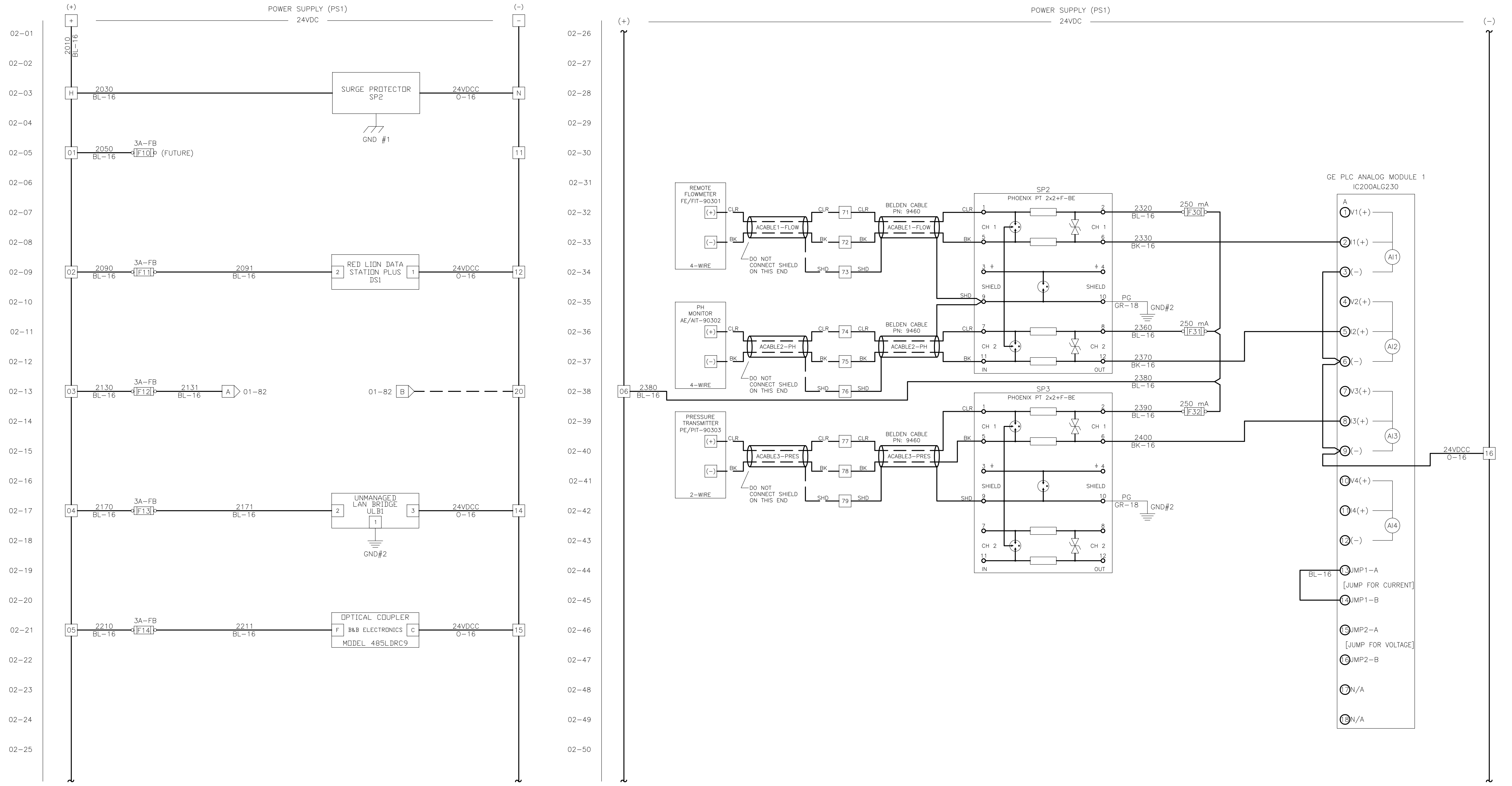

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BIOREACTOR

SHEET TITLE
RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

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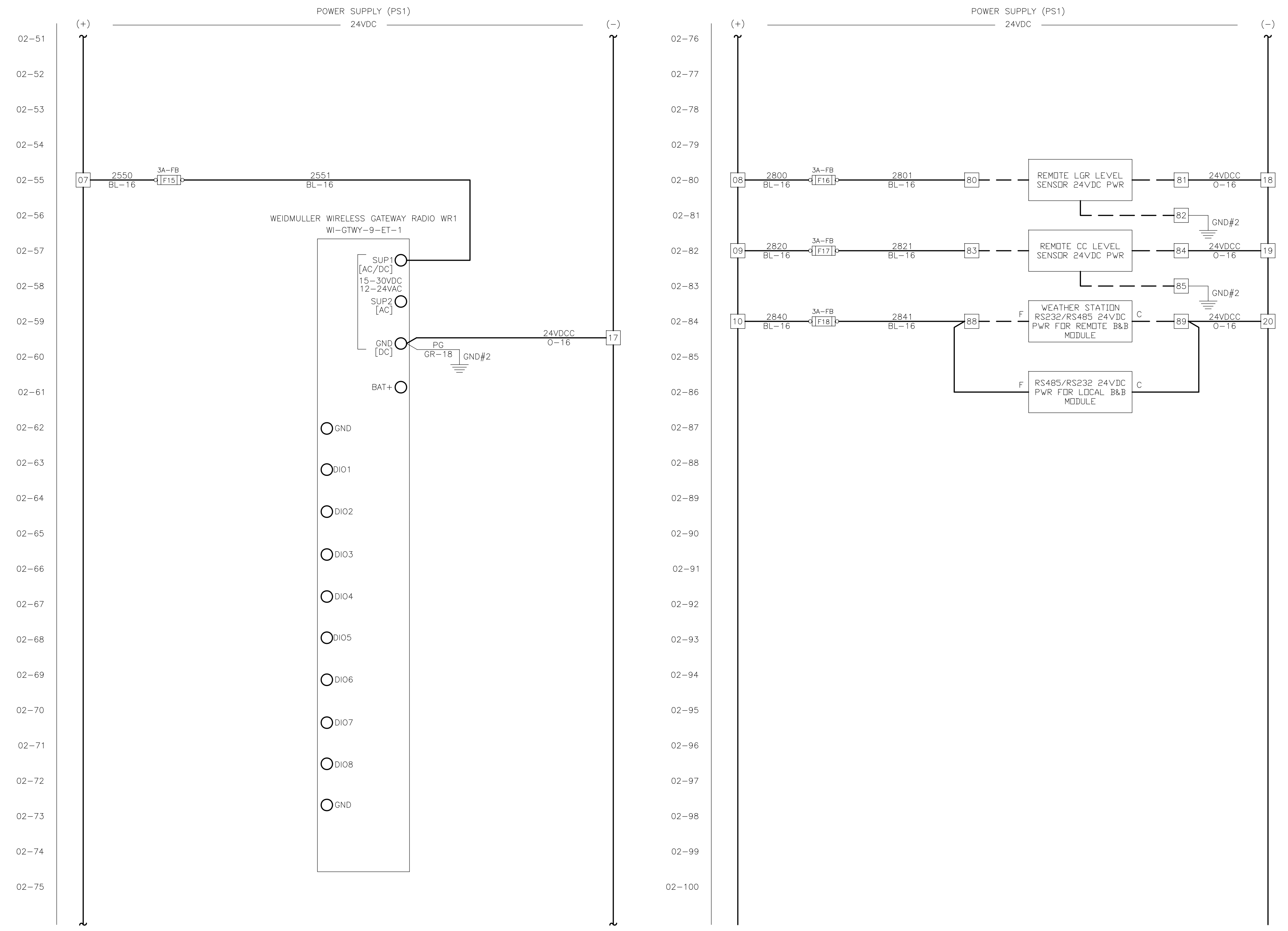

NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

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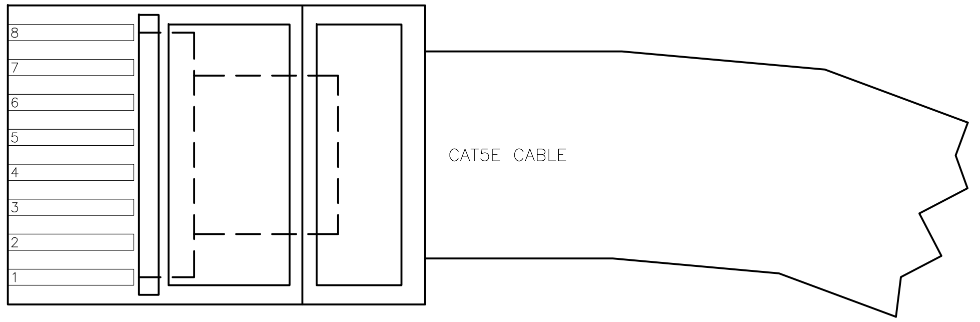
BIOREACTOR

SHEET TITLE
RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

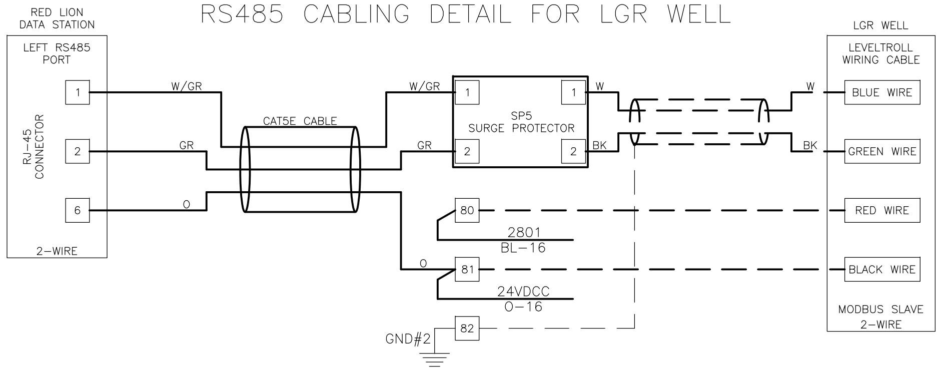
DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 4
OF 12

RED LION USING USING RJ-45 CONNECTOR FOR RS485 SIGNAL

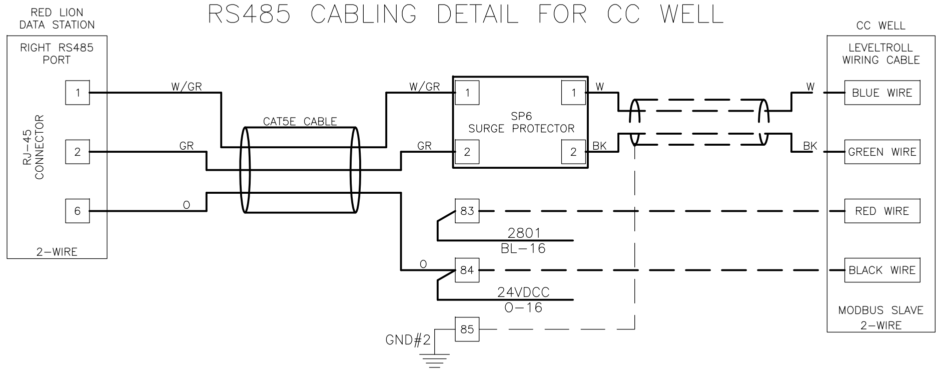


STANDARD ETHERNET WIRE COLOR CABLE USING RJ-45 PIN-OUT DETAIL				
RJ-45 PIN	WIRE COLOR	RED LION SIGNAL PIN OUT	RED LION RS485 2-WIRE	RJ-45 PIN
1	WHITE-GREEN	TxB	YES	1
2	GREEN	TxA	YES	2
3	WHITE-ORANGE	RxA		3
4	BLUE	RxB		4
5	WHITE-BLUE	TxEN		5
6	ORANGE	COM	YES	6
7	WHITE-BROWN	TxB		7
8	BROWN	TxA		8

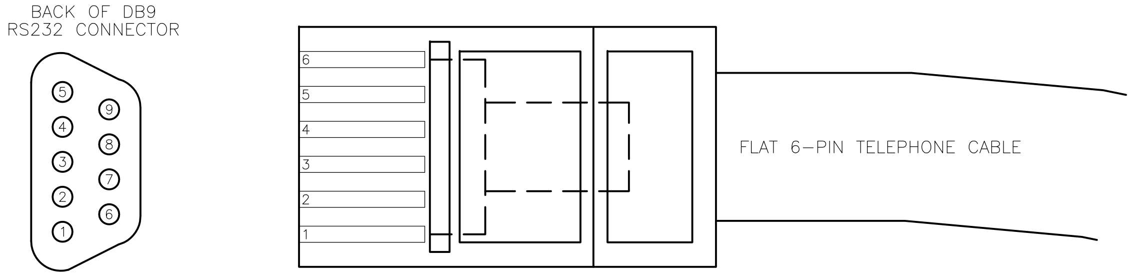
RS485 CABLING DETAIL FOR LGR WELL



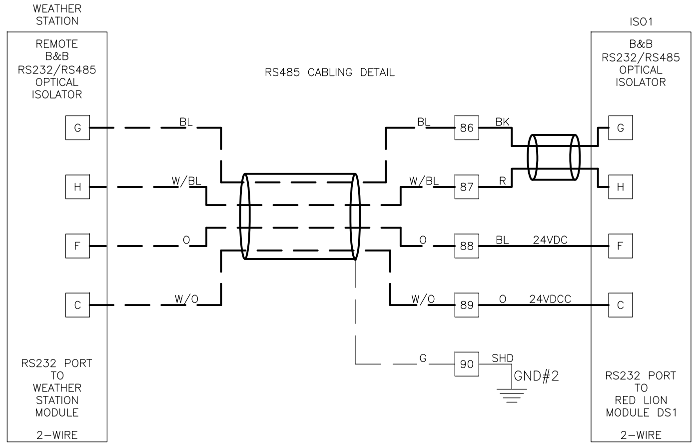
RS485 CABLING DETAIL FOR CC WELL



RED LION USING USING 6-PIN CONNECTOR FOR RS232 SIGNAL



DB9 RS232 CUSTOM CONNECTOR TO 6-PIN TELEPHONE CONNECTOR PIN OUT				
DB9 RS232 CONNECTOR	JUMPER WIRE COLOR	RED LION SIGNAL PIN OUT	RED LION RS232	6-PIN TELE CONNECTOR
8	<-- ORANGE	CTS	YES	1
2	<-- BLACK	Rx	YES	2
-	<-- RED	COM		3
5	<-- GREEN	COM	YES	4
3	<-- YELLOW	Tx	YES	5
7	<-- BROWN	RTS	YES	6



COLOR CODE	
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BK	BLACK
BR	BROWN
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NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

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BIOREACTOR

SHEET TITLE
RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

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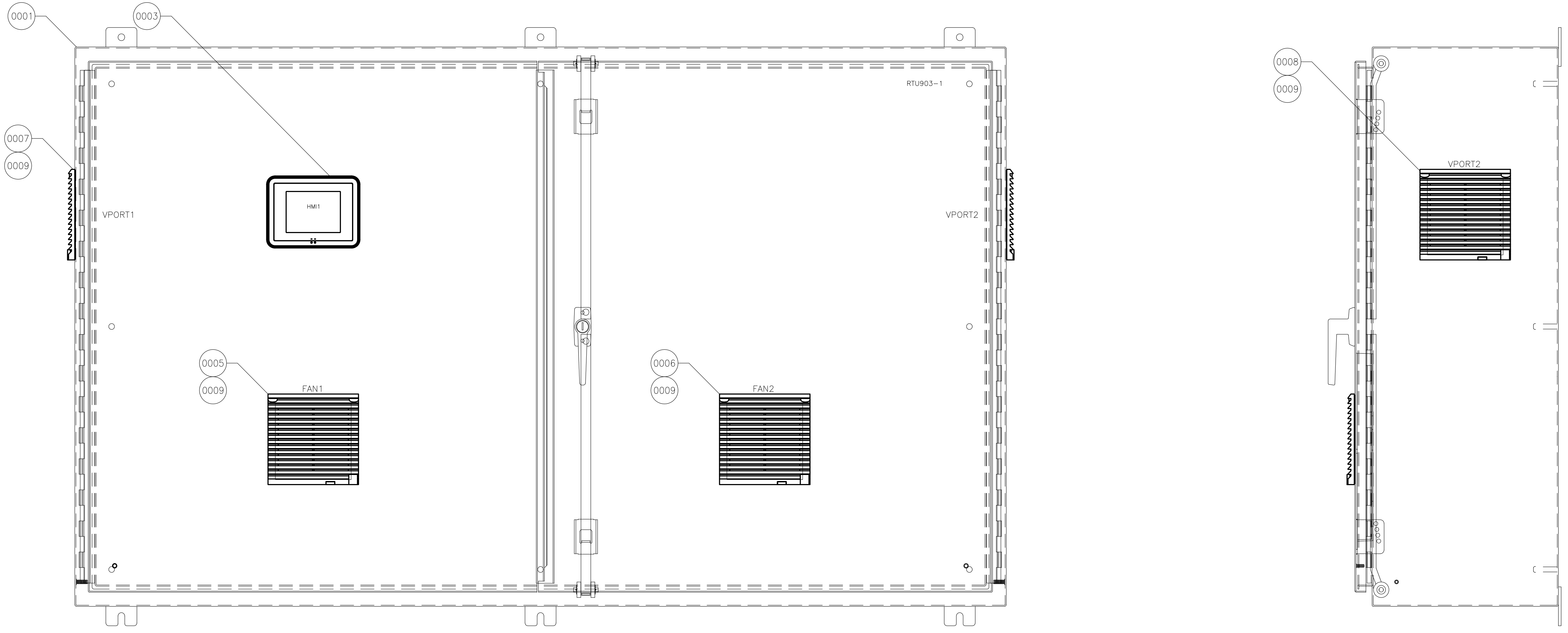

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PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
ENCLOSURE LAYOUT

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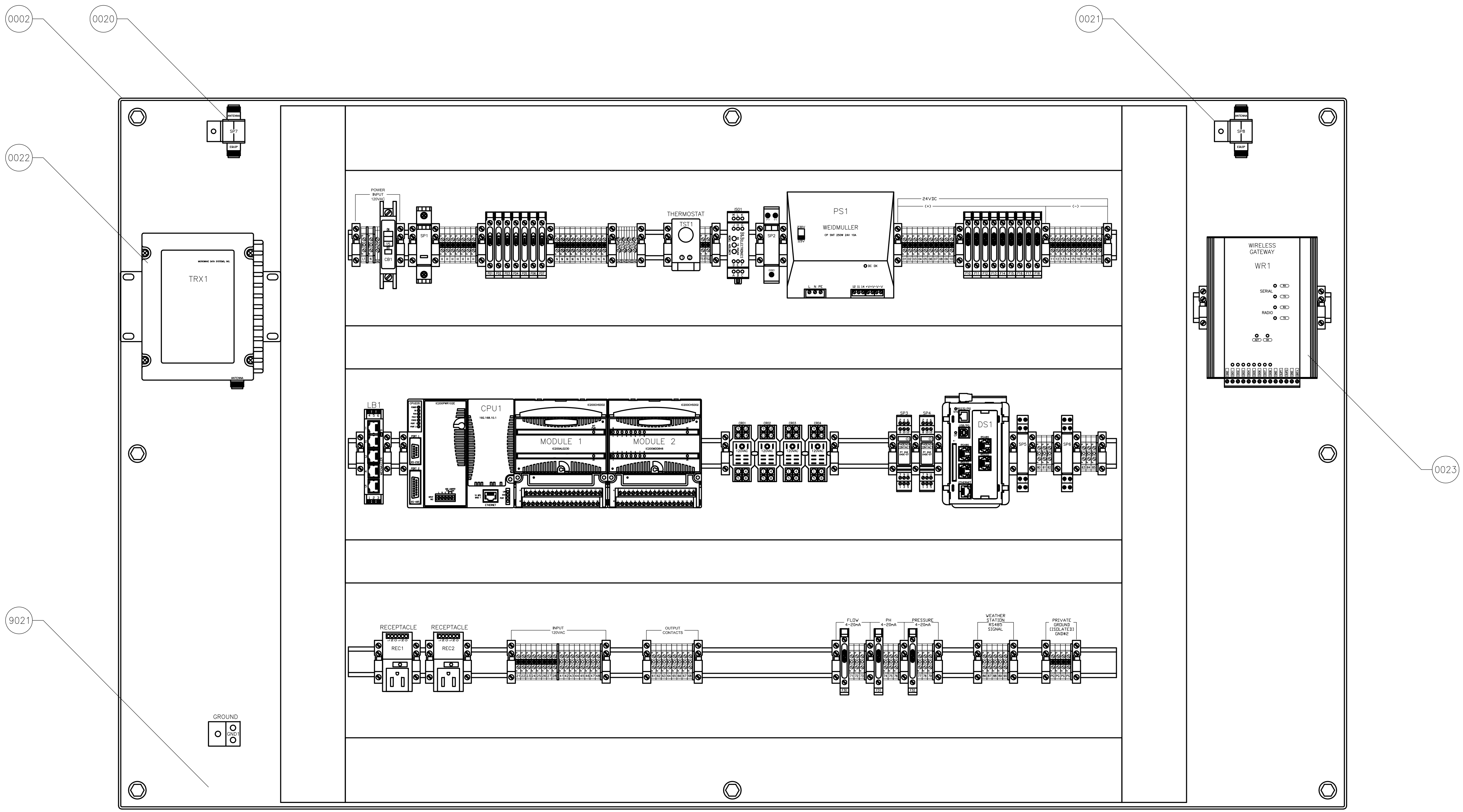

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PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BACK PANEL
LAYOUT

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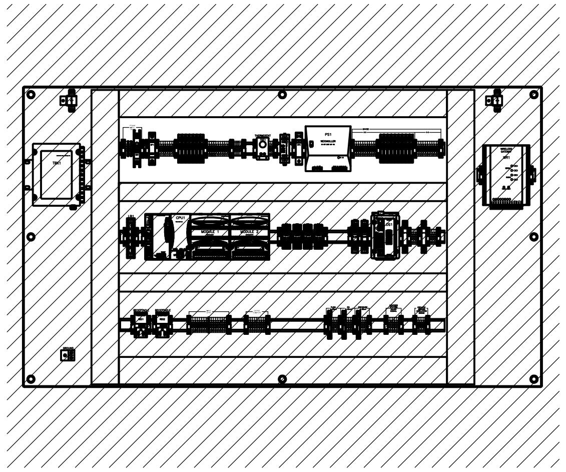
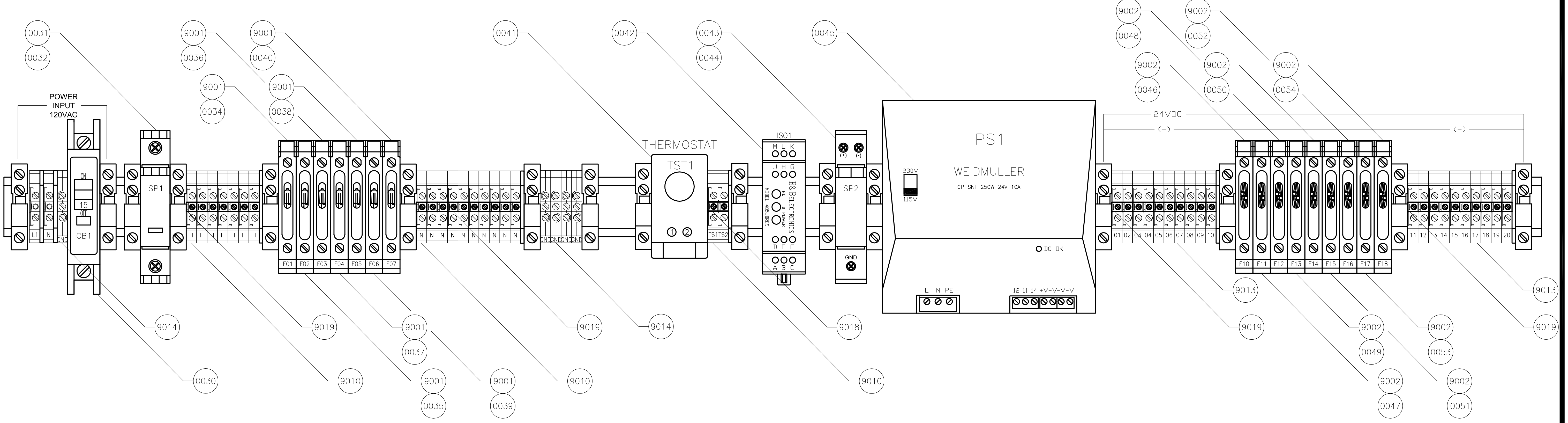
SH 7
OF 12





REV # | DATE | REVISION

SYSTEM CONTROLS & INSTRUMENTATION

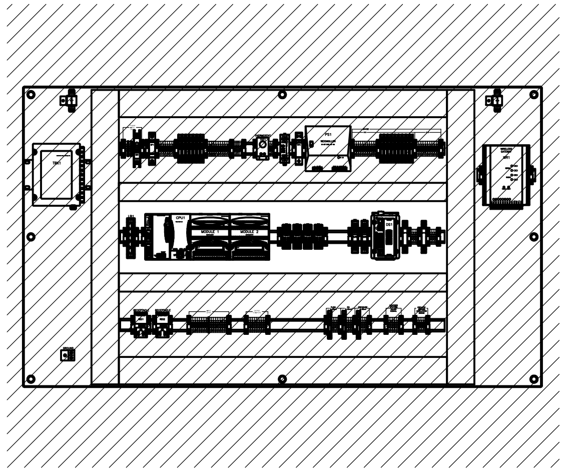
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

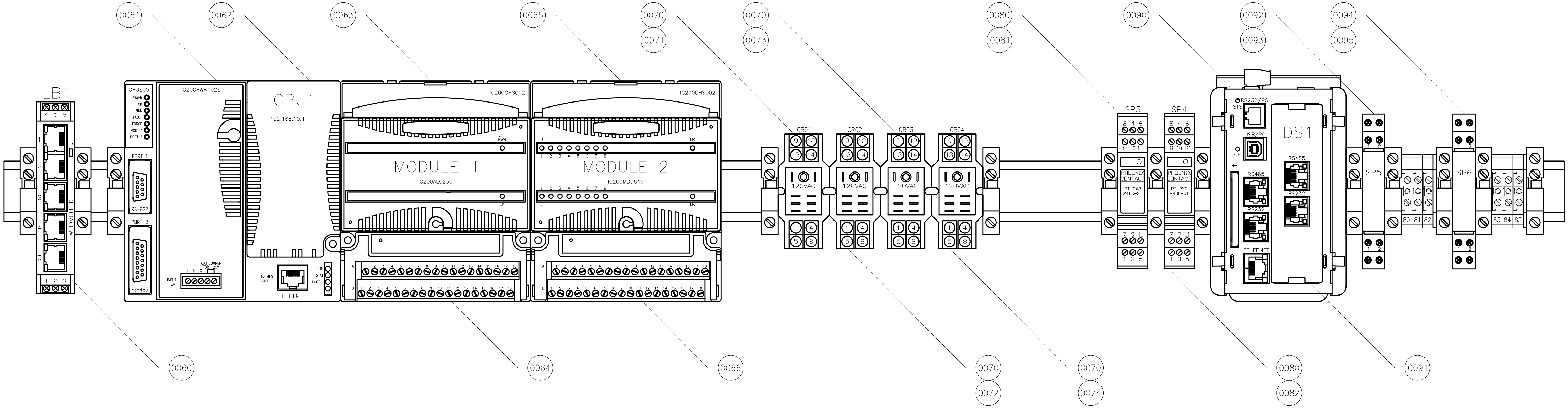
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BACK PANEL LAYOUT

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 8
OF 12





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CAD FILE SCI3079_RTU903-1
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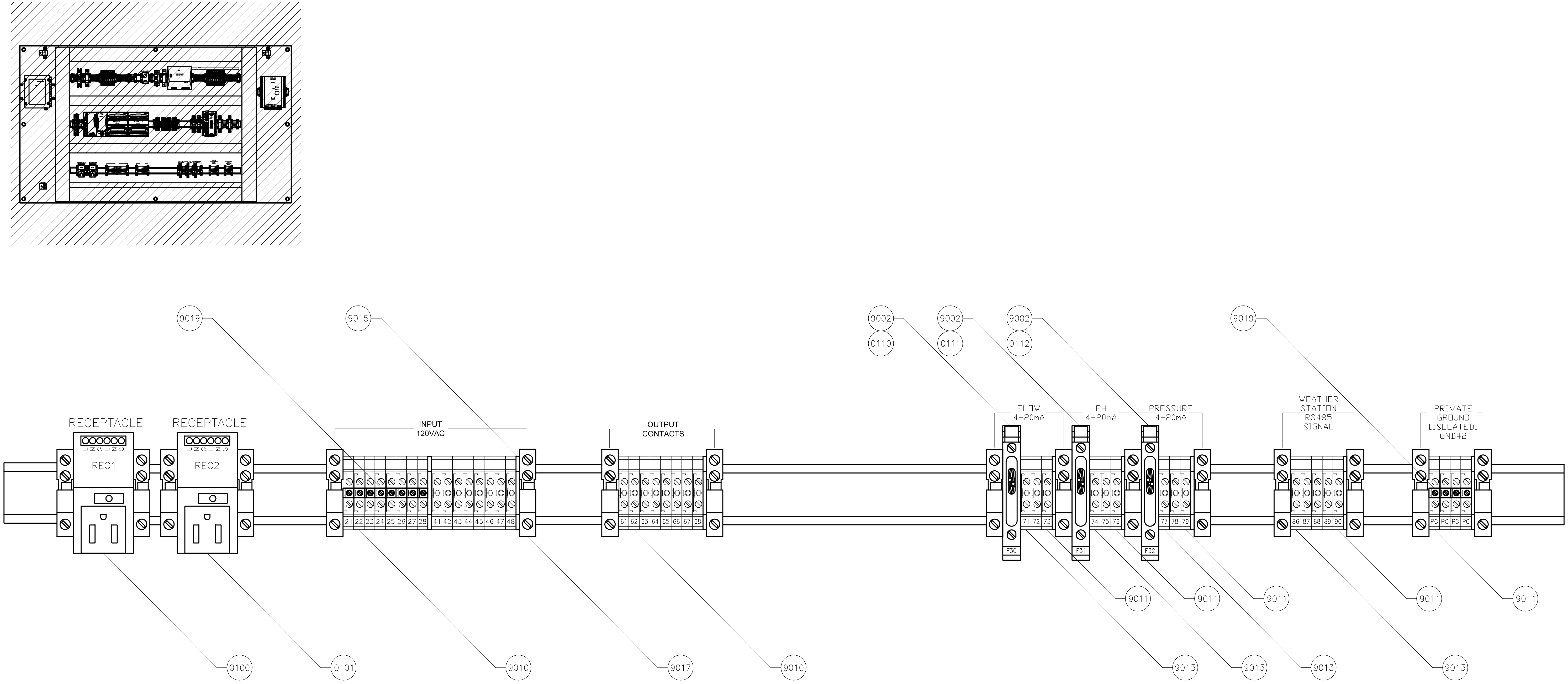
SH 9
OF 12



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DWG. NO. 3079
SH 10
OF 12

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-1	1	ENCLOSURE, 36"HX60"WX12"D, NEMA12	A366012WFLP	HOFFMAN
0002	RTU903-1	1	BACK PANEL, 36"HX60"W, STEEL	A60P36	HOFFMAN
0003	HMI1	1	HMI 6" COLOR TOUCH SCREEN, 24VDC, LAN PORT	IC754VSI06STD	GE FANUC
0005	FAN1	1	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), CUTOUT 124MM SQUARE	3322.117	RITTAL
0006	FAN2	1	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), CUTOUT 124MM SQUARE	3322.117	RITTAL
0007	VPORT1	1	FILTER UNIT, HOLDER ONLY, 124MM	SK3322-207	RITTAL
0008	VPORT2	1	FILTER UNIT, HOLDER ONLY, 124MM	SK3322-207	RITTAL
0009		4	REPLACEMENT FILTER PADS, FOR 5.8"SQ FANS	3322.700	RITTAL
0020	SP7	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0021	SP8	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0022	TRX1	1	DATA TRANSCEIVER, 173MHZ, RS232 INPUT, 13.8VDC	MDS 1710A	MOCROWAVE DATA SYSTEMS
0023	WR1	1	WIRELESS GATEWAY RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS/OUTPUTS, ETHERNET, RS485	WI-GTWY-9-ET1	WEIDMULLER
0030	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0031	SP1	1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	PU II 1	WEIDMULLER
0032		1	HOLDER, SURGE PROTECTION	PU II 1S	WEIDMULLER
0034		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0035		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0036		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0037		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0038		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0039		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0040		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0041	TST1	1	THERMOSTAT, DIN-RAIL MOUNT, 30-140F, HYSTERESIS +/-4F, 15A, 120VAC	SKT011419NO	HAMMOND
0042		1	OPTICAL ISOLATOR, RS-232 TO RS-422/485 CONVERTER	485LDRC9	B&B ELECTRONICS
0043	SP2	1	SURGE PROTECTION MODULE, 24VDC, IMAX:2KA, VMAX: 30V	DS210-24DC	CITEL
0044		1	HOLDER, SURGE PROTECTION	DS210-24DC	CITEL
0045	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3.6A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 10.0A, 250W	CP SNT 250W 24V 10A	WEIDMULLER
0046		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0047		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0048		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0049		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0050		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0051		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0052		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0053		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0054		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0060	LB1	1	UNMANAGED LAN BRIDGE, 5-PORT, 4W/ 10-35VDC, 6VA 10-24VAC, 32-140F, CLASS 1 DIV 2	IE-SW5-WAVE	WEIDMULLER
0061		1	POWER SUPPLY, 120/240VAC. 27VA, 50/60HZ, EXPANDED 3.3VDC	IC200PWR102E	GE FANUC
0062	CPU1	1	PLC CPU MODULE	CPUE05	GE FANUC
0063		1	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	IC200CHS002	GE FANUC
0064	MODULE 1	1	ANALOG MODULE, 4-CH, 12 BIT, VOLTAGE/CURRENT	IC200ALG230	GE FANUC
0065		1	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	IC200CHS002	GE FANUC
0066	MODULE 2	1	MIXED MODULE, 8-INPUT, 8-OUTPUT, 120VAC INPUT, RELAY OUTPUT	IC200MDD846	GE FANUC
0070		4	RELAY, 2PDT, COIL: 120VAC/ 9.2MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-AC120V	IDEC
0071		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0072		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0073		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0074		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0080		2	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PT 2X2-24DC-ST	PHOENIX
0081		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0082		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0090	DS1	1	DATA STATION PLUS, PROTOCOL CONVERTER, 24VDC@200MA, 1A MAX, W/ WEB SERVER & DATA LOGGER	DSPSX000	RED LION
0091		1	DATA STATION PLUS, RS-232/RS-485 ADD-ON MODULE	XCRS0000	RED LION
0092	SP5	1	SURGE PROTECTION MODULE, RS232/RS485, IMAX:20KA, VMAX: 8VDC, 1PAIR SHIELD	DLA-06D3	CITEL
0093		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-06D3	CITEL
0094	SP6	1	SURGE PROTECTION MODULE, RS232/RS485, IMAX:20KA, VMAX: 8VDC, 1PAIR SHIELD	DLA-06D3	CITEL
0095		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-06D3	CITEL
0100	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0101	REC2	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0110		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0111		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0112		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		7	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		12	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9009		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9010		40	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		10	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9013		34	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		5	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		17	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		47	END CLAMP, GRAY	E/UK	PHOENIX
9018		1	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	FBI 2-6	PHOENIX
9019		5	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9020		1	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

REV #	DATE	REVISION

SCI
SYSTEM CONTROLS & INSTRUMENTATION

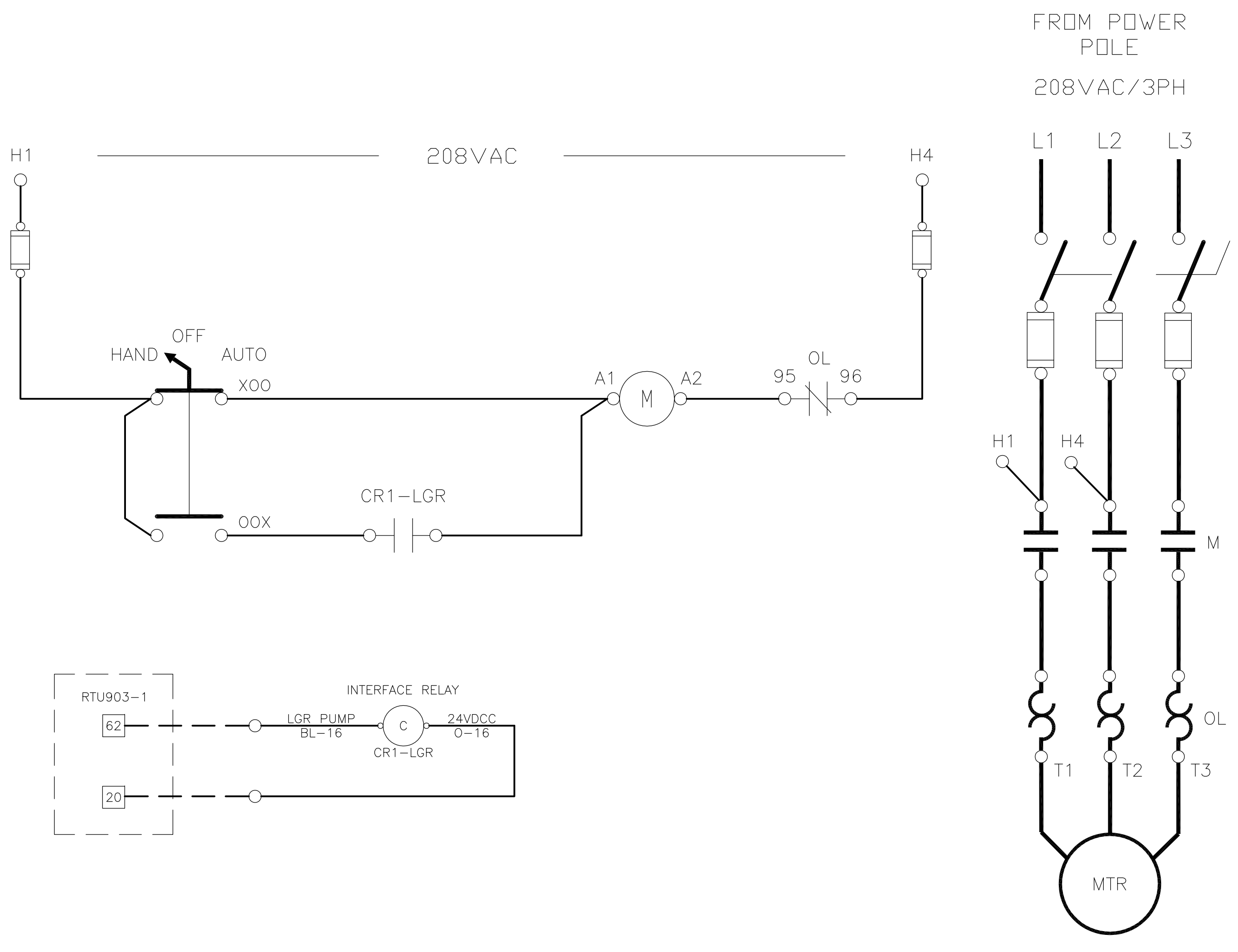
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

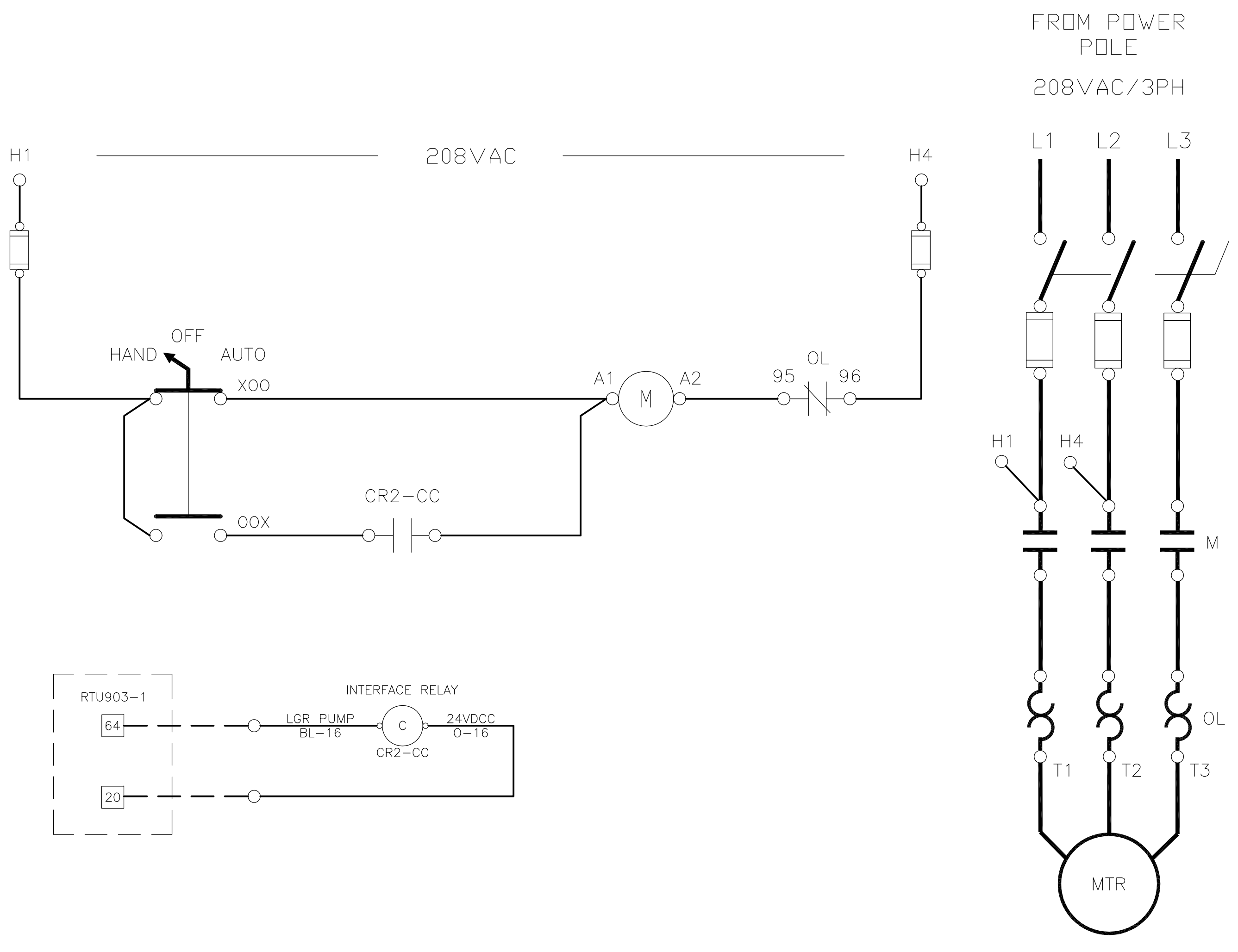
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BILL OF MATERIALS

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 11 OF 12



CS-16 LGR WELL PUMP



CS-MW 16CC WELL PUMP

NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

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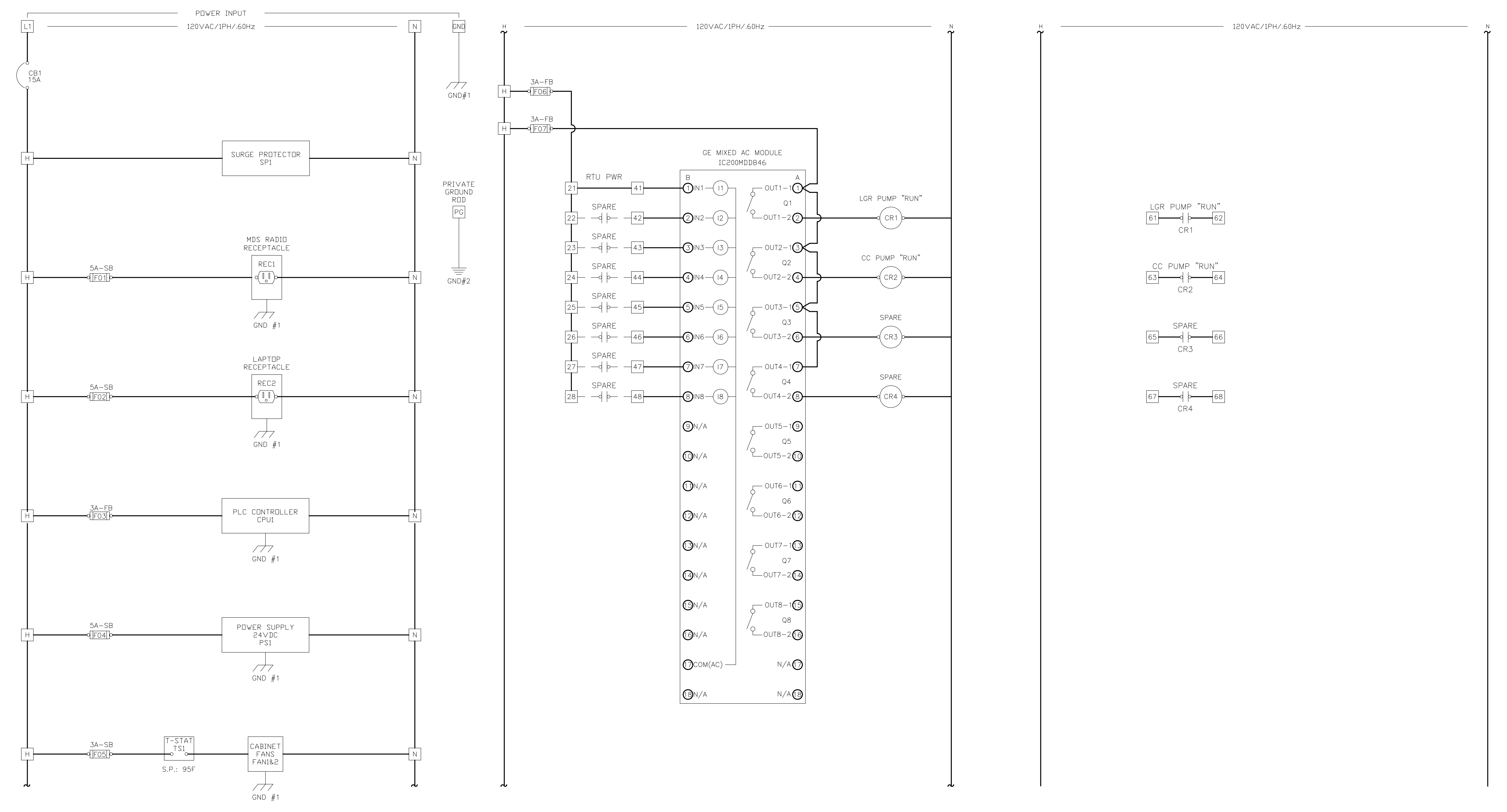
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
LGR / CC PUMP PANELS
LINE-TO-LINE
FIELD WIRING DIAGRAM

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 12
OF 12



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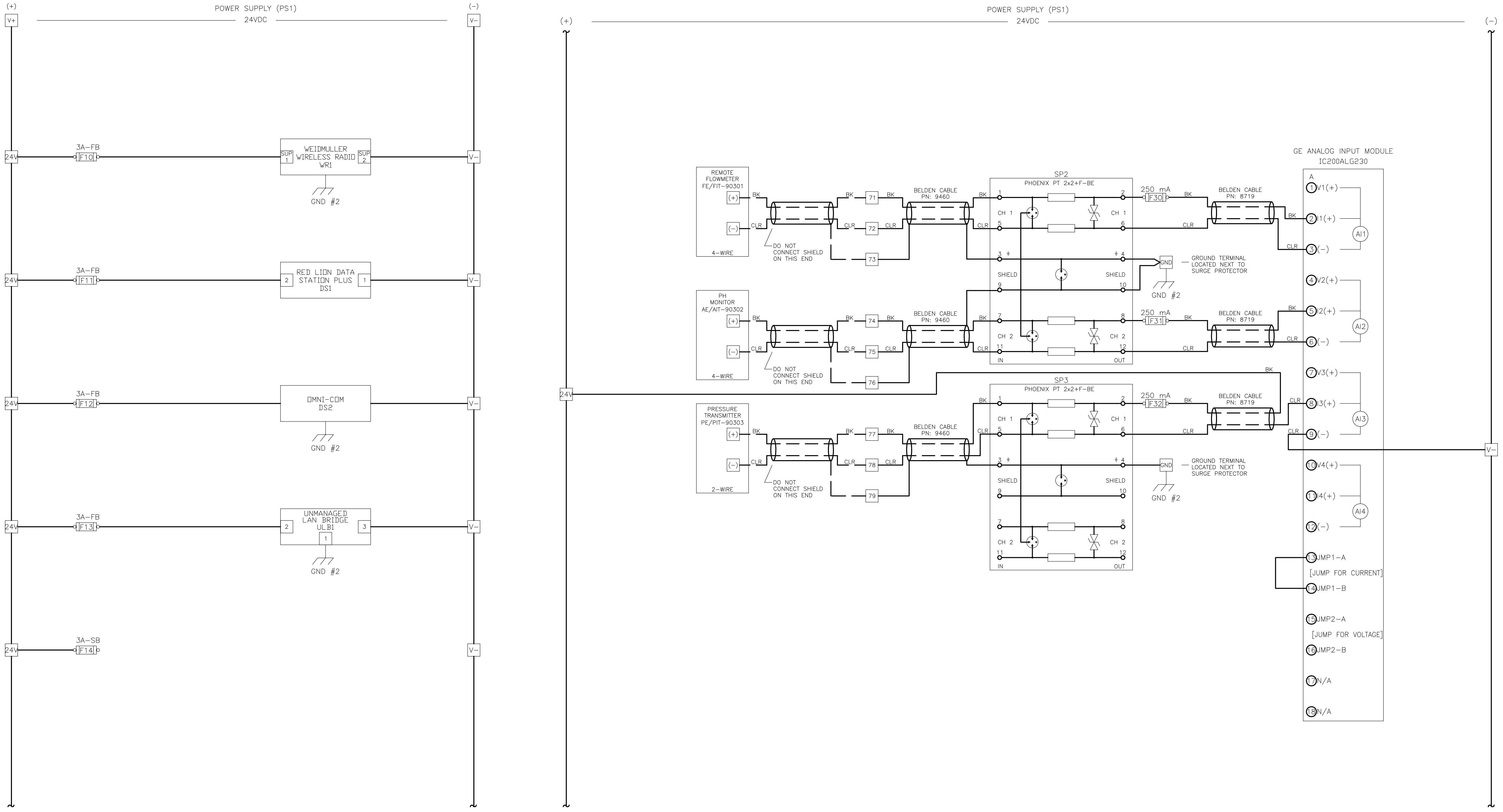
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-3
DWG. NO. 2829
SH 1 OF 9



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ENGINEER

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CAMP STANLEY
BIOREACTOR

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RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

DATE: 8/10/2009
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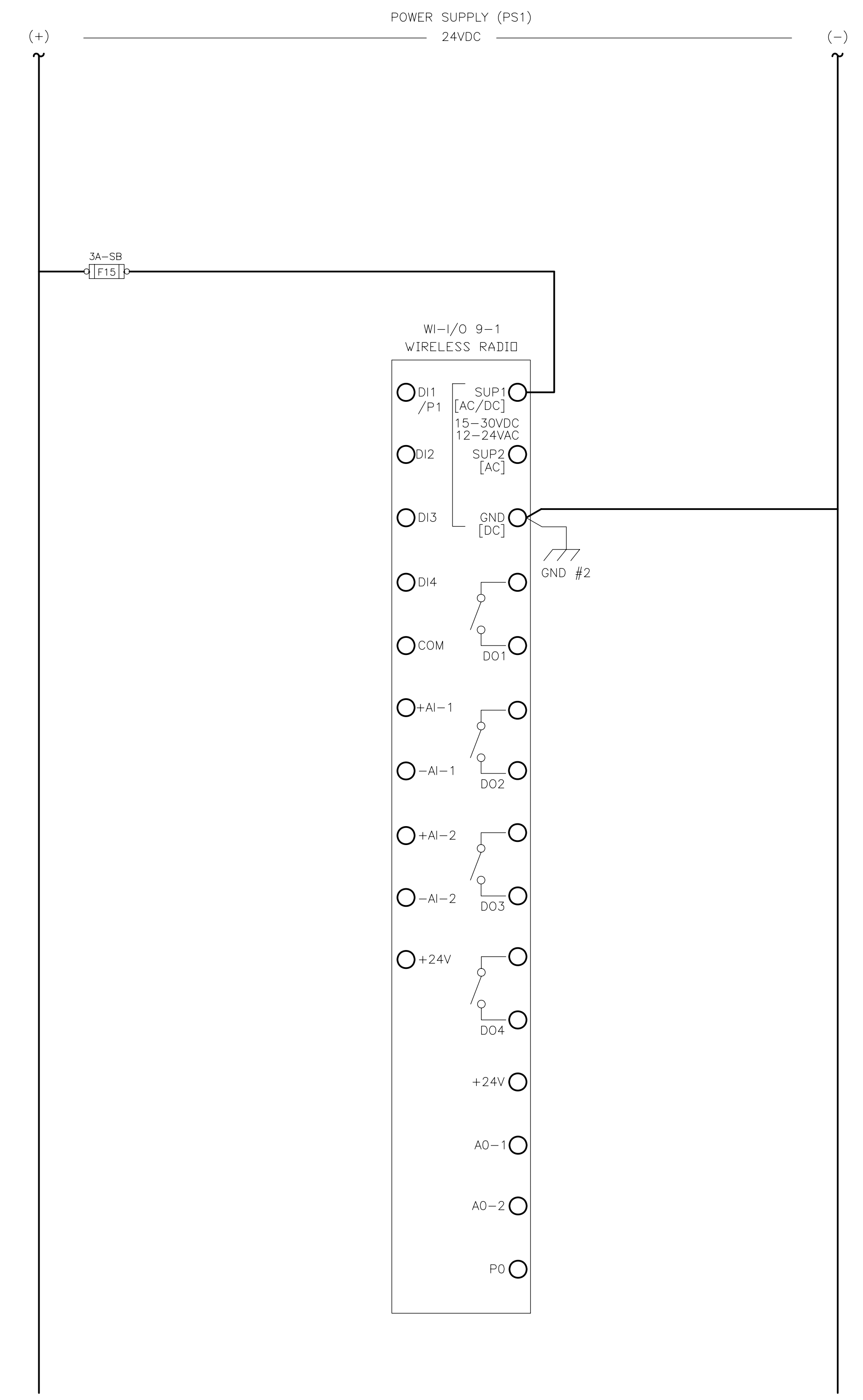
SH 2 OF 9



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WIRING DIAGRAM

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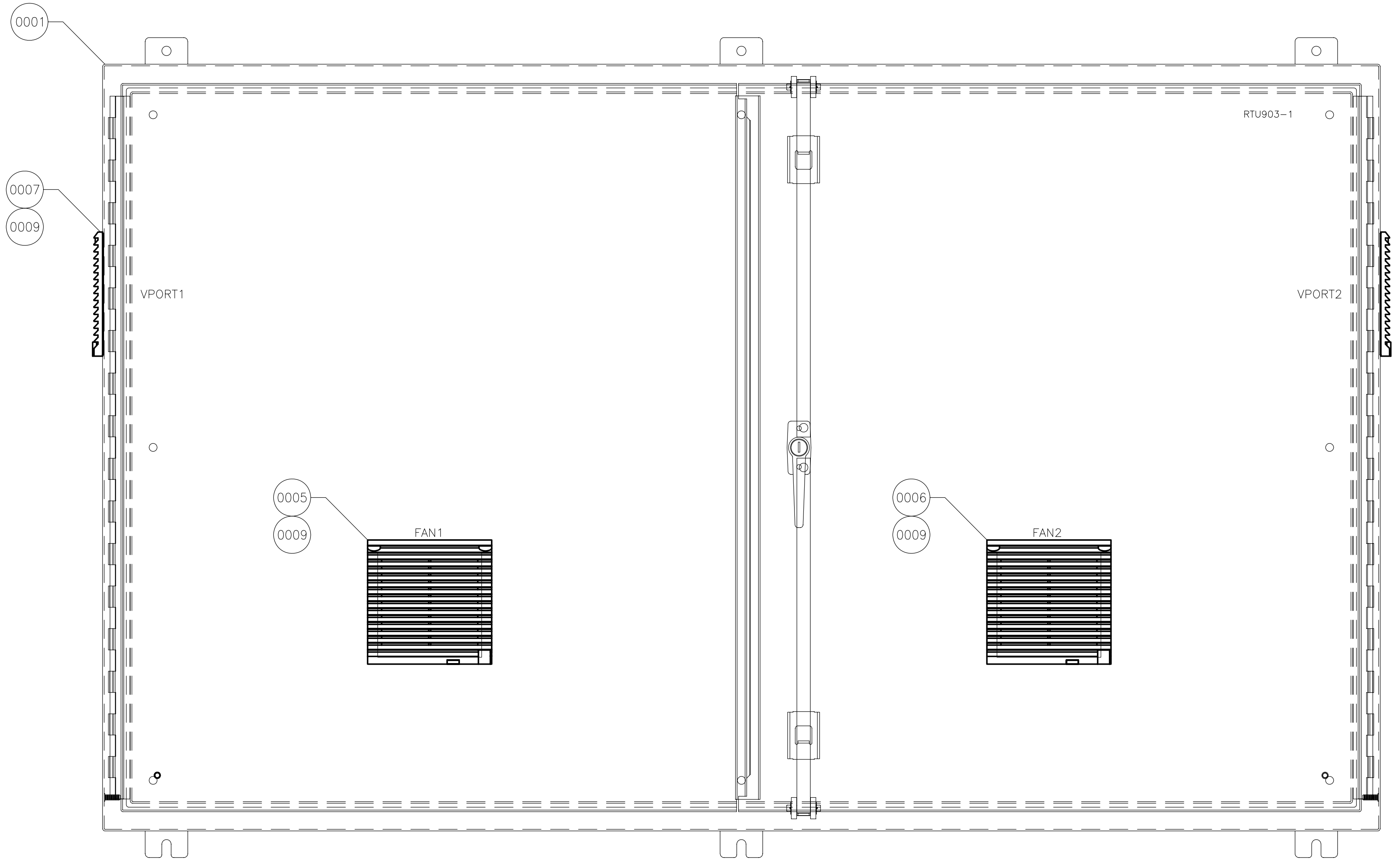

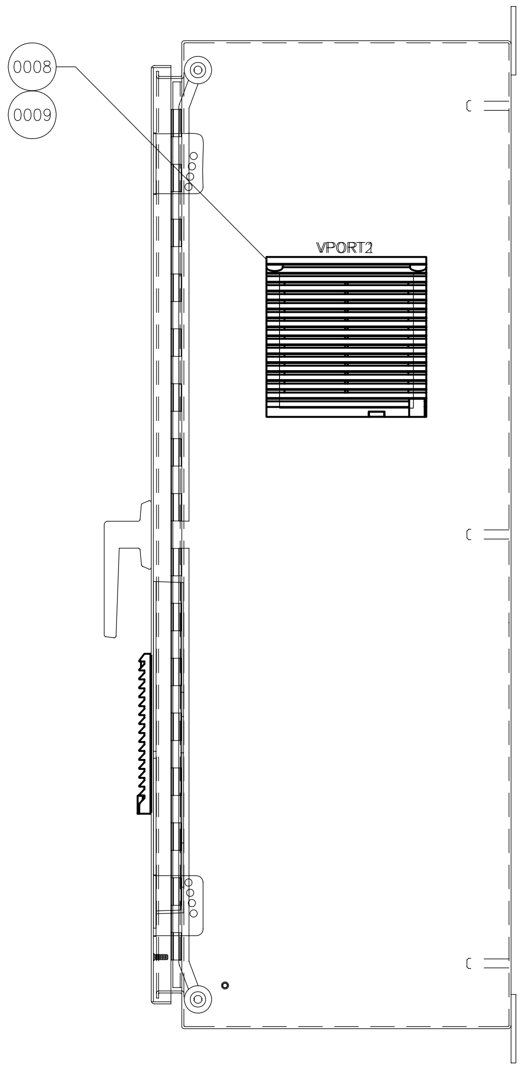

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ENGINEER

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CAMP STANLEY
BIOREACTOR

SHEET TITLE

RTU 903-1
ENCLOSURE LAYOUT

DATE:	8/10/2009
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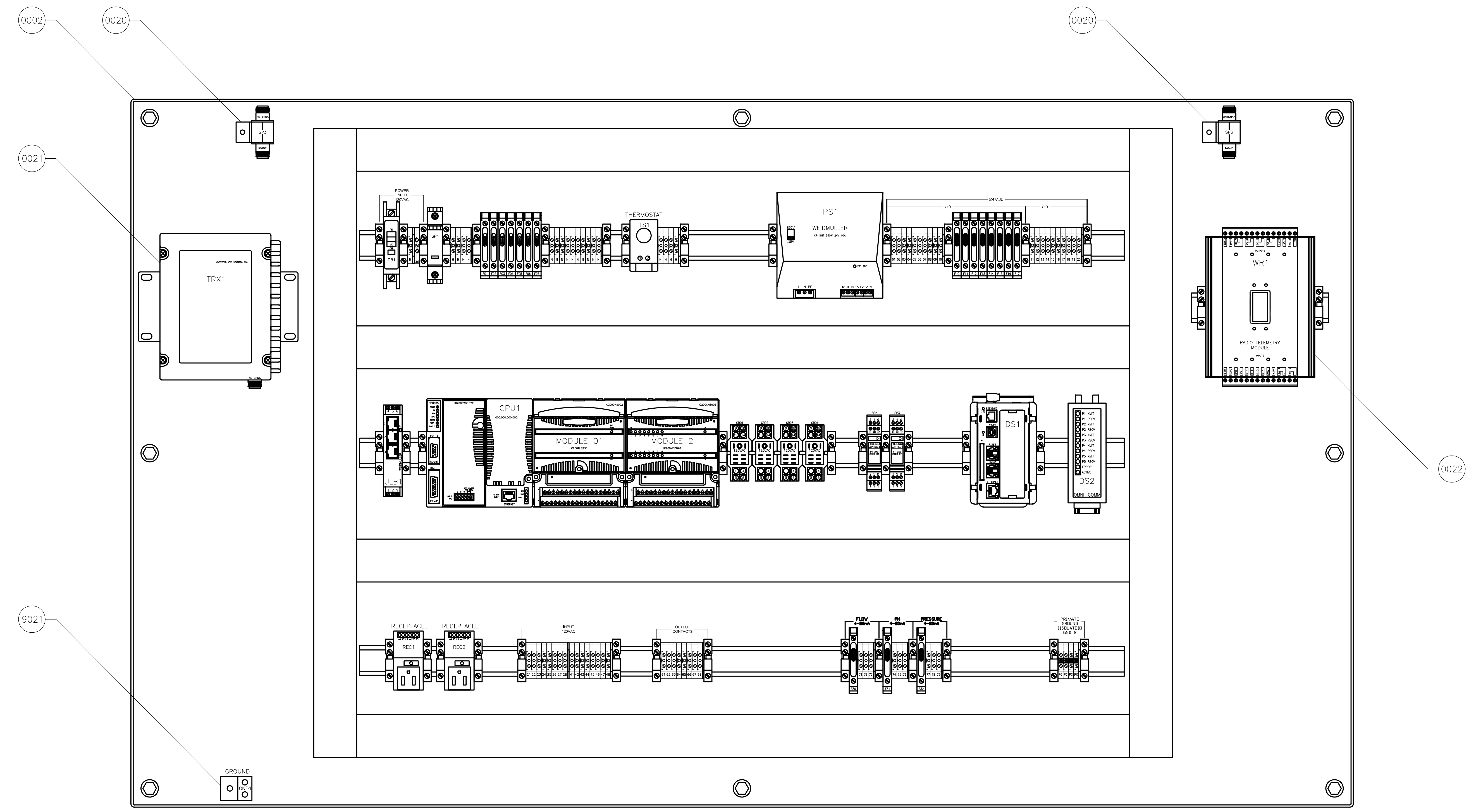
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	4
OF	9



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CAMP STANLEY
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SHEET TITLE
RTU 903-1
BACK PANEL LAYOUT

DATE: 8/10/2009
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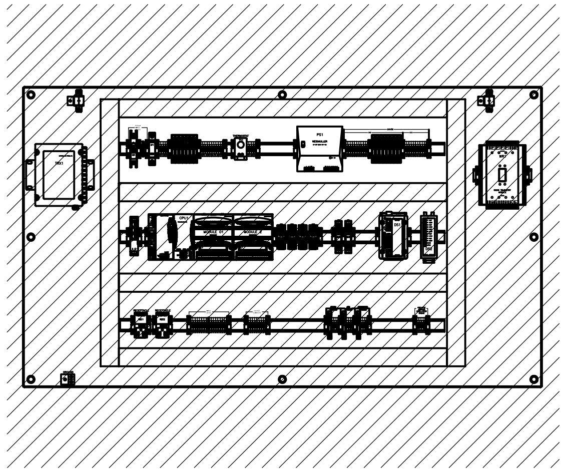

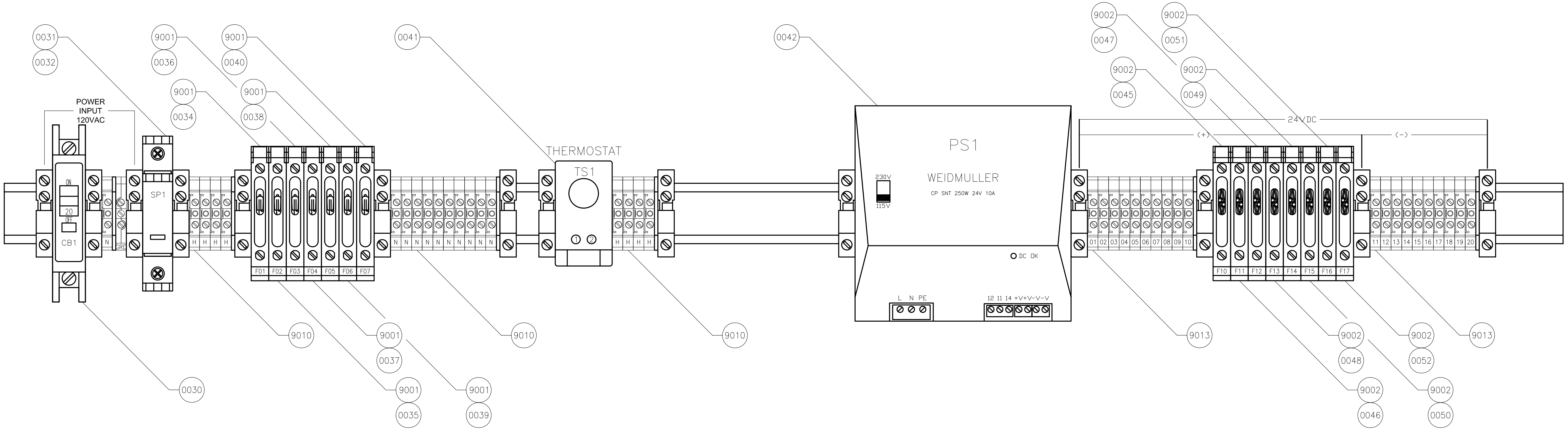

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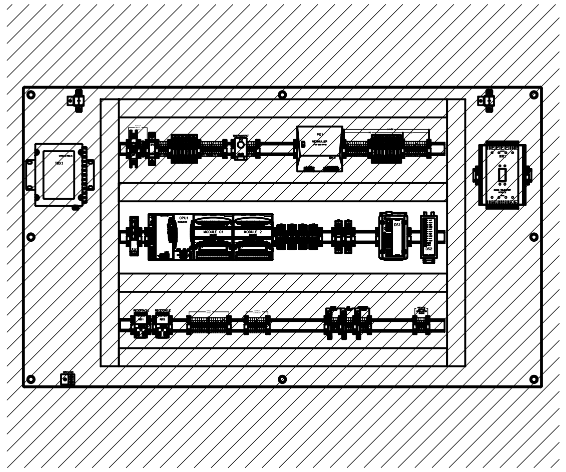

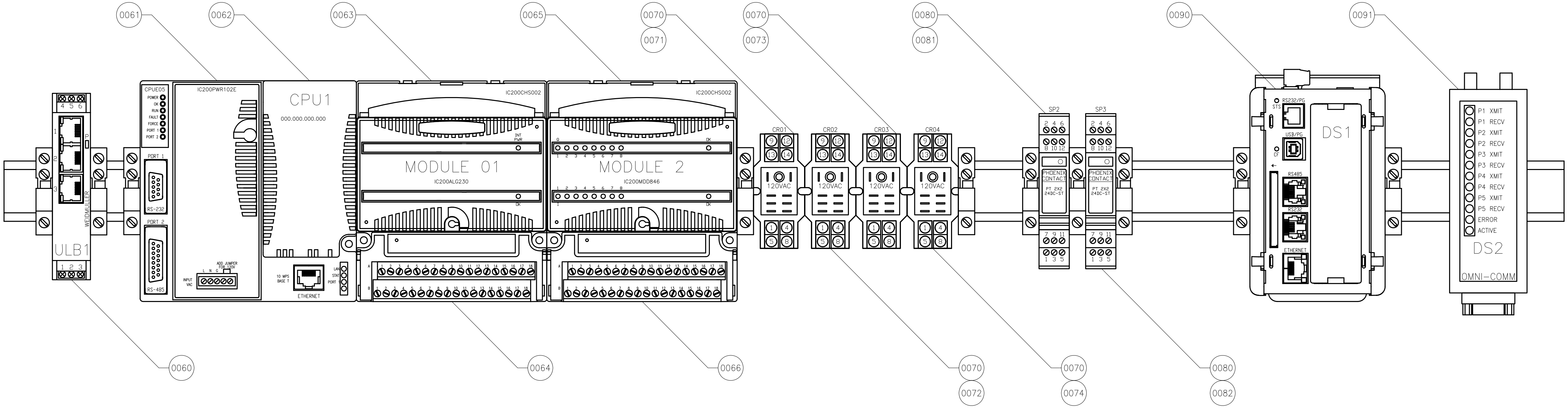

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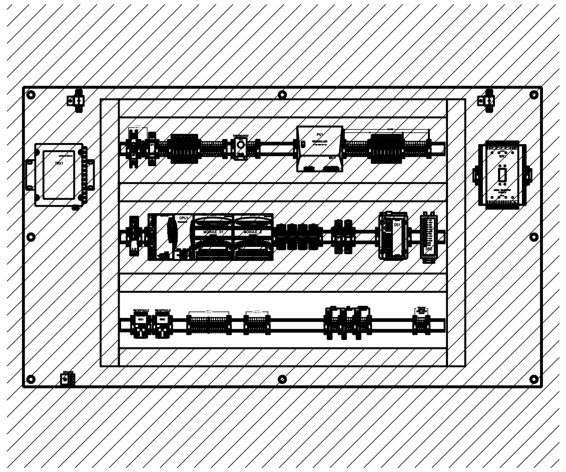

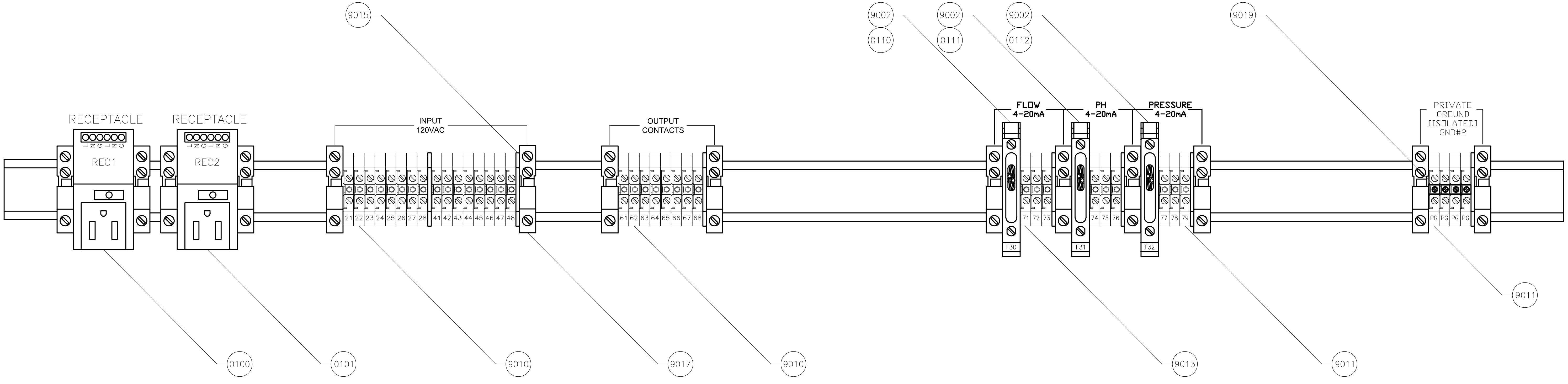

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DWG. NO.	2829
SH	8
OF	9

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-1	1	A366012WFLP	ENCLOSURE, 36"HX60"WX12"D, NEMA12	HOFFMAN	
0002	RTU903-1	1	A60P36	BACK PANEL, 36"HX60"W, STEEL	HOFFMAN	
0005	FAN1	1	3322.117	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), 124MM	RITTAL	837000
0006	FAN2	1	3322.117	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), 124MM	RITTAL	837000
0007	VPORT1	1	SK3322-007	FILTER UNIT, HOLDER ONLY, 124MM	RITTAL	835000
0008	VPORT2	1	SK3322-007	FILTER UNIT, HOLDER ONLY, 124MM	RITTAL	835000
0009		4	3322.700	REPLACEMENT FILTER PADS, FOR 5.8"SQ FANS	RITTAL	840000
0020	SP3	2	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		2	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021	TRX1	1	MDS 9810	DATA TRANSCEIVER, RS232 INPUT, 13.8VDC	MOCROWAVE DATA SYSTEMS	
0021		2	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	XXXXXX
0022		2	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		2	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0030	CB1	1	QOU120	CIRCUIT BREAKER, 20A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0031		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0032	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0034		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0035		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0036		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0037		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0038		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0039		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0040		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0041	TS1	1	SKT011419NO	THERMOSTAT, DIN-RAIL MOUNT, 30-140F, HYSTERESIS +/-4F, 15A, 120VAC	HAMMOND	
0042	PS1	1	CP SNT 250W 24V 10A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3.6A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 10.0A, 250W	WEIDMULLER	8708670000
0060	ULB1	1	IE-SW3-WAVE	UNMANAGED LAN BRIDGE, 3-PORT, 4W/ 10-35VDC, 6VA 10-24VAC, 32-140F, CLASS 1 DIV 2	WEIDMULLER	8897710000
0061		1	IC200PWR102E	POWER SUPPLY, 120/240VAC. 27VA, 50/60HZ, EXPANDED 3.3VDC	GE FANUC	IC200PWR102E
0062	CPU1	1	CPUE05	PLC CPU MODULE	GE FANUC	IC200CPUE05-CG
0063		1	IC200CHS002	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	GE FANUC	IC200CHS002
0064	MODULE 01	1	IC200ALG230	ANALOG MODULE, 4-CH, 12 BIT, VOLTAGE/CURRENT	GE FANUC	IC200ALG230
0065		1	IC200CHS002	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	GE FANUC	IC200CHS002
0066	MODULE 2	1	IC200MDD846	MIXED MODULE, 8-INPUT, 8-OUTPUT, 120VAC INPUT, RELAY OUTPUT	GE FANUC	IC200MDD846
0070		4	RH2B-ULC-AC120V	RELAY, 2PDT, COIL: 120VAC/ 9.2MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0071		1	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0072		1	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0073		1	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0074		1	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0080		2	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0081		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0082		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0090	DS1	1	IE-SW3-WAVE	DATA STATION PLUS, PROTOCOL CONVERTER, 24VDC@200MA, 1A MAX, W/ WEB SERVER & DATA LOGGER	WEIDMULLER	8897710000
0091	DS2	1	266-500-220	PROTOCOL CONVERTER, 24VDC@40MA, 4 - RS232/485 INPUT PORTS, 1 RS232/485 OUTPUT PORT	MILLE APPLIED RESEARCH	
0100	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0101	REC2	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0110		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0111		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0112		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		7	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		11	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		43	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		7	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9013		26	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		13	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		40	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9019		1	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

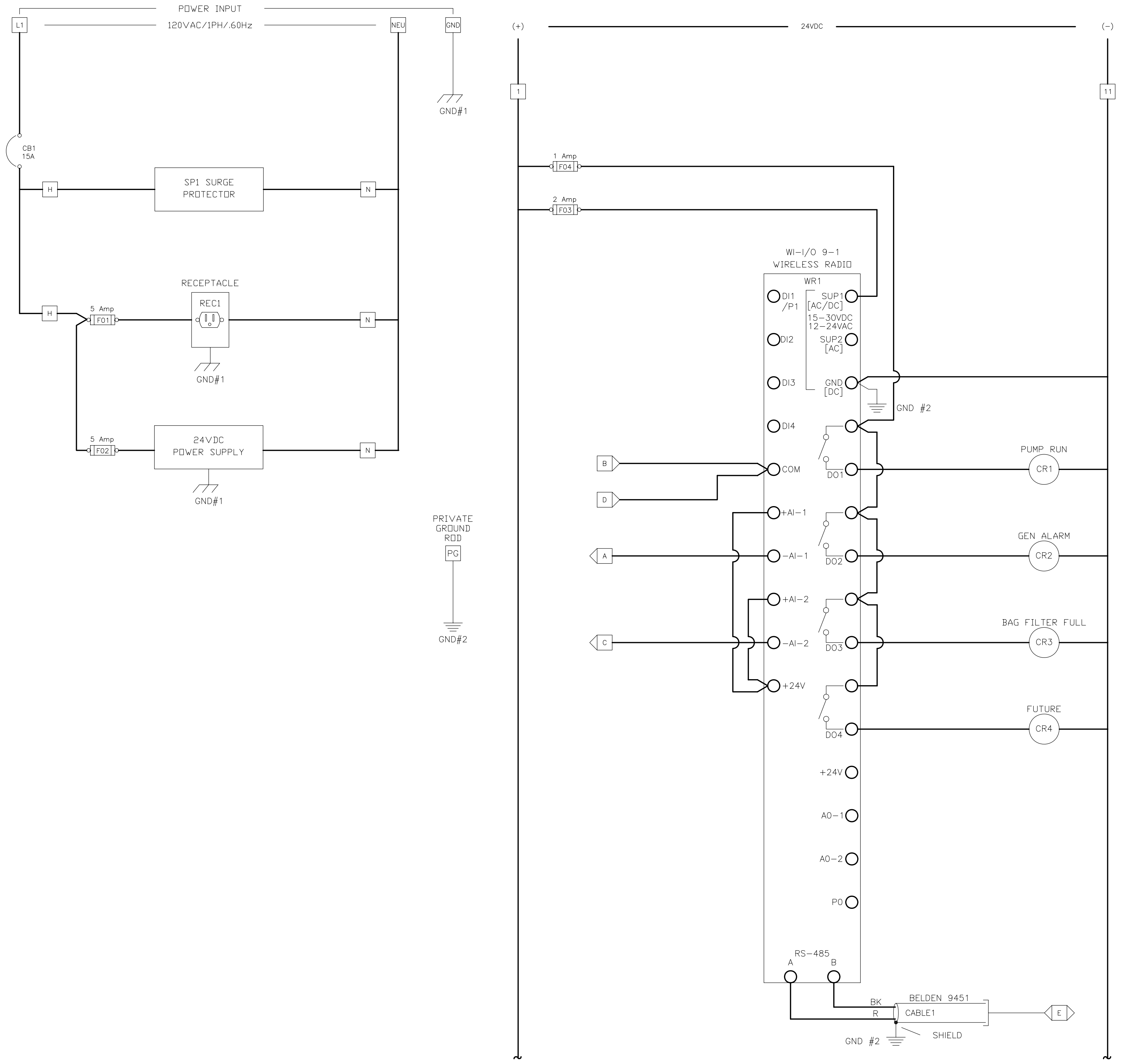
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BILL OF MATERIALS

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-3
DWG. NO. 2829
SH 9 OF 9

RTU 903-2: BIOREACTOR TANK AND TRANSFER PUMP



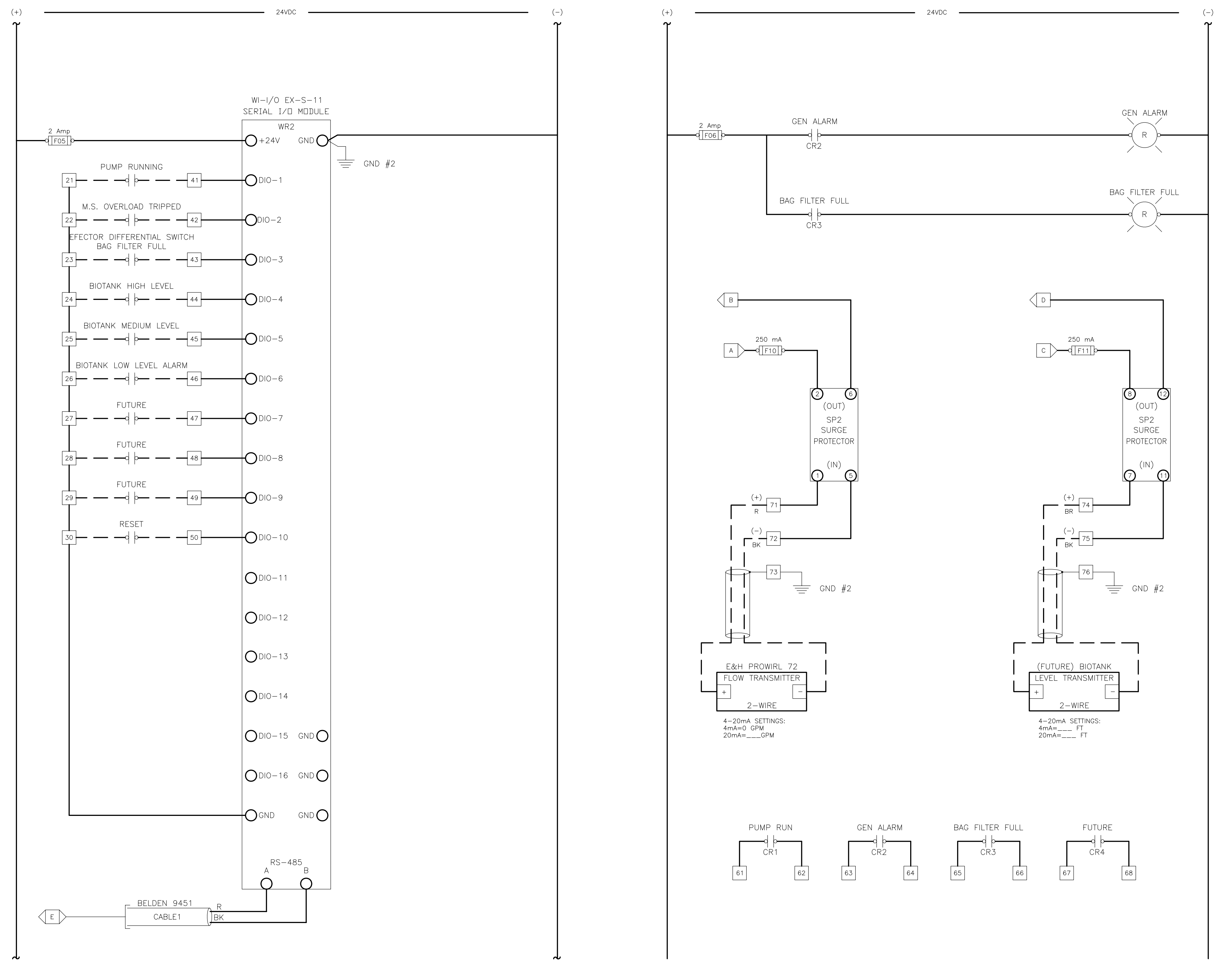
REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER	PROJECT TITLE	SHEET TITLE
	CAMP STANLEY BIOREACTOR	RTU 903-2 PROCESS TANK WIRING DIAGRAM

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-2
DWG. NO.	2829
SH	1
OF	6



REV # DATE REVISION

SYSTEM CONTROLS & INSTRUMENTATION

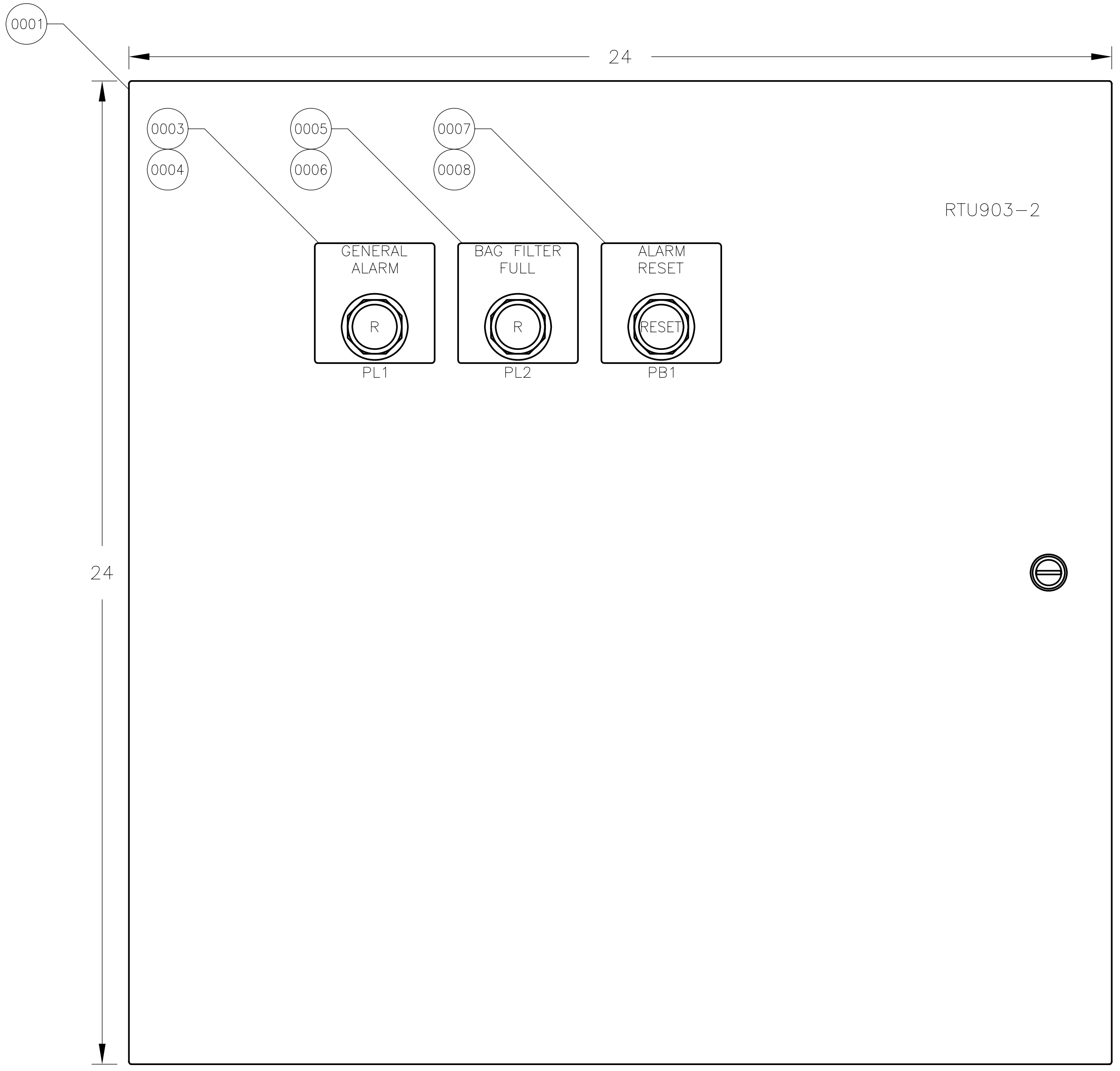
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

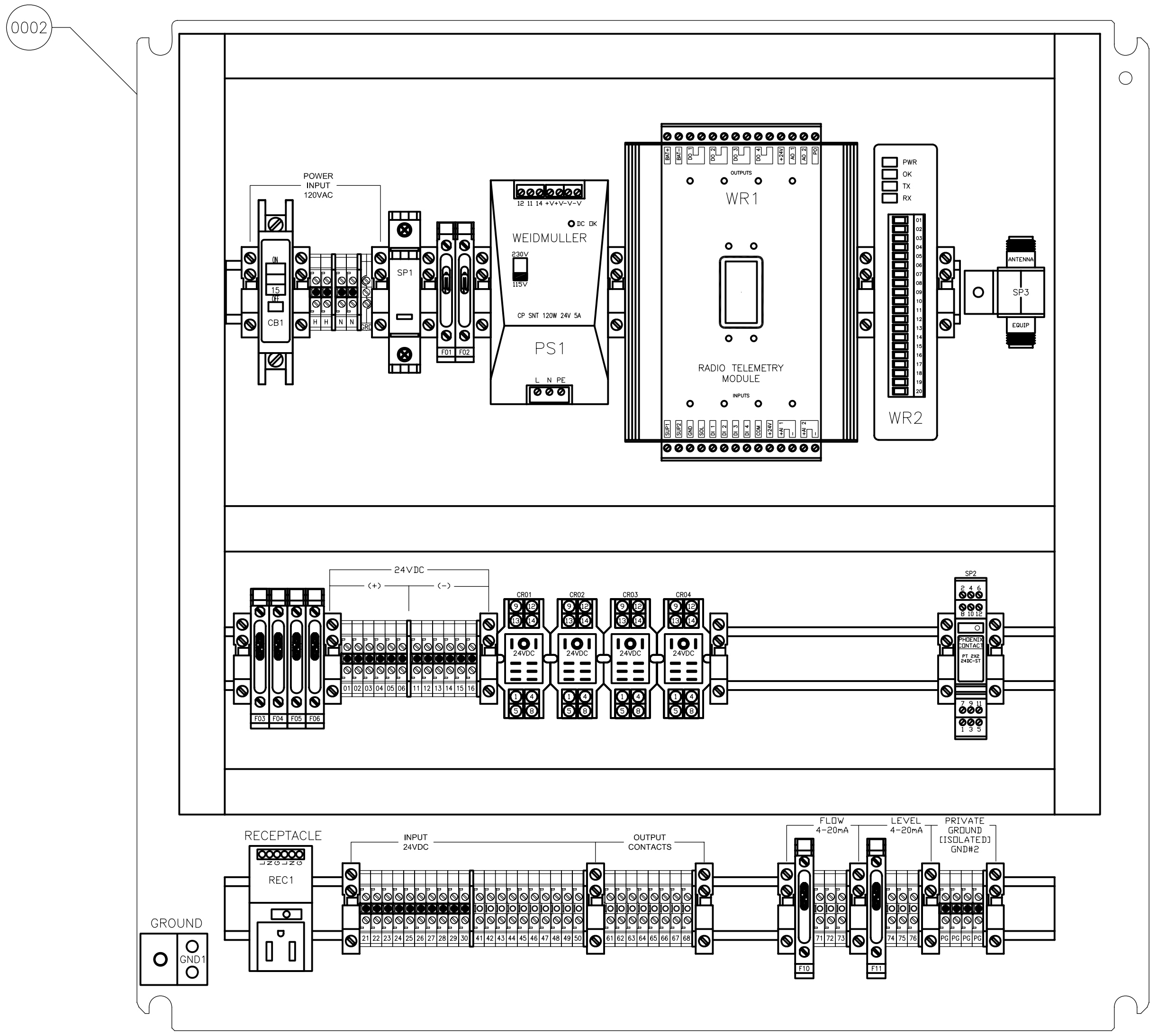
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK WIRING DIAGRAM

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-2
DWG. NO.	2829
SH	2
OF	6





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

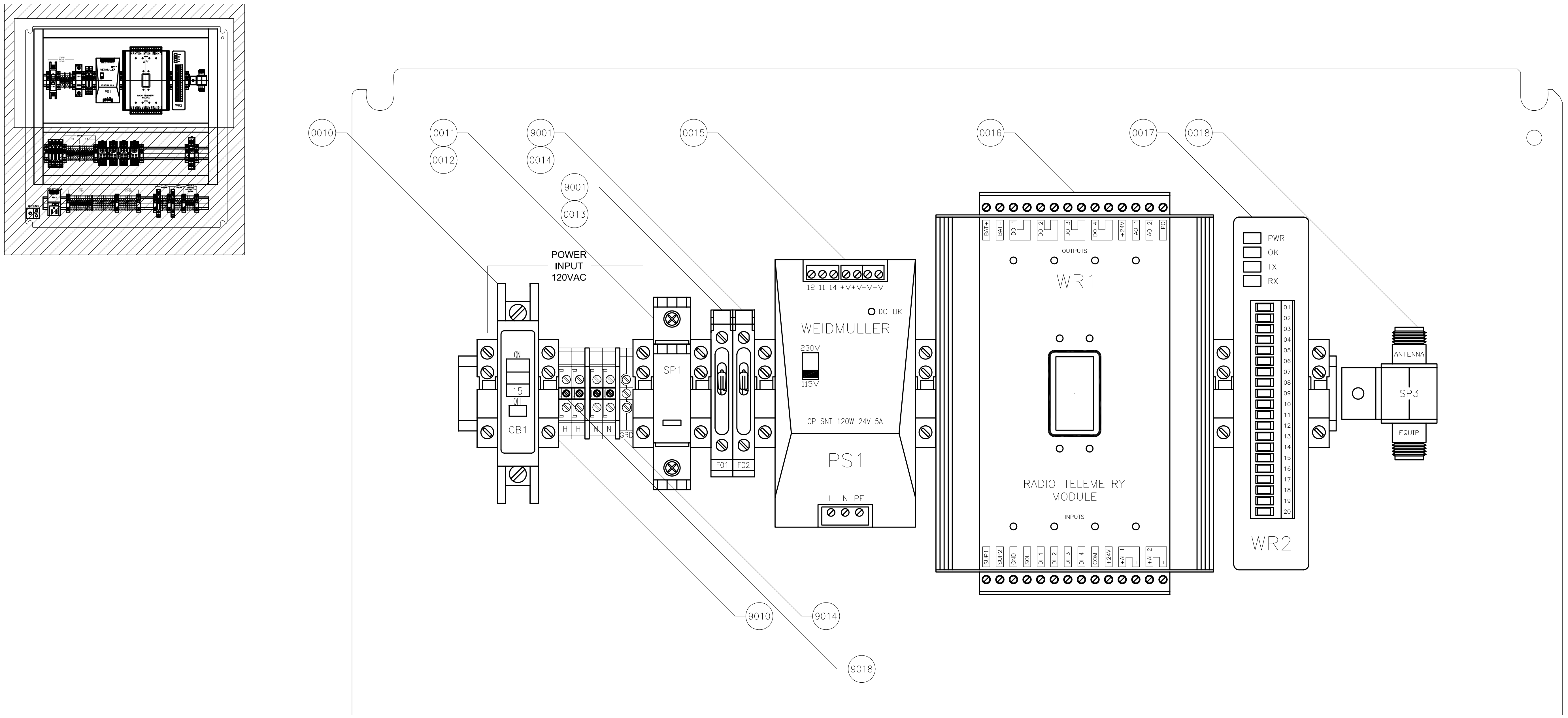
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK BACK PANEL LAYOUT

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-2
DWG. NO. 2829
SH 3 OF 6



REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

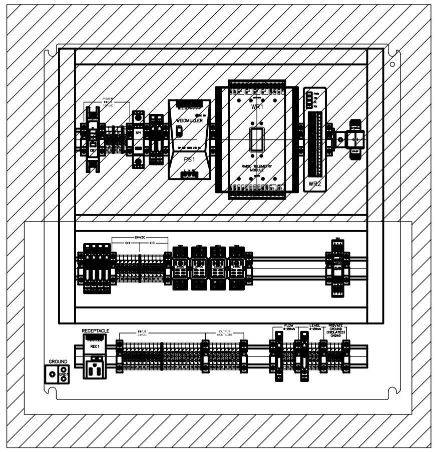
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

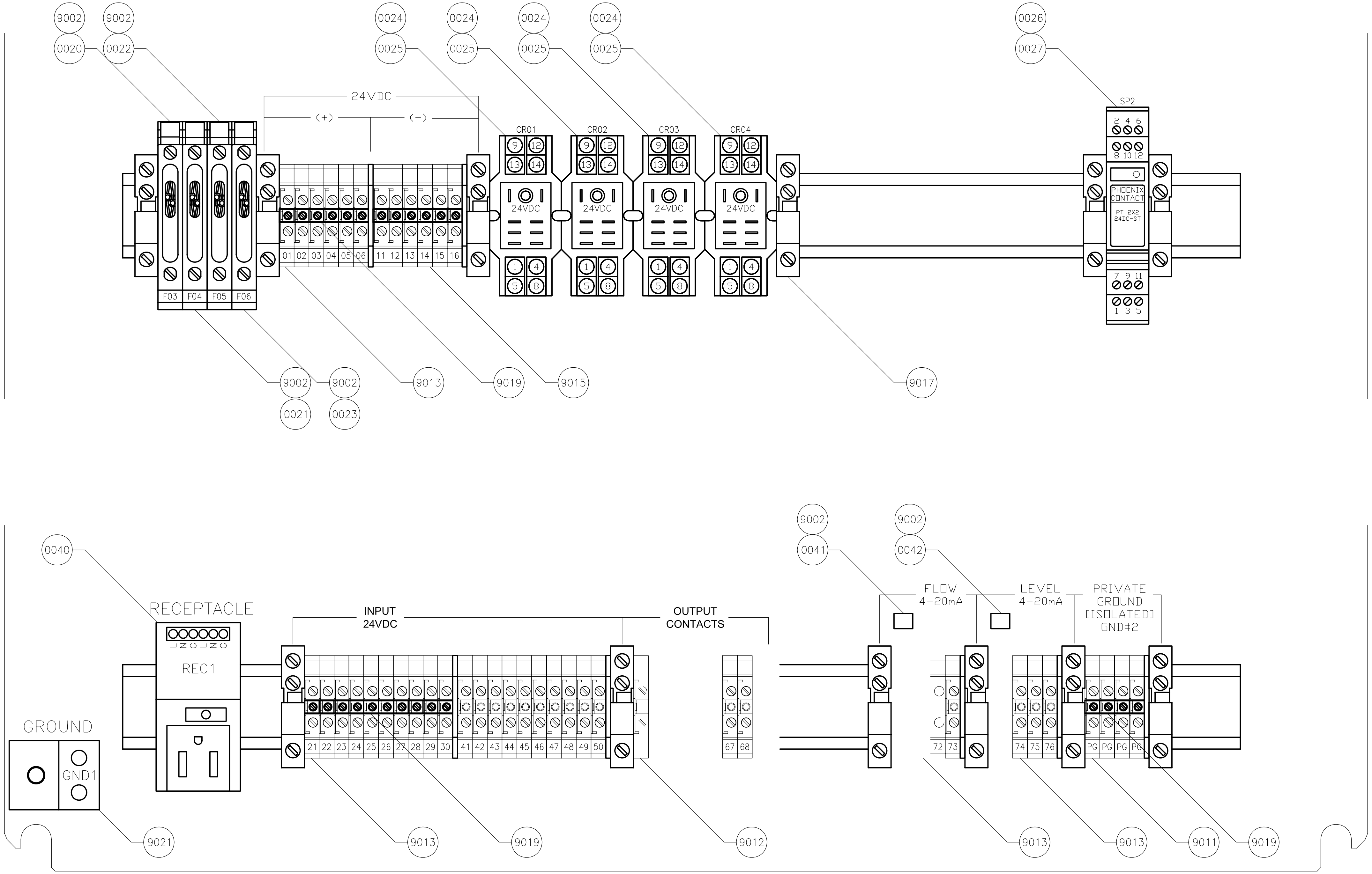
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK PARTS LAYOUT

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-2
DWG. NO.	2829
SH	4
OF	6





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK PARTS LAYOUT

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-2
DWG. NO.	2829

SH 5 OF 6

BILL OF MATERIAL						
ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-2	1	CSD242410SS	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	HOFFMAN	
0002	RTU903-2	1	CP2424	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	HOFFMAN	
0003	PL1	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0004	PL1	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0005	PL2	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0006	PL2	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0007	PB1	1	800T-A707WA	PUSH BUTTON OPERATOR, METAL, 30.5MM, FLUSH HEAD, BLUE W/WHITE LETTERING, 1-NO / 1-NC	AB	
0008	PB1	1		PUSH BUTTON LABEL, PLASTIC, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0010	CB1	1	QOU115	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0011	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0012		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0013		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0014		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0015	PS1	1	CP SNT 120W 24V 5A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	WEIDMULLER	
0016	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	8708670000
0017	WR2	1	WI-I/O-EX-S-11	EXPANSION I/O MODULE, 10.8-30VDC, 16 I/O INPUT/OUTPUTS, DIN RAIL MOUNTING	WEIDMULLER	67200005038-11
0018	SP3	1	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021		1	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0024		4	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0025		4	RH2B-ULC-DC24V	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0026		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0027		1	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0040	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0041		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0042		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		2	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		6	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		4	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		6	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9012		8	UK 5 N YE	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	PHOENIX	3003952
9013		36	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		10	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		21	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9018		2	FBI 2-6	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	PHOENIX	0203438
9019		1	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		1	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

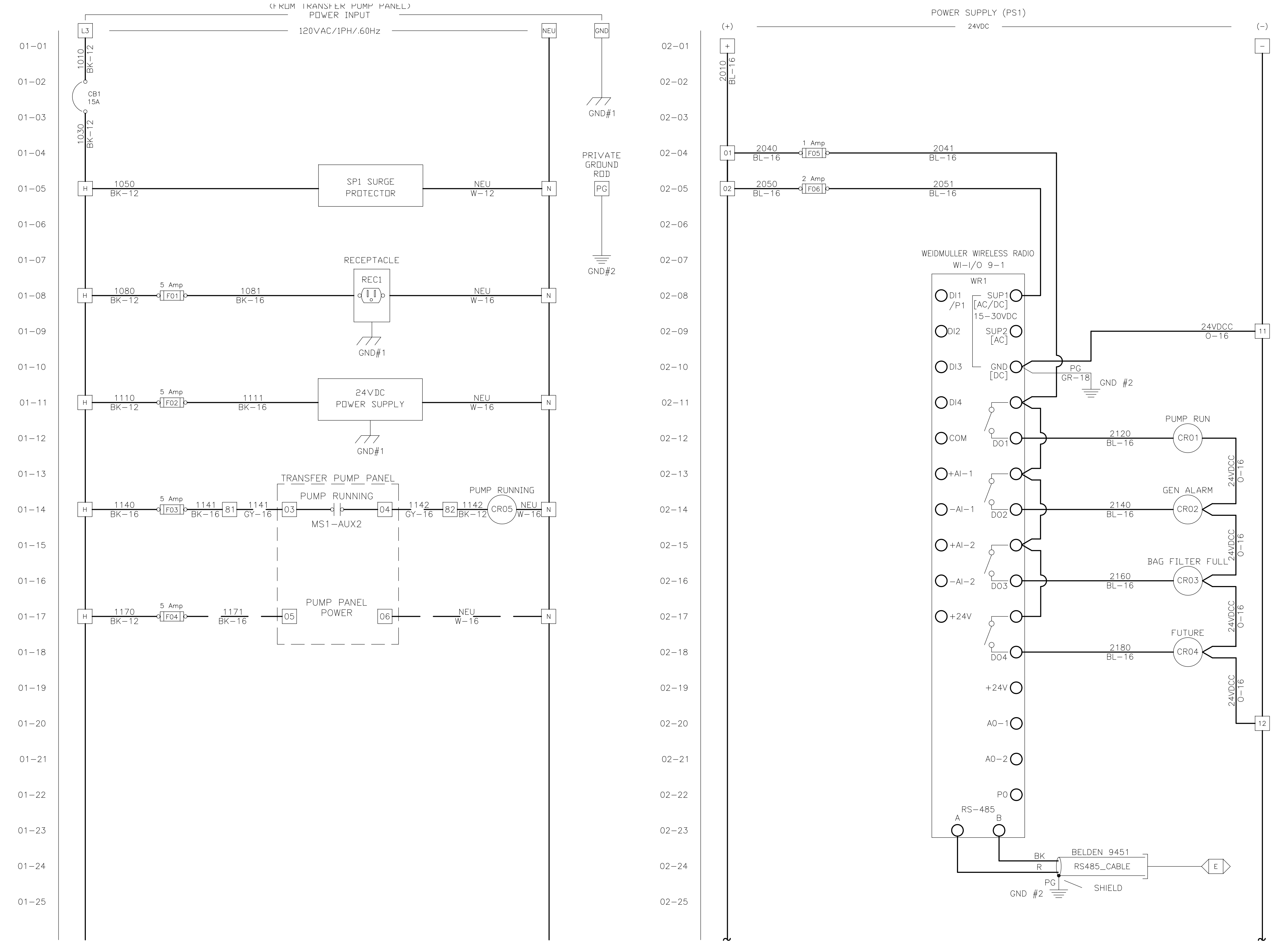
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK BILL OF MATERIALS

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-2
DWG. NO. 2829
SH 6 OF 6



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

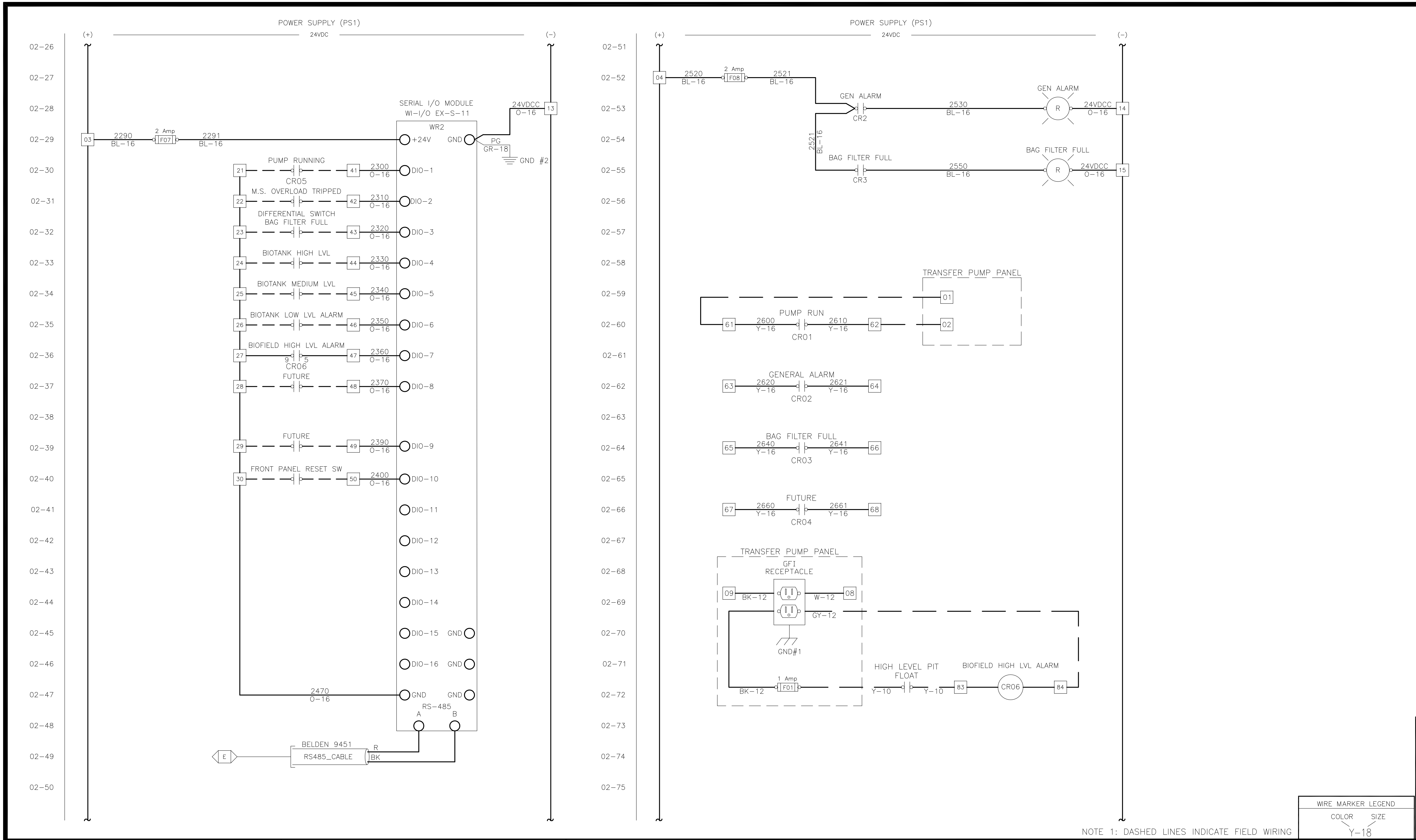
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK WIRING DIAGRAM

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-2

DWG. NO.	SH	OF
3079	1	8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

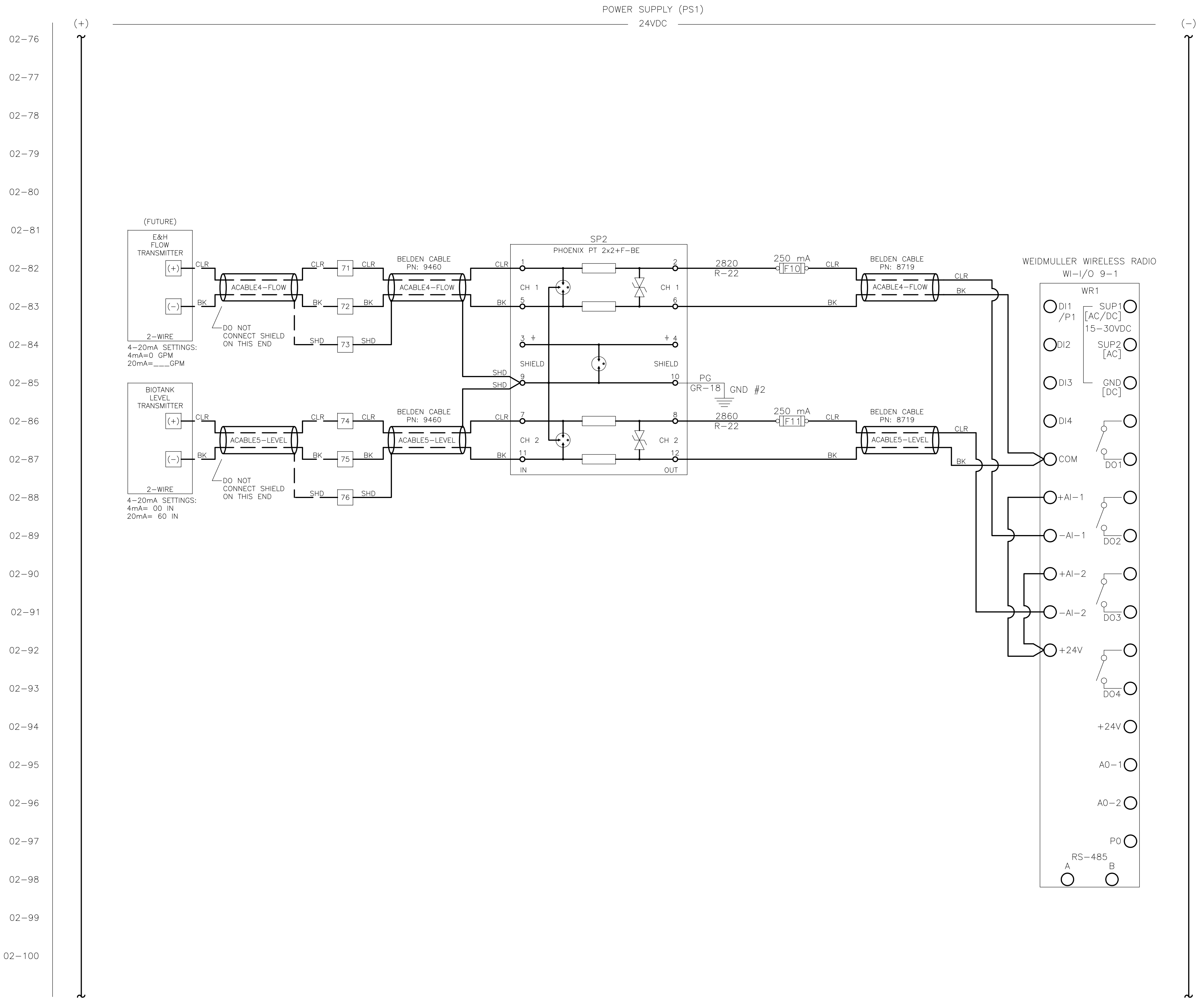
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK WIRING DIAGRAM

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 2
OF 8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y−18

COLOR CODE	
CLR	CLEAR
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GY	GREY
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REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

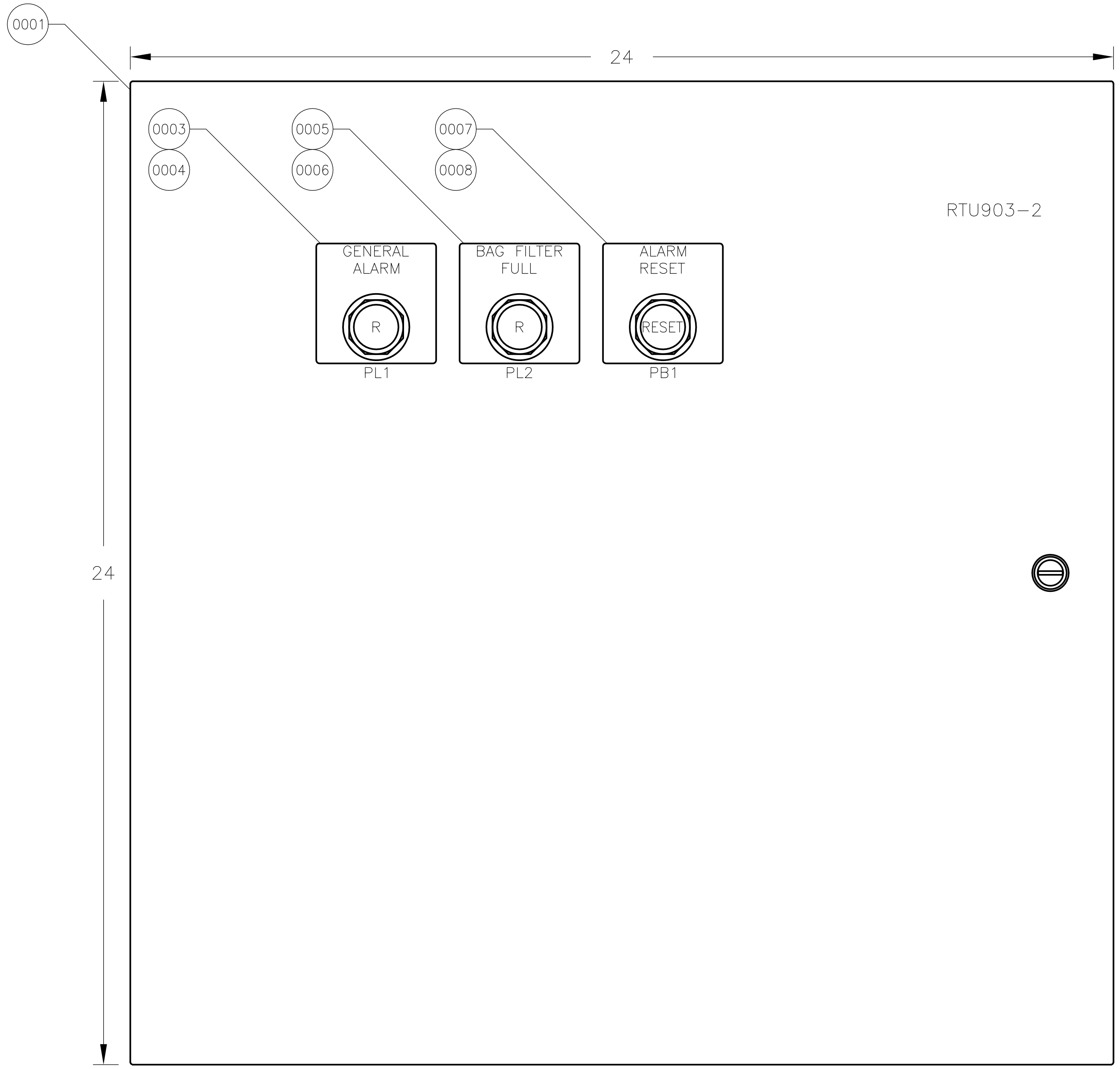
11218 IH−10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661−9901

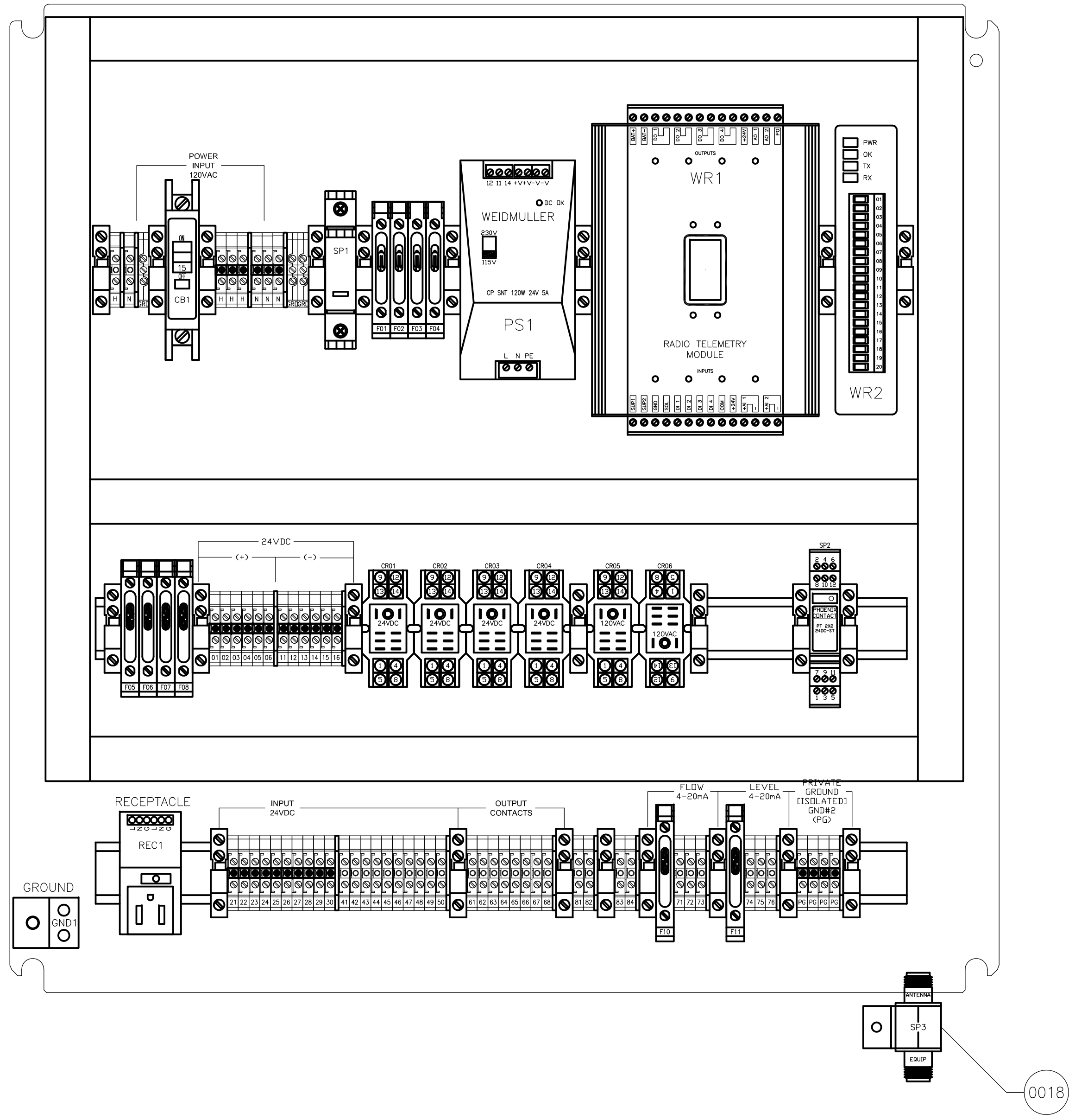
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903−2
PROCESS TANK WIRING DIAGRAM

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903−2
DWG. NO. 3079
SH 3
OF 8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

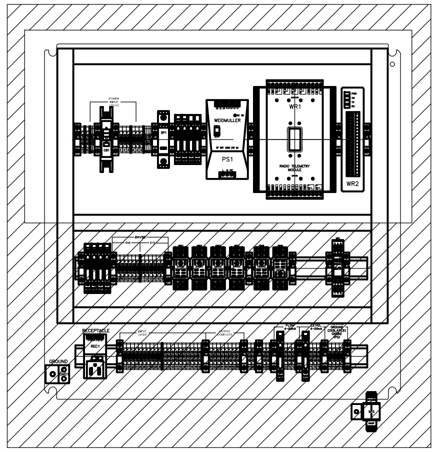
ENGINEER

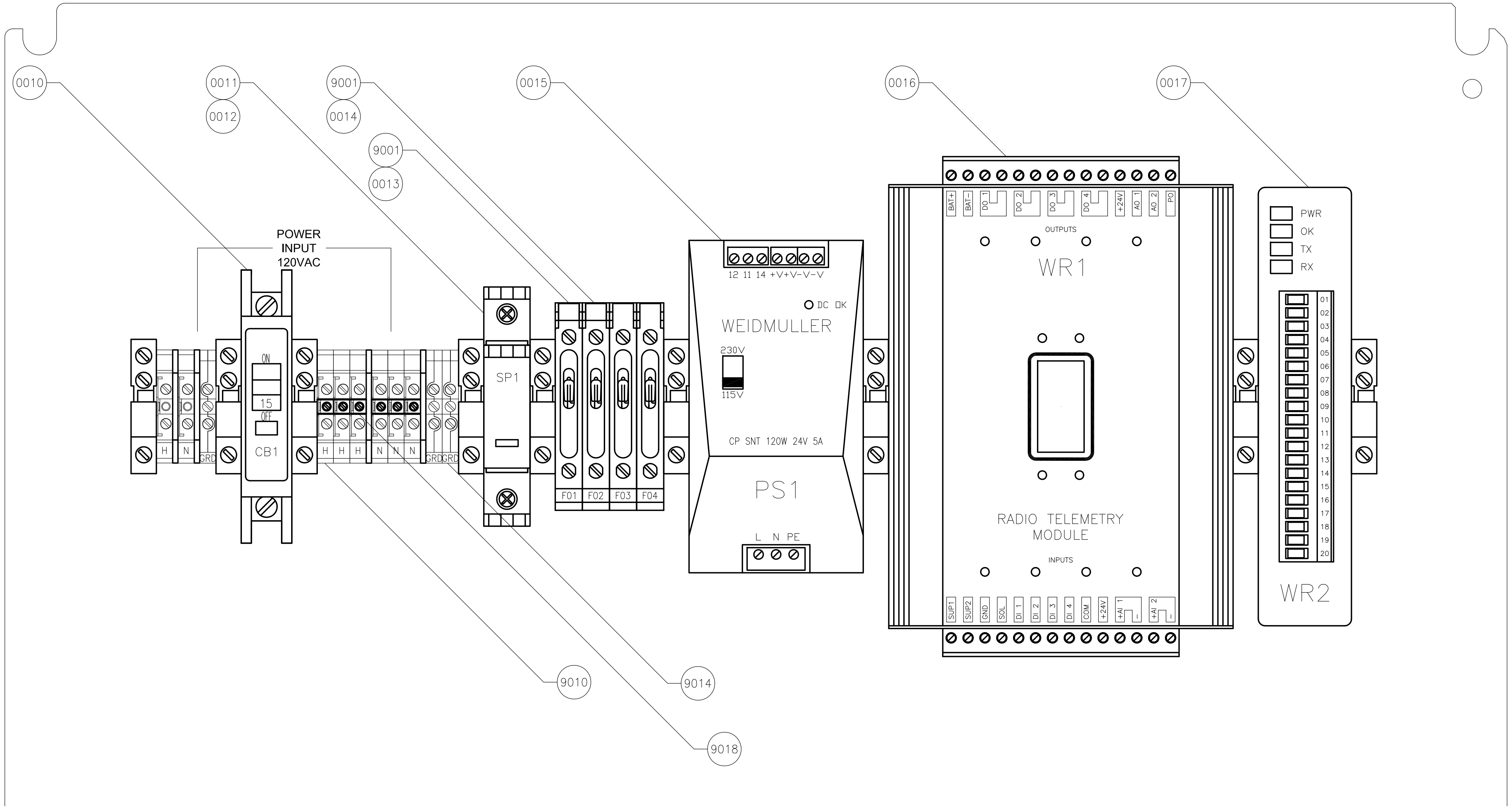
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK FRONT PANEL
& BACK PANEL LAYOUT

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-2

DWG. NO.	SH	OF
3079	4	8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

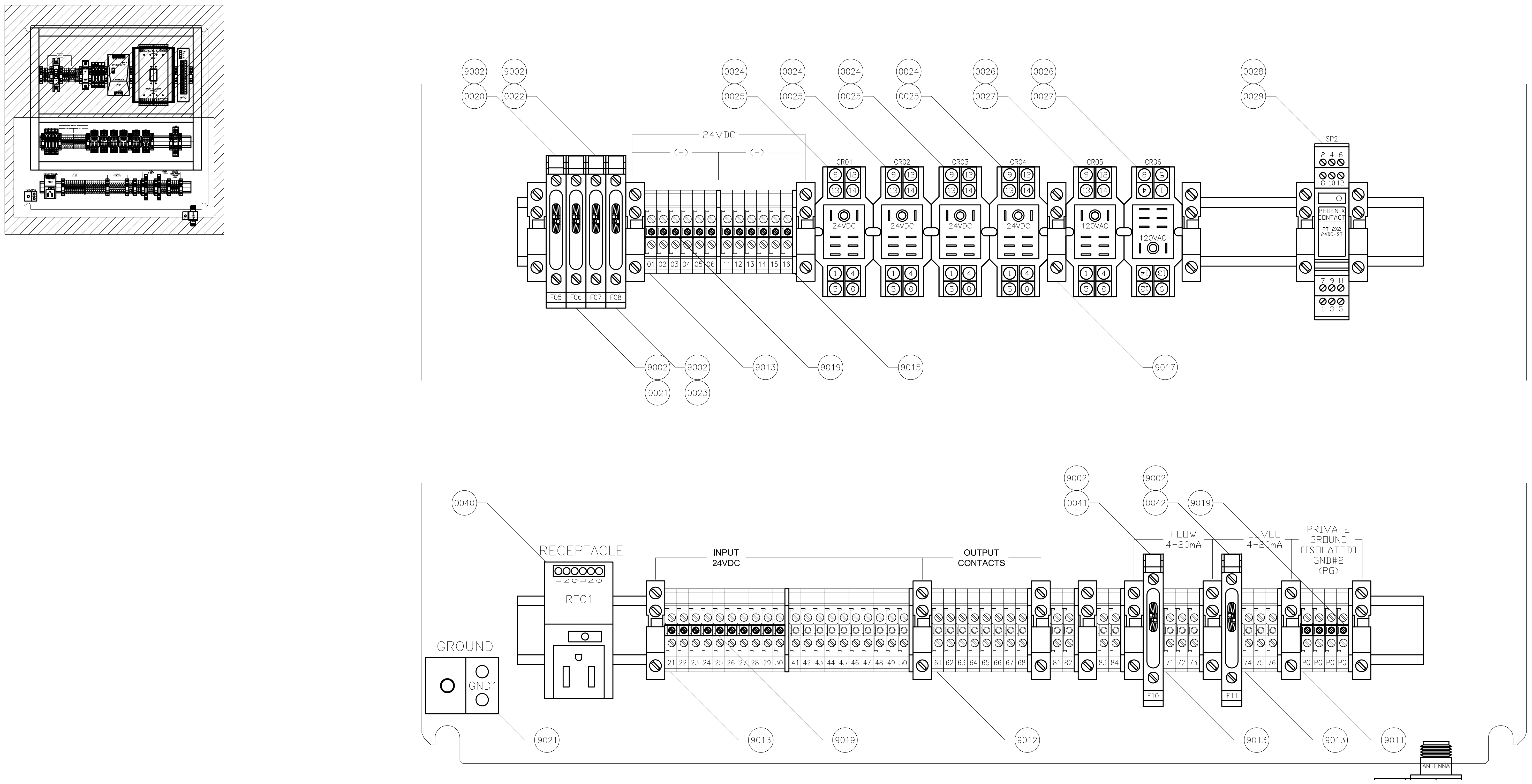
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK PARTS LAYOUT

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 5
OF 8



REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK PARTS LAYOUT

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 6
OF 8

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-2	1	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	CSD242410SS	HOFFMAN
0002	RTU903-2	1	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	CP2424	HOFFMAN
0003	PL1	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0004	PL1	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0005	PL2	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0006	PL2	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0007	PB1	1	PUSH BUTTON OPERATOR, METAL, 30.5MM, FLUSH HEAD, BLUE W/WHITE LETTERING, 1-NO / 1-NC	800T-A707WA	AB
0008	PB1	1	PUSH BUTTON LABEL, PLASTIC, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0010	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0011	SP1	1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	PU II 1	WEIDMULLER
0012		1	HOLDER, SURGE PROTECTION	PU II 1S	WEIDMULLER
0013		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0014		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0015	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	CP SNT 120W 24V 5A	WEIDMULLER
0016	WR1	1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WI-I/O 9-1	WEIDMULLER
0017	WR2	1	EXPANSION I/O MODULE, 10.8-30VDC, 16 I/O INPUT/OUTPUTS, DIN RAIL MOUNTING	WI-I/O-EX-S-11	WEIDMULLER
0018	SP3	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0020		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0021		1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	AGC-1	BUSSMANN
0022		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0023		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0024		4	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0025		4	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-DC24V	IDEC
0026		2	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0027		2	RELAY, 2PDT, COIL: 120VAC, 1/6HP, W/INDICATOR	RH2B-ULC-AC120V	IDEC
0028		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0029		1	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PT 2X2-24DC-ST	PHOENIX
0040	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0041		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0042		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		4	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		6	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9010		12	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		6	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9012		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9013		36	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		3	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		14	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		24	END CLAMP, GRAY	E/UK	PHOENIX
9018		2	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9019		4	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

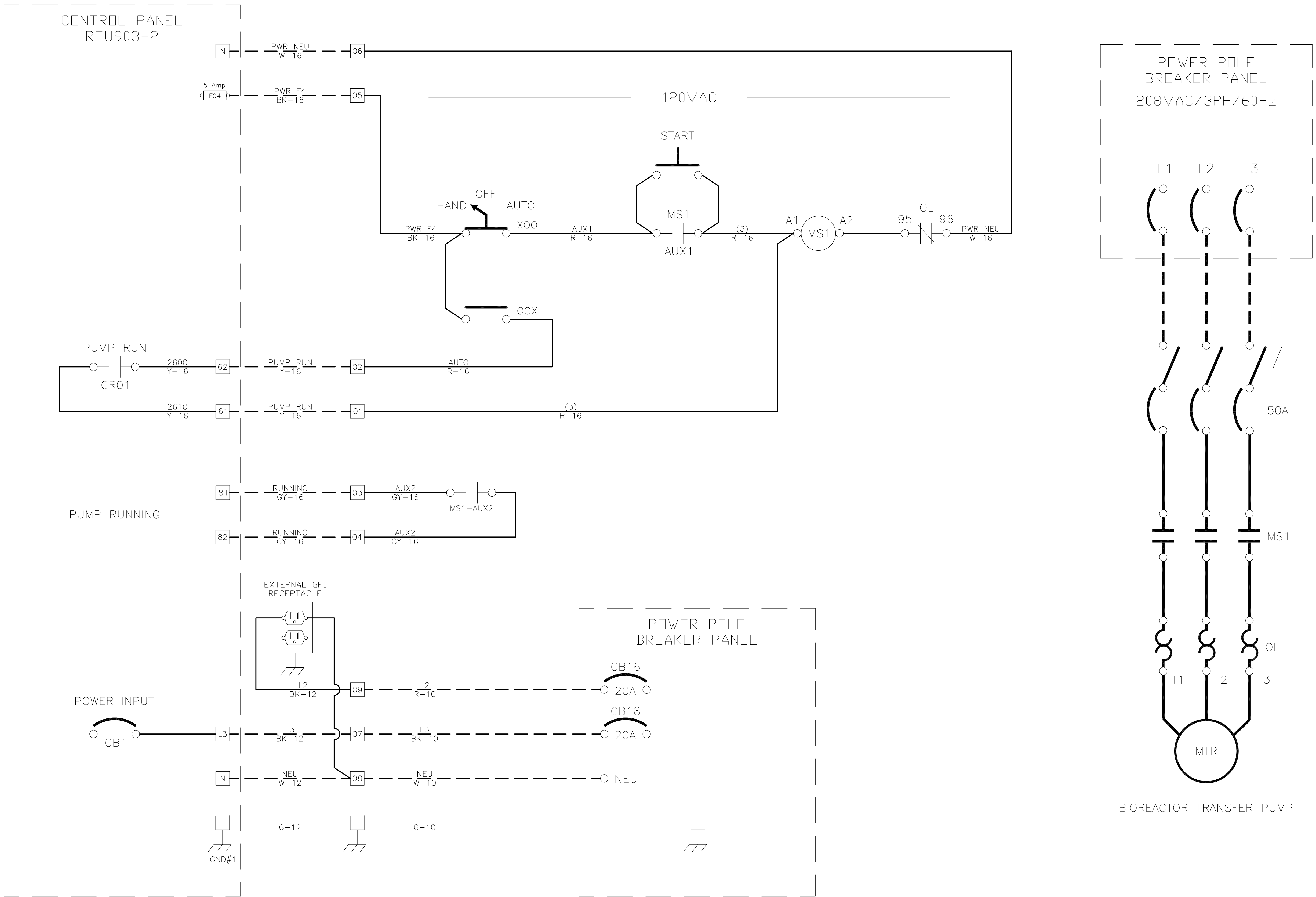
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK BILL OF MATERIALS

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 7
OF 8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

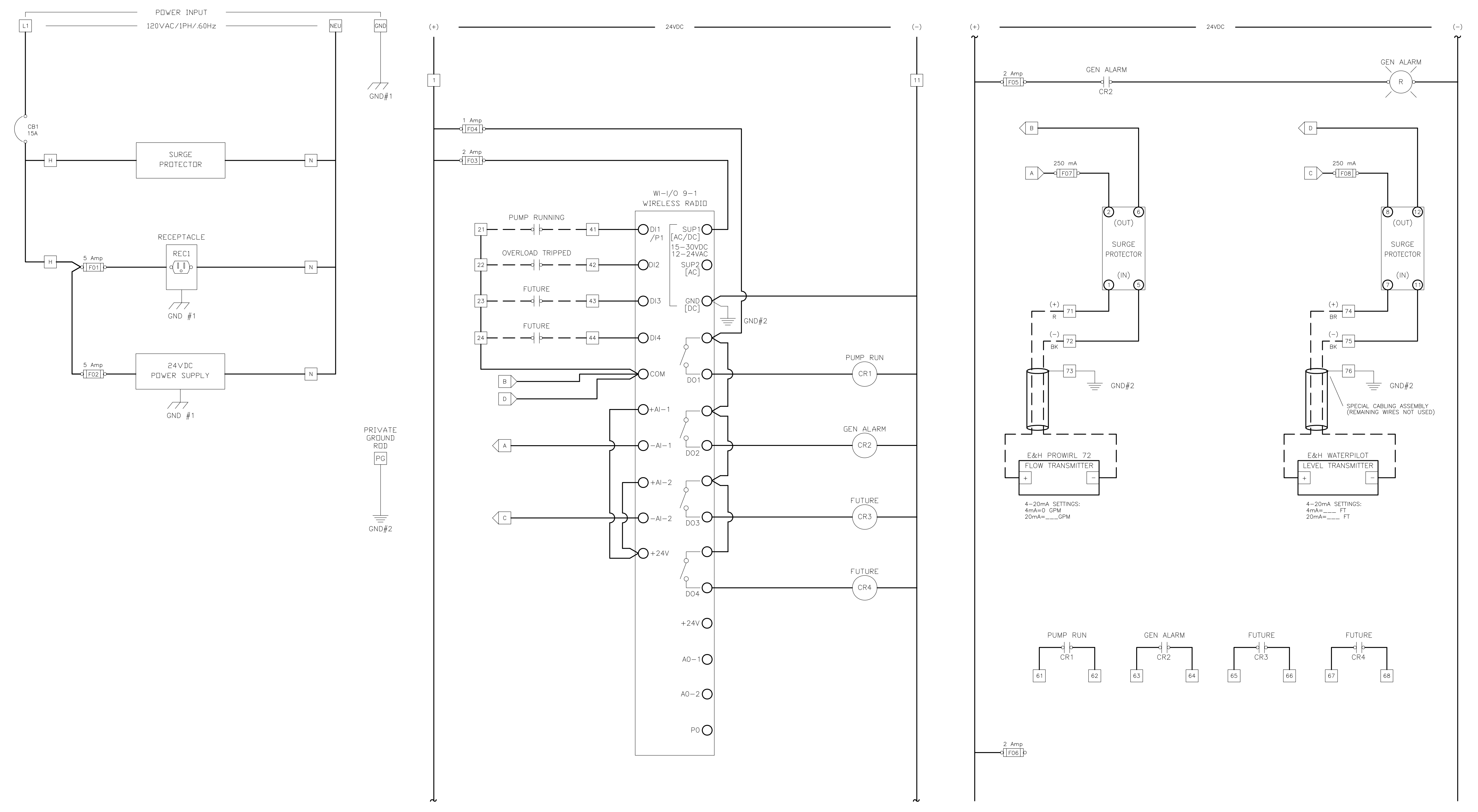
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
TRANSFER PUMP PANEL
FIELD WIRING DIAGRAM

DATE:	4/1/2010
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-2

DWG. NO.	SH	OF
3079	8	8

RTU 903-3: CS-EXW01



REV #	DATE	REVISION

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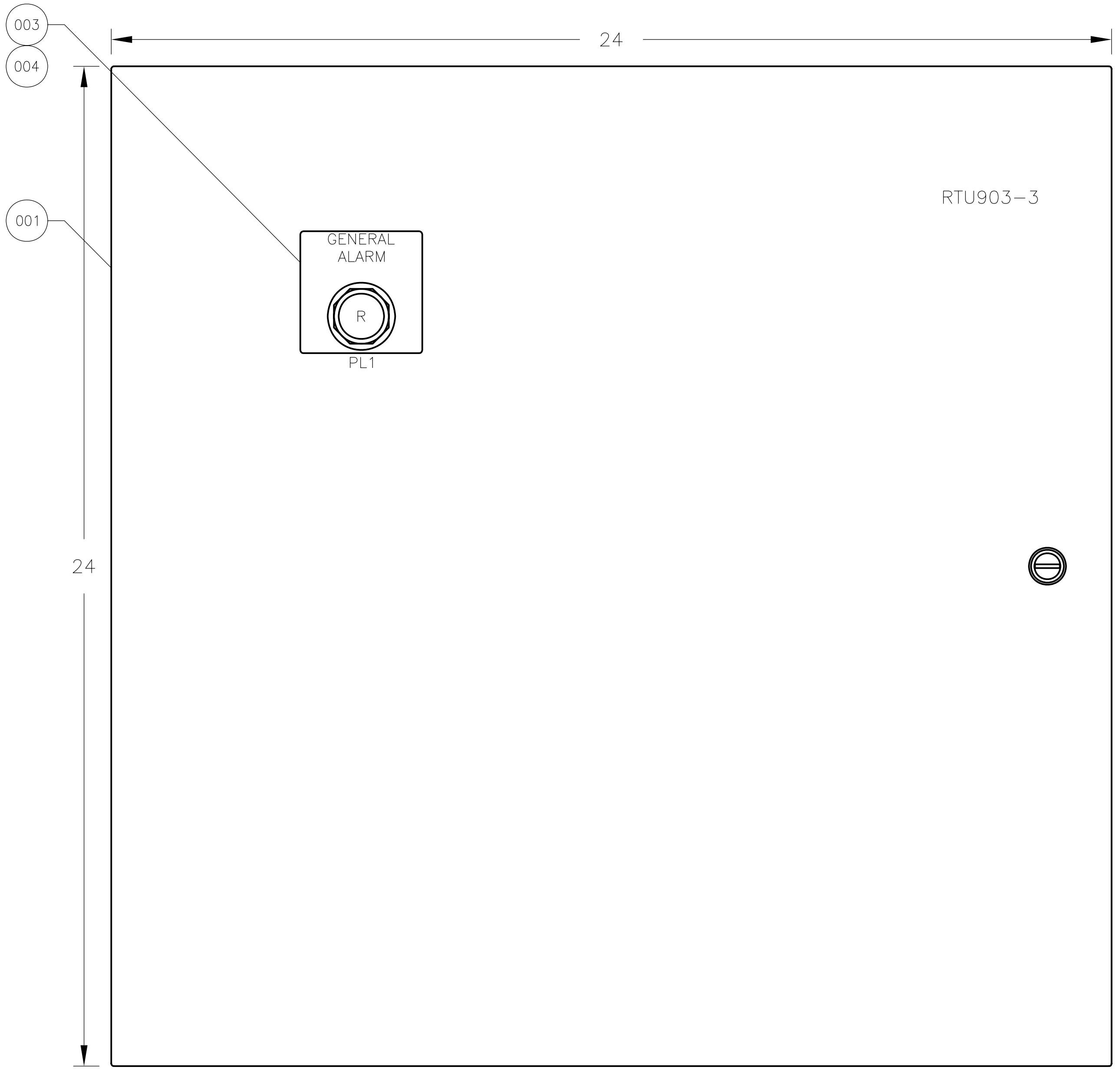
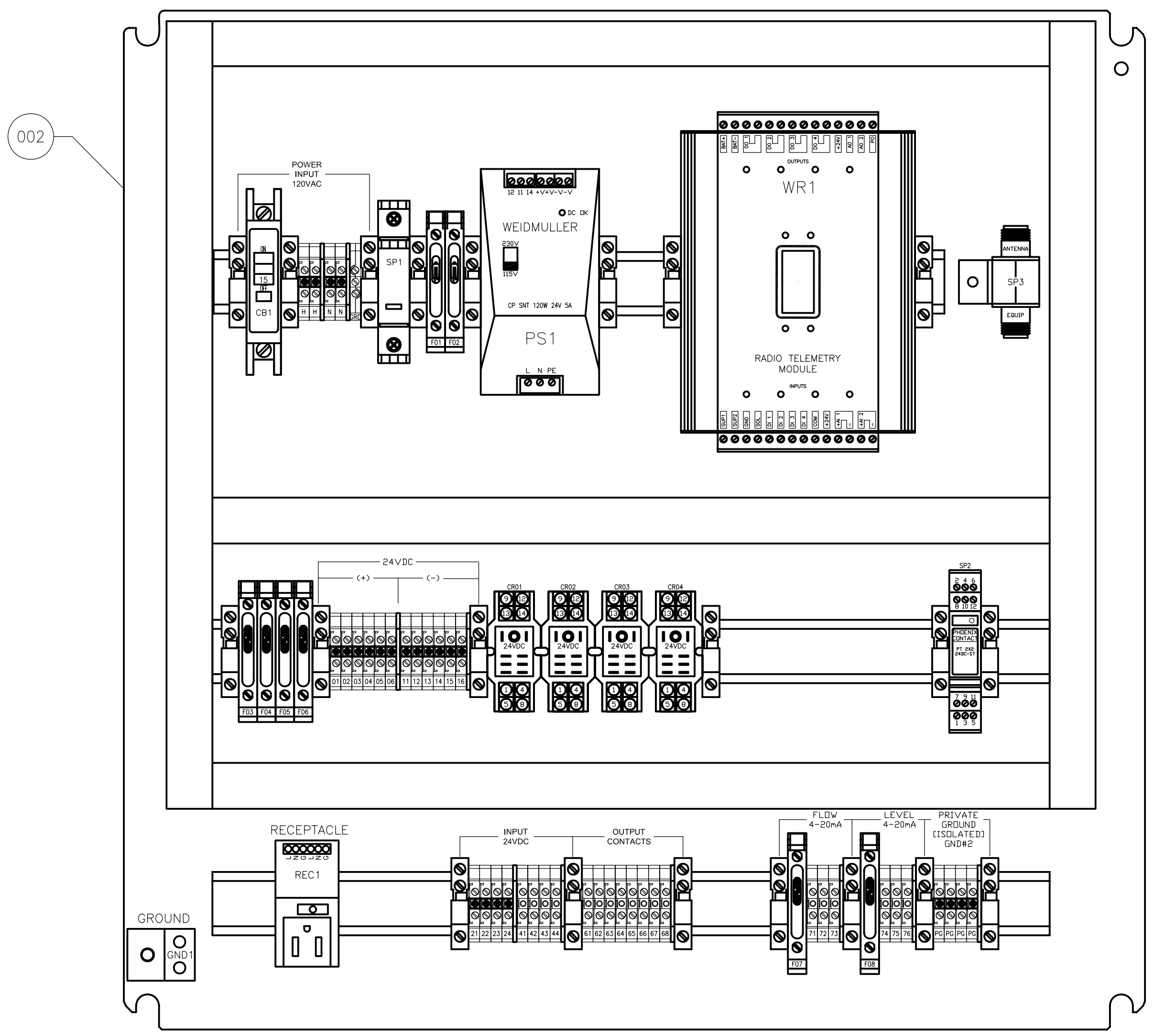
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 WIRING DIAGRAM

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-3
DWG. NO. 2829
SH 1 OF 5





REV #	DATE	REVISION

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11218 IH-10 EAST
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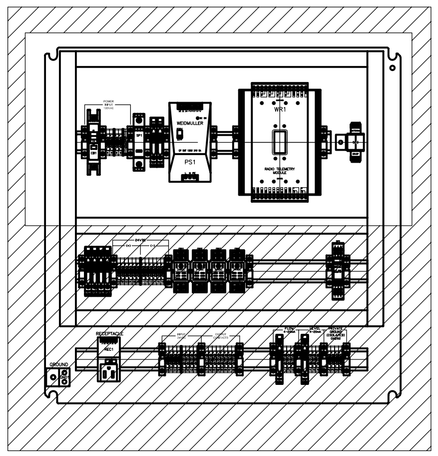
PHONE (210) 661-9901

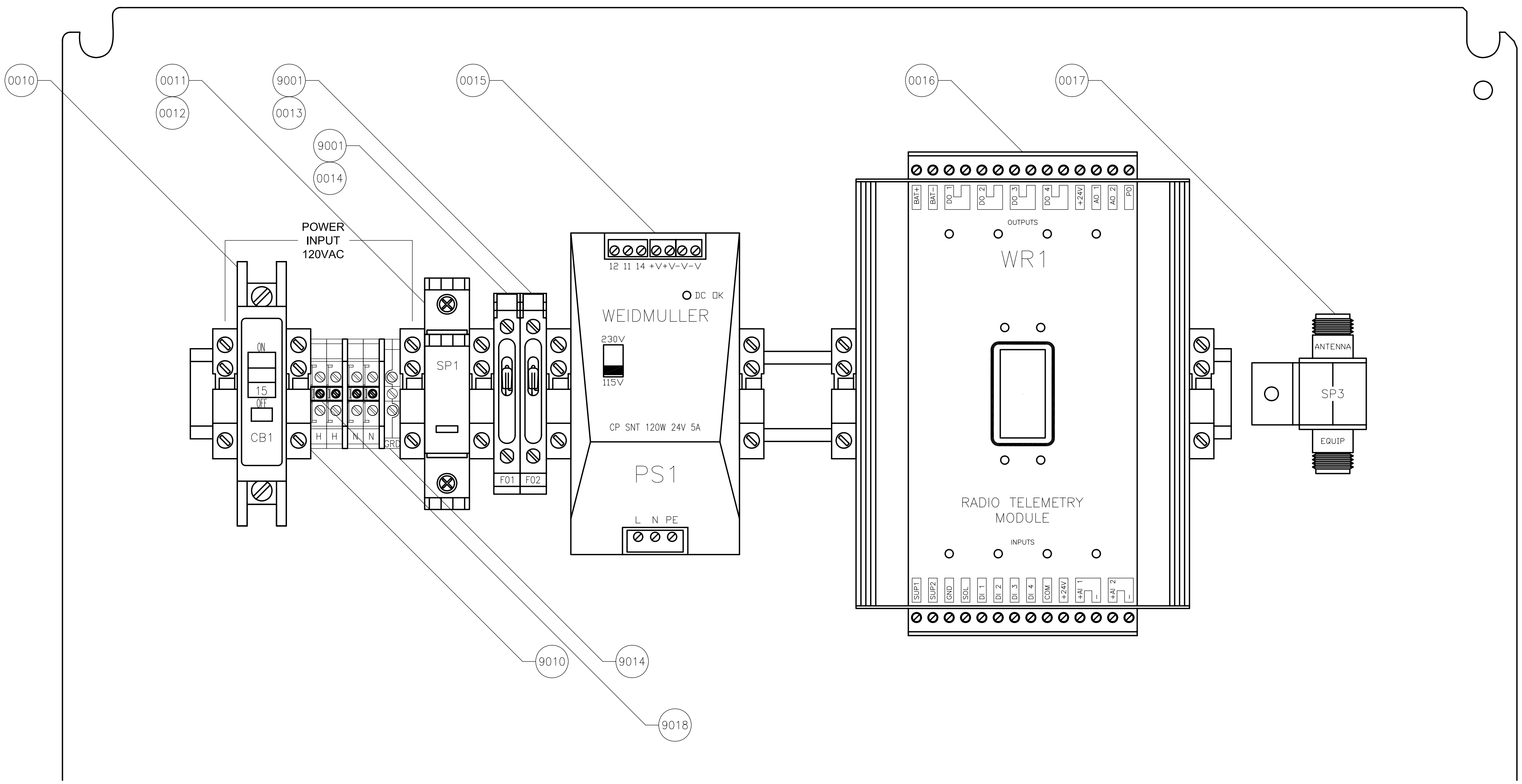
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 BACK PANEL LAYOUT

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	2
OF	5





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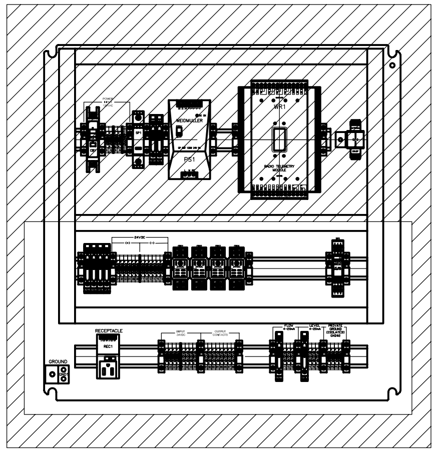
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

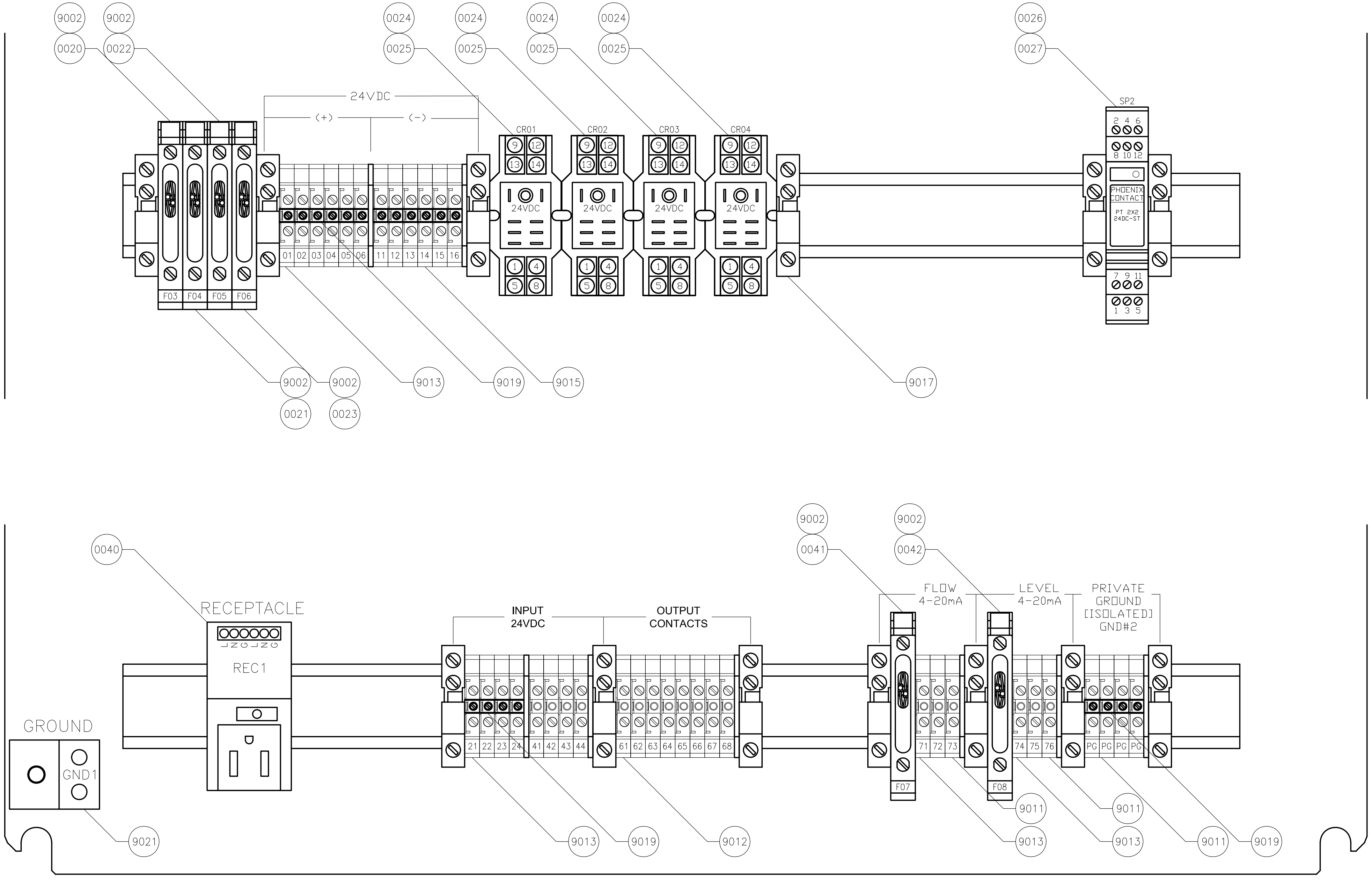
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 PARTS LAYOUT

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	3
OF	5





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 PARTS LAYOUT

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	4
OF	5

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-3	1	CSD242410SS	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	HOFFMAN	
0002	RTU903-3	1	CP2424	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	HOFFMAN	
0003	PL1	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0004	PL1	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0010	CB1	1	QOU115	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0011		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0012	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0013		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0014		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0015	PS1	1	CP SNT 120W 24V 5A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	WEIDMULLER	
0016	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	8708670000
0017	SP3	1	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021		1	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0024		4	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0025		4	RH2B-ULC-DC24V	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0026		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0027		1	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0040	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0041		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0042		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		2	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		6	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		4	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		6	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9012		8	UK 5 N YE	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	PHOENIX	3003952
9013		24	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		10	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		21	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9018		2	FBI 2-6	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	PHOENIX	0203438
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

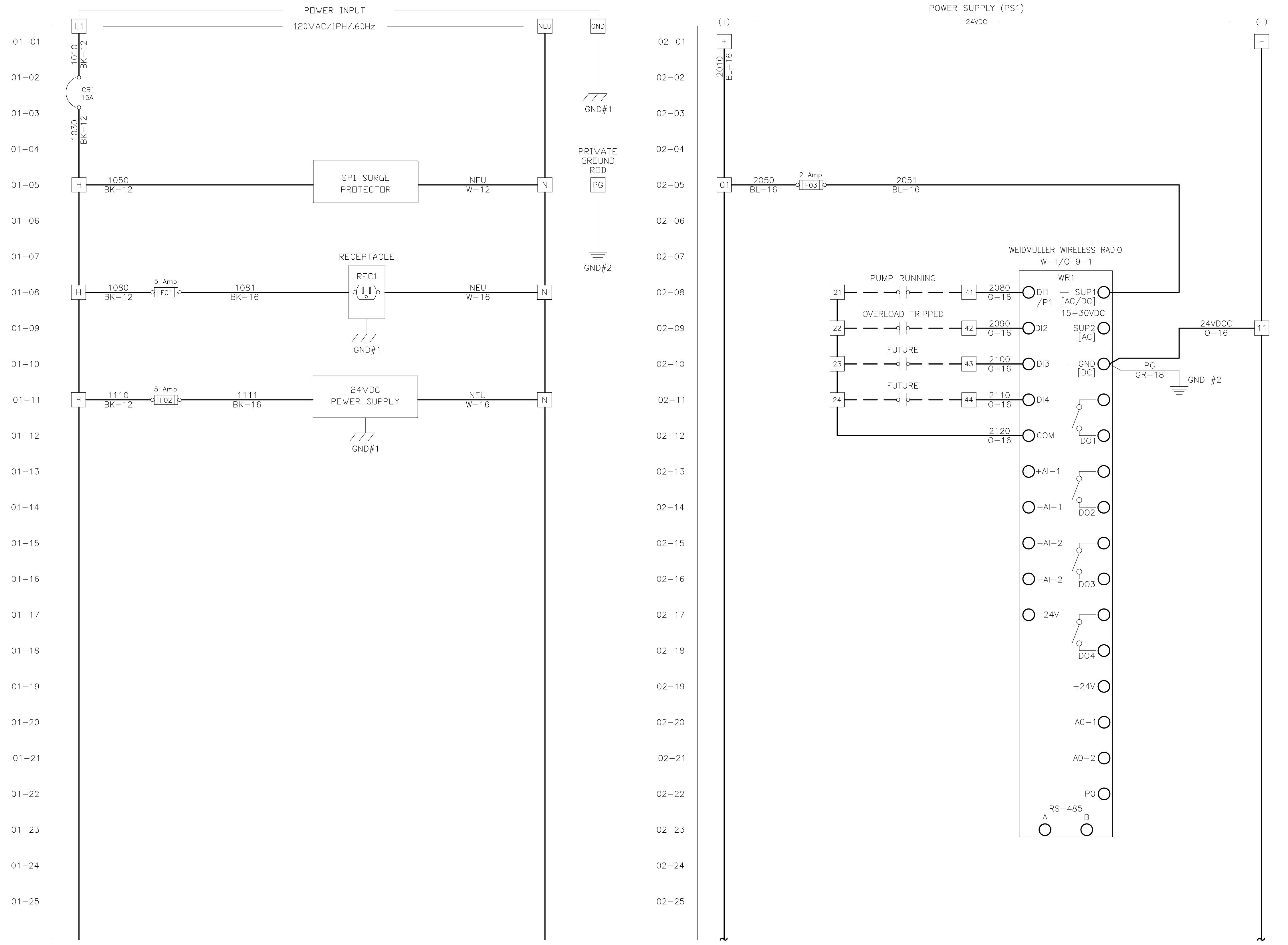
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 BILL OF MATERIALS

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	5
OF	5



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

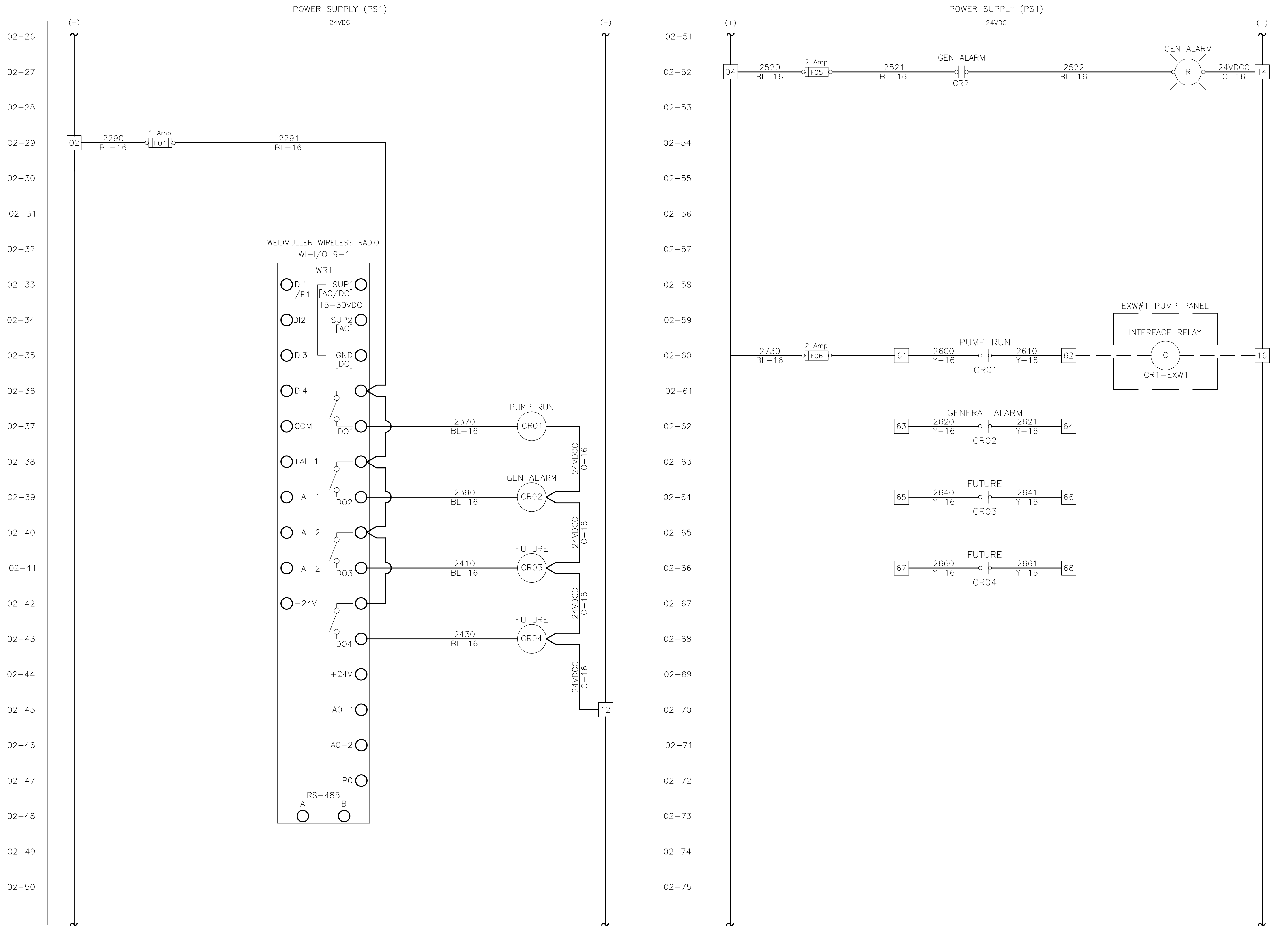
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL FOR
EXTRACTION WELL #1

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-3

DWG. NO.	SH	OF
3079	1	8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

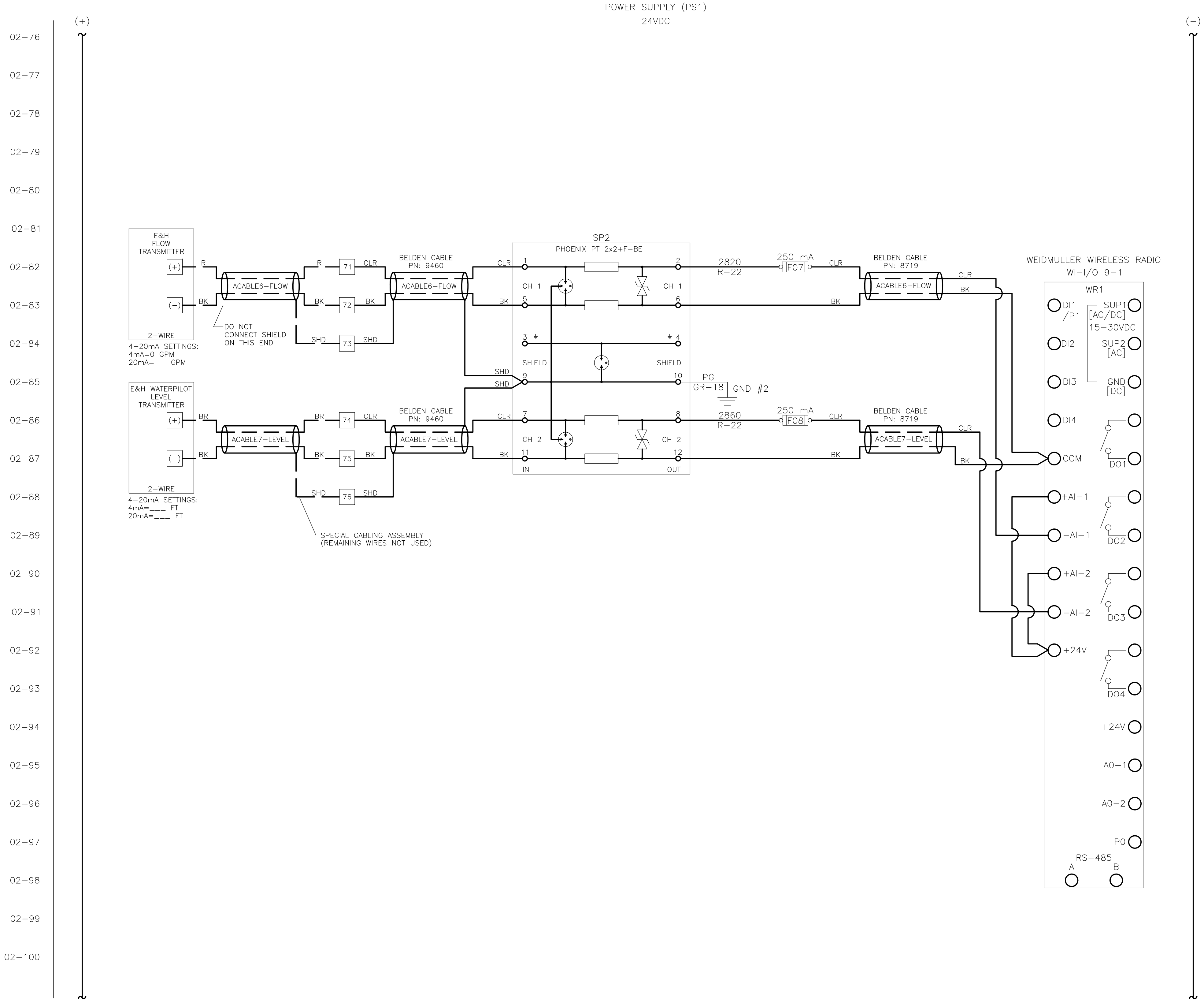
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL FOR
EXTRACCTION WELL #1

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 2 OF 8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y−18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
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REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

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CONVERSE, TEXAS 78109
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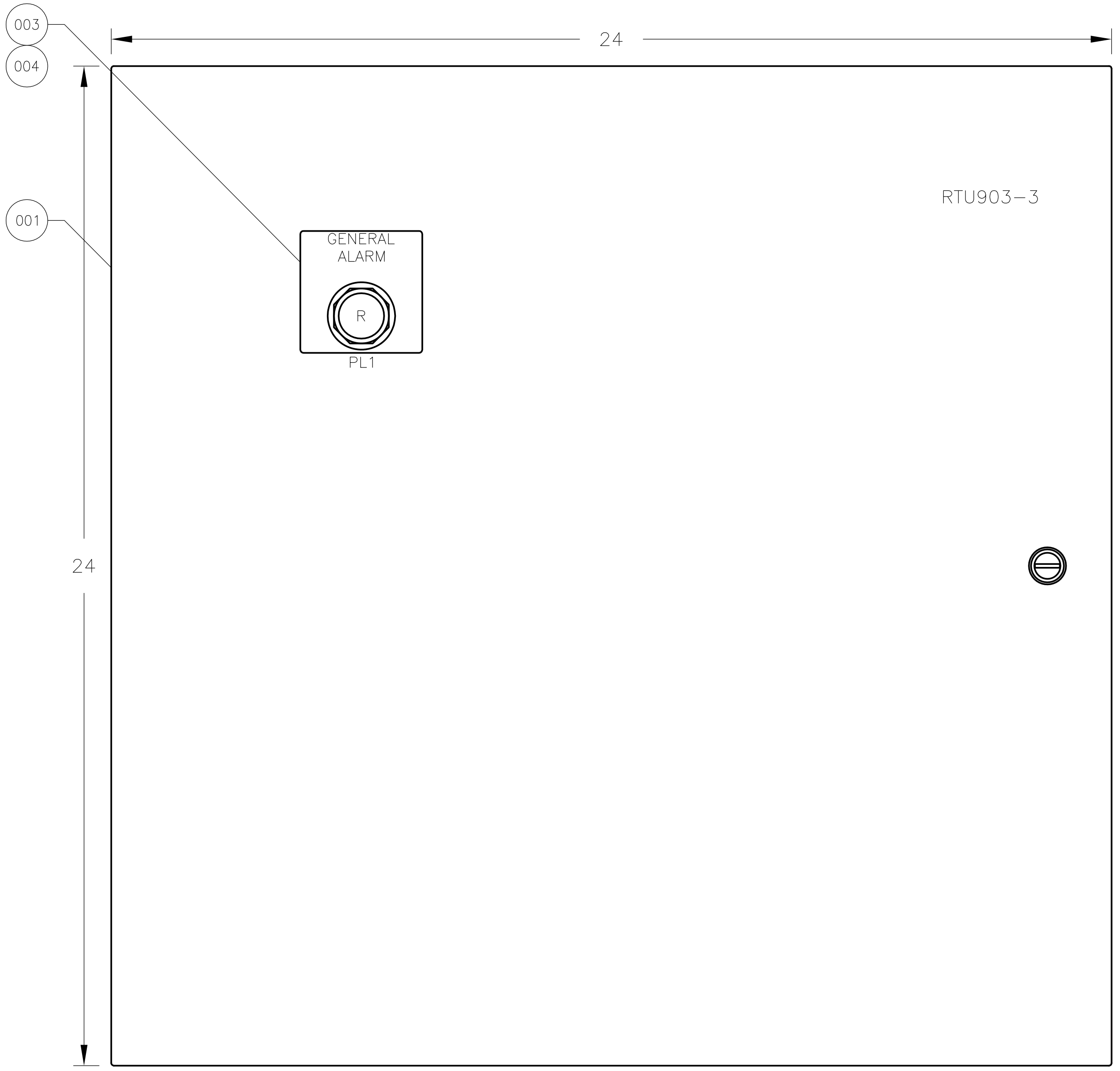
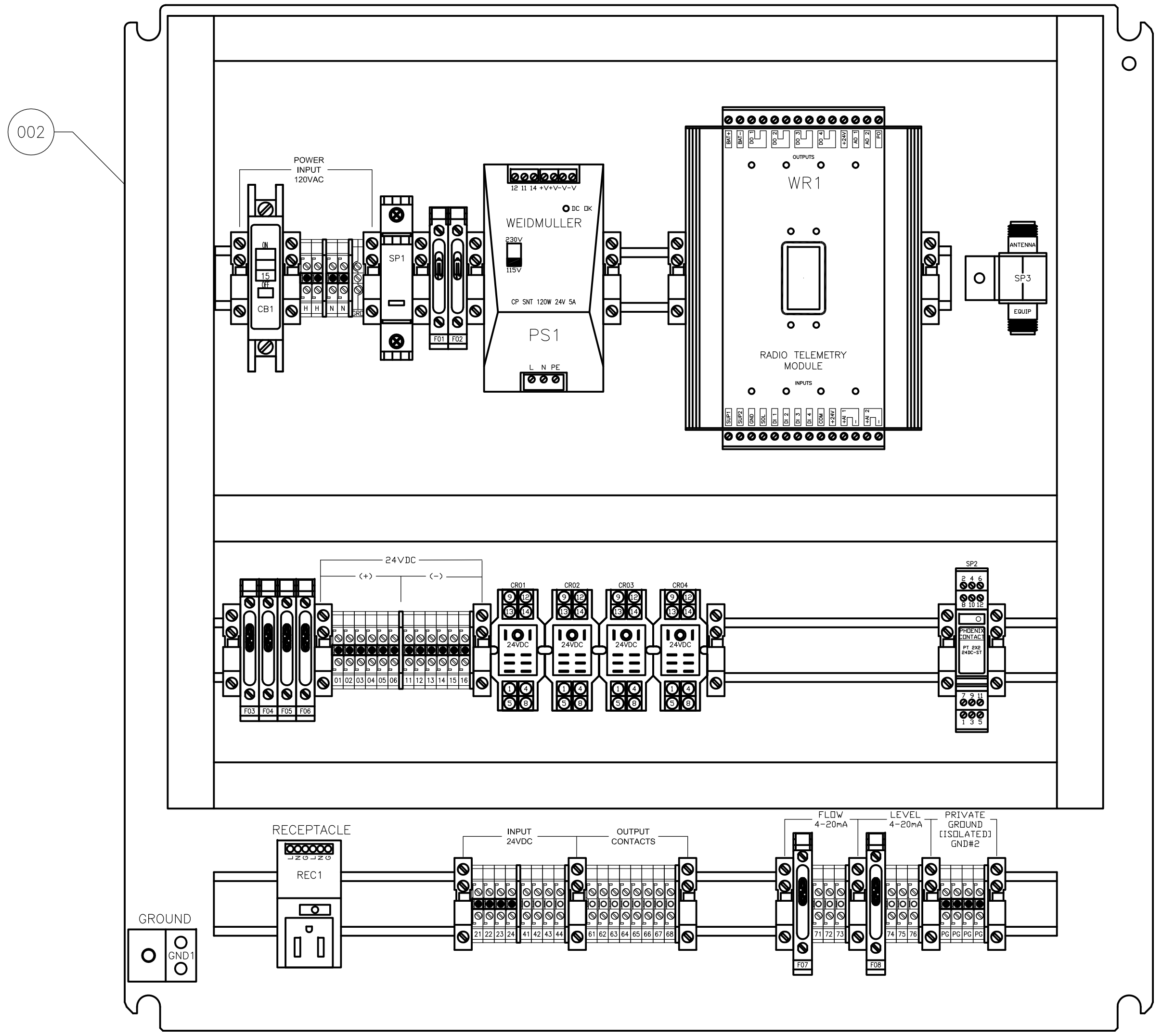
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903−3
CONTROL PANEL FOR
EXTRACTION WELL #1

DATE: *8/10/2009*
SCALE: *N/A*
DRAWN BY: *RMF*
CAD FILE *SCI3079_RTU903−3*
DWG. NO. *3079*
SH *3*
OF *8*





REV # | DATE | REVISION

SYSTEM CONTROLS & INSTRUMENTATION

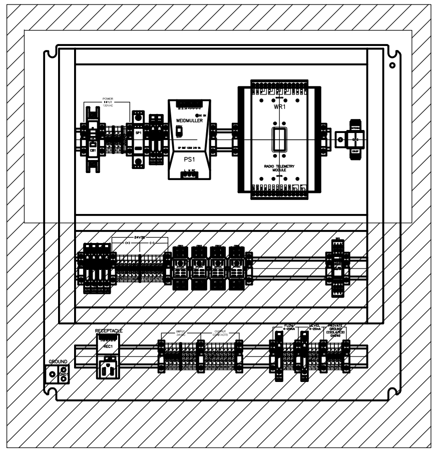
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

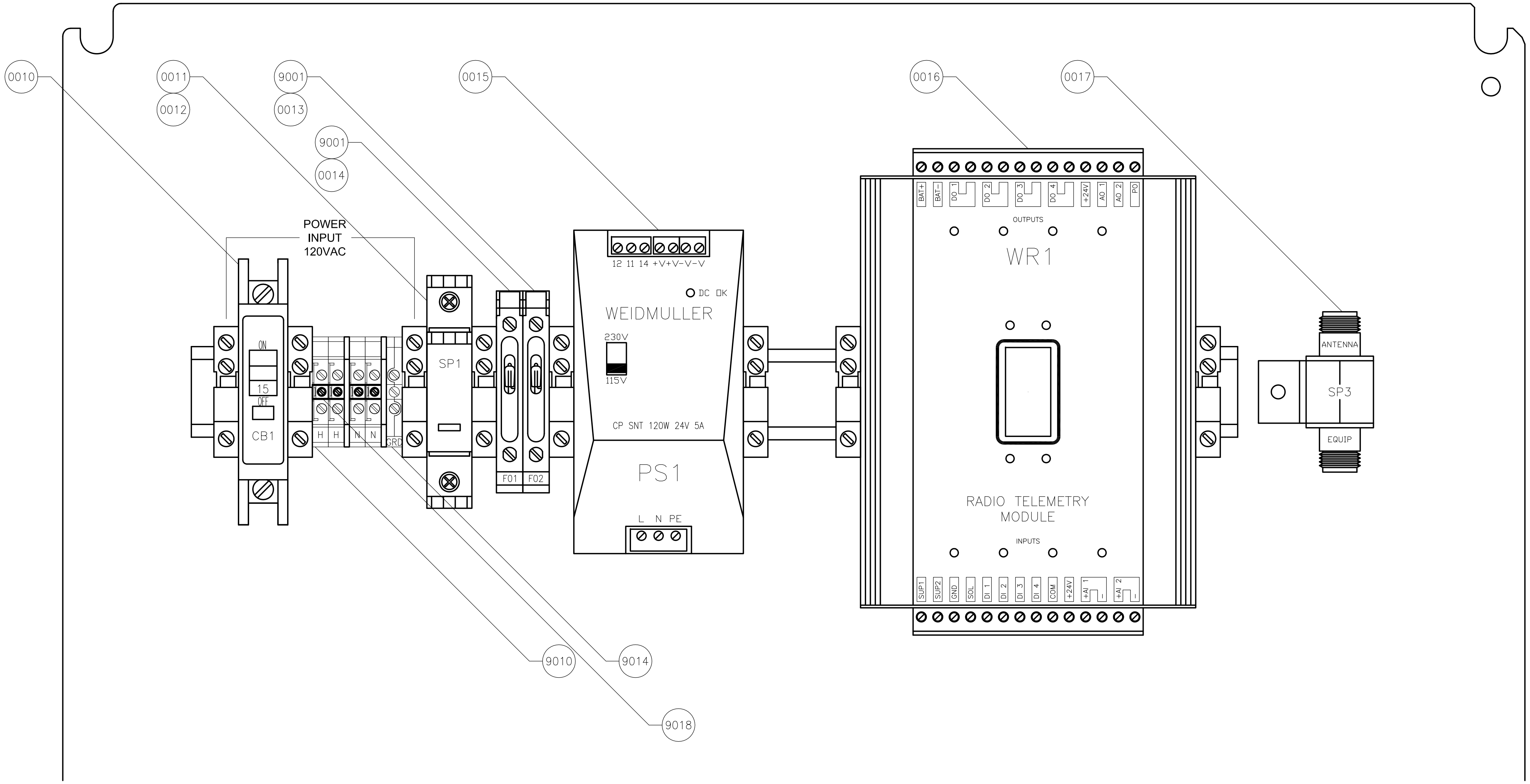
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL BACK PANEL
FOR EXTRACTION WELL #1

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 4
OF 8





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SYSTEM CONTROLS & INSTRUMENTATION

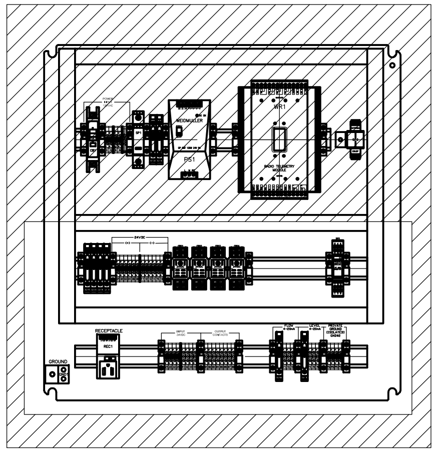
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

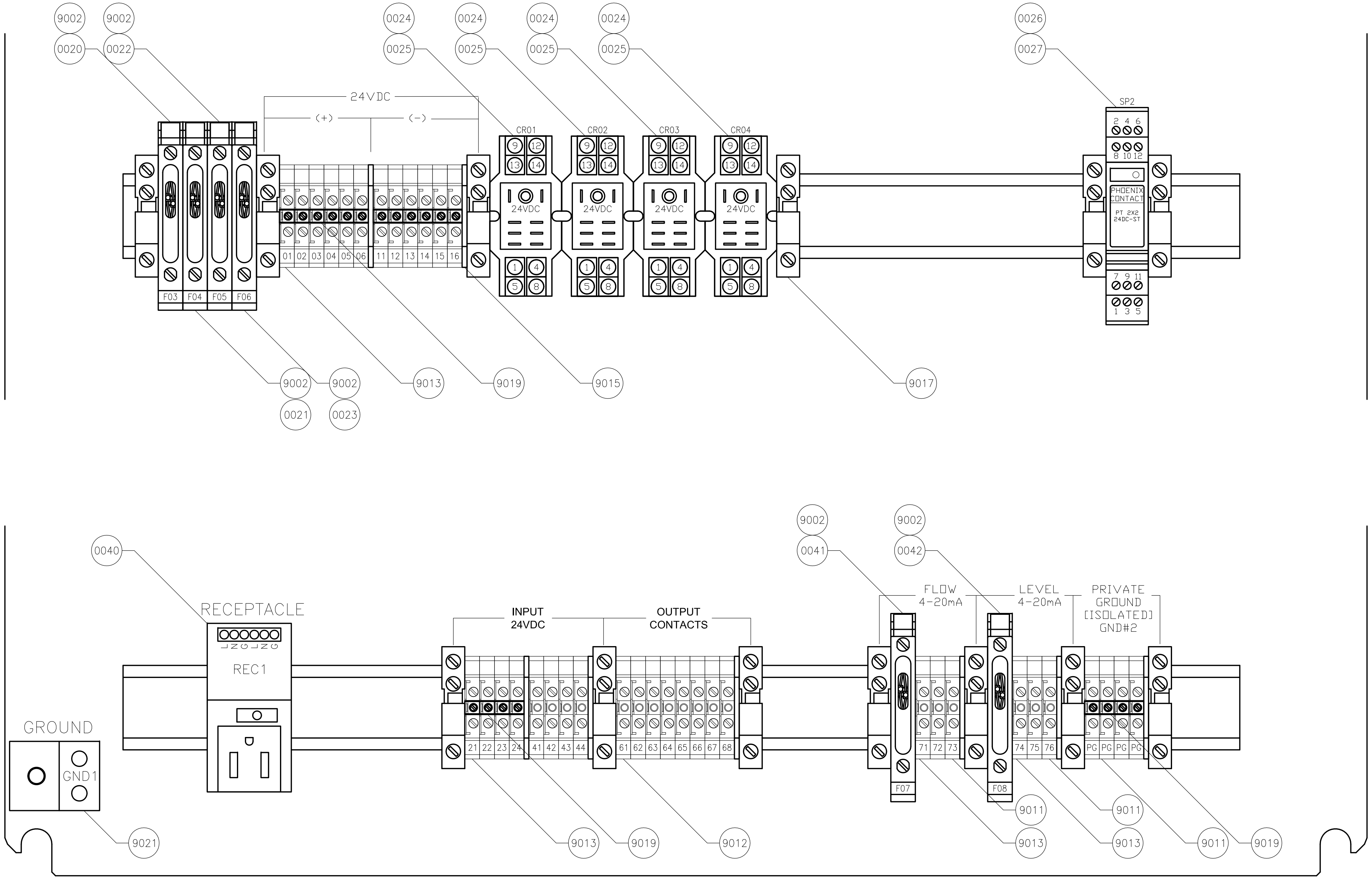
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL PARTS LAYOUT
EXTRACTION WELL #1

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 5
OF 8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL PARTS LAYOUT
EXTRACTION WELL #1

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 6 OF 8

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-3	1	CSD242410SS	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	HOFFMAN	
0002	RTU903-3	1	CP2424	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	HOFFMAN	
0003	PL1	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0004	PL1	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0010	CB1	1	QOU115	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0011		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0012	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0013		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0014		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0015	PS1	1	CP SNT 120W 24V 5A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	WEIDMULLER	
0016	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	8708670000
0017	SP3	1	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021		1	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0024		4	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0025		4	RH2B-ULC-DC24V	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0026		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0027		1	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0040	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0041		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0042		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		2	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		6	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		4	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		6	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9012		8	UK 5 N YE	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	PHOENIX	3003952
9013		24	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		10	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		21	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9018		2	FBI 2-6	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	PHOENIX	0203438
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

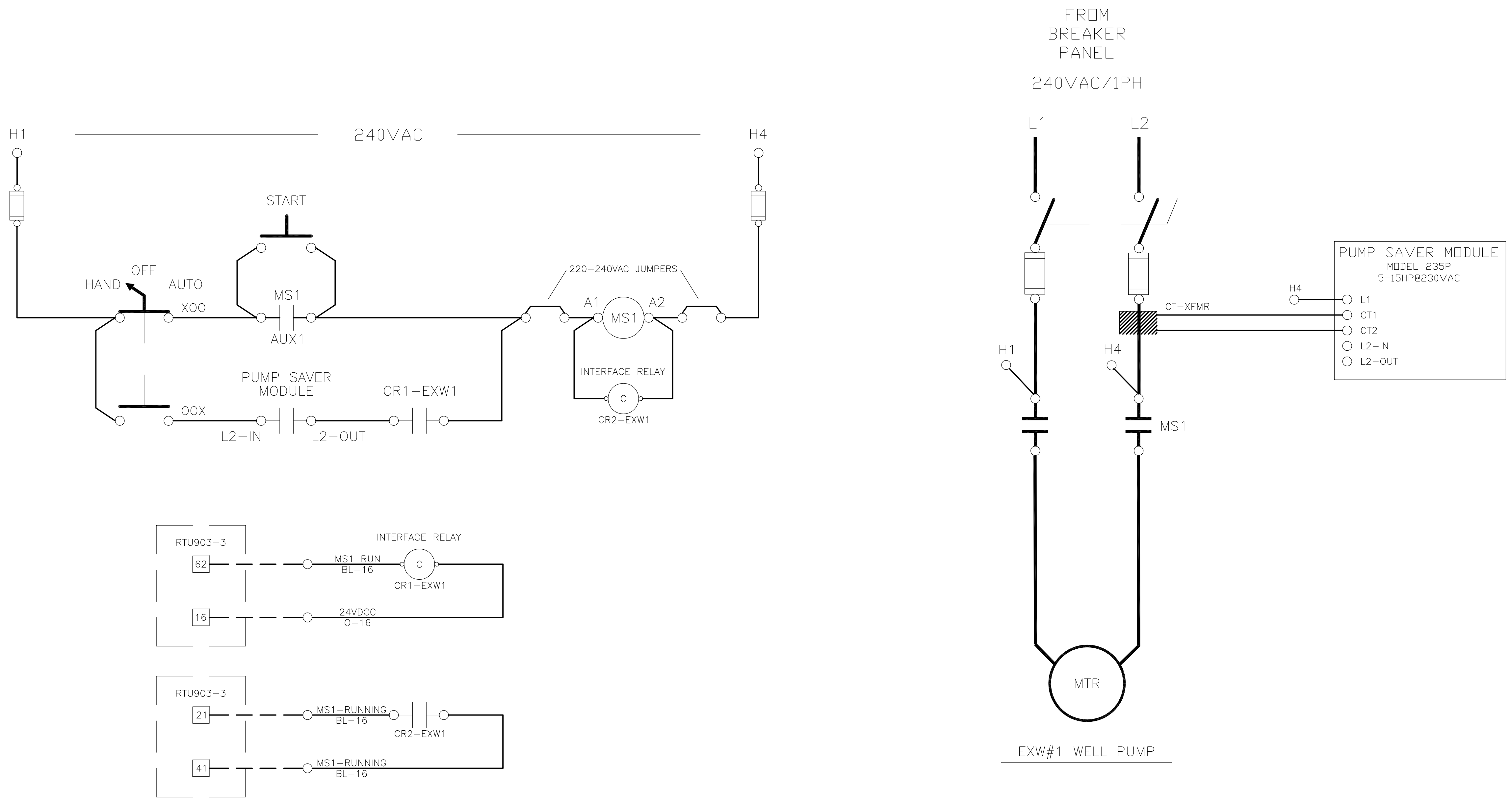
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL BILL OF MATERIALS
FOR EXTRACTION WELL #1

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 7
OF 8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

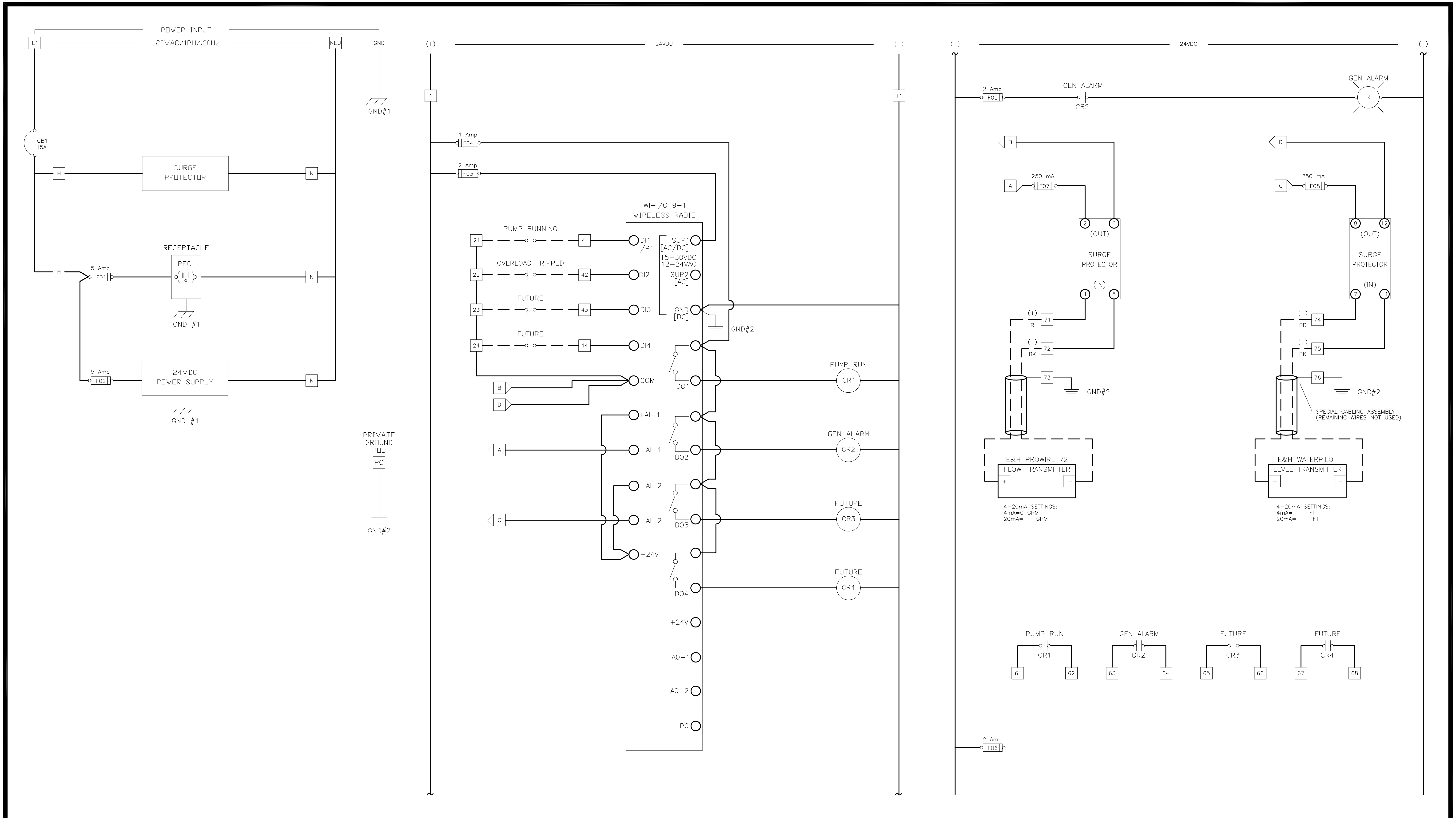
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
PUMP CONTROL PANEL
FIELD WIRING DIAGRAM
FOR EXTRACTION WELL #1

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 8
OF 8

RTU 903-4: CS-EXW02



REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

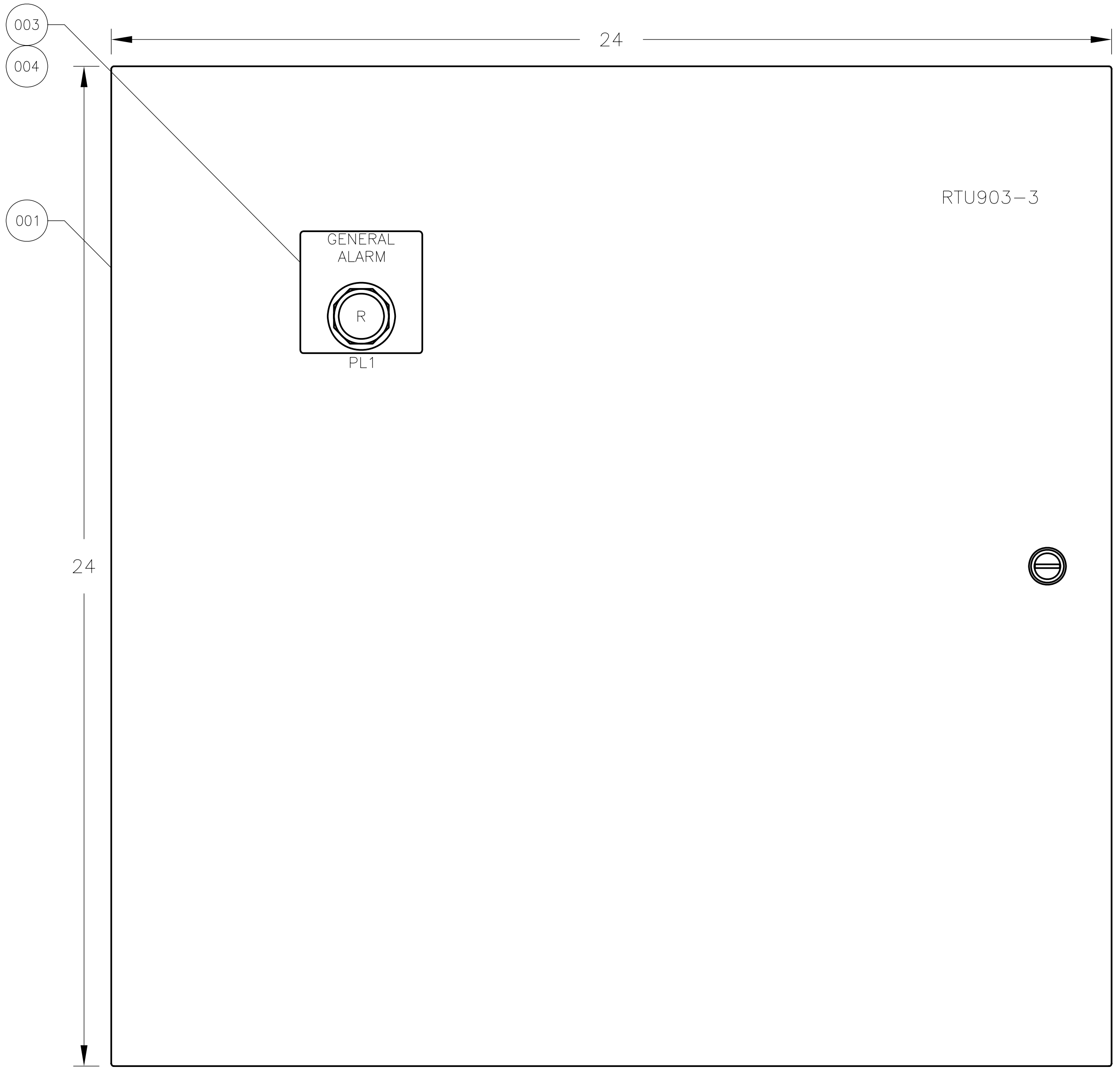
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

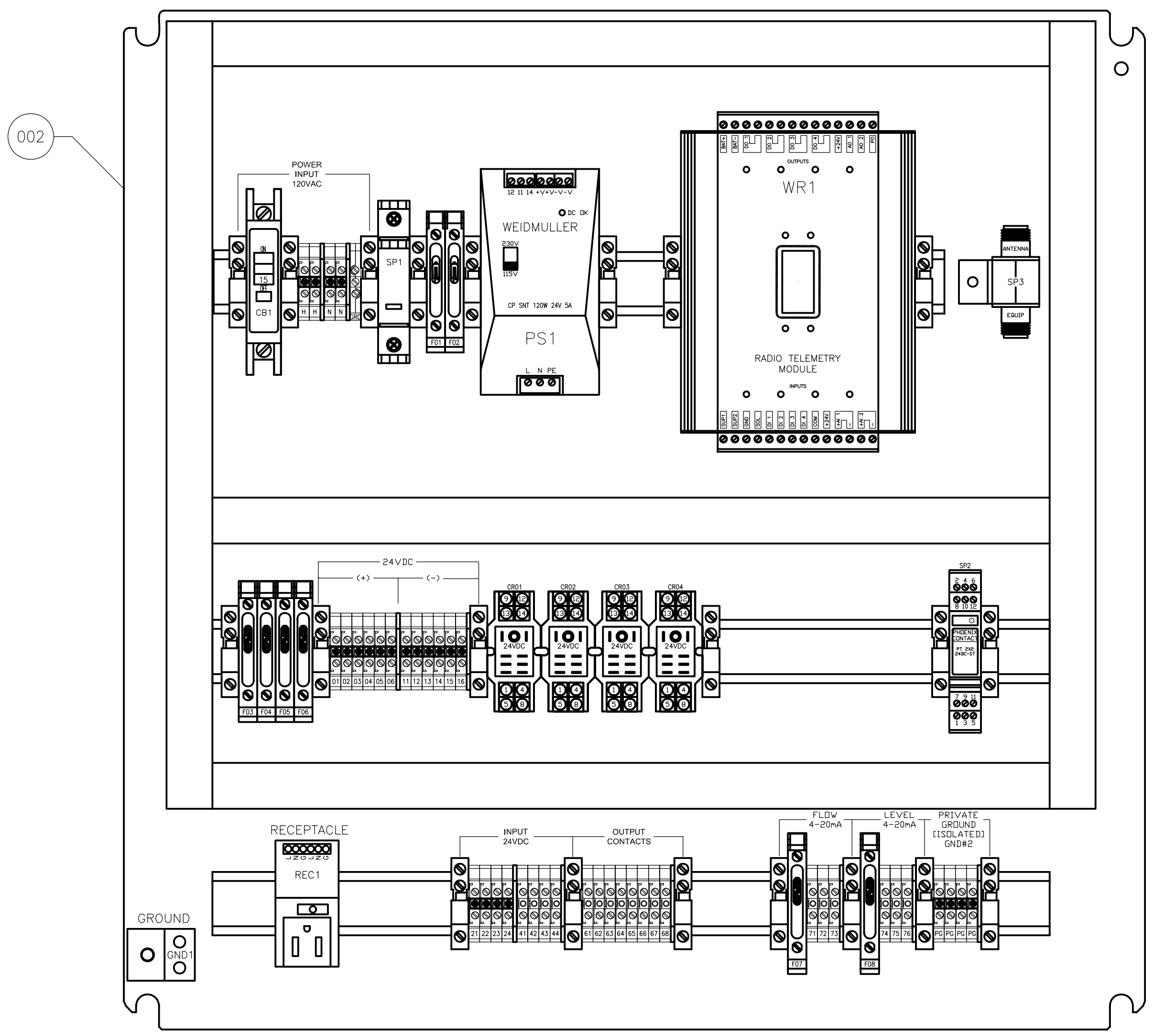
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 WIRING DIAGRAM

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	1
OF	5





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

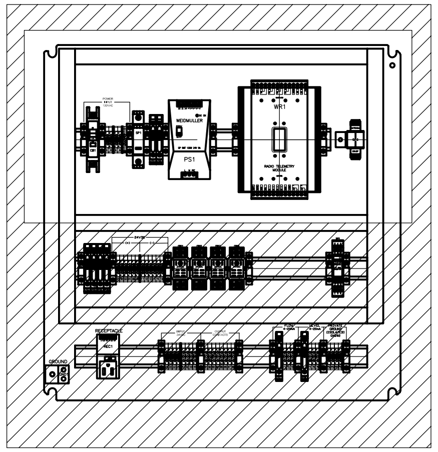
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

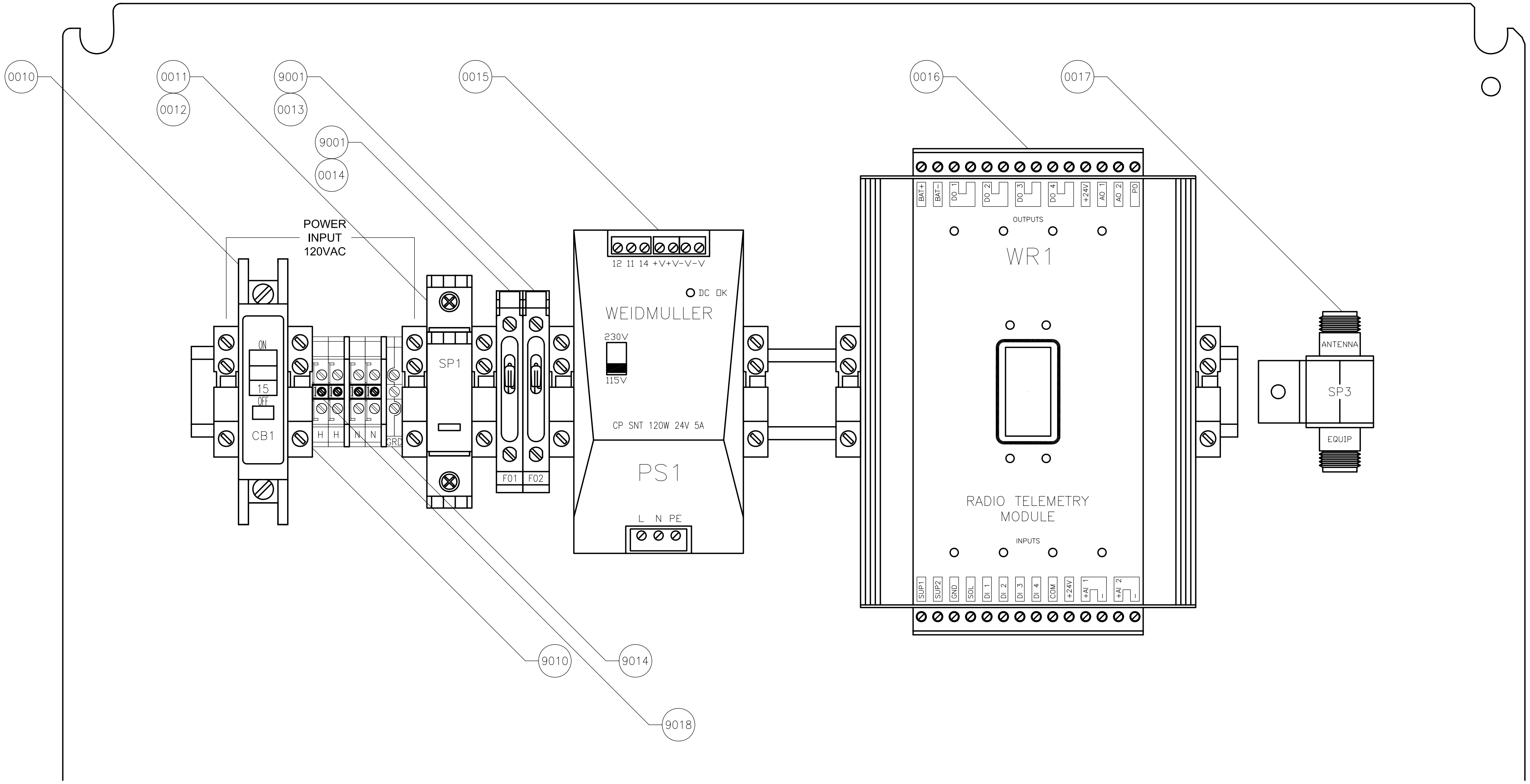
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 BACK PANEL LAYOUT

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	2
OF	5





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

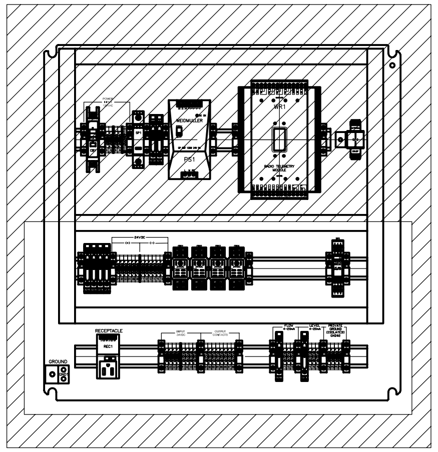
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

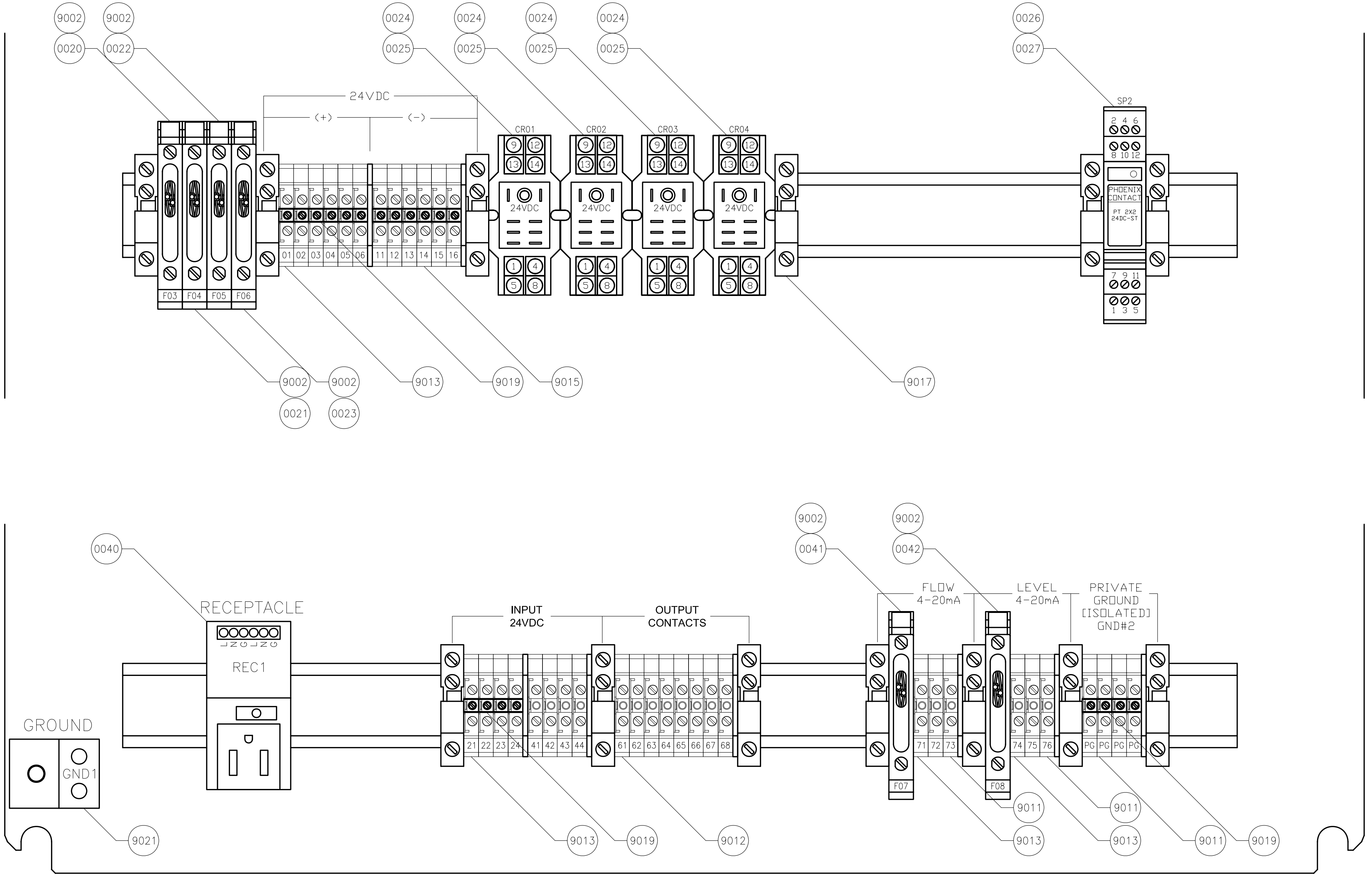
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 PARTS LAYOUT

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	3
OF	5





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 PARTS LAYOUT

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-3
DWG. NO. 2829
SH 4 OF 5

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-3	1	CSD242410SS	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	HOFFMAN	
0002	RTU903-3	1	CP2424	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	HOFFMAN	
0003	PL1	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0004	PL1	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0010	CB1	1	QOU115	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0011		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0012	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0013		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0014		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0015	PS1	1	CP SNT 120W 24V 5A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	WEIDMULLER	
0016	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	8708670000
0017	SP3	1	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021		1	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0024		4	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0025		4	RH2B-ULC-DC24V	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0026		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0027		1	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0040	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0041		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0042		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		2	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		6	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		4	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		6	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9012		8	UK 5 N YE	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	PHOENIX	3003952
9013		24	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		10	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		21	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9018		2	FBI 2-6	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	PHOENIX	0203438
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

REV # DATE REVISION

SYSTEM CONTROLS & INSTRUMENTATION

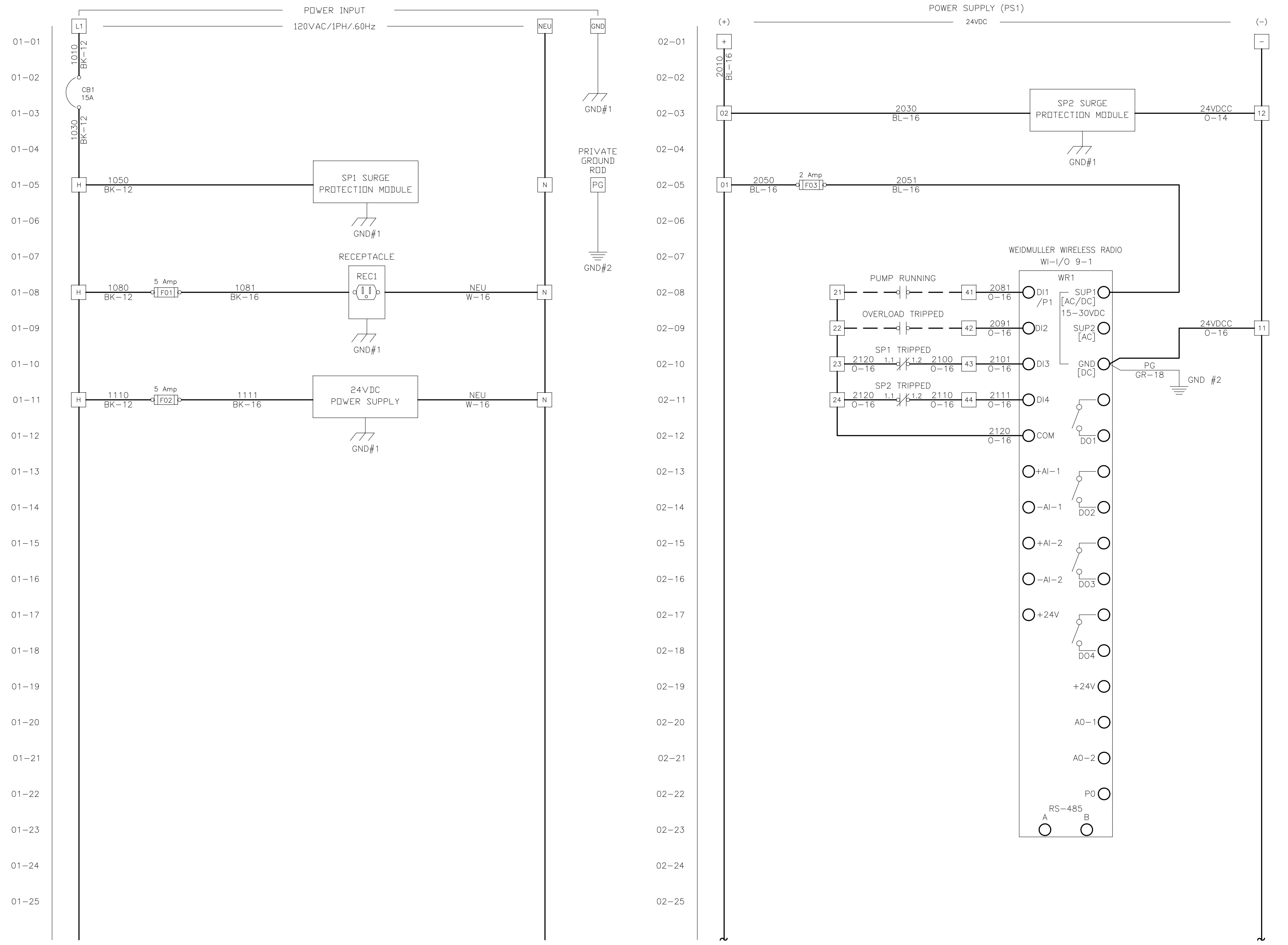
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
WELL #1 BILL OF MATERIALS

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-3
DWG. NO.	2829
SH	5
OF	5



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

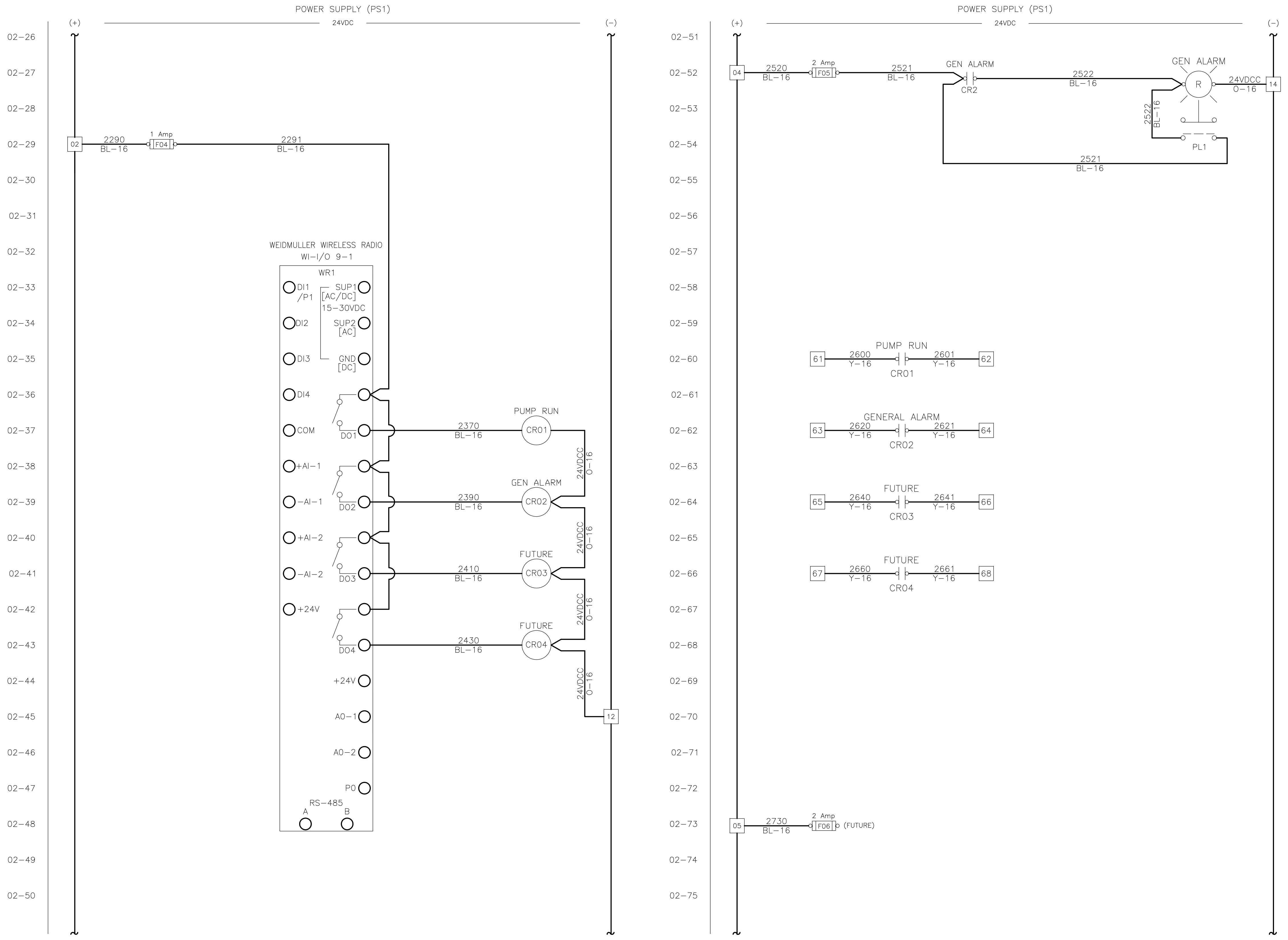
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 WIRING DIAGRAM

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 1
OF 7



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

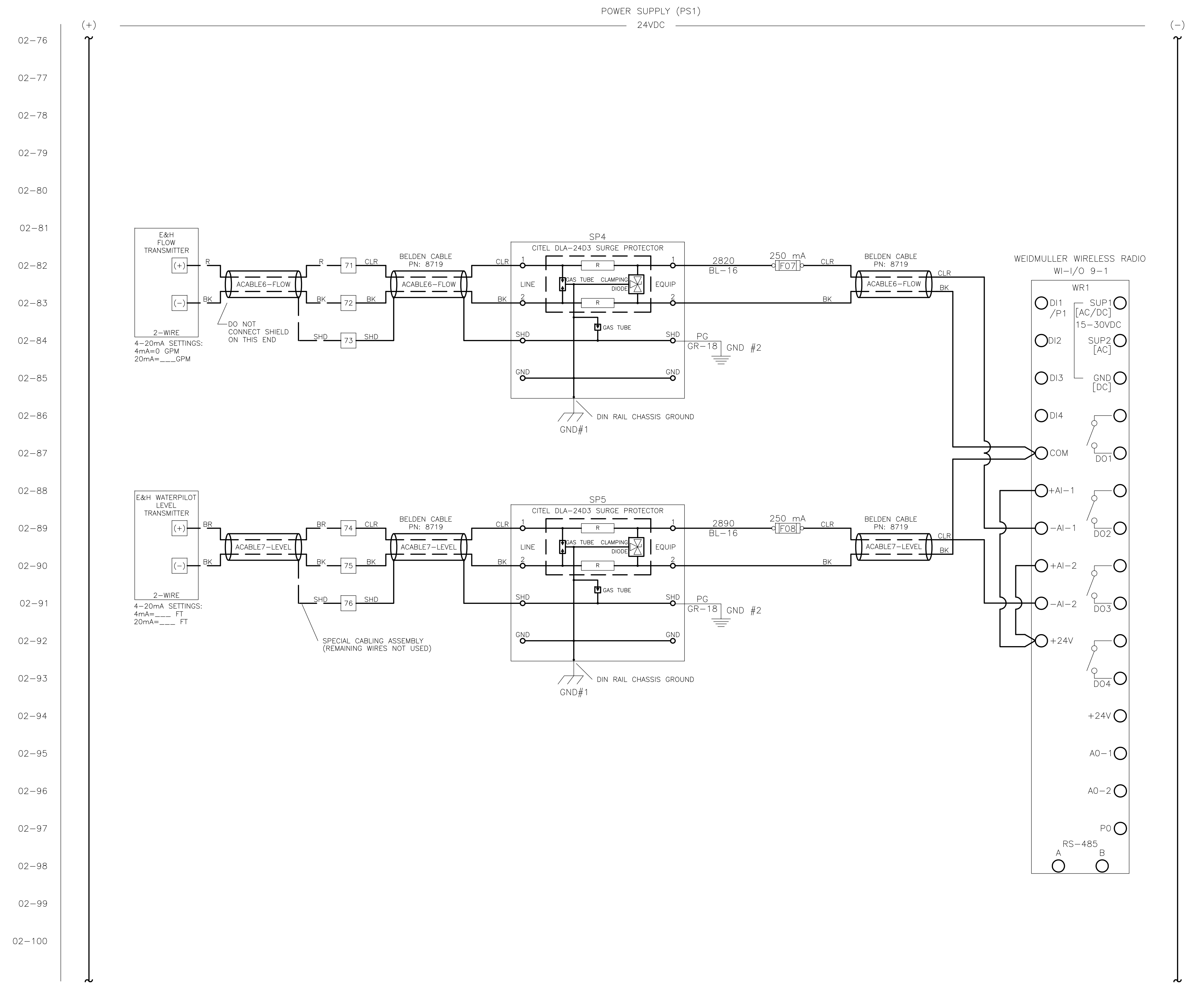
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 WIRING DIAGRAM

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 2
OF 7



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
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REV #	DATE	REVISION

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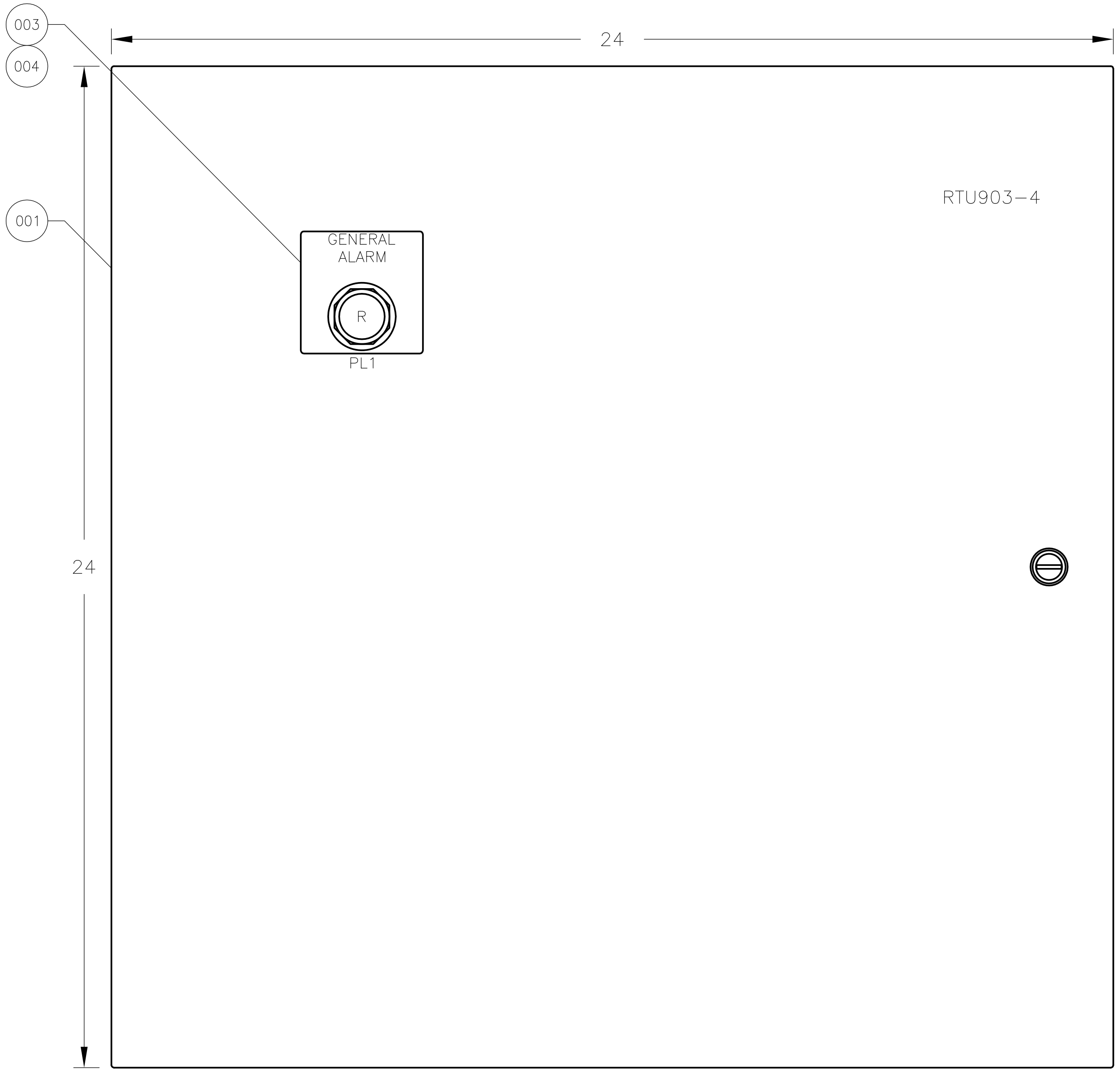
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

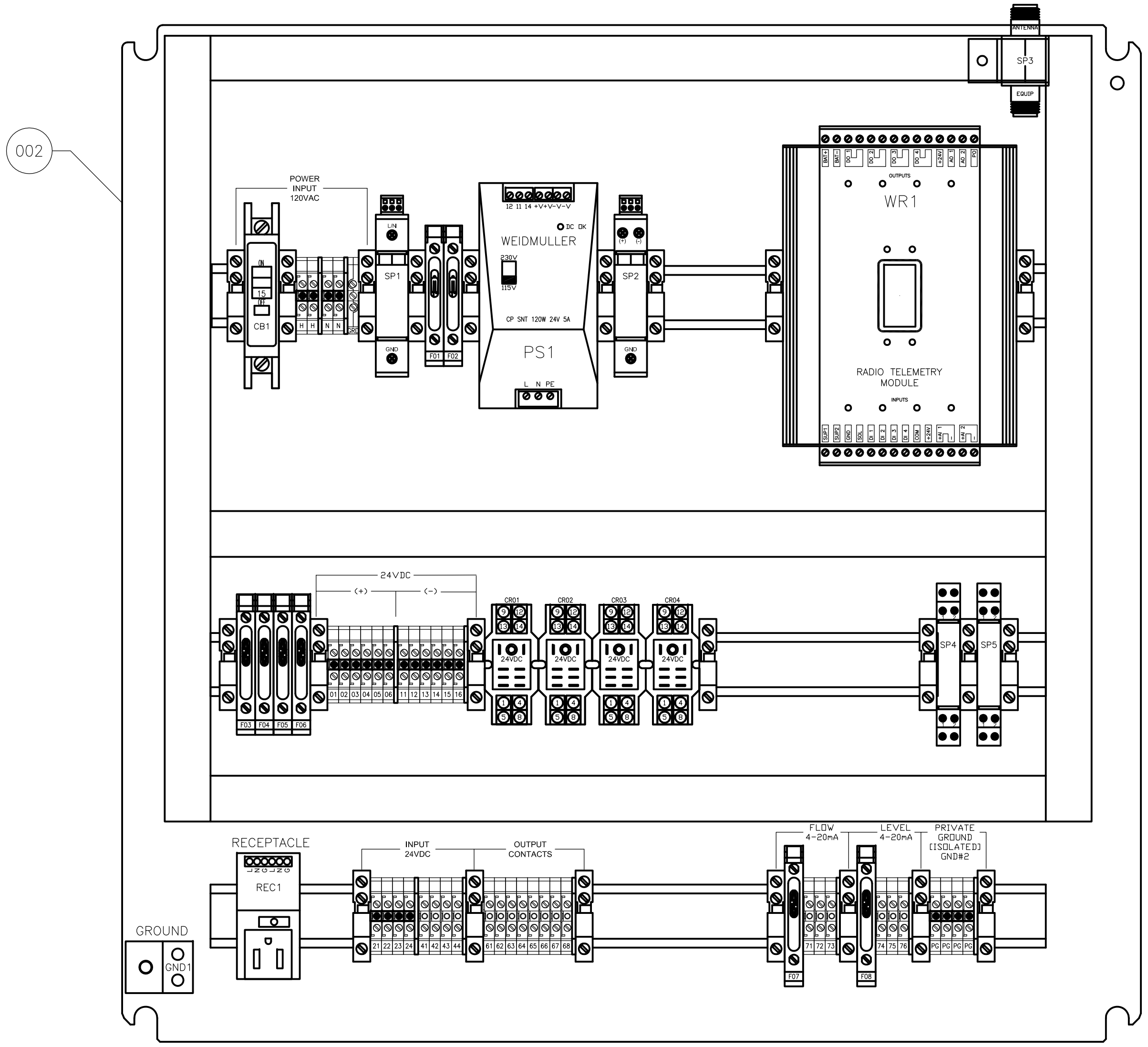
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 WIRING DIAGRAM

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 3 OF 7





REV # | DATE | REVISION

SYSTEM CONTROLS & INSTRUMENTATION

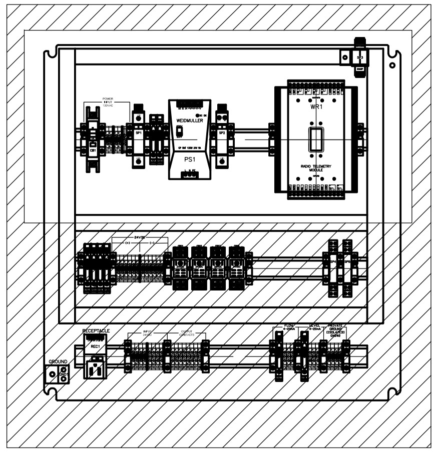
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

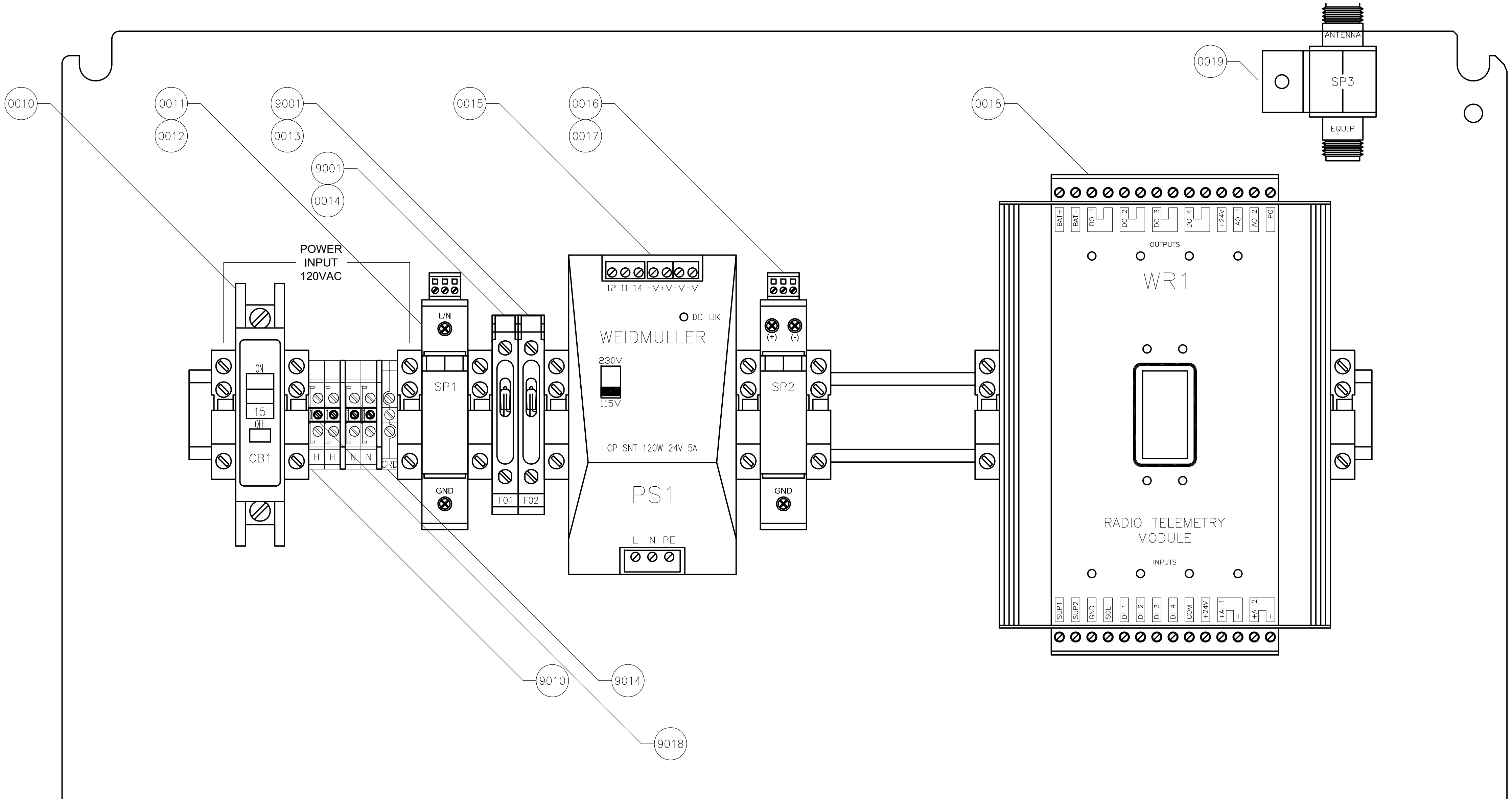
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 BACK PANEL LAYOUT

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 4
OF 7





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

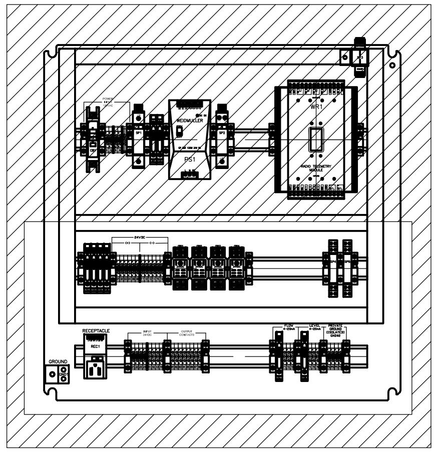
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

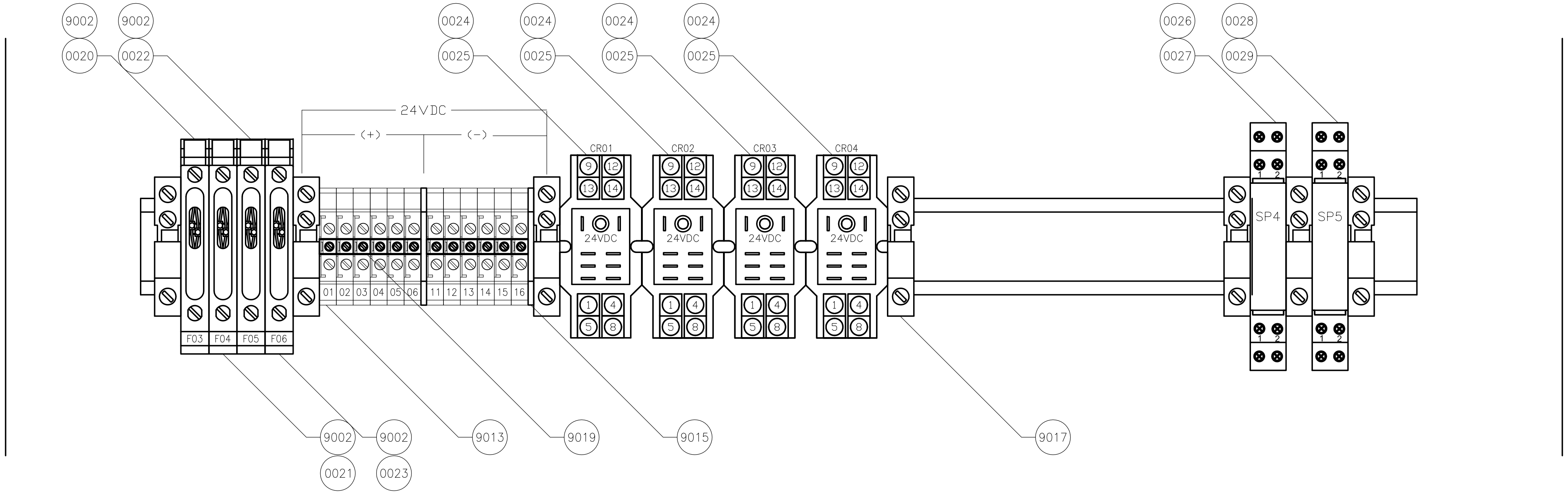
ENGINEER

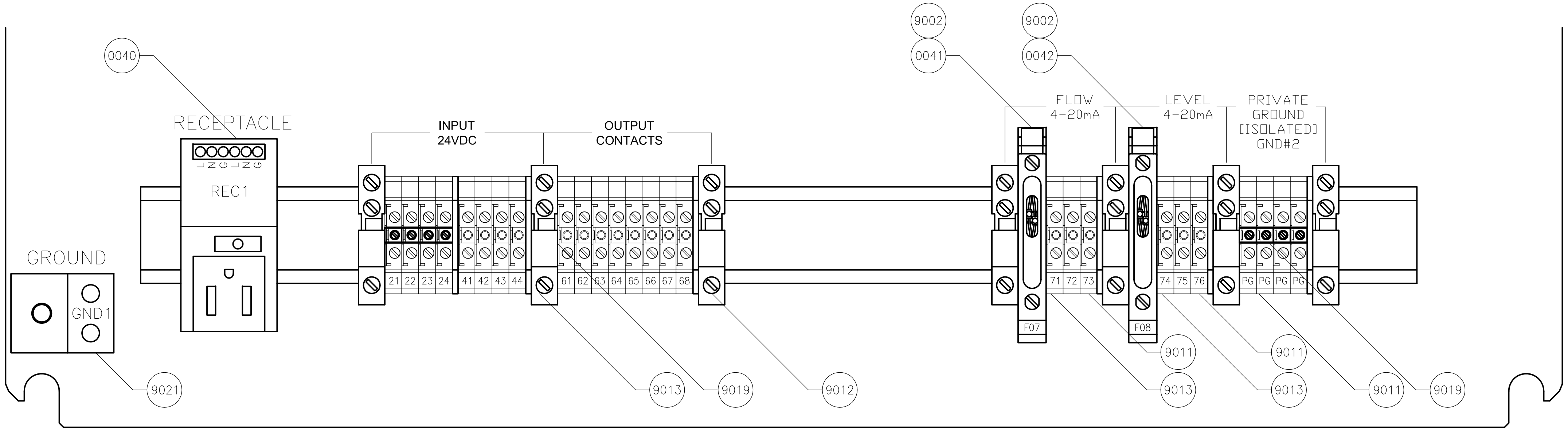
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 PARTS LAYOUT

DATE: 3/1/2010
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 5
OF 7







REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 PARTS LAYOUT

DATE: 3/1/2010
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 6 OF 7

BILL OF MATERIALS

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-4	1	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	CSD242410SS	HOFFMAN
0002	RTU903-4	1	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	CP2424	HOFFMAN
0003	PL1	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0004	PL1	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0010	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0011	SP1	1	SURGE PROTECTION MODULE, 120VAC, IMAX:40KA, VMAX: 150V	DS41-120	CITEL
0012		1	HOLDER, SURGE PROTECTION	DS41-120	CITEL
0013		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0014		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0015	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	CP SNT 120W 24V 5A	WEIDMULLER
0016	SP2	1	SURGE PROTECTION MODULE, 24VDC, IMAX:2KA, VMAX: 30V	DS220-24DC	CITEL
0017		1	HOLDER, SURGE PROTECTION	DS220-24DC	CITEL
0018	WR1	1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WI-I/O 9-1	WEIDMULLER
0019	SP3	1	SURGE PROTECTOR, GAS TUBE, DC-5GHZ, 50 OHM, MAX POWER: 25W, VSWR: 1.2:1, SURGE 20KA, N-FEMALE X N-FEMALE, BULKHEAD MOUNT	P8AX09-N/FF	CITEL
0020		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0021		1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	AGC-1	BUSSMANN
0022		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0023		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0024		4	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0025		4	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-DC24V	IDEC
0026	SP4	1	SURGE PROTECTION MODULE, 4-20MA, IMAX:20KA, VMAX: 28VDC	DLA-24D3	CITEL
0027		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-24D3	CITEL
0028	SP5	1	SURGE PROTECTION MODULE, 4-20MA, IMAX:20KA, VMAX: 28VDC	DLA-24D3	CITEL
0029		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-24D3	CITEL
0040	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0041		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0042		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		2	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		6	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9010		4	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		6	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9012		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9013		24	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		1	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		10	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		23	END CLAMP, GRAY	E/UK	PHOENIX
9018		2	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	FBI 2-6	PHOENIX
9019		4	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

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DWG. NO. 2829
SH 7 OF 7

Appendix G

Product Information

FT415 Flow Computer, GPI TM150, and Endress+Hauser Prowhirl 72F

GPI TM150 Turbine Meter

SAVE THESE INSTRUCTIONS

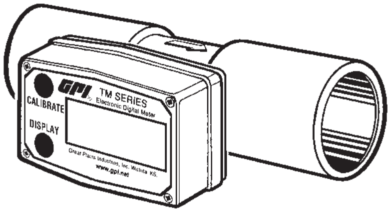
GPI®
5252 East 36th Street North
Wichita, KS USA 67220-3205
TEL: 316-686-7361
FAX: 316-686-6746

GREAT PLAINS INDUSTRIES, INC.
"A Great Plains Ventures Subsidiary"
www.gpi.net
1-888-996-3837

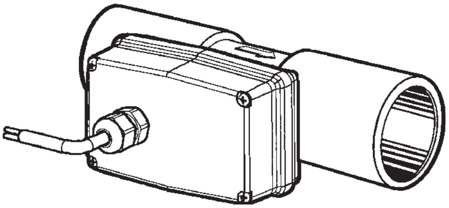
TM Series Electronic Water Meters

CE

User Manual



TM Meter with Computer Display



TM Digital Pulse Meter

TABLE OF CONTENTS

ENGLISH

IMPORTANT NOTICE

Use TM Series meters with water and other chemicals compatible with wetted components (see Specifications Section). Do not use to meter fuel or incompatible chemicals. TM Series meters are available with either a computer for local electronic display, or a conditioned signal output module to provide a digital signal to customer interfacing equipment. TM Series meters with computer display measure in gallons or litres. Refer to the Calibration Section for details.

These meters are not legal for trade applications.

TM Series meters are very sensitive to electric noise if operated within 1 to 2 inches of some electric motors or other sources of electronic noise.

INSTALLATION

Connections

Install your meter in-line either horizontally or vertically or at the end of the hose adjacent to the nozzle. Installation to metal connections is not recommended. Install as follows:

1. Plan to install turbine with a minimum straight pipe length as follows:
   - Upstream from the turbine, allow a minimum straight pipe length of 10 times the internal diameter of the turbine.
   - Downstream from the turbine, allow a minimum straight pipe length of 5 times the internal diameter of the turbine.
2. For Spigot (Pipe) End use only primer and solvents approved for PVC gluing.

For NPT Fittings wrap all connections with 3 to 4 wraps of thread tape. Make sure the tape does not intrude into the flow path.

3. Attach meter with arrow pointed in the direction of flow.
4. For NPT Fittings - Hand tighten the meter at the housing ends. Do no use a wrench or similar tool to tighten. This can damage the housing.

Conditioned Signal Output Module Wiring

This conditioned signal output module can be wired to provide an open collector signal output or 6-volt square wave output.

Open Collector Signal Output

To achieve an open collector signal output, reference Wiring Diagram 1. The terminal block is located on the back side of the module. The module is factory assembled for open collector signal output. Please provide the (820 ohm minimum) resistor.

Ten feet (3m) of cable is provided with the module. Trim it to desired length or extend it as necessary. Distances up to 5,000 feet (1,524m) can be achieved for open collector signal output.

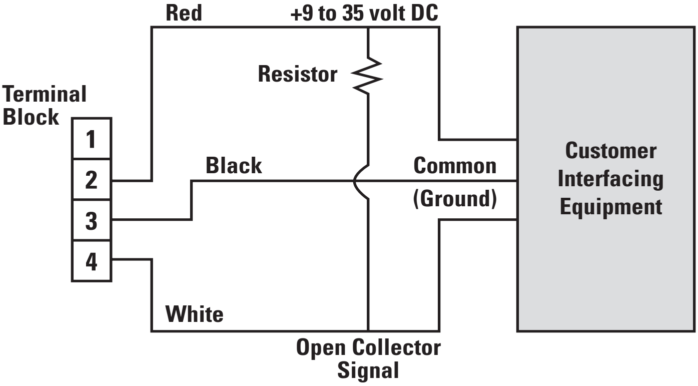
Square Wave Output

To achieve square wave output, reference Wiring Diagram 2 and use an Electronic Digital Meter Battery Kit (sold separately) for battery power. The terminal block and battery location are located on the back side of the module. Access as follows:

1. Remove the four Phillips-head screws from the front of the module and lift the module from the turbine.
2. To change terminal block connections, loosen the appropriate screws. Reconnect the wires in the proper positions and tighten the screws.
3. Install the batteries. Make sure the positive post is in the correct position.
4. Position the module on the turbine housing. To avoid moisture damage, make sure the seal is fully seated. Tighten the four screws on the front of the module.

Wiring Diagram 1

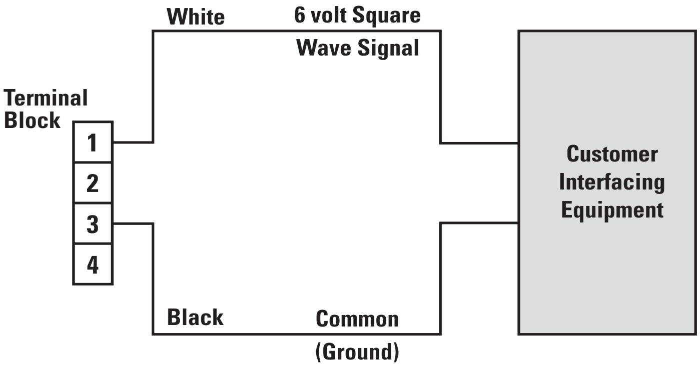
OPEN COLLECTOR SIGNAL OUTPUT



The terminal block is identified as follows:
Pin #1 6 volt square wave (not used)
Pin #2 +9 to 35 volt DC Input
Pin #3 Common Ground
Pin #4 Open Collector signal Output

Wiring Diagram 2

SQUARE WAVE OUTPUT



The terminal block is identified as follows:

Pin #1 6 volt square wave
Pin #2 +9 to 35 volt DC Input (not used)
Pin #3 Common Ground
Pin #4 Open Collector signal Output (not used)

Ten feet (3m) of cable is provided with the module. Trim the cable to desired length or extend it as necessary.

Verify Meter Accuracy

Before using, check the meter's accuracy and verify calibration.

1. Make sure there is no air in the system by starting the flow until it runs steadily. Then, stop the flow using a valve or nozzle.
2. Meter an exact known volume into an accurate container. For best results, meter with one continuous full stream.
3. Check the volume against the display or recording equipment. If the amount metered is accurate, further calibration is not necessary. If not, refer to the Calibration Section for further instructions.

OPERATION

Computer Display – Batch and Cumulative Totals

The computer maintains two totals. The Cumulative Total provides continuous measurement and cannot be manually reset. The Batch Total can be reset to measure flow during a single use. The Cumulative Total is labeled with TOTAL 1 LOCKED indicating that this total is locked and cannot be manually zeroed. Batch Total is labeled with TOTAL 2.

When the Cumulative Total reaches a maximum reading of 999,999, it will automatically reset to zero.

Press the DISPLAY button briefly to switch between the batch, cumulative total, and flowrate.

NOTE: Totalization counts total units without differentiating between gallons, litres or field calibrated units.

Flowrate Feature

To use this feature, press and release DISPLAY until FLOWRATE appears to the left of the bottom line.

When FLOWRATE is displayed, the numbers on the middle line reflect the rate of flow, for example, the current gallons per minute (GPM) or litres per minute (LPM).

Activate the Meter

Turn the computer display ON by starting water flow or briefly pressing the DISPLAY button. The Batch or Cumulative Total from last use will be displayed.

Press DISPLAY briefly to display the Batch Total. Hold the DISPLAY button down for 3 seconds to reset the Batch Total to zero.

The computer display is programmed to turn off automatically if not used for 4 minutes.

Factory and Field Calibration Curves

All calibration information is visible to the user as words in the upper part of the display, above the numeric digits.

All units are configured with a "factory" calibration curve. Both gallons and litres are available ("GAL" or "LTR" will be displayed). Use the CALIBRATE and DISPLAY buttons to switch between gallons and litres. This curve is NOT user adjustable: the word "PRESET" is displayed to show this. (The factory calibration is stored permanently in the computer's memory.)

The "field" calibration curve may be set by the user, and can be changed or modified at any time using the calibration procedure described below in the Calibration Section. Totals or flowrate derived from the field calibration are visible when the field calibration setting is selected ("CAL B" will be visible on the top line).

Selecting a Different Calibration Setting

You can switch between GAL and LTR modes at will without "corrupting" totalizer contents. For example, the computer can totalize 10.00 gallons. If the user switches to LTR mode, the display will immediately change to "37.85" (the same amount in units of litres). GAL / LTR switching also works in FLOWRATE mode.

To select a different calibration setting, first press and hold the CALIBRATE button. Continue to hold it while also pressing and releasing the DISPLAY button. (You may then also release the CALIBRATE button.) The flag indicators in the top line of the display will change to show the newly selected calibration setting. Calibration settings change in this order: GAL, LTR, CAL B, GAL, etc. While fluid is flowing, only the GAL and LTR selections may be made. However, when NO fluid flow is occurring, any setting may be selected.

CALIBRATION

Before Beginning Field Calibration

For the most accurate results, dispense at a flowrate which best simulates your actual operating conditions. Avoid "dribbling" more fluid or repeatedly starting and stopping the flow. This can result in less accurate calibrations.

Make sure you meet the meter's minimum flowrate requirements:

TM Series Meters

1/2 inch meter	1 GPM (3.8 LPM)
3/4 inch meter	2 GPM (7.5 LPM)
1 inch meter	5 GPM (18.8 LPM)
1-1/2 inch meter	10 GPM (37.5 LPM)
2 inch meter	20 GPM (75 LPM)

The use of a uniformly dependable, accurate calibration container is highly recommended for the most accurate results. Due to high flowrate, it is strongly recommended that calibration be completed with a combination of volume and weight using fine resolution scales.

For best results, the meter should be installed and purged of air before field calibration.

Field Calibration with Computer Display

Field Calibration and Factory Calibration are defined in the previous section. Factory calibration settings are custom programmed into each computer during production, using water at 70°F (21°C). Readings using the standard factory calibration curves may not be accurate in some situations, for example, under extreme temperature conditions or with fluids other than water.

For improved accuracy under such conditions, the GPI flow computer allows for "field" calibration, that is, user entry of custom calibration parameters. A "single point" calibration may yield acceptable accuracy in the middle of the flow range, but five or more calibration points may yield a higher level of accuracy, especially at the lower end of the flow range. Up to 15 custom calibration points can be entered.

Dispense/Display Field Calibration Procedures

1. Hold down CALIBRATE while pressing and releasing DISPLAY until the field calibration curve appears ("CAL B" message will be displayed). Release both buttons.
2. To calibrate, press and hold the CALIBRATE button. While continuing to hold CALIBRATE, also press and hold the DISPLAY button. Hold both buttons for about 3 seconds until you see a blinking "dd CAL" message. Once the "dd CAL" message appears, release both buttons. You are now in field calibration mode.
3. Once the buttons have been released from Step 2, the display will show the blinking message "run 01". If you want to exit the calibration now before dispensing any fluid, go to Step 11.
4. If you want to continue with the calibration, but have not dispensed any fluid yet, make your final preparations to your pumping system, but don't start pumping yet.
5. Start your pumping system so that fluid flows through the meter. The display will stop blinking and show the "run 01" message. Dispense into a container that allows you to judge the amount of fluid pumped. When you have pumped the desired amount (for example, 10 gallons), stop the fluid flow quickly.
6. Once the flow has stopped, briefly press and release both buttons. At this point the computer display will change to "0000.00" with the left-hand digit blinking.
7. Enter the volume (amount) of fluid that you dispensed (for example, if your 10-gallon container is full, enter "10.0" for gallons or "37.85" for litres). To enter numbers, use the CALIBRATE button to change the value of the digit that is blinking and use the DISPLAY button to shift the "blink" to the next digit.
8. Once the correct number is entered, briefly press and release both buttons. The display will now change to a blinking "run 02" message. You have installed the new cal-curve point. You are ready to end calibration (Step 10) or enter another new calibration point (Step 9).
9. To enter another calibration point, go back and repeat Steps 3 through 8. It is possible to set up to 15 cal-curve points, and the "run ##" message will increment each time you repeat the calibration process (run 01, run 02, run 03, etc., up to run 15).
10. To end calibration, press and hold both buttons for about 3 seconds until you see the "CAL End" message. After you release the buttons the computer will resume normal operations with the new cal point(s) active.
11. If you HAVE NOT dispensed any fluid, you can exit calibration without changing the cal curve. If the message "run 01" is showing and you have not dispensed any fluid, hold both buttons for about 3 seconds until you see a "CAL End" message. After you release the buttons, the computer will resume normal operation and the old curve (if you entered one in the past) is still intact.

Calibration with Conditioned Signal Output Module

The K-factor of your meter appears on the calibration report as the number of pulses per gallon. The factor is determined during production using water at 70°F (21°C). This K-factor may be used for "single point" calibration and provide acceptable accuracy. However, readings may not be accurate when using this calibration method in some situations. One example is when using the meter under extreme temperature conditions or with fluids other than water.

For improved accuracy under such conditions, we recommend that a K-factor specific to the application be determined and used for calibration. A "single point" calibration may yield acceptable accuracy in the middle of the flow range, but five or more calibration points may yield a high level of accuracy, especially at the lower end of the flow range.

MAINTENANCE

Proper handling and care will extend the life and service of the meter.

Turbine Rotor

The meter is virtually maintenance-free. However, it is important the rotor moves freely. Keep the meter clean and free of contaminants.

If the rotor does not turn freely, apply a penetrating lubricant on the rotor, shaft, and bearings. Remove any debris or deposits from the rotor using a soft brush or small probe. Be careful not to damage the turbine rotor or supports.

⚠ CAUTION

Blowing compressed air through the turbine assembly could damage the rotor.

Battery Replacement

The computer display is powered by two 3-volt lithium batteries which may be replaced while the meter is installed. When batteries are removed or lose power, the batch and cumulative totals reset to zero but the field and factory calibrations are retained.

If the display becomes dim or blank, replace the batteries as follows:

1. Remove the four Phillips-head screws from the face of the meter and lift the faceplate from the turbine.
2. Remove the old batteries and clean any corrosion from the terminals.
3. Install new batteries. Make sure the positive post is in the correct position.
4. When the batteries are replaced, the faceplate will power ON. Check the display to ensure normal functions have resumed before assembling again.
5. Reseat batteries, if necessary, and position the faceplate on the turbine housing. To avoid moisture damage, make sure the seal is fully seated. Tighten the four screws on the faceplate.

SPECIFICATIONS

Inlet and Outlet:

Spigot (Pipe) End Models:

TM050/TM050-P	1/2 inch Schd. 80, Spigot (Pipe)
TM075/TM075-P	3/4 inch Schd. 80, Spigot (Pipe)
TM100/TM100-P	1 inch Schd. 80, Spigot (Pipe)
TM150/TM150-P	1-1/2 inch Schd. 80, Spigot (Pipe)
TM200/TM200-P	2 inch Schd. 80, Spigot (Pipe)

NPT Models:

TM050-N/TM050-N-P	1/2 inch NPT
TM075-N/TM075-N-P	3/4 inch NPT
TM100-N/TM100-N-P	1 inch NPT
TM150-N/TM150-N-P	1-1/2 inch NPT
TM200-N/TM200-N-P	2 inch NPT

Design Type: Turbine

Wetted Components:

Housing: PVC
Journal Bearings: Ceramic
Shaft: Tungsten Carbide
Rotor and Supports: PVDF
Retaining Washer: Stainless Steel

Fitting Types: Spigot - Schd. 80 or NPT (female)

Max. Working Pressure: 225 PSIG @ 73°F

U.S. Measurement

Unit of Measure: Gallon

Flow Range:

1/2 inch	1 - 10 GPM
3/4 inch	2 - 20 GPM
1 inch	5 - 50 GPM
1-1/2 inch	10 - 100 GPM
2 inch	20 - 200 GPM

Accuracy with Computer: ± 3.0% (Accuracy can be improved with field calibration)

Operating Temperature: +32° to +140° F (Do not allow fluid to freeze inside meter.)

Storage Temperature: –40° to +158° F

Product Weight:*

	Spigot (Pipe)	NPT
1/2 inch	.38 lbs.	.55 lbs.
3/4 inch	.43 lbs.	.67 lbs.
1 inch	.49 lbs.	.84 lbs.
1-1/2 inch	.66 lbs.	1.38 lbs.
2 inch	.78 lbs.	1.78 lbs.

Dimensions - Inches (W x H x L):**

	Without Fitting	With Fitting
1/2"	2.0 x 2.6 x 3.8	2.0 x 2.8 x 5.5
3/4"	2.0 x 2.7 x 3.8	2.0 x 2.9 x 5.5
1"	2.0 x 3.1 x 4.1	2.0 x 3.3 x 6.2
1-1/2"	2.1 x 3.7 x 5.4	2.3 x 3.9 x 7.6
2"	2.4 x 4.2 x 5.5	3.5 x 4.5 x 7.9

* Weight with computer display. Conditioned signal output module adds .30 lbs.

** Dimensions with computer display. Conditioned signal output module adds 1.1 inch to height.

Metric Measurement

Unit of Measure: Litre

Flow Range:

1/2 inch	3.8 - 38 LPM
3/4 inch	7.6 - 76 LPM
1 inch	19 - 190 LPM
1-1/2 inch	38 - 380 LPM
2 inch	76 - 760 LPM

Accuracy with Computer: ± 3.0% (Accuracy can be improved with field calibration)

Operating Temperature: 0° to +60° C (Do not allow fluid to freeze inside meter.)

Storage Temperature: −40° to +70° C

Product Weight:*

	Spigot (Pipe)	NPT
1/2 inch	.172 kg	.249 kg
3/4 inch	.195 kg	.304 kg
1 inch	.222 kg	.381 kg
1-1/2 inch	.299 kg	.626 kg
2 inch	.354 kg	.807 kg

Dimensions - cm (W x H x L):**

	Without Fitting	With Fitting
1/2"	5.0 x 6.6 x 9.6	5.0 x 7.1 x 13.9
3/4"	5.0 x 6.8 x 9.6	5.0 x 7.3 x 13.9
1"	5.0 x 7.8 x 10.4	5.0 x 8.3 x 15.7
1-1/2"	5.8 x 9.3 x 13.7	5.8 x 9.9 x 19.3
2"	6.0 x 10.6 x 13.9	8.8 x 11.4 x 20.0

* Weight with computer display. Conditioned signal output module adds .136 kg.

** Dimensions with computer display. Conditioned signal output module adds 2.8 cm to height.

PARTS

The following replacement parts and accessories are available for the TM Series meters:

Part No.	Description
113435-1	Conditioned Signal Output Module
113520-1	Battery Replacement Kit
116000-1	Calibration Container, Large (5 gallon)
125508-03	1/2 inch, Turbine Assy Kit
125508-04	1/2 inch NPT, PVC Turbine Assy Kit
125510-03	3/4 inch, Turbine Assy Kit
125510-04	3/4 inch NPT, PVC Turbine Assy Kit
125512-03	1 inch, Turbine Assy Kit
125512-04	1 inch NPT, PVC Turbine Assy Kit
125514-03	1-1/2 inch, Turbine Assy Kit
125514-04	1-1/2 inch NPT, PVC Turbine Assy Kit
125516-03	2 inch, Turbine Assy Kit
125516-04	2 inch NPT, PVC Turbine Assy Kit
901002-52	Seal
Computer Kits:	
125509-03	1/2 inch, Computer Assy Kit
125511-03	3/4 inch, Computer Assy Kit
125513-03	1 inch, Computer Assy Kit
125515-03	1-1/2 inch, Computer Assy Kit
125517-03	2 inch, Computer Assy Kit

SERVICE

For warranty consideration, contact your local distributor. If you need further assistance, contact the GPI Customer Service Department at:

1-800-835-0113

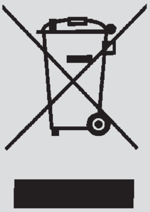
You will need to:

- Provide information from the decal on your meter.
- Receive a Return Authorization number.
- Flush any fluid from the meter before shipping to the factory.
- If possible leave customer installed fittings or ample length of bare pipe for reinstallation.

⚠ CAUTION

Do not return the meter without specific authority from the GPI Customer Service Department. Due to strict regulations governing transportation, handling, and disposal of hazardous or flammable liquids, GPI will not accept meters for rework unless they are completely free of liquid residue.

WEEE DIRECTIVE



The Waste Electrical and Electronic Equipment (WEEE) directive (2002/96/EC) was approved by the European Parliament and the Council of the European Union in 2003. This symbol indicates that this product contains electrical and electronic equipment that may include batteries, printed circuit boards, liquid crystal displays or other components that may be subject to local disposal regulations at your location. Please understand those regulations and dispose of this product in a responsible manner.

ESPAÑOL

AVISO IMPORTANTE

Utilizar los medidores de los Series del TM con agua y otros productos químicos que son compatibles con los componentes que se exponen al líquido (véase la sección de especificaciones). No utilizar este medidor con combustible u otros productos qulmicos incompatibles. Los medidores de la serie de TM están disponibles con una computadora para la visualización electrónica local, o un módulo de salida condicionado de la señal que proporcione una señal numérica al equipo de interconexión del cliente. Los medidores de las Series TM miden en galones o litros. Referirse a la sección de la calibración para mayores detalles.

Estos medidores no son legales para las aplicaciones comerciales.

Los medidores de las Series TM son muy sensibles a interferencia electrónica si funcionan a 1 o 2 pulgadas de algunos motores eléctricos o de otras fuentes del uso electrónico.

INSTALACIÓN

Conexiones

Instalar su medidor en línea, u horizontalmente, o verticalmente, o en el extremo de la manguera adyacente al inyector. No se recomienda la instalación a las conexiones de metal. Siga estos pasos para instalar:

1. Planee instalar la turbina con una longitud mínima de la pipa recta de esta manera:
   - Contra la corriente de la turbina, permita a una longitud mínima de la pipa recta de 10 veces el diámetro interno de la turbina.
   - Con la corriente de la turbina, permita una longitud mínima de la pipa recta de 5 veces el diámetro interno de la turbina.
2. <u>Para Espiga (de tubo) Fin</u> utilizar solamente los solventes aprobados para pegar PVC.

   <u>Para Las Conexiones Del NPT</u> cubrir las conexiones de pipa con la cinta del Teflon® 3 a 4 veces. Cerciorarse de que la cinta no imponga en la trayectoria del flujo.

3. Unir el medidore con la flecha señalada en la dirección del flujo.
4. Para Las Conexiones Del NPT utilizar solamente sus manos para apretar las conexiones del medidore. No utilizar una llave inglesa o una herramienta similar para apretar. Esto puede dañar la cubierta.

Señal de Salida Condicionada Cableado De Módulo

Este módulo de Señal de salida condicionada se puede conectar para proporcionar una salida de colector abierta o de señal de onda cuadra-da de 6-voltios.

Señal de Salida De Colector Abierto

Para alcanzar una señal de salida de colector abierto, refierase por favor al digrama eléctrico 1. El bloque de terminales está situado en el lado trasero del módulo. El módulo viene montado de fábrica para señal de colector abierta. Por favor proporcionar el resistor de un minimo de 820 ohmios.

Diez pies (3m) de cable se proporcionan con el módulo. Ajustar el cable a la longitud deseada o extender el cable cuanto le sea necesario. Se puede alcanzar una señal de salida de colector abierto hasta distancias de 5.000 pies (1,524m).

Salida de corrente de Onda Cuadrada

Para lograr una salida de corriente de onda cuadrada, refierase por favor al digrama eléctrico 2 y utilize un kit electrónico de bateria del medidor digital (vendido por separado) para la fuente de energia de la bateria. El bloque de terminales y la localización de la bateria están situados en el lado trasero del modulo. Acceda al módulo de la siguiente manera:

1. Quitar los cuatro tornillos de cabeza Phillips del frente del módulo. Levantar el módulo de la turbina.
2. Para cambiar las conexiones del bloque de terminales, aflojar los tornillos apro-piados. Volver a conectar los alambres en las posiciones apropiadas y apretar los tornillos.
3. Instalar las baterias. Cerciorarse de que el poste positivo esté en la posición correcta.
4. Colocar el módulo en la cubierta de la turbina. Para evitar daños causados por la humedad, cerciorarse de que el anillo esté asentado completamente. Apretar los cuatro tornillos en el frente del módulo.

Diez pies (3m) de cable se proporcionan con el módulo. Ajustar el cable a la longitud deseada o extender el cable cuanto le sea necesario.

Verificar La Exactitud Del Metro

Antes de usar, comprobar la exactitud del metro y verificar la calibración.

1. Cerciorarse de que no haya aire en el sistema comenzando el flujo hasta que funciona constantemente. Entonces, detenga el flujo usando una válvula o un inyector.
2. Con el medidor, mida un volumen exacto en un envase exacto. Para mejores resultados, medir con una corriente complete y continua.
3. Comprobar el volumen con lo indicado en la pantalla o el equipo de grabación. Si la cantidad medida es exacta, no es necesario mayor calibración. Si no, referir a la sección de la calibración.

OPERACIÓN

Pantalla De la Computadora – lotes y totales acumulativos

El computadora mantiene dos totales. El total acumulativo proporciona la medida continua y no puede ser reajustado manualmente. El total de hornada se puede reajustar para medir el flujo durante una sola vez. El total acumulativo se etiqueta con el TOTAL 1 LOCKED. Esto indica que el total esta bloqueado y no puede ser puesto a cero manualmente. El total de hornada se etiqueta con el TOTAL 2.

Cuando el total acumulativo alcanza una lectura máxima de 999.999, se reajustará automáticamente a cero.

Presionar el botón de DISPLAY brevemente para cambiar entre la hornada, el total acumulativo, y el índice de flujo.

NOTA: Totalization cuenta las unidades totales sin distinguir entre los galones, los litros o las unidades calibradas de campo.

Atributo Del Indice De Flujo

Para utilizar este atributo, presionar y soltar el "DISPLAY" hasta que "FLOWRATE" aparezca abajo a la izquierda.

Cuando aparece "FLOWRATE", los números en la linea de el centro reflejan el Índice de flujo. Por ejemplo, los galones por minuto (GPM) o litros por minuto (LPM).

Activar El Medidor

Encienda el pantalla de la computadora comenzando el flujo del agua o brevemente presionando el botón del DISPLAY. El lote o el total acumulativo del uso pasado será exhibido.

Presionar el botón del DISPLAY brevemente para exhibir el total de hornada. Oprima el botón de DISPLAY por 3 segundos para reajustar el total de hornada a cero.

El medidor se apaga automáticamente si no es usado durante 4 minutos.

Curvas De Calibración De La Fábrica y Del Campo

Toda la información de la calibración es visible al usuario como palabras en la parte superior de la exhibición, sobre los dígitos numéricos.

Todas las unidades se configuran con una curva de calibración de la "fábrica". Los galones y los litros están disponibles. (el "GAL" o el "LTR" será visible). Utilizar los botones del CALIBRATE y del DISPLAY para cambiar entre los galones y los litros. Esta curva de calibración no es ajustable por el usuario. La palabra PRESET se exhibe para demostrar esto. (La calibración de la fábrica se almacena permanentemente en la memoria de computadora.)

La curva de calibración de "campo" se puede fijar por el usuario. La calibración se puede cambiar o modificar en cualquier momento usando los procedimientos de la calibración descritos en la sección de la calibración. Los totales o el índice de flujo derivados de la calibración de campo son visibles cuando se selecciona el ajuste de la calibración de campo (la "CAL B" será visible en la línea superior).

Seleccionar un Ajuste Diverso De La Calibración

Usted puede cambiar entre los modos del GAL y del LTR a voluntad sin afectar los totales. Por ejemplo, la computadora puede sumar 10,00 galones. Si el usuario cambia al modo del LTR, la exhibición cambiará inmediatamente a "37,85" (la misma cantidad en las unidades de los litros). La conmutación del GAL/LTR también trabaja en el modo del FLOWRATE.

Para seleccionar un ajuste diverso de CALIBRATE, oprima y sostenga el botón de la CALIBRATE. Continuar presionando el botón mientras que también presiona y suelta el botón de DISPLAY. (usted puede entonces también soltar el botón de CALIBRATE.) Los indicadores de la bandera de la línea superior de la exhibición cambiarán para demostrar el nuevo ajuste seleccionado de la calibración. Los ajustes de la calibración se cambian en este orden: GAL, LTR, CAL B, GAL, etc. Mientras que está fluyendo el líquido, sólo las selecciones del galón y del litro pueden ser hechas. Sin embargo, cuando no está fluyendo NINGÚN líquido, cualquier selección puede ser hecha.

CALIBRACIÓN

Antes De Comenzar La Calibración

Para resultados más exactos, dispense un índice de flujo que simule lo mejor posible sus condiciones de funcionamiento reales. Evite "de gotear" más líquido o en varias ocasiones, o el comenzar y de parar el flujo. Estas acciones darán lcomo resultado calibraciones menos exactas.

Cerciorese de reunir todos los requisitos mínimos del índice de flujo del medidor:

Metros de la Serie TM

Medidores de 1/2 pulgada de
1 GPM (3,8 LPM)

Medidores de 3/4 pulgada de
2 GPM (7,5 LPM)

Medidores de 1 pulgada de
5 GPM (18,8 LPM)

Medidores de 1-1/2 pulgadas de
10 GPM (37,5 LPM)

Medidores de 2 pulgadas de
20 GPM (75 LPM)

Se recomienda para resultados más exactos de la calibración el uso de un envase uniforme, confiable, y exacto. Debido al alto indice de flujo, se recomienda que la calibración esté terminada con una combinación de volumen y de peso usando escalas de alta resolución.

Para mejores resultados, el medidor se debe instalar y purgar del aire antes de la calibración de campo.

Calibración De Campo Con La Pantalla De La Computadora

La calibración de campo y la calibración de fábrica se explican en la sección anterior. La calibración de campo y la calibración de fábrica se explican en la sección anterior. Los ajustes de la calibración de la fábrica se programan especificamente en cada flujó-medidor durante su producción usando agua a 70°F (21°C). Las lecturas que utilizan las curvas de calibración estándares de la fábrica pueden no ser exactas en algunas situaciones. Por ejemplo, cuando se encuentran bajo condiciones de temperatura extremas, o con los liquidos con excepción del agua.

Para la exactitud mejorada bajo tales condiciones, la computadora GPI de flujo tienen en cuenta la calibración del "campo" (es decir un apunte del usuario dentro de los parámetros de calibración especiales). La calibración de "un solo punto" puede rendir una exactitud aceptable en medio de la gama del flujo. Cinco o más puntos de calibración pueden rendir un nivel más alto de exactitud, especialmente en el extremo inferior de la gama del flujo. Hasta 15 puntos de calibración especiales pueden ser inforporados.

Dispensar/Presentar Los Procedimientos De La Calibración De Campo

1. Mantener oprimido el botón del CALIBRATE mientras que presiona y suelta el boton DISPLAY hasta que aparece la curva de calibración de campo (mensaje de "CAL B" será exhibido). Suelte ambos botones.
2. Para calibrar, presionar y sostener el botón del CALIBRATE. Mientras que continúa oprimiendo el CALIBRATE, también presionar y sostener el botón del DISPLAY. Sostener ambos botones por cerca de 3 segundos hasta que usted vea el mensaje de "dd-CAL" en centelleo. Una vez que mensaje del "dd-CAL", aparezca, suelte ambos botones. Usted ahora está en el modo de la calibración de campo.
3. Una vez que los botones se hayan soltado (el paso 2), la exhibición demostrará el mensaje del centelleo "RUN 01". Si usted desea salir del proceso de la calibración antes de dispensar cualquier líquido, ir al paso 11.
4. Si usted desea continuar con la calibración, pero no ha dispensado ningún líquido todavía, hacer las preparaciones finales a su sistema de bombeo, pero no comenzar a bombear todavía
5. Comience su sistema de bombeo de modo que el líquido atraviese el medidor. La exhibición parará el centelleo y demostrará el mensaje del " RUN 01". Dispense el líquido en un envase que permita que usted juzgue la cantidad de líquido bombeada. Cuando usted ha bombeado la cantidad deseada (por ejemplo, 10 galones), detenga el flujo fdel liquido inmediatamente.
6. El flujo ha parado; brevemente presione y suelte una vez ambos botones. En este momento la exhibición de la computadora cambiará al "0000.00" con el centelleo a la izquierda del dígito.
7. Introduzca el volumen (cantidad) de líquido que usted ha dispensado (por ejemplo, si su envase de los 10-gallon esté lleno, introducir "10,0" para los galones o "37,85" para los litros). Para incorporar los números, utilizar el botón del CALIBRATE para cambiar el valor del dígito que está en centelleo. Utilizar el botón del DISPLAY para cambiar de puesto el "centelleo" al dígito siguiente.

8. Una vez que se incorpore el número correcto, presionar y soltar brevemente ambos botones. La exhibición ahora cambiará a un mensaje “RUN 02” en centelleo. Usted ahora ha instalado el nuevo punto de la cal-curva. Usted esta listo para terminar la calibración (paso 10) o incorporar otro nuevo punto de calibración (paso 9).
9. Para incorporar otro punto de calibración, vuelva a repetir los pasos del 3 al 8. Es posible fijar hasta 15 puntos de la cal-curva, y “run ##” del funcionamiento incrementará cada vez que usted repite el proceso de la calibración (run 01, run 02, run 03, etc., hasta el run 15).
10. Para terminar el proceso de la calibración, presionar y sostener ambos botones por cerca de 3 segundos hasta que usted vea el mensaje del “CAL End”. Después de que usted suelte los botones, la computadora reasumirá las operaciones normales con el nuevo punto(s) activos calibrados.
11. Si usted no ha dispensado ningún líquido, usted puede salir de la calibración sin cambiar la curva. Si el mensaje “run 01” está mostrando y usted no ha dispensado ningún líquido, sostenga ambos botones por cerca de 3 segundos hasta que usted vea el mensaje en un extremo del “CAL End”. Después de soltar los botones, la computadora reasumirá la operación normal y la vieja curva (si usted introdujo una en el pasado) sigue intacta.

Calibración Con El Módulo De Señal De Salida Condicionada

El factor K de su medidor aparece en el informe de la calibración como el número de pulsos por galón. El factor se determina durante la producción usando el agua a 70°F (21°C). Este factor K se puede utilizar para la calibración de “un solo punto” y proporcionará una exactitud aceptable. Sin embargo, las lecturas pueden no ser exactas cuando usted utiliza este método de la calibración en algunas situaciones. Un ejemplo es cuando usted utiliza el metro bajo condiciones de temperatura extremas o lo utiliza con los liquidos con excepción del agua.

Para mejorar la exactitud durante tales condiciones, recomendamos que un factor K especifico de uso esté determinado y utilizado para la calibración. Una calibración de “un solo punto” puede rendir una exactitud aceptable en el centro de la gama del flujo, pero cinco o más puntos de calibración pueden rendir un alto nivel de exactitud, especialmente en el extremo inferior de la gama del flujo.

MANTENIMIENTO

La utilización y el cuidado apropiados ampliarán la vida y el servicio del medidor.

Rotor De Turbina

El medidor practicamente no tiene necesidad de mantenimiento. Sin embargo, es importante que los movimientos del rotor ocurran libremente. Mantener el medidor limpio y libre de contaminantes.

Si el rotor no da vuelta libremente, aplicar un lubricante penetrante en el rotor, el eje, y los rodamientos. Quitar cualquier desecho o depósito del rotor usando un cepillo suave o una punta de prueba pequeña. Tenga cuidado de no dañar el rotor de turbina o los soportes.

⚠ PRECAUCIÓN

El aire comprimido a través del montaje de la turbina podría dañar el rotor.

Reemplazo De La Batería

El pantalla de la computadora funciona a través de dos baterías del litio de 3-voltios que puedan ser substituidas mientras que el medidor está instalado. Cuando las baterías se quitan o pierden la potencia, la hornada y los totales acumulativos seran reajustados a cero, pero las calibraciones de campo y de la fábrica se conservan.

Si la exhibición del medidor llega a estar débil o en blanco, substituir las baterías de esta manera:

1. Quitar los cuatro tornillos de la cara del metro y levantar la placa frontal de la turbina.
2. Quitar las viejas baterías y limpiar cualquier corrosión de los terminales.

3. Instalar las baterías nuevas. Cerciorarse de que el poste positivo esté en la posición correcta.
4. Cuando se substituyen las baterías, la placa frontal estará encendida. Comprobar la exhibición para asegurarse de que las funciones normales han resumido antes de montar otra vez.
5. Volver a sentar las baterías, en caso necesario, colocar la placa frontal en la cubierta de la turbina. Evite el daño causado por la humedad, cerciorarse de que el anillo esté asentado completamente. Apretar los cuatro tornillos en la placa frontal.

ESPECIFICACIONES

Entrada y Enchufe:

Modelos de Espiga (de tubo)

TM050/TM050-P	1/2 pulgada de 80, Espiga (de tubo)
TM075/TM075-P	3/4 pulgada de 80, Espiga (de tubo)
TM100/TM100-P	1 pulgada de 80, Espiga (de tubo)
TM150/TM150-P	1-1/2 pulgada de 80, Espiga (de tubo)
TM200/TM200-P	2 pulgada de 80, Espiga (de tubo)

Modelos de NPT

TM050-N/TM050-N-P	1/2" de NPT
TM075-N/TM075-N-P	3/4" de NPT
TM100-N/TM100-N-P	1" de NPT
TM150-N/TM150-N-P	1-1/2" de NPT
TM200-N/TM200-N-P	2" de NPT

Tipo Del Diseño: Turbina

Componentes Mojados:
Cubierta: PVC
Rodamientos: De Cerámica
Eje: Carburo De Tungsteno
Rotory Soportes: PVDF
Arandela De Retención: Acero Inoxidable

Tipo De Las Guarniciones: Espiga - de 80 o NPT (hembra)

Máxima Presión De Funcionamiento:
225 PSIG a los 73°F

Medidas De Estados Unidos

Unidad De La Medida: Galón

Gama Del Flujo:

1/2 pulgada	1 - 10 GPM
3/4 pulgada	2 - 20 GPM
1 pulgada	5 - 50 GPM
1-1/2 pulgada	10 - 100 GPM
2 pulgada	20 - 200 GPM

Exactitud con la Computadora: ±3.0% (la exactitud se puede mejorar con la calibración del campo)

Temperatura De Funcionamiento:
+32° a +140° F (No permitir que el líquido se congele dentro del metro.)

Temperatura Del Almacenaje:
-40° a +158° F

Peso Del Producto:*

	Espiga (de tubo)	**NPT**
1/2 pulgada	.38 lbs.	.55 lbs.
3/4 pulgada	.43 lbs.	.67 lbs.
1 pulgada	.49 lbs.	.84 lbs.
1-1/2 pulgada	.66 lbs.	1.38 lbs.
2 pulgada	.78 lbs.	1.78 lbs.

Dimensiones - Pulgadas
(Grosor x Altura x Longitud):**

	Sin conexión	**Con conexión**
1/2"	2.0 x 2.6 x 3.8	2.0 x 2.8 x 5.5
3/4"	2.0 x 2.7 x 3.8	2.0 x 2.9 x 5.5
1"	2.0 x 3.1 x 4.1	2.0 x 3.3 x 6.2
1-1/2"	2.1 x 3.7 x 5.4	2.3 x 3.9 x 7.6
2"	2.4 x 4.2 x 5.5	3.5 x 4.5 x 7.9

* El peso con la pantalla de la computadora. El módulo de señal de salida condicionada agrega .30 libras.

** Las dimensiones con la pantalla de la computadora. El módulo señal de salida condicionada agrega 1.1 pulgadas a la altura.

Medida Métrica

Unidad De La Medida: Litro

Gama Del Flujo:

1/2 pulgada	3,8 - 38 LPM
3/4 pulgada	7,6 - 76 LPM
1 pulgada	19 - 190 LPM
1-1/2 pulgada	38 - 380 LPM
2 pulgada	76 - 760 LPM

Exactitud con la Computadora: ±3.0% (la exactitud se puede mejorar con la calibración del campo)

Temperatura De Funcionamiento:
0° a +60° C (No permitir que el líquido se congele dentro del metro.)

Temperatura Del Almacenaje:
-40° a +70° C

Peso Del Producto:*

	Espiga (de tubo)	NPT
1/2 pulgada	.172 kg	.249 kg
3/4 pulgada	.195 kg	.304 kg
1 pulgada	.222 kg	.381 kg
1-1/2 pulgada	.299 kg	.626 kg
2 pulgada	.354 kg	.807 kg

Dimensiones - Centímetro (Grosor x Altura x Longitud): **

	Sin conexión	Con conexión
1/2"	5.0 x 6.6 x 9.6	5.0 x 7.1 x 13.9
3/4"	5.0 x 6.8 x 9.6	5.0 x 7.3 x 13.9
1"	5.0 x 7.8 x 10.4	5.0 x 8.3 x 15.7
1-1/2"	5.8 x 9.3 x 13.7	5.8 x 9.9 x 19.3
2"	6.0 x 10.6 x 13.9	8.8 x 11.4 x 20.0

* El peso con la pantalla de la computadora. El módulo de señal de salida condicionada agrega .136 kg.

** Las dimensiones con la pantalla de la computadora. El módulo señal de salida condicionada agrega 2.8 cm a la altura.

PIEZAS

Las piezas y los accesorios siguientes de recambio están disponibles para los medidores de los Series del TM:

Parte No.	Descripción
113435-1	Señal de salida condicionada cableado de módulo
113520-1	Systema de reemplazo de la batería
116000-1	Envase de calibración, grande (5 galones)
125508-03	1/2" - kit de la asamblea de la turbina
125508-04	1/2" NPT, PVC - kit de la asamblea de la turbina
125510-03	3/4" - kit de la asamblea de la turbina
125510-04	3/4" NPT, PVC - kit de la asamblea de la turbina
125512-03	1" - kit de la asamblea de la turbina
125512-04	1" NPT, PVC - kit de la asamblea de la turbina
125514-03	1-1/2" - kit de la asamblea de la turbina
125514-04	1-1/2" NPT, PVC - kit de la asamblea de la turbina
125516-03	2" - kit de la asamblea de la turbina
125516-04	2" NPT, PVC - kit de la asamblea de la turbina
901002-52	Anillo

Kits De la Computadora:

125509-03	1/2" - kit de la asamblea de la computadora
125511-03	3/4" - kit de la asamblea de la computadora
125513-03	1" - kit de la asamblea de la computadora
125515-03	1-1/2" - kit de la asamblea de la computadora
125517-03	2" - kit de la asamblea de la computadora

SERVICIO

Para la consideración de la garantía, contacte con su distribuidor local. Si usted necesita ayuda adicional, contacte con el departamento de servicios al cliente de GPI:

1-800-835-0113

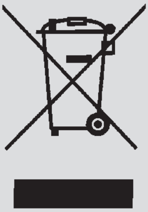
Usted necesitará:

- Proporcionar la información de la etiqueta en su medidor.
- Recibir un número de la autorización de devolución.
- Limpiar cualquier líquido con un chorro de agua del medidor antes de enviar a la fábrica.
- Si es posible, dejar las guarniciones instaladas por el cliente o una longitud amplia de la pipa pelada para la reinstalación.

⚠ PRECAUCIÓN

No devolver el metro sin la autoridad específica del departamento de servicios al cliente de GPI. Debido a las regulaciones terminantes gubernamentales GPI no aceptará los medidores para la reanudación a menos que estén totalmente libres de residuos líquidos peligrosos o inflamables, o líquidos de todos tipos durante el transporte, la dirección, y la disposición.

WEEE DIRECTIVA



La Directiva 2002/96/CE del Parlamento Europeo y del Consejo de la Unión Europea sobre Residuos de Aparatos Eléctricos y Electrónicos (RAEE) fue aprobada por el Parlamento Europeo y el Consejo de la Union Europea en 2003. Este símbolo indica que este producto contiene equipo eléctrico y electrónico que puede incluir baterías, tableros de circuito impresos, indicadores de crystal líquido u otros componentes que pueden estar sujetos a regulaciones locales de desecho. Por favor informese acerca de estas reglas y deseche de este producto de manera responasble.

DEUTSCH

WICHTIGE HINWEISS

Die TM Series Meßinstrumente mit Wasser und anderen Chemikalien benutzen, die mit Bestandteilen kompatibel sind, die Flüssigkeit (Spezifikationen Abschnitt sehen). Dieses Meßinstrument mit Kraftstoff oder anderen inkompatiblen Chemikalien nicht benutzen. TM Series Meßinstrumente sind entweder mit einem Computer für lokale elektronische Anzeige oder einer konditionierten Signalaus-gabebaugruppe vorhanden, die ein digitales Signal zu Kunde Schnittstellenmodul. TM Series mißt in Gallonen oder Litern. Auf den Kalibrie-rungsabschnitt für Einzelheit beziehen.

Diese Meßinstrumente sind nicht für den Handel zulässig.

TM Series Meßinstrumente sind gegen elektronische Störung sehr empfindlich, wenn sie innerhalb 2,5 bis 5 cm einiger Elektromotoren oder anderer Quellen des elektronischen Gebrauches bedient werden.

AUFSTELLUNG

Anschlüsse

Ihr Meßinstrument inline entweder am Ende des Schlauches neben der Düse horizontal oder vertikal anbringen. Installation zu Metallan-schlüssen wird nicht empfohlen. Diesen Schritten folgen, um anzubringen:

1. Planen, die Turbine mit einer minimalen Länge geraden Rohres anzubringen:
   - Gegen den Strom von der Turbine, einer minimalen Länge des geraden Rohres von 10mal dem internen Durchmesser der Turbine erlauben.
   - Stromabwärts von der Turbine, eine minimale Länge des geraden Rohres von 5mal dem inneren Durchmesser der Turbine erlauben.

2. Für Zentrierring (Pipe) Ende nur Spachtelmasse und Lösungsmittel verwenden, die zum Kleben von PVC erlaubt sind.
   Für NPT Befestigungen spule Teflon® Klebeband 3 bis 4 mal um die Pipe-Verbindungen. Sicherstellen, daß das Klebeband nicht das Innere des Rohres berührt.
3. Das Meßinstrument mit dem Pfeil anbringen, der in die Richtung des Flusses zeigt.
4. Für NPT Befestigungen nur Ihre Hände benutzen um die Pipe-Verbindun. Wenn Sie die Anschlüsse festziehen, sich erinnern, keine Werkzeuge zu benutzen.

Konditioniertes Signal Ausgeben Baugruppenverdrahtung

Diese konditionierte Signalausgabebaugruppe kann verdrahtet werden, um einen geöffneten Kollektorsignal-Ausgang oder Welle des Quadrats 6-volt Ausgang zur Verfügung zu stellen.

Öffnen Kollektor-Signal-Ausgang

Um einen geöffneten Kollektor Ausgang zu erzielen, Bezugsbauschaltplan 1 signalisieren. Der Klemmenblock ist auf der Rückseite des Moduls. Das Modul ist die Fabrik, die für geöffneten Kollektorsignalausgang. Zusammengebaut wird Den (820-Ohm-Minimum) Widerstand bitte zur Verfügung stellen.

10 Fuß (3m) Kabel wird mit dem Modul. Versehen Das Kabel zur gewünschten Länge trimmen oder das Kabel wie benötigt verlängern. Abstände bis 5.000 Fuß (1,524m) könne für geöffneten Kollektorsignalausgang erzielt werden.

Quadratischer Welle Ausgang

Um Quadratischen Welle Ausgang zu erzielen, Bezugsbauschaltplan 2 signalisieren und einen elektronischen Digital Meßinstrument-Batterie-Installationssatz (separat verkauft) für die Batterieleistung benutzen. Der Klemmenblock und die Batterieposition sind auf der Rückseite des Moduls. Zugang wie folgt:

1. Die vier Kreuzkopfschrauven von der Frontseite des Moduls entfernen. Das Modul von der Turbine anheben.
2. Um die Klemmenblockanschlüsse zu ändern, die passenden Schrauben lösen. Die Leitungen in den korrekten Positionen wieder anschließen und die Schrauben festziehen.
3. Die Batterien anbringen. Sicherstellen, daß der positive Pfosten in der richtigen Position ist.
4. Das Modul auf das Turbinegehäuse in Position bringen. Um Feuchtigkeit Beschädigung zu vermeiden, sicherstellen daß der dichtung völlig setzt. Die vier Schrauben an der Frontseite des Moduls festziehen.

10 Fuß (3m) Kabel wird mit dem Modul versehen. Das Kabel zur gewünschten Länge trimmen oder das Kabel wie benötigt verlängern.

MeßinstrumentGenauigkeit Überprüfen

Bevor Sie verwenden, die Genauigkeit des Meßinstruments überprüfen und die Kalibrierung überprüfen.

1. Überprüfen, daß es keine Luft in der Anlage gibt, indem Sie den Fluß beginnen, bis er ständig läuft. Dann den Fluß mit einem Ventil oder einer Düse stoppen.
2. Das Meßinstrument ein genau bekanntes Volumen in einen genauen Behälter abgeben lassen. Für beste Resultate mit einem ununterbrochenen vollen Strom messen.
3. Das Volumen gegen die Anzeige Oder die Aufnahmeausrüstung überprüfen. Wenn die Menge, die gemessen wird, genau ist, ist weitere Kalibrierung nicht notwendig. Wenn nicht, auf den Kalibrierungsabschnitt für weitere Anweisungen beziehen.

BETRIEB

Computer-Anzeige – Reihe und kumulative Gesamtmengen

Das Fließgeschwindigkeit-Eigenschaft behält zwei Gesamtmengen bei. Die kumulative Gesamtmenge liefert ununterbrochenes Maß und kann nicht manuell zurückgestellt werden. Die Zwischensumme kann zurückgestellt werden, um den Fluß während eines einzelnen Gebrauches zu messen. Die kumulative

Gesamtmenge wird mit TOTAL 1 LOCKED beschriftet. Dieses zeigt an, daß die Gesamtmenge verschlossen ist und nicht manuell auf Null eingestellt werden kann. Zwischensumme wird mit TOTAL 2 beschriftet.

Wenn die kumulative Gesamtmenge eine maximale Anzeige von 999.999 erreicht, stellt sich sie automatisch bis null zurück.

Die DISPLAY Anzeigentaste kurz betätigen, um zwischen Reihe, kumulative Gesamtmenge und Fließgeschwindigkeit zu schalten.

ANMERKUNG: Totalization zählt die Gesamtmaßeinheiten, ohne zwischen Gallonen, Litern oder nachgeeichten Maßeinheiten zu unterscheiden.

Fließgeschwindigkeit-Eigenschaft

Diese Funktion zu benutzen, betätigen und freizugeben "DISPLAY" bis "FLOWRATE" zu erscheint auf der linken Seite des Endergebnisses.

Wenn "FLOWRATE" angezeigt wird, reflektieren die Zahlen auf der mittleren Linie die Durchflußgeschwindigkeit, Z.B. die gegenwärtigen Gallonen pro Minute (GPM) oder Liter pro Minute (LPM).

Das Meßinstrument betätigen

Das Computeranzeige einschalten, indem Sie den Wasserfluß beginnen oder indem Sie kurz die DISPLAY-Taste betätigen. Die Reihe oder die kumulative Gesamtmenge vom letzten Gebrauch werden angezeigt.

Die DISPLAY-Taste kurz betätigen, um die Zwischensumme anzuzeigen. Die DISPLAY-Taste 3 Sekunden lang niederhalten, um die Zwischensumme auf Null zurückzustellen.

Das Meßinstrument ist so programmiert, das es sich automatisch abschaltet, wenn es 4 Minuten lang nicht in Betrieb ist.

Fabrik- und Nacheichungskurven

Alle Kalibrierungsinformationen sind als Wörter im oberen Teil der Anzeige, über den numerischen Stellen sichtbar.

Alle Maßeinheiten werden mit einer "Fabrik" Eichkurve hergestellt. Sie können entweder Gallonen oder Liter wählen ("GAL" oder "LTR" sind sichtbar). Die CALIBRATE und DISPLAY Tasten benutzen, um zwischen Gallonen und Liter zu schalten. Diese Eich-kurve ist NICHT vom Benutzer verstellbar. Das Wort PRESET Wird angezeigt, um dieses zu zeigen. (die Fabrikkali-brierung wird dauerhaft im Computerspeicher gespeichert.)

Die "Nacheichungskurve" kann vom Benutzer eingestellt werden. Die Kalibrierung kann jederzeit mit den Kalibrierungsverfahren, die im Kalibrierungsabschnitt beschrieben sind, geändert oder umgesteuert werden. Gesamtmengen oder Fließgeschwindigkeiten, die auf Nacheichung beruhen, werden sichtbar, wenn die Nacheichungseinstellung vorgewählt wird ("CAL B" ist auf der oberen Linie sichtbar).

Eine andere Kalibrierungseinstellung vorwählen

Sie können mit Leichtigkeit von GAL zum LTR Modus wechseln, ohne die Gesamtmengen zu verderben. Z.B. kann der Computer 10,00 Gallonen zusammenzählen. Wenn der Benutzer zum LTR-Modus schälter, auf ändert die Anzeige sofort "37,85" (die gleiche Menge in den Maßeinheiten von Litern). GAL/LTR-Schaltung arbeitet auch im FLOWRATE-Modus.

Um eine andere Kalibrierungseinstellung zu wählen, zuerst die CALIBRATE Taste drücken und halten. Weiterhin halten, Uahrend Sie die DISPLAY Taste ebenfalls pressen und freigeben. (Sie können die KALIBRIEREN-TASTE dann auch freigeben.) Die Markierungsfahnenanzeiger auf der obersten Linie ändern sich, sodass sie die neugewählte Kalibrierung anzeigen. Die Kalibrierungseinstellungen ändern sich in dieser Reihenfolge: GAL, LTR, CAL B, GAL, usw. Während die Flüssigkeit fließt, können nur GAL oder LTR gewahlt werden. Jedoch wenn KEINE Flüssigkeit fließt, kann irgendeine Vorwähl betätigt werden.

KALIBRIERUNG

Vor Dem Beginn, Kalibrierung auffangen

Für die genauesten Resultate an einer Fließgeschwindigkeit zuführen, die gut Ihre tatsächlichen Betriebsbedingungen. Simuliert Vermeiden, mehr Flüssigkeit "zu tröpfein" oder wiederholt den Fluß zu beginnen und zu stoppen. Dieses kann weniger genaue Kalibrierungen ergeban.

Stellen Sie Treffen die minimalen Fließgeschwindigkeitanforderungen des Meßinstruments sicher:

TM Series Meßinstrumente

1/2 Zoll	1 GPM (3,8 LPM)
3/4 Zoll	2 GPM (7,5 LPM)
1 Zoll	5 GPM (18,8 LPM)
1-1/2 Zoll	10 GPM (37,5 LPM)
2 Zoll	20 GPM (75 LPM)

Der Gebrauch eines gleichmäßig zuverlässigen, genauen Kalibrierung Behälters wird in hohem Grade für die genauesten Resultate empfohlen. Wegen der hohen Fließgeschwindigkeit, wird es stark empfohlen, daß Kalibrierung mit einer Kombination des Volumens und des Gewichts mit feine Auflösung Skalen durchgeführt wird.

Für beste Resultate sollte das Meßinstrument angebracht werden und bereinigt worden von der Luft vor Kalibrierung auffangen.

Kalibrierung mit Computer-Anzeige auffangen

Kalibrierung auffangen und Fabrik-Kalibrierung werden im vorhergehenden Abschnitt definiert. Die Fabrikkalibrierungseinstellung ist in jeden Strömungsmesser zur Zeit der Herstellung einprogrammiert worden, indem Wasser von 70°F (21°C) verwendet wurde. Anzeigen, die die Standardfabrikeichkurven benutzen, können möglicherweise nicht in einigen Situationen genau sein, Z.B. unter extremen Temperaturbedingungen. Wenn Sie ander Flüssigkeiten ausgenommen Wasser benutzen, können Sie Bereich-Kalibrieren das Meßinstrument.

Für verbesserte Genauigkeit unter solchen Bedingungen, erlaubt der Computer Nachei-chung, d.h., kundenspezifischen Kalibrierung-sparameter können eingegeben werden. Kalibrierung auf eine “einzelnen Punk” kann akzeptable Genauigkeit in der Mitt der Durchflußmenge ergeben, fünf oder mehr Kalibrierstellen können ein höheres Niveau der Genauigkeit, besonders am untereren Ende der Durchflußmenge erbringen. Bis 15 kundenspezifische Kalibrierstellen können eingetragen werden.

Zuführen/Anzeige auffangen Kalibrierung Verfahren

1. Die CALIBRATE-Taste heruntergedrückt halten während Sie DISPLAY betätigen und freigeben, bis die Nacheichungs-kurve erscheint (“CAL B” wird angezeigt). Beide der Tasten freigeben.
2. Zum Kalibrieren, die CALIBRATE-Taste betätigen und halten. Fortfahren, CALIBRATE Zu halten, die DISPLAY-Taste auch betätigen und halten. Beide der Tasten für ungefähr 3 Sekunden halten, bis Sie die blinkende Anzeige “dd-CAL” sehen. Sobald “dd-CAL” erscheint, beide der Tasten freigeben. Sie sind jetzt im Nacheichungsmodus.
3. Sobald die Tasten von Schritt 2 freigegeben worden sind, erscheint die Blinkenanzeige “run 01”. Wenn Sie den Kalibrierungsprozeß jetzt beenden möchten, bevor Sie irgendeine Flüssigkeit zuführen, zu Schritt 11 gehen.
4. Wenn Sie mit der Kalibrierung fortfahren möchten, aber noch keine Flüssigkeit zugeführt haben, die abschließenden Vorbereitungen an Ihrem Pumpsystem ausführen ohne mit pumpen anzufangen.
5. Ihr Pumpsystem anlassen, damit Flüssigkeit das Meßinstrument durchfließt. Die Anzeige stoppt zu blinken und zeigt die Anzeige “run 01”. Flüssigkeit in einen Behälter zuführen, der Ihnen erlaubt, die Menge der Flüssigkeit zu beurteilen. Wenn Sie die gewünschte Menge (zum Beispiel, 10 Gallonen) gepumpt haben, den Fluß schnell stoppen.
6. Wenn die Flüßigkeit aufgehört hat, zu fliessen, beide Tasten kurz betätigen und freigeben. An diesem Punkt ändert sich die Computeranzeige zum “0000.00” mit dem linken Stellenblinken.
7. Das Volumen (Menge) der Flüssigkeit eintragen, die Sie gepumpt haben (wenn Ihr 10-Gallonen-Behälter voll ist, “0,0” für Gallonen oder “37,85” für Liter zum Beispiel eintragen). Um die Zahlen einzutragen, die CALIBRATE-Taste benutzen, um den Wert der Stelle zu ändern, die blinkt. Die DISPLAY-Taste benutzen, um das “Blinzeln” auf die folgende Stelle zu verschieben.

8. Sobald die korrekte Zahl eingetragen ist, beide der Tasten kurz betätigen und freigeben. Die Anzeige ändert sich jetzt zum blinkenden “run 02”. Sie haben jetzt den neuen Calkurvenpunkt angebracht. Sie sind bereit, Kalibrierung (Schritt 10) zu beenden oder eine andere neue Kalibrierstelle (Schritt 9) einzutragen.
9 Um eine andere Kalibrierstelle einzutragen, zurück gehen und Schritte 3 bis 8 wiederholen. Es ist möglich, bis 15 Calkurvenpunkte einzustellen, und die “run ##” erhöht sich jede Mal, wenn Sie den Kalibrierungsprozeß wiederholen (run 01, run 02, run 03, usw., bis run 15).
10. Um den Kalibrierungsprozeß zu beenden, beide der Tasten für ungefähr 3 Sekunden betätigen und halten, bis Sie Anzeige “CAL End” sehen. Nachdem Sie die Tasten freigeben, nimmt der Computer Normalbetriebe mit dem neuen aktiven cal-point(s) wieder auf.
11. Wenn Sie keine Flüssigkeit zugeführt haben, können Sie Kalibrierung beenden, ohne die cal-Kurve zu ändern. Wenn “run 01” angezeigt ist und sie keine Flüßigkeit ausgelassen haben, beide Tasten ungefähr 3 Sekunden lang halten, bis Sie Anzeige “CAL End” sehen. Nach dem Sie die Tasten freigeben, nimmt der Computer Normalbetrieb wieder auf und die alte Kurve (wenn Sie vorher eine eingaben), ist noch intakt.

Kalibrierung mit konditionierter Signal-Ausgabebaugruppe

Der K-Faktor Ihres Meßinstruments erscheint auf dem Kalibrierung Report als die Zahl Impulsen pro Gallone. Der Faktor wird während der Produktion mit Wasser an 70°F (21°C) festgestellt. Dieser K-Faktor kann für Kalibrierung “des einzelnen Punktes” verwendet werden und wird eine annehmbare Genauigkeit liefern. Jedoch können die Messwerte möglicherweise nicht genau sein, wenn Sie diese Kalibrierung Methode in einigen Situationen verwenden. Ein Beispiel ist, wenn Sie das Meßinstrument unter extremen Temperaturbedingungen benutzen oder mit Flüssigkeiten anders als Wasser verwenden. Für verbesserte Genauigkeit unter solchen Bedingungen, empfehlen wir, daß ein K-Faktor Besondere zur Anwendung für die Kalibrierung festgestellt und verwendet wird. Eine Kali-brierung “des einzelnen Punktes” kann eine annehmbare Genauigkeit mitten in der Fluß-strecke erbringen, aber fünf oder mehr Kalibrierstellen können ein hohes Niveau der Genauigkeit, besonders am untereren Ende der Fluß-strecke erbringen.

WARTUNG

Die korrekte Behandlung und die Wartung verlängern das Leben und den Service des Meßinstruments.

Turbinenrotor

Das Meßinstrument ist praktisch wartungsfrei. Jedoch ist es wichtig, dass sich der Rotor frei bewegen kann. Das Meßinstrument sauber halten und von Verunreinigung freihalten.

Wenn der Läufer sich nicht frei dreht, ein Durchdringungsschmiermittel auf dem Läufer, der Welle und den Wellenlagern anwenden. Allen möglichen Rückstand oder Ablagerungen vom Läufer mit einer weichen Bürste oder einem kleinen Fühler entfernen. Achtgeben, daß Sie nicht den Turbinenrotor oder die Stützen beschädigen.

⚠ VORSICHT

Pressluft durch die Turbine blasen kann den Rotor beschädigen.

BatterieAustausch

Das Computeranzeige wird durch zwei 3-Volt Lithium Batterien angetrieben, die ausgetauscht werden können, während das Meßinstrument installiert ist. Die Zwischensummen und kumulativen Gesamtmengen stellen sich auf Null zurück, wenn die Batterien schwach werden oder entfernt worden sind. Die Fabrik- und Nacheichung bleibt erhalten.

Wenn die Meßinstrumentanzeige sich verdunkelt oder ausgeht, die Batterien austauschen, wie folgt:

1. Die vier Kreuzschlitzschrauben von der Vorderseite des Meßinstruments entfernen und die Frontplatte von der Turbine anheben.
2. Die alten Batterien entfernen und jede mögliche Korrosion von den Klemmen säubern.
3. Neue Batterien anbringen. Überprüfen, daß der positive Pfosten in der richtigen Position ist.
4. Wenn die Batterien ausgetauscht sind,zeigt die Frontplatte “POWER ON”. Die Anzeige überprüfen, um normale Funktionen sicherzustellen, bevor Sie wieder zusammenbauen.
5. Falls nötig, Batterieeinsetzung berichtigen, und die Frontplatte auf das Turbinegehäuse in Position bringen. Um Feuchtigkeitsbeschädigung zu vermeiden, überprüfen, daß der dichtung völlig sitzt. Die vier Schrauben an der Frontplatte festziehen.

SPEZIFIKATIONEN

Eingang und Anschluß:

Zentrierring (Pipe) Ende

TM050/TM050-P	1/2" Zeitplan 80, Zentrierring (Pipe) ende
TM075/TM075-P	3/4" Zeitplan 80, Zentrierring (Pipe) ende
TM100/TM100-P	1" Zeitplan 80, Zentrierring (Pipe) ende
TM150/TM150-P	1-1/2" Zeitplan 80 Zentrierring (Pipe) ende
TM200/TM200-P	2" Zeitplan 80, Zentrierring (Pipe) ende

Für NPT Befestigungen

TM050-N/TM050-N-P	1/2 Zoll NPT
TM075-N/TM075-N-P	3/4 Zoll NPT
TM100-N/TM100-N-P	1 Zoll NPT
TM150-N/TM150-N-P	1-1/2 Zoll NPT
TM200-N/TM200-N-P	2 Zoll NPT

DesignBaumuster: Turbine

Naßgemachte Bauteile:

Gehäuse: PVC
Achslager: Keramisch
Welle: Hartmetall
Läufer und Halterungen: PVDF
Haltering: Rostfreier Stahl

Zentrierring

Verbindungstyp: Zentrierring - Zeitplan 80 oder NPT (*Hohlgewinde)

Max. FunktionsDruck: 150 PSIG @ 73°F

U.S. Maß

Maßeinheit der Maßnahme: Gallone

FlußStrecke:

1/2 Zoll	1 - 10 GPM
3/4 Zoll	2 - 20 GPM
1 Zoll	5 - 50 GPM
1-1/2 Zoll	10 - 100 GPM
2 Zoll	20 - 200 GPM

Genauigkeit mit Computer: ± 3.0% (Genauigkeit kann mit verbessert werden auffangen Kalibrierung)

Betriebstemperatur: +32° zu +140° F (Flüssigkeit nicht innerhalf des Meßinstruments einfrieren lassen.)

SpeicherTemperatur: -40° zu +158° F

Gewicht des Produktes:*

	Zentrierring (Pipe)	NPT
1/2 Zoll	.38 lbs.	.55 lbs.
3/4 Zoll	.43 lbs.	.67 lbs.
1 Zoll	.49 lbs.	.84 lbs.
1-1/2 Zoll	.66 lbs.	1.38 lbs.
2 Zoll	.78 lbs.	1.78 lbs.

Abmessungen - Zoll (W x H x L):**

	Ohne Befestigungen	Mit Befestigungen
1/2"	2.0 x 2.6 x 3.8	2.0 x 2.8 x 5.5
3/4"	2.0 x 2.7 x 3.8	2.0 x 2.9 x 5.5
1"	2.0 x 3.1 x 4.1	2.0 x 3.3 x 6.2
1-1/2"	2.1 x 3.7 x 5.4	2.3 x 3.9 x 7.6
2"	2.4 x 4.2 x 5.5	3.5 x 4.5 x 7.9

* Das Gewicht mit der Computeranzeige. Die konditionierte Signalausgabebaugruppe addiert .30 Pfund.

** Die Maße mit der Computeranzeige. Konditionierte Signalausgabebaugruppe fügt 1.1 Zoll Höhe. hinzu.

Metrisches Maß

Maßeinheit: Liter

FlußStrecke:

1/2 Zoll	3,8 - 38 LPM
3/4 Zoll	7,6 - 76 LPM
1 Zoll	19 - 190 LPM
1-1/2 Zoll	38 - 380 LPM
2 Zoll	76 - 760 LPM

Genauigkeit mit Computer: ±3.0% (Genauigkeit kann mit verbessert werden auffangen Kalibrierung)

Betriebstemperatur: 0° zu +60° C (Flüssigkeit nicht innerhalf des Meßinstruments einfrieren lassen.)

SpeicherTemperatur: -40° zu +70° C

Gewicht des Produktes: *

	Zentrierring (Pipe)	NPT
1/2 Zoll	.172 kg	.249 kg
3/4 Zoll	.195 kg	.304 kg
1 Zoll	.222 kg	.381 kg
1-1/2 Zoll	.299 kg	.626 kg
2 Zoll	.354 kg	.807 kg

Abmessungen - Zentimeter (W x H x L):**

	Ohne Befestigungen	Mit Befestigungen
1/2"	5.0 x 6.6 x 9.6	5.0 x 7.1 x 13.9
3/4"	5.0 x 6.8 x 9.6	5.0 x 7.3 x 13.9
1"	5.0 x 7.8 x 10.4	5.0 x 8.3 x 15.7
1-1/2"	5.8 x 9.3 x 13.7	5.8 x 9.9 x 19.3
2"	6.0 x 10.6 x 13.9	8.8 x 11.4 x 20.0

* Das Gewicht mit der Computeranzeige. Die konditionierte Signalausgabebaugruppe addiert 136 Kilogramm.

** Die Maße mit der Computeranzeige. Konditionierte Signalausgabebaugruppe fügt 2.8 Zentimeter Höhe. hinzu

TEILE

Die folgenden Ersatzteile und die Zusatzgeräte sind für die TM Series Meßinstrumente vorhanden:

Teil Nr.	Beschreibung
113435-1	Konditioniertes Signal-Ausgabebau-gruppe
113520-1	Batterie AustauschInstallationssatz
116000-1	Kalibrierungsbehälter, groß (5 Gallone)
125508-03	1-/2 Zoll, Turbineeinheitsinstallationssatz
125508-04	1-/2 Zoll, NPT, PVC, Turbineeinheitsinstallationssatz
125510-03	3/4 Zoll, Turbineeinheitsinstallationssatz
125510-04	3/4 Zoll, NPT, PVC, Turbineeinheitsinstallationssatz
125512-03	1 Zoll, Turbineeinheitsinstallationssatz
125512-04	1 Zoll, NPT, PVC, Turbineeinheitsinstallationssatz
125514-03	1-1/2 Zoll, Turbineeinheitsinstallationssatz
125514-04	1-1/2 Zoll, NPT, PVC, Turbineeinheitsinstallationssatz
125516-03	2 Zoll, Turbineeinheitsinstallationssatz
125516-04	2 Zoll, NPT, PVC, Turbineeinheitsinstallationssatz
901002-52	Dichtung
Computereinheitsinstallationssatz:	
125509-03	1-/2 Zoll, Computereinheitsinstallationssatz
125511-03	3/4 Zoll, Computereinheitsinstallationssatz
125513-03	1 Zoll, Computereinheitsinstallationssatz
125515-03	1-1/2 Zoll, Computereinheitsinstallationssatz
125517-03	2 Zoll, Computereinheitsinstallationssatz

SERVICE

Für Garantiansprüche mit Ihrem lokalen Verteiler in Verbindung treten. Wenn Sie weitere Unterstützung benötigen, mit der GPI-Kundendienstabteilung in Verbindung treten:

1-800-835-0113

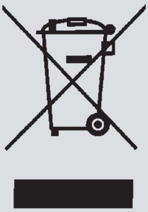
Sie benötigen:

- Informationen vom Abziehbild auf Ihrem Meßinstrument zur Verfügung stellen.
- Eine Rückholermächtigungszahl empfangen.
- Jede mögliche Flüssigkeit vom Meßinstrument spülen, bevor Sie zur Fabrik versenden.
- Wenn möglich, Abnehmer-angebrachte Befestigungen oder eine reichliche Länge des Rohres für Wiedereinbau belassen.

⚠ VORSICHT

Das Meßinstrument nicht ohne die spezifische Berechtigung der GPI-Kundendienstabteilung zurückbringen. Wegen der strengen Regelungen des Transportes, der Behandlung und der Beseitigung der gefährlichen oder feuergefährlichen Flüssigkeiten, nimmt GPI nicht Meßinstrumente für Überarbeitung an, es sei denn, class sie vom flüssigen Überrest vollständig frei sind.

WEEE RICHTLINIE



Der Richtlinie 2002/96/EG über Elektro- und Elektronik-Altgeräte (WEEE) des Europäischen Parlaments bzw. des EU-Ministerrats. Dieses simbol zeigt an, daß dieses Produkt elektrische und elektronische Ausrüstung, die Batterien mit einschließen kann, Printplatte verschalt, Flüssigkristall-Sichtanzeigen oder andere Bestandteile enthält, die abhängig von Einheimischvergeudung Regelungen sein können. Bitte verstehen Sie jene Regelungen wenn Sie dieses Produkt sich entledigen.

ITALIANO

AVVISO IMPORTANTE

Usare i tester dei Series del TM con acqua ed altri prodotti chimici che sono compatibili con le parti che sono esposti a liquido (vedere la sezione di specifiche). Non utilizzare questo tester con combustibile o altri prodotti chimici incompatibili. I tester di serie de TM sono disponib ili con un calcolatore per visualizzazione elettronica locale, o un modulo di uscita condizionato del segnale che fornisce un segnale numerico all'apparecchiatura di collegamento del cliente. I Series di TM misura la misura con un contatore nei galloni o nei litri. Riferirsi alla sezione di taratura per i particolari.

Questi tester non sono per le applicazioni commerciali.

I tester dei Series del TM sono molto sensibili ad interferenza elettronica se sono funzionati all'interno di 1 - 2 pollici di alcuni motori elettrici o di altre fonti di uso elettronico

INSTALLAZIONE

Collegamenti

Installare il vostro tester in linea orizzontalmente o verticalmente o all'estremità del tubo flessibile adiacente all'ugello. L'installazione ai collegamenti del metallo non è suggerita. Seguire questi punti per installare:

1. Progettare installare la turbina con una lunghezza minima del tubo diritto:
   - A monte dalla turbina, concedere ad una lunghezza minima di un tubo diritto di 10 volte il diametro interno della turbina.
   - A valle dalla turbina, concedere ad una lunghezza minima di un tubo diritto di 5 volte il diametro interno della turbina.
2. Per Spigot (Tuboture) scade usare soltanto più solventi approvati per l'incollatura del PVC.

   Per i Montaggi Del NPT circondare i collegamenti di tubo con nastri adesivi del Teflon® 3 -4 volte.
3. Fissare il tester con la freccia indicata nel senso del flusso.

4. Per i Montaggi Del NPT utilizzare soltanto le vostre mani per stringere i collegamenti. Non utilizzare gli attrezzi per stringere. Ciò può causare danni.

Segnale Condizionato Produrre Cablaggio Di Modulo

Questo modulo di segnale condizionato del può essere legato per fornire del collettore dell' segnale aperta o dell'onda del quadrato di 6-volti.

Collettore dell'Segnale Aperta

Per raggiungere Collettore dell' Segnale Aperta, Riferiscasi allo schema elettrico di riferimento 1. Il blocchetto terminali è situato dal lato posteriore del modulo. Il modulo è fabbrica montata per collettore dell' segnale aperta. Fornire prego il resistore di minimo di 820 Ohm.

Dieci piedi (3m) di cavo è fornito del modulo. Assettare il cavo alla lunghezza voluta o estendere il cavo come necessario. Le distanze fino a 5.000 piedi (1,524m) possono essere realizzate per l'collettore dell' segnale aperta.

Segnale Dell'Onda Quadrata

Per raggiungere segnale Dell'Onda Quadrata, Riferiscasi allo schema elettrico di riferimento 2 ed usare un corredo elettronico della batteria del tester di Digital (venduto esclusivamente) per la potenza della batteria. Il blocchetto terminali e la posizione della batteria sono situati dal modulo. Accesso come segue:

1. Rimuovere le quattro viti Phillips dalla parte anteriore del modulo. Alzare il modulo dalla turbina.
2. Per cambiare i collegamenti del blocchetto terminali, allentare le viti adatte. Ricollegare i legare nelle posizioni adequate e stringere le viti.
3. Installare le batterie. Assicurarsi che l'alberino positivo è nella posizione corretta.
4. Posizionare il modulo sull'alloggiamento della turbina. Evitare danni dell'umidità, assicurarsi che l'anello completamente è messo. Stringere le quattro viti sulla parte anteriore del modulo.

Dieci piedi (3m) di cavo è fornito del modulo. Assettare il cavo alla lunghezza voluta o estendere il cavo come necessario.

Verificare L'Esattezza Del Tester

Prima di utilizzare, controllare l'esattezza del tester e verificare la taratura.

1. Assicurarsi che non ci è aria nel sistema iniziando la quantità di fluido fino a che non funzioni costantemente. Allora, arrestare il flusso usando una valvola o un ugello.
2. Per mezzo del tester, misurare un volume conosciuto esatto in un contenitore esatto. Per i risultati migliori, misurare con un flusso pieno continuo.
3. Controllare il volume contro l'esposizione o l'apparecchiatura di registrazione. Se l'importo misurato è esatto, ulteriore calibratura non è necessaria. Se non, riferirsi alla sezione di taratura per ulteriori istruzioni.

FUNZIONAMENTO

Visualizzatore del computer - Partita e totali comulativi

Il computer effettua due totali. Il totale cumulativo fornisce la misura continua e non può essere ripristinato manualmente. Il totale in lotti può essere ripristinato per misurare il flusso durante il monouso. Il totale cumulativo è identificato con il del TOTAL 1 LOCKED. Ciò indica che il totale è locked e non può essere azzerato manualmente. Il totale in lotti è identificato con il TOTAL 2.

Quando il totale cumulativo raggiunge una lettura massima di 999.999, si ripristinerà automaticamente a zero.

Premere il tasto dell' DISPLAY brevemente per commutare fra il batch, il totale cumulativo ed il debito.

NOTA: Totalization conta le unità totali senza differenziare fra i galloni, i litri o le unità campotaratura.

Caratteristica indice di flusso

Usare questa caratteristica, premere e liberare "DISPLAY" fino "FLOWRATE" compare alla sinistra della linea inferiore.

Quando "FLOWRATE" è visualizzato, i numeri sulla linea centrale riflettono la portata. Per esempio, i galloni correnti per il minuto (gal/mn) o litri al minuto (LPM).

Attivare il Tester

Accendere il visualizzatore del computer iniziando il flusso dell' acqua o brevemente premendo il tasto del DISPLAY. Partita o il totale cumulativo dall'ultimo uso sarà visualizzato.

Premere il tasto del DISPLAY brevemente per visualizzare il totale in lotti. Tenere il tasto dell' DISPLAY affinchè 3 secondi ripristinino il totale in lotti a zero.

Il tester è programmato per spenga di automaticamente se non usato per 4 minuti.

Curve di calibratura del campo e della fabbrica

Tutte le informazioni di taratura sono visibili all'utente come parole nella parte superiore dell'esposizione, sopra le cifre numeriche.

Tutte le unità sono configurate con una curva di taratura "della fabbrica". Potete scegliere i galloni o i litri ("GAL" o "LTR" sarà visibile). Utilizzare i tasti del DISPLAY el del CALIBRATE per alternarsi fra i galloni ed i litri. Questa curva di taratura non è utente registrabile. La parola PRESET é visualizzata per mostrare questa. (la taratura della fabbrica sarà immagazzinata permanente nella memoria del calcolatore.)

La curva di taratura "del campo" può essere regolata dall'utente. La taratura può essere cambiata o modificata in qualunque momento seguendo le procedure di taratura descritte nella sezione di taratura. I totali o il debito hanno derivato dalla taratura del campo sono visibili quando la regolazione di taratura del campo è selezionata ("CAL B" sarà visibile sulla linea superiore).

Selezione della regolazione differente di calibratura

Si può commutare fra i modi del LTR e del GAL alla volontà senza "corrompere" i totali. Per esempio, il calcolatore può ammontare a 10,00 galloni. Se l'utente commuta al modo del LTR, l'esposizione immediatamente cambierà "a 37,85" (la stessa quantità nelle unità dei litri). La commutazione del GAL/LTR inoltre funziona nel modo del FLOWRATE.

Per selezionare una regolazione differente di taratura, una prima pressa e tenere il tasto di taratura (CALIBRATE). Continuare a tenere il tasto mentre però premendo e liberando il tasto dell'Esposizione (DISPLAY). (si può allora anche liberare il tasto di CALIBRATE.) Gli indicatori della bandierina nella linea superiore dell' esposizione cambieranno per mostrare la regolazione recentemente selezionata di taratura. Le regolazioni di taratura cambiano in questo ordine: GAL, LTR, CAL B, GAL, ecc. Mentre il liquido sta fluendo, solo le selezioni di LTR e di GAL possono essere fatte. Tuttavia, quando NESSUN liquido sta fluendo, qualsiasi selezione può essere fatta.

CALIBRATURA

Prima Di Cominciare Calibratura Del Campo

Per i risultati più esatti, erogare ad un debito che simula il più bene le vostre condizioni di gestione reali. Evitare di "gocciolare" più liquido o ripetutamente iniziare ed arrestare il flusso. Queste azioni provocheranno le calibrature meno esatte.

Vi assicurate raduno i requisiti minimi di debito del tester:

Tester Di Series di TM
Tester di 1/2 Pollice 1 GPM (3,8 LPM)
Tester da 3/4 di Pollice 2 GPM (7,5 LPM)
Tester da 1 Pollice 5 GPM (18,8 LPM)
Tester di 1-1/2 Pollice 10 GPM (37,5 LPM)
Tester da 2 Pollici 20 GPM (75 LPM)

Usando un contenitore credibile e ed esatto di taratura altamente è suggerito per i risultati più esatti. Dovuto l' alto debito, è suggerito vivamente che la calibratura è completata con una combinazione di volume e di peso usando le scale di alta risoluzione.

Per i risultati migliori, il tester dovrebbe essere installato ed eliminato l'inceppo di aria prima della taratura del campo.

Calibratura del campo con il visualizzatore del computer

La calibratura del campo e la calibratura della fabbrica sono definite nella sezione precedente. Le regolazioni di calibratura della fabbrica l'abitudine si è programmata in ogni flussometro durante la loro produzione usando l'acqua a 70°F (21°C). Le letture che usano le curve di taratura standard della fabbrica non possono essere esatte in alcune situazioni. Per esempio, quando nelle condizioni termiche estreme. Potete campo calibrare il tester se decidete misurare i liquidi tranne acqua.

Per esattezza migliorata in tali circostanze, i GPI fluiscono calcolatore tengono conto la taratura "del campo" (entrata di utente dei parametri di taratura su ordinazione) A "che la taratura del singolo punto" può rendere un'esattezza accettabile nel mezzo della gamma di flusso. Cinque o il più punti di taratura possono rendere un livello elevato di esattezza, particolarmente all'estremità più inferiore della gamma di flusso. Fino a 15 punti di taratura su ordinazione possono essere inseriti.

Erogare/Procedure Di Calibratura Campo Dell'Esposizione

1. Mantenere il tasto del CALIBRATE mentre premere e liberare il DISPLAY si abbottonano fino a che la curva di taratura del campo non compaia (messaggio di "CAL B" sarà visualizzata). Liberare entrambi i tasti.
2. Per calibrare, premere e tenere il tasto del CALIBRATE. Mentre continuano a tenere il CALIBRATE, inoltre premere e tenere il tasto del DISPLAY. Tenere entrambi i tasti per circa 3 secondi fino a che non vediate messaggio del "dd-CAL" di lampeggiamento. Una volta che il messaggio del "dd-CAL" compare, liberare entrambi i tasti. Siete ora nel modo di taratura del campo.
3. Una volta che i tasti sono stati liberati da punto 2, l'esposizione mostrerà che il messaggio di lampeggiamento "run 01". Se desiderate ora rimuovere il processo di taratura prima dell' erogazione del qualsiasi liquido, passare al punto 11.
4. Se desiderate continuare con la taratura, ma non avete erogato alcun liquido ancora, fare le vostre preparazioni finali al vostro sistema di pompaggio, ma non iniziare a pompare ancora.
5. Iniziare il vostro sistema di pompaggio in modo che il liquido attraversi il tester. L'esposizione smetterà di lampeggiare e mostrerà il messaggio di "run 01". Erogare il liquido in un contenitore che permette che giudichiate la quantità di liquido pompata. Quando avete pompato l'importo voluto (per esempio, 10 galloni), arrestare rapidamente la quantità di fluido.
6. Una volta il flusso ha arrestato, brevemente preme e libera entrambi i tasti. A questo punto il visualizzatore del computer cambierà a "0000.00" con il lampeggiamento a mano sinistra della cifra.
7. Entrare nel volume (importo) di liquido quello che avete erogato (per esempio, se il vostro contenitore di 10-gallon è pieno, impostare "10,0" per i galloni o "37,85" per i litri). Per entrare nei numeri, utilizzare il tasto del CALIBRATE per cambiare il valore della cifra che sta lampeggiando. Utilizzare il tasto del DISPLAY per spostare "il lampeggio" alla cifra seguente.
8. Una volta che il numero corretto è inserito, brevemente premere e liberare entrambi i tasti. L'esposizione ora cambierà ad un messaggio "run 02" di lampeggiamento. Ora avete installato il nuovo punto della caloria-curva. Siete pronti a concludere la taratura (punto 10) o ad entrare in un altro nuovo punto di taratura (punto 9).
9. Entrare in un altro punto di taratura, andare indietro e ripetere punti da 3 a 8. È possibile da installare a 15 punti della caloria-curva e il messaggio del "run ##" di funzionamento increment ogni volta ripetete il processo di taratura (run 01, run 02, run 03, ecc., fino al run 15).
10. Per concludere il processo di taratura, premere e tenere entrambi i tasti per circa 3 secondi fino a che non vediate messaggio dell "CAL End". Dopo che liberiate i tasti il calcolatore riprenderà i funzionamenti normali con il nuovo point(s) di caloria attivo.
11. Se non avete erogato alcun liquido, si può rimuovere la taratura senza cambiare la curva di caloria. Se il messaggio "run 01" sta mostrando e non avete erogato alcun liquido, tenete entrambi i tasti per circa 3 secondi fino a che non vedeste il messaggio dell' "CAL End". Dopo voi liberare i tasti, il calcolatore riprenderà il funzionamento normale e la vecchia curva (se impostaste uno nel passato) è ancora intatta.

Calibratura con il modulo di Segnale Condizionato Produrre

Il fattore K del vostro tester compare sul rapporto di calibratura come il numero di impulsi per il gallone. Il fattore è determinato durante la produzione usanto l'acqua a 70°F (21°C). Questo fattore K può essere usato per "la calibratura del singolo punto" e fornirà un'esattezza accettabile. Tuttavia, le letture non possono essere esatte quando usate questo metodo di calibrature in alcune situazioni. Un esempio è quando utilizzate il tester nelle condizioni termiche estreme o usate con i liquidi tranne acqua.

Per esattezza migliorata in tali circostanze, suggeriamo che un fattore K specifico all'applicazione è determinato ed usato per la calibratura. "Una calibratura del singolo punto" può rendere un'esattezza accettabile nel mezzo della gamma di flusso, ma cinque o il più punti di calibratura possono rendere un livello elevato di esattezza, particolarmente all'estremità più inferiore della gamma di flusso.

MANUTENZIONE

Il maneggiamento e la cura adeguati estenderanno la durata ed il servizio del tester.

Rotore Di Turbina

Il tester è virtualmente manutenzione-free. Tuttavia, è liberamente importante i movimenti del rotore. Mantenere il tester pulito ed esente dagli agenti inquinanti.

Se il rotore non gira liberamente, applicare un lubrificante penetrante sul rotore, sull'albero e sui cuscinetti. Rimuovere tutti i residui o depositi dal rotore usando una spazzola molle o una piccola sonda. Fare attenzione non danneggiare il rotore di turbina o i supporti.

⚠ ATTENZIONE

Appiattito fornisc tramite il complessivo della turbina ha potuto danneggiare il rotore.

Rimontaggio Della Batteria

Il visualizzatore del computer è alimentato da due batterie del litio 3-volt che possono essere sostituite mentre il tester è installato. Quando le batterie sono rimosse o perdono l'alimentazione, il batch ed i totali cumulativi ripristinati a zero ma le calibrature della fabbrica e del campo sono mantenuti.

Se l'esposizione del tester diventa fioca o in bianco, sostituire le batterie come segue:

1. Rimuovere le quattro viti della Phillips-testa dalla faccia del tester ed alzare la piastra frontale dalla turbina.
2. Rimuovere le vecchie batterie e liberare tutta la corrosione dai terminali.
3. Installare le nuove batterie. Assicurarsi che l'alberino positivo è nella posizione corretta.
4. Quando le batterie sono sostituite, la piastra frontale alimenterà SOPRA. Controllare l'esposizione per accertare le funzioni normali hanno ripreso prima del montaggio ancora.
5. Riposizionare le batterie, se necessario e posizionare la piastra frontale sull'alloggiamento della turbina. Evitare danni dell' umidità, assicurarsi che l'anello completamente è messo. Stringere le quattro viti sulla piastra frontale.

SPECIFICHE

Ingresso e Presa:

Montaggi Spigot (Tuboture) scade

TM050/TM050-P	1/2" Programma 80, Spigot (Tuboture)
TM075/TM075-P	3/4" Programma 80, Spigot (Tuboture)
TM100/TM100-P	1" Programma 80, Spigot (Tuboture)
TM150/TM150-P	1-1/2" Programma 80, Spigot (Tuboture)
TM200/TM150-P	2" Programma 80, Spigot (Tuboture)

Montaggi Del NPT

TM050-N/TM050-N-P	1/2 pollice NPT
TM075-N/TM075-N-P	3/4 pollice NPT
TM100-N/TM100-N-P	1 pollice NPT
TM150-N/TM150-N-P	1-1/2 pollice NPT
TM200-N/TM200-N-P	2 pollice NPT

Tipo Di Disegno: Turbina

Componenti Bagnati:

Alloggiamento: PVC
Cuscinetti: Di Ceramica
Albero: Carburo Di Tungsteno
Rotore e Supporti: PVDF
Fermo: Acciaio Inossidabile

Tipo Dei Collegamento: Spigot - Programma 80, o NPT (femmina)

Massimo Pressione Di Esercizio: 225 PSIG @ 73°F

Misura Degli Stati Uniti

Unità Della Disura: Gallone

Gamma Di Flusso:

1/2 pollice	1 - 10 GPM
3/4 pollice	2 - 20 GPM
1 pollice	5 - 50 GPM
1-1/2 pollice	10 - 100 GPM
2 pollice	20 - 200 GPM

Esattezza con il computer: ±3.0% (esattezza può essere migliorata con la calibratura del campo)

Temperatura Di Funzionamento: +32° a +140° F (Non lasciare che il liquido congeli all'inerno del tester.)

Temperatura Di Immagazzinaggio: -40° a +158° F

Peso Del Prodotto:*

	Spigot (Tuboture)	NPT
1/2 pollice	.38 lbs.	.55 lbs.
3/4 pollice	.43 lbs.	.67 lbs.
1 pollice	.49 lbs.	.84 lbs.
1-1/2 pollice	.66 lbs.	1.38 lbs.
2 pollice	.78 lbs.	1.78 lbs.

Dimensioni - Pollici (Larghezza, Altezza, Lunghezza):**

	Senza Montaggio	Con Montaggio
1/2"	2.0 x 2.6 x 3.8	2.0 x 2.8 x 5.5
3/4"	2.0 x 2.7 x 3.8	2.0 x 2.9 x 5.5
1"	2.0 x 3.1 x 4.1	2.0 x 3.3 x 6.2
1-1/2"	2.1 x 3.7 x 5.4	2.3 x 3.9 x 7.6
2"	2.4 x 4.2 x 5.5	3.5 x 4.5 x 7.9

* Il peso con il visualizzatore del computer. Il modulo di segnale condizionato produrre aggiunge .30 libbre.

** Le dimensioni con il visualizzatore del computer. Il modulo di segnale condizionato produrre aggiunge 1.1 pollice ad altezza.

Misura Metrica

Unità Della Misura: Litro

Gamma Di Flusso:

1/2 pollice	3,8 - 38 LPM
3/4 pollice	7,6 - 76 LPM
1 pollice	19 - 190 LPM
1-1/2 pollice	38 - 380 LPM
2 pollice	76 - 760 LPM

Esattezza con il computer: ± 3.0% (esattezza può essere migliorata con la calibratura del campo)

Temperatura Di Funzionamento: 0° a +60° C (Non lasciare che il liquido congeli all'inerno del tester.)

Temperatura Di Immagazzinaggio: -40° a +70° C

Peso Del Prodotto:*

	Spigot (Tuboture)	NPT
1/2 pollice	.172 kg	.249 kg
3/4 pollice	.195 kg	.304 kg
1 pollice	.222 kg	.381 kg
1-1/2 pollice	.299 kg	.626 kg
2 pollice	.354 kg	.807 kg

Dimensioni - Centimetro (Larghezza, Altezza, Lunghezza):**

	Senza Montaggio	Con Montaggio
1/2"	5.0 x 6.6 x 9.6	5.0 x 7.1 x 13.9
3/4"	5.0 x 6.8 x 9.6	5.0 x 7.3 x 13.9
1"	5.0 x 7.8 x 10.4	5.0 x 8.3 x 15.7
1-1/2"	5.8 x 9.3 x 13.7	5.8 x 9.9 x 19.3
2"	6.0 x 10.6 x 13.9	8.8 x 11.4 x 20.0

** Il peso con il visualizzatore del computer. Il modulo di segnale condizionato produrre aggiungil 136 chilogrammo.

*** Le dimensioni con il visualizzatore del computer. Il modulo di segnale condizionato produrre aggiunge 2.8 centimetri ad altezza.

PARTI

Le seguenti parti ed accessori di ricambio sono disponibili per i tester dei Series del TM:

Parte No.	Descrizione
113435-1	Segnale Condizionato Cablaggio Di Modulo
113520-1	Corredo Del Rimontaggio Della Batteria
116000-1	Contenitore Di Taratura, Grande (5 galloni)
125508-03	1/2 Pollice, Corredo Dell' Assemblea Della Turbina
125508-04	1/2 Pollice, NPT, PVC, Corredo Dell'Assemblea Della Turbina
125510-03	3/4 Di Pollice, Corredo Dell' Assemblea Della Turbina
125510-04	3/4 Di Pollice, NPT, PVC, Corredo Dell'Assemblea Della Turbina
125512-03	1 Pollice, Corredo Dell' Assemblea Della Turbina
125512-04	1 Pollice, NPT, PVC, Corredo Dell'Assemblea Della Turbina
125514-03	1-1/2 Pollice, Corredo Dell' Assemblea Della Turbina
125514-04	1-1/2 Pollice, NPT, PVC, Corredo Dell'Assemblea Della Turbina
125516-03	2 Pollici, Corredo Dell' Assemblea Della Turbina
125516-04	2 Pollici, NPT, PVC, Corredo Dell'Assemblea Della Turbina
901002-52	Anello
Corredo Del Calcolatore:	
125509-03	1/2 Pollice, Corredo Dell' Assemblea Del Calcolatore
125511-03	3/4 Di Pollice, Corredo Dell' Assemblea Del Calcolatore
125513-03	1 Pollice, Corredo Dell' Assemblea Del Calcolatore
125515-03	1-1/2 Pollice, Corredo Dell' Assemblea Del Calcolatore
125517-03	2 Pollici, Corredo Dell' Assemblea Del Calcolatore

SERVIZIO

Per considerazione della garanzia, mettersi in contatto con il vostro distributore locale. Se avete bisogno di ulteriore assistenza, mettersi in contatto con il reparto di servizio del cliente di GPI a:

1-800-835-0113

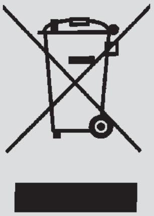
Avrete bisogno di:

- Fornire le informazioni dalla decalcomania sul vostro tester.
- Ricevere un numero di ritorno di autorizzazione.
- Irrigare tutto il liquido dal tester prima della spedizione alla fabbrica.
- Se possibile, lasciare i montaggi cliente-installati o una lunghezza ampia del tubo nudo per reinstallazione.

⚠ ATTENZIONE

Non restituire il tester senza l'autorità specifica dal reparto di servizio del cliente di GPI. dovuto le regolazioni rigorose governare il trasporto, il maneggiamento e l'eliminazione dei liquidi pericolosi o infiammabili, GPI non accetterà i tester per la ripresa a meno che siano completamente esenti da residuo liquido.

WIII DIRETTIVA



La direttiva 2002/96/EC del Parlamento europeo e del Consiglio dell'Unione europea sui rifiuti di apparecchiature elettriche ed elettroniche (RAEE) e stato aprovatto del Parlamento europeo e del Consiglio dell'Unione europea. Questo simbolo indica che questo prodotto contiene l'apparecchiatura elettrica ed elettronica che può includere le batterie, i bordi stampati del circuito, i display a cristalli liquidi o altri componenti che possono essere conforme alle regolazioni locali di eliminazione. Prego capire quelle regolazioni e disfare di questo prodotto in un modo responsabile.

FRANÇAIS

NOTIFICATION IMPORTANTE

Utilisez les compteurs de Séries de TM avec l'eau et d'autres produits chimiques qui sont compatibles avec les composants qui sont exposés au fluide (voir la section de caractéristiques). N'utilisez pas ce compteur avec du carburant ou d'autres produits chimiques incompatibles. Les compteurs de la série de TM sont disponibles avec un ordinateur pour la visualisation électronique locale, ou module du signal de sortie conditionné qui fournit un signal numérique à l'équipement d'interface de client. Les Séries de TM dosent la mesure en gallons ou litres. Référez-vous à la section de calibrage pour des détails.

Ces compteurs ne sont pas légaux pour les applications commerciales.

Les compteurs de Séries de TM sont très sensibles à l'interférence électronique s'ils sont actionnés à moins de 1 à 2 pouces de quelques moteurs électriques ou d'autres sources de bruit électronique.

INSTALLATION

Raccordements

Installez votre compteur en ligne horizontalement ou verticalement ou à l'extrémité du tuyau à côté du bec. L'installation aux raccordements en métal n'est pas recommandée. Suivez ces étapes pour installer:

1. Projetez installer la turbine avec une longueur minimum de pipe droite :
   - En amont de la turbine, permettez à une longueur minimum de la pipe droite de 10 fois le dia diamètre interne de la turbine.
   - En aval de la turbine, permettez à une longueur minimum de la pipe droite de 5 fois le diamètre interne de la turbine.
2. Pour des Spigot (Pipeau) Fin employez seulement mieux habillé et les dissolvants approuvés pour le collage de PVC.
   Pour des Raccordements de NPT enveloppez tous les raccordements de pipe avec la bande adhésive de Teflon® 3 ou 4 fois. Ne laissez pas le Teflon® glisser à l'intérieur de la pipe.
3. Attachez le compteur avec la flèche dirigée dans la direction de l'écoulement.
4. Pour des Raccordements de NPT utilisez vos mains pour serrer le compteur aux extrémités des raccordements. N'utilisez aucun outil pour serrer. Ceci peut endommager le logement.

Le Signal de Sortie Conditionné Le Câblage de Module

Ce module du signal de sortie conditionné peut être installer pour fournir un signal ouvert collecteur de sortie ou un signal carré de sortie de 6-V.

Le Signal Ouvert Collecteur de Sortie

Pour obtenir un signal ouvert collecteur de sortie, référez le diagramme de câblage 1. Le bloc terminal est situé de l'arrière du module. Le module est usine assemblée pour le signal ouvert collecteur de sortie. Fournissez la résistance (de minimum de 820 ohms).

Dix pieds (3m) de câble est fourni avec le module. Coupez le câble à la longueur désirée ou prolongez le câble selon les besoins. Les distances jusqu'a 5.000 pieds (1,524m) peuvent être obtenues pour le signal ouvert collecteur de sortie.

Le Signal Carré de Sortie

Pour obtenir le signal carré de sortie, référez le diagramme de câblage 2 et utilisez un kit électronique de batterie de compteur numérique (vendu séparément) pour la puissance de batterie. Le bloc terminal et l'endroit de batterie sont situés de'arière du module. Accès comme suit:

1. Enlevez les quatre vis Phillips de'avant du module. Soulevez le module de la turbine.

2. Pour changer les raccordements du block terminal, desserrez les vis appropriées. Rebranchez les fils en les positions appropriées et serrez les vis.
3. Installez les batteries. Assurez-vous que le poteau positif est en la position correcte.
4. Placez le module sur le logement de la turbine. Pour éviter les dommages d'humidité, vérifiez que le rondelle est entièrement sécurise. Serrez les quatre vis sur l'avant du module.

Dix pieds (3m) de câble est fourni avec le module. Coupez le câble à la longueur désirée ou prolongez le câble selon les besoins.

Vérifiez L'Exactitude de Compteurs

Avant l'utilisation, vérifiez l'exactitude du compteur et vérifiez le calibrage.

1. Assurez-vous qu'il n'y a aucun d'air dans le système en commençant l'écoulement de fluide jusqu'à ce qu'il fonctionne de façon constante. Puis, arrêtez l'écoulement en utilisant une valve ou un bec.
2. Mesurez un volume connu exact dans un récipient précis. Pour les meilleurs résultats, dosez avec un plein jet continu.
3. Vérifiez le volume contre l'écran ou l'équipement d'enregistrement. Si la quantité dosée est précise, le calibrage n'est pas nécessaire. Si pas, référez-vous à la section de calibrage pour des instructions complémentaires.

OPÉRATION

L'Ecran d'Ordinateur - La Groupe et les Totaux Cumulatifs

Le compteur maintient deux totaux. Le total cumulatif fournit la mesure continue et ne peut pas être manuellement remis à zéro. Le total de contrôle peut être remis à zéro pour mesurer l'écoulement pendant un à usage unique. Le total cumulatif est marqué avec le TOTAL 1 LOCKED. Ceci indique que le total est verrouillé et ne peut pas être manuellement mis à zéro. Le total de contrôle est marqué avec le TOTAL 2.

Quand le total cumulatif atteint une lecture maximum de 999.999, il remettra à zéro automatiquement à zéro.

Appuyez sur le bouton DISPLAY brièvement pour commuter entre le groupe, le total cumulatif, et le débit.

NOTE : Le compte totalization nombre toutes les unités sans différencier entre les gallons, les litres ou les unités champ-calibrées.

La Caractéristique du Débit

Pour utiliser cette caractéristique. Serrez et libérez DISPLAY jusqu'au FLOWRATE apparaît à la gauche du résultat inférieur.

Quand le FLOWRATE est montré, les nombres sur la ligne moyenne reflètent le débit, par exemple, les gallons par minute (GPM) ou les litres par minute (LPM).

Activez le Compteur

Mettez le L'ecran d'ordinateur ON en commençant l'écoulement de l'eau ou en appuyant sur brièvement le bouton de DISPLAY. Le groupe ou le total cumulatif de la dernière utilisation sera montré.

Appuyez sur le bouton de DISPLAY brièvement pour montrer le total de contrôle. Maintenez le bouton de DISPLAY pendant 3 secondes pour remettre le total de contrôle à zéro.

L'écran d'ordinateur est programmé pour s'arrêter automatiquement si non utilisé pendant 4 minutes.

Les Courbes Calibrage d'Usine et de Domaine

Toute l'information de calibrage est évidente à l'utilisateur comme mots dans la partie supérieure de l'affichage, au-dessus des chiffres numériques.

Toutes les unités sont configurées avec une courbe de calibrage "d'usine". Les gallons et les litres sont disponibles ("GAL" ou "LTR" sera évident). Utilisez les boutons de CALIBRATE et de DISPLAY pour commuter entre les gallons et les litres. Cette courbe de calibrage n'est pas utilisateur réglable. Le mot PRESET est montré pour montrer ceci. (Le calibrage d'usine est stocké de manière permanente dans la mémoire d'ordinateur.)

La courbe de calibrage de "champ" peut être placée par l'utilisateur, et peut être changé ou modifié à tout moment en utilisant les procédures de calibrage décrites dans la section de calibrage. Les totaux ou le débit ont dérivé du calibrage de champ sont évidents quand l'arrangement de calibrage de champ est choisi ("CAL B" sera évidente sur la ligne supérieure).

La Sélection d'un Réglage de Calibrage Différent

Vous pouvez commuter entre les modes de GAL et de LTR à la volonté sans contenu "de corruption" les totaux. Par exemple, l'ordinateur peut se monter à 10.00 gallons. Si l'utilisateur commute au mode de LTR, l'affichage changera immédiatement en "37.85" (la même quantité dans les unités des litres). La commutation de GAL/LTR fonctionne également en mode de FLOWRATE.

Pour choisir un arrangement différent de calibrage, une première, pressez et teniz le bouton de CALIBRATE. Continuez à tenir le bouton tout en également poussant et en libérant le bouton de DISPLAY. (Vous pouvez alors également libérer le bouton de CALIBRATE.) Les indicateurs dans la ligne supérieure de l'affichage changeront pour montrer le réglage nouvellement choisi de calibrage. Les arrangements de calibrage changent dans cet ordre: GAL, LTR, CAL B, GAL, etc… Tandis que le fluide coule, seulement les choix de GAL et de LTR peuvent être faits. Cependant, quand AUCUN fluide ne coule, n'importe quel réglage peut être choix.

CALIBRAGE

Avant de Commencer le Calibrage de Champ

Pour les résultats les plus précis, distribuez au débit qui simule mieux vos conditions de fonctionnement réelles. Évitez "de ruisseler" plus de fluide ou à plusieurs reprises de commencer et arrêter l'écoulement. Ces actions auront comme conséquence des calibrages moins précis.

Assurez-vous de répondre aux conditions minimum du débit du compteur:

Les Compteurs de Série de TM
Compteur de 1/2 pouce 1 GPM (3.8 LPM)
Compteur de 3/4 pouce 2 GPM (7.5 LPM)
Compteur de 1 pouce 5 GPM (18.8 LPM)
Compteur de 1-1/2 pouce 10 GPM (37.5 LPM)
Compteur de 2 pouces 20 GPM (75 LPM)

L'utilisation d'un récipient uniformément sûr et précis de calibrage est fortement recommandé pour les résultats les plus précis. En raison du débit élevé, on lui recommande vivement que le calibrage de champ soit accompli avec combinaison de volume et de poids en utilisant des balances de résolution fine.

Pour les meilleurs résultats, le compteur devrait être installé et purgé d'air avant le calibrage de champ.

Calibrage de Domaine avec l'Ecran d'Ordinateur

Le calibrage de domaine et le calibrage d'usine sont définis dans la section précédente. Les arrangements de calibrage d'usine sont programmés coutumes dans chaque ordinateur pendant leur production en utilisant l'eau à 70°F (21°C). Les lectures qui emploient les courbes de calibrage standard d'usine ne peuvent pas être précises dans quelques situations. Par exemple, dans des conditions extrêmes de la température ou avec les fluides autrement que l'eau.

Pour l'exactitude améliorée dans de telles conditions, l'ordinateur coulent de GPI tiennent compte du calibrage de "champ" (entrée d'utilisateur des paracompteurs de calibrage faits sur commande) Un calibrage de "seul point" peut rapporter une exactitude acceptable au milieu de la gamme d'écoulement, mois 5 points de calibrage ou plus peuvent rapporter un niveau plus élevé d'exactitude, particulièrement à l'extrémité inférieure de la gamme d'écoulement. Jusqu'à 15 points de calibrage faits sur commande peuvent être écrits.

Les Procédures de Distribuer/ Montrer de Calibrage de Champ

1. Maintenez le bouton de CALIBRATE tout en poussant et en libérent du DISPLAY jusqu'à ce que la courbe de calibrage de champ apparaisse (message de “CAL B” sera montré). Libérez les deux boutons.

2. Pour calibrer, pressez et tenez le bouton de CALIBRATE. Tout en continuant à tenir le CALIBRATE, également pressez et tenez le bouton de DISPLAY. Tenez les deux boutons pendant environ 3 secondes jusqu'à ce que vous voyiez un message clignotement “dd-CAL”. Quand le message du “dd-CAL” apparaît, libérez les deux boutons. Vous êtes maintenant en mode de calibrage de champ.

3. Quand les boutons ont été libérés de l'étape 2, l'affichage montrera le message de clignotement “run 01”. Si vous voulez sortir le procédé de calibrage maintenant avant de distribuer n'importe quel fluide, passez à l'étape 11.

4. Si vous voulez continuer le calibrage, mais n'as pas distribué n'importe quel fluide encore, faites vos préparations finales à votre système de pompage, mais ne commencez pas à pomper encore.

5. Commencez votre système de pompage de sorte que le fluide traverse le compteur. L'affichage cessera de clignoter et montrera le message de “run 01". Distribuez le fluide dans un récipient qui vous permet de juger la quantité de fluide pompée. Quand vous avez pompé la quantité désirée (par exemple, 10 gallons), arrêtez le flux de fluide rapidement.

6. Quand l'écoulement a arrêté, brièvement pressez et libérez tous les deux boutons. En ce moment l'affichage d'ordinateur changera en “0000.00” avec le chiffre à gauche clignotant.

7. Entrez le volume (quantité) de fluide cela que vous avez distribué (par exemple, si votre récipient de 10-gallon est plein, écrivez “10.0” pour des gallons ou “37.85” pour des litres). Pour écrire les nombres, utilisez le bouton de CALIBRATE pour changer la valeur du chiffre qui clignote. Utilisez le bouton de DISPLAY pour décaler le “clignotement” au prochain chiffre.

8. Quand le nombre correct est écrit, brièvement pressez et libérez tous les deux boutons. L'affichage changera maintenant en message de clignotement à “run 02”. Vous avez maintenant installé le nouveau point de cal-courbe. Vous étes prêts à finir le calibrage (étape 10) ou à écrire un autre nouveau point de calibrage (étape 9).

9. Pour écrire un autre point de calibrage, retournez et répétez les étapes 3 à 8. Il est possible d'installer à 15 points de cal-courbe, et le message de “run ##” incrémentera chaque fois que vous répétez le procédé de calibrage (run 01, run 02, run 03, etc., jusqu'à la run 15).

10. Pour finir le calibrage, pressez et tenez tous les deux boutons pendant environ 3 secondes jusqu'à ce que vous voyiez le message “CAL End”. Après que vous libérez les boutons l'ordinateur reprendra des opérations normales avec le nouveau point(s) de calibrage actif.

11. Si vous n'avez distribué aucun fluide, vous pouvez sortir le calibrage sans changer la courbe de calibrage. Si le message “run 01” et vous n'avez distribué aucun fluide, tenez les deux boutons pendant environ 3 secondes jusqu'à ce que vous voyiez le message de “CAL End”. Après vous libérez les boutons, l'ordinateur reprendra l'opération normale et la vieille courbe (si vu écriviez un du passé) est encore intacte.

Le Calibrage avec le Signal de Sortie Conditionné

Le K-facteur de votre compteur apparaît sur le rapport de calibrage comme les nombres d'impulsions par gallon. Le facteur est déterminé pendant la production en utilisant l'eau à 70°F (21°C). Ce K-facteur peut être utilisé pour le calibrage de “Point Seul” et fournira une exactitude acceptable. Cependant, les indications ne peuvent être pas précises quand vous utilisez cette méthode de calibrage dans quelques situations. Par exemple, quand vous utilisez le compteur dans les conditions extrêmes de la température ou quand vous utilisez le compteur avec d'autres fluides que l'eau.

Pour l'exactitude améliorée dans de telles conditions, nous recommandons qu'un K-facteur spécifique à l'application soit déterminé et utilisé pour le calibrage. Un calibrage de "Point Seul" peut produire une exactitude acceptable au milieu de la gamme de débit, mais cinq ou plus points de calibrage peuvent produire un niveau élevé d'exactitude, particulièrement à l'extrémité inférieure de la gamme de débit.

ENTRETIEN

La manipulation et le soin appropriés prolongeront la vie et le service du compteur.

Rotor De Turbine

Le compteur est pratiquement exempt d'entretien.Cependant, il est important que les rotor bouge librement. Maintenez le compteur propre et exempt des contaminations.

Si le rotor ne tourne pas librement, appliquez un lubrifiant pénétrant sur le rotor, l'axe, et les roulements. Enlevez tous les débris ou gisements du rotor en utilisant une brosse molle ou une petite sonde. Faites attention à n'endommager pas le rotor de turbine ou les appuis.

⚠ ATTENTION

Soufflage d'air comprimé à la turbine pourrait endommager le rotor.

Le Remplacement de la Batterie

L'écran d'ordinateur est actionné par deux batteries du lithium 3-volt qui peuvent être remplacées tandis que le compteur est installé. Quand les batteries sont enlevées ou perdent la puissance, le groupe et les totaux cumulatifs remis à zéro mais les calibrages de champ et d'usine sont maintenus.

Si l'affichage de l'écran d'ordinateur devient faible ou blanc, remplacez les batteries comme suit :

1. Enlevez les quatre vis de "Phillips" d'avant du compteur et soulevez et la plaque avant de la turbine.
2. Enlevez les vieilles batteries et nettoyez toute corrosion des bornes.
3. Installez les nouvelles batteries. Assurez-vous que le poteau positif est en position correcte.
4. Quand les batteries sont remplacées, la plaque actionnerait ON. Vérifiez l'affichage pour assurer des fonctions normales ont repris avant de se réunir encore.
5. Repositionnez les batteries, si nécessaire, et placez la plaque avant sur le logement de turbine. Pour éviter des dommages d'humidité, vérifiez que l'rondelle entièrement sécurise. Serrez les quatre vis sur l'avant de la plaque.

CARACTÉRISTIQUES

Admission Et Sortie:

Spigot (Pipeau) Fin de Modèle

TM050/TM050-N	Programme 80, Spigot (Pipeau) De 1/2"
TM075/TM075-N	Programme 80, Spigot (Pipeau) De 3/4"
TM100/TM100-N	Programme 80, Spigot (Pipeau) De 1"
TM150/TM150-N	Programme 80, Spigot (Pipeau) De 1-1/2"
TM200/TM200-N	Programme 80, Spigot (Pipeau) De 2"

Raccordements de NPT de Modèle

TM050-N/TM050-N-P	NPT De 1/2"
TM075-N/TM075-N-P	NPT De 3/4"
TM100-N/TM100-N-P	NPT De 1"
TM150-N/TM150-N-P	NPT De 1-1/2"
TM200-N/TM200-N-P	NPT De 2"

Type de Plan: Turbine

Composants Mouillés:

Loger: PVC
Coussinets: En Céramique
Axe: Carbure De Tungstène
Rotor Et Supports: PVDF
Arrêtoir: Acier Inoxydable

Type de Garniture: Spigot - Programme 80, ou NPT (femelle)

Pression d'Utilisation Maximale:
225 PSIG @ 73°F

Mésure des U.S.

Unité de Mesure: Gallon

Chaîne de écoulement:

1/2 pouce	1 - 10 GPM
3/4 pouce	2 - 20 GPM
1 pouce	5 - 50 GPM
1-1/2 pouce	10 - 100 GPM
2 pouce	20 - 200 GPM

L'exactitude avec l'ordinateur: ± 3.0% (l'exactitude peut être améliorée avec le calibrage de champ)

La Température de Fonctionnement: +32° à +140° F (Ne laissez pas le fluide de geler à l'intérieur du compteur.)

La Température de Stockage: -40° à +158° F

Les Poids de Produit:*

	Spigot (Pipeau)	**NPT**
1/2 pouce	.38 lbs.	.55 lbs.
3/4 pouce	.43 lbs.	.67 lbs.
1 pouce	.49 lbs.	.84 lbs.
1-1/2 pouce	.66 lbs.	1.38 lbs.
2 pouce	.78 lbs.	1.78 lbs.

Les Dimensions - Pouces (W x H x L):**

	Sans Raccord	**Avec Raccord**
1/2"	2.0 x 2.6 x 3.8	2.0 x 2.8 x 5.5
3/4"	2.0 x 2.7 x 3.8	2.0 x 2.9 x 5.5
1"	2.0 x 3.1 x 4.1	2.0 x 3.3 x 6.2
1-1/2"	2.1 x 3.7 x 5.4	2.3 x 3.9 x 7.6
2"	2.4 x 4.2 x 5.5	3.5 x 4.5 x 7.9

* Le poids avec l'écran d'ordinateur. Le signal de sortie conditionné ajoute .30 livres.

** Les dimensions avec l'écran d'ordinateur. Le signal de sortie conditionné ajoute 1.1 pouce à la hauteur.

Mesure Métrique

Unité de Mesure: Litre

Chaîne de l'Ecoulement:

1/2"	3.8 - 38 LPM
3/4"	7.6 - 76 LPM
1"	19 - 190 LPM
1-1/2"	38 - 380 LPM
2"	76 - 760 LPM

L'exactitude avec l'ordinateur: ± 3.0% (l'exactitude peut être améliorée avec le calibrage de champ)

La Température de Fonctionnement: 0° à +60° C (Ne laissez pas le fluide de geler à l'intérieur du compteur.)

La Température de Stockage: -40° à +70° C

Les Poids de Produit:*

	Spigot (Pipeau)	**NPT**
1/2 inch	.172 kg	.249 kg
3/4 inch	.195 kg	.304 kg
1 inch	.222 kg	.381 kg
1-1/2 inch	.299 kg	.626 kg
2 inch	.354 kg	.807 kg

Les Dimensions - cm (W x H x L):**

	Sans Raccord	**Avec Raccord**
1/2"	5.0 x 6.6 x 9.6	5.0 x 7.1 x 13.9
3/4"	5.0 x 6.8 x 9.6	5.0 x 7.3 x 13.9
1"	5.0 x 7.8 x 10.4	5.0 x 8.3 x 15.7
1-1/2"	5.8 x 9.3 x 13.7	5.8 x 9.9 x 19.3
2"	6.0 x 10.6 x 13.9	8.8 x 11.4 x 20.0

* Le poids avec l'écran d'ordinateur. Le signal de sortie conditionné ajoute 136 kilogramme.

** Les dimensions avec l'écran d'ordinateur. Le signal de sortie conditionné ajoute 2.8 centimètres à la hauteur.

PIÉCES

Les pièces et les accessoires de rechange suivants sont disponibles pour les compteurs de Séries de TM :

Le Numéro de Pièce	**La Description**
113435-1	Le Signal Conditionné Câblage de Module
113520-1	Kit de rechange de Batterie
116000-1	Récipient de calibrage, grand (5 gallons)
125508-03	1/2 pouce, kit d'Assemblée de turbine
125508-04	1/2 pouce, NPT, PVC, kit d'Assemblée de turbine
125510-03	3/4 pouce, kit d'Assemblée de turbine
125510-04	3/4 pouce, NPT, PVC, kit d'Assemblée de turbine
125512-03	1 pouce, kit d'Assemblée de turbine
125512-04	1 pouce, NPT, PVC, kit d'Assemblée de turbine
125514-03	1-1/2 pouce, kit d'Assemblée de turbine
125514-04	1-1/2 pouce, NPT, PVC, kit d'Assemblée de turbine
125516-03	2 pouces, kit d'Assemblée de turbine
125516-04	2 pouces, NPT, PVC, kit d'Assemblée de turbine
901002-52	Rondelle

Kits D'Ordinateur:

125509-03	pouce de 1/2, kit d'Assemblée d'ordinateur
125511-03	3/4 pouce, kit d'Assemblée d'ordinateur
125513-03	1 pouce, kit d'Assemblée d'ordinateur
125515-03	1-1/2 pouce, kit d'Assemblée d'ordinateur
125517-03	2 pouces, kit d'Assemblée d'ordinateur

SERVICE

Pour la considération de garantie, contactez votre distributeur local. Si vous avez besoin d'aide, contact le service à la clientèle de GPI à:

1-800-835-0113

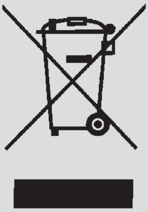
Vous aurez besoin:

- Fournissez les informations du décalque sur votre compteur.
- Recevez un nombre de retour d'autorisation.
- Rincez n'importe quel fluide du compteur avant l'expédition à l'usine.
- S'il est possible, laissez les garnitures installées par client ou de la longueur suffisante de la pipe nue pour la réinstallation.

⚠ ATTENTION

Ne renvoyez pas le compteur sans autorité spécifique du département de service à la clientèle de GPI. En raison des règlements stricts régir le transport, la manipulation, et la disposition des liquides dangereux ou inflammables, GPI n'acceptera pas des compteurs pour la reprise à moins qu'ils soient complètement exempts de résidu liquide.

WEEE DIRECTIVE



Le Waste Electrical and Electronic Equipment (WEEE) directive (2002/96/EC) a été approuvé par le Parlement Européan et le Conseil de l'Union Européene en 2003. Ce symbole indique que ce produit contient l'équipement électrique et électronique qui peut inclure les batteries, les cartes électroniques les affichages à cristaux liquides ou d'autres composants qui peuvent être sujets à des règlements locaux de disposition à votre endroit. Veuillez comprendre ces règlements et débarassez-vous de ce produit d'une façon responsable.

Declaration of Conformity

Manufacturer's Name: Great Plains Industries, Inc.
Manufacturer's Address: 5252 East 36th Street North
Wichita, KS USA 67220-3205

Declares, that the product:

Product Name: Conditioned Signal Module
TM Water Meter / Pulse Out
Model Numbers: 0N-0278
TM***-P
TM***-N-P

*Model numbers include all combinations
of an alpha-numeric series as illustrated above.*

Conform to the following Standards:

EMC: EN 50081-1 (Reference EN 55022)
EN 55082-1
EN 61000-3-2
EN 61000-3-3
EN 61000-4-2
EN 61000-4-3

Supplementary Information:
"The products comply with the requirements of the EMC Directive 89/336/EEC."

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature: Grant Nutter
Full Name: Mr. Grant Nutter
Position: President
Great Plains Industries, Inc.
Place: Wichita, KS USA
November 2007

CE

Declaration of Conformity

Manufacturer's Name: Great Plains Industries, Inc.
Manufacturer's Address: 5252 East 36th Street North
Wichita, KS USA 67220-3205

Declares, that the product:

Product Name: TM Series Water Meter
Model Numbers: TM050
TM075
TM100
TM150
TM200

Model numbers may include the suffix "-N"
to indicate thread type.

Conform to the following Standards:

EMC: EN 50081-1 (Reference EN 55022)
EN 55082-1

Supplementary Information:
"The products comply with the requirements of the EMC Directive 89/336/EEC."

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature: Grant Nutter
Full Name: Mr. Grant Nutter
Position: President
Great Plains Industries, Inc.
Place: Wichita, KS USA
November 2007

CE

Limited Warranty Policy

Great Plains Industries, Inc. 5252 E. 36th Street North, Wichita, KS USA 67220-3205, hereby provides a limited warranty against defects in material and workmanship on all products manufactured by Great Plains Industries, Inc. This product includes a 1 year warranty. Manufacturer's sole obligation under the foregoing warranties will be limited to either, at Manufacturer's option, replacing or repairing defective Goods (subject to limitations hereinafter provided) or refunding the purchase price for such Goods theretofore paid by the Buyer, and Buyer's exclusive remedy for breach of any such warranties will be enforcement of such obligations of Manufacturer. The warranty shall extend to the purchaser of this product and to any person to whom such product is transferred during the warranty period.

The warranty period shall begin on the date of manufacture or on the date of purchase with an original sales receipt. This warranty shall not apply if:

A. the product has been altered or modified outside the warrantor's duly appointed representative;
B. the product has been subjected to neglect, misuse, abuse or damage or has been installed or operated other than in accordance with the manufacturer's operating instructions.

To make a claim against this warranty, contact the GPI Customer Service Department at 316-686-7361 or 888-996-3837. Or by mail at:

Great Plains Industries, Inc.
5252 E. 36th St. North
Wichita, KS, USA 67220-3205

The company shall, notify the customer to either send the product, transportation prepaid, to the company at its office in Wichita, Kansas, or to a duly authorized service center. The company shall perform all obligations imposed on it by the terms of this warranty within 60 days of receipt of the defective product.

GREAT PLAINS INDUSTRIES, INC., EXCLUDES LIABILITY UNDER THIS WARRANTY FOR DIRECT, INDIRECT, INCIDENTAL AND CONSEQUENTIAL DAMAGES INCURRED IN THE USE OR LOSS OF USE OF THE PRODUCT WARRANTED HEREUNDER.

The company herewith expressly disclaims any warranty of merchantability or fitness for any particular purpose other than for which it was designed.

This warranty gives you specific rights and you may also have other rights which vary from U.S. state to U.S. state.

Note: In compliance with MAGNUSON MOSS CONSUMER WARRANTY ACT – Part 702 (governs the resale availability of the warranty terms).

GPI®
5252 East 36th Street North
Wichita, KS USA 67220-3205
TEL: 316-686-7361
FAX: 316-686-6746

GREAT PLAINS INDUSTRIES, INC.
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www.gpi.net
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Endress+Hauser Prowirl 72F

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Proline Prowirl 72F, 72W, 73F, 73W

Vortex flow measuring system
Reliable flow measurement of gas, steam and liquids

Application
For the universal measurement of the volume flow of gases, steam and liquids.
The mass flow of steam, water (as per IAPWS-IF97 ASME), natural gas (as per AGA NX-19/AGA8-DC92 detailed method/AGA8 Gross Method 1/SGERG-88), compressed air, other gases and liquids can also be measured with the aid of integrated temperature measurement and by reading in external pressure values (optional).

Maximum range of applications thanks to:
- Fluid temperature range from –200 to +400 °C
- Pressure ratings up to PN 250/Class 1500
- Sensor with integrated (optional) diameter reduction by one line size (R Style) or two line sizes (S Style)
- Dualsens version (optional) for redundant measurements with two sensors and electronics

Approvals for:
- ATEX, FM, CSA, TIIS, NEPSI, IEC
- HART, PROFIBUS PA, FOUNDATION Fieldbus
- Pressure Equipment Directive, SIL 2

Your benefits
The robust **Prowirl sensor**, tried and tested in over 100 000 applications, offers:
- High resistance to vibrations, temperature shocks, contaminated fluids and water hammer
- No maintenance, no moving parts, no zero-point drift ("lifetime" calibration)
- Software initial settings save time and costs

Additional possibilities:
- Complete saturated steam or liquid-mass measuring point in one single device
- Calculation of the mass flow from the measured variables volume flow and temperature in the integrated flow computer
- External pressure value read-in for superheated steam and gas applications (optional)
- External temperature value read-in for delta heat measurement (optional)

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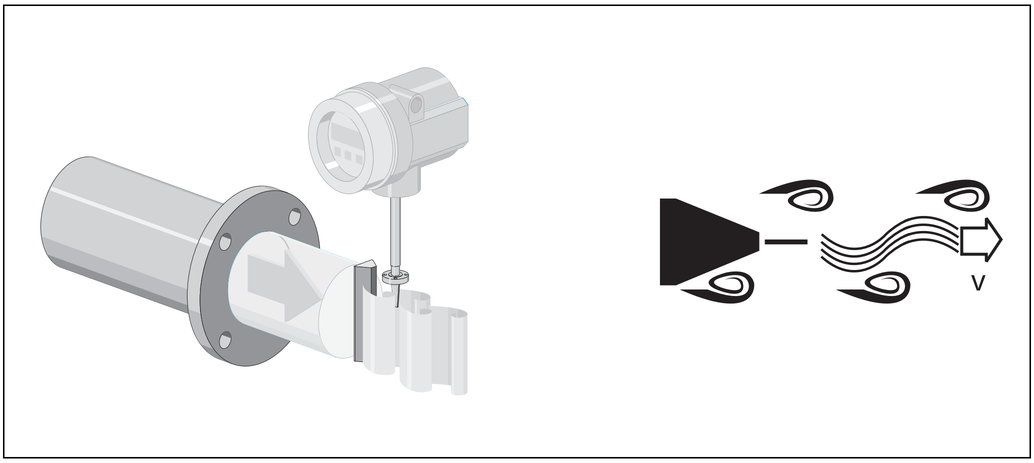
Table of contents

Function and system design

Measuring principle

Vortex meters work on the principle of the Karman vortex street. When fluid flows past a bluff body, vortices are alternately formed on both sides with opposite directions of rotation. These vortices each generate a local low pressure. The pressure fluctuations are recorded by the sensor and converted to electrical pulses. The vortices develop very regularly within the permitted application limits of the device. Therefore, the frequency of vortex shedding is proportional to the volume flow.



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The K-factor is used as the proportional constant:

$$\text{K-Factor} = \frac{\text{Pulses}}{\text{Unit Volume [dm}^3\text{]}}$$

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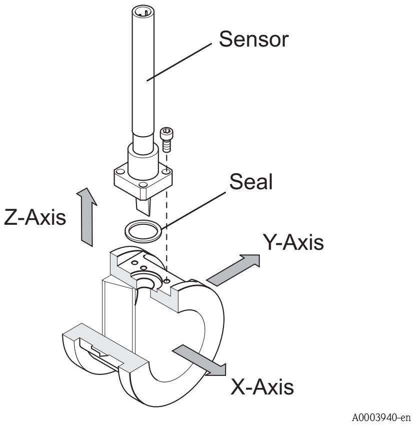
- Within the application limits of the device, the K-factor only depends on the geometry of the device. It is independent of the fluid velocity and the fluid properties viscosity and density. In this way, the K-factor is also independent of the type of matter that is to be measured, regardless of whether this is steam, gas or liquid.
- The primary measuring signal is already digital (frequency signal) and linear to the flow.
  After production, the K-factor is determined in the factory by means of calibration and is not subject to long-term or zero-point drift.
- The device does not contain any moving parts and does not require maintenance.

The capacitive sensor

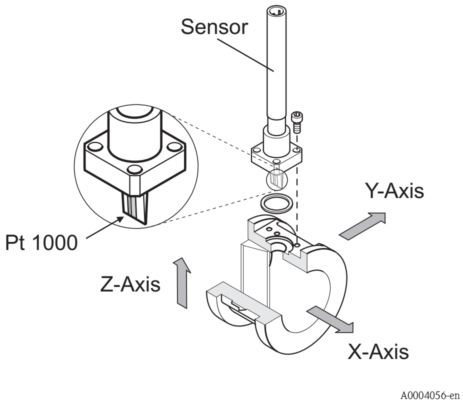
The sensor of a vortex flowmeter has a major influence on the performance, robustness and reliability of the whole measuring system.

The robust DSC sensor – with an integrated temperature measurement (Pt 1000) with Prowirl 73 – is burst-tested and vibration and temperature-shock-tested (temperature shocks of 150 K/s). The Prowirl uses the tried-and-tested capacitive measuring technology of Endress+Hauser applied in over 100 000 measuring points worldwide.

The DSC (differential switched capacitance) sensor patented by Endress+Hauser has complete mechanical balancing. It only reacts to the measured variable (vortex), not to vibrations. Even in the event of pipe vibrations, the smallest of flows can be reliably measured at low density thanks to the unimpaired sensitivity of the sensor. Thus, the wide turndown is also maintained even in the event of harsh operating conditions. Vibrations up to 1 g, in frequencies up to 500 Hz in every axis (X, Y, Z), do not affect the flow measurement. Due to its design, the capacitive sensor is also particularly mechanically resistant to temperature shocks and water hammers in steam lines.



DSC sensor, Prowirl 72



DSC sensor, Prowirl 73 with integrated thermometer (Pt 1000)

"Lifetime" calibration

Experience has shown that recalibrated Prowirl devices exhibit a very high degree of stability compared to their original calibration: The recalibration values were all within the original measuring accuracy specifications of the devices.
Various tests and simulation procedures carried out on devices by filing away the edges of Prowirl's bluff body found that there was no negative impact on the accuracy up to a rounding diameter of 1 mm.

Generally the following statements are true:
- Experience has shown that if the fluid is non-abrasive and non-corrosive (e.g. most water and steam applications), the meter's edges will never show rounding at the edges that is 1 mm or more.
- If the rounding of the meter's edges is always 1 mm or less, the meter will never show a calibration shift that is out of the meter's original specifications.
- Typically, the bluff body's edges exhibit a small rounding that is less than 1 mm. The meter, however, is calibrated with this rounded edge. Therefore, the meter will stay within the tolerance specifications as long as the additional wear and tear of the edge does not exceed an additional 1 mm.

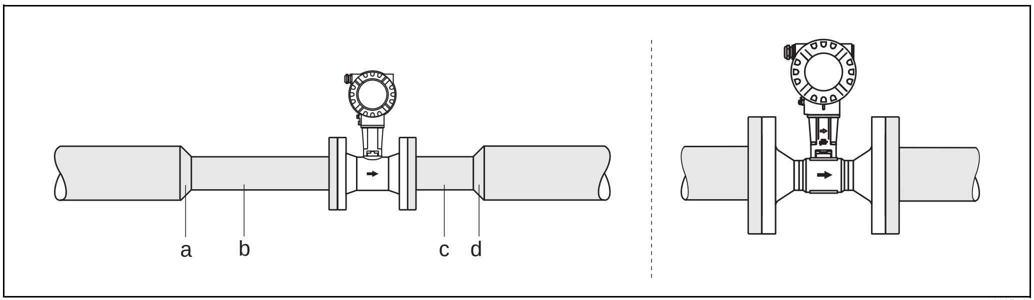
Thus, the Prowirl product line offers calibration for life if the measuring device is used in non-abrasive and non-corrosive fluids.

Sensor with integrated nominal diameter reduction

In many applications, the nominal diameter of the customer's pipe does not correspond to the nominal diameter that is optimum for a vortex meter as the flow velocity is too low for vortex formation after the bluff body. This is expressed in a signal loss in the lower flow range. To reduce the nominal diameter by one or two steps, and thus increase the flow velocity, it is common practice nowadays to fit such measuring points with the following adapters:

- Reducer (a)
- Straight pipe segment (b) as the inlet run (min. 15 × DN) in front of the vortex meter
- Straight pipe segment (c) as the outlet run (min. 5 × DN) after the vortex meter
- Expansion (d)

Endress+Hauser is now offering the Prowirl 72/73 vortex meter with integrated nominal diameter reduction for such applications.



Left: Traditional means for reducing pipeline section
Right: Nominal diameter reduction by using Prowirl with integrated line size reduction

Nomenclature for Prowirl vortex meters (flanged devices) with integrated nominal diameter reduction:
- Prowirl 72F/73F "R Style": single reduction of line size, e.g. from DN 80 to DN 50
- Prowirl 72F/73F "S Style": double reduction of line size, e.g. from DN 80 to DN 40 (S = "super" reduced).

These models offer the following benefits:

- Cost and time saving as the adapter pieces with inlet and outlet runs are completely replaced by one single device (additional inlet and outlet runs to be considered → 🗎 25)
- Measuring range extended for lower flow rates
- Lower risk (of incorrect measuring device layout) in the planning phase as R Style and S Style measuring devices have the same lengths as standard flanged devices. Each device type can be used alternatively without making complicated changes to the layout.
- Accuracy specifications identical to those for standard devices.

Temperature measurement (Prowirl 73)

In addition to the volume flow, the Prowirl 73 also measures the fluid temperature. The temperature is measured by means of a temperature sensor Pt 1000 which is located in the paddle of the DSC sensor, i.e. directly in the fluid (→ 🗎 4).

Flow computer (Prowirl 73)

The electronics of the measuring device have an integral flow computer. With the aid of this flow computer other process variables can be calculated from the primary measured variables (volume flow and temperature), e.g.:
- The mass flow and heat flow of saturated steam and water in accordance with IAPWS-IF97/ASME
- The mass flow and heat flow of superheated steam (at constant pressure or pressure read in via HART/ PROFIBUS PA/FOUNDATION Fieldbus) in accordance with IAPWS-IF97/ASME
- The mass flow and corrected volume flow of gases (at constant pressure or pressure read in via HART/ PROFIBUS PA/FOUNDATION Fieldbus), e.g. compressed air and natural gas AGA NX-19 (see below). Additional gases can be programmed using the real gas equation.
  In the case of 4 to 20mA HART devices, the following gases are preprogrammed:

Ammonia
Argon
Butane
Carbon dioxide
Chlorine
Ethane
Ethylene (ethene)

Helium 4
Hydrogen (normal)
Hydrogen chloride
Hydrogen sulfide
Krypton
Methane
Neon

Nitrogen
Oxygen
Propane
Xenon
Mixtures of up to 8 components of these gases

The heat flow (energy) of these gases is calculated as per ISO 6976 - based on the net calorific value or gross calorific value.

- Optional: natural gas AGA NX-19 (corrected volume flow and mass flow);
  Only for 4 to 20 mA HART: AGA8-DC92/ISO 12213-2/AGA8 Gross Method 1/SGERG-88 (corrected volume flow, mass flow, heat flow). For AGA8 Gross Method 1 and SGERG-88, the gross calorific value or the net calorific value can be entered to calculate the heat flow (energy). For AGA8-DC92 and ISO 12213-2, the data for the gross calorific value and net calorific value are stored in the device according ISO 6976.
- The mass flow of any liquid (linear equation). The gross calorific value or the net calorific value can be entered to calculate the heat flow (energy).
- Delta heat between saturated steam and condensate (second temperature value read in via HART) in accordance with IAPWS-IF97/ASME,
- Delta heat between warm water and cold water (second temperature value read in via HART) in accordance with IAPWS-IF97/ASME,
- In saturated steam measurements, the pressure of the steam can also be calculated from the measured temperature and output in accordance with IAPWS-IF97/ASME.

The mass flow is calculated as the product of volume flow x operating density. In the case of saturated steam, water and other liquids, the operating density is a function of the temperature. In the case of superheated steam and all other gases, the operating density is a function of the temperature and pressure.
The corrected volume flow is calculated as the product of volume flow x operating density, divided by the reference density. In the case of water and other liquids, the operating density is a function of the temperature. In the case of all other gases, the operating density is a function of the temperature and pressure.
The heat flow is calculated as the product of volume flow x operating density. In the case of saturated steam and water, the operating density is a function of the temperature. In the case of superheated steam, natural gas AGA8-DC92, natural gas ISO 12213-2, natural gas AGA8 Gross Method 1 and natural gas SGERG-88, the operating density is a function of the temperature and pressure.

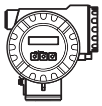
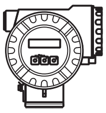
Diagnostic functions (Prowirl 73)

Extensive diagnostic options, such as retracing fluid and ambient temperatures, extreme flows etc., are also optionally available for the measuring device.

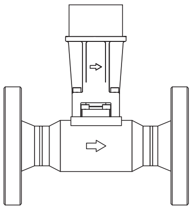
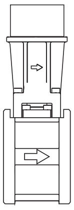
Measuring system

The measuring system comprises a sensor and a transmitter. Two versions are available:
- Compact version: sensor and transmitter form a mechanical unit.
- Remote version: sensor is mounted separate from the transmitter (up to max. 30 m).

Transmitter

Prowirl 72  A0009906	▪ Two-line liquid crystal display ▪ Configuration using pushbuttons ▪ Quick Setup for rapid commissioning ▪ Volume flow and calculated variables (mass flow or corrected volume flow)
Prowirl 73  A0009906	▪ Two-line liquid crystal display ▪ Configuration using pushbuttons ▪ Quick Setup for rapid commissioning ▪ Volume flow and temperature as well as calculated variables (mass flow, heat flow or corrected volume flow)

Sensor

F  A0009921	■ Flanged version ■ Range of nominal diameters DN 15 to 300 (½" to 12") ■ Material of measuring tube: e.g. – Stainless steel, A351-CF3M – Alloy C-22 (only for Prowirl 72)
W  A0009922	■ Wafer version (flangeless version) ■ Range of nominal diameters DN 15 to 150 (½" to 6") ■ Material of measuring tube: e.g. stainless steel, A351-CF3M

Input

Measured variable

Prowirl 72

- Volumetric flow (volume flow) is proportional to the frequency of vortex shedding after the bluff body.
- The following can be output as the output variable:
  - Volume flow
  - Mass flow or corrected volume flow (if process conditions are constant)

Prowirl 73

- Volumetric flow (volume flow) is proportional to the frequency of vortex shedding after the bluff body.
- The temperature can be output directly and is used to calculate the mass flow for example.
- The following can be output as the output variable:
  - The measured process variables volume flow and temperature
  - The calculated process variables mass flow, heat flow or corrected volume flow

Measuring range

The measuring range depends on the fluid and the nominal diameter.

Start of measuring range

Depends on the density and the Reynolds number ($Re_{min} = 4000$, $Re_{linear} = 20\,000$).
The Reynolds number is dimensionless and is the ratio of inertial forces to viscous forces of the fluid. It is used for characterizing the flow. The Reynolds number is calculated as follows:

$$Re = \frac{4 \cdot Q\ [m^3/s] \cdot \rho\ [kg/m^3]}{\pi \cdot di\ [m] \cdot \mu\ [Pa{\cdot}s]}$$

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Re = Reynolds number; Q = flow; di = internal diameter; m = dynamic viscosity, r = density

$$DN\ 15...25 \quad \rightarrow \quad v_{min.}{}^{*} = \frac{6}{\sqrt{\rho\ [kg/m^3]}}\ [m/s] \qquad DN\ 40...300 \quad \rightarrow \quad v_{min.}{}^{*} = \frac{7}{\sqrt{\rho\ [kg/m^3]}}\ [m/s]$$

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** with amplification 5*

Full scale value

Liquids: $v_{max} = 9$ m/s
Gas/steam: see table

Nominal diameter	v_{max}
Standard version: DN 15 (½") R Style: DN 25 (1") > DN 15 (½") S Style: DN 40 (1½") >> DN 15 (½")	46 m/s or Mach 0.3 (depending on which value is smaller)
Standard version: DN 25 (1"), DN 40 (1½") R Style: – DN 40 (1½") > DN 25 (1") – DN 50 (2") > DN 40 (1½") S Style: – DN 80 (3") >> DN 40 (1½")	75 m/s or Mach 0.3 (depending on which value is smaller)
Standard version: DN 50 (2") to 300 (12") R Style: – DN 80 (3") > DN 50 (2") – Nominal diameters larger than DN 80 (3") S Style: – DN 100 (4") >> DN 50 (2") – Nominal diameters larger than DN 100 (4")	120 m/s or Mach 0.3 (depending on which value is smaller) Calibrated range: up to 75 m/s

✎ Note!
By using the selection and planning program "Applicator", you can determine the exact values for the fluid you use. You can obtain the Applicator from your Endress+Hauser sales center or on the Internet under www.endress.com.

K-factor range

The table is used for orientation purposes. The range in which the K-factor can be is indicated for individual nominal diameters and designs.

Nominal diameter		K-factor range (pulses/dm^3)	
DIN/JIS	ANSI	72F/73F	72W/73W
DN 15	½"	390 to 450	245 to 280
DN 25	1"	70 to 85	48 to 55
DN 40	1½"	18 to 22	14 to 17
DN 50	2"	8 to 11	6 to 8
DN 80	3"	2.5 to 3.2	1.9 to 2.4
DN 100	4"	1.1 to 1.4	0.9 to 1.1
DN 150	6"	0.3 to 0.4	0.27 to 0.32
DN 200	8"	0.1266 to 0.1400	–
DN 250	10"	0.0677 to 0.0748	–
DN 300	12"	0.0364 to 0.0402	–

Measuring range for gases [m³/h or Nm³/h]

In the case of gases, the start of the measuring range depends on the density. With ideal gases, the density [ρ] or corrected density [ρ_N] can be calculated using the following formulae:

$$\rho\ [\text{kg/m}^3] = \frac{\rho_N\ [\text{kg/Nm}^3] \cdot P\ [\text{bar abs}] \cdot 273.15\ [\text{K}]}{T\ [\text{K}] \cdot 1.013\ [\text{bar abs}]} \qquad \rho_N\ [\text{kg/Nm}^3] = \frac{\rho\ [\text{kg/m}^3] \cdot T\ [\text{K}] \cdot 1.013\ [\text{bar abs}]}{P\ [\text{bar abs}] \cdot 273.15\ [\text{K}]}$$

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The following formulae can be used to calculate the volume [Q] or corrected volume [Q_N] in the case of ideal gases:

$$Q\ [\text{m}^3/\text{h}] = \frac{Q_N\ [\text{Nm}^3/\text{h}] \cdot T\ [\text{K}] \cdot 1.013\ [\text{bar abs}]}{P\ [\text{bar abs}] \cdot 273.15\ [\text{K}]} \qquad Q_N\ [\text{Nm}^3/\text{h}] = \frac{Q\ [\text{m}^3/\text{h}] \cdot P\ [\text{bar abs}] \cdot 273.15\ [\text{K}]}{T\ [\text{K}] \cdot 1.013\ [\text{bar abs}]}$$

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T = Operating temperature, P = operating pressure

Input signal

HART input functionality

Prowirl 73 (4 to 20 mA/HART version) is able to read in an external pressure, temperature or density value. The following order options are required for this purpose:

- Prowirl 73: output/input → option W (4–20 mA HART) or A (4–20 mA HART + frequency)
- 2 × active barrier RN221N–x1 (for x: A = for non-hazardous areas, B = ATEX, C = FM, D = CSA)
- If reading in pressure: 1 × Cerabar M or Cerabar S in burst mode (Cerabar can be set to burst mode using a HART handheld DXR275 or DXR375. Cerabar S Evolution can also be set to the burst mode via "FieldCare". Alternatively, Cerabar can also be ordered with the burst mode ready activated as a special product with the following order number: Cerabar M: TSPSC2821/52025523; Cerabar S: TSPSC2822/52025523.

When this functionality is used, the following signals can be made available to the control system, e.g. in an application with superheated steam:

- Pressure as 4 to 20 mA signal
- Temperature as 4 to 20 mA signal or frequency signal (only for Prowirl 73, option A (4 to 20 mA HART + frequency))
- Mass flow as pulse or frequency signal (only for Prowirl 73; output/input → option A)

Pressure input (PROFIBUS PA, FOUNDATION Fieldbus)

An external pressure value function block can be read in with Prowirl 73 (bus version). The following order options are required for this purpose:

PROFIBUS PA:
- Prowirl 73 → output/input → option H (PROFIBUS PA)
- Cerabar M → electronics/display → option P or R; → ceramic sensor → option 2F, 2H, 2M, 2P or 2S
  Cerabar S Evolution → output/operation → option M, N or O; → d:sensor range → option 2C, 2E, 2F, 2H, 2K, 2M, 2P or 2S

FOUNDATION Fieldbus (FF):
- Prowirl 73 → output/input → option K (FOUNDATION Fieldbus)
- Cerabar S Evolution → output/operation → option P, Q or R; → d:sensor range → option 2C, 2E, 2F, 2H, 2K, 2M, 2P or 2S

Output

Prowirl 72

By means of the outputs in the 4 to 20 mA/HART version of Prowirl 72, the volume flow and, if process conditions are constant, the calculated mass flow and corrected volume flow can be output via the current output and optionally via the pulse output or as a limit value via the status output.

Prowirl 73

By means of the outputs in the 4 to 20 mA/HART version of Prowirl 73, the following measured variables can generally be output:

	4 to 20 mA HART measuring devices				Profibus - PA (4 AI Blocks)	Foundation Fieldbus FF (7 AI Blocks)
	Current output	**Frequency output (only for output option A)**	**Pulse output (only for output option A)**	**Status output (only for output option A)**		
Saturated steam	■ Volume flow/mass flow/heat flow ■ Temperature ■ Saturation steam pressure	■ Volume flow/mass flow/heat flow ■ Temperature ■ Saturation steam pressure	■ Volume ■ Mass ■ Heat	■ Volume flow/mass flow/heat flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ Calculated saturated steam pressure limit value	■ Volume flow/mass flow/heat flow ■ Temperature ■ Saturation steam pressure ■ Specific enthalpy ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature	■ Volume flow/mass flow/heat flow ■ Temperature ■ Saturation steam pressure ■ Specific enthalpy ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature
Superheated steam	■ Volume flow/mass flow/heat flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume flow/mass flow/heat flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume ■ Mass ■ Heat	■ Volume flow/mass flow/heat flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ External pressure limit value (if it can be read in)	■ Volume flow/mass flow/heat flow ■ Temperature ■ Specific enthalpy ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature	■ Volume flow/mass flow/heat flow ■ Temperature ■ Specific enthalpy ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature
Water	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume ■ Mass ■ Heat ■ Corrected volume	■ Volume flow/mass flow/heat flow/corrected volume flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ External pressure limit value (if it can be read in)	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ Specific enthalpy ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ Specific enthalpy ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature

	4 to 20 mA HART measuring devices				**Profibus - PA (4 AI Blocks)**	**Foundation Fieldbus FF (7 AI Blocks)**
	Current output	**Frequency output (only for output option A)**	**Pulse output (only for output option A)**	**Status output (only for output option A)**		
Compressed air	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume ■ Mass ■ Corrected volume	■ Volume flow/mass flow/heat flow/corrected volume flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ External pressure limit value (if it can be read in)	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ Compressibility ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ Compressibility ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: – Reynolds number – Electronics temperature
Ar, NH3, C4H10, CO2, CO, Cl2, C2H6, C2H4, He 4, H2 (normal), HCl, H2S, Kr, CH4, Ne, N2, O2, C3H8, Xe*	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume ■ Mass ■ Heat ■ Corrected volume	■ Volume flow/mass flow/corrected volume flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ External pressure limit value (if it can be read in)	No data → Use real gas equation	No data → Use real gas equation
Mixtures of up to 8 of the components above	■ Volume flow/mass flow/heat flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume ■ Mass ■ Heat ■ Corrected volume	■ Volume flow/mass flow/corrected volume flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ External pressure limit value (if it can be read in)	No data → Use real gas equation	No data → Use real gas equation
Real gas equation	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ External pressure (if it can be read in)	■ Volume ■ Mass ■ Corrected volume	■ Volume flow/mass flow/corrected volume flow limit value ■ Temperature limit value ■ Totalizer limit value ■ Velocity limit value ■ External pressure limit value (if it can be read in)	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: electronics temperature	■ Volume flow/mass flow/corrected volume flow ■ Temperature ■ Frequency ■ Flow velocity ■ Totalizer ■ Optional: electronics temperature
* Argon, ammonia, butane, carbon dioxide, carbon monoxide, chlorine, ethane, ethylene (ethene), helium 4, hydrogen (normal), hydrogen chloride, hydrogen sulfide, krypton, methane, neon, nitrogen, oxygen, propane, xenon						

	4 to 20 mA HART measuring devices				**Profibus - PA (4 AI Blocks)**	**Foundation Fieldbus FF (7 AI Blocks)**
	Current output	**Frequency output (only for output option A)**	**Pulse output (only for output option A)**	**Status output (only for output option A)**		
Natural gas AGA NX-19	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/ corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External pressure limit value (if it can be read in)	▪ Volume flow/ mass flow/ corrected volume flow ▪ Temperature ▪ Supercompressibility ▪ Frequency ▪ Flow velocity ▪ Totalizer ▪ Optional: – Reynolds number – Electronics temperature	▪ Volume flow/ mass flow/ corrected volume flow ▪ Temperature ▪ Supercompressibility ▪ Frequency ▪ Flow velocity ▪ Totalizer ▪ Optional: – Reynolds number – Electronics temperature
Natural gas AGA8-DC92 detailed method	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/heat flow/corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External pressure limit value (if it can be read in)	No data → Use natural gas AGA NX-19 or real gas equation	No data → Use natural gas AGA NX-19 or real gas equation
Natural gas ISO 12213-2	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/heat flow/corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External pressure limit value (if it can be read in)	No data → Use natural gas AGA NX-19 or real gas equation	No data → Use natural gas AGA NX-19 or real gas equation
Natural gas AGA8 Gross Method 1	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/heat flow/corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External pressure limit value (if it can be read in)	No data → Use natural gas AGA NX-19 or real gas equation	No data → Use natural gas AGA NX-19 or real gas equation
* Argon, ammonia, butane, carbon dioxide, carbon monoxide, chlorine, ethane, ethylene (ethene), helium 4, hydrogen (normal), hydrogen chloride, hydrogen sulfide, krypton, methane, neon, nitrogen, oxygen, propane, xenon						

	4 to 20 mA HART measuring devices				Profibus - PA (4 AI Blocks)	Foundation Fieldbus FF (7 AI Blocks)
	Current output	Frequency output (only for output option A)	Pulse output (only for output option A)	Status output (only for output option A)		
Natural gas SGERG-88	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External pressure (if it can be read in)	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/heat flow/corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External pressure limit value (if it can be read in)	No data → Use natural gas AGA NX-19 or real gas equation	No data → Use natural gas AGA NX-19 or real gas equation
User-defined liquid	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/ corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value	▪ Volume flow/ mass flow/ corrected volume flow ▪ Temperature ▪ Frequency ▪ Flow velocity ▪ Totalizer ▪ Optional: electronics temperature	▪ Volume flow/ mass flow/ corrected volume flow ▪ Temperature ▪ Frequency ▪ Flow velocity ▪ Totalizer ▪ Optional: electronics temperature
Water delta heat application	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External temperature	▪ Volume flow/ mass flow/heat flow/corrected volume flow ▪ Temperature ▪ External temperature	▪ Volume ▪ Mass ▪ Heat ▪ Corrected volume	▪ Volume flow/ mass flow/heat flow/corrected volume flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External temperature limit value	No data	No data
Saturated steam delta heat application	▪ Volume flow/ mass flow/heat flow ▪ Temperature ▪ External temperature	▪ Volume flow/ mass flow/heat flow ▪ Temperature ▪ External temperature	▪ Volume ▪ Mass ▪ Heat	▪ Volume flow/ mass flow/heat flow limit value ▪ Temperature limit value ▪ Totalizer limit value ▪ Velocity limit value ▪ External temperature limit value	No data	No data
* Argon, ammonia, butane, carbon dioxide, carbon monoxide, chlorine, ethane, ethylene (ethene), helium 4, hydrogen (normal), hydrogen chloride, hydrogen sulfide, krypton, methane, neon, nitrogen, oxygen, propane, xenon						

If configured, the following calculated measured variables can also be displayed via the local display in Prowirl 73:

- Density
- Specific enthalpy
- Saturation steam pressure (for saturated steam)
- Z-factor
- Flow velocity

Output signal

Prowirl 72

Current output:

- 4 to 20 mA with HART,
- Full scale value and time constant (0 to 100 s) can be set

Pulse/status output:

- Open collector, passive, galvanically isolated
  - Non-Ex, Ex d/XP version: U_{max} = 36 V, with 15 mA current limiting, R_i = 500 Ω
  - Ex i/IS and Ex n version: U_{max} = 30 V, with 15 mA current limiting, R_i = 500 Ω

The pulse/status output can be configured as:

- Pulse output:
  - Pulse value and polarity can be selected
  - Pulse width can be configured (0.005 to 2 s)
  - Pulse frequency max. 100 Hz
- Status output:
  Can be configured for error messages or flow limit values
- Vortex frequency:
  - Direct output of unscaled vortex pulses 0.5 to 2850 Hz (e.g. for connecting to an RMC621 flow computer)
  - Pulse ratio 1:1
- PFM signal (pulse/frequency modulation):
  With external connection via flow computer RMC621 or RMS621

PROFIBUS PA interface:

- PROFIBUS PA in accordance with EN 50170 Volume 2, IEC 61158-2 (MBP), galvanically isolated
- Current consumption = 16 mA
- Error current FDE (fault disconnection electronic) = 0 mA
- Data transmission rate: supported baudrate = 31.25 kBit/s
- Signal encoding = Manchester II
- Function blocks: 1 × Analog Input, 1 × totalizer
- Output data: volume flow, calculated mass flow, corrected volume flow, totalizer
- Input data: positive zero return (ON/OFF), totalizer control
- Bus address can be set at the device via DIP switches

FOUNDATION Fieldbus interface:

- FOUNDATION Fieldbus H1, IEC 61158-2, galvanically isolated
- Current consumption = 16 mA
- Error current FDE (fault disconnection electronic) = 0 mA
- Data transmission rate: supported baudrate = 31.25 kBit/s
- Signal encoding = Manchester II
- Function blocks: 2 × Analog Input, 1 × Discrete Output
- Output data: volume flow, calculated mass flow, corrected volume flow, totalizer
- Input data: positive zero return (ON/OFF), totalizer reset
- Link Master (LM) functionality is supported

Prowirl 73

Current output:

- 4 to 20 mA with HART,
- Full scale value and time constant (0 to 100 s) can be set

Frequency output, pulse/status output:

- Frequency output (optional): open collector, passive, galvanically isolated
  - Non-Ex, Ex d/XP version: U_{max} = 36 V, with 15 mA current limiting, R_i = 500 Ω
  - Ex i/IS and Ex n version: U_{max} = 30 V, with 15 mA current limiting, R_i = 500 Ω

The pulse/status output can be configured as:

- Frequency output:
  - End frequency 0 to 1000 Hz (fmax = 1250 Hz)
- Pulse output:
  - Pulse value and polarity can be selected
  - Pulse width can be configured (0.005 to 2 s)
  - Pulse frequency max. 100 Hz
- Status output:
  Can be configured for error messages or flow values, temperature values, pressure limit values
- Vortex frequency:
  - Direct output of unscaled vortex pulses 0.5 to 2850 Hz
    (e.g. for connecting to an RMC621 flow computer)
  - Pulse ratio 1:1

PROFIBUS PA interface:

- PROFIBUS PA in accordance with EN 50170 Volume 2, IEC 61158-2 (MBP), galvanically isolated
- Current consumption = 16 mA
- Error current FDE (fault disconnection electronic) = 0 mA
- Data transmission rate: supported baudrate = 31.25 kBit/s
- Signal encoding = Manchester II
- Function blocks: 4 × Analog Input, 2 × totalizer
- Output data: volume flow, mass flow, corrected volume flow, heat flow, temperature, density, specific enthalpy, calculated steam pressure (saturated steam), operating Z-factor, vortex frequency, electronics temperature, Reynolds number, velocity, totalizer
- Input data: positive zero return (ON/OFF), totalizer control, absolute pressure, display value
- Bus address can be set at the device via DIP switches

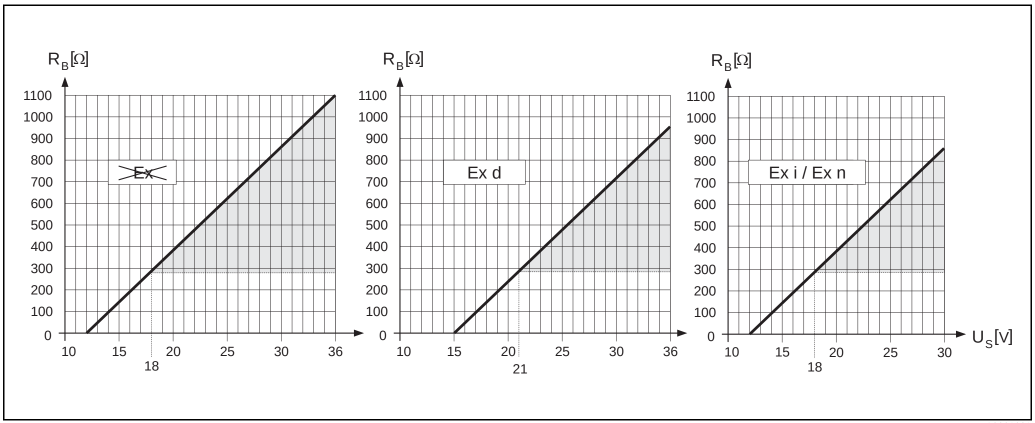
FOUNDATION Fieldbus interface:

- FOUNDATION Fieldbus H1, IEC 61158-2, galvanically isolated
- Current consumption = 16 mA
- Error current FDE (fault disconnection electronic) = 0 mA
- Data transmission rate: supported baudrate = 31.25 kBit/s
- Signal encoding = Manchester II
- Function blocks: 6 × Analog Input, 1 × Discrete Output, 1 × Analog Output
- Output data: volume flow, mass flow, corrected volume flow, heat flow, temperature, density, specific enthalpy, calculated steam pressure (saturated steam), operating Z-factor, vortex frequency, electronics temperature, Reynolds number, velocity, totalizer 1 + 2
- Input data: positive zero return (ON/OFF), totalizer reset, absolute pressure
- Link Master (LM) functionality is supported

Signal on alarm

- Current output: error response can be selected (e.g. in accordance with NAMUR Recommendation NE 43)
- Pulse output: error response can be selected
- Status output: "not conducting" in event of fault

Load



The area shaded gray refers to the permitted load (for HART: min. 250 Ω)
The load is calculated as follows:

$$R_B = \frac{(U_S - U_{Kl})}{(I_{max} - 10^{-3})} = \frac{(U_S - U_{Kl})}{0.022}$$

R_B	*Load, load resistance*
U_S	*Supply voltage: non-Ex = 12 to 36 V DC; Ex d /XP= 15 to 36 V DC; Ex i /IS and Ex n = 12 to 30 V DC*
U_{Kl}	*Terminal voltage: non-Ex = min. 12 V DC; Ex d/XP = min. 15 V DC; Ex i/IS and Ex n = min. 12 V DC*
I_{max}	*Output current (22.6 mA)*

Low flow cut off

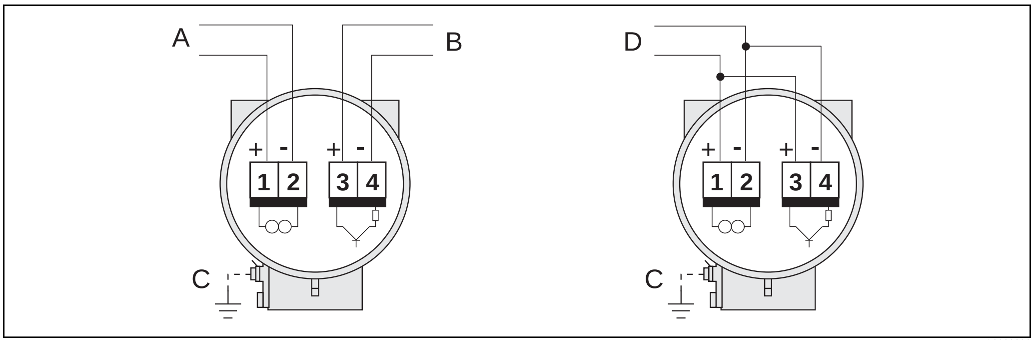
Switch points for low flow cut off can be selected as required.

Galvanic isolation

All electrical connections are galvanically isolated from one another.

Power supply

Electrical connection



A0003392

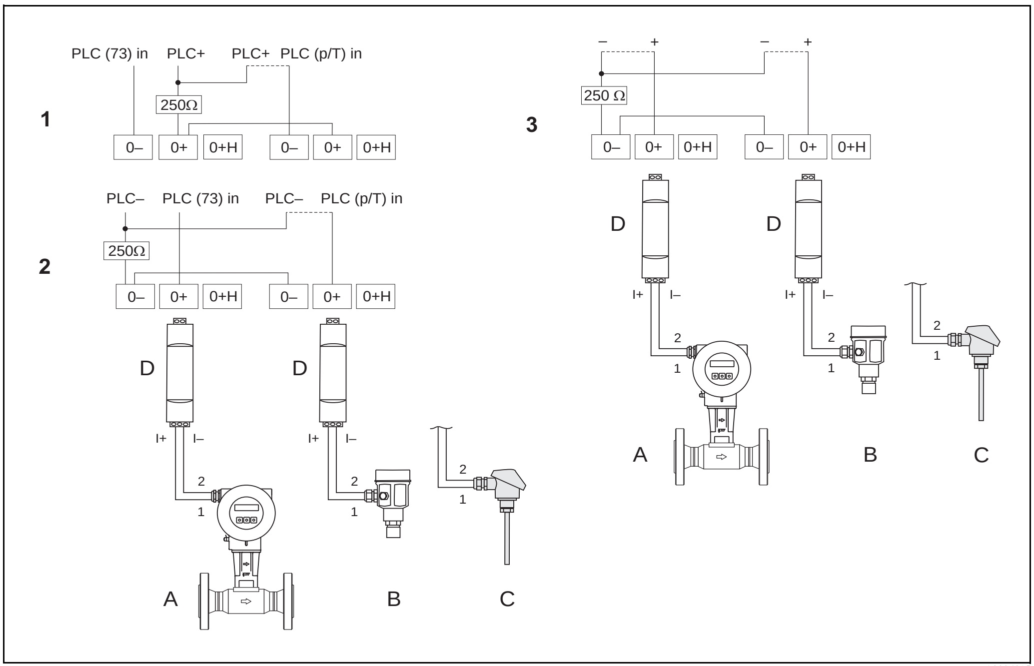
A *– HART: power supply, current output*
– PROFIBUS PA: 1 = PA+, 2 = PA–
– FOUNDATION Fieldbus: 1 = FF+, 2 = FF–

B *Optional pulse output (not for PROFIBUS PA and FOUNDATION Fieldbus), can also be operated as:*
– Status output
– Only Prowirl 73: frequency output
– Only Prowirl 73: as a PFM output (pulse/frequency modulation) together with an RMC621 or RMS621 flow computer

C *Ground terminal (relevant for remote version)*

D *Only Prowirl 72: PFM (pulse/frequency modulation) wiring for connecting to flow computer RMC621 or RMS621*

Wiring HART input



A0004215

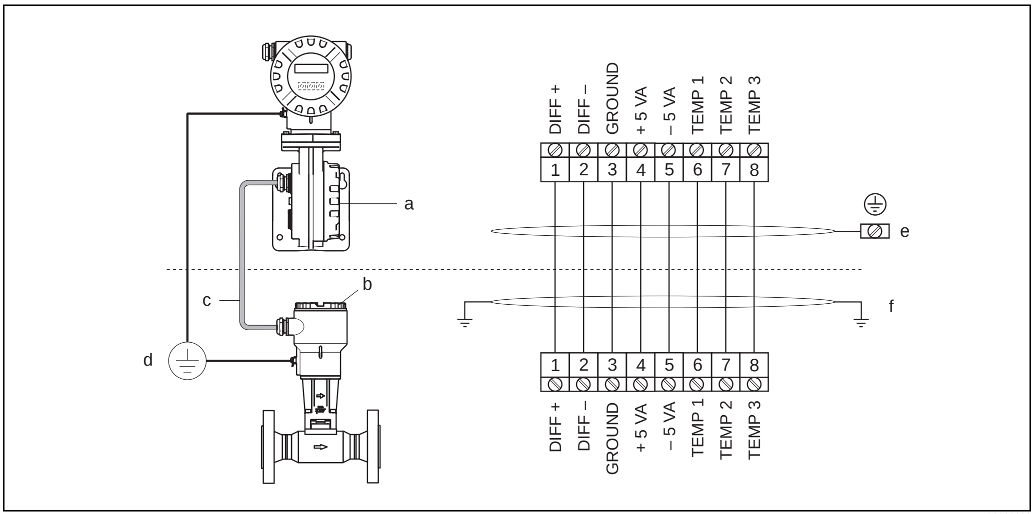
1 *Connection diagram for PLC with common "plus"*
Dotted line = alternative wiring when only the signal of the Prowirl 73 is fed to the PLC.

2 *Connection diagram for PLC with common "minus"*
Dotted line = alternative wiring when only the signal of the Prowirl 73 is fed to the PLC.

3 *Connection diagram without PLC*
Dotted line = wiring without connection to external components (e.g. recorder, displays, Fieldgate, etc.)

A = Prowirl 73, B = pressure sensor (Cerabar M), C = temperature sensor (Omnigrad TR10) or other external measuring devices (HART-enabled and burst-enabled), D = active barrier RN221N

Wiring remote version



Connecting the remote version

a = Connection compartment cover (transmitter)
b = Connection compartment cover (sensor)
c = Connecting cable (signal cable)
d = Identical potential matching for sensor and transmitter
e = Connect shielding to ground terminal in transmitter housing and keep as short as possible
f = Connect shielding to cable strain relief clamp in connection housing

Wire colors (color code according to DIN 47100):
Terminal number: 1 = white; 2 = brown; 3 = green; 4 = yellow, 5 = gray; 6 = pink; 7 = blue; 8 = red

Supply voltage

HART:

- Non-Ex: 12 to 36 V DC (with HART: 18 to 36 V DC)
- Ex i/IS and Ex n: 12 to 30 V DC (with HART: 18 to 30 V DC)
- Ex d/XP: 15 to 36 V DC (with HART: 21 to 36 V DC)

PROFIBUS PA and FOUNDATION Fieldbus:

- Non-Ex: 9 to 32 V DC
- Ex i/IS and Ex n: 9 to 24 V DC
- Ex d/XP: 9 to 32 V DC
- Current consumption → PROFIBUS PA: 16 mA, FOUNDATION Fieldbus: 16 mA

Cable entries

Power supply and signal cables (outputs):
- Cable entry M20 × 1.5 (6 to 12 mm)
- Thread for cable entry: ½" NPT, G ½", G ½" Shimada
- Fieldbus connector

Cable specifications

- Permitted temperature range:
  Between –40 °C and the max. ambient temperature permitted plus 10 °C

Power supply failure

- Totalizer stops at the last value determined.
- All settings are kept in the EEPROM.
- Error messages (incl. value of operated hours counter) are stored.

Performance characteristics

Reference operating conditions

Error limits following ISO/DIN 11631:
- 20 to 30 °C
- 2 to 4 bar
- Calibration rig traceable to national calibration standards
- Calibration with the process connection corresponding to the standard in question.

Maximum measured error

Prowirl 72

- Liquid:
  <0.75% o.r. for Re > 20 000
  <0.75% o.f.s for Re between 4000 and 20 000
- Gas/steam:
  <1% o.r. for Re > 20 000 and v < 75 m/s
  <1% o.f.s for Re between 4000 and 20 000

o.r. = of reading, o.f.s = of full scale value, Re = Reynolds number

Prowirl 73

- Volume flow (liquid):
  <0.75% o.r. for Re > 20 000
  <0.75% o.f.s for Re between 4000 and 20 000
- Volume flow (gas/steam):
  <1% o.r. for Re > 20 000 and v < 75 m/s
  <1% o.f.s for Re between 4000 and 20 000
- Temperature:
  <1°C (T > 100 °C, saturated steam and for liquids at ambient temperature);
  <1% o.r. [K] (gas)
  Rise time 50% (agitated under water, following IEC 60751): 8 s
- Mass flow (saturated steam):
  - For flow velocities 20 to 50 m/s, T > 150 °C (423 K)
    <1.7% o.r. (2% o.r. for remote version) for Re > 20 000
    <1.7% o.f.s (2% o.f.s for remote version) for Re between 4000 and 20 000
  - For flow velocities 10 to 70 m/s, T > 140 °C (413 K)
    <2% o.r. (2.3% o.r. for remote version) for Re > 20 000
    <2% o.f.s (2.3% o.f.s for remote version) for Re between 4000 and 20 000
- Mass flow of superheated steam and gas (air, natural gas AGA NX-19, AGA8-DC92, ISO 12213-2, AGA8 Gross Method 1, SGERG-88, preprogrammed gases - does not apply to the real gas equation):

  ✎ Note!
  A Cerabar S device has to be used for the measuring errors listed below. The measured error used to calculate the error in the measured pressure is 0.15%.

  <1.7% o.r. (2.0% o.r. for remote version) for Re > 20 000 and process pressure < 40 bar abs
  <1.7% o.f.s. (2.0% for remote version) for Re between 4000 and 20 000 and process pressure < 40 bar abs
  <2.6% o.r. (2.9% o.r. for remote version) for Re > 20 000 and process pressure < 120 bar abs
  <2.6% o.f.s. (2.9% o.r. for remote version) for Re between 4000 and 20 000 and process pressure < 120 bar abs
- Mass flow (water):
  <0.85% o.r. (1.15% o.r. for remote version) for Re > 20 000
  <0.85% o.f.s (1.15% o.f.s for remote version) for Re between 4000 and 20 000
- Mass flow (customer-defined liquids):
  To specify the system accuracy, Endress+Hauser requires information on the type of liquid and its operating temperature, or information in tabular form on the dependency between the liquid density and temperature.
  Example: Acetone is to be measured at fluid temperatures between 70 and 90 °C. The parameters TEMPERATURE VALUE (here 80 °C), DENSITY VALUE (here 720.00 kg/m^3) and EXPANSION COEFFICIENT (here 18.0298 x 10E-4 1/°C) have to be entered in the transmitter for this purpose. The overall system uncertainty, which is smaller than 0.9% for the example cited above, is made up of the following measuring uncertainties: Uncertainty of volume flow measurement, uncertainty of temperature measurement, uncertainty of the density-temperature correlation used (incl. the resulting uncertainty of density).
- Mass flow (other fluids):
  Depends on the pressure value specified in the device functions and the fluid selected.
  An individual error observation must be carried out.

o.r. = of reading, o.f.s = of full scale value, Re = Reynolds number

Diameter mismatch correction

Both Prowirl 72 and 73 can correct shifts in the calibration factor - e.g. caused by a change in the diameter between the device flange (e.g. ANSI, 2", Sched. 80) and the mating pipe (ANSI, 2", Sched. 40). The diameter mismatch should only be corrected within the limit values listed below, for which test measurements have also been performed.

Flange connection:
- DN 15 (½"): ±20% of the internal diameter
- DN 25 (1"): ±15% of the internal diameter
- DN 40 (1½"): ±12% of the internal diameter
- DN ≥ 50 (2"): ±10% of the internal diameter

Wafer:
- DN 15 (½"): ±15% of the internal diameter
- DN 25 (1"): ±12% of the internal diameter
- DN 40 (1½"): ±9% of the internal diameter
- DN ≥ 50 (2"): ±8% of the internal diameter

If the standard internal diameter of the process connection ordered for the measuring device and the internal diameter of the mating pipe differ, an additional measuring uncertainty of typically 0.1% o.r. (of reading) must be added for every 1 mm diameter deviation.

Repeatability

±0.25% o.r. (of reading)

Reaction time/step response time

If all the configurable functions for filter times (flow damping, display damping, current output time constant, frequency output time constant, status output time constant) are set to 0, a reaction time/step response time of 200 ms must be reckoned with for vortex frequencies as of 10 Hz. For other settings, a reaction time/step response time of 100 ms must always be added to the total filter reaction time for vortex frequencies as of 10 Hz.

Influence of ambient temperature

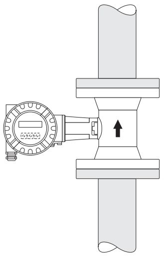
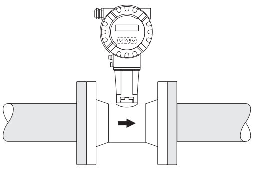
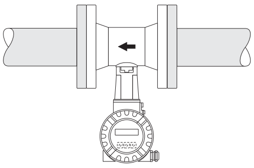
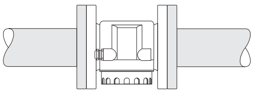
Current output (additional error, in reference to the span of 16 mA):
- Zero point (4 mA):
  Average Tk: 0.05%/10K, max. 0.6% over the entire temperature range –40 to +80 °C
- Span (20 mA):
  Average Tk: 0.05%/10K, max. 0.6% over the entire temperature range –40 to +80 °C

Digital outputs (pulse output, PFM, HART, frequency output; Prowirl 73 only)
Due to the digital measuring signal (vortex pulse) and further digital processing, there is no interface-related error from changing ambient temperature.

Operating conditions: installation

Installation instructions

Vortex meters require a fully developed flow profile as a prerequisite for correct volume flow measurement.
Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow (direction of fluid flow through the pipe).
The device can generally be installed in any position in the piping. However, note the following points:

Orientation		High fluid temperature (TM) ≥ 200 °C	Low fluid temperature (TM)
Fig. A: Vertical orientation	 A0009522	Recommended (①)	Recommended (①)
Fig. B: Horizontal orientation Transmitter head up	 A0009523	Not permitted for Prowirl 73 W DN 100 (4")/DN 150 (6") (②)	Recommended (③)
Fig. C: Horizontal orientation Transmitter head down	 A0009524	Recommended (④)	
Fig. D: Horizontal orientation Transmitter head at front with display pointing downwards	 A0009525	Recommended (④)	Recommended (③)

① In the case of liquids, there should be upward flow in vertical pipes to avoid partial pipe filling (see Fig. A).

Caution!
Disruption in flow measurement!
To guarantee the flow measurement of liquids, the measuring tube must always be completely full in pipes with vertical downward flow.

② Caution!
Danger of electronics overheating!
If fluid temperature is ≥200 °C, orientation B is not permitted for the wafer version (Prowirl 73 W) with nominal diameters DN 100 (4") and DN 150 (6").

In order to ensure that the maximum permissible ambient temperature for the transmitter is not exceeded (→ 27), we recommend the following orientations:

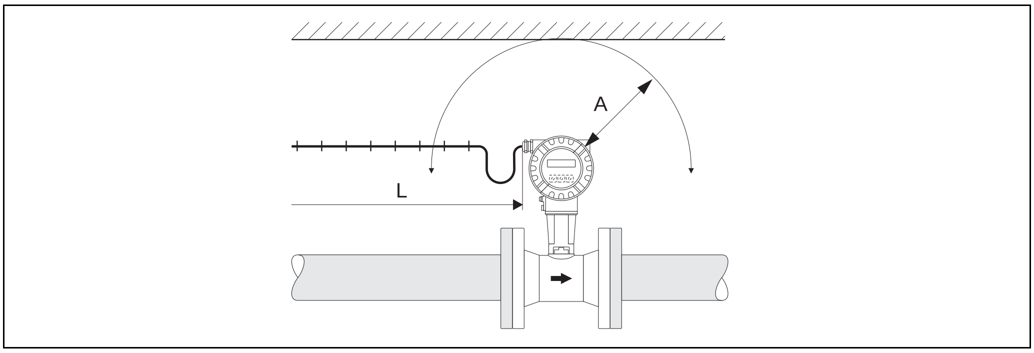
③ Select orientation C or D for hot fluids (e.g. steam or fluid temperature (TM) ≥200 °C

④ Select orientation B or D for very cold fluids (e.g. liquid nitrogen).

Minimum spacing and cable length

To ensure problem-free access to the measuring device for service purposes, we recommend you observe the following dimensions:

- Minimum spacing (A) in all directions = 100 mm
- Necessary cable length (L): L + 150 mm



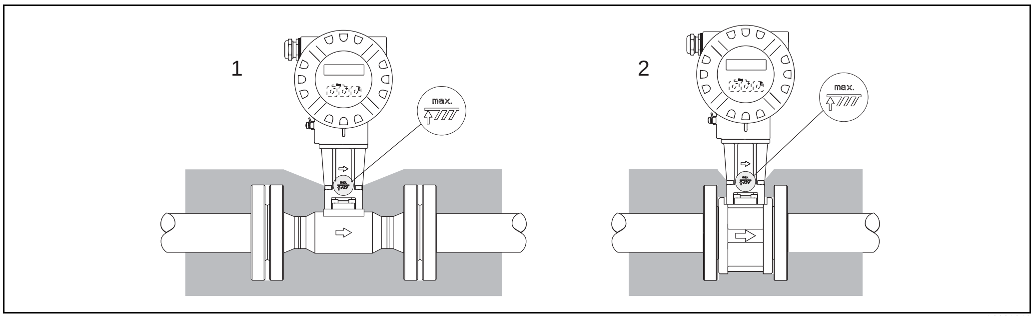
A0001870

Rotating the electronics housing and the display

The electronics housing can be rotated continuously 360° on the housing support. The display unit can be rotated in 45° stages. This means you can read off the display comfortably in all orientations.

Piping insulation

When insulating, please ensure that a sufficiently large area of the housing support is exposed.
The uncovered part serves as a radiator and protects the electronics from overheating (or undercooling).
The maximum insulation height permitted is illustrated in the diagrams. These apply equally to both the compact version and the sensor in the remote version.

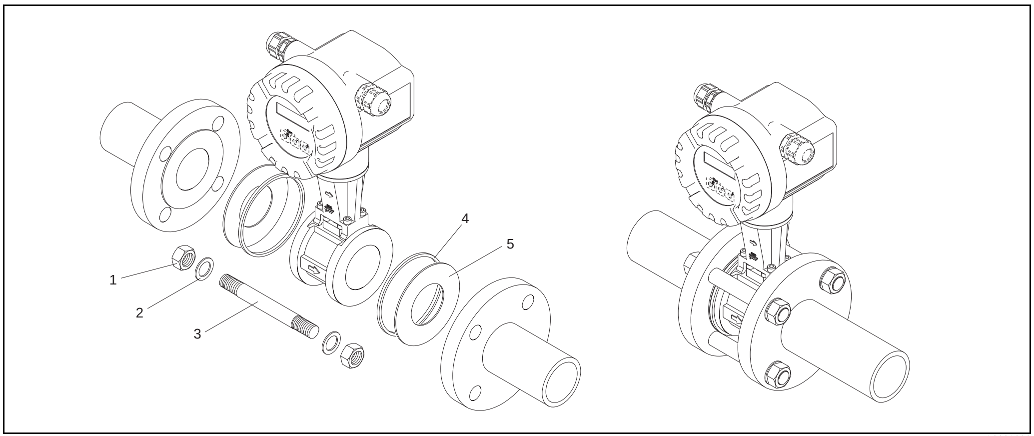


A0001868

1 = Flanged version
2 = Wafer version

Wafer version mounting set

The centering rings supplied are used to mount and center the wafer-style devices. A mounting set consisting of tie rods, seals, nuts and washers can be ordered separately.



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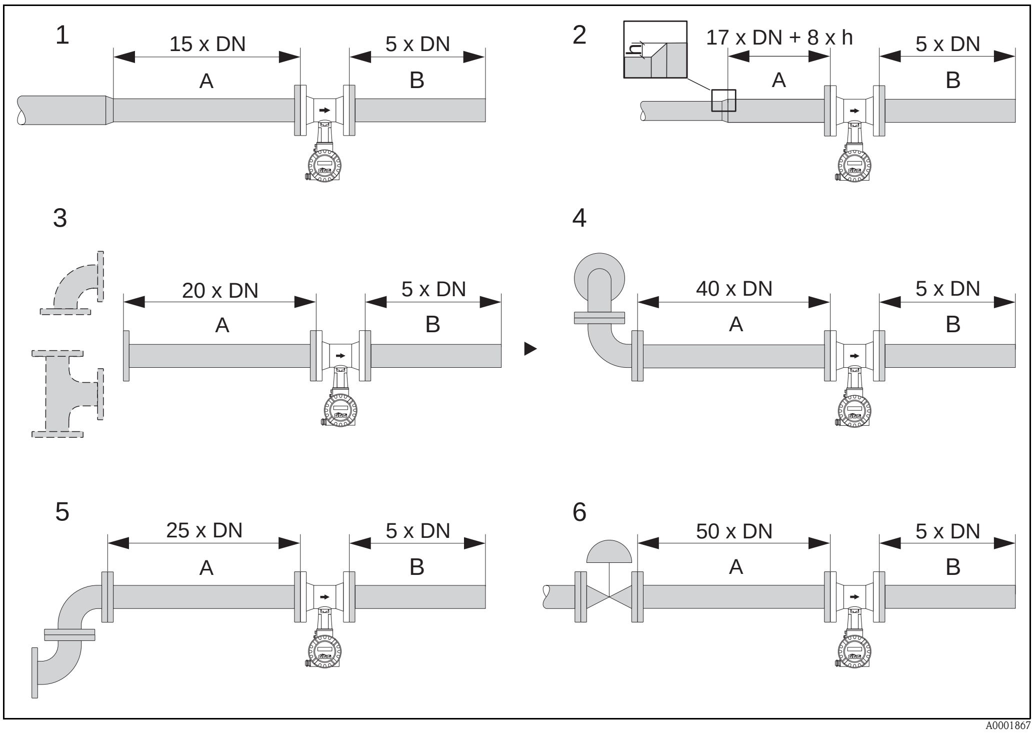
Mounting wafer version
1 = Nut
2 = Washer
3 = Tie rod
4 = Centering ring (is supplied with the device)
5 = Seal

Inlet and outlet run

As a minimum, the inlet and outlet runs shown below must be observed to achieve the specified accuracy of the device. The longest inlet run shown must be observed if two or more flow disturbances are present.



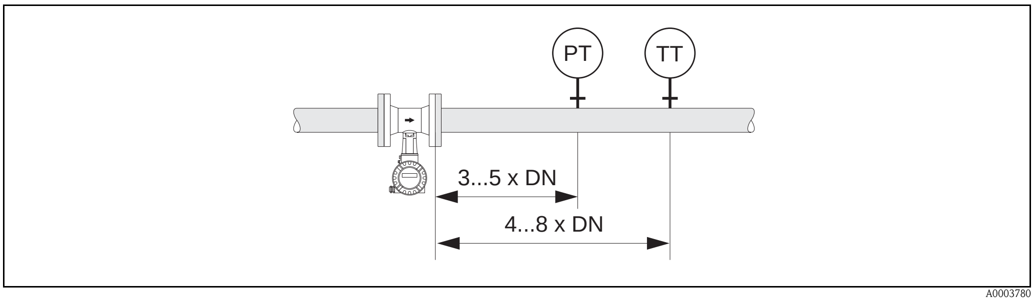
Minimum inlet and outlet runs with various flow obstructions

A = Inlet run
B = Outlet run
h = Difference in expansion
1 = Reduction
2 = Extension
3 = 90° elbow or T-piece
4 = 2 × 90° elbow, 3-dimensional
5 = 2 × 90° elbow
6 = Control valve

✎ Note!
A specially designed perforated plate flow conditioner can be installed if it is not possible to observe the inlet runs required (→ 🗎 26).

Outlet runs with pressure and temperature measuring points

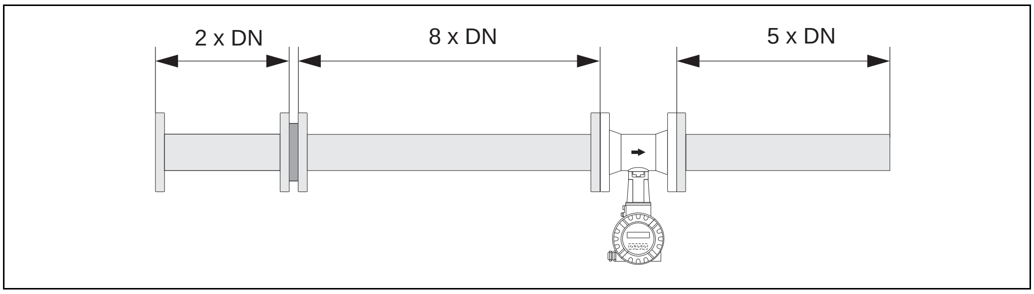
If pressure and temperature measuring points are installed after the device, please ensure there is a large enough distance between the device and the measuring point so there are no negative effects on vortex formation in the sensor.



PT = Pressure measuring point
TT = Temperature measuring point

Perforated plate flow conditioner

A specially designed perforated plate flow conditioner, available from Endress+Hauser, can be installed if it is not possible to observe the inlet runs required. The flow conditioner is fitted between two piping flanges and centered with the mounting bolts. Generally, this reduces the inlet run required to 10 x DN with complete accuracy.



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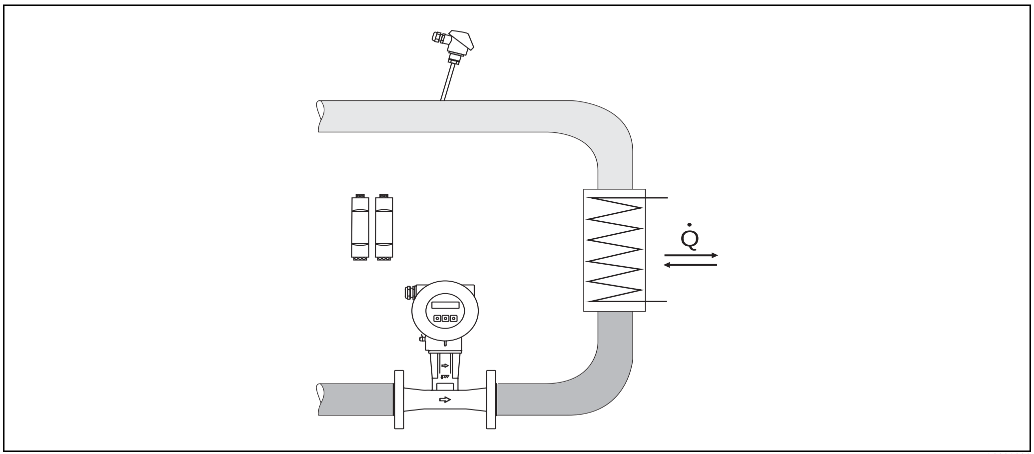
The pressure loss for flow conditioners is calculated as follows:
Δp [mbar] = 0.0085 · ρ [kg/m³] · v^2 [m/s]

Example with steam
p = 10 bar abs
t = 240 °C → ρ = 4.39 kg/m³
v = 40 m/s
$\Delta p = 0.0085 \cdot 4.39 \cdot 40^2 = 59.7$ mbar

Example with H_2O condensate (80 °C)
ρ = 965 kg/m³
v = 2.5 m/s
$\Delta p = 0.0085 \cdot 965 \cdot 2.5^2 = 51.3$ mbar

Installation for delta heat measurement (Prowirl 73 HART)

- The second temperature measurement takes place by means of a separate sensor and is read in via HART.
- Prowirl 73 generally has to be installed on the steam side for saturated steam delta heat measurement.
- For water-delta heat measurement, Prowirl 73 can be installed on both the cold side and the warm side.
- The inlet and outlet runs specified above must be observed.



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Layout for delta heat measurement of saturated steam and water

Operating conditions: environment

Ambient temperature range

- Compact version:
  - Standard: –40 to +70 °C
  - EEx-d/XP version: –40 to +60 °C
  - ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C
  - Display can be read between –20 and +70 °C
- Remote version sensor:
  - Standard:–40 to +85 °C
  - ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C
- Remote version transmitter:
  - Standard: –40 to +80 °C
  - EEx-d/XP version: –40 to +60 °C
  - ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C
  - Display can be read between –20 and +70 °C
  - Version up to –50 °C on request

When mounting outside, protect from direct sunlight with a protective cover (order number 543199-0001), especially in warmer climates with high ambient temperatures.

Storage temperature

- Standard: –40 to +80 °C
- ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C
- Version up to –50 °C on request

Degree of protection

IP 67 (NEMA 4X) in accordance with EN 60529

Vibration resistance

Acceleration up to 1 g, 10 to 500 Hz, following IEC 60068-2-6

Electromagnetic compatibility (EMC)

To IEC/EN 61326 and NAMUR Recommendation NE 21.

Operating conditions: process

Medium temperature range

Prowirl 72

DSC sensor (differential switched capacitor; capacitive sensor)

DSC standard sensor	–40 to +260 °C
DSC high/low temperature sensor	–200 to +400 °C
DSC sensor Inconel (PN 63 to 160, Class 600, JIS 40K)	–200 to +400 °C
DSC sensor titanium Gr. 5 (PN 250, Class 900 to 1500 and butt-weld version)	–50 to +400 °C
DSC sensor Alloy C-22	–200 to +400 °C

Seals

Graphite	–200 to +400 °C
Viton	–15 to +175 °C
Kalrez	–20 to +275 °C
Gylon (PTFE)	–200 to +260 °C

Sensor

Stainless steel	–200 to +400 °C
Alloy C-22	–40 to +260 °C

Special version for high fluid temperatures (on request)	–200 to +450 °C –200 to +440 °C, Ex version

Prowirl 73

DSC sensor (differential switched capacitor; capacitive sensor)

DSC standard sensor	–200 to +400 °C
DSC sensor Inconel (PN 63 to 160, Class 600, JIS 40K in development)	–200 to +400 °C

Seals

Graphite	–200 to +400 °C
Viton	–15 to +175 °C
Kalrez	–20 to +275 °C
Gylon (PTFE)	–200 to +260 °C

Sensor

Stainless steel	–200 to +400 °C
Special version for high fluid temperatures (on request)	–200 to +450 °C –200 to +440 °C, Ex version

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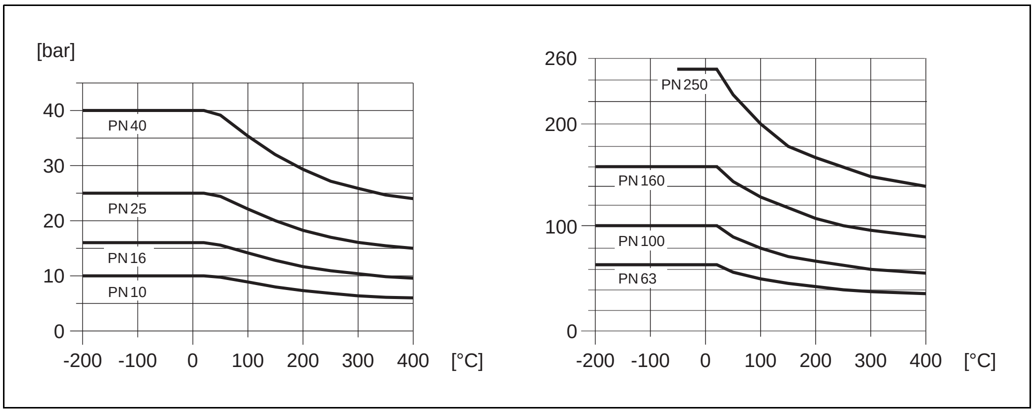
Medium pressure

Prowirl 72

Pressure-temperature curve to EN (DIN), stainless steel

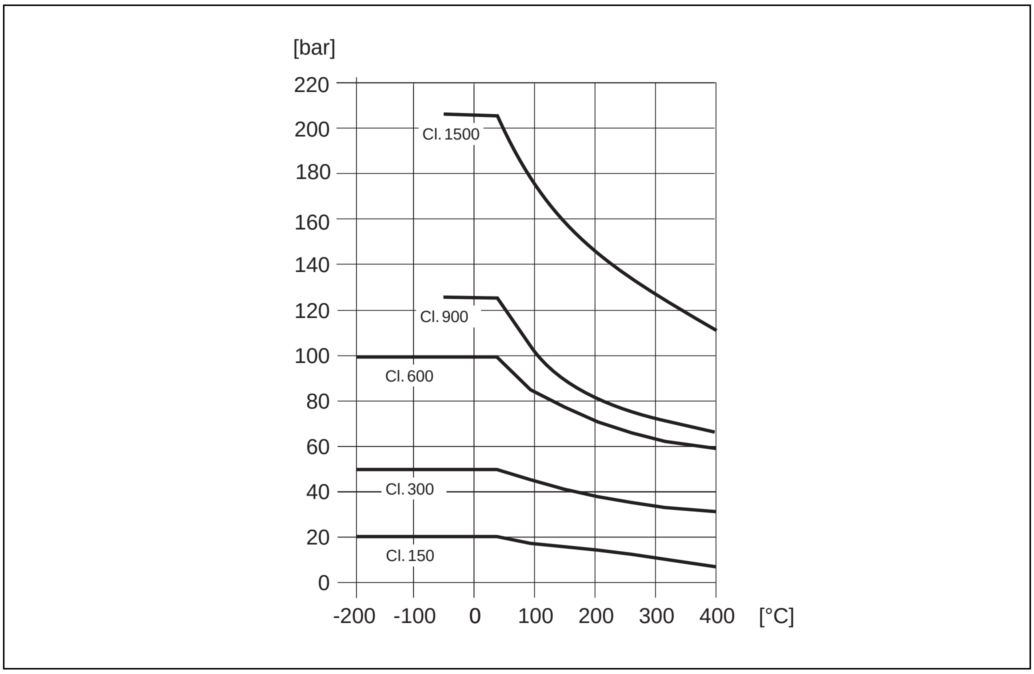
PN 10 to 40 → Prowirl 72W and 72F
PN 63 to 250 → Prowirl 72F



A0003238-en

Pressure-temperature curve to ANSI B16.5, stainless steel

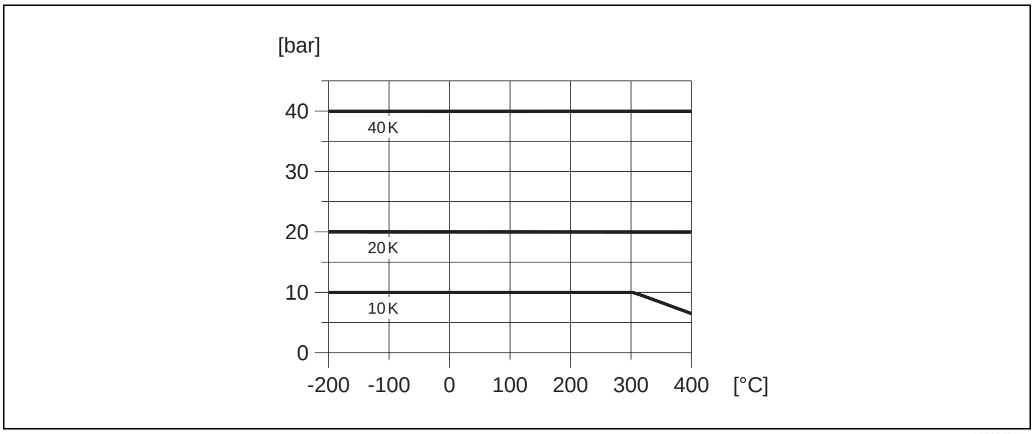
Class 150 to 300 → Prowirl 72W and 72F
Class 600 to 1500 → Prowirl 72F



A0003402-en

Pressure-temperature curve to JIS B2220, stainless steel:

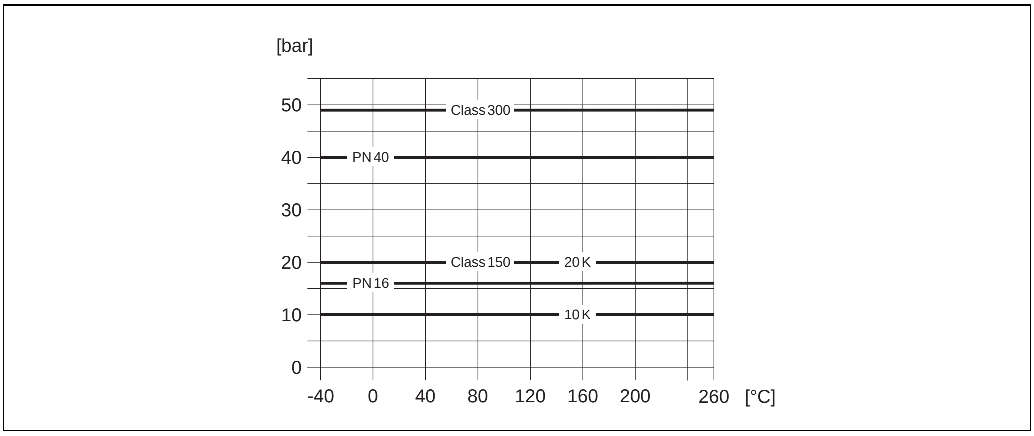
10 to 20K → Prowirl 72W and 72F
40K → Prowirl 72F



A0003404-en

Pressure-temperature curve to EN (DIN), ANSI B16.5 and JIS B2220, Alloy C-22

PN 16 to 40, Class 150 to 300, 10 to 20K → Prowirl 72F

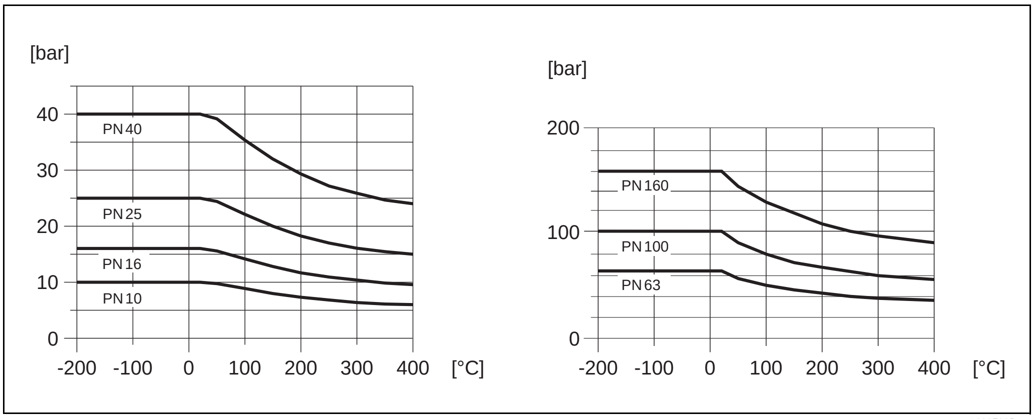


A0003395-en

Prowirl 73

Pressure-temperature curve to EN (DIN), stainless steel

PN 10 to 40 → Prowirl 73W and 73F
PN 63 to 160 → Prowirl 73F (in development)

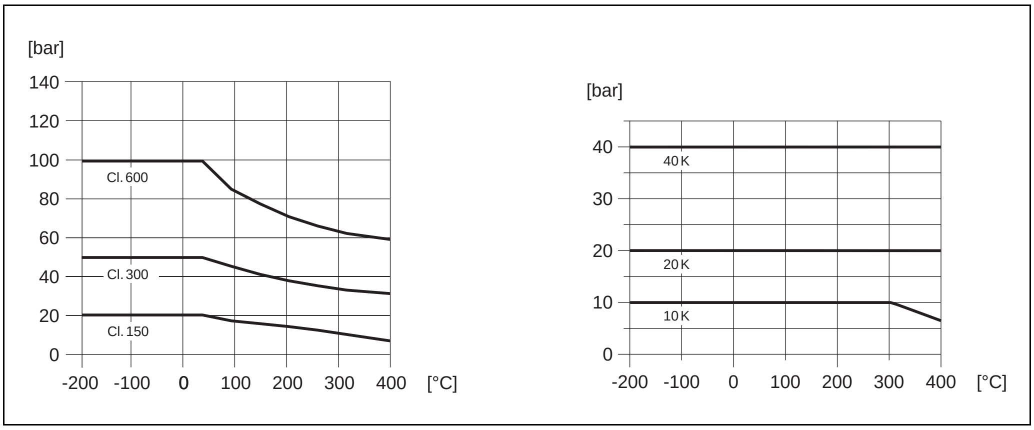


A0007085-en

Pressure-temperature curve to ANSI B16.5 and JIS B2220, stainless steel

ANSI B16.5:
Class 150 to 300 → Prowirl 73W and 73F
Class 600 → Prowirl 73F (in development)

JIS B2220:
10 to 20K → Prowirl 73W and 73F
40K → Prowirl 73F (in development)



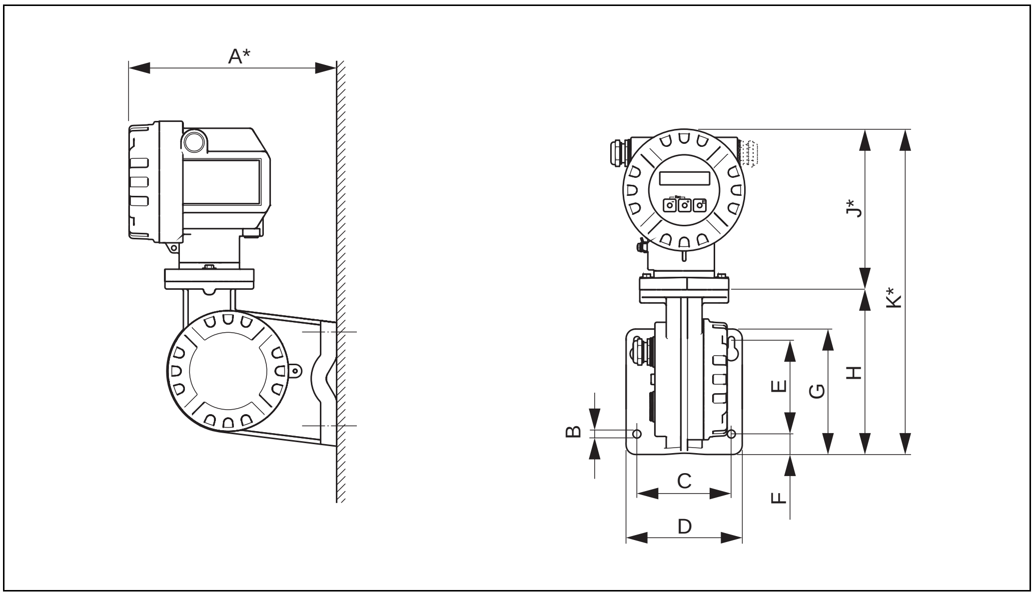
A0001923-en

Pressure loss The pressure loss can be determined with the aid of the Applicator. The Applicator is software for selecting and planning flowmeters. The software is available both via the Internet (www.applicator.com) and on a CD-ROM for local PC installation.

Mechanical construction

Design, dimensions

Dimensions of transmitter, remote version



A0003594

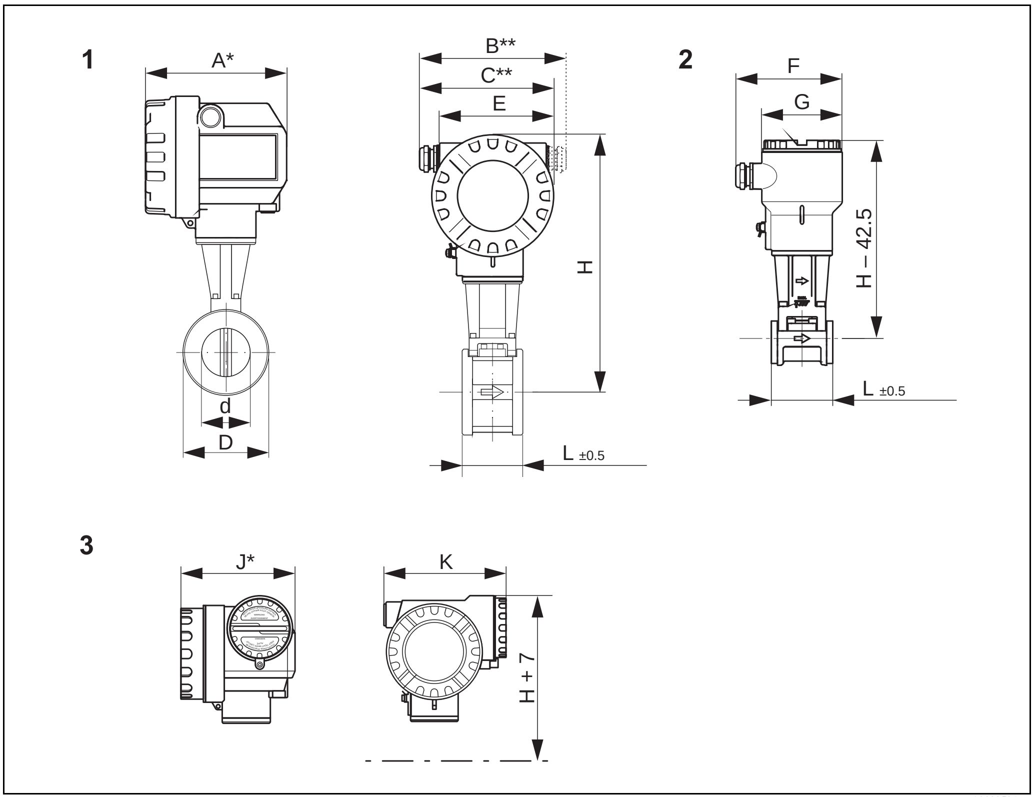
A	B	C	D	E	F	G	H	J	K
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
232	∅ 8.6 (M8)	100	123	100	23	144	170	170	340

* The following dimensions differ depending on the version:
– The dimension 232 mm changes to 226 mm in the blind version (without local operation).
– The dimension 170 mm changes to 183 mm in the Ex d/XP version.
– The dimension 340 mm changes to 353 mm in the Ex d/XP version.

✎ Note!
The transmitter housing has one cable gland or cable entry. Measuring devices with a pulse, frequency or status output have two cable glands or cable entries (devices with TIIS approval only have one cable gland).

Dimensions of wafer versions Prowirl 72W, 73W

Wafer version for flanges to:
- EN 1092-1 (DIN 2501), PN 10 to 40
- ANSI B16.5, Class 150 to 300, Sch. 40
- JIS B2220, 10 to 20K, Sch. 40



1 = Standard as well as Ex i/IS and Ex n version
2 = Remote version
3 = Ex d version (transmitter)

A [mm]	B [mm]	C [mm]	E [mm]	F [mm]	G [mm]	J [mm]	K [mm]
149	161 to 181	141 to 151	121	105	95	151	157

* The dimensions change as follows in the blind version (without local operation):
– Standard, Ex i/IS and Ex n version: The dimension 149 mm changes to 142 mm in the blind version.
– Ex d/XP version: The dimension 151 mm changes to 144 mm in the blind version.
** The dimension depends on the cable gland used.

✎ Note!
The transmitter housing has one cable gland or cable entry. Measuring devices with a pulse, frequency or status output have two cable glands or cable entries (devices with TIIS approval only have one cable gland).

DN		d	D	H[1]	L	Weight[2]
DIN/JIS	ANSI	mm	mm	mm	mm	kg
15	½"	16.5	45.0	247	65	3.0
25	1"	27.6	64.0	257	65	3.2
40	1½"	42.0	82.0	265	65	3.8
50	2"	53.5	92.0	272	65	4.1
80	3"	80.3	127.0	286	65	5.5
100 (DIN)	–	104.8	157.2	299	65	6.5
100 (JIS)	4"	102.3	157.2	299	65	6.5
150	6"	156.8	215.9	325	65	9.0

1) The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (version with extended temperature range).

2) The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (version with extended temperature range).

Dimensions of flanged versions (standard devices)
Prowirl 72F, 73F

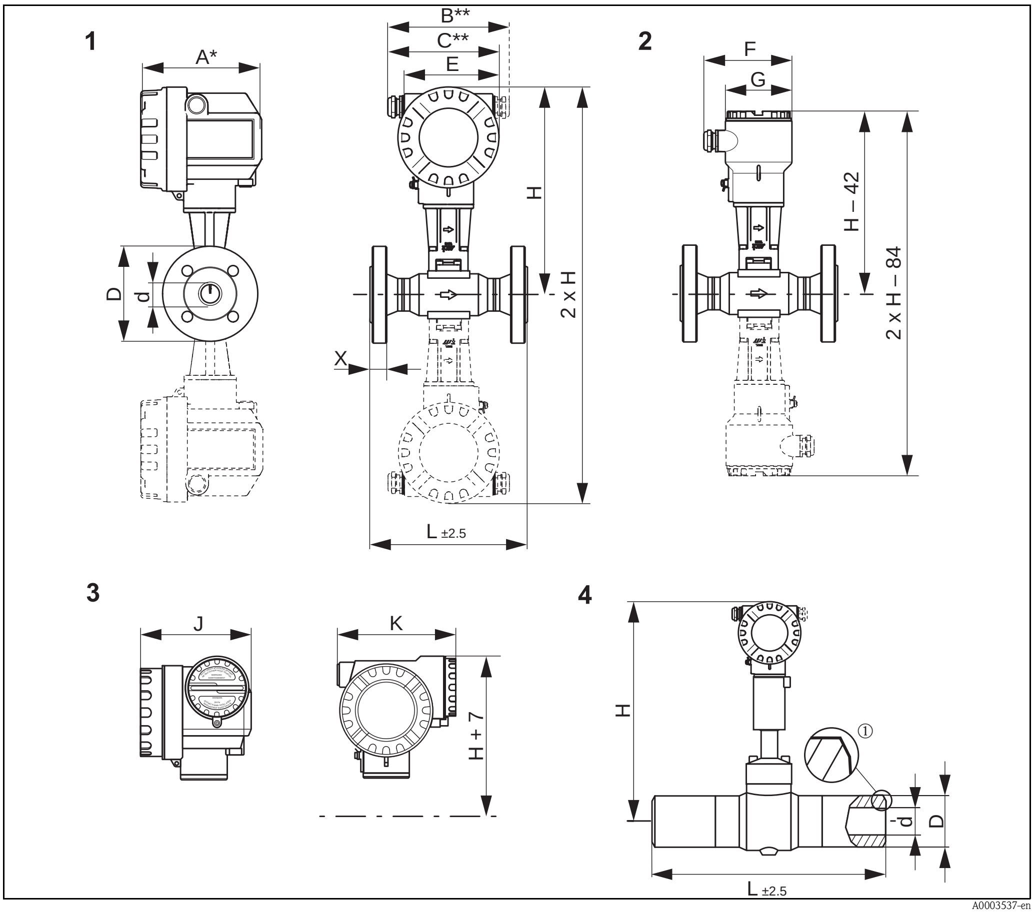
Flange connection dimensions in accordance with flange standard:

- EN 1092-1 (DIN 2501), Ra = 6.3 to 12.5 µm
- Raised face to:
  - EN 1092-1 Form B1 (DIN 2526 Form C), PN 10 to 40, Ra = 6.3 to 12.5 µm, optional with groove to EN 1091-1 Form D (DIN 2512 Form N)
  - EN 1092-1 Form B2 (DIN 2526 Form E), PN 63 to 100, Ra = 1.6 to 3.2 µm[1] [2]
  - DIN 2526 Form E, PN 160 to 250[3], Ra = 1.6 to 3.2 µm[1]
- ANSI B16.5, Class 150 to 1500, Ra = [1] [2]125 to 250 µin[2]
- JIS B2220, 10 to 40K[1], Ra = 125 to 250 µin

[1] Prowirl 73F: PN 63 to 160, Class 600 and 40K in development

[2] Prowirl 73F: only Class 150 to 600

[3] Prowirl 73F: only PN 160



1 = Standard, Ex i and Ex n version ; d: connection pipe internal diameter
2 = Remote version
3 = Ex d /XP version (transmitter)
4 = Butt-weld version (only available for Prowirl 72)

① *Groove type 22 in accordance with DIN 2559*
Dotted line: Dualsens version

A [mm]	B [mm]	C [mm]	E [mm]	F [mm]	G [mm]	J [mm]	K [mm]
149	161 to 181	141 to 151	121	105	95	151	161

A [mm]	B [mm]	C [mm]	E [mm]	F [mm]	G [mm]	J [mm]	K [mm]

* The dimensions below change as follows in the blind version (without local operation):
– Standard, Ex i/IS and Ex n version: The dimension 149 mm changes to 142 mm in the blind version.
– Ex d/XP version: The dimension 151 mm changes to 144 mm in the blind version.
** The dimension depends on the cable gland used.

Note!
The transmitter housing has one cable gland or cable entry. Measuring devices with a pulse, frequency or status output have two cable glands or cable entries (devices with TIIS approval only have one cable gland).

Flanged versions (standard devices) to EN 1092-1 (DIN 2501)
Prowirl 72F, 73F

DN	Pressure rating	d [mm]	D [mm]	H[3] [mm]	L [mm]	X [mm]	Weight[4] [kg]
15[5]	PN 40	17.3	95.0	248	200	16	5
	PN 160[2]	17.3	105.0	288	200	23	7
	PN 250[1]	16.1	130.0	310	248	26	15
	Butt-weld[1]	16.1	23.4	310	248	–	9
25[5]	PN 40	28.5	115.0	255	200	18	7
	PN 100[2]	28.5	140.0	295	200	27	11
	PN 160[2]	27.9	140.0	295	200	27	11
	PN 250[1]	26.5	150.0	310	248	28	16
	Butt-weld[1]	24.3	35.6	310	248	–	9
40	PN 40	43.1	150.0	263	200	18	9
	PN 100[2]	42.5	170.0	303	200	31	15
	PN 160[2]	41.1	170.0	303	200	31	15
	PN 250[1][5]	38.1	185.0	315	278	34	21
	Butt-weld[1][5]	38.1	48.3	315	278	–	9
50	PN 40	54.5	165.0	270	200	20	11
	PN 63[2]	54.5	180.0	310	200	33	17
	PN 100[2]	53.9	195.0	310	200	33	19
	PN 160[2]	52.3	195.0	310	200	33	19
	PN 250[1][5]	47.7	200.0	306	288	38	23
	Butt-weld[1][5]	47.7	60.3	306	288	–	9
80	PN 40	82.5	200.0	283	200	24	16
	PN 63[2]	81.7	215.0	323	200	39	24
	PN 100[2]	80.9	230.0	323	200	39	27
	PN 160[2]	76.3	230.0	323	200	39	27
	PN 250[1][5]	79.6	255.0	311	325	46	41
	Butt-weld[1][5]	79.6	101.6	311	325	–	13
100	PN 16	107.1	220.0	295	250	20	18
	PN 40	107.1	235.0	295	250	24	21
	PN 63[2]	106.3	250.0	335	250	49	39
	PN 100[2]	104.3	265.0	335	250	49	42
	PN 160[2]	98.3	265.0	335	250	49	42
	PN 250[1][5]	98.6	300.0	323	394	54	64
	Butt-weld[1][5]	98.6	127.0	323	394	–	21

Flanged versions (standard devices) to EN 1092-1 (DIN 2501)
Prowirl 72F, 73F

DN	Pressure rating	d [mm]	D [mm]	H[3] [mm]	L [mm]	X [mm]	Weight[4] [kg]
150	PN 16	159.3	285.0	319	300	22	30
	PN 40	159.3	300.0	319	300	28	37
	PN 63[2]	157.1	345.0	359	300	64	86
	PN 100[2]	154.1	355.0	359	300	64	88
	PN 160[2]	146.3	355.0	359	300	64	88
	PN 250[1] [5]	142.8	390.0	339	566	68	152
	Butt-weld[1] [5]	142.8	177.8	339	566	–	53
200	PN 10	207.3	340.0	348	300	42	63
	PN 16	207.3	340.0	348	300	42	62
	PN 25	206.5	360.0	348	300	42	68
	PN 40	206.5	375.0	348	300	42	72
250[5]	PN 10	260.4	395	375	380	48	88
	PN 16	260.4	405	375	380	48	92
	PN 25	258.8	425	375	380	48	100
	PN 40	258.8	450	375	380	48	111
300[5]	PN 10	309.7	445	398	450	51	121
	PN 16	309.7	460	398	450	51	129
	PN 25	307.9	485	398	450	51	140
	PN 40	307.9	515	398	450	51	158

[1] In contrast to the other versions, devices have a sensor in the bluff body.
Only available for 72F.

[2] Pressure ratings are in development for Prowirl 73.

[3] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

[4] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

[5] Not available as Dualsens version.

Flanged versions (standard devices) to ANSI B16.5
Prowirl 72F, 73F

DN	Pressure rating		d	D	H[3]	L	X	Weight[4]
			mm	mm	mm	mm	mm	kg
½" [5]	Schedule 40	Cl. 150	15.7	88.9	248	200	11.2	5
		Cl. 300	15.7	95.0	248	200	14.2	5
	Schedule 80	Cl. 150	13.9	88.9	248	200	11.2	5
		Cl. 300	13.9	95.0	248	200	14.2	5
		Cl. 600[2]	13.9	95.3	288	200	23	6
		Cl. 1500[1]	14.0	120.6	310	262	22.3	13
		Butt-weld[1]	14.0	21.3	310	248	–	9
1" [5]	Schedule 40	Cl. 150	26.7	107.9	255	200	15.7	6
		Cl. 300	26.7	123.8	255	200	19.1	7
	Schedule 80	Cl. 150	24.3	107.9	255	200	15.7	6
		Cl. 300	24.3	123.8	255	200	19.1	7
		Cl. 600[2]	24.3	124.0	295	200	27	9
		Cl. 1500[1]	24.3	149.3	310	287.7	28.4	17
		Butt-weld[1]	24.3	33.4	310	248	–	9

Flanged versions (standard devices) to ANSI B16.5
Prowirl 72F, 73F

DN	Pressure rating		d	D	H 3)	L	X	Weight 4)
			mm	mm	mm	mm	mm	kg
1½"	Schedule 40	Cl. 150	40.9	127.0	263	200	17.5	8
		Cl. 300	40.9	155.6	263	200	20.6	10
	Schedule 80	Cl. 150	38.1	127.0	263	200	17.5	8
		Cl. 300	38.1	155.6	263	200	20.6	10
		Cl. 600 2)	38.1	155.4	303	200	31	13
		Cl. 1500 1) 5)	38.1	177.8	315	305.8	31.7	20
		Butt-weld 1) 5)	38.1	48.3	315	278	–	9
2"	Schedule 40	Cl. 150	52.6	152.4	270	200	19.1	10
		Cl. 300	52.6	165.0	270	200	22.4	12
	Schedule 80	Cl. 150	49.2	152.4	270	200	19.1	10
		Cl. 300	49.2	165.0	270	200	22.4	12
		Cl. 600 2)	49.2	165.1	310	200	33	14
		Cl. 1500 1) 5)	49.3	215.9	306	344	38.1	30
		Butt-weld 1) 5)	47.7	60.3	306	288	–	9
3"	Schedule 40	Cl. 150	78.0	190.5	283	200	23.9	15
		Cl. 300	78.0	210.0	283	200	28.4	19
	Schedule 80	Cl. 150	73.7	190.5	283	200	23.9	15
		Cl. 300	73.7	210.0	283	200	28.4	19
		Cl. 600 2)	73.7	209.6	323	200	39	22
		Cl. 900 1) 5)	73.7	241.3	311	349	38.1	37
		Cl. 1500 1) 5)	73.7	266.7	311	380.4	47.7	49
		Butt-weld 1) 5)	73.7	95.7	311	325	–	13
4"	Schedule 40	Cl. 150	102.4	228.6	295	250	24.5	22
		Cl. 300	102.4	254.0	295	250	31.8	30
	Schedule 80	Cl. 150	97.0	228.6	295	250	24.5	22
		Cl. 300	97.0	254.0	295	250	31.8	30
		Cl. 600 2)	97.0	273.1	335	250	49	43
		Cl. 900 1) 5)	97.3	292.1	323	408	44.4	57
		Cl. 1500 1) 5)	97.3	311.1	323	427	53.8	71
		Butt-weld 1) 5)	97.3	125.7	323	394	–	21
6"	Schedule 40	Cl. 150	154.2	279.4	319	300	25.4	34
		Cl. 300	154.2	317.5	319	300	36.6	50
	Schedule 80	Cl. 150	146.3	279.4	319	300	25.4	34
		Cl. 300	146.3	317.5	319	300	36.6	50
		Cl. 600 2)	146.3	355.6	359	300	64	87
		Cl. 900 1) 5)	131.8	381.0	339	538	55.6	131
		Cl. 1500 1) 5)	146.3	393.7	339	602	82.5	173
		Butt-weld 1) 5)	146.3	168.3	339	566	–	53
8"	Schedule 40	Cl. 150	202.7	342.9	348	300	42	64
		Cl. 300	202.7	381.0	348	300	42	76
10" 5)	Schedule 40	Cl. 150	254.5	406.4	375	380	48	92
		Cl. 300	254.5	444.5	375	380	48	109
12" 5)	Schedule 40	Cl. 150	304.8	482.6	398	450	60	143
		Cl. 300	304.8	520.7	398	450	60	162

Flanged versions (standard devices) to ANSI B16.5
Prowirl 72F, 73F

DN	Pressure rating	d mm	D mm	H[3] mm	L mm	X mm	Weight[4] kg

[1] In contrast to the other versions, devices have a sensor in the bluff body.
Only available for 72F.

[2] Pressure ratings are in development for Prowirl 73.

[3] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

[4] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

[5] Not available as Dualsens version.

Flanged versions (standard devices) to JIS B2220
Prowirl 72F, 73F

DN	Pressure rating		d [mm]	D [mm]	H[2] [mm]	L [mm]	X [mm]	Weight[3] [kg]
15[4]	Schedule 40	20K	16.1	95	248	200	14	5
	Schedule 80	20K	13.9	95	248	200	14	5
	Schedule 80	40K[1]	13.9	115	288	200	23	8
25[4]	Schedule 40	20K	27.2	125	255	200	16	7
	Schedule 80	20K	24.3	125	255	200	16	7
	Schedule 80	40K[1]	24.3	130	295	200	27	10
40	Schedule 40	20K	41.2	140	263	200	18	9
	Schedule 80	20K	38.1	140	263	200	18	9
	Schedule 80	40K[1]	38.1	160	303	200	31	14
50	Schedule 40	10K	52.7	155	270	200	16	10
	Schedule 40	20K	52.7	155	270	200	18	10
	Schedule 80	10K	49.2	155	270	200	16	10
	Schedule 80	20K	49.2	155	270	200	18	10
	Schedule 80	40K[1]	49.2	165	310	200	33	15
80	Schedule 40	10K	78.1	185	283	200	18	14
	Schedule 40	20K	78.1	200	283	200	22	15
	Schedule 80	10K	73.7	185	283	200	18	14
	Schedule 80	20K	73.7	200	283	200	22	15
	Schedule 80	40K[1]	73.7	210	323	200	39	24
100	Schedule 40	10K	102.3	210	295	250	18	18
	Schedule 40	20K	102.3	225	295	250	24	21
	Schedule 80	10K	97.0	210	295	250	18	18
	Schedule 80	20K	97.0	225	295	250	24	22
	Schedule 80	40K[1]	97.0	240	335	250	49	36
150	Schedule 40	10K	151.0	280	319	300	22	33
	Schedule 40	20K	151.0	305	319	300	28	40
	Schedule 80	10K	146.3	280	319	300	22	33
	Schedule 80	20K	146.3	305	319	300	28	40
	Schedule 80	40K[1]	146.6	325	359	300	64	77
200	Schedule 40	10K	202.7	330	348	300	42	58
	Schedule 40	20K	202.7	350	348	300	42	64
250[4]	Schedule 40	10K	254.5	400	375	380	48	90
	Schedule 40	20K	254.5	430	375	380	48	104

Flanged versions (standard devices) to JIS B2220
Prowirl 72F, 73F

DN	Pressure rating		d [mm]	D [mm]	H[2] [mm]	L [mm]	X [mm]	Weight[3] [kg]
300[4]	Schedule 40	10K	304.8	445	398	450	51	119
	Schedule 40	20K	304.8	480	398	450	51	134

[1] Pressure rating 40K for Prowirl 73 in development.

[2] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

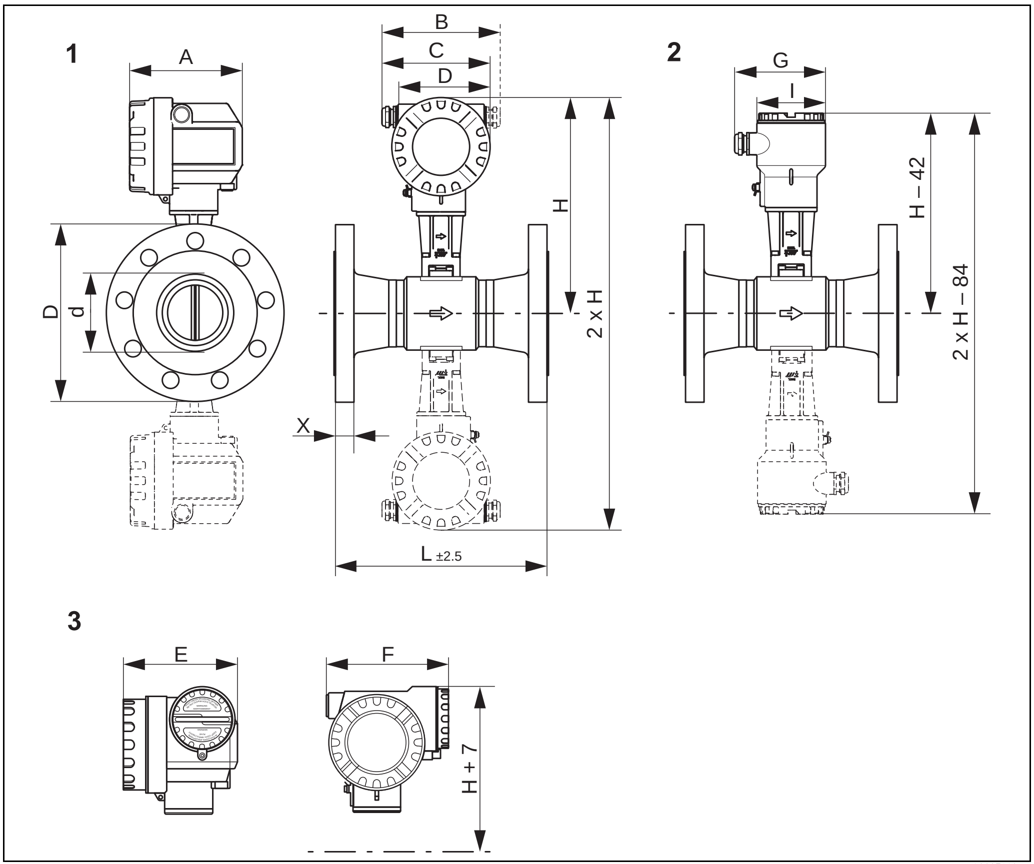
[3] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

[4] Not available as Dualsens version.

Dimensions of flanged versions "R Style" (single reduction of line size) Prowirl 72F, 73F

Versions with integrated line size reduction (hydraulically effective cross-section smaller than connection nominal diameter) offering improved measurement in the lower flow range.

Flange connection dimensions in accordance with flange standard:
- EN 1092-1 (DIN 2501), Ra = 6.3 to 12.5 µm
- Raised face to:
  EN 1092-1 Form B1 (DIN 2526 Form C), PN 10 to 40, Ra = 6.3 to 12.5 µm,
  optional with groove to EN 1091-1 Form D (DIN 2512 Form N)
- ANSI B16.5, Class 150 to 300, Ra = 125 to 250 µin
- JIS B2220, 10 to 20K, Ra = 125 to 250 µin



1 = Standard, Ex i and Ex n version ; d: connection pipe internal diameter
2 = Remote version
3 = Ex d /XP version (transmitter)

Dotted line: Dualsens version

A [mm]	B [mm]	C [mm]	E [mm]	F [mm]	G [mm]	J [mm]	K [mm]
149	161 to 181	141 to 151	121	105	95	151	161

* The dimensions below change as follows in the blind version (without local operation):
– Standard, Ex i/IS and Ex n version: The dimension 149 mm changes to 142 mm in the blind version.
– Ex d/XP version: The dimension 151 mm changes to 144 mm in the blind version.
** The dimension depends on the cable gland used.

Note!
The transmitter housing has one cable gland or cable entry. Measuring devices with a pulse, frequency or status output have two cable glands or cable entries (devices with TIIS approval only have one cable gland).

Flanged versions (R Style) to EN 1092-1 (DIN 2501)
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating	d [mm]	D [mm]	H[1] [mm]	L [mm]	X [mm]	Weight[2] [kg]
25[3]	15	PN 40	22.0	115	248	200	18.0	6
40[3]	25	PN 40	30.0	150	255	200	21.0	10
50	40	PN 40	45.0	165	263	200	22.0	12
80	50	PN 40	56.5	200	270	200	25.0	16
100	80	PN 16	87.0	220	283	250	22.0	20
		PN 40	87.0	235	283	250	26.5	23
150	100	PN 16	112.0	285	295	300	25.0	36
		PN 40	112.0	300	295	300	31.0	42
200	150	PN 10	146.3	340	319	300	24.0	48
		PN 16	146.3	340	319	300	24.0	48
		PN 25	146.3	360	319	300	30.0	55
		PN 40	146.3	375	319	300	36.5	63

[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).
[2] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.
[3] Not available as Dualsens version.

Flanged versions (R Style) to ANSI B16.5
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating		d mm	D mm	H[1] mm	L mm	X mm	Weight[2] kg
1" [3]	½"	Sched. 40	Cl. 150	22.0	108.0	248	200	18	6
		Sched. 40	Cl. 300	22.0	124.0	248	200	22.0	8
		Sched. 80	Cl. 150	22.0	108.0	248	200	18.5	6
		Sched. 80	Cl. 300	22.0	124.0	248	200	22.0	8
1½" [3]	1"	Sched. 40	Cl. 150	30.0	127.0	255	200	18.0	7
		Sched. 40	Cl. 300	30.0	155.4	255	200	25.0	10
		Sched. 80	Cl. 150	30.0	127.0	255	200	18.0	7
		Sched. 80	Cl. 300	30.0	155.4	255	200	25.0	10
2"	1½"	Sched. 40	Cl. 150	45.0	152.4	263	200	20.0	10
		Sched. 40	Cl. 300	45.0	165.1	263	200	25.0	12
		Sched. 80	Cl. 150	45.0	152.4	263	200	20.0	10
		Sched. 80	Cl. 300	45.0	165.1	263	200	25.0	12
3"	2"	Sched. 40	Cl. 150	56.5	190.5	270	200	23.9	15
		Sched. 40	Cl. 300	56.5	209.6	270	200	28.9	22
		Sched. 80	Cl. 150	56.5	190.5	270	200	23.9	15
		Sched. 80	Cl. 300	56.5	209.6	270	200	28.9	22
4"	3"	Sched. 40	Cl. 150	87.0	228.6	283	250	24.5	22
		Sched. 40	Cl. 300	87.0	254.0	283	250	31.8	31
		Sched. 80	Cl. 150	87.0	228.6	283	250	24.5	22
		Sched. 80	Cl. 300	87.0	254.0	283	250	31.8	31

Flanged versions (R Style) to ANSI B16.5
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating		d mm	D mm	H[1] mm	L mm	X mm	Weight[2] kg
6"	4"	Sched. 40	Cl. 150	112.0	279.4	295	300	25.5	38
		Sched. 40	Cl. 300	112.0	317.5	295	300	38.5	55
		Sched. 80	Cl. 150	112.0	279.4	295	300	26.0	38
		Sched. 80	Cl. 300	112.0	317.5	295	300	39.0	55
8"	6"	Sched. 40	Cl. 150	146.3	342.9	319	300	28.4	55
		Sched. 40	Cl. 300	146.3	381	319	300	41.1	75

[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

[2] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

[3] Not available as Dualsens version.

Flanged versions (R Style) to JIS B2220
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating		d [mm]	D [mm]	H[1] [mm]	L [mm]	X [mm]	Weight[2] [kg]
25[3]	15	Sched. 40	20K	22.0	125	248	200	18.5	7
		Sched. 80	20K	22.0	125	248	200	18.5	7
40[3]	25	Sched. 40	20K	30.0	140	255	200	18.5	8
		Sched. 80	20K	30.0	140	255	200	19.0	8
50	40	Sched. 40	10K	45.0	155	263	200	20.0	10
		Sched. 40	20K	45.0	155	263	200	22.0	10
		Sched. 80	10K	45.0	155	263	200	20.0	10
		Sched. 80	20K	45.0	155	263	200	22.0	10
80	50	Sched. 40	10K	56.5	185	270	200	22.0	13
		Sched. 40	20K	56.5	200	270	200	26.5	16
		Sched. 80	10K	56.5	185	270	200	22.0	13
		Sched. 80	20K	56.5	200	270	200	27.0	16
100	80	Sched. 40	10K	87.0	210	283	250	22.0	17
		Sched. 40	20K	87.0	225	283	250	25.5	20
		Sched. 80	10K	87.0	210	283	250	22.0	17
		Sched. 80	20K	87.0	225	283	250	26.0	20
150	100	Sched. 40	10K	112.0	280	295	300	31.0	36
		Sched. 40	20K	112.0	305	295	300	37.5	46
		Sched. 80	10K	112.0	280	295	300	31.5	36
		Sched. 80	20K	112.0	305	295	300	37.5	46
200	150	Sched. 40	10K	146.3	330	319	300	26.5	45
		Sched. 40	20K	146.3	350	319	300	31	53

[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

[2] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

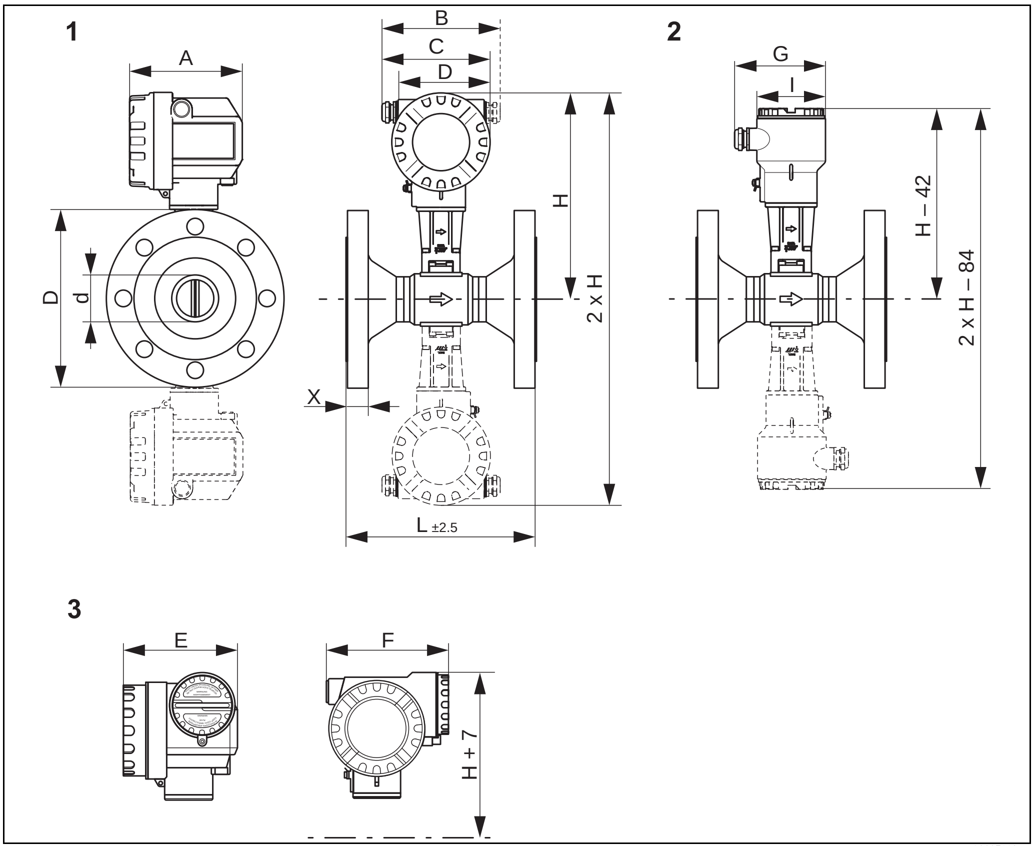
[3] Not available as Dualsens version.

Dimensions of flanged versions "S Style" (double reduction of line size) Prowirl 72F, 73F

Versions with integrated line size reduction (hydraulically effective cross-section smaller than connection nominal diameter) offering improved measurement in the lower flow range.

Flange connection dimensions in accordance with flange standard:

- EN 1092-1 (DIN 2501), Ra = 6.3 to 12.5 µm
- Raised face to:
  EN 1092-1 Form B1 (DIN 2526 Form C), PN 10 to 40, Ra = 6.3 to 12.5 µm,
  optional with groove to EN 1091-1 Form D (DIN 2512 Form N)
- ANSI B16.5, Class 150 to 300, Ra = 125 to 250 µin
- JIS B2220, 10 to 20K, Ra = 125 to 250 µin



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1 = Standard, Ex i and Ex n version ; d: connection pipe internal diameter
2 = Remote version
3 = Ex d/XP version (transmitter)

Dotted line: Dualsens version

A [mm]	B [mm]	C [mm]	E [mm]	F [mm]	G [mm]	J [mm]	K [mm]
149	161 to 181	141 to 151	121	105	95	151	161

* The dimensions below change as follows in the blind version (without local operation):
– Standard, Ex i/IS and Ex n version: The dimension 149 mm changes to 142 mm in the blind version.
– Ex d/XP version: The dimension 151 mm changes to 144 mm in the blind version.
** The dimension depends on the cable gland used.

Note!
The transmitter housing has one cable gland or cable entry. Measuring devices with a pulse, frequency or status output have two cable glands or cable entries (devices with TIIS approval only have one cable gland).

Flanged versions (S Style) to EN 1092-1 (DIN 2501)
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating	d [mm]	D [mm]	H[1] [mm]	L [mm]	X [mm]	Weight[2] [kg]
40[3]	15	PN 40	22	150	248	200	21.0	9
50[3]	25	PN 40	30	165	255	200	21.0	11
80	40	PN 40	45	200	263	200	25.5	16
100	50	PN 16	62	220	270	250	24.0	19
		PN 40	62	235	270	250	27.5	22
150	80	PN 16	92	285	283	300	25.0	32
		PN 40	92	300	283	300	32.0	42
200	100	PN 10	112	340	295	300	26.0	48
		PN 16	112	340	295	300	27.0	48
		PN 25	112	360	295	300	33.5	59
		PN 40	112	375	295	300	38.5	69
250	150	PN 10	202.7	395	319	380	24	64
		PN 16	202.7	405	319	380	27	66.5
		PN 25	202.7	425	319	380	32	79
		PN 40	202.7	450	319	380	39	103

[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).
[2] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.
[3] Not available as Dualsens version.

Flanged versions (S Style) to ANSI B16.5
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating		d mm	D mm	H[1] mm	L mm	X mm	Weight[2] kg
1½" [3]	½"	Sched. 40	Cl. 150	22	127.0	248	200	19.0	8
		Sched. 40	Cl. 300	22	155.4	248	200	27.0	11
		Sched. 80	Cl. 150	22	127.0	248	200	19.5	8
		Sched. 80	Cl. 300	22	155.4	248	200	27.0	11
2" [3]	1"	Sched. 40	Cl. 150	30	152.4	255	200	21.0	10
		Sched. 40	Cl. 300	30	165.1	255	200	26.0	13
		Sched. 80	Cl. 150	30	152.4	255	200	21.0	10
		Sched. 80	Cl. 300	30	165.1	255	200	26.0	13
3"	1½"	Sched. 40	Cl. 150	45	190.5	263	200	25.0	17
		Sched. 40	Cl. 300	45	209.6	263	200	37.9	22
		Sched. 80	Cl. 150	45	190.5	263	200	25.0	17
		Sched. 80	Cl. 300	45	209.6	263	200	37.9	22
4"	2"	Sched. 40	Cl. 150	62	228.6	270	250	26.5	23
		Sched. 40	Cl. 300	62	254.0	270	250	31.8	31
		Sched. 80	Cl. 150	62	228.6	270	250	26.5	23
		Sched. 80	Cl. 300	62	254.0	270	250	31.8	31
6"	3"	Sched. 40	Cl. 150	92	279.4	283	300	26.5	40
		Sched. 40	Cl. 300	92	317.5	283	300	41.5	60
		Sched. 80	Cl. 150	92	279.4	283	300	27.0	40
		Sched. 80	Cl. 300	92	317.5	283	300	42.0	60

Flanged versions (S Style) to ANSI B16.5
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating		d mm	D mm	H[1] mm	L mm	X mm	Weight[2] kg
8"	4"	Sched. 40	Cl. 150	112	342.9	295	300	28.4	61
		Sched. 40	Cl. 300	112	381.0	295	300	47.5	92
10"	6"	Sched. 40	Cl. 150	202.7	406.4	319	380	31.4	91
		Sched. 40	Cl. 300	202.7	444.5	319	380	46.9	129

[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

[2] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

[3] Not available as Dualsens version.

Flanged versions (S Style) to JIS B2220
Prowirl 72F, 73F

DN	Inner diameter	Pressure rating		d [mm]	D [mm]	H[1] [mm]	L [mm]	X [mm]	Weight[2] [kg]
40[3]	15	Sched. 40	20K	22	140	248	200	20.5	8
		Sched. 80	20K	22	140	248	200	20.5	8
50[3]	25	Sched. 40	10K	30	155	255	200	20.5	9
		Sched. 40	20K	30	155	255	200	21.0	11
		Sched. 80	10K	30	155	255	200	20.5	9
		Sched. 80	20K	30	155	255	200	21.0	11
80	40	Sched. 40	10K	45	185	263	200	22.0	13
		Sched. 40	20K	45	200	263	200	25.5	17
		Sched. 80	10K	45	185	263	200	22.0	13
		Sched. 80	20K	45	200	263	200	25.5	17
100	50	Sched. 40	10K	62	210	270	250	25.5	17
		Sched. 40	20K	62	225	270	250	29.0	21
		Sched. 80	10K	62	210	270	250	26.0	17
		Sched. 80	20K	62	225	270	250	29.5	21
150	80	Sched. 40	10K	92	280	283	300	31.0	34
		Sched. 40	20K	92	305	283	300	38.5	45
		Sched. 80	10K	92	280	283	300	31.5	34
		Sched. 80	20K	92	305	283	300	39.0	45
200	100	Sched. 40	10K	112	330	295	300	33.5	50
		Sched. 40	20K	112	350	295	300	43.5	67
250	150	Sched. 40	10K	202.7	400	319	380	30.5	73
		Sched. 40	20K	202.7	430	319	380	37	95

[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure ratings up to PN 40, Cl. 300, 20K).

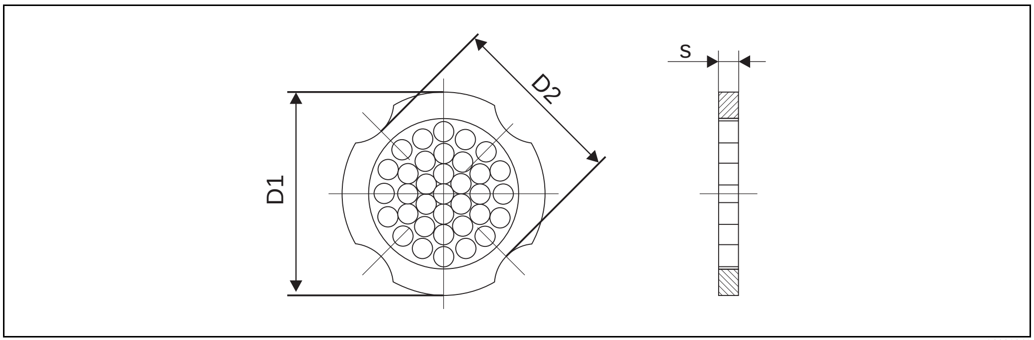
[2] The weight data refer to the compact version. The weight increases by 0.5 kg for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (pressure rating up to PN 40, Cl. 300, 20K). The weight is increased by 6 kg for the Dualsens version.

[3] Not available as Dualsens version.

Dimensions of flow conditioner to EN (DIN)/ANSI/JIS (accessory)

Dimensions to:
- EN 1092-1 (DIN 2501)
- ANSI B16.5
- JIS B2220

Material 1.4404 (316L) or 1.4435 (316L), in compliance with NACE MR0175-2003 and MR0103-2003.



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D1: The flow conditioner is fitted at the external diameter between the bolts.
D2: The flow conditioner is fitted at the indentations between the bolts.

Flow conditioner to EN (DIN)					
DN	Pressure rating	Centering diameter [mm]	D1/D2 *	s [mm]	Weight [kg]
15	PN 10 to 40 PN 63	54.3 64.3	D2 D1	2.0	0.04 0.05
25	PN 10 to 40 PN 63	74.3 85.3	D1 D1	3.5	0.12 0.15
40	PN 10 to 40 PN 63	95.3 106.3	D1 D1	5.3	0.3 0.4
50	PN 10 to 40 PN 63	110.0 116.3	D2 D1	6.8	0.5 0.6
80	PN 10 to 40 PN 63	145.3 151.3	D2 D1	10.1	1.4
100	PN 10/16 PN 25/40 PN 63	165.3 171.3 176.5	D2 D1 D2	13.3	2.4
150	PN 10/16 PN 25/40 PN 63	221.0 227.0 252.0	D2 D2 D1	20.0	6.3 7.8 7.8
200	PN 10 PN 16 PN 25 PN 40	274.0 274.0 280.0 294.0	D1 D2 D1 D2	26.3	11.5 12.3 12.3 15.9
250	PN 10/16 PN 25 PN 40	330.0 340.0 355.0	D2 D1 D2	33.0	25.7 25.7 27.5
300	PN 10/16 PN 25 PN 40	380.0 404.0 420.0	D2 D1 D1	39.6	36.4 36.4 44.7

* D1 → The flow conditioner is fitted at the external diameter between the bolts.
D2 → The flow conditioner is fitted at the indentations between the bolts.

Flow conditioner to ANSI						
DN		Pressure rating	Centering diameter [mm]	D1/D2 *	s [mm]	Weight [kg]
15	½"	Cl. 150 Cl. 300	50.1 56.5	D1 D1	2.0	0.03 0.04
25	1"	Cl. 150 Cl. 300	69.2 74.3	D2 D1	3.5	0.12
40	1½"	Cl. 150 Cl. 300	88.2 97.7	D2 D2	5.3	0.3
50	2"	Cl. 150 Cl. 300	106.6 113.0	D2 D1	6.8	0.5
80	3"	Cl. 150 Cl. 300	138.4 151.3	D1 D1	10.1	1.2 1.4
100	4"	Cl. 150 Cl. 300	176.5 182.6	D2 D1	13.3	2.7
150	6"	Cl. 150 Cl. 300	223.9 252.0	D1 D1	20.0	6.3 7.8
200	8"	Cl. 150 Cl. 300	274.0 309.0	D2 D1	26.3	12.3 15.8
250	10"	Cl. 150 Cl. 300	340.0 363.0	D1 D1	33.0	25.7 27.5
300	12"	Cl. 150 Cl. 300	404.0 402.0	D1 D1	39.6	36.4 44.6

* D1 → The flow conditioner is fitted at the external diameter between the bolts.
D2 → The flow conditioner is fitted at the indentations between the bolts.

Flow conditioner to JIS					
DN	Pressure rating	Centering diameter [mm]	D1/D2 *	s [mm]	Weight [kg]
15	10K	60.3	D2	2.0	0.06
	20K	60.3	D2	2.0	0.06
	40K	66.3	D1	2.0	0.06
25	10K	76.3	D2	3.5	0.14
	20K	76.3	D2	3.5	0.14
	40K	81.3	D1	3.5	0.14
40	10K	91.3	D2	5.3	0.31
	20K	91.3	D2	5.3	0.31
	40K	102.3	D1	5.3	0.31
50	10K	106.6	D2	6.8	0.47
	20K	106.6	D2	6.8	0.47
	40K	116.3	D1	6.8	0.5
80	10K	136.3	D2	10.1	1.1
	20K	142.3	D1	10.1	1.1
	40K	151.3	D1	10.1	1.3
100	10K	161.3	D2	13.3	1.8
	20K	167.3	D1	13.3	1.8
	40K	175.3	D1	13.3	2.1
150	10K	221.0	D2	20.0	4.5
	20K	240.0	D1	20.0	5.5
	40K	252.0	D1	20.0	6.2
200	10K	271.0	D2	26.3	9.2
	20K	284.0	D1	26.3	9.2

Flow conditioner to JIS

DN	Pressure rating	Centering diameter [mm]	D1/D2 *	s [mm]	Weight [kg]
250	10K	330.0	D2	33.0	15.8
	20K	355.0	D2	33.0	19.1
300	10K	380.0	D2	39.6	26.5
	20K	404.0	D1	39.6	26.5

* D1 → The flow conditioner is fitted at the external diameter between the bolts.
D2 → The flow conditioner is fitted at the indentations between the bolts.

Weight

- Weight of Prowirl 72W, 73W → 🗎 33 ff.
- Weight of Prowirl 72F, 73F → 🗎 35 ff.
- Weight of flow conditioner to EN (DIN)/ANSI/JIS → 🗎 48 ff.

Material

Transmitter housing

- Powder-coated die-cast aluminum AlSi10Mg
  - In accordance with EN 1706/EN AC-43400 (EEx d/XP version: cast aluminum EN 1706/EN AC-43000)

Sensor

- Flanged version
  - Stainless steel, A351-CF3M (1.4404), in compliance with NACE MR0175-2003 and MR0103-2003
  - Pressure ratings PN 250, Class 900 to 1500 and butt-weld version (only for Prowirl 72) 1.4571 (316Ti; UNS S31635); in compliance with NACE MR0175-2003 and MR0103-2003
- Alloy C-22 version (only for Prowirl 72)
  - Alloy C-22 2.4602 (A 494-CX2MW/N 26022); in compliance with NACE MR0175-2003 and MR0103-2003
- Wafer version
  - Stainless steel, A351-CF3M (1.4404), in compliance with NACE MR0175-2003 and MR0103-2003

Flanges

- EN (DIN)
  - Stainless steel, A351-CF3M (1.4404), in compliance with NACE MR0175-2003 and MR0103-2003
  - DN 15 to 150 with pressure ratings to PN 40 and all devices with integrated diameter reduction (R Style, S Style): construction with weld-on flanges made of 1.4404 (AISI 316L).
    PN 63 to 160 (in development for Prowirl 73), nominal diameters DN 200 to 300: fully cast construction A351-CF3M (1.4404 (AISI 316L)), in compliance with NACE MR0175-2003 and MR0103-2003
  - Pressure rating PN 250 (only for Prowirl 72) 1.4571 (316Ti, UNS S31635); in compliance with NACE MR0175-2003 and MR0103-2003
- ANSI and JIS
  - Stainless steel, A351-CF3M, in compliance with NACE MR0175-2003 and MR0103-2003
  - ½ to 6" with pressure ratings to Class 300 and DN 15 to 150 with pressure ratings to 20K and all devices with integrated diameter reduction (R Style, S Style): construction with weld-on flanges made of 316/316L, in compliance with NACE MR0175-2003 and MR0103-2003.
    Class 600 (in development for Prowirl 73), DN 15 to 150 with pressure rating 40K, (in development for Prowirl 73), nominal diameters 8 to 12": fully cast construction A351-CF3M; in compliance with NACE MR0175-2003 and MR0103-2003
  - Pressure ratings Class 900 to 1500: 316/316L; in compliance with NACE MR0175-2003 and MR0103-2003 (only Prowirl 72)
- Alloy C-22 version (EN/DIN/ANSI/JIS)
  - Alloy C-22 2.4602 (A 494-CX2MW/N 26022); in compliance with NACE MR0175-2003 and MR0103-2003

DSC sensor (differential switched capacitor)

- Wetted parts (marked as "wet" on the DSC sensor flange):
  - Standard for pressure ratings up to PN 40, Class 300, JIS 40K:
    Stainless steel 1.4435 (316L), in compliance with NACE MR0175-2003 and MR0103-2003
  - Pressure ratings PN 63 to 160, Class 600, 40K (in development for Prowirl 73):
    Inconel 2.4668/N 07718 (B637) (Inconel 718); in compliance with NACE MR0175-2003 and MR0103-2003
  - Pressure ratings PN 250, Class 900 to 1500 and butt-weld version (only for Prowirl 72):
    titanium Gr. 5 (B-348; UNS R50250; 3.7165)
  - Alloy C-22 sensor (only for Prowirl 72):
    Alloy C-22, 2.4602/N 06022; in compliance with NACE MR0175-2003 and MR0103-2003

Non-wetted parts

- Stainless steel 1.4301 (304)

Support

- Stainless steel, 1.4308 (CF8)
- Pressure ratings PN 250, Class 900 to 1500 and butt-weld version (only for Prowirl 72): 1.4305 (303)

Seals

- Graphite
  - Pressure rating PN 10 to 40, Class 150 to 300, JIS 10 to 20K: Sigraflex Folie Z
    (BAM-tested for oxygen applications)
  - Pressure rating PN 63 to 160, Class 600, JIS 40K: Sigraflex Hochdruck^{TM} with stainless steel sheet reinforcement made of 316(L)
    (BAM-tested for oxygen applications, "high quality in terms of TA Luft (German Clean Air Act)"
  - Pressure rating PN 250, Class 900 to 1500: Grafoil with perforated stainless steel reinforcement made of 316
- Viton
- Kalrez 6375
- Gylon (PTFE) 3504 (BAM-tested for oxygen applications, "high quality in terms of TA Luft (German Clean Air Act)"

Human interface

Display elements

Liquid crystal display, double-spaced, plain text display, 16 characters per line
Display can be configured individually, e.g. for measured variables and status values, totalizers

Operating elements (HART)

Local operation with three keys +, -, E)
Quick Setup for quick commissioning
Operating elements accessible also in Ex-zones

Remote operation

Operation via:
- HART
- PROFIBUS PA
- FOUNDATION Fieldbus
- FieldCare (software package from Endress+Hauser for complete configuration, commissioning and diagnosis)

Certificates and approvals

CE mark

The measuring system described in these Operating Instructions complies with the legal requirements of the EU Directives. Endress+Hauser confirms this by affixing the CE mark to it and by issuing the CE Declaration of Conformity.

C-tick mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Ex-approval

- Ex i/IS and Ex n:
  - ATEX/CENELEC
    II1/2G, EEx ia IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
    II1/2GD, EEx ia IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
    II1G, EEx ia IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
    II2G, EEx ia IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
    II3G, EEx nA IIC T1 to T6 X (T1 to T4 X for PROFIBUS PA and FOUNDATION Fieldbus)
  - FM
    Class I/II/III Div. 1/2, Group A to G; Class I Zone 0, Group IIC
  - CSA
    Class I/II/III Div. 1/2, Group A to G; Class I Zone 0, Group IIC
    Class II Div. 1, Group E to G
    Class III
  - NEPSI
    Ex ia IIC
    Ex nA
- Ex d/XP:
  - ATEX/CENELEC
    II1/2G, EEx d [ia] IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
    II1/2GD, EEx ia IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
    II2G, EEx d [ia] IIC T1 to T6 (T1 to T4 for PROFIBUS PA and FOUNDATION Fieldbus)
  - FM
    Class I/II/III Div. 1, Groups A to G
  - CSA
    Class I/II/III Div. 1, Groups A to G
    Class II Div. 1, Groups E to G
    Class III
  - TIIS
    Ex d [ia] IIC T1
    Ex d [ia] IIC T4

More information on the Ex-approvals can be found in the separate Ex-documentation.

Pressure measuring device approval

All measuring devices, including those with a nominal diameter smaller than or equal to DN 25, correspond to Article 3(3) of the EC Directive 97/23/EC (Pressure Equipment Directive) and have been designed and manufactured according to good engineering practice. For nominal diameters greater than DN 25 (depending on the fluid and process pressure), there are additional optional approvals according to category II/III.

Certification FOUNDATION Fieldbus

The flowmeter has successfully passed all test procedures and is certified and registered by the Fieldbus FOUNDATION. The device thus meets all the requirements of the following specifications:

- Certified to FOUNDATION Fieldbus Specification
- The device meets all the specifications of the FOUNDATION Fieldbus-H1.
- Interoperability Test Kit (ITK), revision status 4.5 (device certification number available on request): The device can also be operated with certified devices of other manufacturers.
- Physical Layer Conformance Test of the Fieldbus FOUNDATION

Certification PROFIBUS PA

The flowmeter has successfully passed all test procedures and is certified and registered by the PNO (PROFIBUS User Organization). The device thus meets all the requirements of the following specifications:

- Certified to PROFIBUS PA Profile Version 3.0 (device certification number: on request)
- The device can also be operated with certified devices of other manufacturers (interoperability)

Other standards and guidelines

- EN 60529
  Degrees of protection by housing (IP code)

- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use

- IEC/EN 61326
  Electromagnetic compatibility (EMC requirements)

- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment

- NAMUR NE 43
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal

- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics

- NACE Standard MR0103-2003
  Standard Material Requirements - Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments

- NACE Standard MR0175-2003
  Standard Material Requirements - Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment

- VDI 2643
  Measurement of fluid flow by means of vortex flowmeters.

- ANSI/ISA-S82.01
  Safety Standard for Electrical and Electronic Test, Measuring, Controlling and
  Related Equipment - General Requirements. Pollution degree 2, Installation Category II

- CAN/CSA-C22.2 No. 1010.1-92
  Safety Standard for Electrical Equipment for Measurement and Control and Laboratory Use. Pollution degree 2, Installation Category II

- The International Association for the Properties of Water and Steam – Release on the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam

- ASME International Steam Tables for Industrial Use (2000)

- American Gas Association (1962)
  A.G.A. Manual for the Determination of Supercompressibility Factors for Natural Gas - PAR Research Project NX-19.

- American Gas Association Transmission Measurement Committee Report No. 8 (AGA8),
  November 1992. American Petroleum Institute MPMS Chapter 14.2: *Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases.*

- ISO 12213 Natural gas (2006) - Calculation of compression factor
  - Part 2: Calculation using molar composition analysis (ISO 12213-2)
  - Part 3: Calculation using physical properties (ISO 12213-2)

- GERG Groupe Européen des Recherches Gazières (1991): Technical Monograph TM 5 - Standard GERG Virial Equation for Field Use. Simplification of the input data requirements for the GERG Virial Equation - an alternative means of compressibility factor calculation for natural gases and similar mixtures. Publishing house of Verein Deutscher Ingenieure (Association of German Engineers), Düsseldorf.

- ISO 6976-1995: Natural gas — Calculation of calorific values, density, relative density and Wobbe index from composition.

- Gas Processors Association GPA Standard 2172-96
- American Petroleum Institute API MPMS 14.5 (1996). Calculation of Gross Heating Value, Relative Density and Compressibility Factor for Natural Gas Mixtures from Compositional Analysis.

Functional safety

Prowirl 72: SIL 2 in accordance with IEC 61508/IEC 61511-1

Prowirl 73: SIL 1

Following the link **http://www.endress.com/sil** you will find an overview of all Endress+Hauser devices for SIL applications including parameters like SFF, MTBF, PFD_{avg} etc.

Ordering information

Ordering information and detailed information on the order code can be obtained from your Endress+Hauser Service Organization.

Additional ordering information for Prowirl 72

Prowirl 72 can also be ordered as a preconfigured unit. For this purpose, the following information is needed when ordering:

- Operating language
- Type of fluid: liquid, gaseous or vaporous.
- 20-mA value: measured value at which a current of 20 mA should be set.
  Optional: time constant and failsafe mode (min. current, max. current, etc.)
- Optionally also pulse value, pulse duration, output signal and failsafe mode if the measuring device has a pulse output.
- Average operating density incl. unit if the flow is to be output in mass units.
- Operating and reference density of the fluid including the unit if the flow is to be output in corrected volume units.
- Optional: assignment of the first and second line on the local display and desired unit for the totalizer.

The measuring device can be reset to the delivery state indicated in the order at any time.

Additional ordering information for Prowirl 73

Prowirl 73 can also be ordered as a preconfigured unit. For this purpose, the following information is needed when ordering:

- Operating language
- Type of fluid: saturated steam, superheated steam, water, compressed air, natural gas AGA NX-19 (optional), real gas, customer-defined liquid, gas volume, liquid volume, water delta heat (only for 4 to 20 mA HART), saturated steam delta heat (only for 4 to 20 mA HART).
- Average operating pressure (in bar absolute) or whether the pressure should be read into Prowirl 73 from an external sensor (possible for superheated steam, compressed air, natural gas AGA NX-19, real gas).
- Average ambient pressure (in bar absolute) if the pressure is read into Prowirl 73 from an external pressure sensor.
- Reference pressure and temperature if corrected volume units are selected as an output.
- For applications with natural gas AGA NX-19, mol-% nitrogen and mol-% carbon dioxide are also required as is the "specific gravity" (ratio of the density of natural gas to that of air at reference operating conditions).
- For real gas applications, the operating Z-factor, the reference Z-factor and the reference density are also required.
- For customer-defined liquid applications, the average operating temperature, the density the fluid has at this temperature and the linear expansion coefficient of the fluid are also required. These values can also be calculated by Endress+Hauser if the customer specifies the fluid and operating temperature or if the dependency between the fluid density and the temperature is made available in tabular form.
- 4-mA value: measured value (e.g. 50 kg/h) at which a current of 4 mA should be output, incl. unit.
- 20-mA value: measured value (e.g. 1000 kg/h) at which a current of 20 mA should be output, incl. unit, time constant and failsafe mode (min. current, max. current etc.)
- Pulse value incl. unit (if the measuring device has a pulse output), pulse duration, output signal and failsafe mode.
- Optional: assignment of the first and second line on the local display and desired unit for the totalizer. In addition, you can also tell us what fault values apply for temperature and pressure, where applicable.

- Optional: configuration of the extended diagnostic functions, e.g. maximum/minimum temperature, maximum flow velocity, etc.

The measuring device can be reset to the delivery state indicated in the order at any time.

Product structure for flanged devices "R Style" and "S Style" (with diameter reduction)

R Style		Single reduction of line size (>)
7*F	**RF** -************	DN 25 (1") > DN 15 (½")
	RG -************	DN 40 (1½") > DN 25 (1")
	RJ -************	DN 50 (2") > DN 40 (1½")
	RK -************	DN 80 (3") > DN 50 (2")
	RM-************	DN 100 (4") > DN 80 (3")
	RN -************	DN 150 (6") > DN 100 (4")
	RR-************	DN 200 (8") > DN 150 (6")
S Style		Double reduction of line size (>>)
7*F	**SF** -************	DN 40 (1½") >> DN 15 (½")
	SG -************	DN 50 (2") >> DN 25 (1")
	SJ -************	DN 80 (3") >> DN 40 (1½")
	SK -************	DN 100 (4") >> DN 50 (2")
	SM-************	DN 150 (6") >> DN 80 (3")
	SN -************	DN 200 (8") >> DN 100 (4")
	SR -************	DN 250 (10") >> DN 150 (6")

Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Detailed information on the order code in question can be obtained from your Endress+Hauser representative.

Device-specific accessories

Accessory	Description	Order code
Transmitter Proline Prowirl 72/73	Transmitter for replacement or for stock. Use the order code to define the following specifications: ▪ Approvals – Degree of protection/version – Cable entry – Display/operation – Software ▪ Outputs/inputs	72XXX – XXXXX ****** 73XXX – XXXXX ******

Measuring principle-specific accessories

Accessory	Description	Order code
Mounting kit for Prowirl 72/73W	Mounting kit for wafer comprising: ▪ Threaded studs ▪ Nuts incl. washers ▪ Flange seals	DKW** – ***
Mounting kit for transmitter	Mounting kit for remote version, suitable for pipe and wall mounting.	DK5WM – B
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific energy consumption, boiler efficiency and other parameters which are important for efficient energy management.	RSG40 – ************
Flow conditioner	To reduce the inlet run downstream of flow disturbances.	DK7ST – ***
Pressure transmitter Cerabar T	Cerabar T is used to measure the absolute and gauge pressure of gases, steams and liquids (compensation with RMC621 for example).	PMC131 – **** PMP131 – ****
Pressure transmitter Cerabar M	Cerabar M is used to measure the absolute and gauge pressure of gases, steams and liquids. ▪ Can also be used for reading external pressure values into Prowirl 73 via the burst mode. ▪ Can also be ordered with ready-activated burst mode (special product with version 9=TSPSC2821). ▪ Can also be used for reading external pressure values into Prowirl 73 via PROFIBUS PA (only absolute pressure).	PMC41 – *********** PMP41 – *********** PM*4* – ******H/J9***

Accessory	Description	Order code
Pressure transmitter Cerabar S	Cerabar S is used to measure the absolute and gauge pressure of gases, steams and liquids. ▪ Can also be used for reading external pressure values into Prowirl 73 via the burst mode. ▪ Can also be ordered with ready-activated burst mode (special product with version 9=TSPSC2822). ▪ Can also be used for reading external pressure values into Prowirl 73 via PROFIBUS PA or FOUNDATION Fieldbus (only absolute pressure).	PMC71 - *********** PMP71 - *********** PM*7* - *A/B/C********9
RTD temperature Omnigrad TR10	Multipurpose temperature sensor, mineral-insulated insert with protection well and transmitter housing. Together with a HART-compatible transmitter, it can be used for to read the temperature into Prowirl 73 in the burst mode.	TR10 - *******R/T**** THT1-L**
Active barrier RN221N	Active barrier with power supply for safe separation of 4 to 20 mA standard signal circuits: ▪ Galvanic isolation of 4 to 20 mA circuits ▪ Elimination of ground loops ▪ Power supply of two-wire transmitters ▪ Can be used in Ex area (ATEX, FM, CSA, TIIS) ▪ HART input-compatible (e.g. for reading in an external pressure value) Note! If RN221N - *3 is used for the HART input, this results in an error message for Prowirl 73 and can not be used for pressure compensation.	RN221N - *1
Process display RIA250	Multifunctional 1-channel display unit: ▪ Universal input ▪ Transmitter power supply ▪ Limit relay ▪ Analog output	RIA250 - ******
Process display RIA251	Digital display unit for looping into 4 to 20 mA current loop; can be used in Ex area (ATEX, FM, CSA).	RIA251 - **
Field display RIA261	Digital field display unit for looping into 4 to 20 mA current loop; can be used in Ex area (ATEX, FM, CSA).	RIA261 - ***
Process transmitter RMA422	Multifunctional 1-2 channel top-hat rail device with intrinsically safe current inputs and transmitter power supply, limit value monitoring, mathematic functions (e.g. difference ascertain) and 1-2 analog outputs. Optional: intrinsically safe inputs, can be used in Ex area (ATEX). Possible applications: leak detection, delta heat (between two Prowirl measuring points), totalizing (of flows in two pipes) etc.	RMA422 - *******
Overvoltage protection HAW562Z	Overvoltage protection for restricting overvoltage in signal lines and components.	51003575
Overvoltage protection HAW569	Overvoltage protection for restricting overvoltage for direct mounting to Prowirl 73 and other devices.	HAW569 - **1A
Heat computer RMS621	Steam and heat computer for industrial energy balancing of steam and water. Calculation of the following applications: ▪ Steam mass ▪ Steam heat quantity ▪ Net steam heat quantity ▪ Steam delta heat ▪ Water heat quantity ▪ Water delta heat Simultaneous calculation of up to three applications per device.	RMS621-*********

Accessory	Description	Order code
Energy Manager RMC621	Universal Energy Manager for gas, liquids, steam and water. Calculation of volumetric flow and mass flow, standard volume, heat flow and energy.	RMC621 - **********
Application Manager RMM621	Electronic recording, display, balancing, control, saving, event and alarm monitoring of analog and digital input signals. Values and states determined are output by means of analog and digital output signals. Remote transmission of alarms, input values and calculated values using a PSTN or GSM modem.	RMM621 - **********
Conversion kits	Several conversion kits are available, e.g.: ▪ Conversion of Prowirl 77 to Prowirl 72 or 73 ▪ Conversion of a compact version to a remote version	DK7UP - **
Weather protection cover	Protective hood against direct sunshine.	543199-0001

Communication-specific accessories

Accessory	Description	Order code
HART Field Communicator DXR375	Handheld terminal for remote configuration and for obtaining measured values via the current output HART (4 to 20 mA) and FOUNDATION Fieldbus (FF). Contact your Endress+Hauser representative for more information.	DXR375 - *******
Fieldgate FXA320	Gateway for remote interrogation of HART sensors and actuators via Web browser: ▪ 2-channel, analog input (4 to 20 mA) ▪ 4 binary inputs with event counter function and frequency measurement ▪ Communication via modem, Ethernet or GSM ▪ Visualization via Internet/Intranet in Web browser and/or WAP cellular phone ▪ Limit value monitoring with alarms sent by e-mail or SMS ▪ Synchronized time-stamping of all measured values	FXA320 - *****
Fieldgate FXA520	Gateway for remote interrogation of HART sensors and actuators via Web browser: ▪ Web server for remote monitoring of up to 30 measuring points ▪ Intrinsically safe version [EEx ia]IIC for applications in Ex area ▪ Communication via modem, Ethernet or GSM ▪ Visualization via Internet/Intranet in Web browser and/or WAP cellular phone ▪ Limit value monitoring with alarms sent by e-mail or SMS ▪ Synchronized time-stamping of all measured values ▪ Remote diagnosis and remote configuration of connected HART devices ✎ Note! If Fieldgate FXA520 is used for the HART input, this results in an error message for Prowirl 73 and is not recommended.	FXA520 - ****

Accessory	Description	Order code
Fieldgate FXA720	Gateway for remote interrogation of PROFIBUS sensors and actuators via Web browser: – Web server for remote monitoring of up to 30 measuring points – Intrinsically safe version [EEx ia]IIC for applications in Ex area – Communication via modem, Ethernet or GSM – Visualization via Internet/Intranet in Web browser and/or WAP cellular phone – Limit value monitoring with alarms sent by e-mail or SMS – Synchronized time-stamping of all measured values – Remote diagnosis and remote configuration of connected HART devices	FXA720 - ****

Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and planning flowmeters. The Applicator can be downloaded from the Internet or ordered on CD-ROM for installation on a local PC. Contact your Endress+Hauser representative for more information.	DXA80 - *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed out and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	FieldCare is Endress+Hauser's FDT-based plant asset management tool. It can configure all intelligent field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition.	See the product page on the Endress+Hauser Web site: www.endress.com
FXA193	Service interface from the measuring device to the PC for operation via FieldCare.	FXA193 – *

Documentation

- Operating Instructions Proline Prowirl 72
- Operating Instructions Proline Prowirl 72 PROFIBUS PA
- Operating Instructions Proline Prowirl 72 FOUNDATION Fieldbus
- Operating Instructions Proline Prowirl 73
- Operating Instructions Proline Prowirl 73 PROFIBUS PA
- Operating Instructions Proline Prowirl 73 FOUNDATION Fieldbus
- Related Ex-documentation: ATEX, FM, CSA etc.
- Supplementary documentation on "Information on the Pressure Equipment Directive"

Registered trademarks

- GYLON®
  Registered trademark of Garlock Sealing Technologies, Palmyar, NY, USA
- HART®
  Registered trademark of the HART Communication Foundation, Austin, USA
- INCONEL®
  Registered trademark of Inco Alloys International Inc., Huntington, USA
- KALREZ®, VITON®
  Registered trademarks of E.I. Du Pont de Nemours & Co., Wilmington, USA
- FieldCare®, Fieldcheck®, Applicator®
  Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

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FM+SGML 6.0 ProMoDo

SeaMetrics FT420 Flow Computer

FT400-Series

FLOW COMPUTER INSTRUCTIONS

- [redacted]
- **FT420**

FT400-SERIES FLOW COMPUTER INSTRUCTIONS

ISO 9001:2000 CERTIFIED

SeaMetrics

The Leader in Flow Meter Value

TABLE OF CONTENTS

General Information

Installation

Connection Diagrams

(Quick) Settings

Settings

Operation

Troubleshooting

TABLES AND DIAGRAMS

GENERAL INFORMATION

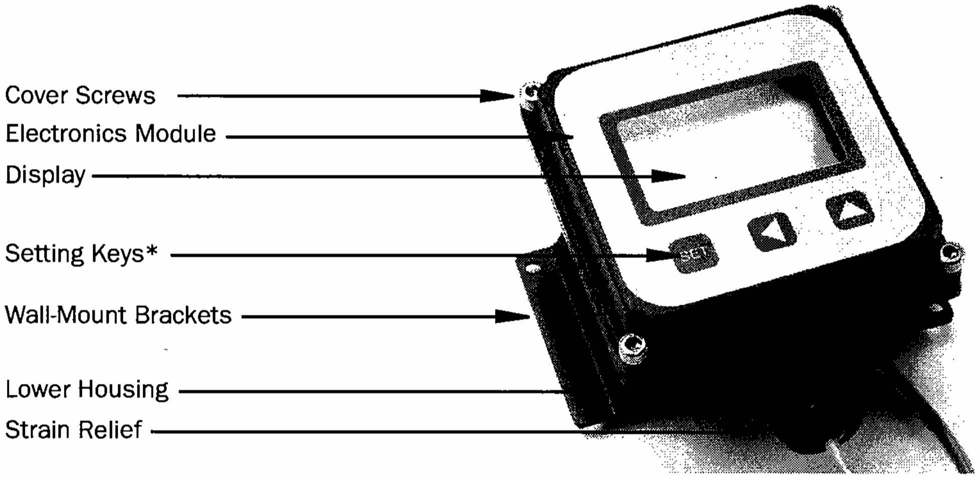
The FT400-Series flow computers are microcontroller-based indicator/transmitters that display flow rate and total and provide output signals. The FT415 is battery-powered and provides a scalable pulse output. The FT420 is powered by external DC voltage and has both pulse and 4-20 mA analog outputs. The FT420 is a "two-wire" or "loop-powered" device, meaning that the 4-20 mA output signal doubles as its power supply. Because of this, it is designed to operate on less than 4 mA of current.

The addition of a dual-relay output board allows for certain applications requiring dry contact output (e.g., certain metering pumps and water treatment controls). Dual relays provide exactly the same pulse output as the standard unit, and each can signal one external device. A non-resettable total is also available. The FT420 can be ordered in a plastic enclosure with a 115 Vac power supply for use with mechanical meters, or with a built-in 115 Vac/12-24 Vdc dual power supply for magmeters.

Both the FT415 and the FT420 can be factory-mounted on the meter (-M) or remotely wall mounted with the brackets provided (-W). The FT420 is also available as a panel mount (-P) with an open back for easy installation in the user's own electrical enclosure. Most FT400's can be converted from wall-to-meter or meter-to-wall mount configurations after installation if needed.

Housings for the -W and -M models are rugged cast aluminum, gasketed for maximum environmental protection. A membrane keypad allows settings to be changed without removing the cover. (Password protection, a standard feature, can be used to prevent settings from being changed.)

FEATURES



*Includes password protection for tamper prevention when needed

SPECIFICATIONS		**FT415**	**FT420**
Power		Lithium "C", 3.6 Vdc, replaceable, 3-5 year life	4 mA DC (4-20 mA loop), 12-32 Vdc
Display	**Rate**	6-digit autorange, 1/2" character height	6-digit autorange, 1/2" character height
	Total	8-digit, 5/16" character height	8-digit, 5/16" character height
Output	**Pulse**	0.1 second open collector pulse (scaled) Sensor pulse (unscaled) High alarm or low alarm	0.1 second open collector pulse (scaled) Sensor pulse (unscaled) High alarm or low alarm
	Analog	None	4-20 mA loop; 24-32 Vdc
Pulse Output Range		0.1 - 9999999.9 units/pulse	0.1 - 9999999.9 units/pulse
Input		Micropower GMR Sensor (square wave)	Open collector/switch @ 5 Vdc
Input Range		1.0 - 2,500 pulses/second	1.0 - 10,000 pulses/second
K-Factor Range		.001 - 99999.999	.001 - 99999.999
Flow Alarm Output Range		.01 - 999999.99	.01 - 999999.99
Temperature		0° C - 70° C (32° - 158° F)	0° C - 70° C (32° - 158° F)
Environmental		NEMA 4X	NEMA 4X

Wall Mount. To mount an FT400-Series indicator to the wall, hold the unit in the desired position, mark the holes in the mounting feet, drill and mount with screws. With the FT420W-65 option, first remove the front cover to gain access to the mounting screw holes.

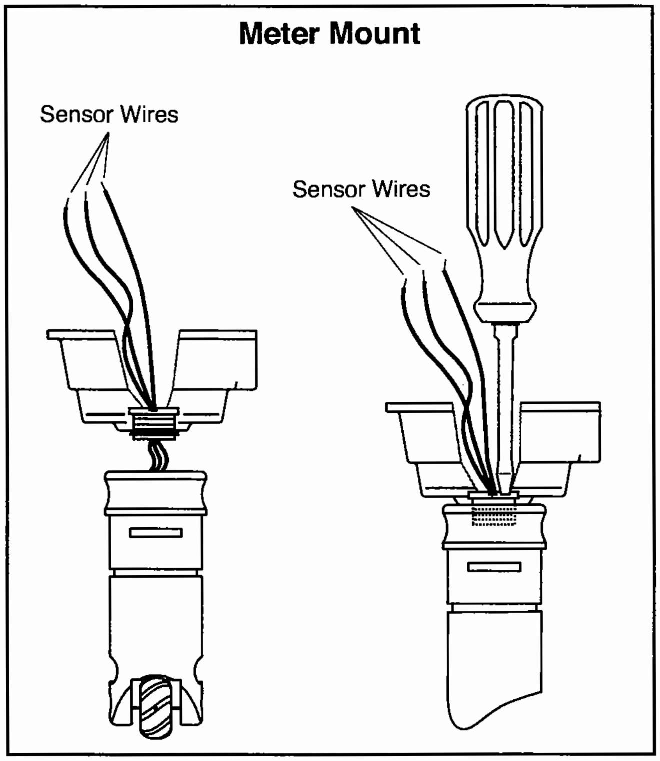
A meter-mounted FT400-Series can be converted to a wall mount using an MK20 mounting kit.

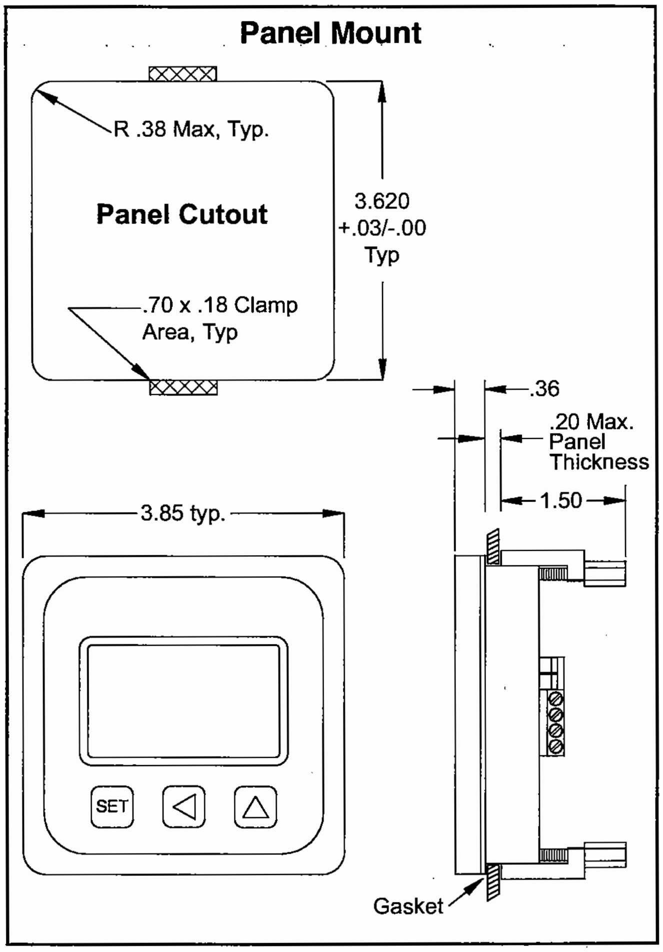
Meter Mount. If the FT400-Series indicator was ordered as an -M model, the housing is already directly mounted to the flow sensor and needs no further installation.

An FT400-Series module can be converted from a wall-to a meter-mount using the MK10 adapter kit that includes a lower housing and associated hardware as follows:

1) Remove the strain relief through which the flow sensor cable runs.
2) Cut the cable to about 6" in length. Carefully strip the cable jacket to expose the three colored wires (red, white, and black) inside.
3) Route the wires through the threaded connector pre-installed in the bottom of the housing.
4) Start the threaded connector into the female thread on the top of the flow sensor. Be sure to match the oblong shape on the bottom of the housing to the depression on the top of the flow sensor.
5) Using an ordinary screwdriver inserted in one side of the slot (see drawing), tighten the screw as much as possible.
6) Strip the wire ends, make the connections to the FT400-Series indicator as shown in Connections Diagrams, and then use the cover screws to attach the indicator to the top of the housing.

Panel Mount (FT420 Only). Using the "Panel Cutout" drawing as a guide, cut a square hole in the panel. Remove the clamps from the back of the FT420P and insert the indicator unit through the cutout, taking care that the panel sealing gasket is in place between the front of the panel and the flange of the indicator. Hold the indicator in place while starting the screw of one of the two clamps. Finger tighten the screw, then install the other clamp. When both are in place, firmly tighten the clamps with a small wrench or nut driver.


Meter Mount


Panel Mount

Connections. To connect the FT400-Series flow computer to a flow sensor or an external device such as a chemical metering pump, follow the Standard Connections diagrams on pages 4-6.

If the FT420's 4-20 mA current signal is not required, connect the power terminals to any Vdc current source.

Dual Relay Output (Option -98). If you purchase the FT420 with option 98, the required component will come preinstalled, and no extra procedures are required.

If you are retrofitting an existing installation of an FT420 with the dual relay board, please follow the instructions below:

1) Peel the backing off of the double-stick tape and affix it to the bottom of the relay board (part #30221).
2) Carefully attach the board to the FT420 as shown in the FT420-98 Connection diagram on page 5. Be sure that the red wire faces the "Sensor Input" side of the FT420, and that the white wire faces the "Pulse Output" side.
3) Connect the white wire to the "Pulse Scaled" positive terminal, and the red wire to the "Power 4-20 mA" positive terminal.
4) Connect devices to the relays as desired.

-98 Relay Board Specifications

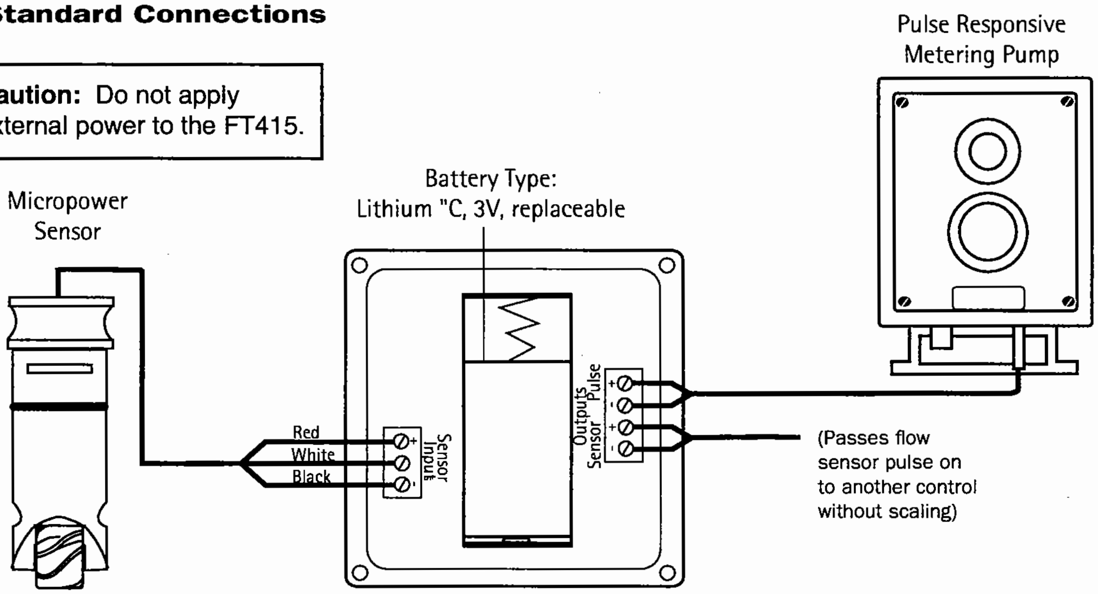
Input Voltage	7-30 Vdc	
Output Current (both outputs)		
Input Voltage	50 C	85 C
12 Vdc	120 mA	70 mA
24 Vdc	120 mA	80 mA
Max Pulses/Second		5
Contact Time Per Output		100 ms

Caution: If output is being used to control an external device, such as a metering pump, do not connect the device until programming is completed. If malfunction or incorrect programming of the output could cause personal injury or property damage, separate safeguards must be installed to prevent such injury or damage.

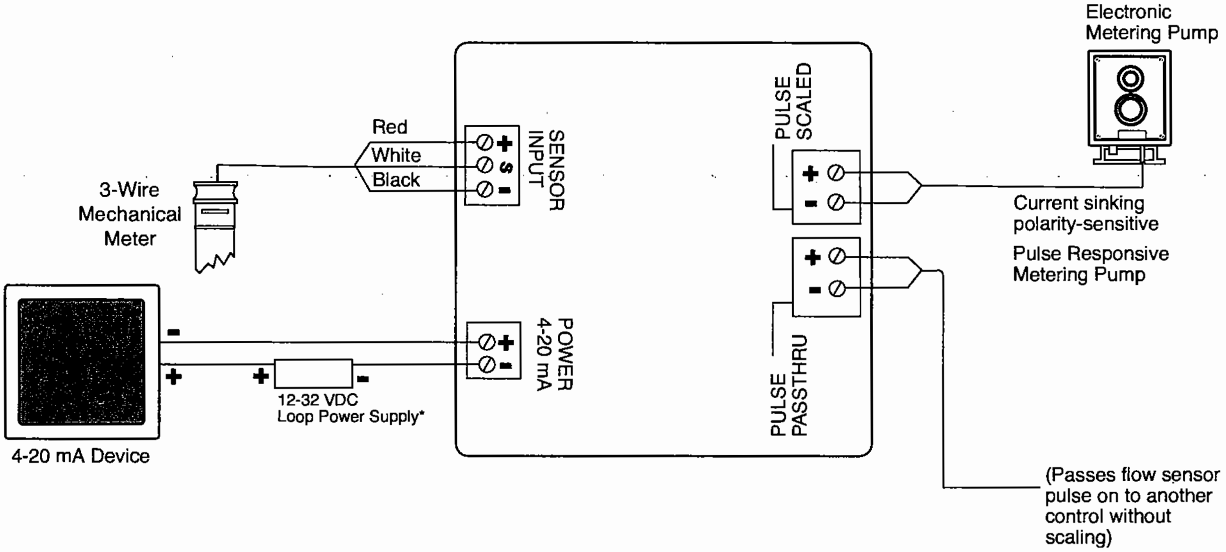
CONNECTION DIAGRAMS

FT415 Standard Connections

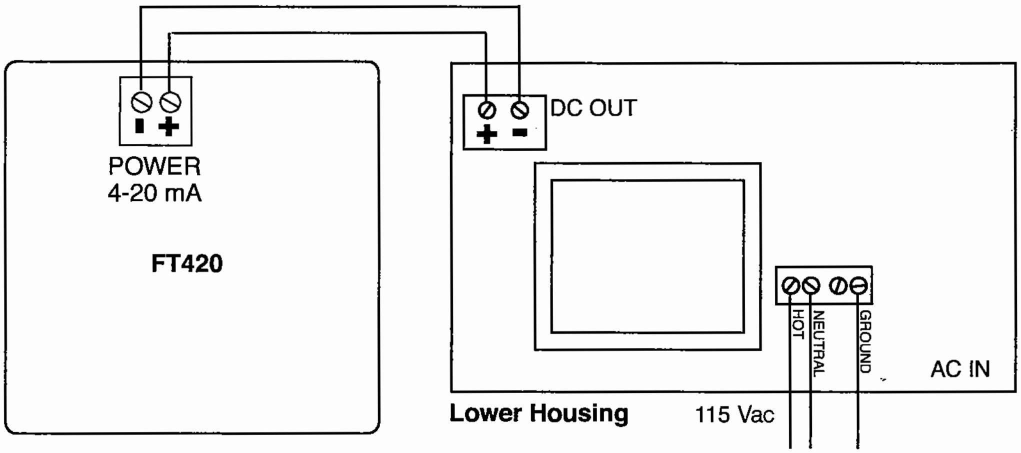
Caution: Do not apply external power to the FT415.



Connections for FT420/3-Wire Mechanical Meter

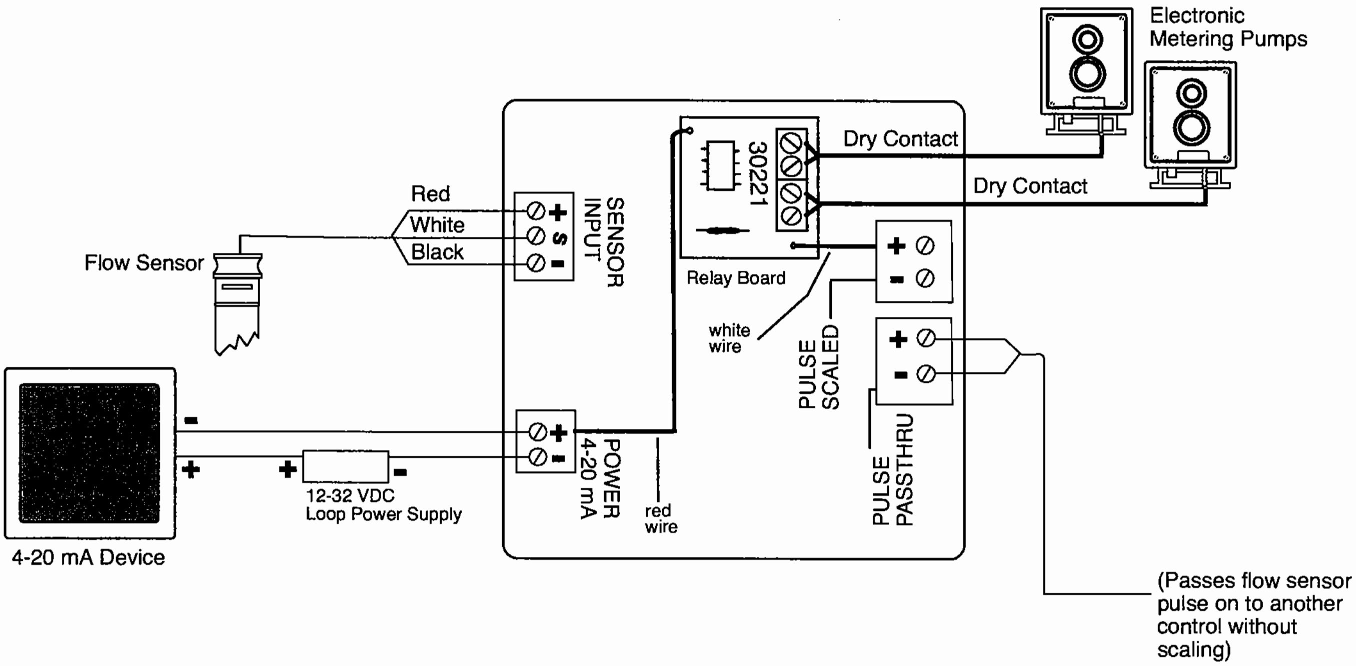


Connections for FT420-65 (115 Vac Option)

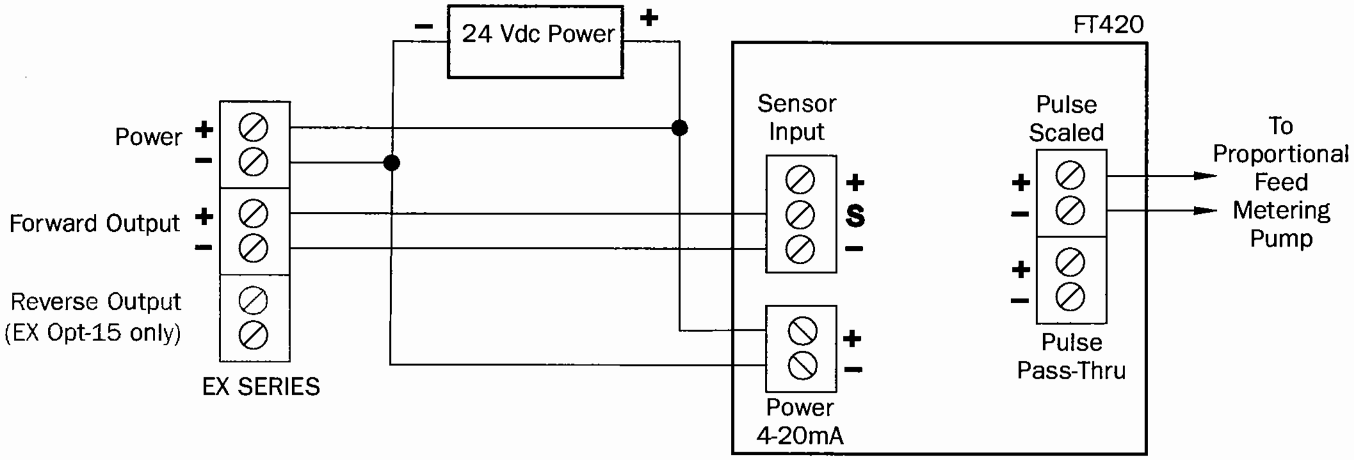


CONNECTION DIAGRAMS

Connections for FT420-98 (Dual Relay Output Option)



Connections for FT420/EX Magmeter

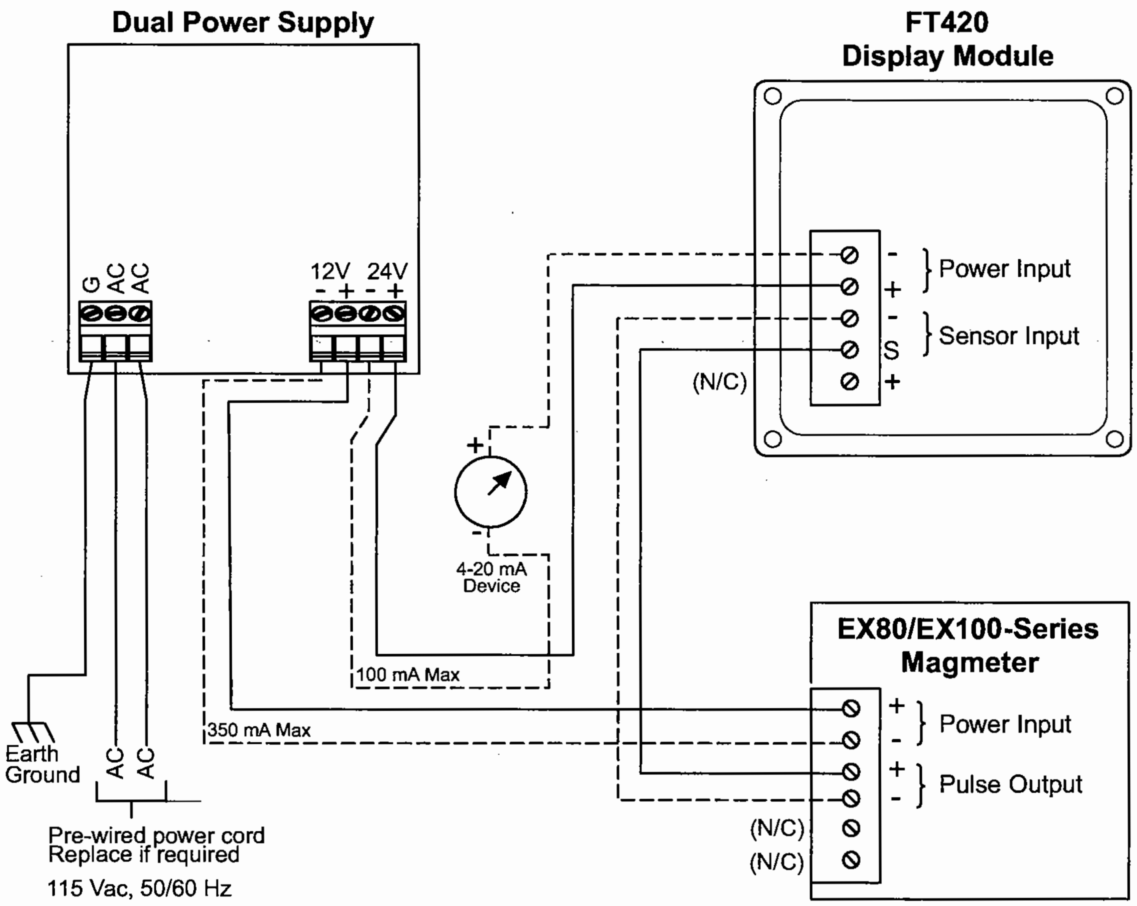


Connections for FT420/EX Magmeter/Dual Power Supply

A dual power supply is required when a 4-20 mA output is needed.

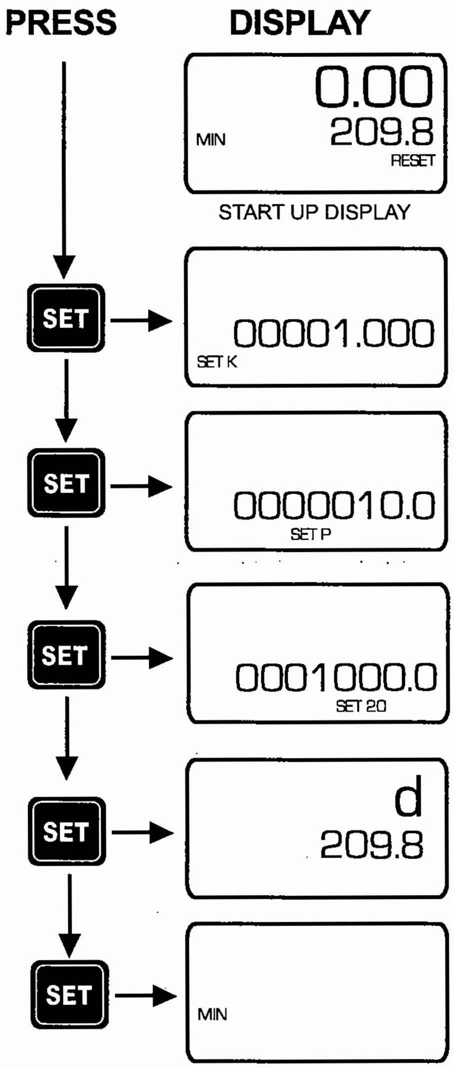
Caution 1: Important! Do not connect power to the power supply until all connections have been made and confirmed correct, and the cover has been put back into place.

Caution 2: It is essential for safety and proper operation to use a ground connection for the 115 Vac power. Do not use this power supply without proper grounding.



QUICK SETTINGS OVERVIEW

See following page for step-by-step instructions on changing these settings



Large digits display instantaneous flow rate (GPM). Small digits display total flow (since last reset).

K is the number of pulses the flow sensor provides for every gallon of flow. Find it on the fitting (80-Series) or chart (100/200-Series) or on the SeaMetrics website.

P is the number of gallons per pulse desired on the scalable pulse output. (Example: P=1 is one pulse per gallon.) Skip without changing if you are not using the pulse output.

20 is the 20 mA maximum analog output. Set the flow rate you want to match maximum output. Example: 250 gpm maximum expected flow, "set 20" to 250. The analog output will scale to 4 mA at zero flow, 20 mA at 250 gpm*. **This setting appears on the FT420 ONLY.**

d is the decimal point. It toggles back and forth with the ▲. Set as many decimal places as needed. For higher flows, no decimal allows maximum number of whole digits.

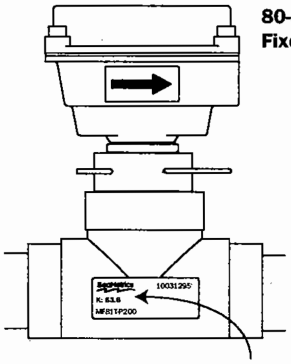
MIN is the time base, for example, gallons *per minute*. Use the ▲ to select sec/min/hour/day.

***NOTE:** Use the up arrow key to reach your desired digit. Then press the left arrow key to move to the next digit. Repeat the process until the entire number is entered.

K-FACTOR

At a minimum, every FT400-Series flow computer must be programmed with the "K-factor". (This is the number of pulses that the meter produces per gallon of flow.) If you wish the FT400 to read in units other than gallons, see below.

The K-factor on any SeaMetrics flow sensor fitting or in-line meter can be found on the model-serial label. The line reading K = xxxx gives the desired number. For depth-adjustable sensors (101,201,115,215 models), look in the instruction manual under your pipe size. For EX meters, use the calculator on our website.



80-Series Fixed Depth Meter

Find Your K-Factor Here

READING IN OTHER UNITS

Changing Volume Units. The default K-factor units are pulses per gallon. To read your total in metric or other units instead, the standard K-factor must be converted to the desired volume units. For example, to read in pulses per liter, the K-factor must be multiplied by the applicable number shown below.

NOTE: Both rate & total will read in whatever units you choose.

To Convert K to:	Multiply by:
Liters	.26418
Cubic Meters	264.18
Fluid Ounces	.0078
Cubic Feet	7.48

Changing Time Units: To read your rate in liters per second (for example), convert the K-factor volume units as shown above and change the time units to Seconds, using the Set Time Unit instructions at right.

Set K. Begin by pressing the SET key once. The prompt SET K should appear on the display. The digit to the far right will be blinking. Use the up arrow key to reach your desired value. Then press the left arrow key to move to the next digit. Repeat the process until the entire number is entered. (Note that the decimal is fixed at three places. If you only have two decimal places for your K-factor, enter a zero for the third digit.) Press SET to advance. (**Note:** If unable to set K-factor, the unit is "locked" to prevent tampering. Please contact your Distributor for assistance.)

Set P/Flow Alarm. At this screen you may select between pulse output (P) or flow alarm (A) functions. If the pulse output and flow alarm features are not being used, this step can be skipped. The P (pulse output) setting does not affect anything if it is not being used.

Set P is the default that appears on a new FT400-Series. On an FT400 that has been previously set up with flow alarm function, an A will appear on this screen. To move between P and A screens, firmly press all three keys for 5-10 seconds, then use the up arrow to scroll through the three options: P, AL HI (high flow alarm) and AL LO (low flow alarm).

Set P. From this screen, follow the same process as for Set K to enter the desired pulse rate. This is the number of gallons (or whatever units are programmed) between pulses. (**Note:** Using the pulse output function disables the high and low flow alarm functions.)

Set Flow Alarm. From the A screen, use the up arrow key to choose either AL HI or AL LO and then press the SET key to set the alarm rate. Use the up arrow and left arrow as above to reach the desired digits. (**Note:** Using the flow alarm function disables the pulse output function.)

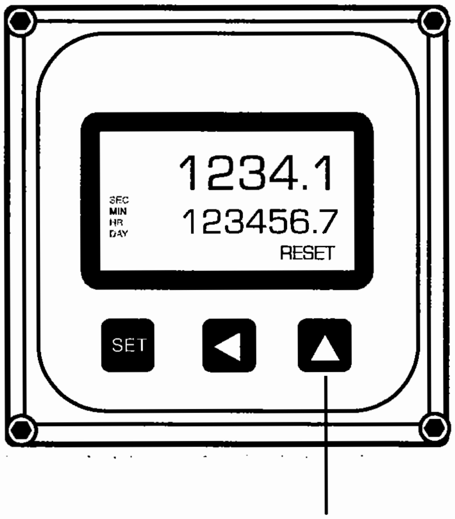
Set 20 mA (FT420 Only). Press the SET key to advance to SET 20, to set the flow rate, in volume units per time unit, at which 20 mA is desired. Use the up arrow key to reach your desired value. Then press the left arrow key to move to the next digit. Repeat the process until the entire number is entered. The processor will automatically scale the 4-20 mA loop accordingly, with 4 mA at zero flow.

Set Decimal Point. Press the SET key again for the D prompt. Pressing the up arrow key switches among no decimal place, one decimal place and two decimal places.

Set Time Unit. When the SET key is pressed again, a blinking time unit appears. Press the up arrow key to select SEC (seconds), MIN (minutes), HR (hours) or DAY (days) (for example, gal/min, or gal/hr).

To return to normal operation after entering settings, press SET again. When the unit is connected to an operating flow sensor, the rate (larger digits) and total (smaller digits) indicator numbers should appear in the display.

Resettable/Non-Resettable Totalizer. Unless the unit has been ordered with the non-reset option, a RESET prompt is visible in the lower right corner above the up arrow key, when the display is in use. Press the up arrow key at any time to reset the totalizer to zero. (**Note:** If you need to reset a unit that has been ordered with a non-resettable totalizer, contact your distributor.)



This key resets total to zero when in normal run mode.

CAUTION: Do not touch up Arrow button ▲ unless you intend to RESET Total to Zero. TOTAL IS NOT RECOVERABLE.

Operation of 4-20 mA Output (FT420 Only). If the 4-20 mA output is in use and is correctly connected, the signal should vary between 4 mA and 20 mA in proportion to the flow, with the top flow rate set by the user (see Settings, page 8). At no time should the signal drop below 4 mA. A reading between 0 and 4 mA indicates a fault of some type, typically in the loop power supply or the connections (see Troubleshooting, back page). In the rare instance that the 4-20 signal fluctuates excessively ("paints") it may need to be damped by additional averaging. Contact Seametrics for information on how to increase filtering.

Operation of the Pulse Output. If the pulse output is being used (either standard electronic or relay-type), it should pulse for 0.1 second every time the set number of gallons has been totalized. If a pulse-responsive metering pump is properly connected to this output, it should stroke periodically. If this does not occur, see Troubleshooting, back page.

FT415 Battery Change. The expected average life of the battery ranges between 3-5 years depending on the frequency of the input. The battery is easily pulled and replaced. When the battery is removed, all of the settings will be retained.

CAUTION: During a battery change, the totalizer will reset to a previous total, which represents the last auto-backup (auto backups occur at approximately 4 minute intervals). If it is necessary to save the exact current total at the time of the battery change, save before removing the battery as follows:

1) Simultaneously press the SET and up arrow keys
2) Press SET again
3) Again simultaneously press the SET and up arrow keys

TROUBLESHOOTING

Problem	Probable Cause	Try...
Display blank	No power to the unit	Check for minimum 12 Vdc at power terminals
	Short in sensor circuit	Disconnect sensor, see if display returns (zero flow rate)
	Battery dead or loose (FT415 only)	Wiggle battery, replace if over three years old
Display missing segments	Damaged display module	Contact distributor for return/replacement
Display reading meaningless characters	Unit's microcontroller crashed	Disconnect and reconnect power, if problem repeats, contact distributor for return/replacement
	Battery nearly dead	Replace battery if over three years old
Display reads normally, flow rate incorrect	Wrong K-factor or time base entered	Enter correct K-factor from meter, fitting, or manual
Display reads normally, incorrect pulse output	Wrong pulse output setting	Use "Set P" to correct pulse output setting
	Polarity reversed on pulse output terminals	Reverse leads
Display reads normally, but no (or incorrect) 4-20 mA output (FT420 only)	Wrong 20 mA setting	Use "Set 20" to correct target top flow rate
	Inadequate loop power supply voltage	Check voltage (For 4-20 mA applications, 24 Vdc recommended)
	Polarity incorrect in 4-20 mA loop circuit	Compare to Connections diagram
Display reads zero when there is flow	Flow sensor failed	Consult flow sensor manual for how to test
	Break in flow sensor circuit	Check for continuity with multimeter
	Flow sensor not battery-compatible	Check flow sensor model number for "micropower option"
Display reads flow rate when there is none	Long flow sensor wire, running parallel to power wires	Reroute wire or change to shielded wire
	Flow sensor malfunction	See flow sensor manual to check
	Flow "jitter" (oscillating slosh) reads as flow	Consult factory for "anti-jitter" setting

SeaMetrics

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SeaMetrics

IP80 Series Flow Sensor Instructions

General Information

The IP80 Series are impeller-type insertion meters designed for use in pipe sizes 1/2" to 8". High-quality jewel bearings and nickel-bound tungsten carbide shaft are used for maximum life and extreme low friction. Bodies are machined from solid rod for maximum precision. Low-flow performance is superior. The rotation of the rotor is detected by a non-drag Hall-effect sensor. Output is a pulse-type square wave, which can be sent long distances (up to 2,000 feet) without a transmitter. This signal can be connected directly to SeaMetrics controls, as well as PLC's, counters, and computer cards.

SeaMetrics IP meters are ideal for chemical proportioning applications. If no display is required, a simple divider such as the PD10 provides adjustable pump pacing. For rate and total display, as well as pump pacing, the FT415/420 flow indicator can be mounted directly on the IP80 Series, or remotely on a wall or panel.

The IP80 Series require special fittings, since they are not depth-adjustable as are the IP 100/200 series meters. Installation in the fitting ensures correct depth placement in the pipe. Fittings are available in PVC, brass, and stainless steel. Sensors are available in brass, 316 stainless steel, PVC, and polypropylene. In plastic pipe 3"-8", use an IP82 sensor, which is 1.00" longer than the IP81 to accommodate the larger fittings.

Specifications

Sensor		
	Hall Effect Sensor	12 VDC current sinking pulse
Materials		
	Sensor Body	PVC, Polypro, Brass, or 316 SS
	Rotor	Kynar
	Shaft	Nickel-bound tungsten carbide, ceramic optional
	Bearings	Ruby jewel
Maximum Pressure		
	PVC	175 PSI (12 bar) at 75° *
	Polypro	175 PSI (12 bar) at 75° *
	Brass	200 PSI (14 bar)
	316 SS	250 PSI (17 bar)
Maximum Temperature		
	PVC,Polypro	130° F (55° C)*
	Brass, SS	200° F (93° C)
Accuracy		1-1/2% FS

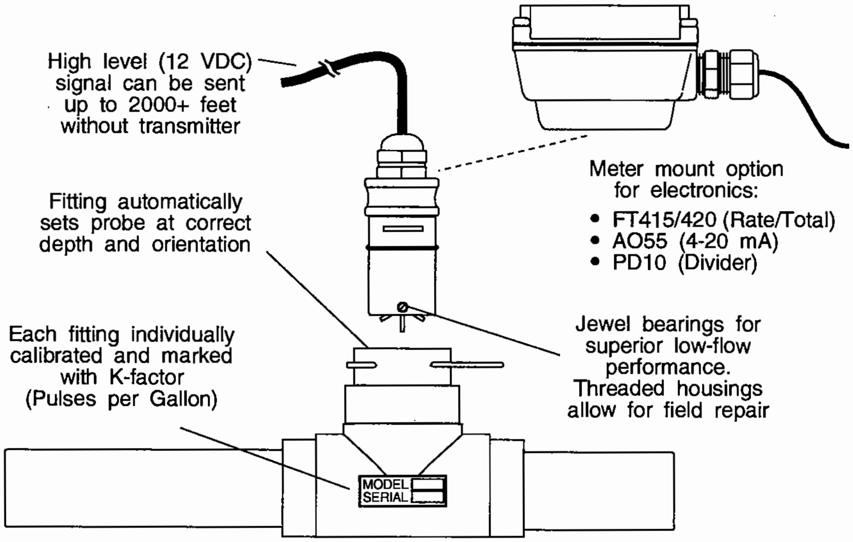
Flow Range (GPM)

	1/2"	3/4"	1"	1-1/2"	2"	3"	4"	6"	8"
Min	0.28	0.5	0.8	1.9	3.1	6.9	12	27	47
Max	28	50	80	190	314	691	1200	2700	4700

Cable #22 AWG 3-con, 18'

* (see Pressure vs. Temperature chart)

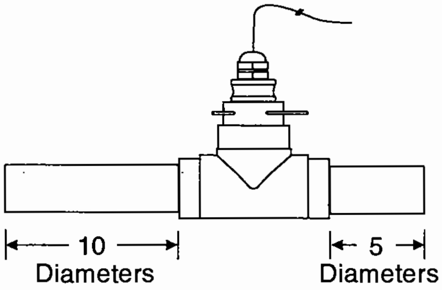
Features



Installation

These water meters are not recommended for installation downstream of the boiler feedwater pump where installation fault may expose the meter to boiler pressure and temperature. Maximum recommended temperature is 130°F (Plastic), 200°F (Metal).

Fitting Installation. IP80 Series meters require special fittings. The meter fitting must first be installed in the pipeline. Straight pipe of at least ten times the diameter upstream of the meter and five diameters downstream are strongly recommended. Inadequate straight pipe, especially downstream of an elbow, change in pipe diameter, or partially-opened valve, can result in significant inaccuracy. Typically this inaccuracy is in the form of the meter reading high. Some IP80 Series meter fittings are supplied with upstream straight pipe.

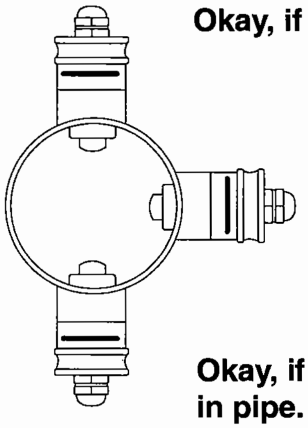


In the larger sizes, the length provided is less than ten diameters upstream and five downstream. It is not advisable to connect directly to the end of these fittings with a flow-disturbing device such as a valve or elbow. If possible, straight pipe should be added to these fittings.

Caution: Never remove the u-clip retainer when the pipe is under pressure. Always remove pressure from the pipe before attempting to remove the meter. Removal under pressure may result in damage or serious injury.

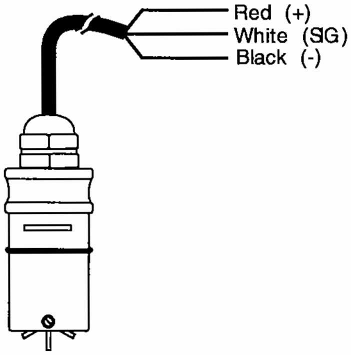
A PVC fitting is usually installed by solvent welding. The stainless steel and brass meter fittings have female pipe threads, requiring the appropriate male threaded fittings. Saddle fittings (size 3" and above) require a hole to be cut in the pipe. The recommended hole size is 1-3/4".

Meter Installation. After the meter fitting is installed in the pipeline, the meter can be installed in the fitting. Press the meter into the fitting as far as it will go. Then retain the meter in place by inserting the u-pin. This pin can be installed from either side. It is sometimes necessary to rotate the probe back and forth slightly to start the pin into the slots on the probe. Slide the pin in as far as it will go.



Meter Connection. See the "IP80 Series Connections" diagram for meter connections. Unless the meter is supplied pre-connected to a meter-mounted FT415/420 flow indicator, three leads must be connected. These three leads are color coded. The red wire is 6-24 VDC positive, the black is negative, and the white wire is the signal lead.

IP80 Series Connections



K-factor. If the IP80 Series meter is ordered with its fitting, the meter is factory calibrated in the fitting. A K-factor (meter factor) is indicated on the side of the fitting. This represents the actual number of pulses per gallon the meter produced during the factory flow test. This number can entered into an FT415/420 or FT5210 flow indicator to make it read properly. If a pulse divider is being used, the K-factor is the starting point for calculating the divider number.

Maintenance and Repair

Rotor Replacement. Rotors are easily field-replaced. Shaft and rotor are a single unit, and are not replaced separately. If replacement is due only to normal shaft wear, bearing replacement is probably not necessary. If the rotor has been damaged by impact, the bearings should also be replaced. Rotor and bearings can be ordered as a kit, Part No.25901. Follow these steps:

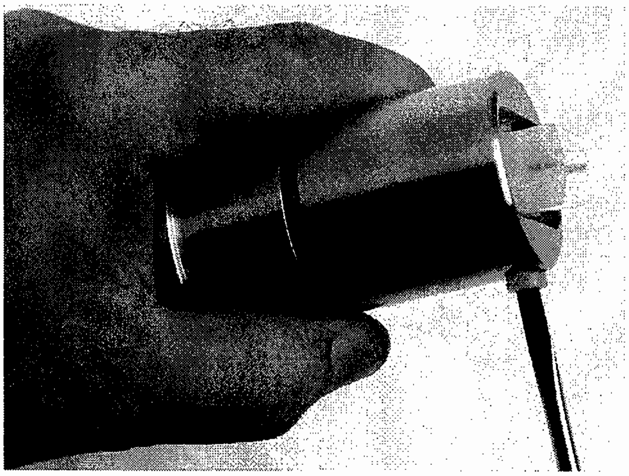
1. Unscrew the threaded bearing housings to expose the shaft ends. If bearings are being replaced, back them completely out.

2. Remove the rotor. Put the new rotor in its place.

3. Thread in one bearing housing part way, then the other. Take care to start the end of the shaft into the bearing hole before tightening further.

4. Screw in bearing housings until they bottom. **Note: Do not use excessive force.**

5. Check for free spin. Blowing lightly on the rotor should result in it spinning rapidly and coasting to a smooth stop.



Sensor Replacement. It is very unusual for a sensor to require replacement in normal use. The primary cause of sensor failure is overvoltage (inadvertent connection of line voltage, for example) or incorrect polarity on hookup. The sensor is replaced by removing the the strain relief, then threading out the sensor retainer plug. Remove the entire sensor capsule by pulling on the cable. The new sensor capsule can then be installed. It is important to orient the sensor capsule properly. Replace the retainer plug, and then replace and tighten the strain relief.

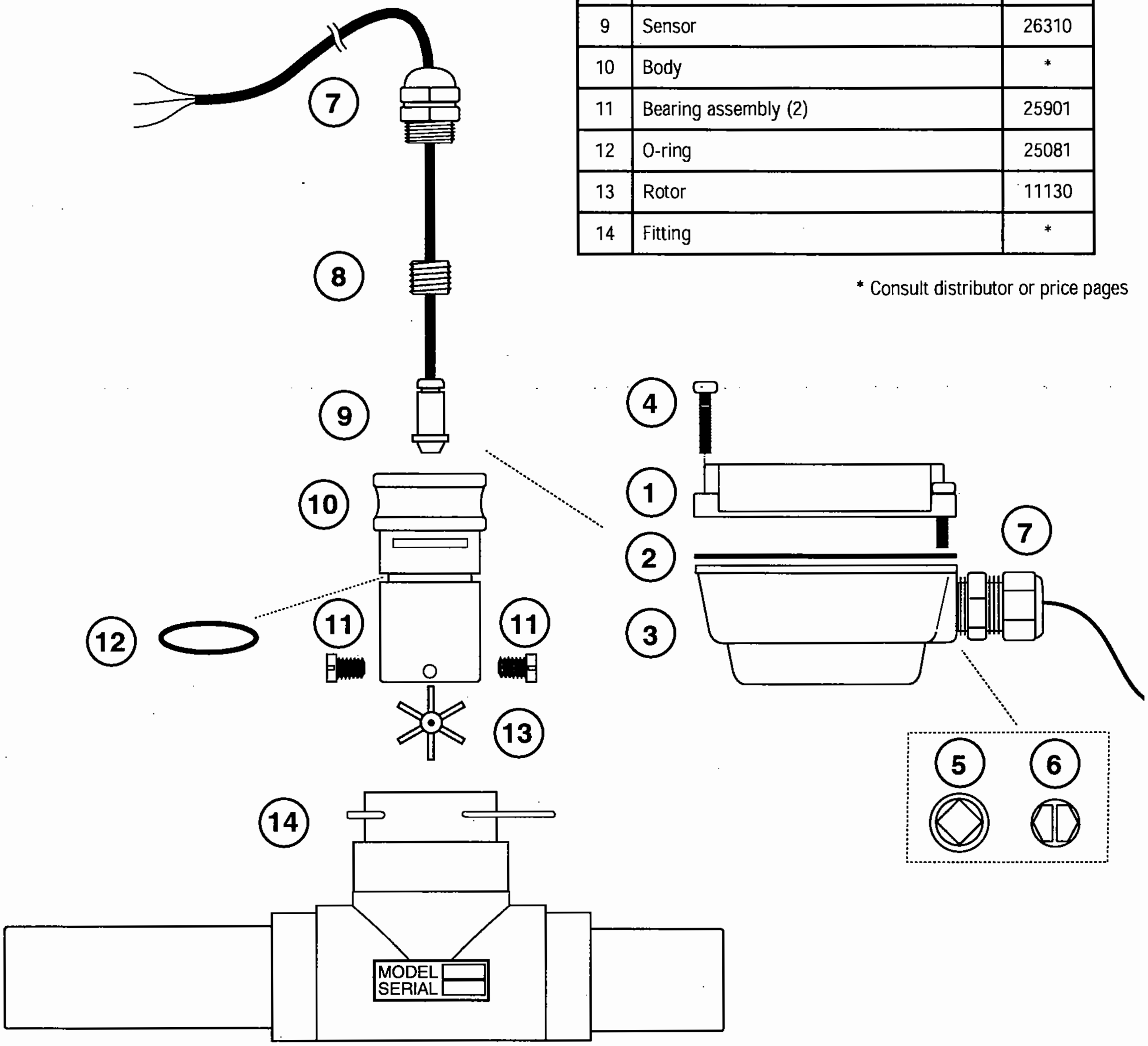
Troubleshooting Guide

Problem	Probable Cause	To Check	To Repair
No signal after installation	Insufficient flow	See Min. GPM for size	Contact SeaMetrics
	Bad connections to control electronics	Check connections at control. Check polarity: red (+), black (-), white (signal)	Re-connect if necessary
	Incompatible control	Does control: 1) provide 6-24VDC power; 2) accept current sinking inputs	Contact SeaMetrics
	Damaged or missing rotor	Remove meter and check visually for free spinning	Obtain new rotor and replace
Inaccurate metering	Not enough straight pipe between meter and flow disturbance	See recommendations, measure	Move meter away from flow disturbance or field calibrate

Fittings Compatibility Chart		
Material	[redacted]	**IP82**
Bronze	1"- 4" Tee	3"- 8" Braze fitting
PVC	1/2"- 2" Tee	3"- 8" Saddle
Polypro	N/A	3"- 8" Tee
Stainless steel	1/2"- 2" Tee	3"- 8" Weld fitting
Carbon steel	1/2"- 2" Tee	3"- 8" Weld fitting

IP80 Series Parts Listing		
1	Upper housing	26181
2	Gasket	26211
3	Lower housing	29930
4	Housing screw	26229
5	Plug, steel	26073
6	Plug, plastic	26079
7	Strain Relief	7655
8	Sensor Retainer	25321
9	Sensor	26310
10	Body	*
11	Bearing assembly (2)	25901
12	O-ring	25081
13	Rotor	11130
14	Fitting	*

* Consult distributor or price pages



Appendix H

Product Information

Magnetrol Liquid Level Switch model C10 and T20

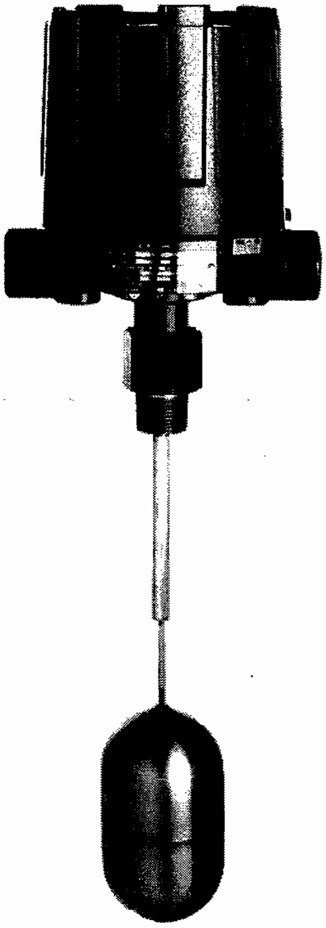
In-Situ LevelTroll 500

Endress+Hauser WaterPilot FMX 167

Magnetrol Liquid Level Switch T21

Top Mounting

Installation and Operating Manual



Liquid

Level

Switches

Models [redacted] & T21

Magnetrol®

STI

Read this Manual Before Installing

This manual provides information on the Top Mounting Liquid Level Switch. It is important that all instructions are read carefully and followed in sequence. Detailed instructions are included in the Installation section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

NOTES

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

WARNINGS

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

Follow all standard industry procedures for servicing electrical equipment when working with or around high voltage. Always shut off the power supply before touching any components.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Low Voltage Directive

For use in Category II installations. If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

Notice of Trademark, Copyright, and Limitations

Magnetrol and Magnetrol logotype and STI and STI logotype are registered trademarks of Magnetrol International.

Performance specifications are effective with date of issue and are subject to change without notice. Magnetrol reserves the right to make changes to the product described in this manual at any time without notice. Magnetrol makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All Magnetrol/STI mechanical level and flow controls are warranted free of defects in materials or workmanship for five full years from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, Magnetrol/STI will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

Magnetrol/STI shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some Magnetrol/STI products.

Quality Assurance

The quality assurance system in place at Magnetrol/STI guarantees the highest level of quality throughout the company. Magnetrol/STI is committed to providing full customer satisfaction both in quality products and quality service.

Magnetrol's quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.

Magnetrol®

STI

Top Mounting
Liquid Level Switches

1.0 Introduction

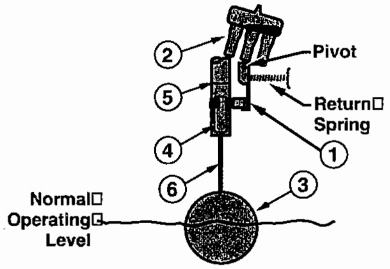
2.0 Installation

4.0 Preventive Maintenance

5.0 Reference Information

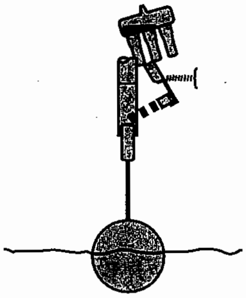
1.0 Introduction

[redacted] and T21 level switches are float operated units designed for top mounting to a tank or vessel by means of threaded or flanged pipe connections. T20 standard units are equipped with a single switch mechanism for high or low level alarm or control applications. T21 tandem units are equipped with two switch mechanisms, each operated by a separate float, for applications requiring widely spaced separate high and low level switch actuation.



Rising Level

Figure 1



Falling Level

Figure 2

1.1 Principle of Operation

The simple and foolproof operation of the top mounted float switches is illustrated in figures 1 and 2.

A magnetic attraction sleeve ④ is fixed at the top of a rigid float stem ⑥. As the float and stem assembly ③ ⑥ move s with the level of the liquid, the attraction sleeve is moved into or out of the field of the switch magnet ①. The presence or the absence of the attraction sleeve causes the switch magnet and attached switch ② to move and change state. A non-magnetic barrier tube ⑤ isolates the process media from the switch without interfering with the field of the switch magnet and provides a static pressure boundary to the process.

2.0 Installation

This section provides detailed procedures for properly installing top mounted level switches.

Caution: If equipment is used in a manner not specified by the manufacturer, protection provided by the equipment may be impaired.

2.1 Unpacking

Unpack the instrument carefully. Inspect all units for damage. Report any concealed damage to carrier within 24 hours. Check the contents of the packing slip against purchase order. Check and record the model number against serial number for future reference when ordering parts.

Model Number: ____________________

Serial Number: ____________________

[illegible]

It is recommended that for critical alarm functions, an additional level switch be installed as a high–high or low–low level alarm for maximum protection.

[illegible]

Caution: Operation of all buoyancy type level devices should be done in such a way as to minimize the action of dynamic forces on the float or displacer sensing element. Good practice for reducing the likelihood of damage to the control is to equalize pressure across the device very slowly.

Ensure that no tubes, rods, or other obstacles in the tank or vessel which could interfere with the operation of float(s).

Caution: This instrument is intended for use in Installation Category II, Pollution Degree 2.

Adjust the process connection as required to bring control to a vertical position. Magnetrol controls must be mounted within three degrees (3°) of vertical in all directions. A three degree slant is noticeable by eye, but installation should be checked with a spirit level on top and/or sides of float stem or enclosing tube.

NOTE: Do not insulate switch mechanism housing.

On controls equipped with pneumatic switch assemblies, consult bulletin on mechanism furnished for air (or gas) piping instructions.

Switch Series Letter	**Description**	**Bulletin No.**
A	Standard Mercury Switch	42-683
B, C, D	Dry Contact Switch	
E	Vibration Resistant Mercury Switch	
F	Hermetically Sealed Snap Switch	
HS	Hermetically Sealed Snap Switch	42-694
J	Bleed Type Pneumatic Switch	42-685
K	Non-Bleed Type Pneumatic Switch	42-686

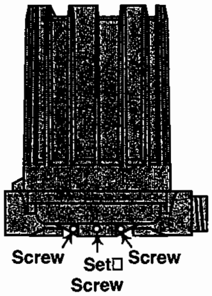


Figure 3
Housing Set Screws

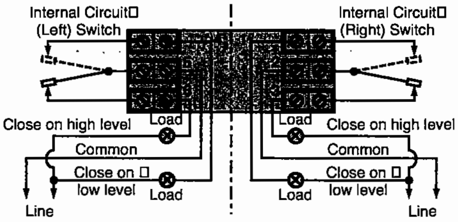


Figure 4
Terminal Connections
DPDT Switch Mechanism
Series A, B, C, D, and E

[illegible]

Caution: All Top Mounting units are shipped from the factory with the enclosing tube tightened and the switch housing set screw locked to the enclosing tube. Failure to loosen the set screw prior to repositioning the supply and output connections may cause the enclosing tube to loosen, resulting in possible leakage of the process liquid or vapor.

Top mounting controls are shipped with the conduit entry of the switch housing placed 180° opposite the tank connections to simplify installation in most cases. If the location of the conduit entry on the level switch is appropriate to the installation, proceed to Step 4 to begin wiring the unit. If another configuration is desired, the switch housing can be easily rotated by first following Steps 1, 2, and 3.

NOTE: A switch or circuit breaker shall be installed in close proximity to equipment and within easy reach of operator. It shall be marked as the disconnecting device for the equipment.

1. Loosen set screw(s) at base of switch housing. Refer to Figure 3.
2. Switch housing may be rotated 360° to allow correct positioning of conduit outlet.
3. Tighten set screw(s) at base of switch housing.
4. Unscrew and remove switch housing cover. The threads have been lubricated to facilitate removal.

NOTE: For supply connections use wire with a minimum rating of 75° C, as required by process conditions. Use a minimum of 14 AWG wire for power and ground field wires. On high temperature applications (above 250° F [121° C] at mounting flange or bushing), high temperature wire should be used between control and first junction box located in a cooler area. On non-hazardous applications, flexible conduit may be used between the control and the first junction box.

5. The switch terminals are located next to the conduit outlet to facilitate wiring. Bring supply wires through conduit outlet. Route extra wire around enclosing tube under the baffle plate, and connect them to the proper terminals. Refer to the wiring diagram, Figure 4, or your switch bulletin for this information.

6. Dress wiring to ensure no interference or contact with tilt of switch, or replacement of switch housing cover.

NOTE: Observe all applicable electrical codes and proper wiring procedures.

Prevent moisture seepage into the enclosure by installing approved seal-drain fittings in the conduit run leading into the unit.

Caution: In hazardous areas, do not power the unit until the conduit is sealed and the enclosure cover is screwed down securely.

7. Replace housing cover.
8. If control has been furnished with an explosion proof or moisture proof switch housing, it must be sealed at the conduit outlet with a suitable compound or non-hardening sealant to prevent entrance of air.
9. Test switch action by varying liquid level in the tank or vessel. The upper switch on Model T21 units is actuated by movement of the lower float, while the lower switch is actuated by the upper float.

NOTE: If switch mechanism fails to function properly, check vertical alignment of control housing and consult installation bulletin on switch mechanism furnished.

10. Check cover to base fit to be certain gasketed joint is tight. A positive seal is necessary to prevent infiltration of moisture laden air or corrosive gasses into switch housing.

Top Switch Differential Adjustment

The standard differential of the single float Model T20 may be field adjusted. Adjustment may be necessary if a wider differential needs to be set to overcome switch chatter caused by the process.

The differential, or the amount of level travel between switch-on and switch-off, may be adjusted by repositioning the lower jam nuts on the float stem. The standard factory setting is for a minimum amount of play (gap) between the top jam nuts and the attraction sleeve as shown in Figure 6.

NOTE: For assistance in computing level differential change for a specific control, consult the factory giving the model and serial numbers of the control.

Caution: Maximum differential adjustment is 0.50 inch.

NOTE: To widen the differential 0.50 inch, the lower jam nuts must be set proportionately lower on the stem (i.e. in this example 0.50 inch).

Caution: Before attempting any work on the control, pull disconnect switch, or otherwise assure that electrical circuit(s) through the control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms.

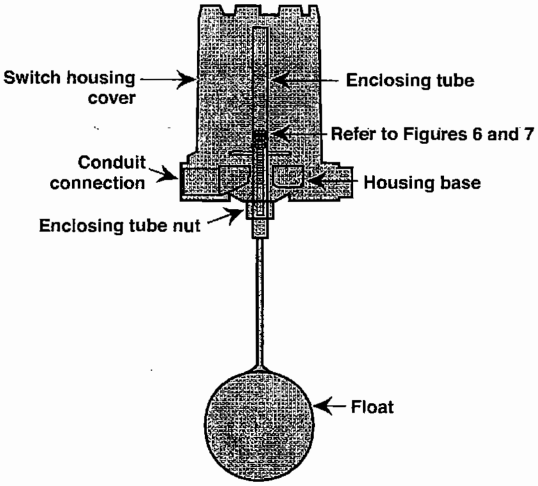


Figure 5

1. Determine what change in differential is necessary.
2. Make sure power source is turned off.
3. Unscrew and remove switch housing cover.
4. Disconnect power supply wires from switch mechanism. Pull wires out of conduit connection opening in housing base. Refer to Figure 5.
5. Perform system shut-down procedures as required to relieve pressure from tank or vessel and drain off liquid head, if required. Allow unit to cool.

NOTE: The amount of level travel between switch-on and switch-off actuation (differential) may be field adjusted by repositioning the lower jam nuts on the float stem. The standard factory setting is for a minimum amount of play (gap) between the top jam nuts and the attraction sleeve, as shown in Figure 6. This setting may be increased to a maximum of 0.50" (13 mm), as shown in Figure 7.

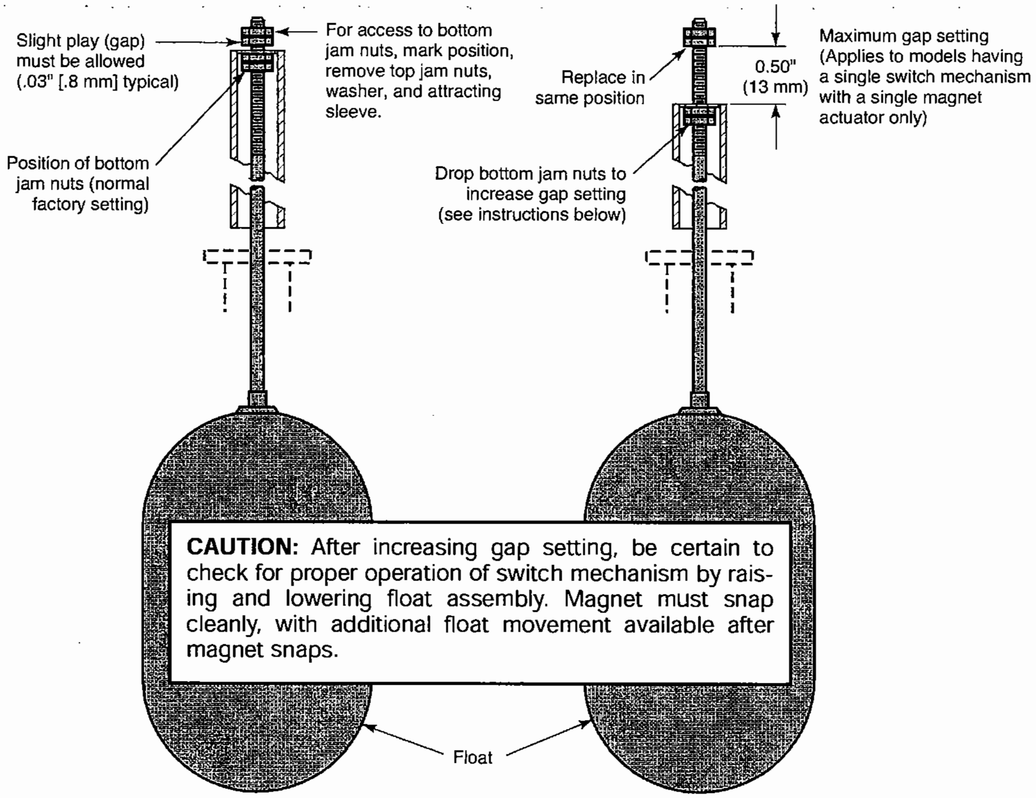
6. Remove switch housing assembly by loosening the enclosing tube nut, which is located immediately below housing base. Refer to Figure 5.

7. With switch housing and enclosing tube removed, jam nuts and attraction sleeve are accessible. Measure position of upper jam nuts from stem end; then loosen and remove upper jam nuts, guide washer, and attraction sleeve.
8. Loosen and adjust lower jam nuts to desired position. Make certain jam nuts are retightened securely.

NOTE: Use new enclosing tube gasket in assembly of switch housing to the mounting bushing or flange. Refer to **Sections 5.4.1.1** and **5.4.2.1** for enclosing tube gasket part numbers.

9. Test switch actuation by varying liquid level in tank or vessel.

Caution: Instructions given are for standard base model units which use a single magnet switch mechanism only. No differential adjustment should be attempted on tandem float models in the field. Switch actuation levels have been set at the factory to meet specific customer specifications. Variations in actual conditions from design conditions usually requires special control modifications. Consult with the factory or local representative for assistance.



CAUTION: After increasing gap setting, be certain to check for proper operation of switch mechanism by raising and lowering float assembly. Magnet must snap cleanly, with additional float movement available after magnet snaps.

Figure 6
Normal Factory Setting (minimum differential)

Figure 7
Differential adjustment

[illegible]

Periodic inspections are a necessary means to keep your level control in good working order. This control is a safety device to protect the valuable equipment it serves. Therefore, a systematic program of "preventive maintenance" must be implemented when the control is placed into service. If the following sections on "what to do" and "what to avoid" are observed, your control will provide reliable protection of your equipment for many years.

[illegible] What to do

4.1.1 Keep control clean

Be sure the switch housing cover is always in place on the control. This cover is designed to keep dust and dirt from interfering with switch mechanism operation. In addition, it protects against damaging moisture and acts as a safety feature by keeping bare wires and terminals from being exposed. Should the housing cover or any seals become damaged or misplaced, obtain a replacement immediately.

4.1.2 Inspect switch mechanisms, terminals, and connections monthly

1. Mercury switches may be visually inspected for short circuit damage. Check for small cracks in the glass tube containing the mercury. Such cracks can allow entrance of air into the tube causing the mercury to "oxidize". This is noticeable as the mercury will appear dirty or dull, and will not break into clean, round pools. If these conditions exist, replace the mercury switch immediately.
2. Dry contact switches should be inspected for excessive wear on actuating lever or misalignment of adjustment screw at point of contact between screw and lever. Such wear can cause false switch actuating levels. See switch mechanism bulletin supplied with control should switch adjustment or replacement be necessary.
3. DO NOT operate your control with defective or maladjusted switch mechanisms (refer to bulletin on switch mechanisms furnished for service instructions.)

4. Level controls may sometimes be exposed to excessive heat or moisture. Under such conditions, insulation on electrical wiring may become brittle, eventually breaking or pealing away. The resulting "bare" wires can cause short circuits.

NOTE: Check wiring carefully and replace at the first sign of brittle insulation.

5. Vibration may sometimes cause terminal screws to work loose. Check all terminal connections to be certain that screws are tight.
6. On units with pneumatic switches, air (or gas) lines subjected to vibration, may eventually crack or become loose at connections causing leakage. Check lines and connections carefully and repair or replace, if necessary.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

4.1.3 Inspect entire unit periodically

Isolate control from vessel. Raise and lower liquid level to check for switch contact and reset.

[illegible]

1. Never leave switch housing cover off the control longer than necessary to make routine inspections.
2. Never place a jumper wire across terminals to "cut-out" the control. If a "jumper" is necessary for test purposes, be certain it is removed before placing control into service.
3. Never attempt to make adjustments or replace switches without reading instructions carefully. Certain adjustments provided for in level controls should not be attempted in the field. When in doubt, consult the factory or your local representative.
4. Never use lubricants on pivots of switch mechanisms. A sufficient amount of lubricant has been applied at the factory to ensure a lifetime of service. Further oiling is unnecessary and will only tend to attract dust and dirt which can interfere with mechanism operation.

5.0 Reference Information

5.1 Troubleshooting

Usually the first indication of improper operation is failure of the controlled equipment to function, i.e.: pump will not start (or stop), signal lamps fail to light, etc. When these symptoms occur, whether at time of installation or during routine service thereafter, check the following potential external causes first.

a. Fuses may be blown.

b. Reset button(s) may need resetting.

c. Power switch may be open.

d. Controlled equipment may be faulty.

e. Wiring leading to control may be defective.

If a thorough inspection of these possible conditions fails to locate the trouble, proceed next to a check of the control's switch mechanism.

5.1.1 Check switch mechanism

1. Pull disconnect switch or otherwise disconnect power to the control.
2. Remove switch housing cover.
3. Disconnect power wiring from switch assembly.
4. Swing magnet assembly in and out by hand to check carefully for any sign of binding. Assembly should require minimal force to move it through its full swing.
5. If binding exists, magnet may be rubbing enclosing tube. If magnet is rubbing, loosen magnet clamp screw and shift magnet position. Retighten magnet clamp screw.
6. If switch magnet assembly swings freely and mechanism still fails to actuate, check installation of control to be certain it is within the specified three (3°) degrees of vertical. (Use spirit level on side of enclosing tube in two places, 90° apart.

7. If mechanism is equipped with a mercury switch, examine glass mercury tube closely as previously described in **Section 4.0 Preventive Maintenance**. If switch is damaged, replace it immediately. If microswitch, check continuity with ohmmeter.
8. If switch mechanism is operating satisfactorily, proceed to check sensing unit.

5.1.2 Check complete unit

1. Reconnect power supply and carefully actuate switch mechanism manually (using a non-conductive tool) to determine whether controlled equipment will operate.

Caution: With electrical power on, care should be taken to avoid contact with switch leads and connections at terminal block.

2. If controlled equipment responds to manual actuation test, trouble may be located in the level sensing portion of the control–float(s), stem(s), and magnetic attraction sleeve(s).

NOTE: Ensure that liquid is entering the storage tank or vessel. A valve may be closed or a pipe line plugged.

Caution: Be certain to pull disconnect switch or otherwise ensure that electrical circuit(s) through control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms.

3. With liquid in tank or vessel, raise the liquid level above the set points. Magnets should "pull-in" on rising level. On Model T21 the lower float actuates the upper switch, and the upper float actuates the lower switch. If magnets fail to "pull-in", lower the level and purge pressure.
   a. Disconnect wiring from supply side of switch mechanism(s) and remove electrical conduit or operating medium line connections to switch housing.
   b. Remove switch housing assembly by loosening hex nut, which is located immediately below housing base.
4. With switch housing assembly removed, inspect attraction sleeve(s) and inside of enclosing tube for excessive corrosion or solids buildup, which could restrict movement, preventing sleeve(s) from reaching field of switch magnet(s).
5. If differential has been changed in the field by repositioning the lower jam nuts on the float stem, check tightness and position of the jam nuts. Refer to Figure 6.

NOTE: Differential adjustment affects a change in the amount of level travel between switch-on and switch-off actuation. Do not attempt adjustment without first consulting factory for assistance in computing level differential change for your control.

6. Check float to be certain it is buoyant in the liquid (tank or vessel must have adequate liquid level). If float is determined to be filled with liquid, or it is collapsed, it must be replaced immediately. Do not attempt to repair a float.

   If all components in the control are in operating condition, the trouble must be (and should be) located external to the control. Repeat inspection of external conditions previously described.

   When communicating about your control, be certain to always specify the complete Model and Serial numbers.

[illegible] Agency Approvals

AGENCY	MODEL APPROVED	APPROVAL CLASSES
FM FM APPROVED	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
CSA	All with a Series A, E, F, HS or H1 electric switch mechanism and a housing listed as CSA TYPE 4X	Class I, Div 2, Groups B, C & D
	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
ATEX / IEC Ex ②	All with an electric switch mechanism and an ATEX housing①	ATEX II 2 G EEx d IIC T6 IEC Ex Ex d IIC T6
CE	Low Voltage Directives 73/23/EEC & 93/68/EEC Per Harmonized Standard: EN 61010-1/1993 & Amendment No. 1	Installation Category II Pollution Degree 2

① Dual stage units with 'HS' switches are not ATEX approved.

② IEC Installation Instructions:

The cable entry and closing devices shall be Ex d certified suitable for the conditions of use and correctly installed.

For ambient temperatures above +55° C or for process temperatures above +150° C, suitable heat resistant cables shall be used.

Heat extensions (between process connection and housing) shall never be insulated.

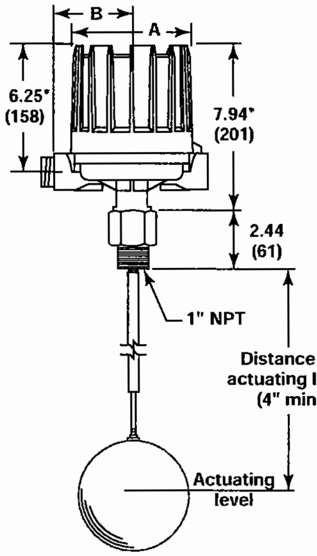
Special conditions for safe use:

When the equipment is installed in process temperatures higher than +85° C the temperature classification must be reduced according to the following table as per IEC60079-0.

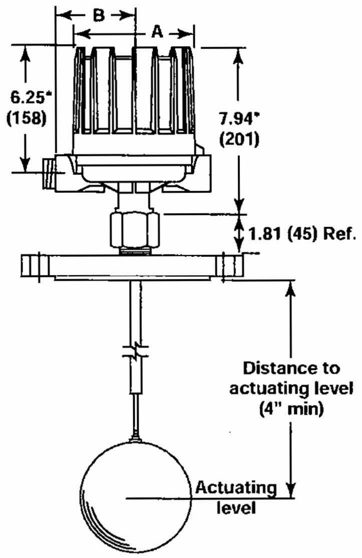
Maximum Process Temperature	Temperature Classification
< 85° C	T6
< 100° C	T5
< 135° C	T4
< 200° C	T3
< 300° C	T2
< 450° C	T1

These units are in comformity with IECEx KEM 05.0020X
Classification Ex d IIC T6
$T_{ambient}$ -40° C to +70° C

5.3.1 **Physical** inches (mm)

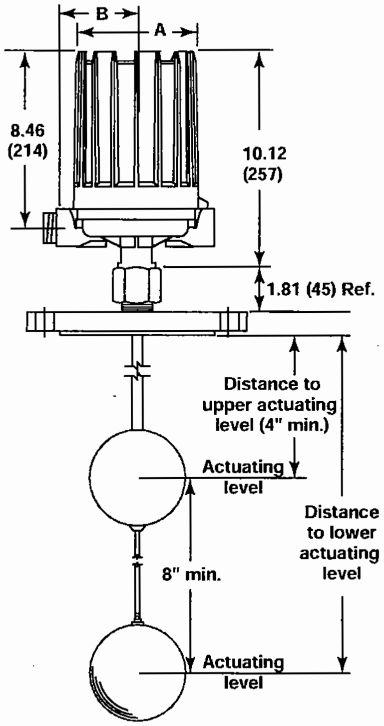


Model T20 with 1" NPT



Model T20 with flange

* These dimensions increase by 2.19 (55) when unit is supplied with an HS switch with terminal block.



Model T21 with flange

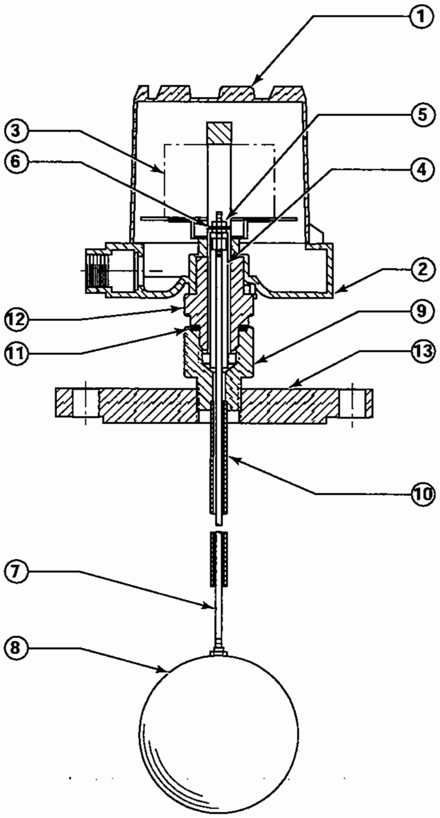
Housing ①	A	B	Conduit Connections
NEMA 4X/7/9, Group B	5.93 (151)	3.87 (98)	1" NPT dual entry
NEMA 1 ② Pneumatics	4.70 (119)	5.00 (127)	¼" NPT single entry

① All housings rotatable 360°.
② Pneumatic switches available with Series T20 units only.

Distance To	Maximum	Minimum
Upper level	40" (1016)	4" (102)
Lower level	48" (1219)	12" (305)

NOTE: On Model T21 the lower float actuates upper switch mechanism. The upper float actuates the lower switch mechanism.

5.4 Replacement Parts



5.4.1 Model T20 Parts Identification

Item	Description
1	Housing cover
2	Housing base
3	Switch mechanism
4	Attraction sleeve
5	Jam nuts
6	Guide washer(s)
7	Float stem
8	Float
9	Adaptor bushing
10	Stem guide tube
11	Enclosing tube gasket
12	Enclosing tube
13	Mounting flange

5.4.1.1 Model T20

	T20-1	T20-4
Housing cover	See below	
Housing base	See below	
Switch mechanism	See below	
Stem kit: includes items 4, 5, 6 & 7	Consult factory	
Float: 3" x 5"	Z07-1202-003	
4.00"	Z07-1102-008	
4.50"	Z07-1102-009	
Adaptor bushing	004-5734-110	004-5734-123
Float stem	Consult factory	
Stem guide tube	Consult factory	
Enclosing tube gasket	012-1301-002	
Enclosing tube	Z32-6325-001	Z32-6326-002
Mounting flange	See below	

5.4.1.2 Mounting flanges

	125 lb cast iron	150 lb forged steel	300 lb forged steel	150 lb forged 304	150 lb forged 316
4" flange	Z04-5840-001	Z04-5840-011	Z04-5840-016	004-5840-021	004-5840-026
5" flange	Z04-5840-002	Z04-5840-012	Z04-5840-017	004-5840-022	004-5840-027
6" flange	Z04-5840-003	Z04-5840-013	Z04-5840-018	004-5840-023	004-5840-028
8" flange	Z04-5840-004	Z04-5840-014	Z04-5840-019	004-5840-024	004-5840-029

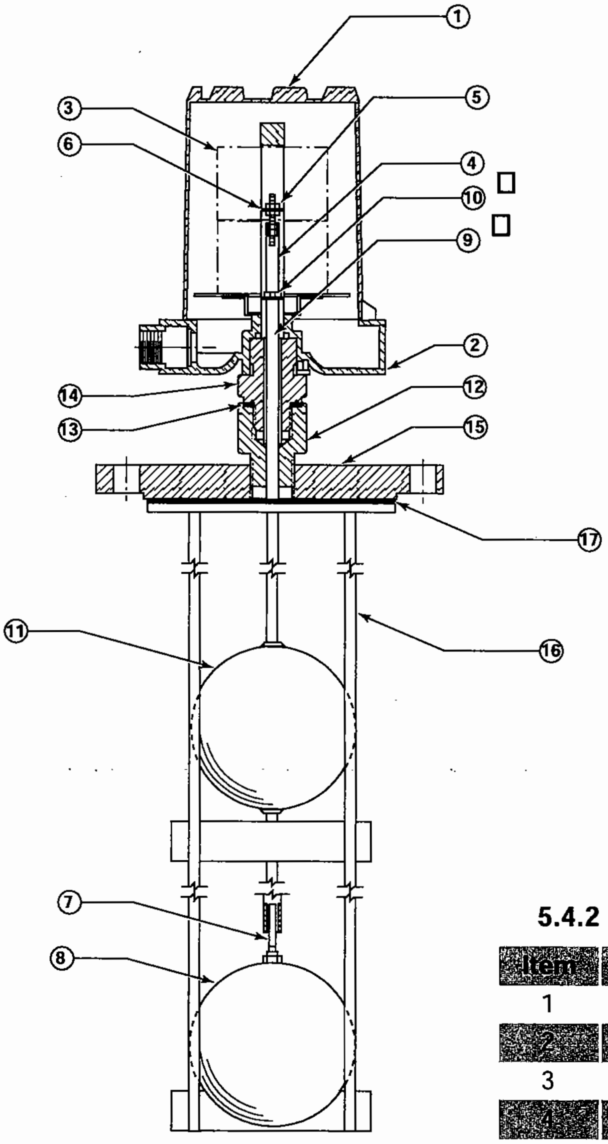
5.4.1.3 Switch and housing reference

	Series Type	Bulletin #
Mercury	A, 3	42-683
Anti-vibration mercury	E, 2	42-683
Dry contact	B, C, D	42-683
Hermetically sealed	F	42-683
Hermetically sealed	HS	42-694
Bleed type pneumatic	J	42-685
Non-bleed type pneumatic	K	42-486

Important: When ordering spare parts, please specify:
A. Model and serial numbers.
B. Name and part number of replacement part or assembly.

All replacement parts are for standard models only. Consult your local representative for ordering assistance on all specially modified models (model numbers preceded by an X).

5.4 Replacement Parts



5.4.2 Model T21 Parts Identification

Item	Description
1	Housing cover
2	Housing base
3	Switch mechanism
4	Upper attraction sleeve
5	Jam nuts
6	Guide washer(s)
7	Upper stem assembly
8	Lower float
9	Lower attraction sleeve, stop tube, and washers
10	Retaining rings
11	Upper float and tube assembly
12	Adaptor bushing
13	Enclosing tube gasket
14	Enclosing tube
15	Mounting flange
16	Float guide cage (optional)
17	Float guide cage gasket (optional)

5.4.2.1 Model T21

	T21-1	T21-4
Housing cover	See below	
Housing base	See below	
Switch mechanism	See below	
Float stem kit: includes items 4, 5, 6, & 7	Consult factory	
Lower float: 3" x 5"	Z07-1201-003	Z07-1202-003
4.00"	Z07-1101-015	Z07-1102-008
4.50"	Z07-1102-009	
Upper float and tube assembly kit: includes items 9, 10, & 11	Consult factory	
Adaptor bushing	Z04-5734-110	004-5734-123
Enclosing tube gasket	012-1301-002	
Enclosing tube	Z32-6325-004	Z32-6325-005
Guide cage kits: includes items 17 & 18	Consult factory	
Mounting flange	See below	

5.4.2.2 Mounting flanges

	125 lb cast iron	150 lb forged steel	300 lb forged steel	150 lb forged 304	150 lb forged 316
4" flange	Z04-5840-001	Z04-5840-011	Z04-5840-016	004-5840-021	004-5840-026
5" flange	Z04-5840-002	Z04-5840-012	Z04-5840-017	004-5840-022	004-5840-027
6" flange	Z04-5840-003	Z04-5840-013	Z04-5840-018	004-5840-023	004-5840-028
8" flange	Z04-5840-004	Z04-5840-014	Z04-5840-019	004-5840-024	004-5840-029

5.4.2.3 Switch and housing reference

	Series type	Bulletin#
Mercury	A, 3	42-683
Anti-vibration mercury	E, 2	42-683
Dry contact	B, C, D	42-683
Hermetically sealed	F	42-683
Hermetically sealed	HS	42-694
Bleed type pneumatic	J	42-685
Non-bleed type pneumatic	K	42-486

Important: When ordering spare parts, please specify:
A. Model and serial numbers.
B. Name and part number of replacement part or assembly.

All replacement parts are for standard models only. Consult your local representative for ordering assistance on all specially modified models (model numbers preceded by an X).

5.5 Model Numbers

5.5.1 Model T20

IMPORTANT: Actuating level(s), in either the rising or falling state, and specific gravity must be provided upon placement of order.

MODEL NUMBER CODE AND MATERIALS OF CONSTRUCTION

Model No.	Set Points	Tank Connection	Float and Trim	Sleeve
T20-1	1—Single float	Carbon steel	300 Series SS	400 Series SS
T20-4		316 SS	316 SS	316 SS

IMPORTANT: The maximum available insertion depth is governed by the liquid specific gravity and selected float size as given in the table below. The minimum insertion depth is four inches.

MAXIMUM INSERTION LENGTH inches (mm)

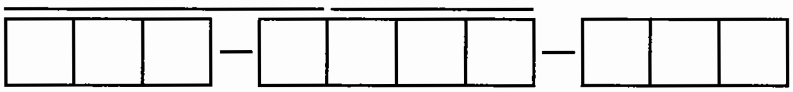
Liquid Specific Gravity	Float Size		
	3.00 x 5.00 (76 x 127)	4.00 (102)	4.50 (114)
1.00	39 (991)	48 (1219)	48 (1219)
0.90	20 (508)	33 (838)	48 (1219)
0.80	—	11 (279)	48 (1219)
0.70	—	—	38 (965)
0.60	—	—	6 (152)

FLOAT PRESSURE RATINGS

Float Size	Pressure Rating psig (bar)	
	@ 100° F (38° C)	@ Maximum Temperature
3.00 x 5.00 (76 x 127)	500 psig (34 bar)	300 psig @ +750° F (21 bar @ +399° C)
4.00 (102) Diameter	600 psig (41 bar)	400 psig @ +750° F (28 bar @ +399° C)
4.50 (114) Diameter	500 psig (34 bar)	340 psig @ +750° F (23 bar @ +399° C)

TANK CONNECTION AND FLOAT SIZE

Tank Connection ①	Float Diameter		
	3.00 x 5.00 (76 x 127)	4.00 (102)	4.50 (114)
1" NPT	B2A	B2B	B2C
4" 125 lb. C.I. flange ② ③	H2A	—	—
4" 150 lb. F.S. flange	H3A	—	—
5" 125 lb. C.I. flange ② ③	J2A	J2B	J2C
5" 150 lb. F.S. flange	J3A	J3B	J3C
6" 125 lb. C.I. flange ② ③	K2A	K2B	K2C
6" 150 lb. F.S. flange	K3A	K3B	K3C
6" 300 lb. F.S. flange	—	—	K4C
8" 125 lb. C.I. flange ② ③	L2A	L2B	L2C
8" 150 lb. F.S. flange	L3A	L3B	L3C



5.5.1 Model T20 (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE

			T20-1 Models		T20-4 Models	
			NEMA 4X/7/9 Aluminum Enclosure ⑤⑥			
Switch Description	Maximum Process ④ Temperature ° F (° C)	One Set Point	Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B
Series A Mercury	550 (288)	SPDT DPDT	AKP ANP	AKT ANT	AKQ ANQ	AKS ANS
Series 3 Mercury with Beaded Leads	750 (399)	SPDT DPDT	3KP 3NP	3KT 3NT	3KQ 3NQ	3KS 3NS
Series B Snap	250 (121)	SPDT DPDT	BKP BNP	BKT BNT	BKQ BNQ	BKS BNS
Series C Snap	450 (232)	SPDT DPDT	CKP CNP	CKT CNT	CKQ CNQ	CKS CNS
Series D Snap for DC Current	250 (121)	SPDT DPDT	DKQ DNQ	DKS DNS	DKQ DNQ	DKS DNS
Series E Mercury Vibration Resistant	550 (288)	SPDT DPDT	EKP ENP	EKT ENT	EKQ ENQ	EKS ENS
Series 2 Mercury Vibration Resistant	750 (399)	SPDT DPDT	2KP 2NP	2KT 2NT	2KQ 2NQ	2KS 2NS
Series HS Snap Hermetically Sealed w/Wiring Leads	550 ⑦ (288)	SPDT DPDT	HMC HMF	HEK ⑧ HET ⑧	HMC HMF	HEK ⑧ HET ⑧
Series HS Snap Hermetically Sealed w/Term. Block	550 ⑦ (288)	SPDT DPDT	HM3 HM7	HM4 HM8	HM3 HM7	HM4 HM8

PNEUMATIC SWITCH MECHANISM AND ENCLOSURE

Switch Description	Maximum Supply Pressure	Maximum Process Temperature	Bleed Orifice Diameter	NEMA 1
Series J Bleed Type	100 psig (7 bar)	400° F (204° C)	.063 (1.6 mm)	JDE
	60 psig (4 bar)		.094 (2.4 mm)	JEE
	100 psig (7 bar)	700° F (371° C)	.055 (1.4 mm)	JFE
Series K Non-Bleed	100 psig (4 bar)	400° F (204° C)	—	KOE
	40 psig (3 bar)		—	KOG

① Flanges are ANSI standard. Forged steel flanges have standard raised face.

② Not available with Model T20-4.

③ Available only in cast iron.

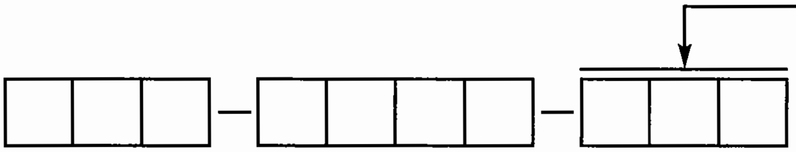
④ Process temperature based on +100° F (+38° C) ambient.

⑤ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosure.

⑥ Consult factory for NEMA 4X/7/9 cast iron housings.

⑦ On steam applications, temperature down-rated to +400° F (+204° C) process at +100° F (+38° C) ambient.

⑧ CSA approval does not apply to Series HE switches.



5.5.2 Model T21

IMPORTANT: Actuating level(s), in either the rising or falling state, and specific gravity must be provided upon placement of order.

MODEL NUMBER CODE AND MATERIALS OF CONSTRUCTION

Model No.	Set Points	Tank Connection	Float and Trim	Sleeve
T21-1	2—Tandem float	Carbon steel	300 Series SS	400 Series SS
T21-4		316 SS	316 SS	316 SS

IMPORTANT: The maximum available insertion depth is governed by the liquid specific gravity and selected float size as given in the table below. The minimum insertion depth is four inches. The minimum distance between the top and bottom insertion depths is eight inches.

MAXIMUM INSERTION LENGTH inches (mm)

Liquid Specific Gravity	Float Size					
	3.00 x 5.00 (76 x 127)		4.00 (102)		4.50 (114)	
	Upper	Lower	Upper	Lower	Upper	Lower
1.00	21 (533)	48 (1219)	32 (813)	48 (1219)	40 (1016)	48 (1219)
0.90	9 (229)	30 (762)	18 (457)	44 (1118)	40 (1016)	48 (1219)
0.80	—	—	4 (102)	21 (533)	40 (1016)	48 (1219)
0.70	—	—	—	—	21 (533)	48 (1219)

FLOAT PRESSURE RATINGS

Float Size	Pressure Rating psig (bar)	
	@ 100° F (38° C)	@ Maximum Temperature
3.00 x 5.00 (76 x 127)	500 psig (34 bar)	300 psig @ +750° F (21 bar @ +399° C)
4.00 (102) Diameter	600 psig (41 bar)	400 psig @ +750° F (28 bar @ +399° C)
4.50 (114) Diameter	500 psig (34 bar)	340 psig @ +750° F (23 bbar @ +399° C)

TANK CONNECTION AND FLOAT SIZE

Tank Connection ①	Float Diameter		
	3.00 x 5.00 (76 x 127)	4.00 (102)	4.50 (114)
4" 125 lb. C.I. flange ② ③	H2A	—	—
4" 150 lb. F.S. flange	H3A	—	—
5" 125 lb. C.I. flange ② ③	J2A	J2B	J2C
5" 150 lb. F.S. flange	J3A	J3B	J3C
6" 125 lb. C.I. flange ② ③	K2A	K2B	K2C
6" 150 lb. F.S. flange	K3A	K3B	K3C
6" 300 lb. F.S. flange	—	—	K4C
8" 125 lb. C.I. flange ② ③	L2A	L2B	L2C
8" 150 lb. F.S. flange	L3A	L3B	L3C

① Flanges are ANSI standard. Forged steel flanges have standard raised face.

② Not available with -4 Materials of Construction.

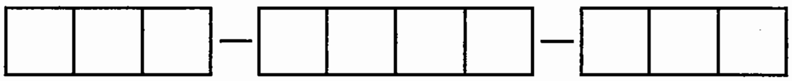
③ Available only in cast iron.

④ Process temperature based on +100° F (+38° C) ambient.

⑤ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosure.

⑥ Consult factory for NEMA 4X/7/9 cast iron housings.

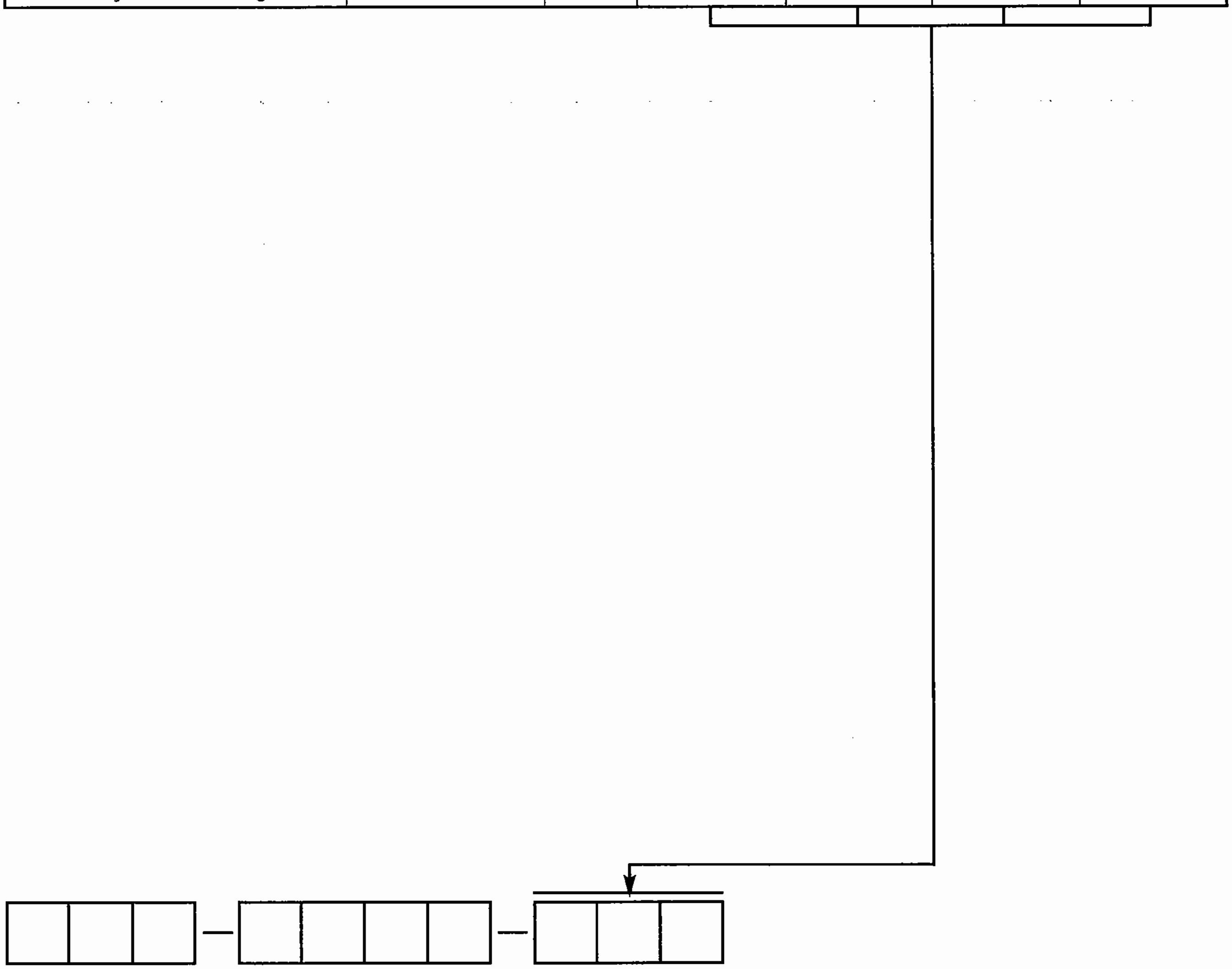
⑦ On steam applications, temperature down-rated to +400° F (+204° C) process at +100° F (+38° C) ambient.



5.5.2 Model T21 (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE

			T21-1 Models		T21-4 Models	
			NEMA 4X/7/9 Aluminum Enclosure ⑤⑥			
Switch Description	**Maximum Process ④ Temperature ° F (° C)**	**One Set Point**	**Class I, Div. 1, Groups C & D**	**Class I, Div. 1, Group B**	**Class I, Div. 1, Groups C & D**	**Class I, Div. 1, Group B**
Series A Mercury	550 (288)	SPDT DPDT	ALA AOA	ALJ AOJ	ALB AOB	ALK AOK
Series 3 Mercury with Beaded Leads	750 (399)	SPDT DPDT	3LA 3OA	3LJ 3OJ	3LB 3OB	3LK 3OK
Series B Snap	250 (121)	SPDT DPDT	BLA BOA	BLJ BOJ	BLB BOB	BLK BOK
Series C Snap	450 (232)	SPDT DPDT	CLA COA	CLJ COJ	CLB COB	CLK COK
Series D Snap for DC Current	250 (121)	SPDT DPDT	DLB DOB	DLK DOK	DLB DOB	DLK DOK
Series E Mercury Vibration Resistant	550 (288)	SPDT DPDT	ELA EOA	ELJ EOJ	ELB EOB	ELK EOK
Series 2 Mercury Vibration Resistant	750 (399)	SPDT DPDT	2LA 2OA	2LJ 2OJ	2LB 2OB	2LK 2OK
Series HS Snap Hermetically Sealed w/Wiring Leads	550 ⑦ (288)	SPDT DPDT	HMN HMY	HMP HMZ	HMN HMY	HMP HMZ



Service Policy

Owners of Magnetrol controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. Magnetrol will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory, prior to the material's return. This is available through Magnetrol's local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

Magnetrol®

5300 Belmont Road • Downers Grove, Illinois 60515-4499 • 630-969-4000 • Fax 630-969-9489 • www.magnetrol.com
145 Jardin Drive, Units 1 & 2 • Concord, Ontario Canada L4K 1X7 • 905-738-9600 • Fax 905-738-1306
Heikensstraat 6 • B 9240 Zele, Belgium • 052 45.11.11 • Fax 052 45.09.93
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STI®

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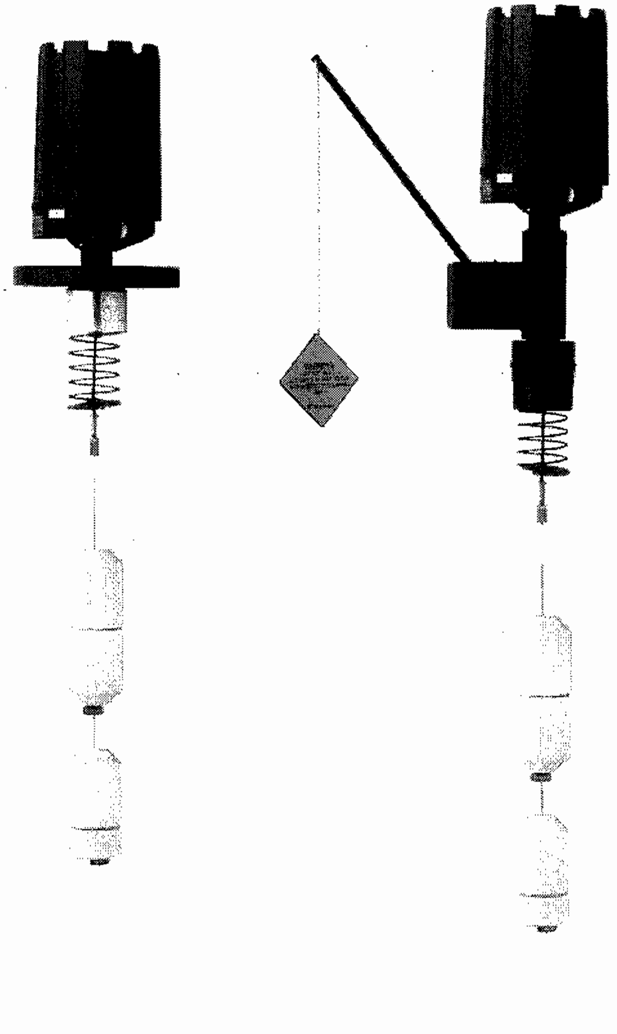
Magnetrol Liquid Level Switch – Displacer Type

[redacted]

Displacer Type

Installation and Operating Manual



Liquid

Level

and

Proof-er®

Switches

Magnetrol®

STI®

Read this Manual Before Installing

This manual provides information on the External Cage Displacer Liquid Level Switch. It is important that all instructions are read carefully and followed in sequence. Detailed instructions are included in the Installation section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

Notes

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Warnings

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

Follow all standard industry procedures for servicing electrical equipment when working with or around high voltage. Always shut off the power supply before touching any components.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Low Voltage Directive

For use in Installation Category II, Pollution Degree 2. If equipment is used in a manner not specified by the manufacturer, protection provided by the equipment may be impaired.

Notice of Trademark, Copyright, and Limitations

Magnetrol reserves the right to make changes to the product described in this manual at any time without notice. Magnetrol makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All Magnetrol/STI mechanical level and flow controls are warranted free of defects in materials or workmanship for five full years from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, Magnetrol/STI will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

Magnetrol/STI shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some Magnetrol/STI products.

Quality Assurance

The quality assurance system in place at Magnetrol/STI guarantees the highest level of quality throughout the company. Magnetrol/STI is committed to providing full customer satisfaction both in quality products and quality service.

Magnetrol's quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.

Magnetrol® **STI®**

Displacer Type
Liquid Level and Proof-er® Switches

1.0 Introduction

2.0 Installation

3.0 Preventive Maintenance

4.0 Reference Information

1.0 Introduction

Displacement type level switches offer the industrial user a wide choice of alarm and control configurations. These units utilize simple buoyancy principle and are well suited for simple or complex applications.

1.1 Principle of Operation

1.1.1 Displacer Controls

The design of displacer operated level switches is based upon the principle that a magnetic field will not be affected by non-magnetic materials such as 316 stainless steel. In this case, the displacer moves a magnetic attraction sleeve within a non-magnetic enclosing tube and actuates a magnetic switch mechanism. The enclosing tube provides a pressure seal to the chamber and, therefore, to the process.

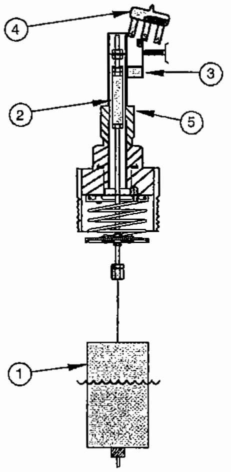


Figure 1
Switch position on rising level

1.2 [illegible]

A spring is loaded with a weighted displacer ① which is heavier than the liquid. Immersion of the displacers caused by rising liquid level imparts buoyancy forces on the displacer allowing the spring to compress. The attraction sleeve ② attached to the spring, moves upward into the field of a permanent magnet ③. The movement of the magnet toward the sleeve causes the switch ④ to actuate. A non-magnetic barrier tube ⑤ provides a static pressure boundary between the switch mechanism and the displacer assembly. As the liquid level falls, the displacer lowers, causing the spring to extend, and moving the attraction sleeve out of the magnetic field of the switch mechanism. This allows the switch to again change position and to break or make. See Figures 1 and 2.

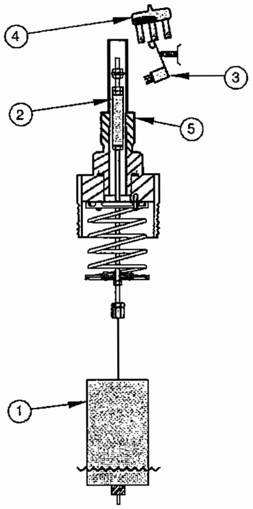


Figure 2
Switch position on falling level

1.3 [illegible]

The purpose of the Proof-er is to check the operation of a displacer control without having to raise the level in the tank. This is accomplished by pulling downward on the Proof-er cable. This causes the spring loaded lever arm to lift the switch actuator, simulating a high or high–high level condition. When the cable is released, the Proof-er returns the actuator to its original position resuming normal operation.

[illegible]

Caution: If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

[illegible]

Top mounting displacer units are shipped from the factory with the displacer and cable assembly removed from the head assembly and packed separately in the same container.

Caution: If reshipping to another location, displacer assembly must again be removed from the control to prevent damage.

Unpack the instrument carefully. Inspect all units for damage. Report any concealed damage to carrier within 24 hours. Check the contents of the packing slip and purchase order. Check and record the serial number for future reference when ordering parts.

Caution: The threaded connection link and stem protruding from the head assembly are extremely fragile. DO NOT handle or place control in a position so that any amount of force is placed on the stem. Proper operation of the control requires that the stem is not damaged or bent.

Caution: Displacer spring and stem are fragile. DO NOT drop displacers into tank. Hand feed cable into position to avoid bending stem.

[illegible]

Caution: This instrument is intended for use in Installation Category II, Pollution Degree 2.

Adjust the displacers on the displacer cable for the desired switch actuating levels (instruction tag is attached to cable). Screw displacer cable fitting to threaded connection link protruding from the underside of control.

Be sure there are no tubes, rods, or other obstacles in the tank or vessel to interfere with the operation of the displacers. No guides into the tank are necessary unless liquid turbulence is excessive, in which case a guide pipe or tube should be at least 1 inch larger than the displacer diameter, open at the bottom end, and with several vent holes located above the maximum high level of the liquid.

Check the installation of pipe or tube to be certain it is plumb.

Caution: Before attaching Magnetrol control to tank or vessel, using a level, check to see that tank mounting flange is within 3° of horizontal in all directions. Proper operation of the control depends on the switch housing being plumb.

2.3 Wiring

Caution: Level controls are shipped from the factory with the enclosing tube tightened and the middle set screw, on the housing base, locked to the enclosing tube. Failure to loosen the set screw prior to repositioning the conduit connection may cause the enclosing tube to loosen, resulting in the possible leakage of the process liquid or vapor.

NOTE: If control is equipped with pneumatic switch mechanism, disregard these instructions and refer to instruction bulletin on mechanism furnished for air (or gas) connections.

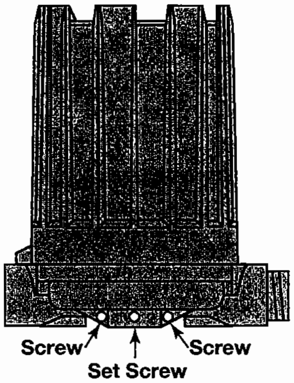


Figure 2
NEMA 4X, NEMA 4X/7/9, NEMA 4X/7/9 Group B

Most switch enclosures are designed to provide 360° positioning of the conduit outlet by loosening the set screw(s) located at the bottom of the switch housing base. To rotate conduit entry:

1. Loosen set screw(s) at base of switch housing. Refer to Figure 2.
2. Rotate switch housing so that conduit entry is positioned as desired.
3. Tighten set screws at base of housing.

At the factory, terminal blocks are positioned next to the conduit entry to facilitate wiring. If repositioning of the switch mechanisms is desired:

1. Unscrew and remove switch housing cover. The threads have been lubricated to facilitate removal.
2. Loosen the frame mounting screw on each switch mechanism. Refer to Figure 3.
3. Carefully rotate the baffle plate and all switch mechanisms together until the terminal blocks are in the desired position.

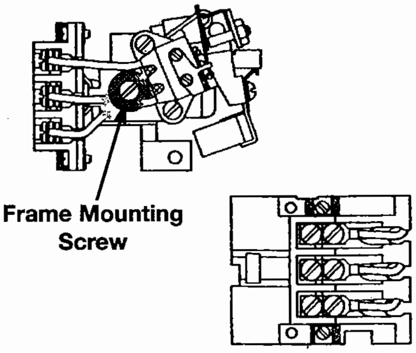
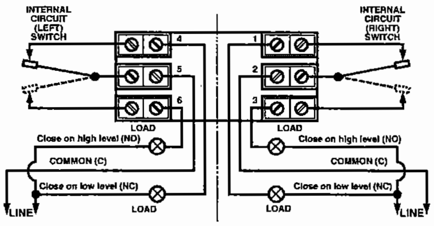


Figure 3
Switch Mechanism

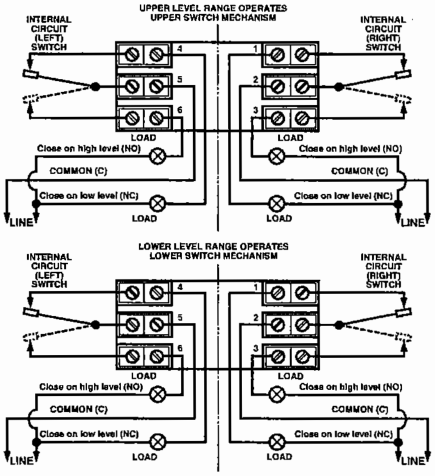
NOTE: On dual and triple stage controls the correct spacing of the mechanisms is maintained using brackets that connect the mechanisms. Take care when rotating the baffle plate and mechanisms to rotate them as a unit and not one at a time. This will ensure that the brackets and mechanisms will not be damaged during repositioning.

4. Ensure that the terminal blocks are aligned vertically to prevent stress on the brackets and mechanisms.
5. Tighten the frame mounting screw on each switch mechanism.



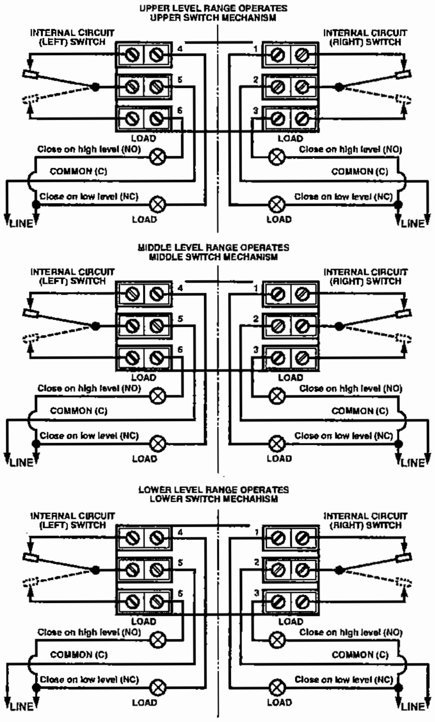
NOTES: 1. Double pole action is obtained by simultaneous operation of the right and left side single pole switches.
2. Rising Level Closes Contacts 5 & 6 and 2 & 3.
3. Falling Level Closes Contacts 4 & 5 and 1 & 2.

Figure 4 – Single Stage with DPDT contacts



NOTES: 1. Double pole action is obtained by simultaneous operation of the right and left side single pole switches.
2. Rising Level Closes Contacts 5 & 6 and 2 & 3.
3. Falling Level Closes Contacts 4 & 5 and 1 & 2.

Figure 5 – Dual Stage with DPDT contacts



NOTES: 1. Double pole action is obtained by simultaneous operation of the right and left side single pole switches.
2. Rising Level Closes Contacts 5 & 6 and 2 & 3.
3. Falling Level Closes Contacts 4 & 5 and 1 & 2.

Figure 6 – Triple Stage with DPDT contacts

NOTE: On high temperature applications above +250° F (+121° C), high temperature wire should be used between control and first junction box located in a cooler area. On non-hazardous applications, flexible conduit may be used between the control and the first junction box.

6. Bring supply wires through conduit entry. Route extra wire around enclosing tube under baffle plate, and connect then to the appropriate terminals. Refer to Figures 4–9 for wiring diagrams, or refer to wiring information in specific switch manuals. Switch instruction manual numbers are as follows:

Switch Series Letter	Description	Bulletin No.
A, T	Standard Mercury Switch	42-683
B, C, D, O, Q	Dry Contact Switch	
E, N	Vibration Resistant Mercury Switch	
HS	Hermetically Sealed Snap Switch	42-694
J	Bleed Type Pneumatic Switch	42-685
K	Non-Bleed Type Pneumatic Switch	42-686

NOTE: For models with a Series HS switch with high temperature lead wire, the leads are routed out through the conduit opening by the factory. A suitable conduit box should be provided for the connection of the leads to the control wiring.

7. Dress wiring to ensure no interference or contact with tilt of switch, or replacement of switch housing cover.

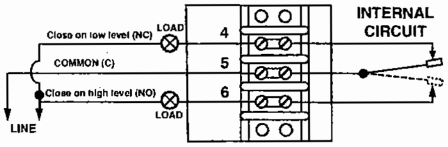
NOTE: Observe all applicable electrical codes and proper wiring procedures.

Prevent moisture seepage into the enclosure by installing approved seal-drain fittings in the conduit run leading into the unit.

Caution: In hazardous areas, do not power the unit until the conduit is sealed and the enclosure cover is screwed down securely.

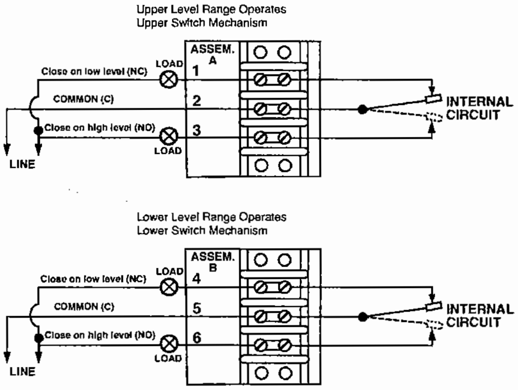
8. Test switch action by varying liquid level or manually moving displacers.
9. Replace housing cover.
10. If control has been furnished with an explosion proof or moisture proof (gasketed) switch housing, it must be sealed at the conduit outlet with a suitable compound or non-hardening sealant to prevent entrance of air.

NOTE: If switch mechanism fails to function properly, check vertical alignment of control housing and consult installation bulletin on switch mechanism furnished.



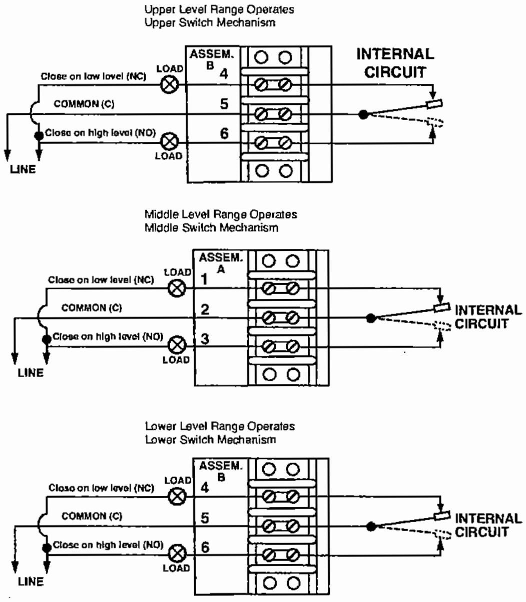
NOTES: 1. Rising level closes contacts 5 & 6.
2. Falling level closes contacts 4 & 5.

Figure 7 – Single Stage with SPDT contacts



NOTES: 1. Rising level closes contacts 5 & 6 and 2 & 3.
2. Falling level closes contacts 4 & 5 and 1 & 2.

Figure 8 – Dual Stage with SPDT contacts



NOTES: 1. Rising level closes contacts 5 & 6 and 2 & 3.
2. Falling level closes contacts 4 & 5 and 1 & 2.

Figure 9 – Triple Stage with SPDT contacts

11. Check cover to base fit to be certain gasketed joint is tight. A positive seal is necessary to prevent infiltration of moisture laden air or corrosive gasses into switch housings.

3.0 Preventive Maintenance

Periodic inspections are a necessary means to keep your level control in good working order. This control is a safety device to protect the valuable equipment it serves. A systematic program of "preventive maintenance" must be implemented when the control is placed into service. If the following sections on "What to do" and "What to avoid" are observed, your control will provide reliable protection of your equipment for many years.

3.1 What to do

3.1.1 Keep control clean

Be sure the switch housing cover is always in place on the control. This cover is designed to keep dust and dirt from interfering with switch mechanism operation. It protects against damaging moisture and acts as a safety feature by keeping bare wires and terminals from being exposed. Should the housing cover or any seal become damaged or misplaced, obtain a replacement immediately.

3.1.2 Inspect switch mechanisms, terminals, and connections monthly

1. Mercury switches may be visually inspected for short circuit damage. Check for small cracks in the glass tube containing the mercury. Such cracks can allow entrance of air into the tube causing the mercury to "oxidize". This is noticeable as the mercury will appear dirty or dull, and will not break into clean, round pools. If these conditions exist, replace the mercury switch immediately.
2. Dry contact switches should be inspected for excessive wear on actuating lever or misalignment of adjustment screw at point of contact between screw and lever. Such wear can cause false switch actuating levels. See switch mechanism bulletin supplied with control should switch adjustment or replacement be necessary.
3. DO NOT operate your control with defective or maladjusted switch mechanisms (refer to bulletin on switch mechanisms furnished for service instructions.)

4. Level controls may sometimes be exposed to excessive heat or moisture. Under such conditions, insulation on electrical wiring may become brittle, eventually breaking or pealing away. The resulting "bare" wires can cause short circuits.

NOTE: Check wiring carefully and replace at the first sign of brittle insulation.

5. Vibration may sometimes cause terminal screws to work loose. Check all terminal connections to be certain that screws are tight.
6. On units with pneumatic switches, air (or gas) lines subjected to vibration, may eventually crack or become loose at connections causing leakage. Check lines and connections carefully and repair or replace, if necessary.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

[illegible]

1. Never leave switch housing cover off the control longer than necessary to make routine inspections.
2. Never place a jumper wire across terminals to "cut-out" the control. If a "jumper" is necessary for test purposes, be certain it is removed before placing control into service.
3. Never attempt to make adjustments or replace switches without reading instructions carefully. Certain adjustments provided for in level controls should not be attempted in the field. When in doubt, consult the factory or your local representative.
4. Never use lubricants on pivots of switch mechanisms. A sufficient amount of lubricant has been applied at the factory to ensure a lifetime of service. Further oiling is unnecessary and will only tend to attract dust and dirt which can interfere with mechanism operation.
5. Never attempt to readjust magnetic attraction sleeve. It is factory set, and tampering may cause failure of control while in service, even if manual operation activates switch.

[illegible]

[illegible]

Usually the first indication of improper operation is failure of the controlled equipment to function, i.e., pump will not start (or stop), signal lamps fail to light, etc. When these symptoms occur, whether at time of installation or during routine service thereafter, check the following potential external causes first.

a. Fuses may be blown.
b. Reset button(s) may need resetting.
c. Power switch may be open.
d. Controlled equipment may be faulty.
e. Wiring leading to control may be defective.

If a thorough inspection of these possible conditions fails to locate the trouble, proceed next to a check of the control's switch mechanism.

4.1.1 Check switch mechanism

1. Pull disconnect switch or otherwise disconnect power to the control.
2. Remove switch housing cover.
3. Disconnect power wiring from switch assembly.
4. Swing magnet assembly in and out by hand to check carefully for any sign of binding. Assembly should require minimal force to move it through its full swing.
5. If binding exists, magnet may be rubbing enclosing tube. If magnet is rubbing, loosen magnet clamp screw and shift magnet position. Retighten magnet clamp screw.
6. If switch magnet assembly swings freely and mechanism still fails to actuate, check installation of control to be certain it is within the specified three degrees of vertical. (Use spirit level on side of enclosing tube in two places, 90° apart.)

7a. If mechanism is equipped with a mercury switch, examine glass mercury tube closely as previously described in Section 3.0 Preventive Maintenance. If switch is damaged, replace it immediately.

7b. If mechanism is equipped with a microswitch, check continuity with ohmmeter.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

8. If switch mechanism is operating satisfactorily, proceed to check sensing unit.

4.1.2 Test control's performance

1. Reconnect power supply and carefully actuate switch mechanism manually, using a non-conductive tool on electrical switch mechanism, to determine whether controlled equipment will operate.

Caution: With electrical power on, care should be taken to avoid contact with switch leads and connections at terminal block.

2. If controlled equipment responds to manual actuation test, trouble may be located in level sensing portion of the control (displacers, spring, stem, and magnetic attracting sleeve).

NOTE: Check first to be certain liquid is entering tank or vessel. A valve may be closed or pipe line plugged.

3. With liquid in tank or vessel, proceed to check level sensing action by removing switch housing assembly.

Caution: Be certain to pull disconnect switch or otherwise assure that electrical circuit(s) through control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms

   a. Disconnect wiring from supply side of switch mechanism(s) and remove electrical conduit or operating medium line connections to switch housing.
   b. Relieve pressure from vessel and allow unit to cool.
   c. Remove switch housing assembly by loosening set screws located at the bottom of the housing base.

4. With switch housing assembly removed, inspect attraction sleeve and inside of enclosing tube for excessive corrosion or solids buildup which could restrict movement, preventing sleeve from reaching field of switch magnet.

5. Inspect displacer stem and spring assembly to assure it is not damaged. If stem or spring is bent or otherwise damaged, movement of the attraction sleeve inside the e-tube will be restricted, preventing proper function of the control.

6. If trouble is still not located, proceed to remove the entire sensing unit from the tank or vessel by unbolting head flange or unscrewing mounting bushing. Inspect displacer assembly and all internal parts for any signs of damage. Check assembly for binding by supporting head flange or mounting bushing over the edge of a bench and move displacer assembly by hand.

NOTE: When in doubt about the condition or performance of a control, contact the factory or consult your local representative.

4.1.3 Proof-er

If the Proof-er is not functioning properly, listed below are potential problems and corrective action.

1. Proof-er does not return to the down position after it is activated.

CAUSE	REMEDY
Defective return spring.	Replace Spring.
Buildup between the shaft and housing restricting movement.	Clean Proof-er to remove buildup.
Handle stops are not adjusted properly.	Adjust handle stop screws in or out to allow the handle to move to the proper position.

2. Switch will not trip when Proof-er is activated.

CAUSE	REMEDY
The switch mechanism is defective and not the Proof-er.	Check switch mechanism.
Handle stops are not adjusted properly.	Adjust handle stop screws in or out to allow the handle to move to the proper position.

Agency Approvals

AGENCY	APPROVED MODEL	APPROVAL CLASSES
FM APPROVED	All with an electric switch mechanism and a housing listed as Type 4X/7/9	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as Type 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
CSA	All with a Series A, E, 2, 3 or HS electric switch mechanism and a housing listed as CSA Type 4X	Class I, Div 2, Groups B, C & D
	All with an electric switch mechanism and a housing listed as Type 4X/7/9 ①	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as Type 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
ATEX / IEC Ex ③	All with an electric switch mechanism and an ATEX housing ②	ATEX II 2 G EEx d IIC T6 IEC Ex Ex d IIC T6
CE	Low Voltage Directives 73/23/EEC & 93/68/EEC Per Harmonized Standard: EN 61010-1/1993 & Amendment No. 1	Installation Category II Pollution Degree 2

① With housing drain, CSA drops Group E and FM drops Group C.

② Models B10 and B15 with 'HS' switches and all Model C10 and C15 are not ATEX approved.

③ IEC Installation Instructions:

The cable entry and closing devices shall be Ex d certified suitable for the conditions of use and correctly installed.

For ambient temperatures above +55° C or for process temperatures above +150° C, suitable heat resistant cables shall be used.

Heat extensions (between process connection and housing) shall never be insulated.

Special conditions for safe use:

When the equipment is installed in process temperatures higher than +85° C the temperature classification must be reduced according to the following table as per IEC60079-0.

Maximum Process Temperature	Temperature Classification
< 85° C	T6
< 100° C	T5
< 135° C	T4
< 200° C	T3
< 300° C	T2
< 450° C	T1

These units are in comformity with IECEx KEM 05.0020X
Classification Ex d IIC T6
$T_{ambient}$ -40° C to +70° C

4.3.1 Basic Electrical Ratings

Displacer	Switch Series and Non-Inductive Ampere Rating									
	A	B	C	D	E	HS	N	O	Q	T
120 VAC	13.00	15.00	15.00	10.00	4.00	5.00	13.00	15.00	15.00	4.00
240 VAC	6.50	15.00	15.00	—	2.00	5.00	6.50	15.00	15.00	2.00
24 VDC	10.00	6.00	10.00	10.00	—	5.00	—	—	6.00	—
120 VDC	10.00	0.50	1.00	10.00	4.00	0.50	10.00	1.00	0.50	4.00
240 VDC	5.00	0.25	0.50	3.00	2.00	0.25	5.00	0.50	0.25	2.00

4.3.2 Pressure/Temperature Ratings

Threaded Models*	800 psig @ +100° F (55 bar @ +38° C) 250 psig @ +400° F (17 bar @ +204° C)
Flanged Models	Limited to the pressure rating of the selected flange or displacer. Cast iron flanges are flat face type conforming to ANSI dimensional specifications
Low Pressure Proof-er Models	25 psig @ +200° F (1.7 bar @ +93° C)
Medium Pressure Proof-er Models	125 psig @ +300° F (8.6 bar @ +149° C)

*Models with stainless steel displacers are rated 720 psig @ +100° F (50 bar @ +38° C)

4.3.3 Model A10 Dimensional Data and Actuating Levels

Inches (mm)

Model A10

Outline Dimensions				
Displacer Type	**Threaded Mounting**		**Flanged Mounting**	
	A	**B**	**A**	**B**
Porcelain	5.00 (127)	122.00 (3098)	7.00 (177)	124.00 (3149)
Stainless Steel or Karbate	4.75 (120)	122.00 (3098)	6.75 (171)	124.00 (3149)

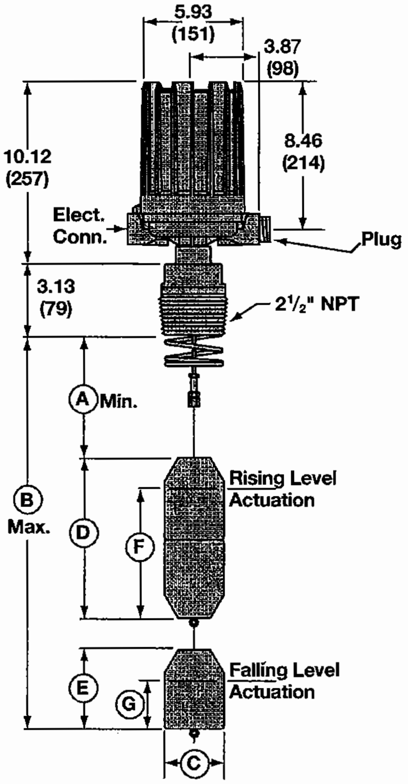
Displacer Type	C	D	E
Porcelain	2.56 (65)	7.25 (184)	3.62 (91)
Stainless Steel or Karbate	2.50 (63)	9.00 (228)	4.50 (114)

Electrical Connections
NEMA 4X/7/9, Group B: 1" NPT NEMA 1 Pneumatic: ¼" NPT

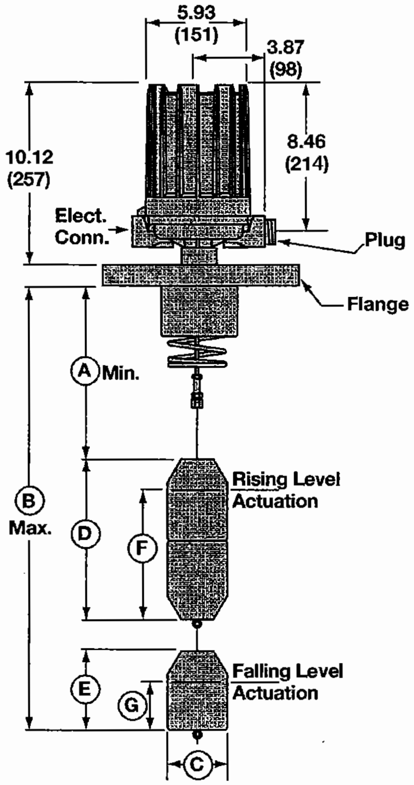
A10 Standard actuating levels and liquid specific gravity

Displacer Type	Liquid Temp. ° F	0.60		0.70		0.80		0.90		1.00	
		F	G	F	G	F	G	F	G	F	G
Porcelain	100	5.30 (134)	1.50 (38)	4.10 (104)	1.20 (30)	3.20 (81)	1.10 (27)	2.50 (63)	1.00 (25)	2.00 (50)	0.90 (22)
	200	—	—	4.80 (121)	2.00 (50)	3.80 (96)	1.80 (45)	3.00 (76)	1.60 (40)	2.50 (63)	1.50 (38)
	300	—	—	—	—	4.30 (109)	2.40 (60)	3.40 (86)	2.10 (53)	2.90 (73)	1.90 (48)
	400	—	—	—	—	—	—	3.40 (86)	2.60 (66)	2.90 (73)	2.40 (60)
Stainless Steel or Karbate	100	7.00 (177)	2.40 (60)	5.30 (134)	2.00 (50)	4.10 (104)	1.80 (45)	3.10 (78)	1.60 (40)	2.40 (60)	1.40 (35)
	200	—	—	5.90 (149)	2.80 (71)	4.70 (119)	2.50 (63)	3.60 (91)	2.20 (55)	2.80 (71)	2.00 (50)
	300	—	—	—	—	5.10 (129)	3.10 (78)	4.00 (101)	2.70 (68)	3.20 (81)	2.40 (60)
Stainless Steel	400	—	—	—	—	—	—	4.40 (111)	3.20 (81)	3.60 (91)	2.90 (73)
	500	—	—	—	—	—	—	—	—	3.90 (99)	3.30 (83)

Note: All levels ±0.25" (6).



Model A10
with Threaded Mounting



Model A10
with Flanged Mounting

4.3.4 Model A15 Dimensional Data and Actuating Levels

Inches (mm)

Model A15

Displacer Type	Outline Dimensions			
	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	5.62 (142)	122.00 (3098)	7.62 (193)	124.00 (3149)
Stainless Steel or Karbate	5.62 (142)	122.00 (3098)	7.62 (193)	124.00 (3149)

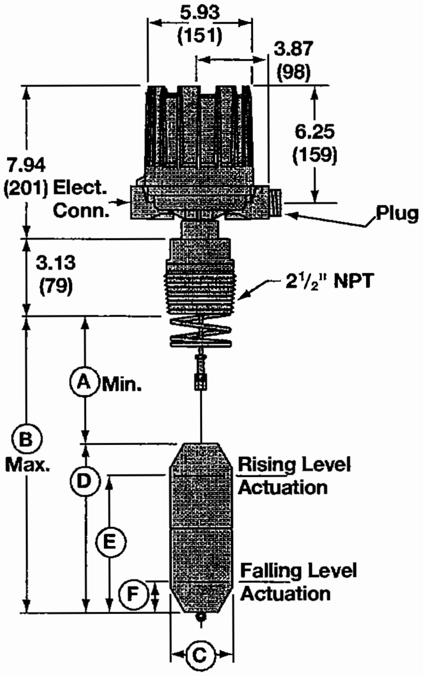
Displacer Type	C	D
Porcelain	2.56 (65)	7.25 (184)
Stainless Steel or Karbate	2.50 (63)	9.00 (228)

Electrical Connections
NEMA 4X/7/9, Group B: 1" NPT NEMA 1 Pneumatic: ¼" NPT

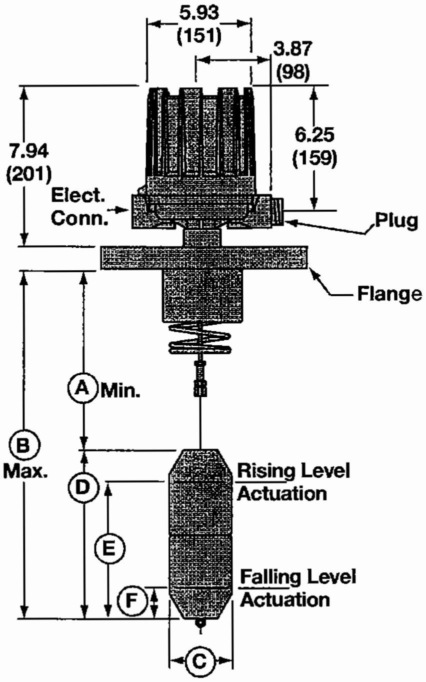
A15 Standard actuating levels and liquid specific gravity

Displacer Type	Liquid Temp. ° F	0.50		0.60		0.70		0.80		0.90		1.00	
		E	F	E	F	E	F	E	F	E	F	E	F
Porcelain	100	—	—	5.10 (129)	2.10 (53)	4.50 (114)	1.70 (43)	3.90 (99)	1.70 (43)	3.50 (88)	1.50 (38)	3.20 (81)	1.40 (35)
	200	—	—	5.60 (142)	2.60 (66)	4.90 (124)	2.10 (53)	4.30 (109)	2.10 (53)	3.80 (96)	1.80 (45)	3.50 (88)	1.70 (43)
	300	—	—	—	—	5.20 (132)	2.40 (60)	4.50 (114)	2.30 (58)	4.10 (104)	2.10 (53)	3.70 (93)	1.90 (48)
	400	—	—	—	—	5.60 (142)	2.80 (71)	4.80 (121)	2.60 (66)	4.30 (109)	2.30 (58)	3.90 (99)	2.10 (53)
	500	—	—	—	—	—	—	5.10 (129)	2.90 (73)	4.60 (116)	2.60 (66)	4.20 (106)	2.40 (60)
Stainless Steel or Karbate	100	5.40 (137)	2.00 (50)	4.50 (114)	1.60 (40)	3.90 (99)	1.40 (35)	3.40 (86)	1.20 (30)	3.00 (76)	1.10 (27)	2.70 (68)	1.00 (25)
	200	6.00 (152)	2.60 (66)	5.00 (127)	2.10 (53)	4.30 (109)	1.80 (45)	3.70 (93)	1.60 (40)	3.30 (83)	1.40 (35)	3.00 (76)	1.30 (33)
	300	6.40 (162)	3.00 (76)	5.30 (134)	2.40 (60)	4.60 (116)	2.10 (53)	4.00 (101)	1.80 (45)	3.60 (91)	1.70 (43)	3.20 (81)	1.50 (38)
Stainless Steel	400	6.90 (175)	3.50 (88)	5.70 (144)	2.80 (71)	4.90 (124)	2.40 (60)	4.30 (109)	2.10 (53)	3.80 (96)	1.90 (48)	3.40 (86)	1.70 (43)
	500	—	—	6.10 (154)	3.20 (81)	5.20 (132)	2.80 (71)	4.60 (116)	2.40 (60)	4.10 (104)	2.20 (55)	3.70 (93)	2.00 (50)

Note: All levels ±0.25" (6).



Model A15
with Threaded Mounting



Model A15
with Flanged Mounting

4.3.5 Model B10 Dimensional Data

Inches (mm)

Model B10

Outline Dimensions				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	4.88 (123)	122.00 (3098)	6.88 (174)	124.00 (3149)
Stainless Steel or Karbate	4.75 (120)	122.00 (3098)	6.75 (171)	124.00 (3149)

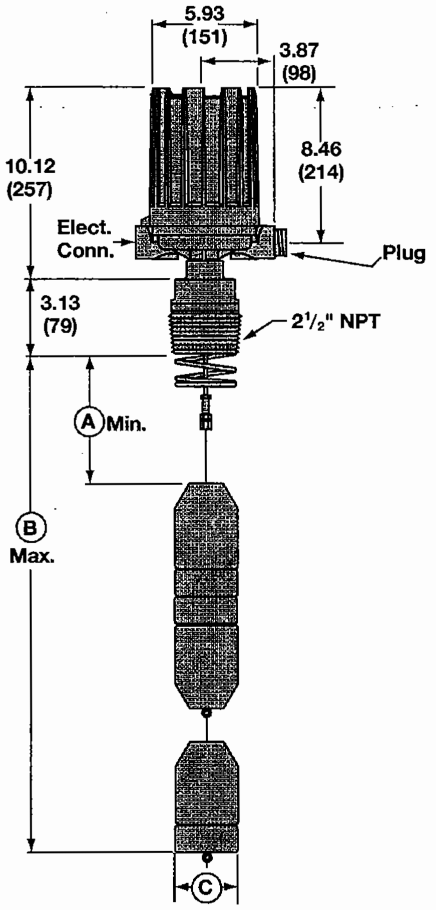
Model B10 with displacer arrangements 1 and 2

Displacer Type	C	D	E
Porcelain	2.56 (65)	10.04 (255)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	12.00 (304)	6.00 (152)

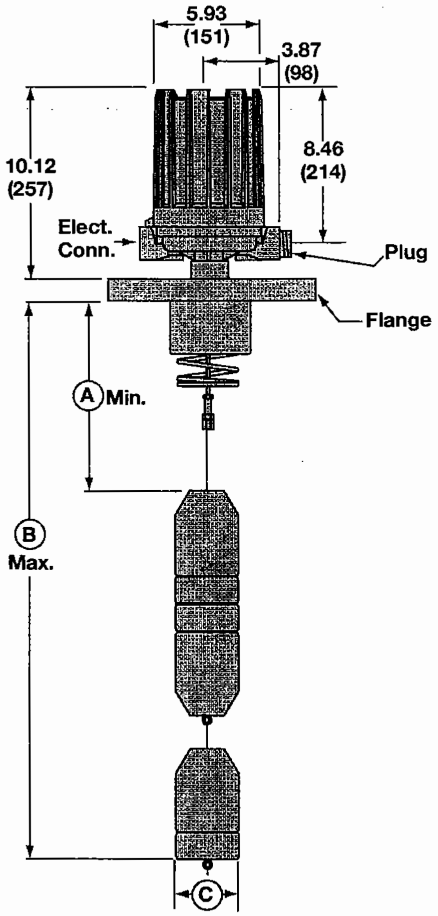
Model B10 with displacer arrangements 3, 4, and 5

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	5.02 (127)	5.02 (127)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	6.00 (152)	6.00 (152)	6.00 (152)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



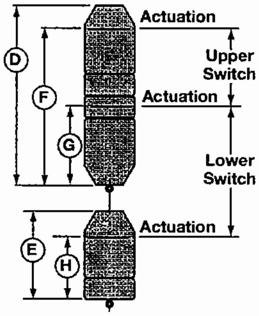
Model B10
with Threaded Mounting



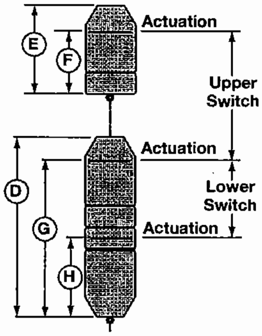
Model B10
with Flanged Mounting

4.3.6 Model B10 Actuating Levels

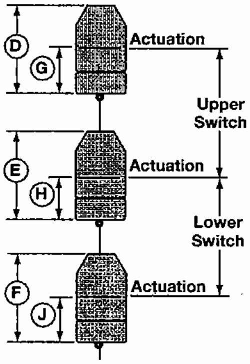
Inches (mm)



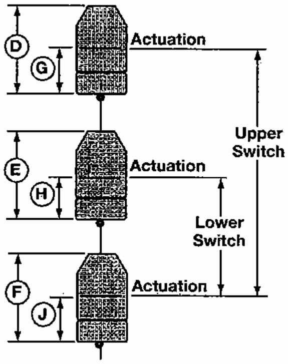
Model B10
Displacer Arrangement 1



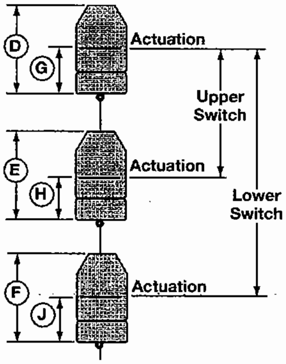
Model B10
Displacer Arrangement 2



Model B10
Displacer Arrangement 3



Model B10
Displacer Arrangement 4



Model B10
Displacer Arrangement 5

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 1

Displacer Type	Liquid Temp. ° F	Level	0.60 – 0.64	0.65 – 0.71	0.72 – 0.73	0.74 – 0.82	0.83 – 0.92	0.93 – 1.00	1.01 – 1.07
Porcelain	100	F	7.79 – 7.04 (197 – 178)	7.66 – 6.65 (194 – 168)	7.22 – 7.06 (133 – 179)	6.91 – 5.81 (175 – 147)	6.73 – 5.65 (180 – 143)	5.55 – 4.86 (140 – 123)	4.97 – 4.53 (126 – 115)
		G	2.62 – 2.19 (56 – 55)	2.88 – 2.28 (73 – 57)	2.91 – 2.81 (73 – 71)	2.71 – 2.03 (68 – 51)	2.99 – 2.28 (75 – 57)	2.21 – 1.76 (56 – 44)	1.90 – 1.63 (48 – 41)
		H	2.01 – 1.89 (51 – 48)	1.86 – 1.70 (47 – 43)	1.68 – 1.65 (42 – 41)	1.63 – 1.47 (41 – 37)	1.45 – 1.31 (36 – 33)	1.30 – 1.21 (33 – 30)	1.02 – 0.97 (25 – 24)
	200	F	7.91 (200)	7.72 – 6.71 (196 – 170)	6.56 – 6.41 (166 – 162)	6.73 – 5.66 (170 – 143)	6.37 – 5.33 (161 – 135)	6.15 – 5.42 (156 – 137)	5.02 – 4.57 (127 – 116)
		G	3.06 (77)	2.95 – 2.34 (74 – 59)	2.25 – 2.16 (57 – 54)	2.54 – 1.87 (64 – 47)	2.63 – 1.95 (66 – 49)	2.81 – 2.32 (71 – 58)	1.94 – 1.67 (49 – 42)
		H	2.76 (70)	2.72 – 2.49 (69 – 63)	2.45 – 2.42 (62 – 61)	2.39 – 2.15 (60 – 54)	2.13 – 1.92 (54 – 48)	1.90 – 1.77 (48 – 44)	1.58 – 1.49 (40 – 37)
	300	F	—	—	—	7.48 – 6.34 (189 – 161)	7.04 – 5.93 (178 – 150)	6.75 – 5.98 (171 – 151)	5.57 – 5.10 (141 – 129)
		G	—	—	—	3.29 – 2.55 (83 – 64)	3.30 – 2.56 (83 – 65)	3.41 – 2.87 (86 – 72)	2.50 – 2.19 (63 – 55)
		H	—	—	—	3.14 – 2.83 (79 – 71)	2.80 – 2.53 (71 – 64)	2.50 – 2.32 (63 – 58)	2.13 – 2.01 (54 – 51)
	400	F	—	—	—	—	—	—	6.12 – 5.62 (155 – 142)
		G	—	—	—	—	—	—	3.05 – 2.72 (77 – 69)
		H	—	—	—	—	—	—	2.68 – 2.53 (68 – 64)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 1

Displacer Type	Liquid Temp. ° F	Level	1.08 – 1.12	1.13 – 1.17	1.18 – 1.27	1.28 – 1.30	1.31 – 1.39	1.40 – 1.50
Porcelain	100	F	4.47 – 4.20 (113 – 106)	4.90 – 4.64 (124 – 117)	4.57 – 4.05 (116 – 102)	3.99 – 3.89 (101 – 98)	4.23 – 3.82 (107 – 97)	3.77 – 3.33 (95 – 84)
		G	1.59 – 1.43 (40 – 36)	2.16 – 1.99 (54 – 50)	1.94 – 1.60 (49 – 40)	1.57 – 1.50 (39 – 38)	1.86 – 1.59 (47 – 40)	1.56 – 1.26 (39 – 32)
		H	0.96 – 0.92 (24 – 23)	0.92 – 0.88 (23 – 22)	0.88 – 0.81 (22 – 20)	0.81 – 0.80 (20 – 20)	0.79 – 0.74 (20 – 18)	0.74 – 0.69 (18 – 17)
	200	F	4.66 – 4.39 (118 – 111)	4.33 – 4.08 (109 – 103)	4.32 – 3.81 (109 – 96)	4.29 – 4.18 (108 – 106)	4.13 – 3.73 (104 – 94)	3.93 – 3.47 (99 – 88)
		G	1.79 – 1.62 (45 – 41)	1.58 – 1.43 (40 – 36)	1.69 – 1.36 (42 – 34)	1.87 – 1.80 (47 – 45)	1.76 – 1.49 (44 – 37)	1.71 – 1.40 (43 – 35)
		H	1.48 – 1.42 (37 – 36)	1.41 – 1.36 (35 – 34)	1.35 – 1.25 (34 – 31)	1.24 – 1.23 (31 – 31)	1.22 – 1.15 (30 – 29)	1.14 – 1.06 (28 – 26)
	300	F	5.18 – 4.89 (131 – 124)	4.82 – 4.56 (122 – 115)	4.79 – 4.25 (121 – 107)	4.73 – 4.61 (120 – 117)	4.56 – 4.13 (115 – 104)	4.32 – 3.84 (109 – 97)
		G	2.31 – 2.12 (58 – 53)	2.08 – 1.91 (52 – 48)	2.16 – 1.80 (54 – 45)	2.31 – 2.23 (58 – 56)	2.19 – 1.90 (55 – 48)	2.11 – 1.78 (53 – 45)
		H	1.99 – 1.92 (50 – 48)	1.90 – 1.84 (48 – 46)	1.82 – 1.69 (45 – 42)	1.68 – 1.66 (42 – 42)	1.64 – 1.55 (41 – 39)	1.54 – 1.43 (39 – 36)
	400	F	5.70 – 5.39 (144 – 136)	5.32 – 5.04 (135 – 128)	5.26 – 4.69 (133 – 119)	5.17 – 5.04 (131 – 128)	4.98 – 4.53 (126 – 115)	4.72 – 4.22 (119 – 107)
		G	2.82 – 2.62 (71 – 66)	2.57 – 2.39 (65 – 60)	2.63 – 2.24 (66 – 56)	2.74 – 2.66 (69 – 67)	2.61 – 2.30 (66 – 58)	2.51 – 2.15 (63 – 54)
		H	2.51 – 2.42 (63 – 61)	2.40 – 2.32 (60 – 58)	2.30 – 2.13 (58 – 54)	2.12 – 2.08 (53 – 52)	2.07 – 1.95 (52 – 49)	1.94 – 1.81 (49 – 45)
	500	F	6.22 – 5.89 (157 – 149)	5.81 – 5.52 (147 – 140)	5.74 – 5.13 (145 – 130)	5.60 – 5.47 (142 – 138)	5.41 – 4.93 (137 – 125)	5.12 – 4.59 (130 – 116)
		G	3.34 – 3.12 (84 – 79)	3.07 – 2.86 (77 – 72)	3.11 – 2.68 (78 – 68)	3.18 – 3.09 (80 – 78)	3.04 – 2.70 (77 – 68)	2.91 – 2.52 (73 – 64)
		H	3.03 – 2.92 (76 – 74)	2.89 – 2.79 (73 – 70)	2.77 – 2.57 (70 – 65)	2.55 – 2.51 (64 – 63)	2.50 – 2.35 (63 – 59)	2.33 – 2.18 (59 – 55)

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel and Karbate	100	F	9.91 – 7.72 (251 – 196)	9.19 – 6.62 (233 – 168)	8.44 – 7.16 (214 – 181)	7.66 – 6.86 (194 – 174)	6.71 – 4.93 (170 – 125)	4.82 – 4.61 (122 – 117)
		G	3.46 – 2.16 (86 – 54)	3.72 – 2.08 (94 – 52)	3.96 – 3.07 (100 – 77)	3.63 – 3.07 ((92 – 77)	2.96 – 1.71 (75 – 43)	1.63 – 1.48 (41 – 37)
		H	2.51 – 2.16 (63 – 54)	2.13 – 1.77 (54 – 44)	1.74 – 1.59 (44 – 40)	1.57 – 1.48 (39 – 37)	1.46 – 1.25 (37 – 31)	1.24 – 1.22 (31 – 30)
	200	F	10.22 – 7.98 (259 – 202)	7.74 – 7.44 (196 – 188)	7.50 – 6.30 (190 – 160)	6.15 – 5.44 (156 – 138)	6.97 – 5.15 (177 – 130)	—
		G	3.76 – 2.42 (95 – 61)	2.27 – 1.89 (57 – 48)	3.02 – 2.22 (76 – 56)	2.12 – 1.64 (53 – 41)	3.22 – 1.93 (81 – 49)	—
		H	3.67 – 3.16 (93 – 80)	3.11 – 2.58 (78 – 65)	2.55 – 2.32 (64 – 58)	2.29 – 2.16 (58 – 54)	2.13 – 1.84 (54 – 46)	—
	300	F	—	9.68 – 7.25 (245 – 184)	8.31 – 7.04 (211 – 178)	6.88 – 6.12 (174 – 155)	7.65 – 5.73 (194 – 145)	—
		G	—	4.30 – 2.70 (109 – 68)	3.83 – 2.96 (97 – 75)	2.84 – 2.32 (72 – 58)	3.89 – 2.51 (98 – 63)	—
		H	—	4.03 – 3.40 (102 – 86)	3.36 – 3.06 (85 – 77)	3.02 – 2.84 (76 – 72)	2.81 – 2.42 (71 – 61)	—

continued on page 16

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 1 (cont.)

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel	400	F	—	—	9.11 – 7.77 (231 – 197)	7.60 – 6.80 (193 – 172)	8.32 – 6.32 (211 – 160)	—
		G	—	—	4.63 – 3.69 (117 – 93)	3.57 – 3.01 (90 – 76)	4.57 – 3.09 (116 – 78)	—
		H	—	—	4.16 – 3.79 (105 – 96)	3.75 – 3.53 (95 – 89)	3.48 – 3.00 (88 – 76)	—
	500	F	—	—	—	—	9.00 – 6.90 (228 – 175)	—
		G	—	—	—	—	5.24 – 3.67 (133 – 93)	—
		H	—	—	—	—	4.16 – 3.58 (105 – 90)	—

Note: All levels ±0.25" (6).

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 2

Displacer Type	Liquid Temp. ° F	Level	0.60 – 0.64	0.65 – 0.71	0.72 – 0.73	0.74 – 0.82	0.83 – 0.92	0.93 – 1.00	1.01 – 1.07
Porcelain	100	F	2.77 – 2.01 (70 – 51)	2.63 – 1.62 (66 – 41)	2.67 – 2.51 (67 – 63)	2.58 – 1.42 (65 – 36)	3.16 – 1.94 (80 – 49)	1.82 – 1.04 (45 – 26)	1.69 – 1.23 (42 – 31)
		G	7.27 – 6.84 (184 – 173)	7.54 – 6.93 (191 – 176)	7.56 – 7.46 (192 – 189)	7.36 – 6.68 (186 – 169)	7.64 – 6.93 (194 – 176)	6.86 – 6.41 (174 – 162)	5.15 – 4.89 (130 – 124)
		H	2.67 – 2.53 (67 – 64)	3.29 – 3.05 (83 – 77)	3.73 – 3.68 (94 – 93)	3.64 – 3.32 (92 – 84)	4.32 – 3.93 (109 – 99)	3.90 – 3.65 (99 – 92)	2.42 – 2.31 (61 – 58)
	200	F	3.15 (80)	2.96 – 1.93 (75 – 49)	1.77 – 1.62 (44 – 41)	2.64 – 1.47 (67 – 37)	2.79 – 1.61 (70 – 40)	2.79 – 1.94 (70 – 49)	1.56 – 1.11 (39 – 28)
		G	7.71 (195)	7.60 – 6.99 (193 – 177)	6.90 – 6.81 (175 – 172)	7.19 – 6.52 (182 – 165)	7.28 – 6.60 (184 – 167)	7.46 – 6.97 (189 – 177)	5.19 – 4.92 (131 – 124)
		H	3.40 (86)	3.36 – 3.10 (85 – 78)	3.07 – 3.03 (77 – 76)	3.46 – 3.16 (87 – 80)	3.96 – 3.61 (100 – 91)	4.50 – 4.21 (114 – 106)	2.46 – 2.35 (62 – 59)
	300	F	—	—	—	3.39 – 2.15 (86 – 54)	3.47 – 2.22 (88 – 56)	3.39 – 2.50 (86 – 63)	2.11 – 1.63 (53 – 41)
		G	—	—	—	7.94 – 7.20 (201 – 182)	7.95 – 7.21 (201 – 183)	8.06 – 7.53 (204 – 191)	5.75 – 5.45 (146 – 138)
		H	—	—	—	4.21 – 3.84 (106 – 97)	4.63 – 4.21 (117 – 106)	5.10 – 4.77 (129 – 121)	3.02 – 2.87 (76 – 72)
	400	F	—	—	—	—	—	—	2.67 – 2.15 (67 – 54)
		G	—	—	—	—	—	—	6.30 – 5.97 (160 – 151)
		H	—	—	—	—	—	—	3.57 – 3.39 (90 – 86)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 2 (cont.)

Displacer Type	Liquid Temp. ° F	Level	1.08 – 1.12	1.13 – 1.17	1.18 – 1.27	1.28 – 1.30	1.31 – 1.39	1.40 – 1.50
Porcelain	100	F	1.16 – 0.89 (29 – 22)	2.04 – 1.75 (51 – 44)	1.68 – 1.10 (42 – 27)	1.04 – 0.92 (26 – 23)	2.05 – 1.56 (52 – 39)	1.50 – 0.97 (38 – 24)
		G	4.84 – 4.68 (122 – 118)	5.41 – 5.24 (137 – 133)	5.20 – 4.85 (132 – 123)	4.82 – 4.75 (122 – 120)	5.11 – 4.84 (129 – 122)	4.81 – 4.51 (122 – 114)
		H	2.29 – 2.22 (58 – 56)	2.97 – 2.88 (75 – 73)	2.86 – 2.68 (72 – 68)	2.66 – 2.63 (67 – 66)	3.01 – 2.85 (76 – 72)	2.84 – 2.67 (72 – 67)
	200	F	1.68 – 1.38 (42 – 35)	1.31 – 1.05 (33 – 26)	1.71 – 1.13 (43 – 28)	1.75 – 1.62 (44 – 41)	1.56 – 1.09 (39 – 27)	1.53 – 1.00 (38 – 25)
		G	5.04 – 4.88 (128 – 123)	4.84 – 4.68 (122 – 118)	4.94 – 4.62 (125 – 117)	5.12 – 5.05 (130 – 128)	5.01 – 4.75 (127 – 120)	4.96 – 4.65 (125 – 118)
		H	2.49 – 2.41 (63 – 61)	2.39 – 2.33 (60 – 59)	2.60 – 2.44 (66 – 61)	2.97 – 2.93 (73 – 70)	2.91 – 2.76 (73 – 70)	2.99 – 2.82 (75 – 77)
	300	F	2.19 – 1.88 (55 – 47)	1.81 – 1.52 (45 – 38)	2.19 – 1.57 (55 – 39)	2.18 – 2.05 (50 – 37)	1.98 – 1.49 (50 – 37)	1.93 – 1.37 (49 – 34)
		G	5.56 – 5.37 (141 – 136)	5.33 – 5.16 (135 – 131)	5.41 – 5.06 (137 – 128)	5.56 – 5.48 (138 – 130)	5.44 – 5.15 (138 – 130)	5.36 – 5.03 (136 – 127)
		H	3.01 – 2.91 (76 – 73)	2.89 – 2.80 (73 – 71)	3.07 – 2.88 (77 – 73)	3.40 – 3.36 (84 – 80)	3.33 – 3.16 (84 – 80)	3.39 – 3.19 (86 – 81)
	400	F	2.71 – 2.38 (68 – 60)	2.30 – 2.00 (58 – 50)	2.66 – 2.01 (67 – 51)	2.62 – 2.48 (61 – 48)	2.41 – 1.90 (61 – 48)	2.33 – 1.74 (59 – 44)
		G	6.08 – 5.87 (154 – 149)	5.82 – 5.64 (147 – 143)	5.89 – 5.49 (149 – 139)	5.99 – 5.91 (152 – 150)	5.87 – 5.55 (149 – 140)	5.76 – 5.40 (146 – 137)
		H	3.52 – 3.41 (89 – 86)	3.38 – 3.28 (85 – 83)	3.55 – 3.32 (90 – 84)	3.84 – 3.79 (97 – 96)	3.76 – 3.56 (95 – 90)	3.79 – 3.56 (96 – 90)
	500	F	3.23 – 2.88 (82 – 73)	2.80 – 2.48 (71 – 62)	3.13 – 2.45 (79 – 62)	3.05 – 2.91 (77 – 73)	2.84 – 2.30 (72 – 58)	2.73 – 2.11 (69 – 53)
		G	6.59 – 6.37 (167 – 161)	6.32 – 6.12 (160 – 155)	6.36 – 5.93 (161 – 150)	6.43 – 6.34 (163 – 161)	6.29 – 5.95 (159 – 151)	6.16 – 5.77 (156 – 146)
		H	4.04 – 3.91 (102 – 99)	3.88 – 3.76 (98 – 95)	4.02 – 3.76 (102 – 95)	4.28 – 4.21 (108 – 106)	4.19 – 3.97 (106 – 100)	4.19 – 3.93 (106 – 99)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 2

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel and Karbate	100	F	3.77 – 1.60 (95 – 40)	4.10 – 1.38 (104 – 35)	4.43 – 2.97 (112 – 75)	4.58 – 3.60 (24 – 91)	3.42 – 1.26 (86 – 31)	1.13 – 0.88 (28 – 22)
		G	9.46 – 8.16 (240 – 207)	9.72 – 8.08 (246 – 205)	9.96 – 9.07 (252 – 230)	9.63 – 9.07 (244 – 230)	8.96 – 7.71 (227 – 195)	7.63 – 7.48 (193 – 189)
		H	3.73 – 3.21 (94 – 81)	4.86 – 4.04 (123 – 102)	5.97 – 5.44 (151 – 138)	6.05 – 5.69 (153 – 144)	5.63 – 4.84 (143 – 122)	4.79 – 4.70 (121 – 119)
	200	F	4.22 – 1.98 (107 – 50)	1.74 – 1.44 (44 – 36)	3.74 – 2.35 (94 – 59)	2.17 – 1.33 (55 – 33)	3.89 – 1.66 (98 – 42)	—
		G	9.76 – 8.42 (247 – 213)	8.27 – 6.88 (210 – 174)	9.02 – 8.22 (229 – 208)	8.12 – 7.64 (206 – 194)	9.22 – 7.93 (234 – 201)	—
		H	4.03 – 3.47 (102 – 88)	3.41 – 2.84 (86 – 62)	5.04 – 4.59 (128 – 116)	4.53 – 4.27 (115 – 108)	5.88 – 5.06 (149 – 128)	—
	300	F	—	4.87 – 2.26 (123 – 57)	4.55 – 3.08 (115 – 78)	2.89 – 2.02 (73 – 51)	4.56 – 2.24 (115 – 56)	—
		G	—	10.30 – 8.70 (261 – 220)	9.83 – 8.96 (249 – 227)	8.84 – 8.32 (224 – 211)	9.89 – 8.51 (251 – 216)	—
		H	—	5.52 – 4.66 (140 – 118)	5.84 – 5.33 (148 – 135)	5.26 – 4.95 (133 – 125)	6.56 – 5.64 (166 – 131)	—
Stainless Steel	400	F	—	—	5.35 – 3.82 (135 – 97)	3.62 – 2.70 (91 – 68)	5.24 – 2.82 (133 – 71)	—
		G	—	—	10.63 – 9.69 (270 – 246)	9.57 – 9.01 (243 – 228)	10.57 – 9.09 (183 – 157)	—
		H	—	—	6.65 – 6.06 (168 – 153)	5.99 – 5.63 (152 – 143)	7.24 – 6.22 (183 – 157)	—
	500	F	—	—	—	—	5.91 – 3.41 (150 – 86)	—
		G	—	—	—	—	11.24 – 9.67 (285 – 245)	—
		H	—	—	—	—	7.91 – 6.80 (200 – 172)	—

Note: All levels ±0.25" (6).

B10 Standard actuating levels and liquid specific gravity with displacer arrangements 3, 4, and 5

Displacer Type	Liquid Temp. ° F	Level	0.60 – 0.64	0.65 – 0.71	0.72 – 0.73	0.74 – 0.82	0.83 – 0.92	0.93 – 1.00	1.01 – 1.07
Porcelain	100	G	2.77 – 2.01 (70 – 51)	2.63 – 1.62 (66 – 41)	2.67 – 2.51 (67 – 63)	2.58 – 1.42 (65 – 36)	3.16 – 1.94 (80 – 49)	1.82 – 1.04 (45 – 26)	1.69 – 1.23 (42 – 31)
		H	2.24 – 1.81 (56 – 45)	2.51 – 1.90 (63 – 48)	2.53 – 2.43 (64 – 61)	2.34 – 1.66 (59 – 42)	2.62 – 1.91 (66 – 48)	1.84 – 1.38 (46 – 35)	1.53 – 1.26 (38 – 32)
		J	2.01 – 1.89 (51 – 48)	1.86 – 1.70 (47 – 43)	1.68 – 1.65 (42 – 41)	1.63 – 1.47 (41 – 37)	1.45 – 1.31 (36 – 33)	1.30 – 1.21 (33 – 30)	1.02 – .097 (25 – 24)
	200	G	3.15 (80)	2.96 – 1.93 (75 – 49)	1.77 – 1.62 (44 – 41)	2.64 – 1.47 (67 – 37)	2.79 – 1.61 (70 – 40)	2.79 – 1.94 (70 – 49)	1.56 – 1.11 (39 – 28)
		H	2.69 (68)	2.57 – 1.96 965 – 49)	1.87 – 1.78 (47 – 45)	2.16 – 1.50 (54 – 38)	2.25 – 1.58 (57 – 40)	2.44 – 1.94 (61 – 49)	1.40 – 1.14 (35 – 28)
		J	2.76 (70)	2.72 – 2.49 (69 – 63)	2.45 – 2.42 (62 – 61)	2.39 – 2.15 (60 – 54)	2.13 – 1.92 (54 – 48)	1.90 – 1.77 (48 – 44)	1.58 – 1.49 (40 – 37)
	300	G	—	—	—	3.39 – 2.15 (86 – 54)	3.47 – 2.22 (88 – 56)	3.39 – 2.50 (86 – 63)	2.11 – 1.63 (53 – 41)
		H	—	—	—	2.92 – 2.18 (74 – 55)	2.93 – 2.18 (74 – 55)	3.04 – 2.50 (77 – 63)	1.95 – 1.66 (49 – 42)
		J	—	—	—	3.14 – 2.83 (79 – 71)	2.80 – 2.53 (71 – 64)	2.50 – 2.32 (63 – 58)	2.13 – 2.01 (54 – 51)
	400	G	—	—	—	—	—	—	2.67 – 2.15 (67 – 54)
		H	—	—	—	—	—	—	2.68 – 2.34 (68 – 59)
		J	—	—	—	—	—	—	2.68 – 2.53 (68 – 64)

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangements 3, 4, and 5 (cont.)

Displacer Type	Liquid Temp. ° F	Level	1.08 – 1.12	1.13 – 1.17	1.18 – 1.27	1.28 – 1.30	1.31 – 1.39	1.40 – 1.50
Porcelain	100	G	1.16 – 0.89 (29 – 22)	2.04 – 1.75 (51 – 44)	1.68 – 1.10 (42 – 27)	1.04 – 0.92 (26 – 23)	2.05 – 1.56 (52 – 39)	1.50 – 0.97 (38 – 24)
		H	1.22 – 1.06 (30 – 26)	1.78 – 1.61 (45 – 40)	1.57 – 1.23 (39 – 31)	1.19 – 1.12 (30 – 28)	1.49 – 1.21 (37 – 30)	1.18 – 0.89 (29 – 22)
		J	0.96 – 0.92 (24 – 23)	0.92 – 0.88 (23 – 22)	0.88 – 0.81 (22 – 20)	0.81 – 0.80 (20 – 20)	0.79 – 0.74 (20 – 18)	0.74 – 0.69 (18 – 17)
	200	G	1.68 – 1.38 (42 – 35)	1.31 – 1.05 (33 – 26)	1.71 – 1.13 (43 – 28)	1.75 – 1.62 (44 – 41)	1.56 – 1.09 (39 – 27)	1.53 – 1.00 (38 – 25)
		H	1.42 – 1.25 (36 – 31)	1.21 – 1.06 (30 – 26)	1.31 – 0.99 (33 – 25)	1.50 – 1.42 (38 – 36)	1.39 – 1.12 (35 – 28)	1.33 – 1.03 (33 – 26)
		J	1.48 – 1.42 (37 – 36)	1.41 – 1.36 (35 – 34)	1.35 – 1.25 (34 – 31)	1.24 – 1.23 (31 – 31)	1.22 – 1.15 (30 – 29)	1.14 – 1.06 (28 – 26)
	300	G	2.19 – 1.88 (55 – 47)	1.81 – 1.52 (45 – 38)	2.19 – 1.57 (55 – 39)	2.18 – 2.05 (50 – 37)	1.98 – 1.49 (50 – 37)	1.93 – 1.37 (49 – 34)
		H	1.93 – 1.75 (49 – 44)	1.70 – 1.53 (43 – 38)	1.79 – 1.43 (45 – 36)	1.93 – 1.85 (49 – 46)	1.81 – 1.52 (45 – 38)	1.73 – 1.40 (43 – 35)
		J	1.99 – 1.92 (50 – 48)	1.90 – 1.84 (48 – 46)	1.82 – 1.69 (45 – 42)	1.68 – 1.66 (42 – 42)	1.64 – 1.55 (41 – 39)	1.54 – 1.43 (39 – 36)
	400	G	2.71 – 2.38 (68 – 60)	2.30 – 2.00 (58 – 50)	2.66 – 2.01 (67 – 51)	2.62 – 2.48 (61 – 48)	2.41 – 1.90 (61 – 48)	2.33 – 1.74 (59 – 44)
		H	2.45 – 2.25 (62 – 57)	2.20 – 2.01 (55 – 51)	2.26 – 1.87 (57 – 47)	2.37 – 2.28 (60 – 57)	2.24 – 1.92 (56 – 23)	2.13 – 1.77 (54 – 44)
		J	2.51 – 2.42 (63 – 61)	2.40 – 2.32 (60 – 58)	2.30 – 2.13 (58 – 54)	2.12 – 2.08 (53 – 52)	2.07 – 1.95 (52 – 49)	1.94 – 1.81 (49 – 45)
	500	G	3.23 – 2.88 (82 – 73)	2.80 – 2.48 (71 – 62)	3.13 – 2.45 (79 – 62)	3.05 – 2.91 (77 – 73)	2.84 – 2.30 (72 – 58)	2.73 – 2.11 (69 – 53)
		H	2.97 – 2.75 (75 – 69)	2.69 – 2.49 (68 – 63)	2.73 – 2.31 (69 – 58)	2.80 – 2.71 (71 – 68)	2.67 – 2.33 (67 – 59)	2.53 – 2.15 (64 – 54)
		J	3.03 – 2.92 (76 – 74)	2.89 – 2.79 (73 – 70)	2.77 – 2.57 (70 – 65)	2.55 – 2.51 (64 – 63)	2.50 – 2.35 (63 – 59)	2.33 – 2.18 (59 – 55)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangements 3, 4, and 5

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel and Karbate	100	G	3.77 – 1.60 (95 – 40)	4.10 – 1.38 (104 – 35)	4.43 – 2.97 (112 – 75)	4.58 – 3.60 (24 – 91)	3.42 – 1.26 (86 – 31)	1.13 – 0.88 (28 – 22)
		H	3.46 – 2.16 (87 – 54)	3.72 – 2.08 (94 – 52)	3.96 – 3.07 (100 – 77)	3.63 – 3.07 (92 – 77)	2.96 – 1.71 ((75 – 43)	1.45 – 1.31 (36 – 33)
		J	2.51 – 2.16 (63 – 54)	2.13 – 1.77 (54 – 44)	1.74 – 1.59 (44 – 40)	1.57 – 1.48 (39 – 37)	1.46 – 1.25 (37 – 31)	1.24 – 1.22 (31 – 30)
	200	G	4.22 – 1.98 (107 – 50)	1.74 – 1.44 (44 – 36)	3.74 – 2.35 (94 – 59)	2.17 – 1.33 (55 – 33)	3.89 – 1.66 (98 – 42)	—
		H	3.76 – 2.42 (95 – 61)	2.27 – 1.89 (57 – 48)	3.02 – 2.22 (76 – 56)	2.12 – 1.64 (53 – 41)	3.22 – 1.93 (81 – 49)	—
		J	3.67 – 3.16 (93 – 80)	3.11 – 2.58 (78 – 65)	2.55 – 2.32 (64 – 58)	2.29 – 2.16 (58 – 54)	2.13 – 1.84 (54 – 46)	—
	300	G	—	4.87 – 2.26 (123 – 57)	4.55 – 3.08 (115 – 78)	2.89 – 2.02 (73 – 51)	4.56 – 2.24 (115 – 56)	—
		H	—	4.30 – 2.70 (109 – 68)	3.83 – 2.96 (97 – 75)	2.84 – 2.32 (72 – 58)	3.89 – 2.51 (98 – 63)	—
		J	—	4.03 – 3.40 (102 – 86)	3.36 – 3.06 (85 – 77)	3.02 – 2.84 (76 – 72)	2.81 – 2.42 (71 – 61)	—
Stainless Steel	400	G	—	—	5.35 – 3.82 (135 – 97)	3.62 – 2.70 (91 – 68)	5.24 – 2.82 (133 – 71)	—
		H	—	—	4.63 – 3.69 (117 – 93)	3.57 – 3.01 (90 – 76)	4.57 – 3.09 (116 – 78)	—
		J	—	—	4.16 – 3.79 (105 – 96)	3.75 – 3.53 (95 – 89)	3.48 – 3.00 (88 – 76)	—
	500	G	—	—	—	—	5.91 – 3.41 (150 – 86)	—
		H	—	—	—	—	5.24 – 3.67 (133 – 93)	—
		J	—	—	—	—	4.16 – 3.58 (105 – 90)	—

Note: All levels ±0.25" (6).

4.3.7 Model B15 Dimensional Data

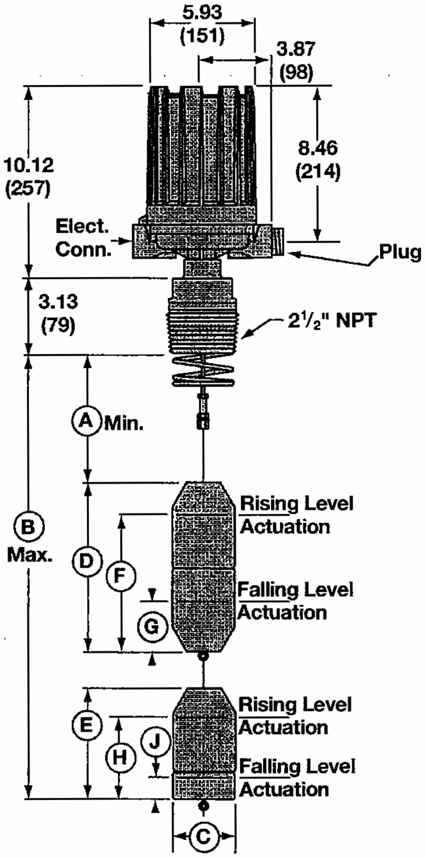
Inches (mm)

Model B15

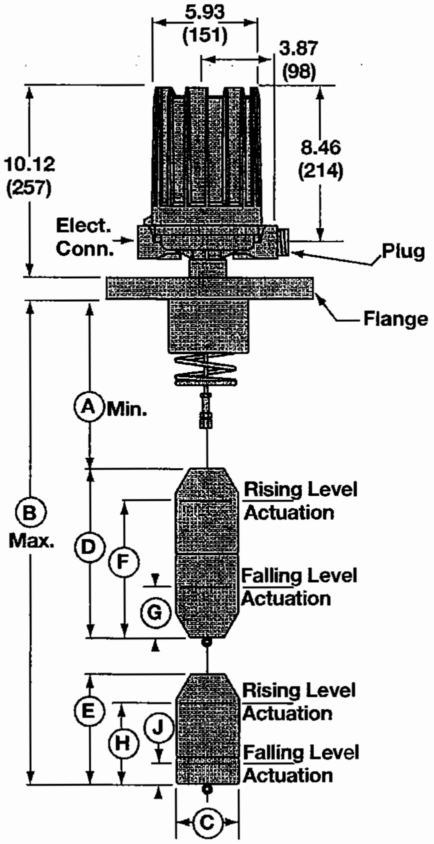
Displacer Type	Outline Dimensions			
	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	5.50 (139)	123.00 (3124)	7.50 (190)	125.00 (3175)
Stainless Steel or Karbate	5.88 (149)	123.00 (3124)	7.88 (200)	125.00 (3175)

Displacer Type	C	D	E
Porcelain	2.56 (65)	7.25 (184)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	10.50 (266)	6.00 (152)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



Model B15
with Threaded Mounting



Model B15
with Flanged Mounting

4.3.8 Model B15 Actuating Levels

Inches (mm)

B15 Standard actuating levels and liquid specific gravity

Displacer Type	Liquid Temp. °F	0.70				0.80			
		F	G	H	J	F	G	H	J
Stainless Steel or Karbate	100	9.50 (241)	5.00 (127)	4.90 (124)	1.30 (33)	7.60 (193)	3.70 (93)	4.30 (109)	1.10 (27)
	200	—	—	—	—	8.20 (208)	4.30 (109)	5.00 (127)	1.80 (45)

Displacer Type	Liquid Temp. °F	0.95				1.00			
		F	G	H	J	F	G	H	J
Porcelain	100	5.50 (139)	2.00 (50)	3.70 (93)	1.00 (25)	5.00 (127)	1.70 (43)	3.50 (88)	0.80 (20)
Stainless Steel	100	5.50 (139)	2.00 (50)	3.70 (93)	1.00 (25)	4.90 (124)	1.70 (43)	3.40 (86)	0.90 (22)
	200	6.00 (152)	2.70 (68)	4.20 (106)	1.50 (38)	5.40 (137)	2.20 (55)	4.00 (101)	1.50 (38)
	300	6.40 (162)	3.10 (78)	4.70 (119)	2.00 (50)	5.70 (144)	2.50 (63)	4.40 (111)	1.90 (48)
	400	—	—	—	—	6.10 (154)	2.90 (73)	4.90 (124)	2.40 (60)
Karbate	100	5.50 (139)	2.00 (50)	3.70 (93)	1.00 (25)	4.90 (124)	1.70 (43)	3.40 (86)	0.90 (22)
	200	6.00 (152)	2.70 (68)	4.20 (106)	1.50 (38)	5.40 (137)	2.20 (55)	4.00 (101)	1.50 (38)
	300	6.40 (162)	3.10 (78)	4.70 (119)	2.00 (50)	5.70 (144)	2.50 (63)	4.40 (111)	1.90 (48)

Note: All levels ±0.25" (6).

4.3.9 Model C10 Dimensional Data

Inches (mm)

Model C10 with all displacer arrangements

Displacer Type	Outline Dimensions			
	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	6.38 (965)	123.00 (3124)	8.38 (212)	125.00 (3175)
Stainless Steel or Karbate	5.75 (146)	123.00 (3124)	7.75 (196)	125.00 (3175)

Model C10 with displacer arrangements A, B, and C

Displacer Type	C	D	E	F	G
Porcelain	2.56 (65)	6.42 (163)	5.02 (127)	5.02 (127)	3.62 (91)
Stainless Steel or Karbate	2.50 (63)	6.00 (152)	6.00 (152)	4.50 (114)	4.50 (114)

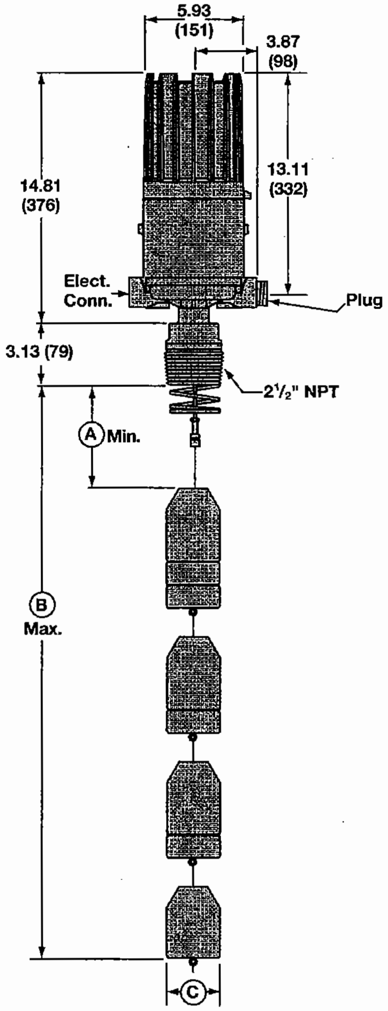
Model C10 with displacer arrangements D and F

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	14.44 (367)	5.02 (127)	3.62 (91)
Stainless Steel or Karbate	2.50 (63)	12.00 (304)	4.50 (114)	4.50 (114)

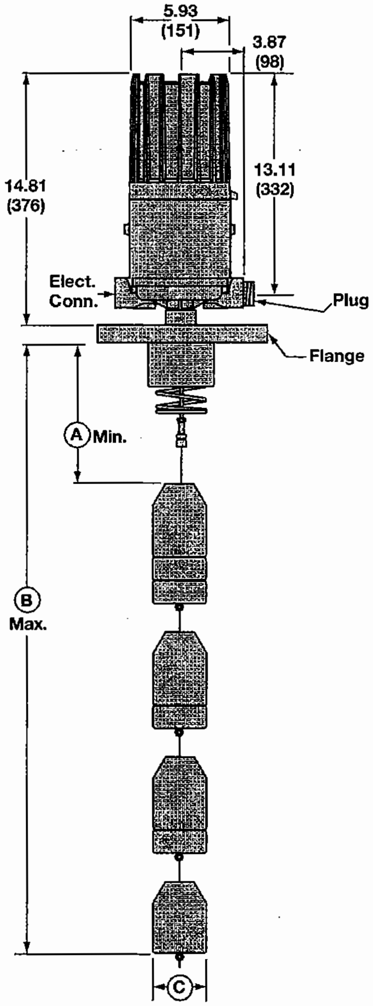
Model C10 with displacer arrangements E and G

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	6.42 (153)	5.02 (127)	8.65 (219)
Stainless Steel or Karbate	2.50 (63)	6.00 (152)	6.00 (152)	9.00 (228)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



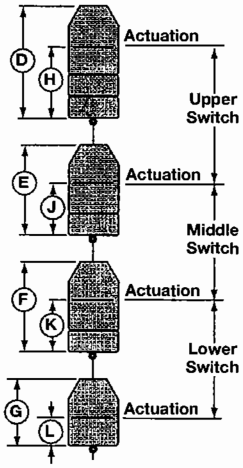
Model C10
with Threaded Mounting



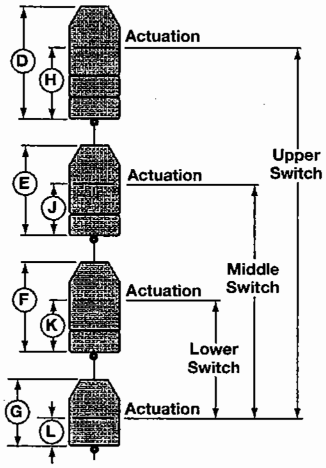
Model C10
with Flanged Mounting

4.3.10 Model C10 Actuating Levels

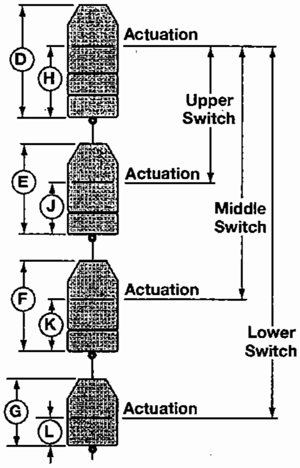
Inches (mm)



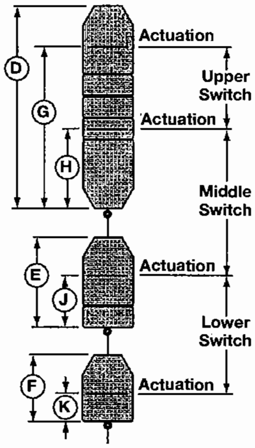
Model C10
Displacer Arrangement A



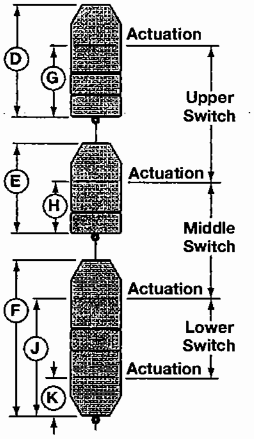
Model C10
Displacer Arrangement B



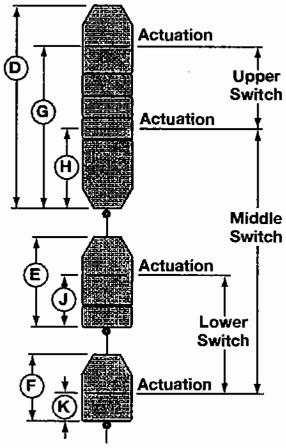
Model C10
Displacer Arrangement C



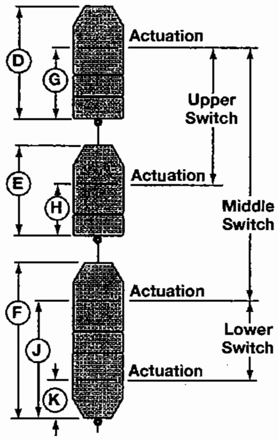
Model C10
Displacer Arrangement D



Model C10
Displacer Arrangement E



Model C10
Displacer Arrangement F



Model C10
Displacer Arrangement G

4.3.10 Model C10 Actuating Levels (cont.)

Inches (mm)

C10 Standard actuating levels and liquid specific gravity with displacer arrangements A, B, and C

Displacer Type	Liquid Temp. ° F	0.58				0.60				0.70				0.80			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	—	—	—	—	—	—	—	—	2.50 (63)	2.20 (55)	2.20 (55)	2.00 (50)	2.30 (58)	2.00 (50)	1.90 (48)	1.70 (43)
Stainless Steel or Karbate	100	4.50 (114)	3.70 (93)	3.20 (81)	2.30 (58)	3.80 (96)	3.20 (81)	3.00 (76)	2.20 (55)	4.20 (106)	3.80 (96)	2.10 (53)	1.90 (48)	1.80 (45)	2.20 (55)	1.30 (33)	1.70 (43)
	200	—	—	—	—	—	—	—	—	—	—	—	—	3.20 (81)	2.90 (73)	2.50 (63)	2.30 (58)

Displacer Type	Liquid Temp. ° F	0.90				1.00				1.10				1.20			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	3.0 (76)	2.4 (61)	2.7 (69)	1.5 (38)	1.4 (36)	1.4 (36)	2.1 (53)	1.4 (36)	3.0 (76)	2.6 (66)	2.5 (64)	1.2 (30)	1.7 (43)	1.7 (43)	2.1 (53)	1.1 (28)
	200	—	—	—	—	3.2 (81)	2.7 (69)	2.8 (71)	1.7 (43)	1.7 (43)	1.7 (43)	2.3 (58)	1.6 (41)	—	—	—	—
Stainless Steel or Karbate	100	3.1 (79)	3.2 (81)	2.5 (64)	1.5 (38)	1.3 (33)	1.9 (48)	1.8 (46)	1.3 (33)	3.1 (79)	3.2 (81)	2.5 (64)	1.3 (33)	1.6 (41)	2.2 (56)	1.9 (48)	1.2 (30)
	200	3.6 (91)	3.6 (91)	1.7 (43)	2.0 (51)	1.7 (43)	2.3 (58)	1.1 (28)	1.8 (46)	—	—	—	—	—	—	—	—
	300	3.4 (86)	3.0 (76)	2.4 (61)	2.7 (69)	1.6 (41)	1.8 (46)	1.7 (43)	2.4 (61)	—	—	—	—	—	—	—	—

C10 Standard actuating levels and liquid specific gravity with displacer arrangements D and F

Displacer Type	Liquid Temp. ° F	0.58				0.60				0.70				0.80			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	—	—	—	—	—	—	—	—	7.50 (190)	2.60 (66)	2.20 (55)	2.00 (50)	6.90 (175)	2.40 (60)	1.90 (48)	1.70 (43)
Stainless Steel or Karbate	100	9.90 (251)	3.70 (93)	3.20 (81)	2.30 (58)	9.20 (233)	3.20 (81)	3.00 (76)	2.20 (55)	8.90 (226)	3.80 (96)	2.10 (53)	1.90 (48)	6.70 (170)	2.20 (55)	1.30 (33)	1.70 (43)
	200	—	—	—	—	—	—	—	—	—	—	—	—	7.40 (187)	2.90 (73)	2.50 (63)	2.30 (58)

Displacer Type	Liquid Temp. ° F	0.90				1.00				1.10				1.20			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	6.60 (167)	2.80 (71)	2.70 (68)	1.50 (38)	5.20 (132)	1.80 (45)	2.10 (53)	1.40 (35)	6.10 (154)	3.00 (76)	2.50 (63)	1.20 (30)	5.00 (127)	2.10 (53)	2.10 (53)	1.10 (27)
	200	—	—	—	—	6.20 (157)	3.10 (78)	2.80 (71)	1.70 (43)	5.20 (132)	2.10 (53)	2.30 (58)	1.60 (40)	—	—	—	—
Stainless Steel or Karbate	100	7.20 (182)	3.20 (81)	2.50 (63)	1.50 (38)	5.50 (139)	1.90 (48)	1.80 (45)	1.30 (33)	6.40 (162)	3.20 (81)	2.50 (63)	1.30 (33)	5.20 (132)	2.20 (55)	1.90 (48)	1.20 (30)
	200	7.60 (193)	3.60 (91)	1.70 (43)	2.00 (50)	5.90 (149)	2.30 (58)	1.10 (27)	1.80 (45)	—	—	—	—	—	—	—	—
	300	7.00 (177)	3.00 (76)	2.40 (60)	2.70 (68)	5.40 (137)	1.80 (45)	1.70 (43)	2.40 (60)	—	—	—	—	—	—	—	—

Note: All levels ±0.25" (6).

4.3.10 Model C10 Actuating Levels (cont.)

Inches (mm)

C10 Standard actuating levels and liquid specific gravity with displacer arrangements E and G

Displacer Type	Liquid Temp. ° F	0.58				0.60				0.70				0.80			
		H	**J**	**K**	**L**	**H**	**J**	**K**	**L**	**H**	**J**	**K**	**L**	**H**	**J**	**K**	**L**
Porcelain	100	—	—	—	—	—	—	—	—	2.50 (63)	2.20 (55)	5.80 (147)	1.90 (48)	2.30 (58)	2.00 (50)	5.50 (139)	2.10 (53)
Stainless Steel or Karbate	100	4.50 (114)	3.70 (93)	7.70 (195)	2.80 (71)	3.80 (96)	3.20 (81)	7.50 (190)	2.70 (68)	4.20 (106)	3.80 (96)	6.60 (167)	2.50 (63)	1.80 (45)	2.20 (55)	5.80 (147)	2.20 (55)
	200	—	—	—	—	—	—	—	—	—	—	—	—	3.20 (81)	2.90 (73)	7.00 (177)	3.40 (86)

Displacer Type	Liquid Temp. ° F	0.90				1.00				1.10				1.20			
		H	**J**	**K**	**L**	**H**	**J**	**K**	**L**	**H**	**J**	**K**	**L**	**H**	**J**	**K**	**L**
Porcelain	100	3.00 (76)	2.40 (60)	6.30 (160)	3.20 (81)	1.40 (35)	1.40 (35)	5.70 (144)	1.90 (48)	3.00 (76)	2.60 (66)	6.10 (154)	3.60 (91)	1.70 (43)	1.70 (43)	5.70 (144)	3.40 (86)
	200	—	—	—	—	3.20 (81)	2.70 (68)	6.40 (162)	3.60 (91)	1.70 (43)	1.70 (43)	5.90 (149)	3.40 (86)	—	—	—	—
Stainless Steel or Karbate	100	3.10 (78)	3.20 (81)	7.00 (177)	3.80 (96)	1.30 (33)	1.90 (48)	6.30 (160)	3.40 (86)	3.10 (78)	3.20 (81)	7.00 (177)	4.40 (111)	1.60 (40)	2.20 (55)	6.40 (162)	4.00 (101)
	200	3.60 (91)	3.60 (91)	6.20 (157)	3.00 (76)	1.70 (43)	2.30 (58)	5.60 (142)	2.70 (68)	—	—	—	—	—	—	—	—
	300	3.40 (86)	3.00 (76)	6.90 (175)	3.70 (93)	1.60 (40)	1.80 (45)	6.20 (157)	3.30 (83)	—	—	—	—	—	—	—	—

Note: All levels ±0.25" (6).

4.3.11 Model C15 Dimensional Data

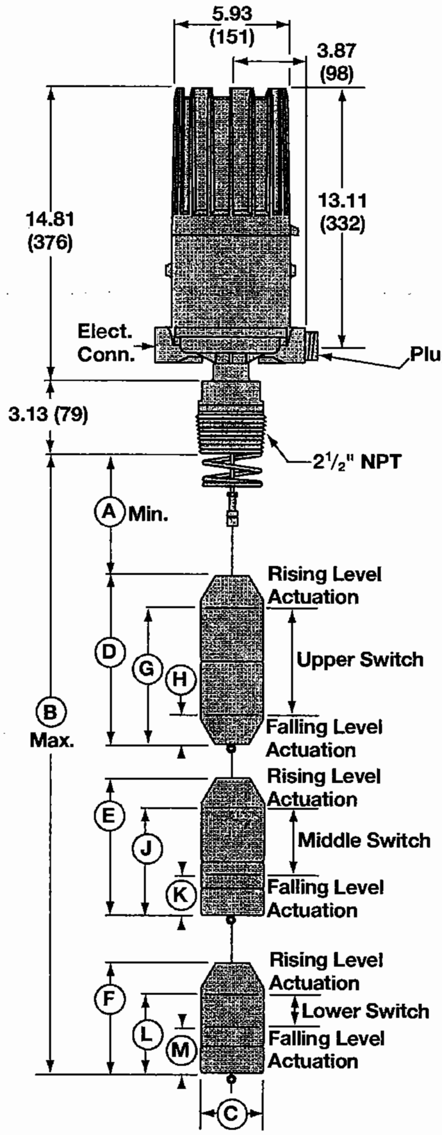
Inches (mm)

Model C15

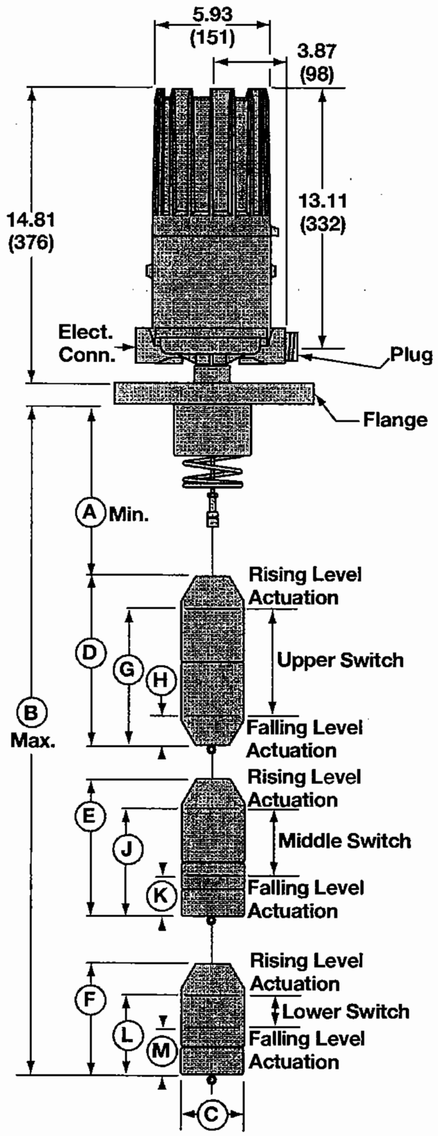
OUTLINE DIMENSIONS				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	7.75 (196)	125.00 (3175)	9.75 (247)	127.00 (3225)
Stainless Steel or Karbate	7.25 (184)	124.00 (3149)	9.25 (234)	126.00 (3200)

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	7.25 (184)	6.42 (163)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	9.00 (228)	7.50 (190)	6.00 (152)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



Model C15
with Threaded Mounting



Model C15
with Flanged Mounting

4.3.12 Model C15 Actuating Levels

Inches (mm)

C15 Standard actuating levels and liquid specific gravity

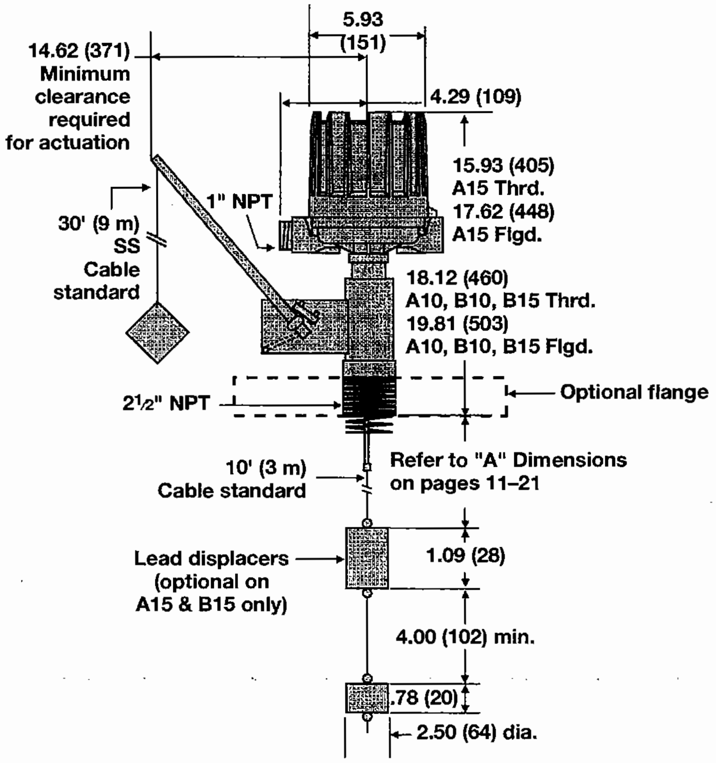
Displacer Type	Liquid Temp. °F	0.65						0.70						0.80					
		G	H	J	K	L	M	G	H	J	K	L	M	G	H	J	K	L	M
Porcelain	0 to +130	—	—	—	—	—	—	—	—	—	—	—	—	6.20 (157)	1.40 (35)	5.30 (134)	1.00 (25)	3.80 (96)	0.90 (22)
Stainless Steel or Karbate	0 to +130	7.70 (195)	2.20 (55)	6.10 (154)	2.00 (50)	4.90 (124)	1.40 (35)	6.70 (170)	1.60 (40)	5.50 (139)	1.60 (40)	4.60 (116)	1.30 (33)	6.50 (165)	2.00 (50)	5.20 (132)	1.60 (40)	4.30 (109)	1.10 (27)

Displacer Type	Liquid Temp. °F	0.90						1.00						1.10					
		G	H	J	K	L	M	G	H	J	K	L	M	G	H	J	K	L	M
Porcelain	0 to +130	6.20 (157)	1.90 (48)	5.00 (127)	1.40 (35)	3.60 (91)	1.00 (25)	4.60 (116)	0.70 (17)	4.00 (101)	0.80 (20)	3.30 (83)	0.90 (22)	4.20 (106)	1.10 (27)	3.80 (96)	1.00 (25)	3.10 (78)	0.90 (22)
Stainless Steel or Karbate	0 to +130	6.60 (167)	2.60 (66)	5.20 (132)	1.80 (45)	4.00 (101)	1.20 (30)	4.60 (116)	1.00 (25)	4.00 (101)	1.00 (25)	3.60 (91)	1.10 (27)	—	—	—	—	—	—

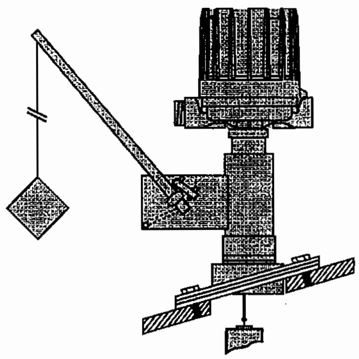
Displacer Type	Liquid Temp. °F	1.20						1.25					
		G	H	J	K	L	M	G	H	J	K	L	M
Porcelain	0 to +130	4.50 (114)	1.60 (40)	3.70 (93)	1.10 (27)	2.90 (73)	0.90 (22)	3.90 (99)	1.10 (27)	3.30 (83)	0.90 (22)	2.80 (71)	0.80 (20)

4.3.13 Proof-er Dimensional Data

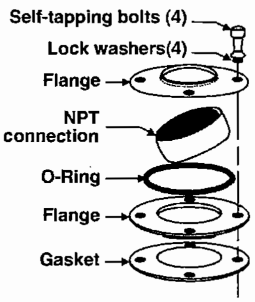
Inches (mm)



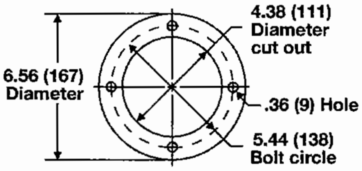
TYPICAL PROOF-ER INSTALLATION WITH VERSA FLANGE



VERSA FLANGE ASSEMBLY
PART NUMBER 089-5207-001

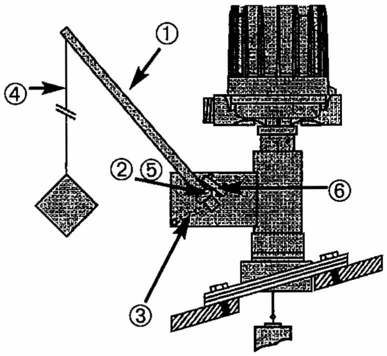


VERSA FLANGE BOLT CIRCLE



4.3.14 Proof-er Replacement Parts

		Proof-er Replacement Part Number	
Item	**Description**	**Low Pressure**	**Medium Pressure**
1	Handle	004-4011-001	004-0490-001
2	O-Ring	Not Required	012-2205-001
3	Spring	018-2502-001	
4	Cable Assembly	089-5807-001	
5	O-Ring Cover	Not Required	004-0489-001
6	Nut	010-2107-004	Not Required



[illegible]

Item No.	Description		A10	A15	B10/B15	C10/C15
1	Enclosing Tube	Standard	Z32-6325-007	Z32-6325-001	Z32-6325-007	Z32-6301-029
		316 SS	Z32-6325-008	Z32-6325-002	Z32-6325-008	Z32-6302-029
2	E-Tube Gasket		012-1301-002			
3	Spring and Stem Kit ①	Standard	089-5327-001	089-5325-001	Consult Factory	
		316 SS	089-5328-001	089-5326-001	Consult Factory	
4	Body Bushing		089-6707-001			
5	Flange and Spring Protector		Specify size and rating. Furnish serial number of control.			

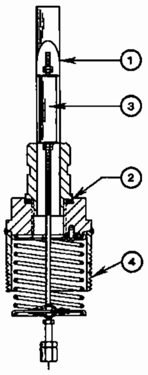
① 316 SS Spring and Stem Kit includes 316 SS sheathed magnetic sleeve.

4.4.1 Displacer Replacement Parts

Displacer Material		A10	A15	B10	B15	C10	C15
Porcelain②		089-6141-001	089-6142-001	089-6143-001	089-6144-001	089-6153-001	089-6156-001
Karbate②		089-6145-001	089-6146-001	089-6147-001	089-6148-001	089-6154-001	089-6157-001
Stainless Steel②		089-6149-001	089-6150-001	089-6151-001	089-6152-001	089-6155-001	089-6158-001
10 feet (3m) Cable	316 SS	089-5802-003③					
with Displacer	Hastelloy	089-5803-003③					
Clamps only	Monel	089-5804-003③					

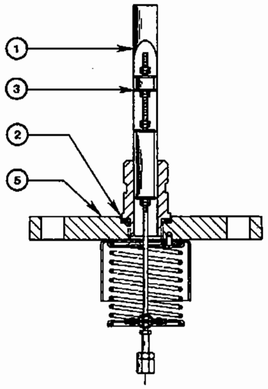
② Kits contain 10 feet (3m) 316 SS cable.
③ For Model C10 with operating sequences A, B, or C order kits:
89-5802-004 (316 SS), 89-5803-004 (Hastelloy), or 89-5804-004 (Monel).

NOTE: Refer to pages 11, 12, 13, 21, 23 & 27 for dimensional specifications of displacers.



Threaded Connection Model
(Typical Single Switch Model)

Flanged Connection Model
(Typical Dual Switch Model)



CAUTION: Location of magnetic sleeve must be maintained for proper switch actuation. DO NOT attempt to alter differential of control by repositioning jam nuts.

4.5.1 A10 & A15 Single Switch Models

PART NUMBER CODE AND SPECIFIC GRAVITY LIMITS*

Part Number Code	Description	Liquid Temp.		Series A thru E, J and K Switches		
		° F	° C	Porcelain	Stainless Steel	Karbate
A10①	Wide Differential, 1 switch	100	38	0.60 to 1.20	0.60 to 1.20	0.60 to 1.20
		200	93	0.70 to 1.20	0.70 to 1.20	0.70 to 1.20
		300	149	0.80 to 1.20	0.80 to 1.20	0.80 to 1.20
		400	204	1.00 to 1.20	0.90 to 1.20	—
		500	260	1.10 to 1.20	1.00 to 1.20	—
A15	Narrow Differential, 1 switch	100	38	0.60 to 2.40	0.40 to 1.65	0.40 to 1.65
		200	93	0.62 to 2.40	0.40 to 1.65	0.45 to 1.65
		300	149	0.65 to 2.40	0.50 to 1.65	0.50 to 1.65
		400	204	0.70 to 2.40	0.55 to 1.65	—
		500	260	0.75 to 2.40	0.60 to 1.65	—

MATERIALS OF CONSTRUCTION

Code	Support Spring	Trim	E-Tube Mtg. Nut	Displacer Clamps/ Susp. Cable	Magnetic Sleeve	Process Connection
1	Inconel 600	300 Series SS	Carbon Steel	316 SS	400 Series SS	Carbon Steel ⑩
2 ①	Inconel 600	316 SS	316 SS	316 SS	316 SS	Carbon Steel⑩
4 ①						316 SS
5 ①	Inconel 600	300 Series SS	Carbon Steel	Monel	400 Series SS	Carbon Steel⑩
6 ①				Hastelloy		
M ①② NACE Const.	Inconel X750	316 SS	316 SS	316 SS	316 SS	316 SS
N ①② NACE Const.	Inconel X750	300 Series SS	316 SS	316 SS	316 SS	Carbon Steel

TANK CONNECTION

Tank Connection	Code
2½" NPT Threaded ③	E2
3" 125 lb. Cast Iron Flange ④⑤⑥	G2
3" 150 lb. Steel Flange ⑤⑦	G3
4" 125 lb. Cast Iron Flange ④⑥	H2
4" 150 lb. Steel Flange ⑦	H3
4" 300 lb. Steel Flange ⑦	H4
6" 125 lb. Cast Iron Flange ④⑥	K2
6" 150 lb. Steel Flange ⑦	K3
6" 300 lb. Steel Flange ⑦	K4

DISPLACER MATERIAL AND PROOF-ER OPTION

Proof-er** Type	Displacer Material			Floating Roof Weight Mat'l
	Porcelain	316 SS	Karbate	Lead
Without Proof-er	A	B	C	K ④
Low Pressure ③	D ④	E ④	F ④	L ④
Medium Pressure ③	G ④	H ④	J ④	—

A 1 ☐ — ☐ ☐ ☐ ☐ — ☐ ☐ ☐

* Specific gravity limits do not apply to floating roof top units not to be used in liquid.

**Proof-er option constructed of carbon steel material.

4.5.1 A10 & A15 Single Switch Models (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE⑧ FOR MODELS A10 AND A15

Switch Description	Max.⑨ Process Temp. ° F (°C)	One Set Point	A10 Codes			A15 Codes		
			Aluminum Polymer Coated NEMA 4X/7/9 ⑩					
			Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	ATEX	Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	ATEX
Series A Mercury Switch	500 (260)	SPDT	AKB	AKK	AC9	AKQ	AKS	AA9
		DPDT	ANB	ANK	AF9	ANQ	ANS	AB9
Series B Snap Switch	250 (121)	SPDT	BKB	BKK	BC9	BKQ	BKS	BA9
		DPDT	BNB	BNK	BF9	BNQ	BNS	BB9
Series C Snap Switch	450 (232)	SPDT	CKB	CKK	CC9	CKQ	CKS	CA9
		DPDT	CNB	CNK	CF9	CNQ	CNS	CB9
Series D Snap Switch For DC Current Applications	250 (121)	SPDT	DKB	DKK	DC9	DKQ	DKS	DA9
		DPDT	DNB	DNK	DF9	DNQ	DNS	DB9
Series E Vibration Resistant Mercury Switch	500 (260)	SPDT	EKB	EKK	EC9	EKQ	EKS	EA9
		DPDT	ENB	ENK	EF9	ENQ	ENS	EB9
Series HS Hermetically Sealed Snap Switch w/Wiring Leads	500⑪ (260)	SPDT	HMJ	HMK	—	HMC	HEK⑫	—
		DPDT	HMS	HMT	—	HMF	HET⑫	—
Series HS Hermetically Sealed Snap Switch w/Terminal Block	500⑪ (260)	SPDT	HM3	HM4	HA9	HM3⑬	HM4⑬	HA9
		DPDT	HM7	HM8	HB9	HM7⑬	HM8⑬	HB9

PNEUMATIC SWITCH MECHANISM AND ENCLOSURE FOR MODELS A10 AND A15

Switch Description	Maximum Supply Pressure		Maximum⑨ Process Temperature		Bleed Orifice Diameter		A10 Codes	A15 Codes
	psig	bar	° F	° C	Inches	mm	NEMA 1	NEMA 1
Series J Bleed Type Pneumatic Switch	100	7	400	204	.063	1.6	JGF	JDE
	60	4	400	204	.094	2.3	JHF	JEE
Series K Non-Bleed Pneumatic Switch	100	7	400	204	—	—	KOF	KOE

① Not available with displacer material and proof-er option codes K, L.

② Not available with displacer material and proof-er option codes D, E, F, G, H, J, K and L.

③ Pressure/temperature ratings on page 10. Flanges are ANSI type.

④ Not available with material of construction codes M and N.

⑤ Not available with displacer material and Proof-er option codes K, L.

⑥ Not available with material of construction code 4.

⑦ 316 SS flange is provided with material of construction code 4 and M.

⑧ Consult factory for NEMA 4X/7/9 cast iron housings.

⑨ Process temperature based on +100° F (+38° C) ambient.

⑩ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosures. Consult factory for standard part numbers.

⑪ On steam applications, temperature down rated to +400° F (+204° C) process at +100° F (+38° C) ambient. Available with a 6" tall cover only.

⑫ CSA approval does not apply to these switch designations.

⑬ Available with a 6" tall cover only.

⑭ 125# flanges will be cast iron.

A 1 ☐ – ☐ ☐ ☐ ☐ – ☐ ☐ ☐

4.5.2 B10 & B15 Dual Switch Models

PART NUMBER CODE AND SPECIFIC GRAVITY LIMITS*

Part Number Code	Description	Liquid Temp.		Series A thru E, J and K Switches		
		° F	° C	Porcelain	Stainless Steel	Karbate
B10	Wide Differential, 2 switches	100	38	0.60 to 1.50	0.50 to 1.00	0.50 to 1.00
		200	93	0.64 to 1.50	0.50 to 1.00	0.50 to 1.00
		300	149	0.80 to 1.50	0.60 to 1.00	0.60 to 1.00
		400	204	1.00 to 1.50	0.72 to 1.00	—
		500	260	1.10 to 1.50	0.84 to 1.00	—
B15	Narrow Differential, 2 switches	100	38	0.95 to 1.20	0.70 to 1.20	0.70 to 1.20
		200	93	1.10 to 1.20	0.80 to 1.20	0.80 to 1.20
		300	149	—	0.90 to 1.20	0.90 to 1.20
		400	204	—	1.00 to 1.20	—
		500	260	—	1.04 to 1.20	—

MATERIALS OF CONSTRUCTION

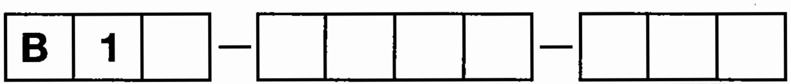
Code	Support Spring	Trim	E-Tube Mtg. Nut	Displacer Clamps/ Susp. Cable	Magnetic Sleeve	Process Connection
1	Inconel 600	300 Series SS	Carbon Steel	316 SS	400 Series SS	Carbon Steel ⑬
2 ①	Inconel 600	316 SS	316 SS	316 SS	316 SS	Carbon Steel ⑬
4 ①						316 SS
5 ①	Inconel 600	300 Series SS	Carbon Steel	Monel	400 Series SS	Carbon Steel ⑬
6 ①				Hastelloy		
M ①② NACE Const.	Inconel X750	316 SS	316 SS	316 SS	316 SS	316 SS
N ①② NACE Const.	Inconel X750	300 Series SS	316 SS	316 SS	316 SS	Carbon Steel

TANK CONNECTION

Tank Connection	Code
2½" NPT Threaded ③	E2
3" 125 lb. Cast Iron Flange ④⑤⑥	G2
3" 150 lb. Steel Flange ⑤⑦	G3
4" 125 lb. Cast Iron Flange ④⑥	H2
4" 150 lb. Steel Flange ⑦	H3
4" 300 lb. Steel Flange ⑦	H4
6" 125 lb. Cast Iron Flange ④⑥	K2
6" 150 lb. Steel Flange ⑦	K3
6" 300 lb. Steel Flange ⑦	K4

DISPLACER MATERIAL AND PROOF-ER OPTION

Proof-er** Type	Displacer Material			Floating Roof Weight Mat'l Model B15 Only
	Porcelain	316 SS	Karbate	Lead
Without Proof-er	A	B	C	K ④
Low Pressure ③	D ④	E ④	F ④	L ④



* Specific gravity limits do not apply to floating roof top units not to be used in liquid.

**Proof-er option constructed of carbon steel material.

4.5.2 B10 & B15 Dual Switch Models (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE ⑧ FOR MODELS B10 AND B15

Switch Description ⑨	Max. ⑩ Process Temp. ° F (°C)	Two Set Points	Switch Enclosure		
			NEMA 4X/7/9 ⑪		
			Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	ATEX
Series A Mercury Switch	500 (260)	SPDT	ALB	ALK	AD9
		DPDT	AOB	AOK	AG9
Series B Snap Switch	250 (121)	SPDT	BLB	BLK	BD9
		DPDT	BOB	BOK	BG9
Series C Snap Switch	450 (232)	SPDT	CLB	CLK	CD9
		DPDT	COB	COK	CG9
Series D Snap Switch For DC Current Applications	250 (121)	SPDT	DLB	DLK	DD9
		DPDT	DOB	DOK	DG9
Series E Vibration Resistant Mercury Switch	500 (260)	SPDT	ELB	ELK	ED9
		DPDT	EOB	EOK	EG9
Series HS Hermetically Sealed Snap Switch w/Wiring Leads	500 ⑫ (260)	SPDT	HMN	HMP	—
		DPDT	HMY	HMZ	—

① Not available with displacer material and proof-er option codes K, L.

② Not available with displacer material and proof-er option codes D, E, F, K and L.

③ Pressure/temperature ratings on page 10. Flanges are ANSI type.

④ Not available with material of construction codes M and N.

⑤ Not available with displacer material and Proof-er option codes K, L.

⑥ Not available with material of construction code 4.

⑦ 316 SS flange is provided with material of construction code 4 and M.

⑥ Not available with displacer material and Proof-er option codes K, L.

⑧ Consult factory for NEMA 4X/7/9 cast iron housings.

⑨ Pneumatic switch mechanisms and enclosures are unavailable for Models B10 and B15 switches.

⑩ Process temperature based on +100° F (+38° C) ambient.

⑪ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosures. Consult factory for standard part numbers.

⑫ On steam applications, temperature down rated to +400° F (+204° C) process at +100° F (+38° C) ambient.

⑬ 125# flanges will be cast iron.

B	1	☐	—	☐	☐	☐	☐	—	☐	☐	☐

4.5.3 C10 & C15 Triple Switch Models

PART NUMBER CODE AND SPECIFIC GRAVITY LIMITS**

Part Number Code	Description	Liquid Temp.		Series A thru E, J and K Switches		
		° F	° C	Porcelain	Stainless Steel	Karbate
C10	Wide Differential, 3 switches	100	38	0.65 to 1.20	0.58 to 1.20	0.58 to 1.20
		200	93	0.95 to 1.10	0.76 to 1.00	0.76 to 1.00
		300	149	—	0.82 to 1.00	0.82 to 1.00
C15*	Narrow Differential, 3 switches	130	54	0.80 to 1.25	0.65 to 1.00	0.65 to 1.00

* Consult factory for high temperatures

** Each C10/C15 instrument is factory calibrated to operate for a given specific gravity within the minimum and maximum values listed

MATERIALS OF CONSTRUCTION

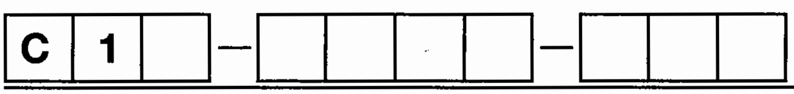
Code	Support Spring	Trim	E-Tube Mtg. Nut	Displacer Clamps/ Susp. Cable	Magnetic Sleeve	Process Connection
1	Inconel 600	300 Series SS	Carbon Steel	316 SS	400 Series SS	Carbon Steel ⑦
2 ①	Inconel 600	316 SS	316 SS	316 SS	316 SS	Carbon Steel ⑦
4 ①						316 SS
5 ①	Inconel 600	300 Series SS	Carbon Steel	Monel	400 Series SS	Carbon Steel ⑦
6 ①				Hastelloy		
M ①② NACE Const.	Inconel X750	316 SS	316 SS	316 SS	316 SS	316 SS
N ①② NACE Const.	Inconel X750	300 Series SS	316 SS	316 SS	316 SS	Carbon Steel

TANK CONNECTION

Tank Connection	Code
2½" NPT Threaded ①	E2
3" 125 lb. Cast Iron Flange ②	G2
3" 150 lb. Steel Flange ③	G3
4" 125 lb. Cast Iron Flange ②	H2
4" 150 lb. Steel Flange ③	H3
4" 300 lb. Steel Flange ③	H4
6" 125 lb. Cast Iron Flange ②	K2
6" 150 lb. Steel Flange ③	K3
6" 300 lb. Steel Flange ③	K4

DISPLACER MATERIAL

Displacer Material		
Porcelain	316 SS	Karbate
A	B	C



4.5.3 C10 & C15 Triple Switch Models (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE ⑥ FOR MODELS C10 AND C15

Switch Description ④	Maximum ⑤ Process Temp. ° F (° C)	Three Set Points	Aluminum Polymer Coated Switch Enclosure NEMA 4X/7/9			
			Class I, Div. 1, Groups C & D	Aluminum With Heater	Aluminum With Drain	Aluminum Class I, Div. 1, Group B
Series N Mercury Switch	300 (149)	SPDT	NMB	NRB	NWB	NMN
		DPDT	NKB	NLB	NNB	NKN
Series O Snap Switch	300 (149)	SPDT	OMB	Not Available	OWB	OMN
		DPDT	OKB		ONB	OKN
Series Q Snap Switch	250 (121)	SPDT	QMB	QRB	QWB	QMN
		DPDT	QKB	QLB	QNB	QKN
Series T Vibration Resistant Mercury Switch	300 (149)	SPDT	TMB	TRB	TWB	TMN
		DPDT	TKB	TLB	TNB	TKN

① Pressure/temperature ratings on page 10. Flanges are ANSI type.

② Not available with material of construction codes 4, M and N.

③ 316 SS flange is provided with material of construction code 4 and M.

④ Pneumatic switch mechanisms and enclosures are unavailable for Models C10 and C15 switches.

⑤ Process temperature based on +100° F (+38° C) ambient.

⑥ Consult factory for NEMA 4X/7/9 cast iron housings.

⑦ 125# flanges will be cast iron.

C	1		–					–				

ASSURED QUALITY & SERVICE COST LESS

Service Policy

Owners of Magnetrol controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. Magnetrol will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory, prior to the material's return. This is available through Magnetrol's local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

Magnetrol

5300 Belmont Road • Downers Grove, Illinois 60515-4499 • 630-969-4000 • Fax 630-969-9489 • www.magnetrol.com
145 Jardin Drive, Units 1 & 2 • Concord, Ontario Canada L4K 1X7 • 905-738-9600 • Fax 905-738-1306
Heikensstraat 6 • B 9240 Zele, Belgium • 052 45.11.11 • Fax 052 45.09.93
Regent Business Ctr., Jubilee Rd. • Burgess Hill, Sussex RH15 9TL U.K. • 01444-871313 • Fax 01444-871317

STI

5300 Belmont Road • Downers Grove, Illinois 60515-4499 • 630-969-4028 • Fax 630-969-9489 • www.sticontrols.com

BULLETIN: 45-610.19
EFFECTIVE: May 2006
SUPERSEDES: December 2005

Endress+Hauser FMU40 Ultrasonic Meter

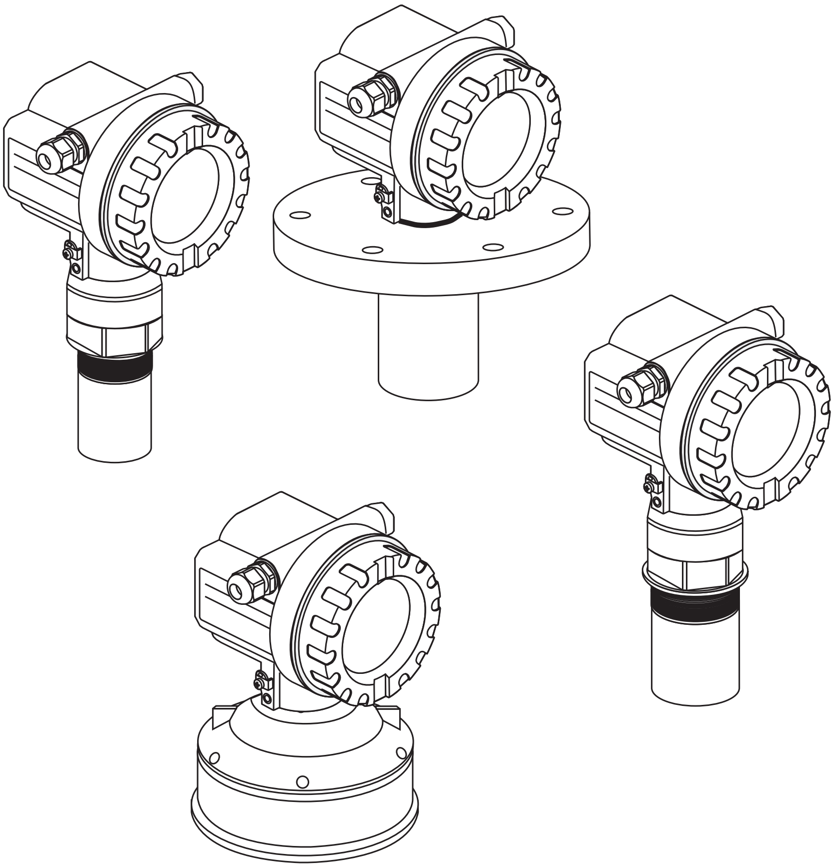
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Prosonic M FMU40/~~41/42/43~~

Ultrasonic Level Measurement

PROFI PROCESS FIELD BUS BUS®



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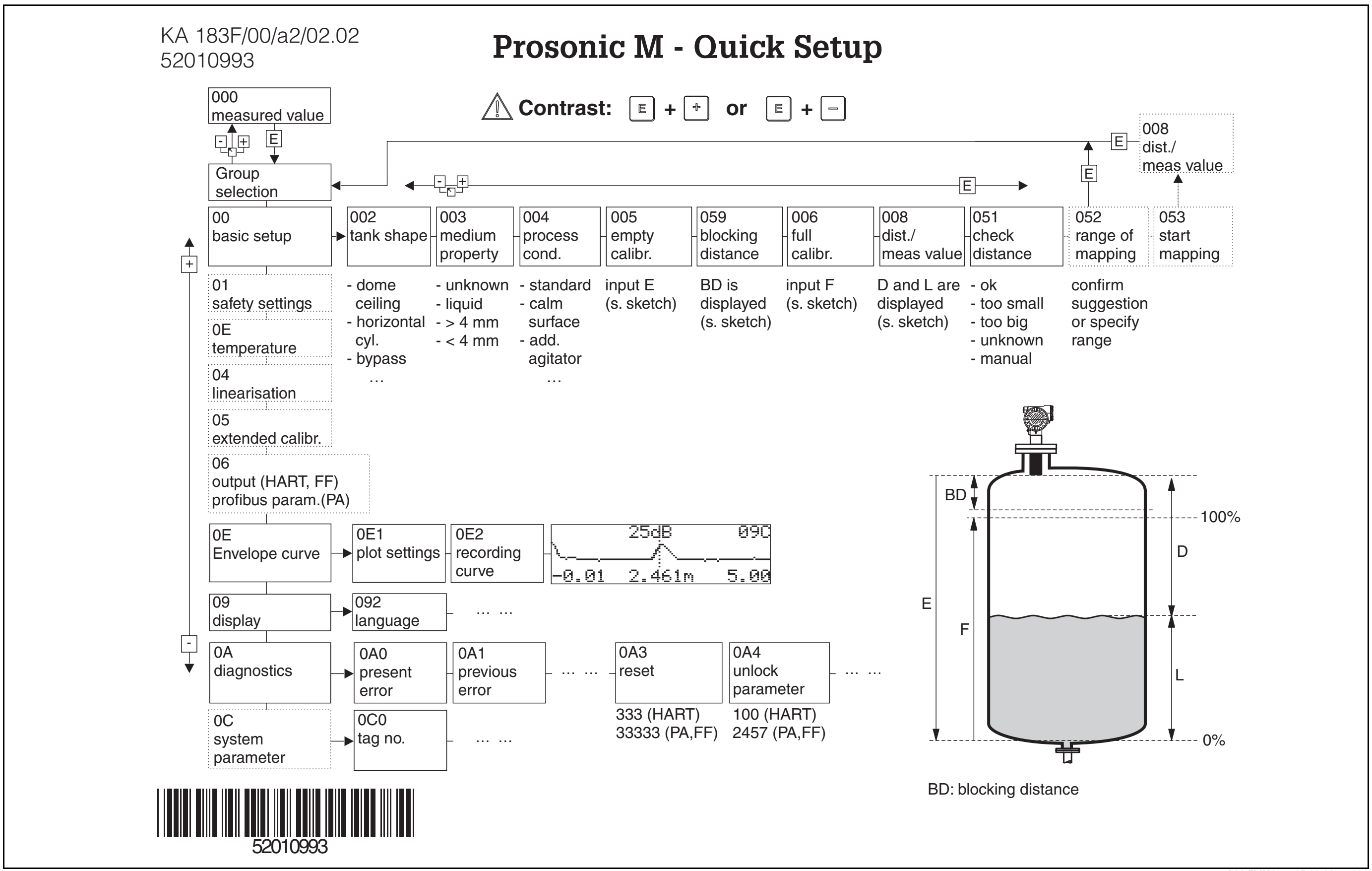
Valid as of software version:
V 01.02.00 (amplifier)
V 01.02.00 (communication)

Endress+Hauser
People for Process Automation

Short instructions



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Contents of the operating instructions

This operating instructions describes the installation and commissioning of the Prosonic M ultrasonic level transmitter. It contains all the functions required for a normal measuring operation. Also, the Prosonic M provides additional functions for optimising the measuring point and for converting the measured value. These functions are not included in this operating instructions.

You can find an **overview of all the device functions** in the Appendix.

You can find a **detailed description of all the device functions** in the operating instructions BA 240F/00/en "Prosonic M - Description of Instrument Functions". This is located on the supplied documentation CD-ROM.

Table of contents

1 Safety instructions

1.1 Designated use

The Prosonic M is a compact measuring device for continuous, non-contact level measurement. Depending on the sensor, the measuring range is up to 15 m in fluids and up to 7 m in bulk solids. By using the linearisation function, the Prosonic M can also be used for flow measurements in open channels and measuring weirs.

1.2 Installation, commissioning, operation

The Prosonic M is fail-safe and is constructed to the state-of-the-art. It meets the appropriate standards and EC directives. However, if you use it improperly or other than for its designated use, it may pose application-specific hazards, e.g. product overflow due to incorrect installation or configuration. Installation, electrical connection, start-up, operation and maintenance of the measuring device must therefore be carried out exclusively by trained specialists authorised by the system operator. Technical personnel must have read and understood these operating instructions and must adhere to them. You may only undertake modifications or repair work to the device when it is expressly permitted by the operating instructions.

1.3 Hazardous area

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local standards and regulations.

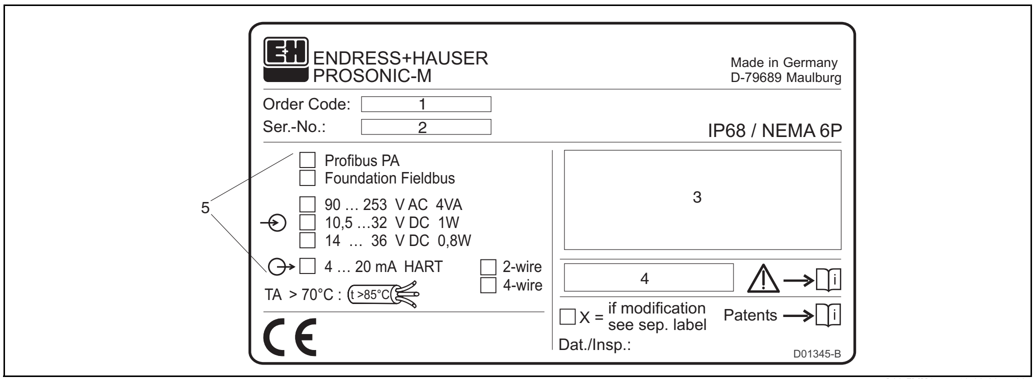
1.4 Notes on safety conventions and symbols

In order to highlight safety–relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.

Safety conventions	
⚠	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument
☝	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument
✎	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned
Explosion protection	
⬡ Ex	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its name plate it can be installed in an explosion hazardous area
△ EX	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. Devices located in and wiring entering areas with the designation “explosion hazardous areas” must conform with the stated type of protection.
~~EX~~	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas
Electrical symbols	
⎓	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied
~	**Alternating voltage** A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied
⏚	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system
⊜	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment
▽	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice
t >85°C	**Temperature resistance of the connection cables** States, that the connection cables must be resistant to a temperature of at least 85 °C.

2 Identification

2.1 Nameplate



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1: Order Code; 2: Serial number; 3: Designation according to Directive 94/9/EC and designation of the type of protection (only for certified device variants); 4: Reference to additional safety-relevant documentation (only for certified device variants); 5: Communication variant and supply voltage (the appropriate option is highlighted)

2.2 Product structure FMU 40

	Certificates	
	A	Variant for non-hazardous area
	1	ATEX II 1/2 G or II 2 G; EEX ia IIC T6
	4	ATEX II 1/2 G or II 2 G; EEX d [ia] IIC T6
	G	ATEX II 3G EEx nA II T6
	2	ATEX II 1/2D, Alu blind cover
	5	ATEX II 1/3D
	S	FM IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2
	T	FM XP Cl. I,II,III Div. 1 Gr. A-G
	U	CSA IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2
	V	CSA XP Cl. I,II,III Div. 1 Gr. A-G
	N	CSA General Purpose
	K	TIIS Ex ia II C T6
	Y	Special certificate

		Process connection	
		R	G 1½“ threadISO 228
		N	NPT 1½“ - 11,5 thread
		Y	Special version

			Power supply/communication	
			B	2 wire, 4...20mA-loop/HART
			H	4 wire, 10,5...32VDC / 4-20mA HART
			G	4 wire, 90...253VAC / 4-20mA HART
			D	2 wire, PROFIBUS PA
			F	2 wire, Foundation Fieldbus
			Y	Special version

				Display / on-site operation	
				1	Without LC display
				2	With LC display VU 331 incl. on-site operation
				3	Prepared for remote display FHX 40
				9	Special version

					Housing	
					A	Aluminium F12 housing coated to IP 68
					C	Aluminium T12 housing coated to IP 68; with separate terminal compartment
					D	Aluminium T12 housing coated to IP 68; with separate terminal compartment; with overvoltage protection
					9	Special version

						Screw union/entry	
						2	M20x1.5 screw union
						3	G 1/2“ entry
						4	NPT 1/2“ entry
						5	M12 PROFIBUS-PA plug-in connector
						6	7/8" FF plug
						9	Special version
FMU 40 -							Product designation

2.3 Product structure FMU 41

	Certificates						
	A	Variant for non-hazardous area					
	1	ATEX II 1/2 G or II 2 G; EEX ia IIC T6					
	4	ATEX II 1/2 G or II 2 G; EEX d [ia] IIC T6					
	G	ATEX II 3G EEx nA II T6					
	2	ATEX II 1/2D, Alu blind cover					
	5	ATEX II 1/3D					
	S	FM IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2					
	T	FM XP Cl. I,II,III Div. 1 Gr. A-G					
	U	CSA IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2					
	V	CSA XP Cl. I,II,III Div. 1 Gr. A-G					
	N	CSA General Purpose					
	K	TIIS Ex ia II C T6					
	Y	Special certificate					
		Process connection					
		R	G 2“ threadISO 228				
		N	NPT 2“ - 11,5 thread				
		Y	Special version				
			Power supply/communication				
			B	2 wire, 4...20mA-loop/HART			
			H	4 wire, 10,5...32VDC / 4-20mA HART			
			G	4 wire, 90...253VAC / 4-20mA HART			
			D	2 wire, PROFIBUS PA			
			F	2 wire, Foundation Fieldbus			
			Y	Special version			
				Display / on-site operation			
				1	Without LC display		
				2	With LC display VU 331 incl. on-site operation		
				3	Prepared for remote display FHX 40		
				9	Special version		
					Housing		
					A	Aluminium F12 housing coated to IP 68	
					C	Aluminium T12 housing coated to IP 68 with separate terminal compartment	
					D	Aluminium T12 housing coated to IP 68; with separate terminal compartment; with overvoltage protection	
					9	Special version	
						Screw union/entry	
						2	M20x1.5 screw union
						3	G 1/2“ entry
						4	NPT 1/2“ entry
						5	M12 PROFIBUS-PA plug-in connector
						6	7/8" FF plug
						9	Special version
FMU 41 -							Product designation

2.4 Product structure FMU 42

	Certificates
A	Variant for non-hazardous area
1	ATEX II 1/2 G EEX ia IIC T6
4	ATEX II 1/2 G EEX d [ia] IIC T6
G	ATEX II 3G EEx nA II T6 (in preparation)
S	FM IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2
T	FM XP Cl. I,II,III Div. 1 Gr. A-G
U	CSA IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2
V	CSA XP Cl. I,II,III Div. 1 Gr. A-G
N	CSA General Purpose
K	TIIS Ex ia II C T6 (in preparation)
Y	Special certificate

	Process connection
M	mounting bracket FAU20
P	DN80/ANSI 3"/JIS10K80, PP, Universal flange
Q	DN80/ANSI 3"/JIS10K80, PVDF, Universal flange
S	DN80/ANSI 3"/JIS10K80, 316L, Universal flange
T	DN100/ANSI 4"/JIS16K100, PP, Universal flange
U	DN100/ANSI 4"/JIS16K100, PVDF, Universal flange
V	DN100/ANSI 4"/JIS16K100, 316L, Universal flange
Y	Special version

	Power supply/communication
B	2 wire, 4...20mA-loop/HART
H	4 wire, 10,5...32VDC / 4-20mA HART
G	4 wire, 90...253VAC / 4-20mA HART
D	2 wire, PROFIBUS PA
F	2 wire, Foundation Fieldbus
Y	Special version

	Display / on-site operation
1	Without LC display
2	With LC display VU 331 incl. on-site operation
3	Prepared for remote display FHX 40
9	Special version

	Housing
A	Aluminium F12 housing coated to IP 68
C	Aluminium T12 housing coated to IP 68, with separate terminal compartment
D	Aluminium T 12 housing coated to IP 68, with separate terminal compartment; with overvoltage protection
Y	Special version

	Gland/Entry
2	M20x1.5 gland
3	G 1/2“ entry
4	NPT 1/2“ entry
5	M12 PROFIBUS-PA plug
6	7/8" FF plug
9	Special version

	Sealing Sensor/Flange
2	VITON flat sealing
3	EPDM flat sealing
9	special version

	Additional options
A	Additional options not selected

FMU 42 -									Product designation

2.5 Product structure FMU 43

Certificates	
A	Variant for non-hazardous area
2	ATEX II 1/2 D or II 2 D, Aluminium Deckel
5	ATEX II 1/3 D or II 3 D, Sichtdeckel
M	FM DIP Class II, III, Div. 1, Gr. E,F,G NI
N	CSA General Purpose
P	CSA DIP, Class II, III, Div. 1, Gr. E,F,G NI
Y	Special version

Process connection/material	
P	Flange DN 100/ANSI 4"/JIS 16K100, PP (universal slip-on flange included)
S	Flange DN 100/ANSI 4"/JIS 16K100, SS 316TI (universal slip-on flange included)
K	Without slip-on flange/without mounting bracket (customer mounting equipment)
M	With mounting bracket
Y	Special version

Power supply/communication	
H	4 wire, 10,5...32VDC / 4-20mA HART
G	4 wire, 90...253VAC / 4-20mA HART
D	2 wire, PROFIBUS PA
F	2 wire, Foundation Fieldbus
Y	Special version

Display / on-site operation	
1	Without LC display
2	With LC display VU 331 incl. on-site operation
3	Prepared for remote display FHX 40
9	Special version

Housing	
A	Aluminium F12 housing coated to IP 68
9	Special version

Screw union/entry	
2	M20x1.5 screw union
3	G 1/2“ entry
4	NPT 1/2“ entry
5	M12 PROFIBUS-PA plug-in connector
6	7/8" FF plug
9	Special version

FMU 43 -							Product designation

2.6 Scope of delivery

2.6.1 Instrument and accessories

- Instrument according to the version ordered
- "ToF Tool - FieldTool Package" (2 CD-ROMs)
- for FMU 40/41 in the versions FMU 40 *R**** and FMU 41 *R****: counter nut (PC)
- for FMU 40/41: sealing ring (EPDM)
- for gland M20x1.5:
  - 1 cable gland for 2-wire instruments
  - 2 cable glands for 4-wire instruments

  The cable glands are mounted on delivery.

2.6.2 Supplied documentation

Short instructions (KA 183F, in the instrument)

intended as a memory jogger for users who are familiar with the operating concept of Endress+Hauser Time-of-Flight instruments.

Operating instructions (BA 238F, this booklet)

This describes the installation and commissioning of the Prosonic M. The operating menu includes all the functions which are required for standard measurement tasks. Any additional functions are **not** included.

Description of Instrument Functions (BA 240F)

contains a detailed description of all the functions of the Prosonic M. You can find this document as a pdf file on the supplied ToF Tool - FieldTool CD-ROM 1.

Safety instructions

Additional safety instructions (XA, ZE, ZD) are supplied with certified device versions. Refer to the nameplate for the names of the safety instructions that apply to your device version.

2.7 Certificates and approvals

CE mark, declaration of conformity

The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

2.8 Registered trademarks

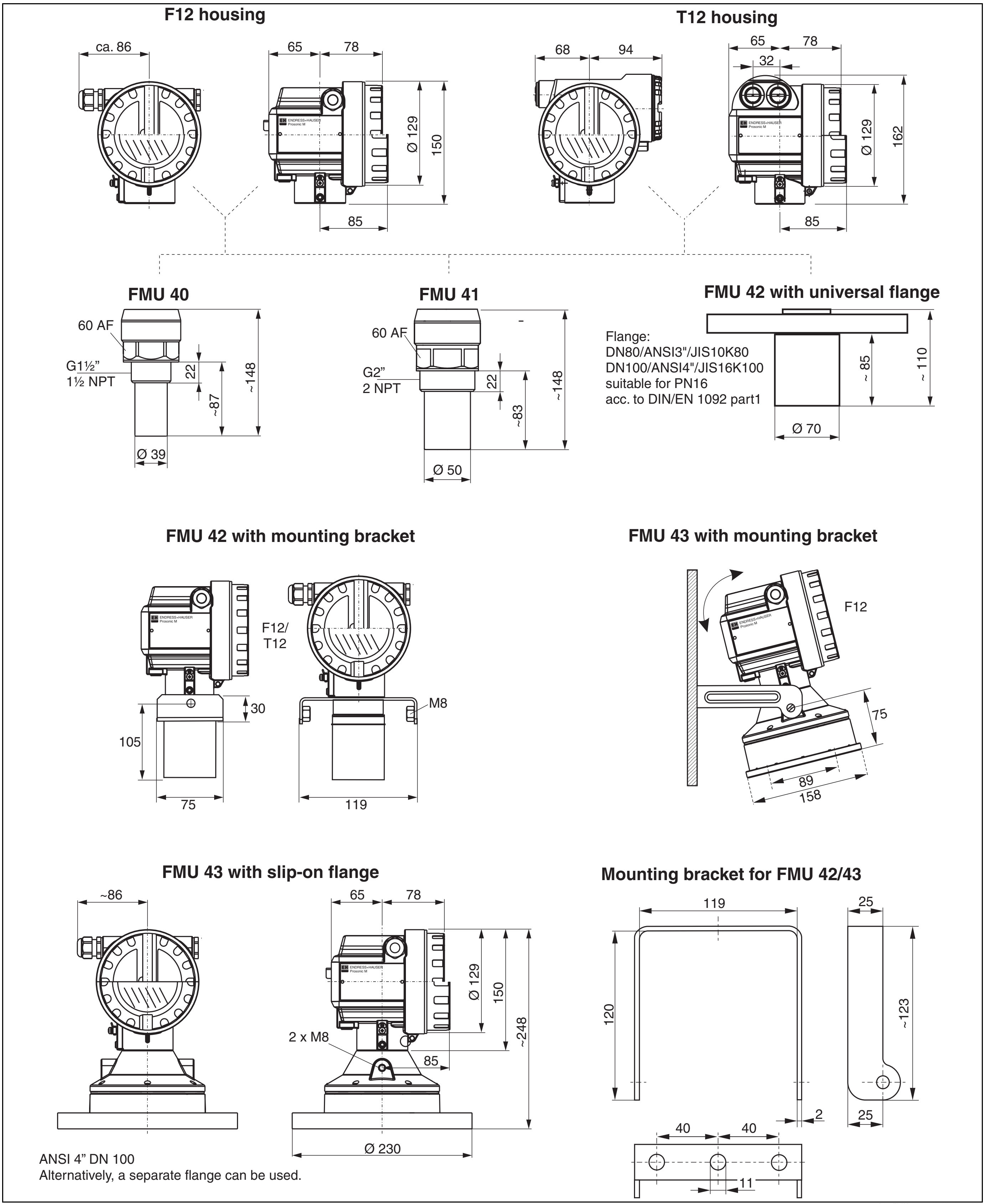
ToF®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

PulseMaster®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

PROFIBUS®
Registered trademark of the PROFIBUS Trade Organisation, Karlsruhe, Germany

3 Installation

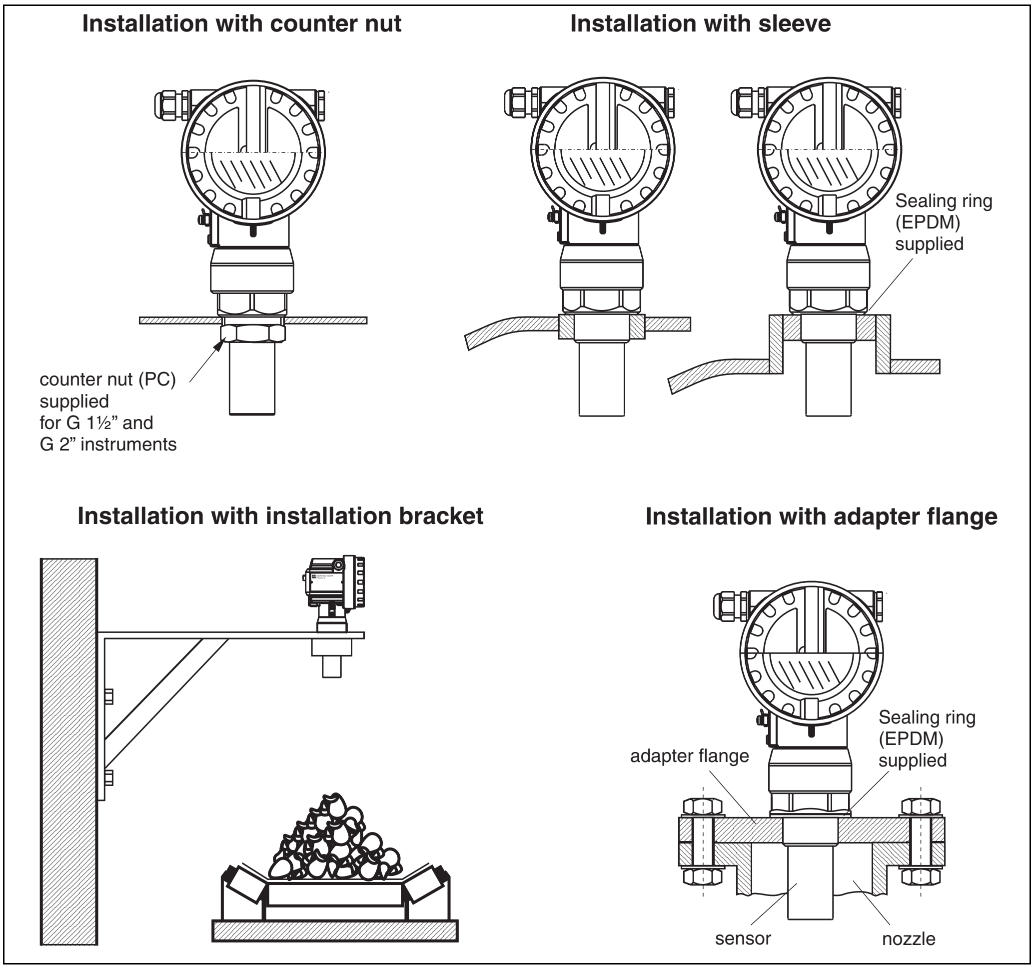
3.1 Dimensions



L00-FMU4xxxx-06-00-00-en-003

3.2 Installation variants

3.2.1 Installation variants FMU 40, FMU 41



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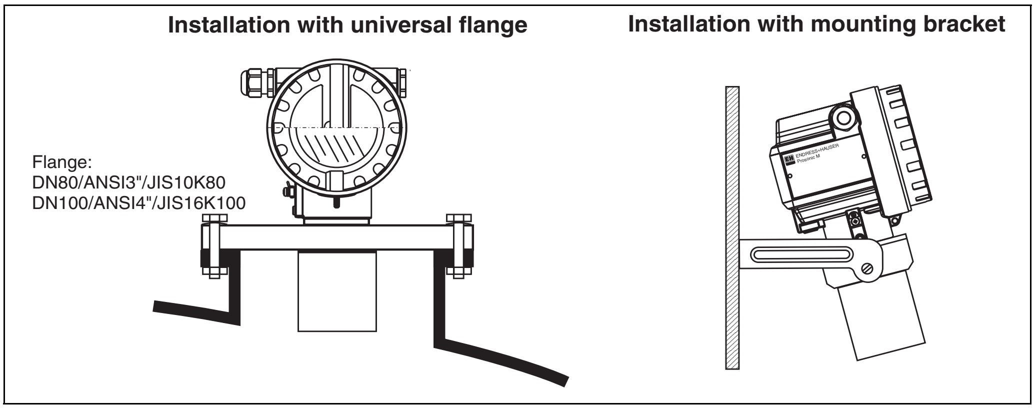
For installation bracket or adapter flange s. chapter "Accessories".

3.2.2 Installation variants FMU 42



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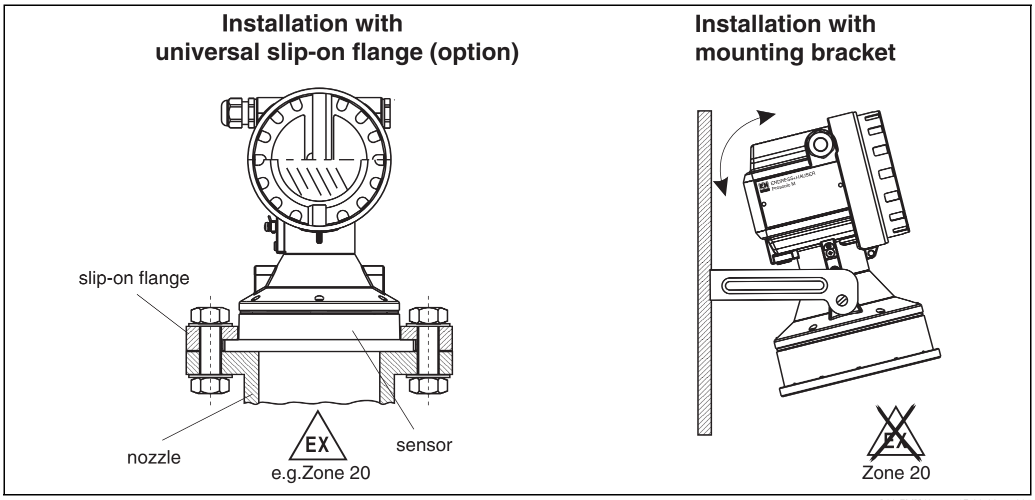
3.2.3 Installation variants FMU 43



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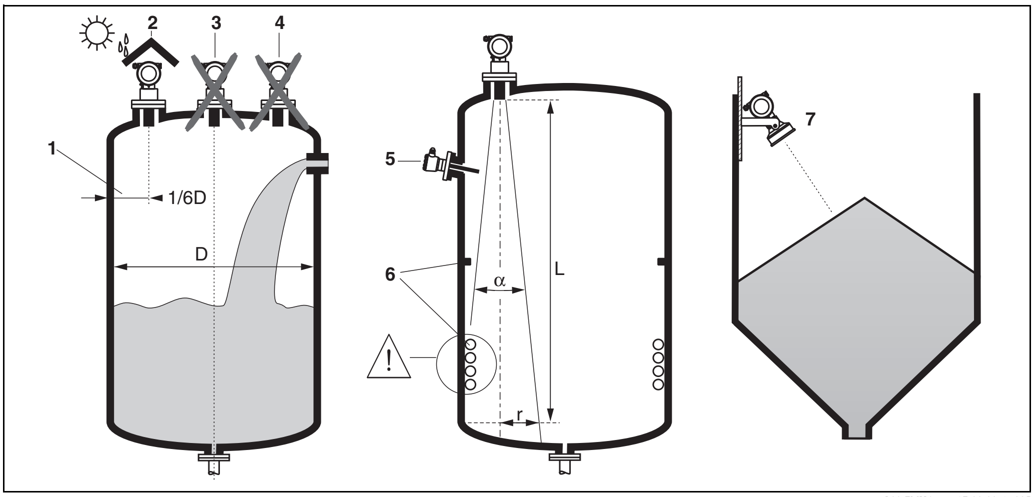
3.3 Installation conditions

3.3.1 Installation conditions for level measurements



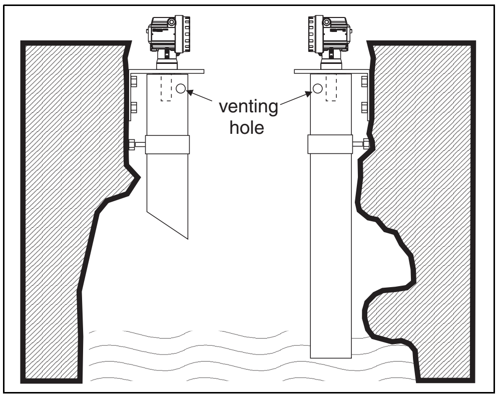
L00-FMU4xxxx-17-00-00-de-005

- Do not install the sensor in the middle of the tank (3). We recommend leaving a distance between the sensor and the tank wall (1) measuring 1/6 of the tank diameter.
- Use a protective cover, in order to protect the device from direct sun or rain (2).
- Avoid measurements through the filling curtain (4).
- Make sure that equipment (5) such as limit switches, temperature sensors, etc. are not located within the emitting angle α. In particular, symmetrical equipment (6) such as heating coils, baffles etc. can influence measurement.
- Align the sensor so that it is vertical to the product surface (7).
- Never install two ultrasonic measuring devices in a tank, as the two signals may affect each other.
- To estimate the detection range, use the 3 dB emitting angle α.

Sensor	α	L_{max}	r_{max}
FMU 40	11°	5 m	0,48 m
FMU 41	11°	8 m	0,77 m
FMU 42	9°	10 m	0,96 m
FMU 43	6°	15 m	0,79 m

3.3.2 Installation in narrow shafts

In narrow shafts with strong interference echoes, we recommend using an ultrasound guide pipe (e.g. PE or PVC wastewater pipe) with a minimum diameter of 100 mm.
Make sure that the pipe is not soiled by accumulated dirt. If necessary, clean the pipe at regular intervals.

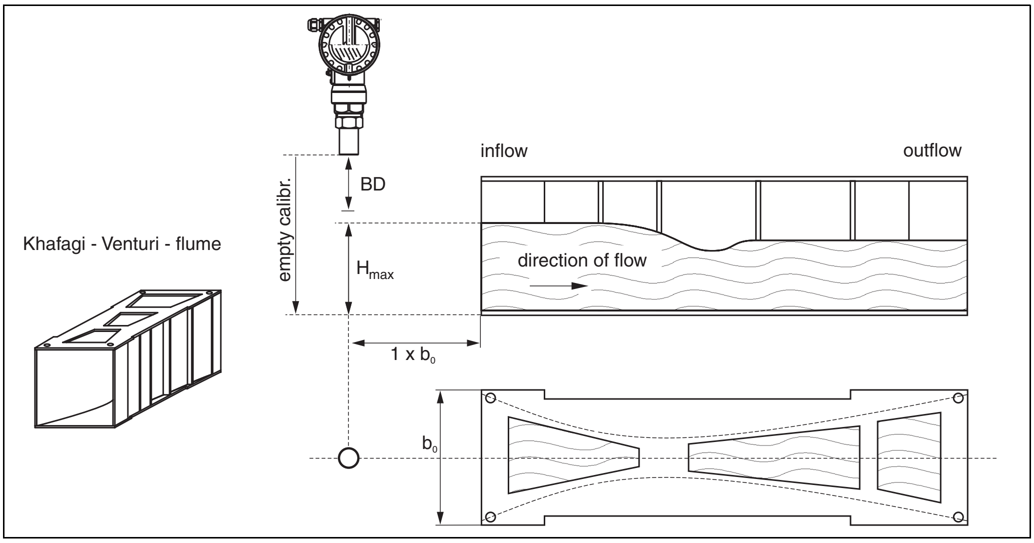


L00-FMU4xxxx-17-00-00-en-010

3.3.3 Installation conditions for flow measurements

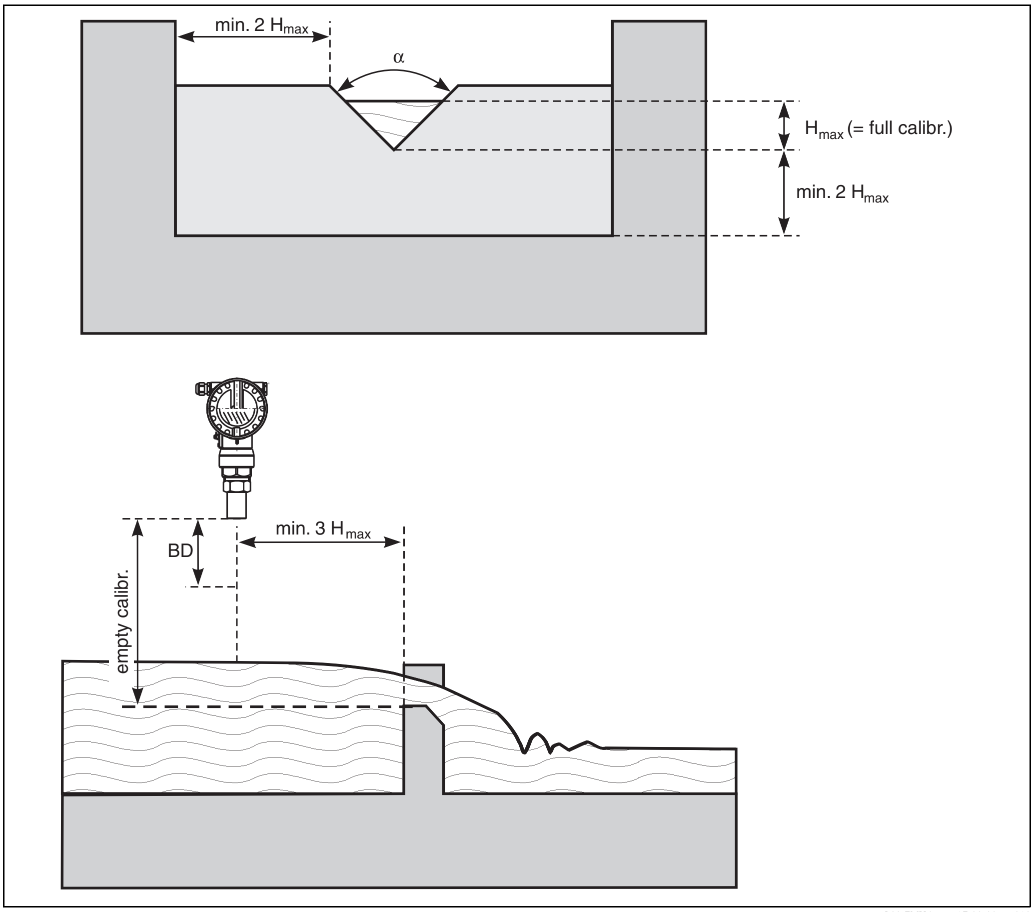
- Install the Prosonic M at the inflow side, as close above the maximum water level H_{max} as possible (take into account the blocking distance BD).
- Position the Prosonic M in the middle of the channel or weir.
- Align the sensor membrane parallel to the water surface.
- Keep to the installation distance of the channel or weir.
- You can enter the "Flow to Level" linearisation curve ("Q/h curve") using ToF Tool or manually via the on-site display.

Example: Khafagi-Venturi flume



L00-FMU4xxxx-17-00-00-en-003

Example: Triangular weir

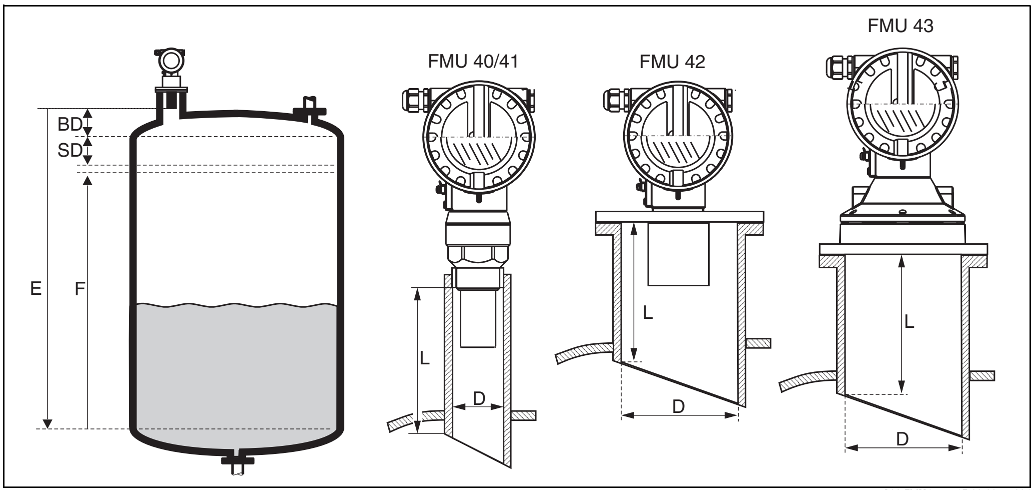


L00-FMU4xxxx-17-00-00-en-012

3.4 Measuring range

3.4.1 Blocking distance, Nozzle mounting

Install the Prosonic M at a height so that the blocking distance BD is not undershot, even at maximum fill level. Use a pipe nozzle if you cannot maintain the blocking distance in any other way. The interior of the nozzle must be smooth and may not contain any edges or welded joints. In particular, there should be no burr on the inside of the tank side nozzle end. Note the specified limits for nozzle diameter and length. To minimise disturbing factors, we recommend an angled socket edge (ideally 45°).



L00-FMU4xxxx-17-00-00-en-004

BD: blocking distance; SD: safety distance; E: empty calibration; F: full calibration (span); D: nozzle diameter; L: nozzle length

Sensor	BD	Max. range liquids	Max. range bulk materials	nozzle diameter	max. nozzle length
FMU 40	0.25 m	5 m	2 m	50 mm	approx. 80 mm
				80 mm	approx. 240 mm
				100 mm	approx. 300 mm
FMU 41	0.35 m	8 m	3.5 m	80 mm	approx. 240 mm
				100 mm	approx. 300 mm
FMU 42	0.4 m	10 m	5 m	80 mm	approx. 250 mm
				100 mm	approx. 300 mm
FMU 43	0.6 m	15 m	7 m	min. 100 mm	approx. 300 mm

Caution!
If the blocking distance is undershot, it may cause device malfunction.

3.4.2 Safety distance

If the level rises to the safety distance SD, the device switches to warning or alarm status.
The size of SD can be set freely in the **"Safety distance" (015)** function.The **"in safety distance" (016)** function defines how the device reacts if the level enters the safety distance.

There are three options:

- **Warning**: The device outputs an error message but continues measurement.
- **Alarm**: The device outputs an error message. The output signal assumes the value defined in the **"Output on alarm" (011)** function (MAX, MIN, user-specific value or holds the last value). As soon as the level drops below the safety distance, the device recommences measurement.
- **Self holding**: The device reacts in the same way as for an alarm. However, the alarm condition continues after the level drops below the safety distance. The device only recommences measurement when you cancel the alarm using the **"Ackn. alarm" (017)** function.

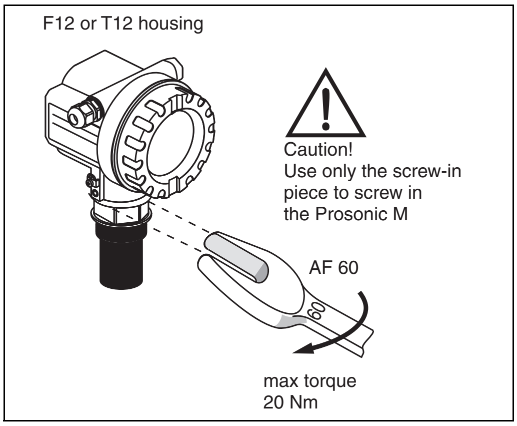
3.4.3 Range

The sensor range is dependent on the measuring conditions. Refer to Technical Information TI 365F/00/en for an estimation. The maximum range is shown in the above diagram (valid for good conditions).

Sensor	maximum range
FMU 40	5 m
FMU 41	8 m
FMU 42	10 m
FMU 43	15 m

3.5 Installation hint for FMU 40/41

Screw the Prosonic M at the screw-in piece using an 60 AF spanner.
Maximum torque: 20 Nm.

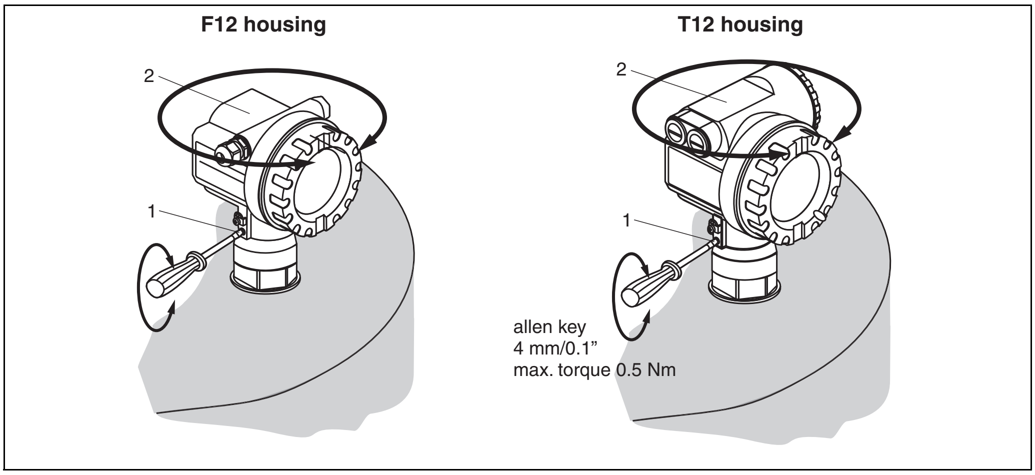


L00-FMU4xxxx-17-00-00-en-009

3.6 Turn housing

After mounting, the housing can be turned 350° in order to simplify access to the display and the terminal compartment. Proceed as follows to turn the housing to the required position:

- Undo the fixing screws (1)
- Turn the housing (2) in the required direction
- Tighten up the fixing screws (1). Maximum torque 0.5 Nm.
- Loctite can be used for securing the screw.



L00-FMU4xxxx-17-00-00-en-013

3.7 Installation check

After installing the device, carry out the following checks:

- Is the device damaged (visual inspection)?
- Does the device correspond to the measuring point specifications for process temperature, process pressure, ambient temperature, measuring range etc.
- If available: Are the measuring point number and labelling correct (visual inspection)?
- Is the measuring device sufficiently protected against precipitation and direct sunlight?
- Are the cable glands tightened correctly?
- After aligning the housing, check the process seal at the nozzle or flange.

4 Wiring

4.1 Electrical connection

Caution!
Before connection please note the following:

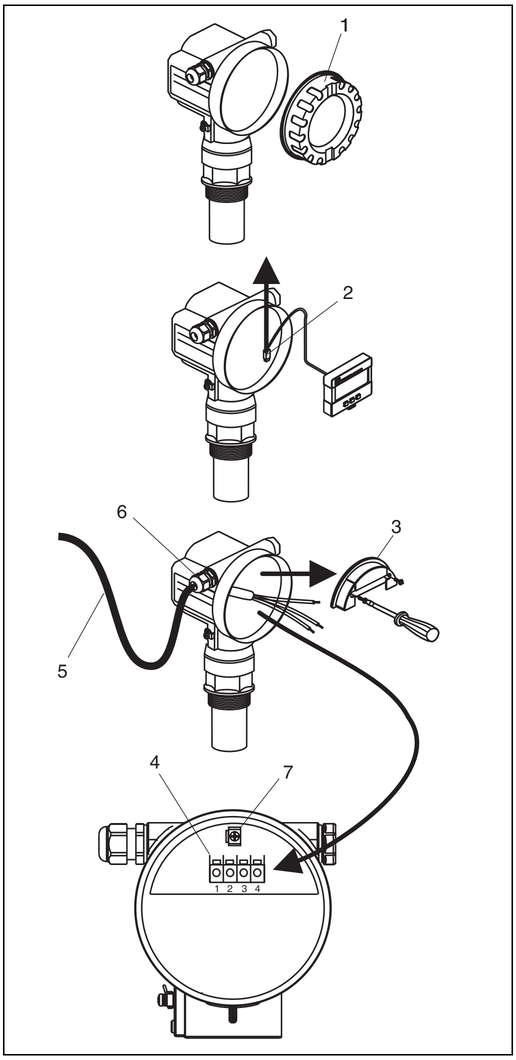
- The power supply must be identical to the data on the nameplate.
- Switch off power supply before connecting up the instrument.
- Connect equipotential bonding to transmitter ground terminal before connecting up the instrument (s. section "Potential matching")

Warning!
When you use the measuring system in hazardous areas, make sure to comply with national standards and the specifications in the safety instructions (XA's). Make sure you use the specified cable gland.

4.1.1 Wiring in the housing F12

1. Unscrew housing cover (1).
2. Remove display (2) if fitted.
3. Remove cover plate (3) from terminal compartment.
4. Pull out terminal module (4) slightly using pulling loop.
5. Insert cable (5) through gland (6).

   Caution!
   If possible, insert the cable from above and let a draining loop in order to avoid intrusion of humidity.
6. Connect cable screen to the grounding terminal (7) within the terminal compartment.
7. Make connection according to terminal assignment (see below).
8. Re-insert terminal module (4).
9. Tighten cable gland (6).
10. Tighten screws on cover plate (3).
11. Insert display (2) if fitted.
12. Screw on housing cover (1).
13. Switch on power supply.

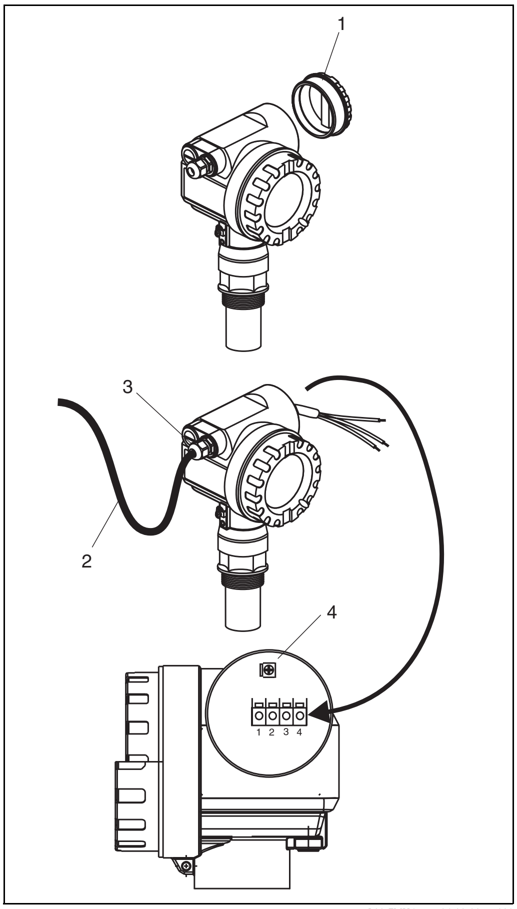


L00-FMU4xxxx-04-00-00-yy-008

4.1.2 Wiring in the housing T12

1. Unscrew the cover (1) of the separate connection room.
2. Insert cable (2) through gland (3).

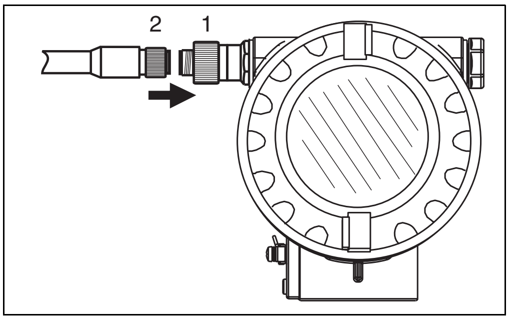
   ☝ Caution!
   If possible, insert the cable from above and let a draining loop in order to avoid intrusion of humidity.
3. Connect cable screen to the grounding terminal (4) within the connection room.
4. Make connection according to the terminal assignment (see below).
5. Tighten cable gland (3).
6. Screw on housing cover (1).
7. Switch on power supply.



L00-FMU4xxxx-04-00-00-yy-009

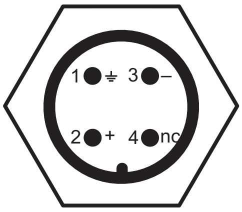
4.1.3 Wiring with M12 plug

1. Insert plug (1) into bushing (2).
2. Screw firmly.
3. Ground instrument according to the desired safety concept.

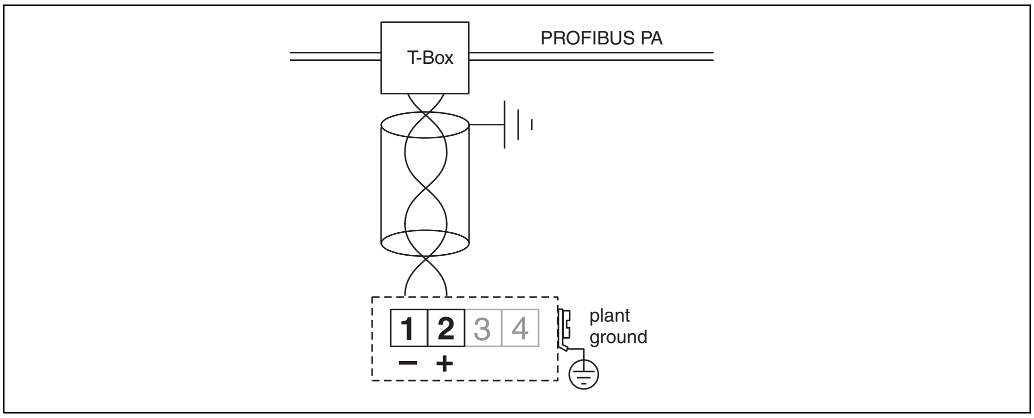


L00-FMU4xxxx-04-00-00-yy-010

Pin assignment of the M12 plug connector (PROFIBUS PA plug)

	Pin	Meaning
 L00-FMxxxxxx-04-00-00-yy-016	1	Ground
	2	PA +
	3	PA –
	4	not connected

4.2 Terminal assignment



L00-FMxxxxxx-04-00-00-en-012

4.3 Cable specifications PROFIBUS

Twisted, screened pairs must be used. The following specification must be met for explosion hazardous application (EN 50 020, FISCO model):

- Loop-resistance (DC): 15…150 Ω/km,
- Specific inductance: 0.4…1 mH/km,
- Specific capacitance: 80…200 nF/km

The following cable types can be used, for example

Non-Ex-area:
- Siemens 6XV1 830-5BH10 (black),
- Kerpen CEL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL (grey)
- Belden 3076F (orange)

Ex-area:
- Siemens 6XV1 830-5AH10 (blue),
- Belden 3076F, Kerpen CEL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL (blue)

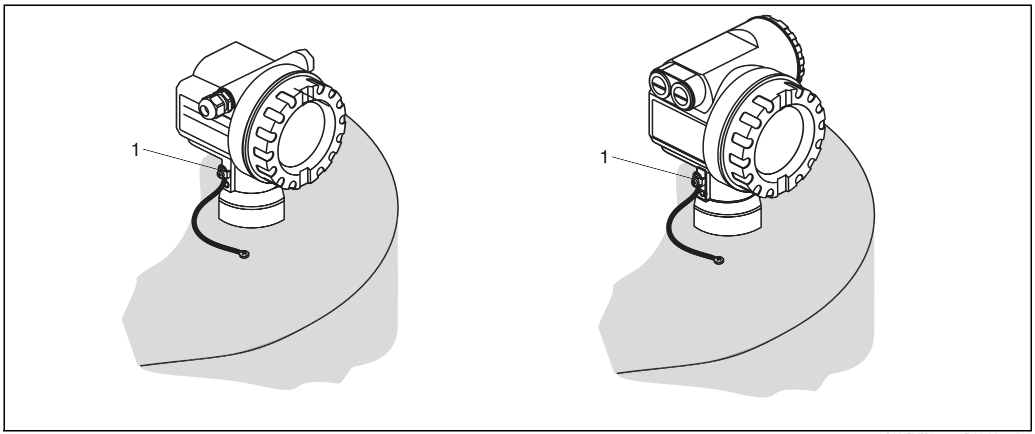
4.4 Supply voltage

The following values are the voltages across the terminals directly at the instrument:

Type	minimum terminal voltage	maximum terminal voltage
standard	9 V	32 V
EEx ia (FISCO model	9 V	17,5 V
EEx ia (Entity concept)	9 V	24 V

The current consumption is approx. 13 mA for the range of voltages given above.

4.5 Recommended connection



L00-FMU4xxxx-17-00-00-yy-014

1: external ground terminal of the transmitter

For maximum EMC protection please observe the following points:
- As the metal housing of the Prosonic M is isolated from the tank by the plastic sensor, a low-impedance connection between the housing and tank/bracket/flange should be installed in order to ensure electromagnetic compatibility (EMC).
  For optimum EMC the connection should be as short as possible. Ideally, a ground strap should be used.
- The external ground terminal on the transmitter must be connected to ground.
- The continuity of the cable screening between tapping points must be ensured.
- If potential equalisation is present between the individual grounding points, ground the screening at each cable end or connect it to the device housing (as short as possible).
- If there are large differences in potential between grounding points, the grounding should run via a capacitor that is suitable for high frequency use (e.g. ceramic 10 nF/250 V~).

Caution!
Applications, which are subject to the explosion prevention, permit only under special conditions the repeated grounding of the protective screen , see to EN 60 079-14..

Note!
Further recommendations concerning the structure and equipotential bonding of the network can be found in Operating Instructions BA 198F "PROFIBUS-DP/-PA: Guidlines for planning and commissioning" and in the PROFIBUS-PA sapecifications EN 50170 (DIN 19245).

4.6 Checking the connection

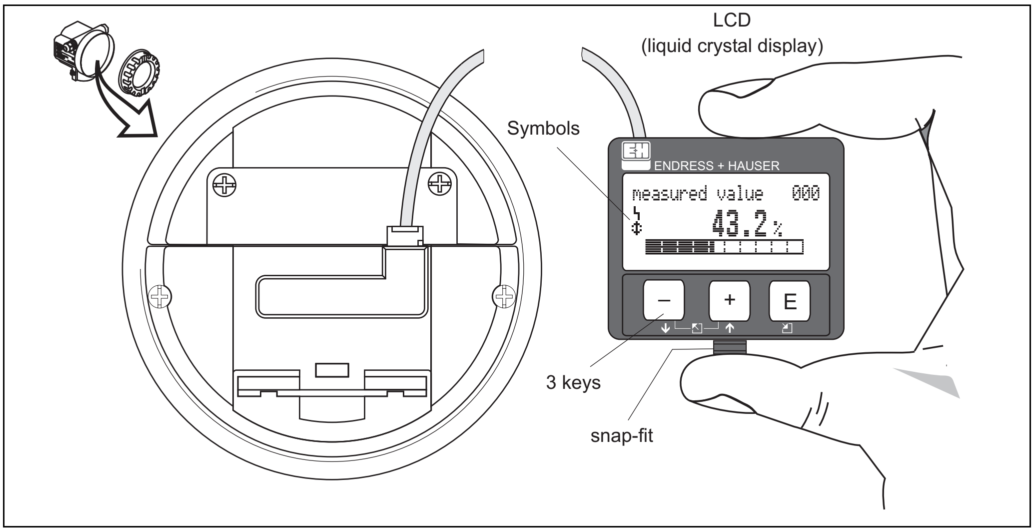
After wiring the device, carry out the following checks:
- Are the terminals correctly assigned?
- Is the cable gland tight?
- Is the M12 connector screwed tight?
- Is the housing cover fully screwed on?
- If power supply available: Does a display appear on the display module?

5 Operation

5.1 Display and operating elements

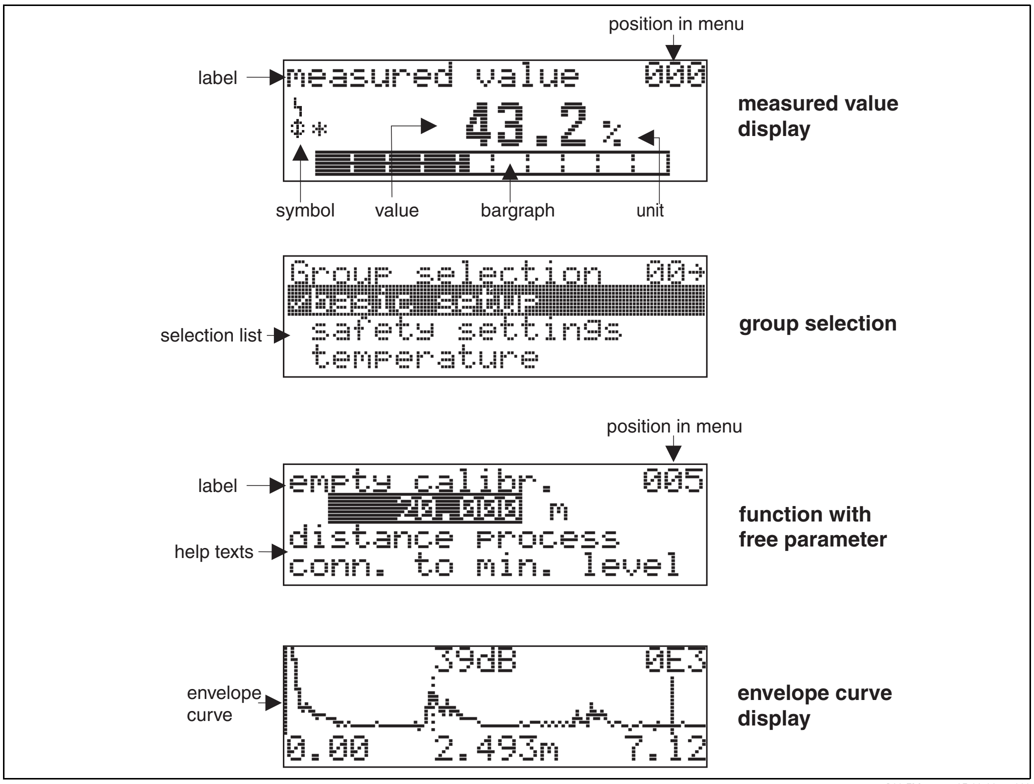
5.1.1 On-site display VU 331

The LCD module VU 331 for display and operation is located beneath the housing cover. The measured value is legible through the glass in the cover. Open the cover to operate the device.



L00-FMxxxxxx-07-00-00-en-001

5.1.2 Display appearance



L00-FMxxxxxx-07-00-00-en-002

In the measured value display, the bargraph corresponds to the output.
The bargraph is segmented in 10 bars. Each completely filled bar represents a change of 10% of the adjusted span.

5.1.3 Display symbols

The following table describes the symbols that appear on the liquid crystal display:

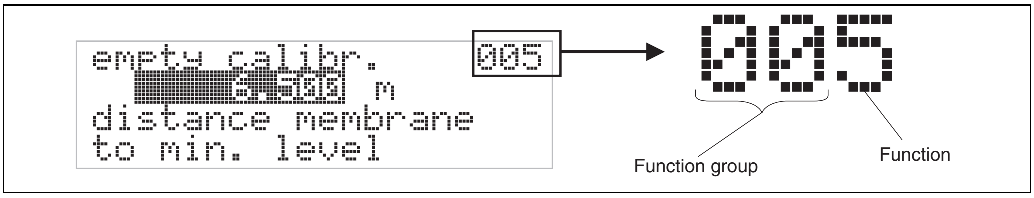
Sybmol	Meaning
ϟ	**ALARM_SYMBOL** This alarm symbol appears when the instrument is in an alarm state. If the symbol flashes, this indicates a warning.
🔒	**LOCK_SYMBOL** This lock symbol appears when the instrument is locked,i.e. if no input is possible.
⇕	**COM_SYMBOL** This communication symbol appears when a data transmission via e.g. HART, PROFIBUS PA or FOUNDATION Fieldbus is in progress.

5.1.4 Function of the keys

Key(s)	Meaning
+ or ↑	Navigate upwards in the selection list Edit numeric value within a function
− or ↓	Navigate downwards in the selection list Edit numeric value within a function
Esc − + or ↖	Navigate to the left within a function group
E	Navigate to the right within a function group, confirmation.
+ and E or − and E	Contrast settings of the LCD
+ and − and E	Hardware lock / unlock After a hardware lock, an operation of the instrument via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

5.2 Function codes

For easy orientation within the function menus, for each function a position is shown on the display.



L00-FMU4xxxx-07-00-00-en-001

The first two digits identify the function group:

■ **basic setup**	**00**
■ **safety settings**	**01**
■ **linearisation**	**04**

. . .

The third digit numbers the individual functions within the function group:

■ **basic setup**	**00**	→	■ **tank shape**	**002**
			■ **medium property**	**003**
			■ **process cond.**	**004**

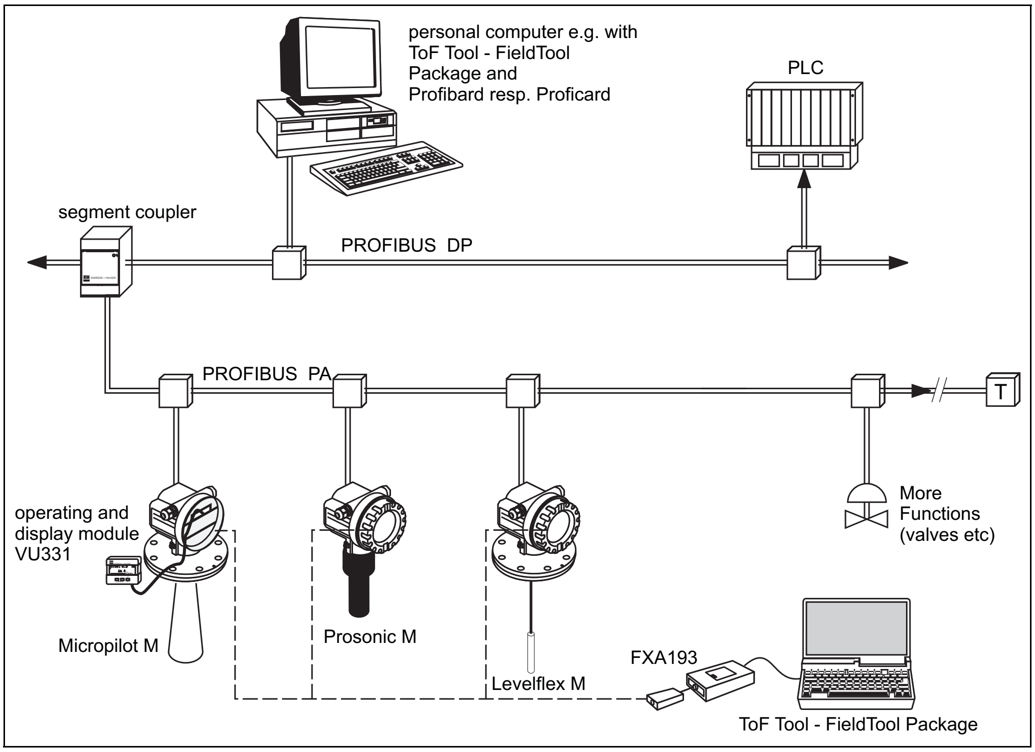
. . .

Hereafter the position is always given in brackets (e.g. "**tank shape**" **(002)**) after the described function.

5.3 PROFIBUS PA interface

5.3.1 System integration using PROFIBUS PA

A maximum of 32 transmitters (8 if mounted in an explosion hazardous location EEx ia IIC according to FISCO-model) can be connected to the bus.The segment coupler provides the operating voltage to the bus. Both on-site as well as remote operation are possible.



L00-FMxxXXXX-14-00-06-en-001

5.3.2 Device address

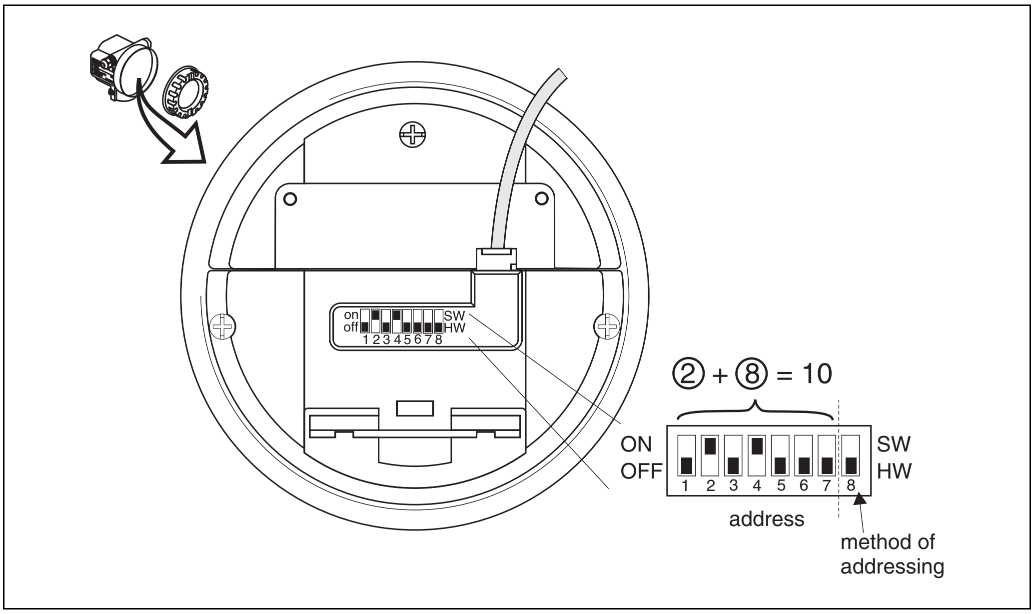
Selecting the device address

- Every PROFIBUS-PA device must be given an address. If the address is not set correctly, the device will not be recognised by the process control system.
- A device address may appear only once within a particular PROFIBUS-PA network, see BA 198F.
- Valid device addresses are in the range 1 and 126. All devices are delivered from the factory with the software address 126.
- The default address can be used to check the function of the device and connect it to an operating PROFIBUS-PA system. Afterwards the address must be changed to allow other devices to be connected to the network.

Software addressing

Software addressing comes into operation, when DIP-switch 8 is in the position "ON". BA 198F/00/en, chap. 5.7 describes, how to set the address in this case.
In ToF Tool, the address can be set via the "**Set address**" function in the "**Device**" menu.

Hardware addressing



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Hardware addressing comes into operation, when DIP switch 8 is in the position "HW (OFF)". In this case the address is determined by the position of DIP-switches 1 to 7 according to the following table:

Switch No.	1	2	3	4	5	6	7
Value in position "OFF"	0	0	0	0	0	0	0
Value in Position "ON"	1	2	4	8	16	32	64

The new address becomes valid 10 seconds after switching.
It results a new device restart.

5.3.3 Device database and type files

A device database file (GSD) contains a description of the properties of the PROFIBUS-PA device, e.g. the supported transmission rates and the type and format of the digital information output to the PLC.
Additional bitmap files are required in order to represent the device by an icon in the network design software.
Every device is allocated an identity code by the PROFIBUS User Organisation (PNO). This appears in the device data base file name (.gsd).

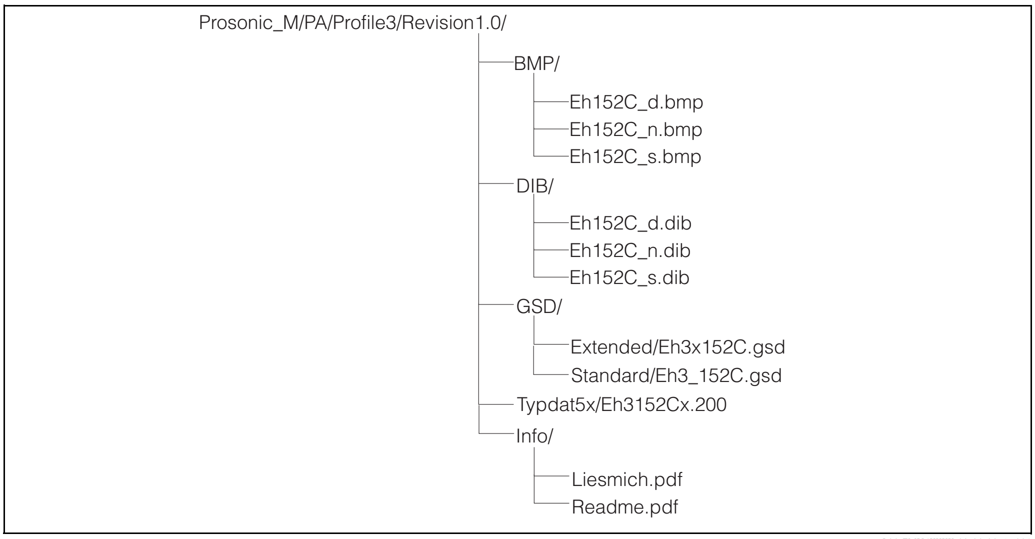
The Prosonic M has the ID number 0x152C(hex) = 5420 (dec).

Sources of supply

- Internet (ftp-Server): ftp://194.196.152.203/pub/communic/gsd
- www.endress.de
  click on "Download" and enter "GSD" into the "Search for" field. A list appears containing the links to all available GSD files.
- CD-ROM with GSD files for all E+H devices. Order-Code: 50097200
- GSD library of the PROFIBUS User Organisation (PNO):http: //www.PROFIBUS.com

Directory structure

The files are organized in the following structure:



L00-FMU4XXXX-02-00-00-de-001

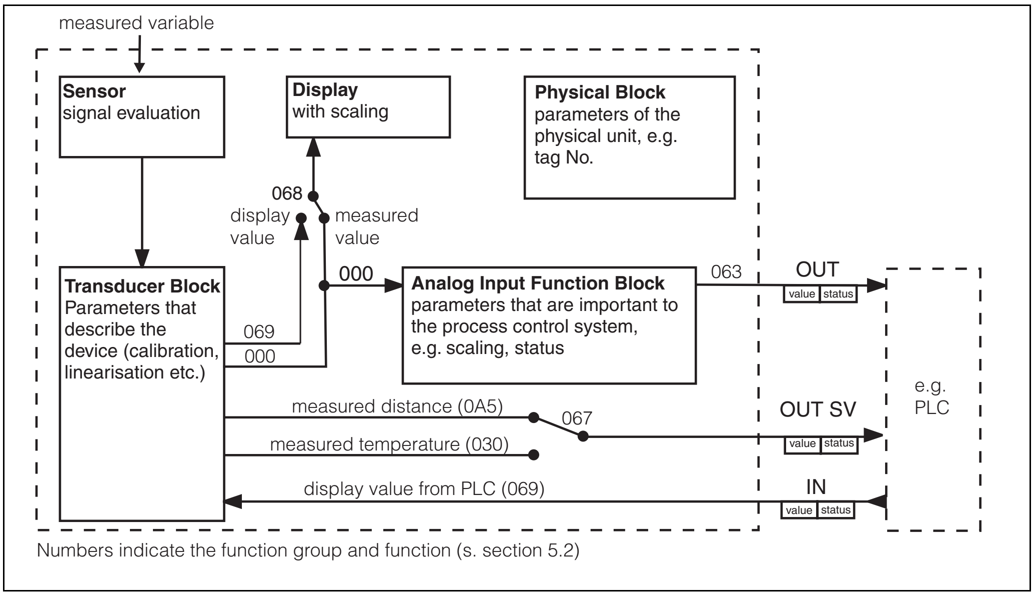
- The GSD files in the directory "Extended" are needed for the network design software STEP 7 of the S7-300/400 PLC family.
- The GSD files in the directory "Standard" are used for PLCs, which do not support an identifier format but only an identifier byte (e.g. PLC5 of Allen-Bradley)
- For the network design tool COM ET200 with Siemens S5 instead of an GSD file the Type file "EH_152Cx.200" and instead of the BMP files the DIB files have to be used.

Universal Database File

As an alternative to the device specific GSD file, the PNO provides an universal database file with the designation PA139700.gsd for devices with one analogue input block. This file supports the transmission of the main value. Transmission of a second cyclic value or a display value is not supported.
When the universal database is used, the option **"profile"** must be selected in the function **"Ident number" (061)**.

5.3.4 Cyclic data exchange

Block model of the Prosonic M



The block model shows, which data are exchanged continously (i.e. by cyclic data transfer) between the Prosonic M and the PLC. The numbers refer to the function groups and functions.

- After linearization and integration in the transducer block the **"measured value"(000)** is transmitted to the Analog-Input Block. There, it may be scaled and checked for limit transgression, and is written out to the PLC. The parameters of the Analog-Input Block are not available when operating via ToF Tool.
- The function **"select V0H0" (068)** determines, if the main value, or a read in value from the PLC is shown on the display in the field for the main value.
- The function **"second cyclic value" (067)** determines, if the **"measured distance" (0A5)** or the **"measured temperature" (030)** is transmitted as the second cyclic value.

Modules for the cyclic data telegram

For the cyclic data telegram the Prosonic provides the following modules:

1. **Main Process Value**
   This is the main measured value scaled by the Analog Input Block (063).
2. **2nd Cyclic Value**
   This is the measured distance between the sensor mebrane and the product surface (0A5) or the measured temperature (030).
3. **Display Value**
   This is a value which can be transferred from the PLC to the Prosonic M in order to be shown on the display.
4. **FREE PLACE**
   This module must be applied during configuration (see below), if the 2nd cyclic value or the display value are not to appear in the data telegram.

Configuration of the cyclic data telegram

Use the configuration software of your PLC in order to compose the data telegram from these modules in one of the following ways:

1. **Main value**
   In order to transmit the main measured value, selct the module **Main Process Value**.
2. **Main value and second cyclic value**
   In order to transmit the main value and the second cyclic value (temperature or measured distance), select the modules in the following order: **"Main Process Value"**, **"2nd Cyclic Value"**, **"FREE PLACE"**.
3. **Main value and display value**
   In order to transmitt the main value and to receive a display value select the modules in the following order: **"Main Process Value"**, **"FREE PLACE"**, **"Display Value"**.
4. **Main value, second cyclic value and display value**
   In order to transmit the main value and the second cyclic value and to receive a display value, select the modules in the following order: **"Main Process Value"**, **"2nd Cyclic Value"**, **"Display Value"**.

The exact way of performing the configuration depends on the configuration software of the PLC.

Structure of the input data (instrument -> SPS)

The input data are transmitted according to the following structure:

Index Input data	**Data**	**Access**	**Format/Remarks**
0, 1, 2, 3	Main value (level)	read	32 bit floating point number (IEEE-754)
4	Status code for main value	read	see. "Status codes"
5, 6, 7, 8 (optional)	Secondary value (measured distance)	read	32 bit floating point number (IEEE-754)
9 (optional)	Status code for secondary value	read	s. "Status codes"

Structure of the output data (SPS Æ Prosonic M)

The output data are transmitted according to the following structure:

Index Output data	**Data**	**Access**	**Format/Remarks**
0, 1, 2, 3	Display value	write	32 bit floating point number (IEEE-754)
4	Status code for Display value	write	s. "Status codes"

IEEE-754 Floating Point Number

The measured value is transmitted as a IEEE 754 floating point number, whereby:
Measured value = $(-1)^{VZ}$ x $2^{(E-127)}$ x (1+F)

Byte 1								Byte 2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sign	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
	Exponent (E)								Mantissa (F)						

Byte 3								Byte 4							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}
Mantissa (F)															

Example:

40 F0 00 00 (hex) = 0**100 0000 1**111 0000 0000 0000 0000 0000 (bin)
= $(-1)^0$ x $2^{(129-127)}$ x $(1 + 2^{-1} + 2^{-2} + 2^{-3})$
= 1 x 2^2 x (1 + 0.5 + 0.25 + 0.125)
= 1 x 4 x 1.875
= 7.5

Stauts codes

The status codes comprise one byte and have got the following meaning:

Status-Code	**Device status**	**Significance**	**Primary value**	**Secondary value**
0C Hex	BAD	device error		X
0F Hex	BAD	device error	X	
1F Hex	BAD	out-of-service (target mode)	X	
40 Hex	UNCERTAIN	non-specific		X
47 Hex	UNCERTAIN	last usable value (Fail-safe-Mode aktiv)	X	
4B Hex	UNCERTAIN	Substitute set (fail-Safe mode active)	X	
4F Hex	UNCERTAIN	initial value (fail-Safe mode active)	X	
5C Hex	UNCERTAIN	Configuration error (limits not set correctly)	X	
80 Hex	GOOD	OK	X	X
84 Hex	GOOD	Active block alarm (static revision counter incremented)	X	
89 Hex	GOOD	LOW_LIM (alarm active)	X	
8A Hex	GOOD	HI_LIM (alarm active)	X	
8D Hex	GOOD	LOW_LOW_LIM (alarm active)	X	
8E Hex	GOOD	HI_HI_LIM (alarm active)	X	

If a stauts other than "GOOD" is sent to the device, the display indicates an error.

5.3.5 Acyclic data exchange

Acyclic data exchange allows device parameters to be changed independently of the communication between the device and a PLC.
Acyclic data exchange is used
- to transmit device parameters during commissioning and maintenance;
- to display measured values that are not acquired in cyclic traffic.

There are two types of acyclic data exchange:

Acyclic communication with a Class 2 master (MS2AC)

In the case of MS2AC, a Class 2 master opens a communication channel via a so-called service access point (SAP) in order to access the device. Class 2 masters are for example:
- ToF Tool
- FieldCare
- PDM

Before data can be exchanged via PROFIBUS, however, the Class 2 master must be made aware of the parameters contained within the field device. This can be done by:
- a device description (DD)
- a device type manager (DTM)
- a software component within the master, which accesses the parameters via slot and index addresses.

Note!
- The DD or DTM is supplied by the device manufacturer.
- The number of Class 2 masters that can simultaneously access a device, is determined by the number of SAPs that the device can provide.
- The use of a Class 2 master increases the cycle time of the bus system. This must be taken into consideration when the control system or PLC is programmed.

Acyclic communication with a Class 1 master (MS1AC)

In the case of MS1AC, a Class 1 master that is already communicating cyclically with a device opens a communication channel via SAP 0x33, a special access point for MS1AC. As is the case for a Class 2 master, the parameter is read or written via the slot and index.

Note!
- At the time of writing, there are only a few PROFIBUS masters that support this type of communication.
- Not all PROFIBUS field devices support MS1AC.

Caution!
Permanent writing of parameters, e.g. with every cycle of the application program, must be avoided, since this can drastically reduce the life of the device.
Acyclic write parameters are stored electrically in the RAM (EEPROM, Flash...). The RAM modules are design for a limited number of write operations only. In standard operation without MS1AC, i.e. during parametrisation of the device, the number of write operations is negligible when compared to the limit. If the application program is badly designed, however, this limit can be reached quickly, and the RAM will fail

5.3.6 Slot/index tables

Device management

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Directory object header		1	0	12	Array of UNSIGNED16	X		constant
Composite list directory entries		1	1	24	Array of UNSIGNED16	X		constant
GAP Directory continuous		1	2-8					
GAP reserved		1	9-15					

Analog Input Block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block Data		1	16	20	DS-32*	X		constant
Static revision		1	17	2	UNSIGNED16	X		non-vol.
Device tag		1	18	32	OSTRING	X	X	static
Strategy		1	19	2	UNSIGNED16	X	X	static
Alert key		1	20	1	UNSIGNED8	X	X	static
Target Mode		1	21	1	UNSIGNED8	X	X	static
Mode		1	22	3		X		dynamic non-vol. constant
Alarm summary		1	23	8		X		dynamic
Batch		1	24	10		X	X	static
Gap		1	25					
Block parameters								
Out		1	26	5	DS-33*	X		dynamic
PV Scale		1	27	8	Array of FLOAT	X	X	static
Out Scale		1	28	11	DS-36*	X	X	static
Linearisation type		1	29	1	UNSIGNED8	X	X	static
Channel		1	30	2	UNSIGNED16	X	X	static
Gap		1	31					
PV fail safe time		1	32	4	FLOAT	X		non-vol.
Fail safe type		1	33	1	UNSIGNED8	X	X	static
Fail safe value		1	34	4	FLOAT	X	X	static
Alarm Hysteresis		1	35	4	FLOAT	X	X	static
Gap		1	36					
HI HI Limit		1	37	4	FLOAT	X	X	static
Gap		1	38					
HI Limit		1	39	4	FLOAT	X	X	static
Gap		1	40					
LO Limit		1	41	4	FLOAT	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Gap		1	42					
LO LO Limit		1	43	4	FLOAT	X	X	static
Gap		1	44-45					
HI HI Alarm		1	46	16	DS-39*	X		dynamic
HI Alarm		1	47	16	DS-39*	X		dynamic
LO Alarm		1	48	16	DS-39*	X		dynamic
LO LO Alarm		1	49	16	DS-39*	X		dynamic
Simulate		1	50	6	DS-51*	X	X	non-vol.
Out unit text		1	51	16	OSTRING	X	X	static
Gap reserved		1	52-60					

Physical Block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block Data		0	16	20	DS-32*	X		constant
Static revision		0	17	2	UNSIGNED16	X		non-vol.
Device tag		0	18	32	OSTRING	X	X	static
Strategy		0	19	2	UNSIGNED16	X	X	static
Alert key		0	20	1	UNSIGNED8	X	X	static
Target mode		0	21	1	UNSIGNED8	X	X	static
Mode		0	22	3	DS-37*	X		dynamic non-vol. constant
Alarm summary		0	23	8	DS-42*	X		dynamic
Block parameters								
Software revision		0	24	16	OSTRING	X		constant
Hardware revision		0	25	16	OSTRING	X		constant
Device manufacturer ID		0	26	2	UNSIGNED16	X		constant
Device ID		0	27	16	OSTRING	X		constant
Device serial number		0	28	16	OSTRING	X		constant
Diagnosis		0	29	4	OSTRING	X		dynamic
Diagnosis extension		0	30	6	OSTRING	X		dynamic
Diagnosis mask		0	31	4	OSTRING	X		constant
Diagnosis mask ext.		0	32	6	OSTRING	X		constant
Device certification		0	33	32	OSTRING	X	X	non-vol.
Security locking		0	34	2	UNSIGNED16	X	X	non-vol.
Factory reset		0	35	2	UNSIGNED16		X	non-vol.
Descriptor		0	36	32	OSTRING	X	X	static
Device message		0	37	32	OSTRING	X	X	static
Device instal. date		0	38	8	OSTRING	X	X	static
Gap reserved		0	39					
Ident number select		0	40	1	UNSIGNED8	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
HW write protection		0	41	1	UNSIGNED8	X	X	static
Gap reserved		0	42-48					
Gap		0	49-53					
E+H parameters								
error code		0	54	2	UNSIGNED16	X		dynamic
last error code		0	55	2	UNSIGNED16	X	X	dynamic
Up Down features		0	56	1	OSTRING	X		constant
Up Down control		0	57	1	UNSIGNED8		X	dynamic
Up Down param		0	58	20	OSTRING	X	X	dynamic
Bus address		0	59	1	UNSIGNED8	X		dynamic
Device SW No.		0	60	2	UNSIGNED16	X		dynamic
set unit to bus		0	61	1	UNSIGNED8	X	X	static
input value		0	62	6	FLOAT+U8+U8	X		dynamic
Select Main value		0	63	1	UNSIGNED8	X	X	dynamic
PA profile revision		0	64	16	OSTRING	X		constant
Gap		0	65-69					
Gap reserved		0	119-125					

E+H specific level transducer block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block data		1	130	20	DS-32*	X		constant
Static revision		1	131	2	UNSIGNED16	X		non-vol.
Device tag		1	132	32	OSTRING	X	X	static
Strategy		1	133	2	UNSIGNED16	X	X	static
Alert key		1	134	1	UNSIGNED8	X	X	static
Target mode		1	135	1	UNSIGNED8	X	X	static
Mode		1	136	3	DS-37*	X		dynamic non-vol. static
Alarm summary		1	137	8	DS-42*	X		dynamic
E+H parameters								
Measured value	V0H0	1	138	4	FLOAT	X		dynamic
tank shape	V0H2	1	140	1	UNSIGNED8	X	X	static
medium cond.	V0H3	1	141	1	UNSIGNED8	X	X	static
process cond.	V0H4	1	142	1	UNSIGNED8	X	X	static
empty calibration	V0H5	1	143	4	FLOAT	X	X	static
full calibration	V0H6	1	144	4	FLOAT	X	X	static
output on alarm	V1H0	1	148	1	UNSIGNED8	X	X	static
outp. echo loss	V1H2	1	150	1	UNSIGNED8	X	X	static
ramp %span/min	V1H3	1	151	4	FLOAT	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
delay time	V1H4	1	152	2	UNSIGNED16	X	X	static
safety distance	V1H5	1	153	4	FLOAT	X	X	static
in safety dist.	V1H6	1	154	1	UNSIGNED8	X	X	static
ackn. alarm	V1H7	1	155	1	UNSIGNED8	X	X	static
measured temp.	V2H0	1	158	1	UNSIGNED8	X	X	static
max. temp. limit	V2H1	1	159	1	UNSIGNED8	X	X	static
max. meas. temp.	V2H2	1	160	1	UNSIGNED8	X	X	static
on high temp.	V2H3	1	161	1	UNSIGNED8	X	X	static
def. temp. sens.	V2H4	1	162	2	ENUM	X	X	static
level/ullage	V3H0	1	168	1	UNSIGNED8	X	X	static
linearisation	V3H1	1	169	1	UNSIGNED8	X	X	static
customer unit	V3H2	1	170	2	UNSIGNED16	X	X	static
table no.	V3H3	1	171	1	UNSIGNED8	X	X	static
input level	V3H4	1	172	4	FLOAT	X	X	static
input volume	V3H5	1	173	4	FLOAT	X	X	static
max. scale	V3H6	1	174	4	FLOAT	X	X	static
diameter vessel	V3H7	1	175	4	FLOAT	X	X	static
check distance	V4H1	1	179	1	UNSIGNED8	X	X	static
range of mapping	V4H2	1	180	4	FLOAT	X	X	static
start mapping	V4H3	1	181	1	UNSIGNED8	X	X	static
pres. map. dist.	V4H4	1	182	4	FLOAT	X		dynamic
cust. Tank map	V4H5	1	183	1	UNSIGNED8	X	X	static
echo quality	V4H6	1	184	1	UNSIGNED8	X		dynamic
offset	V4H7	1	185	4	FLOAT	X	X	static
output damping	V4H8	1	186	4	FLOAT	X	X	static
blocking dist.	V4H9	1	187	4	FLOAT	X	X	static
instrument_addr.	V5H0	1	188	1	UNSIGNED8	X		dynamic
ident number	V5H1	1	189	1	UNSIGNED8	X	X	static
set unit to bus	V5H2	1	190	1	UNSIGNED8	X	X	static
out value	V5H3	1	191	4	FLOAT	X		dynamic
out status	V5H4	1	192	1	UNSIGNED8	X		dynamic
simulation	V5H5	1	193	1	UNSIGNED8	X	X	static
simulation value	V5H6	1	194	4	FLOAT	X	X	static
2nd cyclic value	V5H7	1	195	1	UNSIGNED8	X	X	static
select V0H0	V5H8	1	196	1	UNSIGNED8	X	X	static
display value	V5H9	1	197	4	FLOAT	X		dynamic
display contrast	V6H1	1	199	1	UNSIGNED8	X	X	static
language	V6H2	1	200	1	UNSIGNED8	X	X	static
back to home	V6H3	1	201	2	INT16	X	X	static
format display	V6H4	1	202	1	UNSIGNED8	X	X	static
no. decimals	V6H5	1	203	1	UNSIGNED8	X	X	static
sep. character	V6H6	1	204	1	UNSIGNED8	X	X	static
display test	V6H7	1	205	1	UNSIGNED8	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
present error	V9H0	1	228	2	U16	X		dynamic
previous error	V9H1	1	229	2	U16	X		dynamic
clear last error	V9H2	1	230	1	UNSIGNED8	X	X	static
reset	V9H3	1	231	2	UNSIGNED16	X	X	static
unlock parameter	V9H4	1	232	2	UNSIGNED16	X	X	static
measured dist.	V9H5	1	233	4	FLOAT	X		dynamic
measured level	V9H6	1	234	4	FLOAT	X		dynamic
application par.	V9H8	1	236	1	UNSIGNED8	X		dynamic
tag no.	VAH0	1	238	32	STRING	X		const.
profile version	VAH1	1	239	32	STRING	X	X	static
protocol+sw-no.	VAH2	1	240	32	STRING	X		const
serial no.	VAH4	1	242	32	STRING	X	X	static
distance unit	VAH5	1	243	2	UNSIGNED16	X	X	static
temperature unit	VAH6	1	244	2	ENUM	X	X	static
download mode	VAH8	1	246	1	UNSIGNED8	X	X	static

Data strings

In der Slot/Index table some data types, e.g. DS-33 are marked by an asterisk. These are data strings according to the PROFIBUS-PA specifications part 1, Version 3.0. They contain several elements, which are addressed by an additional subindex. The following table gives an example.

Data type	Subindex	Type	Size [bytes]
DS-33	1	FLOAT	4
	5	UNSIGNED8	1

5.3.7 Parameter access via Commuwin II

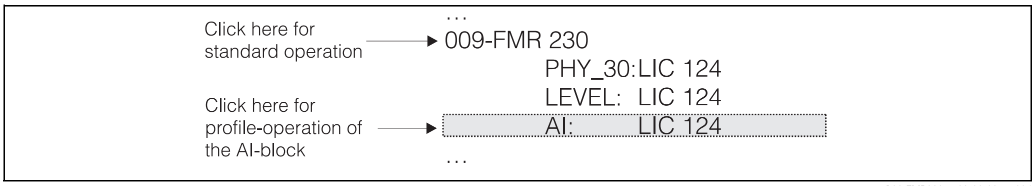
The block parameters can be accessed by a PROFIBUS-DP Class 2 master, for example, Commuwin II. Commuwin II runs on an IBM-compatible computer or laptop. The computer must be equipped with a PROFIBUS interface, i.e. PROFIBOARD for PCs and PROFICARD for laptops. During the system integration, the computer is registered as a Class 2 master.

Connection

- Profiboard for connection to a PC
- Proficard for connection to a Laptop

Generating the device list

- The PA-DPV1 server must be installed. The connection to Commuwin II is opened selecting the PA-DPV1 server in the "Open connection" function in the "Connect" menu. The empty device list appears.
- The function "Display with tags" in the "Connect" menu generates the live list with measuring point tags.
- Two operation modes are possible:
  - – The **E+H standard operation** is selected by clicking on the device name
  - – The **profile operation** is selected by clicking on the tag for the appropriate block
- The settings are entered in the device menu.



Device menu

The device menu allows matrix or graphical operation to be selected.

- In the case of **matrix operation**, the device or profile parameters are displayed in a matrix. For the standard operation this is the E+H standard matrix. For the profile operation this is the matrix of the selected blockA parameter can be changed when the corresponding matrix field is selected.
- In the case of **graphical operation**, the operating sequence is shown in a series of templates with parameters. For profile operation, the pictures Diagnosis, Scaling, Simulation and Block are of interest.

The meaning and the parametrization of the parameters is described in Chapter 6.

Note!
The instrument can also be operated locally using the keys. If operation is prevented by the keys being locked locally, parameter entry via communication is not possible either.

Note!
Further information on Commuwin II is given in the Operating Manual BA 124F/00/en

5.3.8 Parameter access via ToF Tool

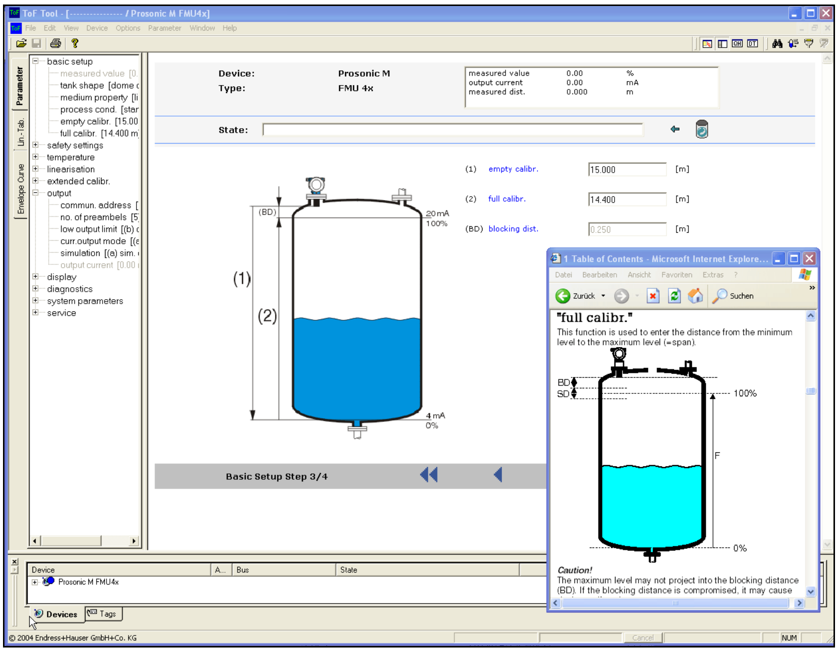
The ToF Tool is a graphical operation software for instruments from Endress+Hauser. It is used to support commissioning, securing of data, signal analysis and documentation of the instruments. It is compatible with the following operating systems: WinNT4.0, Win2000 and WinXP.

The ToF Tool supports the following functions:
- Online configuration of transmitters
- Signal analysis via envelope curve
- Linearisation table (graphically supported creation, editing, importing and exporting)
- Loading and saving of instrument data (Upload/Download)
- Documentation of measuring point

Note!
Further information you may find on the CD-ROM, which is enclosed to the instrument.

Note!
The parameters of the Analog-Input block are presently not accessible via ToF Tool.

Menu-guided commissioning



Device: Prosonic M
Type: FMU 4x

measured value 0.00 %
output current 0.00 mA
measured dist. 0.000 m

(1) empty calibr. 15.000 [m]
(2) full calibr. 14.400 [m]
(BD) blocking dist. 0.250 [m]

"full calibr."
This function is used to enter the distance from the minimum level to the maximum level (=span).

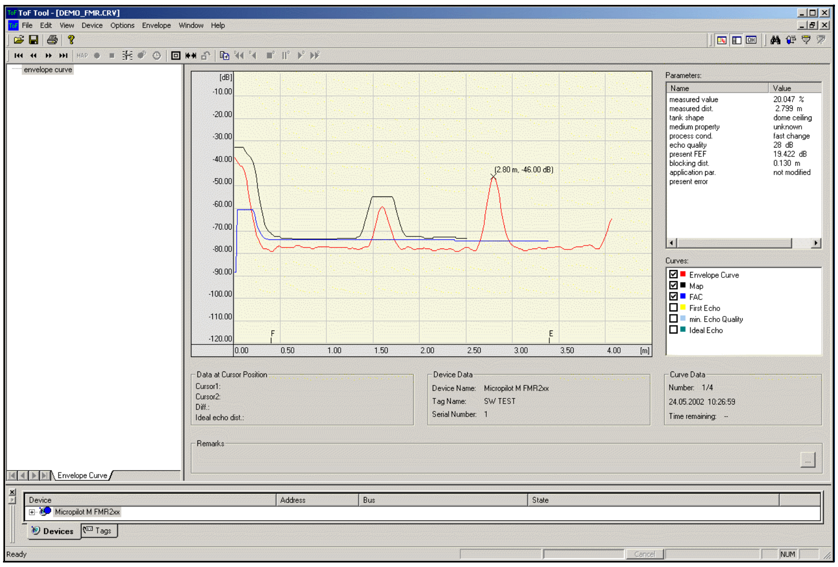
Caution!
The maximum level may not project into the blocking distance (BD). If the blocking distance is compromised, it may cause

L00-FMU4xxxx-19-00-00-en-003

- You can find the function groups and functions of the device in the **navigation bar**.
- You can find the input fields for the parameters in the **main window**.
- If you click on a parameter name, the **Help pages** open with precise explanations of the required input.

Signal analysis via envelope curve

The ToF Tool offers easy analysis of the envelope curve via the "Envelope" menu:



Parameters:

Name	Value
measured value	20.047 %
measured dist.	2.799 m
tank shape	dome ceiling
medium property	unknown
process cond.	fast change
echo quality	28 dB
present FEF	19.422 dB
blocking dist.	0.130 m
application par.	not modified
present error	

Data at Cursor Position
Cursor1:
Cursor2:
Diff.:
Ideal echo dist.:

Device Data
Device Name: Micropilot M FMR2xx
Tag Name: SW TEST
Serial Number: 1

Curve Data
Number: 1/4
24.05.2002 10:26:59
Time remaining: --

L00-FMU4xxxx-19-00-00-en-004

Connection options:

- Service-interface with adapter FXA 193
- Profiboard for connection to a Laptop
- Proficard for connection to a PC

5.3.9 Scaling of the output data

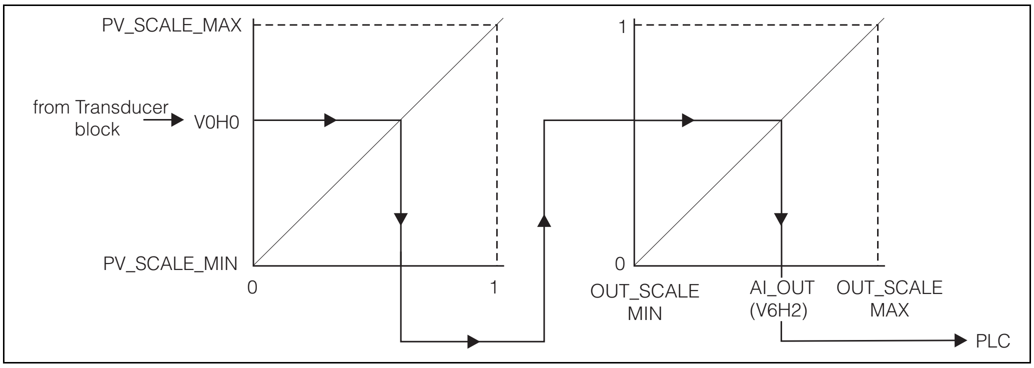
The on-site display and the digital output are working independently of each other.

On-site display

The on-site display always displayes the main value V0H0 directly from the Transducer Block.

Digital output

For the digital output this value is rescaled in two steps:



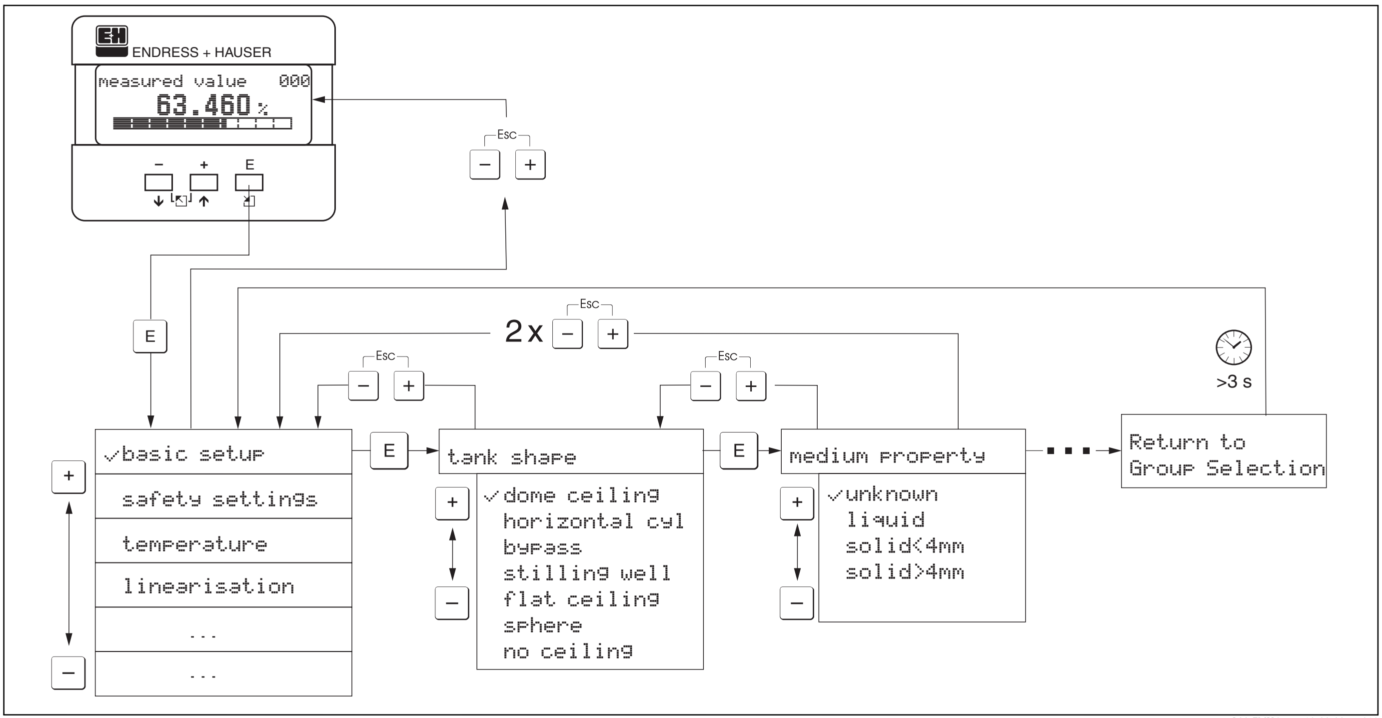
L00-FMUx3xxx-05-00-00-en-001

1. In a first step, the main value is mapped to the interval [0;1]. PV_SCALE_MIN and PV_SCALE_MAX determine the limits of this mapping.
2. In a second step, the interval [0,1] is mapped to the interval [OUT_SCALE_MIN, OUT_SCALE_MAX]. The value resulting from this mapping is transfered via V6H2 to the PLC.

Note!
The scaling of the ouptut value is required by the Profibus profiles. It prevents uncontrolled jumps of the output value when one changes the unit of the measuring value in the Transducer Block. If units are changed, PV_SCALE_MIN and PV_SCALE_MAX automatically adapt themselves in such a way that the output value remains unchanged. Only after confirming the change by the "**Set unit to bus**" **(062)** function,
OUT_SCALE_MIN is set equal to PV_SCALE_MIN and
OUT_SCALE_MAX equal to PV_SCALE_MAX.
Thereby the new unit also becomes effective at the output.

Caution!
If a linearisation has been carried out, it must be confirmed by the "**Set unit to bus**" **(062)** function in order to become effective at the digital output.

5.4 Operation using the on-site display VU 331



L00-FMU4xxxx-19-00-00-en-018

1. Change from Measured Value Display to **Group Selection** by pressing E.
2. Press − or + to select the required **Function Group** and confirm by pressing E.
   The active selection is marked by a 3 in front of the menu text.
3. Activate Edit mode with + or − .

   Selection menus

   a. Select the required **Parameter** in selected **function** with − oder + .

   b. E confirms selection; 3appears in front of the selected parameter.

   c. E confirms the edited value; system quits edit mode.

   d. + and − (= +−) interrupts selection; system quits edit mode.

   Typing in numerals and text

   a. Press + or − to edit the first character of the **numeral / text**.

   b. E positions the cursor at the next character; continue with a. until you have completed your input.

   c. If a ↵ symbol appears at the cursor, press E to accept the value entered; system quits edit mode.

   d. If a ← symbol appears at the cursor, press E to return to the previous character (e.g. for correction of entries).

   e. + and − (= +−) interrupts selection; system quits edit mode.
4. Press E to select the next **function**.
5. Press + and − (= +−) once; return to previous **function**.
   Press + and − (= +−) twice; return to **Group Selection**.
6. Press + and − (= +−) to return to **Measured value display**.

5.5 Lock/unlock configuration

5.5.1 Software security locking

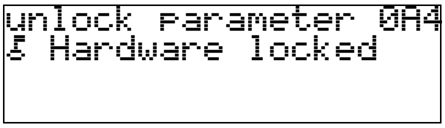
Enter a number ≠ 2457 in the **"unlock parameter" (0A4)** function in the **"diagnostics" (0A)** function group.
The 🔒 symbol appears on the display. Inputs are no longer possible.

If you try to change a parameter, the device jumps to the **"unlock parameter" (0A4)** function.
Enter "2457"
Now change the parameters.

5.5.2 Hardware security locking

Press [–], [+] and [E] simultaneously.
Inputs are no longer possible.

If you try to change a parameter, the following appears:



```
unlock parameter 0A4
🔒 Hardware locked
```

L00-fmrxf0a4-20-00-00-de-001

Press [–], [+] and [E] simultaneously. The **"unlock parameter" (0A4)** function appears.
Enter "2457"
Now change the parameters.

Note!
A hardware locking can **only** be unlocked again via the display by pressing the [+], [–] and [E] keys at the same time again. It is **not** possible to unlock the hardware by communication.

5.6 Resetting the customer parameters

It is advisable to reset the customer parameters if you want to use a device with an unknown history.

Effects of resetting:
- All customer parameters are reset to their default values.
- Customer interference echo suppression is **not** deleted.
- Linearisation is switched to **"linear"**, but the table values are kept. The table can be switched back on in the **"linearisation" (04)** function group in the **"linearisation" (041)** function.

In order to carry out the reset, enter the number "33333" in the **"reset" (0A3)** function in the **"diagnostics" (0A)** function group.

Caution!
A reset may lead to impairment of the measurement. As a rule, a basic calibration is required after a reset.

Note!
The default values of each parameter are shown in bold in the menu overview in the appendix.

5.7 Resetting an interference echo suppression (tank map)

It is always advisable to reset the interference echo suppression (tank mapping) when:
- a device with an unknown history is used
- an incorrect suppression was input.

Proceed as follows:

1. Switch to the **"extended calibr." (05)** function group and to the **"selection" (050)** function.
2. Select **"extended map."**
3. Then proceed to the **"cust. tank map" (055)** function.
4. Select
   - **"reset"**, to delete (reset) the existing interference echo suppression.
   - **"inactive"** to deactivate an existing interference echo suppression. The suppression remains saved.
   - **"active"** to reactivate an existing interference echo suppression.

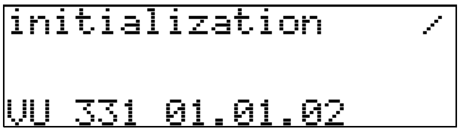
6 Commissioning

Commission the Prosonic M in the following stages:
- Installation check
- Power-up device
- Basic calibration
- Measuring signal check using the envelope curve

The chapter describes the commissioning process using the on-site display. Commissioning using ToF Tool is identical. Access to the device functions using ToF Tool is described on Page 21. You can find detailed information in the Tof Tool operating instructions (BA 224F/00/en) on the supplied CD-ROM.

6.1 Power up instrument

After switching on the supply voltage, the instrument is first initialised.



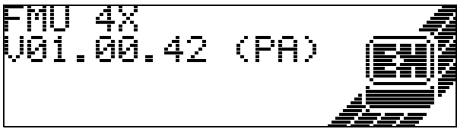
initialization /

VU 331 01.01.02

L00-fmp-fxxx-20-00-00-en-003

Then the following appear for approximately five seconds:
- Device type
- Software version
- Type of digital communication signal

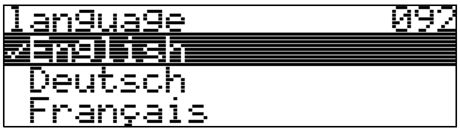
Press E to exit this display.



FMU 4X
V01.00.42 (PA)

L00-fmuxfxxx-20-00-00-de-002

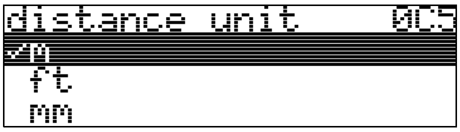
On first power-up, you are requested to select the language for the display texts.



language 092
✓English
Deutsch
Français

L00-fmrxf092-20-00-00-en-001

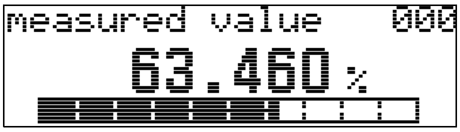
Then you are requested to select the unit of length for your measurements.



distance unit 0C5
✓m
ft
mm

L00-fmrxf0c5-20-00-00-en-001

A measured value is displayed. This is NOT equivalent to the level in your tank. Firstly carry out a basic calibration.



measured value 000
63.460 %

L00-fmrxf000-20-00-00-en-001

Press E to switch to the group selection.
Press E again to start the basic calibration.

Group selection 00→
✓basic setup
safety settings
linearisation

L00-fmrxfg00-20-00-00-en-001

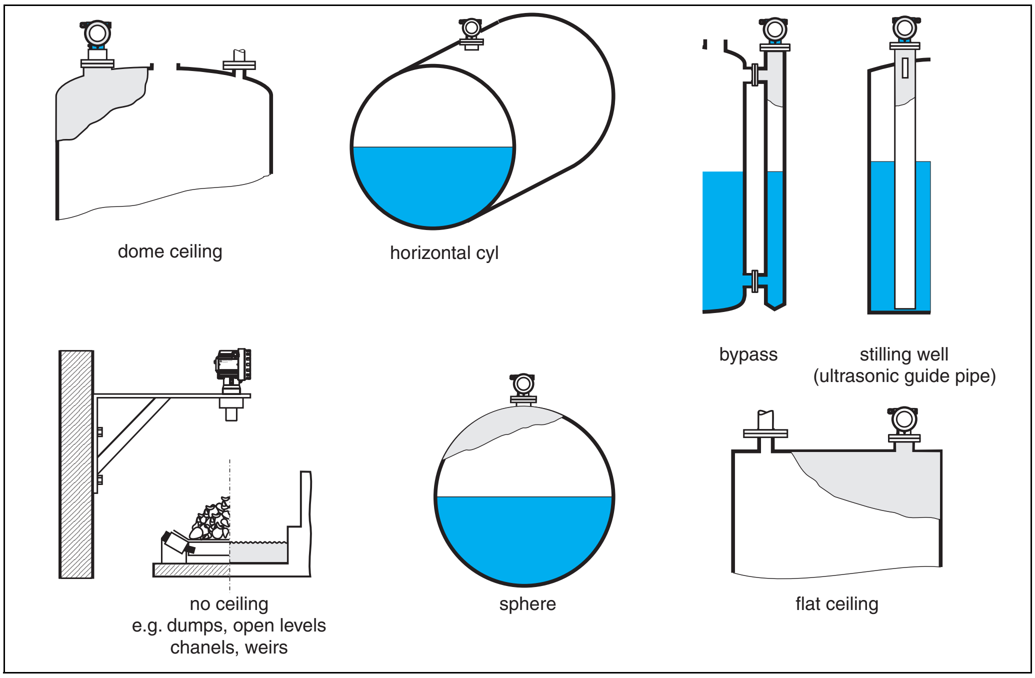
6.2 Basic calibration

The **"Basic setup" (00)** function group lists all the functions which are required for a standard measurement task to commission the Prosonic M. When you have completed your input for a function, the next function appears automatically. In this way, you are guided through the complete calibration.

6.2.1 Measuring point settings

Function "tank shape" (002)

In this function, select one of the following options:



L00-FMU4xxxx-14-00-06-en-001

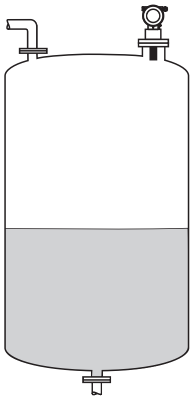
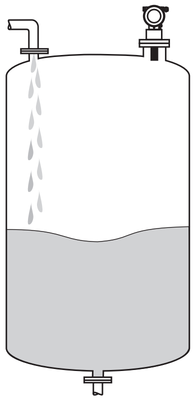
Function "medium property" (003)

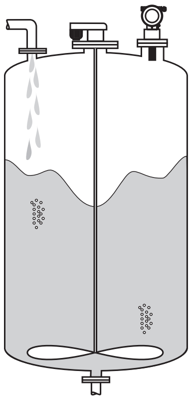
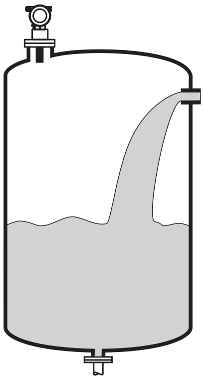
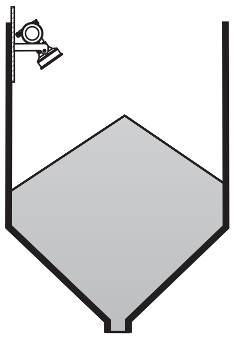
Set the medium type in this function.

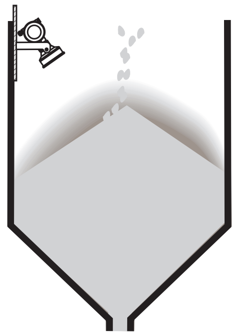
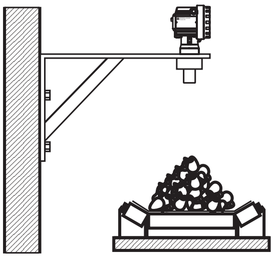
You have the following options:
- unknown (e.g. pasty media such as greases, creams, gels etc.)
- liquid
- solid, grain size < 4mm (fine)
- solid, grain size > 4mm (coarse)

Function "process conditions" (004)

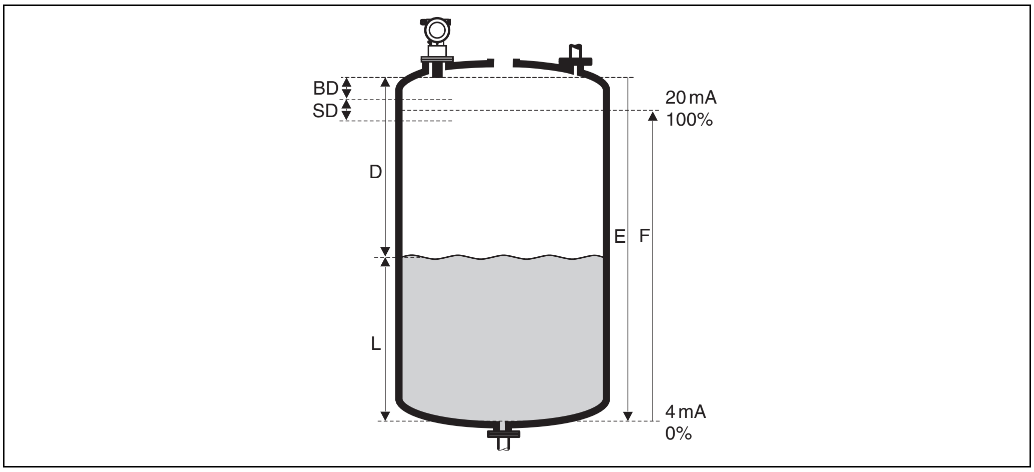
For this function, you have the following options:

standard liquids	calm surface	turb. surface
For all fluid applications which do not fit in any of the following groups.	Storage tanks with immersion tube or bottom filling	Storage / accumulation tanks with uneven surface due to free filling, mixing nozzles or small bottom stirrers
	 L00-FMU4xxxx-14-00-00-xx-001	 L00-FMU4xxxx-14-00-00-xx-002
The filters and output damping are set to average values.	The averaging filters and output damping are set to large values. -> Stable measured value -> Accurate measurement -> Slow reaction time	Special filters for stabilising the input signal are activated. -> Stable measured value -> Medium reaction time

add. agitator	fast change	standard solid
Moving surfaces (poss. with vortex formation) due to agitators	Rapid level change, particularly in small tanks	For all bulk solids applications which do not fit in any of the following groups.
 L00-FMU4xxxx-14-00-00-xx-003	 L00-FMU4xxxx-14-00-00-xx-004	 L00-FMU4xxxx-14-00-00-xx-006
Special filters for stabilising the input signal are set to large values. -> Stable measured value -> Medium reaction time	The averaging filters are set to small values. -> Rapid reaction time -> Possibly unstable measured value	The filter and output damping are set to average values.

solid dusty	conveyor belt	Test: no filter
Dusty bulk solids	Bulk solids with rapid level change	All the filters can be switched off for purposes of service and diagnosis.
 L00-FMU4xxxx-14-00-00-xx-007	 L00-FMU4xxxx-14-00-00-xx-005	
The filters are set to detect even relatively weak signals.	The averaging filters are set to small values. -> Rapid reaction time Possibly unstable measured value	All filters off

6.2.2 Empty and full calibration



L00-FMU4xxxx-19-00-00-yy-019

Function "empty calibration" (005)

In this function, enter the distance E from the sensor membrane to the minimum level (zero point).

Caution!
With dished boiler heads or conical outflows, the zero point should not be deeper than the point at which the ultrasonic wave impinges on the tank bottom.

Function "blocking distance" (059)

In this function the blocking distance (BD) of the sensor is displayed.

Caution!
When entering the full calibration (span), please take into account, that the maximum level may not project into the blocking distance (BD)

Note!
After basic calibration, enter a safety distance (SD) in the **"safety distance" (015)** function. If the level is within this safety distance, the Prosonic M signals a warning or an alarm, depending on your selection in the **"in safety distance" (016)** function.

Function "full calibration" (006)

In this function, enter the span F, i.e. the distance from the minimum level to the maximum level.

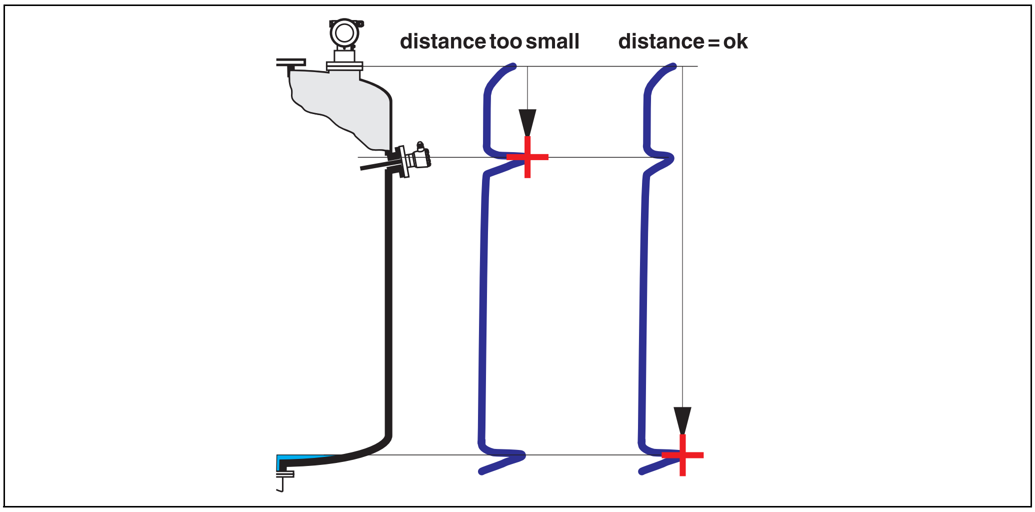
6.2.3 Interference echo suppression (tank mapping)

Function "dist./measured value" (008)

In the **"dist./meas.value" (008)** function, the measured distance D from the sensor membrane to the product surface is displayed together with level L. Check these values.

Function "check distance" (051)

The mapping is initialized by this function.



L00-FMR2xxxx-14-00-06-en-010

Select

- **"distance=ok"** if the correct distance is displayed. Any echoes closer to the sensor will be suppressed by the following interference echo suppression.
- **"dist. too small"** if the displayed distance is too small. In this case, the signal comes from an interference echo which will be suppressed.
- **"dist. too big"** if the displayed distance is too large. This error cannot be cancelled by suppressing the interference echo. This means that the following two functions are skipped. Check the application parameters **"tank shape" (002)**, **"medium proerty" (003)** and **"process cond." (004)** and the **"empty calibr."(005)** in the **"basic setup" (00)** function group.
- **"dist. unknown"** if you do not know the actual distance. This means that the following two functions are skipped.
- **"manual"** if you want to specify the suppression area yourself in the following function.

Function "range of mapping" (052)

The suggested suppression area is displayed in this function. The reference point is always the sensor membrane. You can still edit the value. With manual suppression, the default value is 0 m.

Caution!
The suppression range must end 0.5 m in front of the echo of the actual level. With an empty tank, do not enter E but E – 0.5 m.

Function "start mapping" (053)

You have the following options for this function:
- **off**: Nothing is suppressed.
- **on**: Starts suppression.

Note!
If a mapping already exists, it will be overwritten up to the distance specified in the **"range of mapping" (052)** function. Beyond this distance the existing mapping remains unchanged.

Function dist./measured value (008)

After suppression, the measured distance D from the sensor membrane to the product surface is displayed together with the level. Check that the values correspond to the actual level and/or the actual distance.

The following cases may occur:
- Distance correct – Level correct -> End of basic calibration
- Distance incorrect – Level incorrect -> An additional interference echo suppression must be carried out. Go back to the **"check distance" (051)** function.
- Distance correct – Level incorrect -> Check the value of the **"empty calibr." (005)** function.

Rücksprung zur Gruppenauswahl

Nach der Störechoausblendung ist der Grundabgleich beendet und das Gerät springt automatisch in die Gruppenauswahl zurück.

6.3 Envelope curve

After the basic setup, an evaluation of the measurement with the aid of the envelope curve ("**envelope curve**" **(0E)** function group) is recommended.

6.3.1 Funxtion "plot settings" (0E1)

In this function, select whether you want to display
- just the envelope curve
- The envelope curve and the echo evaluation line FAC
- The envelope curve and interference echo suppression (map)

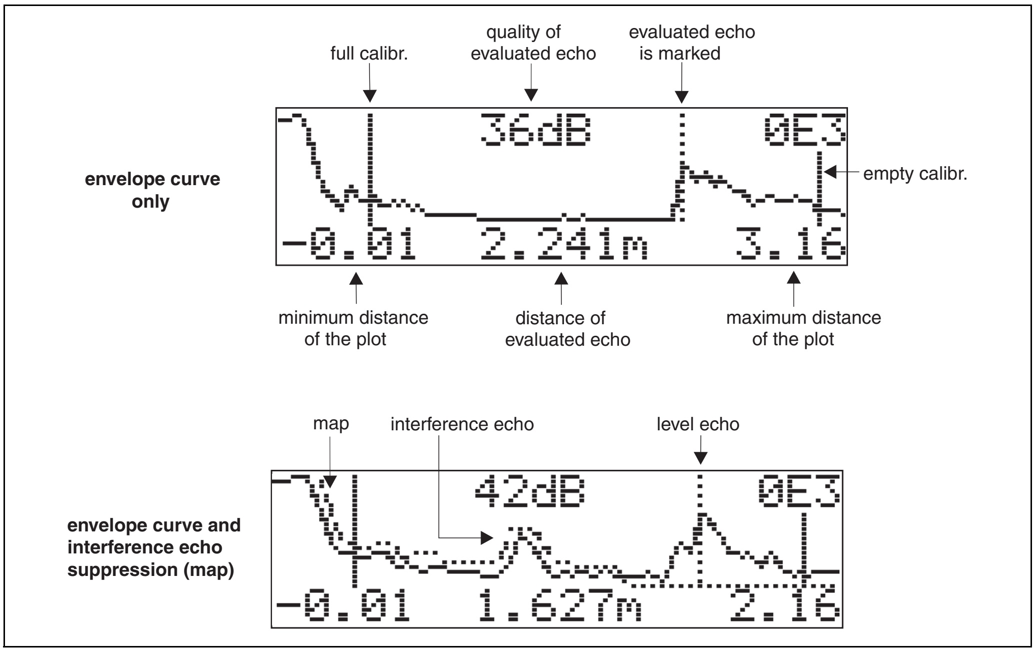
Note!
The FAC and the interference echo suppression (map) are explained in BA 240F "Prosonic M – Description of Instrument Functions"

6.3.2 Function "recording curve" (0E2)

In this function, specify whether you want to display
- an individual envelope curve
- The current envelope curve, with cyclical refreshment.

6.3.3 Function "envelope curve display" (0E3)

The envelope curve is displayed in this function. You can use it to obtain the following information:



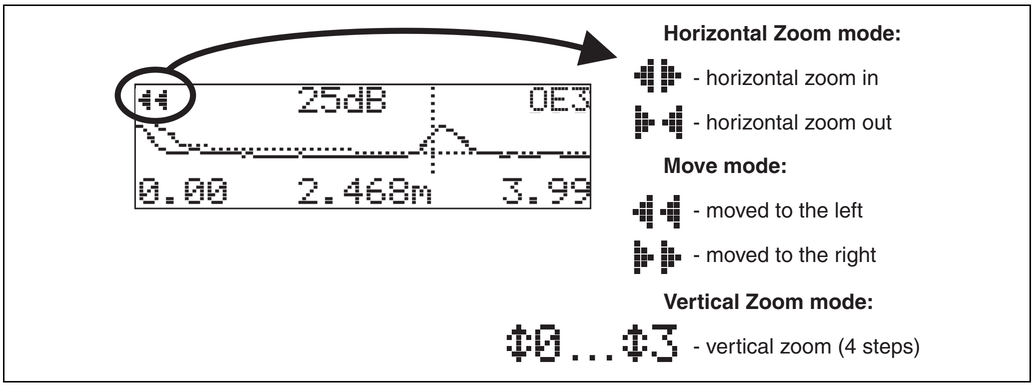
L00-FMU4xxxx-07-00-00-en-003

Check that the following conditions are fulfilled:
- The echo quality at the end of measuring range should be at least 10dB.
- There should be practically no interference echoes in front of the level signal.
- If interference echoes cannot be avoided, they must be below the suppression curve.

Note!
If the cyclical envelope curve display is still active on the display, the measured value is updated at a slower cycle time. We therefore advise you to exit the envelope curve display after optimising the measuring point. To do this, press E. (The instrument does not leave the envelope curve display automatically.)

6.3.4 Navigation in the envelope curve display

Using navigation, the envelope curve can be scaled horizontally and vertically and shifted to the left or the right. The active navigation mode is indicated by a symbol in the top left hand corner of the display.

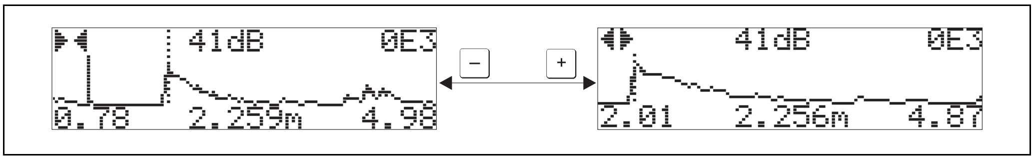


L00-FMxxxxxx-07-00-00-en-004

Horizontal Zoom mode

Firstly, go into the envelope curve display. Then press + or – to switch to the envelope curve navigation. You are then in Horizontal Zoom mode. Either ◀▶ or ▶◀ is displayed.

- + increases the horizontal scale.
- – reduces the horizontal scale.

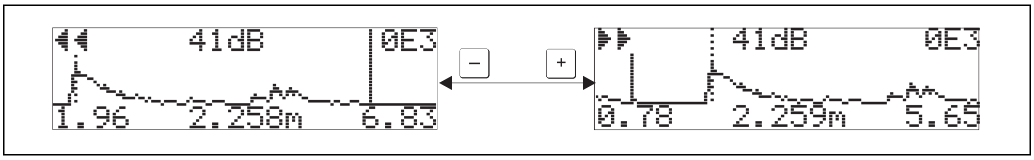


L00-FMxxxxxx-07-00-00-yy-007

Move mode

Then press E to switch to Move mode. Either ▶▶ or ◀◀ is displayed.

- + shifts the curve to the right.
- – shifts the curve to the left.



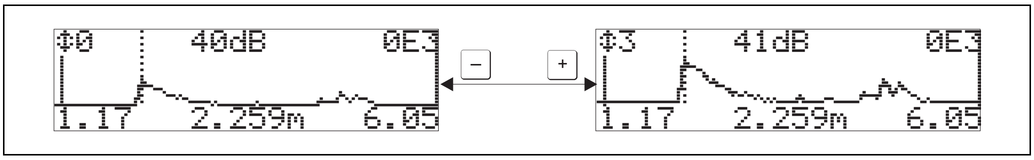
L00-FMxxxxxx-07-00-00-yy-008

Vertical Zoom mode

Press E once more to switch to Vertical Zoom mode. ⇕1 is displayed. You now have the following options.

- + increases the vertical scale.
- – reduces the vertical scale.

The display icon shows the current zoom factor (⇕0 to ⇕3).



L00-FMxxxxxx-07-00-00-yy-009

Exiting the navigation

- Press E again to run through the different modes of the envelope curve navigation.
- Press + and − to exit the navigation. The set increases and shifts are retained. Only when you reactivate the "**recording curve**" **(0E2)** function the display settings return to their standard values.

7 Troubleshooting

7.1 System error messages

7.1.1 Current error

Errors which the Prosonic M detects during commissioning or operation are displayed:

- In the **"measured value" (000)** function
- In the **"diagnostics" (0A)** function group in the **"present error" (0A0)** function
  Only the highest priority error is displayed; in the case of multiple errors, you can scroll between the different error messages by pressing ⊞ or ⊟.
- by the status of the main value

7.1.2 Last error

The last error is displayed in the **"diagnostics" (0A)** function group in the **"previous error" (0A1)** function. This display can be deleted in the **"clear last error" (0A2)** function.

7.1.3 Types of error

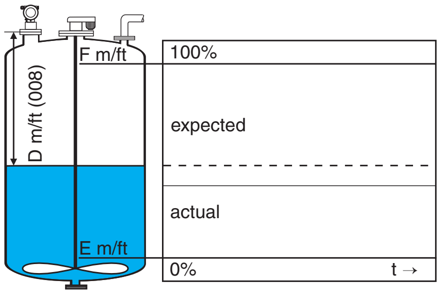
Type of error	Symbol	Meaning
Alarm (A)	ϟ continuous	The output signal assumes a value which can be set using the **"output on alarm" (010)** function: ■ MAX: 110% ■ MIN: -10% ■ Hold: last value is on hold ■ User-specific value
Warning (W)	ϟ flashing	The device continues measurement. An error message is displayed.
Alarm/Warning (E)	You can define whether the error should behave as an alarm or as a warning.	

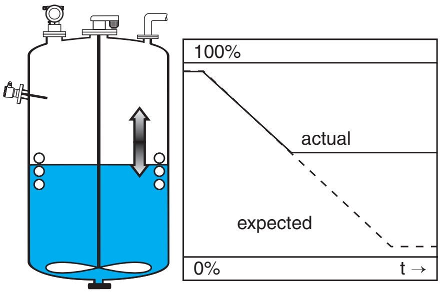
7.1.4 Error codes

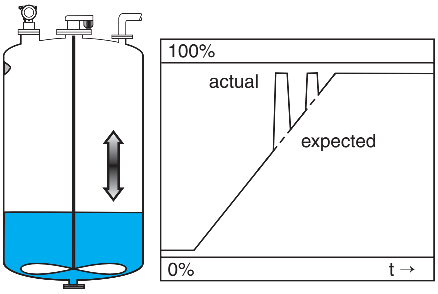
Code	Error description	Action
A102 A110 A152 A160	checksum error	Reset; If alarm still present after reset, replace electronics
W103	initialising	If the message does not disappear after several seconds, replace the electronics
A106	downloading	Wait; Message disappears after load sequence
A111 A113 A114 A115 A121 A125 A155 A164 A171	electronics defect	Reset; Check system for EMC, improve as necessary If alarm still present after reset, replace electronics
A116	download error	Check connection; Restart download
W153	initialising	Wait a few seconds; if error is still displayed, switch the power off and on again
A231	sensor defect	Check connection, if necessary replace HF module or electronics

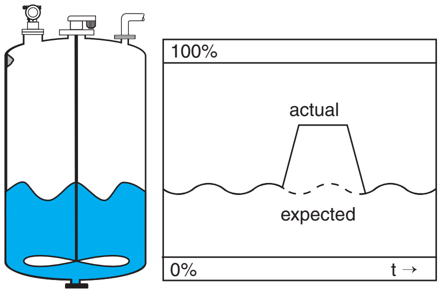
Code	Error description	Action
A281	interruption temperature sensor	Exchange sensor
A502	Sensor type not detected	Exchange sensor and/or electronics
A512	recording of mapping	Alarm disappears after a few seconds
A521	new sensor type detected	Reset
W601	linearisation curve not monotone	Correct table (enter monotonously increasing table)
W611	less than 2 linea-risation points	Enter additional value pairs
W621	simulation on	Switch simulation mode off [**"output" (06)** function group, **"simulation" (065)** function]]
E641	no usable echo	Check basic calibration
E651	level in safety distance - risk of overspill	Error disappears when the level leaves the safety distance. Possibly reset the lock. [**"safety settings" (01)** function group, **"ackn. alarm" (017)** function]]
A661	Sensor overtemperature	
A671	Linearisation incomplete	Activate linearisation table
W681	current out of range	Carry out basic calibration; check linearisation
W691	Filling noise detected, level ramp is active	

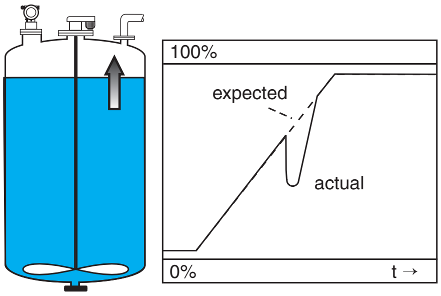
7.2 Application errors

<table>
<tr><th>Error</th><th>Example</th><th>Elimination</th></tr>
<tr><td>Measured value (00) is incorrect but measured distance (008) is correct</td><td rowspan="2">

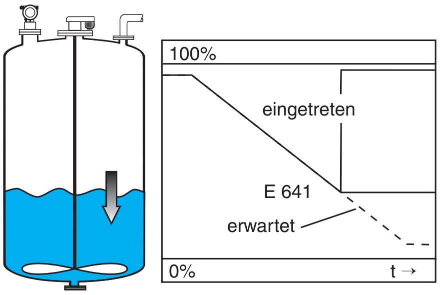
L00-FMR2xxxx-19-00-00-en-019</td><td>1. Check empty calibration (005) and full calibration (006).
2. Check linearisation
– level/ullage (040)
– max. scale(046)
– diameter vessel(047)
– linearisation table</td></tr>
<tr><td>Measured value (000) and measured distance (008) are incorrect</td><td>1. For measurements in bypass or stilling well: Select the according option in the "tank shape" (002) function.
2. Carry out interference echo suppression.</td></tr>
<tr><td>No change in measured value on filling/ emptying</td><td>

L00-FMR2xxxx-19-00-00-en-014</td><td>1. Carry out interference echo suppression.
2. Clean sensor if necessary
3. If necessary, select better installation position
4. If necessary due to wide interference echoes, set function "detection window" (0A7) to "off".</td></tr>
<tr><td>With an uneven surface (e.g. filling, emptying, running agitator) the measured value may jump sporadically to higher levels</td><td>

L00-FMR2xxxx-19-00-00-en-015


L00-FMR2xxxx-19-00-00-en-016</td><td>1. Carry out interference echo suppression
2. Set the process cond. (004) to "calm surface" or "add. agitator"
3. Increase output damping (058).
4. If necessary, select a different installation position and/or a larger sensor</td></tr>
<tr><td>On filling/emptying the measured value drops</td><td>

L00-FMR2xxxx-19-00-00-en-017</td><td>1. Check tank shape (002), e.g. "dome ceiling" or "horizontal cyl."
2. If possible, do not select a central installation position
3. Possible user stilling well/echo guide pipe</td></tr>
</table>

Error	Example	Elimination
E 641 (echo loss)	 L00-FMR2xxxx-19-00-00-en-018	1. Check application parameters (002), (003) and (004) 2. If necessary, select a different installation position and/or a larger sensor 3. Align the sensor parallel to the product surface (particularly for bulk solids applications)

8 Maintenance and repairs

8.1 Exterior cleaning

When cleaning the exterior, always use cleaning agents that do not attack the surface of the housing and the seals.

8.2 Repairs

The Endress+Hauser repair concept assumes that the measuring devices have a modular design and that customers are able to undertake repairs themselves.
Spare parts are contained in suitable kits. They contain the related replacement instructions.
All the spare parts kits which you can order from Endress+Hauser for repairs are listed with their order numbers in the section "Spare parts".
For more information on service and spare parts, contact the Service Department at Endress+Hauser.

8.3 Repairs to Ex-approved devices

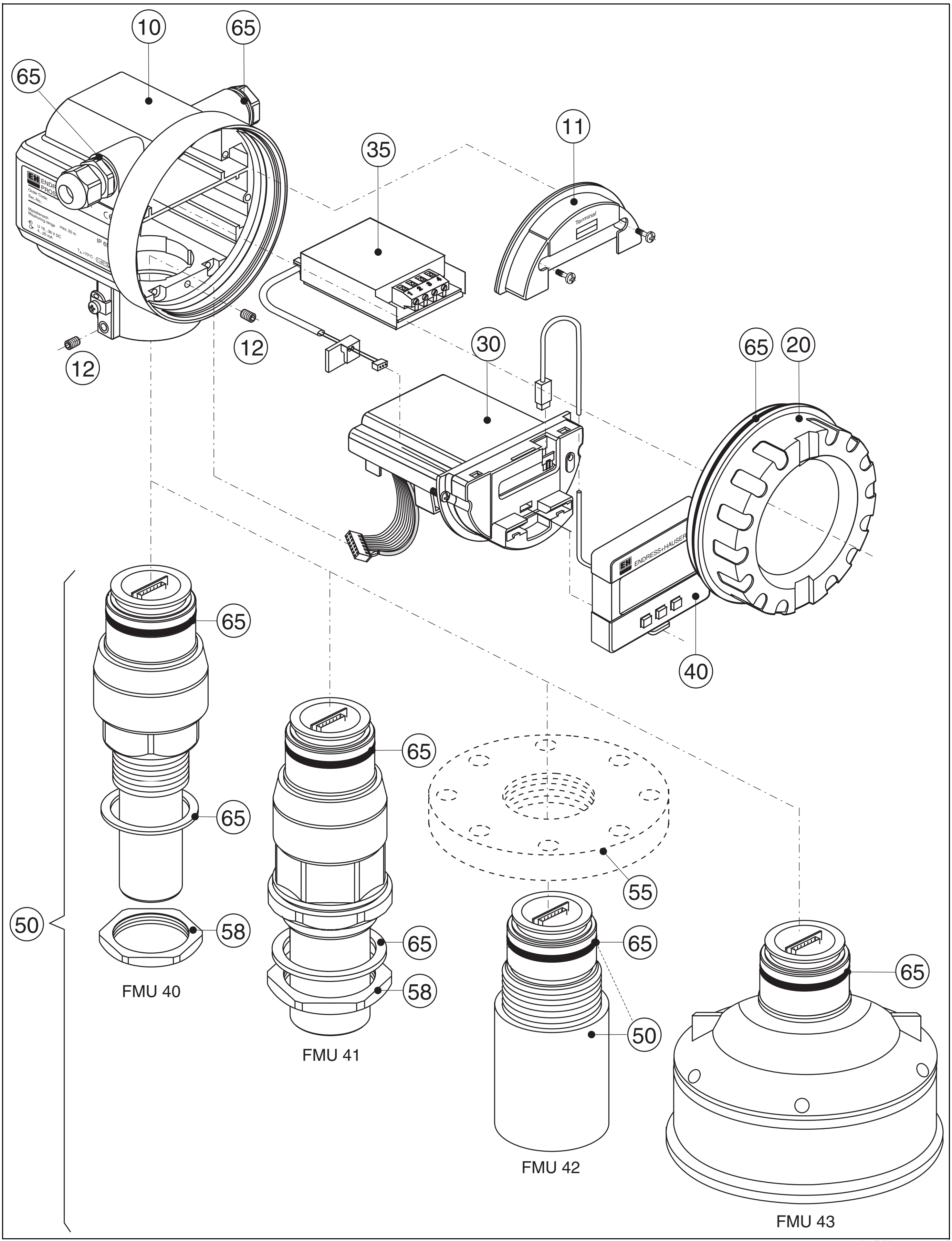
When carrying out repairs to Ex-approved devices, please note the following:

- Repairs to Ex-approved devices may only be carried out by trained personnel or by the Endress+Hauser Service.
- Comply with the prevailing standards, national Ex-area regulations, safety instructions (XA) and certificates.
- Only use original spare parts from Endress+Hauser.
- When ordering a spare part, please note the device designation on the nameplate. Only replace parts with identical parts.
- Carry out repairs according to the instructions. On completion of repairs, carry our the specified routine test on the device.
- Only Endress+Hauser Service may convert a certified device into a different certified variant.
- Document all repair work and conversions.

8.4 Replacement

After a complete instrument or electronic module has been replaced, the parameters can be downloaded into the instrument again via the communication interface. Prerequisite to this is that the data were uploaded to the PC beforehand using the ToF Tool / Commuwin II. Measurement can continue without having to carry out a new setup. Only a linearisation and a tank map (interference echo suppression) have to be recorded again.

8.5 Spare parts (housing type F12)



L00-FMU4x-00-00-00-yy-007

10 Housing

543120-0022 Housing F12, aluminium, G1/2

543120-0023 Housing F12, aluminium, NPT1/2

543120-0024 Housing F12, aluminium, M20

52001992 Housing F12, aluminium, M20, PA connector

52008556 Housing F12, aluminium, M20, FF connector

52013350 Housing F12, aluminium, coated, M20, 4-wire

52013351 Housing F12, aluminium, coated, M20, metal

52013348 Housing F12, aluminium, coated, G1/2, 4-wire

52013349 Housing F12, aluminium, coated, NPT1/2, 4-wire

11 Hood for terminal compartment

52006026 Cover for the connection compartment F12

52019062 Cover for the connection compartment F12, FHX40

12 Set of screws

535720-9020 Set of screws for housing F12/T12

20 Cover

52005936 Cover F12/T12 aluminium, inspection glass, seal

517391-0011 Cover F12/T12 aluminium, coated, seal

30 Electronics

71025600 electronics FMU4x, Ex, 2-wire HART, V4.0

71025602 electronics FMU4x, Ex, 4-wire HART, V4.0

71025603 electronics FMU4x, Ex, PROFIBUS PA, V4.0

52023759 Electronics Prosonic M, Ex, FF, V2.04

35 Terminal module / power unit

52006197 Terminal module 4-pin, HART, 2-wire with connecting cable

52012156 Terminal module 4-pin, PROFIBUS PA, Foundation Fieldbus

52013304 Power unit, 10.5...32V DC (housing F12) for electronics, 4-wire

52013305 Power unit, 90 ...250V AC (housing F12) for electronics, 4-wire

52015585 Power unit, CSA, 10.5...32V DC (housing F12) for electronics, 4-wire

52015586 Power unit, CSA, 90...250V AC (housing F12) for electronics, 4-wire

40 Display

52005585 Display/operating module VU331

50 Probe with process connection

52010509 Sensor FMU40 G1-1/2

52010507 Sensor FMU40 NPT1-1/2

52010510 Sensor FMU41 G2

52010508 Sensor FMU41 NPT2

52023965 Sensor FMU42

52013543 Sensor FMU43 4", gasket

55 Flanges

52023919 Flange, Uni-DN80/ANSI 3"/JIS 80A, PP
52023920 Flange, Uni-DN80/ANSI 3"/JIS 80A, PVDF
52023921 Flange, Uni-DN80/ANSI 3"/JIS 80A, 316L
52023922 Flange, Uni-DN100/ANSI 4"/JIS 100A, PP
52023923 Flange, Uni-DN100/ANSI 4"/JIS 100A, PVDF

58 Hexagon nut

52000599 Hexagon nut (SW60) G1-1/2, bk, PC
52000598 Hexagon nut (SW70) G2, bk, PC

65 Sealing kit

52010526 Sealing kit FMU4x

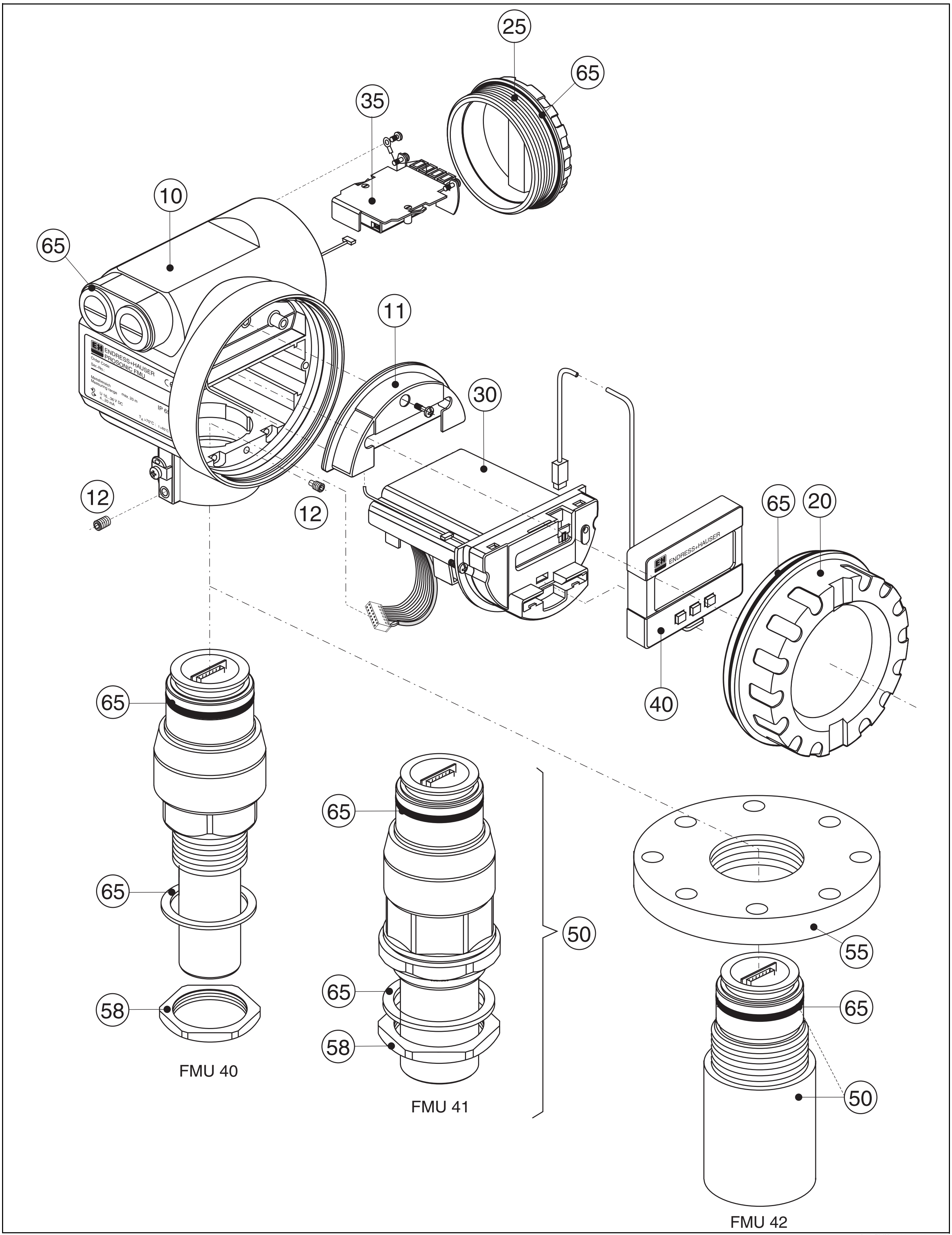
Miscellaneous

52010545 Nameplate Prosonic M, modification

Spare parts for FHX40

52018204 Adaption kit housing F12, 2-wire, FHX40
52018205 Adaption kit housing F12, 4-wire, FHX40
52016334 Cable FHX40, 20m

8.6 Spare parts (housing type T12)



L00-FMU4x-00-00-00-yy-008

10 Housing

543180-1023 Housing T12, aluminium, NPT1/2, PEL

52006204 Housing T12, aluminium, G1/2, PEL, cover

52006205 Housing T12, aluminium, M20, PEL, cover

11 Hood for terminal compartment

52005643 Hood T12

12 Set of screws

535720-9020 Set of screws for housing F12/T12

20 Cover

517391-0011 Cover F12/T12 aluminium, coated, seal

52005936 Cover F12/T12 aluminium, inspection glass, seal

25 Cover for the connection compartment

518710-0020 Cover T3/T12, aluminium, coated, seal

30 Electronics

71025600 electronics FMU4x, Ex, 2-wire HART, V4.0

71025603 electronics FMU4x, Ex, PROFIBUS PA, V4.0

52023759 Electronics Prosonic M, Ex, FF, V2.04

35 Terminal module / power unit

52013302 Terminal module Ex d, 4-pin, 2-wire, HART, T12

52013303 Terminal module Ex d, 2-pin, 2-wire, PROFIBUS PA, Foundation Fieldbus, T12

52018949 Terminal module EEx ia, 4-pin, HART, T12, OVP

52018950 Terminal module EEx ia, 4-pin, PROFIBUS PA, Foundation Fieldbus, T12, OVP

40 Display

52005585 Display/operating module VU331

50 Probe with process connection

52010509 Sensor FMU40 G1-1/2

52010507 Sensor FMU40 NPT1-1/2

52010510 Sensor FMU41 G2

52010508 Sensor FMU41 NPT2

52023965 Sensor FMU42

55 Flanges

52023919 Flange, Uni-DN80/ANSI 3"/JIS 80A, PP

52023920 Flange, Uni-DN80/ANSI 3"/JIS 80A, PVDF

52023921 Flange, Uni-DN80/ANSI 3"/JIS 80A, 316L

52023922 Flange, Uni-DN100/ANSI 4"/JIS 100A, PP

52023923 Flange, Uni-DN100/ANSI 4"/JIS 100A, PVDF

52023924 Flange, Uni-DN100/ANSI 4"/JIS 100A, 316L

58 Hexagon nut

52000598 Hexagon nut (SW70) G2, bk, PC

52000599 Hexagon nut (SW60) G1-1/2, bk, PC

65 Sealing kit

52010526 Sealing kit FMU4x

Miscellaneous

52010545 Nameplate Prosonic M, modification

8.7 Return

The following procedures must be carried out before a transmitter is sent to Endress+Hauser e.g. for repair or calibration:

- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- Always enclose a duly completed "Declaration of contamination" form (a copy of the “Declaration of contamination” is included at the end of this operating manual). Only then can Endress +Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.

Additionally specify:

- An exact description of the application.
- The chemical and physical characteristics of the product.
- A short description of the error that occurred (specify error code if possible)
- Operating time of the device.

8.8 Disposal

In case of disposal please seperate the different components according to their material consistence.

8.9 Software history

Software version / date	Changes to software	Changes to documentation
V 01.02.00 / 01.2002 V 01.02.02 / 03.2003	Original software Compatible with: ■ ToF Tool ■ Commuwin II (version 2.05.03 and higher ■ HART Communicator DXR 275 (from OS 4.6) with Rev. 1, DD 1	
V 01.02.04/02.2004	■ FMU 42 added ■ compatible with HART Communicator DXR 375	FMU 42 added
V 01.04.00/07.2006	■ "detection window" function added can be operated via: ■ ToF Tool from version 4.50 ■ HART Communicator DXR375 with Rev. 1, DD1	"detection window" added Version: 07.06

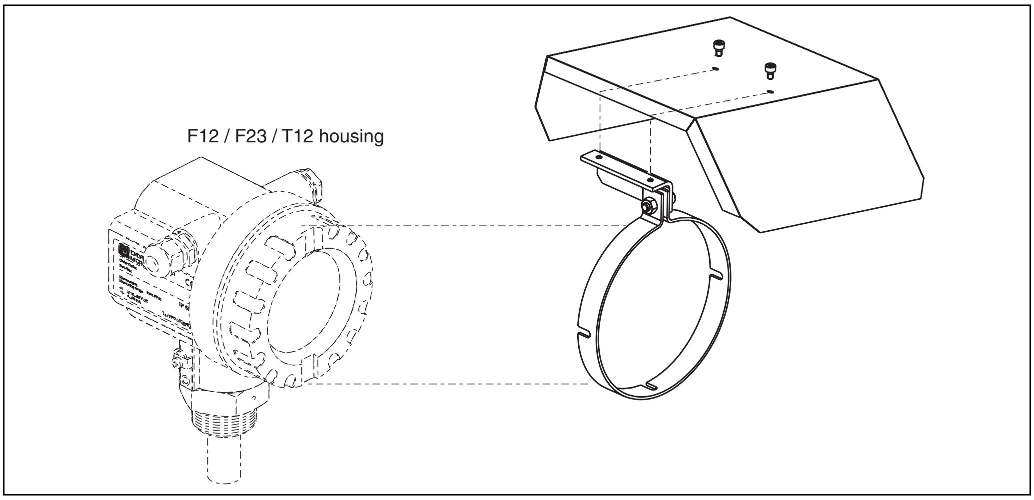
8.10 Contact addresses of Endress+Hauser

Contact addresses can be found on our homepage: www.endress.com/worldwide. If you have any questions, please do not hesitate to contact your Endress+Hauser representative.

9 Accessories

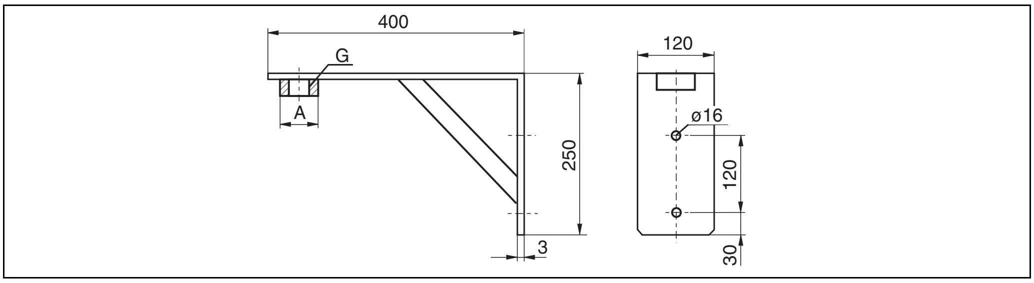
9.1 Weather protection cover

A Weather protection cover made of stainless steel is recommended for outdoor mounting (order code: 543199-0001). The shipment includes the protective cover and tension clamp.



L00-FMR2xxxx-00-00-06-en-001

9.2 Installation bracket for FMU 40/41

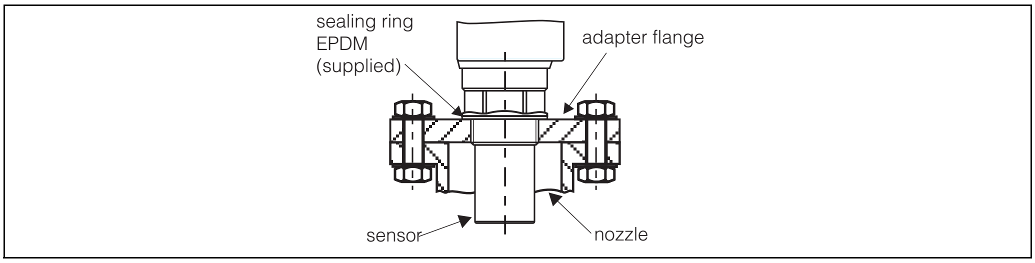


L00-FMU4x-00-00-00-de-001

- for FMU 40, G1½: Order No. 942669-0000
- for FMU 41, G2: Order No. 942669-0001

suited for NPT 1½" and 2" as well

9.3 Adapter flange



L00-FMUX3XXX-00-00-00-en-001

9.3.1 Version with metrical thread (FAU 70 E)

	Process Connection	
	12	DN 50 PN 16 A, flange EN1092-1 (DIN2527 B)
	14	DN 80 PN 16 A, flange EN1092-1 (DIN2527 B)
	15	DN 100 PN 16, A, flange EN1092-1 (DIN2527 B)

		Sensor Connection	
		3	Thread ISO228 G1-1/2
		4	Thread ISO228 G2

			Flange Material	
			2	316L
			7	Polypropylene

FAU 70 E				Product designation

9.3.2 Version with conical thread(FAU 70 A)

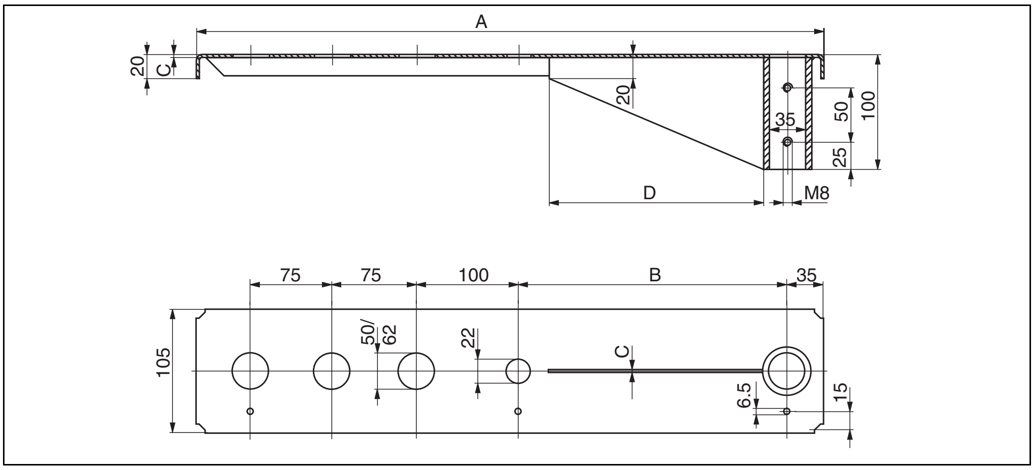
	Process Connection	
	22	2" 150lbs FF, flange ANSI B16.5
	24	3" 150lbs FF, flange ANSI B16.5
	25	4" 150lbs FF, flange ANSI B16.5

		Sensor Connection	
		5	Thread NPT1-1/2
		6	Thread NPT2

			Flange Material	
			2	316L
			7	Polypropylene

FAU 70 A				Product designation

9.4 Cantilever

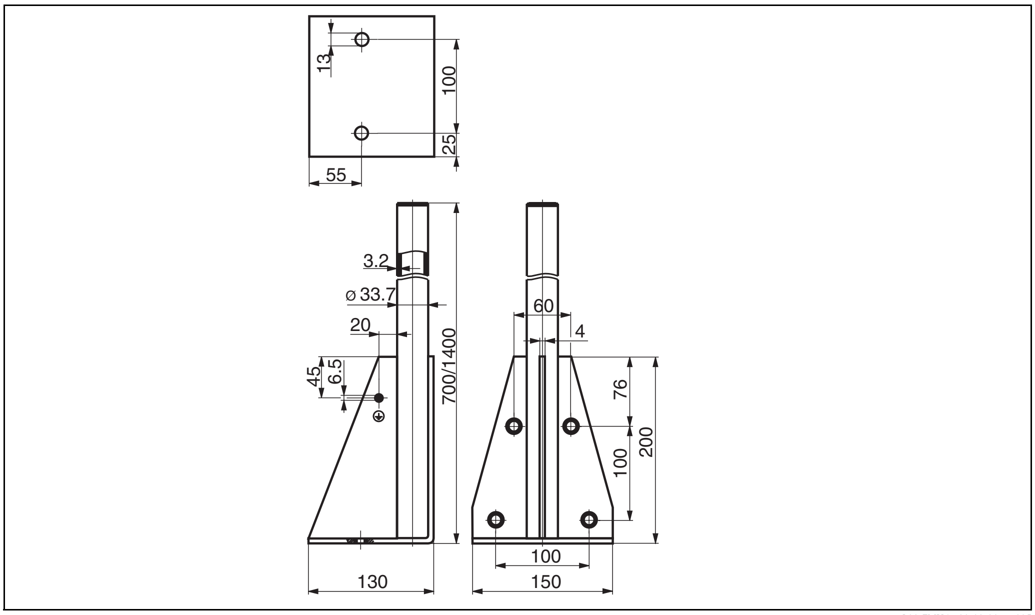


L00-FMU4xxxx-06-00-00-yy-005

A	B	C	D	for Sensor	Material	Order Code
585 mm	250 mm	2 mm	200 mm	FMU 40	1.4301 (AISI 304)	52014132
					galv. steel	52014131
				FMU 41	1.4301 (AISI 304)	52014136
					galv. steel	52014135
1085 mm	750 mm	3 mm	300 mm	FMU 40	1.4301 (AISI 304)	52014134
					galv. steel	52014133
				FMU 41	1.4301 (AISI 304)	52014138
					galv. steel	52014137

- The 50 mm or 62 mm orifices serve for the mounting of the FMU 40 or FMU 41 sensor, respecitvely.
- The 22 mm orifice may be used for an additional sensor.

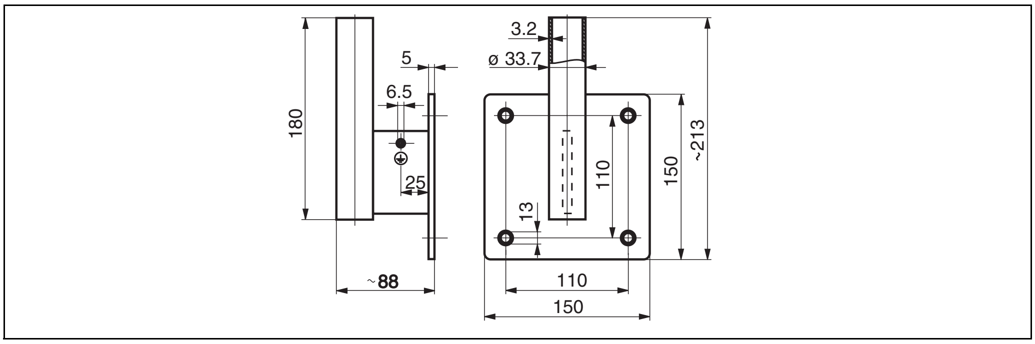
9.5 Mounting Frame



L00-FMU4x-00-00-00-yy-005

Height	Material	Order Code
700 mm	galv. steel	919791-0000
700 mm	1.4301 (AISI 304)	919791-0001
1400 mm	galv. steel	919791-0002
1400 mm	1.4301 (AISI 304)	919791-0003

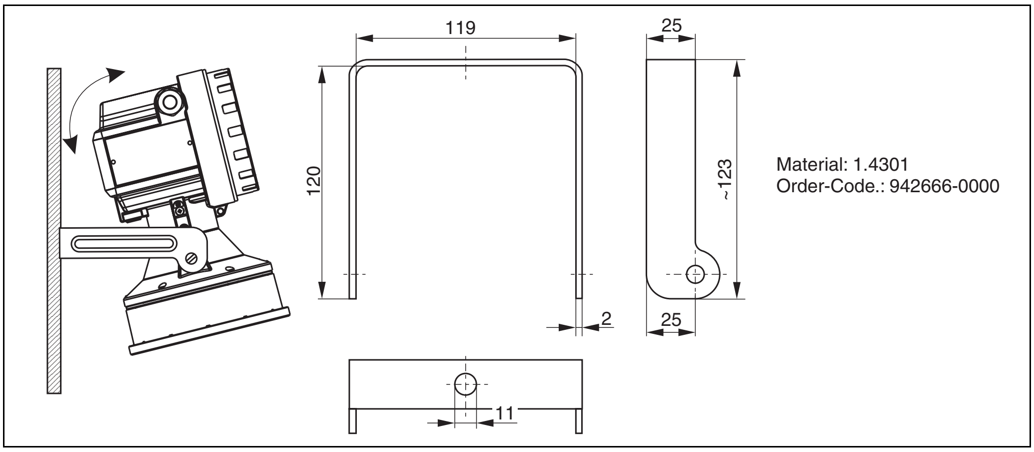
9.6 Wall Bracket



L00-FMU4x-00-00-00-yy-006

Material	Order Code
galv. steel	919792-0000
316Ti/1.4571	919792-0001

9.7 Mounting bracket for FMU 43



L00-FMU4x-00-00-00-en-003.eps

9.8 Commubox FXA291

The Commubox FXA291 connects Endress+Hauser field instruments with CDI interface (= Endress+Hauser Common Data Interface) to the USB interface of a personal computer or a notebook. For details refer to TI405C/07/en.

Note!
For the following Endress+Hauser instruments you need the "ToF Adapter FXA291" as an additional accessory:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70
- Gammapilot M FMG60
- Levelflex M FMP4x
- Micropilot FMR130/FMR131
- Micropilot M FMR2xx
- Micropilot S FMR53x, FMR540
- Prosonic FMU860/861/862
- Prosonic M FMU4x
- Tank Side Monitor NRF590 (with additional adapter cable)

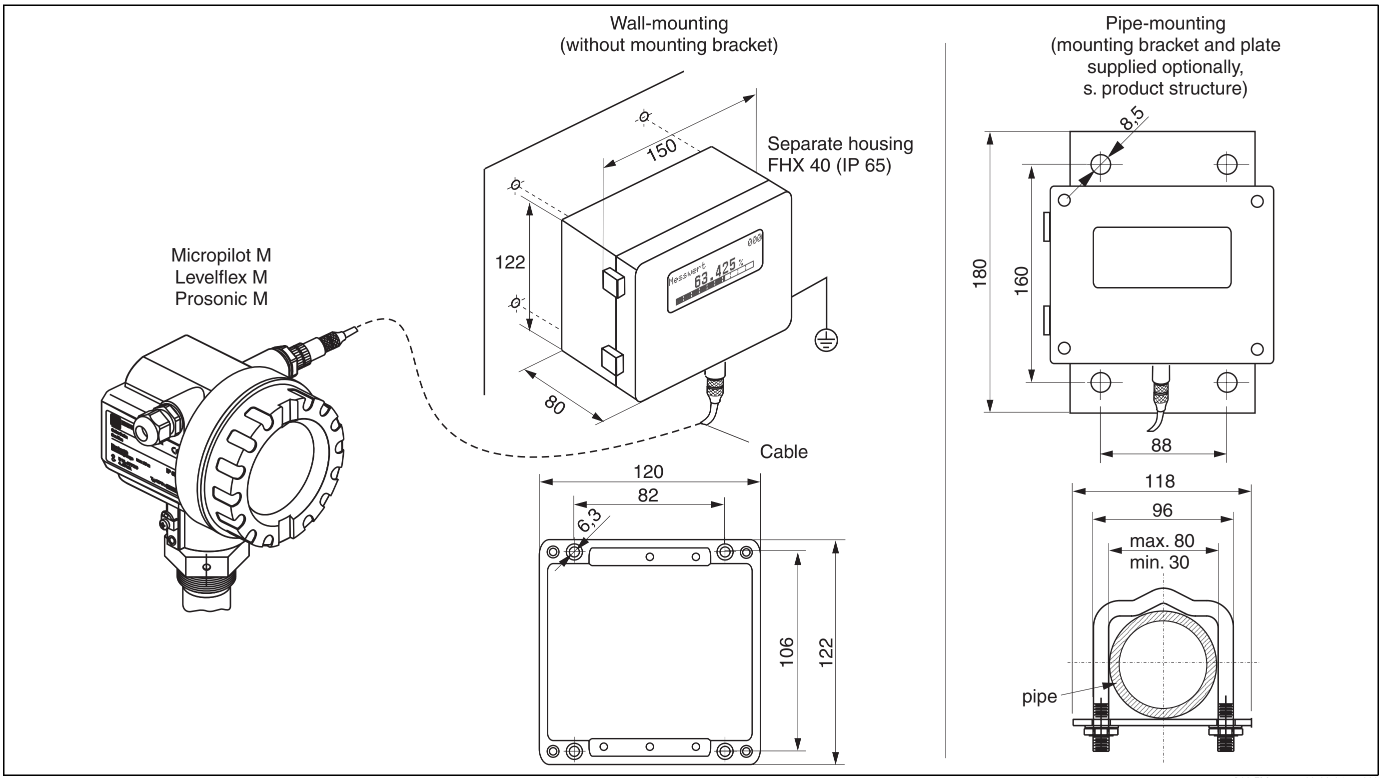
9.9 ToF Adapter FXA291

The ToF Adapter FXA291 connects the Commubox FXA291 via the USB interface of a personal computer or a notebook to the following Endress+Hauser instruments:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70
- Gammapilot M FMG60
- Levelflex M FMP4x
- Micropilot FMR130/FMR131
- Micropilot M FMR2xx
- Micropilot S FMR53x, FMR540
- Prosonic FMU860/861/862
- Prosonic M FMU4x
- Tank Side Monitor NRF590 (with additional adapter cable)

For details refer to KA271F/00/a2.

9.10 Remote display FHX40



L00-FMxxxxxx-00-00-06-en-003

9.10.1 Technical data (cable and housing) and product structure:

Max. cable length	20 m (65 ft)
Temperature range	-30 °C...+70 °C (-22 °F...158 °F)
Degree of protection	IP65 acc. to EN 60529 (NEMA 4)
Materials	Housing: AlSi12; cable glands: nickle plated brass
Dimensions [mm] / [inch]	122x150x80 (HxWxD) / 4.8x5.9x3.2

	Approval:			
	A			Nn-hazardous area
	1			ATEX II 2 G EEx ia IIC T6, ATEX II 3D
	S			FM IS Cl.I Div.1 Gr.A-D
	U			CSA IS Cl.I Div.1 Gr.A-D
	N			CSA General Purpose
	K			TIIS ia IIC T6 (in preparation)
		Cable:		
		1		20m/65ft; for HART
		5		20m/65ft; for PROFIBUS PA/FOUNDATION Fieldbus
			Additional option:	
			A	Basic version
			B	Mounting bracket, pipe 1"/ 2"
FHX40 -				Complete product designation

For connection of the remote display FHX40 use the cable which fits the communication version of the respective instrument.

10 Technical Data

10.1 Technical data at a glance

10.1.1 Input

Measured variable

The distance D between the sensor membrane and the product surface is measured.

Using the linearisation function, the device uses D to calculate:
- level L in any units
- volume V in any units
- flow Q across measuring weirs or open channels in any units

Maximum range/blocking distance

Sensor	Maximum range in liquids[1]	Maximum range in solids[1]	blocking distance
FMU 40	5 m	2 m	0,25 m
FMU 41	8 m	3,5 m	0,35 m
FMU 42	10 m	5 m	0,4 m
FMU 43	15 m	7 m	0,6 m

[1] The actual range is dependent on the measuring conditions. Refer to Technical Information TI 365F/00/en for an estimation.

10.1.2 Output

Output signal

PROFIBUS PA

Signal on alarm

- Error symbol, error code and plain text description on the on-site display
- Status byte of the digital signal input

10.1.3 Auxiliary energy

Cable entry

- Cable gland M20x1.5 (recommended cable diameter 6 ... 10 mm)
- Cable entry G½ or ½ NPT
- PROFIBUS M12 plug

Supply voltage

9 V ... 32 V
There may be additional restrictions for devices with an explosion protection certificate. Refer to the notes in the appropriate safety instructions (XA).

Current consumption

approx. 12 mA for the range of voltages given above

10.1.4 Performance characteristics

Reaction time

The reaction time depends on the parameter settings (min. 2s).

Reference operating conditions

- Temperature = +20 °C
- Pressure = 1013 mbar abs.
- Humidity = 50 %
- Ideal reflective surface (e.g. calm, smooth fluid surface)
- No interference reflections within signal beam
- Set application parameters:
  - Tank shape = flat ceiling
  - Medium property = liquid
  - process conditions = calm surface

Measured value resolution

Sensor	**Measured value resolution**
FMU 40	1 mm
FMU 41	1 mm
FMU 42	2 mm
FMU 43	2 mm

Measuring error

Typical specifications for reference operating conditions (include linearity, repeatability, and hysteresis):

Sensor	**Measuring error**
FMU 40	±2mm or 0.2% of set measuring distance (empty calibration)[1]
FMU 41	± 2 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU 42	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU 43	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]

[1] whichever is greater

10.1.5 Ambient conditions

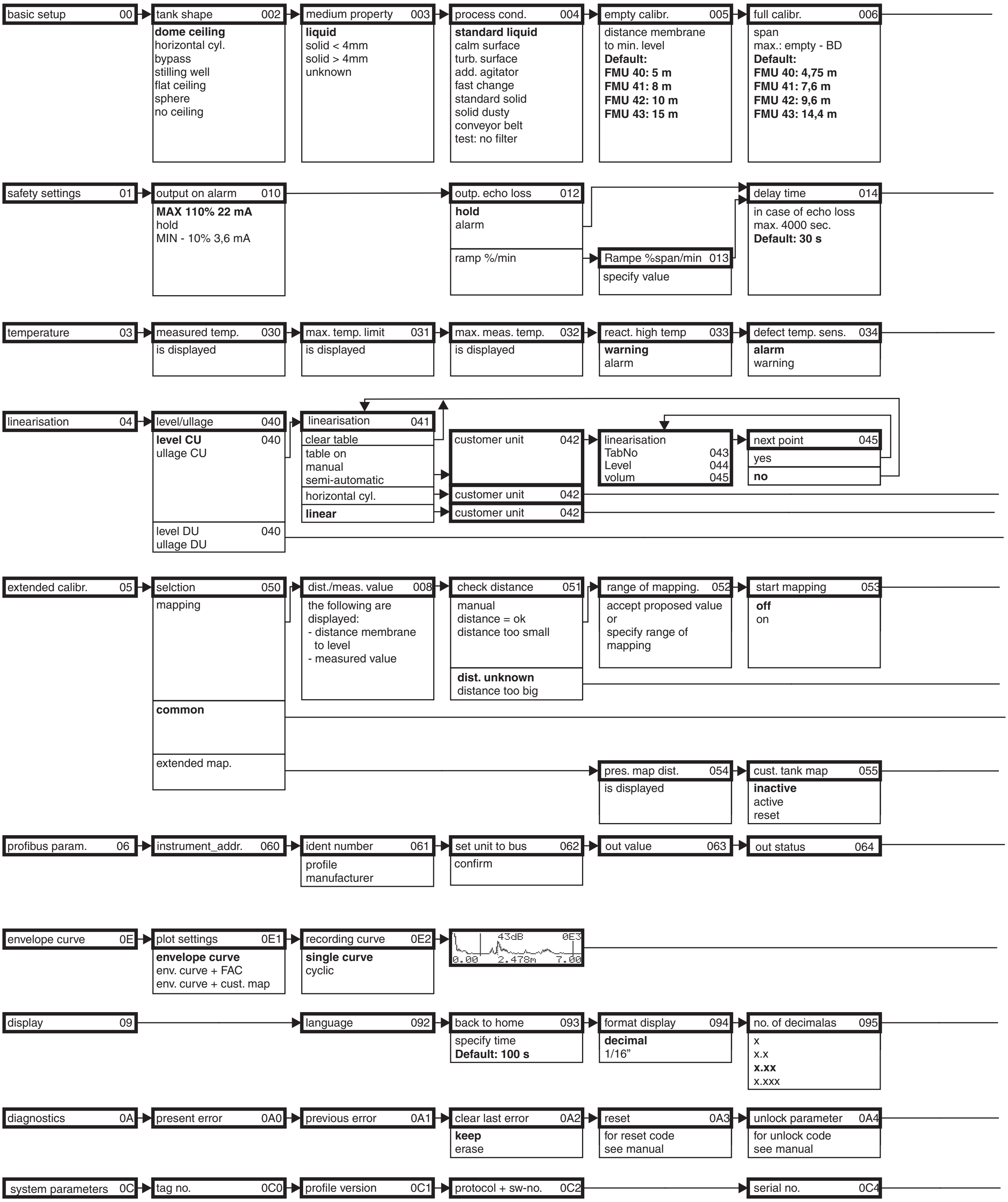
Ambient temperature	-40 °C ... +80 °C The functionality of the LC display becomes restricted at Tu<-20 °C and Tu>+60 °C. If the device is operated outdoors in strong sunlight, you should use a protective cover.
Storage temperature	-40 °C ... +80 °C
Climate class	DIN EN 60068-2-38 (Test Z/AD) DIN/IEC 68 T2-30Db
Ingress protection	▪ With closed housing, tested according to – IP 68, NEMA 6P (24h at 1.83m under water surface) – IP 66, NEMA 4x ▪ With open housing: IP 20, NEMA 1 (also ingress protection of the display)
Vibration resistance	DIN EN 60068-2-64 / IEC 68-2-64: 20…2000 Hz, 1 $(m/s^2)^2$/Hz; 3 x 100 min
Electromagnetic compatibility (EMC)	▪ Interference emission to EN 61326, Equipment Class B ▪ Interference immunity to EN 61326, Appendix A (Industrial) and NAMUR Recommendation NE 21 (EMC). ▪ A standard installation cable is sufficient if only the analogue signal is used. Use a screened cable when working with a superimposed communication signal (HART).

10.1.6 Process conditions

Process temperature	-40°C ... +80°C A temperature sensor is integrated in the sensor for correction of the temperature-dependent time-of-flight.
Process pressure	▪ FMU 40/41: 0.7 bar ... 3bar abs. ▪ FMU 42/43: 0.7 bar ... 2.5bar abs. Note! For pressures less than 0.7 bar please contact Endress+Hauser

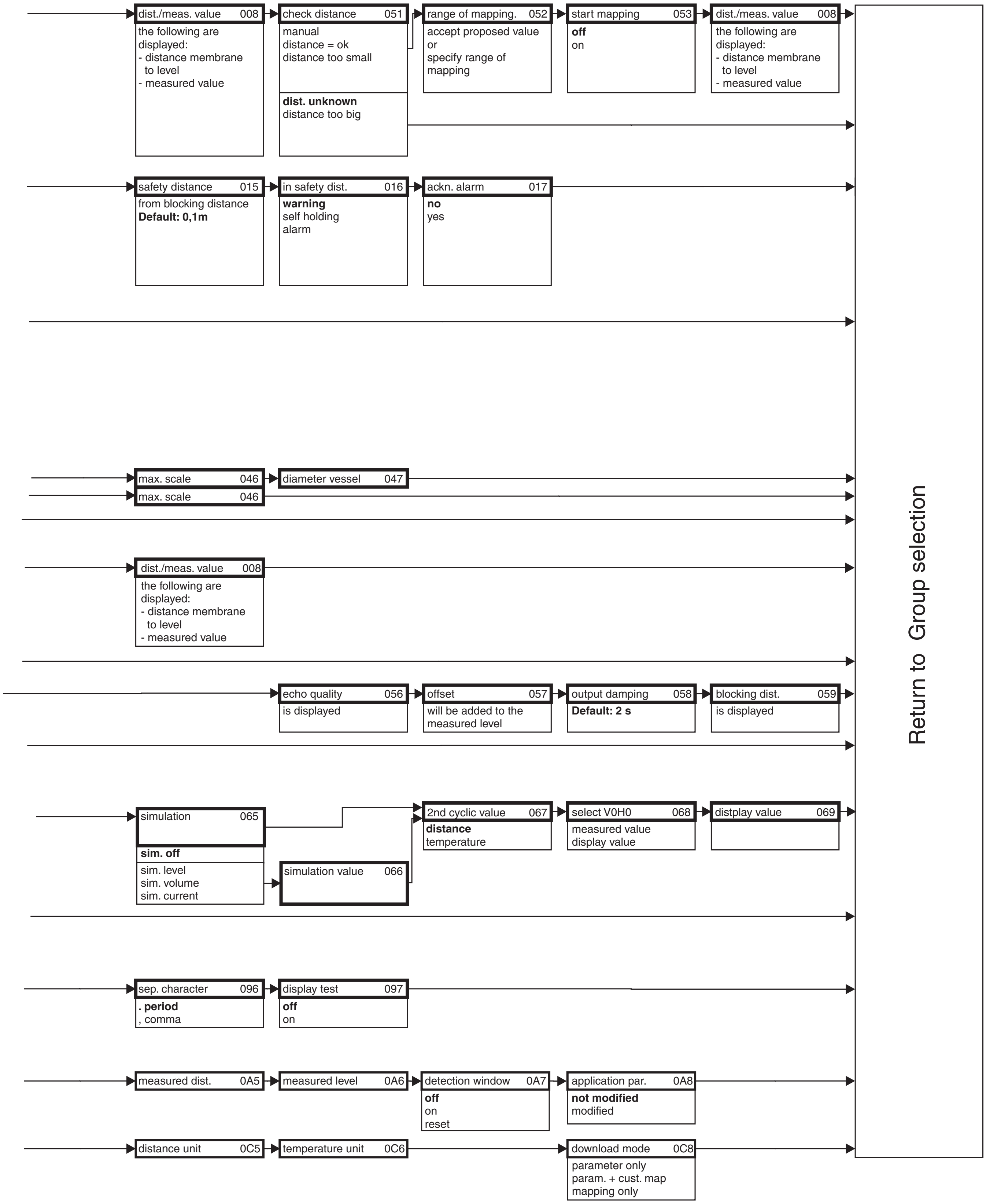
11 Appendix

11.1 Operating menu



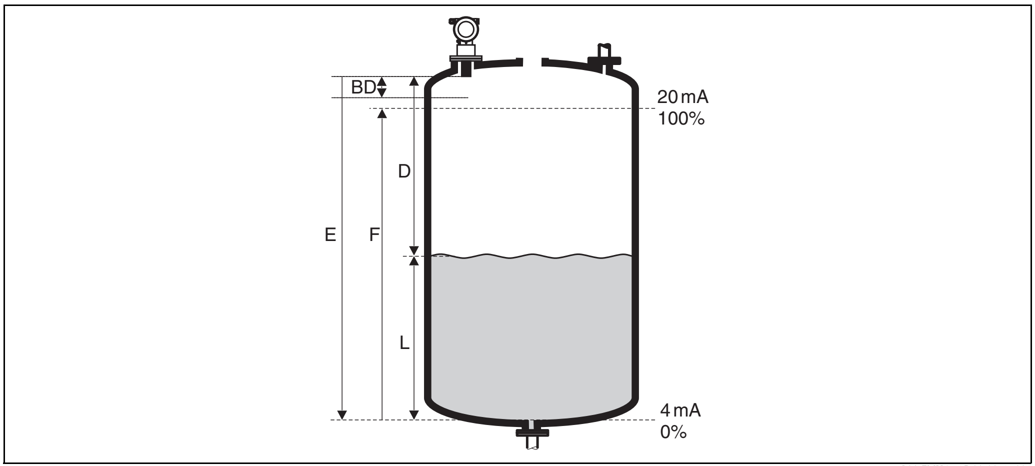
Note! The Default values of the parameters are typed in bold face.

L00-FMU4xxxx-19-00-01-en-016



L00-FMU4xxxx-19-00-02-en-016

11.2 Measuring principle



E: Empty distance; F: Span (full distance); D: Distance from sensor membrane - product surface; L: Level; BD: Blocking distance

Sensor	BD	Max. range fluids	Max. range bulk materials
FMU 40	0.25 m	5 m	2 m
FMU 41	0.35 m	8 m	3.5 m
FMU 42	0.4 m	10 m	5 m
FMU 43	0.6 m	15 m	7 m

11.2.1 Time-of-flight method

The sensor of the Prosonic M transmits ultrasonic pulses in the direction of the product surface. There, they are reflected back and received by the sensor. The Prosonic M measures the time t between pulse transmission and reception. The instrument uses the time t (and the velocity of sound c) to calculate the distance D between the sensor membrane and the product surface:

$D = c \cdot t/2$

As the device knows the empty distance E from a user entry, it can calculate the level as follows:

$L = E - D$

An integrated temperature sensor compensates for changes in the velocity of sound caused by temperature changes.

11.2.2 Interference echo suppression

The interference echo suppression feature on the Prosonic M ensures that interference echos (e.g. from edges, welded joints and installations) are not interpreted as a level echo.

11.2.3 Calibration

Enter the empty distance E and the span F to calibrate the device.

11.2.4 Blocking distance

Span F may not extend into the blocking distance BD. Level echos from the blocking distance cannot be evaluated due to the transient characteristics of the sensor.

Index

Endress+Hauser
People for Process Automation

Declaration of Hazardous Material and De-Contamination
Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.
Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp ____________________

Serial number
Seriennummer ____________________

☐ **Used as SIL device in a Safety Instrumented System /** *Einsatz als SIL Gerät in Schutzeinrichtungen*

Process data/ *Prozessdaten*

Temperature / *Temperatur* _____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

	Medium /concentration *Medium /Konzentration*	Identification CAS No.	flammable *entzündlich*	toxic *giftig*	corrosive *ätzend*	harmful/ irritant *gesundheits-schädlich/ reizend*	other * *sonstiges**	harmless *unbedenklich*
Process medium *Medium im Prozess*								
Medium for process cleaning *Medium zur Prozessreinigung*								
Returned part cleaned with *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / *Fehlerbeschreibung* ____________________

Company data / *Angaben zum Absender*

Company / *Firma* ____________________
Address / *Adresse* ____________________
Phone number of contact person / *Telefon-Nr. Ansprechpartner:* ____________________
Fax / E-Mail ____________________
Your order No. / *Ihre Auftragsnr.* ____________________

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."
"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

(place, date / *Ort, Datum)*
Name, dept./*Abt.* (please print / *bitte Druckschrift*)
Signature / *Unterschrift*

P/SF/Konta XIV

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People for Process Automation

BA238F/00/en/08.06
CCS/FM+SGML 6.0/ProMoDo

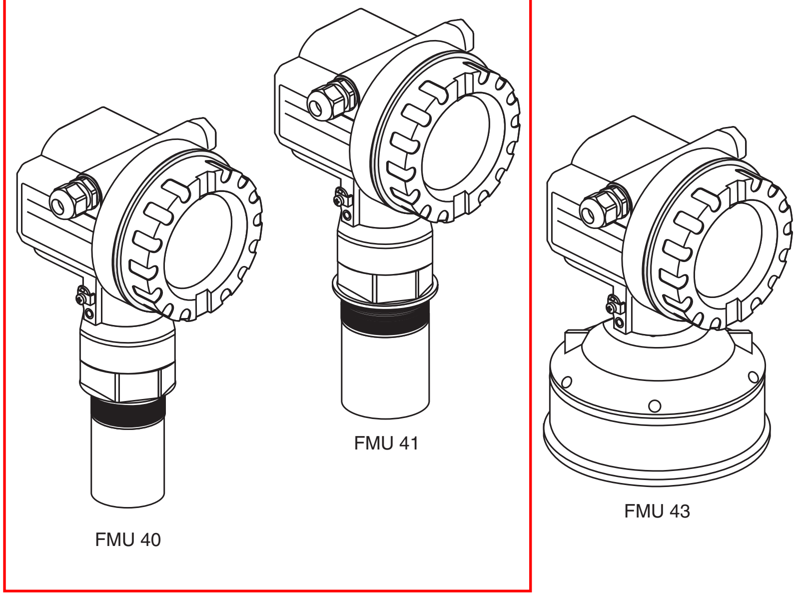
52010986

BA 240F/00/en/01.02
Nr. 52011048

Valid as of software version:
V 01.02.00 (amplifier)
V 01.02.00 (communication)

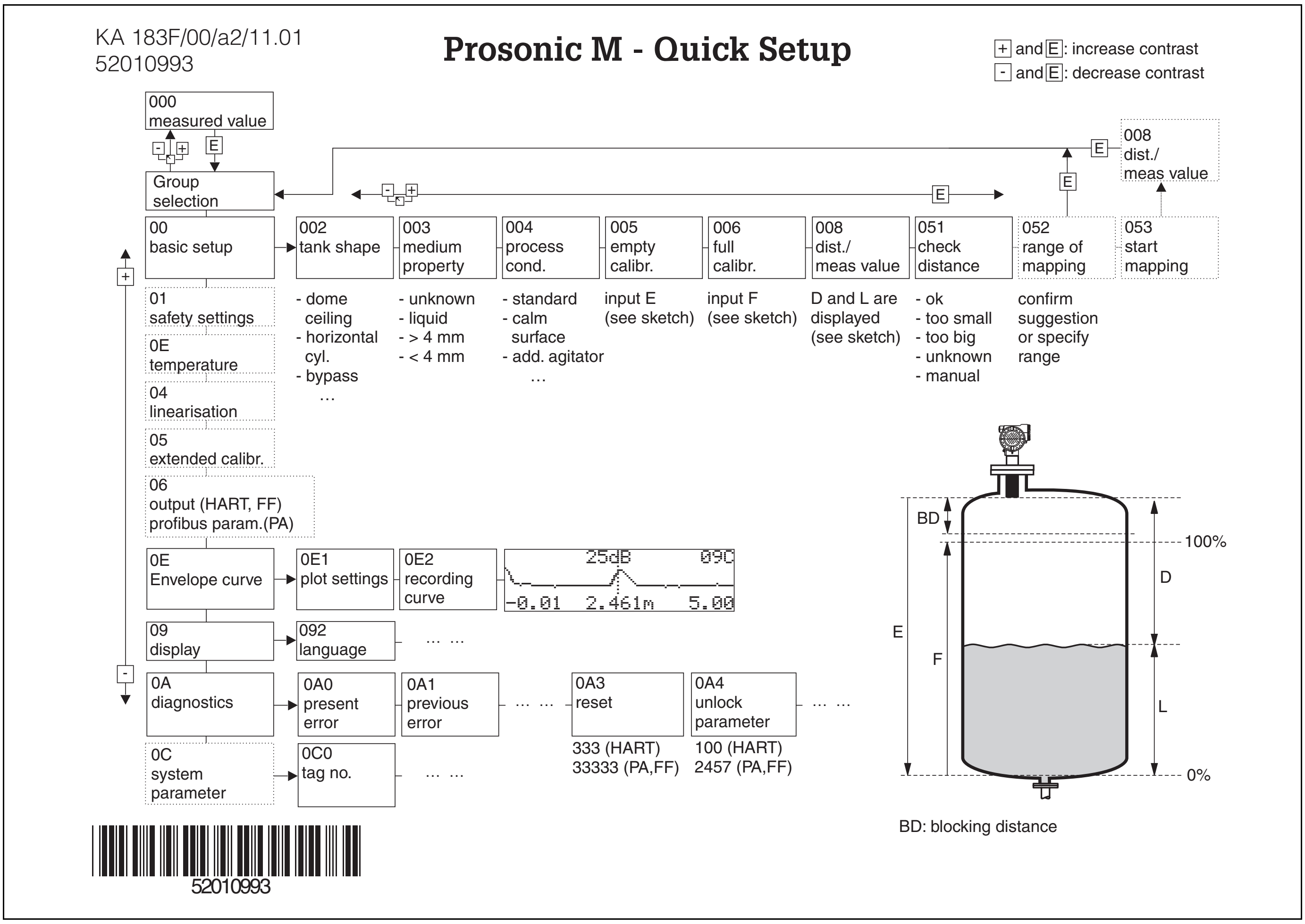
prosonic M
FMU 40/41/43
with HART, PROFIBUS-PA and Foundation Fieldbus
Ultrasonic Level Measurement

Description of Instrument Functions



Endress+Hauser
The Power of Know How

Short instructions



Contents of the operating instructions

This operating instrucitons contain all functions off the Prosonic M operating menu. All types of devices (FMU 40/41/43) and all communication variants are considered.

Information on mounting, wiring, trouble shooting and maintenance can be found in the following documents which are supplied together with the instrument:

- BA 237F/00/en (HART)
- BA 238F/00/en (PROFIBUS-PA)
- BA 239F/00/en (Foundation Fieldbus)

These documents can also be found on the second ToF Tool CD-ROM "Device Desriptions + Documentation"

Table of contents

1 Notes on use

You have various options for accessing the descriptions of instrument functions or how to enter parameters.

1.1 Using the table of contents to locate a function description

All the functions are listed in the table of contents sorted by function group (e.g. basic setup, safety settings, etc.). You can access a more detailed description of a function by using a page reference / link.
The table of contents is on Page 3.

1.2 Using the graphic of the function menu to locate a function description

This guides you step by step from the highest level, the function groups, to the exact function description you require.

All the available function groups and instrument functions are listed in the table (see Page 11). Select your required function group or function. You can access an exact description of the function group or function by using a page reference.

1.3 Using the index of the function menu to locate a function description

To simplify navigation within the function menu, each function has a position which is shown in the display. You can access each function via a page reference in the function menu index (see page 79) which lists all the function names alphabetically and numerically.

1.4 General structure of the operating menu

The operating menu is made up of two levels:

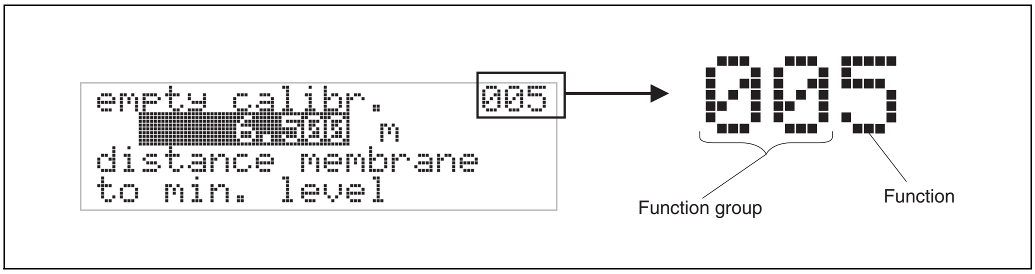
- **Function groups (00, 01, 03, …, 0C, 0D):**
  The individual operating Selection of the instrument are split up roughly into different function groups. The function groups that are available include, e.g.: "**basic setup**", "**safety settings**", "**output**", "**display**", etc.
- **Functions (001, 002, 003, …, 0D8, 0D9):**
  Each function group consists of one or more functions. The functions perform the actual operation or parameterisation of the instrument. Numerical values can be entered here and parameters can be selected and saved. The available functions of the "**basic setup (00)**" function group include, e.g.: "**tank shape (002)**", "**medium property (003)**", "**process cond. (004)**", "**empty calibr. (005)**", etc.

If, for example, the application of the instrument is to be changed, carry out the following procedure:

1. Select the "**basic setup (00)**" function group.
2. Select the "**tank shape (002)**" function (where the existing tank shape is selected).

1.4.1 Identifying the functions

For simple orientation within the function menus (see Page 11 ff.), for each function a position is shown on the display.



The first two digits identify the function group:

• **basic setup**	**00**
• **safety settings**	**01**
• **temperature**	**03**

…

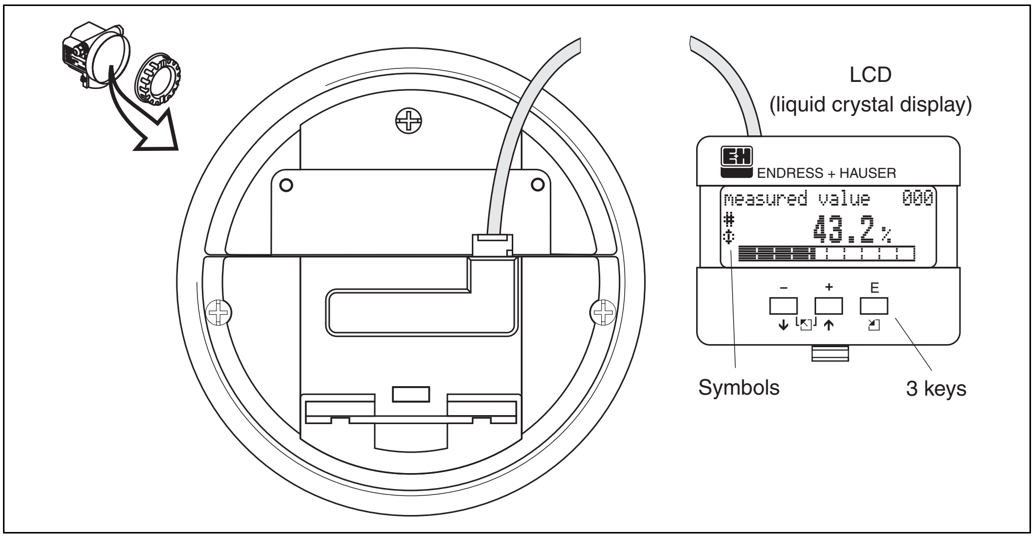
The third digit numbers the individual functions within the function group:

• **basic setup**	**00**	→	• **tank shape**	**002**
			• **medium property**	**003**
			• **process cond.**	**004**

…

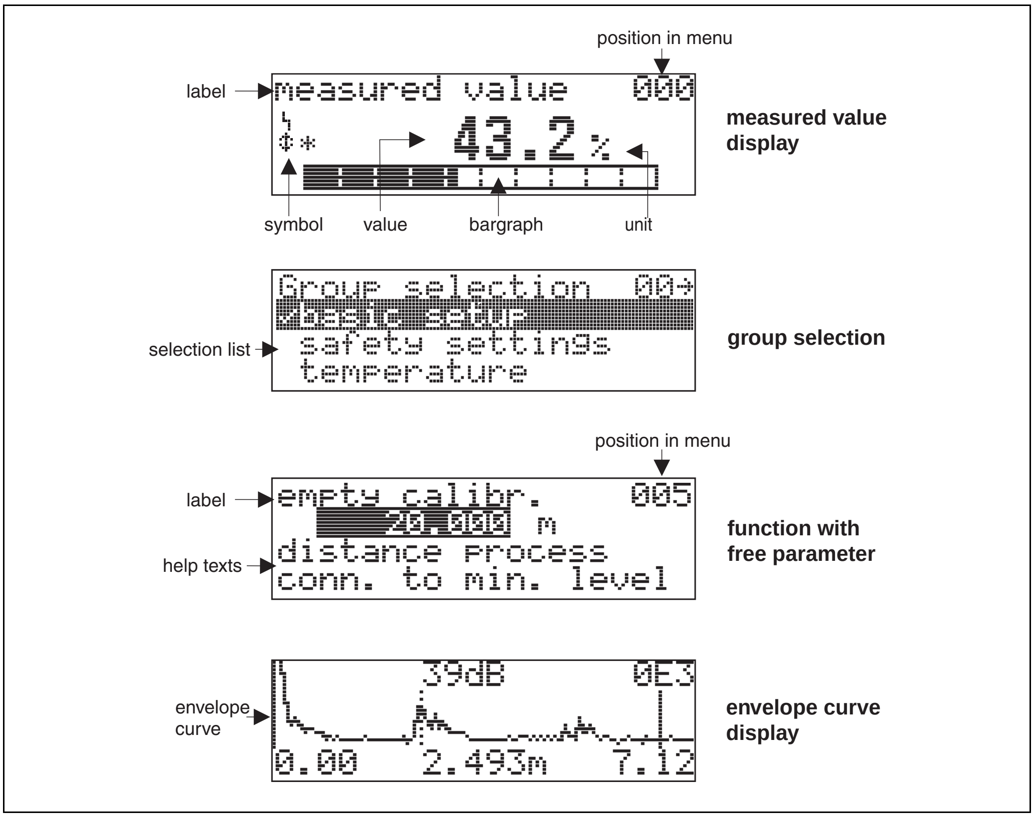
Hereafter the position is always given in brackets (e.g. "**tank shape**" **(002)**) after the described function.

1.5 Display and operating elements



1.5.1 Display

Liquid crystal display (LCD):
Four lines with 20 characters each. Display contrast adjustable through key combination.



1.5.2 Display symbols

The following table describes the symbols that appear on the liquid crystal display:

Symbols	Meaning
ϟ	**ALARM_SYMBOL** This alarm symbol appears when the instrument is in an alarm state. If the symbol flashes, this indicates a warning.
🔒	**LOCK_SYMBOL** This lock symbol appears when the instrument is locked,i.e. if no input is possible.
⇕	**COM_SYMBOL** This communication symbol appears when a data transmission via e.g. HART, PFOFIBUS-PA or Foundation Fieldbus is in progress.
✱	**SIMULATION_SWITCH_ENABLE** This communication symbol appears when simulation in FF is enabled via the DIP switch.

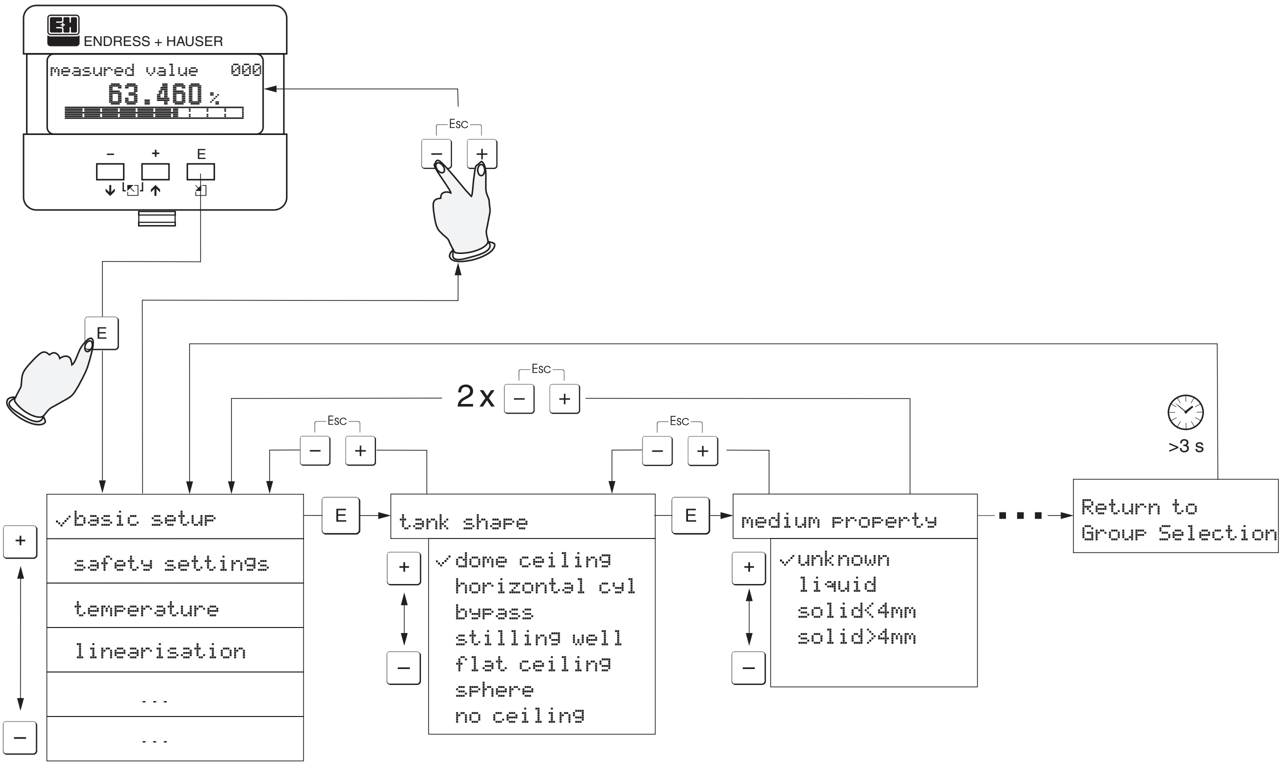
1.5.3 Key assignment

The operating elements are located inside the housing and are accessible for operation by opening the lid of the housing.

Function of the keys

Key(s)	Meaning
+ or ↑	Navigate upwards in the selection list Edit numeric value within a function
– or ↓	Navigate downwards in the selection list Edit numeric value within a function
Esc – + or ↖	Navigate to the left within a function group
E or E	Navigate to the right within a function group, confirmation.
+ and E or – and E	Contrast settings of the LCD
+ and – and E	Hardware lock / unlock After a hardware lock, an operation of the instrument via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

1.5.4 Operation with the VU 331



Selection and configuration in Operation menu:

1.) Change from Measured Value Display to **Group Selection** by pressing E

2.) Press − or + to select the required **Function Group** (e.g.. "basic setup (00)") and confirm by pressing E

➜ First f**unction** (e.g. "tank shape (002)") is selected.

Note!
The active selection is marked by a ✔ in front of the menu text.

3.) Activate Edit mode with + or −.

Selection menus:

a) Select the required **Parameter** in selected **function** (e.g. "tank shape (002)") with − or +.

b) E confirms selection ➜ ✔ appears in front of the selected parameter

c) E confirms the edited value ➜ system quits Edit mode

d) + / − (= Esc − +) interrupts selection ➜ system quits Edit mode

Typing in numerals and text:

a) Press + or − to edit the first character of the **numeral / text** (e.g. "empty calibr. (005)")

b) E positions the cursor at the next character ➜ continue with (a) until you have completed your input

c) if a ↵ symbol appears at the cursor, press E to accept the value entered
➜ system quits Edit mode

d) if a ← symbol appears at the cursor, press E to return to the previous character
(e.g. for correction of entries)

e) + / − (= Esc − +) interrupts the input, system quits Edit mode

4) Press E to select the next **function** (e.g. "medium property (003)")

5) Press + / − (= Esc − +) once ➜ return to previous **function** (e.g. "tank shape (002)")

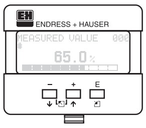
Press + / − (= Esc − +) twice ➜ return to **Group selection**

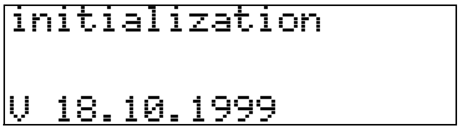
6) Press + / − (= Esc − +) to return to **Measured value display**

1.6 Commissioning

1.6.1 Switching on the measuring device

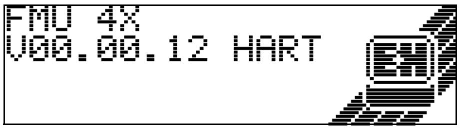
When the instrument is switched on for the first time, the following messages appear on the display:



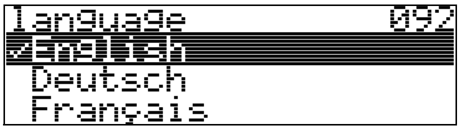

initialization

V 18.10.1999

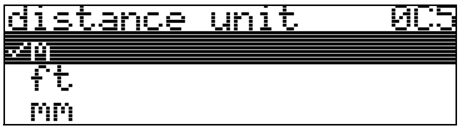
After 5 s, the following message appears


FMU 4X
V00.00.12 HART

After 5 s or after you have pressed E the following message appears


language 092
✓English
Deutsch
Français

Select the language
(this message appears the first time the instrument is switched on)

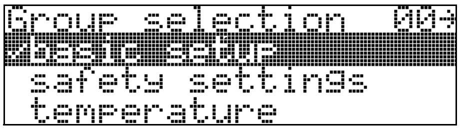

distance unit 0C5
✓m
ft
mm

Select the basic unit
(this message appears the first time the instrument is switched on)


measured value 000
63.460 %

The current measured value is displayed

After E is pressed, you reach the group selection.


Group selection 00→
✓basic setup
safety settings
temperature

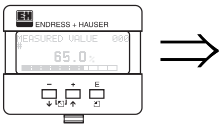
This selection enables you to perform the basic setup

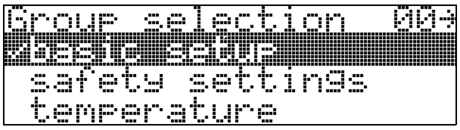
2 Function menu Prosonic M

Function group			Function			Description
basic setup	**00**	⇒	measured value	000	→	Page 13
(see Page 13)			tank shape	002	→	Page 13
⇓			medium property	003	→	Page 14
			process cond.	004	→	Page 14
			empty calibr.	005	→	Page 16
			blocking dist.	059	→	Page 16
			full calibr.	006	→	Page 17
			display	008		Page 17
			check distance	051	→	Page 18
			range of mapping	052	→	Page 19
			start mapping	053	→	Page 19
			display	008		Page 20
safety settings	**01**	⇒	output on alarm	010	→	Page 21
(see Page 21)			output on alarm (HART only)	011	→	Page 23
⇓			outp. echo loss	012	→	Page 23
			ramp %span/min	013	→	Page 24
			delay time	014	→	Page 25
			safety distance	015	→	Page 25
			in safety dist.	016	→	Page 26
			ackn. alarm	017	→	Page 28
temperature	**03**	⇒	measured temp.	030	→	Page 29
(see Page 29)			max. temp. limit	031	→	Page 29
⇓			max. meas. temp.	032	→	Page 29
			react high temp.	033	→	Page 30
			defect temp. sens.	034	→	Page 30
linearisation	**04**	⇒	level/ullage	040	→	Page 31
(see Page 31)			linearisation	041	→	Page 32
⇓			customer unit	042	→	Page 36
			table no.	043	→	Page 37
			input level	044	→	Page 37
			input volume	045	→	Page 38
			max. scale	046	→	Page 38
			diameter vessel	047	→	Page 38
extended calibr.	**05**	⇒	selection	050	→	Page 39
(see Page 39)			check distance	051	→	Page 39
⇓			range of mapping	052	→	Page 40
			start mapping	053	→	Page 41
			pres. map dist.	054	→	Page 41
			cust. tank map	055	→	Page 42
			echo quality	056	→	Page 42
			offset	057	→	Page 43
			output damping	058	→	Page 43
			blocking dist.	059	→	Page 43

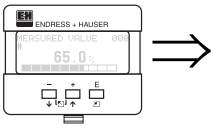
Function group			Function			Description
output	**06**	⇒	commun. address (HART only)	060	→	Page 44
profibus param.	**06**		instrument addr. (PROFIBUS-PA only)	060	→	Page 44
PROFIBUS-PA only			no. of preambels (HART only)	061	→	Page 45
(see Page 44)			ident number (PROFIBUS-PA only)	061	→	Page 45
⇓			thres. main val. (HART only)	062	→	Page 46
			set unit to bus (PROFIBUS-PA only)	062	→	Page 46
			current output mode (HART only)	063	→	Page 47
			out value (PROFIBUS-PA only)	063	→	Page 47
			fixed cur. value (HART only)	064	→	Page 48
			out status (PROFIBUS-PA only)	064	→	Page 48
			simulation	065	→	Page 49
			simulation value	066	→	Page 50
			output current (HART only)	067	→	Page 51
			2nd cyclic value (PROFIBUS-PA only)	067	→	Page 51
			4 mA value	068	→	Page 51
			select v0h0 (PROFIBUS-PA only)	068	→	Page 52
			20 mA value		→	Page 52
			display value (PROFIBUS-PA only)	069	→	Page 52
envelope	**0E**	⇒	plot settings	0E1	→	Page 53
(see Page 53)			recording curve	0E2	→	Page 53
⇓			envelope curve display	0E3	→	Page 54
display	**09**	⇒	language	092	→	Page 56
(see Page 56)			back to home	093	→	Page 56
⇓			format display	094	→	Page 57
			no.of decimals	095	→	Page 57
			sep. character	096	→	Page 57
			display test	097	→	Page 58
diagnostics	**0A**	⇒	present error	0A0	→	Page 60
(see Page 59)			previous error	0A1	→	Page 60
⇓			clear last error	0A2	→	Page 60
			reset	0A3	→	Page 61
			unlock parameter	0A4	→	Page 62
			measured dist.	0A5	→	Page 63
			measured level	0A6	→	Page 64
			application par.	0A8	→	Page 64
system parameter	**0C**	⇒	tag no.	0C0	→	Page 65
(see Page 65)			device tag (Foundation Fieldbus only)	0C0	→	Page 65
⇓			Profile Version (PROFIBUS-PA only)	0C1	→	Page 65
			protocol+sw-no.	0C2	→	Page 65
			serial no.	0C4	→	Page 66
			device id (Foundation Fieldbus only)	0C4	→	Page 66
			distance unit	0C5	→	Page 66
			temperature unit	0C6	→	Page 67
			download mode	0C8	→	Page 67
service	**D00**	⇒	service level	D00		Page 68

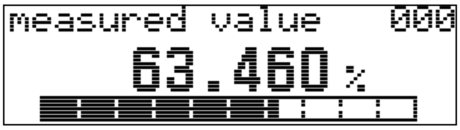
3 Function group "basic setup" (00)




```
Group selection  00→
⇒basic setup
 safety settings
 temperature
```

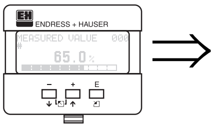
3.1 Function "measured value" (000)




```
measured value  000
      63.460 %
```

This function displays the current measured value in the selected unit (see "**customer unit**" **(042)** function). The number of places after decimal point can be selected in the "**no.of decimals**" **(095)** function.

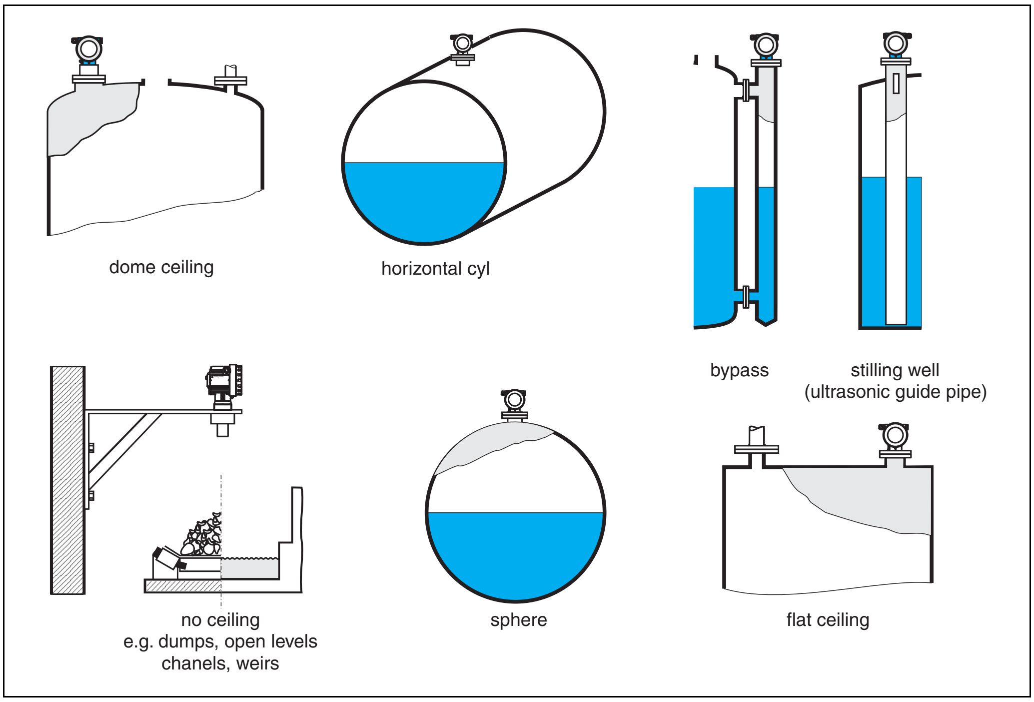
3.2 Function "tank shape" (002)



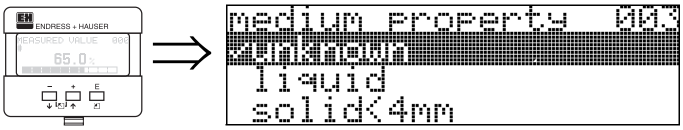

```
tank shape      002
⇒dome ceiling
 horizontal cyl
 bypass
```

This function is used to select the tank shape.

Selection



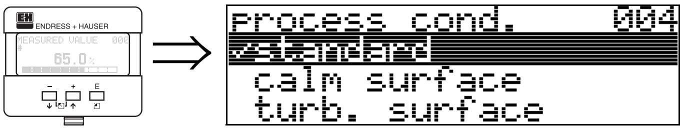
3.3 Function "medium property" (003)



This function is used to set the medium properties:

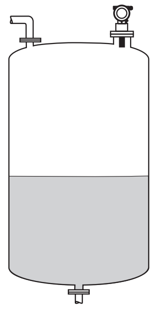
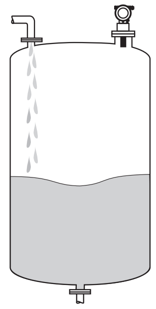
- **unknown** (e.g. pasty media such as greases, creams, gels etc.)
- liquid
- solid, grain size < 4mm (fine)
- solid, grain size > 4mm (coarse)

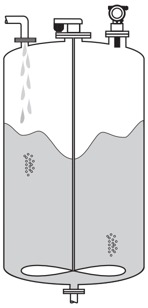
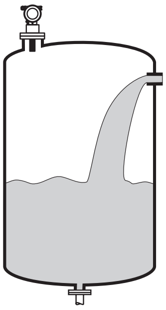
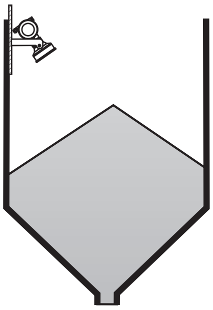
3.4 Function "process cond." (004)

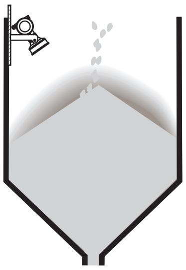
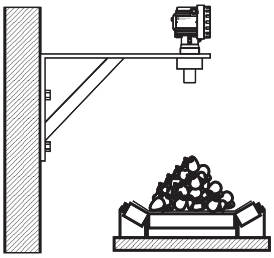


This function is used to select the process conditions.

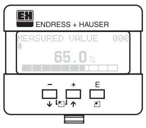
Selection:

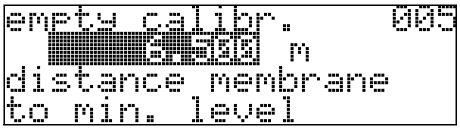
standard liquids	calm surface	turb. surface
For all fluid applications which do not fit in any of the following groups.	Storage tanks with immersion tube or bottom filling	Storage / accumulation tanks with uneven surface due to free filling, mixing nozzles or small bottom stirrers
		
The filters and output damping are set to average values.	The averaging filters and output damping are set to large values. -> Stable measured value -> Accurate measurement -> Slow reaction time	Special filters for stabilising the input signal are activated. -> Stable measured value -> Medium reaction time

add. agitator	fast change	standard solid
Moving surfaces (poss. with vortex formation) due to agitators	Rapid level change, particularly in small tanks	For all bulk solids applications which do not fit in any of the following groups.
		
Special filters for stabilising the input signal are set to large values. -> Stable measured value -> Medium reaction time	The averaging filters are set to small values. -> Rapid reaction time -> Possibly unstable measured value	The filter and output damping are set to average values.

solid dusty	conveyor belt	Test: no filter
Dusty bulk solids	Bulk solids with rapid level change	All the filters can be switched off for purposes of service and diagnosis.
		
The filters are set to detect even relatively weak signals.	The averaging filters are set to small values. -> Rapid reaction time -> Possibly unstable measured value	All filters off

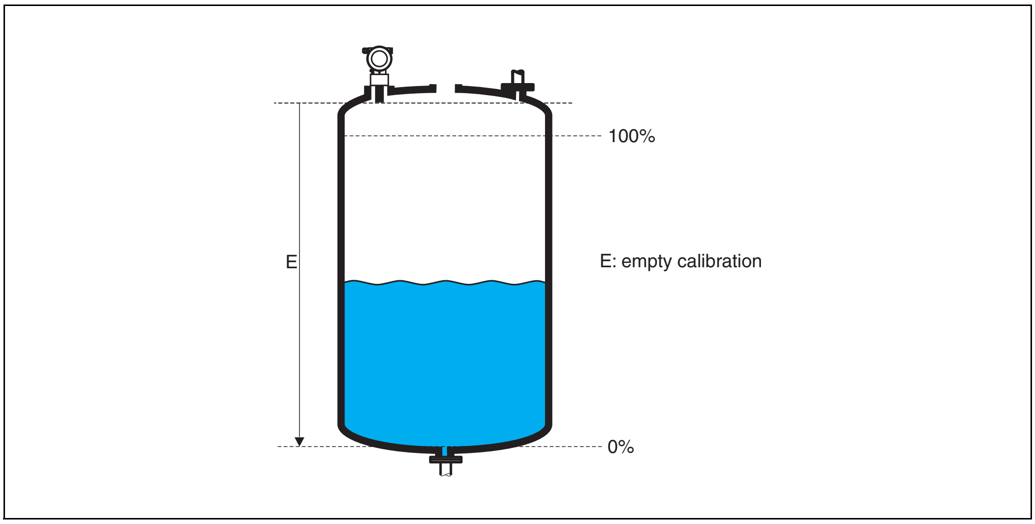
3.5 Function "empty calibr." (005)





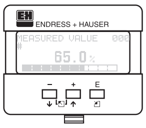
```
empty calibr.     005
      6.500 m
distance membrane
to min. level
```

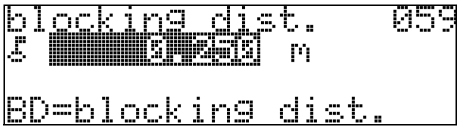
This function is used to enter the distance from the sensor membrane (reference point of the measurement) to the minimum level (=zero).



Caution!
For dish bottoms or conical outlets, the zero point should be no lower than the point at which the radar beam hits the bottom of the tank.

3.6 Function "blocking dist." (059)



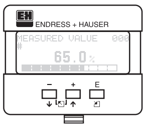


```
blocking dist.    059
      0.250 m

BD=blocking dist.
```

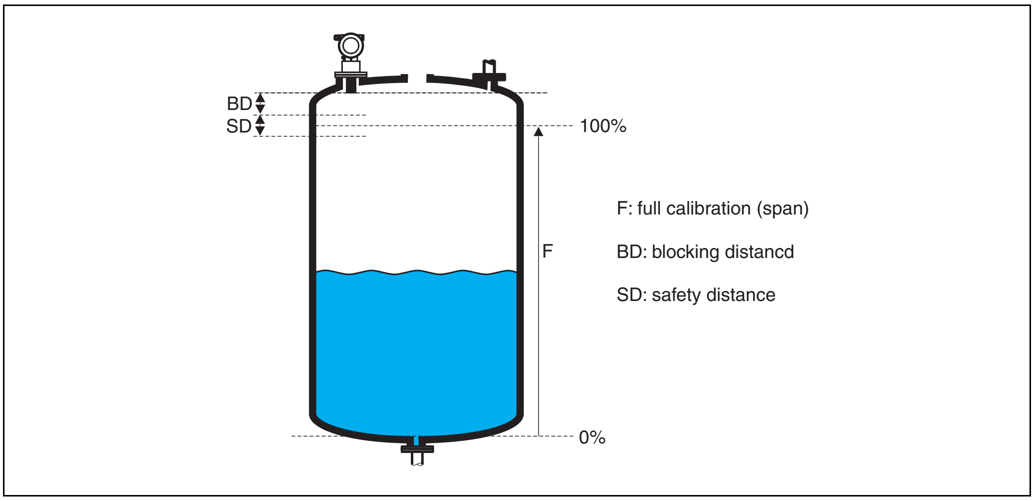
In this function the blocking distance is displayed. Level echoes within the blocking distance can not be detected by the Prosonic M. Make sure that the maximum level will never run into the blocking distance.

3.7 Function "full calibr." (006)



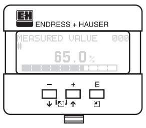
```
full calibr.      006
       4.750  m
span
max: empty - BD
```

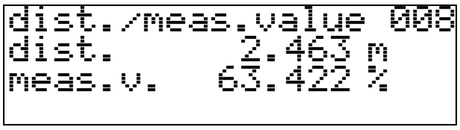
This function is used to enter the distance from the minimum level to the maximum level (=span).



Caution!
The maximum level may not project into the blocking distance (BD). If the blocking distance is compromised, it may cause device malfunction.
After basic calibration, enter a safety distance (SD) in the **"safety distance" (015)** function. If the level is within this safety distance, the Prosonic M signals a warning or an alarm, depending on your selection in the **"in safety distance" (016)** function.

3.8 Display (008)



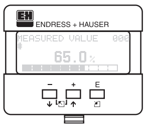


```
dist./meas.value 008
dist.      2.463 m
meas.v.   63.422 %
```

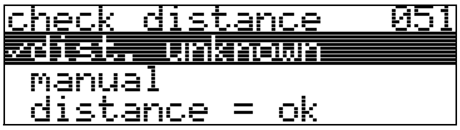
The **distance** measured from the sensor membrane to the product surface and the **level** calculated with the aid of the empty calibration are displayed. Check whether the values correspond to the actual level or the actual distance. The following cases can occur:

- Distance correct – level correct -> continue with the next function, "**check distance**" **(051)**
- Distance correct – level incorrect -> Check "**empty calibr.**" **(005)**
- Distance incorrect – level incorrect -> continue with the next function, "**check distance**" **(051)**

3.9 Function "check distance" (051)



⇒

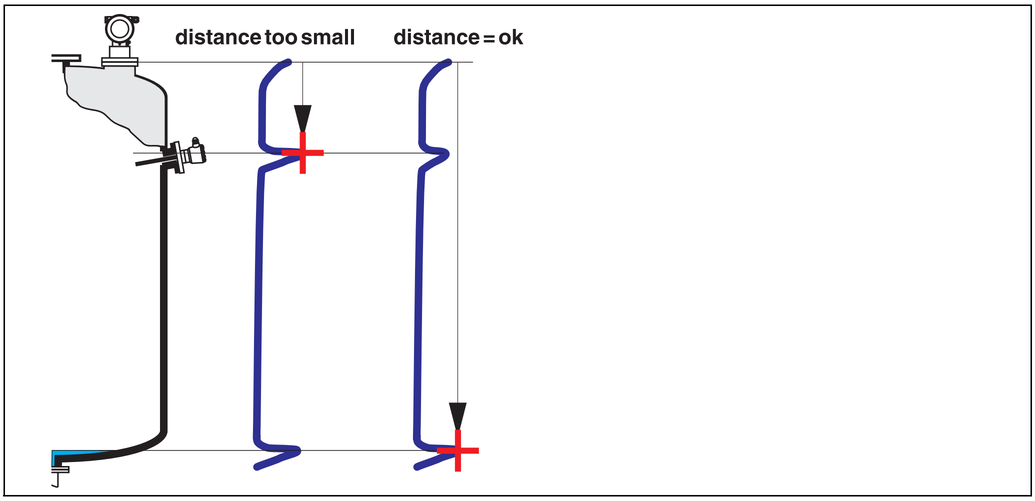


```
check distance    051
✓dist. unknown
 manual
 distance = ok
```

This function triggers the mapping of interference echoes. To do so, the measured distance must be compared with the actual distance to the product surface. The following options are available for selection:

Selection:

- distance = ok
- dist. too small
- dist. too big
- **dist. unknown**
- manual



distance = ok

- mapping is carried out up to the currently measured echo
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

Anyway, it is wise to carry out a mapping even in this case.

dist. too small

- At the moment, an interference is being evaluated
- Therefore, a mapping is carried out including the presently measured echoes
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

dist. too big

- This error cannot be remedied by interference echo mapping
- Check the application parameters **(002), (003), (004)** and "**empty calibr.**" **(005)**

dist. unknown

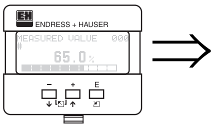
If the actual distance is not known, no mapping can be carried out.

manual

A mapping is also possible by manual entry of the range to be suppressed. This entry is made in the "**range of mapping (052)**" function.

Caution!
The range of mapping must end 0.5 m (20") before the echo of the actual level. For an empty tank, do not enter E, but E – 0.5 m (20").

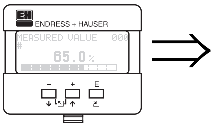
3.10 Function "range of mapping" (052)




```
range of mapping 052
   0.000 m
input of
mapping range
```

This function displays the suggested range of mapping. The reference point is always the sensor membrane. This value can be edited by the operator.
For manual mapping, the default value is: 0 m.

3.11 Funktion "start mapping" (053)



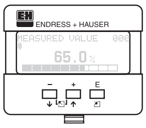

```
start mapping     053
✓off
 on
```

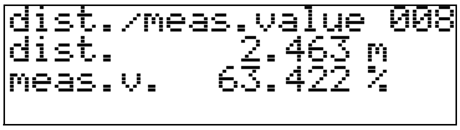
This function is used to start the interference echo mapping up to the distance given in "**range of mapping**" **(052)**.

Selection:
- **off**: no mapping is carried out
- on: mapping is started

Note!
If a mapping already exists, it is overwriten up to the distance specified in "**range of mapping**" **(052)**. Beyond this value the existing mapping remains unchanged.

3.12 Display (008)

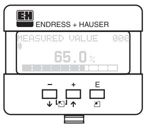


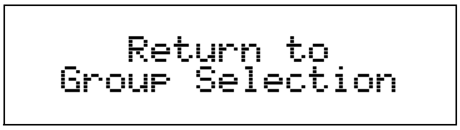


```
dist./meas.value 008
dist.      2.463 m
meas.v.   63.422 %
```

The distance measured from the reference point to the product surface and the level calculated with the aid of the empty alignment are displayed again. Check whether the values correspond to the actual level or the actual distance. The following cases can occur:

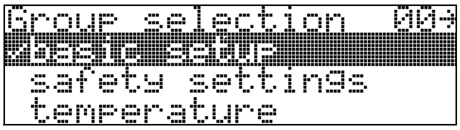
- Distance correct – level correct -> basic setup completed
- Distance incorrect – level incorrect -> a further interference echo mapping must be carried out "**check distance**" (**051)**.
- Distance correct – level incorrect -> check "**empty calibr.**" **(005)**





```
    Return to
 Group Selection
```

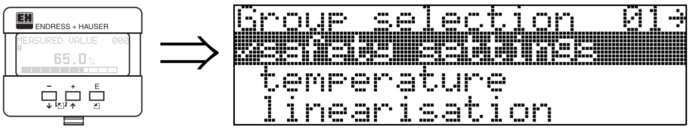
After 3 s, the following message appears



```
Group selection  00→
✓basic setup
 safety settings
 temperature
```

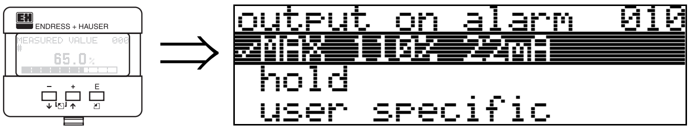
Note!
After the basic setup, an evaluation of the measurement with the aid of the envelope curve ("**display**" **(09)** function group) is recommended.

4 Function group "safety settings" (01)



```
Group selection  01→
✓safety settings
 temperature
 linearisation
```

4.1 Function "output on alarm" (010)

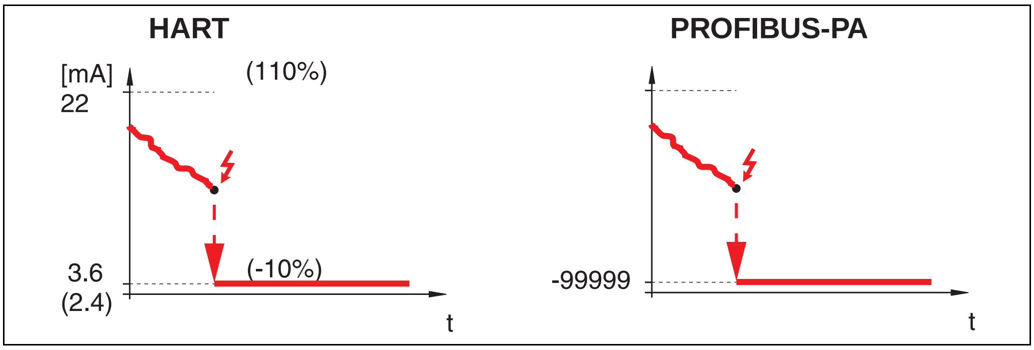


```
output on alarm  010
✓MAX 110% 22mA
 hold
 user specific
```

This function is used to select the reaction of the device on an alarm.

Selection:
- MIN (<= 3.6mA)
- **MAX (22mA)**
- hold
- user specific

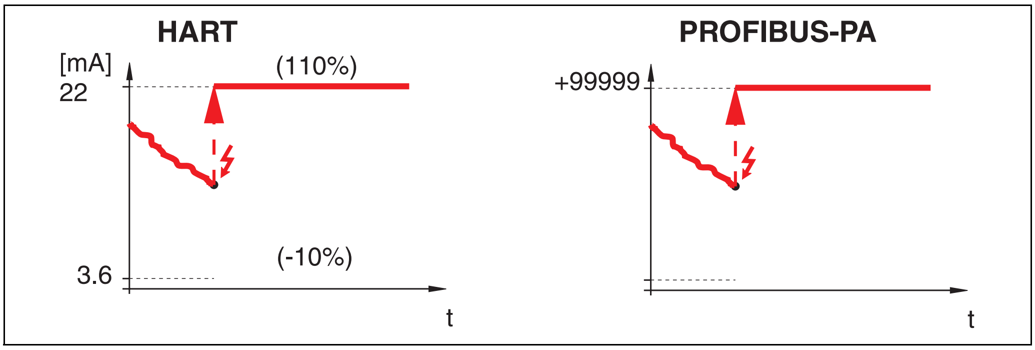
MIN (<= 3.6 mA)



If the instrument is in alarm state, the output changes as follows:

• HART:	MIN-Alarm 3.6 mA (2.4 mA for four-wire instruments)
• PROFIBUS-PA:	MIN-Alarm -99999

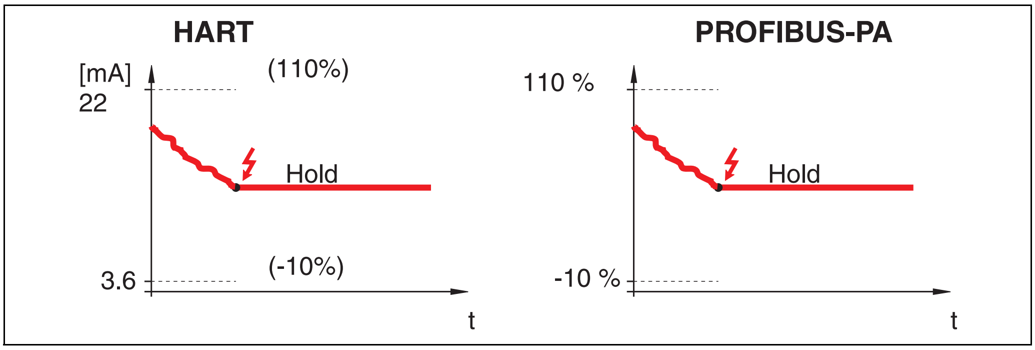
MAX (22mA)



If the instrument is in alarm state, the output changes as follows:

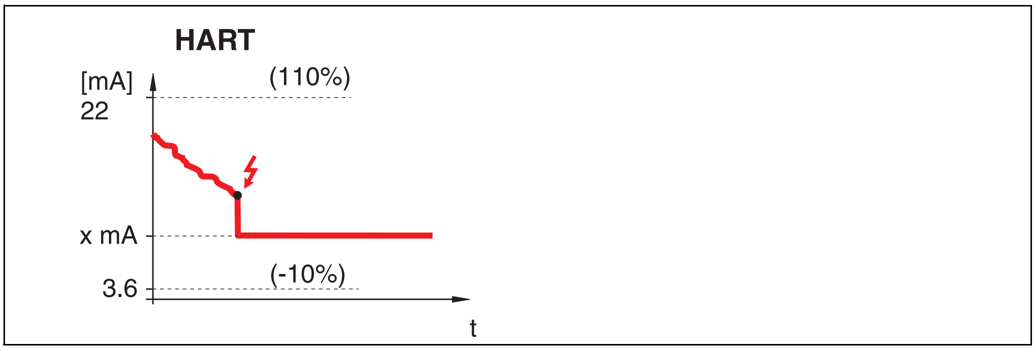
• HART:	MAX-Alarm 22 mA
• PROFIBUS-PA:	MAX-Alarm +99999

hold



If the instrument is in alarm state, the last measured value is held.

user specific

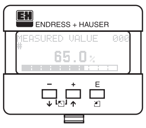


If the instrument is in an alarm state, the output is set to the value configured in "**output on alarm**" **(011)** (x mA).

Caution!
This selection is available for HART devices only!

4.2 Function "output on alarm" (011), HART only

```
output on alarm   010
✓user specific
 MIN -10% 3.6mA
 MAX 110% 22mA
```

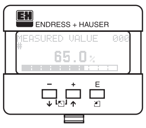


```
output on alarm   011
    22.00  mA
```

The current (in mA) which will be output in case of an alarm. This function is active when you selected "**user specific**" in the "**output on alarm**" **(010)** function.

Caution!
This function is available for HART devices only!

4.3 Function "outp. echo loss" (012)

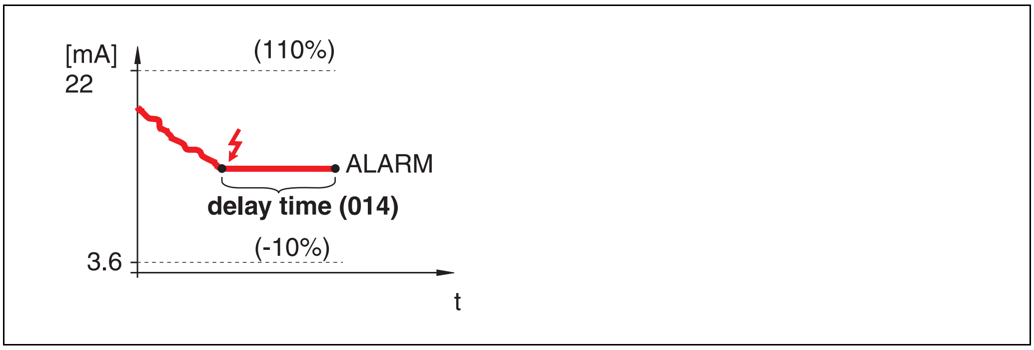


```
outp. echo loss   012
✓hold
 ramp %/min
 alarm
```

Use this function to set the output response on echo loss.

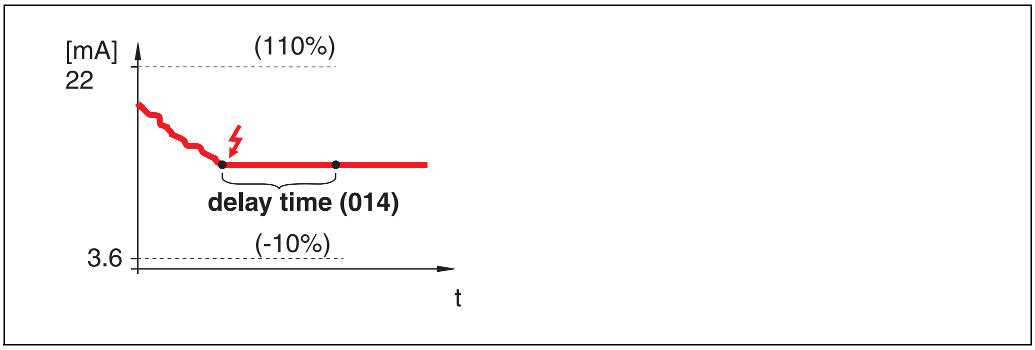
Selection:
- alarm
- **hold**
- ramp %/min

alarm



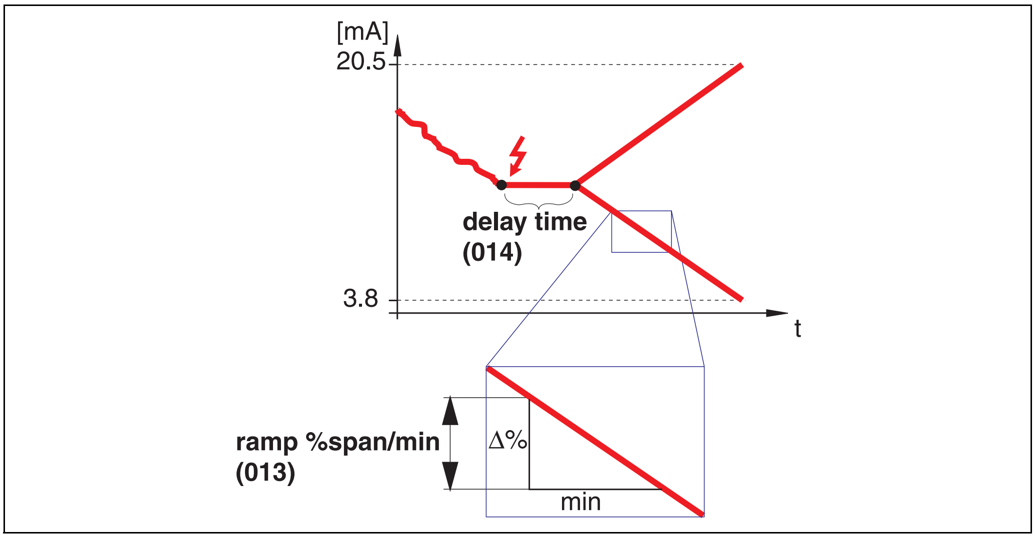
On echo loss, the instrument switches to alarm state after an adjustable "**delay time**" **(014)**. The output response depends on the configuration set in "**output on alarm**" **(010)**.

hold



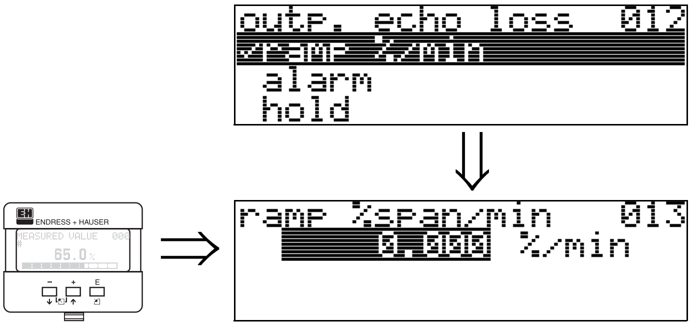
On echo loss, a warning is generated after a definable "**delay time**" **(014)**. Output is held.

ramp %/min



On echo loss, a warning is generated after a definable "**delay time**" **(014)**. The output is changed towards 0% or 100% depending on the slope defined in "**ramp %span/min**" **(013)**.

4.4 Function "ramp %span/min" (013)

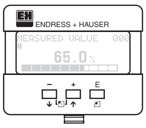


```
outp. echo loss  012
✓ramp %/min
  alarm
  hold
```

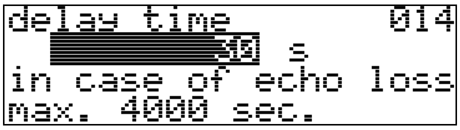
```
ramp %span/min   013
       0.000  %/min
```

Ramp slope which defines the output value on echo loss. This value is used if "**ramp %span/min**" is selected in "**outp. echo loss**" **(012)**. The slope is given in % of the measuring range per minute.

4.5 Function "delay time" (014)



⇒

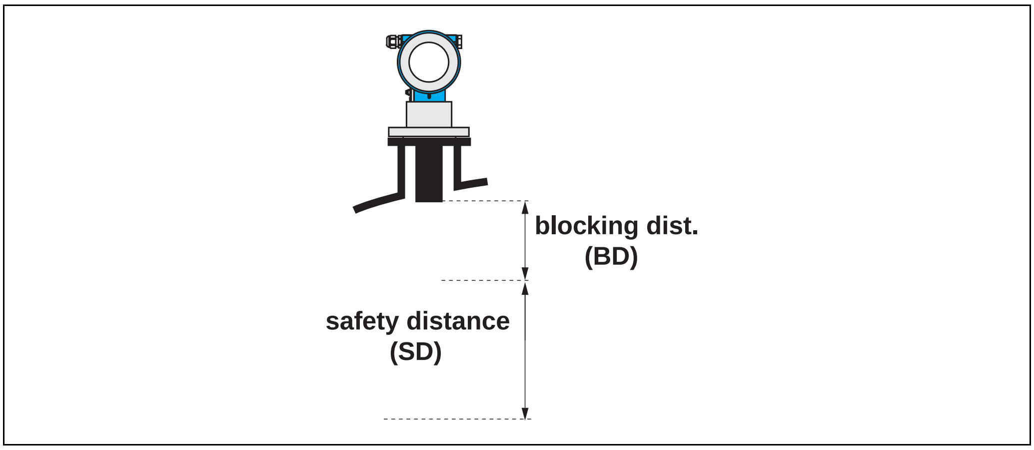


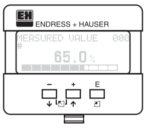
```
delay time         014
         30  s
in case of echo loss
max. 4000 sec.
```

Use this function to enter the delay time (Default = 30 s) after which a warning is generated on echo loss, or after which the instrument switches to alarm state.

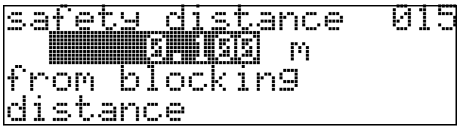
4.6 Function "safety distance" (015)

A configurable safety distance is placed before the "**blocking dist.**" **(059)** (Page 43). This distance warns you that any further level increase would make the measurement invalid, because the blocking distance would be compromised.





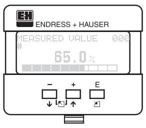
⇒



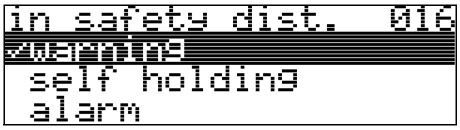
```
safety distance   015
       0.100 m
from blocking
distance
```

Enter the size of the safety distance here. The default value is: 0.1 m.

4.7 Function "in safety dist." (016)



⇒

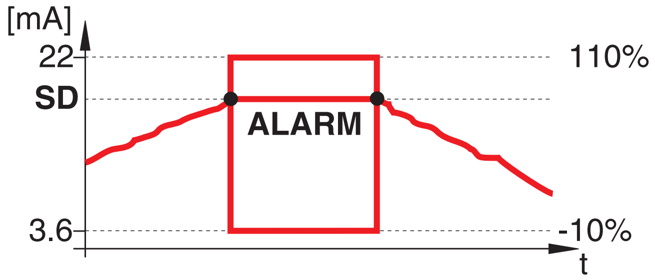


```
in safety dist.  016
✓warning
 self holding
 alarm
```

This function defines the response when the level enters the safety distance .

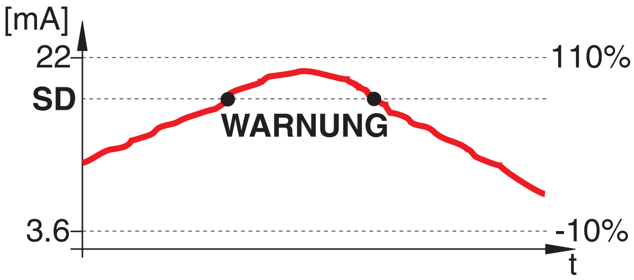
Selection:
- alarm
- **warning**
- self holding

alarm



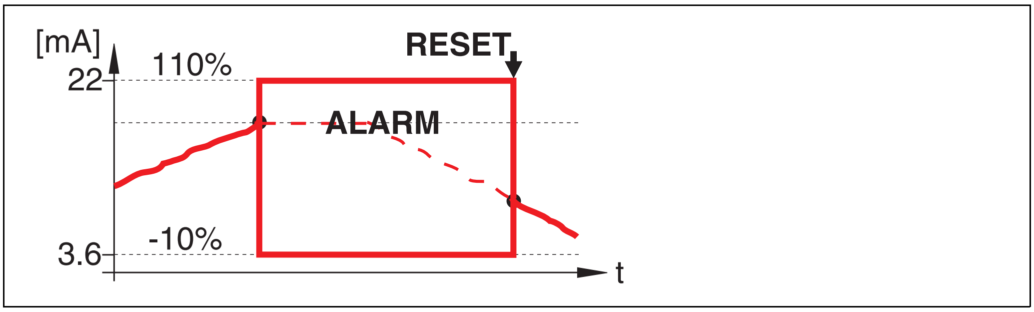
Instrument enters the defined alarm state ("**output on alarm**" **(011)**). The alarm message **E651** - "**level in safety distance** - **risk of overspill**" is displayed.
If the level drops out of the safety distance, the alarm warning disappears and the instrument starts to measure again.

warning



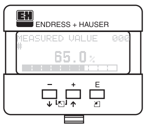
Instrument displays a warning **E651** - "**level in safety distance** - **risk of overspill**", but continues to measure. If the level leaves the safety distance, the warning disappears.

self holding

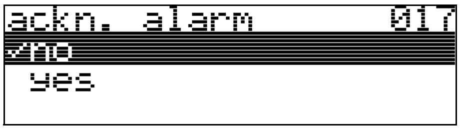


Instrument switches to defined alarm state ("**output on alarm**" **(011)**). The alarm message **E651** - "**level in safety distance - risk of overspill**" is displayed.
If the level leaves the safety distance, the measurement continues only after a reset of the self holding (function: "**ackn. alarm**" **(017)**).

4.8 Function "ackn. alarm" (017)



⇒



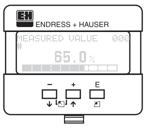
```
ackn. alarm         017
✓no
 yes
```

This function acknowledges an alarm in case of "**self holding**".

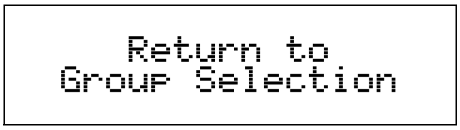
Selection:
- **no**
- yes

no
The alarm is not acknowledged.

yes
Acknowledgement takes place.



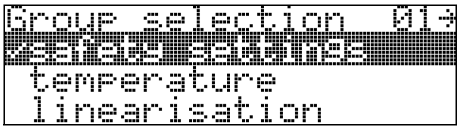
⇒



```
     Return to
  Group Selection
```

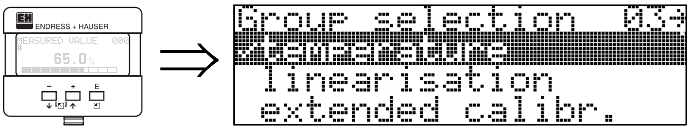
⇓

After 3 s, the following message appears



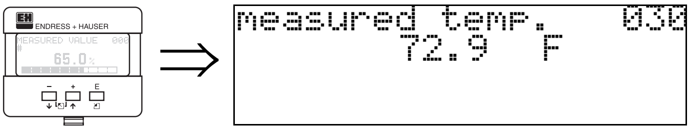
```
Group selection   01→
✓safety settings
 temperature
 linearisation
```

5 Function group "temperature" (03)



```
Group selection  03→
✓temperature
 linearisation
 extended calibr.
```

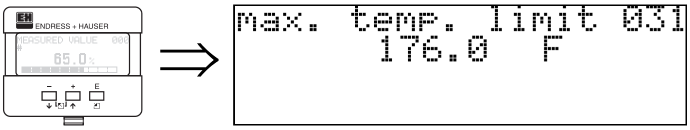
5.1 Function "measured temp." (030)



```
measured temp.    030
          72.9   F
```

In this function the temperature at the sensor is displayed. The temperature unit is determined by the function **"temperature unit" (0C6)**.

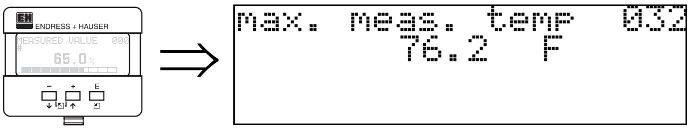
5.2 Function "max. temp. limit" (031)



```
max. temp. limit 031
        176.0   F
```

In this function the maximum permitted temperature of the sensor is displayed. The temperature unit is determined by the function **"temperature unit" (0C6)**. If this temperature is exceeded, the sensor may become damaged.

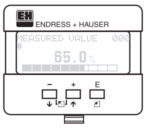
5.3 Function "max. meas. temp." (032)



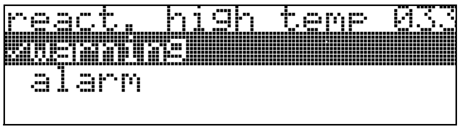
```
max. meas. temp   032
          76.2   F
```

In this function the maximum temperature, which has ever been measured at the senosr, is displayed. The temperature unit is determined by the function **"temperature unit" (0C6)**. This function is not influenced by a reset of the parameters.

5.4 Function "react high temp." (033)



⇒



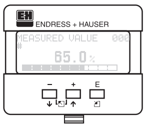
```
react. high temp 033
✓warning
 alarm
```

In this function you determine, how the Prosonic M will react if the maximum permitted temperature of the sensor is exceeded.
You may choose one of the following options:

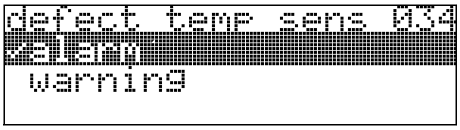
Warning
The instrument continues measuring. An error message is displayed.

Alarm
The current output adopts the value defined in the funcion **"output on alarm" (010)**. Additionally an error message is displayed.

5.5 Function "defect temp. sens." (034)



⇒



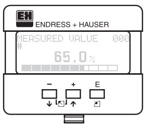
```
defect temp sens 034
✓alarm
 warning
```

In this function you determine, how the Prosonic M will react, if the maximum permitted temperature of the sensor is exceeded.
You may choose one of the following options:

Alarm
The current output adopts the value defined in the funcion **"output on alarm" (010)**. Additionally an error message is displayed.

Warning
The instrument continues measuring. An error message is displayed.

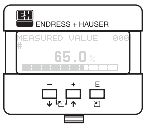
6 Function group "linearisation" (04)



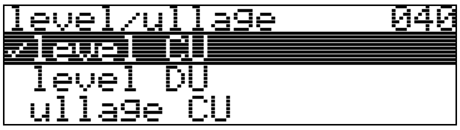
⇒

```
Group selection  04→
✓linearisation
 extended calibr.
 output
```

6.1 Function "level/ullage" (040)



⇒



```
level/ullage     040
✓level CU
 level DU
 ullage CU
```

Selection:
- **level CU**
- level DU
- ullage CU
- ullage DU

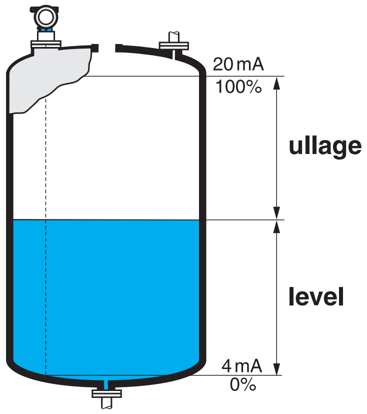
level CU
Level in customer units. The measured value can be linearised.
The "**linearisation**" **(041)** default value is set to a linear 0...100%.

level DU
Level in the selected "**distance unit**" **(0C5)**.

ullage CU
Ullage in customer units. The value can be linearised.
The "**linearisation**" **(041)** default value is set to a linear 0...100%.

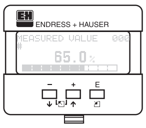
ullage DU
Ullage in the selected "**distance unit**" **(0C5)**.

Note!
Reference point for the ullage is "full calibr." (=span).



6.2 Function "linearisation" (041)

Linearisation defines the ratio of level to container volume or product weight and allows a measurement in customer units, e.g. metres, hectolitres etc. The measured value in (000) is then displayed in the selected unit.

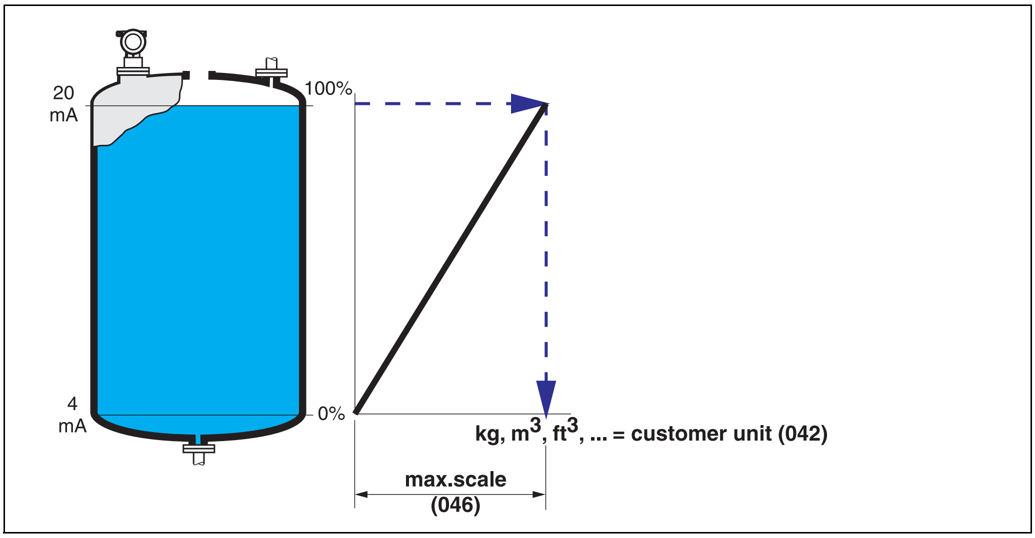



linearisation 041
✓linear
horizontal cyl
manual

This function is used to select the linearisation modes.

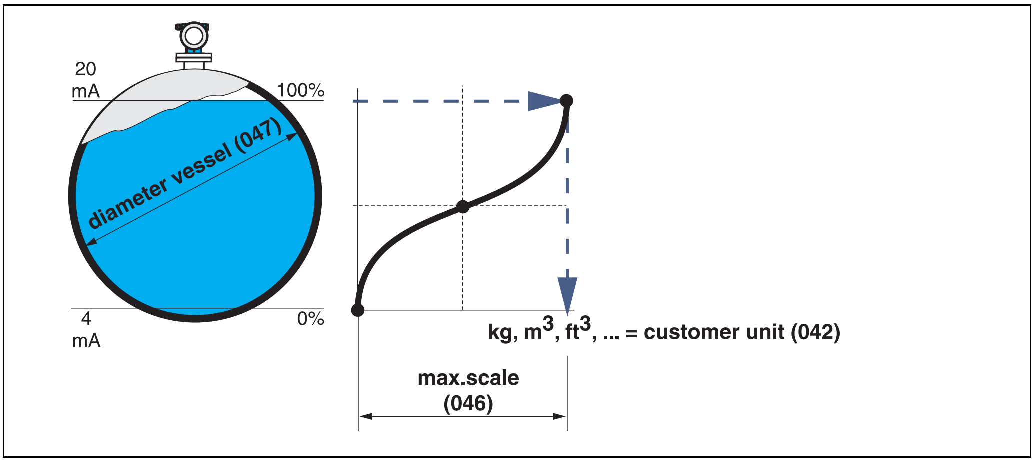
Selection:
- **linear**
- horizontal cyl
- manual
- semi-automatic
- table on
- clear table

linear
The tank is linear e.g. a cylindrical vertical tank. You can measure in customer units by entering a maximum volume/weight.
You can select the "**customer unit**" **(042)**. Define the volume value corresponding to the calibration in "**max. scale**" **(046)**. This value corresponds to an output of 100% (= 20 mA for HART).



horizontal cyl

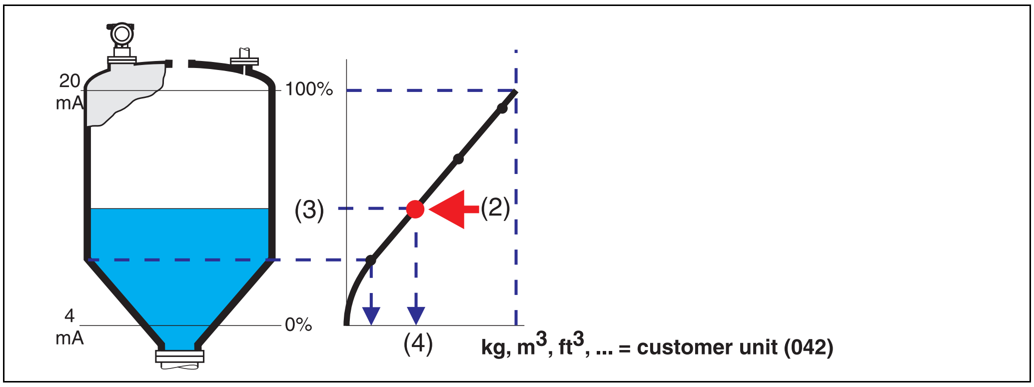
The volume, mass etc. are calculated automatically in cylindrical horizontal tanks by entering the "**diameter vessel**" **(047)**, the "**customer unit**" **(042)** and the "**max. scale**" **(046)**. The "**max. scale**" **(046)** corresponds to an output of 100% (= 20 mA for HART).



manual

If the level is not proportional to the volume or weight within the set measuring range, you can enter a linearisation table in order to measure in customer units. The requirements are as follows:

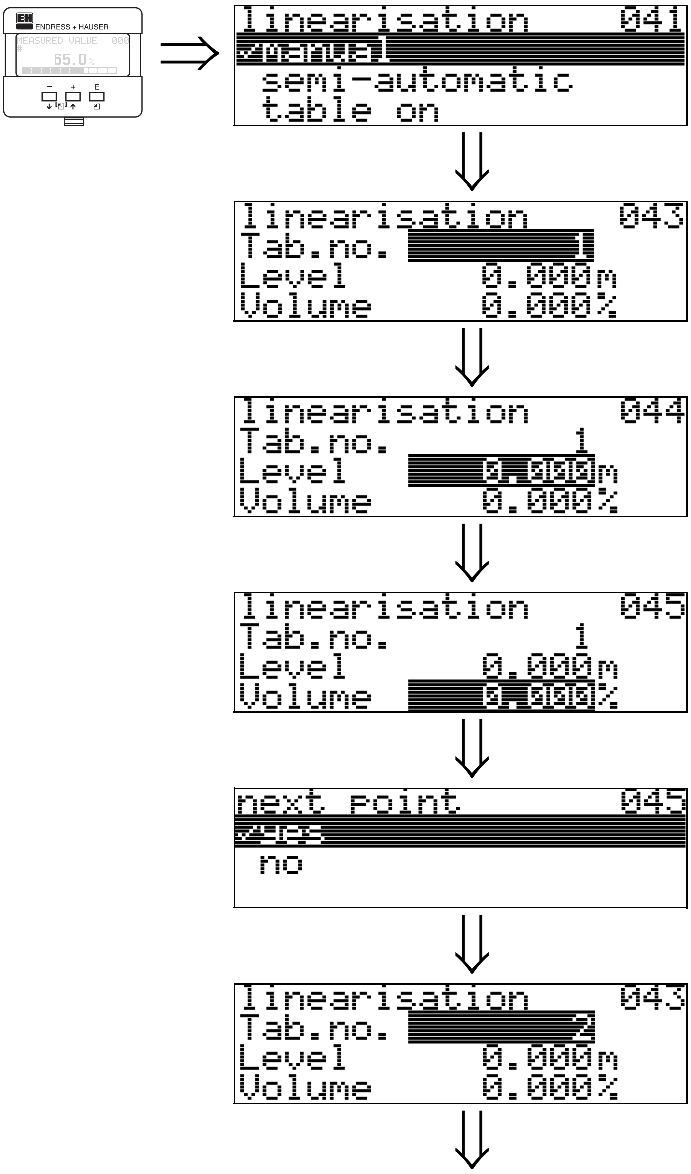
- The 32 (max.) value pairs for the linearisation curve points are known.
- The level values must be given in ascending order. The curve is monotonously increasing.
- The level heights for the first and last points on the linearisation curve correspond to empty and full calibration respectively.
- The linearisation takes place in the basic setup unit ("**distance unit**" **(0C5)**).



Each point (2) in the table is described by a value pair: level (3) and, for example, volume (4). The last value pair defines the 100% output (= 20 mA for HART).

Note!

The manual linearisation mode can also be used for flow measurements. To do this, simply enter the respective flow level (instead of the volume) into the table. You can find the appropriate flow values in the Q/h table of your channel or weir.



Select the table point (Point 1).

Enter the level belonging to Point 1.

Enter the corresponding volume.

Enter a further table point?

Next table point.

...
Continue until "**next point**" **(045)** is answered with no.

Note!
After making entries into the table, activate it with "**table on**".
The 100% value (=20 mA for HART) is defined by the last point in the table.

Note!
Before confirming 0.00 m as the level or 0.00% as the volume, activate the Edit mode with + or –.

Entries can be made into the linearisation table in ToF Tool using the table editor.
You can also display the contents graphically.

semi-automatic

The tank is filled in stages when the linearisation curve is entered semi-automatically. The Prosonic M automatically detects the level and the corresponding volume/weight has to be entered.

The procedure is similar to manual table entry, where the level value for each table point is given automatically by the instrument.

Note!

If the tank is emptied (out litres), pay attention to the following points:

- The number of points must be known in advance.
- The first table number = (32 - number of points).
- Entries in "**Tab. no.**" **(043)** are made in reverse order (last entry = 1).

table on

An entered linearisation table only becomes effective when activated.

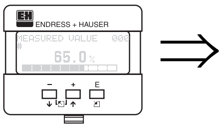
clear table

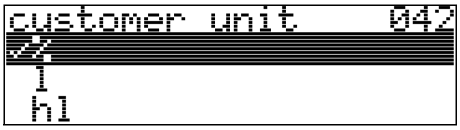
Before making entries into the linearisation table, any existing tables must be deleted. The linearisation mode automatically switches to linear.

Note!

A linearisation table can be deactivated by selecting "**linear**" or "**horizontal cyl**" (or the "**level/ullage**" **(040)** function = "**level DU**", "**ullage DU**"). It is not deleted and can be reactivated at any time by selecting "**table on**".

6.3 Function "customer unit" (042)





```
customer unit     042
%
l
hl
```

You can select the customer unit with this function.

Selection:

- **%**
- Volume: l, hl, m3, dm3, cm3, ft3, usgal, i gal
- Weight: kg, t, lb, ton
- Length: m, ft, mm, inch
- Flow: l/s, l/min, l/h, m3/s, m3/min, m3/h, ft3/s, gal/s, gal/m, gal/hr, mgal/d, igal/s, igal/min, igal/h

Dependence

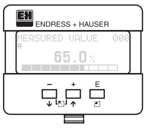
The units of the following parameters are changed:

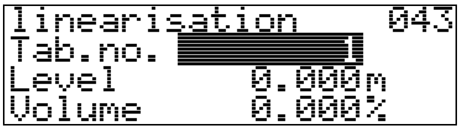
- measured value (000)
- input volume (045)
- max. scale (046)
- simulation value (066)

6.4 Function "table no." (043)

```
linearisation    041
 table on
 clear table
 linear
```

```
linearisation    041
✓manual
 semi-automatic
 table on
```



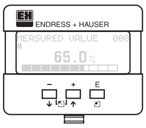


```
linearisation    043
Tab.no.            1
Level         0.000m
Volume        0.000%
```

Position of the value pair in the linearisation table.

Dependence
Updates "**input level**" **(044)** , "**input volume**" **(045)**.

6.5 Function "input level" (044)

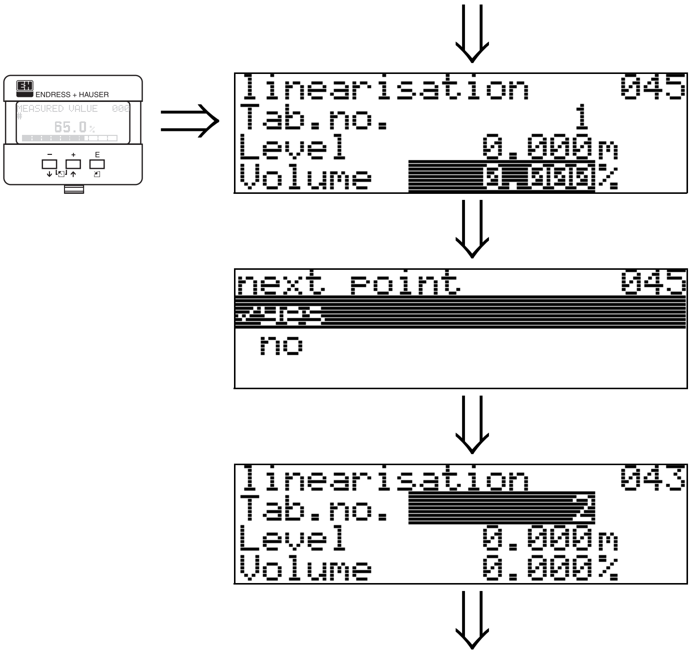


```
linearisation    044
Tab.no.            1
Level         0.000m
Volume        0.000%
```

You can enter the level for each point of the linearisation curve with this function. When the linearisation curve is entered semi-automatically, Micropilot detects the level automatically.

User input:
Level in "**distance unit**" **(0C5)**.

6.6 Function "input volume" (045)



```
linearisation    045
Tab.no.          1
Level        0.000m
Volume       0.000%
```

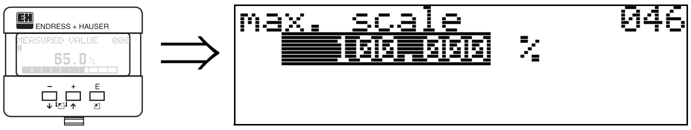
```
next point       045
✓yes
 no
```

```
linearisation    043
Tab.no.          2
Level        0.000m
Volume       0.000%
```

Specify the volume for each point of the linearisation curve with this function.

User input:
Volume in "**customer unit**" **(042)**.

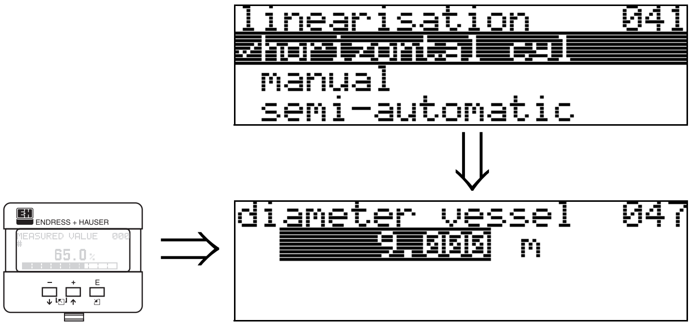
6.7 Function "max. scale" (046)



```
max. scale       046
   100.000  %
```

You can enter the end value of the measuring range with this function. This input is necessary if you selected "**linear**" or "**horizontal cyl**" in the "**linearisation**" **(041)** function.

6.8 Function "diameter vessel" (047)

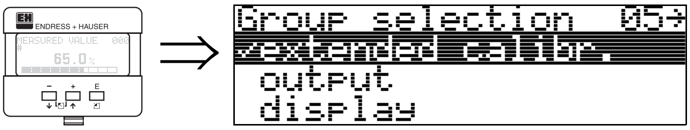


```
linearisation    041
✓horizontal cyl
 manual
 semi-automatic
```

```
diameter vessel  047
     9.000  m
```

Enter the tank diameter with this function. This entry is necessary if you selected "**horizontal cyl**" in the "**linearisation**" **(041)** function.

7 Function group "extended calibr." (05)



7.1 Function "selection" (050)

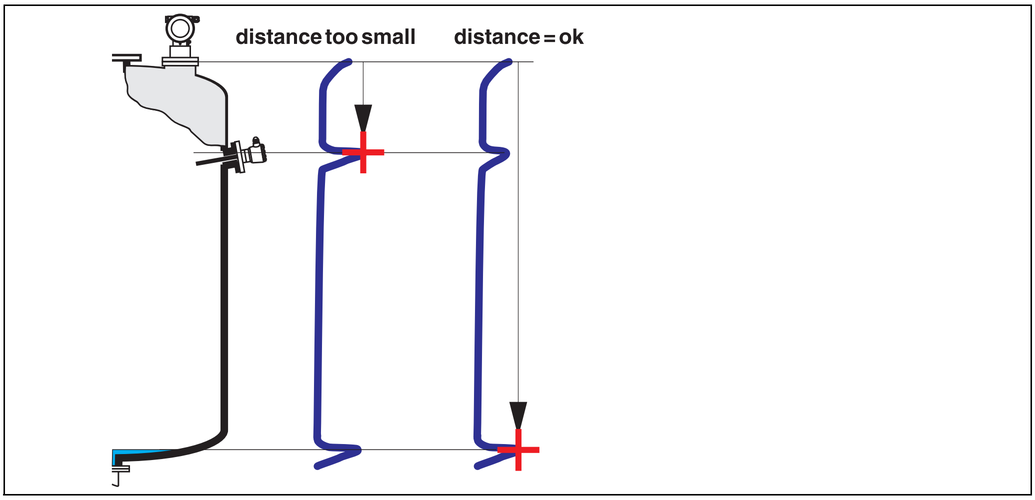
Select the function of the extended calibration.

Selection:
- **common**
  leads to the functions **"echo quality" (056)**, **"offset" (057)**, **"output damping" (058)** and **"blocking distance" (059)**
- mapping
  leads to the functions for an interference echo suppression (tank map): **(051) ... (053)**
- extended map
  leads to the functions **" pres. map. dist." (054)** and **"cust. tank map" (055)**

7.2 Function "check distance" (051)

This function triggers the mapping of interference echoes. To do so, the measured distance must be compared with the actual distance to the product surface. The following options are available for selection:

Selection:
- distance = ok
- dist. too small
- dist. too big
- **dist. unknown**
- manual



distance = ok
- mapping is carried out up to the currently measured echo
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

Anyway, it is wise to carry out a mapping even in this case.

dist. too small
- At the moment, an interference is being evaluated
- Therefore, a mapping is carried out including the presently measured echoes
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

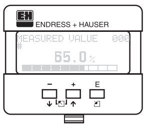
dist. too big
- This error cannot be remedied by interference echo mapping
- Check the application parameters **(002), (003), (004)** and "**empty calibr.**" **(005)**

dist. unknown
If the actual distance is not known, no mapping can be carried out.

manual
A mapping is also possible by manual entry of the range to be suppressed. This entry is made in the "**range of mapping (052)**" function.

Caution!
The range of mapping must end 0.5 m (20") before the echo of the actual level. For an empty tank, do not enter E, but E – 0.5 m (20").

7.3 Function "range of mapping" (052)

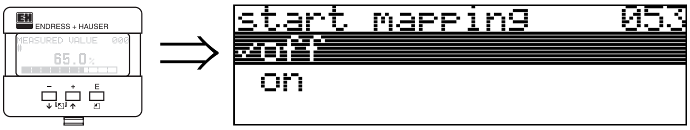


⇒

```
range of mapping 052
   0.000 m
input of
mapping range
```

This function displays the suggested range of mapping. The reference point is always the sensor membrane. This value can be edited by the operator.
For manual mapping, the default value is: 0 m.

7.4 Function "start mapping" (053)



```
start mapping     053
✓off
 on
```

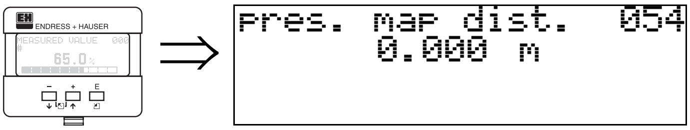
This function is used to start the interference echo mapping up to the distance given in "**range of mapping**" **(052)**.

Selection:

- **off**: no mapping is carried out
- on: mapping is started

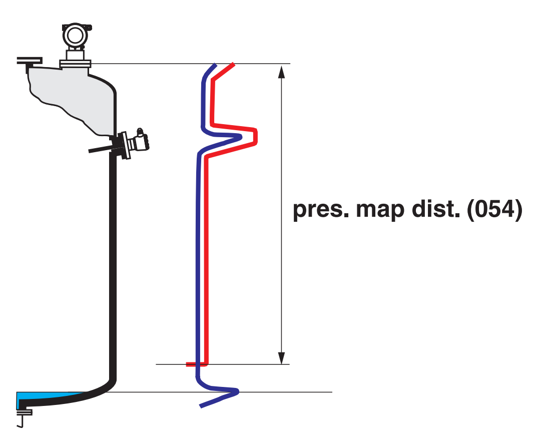
Caution!
If a mapping already exists, it is overwriten up to the distance specified in "**range of mapping**" **(052)**. Beyond this value the existing mapping remains unchanged.

7.5 Function "pres. map dist." (054)



```
pres. map dist.   054
      0.000  m
```

Displays the distance up to which a mapping has been recorded.
A value of 0 indicates that no mapping was recorded so far.



7.6 Function "cust. tank map" (055)

cust. tank map 055
✓inactive
active
reset

This function displays the evaluation mode using the customer tank map.

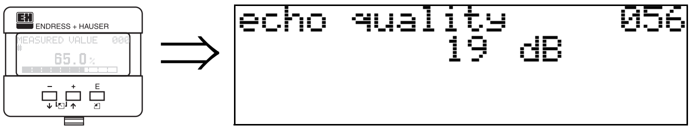
Selection:
- **inactive**
- active
- reset

inactive
No tank mapping has been recorded, or map is switched off. Evaluation is only using FAC (Page 71).

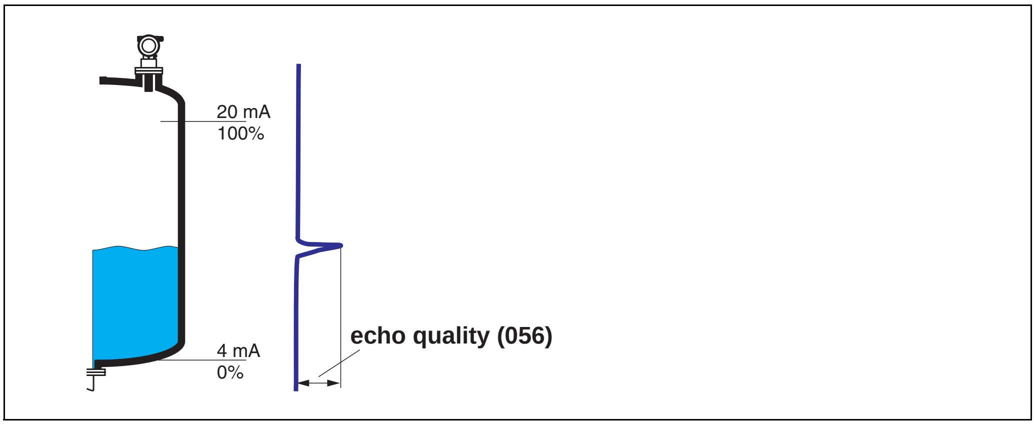
active
Evaluation is using the customer tank map (Page 70).

reset
Deletes the complete tank map.

7.7 Function "echo quality" (056)



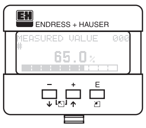
echo quality 056
19 dB



The echo quality is the benchmark for measurement reliability. It describes the amount of reflected energy and depends primarily on the following conditions:
- Surface characteristics (waves, foam etc.)
- Distance between sensor and product

Low values increase the probability that the echo is lost through a change in measurement conditions, e.g. turbulent surface, foam, large measuring distance.

7.8 Function "offset" (057)

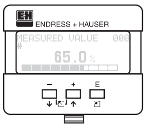


⇒


offset 057
0.000 m
will be added to the
measured level

This function corrects the measured level by a constant value. The entered value is added to the measured level.

7.9 Function "output damping" (058)



⇒

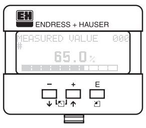

output damping 058
5.0 s

Influences the time an output requires to react to a sudden level jump (63% of steady state). A high value attenuates, for example, the influences of rapid changes on the measured variable.

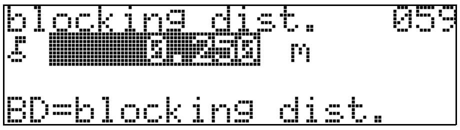
User input:
0...255 s

The default value depends on the selected application parameters "**tank shape**" **(002)**, "**medium property**" **(003)** and "**process cond.**" **(004)**.

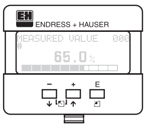
7.10 Function "blocking dist." (059)



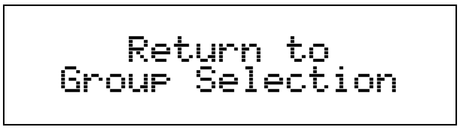
⇒


blocking dist. 059
0.250 m
BD=blocking dist.

In this function the blocking distance is displayed. Level echoes within the blocking distance can not be detected by the Prosonic M. Make sure that the maximum level will never run into the blocking distance.



⇒


Return to
Group Selection

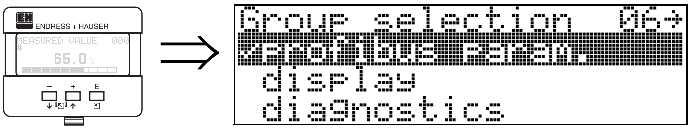
⇓

After 3 s, the following message appears


Group selection 05↑
extended calibr.
output
display

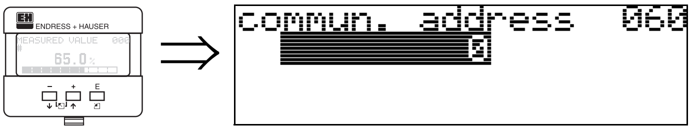
8 Function group "output" (06), - "profibus param." (06), PROFIBUS-PA only

Display at HART and Foundation Fieldbus instrument



Display at PROFIBUS-PA instrument

8.1 Function "commun. address" (060), HART only

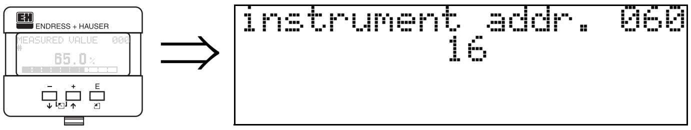


Enter the communication address for the instrument with this function.
- Standard: 0
- Multidrop: 1-15

The output current is constant at 4mA in multidrop mode.

Caution!
This function is available for HART devices only!

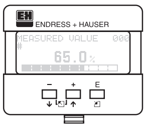
8.2 Function "instrument addr." (060), PROFIBUS-PA only



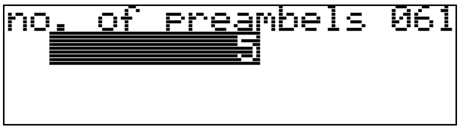
The PA bus address is displayed in this field. The address is set either directly on the instrument using DIP switches (see instrument operating instructions) or using a special SetSlaveAddress command via the bus, e.g. by the ToF Tool.

Caution!
This function is available for PROFIBUS-PA devices only!

8.3 Function "no. of preambels" (061), HART only



⇒

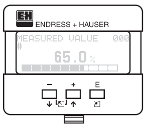


```
no. of preambels 061
  5
```

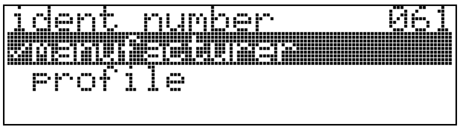
Enter the number of preambles for the HART protocol with this function.
An increase in the value is advisable for "bad" lines with communications problems.

Caution!
This user input is available for HART devices only!

8.4 Function "ident number" (061), PROFIBUS-PA only



⇒



```
ident number     061
✓manufacturer
 profile
```

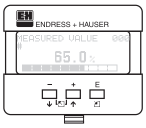
- **manufacturer**
- profile

manufacturer
Set to152C hex according to manufacturer (PNO registered).

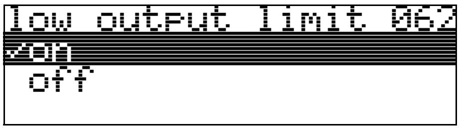
profile
Setting defined as in PA Profile 3.0: 9700 hex - instrument with one AI block.

Caution!
This function is available for PROFIBUS-PA devices only!

8.5 Function "thres. main val." (062), HART only



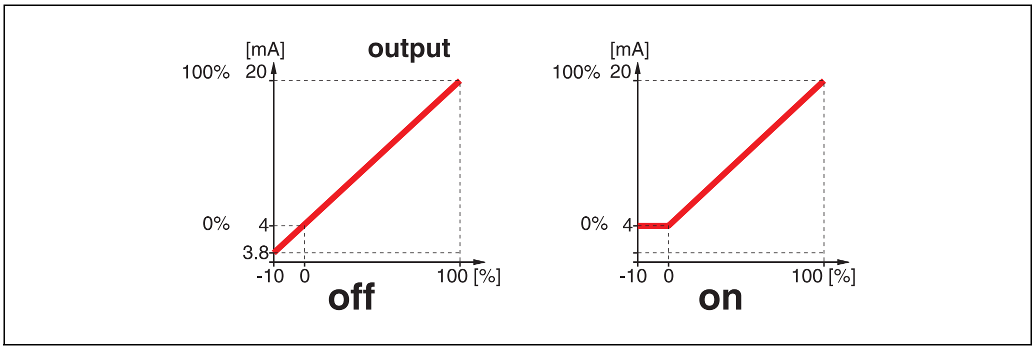
⇒



```
low output limit 062
✓on
 off
```

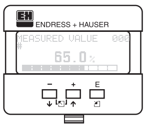
The output of negative level values can be suppressed with this function.

Selection:
- **off**: minimum output -10% (3.8 mA for HART)
- on**:** minimum output 0% (4 mA for HART)

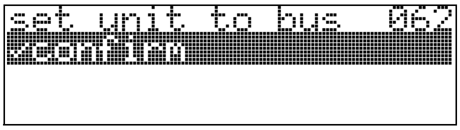


Caution!
This user input is available for HART devices only!

8.6 Function "set unit to bus" (062), PROFIBUS-PA only



⇒



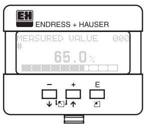
```
set unit to bus  062
✓confirm
```

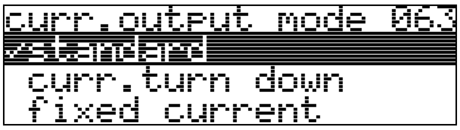
- confirm

After confirming this function, the unit of the measured variable is taken over in the AI block (PV scale -> Out scale).
This function must always be executed after changing the unit.

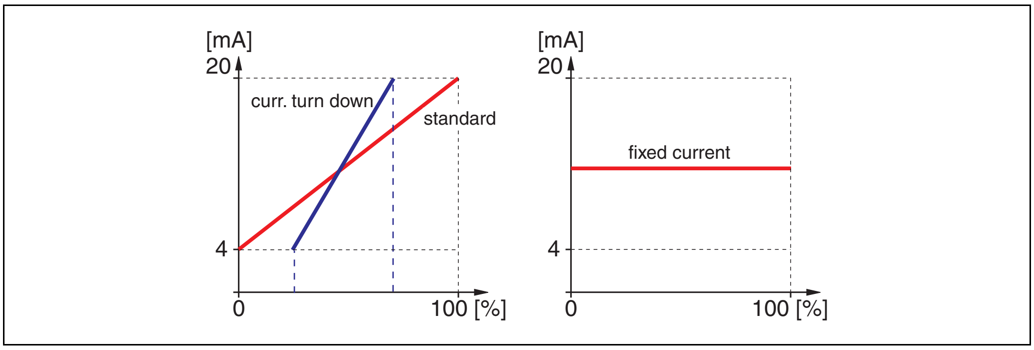
Caution!
This function is available for PROFIBUS-PA devices only!

8.7 Function "curr. output mode" (063), HART only




curr.output mode 063
✓standard
curr.turn down
fixed current

In this function you specify the mode of the current output.
You may choose one of the following options:



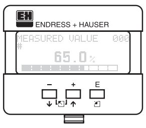
standard
The total measuring range (0 ... 100%) will be mapped to the current intervall (4 ... 20 mA).

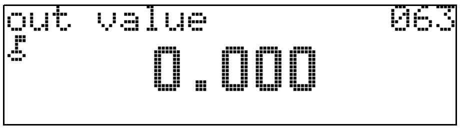
curr. turn down
Only a part of the measuring range will be mapped to the current intervall (4 ... 20 mA).
Use the functions **"4-mA-value" (068)** and **"20-mA-value" (069)** to define the concerning range.

fixed current
The current is fixed. The measured value is transmitted by the HART signal only. The value of the current is defined in the **"fixed current" (064)** function.

Caution!
This function is active for HART devices only.

8.8 Function "out value" (063), PROFIBUS-PA only

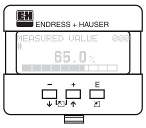


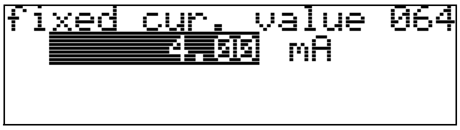

out value 063
0.000

This displays the AI block output.

Caution!
This function is available for PROFIBUS-PA devices only!

8.9 Function "fixed cur. value" (064), HART only





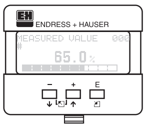
```
fixed cur. value 064
        4.00 mA
```

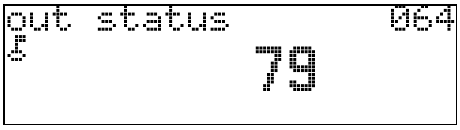
Set the fixed current value with this function. This entry is necessary when you have switched on the "**fixed current**" **(063)** function.

User input:
3,8...20,5 mA

Caution!
This user input is available for HART devices only!

8.10 Function "out status" (064), PROFIBUS-PA only



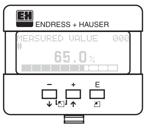


```
out status       064
           79
```

Displays the current output status (for value, see operating instructions of relevant instrument).

Caution!
This function is available for PROFIBUS-PA devices only!

8.11 Function "simulation" (065)

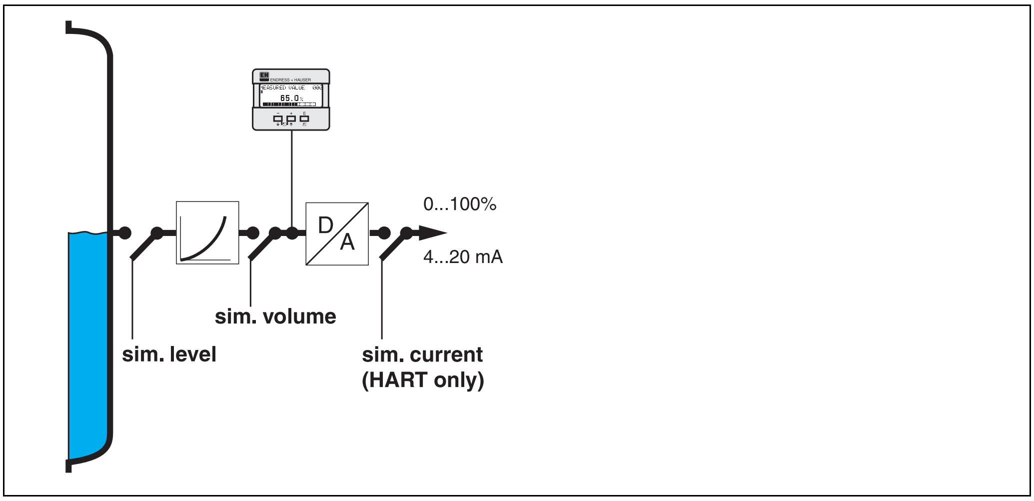


⇒

```
simulation          065
✓sim. off
 sim. level
 sim. volume
```

If necessary, linearisation, the output signal and the current output can be tested with the simulation function. You have the following simulation options:

Selection:
- **sim. off**
- sim. level
- sim. volume
- sim. current (HART only)



sim. off
Simulation is switched off.

sim. level
Enter the level value in "**simulation value**" **(066)**.
The functions
- measured value (000)
- measured level (0A6)
- output current" (067) - only with HART instruments!

follow the entered values.

sim. volume
Enter the volume value in "**simulation value**" **(066)**.
The functions
- measured value (000)
- output current" (067) - only with HART instruments!

follow the entered values.

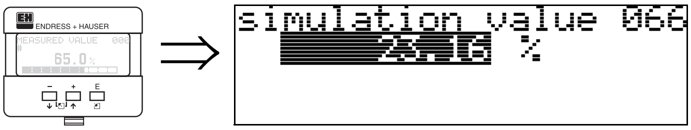
sim. current (HART only)
Enter the current value in "**simulation value**" **(066)**.
The function
- output current" (067) - only with HART instruments!

follows the entered values.

8.12 Function "simulation value" (066)

```
simulation value 066
    2.54  m
```

After selecting the "**sim. level**" option in the "**simulation**" **(065)** function, the following message appears in the display: you can enter the level.



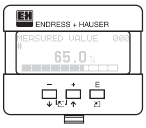
```
simulation value 066
    23.16  %
```

After selecting the "**sim. volume**" option in the "**simulation**" **(065)** function, the following message appears in the display: you can enter the volume.

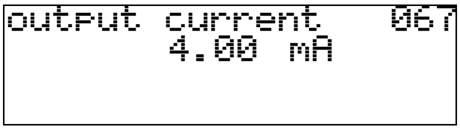
```
simulation value 066
    8.00  mA
```

After selecting the "**sim. current**" option in the "**simulation**" **(065)** function, the following message appears in the display: Enter the output current (only for HART instruments).

8.13 Function "output current" (067), HART only



⇒

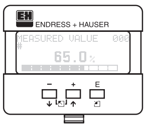


```
output current   067
       4.00 mA
```

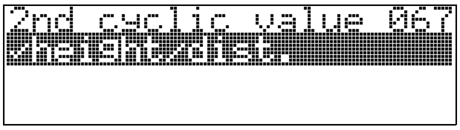
Displays the output current in mA.

Caution!
This function is available for HART devices only!

8.14 Function "2nd cyclic value" (067), PROFIBUS-PA only



⇒



```
2nd cyclic value 067
✓height/dist.
```

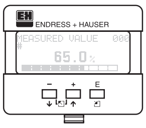
Selects the second cyclical value.

- height/dist.

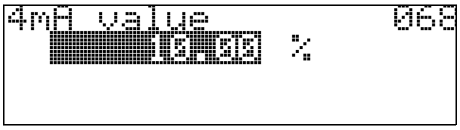
The Prosonic M always transmits the distance as the second cyclical value.

Caution!
This function is available for PROFIBUS-PA devices only!

8.15 Function "4mA-value" (068), HART only



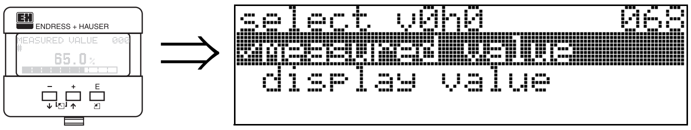
⇒



```
4mA value         068
       10.00  %
```

In this function specify the level (or volume, weight, flow resp.), at which the output current should be 4 mA. This value will be used if you choose the option "curr. turn down" in the **"current output mode" (063)** function.

8.16 Function "select v0h0" (068), PROFIBUS-PA only



```
select v0h0      068
✓measured value
 display value
```

Selects the value displayed in "**measured value**" **(000)**.

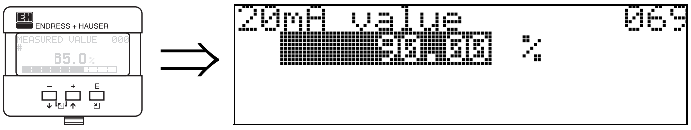
Selection:
- **measured value**
- display value

measured value
The configured measured value is displayed in the "**measured value**" **(000)** function.

display value
The value in "**display value**" **(069)** is displayed in the "**measured value**" **(000)** function.

Caution!
This function is available for PROFIBUS-PA devices only!

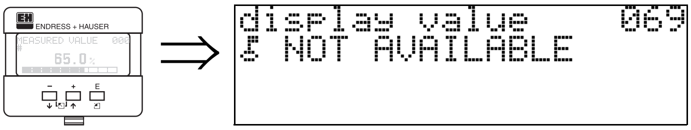
8.17 Function "20mA-value" (069), HART only



```
20mA value       069
      90.00  %
```

In this function specify the level (or volume, weight, flow resp.), at which the output current should be 20 mA. This value will be used if you choose the option "curr. turn down" in the **"current output mode" (063)** function.

8.18 Function "display value" (069), PROFIBUS-PA only

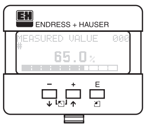


```
display value    069
  NOT AVAILABLE
```

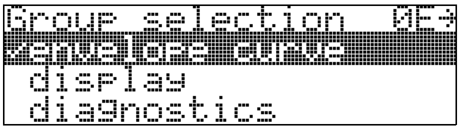
This field can be set externally, e.g. from a PLC. The value is then displayed as the main measured variable in the display by selecting the "**select v0h0**" **(068)** = "**display value**" function.

Caution!
This function is available for PROFIBUS-PA devices only!

9 Function group "Enelope curve" (0E)

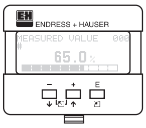


⇒

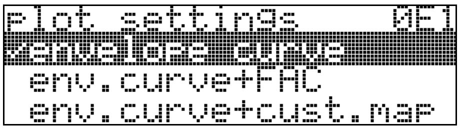


```
Group selection   0E→
✓envelope curve
 display
 diagnostics
```

9.1 Function "plot settings" (0E1)



⇒

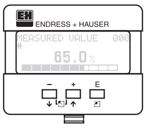


```
plot settings     0E1
✓envelope curve
 env.curve+FAC
 env.curve+cust.map
```

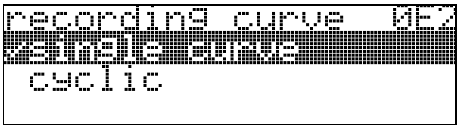
Here select which information is displayed in the LCD:
- **envelope curve**
- env.curve+FAC (on FAC see Page 71)
- env.curve+cust.map (i.e. customer tank map is also displayed, see Page 70)

9.2 Function "recording curve" (0E2)

This function defines whether the envelope curve is read as a
- **single curve**
  or
- cyclic.



⇒

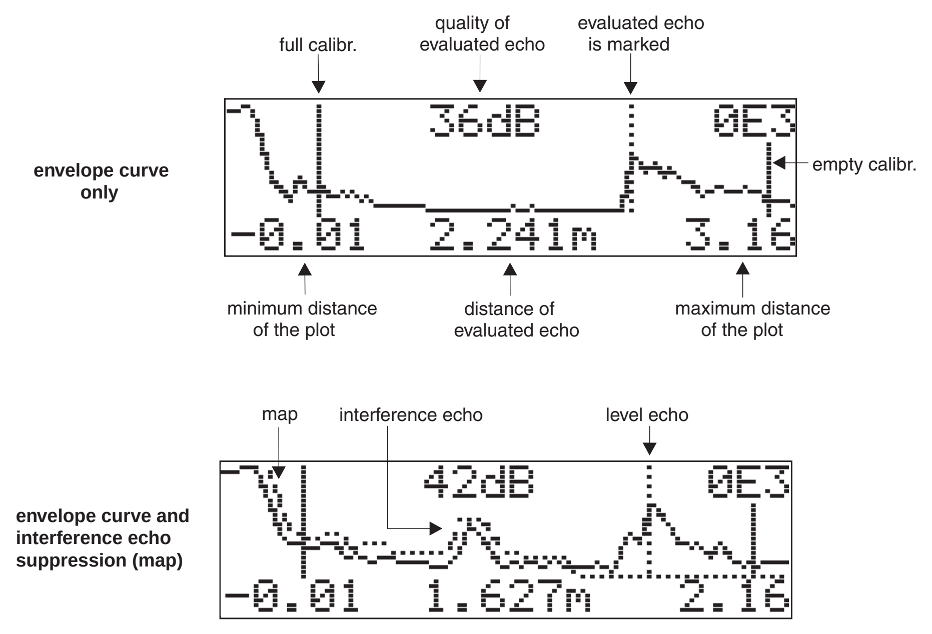


```
recording curve   0E2
✓single curve
 cyclic
```

Note!
If the cyclical envelope curve is active in the display, the measured variable is refreshed in a slower cycle time. It is therefore recommended to exit the envelope curve display after optimising the measuring point.

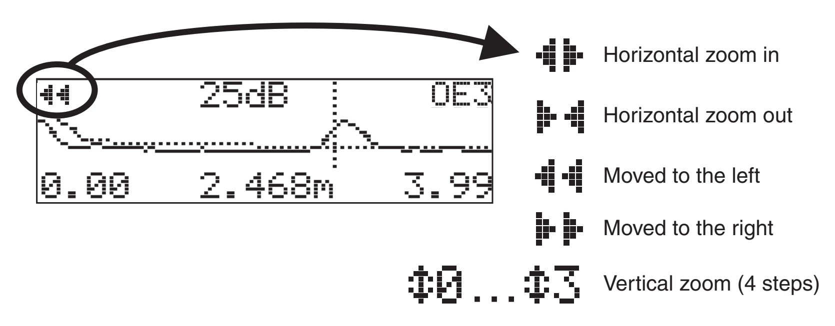
9.3 Function "envelope curve display" (0E3)

The envelope curve is displayed in this function. You can use it to obtain the following information:



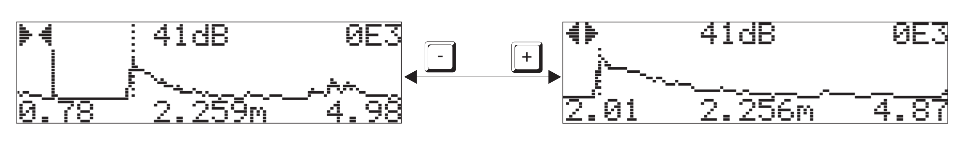
Navigating in the envelope curve display

Using navigation, the envelope curve can be scaled horizontally and vertically and shifted to the left or the right. The active navigation mode is indicated by a symbol in the top left hand corner of the display.



Horizontal Zoom mode

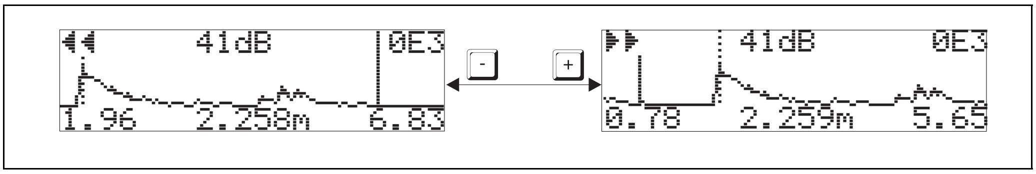
Firstly, go into the envelope curve display (see Page 31). Then press + or - to switch to the envelope curve navigation. You are then in Horizontal Zoom mode. Either ◀▶ or ▶◀ is displayed.
You now have the following options:
- + increases the horizontal scale.
- - reduces the horizontal scale.



Move mode

Then press E to switch to Move mode. Either ▶▶ or ◀◀ is displayed.
You now have the following options:

- + shifts the curve to the right.
- - shifts the curve to the left.

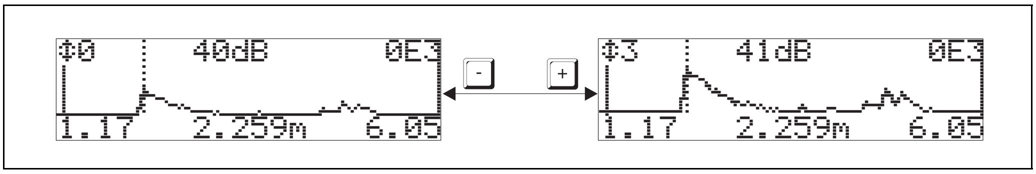


Vertical Zoom mode

Press E once more to switch to Vertical Zoom mode. ⇕1 is displayed.
You now have the following options:

- + increases the vertical scale.
- - reduces the vertical scale.

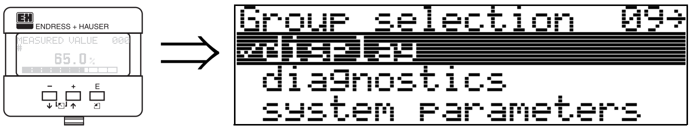
The display icon shows the current zoom factor (⇕0 to ⇕3).



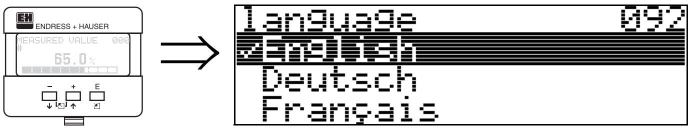
Exiting the navigation

- Press E again to run through the different modes of the envelope curve navigation.
- Press + and - to exit the navigation. The set increases and shifts are retained. Only when you reactivate the **"recording curve" (0E2)** function does the Prosonic use the standard display again.

10 Function group "display" (09)



10.1 Function "language" (092)



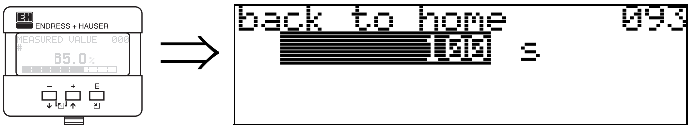
Selects the display language.

Selection:
- **English**
- Deutsch
- Français
- Español
- Italiano
- Nederlands

Dependence
All texts are changed.

Caution!
This function is not visualised in Commuwin II!

10.2 Function "back to home" (093)



If no entry is made using the display during the specified time period, the display returns to the measured value display.
9999 s means that there is no return.

User input:
3...9999 s

Caution!
This function is not visualised in Commuwin II!

10.3 Function "format display" (094)

format display 094
✓decimal
1/16''

Selects the display format.

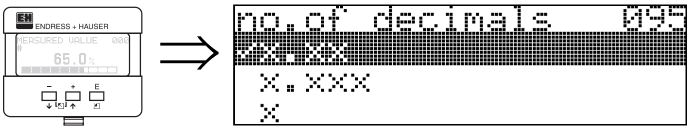
Selection:
- **decimal**
- 1/16''

decimal
The measured value is given in decimal form in the display (e.g. 10.70%).

1/16"
The measured value is given in the display in this format (e.g 5'05-14/16").
This option is only possible for "**distance unit**" **(0C5)** - "**ft**" and "**in**"!

Caution!
This function is not visualised in Commuwin II!

10.4 Function "no.of decimals" (095)



no.of decimals 095
✓x.xx
x.xxx
x

Selection:
- x
- x.x
- **x.xx**
- x.xxx

10.5 Function "sep. character" (096)

sep. character 096
✓.
,

Selection:
- **.**
- ,

.
The decimal place is separated by a point.

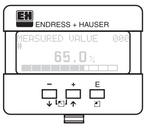
,
The decimal place is separated by a comma.

10.6 Function "display test" (097)

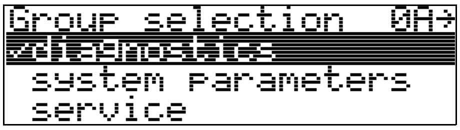
```
display test     097
✓off
 on
```

All display pixels are switched on. If the whole LCD is dark, it is working correctly.

11 Function group "diagnostics" (0A)



⇒


Group selection 0A→
diagnostics
system parameters
service

In the "**diagnostics**" function group, you can display and confirm error messages.

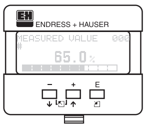
Type of error

Errors that occur during commissioning or measuring are displayed immediately on the local display. If two or more system or process errors occur, the error with the highest priority is the one shown on the display.

The measuring system distinguishes between two types of error:

- **A (Alarm):**
  Instrument goes into a defined state (e.g. MAX)
  Indicated by a constant ϟ symbol.
  (For a description of the codes, see Page 73)
- **W (Warning):**
  Instrument continue measuring, error message is displayed.
  Indicated by a flashing ϟ symbol.
  (For a description of the codes, see Page 73)
- **E (Alarm / Warning):**
  Configurable (e.g. loss of echo, level within the safety distance)
  Indicated by a constant/flashing ϟ symbol.
  (For a description of the codes, see Page 73)

11.1 Function "present error" (0A0)

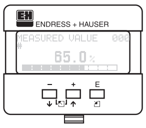


⇒

```
present error     0A0
linearisation ch1
not complete,
not usable       A671
```

The present error is shown using this function.

11.2 Function "previous error" (0A1)

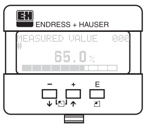


⇒

```
previous error    0A1
simulation ch. 1
on
                 W621
```

The last error presented is shown with this function.

11.3 Function "clear last error" (0A2)



⇒

```
clear last error 0A2
✓keep
 erase
```

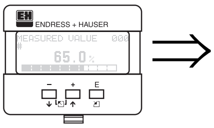
Selection:
- **keep**
- erase

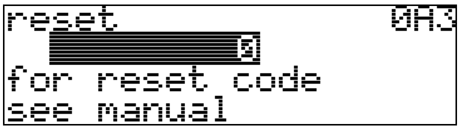
Caution!
This function can be performed on the display only!

11.4 Function "reset" (0A3)

Caution!
A reset sets the instrument back to the factory settings. This can lead to an impairment of the measurement. Generally, you should perform a basic setup again following a reset.

A reset is only necessary:
- if the instrument no longer functions
- if the instrument must be moved from one measuring point to another
- if the instrument is being de-installed /put into storage/installed





reset 0A3
0
for reset code
see manual

Entry ("reset" (0A3)):
- 333 = customer parameters (HART)
- 33333 = customer parameters (PROFIBUS-PA and Foundation Fieldbus)

333 = reset customer parameters for HART
33333 = reset customer parameters for PROFIBUS-PA and Foundation Fieldbus
This reset is recommended whenever an instrument with an unknown 'history' is to be used in an application:
- The Micropilot is reset to the default values.
- The customer specific tank map is not deleted.
- A linearisation is switched to "**linear**" although the table values are retained. The table can be reactivated in the "**linearisation**" **(04)** function group.

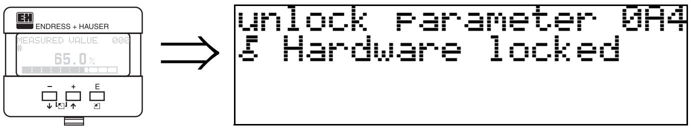
List of functions that are affected by a reset:

- tank shape (002)
- empty calibr. (005)
- full calibr. (006)
- output on alarm (010)
- output on alarm (011)
- outp. echo loss (012)
- ramp %span/min (013)
- delay time (014)
- safety distance (015)
- in safety dist. (016)
- level/ullage (040)
- linearisation (041)
- customer unit (042)
- diameter vessel (047)
- range of mapping (052)
- pres. Map dist (054)
- offset (057)
- low output limit (062)
- fixed current (063)
- fixed cur. value (064)
- simulation (065)
- simulation value (066)
- format display (094)
- distance unit (0C5)
- download mode (0C8)

The tank map can also be reset in the "**cust. tank map**" **(055)** function of the "**extended calibr.**" **(05)** function group.

This reset is recommended whenever an instrument with an unknown 'history' is to be used in an application or if a faulty mapping was started:
- The tank map is deleted. The mapping must be recommenced.

11.5 Function "unlock parameter" (0A4)



unlock parameter 0A4
🔒 Hardware locked

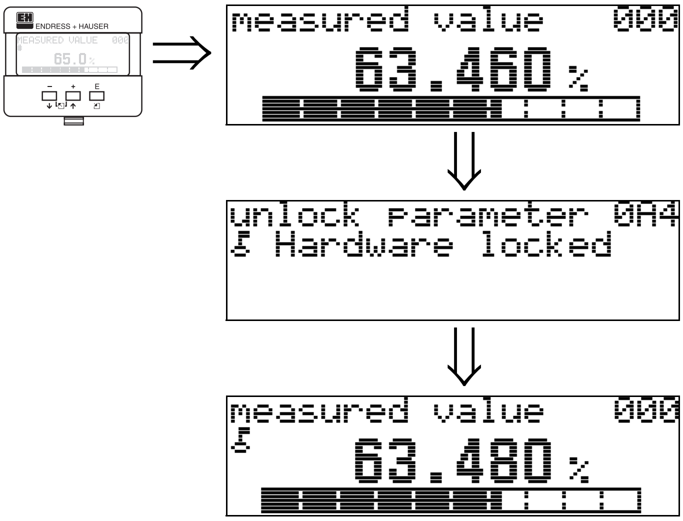
Set-up can be locked and unlocked with this function.

11.5.1 Locking of the configuration mode

The Micropilot can be protected in two ways against unauthorised changing of instrument data, numerical values or factory settings:

"**unlock parameter**" **(0A4):**
A value **<> 100 for HART** (e.g. 99) or **<> 2457 for PROFIBUS-PA and Foundation Fieldbus** (e.g. 2456) must be entered in "**unlock parameter**" **(0A4)** in the "**diagnostics**" **(0A)** function group. The lock is shown on the display by the 🔒 symbol and can be released again either via the display or by communication.

Hardware lock:
The instrument is locked by pressing the + and − and E keys at the same time.
The lock is shown on the display by the 🔒 symbol and can **only** be unlocked again via the display by pressing the + and − and E keys at the same time again. It is **not** possible to unlock the hardware by communication.
All parameters can de displayed even if the instrument is locked.



measured value 000
63.460 %

+ and − and E press simultaneous

unlock parameter 0A4
🔒 Hardware locked

measured value 000
🔒 63.480 %

The LOCK_SYMBOL appears on the LCD.

11.5.2 Unlocking of configuration mode

If an attempt is made to change parameters when the instrument is locked, the user is automatically requested to unlock the instrument:

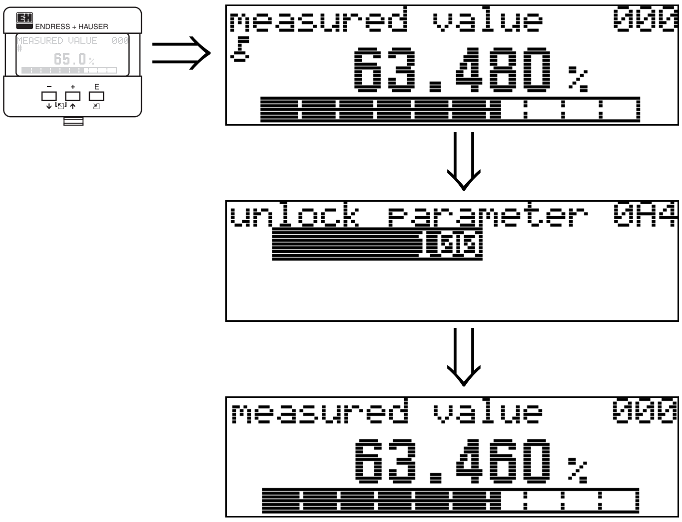
"**unlock parameter**" **(0A4):**
By entering the unlock parameter (on the display or via communication)

100 = for HART devices
2457 = for PROFIBUS-PA and Foundation Fieldbus devices

the Micropilot is released for operation.

Hardware-Verriegelung:
After pressing the + and − and E keys at the same time, the user is asked to enter the unlock parameter

100 = for HART devices
2457 = for PROFIBUS-PA and Foundation Fieldbus devices.

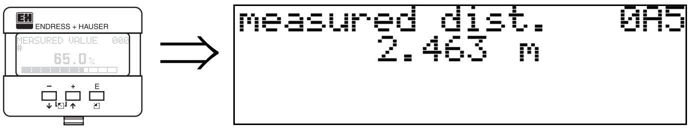


+ and − and E press simultaneous

Please enter unlock code and confirm with E.

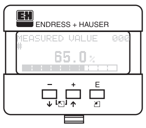
Caution!
Changing certain parameters such as all sensor characteristics, for example, influences numerous functions of the entire measuring system, particularly measuring accuracy. There is no need to change these parameters under normal circumstances and consequently, they are protected by a special code known only to the E+H service organization. Please contact Endress+Hauser if you have any questions.

11.6 Function "measured dist." (0A5)

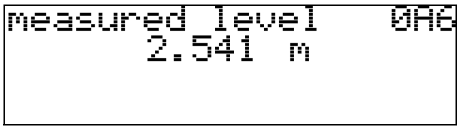


Display of measured distance in the selected "**distance unit**" **(0C5)**.

11.7 Function "measured level" (0A6)

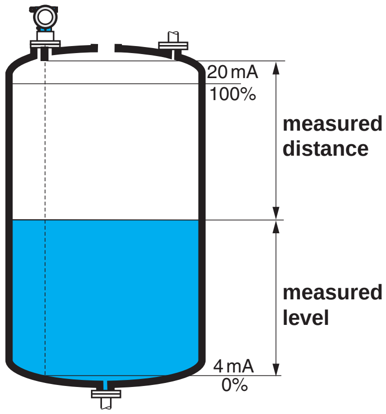


⇒

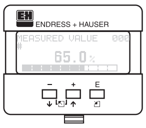


```
measured level    0A6
     2.541  m
```

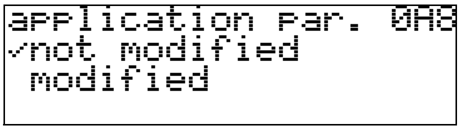
Display of measured level in the selected "**distance unit**" **(0C5)**.



11.8 Function "application par." (0A8)



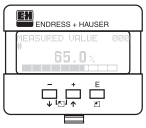
⇒



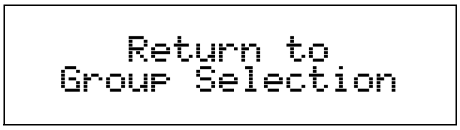
```
application par. 0A8
✓not modified
 modified
```

Displays whether or not one of the settings dependent on the "**tank shape**" **(002)**, "**medium property**" **(003)** and "**process cond.**" **(004)** application parameters has been changed or not.
If, for example, the "**output damping**" **(058)** is changed, the "**application par.**" shows "**modified**".

Display:
- **not modified**
- modified



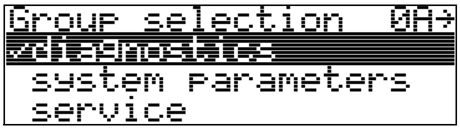
⇒



```
     Return to
  Group Selection
```

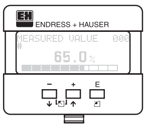
⇓

After 3 s, the following message appears



```
Group selection  0A→
✓diagnostics
 system parameters
 service
```

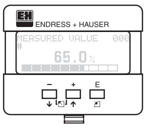
12 Function group "system parameters" (0C)



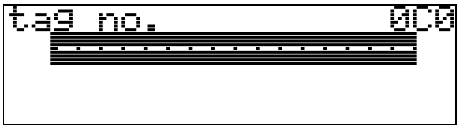
⇒


Group selection 0C→
system parameters
service
basic setup

12.1 Function "tag no." (0C0)



⇒


tag no. 0C0

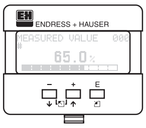
You can define the tag number with this function.

User input:
- 16 alphanumeric characters for HART instruments (8 using the HART universal command)
- 32 alphanumeric characteristics for PROFIBUS-PA instruments

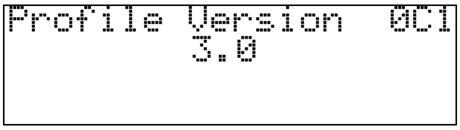
12.2 Function "device tag" (0C0), Foundation Fieldbus only

This function displays the tag number.

12.3 Function "Profile Version" (0C1), PROFIBUS-PA only



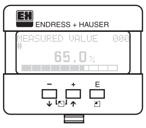
⇒


Profile Version 0C1
3.0

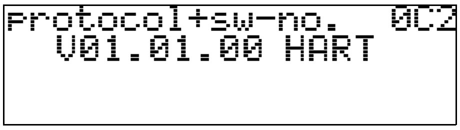
The PA Profile version is shown using this function (Profile 3.0).

Caution!
This function is available for PROFIBUS-PA devices only!

12.4 Function "protocol+sw-no." (0C2)



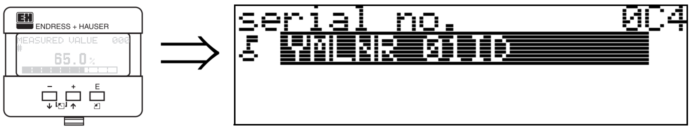
⇒


protocol+sw-no. 0C2
V01.01.00 HART

This function shows the protocol and the hardware and software version: Vxx.yy.zz.prot.

Display:
xx: hw-version
yy: sw-version
zz: sw-revision
prot: protocoll type (e.g. HART)

12.5 Function "serial no." (0C4)



This function displays the instrument serial number.

12.6 Function "device id" (0C4), Foundation Fieldbus only

This function displays the instrument serial number.

12.7 Function "distance unit" (0C5)

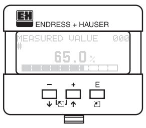
You can select the basic distance unit with this function.

Selection:
- **m**
- ft
- mm
- inch

Dependence
m, mm: "**format display**" **(094)** can only be "**decimal**".

The units are changed for the following parameters:
- empty calibr. (005)
- full calibr. (006)
- safety distance (015)
- input level (044)
- diameter vessel (047)
- range of mapping (052)
- cust. tank map (055)
- offset (057)
- simulation value (066)
- measured dist. (0A5)
- measured level(0A6)

12.8 Function "temperature unit" (0C6)



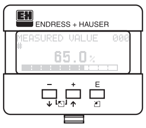

temperature unit 0C6
✓ F
C

In this function you select the temperature unit.

Selection:
- °C
- **°F**

The unit is changed for the following functions
- Function **"measured temp." (030)**
- Function **"max. temp. limit" (031)**
- Function **"max. meas. temp" (032)**

12.9 Function "download mode" (0C8)

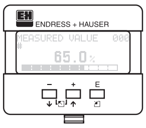


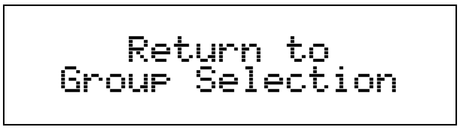

download mode 0C8
✓parameter only
param+cust.map
mapping only

This parameter defines which values are written to the instrument during a ToF Tool or Commuwinn II configuration download.

Selection:
- **parameter only**
- param+cust.map
- mapping only

Note!
This parameter must not be described explicitly in ToF Tool. The various possibilities can be selected from the download dialog.




Return to
Group Selection

After 3 s, the following message appears


Group selection 0C→
✓system parameters
service
basic setup

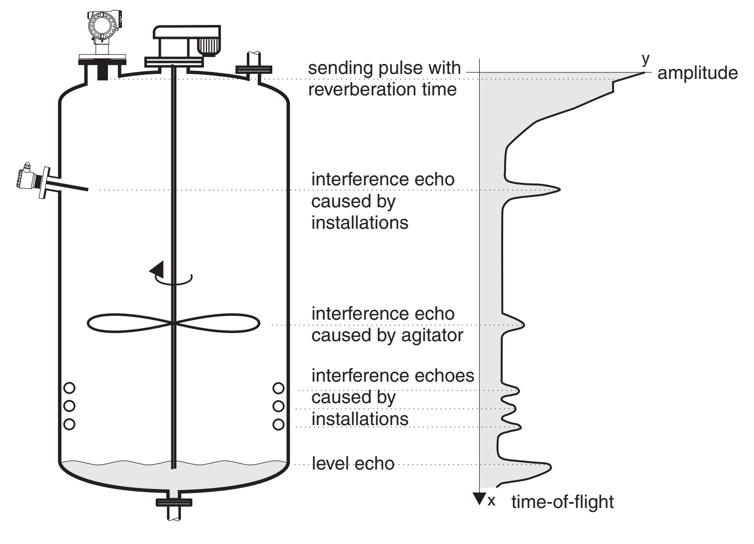
13 Function group "service" (0D)

You can find a detailed description of the "Service" function group as well as a detailed overview of the function menu in the Service Manual: SM 10F for Prosonic M.

14 Signal evaluation

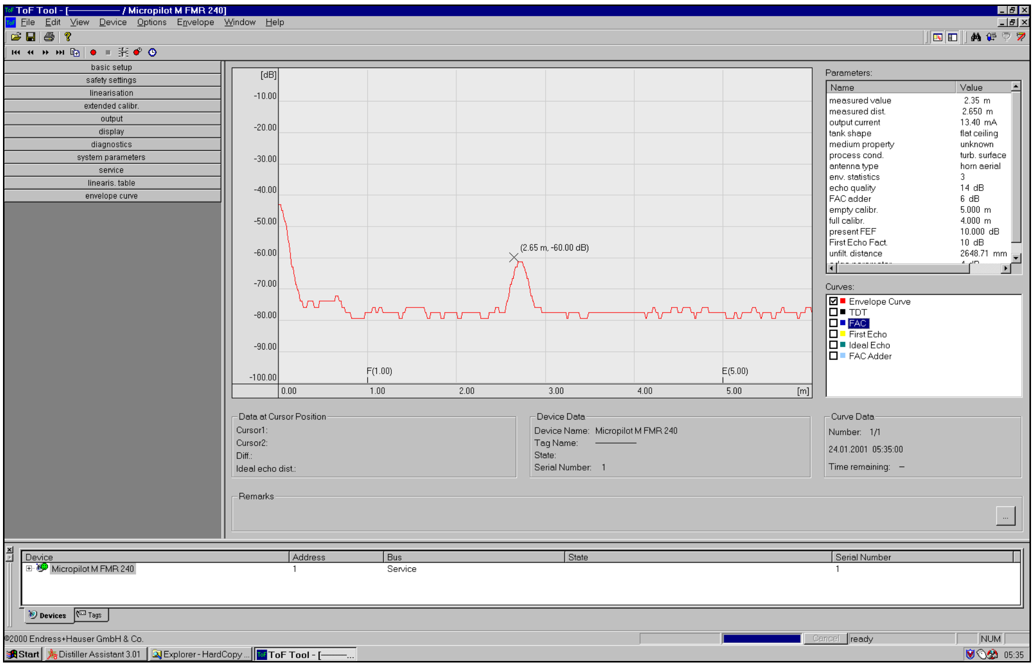
14.1 Envelope curve

The echo of an ultrasonic impulse does not only contain the desired echo from the product surface, but also interference echoes (e.g. from tank fittings or multiple reflections). In order to identify these echoes one plots the logarithmic amplitude of the echo versus the time-of-flight of the ultrasonic impulse. This plot is called **envelope curve**.



The envelope curve can be displayed in the **"envelope curve" (0E)** function group (see Page 52).

In the ToF Tool the envelope curve may also be displayed in the "envelope" menu:



Parameters:

Name	Value
measured value	2.35 m
measured dist.	2.650 m
output current	13.40 mA
tank shape	flat ceiling
medium property	unknown
process cond.	turb. surface
antenna type	horn aerial
env. statistics	3
echo quality	14 dB
FAC adder	6 dB
empty calibr.	5.000 m
full calibr.	4.000 m
present FEF	10.000 dB
First Echo Fact.	10 dB
unfilt. distance	2648.71 mm

Data at Cursor Position
Cursor1:
Cursor2:
Diff.:
Ideal echo dist.:

Device Data
Device Name: Micropilot M FMR 240
Tag Name: ————
State:
Serial Number: 1

Curve Data
Number: 1/1
24.01.2001 05:35:00
Time remaining: –

Remarks

Device	Address	Bus	State	Serial Number
Micropilot M FMR 240	1	Service		1

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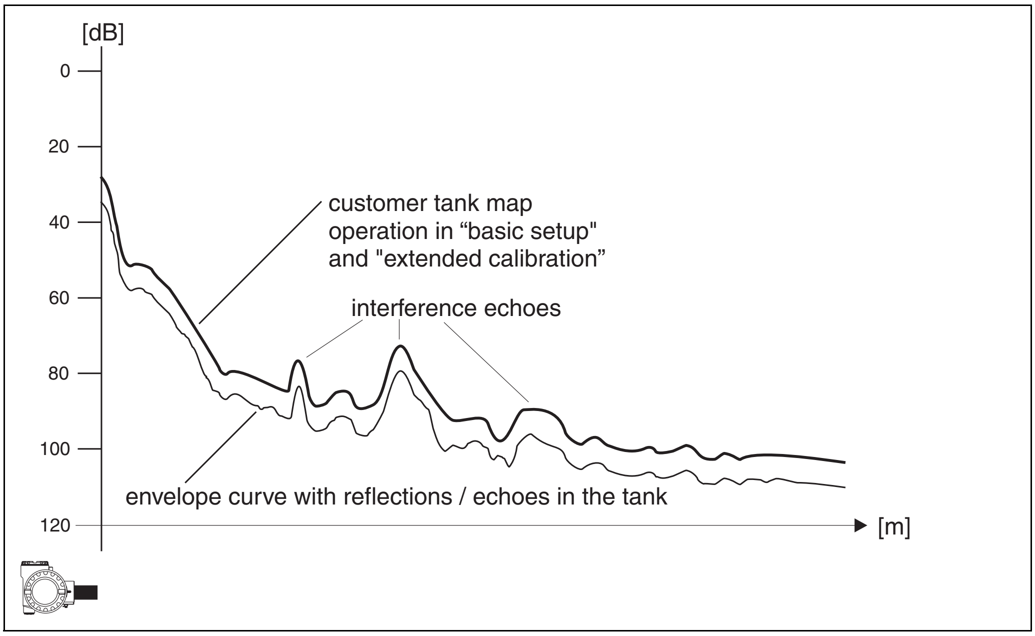
14.2 Interference echo suppression (tank mapping)

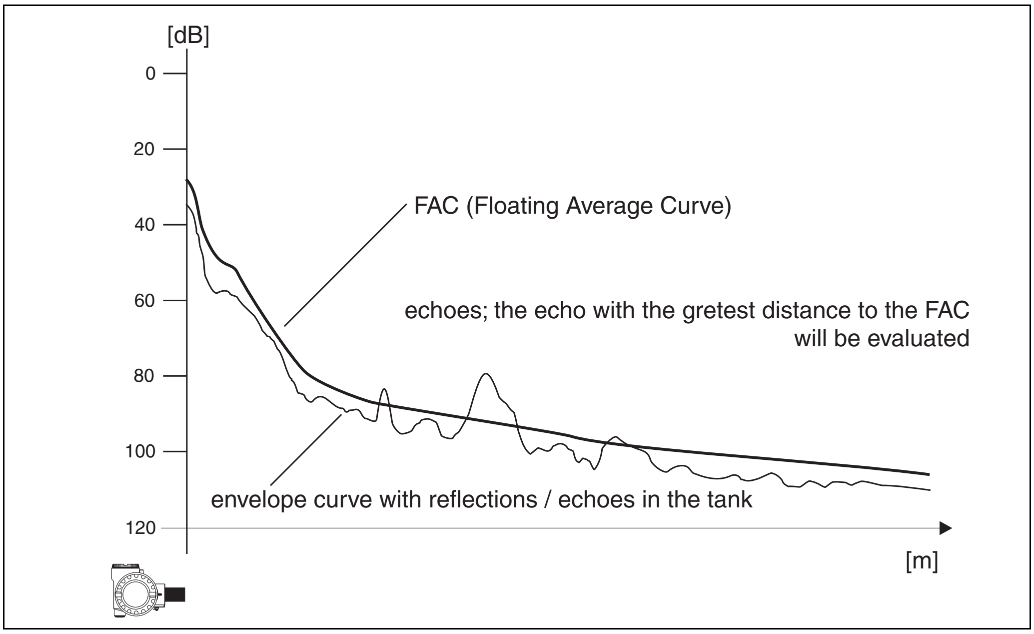
The interference echo suppression of the Prosonic M makes sure that interference echoes are not interpreted as the level echo by fault.
In order to carry out the interference echo suppression one must record a time-of-flight dependent threshold (**TDT**), which is also called the **tank map**.
All maxima of the envelope curve which are situated below the TDT are discarded by the signal evaluation procedures.



It is recommended to record the tank map when the vessel is as possible empty. Then, the map will inclue all echoes except the level echo.
But even, if it is not possible to empty the vessel during the commissioning of the Prosonic M, you should perform the map. In this case it is recommended to repeat the record of the mapping at a later time - when the vessel is as possible empty.

The tank map is recorded in the function group **"extended calibration" (05)**. Select the option "mapping" in the **"selection" (050)** function.

14.3 Floating Average Curve (FAC)



The function of the Floating Average Curve (FAC) is similar to the interference echo suppression.
The main difference is, that the tank map is recorded only once whilst the FAC adjusts itself continuously to the changing measuring conditions.
By this procedure changes of the interference echoes (e.g. by build-up) can be compensated for.
In contrast to the tank map, the FAC can only register small interference echoes.
The FAC is always used in the signal evaluation, even if the tank map has been deactivated.
In the envelope curve, the maximum with the largest distance to the FAC is interpreted as the level echo.

15 Trouble shooting

15.1 System error messages

Current error

Errors which the Prosonic M detects during commissioning or operation are displayed:

- In the **"measured value" (000)** function
- In the **"diagnostics" (0A)** function group in the **"present error" (0A0)** function (only the highest priority error is displayed; in the case of multiple errors, you can scroll between the different error messages by pressing ⊞ or ⊟.)

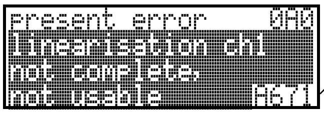
Last error

The last error is displayed in the **"diagnostics" (0A)** function group in the **"previous error" (0A1)** function. This display can be deleted in the **"clear last error" (0A2)** function.

Types of errors

Type of error	Symbol	Meaning
Alarm (A)	ϟ Continuous	The output signal assumes a value which can be set using the **"**output on alarm**" (010)** function: • MAX: 110%, 22mA • MIN: -10%, 3.8mA • Hold: last value is on hold • User-specific value
Warning (W)	ϟ Flashing	The device continues measurement. An error message is displayed.
Alarm/Warning (E)	You can define whether the error should behave as an alarm or as a warning.	

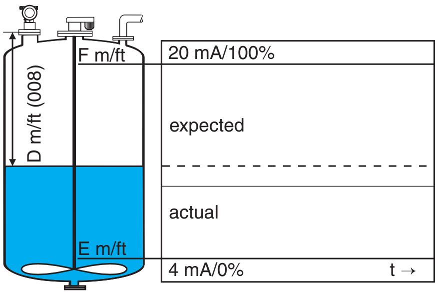
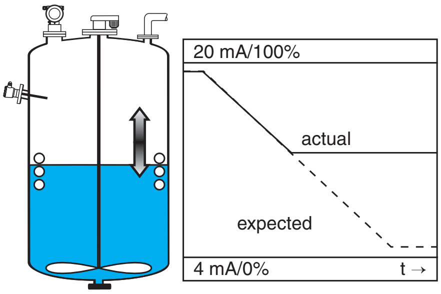
Error codes

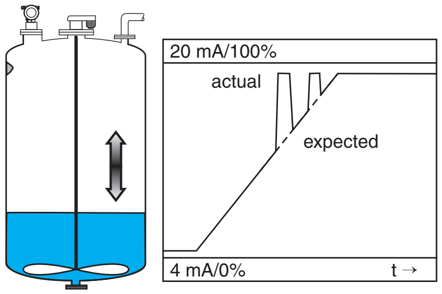
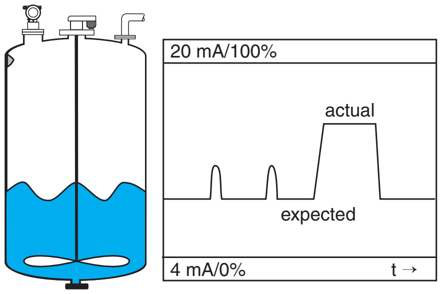
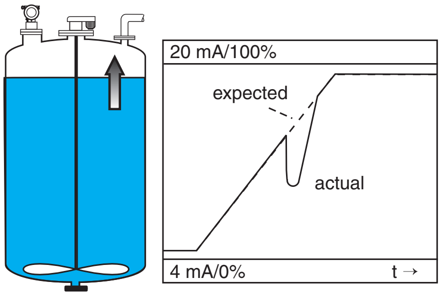
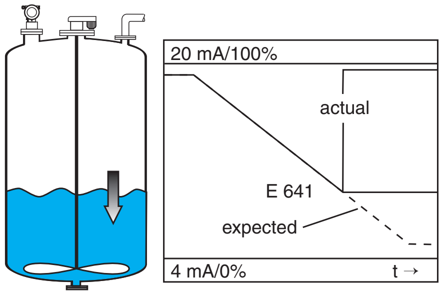


present error 0A0
linearisation chl
not complete,
not usable A671

Code	Error description (on the display)	Action
A101 A102 A110 A152 A160	checksum error	Reset; If alarm still present after reset, replace electronics
W103	initialising	If the message does not disappear after several seconds, replace the electronics
A106	downloading	Wait Message disappears after load sequence
A111 A113 A114 A115 A121 A125 A155 A164 A171	electronics defect	Reset; Check system for EMC, improve as necessary If alarm still present after reset, replace electronics
A116	download error	Check connection Restart download
W153	initialising	Wait a few seconds; if error is still displayed, switch the power off and on again
A231	sensor defect	Check connection, if necessary replace HF module or electronics
A281	interruption temperature sensor	Exchange sensor
A502	Sensor type not detected	Exchange sensor and/or electronics
W511	no factory calibration	Carry out factory calibration
A512	recording of mapping	Alarm disappears after a few seconds
A521	new sensor type detected	Reset
W601	linearisation curve not monotone	Correct table (enter monotonously increasing table)
W611	less than 2 linearisation points	Enter additional value pairs
W621	simulation on	Switch simulation mode off [**"output" (06)** function group, **"simulation" (065)** function]
E641	no usable echo	Check basic calibration (see Page 26)
E651	level in safety distance - risk of overspill	Error disappears when the level leaves the safety distance. Possibly reset the lock. [**"safety settings" (01)** function group, **"ackn. alarm" (017)** function]
A661	Sensor overtemperature	
A671	Linearisation incomplete	Activate linearisation table
W681	current out of range	Carry out basic calibration; check linearisation
W691	Filling noise detected, level ramp is active	

15.2 Application errors

Error	Output	Possible cause		Elimination
A warning or alarm is present.	Depending on the configuration	See Error Codes table (Page 73)		1. See Error Codes table (Page 73)
Measured value (00) is incorrect		Measured distance (008) OK?	yes →	1. Check empty calibration (005) and full calibration (006). 2. Check linearisation: → level/ullage (040) → max. scale(046) → diameter vessel(047) → Check table
		no ↓ Measurement in bypass or stilling well?	yes →	1. In tank shape(002) is bypass or stiliing well selected?
		no ↓ An interference echo might be under evaluation.	yes →	1. Carry out interference echo suppression → basic setup
No change in measured value on filling/ emptying		Interference echoes from fixings, nozzles or build-up on sensor membrane		1. Carry out interference echo suppression → basic setup 2. Clean sensor if necessary 3. If necessary, select better installation position

Error	Output	Possible cause		Elimination
With an uneven surface (e.g. filling, emptying, running agitator) the measured value may jump sporadically to higher levels	 	Signal is weakened by uneven surface — periodically interference echos, e.g. from internals, are stronger		1. Carry out interference echo suppression ⟶ basic setup 2. Set the process cond. (004) to "calm surface" or "add. agitator" 3. Increase output damping (058) 4. If necessary, select a different installation position and/or a larger sensor
On filling/ emptying the measured value drops		Multiple echoes	yes ⟶	1. Check tank shape (002), e.g. "dome ceiling" or "horizontal cyl." 2. In the blocking distance range (059) there is no echo evaluation 3. If possible, do not select a central installation position 4. Possible user stilling well/echo guide pipe
E 641 (echo loss)		Level echo is too weak. Possible causes: • Uneven surface through filling/ emptying • Active agitator • Foam • Sensor not aligned parallel to product surface	yes ⟶	1. Check application parameters (002), (003) and (004) 2. If necessary, select a different installation position and/or a larger sensor 3. Align the sensor parallel to the product surface (particularly for bulk solids applications)

Index function menu

Function group

Function

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In-Situ LevelTroll 500

In-Situ Inc.

Level **TROLL**®

OPERATOR'S MANUAL

Level **TROLL** *300*

Level **TROLL** *500*

Level **TROLL** *700*

*Baro***TROLL**

September 2006

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Contents

1 INTRODUCTION

SYSTEM DESCRIPTION

Your new Level TROLL is a compact, modular system for measuring level and temperature in natural groundwater and surface water, as well as industrial, waste, and other installations. Components include the instrument body, vented and non-vented cables, communication cables, external power accessories, desiccants and other installation accessories, and software.

HOW TO USE THIS MANUAL

This operator's manual is designed as both a start-up guide and a permanent reference for the Level TROLL's features and applications.

Section 1: Introduction to the Level TROLL Operator's Manual and to In-Situ Inc. — Warranty Provisions — Instrument Repair & Return Recommendations

Section 2: Components and features of the Level TROLL system — Accessories — Product Specifications

Section 3: Getting Started — Attaching Cable — Installing & Launching the Software

Section 4: Using Win-Situ — Connecting for the First Time — Setting the Clock — Setting a Device Site — Preparing to Log Data —Disconnecting

Section 5: About the Pressure (Level) Sensor: The two basic types of pressure sensors — Factory and field calibration

Section 6: Field Installation — Guidelines and Precautions for Long-Term Deployment of the Level TROLL

Section 7: The BaroTROLL

Section 8: Connecting for use with SDI-12, Analog (4-20 mA), and Modbus loggers and controllers

Section 9: Care & Maintenance

Section 10: Troubleshooting

CONVENTIONS

Throughout this operator’s manual you will see the following symbols.

✓ *The check mark highlights a tip about a convenient feature of the Level TROLL*

⚠ *The exclamation point calls your attention to a requirement or important action that should not be overlooked*

CERTIFICATION

The Level TROLL complies with all applicable directives required by CE and the FCC and found to comply with EN 61326, ICES-003, and FCC Part 15 specifications. Declarations of conformity may be found at end of this manual.

UNPACKING AND INSPECTION

Your Level TROLL was carefully inspected before shipping. Check for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carriers involved if there is any such damage; do not attempt to operate the instrument. Accessories may be shipped separately and should also be inspected for physical damage and the fulfillment of your order.

TIP: *Please save packing materials for future storage and shipping of your Level TROLL. The shipping boxes have been performance-tested and provide protection for the instrument and its accessories.*

SERIAL NUMBER

The serial number is engraved on the body of the Level TROLL. It is also programmed into the instrument and displayed when the instrument is connected to a computer running Win-Situ 5 or Win-Situ Mobile. We recommend that owners keep a separate record of this number. Should your Level TROLL be lost or stolen, the serial number is often necessary for tracing and recovery, as well as any insurance claims. If necessary, In-Situ maintains complete records of original owner's names and serial numbers.

TO OUR CUSTOMERS . . .

Thank you for your purchase of an In-Situ product. We are glad you chose us and our products to help you with your environmental monitoring needs. In-Situ Inc. has been designing and manufacturing world-class environmental monitoring instrumentation for over 25 years in the Rocky Mountains of the United States. As it was in the beginning, our expectation is that this product will provide you with many trouble-free years of use. To that end, we pride ourselves on delivering the best customer service and support possible—24 hours a day, 7 days a week. We believe that this level of commitment to you, our customer, is imperative in helping you ensure clean, safe groundwater and surface water resources across the globe. We also understand the need for accurate, reliable assessments and we continue to make significant investments in Research and Development to ensure that we deliver the latest product and technological innovations to support your needs.

Whether you are gathering information about your body of water for a few moments, or over a period of years, you can rely upon us to provide you with a quality product and outstanding customer support at a fair price and have that product delivered to you when and where you need it.

We want your experience with In-Situ Inc. to be pleasant and professional, whether you are renting from us, or purchasing from us. We would be pleased to hear from you and learn more about your needs, and your experiences with our products. Again, we thank you for choosing In-Situ Inc. and we look forward to serving your needs now, and in the future.

Bob Blythe

Bob Blythe, President and CEO
In-Situ Inc.
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WHAT WE PROVIDE

WARRANTY PROVISIONS

In-Situ Inc. warrants all products sold against defects in materials and workmanship under normal operating conditions. Consult the separate warranty for specific warranties that may apply.

Maintenance & calibration plans as well as extended warranties are available for U.S. customers. Contact your In-Situ representative for complete information.

FIRMWARE & SOFTWARE UPGRADES

The Level TROLL is upgradeable. Contact In-Situ Inc. for details.

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Internet: www.in-situ.com
e-mail: support@in-situ.com

TO OBTAIN REPAIR SERVICE (U.S.)

If you suspect that your Level TROLL is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call or e-mail In-Situ Technical Support (support@in-situ.com). Have the product model and serial number handy.

2. Be prepared to describe the problem, including how the instrument was being used and the conditions noted at the time of the malfunction.

*✓ **TIP:** Please keep your RMA number for future reference.*

3. If Tech Support determines that service is needed, they will ask that your company pre-approve a specified dollar amount for repair charges. When the pre-approval is received, Tech Support will assign an RMA (Return Material Authorization) number.

4. Clean the Level TROLL and cable. Decontaminate thoroughly if it has been used in a toxic or hazardous environment. See the Cleaning Guidelines and form on page 13.

5. Carefully pack your Level TROLL in its original shipping box, if possible. Include a statement certifying that the instrument and cable have been decontaminated, and any supporting information.

6. Mark the RMA number clearly on the outside of the box with a marker or label.

7. Send the package, shipping prepaid, to

   In-Situ Inc.
   ATTN: Repairs
   221 E. Lincoln Ave.
   Fort Collins, CO 80524

The warranty does not cover damage during transit. We recommend the customer insure all shipments. Warranty repairs will be shipped back prepaid.

Outside the U.S.

Contact your international In-Situ distributor for repair and service information.

GUIDELINES FOR CLEANING RETURNED EQUIPMENT

If an instrument returned for servicing shows evidence of having been deployed in a toxic or hazardous environment, Customer Service personnel will require written proof of decontamination before they can service the unit.

Please help us protect the health and safety of our employees by cleaning and decontaminating equipment that has been subjected to any potential biological or health hazards, and labeling such equipment. Unfortunately, *we cannot service your equipment without such notification*. Please complete and sign the form on page 13 (or a similar statement certifying that the equipment has been cleaned and decontaminated) and send it along to us with each downhole instrument.

- We recommend a good cleaning solution, such as Alconox®, a glassware cleaning product available from In-Situ (Catalog No. 0029810) and laboratory supply houses.
- Clean all cabling. Remove all foreign matter.
- Clean cable connector(s) with a clean, dry cloth. Do not submerge.
- Clean the probe body—including the nose cone, cable head, and protective caps. Remove all foreign matter.

***TIP:** Alconox® is available from In-Situ Inc. (Catalog No. 29810).*

If an instrument is returned to our Service Center for repair or recalibration without a statement that it has been cleaned and decontaminated, or in the opinion of our Service Representatives presents a potential health or biological hazard, we reserve the right to withhold service until proper certification has been obtained.

Decontamination & Cleaning Statement

Company Name ____ Phone _____________________

Address ____

City ________________________________ State _______________ Zip ____________________

Instrument Type ________________________________ Serial Number _______________________

Contaminant(s) (if known) ____

____

Decontamination procedure(s) used ____

____

Cleaning verified by ______________________________________ Title _______________________

Date ____________________________

In-Situ Inc.

2 SYSTEM COMPONENTS

BODY

There are no user-serviceable parts in the Level TROLL body.

The completely sealed Level TROLL contains pressure and temperature sensors, real-time clock, microprocessor, sealed lithium battery, data logger, and memory. Options include a vented or non-vented pressure sensor in a variety of ranges.

CABLE

Several basic cable types are used in the Level TROLL system.

- RuggedCable™, TPU-jacketed (Thermoplastic PolyUrethane)
    - vented or non-vented
    - Halogen-Free vented or non-vented (LSZH-rated, low smoke zero halide)
- Vented FEP* cable
- Stainless steel suspension wire for deployment of a non-vented instrument
- Communication cables for programming the device/downloading the logged data

***TIP:** Cable markings include VF = vent-free, HF = halogen-free*

** FEP (fluorinated ethylene propylene) is the generic equivalent of DuPont Teflon®*

RuggedCable™

Cable includes conductors for power and communication signals, a strength member, and a Kellems® grip to anchor the Level TROLL securely. Available in standard and custom lengths.

Uphole and downhole ends are identical “female” bayonet-type Twist-Lock connectors that mate with the Level TROLL body, TROLL Com communication cable, desiccants, and other accessories. Available in rugged all-titanium or standard carbon-filled ABS plastic.

Vented cable is designed for use with vented pressure/ level sensors (gauged measurements). The cable vent tube insures that atmospheric pressure is the reference pressure applied to the sensor diaphragm. Vented cable includes a small desiccant cap.

Non-vented cable may be used with non-vented pressure/level sensors (absolute measurements).

RuggedCable "Stripped & Tinned"

In place of the "uphole" Twist-Lock connector, this cable ends in bare conductors for wiring to a logger or controller using SDI-12, analog (4-20 mA), or Modbus communication protocols. Vented cable includes an outboard desiccant to protect against condensation.

Also available in a shorter length ending in a "male" Twist-Lock connector to mate with RuggedCable.

For connections, refer to wiring diagrams in Section 7.

Suspension Wire

FEP-coated stainless steel suspension cable is ideal for deployment of instruments with non-vented pressure sensors: Level TROLL 300, non-vented Level TROLL 500 or 700, and BaroTROLL.

Small Desiccant

Vented cable includes a clear cap of indicating silica gel desiccant to protect the cable and electronics from condensation. The desiccant is blue when active. It will absorb moisture from the top down and for best results should be replaced before the entire volume has lost its color. Replacements are available from In-Situ Inc. or your distributor.

Large Desiccant

The optional high-volume desiccant pack may last up to 20 times longer than the small desiccant in humid environments. It attaches to vented Level TROLL cable in the same way. Refill kits are also available from In-Situ Inc. or your distributor.

TIP: *Protect new desiccant from moisture until ready to use.*

Outboard Desiccant

Vented “stripped & tinned” cable includes an outboard desiccant pack attached to the cable vent tube. Same size as large desiccant. Replacements and refills are available.

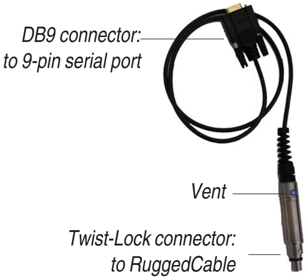
Accessory	Catalog No.
Small desiccant (3)	52230
Large desiccant	51810
Outboard desiccant (replacement)	51380
Refill kit for large & outboard desiccant	29140

COMMUNICATION CABLES

Comm cables provide an interface between the Level TROLL and a desktop/laptop PC or handheld PDA for profiling, programming, and downloading.

The computer connectors are not submersible.

For Connection to Cable



TROLL Com, RS232

Vented polyurethane cable (0.9 m, 3 ft), connects the Level TROLL's RuggedCable to a PC's serial port. Converts the Level TROLL's RS485 signal to a standard RS232 signal for communication via the serial port on a host computer. Weatherproof, withstands a temporary immersion. Cable vents into unit, protected by a hydrophobic membrane.

USB TROLL Com

Same as the RS232 TROLL Com but connects the Level TROLL's RuggedCable to a USB port.

Accessory	Catalog No.
TROLL Com, RS232	51460
USB to serial adapter	31090
USB TROLL Com	52500

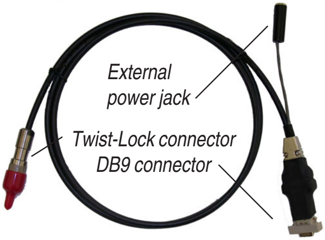
For Direct Connection to Level TROLL

These connect a Level TROLL directly to a serial or USB port for programming and downloading. A good choice for permanent connection to a PC, or for programming a non-vented Level TROLL that will be deployed without RuggedCable.

Programming Cable (RS232)

The computer connectors are not submersible.

Vented polyurethane or halogen-free polyurethane cable (1.8 m, 6 ft) combines the functions of the RuggedCable and TROLL Com; connects the Level TROLL directly to a serial port; includes RS485/RS232 converter and external power input jack; ideal for profiling.



Direct USB TROLL Com

“Female” connector attaches directly to the Level TROLL. No external power input. The non-locking connector is not designed for submersion, but may be used for brief dips into shallow water--hold on to the Level TROLL, not the cable.

Accessory	Catalog No.
USB TROLL Com, direct to Level TROLL	52510
Programming cable	51840
Programming cable, halogen-free	51850

POWER COMPONENTS

*✓ **TIP:** Win-Situ 5 can display the approximate percentage of internal battery life remaining when the Level TROLL is connected to a computer.*

INTERNAL POWER

The Level TROLL operates on 3.6 VDC, supplied by a completely sealed, non-replaceable AA lithium battery. Battery life depends on sampling speed. Typical battery life is 5 years or 2,000,000 data records, whichever occurs first.

EXTERNAL POWER

External Battery Pack

*✓ **TIP:** When a Level TROLL is used as an Analog (4-20 mA), SDI-12, or Modbus device, power is supplied by the data logger or controller to which the Level TROLL is wired.*

The sealed, submersible TROLL Battery Pack (lithium) supplies 14.4 V. When this power source is connected, the Level TROLL will use the external battery source first and switch to the internal batteries when external battery power is depleted. Battery life depends on sampling speed.

0.5 sec sampling interval	1.2 months
1 sec sampling interval	2.3 months
1 min sampling interval or longer	1 year

AC Adapter

Use only In-Situ's AC adapter. Damage to the Level TROLL caused by the use of third-party converters is not covered by the warranty.

In-Situ's AC adapter provides 24 VDC, 0.75 A, AC input 100-250 V, includes North American power cord. The Programming Cable includes an external power input for connection to this adapter.

Accessory	Catalog No.
External Battery Pack	51450
AC Adapter	52440

INSTALLATION ACCESSORIES

- 1/4” NPT Adapter: allows Level TROLL installation in piping
- Twist-Lock Hanger: titanium or stainless steel hanger to suspend a non-vented Level TROLL or BaroTROLL while taking data; no venting, no communication capabilities
- Cable Extender: connects two lengths of RuggedCable
- Wellcaps, locking and vented
- Well Docks: top-of-well support for 2”, 4”, or 6” well
- Panel-mounted bulkhead for connection to RuggedCable

Accessory	Catalog No.
NPT Adapter	51470
Twist-Lock Hanger, titanium for Level TROLL 500, 700, Baro	51480
Twist-Lock Hanger, stainless steel for Level TROLL 300	55050
Cable Extender	51490
Locking Wellcap, 2”	20360
Locking Wellcap, 2” vented	20370
Locking Wellcap, 4”	20380
Locking Wellcap, 4” vented	20390
Top-of-well installation ring	WELLDOCK2”, 4”, 6”
Bulkhead connector	53240
Weighted nose cone	57570

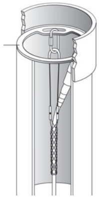
NPT Adapter

Twist-Lock Hanger

Cable Extender

Weighted nose cone

Locking Wellcap



Well Dock

CONTROL SOFTWARE

Win-Situ® 5 is easy-to-use software for programming the Level TROLL.

TIP: *Win-Situ connects through a serial COM port. If your computer does not have one, a USB-to-serial adapter is available from In-Situ Inc. (Catalog No. 31090).*

Win-Situ provides instrument control for direct reads and profiling, long-term data logging, data downloads, data viewing, data export to popular spreadsheet programs, choice of units and other display options, battery/memory usage tracking, interface to networks and telemetry.

Minimum system requirements: 400 MHz Pentium® II processor, 128 Mb RAM, 100 Mb free disk space, Internet Explorer® 6.01 or higher, Windows® 2000 Professional SP4 or higher, or Windows XP Professional SP1 or higher, CD-ROM drive, and a serial communications port.

Complete information on using the software is available from Win-Situ's Help menu.

Win-Situ® Mobile (formerly Pocket-Situ 5) provides Win-Situ's features and functions on a field-portable platform. Requirements: supported PDA with Microsoft Pocket PC 2003 (Windows Mobile) or later operating system, serial communications port, and at least 16 Mb for data storage (SD card, CF card, or the device's built-in non-volatile memory). For installation and file exchange, Microsoft® ActiveSync® must be installed on an office desktop or laptop computer.

Accessory	Catalog No.
Win-Situ 5 (no license required)	51980
Win-Situ Mobile license for RuggedReader	47520
Win-Situ Mobile license (upgrade from Pocket-Situ 4)	47550

PRODUCT SPECIFICATIONS

	Level TROLL 300	Level TROLL 500	Level TROLL 700
Operating Temperature	-5 to 50°C (23 to 122°F)	-20 to 80°C (-4 to 176°F)	-20 to 80°C (-4 to 176°F)
Storage Temperature	-40 to 80°C (-40 to 176°F)	-40 to 80°C (-40 to 176°F)	-40 to 80°C (-40 to 176°F)
Dimensions			
O.D.	0.82" (20.82 mm)	0.72" (18.3 mm)	0.72" (18.3 mm)
Length	9.0" (22.9 cm)	8.5" (21.6 cm)	8.5" (21.6 cm)
Weight	0.54 lb (0.24 kg)	0.43 lb (0.197 kg)	0.43 lb (0.197 kg)
Material			
Housing	316L Stainless steel	Titanium	Titanium
Nose Cone	Black Delrin®	Black Delrin®	Black Delrin®
Output Options	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA
Power			
Internal Battery	3.6V lithium	3.6V lithium	3.6V lithium
Battery Life	5 yrs or 1M data records	5 yrs or 2M data records	5 yrs or 2M data records
External Power	8-36 VDC	8-36 VDC	8-36 VDC
Memory	1 MB	2 MB	4 MB
Data Records	50,000	100,000	350,000
Fastest Logging Rate	1 per sec	2 per sec	4 per sec
Real-Time Sampling Rate			
Modbus	2 per sec	2 per sec	2 per sec
SDI-12	2 per sec	2 per sec	2 per sec
4-20 mA update rate	2 per sec	2 per sec	2 per sec
Max. no. of logs	2	2	50
Log Types	Linear, Fast Linear	Linear, Fast Linear	Linear, Fast Linear, Linear Average, Step Linear, Event, True Logarithmic

	Level TROLL 300	Level TROLL 500	Level TROLL 700
Pressure/Level Sensor			
Type	Silicon strain gauge	Silicon strain gauge	Silicon strain gauge
Material	Stainless steel	Titanium	Titanium
Accuracy*			
@ 15°	± 0.2% FS	± 0.05% FS	± 0.05% FS
-5 to +50°C	± 0.2% FS	± 0.1% FS	± 0.1% FS
-20 to -5 & +50 to +80°C	NA	± 0.25% FS typical	± 0.25% FS typical
Resolution	± 0.01% FS or better	± 0.005% FS or better	± 0.005% FS or better
Range			
Non-Vented (PSIA)	30, 100, 300	30, 100, 300, 500	30, 100, 300, 500
Vented (PSIG)	––	5, 15, 30, 100, 300, 500	5, 15, 30, 100, 300, 500
Max. pressure	2X range	2X range	2X range
Burst pressure	3X range	3X range	3X range
Temperature Sensor			
Material	Silicon	Silicon	Silicon
Accuracy	± 0.25°C	± 0.1°C	± 0.1°C
Resolution	0.1°C	0.01°C	0.01°C

** FS = full scale. Accuracy with 4-20 mA output option: ± 0.25% FS typical*

Range and Usable Depth

Non-Vented Level TROLL

Range	Effective Range**		Usable Depth	
PSIA	PSIA	kPa	Meters	Feet
30	15.5	106.9	0-10.9	0-35.8
100	85.5	589.5	0-60.1	0-197.3
300	285.5	1968	0-200.7	0-658.7
500	485.5	3347	0-341.3	0-1120

*** At sea level (14.5 PSI atmospheric pressure).*

Vented Level TROLL

Range		Usable Depth	
PSIG	kPa	Meters	Feet
5	34.5	0-3.5	0-11.5
15	103.4	0-11	0-35
30	206.8	0-21	0-69
100	689.5	0-70	0-231
300	2068	0-210	0-692
500	3447	0-351	0-1153

BaroTROLL

Same as Level TROLL 500 specs, **except** Pressure Range: 0 to 16.5 PSIA (1.14 bar, 33.59 in Hg), Log Types: Linear, Fastest Logging Rate: 1 per minute

Cable

Jacket options	Polyurethane, halogen-free (HF) polyurethane, FEP*
Connector	Titanium or carbon-filled ABS plastic, 18.5 mm (0.73 in) O.D.
Conductors	6 conductors, 24 AWG, polypropylene insulation
Diameter	6.7 mm (0.265 in)
Break strength	127 kg (280 lb)
Minimum bend radius (vented cable)	2X cable diameter (13.5 mm, 0.54 in)
Weight	Vented, regular & HF: 14 kg/300 m (32.3 lb/1000 ft) Non-vented, regular & HF: 16 kg/300 m (35.6 lb/1000 ft) Vented FEP: 23 kg/300 m (52 lb/1000 ft)

Suspension Wire

Material	304 stainless steel, 7 x 7 strand
Coating	Recycled FEP*, 0.5 mm (0.020 in) thick
Weight	4.3 kg /300 m (9.75 lb/1000 ft)
Overall O.D.	2.2 mm (approx. 1/16 in)
Break strength	122 kg (270 lb)

** FEP = fluorinated ethylene propylene, the generic equivalent of DuPont Teflon®*

3 GETTING STARTED

This section provides a quick overview of the initial steps necessary to get the instrument ready to log data.

You will need—

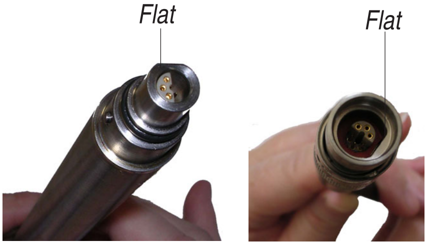
- Level TROLL or BaroTROLL
- Cable
  - RuggedCable and TROLL Com communication cable (for devices that will be deployed on RuggedCable),
    or
  - Programming Cable (for devices that will be deployed on suspension wire)
- In-Situ Software/Resource CD
- Desktop / laptop PC
- Optional: RuggedReader® handheld PDA
- Software License Certificate for licensed software (Win-Situ Mobile)

A. CONNECT THE RUGGEDCABLE OR PROGRAMMING CABLE TO THE LEVEL TROLL

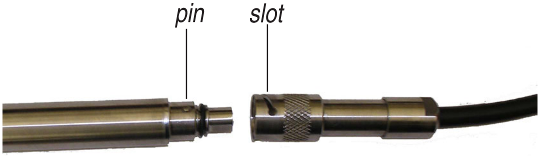
1. Remove the protective caps from the Level TROLL and cable.

TIP: *Retain the dust caps to protect the pins and o-ring from damage when cable is not attached.*

2. Take a moment to look at the connectors. Each has a flat side.



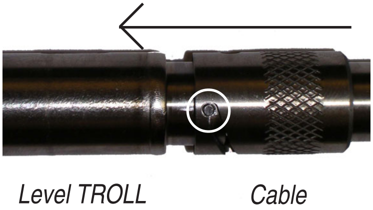
Note the pins on the body connector (one on each side) and the slots on the cable connector (one on each side).



3. Slide back the sleeve on the cable connector.

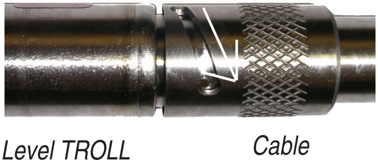
4. Orient the “flats” so they will mate up, and insert the Level TROLL connector firmly into the cable connector.

5. Slide the sleeve on the cable toward the Level TROLL body until the pin on the body pops into the round hole in the slot on the cable connector.



6. Grasp the knurled (textured) section of the cable connector in one hand and the Level TROLL body in the other. Push and twist firmly so that the pin on the body connector slides along the slot on the cable connector and locks securely into the other hole.

Be sure you hear the "click." The "click" ensures the cable is securely attached.



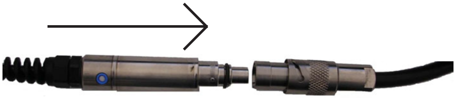
If you connected RuggedCable, continue to step B. If you connected a Programming Cable, skip to step C.

B. CONNECT THE TROLL COM TO THE RUGGEDCABLE

1. Remove the desiccant from the free end of the RuggedCable (if present) by grasping the knurled (textured) section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.

2. Slide back the sleeve on the cable connector. Locate the “flats” on the cable connector and the TROLL Com connector as before.

3. Orient the “flats” so they will mate up, and insert the TROLL Com connector firmly into the cable connector.



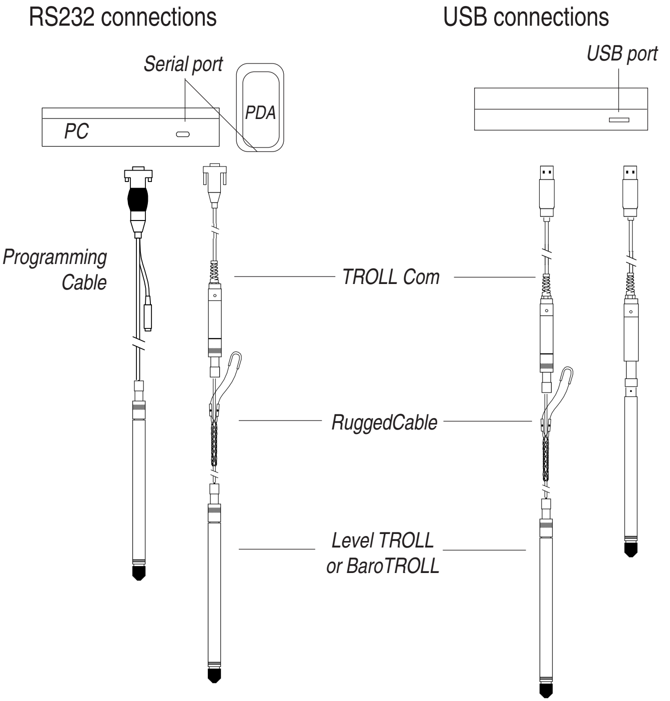
4. Slide the metal sleeve on the cable toward the TROLL Com body until the pin on the body pops into the hole in the slot on the cable connector.

Be sure you hear the “click.” The “click” ensures the cable is securely attached.

5. Grasp the knurled (textured) section of the cable connector in one hand and the TROLL Com body in the other. Push and twist firmly so that the pin on the body slides along the slot on the cable connector and snaps securely into the other hole.

C. CONNECT TO THE HOST PC

Attach the TROLL Com or Programming Cable to a PC's RS232 serial port or USB port.



D. INSTALL THE SOFTWARE

Install Win-Situ 5 from the In-Situ software/resource CD or from the In-Situ website:

1. Insert the In-Situ software/resource CD in your computer's CD drive.
2. Select Win-Situ 5, then click on Setup. Follow the instructions to install Win-Situ 5 to your local hard drive.

TIP: *If the CD menu does not display automatically, choose Run from the Windows Start Menu and type D:\ISISoftwareCD.html, where* D *is your CD-ROM drive letter.*

For communication using a RuggedReader handheld in the field, install the desktop component of Win-Situ Mobile (formerly called Pocket-Situ 5) on the same desktop/laptop computer:

1. Return to the website or the CD main menu and select Win-Situ Mobile. Click on Setup and follow the instructions to install the Win-Situ Software Manager to your local hard drive.
2. Connect the RuggedReader to the desktop computer, establish a connection in Microsoft ActiveSync®, launch the Win-Situ Software Manager, and follow the instructions to install Win-Situ Mobile on the RuggedReader.

TIP: *Insure Microsoft ActiveSync is installed on the desktop or laptop PC and a Guest connection or partnership has been established between the computers.*

E. LAUNCH THE SOFTWARE

Start Win-Situ by double-clicking the shortcut WS created on the desktop during installation.

The next section of this manual provides a brief overview of Win-Situ. For more detailed information, see Win-Situ's Help menu.

4 USING WIN-SITU

Win-Situ® 5 is In-Situ's instrument control software for Level TROLLs. Use Win-Situ to

- display real-time readings from the connected Level TROLL, in meter, tabular, or graphic format
- program the device to log data; download the logged data
- customize the output of a pressure/level sensor to record draw-down, surface water elevation, gauge height, stage height, etc.
- set communication options in the device—Modbus, SDI-12, analog, IP, telemetry, etc.

✓ ***TIP:*** *Win-Situ® Mobile provides Win-Situ's features and functionality in a convenient field-worthy platform.*

CONNECT TO THE LEVEL TROLL

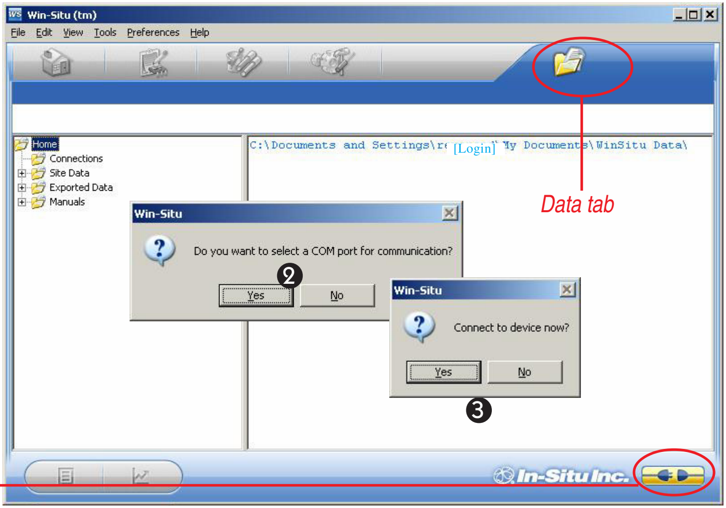
1. Start Win-Situ by double-clicking the shortcut WS created on the desktop during installation.

Win-Situ launches and displays the Data area (“tab”).

TIP: The port is usually COM 1 for direct serial connection. This is Win-Situ’s default.

2. Check the COM port (optional). When you launch for the first time, the software may ask if you want to select a COM port. Do one of the following:
    - Answer Yes to the prompt, then check or change the port in the Comm Settings dialog, and click OK ✓ to close it, or
    - Answer No to bypass this step.
3. Win-Situ asks if you want to connect to the Level TROLL (the “device”). If the Level TROLL is connected to your computer as described in the previous section, answer Yes.

TIP: *You can turn off the “Connect now?” prompt: Select Preferences menu > General Settings, deselect “Prompt for connect at startup,” click OK. In this case, connect to the device by clicking the Connect button*



C:\Documents and Settings\r[Login]\My Documents\WinSitu Data\

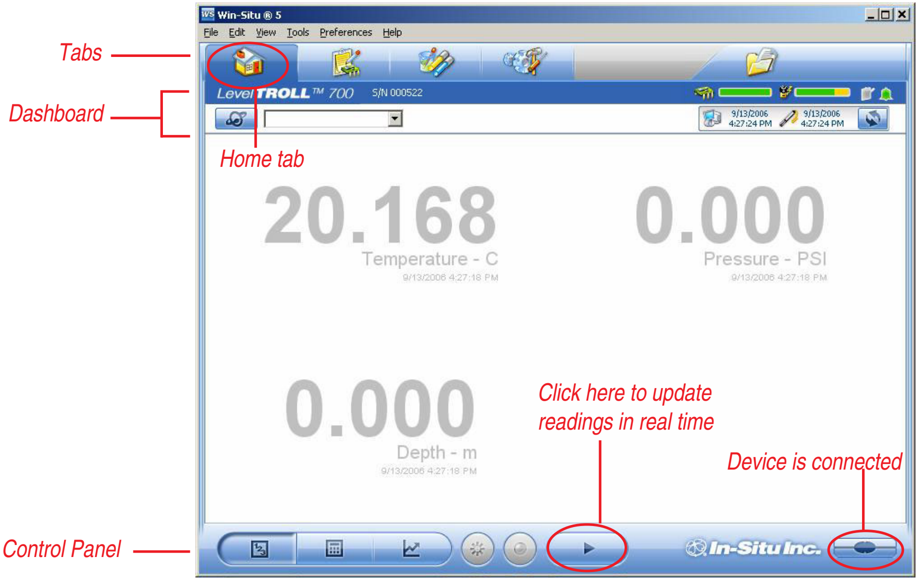
Do you want to select a COM port for communication?

Connect to device now?

Data tab

Connect button

4. The software connects and displays current temperature, pressure, and level/depth readings (temperature and pressure for a BaroTROLL).



9/13/2006 4:27:24 PM
9/13/2006 4:27:24 PM

20.168
Temperature - C
9/13/2006 4:27:18 PM

0.000
Pressure - PSI
9/13/2006 4:27:18 PM

0.000
Depth - m
9/13/2006 4:27:18 PM

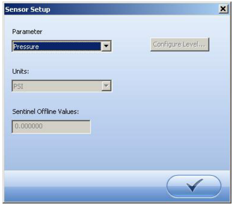
THE HOME SCREEN

- Note the **Tabs** at the top of the screen— this is the Home tab, which displays current readings from the connected device.
- The **Dashboard** (status area) below the tabs displays the device model and serial number, battery and memory capacity, the device clock and the computer clock, and other device information.
- The **Control Panel** at the bottom contains action buttons. You can start updating the readings in real time by pressing ▶.

CUSTOMIZING THE HOME SCREEN DISPLAY

Changing Units

1. Click the Sensors tab, select the level/pressure sensor.
2. Click the Configure button in the control panel.
3. In the Sensor Setup screen, select a parameter, then select a unit. Repeat for each parameter as necessary.



Parameter: Pressure

Units: PSI

Sentinel Offline Values: 0.000000

4. Click OK ✓ to change the units and return to the Sensors tab.

Changing the Rate at Which the Readings Update

Also called the “poll rate,” this can range from 1 to 30 seconds.

1. Select Preferences menu > Home View Settings.
2. Adjust the Poll Rate. Default: 5 seconds.

Changing the Significant Digits

To change the number of significant digits displayed for each reading:

1. Select Preferences menu > General Settings.
2. Under Parameter Defaults, select the significant digits for each parameter.

Real-Time Graphing

To view a real-time trend graph: click the graph button

To view a graph with a data table below it, select Preferences menu > Graph Settings. Check ☑ the Data Panel option. Click OK.

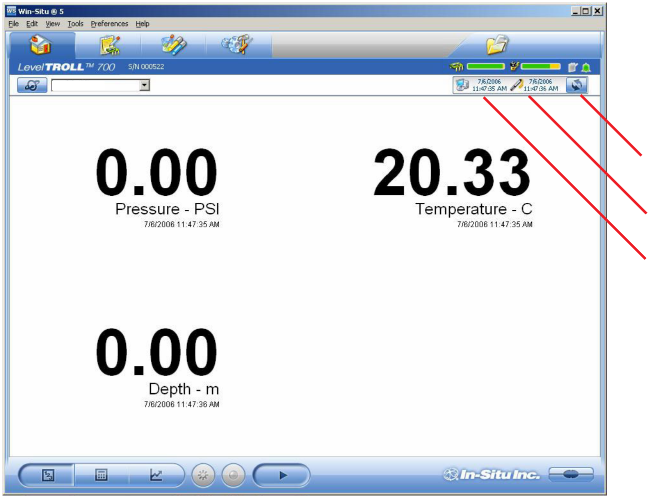
Now you're ready to give the Level TROLL some specific information through the software. Win-Situ provides many options. At a minimum:

- set the Level TROLL clock
- enter a name for the site where the Level TROLL will collect data
- enter data logging instructions

A brief overview is provided here. For more detailed information, see Win-Situ's Help menu.

SETTING THE CLOCK

Data collection schedules depend on the device's real-time clock. Both the device clock and the system (PC) clock are shown on the dashboard. The clocks update every 2 seconds. If the device clock differs by more than 2 seconds from the system clock, the device clock is displayed in red. To synchronize the clocks, click the Sync button.



7/6/2006 11:47:35 AM
7/6/2006 11:47:36 AM

0.00
Pressure - PSI
7/6/2006 11:47:35 AM

20.33
Temperature - C
7/6/2006 11:47:35 AM

0.00
Depth - m
7/6/2006 11:47:36 AM

Clock Sync button

Device clock

PC clock

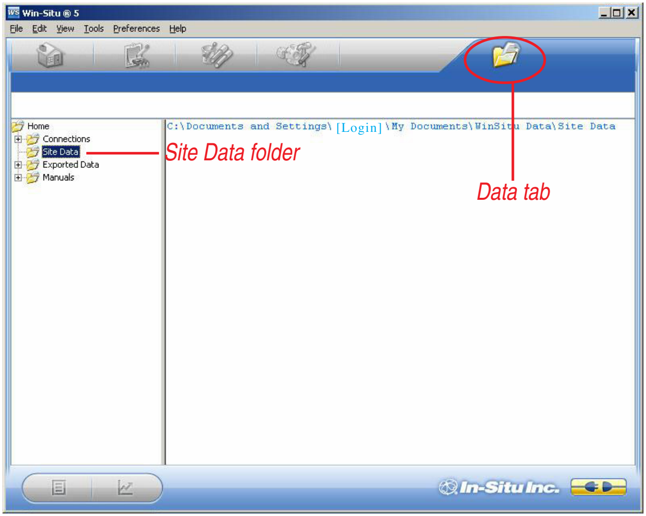
ADDING A NEW SITE

***TIP:** For complete information on Sites, see Win-Situ's On-Line Help.*

Logged data are organized and filed by the **site** where the data were logged. This feature can help you manage data from multiple sites. You can create as many sites as you like, with or without a Level TROLL connected. Sites are stored in the site database in your Win-Situ working directory and are available to select for any Level TROLL, any log.

You will need a site when setting up a data log. Here are the steps to set up a new site:

1. On the Data tab, click the Site Data folder.
2. Select File menu > New > Site.



Site Data folder

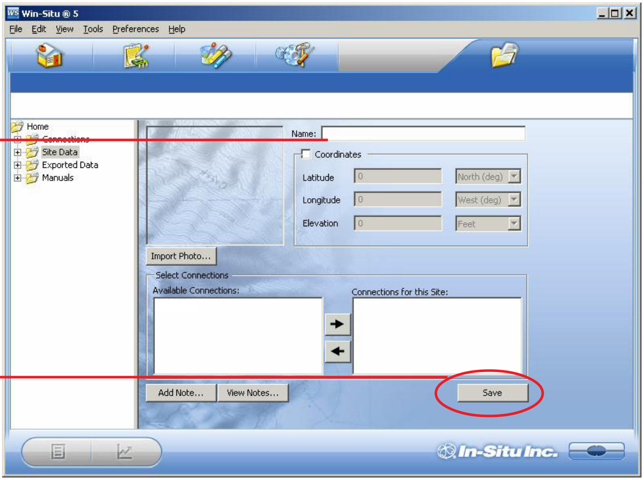
Data tab

3. In the Site Information screen, enter a name for the site. A short, descriptive name is best—for example, a project, well, water body, gauging station, town, nearby landmark, etc. Length is limited to 32 characters.

   A site name the only required field, but there are many additional options for identifying a site. To include site Coordinates, check ☑ Coordinates, then enter Latitude (0.00 to 90.00, select North or South from listbox), Longitude (0.00 to 180.00, select East or West) and Elevation (select Feet or Meters). You can add a short descriptive Note, import a site Photo (bitmap), and/or specify a custom Connection. (If any connections have been defined, they will be displayed.)

4. When finished, click **Save** to save the site.

TIP: *The site coordinates are optional. They are used to uniquely identify a data site. They are not used elsewhere by the software.*



Name the site

Save the site

Name:

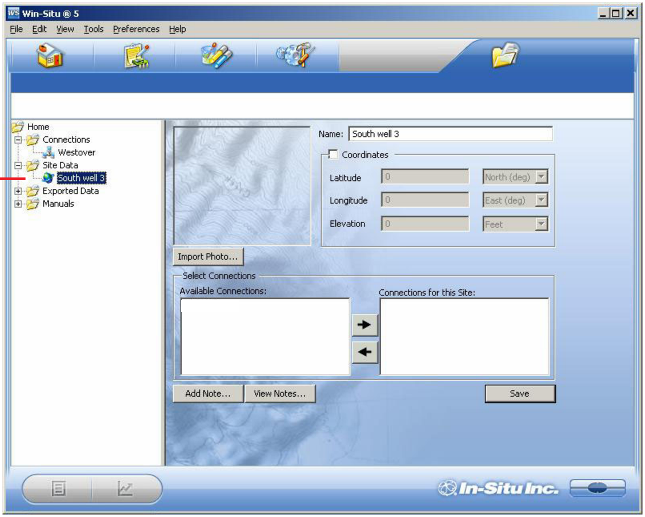
☐ Coordinates

Latitude 0 North (deg)

Longitude 0 West (deg)

Elevation 0 Feet

The new site will appear in the Site Data folder, and Win-Situ will add it to the site database in the working directory on your computer. It is now available to select for any device, any log.



New site appears in Site Data folder

Name: South well 3

☐ Coordinates

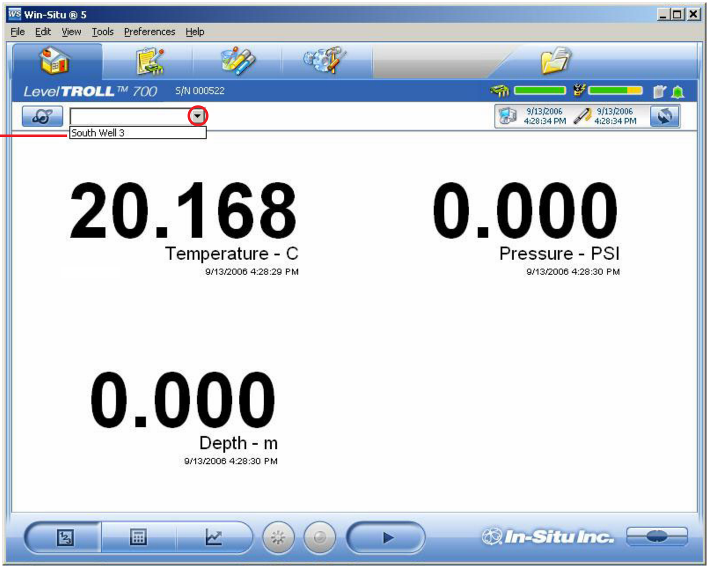
Latitude 0 North (deg)

Longitude 0 East (deg)

Elevation 0 Feet

5. To set this new site in the connected Level TROLL: Return to the Home tab, click the down arrow beside the site box, and select your new site.

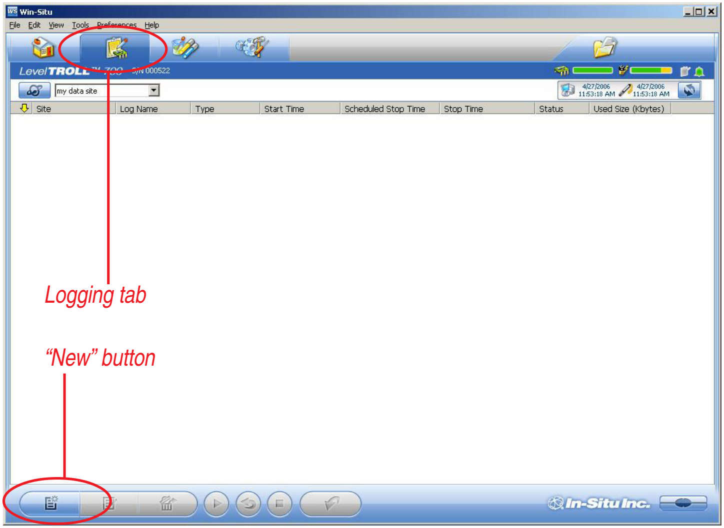
   This site now becomes the “current” site for the connected Level TROLL, and is available to use in data logs.



Select the new site

PREPARING TO LOG DATA

1. To program the device to log data, first select the Logging tab.
2. Click the “New” button.



Logging tab

“New” button

The Logging Setup Wizard will prompt you through the configuration of a data log—including the site, log name, parameters to measure, sample schedule, start time, stop time, output (depth or level), and other options. For details on setting the pressure sensor output, refer to Win-SItu’s Help menu, or Section 5 in this manual.

TIP: *For more complete information on setting up data logs, see Win-Situ’s Help menu.*

TIP: *For a Level TROLL 300 or other non-vented Level TROLL that will be deployed on wire, be sure to select a Scheduled Start so the log will start by itself, without a communication connection.*

To Start logging:

- A “Pending” (scheduled) log will start at its programmed time
- You can start a “Ready” (manual) log at any time while connected by selecting the log and pressing “Start”

To Stop logging:

- Select the log and press the “Stop” button
- Or suspend (temporarily stop) it with the “Pause” button

To Download the log to the connected PC:

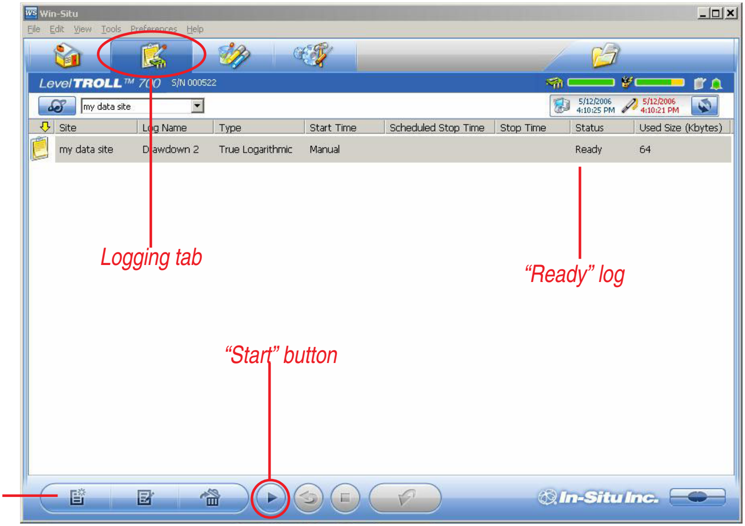
- Select the log and press the “Download” button

To View the log after downloading:

- Go to the Data tab and select the log; for a graph press

TIP: *As an alternative to the log control buttons, right-click a log to display a short context menu of available actions.*

TIP: *The available log control buttons will vary depending on the status of the log selected.*



Site	Log Name	Type	Start Time	Scheduled Stop Time	Stop Time	Status	Used Size (Kbytes)
my data site	Drawdown 2	True Logarithmic	Manual			Ready	64

Logging tab

“Ready” log

“Start” button

Log control buttons

DISCONNECTING

After the Level TROLL is programmed to log data, you're ready to

- Exit the software (File menu > Exit).
- Disconnect the TROLL Com from the cable connector, by grasping the knurled (textured) section of the cable connector in one hand and the TROLL Com in the other. Twist in opposite directions to unlock the TROLL Com from the cable.
- Vented cable: Attach desiccant to the cable connector—line up the flat sides of the connectors, push, twist, and click to lock the desiccant to the cable. Remove red dust cap (if present) from the desiccant's vent.
- Non-vented Level TROLL or BaroTROLL: Attach a Twist-Lock hanger to prevent flooding, and suspension wire (if using).
- Install the instrument in its field location. See Section 6 for guidelines.

Be sure to remove the desiccant dust cap (if present) before deployment to allow air to reach the cable's vent tube.

5 ABOUT THE PRESSURE/ LEVEL SENSOR

A pressure transducer senses changes in pressure, measured in force per square unit of surface area, exerted by water or other fluid on an internal media-isolated strain gauge. Common measurement units are pounds per square inch (PSI) or newtons per square meter (pascals).

NON-VENTED (ABSOLUTE) VS. VENTED (GAUGED) SENSORS

A non-vented or “absolute” pressure sensor measures all pressure forces exerted on the strain gauge, including atmospheric pressure. Its units are **PSIA** (pounds per square inch “absolute”), measured with respect to zero pressure.

Non-vented pressure measurements are useful in vacuum testing, in short-term testing when atmospheric pressure would not be expected to change, in very deep aquifers where the effects of atmospheric pressure are negligible, and in unconfined aquifers that are open to the atmosphere.

With vented or “gauged” pressure sensors, a vent tube in the cable applies atmospheric pressure to the back of the strain gauge. The basic unit for vented measurements is **PSIG** (pounds per square inch “gauge”), measured with respect to atmospheric pressure. Vented sensors thus exclude the atmospheric or barometric pressure component.

This difference between absolute and gauged measurements may be represented by a simple equation:

$$P_{\text{gauge}} = P_{\text{absolute}} - P_{\text{atmosphere}}$$

PRESSURE, DEPTH, AND LEVEL

Output options for pressure measurement are completely software-selectable. Each log configuration presents the following choices:

- Pressure in PSI or kPa
- Depth in feet or meters
- Water Level with a reference (an “offset”)
    - Surface Elevation reference
    - Depth to Water (drawdown) reference

Pressure is a simple check box. For depth or level, the software presents additional options:

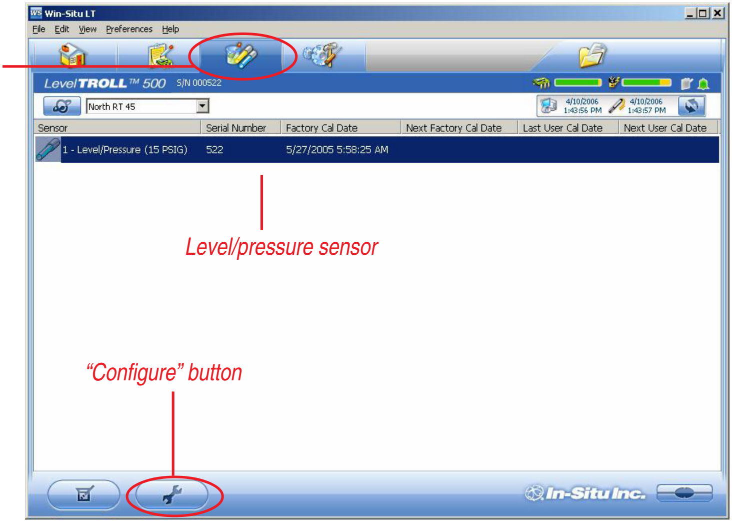
- The type of Level measurement you wish to log
- The Level Reference you wish to use
- The type of water you will be monitoring in (fresh, brackish, or saline). Or choose the **Advanced** button for a pressure-to-level conversion that compensates pressure readings for fluid density, latitude, and elevation

CONFIGURING DEPTH AND LEVEL

__TIP:__ When you configure level using the Sensors tab, the settings are stored in the Level TROLL and are available for use in Modbus, SDI-12, and analog communications, as well as in Win-Situ. Different configuration may be selected when setting up a log.

This procedure stores the configuration settings in the Level TROLL. When setting up a log, the same options are presented.

1. While connected to the Level TROLL in software, click the Sensors tab.
2. Select the level/pressure sensor and click the "Configure" button . (Not available for a BaroTROLL.)



Sensor	Serial Number	Factory Cal Date	Next Factory Cal Date	Last User Cal Date	Next User Cal Date
1 - Level/Pressure (15 PSIG)	522	5/27/2005 5:58:25 AM			

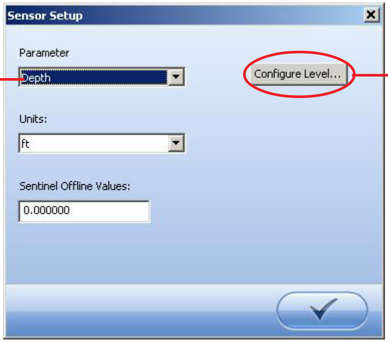
Sensors tab

Level/pressure sensor

"Configure" button

TIP: *The Level TROLL measures three parameters—Pressure, Temperature, and Level—on one sensor. A BaroTROLL does not measure Level, so the Configure Level option is not available.*

3. In the Sensor Setup window, select the Level parameter, then click Configure Level. The Level parameter shown is the one currently stored in the device (device's default or the most recent choice). You will have a chance to change this in a moment.



Sensor Setup

Parameter: Depth

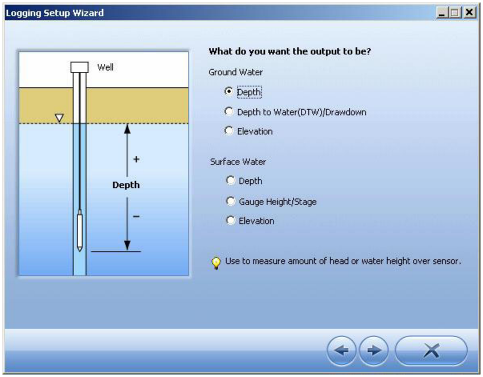
Units: ft

Sentinel Offline Values: 0.000000

Select the Level parameter

Click Configure Level

4. In the Level Configuration Wizard, select the options you want. Each choice includes an illustration. For more information, see Win-Situ's On-Line Help.



What do you want the output to be?

Ground Water

● Depth
○ Depth to Water(DTW)/Drawdown
○ Elevation

Surface Water

○ Depth
○ Gauge Height/Stage
○ Elevation

Use to measure amount of head or water height over sensor.

PRESSURE SENSOR CALIBRATION

FACTORY RECALIBRATION

Pressure sensor accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse, as well as normal drift in the device's electronic components. Aside from damage to the sensor, the need for factory recalibration is dependent upon the amount of drift a customer is willing to tolerate. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan.

FIELD RECALIBRATION

The following procedure may be used, **with caution,** to "zero" the offset of a vented pressure sensor to correct for electronic drift. The drifted offset is visible when the sensor is in air and reading other than zero.

✓ ***TIP:*** *Field recalibration is not available for a BaroTROLL.*

It is recommended you **do not** zero the offset if it is outside the specified accuracy of your pressure sensor, as shown in the table below. If the reading in air deviates from zero by more than the amounts shown, you may want to consider a factory recalibration.

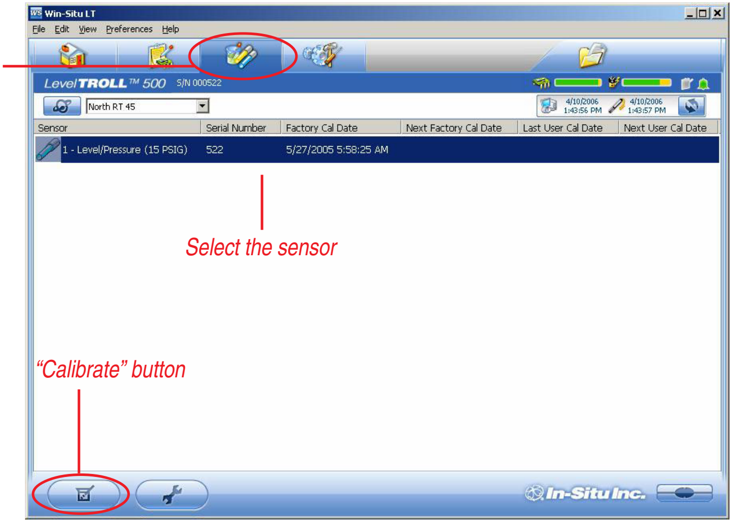
Sensor range	Accuracy (-5°C to +50°C)	Acceptable Offset from zero
5 PSI	± 0.1% FS	± 0.005 PSI
15 PSI	± 0.1% FS	± 0.015 PSI
30 PSI	± 0.1% FS	± 0.03 PSI
100 PSI	± 0.1% FS	± 0.10 PSI
300 PSI	± 0.1% FS	± 0.30 PSI
500 PSI	± 0.1% FS	± 0.50 PSI

Field Recalibration Procedure

1. With the Level TROLL connected in software, select the **Sensors** tab.
2. Select the pressure sensor and click the **Calibrate** button.

   You will be prompted to ensure the device is in air.
3. With the device in air, click **Calibrate**.

The current pressure reading will be set to zero.



Sensor	Serial Number	Factory Cal Date	Next Factory Cal Date	Last User Cal Date	Next User Cal Date
1 - Level/Pressure (15 PSIG)	522	5/27/2005 5:58:25 AM			

Sensors tab

Select the sensor

"Calibrate" button

BAROMETRIC COMPENSATION OF NON-VENTED PRESSURE/LEVEL DATA USING BAROMERGE™

Win-Situ BaroMerge can post-correct absolute (non-vented) level sensor data to eliminate barometric pressure from the measurements. BaroMerge provides 3 options:

- Fixed Correction – A single offset value is applied to all selected log data. Use this option if you know what the barometric pressure was during the log, and it did not change
- Manual Entry – Specify 2 or more correction values to apply to the log data. Use this option if you know that barometric pressure changed during the log
- BaroTROLL log file – Absolute level sensor data are corrected by barometric pressure values logged by an In-Situ BaroTROLL during the same general time period

Launching BaroMerge

BaroMerge may be launched as a stand-alone application from the program group In-Situ Inc., or accessed from Win-Situ's Tools menu when both are installed on the same system.

Input

In the Fixed Correction and Manual Entry options, it is important to know the barometric pressure for the general time period covered by the log or logs you want to correct.

BaroMerge uses a Wizard-like interface consisting of three main steps:

1. First, choose the type of compensation/correction you wish to use

2. Then, choose the absolute (non-vented) log file or files you wish to correct. BaroMerge displays these automatically
3. Click OK and the barometric compensation is applied

Output

Your original log file is not changed. A new, corrected log file with the same name and path is created. The original ".wsl" extension is replaced by "-BaroMerge.wsl".

For help on using Win-Situ BaroMerge, press F1 at any BaroMerge screen.

For more detailed information on barometric compensation see the tech notes installed with Win-Situ. They are accessible in Win-Situ from the Data tab. They are also on the In-Situ software/resource CD, and available in the Downloads section of the In-Situ website at *www.In-Situ.com/downloads.*

6 FIELD INSTALLATION

POSITION THE LEVEL TROLL

Lower the Level TROLL gently to approximately the desired depth. Position the instrument below the lowest anticipated water level, but not so low that its range might be exceeded at the highest anticipated level. Refer to the tables below for usable depth.

Note that a Baro TROLL is not designed for submersion. Position it above water level near a submerged Level TROLL.

Vented Level TROLL

Range		Usable Depth	
PSIG	kPa	Meters	Feet
5	34.5	0-3.5	0-11.5
15	103.4	0-11	0-35
30	206.8	0-21	0-69
100	689.5	0-70	0-231
300	2068	0-210	0-692
500	3447	0-351	0-1153

Non-Vented Level TROLL

Range	Effective Range*		Usable Depth	
PSIA	PSIA	kPa	Meters	Feet
30	15.5	106.9	0-10.9	0-35.8
100	85.5	589.5	0-60.1	0-197.3
300	285.5	1968	0-200.7	0-658.7
500	485.5	3347	0-341.3	0-1120

** At sea level (14.5 PSI atmospheric pressure).*

CHECK THE INSTRUMENT'S DEPTH

At this point, if convenient, you can connect the Level TROLL to a PC, launch the software, and take a reading. If the instrument is at the desired depth, secure it in position as suggested below. If not, reposition the Level TROLL as necessary.

If you requested the software to “Remind me later” to set a Level Reference, enter the level reference after installation when prompted.


Kellems grip

SECURE THE CABLE

The RuggedCable has a handy device called a Kellems® grip near the surface end. You can slide it along the cable to the desired position by compressing it. When you pull on it, it tightens and stops sliding. You may need to pull on both ends of the Kellems grip to properly tighten it and keep it from slipping.

Use the loop of the Kellems grip to anchor the cable to a convenient stationary object. It works well with In-Situ’s “well dock” installation ring. Simply insert the loop into the locking clip on the well dock, and position the assembly on the top of a well.

INSTALLATION TIPS

- Never let a probe “free fall” down a well. The resulting shock wave when it hits the water surface can damage the strain gauge (the “waterhammer” effect).
- It is always wise to check the level of water above the probe, then move it and read again to be sure that the probe is giving a reasonable reading and showing change. It might not be

located where you think it is — for example, it could be wedged against the casing with a loop of cable hanging below it. A probe in such a position might become dislodged and move while logging, giving a false change in level. *A secure placement is critical to accurate measurements.*

The minimum bend radius for vented cable is 13.5 mm (0.54 in).

- Do not allow the vented cable to kink or bend. If the internal vent tube is obstructed, water level measurements can be adversely affected. The recommended minimum bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.
- For accurate measurements, the instrument should remain immobile while logging data.

Do not submerge the connector at the uphole end of the cable.

- Be sure the “uphole” cable end is capped—desiccant cap on the vented cable connector, soft dust cap on non-vented cable—and positioned above the highest anticipated water level. Avoid areas that may flood.

STABILIZATION TIME

Allow the Level TROLL to stabilize to the water conditions for *about an hour* before logging data. A generous stabilization time is always desirable, especially in long-term deployments. Even though the cable is shielded, temperature stabilization, stretching, and unkinking can cause apparent changes in the probe reading. If you expect to monitor water levels to the accuracy of the probe, it’s worth allowing the extra time for the probe to stabilize to its environment.

INSTALLATION OF A LEVEL TROLL 300 OR OTHER NON-VENTED LEVEL TROLL

TIP: Be sure to program a non-vented Level TROLL or BaroTROLL before attaching the Twist-Lock Hanger, as this accessory has no communication capability.

All Level TROLL 300s and non-vented Level TROLL 500s and 700s include non-vented (absolute, PSIA) pressure sensors and do not require vented cable for proper operation. They may be deployed on non-vented RuggedCable or with a Twist-Lock Hanger and economical stainless steel suspension wire while logging data.

- Because the Twist-Lock Hanger has no communication capabilities, program the Level TROLL in advance, and download the data the same way
- Logged pressure data will show the effects of changes in barometric pressure (unlike vented Level TROLLs). However, post-processing tools such as Win-Situ BaroMerge may be used to eliminate the effects of barometric pressure changes from the data, if required.

DO NOT submerge a non-vented Level TROLL 500 or 700 without first attaching a Twist-Lock Hanger, or a cable, as the unit could be damaged by flooding.

Although the Level TROLL 300 is completely sealed from flooding, a Hanger is recommended.

7 BAROTROLL

TIP: For more detailed information on barometric compensation see the tech notes installed with this manual and accessible in Win-Situ from the My Data tab. They are also on the In-Situ software/ resource CD, and available in the Downloads section of the In-Situ website at www.In-Situ.com

In-Situ's BaroTROLL® is a special model of non-vented Level TROLL designed to log barometric pressure from 0 to 16.5 PSIA (1.14 bar, 33.59 in Hg) at the surface near a submerged non-vented Level TROLL. BaroTROLL data may then be used to correct the Level TROLL data for barometric pressure fluctuations.

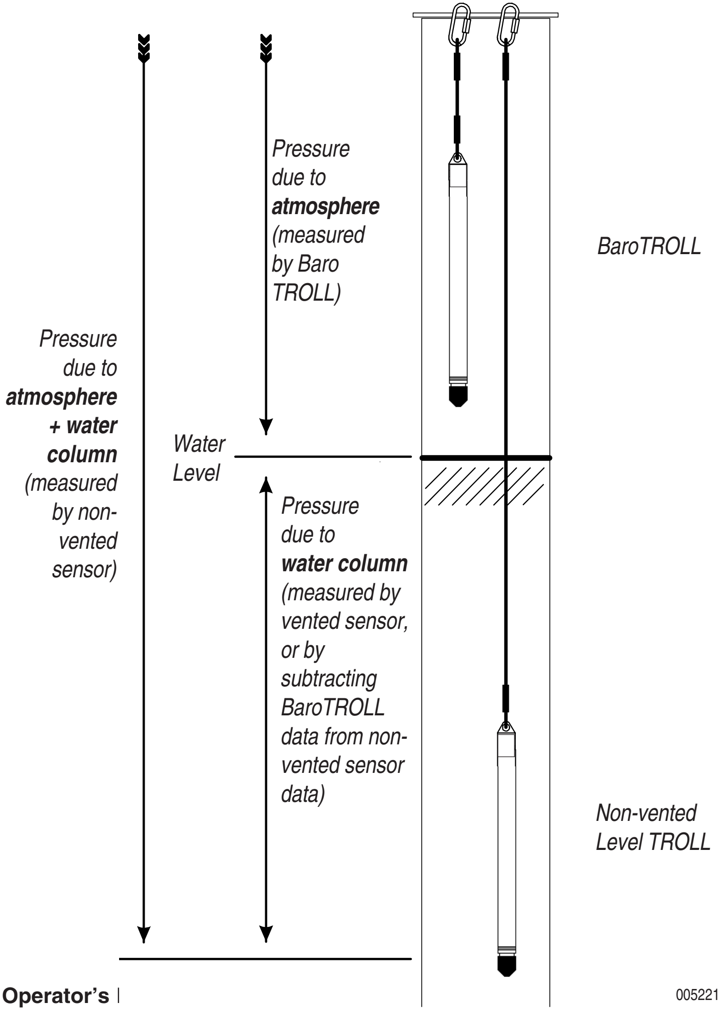
PROGRAMMING

- Program before installation. Be sure to sync the clock.
- Schedule a log with the same start time as that in the paired non-vented Level TROLL. Select the same sample interval.

INSTALLATION

After programming, install the BaroTROLL in a protected location above water level. Install the BaroTROLL near the submerged non-vented unit. One possibility is shown below, using a Twist-Lock Hanger and suspension wire.

- Be sure to attach the Twist-Lock Hanger before installation to prevent flooding.


Pressure due to **atmosphere** (measured by Baro TROLL)
Pressure due to **atmosphere + water column** (measured by non-vented sensor)
Water Level
Pressure due to **water column** (measured by vented sensor, or by subtracting BaroTROLL data from non-vented sensor data)
BaroTROLL
Non-vented Level TROLL

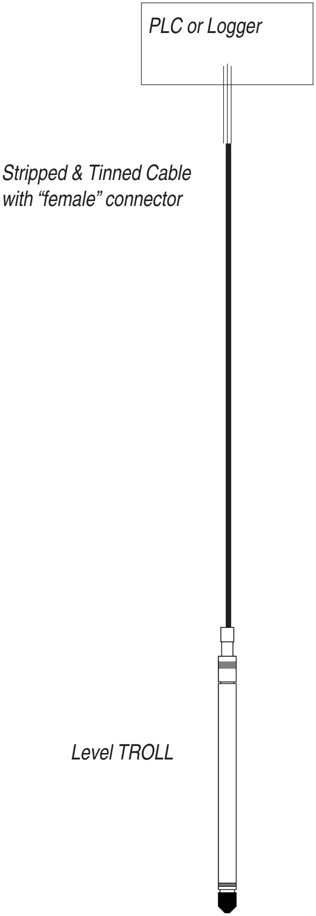
8 ANALOG, SDI-12 & MODBUS CONNECTIONS

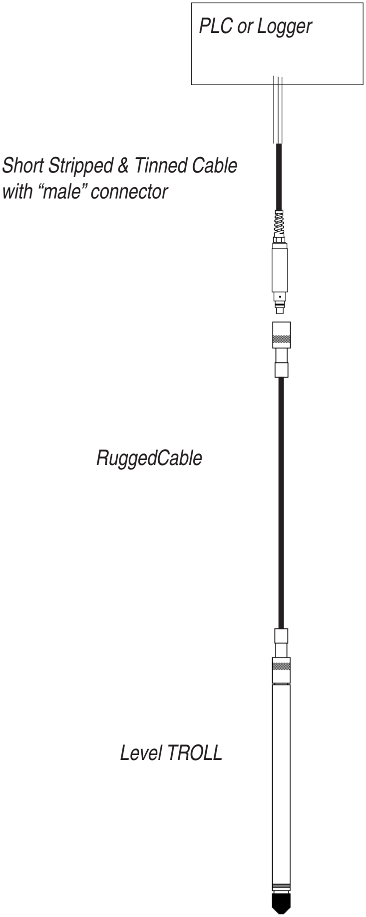
The Level TROLL may be connected to a controller or logger for communication via:

- Analog (4-20 mA)
- SDI-12
- RS485 Modbus
- RS232 Modbus (with a customer-supplied converter)

RuggedCable™ Stripped & Tinned has a “female” Twist-Lock connector on one end to mate with the Level TROLL body. The uphole end terminates in bare wires for connection to a PLC or data logger.

Also available in a shorter length ending in a “male” Twist-Lock connector to mate with RuggedCable.


PLC or Logger
Stripped & Tinned Cable
with “female” connector
Level TROLL


PLC or Logger
Short Stripped & Tinned Cable
with “male” connector
RuggedCable
Level TROLL

DESICCANT

Vented cable includes removable outboard desiccant to protect the cable vent tube and Level TROLL electronics from condensation in high-humidity environments.

The desiccant may be removed from the vent tube, if needed, to trim the conductor wires. Pull the vent tube extender off the cable vent tube to remove, replace desiccant after trimming and connecting wires.

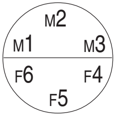
Outboard desiccant is attached to cable vent tube

and secured to cable with strap

WIRING

Refer to diagrams on the following pages. Trim back and insulate unused wires. The shield should be wired to a chassis ground or earth ground.

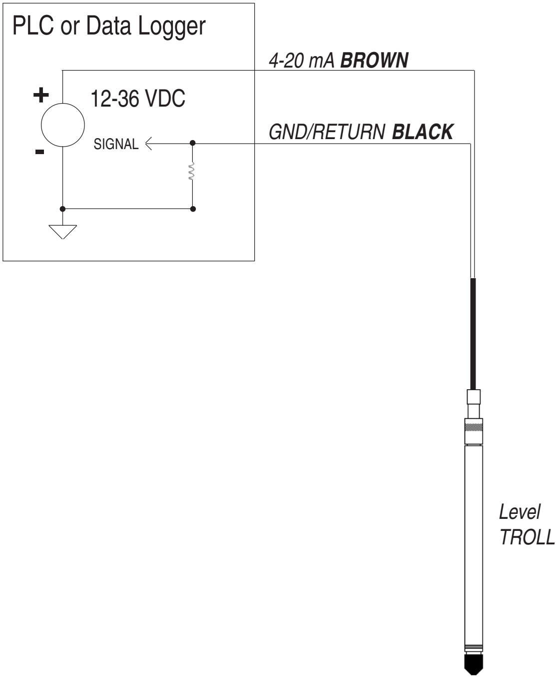
RuggedCable (TPU)

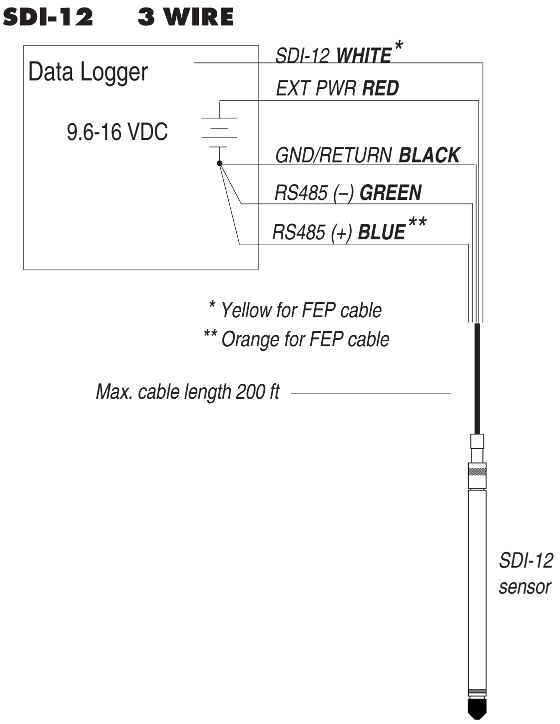
Signal	Color	Pin	
Gnd/Return	BLACK	6	
Ext Power	RED	5	
4-20 mA	BROWN	4	
RS485(–)	GREEN	3	
RS485(+)	BLUE	2	
SDI-12	WHITE	1	

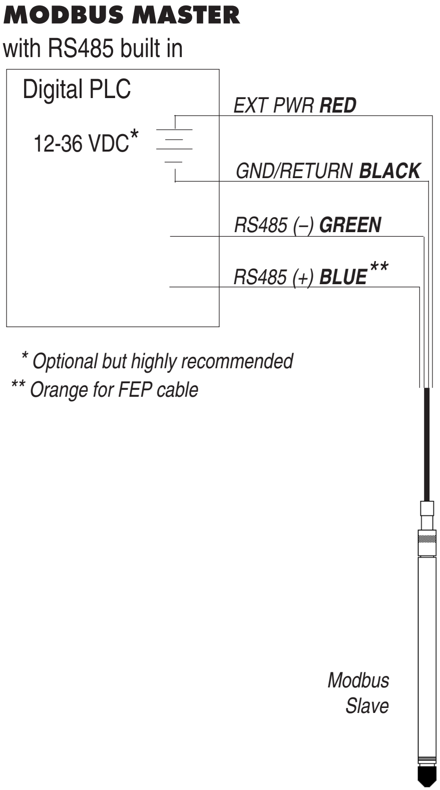
FEP Cable

Signal	Color
Gnd/Return	BLACK
Ext Power	RED
4-20 mA	BROWN
RS485(–)	GREEN
RS485(+)	ORANGE
SDI-12	YELLOW

ANALOG (4-20 mA) 2 WIRE




SDI-12 3 WIRE
Data Logger
9.6-16 VDC
SDI-12 WHITE*
EXT PWR RED
GND/RETURN BLACK
RS485 (–) GREEN
RS485 (+) BLUE**
* Yellow for FEP cable
** Orange for FEP cable
Max. cable length 200 ft
SDI-12 sensor

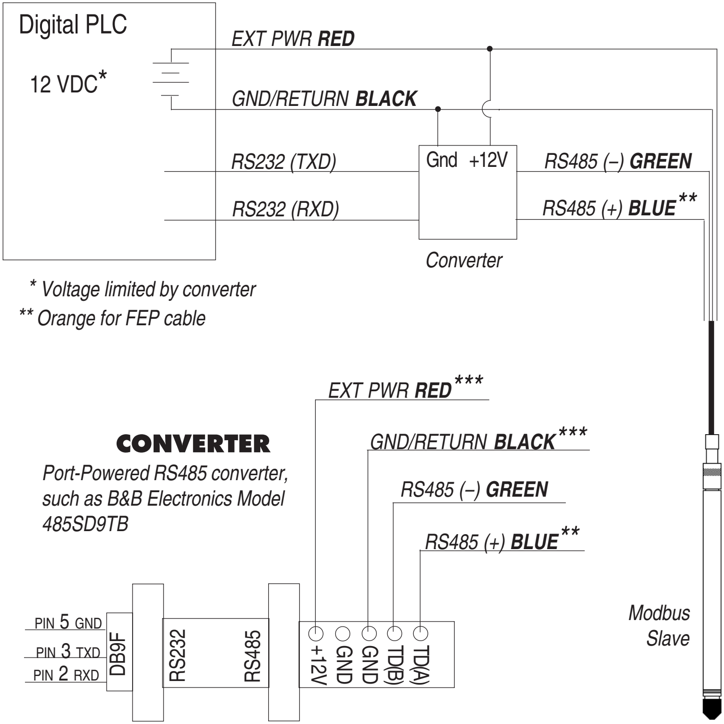


* Optional but highly recommended

** Orange for FEP cable

MODBUS MASTER

with RS232 built in (converter required)



** Voltage limited by converter*

*** Orange for FEP cable*

CONVERTER

Port-Powered RS485 converter, such as B&B Electronics Model 485SD9TB

****Required if port power is not available*

POWER CONNECTIONS

The Red wire provides power for Modbus and SDI-12 modes. The Brown wire provides power for the 4-20 mA mode. If power is present on the Brown wire and not on the Red wire, the device enters the 4-20 mA mode automatically and stays in the 4-20 mode until power is removed from the Brown wire or is applied to the Red wire. The Red wire has priority — if power is applied to both wires at the same time, the device will operate in Modbus or SDI-12 modes but not in 4-20.

COMMUNICATIONS

The device automatically switches between Modbus and SDI-12 modes depending on which of the two interfaces has activity. Modbus and SDI-12 cannot be used at the same time — whichever one is currently in use will block communication on the other.

USING WIN-SITU

Win-Situ provides options for configuring analog/SDI-12 communications (Setup tab) and Modbus communications (File menu > Settings). In addition, the Level TROLL is capable of internal logging (programmed in Win-Situ) while participating in a Modbus, SDI-12 or analog network. However, Win-Situ cannot communicate with the Level TROLL while it is transmitting Modbus, SDI-12 or analog data, and conversely, the instrument cannot receive or respond to Modbus, SDI-12 or analog commands while connected to a PC serial port.

This “redundant logging” feature means

- if the PLC or recorder somehow “loses” data, the Level TROLL data can be retrieved using Win-Situ.

- if the PLC or recorder ceases to function due to power loss, the Level TROLL will continue to collect data using its own internal batteries and clock.

A port-powered RS485 converter like that shown for Modbus connections may be used for temporary connection of the Level TROLL to a serial port on a PC.

FOR MORE INFORMATION

For additional information on Modbus and SDI-12 communications, including the SDI-12 commands, see the tech notes and application notes installed with this manual and accessible in Win-Situ from the My Data tab. They are also on the In-Situ software/resource CD, and available in the Downloads section of the In-Situ website at www.In-Situ.com.

9 CARE & MAINTENANCE

OPERATING CONSIDERATIONS

The Level TROLL has been designed to withstand harsh field conditions. However, as with any electronic instrument, it can be permanently damaged if used outside its operating specifications.

TEMPERATURE

The Level TROLL 500 and Level TROLL 700 operate within a temperature range of -20°C to +80°C (-4°F to 176°F). The Level TROLL 300's temperature range is -5°C to 50°C (23°F to 122°F)

PRESSURE RANGE

The Level TROLL can withstand pressures of up to two times (2X) the rated range of the pressure sensor without damage, although it may not read correctly at such pressure. If the pressure range is exceeded by 3X, the sensor will be destroyed.

CALIBRATION

Accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan.

STORAGE

Store the Level TROLL clean and dry. Place the protective red dustcap on the cable end, or store with cable attached to protect the connector pins and o-ring.

Store the instrument where it will be safe from mechanical shocks that may occur, such as rolling off a bench onto a hard surface.

Protect the instrument from temperature extremes. Store within a temperature range of -40°C to +80°C (-40°F to +176°F).

GENERAL MAINTENANCE

CLEANING—BODY AND FRONT END

When the nose cone is removed, the sensitive pressure sensor diaphragm is completely exposed. Do not touch this area with any object! Replace the nose cone as soon as possible.

Clean the Level TROLL body with water and a soft brush, or soak overnight in a mild acidic solution, such as household vinegar, or clean in an ultrasonic bath with a good concentrated detergent solution.

If the ports in the front end are clogged with silt or mud, try the following:

- Swish the instrument vigorously in a bucket of clean water
- Apply a gentle squeeze of water from a wash bottle
- In severe cases, remove the nose cone and clean out the holes with a soft brush or pipe cleaner

Nose cone in place

Nose cone removed

To avoid damage to the pressure sensor diaphragm, *do not insert any object into the sensor opening or attempt to dig out dirt or other materials.*

Damage caused by digging or scraping in the pressure sensor opening to remove silt, mud, etc. is not covered by the warranty.

If contamination cannot be removed using the recommendations above, please contact In-Situ Inc. for cleaning.

Do not submerge the cable connector; do not immerse in any fluid.

TWIST-LOCK CONNECTORS

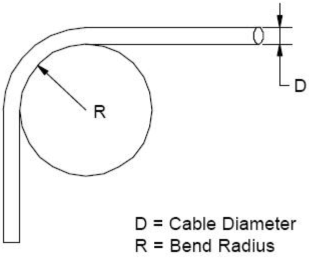
Keep the pins on all connectors free of dirt and moisture by using the soft protective dustcap when cable is not attached.

CABLE VENT TUBE (VENTED CABLE)

Vented cable assures that atmospheric pressure is the reference pressure to the vented pressure sensor diaphragm. *The vent tube should not be blocked, kinked, or otherwise obstructed.* Such obstructions will cause barometric pressure to appear in measurements, and errors will be introduced due to thermal expansion and contraction of air within the vent tube and probe body.

The minimum bend radius for vented cable is 13.5 mm (0.54 in).

The recommended minimum bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.



TIP: If batteries are completely exhausted, remember that external power and battery pack options are available.

BATTERIES

Internal batteries in the Level TROLL are not user-replaceable. The approximate percentage remaining is displayed on the Dashboard when the Level TROLL is connected in software.

10 TROUBLESHOOTING

TROUBLESHOOTING CONNECTIONS

Problem: Win-Situ cannot connect to the Level TROLL

Probable Cause: Wrong COM port selected, incompatible Communication settings, loose or dirty cable connections, low batteries

Suggested Remedy: Check the following:

- all cable connections are tight, connectors are clean and dry
- the cable is securely attached to the instrument
- the correct COM port is selected (select Comm Settings from Win-Situ's Preferences menu to check this)
- the software settings are correct for the device (check Win-Situ's on-line Help for "Communication Settings")
- the internal battery has voltage remaining

Problem: Real-time readings are in the wrong units

Probable Cause: Default units are being used

Suggested Remedy: Click the Sensors tab, select the sensor, click the configure button 🔧 and select the desired units for each parameter in the Sensor Setup window. Click OK ✓.

Problem: I cannot add a new log

Probable Cause 1: Only one “active” log can reside in the device at a time—an “active” log is a log that is Ready, Pending, Running, or Suspended as shown in the Status column of the Logging Tab

Probable Cause 2: The device has its maximum number of logs already stored—the Level TROLL 300, 500, and Baro TROLL have a capacity of 2 logs

Suggested Remedy: Download, and then delete a log you are through with. This will make room for an additional log on the device

Problem: I just defined a new log, but the software is telling me it exceeds the available memory

Probable Cause: The log as configured would exceed the device memory

Suggested Remedy: Edit the log and try these:
Select a longer sampling interval
If available, select the “Wrap data” option (later data will overwrite earlier data when the memory is full)
For a log with a scheduled start, select “None” as the stop condition, or select a stop time that is closer to the start time

Index

In-Situ Inc.

221 East Lincoln Avenue • Fort Collins, CO 80524 USA
1 800 446 7488 • 1 970 498 1500 *(Tel)*
1 970 498 1598 *(Fax)*

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer:
In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name:	Level TROLL
Model:	Level TROLL 300
Product Description:	The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

In-Situ Inc.

221 East Lincoln Avenue • Fort Collins, CO 80524 USA
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1 970 498 1598 *(Fax)*

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name:	Level TROLL
Model:	Level TROLL 500
Product Description:	The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

In-Situ Inc.

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1 970 498 1598 (Fax)

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name:	Level TROLL
Model:	Level TROLL 700
Product Description:	The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

In-Situ Inc.®

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1 970 498 1598 *(Fax)*

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Product name: Baro TROLL
Product Description: The Baro TROLL measures and logs barometric pressure and temperature.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

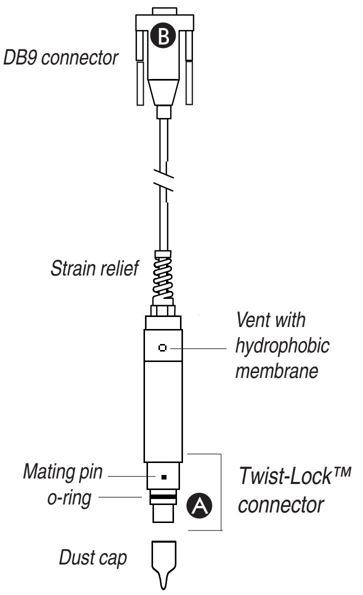
In-Situ Inc.

Level **TROLL**™
Multi-Parameter Water Quality **TROLL**®

Information Sheet

Catalog No. 51460

TROLL COM™
COMMUNICATION INTERFACE



APPLICATION

Communication interface between a Level TROLL or MP TROLL 9500 and a desktop/laptop PC or handheld PDA. Contains a port-powered RS485 – RS232 converter. Vented deployment cable vents through the unit, protected by a hydrophobic membrane.

PHYSICAL DESCRIPTION

Wetted materials	Titanium, nylon, Viton®, polyurethane
Environmental rating	IP67 when connected (3 meters for 30 minutes), up to the DB9 connector
Dimensions	8.9 cm (3.5 in) long, 18.3 mm (0.72 in) O.D.
Input	MP TROLL 9500 RS485 Level TROLL RS485 Modbus
Output	RS232
Cable	Black polyurethane, 91 cm (3 ft) long
Temperature range	-5°C to 60°C (23°F to 140°F)
PC Interface	DB 9 pin, null modem (crossover), DTE to DTE

CONNECTIONS

Ⓐ Mates with the Twist-Lock Connector on the instrument's RuggedCable™

Ⓑ Connects to the 9-pin serial port on a PC or PDA

INSTALLATION

Tip: The desiccant protects the Level TROLL's vented cable from condensation during deployment. The TROLL Com enables connection to a PC for programming the Level TROLL. Be sure to re-attach the desiccant after programming, before deployment.

1. Remove the desiccant (if present) from the free end of the RuggedCable by grasping the knurled (textured) section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.

2. Follow these steps to attach the TROLL Com to the cable:

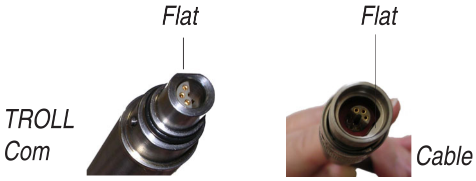
   2a. Remove the protective caps from the TROLL Com and cable (if present).

(over)

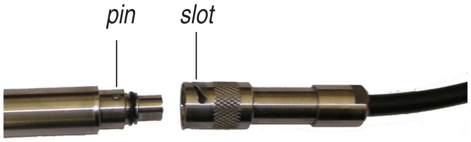
TROLL COM

Catalog No. 51460

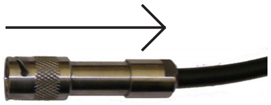
2b. Note that each connector has a flat side.



Note the pins on the TROLL Com connector and the slots on the cable connector.

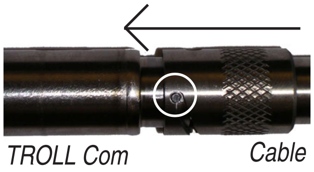


2c. Slide back the sleeve on the cable connector.



2d. Orient the "flats" so they will mate up, and insert the TROLL Com connector firmly into the cable connector.

2e. Slide the sleeve toward the TROLL Com until the pin on the TROLL Com pops into the round hole in the slot on the cable connector.

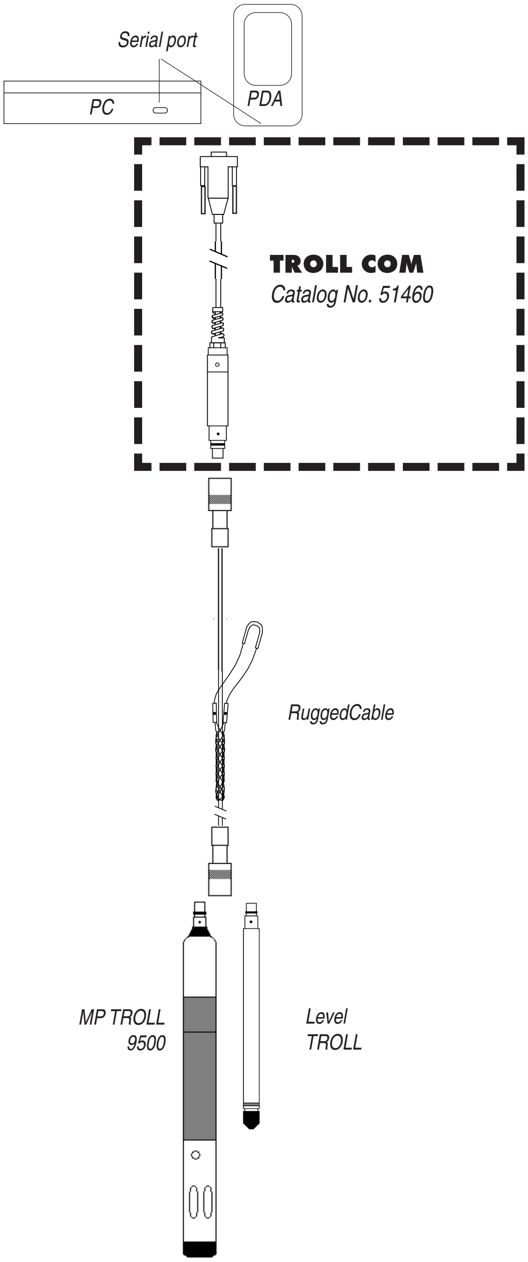


2f. Grasp the knurled (textured) section of the cable connector in one hand and the TROLL Com in the other, push and twist firmly so that the pin on the TROLL Com slides along the slot on the cable connector and locks securely into the other hole. The "click" ensures the connectors are securely mated.

3. Attach the DB9 connector on the TROLL Com to a PC's standard 9-pin RS232 serial port.

GUIDELINES AND PRECAUTIONS

- A serial cable, serial card, and/or a null-modem adapter may be needed with some PDAs
- The DB9 connector is not waterproof
- Soft dust caps protect the connectors during shipping. Keep the dust caps to protect the connector pins and o-ring when the connectors are not mated.



Endress+Hauser WaterPilot FMX167

BA 231P/24/ae/07.01
52010550

Waterpilot FMX 167
Hydrostatic Level Measurement

Operating Instructions

Endress + Hauser
The Power of Know How

Table of contents

1 Safety instructions

1.1 Intended application

The Waterpilot FMX 167 is a hydrostatic pressure sensor for measuring the level of fresh water, drinking water and wastewater. Versions with a Pt 100 resistance thermometer can also measure temperature. The optional temperature transmitter converts the Pt 100 signal into a 4-20 mA signal.

The manufacturer shall not accept any liability for damage arising from improper use or if the device is used for purposes for which it was not intended.

1.2 Installation, setup, operation

The Waterpilot FMX 167 and the temperature transmitter (optional) are designed as fail-safe to the state of the art and comply with prevailing regulations and EC directives. If the devices are not used properly or for purposes for which they were not intended, they may become hazards arising from the particular application, e.g. product overflow through incorrect installation or adjustment. For these reasons, only trained personnel authorized by the plant operator may install, connect electrically, set up, operate and maintain the measuring system. Trained personnel must have read and understood these Operating Instructions and follow the instructions. Any changes and repairs to the devices may only be performed if the Operating Instructions expressly permit this.

1.3 Operational safety

Explosion hazardous area:
If the measuring system is used in explosion hazardous areas, you must comply with the prevailing national standards. The device is supplied with a separate document on explosion hazards which is a component part of this documentation. Please comply with the installation instructions, connecting values and safety instructions contained therein.

- Make sure that personnel have received sufficient training.
- Please comply with the technical measuring and safety conditions at the measuring points.

Order Code (refer to Chapter 2 "Identification")
FMX 167 - ☐ ☐ ☐ ☐☐ ☐ ☐ ☐

Code	Certificate	Protection
B	ATEX	ATEX II 2 G EEx ia IIC T6
C	ATEX	ATEX II 3 G EEx nA II T6
D	FM	IS, Class I, Division 1, Groups A-D
E	CSA	IS, Class I, Division 1, Groups A-D

1.4 Safety warnings and symbols

In order to emphasize safety or alternative processes, we have defined the following safety warnings and appended a pictogram to each one.

Safety warnings

Symbol	Meaning
⚠ Warning!	**Warning!** Warning indicates activities or processes which – if they are not performed properly – will lead to serious personal injury, a safety hazard or destruction of the device.
☝ Caution!	**Caution!** Caution indicates activities or processes which – if they are not performed properly – will lead to personal injury or malfunctioning of the device.
✎ Note!	**Note!** Note indicates activities or processes which – if they are not performed properly – may have an indirect impact on functioning or an unforeseen response from the device.

Type of protection

⬡Ex	**Explosion-protected, type tested apparatus** If this symbol is on the device nameplate, the device may be used in explosion hazardous areas or in non explosion hazardous areas, depending on the approval.
△Ex	**Explosion hazardous area** This symbol in drawings in these Operating Instructions identifies an explosion hazardous area. – Devices which are located in a hazardous area or cables for such devices must be suitably protected.
△~~Ex~~	**Safe area (non explosion hazardous area)** This symbol in drawings in these Operating Instructions identifies a non explosion hazardous area. – Devices in a non explosion hazardous area must also be certified if connecting cables are routed in the explosion hazardous area.

Electrical symbols

⎓	**DC voltage** A terminal to which a DC voltage is applied or through which a DC voltage flows.
∼	**AC voltage** A terminal to which a (sinusoidal) AC voltage is applied or through which an AC voltage flows.
⏚	**Ground connection** A grounded terminal which is already grounded by a grounding system from the user's viewpoint.
⊜	**Protective earth terminal** A terminal which must be grounded before any other connections are made.
▽	**Potential Equalization terminal** A terminal which must be connected with the equipment grounding system: this may be a potential matching line or a star-shaped grounding system, depending on national or corporate practice.

2 Identification

2.1 Device designation

- Waterpilot FMX 167 for hydrostatic level measurement, refer to Chapter 2.1.1.
- Waterpilot FMX 167 with optional Pt 100 resistance thermometer for simultaneous level and temperature measurement, refer to Chapter 2.1.1.
- Waterpilot FMX 167 with optional Pt 100 resistance thermometer and optional temperature transmitter TMT 181, refer to Chapters 2.1.1 and 2.1.2.

2.1.1 Nameplate of Waterpilot FMX 167

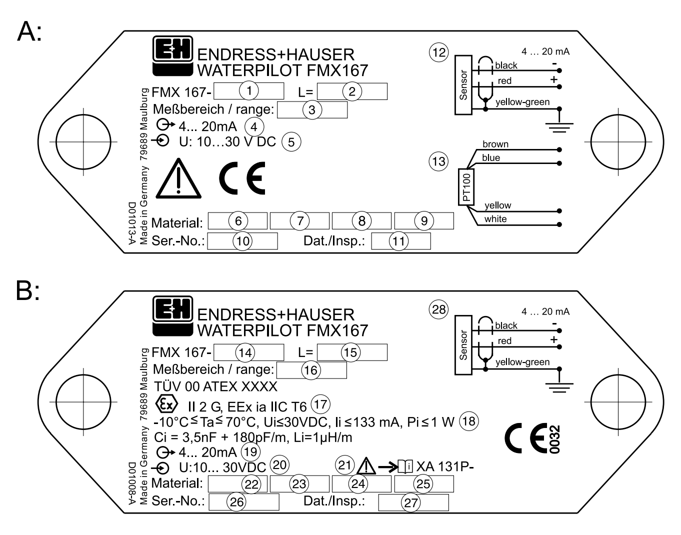


Fig. 1: Nameplates for Waterpilot FMX 167

Nameplate A: Example for non hazardous area

1 *Order Code*
The meaning of the individual letters and numbers is specified in the order confirmation. See page 31.
2 *Length of support cable*
3 *Measuring range*
4 *Current output: 4-20 mA*
5 *Auxiliary energy/Supply voltage: 10 - 30 V DC*
6 *Housing material: 1.4435 (AISI 316L)*
7 *Measuring cell material: aluminum oxide Al_2O_3*
8 *Support cable material: (PE) polyethylene*
9 *Seal material: 1: Viton, 2: EPDM*
10 *Serial No.*
11 *Test date/Tester*
12 *Wiring diagram of FMX 167*
13 *Wiring diagram of FMX 167 with Pt 100 if Waterpilot FMX 167 was ordered with Pt 100.*

Nameplate B: Example for hazardous area

14 *Order Code*
The meaning of the individual letters and numbers is specified in the order confirmation. See page 31.
15 *Length of support cable*
16 *Measuring range*
17 *Type of protection*
18 *Permissible ambient temperature range and other electrical data*
19 *Current output: 4-20 mA*
20 *Auxiliary energy/Supply voltage: 10 - 30 V DC*
21 *Reference to related Safety Instructions (e.g. XA 131P)*
22 *Housing material: 1.4435 (AISI 316L)*
23 *Measuring cell material: aluminum oxide Al_2O_3*
24 *Support cable material: (PE) polyethylene*
25 *Seal material: 1: Viton, 2: EPDM*
26 *Serial No.*
27 *Test date/Tester*

Note!
A sensor number and the measuring range are specified on each probe; in addition a certificate and the type of protection are specified on probes designed for explosion hazardous areas.
The nameplate does not specify the sensor number. If you need to assign a nameplate to a probe at a later date, please refer to the supplied calibration report. This is where the sensor and the serial number are specified.

2.1.2 Nameplate of Temperature Transmitter TMT 181

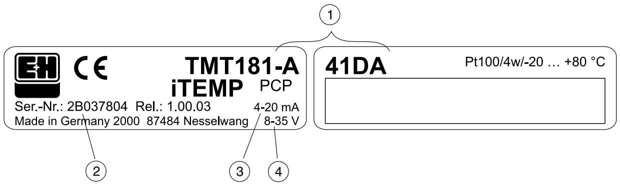


Fig. 2: Nameplate of Temperature Transmitter iTEMP® PCP TMT181

1 *Order Code of Temperature Transmitter TMT 181-A41DA*
  A: Variant for non-hazardous area
  4: 4-wire
  1: Sensor Pt 100
  D: Temperature transmitter with settings for –4 to +176°F (–20 to +80°C) range
  A: Label: standard version
2 *Serial No.*
3 *Current output: 4 to 20 mA*
4 *Supply voltage: 8 to 35 V DC*

2.2 Scope of supply

The scope of supply is comprised of:
- Waterpilot FMX 167, optionally with integrated Pt 100 temperature sensor
- Optional accessories, refer to Chapter 7

Supplied documentation:
- Operating Instructions (this manual)
- Calibration report
- For hazardous areas: additional "Safety Instructions" (XA…)
- For FM, CSA: Control Drawing or Installation Drawing
- Drinking water approval (optional)

2.2.1 CE symbol, Declaration of Conformity

The devices are designed fail-safe to the state of the art and left the factory in perfect condition with regard to safety. The devices comply with the prevailing standards and regulations contained in DIN EN 61010 “Safety requirements for electrical equipment for measurement, control and laboratory use”.
The measuring system described in these Operating Instructions therefore meet the statutory requirements of EC directives. Endress+Hauser confirms the successful testing of the device by affixing the CE symbol.

3 Installation

3.1 Incoming acceptance

Check the following items upon receipt of the product:
- Check whether the packaging or its contents are damaged.
- Check the delivered products for completeness and compare the contents with your order data.

3.2 Installation guidelines

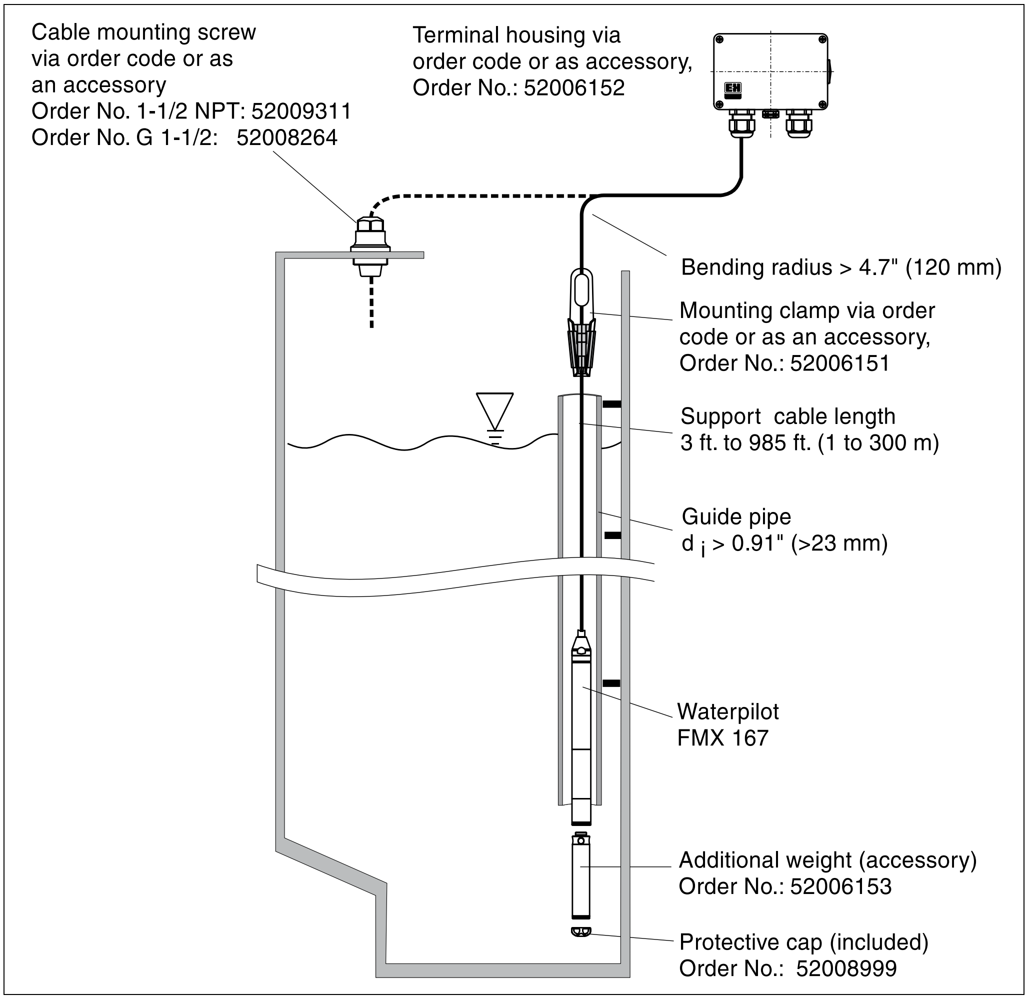


Fig. 3: Installation examples

The FMX 167 should be installed at a point that is free from flow or turbulence, or mounted in a guide tube with an inner diameter greater than 0.90" (23 mm). If the cable is terminated outdoors, a junction box from E+H is recommended (Part No. 52006152). The atmospheric pressure compensation tube (located inside cable) must be kept from blockage or kinking. The atmospheric compensation tube is protected from condensation by a teflon filter and an additional GORE-TEX® filter which is terminated in the junction box.

3.2.1 Installation dimensions

See Chapter 9.3 "Technical data, Dimensions" for the dimensions.

3.3 Installation instructions

3.3.1 Installing Waterpilot with a mounting clamp

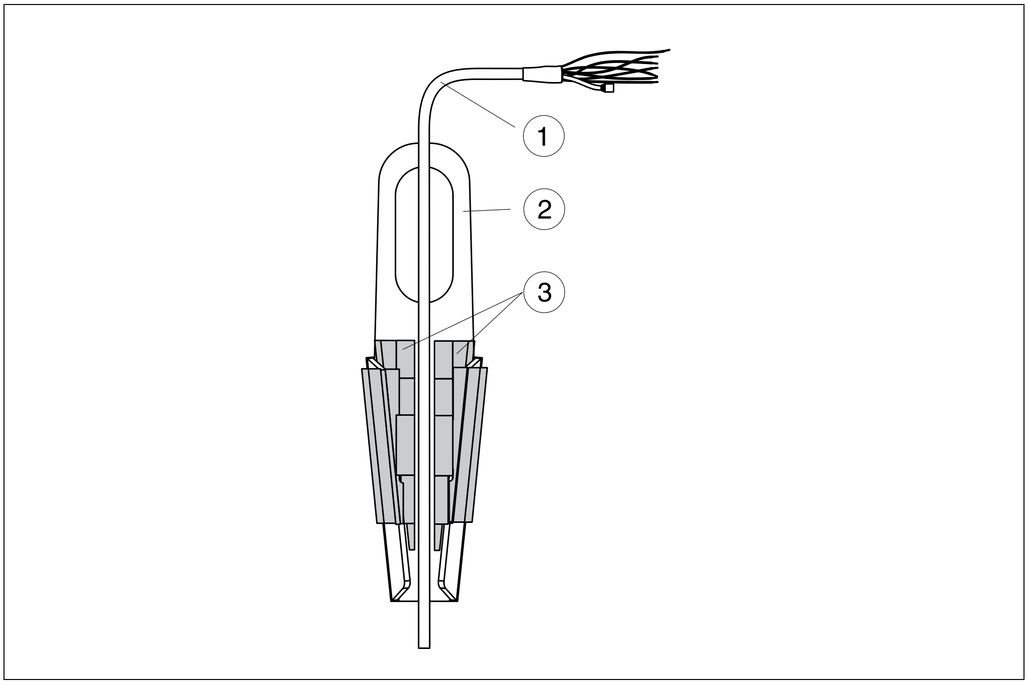


Fig. 4: Installing Waterpilot FMX 167 with a mounting clamp

1 Support cable
2 Mounting clamp
3 Clamping jaws

How to mount the mounting clamp:

1. Mount the mounting clamp (Pos. 2). When selecting the type of mounting, note the weight of the support cable (Pos. 2) and the device (refer to Chapter 9.1.).
2. Raise clamping jaws (Pos. 3). Place support cable (Pos. 1) acc. to Fig. 4 between clamping jaws.
3. Hold support cable (Pos. 1) tight and push clamping jaws (Pos. 3) back down. Set clamping jaws by tapping lightly.

Note!
By attaching a piece of electrical tape or a cable-tie to the cable, re-installation to identical depth is ensured after inspection or temporary removal.

Note!

3.3.2 Installing Waterpilot with cable mounting screw

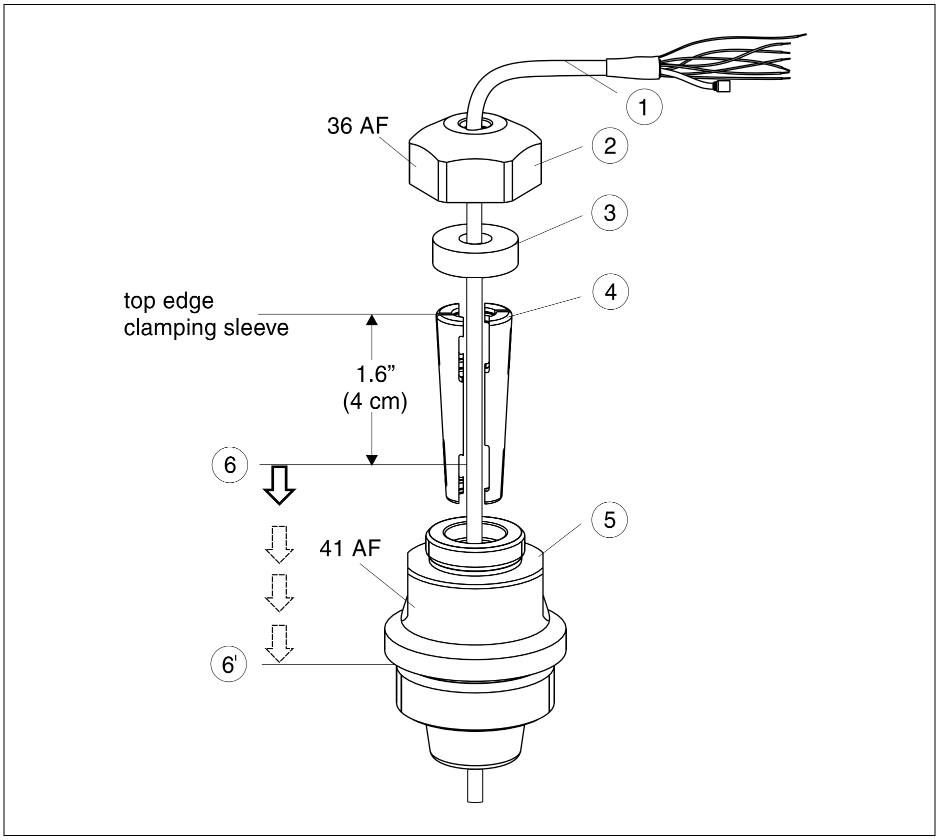


Fig. 5: Installing the Waterpilot FMX 167 with cable mounting screw, depicted here with G 1 1/2 thread

1	*Support cable*
2	*Mounting screw cap nut*
3	*Sealing ring*
4	*Clamping sleeve*
5	*Mounting screw adapter*
6	*Required length of support cable and FMX 167 probe before assembly*
6´	*After assembly Pos. 6) is located next to the mounting screw with* *G 1 1/2 thread: sealing surface of mounting screw adapter* *1 1/2 NPT thread: thread run-out of mounting screw adapter*

Note!

If you want to lower the level probe to a certain depth, place the top edge of the clamping sleeve 1.6" (4 cm) higher than the required depth. Then push the support cable and the clamping sleeve into the adapter as described in the following section, Step 6.

How to mount the cable mounting screw with G 1 1/2 or 1 1/2 NPT thread:

1. Mark required length of support cable, refer to "Note" on this page.
2. Insert probe through measuring opening and carefully lower on support cable. Hold support cable to prevent it from slipping.
3. Push adapter (Pos. 5) over support cable and screw tightly in measuring opening.
4. Push sealing ring (Pos. 3) and cap (Pos. 2) from top onto cable. Press sealing ring into cap.
5. Place clamping sleeve (Pos. 4) around support cable (Pos. 1) acc. to Figure 5.
6. Push support cable and clamping sleeve (Pos. 4) into adapter (Pos. 5).
7. Push cap (Pos. 2) and sealing ring (Pos. 3) onto adapter (Pos. 5) and screw tightly to adapter (Pos. 5).

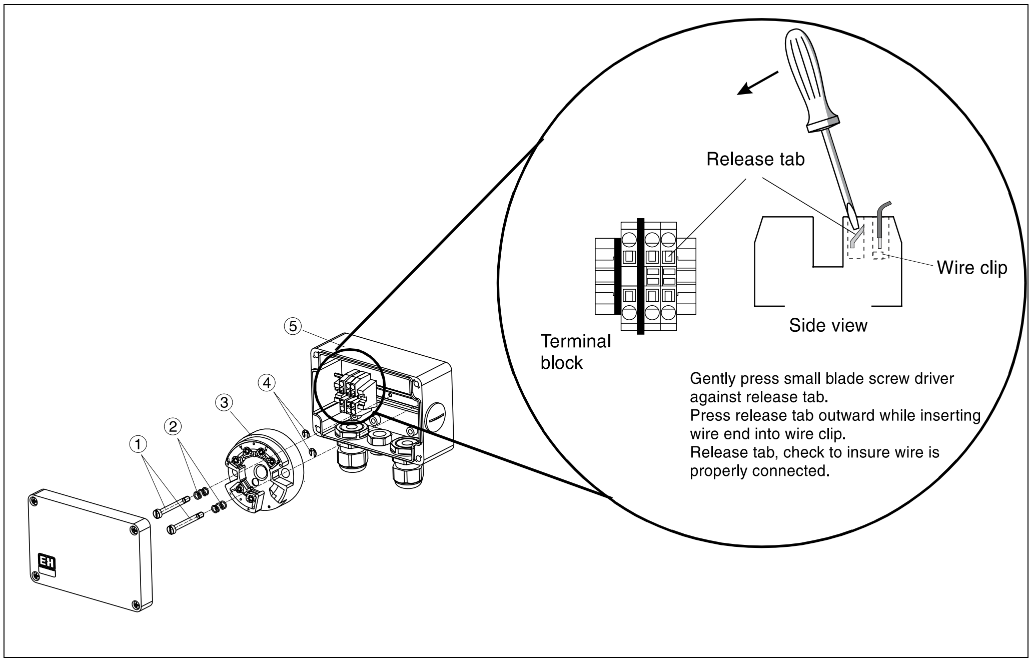
Note!
Remove the cable mounting screw in the opposite sequence of operation to installation.

Note!

3.3.3 Mounting the terminal housing

Mount the optional terminal housing with four screws (M 4). See Chapter 9.3 "Dimensions" for the dimensions of the terminal housing. The drilling template for the housing is located in Chapter 10.2.

3.3.4 Mounting the Temperature Transmitter TMT 181



Gently press small blade screw driver against release tab.
Press release tab outward while inserting wire end into wire clip.
Release tab, check to insure wire is properly connected.

Fig. 6: Mounting the temperature transmitter, depicted here with terminal housing

1 Mounting screws
2 Mounting springs
3 Temperature Transmitter TMT 181
4 Screw retainers
5 Terminal housing

How to mount the temperature transmitter

1. Insert the mounting screws (Pos. 1) with the mounting springs (Pos. 2) through the boring of the temperature transmitter (Pos. 3).
2. Set the mounting screws with the screw retainers (Pos. 4).
   The screw retainers, mounting screws and springs are contained in the contents of the temperature transmitter.
3. Screw the temperature transmitter tightly in the field housing.

Caution!
Do not overtighten the mounting screws to avoid damage to the temperature transmitter.

Caution!

3.4 Checking the installation

Check that all screws are seated firmly.

4 Wiring

Warning!
When connecting devices with explosion protection certificates, please comply with national standards and the warnings and wiring diagrams in the additional explosion protection documentation accompanying these Operating Instructions. Also refer to Chapters 9.1 and 9.2, Section "Supplementary documentation". If you have any questions, please contact your nearest Endress+Hauser Service Organization.

4.1 Electrical connection

How to connect the devices:

- The supply voltage must match the specification on the nameplate, refer to Chapters 2.1.1 and 2.1.2.
- Switch off supply voltage before you connect the device.
- The cable must end in a dry room or in a proper terminal housing. The terminal housing with GORE-TEX® filter, NEMA 4/NEMA 4X (IP 66/IP 67) from Endress+Hauser is suitable for outdoor installation.
- Connect device according. to Figures 7 and 8. A polarity protection is integrated in the Waterpilot FMX 167 and the Temperature Transmitter TMT 181. Changing the polarities will not destroy the devices.

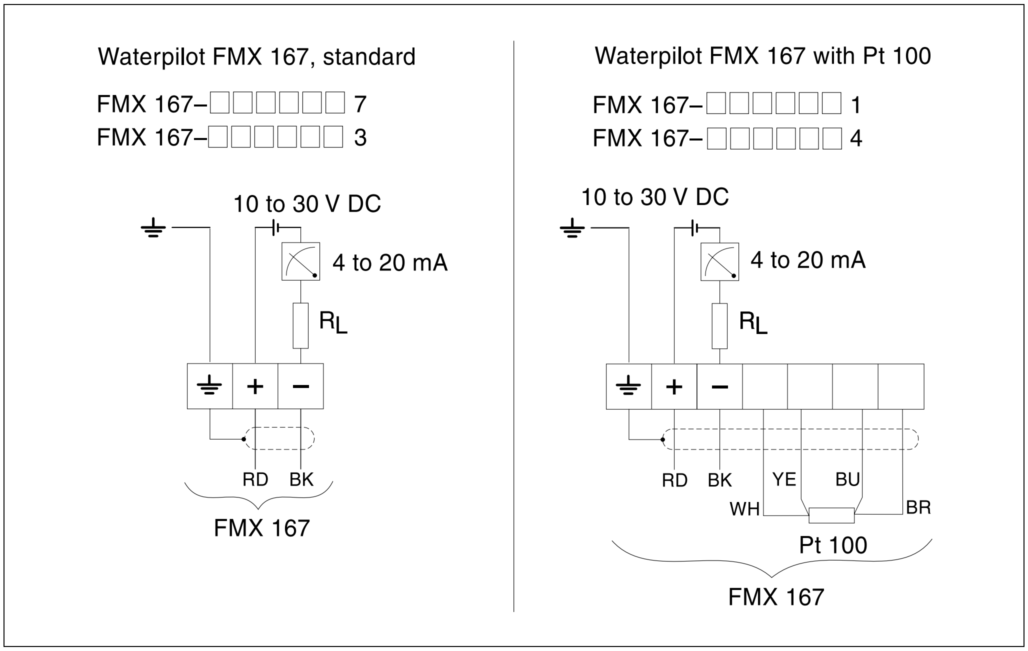


Fig. 7: Electrical connection: left for FMX 167, right for FMX 167 with Pt 100

Wire colors
RD = red
BK = black
WH = white
YE = yellow
BU = blue
BR = brown

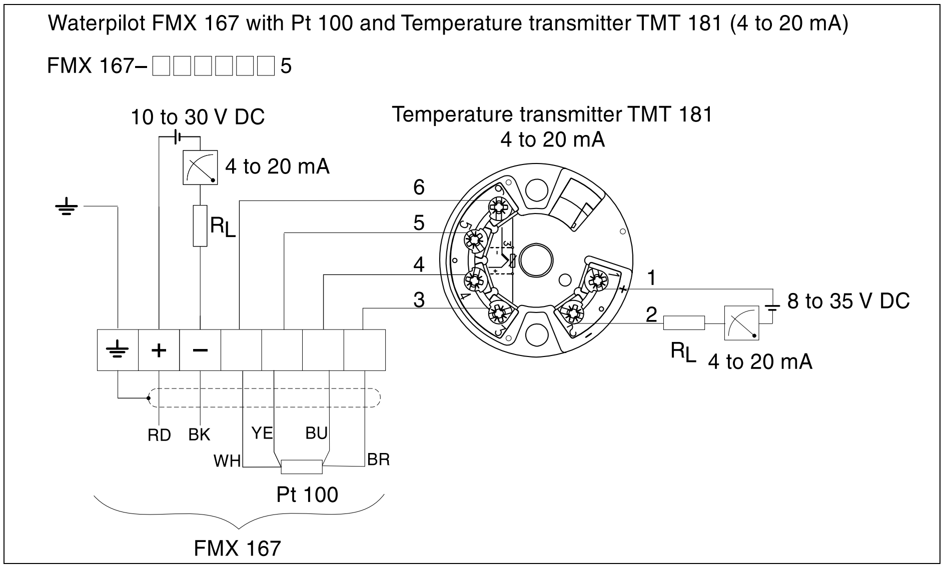


Fig. 8: Electrical connection: FMX 167 with Pt 100 and Temperature Transmitter TMT 181

Wire colors
RD = red
BK = black
WH = white
YE = yellow
BU = blue
BR = brown

Supply voltage

Certificate	**Supply voltage**		**Supply voltage**
	FMX 167	**FMX 167 + Pt 100**	**Temperature transmitter**
standard	10 to 30 V DC	10 to 30 V DC	8 to 35 V DC
EEx nA IIC T6	10 to 30 V DC	10 to 30 V DC	–
FM IS **CSA IS** **EEx ia IIC T6**	10 to 30 V DC	–	–

Cable specification

FMX 167 with Pt 100 (optional)	**Temperature transmitter (optional)**
– Commercially available installation cable – Terminals in terminal housing FMX 167: ≤14 AWG (2.5 mm^2).	– Commercially available installation cable – Terminals in terminal housing FMX 167: – ≤14 AWG (2.5 mm^2) – Transmitter terminals: max. 15 AWG (1.75 mm^2)

Note!
The support cable of the Waterpilot FMX 167 is shielded. In the following cases Endress+Hauser recommends use of a shielded cable for the cable extension:
– for large distances between support cable end and display and/or evaluation unit,
– for large distances between support cable end and temperature transmitter
– for directly connecting Pt 100 signals to the display and/or evaluation unit.

Power consumption/current drain

	FMX 167	FMX 167 + Pt 100	Temperature transmitter TMT 181
Power consumption	≤ 0.675 W at 30 V DC	≤ 0.675 W at 30 V DC	≤ 0.77 W at 35 V DC
Current drain	max. ≤ 22.5 mA min. ≥ 3.5 mA	max. ≤ 22.5 mA min. ≥ 3.5 mA Pt 100: ≤ 0.6 mA	max. ≤ 22 mA min. ≥ 3.5 mA

Load

The maximum load resistance is dependent on the supply voltage (U_b) and must be determined for every current loop separately. Refer to equations and diagrams for "FMX 167 with Pt 100 (optional)" and "Temperature transmitter".
The total resistance resulting from the resistances of the connected devices, the connecting cable and if necessary, the resistor of the support cable may not exceed the load resistance.

FMX 167 with Pt 100 (optional)	Temperature transmitter (optional) TMT 181
$R_{tot} \leq \frac{U_b - 10\ V}{0.0225\ A} - 2 \cdot 0.09\ \frac{\Omega}{m} \cdot l - R_{add}$	$R_{tot} \leq \frac{U_b - 8\ V}{0.022\ A} - R_{add}$

R_{tot} = Max. load resistance [Ω]
R_{add} = Additional resistances, e.g. resistance of evaluating device and/or the display instrument, line resistance [Ω]
U_b = Supply voltage [V]
l = Simple length of support cable [m] (cable resistance per wire ≤ 0.09 Ω/m)

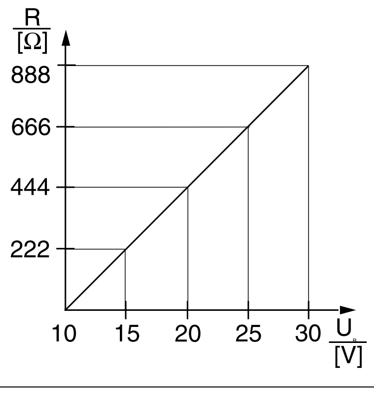


Fig. 9:
Load chart FMX 167 for estimating load resistance

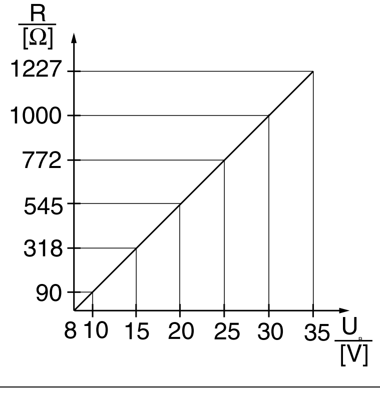


Fig. 10:
Load chart of temperature transmitter TMT 181 for estimating load resistance

Note!
Additional resistances, e.g. resistance of support cable, must then be subtracted from the value determined from the diagram, as shown in the equation.

4.2 Wiring the measuring unit

Overvoltage protection

Note!
In order to protect the Waterpilot FMX167 and the Temperature Transmitter TMT 181 from large transients, Endress+Hauser recommends the installation of an overvoltage protector upstream and downstream of the display and/or evaluation device as shown in the figure.
The Waterpilot FMX 167 has an integrated overvoltage protection to EN 61000 of ≤ 1.2 kV as standard.

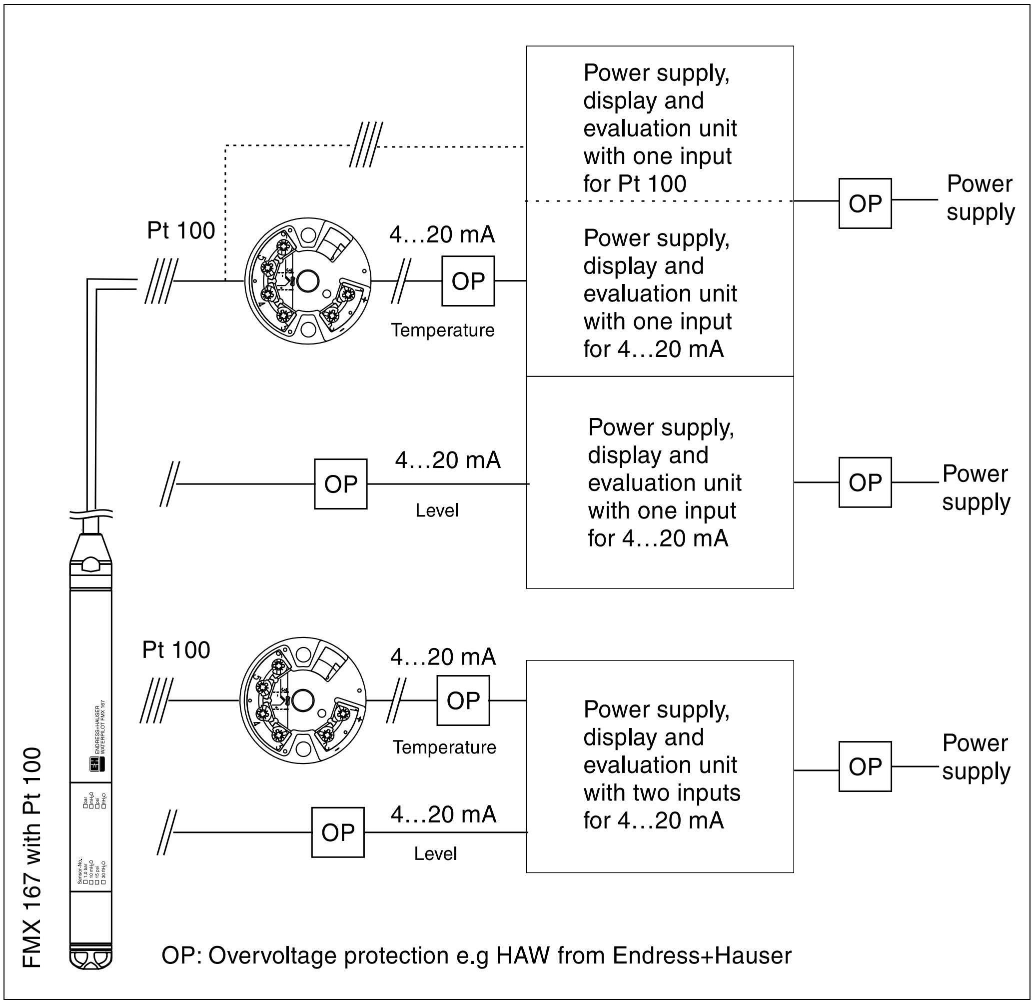


Fig. 11: Wiring the measuring unit

4.3 Checking the wiring

After wiring the measuring instrument, carry out the following inspections:
- Does the supply voltage match the specification on the nameplate?
- Is the device connected as shown in Figures 7 and 8?
- Are all the screws tightened?
- Optional terminal housing: are the conduit entries tight?

5 Operation

Note!

Note!
Endress+Hauser offers extensive measuring point solutions with display and/or evaluation units for the Waterpilot FMX 167 and the Temperature Transmitter TMT 181. For more information, please contact your nearest Endress+Hauser Service Organization. Please refer to the back page of this documentation for contact addresses.

6 Maintenance

No special maintenance work is required for the Waterpilot FMX 167 or for the optional Temperature Transmitter TMT 181.

Cleaning the device exterior

When cleaning the exterior of the measuring device, please note the following:

- Do not use a cleaning agent that is aggressive to the housing surface or the seal.
- Waterpilot FMX 167: avoid any mechanical damage to the membrane or the support cable.

7 Accessories

There are a number of accessories available for the Waterpilot FMX 167. You can order them separately from Endress+Hauser.

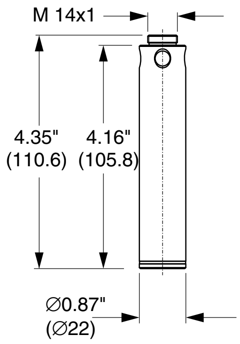
Mounting clamp

Endress+Hauser offers a mounting clamp for simple mounting. Refer to page 26.
Material: 1.4435 (AISI 316L), Order No.: 52006151

Terminal housing

Terminal housing NEMA 4/NEMA 4X (IP 66/IP 67) with GORE-TEX® filter including three mounted terminals.
The terminal housing is also suitable for installing a temperature transmitter (Order No. 52008794) or for four additional terminals (Order No. 52008938).
Refer to page 27.
Order No.: 52006152

Additional weight



To prevent sideways movement leading to measuring errors or to ensure that the device lowers into a guide tube, Endress+Hauser provides additional weights. You can attach several weights to the FMX 167.

Material: 1.4435 (AISI 316L)
Weight: 10.6 oz. (300 g)
Order No.: 52006153

Temperature Transmitter TMT 181, 4-20 mA

Temperature transmitter, 2-wire, pre-set for measuring range from –4 to +176°F (–20 to +80°C).
This setting offers an easily displayable temperature range of (212°F) 100°C. Note that the Pt 100 resistance thermometer is designed for a temperature range of +14 to +158°F (–10 to +70°C). Refer to page 27.
Order No.: 52008794

Cable mounting screw

Endress+Hauser offers cable mounting screws to simplify the installation of the FMX 167.
Refer to page 26. Material: 1.4301 (AISI 304)
Order No. for cable mounting screw with G 1 1/2 A thread: 52008264
Order No. for cable mounting screw with 1 1/2 NPT thread: 52009311

Terminals

Four terminals in strip for FMX 167 terminal housing,
suitable for wire cross section of $\leq$14 AWG (0.08 to 2.5 mm^2)
Order No.: 52008938
Protective front cap (set of 5)
Order No.: 52008999

Membrane protective cap
5 pieces in set, refer to Fig. 3, page 8
Order No.: 52008999

Pressure compensation set
10 pieces in set, comprised of Teflon filter and sleeve for support cable, refer to Fig. 3, page 8
Order No.: 52005578

8 Trouble-shooting

8.1 Faults on Waterpilot FMX 167 and Waterpilot FMX 167 with Pt 100 (optional)

Error description	Cause	Action
No measuring signal	Connection of 4-20 mA line incorrect	Connect device according to Chapter 4.1, Figs. 7 or 8
	No supply voltage over 4-20 mA line	Check current loop
	Supply voltage too low (min. 10 V DC)	Check supply voltage Total resistance greater than max. load resistance, refer to Chapter 4.1, page 14
	Waterpilot defective	Replace Waterpilot
Temperature measuring value inaccurate/incorrect (only with Waterpilot FMX 167 with Pt 100)	Pt 100 connected to 2-wire circuit, line resistance not compensated	Compensate line resistance Connect Pt 100 as 3-wire or 4-wire circuit

8.2 Faults of Temperature Transmitter TMT 181 (optional)

Error description	Cause	Action
No measuring signal	Connection of 4-20 mA line incorrect	Connect device according to Chapter 4.1, Fig. 8
	No supply voltage over 4-20 mA line	Check current loop
	Supply voltage too low (min. 8 V DC)	Check supply voltage Total resistance greater than max. load resistance, refer to Chapter 4.1, page 14
Error current ≤ 3.6 mA or ≥ 21 mA	Connection of Pt 100 incorrect	Connect device according to Chapter 4.1, Fig. 8
	Connection of 4-20 mA line incorrect	Connect device according to Chapter 4.1, Fig. 8
	No supply voltage over 4-20 mA line	Check current loop, refer to Chapter 4.1, Fig. 8
	Pt 100 element defective	Replace Waterpilot FMX 167
	Temperature transmitter defective	Replace temperature transmitter
Measuring value inaccurate/ incorrect	Pt 100 connected in 2-wire circuit, line resistance not compensated	Compensate line resistance Connect Pt 100 as 3-wire or 4-wire circuit

8.3 Spare Parts

Note!

Note!
You can order spare parts directly from your nearest Endress+Hauser Service Organization.

9 Technical Data

9.1 Technical Data Waterpilot FMX 167 and Waterpilot FMX 167 with Pt 100 (optional)

Applications

Applications	The Waterpilot FMX 167 is a hydrostatic pressure sensor for measuring the level of fresh water, drinking water and wastewater. The version with a Pt 100 resistance sensor measures temperature at the same time.

Input Parameters

Measured variable	• Hydrostatic pressure of a liquid • Pt 100: Temperature of a liquid
Measuring range	• Nine fixed pressure measuring ranges in psi, ftH$_2$O, bar and mH$_2$O, • Customer-specific measuring ranges between 1.5 and 300 psi (3 to 600 ftH$_2$O); factory-calibrated and special measuring ranges on request • Pt 100 (optional): Temperature measurement from –4 to +176°F (–20 to +80°C)

Output Parameters

Output signal	• 4-20 mA for hydrostatic pressure measured value, two-wire loop powered • Pt 100 (optional): temperature-dependent resistance of the Pt 100
Load	see Chapter 4.1, section "Load"

Auxiliary energy

Electrical connection	see Chapter 4.1, integrated polarity protection
Supply voltage	• 10 - 30 V DC, EEx nA and EEx ia: 10 - 30 V DC • Pt 100: 10 - 30 V DC, EEx nA: 10 - 30 V DC
Power consumption	≤ 0.675 W at 30 V DC
Current drain	• Max. current drain: ≤ 22.5 mA; Min. current drain: ≥ 3.5 mA • Pt 100 (optional): ≤ 0.6 mA
Residual ripple	No effect for 4-20 mA signal up to ± 5% residual ripple within permissible range

Performance characteristics

Reference operating conditions	DIN EN 60770 T_U= 77°F (25°C)
Accuracy	• Linearity including hysteresis and repeatability as per DIN EN 60770: ± 0.2% of Full Scale • Pt 100: max.: ±0.7 K (Class B to DIN EN 60751)
Long-term stability	±0.1 % of Full Scale per year
Influence of medium temperature	• Thermal change in zero signal and output span for typical temperature range +32 to +86°F (0 to +30°C): ± 0.4 % (± 0.5 %)* of span • Thermal change in zero signal and output span for the total medium temperature range +14 to +158°F (–10 to +70°C): ± 1.0 % (± 1.5 %)* of span • Maximum temperature coefficient (T_K) in zero signal and output span: 0.15 %/10 K (0.3 %/10 K)* of span * Specifications for sensors 1.5 psi (3 ft H$_2$O, 0.1 bar, 1 mH$_2$O), 10 psi (20 ft H$_2$O, 0.6 bar, 6 mH$_2$O)

Performance characteristics (continuation)

Warm-up period	20 ms
Rise time (T90-time)	• 80 ms • Pt 100 (optional): 160 s
Setting time	• 150 ms • Pt 100 (optional): 300 s

Ambient Conditions

Ambient temperature range	+14 to +158°F (–10 to +70°C), (= Medium temperature range)
Storage temperature	–40 to +176°F (–40 to +80°C)
Ingress protection	– NEMA 6P (IP 68), permanently submersible to 700 ftH_2O – Optional terminal housing: NEMA 4/NEMA 4X (IP 66/IP 67)
Electromagnetic compatibility	Interference emission to EN 61326; Equipment Class B Interference immunity to EN 61326, Appendix A (industrial usage)
Overvoltage protection	Integrated overvoltage protection to EN 61000-4-5 ≤ 1.2 kV Install overvoltage protection ≥ 1.2 kV, external if necessary.

Process Conditions

Medium temperature range	+14 to +158°F (–10 to +70°C) For devices approved for use in hazardous areas, see Safety Instructions.
Medium temperature limits	–4 to 158°F (–20 to +70°C) (You may operate the FMX 167 in this temperature range. The values quoted in the specifications may then be exceeded, e.g. measuring accuracy. Also refer to DIN 16086.)

Mechanical Construction

Construction, Dimensions	see Chapter 9.3
Weight	– Cable probe: 10 oz. (290 g) – Support cable: Approximately 2 oz/ft (52 g/m) – Mounting clamp: 6 oz. (170 g) – Cable mounting screw G 1 1/2 A: 1.7 lb. (0.77 kg) – Cable mounting screw 1 1/2 NPT: 1.6 lb. (0.72 kg) – Terminal housing: 8.3 oz. (235 g) – Additional weight: 10.6 oz. (300 g)
Materials	Cable probe: – Cable probe 1.4435 (AISI 316L) – Process ceramic: Al_2O_3 aluminum oxide ceramic – Seal (internal): EPDM or Viton – Protective cap: PE-HD (high-density polyethylene) – Support cable insulation: PE (polyethylene), for more details, see section "Support cable" optional: – Mounting clamp 1.4435 (AISI 316L) and glass fiber reinforced PA (polyamide) – Cable mounting screw G 1 1/2 A: 1.4301 (AISI 304) – Cable mounting screw 1 1/2 NPT: 1.4301 (AISI 304) – Additional weight: 1.4435 (AISI 316L) – Temperature transmitter: Housing PC (polycarbonate)

Mechanical Construction (continuation)

Support cable	Construction – Slip-resistant extension cable with strain-relief members made of Kevlar; shielded using aluminum-coated film; insulated with polyethylene (PE), black; copper wires, twisted – Pressure compensation tube with Teflon filter Cross section – FMX 167: 3 x 0.0004 in^2 (0.227 mm^2) + pressure compensation tube with Teflon filter – FMX 167 with Pt 100 (optional): 7 x 0.0004 in^2 (0.227 mm^2) + pressure compensation tube with Teflon filter – Total outer diameter: 0.315 inch ± 0.0098 inch (8.0 mm ± 0.25 mm) – Pressure compensation tube with Teflon filter: Outer diameter OD = 0.098 inch (2.5 mm), Internal diameter ID = 0.059 inch (1.5 mm) Cable resistance – Cable resistance per wire: ≤ 90 Ω/km Cable length – Max. free suspended length (mechanical stability under load): 3280 feet (1000 m) – Max. free length for non-Ex and EEx nA IIC T6: see Section "Load", Chapter 4.1 Max. free length for EEx ia IIC T6: see Safety Instructions (XA…) Further technical data – Minimum bending radius: 4.7 inch (120 mm) – Tensile strength: ≥ 269 lb force (1200 N) – Cable extraction force: ≥ 101 lb force (450 N) (The extension cable could be extracted from the cable probe at a tensile force ≥ 101 lb force (450 N).) – Approved for use with drinking water NSF 61 – Increased resistance to UV light
Terminals	– 3 standard terminals in terminal housing – 4-terminal strip available as accessory , Order No. 52008938 for wire cross section of 0.0001 in^2 to 0.004 in^2 (0.08 to 2.5 mm^2)

Certificates and Approvals

Explosion protection approval, Type of protection	– ATEX II 2G/EEx ia IIC T6 – ATEX II 3 G/EEx nA II T6 – FM: IS, Class I, Division 1, Groups A-D – CSA: IS, Class I, Division 1, Groups A-D Note: Waterpilot FMX 167 with integrated Pt 100 is not available for FM, IS, Class 1, Div. 1, Groups A-D; CSA, IS, Class 1, Div. 1, Groups A-D and ATEX. Waterpilot FMX 167 with integrated Pt 100 is available for CSA, General purpose and for the Standard version. All explosion protection data are contained in separate explosion protection documentation which you can also request. Explosion protection documents are supplied as standard for all devices approved for use in explosion hazadous areas.

Ordering Information

Ordering information	You will receive ordering information and Order Code details from Endress+Hauser Service Organization. Refer also to Technical Information Waterpilot FMX 167 (TI 351P/24/ae)

Supplementary Documentation

Supplementary Documentation	– System Information Waterpilot (SI 028P/00/en) – Technical Information Waterpilot FMX 167 (TI 351P/24/ae) – Safety Instructions, ATEX II 2 G/EEx ia IIC T6 (XA 131P/01/a3) – Safety Instructions, ATEX II 3 G/EEx nA II T6 (XA 132P/01/a3)

9.2 Technical Data Temperature Transmitter TMT 181 (optional)

Applications

Applications	The temperature transmitter TMT 181 converts the Pt 100 signal into a 4-20 mA.

Input Parameters

Measured variable	Temperature
Measuring range	The temperature transmitter is pre-set for a measuring range of –4 to +176°F (–20 to +80°C). This setting offers an easily displayable temperature range of 212°F (100°C). Please note that the Pt 100 resistance thermometer is designed for a temperature range of 14 to 158°F (-10 to +70°C)
Input signal	Pt 100 resistance signal, 4-wire

Output Parameters

Output signal	4 to 20 mA for temperature measured value, two-wire
Load	see Chapter 4.1, section "Load"

Auxiliary energy

Electrical connection	see Chapter 4.1, integrated polarity protection
Supply voltage	8 - 35 V DC, EEx ia: 9.6 - 30 V DC
Cable specifications	see Chapter 4.1, section "Cable specifications"
Power consumptionn	≤ 0.77 W at 35 V DC
Current drain	• Max. current drain: ≤ 22 mA Min. current drain: ≥ 3.5 mA • with optional Pt 100 of the FMX 167: ≤ 0.6 mA
Residual ripple	$U_{ss} \leq 5$ V at $U_B \geq 13$ V, $f_{max.}$= 1 KHz

Performance characteristics

Reference operating conditions	Calibration temperature: 73°F (23°C) ± 5K
Accuracy	• ±0.2 K • with optional Pt 100 of the FMX 167: max. ±0.9 K
Warm-up period	4 s

Ambient Conditions

Ambient temperature range	–40 to +185°F (–40 to +85°C)
Storage temperature	–40 to +212°F (– 40 to +100°C)
Ingress protection	– IP 00, moisture condensation permissible – When mounted in optional terminal housing: NEMA 4X (IP 66/IP 67)
Electromagnetic compatibility (EMC)	Interference emission to EN 61326; Equipment Class B Interference immunity to EN 61326, Appendix A (industrial usage)
Overvoltage protection	Install overvoltage protection, external if necessary.

Mechanical Construction

Construction, dimensions	see Chapter 9.3
Weight	1.4 oz. (40 g)
Material	Housing PC (polycarbonate)

Terminals	Connection terminals temperature transmitter: 15 AWG (1.75 mm^2)

Certificates and Approvals

Explosion protection approval, Type of protection	FM IS Class 1, Div. 1, Group A-D Non Incendive, Class 1, Div. 2, Group A-D Note: Waterpilot FMX 167 with integrated Pt 100 is not available for FM IS, Class 1, Div. 1, Groups A-D; CSA IS, Class 1, Div. 1, Groups A-D and ATEX. Waterpilot FMX 167 with integrated Pt 100 is available for CSA, General purpose and for the Standard version.

Ordering Information

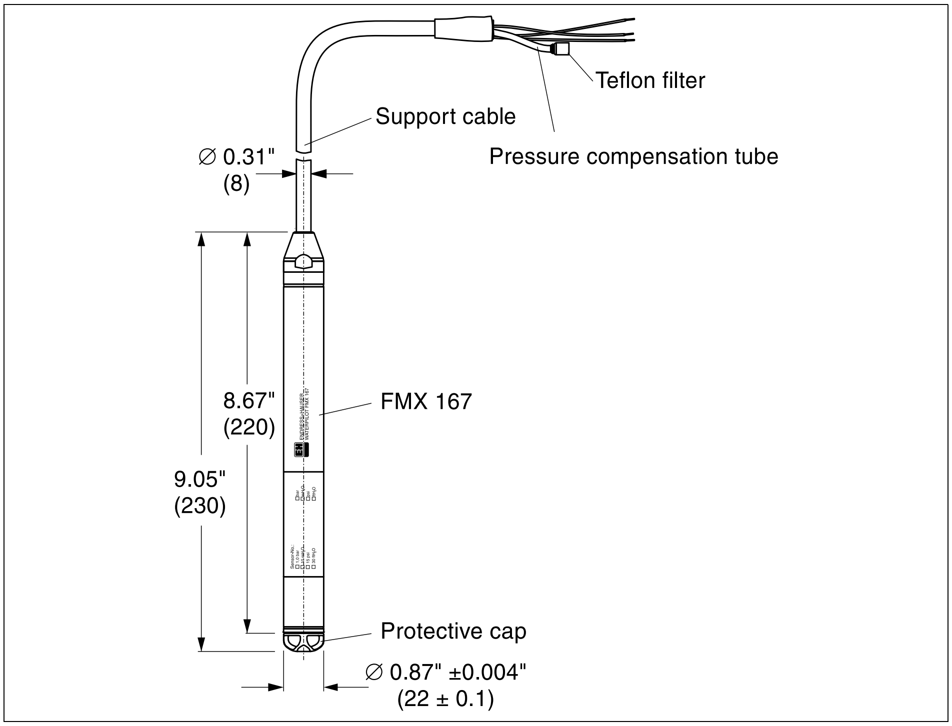
Ordering information	You will receive ordering information and Order Code details from Endress+Hauser Service Organization. See also Technical Information Temperature Head Transmitter iTEMP PCP TMT 181 (TI 070R/09/en).

Supplementary Documentation

Supplementary Documentation	– System Information Waterpilot (SI 028P/00/en) – System Information System Components (SI 006R/09/en) (Display, Power, Convert, Separate and Switch) – System Information Recorders with System Integration (SI 007R/09/en) – Technical Information Temperature Head Transmitter iTEMP PCP TMT 181 (TI 070R/09/en)

9.3 Dimensions

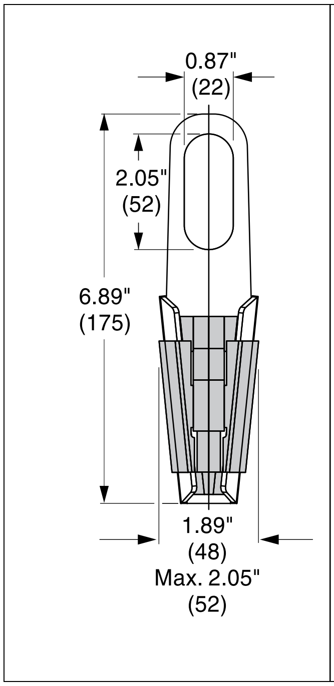
Dimensions of cable probe

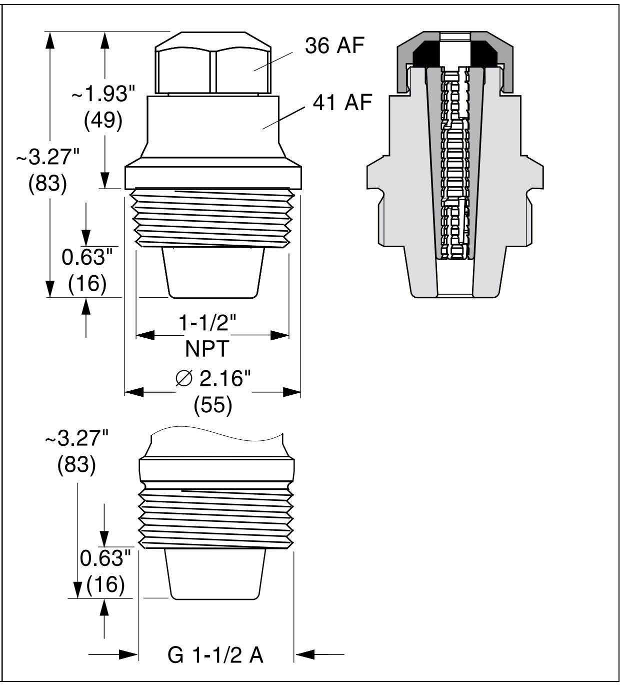


Dimensions of cable mounting screw G 1 1/2 A
FMX 167-☐3☐☐☐☐☐☐

Dimensions of mounting clamp
FMX 167-☐2☐☐☐☐☐☐

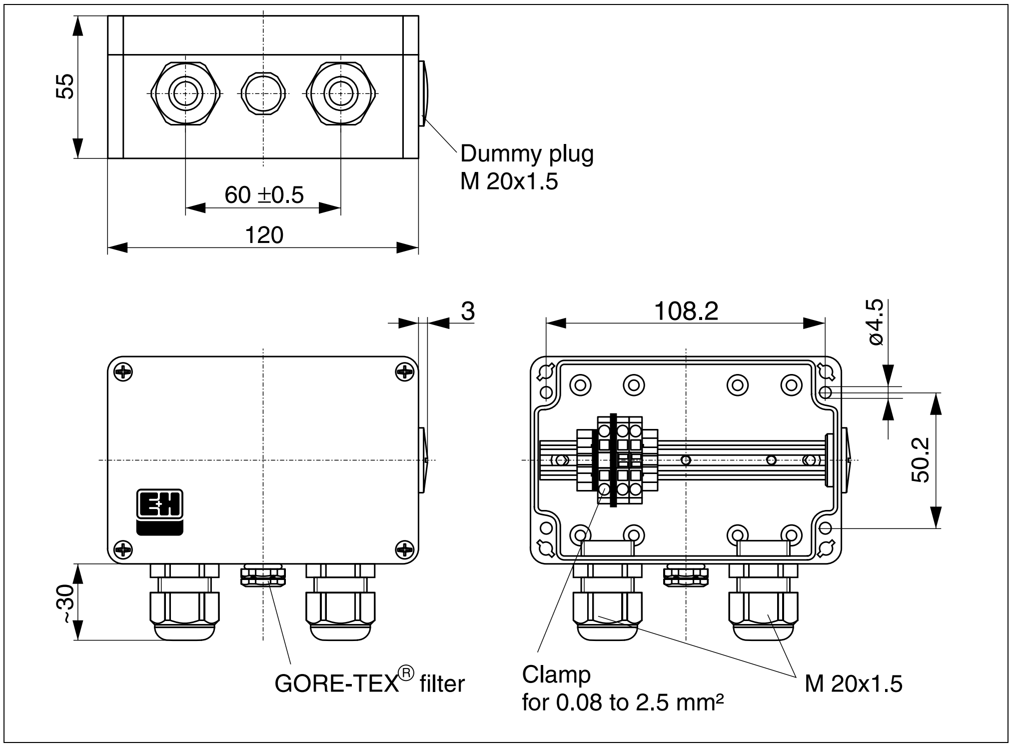
Dimensions of cable mounting screw 1 1/2 NPT
FMX 167-☐4☐☐☐☐☐☐





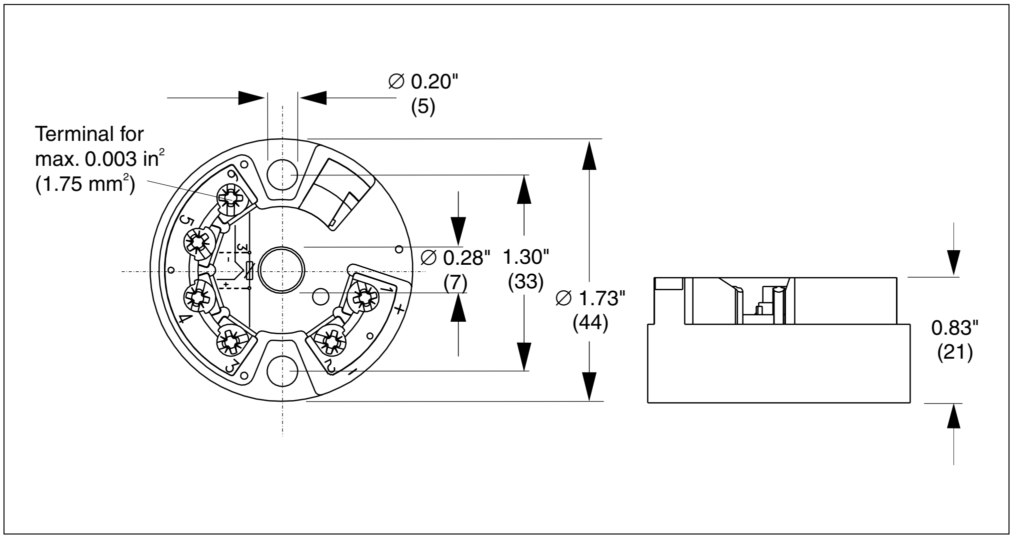
Dimensions terminal housing IP 66/IP 67 with filter

FMX 167 - ❑❑❑❑❑❑❑3:Terminal housing incl. 3 terminals,
FMX 167 - ❑❑❑❑❑❑❑4:Terminal housing incl. 7 terminals for FMX 167 with Pt 100,
FMX 167 - ❑❑❑❑❑❑❑5:Terminal housing incl. 3 terminals +
temperature transmitter TMT 181, 4-20 mA for FMX 167 with Pt 100



Dimensions temperature transmitter TMT 181 (4…20 mA)

FMX 167 - ❑❑❑❑❑❑❑5:Terminal housing incl. 3 terminals +
temperature transmitter TMT 181, 4-20 mA for FMX 167 with Pt 100



10 Appendix

10.1 Functions and system design

The FMX 167 is a submersible level transmitter with a ceramic pressure sensor for the level measurement of liquids. The Waterpilot is available with nine permanently calibrated measuring ranges from 3 to 600 ftH2O to ensure use in all standard applications (optional application specific range). Due to its compact outer diameter of only 0.87" (22 mm), it is ideal for use in 1" well casings. Options include output for temperature measurement.

The FMX 167 is a loop-powered self-contained 4-20 mA device. The hydrostatic column acts directly on the ceramic diaphragm. The deflection of the diaphragm generates a change in the capacitance of the sensor. The transmitter electronics, which is located in the 316L SS probe, converts the capacitance change to a repeatable and accurate 4-20 mA output signal.

A complete measuring system consists of the FMX 167 and a transmitter power supply unit (10 to 30 VDC). Endress+Hauser has a complete line of power supplies with displays and/or indicators.

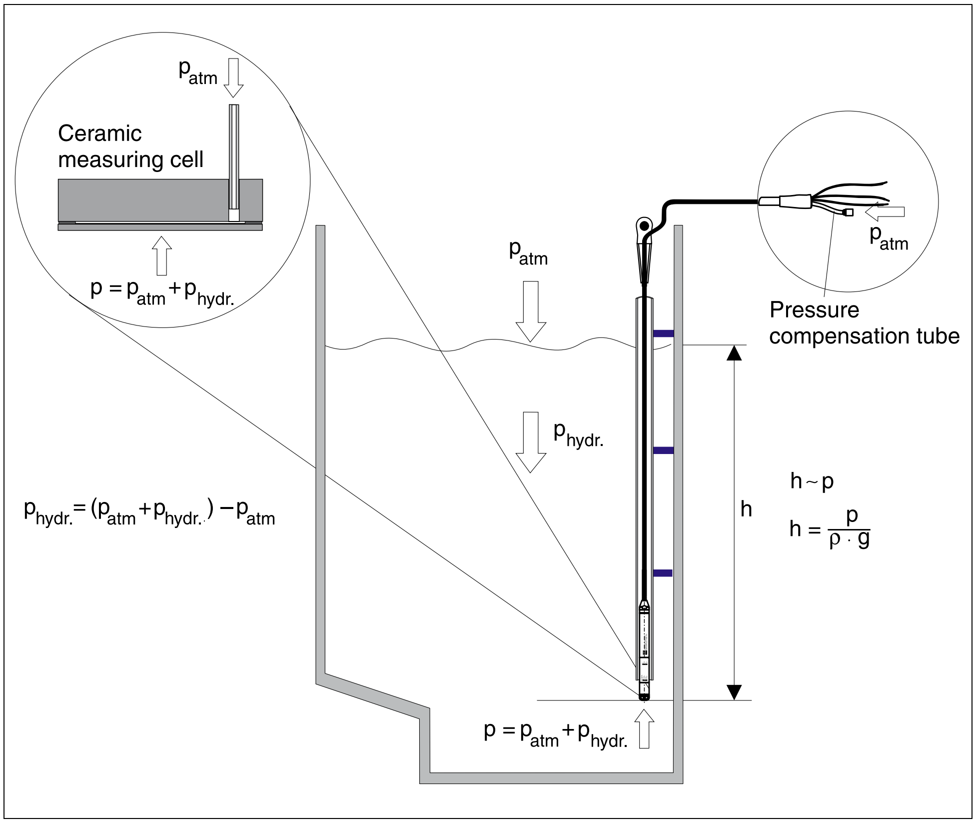


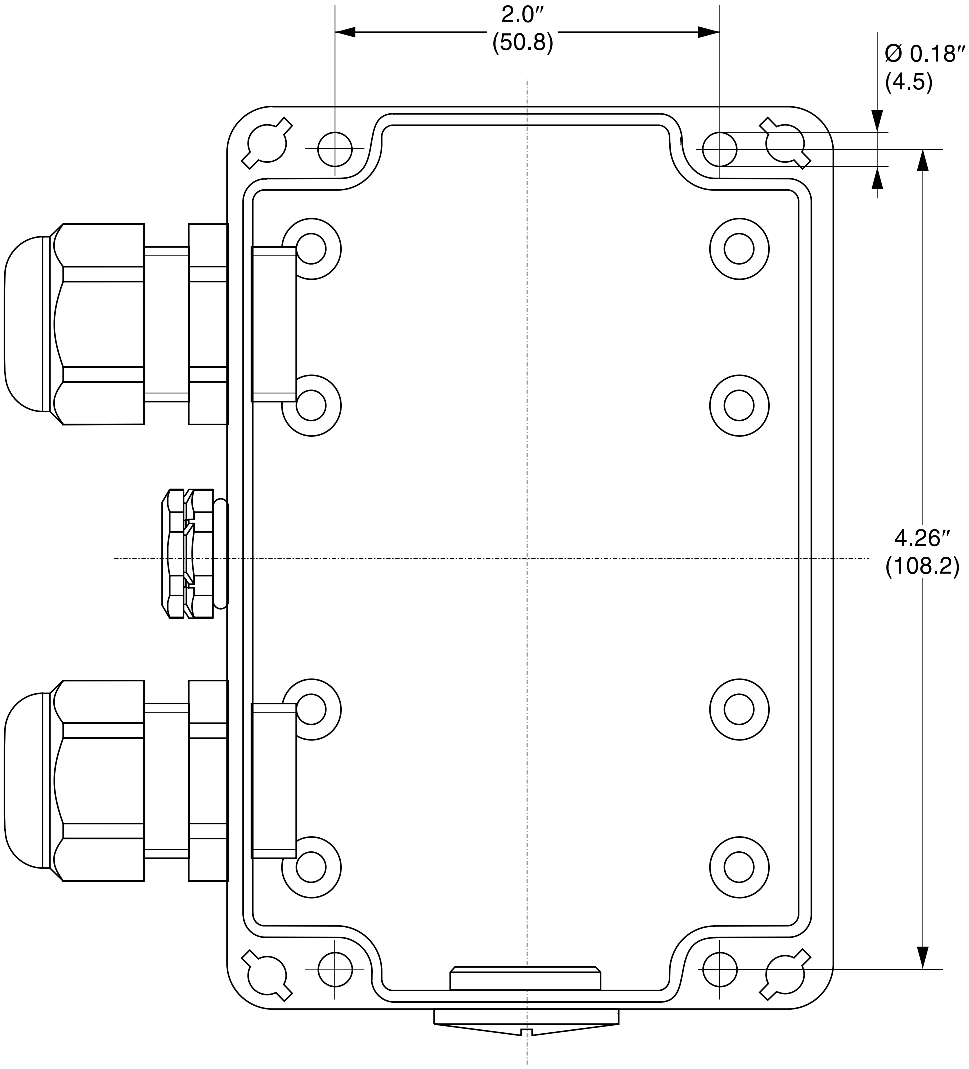
Fig. 12: Functions and system design

h = level height
p = total pressure = hydrostatic pressure + atmospheric pressure
ρ = medium density
g = gravitational acceleration
$p_{hydr.}$ = hydrostatic pressure
p_{atm} = atmospheric pressure

Temperature measurement with Pt 100 (optional)
Endress+Hauser offers an optional 4-wire Pt 100 resistance sensor for Waterpilot FMX 167 to measure level and temperature simultaneously. The Pt 100 belongs to Accuracy Class B to DIN EN 60751.

Temperature measurement with Pt 100 and Temperature Transmitter TMT 181 (optional)
To convert Pt 100 signals into a 4-20 mA signal Endress+Hauser also offers a temperature transmitter for mounting in the FMX 167 terminal housing.

10.2 Drilling template terminal housing



10.3 Control Drawing - Waterpilot FMX 167

Hazardous location

Class I, DIV. 1, Groups A, B, C, D
AEx ia IIC T6, Ta = 70°C
Class I, DIV. 2, Groups A, B, C, D

Non hazardous location

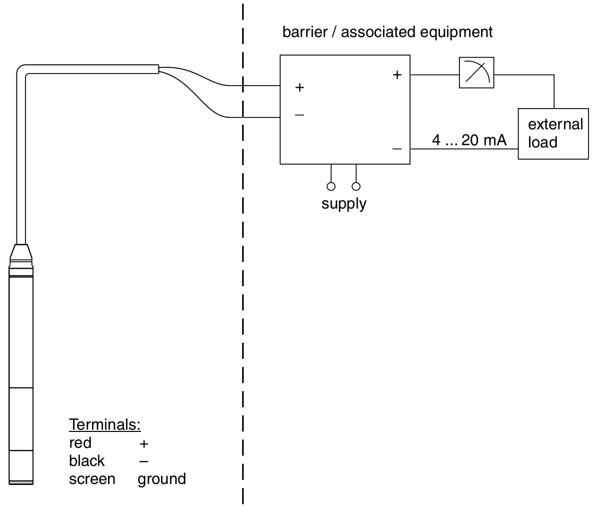


Table: Entity parameters
sensor:

Vmax. = 30 VDC
I max. = 133 mA
Pmax. = 1 W
Ci see table
Li see table

Intrinsically safe (entity), Class I, DIV. 1, Groups A, B, C, D
Hazardous Location Installations

1. Control room equipment may not use or generate over 250 V
2. Use Factory Mutual Entity-approved intrinsic safety barrier with Voc or Vt ≤ Vmax, Isc or It ≤ Imax, Ca ≥ Ci + C_{cable}, La ≥Li + L_{cable}
   Barrier must be incapable of delivering more than 1 Watt to a matched load.
   Transmitter entity parameters are as follows: Vmax = 30 VDC
   I max = 133 mA
   Pmax = 1 W

   Ci and Li per table:

Length of sensor cable	Ci (5.3 nF + 180pF/m)	Li (1 µH/m)
5 m	6.2 nF	5 µH
10 m	7.1 nF	10 µH
20 m	8.9 nF	20 µH
30 m	10.7 nF	30 µH
50 m	14.3 nF	50 µH
100 m	23.3 nF	100 µH
200 m	41.3 nF	200 µH
300 m	59.3 nF	300 µH

3. Installation should be in accordance with ANSI/ISA RP 12.6 "Installation of intrinsically safe systems for hazardous (classified) locations" and the National Electrical Code (ANSI/NFPA 70).
4. Warning: Substitution of Components may impair intrinsic safety.
5. Intrinsic safety barrier manufacturer's installation drawing must be followed, when installing this equipment: The configuration of the intrinsic safety barrier(s) must be FMRC approved.
6. Use supply wires suitable for 5°C above surrounding ambient.

Non-incendive Class I, DIV. 2, Groups A, B, C, D
Hazardous Location Installation

1. Install per National Electrical Code (NEC)
   DIV. 2 barrier required
   max. supply voltage 30 VDC

2. Warning: Explosion Hazard – Do not disconnect equipment unless power has been switched off or area is known to be non hazardous.
   Warning: Substitution of Components may impair suitability for Class I, DIV.2

Note: For non-incendive field circuit evaluations, the input current (Imax or li) of the receiving device need not match the output current (Isc or Io) of the barrier/associated equipment supplying the energy.

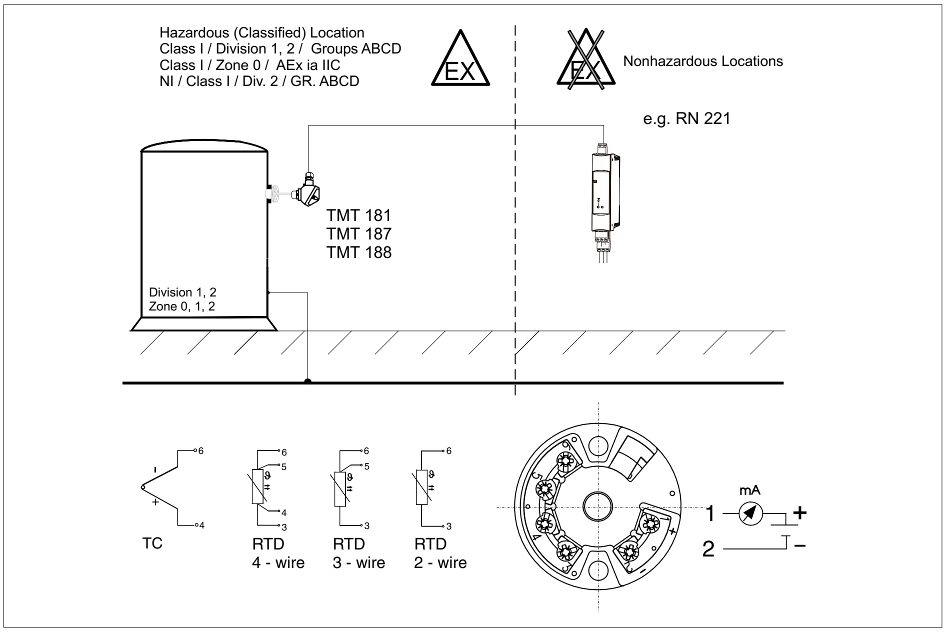
Agency controlled drawing.
No changes without prior agency approval.

ZD 063P-A/01/en/03.01/CCS
FM / A 30.10.00
52008498

Control drawing (IS)
960503-1009 A
Waterpilot FMX 167

Endress+Hauser

10.4 Control Drawing TMT 181



Installation Notes TMT 181, TMT 187, TMT 188

1) FMRC certified apparatus must be installed in accordance with manufacturer instructions.
2) FMRC certified associated apparatus must meet the following requirements:
   Uo or Voc < Ui or Vmax Io or Isc < Ii or Imax Po or Pmax < Pi or Pmax Ca > Ci + Ccable La > Li + Lcable
3) The installation must be in accordance with the National Electrical Code.
   NEC ANSI / NFPA 70, Article 504 and ANSI / ISA-RP 12.6
4) Use supply wires suitable for 5°C above surrounding.
5) The configuration of the headtransmitter TMT 181 is only pemitted in nonhazardous locations.
6) The voltage of the "tools" used for configuration should not exceed Um = 30 V. This can be achieved e.g. by a batterie powered laptop. An approved adapter with barrier (e.g. TMT181A) has to be used for configuration using a PC with mains connection (Um < 253V).

Warning:
- Substitution of Components may impair intrinsic safety

TMT 181 / TMT 187 / TMT 188			**IS / Class I / Division 1 / Groups ABCD / T4/T5/T6** **Class I / Zone 0 / AEx ia IIC / T4/T5/T6** **NI / Class I / Division 2 / Groups ABCD / T4/T5/T6**	
Supply circuit (Terminal 1 and 2)			Vmax = Ui < 30 VDC Imax = Ii < 100 mA Pmax = Pi < 750 mW Ci ~ 0 Li ~ 0	
Sensor circuit (Terminal 3 until 6)			Voc = Uo < 8.2 VDC Isc = Io < 4.6 mA P = Po < 9.35 mW	
Max. Connecting Values	Group A, B Group C Group D	Ex ia IIC Ex ia IIB Ex ia IIA	La = Lo = 4.5 mH La = Lo = 8.5 mH La = Lo = 1000 mH	Ca = Co = 974 nF Ca = Co = 1900 nF Ca = Co = 210 µF
Temperature range			T6: Ta = -40°C ... +55°C T5: Ta = -40°C ... +70°C T4: Ta = -40°C ... +85°C	

Nr.: 510 01932

	NO.	DRAWN	APP'D	DATE
H				
G				
F				
E				
D				
C				
B				
A		Keller-mann	Keller-mann	01.09.00

GEOMETRICAL TOLERANCING DIN ISO 1101
SURFACE TEXTURE DIN ISO 1302
EDGES OF WORKING PARTS DIN 6784

	DATE	NAME
DESIGN		
DRAWN	13.12.99	Kellermann
APPROVED	07.12.00	Kellermann

DOCUMENT PROTECTED BY DIN 34

Endress+Hauser
87484 Nesselwang, Germany

SCALE
TITLE Control Drawing FM TMT 181(7)(8)
DRAWING NO. 14 05 00 111
TOLERANCE
MATERIAL
REPL. FOR
REPL. BY
SHEET SIZE A4

Ordering Information

1 2 3 4 5 6 7
FMX 167 - ☐☐☐☐☐☐☐

1 Certificate

A	Standard	
B	ATEX II 2 G	EEx ia IIC T6
C	ATEX II 3 G	EEx nA IIC T6
D	FM approved	IS, Class I, Div. 1, Grps. A-D
E	CSA approved	IS, Class I, Div. 1, Grps. A-D
F	CSA	General purpose

2 Mechanical connection (cable suspension)
- 1 None
- 2 Mounting clamp, 316L SS
- 3 Cable mounting screw G 1-1/2 A, 304 SS
- 4 Cable mounting screw 1-1/2” NPT, 304 SS
- 9 Special version

3 Measuring cell tube material
- A 316L SS cell enclosure
- D 316L SS cell enclosure, with drinking water approval (NSF std. 61) for all parts in contact with the medium (only for probes with EPDM seals)
- Y Special version

4 Measuring range

				Max. overload
FA	0 to 3 ftH_2O	PA	0 to 1.5 psi	73 psi
FB	0 to 6 ftH_2O	PB	0 to 3 psi	73 psi
FC	0 to 15 ftH_2O	PC	0 to 6 psi	101 psi
FD	0 to 20 ftH_2O	PD	0 to 10 psi	145 psi
FE	0 to 30 ftH_2O	PE	0 to 15 psi	145 psi
FF	0 to 60 ftH_2O	PF	0 to 30 psi	261 psi
FG	0 to 150 ftH_2O	PG	0 to 60 psi	362 psi
FH	0 to 300 ftH_2O	PH	0 to 150 psi	580 psi
FK	0 to 600 ftH_2O	PK	0 to 300 psi	580 psi
BA	0 to 0.1 bar	MA	0 to 1 mH_2O	5 bar
BB	0 to 0.2 bar	MB	0 to 2 mH_2O	5 bar
BC	0 to 0.4 bar	MC	0 to 4 mH_2O	7 bar
BD	0 to 0.6 bar	MD	0 to 6 mH_2O	10 bar
BE	0 to 1.0 bar	ME	0 to 10 mH_2O	10 bar
BF	0 to 2.0 bar	MF	0 to 20 mH_2O	18 bar
BG	0 to 4.0 bar	MG	0 to 40 mH_2O	25 bar
BH	0 to 10.0 bar	MH	0 to 100 mH_2O	40 bar
BK	0 to 20.0 bar	MK	0 to 200 mH_2O	40 bar

- VV Adjusted to customer specifications from 0 _____ (full scale value) to _____ (units)
- YY Special version

5 Measuring cell seal
- 1 Viton
- 2 EPDM
- 9 Special version

6 Extension cable
- A Length in ________ meters, PE cable, can be shortened, from 1 to 300 m
- B 10 m PE cable, can be shortened
- C 20 m PE cable, can be shortened
- E 30 ft cable, PE, can be shortened
- F 60 ft cable, PE, can be shortened
- G Length in ________ feet, PE cable, can be shortened, from 1 to 985 ft
- Y Special version

7 Additional equipment
- 1 Probe with integrated Pt 100, 4-wire
- 3 Terminal housing with GORE-TEX® filter, NEMA 4X
- 4 Probe with integrated Pt 100, 4-wire and terminal housing with GORE-TEX® filter, NEMA 4X
- 5 Probe with integrated Pt 100, -4° to +176°F (-20° to +80°C), TMT 181 temperature transmitter, 4 to 20 mA, 2-wire in terminal housing with GORE-TEX® filter, NEMA 4X
- 7 No additional equipment

Index

IMPORTANT NOTICE
RETURN AUTHORIZATION POLICY

Endress + Hauser must pre-approve and assign a Return Authorization number to any instrument you plan to return. Please identify the Return Authorization number clearly on all shipping cartons and paperwork.

Please note that the issuance of a Return Authorization number does not automatically mean that credit will be issued, or that the return is covered by our warranty. An Endress + Hauser associate will contact you regarding the disposition of your returned equipment.

In order to serve you better, and to protect our employees from any potentially hazardous contaminants, Endress + Hauser must return unopened, at the sender's expense, all items that do not have a Return Authorization number.

To get a Return Authorization number, call

1-800-428-4344

Please be sure to include the following information when requesting a Return Authorization number. This information will help us speed up the repair and return process.

Customer name:
Customer address:
Customer phone number:
Customer contact:
Equipment type:
Original sales order or purchase order number:
Reason for return:
Failure description, if applicable:
Process material(s) to which the equipment has been exposed:

> OSHA Hazard Communication Standard 29CFR 1910.1200 mandates that we take specific steps to protect our employees from exposure to potentially hazardous materials. Therefore, all equipment so exposed must be accompanied by a letter certifying that the equipment has been decontaminated prior to its acceptance by Endress + Hauser.

The employees of Endress + Hauser sincerely appreciate your cooperation in following this policy.

Address your equipment to:

Endress + Hauser
2350 Endress Place
Greenwood, IN 46143
Return Authorization number:

Effective November 1987

United States

Endress+Hauser
2350 Endress Place
Greenwood, IN 46143
Phone: (317) 535-7138
1-800-428-4344
FAX: (317) 535-8498

Regional Office
Endress+Hauser
P.O. Box 901
Harvey, LA 70059
Phone: (504) 366-3264
1-800-288-2364
FAX: (504) 366-3816

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Charlotte, NC 28217
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FAX: (704) 527-5005

Regional Office
Endress+Hauser
2901 West Sam Houston
Parkway North, Ste. C-250
Houston, TX 77043
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FAX: (832) 590-6202

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Div. of Endress+Hauser
68950 Powell Road
Romeo, MI 48065
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FAX: (810) 752-0705

Regional Office
Endress+Hauser
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1-877-880-1750
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Col. Jardines del Pedregal
01900, Mexico D.F.
MEXICO
Phone: (525) 568-2405
FAX: (525) 568-7459

Endress+Hauser
The Power of Know How

Appendix I

SCADA CONTROL COMPONENTS

REMOTE RTU903-1

System Controls & Instrumentation, Ltd

11218 IH-10 E.	1108 Quail Hollow
Converse, TX 78109	Laredo, TX 78045
Phone: 210-661-9901	Phone: 956-725-1239
Fax: 210-666-5575	Fax: 956-726-1774

TECL # 18461

April 29, 2010

Operating & Maintenance Manual

FOR

RTU903-1

AT

Camp Stanley Storage Bioreactor Facility

Bldg. 903

Instrumentations & Controls

SCI FILE 3079

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SUMMARY:

SCI overhauled the previous design to consolidate command and control following industry process control methodology. All control process signals, settings, and operation reside in the new RTU903-1 main control panel with a new HMI Touch Screen located on the door.

The current SCADA control system located on the base is capable of making certain operational changes to the new control system along with data logging discrete and analog signals.

Command and control fail-over is incorporated into the new control system software design to allow the Bioreactor Process to operate in stand-alone mode when a SCADA network outage occurs. All parameters and settings made locally at the new control system's HMI will automatically be transferred to SCADA when the network outage ends.

Wireless integration of remote I/O is incorporated in the new design to eliminate existing and future underground conduit. The current design allows up to a total of 127 unit addresses for radios and expansion modules on one wireless gateway module that is located in the main control panel. Five (5) unit addresses are now in use including the new RTU-903-4 remote panel. This leaves a total of 122 unit addresses for future growth across the base.

The wireless network equipment also incorporates fail-over implementation. When power is lost at one or more of the remote I/O panels, the wireless gateway module at RTU-903-1 will wait five (5) minutes before clearing the registers and shutting down critical equipment being operated or monitored from that location. If the main control system fails, the wireless remote I/O panels will remain operational for one (1) minute before releasing all active I/O.

HARDWARE:

A new Nema 12 double door control cabinet houses all the controls. Some items from the existing control panel are used and incorporated into the controls upgrade as needed such as the GE MDS 1710 Radio, 173 MHz Antenna, etc.

Surge protection is provided using Weidmuller and Phoenix modules on all power and signals entering the control panel along with providing separate chassis ground and isolated signal ground. A new ground rod is installed at the control panel to provide additional grounding of the controls.

A new data concentrator manufactured by Red Lion is incorporated into the new control system for all Modbus communication. All digital traffic within the control panel along with remote external equipment is transferred to and from the PLC using Red Lion's Data Station Model DSPSX000.

The RS232 signal from the weather station is now converted to RS485 using a B&B Model 485LDRC9 Industrial Isolator with 2KV of isolation on both ends. To eliminate draining the battery/solar powered equipment at the weather station, the external B&B module is directly powered from the main control panel's 24VDC power supply.

SOFTWARE:

Modifications to the PLC software at RTU903-1 include all the original I/O points along with new ones added to the system for the remote I/O panels. The new HMI screen is now integrated into the main PLC to control the Bioreactor Process requiring an operator passcode to make changes.

Software modifications to SCADA's RTU38 Wireless Hub operations allow additional read/write operations to and from RTU903-1 control system.

New screens are now active on SCADA displaying the original points along with new points added to the Bioreactor Process.

System Controls & Instrumentation, Ltd

11218 IH-10 E.
Converse, TX 78109
Phone: 210-661-9901
Fax: 210-666-5575

1108 Quail Hollow
Laredo, TX 78045
Phone: 956-725-1239
Fax: 956-726-1774

TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-1

Table of Contents

SCI FILE 3079

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System Controls & Instrumentation, Ltd

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Fax: 210-666-5575	**Fax: 956-726-1774**

TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-1

BILL OF MATERIAL

SCI FILE 3079

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BILL OF MATERIAL

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-1	1	ENCLOSURE, 36"HX60"WX12"D, NEMA12	A366012WFLP	HOFFMAN
0002	RTU903-1	1	BACK PANEL, 36"HX60"W, STEEL	A60P36	HOFFMAN
0003	HMI1	1	HMI 6" COLOR TOUCH SCREEN, 24VDC, LAN PORT	IC754VSI06STD	GE FANUC
0005	FAN1	1	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), CUTOUT 124MM SQUARE	3322.117	RITTAL
0006	FAN2	1	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), CUTOUT 124MM SQUARE	3322.117	RITTAL
0007	VPORT1	1	FILTER UNIT, HOLDER ONLY, 124MM	SK3322-207	RITTAL
0008	VPORT2	1	FILTER UNIT, HOLDER ONLY, 124MM	SK3322-207	RITTAL
0009		4	REPLACEMENT FILTER PADS, FOR 5.8"SQ FANS	3322.700	RITTAL
0020	SP7	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0021	SP8	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0022	TRX1	1	DATA TRANSCEIVER, 173MHZ, RS232 INPUT, 13.8VDC	MDS 1710A	MOCROWAVE DATA SYSTEMS
0023	WR1	1	WIRELESS GATEWAY RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS/OUTPUTS, ETHERNET, RS485	WI-GTWY-9-ET1	WEIDMULLER
0030	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0031	SP1	1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	PU II 1	WEIDMULLER
0032		1	HOLDER, SURGE PROTECTION	PU II 1S	WEIDMULLER
0034		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0035		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0036		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0037		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0038		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0039		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0040		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0041	TST1	1	THERMOSTAT, DIN-RAIL MOUNT, 30-140F, HYSTERESIS +/-4F, 15A, 120VAC	SKT011419NO	HAMMOND
0042		1	OPTICAL ISOLATOR, RS-232 TO RS-422/485 CONVERTER	485LDRC9	B&B ELECTRONICS
0043	SP2	1	SURGE PROTECTION MODULE, 24VDC, IMAX:2KA, VMAX: 30V	DS210-24DC	CITEL
0044		1	HOLDER, SURGE PROTECTION	DS210-24DC	CITEL
0045	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3.6A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 10.0A, 250W	CP SNT 250W 24V 10A	WEIDMULLER
0046		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0047		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0048		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0049		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0050		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0051		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0052		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0053		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0054		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0060	LB1	1	UNMANAGED LAN BRIDGE, 5-PORT, 4W/ 10-35VDC, 6VA 10-24VAC, 32-140F, CLASS 1 DIV 2	IE-SW5-WAVE	WEIDMULLER
0061		1	POWER SUPPLY, 120/240VAC. 27VA, 50/60HZ, EXPANDED 3.3VDC	IC200PWR102E	GE FANUC
0062	CPU1	1	PLC CPU MODULE	CPUE05	GE FANUC
0063		1	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	IC200CHS002	GE FANUC
0064	MODULE 1	1	ANALOG MODULE, 4-CH, 12 BIT, VOLTAGE/CURRENT	IC200ALG230	GE FANUC
0065		1	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	IC200CHS002	GE FANUC
0066	MODULE 2	1	MIXED MODULE, 8-INPUT, 8-OUTPUT, 120VAC INPUT, RELAY OUTPUT	IC200MDD846	GE FANUC
0070		4	RELAY, 2PDT, COIL: 120VAC/ 9.2MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-AC120V	IDEC
0071		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0072		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0073		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0074		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0080		2	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PT 2X2-24DC-ST	PHOENIX
0081		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0082		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0090	DS1	1	DATA STATION PLUS, PROTOCOL CONVERTER, 24VDC@200MA, 1A MAX, W/ WEB SERVER & DATA LOGGER	DSPSX000	RED LION
0091		1	DATA STATION PLUS, RS-232/RS-485 ADD-ON MODULE	XCRS0000	RED LION
0092	SP5	1	SURGE PROTECTION MODULE, RS232/RS485, IMAX:20KA, VMAX: 8VDC, 1PAIR SHIELD	DLA-06D3	CITEL
0093		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-06D3	CITEL
0094	SP6	1	SURGE PROTECTION MODULE, RS232/RS485, IMAX:20KA, VMAX: 8VDC, 1PAIR SHIELD	DLA-06D3	CITEL
0095		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-06D3	CITEL
0100	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0101	REC2	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0110		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0111		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0112		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		7	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		12	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9009		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9010		40	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		10	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9013		34	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		5	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		17	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		47	END CLAMP, GRAY	E/UK	PHOENIX
9018		1	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	FBI 2-6	PHOENIX
9019		5	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9020		1	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

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System Controls & Instrumentation, Ltd

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TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-1

PRODUCT DATA
OPERATION MANUAL

SCI FILE 3079

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Type 12 Wall-Mount Enclosures

Continuous Hinge Two-Door with Handle, Type 12

Industry Standards

UL 508A Listed; Type 12; File No. E61997
cUL Listed per CSA C22.2 No. 94; Type 12; File No. E61997

NEMA/EEMAC Type 12
CSA, File No. 42186: Type 12
IEC 60529, IP55

Application

Ideal for larger wall-mount applications requiring ease of installation and access to full-width internal panel. Overlapping door design allows easy access in areas with minimal aisle space.

Specifications

- 14 gauge steel
- Seams continuously welded and ground smooth
- External wall-mounting brackets
- Formed external flange around all sides of enclosure door opening
- Gasketed overlapping doors eliminate need for center post
- 3-point latch mechanism operated by oil-tight key-locking handle
- Latch rod rollers for easy door closing
- Removable heavy gauge continuous hinge pin
- Data pocket is high-impact thermoplastic
- Collar studs provided for mounting optional panels
- Bonding provision on both doors

Finish

White inside with ANSI 61 gray outside finish

Accessories

See also Accessories.
Door Stop Kit
Compact Cooling Fans
Incandescent Light Package
Steel and Stainless Steel Window Kits

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

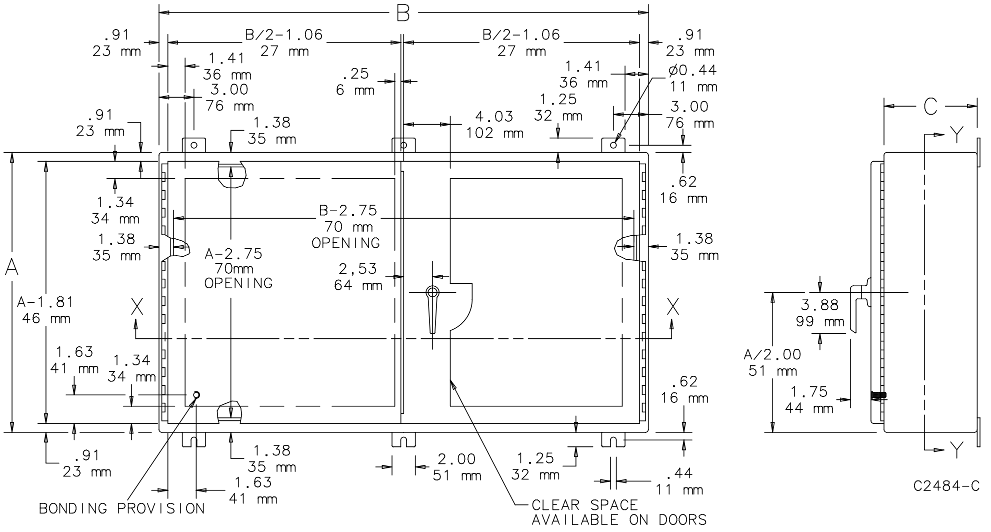
Bulletin: A12

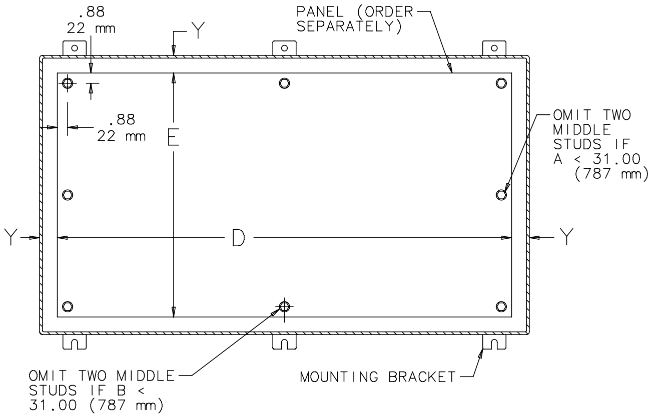
Standard Product

Catalog Number	AxBxC in./mm	Panel	Conductive Panel	Panel Gauge	Panel Size D x E in./mm	Y in./mm	Stiffener (Body)
A244208WFLP	24.00 x 42.00 x 8.00 610 x 1067 x 203	A42P24	A42P24G	12	39.00 x 21.00 991 x 533	1.50 38	0
A244808WFLP	24.00 x 48.00 x 8.00 610 x 1219 x 203	A48P24	A48P24G	12	45.00 x 21.00 1143 x 533	1.50 38	0
A304210WFLP	30.00 x 42.00 x 10.00 762 x 1067 x 254	A42P30	A42P30G	12	39.00 x 27.00 991 x 686	1.50 38	0
A304810WFLP	30.00 x 48.00 x 10.00 762 x 1219 x 254	A48P30	A48P30G	12	45.00 x 27.00 1143 x 686	1.50 38	0
A306010WFLP	30.00 x 60.00 x 10.00 762 x 1524 x 254	A60P30	A60P30G	12	57.00 x 27.00 1448 x 686	1.50 38	0
A364212WFLP	36.00 x 42.00 x 12.00 914 x 1067 x 305	A42P36	A42P36G	12	39.00 x 33.00 991 x 838	1.50 38	0
A364812WFLP	36.00 x 48.00 x 12.00 914 x 1219 x 305	A48P36	A48P36G	12	45.00 x 33.00 1143 x 838	1.50 38	0
A366012WFLP	36.00 x 60.00 x 12.00 914 x 1524 x 305	A60P36	A60P36G	12	57.00 x 33.00 1448 x 838	1.50 38	0
A424212WFLP	42.00 x 42.00 x 12.00 1067 x 1067 x 305	A42P42	A42P42G	12	39.00 x 39.00 991 x 991	1.50 38	3
A424812WFLP	42.00 x 48.00 x 12.00 1067 x 1219 x 305	A48P42	A48P42G	12	45.00 x 39.00 1143 x 991	1.50 38	3
A426012WFALP	42.00 x 60.00 x 12.00 1067 x 1524 x 305	A60BFP42	A60BFP42G	10	56.00 x 38.00 1422 x 965	2.00 51	1
A484812WFLP	48.00 x 48.00 x 12.00 1219 x 1219 x 305	A48P48	A48P48G	10	44.00 x 44.00 1118 x 1118	2.00 51	0

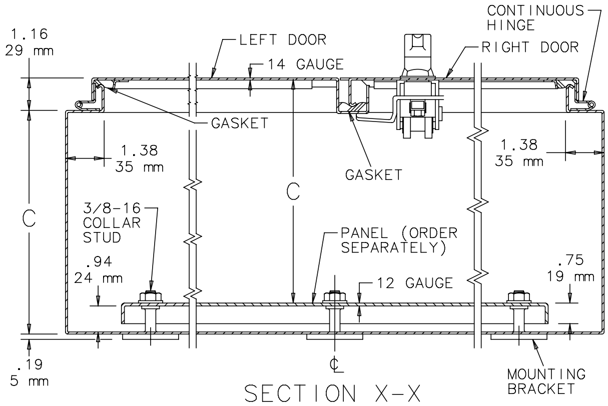
Purchase panels separately. Optional stainless steel, conductive, composite and aluminum panels are available for most sizes.
A484812WFLP back is 10 gauge.

Type 12 Wall-Mount Enclosures





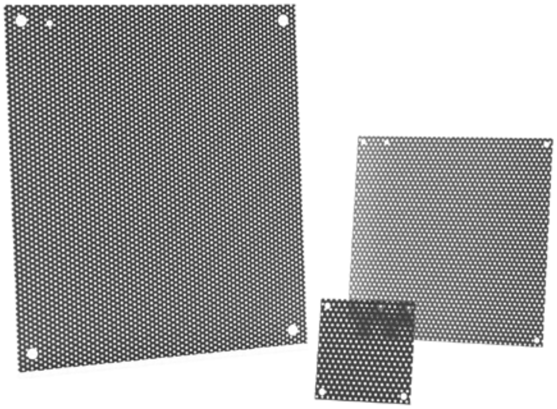
SECTION Y-Y



SECTION X-X

Panels for Enclosures

Perforated Panels



Perforated panels are 16 gauge steel and accept self-tapping screws and eliminate the need to measure, mark and drill when mounting components. Use for mounting lightweight control components.

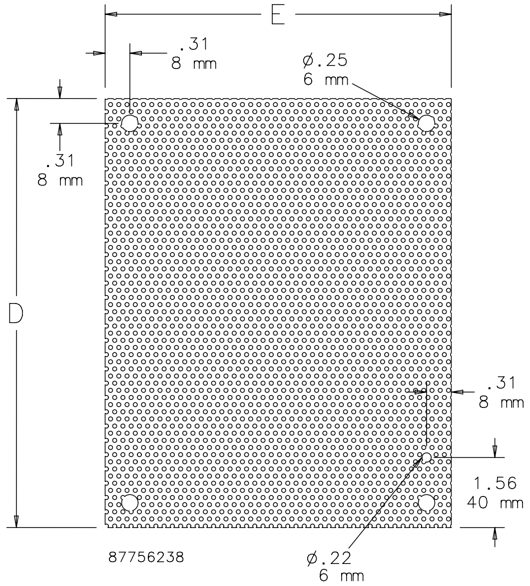
Bulletin: PNLP

Catalog Number	Use in	Panel Size D x E (in.)	Panel Size D x E (mm)
A6N6PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	4.25 x 4.25	108 x 108
A8N6PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	6.25 x 4.25	159 x 108
A8N8PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	6.25 x 6.25	159 x 159
A10N8PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	8.25 x 6.25	210 x 159
A10N10PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	8.25 x 8.25	210 x 210
A12N10PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	10.25 x 8.25	260 x 210
A12N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	10.25 x 10.25	260 x 260
A14N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	12.25 x 10.25	311 x 260
A16N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	14.25 x 10.25	362 x 260
A20N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	18.25 x 10.25	464 x 260
A16N12MPP	Medium Type 1 Panel Enclosures	10.50 x 13.00	267 x 330
A16N16MPP	Medium Type 1 Panel Enclosures	14.50 x 13.00	368 x 330
A16N20MPP	Medium Type 1 Panel Enclosures	18.50 x 13.00	470 x 330
A18N18MPP	Medium Type 1 Panel Enclosures	16.50 x 15.00	419 x 381
A20N12MPP	Medium Type 1 Panel Enclosures	10.50 x 17.00	267 x 432
A20N16MPP	Medium Type 1 Panel Enclosures	14.50 x 17.00	368 x 432
A20N20MPP	Medium Type 1 Panel Enclosures	18.50 x 17.00	470 x 432
A24N16MPP	Medium Type 1 Panel Enclosures	14.50 x 21.00	368 x 533
A24N20MPP	Medium Type 1 Panel Enclosures	18.50 x 21.00	470 x 533
A24N24MPP	Medium Type 1 Panel Enclosures	22.50 x 21.00	572 x 533
A30N20MPP	Medium Type 1 Panel Enclosures	18.50 x 26.00	470 x 660
A30N24MPP	Medium Type 1 Panel Enclosures	22.50 x 26.00	572 x 660
A30N30MPP	Medium Type 1 Panel Enclosures	28.50 x 26.00	724 x 660
A36N24MPP	Medium Type 1 Panel Enclosures	22.50 x 32.00	572 x 813
A36N30MPP	Medium Type 1 Panel Enclosures	26.50 x 32.00	724 x 813
A16P12PP	Medium Type 3R Hinged-Cover Panel Enclosures	13.00 x 9.00	330 x 229
A16P16PP	Medium Type 3R Hinged-Cover Panel Enclosures	13.00 x 13.00	330 x 330
A20P16PP	Medium Type 3R Hinged-Cover Panel Enclosures	17.00 x 13.00	432 x 330
A18P18PP	Medium Type 3R Hinged-Cover Panel Enclosures	15.00 x 15.00	381 x 381
A20P20PP	Medium Type 3R Hinged-Cover Panel Enclosures	17.00 x 17.00	432 x 732
A24P20PP	Medium Type 3R Hinged-Cover Panel Enclosures	21.00 x 17.00	533 x 432
A24P24PP	Medium Type 3R Hinged-Cover Panel Enclosures	21.00 x 21.00	533 x 533
A30P24PP	Medium Type 3R Hinged-Cover Panel Enclosures	27.00 x 21.00	686 x 533
A36P24PP	Medium Type 3R Hinged-Cover Panel Enclosures	33.00 x 21.00	838 x 533
A30P30PP	Medium Type 3R Hinged-Cover Panel Enclosures	27.00 x 27.00	686 x 686
A36P30PP	Medium Type 3R Hinged-Cover Panel Enclosures	33.00 x 27.00	838 x 686
A36P36PP	Medium Type 3R Hinged-Cover Panel Enclosures	33.00 x 33.00	838 x 838

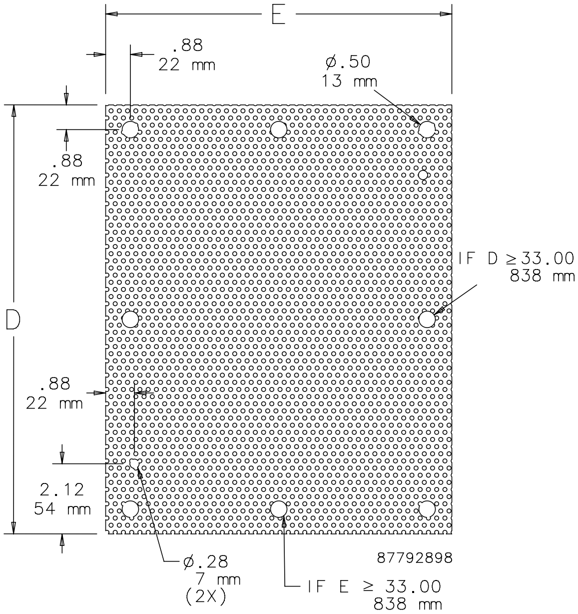
A24N24MPP, A30N20MPP, A30N24MPP, A36N24MPP, A30N30MPP and A36N30MPP are flanged on all four sides.
A24P24PP, A30P24PP, A30P30PP, A36P24PP, A36P30PP and A36P36PP are flanged on all four sides.

Panels for Enclosures

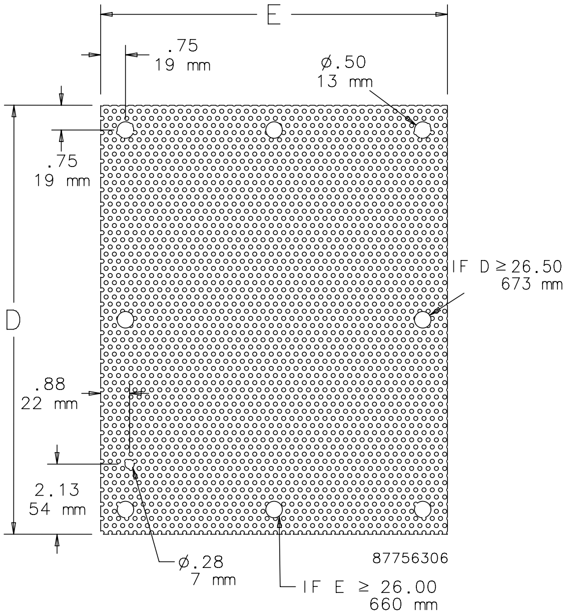
Small Perforated Panels



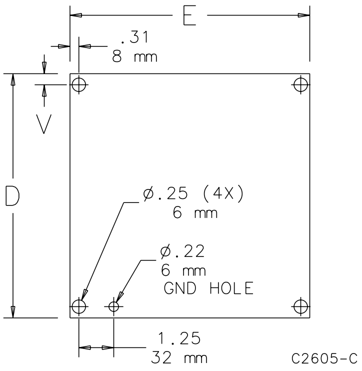
Medium Type 3R Hinged Cover Perforated Panels



Medium Type 1 Perforated Panels



Panels for Junction Boxes



Steel panels are 14 gauge, finished with white polyester powder paint or with a conductive, corrosion-resistant coating. Stainless steel panels are 14 gauge Type 304 and have a commercial #2B finish which is protected on one side with a plastic film. Aluminum panels are 5052-H32 aluminum alloy 0.080-in. (2-mm) thick and protected on one side with a plastic film. Panel mounting hardware is furnished with all enclosures which accept these panels.

Bulletin: PNLJ, PNLWM

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	V (in.)	V (mm)
A6P4	Painted steel	4.88 x 2.88	124 x 73	0.31	8
A6P4G	Conductive steel	4.88 x 2.88	124 x 73	0.31	8
A6P4SS	Stainless Steel	4.88 x 2.88	124 x 73	0.31	8
A6P4AL	Aluminum	4.88 x 2.88	124 x 73	0.31	8
A6P6	Painted steel	4.88 x 4.88	124 x 124	0.31	8
A6P6G	Conductive steel	4.88 x 4.88	124 x 124	0.31	8
A6P6SS	Stainless Steel	4.88 x 4.88	124 x 124	0.31	8
A6P6AL	Aluminum	4.88 x 4.88	124 x 124	0.31	8
A8P6	Painted steel	6.75 x 4.88	171 x 124	0.25	6
A8P6G	Conductive steel	6.75 x 4.88	171 x 124	0.25	6
A8P6SS	Stainless Steel	6.75 x 4.88	171 x 124	0.25	6
A8P6AL	Aluminum	6.75 x 4.88	171 x 124	0.25	6
A8P8	Painted steel	6.75 x 6.88	171 x 175	0.25	6
A8P8AL	Aluminum	6.75 x 6.88	171 x 175	0.25	6
A10P8	Painted steel	8.75 x 6.88	222 x 175	0.25	6
A10P8G	Conductive steel	8.75 x 6.88	222 x 175	0.25	6
A10P8SS	Stainless Steel	8.75 x 6.88	222 x 175	0.25	6
A10P8AL	Aluminum	8.75 x 6.88	222 x 175	0.25	6
A10P10	Painted steel	8.75 x 8.88	222 x 226	0.25	6
A10P10G	Conductive steel	8.75 x 8.88	222 x 226	0.25	6
A10P10AL	Aluminum	8.75 x 8.88	222 x 226	0.25	6
A12P6	Painted steel	10.75 x 4.88	273 x 124	0.25	6
A12P6G	Conductive steel	10.75 x 4.88	273 x 124	0.25	6
A12P10	Painted steel	10.75 x 8.88	273 x 226	0.25	6
A12P10G	Conductive steel	10.75 x 8.88	273 x 226	0.25	6
A12P10SS	Stainless Steel	10.75 x 8.88	273 x 226	0.25	6
A12P10AL	Aluminum	10.75 x 8.88	273 x 226	0.25	6
A12P12	Painted steel	10.75 x 10.88	273 x 276	0.25	6
A12P12G	Conductive steel	10.75 x 10.88	273 x 276	0.25	6
A12P12SS	Stainless Steel	10.75 x 10.88	273 x 276	0.25	6
A14P8	Painted steel	12.75 x 6.88	324 x 175	0.25	6
A14P8G	Conductive steel	12.75 x 6.88	324 x 175	0.25	6
A14P12	Painted steel	12.75 x 10.88	324 x 276	0.25	6
A14P12G	Conductive steel	12.75 x 10.88	324 x 276	0.25	6
A14P12SS	Stainless Steel	12.75 x 10.88	324 x 276	0.25	6
A14P12AL	Aluminum	12.75 x 10.88	324 x 276	0.25	6
A16P10	Painted steel	14.75 x 8.88	375 x 226	0.25	6
A16P10G	Conductive steel	14.75 x 8.88	375 x 226	0.25	6
A16P14	Painted steel	14.75 x 12.88	375 x 327	0.25	6
A16P14G	Conductive steel	14.75 x 12.88	375 x 327	0.25	6
A16P14SS	Stainless Steel	14.75 x 12.88	375 x 327	0.25	6
A16P14AL	Aluminum	14.75 x 12.88	375 x 327	0.25	6
A18P16	Painted steel	16.75 x 14.88	425 x 378	0.25	6
A18P16G	Conductive steel	16.75 x 14.88	425 x 378	0.25	6
A18P16SS	Stainless Steel	16.75 x 14.88	425 x 378	0.25	6
A18P16AL	Aluminum	16.75 x 14.88	425 x 378	0.25	6

Panels for Enclosures

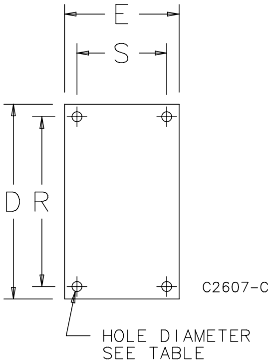
Composite Panels for Junction Boxes and UL/NEMA Wall-Mount Enclosures

Manufactured from light-brown, reinforced phenolic laminate sheet stock. This material has exceptional strength and chemical resistance, which makes it ideally suited for the most corrosive environments. Composite panels are intended for use in corrosion-resistant enclosures. Panel sizes are available for junction boxes and UL/NEMA size enclosures. Composite panels may be drilled and tapped but work equally as well with self-threading or thread-cutting screws. Refer to the table for recommended mounting specifications.

Bulletin: PNLC

Standard Product

Catalog Number	Panel Size D x E in./mm	R in./mm	S in./mm	Hole Dia. in./mm	Panel Thickness in./mm
A6P4C	4.88 x 2.88 124 x 73	4.25 108	2.25 57	0.25 6	0.12 3
A6P6C	4.88 x 4.88 124 x 124	4.25 108	4.25 108	0.25 6	0.12 3
A8P6C	6.75 x 4.88 171 x 124	6.25 159	4.25 108	0.25 6	0.12 3
A10P8C	8.75 x 6.88 222 x 175	8.25 210	6.25 159	0.25 6	0.12 3
A12P10C	10.75 x 8.88 273 x 226	10.25 260	8.25 210	0.25 6	0.19 5
A14P12C	12.75 x 10.88 324 x 276	12.25 311	10.25 260	0.25 6	0.19 5
A16P14C	14.75 x 12.88 375 x 327	14.25 362	12.25 311	0.25 6	0.19 5
A18P16C	16.75 x 14.88 425 x 379	16.25 413	14.25 362	0.25 6	0.19 5
A20P16C	17.00 x 13.00 432 x 330	15.25 387	11.25 286	0.50 13	0.19 5
A20P20C	17.00 x 17.00 432 x 432	15.25 387	15.25 387	0.50 13	0.19 5
A24P20C	21.00 x 17.00 533 x 432	19.25 489	15.25 387	0.50 13	0.19 5
A24P24C	21.00 x 21.00 533 x 533	19.25 489	19.25 489	0.50 13	0.19 5
A30P24C	27.00 x 21.00 686 x 533	25.25 641	19.25 489	0.50 13	0.19 5



Composite Panel Mounting Recommendations

Screw Type	Screw Size	Hole Size in./mm	Max. Insertion Torque (lb.) in 0.12 in. Material	Max. Insertion Torque (lb.) in 0.19 in. Material	Max. Load (lb. per screw) in 0.12 in. Material	Max. Load (lb. per screw) in 0.19 in. Material
Machine (tapped hole)	8-32	.136 3	15	25	40	45
Machine (tapped hole)	10-32	.161 4	15	25	35	40
Machine (tapped hole)	1/4-20	.204 5	20	25	30	35
Thread Cutting Type T	8-32	.144 4	15	25	40	45
Thread Cutting Type T	10-32	.166 4	15	25	35	40
Thread Cutting Type T	1/4-20	.288 7	20	25	30	35
Sheet Metal A-B	8-32	.147 4	Not recommended	10	40	45
Sheet Metal A-B	10-32	.166 4	Not recommended	10	35	40
Sheet Metal A-B	1/4-20	.221 6	Not recommended	15	30	35

Junction Box and Wall-Mount Enclosure Swing-Out Panel Kit

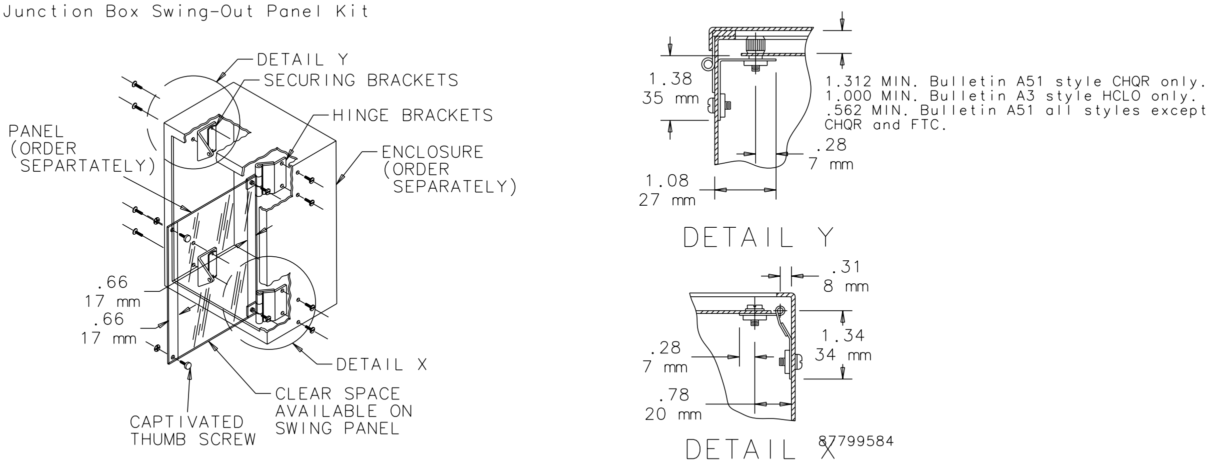
Kits allow mounting standard Hoffman junction box and NEMA style panels (purchase separately) near the front of the enclosure for easy access to or reading of gauges, switches, pilot lights and other components. Kits consist of heavy-gauge brackets and hinges which are easily installed by drilling small holes in the sides of the enclosure and bolting the brackets in place. External screws are stainless steel; internal components are plated steel. All mounting hardware and instructions are provided. Sealing washers ensure the enclosure will meet original JIC or NEMA standards after installation.
Swing-Out Panel Kits do not fit single-door disconnect enclosures.

Bulletin: A80

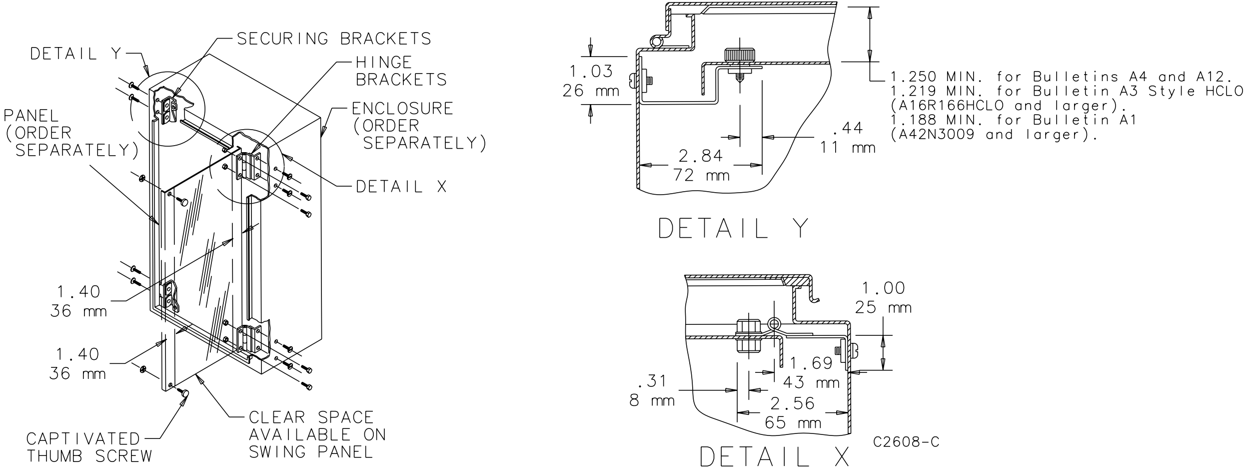
Catalog Number	Description	Maximum Load (lb.)	Maximum Load (kg)	Use In
AJCDFK	Junction Box Kit	25	11.3	- Junction boxes where A x B is 8.00 x 6.00 in. (203 x 152 mm) or larger - HCLO Type 3R enclosures where A x B is 16.00 x 12.00 in. (406 x 305 mm) or smaller
ANADFK	Wall-Mount Enclosure Kit	100	45.4	- One-door Type 4, 12 and 13 enclosures where A x B is 12.00 x 12.00 in. (305 x 305 mm) or larger - HCLO Type 3R enclosures where A x B is 16.00 x 16.00 in. (406 x 406 mm) or larger - HCR Type 3R enclosures where A x B is 16.00 x 12.00 (406 x 305 mm) or larger - Type 1 enclosures where A x B is 42.00 x 30.00 in. (1067 x 762 mm) or larger

Both kits maintain UL Type 4 rating when properly installed in a Hoffman enclosure.
Maximum load includes the weight of the panel plus the weight of the components, with the weight of the components spread evenly over the panel.

Junction Box Swing-Out Panel Kit



Wall-Mount Enclosure Swing-Out Panel Kit

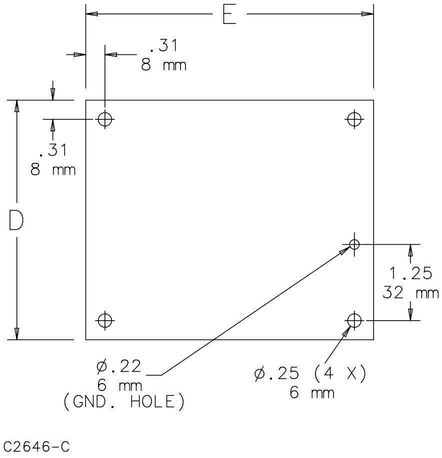


Panels for Type 1 Enclosures and Small Type 3R Enclosures

Steel panels are 14 gauge, finished with white polyester powder paint. Panel mounting hardware is furnished with enclosure.

Bulletin: PNLT1

Catalog Number	Panel Size D x E (in.)	Panel Size D x E (mm)
A6N4P	4.25 x 2.25	108 x 57
A6N6P	4.25 x 4.25	108 x 108
A8N6P	6.25 x 4.25	159 x 108
A8N8P	6.25 x 6.25	159 x 159
A10N8P	8.25 x 6.25	210 x 159
A10N10P	8.25 x 8.25	210 x 210
A12N10P	10.25 x 8.25	260 x 210
A12N12P	10.25 x 10.25	260 x 260
A14N12P	12.25 x 10.25	311 x 260
A16N12P	14.25 x 10.25	362 x 260
A20N12P	18.25 x 10.25	464 x 260

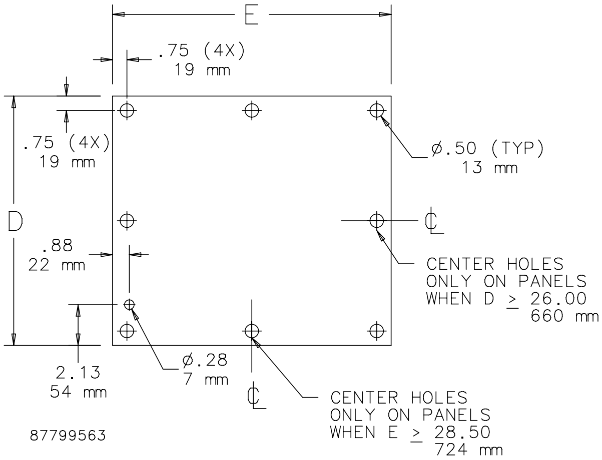


Panels for Medium Type 1 Enclosures

Steel panels are 14 or 12 gauge with a white polyester powder paint finish. Panel mounting hardware is furnished with enclosure.

Bulletin: PNLT1

Catalog Number	Panel Thickness (ga.)	Panel Size D x E (in.)	Panel Size D x E (mm)
A16N12MP	14	13.00 x 10.50	330 x 267
A20N12MP	14	17.00 x 10.50	432 x 267
A16N16MP	14	13.00 x 14.50	330 x 368
A20N16MP	14	17.00 x 14.50	432 x 368
A24N16MP	14	21.00 x 14.50	533 x 368
A18N18MP	14	15.00 x 16.50	381 x 419
A16N20MP	14	13.00 x 18.50	330 x 470
A20N20MP	14	17.00 x 18.50	432 x 470
A24N20MP	14	21.00 x 18.50	533 x 470
A30N20MP	14	26.00 x 18.50	660 x 470
A24N24MP	12	21.00 x 22.50	533 x 571
A30N24MP	12	26.00 x 22.50	660 x 571
A36N24MP	12	32.00 x 22.50	813 x 571
A30N30MP	12	26.00 x 28.50	660 x 724
A36N30MP	12	32.00 x 28.50	813 x 724



Panels for Enclosures

Panels for Type 3R, 4, 4X, 12 and 13 Enclosures

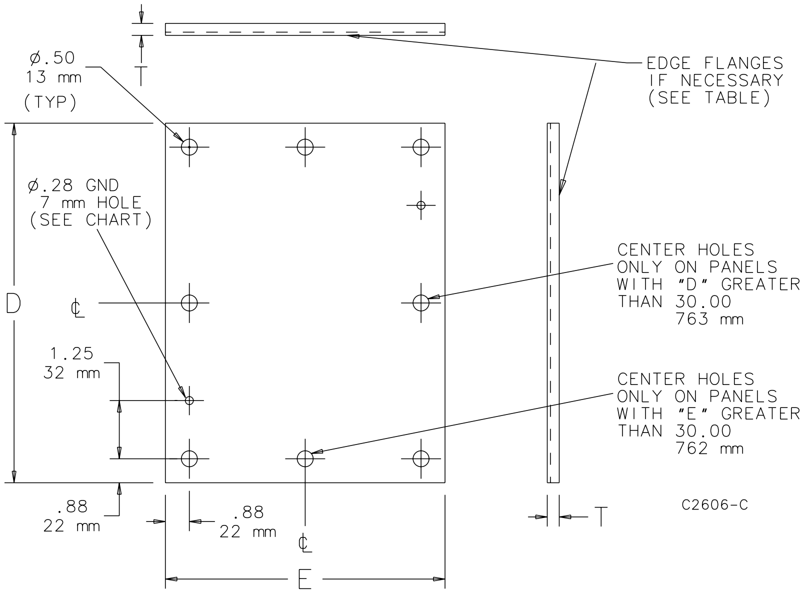
Steel panels are 12 gauge, finished with white polyester powder paint or a conductive, corrosion-resistant coating. Larger panels have flanges on two or four sides. Some larger steel panels are 10 gauge and include extra holes for panel lifting. Aluminum panels are 5052-H32 aluminum alloy. Larger panels have flanges on four sides. Aluminum panels are protected on one side with a plastic film. Stainless steel panels are Type 316 stainless steel. Panel mounting hardware is furnished with all enclosures which accept these panels.

Bulletin: PNLFS, PNLJ, PNLWM

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	Panel Gauge or Thickness	Edge Flanges	T (in.)	T (mm)	Number of Holes
A12P24	Painted steel	9.00 x 21.00	229 x 533	12 ga.	None	—	—	4
A12P24G	Conductive steel	9.00 x 21.00	229 x 533	12 ga.	None	—	—	4
A16P12	Painted steel	13.00 x 9.00	330 x 229	12 ga.	None	—	—	4
A16P12G	Conductive steel	13.00 x 9.00	330 x 229	12 ga.	None	—	—	4
A16P12SS6	Stainless Steel	13.00 x 9.00	330 x 229	12 ga.	None	—	—	4
A16P12AL	Aluminum	13.00 x 9.00	330 x 229	0.10 in./3 mm	None	—	—	4
A16P16	Painted steel	13.00 x 13.00	330 x 330	12 ga.	None	—	—	4
A16P16G	Conductive steel	13.00 x 13.00	330 x 330	12 ga.	None	—	—	4
A16P16SS6	Stainless Steel	13.00 x 13.00	330 x 330	12 ga.	None	—	—	4
A16P16AL	Aluminum	13.00 x 13.00	330 x 330	0.10 in./3 mm	None	—	—	4
A18P18	Painted steel	15.00 x 15.00	381 x 381	12 ga.	None	—	—	4
A18P18G	Conductive steel	15.00 x 15.00	381 x 381	12 ga.	None	—	—	4
A20P12	Painted steel	17.00 x 9.00	432 x 229	12 ga.	None	—	—	4
A20P12G	Conductive steel	17.00 x 9.00	432 x 229	12 ga.	None	—	—	4
A20P16	Painted steel	17.00 x 13.00	432 x 330	12 ga.	None	—	—	4
A20P16G	Conductive steel	17.00 x 13.00	432 x 330	12 ga.	None	—	—	4
A20P16SS6	Stainless Steel	17.00 x 13.00	432 x 330	12 ga.	None	—	—	4
A20P16AL	Aluminum	17.00 x 13.00	432 x 330	0.10 in./3 mm	None	—	—	4
A20P20	Painted steel	17.00 x 17.00	432 x 432	12 ga.	None	—	—	4
A20P20G	Conductive steel	17.00 x 17.00	432 x 432	12 ga.	None	—	—	4
A20P20SS6	Stainless steel	17.00 x 17.00	432 x 432	12 ga.	None	—	—	4
A20P20AL	Aluminum	17.00 x 17.00	432 x 432	0.10 in./3 mm	None	—	—	4
A24P16	Painted steel	21.00 x 13.00	533 x 330	12 ga.	None	—	—	4
A24P16G	Conductive steel	21.00 x 13.00	533 x 330	12 ga.	None	—	—	4
A24P16SS6	Stainless Steel	21.00 x 13.00	533 x 330	12 ga.	None	—	—	4
A24P20	Painted steel	21.00 x 17.00	533 x 432	12 ga.	2	0.75	19	4
A24P20G	Conductive steel	21.00 x 17.00	533 x 432	12 ga.	2	0.75	19	4
A24P20SS6	Stainless Steel	21.00 x 17.00	533 x 432	12 ga.	2	0.75	19	4
A24P20AL	Aluminum	21.00 x 17.00	533 x 432	0.10 in./3 mm	4	0.75	19	4
A24P24	Painted steel	21.00 x 21.00	533 x 533	12 ga.	2	0.75	19	4
A24P24G	Conductive steel	21.00 x 21.00	533 x 533	12 ga.	2	0.75	19	4
A24P24SS6	Stainless Steel	21.00 x 21.00	533 x 533	12 ga.	2	0.75	19	4
A24P24AL	Aluminum	21.00 x 21.00	533 x 533	0.10 in./3 mm	2	0.75	19	4
A30P16	Painted steel	27.00 x 13.00	686 x 330	12 ga.	2	0.75	19	4
A30P16G	Conductive steel	33.00 x 27.00	838 x 686	12 ga.	2	0.75	19	4
A30P20	Painted steel	27.00 x 17.00	686 x 432	12 ga.	2	0.75	19	4
A30P20G	Conductive steel	27.00 x 17.00	686 x 432	12 ga.	2	0.75	19	4
A30P20SS6	Stainless Steel	27.00 x 17.00	686 x 432	12 ga.	2	0.75	19	4
A30P24	Painted steel	27.00 x 21.00	686 x 533	12 ga.	2	0.75	19	4
A30P24G	Conductive steel	27.00 x 21.00	686 x 533	12 ga.	2	0.75	19	4
A30P24SS6	Stainless Steel	27.00 x 21.00	686 x 533	12 ga.	2	0.75	19	4
A30P24AL	Aluminum	27.00 x 21.00	686 x 533	0.10 in./3 mm	2	0.75	19	4
A30P30	Painted steel	27.00 x 27.00	686 x 686	12 ga.	4	0.75	19	4
A30P30G	Conductive steel	27.00 x 27.00	686 x 686	12 ga.	4	0.75	19	4
A30P30SS6	Stainless Steel	27.00 x 27.00	686 x 686	12 ga.	4	0.75	19	4
A36P16	Painted steel	33.00 X 13.00	838 X 330	12 ga.	2	0.75	19	4
A36P16G	Conductive steel	33.00 x 13.00	838 x 330	12 ga.	2	0.75	19	4
A36P24	Painted steel	33.00 x 21.00	838 x 533	12 ga.	2	0.75	19	6
A36P24G	Conductive steel	33.00 x 21.00	838 x 533	12 ga.	2	0.75	19	6
A36P24SS6	Stainless Steel	33.00 x 21.00	838 x 533	12 ga.	2	0.75	19	6
A36P24AL	Aluminum	33.00 x 21.00	838 x 533	0.10 in./3 mm	2	0.75	19	6
A36P30	Painted steel	33.00 x 27.00	838 x 686	12 ga.	4	0.75	19	6
A36P30G	Conductive steel	33.00 x 27.00	838 x 686	12 ga.	4	0.75	19	6
A36P30SS6	Stainless Steel	33.00 x 27.00	838 x 686	12 ga.	4	0.75	19	6
A36P30AL	Aluminum	33.00 x 27.00	838 x 686	0.10 in./3 mm	4	0.75	19	6
A36P36	Painted steel	33.00 x 33.00	838 x 838	12 ga.	4	0.75	19	8
A36P36G	Conductive steel	33.00 x 33.00	838 x 838	12 ga.	4	0.75	19	8
A36P36SS6	Stainless Steel	33.00 x 33.00	838 x 838	12 ga.	4	0.75	19	8
A40P24	Painted steel	37.00 x 21.00	940 x 533	12 ga.	4	0.75	19	6
A40P24G	Conductive steel	37.00 x 21.00	940 x 533	12 ga.	4	0.75	19	6
A40P30	Painted steel	37.00 x 29.00	940 x 737	12 ga.	4	0.75	19	4 (no D dim. center hole)
A40P30G	Conductive steel	37.00 x 29.00	940 x 737	12 ga.	4	0.75	19	4 (no D dim. center hole)
A42P24	Painted steel	39.00 x 21.00	991 x 533	12 ga.	2	0.75	19	6
A42P24G	Conductive steel	39.00 x 21.00	991 x 533	12 ga.	2	0.75	19	6
A42P30	Painted steel	39.00 x 27.00	991 x 686	12 ga.	4	0.75	19	6
A42P30G	Conductive steel	39.00 x 27.00	991 x 686	12 ga.	4	0.75	19	6
A42P30SS6	Stainless Steel	39.00 x 27.00	991 x 686	12 ga.	4	0.75	19	6
A42P36	Painted steel	39.00 x 33.00	991 x 838	12 ga.	4	0.75	19	8
A42P36G	Conductive steel	39.00 x 33.00	991 x 838	12 ga.	4	0.75	19	8
A42P36SS6	Stainless Steel	39.00 x 33.00	991 x 838	12 ga.	4	0.75	19	8
A42P42	Painted steel	39.00 x 39.00	991 x 991	12 ga.	4	0.75	19	8

Panels for Enclosures

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	Panel Gauge or Thickness	Edge Flanges	T (in.)	T (mm)	Number of Holes
A42P42G	Conductive steel	39.00 x 39.00	991 x 991	12 ga.	4	0.75	19	8
A48P24	Painted steel	45.00 x 21.00	1143 x 533	12 ga.	2	0.75	19	6
A48P24G	Conductive steel	45.00 x 21.00	1143 x 533	12 ga.	2	0.75	19	6
A48P30	Painted steel	45.00 x 27.00	1143 x 686	12 ga.	4	0.75	19	6
A48P30G	Conductive steel	45.00 x 27.00	1143 x 686	12 ga.	4	0.75	19	6
A48P36	Painted steel	45.00 x 33.00	1143 x 838	12 ga.	4	0.75	19	8
A48P36G	Conductive steel	45.00 x 33.00	1143 x 838	12 ga.	4	0.75	19	8
A48P36SS6	Stainless Steel	45.00 x 33.00	1143 x 838	12 ga.	4	0.75	19	8
A48P36AL	Aluminum	45.00 x 33.00	1143 x 838	0.10 in./3 mm	4	0.75	19	8
A48P42	Painted steel	45.00 x 39.00	1143 x 991	12 ga.	4	0.75	19	8
A48P42G	Conductive steel	45.00 x 39.00	1143 x 991	12 ga.	4	0.75	19	8
A48P48	Painted steel	44.00 x 44.00	1118 x 1118	10 ga.	4	0.88	22	8
A48P48G	Conductive steel	44.00 x 44.00	1118 x 1118	10 ga.	4	0.88	22	8
A54P42	Painted steel	50.00 x 38.00	1270 x 965	12 ga.	4	0.75	19	8
A54P42G	Conductive steel	50.00 x 38.00	1270 x 965	10 ga.	4	0.75	19	8
A60P24	Painted steel	57.00 x 21.00	1448 x 533	12 ga.	4	0.75	19	6
A60P24G	Conductive steel	57.00 x 21.00	1448 x 533	12 ga.	4	0.75	19	6
A60P30	Painted steel	57.00 x 27.00	1448 x 686	12 ga.	4	0.75	19	6
A60P30G	Conductive steel	57.00 x 27.00	1448 x 686	12 ga.	4	0.75	19	6
A60P36	Painted steel	57.00 x 33.00	1448 x 838	12 ga.	4	0.75	19	8
A60P36G	Conductive steel	57.00 x 33.00	1448 x 838	12 ga.	4	0.75	19	8
A60P36SS6	Stainless Steel	57.00 x 33.00	1448 x 838	12 ga.	4	0.75	19	8
A60P36AL	Aluminum	57.00 x 33.00	1448 x 838	0.10 in./3 mm	4	0.75	19	8
A60BFP42	Painted steel	56.00 x 38.00	1422 x 965	10 ga.	4	0.88	22	10
A60BFP42G	Conductive steel	56.00 x 38.00	1422 x 965	10 ga.	4	0.88	22	10
A60P48	Painted steel	56.00 x 44.00	1422 x 1118	10 ga.	4	0.88	22	12
A60P48G	Conductive steel	56.00 x 44.00	1422 x 1118	10 ga.	4	0.88	22	12
A60P60	Painted steel	56.00 x 56.00	1422 x 1422	10 ga.	4	0.88	22	10
A60P60G	Conductive steel	56.00 x 56.00	1422 x 1422	10 ga.	4	0.88	22	10
A72P36	Painted steel	69.00 x 33.00	1753 x 838	12 ga.	4	0.75	19	8
A72P36G	Conductive steel	69.00 x 33.00	1753 x 838	12 ga.	4	0.75	19	8
A72P60	Painted steel	68.00 x 56.00	1727 x 1422	10 ga.	4	0.88	22	12
A72P60G	Conductive steel	68.00 x 56.00	1727 x 1422	10 ga.	4	0.88	22	12
A72P72	Painted steel	68.00 x 68.00	1727 x 1727	10 ga.	4	0.88	22	10
A72P72G	Conductive steel	68.00 x 68.00	1727 x 1727	10 ga.	4	0.88	22	10



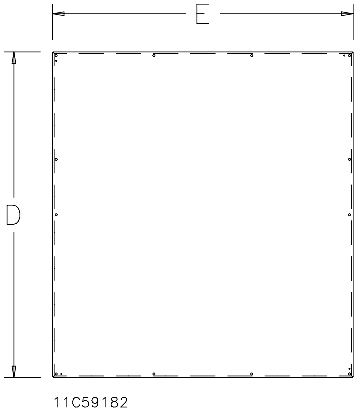
Panels for Enclosures

Panels for Large Bulletin A27, A28, A28S4 and A34 Multi-Door Enclosures

Extra panels for large enclosures (Bulletins A27, A28, A28S4 and A34) can be ordered for panel assembly prior to receiving the enclosures (enclosures include panels). Panels are 12 gauge steel with .88-in. (22-mm) flanges on four sides. Finish is white polyester powder paint or a conductive, corrosion-resistant coating. Two extra holes are provided for lifting and installing panels. Mounting hardware included with enclosure.

Bulletin: PNLFS

Catalog Number	Finish	Panel Size D x E (in.)	Panel Size D x E (mm)	Number of Holes	Fits Enclosure Height
A72PM28	Painted steel	60.00 x 21.75	1524 x 552	8	72 in.
A72PM28G	Conductive	60.00 x 21.75	1524 x 552	8	72 in.
A72PM34	Painted steel	60.00 x 27.75	1524 x 705	8	72 in.
A72PM34G	Conductive	60.00 x 27.75	1524 x 705	8	72 in.
A72PM40	Painted steel	60.00 x 33.75	1524 x 857	8	72 in.
A72PM40G	Conductive	60.00 x 33.75	1829 x 857	8	72 in.
A72PM54	Painted steel	60.00 x 48.00	1524 x 1219	10	72 in.
A72PM54G	Conductive	60.00 x 48.00	1524 x 1219	10	72 in.
A72PM66	Painted steel	60.00 x 60.00	1524 x 1524	10	72 in.
A72PM66G	Conductive	60.00 x 60.00	1524 x 1524	10	72 in.
A72PM78	Painted steel	60.00 x 72.00	1524 x 1829	12	72 in.
A72PM78G	Conductive	60.00 x 72.00	1524 x 1829	12	72 in.
A84PM40	Painted steel	72.00 x 33.75	1829 x 857	8	84 in.
A84PM40G	Conductive	72.00 x 33.75	1829 x 857	8	84 in.
A84PM78	Painted steel	72.00 x 72.00	1829 x 1829	12	84 in.
A84PM78G	Conductive	72.00 x 72.00	1829 x 1829	12	84 in.
A86PM37	Painted steel	78.00 x 34.00	1981 x 864	8	86 in.
A86PM37G	Conductive	78.00 x 34.00	1981 x 864	8	86 in.
A86PM75	Painted steel	78.00 x 70.00	1981 x 1778	12	86 in.
A86PM75G	Conductive	78.00 x 70.00	1981 x 1778	12	86 in.
A90PM40	Painted steel	78.00 x 33.75	1981 x 857	8	90 in.
A90PM40G	Conductive	78.00 x 33.75	1981 x 857	8	90 in.
A90PM78	Painted steel	78.00 x 72.00	1981 x 1829	12	90 in.
A90PM78G	Conductive	78.00 x 72.00	1981 x 1829	12	90 in.



Panels for Enclosures

Panels for Free-Stand Type 1 Large One-Door Enclosures

Panels for free-stand Type 1 large one-door standard and disconnect enclosures are 12 gauge steel. Panels have either polyester powder paint finish or a conductive, corrosion-resistant coating.

Bulletin: A38P

Catalog Number	Finish	Panel Size D x E (in.)	Panel Size D x E (mm)
A37P21N	Painted steel	37.16 x 21.50	944 x 546
A37P21NG	Conductive	37.16 x 21.50	944 x 546
A49P21N	Painted steel	49.16 x 21.50	1249 x 546
A49P21NG	Conductive	49.16 x 21.50	1249 x 546
A61P21N	Painted steel	61.16 x 21.50	1553 x 546
A73P21N	Painted steel	73.16 x 21.50	1858 x 546
A73P21NG	Conductive	73.16 x 21.50	1858 x 546
A49P32N	Painted steel	49.16 x 32.00	1249 x 813
A49P32NG	Conductive	49.16 x 32.00	1249 x 813
A61P32N	Painted steel	61.16 x 32.00	1553 x 813
A61P32NG	Conductive	61.16 x 32.00	1553 x 813
A73P32N	Painted steel	73.16 x 32.00	1858 x 813
A73P32NG	Conductive	73.16 x 32.00	1858 x 813

Panels for Free-Stand Type 1 Large Two-Door Enclosures

Panels for free-stand Type 1 large two-door standard and disconnect enclosures are 10 gauge steel. Panels have either polyester powder paint finish or a conductive, corrosion-resistant coating.

Bulletin: A38P

Catalog Number	Finish	Panel Size D x E (in.)	Panel Size D x E (mm)
A37P48N	Painted steel	37.16 x 48.00	944 x 1219
A37P48NG	Conductive	37.16 x 48.00	944 x 1219
A49P48N	Painted steel	49.16 x 48.00	1249 x 1219
A49P48NG	Conductive	49.16 x 48.00	1249 x 1219
A49P68N	Painted steel	49.16 x 68.00	1249 x 1727
A49P68NG	Conductive	49.16 x 68.00	1249 x 1727
A61P68N	Painted steel	61.16 x 68.00	1553 x 1727
A61P68NG	Conductive	61.16 x 68.00	1553 x 1727
A73P68N	Painted steel	73.16 x 68.00	1858 x 1727
A73P68NG	Conductive	73.16 x 68.00	1858 x 1727

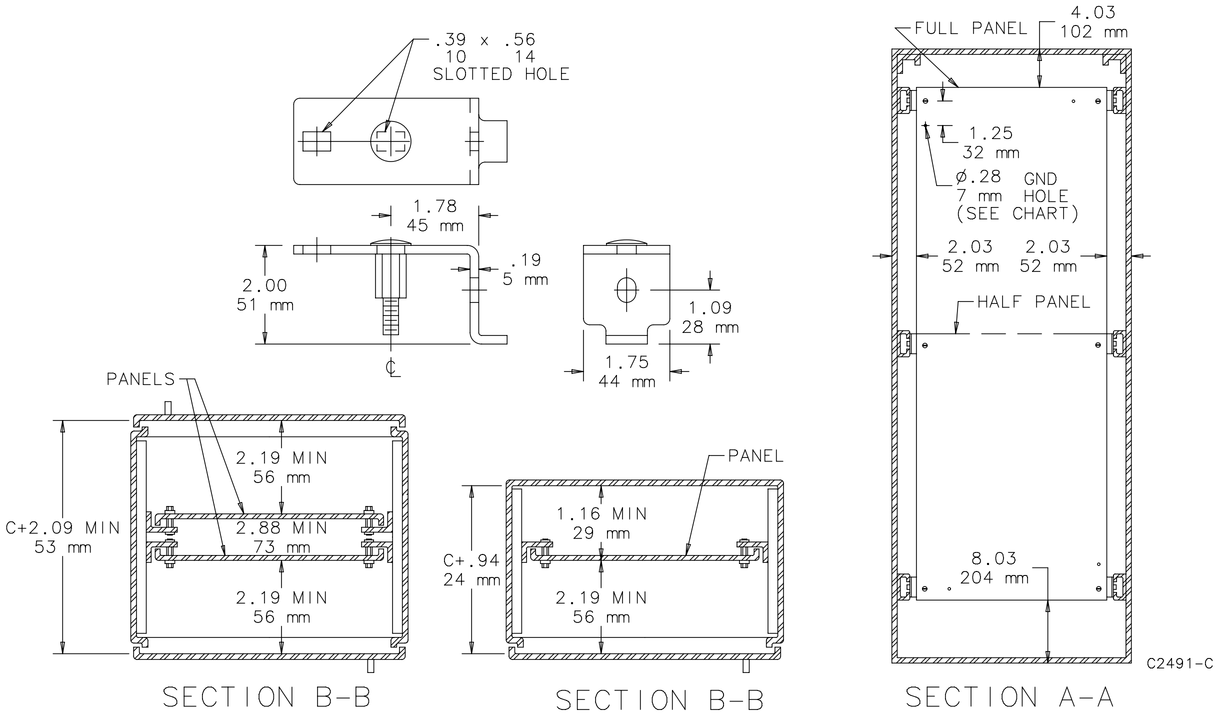
Panels for Free-Stand Type 4, 4X and 12 Single- and Dual-Access One-Door Enclosures with Mounting Channel

Panels for one-door, single-access and one-door, dual-access Free-Stand Type 12 Enclosures, Free-Stand Type 4 Enclosures and One-Door Type 4X Free-Stand Fiberglass Enclosures. Panels are 12 gauge steel and can be positioned anywhere along horizontal mounting channels (see dimension drawing Sections B-B for limitations). Half-length panels can be located in the upper or lower portion of the enclosure. Panels are finished with white polyester powder paint or a conductive, corrosion-resistant coating and furnished with plated mounting hardware.

Bulletin: PNL30

Catalog Number	Description	Finish	Panel Size (in.)	Panel Size (mm)	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)
A60P24F1	Full Panel	Painted steel	48.00 x 20.00	1218 x 508	60.00 x 24.00	1524 x 610
A60P24F1G	Full Panel	Conductive	48.00 x 20.00	1218 x 508	60.00 x 24.00	1524 x 610
A60P24F2	Half Panel	Painted steel	24.88 x 20.00	632 x 508	60.00 x 24.00	1524 x 610
A60P24F2G	Half Panel	Conductive	24.88 x 20.00	632 x 508	60.00 x 24.00	1524 x 610
A72P24F1	Full Panel	Painted steel	60.00 x 20.00	1524 x 508	72.00 x 24.00	1829 x 610
A72P24F1G	Full Panel	Conductive	60.00 x 20.00	1524 x 508	72.00 x 24.00	1829 x 610
A72P24F2	Half Panel	Painted steel	30.88 x 20.00	784 x 508	72.00 x 24.00	1829 x 610
A72P24F2G	Half Panel	Conductive	30.88 x 20.00	784 x 508	72.00 x 24.00	1829 x 610
A90P24F1	Full Panel	Painted steel	78.00 x 20.00	1981 x 508	90.00 x 24.00	2286 x 610
A90P24F1G	Full Panel	Conductive	78.00 x 20.00	1981 x 508	90.00 x 24.00	2286 x 610
A90P24F2	Half Panel	Painted steel	39.88 x 20.00	1013 x 508	90.00 x 24.00	2286 x 610
A90P24F2G	Half Panel	Conductive	39.88 x 20.00	1013 x 508	90.00 x 24.00	2286 x 610
A72P30F1	Full Panel	Painted steel	60.00 x 26.00	1524 x 660	72.00 x 30.00	1829 x 762
A72P30F1G	Full Panel	Conductive	60.00 x 26.00	1524 x 660	72.00 x 30.00	1829 x 762
A72P30F2	Half Panel	Painted steel	30.88 x 26.00	784 x 660	72.00 x 30.00	1829 x 762
A72P30F2G	Half Panel	Conductive	30.88 x 26.00	784 x 660	72.00 x 30.00	1829 x 762
A60P36F1	Full Panel	Painted steel	48.00 x 32.00	1219 x 813	60.00 x 36.00	1524 x 914
A60P36F1G	Full Panel	Conductive	48.00 x 32.00	1219 x 813	60.00 x 36.00	1524 x 914
A60P36F2	Half Panel	Painted steel	24.88 x 32.00	632 x 813	60.00 x 36.00	1524 x 914
A60P36F2G	Half Panel	Conductive	24.88 x 32.00	632 x 813	60.00 x 36.00	1524 x 914
A72P36F1	Full Panel	Painted steel	60.00 x 32.00	1524 x 813	72.00 x 36.00	1829 x 914
A72P36F1G	Full Panel	Conductive	60.00 x 32.00	1524 x 813	72.00 x 36.00	1829 x 914
A72P36F2	Half Panel	Painted steel	30.88 x 32.00	784 x 813	72.00 x 36.00	1829 x 914
A72P36F2G	Half Panel	Conductive	30.88 x 32.00	784 x 813	72.00 x 36.00	1829 x 914
A90P36F1	Full Panel	Painted steel	78.00 x 32.00	1981 x 813	90.00 x 36.00	2286 x 914
A90P36F1G	Full Panel	Conductive	78.00 x 32.00	1981 x 813	90.00 x 36.00	2286 x 914
A90P36F2	Half Panel	Painted steel	39.88 x 32.00	1013 x 813	90.00 x 36.00	2286 x 914
A90P36F2G	Half Panel	Conductive	39.88 x 32.00	1013 x 813	90.00 x 36.00	2286 x 914

Use combinations of panels for 3-5 door A 28 enclosures.



Panels for Free-Standing Type 4, 4X and 12 Single- and Dual-Access Two-Door Enclosures with Mounting Channel

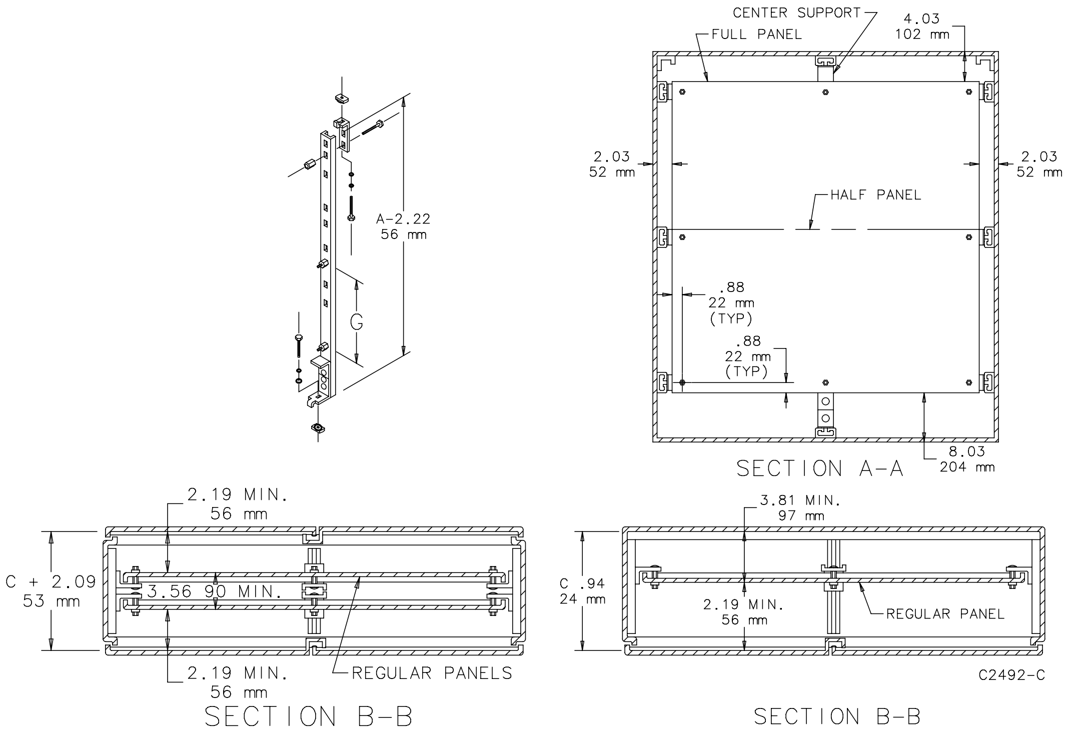
Panels for two-door single access and two-door dual access Free-Stand Type 4, 4X and 12 Enclosures with mounting channel are 10 gauge steel and can be positioned anywhere along horizontal mounting channels (see Sections B-B for limitations). Half-length panels can be located in the upper or lower portion of the enclosure. Some assembly is required.

Panels are finished with white polyester powder paint or a conductive, corrosion-resistant coating and furnished with plated mounting hardware.

Center support is furnished with each full panel or half panel for two-door enclosures. The center support attaches to the top and bottom mounting channels and can be positioned from front to back in the enclosure. The center support can be used with heavy duty panel supports to support panels of various heights.

Bulletin: PNL30

Catalog Number	Description	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)	Panel Size (in.)	Panel Size (mm)	G (in.)	G (mm)
A60P48F1	Full Panel	60.00 x 48.00	1524 x 1219	48.00 x 44.00	1219 x 1118	23.12	587
A60P48F1G	Full Panel	60.00 x 48.00	1524 x 1219	48.00 x 44.00	1219 x 1118	23.12	587
A72P48F1	Full Panel	72.00 x 48.00	1829 x 1219	60.00 x 44.00	1524 x 1118	29.12	740
A72P48F1G	Full Panel	72.00 x 48.00	1829 x 1219	60.00 x 44.00	1524 x 1118	29.12	740
A72P48F2	Half Panel	72.00 x 48.00	1829 x 1219	30.88 x 44.00	784 x 1118	29.12	740
A72P48F2G	Half Panel	72.00 x 48.00	1829 x 1219	30.88 x 44.00	784 x 1118	29.12	740
A90P48F1	Full Panel	90.00 x 48.00	2286 x 1219	78.00 x 44.00	1981 x 1118	38.12	968
A90P48F1G	Full Panel	90.00 x 48.00	2286 x 1219	78.00 x 44.00	1981 x 1118	38.12	968
A90P48F2	Half Panel	90.00 x 48.00	2286 x 1219	39.88 x 44.00	1013 x 1118	38.12	968
A90P48F2G	Half Panel	90.00 x 48.00	2286 x 1219	39.88 x 44.00	1013 x 1118	38.12	968
A72P60F1	Full Panel	72.00 x 60.00	1829 x 1524	60.00 x 56.00	1524 x 1422	29.12	740
A72P60F1G	Full Panel	72.00 x 60.00	1829 x 1524	60.00 x 56.00	1524 x 1422	29.12	740
A72P60F2	Half Panel	72.00 x 60.00	1829 x 1524	30.88 x 56.00	784 x 1422	29.12	740
A72P60F2G	Half Panel	72.00 x 60.00	1829 x 1524	30.88 x 56.00	784 x 1422	29.12	740
A72P72F1	Full Panel	72.00 x 72.00	1829 x 1829	60.00 x 68.00	1524 x 1727	29.12	740
A72P72F1G	Full Panel	72.00 x 72.00	1829 x 1829	60.00 x 68.00	1524 x 1727	29.12	740
A72P72F2	Half Panel	72.00 x 72.00	1829 x 1829	30.88 x 68.00	784 x 1727	29.12	740
A72P72F2G	Half Panel	72.00 x 72.00	1829 x 1829	30.88 x 68.00	784 x 1727	29.12	740
A90P72F1	Full Panel	90.00 x 72.00	2286 x 1829	78.00 x 68.00	1981 x 1727	38.12	968
A90P72F1G	Full Panel	90.00 x 72.00	2286 x 1829	78.00 x 68.00	1981 x 1727	38.12	968
A90P72F2	Half Panel	90.00 x 72.00	2286 x 1829	39.88 x 68.00	1013 x 1727	38.12	968
A90P72F2G	Half Panel	90.00 x 72.00	2286 x 1829	39.88 x 68.00	1013 x 1727	38.12	968

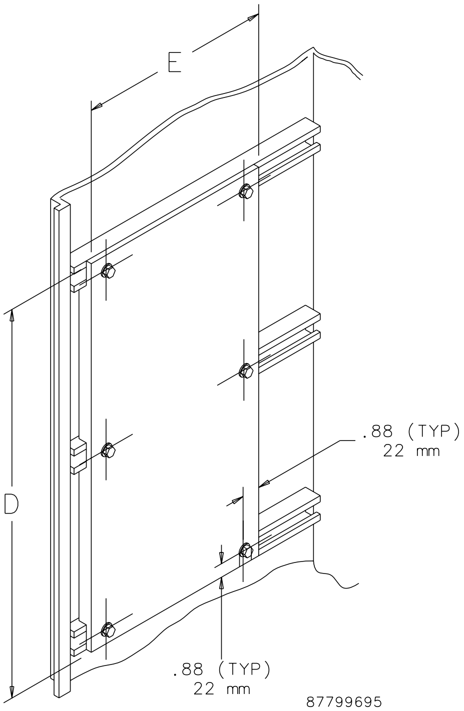


Panels for Enclosures

Side-Mounted Panels

Panels provide extra mounting space on the sides of enclosures. 12 gauge steel side-mounting panels are painted white. Conductive panels are steel with a conductive, corrosion-resistant coating. Panels attach securely to mounting channels. Plated steel mounting hardware is furnished.

Bulletin: PNL30



Catalog Number	Description	Panel Size D x E in./mm	Fits Enclosure A in./mm
A60SMP14	Painted steel	48.00 x 14.00	60.00
		1219 x 356	1524
A60SMP14G	Conductive	48.00 x 14.00	60.00
		1219 x 356	1524
A72SMP14	Painted steel	60.00 x 14.00	72.00
		1524 x 356	1829
A72SMP14G	Conductive	60.00 x 14.00	72.00
		1524 x 356	1829
A72SMP20	Painted steel	60.00 x 20.00	72.00
		1524 x 508	1829
A72SMP20G	Conductive	60.00 x 20.00	72.00
		1524 x 508	1829
A90SMP14	Painted steel	78.00 x 14.00	90.00
		1981 x 356	2286
A90SMP14G	Conductive	78.00 x 14.00	90.00
		1981 x 356	2286
A90SMP20	Painted steel	78.00 x 20.00	90.00
		1981 x 508	2286
A90SMP20G	Conductive	78.00 x 20.00	90.00
		1981 x 508	2286

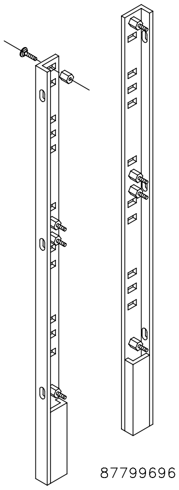
A90SMP14 and A90SMP14G will not fit 18.06-in.deep two-door enclosures (FSD style) if regular panel is also installed.

A90SMP20 and A90SMP20G will not fit 20.12-in. deep enclosures. Will not fit 24.12-in. deep two-door enclosures (FSD style) if regular panel is also installed.

Heavy Duty Panel Supports

Heavy Duty Panel Supports, sold in pairs, are used in place of the panel supports furnished with panels when heavy equipment will be installed on the panels. They extend to the bottom of the enclosure. Adjustable mounting studs allow mounting of different height panels or a combination of panels. Use mounting hardware furnished with panels.

Bulletin: A80



Catalog Number	Fits Enclosure A in./mm	Support Length in./mm
A60FSHDPS	60.00	57.25
	1524	1454
A72FSHDPS	72.00	69.25
	1829	1759
A90FSHDPS	90.00	87.25
	2286	2216

Center Panel Supports

Center panel supports are used with Free-Stand Type 12 (Bulletin A30) two-door enclosures. They permit the installation of panels, swing-out panels and rack-mounting angles sized for one-door enclosures. The Center Panel Support can be positioned from front to back of the enclosure.

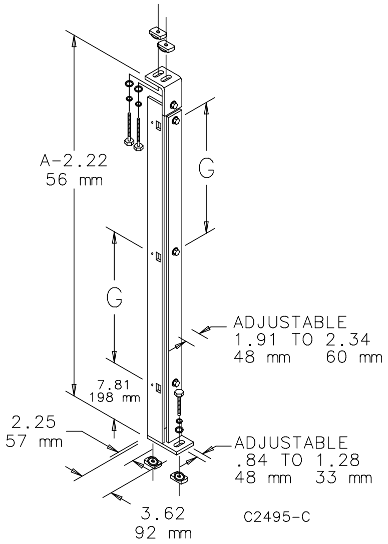
Bulletin: A80

Standard Product **Panel Supports**

Catalog Number	Fits Enclosure A (in.)	Fits Enclosure A (mm)	G (in.)	G (mm)
A60FSCPS	60.00	1524	23.12	587
A72FSCPS	72.00	1829	29.12	740
A90FSCPS	90.00	2286	38.12	968

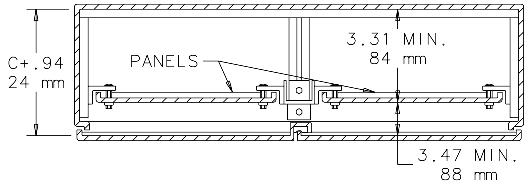
Accessory Width with Center Panel Supports

Two Door Enclosure Width (in.)	Two Door Enclosure Width (mm)	Accessory Width (in.)	Accessory Width (mm)
48.00	1219	24.00	610
60.00	1524	30.00	762
72.00	1829	36.00	914



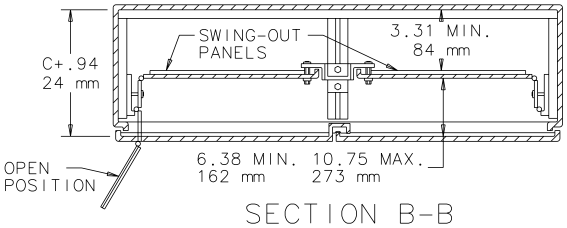
Panels for Enclosures

Center Panel Supports Enclosure Section Views



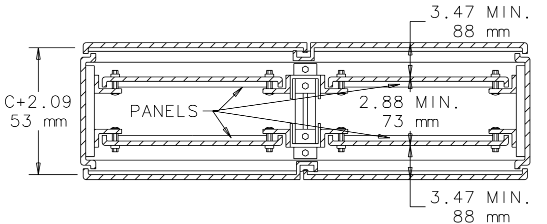
SECTION B-B

Showing two panels (for one-door enclosures)and center panel support mounted in two-door enclosure.



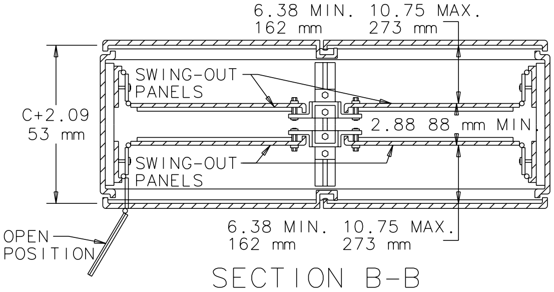
SECTION B-B

Showing four swing-out panels and center panel support mounted in two-door enclosure.



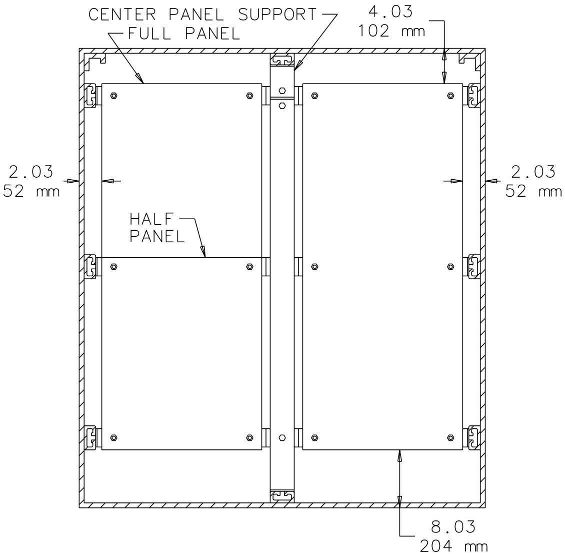
SECTION B-B

Showing four panels (for one-door enclosures) and two center panel supports mounted in two-door access enclosure.



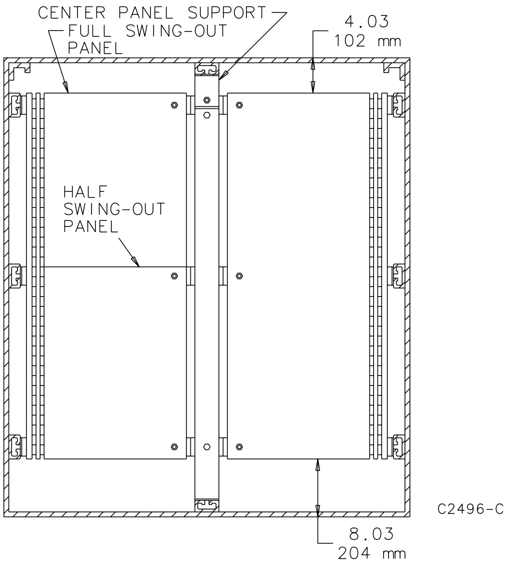
SECTION B-B

Showing four swing-out panels and two center panel supports mounted in two-door dual access enclosure.



SECTION A-A

Panels shown are for one-door free-stand enclosures. Half panel fits in top or bottom half of enclosure.



SECTION A-A

Showing swing-out panels installed in one-door enclosure.

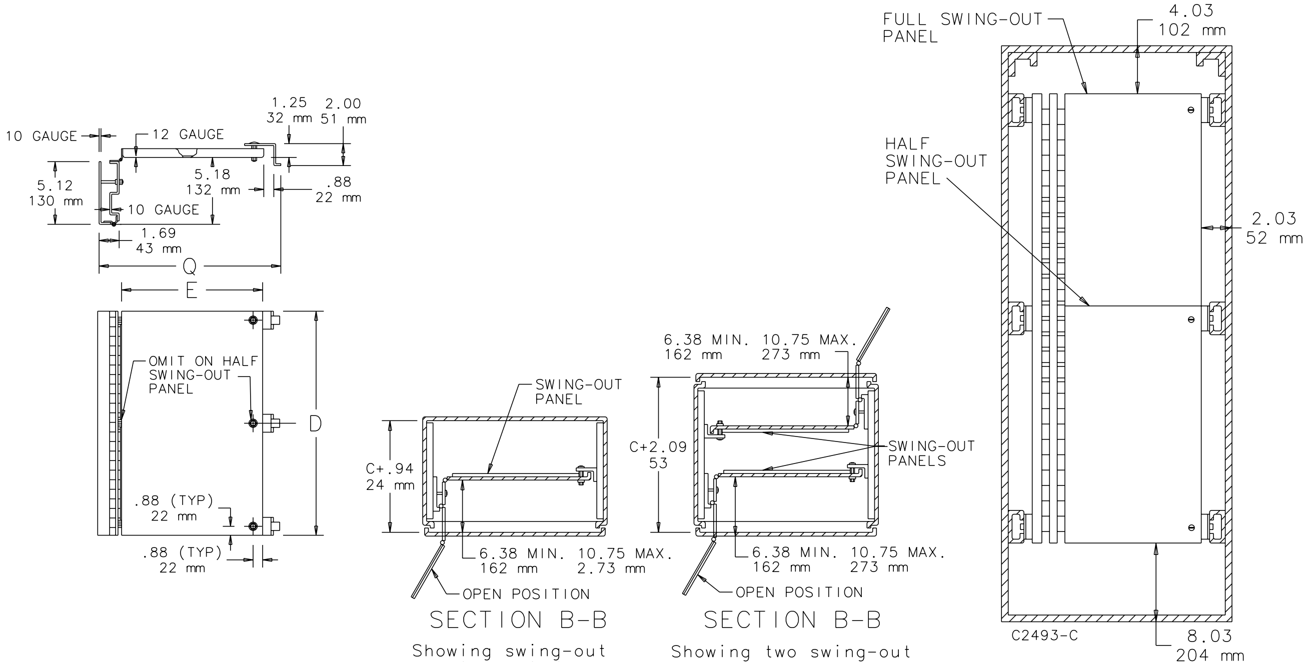
Panels for Enclosures

Swing-Out Panels for Free-Stand Type 4, 4X and 12 Enclosures with Mounting Channel

Panels for Free-Stand Type 12 Enclosures, Free-Stand Type 4 Enclosures and One-Door Type 4X Free-Stand Fiberglass Enclosures. Full-length and half-length swing-out panels are available. Half-length panels can be located in the upper or lower portion of the enclosures. Swing-out panels have a 10 gauge steel support frame and two heavy-gauge continuous hinges which permit the panel to swing completely out of the enclosure if it is located within approximately 10.75 in. (273 mm) of the door. These panels are 12 gauge steel and can be mounted on either side of the enclosure. Panels are finished with white polyester powder paint and furnished with plated mounting hardware.

Bulletin: PNL30

Catalog Number	Description	Panel Size D x E (in.)	Panel Size D x E (mm)	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)	Q (in.)	Q (mm)
A72SP24F3	Full Panel	60.00 x 18.81	1524 x 478	72.00 x 24.00	1829 x 610	21.84	555
A72SP24F4	Half Panel	30.88 x 18.81	784 x 478	72.00 x 24.00	1829 x 610	21.84	555
A72SP30F3	Full Panel	60.00 x 24.81	1524 x 630	72.00 x 30.00	1829 x 762	27.84	707
A72SP30F4	Half Panel	30.88 x 24.81	784 x 630	72.00 x 30.00	1829 x 762	27.84	707
A72SP36F3	Full Panel	60.00 x 30.81	1524 x 783	72.00 x 36.00	1829 x 914	33.84	860
A72SP36F4	Half Panel	30.88 x 30.81	784 x 783	72.00 x 36.00	1829 x 914	33.84	860
A90SP36F3	Full Panel	78.00 x 30.81	1981 x 783	90.00 x 36.00	2286 x 914	33.84	860
A90SP36F4	Half Panel	39.88 x 30.81	1013 x 783	90.00 x 36.00	2286 x 914	33.84	860



SECTION B-B

Showing swing-out panel mounted in one-door enclosure

SECTION B-B

Showing two swing-out panels mounted in one-door dual access enclosure

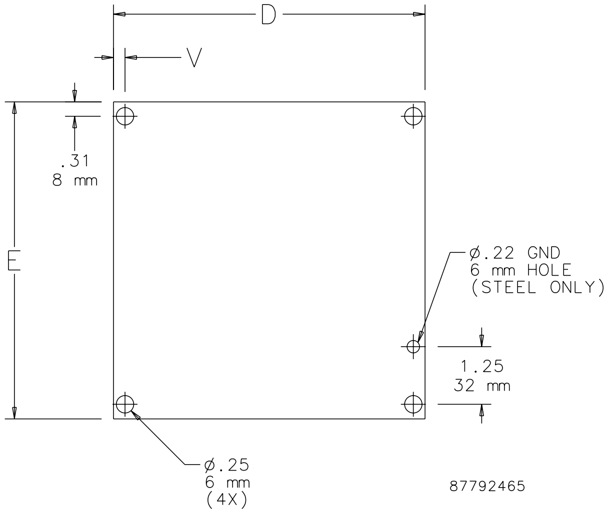
SECTION A-A

Panels for WiFi Cabinets and Small Wall-Mount Enclosures

Panels are available in both steel and wood. Steel panels are 14 gauge steel with a white polyester powder paint finish. Wood panels are 3/4-in. plywood and are unfinished. Wood panels are supplied with Fiberglass Hinged-Cover and POLYPRO® Type 4X WiFi Cabinets.

Bulletin: DWS12, PNLJ, PNLWM

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	V (in.)	V (mm)
A6P6	Steel	4.88 x 4.88	124 x 124	0.31	8
A6P6WD	Wood	4.88 x 4.88	124 x 124	0.31	8
A16P14	Steel	14.75 x 12.88	375 x 327	0.25	6
A16P14WD	Wood	14.75 x 12.88	375 x 327	0.25	6
A18P16	Steel	16.75 x 14.88	425 x 378	0.25	6
A18P16WD	Wood	16.75 x 14.88	425 x 378	0.25	6



Hardware User’s Guide

6” QuickPanel View

Intermediate, color STN & monochrome, round bezel

IC754VSI06STD
IC754VBI06STD
IC754VSI06MTD
IC754VBI06MTD

January 2007
GFK-2325A

Disclaimer of Warranties and Liability

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Notices

GE Fanuc Automation reserves the right to make improvements to the products described in this publication at any time and without notice.

The 6″ QuickPanel View has been tested and found to meet or exceed the requirements of U.S. (47 CFR 15), Canadian (ICES-003), Australian (AS/NZS 3548) and European (EN55022) regulations for Class A digital devices when installed in accordance with guidelines noted in this manual.

Microsoft® requires the following notes be published according to their additional licensing provisions:

Users are advised that a maximum of ten (10) computers or other electronic devices may simultaneously connect to, access and use services of the Microsoft Windows® CE Operating system on the QuickPanel View solely for remote access (including connection sharing) The ten connection maximum includes any indirect connections made through 'multiplexing', or other software or hardware which pools or aggregates connections.

Note that the QuickPanel View does not provide any server functionality utilizing Remote Desktop Protocol (RDP) to remotely connected client computers or devices. However, it does support connectivity to a remote Microsoft® Terminal Services server. The server providing these services must meet these restrictions and other Microsoft licensing requirements as applicable.

Notice Regarding Video Standards

This product is licensed under one or more video patent portfolio licenses such as and without limitation VC-1 and MPEG4 Part 2 Visual for the personal and non-commercial use of a consumer to:

(i) Encode video in compliance with the standards licensed under such patent portfolio licenses and/or

(ii) Decode video that was encoded by a consumer engaged in a personal and non-commercial activity and/or was obtained from a video provider licensed to provide video under such patent portfolio licenses.

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The FCC requires the following note to be published according to FCC guidelines:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Any changes or modifications to the product or installation that are not expressly approved by GE Fanuc Automation could void the user's authority to operate the equipment under FCC rules.

Industry Canada requires the following note to be published:

> This Class A digital apparatus complies with Canadian ICES-003.

The following statements are required to appear for Class I Div 2 Hazardous Locations.

1. WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIV. 2.

2. WARNING - EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES.

3. WARNING - EXPLOSION HAZARD - DO NOT CONNECT OR DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR AREA IS KNOWN TO BE NON-HARZARDOUS.

Power, input and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods, Article 501 4(b) of the National Electric Code, NFPA 70 and in accordance with the authority having jurisdiction.

For a complete list of agency qualifications, please refer to Appendix A1.

We want to hear from you. If you have any comments, questions, or suggestions about our documentation, send them to the following email address: doc@gefanuc.com.

Contents

1

Welcome

Congratulations on your purchase of a QuickPanel View, the most advanced compact HMI available. The QuickPanel View is available in different configurations to suit your requirements. Equally at home in a networked environment or as a stand-alone unit, the QuickPanel View is the ideal solution for factory floor HMI.

Powered by Microsoft Windows CE.NET™, today's embedded operating system of choice, the QuickPanel View provides a fast track for application program development. The commonality with other versions of Windows simplifies porting your existing program code. Another benefit of Windows CE is the familiarity of the user interface, shortening the learning curve for operators and developers alike. The availability of third-party application software makes this operating system even more attractive.

The 6" QuickPanel View is an all-in-one microcomputer designed for maximum flexibility. The design, based on an advanced Intel® microprocessor, brings together a high-resolution operator interface with a variety of I/O options. With many standard ports and expansion busses from which to choose, you can connect to most industrial equipment.

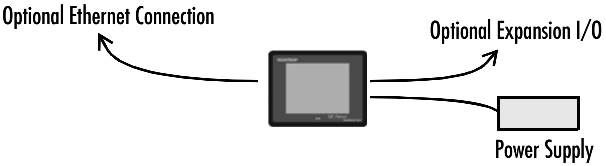
The QuickPanel View is equipped with several memory types to satisfy even the most demanding applications. A 32 MB section of DRAM is split between the operating system, an object store, and application memory. A 32 MB section of non-volatile FLASH memory, functioning as a virtual hard drive, is divided between the operating system and persistent storage for application programs. The retentive memory consists of 512 KB of battery-backed SRAM for data storage, ensuring your valuable data will never be lost, even during a power failure.

The many features of the QuickPanel View make it an obvious choice for a world of applications. Your smart choice will provide reliable operation for years to come.

GETTING STARTED

Basic Setup

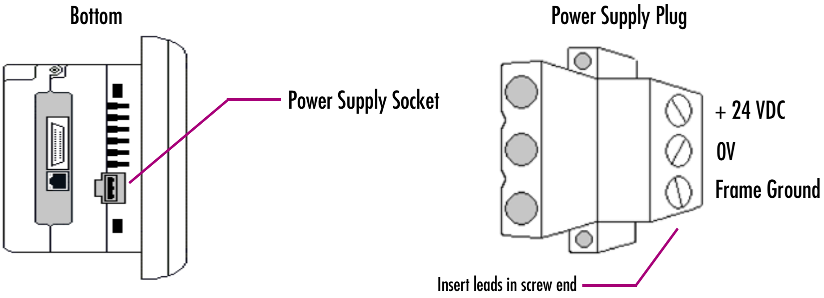
Your 6" QuickPanel View is shipped ready for use after a few configuration steps. To power up all you need to do is connect a DC power supply via the supplied quick-connect plug. Depending on your application, you may also want to connect and configure optional input devices (see page 31), communications ports (see page 36) and expansion adapters (see page 47).



Caution - Electrical Shock Hazard: To avoid personal injury or damage to equipment, ensure that the DC supply is disconnected from power and that the leads are not energized before attaching them to the unit's power supply plug.

To connect a DC power supply

1. Using the three screw terminals shown in the following diagram, attach a 24VDC, 24W power supply to the plug supplied with the QuickPanel View. See the **DC Power** section starting on page 59 for power supply and conductor specifications.
2. Insert the plug into the power supply socket and securely tighten the attaching screws.



Note: The torque range for the attaching screws is 4-6 inch/lbs.

Unit Runtime Setup

To download an application to a QuickPanel View, you must set up a data link between it and your development workstation. For more information, see “Ethernet” (page 36) and look up “Downloading a Machine Edition Project” in Proficy Machine Edition online help.

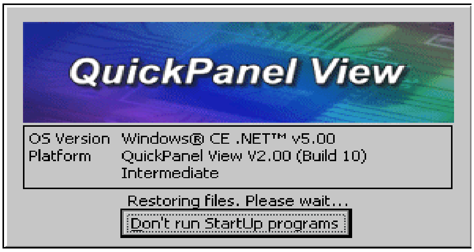
Startup

When you first start up the QuickPanel View, a few configuration steps are necessary.

To start the QuickPanel View

1. Apply AC power to the 24VDC supply.

   Once power is applied, the QuickPanel View begins initializing. The first thing to appear on the display is the splash screen.

   OS Version Windows® CE .NET™ v5.00
   Platform QuickPanel View V2.00 (Build 10)
   Intermediate

   Restoring files. Please wait...

2. To skip running any programs included in the StartUp folder, tap **Don’t run StartUp programs**.

   The splash screen disappears automatically after about 5 seconds. The Windows CE desktop then becomes visible.

3. Tap **Start**, point to **Settings**, then tap **Control Panel**.
4. In the Control Panel, double-tap **Display** to configure the LCD display (see page 26).
5. In the Control Panel, double-tap **Stylus** to configure the touch screen (see page 28).
6. In the Control Panel, double-tap **Date and Time** to configure the system clock (see page 55).
7. In the Control Panel, double-tap **System** to configure a network machine name (see page 45). Many applications, including Proficy Historian, require a unique machine name. It is recommended procedure to set a unique network name for the QuickPanel View to avoid future conflicts.
8. In the Control Panel, double-tap **Network and Dial-up Connections** to configure network settings (see page 44).

9. On the desktop, double-tap **Backup** to save any new settings through a power cycle (see page 16).

Shutdown

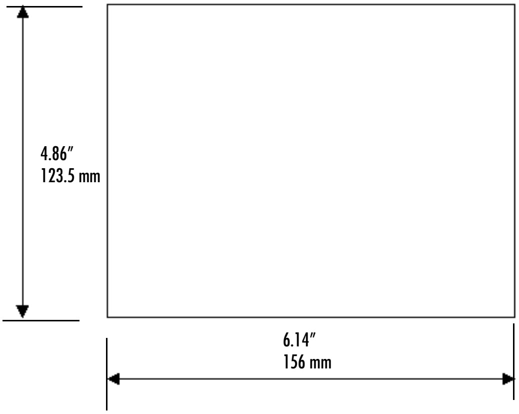
There are no specific dangers associated with a power failure or other unplanned shutdown of the QuickPanel View. In general, programs are retained in FLASH memory and user data can be retained in battery-backed SRAM. However, some operating system settings are retained only with user intervention (noted throughout this manual), so in order to carry out a graceful shutdown of the QuickPanel View, we recommend you perform the following procedure.

To shut down the QuickPanel View

1. Quit any programs that are running and wait for all file operations to complete.
2. To save changes to operating system settings (e.g., contrast or touch screen sensitivity), run Backup (see page 16).
3. Run Reboot (see page 17). When the Windows CE desktop reappears, remove AC power from the 24VDC supply.

Panel Cutout

For enclosure mounting, cut an opening in the panel according to the following specifications.



Panel Cutout

Height: 4.86″ (+0.103″, -0″)
(123.5mm [+2.6mm, -0mm])

Width 6.14″ (+0.55″, -0″)
(156mm, [+14mm, -0mm])

Depth 2.76″ (70 mm)

Bezel Dimensions

Height: 6.17″ (156.7mm)

Width: 8 in. (203.2mm)

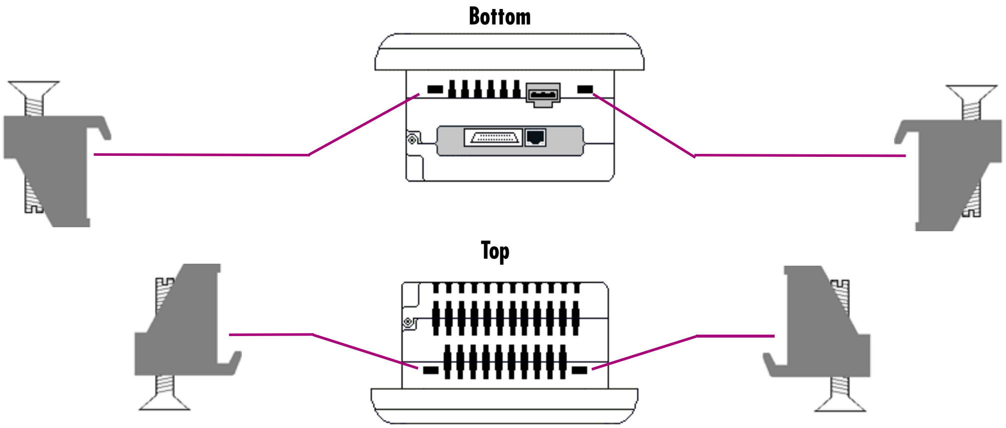
Panel thickness range:.063″ to.196″ (1.6mm to 5mm)

Notes:

- For compliance to NEMA 4, 4x, and 12 qualification, the unit must be mounted in a comparably NEMA rated (IP56 equivalent) panel or enclosure.
- For compliance to ATEX agency qualification, the unit must be mounted in an IP66 panel or enclosure.

- To avoid gasket degradation, limit repeated insertions or removals of the unit and retightening of the mounting clips. For full protection, always use a fresh gasket. Replacement gaskets may be ordered using part number IC754ACC06GAS.
- For adequate ventilation, allow at least 3 inches of space between adjacent equipment and all sides of the QuickPanel. Ensure that specified conditions of temperature and humidity are not exceeded.
- In outdoor applications, direct sun exposure may impose increased thermal loads on the QuickPanel leading to excessive temperature rises. Cabinet design and orientation must be carefully considered to avoid exceeding the operational temperature limits. These considerations could include shading for the QuickPanel and its cabinet with awnings or other solar opaque materials, avoiding a due East or West facing of the cabinet, ventilation or active cooling of the cabinet, or other methods.

The unit will **not** fit through this cutout with a CF card inserted in the port, with any cables connected, or with the power supply plug inserted in the socket. To secure the QuickPanel View to a panel, use the four included mounting brackets. They hook into openings located on the top and bottom of the housing.

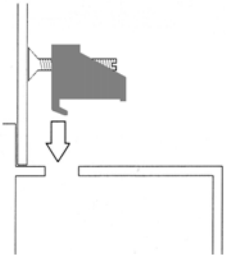


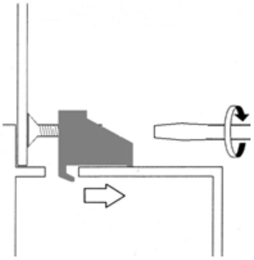
To mount the QuickPanel View in a panel

1. Verify that the gasket is properly seated in the bezel channel, then insert the unit into the panel cutout (without a CF card in the CF port).
2. Insert the hook of each mounting bracket in the housing openings as shown below.
3. Firmly tighten the screws.

   Note: The torque range for the mounting bracket screws is 2.6-4.4 inch/lbs (0.3-0.5 Nm).

The mounting brackets hold the unit in place by tension alone. No drilling is required.





Do not damage the gasket attached to the back of the unit's bezel. This gasket prevents shock hazards and damage caused by liquids accidentally entering the unit after installation. Also, limit the number of times you remove and reinstall the unit. Too many installations may cause gasket "set" and degradation of the seal.

TECHNICAL SUPPORT

If you are located in North America and have technical problems that cannot be resolved with the information in this guide, please contact us by telephone, fax, or email; or visit one of the links on our website:

Telephone: 1-800-GE-FANUC (1-800-433-2682)

Fax: (780) 420-2049

Email: support@gefanuc.com

In South America:

Telephone: +58 (261) 760-2862

Fax: +58 (261) 765-0909

Email: support@gefanuc.com

In Europe, the Middle East, and Africa:

Telephone: +800 1-GE-FANUC (+1 780-401-7717)

Email: support.emea@gefanuc.com

In Asia Pacific:

Telephone: +86-400-820-8208

Email: support.cn@gefanuc.com (China customers)

support.jp@gefanuc.com (Japan customers)

support.in@gefanuc.com (India and remaining Asia customers)

Web: http://globalcare.gefanuc.com (to locate the Technical Advisor page and a listing of supported devices (CF cards, etc.) click on the Operator Interface Product Family link or choose QuickPanel View from the Product list).

Comments about our manuals or help: doc@gefanuc.com

2

Overview

This chapter provides introductory information on the 6" QuickPanel View hardware and software with descriptive procedures for completing some of the most common tasks you will encounter.

In this chapter:

QUICKPANEL VIEW HARDWARE

Layout Diagram

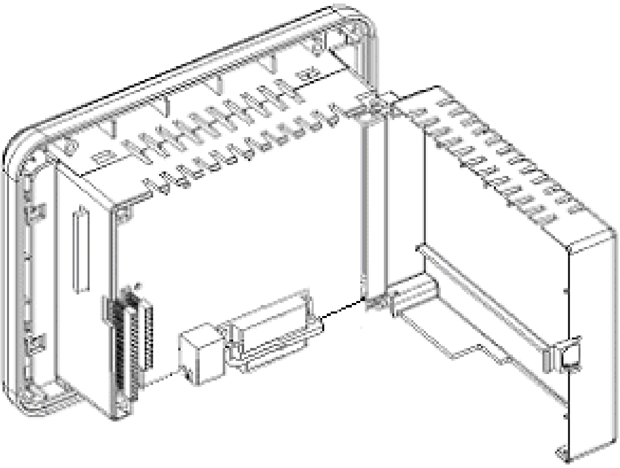
In addition to the primary touch screen interface, the 6" QuickPanel View supports a variety of communication ports including an expansion bus to allow great flexibility in application. The back of the QuickPanel opens allowing access to the expansion bus connector, memory expansion connector, DIP switches and battery. The following diagram shows the physical layout of the QuickPanel View and the locations of ports and connections.

Caution: Remove power from the QuickPanel View before opening the back. Working on a "live" unit may result in damage to equipment and injury to personnel. Always use anti-static precautions (i.e. grounded wrist strap) when accessing the interior of the unit. Do not allow conductive material, liquid or solid, to contact the electronics of the QuickPanel.

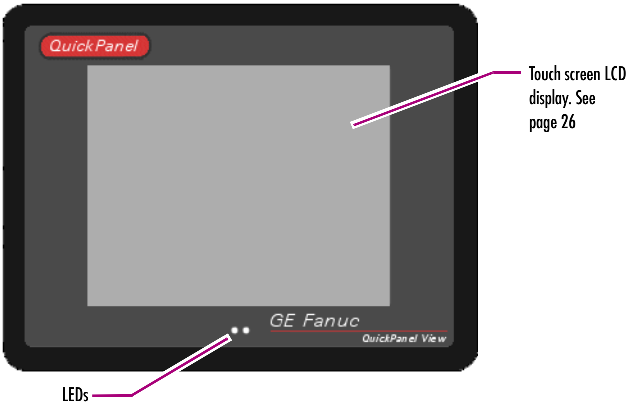
The left LED below the display is green when power is applied and amber if the backlight fails;[1] the right LED is tricolor (green, red, or amber) and programmable.

[1] Backlight is not field replaceable.

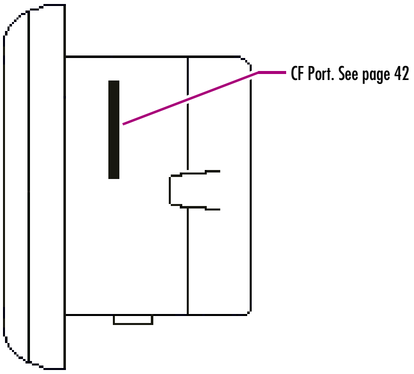
Rear View with back panel open



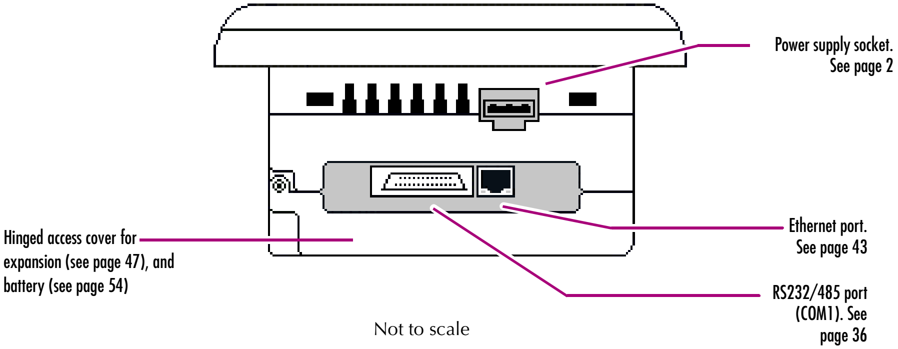
Front



Right Side



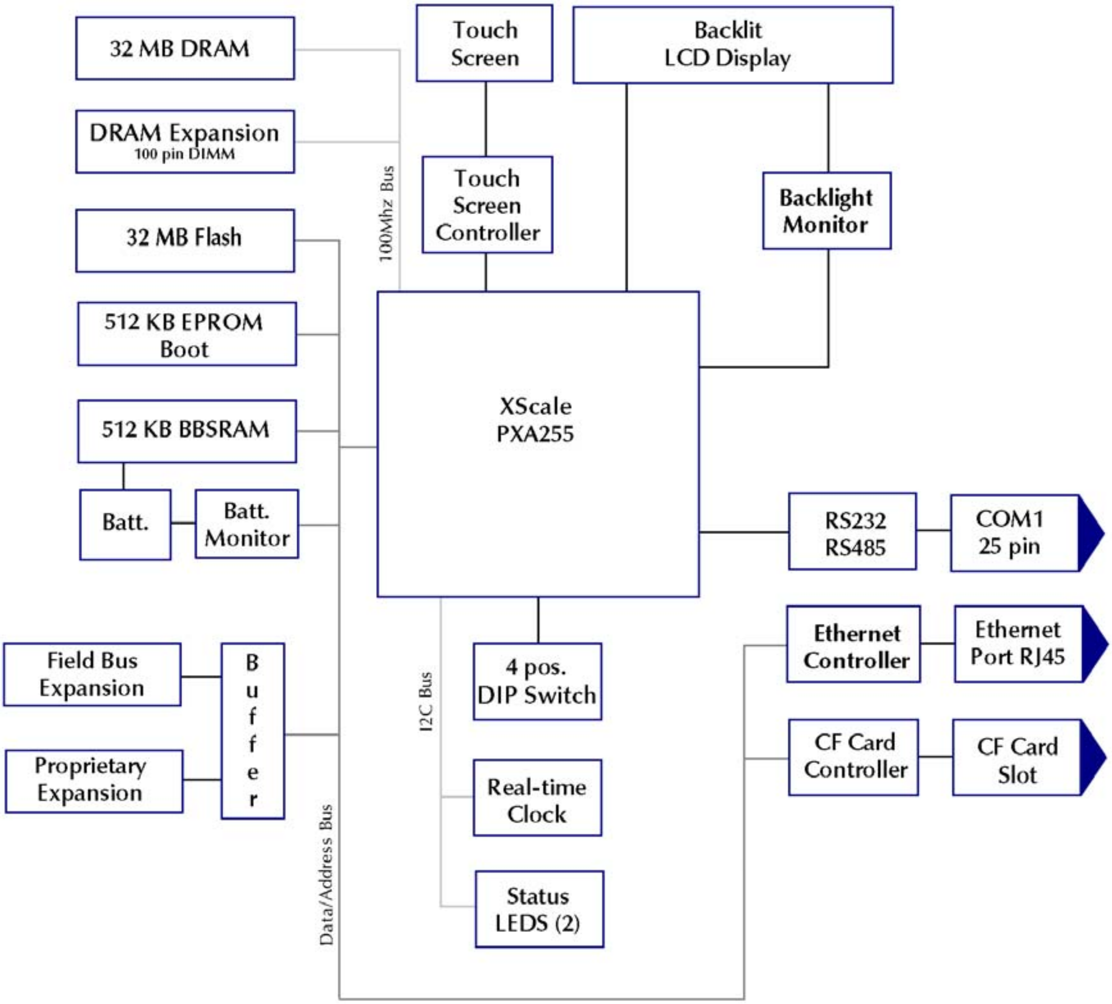
Bottom



Not to scale

Block Diagram

The 6" QuickPanel View is based on the Intel® XScale™ PXA255 microprocessor, and employs large-scale integration to provide high performance with a small footprint. The following block diagram illustrates the major functional areas of the QuickPanel View and the interfaces between them.



QUICKPANEL VIEW SOFTWARE

Windows CE.NET

Microsoft Windows CE.NET is the operating system for the QuickPanel View. It is a full 32-bit O/S with a graphical user interface. This operating system is finding widespread application in hand-held PCs and embedded HMI's, such as the QuickPanel View. From a user's perspective, the familiar look and feel of the Windows CE environment shortens the learning curve for those having experience with Windows 95/98/NT/2000/ME/XP. From the software developer's perspective, the CE environment is a subset of the WIN32 application programming interface, simplifying the porting of existing software from other versions of Windows.

The QuickPanel View operating system is stored in a 16 MB block of FLASH memory and copied to DRAM for execution. The operating system starts automatically following a power-up or reset of the QuickPanel View.

For more on Windows CE visit **www.microsoft.com/windows/embedded/windowsce/default.mspx**.

Working with Windows CE

Although the main user input device when working with Windows CE is the touch screen, it can often be convenient to use keyboard shortcuts, such as those described in the following table.

Keyboard Shortcut	Action
CTRL+ESC or ⊞	Opens the Windows CE **Start** menu. Use arrow keys to select a program and ENTER to run it.
ALT+TAB	Starts the Task Manager. Use it to quit unresponsive programs.
CTRL+ALT+=	Starts the touch screen calibration.
SPACEBAR	Equivalent to single-tap.
ENTER	Equivalent to double-tap. In a dialog box, equivalent to **OK**.
TAB	In a dialog box, select next control.
SHIFT+TAB	In a dialog box, select previous control.
CTRL+TAB	In a tabbed dialog box, open the next tab.
ESC	Close dialog box, discarding changes.
ARROW KEYS	In a dialog box, select controls or items from a list .

To place a program in the Start menu

1. Start Windows Explorer.
2. Navigate to the program you want to place in the **Start** menu.
3. Tap the program's icon to select it.
4. From the **Edit** menu, choose **Copy**.
5. Navigate to the '\Windows\Programs\' folder.
6. From the **Edit** menu, choose **Paste Shortcut**.
7. To save the settings, run **Backup** (see page 16).

Pocket Internet Explorer

Microsoft's Pocket Internet Explorer is a full featured browser that is fully integrated with the Windows CE operating system. This browser allows you to connect with an internet service provider, view Web pages and download from FTP sites.

Pocket Internet Explorer supports JScript. Java support can be added from third-party sources. Pocket Internet Explorer does not support VBScript; however, VBScript components are included in the operating system and may be used by third-party applications such as Proficy Machine Edition.

A connection can be established over an Ethernet network or a dial-up connection (default). The Ethernet or dial-up connection must be properly configured.

To configure a dial-up connection

1. Start Pocket Internet Explorer.
2. From the **Tools** menu, choose **Options**.

The **Internet Options** dialog box appears.

Port: 80

3. On the **Connection** tab, select the dial up connection from the combo list.
4. Tap **OK**.
5. To save the settings, run **Backup** (see page 16).

To configure a LAN connection

1. Start Pocket Internet Explorer.
2. From the **Tools** menu, choose **Options**.

   The **Internet Options** dialog box appears.

☑ Use LAN
Autodial name: Desktop @ 192
☐ Access the Internet using a proxy server
Address:
Port: 80
☐ Bypass proxy server for local addresses

3. On the **Connection** tab, select the **Use LAN** check box.
4. Tap **OK**.
5. To save the settings, run **Backup** (see page 16).

To configure a Proxy server

1. Start Pocket Internet Explorer.
2. From the **Tools** menu, choose **Options**.

   The **Internet Options** dialog box appears.

☐ Use LAN
Autodial name:
☑ Access the Internet using a proxy server
Address: MyProxy.com
Port: 80
☑ Bypass proxy server for local addresses

3. On the **Connection** tab, select the **Access the Internet using a proxy server** check box.
4. In the **Address** box, type the URL of your proxy server (see your ISP or network administrator).
5. In the **Port** box, type the server's port number for HTTP access.
6. Select the **Bypass Proxy for Local Addresses** check box to connect directly to sites in your intranet.
7. Tap **OK**.
8. To save the settings, run **Backup** (see page 16).

Backup

Backup saves changes that you make to the Windows Registry or Desktop to Flash memory. This utility is required because the QuickPanel View is not battery powered. Specifically, Backup does the following:

- It stores the Windows CE registry (including any control panel settings) in Flash memory.
- It stores any changes (or additions) made to the ‘Windows’ subtree of the file system in the user block of FLASH memory.

Run Backup whenever you make configuration changes to the operating system or installed applications, and prior to shutting down the QuickPanel View.

To run the Backup program

1. On the desktop, double-tap **Backup**.

   The **Backup** dialog box appears.

   Completed successfully

2. Tap **OK**.

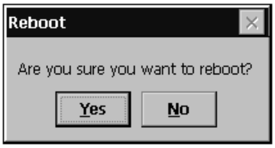
Reboot

Reboot performs a controlled and orderly shut down of the Windows CE operating system, then restarts the QuickPanel View. This ensures all open files are closed properly.

To reboot the system

1. To save changes to system configurations, run **Backup** (see page 16).
2. Tap **Start**, point to **Programs**, then the **System** folder, and tap **Reboot**

   A confirmation dialog box appears.

   Are you sure you want to reboot?

3. Tap **Yes**.

   The operating system reboots.

Storage Manager

Use Storage Manager to repair or format lost or corrupted data volumes. Storage Manager can repair data volumes existing either in Compact Flash (CF) or battery-backed SRAM (BBSRAM). Data volumes existing in the main flash file system of the QuickPanel View may not be repaired by Storage Manager.

Storage Manager, accessed from the Control Panels folder, is a Microsoft product for which on-line help is available.

System Information

System Information is a custom utility that displays a splash screen with the following information:

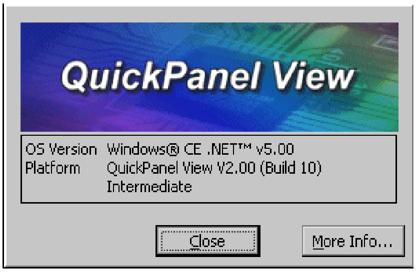
- **Operating System version.** For example, 'Windows CE 5.00'.
- **Platform.** Identifies the host hardware, its version and build number.

Tapping **More Info** on the splash screen opens the Advanced System Information window, which provides information such as hardware version and serial number, CPU type and specifications, etc. This information can be especially useful if you are contacting GE Fanuc Support.

To run the System Information program

1. On the desktop, double-tap **System Information.**

   The **System Information** splash screen appears.



OS Version Windows® CE .NET™ v5.00
Platform QuickPanel View V2.00 (Build 10)
Intermediate

2. Tap **More Info** to open the Advanced System Information window, or tap **Close** to continue.

   Network information alone can be viewed by double-tapping the **LAN** icon displayed on the taskbar for each connection.

Copy Project to Flash Card

RestorePCCard is a custom utility for transferring Proficy™ Machine Edition™ Projects between compatible QuickPanel View units via CF cards.

To copy a Machine Edition project onto a CF card

1. Ensure there is a blank CF card in the in the CF port.
2. Double tap the **Copy Project to Flash Card** icon on the desktop.
3. Tap **Yes** when the **Proceed with Copy to CF Card** confirmation dialog box appears.

   The system copies the project onto the blank CF Card.

To update a Machine Edition project

You can update a Machine Edition project currently stored on the QuickPanel View with a revision stored on a CF Card.

1. Insert the CF Card containing an upgraded version of the Machine Edition project in the CF port.
2. Reboot the machine (see page 17).

   The QuickPanel View automatically loads the new project from the CF Card, overwriting the old project on the machine.
3. Remove the CF Card from the slot.

Emulate PPC

Emulate PPC is a utility that allows the QuickPanel to emulate a Pocket PC 2003 platform during an ActiveSync session, enabling the download of third-party Pocket PC 2003 software.

To use Emulate PPC during an ActiveSync session

1. Start **Windows Explorer** , double tap **Windows**, then double tap **EmulPPC**.

   The Emulate PPC dialog box appears.
2. Start the ActiveSync session. When installation of third-party software is complete, close the dialog box to deactivate Emulate PPC.

HTTP File Transfer Utility

The HTTP File Transfer Utility (HFTU) is a small, standalone command line program that allows you to send and delete files to and from computers over a network. The HFTU uses the HTTP protocol, so you can even send files to computers over the Internet.

Run the HTTP utility from a command line prompt, from a batch file (.BAT) or as an application call in a script. The HTTP utility is an executable (.EXE) file included in the 6" QuickPanel View's operating system.

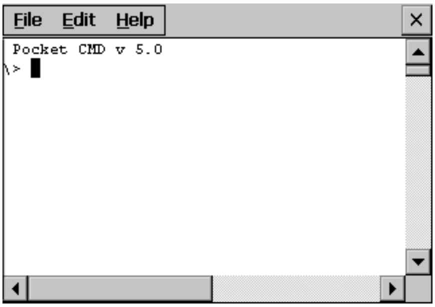
The HTTP utility currently supports two file transfer commands: COPY and DELETE.

Note: In order to function, the HTTP File Transfer utility requires both computers to have web servers that support PUT functionality. (Most web servers support PUT, including the Proficy Machine Edition web server installed with the runtimes for View and Logic Developer - PC.) If in doubt, check the documentation for your web server.

To use the HTTP utility

1. From Programs in the **Start** menu, choose Programs, then choose **Command Prompt.**

The **Command Line** editor appears.



```
Pocket CMD v 5.0
\>
```

2. Type commands as required.
3. Use the following syntax:

HTTPUTIL COPY source destination

Where “source” is the URL of the source file, and “destination” is the URL of the destination file. For example:

```
HTTPUTIL COPY \MyFile.txt http://MyServer/webfiles/MyFileBACKUP.txt
```

Copies a file called MyFile.txt on drive C: of the local computer to the webfiles folder under the web server at //MyServer. Note that you can rename a file as you copy it.

HTTPUTIL DELETE url

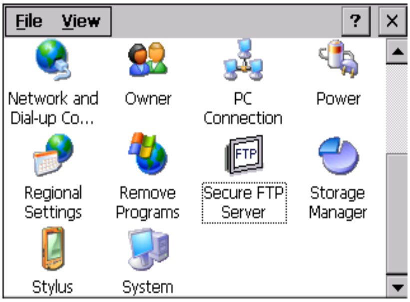
Where “url” is the remote URL of the file you want to delete. This URL must use the “//” or ”HTTP://” syntax. For example:

```
HTTPUTIL DELETE http://MyServer/webfiles/MyFileBACKUP.txt
```

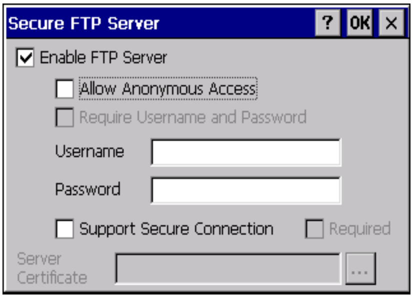
Deletes a file called MyFileBACKUP.txt from the webfiles directory under the web server at HTTP://MyServer.

FTP Server

The FTP Server included with the QuickPanel View supports both standard (RFC 959) and Explicit FTPS (i.e., FTP/SSL, Auth TLS, TLS-C, RFC-4217). It does not support SFTP or implicit FTPS, which uses different ports and is based on SSH rather than SSL.



All configuration of the FTP server is accomplished with the Secure FTP Server control panel applet. By default, the server is not enabled. Once enabled, a background program will run, waiting for clients to connect. Up to ten connections are supported. Sessions that are idle for five minutes are terminated by the server.



☑ Enable FTP Server

☐ Allow Anonymous Access

☐ Require Username and Password

Username

Password

☐ Support Secure Connection ☐ Required

Server Certificate

The Server supports:

- Non-secure operation. All information including username, password, and data is transmitted with no encryption and susceptable to packet sniffing and various FTP attacks. This is the default.
- Both secure and non-secure operation. This mode of operation, either secure or non-secure, is determined by the client when it connects. This operation is active when ‘Support Secure Connection’ is enabled, but ‘Required’ is not.

- Secure operation only. Secure operation uses encrypted connections for the control connection. The data connections are encrypted or non-encrypted based on the settings of the client. Secure operations also require the server to have a signed server certificate it can use to prove it is the actual machine the client wanted to reach and not an imposter. This mode is active when both ‘Support Secure Connection’ and ‘Required’ are enabled.

By default, the server requires a username/password combination to be configured. The server supports one username/password combination to authenticate remote users. There are three modes of authentication operation:

- No support for anonymous login. This is the default.
- Anonymous with no password. This is enabled when ‘Allow Anonymous Access’ is checked, but ‘Require Username and Password‘ is not checked.
- Anonymous with password requested (but not validated). This is enabled when ‘Allow Anonymous Access’ and ‘Require Username and Password’ are checked. This can prevent some types of attacks and is required by some clients.

Once connected, a remote user is logged into the FTP root directory. This is available from the QuickPanel View as \Temp\ftp and is a volatile RAM area. Files placed in this area are not persisted over a power cycle/reboot and use memory from the Storage Memory allocation. For this reason, remote users are only able to read, rename, and delete files from the FTP root directory. Programs running on the QuickPanel can access \Temp\ftp like any other directory, but remote users cannot fill up Storage Memory remotely.

All removable flash devices appear to remote FTP users as directories off of the FTP root directory. PC Flash cards partitions appear as directories such as \PCFlashStorage. The names contain no spaces as FTP commands do not support spaces in filenames. Full access privileges are granted for the client in these folders/devices.

Removable flash device directories are captured when a session is opened and are not changed while the session exists. If you start without a CF card installed, you will have to close your session and login again to see the CF directory. If the CF card existed when you logged in and is removed and inserted, it will still work provided the CF card’s device name did not change during reinsertion.

A server certificate is a special type of document which contains information about the server’s settings and a chain of electronic signatures to guarantee the document has not been altered. A Server certificate must be chosen from the certificates available in the QuickPanel View Secure FTP Server control panel applet.

The certificate itself is imported with the Certificates control panel applet. The main requirements of the certificate are that it must have the server authentication key usage attribute set and the name of the certificate should match the name used to connect to the FTP server (which could be the IP address of the server).

Certificates can either be purchased from an online vendor and imported into the QuickPanel View, or a self-signed certificate can be generated from the QuickPanel View. The benefit of a purchased certificate is that any user that has the root certificate used by the online vendor can determine the certificate is valid without the need for any additional information. A self-signed certificate is only known to be valid by clients that have added the certificate to their trusted list. Users can still access a server using a self-signed certificate, but they lose the ability to verify that no one is operating as an imposter somewhere on the network between them and the server.

To create a self-signed certificate

1. **Double click the genslfcert.exe utility in the QuickPanel View/Control.**
2. **From the command prompt, type "genslfcert CN=<unique identifier>".**

   You may specify a unique identifier of your choice, such as machine name, machine location, or IP address in place of unique identifier.
3. **A self-signed certificate is created in the My Certificates section of the certificates Control Panel.**

   This will create a self-signed certificate in the My Certificates section of the certificates control panel and a SelfSigned.cer file in My Computer which can be transferred to FTP Clients as a trusted source. Certificates may be managed through snap-in's to the Microsoft® Management Console or other third party management consoles.

   A Backup should be performed after configuring the FTP server and/or creating the self-signed certificate.

To install a certificate on an FTP Client

1. Double click the certificate. Select the **General Tab**.

   The Certificate properties are displayed.

2. Click the **Install Certificate** button.

   The Certificate Import Wizard appears.

3. Click **Next** to continue.

   The Certificate Store screen appears.

4. Specify whether Windows should place the certificate in a certificate store or select another location. Click **Next** to continue.

   The Completing the Certificate Import Wizard screen appears.

5. Click **Finish** to complete the installation of the certificate.

   The Security Warning message appears. This message informs you Windows will automatically trust any certificate issued by this Certification Authority.

6. Click **Yes** to allow Windows to trust any certificate issued by this Certification Authority.

3

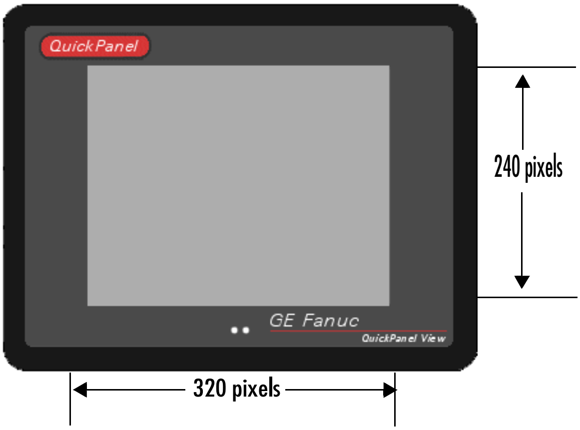
Detailed Operation

TOUCH SCREEN DISPLAY

The QuickPanel View has an integrated flat-panel color or monochrome display, depending on model. The color model is backlit, measures 5.7" diagonally, and uses passive STN technology. The monochrome model is backlit, measures 5.7" diagonally, and uses passive FSTN technology.

The resolution of the color display is 320 x 240 pixels and 65,536 colors; the resolution of the monochrome display is 320 x 240 pixels and 256 shades of gray.

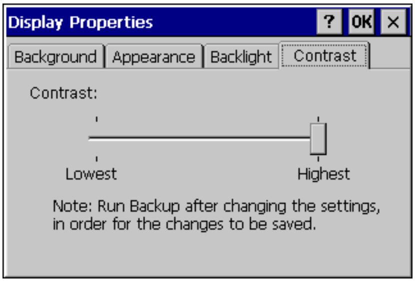
A backlight timer is featured on all models. You can extend backlight life by turning the backlight off automatically.



To adjust the display contrast

1. In the Control Panel, double-tap Display and choose the Contrast tab.

   The **Contrast** dialog box appears.



Note: Run Backup after changing the settings, in order for the changes to be saved.

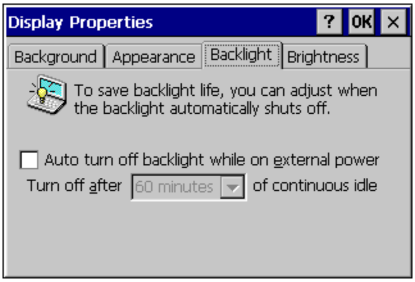
2. Drag the **Contrast** slider between Lowest and Highest.

3. Tap **OK** to exit the control panel. To save the settings, run Backup (see page 16).

To set backlight for auto turn off

1. In the Control Panel, double-tap **Display** and choose the **Backlight** tab.

   The **Backlight** dialog box appears.



To save backlight life, you can adjust when the backlight automatically shuts off.

☐ Auto turn off backlight while on external power

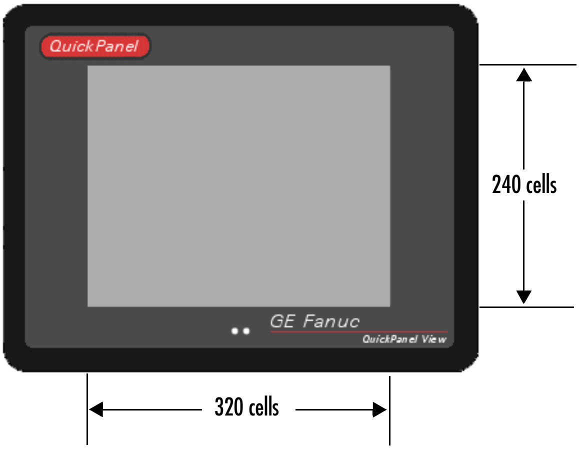
Turn off after 60 minutes of continuous idle

2. Select Auto turn off backlight while on external power.
3. Tap **OK** to exit the control panel.

   To save the settings, run **Backup** (see page 16).

TOUCH SCREEN

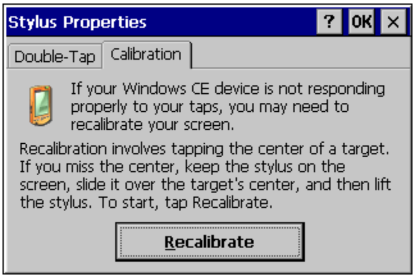
The QuickPanel View display is coupled to a resistive touch panel with 12-bit resolution. When the QuickPanel View is properly calibrated, this translates into a grid of touch cells on the face of the display. Although you can use your finger to activate the touch screen, use of a blunt stylus is recommended.



To calibrate the touch screen

1. In the Control Panel, double-tap **Stylus**.

   The **Stylus Properties** dialog box appears.

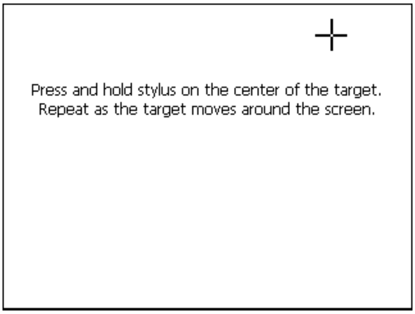


If your Windows CE device is not responding properly to your taps, you may need to recalibrate your screen.

Recalibration involves tapping the center of a target. If you miss the center, keep the stylus on the screen, slide it over the target's center, and then lift the stylus. To start, tap Recalibrate.

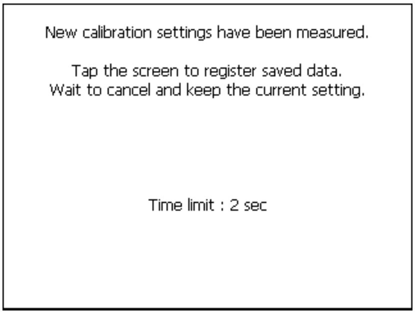
2. Choose the **Calibration** tab.
3. Tap the **Recalibrate** button.

   A cross hair target is displayed.



Press and hold stylus on the center of the target.
Repeat as the target moves around the screen.

4. Follow the directions given to calibrate the touch screen.
5. Tap the screen to preserve the new setting or wait out the time limit to revert to previous settings.



New calibration settings have been measured.

Tap the screen to register saved data.
Wait to cancel and keep the current setting.

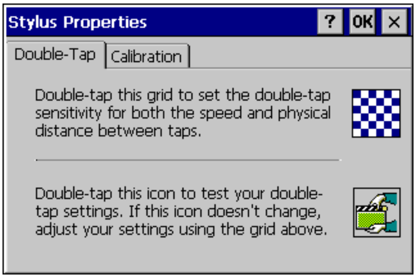
Time limit : 2 sec

6. To save the settings, run **Backup** (see page 16).

To set the double-tap sensitivity

1. In the Control Panel, double-tap **Stylus**.

   The **Stylus Properties** dialog box appears.



Double-tap this grid to set the double-tap sensitivity for both the speed and physical distance between taps.

Double-tap this icon to test your double-tap settings. If this icon doesn't change, adjust your settings using the grid above.

2. Choose the **Double-Tap** tab.
3. Double-tap the grid to enter a setting.
4. Double-tap the test icon to check the setting.

   If the test icon doesn’t change when you double-tap it, double-tap the grid again.
5. Tap **OK** to finish.
6. To save the settings, run **Backup** (see page 16).

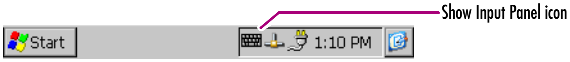
KEYBOARD

The QuickPanel View can be configured to use a software emulation keyboard as a operator data input device.

Soft Input Panel

The Soft Input Panel (SIP) is a touch screen version of a standard keyboard, which can be used in place of a standard hardware keyboard.

An icon in the system tray lets you view or hide the SIP.



Show Input Panel icon

To show/hide the Soft Input Panel

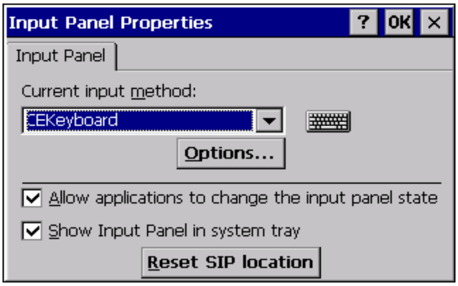
- On the system tray of the task bar, double-tap the ⌨ icon. The Soft Input Panel appears/disappears.

Note: When the SIP is visible, it can be dragged around the screen by its title bar to reveal different parts of the screen that would be obstructed from view by the SIP.

To display the Soft Input Panel icon in the system tray

1. In the Control Panel, double-tap **Input Panel**.

   The **Input Panel Properties** dialog box appears.



Current input method: CEKeyboard

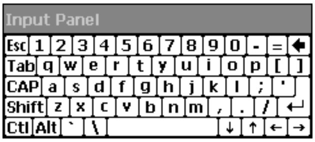
☑ Allow applications to change the input panel state

☑ Show Input Panel in system tray

2. Select the **Allow applications to change the input panel state** check box.
3. Select or clear the **Show Input Panel in system tray** check box.
4. Tap **OK**.
5. To save the settings, run **Backup** (see page 16).

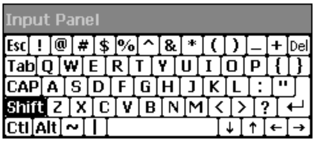
The Soft Input Panel has two basic configurations: **Small key** and **Large key**.

Small Key configuration: Provides a standard QWERTY key layout with numeric keys at the top row as illustrated in the following picture.



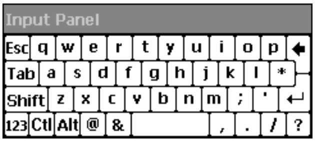
Small key: lower case

Uppercase characters are accessed by pressing the SHIFT key once. This is equivalent to holding down the SHIFT key on a conventional keyboard. The SHIFT key is active while the next key is pressed then reverts back to its unselected state. The CAP key does the same thing as SHIFT but does not revert to lower case after another key is pressed. Rather, the Soft Input Panel remains in the Uppercase mode until the CAP key is pressed again. The CTRL and ALT keys behave the same as the SHIFT key.



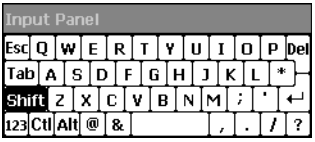
Small key: upper case

Large Key configuration: Provides alphabetic or numeric keys alone. No numeric keys are displayed at the top of the alpha panel; alpha keys are not displayed on the numeric panel.



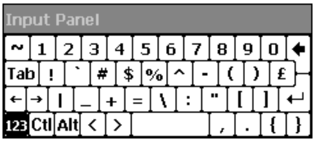
Large key: lower case

As with the small key configuration, upper or lower case alpha keys can be displayed by using the SHIFT key.



Large key: upper case

Pressing the **123** key once locks the panel in numeric mode until the **123** key is pressed again.

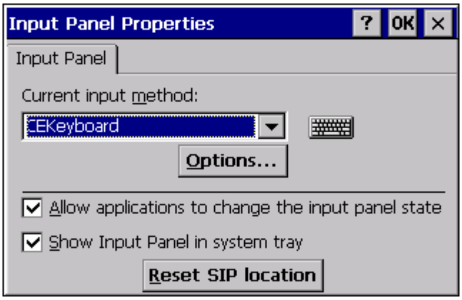


Large key: numeric

To change key configurations

1. In the Control Panel, double-tap **Input Panel**.

The **Input Panel Properties** dialog box appears.



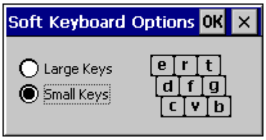
Current input method: CEKeyboard

☑ Allow applications to change the input panel state

☑ Show Input Panel in system tray

2. From the **Current input method** list, choose **CE Keyboard**.
3. Tap **Options**.

The **Soft Keyboard Options** dialog box appears.



○ Large Keys

● Small Keys

4. Select **Large Buttons** or **Small Keys**.

A preview of the key size is displayed on the dialog box.

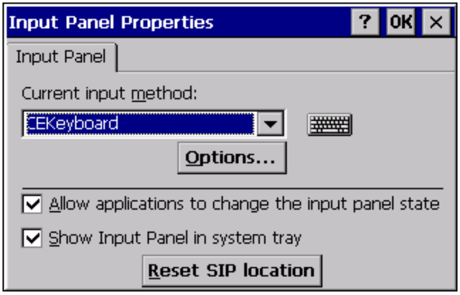
5. Tap **OK** twice to finish.
6. To save the settings, run **Backup** (see page 16).

To reset SIP location

In the event the user accidentally drops the SIP off screen and can’t drag it back on screen, the following steps will reset the SIP to the centre of the screen.

1. In the Control Panel, double-tap **Input Panel**.

The **Input Panel Properties** dialog box appears.



Current input method: CEKeyboard

☑ Allow applications to change the input panel state

☑ Show Input Panel in system tray

2. Select **Reset SIP location**.

COMMUNICATION PORT

The QuickPanel View has one serial data communication port (COM1).

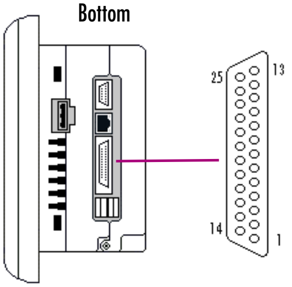
COM1- Serial

The COM1 port is a general purpose bidirectional serial data channel that supports the EIA232C and EIA485 electrical standards. The COM1 port can be accessed and configured:

- as a direct or dial-up remote networking connection.
- from a user-created application program.

A connection can be configured to reside on a network supporting a TCP/IP protocol.

A DB25S (female) connector, mounted on the bottom of the enclosure, provides standard signals as described in the following table.



1	GND - Frame Ground	14	VCC - 5VDC, 0.5A
2	TX - (EIA232C)	15	TXB (EIA485)
3	RX - (EIA232C)	16	RXB (EIA485)
4	RTS - (EIA232C)	17	n/c
5	CTS - (EIA232C)	18	CSB (EIA485)
6	DSR - (EIA232C)	19	ERB (EIA485)
7	SG - Signal Ground	20	DTR (EIA232C)
8	DCD - (EIA232C)	21	CSA (EIA485)
9	TRMRXB (EIA485)	22	ERA (EIA485)
10	RXA (EIA485)	23	n/c
11	TXA (EIA485)	24	n/c
12	n/c	25	n/c
13	n/c		

Note: Pin 14 is fused with a field-replaceable, 1.0A fast-blow fuse.

Recommended Cabling for TIA/EIA422 or TIA/EIA485

The COM1 port on the QuickPanel View provides connections to devices, which support either TIA/EIA422 or TIA/EIA485. These electrical standards specify a differential signaling technique which provides high data rates, long distances and good noise rejection. The standards do not address signal encoding (protocol), connectors, or cabling. However, certain characteristics of interfacing these devices should be considered in order to ensure reliable connections.

Connections

Connect nodes in a daisy chain fashion. Do not connect in other arrangements, especially "star." The standards do not specify the maximum number of nodes or devices that can be connected to a TIA/EIA 422 or 485 network. Instead, the standards limit the number of electrical connections by specifying that a maximum of 32 unit loads (UL) may be connected. The QuickPanel View presents one UL.

Interconnect media

Always use twisted pair cabling and group complimentary signals into conductor pairs; TXA with TXB, for example. Use a cable with a characteristic impedance of 100 ohms to 120 ohms. A wire gauge of 24 AWG is commonly used. Maximum cable length is 4,000' (1,219.2m), but may be less due to cable impedance, connection quality, data rates, and other factors.

Shield is optional. See “Shielding” on page 38.

Termination

Always provide proper termination at each end of the 422/485 network. The QuickPanel View provides built-in termination resistance when pin #9 (TRMRXB) is connected to pin #10 (RXA).

Caution: Do not terminate every node. Only terminate the end nodes.

Grounding

A signal return path between transmitting and receiving devices must be provided. This return path is separate from the Rx and Tx data lines and the other 422/485 signals supported by the QuickPanel View, and may be provided by a separate conductor in the cable. Connect both ends of the signal return conductor to Signal Ground (pin #7). Shielding or use of a twisted pair for this connection is not necessary.

For installations where all devices are in the same cabinet and have the same ground potential between devices, connecting Signal Ground between all the devices on the 422/485 network is adequate to ensure proper voltage levels at the devices.

However, if there is a difference in ground potential between devices, such as when the devices are in widely separated cabinets, then signal grounds on a 422/485 network should not be tied together. The cable shield and cable ground should be connected together at only one device, closest to the earth ground connection.

The signal and frame grounds of the QuickPanel View are capacitively coupled, but in some devices these ground references are connected together. Connect Signal Ground (pin #7) to Frame Ground (pin #1) and then to earth ground on the QuickPanel View only in the circumstance where the other devices separate their signal and frame grounds and the QuickPanel View is the only device with frame and signal ground connected to earth ground.

Shielding

Shielded cable is required for compliance with CE and FCC requirements. The cable shield should be connected to the metal connector shell or by pin #1 of the QuickPanel 25-pin serial connector. Shield and cable ground (pin #7 of the 25-pin connector or pin #5 of the 9-pin connector) should not be connected directly together.

The Frame Ground (pin #1) of the QuickPanel View should be used for attaching the cable shield in these applications.

Caution: Do not connect Signal Ground (pin #7) to Frame Ground (pin #1) on the QuickPanel View, except in the specific and limited circumstances noted in the Grounding section on page 37.

Working with the COM port

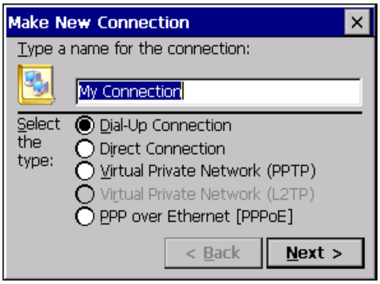
To add a new remote networking serial connection

1. From the **Start** menu, tap **Settings**, then **Network and Dial-up Connections**.

   The **Connection** window appears.

2. Double-tap **Make New Connection**.

   The **Make New Connection** wizard appears.



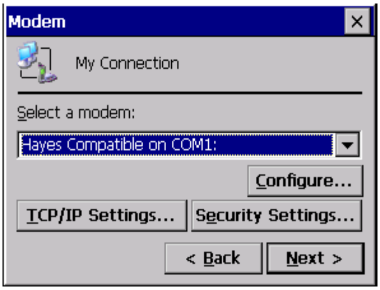
Make New Connection

Type a name for the connection: My Connection

Select the type:
● Dial-Up Connection
○ Direct Connection
○ Virtual Private Network (PPTP)
○ Virtual Private Network (L2TP)
○ PPP over Ethernet [PPPoE]

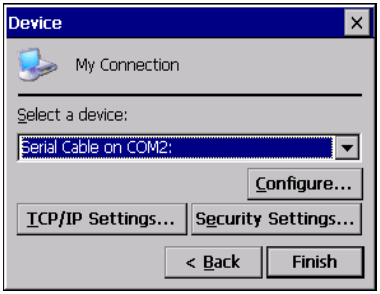
3. Type a name for the new connection.
4. Choose a connection type. If you are configuring a Modem, choose **Dial-Up Connection**. If you have a Device, select **Direct Connection**.
5. Tap **Next**.

The **Modem** or **Device** Connection window appears, depending on the connection type.



Select a modem: Hayes Compatible on COM1:

or



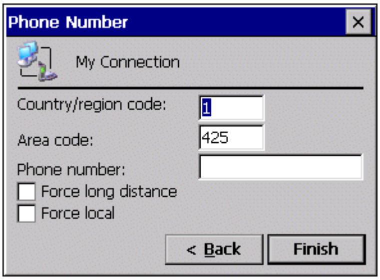
Select a device: Serial Cable on COM2:

6. From the list, choose the modem or device you want to use. (If a serialCF card is inserted, it is available in the device list).

   You can **Configure** your device or **TCP/IP Settings** at this time if you wish.

7. Tap **Finish** for direct connection (Device dialog box) or **Next** for dial-up (Modem dialog box).

   If you are adding a dial-up connection the following dialog box appears.



Country/region code: 1
Area code: 425
Phone number:
☐ Force long distance
☐ Force local

8. Type the destination **Country/region code**, **Area code**, and **Phone number** in the appropriate boxes.
9. Select or clear the **Force Long Distance** or **Force Local** check boxes.
10. Tap **Finish**.

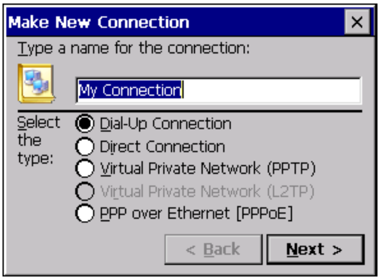
To add a virtual private network or PPP over Ethernet

1. From the **Start** menu, tap **Settings**, then **Network and Dial-up Connections**.

   The **Connection** window appears.

2. Double-tap **Make New Connection**.

The **Make New Connection** wizard appears.



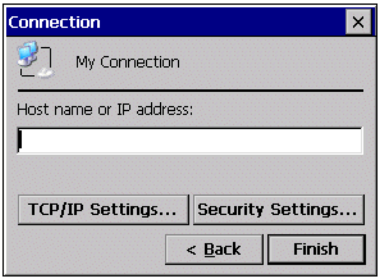
Make New Connection

Type a name for the connection: My Connection

Select the type:
● Dial-Up Connection
○ Direct Connection
○ Virtual Private Network (PPTP)
○ Virtual Private Network (L2TP)
○ PPP over Ethernet [PPPoE]

3. Type a name for the new connection.
4. Choose a connection type. Select **Virtual Private Network** to configure a VPN connection. Select **PPP over Ethernet** for a PPPoE connection.
5. Tap **Next**.

   The **VPN** or **PPPoE** Connection window appears, depending on the connection type.



Connection

My Connection

Host name or IP address:

or

Connection

My Connection

PPPoE Service Name (blank for any service):

Select a device: PPPoE Line 0

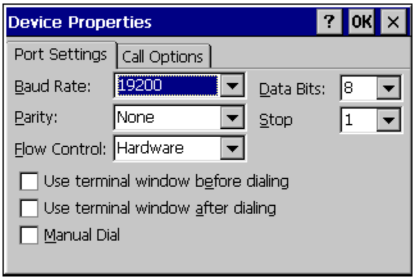
6. Enter the Host Name or IP address for a VPN connection, or a PPPoE Service Name for a PPPoE connection.

   You can configure your **TCP/IP Settings** at this time if you wish.
7. Tap **Finish**.

To change the default device properties

1. From either the Device or Modem dialog box, tap **Configure**.

The **Device Properties** dialog box appears.



Device Properties

Baud Rate: 19200

Data Bits: 8

Parity: None

Stop 1

Flow Control: Hardware

☐ Use terminal window before dialing

☐ Use terminal window after dialing

☐ Manual Dial

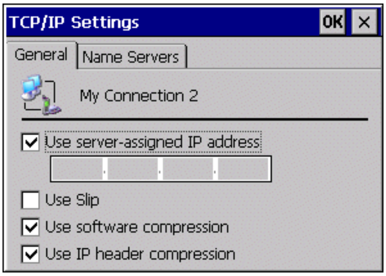
2. In the **Port Settings** tab, choose settings for all connection preferences.
3. If the connection is for terminal emulation, select or clear the terminal-related check boxes.

   You can use the QuickPanel View to emulate a terminal attached via a modem link (Hayes compatible) to COM1. A terminal emulation definition is added as a unique session.

To change the default TCP/IP settings

1. Obtain correct TCP/IP settings from your network administrator.
2. From either the **Device, Modem, PPPoE Connection, or VPN Connection** dialog box, tap **TCP/IP Settings**.

   The **TCP/IP Settings** dialog box appears.



TCP/IP Settings

My Connection 2

☑ Use server-assigned IP address

☐ Use Slip

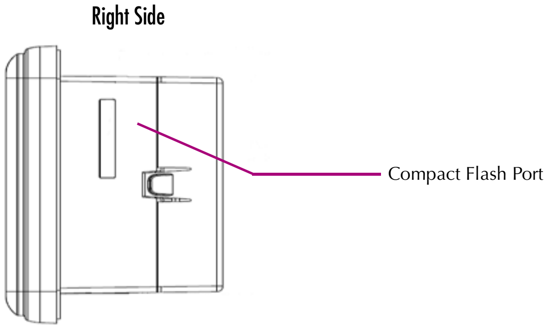
☑ Use software compression

☑ Use IP header compression

3. Use the TCP/IP settings from your internet provider.

CF PORT

To enhance the QuickPanel View's capabilities with additional flash memory, the unit is equipped with a CF (Compact Flash) Type 2 port on its side.



A CF card is inserted in this port with its front facing the front panel of the unit (the narrow side slot on the card should be toward the top). The card should slide in easily—to avoid damage, do not force it.

Note: For full protection from electrostatic discharge, peel off the paper label on the side of the CF card facing away from the bezel to allow contact between the card and the internal frame ground contacts on the CF connector.

The Copy Project to Flash Card utility (see page 20) lets you transfer Machine Edition projects between QuickPanel View units via CF Cards.

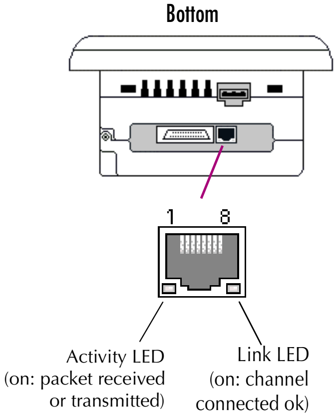
No Compact Flash cards are supplied with the QuickPanel View. A list of cards (and other devices) that have been tested and are compatible can be found by visiting http://globalcare.gefanuc.com, then select the Operator Interface category, then select the QuickPanel View product name.

The CF port only supports 3.3v CF cards. 5v CF cards are not suported.

Caution: Do not remove power while the system is writing to the CF card, such as when copying a Proficy Machine Edition project. Removing power while writing may lead to data loss and file or CF card corruption. To ensure the system completes writing to flash and closes all files, see “Shutdown” on page 4.

ETHERNET

The QuickPanel View is equipped with a 10BaseT/100BaseTx auto-negotiate Ethernet port (IEEE802.3), and you can connect an Ethernet network cable (unshielded, twisted pair, UTP CAT 5) to the unit via the RJ45 connector on the bottom of the enclosure. LED indicators on the port indicate channel status. Access to the port is possible either by Windows CE network communications, or by your custom application. The following diagram shows the location, orientation, and pin out of the Ethernet port.



1	**TX_D1 +**
2	**TX_D1 -**
3	**RX_D2 +**
4	**B1_D3 +**
5	**B1_D3 -**
6	**RX_D2 -**
7	**B1_D4 +**
8	**B1_D4 -**

There are two methods for setting an IP address on the QuickPanel View:

- **DHCP (Dynamic Host Configuration Protocol).** This is the default method that is carried out automatically.

Note: There must be a DHCP server on the connected network for a valid IP address to be assigned. Contact your network administrator to ensure correct DHCP server configuration.

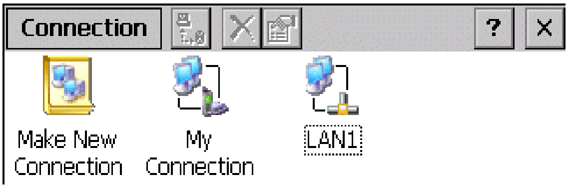
- **Manual method.** The user uniquely specifies the numeric addresses for the QuickPanel View, the Subnet Mask (if applicable), and the Default Gateway.

Note: Use a crossover cable to connect the QuickPanel View to a PC directly; when connecting to a LAN HUB, use a straight through cable. Contact your network administrator if you require further information.

To set an IP address

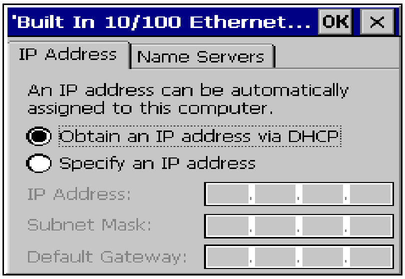
1. From the Control Panel, tap **Network and Dial-up Connections.**

   The **Connection** window appears.



2. Select a connection and choose Properties.

   The **Built-in Ethernet Port Settings** dialog box appears.


'Built In 10/100 Ethernet... OK

IP Address | Name Servers

An IP address can be automatically assigned to this computer.

● Obtain an IP address via DHCP

○ Specify an IP address

IP Address:

Subnet Mask:

Default Gateway:

3. Select a method:
   - **Obtain an IP address via DHCP** (automatic).
   - **Specify an IP address** (manual).

1. Enter the **IP Address**, **Subnet Mask** and **Default Gateway** numbers obtained from your network administrator (manual method only).
2. Tap **OK**.
3. To save the settings, run **Backup** (see page 16).

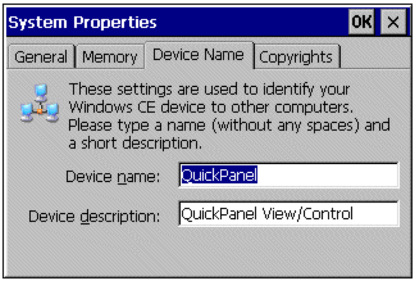
   If the DHCP method was selected, the network server will assign an IP address while the QuickPanel View is initializing. (You must be connected to the network).

   After setting an IP address for the QuickPanel View, you can access any network drives or shared resources for which you have permission.

To set up access to a Windows network

1. In the Control Panel, double-tap **System**.

   The **System Properties** dialog box appears.



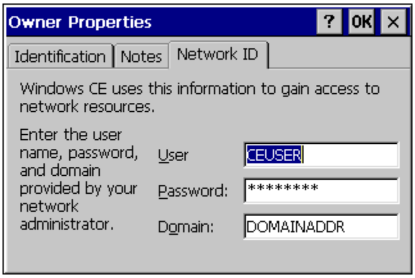
These settings are used to identify your Windows CE device to other computers. Please type a name (without any spaces) and a short description.

Device name: QuickPanel

Device description: QuickPanel View/Control

2. On the **Device Name** tab, in the **Device name** box, type a unique name for your QuickPanel View. In the Device description box, type a description.
3. Tap **OK**.
4. In the Control Panel, double-tap **Owner**.

   The **Owner Properties** dialog box appears.



Windows CE uses this information to gain access to network resources.

Enter the user name, password, and domain provided by your network administrator.

User CEUSER

Password: ********

Domain: DOMAINADDR

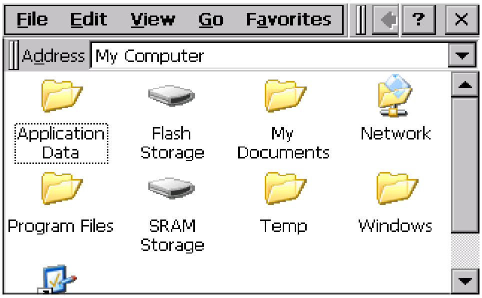
5. On the **Network ID** tab, type your assigned **User name, Password** and **Domain**.
6. Tap **OK**.
7. To save the settings, run **Backup** (see page 16).

Using Windows CE Explorer, you can now access anything on your local network for which you have permission.

To access a remote resource on a Windows network

1. Start **Windows Explorer.**

   The **Explorer** window appears.



Address My Computer

2. Type in the **Address** box, or choose from a list, the path to a remote resource.

   For example '\\MyRemoteComputer\MyFolder' specifies the folder named 'MyFolder' on a computer with the name 'MyRemoteComputer'.

3. Press ENTER.

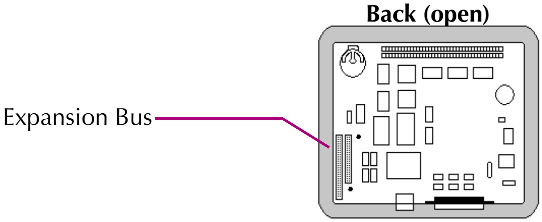
   The resource specified is displayed as a collection of files and folders. It can take a few moments to retrieve the data from your local network.

   Note: You can use the NET command from the shell to map a network resource to the QuickPanel View for frequent access. The resource then appears in the **Network** folder.

EXPANSION BUS

An expansion bus is included with the QuickPanel View, and optional modules that mount directly to it are available. For more information on expansion modules, contact your distributor.

The expansion bus connectors are accessed by opening the back of the unit.



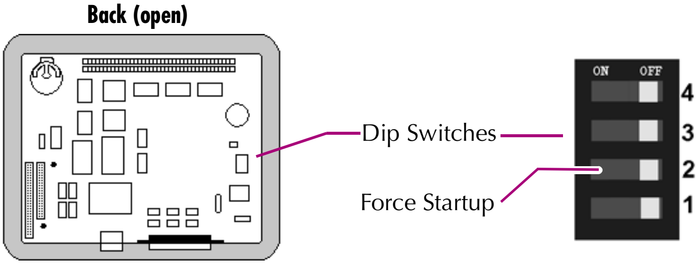
Caution: Remove power from the QuickPanel View before opening the back. Working on a "live" unit may result in damage to equipment and injury to personnel. Always use anti-static precautions (i.e. grounded wrist strap) when accessing the interior of the unit. Do not allow conductive material, liquid or solid, to contact the electronics of the QuickPanel.

Caution: Ensure all pins are properly aligned when inserting expansion cards. Misalignment could cause damage to the QuickPanel View and/or the expansion card.

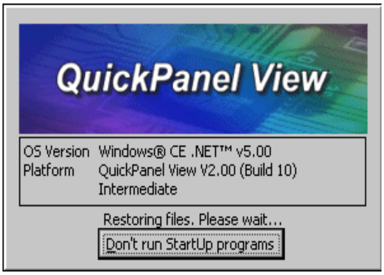
DIP SWITCHES

The QuickPanel View is equipped with four DIP switches that each control separate functions.

DIP switches are set to “OFF” by default in the factory. DIP switch 2 is the Force Startup switch. Turning this switch on forces the startup applications to run when the operating system is started.



When the switch is set to “OFF”, the QuickPanel View operates normally, displaying the startup splash screen. You can skip running the startup applications by tapping the “Don’t run StartUp Programs” button on the startup splash screen.



QuickPanel View

OS Version Windows® CE .NET™ v5.00
Platform QuickPanel View V2.00 (Build 10)
Intermediate

Restoring files. Please wait...

When the switch is set to “ON”, the startup programs are forced to run and the “Don’t run Startup Programs” button is not available on the startup splash screen.

Note: Do not adjust switches other than switch 2. They are reserved for factory functions.

To configure startup behavior with DIP switch 2

Caution: Remove power from the QuickPanel View before opening the back. Working on a “live” unit may result in damage to equipment and injury to personnel. Always use anti-static precautions (i.e. grounded wrist strap) when accessing the interior of the unit. Do not allow conductive material, liquid or solid, to contact the electronics of the QuickPanel.

1. **Open the back cover of the QuickPanel View.**
2. **Locate the DIP switches and set DIP switch 2 to “ON”.**

   The startup applications are now forced.

   Note: Do not adjust the other switches. They are reserved for factory functions.

MEMORY

The QuickPanel View supports a variety of memory subsystems to ensure the requirements of your application are met. All system memory is tied directly to the microprocessor's address and data busses for fastest access. To increase DRAM by up to 64 MB, a 100-pin DIMM memory expansion slot is also included.

Flash Memory

This 32 MB block of non-volatile memory is the main long-term program storage for the QuickPanel View, operating like a virtual hard drive from the point of view of Windows CE. It is divided into two areas, of which only one is accessible from Windows CE Explorer. The **Flash Storage** folder represents a 16 MB block of memory available for long-term storage of user application programs. Another 16 MB block is used to store the Windows CE operating system, and is not directly accessible from Windows CE Explorer.

The operating system and all user application programs are transferred from Flash to DRAM for execution. Any user additions to the **Windows** folder are retained in **Flash Storage** when the **Backup** utility is run.

FLASH memory has a limited write-cycle lifetime. That is, the physical memory devices wear out after approximately 100,000 cycles (minimum), so it is advisable to limit file operations such as copy, delete, etc.

The write cycle is much slower for FLASH than it is for other portions of RAM, therefore FLASH is not recommended for the storage of program variables, or any data items whose values are dynamic.

Flash memory can optionally be added with a CF Card, which will appear as the **PCFlash Storage** folder.

Caution: Do not remove power while the system is writing to flash memory, such as when downloading a Proficy Machine Edition project. Removing power while writing may lead to data loss and file system corruption. To ensure the system completes writing to flash and closes all files, see "Shutdown" on page -4.

To add External Flash memory with a CF Card

- Insert a Compact Flash card into CF Port (see page 42).

The unit immediately reads the new secondary storage. If the disk requires formatting, you will be prompted to do so.

New memory appears in Windows CE Explorer as **PCFlash Storage**.

External flash memory devices are named after their types of connection and order of attachment. For example, if you connect two flash memory devices, one via the CF port and one via the fieldbus connector, the first device connected device is named *PCFlash Storage*, and the second device is named *PCFlash Storage2*. At powerup, a CF port device is recongnized and named first. Otherwise, the name depends on connection order.

SRAM Memory

This 512 KB block of static RAM is battery-backed to provide data retention through a power cycle. This memory block is shared by the operating system and user applications. A portion of the SRAM memory, represented as the **SRAM Storage** folder, operates as a virtual hard drive and is accessible from the Windows CE Explorer. Typical application programs create files in this folder in which to store critical program data.

The portions of SRAM memory used by the operating system and by user applications varies between models.

DRAM Memory

The QuickPanel View is equipped with 32 MB of dynamic RAM. Part of the DRAM (13.2 MB) is reserved for the Windows CE operating system and is not accessible by user applications. The other 18.8 MB is split between two functions: an object store for temporary file storage, and the main memory for running programs.

Typically, compressed programs stored in FLASH are expanded and moved to DRAM for execution. Temporary storage of program variables or data files is also provided by DRAM—any data stored in DRAM will not be retained through a power cycle.

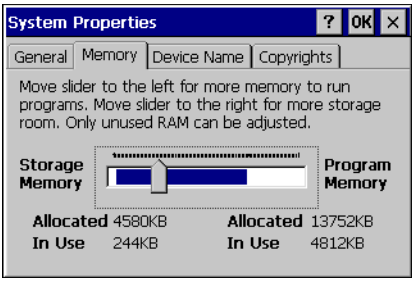
The split between program memory and storage memory may be adjusted as necessary to make more room for one or the other, depending on your specific application needs. For example, if you find that an application is short of memory, use the System Properties dialog box to alter DRAM memory allocation.

Caution: Setting Program Memory too low may prevent additional applications from starting , or may cause currently running applications to fail due to lack of memory. Setting Storage Memory too low may prevent the saving of files into the object store portion of the file system, which may also cause application failures.

To change the DRAM memory allocation

1. In the Control Panel, double-tap **System.**

The **System Properties** dialog box appears.



Move slider to the left for more memory to run programs. Move slider to the right for more storage room. Only unused RAM can be adjusted.

Storage Memory		Program Memory	
Allocated	4580KB	Allocated	13752KB
In Use	244KB	In Use	4812KB

2. On the **Memory** tab, drag the slider to divide the DRAM into Storage and Program memory.

   The amount of memory allocated to and used by each area is displayed numerically. The blue bar indicates the current amount of unallocated DRAM and determines the boundaries within which the slider can move.

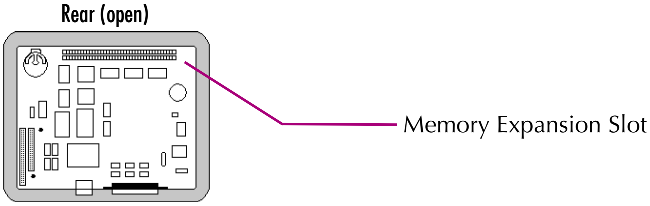
3. Tap **OK** to apply the new setting.
4. To save the settings, run **Backup** (see page 16).

Boot Loader ROM

The Boot Loader ROM provides 512 KB of non-volatile storage for the QuickPanel View's initialization program. This program configures the QuickPanel View hardware then starts the operating system's execution. This memory is not accessible from Windows CE Explorer, nor should any attempts be made to modify the contents of this ROM.

Memory Expansion Slot

The QuickPanel View is equipped with a 100-pin DIMM memory expansion slot which lets you increase DRAM to a total of 96 MB.



Caution: Remove power from the QuickPanel View before opening the back. Working on a "live" unit may result in damage to equipment and injury to personnel. Always use anti-static precautions when accessing the interior of the

QuickPanel View. Do not allow conductive material, liquid or solid, to contact the electronics of the QuickPanel.

To install additional DRAM

1. Disconnect AC power from the 24VDC supply.
2. Open the rear access panel.
3. Insert the new DIMM carefully into the expansion slot, noting the orientation of the pin locators. When the DIMM is fully seated, lift each side clip until it clicks into place.

OTHER SUBSYSTEMS

Power Management

The QuickPanel View's Power Properties control panel displays the status of the backup battery. The Battery Very Low Or Missing icon displays in the taskbar when the battery is either missing or very low.

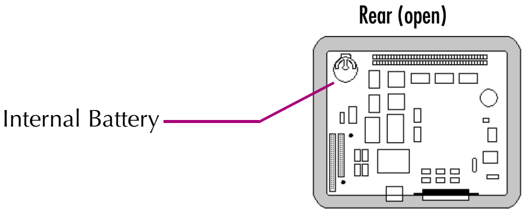
To access the Power Properties control panel

1. In the Control Panel, double-tap Power.

The Power Properties dialog box appears.

Battery Backup

Auxiliary backup power for the real-time clock and SRAM is provided by a ***non-rechargeable***, internal lithium battery (+3VDC, BR2032), ensuring that no loss of data occurs when the main 24VDC supply is removed. Backup power is enabled or disabled by installing or removing the battery, accessed via the rear panel as shown in the following illustration.



Caution: Remove power from the QuickPanel View before opening the back. Working on a "live" unit may result in damage to equipment and injury to personnel. Always use anti-static precautions when accessing the interior of the QuickPanel View. Do not allow conductive material, liquid or solid, to contact the electronics of the QuickPanel.

To remove the internal battery

1. Disconnect AC power from the 24VDC supply.
2. Open the rear access panel.
3. Release the battery by *gently* lifting it from the completely exposed side, past the small protrusions. To avoid breaking the battery retainer clips, do not apply excessive upward pressure.
4. Slide the battery out of its carrier, noting the arrow on the carrier indicating the direction of removal.

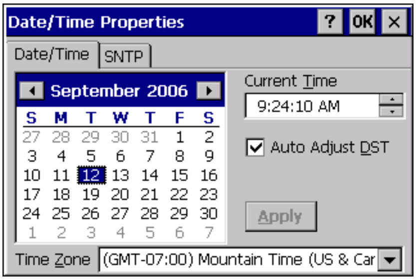
Real-time Clock

The QuickPanel View has a programmable real-time clock capable of reporting the current time in Year/Month/Day/Hour/Minute/Second. The time is set from the Windows CE interface and retained through a power cycle if battery backup is available. Automatic adjustment for daylight savings time is enabled by a check box within the dialog box. The time can be displayed in the system tray on the task bar. Help for this dialog box is activated by selecting the question mark.

To set the real-time clock

1. In the Control Panel, double-tap **Date/Time**.

   The **Date/Time Properties** dialog box appears.



September 2006

S	M	T	W	T	F	S
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
1	2	3	4	5	6	7

Current Time: 9:24:10 AM
☑ Auto Adjust DST
Time Zone: (GMT-07:00) Mountain Time (US & Car

Note: Tap Apply after making changes in any box.

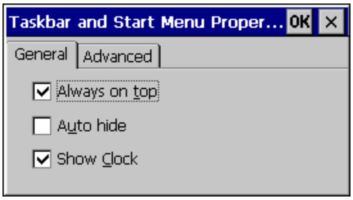
2. To modify the date, select the Date/Time tab.
3. Tap the year to choose a new year; tap the month to choose a new month.
4. Tap a date to specify the day of month.
5. From the **Time Zone** box, choose your zone.
6. Select **Auto Adjust DST** to have the clock automatically compensate for daylight savings time.
7. In the **Current Time** box, adjust the hours, minutes and seconds.
8. Tap **OK** to finish.

   The time can be displayed in the system tray on the task bar.

To display the time on the taskbar

1. From the **Start** menu, choose **Settings,** then **Taskbar and Start Menu....**

   The **Taskbar Properties** dialog box appears.



☑ Always on top
☐ Auto hide
☑ Show Clock

2. On the **Taskbar Options** tab, select **Show Clock.**
3. Tap **OK.**

   An hours and minutes display now appears in the taskbar.

Clock Display

Configuring SNTP

There are two levels of Network Time Protocol (NTP) time servers available on the Internet.

First-level time servers are primarily intended to act as source time servers for second-level time servers. First-level time servers may also be capable of providing mission-critical time services. Some first-level time servers may have a restricted access policy.

Second-level time servers are intended for general SNTP time service needs and usually enable public access. It is recommended that you use second-level time servers for normal SNTP time server configuration because they are normally located on a closer network that can produce faster updates.

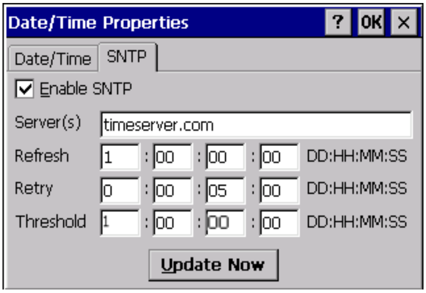
It is recommended that you research any time server selection to ensure that it can meet your specific time server requirements. More information and a list of SNTP time servers can be found at http://support.microsoft.com/kb/262680/.

If the time on the time server is more than the threshold value away from the current time on the QuickPanel View, then the time is not updated. Setting the Threshold to 0 tells the utility to always accept the time from the server. This setting would be useful in a case where the backup battery has died and the QuickPanel View was power cycled, since the internal clock would have reset back to January 1, 1980 12:00 am.

To set SNTP

1. In the Control Panel, double-tap **Date/Time**.

   The **Date/Time Properties** dialog box appears.



☑ Enable SNTP

Server(s) timeserver.com

Refresh 1 : 00 : 00 : 00 DD:HH:MM:SS

Retry 0 : 00 : 05 : 00 DD:HH:MM:SS

Threshold 1 : 00 : 00 : 00 DD:HH:MM:SS

Note: Tap Apply after making changes in any box.

2. To add or modify SNTP settings, select the SNTP tab.
3. To enable SNTP, ensure the **Enable SNTP** check box is selected.
4. Enter the time server name in the **Server(s)** field.
5. Set the **Refresh**, **Retry**, and **Threshold** parameters.
6. Tap **Update Now** to update SNTP settings immediately.
7. Tap **OK** to finish.

A1

Design Specifications

The specifications listed in this appendix are the design goals for the QuickPanel View. In most cases the "as built" or tested specifications are identical. See page 64 for a list of agency approvals for environmental service and safety.

Physical

Enclosure dimensions (use for panel cutout)	Height: 4.86 in (126 mm) Width: 6.14 in (158 mm) Depth: 2.76 in (70 mm)
Bezel dimensions	Height: 6.17 in (156.7 mm) Width: 8 in. (203.2mm) Depth: 0.85 in (21.5 mm)
Weight	2.5lb (1.16 kg)

DC Power

Input Voltage	12 to 30 VDC
Power Dip Tolerance	-30% nominal input voltage, 10msec
Insulation Resistance	268Mohm @1000V frame ground to 0V 366Mohm @1000V frame ground to 24V
Real Power	12 W Power requirement nominal for startup when DC supply is already powered and stable. Applying power to the supply while connected to the QuickPanel View increases total inrush current requirements. In this case, supply should be rated at 10x the nominal startup current. Otherwise, an interposing relay or switch must be used between the DC supply and the QuickPanel View. NOTE: For compliance with UL 1604, switches or relays in-line with the DC power wiring cannot be used in hazardous locations.
Connector (Vendor, p/n)	Phoenix Contact, 1777992 NOTE**:** The torque range for the attaching screws is 4-6 inch/lbs.

Power Supply Conductor Size	12 to 18 AWG For compliance to CE Mark, the isolated frame ground must be connected. Recommended frame ground connection is via the shortest possible route, using a 14 AWG conductor.

Display

Size	5.75″ 14.6 cm
Colors	65,536 (color) 256 shades of gray (monochrome)
Resolution	320 X 240
Fabrication	Passive STN Transmissive (color) Passive FSTN (monochrome)
Backlight	Cold Cathode Fluorescent (CCFL) - rated half life: 50,000 hours (Monchrome) Cold Cathode Fluorescent (CCFL) - rated half life: 40,000 hours (Color) Backlight not field replaceable.
Luminance	150 NITS (color) 100 NITS (monochrome)

Front Panel

Bezel Material		Valox 3706 For material specifications, visit **www.gepolymerland.com**
Membrane Material		Lexan HP60 For material specifications, visit **www.geplastics.com**
LEDs	Left	Power status indicator (green with power applied, amber if backlight fails)
	Right	Programmable tri-color (green, red, amber)

Touch Screen

Type	Resistive, 12 bit
Resolution	X axis- 320 cells Y axis - 240 cells (after calibration)

CPU

Processor	Intel XScale PXA255
Clock speed	300 Mhz

Memory

FLASH	32 MB
SRAM	512KB (power off retention is the life of the battery)
DRAM	32 MB
ROM	512 KB (Boot loader)

Memory Expansion Slot

Form Factor	100 pin DIMM
Memory Type	SDRAM
Maximum DRAM	64 MB
Maximum Devices/Module	4
Bus Width	32 bits
Bus Speed	100 MHz or faster
Voltage	3.3 VDC
CAS Latency	CL=3
Refresh Type	Self
Refresh Cycle Time	64 ms maximum
Error Correction	Non-ECC
Error Detection	No parity
Buffering	None
Device Row Addressing	12 Address Lines (A0 to A11)
Expansion Memory Catalog Number	32MB - IC754ACC32MEM 64MB - IC754ACC64MEM

Expansion Ports

Compact Flash Memory	One slot (Type 2), 3.3v only
FieldBus	One slot

Communication Ports

Ethernet	IEEE 802.3 10BaseT/100BaseTx RJ45 connector Two status LEDs Maximum cable length: 30M
Serial COM1	EIA232C/EIA485, DP25S (female)
Speed	300 bps - 115200 bps
Mounting h/w	M2.6 jackscrew
Fuse	1.0A, 125V fast blow cartridge type, Littlefuse part #154001

Environmental

	Mono	Color
Operating Temperature[1]	14°F to 140°F (-10°C to 60°C)	32°F to 140°F (0°C to 60°C)
Operating Humidity	10% to 85%, non-condensing	10% to 90%, non-condensing
Storage Temperature[1]	-4 to 158°F -20 to 70 °C	-4 to 158°F -20 to 70 °C
Storage Humidity	10% to 85%, non-condensing	10% to 90%, non-condensing
NEMA Rating	4, 4x, and 12 - Applies to front of installed unit when mounted in a comparably rated NEMA panel. (NEMA 4 is approximately equal to IP56; visit www.nema.org).	4, 4x, and 12 - Applies to front of installed unit when mounted in a comparably rated NEMA panel. (NEMA 4 is approximately equal to IP56; visit www.nema.org).
Operational Vibration	IEC 68-2-6 10 - 57Hz, 0.012″ peak to peak displacement 57 - 500Hz, 1.0g acceleration	IEC 68-2-6 10 - 57Hz, 0.012″ peak to peak displacement 57 - 500Hz, 1.0g acceleration
Operational Shock	IEC 68-2-27 15g, 11ms (sine wave)	IEC 68-2-27 15g, 11ms (sine wave)

[1] Rated temperature limits refers to the ambient air temperature immediately surrounding (less than 3″ or 7.6 cm) the QuickPanel inside the enclosure in which the QuickPanel is mounted. Additional provisions for remaining within the stated limits must be considered where additional, external thermal loads are imposed on the QuickPanel. These could include large heat producing motor drives, or power supplies in the same cabinet or in outdoor applications involving direct sun exposure.

Battery

Type	BR2032 (3V, 190mAh, lithium)
Life (Approximate)	5 years

Calendar/Clock

Resolution	1 second
Accuracy	+/- 2 to 3 minutes/month
Retention	Life of battery

Agency Qualifications

Model # ES0601 (mono)
Model # ES0611 (color)

Description	Agency Standard or Marking	Comments
North American Safety for Industrial Control Equipment	UL 508/C-UL	Certification by Underwriter's Laboratories to UL standard and equivalent CSA standard
North American Safety for Hazardous Locations Class I, Div. 2, Groups A, B, C, D	UL 1604/C-UL	Certification by Underwriter's Laboratories to UL standard and equivalent CSA standard
Enclosures for Electrical Equipment	UL 50	Certification by Underwriter's Laboratories to Type 4, 4X
Explosive Atmospheres Directive European Safety for Hazardous Locations Equipment Group II, Category 3	ATEX (when mounted in an IP66-rated panel)	Certification in accordance with European directives; refer to Declaration of Conformity and Independent 3rd Party Assessment Certificate
Low Voltage Directive European Safety for Industrial Control Equipment	CE	Self-declaration in accordance with European directives; refer to Declaration of Conformity

Description	Agency Standard or Marking	Comments
Electromagnetic Compatibility Directive European EMC for Industrial Control Equipment	CE	Certification by competent body in accordance with European directives; refer to Declaration of Conformity

A2 Troubleshooting

The tables contained in this appendix can be used to identify and remedy problems that can occur with the 6" QuickPanel View.

Power up

Problem	Suggested remedy
Blank screen.	Check all power connections to the QuickPanel. **Note:** Left LED glows amber when backlight fails.

Pocket Internet Explorer

Problem	Suggested remedy
Cannot access any URLs when using a dial-up connection to an ISP.	If you have previously set up an IP address on a local Ethernet Network, it must be cleared. Disconnect your Ethernet cable and reboot. Your ISP will reassign an IP address when you reconnect the cable.

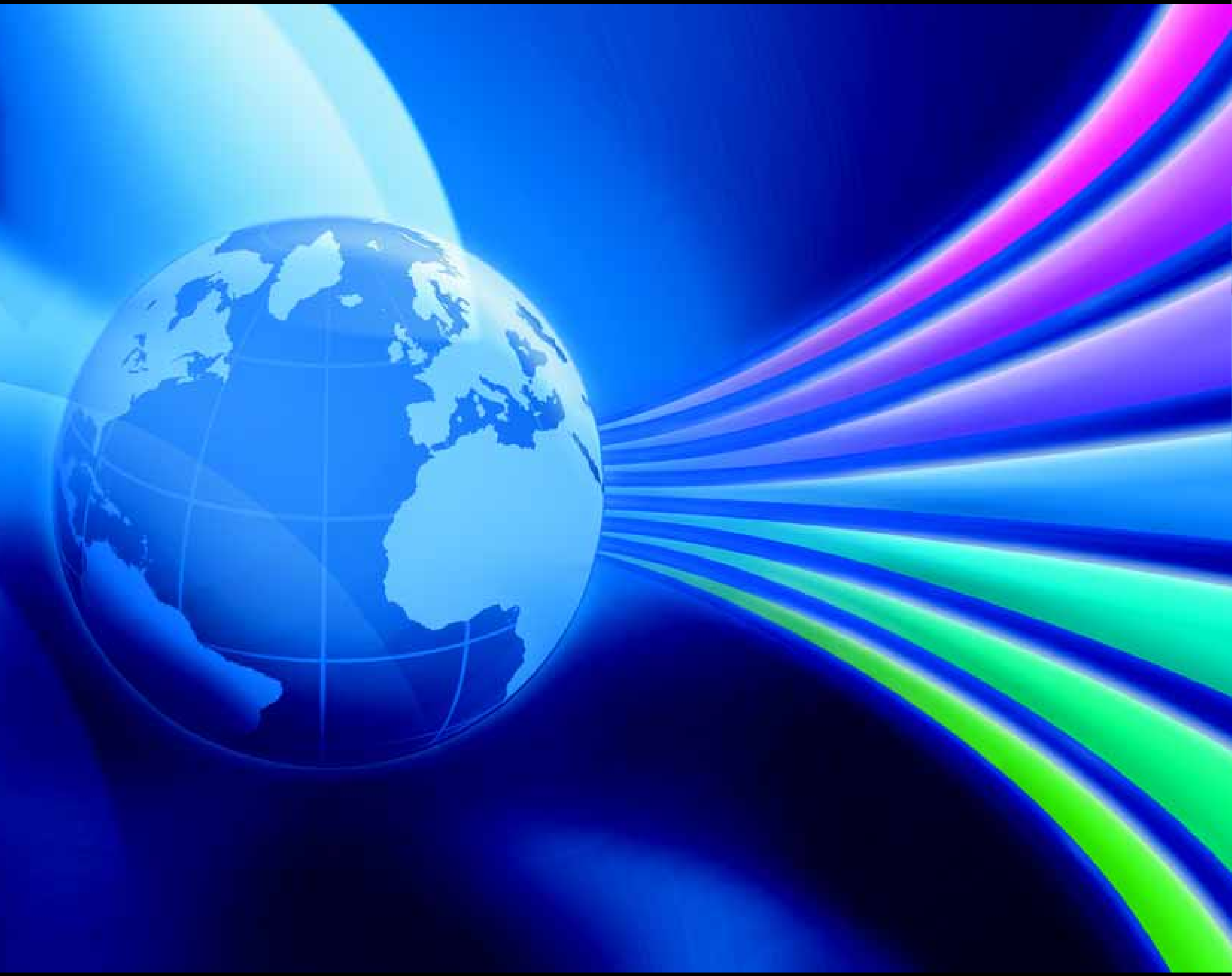
Physical Unit

Problem	Suggested remedy
Slow or sluggish touch response.	Ensure that configured I/O or communications channels such as serial or Ethernet are operating without error. These errors can cause higher system overhead leading to delayed response to touch inputs. Ensure that flash drives, internal or external, are operating without error. If the flash drives are highly fragmented or corrupted, reads & writes to the drive can experience significant delays leading to delayed response to touch inputs. Corrupted external flash drives may be corrected with Storage Manager. See “Storage Manager” on page 18.

Problem	Suggested remedy
After adding expansion memory in the DIMM connector, the system won't boot, or, if it does boot, it displays an error message.	When the system is first started, observe the screen to notice any memory error messages from the boot loader. If error messages such as the following are seen, "DIMM not 12 row" or "DIMM not 32 bit" or "DIMM Refresh Unsupported", power down the system and remove the memory module. If the error message is displayed from the Windows CE desktop, also power down the system and remove the memory module. For proper operation, expansion memory modules must meet the requirements stated in the Design Specifications on page 59.

Index

Catalogue 32



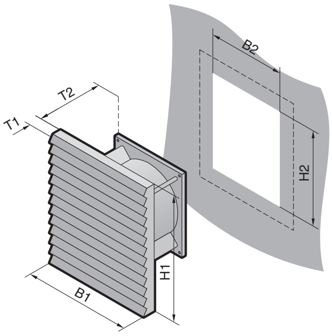
Global = Faster, better, more efficient.

FRIEDHELM LOH GROUP

RITTAL®

Fan-and-filter units

Air throughput 20/55 m^3/h



B = Width
T = Depth

Supply includes:
Fan-and-filter units ready for installation, including filter mats.

German registered design no. M 93 04 846

Approvals,
see page 85.

Performance diagrams,
available on the Internet.

Model No. fan-and-filter unit SK		**3321.107**	**3321.117**	**3321.027**	**3321.047**[1]	**3322.107**	**3322.117**	**3322.027**	**3322.047**[1]
Rated operating voltage V, Hz		230, 50/60	115, 50/60	24 (DC)	48 (DC)	230, 50/60	115, 50/60	24 (DC)	48 (DC)
Dimensions in mm	B1/H1	116.5				148.5			
	B2/H2	92 + 0.8[2]				124[2]			
	T1	10				10.5			
Max. installation depth mm	T2	42				57			
Air throughput, unimpeded air flow		**20/25 m^3/h**		**20 m^3/h**		**55/66 m^3/h**		**55 m^3/h**	
Air throughput with outlet filter including standard filter mat		1 x SK 3321.207: **15/18 m^3/h**				1 x SK 3322.207: **43/50 m^3/h**			
Axial fan		Self-starting shaded pole motor		DC motor		Self-starting shaded pole motor		DC motor	
Rated current max.		69 mA 58 mA	138 mA 115 mA	125 mA	90 mA	0.12 A 0.11 A	0.24 A 0.23 A	0.35 A	90 mA
Power		12.5 W/10.3 W		3.0 W	4.1 W	19.0 W/18.0 W		7.7 W	4.4 W
Noise level		41/46 dB (A)		41 dB (A)		46/49 dB (A)		46 dB (A)	
Temperature range		–10°C to +55°C							
Colour		RAL 7035[3]							
Protection category to EN 60 529/09.2000		IP 54 standard IP 56 when using a hose-proof hood							
Model No. outlet filter SK		**3321.207**				**3322.207**			

Accessories	Packs of									Page
Spare filter mats	5	3321.700				3322.700				725
Thermostat	1	3110.000								715
Temperature indicator	1	3114.100	3114.115	3114.024	–	3114.100	3114.115	3114.024	–	714
Speed control	1	3120.000	3120.115	–	–	3120.000	3120.115	–	–	716
Hose-proof hood	1	3321.800				3322.800				721

[1] Delivery times on request.
[2] For metal thickness > 2.5 mm the cut-out B2/H2 must be 1 mm larger.
[3] RAL 7032 on request.
Special voltages available on request. We reserve the right to make technical modifications.

Accessories Page 710 **EMC-protected design** Page 694 **Configuration software** Page 1155

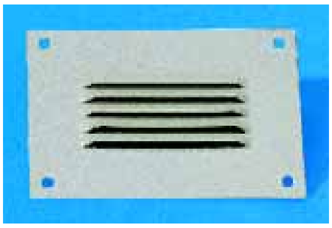
Handbook 31

www.fascinating-future.com

FRIEDHELM **LOH** GROUP

Accessories For Climate Control

General



Integrated louvers

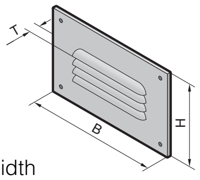
For ventilation by convection; easily retrofitted using 4 screws.

Material:
Sheet steel

Color:
RAL 7035 (light gray)

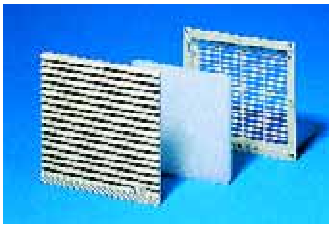
H mm (inches)	W mm (inches)	D mm (inches)	PU	**Part No. SK**
110 (4.3)	160 (6.3)	8 (0.3)	4	**2541.235**
100 (3.9)	210 (8.3)	8 (0.3)	4	**2542.235**
110 (4.3)	330 (13.0)	8 (0.3)	4	**2543.235**

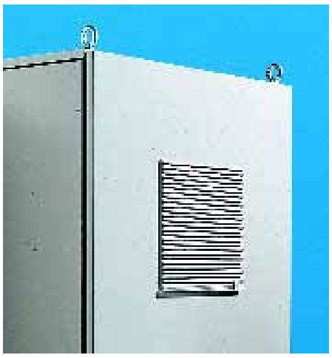
For RAL 7032 (pepple gray), use order extension .200;
to order primed version, use extension .300.
Delivery times available on request.



B = Width
T = Depth

Detailed drawing,
see page 1184.





Outlet filter

For ventilation by convection, an outlet filter can be installed in the upper and lower sections of the modular enclosure.

Material:
ABS,
material resistance to UL 94-V0.

Color:
RAL 7035 (light gray)

Configuration:
Outlet filter including filter mat.

Dimensions in mm (inches)	**Part No. SK**
116 x 22 (4.6 x 0.9)	**3321.207**
148 x 24.5 (5.9 x 1.0)	**3322.207**
204 x 30 (8.0 x 1.2)	**3323.207**
255 x 30 (10.0 x 1.2)	**3325.207**
323 x 30 (12.7 x 1.2)	**3326.207**

For RAL 7032 (pebble gray), use order extension .200.

Note:
EMC version,
see page 640.

Accessories:

Spare filter mats,
see page 670.
Fine filter mats,
see page 670.

Hose-proof hoods

For filter fan units/outlet filters

When the hose-proof hood is mounted above the filter fan unit and outlet filter in conjunction with a fine filter mat, a rating of IP 56 (NEMA 3R) to EN 60 529/10.91 is achieved. Particularly suitable for use in the food industry.

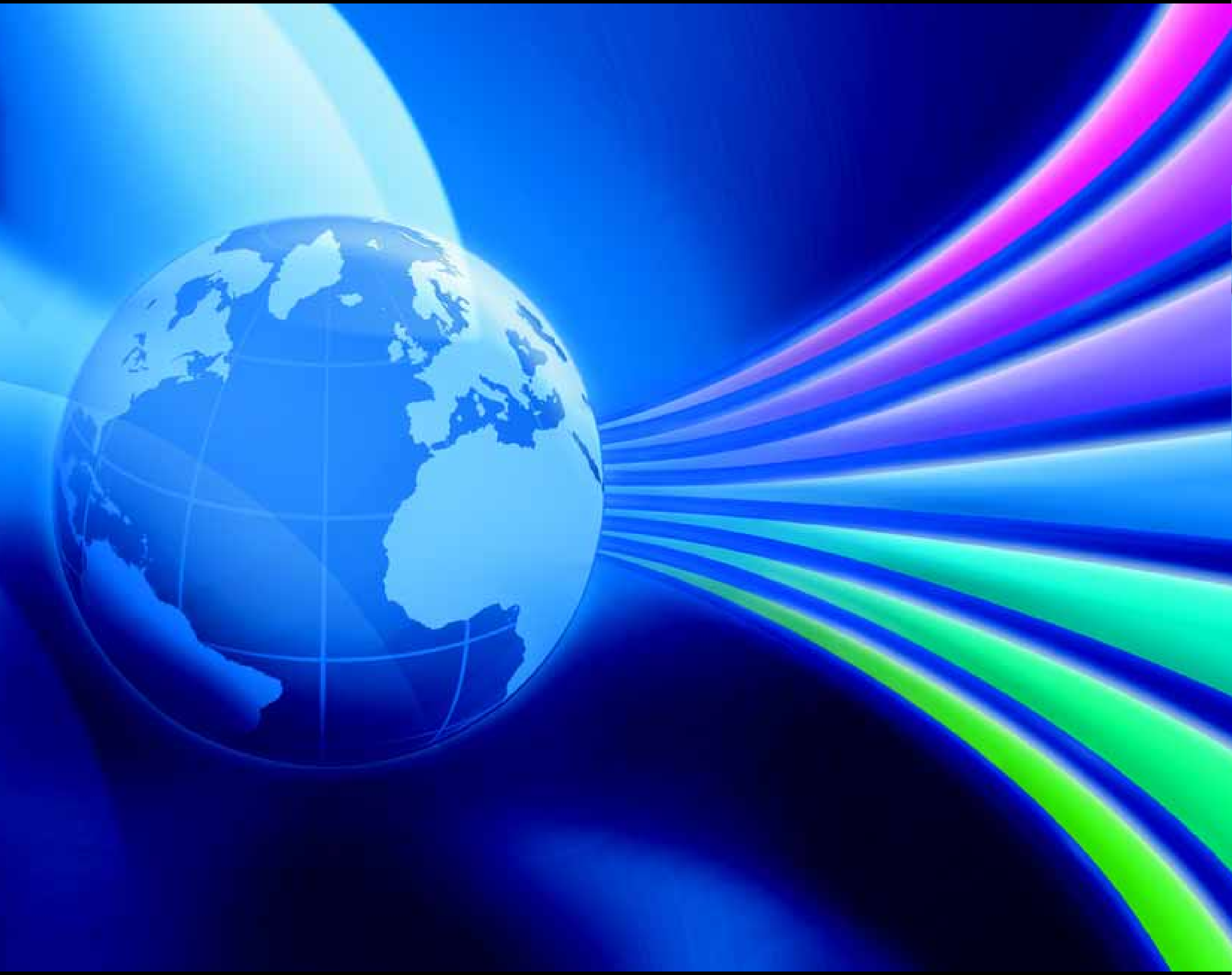
Material:
Stainless steel

Protection ratings:
In conjunction with the filter fan units/outlet filters, NEMA 3R + 12 is met.

For	Dimensions in mm (inches)	**Part No. SK**
SK 3321. . . .	260 x 150 x 40 (10.2 x 5.9 x 1.6)	**3321.800[1]**
SK 3322. . . .	270 x 176 x 55 (10.6 x 6.9 x 2.2)	**3322.800**
SK 3323. . . .	410 x 233 x 55 (16.1 x 9.2 x 2.2)	**3323.800**
SK 3324. . . . SK 3325. . . .	500 x 282 x 85 (19.7 x 11.1 x 3.3)	**3324.800**
SK 3326. . . . SK 3327. . . .	560 x 350 x 110 (22.0 x 13.8 x 4.3)	**3326.800**

[1] Delivery times available on request.

Catalogue 32



Global = Faster, better, more efficient.

FRIEDHELM LOH GROUP

RITTAL®

Filter technology for cooling units

Lint screen

Especially for the use of cooling units and air/air heat exchangers where there is a high proportion of lint in the ambient air.

Material:
Stainless steel mesh

For devices	Packs of	**Model No. SK**
SK 3304. . . . ./SK 3305. . . . ./ SK 3328. . . . ./SK 3329. . . . ./ SK 3338.	1	**3329.904**

Delivery times available on request.

Louvred grille for lint screen

Material:
ABS

For	Packs of	**Model No. SK**
SK 3329.904	1	**3329.903**

Delivery times available on request.

Spare filter mats for fan-and-filter units

Made of chopped-fibre mat with a progressive structure.
Temperature-resistant to 100°C, self-extinguishing category F1 to DIN 53 438.
Dust-laden air side: Open structure.
Clean air end: Closed structure.
Reliable filtering of virtually all types of dust from a particle size of 10 µm.

Material:
Chemical fibre

For fan-and-filter units	W x H x D mm	Packs of	**Model No. SK**
SK 3321. . . .	89 x 89 x 10	5	**3321.700**
SK 3322. . . .	120 x 120 x 12	5	**3322.700**
SK 3323. . . .	173 x 173 x 17	5	**3171.100**
SK 3324. . . ./SK 3325. . . .	221 x 221 x 17	5	**3172.100**
SK 3326. . . .	289 x 289 x 17	5	**3173.100**
SK 3327. . . .	286 x 286 x 10	5	**3327.700**

For filter holders	W x H x D mm	Packs of	**Model No. SK**
SK 3175.000	338 x 242 x 20	3	**3174.000**

Fine filter mats for fan-and-filter units

Made of chopped-fibre mat with a progressive structure. Temperature-resistant to 100°C, self-extinguishing category F1 to DIN 53 438.
Dust-laden air side: Open structure.
Clean air end: Closed structure.
Reliable filtering of virtually all types of dust from a particle size of 10 µm.

Material:
Chemical fibre

For fan-and-filter units/outlet filters	W x H x D mm	Packs of	**Model No. SK**
SK 3323. . . .	173 x 173 x 12	5	**3181.100**
SK 3324. . . ./SK 3325. . . .	221 x 221 x 12	5	**3182.100**
SK 3326. . . ./SK 3327. . . .	289 x 289 x 12	5	**3183.100**

MDS 1710 Transceiver Series

Fixed Frequency Licensed Solutions

Features

- High Performance – Digital Signal Processing (DSP) Engine
- Flexibility – Single Unit Configurable as Master or Remote Radio

Applications

- Gas/oil production and distribution
- Water, gas and electric utilities
- Lotteries
- Traffic control
- Industrial process control
- Railroad communication systems

MDS...Global wireless solutions. Industrial Wireless Performance.

For nearly two decades, Microwave Data Systems (MDS) has been providing highly secure, industrial strength mission critical wireless communications solutions for a broad spectrum of public and private sector clients worldwide. With an installed base approaching 1,000,000 radios in 110 countries, MDS offers both licensed and license-free solutions with applications in SCADA, telemetry, public safety, telecommunications, and online transaction markets.

MDS Transceiver Series Overview

The MDS 1710 Transceiver Series is a price/performance leading solution for licensed radio in the 130-174 MHz frequency range. MDS 1710 is available in the following VHF bands: 130-140 MHz, 140-150 MHz, 150-165 MHz, and 165-174 MHz. These radios provide increased throughput, and longer-range for multiple address systems. Transparent and direct asynchronous communication offers real-time communication.

No extra software or programming is needed to implement communications using standard asynchronous protocols. A general purpose (unconditioned) digital output is available.

The MDS Transceiver Series is field configurable as a master station or remote radio. They can operate as a half-duplex or simplex radio. They support all splits in duplex frequencies. When operating as a master station, full network diagnostics are available. Simplex mode permits peer-to-peer radio communications.

Why Consider a MDS Transceiver Series Solution?

High system performance and data integrity! Through robust construction, digital signal processing technology (DSP) and up to 19.2 kbps data throughput.

Rapid Installation! Quick return on investment due to ease of wireless installation. This licensed radio offers the ability to communicate with any asynchronous protocol without extra software or extra programming.

Performance under the most adverse conditions! Exceptional design provides excellent performance in the face of interference or difficult signal paths.

Network Wide Diagnostics! MDS InSite™ Network Management software simplifies maintenance tasks and reduces the cost of managing the network infrastructure. Provides a non-intrusive means of maintenance and link monitoring.

MDS

INDUSTRIAL WIRELESS PERFORMANCE

MDS 1710 Transceiver Series Specifications

General

MDS 1710A

- Frequency Band: 130 to 174 MHz
- Banding (MHz) : 130-140, 140-150, 150-165, 165-174
- Freq. Programmability: 5, 6.25 kHz increments, any MAS channel pair
- 4 Wire Analog
- Data Rate: 9600 bps (rf)
- Port Speed: 110 bps - 38,400 kbps (data)
- Channel Spacing: 12.5, 15 kHz
- Bit Error Rate: BER 1x10^{-6} @ -110 dBm typical
- Diagnostics: Network Wide Diagnostic Option
- Agency Approvals: FCC Part 90 (150-174 MHz bands)
- Available Now

MDS 1710C

- Frequency Band: 130 to 174 MHz
- Banding (MHz): 130-140, 140-150, 150-165, 165-174
- Freq. Programmability: 5, 6.25 kHz increments, any MAS channel pair
- 4 Wire Analog
- Data Rate: 19,200 bps (rf)
- Port Speed: 110 bps - 38,400 kbps (data)
- Channel Spacing: 25, 30 kHz
- Bit Error Rate: BER 1x10^{-6} @ -105 dBm typical
- Diagnostics: Network Wide Diagnostic Option
- Agency Approvals: FCC Part 90 (150-174 MHz bands)
- Available Now

All Models

- Operational Modes: Async. - Simplex, half-duplex
- Data Interface: RS-232, DB-25 Female Connector
  Supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX POWER, DSR, and GND

Transmitter

- Frequency Stability: +/- 0.00015% 1.5 ppm (MDS 1710F = 1.0 ppm)
- Carrier Power: 0.1 to 5 Watts Programmable
- Carrier Power Accuracy: Normal +/- 1.5 dB
- Duty Cycle: Continuous
- Output Impedance: 50 Ohms

Receiver

- Type: Double Conversion Superheterodyne
- Frequency Stability: +/- 0.00015% (1.5 ppm)
- Adjacent Channel (EIA): 60 dB nominal

Power Supplies

- Primary Power: Voltage 13.8 Vdc nominal (10.5 to 16 Vdc operating range)
- Tx Current: 2A Typical at 5 Watts
- Rx Current: <125 mA
- Sleep Mode: 15 mA nominal

Modem / Diagnostics

- Modulation: Digital / CPFSK
- CTS Delay: 0-255 msec programmable in 1 msec increments
- PTT Delay: 0-255 msec programmable in 1 msec increments

Physical

- Case: Rugged Die Cast Aluminum
- Dimensions: 5.08 H x 14.29 W x 18.4 D cm. (2.0 H x 5.625 W x 7.25 D in.)
- Weight: 1 kg. (2.2 lbs.)

Environmental

- Temperature Range: -30°C to +60°C (-22°F to +140°F)
- Humidity: 95% at 40°C (104°F) non-condensing

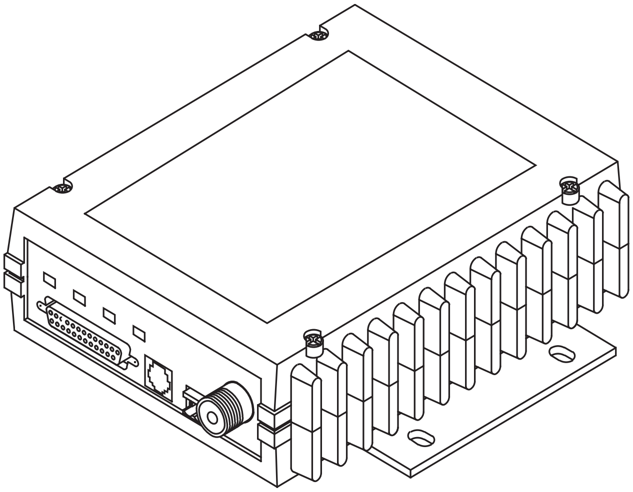
Microwave Data Systems Inc.
175 Science Parkway
Rochester, New York 14620, USA
Phone (585) 242-9600
Fax (585) 242-9620
www.microwavedata.com

(Part No. 1710) SL0103 Rev. F, 09-29-03

Installation & Operation Guide

Microwave Data Systems Inc.

MDS 1710 A/C
MDS 2710A/C/D



Data Transceiver

MDS 05-3447A01, REV. F
SEPTEMBER 2004

industrial/wireless/performance

QUICK START GUIDE

Below are the basic steps for installing the transceiver. Detailed instructions are provided in “Installation Steps” on Page 9 of this manual.

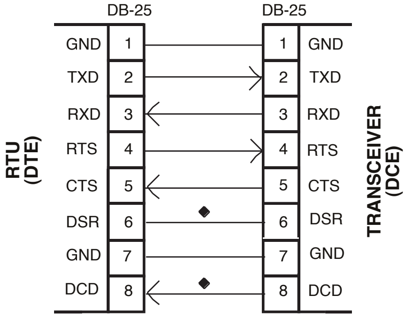
1. Install and connect the antenna system to the radio

- Use good quality, low loss coaxial cable. Keep the feedline as short as possible.
- Preset directional antennas in the direction of desired transmission/reception.

2. Connect the data equipment to the radio’s INTERFACE connector

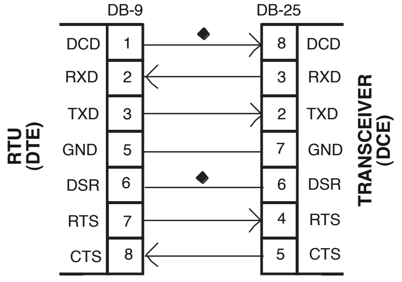
- Connection to the radio must be made with a DB-25 Male connector. Connections for typical systems are shown below.
- Connect only the required pins. Do not use a straight-through RS-232 cable with all pins wired.
- Verify the data equipment is configured as DTE. (By default, the radio is configured as DCE.)

DB-25 to DB-25 Example



◆ As required for application

DB-9 to DB-25 Example



◆ As required for application

3. Apply DC power to the radio (10.5–16 Vdc @ 2.5 A minimum)

- Observe proper polarity. The red wire is the positive lead; the black is negative.

4. Set the radio’s basic configuration with a Hand-Held Terminal (HHT)

- Set the transmit frequency (**TX xxx.xxxxx**).
- Set the receive frequency (**RX xxx.xxxxx**).
- Set/verify the data rate using the **BAUD** command. The default setting is **BAUD 4800 8N1**. (Refer to “TRANSCEIVER PROGRAMMING” on Page 17 for command details.)

5. Verify proper operation by observing the LED display

- Refer to Table 5 on Page 16 for a description of the status LEDs.
- Refine directional antenna headings for maximum receive signal strength using the **RSSI** command.

TABLE OF CONTENTS

Copyright Notice

To Our Customers

We appreciate your patronage. You are our business. We promise to serve and anticipate your needs. We will strive to give you solutions that are cost effective, innovative, reliable and of the highest quality possible. We promise to build a relationship that is forthright and ethical, one that builds confidence and trust.

RF Safety Notices

RF Exposure

MDS 1710, 5 Watts

The radio equipment described in this guide emits radio frequency energy. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. Do not allow people to come closer than **1.80** meters to the front of the antenna when the transmitter is operating with a 7 dBd (9.15 dBi) gain antenna. Use of higher gain antennas means increasing the distance accordingly.

This manual is intended to guide a *professional installer* to install, operate and perform basic system maintenance on the described radio.

MDS 2710A/C, 2 Watts

The radio equipment described in this guide emits radio frequency energy. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. Do not allow people to come closer than **0.425** meters to the front of the antenna when the transmitter is operating with a 0 dBd (2.15 dBi) gain antenna. Use of higher gain antennas means increasing the distance accordingly.

This manual is intended to guide a *professional installer* to install, operate and perform basic system maintenance on the described radio.

MDS 2710D, 5 Watts

The radio equipment described in this guide emits radio frequency energy. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. Do not allow people to come closer than **1.50** meters to the front of the antenna when the transmitter is operating with a 7 dBd (9.15 dBi) gain antenna. Use of higher gain antennas means increasing the distance accordingly.

This manual is intended to guide a *professional installer* to install, operate and perform basic system maintenance on the described radio.

ISO 9001 Registration

Microwave Data Systems' adheres to this internationally accepted quality system standard.

FCC Approval Notice

At the printing date, MDS 1710 models are approved for operation in the USA from150 to 174 MHz. MDS 2710 models are approved for operation in the USA from 216 to 222 MHz. Contact MDS for current approval status.

CSA/US Notice

This product is available for use in Class I, Division 2, Groups A, B, C & D Hazardous Locations. Such locations are defined in Article 500 of the National Fire Protection Association publication NFPA 70, otherwise known as the National Electrical Code.

The product has been recognized for use in hazardous locations by the Canadian Standards Association (CSA), which also issues the US mark of approval (CSA/US). The CSA Certification is in accordance with CSA STD C22.2 No. 213-M1987. The product has been evaluated in accordance with the following standards:

- CSA Std C22.2 No. 142-M1987 - Process Control Equipment
- CSA Std C22.2 No. 213-M1987 - Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
- ANSI/UL Std No. 508 - Industrial Control Equipment
- UL Std No. 1604 - Electrical Equipment for Use in Class I and II, Division 2; Class III Hazardous (Classified) Locations

FCC Part 15 Notice

The transceiver complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. This device is specifically designed to be used under Section 15.247 of the FCC Rules and Regulations. Any unauthorized modification or changes to this device without the express approval of Microwave Data Systems may void the user's authority to operate this device. Furthermore, this device is intended to be used only when installed in accordance with the instructions outlined in this manual. Failure to comply with these instructions may also void the user's authority to operate this device.

Manual Revision and Accuracy

While every reasonable effort has been made to ensure the accuracy of this manual, product improvements may result in minor differences between the manual and the product shipped to you. If you have additional questions or need an exact specification for a product, please contact our Customer Service Team using the information at the back of this guide. In addition, manual updates can often be found on the MDS Web site at www.microwavedata.com. Microwave Data Systems Inc. reserves the right to correct all errors or omissions in this document without obligation to any party.

1.0 GENERAL

1.1 Introduction

This guide presents installation and operating instructions for MDS 1710A/C and MDS 2710 A/C/D series digital radio transceivers.

These transceivers (Figure 1) are data telemetry radios designed to operate in a point-to-multipoint environment, such as electric utility Supervisory Control and Data Acquisition (SCADA) and distribution automation, gas field automation, water and wastewater SCADA, and on-line transaction processing applications. They use microprocessor control and Digital Signal Processing (DSP) technology to provide highly reliable communications even under adverse conditions.

MDS 1710/2710 Series radios use continuous-phase frequency shift keying (CPFSK) modulation with root duo-binary filtering (the sum of two Nyquist-shaped, root-raised cosine responses). Demodulation uses a Virterbi decoder and equalization with soft decision decoding.

Modulation and demodulation is accomplished using Digital Signal Processing (DSP). DSP adapts to differences between components from unit to unit, and ensures consistent and repeatable performance in ambient temperatures from –30 to +60 degrees Celsius. The use of Digital Signal Processing eliminates the fluctuations and variations in modem operation that can degrade the operation of analog circuits.

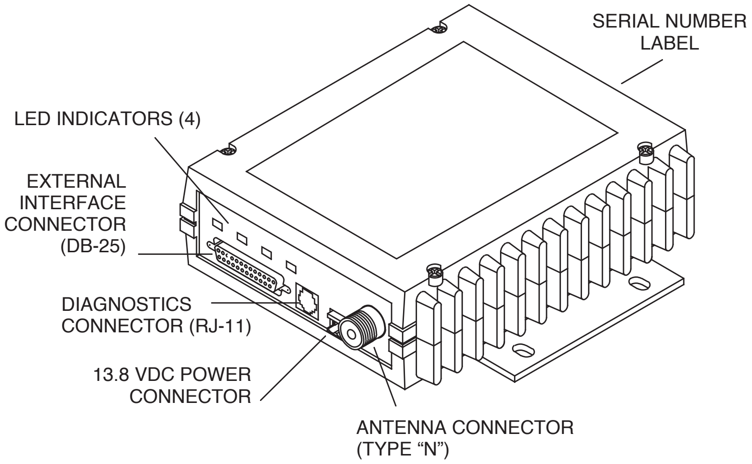


Figure 1. Transceiver Connectors and Indicators

The transceiver is designed for trouble-free operation with data equipment provided by many other manufacturers, including Remote Terminal Units (RTUs), programmable logic controllers (PLCs), flow computers, lottery terminals, automatic teller machines, and others.

NOTE: Some features may not be available, based on the options purchased and the applicable regulations for the region in which the radio will operate.

1.2 Differences Between Models

All models of the MDS 1710/2710 Series are very similar in appearance and functionality. The major differences are in frequency coverage, channel bandwidth and data speed. Table 1 summarizes the available models and identifies the characteristics of each.

To determine the specific settings for your radio (as originally shipped from the factory), please refer to the Product Configurator chart shown in Figure 4.

Table 1. MDS 1710/2710 Series Characteristics

Radio Model No.	Operating Frequency	Channel Bandwidth	Over-the-Air Data Speed	Output Power (W)
MDS 1710A	130–174 MHz	12.5 kHz	9600 bps	5
MDS 1710C	130–174 MHz	25 kHz	19200 bps	5
MDS 2710A	216–220 MHz	12.5 kHz	9600 bps	2
MDS 2710A	220–240 MHz	12.5 kHz	9600 bps	5
MDS 2710C	216–220 MHz	25 kHz	19200 bps	2
MDS 2710C	220-240 MHz	25 kHz	19200 bps	5
MDS 2710D	220–222 MHz	5 kHz	3200 bps	5

Consult factory for current regulatory approvals on these products.

NOTE: The operating software for A, C, and D models is *not* interchangeable.

NOTE: The narrow bandwidth of the MDS 2710D transceiver is not compatible with standard analog modems, including the widely used Bell 202T. The MDS 2710D is intended for digital RS-232 data only.

1.3 Applications

Point-to-Multipoint, Multiple Address Systems (MAS)

This is the most common application of the transceiver. It consists of a central master station and several associated remote units as shown in Figure 2. An MAS network provides communications between a central host computer and remote terminal units (RTUs) or other data collection devices. The operation of the radio system is transparent to the computer equipment.

Often, a radio system consists of many widely separated remote radios. A point-to-multipoint or SCADA (Supervisory Control and Data Acquisition) system may be a new installation for automatic, remote monitoring of gas wells, water tank levels, electric power distribution system control and measurement, etc.

The radio system may replace a network of remote monitors currently linked to a central location via leased telephone line. At the central office of such a system, there is usually a large mainframe computer and some means of switching between individual lines coming from each remote monitor. In this type of system, there is a modulator/demodulator (modem) at the main computer, and at each remote site, usually built into the remote monitor itself. Since the cost of leasing a dedicated-pair phone line is quite high, radio is often used as an alternative communication medium.

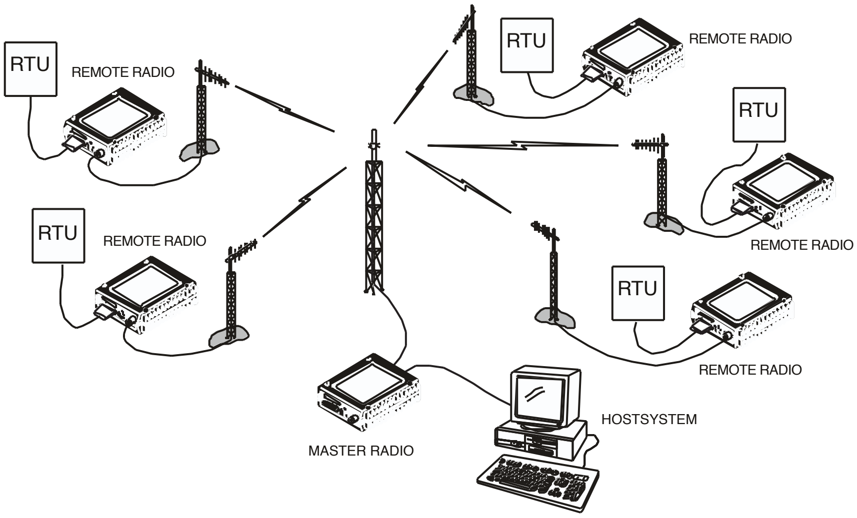


Figure 2. Typical MAS Point-to-Multipoint Network

Point-to-Point System

Where permitted, the transceiver may also be used in a point-to-point arrangement. A point-to-point system consists of just two radios—one serving as a master and the other as a remote—as shown in Figure 3. It provides a simplex or half-duplex communications link for the transfer of data between two locations.

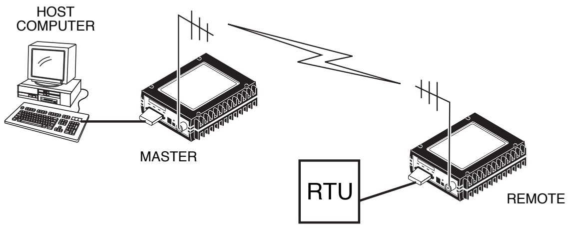


Figure 3. Typical Point-to-Point Link

Continuously Keyed vs. Switched Carrier Operation

The keying behavior of the master station can be used to describe an MAS system.

Continuously Keyed operation means the master station transmitter is always transmitting a carrier, even when there is no data to send. The master station is always simultaneously transmitting and continuously listening. Different frequencies must be used for transmit and receive.

Switched Carrier operation is a half-duplex mode of operation where the master station transmitter is keyed to send data and unkeyed to receive.

Single Frequency (Simplex) Operation

Single frequency operation (also known as simplex) is a special case of switched carrier operation. Single frequency operation is automatically selected whenever the transmit and receive frequencies are set to the same value. Note that data turn-around times are increased when a single frequency configuration is used.

1.4 Product Configurator Codes

The full radio model number is printed on the radio enclosure. It provides key information about how the radio was configured when it was originally shipped from the factory. See Figure 4 for an explanation of the configurator codes.

THIS INFORMATION IS SUBJECT TO CHANGE.

DO NOT USE FOR PRODUCT ORDERING.

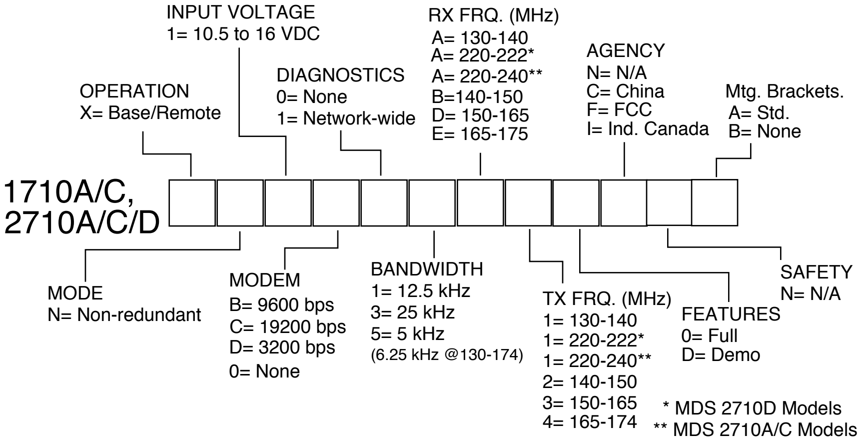


Figure 4. MDS 1710x/2710x Product Configurator Codes

1.5 Accessories

The transceiver can be used with one or more of the accessories listed in Table 2. Contact Microwave Data Systems for ordering information.

Table 2. MDS 1710/2710 Series Optional Accessories

Accessory	Description	MDS P/N
Hand-Held Terminal Kit (HHT)	Terminal that plugs into the radio for programming, diagnostics & control. Includes carrying case, instructions and cable set.	02-1501A01
RTU Simulator	Test module that simulates data from a remote terminal unit. Comes with MDS polling software (02-2093Axx) that runs on a PC. Useful for testing radio operation.	03-2512A01
Order Wire Module	External device that allows temporary voice communication. Useful during setup & testing of the radio system.	02-1297A01
Power Supply Kit	AC adaptor that converts 110/220 Vac to 12 Vdc at 30 watts.	01-3682A01
Order Wire Handset	Used with Order Wire Module (above).	12-1307A01
RJ-11 to DB-9 Adapter	Used to connect a PC to the radio's DIAG. port	03-3246A01
EIA-232 to EIA-422 Converter Assembly	External adapter plug that converts the radio's DATA INTERFACE connector to EIA-422 compatible signaling.	03-2358A01
TTL Converter Assembly	External adapter plug that converts the radio's DATA INTERFACE connector to TTL compatible signaling.	03-2223A01
Radio Configuration Software	Provides diagnostics of the transceiver (Windows-based PC required.)	03-3156A01
VOX Assembly	External unit used to key the radio when audio input is present.	03-1098A02
19-inch Rack Mounting Kit	Allows mounting the transceiver in a standard 19 inch rack cabinet. (Power supply and Interface Board not included.)	02-1983A02
Brown-Out Protection Board	PCB that protects against low voltage conditions.	03-2567A01

2.0 GLOSSARY OF TERMS

If you are new to digital radio systems, some of the terms used in this guide may be unfamiliar. The following glossary explains many of these terms and will prove helpful in understanding the operation of the transceiver.

Active Messaging—This is a mode of diagnostic gathering that may interrupt SCADA system polling communications (contrast with *passive messaging*). Active (or intrusive) messaging is much faster than passive messaging because it is not dependent upon the RTU polling cycle.

Antenna System Gain—A figure, normally expressed in dB, representing the power increase resulting from the use of a gain-type antenna. System losses (from the feedline and coaxial connectors, for example) are subtracted from this figure to calculate the total antenna system gain.

Bit—The smallest unit of digital data, often represented by a one or a zero. Eight bits (plus start, stop, and parity bits) usually comprise a byte.

Bits-per-second—See *BPS*.

BPS—Bits-per-second. A measure of the information transfer rate of digital data across a communication channel.

Byte—A string of digital data usually made up of eight data bits and start, stop and parity bits.

Decibel (dB)—A measure computed from the ratio between two signal levels. Frequently used to express the gain (or loss) of a system.

Data Circuit-terminating Equipment—See *DCE*.

Data Communications Equipment—See *DCE*.

Data Terminal Equipment—See *DTE*.

dBi—Decibels referenced to an "ideal" isotropic radiator in free space. Frequently used to express antenna gain.

dBm—Decibels referenced to one milliwatt. An absolute unit used to measure signal power, as in transmitter power output, or received signal strength.

DCE—Data Circuit-terminating Equipment (or Data Communications Equipment). In data communications terminology, this is the "modem" side of a computer-to-modem connection. The transceiver described in this guide is a DCE device.

Digital Signal Processing—See *DSP*.

DSP—Digital Signal Processing. In the transceiver, the DSP circuitry is responsible for the most critical real-time tasks; primarily modulation, demodulation, and servicing of the data port.

DTE—Data Terminal Equipment. A device that provides data in the form of digital signals at its output. Connects to the DCE device.

Equalization—The process of reducing the effects of amplitude, frequency or phase distortion with compensating networks.

Fade Margin—The greatest tolerable reduction in average received signal strength that will be anticipated under most conditions. Provides an allowance for reduced signal strength due to multipath, slight antenna movement or changing atmospheric losses. A fade margin of 20 to 30 dB is usually sufficient in most systems.

Frame—A segment of data that adheres to a specific data protocol and contains definite start and end points. It provides a method of synchronizing transmissions.

Hardware Flow Control—A transceiver feature used to prevent data buffer overruns when handling high-speed data from the RTU or PLC. When the buffer approaches overflow, the radio drops the clear-to-send (CTS) line, which instructs the RTU or PLC to delay further transmission until CTS again returns to the high state.

Host Computer—The computer installed at the master station site, which controls the collection of data from one or more remote sites.

Intrusive Diagnostics—A mode of remote diagnostics that queries and commands radios in a network with an impact on the delivery of the system "payload" data. See *Active messaging*.

Latency—The delay (usually expressed in milliseconds) between when data is applied to TXD (Pin 2) at one radio, until it appears at RXD (Pin 3) at the other radio.

MAS—Multiple Address System. A radio system where a central master station communicates with several remote stations for the purpose of gathering telemetry data.

Master (Station)—Radio which is connected to the host computer. It is the point at which polling enters the network.

MCU—Microcontroller Unit. This is the processor responsible for controlling system start-up, synthesizer loading, and key-up control.

Microcontroller Unit—See *MCU*.

Multiple Address System—See *MAS*.

Network-Wide Diagnostics—An advanced method of controlling and interrogating MDS radios in a radio network.

Non-intrusive diagnostics—See *Passive messaging*.

Passive messaging—This is a mode of diagnostic gathering that does not interrupt SCADA system polling communications. Diagnostic data is collected non-intrusively over a period of time; polling messages are carried with SCADA system data (contrast with *active messaging*).

Payload data—This is the application's user communication data which is sent over the radio network. It is the transfer of payload data that is the primary purpose of the radio communications network.

Point-Multipoint System—A radio communications network or system designed with a central control station that exchanges data with a number of remote locations equipped with terminal equipment.

Poll—A request for data issued from the host computer (or master PLC) to a remote radio.

PLC—Programmable Logic Controller. A dedicated microprocessor configured for a specific application with discrete inputs and outputs. It can serve as a host or as an RTU.

Programmable Logic Controller—See *PLC*.

Remote (Station)—A radio in a network that communicates with an associated master station.

Remote Terminal Unit—See *RTU*.

Redundant Operation—A station arrangement where *two* transceivers and two power supplies are available for operation, with automatic switchover in case of a failure.

RTU—Remote Terminal Unit. A data collection device installed at a remote radio site. An internal RTU *simulator* is provided with the transceiver to isolate faults to either the external RTU or the radio.

SCADA—Supervisory Control And Data Acquisition. An overall term for the functions commonly provided through an MAS radio system.

Standing Wave Ratio—See *SWR*.

Supervisory Control And Data Acquisition—See *SCADA*.

SWR—Standing Wave Ratio. A parameter related to the ratio between forward transmitter power and the reflected power from the antenna system. As a general rule, reflected power should not exceed 10% of the forward power (≈ 2:1 SWR).

3.0 INSTALLATION

There are three main requirements for installing the transceiver—adequate and stable primary power, a good antenna system, and the correct data connections between the transceiver and the data device. Figure 5 shows a typical remote station arrangement.

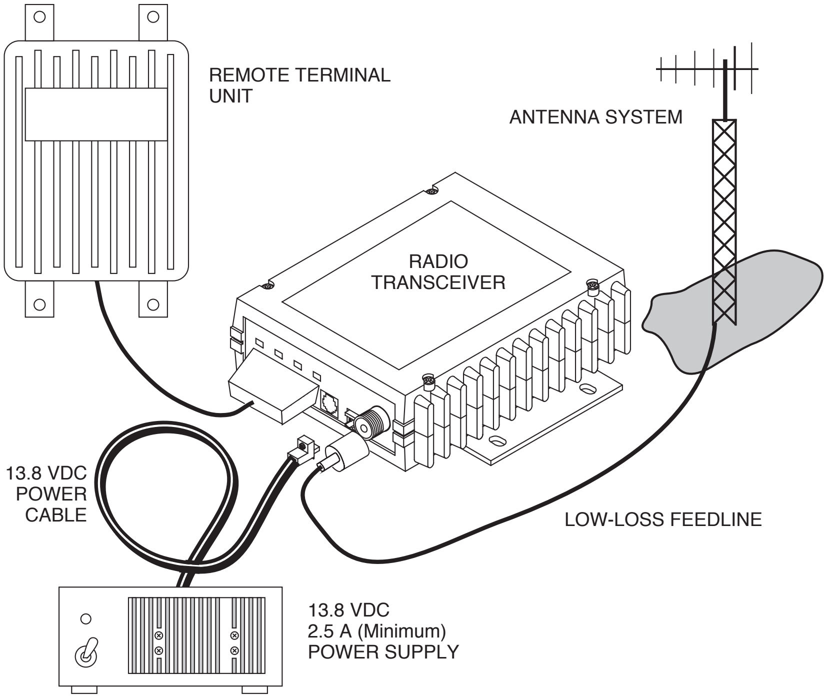


Figure 5. Typical Remote Station Arrangement

3.1 Installation Steps

Below are the basic steps for installing the transceiver. In most cases, these steps alone are sufficient to complete the installation. More detailed explanations appear at the end of these steps.

1. Mount the transceiver to a stable surface using the brackets supplied with the radio.

2. Install the antenna and antenna feedline for the station. Preset directional antennas in the desired direction.

3. Connect the data equipment to the transceiver's DATA INTERFACE connector. Use only the required pins for the application—Do *not* use a fully pinned (25 conductor) cable. Basic applications may require only the use of Pin 2 (transmit data—TXD), Pin 3 (Received Data—RXD) and Pin 7 (signal ground). The radio can be keyed with the use of the **DATAKEY** command.

   Additional connections may be required for some installations. Refer to the complete list of pin functions provided in Table 4 on page 14.

4. Measure and install the primary power for the radio. The red wire on the power cable is the positive lead; the black is negative.

NOTE: Use the radio in negative ground systems only.

5. Set the radio configuration. The transceiver is designed for quick installation with a minimum of software configuration required in most cases. The selections that *must* be made or verified for new installations are:

   - Transmit frequency
   - Receive frequency

   The operating frequencies are not set at the factory unless they were specified at the time of order. Determine the transmit and receive frequencies to be used, and follow the steps below to program them.

6. Connect a hand-held terminal (HHT) to the DIAG. connector. When the HHT beeps, press ENTER to receive the ready ">" prompt.

   - Set the operating frequencies using the **TX xxx.xxxxx** (transmit) and **RX xxx.xxxxx** (receive) commands.
   - Press ENTER after each command. After programming, the HHT reads **PROGRAMMED OK** to indicate successful entry.
   - Set other transceiver parameters as required. A complete list of transceiver commands is provided in *Section 5.0, TRANSCEIVER PROGRAMMING*.

3.2 Transceiver Mounting

Figure 6 shows the mounting dimensions of the transceiver.

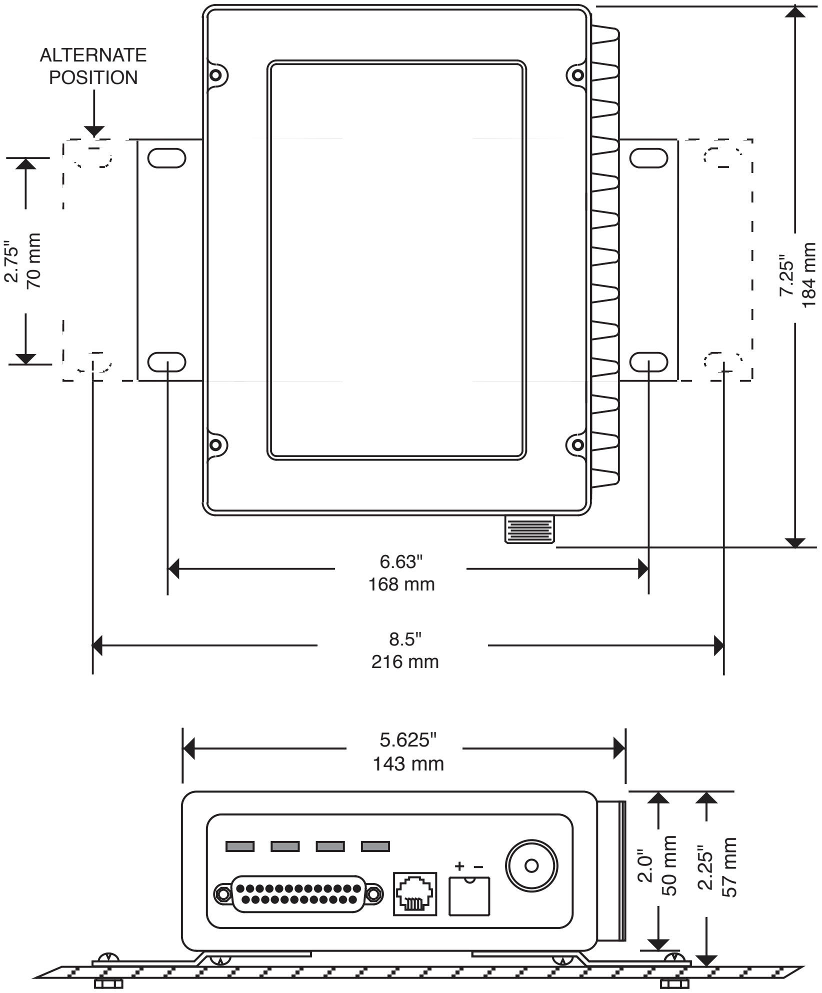


Figure 6. Transceiver Mounting Dimensions

3.3 Antennas and Feedlines

Antennas

The transceiver can be used with a number of antennas. The exact style depends on the physical size and layout of the radio system. A directional Yagi (Figure 7) or corner reflector antenna is generally recommended at remote sites to minimize interference to and from other users. Antennas of this type are available from several manufacturers.

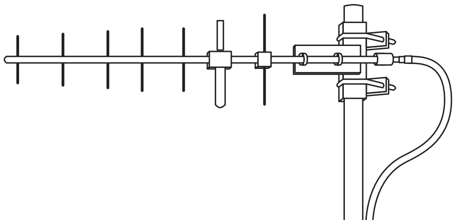


Figure 7. Typical Yagi Antenna (mounted to mast)

Feedlines

The selection of antenna feedline is very important. Poor quality cables should be avoided as they will result in power losses that may reduce the range and reliability of the radio system.

Table 3 shows the losses that will occur when using various lengths and types of cable at 200 MHz. Losses at 130-174 MHz will be slightly lower. Regardless of the type of cable used, it should be kept as short as possible to minimize signal loss

Table 3. Length vs. Loss in Coaxial Cables at 200 MHz†

Cable Type	3 Meters (10 Feet)	15 Meters (46 Feet)	30 Meters (91 Feet)	150 Meters (525 Feet)
RG-8A/U	0.32 dB	1.6 dB	3.2 dB	16 dB
1/2 inch HELIAX	0.10 dB	0.49 dB	0.98 dB	4.9 dB
7/8 inch HELIAX	0.05 dB	0.27 dB	0.54 dB	2.7 dB
1-1/4 inch HELIAX	0.04 dB	0.20 dB	0.40 dB	2.0 dB
1-5/8 inch HELIAX	0.03 dB	0.17 dB	0.33 dB	1.65 dB

† Cable loss slightly lower at 130-174 MHz.

3.4 Power Connection

The transceiver can be operated from any well-filtered 10.5 to 16 Vdc power source. The power supply should be capable of providing at least 2.5 amperes of continuous current.

The red wire on the power cable is the positive lead; the black is negative.

NOTE: The radio is designed for use only in negative ground systems.

3.5 Data Interface Connections

The transceiver's DATA INTERFACE connector is used to connect the transceiver to an external DTE data terminal that supports the EIA-232 (formally RS-232) format. The transceiver supports asynchronous data rates of up to 38400 bps. The data rate at the DATA INTERFACE connector may differ from the data rate used over the air.

Table 4 lists each pin on the DATA INTERFACE connector and describes its function.

CAUTION

USE ONLY REQUIRED PINS

Do not use a 25 wire (fully pinned) cable for connection to the DATA INTERFACE connector. Use *only* the required pins for the application. Damage may result if improper connections are made. Typical applications require the use of *only* Pins 1 through 8 for EIA-232 signaling.

3.6 Using the Radio's Sleep Mode

In some installations, such as at solar-powered sites, it may be necessary to keep the transceiver's power consumption to an absolute minimum. This can be accomplished using the Sleep Mode. In this mode, power consumption is reduced to less than 16 milliamperes (nominal).

Sleep mode can be enabled under RTU control by asserting a ground (or EIA-232 low) on Pin 12 of the radio's DATA INTERFACE connector.

When Pin 12 is opened (or an EIA-232 high is asserted), the radio will be ready to receive data within 75 milliseconds.

All normal functions are suspended while the radio is in sleep mode. The PWR LED will be off, except for a quick flash every 5 seconds.

Sleep Mode Example

The following example describes Sleep Mode implementation in a typical system. Using this information, you should be able to configure a system that will meet your own particular needs.

Example:

> Suppose you need communications to each remote site only once per hour. Program the RTU to raise an EIA-232 line once each hour (DTR for example) and wait for a poll and response before lowering it again. Connect this line to Pin 12 of the radio's DATA INTERFACE connector. This will allow each RTU to be polled once per hour with a significant savings in power consumption.

Table 4. DATA INTERFACE Connector Pinouts

Pin Number	Input/ Output	Pin Description
1	--	**Protective Ground.** Connects to ground (negative supply potential) on the radio's PC board and chassis.
2	IN	**TXD—Transmitted Data.** Accepts TX data from the connected device.
3	OUT	**RXD—Received Data.** Outputs received data to the connected device.
4	IN	**RTS—Request-to-Send Input.** Keys the transmitter when RTS is at logic high.
5	OUT	**CTS—Clear-to-Send Output.** Goes "high" after the programmed CTS delay time has elapsed (DCE) or keys an attached radio when RF data arrives (CTS KEY).
6	OUT	**DSR—Data Set Ready.** Provides a +6 Vdc DSR signal through a 2.5 kΩ resistor.
7	--	**Signal Ground.** Connects to ground (negative supply potential) at radio's PC board.
8	OUT	**DCD—Data Carrier Detect.** Goes "high" when the modem detects a data carrier from the master station.
9	IN	**Transmit Audio Input.** Connects to the audio output of an external (AFSK) modem. The input impedance is 600 Ω. Use Pin 7 for the modem's return lead.
10	OUT	**RUS—Receiver Unsquelched Sensor.** Not used in most installations, but is available as a convenience. Provides +8 Vdc through a 1 kΩ resistor whenever the receiver squelch is open, and drops to less than 1 Vdc when the squelch is closed.
11	OUT	**Receive Audio Output.** Connects to the audio input of an external (AFSK) modem. The output impedance is 600 Ω, and the level is factory set to suit most installations. Use Pin 7 for the modem's return lead.
12	IN	**Radio Inhibit (Sleep).** A ground on this pin places the radio into the "sleep" mode. It turns off most circuits in the radio, including transmit, receive, modem and diagnostic functions. This allows for greatly reduced power consumption, yet preserves the radio's ability to be quickly brought online.
13	--	Do not connect—Reserved for future use.
14	IN	**PTT—Push to Talk.** This line is used to key the radio with an active-high signal of +5 Vdc.
15	OUT	**Remote RTU Reset.** Do not connect—Reserved for future use.
16	IN	**$\overline{\text{PTT}}$—Push to Talk.** This line is used to key the radio with an active-low signal of 0 Vdc.
17	--	Do not connect—Reserved for future use.
18	IN/OUT	**Accessory Power.** Unregulated Input/Output. Provides a source of input power for low current accessories. Excessive drain on this connection will trip self-resetting fuse F1 on the transceiver PC board. The voltage at this pin will match the input voltage to the transceiver.

Table 4. DATA INTERFACE Connector Pinouts *(Continued)*

Pin Number	Input/ Output	Pin Description
19	OUT	**9.9 Vdc Regulated Output.** Provides a source of regulated voltage at 100 mA for low power accessories.
20	--	Do not connect—Reserved for future use.
21	OUT	**RSSI—Received Signal Strength Indication.** A DC voltmeter may be connected to this pin to read the relative strength of the incoming signal. Figure 8 is a chart showing RSSI vs. DC voltage.
22	--	Do not connect—Reserved for future use.
23	IN	**Diagnostic Channel Enable.** A ground on this pin causes the radio's microcontroller to open the DB-25 DATA INTERFACE for diagnostics and control instead of the normal RJ-11 DIAG. connection.
24	--	Do not connect—Reserved for future use.
25	OUT	**Alarm.** A logic low (less than 0.5 volts) on this pin indicates normal operation. A logic high (greater than 4 volts) indicates that some alarm condition is present. This pin can be used as an alarm output, provided the internal series resistance of 1 kΩ is considered.

4.0 OPERATION

In-service operation of the transceiver is completely automatic. Once the unit has been properly installed and configured, operator actions are limited to observing the front panel LED status indicators for proper operation.

If all parameters are correctly set, operation of the radio can be started by following these steps:

1. Apply DC power to the transceiver.

2. Observe the LED status panel for the proper indications (Table 5).

3. If not done earlier, refine the antenna heading of the station to maximize the received signal strength (RSSI) from the master station.

   Use the **RSSI** command from an HHT connected to the radio's DIAG. connector.—See *Section 5.0, TRANSCEIVER PROGRAMMING*. This can also be done with a DC voltmeter as described in *Section 4.2, RSSI Measurement*.

4.1 LED Indicators

Table 5 describes the function of each status LED.

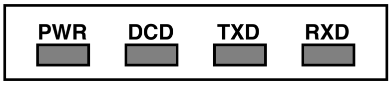


Table 5. LED Status Indicators

LED Name	Description
PWR	• Continuous—Power is applied to the radio, no problems detected. • Rapid flash (five times-per-second)—Fault indication. • Flashing once every 5 seconds—Radio is in Sleep mode.
DCD	• Flashing—Indicates the radio is receiving intermittent data frames. • Continuous—Radio is receiving a data signal from a continuously keyed radio.
TXD	An EIA-232 mark signal is being received at the DATA INTERFACE connector.
RXD	An EIA-232 mark signal is being sent out from the DATA INTERFACE connector.

4.2 RSSI Measurement

As an alternative to using an HHT, the radio's received signal strength (RSSI) may be read with a DC voltmeter connected to Pin 21 of the DATA INTERFACE connector. Figure 8 shows the relationship between received signal level and the DC voltage on Pin 21 of the DATA INTERFACE connector. (Note: Readings are not accurate for signals stronger than –50 dBm.)

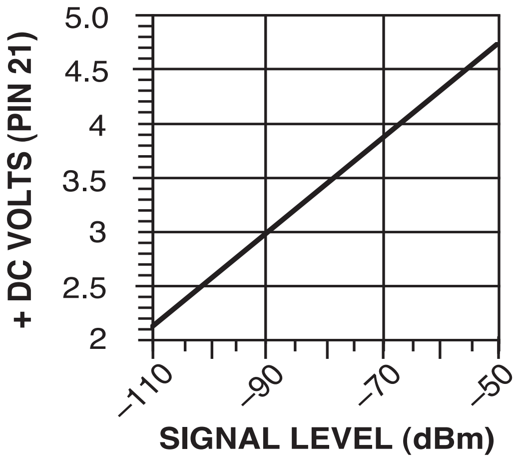


Figure 8. RSSI vs. Vdc (Typical)

5.0 TRANSCEIVER PROGRAMMING

Programming and control of the transceiver is performed through the radio's RJ-11 DIAG. (Diagnostics) connector with an MDS Hand-Held Terminal (MDS P/N 02-1501A01). This section contains a reference chart (Table 7) followed by detailed descriptions for each user command.

NOTE: In addition to HHT control, Windows-based software is available (MDS P/N 03-3156A01) to allow diagnostics and programming using a personal computer. An installation booklet and on-line instructions are included with the software. Contact MDS for ordering information.

5.1 Hand-Held Terminal Connection & Startup

This section gives basic information for connecting and using the MDS Hand-Held Terminal. For more information about the terminal, refer also to the instructions included with each HHT kit.

The steps below assume that the HHT has been configured for use with the transceiver (80 character screen display). If the HHT was previously used with a different model transceiver, or if its default settings have been changed, refer to *Section 5.2, Hand-Held Terminal Setup* for setup details.

Follow these steps to connect the HHT:

1. Connect the HHT's coiled cord to the DIAG. (RJ-11) jack on the radio as shown in Figure 9. This automatically places the radio into the control and programming mode.

   As an alternative, the DATA INTERFACE (DB-25) connector may be used for programming instead of the DIAG. jack. With this arrangement, Pin 23 of the HHT cable must be grounded to enable the diagnostic channel. (See Table 4.)

2. When the HHT is connected, it runs through a brief self-check, ending with a beep. After the beep, press **ENTER** to obtain the ready "**>**" prompt.

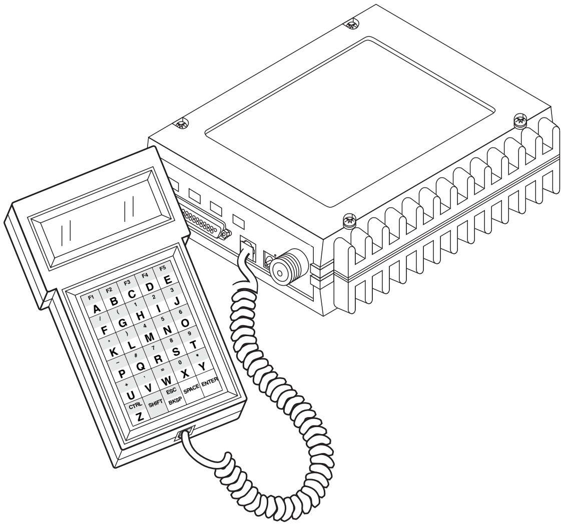


Figure 9. Hand-Held Terminal Connected to the Transceiver

5.2 Hand-Held Terminal Setup

The following is a set of instructions for re-initializing an HHT for use with the transceiver. These steps may be required if the HHT was previously used with a different radio, or if the HHT default settings have been inadvertently altered.

1. Plug the HHT into the DIAG. connector. Enable the setup mode by pressing the SHIFT, CTRL and SPACE keys in sequence. The display shown in Figure 10 appears.

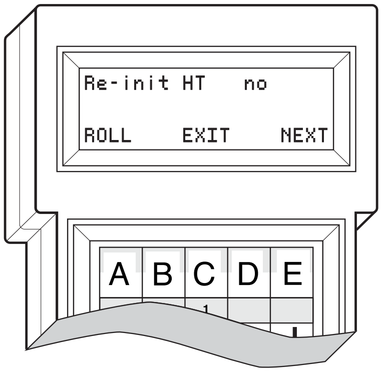


Figure 10. HHT Setup Display

2. The first of 15 menu items is displayed. Settings are reviewed by pressing the NEXT function controlled by the E key. Parameter settings are changed by pressing the ROLL function controlled by the A key.

3. Set up the HHT as listed in Table 6.

Table 6. HHT Operational Settings

Parameter	Setting	Parameter	Setting
Re-init HT	NO	Scroll On	33rd
Baud Rate	9600	Cursor	ON
Comm bits	8,1,n	CRLF for CR	OFF
Parity Error	OFF	Self Test	FAST
Key Repeat	OFF	Key Beep	ON
Echo	OFF	Screen Size	80
Shift Keys	YES	Menu Mode	LONG
Ctl Chars	PROCS		

5.3 Keyboard Commands

Table 7 is a reference chart of software commands for the transceiver. Programmable information is shown in brackets [ ] following the command name. See *Section 5.4, Detailed Command Descriptions* for detailed command descriptions.

Entering Commands

To enter a command, type the command, followed by an **ENTER** keystroke. For programming commands, the command is followed by **SPACE** and the appropriate information or values, then **ENTER**.

Here are some additional points to remember when using the HHT:

- Use the **SHIFT** key to access numbers; press again to return to letter mode.
- Use the **ESC/BKSP** key to edit information or commands entries.
- The flashing square cursor (▫) indicates that letter mode is selected.
- The flashing superscript rectangular cursor (▭) indicates that number mode is selected.

Error Messages

Listed below are some possible error messages that may be encountered when using the HHT:

UNKNOWN COMMAND—The command was not recognized. Refer to the command description for command usage information.

INCORRECT ENTRY—The command format or its associated values were not valid. Refer to the command description for command usage information.

COMMAND FAILED—The command was unable to successfully complete. This may indicate an internal software problem.

NOT PROGRAMMED—Software was unable to program the internal radio memory or the requested item was not programmed.This is a serious internal radio error. Contact MDS for assistance.

TEXT TOO LONG—Response to **OWN** or **OWM** command when too many characters have been entered. Refer to the command description for command usage information.

NOT AVAILABLE—The entered command or parameter was valid, but it referred to a currently unavailable choice. Refer to the command description for command usage information.

ACCESS DENIED—The command is unavailable to the user. Refer to the command descriptions for command information.

EEPROM FAILURE— The **INIT** command was unable to write to EEPROM. This is a serious internal radio error. Contact MDS for assistance.

Table 7. Command summary

Command name	Function
AMASK [0000 0000–FFFF FFFF] *Details page 22*	Set or display hex code identifying which events trigger an alarm.
ASENSE [HI/LO] *Details page 23*	Set or display the state of the alarm output signal to ACTIVE HI or ACTIVE LO.
BAUD [xxxxx abc] *Details page 23*	Set or display the DATA INTERFACE data rate and control bits.
BUFF [ON, OFF] *Details page 23*	Enables or disables the internal radio data buffer.
CTS [0–255] *Details page 24*	Set or display the Clear-to-Send delay in seconds.
CKEY [ON–OFF] *Details page 24*	Enables or disables the continuously keyed mode. Note: Remotes cannot receive when keyed.
DATAKEY [ON, OFF] *Details page 24*	Toggles between key-on-data and key-on-RTS.
DKEY *Details page 25*	Dekey the radio (transmitter OFF). This is generally a radio test command.
DLINK [ON/OFF/xxxx] *Details page 25*	Configures local diagnostic link protocol.
DMGAP [xx] *Details page 25*	(*Diagnostics*) Sets the amount of time to wait after the receipt of a character before interpreting the next received character as the start of a new message.

Table 7. Command summary *(Continued)*

Command name	Function
DTYPE [NODE/ROOT] *Details page 25*	(*Diagnostics*) Sets up a radio as a Root or Node radio. Associated commands are GATE and PEER. (See MDS' Network-Wide Diagnostics System Handbook (MDS P/N 05-3467A01) for details.)
DUMP *Details page 26*	Display all programmable settings.
HREV *Details page 26*	Display the Hardware Revision level, if programmed.
INIT *Details page 26*	Set radio parameters to factory defaults.
INIT [2710] *Details page 26*	Restores certain transceiver defaults before using the **INIT xx20** command.
INIT [2720] *Details page 26*	Configure radio for use with an MDS model P-20 chassis.
KEY *Details page 27*	Key the radio (transmitter ON). This is generally used for radio testing.
MODEL *Details page 27*	Display the model number of the radio.
MODEM [xxxx, NONE] *Details page 27*	Set the modem characteristics of the radio.
OWM [XXX...] *Details page 27*	Set or display the owner's message.
OWN [XXX...] *Details page 27*	Set or display the owner's name.
PTT [0–255] *Details page 27*	Set or display the Push-to-Talk delay in milliseconds.
PWR [20–37] *Details page 27*	Set or display the transmit power setting.
RSSI *Details page 28*	Display the Received Signal Strength Indication.
RTU [ON/OFF/0-80] *Details page 28*	Enables or disables the radio's internal RTU simulator and sets the RTU address.
RX [xxx.xxxxx] *Details page 28*	Set or display receiver frequency.
RXTOT [NONE, 1-255] *Details page 28*	Set or display the value of the receive time-out timer.
SCD [0-255] *Details page 28*	Set or display the Soft-carrier Dekey delay in milliseconds.
SER *Details page 28*	Display the radio serial number.
SHOW [DC, PORT, PWR] *Details page 29*	Display the DC voltages, diagnostics port, and transmit power level.
SREV *Details page 29*	Display the Software Revision Level.
STAT *Details page 29*	Display radio status and alarms.

Table 7. Command summary *(Continued)*

Command name	Function
TEMP *Details page 29*	Display the internal temperature of the radio in degrees Celsius.
TOT [1-255, ON, OFF] *Details page 30*	Set or display the Time-out Timer delay in seconds.
TX [xxx.xxxxx] *Details page 30*	Set or display the transmit frequency.
UNIT [10000...65000] *Details page 30*	Set or display the transceiver's unit address.

5.4 Detailed Command Descriptions

The only *critical* commands for most applications are transmit and receive frequencies (**RX xxx.xxxxx, TX xxx.xxxxx**). However, proper use of the additional commands allows you to tailor the transceiver for a specific use, or conduct basic diagnostics on the radio. This section gives more detailed information for the user commands previously listed in Table 7.

In many cases, the commands shown here can be used in two ways. First, you can type *only* the command name to view the currently programmed data. Secondly, you can set or change the existing data by typing the command, followed by a space, and then the desired entry. In the list below, allowable programming variables, if any, are shown in brackets following the command name.

AMASK [0000 0000–FFFF FFFF]

The **AMASK** (alarm mask) command displays or sets which events cause the alarm output signal to be active. Normally, the mask is **FFFF FFFF**, meaning that any of the 32 possible events will activate the alarm output signal. No special configuration is required for typical applications.

Entering the **AMASK** command alone displays the current setting of alarm events in hexadecimal format.

Entering the **AMASK** command followed by an eight-digit hexadecimal number reprograms the specified events to trigger an alarm.

The eight-digit hexadecimal number used as the command parameter is used to classify up to 32 events as alarm triggers for the alarm output status line. (See Table 8 on page 32 for a list of event codes.) The hex value for the mask corresponds to the hex value for the **STAT** command (see the **STAT** command description).

Each bit that is a ‘1’ identifies an associated alarm condition that can trigger the alarm output status line. Each bit that is a ‘0’ treats the associated alarm as irrelevant when deciding whether or not to assert the alarm output status line. For more information on tailoring the alarm response, contact the MDS Technical Services Department.

ASENSE [HI/LO]

The **ASENSE** command sets or displays the sense of the alarm output at Pin 25 of the DATA INTERFACE connector.

Entering the **ASENSE** command alone shows whether the alarm output is active high or low. Entering the **ASENSE** command followed by **HI** or **LO** resets the alarm output to active high or low.

BAUD [xxxxx abc]

This command sets (or displays) the communication attributes for the DATA INTERFACE port. It has no effect on the RJ-11 DIAG. port.

The first parameter (**xxxxx**) is baud rate. Baud rate is specified in bits-per-second (bps) and must be one of the following speeds: 110, 300, 1200, 2400, 4800, 9600, 19200, or 38400.

The second parameter of the **BAUD** command (**abc**) is a three-character block indicating how the data is encoded:

a = Data bits (7 or 8)
b = Parity (N for None, O for Odd, E for Even)
c = Stop bits (1 or 2)

The factory default setting is 4800 baud, 8 data bits, no parity, 1 stop bit (Example: **4800 8N1**).

NOTE: 7N1, 8O2, and 8E2 are invalid communication settings and are not supported by the transceiver.

BUFF [ON, OFF]

This command sets or displays the received data handling mode of the radio. The command parameter is either **ON** or **OFF**. The default is **ON**. The setting of this parameter affects the timing of how received RF data is sent out the INTERFACE connector. Outgoing (transmitted) data is not affected by this setting.

If data buffering is **OFF**, the radio operates with the lowest possible average latency. Data bytes are thus sent out the INTERFACE port as soon as an incoming RF data frame is disassembled. Average and typical latency will both be below 10 ms, but idle character gaps may be introduced into the outgoing data flow.

If data buffering is **ON**, the radio operates in seamless mode. Data bytes will be sent over the air as quickly as possible, but the receiver buffers (stores) the data until enough bytes have arrived to cover worst-case gaps in transmission. This mode of operation is required for protocols such as MODBUS™ that do not allow gaps in their data transmission.

Note that seamless mode (**BUFF ON**) is intended only for applications where the transmitter's baud rate is greater than or equal to the receiver's baud rate. Adherence to this rule is left up to the user.

CKEY [ON–OFF]

The **CKEY** command enables or disables the continuously-keyed function of the radio. When **CKEY** is set to **ON**, the radio is continuously keyed.

CTS [0–255]

The **CTS** (clear-to-send) command selects or displays the timer value associated with the CTS line response. The command parameter ranges from 0 to 255 milliseconds.

For DCE operation, the timer specifies how long to wait after the RTS line goes high, before the radio asserts CTS and the DTE can transmit the data. A CTS value of zero keys the radio and asserts the CTS line immediately after the RTS line goes high.

For CTS Key operation (see **DEVICE** command), the timer specifies how long to wait after asserting the CTS, before sending data out the DATA INTERFACE port. A timer value of zero means that data will be sent out the data port without imposing a key-up delay. (Other delays may be present based on selected radio operating parameters.)

DATAKEY [ON, OFF]

The **DATAKEY** command sets or displays the ability of the radio to key the transmitter as data is received at the DATA INTERFACE connector. Asserting RTS keys the radio regardless of this command setting.

If **DATAKEY** is set to **ON**, the radio will key when a full data-character is received at the transceiver's DATA INTERFACE connector. If **DATAKEY** is set to **OFF**, the radio needs to be keyed by asserting either the RTS or PTT signal or with the **CKEY** or **KEY** command.

DEVICE [DCE, CTS KEY]

The **DEVICE** command sets or displays the device behavior of the radio. The command parameter is either **DCE** or **CTS KEY**.

The default selection is **DCE**. In this mode, CTS will go high following RTS, subject to the CTS programmable delay time. If the **DATAKEY** command is set to **ON**, keying can be stimulated by the input of characters at the data port. Hardware flow control is implemented by signaling the CTS line if data arrives faster than it can be buffered and transmitted.

If **CTS KEY** is selected, the radio is assumed to be controlling another radio. The RTS line is ignored and the CTS line is used as a keyline control for the other radio. CTS is asserted immediately following the receipt of RF data, but data will not be sent out the DATA INTERFACE port until after the CTS programmable delay time has expired. (This gives the other radio time to key.)

DKEY

This command deactivates the transmitter after it has been keyed with the **KEY** command.

DLINK [ON/OFF/xxxx]

This command is used to configure the local diagnostic link protocol used in network-wide diagnostics.

Entering **DLINK ON** enables the diagnostic link. Entering **DLINK OFF** disables the diagnostic link.

To change the diagnostic link, enter **DLINK** followed by one of the following baud rates: 1200, 2400, 4800, 9600, 19200 (default).

DMGAP [xx]

The **DMGAP** command sets the amount of time in milliseconds to wait after the receipt of a character before interpreting the next received character as the start of a new message. When data port baud rates are slow, the gap between characters within a poll may be so long that the radio interprets the next character as the start of a new poll. When diagnostics is being performed using passive messaging (see *Performing Network-Wide Remote Diagnostics* on page 34), this command may be used to change this behavior.

DTYPE [NODE/ROOT]

This command establishes the local radio as a root radio or node radio for network-wide diagnostics. Entering **DTYPE NODE** configures the radio as a node radio. Entering **DTYPE ROOT** configures the radio as a root radio. Entering the **DTYPE** command alone displays the current setting. See “Performing Network-Wide Remote Diagnostics” on page 34. Two associated commands are **GATE** and **PEER**. See MDS’ Network-Wide Diagnostics System Handbook (MDS P/N 05-3467A01) for details.

DUMP

This command displays all the programmed settings of the radio. The HHT display is too small to list all the command settings at one time. Therefore, this command is most useful if the command is issued from a computer or full-screen terminal.

HREV

This command displays the transceiver’s hardware revision level if it has been programmed at the factory.

INIT

The **INIT** command is used to re-initialize the radio’s operating parameters to the factory defaults. This may be helpful when trying to resolve configuration problems that may have resulted from the entry of one or more improper command settings. Entry of this command allows you to get back to a known working state. The following changes to the radio are made when **INIT** is entered:

- **CTS** is set to 0
- **DATAKEY** is set to **ON**
- **DEVICE** is set to **DCE**
- **PTT** is set to 0
- **SCD** is set to 0
- **TOT** is set to 30 seconds and set to **ON**
- **PWR** is set to +37 dBm (5 watts)

All other commands stay at their previously established settings.

INIT [2710]

This command sets the transceiver for operation *outside* the MDS model P-20 chassis by setting the following parameters as shown.

ASENSE	**ACTIVE HI**
AMASK	**FFFF FFFF** (assert alarm output on all alarms)
RXTOT	**NONE** (receive time-out timer disabled)

This command can be used subsequent to using the **INIT 2720** command to restore the standard transceiver defaults.

INIT [2720]

This command sets the transceiver for operation *inside* the model P-20 chassis by setting the following parameters as shown.

ASENSE	**ACTIVE LO**
AMASK	**FFFF 0000** (trigger on major alarms)
RXTOT	**20** (20 minute time-out timer)

KEY

This command activates the transmitter. See also the **DKEY** command.

MODEL

This command displays the radio's model number code.

MODEM [xxxx, NONE]

This command selects the radio's modem characteristics. Enter 9600 or 3200 for digital operation, or enter NONE to select analog operation. For MDS 1710 digital operation the proper settings are **9600** for the MDS 2710A, **19200** for the MDS 1710C.

For MDS 2710 operation, the proper settings are **3200** for the MDS 2710D, **9600** for the MDS 2710A, and **19200** for the MDS 2710C.

OWM [XXX...]

This is a command to display or program an owner's message. To program the owner's message, type **OWM** then the message, followed by **ENTER**.

To display the owner's message, type **OWM** then **ENTER**. The owner's message appears on the display.

OWN [XXX...]

This is a command to display or program an owner's name. To program the owner's name, type **OWN** then the name, followed by **ENTER**.

To display the owner's name, type **OWN** then **ENTER**. The owner's name appears on the display.

PTT [0–255]

This command sets or displays the key-up delay in milliseconds.

This timer specifies how long to wait after the radio receives a key signal from either the PTT or RTS lines (on the DATA INTERFACE), before actually keying the radio.

PWR [20–37]

NOTE: This function may not be available, depending on certification requirements in a particular country.

This command displays or sets the desired RF forward output power setting of the radio. The **PWR** command parameter is specified in dBm and can range from 20 through 37. The default setting is 37 dBm (5 watts). To read the actual (measured) power output of the radio, use the **SHOW PWR** command. A dBm-to-watts conversion chart is provided in Section 7.6.

RSSI

This command continuously displays the radio’s Received Signal Strength Indication (RSSI) in dBm units, until you press the Enter key. Incoming signal strengths from –50 dBm to –120 dBm can be read.

RTU [ON/OFF/0-80]

This command re-enables or disables the radio’s internal RTU simulator, which runs with MDS’ proprietary polling programs (poll.exe and rsim.exe). The internal RTU simulator is available whenever a radio has diagnostics enabled. This command also sets the RTU address that the radio will respond to.

The internal RTU can be used for testing system payload data or *pseudo* bit error rate testing. It can also be helpful in isolating a problem to either the external RTU or the radio.

RX [xxx.xxxxx]

This command selects or displays the radio’s receive frequency in MHz. The frequency step size is 6.25 kHz for the MDS 2710A/C and 5.0 kHz for the MDS 2710D.

If the customer frequency has not been programmed at the factory, a default frequency will be programmed in the radio near the center of the frequency band.

RXTOT [NONE, 1-255]

The **RXTOT** command selects or displays the receive time-out timer value in minutes. This timer triggers an alarm (event 12) if data is not detected within the specified time.

Entering the **RXTOT** command without a parameter displays the timer value in minutes. Entering the **RXTOT** command with a parameter ranging from 0 to 255 resets the timer in minutes. Entering the **RXTOT** command with the parameter **NONE** disables the timer.

SCD [0-255]

This command displays or changes the soft-carrier dekey delay in milliseconds.

This timer specifies how long to wait after the removal of the keying signal before actually releasing the transmitter. A value of 0 milliseconds will unkey the transmitter immediately after the removal of the keying signal.

SER

This command displays the radio’s serial number as recorded at the factory.

SHOW [DC, PORT, PWR]

The **SHOW** command displays different types of information based on the command variables. The different parameters are:

- **DC**—Display DC input/output voltages
- **PORT**—Display the connector port (RJ-11 or DB-25) that is active for diagnostics and control.
- **PWR**—Display RF power output

SNR

This command continuously displays the signal-to-noise ratio of the received signal expressed in dB, until you press the Enter key. As used in this guide, the signal-to-noise measurement is based upon the signal level following equalization, for received frames.

The SNR is an indication of the received signal quality. The SNR indication ranges from 10 dB to 33 dB. A value of 10 dB represents a very poor signal. A value of 24 dB represents a very good signal.

When the SNR command is used, it causes the DIAG. port to enter an update mode, and the signal-to-noise ratio is updated and redisplayed every 2 seconds. The SNR continuously updates until the **ENTER** key is pressed.

SREV

This command displays the software revision level of the transceiver firmware.

STAT

This command displays the current alarm status of the transceiver.

If no alarms exist, the message **NO ALARMS PRESENT** appears at the top of the HHT display.

If an alarm does exist, a two-digit code (00–31) is displayed and the alarm is identified as “Major” or “Minor.” A brief description of the alarm code is also given.

If more than one alarm exists, the word **MORE** appears at the bottom of the screen and additional alarms are viewed by pressing the **ENTER** key. Detailed descriptions of event codes are provided in Table 8 on page 32.

TEMP

This command displays the internal temperature of the transceiver in degrees Celsius.

TOT [1-255, ON, OFF]

This command sets or displays the transmitter Time-out Timer value (1–255 seconds), as well as the timer status (**ON** or **OFF**). If the timer is on, and the radio remains keyed for a longer duration than the **TOT** value, the transmitter is automatically unkeyed.

When this happens, the radio must be commanded back to an unkeyed state before a new keying command is accepted. The default timer value is 30 seconds.

TX [xxx.xxxxx]

This command selects or displays the radio's transmit frequency in MHz. The frequency step size is 6.25 kHz for the MDS 2710A/C and 5.0 kHz for the MDS 2710D.

If the customer frequency has not been programmed at the factory, a default frequency will be programmed in the radio near the center of the frequency band.

UNIT [10000...65000]

This command selects or displays the radio's unit address. The factory default setting is the last four digits of the transceiver's serial number. The unit address is used in network diagnostics. See MDS' Network-Wide Diagnostics System Handbook (MDS P/N 05-3467A01) for more information.

6.0 TROUBLESHOOTING

Successful troubleshooting of the radio system is not difficult, but it requires a logical approach. It is best to begin troubleshooting at the master station, as the rest of the system depends on the master for polling commands. If the master station has problems, the operation of the entire network can be compromised.

It is good practice to start by checking the simple things. For proper operation, all radios in the network must meet these basic requirements:

- Adequate and stable primary power. The radio contains an internal self-resetting fuse (4A). Remove and re-apply primary power to reset.
- Secure connections (RF, data and power)
- An efficient and properly aligned antenna system with a good received signal strength (at least –90 dBm). It is possible for a system to operate with weaker signals, but reliability will be degraded.
- Proper programming of the transceiver's operating parameters (see *Section 5.0, TRANSCEIVER PROGRAMMING*).

- The correct interface between the transceiver and the connected data equipment (correct cable wiring, proper data format, timing, etc.)

6.1 LED Indicators

The LED status indicators are an important troubleshooting tool and should be checked whenever a problem is suspected. Table 5 on page 16 describes the function of each status LED.

6.2 Event Codes

When an alarm condition exists, the transceiver creates a code that can be read on an HHT connected to the DIAG. port. These codes can be very helpful in resolving many system difficulties. Refer to Table 8 for a definition of the event codes.

Checking for Alarms—*STAT command*

To check for alarms, enter **STAT** on the HHT. If no alarms exist, the message **NO ALARMS PRESENT** appears at the top of the display (Figure 11).

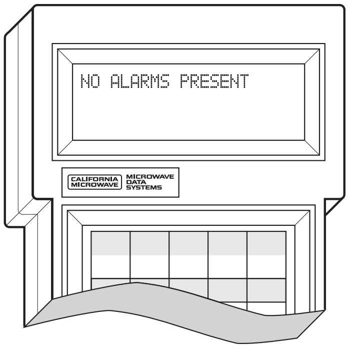


Figure 11. HHT Display in Response to STAT Command

If an alarm does exist, a two-digit alarm code (00–31) is displayed and the event is identified as a Major or Minor Alarm. A brief description of the alarm is also given.

If more than one alarm exists, the word **MORE** appears at the bottom of the screen. To view additional alarms, press **ENTER**.

Major Alarms vs. Minor Alarms

Major Alarms—report serious conditions that generally indicate a hardware failure, or other abnormal condition that will prevent (or seriously degrade) further operation of the transceiver. Major alarms generally indicate the need for factory repair. Contact MDS for further assistance.

Minor Alarms—report conditions that, under most circumstances will not prevent transceiver operation. This includes out-of-tolerance conditions, baud rate mismatches, etc. The cause of these alarms should be investigated and corrected to prevent eventual system failure.

Event Code Definitions

Table 8 contains a listing of all event codes that may be reported by the transceiver.

Table 8. Event Codes

Event Code	Event Class	Description
01	Major	Improper software detected for this radio model.
02	Major	The model number of the transceiver is unprogrammed.
04	Major	One or both of the internal programmable synthesizer loops is reporting an out-of-lock condition.
06	Major	An unrecoverable fault was detected on the A-to-D chip. The radio will not receive data.
07	Major	One or more of the radio's internal voltage regulators is reporting a failure. The radio will not operate.
08	Major	The system is reporting that it has not been calibrated. Factory calibration is required for proper radio operation.
09	--	Not used.
10	Major	The internal microcontroller was unable to properly program the system to the appropriate EEPROM defaults. A hardware problem may exist.
11	--	Not used.
12	Major	Receiver time-out. No data received within the specified receiver time-out time.
13	Major	Transmitter time-out. The radio was keyed for a duration exceeding the time-out timer setting. (This alarm clears the next time the radio keys.)
14–15	--	Not used.
16	Minor	Not used.
17	Minor	A data parity fault has been detected on the DATA INTERFACE connector. This usually indicates a parity setting mismatch between the radio and the RTU.
18	Minor	A data framing error has been detected on the DATA INTERFACE connector. This may indicate a baud rate mismatch between the radio and the RTU.
19–24	--	Not used.
25	Minor	The 5.6 volt power regulator is out-of-tolerance. If the error is excessive, operation may fail.
26	Minor	The DC input voltage is out-of-tolerance. If the voltage is too far out of tolerance, operation may fail.
27, 28	--	Not used
31	Minor	The transceiver's internal temperature is approaching an out-of-tolerance condition. If the temperature drifts outside of the recommended operating range, system operation may fail.

7.0 TECHNICAL REFERENCE

7.1 Transceiver Specifications

TRANSMITTER SYSTEM SPECIFICATION

Operating Frequency:	See Transmitter Specifications
Frequency Stability:	±1.5 ppm
Adjacent Channel Power:	–65 dBc (MDS 1710A/2710A) –60 dBc (MDS 1710C/2710C) –55 dBc (MDS 2710D)
Carrier Power Accuracy:	±2 dB

RECEIVER SYSTEM SPECIFICATION

Operating Frequency:	See Receiver Specifications
Maximum Usable Sensitivity:	–111 dBm for 1 x 10^{-6} BER
Co-Channel Rejection:	–12 dB

DATA CHARACTERISTICS

Signaling Standard:	EIA-232
Connector:	DB-25 Female
Data Interface Rates:	110 bps to 38.4 kbps1200, 2400, 4800, 9600, 19200, 38400 bps—asynchronous
Data Latency:	10 ms maximum, including RTS/CTS delay
Byte Length:	10 or 11 bits

TRANSMITTER

Frequency Range:	130-174 MHz (MDS 1710A/C) 216-220 MHz (MDS 2710 A/C) FCC 220-240 MHz (MDS 2710A/C) 220-222 MHz (MDS 2710D) FCC *See Figure 4 on Page 4 for detailed listing*
Modulation Type:	Binary CPFSK
Carrier Power:	0.1 Watts to 5 Watts @13.8 Vdc
Duty Cycle:	Continuous
Output Impedance:	50 ohms
Frequency Stability:	MDS 1710 ±1.0 ppm MDS 2710 ±1.5 ppm
Channel Spacing:	6.25 kHz steps (MDS 1710A/C and 2710A/C) 5.0 kHz steps (MDS 2710D) 6.25 kHz (MDS 1710A/C @ 130-174 MHz)
Transmitter Spurious Radiated Emissions:	–57 dBm, 30 MHz to 1 GHz –47 dBm, 1 GHz to 12.5 GHz
Harmonics:	
2nd harmonic:	57 dBc
3rd harmonic & higher:	57 dBc
Time-out Timer:	30 seconds (default). Selectable with **TOT** command
Transmitter Keying:	Data activated or RTS

RECEIVER

Frequency Range:	130-174 MHz (MDS 1710A/C) 216-220 MHz (MDS 2710 A/C) 220-240 MHz (MDS 2710A/C) 220-222 MHz (MDS 2710D) *See Figure 4 on Page 4 for detailed listing*
Type:	Double conversion superheterodyne
Frequency Stability:	±1.5 ppm
Maximum Usable Sensitivity:	–111 dBm for 1 x 10^{-6} BER
Spurious Response Rejection:	70 dB
Intermodulation Response Rejection:	65 dB
Receiver Spurious Conducted Emissions:	–57 dBm, 9 kHz to 1 GHz –47 dBm, 1 GHz to 12.5 GHz
Receiver Spurious Radiated Emissions:	–57 dBm, 30 MHz to 1 GHz –47 dBm, 1 GHz to 12.5 GHz
Bandwidth:	5 kHz (MDS 2710D) 12.5 kHz (MDS 1710A, 2710A) 25 kHz (MDS 1710C, 2710C)

PRIMARY POWER

Voltage:	13.8 Vdc Nominal (10.5 to 16 Vdc)
TX Supply Current:	2.5 amps max
RX Supply Current:	*Operational*—150 mA (nominal) *Standby (sleep)*—Less than 16 mA (nominal)
Fuse:	4 Amp Polyfuse, Self-Resetting, Internal (Remove Primary Power to Reset)
Reverse Polarity Protection:	Diode across primary input

ENVIRONMENTAL

Humidity:	95% at 40 degrees C
Temperature Range:	–30 to 60 degrees C (full performance) –40 to 70 degrees C (operational)
Weight:	1.6 kilograms
Case:	Die-cast Aluminum

DIAGNOSTICS INTERFACE

Signaling Standard:	EIA-232
Connector:	RJ-11 (may use radio's DB-25 instead if Pin 23 is grounded to enable diagnostics channel)
I/O Devices:	MDS Hand Held Terminal or PC with MDS software

7.2 Performing Network-Wide Remote Diagnostics

Diagnostics data from a remote radio can be obtained by connecting a laptop or personal computer running MDS InSite diagnostics software to any radio in the network.

Figure 12 shows an example of a setup for performing network-wide remote diagnostics from both a Root (master station) location, and a Node (remote station) location.

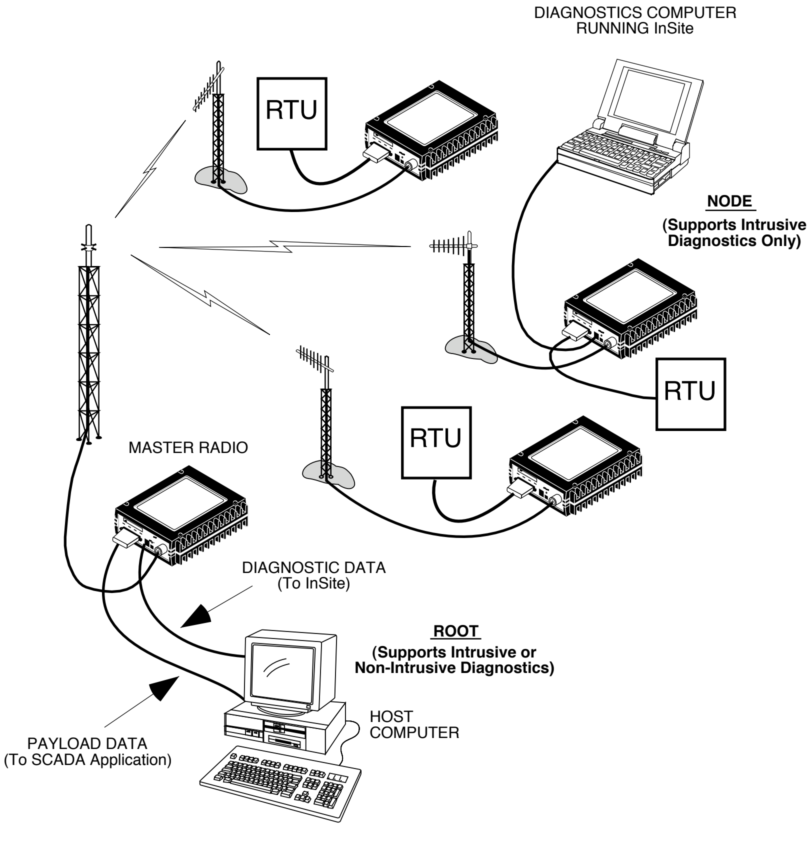


Figure 12. Network-Wide Remote Diagnostics Setup

If a PC is connected to any radio in the network, intrusive polling (polling which briefly interrupts payload data transmission) can be performed. To perform diagnostics without interrupting payload data transmission, connect the PC to a radio defined as the “root” radio. A radio is defined as a root radio using the **DTYPE ROOT** command locally, at the radio.

A complete explanation of remote diagnostics can be found in MDS’ Network-Wide Diagnostics System Handbook (MDS P/N 05-3467A01). See the Handbook for more information about the basic diagnostic procedures outlined below.

1. Program one radio in the network as the root radio by entering the **DTYPE ROOT** command at the radio.
2. At the root radio, use the **DLINK ON** and **DLINK [baud rate]** commands to configure the diagnostic link protocol on the RJ-11 port.

3. Program all other radios in the network as nodes by entering the **DTYPE NODE** command at each radio.

4. Use the **DLINK ON** and **DLINK [baud rate]** commands to configure the diagnostic link protocol on the RJ-11 port of each node radio.

5. Connect same-site radios using a null-modem cable at the radios' diagnostic ports.

6. Connect a PC on which MDS InSite software is installed to the root radio, or to one of the nodes, at the radio's diagnostic port. (This PC may be the PC being used to collect payload data, as shown in Figure 12.)

   To connect a PC to the radio's DIAG. port, an RJ-11 to DB-9 adapter (MDS P/N 03-3246A01) is required. If desired, an adapter cable may be constructed from scratch using the information shown in Figure 13.

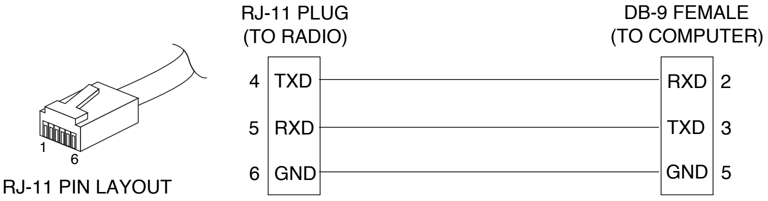


Figure 13. RJ-11 to DB-9 Adapter Cable

7. Launch the MDS InSite application at the PC. (See the MDS InSite User's Guide for instructions.)

7.3 Bench Testing Setup

Figure 14 shows a sample test setup that can be used to verify the basic operation of transceivers in a shop setting. The test can be performed with any number of remote radios by using a power divider with the required number of output connections.

The RTU simulator shown in the test setup (MDS Part No. 03-2512A01) is a microcontroller that emulates a remote terminal unit operating at 1200, 2400, 4800, or 9600 bps. Custom software is supplied with the RTU simulator that allows continuous polling of remote radios using an IBM-compatible personal computer. The software reports the number of polls sent, polls received, and the number of errors detected.

As an alternative to using an external RTU simulator, the transceiver's internal RTU simulator may be used (see **RTU** command in Table 7 on page 20). (This will not provide as conclusive a test as an external simulator because it does not utilize the transceiver's data connector.)

NOTE: It is very important to use attenuation between all units in the test setup. The amount of attenuation required will depend on the number of units being tested and the desired signal strength (RSSI) at each transceiver during the test. In no case should a signal greater than –50 dBm be applied to any transceiver in the test setup.

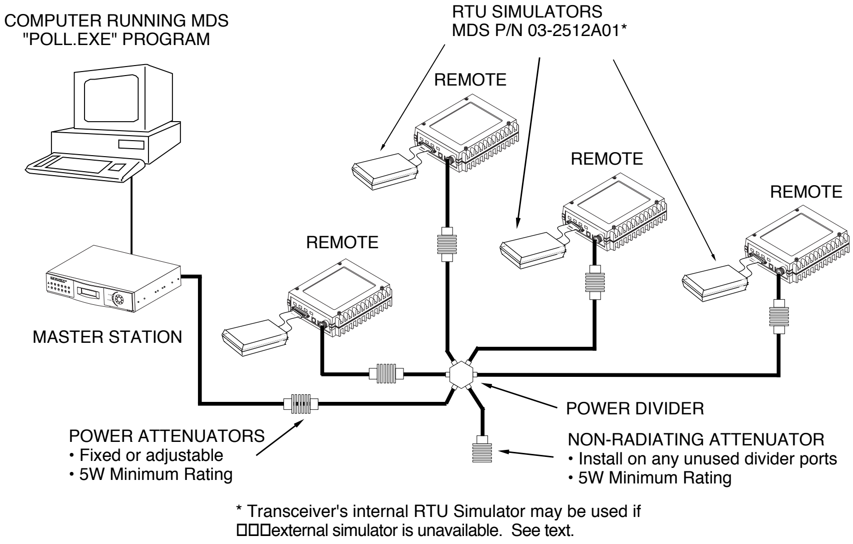


Figure 14. Typical setup for bench testing of radios

7.4 Helical Filter Adjustment

If the operating frequency of the radio is changed significantly, the helical filters should be adjusted for maximum received signal strength (RSSI). To adjust the filters, proceed as follows:

1. Remove the top cover from the transceiver by loosening the four screws and lifting straight up.

2. Locate the helical filters on the PC board. See Figure 15.

3. Apply a steady signal to the radio at the programmed receive frequency (–80 dBm level recommended; no stronger than –60 dBm). This can be done with a signal generator or an over-the-air signal.

4. Measure the radio’s RSSI using one of the following methods:
    - With an HHT (See *Section 5.0, TRANSCEIVER PROGRAMMING* on page 17).
    - With MDS Radio Configuration Software (See *Section 7.5, Upgrading the Radio’s Software* on page 38).
    - With a voltmeter connected to Pin 21 of the DATA INTERFACE connector (See *Section 4.2, RSSI Measurement* on page 16).

5. With a small adjustment tool, adjust each section of the helical filter for maximum RSSI. Re-install the cover to the transceiver.

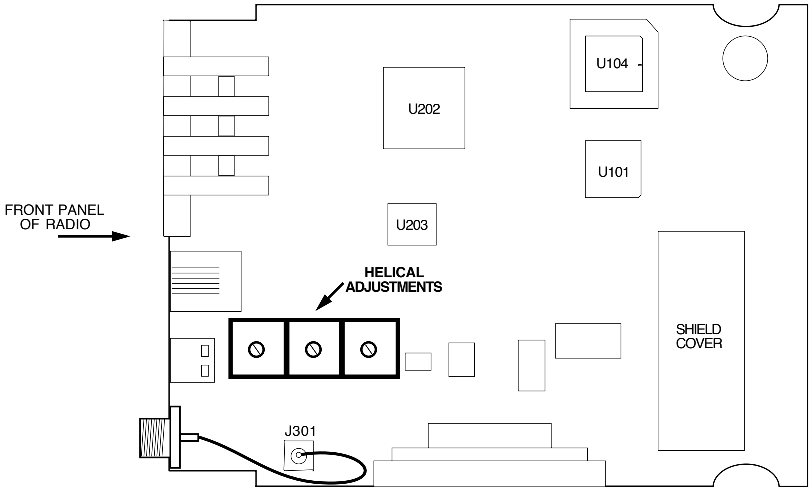


Figure 15. Helical Filter Location

7.5 Upgrading the Radio's Software

From time to time, new product features or software maintenance files may become available from MDS. This section describes the steps necessary to install new software into the transceiver using a PC connected to the radio's DIAG. port.

Upgrade software can be obtained in a number of ways. The MDS Web site at **www.microwavedata.com** contains an FTP area with software files for several radio models. You can browse the listings to see if there are files pertaining to your particular model. There is no charge for this service.

In addition, you can also contact MDS to request radio software. Software files may be sent to you via e-mail, or on a 3.5" diskette. There may be a nominal charge for the software depending on the nature of the upgrade.

NOTE: Software upgrades are distributed as ASCII files with a ".S28" extension. These files use the Motorola S-record format.

Using Radio Software Upgrade Diskette

A software upgrade diskette may be purchased from MDS to add new product features to the radio such as Network-wide Diagnostics. The upgrade kit includes a diskette (MDS P/N 06-3501A01) with the most current radio software, authorization codes, and an instruction booklet. Contact MDS for ordering information. When calling, please have the serial number(s) available for the radio(s) that you wish to upgrade.

The upgrade software can be run on an IBM-compatible computer connected to the radio's DIAG. port via an RJ-11 to DB-9 adapter (MDS P/N 03-3246A01). If desired, an adapter cable may be constructed from scratch using the information shown in Figure 13.

To initiate the upgrade, insert the upgrade diskette in Drive A:. Set the working directory to **A:** (example: from a DOS prompt type **A:**). Next, type **UPGRADE** and press the **ENTER** key. (If you have the radio connected via the Com2 serial port, type **UPGRADE-2** instead.) The upgrade software will normally run automatically without any further prompts.

The radio's PWR LED will flash rapidly to confirm that a download is in process. The download takes about two minutes.

NOTE: If a software download fails, the radio is left unprogrammed and inoperative. This is indicated by the PWR LED flashing slowly (1 second on, 1 second off). This condition is only likely if a power failure occurred to the computer or radio during the downloading process. The download can be attempted again when the fault has been corrected.

Using Radio Configuration Software

If you already have software that you wish to download into the transceiver, Radio Configuration Software (MDS P/N 03-3156A01) may be used to perform the installation. To use this method, proceed as follows:

Connect a PC to the radio's DIAG. port via an RJ-11 to DB-9 adapter (MDS P/N 03-3246A01). If desired, an adapter cable may be constructed from scratch using the information shown in Figure 13.

Run the Radio Configuration software. Under the **SYSTEM** menu, select **RADIO SOFTWARE UPGRADE**. Follow the prompts and online instructions to locate the desired software and complete the upgrade.

The radio's PWR LED will flash rapidly to confirm that a download is in process. The download takes about two minutes.

NOTE: If a software download fails, the radio is left unprogrammed and inoperative. This is indicated by the PWR LED flashing slowly (1 second on, 1 second off). This condition is only likely if a power failure occurred to the computer or radio during the downloading process. The download can be attempted again when the fault has been corrected.

7.6 dBm-Watts-Volts Conversion Chart

Table 9 is provided as a convenience for determining the equivalent wattage or voltage of an RF power expressed in dBm.

Table 9. dBm-Watts-Volts Conversion—for 50 Ohm Systems

dBm	V	Po
+53	100.0	200W
+50	70.7	100W
+49	64.0	80W
+48	58.0	64W
+47	50.0	50W
+46	44.5	40W
+45	40.0	32W
+44	32.5	25W
+43	32.0	20W
+42	28.0	16W
+41	26.2	12.5W
+40	22.5	10W
+39	20.0	8W
+38	18.0	6.4W
+37	16.0	5W
+36	14.1	4W
+35	12.5	3.2W
+34	11.5	2.5W
+33	10.0	2W
+32	9.0	1.6W
+31	8.0	1.25W
+30	7.10	1.0W
+29	6.40	800mW
+28	5.80	640mW
+27	5.00	500mW
+26	4.45	400mW
+25	4.00	320mW
+24	3.55	250mW
+23	3.20	200mW
+22	2.80	160mW
+21	2.52	125mW
+20	2.25	100mW
+19	2.00	80mW
+18	1.80	64mW
+17	1.60	50mW
+16	1.41	40mW
+15	1.25	32mW
+14	1.15	25mW
+13	1.00	20mW
+12	.90	16mW
+11	.80	12.5mW
+10	.71	10mW
+9	.64	8mW
+8	.58	6.4mW
+7	.500	5mW
+6	.445	4mW
+5	.400	3.2mW
+4	.355	2.5mW
+3	.320	2.0mW
+2	.280	1.6mW
+1	.252	1.25mW

dBm	V	Po
0	.225	1.0mW
-1	.200	.80mW
-2	.180	.64mW
-3	.160	.50mW
-4	.141	.40mW
-5	.125	.32mW
-6	.115	.25mW
-7	.100	.20mW
-8	.090	.16mW
-9	.080	.125mW
-10	.071	.10mW
-11	.064	
-12	.058	
-13	.050	
-14	.045	
-15	.040	
-16	.0355	

dBm	mV	Po
-17	31.5	
-18	28.5	
-19	25.1	
-20	22.5	.01mW
-21	20.0	
-22	17.9	
-23	15.9	
-24	14.1	
-25	12.8	
-26	11.5	
-27	10.0	
-28	8.9	
-29	8.0	
-30	7.1	.001mW
-31	6.25	
-32	5.8	
-33	5.0	
-34	4.5	
-35	4.0	
-36	3.5	
-37	3.2	
-38	2.85	
-39	2.5	
-40	2.25	.1µW
-41	2.0	
-42	1.8	
-43	1.6	
-44	1.4	
-45	1.25	
-46	1.18	
-47	1.00	
-48	0.90	

dBm	mV	Po
-49	0.80	
-50	0.71	.01µW
-51	0.64	
-52	0.57	
-53	0.50	
-54	0.45	
-55	0.40	
-56	0.351	
-57	0.32	
-58	0.286	
-59	0.251	
-60	0.225	.001µW
-61	0.200	
-62	0.180	
-63	0.160	
-64	0.141	

dBm	µV	Po
-65	128	
-66	115	
-67	100	
-68	90	
-69	80	
-70	71	.1nW
-71	65	
-72	58	
-73	50	
-74	45	
-75	40	
-76	35	
-77	32	
-78	29	
-79	25	
-80	22.5	.01nW
-81	20.0	
-82	18.0	
-83	16.0	
-84	11.1	
-85	12.9	
-86	11.5	
-87	10.0	
-88	9.0	
-89	8.0	
-90	7.1	.001nW
-91	6.1	
-92	5.75	
-93	5.0	
-94	4.5	
-95	4.0	
-96	3.51	
-97	3.2	

dBm	µV	Po
-98	2.9	
-99	2.51	
-100	2.25	.1pW
-101	2.0	
-102	1.8	
-103	1.6	
-104	1.41	
-105	1.27	
-106	1.18	

dBm	nV	Po
-107	1000	
-108	900	
-109	800	
-110	710	.01pW
-111	640	
-112	580	
-113	500	
-114	450	
-115	400	
-116	355	
-117	325	
-118	285	
-119	251	
-120	225	.001pW
-121	200	
-122	180	
-123	160	
-124	141	
-125	128	
-126	117	
-127	100	
-128	90	
-129	80	.1ƒW
-130	71	
-131	61	
-132	58	
-133	50	
-134	45	
-135	40	
-136	35	
-137	33	
-138	29	
-139	25	
-140	23	.01ƒW

INDEX

NOTES

IN CASE OF DIFFICULTY...

MDS products are designed for long life and trouble-free operation. However, this equipment, as with all electronic equipment may have an occasional component failure. The following information will assist you in the event that servicing becomes necessary.

FACTORY TECHNICAL ASSISTANCE

Technical assistance for MDS products is available from our Customer Support Team during business hours (8:00 A.M.–5:30 P.M. Eastern Time). When calling, please give the complete model number of the radio, along with a description of the trouble symptom(s) that you are experiencing. In many cases, problems can be resolved over the telephone, without the need for returning the unit to the factory.

Please use one of the following means for product assistance:

Phone: 585-241-5510

E-mail: techsupport@microwavedata.com

Web: www.microwavedata.com

FAX: 585-242-8369

FACTORY REPAIRS

Component-level repair of radio equipment is *not* recommended in the field. Many components are installed using surface mount technology, which requires specialized training and equipment for proper servicing. For this reason, the equipment should be returned to the factory for any PC board repairs. The factory is best equipped to diagnose, repair and align your radio to its proper operating specifications.

If return of the equipment is necessary, you will be issued a Service Return Order (SRO) number. The SRO number will help expedite the repair so that the equipment can be repaired and returned to you as quickly as possible. Please be sure to include the SRO number on the outside of the shipping box, and on any correspondence relating to the repair. *No equipment will be accepted for repair without an SRO number.*

A statement should accompany the radio describing, in detail, the trouble symptom(s), and a description of any associated equipment normally connected to the radio. It is also important to include the name and telephone number of a person in your organization who can be contacted if additional information is required.

The radio must be properly packed for return to the factory. The original shipping container and packaging materials should be used whenever possible. All factory returns should be addressed to:

Microwave Data Systems Inc.
Product Service Department
(SRO No. XXXX)
175 Science Parkway
Rochester, NY 14620 USA

When repairs have been completed, the equipment will be returned to you by the same shipping method used to send it to the factory. Please specify if you wish to make different shipping arrangements. To inquire about an in-process repair, you may contact our Product Services Group at: 585-241-5540 (FAX: 585-242-8400) or vie e-mail at:
ProductServices@microwavedata.com.

industrial/wireless/performance

MDS

industrial/wireless/performance

Microwave Data Systems Inc.
175 Science Parkway
Rochester, NY 14620
General Business: +1 585 242-9600
FAX: +1 585 242-9620
Web: www.microwavedata.com

A product of Microwave Data Systems Inc.

C1D2

Radio communications can be configured for combination of event reporting (change-of-value), update time, read/write blocks and poll response. Radio message includes system addressing, unit addressing, error checking and configurable security encryption.Communication control includes message acknowledgments and up to four re-transmissions. Peer to peer addressing. Messages may be routed through four intermediate repeater addresses. Fail-to-transmit and fail-to-receive alarms configurable

WI-GTWY-9-PR2
Profibus DP Master

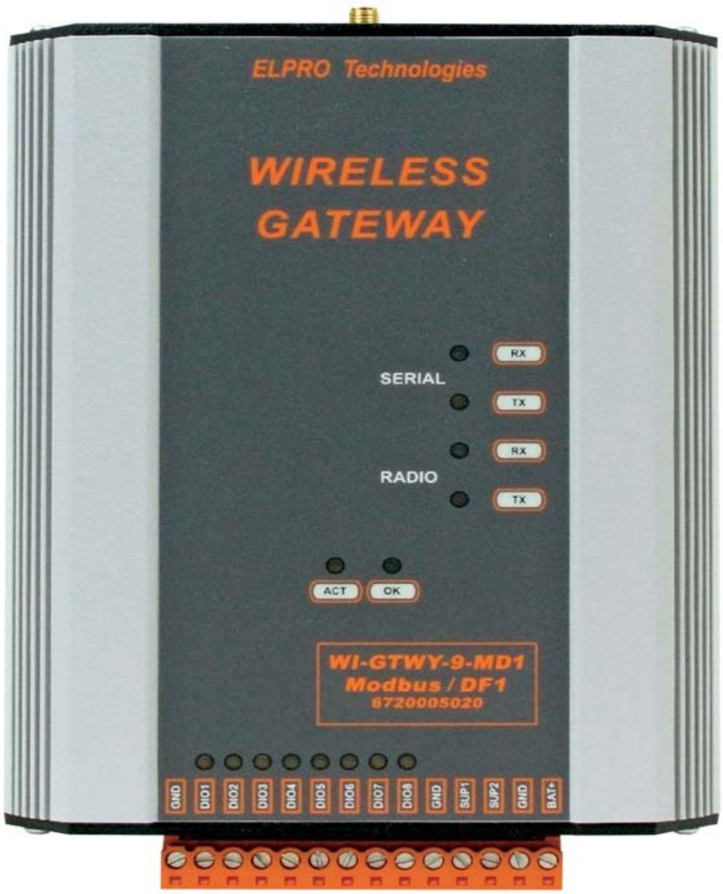
WI-GTWY-9-ET1
Ethernet IP, Modbus TCP, TCP/IP functions

Technical Data		
Power Supply	9 - 30VDC / 12 - 24VAC Battery charging circuit included for 12V back-up battery, max charge current regulated to 0.7A (>12V supply) Normal current drain MD1 version 12V 150mA; 24V 90mA Other version 12V 270mA; 24V 170mA Add 5mA per active I/O	9 - 30VDC / 12 - 24VAC Battery charging circuit included for 12V back-up battery, max charge current regulated to 0.7A (>12V supply) Normal current drain MD1 version 12V 150mA; 24V 90mA Other version 12V 270mA; 24V 170mA Add 5mA per active I/O
Current drain during radio transmission	Add 12V 350mA; 24V 200mA to above	Add 12V 350mA; 24V 200mA to above
I/O Capacity	2048 bytes input and 2048 bytes output up to 4300 discrete I/O points, or up to 1024 analog in / 1024 analog out	2048 bytes input and 2048 bytes output up to 4300 discrete I/O points, or up to 1024 analog in / 1024 analog out
Register Size	16 bit	16 bit
Number of remote WI-GTWY-9 addresses	500	500
General Data		
Operating Temperature	0 to 60°C (30 to 140°F)	0 to 60°C (30 to 140°F)
Humidity	0 - 95 %RH	0 - 95 %RH
EMC Standards	EN 301 489, FCC Part 15, Approved to FCC Part 15.247, RS210	EN 301 489, FCC Part 15, Approved to FCC Part 15.247, RS210
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting,	DIN rail mounting,
LED indication	for processor OK, radio TX and RX, serial TX and RX, active status	for processor OK, radio TX and RX, serial TX and RX, active status
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)
Wireless Communications	Profibus-DP functionality according to EN 50170. RS-485 optically isolated with on-board DC/DC converter, automatic baudrate detection (9600 bit/s - 12 Mbit/s)	10/100 Mbit/s, RJ45 connector, Transformer isolated interface Modbus/TCP class 0, class 1 and partially class 2 slave EtherNet/IP level 2 I/O Server Embedded Web system (Dynamic HTTP), on-board file system (1.4MB flash disc), user downloadable web pages through FTP server, Email functionality (SMTP)
On-board I/O	Eight discrete I/O, individually configurable as input or output. Inputs suitable for voltage free contacts. Outputs are FET, 30VDC 500mA.	Eight discrete I/O, individually configurable as input or output. Inputs suitable for voltage free contacts. Outputs are FET, 30VDC 500mA.
Configuration	via free Windows software	via free Windows software
Diagnostics	on-line read/write of I/O registers, radio signal strength values from remote units, and off-line testing of data bus protocol.	on-line read/write of I/O registers, radio signal strength values from remote units, and off-line testing of data bus protocol.
Radio Transceiver		
Frequency hopping spread spectrum	902-908 MHz, sub-bands configurable	902-908 MHz, sub-bands configurable
Transmit power	1W	1W
Receiver data sensitivity	108dBm	108dBm
Maximum line-of-sight range	USA/Canada, 4W ERP, 20+ miles	USA/Canada, 4W ERP, 20+ miles
Data rate	19.2 Kb/s with forward-error correction	19.2 Kb/s with forward-error correction
Antenna connector	SMA female coaxial	SMA female coaxial

Ordering Data	Type	Part No.	Type	Part No.
	WI-GTWY-9-PR2	**6720005022**	WI-GTWY-9-ET1	**6720005023**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

User Manual

WI-GTWY-9-xxx Wireless Gateway



W Interconnections Inc., 821 Southlake Blvd., Richmond, VA 23236

Tel: (804) 794-2877 Fax: (804) 897-4136

Web: www.weidmuller.com

Thank you for your selection of the WI-GTWY-9 module. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may
cause internal damage and will void warranty.
To ensure your WI-GTWY-9 enjoys a long life,
double check ALL your connections with
the user's manual
before turning the power on.

Caution!

For continued protection against risk of fire, replace the module fuse F1 only with the same type and rating.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to **provide a separation distance of at least 20 cm from all persons** to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 20 cm of the antenna
- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.
- operate the equipment near electrical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

FCC Notice: WI-I/O 9-x Wireless I/O Module

This user's manual is for the WI-GTWY-9-xxx

radio telemetry module. This device complies with Part 15.247 of the FCC Rules.

Operation is subject to the following two conditions:

1) This device may not cause harmful interference and
2) This device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by W Interconnections. Any changes or modifications made to the device without the written consent of W Interconnections. May void the user's authority to operate the device.

End user products that have this device embedded must be supplied with non-standard antenna connectors, and antennas available from vendors specified by W Interconnections. Please contact W Interconnections for end user antenna and connector recommendations.

Notices: Safety

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in Docket 93-62 and OET Bulletin 65 Edition 97-01.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to provide a separation distance of at least 20 cm from all persons to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 20 cm of the antenna
- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.
- operate the equipment near electrical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

Limited Lifetime Warranty, Disclaimer and Limitation of Remedies

W Interconnections products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W Interconnections, W Interconnections will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W Interconnections' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W Interconnections is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W Interconnections is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W Interconnections or its representatives or by any other party, except as expressed solely in this document..

Important Notice

W Interconnections' products are designed to be used in industrial environments, by experienced industrial engineering personnel with adequate knowledge of safety design considerations.

W Interconnections radio products are used on unprotected license-free radio bands with radio noise and interference. The products are designed to operate in the presence of noise and interference, however in an extreme case, radio noise and interference could cause product operation delays or operation failure. Like all industrial electronic products, W Interconnections' products can fail in a variety of modes due to misuse, age, or malfunction. We recommend that users and designers design systems using design techniques intended to prevent personal injury or damage during product operation, and provide failure tolerant systems to prevent personal injury or damage in the event of product failure. Designers must warn users of the equipment or systems if adequate protection against failure has not been included in the system design. Designers must include this Important Notice in operating procedures and system manuals.

These products should not be used in non-industrial applications, or life-support systems, without consulting W Interconnections first.

1. For WI-GTWY-9-xxx modules, a radio license is not required in most countries, provided the module is installed using the aerial and equipment configuration described in the WI-I/O 9-x *Installation Guide.* Check with your local WI-GTWY-9-xxx distributor for further information on regulations.
2. For WI-GTWY-9-xxx modules, operation is authorized by the radio frequency regulatory authority in your country on a non-protection basis. Although all care is taken in the design of these units, there is no responsibility taken for sources of external interference. The WI-I/O 9-x intelligent communications protocol aims to correct communication errors due to interference and to retransmit the required output conditions regularly. However some delay in the operation of outputs may occur during periods of interference. Systems should be designed to be tolerant of these delays.
3. To avoid the risk of electrocution, the aerial, aerial cable, serial cables and all terminals of the WI-GTWY-9-xxx module should be electrically protected. To provide maximum surge and lightning protection, the module should be connected to a suitable earth and the aerial, aerial cable, serial cables and the module should be installed as recommended in the Installation Guide.
4. To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the WI-I/O 9-x module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. E.g. "This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments."
5. The WI-GTWY-9-xxx module is not suitable for use in explosive environments without additional protection.

How to Use This Manual

To receive the maximum benefit from your WI-GTWY-9-xxx product, please read the **Introduction**, **Installation** and **Operation** chapters of this manual thoroughly before using the WI-GTWY-9-xxx.

Chapter Four **Configuration** explains how to configure the modules using the Configuration Software available.

Chapter Six **Troubleshooting** will help if your system has problems.

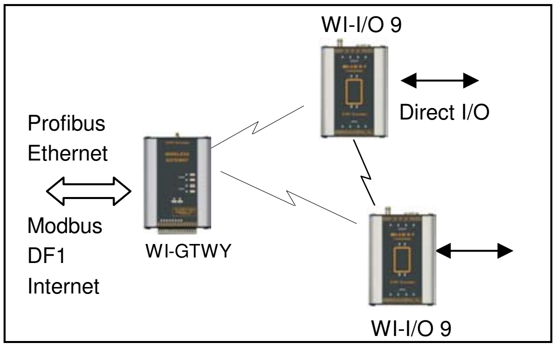
The foldout sheet *WI-GTWY-9-xxx Installation Guide* is an installation drawing appropriate for most applications.

CONTENTS

Chapter 1 INTRODUCTION

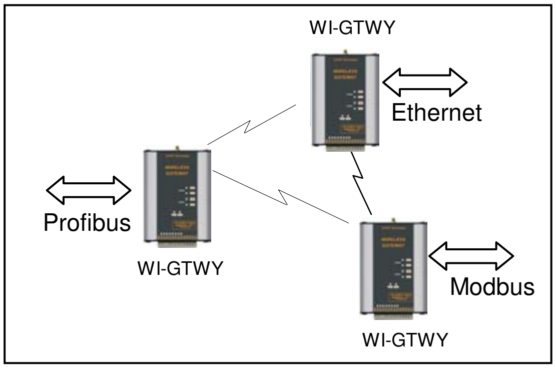
1.1 Overview

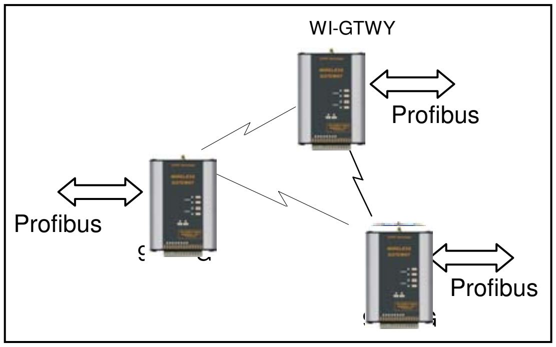
The Wireless Gateway products provide a wireless interface between various fieldbus protocols used in process and automation applications. The WI-GTWY-9-xxx includes an integral 900MHz license-free radio transceiver, and transfers transducer and control signals (I/O) using a highly secure and highly reliable radio protocol. The 105U-G units provide the same functionality as the WI-GTWY-9-xxx, but with a fixed frequency radio suitable for licensed frequencies in the 380 – 520 MHz radio band.

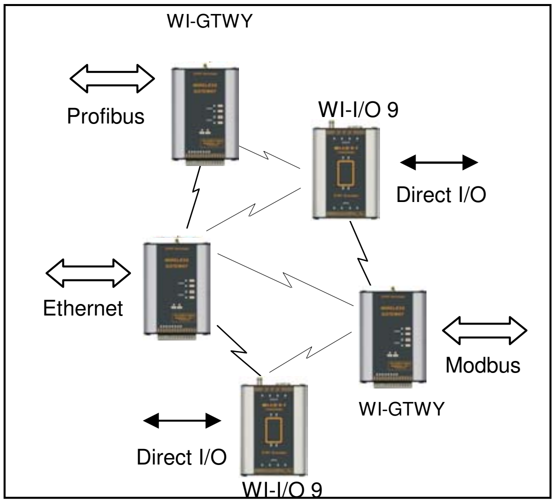


Functionality discussed in this manual for the WI-GTWY-9-xxx range also applies to the 105U-G range.

The WI-I/O 9-x radio protocol is designed for very efficient radio band usage, with event reporting communications, automatic acknowledgment and error-correction, peer to peer addressing, multiple path routing, and frequency encoding and data encryption for system security.







Application types include:

- The WI-GTWY-9-xxx interfaces between WI-I/O 9-x wireless I/O and various fieldbus protocols. Connect wireless I/O to PLC's, DCS, SCADA or Internet.
- Wireless extension of factory automation buses such as Profibus.
- Wireless interconnectivity between different fieldbuses - Ethernet to Profibus to Modbus to DF1.

- Combined networks of the above.

The WI-GTWY-9-xxx has eight on-board discrete I/O. Each I/O point can be configured individually as a contact input signal, or a discrete output signal. Input signals can be sent via its fieldbus connection to a host device (PLC, DCS etc) or be transmitted by radio to other WI-I/O 9-x units. The output signals can be driven by a host device, or linked to inputs on remote WI-I/O 9-x units.

This document assumes the reader is familiar with the operation of the WI-I/O 9-x I/O modules - for further information, please refer to the User Manuals for these products.

Ordering information:

WI-GTWY-9-MD1	Modbus Master & Slave / DF1 interface
WI-GTWY-9-PR1	Profibus-DP Slave interface
WI-GTWY-9-PR2	Profibus-DP Master interface
WI-GTWY-9-ET1	Ethernet interface - Modbus TCP, Ethernet IP, FTP, HTML, Email
WI-GTWY-9-DE1	DeviceNet Slave interface
WI-GTWY-9-M+1	Modbus Plus Slave interface

The same ordering codes apply to the WI-GTWY-1 product range.

1.1.1 Modbus / DF1 WI-GTWY-9-MD1

The WI-GTWY-9-MD1 can be configured for Modbus master interface, Modbus slave, or DF1.

Modbus is a Master-Slave protocol originally developed by Modicon (now part of the Schneider group). It became a popular interconnect protocol with many equipment manufacturers. One Modbus master controls the Modbus network communications, which can comprise up to 250 Modbus slave devices. The Modbus master can read or write I/O values to/from Modbus slaves. The WI-GTWY-9-MD1 can be configured as either Modbus Master or Modbus Slave. The variation of Modbus supported by the WI-GTWY-9-MD1 is “Modbus RTU” (also known as “Modbus binary”).

DF1 is an Allen-Bradley protocol (Allen-Bradley is now part of the Rockwell Automation group). DF1 offers both full-duplex (point to point) and half-duplex (multidrop) operation. The WI-GTWY-9-MD1 only supports the full-duplex operation - this is the default DF1 mode on most equipment. DF1 full-duplex is a “peer-to-peer” protocol. Either DF1 device can initiate commands to the other device, and both devices will respond to commands from the other device.

The WI-GTWY-9-MD1 has two serial connections - RS232 and RS485, on the bottom end plate of the module. The serial port provides both RS232 and RS485 hardware connections, however both connections are paralleled internally - both connections cannot be used at the same time. Either RS232 or RS485 can be used for Modbus communications, **however only the RS232 port can be used for DF1**. The serial port must be configured to suit the host device. Serial data rates between 1200 and 19200 baud may be selected, and character types with 7 or 8 data bits, even/odd/none parity, and 1 or 2 stop bits may be selected.

The Modbus/DF1 WI-GTWY-9-MD1 has 4300 general-purpose I/O registers. Each discrete, analog and pulse I/O point takes up one register.

1.1.2 Profibus WI-GTWY-9-PRx

The Profibus WI-GTWY-9-PR1 provides Profibus-DP Slave functionality according to EN 50170. Profibus is a popular automation fieldbus that originated in Germany and is used extensively by Siemens and other automation suppliers.

The Profibus connection on the WI-GTWY-9-PRx is optically isolated RS485 using an on-board DC/DC converter. The Profibus port has automatic baudrate detection (9600 bit/s - 12 Mbit/s).

The Profibus Slave WI-GTWY-9-PR1 will connect to a Profibus LAN controlled by an external master device. The Profibus Master WI-GTWY-9-PR2 will control communications on a Profibus LAN, and can connect to up to 125 Profibus slave devices.

The Profibus WI-GTWY-9-PR2 I/O database has 4300 registers (each of 16 bit value), however the Profibus interface limits the amount of I/O that can be transferred via the Profibus port.

Slave unit (PR1). The PR1 slave unit only supports 416 x 8 bit bytes of I/O. Of the 416 bytes of I/O, there is a maximum 244 input bytes and maximum 244 output bytes - that is, if 244 input bytes are used then only 172 output bytes can be used (416 – 244). Each byte can represent 8 discrete inputs or outputs, or an 8-bit value, or two bytes can represent a 16-bit value. That is, analog or pulse I/O can be transferred as 8-bit registers (1 byte) or 16-bit registers (2 consecutive bytes).

An “output” is a value coming into the WI-GTWY-9-PR1 via the fieldbus (that is, a value written to the WI-GTWY-9-PR1 from the Profibus master). An input is a value going out from the WI-GTWY-9-PR2 via the fieldbus (a value read by the Profibus master).

So a Profibus Slave WI-GTWY-9-PR1 could handle up to 1952 (244 x 8) discrete inputs or 244 low resolution analog inputs or 122 (244 x ½) high resolution analog inputs, or some combination in between.

For example, a Profibus WI-GTWY-9-PR1 can handle 400 discrete inputs, 240 discrete outputs, 90 analog inputs and 60 analog outputs (assume analogs are 16-bit). The number of input bytes is 230 (400/8 + 90*2). The number of output bytes is 150 (240/8 + 60*2). The total number of I/O bytes is 380. If the number of analog outputs was increased to 90, then the total output bytes would be 210 (240/8 + 90*2), and the total number of I/O bytes is 440 - this exceeds the capacity of the Profibus interface.

Master unit (PR2). The Profibus master interface supports 2048 input bytes and 2048 output bytes. Each byte can be 8 discrete inputs or outputs, but analog or pulse I/O take up 1 byte for low resolution values (8-bit) or 2 bytes for high resolution values (16-bit).

So a Profibus Master WI-GTWY-9-PR2 can handle up to 4300 I/O total, but analog or pulse inputs are limited to 2048 x 8-bit values or 1024 x 16-bit values. The same limit applies to outputs.

For example, a Profibus Master WI-GTWY-9-PR2 can handle 2000 discrete inputs and 500 analog inputs (assume analogs are 16-bit). The number of input bytes is 1250 (2000/8 + 500*2). The same unit could handle 4000 discrete outputs and 750 analog outputs. The number of output bytes is 2000 (4000/8 + 750*2). The total number of I/O is 3250 which is less than the total limit of 4300.

1.1.3 Ethernet WI-GTWY-9-ET1

The Ethernet WI-GTWY-9-ET1 provides several different types of Ethernet functionality:

- Modbus TCP. Modbus TCP uses Modbus as a base protocol within an Ethernet communications structure. The WI-GTWY-9-xxx provides class 0, 1 and partially class 2 slave functionality.
- EtherNet IP. EtherNet IP is the version of Ethernet used by Allen-Bradley devices. The WI-GTWY-9-ET1 provides level 2 I/O server CIP (ControlNet and DeviceNet).
- Internet functionality. The WI-GTWY-9-ET1 has 1.4Mbyte of non-volatile “flash” memory for embedded web “pages” (dynamic HTTP), on-board file system, user downloadable web pages through FTP server, and email functionality (SMTP).

The Ethernet connection is a transformer isolated RJ45 connector, 10/100 Mbit/sec.

The Ethernet WI-GTWY-9-ET1 I/O database has 4300 registers (each of 16 bit value), however the Ethernet interface only supports 2048 input bytes and maximum 2048 output bytes. Each byte can be 8 discrete inputs or outputs, but analog or pulse I/O take up 1 byte for low resolution values (8-bit) or 2 bytes for high resolution values (16-bit).

An “output” is a value coming into the WI-GTWY-9-ET1 via the fieldbus. An input is a value going out from the WI-GTWY-9-ET1 via the fieldbus.

So an Ethernet WI-GTWY-9-ET1 can handle up to 4300 I/O total, but analog or pulse inputs are limited to 2048 x 8-bit values or 1024 x 16-bit values. The same limit applies to outputs.

For example, an Ethernet WI-GTWY-9-ET1 can handle 2000 discrete inputs and 500 analog inputs (assume analogs are 16-bit). The number of input bytes is 1250 (2000/8 + 500*2). The same unit could handle 4000 discrete outputs and 750 analog outputs. The number of output bytes is 2000 (4000/8 + 750*2). The total number of I/O is 3250 which is less than the total limit of 4300.

1.1.4 DeviceNet WI-GTWY-9-DE1

The DeviceNet WI-GTWY-9-DE1 provides DeviceNet 2.0 Slave functionality. DeviceNet is an automation fieldbus developed by Allen-Bradley (Rockwell Automation).

The DeviceNet connection on the WI-GTWY-9-DE1 is optically isolated RS422 with selectable baudrate between 125 and 500 Kbit/sec.

The WI-GTWY-9-DE1 I/O database has 4300 registers (each of 16 bit value), however the DeviceNet interface only supports 512 x 8 bit input bytes and 512 x 8 bit output bytes, and this limits the amount of I/O that can be transferred via the DeviceNet port.

Each byte can represent 8 discrete inputs or outputs, or an 8-bit value, or two bytes can represent a 16-bit value. That is, analog or pulse I/O can be transferred as 8-bit registers (1 byte) or 16-bit registers (2 consecutive bytes).

An “output” is a value coming into the WI-GTWY-9-DE1 via the fieldbus (that is, a value written to the WI-GTWY-9-DE1 from the DeviceNet master). An input is a value going out from the WI-GTWY-9-DE1 via the fieldbus (a value read by the DeviceNet master).

So a DeviceNet WI-GTWY-9-DE1 can normally handle up to 4096 (512 x 8) discrete inputs or 512 low resolution analog inputs or 256 (512 x ½) high resolution analog inputs, or some combination in between. It can also handle the same number of outputs; however the total I/O count cannot exceed the WI-GTWY-9-DE1 database size of 4300.

1.1.5 Modbus Plus WI-GTWY-9-M+1

The Modbus Plus WI-GTWY-9-M+1 provides Modbus Plus Slave functionality. The Modbus Plus connection on the WI-GTWY-9-M+1 is optically isolated RS485 with standard baudrate of 1 Mbit/sec.

The WI-GTWY-9-M+1 I/O database has 4300 registers (each of 16 bit value), however the Modbus Plus interface only supports 1024 input registers and maximum 1024 output registers. Each register can be 16 discrete inputs or outputs, or one analog or counter 16-bit value.

An “output” is a value coming into the WI-GTWY-9-M+1 via the fieldbus. An input is a value going out from the WI-GTWY-9-M+1 via the fieldbus.

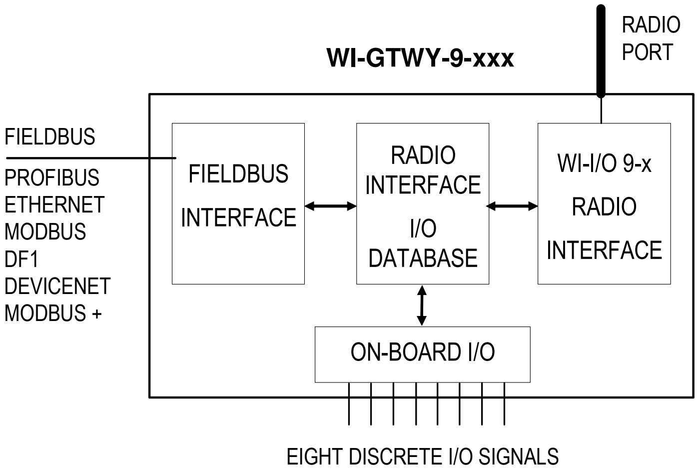
So an Modbus Plus WI-GTWY-9-M+1 can handle up to 4300 I/O total, but analog or pulse inputs are limited to 1024 x 16-bit values. The same limit applies to outputs.

The Modbus Plus interface allows global data base transactions with routing for up to six Modbus Plus networks.

1.2 The WI-GTWY-9-xxx Structure

The WI-GTWY-9-xxx has three functional sections:

- The Radio Interface consists of an I/O database (or "Process Image") that maintains the latest values of all I/O in the wireless I/O system. The I/O database comprises 4300 x 16 bit I/O registers and 4300 x 16 bit status registers. There are also other registers in the database that can be used for system management - they are discussed later in this manual. NOTE – the terms ‘Radio Interface’ and ‘I/O database’ are used interchangeably throughout the manual.



- The radio port allows the WI-GTWY-9-xxx to communicate with other WI-GTWY-9-xxx and/or WI-I/O 9-x modules using the WI-I/O 9-x protocol. Messages from the WI-I/O 9-x modules are received by the radio port and used to update the input values in the WI-GTWY-

9-xxx Radio Interface. The radio port also creates the correct radio message to set outputs on the remote WI-I/O 9-x modules.

The WI-I/O 9-x protocol is an extremely efficient protocol for radio communications. Radio messages can be sent using exception reporting - that is, when there is a change of an input signal - or by read/write messages. Each message can comprise a single I/O value, or multiple I/O values (termed a "block" of I/O). There are also update messages, which are sent for integrity purposes. Messages include error checking, with the destination address sending a return acknowledgment. Up to five attempts are made to transmit the message if an acknowledgment is not received. The WI-I/O 9-x protocol is designed to provide reliable radio communications on an open license-free radio channel.

- The Fieldbus port enables communications between a host device, which could be a PLC, DCS, HMI, intelligent transducer, etc), and the WI-GTWY-9-xxx Radio Interface database. A "host device" may be one or several devices connected to the same fieldbus or network (for example, an Ethernet LAN) - in this manual, the LAN is considered as a "host device".

The fieldbus port decodes messages from the host device and reads or writes I/O values to the database. The fieldbus port can also generate messages to the host device.

The WI-GTWY-9-xxx I/O database effectively isolates the fieldbus and the radio network. This provides a high level of system performance. The WI-I/O 9-x radio protocol is very efficient and reliable for radio communications. It minimizes radio channel usage by "change-of-state" reporting, and allows the use of intermediate repeater addresses. It also allows peer-to-peer (WI-I/O 9-x to WI-I/O 9-x, WI-GTWY-9-xxx to WI-GTWY-9-xxx) and peer-to-master (WI-I/O 9-x to WI-GTWY-9-xxx) communications. PLC protocols, by comparison, are designed to provide transfer of large I/O files by "wire" link. The WI-GTWY-9-xxx retains the advantage of both protocols in their respective communications media.

1.2.1 On-board I/O

The WI-GTWY-9-xxx has eight on-board discrete I/O. Each I/O point can be used as either a discrete input (voltage free contact input) or discrete output (transistor output) - an I/O point cannot be used as both input and output. Each I/O point is linked to two separate I/O registers in the database - one for the "input" function and one for the "output" function.. If the output register is set "on" by the fieldbus or by a radio message from a remote module, then the WI-GTWY-9-xxx will automatically set the input register for the same I/O point to "off". This means that the output register has priority over the input register - if there is a conflict, the input value is ignored.

The WI-GTWY-9-xxx also has three internal inputs linked to I/O registers:

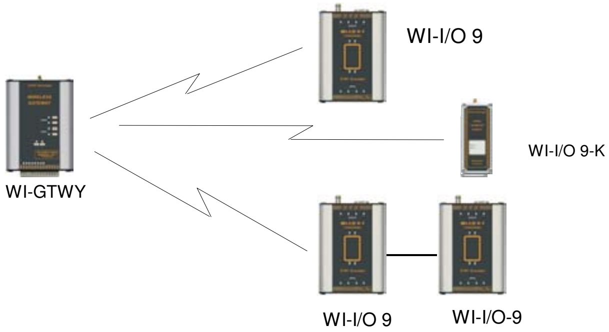
- ♦ Supply voltage status - if the normal supply fails, this status is set on.
- ♦ Low battery voltage. The WI-GTWY-9-xxx has an internal battery charger to trickle charge a back-up battery. If the battery voltage is low, this status is set.
- ♦ Battery voltage - the actual value of the connected battery voltage.

1.2.2 I/O Expansion - WI-I/O-EX-1-S-xx modules

The WI-GTWY-9-xxx provides eight on-board discrete I/O. Where additional I/O is required, WI-I/O-EX-1-S-xx modules can be connected to the RS485 port of the WI-GTWY-9-xxx module.

Note: WI-I/O-EX-1-S-xx cannot be connected to the WI-GTWY-9-MD1 unit (it uses the RS485 port for Modbus or DF1 communications), unless this unit is configured as “Repeater-only” and does not have a host device connected.

1.3 The Wireless Network



The WI-GTWY-9-xxx can communicate with up to 490 other addresses - this could be 490 other WI-I/O 9-x modules, or in the case of WI-I/O 9-K modules, it could be many thousands of modules (as many WI-I/O 9-K modules can share the same address). WI-GTWY-9-xxx modules may take up more than one address under some circumstances.

Any WI-GTWY-9-xxx or WI-I/O 9-x module can act as a radio repeater for other modules - that is, radio messages can be passed onto other modules. Up to five repeater addresses can be configured for messages transmitted to a WI-GTWY-9-xxx module.

Each module can have a unit address between 1 – 95, but the WI-GTWY-9-xxx also recognizes repeater addresses in conjunction with the unit address as the module “identifier”. Hence module #2 is recognized as different to #2 via #57 - #57 being a repeater.

1.3.1 WI-I/O 9-x to WI-GTWY-9-xxx Network

In the wireless I/O system, the WI-GTWY-9-xxx acts as a normal WI-I/O 9-x module (this covers WI-I/O 9-x I/O, WI-I/O-EX-1-S-1x I/O, WI-I/O 9-x-K and WI-I/O 9-x-C modules).

WI-I/O 9-x modules transmit messages to the WI-GTWY-9-xxx address and the WI-GTWY-9-xxx acknowledges these messages like a normal WI-I/O 9-x module. When a WI-GTWY-9-xxx transmits messages to change remote outputs, it will "re-try" if it does not receive an acknowledgment, like a normal WI-I/O 9-x module.

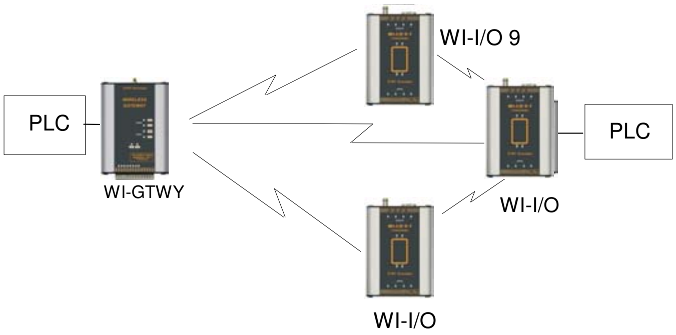
Remote WI-I/O 9-x modules can connect to WI-I/O-EX-1-S-1x modules in the normal way. The WI-GTWY-9-xxx host can access I/O on WI-I/O-EX-1-S-1x modules by using the intermediate WI-I/O 9-x as a repeater.

WI-I/O 9-x modules can transmit input messages directly to outputs on other WI-I/O 9-x module, as well as the WI-GTWY-9-xxx. The same input can be transmitted to different addresses by entering two "mapping" configurations at the remote module.

Normal WI-I/O 9-x Messages

I/O registers in a WI-GTWY-9-xxx can be configured (mapped) to outputs at remote WI-I/O 9-x modules, or I/O registers in WI-GTWY-9-xxx modules. The WI-GTWY-9-xxx will transmit an

I/O message when a "change-of-state" occurs for that I/O register. Registers have a configurable "sensitivity" value - this determines how much the register value has to change to trigger a change message. A change-of-state occurs when the register value has changed by more than the sensitivity value since the last transmission.



The WI-GTWY-9-xxx also transmits periodic update messages if there has been no change - if an I/O register is mapped to a remote output or another WI-GTWY-9-xxx, then that register can be configured with an update time.

WI-GTWY-9-xxx modules can transmit to WI-GTWY-9-xxx modules as well as other WI-GTWY-9-xxx modules. There can be multiple WI-GTWY-9-xxx modules in a network - as well as WI-I/O 9-x I/O. Because the WI-I/O 9-x protocol is peer-to-peer, there are few constraints on communications between multiple WI-I/O 9-x modules.

Poll Messages

A WI-GTWY-9-xxx can also generate poll messages to remote WI-I/O 9-x modules. These poll messages act in the same way as a start-up poll - the remote module immediately responds with update messages for any I/O mappings configured to the WI-GTWY-9-xxx.

Poll messages can be triggered by:

- time period, configurable 1 – 4096 sec (1.1 hour), or
- real time clock, or
- on demand by the host device, by writing to a "trigger register" in the WI-GTWY-9-xxx

1.3.2 WI-GTWY-9-xxx to WI-GTWY-9-xxx Network

Different types of WI-GTWY-9-xxx modules can communicate - for example, a Modbus WI-GTWY-9-xxx can communicate with an Ethernet WI-GTWY-9-xxx. I/O registers in one WI-GTWY-9-xxx can be transmitted to I/O registers in another WI-GTWY-9-xxx. When the WI-GTWY-9-xxx is configured, "mappings" can be entered linking I/O registers to registers in another WI-GTWY-9-xxx.

As well as the normal "I/O change" messages and update messages, the WI-GTWY-9-xxx has "block read" and "block write" messages for use with other WI-GTWY-9-xxx modules. These messages will transmit multiple register values instead of only one as in the normal WI-I/O 9-x message. The block read/write messages increase the efficiency of radio communications where a WI-GTWY-9-xxx "sees" a large number of changes in its database at the one time. For example, if a host writes a block of 100 signal values to a WI-GTWY-9-xxx, and 20 of these values have changed since the last write-operation. If the block is mapped to another WI-GTWY-9-xxx, then the WI-GTWY-9-xxx can transmit all 20 values in one radio message, instead of 20 messages.

Normal I/O messages can be repeated by any type of WI-I/O 9-x I/O module, however block read/write messages can only be repeated by other WI-GTWY-9-xxx modules.

Block Read Message

A block read message is a request to another WI-GTWY-9-xxx to transmit the values of a consecutive block of registers. The destination WI-GTWY-9-xxx will respond with the values, which will be stored in a corresponding block of registers in the originating WI-GTWY-9-xxx. A block read message can be triggered by:

- ♦ time period, configurable 1 – 4096 sec (1.1 hour), or
- ♦ real time clock, or
- ♦ on demand by the host device, by writing to a "trigger register" in the WI-GTWY-9-xxx.

Block Write Message

A block write message transmits a consecutive block of register values from one WI-GTWY-9-xxx to a destination WI-GTWY-9-xxx. It can be triggered by:

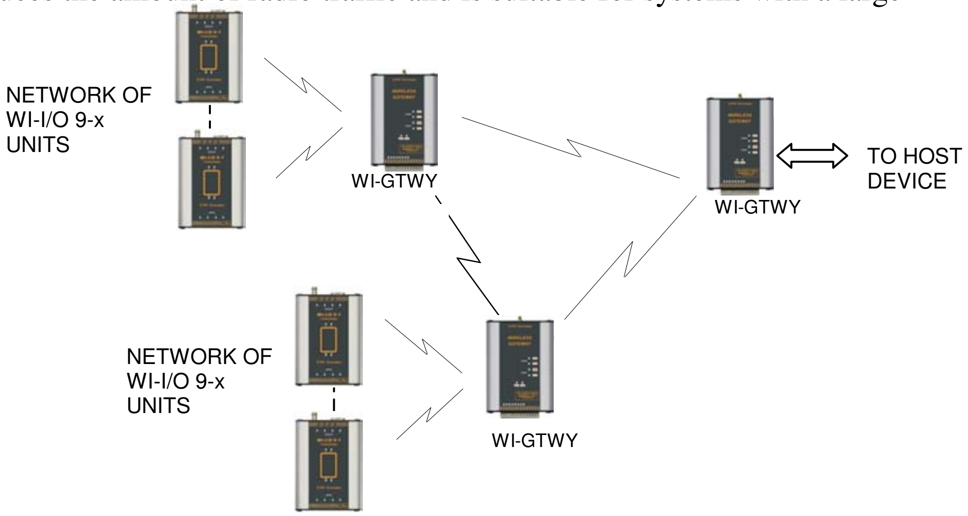
- ♦ time period, configurable 1 – 4096 sec (1.1 hour), or
- ♦ real time clock, or
- ♦ on demand by the host device, by writing to a "trigger register" in the WI-GTWY-9-xxx, or
- ♦ a change-of-state event occurring within the block of I/O registers.

If a block write message has been configured to be transmitted on change-of-state, a "time window" is configured. When a change-of-state occurs in one of the registers in the block, the time window will be activated. All changes during the time window will be grouped together and transmitted as one block write message. That is, the block write message will not be sent immediately the first change-of-state occurs (unless the time window is configured to zero), but will be sent at the end of the time window - any other registers in the block that change during the time window will be sent as part of the same message. The time window can be configured from 0 – 255 seconds.

1.3.3 "Data Concentrator" Networks

WI-GTWY-9-xxx units can act as "data concentrator" units to collect I/O from a local network of WI-I/O 9-x wireless I/O modules and pass the I/O on to another WI-GTWY-9-xxx as a block.

This type of network reduces the amount of radio traffic and is suitable for systems with a large number of I/O modules. The system is divided into local sub-networks, each with a WI-GTWY-9-xxx unit. The WI-I/O 9-x modules transmit their I/O vlaues to the WI-GTWY-9-xxx. The WI-GTWY-9-xxx then transfers these values to the "central" WI-GTWY-9-xxx



using a block transfer which is very efficient compared to a lot of individual I/O transmissions.

The data concentrator network is different than using the WI-GTWY-9-xxx as a repeater. A repeater re-transmits each message in the same format. A data concentrator collects the I/O values as a block, and transmits the complete block in one transmission.

1.3.4 WI-GTWY-9-xxx Repeaters

Any WI-I/O 9-x module can repeat a normal radio message, however only WI-GTWY-9-xxx modules can repeat a block message. WI-GTWY-9-xxx units connected to a host device can also act as a repeater for other modules.

Where a WI-GTWY-9-xxx is being used without a host device as a repeater or data-concentrator, it can be configured as “Repeater-only”. This allows the RS232/485 port to be used for on-line diagnostics

Chapter 2 OPERATION

2.1 Start-up

The WI-GTWY-9-xxx operating software and the database configuration are stored in non-volatile memory; however the database I/O register values are lost on power failure (in the same way as a PLC).

On start-up, the WI-GTWY-9-xxx sends "start-up poll" messages to remote modules based on the source address of inputs configured in the database (the start-up messages can be disabled by configuration). The remote modules respond with update messages for their inputs, which sets initial values in the WI-GTWY-9-xxx I/O database registers. The WI-GTWY-9-xxx provides a delay of 5 seconds between each start-up poll, to allow the remote module to respond and to avoid overloading the radio channel.

If there are a lot of remote modules, then this start-up stage may take a significant time, and this should be allowed for in the system design. The WI-GTWY-9-xxx has an internal battery charger feature and the use of a back-up battery should be considered if this start-up delay presents a constraint to system reliability. Start-up polls may be disabled for individual remote modules in the database configuration.

For the host device, the WI-GTWY-9-xxx provides an "Active" signal on the RS232 port (DCD pin 1). Its purpose is to indicate to the host that the WI-GTWY-9-xxx is now processing output messages for the remote modules. When the WI-GTWY-9-xxx powers down (or should an internal fault occur), the "Active" signal resets (turn “off” or “0”). When the WI-GTWY-9-xxx starts-up, it holds the "Active" signal in a reset condition (“off” or “0”) for a time equal to the number of remote addresses (or modules) configured times 5 seconds plus any delay if remote addresses are offline. For example, if there are 20 remote addresses configured in the WI-GTWY-9-xxx database, then the “active” signal will be held in the reset state for 100 seconds (20 x 5). During this period, the WI-GTWY-9-xxx will not change any output values in its database. After this time, the WI-GTWY-9-xxx will set the "Active" signal (to “on” or “1”) - the host can then send messages to the WI-GTWY-9-xxx to update the output values in the database.

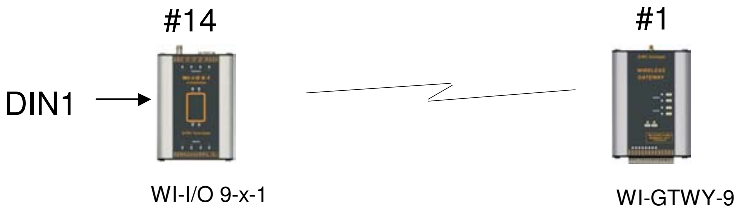
2.2 Operation

The WI-GTWY-9-xxx database can hold values for 4300 I/O signals plus the 8 on-board I/O. The database registers (also called I/O registers) can be accessed by both the radio port and the fieldbus port. The host device can change values in the database via the fieldbus, and the WI-GTWY-9-xxx can transmit radio messages out with the new values. Radio messages can be received with new values for database registers, and these new values can be written to the host device or read by the host device, via the fieldbus.

The WI-GTWY-9-xxx operation must be configured before the WI-GTWY-9-xxx will function. Configuration is achieved by creating a configuration file on a PC and downloading this file to the WI-GTWY-9-xxx. The WI-GTWY-9-xxx configuration may also be "uploaded" to a PC for viewing and modification. For more information, refer to the **Configuration** section of this document.

Each I/O register in the WI-GTWY-9-xxx database has a 16-bit value. It doesn't matter if the remote I/O is digital (discrete), analog or pulse. The host protocol driver in the WI-GTWY-9-xxx will convert the 16 bit value into a value that the host will understand. For example, if the host device requests a binary/digital read command, the WI-GTWY-9-xxx will convert the 16 bit value into a binary (1 bit) value before it responds.

The WI-GTWY-9-xxx is able to scale the I/O value between the I/O database and the host device - this is a user-configurable function.



An example of normal operation - assume that a remote module has address 14 and the WI-GTWY-9-xxx is address 1. Module #14 is configured with a mapping DI1 → I/O Reg 76 at #1. When DI1 turns "on", module #14 transmits a message. If the WI-GTWY-9-xxx can hear this message, it will transmit an acknowledgment back to module #14, and updates the value of I/O register 76 in the WI-GTWY-9-xxx database. The host device can read I/O register 76 via the data-bus, or the WI-GTWY-9-xxx may write the value of I/O register 76 to the host device.

I/O registers that receive values from other WI-I/O 9-x or G modules via radio are configured with a "Communications fail time". If the WI-GTWY-9-xxx does not receive a message for this I/O register within the comms-fail time, then the I/O register is given a "comms fail" status which the host device can read. The I/O value can also be configured to reset to zero on comms-fail.

I/O registers that transmit out to other WI-I/O 9-x or WI-GTWY-9xxx modules are configured with an "update time" and a "sensitivity". The WI-GTWY-9-xxx will transmit a message to the configured remote output whenever the I/O register value changes by the sensitivity amount – if it has not changed within the update time, the WI-GTWY-9-xxx will send a message anyway. The WI-GTWY-9-xxx will make five attempts to send a message - if it does not receive an acknowledgment from the remote module, then the I/O register is given a "comms fail" status which the host device can read.

Each I/O register has an associated "status" register, which includes information such as comms-fail status. As well as each I/O register having an individual comms-fail status, each remote module has an overall comms fail status. This status is "set" (on) whenever a comms-fail occurs for an individual I/O register, and is "reset" (off) whenever a message is received from the remote module. The WI-GTWY-9-xxx can be configured to not send any update messages to a remote module if it senses that the remote module is in "comms fail" - that is, if any I/O register associated with the remote module is in "comms fail". It will start sending update messages again when the WI-GTWY-9-xxx receives a message from the remote module. The default configuration is that output updates ARE sent during comms fail conditions.

2.3 Database

The WI-GTWY-9-xxx database (Radio Interface) has 10 000 registers, each of 16 bit size. The structure of the database is:

Registers	Purpose
0 - 4299	I/O registers
4300 - 4399	On-board I/O
4401 - 4499	Comms-fail status and radio strengths for remote modules
5000 - 9499	Status registers - 16 bit status for each I/O signal
9500 - 9999	Status registers for block read/write messages

The register numbers may be used by the Host Protocol Driver to access I/O values and I/O status information. Each configured I/O point has a 16 bit value (in registers 0000 - 4299), and a 16 bit status value. The status register is located at 5000 plus the I/O value register. For example, an I/O point in register number 2560 has a status value in register number 7560 (5000 + 2560).

Details of the status register are provided in Appendix A. The most important part of the status register is the 15th or most significant bit - this indicates comm-fail status for the I/O register. If the most significant bit is set, then the I/O register is in comms-fail.

The host device can read the status registers. For example, the communications status of an output configured at register number 3001 can be examined by reading register number 8001 (5000 + 3001). If the register value is greater than 32767, then the 15th bit is set, indicating that the output has a communications failure.

2.3.1 On-board I/O and Internal I/O

The WI-GTWY-9-xxx has eight discrete I/O points. These may be used as inputs or as outputs. Inputs are linked to registers 4300-4307. That is, if a contact connected to DIO1 is "on", then register 4300 is given an "on" value. The inverse of the input values are stored in registers 4370-4377.

Outputs are controlled from registers 4320-4327; that is, if register 4327 is set to an "on" value, then output DIO8 is activated.

Whenever an output register is set "on", the corresponding input register is automatically set "off". For example, if register 4321 is set to "1", the WI-GTWY-9-xxx will also set 4301 to "0". This means that if both the input and output registers corresponding to the same I/O point are used in the configuration, then the output register has priority.

Outputs may be written to by either the host device or by a remote WI-I/O 9-x via the radio port. Input values can be sent to the host device or to a remote module via the radio port.

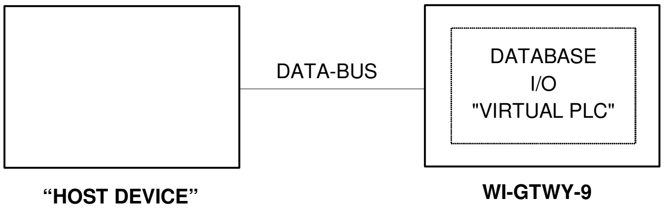
The WI-GTWY-9-xxx also monitors its battery voltage and supply voltage. These are stored in registers 4310 and 4311 respectively, as 16 bit values, scaled so that a value of 16384 decimal (hex 4000) corresponds to 8 V, and a value of 49152 (hex C000) corresponds to 40V.

A low battery alarm is available at register 4308. This becomes active when the battery voltage falls below 11.3V, and clears when the battery voltage rises above 11.8V. Supply voltage is also monitored, and an alarm is available at register 4309. This becomes active if the supply voltage falls below 8.0V, and clears when the supply voltage rises above 9.0V.

I/O Register	Description	I/O Register	Description
4300	Input value DIO 1	4320	Output value DIO 1
4301	Input value DIO 2	4321	Output value DIO 2
4302	Input value DIO 3	4322	Output value DIO 3
4303	Input value DIO 4	4323	Output value DIO 4
4304	Input value DIO 5	4324	Output value DIO 5
4305	Input value DIO 6	4325	Output value DIO 6
4306	Input value DIO 7	4326	Output value DIO 7
4307	Input value DIO 8	4327	Output value DIO 8
4308	Low battery voltage status		
4309	Supply voltage fail status		
4310	Battery voltage value		
4311	Supply voltage value		
4370 - 4379	Inverse values of 4300 - 4309		

2.4 The Host - WI-GTWY-9-xxx Link

For the host device, the WI-GTWY-9-xxx "looks" like a single device (or a "virtual PLC"), containing the I/O for the complete wireless I/O system.



2.4.1 Modbus / DF1

The user selects whether the WI-GTWY-9-MD1 should act as a Modbus Master or Modbus Slave or DF1 device.

The data type and baud rate of the serial communications must be configured at the WI-GTWY-9-xxx to match the host. Data types can be 7 or 8 bit, even/odd/no parity, with 1 or 2 stop bits. Data rates can be 300 - 19200 baud.

The full WI-GTWY-9-xxx database (4300 registers) can be accessed by the Host Device.

2.4.2 Profibus

The Profibus port has auto-detect of baud rate from 9600 bits/sec to 12Mbit/sec - no configuration is required.

The Profibus units have internal hardware comprising the Profibus Interface. The Profibus Interface handles all Profibus DP Network communications. The internal Radio Interface is separate to the Profibus Interface, and handles all radio communications. I/O in the Radio Interface is linked to I/O in the Profibus Interface in a flexible way via WI Series Configuration Software.

The Profibus Slave interface provides a total of 416 I/O bytes, with a maximum 244 input bytes and maximum 244 output bytes. A Profibus byte can contain 8 discrete (binary) values, or two bytes can be used for a 16-bit analogue or pulse register. So the Profibus interface is limited to 1952 discrete inputs or 122 analogue inputs or a combination. The same applies for outputs.

For example, a Profibus host wants to read 800 discrete inputs (100 bytes) and write 400 discrete outputs (50 bytes). This will take up 150 bytes of the Profibus Interface, leaving 266 left. The remaining bytes could be used for 133 analogue I/O - up to 72 analogue inputs (244 – 100 discrete input bytes) plus 61 analogue outputs - or vice-versa.

The Profibus Master interface provides a total of 2048 input bytes and 2048 output bytes. A byte can contain 8 discrete (binary) values, or two bytes can be used for a 16-bit analogue or pulse register. So the interface is limited to 4300 discrete inputs (the limit of the WI-GTWY-9-xxx database) or 1024 analogue inputs (the limit of the HMS interface) or a combination. The same applies for outputs.

2.4.3 Ethernet

The Ethernet port automatically handles Ethernet communications at 10 or 100 Mbit/sec. An IP address is entered so that other Ethernet devices can recognize the WI-GTWY-9-xxx.

The Ethernet units have internal hardware comprising the Ethernet Interface. The Ethernet Interface handles all Ethernet Network communications. The internal Radio Interface is separate to the Ethernet Interface, and handles all radio communications. I/O in the Radio Interface is linked to I/O in the Ethernet Interface in a flexible way via WI Series Configuration Software.

The Ethernet Interface provides a total of 2048 input bytes and 2048 output bytes. An Ethernet byte can contain 8 discrete (binary) values, or two bytes can be used for a 16-bit analog or pulse register. So the Ethernet Interface is limited to 4300 discrete inputs (the limit of the WI-GTWY-9-xxx database) or 1024 analog inputs (the limit of the Ethernet interface) or a combination. The same applies for outputs.

For example, an Ethernet host wants to read 500 analog inputs (1000 bytes). The remaining input bytes (1548) could be used for 12,384 discrete inputs - but the WI-GTWY-9-xxx database is not this big. Provided there are no outputs required, there could be 3800 discrete inputs (4300

– 500 analogs). If there are outputs required, then the number of discrete inputs available will be further limited.

2.5 Radio System Design

Each wireless I/O system can have up to 95 unit addresses, although up to 255 WI-I/O 9-K module can share the same unit address (refer to WI-I/O 9-K User Manual).

Each WI-I/O 9-x module can have up to 31 x WI-I/O-EX-1-S-1x modules connected to it. These modules are addressed 96 - 127. More than one WI-I/O-EX-1-S-1x module can have the same address, provided they are not connected to the same WI-I/O 9-x module - that is, #100 via #16 is identified as a different module to #100 via #65.

A constraint that needs to be considered is the capacity of the radio channel. If there is too much traffic on the radio channel, then the system quickly becomes unreliable. The recommended maximum average traffic density is 100 messages per minute provided all radio paths are reliable. If there are marginal radio paths, resulting in re-tries of transmitted messages, then the maximum traffic density is reduced considerably. Each block read/write messages should be counted as two messages because of the length of these messages.

A WI-GTWY-9-xxx can be used as a repeater module for messages between other modules.

2.5.1 Radio Signal Strength

The WI-GTWY-9-xxx records the radio signal strength of remote modules that communicate directly (that is, not via repeaters). There are 95 database registers (4401 – 4495) which store the radio strengths – corresponding to remote addresses #1 - #95. The radio strength (RSSI) is measured in dBm (relative to 1mW of RF power). The RSSI value is stored in the 8 least significant bits of each register - a value of –84 dBm would be stored as decimal 84.

These database registers will hold the strength of the last message received from the address. If a message is received from a remote module via a repeater, then the measurement is recorded in the address of the last repeater. For example, if a message is received from #24 directly, then the RSSI will be recorded in register 4424. If a message is received from #24 via #25, then the RSSI is recorded in register 4425. The WI-GTWY-9-xxx will not know what the radio strength of the message from #24 to #25 is. If #25 is another WI-GTWY-9-xxx, then it can record this RSSI and this register could be mapped to an I/O register in the first WI-GTWY-9-xxx.

The RSSI registers can be read by the host device, or mapped to I/O registers in other WI-GTWY-9-xxx modules.

The first half of the register (8 most significant bits) will be decimal 0 (hex 00) if the remote module has active communications. If a comms fail status to this address occurs, the most significant bit will be set. For example, if the last message received from #38 is –99dBm, then the 16 bit value of register 4438 will be decimal 99 or hex 0063. If the “comms fail” status for #38 is set, the 16 bit value of register 4438 will become decimal 32,867 (32768 + 99) or hex 8063.

2.5.2 Repeaters

Radio paths may be extended by using intermediate modules as repeaters. A repeater will receive and re-transmit the radio message. Up to five repeater addresses can be configured - that is, a radio message can pass through five intermediate modules. For normal I/O messages, any WI-I/O 9-x module (except WI-I/O 9-x-K modules) can be used as a repeater, however for block read/write messages, only WI-GTWY-9-xxx modules can act as repeaters.

2.6 Radio Comms Failure

The WI-GTWY-9-xxx has an internal "communications failure" (comms fail) status for each I/O point in its database. There is also a comms fail status for each module with direct communications - see 2.5.1 above.

For I/O registers which are mapped to a remote output or another WI-GTWY-9-xxx, the comms fail status is set if the WI-GTWY-9-xxx does not receive an acknowledgment for a message being sent to that remote output. The comms fail status resets when a successful transmission occurs.

For I/O registers which have been mapped , from a remote input or another WI-GTWY-9-xxx, a comms fail time period may be configured. If a radio message for this I/O register has not been received within this time, then this registers comms fail status is set. The comms fail status will reset when a message is received for this register. If the comms fail time is configured as zero, then the comms fail status will never be activated.

The communications failure status is bit 15 of the status register for each I/O point. If the host device reads a register as a digital or binary value, then the WI-GTWY-9-xxx returns bit 15 of the register (0 or 1) - this is the comms fail bit of a status register.

It is important to use the comms fail status in the overall system design, as any system can fail.

The WI-GTWY-9-xxx also provides an additional comms failure feature to stop the WI-GTWY-9-xxx transmitting output messages to an individual remote address if the WI-GTWY-9-xxx already knows that this remote address is in communication failure. This prevents the WI-GTWY-9-xxx from congesting the radio channel with a lot of unnecessary transmissions (and re-transmissions). This function is called "Don't Send if In Comm Fail" and is configurable by the user for each individual remote address. The WI-GTWY-9-xxx retains a "remote address comms fail" status for the remote addresses configured for this function. If any output with this remote address goes into communications failure, then the remote address comms fail status is set ("on" or 1) - every time an input with this remote address receives a radio message, then the remote address comms fail status is reset ("off" or 0). While the remote address comms fail status is set, the WI-GTWY-9-xxx disables any output messages being sent to this remote address.

When this feature is configured, all output transmissions are stopped if communications with a remote module fails for a short period. They will start again when an input message from this module is received. If the WI-GTWY-9-xxx determines that a output message should be sent to an output which is disabled because of this feature, then the output message will not be sent and the comms fail status of that output is set ("on" or 1).

If it is desired to use this function with a remote WI-I/O 9-x module, but there are no inputs from this module being used, then it is easy to configure an unused input or an internal input (mains fail or low battery voltage etc). It is the comms fail status for the input, which is used, not the input itself.

2.6.1 Monitoring Communications Failure

The host device can monitor the communications status of an I/O point by reading the status register for this point as a binary/discrete register. Modbus, and many other protocols, will convert a 16 bit register value to a binary/discrete value by returning the most significant bit - for the status register, this corresponds to the comms status bit.

For example, to monitor the comms status of I/O register 1045, perform a binary/discrete read on register 6045 (the status register for 1045). A value of "1" will be returned if this I/O point is in comms fail, and a "0" returned if the status is normal.

If it is desired to monitor the comms status of all I/O points, it is more efficient to only monitor the comms status of one I/O point at each remote module (if this point is in comms fail, then all points at the remote module will be in comms fail). If this point is an input, then the comms fail time for this input can be made short, to give an early warning of a comms problem (this means that the corresponding update time for the input at the WI-I/O 9-x will need to be short). If the point is an output, then the update time for the output should be made short.

2.7 Security Considerations

There are three dimensions of security considerations:

1. Failure to operate when required - or "operational reliability".

   The features discussed above optimize operating reliability. Using an acknowledgment and re-try protocol ensures that the transmitting module is aware whether the transmitted message has been transmitted reliably. The "comms fail" alarms provide indication if the radio link has failed to operate.

2. Mal-operation, or operating when not requested.

   This problem occurs when an output is "triggered" by the wrong radio device. The WI-GTWY-9-xxx modules use frequency encoding and a very secure addressing system to ensure this does not occur. An additional security level using data encryption can also be selected.

3. Malicious operation, or "hacking"

   This is the problem most associated with security concerns - the ability for someone to access information from a radio system by "listening-in", or to cause damage by transmitting radio messages to force outputs.

   A security option can be selected during the module configuration to protect against this. The security option (if selected) adds data encryption to radio messages. Modules in the same system are automatically configured with the encryption key, such that only these modules can understand each other. “Foreign” modules will hear the messages, but cannot decrypt the messages. For more information, refer to section 4.2.2.

Chapter 3 INSTALLATION

3.1 General

The WI-GTWY-9-xxx module is housed in a rugged aluminum case, suitable for DIN-rail mounting. Terminals will accept wires up to 12 gauge (2.5 sqmm) in size.

All connections to the module must be low voltage (SELV). Normal 110-240V mains supply should not be connected to any terminal of the WI-GTWY-9-xxx module. Refer to Section 3.3 **Power Supply**.

Before installing a new system, it is preferable to bench test the complete system. Configuration problems are easier to recognize when the system units are adjacent. Following installation, the most common problem is poor communications caused by incorrectly installed aerials, or radio interference on the same channel, or the radio path being inadequate. If the radio path is a problem (i.e. path too long, or obstructions in the way), then higher performance aerials or a higher mounting point for the aerial may rectify the problem. Alternately, use an intermediate WI-I/O 9-x Module as a repeater.

The foldout sheet WI-GTWY-9-xxx ***Installation Guide*** provides an installation drawing appropriate to most applications. Further information is detailed below.

Each WI-GTWY-9-xxx module should be effectively earthed/grounded via the "GND" terminal on the WI-I/O 9-x module - this is to ensure that the surge protection circuits inside the module are effective.

3.2 Antenna Installation

The WI-GTWY-9-xxx and WI-I/O 9-x modules will operate reliably over large distances. The distance which may be reliably achieved will vary with each application - depending on the type and location of antennas, the degree of radio interference, and obstructions (such as hills or trees) to the radio path. Typical reliable distances are :

USA/Canada	15 miles	6dB net gain antenna configuration permitted (4W ERP)
Australia/NZ	12 km	unity gain antenna configuration (1W ERP)

Longer distances can be achieved if one antenna is mounted on top of a hill.

To achieve the maximum transmission distance, the antennas should be raised above intermediate obstructions so the radio path is true “line of sight”. Because of the curvature of the earth, the antennas will need to be elevated at least 15 feet (5 metres) above ground for paths greater than 3 miles (5 km). The modules will operate reliably with some obstruction of the radio path, although the reliable distance will be reduced. Obstructions that are close to either antenna will have more of a blocking effect than obstructions in the middle of the radio path. For example, a group of trees around the antenna is a larger obstruction than a group of trees further away from the antenna. The WI-GTWY-9-xxx modules provide a test feature that displays the radio signal strength.

Line-of-sight paths are only necessary to obtain the maximum range. Obstructions will reduce the range, however may not prevent a reliable path. A larger amount of obstruction can be tolerated for shorter distances. For very short distances, it is possible to mount the antennas inside buildings. An obstructed path requires testing to determine if the path will be reliable - refer the section 6 of this manual.

> Longer distances can be achieved using the licensed 105U units, because they use a lower frequency and licensed conditions generally allow a higher RF power to be used.

Where it is not possible to achieve reliable communications between two modules, then another WI-I/O 9-x or WI-GTWY-9-xxx module may be used to receive the message and re-transmit it. This module is referred to as a repeater.

An antenna should be connected to the module via 50 ohm coaxial cable (eg RG58, RG213 or Cellfoil) terminated with a male SMA coaxial connector. The higher the antenna is mounted, the greater the transmission range will be, however as the length of coaxial cable increases so do cable losses. For use on unlicensed frequency channels, there are several types of antennas suitable for use. It is important antenna are chosen carefully to avoid contravening the maximum power limit on the unlicensed channel - if in doubt refer to an authorized service provider.

The net gain of an antenna/cable configuration is the gain of the antenna (in dBi) less the loss in the coaxial cable (in dB).

The maximum net gain of the antenna/cable configuration permitted is

Country	**Max. gain (dB)**
USA / Canada	6
Australia / New Zealand	0

The gains and losses of typical antennas are

Antenna	**Gain (dB)**	**W Interconnections Part Nos.**
Dipole with integral 15’ cable	0	WI-ANT-DPL-0-16
5dBi Collinear (3dBd)	5	WI-ANT-COL-5-32
8dBi Collinear (6dBd)	8	WI-ANT-COL-8-54
6 element Yagi	10	WI-ANT-YGI-10-6
16 element Yagi	15	WI-ANT-YGI-15-16

Cable type	**Loss (dB per 30 ft / 10 m)**	
RG58	-5	
RG213	-2.5	
Cellfoil	-3	WI-CCSMA-N-33 (33’ or 10m) WI-CCSMA-N-66 (66’ or 20m)

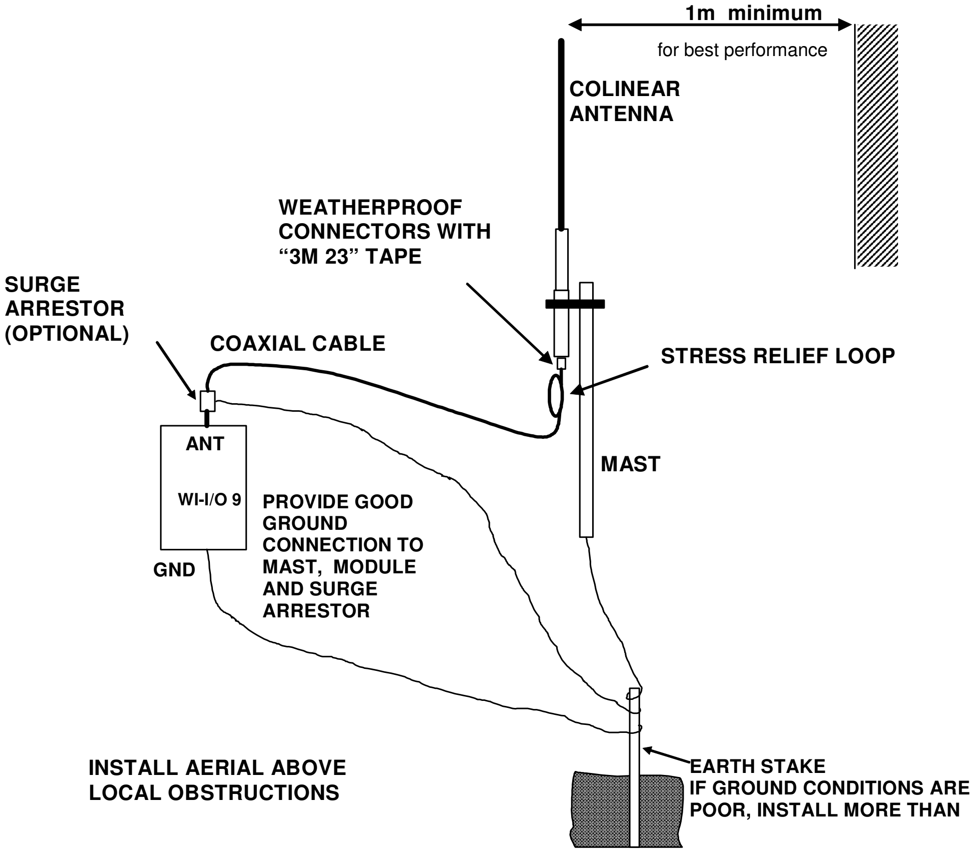
The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6 element Yagi with 66 feet (20 meters) of Cellfoil has a net gain of 4dB (10dB – 6dB).

For information on antennas and cables for the WI-GTWY-1 licensed products, please refer to W Interconnections or an authorized distributor.

Connections between the antenna and coaxial cable should be carefully taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems, as it greatly increases the radio losses. We recommend that the connection be taped, firstly with a layer of PVC Tape, then with a vulcanizing tape such as "3M 23 tape", and finally with another layer of PVC UV Stabilized insulating tape. The first layer of tape allows the joint to be easily inspected when trouble shooting as the vulcanizing seal can be easily removed.

Where antennas are mounted on elevated masts, the masts should be effectively earthed to avoid lightning surges. For high lightning risk areas, surge suppression devices between the module and the antenna are recommended. If the antenna is not already shielded from lightning strike by an adjacent earthed structure, a lightning rod should be installed above the antenna to provide shielding.

3.2.1 Dipole and Collinear antennas.



A collinear antenna transmits the same amount of radio power in all directions - it is easy to install and use. The dipole antenna with integral 15 ft (5m) cable does not require any additional coaxial cable, however the other collinear antennas do not have integral cable and an external cable length must be connected - such as the WI-CCSMA-N-33 or WI-CCSMA-N-66 cable kits..

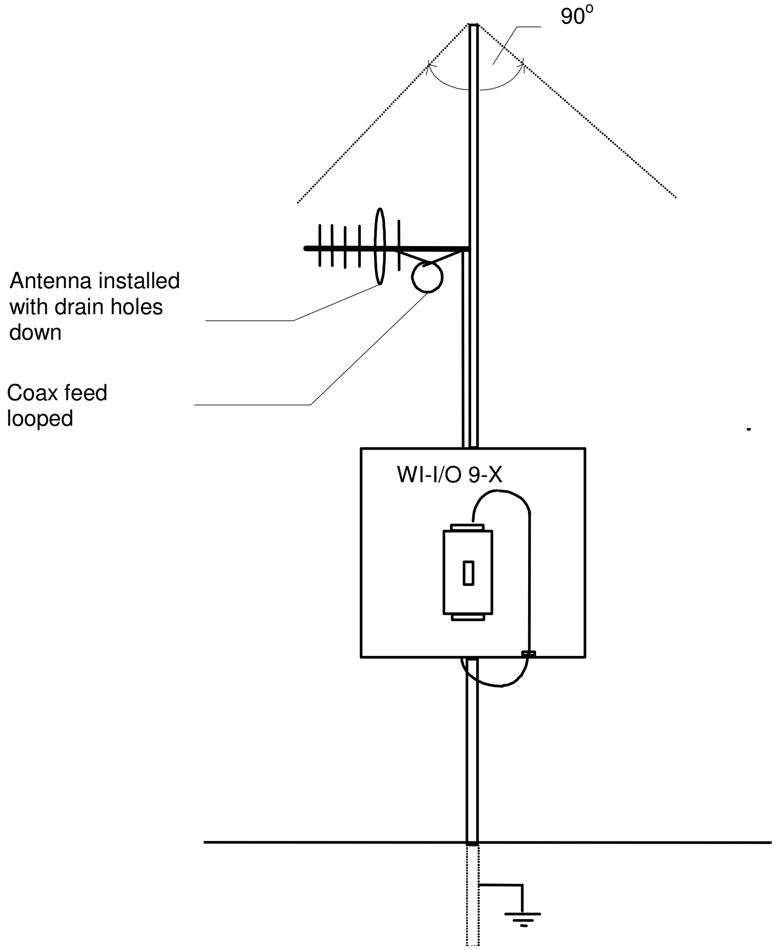
Collinear and dipole antennas should be mounted vertically, preferably no less than 2 ft (0.6 metre) away from a wall or mast to obtain maximum range. The WI-ANT-DPL-0-16 dipole antenna is the preferred antenna for use in industrial plants and factories.

3.2.2 Yagi antennas.

A Yagi antenna provides high gain in the forward direction, but lower gain in other directions. This may be used to compensate for coaxial cable loss for installations with marginal radio path.

The Yagi gain also acts on the receiver, so adding Yagi antennas at both ends of a link provides a double improvement.

Yagi antennas are directional. That is, they have positive gain to the front of the antenna, but negative gain in other directions. Hence Yagi antennas should be installed with the central beam horizontal and must be pointed exactly in the direction of transmission to benefit from the gain of the antenna. The Yagi antennas may be installed with the elements in a vertical plane (vertically polarized) or in a horizontal plane (horizontally polarized). For a two station installation, with both modules using Yagi antennas, horizontal polarization is recommended.



If there are more than two stations transmitting to a common station, then the Yagi antennas should have vertical polarization, and the common (or “central” station should have a collinear (non-directional) antenna.

Also note that Yagi antennas normally have a drain hole on the folded element - the drain hole should be located on the bottom of the installed antenna.

3.3 Power Supply

The WI-GTWY-9-xxx power supply is a switch-mode design which will accept either AC or DC supply. The module includes an integral battery charger for a backup battery.

The module accepts supply voltages in the following ranges:

12 – 24 volts AC RMS or 9 – 30 volts DC at the "supply" terminals, or

10.8 –15 volts DC at the "battery" terminals.

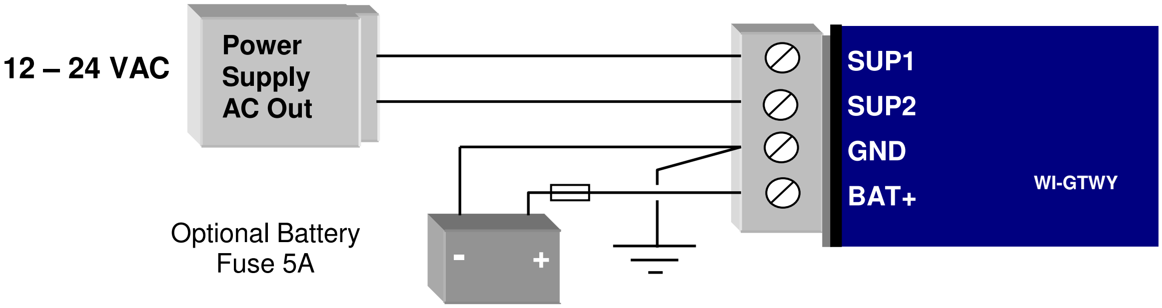
The power supply should be rated at 1.5 Amps and be CSA Certified Class 2. For use in Class 1 Div 2 explosive areas (USA/Canada), the power supply must be approved for Class 1 Div 2 use.

Note: Connect module to the same ground/earth point as the antenna mounting to avoid differences in earth potential during voltage surges. The modules need an earth connection for the internal surge protection to be effective.

For licensed 105U units with RF power above 2W, the unit needs to be powered from the 12V "Battery" terminals with a power supply of at least 2A rating. Alternately, the unit can be powered via the SUP1 / SUP2 terminals, provided a backup battery is connected to the "Battery" terminals to supply the inrush current for the radio transmitter. This is not required for units with radio power less than 2W.

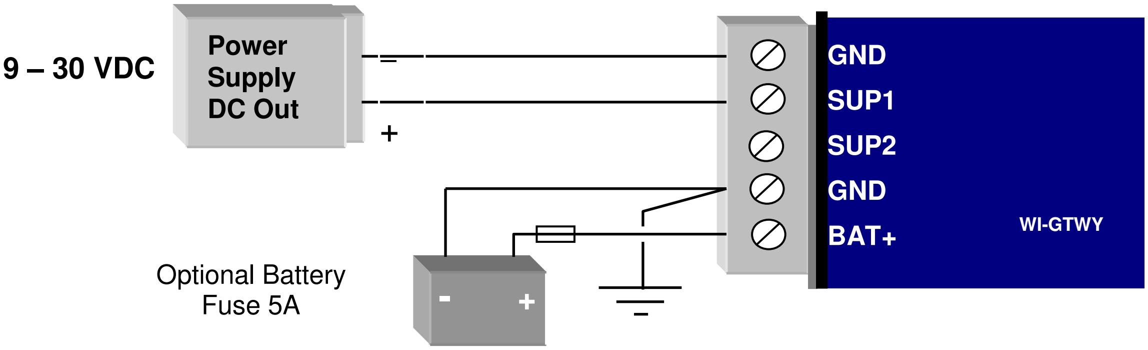
3.3.1 AC Supply

The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below. The AC supply should be "floating" relative to earth.

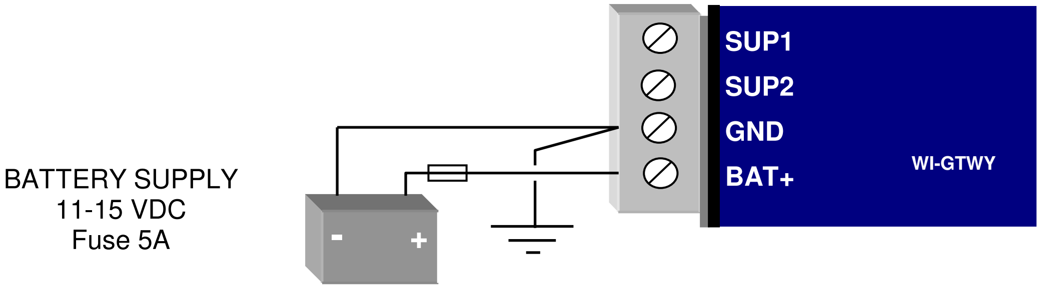


3.3.2 DC Supply

For DC supplies, the positive lead is connected to "SUP1" and the negative to "GND". The positive side of the supply **<u>must not be connected to earth.</u>** The DC supply may be a floating supply or negatively grounded.



The module may also be powered from an external 11 – 15 VDC battery supply without the need for a "normal" supply connected to "SUP1". This external battery supply is connected to "BAT+" and "GND" terminals. The positive lead of the external supply should be protected by a 5A fuse



.Upon failure of the normal supply, the module may continue to operate for several hours from a backup battery. The battery charger is designed for sealed or vented lead acid batteries between 5 and 24 amphours - **other types of batteries should not be used**. Typically, a 5 AHr battery will supply the WI-GTWY-9-xxx for 1 – 2 days, depending on the type of WI-GTWY-9-xxx.

On return of normal supply, the unit will recharge the battery. The maximum output of the battery charger is 0.7A when the supply voltage is greater than 12V, and 0.3A for less than 12V.

The WI-GTWY-9-xxx monitors the power supply and provides the following internal values, which can be mapped as I/O values:

- Power failure (I/O Reg 4309) - if the supply voltage drops below 8V, this status value is set on, and set off again when the voltage is more than 9V. For AC Supplies, this indicates low voltage at approximately 10 VAC, and the status is cleared when the supply voltage rises above approximately 12VAC
- Low battery voltage (I/O Reg 4308) - this status value is set on if the battery voltage drops to 11.3, and resets off when the battery voltage is more than 11.8V.
- Battery voltage value (I/O Reg 4310) - 8 – 40VDC corresponds to hex 4000 – hex C000.
- Supply voltage (I/O Reg 4311) - 8 – 40VDC corresponds to hex 4000 – hex C000.

3.3.3 Solar Supply

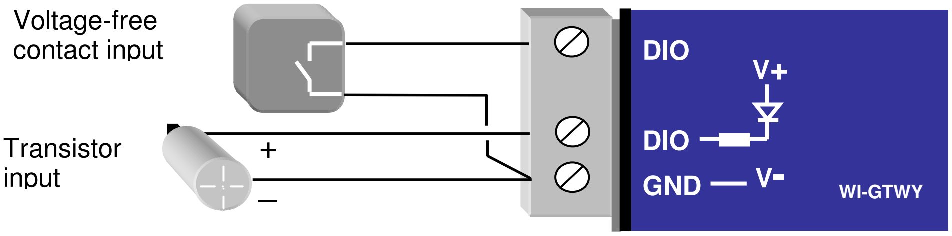
A WI-GTWY-9-xxx can be powered from a solar supply using an external regulator. If a 12V solar supply is used, the 12V battery can be connected to the battery supply connections of the WI-GTWY-9-xxx and the WI-GTWY-9-xxx will monitor for low battery status and also battery voltage. If a 24V solar supply is used, the 24V battery should be connected as a DC supply (SUP1 and GND) - the supply voltage can be monitored however the "supply fail" voltage will activate too low to be used as a battery fail status.

3.4 Input / Output

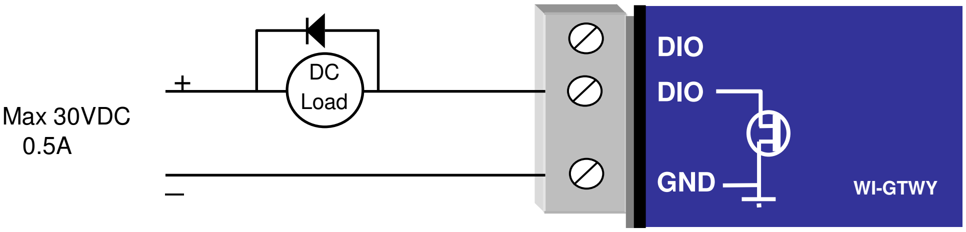
The WI-GTWY-9-xxx has eight on-board discrete/digital I/O. These act as both discrete inputs and discrete outputs.

3.4.1 Digital Inputs / Outputs

All eight of the WI-GTWY-9-xxx DIO terminals may be used as discrete inputs. These inputs are suitable for voltage free contacts (such as mechanical switches) or NPN transistor devices (such as electronic proximity switches). PNP transistor devices are not suitable. Contact wetting current of approximately 5mA is provided to maintain reliable operation of driving relays.



Each digital input is connected between the appropriate "DIO" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200 ohms, the device will be able to activate the digital input.



All eight of the WI-GTWY-9-xxx DIO terminals may also be used as discrete outputs. The digital outputs are transistor switched DC signals, FET output to common rated at 30VDC 500 mA.

Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 4 **Configuration** for further details.

The output circuit is connected to the appropriate "DIO" terminal. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

3.5 Serial Port

3.5.1 RS232 Serial Port

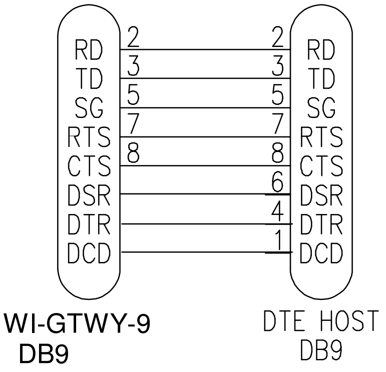
The serial port is a 9 pin DB9 female and provides for connection to a terminal or to a PC for configuration, field testing and for factory testing. It is also used by the Modbus/DF1 version for fieldbus connection.

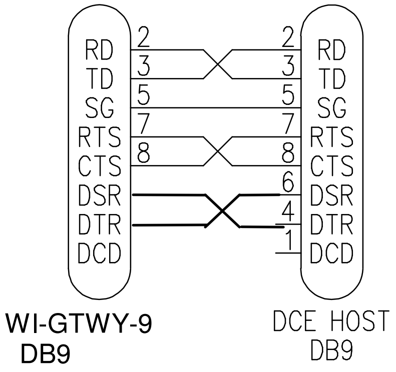
This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS232 signals. The WI-GTWY-9-xxx is configured as DCE equipment with the pinout detailed below.

DB9 Connector Pinout:

Pin	Name	Direction	Function
1	DCD	Out	Used for "active" signal.
2	RD	Out	Serial Data Output
3	TD	In	Serial Data Input
4	DTR	In	Data Terminal Ready - may be used by Host Protocol Driver
5	SG		Signal Ground
6	DSR	Out	Data Set Ready - always high when unit is powered on.
7	RTS	In	Request to Send - may be used by Host Protocol Driver
8	CTS	Out	Clear to send - may be used by Host Protocol Driver
9	RI		Ring indicate - not connected

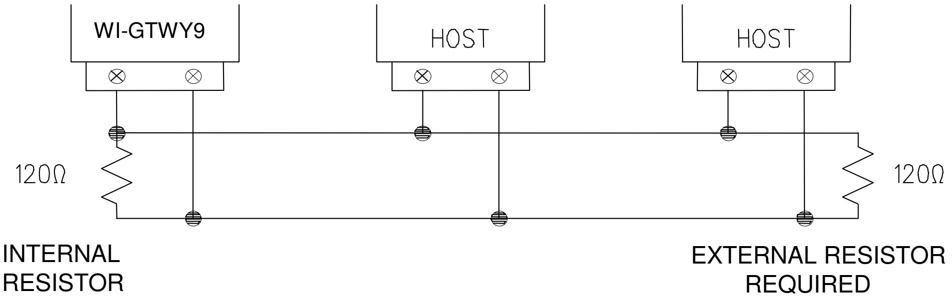
Hardware handshaking using the CTS/RTS lines is provided, and are under the control of the Host Comms Driver. Example cable drawings for connection to a DTE host (a PC) or another DCE host are detailed below:

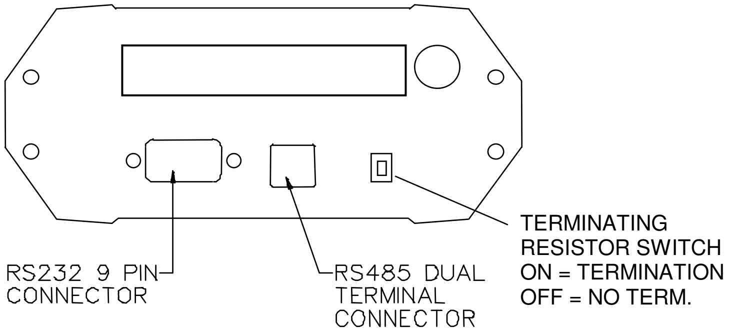




3.5.2 RS485 Serial Port

RS485 should not be used with the DF1 unit. The RS485 port provides for communication between the WI-GTWY-9-xxx unit and its host device using a multi-drop cable. Up to 32 devices may be connected in each multi-drop network. Note that the RS485 port is shared internally with the RS232 port - make sure that the RS232 port is disconnected before using the RS485 port.





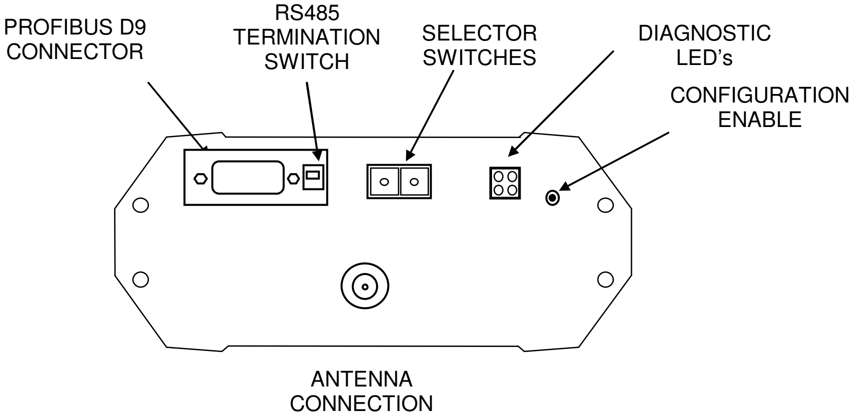
RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential RFI. An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120-ohm resistor. On-board 120 ohm resistors are provided and may be engaged by operating the single DIP switch in the end plate next to the RS485 terminals. The DIP switch should be in the “1” or “on” position to connect the resistor. If the module is not at one end of the RS485 cable, the switch should be off.

It is important to maintain the polarity of the two RS485 wires. On the WI-GTWY-9-xxx, terminal A (the terminal on the right) is positive and terminal B is negative.

3.6 Profibus Port

The Profibus RS485 connector is a D9 connector in the top end-plate of the module (see below).

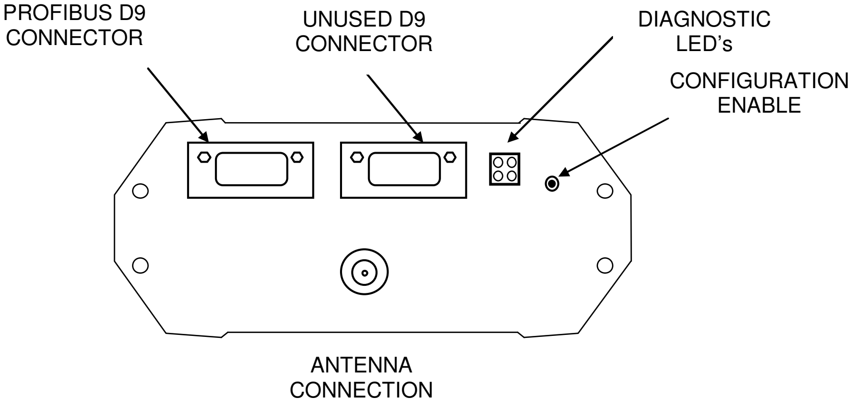
WI-GTWY-9-PR1 (Profibus Slave) End Plate:



Note: If the "Use Rotary Switch Address" option in configuration software is selected, the two rotary switches are used to specify the Profibus Node Address in the range 0 – 99. In this case, the value on the left switch is multiplied by 10 and added to the value on the right switch to give the node address.

Where the WI-GTWY-9-xxx module is mounted at the end of the RS485 link, the RS485 link should be terminated by switching the termination switch "on" (down in the above diagram).

WI-GTWY-9-PR2 (Profibus Master) End Plate:



For the Profibus Master WI-GTWY-9-PR2 a second, unused, connector is also present.

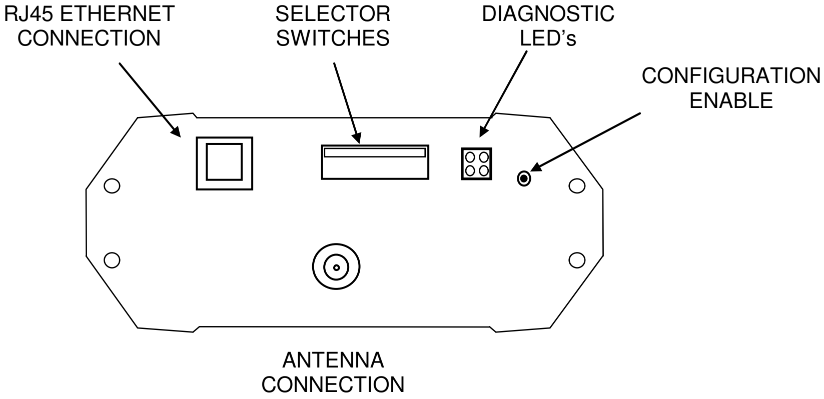
The Profibus RS485 connection should be made to pins 3 and 8 of the Profibus D9 connector. The pinouts for this connector are:

Pin	Description
1	Not connected
2	Not connected
3	+ve RS485 (Positive)
4	RTS (request to send)
5	GND - Isolated GND from RS485 side
6	+5V - Isolated 5V from RS485 side
7	Not connected
8	-ve RS485 (Negative)
9	Not connected

3.7 Ethernet Port

For WI-GTWY-9-ET1 modules only.

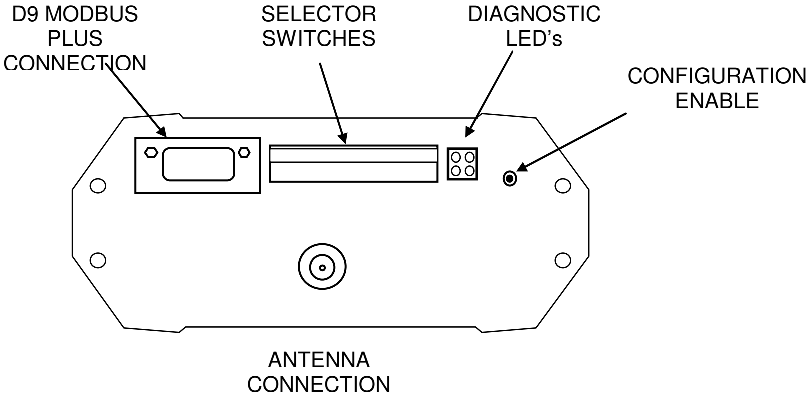
The Ethernet connection uses a standard RJ45 connector on the top end-plate of the module. The selector switches should all be “off” (in the diagram below, “off” is up).



3.8 Modbus Plus Port

For WI-GTWY-9-M+1 modules only.

Connection to the Modbus Plus Network is via the 9-pin D-SUB connector located at the antenna end of the module. Pin-outs are outlined in the table below.



See section on configuration for description of selector switches.

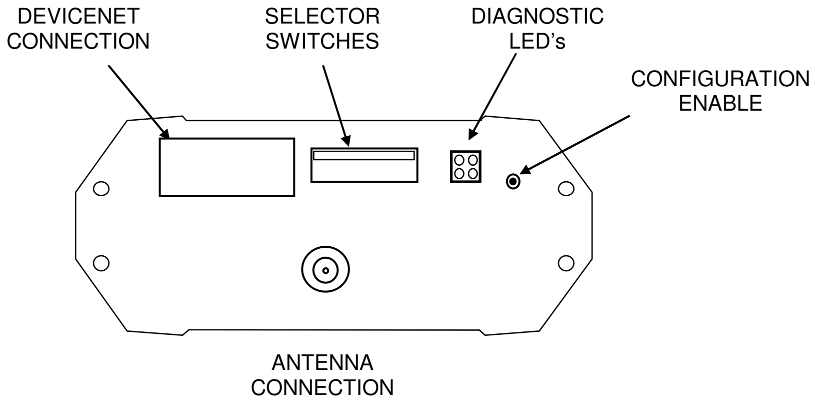
Modbus Plus 9-pin D-SUB Connector:

Pin	Name
1	Cable Shielding
2	MBP Line B
3	MBP Line A
Housing	PE

3.9 DeviceNet Port

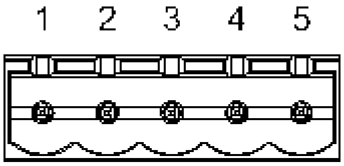
For WI-GTWY-9-DE1 modules only.

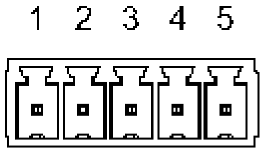
Connection to the DeviceNet Network is via the 5-pin plugable screw terminal connector located at the antenna end of the module. Pin-outs are specified below.



5-pin plugable screw terminal fieldbus connector:

Pin	Signal	Description
1	V-	Negative Supply Voltage
2	CAN_L	CAN_L bus line
3	SHIELD	Cable shield
4	CAN_H	CAN_H bus line
5	V+	Positive supply voltage





DeviceNet uses termination resistors at each physical end of the bus. The termination resistor should be 121 ohm. This should be connected between CAN_H and CAN_L on the bus.

Chapter 4 CONFIGURATION

4.1 Introduction

A Windows program is provided to configure the WI-I/O 9-x system. The configuration is done on a system basis - referred to as a “project” in the program. After the system configuration is entered, the configuration file can be loaded into each module via the RS232 port.

Each Project is configured with:

- a system address, which is common to every module in the same system, and is used to prevent "cross-talk" between modules in different systems. Separate networks with different system addresses may operate independently in the same area without affecting each other. The system address may be any number between 1 and 32 767. The actual value of the system address is not important, provided all modules in the same system have the same system address value. **A system address of zero should not be used.** The configuration program automatically offers a random number for the system address - you can change this to any number in the valid range but we recommend that you use the random number.
- a password for access protection. This is an optional feature. If selected, the project file can only be opened by entering the correct password.
- a security encryption key, used to encrypt and decrypt radio messages. This is an optional feature. If selected, the configuration program will offer a random security key, or this can be over-written with your own key. A key is a string of any 8 ASCII characters.

Each module in the project is configured with a unit address. Each module must have a unique unit address within the one system. A valid unit address for a WI-GTWY-9-xxx is 1 to 95. A network may have up to 95 addresses communicating directly via radio (unit addresses 1 to 95). WI-I/O 9-x I/O modules can have up to 31 modules communicating via RS485 (unit addresses 96 to 127).

The configuration program may allocate more than one unit address to a WI-GTWY-9-xxx if it is required because of the size of the system. If this is necessary, it will be done automatically by the configuration software.

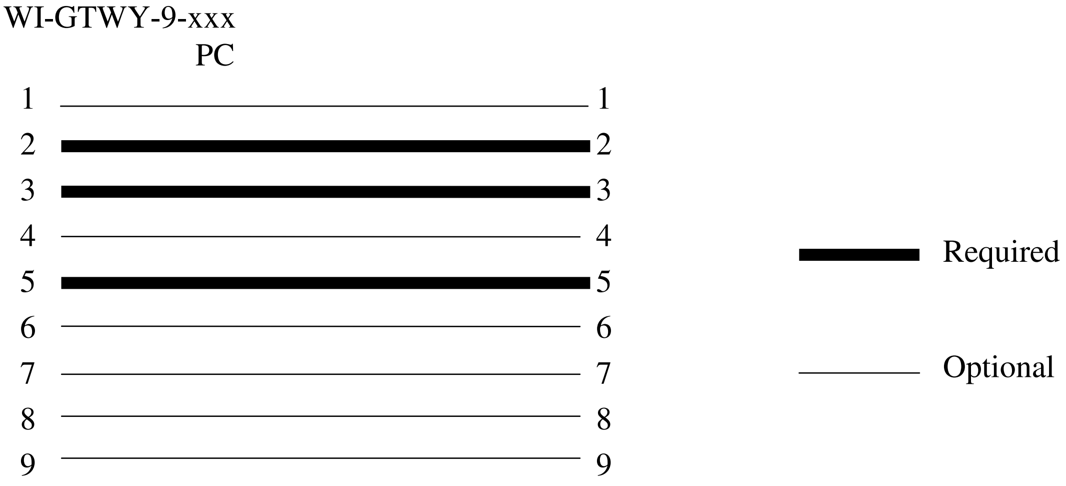
Configuration consists of:

1. selecting the types of modules in the system and selecting address values
2. linking (called “mapping”) I/O registers to remote I/O
3. setting operating parameters such as change sensitivities and update times
4. selecting “block mappings” - only for block transfer of I/O registers between WI-GTWY-9-xxx modules
5. selecting fieldbus addressing, and serial port configuration (Modbus & DF1 only)
6. linking Radio Interface registers to Fieldbus Interface registers (All modules except MD1)

All of these steps must be performed to configure the WI-GTWY-9-xxx module.

4.2 Configuration Program

The configuration software is available on a CD, and needs to be installed on your PC before you can use it. The CD contains a setup file called *setup.exe*. Select the configuration software window on the Product CD and an installation Wizard will guide you through the installation procedure. To upload and download configuration files to a module, you will need a RS-232 serial cable as shown below.

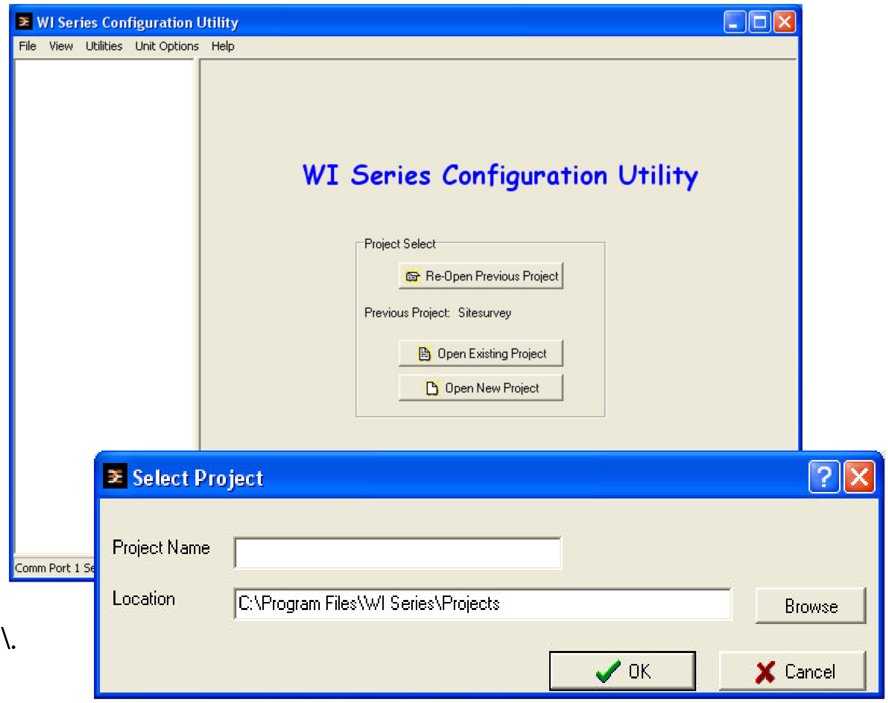


4.2.1 Program Operation

Start the software by either clicking on the start bar and navigating to the Configuration menu or by running WI SERIES.EXE in the directory selected in the setup stage.

The Initial screen will appear.

From the initial screen, , you can select an existing project, or start a new project. The name of the project will create a new folder which will eventually contain the configuration files for the modules in this system. Project folders are located under the folder \Projects\ - for example, if you create a project called “Fire Pumps”, then the files for this project will be found in the folder c:\……\Projects\Fire Pumps\.



Previous Project: Sitesurvey

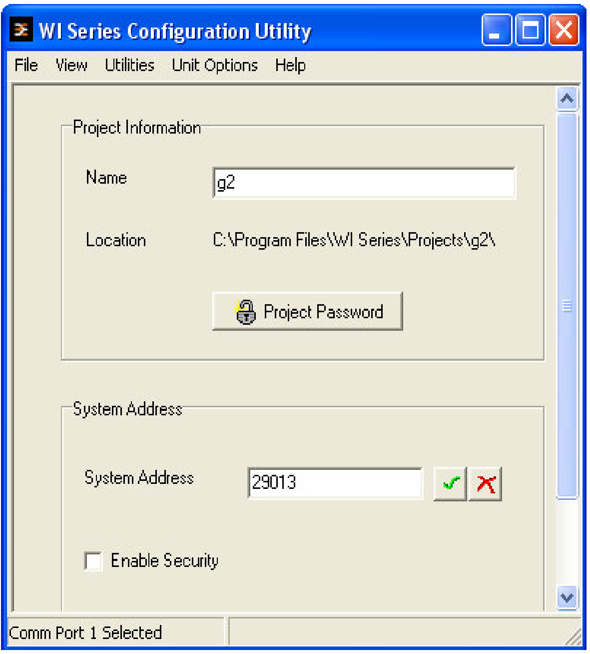
Location: C:\Program Files\WI Series\Projects

When you have selected the project, a screen will appear where you may enter the system address.

If you are editing an existing project, the system address will already have been entered. Do not change the system address unless you are going to re-program all of the modules in the system.

Password. You have the option of entering a password to protect the configuration files against unauthorized changes. When you open a new project, you will be asked to enter a password - if you do not enter any text - that is, press “ESC” or “Enter”, then password protection is disabled. If you do enter a password, then you will need to enter this password to access the project. Without the password, you are unable access the project

The password can be between 6 and 256 characters. You



Name: g2

Location: C:\Program Files\WI Series\Projects\g2\

System Address: 29013

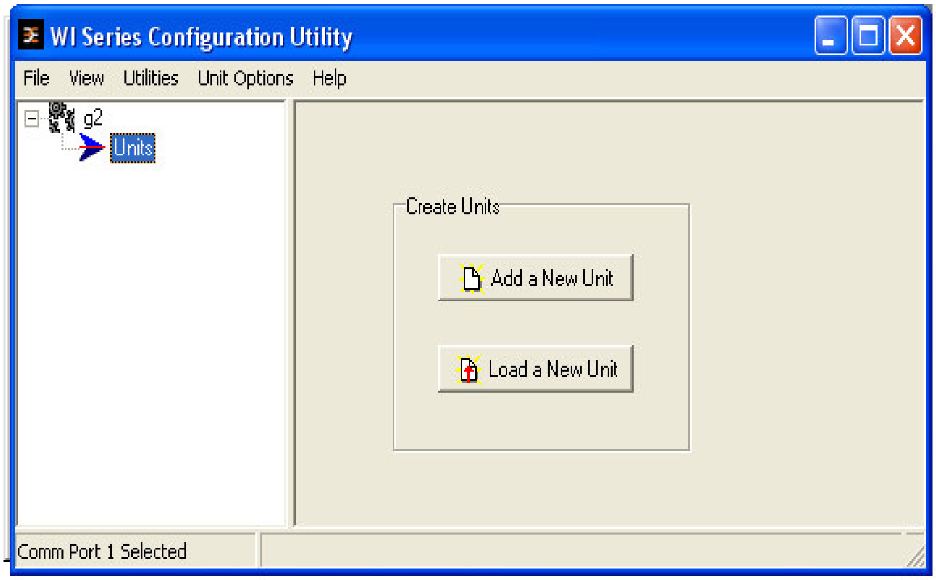
☐ Enable Security

Comm Port 1 Selected

can also change password at any time by over-typing the passowrd.

If you are starting a new project, you have the option of “Enabling Security”. This option enables encryption of the data sent over the radio. - please read Section 4.2.2 and the associated warnings before using this option.

To proceed with the configuration, double-click on the project name on the menu on the left side of the screen. “Units” will appear. You can now enter the types of units which will be used in the system. If you double-click on “Units”or select the “+” sign beside “Units”, then the modules that have already been created will be displayed.

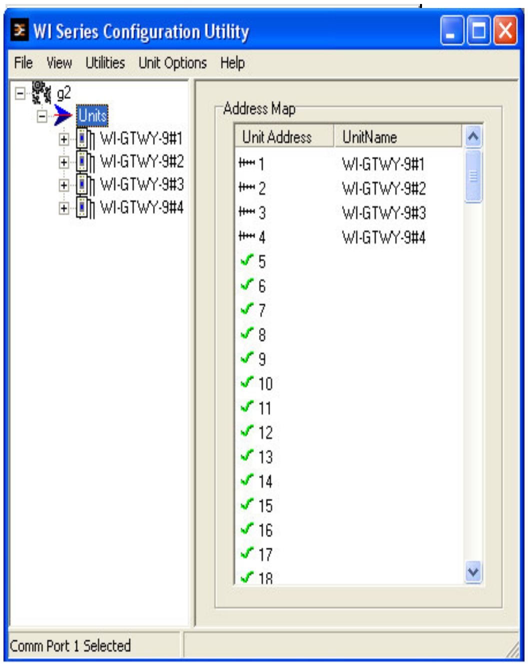


Comm Port 1 Selected

Loading configuration from an existing module
To load the configuration from a module, connect the module to the PC via the RS232 cable, put the module into “Configuration Mode” by pressing the configuration button on the top end-plate, and click on “Load Unit”. This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3 for full details.

Adding a new module to the system configuration
To add a new module to the system configuration, click “Units” on the left-hand menu and then “Add Unit”. Select the type of module from the list. For WI-GTWY-xxx modules, you will be asked to select the bus protocol. This must match the WI-GTWY-9-xxx module type you have installed.

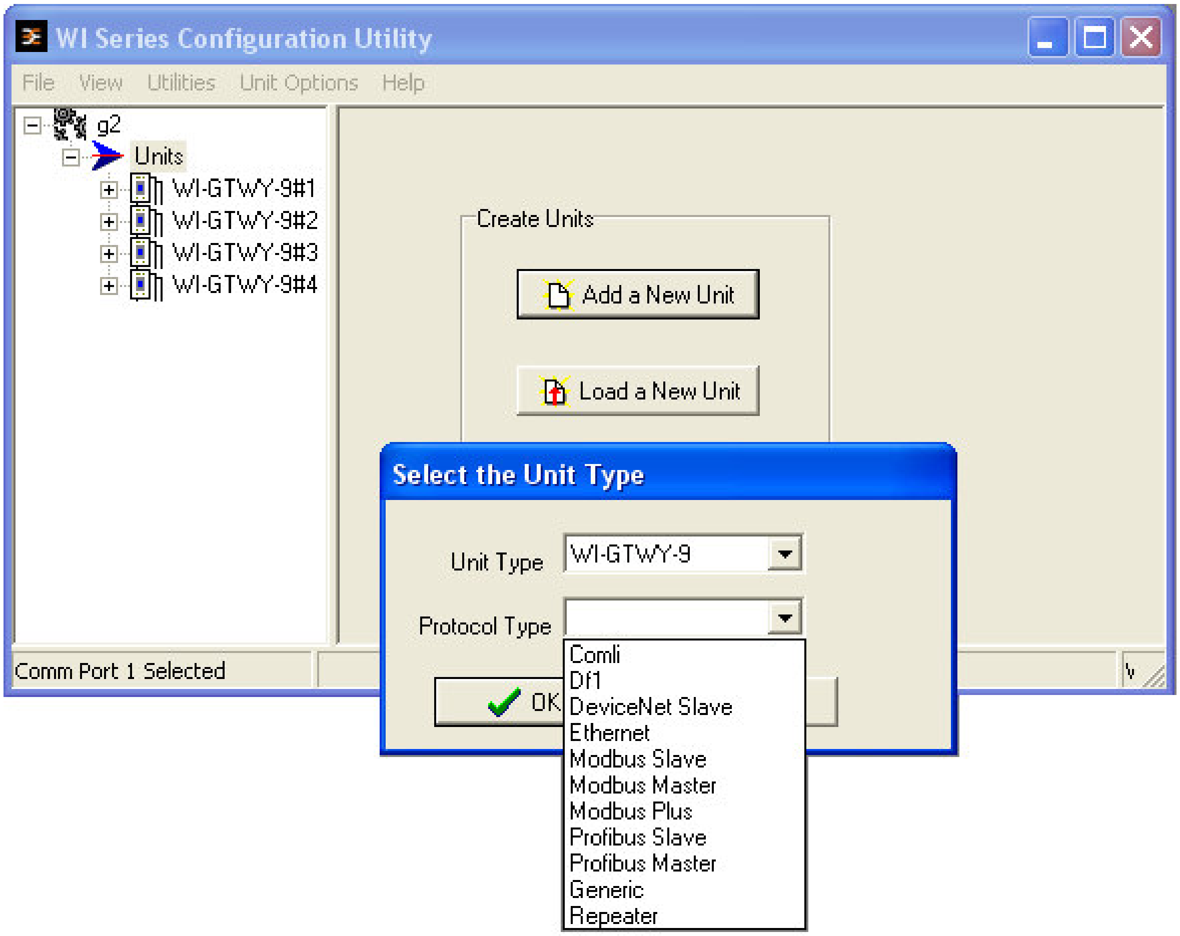
You have the option of selecting a unit address for the module, or allowing the program to select one automatically. If you choose to select the unit address the program will display the list of available addresses for to select - valid addresses are 1 – 95.



Unit Address	UnitName
1	WI-GTWY-9#1
2	WI-GTWY-9#2
3	WI-GTWY-9#3
4	WI-GTWY-9#4
✓ 5	
✓ 6	
✓ 7	
✓ 8	
✓ 9	
✓ 10	
✓ 11	
✓ 12	
✓ 13	
✓ 14	
✓ 15	
✓ 16	
✓ 17	
✓ 18	

Comm Port 1 Selected

The default name for a unit will include the unit address. For example, “WI-GTWY#10” is a WI-GTWY-9-xxx module with unit address 10. You can change the name of a unit - for example, you could replace the default name with “Pump Station 14”.

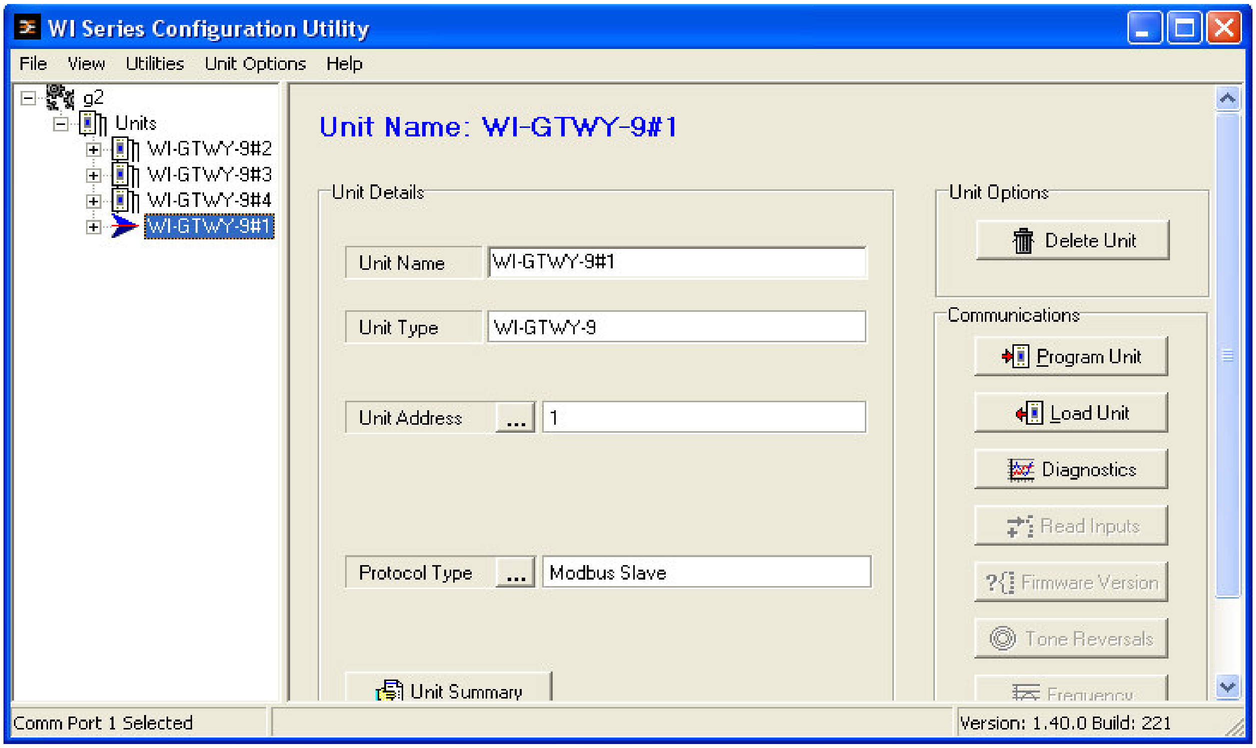


Unit Type: WI-GTWY-9

Protocol Type:

Deleting a Unit

A module can be deleted from the configuration by highlighting the unit and selecting "Delete Unit".



Unit Name: WI-GTWY-9#1

Unit Details

Unit Name: WI-GTWY-9#1

Unit Type: WI-GTWY-9

Unit Address: 1

Protocol Type: Modbus Slave

Comm Port 1 Selected

Version: 1.40.0 Build: 221

4.2.2 Security

There are two security features available. You can enter a password to protect the configuration files, and you can enable security encryption of the radio transmissions.

The password can be between 6 and 256 characters. The password is case sensitive and any ASCII characters can be used. If you have entered a password, then this password will need to be entered whenever the configuration is changed. You are able to change the password from the "Utilities" menu. If unauthorized access to the files is a concern, we recommend that you change the password regularly or whenever there is a change of staff.

Data Encryption is an additional level of security. The security option uses a 64 bit security key to provide data encryption of the radio messages. All modules in the same system will be configured with the same security key used to encrypt and decrypt the messages. This feature is available for modules with firmware version 2.1 and higher. If you are adding modules to an old system which does not have the security encryption feature, then you cannot use security encryption on the new modules.

Note that the security key is different than the password.

- To enable the security encryption, select the "Enable Security" box on the project display. An 8-character random security key is automatically generated. If desired, a different security key may be entered and you will be prompted to enter the security code a second time to confirm. The security key can be any characters or numbers. Characters are case sensitive. The security key will never be displayed.

- If you do not enable security, there will be no data encryption of the radio messages. This is the default setting.
- If a security key has been entered, this key is downloaded into each module as part of the configuration download process. You can download another configuration at any time - if the security key is different, or if there is no security key in the new configuration, the old key will be over-written.
- You can change the security key in the configuration files simply by entering a new security key in the security key window. You will be prompted to confirm the new security key. Note that if you change the security key, it will not match the security key previously loaded into existing modules.
- If you want to change a configuration, we recommend that you change the archived configuration, and then download the configuration onto the module. The archived configuration already has the valid security key.
- If you lose the archived configuration, you can upload the configuration from a module, but you cannot upload a security key. That is, you can upload the module configuration, view it, change it - but if you don't know the original security key, the old key will be over-written when you download the new configuration. This module will no longer communicate with other modules in the system as the security key is different.

Warning!!

These security options provide a high level of security, but no data-security system can provide "100% protection". But it does make it very difficult for someone to interfere with the WI-I/O 9-x system - difficult to the point where there would be many easier alternate ways to cause malicious damage.

The password must be kept in a secure place. Security procedures need to be adopted. If staff with access to the password leave your organization, we recommend that the password be changed.

We recommend that you use a random 8-character string for the security key and that you do not record the key. It is not necessary to know what the security key is. The key will be recorded in the archived configuration files, and therefore the configuration files should be held in a secure place and backed up.

The security key does not prevent a hacker uploading a configuration from a module and downloading with a new security key. This module will no longer operate with other modules in the system. To prevent this, unauthorized access to modules must be prevented.

The security options provide security against a "hacker" in the following way:

- ❑ A hacker cannot listen-in to radio messages without the security key to decrypt the radio messages. Similarly, a hacker cannot force outputs by transmitting a radio message to a module without the security key.

- A hacker cannot access the security key from an installed module or from the configuration files.
- The archived configuration files cannot be changed, downloaded or uploaded without the password.

If you lose the configuration files, you can regenerate these by uploading the configuration from every module in the system into a new project with a new security key. After uploading each module, download the configuration with the new security key.

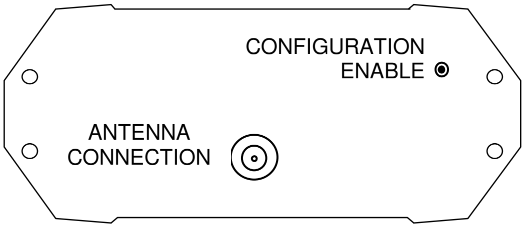
If you wish to change the security key, simply enter a new key in the configuration program, and download the new configuration to all modules in the system.

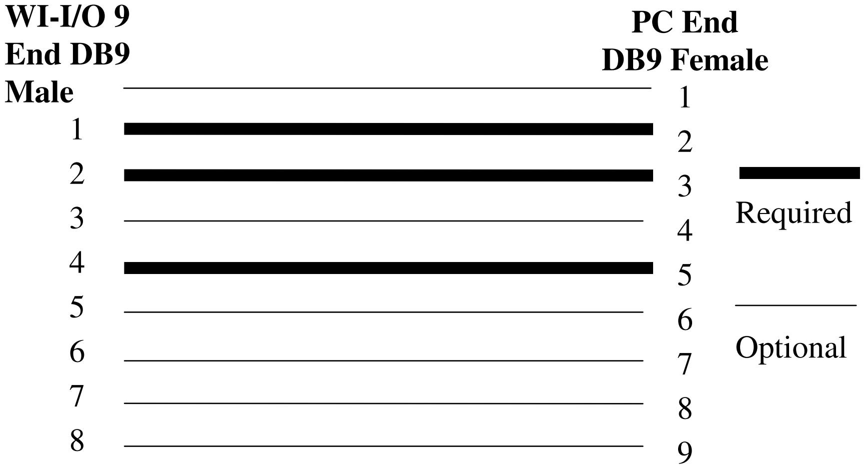
Note on Ethernet WI-GTWY-9-xxx. You are able to access the module configuration of an Ethernet WI-GTWY-9-xxx via the Ethernet port. To prevent this access, do not select “Enable Ethernet Debug” on the Ethernet configuration display - see section 4.8.

4.3 Uploading and Downloading

To upload or download a configuration file, the WI-GTWY-9-xxx must be connected to the PC via a RS232 cable. For Modbus/DF1 units, the host device must be disconnected, even if it is connected to the RS485 port. Other units do not need to disconnect the data bus. When the PC is connected, put the WI-GTWY-9-xxx into configuration mode by pressing the small pushbutton switch in the end plate of the module for 5 seconds, until the ACT LED starts flashing.

In configuration mode, the WI-GTWY-9-xxx will stop its normal functions. Make sure the correct communications port is selected on the PC - if necessary, change the selection from the Utilities menu. Connect the PC to the module using the configuration cable.



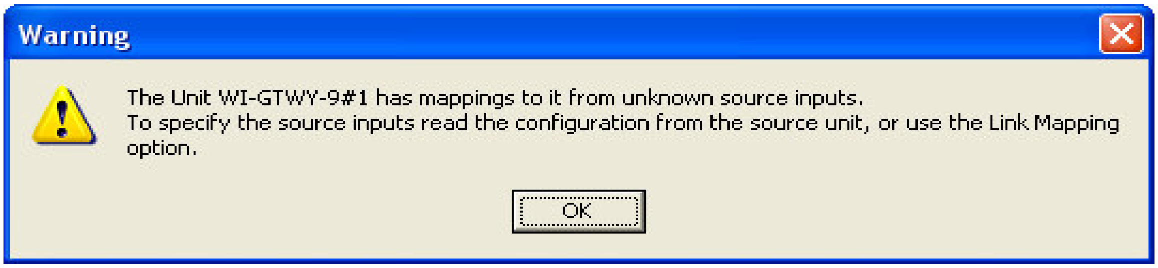


The configuration may be programmed into a WI-GTWY-9-xxx, or a configuration may be loaded from a WI-GTWY-9-xxx. After programming or loading is complete, disconnect the PC from the WI-GTWY-9-xxx. Reset the WI-GTWY-

9-xxx by removing power and re-connecting power. The WI-GTWY-9-xxx will start up normally and the OK LED will be on. The serial port will have its original set-up.

4.3.1 Loading from a WI-GTWY-9-xxx

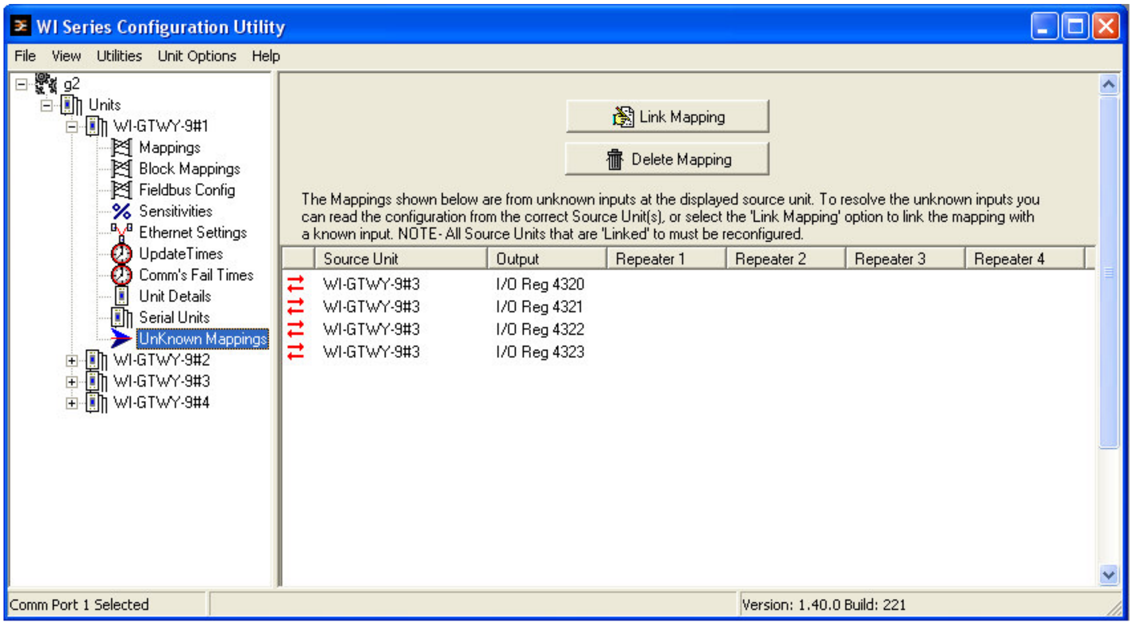
If you load a configuration from a WI-GTWY-9-xxx into a “blank” or new project, then the program will not be able to display the mappings from remote modules (as the program does not know what the remote modules are). You will get a warning message like this:



The Unit WI-GTWY-9#1 has mappings to it from unknown source inputs.
To specify the source inputs read the configuration from the source unit, or use the Link Mapping option.

If you open the archived project first, and load into the archived project, then all mappings will display as normal - any mappings to/from the WI-GTWY-9-xxx will be over-written on the PC display by the loading process.

If you are unable to load into the archived project, then mappings to remote modules will be displayed, but mappings from remote inputs will be shown as “Unknown Mappings”.



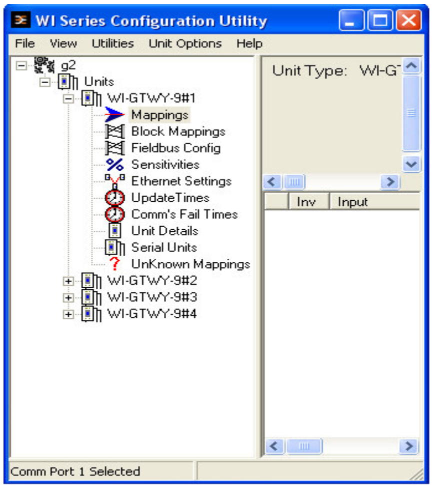
The Mappings shown below are from unknown inputs at the displayed source unit. To resolve the unknown inputs you can read the configuration from the correct Source Unit(s), or select the 'Link Mapping' option to link the mapping with a known input. NOTE- All Source Units that are 'Linked' to must be reconfigured.

Source Unit	Output	Repeater 1	Repeater 2	Repeater 3	Repeater 4
WI-GTWY-9#3	I/O Reg 4320				
WI-GTWY-9#3	I/O Reg 4321				
WI-GTWY-9#3	I/O Reg 4322				
WI-GTWY-9#3	I/O Reg 4323				

If you also load the configurations from the other remote modules in the system, then these unknown mappings will disappear as the program can determine where the remote inputs are. Alternately, you can select “Link Mapping” and manually enter the remote inputs.

4.4 Mappings WI-GTWY-9-xxx to WI-I/O 9-x I/O Modules

To transfer remote input signals to a WI-GTWY-9-xxx, or transfer a value to a remote output from a WI-GTWY-9-xxx, you set up “I/O mappings”. You enter mappings into the source unit, not the destination unit. That is, you configure a mapping at the “input” module. If you want to



transfer an input signal at a WI-I/O 9-x module to a WI-GTWY-9-xxx register, you enter a mapping at the WI-I/O 9-x I/O module. If you want to transfer a WI-GTWY-9-xxx register to an output signal at a WI-I/O 9-x module, you enter a mapping at the WI-GTWY-9-xxx module.

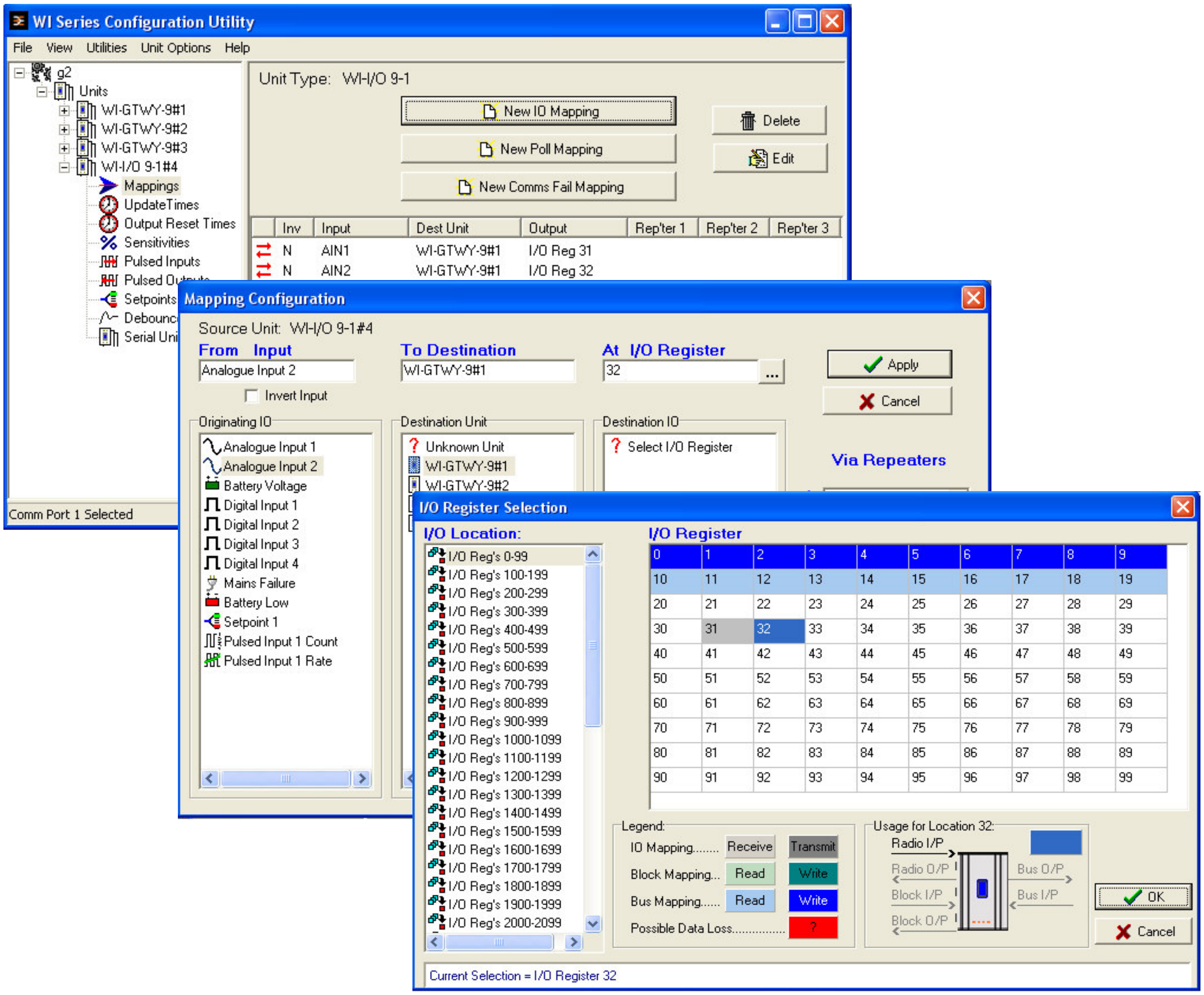
To configure mappings, double-click on the module in the left-hand menu - the menu will expand with selections for that module. Select "Mappings".

Each mapping comprises only one I/O point. "Block Mappings" provide more advanced communications between WI-GTWY-9-xxx modules.

4.4.1 Mappings from Inputs at Remote WI-I/O 9-x I/O Modules

Refer to the WI-I/O 9-x I/O User Manual.

When mapping inputs to a WI-GTWY-9-xxx, you will be asked to select an I/O Register. Select the "…" box beside the "At I/O Register" heading - this will allow you to select the I/O register between 0 and 4299.



Unit Type: WI-I/O 9-1

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
⇄	N	AIN1	WI-GTWY-9#1	I/O Reg 31			
⇄	N	AIN2	WI-GTWY-9#1	I/O Reg 32			

Source Unit: WI-I/O 9-1#4

From Input: Analogue Input 2

To Destination: WI-GTWY-9#1

At I/O Register: 32 ...

I/O Register

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

Current Selection = I/O Register 32

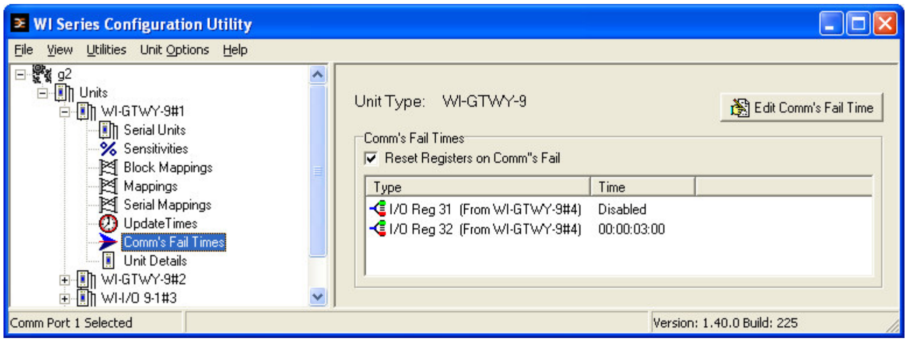
Any I/O registers that have already been selected will have a color shading.

The update times, analog sensitivities for these mappings can be set as per normal I/O mappings.

To map several inputs to consecutive I/O registers, use “Shift”-select or “Ctrl” - select to highlight the inputs, and select the first I/O register in the range. The selected mappings will be entered with consecutive I/O registers.

For each “remote input” configured to a WI-GTWY-9-xxx, there is a comms-fail time parameter in the WI-GTWY-9-xxx. If the WI-GTWY-9-xxx does not receive a message destined to that I/O register within the “comms fail” time, then the “comms fail” status for that I/O register will be set - the most significant bit of the status register will be set to 1. The comms fail time should be more than the corresponding update time at the remote input.

To set the comms fail times, select the WI-GTWY-9-xxx, and select the “Comms Fail Time” option. Each remote input already mapped to the WI-GTWY-9-xxx will automatically be listed, including the remote module containing the mapping.



Unit Type: WI-GTWY-9

Comm's Fail Times

☑ Reset Registers on Comm"s Fail

Type	Time
I/O Reg 31 (From WI-GTWY-9#4)	Disabled
I/O Reg 32 (From WI-GTWY-9#4)	00:00:03:00

Comm Port 1 Selected

Version: 1.40.0 Build: 225

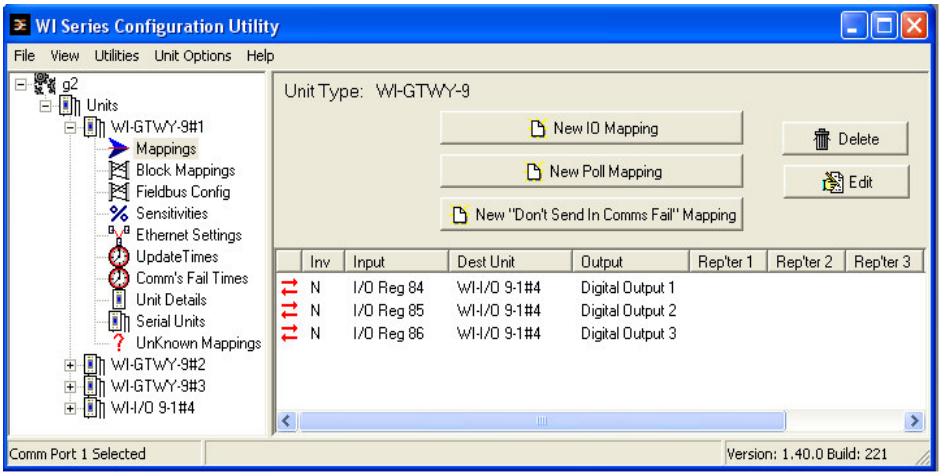
The default value for the comms-fail time is “disabled” or zero. To enter a time, select the I/O register from the list. The comms-fail time should be greater than the update time of the remote input.

Firmware version 1.76 and later:

The I/O value in the I/O registers can be reset to zero on comms-fail. To enable this, select the enable box in the “Comms Fail Times” configuration screen. Note that this is a global selection; comms-fail-reset is configured on all registers or no registers.

4.4.2 Mappings from WI-GTWY-9-xxx to Outputs at Remote WI-I/O 9-x I/O Modules

Mappings can be entered in the WI-GTWY-9-xxx to remote outputs. Select the “Mappings” option under the WI-GTWY-9-xxx. Select an I/O register and select the remote module and the output channel.



Unit Type: WI-GTWY-9

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
N	I/O Reg 84	WI-I/O 9-1#4	Digital Output 1			
N	I/O Reg 85	WI-I/O 9-1#4	Digital Output 2			
N	I/O Reg 86	WI-I/O 9-1#4	Digital Output 3			

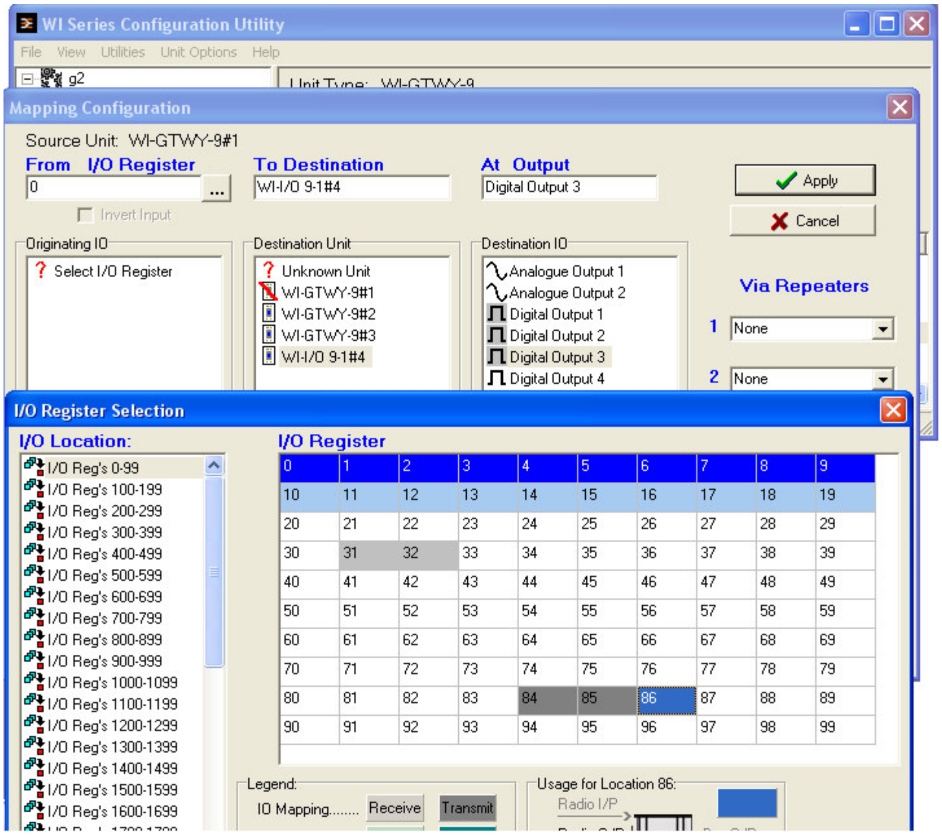
Comm Port 1 Selected

Version: 1.40.0 Build: 221

To map several consecutive I/O registers to several outputs, select the first I/O register in the range and use “Shift”-select or “Ctrl” - select to highlight the multiple outputs. The selected mappings will be entered with consecutive I/O registers.

Change Sensitivities

Radio messages to remote modules can be change messages (when the value of the I/O register changes) or update messages (when the update time has elapsed). If a change message is sent, the update period restarts.



Unit Type: WI-GTWY-9

Source Unit: WI-GTWY-9#1

From I/O Register: 0

To Destination: WI-I/O 9-1#4

At Output: Digital Output 3

Via Repeaters

1 None

2 None

I/O Register

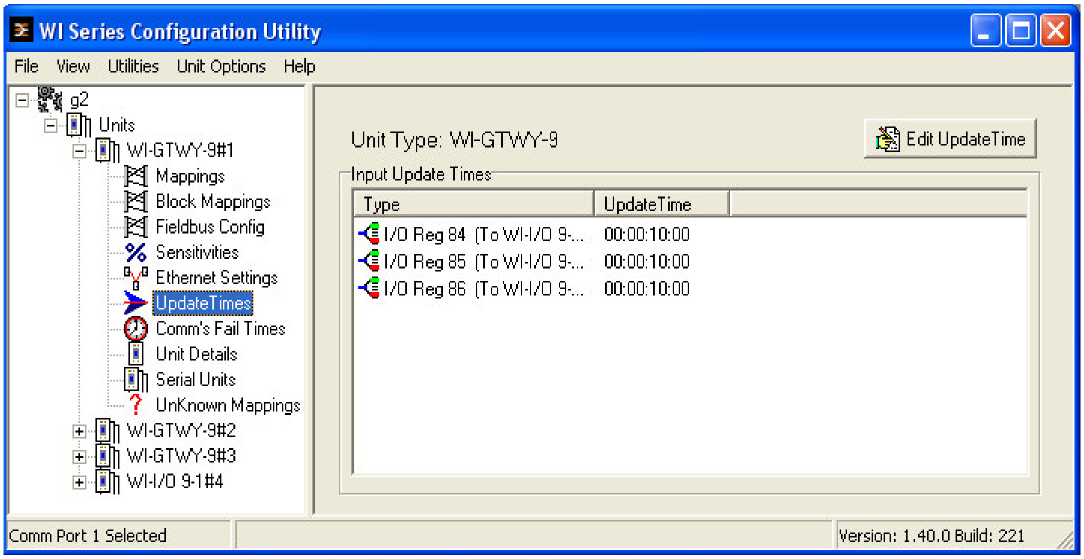
0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

Usage for Location 86:

You can configure the amount of change required to trigger a change message - this is called the change sensitivity. Sensitivities are configured for blocks of I/O registers - that is, each I/O register does not have a unique sensitivity. You can configure up to 50 sensitivity values - that is, there can be 50 blocks of registers with different sensitivities.

For more information on this, refer to section 4.6.

Update Times



Unit Type: WI-GTWY-9

Input Update Times

Type	UpdateTime
I/O Reg 84 (To WI-I/O 9-...	00:00:10:00
I/O Reg 85 (To WI-I/O 9-...	00:00:10:00
I/O Reg 86 (To WI-I/O 9-...	00:00:10:00

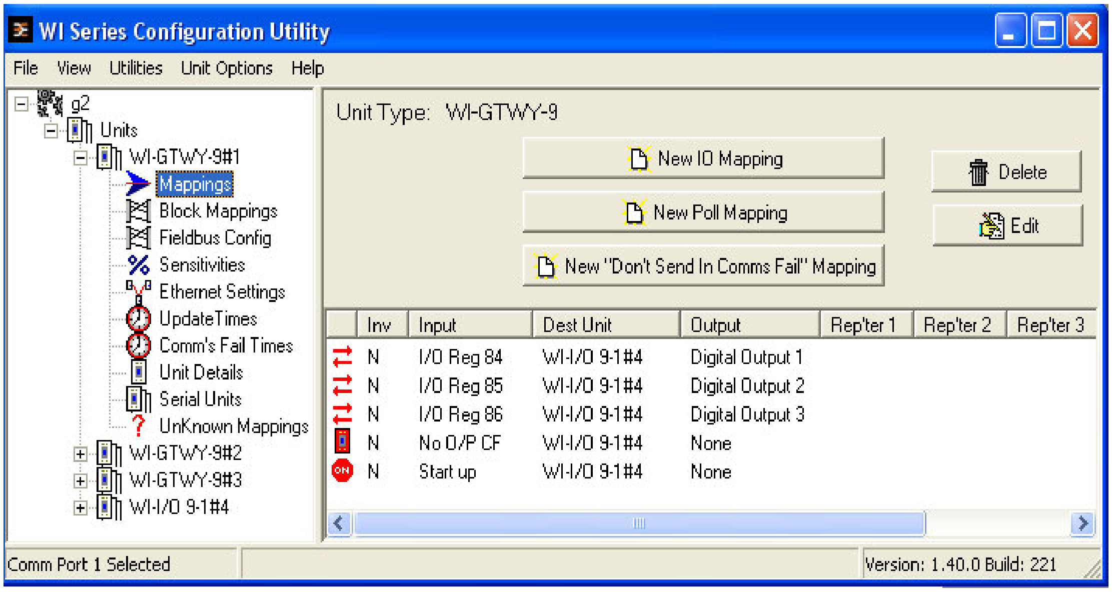
To change the update times of output mappings, select the Update Times option. Any I/O registers that have already been mapped to remote outputs will automatically be listed. The default update time is 10 minutes.

Changing Multiple Settings

You can change the Comms Fail Times or Update Times of several I/O points simultaneously by using the <Shift> Select feature. For example, if you want to change all times to 1 minute, you could change each individually, or you could “block” all entries using the “Shift” Select feature and select “Edit”. You only need to enter the change once to change all of the inputs selected. This feature is also available with the other configurable parameters.

4.4.3 Don’t Send if in Comm Fail

You can configure a special “Don’t Send if in Comms Fail” mapping. If this is configured for a particular remote module, the WI-GTWY-9-xxx will not transmit output messages to this remote address, if there is a communications failure status on any input or output configured for the same remote address. Output messages will re-start when a message is received from the remote module. The use of this option can prevent the radio channel becoming congested if there are many outputs at that module.



Unit Type: WI-GTWY-9

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
N	I/O Reg 84	WI-I/O 9-1#4	Digital Output 1			
N	I/O Reg 85	WI-I/O 9-1#4	Digital Output 2			
N	I/O Reg 86	WI-I/O 9-1#4	Digital Output 3			
N	No O/P CF	WI-I/O 9-1#4	None			
N	Start up	WI-I/O 9-1#4	None			

To configure this special mapping, select the "New Don't Send in Comms Fail Mapping" box. You will be asked to select which remote module this function applies to. You can enter more than one of these mappings if there are more than one modules.

4.4.4 Startup Polls

You can enter start up polls for remote modules by using the "New Poll Mapping" box. This function is the same as for the WI-I/O 9-x I/O modules. A start-up poll is a special message sent when the WI-GTWY-9-xxx starts up. When the remote module receives a start-up poll, it will immediately respond with update messages for all its inputs that are mapped to the WI-GTWY-9-xxx. This allows the WI-GTWY-9-xxx to have correct values on start-up.

4.4.5 Polls to Remote Modules

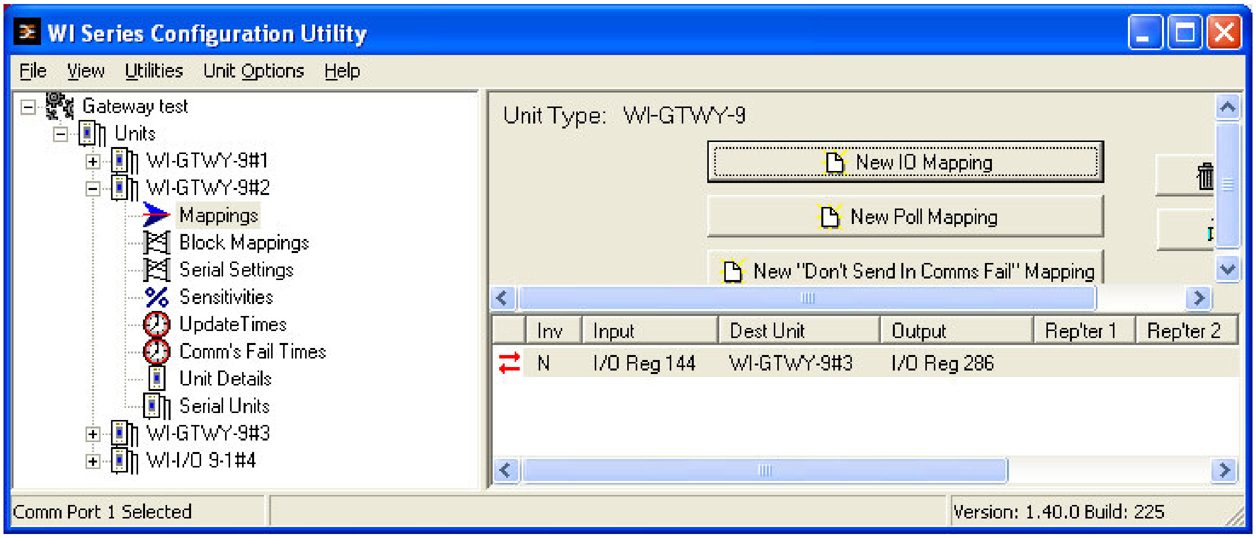
It is possible for a WI-GTWY-9-xxx to send a poll to a remote module at other times apart from start-up. A poll can be sent under the following events:

- based on a configurable time period
- based on real time clock
- on-demand by the host device.

For information on this configuration, refer to the next section on "Block Mappings".

4.5 Mappings from WI-GTWY-9-xxx to other WI-GTWY-9-xxx Modules

Individual links between WI-GTWY-9-xxx modules can be configured under the "Mappings" selection as described in the previous section. For example, if you want to transfer I/O Reg 144 in WI-GTWY-9-xxx#2 to I/O Reg 286 in WI-GTWY-9-xxx#3, you can enter the following mapping:



Unit Type: WI-GTWY-9

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2
N	I/O Reg 144	WI-GTWY-9#3	I/O Reg 286		

Comm Port 1 Selected

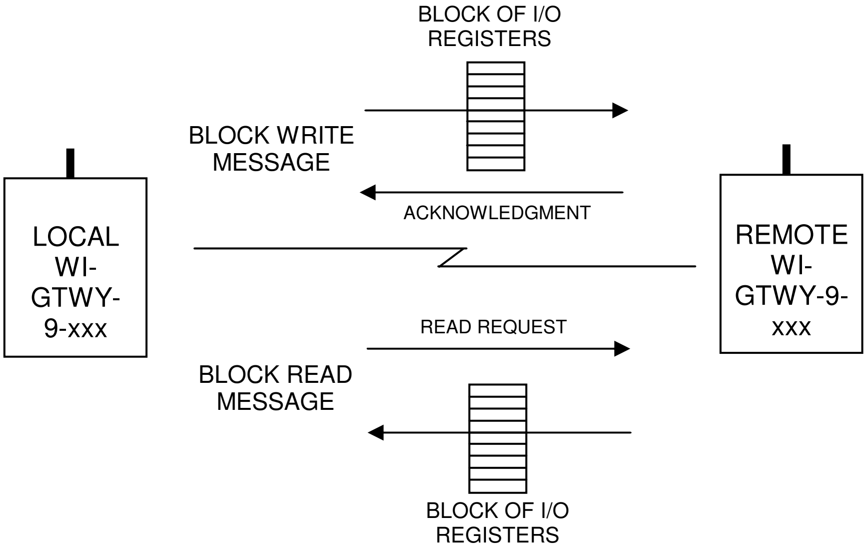
Version: 1.40.0 Build: 225

Whenever I/O Reg 144 changed by the sensitivity amount, WI-GTWY-9-xxx#2 would send a message to WI-GTWY-9-xxx#3 to write the value in I/O Reg 286. The problem arises if there are a lot of these mappings. Each radio message only relates to one register-register link. If you want to map 1000 registers from one WI-GTWY-9-xxx to another, then this could generate a lot of radio messages.

To get around this problem, it is possible to configure "block mappings". With a block mapping, multiple registers (a "block of registers") can be transferred together in the one radio message. This improves the efficiency of the radio communications.

Read/Write Mappings

The mappings can be "read" or "write" mappings. A Read mapping is a request sent to another WI-GTWY-9-xxx to return a block of values. A Write mapping is a message sending a block of values to another WI-GTWY-9-xxx. A Read mapping from WI-GTWY-9-xxx#2 to WI-GTWY-9-xxx#3 could be the same as a Write mapping from WI-GTWY-9-xxx#3 to WI-GTWY-9-xxx#2 (that is, in the reverse direction) - except the Read mapping is initiated from #2 and the Write mapping is initiated from #3.



Word/Bit Mappings

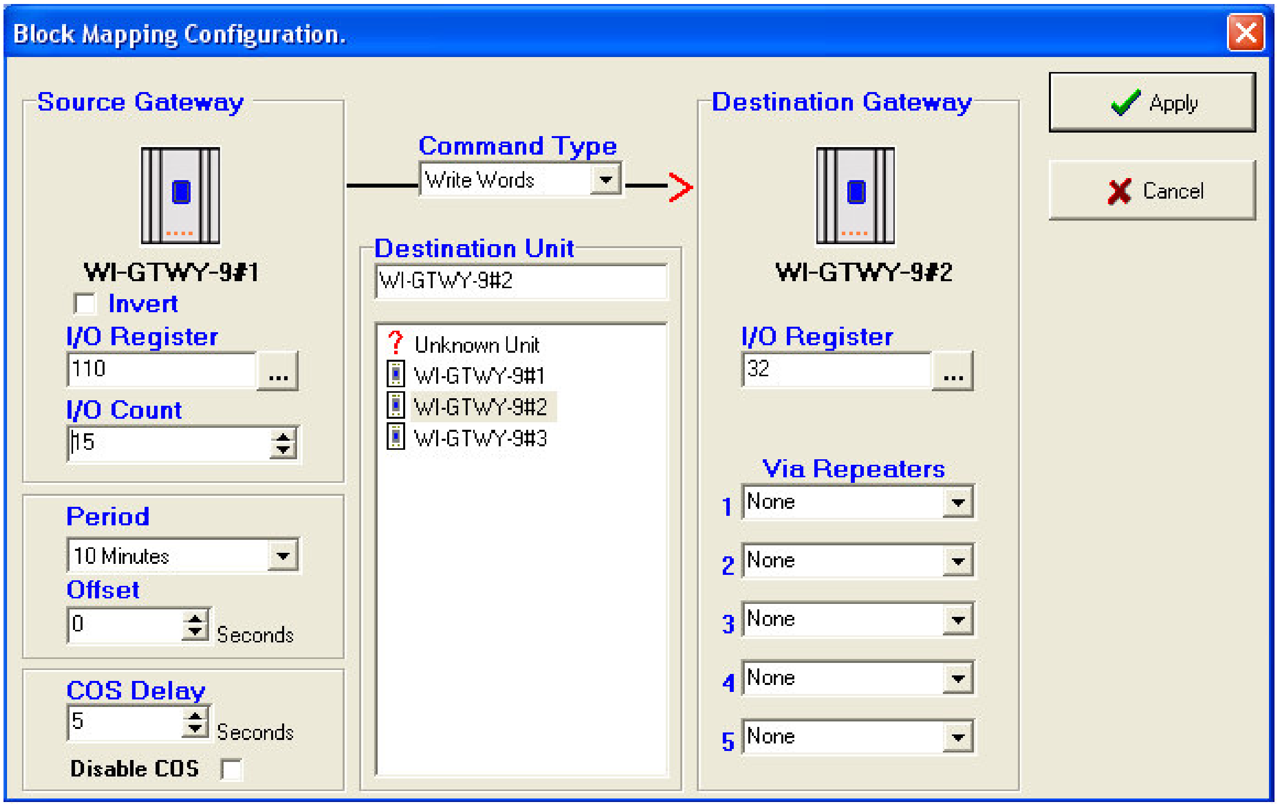
Read and Write mappings are also selected as Word or Bit mappings - that is, you can select a Read Word mapping or a Read Bit mapping and you can select a Write Word mapping or a Write Bit mapping. "Word" refers to a complete 16-bit register value; "Bit" refers to the value of the most significant bit of a register - this bit is the "binary value" or "digital value" of the register.

If you use a Word block mapping of 50 registers, you are transferring a block of 50 x 16-bit values. If you use a Bit block mapping of 50 registers, you are only transferring the digital value of each register - that is 50 x 1 bit values. This is a lot more efficient for a radio message, but bit mappings are only suitable for discrete or digital I/O. A Bit mapping will convert the 16-bit register to a single bit, transfer it and store the bit value in the most significant bit of the destination register.

Note: The maximum block size for each block mapping is 64 registers.

4.5.1 Entering a Block Mapping

Select the "source" WI-GTWY-9-xxx on the left hand menu - select "Block Mappings" and then "New Block Mapping" from the right-hand display. The Block Mapping Configuration display will appear.



Block Mapping Configuration.

Source Gateway

WI-GTWY-9#1

☐ Invert

I/O Register: 110

I/O Count: 15

Period: 10 Minutes

Offset: 0 Seconds

COS Delay: 5 Seconds

Disable COS ☐

Command Type: Write Words

Destination Unit: WI-GTWY-9#2

- ? Unknown Unit
- WI-GTWY-9#1
- WI-GTWY-9#2
- WI-GTWY-9#3

Destination Gateway

WI-GTWY-9#2

I/O Register: 32

Via Repeaters

1 None

2 None

3 None

4 None

5 None

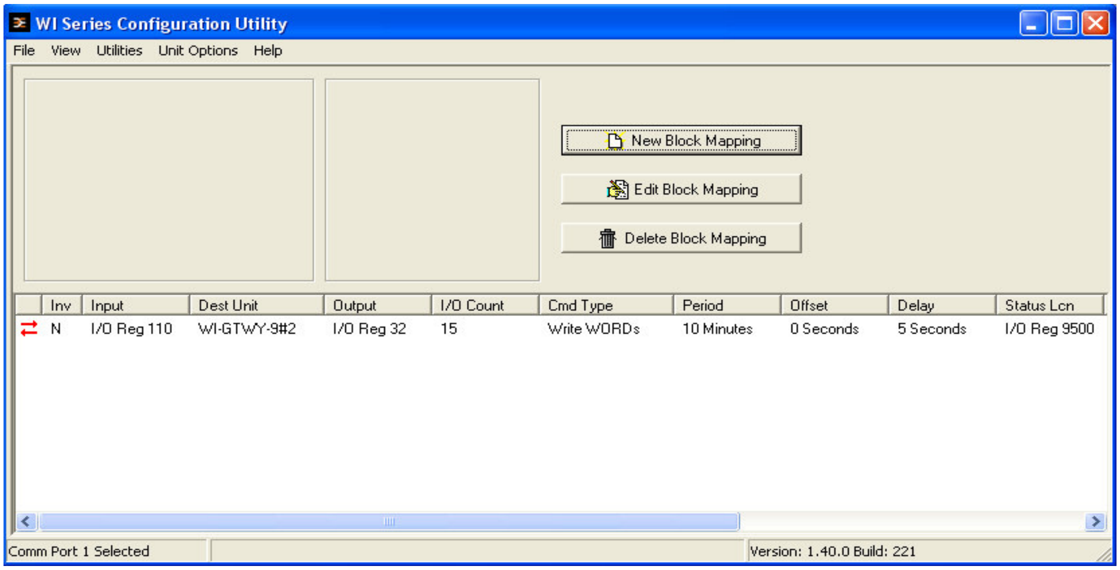
Select the "Command Type" from the pop-down window in the centre of the display. The red arrow will confirm the direction of the block transfer. Now select the destination module - only the WI-GTWY-9-xxx modules already configured will be shown. If you need to use repeaters in the radio link, enter the repeater addresses, starting with the repeater closest to the source module.

Under "Source Gateway", enter the I/O Register and I/O Count. The I/O Register is the first register in the block and the I/O Count is the number of registers - in the above example, the block of registers will be 110 – 124 (15 registers starting at I/O Reg 110).

If you are entering a Write mapping, then the values in this block will be sent to another WI-GTWY-9-xxx. If it is a Read mapping, then values from another WI-GTWY-9-xxx will be sent to this block.

Under "Destination Gateway", enter the I/O Register - this is the first register in the block. You do not need to enter the block size as this will always be the same as the block size in the source WI-GTWY-9-xxx. In the above example, the destination block will be I/O registers 32 – 46 (15 registers starting at register 32). So, in the above example, a block of 15 x 16-bit values will be written from I/O Reg 110 – 124 in WI-GTWY-9-xxx#1 to I/O Reg 32 – 46 in WI-GTWY-9-xxx#2.

Each mapping entered is allocated a status register - the register number appears on the right hand of the Block Mapping display. These registers store relevant status information about the block mapping - the structure of the Block Mapping status registers is shown in Appendix 1.



	Inv	Input	Dest Unit	Output	I/O Count	Cmd Type	Period	Offset	Delay	Status Lcn
⇄	N	I/O Reg 110	WI-GTWY-9#2	I/O Reg 32	15	Write WORDs	10 Minutes	0 Seconds	5 Seconds	I/O Reg 9500

Comm Port 1 Selected

Version: 1.40.0 Build: 221

In the above example, the status register for the block mapping has been automatically assigned to register 9500.

The rest of the mapping configuration involves the mapping trigger - or what initiates the mapping message.

Mapping “Triggers”

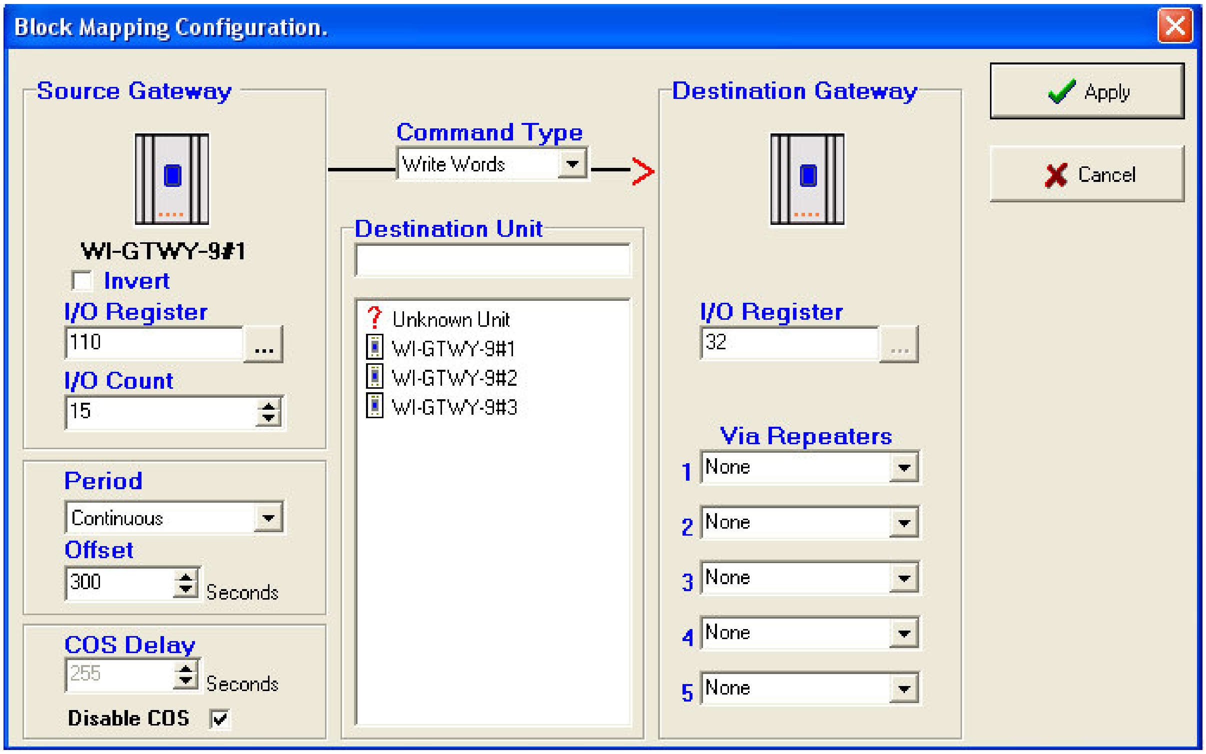
A block mapping can be “triggered” or initiated by several different methods.

- By the host device writing to a “trigger register” in the source WI-GTWY-9-xxx - the block mapping message is sent each time the host device writes to the trigger register.
- By configuring a time period - the WI-GTWY-9-xxx will send the block mapping message if this time period has elapsed since the last message has been sent.
- By configuring a real-time clock - the WI-GTWY-9-xxx will send the block mapping message at the configured times.
- By a change-of-state within the I/O block. This can only occur for Write mappings. If a value in the block changes by more than the sensitivity amount, then the block message will be sent. You can enter a delay period such that the message is sent after the delay period.

Combinations of the above triggers can occur - for example, the block mapping message will be sent if a change-of-state occurs, AND at the configured real-time, AND when the host device writes to the trigger register.

4.5.2 Host Device Trigger

Each block mapping that is configured is allocated a status register in the range 9500 – 9999 (i.e. one status register for a maximum of 500 possible block mappings). The status register for a given block mapping is shown on the right hand side of the Block Mapping display (under the heading “Status Lcn”). Bit 13 of the associated status register is the “Force bit” - if Bit 13 is turned “on”, then the associated mapping is forced, or triggered. Depending on the module version, a particular algorithm may apply to the setting of the force bit. This algorithm and details of the block status registers are given in Appendix 1.



Source Gateway: WI-GTWY-9#1

☐ Invert

I/O Register: 110

I/O Count: 15

Period: Continuous

Offset: 300 Seconds

COS Delay: 255 Seconds

Disable COS ☑

Command Type: Write Words

Destination Unit:
- ? Unknown Unit
- WI-GTWY-9#1
- WI-GTWY-9#2
- WI-GTWY-9#3

Destination Gateway I/O Register: 32

Via Repeaters:
1 None
2 None
3 None
4 None
5 None

4.5.3 Time Period

On the Block Mapping display, there are two configuration windows - “Period” and “Offset” - these determine the time period trigger and real-time trigger.

For a time-period trigger, select “Continuous” in the “Period” pop-down window. Under “Offset” enter the time-period in seconds. In the above example, the mapping will be sent every 300 seconds or 5 minutes.

Note that the time period is after the last transmission - if the block mapping message is triggered by the host device, or by a change-of-state, then the timer is reset and the time period starts again.

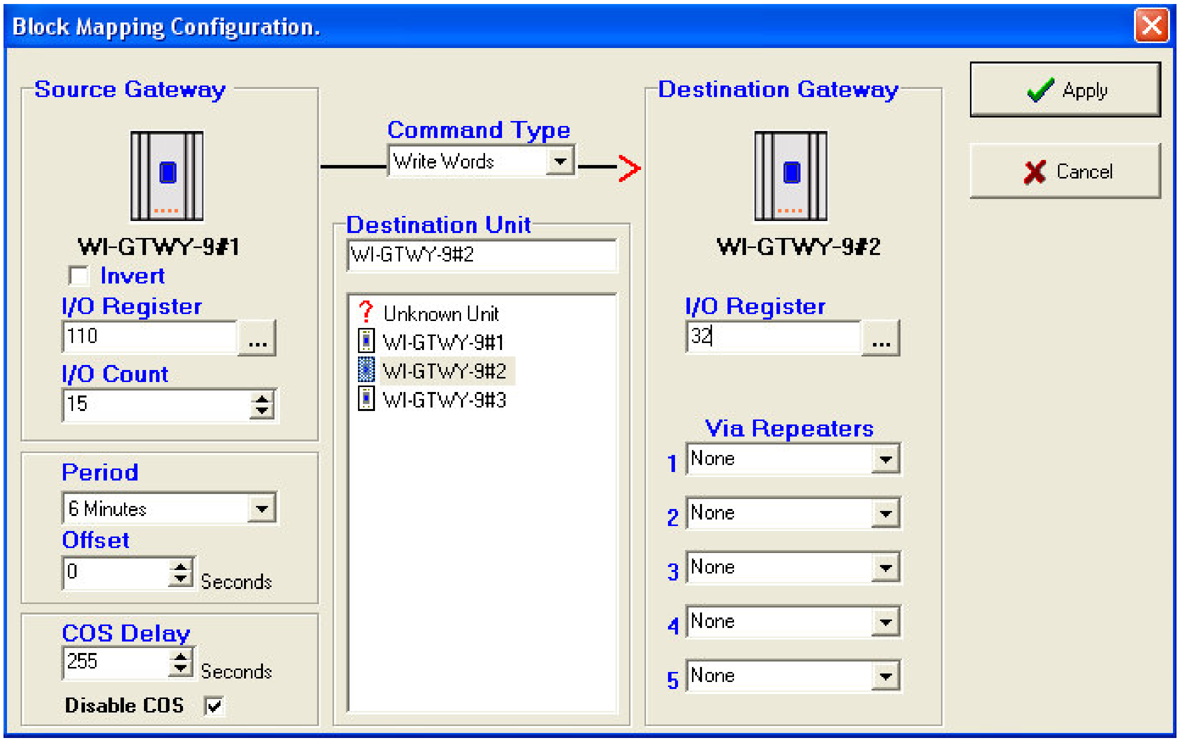
The “Offset” value can be set from 0 – 4095 seconds (68 minutes). If you do not want the message to be sent on a time period, set the “Offset” value to zero.

If you want the block mapping to be sent only on time period (and not on change as well), select the “Disable” box in the bottom left hand corner - this disables change messages for this block mapping.

4.5.4 Real-Time

The block mapping message can be sent at a real-time by setting the “Period” value. In this example, “period” is set to 6 minutes - the message will be sent every 6 minutes starting at the beginning of each hour. That is, the message will be sent at XX:00, XX:06, XX:12, XX:18, XX:24 …. XX:54 - where XX represents any hour of the day.

If “Period” was set to 1 minute, then the message would be sent every minute, on the minute.



Block Mapping Configuration.

Source Gateway

WI-GTWY-9#1

☐ Invert

I/O Register: 110

I/O Count: 15

Period: 6 Minutes

Offset: 0 Seconds

COS Delay: 255 Seconds

Disable COS ☑

Command Type: Write Words

Destination Unit: WI-GTWY-9#2

Unknown Unit
WI-GTWY-9#1
WI-GTWY-9#2
WI-GTWY-9#3

Destination Gateway

WI-GTWY-9#2

I/O Register: 32

Via Repeaters
1 None
2 None
3 None
4 None
5 None

The “Offset” value provides an offset to the specified time. In this example, if the “Offset” was set to 10 seconds, then the messages will be sent 10 seconds later - at XX:00:10, XX:06:10, XX:12:10 etc.

The reason for the offset is to stagger messages with the same time setting. For example, if you configure 5 block mappings all to be sent at 10 minutes, then the WI-GTWY-9-xxx will try to send these messages at the same time - some of the messages will have to wait until the earlier messages have been sent. If you are sending Read messages as well as Write messages, then the return messages could clash with outgoing messages.

To avoid this, you can delay some messages using the Offset feature. For example, if you have 5 mappings to be sent at 10 minutes, then the first could have zero offset, the second 3 sec offset, the third 6 sec offset etc.

If you do not wish to have a real-time trigger, set “Period” to continuous.

If you want the block mapping to be sent only on real-time (and not on change as well), select the “Disable” box in the bottom left hand corner - this disables change messages for this block mapping.

Setting the Clock

The clock within the WI-GTWY-9-xxx can be set by the host device, and read by the host device. The WI-GTWY-9-xxx provides four clock registers for days/hours/minutes/seconds - the registers are 4330 – 4333. On power-up, these registers are set to zero. Reg 4333 increments each second, Reg 4332 increments each minute, Reg 4331 each hour and Reg 4330 each day.

The clock registers are used by the WI-GTWY-9-xxx for the real-time-clock trigger. The host device can read these registers. The host device can also set the WI-GTWY-9-xxx clock at any time by writing to the appropriate *Set* register. The *Set* registers are : 4340 – 4343. The procedure for setting the real time clock via these registers depends on the module firmware version (to find out what firmware version the module contains, simply display the diagnostics menu – see section on diagnostics). The *set registers* can also be set via radio using appropriate I/O or block mappings.

Item	Clock Location	Set Location
Days	4330	4340
Hours	4331	4341
Minutes	4332	4342
Seconds	4333	4343

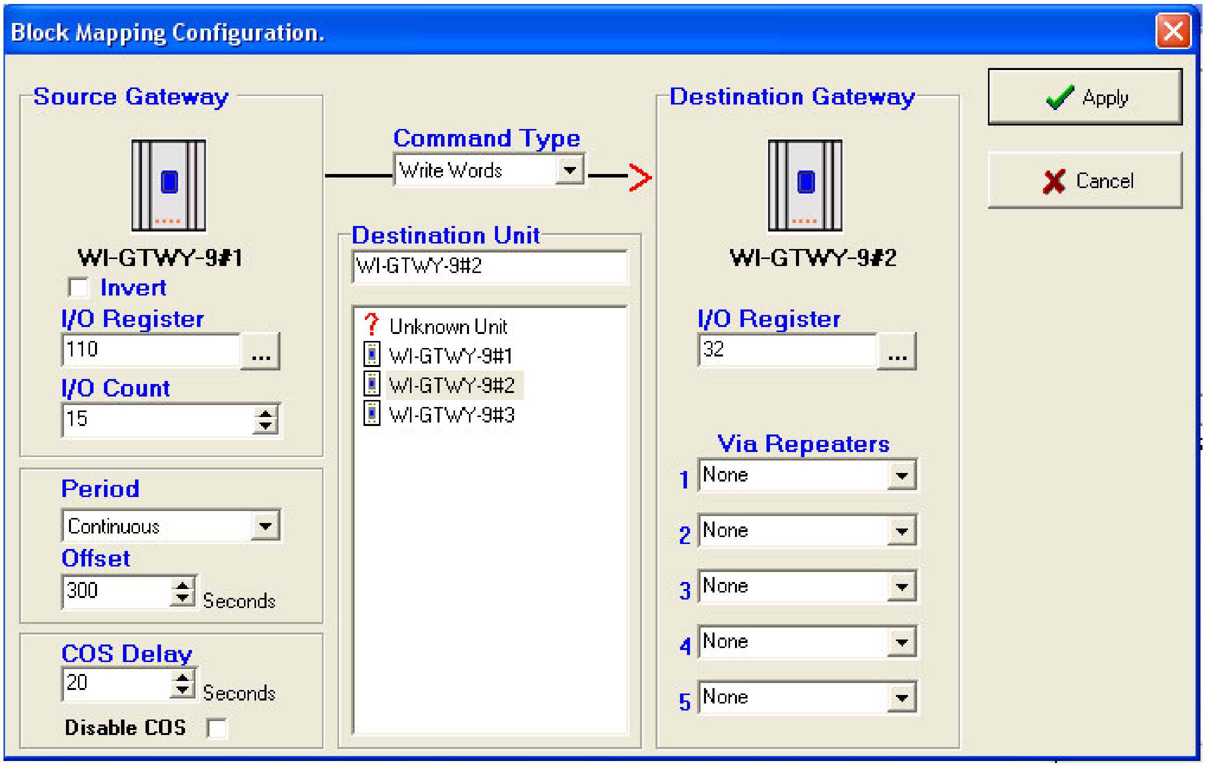
Firmware versions up to 1.50:

Registers 4340 – 4343 are normally zero. When a value is written into one of these registers, the WI-GTWY-9-xxx copies the value into the corresponding clock register, and then sets the *Set* register back to zero. For example, if the host device writes a value of 7 into Reg 4341, the WI-GTWY-9-xxx will write 7 into 4331 and set 4341 back to zero.

Firmware version 1.50 and later:

Registers 4340 – 4343 will only be transferred to the corresponding clock registers when their value changes from 0. For example to write a value of 7 to the hours register, first write the value 0 to the *Set hours* register 4341, then write the value 7 to the same register. (i.e. by always first writing the value 0 to the *Set* register this ensures that the change-of-state from 0 will be detected). Values must be held (i.e. not change) for approx 200msec to be detected.

4.5.5 Change-of-State



Block Mapping Configuration.

Source Gateway: WI-GTWY-9#1

☐ Invert

I/O Register: 110

I/O Count: 15

Period: Continuous

Offset: 300 Seconds

COS Delay: 20 Seconds

Disable COS ☐

Command Type: Write Words

Destination Unit: WI-GTWY-9#2

Destination Gateway: WI-GTWY-9#2

I/O Register: 32

Via Repeaters:
1 None
2 None
3 None
4 None
5 None

If a value in the block changes by more than the sensitivity amount, then the block message will be sent (this can only occur for Write mappings). The sensitivity values are set under the “Sensitivity” option as per section 4.6.

A delay time can be entered to reduce the number of change triggers in active systems. For example, if 20 seconds is selected in the “Delay” window, then the change message will be sent 20 seconds after the change-of-state occurs - if other changes occur during the 20 second period, all of these changes are sent in the one message.

The delay time can be set from 0 – 254 seconds.

If you do not wish change messages to occur, select the “Disable” box.

4.5.6 Mixing Normal Mappings and Block Mappings

Block mappings can include I/O Registers already used with normal I/O mappings.

For example, a remote WI-I/O 9-x I/O module could map a remote input to I/O Reg 743. At the WI-GTWY-9-xxx, the host device could read I/O Reg 743, and you could also configure a block mapping including this register to another WI-GTWY-9-xxx. You could write a block I/O Reg 700 – 800 to another WI-GTWY-9-xxx.

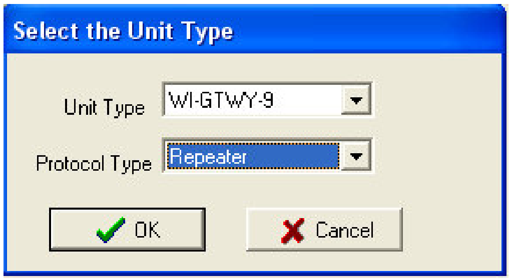
4.5.7 Comms Fail for Block Mappings

Each block mapping has an associated mapping number. Up to 500 block mappings may be entered. A status register is maintained for each block mapping. The most significant bit of this register contains the comm fail status.

If a block mapping does not receive an acknowledgement from the remote module, then the comms fail status is set - this can be monitored by the host device.

4.5.8 "Repeater-only" Configuration

Any WI-GTWY-9-xxx module can act as a repeater unit. However a WI-GTWY-9-xxx may need to be installed as a repeater only (that is, there is no host device connected). In this case, the base WI-GTWY-9-xxx, the WI-GTWY-9-xxx-MD1 unit would normally be used as this is the lowest cost of the WI-GTWY-9-xxx modules.


Select the Unit Type

Unit Type: WI-GTWY-9

Protocol Type: Repeater

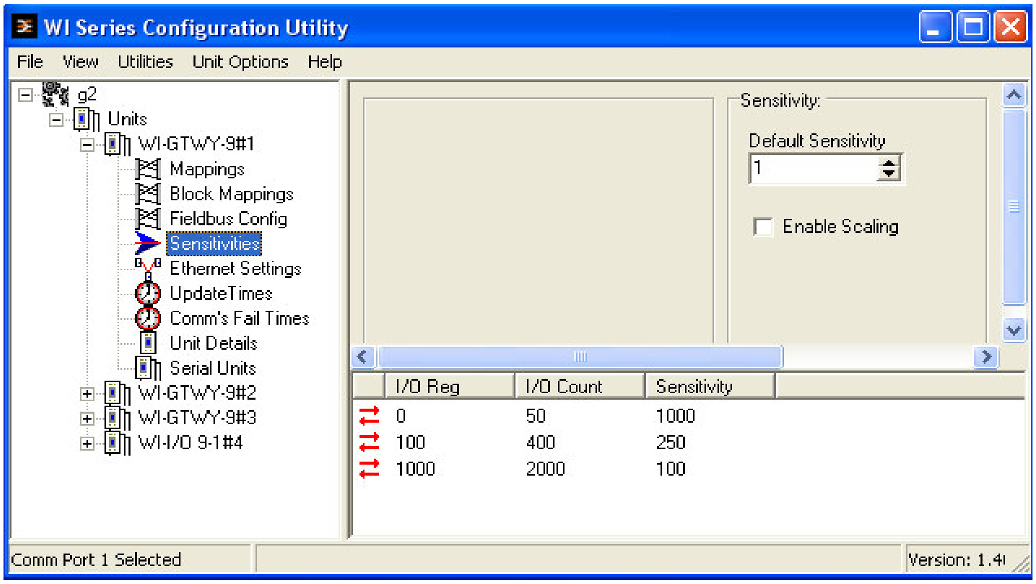
A repeater can be configured as a "Repeater-only" unit. The advantages are:

- the serial port will then provide on-line diagnostics (instead of off-line diagnostics), or
- WI-I/O-EX-1-S-1x serial I/O modules can be connected to the serial port - normally WI-I/O-EX-1-S-1x modules cannot be used with MD1 units.

4.6 Change Sensitivity & I/O Value Scaling

4.6.1 Change Sensitivity

"Change" messages for both individual I/O mappings and block mappings use a sensitivity value to trigger the message. Sensitivities are configured for blocks of I/O registers - that is, each I/O register does not have a unique sensitivity. You can configure up to 50 sensitivity values - that is, there can be 50 blocks of registers with different sensitivities.


WI Series Configuration Utility

Sensitivity:

Default Sensitivity: 1

☐ Enable Scaling

I/O Reg	I/O Count	Sensitivity
0	50	1000
100	400	250
1000	2000	100

Comm Port 1 Selected

Version: 1.4!

In the above example, three sensitivity blocks have been configured:

1. I/O registers 0 – 49 have a sensitivity of 1000 (or 1.5% of the 16 bit range)
2. I/O registers 100 – 499 have a sensitivity of 250 (or 0.4% of the 16 bit range)
3. I/O registers 1000 – 2999 have a sensitivity of 100 (or 0.15% of the 16 bit range)

All of the registers between 0 and 49 have a sensitivity value of 1000. If register 34 has changed value by more than 1000 since the last transmission for that register, then a change trigger will occur for register 34. Sensitivity values are in decimal and can vary between 1 and 65535 (16-bit).

Up to 50 blocks of sensitivities can be configured. If a register is included in more than one block, then the first sensitivity value configured will be accepted and later values ignored. If Scaling is configured (refer next section), then the number of blocks is reduced to 25.

Registers which are not included in any block use the "default" sensitivity which is also user-configurable. In the above example, the default sensitivity is 1 and is the sensitivity for all I/O registers not included in the three blocks.

Important Note. Sensitivity values need to be selected carefully for analogue or counting registers as small values can result in a large number of change messages, which can overload the radio channel. A sensitivity value of 1 in 65535 is a change of 0.0015%. If the host device writes an analogue value to a WI-GTWY-9-xxx every 100msec, it will change by at least 1 bit each time. A small sensitivity value will cause a change message to be sent every 100msec. If there are many analogue values in the same situation, then there would be many change messages every 100msec. Sensitivity values for analogue I/O should be set to be greater than the normal process noise of the signal. For example, if a flow signal has a normal process oscillation of 2.5%, then the sensitivity should be set to 3% (or a value of 2000) to avoid change transmissions from the process oscillations.

4.6.2 I/O Value Scaling

Firmware version 1.76 and later:

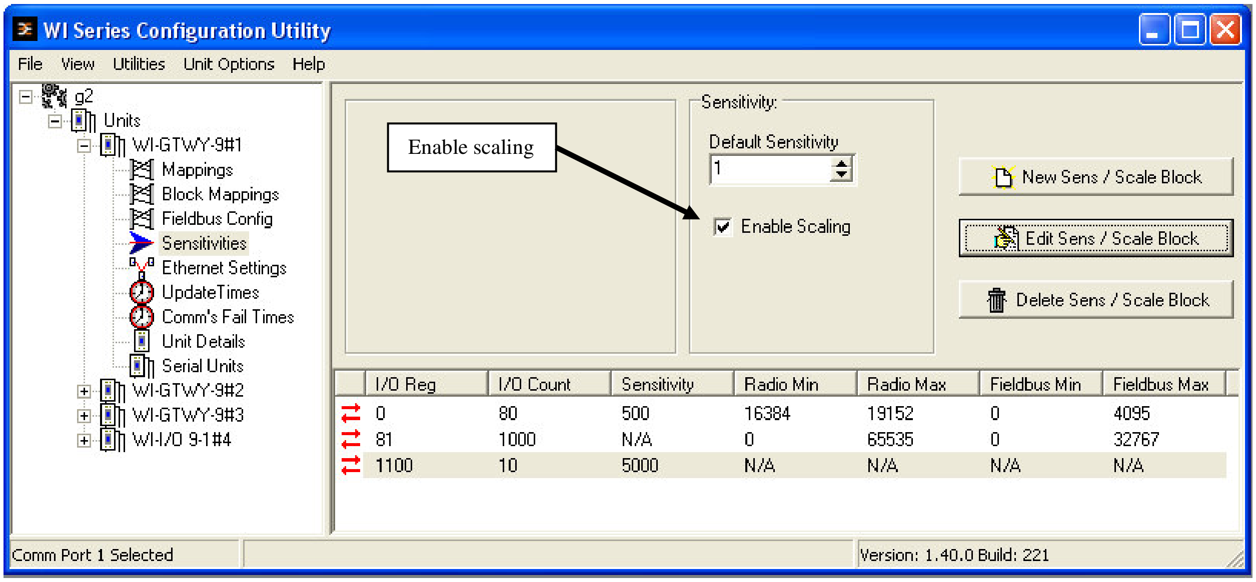
The values in I/O registers can be scaled as the values are transferred to the data bus, or from the data bus.

The I/O values in the WI-GTWY-9-xxx database registers are stored as 16-bit values (between 0 and FFFF hexidecimal or 0 and 65,535 decimal). Analog inputs at a WI-I/O 9-x I/O module are scaled hex 4000 (dec 16,384) for 4mA and hex C000 (dec 49152) for 20mA. A 12 mA signal is half-way in this range at hex 8000 (dec 32,768).

The reason for adding additional scaling between the WI-GTWY-9-xxx database (radio side) and the data bus is to cater for external host devices which do not handle normal 16-bit values. Two examples are:

- Honeywell Modbus gateways which only handle 12-bits values (0-4,095 decimal), and
- Sensor / analyzer devices with "signed 16-bit" values. A signed 16-bit value is a 15-bit value with an additional bit to signify plus (0) or minus (1).

Scaling of I/O registers can be configured in blocks. Different blocks can have different scaling.



Sensitivity:

Default Sensitivity: 1

☑ Enable Scaling

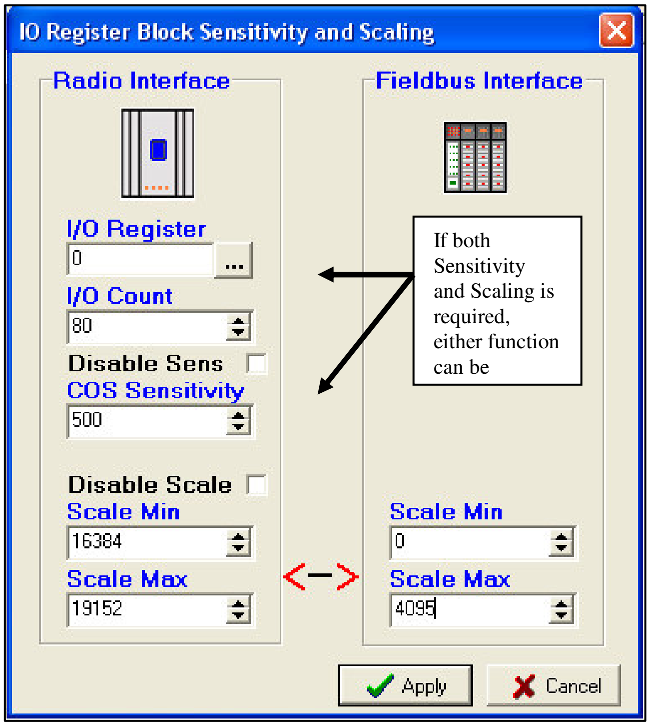
I/O Reg	I/O Count	Sensitivity	Radio Min	Radio Max	Fieldbus Min	Fieldbus Max
0	80	500	16384	19152	0	4095
81	1000	N/A	0	65535	0	32767
1100	10	5000	N/A	N/A	N/A	N/A

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Note that scaling only affects values transferred in or out of the data bus port. It has no affect on the radio side.

Scaling is configured in the "Sensitivities" section of the configuration software. If you select a new sensitivity/scaling block, you can select/deselect sensitivity or scaling or both. There is no relationship between sensitivity and scaling - we use the same configuration area as it is convenient because both features use blocks of I/O registers.



I/O Register: 0

I/O Count: 80

Disable Sens ☐

COS Sensitivity: 500

Disable Scale ☐

Radio Interface Scale Min: 16384

Radio Interface Scale Max: 19152

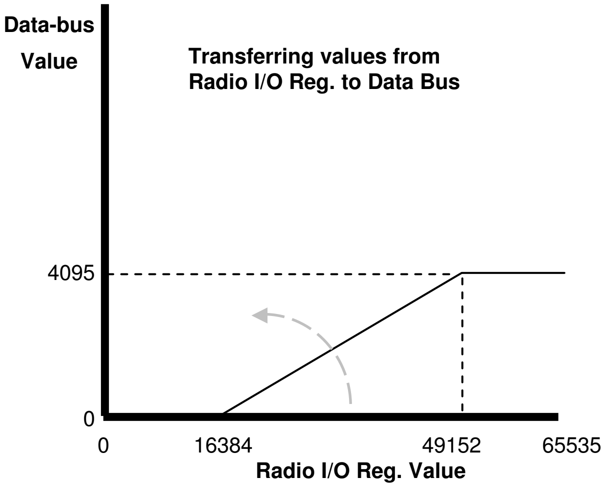
Fieldbus Interface Scale Min: 0

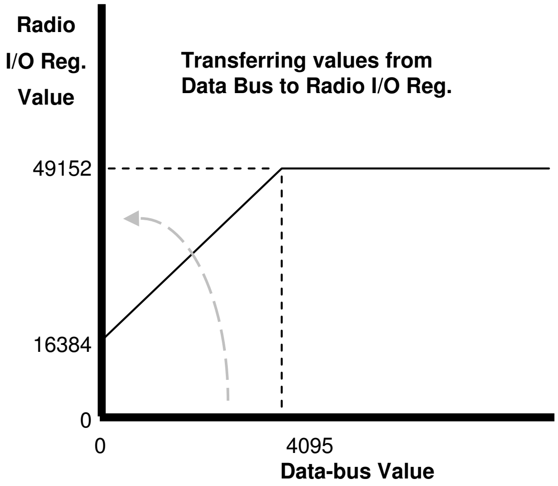
Fieldbus Interface Scale Max: 4095

In the first example, a block of I/O registers is configured for both sensitivity and scaling. I/O block 0 to 79 (total of 80 registers) is configured with a sensitivity value of 500. The same block has scaling configured converting the range 16384-49152 on the radio side to 0-4095 on the data bus side.

This is an example of converting a 4-20mA value to a "Honeywell 12-bit value". Note that the scaling works in both directions - for values being read from the I/O registers to the data bus, and values written from the data bus to the I/O registers.

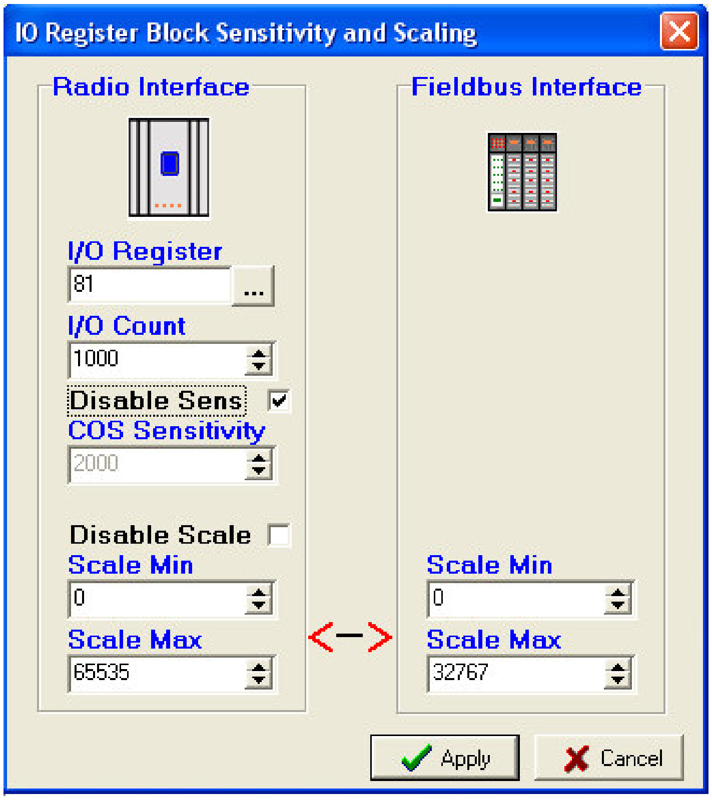
Any values outside of the scaling range are set to the minimum or maximum value. For example, if the data bus read a value of 10,000 from a register in this block, as it is less than the minimum range on the radio side (the min. is 16,384) it will be transferred as 0 which is the minimum value on the data bus side. If a value of 65,535 is read from another register, then as it is more than the maximum value on the radio side (max. value is 49,152), then the value is transferred as 4095 which is the maximum on the data bus side. This works in both directions - if the data bus tries to write a value of 10,000 to an I/O register in this block, it will be written as value 49,152 (which is the max. value on the radio side.





The second example shows another I/O block (registers 81 to 1080) that has been selected for scaling only - the sensitivity function has been disabled (these registers will use the default sensitivity of 2000 configured on the main Sensitivity configuration screen).

In this example, the full 16-bit range (0-65535) is scaled to "signed 16-bit values". A value greater than 32767 (which will be seen as a negative value) can't be written to the data bus.



I/O Register: 81

I/O Count: 1000

Disable Sens ☑

COS Sensitivity: 2000

Disable Scale ☐

Radio Interface Scale Min: 0

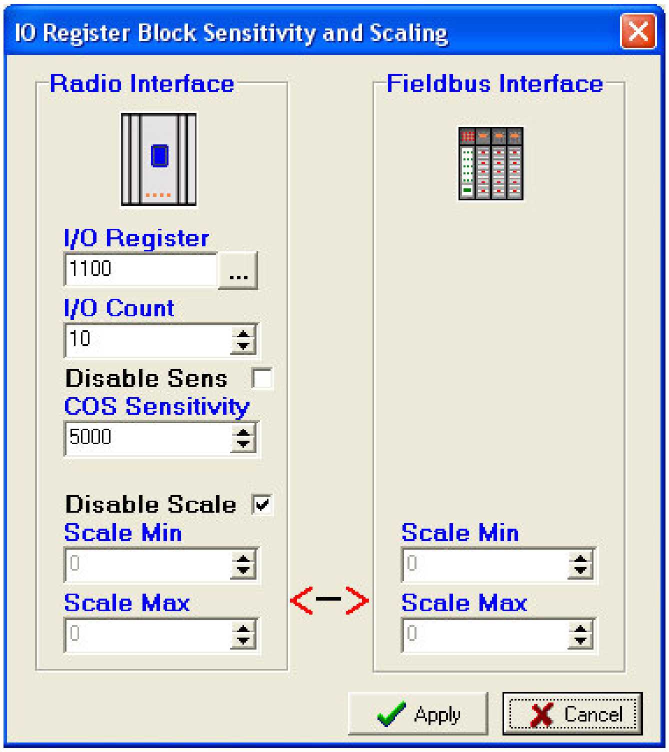
Radio Interface Scale Max: 65535

Fieldbus Interface Scale Min: 0

Fieldbus Interface Scale Max: 32767

In the last example, Scaling has been disabled for register block 1100 – 1109. Only sensitivity functionality is being used.

Note: If Scaling is not used at all, up to 50 blocks can be configured with different sensitivity values. However is Scaling is used, then only half this number of blocks is available.



Radio Interface:
I/O Register: 1100
I/O Count: 10
Disable Sens ☐
COS Sensitivity: 5000
Disable Scale ☑
Scale Min: 0
Scale Max: 0

Fieldbus Interface:
Scale Min: 0
Scale Max: 0

4.7 Serial Configuration - MODBUS

The WI-GTWY-9-xxx-MD1 module provides interface for Modbus Slave, Modbus Master and Allen-Bradley DF1. This Modbus interface uses the Modbus RTU protocol - also known as the Modbus Binary protocol. This manual assumes that the reader has a good understanding of the Modbus or DF1 protocol.

4.7.1 MODBUS Slave

If you use the WI-GTWY-9-xxx Modbus Slave interface, then the host device will be a Modbus Master device. The only configuration required for the Modbus slave interface is selecting the Modbus address and serial port parameters. This is done in the “Serial Settings” screen. A valid Modbus slave address is 1 to 255.

Each I/O register (and status register) in the WI-GTWY-9-xxx can act as one of the following types of Modbus registers

00001-09999 = Output Coils (digital/single bit)

10001-19999 = Input Bits (digital/single bit)

30001-39999 = Input Registers (analog/16 bit)

40001-49999 = Output Registers (analog/16 bit)

For example:

- If the Modbus Master sends the WI-GTWY-9-xxx a “read” command for Modbus input 10457, then the WI-GTWY-9-xxx will respond with the value in I/O register 457.
- If the Modbus Master sends the WI-GTWY-9-xxx a “write” command for Modbus output 02650, then the WI-GTWY-9-xxx will write the value to I/O register 2650.
- If the Modbus Master sends the WI-GTWY-9-xxx a “read” command for Modbus input 30142, then the WI-GTWY-9-xxx will respond with the value in I/O register 142.
- If the Modbus Master sends the WI-GTWY-9-xxx a “write” command for Modbus output 40905, then the WI-GTWY-9-xxx will write the value to I/O register 905.

The WI-GTWY-9-xxx I/O register values are 16 bit (hexadecimal values ‘0000’ to ‘FFFF’, or decimal 0 to 65535), regardless of whether the register represents a discrete, analog or count point.

The value of a discrete (digital) I/O point is stored in the WI-GTWY-9-xxx database as a hexadecimal '0000' (“off”) or hex 'FFFF' (“on”). However the WI-GTWY-9-xxx will respond with either a ‘0’ (“off”) or ‘1’ (“on”) to a digital read command from the Modbus master - these are commands 01 and 02. Similarly, the WI-GTWY-9-xxx will accept ‘0’ or ‘1’ from the Modbus master in a digital write command and store ‘0000’ or ‘FFFF’ in the database location - these commands are 05 and 15.

The Modbus function codes that the WI-GTWY-9-xxx will respond to are shown in the table below.

Supported Modbus Function Codes:

Function Code	**Meaning**
01	Read the state of multiple digital output points
02	Read the state of multiple digital input points
03	Read the value of multiple output registers
04	Read the value of multiple input registers
05	Set a single digital output ON or OFF
06	Set the value of a single output register
07	Read Exception Status - compatibility - returns zero
08	Loopback test Supported codes 0 return query data 10 clear diagnostic counters 11 bus message count 12 CRC error count 14 slave message count
15	Set multiple digital output points ON or OFF
16	Set multiple output registers

Analog I/O are 16 bit register values. A value of decimal 8192 (hex 2000) represents 0mA. A value of 49152 (hex C000) represents 20mA. Each 1 mA has a value of 2048 (hex 0800) - a change of 4096 (hex 1000) is equivalent to a change of 2mA. A 4-20mA signal will vary between 16384 (hex 4000) and 49152 (hex C000). A 0-20mA signal will vary between 8192 (hex 2000) and 49152 (hex C000).

Pulse counts are stored as a 16-bit register. When the register rolls over, from ‘FFFF’ (hex), the next value will be ‘0001’. The register will only have a value of ‘0000’ when the remote module starts up, and the previous count is lost. This value will indicate that the counter has reset.

Modbus Errors

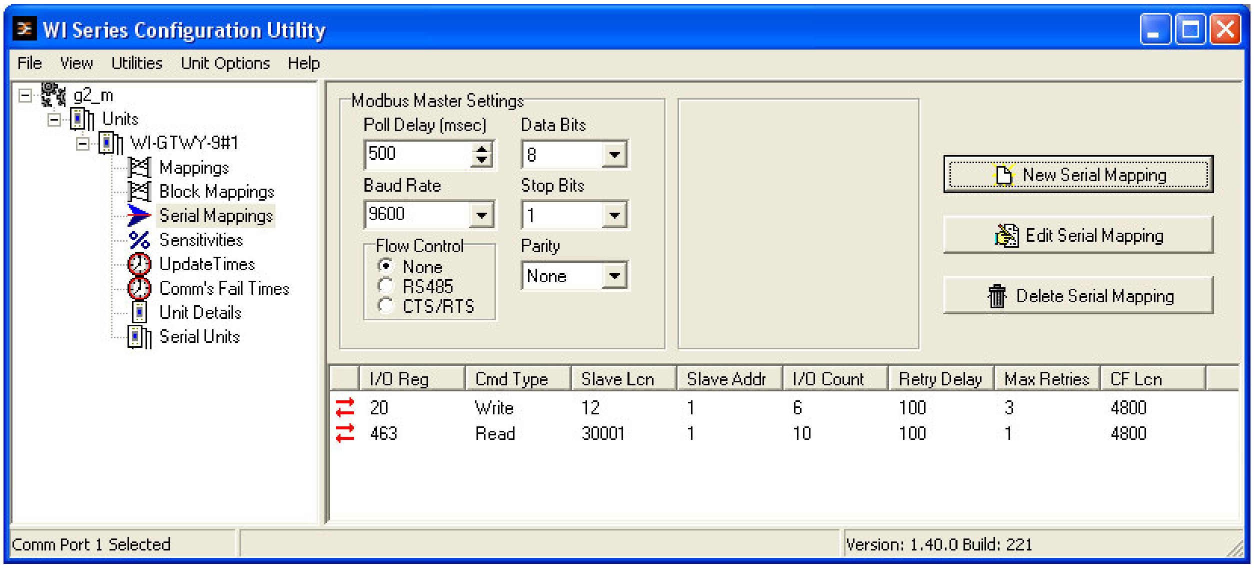
Four Modbus error messages are reported to the Modbus Master. An error response is indicated by the address of the return message being 128 plus the original slave address.

Supported Exception Codes:

Exception Code	Name	Description
01	Illegal function	The module does not support the function code in the query
02	Illegal data address	The data address received in the query is outside the initialized memory area
03	Illegal data value	The data in the request is illegal
06	Busy	Unable to process message

4.7.2 MODBUS Master

If you use the WI-GTWY-9-xxx as a Modbus Master, then the host device/s will be Modbus Slave device/s. If the RS485 port is used, then multiple Modbus Slave devices can be connected



Modbus Master Settings

Poll Delay (msec): 500

Data Bits: 8

Baud Rate: 9600

Stop Bits: 1

Flow Control: ● None ○ RS485 ○ CTS/RTS

Parity: None

I/O Reg	Cmd Type	Slave Lcn	Slave Addr	I/O Count	Retry Delay	Max Retries	CF Lcn
20	Write	12	1	6	100	3	4800
463	Read	30001	1	10	100	1	4800

Comm Port 1 Selected

Version: 1.40.0 Build: 221

to the WI-GTWY-9-xxx. The WI-GTWY-9-xxx Modbus Master will generate Modbus read and write commands to the Modbus Slave devices.

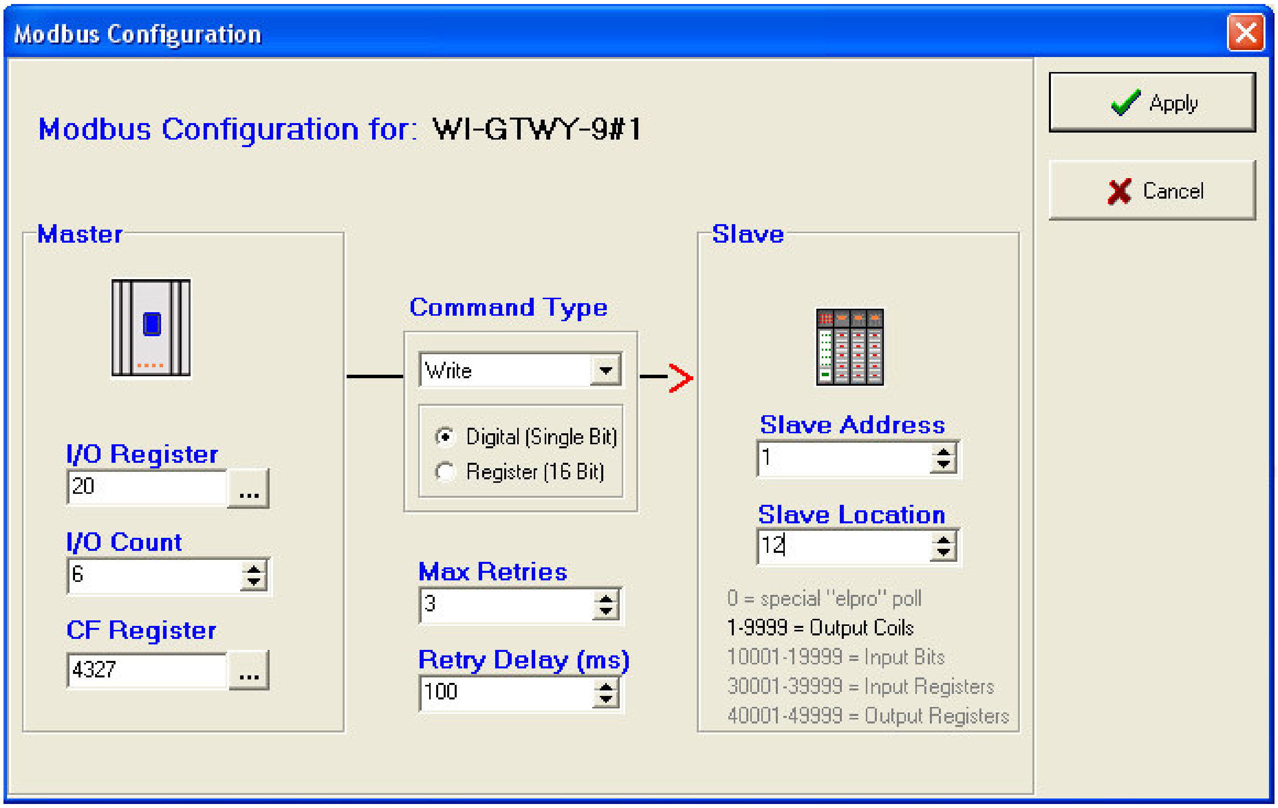
First read the above section on Modbus Slave operation, for an understanding of how the WI-GTWY-9-xxx handles Modbus registers, and the types of Modbus commands the WI-GTWY-9-xxx Master can generate.

The Modbus Master commands are configured in the “Serial Mapping” screen. The serial port is configured in the same way as described in the above section on Modbus Slave.

To enter a Modbus command, select “New Serial Mapping”. The following example is a digital write command which writes WI-GTWY-9-xxx I/O registers 20 – 25 (6 registers) to Modbus outputs 00012 – 00017, at Modbus Slave address 1.

The entry under “I/O Register” is the first I/O register in the WI-GTWY-9-xxx to be transferred - the “I/O count” is the number of registers to be transferred. If the selected Modbus slave does not respond to the command, then the WI-GTWY-9-xxx will write a ‘FFFF’ value to one of its own registers, configured under “CF Register” - in this case it is register 4800.

The “Command Type” selected is a write command (you can select read or write) - which means that the values are sent from the WI-GTWY-9-xxx to the Modbus Slave. The type of write command is a “Digital” write, meaning that the register values will be written as digital/binary values”.



Modbus Configuration for: WI-GTWY-9#1

I/O Register: 20

I/O Count: 6

CF Register: 4327

Command Type: Write

● Digital (Single Bit)
○ Register (16 Bit)

Max Retries: 3

Retry Delay (ms): 100

Slave Address: 1

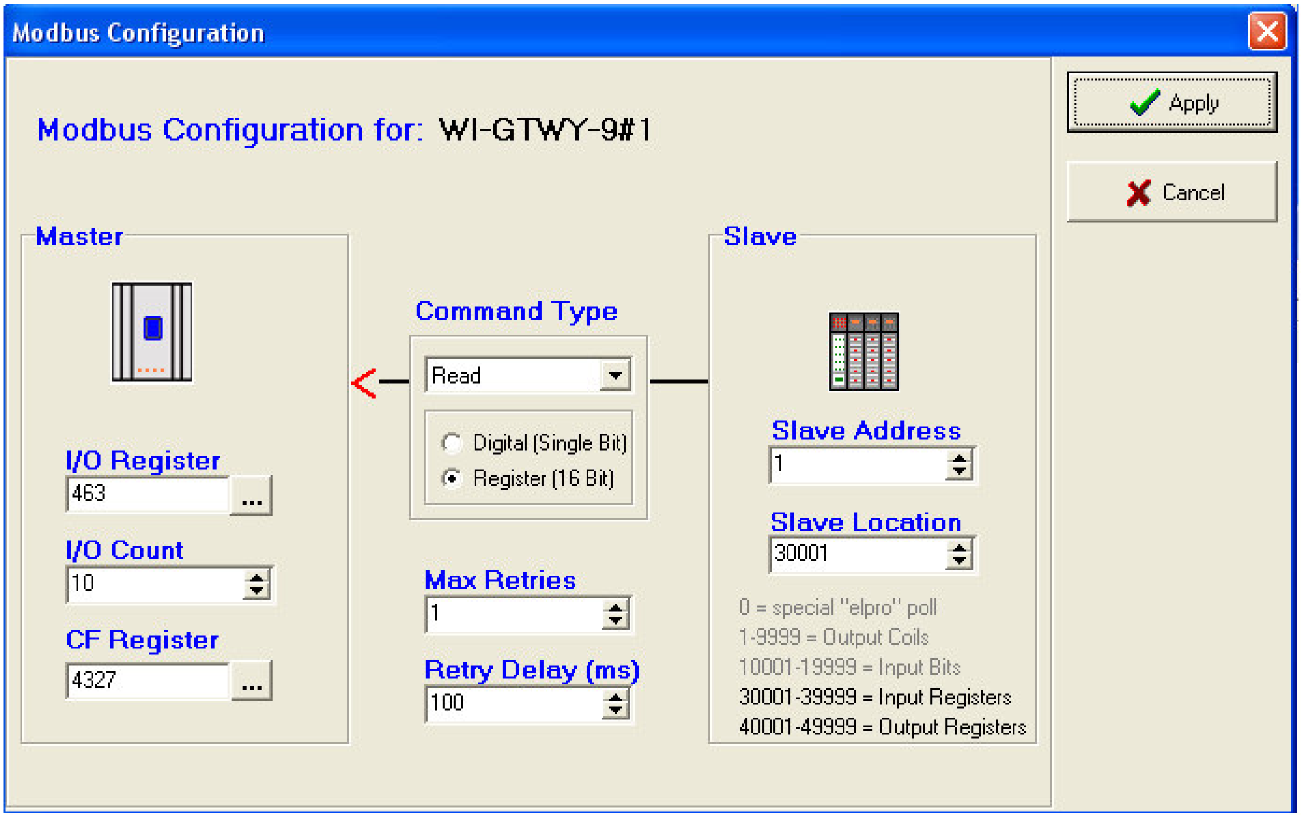
Slave Location: 12

0 = special "elpro" poll
1-9999 = Output Coils
10001-19999 = Input Bits
30001-39999 = Input Registers
40001-49999 = Output Registers

If the Modbus Slave device does not respond to the Modbus command, the WI-GTWY-9-xxx will try another 3 times (“Max Retries” = 3). The Modbus command will be sent to the Modbus Slave every 100msec. The address of the Modbus Slave is 1 (permissible addresses are 1 – 255). Because a digital write command has been selected, the destination register type will be digital outputs, with Modbus tag “0xxxxx”. The first destination Modbus location is 12 (or 00012) - as there are 6 registers transferred, the destination locations will be 00012 – 00017.

The second example is a register read command to the same Modbus Slave (address 1). The command requests the Modbus Slave to return the values of 10 registers which will be stored in I/O registers 463 - 473 in the WI-GTWY-9-xxx. As the command is a “register read” command, the target Modbus locations will be of the type 3xxxx. The starting location is 30001. So the values of locations 30001 – 30010 in Modbus Slave 1 will be transferred to I/O registers 463 – 473 in the WI-GTWY-9-xxx.

The CF Register (“comms fail” register) acts as a digital alarm – the value of the register will normally be 0, and will be set to FFFF (hex) if the slave device does not positively respond to the serial command within *Max Retries* attempts. In the examples, the same CF Register (4327 – i.e. DOT8) has been used for both serial mappings, such that the local digital output will be activated if the slave fails to respond to either serial command. Alternately, any other internal register could have been chosen and mapped via radio if desired.



Modbus Configuration for: WI-GTWY-9#1

I/O Register: 463

I/O Count: 10

CF Register: 4327

Command Type: Read

○ Digital (Single Bit)

● Register (16 Bit)

Max Retries: 1

Retry Delay (ms): 100

Slave Address: 1

Slave Location: 30001

0 = special "elpro" poll
1-9999 = Output Coils
10001-19999 = Input Bits
30001-39999 = Input Registers
40001-49999 = Output Registers

To complete the Fieldbus Configuration, enter any other Modbus commands that may be required to transfer I/O points between the WI-GTWY-9-xxx and the Modbus Slave devices.

Digital I/O

The value of a digital I/O point is stored in the WI-GTWY-9-xxx database as a hexadecimal '0000' (“off”) or hex 'FFFF' (“on”). However the WI-GTWY-9-xxx will generate either a ‘0’ (“off”) or

‘1’ (“on”) to a digital output point (Coil) when sending commands to a Modbus slave - these are commands 05 and 15. Similarly, the WI-GTWY-9-xxx will accept ‘0’ or ‘1’ from the Modbus slave in response to a digital read command and store ‘0000’ or ‘FFFF’ in the database location - these commands are 01 and 02.

Analog I/O

Analog I/O from the remote WI-I/O 9-x modules are 16 bit register value. A value of 8192 (hex 2000) represents 0mA. A value of 49152 (hex C000) represents 20mA. Each mA has value of 2048 (hex 0800) - a change of 4096 (hex 1000) is equivalent to a change of 2mA. A 4-20mA signal will vary between 16384 (hex 4000) and 49152 (hex C000). A 0-20mA signal will vary between 8192 (hex 2000) and 49152 (hex C000).

Pulse I/O

Pulse counts from the remote WI-I/O 9-x modules are shown as a 16-bit register. When the register rolls over, from ‘FFFF’ (hex), the next value will be ‘0001’. The register will only have a value of ‘0000’ when the remote module starts up, and the previous count is lost. This value will indicate that the counter has reset.

Modbus Retry Delay

The WI-GTWY-9-xxx Modbus Master configuration includes a feature to limit the frequency at which slave devices are polled for data. The WI-GTWY-9-xxx will poll each Modbus slave in order. If there is no delay time entered, the WI-GTWY-9-xxx will poll as quickly as it is able to. If there is a delay time entered, then this delay time will occur between each poll message.

When updated values are received from the WI-I/O 9-x radio network, the current polling sequence is interrupted, and the new values are written immediately to the appropriate slaves.

Re-tries on the Serial Port

When communicating with Modbus slaves, the WI-GTWY-9-xxx may be configured to re-try (or re-send) a message zero or more times if no response is received from a slave. If all retries are used up, that slave is flagged as being in communication failure. Further attempts to communicate with the slave will have zero re-tries. When a successful response is received from the Modbus slave, the communication failure flag is reset and the configured number of re-tries will be used. This means that an off-line slave device will not unduly slow down the communications network.

Comms Fail

A “Comms Fail” image location in the WI-GTWY-9-xxx database. This image location should be in the range 4500 to 4999. If a response is not received from the Modbus slave after all re-tries have been sent, the WI-GTWY-9-xxx will set this Comms Fail image location to hex(FFFF). When the WI-GTWY-9-xxx sends the next poll for this I/O Command, it will not send any re-tries if a response is not received to the first message. When a response is eventually received, the WI-GTWY-9-xxx will reset the value in Comms Fail image location to 0, and the normal re-try sequence will operate.

Different I/O Commands can use different Comms Fail image locations, however we recommend that you use the same image location for all I/O Commands to the same Modbus slave address.

4.8 Serial Configuration - DF1

The WI-GTWY-9-xxx DF1 Driver allows the WI-GTWY-9-xxx to communicate with Allen-Bradley devices supporting the DF1 protocol. Supported commands allow communication with 500 CPU devices (SLC and Micrologix) and with PLC2 series devices. DF1 offers both full-duplex (point to point) and half-duplex (multidrop) operation. The WI-GTWY-9-xxx only supports the full-duplex operation - this is the default DF1 mode on most equipment. DF1 full-duplex is a “peer-to-peer” protocol. Either DF1 device can initiate commands to the other device, and both devices will respond to commands from the other device. The WI-GTWY-9-xxx can act as both a command initiator and a command responder.

An Application Note and configuration files are available describing how to configure an Allen-Bradley PLC to communicate with a DF1 WI-GTWY-9-xxx. This is available from the W Interconnections website www.weidmuller.com

The WI-GTWY-9-xxx will initiate the following command types to a command responder, according to the configuration. The WI-GTWY-9-xxx will automatically generate the correct command type depending on the configuration you enter. The WI-GTWY-9-xxx will also respond to these command types if they are sent from a command initiator.

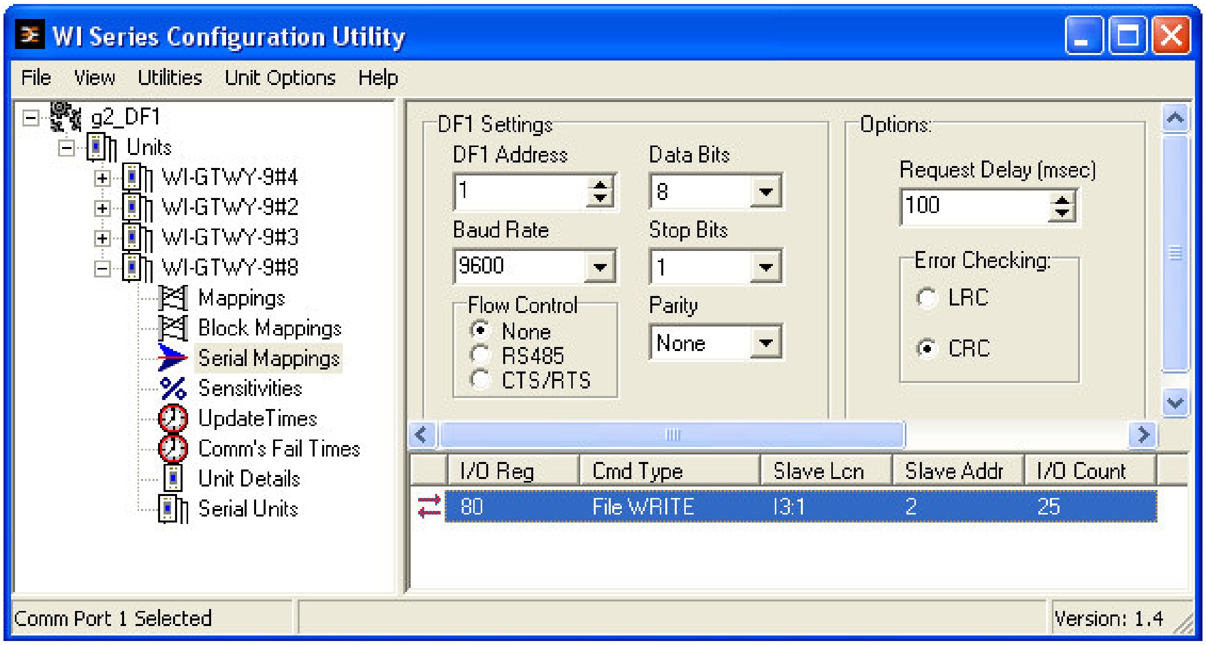
Command Description		**Code**	**Function Code**	**Comment**	
Protected Write		0x00	NONE	PLC2 series and SLC / Micrologix	
Unprotected Read		0x01	NONE	PLC2 series and SLC / Micrologix	
Diagnostic Status		0x06	0x00	Diagnostic Commands	
	Echo message	0x06	0x00		
Unprotected Write		0x08	NONE	PLC2 series and SLC500 / Micrologix	
Typed logical Read		0x0F	0xA2	Type	SLC500 and Micrologix
	Read Bits	0x0F	0xA2	0x85	Reads MSB of each WI-GTWY-9-xxx I/O register and writes the bits to the destination register, starting at the LSB of the register. Min. transfer is 16 bits.
	Read Integers	0x0F	0xA2	0x89	Return signed 16 bit value
	Read Long Ints	0x0F	0xA2	0x91	Unsigned 16 bit register per long-word
Typed logical Write		0x0F	0xAA	Type	SLC500 and Micrologix
	Write Bits	0x0F	0xAA	0x85	Writes bits from the source register, starting at the LSB, to the MSB of a block of WI-GTWY-9-xxx I/O registers. Min. transfer is 16 bits.
	Write Integers	0x0F	0xAA	0x89	Writes a signed 16 bit value
	Write LongIntegers	0x0F	0xAA	0x91	Low 16 bits of long-word placed in register. Upper 16 bits ignored.

The SLC and Micrologic PLC's read/write two types of registers. An "Integer" has a signed 16 bit value (-32768 to 32767). A "Long Integer" has a 32 bit value. The WI-GTWY-9-xxx registers contain an unsigned 16 bit value (0 to 65535). We recommend that you use Long Integer read/write commands - the upper 16 bits of the 32 bit value will be ignored. Refer to more information in the Analog I/O and Pulse I/O sections below. The PLC2 uses unsigned 16 bit registers in the same format as the WI-GTWY-9-xxx.

The WI-GTWY-9-xxx DF1 driver will update remote outputs whenever a data value changes by more than the I/O register sensitivity. If the response from a data request contains a changed data value, the new value will be transmitted to the remote WI-I/O 9-x on the radio network. Similarly, if the WI-GTWY-9-xxx receives a command to change a data value, the new value will be transmitted to the remote WI-I/O 9-x module.

The DF1 commands are configured in the "Serial Mapping" screen. The serial port should be configured in the same way as the host device. If the WI-GTWY-9-xxx acts only as a command responder, no further configuration is required.

If the WI-GTWY-9-xxx acts as a command initiator, you can enter a "Request Delay" between commands sent to the host. To enter a DF1 command, select "New Serial Mapping". The following example is a file write command which writes WI-GTWY-9-xxx I/O registers 80 – 104 (25 registers) to DF1 files I3.1 to I27.1 at DF1 address 2.



DF1 Address: 1
Data Bits: 8
Baud Rate: 9600
Stop Bits: 1
Flow Control: ● None ○ RS485 ○ CTS/RTS
Parity: None
Request Delay (msec): 100
Error Checking: ○ LRC ● CRC

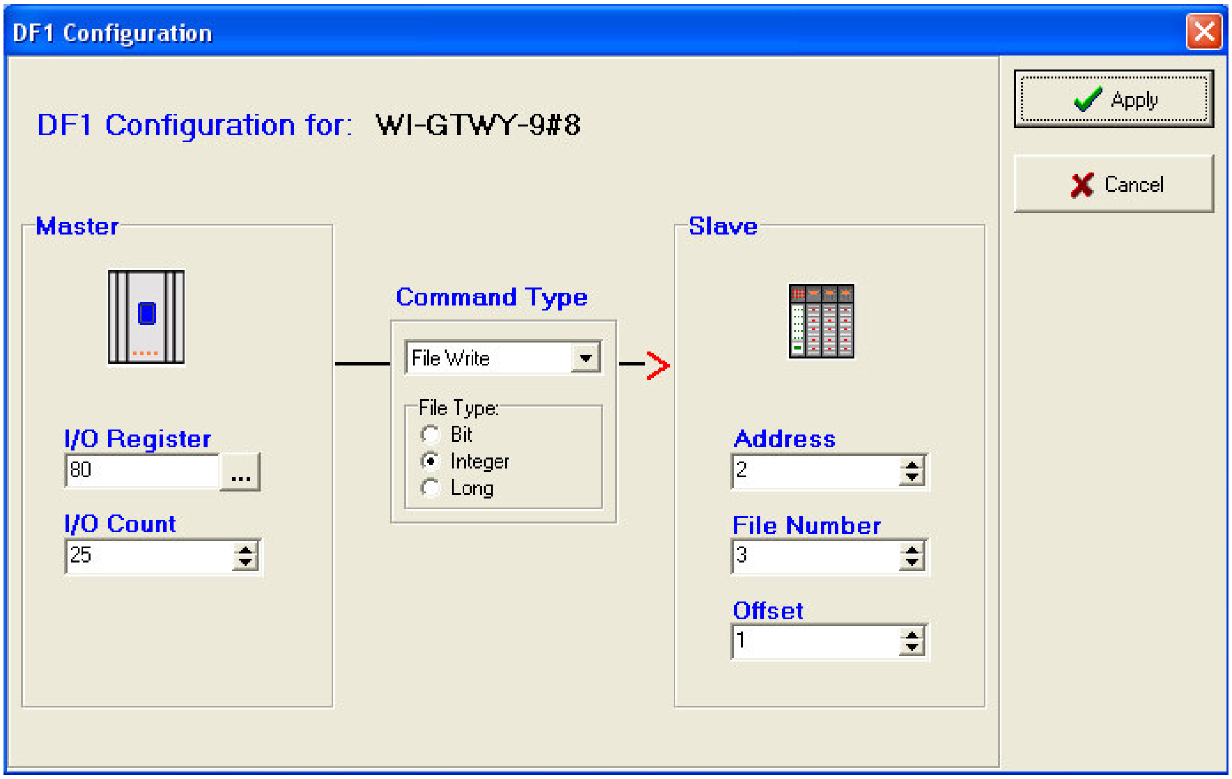
I/O Reg	Cmd Type	Slave Lcn	Slave Addr	I/O Count
80	File WRITE	I3:1	2	25

Comm Port 1 Selected
Version: 1.4

The entry under "I/O Register" (see below) is the first I/O register in the WI-GTWY-9-xxx to be transferred - the "I/O count" is the number of registers to be transferred.

The "Command Type" selected is a file write command (you can select read or write) - which means that the values are sent from the WI-GTWY-9-xxx to the host device. The type of write command is a "Integer" write, meaning that the register values will be written as register values.

The DF1 address of the host device (or "Slave") is 2.



DF1 Configuration for: WI-GTWY-9#8

Master

I/O Register: 80

I/O Count: 25

Command Type: File Write

File Type:
○ Bit
● Integer
○ Long

Slave

Address: 2

File Number: 3

Offset: 1

Discrete I/O

The value of a digital I/O point is stored in the WI-GTWY-9-xxx database as a hexadecimal '0000' (“off”) or hex 'FFFF' (“on”). However the WI-GTWY-9-xxx will generate either a ‘0’ (“off”) or ‘1’ (“on”) to a binary file when initiating a “Typed Logical Write” command or responding to a “Typed Logical Read” command. Similarly, the WI-GTWY-9-xxx will accept ‘0’ or ‘1’ from responding device to a “Typed Logical Read” command or from an initiating device generating a “Typed Logical Write” command and store ‘0000’ or ‘FFFF’ in the database location. The file type for a binary file (bit file) is 0x85.

In the PLC (that is, the DF1 host device), discrete values (“bits”) are stored in 16 bit registers - each register stores 16 bit values (or 16 discrete values). You can only transfer these values in groups of 16. That is, a read or write command will transfer a minimum of 16 bits to/from the WI-GTWY-9-xxx. If more than 16 are transferred, then they will be transferred in multiples of 16. You cannot transfer an individual bit - you must transfer the 16 bits in that PLC register, which will be transferred to/from 16 consecutive I/O registers in the WI-GTWY-9-xxx.

Note: The PLC reads or writes digital bits starting at the LSB of each register. In the WI-GTWY-9-xxx, only one bit is written to each I/O register, and this is the MSB.

Analog I/O

Analog I/O from the remote WI-I/O 9-x modules are 16 bit register value. A value of 8192 (hex 2000) represents 0mA. A value of 49152 (hex C000) represents 20mA. Each mA has value of 2048 (hex 0800) - a change of 4096 (hex 1000) is equivalent to a change of 2mA. A 4-20mA signal will vary between 16384 (hex 4000) and 49152 (hex C000). A 0-20mA signal will vary between 8192 (hex 2000) and 49152 (hex C000).

Note: If analog values are read to and written from an integer file in an SLC or Micrologix CPU, integer files contain 16 bit ***signed*** values. These represent values in the range -32768 to 32767. The data values from the WI-I/O 9-x modules are treated as 16 bit ***unsigned*** values. To convert the data from an analog input, move the data from the integer file to a long file (MOV command) then mask out the high 16 bits (MVM with mask value FFFF). This will result in a long integer value in the range 0 to 65535.

Alternatively, use a long integer file type to transfer the analog value as a long integer in the range 0-65535.

Pulse I/O

Pulse counts from the remote WI-I/O 9-x modules are shown as a 16-bit register. When the register rolls over, from 'FFFF' (hex), the next value will be '0001'. The register will only have a value of '0000' when the remote module starts up, and the previous count is lost. This value will indicate that the counter has reset.

Note: The values from the WI-GTWY-9-xxx module are 16 bit ***unsigned*** values. When they are copied to the Integer file in the PLC, they will be treated as 16 bit ***signed*** values. These values may be converted to the original (unsigned) values using the MOV and MVM instructions described in the previous section (Analog I/O). Again, using a Long Integer type will avoid this problem.

500 CPU (SLC and MicroLogix) file types and addressing

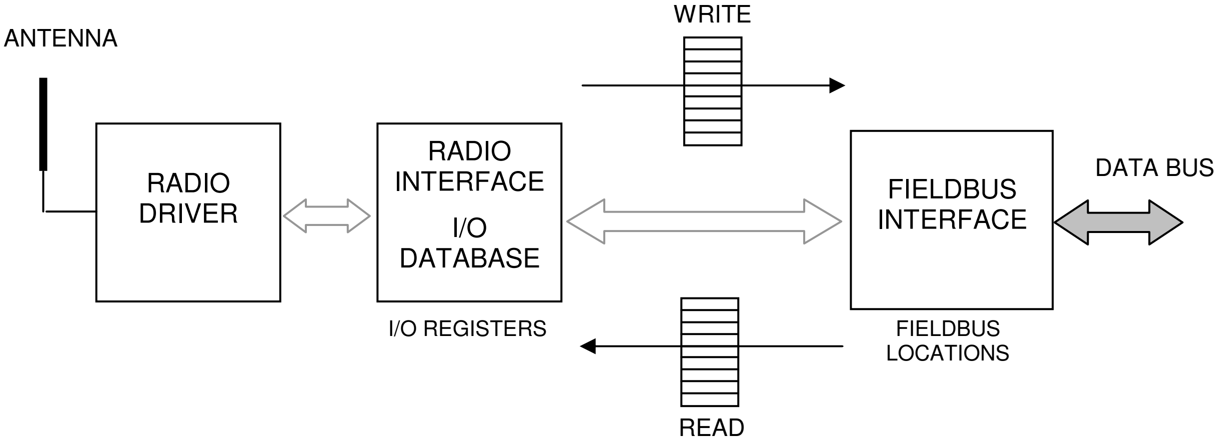
The WI-GTWY-9-xxx provides a linear address space of 10,000 data words. This is compatible with PLC2 addresses, but does not match the addressing used by the 500CPU modules (SLC and Micrologic). These address data by file number and file offset. To address an I/O register, *L,* in the WI-GTWY-9-xxx, use DF1 file number *L* / 100, with the remainder value (L % 100) as the DF1 file offset. For example, to read I/O register 2643 in the WI-GTWY-9-xxx, read from file number 26, offset 43.

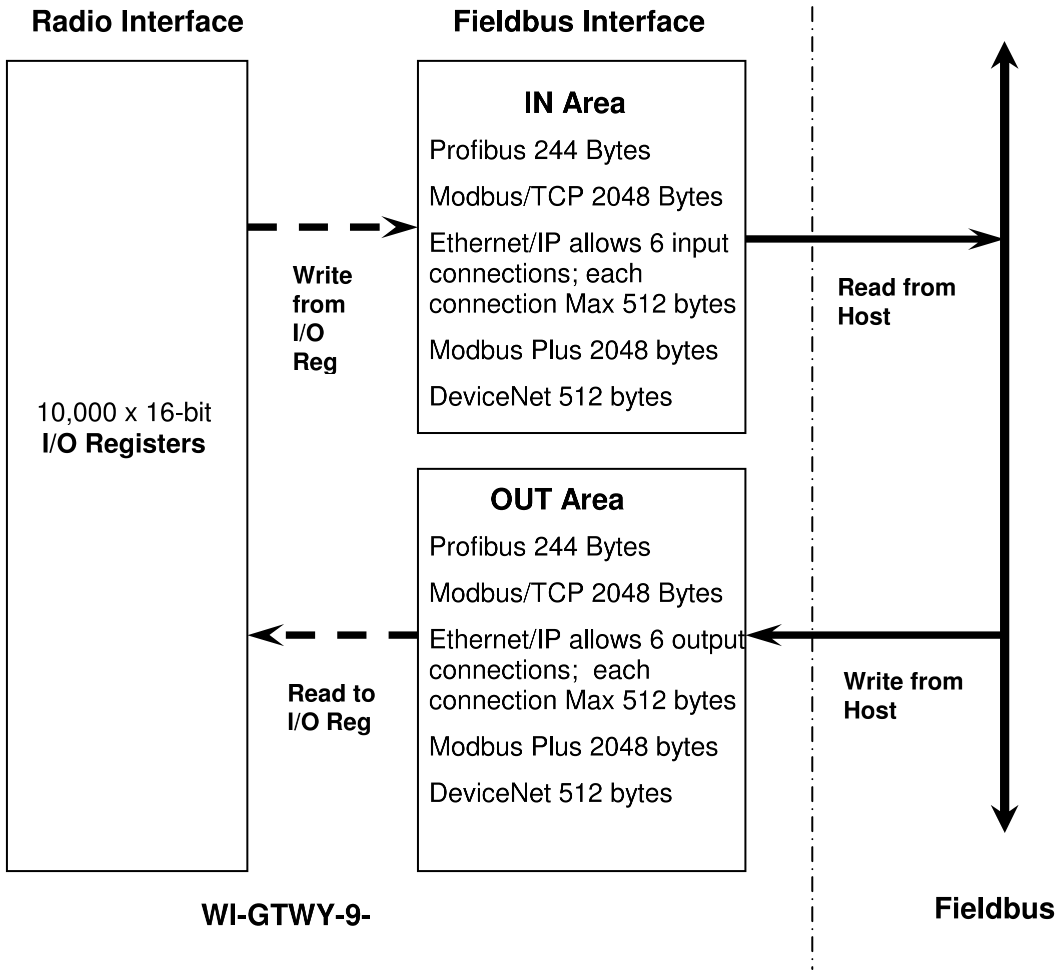
4.9 Fieldbus Configuration

All WI-GTWY-9-xxx modules (*except MD1*) have separate internal hardware comprising the Fieldbus Interface, consisting of a separate microprocessor and appropriate hardware for the network connection. This Fieldbus Interface handles all fieldbus communications, and transfers I/O in the Fieldbus Interface Registers to/from the fieldbus. Conversely, the WI-GTWY-9-xxx Radio Interface handles all radio communications, and transfers I/O in the Radio Interface Registers to/from the radio network. For I/O transfer between the radio network and the fieldbus network, I/O Registers in the Radio Interface must be linked with registers in the Fieldbus Interface using configuration software.

Depending on the fieldbus protocol, the size of the Fieldbus Interface may be limited (for example, the Profibus Slave interface supports only 416 bytes I/O). The Radio Interface supports 10,000 registers, of which 4300 are general-purpose I/O registers. Each Radio Interface register is 16-bit, even for discrete (or "digital") input or output values. The Fieldbus Interface comprises a block of 8-bit bytes (referred to as "locations"). Digital I/O can be packed - each fieldbus location can hold 8 digital inputs or outputs. Analog or pulse values can be stored as a low resolution 8-bit value (a single fieldbus location) or as a high resolution 16-bit value (two consecutive fieldbus locations).

To optimize I/O usage, the WI-GTWY-9-xxx provides a flexible method of data transfer between the Radio Interface and the Fieldbus Interface. The user configures *links* between the Radio Interface and Fieldbus Interface via *Fieldbus Mappings* in the WI Series Configuration Software. The diagram shows in more detail the relationship between the Radio Interface and Fieldbus Interface.





4.9.1 Fieldbus Mappings

The Fieldbus Interface is divided into two distinct areas. The IN Area contains input data that is made available to the host device. The OUT Area contains output data from the host device. This is in contrast to the Radio Interface, in which each 16-bit register can be used as input *or* output. Also note the size of the Fieldbus Interface is variable, depending on the type of fieldbus.

WI Series Configuration Software provides user configurable *Fieldbus Mappings* to *link* the required Fieldbus I/O to the Radio Interface. *Write* mappings write I/O values from the Radio Interface *to* the Fieldbus IN Area. *Read* mappings read I/O values *from* the Fieldbus OUT Area to the Radio Interface.

If you want to send a value from the WI-GTWY-9-xxx to the host device, use a Fieldbus *Write* Mapping. The input data from the Radio Interface (i.e. input data that has either come in from the radio or from local I/O) will be transferred to the IN Area via the fieldbus write mapping. The host device can then read this input data from the IN Area.

If you want to send a value from the host device to the WI-GTWY-9-xxx, use a Fieldbus *Read* Mapping. The host device can write output data to the OUT Area. The output data from the OUT Area will then be transferred to the Radio Interface via the fieldbus read mapping. The radio driver can then either send this output over the radio or to a local I/O.

Several different configurable *transfer modes* are also available for fieldbus mappings to ensure the I/O is formatted according to the requirements of the particular fieldbus protocol or host device. The six possible types of Fieldbus Mapping are outlined in the table below.

Fieldbus Mapping Types

Transfer Mode	*Read Mapping*	*Write Mapping*
Single Bit	The WI-GTWY-9-xxx reads a block of consecutive bits from Fieldbus OUT Area and stores each bit in consecutive I/O Registers, as hex FFFF or 0000.	The WI-GTWY-9-xxx takes the MSB (most significant bit) of a block of consecutive I/O Registers, converting the 16 bit I/O register values into 0 or 1, and writes to consecutive bits of Fieldbus IN Area.
Byte (8-bit)	The WI-GTWY-9-xxx reads consecutive bytes (8-bit values) from Fieldbus OUT Area and stores each byte in the most significant 8-bits of a consecutive I/O register.	The WI-GTWY-9-xxx takes the most significant 8-bits of consecutive I/O registers and writes them to consecutive bytes (8-bit values) of the Fieldbus IN area.
Word (16-bit)	The WI-GTWY-9-xxx reads consecutive words (2x8-bit values) form Fieldbus OUT Area and stores each word in a consecutive I/O Register.	The WI-GTWY-9-xxx takes consecutive I/O registers and writes them to consecutive words (2x8-bit values) of Fieldbus IN Area.

4.9.2 Transfer Mode

Radio Interface registers are all 16-bit general-purpose input or output registers. That is, analog inputs or outputs are stored as a 16-bit value. Digital inputs or outputs occupy a whole 16-bit register and are stored as either 0000(hex) or FFFF(hex) for compatibility with the Radio Protocol. However, the Fieldbus Interface may contain (depending on the protocol) significantly less registers than the Radio Interface (see diagram above). Also, certain protocols may require a different I/O structure than that used by the Radio Interface registers. Consequently, depending on the fieldbus mapping transfer mode (see above table), Radio Interface registers may or may not be compressed.

“Word” transfer mode offers no compression, but rather a direct transfer of 16-bit registers between Radio Interface and Fieldbus Interface. This mode would suit the transfer of registers containing pulse counts or analog values with no loss of resolution.

“Byte” transfer mode operates on only the most significant BYTE (the first 8 bits) of Radio Interface registers, but allows these bytes to be consecutively packed in the Fieldbus Interface. This mode would suit the transfer of analog values in low-resolution, in cases where I/O space is at a premium. Byte *Address Mode* is recommended when using byte transfer mode (see Address Mode section below).

Bit transfer mode operates on only the most significant BIT of Radio Interface registers, but allows these bits to be consecutively packed in the Fieldbus Interface. This mode would suit the transfer of digital I/O in cases where it is not desirable (or possible) to use a whole 16-bit register just to store a 0 or 1 value.

4.9.3 Address Mode

Configuration software allows the Fieldbus Interface IN and OUT areas to be addressed as an array of 8-bit bytes (*Byte Address Mode*) or an array of 16-bit words (*Word Address Mode*). The address mode may be required to change depending on the transfer mode, the protocol, or the particular host device. The Address Mode option is included so that the configuration software can be setup to use the same I/O addressing method used by the host device. The actual structure of I/O in this database can only be physically altered via the transfer mode.

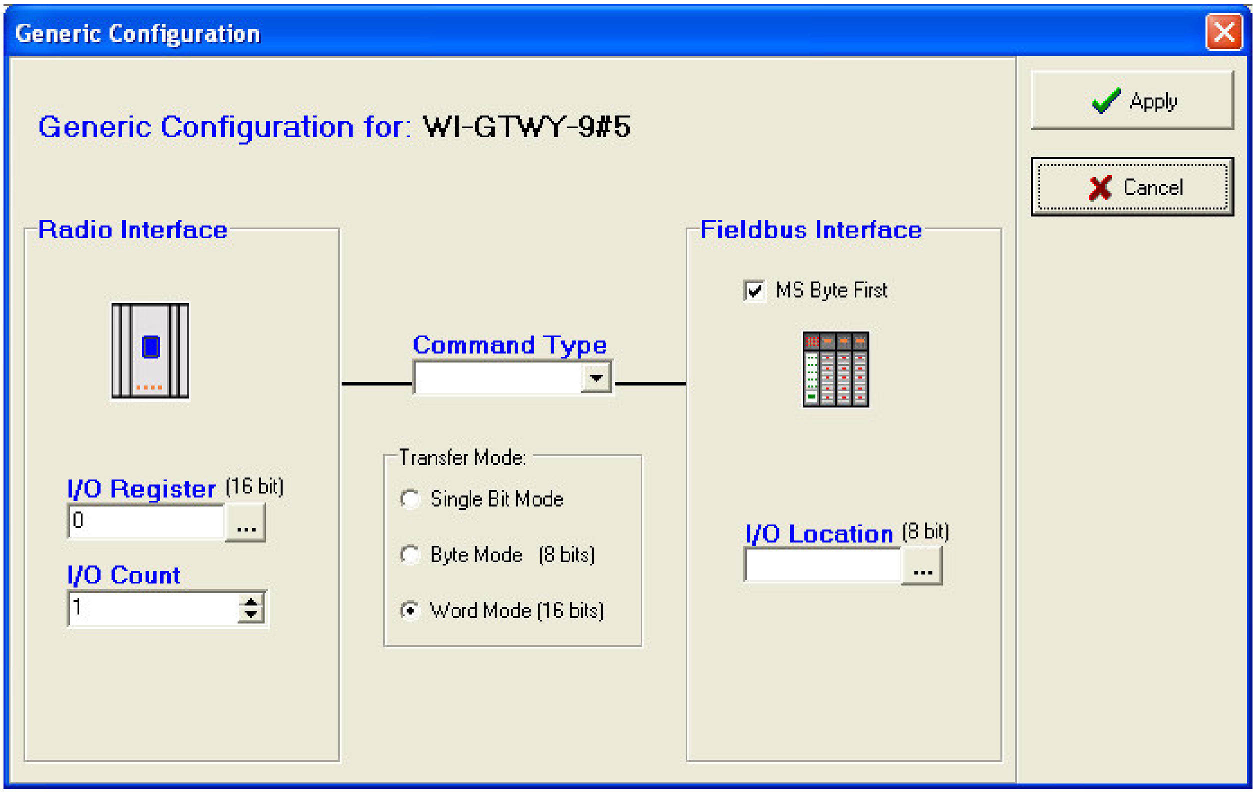
The Fieldbus Interface IN and OUT areas are simply a block of I/O memory, exchanged according to the configured protocol. For example, with a Profibus slave that supports 244 bytes of inputs, the fieldbus interface IN area could be addressed either as byte locations 1 to 244 or as word locations 1 to 122. Note that in either case, the underlying database structure is unchanged, the difference is limited to the Fieldbus IN/OUT Area address that is displayed by configuration software.

Certain protocols have an inherent or preferred byte or word structure – for example, Modbus is a protocol that usually operates on 16-bit (word) registers. Consequently, configuration software will default to the most common address mode for that protocol. Configuration software may also apply an offset and/or scaling to the IN/OUT Area addressing to suit the particular protocol. For example Modbus/TCP areas start from location 1, but other fieldbuses may start at location 0.

Note:

- The Fieldbus Interface IN *and* OUT Area both number from 0 - that is, there is an input 0 as well as an output 0 (an offset may apply for some protocols).
- All IN/OUT Area locations accessed by the fieldbus must be part of a fieldbus mapping in the WI-GTWY-9-xxx - that is, if a host device is writing to bytes 0 – 100 in the OUT Area, there must be at least one fieldbus read mapping that uses these locations - if not, the Fieldbus Interface will generate an error response message.
- Fieldbus mappings to/from the IN/OUT areas should always start at location 0 if possible (or the lowest available unused location). Configuration Software will always automatically choose the next lowest available location – it is strongly recommended that this topology be used so as not to place unnecessary processing overhead on the module.

4.9.4 **Fieldbus Mapping Configuration**The example below shows the Fieldbus Mapping configuration screen when adding new or editing existing Fieldbus Mappings. Starting from the left of the screen, the I/O Register selection specifies the starting I/O Register from the Radio Interface (press the "…" button to make a selection graphically). The I/O Count parameter specifies how many consecutive I/O Registers are to be transferred or *linked*. Command Type and Transfer Mode specify the type of Fieldbus Mapping (see Fieldbus Mappings table above). Finally, I/O Location specifies the IN or OUT Area location in the Fieldbus Interface (see earlier diagram).



Generic Configuration for: WI-GTWY-9#5

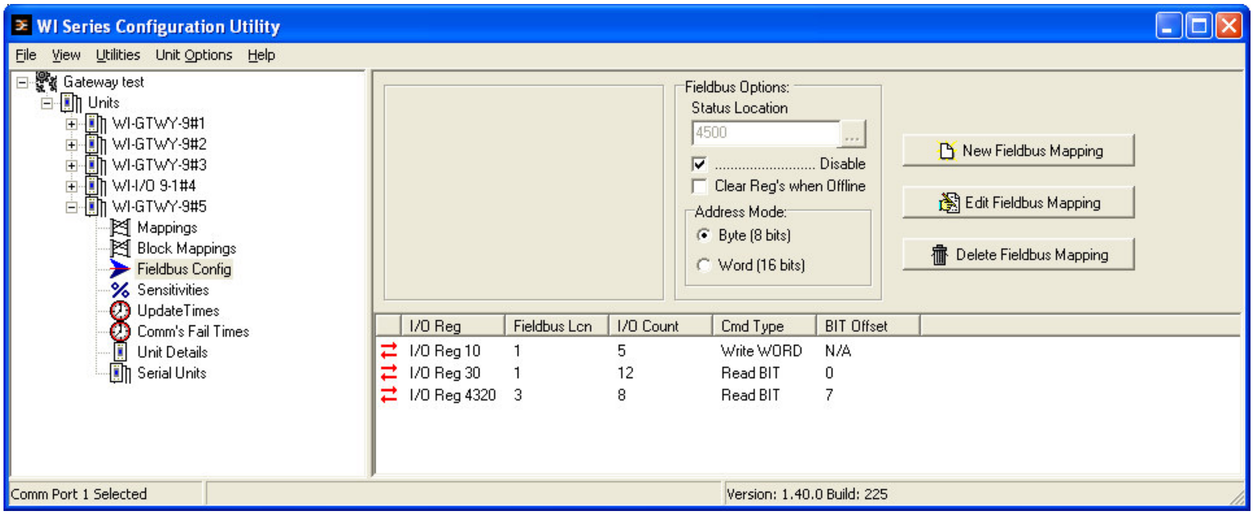
☑ MS Byte First

I/O Register (16 bit): 0

I/O Count: 1

I/O Location (8 bit):

Transfer Mode:
- ○ Single Bit Mode
- ○ Byte Mode (8 bits)
- ● Word Mode (16 bits)



Fieldbus Options:
Status Location: 4500
☑ .... Disable
☐ Clear Reg's when Offline
Address Mode:
● Byte (8 bits)
○ Word (16 bits)

I/O Reg	Fieldbus Lcn	I/O Count	Cmd Type	BIT Offset
I/O Reg 10	1	5	Write WORD	N/A
I/O Reg 30	1	12	Read BIT	0
I/O Reg 4320	3	8	Read BIT	7

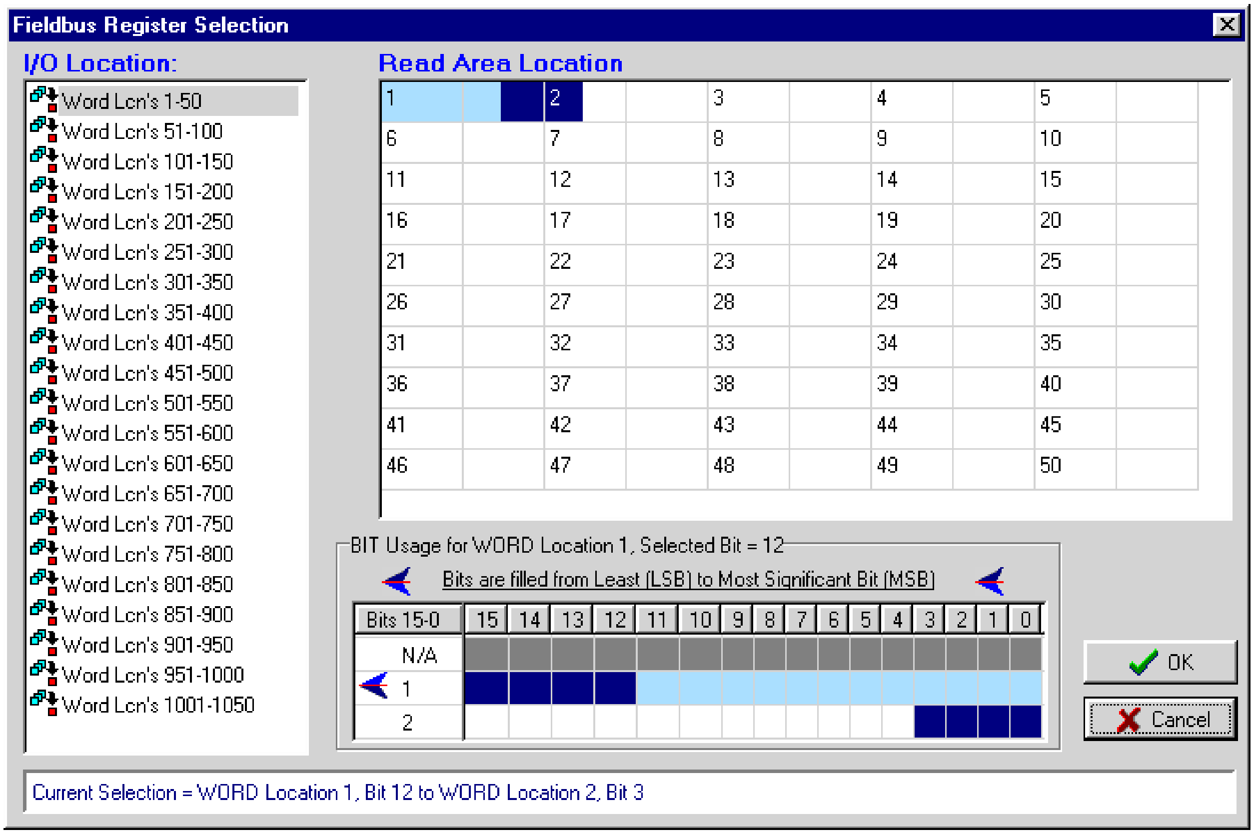
Comm Port 1 Selected   Version: 1.40.0 Build: 225

Three Fieldbus Mappings are illustrated in the example above. Note that "Word Address Mode" is selected, meaning that the Fieldbus Interface IN and OUT Areas will be treated as word-addressed arrays by configuration software. The parameters for each fieldbus mapping were setup using the mapping configuration screen as described above.

The first Fieldbus Mapping is a "Write WORD" mapping, writing I/O Registers 10 – 15 from the Radio Interface to word-locations 1 – 5 in the Fieldbus IN Area. Because the *transfer mode* is "word" complete 16-bit registers are transferred.

The second mapping is a “Read BIT” mapping, reading 12 *bits* from Fieldbus OUT Area *word-location* 1(word address mode is selected) to I/O Registers 30 – 41. Remember that for such a BIT transfer, that each individual bit in the Fieldbus Interface is transferred to an entire 16-bit I/O Register. Note also that there is a word-location 1 for both the Fieldbus OUT *and* IN areas.

The third mapping is another “Read BIT” mapping, reading 8 bits from Fieldbus OUT Area word-location 1 to I/O Registers 4320 – 4327 (i.e. local DOT 1 – 8). Note here that we are again reading from Fieldbus OUT Area word-location 1 (as with the previous mapping). However, since each word-location contains 16-bits and the last mapping used only 12 of those, we have been able to follow on from the previous mapping (see below).



1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50

BIT Usage for WORD Location 1, Selected Bit = 12

Bits 15-0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N/A																
1																
2																

Current Selection = WORD Location 1, Bit 12 to WORD Location 2, Bit 3

The Fieldbus Register Selection screen above was shown when selecting the Fieldbus OUT Area location for the third mapping in the above example. This screen shows the currently used portion of the Fieldbus OUT Area, and allows the user to graphically select the location for the current mapping. NOTE – by default configuration software will always choose the next available Fieldbus Interface register for fieldbus mappings. Allowing configuration software to automatically make the selection is strongly recommended wherever possible.

Clicking on the required location in the top panel will alter the currently selected word-location. Further, clicking individual bits in the “Bit Usage” panel at the bottom of the screen, allows the current BIT mapping to be specified at the bit-level of the currently selected word.

The lighter blue areas indicate the extent of already existing fieldbus mappings. It can be seen that bits 0 – 11 of word location 1 have already been used (by the second mapping in the example). The dark blue area in the register selection screen above shows the extent and location of the current fieldbus mapping graphically. The status panel at the bottom of the window always displays the extent of the current selection, which can be seen to be word 1, bit 12 to word 2, bit 3.

A status location (4500) may be used to give the host device status information about the Fieldbus Interface. This register will be value 0x0000 if the Fieldbus Interface is “on-line” and communicating with the fieldbus, or value 0xFFFF if it is “off-line”. If you wish to use a status register, select the “Enable Status Location” box. This register could be mapped to a remote module or local output as an alarm.

4.10 Fieldbus Configuration - Profibus Slave

The Profibus WI-GTWY-9-xxx-PR1 acts as a Profibus DP Slave - the host device is a Profibus Master. If you use the WI-GTWY-9-xxx with a PLC, the PLC configuration tool will require a GSD file so it can recognize the Profibus interface in the WI-GTWY-9-xxx. This file loads into the PLC configuration software (for example, Siemens STEP 7). The file is available on the same CD as the configuration software or from the W Interconnections web page www.weidmuller.com.

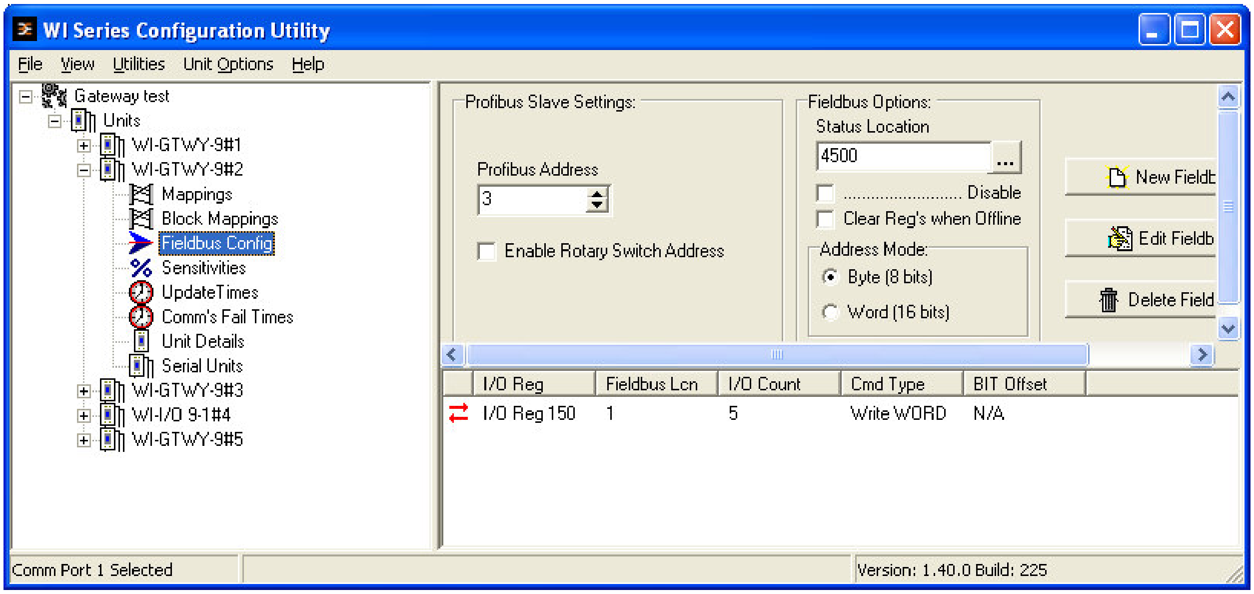
Configuration of the Profibus Fieldbus Interface comprises allocating a Profibus Slave address to the WI-GTWY-9-xxx, and configuring links between the Radio Interface and the Fieldbus Interface (i.e. Fieldbus Mappings).

The Profibus address can be set in the “Fieldbus Config” screen or via the rotary switch on the end-plate of the module- valid slave addresses are 1 – 126. If the “Enable Rotary Switch” box is not selected, then the address entered in the program will be used and the rotary switch value ignored. If the “Enable Rotary Switch” box is selected, then the address entered in the configuration program will be ignored and the rotary switch read on start-up of the WI-GTWY-9-xxx.

The Profibus interface has 416 bytes, of which 244 can be used as input bytes, or 244 can be used as output bytes.

Note: For bit transfers, the bit offset is counted from the least significant bit (LSB) of the byte (with bit 0 being the LSB) - if you transfer 3 bits with a bit offset of 5, then you will transfer bits 5-7 of the byte. This is different than the Ethernet unit which counts the offset from the most significant bit - refer next section.

The fieldbus write mapping in the example below transfers 5x16-bit registers (words) from the radio interface to the fieldbus interface. Care should be taken that the Profibus Master device does *not* attempt to access more I/O than has been setup via fieldbus mappings. i.e. in the example below, the Profibus Master can read a *maximum* of 5 words (10 bytes) only from the WI-GTWY-9-xxx.



Profibus Slave Settings:

Profibus Address: 3

☐ Enable Rotary Switch Address

Fieldbus Options:

Status Location: 4500

☐ .... Disable

☐ Clear Reg's when Offline

Address Mode:

● Byte (8 bits)

○ Word (16 bits)

I/O Reg	Fieldbus Lcn	I/O Count	Cmd Type	BIT Offset
I/O Reg 150	1	5	Write WORD	N/A

4.11 Fieldbus Configuration - Profibus Master

The WI-GTWY-9-xxx-PR2 implements a complete Profibus-DPV0/DPV1 master. The hardware is optimized for high throughput and can be used in mono or multi master networks up to 12 Mbit/s. Up to 125 slaves with a total max of 2048 byte input and 2048 byte output data can be connected.

4.11.1 GSD File

Each device in a Profibus network is associated with a GSD file, containing all necessary information about the device. In general, the Profibus slave device manufacturer supplies the relevant GSD files. WI Series Configuration Software uses these files during network configuration.

4.11.2 Protocol and Supported Functions

The WI-GTWY-9-xxx-PR2 implements a complete Profibus-DPV0/DPV1 master and includes the following features:

- Up to 125 slaves can be connected
- Up to 2048 bytes input &output data
- Up to 12 Mbit/s on Profibus
- RS-485 optically isolated Profibus interface with on-board DC/DC converter
- Configuration via WI Series Configuration Software
- Acyclic Communication (DPV1)
- Alarm Handling (DPV1)

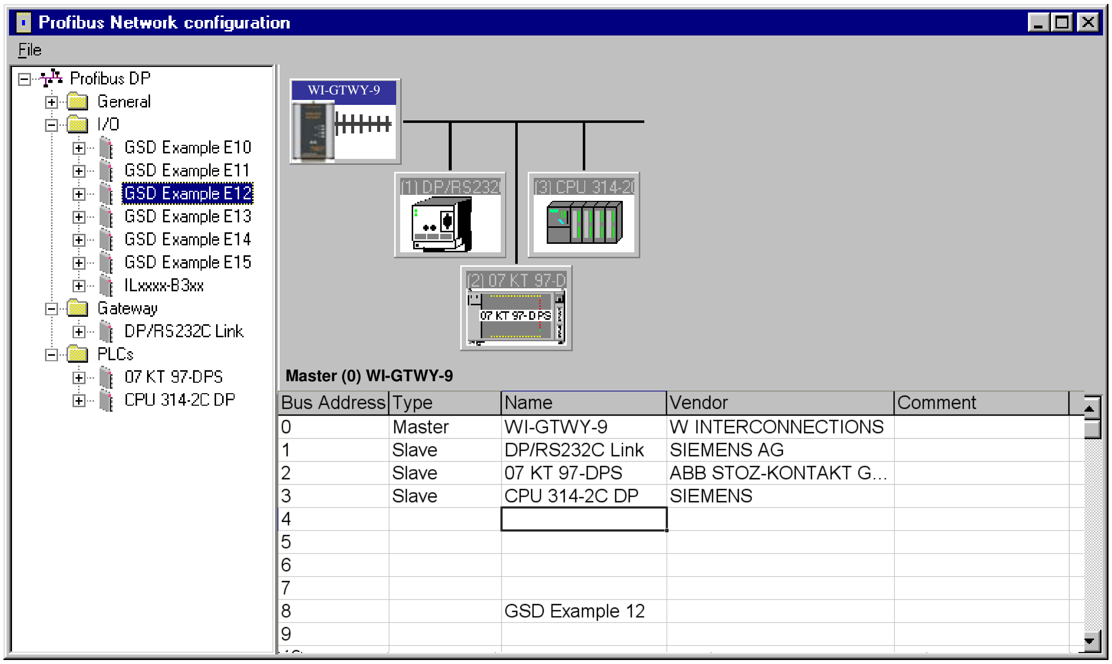
4.11.3 Configuration

Profibus network configuration is performed via the WI Series Configuration Utility. The WI-GTWY-9-xxx Profibus Master provides up to 2048 bytes of inputs and 2048 bytes of outputs in the fieldbus interface for I/O on the Profibus network. I/O in the fieldbus interface must be linked with I/O in the radio interface via appropriate *fieldbus mappings* (see *4.8 Fieldbus Configuration* above) for I/O transfer with the radio network.

Configuration of the Profibus network is through the *Profibus Network Config* tab in WI Series Configuration Software. Through this section, the entire (local) Profibus network including I/O data transfer with Profibus slaves is configured. Before a Profibus slave is configured on the network, its corresponding GSD file must be installed. To install a GSD file choose *File|Install GSD File*. Once the GSD file(s) have been installed, the devices corresponding to those GSD files will appear as devices on the Profibus DP *treeview* on the left side of the network configuration screen.

The Profibus network configuration screen is divided into three main areas (see below). The left hand *Profibus DP Treeview* displays all the available slaves, i.e. those whose corresponding GSD files have been installed. The right hand top section *Busview* displays graphically the devices that are currently configured on the Profibus network – individual devices can be selected here and their I/O configuration and other properties viewed/altered. The right hand bottom section *Listview* shows the I/O configuration of a particular slave when a slave device is selected in the busview, or the network configuration (i.e. what slaves are configured and their corresponding addresses) when the Profibus master node is selected in the busview.

300Adding a Slave to the Network



Master (0) WI-GTWY-9

Bus Address	Type	Name	Vendor	Comment
0	Master	WI-GTWY-9	W INTERCONNECTIONS	
1	Slave	DP/RS232C Link	SIEMENS AG	
2	Slave	07 KT 97-DPS	ABB STOZ-KONTAKT G...	
3	Slave	CPU 314-2C DP	SIEMENS	
4				
5				
6				
7				
8		GSD Example 12		
9				

To add a Profibus slave to the network, locate the required slave and simply drag the slave icon onto the visible bus cable on the busview, or right click the required slave and choose *add to network*. To add a slave with a specific Profibus node address to the network, locate the required slave and drag the icon to the network listview (ensure that the master node is selected in the busview so that the network list is displayed in the listview rather than the slave I/O configuration list). The above example shows a slave device being added to the network at node address 7.

Slave Address

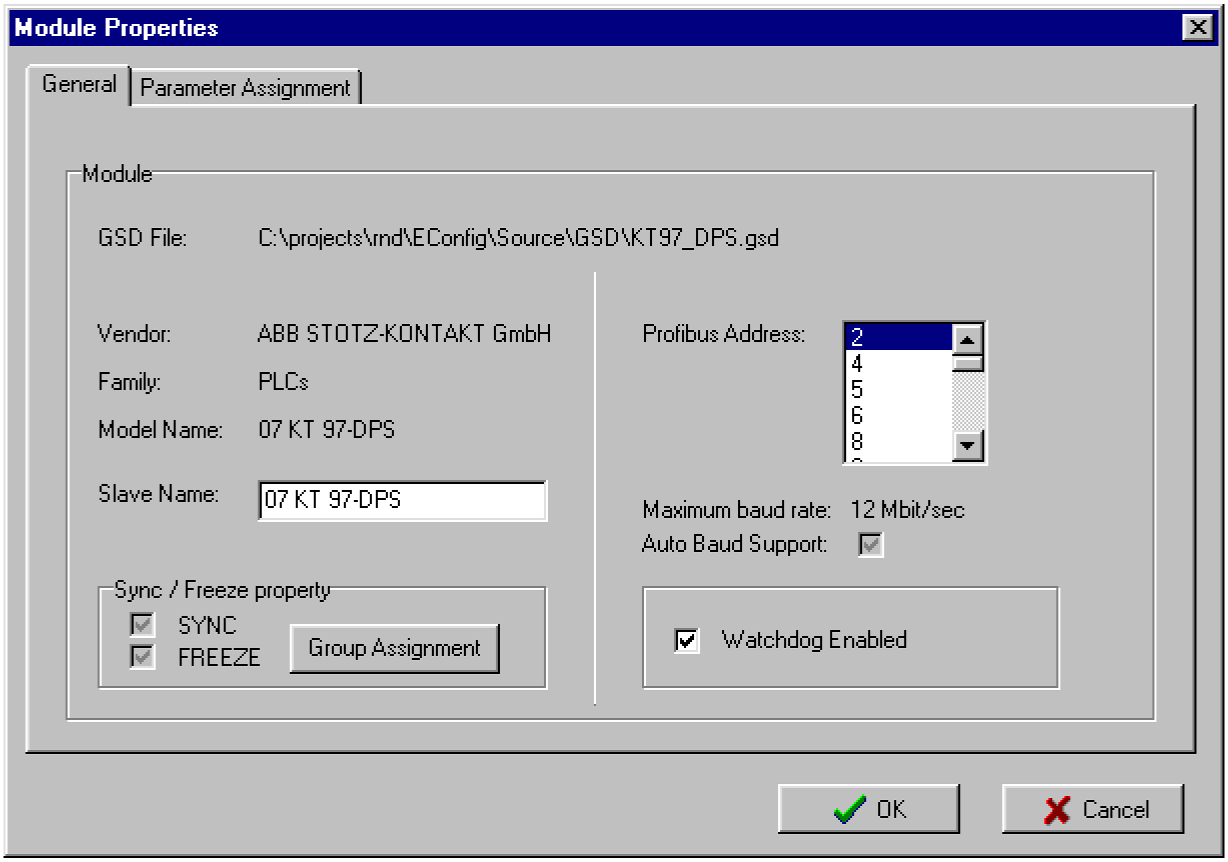
To change the node address of a slave already configured on the network, locate the slave in the network listview and drag it to the position in the list corresponding to the desired address. Alternately, the slave address can be modified from the *module properties* page (see below).

Module Properties (Slave)

To display the properties of a given slave, right click the required slave in the busview and choose *properties* (or double click the icon in the busview). Under the *general* tab, various details (including GSD file details) relating to the selected slave device are displayed. Several configurable options are also available (see below).

Profibus Address

The actual Profibus address of the selected slave is shown in the address selection box. Only available addresses are listed and can be selected as new address.



GSD File: C:\projects\rnd\EConfig\Source\GSD\KT97_DPS.gsd

Vendor: ABB STOTZ-KONTAKT GmbH

Family: PLCs

Model Name: 07 KT 97-DPS

Slave Name: 07 KT 97-DPS

Profibus Address: 2 4 5 6 8

Maximum baud rate: 12 Mbit/sec

Auto Baud Support: ☑

Sync / Freeze property

☑ SYNC

☑ FREEZE

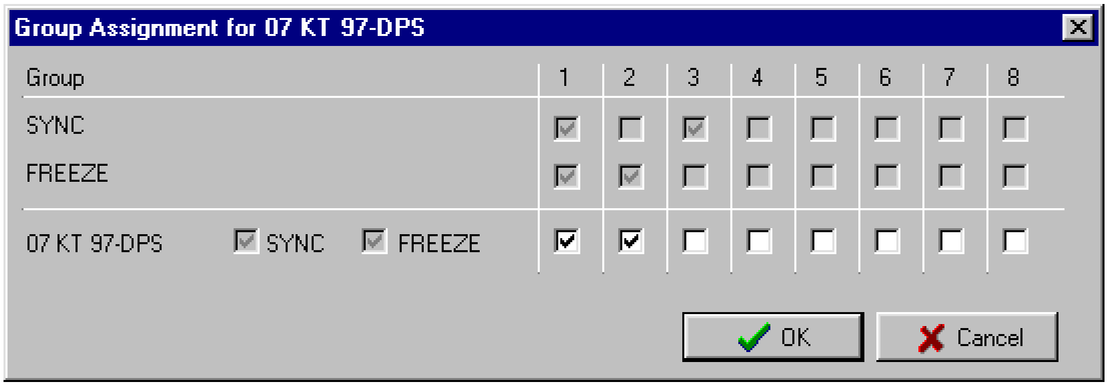
☑ Watchdog Enabled

Watchdog

According to the Profibus specification, a slave device may be configured with a watchdog function such that the master must poll the slave within a defined interval. If this feature is enabled and the master fails, the slaves watchdog timer will timeout and the slave will reset itself.

Group Assignment

If the slave supports sync/freeze functionality, it can be assigned to the masters sync/freeze groups by clicking on the checkboxes. The sync/freeze assignment of the groups is also displayed (these can be changed via the master properties dialog).



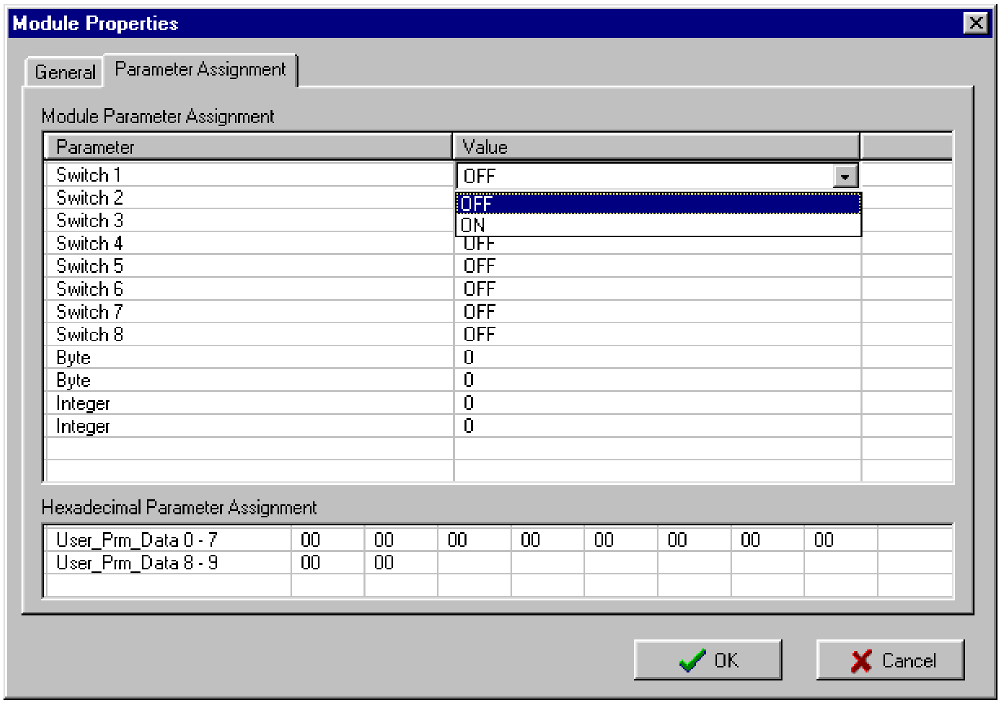
Group Assignment for 07 KT 97-DPS

Group	1	2	3	4	5	6	7	8
SYNC	☑	☐	☑	☐	☐	☐	☐	☐
FREEZE	☑	☑	☐	☐	☐	☐	☐	☐
07 KT 97-DPS ☑ SYNC ☑ FREEZE	☑	☑	☐	☐	☐	☐	☐	☐

Parameter Assignment

A slaves user-specific parameters can be changed via the *parameter assignment* page. User-specific parameters for a slave device are defined in the corresponding GSD file for the device, the definition of which are device-specific and should be found in the documentation for the device.

Parameters can be altered via combo boxes or via direct input of hexadecimal values. The hexadecimal values for the user_prm_data are displayed at the bottom of the screen and can be



Module Parameter Assignment

Parameter	Value
Switch 1	OFF OFF ON
Switch 2	
Switch 3	
Switch 4	OFF
Switch 5	OFF
Switch 6	OFF
Switch 7	OFF
Switch 8	OFF
Byte	0
Byte	0
Integer	0
Integer	0

Hexadecimal Parameter Assignment

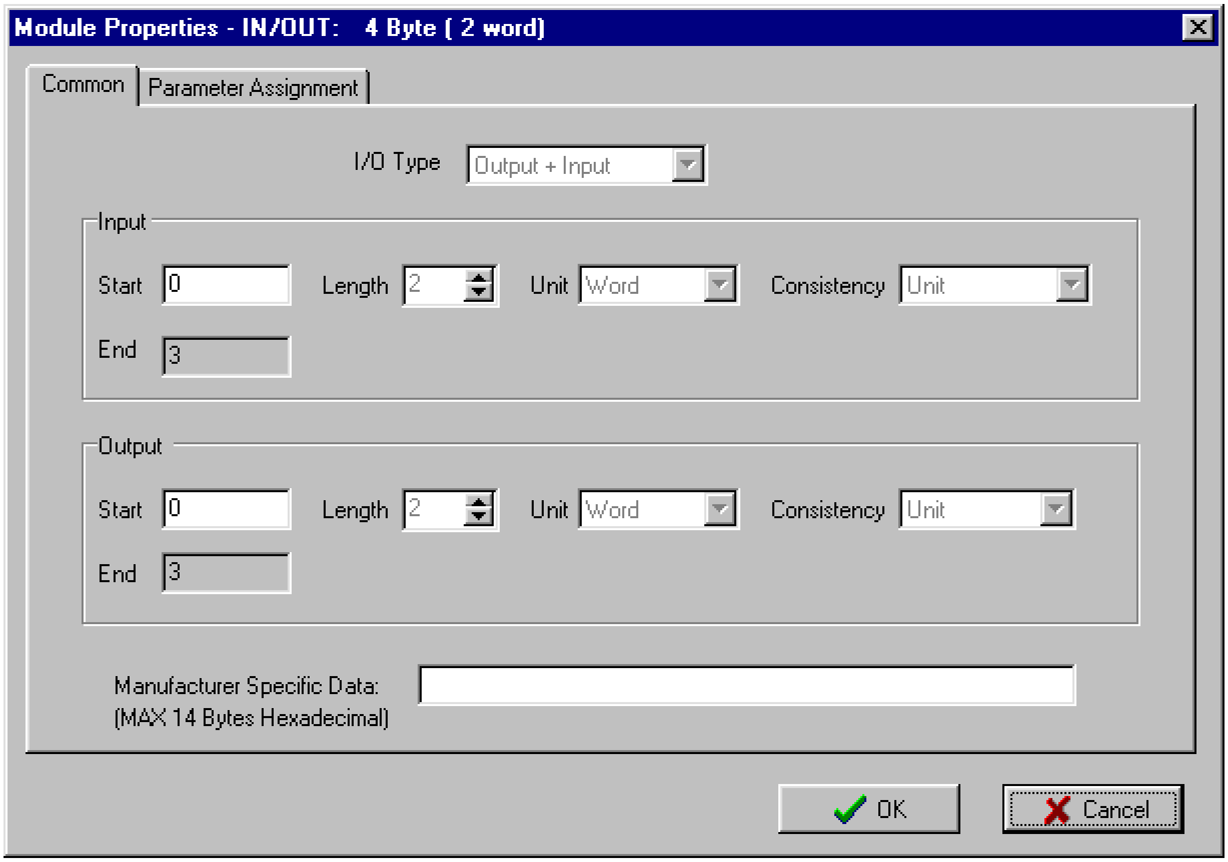
User_Prm_Data 0 - 7	00	00	00	00	00	00	00	00
User_Prm_Data 8 - 9	00	00						

edited directly (consult the device specific documentation for the meaning of these values).

Adding I/O to a Slave

The possible I/O combinations for a given slave may be fixed or configurable (i.e. modular) depending on the GSD file for the device. When the I/O configuration is fixed, the fixed I/O are always defined whenever the device is added to the network. However, for modular devices, the I/O configuration must be assigned manually.

The GSD file for a modular slave will define a maximum number of I/O *slots* – each of which may be configured with an I/O *module*. The available I/O module's for a particular slave can be viewed by expanding the slave node in the Profibus DP Treeview. To add an I/O module to a slave, first ensure the required slave is selected in the busview, then drag the required I/O module into a spare slot of the slave listview.



Module Properties - IN/OUT: 4 Byte (2 word)

I/O Type: Output + Input

Input

Start: 0 Length: 2 Unit: Word Consistency: Unit

End: 3

Output

Start: 0 Length: 2 Unit: Word Consistency: Unit

End: 3

Manufacturer Specific Data:
(MAX 14 Bytes Hexadecimal)

When an I/O module is added to a slave, configuration software will automatically assign that I/O to the next available space in the fieldbus interface. The input and output addresses that are assigned here will correspond to the locations that must be transferred via fieldbus mappings in order to make the I/O available to the radio network. The input and/or output address assigned by software for a given I/O module can be altered by double clicking on that I/O module entry in the slave listview (see above).

The start address in the fieldbus interface for the inputs or outputs can be altered in the corresponding *Start* field as shown above. Since the WI-GTWY-9-xxx provides for up to 2048 bytes of inputs and 2048 bytes of outputs, the possible range for inputs or outputs is 0 – 2047.

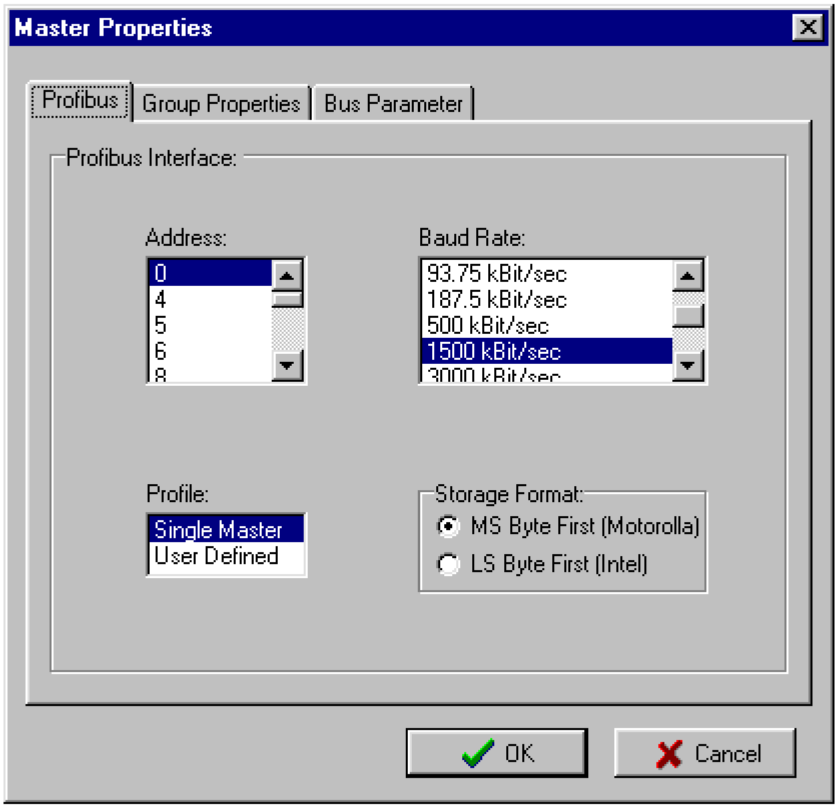
I/O modules may also have associated user parameter data defined by the corresponding GSD file. The meaning of these parameters (if applicable) is specific to the slave implementation, and may be altered via the *Parameter Assignment* tab of the *Module Properties* form.

Configuration software also provides an additional I/O module to all slaves that is *not* defined in the GSD files, which is the *Universal Module*. The universal module allows the input/output length, unit, and consistency to be assigned custom values as required – however not all slave implementations will support this feature (consult the specific slave documentation for details).

The *Length* parameter defines the length of the input or output module in either bytes or words (according to the corresponding *Unit* parameter). The data *consistency* over the Profibus network may be applied to the selected unit (i.e. byte or word) or to the total length of the input or output selection.

Depending on the particular slave, *Manufacturer Specific Data* may also apply to an I/O module. This data is a string of hexadecimal bytes, the meanings of which (if applicable) are device specific and should be detailed in the documentation for the particular device.

Master Properties



Master Properties

Profibus | Group Properties | Bus Parameter

Profibus Interface:

Address: 0 (selected); 4; 5; 6; 8

Baud Rate: 93.75 kBit/sec; 187.5 kBit/sec; 500 kBit/sec; 1500 kBit/sec (selected); 3000 kBit/sec

Profile: Single Master (selected); User Defined

Storage Format:
● MS Byte First (Motorolla)
○ LS Byte First (Intel)

The Profibus master WI-GTWY-9-xxx has some configurable properties that affect the entire Profibus network. These properties can be accessed by double clicking the master icon in the network busview, or right-clicking the icon and choosing *properties*.

Profibus Tab

The *Address* parameter specifies the actual Profibus address of the Profibus master (default = 0). Only available addresses are listed and can be selected as new address. The serial *baud rate* for the entire Profibus network is selected – this is the baud rate that will be used by the master and therefore must also be supported by all slave devices on the network. Most slaves will support auto baud rate detect, but it should be ensured that any slave on the network supports the configured baud rate.

The *Profile* parameter controls the assignment of *Bus Parameters* for the Profibus network. In the single master (default) profile, the bus parameters are calculated automatically by configuration software and are optimized for speed – no other masters may be connected to the network. The *User Defined* profile allows the bus parameters to be manually configured for special network configurations and should only be used if the user is familiar with the individual Profibus parameters (see *Bus Parameters Tab* below).

The storage format determines if word values are stored in big endian (Motorola – most significant byte has lowest address) or little endian (Intel – Least significant byte has lowest address) format.

Group Properties Tab

A DP master can send the SYNC and/or FREEZE control commands simultaneously to a group of slaves for synchronization purposes. Therefore the slaves must be assigned to Sync/Freeze - groups. Up to 8 groups may be configured as SYNC and/or FREEZE groups. Any slaves that are configured to belong to a particular group (via that slaves *module properties|group assignment* configuration) may be synchronized using the *Message Interface* instruction *SET_SLAVE_MODE* (see section on the *Message Interface* below).

Bus Parameters Tab

The bus parameters can be adjusted only when the selected profile is *user defined* (see *Profibus Tab* above). These parameters should only be changed if the user is familiar with the individual Profibus parameters according to the Profibus specification.

Adjustable bus parameters:

Tslot

The slot time determines the maximum length of time the sender has to wait to receive a response from the partner.

Max. Tsdr + 15 **<= Tslot** <= 16.383 t_bit

Max Tsdr

The maximum station delay responder determines the maximum length of time required by the responding node to respond

35 + 2*Tset + Tqui <= **Max. Tsdr** <= 1.023 t_bit

Min Tsdr

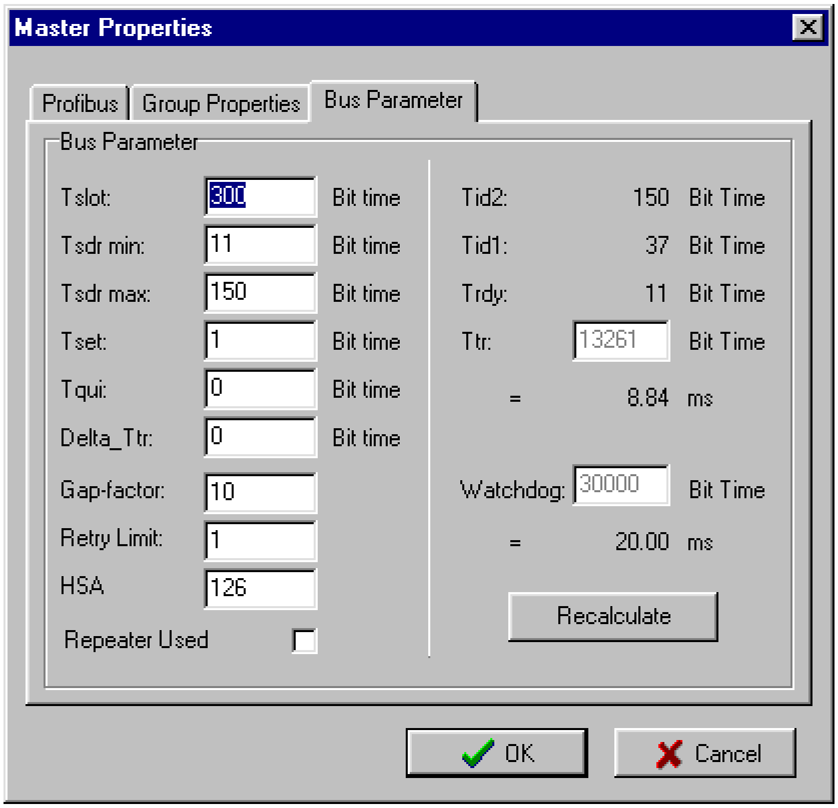
The minimum station delay responder determines the minimum length of time permitted for the responding node to respond.

11 t_bit <= **Min. Tsdr** <=Max. Tsdr - 1

Tset

The setup time determines the length of time elapsing in the node between a data frame being received and a response occurring

1 t_bit <= **Tset** <= 494 t_bit



Tslot: 300 Bit time
Tsdr min: 11 Bit time
Tsdr max: 150 Bit time
Tset: 1 Bit time
Tqui: 0 Bit time
Delta_Ttr: 0 Bit time
Gap-factor: 10
Retry Limit: 1
HSA 126
Repeater Used ☐

Tid2: 150 Bit Time
Tid1: 37 Bit Time
Trdy: 11 Bit Time
Ttr: 13261 Bit Time
= 8.84 ms
Watchdog: 30000 Bit Time
= 20.00 ms

Tqui

The quiet time is the time a modulator needs after recognizing a send frame to switch from send to receive.

0 t_bit <= **Tqui** <= MIN(31 t_bit, Min. Tsdr - 1)

Gap Factor

The Gap Factor determines how many token rounds occur before a new active node (master) can be added to the token ring.

1 <= **Gap Factor** <= 100

Retry Limit

The Retry Limits determines the number of attempts (repeated message frames) allowed to access a node.

1 <= **Retry Limit** <= 15

HSA

All active nodes (masters) scan the network continuously up to the HSA (highest station address). HSA must be set at minimum to the highest Profibus address (master or slave) connected to the network.

0 <= **HSA** <= 126

Delta_Ttr

This value can be set for multi master networks with the selected profile *Multi Master*. Delta Ttr is added to the calculated Ttr to increase the Ttr for using multiple masters in a network.

256 t_bit <= **Ttr** <= 16.776.960 t_bit

Non-adjustable bus parameters

Ttr

The target rotation time determines the maximum available time for a token pass. During this time all active nodes (masters) obtain the token one time to send data. WI Series Configuration Software calculates an optimized Ttr depending on the values of other bus parameters. If an individual bus parameter is changed, pressing the Recalculate-button recalculates the **Ttr** including **Delta_Ttr**.

Watchdog

The watchdog determines the watchdog time transferred to slaves if the watchdog is enabled.

Tid2

The idle time 2 determines the maximum length required before a transmitting node can send the next message after sending a message frame that is not acknowledged.

Tid2 = Max. Tsdr

Tid1

The idle time 1 determines the minimum length required before a transmitting node can send the next message after sending a message frame that is not acknowledged.

Tid1 = 35 + 2*Tset + Tqui

Trdy

The ready time determines the minimum time for a transmitting node to receive a response message frame.

Trdy = Min. Tsdr

4.11.4 Configuration Example

The Following example describes a simple configuration of a WI-GTWY-9-xxx connected to a simple Profibus Slave I/O device. Described is the configuration of the local WI-GTWY-9-xxx Profibus master only, for more detailed configuration examples, an application note can be downloaded from www.weidmuller.com.

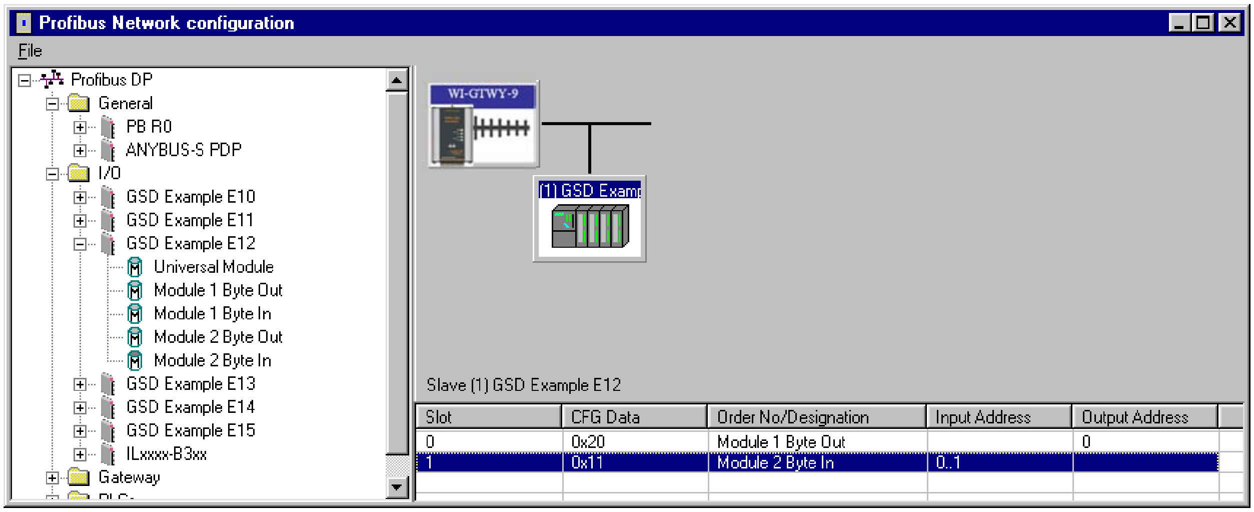
The example will transfer 8 x digital points from the radio network *to* the slave device. A single 16-bit analog value will be transferred from the Profibus slave to the radio network. Several configuration steps via WISeries Configuration Software are required:

- Profibus Network Configuration
- Fieldbus Configuration (Fieldbus Mappings)

- Radio Configuration (I/O or Block Mappings)

Profibus Network Configuration

Once the GSD file for the Profibus slave has been installed, the slave device can be added to the Profibus network (see *Configuration* section above). For this example, the slave is a *modular* device, therefore we add the necessary I/O modules to the slave. The example requires 8 x digital points to be transferred *to* the slave - hence we add the *'1 Byte Out'* module - and 1 x analog point (16-bit) to be transferred *from* the slave – hence we add the *'2 Byte In'* module (see below).



Slave (1) GSD Example E12

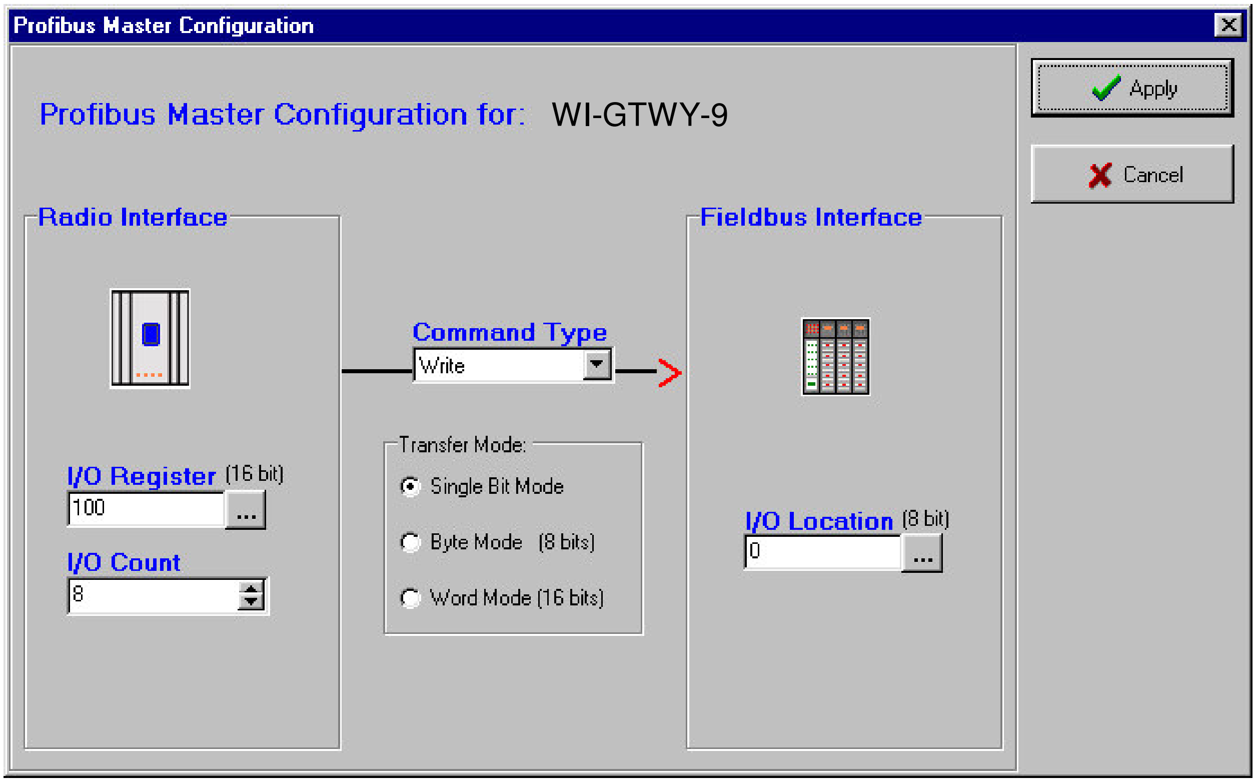
Slot	CFG Data	Order No/Designation	Input Address	Output Address
0	0x20	Module 1 Byte Out		0
1	0x11	Module 2 Byte In	0..1	

When these modules are added, configuration software automatically picks the next free *fieldbus interface* registers (shown in the *Input Address* and *Output Address* columns), which may later be altered by double-clicking on the relevant I/O module. In this example, the automatically chosen locations are *Fieldbus IN* locations 0..1, and *Fieldbus OUT* location 0.

Fieldbus Configuration.

The next configuration step is to transfer the I/O in the *Fieldbus Interface* to the *Radio Interface* so that the Profibus I/O is available to the radio network. The 8 x digital output to be sent to the Profibus slave are transferred using a *fieldbus write mapping*. Since the 8 x digital outputs are all contained in a '1 Byte Out' module, we use *'Single Bit Mode'* for the fieldbus write mapping. The configured mapping (see below) transfers the 8 x I/O Registers 100..107 in the radio interface to single bits in Fieldbus Location 0 of the fieldbus interface (corresponding to the Output Address of the corresponding '1 Byte Out' module).

The 1 x analog input to be read from the slave must now be transferred to the radio interface. Here we use a fieldbus read mapping using a 'Word Mode' (16-bit) transfer from Fieldbus Locations 0..1 to I/O Register 200.



Profibus Master Configuration for: WI-GTWY-9

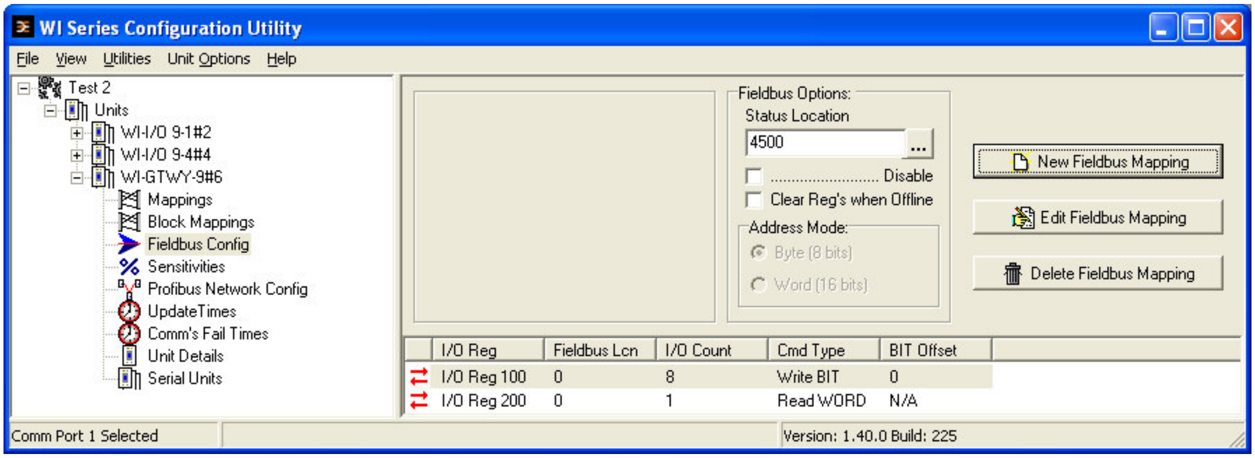
Command Type: Write

Transfer Mode:
● Single Bit Mode
○ Byte Mode (8 bits)
○ Word Mode (16 bits)

I/O Register (16 bit): 100

I/O Count: 8

I/O Location (8 bit): 0



Fieldbus Options:
Status Location: 4500
☐ Disable
☐ Clear Reg's when Offline
Address Mode:
● Byte (8 bits)
○ Word (16 bits)

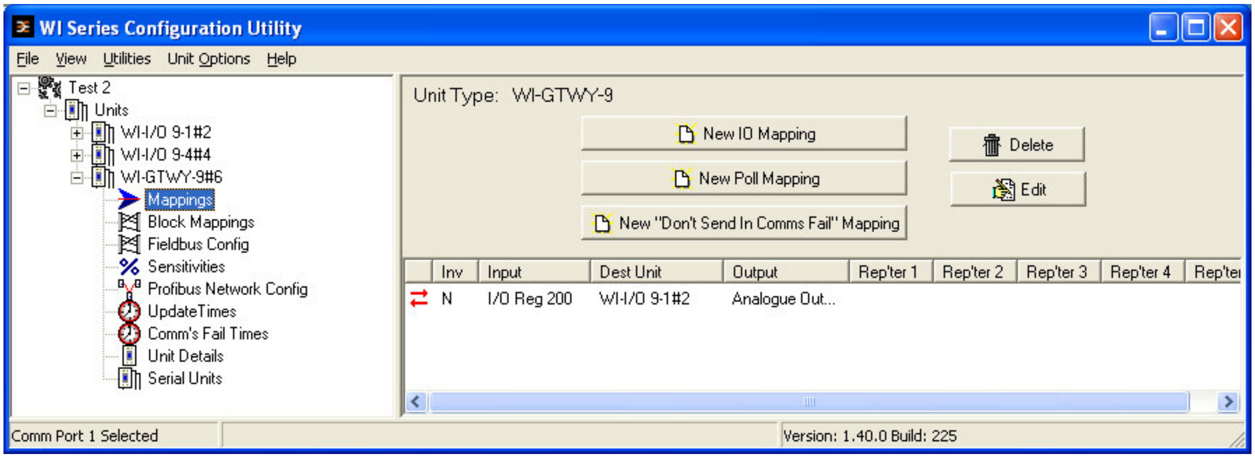
I/O Reg	Fieldbus Lcn	I/O Count	Cmd Type	BIT Offset
I/O Reg 100	0	8	Write BIT	0
I/O Reg 200	0	1	Read WORD	N/A

Comm Port 1 Selected

Version: 1.40.0 Build: 225

1) Radio Configuration

To complete the configuration, the I/O that has now been transferred to the radio interface must be mapped over the radio network. The analog input from the slave is mapped to an analog output at a remote WI-I/O 9-x-1, the 8 x digital output at the Profibus slave will be activated in this example via appropriate mapping from 8 x digital input at a remote WI-I/O 9-x-4 (see below).

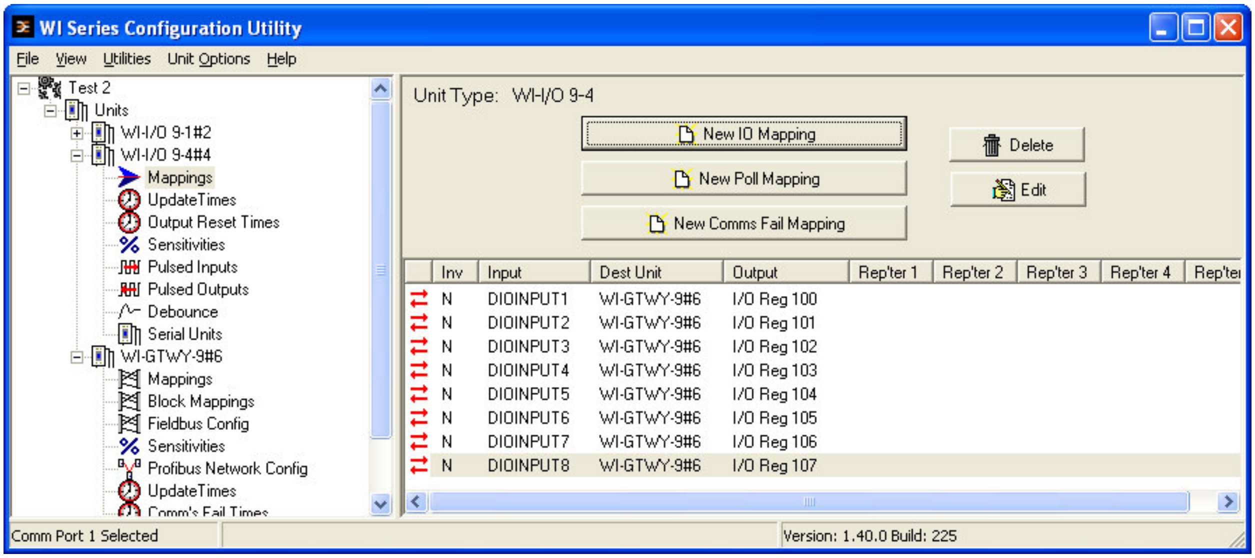


Unit Type: WI-GTWY-9

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'ter 4	Rep'te
⇄	N	I/O Reg 200	WI-I/O 9-1#2	Analogue Out...					

Comm Port 1 Selected

Version: 1.40.0 Build: 225



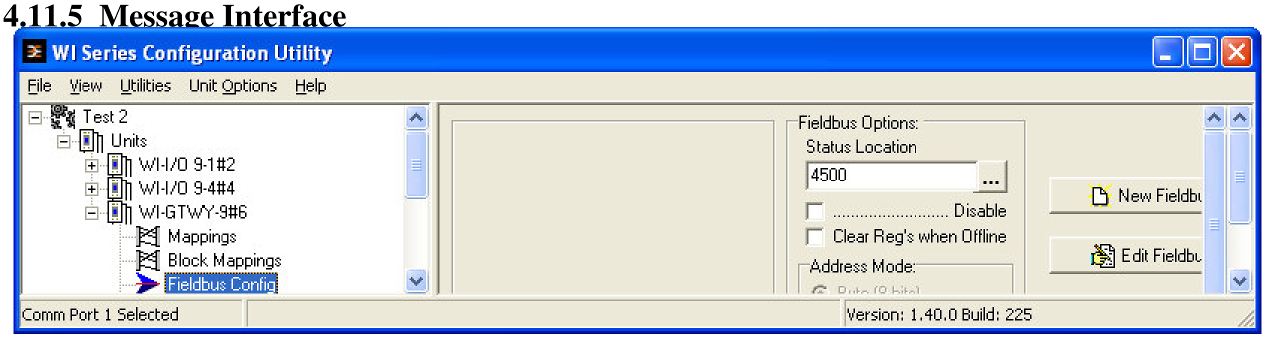
Unit Type: WI-I/O 9-4

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'ter 4	Rep'te
⇄	N	DIOINPUT1	WI-GTWY-9#6	I/O Reg 100					
⇄	N	DIOINPUT2	WI-GTWY-9#6	I/O Reg 101					
⇄	N	DIOINPUT3	WI-GTWY-9#6	I/O Reg 102					
⇄	N	DIOINPUT4	WI-GTWY-9#6	I/O Reg 103					
⇄	N	DIOINPUT5	WI-GTWY-9#6	I/O Reg 104					
⇄	N	DIOINPUT6	WI-GTWY-9#6	I/O Reg 105					
⇄	N	DIOINPUT7	WI-GTWY-9#6	I/O Reg 106					
⇄	N	DIOINPUT8	WI-GTWY-9#6	I/O Reg 107					

Comm Port 1 Selected

Version: 1.40.0 Build: 225

4.11.5 Message Interface



Fieldbus Options:

Status Location: 4500

☐ .... Disable

☐ Clear Reg's when Offline

Address Mode:

Comm Port 1 Selected

Version: 1.40.0 Build: 225

In addition to cyclic data exchange with slave devices, the WI-GTWY-9-xxx Profibus Master also supports a number of acyclic services that may be triggered via a special *Message Interface*. The message interface is by default disabled, but will become enabled by also enabling a “Status Location” via the *fieldbus configuration* tab in configuration software.

The message interface is used to instruct the WI-GTWY-9-xxx to perform a specific task, to request data, to indicate certain events (alarms), or to respond to requests. The message interface can be controlled via a host or other smart device by constructing the appropriate message in the Message Interface Area of the WI-GTWY-9-xxx I/O Registers (radio interface). Since the message interface is part of the radio interface, it may be controlled either remotely via appropriate block mappings (i.e. remote WI-GTWY-9-xxx), or locally via a device on the Profibus network (i.e. configuration tool, PLC, or other smart device).

The supported messages are listed in the table below.

Message	Description
SET_SLAVE_MODE	Send control command to slave(s) (Sync/Freeze)
GET_SLAVE_DIAG	Get diagnostic information from a slave
GET_SLAVE_CONFIG	Get slave configuration
SET_SLAVE_ADDRESS	Set node address of a slave (If supported by slave)
MSAC1_READ	acyclic read (class 1)
MSAC1_WRITE	acyclic write (class 1)
GET_LIVE_LIST	Get information from all nodes on the network
MSAC1_PROFIDRIVE_V3_PARAM_WRITE	PROFIdrive v.3 acyclic parameter access
MSAL1_ALARM_IND	Alarm indication from DPV1 slave
MSAL1_ALARM_CON	Confirmation to FB_MSAL1_ALARM_IND

The message interface supports the following types of communication:

- **Command - Response**

  A message is sent by the message initiator, and the message recipient is required to respond. The message initiator can be either the WI-GTWY-9-xxx or host device.

- **Indication**

  A message is sent by the message initiator, and no response is required. The message initiator can be either the WI-GTWY-9-xxx or host device.

Message Structure

A message consists of a message header and message data (see table below). The header consists of a series of 16-bit registers that specifies the type of message and the length of the message data. The message data may be up to 128 x 16bit registers in length and contain data that is specific to the particular message.

Offset:	**Register:**
0	Message ID
1	Message Information
2	Command Number
3	Data Size
4	Extended Word 1
5	Extended Word 2
6	Extended Word 3
7	Extended Word 4
8	Extended Word 5
9	Extended Word 6
10	Extended Word 7
11	Extended Word 8
12 ::: 139	Message Data (up to 256 Bytes)

Message ID

The Message ID register contains a 16-bit integer identifier for the command. When a response is sent back to the message initiator, the same message ID is used in that message. Message ID's can be selected arbitrarily, but successive messages must contain different ID's so as to trigger the execution of the message (i.e. a message will only be executed upon the ID value changing).

Message Information

This register contains information about whether the message is a command or a response, and may also indicate an error (see below).

<table>
<tr><th>b15</th><th>b14</th><th>b13</th><th>b12</th><th>b11</th><th>b10</th><th>b9</th><th>b8</th><th>b7</th><th>b6</th><th>b5</th><th>b4</th><th>b3</th><th>b2</th><th>b1</th><th>b0</th></tr>
<tr><td>Err</td><td>C/
R</td><td colspan="2">(reserved)</td><td colspan="4">Error Code</td><td colspan="8">Message Type</td></tr>
</table>

For example, a command message will always contain the value 4002h in this register. A response message will contain 0002h, and may contain error information as detailed in the table below.

Bit/Field	Description	Contents
Err	This bit indicates if the received message contains any errors	0: Message OK 1: Error
C/R	This bit indicates if the message is a command or a response	0: Response Message 1: Command Message
Error Code	If the Err bit is set this field contains additional error information	0h: Invalid Message ID 1h: Invalid Message Type 2h: Invalid Command 3h: Invalid Data Size 4h-6h: Message header malformed 8h: Invalid Response 9h: Flash Config Error Fh: Invalid Other (All other values are reserved)
Message Type	This field specifies the message type	2h: This field must always equal 2.

Command Number

This register contains a 16 bit command identifier, which contains the identifier corresponding to the exact message command to be executed.

Data Size

This register specifies the size of the Message Data in bytes. The maximum Message Data size is 256 bytes.

Extended Words 1 ... 8

These registers are specific for each command. Consult the specification for each command for further information.

Message Interface Addressing

Command messages and response messages are allocated fixed locations in the radio interface (I/O Registers). Also, spontaneously generated alarm messages are allocated unique fixed locations in the radio interface. The memory allocation of these messages in the radio interface is outlined in the table below.

I/O Register	Purpose
4550 - 4689	Message IN Area (i.e. Messages to send *to* Profibus Interface)
4700 - 4839	Message OUT Area (i.e. Messages *from* Profibus Interface)
4850 - 4899	Spontaneous Message OUT Area (i.e. Alarm Messages *from* Profibus)
4900 – 4949	Spontaneous Alarm ACK IN Area (i.e. ACK *to* above)

For example, a message could be sent to the Profibus Interface by constructing the required message in the “Message IN Area”, either via radio using appropriate block mapping(s) or locally via a host device or configuration tool. This message is activated upon change-of-state of the Message ID field (see “Message Structure” above). The Profibus interface may generate a response to this message in the “Message OUT Area”, which may then also be transmitted via radio using appropriate block mappings or locally via the host device.

Set Slave Mode

SET_SLAVE_MODE: Command Number = 0003h.

In addition to station related user data transfer, which is executed automatically, the master can send control commands to a single slave, a group of slaves or all slaves simultaneously. These control commands are transmitted as multicast commands. This permits use of sync and freeze modes for event controlled synchronization of the slaves.

The slaves begin sync mode when they receive a sync command from their assigned master. The outputs of all addressed slaves are then frozen in their current state. During subsequent user data transmissions, the output data are stored at the slaves, but the output states remain unchanged. The stored output data are not sent to the outputs until the next sync command is received. Sync mode is concluded with the unsync command.

Similarly, a freeze control command causes the addressed slaves to assume freeze mode. In this operating mode, the states of the inputs are frozen until the master sends the next freeze command. Freeze mode is concluded with the unfreeze command.

Note : Not all slaves supports this feature. Consult the documentation for the actual slave for further information.

Command and response layout

	Command		Response	
Message ID	(ID)		(ID)	
Message Information	4002h		0002h	
Command Number	0003h		0003h	
Data Size	0000h		0000h	
Extended Word 1	Slave Address	Group Select	Slave Address	Group Select
Extended Word 2	Control Command	-	Control Command	-
Extended Word 3	-		-	
Extended Word 4	-		-	
Extended Word 5	-		-	
Extended Word 6	-		-	
Extended Word 7	-		Extended Fault Info	
Extended Word 8	-		Fault Information	

- **Slave Address**

  Range 1-125; 127

  If the request applies for only one slave, that Slave Address must be entered in the range 1-125. If a slave group is to be addressed, Slave Address should be 127 (Multicast address).

- **Group Select**

  Range 01h -FFh (Bit coded)

  This parameter decides which group should be addressed, see below.

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Group 8	Group 7	Group 6	Group 5	Group 4	Group 3	Group 2	Group 1

Example: To address Group 1, 2 and 4, the Group Select value should be 0Dh. If an individual slave should be addressed the correct group selection must also be made, since the slave will ignore the message if it does not belong to the requested group(s).

The group(s) a slave belongs to is determined during network configuration with WI Series Configuration Software, and is downloaded during initialization to each slave via the Profibus telegram Set_Prm.

- **Control Command**

This parameter specifies the command to send.

Bit	Explanation
0 (LSB)	Reserved (set to zero)
1	Reserved (set to zero)
2	Unfreeze input data
3	Freeze input data
4	Unsynchronize output data
5	Synchronize output data
6	Reserved (set to zero)
7 (MSB)	Reserved (set to zero)

- **Fault Information &Extended Fault Information**

If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

‘Fault Information’ contents		‘Extended Fault Information’ contents	
0001h	Address out of range	-	
0002h	Group number 0 not permitted	-	
000Ah	Failed to send Global Control request	000Ah	Incorrect operation mode
		5001h	Invalid Freeze group (Group is not initiated to be Freeze group)
		5002h	Invalid Sync group (Group is not initiated to be a Sync group)
		5003h	Incorrect Control Command
		5004h	No Sync-/ or Freeze groups enabled in master configuration.
00FFh	Module not initialized	-	

Get Slave Diagnostics

GET_SLAVE_DIAG: Command Number = 0004h

This command reads diagnostic data from a specified slave.

Note: The response data size depends on the actual slave implementation. Range 6 -244.

Command and response layout:

	Command		Response	
Message ID	(ID)		(ID)	
Message Information	4002h		0002h	
Command Number	0004h		0004h	
Data Size	0000h		(Size of data)	
Extended Word 1	Slave Address	Type of request	Slave Address	Type of request
Extended Word 2	-		-	
Extended Word 3	-		-	
Extended Word 4	-		-	
Extended Word 5	-		-	
Extended Word 6	-		-	
Extended Word 7	-		Extended Fault Info	
Extended Word 8	-		Fault Information	
Response data word 1			Station Status 1	Station Status 2
Response data word 2			Station Status 3	Master Address
Response data word 3			Ident Number	
Response data word 4			Extended Diagnostic Data	
:::				
Response data word n				

- **Slave Address**

  Range 1-125, specifies the slave to read diagnostics from.

- **Type of request**

  0x00: Internal slave diagnostic request. The diagnostic information stored in the master is returned. Can only be requested for slaves configured by the master.

  0x01: External slave diagnostic request. A diagnostic request is sent on the network to the specified slave. Can be requested for all slaves on the network.

- **Station Status [1 ...3]**

  Consult EN50170 Vol.2 for further information.

- **Master Address**

  Address of the master that parameterized the slave

- **Ident Number**

  Unique ID assigned by the Profibus User Organization

- **Extended Diagnostic Data**

  Slave user specific diagnostic data. Consult the documentation for the actual slave for further information.

- **Fault Information &Extended Fault Information**

  If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

‘Fault Information’ contents		**‘Extended Fault Information’ contents**	
0001h	Address out of range	-	
000Ah	Failed to read Diagnostic Data from slave	0018h	DPMC_M_START has not yet occurred (DPMC_ERR_M_NOT_ALLOWED)
		002Bh	Buffer provided by the user is not sufficient. (DPMC_ERR_M_BLOCK_LEN_INVALID)
00FFh	Module not initialized	-	

Set Slave Address

SET_SLAVE_ADDRESS: Command Number = 0006h

This command makes it possible to set the node address of a specified slave, provided that the slave supports this feature.

Note: The message data size depends on the actual slave implementation; range 0 -240 bytes.

Command and response layout:

	Command		Response	
Message ID	(ID)		(ID)	
Message Information	4002h		0002h	
Command Number	0006h		0006h	
Data Size	(Size of data)		(Size of data)	
Extended Word 1	Current Slave Add	New Slave Add	Current Slave Add	New Slave Add
Extended Word 2	Slave Ident Number		Slave Ident Number	
Extended Word 3	No_add_Chg	-	No_add_Chg	-
Extended Word 4	-		-	
Extended Word 5	-		Err Code1	Err Code2
Extended Word 6	-		Err Code3	Err Code4
Extended Word 7	-		Return Code	
Extended Word 8	-		Fault Information	
Message data byte 1	Slave Data 1		Slave Data 1	
:::	:::		:::	
Message data byte n	Slave Data n		Slave Data n	

- **Current Slave Address**

  Range 1-125, specifies the current address of the slave

- **New Slave Address**

  Range 1-125, specifies the new address of the slave

- **Slave Ident Number**

  Ident number for the slave, whose address should be altered

- **No_add_Chg**

  This parameter specifies whether it is allowed to change the slave address again at a later stage. If this is not allowed, then it is only possible to change the address with this function after initial reset. After the initial reset the slave takes the default address 126.

00h: Change of address is still possible at a later stage

01h-FFh: Change of address only possible after the initial address (i.e. default address = 126)

- **Error Code [1 ...4]**

  If ‘Return Code ’ equals 8030h (‘Negative indication from lower layer ’), status values according to the DP-specification are available in ‘Error Code 1 ’. Error Codes 2 ...3 are reserved.

  (See "Return Codes" and "Error Codes" in section 4.10.5 below.)

- **Return Code**

  See "Return Codes" in section 4.10.5 “DP Error Codes ”.

- **Fault Information**

  If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

  0001h: Current slave address out of range.

  0002h: New slave address out of range.

  000Ah: Failed to execute request.(See ‘Return Code ’ for additional fault information))

  000Bh: Remote station failure.(See ‘Return Code ’ for additional fault information)

  00FFh: Module not initialized.

- **Slave Data**

  With this parameter it is possible to deliver user specific data. The data is stored in the slave if possible (i.e. EEPROM, FLASH etc.)

Get Live List

GET_LIVE_LIST: Command Number = 0018h

This command returns 127 bytes of information about the nodes on the network. Every byte stands for one bus subscriber, and the position of the byte in the response data assigns the address

Command and response layout:

	Command	Response
Message ID	(ID)	(ID)
Message Information	4002h	0002h
Command Number	0018h	0018h
Data Size	0000h	007Fh
Extended Word 1	-	-
Extended Word 2	-	-
Extended Word 3	-	-
Extended Word 4	-	-
Extended Word 5	-	-
Extended Word 6	-	-
Extended Word 7	-	Return Code
Extended Word 8	-	Fault Information
Response data byte 1		Station Type 0
Response data byte 2		Station Type 1
:::		:::
Response data byte 127		Station Type 126

- **Station Type [0 ...126]**

  00h: Slave Station

  01h: Master Station not yet ready for Token ring (station only physically at the bus)

  02h: Master Station ready to enter Token ring (there is not yet any Token transmission)

  03h: Master Station in Token ring (Token transmission through the station)

  04h: Station does not exist

- **Fault Information**

  If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

  000Ah: Failed to build Live List

  00FFh: Module not initialized

DPV1 Acyclic Read

MSAC1_READ: Command Number = 0020h

This command initiates a DPV1 Class 1 acyclic read request. Consult EN50170 (DPV1) for more information.

Command and response layout:

	Command		**Response**	
Message ID	(ID)		(ID)	
Message Information	4002h		0002h	
Command Number	0020h		0020h	
Data Size	0000h		(Size of data)	
Extended Word 1	Slave Add	Slot No.	Slave Add	Slot No.
Extended Word 2	Index	Length	Index	Length
Extended Word 3	-		-	
Extended Word 4	-		-	
Extended Word 5	-		-	Error Decode
Extended Word 6	-		Err Code1	Err Code2
Extended Word 7	-		Return Code	
Extended Word 8	-		Fault Information	
Response data byte 1			Data 1	
Response data byte 2			Data 2	
:::			:::	
Response data byte n			Data n	

- **Slave Address**

  Station address of the slave responder

- **Slot Number &Slot Index**

  Used in the slave to address the desired data block.

- **Length**

  This parameter specifies the number of bytes of the data block that has to be read. If the server data block length is less than requested, the length of the response will be the actual length of the data block. If the server data block is greater or equal, then the response will contain the same amount of data.

  The slave may answer with an error response if the data access is not allowed.

- **Data [1 ...n]**

  Returned data

- **Return Code**

  See "Return Codes" in section “DP Error Codes ” below.

- **Fault Information**

  If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

0001h:	Address out of range
000Ah:	Failed to execute MSAC1_Alarm_Ack request
000Bh:	Remote station failure
0010h:	Remote Station DPV1 Failure (see ‘Error Decode’ below).
00FFh:	Module not initialized

- **Error Decode, Error Code 1 & Error Code 2**

  If ‘Fault Information ’ contains error code 0010h, more information according to the DPV1 specification can be found here.

DPV1 Acyclic Write

MSAC1_WRITE: Command Number = 0021h

This command initiates a DPV1 Class 1 acyclic write request. Consult EN50170 (DPV1) for more information.

Command and response layout:

	Command		Response	
Message ID	(ID)		(ID)	
Message Information	4002h		0002h	
Command Number	0021h		0021h	
Data Size	(Size of data)		(Size of data)	
Extended Word 1	Slave Add	Slot No.	Slave Add	Slot No.
Extended Word 2	Index	Length	Index	Length
Extended Word 3	-		-	
Extended Word 4	-		-	
Extended Word 5	-		-	Error Decode
Extended Word 6	-		Err Code1	Err Code2
Extended Word 7	-		Return Code	
Extended Word 8	-		Fault Information	
Message data byte 1	Data 1		Data 1	
:::	:::		:::	
Message data byte n	Data n		Data n	

- **Slave Address**

  Station address of the slave responder

- **Slot Number & Slot Index**

  Used in the slave to address the desired data block.

- **Length**

  This parameter specifies the number of bytes that has to be written. If the destination data block size is less than requested, the response will contain an error message. If the data block length is greater than or equal to the requested length, the response contains the number of bytes that has been written. The slave may answer with an error response if the data access is not allowed.

- **Data [1 ...n]**

  Data that should be written.

- **Fault Information**

  If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

  0001h: Address out of range

  000Ah: Failed to execute MSAC1_Alarm_Ack request

  000Bh: Remote station failure

  0010h: Remote Station DPV1 Failure (see ‘Error Decode’ below).

  0011h: Too much data is sent to the slave (more than Max_Channel_Data_Len)

  00FFh: Module not initialized

- **Error Decode, Error Code 1 & Error Code 2**

  If ‘Fault Information’ contains error code 0010h, more information according to the DPV1 specification can be found here.

Alarm Indication

MSAL1_ALARM_IND: Command Number = 0022h

This message indicates that a DPV1 slave has transferred an Alarm message to the master. This message is sent spontaneously by the WI-GTWY-9-xxx, i.e. the module itself initiates the message instruction in the “Spontaneous Message OUT Area” (see “Message Interface Addressing” above).

Detailed information about the alarm cause is presented in extended words 1-3 and the message data field, see below.

The WI-GTWY-9-xxx may be configured to automatically provide a response to this command (default), or the response may be provided externally via the message interface. The response will trigger the module to send an MSAC1_Alarm_Ack to the slave. This will tell the slave that the master has configured the alarm. The slave will in turn respond with a confirmation message, see “Alarm Confirmation (MSAL1_ALARM_CON)” below.

Command and response layout:

	Command		Response
Message ID	(ID)		(ID)
Message Information	4002h		0002h
Command Number	0022h		0022h
Data Size	(request length)		0000h
Extended Word 1	Slave Add	Slot No	-
Extended Word 2	Seq Number	Alarm Spec Ack	-
Extended Word 3	Alarm Type	Ext Diag	-
Extended Word 4	-		-
Extended Word 5	-		-
Extended Word 6	-		-
Extended Word 7	-		-
Extended Word 8	Fault Information		-
Message data byte 1	Data 1		
:::	:::		
Message data byte n	Data n		

- **Slave Address**

  Station address of the slave that indicates the alarm

- **Slot Number**

  Used by the slave to indicate the source of the alarm.

  Range 0 -254

- **Seq Number**

  Unique identification number of the alarm.

  Range 0 -31

- **Alarm Spec Ack**

  Gives additional information about the Alarm, such as an error appears, or disappears. It also indicates whether the slave needs additional acknowledge from the Master (Example: Writing to a certain memory area with an Acyclic Write request).

  Range 0 -7

- **Alarm Type**

  Identifies the alarm type, such as Process Alarm, Plug Alarm etc.

  Range 1 -6, 32 -126

- **Extended Diagnostic Flag**

  FFh: Slave sends an alarm message with “Extended Diag flag ”set

  00h: Slave sends an alarm message with “Extended Diag flag ”cleared

- **Data [1 ...n]**

  Additional manufacturer specific alarm information (Alarm -PDU)

- **Fault Information**

  If the Message Information word in the header of the message indicates ‘Invalid Other’, additional information is available in this register.

  003Eh: Module has received an invalid alarm indication data structure from a DPV1 slave. (‘Slave Address ’ contains the node address of the slave that issued the erroneous indication)

  Note: A response does not have to be sent in this case, since the module can ’t send an Alarm Acknowledge to the slave because of this fault.

Alarm Confirmation

FB_ABM_MSAL1_ALARM_CON: Command Number = 0023h

This message indicates that a slave has confirmed a previous MSAC1_Alarm_Ack, see "Alarm Indication (MSAL1_ALARM_IND)" above. This message is sent spontaneously by the WI-GTWY-9-xxx, i.e. the module itself initiates the message instruction in the "Spontaneous Message OUT Area" (see "Message Interface Addressing" above).

Note: This message must *not* be responded to!

Message layout:

	Command		**Response**
Message ID	(ID)		(no response)
Message Information	4002h		
Command Number	0023h		
Data Size	0000h		
Extended Word 1	Slave Add	Slot No	
Extended Word 2	Seq Number	Alarm Spec Ack	
Extended Word 3	Alarm Type	Ext Diag	
Extended Word 4	-		
Extended Word 5	-	Error Decode	
Extended Word 6	Err Code1	Err Code2	
Extended Word 7	Return Code		
Extended Word 8	Fault Information		

- **Slave Address**

  Station address of the slave that indicates the alarm

- **Slot Number**

  Used by the slave to indicate the source of the alarm

  Range 0 -254

- **Seq Number**

  Unique identification number of the alarm

  Range 0 –31

- **Alarm Spec Ack**

  Gives additional information about the Alarm, such as an error appears, or disappears. It also indicates whether the slave needs additional acknowledge from the Master (Example:Writing to a certain memory area with an Acyclic Write request)

  Range 0 -7

- **Alarm Type**

  Identifies the alarm type, such as Process Alarm, Plug Alarm etc.

  Range 1 -6, 32 -126

- **Extended Diagnostic Flag**

FFh:	Slave sends an alarm message with “Extended Diag flag ”set
00h:	Slave sends an alarm message with “Extended Diag flag ”cleared

- **Fault Information**

  If ‘Invalid Other ’is returned in the Message Information word in the header of the response, information about the fault can be found here.

000Ah:	Failed to execute MSAC1_Alarm_Ack request
000Bh:	Remote station failure
0010h:	Remote Station DPV1 Failure (see ‘Error Decode’ below).

- **Error Decode, Error Code 1 & Error Code 2**

  If ‘Fault Information’ contains error code 0010h, more information according to the DPV1 specification can be found here.

4.11.6 DP Return Codes

Possible DP error codes in Message Data word 'Return Code '

Return Code	Name	Meaning
8010h	DPMC_ERR_V1C_CLOSED	Internal DPMC instance no longer exists.
8011h	DPMC_ERR_V1C_STOPPED	Internal DPMC instance already stopped
8012h	DPMC_ERR_V1C_STARTED	Internal DPMC instance already started
8013h	DPMC_ERR_V1C_STATE_UNKNOWN	Internal DPMC instance has entered an undefined state
8021h	DPMC_ERR_V1C_REQ_ACTIVE	A request is already active
8022h	DPMC_ERR_V1C_NOT_ALLOWED	Internal DPMC module not initialized
8023h	DPMC_ERR_V1C_INVALID_PAR	Invalid parameter in user request
8024h	DPMC_ERR_V1C_MEM_ALLOC	Internal memory allocation error
8025h	DPMC_ERR_V1C_L2_REQ	Unknown opcode in the confirmation
8026h	DPMC_ERR_V1C_TIMEOUT	Active request terminated with timeout
8028h	DPMC_ERR_V1C_INVALID_LEN	Invalid length in user request
8030h	DPMC_ERR_V1C_REQ_NEG*	Negative indication from lower layer
8031h	DPMC_ERR_V1C_REQ_RE	Message frame format error in response
8042h	DPMC_ERR_V1C_REQ_WITHDRAW	Request was recalled
8043h	DPMC_ERR_V1C_REQ_NOT_FOUND	Associated request block not found
80C1h	DPMC_ERR_V1C_MM_FE	Format error in request frame
80C2h	DPMC_ERR_V1C_MM_NI	Function not implemented
80C3h	DPMC_ERR_V1C_MM_AD	Access denied
80C4h	DPMC_ERR_V1C_MM_EA	Area too large
80C5h	DPMC_ERR_V1C_MM_LE	Data block length to large
80C6h	DPMC_ERR_V1C_MM_RE	Format error in response frame
80C7h	DPMC_ERR_V1C_MM_IP	Invalid parameter
80C8h	DPMC_ERR_V1C_MM_SC	Sequence conflict
80C9h	DPMC_ERR_V1C_MM_SE	Sequence error
80CAh	DPMC_ERR_V1C_MM_NE	Area non existent
80CBh	DPMC_ERR_V1C_MM_DI	Data incomplete or incorrect
80CCh	DPMC_ERR_V1C_MM_NC	Master parameter set not compatible

* See "Error Codes" below.

Error Codes

If return code indicates ‘DPMC_ERR_V1C_REQ_NEG ’, the status values according to the DP-standard may be available in ‘Error Code 1 ’ (See below). Consult the Profibus DP specification for information on how to interpret these status values.

Error Code	Name	Meaning
01h	L2_STATUS_UE	Consult Profibus DP Specification
02h	L2_STATUS_RR	
03h	L2_STATUS_RS	
0Ch	L2_STATUS_RDL	
0Dh	L2_STATUS_RDH	
0Fh	L2_STATUS_NA	

DPV1 Return Codes

Possible DPV1 related Error Codes in Message Data word ‘Return Code’

Return Code	Name	Meaning
0003h	DPMC_ERR_M_MEM_ALLOC	Internal memory allocation error
0004h	DPMC_ERR_M_L2_REQ	Unknown opcode in the confirmation
0005h	DPMC_ERR_M_INVALID_PAR	Invalid parameter in user request
0007h	DPMC_ERR_M_NOT_IN_DATA	Slave is not in DataExchange (thus no DPV1 requestcan exist)
0012h	DPMC_ERR_M_REQ_ACTIVE	A request is already active
0018h	DPMC_ERR_M_NOT_ALLOWED	Internal DPMC module not initialized correctly
0021h	DPMC_ERR_M_CLOSED	Internal DPMC instance no longer exists
0022h	DPMC_ERR_M_STOPPED	Internal DPMC instance has already been stopped
0023h	DPMC_ERR_M_STARTED	Internal DPMC instance has already been started
0024h	DPMC_ERR_M_STATE_UNKNOWN	Internal DPMC instance has entered an undefined state
002Fh	DPMC_ERR_M_SLAVE_NOT_FOUND	Slave does not respond
0031h	DPMC_ERR_M_TIMEOUT	Active request terminated with timeout
0034h	DPMC_ERR_M_INVALID_LEN	Invalid length in user request
0035h	DPMC_ERR_M_REQ_NEG	Negative indication from lower layer
0036h	DPMC_ERR_M_REQ_RE	Message frame format error in response
0037h	DPMC_ERR_M_REQ_WITHDRAW	Request was recalled
0038h	DPMC_ERR_M_REQ_NOT_FOUND	Associated request block not found
0040h	DPMC_ERR_M_MM_FE	Format error in request frame
0041h	DPMC_ERR_M_MM_NI	Function not implemented
0042h	DPMC_ERR_M_MM_AD	Access denied
0043h	DPMC_ERR_M_MM_EA	Area too large
0044h	DPMC_ERR_M_MM_LE	Data block length to large
0045h	DPMC_ERR_M_MM_RE	Format error in response frame
0046h	DPMC_ERR_M_MM_IP	Invalid parameter
0047h	DPMC_ERR_M_MM_SC	Sequence conflict
0048h	DPMC_ERR_M_MM_SE	Sequence error
0049h	DPMC_ERR_M_MM_NE	Area non existent
004Ah	DPMC_ERR_M_MM_DI	Data incomplete or incorrect
004Bh	DPMC_ERR_M_MM_NC	Master parameter set not compatible
004Ch	DPMC_ERR_M_S7_XA	Profibus error for DPV1 (NRS-PDU received)
004Dh	DPMC_ERR_M_S7_XR	

004Eh	DPMC_ERR_M_S7_XW	

4.12 Fieldbus Configuration - Ethernet

The WI-GTWY-9-xxx provides the following Ethernet functionality:

1. Modbus/TCP. The module supports the Modbus/TCP protocol and conforms to the Modbus/TCP specification 1.0 (full information on this protocol can be obtained from http://www.modicon.com/openmbus/index.html). Refer to section 4.12.2 below for configuration details.
2. EtherNet/IP. EtherNet/IP is based on the Allen-Bradley Control and Information protocol, CIP, which is also the framework for both DeviceNet and ControlNet, to carry and exchange data between nodes. Refer to section 4.12.3 below for configuration details.

Note! The WI-GTWY-9-xxx only supports true EtherNet IP commands as found in A-B ControlLogix, MicroLogix, and CompactLogix PLC's, but does not support earlier A-B Ethernet commands used with SLC5 PLC's.

3. IT-Functionality. The Ethernet WI-GTWY-9-xxx has several IT features, including Internet functionality.
   - Filesystem. The module features a flexible file system with two security levels. The size available for user files is approximately 1.4 Mbyte of non-volatile memory.
   - FTP Server. The FTP Server provides easy file management using standard FTP clients.
   - Telnet Server. The Telnet server features a command line interface similar to the MS-DOS™ environment.
   - HTTP Server. The module features a flexible HTTP server with SSI functionality. This enables the user to configure a web interface (or web page) accessing I/O values in the WI-GTWY-9-xxx.
   - Email Client (SMTP). Predefined messages stored within the file system can be sent, triggered by a specified I/O value in the WI-GTWY-9-xxx. It is also possible to include I/O values in emails, using SSI functionality.
   - IP Access Control. It is possible to configure which IP addresses and what protocols that are allowed to connect to the module.

For further details, refer to Appendix 2.

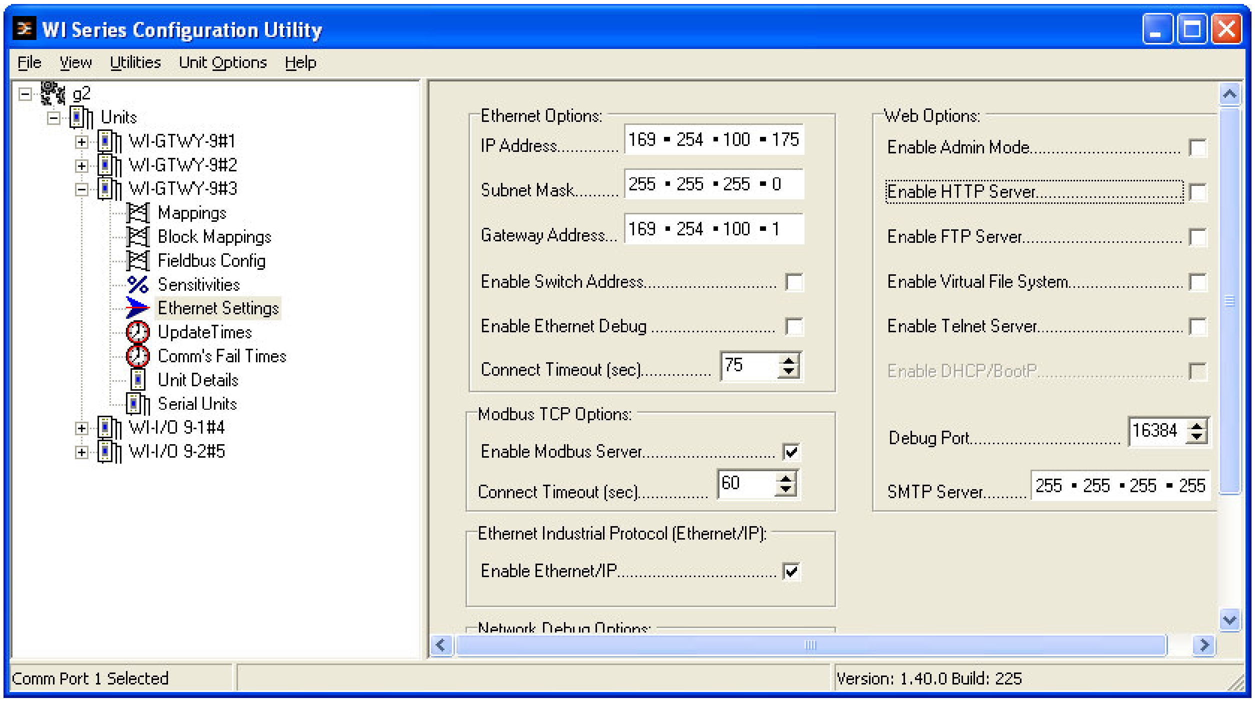
4.12.1 Setting IP Address

The Ethernet IP address can be set from the configuration software or via the Ethernet port or via the selector switches in the top end-plate of the module. If the "Enable Switch Address" box is not selected, then the address entered in the program will be used and the switch value ignored. The IP address can be overwritten from the Ethernet port. If the "Enable Switch Address" box is selected, then the address entered in the configuration program will be ignored and the rotary switch read on start-up of the WI-GTWY-9-xxx.

The IP address is used to identify each node on the Ethernet network. Therefore, each node on the network must have a unique IP address. IP addresses are written as four decimal integers (0-255) separated by periods, where each integer represents the binary value of one byte in the IP address. This is called dotted-decimal notation. Example: 169.254.100.175

Subnet Mask

An IP Address is divided into two main parts *subnet* ID and *host* ID. All devices on the same local network must have the same subnet ID, but a unique host ID. To separate these two parts a *subnet mask* is used. In its simplest form, the subnet mask is a four byte pattern where a value of 255 allocates the corresponding byte of the IP Address to the subnet ID, and a value of 0 allocates the corresponding byte of the IP Address to the host ID.



Ethernet Options:
IP Address............. 169 . 254 . 100 . 175
Subnet Mask.......... 255 . 255 . 255 . 0
Gateway Address... 169 . 254 . 100 . 1
Enable Switch Address.............................. ☐
Enable Ethernet Debug .... ☐
Connect Timeout (sec)............... 75

Modbus TCP Options:
Enable Modbus Server.............................. ☑
Connect Timeout (sec)............... 60

Ethernet Industrial Protocol (Ethernet/IP):
Enable Ethernet/IP.................................. ☑

Web Options:
Enable Admin Mode.................................. ☐
Enable HTTP Server.................................. ☐
Enable FTP Server.................................... ☐
Enable Virtual File System......................... ☐
Enable Telnet Server................................ ☐
Enable DHCP/BootP.................................. ☐
Debug Port.................................. 16384
SMTP Server......... 255 . 255 . 255 . 255

Comm Port 1 Selected
Version: 1.40.0 Build: 225

For example, a common subnet mask is shown in the example below. Looking at the IP Address located directly above the Subnet Mask in this example, it can be seen that the IP Address values directly above a subnet mask value of 255 correspond to the subnet ID. Conversely, the IP Address values directly above a subnet mask value of 0 correspond to the host ID. So, in this example, the subnet ID is 169.254.100 and the host ID is 175.

Special case IP addresses

Devices on an Ethernet network are not allowed to be configured to the following IP addresses; therefore do not configure the module to use any of them.

0.x.x.x - IP address where the first byte is zero

127.x.x.x - IP address where the first byte is 127

x.x.x.0 - IP address where the last byte is zero

x.x.x.255 - IP address where the last byte is 255

Gateway

The Gateway IP is the IP address of the LAN server or the host device.

Connect Timeout

The Connect Timeout parameter in the IP addressing section of the display refers to the IP functionality of the module. If an IP connection to the module has not been active for this amount of time, the WI-GTWY-9-xxx will timeout and disconnect that connection. Note that there can be several active connections at the same time - only the inactive connection will be disconnected.

Enable Ethernet Debug

Select this box if you wish to enable Ethernet Diagnostics on the WI-GTWY-9-xxx via configuration software (see section 6.3 for details). For security reasons, disabling this option will disallow all Ethernet diagnostics functions accessible to configuration software, and can only be reactivated via serial port configuration.

4.12.2 Modbus TCP

To use Modbus TCP, select the Enable Modbus Server box and deselect the Enable Ethernet/IP box. This will automatically remove the “I/O Instance” selection for all fieldbus mappings. It is possible for both Modbus TCP and Ethernet/IP to be selected - in this case, select “Disable I/O Instance” individually for each Modbus TCP fieldbus mapping.

Supported Commands:

Function Code	Function Name	Class	Affects Area	Address Method
1	Read coils	1	IN/OUT	Bit
2	Read Input discretes	1	IN/OUT	Bit
3	Read multiple registers	0	IN/OUT	Word
4	Read input registers	1	IN/OUT	Word
5	Write coil	1	OUT	Bit
6	Write single register	1	OUT	Word
7	Read exception status	1	-	-
15	Force multiple coils	2	OUT	Bit
16	Force multiple registers	0	OUT	Word
22	Mask write register	2	OUT	Word
23	Read/Write registers	2	IN/OUT	Word

Supported Exception Codes:

Exception Code	Name	Description
01	Illegal function	The module does not support the function code in the query
02	Illegal data address	The data address received in the query is outside the initialized memory area
03	Illegal data value	The data in the request is illegal

Modbus/TCP Addressing

The IN and OUT areas of the Ethernet interface are addressed under Modbus/TCP according to the tables below. Since Modbus uses a 16-bit format, "Word (16-bit) Address Mode" will be automatically applied whenever the "Modbus/TCP" checkbox is checked. If Ethernet/IP is also enabled, the "Disable I/O Instance" option must be selected for each fieldbus mapping to which Modbus/TCP Addressing is to apply.

IN Area Modbus TCP Addresses (WI-GTWY-9-xxx Write Locations 0 – 1023*)

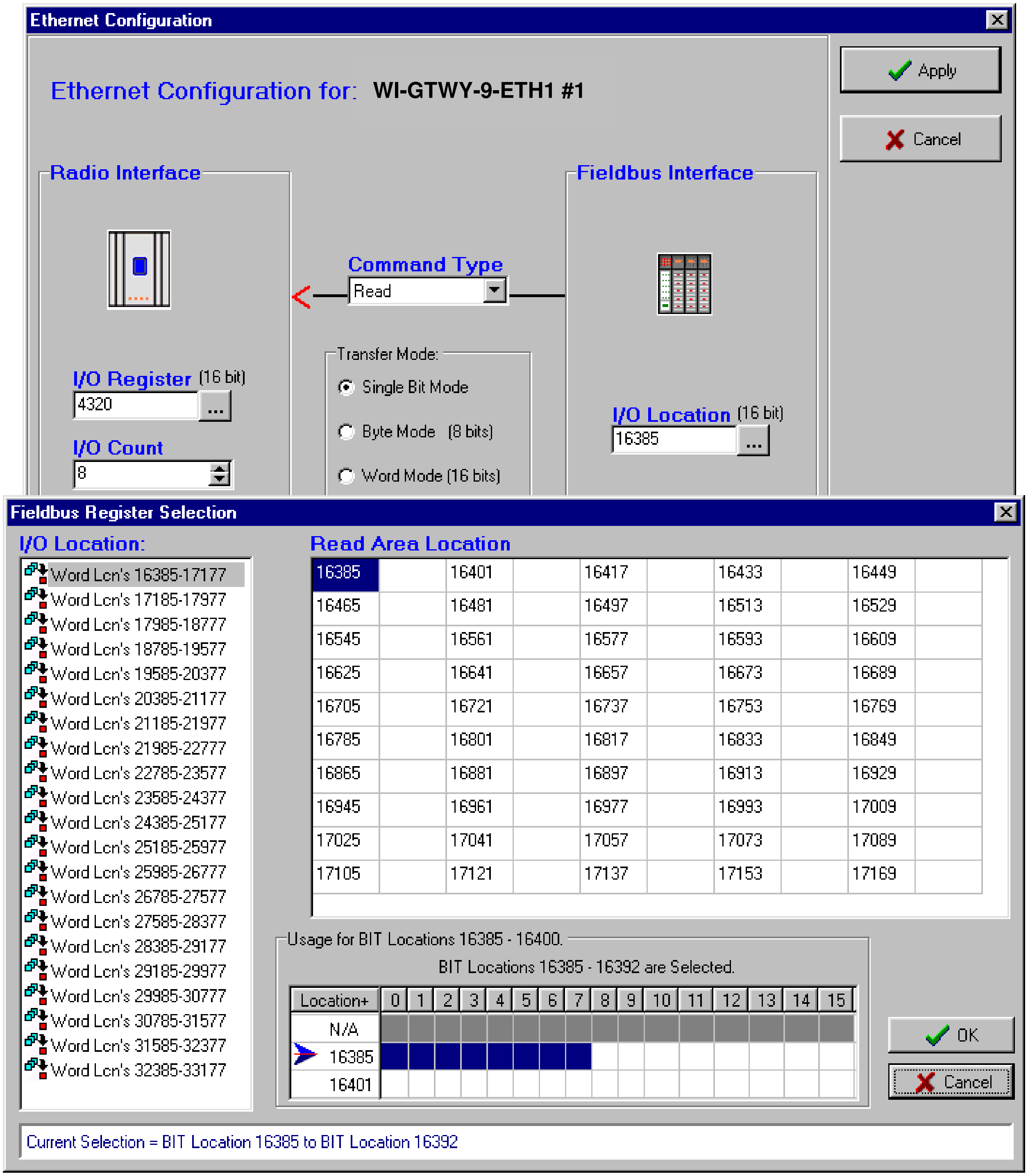
IN Area Location	Modbus Word Address	Modbus Bit Address						
		Bit 15	Bit 14	Bit 13	---	Bit 2	Bit 1	Bit 0
0	1	1	2	3	---	14	15	16
1	2	17	18	19	---	30	31	32
---	---	---	---	---	---	---	---	---
1022	1023	16353	16354	16355	---	16382	16383	16384
1023	1024	16369	16370	16371	---	16382	16383	16384

OUT Area Modbus TCP Addresses (Fieldbus READ Locations 0 – 1023*)

OUT Area Location	Modbus Word Address	Modbus Bit Address						
		Bit 15	Bit 14	Bit 13	---	Bit 2	Bit 1	Bit 0
0	1025	16385	16386	16387	---	16398	16399	16400
1	1026	16401	16402	16403	---	16414	16415	16416
---	---	---	---	---	---	---	---	---
1022	2047	32737	32738	32739	---	32750	32751	32752
1023	2048	32753	32754	32755	---	32766	32767	32768

* Assumes Word Mode Addressing is selected in Configuration Software

The Fieldbus IN and OUT areas can be configured to a maximum size of 1024 words (2048 bytes) each, depending on the configured fieldbus mappings. The highest mapped location will correspond to the highest available Modbus register (or coil) available to a Modbus/TCP client. A Modbus/TCP client must use the appropriate Modbus Coil or Modbus Word addresses corresponding to configuration software, as well as the correct function code (see 4.12.2 Supported Commands).



Ethernet Configuration for: WI-GTWY-9-ETH1 #1

Command Type: Read

I/O Register (16 bit): 4320

I/O Count: 8

Transfer Mode:
● Single Bit Mode
○ Byte Mode (8 bits)
○ Word Mode (16 bits)

I/O Location (16 bit): 16385

I/O Location:
- Word Lcn's 16385-17177
- Word Lcn's 17185-17977
- Word Lcn's 17985-18777
- Word Lcn's 18785-19577
- Word Lcn's 19585-20377
- Word Lcn's 20385-21177
- Word Lcn's 21185-21977
- Word Lcn's 21985-22777
- Word Lcn's 22785-23577
- Word Lcn's 23585-24377
- Word Lcn's 24385-25177
- Word Lcn's 25185-25977
- Word Lcn's 25985-26777
- Word Lcn's 26785-27577
- Word Lcn's 27585-28377
- Word Lcn's 28385-29177
- Word Lcn's 29185-29977
- Word Lcn's 29985-30777
- Word Lcn's 30785-31577
- Word Lcn's 31585-32377
- Word Lcn's 32385-33177

Read Area Location

16385	16401	16417	16433	16449
16465	16481	16497	16513	16529
16545	16561	16577	16593	16609
16625	16641	16657	16673	16689
16705	16721	16737	16753	16769
16785	16801	16817	16833	16849
16865	16881	16897	16913	16929
16945	16961	16977	16993	17009
17025	17041	17057	17073	17089
17105	17121	17137	17153	17169

Usage for BIT Locations 16385 - 16400.

BIT Locations 16385 - 16392 are Selected.

Location+	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N/A	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
➤ 16385	■	■	■	■	■	■	■	■								
16401																

Current Selection = BIT Location 16385 to BIT Location 16392

Appropriate Modbus prefixes may need to be added to the Modbus Address depending on the host device. For example, a "word write" fieldbus mapping in the WI-GTWY-9-xxx to Modbus location 10, can be read by a host device as 30010 (30000 for an input register + 10 as the address). Alternatively, a "word read" fieldbus mapping in the WI-GTWY-9-xxx from Modbus Location 1025, can be written to by a host device as 41025 (40000 for an output register + 1025 as the address).

Conversely, for Modbus bit/binary commands the appropriate 0x or 1x prefix may need to be added depending on the host device. The example below shows 8 bits being read from Modbus locations 16385 – 16392 into I/O registers 4300 – 4307 (DOT 1-8). The Modbus/TCP host device would write to these as Modbus addresses 016385 – 016392 (using the 0x prefix to denote output coils).

Connect Timeout

The Connect Timeout parameter in the Modbus TCP section of the display refers to the Modbus TCP functionality of the module. If a TCP connection to the module has not been active for this amount of time, the WI-GTWY-9-xxx will timeout and disconnect that connection. Note that there can be several active connections at the same time - only the inactive connection will be disconnected.

4.12.3 EtherNet/IP

Ethernet/IP (Ethernet Industrial Protocol) is based on the Control and Information Protocol (CIP), which is also the framework for both DeviceNet and ControlNet, to carry and exchange data between nodes. The Ethernet/IP implementation is a Level 2 I/O Server, which means that the module will respond to both explicit and IO messages but requires that an Ethernet/IP client initiate IO connections.

For additional information on the Ethernet/IP protocol see www.ethernet-ip.org and www.odva.org. The rest of this section assumes the reader is familiar with Ethernet/IP.

If you use the WI-GTWY-9-xxx with a PLC, the PLC configuration tool will require an EDS file so it can recognize the Ethernet/IP interface in the WI-GTWY-9-xxx. The file is available on the same CD as the configuration software, or on the W Interconnections web site.

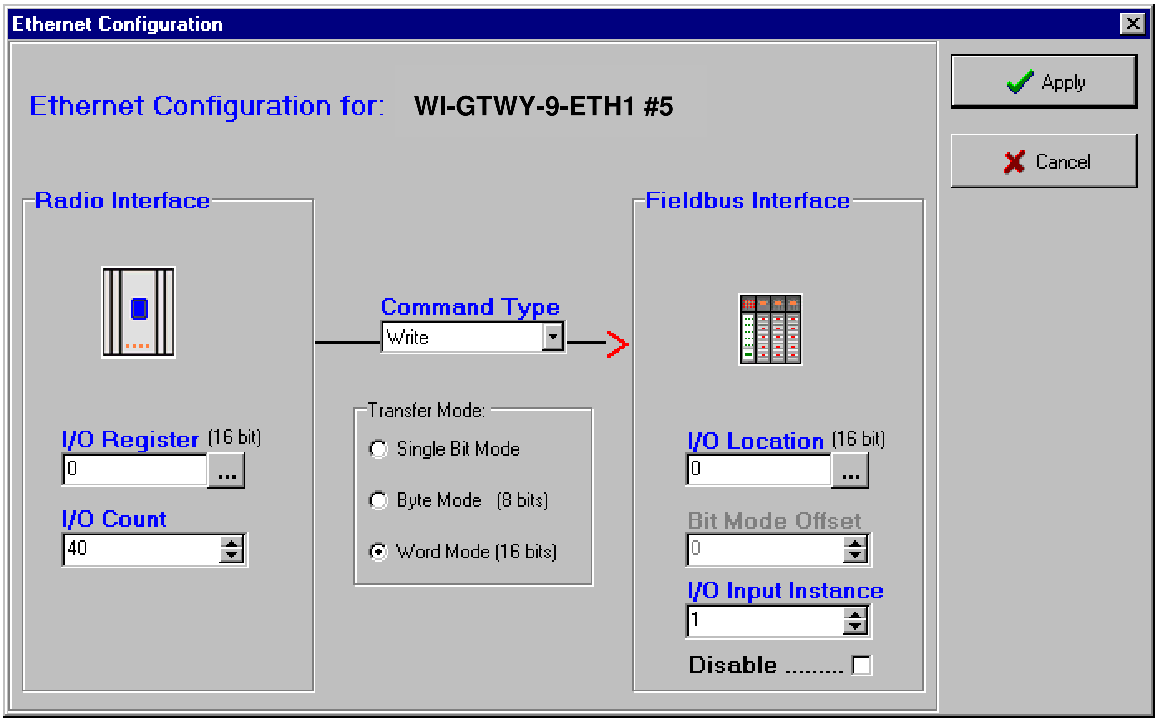
Implemented Objects:

EtherNet/IP requires some mandatory objects; these are implemented, as well as some vendor specific objects. The mandatory objects are the ones in the specification from ODVA.

The following vendor specific objects are implemented:

- I/O data input mapping object, Class A0h
- I/O data output mapping object, Class A1h

The WI-GTWY-9-xxx can handle multiple EtherNet/IP connections simultaneously - up to 6 produced IO connections ("write" connections) and 6 consumed IO connections ("read" connections). Each connection is a "virtual" connection, not a "physical" connection and is called an "I/O instance".



Ethernet Configuration for: WI-GTWY-9-ETH1 #5

I/O Register (16 bit): 0

I/O Count: 40

Command Type: Write

Transfer Mode:

○ Single Bit Mode
○ Byte Mode (8 bits)
● Word Mode (16 bits)

I/O Location (16 bit): 0

Bit Mode Offset: 0

I/O Input Instance: 1

Disable .... ☐

The maximum individual connection size is 512 bytes. If more than 512 bytes is to be transferred, then more than one connection is required - a connection is known as an "IO Instance". Ethernet/IP interface to these IO connections is made available in the mandatory Ethernet/IP 'Assembly Object' (class 04h) as vendor specific instance attributes 64h-69h for produced IO (i.e. IO data configured using fieldbus *write* commands) and 96-9Bh for consumed IO (i.e. IO data configured using fieldbus *read* commands). The same IO are also available in the vendor specific objects I/O data input mapping object (class A0h) and IO data output mapping object (class A1h) respectively as instance attributes 1 – 6. (See Object Specifications below)

To make I/O data available via Ethernet/IP, ensure that the Enable Ethernet/IP checkbox on the Ethernet Settings page is checked. Appropriate Fieldbus Mappings need to be configured to link the required I/O registers to the Fieldbus Interface, as described above in the Profibus and Modbus/TCP sections. An "*I/O Instance*" for each fieldbus link must also be specified so that the configured I/O data is made available to one of the six possible Ethernet connections.

In this example, 40 I/O Registers (80 bytes) are transferred to I/O Input Instance 1 (i.e. Ethernet connection 1). As per the table below, this data would then be available via Ethernet/IP in class 04h, Instance Attribute 64h *or* in class A0h, Instance Attribute 1. If the *Disable* option is checked, the I/O transfer will not be made available to Ethernet/IP. The table below shows the possible IO Instances and their corresponding Ethernet/IP locations.

IO Instance	*Assembly Object*	*Vendor Specific Object*
IO Input Instance 1-6	Class 04h, Instance 64h-69h	Class A0h, Attribute 01h-06h
IO Output Instance 1-6	Class 04h, Instance 96h-9Bh	Class A1h, Attribute 01h-06h

Assembly Object, Class 04h

The Assembly Object binds all mapped I/O data. This data is used for I/O connections. This object is set-up dynamically via fieldbus mappings through configuration software.

Class Attributes:

ID#	Name	Service	Description	Semantics	Def, Min, Max	Type
01h	Revision	Get_attribute_all	Object Revision	The revision attribute containing the revision of the object	1, 1, 1	UINT

Input Area, Instance 64h:

ID#	Name	Service	Description	Type
03h	Data	Get_attribute_single	The data produced is configured from fieldbus write mappings to I/O Input Instance 1.	Array of USINT

Note: This data is also available in the vendor specific object: I/O Data Input Mapping Object, Class A0h, Instance Attribute 01h, and Attribute ID 01h (see I/O Data Input Mapping Object).

Input Area, Instance 65h – 69h:

ID#	Name	Service	Description	Type
03h	Data	Get_attribute_single	The data produced is configured from fieldbus write mappings to I/O Input Instance 2-6.	Array of USINT

Note: This data is also available in the vendor specific object: I/O Data Input Mapping Object, Class A0h, Instance Attribute 01h, and Attribute ID's 02h to 06h (see I/O Data Input Mapping Object).

Output Area, Instance 96h:

ID#	Name	Service	Description	Type
03h	Data	Get_attribute_single Set_attribute_single	The data produced is configured from fieldbus read mappings from I/O Output Instance 1.	Array of USINT

Note: This data is also available in the vendor specific object: I/O Data Output Mapping Object, Class A1h, Instance Attribute 01h, and Attribute ID 01h (see I/O Data Output Mapping Object).

Output Area, Instance 97h – 9Bh:

ID#	Name	Service	Description	Type
03h	Data	Get_attribute_single Set_attribute_single	The data produced is configured from fieldbus read mappings from I/O Output Instance 2-6.	Array of USINT

Note: This data is also available in the vendor specific object: I/O Data Output Mapping Object, Class A1h, Instance Attribute 01h, and Attribute ID 01h (see I/O Data Output Mapping Object).

I/O Data Input Mapping Object, Class A0h

This object is setup dynamically via fieldbus read mappings through configuration software. This data is also available as vendor specific Instance Attributes (64h to 69h) in the Assembly Object.

Class Attributes*:*

ID#	Name	Service	Description	Semantics	Def, Min, Max	Type
01h	Revision	Get_attribute_all	Object Revision	The revision attribute containing the revision of the object	1, 1, 1	UINT

Instance Attributes, Instance 01h:

ID#	**Name**	**Service**	**Description**	**Type**
01h	Data	Get_attribute_single	The data produced is configured from fieldbus write mappings to I/O Input Instance 1.	Array of USINT
…	…	…	…	…
06h	Data	Get_attribute_single	The data produced is configured from fieldbus write mappings to I/O Input Instance 6.	Array of USINT

I/O Data Output Mapping Object, Class A1h

This object is setup dynamically via fieldbus write mappings through configuration software. This data is also available as vendor specific Instance Attributes (96h to 9Bh) in the Assembly Object.

Class Attributes:

ID#	Name	Service	Description	Semantics	Def, Min, Max	Type
01h	Revision	Get_attribute_all	Object Revision	The revision attribute containing the revision of the object	1, 1, 1	UINT

Instance Attributes, Instance 01h:

ID#	**Name**	**Service**	**Description**	**Type**
01h	Data	Get_attribute_single Set_attribute_single	The data produced is configured from fieldbus write mappings to I/O Input Instance 1.	Array of USINT
…	…	…	…	…
06h	Data	Get_attribute_single Set_attribute_single	The data produced is configured from fieldbus write mappings to I/O Input Instance 6.	Array of USINT

4.13 Fieldbus Configuration – DeviceNet

4.13.1 DeviceNet Introduction

DeviceNet is a broadcast-oriented communications protocol based on the Controller Area Network (CAN). The physical fieldbus is a shielded copper cable composed of one twisted pair and two cables for the external power supply. The baud rate can be changed between 125k, 250k, and 500kbit/s via Configuration Software or DIP-switch.

DeviceNet has a user organization, the Open DeviceNet Vendor Association - for further information see www.ODVA.org

4.13.2 DeviceNet Address Setting

On a DeviceNet network, each node must be assigned its own unique Mac ID (Node Address). The Mac ID is a value between 0 and 63 used to identify each node. On the WI-GTWY-9-xxx DeviceNet module, the Mac ID and Baud rate settings can be set either using a physical DIP-switch or via the Configuration Software (Fieldbus Configuration page). To use the switch address settings, the "Enable Switch Address" option in configuration software must be selected, otherwise switch settings are ignored. We recommend that you do NOT use the DIP switch to set address/baud rate as switches can be accidentally changed during operation

The DIP-switches are numbered 1 through 8. Switch 1 and 2 are used to configure the Baud rate, and switches 3 through 8 are used to configure the Mac ID using binary format (see tables below)

Mac ID Switch Setting:

Address	SW. 3 (MSB)	SW. 4	SW. 5	SW. 6	SW. 7	SW. 8 (LSB)
0	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
---	---	---	---	---	---	
62	ON	ON	ON	ON	ON	OFF
63	ON	ON	ON	ON	ON	ON

Baud Rate Settings:

Baud Rate, bit/sec	SW. 1	SW. 2
125k	OFF	OFF
250k	OFF	ON
500k	ON	OFF
Reserved	ON	ON

4.13.3 EDS File

Each device in a DeviceNet network is associated with an EDS file, containing all necessary information about the device. This file is used by the network configuration tool during network configuration. The EDS file can either be downloaded from the W Interconnections website, or found on the Product CD supplied with the module.

4.13.4 Protocol and Supported Functions

The WI-GTWY-9-xxx DeviceNet module is implemented according to the ODVA specification for a communication adapter (profile no 12) and acts as a group two only server on the DeviceNet network.

The WI-GTWY-9-xxx DeviceNet supports the following connection types:

- Explicit Messaging
- Polled I/O
- Bit-strobed I/O
- Change-of-state / Cyclic I/O

The WI-GTWY-9-xxx DeviceNet supports up to 512 bytes of input and 512 bytes of output data via the DeviceNet interface. I/O Data exchange with a DeviceNet Scanner can be performed using any of the above connection types. DeviceNet Scanner configuration towards the WI-GTWY-9-xxx is possible via an EDS file.

DeviceNet is based on the Control and Information Protocol (CIP), which is also the framework for both ControlNet and Ethernet/IP, to carry and exchange data between nodes. The WI-GTWY-9-xxx supports the mandatory objects as well as some vendor specific objects. The mandatory objects are the ones in the specification from ODVA. The following vendor specific objects are implemented:

- I/O data input mapping object, Class A0h
- I/O data output mapping object, Class A1h

Since theses objects are the same as for Ethernet/IP, for the specification of these objects see section '4.12.3 Ethernet/IP'. For further examples refer to the WI-GTWY-9-xxx DeviceNet Application Note.

4.14 Fieldbus Configuration – Modbus Plus

4.14.1 Modbus Plus Introduction

Modbus Plus is a local area network system designed for industrial control and monitoring applications. The network enables programmable controllers, host computers and other devices to communicate throughout plants and substations. Modbus Plus is normally used in industrial automation, to transfer fast data for motor controllers, MMI, I/O units and other industrial equipment.

The WI-GTWY-9-xxx Modbus Plus module communicates according to the Modbus Plus Protocol. This means that it can communicate with all Modbus Plus nodes that comply with this protocol, but it does not necessarily mean that all services available in the Modbus Plus protocol are supported.

4.14.2 Modbus Plus Addressing

Modbus Plus node addressing can be set using switches or via configuration software. To use the switch address settings, the “Enable Switch Address” option in configuration software must be selected, otherwise switch settings are ignored. NOTE – software address configuration is the recommended option if use of the GDB Offset and Count parameters is required (see section 4.11.4).

Two sets of six switches are available: Node Address (S1, the left-most set of switches, closest to the D-SUB connector), and Source Address (S2, the right-most set of switches). Address settings for both switches use the same binary format illustrated in the table below.

1 MSB	2	3	4	5	6 LSB	Function
ON	ON	ON	ON	ON	ON	Node Address set to 1
ON	ON	ON	ON	ON	OFF	Node Address set to 2
ON	ON	ON	ON	OFF	ON	Node Address set to 3
---	---	---	---	---	---	
OFF	OFF	OFF	OFF	OFF	ON	Node Address set to 63
OFF	OFF	OFF	OFF	OFF	OFF	Node Address set to 64

4.14.3 Protocol & Supported Functions

Devices on a Modbus Plus network have two ways of exchanging data. One is through fast cyclic I/O data called Global Data, and one through a somewhat slower Modbus protocol for point-to-point parameter data transfer. The WI-GTWY-9-xxx supports both Global Data and point-to-point data, however the module cannot initiate point-to-point commands but only respond to and accept point-to-point commands initiated by other nodes on the network.

Modbus Plus is a token bus network. This means that each device on the network will receive the token on a cyclic basis. When a device on the network receives the token it is able to broadcast up to 32 words of Global Data. All other devices on the network will ‘see’ this data, and depending on their configuration have the option to use some, or all, of the broadcast data. Consequently, the WI-GTWY-9-xxx Modbus Plus module supports up to 32 words of Global Outputs (i.e. Data To Network) and up to 32 words of Global Inputs (i.e. Data From Network).

The WI-GTWY-9-xxx also supports point-to-point data, however the module cannot initiate point-to-point commands but only respond to and accept point-to-point commands. The WI-GTWY-9-xxx Modbus Plus supports only the following point-to-point operations on Modbus 40000 (4X) registers:

- (0x03) Read holding Registers
- (0x06) Preset Single Register
- (0x10) Preset multiple Registers

The WI-GTWY-9-xxx Modbus Plus supports the following exception responses:

- (0x01) Illegal function for the addressed slave
- (0x02) Illegal data address within the information field for the addressed slave
- (0x03) Illegal data value in the information field for the addressed slave

The WI-GTWY-9-xxx Modbus Plus supports up to 1024 words of output data and 1024 words of input data. Converting this to 40000 registers, the possible output registers (Data To Network) range is 40001 – 41024 of which the first 32 words (i.e. 40001 – 40032) are global output data. However all output registers, including the global output registers, may also be read from the module using the point-to-point command Read Holding Registers (0x03). The possible input registers (Data From Network) range is 41025 – 42048 of which the first 32 words (i.e. 41025 – 41056) is global input data (i.e. data extracted from another network device's global output data). Only data *not* assigned to global input data (i.e. 41057 – 42048) may be written by the point-to-point preset register commands.

4.14.4 Configuration

The "Node Address" will be the Modbus Plus network address of the WI-GTWY-9-xxx, (allowable values are 1 – 64) and must be unique for the network segment. The "Source Address" will be the Modbus Plus network address of another module on the network from which the WI-GTWY-9-xxx will extract Global Data (i.e. Data From Network). Only 1 source address can be added to the configuration (i.e you can only extract data from one source device). "GDB I/P Count" (up to 32 words max) specifies the amount of Global Data to extract from the "Source Address" each cycle. An offset into the source unit's global data ("GDB I/P Offset") may also be specified in order to read a specific portion of the 32 word global data of the source address. However, since only 32 words max of global data are produced, the sum of GDB I/P Offset and GDB I/P Count must never exceed 32. After setting these parameters, the WI-GTWY-9-xxx I/O Registers must be linked to Modbus Plus 40000 registers with appropriate "Fieldbus mappings".

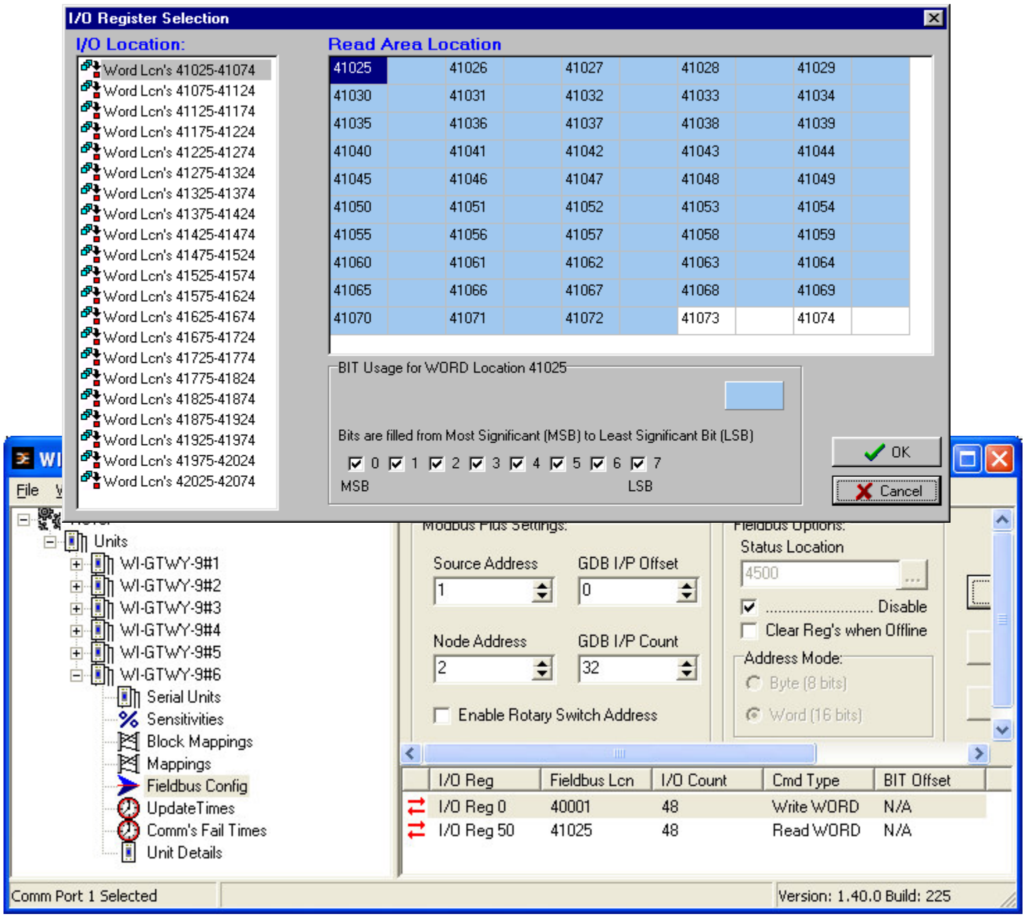
In the below example there is one "Fieldbus Write Mapping" (this will make available Data To Network) and one "Fieldbus Read Mapping" (this will make available Data From Network). When adding mappings, software will automatically adjust the available 40000 register address range depending on the command type (i.e. read or write fieldbus mapping), see below.

The I/O Register selection below for the fieldbus read mapping illustrates the allowable 40000 register address range base upon the chosen command type.

The fieldbus write mapping links the 48 I/O registers 0 – 47 to the fieldbus interface 4X registers 40001 – 40048. As described earlier, fieldbus interface registers 40001 – 40032 are always assigned as Global Data Out registers (i.e. Data To Network), these registers will be broadcast to the network on each token rotation cycle. The remaining registers (40033 – 40048) can be accessed via Modbus 40000 point-to-point Read Register commands described in section 4.14.3

NOTE - the option also exists for the Global Data output registers 40001 – 40032 to be read by the point-to-point commands also.

The fieldbus read mapping links the 48 fieldbus interface registers 41025 – 41072 to the I/O registers 50 – 97. As described earlier, fieldbus interface registers 41025 – 41056 are always assigned as Global Data In registers (i.e. Data From Network). These registers will be filled with Global Data broadcast by the “Source Unit” according to the “GDB I/P Offset” and “GDB I/P Count” parameters. In the above example, the values of the Offset = 0 and Count = 32, indicating that the entire 32 word Global Data broadcast from the Source Unit will be read into fieldbus interface registers 41025 – 41056. Other nodes on the network can write to the remaining registers (41057 – 41072) only by using the Modbus point-to-point Write Register commands described in section 4.14.3. NOTE – the point-to-point Write Register commands can *not* be used to write to the Global Data Input registers 41025 – 41056.



I/O Location:

- Word Lcn's 41025-41074
- Word Lcn's 41075-41124
- Word Lcn's 41125-41174
- Word Lcn's 41175-41224
- Word Lcn's 41225-41274
- Word Lcn's 41275-41324
- Word Lcn's 41325-41374
- Word Lcn's 41375-41424
- Word Lcn's 41425-41474
- Word Lcn's 41475-41524
- Word Lcn's 41525-41574
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- Word Lcn's 41625-41674
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- Word Lcn's 41725-41774
- Word Lcn's 41775-41824
- Word Lcn's 41825-41874
- Word Lcn's 41875-41924
- Word Lcn's 41925-41974
- Word Lcn's 41975-42024
- Word Lcn's 42025-42074

Read Area Location

41025	41026	41027	41028	41029
41030	41031	41032	41033	41034
41035	41036	41037	41038	41039
41040	41041	41042	41043	41044
41045	41046	41047	41048	41049
41050	41051	41052	41053	41054
41055	41056	41057	41058	41059
41060	41061	41062	41063	41064
41065	41066	41067	41068	41069
41070	41071	41072	41073	41074

BIT Usage for WORD Location 41025

Bits are filled from Most Significant (MSB) to Least Significant Bit (LSB)

☑ 0 ☑ 1 ☑ 2 ☑ 3 ☑ 4 ☑ 5 ☑ 6 ☑ 7
MSB LSB

- Units
  - WI-GTWY-9#1
  - WI-GTWY-9#2
  - WI-GTWY-9#3
  - WI-GTWY-9#4
  - WI-GTWY-9#5
  - WI-GTWY-9#6
    - Serial Units
    - Sensitivities
    - Block Mappings
    - Mappings
    - Fieldbus Config
    - UpdateTimes
    - Comm's Fail Times
    - Unit Details

Modbus Plus Settings:

Source Address: 1
GDB I/P Offset: 0
Node Address: 2
GDB I/P Count: 32
☐ Enable Rotary Switch Address

Fieldbus Options:

Status Location: 4500
☑ .... Disable
☐ Clear Reg's when Offline
Address Mode:
○ Byte (8 bits)
● Word (16 bits)

I/O Reg	Fieldbus Lcn	I/O Count	Cmd Type	BIT Offset
I/O Reg 0	40001	48	Write WORD	N/A
I/O Reg 50	41025	48	Read WORD	N/A

Comm Port 1 Selected

Version: 1.40.0 Build: 225

Finally, it must be taken into consideration that the WI-GTWY-9-xxx Modbus Plus module dynamically adjusts the 4X register range available to the network depending on the fieldbus mappings configured. The WI-GTWY-9-xxx will terminate the available 4X register range at the last mapped 4X register for both the read and write area. In the example above this means that the only 4X registers that are available to the Modbus Plus network are 40001 – 40048 and 41025 – 41072.

NOTE – considering this constraint, it is still strongly advised to use fieldbus interface registers always starting at the lowest addressed locations, thus limiting unnecessary processing overhead on the WI-GTWY-9-xxx.

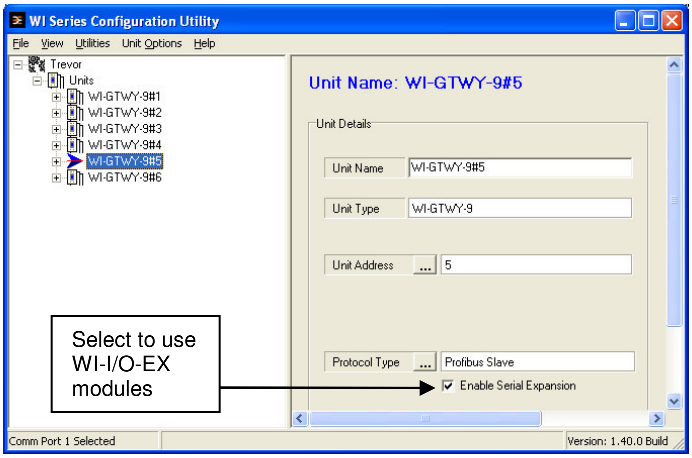
4.15 Connecting WI-I/O-EX-1-S-1x Serial I/O

NOTE – Serial I/O Expansion is only possible for WI-GTWY-9-xxx Firmware versions 1.50 onwards.

WI-I/O-EX-1-S-1x modules can be connected to the RS485 port of all WI-GTWY-9-xxx units except for the WI-GTWY-9-xxx-MD1 unit. WI-I/O-EX-1-S-1x modules can be connected to the MD1 if the WI-GTWY-9-xxx is configured as “Repeater-only” - refer section 4.4.8.

.Up to 31 x WI-I/O-EX-1-S-1x addresses can be connected to each WI-GTWY-9-xxx. The WI-I/O-EX-1-S-1x-1 and WI-I/O-EX-1-S-1x-2 modules use one address per module, and the WI-I/O-EX-1-S-1x-3 and WI-I/O-EX-1-S-1x-4 modules take up two addresses.

To enable the WI-GTWY-9-xxx serial port for WI-I/O-EX-1-S-1x expansion, select the “Enable Serial Expansion” box in the configuration software.



Unit Name: WI-GTWY-9#5

Unit Name: WI-GTWY-9#5

Unit Type: WI-GTWY-9

Unit Address: 5

Protocol Type: Profibus Slave

☑ Enable Serial Expansion

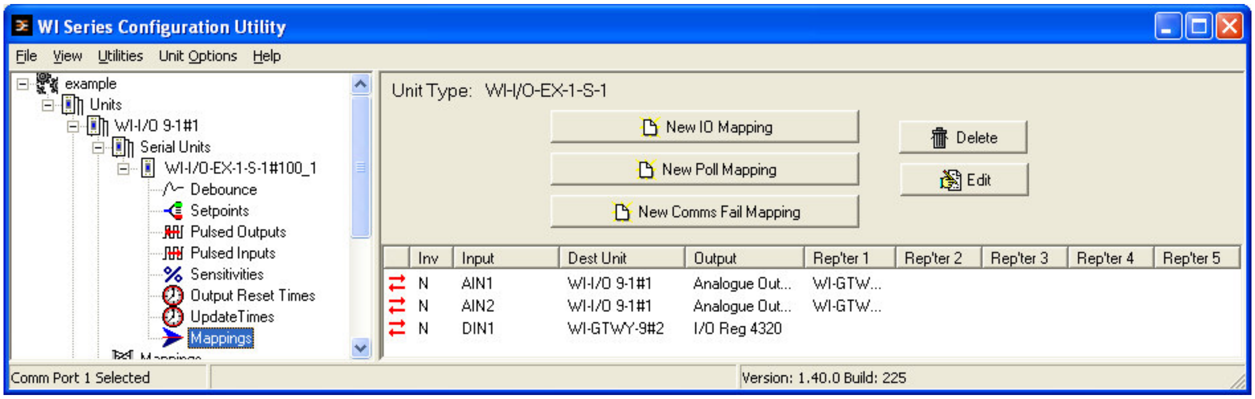
Comm Port 1 Selected

Version: 1.40.0 Build

Select to use WI-I/O-EX modules

Note that enabling WI-I/O-EX-1-S-1x expansion also disables on-line diagnostics via the serial port.

Mapping to or from the WI-I/O-EX-1-S-1x I/O is the same as if the WI-I/O-EX-1-S-1x modules are connected to a WI-I/O 9-x I/O module. Each WI-I/O-EX-1-S-1x module has an address between 96 and 127. The WI-GTWY-9-xxx acts as a repeater address in the mapping. The WI-GTWY-9-xxx I/O registers can also be mapped to/from the WI-I/O-EX-1-S-1x I/O.



Unit Type: WI-I/O-EX-1-S-1

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'ter 4	Rep'ter 5
N	AIN1	WI-I/O 9-1#1	Analogue Out...	WI-GTW...				
N	AIN2	WI-I/O 9-1#1	Analogue Out...	WI-GTW...				
N	DIN1	WI-GTWY-9#2	I/O Reg 4320					

Comm Port 1 Selected

Version: 1.40.0 Build: 225

4.16 Access to Message Buffer Count

The number of messages in buffers is stored in I/O registers for access from the data bus. This provides a powerful diagnostics feature for troubleshooting busy systems. The number of "free" messages is also provided - this is the amount of space available in the message buffers.

I/O Reg **Description**

4350 – Number of Free COS (change-of-state) messages (max. is 1500)

4351 – Number of Free Block Messages (for queuing block mappings and repeated messages – max. is 200)

4352 – Number of Free Ack Messages (max. is 10)

4353 – Number of Free "Rx Messages for Ethernet Monitor Comms only" (Max is 20)

4354 – Repeater messages queue (number of queued messages to be Repeated waiting to be sent)

4355 – Block Message queue (number of block mappings queued waiting to be sent)

4356 – COS Message queue (number of COS messages queued waiting to be sent)

4357 – Update Message queue (number of update messages queued waiting to be sent)

4358 – ACK queue (number of ACK messages queued waiting to be sent)

4359 – Radio Data Change queue (number of COS received on radio waiting to be sent through to fieldbus)

The following four are buffer empty alarms (i.e. hex 0000 for OK, hex FFFF for buffer empty)

4360 – Free COS message buffer empty alarm (i.e. triggered when reg 4350 is 0)

4361 – This register counts the number of times the above alarm has been triggered

4362 – Free Block message buffer empty alarm (i.e. triggered when reg 4351 is 0)

4362 - This register counts the number of times the above alarm has been triggered

Chapter 5 SPECIFICATIONS

General		
WI-I/O 9-x Radio standards	FCC Part 15A, Part 15.247	902 – 928 MHz, 1W
WI-I/O-1-x Radio standards	FCC Part 90, Part 15, RSS-119	380 – 520 MHz, 12.5 / 25KHz, 0.5 – 5W
Housing	130 x 185 x 60mm DIN rail mount Refer section 5.1 for dimensioned drawing	Powder-coated, extruded aluminium
Terminal blocks	Removable	Suitable for 12 gauge / 2.5 mm^2 conductors
LED indication	Power supply/OK, Active operation, digital I/O, Radio RX and TX, Serial RX and TX	
Operating Temperature	WI-GTWY-9-xxx-MD1 WI-GTWY-9-xxx-PR1 WI-GTWY-9-xxx-ET1 WI-GTWY-9-xxx-DE1 WI-GTWY-9-xxx-M+1	-40 to 140 degF, -40 to 60 degC 30 to 140 degF, 0 to 60 degC 30 to 140 degF, 0 to 60 degC 30 to 140 degF, 0 to 60 degC 30 to 140 degF, 0 to 60 degC
Humidity	0 – 99% RH non-condensing	
Power Supply		
Battery supply	11.3 - 15.0 VDC	
AC supply	12 - 24 VAC, 50/60 Hz	Overvoltage protected Battery required for 105U units with more than 2W RF power
DC supply	9 - 30 VDC	Overvoltage and reverse voltage protected > 17VDC required for charging battery Battery required for 105U units with more than 2W RF power
Battery Charging circuit	Included, suitable for 12Vsealed lead acid batteries	Regulated to max 1.5 amp charging current
Normal Current Drain at 12VDC	WI-GTWY-9-xxx-MD1 WI-GTWY-9-xxx-other	150 mA 270 mA 270 mA add 5mA per active I/O

Normal Current Drain at 24VDC	WI-GTWY-9-xxx-MD1 WI-GTWY-9-xxx-other	90 mA 170 mA add 3mA per active I/O
Radio transmitter inrush	WI-I/O 9-x 105U	350mA @ 13.8VDC; 250mA @ 24VDC 450mA @ 13.8VDC (0.5W) 600mA @ 13.8VDC (1W) 800mA @ 13.8VDC (2W) 1.25A @ 13.8VDC (5W)
Power fail status	Monitored	Can be transmitted to remote modules
Battery voltage	Monitored	Analog value can be transmitted Low voltage status can be transmitted
Radio Transceiver (WI-I/O 9-x)		
Spread spectrum	Frequency hopping	16 hop sequences x 100 channels
Frequency	USA/Canada Australia New Zealand	902 – 928 MHz 915 – 928 MHz 922 – 928 MHz
Transmission Power	1W	
Signal detect / RSSI	-120 to –40 dBm	
Expected line-of-sight range (subject to local conditions)	20 miles + @ 4W ERP 15 km + @ 1W ERP depending on local conditions	USA / Canada Australia / New Zealand Range may be extended by up to 5 intermediate modules as repeaters
Antenna Connector	Female SMA coaxial	
Data transmission rate	19200 baud	
Radio Transceiver (WI-I/O 1-x)		
Fixed Frequency	Channel spacing 12.5 / 25 KHz	380 – 400 MHz; 400 – 420 MHz; 420 – 440 MHz; 430 – 450 MHz; 450 – 470 MHz; 470 – 490 MHz, 490 – 512 MHz
Transmission Power	Configurable	0.5 – 5W
Signal detect / RSSI	-120 to –50 dBm	
Expected line-of-sight range (subject to local conditions)	70 miles @ 10W ERP 25 miles @ 2W ERP depending on local conditions	ERP allowed depends on license conditions Range may be extended by up to 5 intermediate modules as repeaters
Antenna Connector	Female SMA coaxial	
Data transmission rate	WI-I/O 9-x 105U	19200 b/s 9600 b/s (12.5KHz); 19200 b/s (25KHz)

Serial Ports		
RS232 Port	DB9 male DCE	RTS/CTS hardware signals provided
RS485 Port	2 pin terminal block	Typical distance 1 - 2 km
Data rate (bit/sec) - configurable	50, 75, 150, 300, 600, 1200, 2400, 4800, 9600, 19200	
Byte format	7 or 8 data bits	Stop/start/parity bits configurable
Profibus Port		
RS485 Port	Optically isolated	Autobaud detection 9.6 Kbit/sec – 12Mbit/sec
Ethernet Port		
RJ45	Transformer isolated	10/100 Mbit/sec
Digital I/O	Eight on-board I/O	3000V surge protection input, voltage free contact output, FET 30VDC 500mA

Chapter 6 DIAGNOSTICS

Bfore installing a new system, it is always best to set up the system on a bench to test the system configuration. It is always easier to detect problems when the modules are together.

After installation, test the radio paths, using the radio strength testing function described later in this section. Record the radio strength and background noise measurements for later reference (refer section 6.2.2 for this feature). If a later test shows that the radio path has changed, this may be the cause of a new problem.

6.1 Diagnostics Chart

The LED indicators on the WI-GTWY-9-xxx have the following meanings: -

INDICATOR	CONDITION	MEANING
OK	OFF continuously ON continuously	Module power off, or module failure Normal Operation
RADIO TX	Flashes yellow	Radio transmitting
RADIO RX	Flashes green Flashes red	Radio receiving good radio signal Radio receiving weak radio signal
SERIAL TX	Flashes yellow Brief flash each second	Sending serial data Configuration Mode
SERIAL RX	Flashes green Flashes red	Receiving serial data Serial RX buffer full
ACTIVE	OFF continuously ON continuously Flashes Yellow	Start-up initializing sequence Diagnostic or configuration menu Module in active operation Re-configuration required

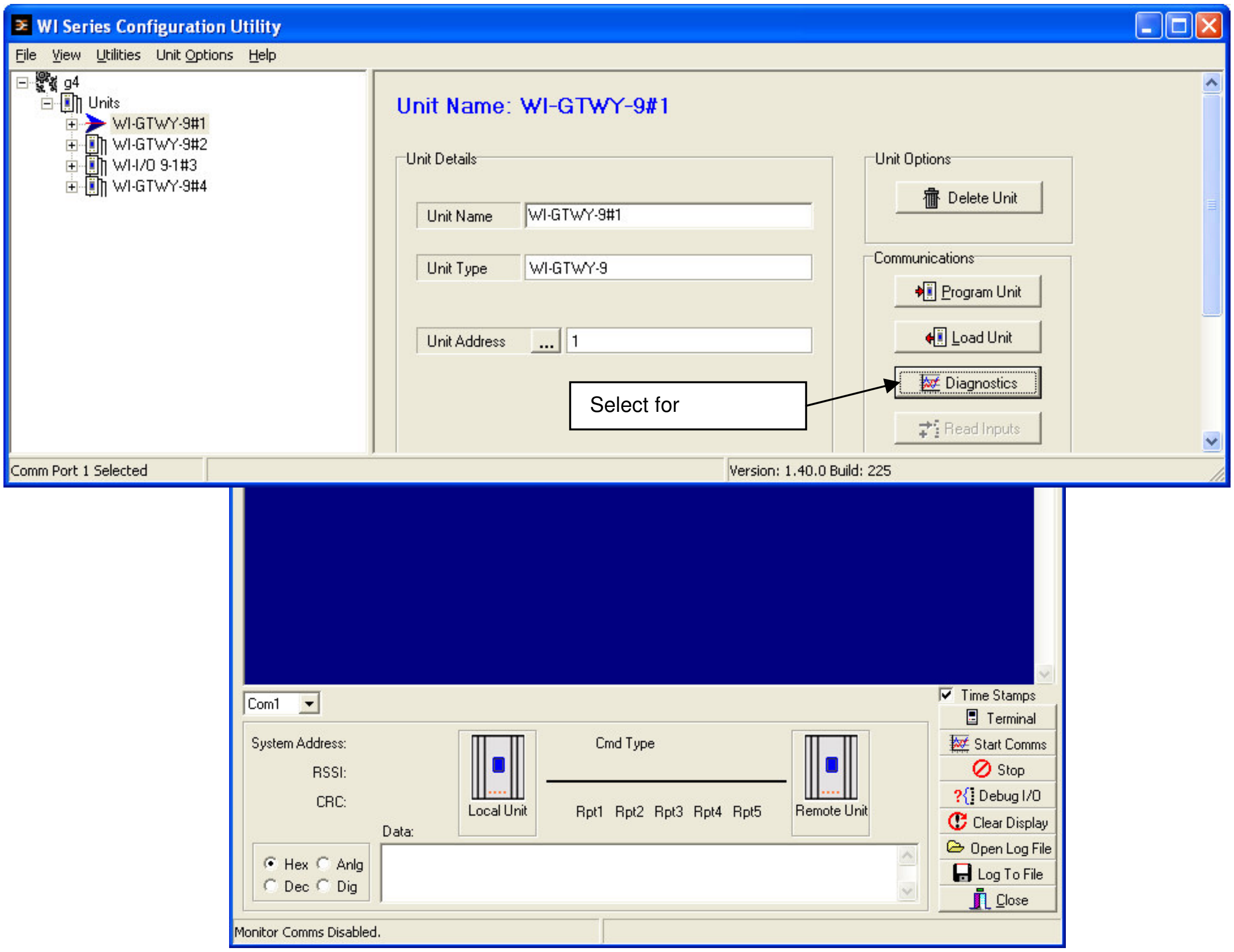
The Ethernet and Profibus modules also have four diagnostic LED's on the end-plate - refer section 6.4.

6.2 Diagnostics Menu

The WI-GTWY-9-xxx provides both offline and online diagnostic features to assist with troubleshooting. The offline diagnostics disable both the radio and fieldbus interface drivers, and are only used for simple radio tests such as “RSSI Measurement” or “Tone Reversals”. The online diagnostics provide more powerful debugging features such as access to the internal I/O Registers and Radio Communications Monitoring while the module is running (i.e. online).

When the configured protocol driver uses the shared RS232/485 port (i.e. Modbus, DF1, or Serial Driver), the online diagnostics must disable the serial protocol driver since the same serial port must be made available for diagnostics. However, the diagnostics still has full access to the radio network. For all other protocol drivers (Ethernet, Profibus, Modbus Plus, and DeviceNet), the serial port is already free and therefore online diagnostics can be used while the module is fully operational.

The module diagnostics can be accessed via any ‘terminal’ package (i.e. hyperterminal, procom), or via configuration software using the terminal available in the “Diagnostics” section. First, ensure that the WI-GTWY-9-xxx is connected to the PC using the RS232 configuration cable, and that the corresponding com port is selected. To access the terminal, select the WI-GTWY-9-xxx and press “Diagnostics”. Press the “terminal” button in the diagnostics window to open the terminal.



Unit Name: WI-GTWY-9#1

Unit Name: WI-GTWY-9#1

Unit Type: WI-GTWY-9

Unit Address: 1

☑ Time Stamps

● Hex ○ Anlg ○ Dec ○ Dig

Comm Port 1 Selected

Version: 1.40.0 Build: 225

Monitor Comms Disabled.

6.2.1 Offline Diagnostics:

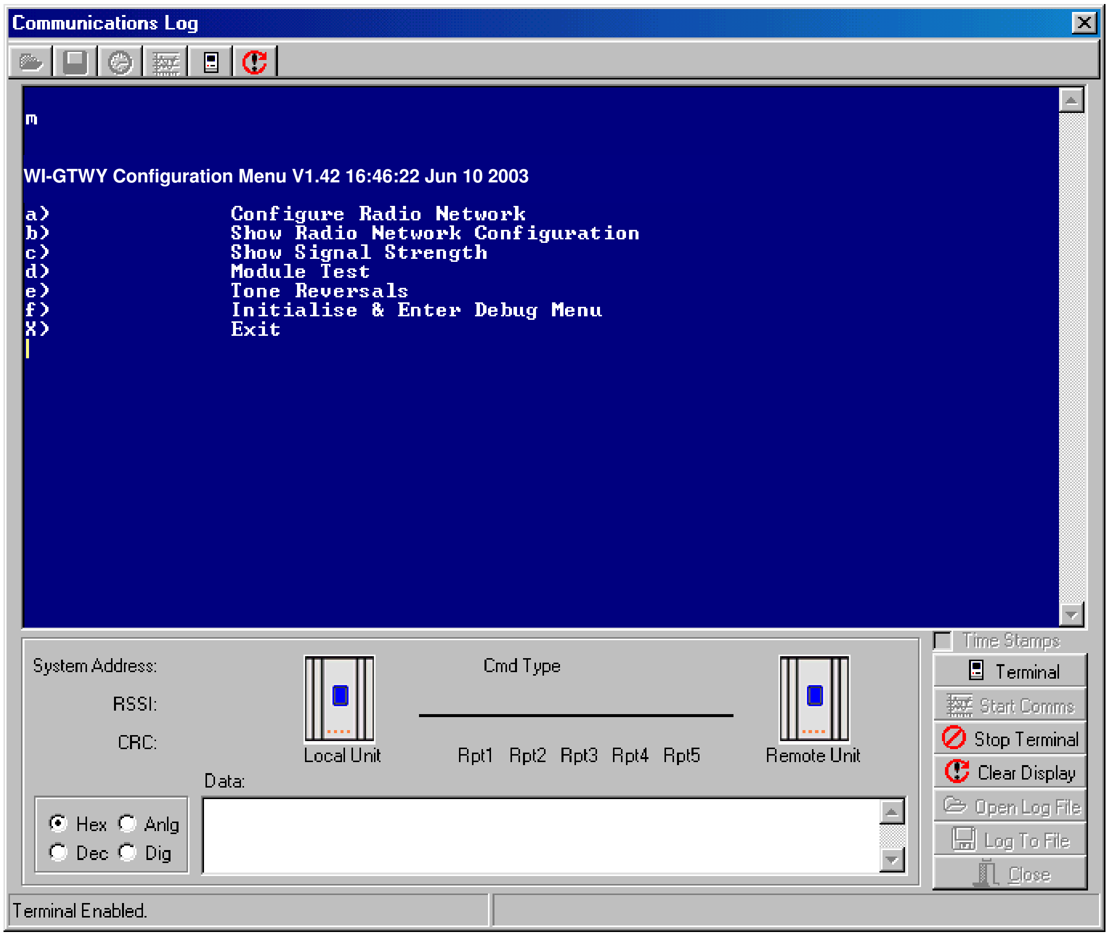
The offline diagnostics menu disables the radio protocol driver *and* the fieldbus protocol driver. Before displaying the offline debug menu open and start the “terminal” window in configuration software (see above), or use any third party terminal package.

To display the offline diagnostics menu:

- Put the WI-GTWY-9-xxx into configuration mode by pressing the small pushbutton switch in the end plate of the module for 5 seconds (as per section 4.9) until the ACT LED flashes - then release (then the ACT is off and the Serial TX LED flashes once every second);
- Type ‘m’ in the terminal window to get the off-line diagnostics menu.

The module will stop normal operations and a menu like the following will appear on the PC screen for all WI-GTWY-9-xxx versions.

Note: Options a), b) and d) are used in factory test and should not be selected.



```
m

WI-GTWY Configuration Menu V1.42 16:46:22 Jun 10 2003

a>              Configure Radio Network
b>              Show Radio Network Configuration
c>              Show Signal Strength
d>              Module Test
e>              Tone Reversals
f>              Initialise & Enter Debug Menu
X>              Exit
```

(c) Show Signal Strength

This option allows measurement of radio path between two locations. This is done by the display of the received radio signal strength at the connected WI-GTWY-9-xxx. With no transmitted signal from the other site, the display will show the strength of the background noise, which is normally between -100 and -130 dBm. At the other site, the transmitter may be turned on (select "e" at the other WI-GTWY-9-xxx, or "Tone Reversals" if the other module is a WI-I/O 9-x). The display will now show the received radio signal from the other transmitter.

The display will initially show the background noise of the radio band. Determine the approximate average of the noise level. The remote unit may then be set up for tone reversals (refer below). Determine the approximate average of the received signal strength. It is normal for the measured values to continually change - the radios are continually changing frequency. Calculate the best average for both the noise and signal.

For reliable operation, the average signal strength should be better than –98dBm (that is, -90dBm, not –100dBm) provided the average background noise is less than –108dBm (between –108 and –130 dBm). If the average noise is greater than –108, the difference between the noise level and the transmitter signal should be at least 10dB for reliable operation. For example, if the average noise level is -101dBm, then a transmitter signal of better than -91dBm is required for reliable operation.

Note the RSSI (received signal strength indication) of a received message is also stored in the database registers when the module is online - refer to section 2.5.1

e) Tone Reversals

If you select this option, the module will continuously transmit - you can use this feature for radio tests. Note that if you are powering the module from a battery only, the battery will be discharged quickly.

f) Initialize and Enter Debug Menu

This option will put the WI-GTWY-9-xxx in *online* debug mode. In online mode, the module will initialize the radio driver and go *online* to the radio network. Where possible, the fieldbus driver will also be initialized (i.e. for Ethernet, Profibus, Modbus Plus, and DeviceNet) – for Modbus, DF1, and Serial Driver the fieldbus driver will be disabled so that the serial port can be used for diagnostics. Note: before going online, the WI-GTWY-9-xxx must complete any "startup polls" that are configured – this may take some time depending on how many polls are configured.

x) Exit

The module will restart via its normal power-up and initialization sequence, and resume its normal operation mode. Select "Stop Terminal" to shut down the terminal and close the com port.

6.2.2 Online Diagnostics

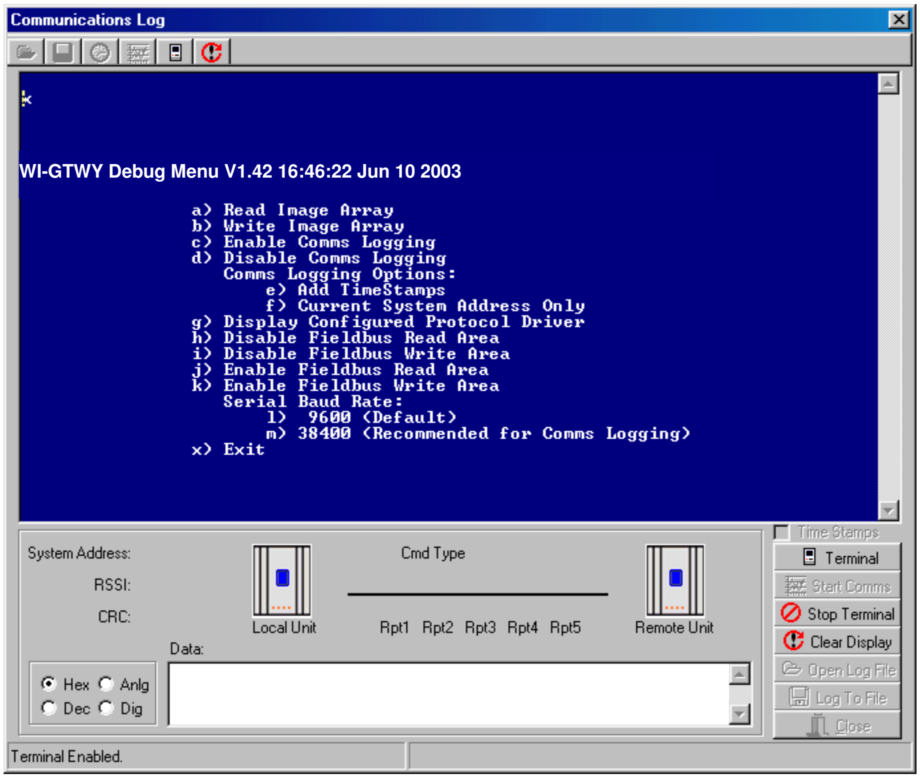
The online diagnostics menu enables the radio protocol driver *and* the fieldbus protocol driver (where possible) to provide online diagnostic information while the module is running. When the configured protocol driver uses the shared RS232/485 port (i.e. Modbus, DF1, or Serial Driver), the online diagnostics must disable the serial protocol driver since the same serial port must be made available for diagnostics.

To access the online diagnostics menu, first connect to the "terminal" in configuration software (see above) or use any third party terminal package. Once the terminal is connected, display the menu using the following procedure:

- If the configured protocol driver uses the shared RS232/485 port (i.e. Modbus, DF1, or Driver), first enter the *offline* diagnostics menu (see 6.2.1 “Offline Diagnostics” above). From the offline menu, select option “f) Initialize and Enter debug Menu”. Once initialized the online menu will be displayed.

- For Ethernet, Profibus, Modbus Plus, or DeviceNet protocol drivers, simply press "Enter" to display the menu. If the module was previously in configuration mode or the offline menu, then first reset power to the module.

A menu like the following will appear on the PC screen for the all models, however



```
WI-GTWY Debug Menu V1.42 16:46:22 Jun 10 2003

                    a) Read Image Array
                    b) Write Image Array
                    c) Enable Comms Logging
                    d) Disable Comms Logging
                       Comms Logging Options:
                           e) Add TimeStamps
                           f) Current System Address Only
                    g) Display Configured Protocol Driver
                    h) Disable Fieldbus Read Area
                    i) Disable Fieldbus Write Area
                    j) Enable Fieldbus Read Area
                    k) Enable Fieldbus Write Area
                       Serial Baud Rate:
                           l)  9600 (Default)
                           m) 38400 (Recommended for Comms Logging)
                    x) Exit
```

● Hex ○ Anlg
○ Dec ○ Dig

Terminal Enabled.

Modbus/DF1 model will not have options h) through k).

The online diagnostics menu is also referred to as the “Debug” menu. The Debug Menu allows the Radio Interface (I/O Registers) to be viewed and modified to confirm the operation of the radio network. These options may be used to check operation of outputs at remote sites, and to check the values of inputs reported from remote sites. When the protocol driver does *not* use the shared RS232/485 port (Ethernet, Profibus, DeviceNet, and Modbus Plus) data is also exchanged with the fieldbus and the I/O Registers according to the configured fieldbus mappings.

Option a) Read Image Array

Displays the I/O registers of the Radio Interface - the register values for a block of 50 registers are updated every 1 second. For example, to display the I/O Database value at locations 0 to 49.

Select a), then enter Location: 0

```
0 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000
```

```
 10 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000
 20 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000
30 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000
40 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000 0x0000
```

Note that I/O Image locations are specified in decimal, whereas register values are displayed and specified in hexadecimal. If you want the WI-GTWY-9-xxx to stop the host device writing values to the I/O database at the same time, then select option i) Disable Fieldbus Write Area.

Press “Enter” to go back to the menu.

Option b) Write Image Array

This option allows you to change the value of an I/O register in the Radio Interface.

To change the value of a register, select option b) write image array.

Enter the location, then the value to be written to the register – for example

```
b

Location: 12

New Value: 0xFFFF
```

Register values should always be written in hexadecimal format. If you want the WI-GTWY-9-xxx to stop the host device reading or writing values to the I/O database at the same time, then select option h) or i).

Options c), d) Enable/Disable Comms logging

These options allow logging and display of radio communications. Once enabled, the radio communications that are displayed is the radio traffic in raw format (i.e. the raw data frame for each received packet is displayed in hexadecimal format). To decode the meaning of each radio data packet, configuration software can be used to decode the data frames.

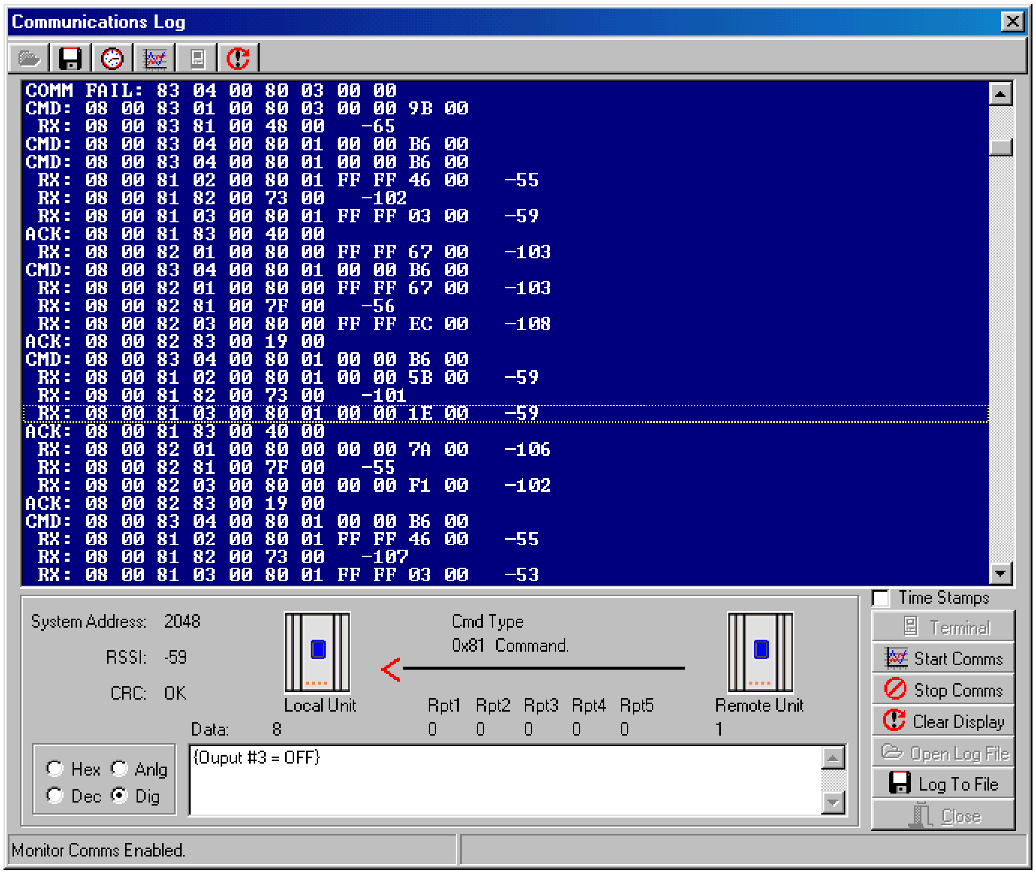
- To decode the radio traffic using configuration software, first start communications logging by selecting option “c) Enable Comms Logging” from the debug menu. Next, in the diagnostics screen select ‘Stop Terminal’ and then ‘Start Comms’. Configuration software now expects the WI-GTWY-9-xxx to be in monitor comms mode, and will decode all radio communications.

The display will show radio messages transmitted and received. Messages starting with RX are received messages, CMD are transmitted messages and ACK are acknowledgment messages. At the end of each received message is the RSSI (radio signal strength indication) in dBm.

If you select any message line with the mouse, information about the message will be displayed at the bottom of the screen - the system address, RSSI and CRC (error-check) status. The “text box” at the bottom middle of the screen decodes the message - that is, it decodes the message to display I/O channel and value. Note – Configuration software can only decode the message completely if the same configuration project corresponding to the system being monitored is open.

You can display the register values in Decimal by selecting “Dec” at the bottom of the screen. If you select “Dig”, the values will be displayed as a 0 or 1 digital value (1 if the 16-bit value is greater than 50% - that is, the most significant bit is 1). If you select “Anlg”, the value will be displayed as a 4-20mA range.

To stop the decoding of “comms logging”, select the “Stop Comms” button. You should then also stop the WI-GTWY-9-xxx from outputting radio comms by pulling up the terminal menu (i.e. press “terminal” and then hit enter in the terminal screen) and selecting “d) Disable Comms Logging”.



```
COMM FAIL: 83 04 00 80 03 00 00
CMD: 08 00 83 01 00 80 03 00 00 9B 00
 RX: 08 00 83 81 00 48 00    -65
CMD: 08 00 83 04 00 80 01 00 00 B6 00
CMD: 08 00 83 04 00 80 01 00 00 B6 00
 RX: 08 00 81 02 00 80 01 FF FF 46 00    -55
 RX: 08 00 81 82 00 73 00    -102
 RX: 08 00 81 03 00 80 01 FF FF 03 00    -59
ACK: 08 00 81 83 00 40 00
 RX: 08 00 82 01 00 80 00 FF FF 67 00    -103
CMD: 08 00 83 04 00 80 01 00 00 B6 00
 RX: 08 00 82 01 00 80 00 FF FF 67 00    -103
 RX: 08 00 82 81 00 7F 00    -56
 RX: 08 00 82 03 00 80 00 FF FF EC 00    -108
ACK: 08 00 82 83 00 19 00
CMD: 08 00 83 04 00 80 01 00 00 B6 00
 RX: 08 00 81 02 00 80 01 00 00 5B 00    -59
 RX: 08 00 81 82 00 73 00    -101
 RX: 08 00 81 03 00 80 01 00 00 1E 00    -59
ACK: 08 00 81 83 00 40 00
 RX: 08 00 82 01 00 80 00 00 00 7A 00    -106
 RX: 08 00 82 81 00 7F 00    -55
 RX: 08 00 82 03 00 80 00 00 00 F1 00    -102
ACK: 08 00 82 83 00 19 00
CMD: 08 00 83 04 00 80 01 00 00 B6 00
 RX: 08 00 81 02 00 80 01 FF FF 46 00    -55
 RX: 08 00 81 82 00 73 00    -107
 RX: 08 00 81 03 00 80 01 FF FF 03 00    -53
```

☐ Time Stamps

System Address: 2048
RSSI: -59
CRC: OK

Cmd Type
0x81 Command.

Data:	8	Rpt1	Rpt2	Rpt3	Rpt4	Rpt5	Remote Unit
		0	0	0	0	0	1

○ Hex ○ Anlg
○ Dec ● Dig

{Ouput #3 = OFF}

Monitor Comms Enabled.

Option e) Add Time Stamps

This option in the debug menu will add a timestamp to each displayed radio message. The timestamp is based on the WI-GTWY-9-xxx internal real time clock. This option is normally used only if monitoring is done from a terminal package only, and configuration software is *not* being used to decode the communications.

When configuration software is being used to decode the radio comms (see above) time stamps can be added by selecting the “Time Stamps” checkbox. This will display the current time and date (according to the PC Clock) alongside each message. The “Comms log” can be saved to a file for future reference by selecting “Log to File”.

Option f) Current System Address only

This option will ensure that only radio messages that have the same system address as the connected WI-GTWY-9-xxx are displayed. If you have another system with a different system address these messages will not be displayed if you choose this option. This option is useful where there is more than one system in the same area so that only the radio messages relevant to the desired system will be displayed.

Option g) Display Configured Protocol Driver

This option displays the configured Protocol Driver for this unit e.g.

Configured Protocol is: Ethernet TCP-IT

Option h, i, j, k) Enable/Disable Fieldbus Read/Write Area

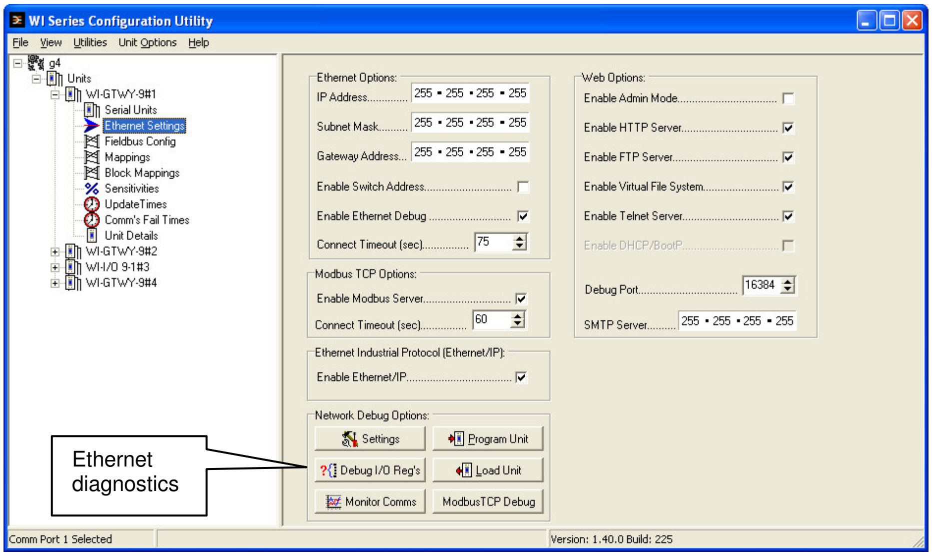
(These options not available on the Modbus/DF1 version)

This option is used to halt data exchange between the Fieldbus Interface and the Radio Interface (I/O Registers). This is mainly used when trying to read or write image arrays. If the Fieldbus read area "h" is not disabled when trying to read or write to the I/O registers then the value in the Fieldbus database will overwrite the I/O register and you may get an incorrect value.

When doing read/write image array and the module has been configured with Fieldbus mappings, you may need to disable the Fieldbus read area option h. This stops the Fieldbus database overwriting the radio database.

6.3 Ethernet Diagnostics

Read and Write image array can also be done via the Ethernet port by selecting 'Debug I/O Registers' from within the Ethernet Settings window in the configuration software. The IP address of the module must have previously been configured in the module - refer to section 4.8.2 for setting IP address.



Ethernet Options:
IP Address............ 255 • 255 • 255 • 255
Subnet Mask......... 255 • 255 • 255 • 255
Gateway Address... 255 • 255 • 255 • 255
Enable Switch Address............................ ☐
Enable Ethernet Debug .... ☑
Connect Timeout (sec)............... 75

Modbus TCP Options:
Enable Modbus Server............................ ☑
Connect Timeout (sec)............... 60

Ethernet Industrial Protocol (Ethernet/IP):
Enable Ethernet/IP.................................. ☑

Network Debug Options:

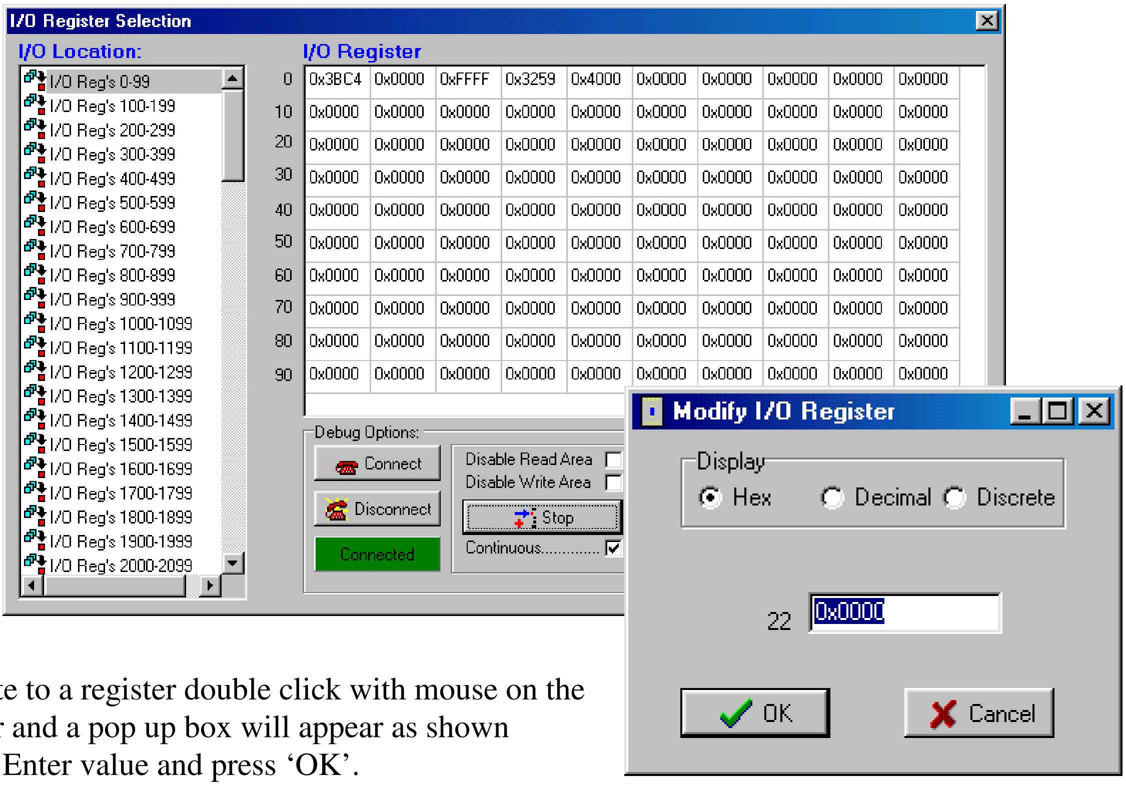
Web Options:
Enable Admin Mode................................ ☐
Enable HTTP Server............................... ☑
Enable FTP Server.................................. ☑
Enable Virtual File System........................ ☑
Enable Telnet Server............................... ☑
Enable DHCP/BootP............................... ☐
Debug Port................................ 16384
SMTP Server......... 255 • 255 • 255 • 255

Comm Port 1 Selected

Version: 1.40.0 Build: 225

Ethernet diagnostics

To debug the registers you will need to select 'Connect' under Debug Options. The Green / Red box will indicate the Connected / Disconnected State. Once connected select "Read" and check "Continuous". The display option allows you to view the registers in different formats, and you can select which I/O register you want to view from the left-hand side of the screen.



I/O Location:

- I/O Reg's 0-99
- I/O Reg's 100-199
- I/O Reg's 200-299
- I/O Reg's 300-399
- I/O Reg's 400-499
- I/O Reg's 500-599
- I/O Reg's 600-699
- I/O Reg's 700-799
- I/O Reg's 800-899
- I/O Reg's 900-999
- I/O Reg's 1000-1099
- I/O Reg's 1100-1199
- I/O Reg's 1200-1299
- I/O Reg's 1300-1399
- I/O Reg's 1400-1499
- I/O Reg's 1500-1599
- I/O Reg's 1600-1699
- I/O Reg's 1700-1799
- I/O Reg's 1800-1899
- I/O Reg's 1900-1999
- I/O Reg's 2000-2099

0	0x3BC4	0x0000	0xFFFF	0x3259	0x4000	0x0000	0x0000	0x0000	0x0000	0x0000
10	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
20	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
30	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
40	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
50	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
60	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
70	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
80	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
90	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000

Disable Read Area ☐
Disable Write Area ☐
Continuous............ ☑

Display: ● Hex ○ Decimal ○ Discrete

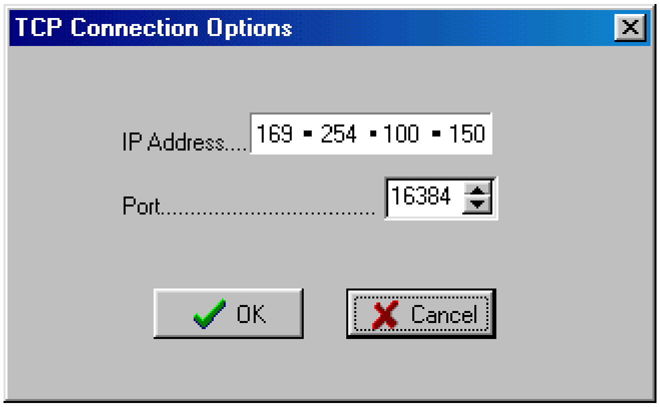
22 0x0000

To write to a register double click with mouse on the register and a pop up box will appear as shown below. Enter value and press ‘OK’.

You can disable the links between the I/O registers and the Ethernet interface by selecting “Disable Read Area” and “Disable Write Area” - if you do this, remember to re-enable before you leave the diagnostics screen.

Settings

You can change your TCP Connection setting i.e. IP address and port.



IP Address.... 169 . 254 . 100 . 150
Port.................................... 16384

Program / Load Unit

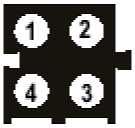
These options allow you to program and upload the configuration from the module via the Ethernet port. Must ensure the IP address has been set on the module before uploading the Configuration

Monitor Comms

Configuration software also provides the option to monitor the radio network communications via the Ethernet port. This allows radio traffic to be monitored from any location where an Ethernet connection to the WI-GTWY-9-xxx can be established. Simply select ‘Monitor Comms’ from the Network Debug Options section of the Ethernet Settings page. Functionality is as per section 6.2.2c above.

6.4 Fieldbus Indicating LEDs

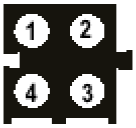
All WI-GTWY-9-xxx modules (*except* MD1) are equipped with four fieldbus indication LED's located in the module end plate, used for diagnostics purposes. The meaning of the LED's for each fieldbus is described below.



6.4.1 Ethernet Indicating LED's

LED no	**Color**	**State**	**Description**
1	Green	-	The Link LED indicates that the module is connected to an Ethernet network.
2	Green	Off	No power applied to module.
2	Green	Steady	Device operating correctly.
2	Green	Flashing	Module has not been configured.
2	Red	Flashing	Minor recoverable fault has been detected.
2	Red	Steady	Major internal error has been detected.
2	Green/Red	Flashing	Power on self-test.
3	Green	Off	No power applied or no IP address has been assigned.
3	Green	Steady	Module has at least one Ethernet/IP connection established.
3	Green	Flashing	No Ethernet/IP connections to the module.
3	Red	Flashing	Connection timeout
3	Red	Steady	Duplicate IP address
3	Green/Red	Flashing	Power on self-test.
4	Green	Flashing	Flashes each time a packet is received or transmitted.

6.4.2 Profibus Slave Indicating LED's

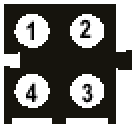


LED No	Indication	Description
1	-	Not Used
2	Green	Module is On-Line and data exchange is possible.
2	Off	Module is not On-Line
3	Red	Module is Off-Line and no data exchange is possible.
3	Off	Module is not Off-Line
4	Flashing Red 1 Hz	Error in configuration: IN and/or OUT length set during initialization of the module is not equal to the length set during configuration of the network.
4	Flashing Red 2 Hz	Error in User Parameter data: The length/contents of the User Parameter data set during initialization of the module is not equal to the length/contents set during configuration of the network.
4	Flashing Red 4 Hz	Error in initialization of the Profibus communication ASIC.
4	Off	No diagnostics present

6.4.3 Profibus Master Indicating LED’s

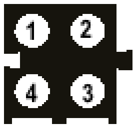
LED No	Indication	Description
1. Master Status	Green	Operate mode
	Green, flashing	Clear mode
	Red	Stop mode
	Off	Offline
2. Database Status	Green	Database OK
	Green, flashing	Database download in progress
	Red	Database invalid
	Off	No database downloaded
4. Communication Status	Green	Data exchange with all configured slaves
	Green, flashing	Data exchange with at least one configured slave
	Red	Bus control error (bus short circuit or configuration error)
	Off	No data exchange with any of the configured slaves
5. Token Hold	Green	The module has the token
	Off	The module does not have the token
All	Red	Fatal error

6.4.4 Modbus Indicating LED’s



LED No	Indication	Description
1	-	Not Used
2	Active Red	**ERROR;** This LED indicates that communication is not OK.
3	Green	**MBP Active;** This LED flashes in different patterns depending on the module’s health (see below). **Flash every 160 ms; on 80ms, then off 80 ms.** Normal operation, the node is receiving and passing token. **Flash every 1 s:** This node is in MONITOR_OFFLINE state. **2 flashes, on 160 ms, then off 480 ms:** This node is in MAC_IDLE never-getting-token state. **3 flashes, on 160 ms, off 240 ms and finally off 1.6 s:** This node is not hearing any other nodes. **4 flashes, on 160 ms, then off 240 ms and finally off 1.2 s:** This node has detected duplicate node address.
4	Active Green	**MBP Init;** This LED indicates if the fieldbus interface is initialized

6.4.5 DeviceNet Indicating LED’s



LED No	Color	State	Description
1	-	-	Reserved for future use
2	-	Off	Not powered / Not online
2	Green	Steady	Link OK, On line, Connected
2	Green	Flashing	On line, Not connected
2	Red	Flashing	Connection timeout
2	Red	Steady	Critical link failure
2	Green/Red	Flashing	Power on self-test.
3	-	Off	No power to device
3	Green	Steady	Device operational
3	Green	Flashing	Data size bigger than configured
3	Red	Flashing	Minor fault
3	Red	Steady	Unrecoverable fault
3	Green/Red	Flashing	Power on self-test.
4	-	-	Reserved for future use

6.5 Radio Path Testing

To carry out a radio path test, you will need two WI-I/O 9-x modules. One module will be “fixed” and the other “mobile”. Both units will need power supplies and antennas. The power supply for the mobile unit is normally a 12V battery, but make sure that the battery is fully charged - batteries with low voltage will lead to low radio power which will affect the test result.

The object of the test is to determine whether radio paths are reliable, marginal or unreliable. A reliable path will have a margin of at least 10dB above the background noise level in good weather - this margin is enough to ensure that the radio path remains reliable in poor conditions. A marginal path will work reliably in good conditions, however will fail during poor conditions. If the test is carried out during rainy or foggy weather, then a margin of only 5dB is required.

Procedure:

- ☐ Configure the modules to the same system address, and on each module, configure DI1 to DO2 on the other module. At the fixed module, wire DO2 to DI1 such that DI1 will turn ON when DO2 turns ON. Connect a switch to DI1 on the mobile unit.
- ☐ When the modules are close to each other, test the system - close the switch, forcing the mobile unit to transmit. The mobile unit will transmit to the fixed unit, and the fixed unit will transmit back to the mobile unit, activating DO2. Turning off the switch will result in two radio transmissions, turning off DO2. Each time the switch is changed, there should be two radio messages (two sets of TX/RX flashes) at the mobile unit. Note that when the modules are within a couple of metres, they may not work well with antennas connected - in this case, test without antennas.
- ☐ Set up the fixed module in one of the test positions - this is normally at a control centre or repeater site. Fix the antenna in a temporary fashion. You will need to make an initial assessment on how high the antenna should be mounted.
- ☐ Take the mobile module to the other end of the radio path. The antenna at this end can be either held by the tester, or fixed in a temporary fashion. Note that a person's body will affect the radiation pattern of an antenna, so if the antenna is hand-held and the test is not successful, try again with the antenna fixed to a 1 metre length of plastic pipe or timber. The tester holds the length of pipe or timber with the antenna above head height.
- ☐ Test the radio path by operating the switch. If the radio path is short, and there is a high level of confidence that the radio path will be reliable, the result can be checked by simply looking at the TX/RX LEDs on the mobile unit. If each TX flash is followed immediately by a RX flash (that is, the TX flash does not flash twice or more times before the RX flashes), then the radio path is likely to be reliable. Operate the switch several times - do not rely on one test. If the test is being done outside, the LEDs will need to be shaded to view the flashes.
- ☐ If the radio path is uncertain, then the result should be measured by connecting a laptop computer, following the procedure outlined in this manual for measuring the radio signal strength. Before the switch is operated, the background noise level should be measured and recorded. This measurement is likely to "jump around" or oscillate, to determine an average measurement. Now operate the switch several times - take the average measurement of the signal transmitted from the fixed unit.
- ☐ The radio path is reliable if the transmitted signal is 10dB above the noise level, or better than –98dBm. For example, if the noise level is –115dBm, then the minimum level for reliability is –98dBm. If the noise level is –100dBm, then you need –90dBm for a reliable path. If the laptop displays a scale measurement instead of a numerical measurement, then the transmitted signal should be at least 3 divisions, and at least 2 divisions above the noise level.
- ☐ If the weather is poor during the test, then the transmitted signal needs to be 5dB above noise, or 1 division. It is best not to do radio tests during poor weather.
- ☐ Record these measurements for comparison later during commissioning or if the system has problems later.

If the radio path test is not successful:

1. Increasing the height of the antenna at either module, or at both modules can significantly improve the result. Sometimes moving the antenna to the side helps, if there is an obvious obstruction in the radio path.
2. Change one or both antennas to a higher gain if regulations allow.
3. Use a shorter coaxial cable between the antenna and the WI-I/O 9-x.(this may involve moving WI-I/O 9-x nearer to antenna mounting), or use a different coaxial cable with lower loss.
4. If a reliable radio path is not possible because of distance or path obstructions, you will need to consider using a repeater module. The ideal repeater is another module in the system, in a good location to act as a repeater. If this is not the case, you need to consider installing a module to act specifically as a repeater.

Chapter 7 WARRANTY

We are pleased that you have purchased this product.

W Interconnections products are warranted to be free from manufacturing defects for the “serviceable lifetime” of the product. The “serviceable lifetime” is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W Interconnections , W Interconnections will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W Interconnections’ liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W Interconnections is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W Interconnections is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W Interconnections or its representatives or by any other party, except as expressed solely in this document..

Full product specifications and maintenance instructions are available from your Service Agent, your source of purchase, or from the master distributor in your country upon request and should be noted if you are in any doubt about the operating environment for your equipment purchase

In the unlikely event of your purchase being faulty, your warranty extends to free repair or replacement of the faulty unit, after its receipt at the master distributor in your country. Our warranty does not include transport or insurance charges relating to a warranty claim.

Should you wish to make a warranty claim, or obtain service, please forward the module to the nearest authorized Service Agent along with proof of purchase. For details of authorized Service Agents, contact your sales distributor.

Appendix 1 Status Registers

I/O Status Registers 5000 - 9499

Bit	Information	Meaning
15	Communications failure	For inputs, this bit is set ("on") if no message has been received from the remote address within the timeout period configured for this input. The bit is reset ("off") when a message is received. For outputs, this bit is set ("on") if transmission to the remote was unsuccessful after five attempts. The bit is reset ("off") when a message is transmitted successfully. This bit may also be set if the Disable Output Transmissions on Comms Fail option is selected - see the Radio Comms Failure section.
14	Start-up status	For inputs, this bit remains set ("on") following start-up until a message has been received for this input to give an initial input value. For outputs, this bit remains set ("on") following start-up until the WI-GTWY-9-xxx sends the first radio message for this output to the remote address.
13	Input / Output status	This bit is set ("on") if this I/O point has been configured as an input.
12	Active status	This bit is set ("on") if the register has been configured as an I/O point.
11-10	Timer Units	This field determines whether the timer counts down every 10 seconds, every minute, or every hour. Timer Units — Timer timebase 00 — Every 10 seconds 01 — Every minute 10 — Every Hour 11 — Every Hour
9 - 0	Timer	For inputs, the timer value is set to the configured comms fail time for the input whenever a message has been received for this input. The timer value will decrease until another message is received. When the timer value reaches zero, the comms fail status is set. If the configured comms fail time is zero, then the comms fail status for this input is never set. For outputs, the timer value is set to the configured update time for the output whenever a message is transmitted by the GTWY-9-xxx to the remote address. The timer value decreases. When the timer value reaches zero, another update message is transmitted to the remote address. If the configured update time is zero, no update messages are transmitted for this output.

Block Message Status Registers 9500 - 9999

Bit	Information	Meaning
15	Communications failure	For read commands – Read Bits and Read Words – This bit is set if no response is received to the read command after a timeout, or if a communication fail response is received to a read. For Write Commands this bit is set if a communication failure response is received to the write command. For a Poll command, this bit should not be set.
14	Startup	This bit is set initially, and remains set until the first time the command executes.
13	Force	*To force the command to happen immediately regardless of the current timer value, write a '1' to this bit.
12	Waiting	This bit is set when the command is active. For Write commands, the command delays before sending to see if any more changes occur. For Read commands, the command delays while waiting for a response from the remote device.
11-0	Timer	When the Waiting bit is clear, this field is either zero, or contains the time (in seconds) until the command next becomes active. If this field is zero, the field will be loaded with the configured delay value at the next update time. When the Waiting bit is set, and the command is a read command, this field contains the time in seconds, within which a reply is expected. If no reply is received within this time, the Communications failure bit is set. When the Waiting bit is set, and the command is a write command, the field contains the time, in seconds before the write command is transmitted.

Using the Force Bit:

* Firmware versions prior to 1.50:

If Bit 13 is set to '1', then the associated mapping is triggered. When the radio message is sent, the WI-GTWY-9-xxx automatically turns Bit 13 "off" again - ready for the host device to trigger the mapping again.

* Firmware version 1.50 and later:

Only Bit 13 of registers 9500 – 9999 may be altered by a host device (i.e. via the fieldbus interface). For WI-GTWY-9-xxx modules with firmware versions later than 1.50, the setting of registers 9500 – 9999 must follow the new change-of-state algorithm. The *Force* bit will only be activated on a transition from 0 – 1. For example to force the corresponding block mapping, first set the Force bit to '0', then set the value of the Force bit to '1' (i.e. by always first writing the value 0 this ensures that the change-of-state from 0 will be detected). Values must be held (i.e. not change) for approx. 200msec to be detected.

Appendix 2 IT Functionality

WI-GTWY-9-xxx-ET1 Ethernet module only

Filesystem

The filesystem is a fixed-size storage area with a hierarchical directory structure. Any user- or application data can be stored in files within the filesystem. Files can be grouped in directories for increased readability.

The filesystem features two security levels. Depending on security level, different users can have access to different files and directories. The filesystem can be accessed via FTP, Telnet, and HTTP.

- **Case Sensitivity**

  The file system is case sensitive. This means that the file 'TEST.txt' is not identical to the file 'test.TXT'.

- **Filename / Pathname length**

  Filenames can be a maximum of 48 characters long. Pathnames can be 256 characters in total, filename included.

- **File size**

  File size is not restricted. However, the size cannot exceed the space available in the file system.

- **Free space**

  Approximately 1.4MB non-volatile (FLASH).

Security

The file system features two security levels; Admin and Normal. Security level is set at a per user basis, or globally via setting Admin Mode in configuration software Ethernet Settings.

- **Normal Mode**

  This mode is recommended for normal operation, so that web pages and other settings are protected from FTP and Telnet access. In this mode, the FTP and Telnet servers are enabled *only* if there is a subdirectory called "\user". When a normal user connects via FTP or Telnet, this directory will be their root directory. The user will not be able to access files outside this directory and it's subdirectories.

  If user/password protection for FTP and Telnet is required in normal mode, a file called "sys_pswd.cfg" must be placed in the directory "\user\pswd\". Files in this directory cannot be accessed from a web browser. If Admin Mode has not been enabled by configuration software and a valid admin password file (See "System Files") is found, the module will operate in this mode (i.e. an admin password file with at least one entry *must* exist, *and* the "\user" directory *must* exist to enable this mode).

- **Admin Mode**

  Admin users have full access to the filesystem through FTP and Telnet. This enables the user to access areas of the filesystem that are restricted or inaccessible in Normal mode. The Admin user accounts are defined in the file 'ad_pswd.cfg'.

If no admin password file (See "System Files") is found or Admin Mode is set by configuration software, the module will run in Admin Mode; i.e. all users will have Admin access rights. No login is needed for Telnet, and the FTP server accepts any username/password combination. Admin Mode is primarily intended for product configuration and testing.

Files within the file system can be protected from web (i.e. HTTP) access through username/password authorization, see sections below on "System Files" and "web_accs.cfg". It is also possible to configure which IP addresses and what protocols are allowed to connect to the module, see "ip_accs.cfg".

System Files

The module uses system files for configuration purposes (see file system "Structure" below). In most cases these files have the file extension '.cfg' and must be created or edited by the user to achieve the desired configuration. The system files are ASCII (text) files and can be edited with any text editor, or copied/moved to/from the file system using FTP or Telnet. Depending on security settings, the files may be inaccessible for normal users. Generally, the module has to be restarted in order for any changes in these files to have effect.

Note: It is very important to follow the exact syntax specifications for each configuration file, otherwise the module might have problems interpreting it, which can result in a faulty or non-expected behaviour.

ad_pswd.cfg & sys_pswd.cfg

User/password information for FTP and Telnet is stored in the files 'sys_pswd.cfg' (Normal users) and 'ad_pswd.cfg' (Admin users) – see "Security" above. These files must be placed in '\user\pswd' and '\pswd\ respectively. These directories are protected from web browser access.

The file format is the following:

```
User1:password1

User2:password2

...

User3:password3
```

Example:

```
TEST:WI-GTWY-9-xxx
```

In this example, the username is 'TEST', and the password is 'WI-GTWY-9-xxx'. If no ':' is present, the password will be equal to the username.

web_accs.cfg

To protect a directory from web access, a file called 'web_accs.cfg' must be placed in the directory to protect. This file shall contain a list of users that are allowed to browse the protected directory and its subdirectories. Multiple of these password files may be present in the system, allowing different users to access different files and directories.

The file format is the same as for the 'ad_pswd.cfg' and 'sys_pswd.cfg' files, except that the optional parameter 'AuthName' can be added. The value of this parameter will be presented in the login window. If it is not given, the requested file/pathname will be presented instead.

File format:

```
User:Password
[AuthName]
(Message goes here)
```

The contents of this file can be redirected by placing the line '[File path]' on the first row, followed by a list of password files.

Example:

```
[File path]
\user\pswd\my_passwords\web_pswd.cfg
```

If any errors in the format of these files are detected the user/password protection will be ignored

ip_accs.cfg

It is possible to configure which IP addresses and what protocols that are allowed to connect to the module. This information is stored in the file '\ip_accs.cfg'. The file contains one or several of the headers below.

```
[Web]
[FTP]
[Telnet]
[Modbus/TCP]
[Ethernet/IP]
[All]
```

Under each header the allowed IP addresses are written. The wildcard '*' can be used to allow series of IP addresses. If a protocol header is not given, the system will use the configuration set below the header 'All'. If the 'All' header is not given, the protocol will not accept any connections.

Example:

```
[Web]
10.10.12.*
10.10.13.*
[FTP]
10.10.12.*
[Telnet]
```

```
10.10.12.*
[All]
*.*.*.*
```

The above example will allow all IP addresses beginning with 10.10.12 to access all protocols in the module. Addresses beginning with 10.10.13 will be able to access the web server, but not the FTP and Telnet servers. The Modbus/TCP and Ethernet/IP servers will accept connections from any IP address.

The contents of this file can be redirected by placing the line '[File path]' on the first row, and a file path on the second. This procedure is exactly the same as with the system file "web_accs.cfg" (see above).

telwel.cfg

The default Telnet welcome message can be changed by creating this file. It shall contain the new welcome message in ASCII form. The contents of this file can be redirected by placing the line '[File path]' on the first row, and a file path on the second.

Example:

```
[File path]

\my_settings\telnet_welcome_message.txt
```

ethcfg.cfg

This file contains the network configuration and is read by the module at start up. The settings in this file may be affected by configuration software and SSI commands. The format of the file is the following:

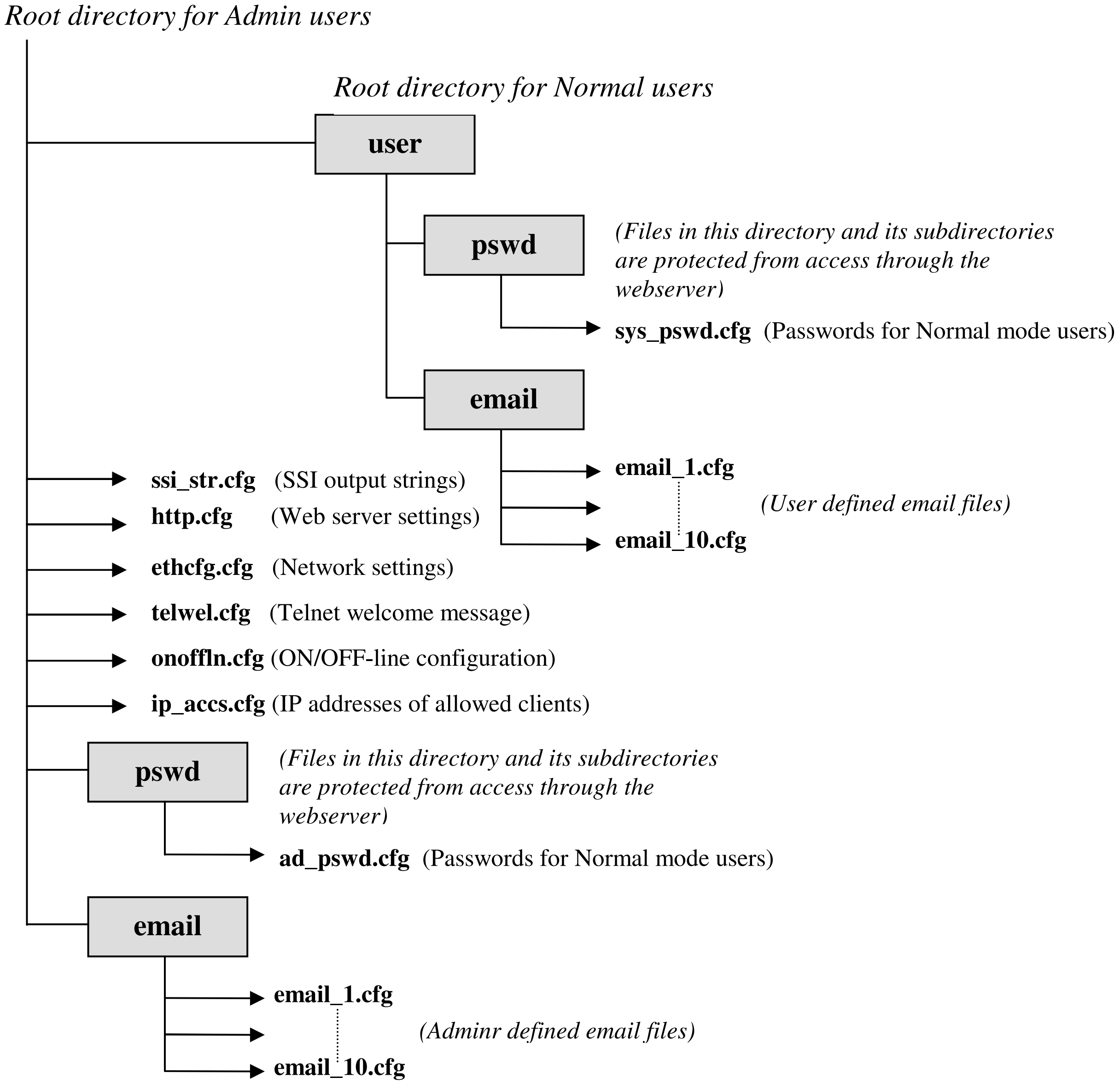
```
[IP address]
192.168.0.150
[Subnet mask]
255.255.255.0
[Gateway address]
192.168.0.1
[DHCP/BOOTP]
OFF                     (allowable values are "ON" and "OFF")
[Speed]
Auto                    (allowable values are "Auto", "100", or "10")
[Duplex]
Auto                    (allowable values are "Auto", "Full", or "Half")
[SMTP address]
0.0.0.0
[SMTP username]
username
[SMTP password]
password
[DNS1 address]          (Primary DNS)
0.0.0.0
[DNS2 address]          (Secondary DNS)
0.0.0.0
[Domain name]
weidmuller.com
[Host name]
GUEST
```

NOTE: In the current firmware implementation "IP Address", "Subnet Mask", "Gateway Address", and "SMTP Address" will *always* be overridden by the values used in configuration software (i.e. those values cannot be set by writing to this file).

The contents of this file can be redirected by placing the line '[File path]' on the first row, and a file path on the second. This procedure is exactly the same as with the system file "ip_accs.cfg" (see above). For example, redirecting the contents of this file to the "\user" directory would allow "Normal Mode" users to have access to this file.

Structure

The figure below illustrates the structure of the file system, where the system files are located, and which areas Normal/Admin users can access. The files and directory structure must be created by the user using FTP or Telnet. The required .cfg file structures are outlined in the 'System Files' section below.



Virtual File System

The module also contains a virtual file system containing a set of files used to build the default configuration webpage. The virtual file system can be overwritten or disabled, but not erased; A file with the same name in the file system replaces the file in the virtual file system until it is removed. The entire virtual file system can be disabled using configuration software on the Ethernet Settings page.

Replacing the virtual files makes it possible to for example replace the default logo by uploading a new logo named '\logo.jpg'. It is also possible to make links from a web page to the virtual configuration page. In that case the link shall point to '\config.htm'.

The virtual file system contains the following files:

\index.htm	- Points to the contents of config.htm
\config.htm	- Configuration frame page
\configform.htm	- Configuration form page
\configform2.htm	- Configuration form page
\store.htm	- Configuration store page
\logo.jpg	- HMS logo
\configuration.gif	- Configuration picture
\boarder.bg.gif	- picture
\boarder_m_bg.gif	- picture

FTP Server

It is possible to upload/download files to/from the file system using a standard FTP client. Depending on security settings, different parts of the filesystem can be accessed by the user (see Security above). Internet Explorer within the Windows Operating System, for example, may also operate as an FTP Client simply by preceding the address in the address bar with "ftp:" instead of "http:"

The FTP Server can be disabled via configuration software on the Ethernet Settings page.

Server Side Include (SSI) Functionality

The SSI functionality makes it possible to display or alter I/O data and configuration settings on a web page. It is also possible to use SSI functions in email messages (see "SSI in Email Messages"). Since this functionality allows reading/writing of I/O values in the Fieldbus Interface, some of the functions described below will use an "offset" parameter to specify the I/O Location within the Fieldbus Interface. It should be noted that the "offset" parameter will *always* refer to a byte-addressed offset from the start of the Fieldbus Interface (i.e. the "Address Mode" in configuration software should be set to "Byte" and the "Modbus TCP Address Mode" option should be disabled – see 4.8 Fieldbus Configuration).

Functions

DisplayIP

Syntax: <?--#exec cmd_argument='DisplayIP'-->

This function returns the currently used IP address.

DisplaySubnet

Syntax: <?--#exec cmd_argument='DisplaySubnet'-->

This function returns the currently used Subnet mask

DisplayGateway

Syntax: <?--#exec cmd_argument='DisplayGateway'-->

This function returns the currently used Gateway address

DisplayDNS1

Syntax: <?--#exec cmd_argument='DisplayDNS1'-->

This function returns the address of the primary DNS server.

DisplayDNS2

Syntax: <?--#exec cmd_argument='DisplayDNS2'-->

This function returns the address of the secondary DNS server

DisplayHostName

Syntax: <?--#exec cmd_argument='DisplayHostName'-->

This function returns the hostname.

DisplayDomainName

Syntax: <?--#exec cmd_argument='DisplayDomainName'-->

This function returns the default domain name.

DisplayDchpState

Syntax:

<?--#exec cmd_argument='DisplayDhcpState("Output when ON", "Output when OFF")'-->

This function returns whether DHCP/BootP is enabled or disabled.

DisplayDhcpSupport

Syntax: <?--#exec cmd_argument='DisplayDhcpSupport("Arg1", "Arg2")'-->

DHCP support can be disabled using configuration software. This function returns 'Arg1' if it's enabled and 'Arg2' if it's disabled.

DisplayEmailServer

Syntax: <?--#exec cmd:argument='DisplayEmailServer'-->

This function returns the currently used SMTP server address.

DipslaySMTPUser

Syntax: <?--#exec cmd:argument='DisplaySMTPUser'-->

This function returns the username used for SMTP authentication.

DipslaySMTPPswd

Syntax: <?--#exec cmd:argument='DisplaySMTPPswd'-->

This function returns the password used for SMTP authentication.

GetText (*Note - This function cannot be used within email messages)*

Syntax:

<?--#exec cmd arbgument='GetText("ObjName", OutWriteString (offset), n)'-->

This SSI function gets the text from an object and stores it in the OUT area.

ObjName	- Name of object.
offset	- Specifies the offset from the beginning of the OUT area (i.e. Fieldbus Location).
n	- Specifies maximum number of characters to read (Optional)

printf

Syntax: <?--#exec cmd_argument='printf("String to write", Arg1, Arg2, ..., ArgN)'-->

This SSI function includes a formatted string, which may contain data from the Fieldbus IN/OUT area, on a web page. The formatting of the string is equal to the standard C function printf().

Like the standard C function printf() the "String to write" for this SSI function contains two types of objects: Ordinary characters, which are copied to the output stream, and conversion specifications, each of which causes conversion and printing of the next successive argument to printf. Each conversion specification begins with the character % and ends with a conversion character. Between the % and the conversion character there may be, in order:

- Flags (in any order), which modify the specification:
  - \- which specifies left adjustment of the converted argument in its field.
  - \+ which specifies that the number will always be printed with a sign (space) if the first character is not a sign, a space will be prefixed.
  - 0 for numeric conversions, specifies padding to the field with leading zeroes.
  - # which specifies an alternate output form. For o, the first digit will be zero. For x or X, 0x or 0X will be prefixed to a non-zero result. For e, E,f, g and G, the output will always have a decimal point; for g and G, trailing zeros will not be removed.
- A number specifying a minimum field width. The converted argument will be printed in a field at least this wide, and wider if necessary. If the converted argument has fewer characters than the field width it will be padded on the left (or right, if left adjustment has been requested) to make up the field width. The padding character is normally space, but can be 0 if the zero padding flag is present.
- A period, which separates the field width from the precision.

- A number, the precision, that specifies the maximum number of characters to be printed from a string, or the number of digits to be printed after the decimal point for e, E, or F conversions, or the number of significant digits for g or G conversion, or the minimum number of digits to be printed for an integer (leading 0s will be added to make up the necessary width)
- A length modifier h, l, or L. "h" Indicates that the corresponding argument is to be printed as a short or unsigned short; "l" or "L" indicates a long or unsigned long.

The conversion characters and their meanings are shown below. If the character after the % is not a conversion character, the behaviour is undefined.

Character	Argument type	Converted to
d, i	byte, word	decimal notation (For signed representation. Use signed argument)
o	byte, word	octal notation (without a leading zero).
x, X	byte, word	hexadecimal notation (without a leading 0x or 0X), using abcdef for 0x or ABCDEF for 0X.
u	byte, word	decimal notation.
c	byte, word	single character, after conversion to unsigned char.
s	char*	characters from the string are printed until a '\0' (i.e. NULL) is reached or until the number of characters indicated by the precision have been printed
f	float	decimal notation of the form [-]mmm.ddd, where the number of d's is specified by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
e, E	float	decimal notation of the form [-]m.dddddd e+-xx or [-]m.ddddddE+-xx, where the number of d's specified by the precision. The default precision is 6; a precision of 0 suppresses the decimal point.
g, G		%e or %E is used if the exponent is less than -4 or greater than or equal to the precision; otherwise %f is used. Trailing zeros and trailing decimal point are not printed.
%	-	print a %

The arguments that can be passed to the SSI function *printf* are:

Argument	Description
InReadSByte(*offset*)	Reads a signed byte from position *offset* in the IN area
InReadUByte(*offset*)	Reads an unsigned byte from position *offset* in the IN area
InReadSWord(*offset*)	Reads a signed word (short) from position *offset* in the IN area
InReadUWord(*offset*)	Reads an unsigned word (short) from position *offset* in the IN area
InReadSLong(*offset*)	Reads a signed longword (long) from position *offset* in the IN area
InReadULong(*offset*)	Reads an unsigned longword (long) from position *offset* in the IN area
InReadString(*offset*)	Reads a string (char*) from position *offset* in the IN area
InReadFloat(*offset*)	Reads a floating point (float) value from position *offset* in the IN area
OutReadSByte(*offset*)	Reads a signed byte from position *offset* in the OUT area
OutReadUByte(*offset*)	Reads an unsigned byte from position *offset* in the OUT area
OutReadSWord(*offset*)	Reads a signed word (short) from position *offset* in the OUT area
OutReadUWord(*offset*)	Reads an unsigned word (short) from position *offset* in the OUT area
OutReadSLong(*offset*)	Reads a signed longword (long) from position *offset* in the OUT area
OutReadULong(*offset*)	Reads an unsigned longword (long) from position *offset* in the OUT area
OutReadString(*offset*)	Reads a NULL terminated string (char*) from position *offset* in the OUT area
OutReadFloat(*offset*)	Reads a floating point (float) value from position *offset* in the OUT area

scanf

Syntax:

```
<?--#exec cmd_argument='scanf( "ObjName", "format", Arg1, ..., ArgN), ErrVal1, ..., ErrvalN'-->
```

This SSI function reads a string passed from an object in a HTML form, interprets the string according to the specification in format, and stores the result in the OUT area according to the passed arguments. The formatting of the string is equal to the standard C function call scanf()

ObjName	- The name of the object with the passed data string
format	- Specifies how the passed string shall be formatted
Arg1 - ArgN	- Specifies where to write the data
ErrVal1 -ErrValN	- Optional; specifies the value/string to write in case of an error.

Character	Input data, Argument Type
d	Decimal number; byte, short
i	Number, byte, short. The number may be in octal (leading 0(zero)) or hexadecimal (leading 0x or 0X)
o	Octal number (with or without leading zero); byte, short
u	Unsigned decimal number; unsigned byte, unsigned short
x	Hexadecimal number (with or without leading 0x or 0X); byte, short
c	Characters; char*. The next input characters (default 1) are placed at the indicated spot. The normal skip over white space is suppressed; to read the next non-white space character, use %1s.
s	Character string (not quoted); char*, pointing to an array of characters large enough for the string and a terminating "\0" that will be added.
e, f, g	Floating-point number with optional sign, optional decimal point and optional exponent; float*
%	Literal %; no assignment is made.

The conversion characters d, i, o, u and x may be preceded by l (small case L) to indicate that a pointer to ‘long’ appears in the argument list rather than a ‘byte’ or a ‘short’

The arguments that can be passed to the SSI function scanf are:

Argument	Description
OutWriteByte(*offset*)	Writes a byte to position *offset* in the OUT area
OutWriteWord(*offset*)	Writes a word (short) to position *offset* in the OUT area
OutWriteLong(*offset*)	Writes a long to position *offset* in the OUT area
OutWriteString(*offset*)	Writes a string to position *offset* in the OUT area
OutWriteFlost(*offset*)	Writes a floating point (float) value to position *offset* in the OUT area

IncludeFile

Syntax: <?--#exec cmd_argument=’IncludeFile("File name")’-->

This SSI function includes the contents of a file on a web page.

Default output:

Success - <File content>

Failure - Failed to open <filename>

SaveToFile

Syntax:

<?--#exec cmd_argument=’SaveToFile("File name", "Separator", [Append|Overwrite])’-->

This SSI function saves the contents of a passed form to a file. The passed name/value pair will be written to the file "File name" separated by the "Separator" string. The contents can either be Appended to the file or overwrite the current content of the file.

Default output:

Success - Form saved to file

Failure - Failed to save form

Web Server

The module features a complete web server with SSI functionality. It is possible to upload web pages to the module, giving access to parameters in the Fieldbus Interface using a customizable interface.

By default the HTTP server is enabled, but it can be enabled/disabled by configuration software on the Ethernet settings page.

Email Client

It is possible to send emails from the module. To send an email, the SMTP server address must be configured. Without a valid SMTP address the module will not be able to send any email messages.

Sending a predefined email on data event

It is possible to send predefined email messages, triggered by an event in the Fieldbus Interface. The Fieldbus Interface is scanned once every 0.5 second. This means that an event must be present longer than 0.5 seconds to ensure that it is detected by the module. It is possible to have up to 10 user defined, and 10 admin defined emails, triggered on different events. These shall be placed in the directories “\user\email\” for user configurable emails and “\email” for non-user configurable emails. The files must be named ‘email_1.cfg’, ‘email_2.cfg’ ... ‘email_10.cfg’.

The files shall have the following format:

```
[Register]
Area, Offset, Type
[Register match]
Match Value, Mask, Match operand
[To]
Recipient(s)
[From]
Sender
[Subject]
Subject line
[Headers]
Extra Headers
[Message]
Message body
```

Parameter	Description
Area	Source Fieldbus Interface Area. Possible values are 'IN' or 'OUT'
Offset	Source offset in Fieldbus Area, shall be written in decimal or hexadecimal.
Type	Source data type. Possible values are 'byte', 'word', and 'long'
Match Value	Value to compare with the source data. Shall be written in decimal or hexadecimal.
Mask	The module performs a logical 'and' on the source data and this Mask before the value is compared with the Match Value. The value shall be written in decimal or hexadecimal.
Match Operand	Specifies how the data shall be compared with the Match Value. Possible values: '<', '=', '>'
Recipient(s)	Destination email addresses, semicolon separated
Sender	Sender email address
Subject line	Email subject (One line only)
Extra Headers	Optional. May be useful for advanced users when for example sending HTML emails etc.
Message Body	The actual email message.

The data is read in the Fieldbus Interface from the area and offset specified by the parameters Area, and Offset. The data size to read is specified by the Type parameter. The module performs a logical 'AND' between the read data and the parameter Mask. The result is compared with the parameter Match Value. How the data shall be compared is specified by the Match Operand.

Example:

```
[Register]
IN, 0x0003, byte
[Register match]
0x20, 0x7F, >
[To]
support@weidmuller.com
[From]
TEST@weidmuller.com
[Subject]
Status
[Message]
All data correct.
```

In the above example:

- A byte is read from the Fieldbus IN area, at byte address 0003h
- The module performs a logical <data> AND 7Fh.
- If the result is larger than 20h, the email message is sent to support@weidmuller.com

Note: If the [Register] or [Register match] information is changed, a reset is required for changes to take effect. Other changes will take effect directly without a reset.

Note: Hexadecimal values must be written in the format 0xN where 'N' is the hexadecimal value.

SSI in Email Messages

For predefined emails it is possible to include data in the mails. This is done in a similar way as data is added to web pages with SSI includes. Due to natural reasons, some SSI functions cannot be used in email messages.

The supported SSI commands for emails are:

- DisplayIP
- DisplaySubnet
- DisplayGateway
- DisplayDNS1
- DisplayDNS2
- DisplayHostName
- DisplayDomainName
- DisplayEmailServer
- DisplaySMTPUser
- DisplaySMTPPswd
- DisplayDhcpState
- DisplayDhcpSupport
- printf
- IncludeFile
- SsiOutput

Telnet Server

Through a Telnet client, the user can access the filesystem using a command line interface similar to MS-DOS™. Depending on security settings, different parts of the filesystem can be accessed by the user (see Security above).

The telnet server can be disabled via configuration software on the Ethernet Settings page.

General Commands

help

Syntax: help [general|diagnostic|filesystem]

version

This command will display version information, serial number and MAC ID

exit

This command closes the Telnet session.

Diagnostic Commands

The following commands can be viewed by the command ‘help diagnostic’

arps

Display ARP stats and table

iface

Display net interface stats

sockets

Display socket list

routes

Display IP route table

File System Operations

For commands where filenames, directory names or paths shall be given as an argument the names can be written directly or within quotes. For names including spaces the filenames must be surrounded by quotes. It is also possible to use relative pathnames using ‘.’, ‘\’ and ’..’

dir

Syntax: dir [path]

Lists the contents of a directory. If no path is given, the contents of the current directory are listed.

md

Syntax: md [[path][directory name]]

Creates a directory. If no path is given, the directory is created in the current directory.

rd

Syntax: rd [[path][directory name]]

Removes a directory. The directory can only be removed if it is empty.

cd

Syntax: cd [path]

Changes current directory.

format

Formats the filesystem. This is a privileged command and can only be called in administration mode.

del

Syntax: del [[path][filename]]

Deletes a file.

ren

Syntax: ren [[path][old name]] [[path][new name]]

Renames a file or directory.

move

Syntax: move [[source path][source file]] [[destination path]]

This command moves a file or directory from the source location to a specified destination.

copy

Syntax: copy [[source path][source file]] [[destination path][destination file]]

This command creates a copy of the source file at a specified location.

type

Syntax: type [[path][filename]]

Types (displays) the contents of a file.

mkfile

Syntax: mkfile [[path][filename]]

Creates an empty file.

append

Syntax: append [[path][filename]] [“The line to append”]

Appends a line to a file.

df

Displays filesystem info.

Product Data Sheet

QOU115

MINIATURE CIRCUIT BREAKER 120/240V 15A

List Price	$40.20 USD
Availability	**Stock Item:** This item is normally stocked in our distribution facility.

Technical Characteristics

Wire Size	#14-2 AWG(Al/Cu)
Depth	2.98 Inches
Height	4.05 Inches
Number of Poles	1-Pole
Switching Duty Rated	Yes
Short Circuit Current Rating	5kA@277VAC - 10kA@120/240VAC
Type	QOU
Marketing Trade Name	QOU
Mounting Type	Flush, Surface or DIN Rail (35mm)
Voltage Rating	120/240VAC
Terminal Type	Line: Box Lug - Load: Box Lug
Approvals	UL489 Listed - CSA 22.2 #5.1 Certified - IEC Rated 60947-2
Ampere Rating	15A
Circuit Breaker Type	Standard
Width	0.75 Inches
For Use With	OEM Panels and Enclosures
HACR Rated	Yes

Shipping and Ordering

Category	00900 - Circuit Breakers, 1 Pole: 10 - 100 Amp, 2 Pole: 10 - 125 Amp, 3 Pole: 10 -125 Amp, Type QOU
Discount Schedule	DE2
Article Number	785901418504
Package Quantity	40
Weight	0.36 lbs.
Availability Code	S
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

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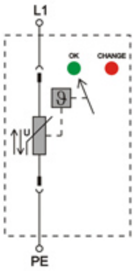


General ordering data

Order No.	8859950000
Part designation	PU II 1 130V/40kA
Version	Surge protection for low-voltage supply, 120 V, without telecomm. contact
EAN	4032248583843
Qty.	1 pc(s).

Dimensions

Clamping range, nom.	25 mm²
Clamping range, min.	4 mm²
Clamping range, max.	25 mm²

temperature

Ambient temperature (operational)	-40...+80°C
Storage temperature	-40 ... +85°C

Product notes

Note, technical data	* This product also fulfils the requirements for Class III with Uoc: 6 kV
Note, accessories	Pluggable spare arrester PU II 0 130V / 40kA - 8860030000
Product description	Class II surge protectionwith Uc: 130 V

Clamped conductors

Conductor cross-section, flexible, AEH (DIN 46228-1), max.	25 mm²
Conductor cross-section, flexible, AEH (DIN 46228-1), min.	4 mm²
Cross-section	25 mm²
Stranded, max.	25 mm²
Stranded, min.	4 mm²
Type of connection	Screw connection

Discharge surge current of top part

Limiting discharge current (8/20 µs) I	40 kA

General data

Signalling contact	250 V 1A 1CO at PU II 1 R
Optical function display	green = OK; red = arrester is defective - replace
Design	Installation housing; 1TE
Protection class	IP 20
Type of connection	Screw connection
Cross-section	25 mm²

Interference voltage

Protection level at 5kA (Up)	< 500 V
Protection level at In (Up)	< 850 V

Protective elements

Optical function display	green = OK; red = arrester is defective - replace

Technical data

Rated voltage	120 V
Rated voltage (AC)	130 V
Max. continuous voltage, Uc (AC)	130 V
max. continuous voltage, Uc (DC)	170 V
Requirements class, acc. to IEC 61643-1	Class II
Highest continuous current AC	130 V
Requirements class, acc. to EN 61643-11	T2
Limiting discharge current (8/20 µs) I	40 kA
Discharge current, max. (8/20 µs)	40 kA
Sparkover time / Drop-out time	≤ 25 ns
Fuse, max.	125 A gL
Protection level at In (Up)	< 850 V
Protection level at 5kA (Up)	< 500 V
Temporary surge - U	150 V
AC/DC/UC	AC

Technical data, signal line

Sparkover time / Drop-out time	≤ 25 ns

Approvals

Approvals institutes	OEVE; UR; CE

Downloads

EPLAN	EPLAN4.zip

Classifications

ETIM30	EC000941
eClass 5.1	27-13-08-01
eClass 6.0	27-13-08-02

Similar products

Order No.	Part designation	Version
8859960000	PU II 1R 130V/40kA	Surge protection for low-voltage supply, 120 V, with telecomm. contact
8859970000	PU II 2 130V/40kA	Surge protection for low-voltage supply, 120 V, without telecomm. contact
8859980000	PU II 2 R 130V/40kA	Surge protection for low-voltage supply, 120 V, with telecomm. contact
8859990000	PU II 3 130V/40kA	Surge protection for low-voltage supply, without telecomm. contact
8860000000	PU II 3 R 130V/40kA	Surge protection for low-voltage supply, with telecomm. contact
8860010000	PU II 4 130V/40kA	Surge protection for low-voltage supply, without telecomm. contact
8860020000	PU II 4 R 130V/40kA	Surge protection for low-voltage supply, with telecomm. contact

¼″ x 1 ¼″ Time-Delay, Glass Tube Fuses

MDL Series

Description

RoHS
2002/95/EC

- Time-delay
- Optional axial leads available
- ¼ x 1 ¼ (6.4 x 31.7mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

Electrical Characteristics

Rated Current	% of Amp Rating	Opening Time
1/16 - 30A	100%	None
	135%	60 minutes maximum
	200%	120 seconds maximum
1/16 - 3A	200%	5 seconds minimum
3-2/10 - 8A	200%	12 seconds minimum

Agency Information

- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDL 1/16 - 8A (Class No. 1422-01)
- CSA Component Acceptance: MDL 9-30A (Class No. 1422-30)
- CE

Environmental Data

- Shock: 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/4A thru 30A – MIL-STD-202, Method 204, Test Condition C (Except 5g, 500HZ)

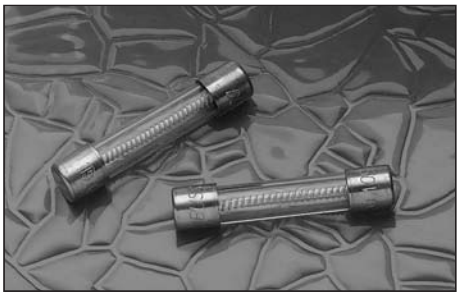
Ordering

Specify packaging code

- Insert packaging code prefix before part number. E.g., BK (or BK1)-MDL-5-R

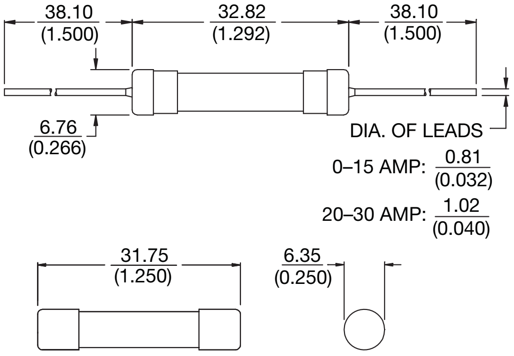
Specify option codes if desired

- For axial leads, insert "V" between catalog series and amp rating. E.g., BK-MDL-V-5-R
- For board washable, insert "B" between catalog series and amp rating. E.g., BK-MDL-B-5-R
- For axial leads and board washable, insert "B" then "V" between catalog series and amp rating. E.g., BK-MDL-BV-5-R



Dimensions - mm (in)

Drawing Not to Scale



Specifications

Part Number	Voltage Rating Vac	AC Interrupting Rating* (amps)@ 250Vac	125Vac	32Vac	Typical DC Cold Resistance** (Ω)	Typical Melting I²t† AC	Typical Voltage Drop‡
MDL-1/16-R	250	35	10000	-	45.6	0.0046	2.79
MDL-1/10-R	250	35	10000	-	15.68	0.0420	1.95
MDL-1/8-R	250	35	10000	-	12.238	0.0422	1.52
MDL-3/16-R	250	35	10000	-	4.81	0.116	1.05
MDL-2/10-R	250	35	10000	-	5.234	0.314	0.972
MDL-1/4-R	250	35	10000	-	3.208	0.447	0.965
MDL-3/10-R	250	35	10000	-	2.046	0.412	0.808
MDL-3/8-R	250	35	10000	-	1.567	0.982	1.46
MDL-1/2-R	250	35	10000	-	0.943	1.656	1.27
MDL-3/4-R	250	35	10000	-	0.397	4.343	1.01
MDL-1-R	250	35	10000	-	0.273	11.498	0.995
MDL-1-1/4-R	250	100	10000	-	0.205	86.2	0.722
MDL-1-1/2-R	250	100	10000	-	0.156	22.7	0.721
MDL-2-R	250	100	10000	-	0.116	62.3	0.644
MDL-2-1/4-R	250	100	10000	-	0.096	49.6	0.535
MDL-2-1/2-R	250	100	10000	-	0.081	63.1	0.410
MDL-3-R	250	100	10000	-	0.057	67.5	0.345
MDL-4-R	250	200	10000	-	0.038	19.3	0.187
MDL-5-R	250	200	10000	-	0.025	32.0	0.160
MDL-6-R	250	200	10000	-	0.022	37.4	0.155
MDL-6-1/4-R	250	200	10000	-	0.02	38.7	0.152
MDL-7-R	250	200	10000	-	0.018	42.7	0.140
MDL-8-R	250	200	10000	-	0.015	47.8	0.119
MDL-9-R	32	-	-	1000	0.012	51.5	0.124
MDL-10-R	32	-	-	1000	0.01	64.4	0.114
MDL-15-R	32	-	-	1000	0.005	354.0	0.130
MDL-20-R	32	-	-	1000	0.004	2914.0	0.530
MDL-25††	32	-	-	1000	0.01225	15221.0	0.30
MDL-30††	32	-	-	1000	0.0011	15581.0	0.40

* Interrupting Ratings (Interrupting ratings were measured at 70% - 80% power factor on AC)

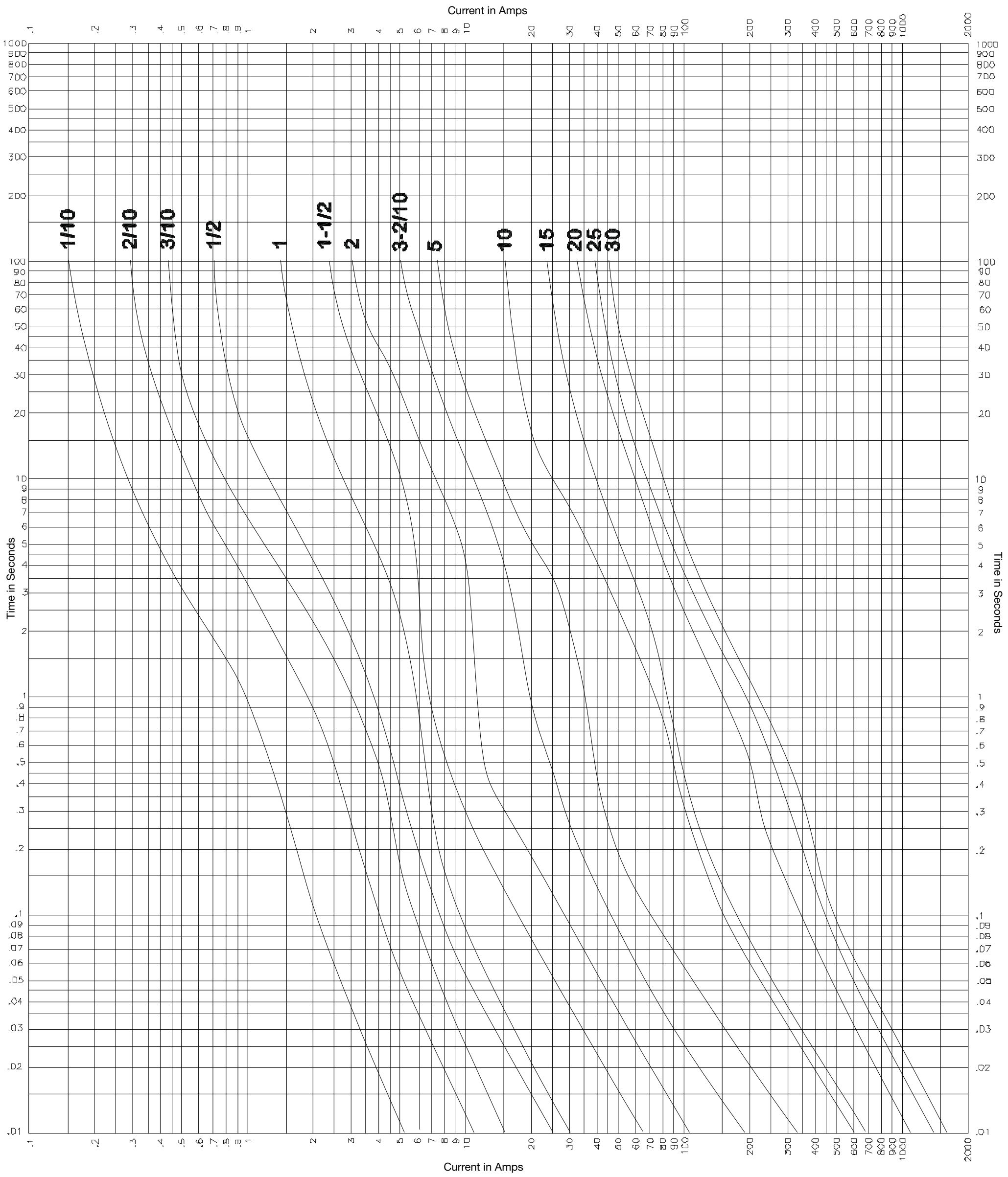
** DC Cold Resistance (Measured at ≤10% of rated current)

† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C±3°C ambient temperature at rated current)

†† MDL-25 & MDL-30 not available in RoHS compliant construction.

Time-Current Curve



Packaging Code

Packaging Code	Description
BK	100 fuses packed into a cardboard carton
BK1	1,000 fuses packed into a cardboard carton
BK8	8,000 fuses packed into a cardboard carton

Option Code

Option Code	Description
B	Sealed to withstand aqueous cleaning (Board Washable)
V	Axial leads - copper tinned wire with nickel plated brass overcaps

St. Louis, MO 63178
www.cooperbussmann.com

COILTRONICS® COOPER Bussmann® PowerStor®

COOPER Bussmann

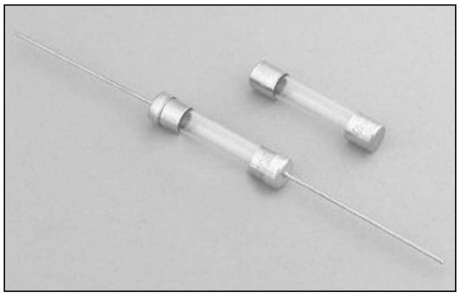
1/4" x 1-1/4" Fuses

AGC Series, Fast Acting, Glass Tube

Description

- Fast-acting, glass tube
- Optional axial leads available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

RoHS
2002/95/EC



ELECTRICAL CHARACTERISTICS	
% of Amp Rating	**Opening Time**
100%	None
135%	60 Minutes Maximum
200%	120 Seconds Maximum

Agency Information

- UL Listed Card: AGC 1/500-10
- UL Recognition Card: AGC 11-45
- CSA Component Acceptance Card (Class No. 1422 30)
- CSA Certification Card (Class No. 1422 01)

Environmental Data

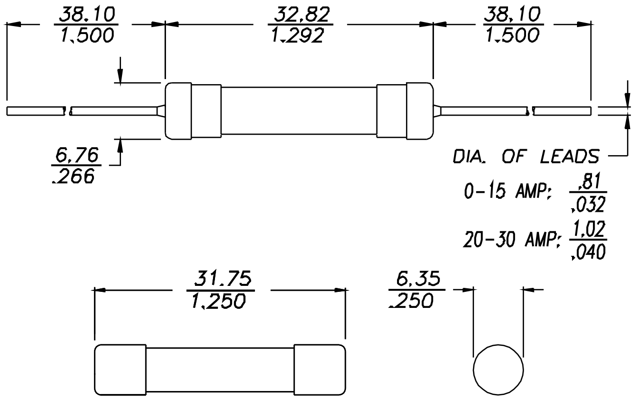
- Shock: 1/100A thru 3/4A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A thru 30A – MIL-STD-202, Method 204, Test Condition A (Except 5g, 500HZ)

Ordering

- Specify packaging, product, and option code

Dimensions (mm/in)

Drawing Not to Scale



SPECIFICATIONS							
Product Code	**Voltage Rating AC**	**AC Interrupting Rating**			**Typical DC Cold Resistance** (ohms)**	**Typical Melting I²t† AC**	**Typical Voltage Drop‡**
		250V	**125V**	**32V**			
AGC-1/20	250V	35A	10000A	-	4.500	0.00773	0.67
AGC-1/16	250V	35A	10000A	-	29.000	0.000181	10.41
AGC-1/10	250V	35A	10000A	-	12.565	0.000787	6.00
AGC-1/8	250V	35A	10000A	-	6.800	0.00131	4.67
AGC-3/16	250V	35A	10000A	-	4.900	0.00637	4.12
AGC-2/10	250V	35A	10000A	-	3.360	0.00435	4.51
AGC-1/4	250V	35A	10000A	-	2.300	0.0148	0.89
AGC-3/10	250V	35A	10000A	-	1.670	0.0208	2.88
AGC-3/8	250V	35A	10000A	-	1.203	0.0321	4.59
AGC-1/2	250V	35A	10000A	-	0.615	0.269	0.59
AGC-3/4	250V	35A	10000A	-	0.312	0.815	0.37
AGC-1	250V	35A	10000A	-	0.190	1.615	0.31
AGC-1-1/4	250V	100A	10000A	-	0.145	0.018	0.35
AGC-1-1/2	250V	100A	10000A	-	0.115	0.0149	0.27
AGC-2	250V	100A	10000A	-	0.078	0.00509	0.28
AGC-2-1/4	250V	100A	10000A	-	0.067	0.00588	0.26
AGC-2-1/2	250V	100A	10000A	-	0.057	0.00879	0.31
AGC-3	250V	100A	10000A	-	0.045	0.0167	0.25
AGC-4	250V	200A	10000A	-	0.030	0.0305	0.22
AGC-5	250V	200A	10000A	-	0.024	0.045	0.23
AGC-6	250V	200A	10000A	-	0.020	0.071	0.23
AGC-7	250V	200A	10000A	-	0.017	0.105	0.23
AGC-7-1/2	250V	200A	10000A	-	0.0146	-	-
AGC-8	250V	200A	10000A	-	0.014	0.152	0.19
AGC-9	250V	200A	10000A	-	0.012	0.21	0.18
AGC-10	250V	200A	10000A	-	0.008	0.492	0.20
AGC-12	32V	-	-	1000A	0.0070	-	-
AGC-14	32V	-	-	1000A	0.0062	-	-
AGC-15	32V	-	-	1000A	0.006	0.566	0.14
AGC-20	32V	-	-	1000A	0.004	1.438	0.12
AGC-25	32V	-	-	1000A	0.003	2.109	0.11
AGC-30	32V	-	-	1000A	0.002	3.807	0.12
AGC-35	32V	-	-	70A	0.0014	-	-
AGC-40	32V	-	-	80A	0.0019	-	-

** DC Cold Resistance (Measured at ≤10% of rated current)

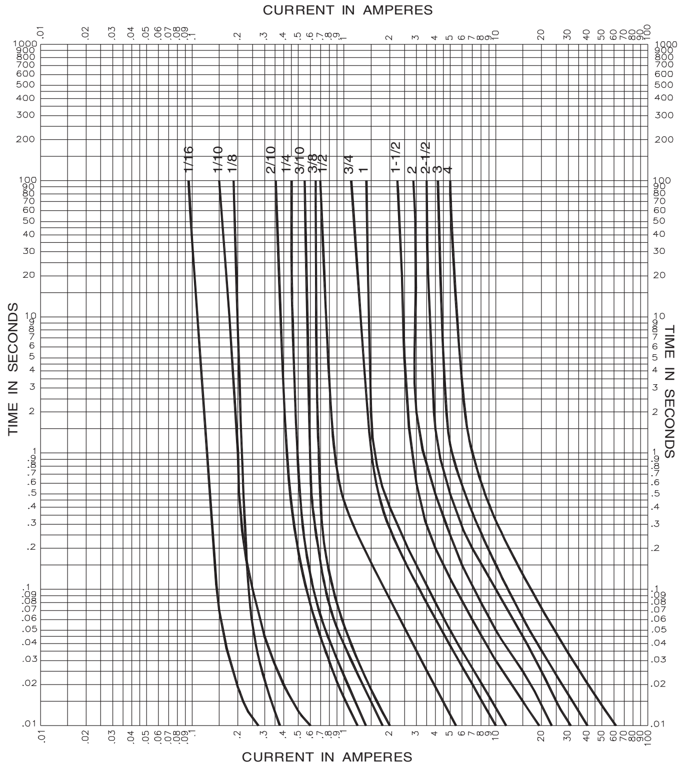
† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

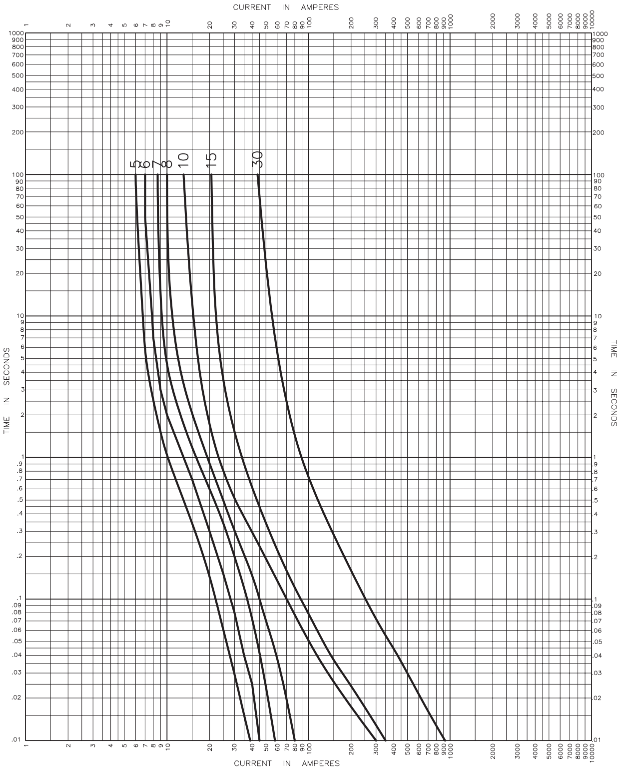
‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

1/4" x 1-1/4" Fuses

AGC Series, Fast Acting, Glass Tube

TIME CURRENT CURVE





	PACKAGING CODE
Packaging Code	**Description**
BK	100 pieces of fuses packed into a cardboard carton with flaps folded
BK1	1,000 pieces of fuses packed into a cardboard carton with flaps folded
BK8	8,000 pieces of fuses packed into a cardboard carton with flaps folded

	OPTION CODE
Option Code	**Description**
B	Board Washable - Hermetically sealed to withstand aqueous cleaning
V	Axial leads - copper tinned wire with nickel plated brass overcaps
-R	RoHS compliant version

Visit us on the web at:
www.cooperbussmann.com

OC-2543 3/07

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Singapore 159303
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Specifications

All Hammond blowers and filter fans are engineered for performance and built for reliability. This versatile line includes blowers, fan trays and filter fans.

Blowers and fans use forced convection cooling, which means ambient air flows through a filter into the enclosure to cool heated components. Both blowers and fans are sized in CFM (cubic feet per minute).

It is recommended that an exhaust filter be used in combination with the blower or filter fan to act both as an exhaust point for the hot internal air plus aid in the pressurization of the enclosure, reducing the chance of unfiltered air entering the enclosure. Whenever possible, the blower or filter fan should be located in the bottom third of the enclosure and the filtered exhaust grill placed as high as possible on the opposing side. Performance levels can be further increased by adding a second exhaust filter.

Sizing Blowers and Fans

To determine the CFM (cubic feet per minute) required in any standard situation, use the following calculation, (non-standard situations would consist of high air density – significantly more than 0.075 lbs. per cubic foot.)

$$\textbf{C.F.M.} = \frac{\text{Power to be dissipated (Watts)} \times 3.17}{\text{Maximum Allowable Internal Temperature (°F)} - \text{Maximum Ambient Temperature(°F)}}$$

Note: The calculation above is exact, but adding an additional 25% to the CFM level is a standard safety factor. If the air density is high (significantly more than 0.075 lbs. per cubic foot), use the number calculated above in the following formula:

$$\frac{\text{CFM} \times (0.075)}{\text{Non-standard air Air Density (lbs per cubic foot)}}$$

Note: Ambient Temperature must be lower than maximum internal temperature for fan/blower to be effective.

THERMOSTAT

- Designed to provide air temperature control and monitoring in cabinets
- Thermostat NO (Normally Open) for control of cooling equipment, or for switching signal transmitters in case of overheating
- Thermostatic bi-metal sensor element
- Available in Fahrenheit (Part Number **SKT011419NO**) or in Celsius (Part Number **SKT011419NO-C**)
- Compact 2.4” High x 1.3” Wide x 1.4” Deep, gray ABS flame retardant plastic (UL94VO)
- 2 pole terminal for AWG 14 wire
- Switching capacity of 15A (120VAC) or 10A (250VAC)
- Temperature range from 30-140 degrees F
- cUR & UR & CE listed

FAN & BLOWER FILTER COAT

- Provides a filter adhesive with a grease like consistency which absorbs and traps dust particles
- 10 oz. bottle with environmentally friendly trigger spray
- Part Number **1475Q**

Model: 485LDRC9

Industrial DIN Rail Mounted Optically Isolated RS-232 to RS-422/485 Converter with Surge Suppression

CE RoHS Compliant

Features

- ✓ **High Speed Communications. Supports data rates up to 115.2 kbps.**
- ✓ **2000V 2-Way Optical Isolation.**
- ✓ **500W Surge Suppression.**
- ✓ **Industrial DIN Rail Mount.**
- ✓ **Wide Temperature Range (-40 to +80 C, -40 to +176 F)**
- ✓ **MODBUS or ASCII RTU Compatible.**

Functional Description

The 485LDRC9 is an industrial RS-232 to RS-422/485 converter. RS-232 signals interface via a terminal block or a convenient DB9 (DCE) female connector. RS-422/485 signals are connect to a terminal block. B&B's Automatic Send Data Control circuitry eliminates the requirement for software control of the RS-422/RS-485 handshake signals. Position the DIP Switches in accordance with tables one and two to change the communications mode and data rate. You can also use a pair of these converters to extend and isolate RS-232 signals. An external 10 – 30 VDC power supply (not included), is required.

Ordering Information

Model Number	Description
485LDRC9	DIN Rail Mount Converter
Accessory Items	
PS5R-A12	DIN Rail Mount Power Supply (12 VDC @7.5 W)
PS5R-A24	DIN Rail Mount Power Supply (24 VDC @ 75 W)
9PAMFx	DB9 Male to Female Cable. Various lengths available.
232NM9MFx	DB9 Male to Female Null Modem Cable (pins 2 and 3 crossed). Various lengths available.

Operation

- Select Data rate and mode by positioning the DIP Switches in accordance with Table 1 and 2.
- Automatic Send Data Control: The first bit of data from the RS-232 side enables the transmitter and disables the receiver. After receiving the last RS-232 data bit, the timeout circuit waits one character length, then disables the transmitter and enables the receiver. Select the timeout by positioning the DIP Switches or changing the value of R-11. Refer to Table 2 for R-11 values and DIP Switch positions.
- If necessary, use termination resistance for high data rates or long cable runs by positioning Switch 5 to "on." Refer to B&B's RS-422/485 Application Note available for download at: http://www.bb-elec.com/tech_articles/rs422_485_app_note/table_of_contents.asp
- Figures one through four are examples of a DTE to DCE connection. The DB9 female connector on this converter will make the same connections using a straight through DB9F to DB9M cable. If the RS-232 device is wired for DCE, then cross pins 2 and 3. Refer to B&B's 485LDRC9 Converter FAQ for details regarding RS-232 wiring. It is available for download at: http://www.bb-elec.com/bb-elec/literature/Tech/FAQ_485LDRC9_Terminals.pdf
- Figure 5 is a mechanical drawing of the converter. It also includes information concerning DIP Switch orientation and the signals associated with the terminal board and DB9 connector.
- Figure 6 demonstrates how to use two converters to extend and isolate RS-232 signals. Detailed information is available for download at: http://www.bb-elec.com/bb-elec/literature/tech/FAQ_485LDRC_Extending_RS232_Connections.pdf

Figure 1 – 2-Wire RS-485

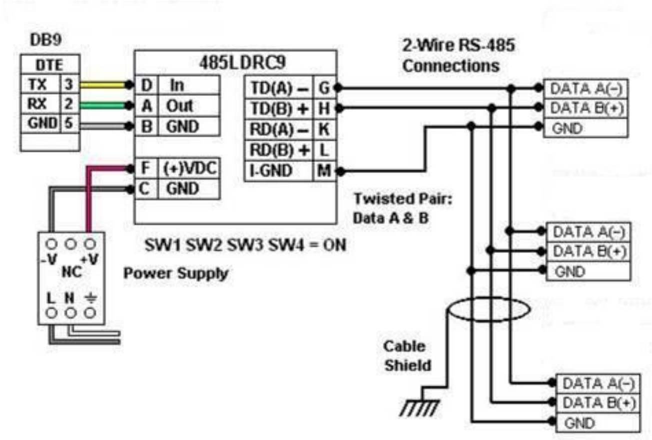


Figure 2 – 4-Wire RS-485

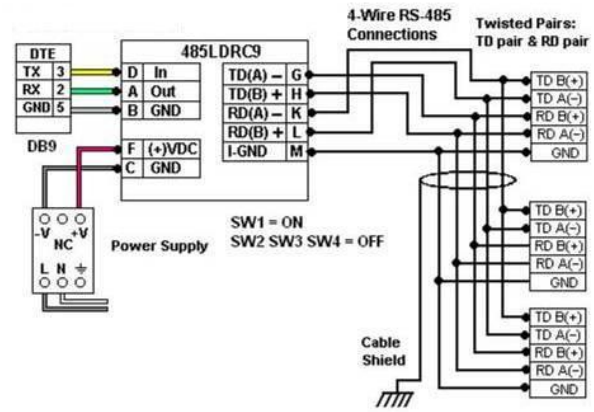


Figure 3 – RS-422

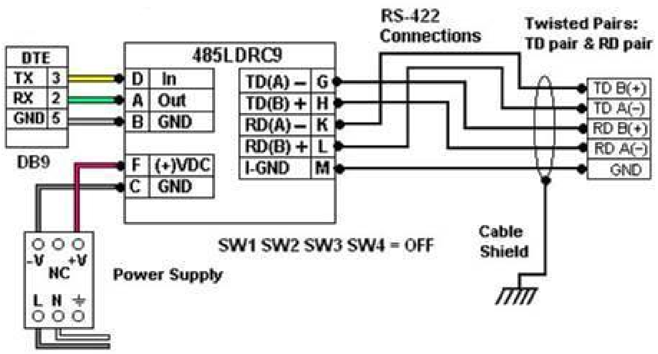


Figure 4 – 2-Wire RS-422 (No RCV)

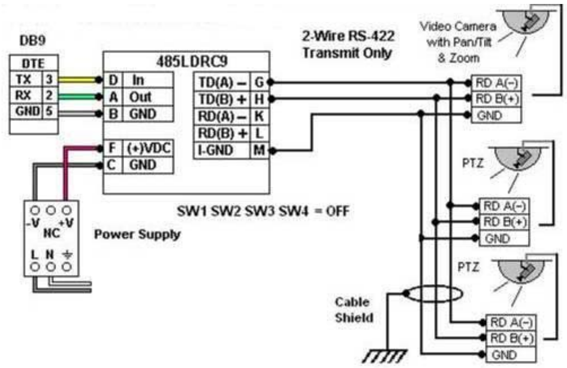
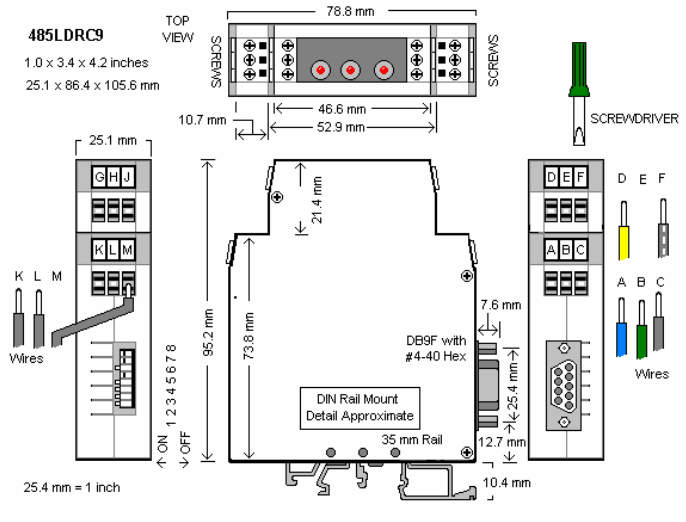


Figure 5 – Mechanical Drawing



RS-232
TD = TB Position D / DB9 Pin 3
RD = TB Position A / DB9 Pin 2
Signal Ground = TB Position B / DB9 Pin 5

RS-422/485
TD A (-) = TB Position G
RD A (-) = TB Position K
TD B (+) = TB Position H
RD B (+) = TB Position L
Isolated Ground = TB Position M

Power
+10 to 30 VDC = TB Position F
Power Ground = TB Position C

Figure 6 – Extend and Isolate RS-232

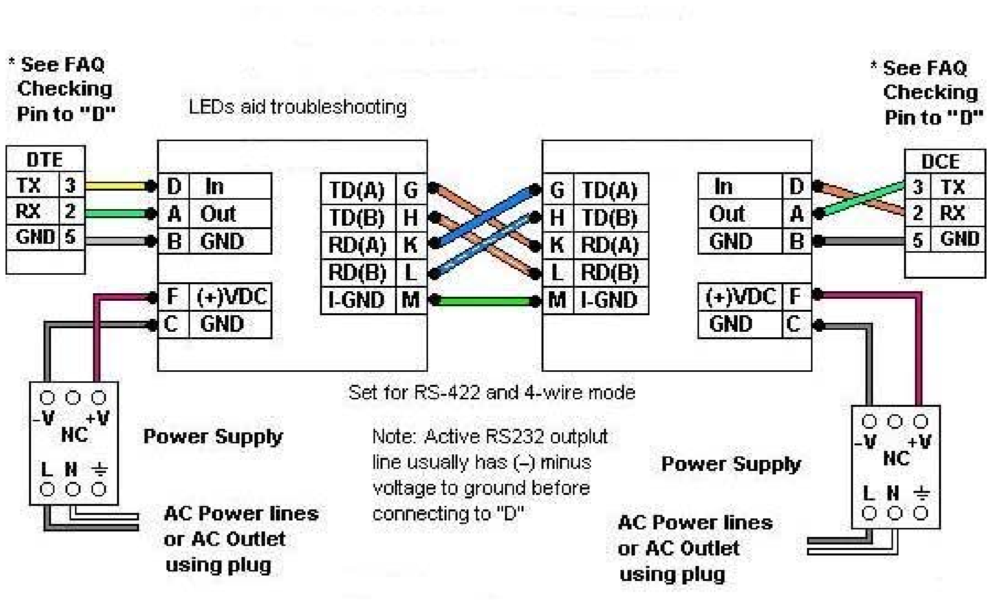


Table 1 – Communications Mode Selection

	Switch 1 TX Enable	**Switch 2** RX Enable	**Switch 3** 2/4 Wire	**Switch 4** 2/4 Wire
RS-485 2-Wire (Half Duplex)	ON	ON	ON	ON
RS-485 4-Wire (Full Duplex)	ON	OFF	OFF	OFF
RS-422 (Full Duplex)	OFF	OFF	OFF	OFF

Table 2 – Data Rate Selection

	Switch 6	Switch 7	Switch 8	R11	Timeout (ms)
1200	OFF	OFF	OFF	820 KΩ	8.33
2400	OFF	OFF	ON	NOT USED	4.16
4800	OFF	ON	OFF	NOT USED	2.08
9600	ON	OFF	OFF	NOT USED	1.04
19200	ON	ON	ON	NOT USED	.580
38400	OFF	OFF	OFF	27 KΩ	.260
57600	OFF	OFF	OFF	16 KΩ	.176
115200	OFF	OFF	OFF	8.2 KΩ	.0868

Specifications

Input Power Requirement	**+10 – 30 VDC.**
Isolation	**2000 VAC Optical Isolation of data signals and ground.**
Surge Suppression	**7.5 V, bi-directional avalanche breakdown device, 500W peak power dissipation. Clamping time <1 picosecond (theoretical).**
Signal Connectors	**Terminal Block for RS-232/422/485. Additional RS-232 connection via DB9 (female).**
Data Rate	**1200 to 115200 bps (2400 to 19200 DIP Switch Selectable).**
Operating Temperature	**-40 to +80 C (-40 to +176 F).**
Operating Humidity	**0 to 95% non-condensing.**
LED Indicators	**Receive Data, Transmit Data, and Power.**
Dimensions	**25x86x107 mm (1x3.4x4.2 in)**
DIN Mount	**35 mm DIN**
Approvals	**CE, RoHS**

DECLARATION OF CONFORMITY

Manufacturer's Name:	B&B Electronics Manufacturing Company
Manufacturer's Address:	P.O. Box 1040 707 Dayton Road Ottawa, IL 61350 USA
Model Numbers:	485OPDRI
Description:	Industrial RS-422/485 Isolator/Repeater
Type:	Light industrial ITE equipment
Application of Council Directive:	89/336/EEC
Standards:	EN 55022 EN 61000-6-1 EN 61000 (-4-2, -4-3, -4-4, -4-5, -4-6, -4-8, -4-11)

Michael J. Fahrion, Director of Engineering

DC Power Surge Protector

DS220..DC

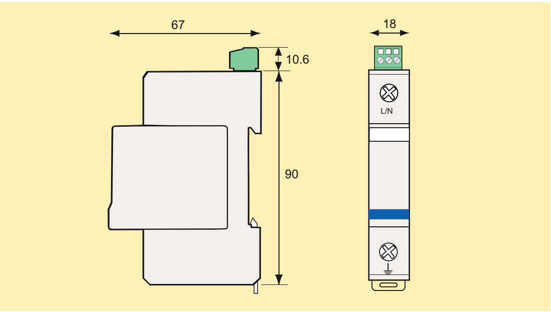
The DS220-24DC surge protector is designed to protect equiptment connected to DC (and AC) power supplies from lightning surges.

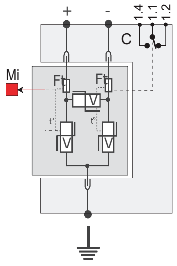
It is based on varistors matched to the network voltage. This SPD is based on varistors equipped with thermal disconnector and failure indicators. Version with remote signaling for disconnection indication is also available. (DS220S-24DC).

In addition, the surge protection function is pluggable to make replacement simple and rapid (spare module: DSM220-DC). The DS220-24DC is DIN rail compatible and is connected in parallel on the line to be protected.

- Surge Protector for DC Supplies
- Remote Signal Contact
- Discharge Currents: 20kA
- Visual Fault Indicator
- Pluggable Module

Dimensions and Diagram



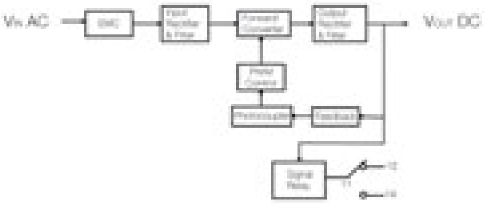


DS220..DC

V: High-energy varistor
Ft: Thermal fuse
C: Remote signaling contact
t°: Thermal disconnection system
Mi : Disconnection indicator

Characteristics

CITEL part number		DS220-24DC
Nominal DC voltage	Un-dc	24 Vdc
Maximal AC voltage	Uc	40 Vac
Maximal DC voltage	Uc-dc	56 Vdc
Nominal discharge current *15 x 8/20 µs impulses*	In	5 kA
Maximum discharge current 1 impulse 8/20µs	Imax	20 kA
Protection level (at In)	Up	180 V
Thermal disconnect or internal		
Fuses		Fuses - 50 A time delay
Dimensions		see diagram
Connection		by screw terminals : #8 AWG MAX
Disconnection indicator		Mechanical Indicator
Mounting		symmetrical rail 35 mm
Operating temperature		-40/+85 °C
Protection class		IP20
Housing material		Thermoplastic UL94-V0



General ordering data	
Order No.	8708680000
Part designation	CP SNT 250W 24V 10A
Version	Switched-mode power supplies
EAN	4032248380848
Qty.	1 pc(s).

Dimensions	
Clamping range, nom.	4 mm²
Clamping range, min.	0.13 mm²
Clamping range, max.	6 mm²

temperature	
Ambient temperature (operational)	
Storage temperature	-20 °C...+85 °C
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Input	
Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Input current	3.6 A @ 115 V AC / 2 A @ 230 V AC
Input frequency, max.	50/ 60 Hz
Input fuse	Fusible link 5 A (T) / 250 V
Input voltage (voltage mode input)	88...132 V AC/176...264 V AC selectable; 250...370 V DC
Surge protection [input]	Varistor

output	
Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Control at 10...100% load	< 2 %
Control at input voltage	0.5 %
Mains failure bridge-over time	10 ms @ 115 V AC / 15 ms @ 230 V AC
Mains failure bridge-over time for 115 V AC	10 ms
Mains failure bridge-over time for 230 V AC	15 ms

output	
Max. capacitance at output	40000 µF
Max. residual ripple	< 100 mV / bandwidth 20 MHz
Output current	0.1…10 A
Output power, max.	240 W
Output voltage	24...28 V DC (adjustable with potentiometer)
Output voltage type	DC
Output voltage, max.	28 V
Output voltage, min.	24 V
Overload protection	105 %..130 % I of max. output load; automatic reset
Parallel connection option	Recommended with diode module
Status relay / CO contact	250 V AC (max. 30 V DC) / 1 A
Surge protection [output]	30...36 V

General data	
Ambient temperature (operational)	
DIN Rail compatibility	TS 35
Degree of efficiency at max. load	84 % @ 230 V AC
Depth	100 mm
EMC standards	EN 55011 EN 55022 EN 55024 EN 61000-6-2, 3
Installation advice	Clearance: above/below ≥ 3 cm
Low Voltage Directive	73/ 23/ EWG
Mounting position, installation notice	horizontally on terminal rail TS 35
Standards	EN 60950 (SELV)
Status indication	Green LED
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Insulation coordination	
Protection class	IP 20
electrical isolation, input-earth	1.5 kV
electrical isolation, input-output	3 kV
electrical isolation, output-earth	0.5 kV

Approvals	
Approvals institutes	CULUS; CURUS; GERMLLOYD; GOSTME25; CE

Classifications	
ETIM20	EC001039
ETIM30	EC001039
eClass 4.1	27-24-04-10
eClass 5.0	27-24-22-13
eClass 5.1	27-04-90-02
eClass 6.0	27-04-90-04

Similar products

Order No.	Part designation	Version
8862780000	CP SNT 1000W 24V 40A	Switched-mode power supplies
8708660000	CP SNT 70W 24V 3A	Switched-mode power supplies

8708670000	CP SNT 120W 24V 5A	Switched-mode power supplies
8778870000	CP SNT 500W 24V 20A	Switched-mode power supplies

General ordering data	
Order No.	8896940000
Part designation	IE-SW5-WAVE
Version	Network switch, IP 20, Number of ports: 5x RJ45, unmanaged
EAN	4032248646357
Qty.	1 pc(s).

Dimensions (1)	
Length	108 mm
Width	22.5 mm
Height	127.8 mm

Industrial Ethernet	
AC input power	4 VA AC
DC input power	4 Watt DC
Standard	IEEE 802.3; 802.3u; 802.3x; Class I, Division 2
Segment length	Copper, 100 m: fibre multimode, 2 km: fibre singlemode 20 km
Type of mounting	TS 35
Storage temperature, min.	-40 °C
Storage temperature, max.	85 °C
Status indication	Data rate Power Connection/Activity
Number of ports	5x RJ45
Data rate	10 Base-T/100 Base-TX (copper) 100 Base-FX (fibre) 10 Base-T/100 Base-TX (copper) 100 Base-FX (fibre)@@@
Aging	300 s
Flow control	HD (backpressure) / FD (pause)
Input voltage AC, min.	12 V
Input voltage AC, max.	24 V
Input voltage DC, min.	35 V
Input voltage DC, max.	10 V
Input frequency	47 - 63 Hz

Industrial Ethernet	
Version	Autonegotiation Autocrossing (RJ45) Redundant power supply
Protection class	IP 20

Technical data	
Version	Autonegotiation Autocrossing (RJ45) Redundant power supply
operating temperature, min.	0 °C
operating temperature, max.	60 °C
Optical budget	8 dB for 62.5/125 µm multimode cable4 dB for 50/125 µm multimode cable
Protection class	IP 20

Approvals	
Approvals institutes	CULUSEX; GOSTME25

Classifications	
eClass 5.1	19-03-01-17
eClass 6.0	19-17-01-06

Similar products

Order No.	Part designation	Version
8897710000	IE-SW3-WAVE	Network switch, IP 20, Number of ports: 3x RJ45, unmanaged
8896920000	IE-SW3/1SC-WAVE	Network switch, IP 20, Number of ports: 1x SC-MM, 3x RJ45, unmanaged
8953090000	IE-SW3/1SCS20-WAVE	Network switch, IP 20, Number of ports: 1x SC-SM-20, 3x RJ45, unmanaged
8896930000	IE-SW3/1ST-WAVE	Network switch, IP 20, Number of ports: 1x ST-MM, 3x RJ45, unmanaged
8944350000	IE-SW3/1LC-WAVE	Network switch, IP 20, Number of ports: 1x LC-MM, 3x RJ45, unmanaged
8896950000	IE-SW6/1SC-WAVE	Network switch, IP 20, Number of ports: 1x SC-MM, 6x RJ45, unmanaged
8953100000	IE-SW6/1SCS20-WAVE	Network switch, IP 20, Number of ports: 1x SC-SM-20, 6x RJ45, unmanaged
8896960000	IE-SW6/1ST-WAVE	Network switch, IP 20, Number of ports: 1x ST-MM, 6x RJ45, unmanaged
8944360000	IE-SW6/1LC-WAVE	Network switch, IP 20, Number of ports: 1x LC-MM, 6x RJ45, unmanaged
8896970000	IE-SW8-WAVE	Network switch, IP 20, Number of ports: 8 x RJ45, unmanaged
8961210000	IE-SW3-ETR-WAVE	Network switch, IP 20, Number of ports: 3x RJ45, unmanaged
8962280000	IE-SW3/1SCS20-ETR-WAVE	Network switch, IP 20, Number of ports: 1x SC-SM-20, 3x RJ45, unmanaged
8961220000	IE-SW5-ETR-WAVE	Network switch, IP 20, Number of ports: 5x RJ45, unmanaged
8962290000	IE-SW6/1SCS20-ETR-WAVE	Network switch, IP 20, Number of ports: 1x SC-SM-20, 6x RJ45, unmanaged
8953770000	IE-SW6/2SC-ETR-WAVE	Network switch, IP 20, Number of ports: 2x SC-MM, 6x RJ45, unmanaged

8953790000	IE-SW6/2ST-ETR-WAVE	Network switch, IP 20, Number of ports: 2x ST-MM, 6x RJ45, unmanaged
8953780000	IE-SW6/2LC-ETR-WAVE	Network switch, IP 20, Number of ports: 2x LC-MM, 6x RJ45, unmanaged
8953800000	IE-SW6/2SCRJ-ETR-WAVE	Network switch, IP 20, Number of ports: 2x SCRJ-MM, 6x RJ45, unmanaged

GE Fanuc Automation

Programmable Control Products

VersaMax® PLC

User's Manual

GFK-1503C

March 2001

Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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PowerMotion
PowerTRAC
ProLoop
PROMACRO
Series Five
Series 90
Series One
Series Six
Series Three
VersaMax
VersaPro
VuMaster
Workmaster

Contents

Contents

Chapter 1 Introduction

Guide to the VersaMax® Document Set

This manual contains general information about CPU operation and program content. It also provides detailed descriptions of specific programming requirements.

Chapter 1 is a general introduction to the VersaMax family of products.

CPU Modules are described in detail in chapters 2 and 3.

Installation procedures are described in Chapter 4.

PLC Configuration is described in chapter 5. Configuration determines certain characteristics of module operation and also establishes the program references used by each module in the system.

Ethernet Configuration for CPU model IC200CPUE05 is described in chapter 6.

CPU Operation is described in chapter 7.

Serial Communications are described in chapter 12.

Ethernet Communications for CPU model IC200CPUE05 is described in chapter 13.

The rest of the manual describes many programming features.

- Elements of an Application Program: chapter 8
- Program Data: chapter 9
- Instruction Set Reference: chapter 10
- The Service Request Function: chapter 11
- The PID Function: chapter 14
- Instruction Timing: appendix A

Other VersaMax Manuals

VersaMax Modules, Power Supplies, and Carriers User's Manual (catalog number GFK-1504)	Describes the many VersaMax I/O and option modules, power supplies, and carriers. This manual also provides detailed system installation instructions.
VersaMax PLC Ethernet Station Manager's Manual (catalog number GFK-1876)	Describes the diagnostic interface to the Ethernet functions of CPU module IC200CPUE05.
VersaMax Ethernet Network Interface Unit User's Manual (catalog number GFK-1860)	Describes the installation and operation of the Ethernet Network Interface Unit module.
VersaMax Genius NIU User's Manual (catalog number GFK-1535)	Describes the installation and operation of the Genius NIU.
VersaMax DeviceNet Communications Modules User's Manual (catalog number GFK-1533)	Describes the installation and operation of the DeviceNet Network Interface Unit module and the DeviceNet Network Slave Module.
VersaMax Profibus Communications Modules User's Manual (catalog number GFK-1534)	Describes the installation and operation of the Profibus Network Interface Unit module and the Profibus Network Communications Module.

The VersaMax® Family of Products

The VersaMax family of products provides universally-distributed I/O that spans PLC and PC-based architectures. Designed for industrial and commercial automation, VersaMax I/O provides a common, flexible I/O structure for local and remote control applications. The VersaMax PLC provides big-PLC power with a full range of I/O and option modules. VersaMax I/O Stations with Network Interface Modules make it possible to add the flexibility of VersaMax I/O to other types of networks. VersaMax meets UL, CUL, CE, Class1 Zone 2 and Class I Division 2 requirements.

As a scaleable automation solution, VersaMax I/O combines compactness and modularity for greater ease of use. The 70-mm depth and small footprint of VersaMax I/O enables easy, convenient mounting as well as space-saving benefits. Modules can accommodate up to 32 points of I/O each.

The compact, modular VersaMax products feature DIN-rail mounting with up to eight I/O and option modules per “rack” and up to 8 racks per VersaMax PLC or VersaMax I/O Station system. Expansion racks can be located up to 750 meters from the main VersaMax PLC or VersaMax I/O Station rack. Expansion racks can include any VersaMax I/O, option, or communications module.

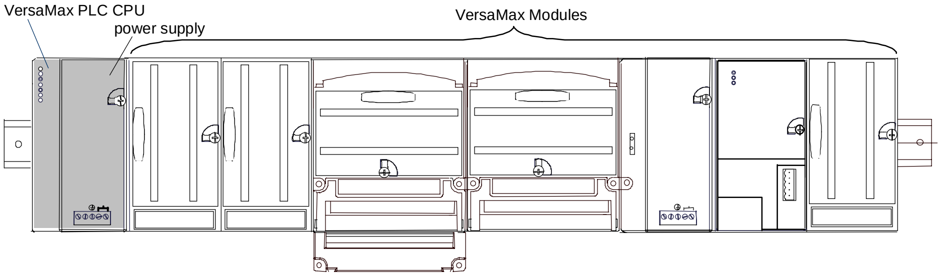
VersaMax provides automatic addressing that can eliminate traditional configuration and the need for hand-held devices. Multiple field wiring termination options provide support for two, three, and four-wire devices.

For faster equipment repair and shorter Mean-Time-To-Repair, the hot insertion feature enables addition and replacement of I/O modules while a machine or process is running and without affecting field wiring.

VersaMax I/O may be remotely located. Remote I/O interfaces for Genius, DeviceNet, Profibus, and Ethernet are available.

CPU Modules for VersaMax PLCs

A VersaMax PLC consists of a group of VersaMax modules with a VersaMax CPU and attached power supply in the first position.



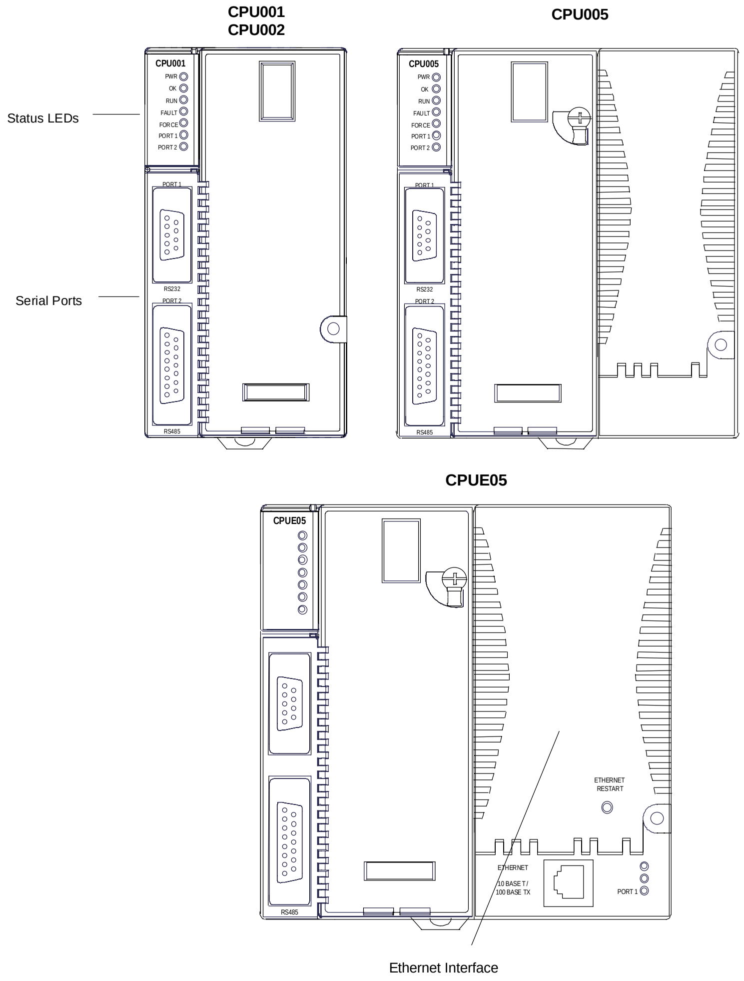
All VersaMax CPUs provide powerful PLC functionality. They are designed to serve as the system controller for up to 64 modules with up to 2048 I/O points. Two serial ports provide RS-232 and RS-485 interfaces for SNP slave and RTU slave communications. CPU model IC200CPUE05 provides a built-in Ethernet port.

Basic CPU Features

- Programming in Ladder Diagram, Sequential Function Chart, and Instruction List
- Floating point (real) data functions
- Non-volatile flash memory for program storage
- Battery backup for program, data, and time of day clock
- Run/Stop switch
- Embedded RS-232 and RS-485 communications
- Compatible with EZ Program Store device

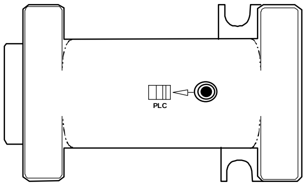
Available VersaMax CPUs

CPU with Two Serial Ports, 34kB of Configurable Memory	IC200CPU001
CPU with Two Serial Ports, 42kB of Configurable Memory	IC200CPU002
CPU with Two Serial Ports, 64kB of Configurable Memory	IC200CPU005
CPU with Two Serial Ports and Embedded Ethernet Interface, 64kB of Configurable Memory	IC200CPUE05



EZ Program Store

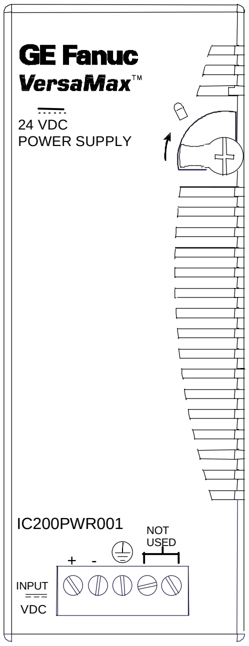
The EZ Program Store device (IC200ACC003) can be used to store and update the configuration, application program, and reference table data of a VersaMax PLC. A programmer and PLC CPU are used to initially write data to the device.



Power Supplies

An AC or DC Power Supply provides +5V and +3.3V power to the modules in the rack. Additional power supplies can be installed on special booster carriers if needed. No booster supply is needed to power conventional I/O modules.

CPU models IC200CPU005 and IC200CPUE05 require the use of an "expanded" 3.3V power supply. See the table below.



Available Power Supplies and Carrier

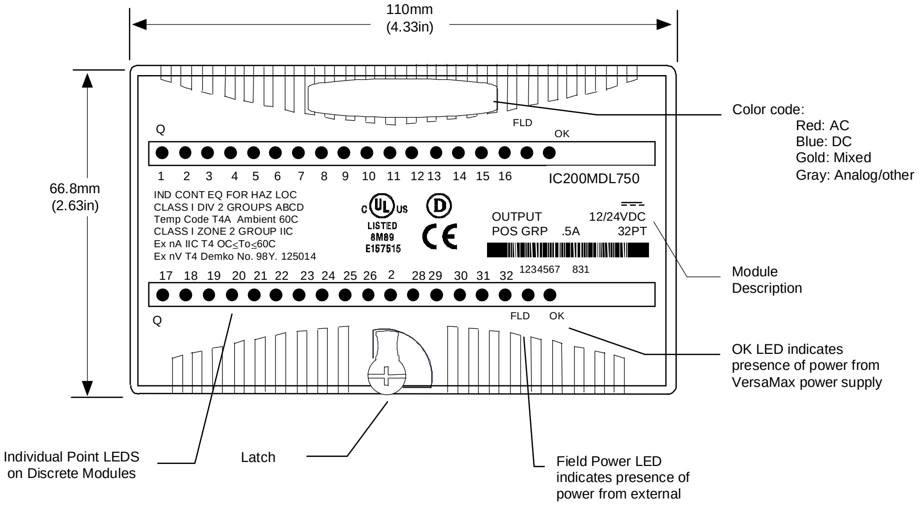
The following VersaMax power supplies and carrier are available:

24VDC Power Supply	IC200PWR001
24VDC Expanded 3.3V Power Supply	IC200PWR002
120/240VAC Power Supply	IC200PWR101
120/240VAC Expanded 3.3V Power Supply	IC200PWR102
12VDC Power Supply	IC200PWR201
12VDC Expanded 3.3V Power Supply	IC200PWR202
Power Supply Booster Carrier	IC200PWB001

Power supplies are described in the *VersaMax Modules, Power Supplies, and Carriers User's Manual* (GFK-1504).

I/O Modules

VersaMax IO and option modules are approximately 110mm (4.33in) by 66.8mm (2.63in) in size. Modules can be mounted either horizontally or vertically on several types of available I/O Carriers. Modules are 50mm (1.956 in) in depth, not including the height of the carrier or the mating connectors.



VersaMax I/O modules are described in the *VersaMax Modules, Power Supplies, and Carriers User's Manual* (GFK-1504).

Available I/O Modules

The following types of VersaMax I/O Modules are available:

Discrete Input Modules	
Input 120VAC 8 Point Grouped Module	IC200MDL140
Input 240VAC 8 Point Grouped Module	IC200MDL141
Input 120VAC 8 Point Isolated Module	IC200MDL143
Input 240VAC 4 Point Isolated Module	IC200MDL144
Input 120VAC (2 Groups of 8) 16 Point Module	IC200MDL240
Input 240VAC (2 Groups of 8) 16 Point Module	IC200MDL241
Input 120VAC 16 Point Isolated Module	IC200MDL243
Input 240VAC 8 Point Isolated Module	IC200MDL244
Input 125VDC Positive/Negative Logic Grouped 8 Point Module	IC200MDL631
Input 125VDC Positive/Negative Logic Grouped 16 Point Module	IC200MDL632
Input 48VDC Positive/Negative Logic Grouped 16 Point Module	IC200MDL635
Input 48VDC Positive/Negative Logic Grouped 32 Point Module	IC200MDL636
Input 24VDC Positive/Negative Logic (2 Groups of 8) 16 Point Module	IC200MDL640
Input 5/12VDC (TTL) Positive/Negative Logic 16 Point Module	IC200MDL643
Input 5/12VDC (TTL) Positive/Negative Logic Grouped 32 Point Module	IC200MDL644
Input 24VDC Positive/Negative Logic (4 Groups of 8) 32 Point Module	IC200MDL650
Discrete Output Modules	
Output 120VAC 0.5A per Point Isolated 8 Point Module	IC200MDL329
Output 120VAC 0.5A per Point Isolated 16 Point Module	IC200MDL330
Output 120VAC 2.0A per Point Isolated 8 Point Module	IC200MDL331
Output 24VDC Positive Logic 2.0A per Point (1 Group of 8) w/ESCP 8 Point Module,	IC200MDL730
Output 12/24VDC Positive Logic 0.5A per Point (1 Group of 16) 16 Point Module	IC200MDL740
Output 24VDC Positive Logic 0.5A per Point (1 Group of 16) w/ESCP 16 Point Module	IC200MDL741
Output 24VDC Positive Logic 0.5A per Point (2 Groups of 16) w/ESCP 32 Point Module	IC200MDL742
Output 5/12/24VDC Negative Logic 0.5A per Point (1 Group of 16) 16 Point Module	IC200MDL743
Output 5/12/24VDC Negative Logic 0.5A per Point (2 Groups of 16) 32 Point Module	IC200MDL744
Output 12/24VDC Positive Logic 0.5A per Point (2 Groups of 16) 32 Point Module	IC200MDL750
Output Relay 2.0A per Point Isolated Form A 8 Point Module	IC200MDL930
Output Relay 2.0A per Point Isolated Form A 16 Point Module	IC200MDL940

Discrete Mixed I/O Modules	
Mixed 24VDC Positive Logic Input Grouped 20 Point / Output Relay 2.0A per Point Grouped 12 Point Module	IC200MDD840
Mixed 24VDC Positive Logic Input 20 Point / Output 12 Point / (4) High Speed Counter, PWM, or Pulse Train Configurable Points	IC200MDD841
Mixed 16 Point Grouped Input 24VDC Pos/Neg Logic / 16 Pt Grouped Output 24VDC Pos. Logic 0.5A w/ESCP	IC200MDD842
Mixed 24VDC Positive Logic Input Grouped 10 Point / Output Relay 2.0A per Point 6 Point Module	IC200MDD843
Mixed 24 VDC Pos/Neg Logic Input Grouped 16 Point / Output 12/24VDC Pos. Logic 0.5A 16 Point Module	IC200MDD844
Mixed 16 Point Grouped Input 24VDC Pos/Neg Logic / 8 Pt Relay Output 2.0A per Pt Isolated Form A	IC200MDD845
Mixed 120VAC Input 8 Point / Output Relay 2.0A per Point 8 Point Module	IC200MDD846
Mixed 240VAC Input 8 Point / Output Relay 2.0A per Point 8 Point Module	IC200MDD847
Mixed 120VAC Input 8 Point / Output 120VAC 0.5A per Point Isolated 8 Point Module	IC200MDD848
Mixed 120VAC In Isolated 8 Point / Output Relay 2.0A Isolated 8 Point Module	IC200MDD849
Mixed 240VAC In Isolated 4 Point / Output Relay 2.0A Isolated 8 Point Module	IC200MDD850
Analog Input Modules	
Analog Input Module, 12 Bit Voltage/Current 4 Channels	IC200ALG230
Analog Input Module, 16 Bit Voltage/Current, 1500VAC Isolation, 8 Channels	IC200ALG240
Analog Input Module, 12 Bit Voltage/Current 8 Channels	IC200ALG260
Analog Input Module, 15 Bit Differential Voltage 8 Channels	IC200ALG261
Analog Input Module, 16 Bit Differential Current 8 Channels	IC200ALG262
Analog Input Module, 15 Bit Voltage 15 Channels	IC200ALG263
Analog Input Module, 15 Bit Current 15 Channels	IC200ALG264
Analog Input Module, 16 Bit RTD, 4 Channels	IC200ALG620
Analog Input Module, 16 Bit Thermocouple, 7 Channels	IC200ALG630
Analog Output Modules	
Analog Output Module, 12 Bit Current, 4 Channels	IC200ALG320
Analog Output Module, 12 Bit Voltage 4 Channels. 0 to +10VDC Range	IC200ALG321
Analog Output Module, 12 Bit Voltage 4 Channels. -10 to +10VDC Range	IC200ALG322
Analog Output Module, 13 Bit Voltage 8 Channels	IC200ALG325
Analog Output Module, 12 Bit Current 8 Channels	IC200ALG326
Analog Output Module, 13 Bit Voltage 12 Channels	IC200ALG327
Analog Output Module, 12 Bit Current 12 Channels	IC200ALG328
Analog Output Module, 16 Bit Voltage/Current, 1500VAC Isolation, 4 Channels	IC200ALG331
Analog Mixed I/O Modules	
Analog Mixed Module, Input Current 4 Channels, Output Current 2 Channels	IC200ALG430
Analog Mixed Module, 0 to +10VDC Input 4 Channels, Output 0 to +10VDC 2 Channels	IC200ALG431
Analog Mixed Module, 12 Bit -10 to +10VDC, Input 4 Channels / Output -10 to +10VDC 2 Channels	IC200ALG432

Carriers

Carriers provide mounting, backplane communications, and field wiring connections for all types of VersaMax modules. I/O modules can be installed on carriers or removed without disturbing field wiring.

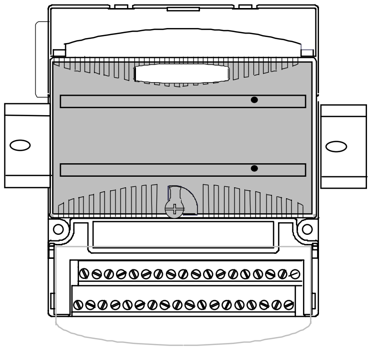
There are three basic I/O Carrier types:

- Terminal-style I/O carriers. Modules mount parallel to the DIN rail.
- Compact Terminal-style I/O Carriers. Modules mount perpendicular to the DIN rail.
- Connector-style I/O Carriers. Modules mount perpendicular to the DIN rail. These carriers are normally used with Interposing I/O Terminals as illustrated below.

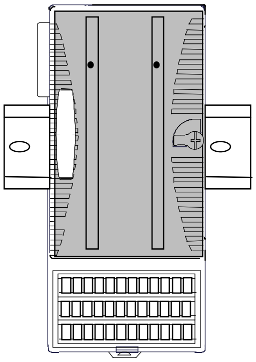
See the *VersaMax Modules, Power Supplies, and Carriers User's Manual* (GFK-1504) for information about VersaMax I/O Carriers.

Terminal-style I/O carriers have 36 individual terminals for direct connection of field wiring. Auxiliary I/O Terminal Strips are available for applications requiring additional wiring terminals.

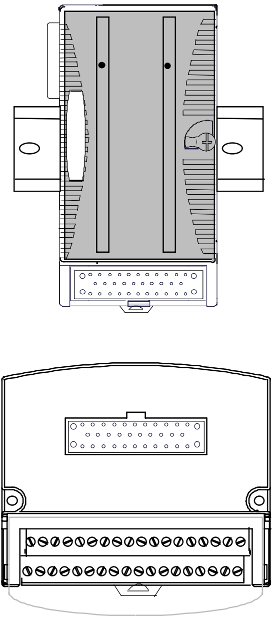
Terminal-style I/O Carrier



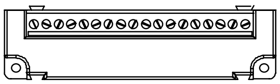
Compact Terminal-style I/O Carrier



Connector-style I/O Carrier and Interposing Terminals



Auxiliary I/O Terminal Strip



Available Carriers and Terminal Strips

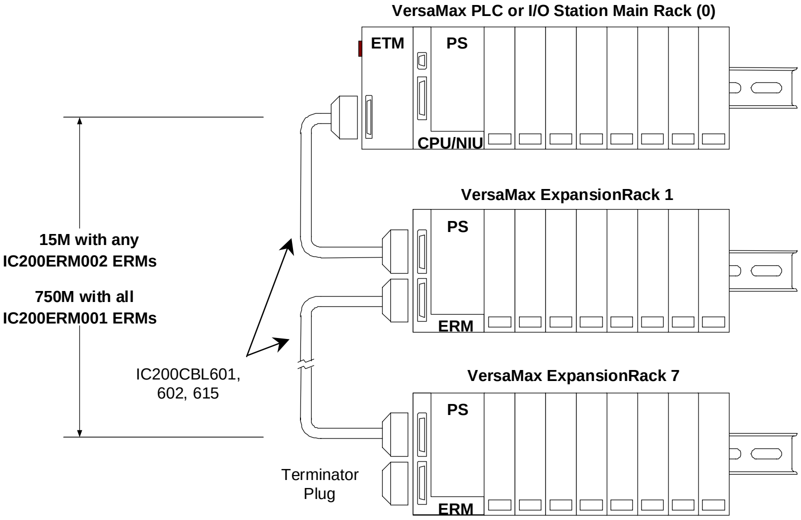
The following types of Carriers, terminals, and cables are available:

Terminal-Style I/O Carriers	
Barrier-Style Terminal I/O Carrier	IC200CHS001
Box-Style Terminal I/O Carrier	IC200CHS002
Spring-Style Terminal I/O Carrier	IC200CHS005
Compact Terminal-Style I/O Carriers	
Compact Box-Style I/O Carrier	IC200CHS022
Compact Spring-Style I/O Carrier	IC200CHS025
Connector-Style I/O Carrier	
Connector-Style I/O Carrier	IC200CHS003
Interposing Terminals for use with Connector-Style Carrier	
Barrier-Style Interposing I/O Terminals	IC200CHS011
Box-Style Interposing I/O Terminals	IC200CHS012
Thermocouple-Style Interposing I/O Terminals	IC200CHS014
Spring-Style Interposing I/O Terminals	IC200CHS015
Cables for use with Connector-Style I/O Carriers	
2 connectors, 0.5m, with shield	IC200CBL305
2 connectors, 1.0m, with shield	IC200CBL310
2 connectors, 2.0m, with shield	IC200CBL320
1 connector, 3.0m, with shield	IC200CBL430
2 connectors, 0.5m, no shield	IC200CBL105
2 connectors, 1.0m, no shield	IC200CBL110
2 connectors, 2.0m, no shield	IC200CBL120
1 connector, 3.0m, no shield	IC200CBL230
Auxiliary I/O Terminal Strips for use with Terminal-style I/O Carriers and Interposing Terminals	
Barrier-Style Auxiliary I/O Terminal Strip	IC200TBM001
Box-Style Auxiliary I/O Terminal Strip	IC200TBM002
Spring-Style Auxiliary I/O Terminal Strip	IC200TBM005
Other Carriers	
Communications Carrier	IC200CHS006
Power Supply Booster Carrier	IC200PWB001

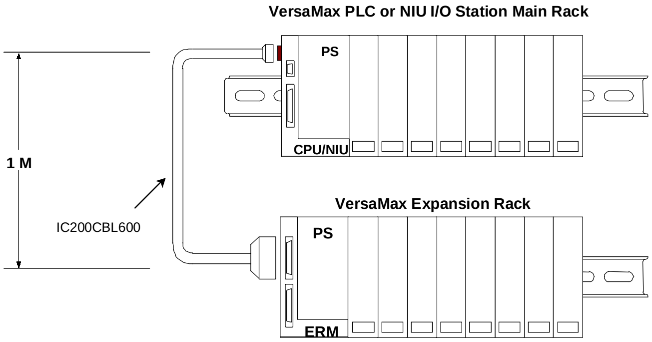
Expansion Modules

There are two basic types of VersaMax I/O expansion systems, Multi-Rack and Single-ended:

- **Multi-Rack:** A VersaMax PLC or NIU I/O Station with an Expansion Transmitter Module (IC200ETM001) and one to seven expansion "racks", each with an Expansion Receiver Module (IC200ERM001 or IC200ERM002). If all the Expansion Receivers are the Isolated type (IC200ERM001), the maximum overall cable length is 750 meters. If the expansion bus includes any non-isolated Expansion Receivers (IC200ERM002), the maximum overall cable length is 15 meters.



- **Single-ended:** A PLC or NIU I/O Station connected directly to one expansion rack with non-isolated Expansion Transmitter Module (IC200ERM002). Maximum cable length is 1 meter.



VersaMax Modules for Expansion Racks

All types of VersaMax I/O and communications modules can be used in expansion racks. Some VersaMax analog modules require specific module revisions as listed below:

Module	Module Revision
IC200ALG320	B or later
IC200ALG321	B or later
IC200ALG322	B or later
IC200ALG430	C or later
IC200ALG431	C or later
IC200ALG432	B or later

Available Expansion Modules

The following Expansion Modules and related products are available:

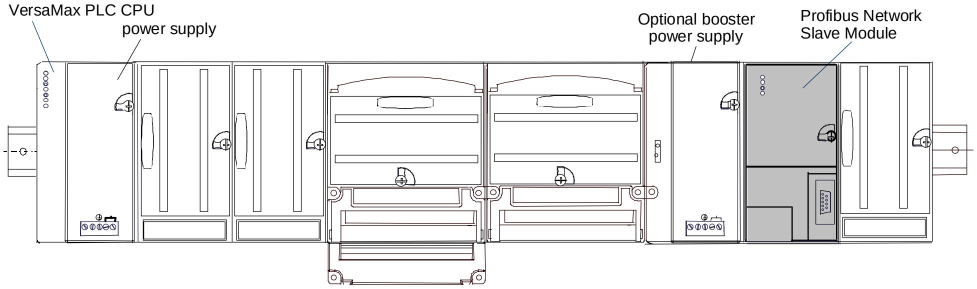
Expansion Modules	
Expansion Transmitter Module	IC200ETM001
Expansion Receiver Module, Isolated	IC200ERM001
Expansion Receiver Module, Non-isolated	IC200ERM002
Cables	
Expansion Cable, 1 meter	IC200CBL601
Expansion Cable, 2 meters	IC200CBL602
Expansion Cable, 15 meters	IC200CBL615
Firmware Update Cable	IC200CBL002
Terminator Plug (included with ETM)	IC200ACC201
Connector Kit	IC200ACC302

See the *VersaMax Modules, Power Supplies, and Carriers User's Manual* (GFK-1504) for information about VersaMax Expansion modules.

Communications Modules

Communications modules provide additional flexibility for VersaMax systems.

These communications modules install on a VersaMax Communications Carrier. Power for the communications module comes from the main system power supply or from a booster supply as shown below.



Available VersaMax PLC Communications Modules

The following VersaMax PLC communications modules are available:

Communications Modules	
Profibus-DP Network Slave Module	IC200BEM002
DeviceNet Network Control Module	IC200BEM103
Communications Carrier	IC200CHS006

For information about the Communications Carrier, please see the *VersaMax Modules, Power Supplies, and Carriers User's Manual* (GFK-1504).

Profibus-DP Network Slave Module

The Profibus-DP Network Slave Module (IC200BEM002) is a communications module that exchanges PLC reference table data on the Profibus network. The VersaMax PLC CPU can read and write this data as though it were conventional bit- and word-type I/O data.

Multiple Profibus-DP Network Slave Modules may be used in the same VersaMax PLC. Each one can read up to 244 bytes of data from the network, and send up to 244 bytes of output data. The total amount of combined inputs and outputs is 384 bytes.

For information about the Profibus-DP Network Slave Module, refer to the *VersaMax System Profibus Network Modules User's Manual* (GFK-1534, revision A or later).

DeviceNet Network Control Module

The DeviceNet Network Control Module (IC200BEM103) is a communications module that can be configured to operate as a master, as a slave, or as both simultaneously. It can exchange up to 512 bytes of input data and 512 bytes of output data with other devices on the DeviceNet network. The VersaMax PLC CPU can read and write this data as though it were conventional bit- and word-type I/O data.

The Network Control Module operates as a Group 2 Only Client (master) and can communicate only with Group 2 Slave devices. It can also operate as a Group 2 Only or a UCMM-capable Server (slave), or as a master and slave simultaneously.

For information about the DeviceNet Network Control Module, refer to the *VersaMax System DeviceNet Network Communications User's Manual* (GFK-1533).

Chapter

2

CPU Module Datasheets: CPU001, CPU002, CPU005

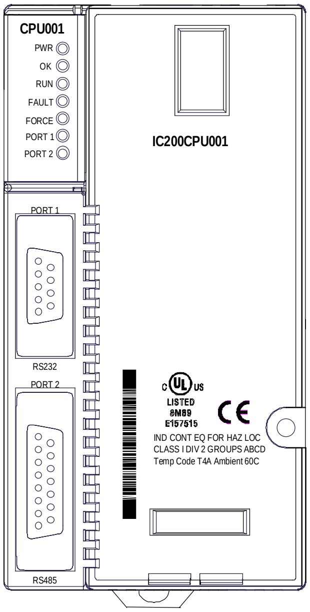
This chapter describes the appearance, features, and functionality of the following VersaMax PLC CPU modules:

■ IC200CPU001	CPU with 34kB Configurable Memory
■ IC200CPU002	CPU with 42kB Configurable Memory
■ IC200CPU005	CPU with 64kB Configurable Memory

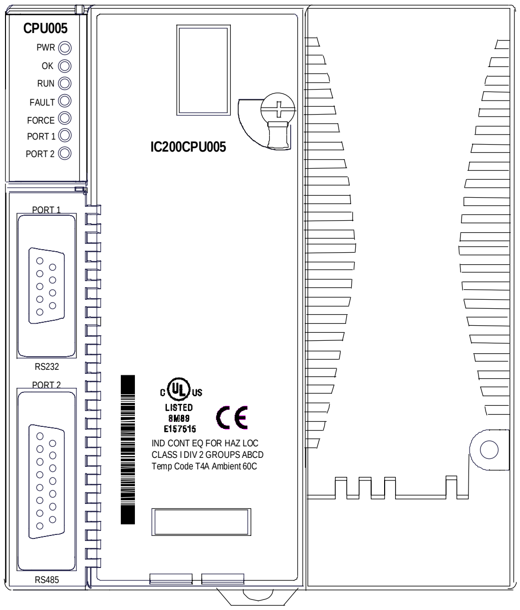
IC200CPU001: CPU with 34kB Configurable Memory
IC200CPU002: CPU with 42kB Configurable Memory
IC200CPU005: CPU with 64kB Configurable Memory

VersaMax® PLC CPUs IC200CPU001, CPU002, and CPU005 provide powerful PLC functionality in a small, versatile system. They are designed to serve as the system controller for up to 64 modules with up to 2048 I/O points. Two serial ports provide RS-232 and RS-485 interfaces for SNP slave and RTU slave communications.

CPU001, CPU002



CPU005



Features

- Non-volatile flash memory for program storage
- Programming in Ladder Diagram, Sequential Function Chart, and Instruction List
- Battery backup for program, data, and time of day clock
- Run/Stop switch
- Floating point (real) data functions
- Embedded RS-232 and RS-485 communications
- 70mm height when mounted on DIN rail with power supply
- Compatible with EZ Program Store device

CPU with 34kB Configurable Memory: IC200CPU001
CPU with 42kB Configurable Memory: IC200CPU002
CPU with 64kB Configurable Memory: IC200CPU005

Module Specifications

Size	CPU001/002: 2.63” (66.8mm) x 5.04” (128mm) CPU005: 4.20” (106.7mm) x 5.04” (128mm)		
Program storage	System flash, battery-backed RAM		
Backplane current consumption: IC200CPU001, IC200CPU002	no serial port converter or EZ Program Store device	5V output: 40mA	3.3V output: 100mA
	with serial port converter or EZ Program Store device	5V output: 140mA	
Backplane current consumption: IC200CPU005	no serial port converter or EZ Program Store device	5V output: 80mA	3.3V output: 290mA*
	with serial port converter or EZ Program Store device	5V output: 180mA	
Floating point	yes		
Embedded communications	RS-232, RS-485		
Boolean execution speed	CPU001, CPU002: 1.8ms/K (typical) CPU005: 0.5ms/K (typical)		
Realtime clock accuracy (for timer functions)	100ppm (0.01%) or +/- 9sec/day		
Time of day clock accuracy	23ppm (0.0023%) or +/- 2sec/day @ 30C. 100 ppm (0.01%) or +/- 9sec/day @ full temperature range		

* CPU005 requires a power supply with expanded 3.3V.

CPU with 34kB Configurable Memory: IC200CPU001
CPU with 42kB Configurable Memory: IC200CPU002
CPU with 64kB Configurable Memory: IC200CPU005

VersaMax General Product Specifications

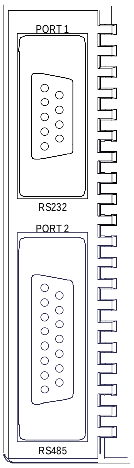
VersaMax products should be installed and used in conformance with product-specific guidelines as well as the following specifications:

Environmental		
Vibration	IEC68-2-6	1G @57-150Hz, 0.012in p--p @10-57Hz
Shock	IEC68-2-27	15G, 11ms
Operating Temp.		0 deg C to +60 deg C ambient
Storage Temp.		-40 deg C to +85 deg C
Humidity		5% to 95%, noncondensing
Enclosure Protection	IEC529	Steel cabinet per IP54: protection from dust & splashing water
EMC Emission		
Radiated, Conducted	CISPR 11/EN 55011	Industrial Scientific & Medical Equipment (Group 1, Class A)
	CISPR 22/EN 55022	Information Technology Equipment (Class A)
	FCC 47 CFR 15	referred to as FCC part 15, Radio Devices (Class A)
EMC Immunity		
Electrostatic Discharge	EN 61000-4-2	8KV Air, 4KV Contact
RF Susceptibility	EN 61000-4-3	$10V_{rms}$ /m, 80Mhz to 1000Mhz, 80% AM
	ENV 50140/ENV 50204	$10V_{rms}$/m, 900MHz +/-5MHZ 100%AM with 200Hz square wave
Fast Transient Burst	EN 61000-4-4	2KV: power supplies, 1KV: I/O, communication
Surge Withstand	ANSI/IEEE C37.90a	Damped Oscillatory Wave: 2.5KV power supplies, I/O [12V-240V]; 1KV communication
	IEC255-4	Damped Oscillatory Wave: Class II, power supplies, I/O [12V-240V]
	EN 61000-4-5	2 kV cm(P/S); 1 kV cm (I/O and communication modules)
Conducted RF	EN 61000-4-6	$10V_{rms}$, 0.15 to 80Mhz, 80%AM
Isolation		
Dielectric Withstand	UL508, UL840, IEC664	1.5KV
Power Supply		
Input Dips, Variations	EN 61000-4-11	During Operation: Dips to 30% and 100%, Variation for AC +/-10%, Variation for DC +/-20%

IC200CPU001: CPU with 34kB Configurable Memory
IC200CPU002: CPU with 42kB Configurable Memory
IC200CPU005: CPU with 64kB Configurable Memory

Serial Ports

The two serial ports are software-configurable for SNP slave or RTU slave operation. 4-wire and 2-wire RTU are supported. If a port is being used for RTU, it automatically switches to SNP slave mode if necessary. Both ports default to SNP slave and both automatically revert to SNP slave when the CPU is in Stop mode, if configured for Serial I/O. Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from Port 2 if it requires 100mA or less at 5VDC.



Port 1: is an RS-232 port with a 9-pin female D-sub connector. The pinout of Port 1 allows a simple straight-through cable to connect with a standard AT-style RS-232 port.

Port 2: is an RS-485 port with a 15-pin female D-sub connector. This can be attached directly to an RS-485 to RS-232 adapter (IC690ACC901).

The following table compares the functions of Port 1 and Port 2.

	Port 1	Port 2
CPU Protocols (SNP slave, RTU slave, Serial I/O)	Defaults to SNP slave	Defaults to SNP slave
Firmware Upgrade	PLC in Stop/No I/O mode.	no
Smart module firmware upgrade	PLC in Stop/No I/O mode	PLC in Stop/No IO mode.

Cable Lengths

Maximum cable lengths the total number of feet from the CPU to the last device attached to the cable are:

Port 1 (RS-232) = 15 meters (50 ft.)
Port 2 (RS-485) = 1200 meters (4000 ft.)

CPU with 34kB Configurable Memory: IC200CPU001
CPU with 42kB Configurable Memory: IC200CPU002
CPU with 64kB Configurable Memory: IC200CPU005

Serial Port Baud Rates

	CPU001, CPU002	CPU005
RTU protocol	1200, 2400, 4800, 9600, 19.2K	1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K**
Serial I/O protocol	4800, 9600, 19.2K	4800, 9600, 19.2K, 38.4K, 57.6K**
SNP protocol	4800, 9600, 19.2K, 38.4K*	4800, 9600, 19.2K, 38.4K*
Firmware Upgrade via WInloader	2400, 4800, 9600, 19.2K, 38.4K	na

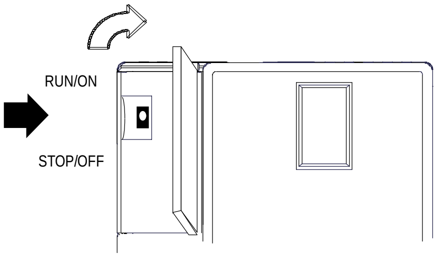
* Only available on one port at a time.

** The VersaPro software allows configuration of RTU and Serial I/O at 115.2K baud. However, these baud rates are not supported by the CPU. If a configuration using these baud rates is stored to the PLC:

1. For RTU, an “Unsupported Feature in Configuration” fault is logged and the PLC transitions to Stop Faulted mode.
2. For Serial I/O, the same fault is logged when the transition to Run mode occurs. The PLC will immediately transition to Stop Faulted mode.

Mode Switch

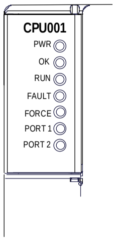
The CPU module has a convenient switch that can be used to place the PLC in Stop or Run mode. The same switch can also be used to block accidental writing to CPU memory and forcing or overriding discrete data. Use of this feature is configurable. The default configuration enables Run/Stop mode selection and disables memory protection.



IC200CPU001: CPU with 34kB Configurable Memory
IC200CPU002: CPU with 42kB Configurable Memory
IC200CPU005: CPU with 64kB Configurable Memory

CPU LEDs

The seven CPU LEDs, visible through the module door, indicate the presence of power and show the operating mode and diagnostic status of the CPU. They also indicate the presence of faults, forces, and communications on the CPU's two ports.



POWER	ON when the CPU is receiving 5V power from the power supply. Does not indicate the status of the 3.3V power output.
OK	ON indicates the CPU has passed its powerup diagnostics and is functioning properly. OFF indicates a CPU problem. Fast blinking indicates that the CPU is running its powerup diagnostics. Slow blinking indicates the CPU is configuring I/O modules. Simultaneous blinking of this LED and the green Run LED indicates that the CPU is in boot mode and is waiting for a firmware update through port 1.
RUN	Green when the CPU is in Run mode. Amber when the CPU is in Stop/IO Scan mode. If this LED is OFF but OK is ON, the CPU is in Stop/No IO Scan mode. If this LED is flashing green and the Fault LED is ON, the module switch was moved from Stop to Run mode while a fatal fault existed. Toggling the switch will continue to Run mode.
FAULT	ON if the CPU is in Stop/Faulted mode because a fatal fault has occurred. To turn off the Fault LED, clear both the I/O Fault Table and the PLC Fault Table. If this LED is blinking and the OK LED is OFF, a fatal fault was detected during PLC powerup diagnostics. Contact PLC Field Service.
FORCE	ON if an override is active on a bit reference.
PORT 1 **PORT 2**	Blinking indicates activity on that port.

CPU with 34kB Configurable Memory: IC200CPU001
CPU with 42kB Configurable Memory: IC200CPU002
CPU with 64kB Configurable Memory: IC200CPU005

Configurable Memory

CPU001 and CPU002 (release 2.0 or later) and CPU005 have configurable user memory. The configurable memory is the amount of memory required for the application program, hardware configuration, registers (%R), analog inputs (%AI), and analog outputs (%AQ).

The amount of memory allocated to the application program and hardware configuration are automatically determined by the actual program and configuration entered from the programmer. The rest of the configurable memory can be easily allocated to suit the application.

Configurable memory	CPU001: 34K bytes maximum CPU002: 42K bytes maximum CPU005: 64K bytes maximum
Application program size (not configurable)	128 bytes minimum
CPU001, for rel. 1.50 compatibility	12K bytes
CPU002, for rel. 1.50 compatibility	20K bytes
Hardware configuration size (not configurable)	400 bytes minimum
Registers (%R)	256 bytes minimum
CPU001/002, for rel. 1.50 compatibility	4,096 bytes
Analog Inputs (%AI)	256 bytes minimum
Analog Outputs (%AQ)	256 bytes minimum

Chapter 3

CPU Module Datasheet: CPUE05

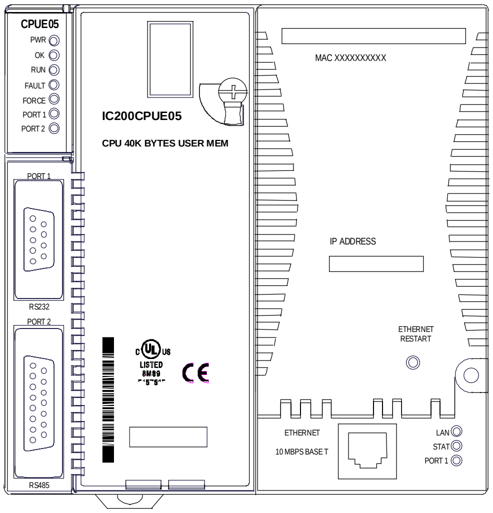
This chapter describes the appearance, features, and functionality of the following VersaMax PLC CPU module:

▪ IC200CPUE05:	CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

IC200CPUE05: CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

VersaMax® PLC CPU IC200CPUE05 shares the basic features of the other VersaMax PLC CPUs. It provides powerful PLC functionality in a small, versatile system. CPUE05 can serve as the system controller for up to 64 modules with up to 2048 I/O points. Two serial ports provide RS-232 and RS-485 interfaces for serial communications. CPUE05 also provides a built-in Ethernet Interface. The RS-232 serial port can be configured for Local Station manager operation to provide access to diagnostic information about the Ethernet interface. CPUE05 has 64kB of configurable memory.

In addition, CPUE05 is compatible with the EZ Program Store device, which can be used to write, read, update, and verify programs, configuration, and reference tables data without a programmer or programming software.



Features

- 64kB of configurable memory
- Programming in Ladder Diagram, Sequential Function Chart, and Instruction List
- Compatible with EZ Program Store device.
- Non-volatile flash memory for program storage
- Battery backup for program, data, and time of day clock
- Run/Stop switch
- Floating point (real) data functions
- Embedded RS-232 and RS-485 communications
- Embedded Ethernet interface
- 70mm height when mounted on DIN rail with power supply

CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory: IC200CPUE05

Module Specifications

Size	4.95" (126mm) x 5.04" (128mm)		
Program storage	System flash, battery-backed RAM		
Backplane current consumption: IC200CPUE05	no serial port converter or EZ Program Store device	5V output: 160mA	3.3V output: 650mA*
	with serial port converter or EZ Program Store device	5V output: 260mA	
Floating point	yes		
Boolean execution speed	0.5ms/K (typical)		
Realtime clock accuracy (for timer functions)	100ppm (0.01%) or +/- 9sec/day		
Time of day clock accuracy	23ppm (0.0023%) or +/- 2sec/day @ 30C. 100 ppm (0.01%) or +/- 9sec/day @ full temperature range		
Embedded communications	RS-232, RS-485, Ethernet interface		
Configurable memory	64K bytes maximum		
Ethernet Interface Specifications			
Number of SRTP server connections	8		
Ethernet data rate	10Mbps		
Physical interface	10BaseT RJ45		
WinLoader support	via CPU port		
Number of Ethernet Global Data configuration-based exchanges	32		
EGD Exchange limits	100 data ranges and 1400 bytes of data per exchange; 1200 total data ranges across all exchanges.		
Time Synchronization	NTP - client only		
Selective Consumption of EGD	yes		
Load EGD configuration from PLC to programmer	yes		
Remote Station Manager over UDP	yes		
Local Station Manager (RS-232)	via CPU port		
Configurable Advanced User Parameters	yes		

* CPUE05 requires a power supply with expanded 3.3V.

IC200CPUE05: CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

VersaMax General Product Specifications

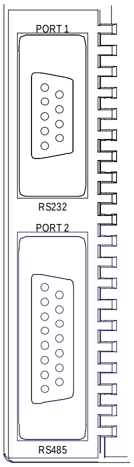
VersaMax products should be installed and used in conformance with product-specific guidelines as well as the following specifications:

Environmental		
Vibration	IEC68-2-6	1G @57-150Hz, 0.012in p--p @10-57Hz
Shock	IEC68-2-27	15G, 11ms
Operating Temp.		0 deg C to +60 deg C ambient
Storage Temp.		-40 deg C to +85 deg C
Humidity		5% to 95%, noncondensing
Enclosure Protection	IEC529	Steel cabinet per IP54: protection from dust & splashing water
EMC Emission		
Radiated, Conducted	CISPR 11/EN 55011	Industrial Scientific & Medical Equipment (Group 1, Class A)
	CISPR 22/EN 55022	Information Technology Equipment (Class A)
	FCC 47 CFR 15	referred to as FCC part 15, Radio Devices (Class A)
EMC Immunity		
Electrostatic Discharge	EN 61000-4-2	8KV Air, 4KV Contact
RF Susceptibility	EN 61000-4-3	$10V_{rms}$ /m, 80Mhz to 1000Mhz, 80% AM
	ENV 50140/ENV 50204	$10V_{rms}$/m, 900MHz +/-5MHZ 100%AM with 200Hz square wave
Fast Transient Burst	EN 61000-4-4	2KV: power supplies, 1KV: I/O, communication
Surge Withstand	ANSI/IEEE C37.90a	Damped Oscillatory Wave: 2.5KV power supplies, I/O [12V-240V]; 1KV communication
	IEC255-4	Damped Oscillatory Wave: Class II, power supplies, I/O [12V-240V]
	EN 61000-4-5	2 kV cm(P/S); 1 kV cm (I/O and communication modules)
Conducted RF	EN 61000-4-6	$10V_{rms}$, 0.15 to 80Mhz, 80%AM
Isolation		
Dielectric Withstand	UL508, UL840, IEC664	1.5KV
Power Supply		
Input Dips, Variations	EN 61000-4-11	During Operation: Dips to 30% and 100%, Variation for AC +/-10%, Variation for DC +/-20%

IC200CPUE05: CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

Serial Ports

The two serial ports are software-configurable for SNP slave or RTU slave operation. 4-wire and 2-wire RTU are supported. If a port is being used for RTU, it automatically switches to SNP slave mode if necessary. Port 1 can also be configured for Local Station Manager operation to provide access to diagnostic information about the Ethernet interface. Both ports default to SNP slave and both automatically revert to SNP slave when the CPU is in Stop mode, if configured for Serial I/O. Either port can be software-configured to set up communications between the CPU and various serial devices. An external device can obtain power from Port 2 if it requires 100mA or less at 5VDC.



Port 1: is an RS-232 port with a 9-pin female D-sub connector. The pinout of Port 1 allows a simple straight-through cable to connect with a standard AT-style RS-232 port.

Port 1 can be configured for either CPU serial communications (SNP, RTU, Serial I/O), or local Station Manager use. If Port 1 has been configured for CPU use, it can be forced to local Station Manager operation using the Restart pushbutton. Once forced, Port 1 remains available for station manager use until the PLC is power cycled, or the Restart pushbutton is pressed.

If Port 1 is configured as a local Station Manager, it cannot be used for CPU serial communications or for firmware upgrades using Winloader. The Restart pushbutton will NOT toggle it to the CPU serial protocols.

Port 2: is an RS-485 port with a 15-pin female D-sub connector. This can be attached directly to an RS-485 to RS-232 adapter (IC690ACC901). Port 2 can be used for program, configuration, and table updates with the EZ Program Store module.

The following table compares the functions of Port 1 and Port 2.

	Port 1	Port 2
CPU Protocols (SNP slave, RTU slave, Serial I/O)	Defaults to SNP slave	Defaults to SNP slave
Local Station Manager	Yes (see above)	no
Firmware Upgrade	PLC in Stop/No I/O mode, Port 1 not disabled or in Local Station Manager mode.	no
Smart module firmware upgrade	PLC in Stop/No I/O mode, Port 1 configured for CPU protocol	PLC must be in Stop/No IO mode.
EZ Program Store device	No	Read, Write, Verify, and Update. PLC must be in Stop/No IO mode.

CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory: IC200CPUE05

Cable Lengths

Maximum cable lengths the total number of feet from the CPU to the last device attached to the cable are:

Port 1 (RS-232) = 15 meters (50 ft.)
Port 2 (RS-485) = 1200 meters (4000 ft.)

Serial Port Baud Rates

	Port 1	Port 2
RTU protocol	1200, 2400, 4800, 9600, 19.2K, 38.4*K, 57.6*K	1200, 2400, 4800, 9600, 19.2K, 38.4*K, 57.6*K
Serial I/O protocol	4800, 9600, 19.2K, 38.4K*, 57.6K*	4800, 9600, 19.2K, 38.4K*, 57.6K*
SNP protocol	4800, 9600, 19.2K, 38.4K*	4800, 9600, 19.2K, 38.4K*
Local Station Manager (this is independent of serial protocol baud rate)	1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K, 115.2K	na
Firmware Upgrade via WInloader	2400, 4800, 9600, 19.2K, 38.4K, 57.6K, 115.2K	na

* Only available on one port at a time.

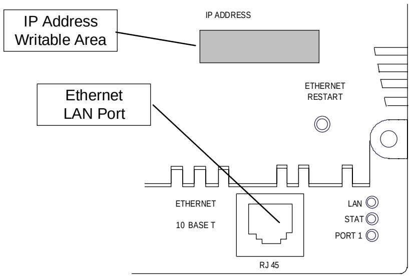
The VersaPro software allows configuration of RTU and Serial I/O at 115.2K baud. However, these baud rates are not supported by the CPU. If a configuration using these baud rates is stored to the PLC:

1. For RTU, an “Unsupported Feature in Configuration” fault is logged and the PLC transitions to Stop Faulted mode.
2. For Serial I/O, the same fault is logged when the transition to Run mode occurs. The PLC will immediately transition to Stop Faulted mode.

Ethernet LAN Port

The Ethernet LAN port supports SRTP Server and Ethernet Global Data. This port connects directly to a 10BaseT (twisted pair) network without an external transceiver. The 10BaseT twisted pair cables must meet applicable IEEE 802 standards. CPUE05 automatically selects either half-duplex of full-duplex operation, as sensed from the network connection.

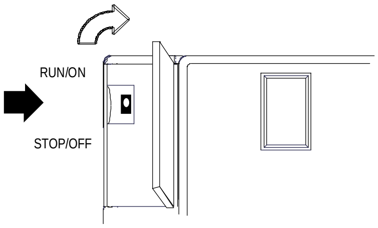
A space is provided on the front of the CPUE05 module where the configured IP Address can be written.



IC200CPUE05: CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

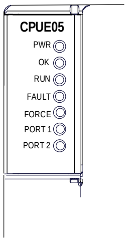
Mode Switch

The Mode switch is located behind the module door. It can be used to place the PLC in Stop or Run mode. It can also be used to block accidental writing to CPU memory and forcing or overriding discrete data. Use of this feature is configurable. The default configuration enables Run/Stop mode selection and disables memory protection.



CPU LEDs

The seven CPU LEDs, visible through the module door, indicate the presence of power and show the operating mode and diagnostic status of the CPU. They also indicate the presence of faults, forces, and communications on the CPU's two ports

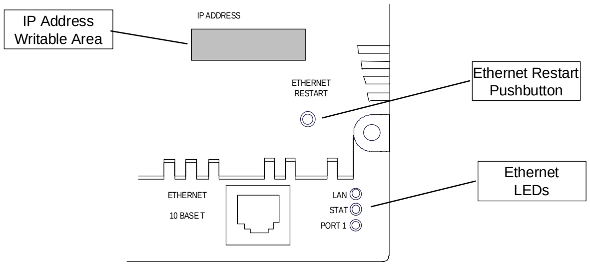


POWER	ON when the CPU is receiving 5V power from the power supply. Does not indicate the status of the 3.3V power output.
OK	ON indicates the CPU has passed its powerup diagnostics and is functioning properly. OFF indicates a CPU problem. Fast blinking indicates that the CPU is running its powerup diagnostics. Slow blinking indicates the CPU is configuring I/O modules. Simultaneous blinking of this LED and the green Run LED indicates that the CPU is in boot mode and is waiting for a firmware update through port 1.
RUN	Green when the CPU is in Run mode. Amber when the CPU is in Stop/IO Scan mode. If this LED is OFF but OK is ON, the CPU is in Stop/No IO Scan mode. If this LED is flashing green and the Fault LED is ON, the module switch was moved from Stop to Run mode while a fatal fault existed. Toggling the switch will continue to Run mode.
FAULT	ON if the CPU is in Stop/Faulted mode because a fatal fault has occurred. To turn off the Fault LED, clear both the I/O Fault Table and the PLC Fault Table. If this LED is blinking and the OK LED is OFF a fatal fault was detected during PLC powerup diagnostics. Contact PLC Field Service.
FORCE	ON if an override is active on a bit reference.
PORT 1 **PORT 2**	Blinking indicates activity on that port when controlled by the CPU.

CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory: IC200CPUE05

Ethernet Restart Pushbutton

The Ethernet Restart pushbutton is located on the right side of the module.



The Ethernet Restart pushbutton has two functions:

- When pressed for less than 5 seconds, it resets the Ethernet hardware, tests the Ethernet LEDs, and restarts the Ethernet firmware. This disrupts any Ethernet communications that are presently underway.
- When pressed for at least 5 seconds, it toggles the function of Port 1 between its configured operation and forced local Station Manager operation. Note that if Port 1 is available for Local Station Manager operation, Winloader cannot be used for a firmware upgrade.

Ethernet LEDs

The three Ethernet LEDs indicate the status and activity of the Ethernet interface.

LAN	indicates the status and activity of the Ethernet network connection. ON/flickering green indicates Ethernet interface is online. ON amber indicates Ethernet interface is offline
STAT	indicates the general status of the Ethernet interface. ON green indicates no “exception” detected. ON amber indicates an exception. Blinking amber indicates error code. Blinking green indicates waiting for configuration or waiting for IP address.
PORT1	indicates when the Ethernet interface is controlling the RS-232 serial port. It also indicates when the Ethernet Restart pushbutton has been used to override configured RS-232 port usage for Local Station Manager operation. ON amber indicates Port 1 is available for Local Station Manager use (either by configuration or forced). OFF indicates PLC CPU is controlling Port 1. (Does not blink to indicate traffic).

The Ethernet LEDs turn ON briefly, first amber then green, whenever a restart is performed in the Operational state by pressing and releasing the Restart pushbutton. This allows you to verify that the Ethernet LEDs are operational. All three LEDs blink green in unison when a software load is in progress.

IC200CPUE05: CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

Configurable Memory

CPUE05 provides a total of 64K bytes of configurable user memory. This 64K of memory is use for the application program, hardware configuration, registers (%R), analog inputs (%AI), and analog outputs (%AQ). The amount of memory allocated to the application program and hardware configuration are automatically determined by the actual program and configuration entered from the programmer. The rest of the 64K bytes can be easily configured to suit the application.

Configurable memory	64K bytes maximum
Application program size (not configurable)	128 bytes minimum
Hardware configuration size (not configurable)	528 bytes minimum
Registers (%R)	256 bytes minimum
Analog Inputs (%AI)	256 bytes minimum
Analog Outputs (%AQ)	256 bytes minimum

CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory: IC200CPUE05

Ethernet Interface Overview

CPUE05 has a built-in Ethernet interface that makes it possible to communicate on a 10BaseT network. Both half-duplex and full-duplex operation are supported. Using 10/100 hubs allows CPUE05 to communicate on a network containing 100Mb devices.-

SRTP Server

CPUE05 supports up to eight simultaneous SRTP Server connections for use by other devices on the Ethernet network, such as the PLC programmer, CIMPLICITY HMI, SRTP channels for Series 90 PLCs, and Host Communications Toolkit applications. No PLC programming is required for server operation.

Ethernet Global Data

CPUE05 supports up to 32 simultaneous Ethernet Global Data exchanges. Global Data exchanges are configured using the PLC programming software, then stored to the PLC. Both Produced and Consumed exchanges may be configured. CPUE05 supports up to 1200 variables across all Ethernet Global Data exchanges, and supports selective consumption of Ethernet Global Data exchanges. See chapter 13for information about Ethernet Global Data.

Station Manager Functionality

CPUE05 has built-in Station Manager functionality. This permits on-line diagnostic and supervisory access through either the Station Manager port or via the Ethernet network. Station Manager services include:

- An interactive set of commands for interrogating and controlling the station.
- Unrestricted access to observe internal statistics, an exception log, and configuration parameters.
- Password security for commands that change station parameters or operation.

Use of the Station Manager function requires a separate computer terminal or terminal emulator.

See GFK-1876 for information about Station Manager operation.

Chapter 4

Installation

This chapter describes:

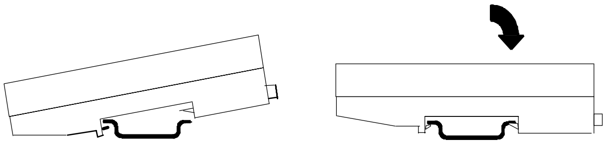
- Installing the CPU
- Installing the power supply
- Installing additional modules
- Activating or replacing the backup battery
- Serial port connections
- Installing expansion modules
- Ethernet connection for CPUE05
- CE Mark installation requirements

System installation instructions, which give guidelines for carrier, power supply, and module installation, as well as information about field wiring and grounding, are located in the *VersaMax Modules, Power Supplies, and Carriers Manual*, GFK-1504.

Mounting Instructions

All VersaMax® modules and carriers in the same PLC “rack” must be installed on a single section of 7.5mm X 35mm DIN rail, 1mm thick. Steel DIN rail is recommended. The DIN rail must be electrically grounded to provide EMC protection. The rail must have a conductive (unpainted) corrosion-resistant finish. DIN rails compliant with DIN EN50022 are preferred. For vibration resistance, the DIN rail should be installed on a panel using screws spaced approximately 15.24cm (6 inches) apart.

The base snaps easily onto the DIN rail. No tools are required for mounting or grounding to the rail.

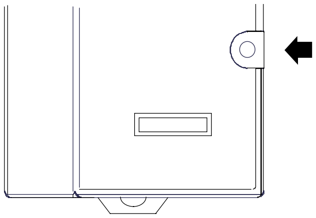


Removing the CPU from the DIN Rail

1. Turn off power to the power supply.
2. (If the CPU is attached to the panel with a screw) remove the power supply module. Remove the panel-mount screw.
3. Slide the CPU along the DIN rail away from the other modules until the connector disengages.
4. With a small flathead screwdriver, pull down on the DIN rail latch tab(s) on the bottom of the module and lift the module off the DIN rail.

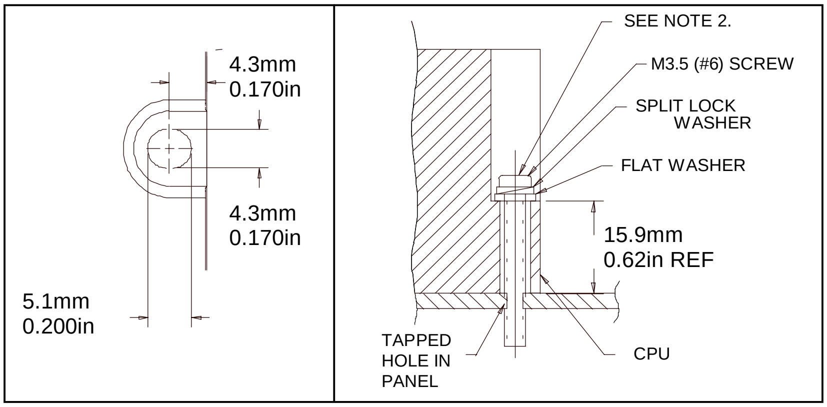
Panel-Mounting

For maximum resistance to mechanical vibration and shock, the equipment must also be installed on a panel. Using the module as a template, mark the location of the module's panel-mount hole on the panel. Drill the hole in the panel. Install the module using an M3.5 (#6) screw in the panel-mount hole.



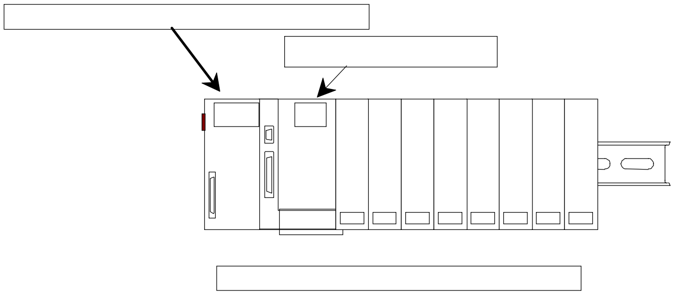
Note 1. Tolerances on all dimensions are +/- 0.13mm +/-0.005in) non-cumulative.

Note 2. 1.1 to 1.4Nm (10 to 12 in/lbs) of torque should be applied to M3.5 (#6-32) steel screw threaded into material containing internal threads and having a minimum thickness of 2.4mm (0.093in).

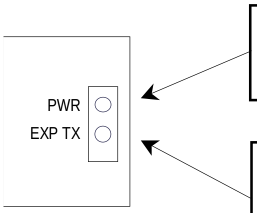


Installing an Expansion Transmitter Module

If the VersaMax PLC will have more than one expansion rack or one expansion rack that uses an Isolated Expansion Receiver Module (IC200ERM001) as its interface to the expansion bus, an Expansion Transmitter Module must be installed to the left of the CPU. The Expansion Transmitter Module must be installed on the same section of DIN rail as the rest of the modules in the main “rack” (rack 0).



1. Make sure rack power is off.
2. Attach the Expansion Transmitter to DIN rail to the left of the CPU position.
3. Install the CPU. Connect the modules and press them together until the connectors are mated.
4. After completing any additional system installation steps, apply power and observe the module LEDs.



On indicates presence of 5VDC power.

Off indicates no 5VDC power.

Blinking or On indicates active communications on expansion bus.

Off indicates no communications.

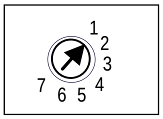
Removing an Expansion Transmitter Module

1. Make sure rack power is off.
2. Slide module on DIN rail away from the CPU in the main rack.
3. Using a small screwdriver, pull down on the tab on the bottom of the module and lift the module off the DIN rail.

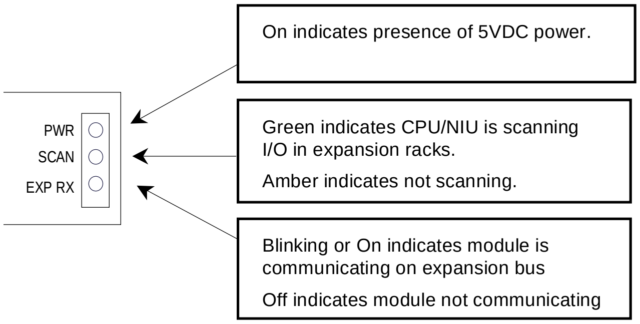
Installing an Expansion Receiver Module

An Expansion Receiver Module (IC200ERM001 or 002) must be installed in the leftmost slot of each VersaMax expansion "rack".

1. Insert the label inside the small access door at the upper left corner of the module.
2. Attach the module to the DIN rail at the left end of the expansion rack.
3. Select the expansion rack ID (1 to 7) using the rotary switch under the access door at upper left corner of the module. Each rack must be set to a different rack ID. With a single-ended cable (one expansion rack only), set the Rack ID to 1.



4. Install a VersaMax Power Supply module on top of the Expansion Receiver. See "Installing a Power Supply" in this chapter for details.
5. Attach the cables. If the system includes an Expansion Transmitter Module, attach the terminator plug to the EXP2 port on the last Expansion Receiver Module.
6. After completing any additional system installation steps, apply power and observe the module LEDs.



On indicates presence of 5VDC power.

Green indicates CPU/NIU is scanning I/O in expansion racks.

Amber indicates not scanning.

Blinking or On indicates module is communicating on expansion bus

Off indicates module not communicating

Removing an Expansion Receiver Module

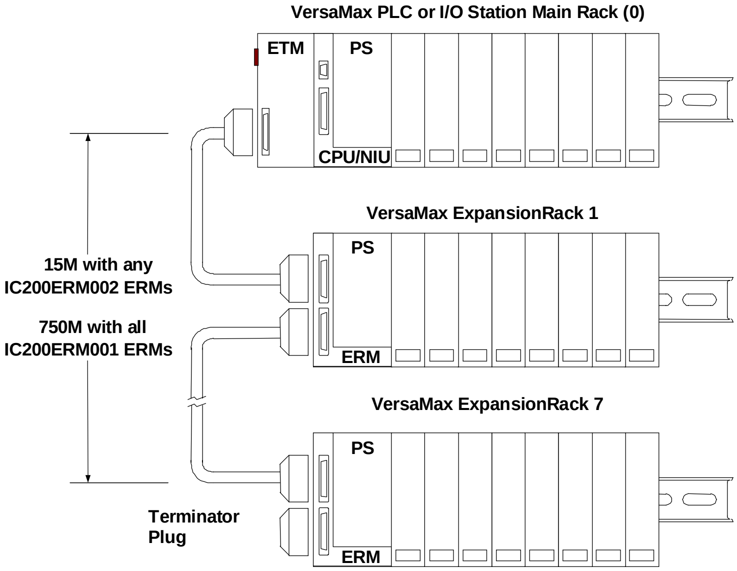
1. Make sure rack power is off.
2. Uninstall the Power Supply module from the Expansion Receiver Module.
3. Slide the Expansion Receiver Module on DIN rail away from the other modules.
4. Using a small screwdriver, pull down on the tab on the bottom of the module and lift the module off the DIN rail.

Expansion Rack Power Sources

Power for module operation comes from the Power Supply installed on the Expansion Receiver Module. If the expansion rack includes any Power Supply Booster Carrier and additional rack Power Supply, it must be tied to the same source as the Power Supply on the Expansion Receiver Module.

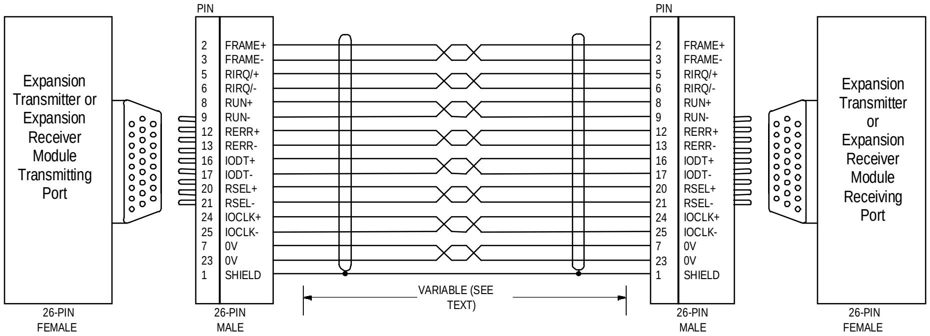
Connecting the Expansion Cable: RS-485 Differential

For a multiple-rack expansion system, connect the cable from the expansion port on the Expansion Transmitter to the Expansion Receivers as shown below. If all the Expansion Receivers are the Isolated type (IC200ERM001), the maximum overall cable length is 750 meters. If the expansion bus includes any non-isolated Expansion Receivers (IC200ERM002), the maximum overall cable length is 15 meters.



Install the Terminator Plug (supplied with the Expansion Transmitter module) into the lower port on the last Expansion Receiver. Spare Terminator Plugs can be purchased separately as part number IC200ACC201 (Qty 2).

RS-485 Differential Inter-Rack Connection (IC200CBL601, 602, 615)

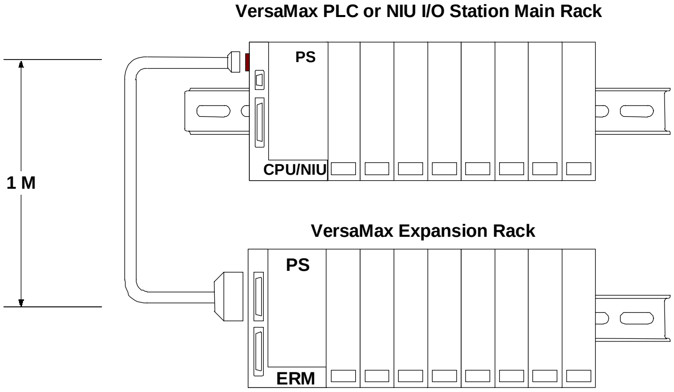


Building a Custom Expansion Cable

Custom expansion cables can be built using Connector Kit IC200ACC202, Crimper AMP 90800-1, and Belden 8138, Manhattan/CDT M2483, Alpha 3498C, or equivalent AWG #28 (0.089mm^2) cable.

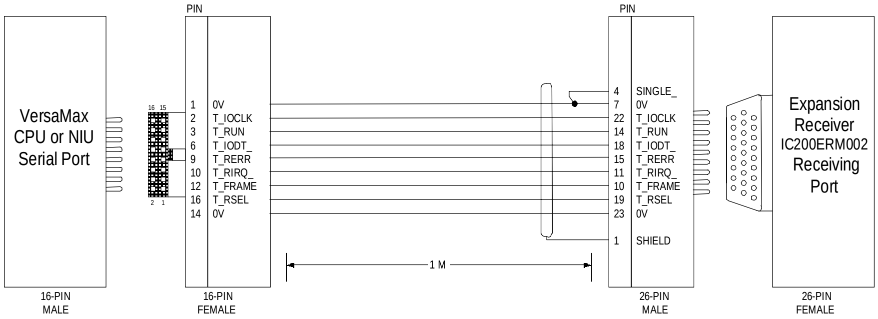
Connecting the Expansion Cable: Single-ended

For a system with one non-isolated expansion rack (IC200ERM002) and NO Expansion Transmitter, connect the expansion cable from the serial port on the VersaMax CPU to the Expansion Receiver as shown below. The maximum cable length is one meter. Cables cannot be fabricated for this type of installation; cable IC200CBL600 must be ordered separately.



No Terminator Plug is needed in a single-ended installation; however, it will not impede system operation if installed.

Single-Ended Inter-Rack Connection (IC200CBL600)



Power Sources for Single-Ended Expansion Rack Systems

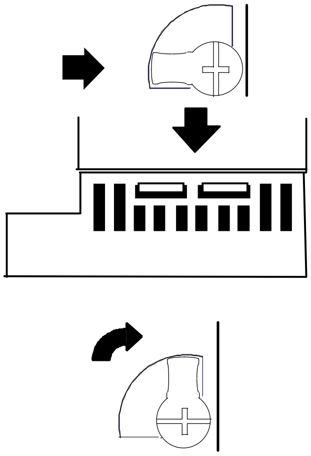
When operating the system in single-ended mode, the power supplies for the main rack and expansion rack must be fed from the same main power source. The main rack and expansion racks cannot be switched ON and OFF separately; either both must be ON or both must be OFF for proper operation.

Power for modules in the expansion rack comes from the Power Supply installed on the Expansion Receiver Module. If the expansion rack includes any Power Supply Booster Carrier and additional rack Power Supply, it must be tied to the same source as the Power Supply on the Expansion Receiver Module.

Installing Power Supply Modules

Power supply modules install directly onto the CPU module, Expansion Receiver Modules, and supplementary power supply carriers.

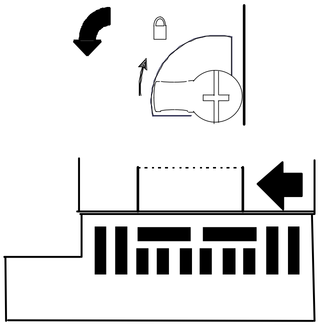
The power supply on the CPU or Expansion Receiver Module supplies +5V and +3.3V to downstream modules through the mating connector. The number of modules that can be supported depends on the power requirements of the modules. Additional booster power supplies can be used as needed to meet the power needs of all modules. If the rack includes any Power Supply Booster Carrier and additional rack Power Supply, it must be tied to the same source as the Power Supply on the CPU. The configuration software provides power calculations with a valid hardware configuration. Power Supply installation instructions are given below.



1. The latch on the power supply must be in the unlocked position.
2. Align the connectors and the latch post and press the power supply module down firmly, until the two tabs on the bottom of the power supply click into place. Be sure the tabs are fully inserted in the holes in bottom edge of the CPU, ERM, or carrier.
3. Turn the latch to the locked position to secure the power supply.

Removing the Power Supply

Exercise care when working around operating equipment. Devices may become very hot and could cause injury.



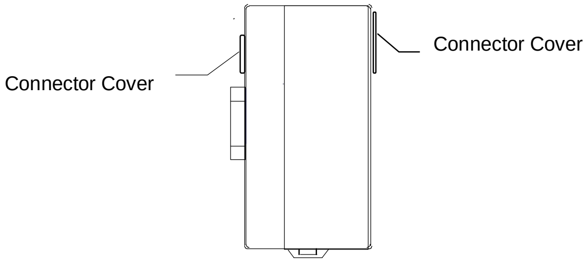
1. Remove power.
2. Turn the latch to the unlocked position as illustrated.
3. Press the flexible panel on the lower edge of the power supply to disengage the tabs on the power supply from the holes in the carrier.
4. Pull the power supply straight off.

Installing Additional Modules

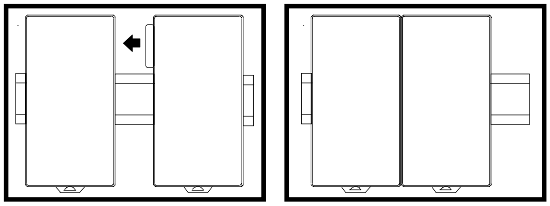
A CPU or Expansion Receiver Module can serve up to 8 additional I/O and option modules on the same section of DIN rail. Power must be off before adding a carrier to the “rack”.

Before joining carriers to the CPU or ERM, remove the connector cover on the righthand side of the CPU/ERM. Do not discard this cover; you will need to install it on the last carrier. It protects the connector pins from damage and ESD during handling and use.

Do not remove the connector cover on the lefthand side.



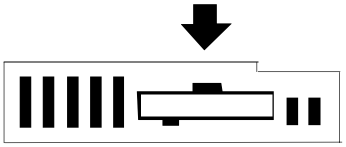
Install each carrier close to the previously-installed carrier, then slide the properly-aligned carriers together to join the mating connectors. To avoid damaging the connector pins, do not force or slam carriers together.



DIN-rail clamps (available as part number IC200ACC313) should be installed at both ends of the station to lock the modules in position.

Activating or Replacing the Backup Battery

The CPU module is shipped with a battery already installed. The battery holder is located in the top side of the CPU module. Before the first use, activate the battery by pulling and removing the insulator tab.



Lithium Battery Replacement

To replace the battery, use a small screwdriver to gently pry open the battery holder.

Replace battery only with one of the following:

GE Fanuc	IC200ACC001
Panasonic	BR2032

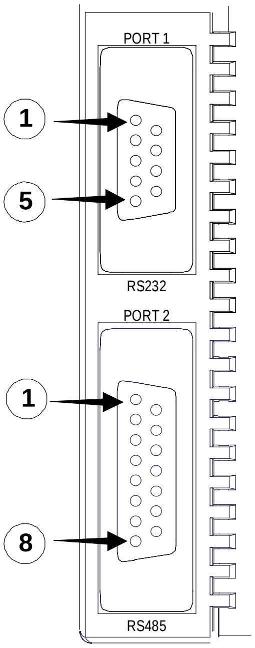
Use of another battery may present a risk of fire or explosion.

Caution

Battery may explode if mistreated.

Do not recharge, disassemble, heat above 100 deg.C (212 deg.F) or incinerate.

Serial Port Connections



Providing Power to an External Device from Port 2

If either port is set up for communications with a serial device that requires 100mA or less at 5VDC, the device can obtain power from Port 2.

Cable Lengths and Baud Rates

Maximum cable lengths (the total number of feet from the CPU to the last device attached to the cable) are:

Port 1 (RS-232) = 15 meters (50 ft.)
Port 2 (RS-485) = 1200 meters (4000 ft.)

Both ports support configurable baud rates, as listed in the CPU descriptions in this manual.

The following pre-assembled cables are available:

IC200CBL001	CPU Programming Cable RS232
IC200CBL002	Expansion Firmware Upgrade Cable

Port 1: RS-232

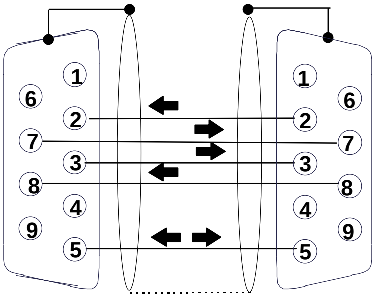
Pin Assignments for Port 1

Port 1 is an RS-232 port with a 9-pin female D-sub connector. It is used as the boot loader port for upgrading the CPU firmware. The pinout of Port 1 allows a simple straight-through cable to connect with a standard AT-style RS-232 port. Cable shielding attaches to the shell.

Pin	Signal	Direction	Function
1	n/c		
2	TXD	Output	Transmit Data output
3	RXD	Input	Receive Data input
4	n/c		
5	GND	--	0V/GND signal reference
6	n/c		
7	CTS	Input	Clear to Send input
8	RTS	Output	Request to Send output
9	n/c		
Shell	SHLD	--	Cable Shield wire connection / 100% (Continuous) shielding cable shield connection

RS-232 Point to Point Connection

In point-to-point configuration, two devices are connected to the same communication line. For RS-232, the maximum length is 15 meters (50ft).



PC 9-Pin Serial Port	CPU Port 1
9-pin female	9-pin male
(2) RXD	(2) TXD
(3) TXD	(3) RXD
(5) GND	(5) GND
(7) RTS	(7) CTS
(8) CTS	(8) RTS

The shield must connect to shell of connectors on both ends of the cable.

Connector and Cable Specifications for Port 1

Vendor Part numbers below are provided for reference only. Any part that meets the same specification can be used.

Cable: Belden 9610	Computer cable, overall braid over foil shield 5 conductor † 30 Volt / 80°C (176°F) 24 AWG tinned copper, 7x32 stranding			
9 Pin Male Connector:	Type:	Vendor:	Plug:	Pin:
	Crimp	ITT/Cannon AMP	DEA9PK87F0 205204-1	030-2487-017 66506-9
	Solder	ITT/Cannon AMP	ZDE9P 747904-2	-- --
Connector Shell:	Kit *– ITT Cannon DE121073-54 [9-pin size backshell kit]: Metal-Plated Plastic (Plastic with Nickel over Copper) † Cable Grounding Clamp (included) 40° cable exit design to maintain low-profile installation Plus – ITT Cannon 250-8501-010 [Extended Jackscrew]: Threaded with #4-40 for secure attachment to CPU001 port † Order Qty 2 for each cable shell ordered			

† Critical Information – any other part selected should meet or exceed this criteria.

* Use of this kit maintains the 70mm installed depth.

Port 2: RS-485

Pin Assignments for Port 2

Port 2 is an RS-485 port with a 15-pin female D-sub connector. This can be attached directly to an RS-485 to RS-232 adapter.

Pin	Signal	Direction	Function
1	SHLD	--	Cable Shield Drain wire connection
2, 3, 4	n/c		
5	P5V	Output	+5.1VDC to power external devices (100mA max.)
6	RTSA	Output	Request to Send (A) output
7	GND	--	0V/GND reference signal
8	CTSB’	Input	Clear to Send (B) input
9	RT	--	Resistor Termination (120 ohm) for RDA’
10	RDA’	Input	Receive Data (A) input
11	RDB’	Input	Receive Data (B) input
12	SDA	Output	Transmit Data (A) output
13	SDB	Output	Transmit Data (B) output
14	RTSB	Output	Request to Send (B) output
15	CTSA’	Input	Clear to Send (A) input
Shell	SHLD	--	Cable Shield wire connection / 100% (Continuous) shielding cable shield connection

Connector and Cable Specifications for Port 2

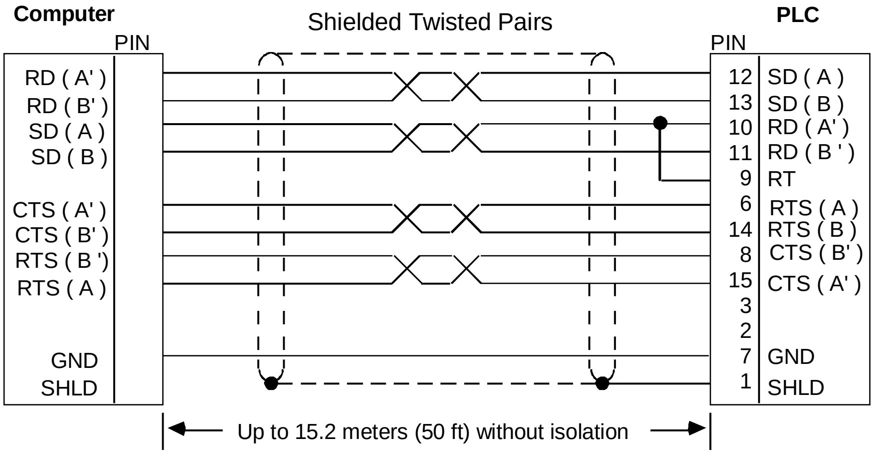
Vendor Part numbers below are provided for reference only. Any part that meets the same specification can be used.

<table>
<tr><td>Cable:
Belden 8105</td><td colspan="4">Low Capacitance Computer cable, overall braid over foil shield
5 Twisted-pairs †
Shield Drain Wire †
30 Volt / 80°C (176°F)
24 AWG tinned copper, 7x32 stranding
Velocity of Propagation = 78%
Nominal Impedance = 100Ω †</td></tr>
<tr><td rowspan="2">15 Pin Male
Connector:</td><td><u>Type:</u>
Crimp</td><td><u>Vendor:</u>
ITT/Cannon
AMP</td><td><u>Plug:</u>
DAA15PK87F0
205206-1</td><td><u>Pin:</u>
030-2487-017
66506-9</td></tr>
<tr><td>Solder</td><td>ITT/Cannon
AMP</td><td>ZDA15P
747908-2</td><td>--
--</td></tr>
<tr><td>Connector
Shell:</td><td colspan="4">Kit* – ITT Cannon DA121073-50 [15-pin size backshell kit]:
Metal-Plated Plastic (Plastic with Nickel over Copper) †
Cable Grounding Clamp (included)
40° cable exit design to maintain low-profile installation
Plus – ITT Cannon 250-8501-009 [Extended Jackscrew]:
Threaded with (metric) M3x0.5 for secure attachment †
Order Qty 2 for each cable shell ordered</td></tr>
</table>

† Critical Information – any other part selected should meet or exceed this criteria.

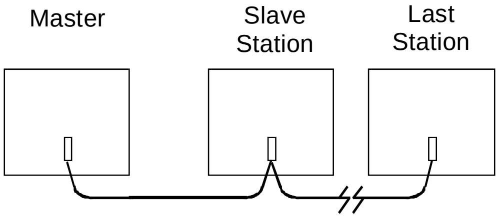
RS485 Point to Point Connection with Handshaking

In point-to-point configuration, two devices are connected to the same communication line. For RS-485, the maximum cable length is 1200 meters (4000 feet). Modems can be used for longer distances.

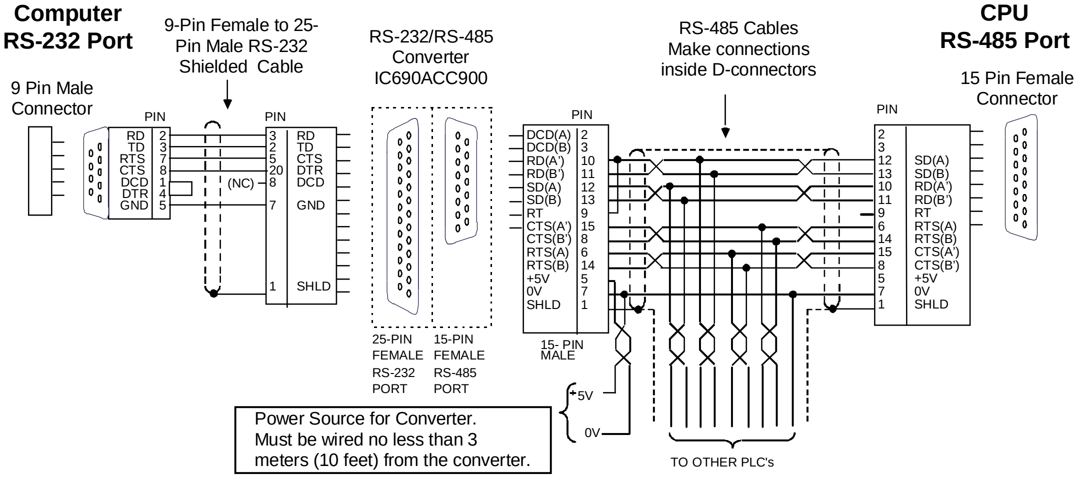


RS-485 Multidrop Serial Connections

In the multidrop configuration, the host device is configured as the master and one or more PLCs are configured as slaves. The maximum distance between the master and any slave may not exceed 4000 feet (1200 meters). This figure assumes good quality cables and a moderately noisy environment. A maximum of 8 slaves can be connected using RS-485 in a *daisy chain* or multidrop configuration. The RS-485 line must include handshaking and use wire type as specified earlier.



When wiring RS-485 multidrop cables, reflections on the transmission line can be reduced by daisy-chaining the cable as shown below. Make connections inside the connector to be attached to the PLC. Avoid using terminal strips to other types of connectors along the length of the transmission line.



Termination resistance for the Receive Data (RD) signal must be connected only on units at the ends of lines. This termination is made at the CPU by connecting a jumper between pin 9 and pin 10 inside the D-shell connector.

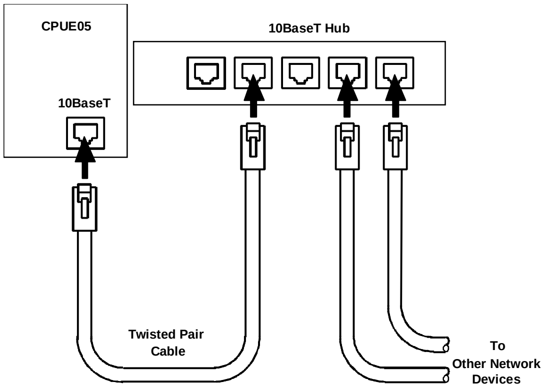
Ground Potential: Multiple units not connected to the same power source must have common ground potential or ground isolation for proper operation of the system.

Ethernet Connection for CPUE05

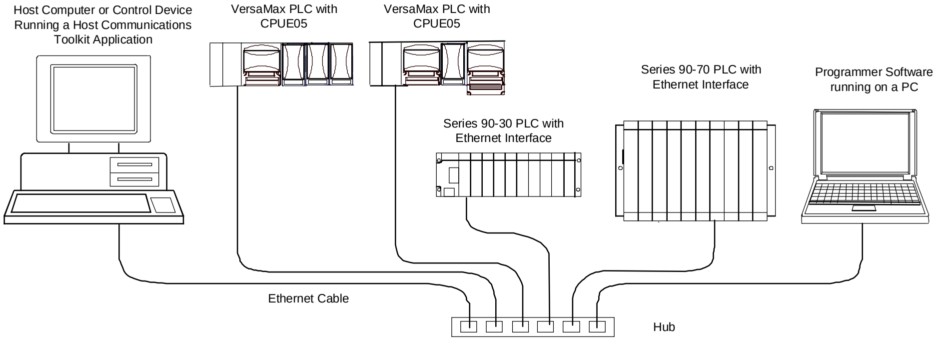
The Ethernet port on PLC module IC200CPUE05 connects directly to a 10BaseT (twisted pair) network without an external transceiver. Connect the port to an external 10BaseT hub or switch or a hub or repeater with auto-sense of 10/100 using a twisted pair cable. Cables are readily available from commercial distributors. GE Fanuc recommends purchasing rather than making cables. Your 10BaseT twisted pair cables must meet the applicable IEEE 802 standards.

Network Connection

Connection of the CPUE05 to a 10BaseT network is shown below:



The cable between each node and a hub or repeater can be up to 100 meters in length. Typical hubs or repeaters support 4 to 12 nodes connected in a star wiring topology.



CE Mark Installation Requirements

The following requirements for surge, electrostatic discharge (ESD), and fast transient burst (FTB) protection must be met for applications that require CE Mark listing:

- The VersaMax PLC is considered to be open equipment and should therefore be installed in an enclosure (IP54).
- This equipment is intended for use in typical industrial environments that utilize anti-static materials such as concrete or wood flooring. If the equipment is used in an environment that contains static material, such as carpets, personnel should discharge themselves by touching a safely grounded surface before accessing the equipment.
- If the AC mains are used to provide power for I/O, these lines should be suppressed prior to distribution to the I/O so that immunity levels for the I/O are not exceeded. Suppression for the AC I/O power can be made using line-rated MOVs that are connected line-to-line, as well as line-to-ground. A good high-frequency ground connection must be made to the line-to-ground MOVs.
- AC or DC power sources less than 50V are assumed to be derived locally from the AC mains. The length of the wires between these power sources and the PLC should be less than a maximum of approximately 10 meters.
- Installation must be indoors with primary facility surge protection on the incoming AC power lines.
- In the presence of noise, serial communications could be interrupted.

Chapter 5

CPU Configuration

This chapter describes the process by which a VersaMax® CPU and the modules it serves are configured. Configuration determines certain characteristics of module operation and also establishes the program references that will used by each module in the system.

- Autoconfiguration or programmer configuration
- Configuring racks and slots
- Configuring CPU parameters
- Configuring CPU memory allocation
- Configuring serial port parameters
- Storing a configuration from a programmer
- Autoconfiguration

Using Autoconfiguration or Programmer Configuration

VersaMax PLCs can be either autoconfigured or configured from a programmer using configuration software. Both types of configuration are described in this chapter.

Autoconfiguration

Autoconfiguration occurs at powerup, when the PLC CPU automatically reads the configuration of the modules installed in the system and creates the overall system configuration. Modules that have software-configurable features can only use their default settings when autoconfigured.

Software Configuration

Most PLC systems use a customized configuration that is created using configuration software and stored to the CPU from a programmer.

The CPU retains a software configuration across power cycles. After a software configuration is stored to the CPU, the CPU will not autoconfigure when power-cycled.

The configuration software can be used to:

- Create a new configuration
- Store (write) a configuration to the CPU
- Load (read) an existing configuration from a CPU
- Compare the configuration in a CPU with a configuration file stored in the programmer
- Clear a configuration that was previously stored to the CPU

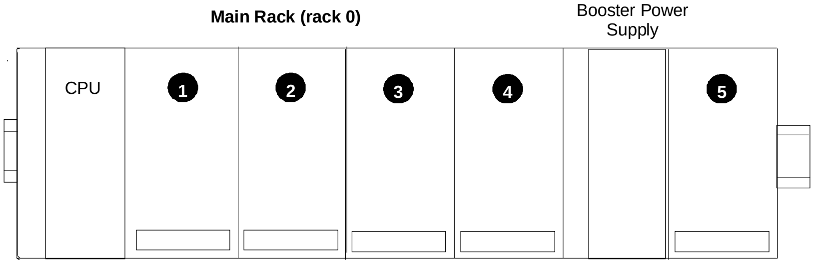
The CPU stores a software configuration in its non-volatile RAM. Storing a configuration disables autoconfiguration, so the PLC will not overwrite the configuration during subsequent startups.

However, actually clearing a configuration from the programmer does cause a new autoconfiguration to be generated. In that case, autoconfiguration is enabled until a configuration is stored from the programmer again.

One of the parameters that can be controlled by the software configuration is whether the CPU reads the configuration and program from Flash at powerup, or from RAM. If Flash is the configured choice, the CPU will read a previously-stored configuration from its Flash memory at powerup. If RAM is the choice, the CPU will read a configuration and application program from its RAM memory at powerup.

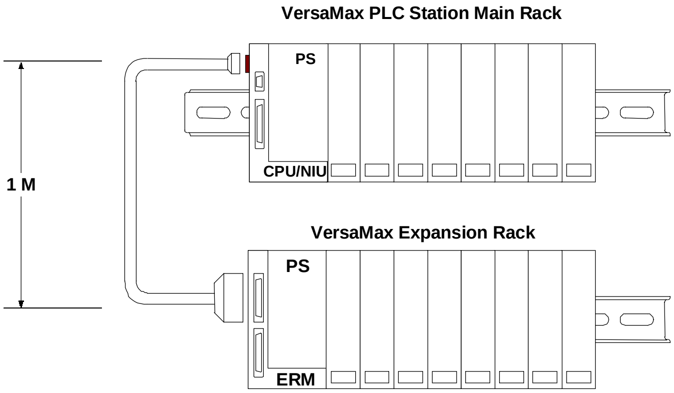
Configuring “Racks” and “Slots”

Even though a VersaMax PLC does not have a module rack, both autoconfiguration and software configuration use the traditional convention of “racks” and “slots” to identify module locations in the system. Each logical rack consists of the CPU or an Expansion Receiver module plus up to 8 additional I/O and option modules mounted on the same DIN rail. Each I/O or option module occupies a “slot”. The module next to the CPU or Expansion Receiver module is in slot 1. Booster power supplies do not count as occupying slots.

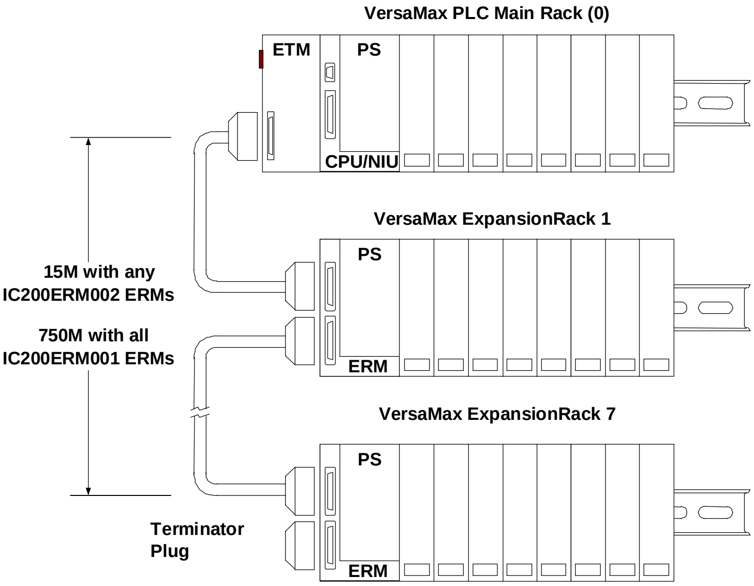


The main rack is rack 0. Additional racks are numbered 1 to 7.

In a system that uses just one expansion rack which is attached to the expansion bus by a non-isolated Expansion Receiver Module (IC200ERM002), the expansion rack must be configured as rack 1.



In a system with an Expansion Transmitter Module (IC200BTM001) and up to seven expansion “racks”, each with an Isolated Expansion Receiver Module (IC200ERM001 or IC200ERM002), the additional racks are configured as rack 1 through rack 7.



Software Configuration

The configuration software makes it possible to create a customized configuration for the VersaMax PLC system. For CPUE05, it is also used to configure Ethernet Global Data.

When you enter Hardware Configuration for VersaMax equipment folders, the default view is the Rack (Main). A new configuration already includes a default power supply (PWR001) and CPU (CPU001). Both can easily be changed to match the actual hardware in the PLC system.

To configure the PLC, you will:

- Configure the rack type (non-expanded, single-ended expanded, or multi-rack expanded).
- Configure the power supply type and any booster power supplies and carriers. (Note that CPU005 and CPUE05 both require an expanded 3.3V supply.)
- Configure the CPU. This includes changing the CPU type if necessary, and assigning its parameters as described in this chapter.
- Configure the parameters of the CPU serial ports, as explained in this chapter.
- For CPUE05, configure its Ethernet parameters, as explained in chapter 6.
- Configure the expansion modules if the system has expansion racks.
- Add module carriers and define wiring assignments.
- Place modules on carriers and select their parameters. Configurable parameters of I/O modules are described in the *VersaMax Modules, Power Supplies, and Carriers User's Manual* (GFK-1504).
- Save the configuration file so that it can be stored to the PLC.

Step-by-step instructions for using the configuration software are provided in the *VersaPro Software User's Manual* (GFK-1670). Additional information is available in the online help.

Configuring CPU and Expansion Parameters

The table below lists configurable parameters for VersaMax PLC CPUs, and for expansion racks.

Parameter	Description	Default	Choices
Scan Parameters			
Sweep Mode	Normal: sweep runs until it is complete. Constant: sweep runs for time specified in Sweep Tmr.	Normal	Normal, Constant Sweep
Sweep Times (mSecs)	If Constant Sweep mode was selected, a Constant Sweep Time (in milliseconds) can be specified.	100mS	5–200mS
Settings Parameters			
I/O Scan-Stop	Determines whether I/O is to be scanned while the PLC is in STOP mode.	No	Yes, No
Powerup Mode	Selects powerup mode.	Last	Last, Stop, Run
Logic/Configuration From	Source of program and configuration when the PLC is powered up.	RAM	RAM, Flash
Registers	Selects source of register data when PLC is powered up.	RAM	RAM, Flash
Passwords	Determines whether the password feature is enabled or disabled. (If passwords are disabled, the only way to enable them is to clear the PLC memory.)	Enabled	Enabled, Disabled
Checksum Words per Sweep	The number words in the application program to be checksummed each sweep	8	8 to 32
Default Modem Turnaround Time	Modem turnaround time (10ms/unit) This is the time required for the modem to start data transmission after receiving the transmit request.	0mS	0–255mS
Default Idle Time	Time (in seconds) the CPU waits to receive the next message from the programming device before it assumes that the programming device has failed and proceeds to its base state. Communication with the programmer is terminated and will have to be reestablished.	10	1–60
SFC Timer Faults	Enables or disables viewing of SFC Timer faults.	Disabled	Enabled/Disabled
SNP ID		None	Editable
Switch Run/Stop	Determines whether the switch will control Run/Stop mode operation	Enabled	Enabled, Disabled
Switch Memory Protect	Determines whether the switch will control RAM memory protection.	Disabled	Enabled, Disabled
Diagnostics	Unless your application requires unusually fast power up, leave this setting ENABLED. The DISABLED setting causes the PLC to power up without running diagnostics.	Enabled	Enabled, Disabled
Fatal Fault Override	Determines whether fatal faults will normally be overridden.	Disabled	Enabled, Disabled
EZ Program Store	Specifies where data that is read from the EZ Program Store device will be loaded.	RAM only	RAM only, RAM & Flash

Configuring CPU Memory Allocation

CPU001 and CPU002 (release 2.0 or later), CPU005 and CPUE05 have configurable user memory. The configurable memory is equal to the sum of the application program, hardware configuration, registers (%R), analog inputs (%AI), and analog outputs (%AQ). The amount of memory allocated to the application program and hardware configuration are automatically determined by the actual program and configuration entered from the programmer.

The rest of the configurable memory can easily be configured to suit the application. For example, an application may have a relatively large program that uses only a small amount of registers and analog memory. Similarly, there might be a small logic program but a larger amount of memory needed for registers and analog inputs and outputs.

Configurable Memory for CPU Module IC200CPU001, CPU002, CPU005

Configurable memory	CPU001: 34K bytes maximum CPU002: 42K bytes maximum CPU005: 64K bytes maximum
Application program size (not configurable)	128 bytes minimum
CPU001, for rel. 1.50 compatibility	12K bytes
CPU002, for rel. 1.50 compatibility	20K bytes
Hardware configuration size (not configurable)	400 bytes minimum
Registers (%R)	256 bytes (128 words) minimum
CPU001/002, for rel. 1.50 compatibility	4,096 bytes (2048 words)
Analog Inputs (%AI)	256 bytes (128 words) minimum
Analog Outputs (%AQ)	256 bytes (128 words) minimum

Configurable Memory for CPU Module IC200CPUE05

Configurable memory	64K bytes maximum
Application program size (not configurable)	128 bytes minimum
Hardware configuration size (not configurable)	528 bytes minimum
Registers (%R)	256 bytes (128 words) minimum
Analog Inputs (%AI)	256 bytes (128 words) minimum
Analog Outputs (%AQ)	256 bytes (128 words) minimum

If you reconfigure memory allocation from the default sizes, storing a hardware configuration to the PLC in the future will clear memory contents. If you want to retain memory contents, first load memory contents from the PLC to the programmer. Then, re-store memory when you store the hardware configuration from the programmer to the PLC.

Configuring Serial Port Parameters

Both ports on a VersaMax PLC CPU are configurable for SNP slave or RTU slave operation. 4-wire and 2-wire RTU are supported. For CPUE05 only, port 1 can also be configured (on another tab) for Local Station Manager operation. The Local Station Manager parameters may differ from the Port A parameters.

Feature	Description	Default	Choices
Port Mode	Defines the protocol.	SNP	SNP, Serial I/O, RTU, Disabled. CPUE05 can also be configured as a Local Station Manager.
Parity	Determines whether parity is added to words	Odd. For CPUE05, when Port Mode is Local Station Manager, default is None.	Odd, Even, None
Data Rate (bps)	Data transmission rate (in bits per second).	Serial comms modes: 19200	SNP: 4800, 9600, 19200, 38400
			RTU: 1200, 2400, 4800, 9600, 19200, 38400, 57600
			Serial I/O: 4800, 9600, 19200, 38400, 57600
		CPUE05 in Local Station Manager mode: 9600	Local Station Manager mode: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Flow Control (not required if Port Mode is SNP)	Specifies the method of flow control to use. When changing "Flow Control" from "None" to "Hardware", Turnaround Delay is reset to 0.	None	RTU mode: None, Hardware
			Serial I/O mode: None, Hardware, Software
			CPUE05 in Local Station Manager mode: None, Hardware
Timeout (If Port Mode is SNP)	Specifies the set of timeout values to be used by Protocol.	Long	Long, Medium, Short, None
Stop Bits (If Port Mode is SNP or Serial I/O)	Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)	1	1, 2
SNP ID	8-byte ID for Port 1.	None	Editable
Receive to transmit delay	Delay between receiving last character of a message to asserting RTS	0	SNP: Not available RTU and Serial IO: 0-255 (units of 10ms, e.g. 10=100ms)
Turnaround delay	Delay between asserting RTS and transmitting a message	SNP: none RTU & Serial IO: 0	SNP: Long, Medium, Short, none RTU & Serial IO: 0-255 (units of 10ms, e.g. 10=100ms)
RTS drop delay	Delay between when the last character of a message is transmitted and when RTS is dropped.	0	SNP: Not Available RTU and Serial IO: 0-255 (units of 10ms, e.g. 10=100ms)

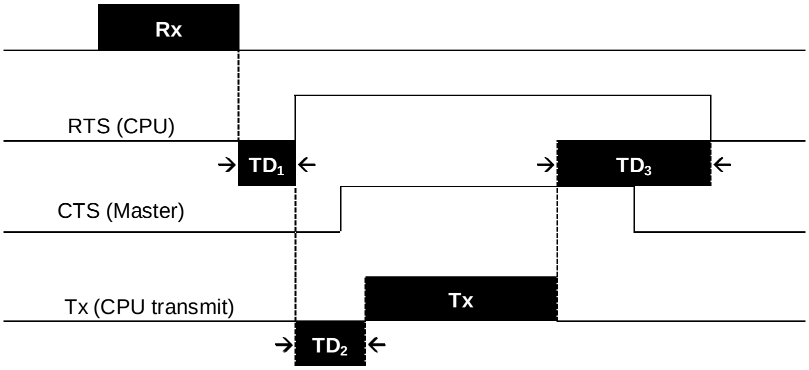
The VersaPro software allows configuration of RTU and Serial I/O at 115.2K baud. However, these baud rates are not supported by the CPU. If a configuration using these baud rates is stored to the PLC:

1. For RTU, an "Unsupported Feature in Configuration" fault is logged and the PLC transitions to Stop Faulted mode.
2. For Serial I/O, the same fault is logged when the transition to Run mode occurs. The PLC will immediately transition to Stop Faulted mode.

RTU and Serial IO Delays

The “receive to transmit”, “turnaround”, and “RTS drop delay” parameters can be configured to customize communications timing for radio modems.

- **receive to transmit delay:** The minimum length of time between the CPU receiving the last character of an incoming message and the CPU asserting RTS. Asserting RTS is followed by the transmission of the response message. This delay is configured as a “minimum” time because the actual delay is dependent upon the CPU sweep time.
- **turnaround delay:** The length of time between the CPU asserting RTS and the CPU beginning to transmit a message.
- **RTS drop delay:** The length of time between the CPU transmitting the last character of a response message and the CPU dropping RTS. The RTS drop delay can vary by ± 1 ms.



- TD_1 is the Receive to Transmit delay
- TD_2 is the Turnaround Delay
- TD_3 is the RTS Drop Delay

Configuration Required to use Winloader

The Winloader utility, which can be used for firmware updates, requires SNP configuration. If Port 1 is configured for another mode or forced to Local Station Manager operation, Winloader will not be able to do a firmware update on port 1.

Note for RTU Communications

When using RTU communications, it may be necessary to increase the RTU timeout configured on the master device as the PLC slave scan time increases. It is not necessary to change the configuration of the VersaMax CPU itself, however.

Storing a Configuration from a Programmer

Ordinarily, a VersaMax PLC system is configured by creating a configuration file on the programmer (computer), then transferring the file from the programmer to the PLC CPU via the CPU port. The CPU stores the configuration file in its non-volatile RAM memory. The configuration is stored whether I/O scanning is enabled or not. After the configuration is stored, I/O scanning is enabled or disabled according to the newly-stored configuration parameters.

Autoconfiguration and Storing a Configuration

Clearing a configuration from the programmer causes a new autoconfiguration to be generated. Autoconfiguration remains enabled until the configuration is stored from the programmer again. Storing a configuration disables autoconfiguration.

Storing a Configuration with Non-default Memory Allocation

If you reconfigure reference tables from the default sizes, storing a hardware configuration to the PLC in the future will clear memory contents. If you want to retain memory contents, first load reference memory contents from the PLC to the programmer. Then, re-store reference memory when you store the hardware configuration from the programmer to the PLC.

Default Serial Port Parameters

When a programmer is first connected, the PLC communicates using the default communications parameters: 19,200 baud, odd parity, one start bit, one stop bit, and eight data bits. If these parameters are re-configured, the new settings will be used at powerup instead.

Serial Port Configuration Takes Effect After Removing Programmer

If a hardware configuration is stored to the CPU, the configuration for the serial port to which the programmer is connected is not actually installed until the programmer is removed. After removal of the programmer, there is a delay before the new protocol begins operating. This delay is equal to the configured T3' time.

Autoconfiguration

When autoconfiguration is enabled and no previous autoconfiguration exists, at powerup the CPU automatically reads the configuration of the modules installed in the system and creates an overall system configuration. If a previous autoconfiguration is present at powerup, the configuration is processed as described on the next page.

Modules that have software-configurable features use their default settings when autoconfigured. These features are described in the *VersaMax Modules, Power Supplies, and Carriers Manual* (GFK-1504).

At powerup, the CPU by default automatically generates a configuration that includes all of the modules that are physically present in the system, starting at slot 1 of rack 0 (the main rack). Autoconfiguration of a rack stops at the first empty slot or faulted module and continues with the next rack. For example, if there are modules physically present in slots 1, 2, 3, 5, and 6, the modules in slots 5 and 6 are not autoconfigured.

To autoconfigure a system with expansion racks, either all racks must be powered from the same source or the expansion racks must be powered up before the main rack.

Autoconfiguration Assigns Reference Addresses

Modules are automatically assigned reference addresses in ascending order. For example, if the system contains a 16 point input module, an 8-point input module, a 16-point output module, and another 16-point input module, in that order, the input modules are assigned reference addresses of %I0001, %I0017, and %I0025, respectively. For modules that utilize multiple data types (for example, mixed I/O modules), each data type is assigned reference addresses individually.

Autoconfiguration Diagnostics

Module Present But Non-Working During Autoconfiguration: If a module is physically present but not working during autoconfiguration, the module is not configured and the CPU generates an *extra module* diagnostic.

Empty Slot During Autoconfiguration: Autoconfiguration of a rack stops at the first empty slot. Modules located after the empty slot are not autoconfigured. The CPU generates an *extra module* diagnostic for each of them.

Previously-Configured Modules Present During Autoconfiguration: Previously-configured modules are not removed from the configuration during autoconfiguration unless no modules are present in the system. For example, if modules are configured in slots 1, 2, and 3 then power is removed and the module in slot 1 is removed, when power is reapplied the modules in slots 2 and 3 are autoconfigured normally. The original module in slot 1 is not removed from the configuration. The CPU generates a *loss of module* diagnostic for slot 1.

Different Module Present During Autoconfiguration: If a slot was previously-configured for one module type but has a different module installed during autoconfiguration, the CPU generates a *configuration mismatch* diagnostic. The slot remains configured for the original module type.

Unconfigured Module Installed After Autoconfiguration: If a module that was not previously-configured is installed-after powerup, the CPU generates an *extra module* diagnostic and the module is not added to the configuration.

Previously-configured Module Installed After Autoconfiguration : If a module that was previously-configured but missing at powerup is installed-after powerup, the CPU generates an *addition of module* diagnostic and the module is added back into the I/O scan.

All Modules Removed After Autoconfiguration: If all modules are absent at powerup, the CPU clears the configuration. This allows modules to be inserted and added to the configuration at the next powerup.

Diagnostic Message Summary

addition of module	A module is present at powerup but not configured. It is added to the configuration. Autoconfiguration is enabled and the module is capable of being autoconfigured.
addition of module	A previously-configured module is inserted after powerup. The CPU resumes scanning of the module.
configuration mismatch	A module was found at or after powerup that does not match the configuration for that slot.
extra module	1. A module is present at powerup but not configured. 2. Autoconfiguration is not enabled. 3. A previously-unconfigured module is inserted after powerup.
loss of module	A configured module is missing during powerup or normal operation.
addition of rack	1. An Expansion Receiver Module that was not previously configured is present during configuration. 2. During normal operation, communication is restored with a previously missing or failed Expansion Receiver Module. The CPU starts scanning I/O for the modules in that rack. “Addition of Module” faults are not generated when scanning resumes. However, if communications cannot be restored with any modules in the rack, “Loss of Module” faults are generated.
loss of rack	1. A previously configured Expansion Receiver Module is not present during configuration. 2. During normal operation, a previously working Expansion Receiver Module stops working. Modules in the same expansion rack are terminated.
extra rack	A previously-unconfigured Expansion Receiver module is inserted after powerup. Modules in the expansion rack are ignored.
Expansion Transmitter mismatch	1. An Expansion Transmitter Module (IC200ETM001) is present but not configured. 2. An Expansion Transmitter Module (IC200ETM001) is configured but not present.
expansion bus speed change	The expansion bus speed automatically calculated by the CPU during autoconfiguration has changed.
unsupported feature	A module is present that is not supported by the CPU.

Chapter
6

Ethernet Configuration

This chapter describes the configuration needed for the Ethernet interface of VersaMax® CPU module IC200CPUE05:

- Ethernet configuration overview
- Configuring the characteristics of the Ethernet interface
- Configuring Ethernet Global Data
- Configuring Advanced User Parameters

The Ethernet interface configuration described in this chapter must be set up in addition to the basic CPU configuration described in chapter 5.

Ethernet Configuration Overview

The Ethernet configuration for CPU module IC200CPUE05 includes:

- Configuring the characteristics of the Ethernet interface. This is part of the CPU configuration.
- Configuring Ethernet Global Data. This is reached via the “rack operations” configuration.
- (Optional, not required for most systems). Configuring advanced parameters. This requires creating a separate ASCII parameter file that is stored to the PLC with the hardware configuration.
- (Optional, not required for most systems). Setting up Port 1 for Local Station Manager operation. This is part of the basic CPU configuration as described in chapter 5. Note that Local Station Manager parameters are configured independently of the Port 1 parameters.

After the configuration is completed and stored to the PLC, it is maintained in memory by the PLC CPU. The configuration may be saved into and retrieved from Flash memory, which provides nearly permanent backup of the configuration data across loss of power and battery backup. Every time CPUE05 is powered up or has its configuration changed or cleared, it delivers the Ethernet configuration data back to the Ethernet interface.

The Ethernet interface portion of CPUE05 saves its configuration data in battery-backed memory. If the CPU battery backup is lost and the configuration has not been saved to Flash, the Ethernet interface loses its backup configuration data. If that happens, after powerup the Ethernet interface operates with its factory default settings until it is reconfigured. This default operation includes reverting to an IP address of 0.0.0.0. Because the backup Ethernet configuration data is actually stored by the Ethernet interface portion of CPUE05, it is not affected by a PLC Clear Configuration operation. When the PLC Configuration is cleared, the CPU operates in Autoconfiguration mode, as described below.

Autoconfiguration

If the PLC CPU has not had a configuration stored from the programmer, it automatically creates its own configuration at powerup. To create the Autoconfiguration, the CPU reads configuration data from each module and from the Ethernet interface. This includes an Advanced User Parameter file for the Ethernet interface.

When an Autoconfiguration is present in the PLC CPU, it is possible to edit some of the Ethernet configuration parameters from the Station Manager. This changes the parameters that are stored in the Ethernet interface itself. If the PLC is power-cycled or cleared, the edited configuration will be retrieved by the CPU from the Ethernet interface.

Configuring the Ethernet Interface

The CPU's fundamental Ethernet operating characteristics must be correctly configured for proper operation over an Ethernet network. *The default configuration cannot supply valid network address data.*

Parameters	Description
Configuration Mode	This is fixed as TCP/IP. It cannot be changed.
IP Address, Subnet Mask, and Gateway IP Address	The IP Address is the unique address of the Ethernet interface as a node on the network. On a large network, a subnet mask can be used to identify a section of the overall network. A gateway address can be used to identify a gateway that joins one network with another. These parameters must be correct or the Ethernet interface may be unable to communicate on the network and/or network operation may be disrupted. It is especially important that each node on the network is assigned a *unique* IP address. These values should be assigned by the person in charge of your network (the network administrator). TCP/IP network administrators are familiar with these parameters. If you have no network administrator and are using a simple *isolated network* with no gateways, you can use the following values as local IP addresses: 10.0.0.2 First PLC 10.0.0.3 Second PLC 10.0.0.4 Third PLC . . 10.0.0.254 PLC Programmer or host Also, in this case, set the subnet mask and Gateway IP address to 0.0.0.0. See chapter 13 for more detailed information about IP Addressing and gateways. **Note:** If this simple, isolated network is ever connected to another network, the IP addresses 10.0.0.2 through 10.0.0.254 must not be used and the subnet mask and Gateway IP address must be assigned by the network administrator. **The IP addresses must be assigned so that they are compatible with the connected network.**
Status Address	The beginning reference for 10 bytes of Ethernet status data. The content of this data is described in chapter 13, "Checking the Status of the Ethernet Interface." The Status address can be assigned to %I, %Q, %R, %AI or %AQ memory. The default value is the next available %I address. Note: Do not use the 10 bytes assigned to the Status bits for other purposes or your data will be overwritten.
Status Length	This value is automatically set to either 80 bits (for %I and %Q Status address locations) or 5 words (for %R, %AI, and %AQ Status address locations).
Network Time Servers	IP addresses of up to 3 NTP time servers used to synchronize timestamps in produced Ethernet Global Data exchanges. If no NTP time servers are configured here, the Ethernet interface is initialized from the clock in the CPU instead. See "Timestamping of Ethernet Global Data Exchanges" in chapter 13 for more information.

Configuring Ethernet Global Data

VersaMax CPU IC200CPUE05 can be configured for up to 32 Ethernet Global Data exchanges (any combination of produced and consumed). (See “Ethernet Global Data” in chapter 13 for a discussion of this feature). Configuration defines both the content of an exchange, its data ranges, and its operational characteristics. Each Ethernet Global Data produced or consumed exchange must be configured individually for each PLC.

You can configure:

- Up to 1200 data ranges for all Ethernet Global Data exchanges for one CPUE05.
- Up to 100 data ranges per exchange.
- A data length of 1 byte to 1400 bytes per exchange. The total size of an exchange is the sum of the lengths of all of the data ranges configured for that exchange.

Different exchanges may have different data ranges. Multiple exchanges can also share some or all of the same data ranges even if the exchanges are produced at different rates. (Note: The programming software will not permit consumed exchanges to share data ranges).

The Ethernet Global Data configuration screens are reached via the rack configuration (not the CPU configuration).

Before You Configure EGD Exchanges

Before configuring Ethernet Global Data exchanges, you will need to collect information about the PLCs that will be exchanging the data. Note that this information will be needed for *each* PLC’s configuration. See chapter 13 for details.

- Determine for each PLC what data needs to be produced and consumed.
- Make a list of the IP addresses of the Ethernet Interfaces in the PLCs that are being used to produce or consume the exchanges.
- Identify the members of up to 32 groups of devices that will share Ethernet Global Data exchanges.
- Decide on appropriate repetition rates and timeout periods for the exchanges.
- Identify the content of each exchange in the producer, and identify appropriate data ranges in the consumers to receive the data.
- It is not necessary to consume all of the data from a produced exchange in each consumer. A consumed exchange may be configured to ignore specified data ranges.

Configuring a Global Data Exchange for a Producer

Each Global Data exchange must be configured in the producer as defined below. The exchange must also be configured in each consumer, as explained next.

<table>
<tr><th>Parameters</th><th colspan="5">Description</th></tr>
<tr><td>Local Producer ID</td><td colspan="5">The address that uniquely identifies the CPUE05 as an Ethernet Global Data device across the network. It is a dotted-decimal number. The default is the same as the IP address of the CPUE05. The default can be changed.</td></tr>
<tr><td>Exchange ID</td><td colspan="5">A number that identifies a specific data exchange.</td></tr>
<tr><td>Adapter Name</td><td colspan="5">Always 0.0 for CPUE05.</td></tr>
<tr><td>Consumer Type</td><td colspan="5">Select whether the data's destination will be a single device (IP address) or one of 32 predefined device groups (Group ID). See "Ethernet Global Data Groups" in chapter 13 for more information.</td></tr>
<tr><td>Consumer Address</td><td colspan="5">If the "Consumer Type" above is IP Address, this is the IP address of a single device to receive the exchange. If the "Consumer Type" is Group ID, this is the group's ID number (1–32). See chapter 13 for more information about IP Addresses.</td></tr>
<tr><td>Send Type</td><td colspan="5">Currently fixed at "always". Ethernet Global Data will always be sent when the PLC's I/O scan is enabled. It will not be sent when the I/O scan is disabled.</td></tr>
<tr><td>Producer Period</td><td colspan="5">The scheduled repetition period for sending the data on the network. The range is 10–3,600,000 milliseconds (10 milliseconds to 1 hour). The default is 200 milliseconds. Round this value to the nearest 10 milliseconds before you enter it. The producer period has a resolution of 10 milliseconds. If you enter a value such as 12 milliseconds, the actual producer period will be rounded up to 20 milliseconds.
For easier troubleshooting and efficient network usage, set the Producer Period to the same value as the Consumer Period. Do not produce data faster than is required by your application. For example, it is usually not useful to produce data faster than the scan time of the producer or consumer PLCs. This reduces the load on the network and on the devices, providing capacity for other transfers.</td></tr>
<tr><td>Reply Rate</td><td colspan="5">Currently not used.</td></tr>
<tr><td>Status Word</td><td colspan="5">A data range that identifies the memory location where the status value for the produced exchange will be placed. See "Checking the Status of an Exchange" in chapter 13 for details. Note that the Status Word address must be unique; it is not automatically assigned the next highest address.</td></tr>
<tr><td>example:</td><td>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><td></td><td>Status</td><td>%R</td><td>99</td><td>99</td><td>Status: Where the PLC will place the status data.</td></tr>
<tr><td>Exchange Data Ranges</td><td colspan="5">A list of 1 to100 data ranges that will be sent in the exchange. Data is sent as a contiguous set of bytes. See "Checking the Status of an Exchange" in chapter 13 for details. The total size can be up to 1400 bytes. The list of data ranges to be sent in an exchange specifies:</td></tr>
<tr><td>example:</td><td>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><td></td><td>0.0</td><td>%R</td><td>100</td><td>105</td><td>Conveyor1 in PLC1</td></tr>
<tr><td></td><td>10.0</td><td>%I</td><td>345</td><td>352</td><td>Conveyor1 limit switch in PLC1</td></tr>
</table>

Configuring a Global Data Exchange for a Consumer

To receive a Global Data Exchange, configure the following information:

<table>
<tr><th>Parameters</th><th colspan="5">Description</th></tr>
<tr><td>Local Producer ID</td><td colspan="5">The address that uniquely identifies the CPUE05 as an Ethernet Global Data device across the network. The default is the same as the IP address of the CPUE05. The default can be changed.</td></tr>
<tr><td>Exchange ID</td><td colspan="5">A number that identifies that specific data exchange. It must match the Exchange ID specified in the produced exchange (in the sending device).</td></tr>
<tr><td>Adapter Name</td><td colspan="5">Always 0.0 for CPUE05</td></tr>
<tr><td>Producer ID</td><td colspan="5">The Local Producer ID of the device sending the exchange.</td></tr>
<tr><td>Group ID</td><td colspan="5">Used only if the same data is consumed by more than one consuming device. Enter the same Group ID that has been configured as the “Consumer Address” in the producer device.</td></tr>
<tr><td>Consumer Period</td><td colspan="5">Not used. Default is 200mS.</td></tr>
<tr><td>Update Timeout</td><td colspan="5">The maximum time the Ethernet interface allows between seeing samples on the network without reporting a refresh error status. This error status means a first or subsequent packet of data has not arrived within the specified time. The range is 0, or 10–3,600,000 milliseconds. The value should be at least double the producer’s producer period value. The default is 0, which disables timeout detection.
The update timeout period should be greater than the exchange production period. (A value at least twice the production period is recommended.)
Round this value to the nearest 10 milliseconds before you enter it. The update timeout has a resolution of 10 milliseconds. If you enter a value such as 22 milliseconds, the actual update timeout will be rounded up to 30 milliseconds.</td></tr>
<tr><td>Status Word</td><td colspan="5">A data range that identifies the memory location where the status value for the consumed exchange will be placed. See chapter 13 for details of the status value. . Note that the Status Word address must be unique; it is not automatically assigned the next highest address.</td></tr>
<tr><td>example:</td><td>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><td></td><td>Status</td><td>%R</td><td>99</td><td>99</td><td>Status: Where the PLC will place the status data.</td></tr>
</table>

Defining a Global Data Exchange for a Consumer *(continued)*

<table>
<tr><th>Parameters</th><th colspan="5">Description</th></tr>
<tr><td>Time Stamp</td><td colspan="5">A data range that identifies the memory location where the timestamp of the last data packet will be placed. The timestamp is not an actual date; it is an 8-byte value representing the time elapsed since midnight, January 1, 1970. The first four bytes contain a signed integer representing seconds and the next four bytes contain a signed integer representing nanoseconds. This value represents the time in the producer when the data sample originated. It can be examined to determine if a new packet received from the network has a new data sample or if it is the same data received previously.
The timestamp information produced by the PLC currently has a resolution of 100 microseconds if no network synchronization is used. If NTP is used to perform network time synchronization, the timestamp information has a resolution of 1 millisecond and has ±10 millisecond accuracy between PLCs on the same LAN.
NTP may be enabled in the configuration of the CPUE05. Once NTP time synchronization is configured, the CPUE05 will synchronize itself to an external NTP time server if one exists.</td></tr>
<tr><td>example:</td><td>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><td></td><td>Time Stamp</td><td>%R</td><td>91</td><td>94</td><td>Time Stamp: Optional place for the PLC to put the timestamp.</td></tr>
<tr><td>Exchange Data Ranges</td><td colspan="5">A list of 1 to100 data ranges that will be received in the exchange. Data is received as a contiguous set of bytes. The total size of all combined elements can be up to 1400 bytes. For consumed exchanges, %S memory types and override references are not allowed. See Table 4-2 for valid memory types.
Note: If the consumed exchange length does not match that of the produced exchange, PLC Faults and Ethernet exception entries occur.
The list of data ranges to be received in an exchange specifies:</td></tr>
<tr><td>example:</td><td>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><td></td><td>0.0</td><td>%R</td><td>100</td><td>104</td><td>Conveyor1 in PLC1</td></tr>
<tr><td></td><td>10.0</td><td>%I</td><td>257</td><td>264</td><td>Conveyor1 limit switch in PLC1</td></tr>
</table>

Selective Consumption

Not all data ranges within a produced exchange need to be consumed by each PLC. For example, a producer is producing an exchange consisting of a 4-byte floating point value, followed by a 2-byte integer, followed by a 2-byte analog value. If the consuming PLC wants to consume only the analog value and place it into %AI003, the consumer might be configured as shown below.

Offset	Reference	Low Point	High Point	Description
0	Ignore (bytes)	1	6	Ignore float and integer
6	%AI	3	3	

Note that the total length of the exchange must be the same in producer and consumer, even if the consumer is ignoring bytes at the end of the message. Failure to configure any ignored bytes in the consumed exchange will result in exchange exception log and fault table entries, error status in the exchange status data, and no data being transferred for the exchange.

Configuring Advanced User Parameters

Advanced User Parameters are internal operating parameters used by the Ethernet interface. For most applications, the default Advanced User Parameters should *not* be changed.

If it is necessary to modify any of these parameters, it must be done by creating an Advanced User Parameter file, using any ASCII text editor. This file must contain the names and values of only those parameters that are being changed. The file must be named “AUP_0_0.apf”. The completed file must be placed into the PLC folder that contains the PLC configuration. When the entire hardware configuration is stored from the programmer to the PLC, the programmer software also stores the parameters from the AUP_0_0.apf file.

Format of the Advanced User Parameters File

The Advanced User Parameters file must have this format:

```
AUP_0_0
<parameter name> = <parameter value>
<parameter name> = <parameter value>
<parameter name> = <parameter value>
```

All parameter names are lowercase. The equal sign (=) is required between the parameter name and parameter value.

Parameter values are converted to lowercase unless they are enclosed in a pair of double quotes. The format for the individual parameter values depends on the parameter. Numeric parameters are entered in decimal or hexadecimal format; hexadecimal values must end with an ‘h’ or ‘H’ character. IP address parameters must be entered in standard dotted decimal format. Character string values are case-sensitive. Uppercase parameter values must be enclosed within a pair of double quotes. (The enclosing quotes are not part of the data and are removed during processing).

Comments in the file must start with a semicolon character. All characters in the same line following a semicolon are ignored. Blank lines are also ignored.

The following example sets the station manager password to “system” and the IP time-to-live for point-to-point Ethernet Global Data exchanges to 4.

Example Advanced User Parameter File

```
AUP_0_0
stpasswd = “system”        ;          set the password to “system”
gucast_ttl=4               ;          set the EGD unicast IP TTL to 4
```

Advanced User Parameter Definitions

The following Advanced User Parameters can be configured for the CPUE05 Ethernet interface.

Name	Description	Default	Range
staudp	Remote Station Manager UDP port	18245 (4745H)	0-65535 (ffffH)
stpasswd	Station Manager password	“system”	0-8 char, case sensitive, no spaces
crsp_tout	Transfer/Response timeout value (in seconds)	16 (0010H)	10 – 3600 (0e10H)
fflush	ARP cache timeout interval (in seconds)	0 – 604800 (93a80H)	600 (0258H)
gctl_port	UDP port for Ethernet Global Data control messages	7937 (1f01H)	0-65535 (ffffH)
gdata_port	UDP port for point-to-point Ethernet Global Data messages	18246 (4746H)	0-65535 (ffffH)
gbcast_ttl	IP time-to-live for global broadcast messages (hop count)	1 (1H)	0-255 (00ffH)
gucast_ttl	IP time-to-live for point-to-point messages (hop count)	16 (10H)	0-255 (00ffH)
gXX_udp	UDP port for host group XX	18246 (4746H)	0-65535 (ffffH)
gXX_ttl	IP time-to-live for host group (multicast) messages (hop count)	1 (1H)	0-255 (00ffH)
gXX_addr	IP group address for host group XX (must be class D address)	224.0.7.XX	224.0.0.2 - 239.255.255.255
ittl	IP header default time-to-live (hop count)	64 (0040H)	0-255 (00ffH)
ifrag_tmr	IP fragment timeout interval (in seconds)	3 (0003H)	0-65535 (ffffH)
wnodelay	TCP nodelay option (0=inactive, 1=active)	0 (000H)	0,1
wkal_idle	TCP keepalive timer value (in seconds)	240 (00f0H) = 4.0 minutes	0-65535 (ffffH)
wkal_cnt	TCP keepalive probe count	2 (0002H)	
wkal_intvl	TCP keepalive probe interval (in seconds)	60 (003cH)	
wmsl	TCP maximum segment lifetime (in seconds)	30 (001eH)	
wsnd_buf	TCP send buffer size in bytes	4096 (1000H)	0-32767 (7fffH)
wrcv_buf	TCP receive buffer size in bytes	4096 (1000H)	
nmin_poll1	NTP min. poll interval for host 1. The value specifies log(2) of the interval in seconds (eg: the value 3 means 8 secs, 4 means 16 sec, etc)	6 (0006H) = 64 seconds	4 – 14 (000eH) (16 – 16384 sec)
nmax_poll1	NTP maximum poll interval for host 1 (in log(2) of seconds)	10 (000aH) = 1024 sec.	
nmin_poll2	NTP min. poll interval for host 2 (in log(2) of seconds)	6 (0006H) = 64 sec.	
nmax_poll2	NTP max. poll interval for host 2 (in log(2) of seconds)	10 (000aH) = 1024 sec.	
nmin_poll3	NTP min. poll interval for host 3 (in log(2) of seconds)	6 (0006H) = 64 sec.	
nmax_poll3	NTP max. poll interval for host 3 (in log(2) of seconds)	10 (000aH) = 1024 sec.	
nsync_tout	NTP synchronization timeout period (in seconds). The max. time between network time updates to remain synchronized).	300 (012cH)	150 – 65535 (0096H – ffffH)

Chapter 7

CPU Operation

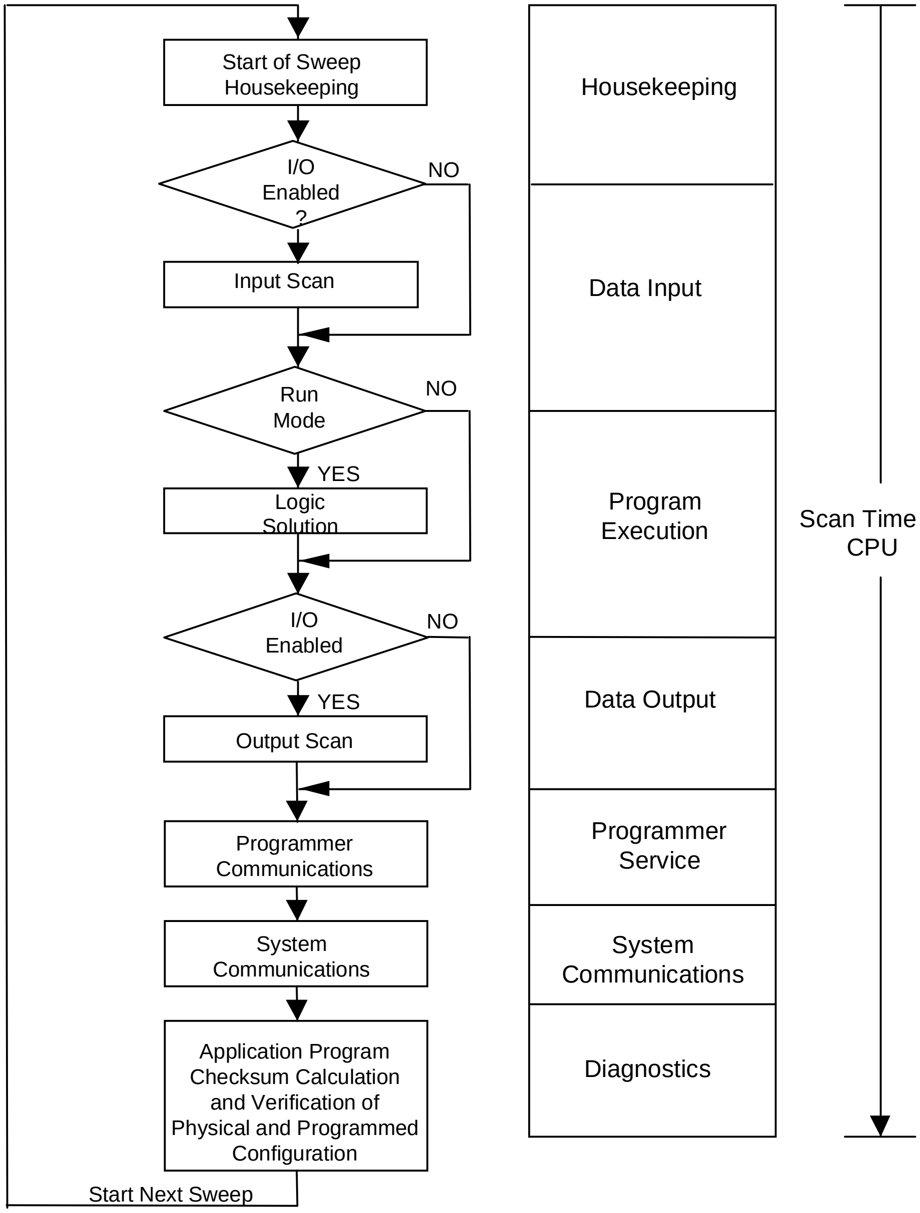
This chapter describes the operating modes of the VersaMax® PLC CPUs, and shows the relationship between the application program execution and other tasks performed by the CPU.

CPU Operating Modes

The application program in a PLC executes repeatedly. In addition to executing the application program, the PLC CPU regularly obtains data from input devices, sends data to output devices, performs internal housekeeping, and performs communications tasks. This sequence of operations is called the **sweep**.

- The basic operating mode of the PLC is called **Standard Sweep** mode. In this mode, the CPU performs all parts of its sweep normally. Each sweep executes as quickly as possible with a different amount of time consumed each sweep.
- The PLC may instead operate in **Constant Sweep Time** mode. In this mode, the CPU performs the same series of actions but each sweep takes the same amount of time.
- The PLC may also be in either of two Stop modes:
  - ☐ Stop with I/O Disabled mode
  - ☐ Stop with I/O Enabled mode

Parts of the CPU Sweep



Parts of the CPU Sweep

Start of Sweep Housekeeping	Housekeeping includes the tasks necessary to prepare for the start of the sweep. Before starting the actual sweep, the CPU: Calculates the sweep time Schedules the start of the next sweep Determines the mode of the next sweep Updates the fault reference tables Resets the Watchdog timer If the PLC is in Constant Sweep Time mode, the sweep is delayed until the required sweep time elapses. If the required time has already elapsed, the OV_SWP %SA0002 contact is set, and the sweep continues without delay. Next, the CPU updates timer values (hundredths, tenths, and seconds).
Input Scan	When the sweep starts, the CPU first scans inputs from input modules and option modules that provide input-type data. Modules are scanned in ascending reference address order. Discrete input modules are scanned before analog input modules. The CPU stores this new input data in the appropriate memories. If the CPU has been configured to not scan I/O in Stop mode, the input scan is skipped when the CPU is in Stop mode. For CPUE05, if the CPU is in run mode and the consumer period of an Ethernet Global Data exchange has expired, the CPU copies the data for that exchange from the Ethernet interface to the appropriate reference memory.
Application Program Logic Scan	Next, the CPU solves the application program logic. It always starts with the first instruction in the program. It ends when the END instruction is executed. Solving the logic creates a new set of output data.
Output Scan	Immediately after the logic solution, the CPU scans all output modules in ascending reference address order. The output scan is completed when all output data has been sent. If the CPU has been configured to not scan I/O in Stop mode, the output scan is also skipped when the CPU is in Stop mode. For CPUE05, if I/O is enabled and the producer period of an Ethernet Global Data exchange has expired, the CPU copies the data for that exchange from the appropriate reference memory to the Ethernet interface.
Programmer Communications Window	If there is a programming device attached, the CPU next executes the programmer communications window. The programmer communications window will not execute if there is no programmer attached. In the default limited window mode, each sweep the CPU honors one service request. The time limit for programmer communications is 6 milliseconds. If the programmer makes a request that requires more than 6 milliseconds to process, the processing is spread out over multiple sweeps.
System Communications Window	Next, the CPU processes communications requests from intelligent option modules. The modules are polled in round-robin fashion, so no module has priority. In default (“Run to Completion”) mode, the length of the system communications window is limited to 400 milliseconds. If a module makes a request that requires more than 400 milliseconds to process, the request is spread out over multiple sweeps. In Limited mode, option modules that communicate with the PLC using the system window have less impact on sweep time, but response to their requests is slower.
Diagnostics	A checksum calculation is performed on the application program at the end of every sweep. You can specify from 0 to 32 words to be checksummed. If the calculated checksum does not match the reference checksum, the program checksum failure exception flag is raised. A fault is entered in the PLC fault table and the PLC goes to Stop mode. If the checksum calculation fails, the programmer communications window is not affected. Each sweep, the CPU verifies the physical configuration of one module against its programmed configuration. A missing, additional, or mismatched module causes a fault to be generated.

Standard CPU Sweep Operation

Standard Sweep operation is the normal operating mode of the PLC CPU. In Standard Sweep operation, the CPU repeatedly executes the application program, updates I/O, and performs communications and other tasks shown in the diagram:

1. The CPU performs its start-of-sweep housekeeping tasks.
2. It reads inputs.
3. It executes the application program.
4. It updates outputs
5. If a programming device is present, the CPU communicates with it.
6. It communicates with other devices.
7. It performs diagnostics

Except for communicating with a programmer, all these steps execute every sweep. Programmer communications occur only when needed.

In this mode, the CPU performs all parts of its sweep normally. Each sweep executes as quickly as possible with a different amount of time consumed each sweep.

The Sweep Windows

The programmer communications window and the system communications window have two operating modes:

Limited Mode	The execution time of the window is 6ms. The window terminates when it has no more tasks to complete or when 6ms has elapsed.
Run to Completion Mode	Regardless of the time assigned to a particular window the window runs until all tasks within that window are completed (up to 400ms).

SVCREQ 2 can be used in the application program to obtain the current times for each window.

The Watchdog Timer

When the CPU is in **Standard Sweep** mode, the Watchdog Timer catches failure conditions that could cause an unusually long sweep. The length of the Watchdog Timer is 500 milliseconds. It restarts from zero at the beginning of each sweep.

If the sweep takes longer than 500mS, the OK LED on the CPU module goes off. The CPU resets, executes its powerup logic, generates a watchdog failure fault, and goes to Stop mode. Communications are temporarily interrupted.

Constant Sweep Time Operation

If the application requires that each CPU sweep take the same amount of time, the CPU can be configured to operate in Constant Sweep Time mode. This operating mode assures that the inputs and outputs in the system are updated at constant intervals. This mode can also be used to implement a longer sweep time, to assure that inputs have time to settle after receiving output data from the program.

Changing the Configured Default for Constant Sweep Mode

If the PLC is in STOP mode, its Configured Constant Sweep mode can be edited. After this is done, the configuration must be Stored to the CPU for the change to take effect. Once stored, Constant Sweep Time mode becomes the default sweep mode.

The Constant Sweep Timer

During operation in Constant Sweep Time mode, the CPU's Constant Sweep Timer controls the length of the sweep. The timer length can be 5 to 500 milliseconds. The time should be at least 10 milliseconds longer than the CPU's sweep time when it is in Standard Sweep mode, to prevent extraneous oversweep faults.

If the Constant Sweep Timer expires before the sweep completes, the CPU still completes the entire sweep, including the windows. However, it automatically provides noticewhen a too-long sweep has occurred. On the next sweep after the oversweep, the CPU places an oversweep alarm in the PLC fault table. Then, at the beginning of the following sweep, the CPU sets the OV_SWP fault contact (%SA0002). The CPU automatically resets the OV_SWP contact when the sweep time no longer exceeds the Constant Sweep Timer. The CPU also resets the OV_SWP contact if it is not in Constant Sweep Time mode.

As with other fault contacts, the application program can monitor this contact to keep informed about the occurrence of oversweep conditions.

Enabling/Disabling Constant Sweep Time, Reading or Setting the Length of the Timer

SVCREQ 1 can be included in the application program to enable or disable Constant Sweep Time mode, change the length of the Constant Sweep Time, read whether Constant Sweep Time is currently enabled, or read the Constant Sweep Time length.

CPU Stop Modes

The PLC may also be in either of two Stop modes:

- Stop with I/O Disabled mode
- Stop with I/O Enabled mode

When the PLC is in Stop mode, the CPU does not execute the application program logic. You can configure whether or not the I/O will scanned during Stop mode. Communications with the programmer and intelligent option modules continue in Stop mode. In addition, faulted board polling and board reconfiguration execution continue in Stop mode.

SVCREQ 13 can be used in the application program to stop the PLC at the end of the next sweep. All I/O will go to their configured default states, and a diagnostic message will be placed in the PLC Fault Table.

Controlling the Execution of a Program

The VersaMax CPU Instruction Set contains several powerful Control functions that can be included in an application program to limit or change the way the CPU executes the program and scans I/O.

Calling a Subroutine Block

The CALL function can be used to cause program execution to go to a specific subroutine. Conditional logic placed before the Call function controls the circumstances under which the CPU performs the subroutine logic. After the subroutine is finished, program execution resumes at the point in the logic directly after the CALL instruction.

Creating a Temporary End of Logic

The END function can be used to provide a temporary end of logic. It can be placed anywhere in a program. No logic beyond the END function is executed, and program execution goes directly back to the beginning. This ability makes the END function useful for debugging a program.

The END function should not be placed in logic associated with or called by a Sequential Function Chart control structure. If this occurs, the PLC will be placed in STOP/FAULT mode at the end of the current sweep and an SFC_END fault will be logged.

Executing Rungs of Logic without Logical Power Flow

The nested Master Control Relay can be used to execute a portion of the program logic with no logical power flow. Logic is executed in a forward direction and coils in that part of the program are executed with negative power flow. Master Control Relay functions can be nested to 8 levels deep.

Jumping to Another Part of the Program

The Jump function can be used to cause program execution to move either forward or backward in the logic. When a nested Jump function is active, the coils in the part of the program that is skipped are left in their previous states (not executed with negative power flow, as they are with a Master Control Relay). Jump functions can also be nested.

Jumps cannot span blocks, SFC actions, SFC transitions, or SFC pre- or post-processing logic.

Run/Stop Mode Switch Operation

The CPU Run/Stop mode switch can be configured to place the CPU in Stop or Run mode. It can also be configured to prevent writing to program or configuration memory and forcing or overriding discrete data. It defaults to enabled Run/Stop mode selection and disabled memory protection.

Configurable Run/Stop Mode Operation

If Run/Stop mode switch operation is enabled, the switch can be used to place the CPU in Run mode.

- If the CPU has non-fatal faults and is not in Stop/Fault mode, placing the switch in Run position causes the CPU to go to Run mode. Faults are NOT cleared.
- If the CPU has fatal faults and is in Stop/Fault mode, placing the switch in Run position causes the Run LED to blink for 5 seconds. While the Run LED is blinking, the CPU switch can be used to clear the fault table and put the CPU in Run mode. After the switch has been in Run position for at least ½ second, move it to Stop position for at least ½ second. Then move it back to Run position. The faults are cleared and the CPU goes to Run mode. The LED stops blinking and stays on. This can be repeated if necessary.
- If the switch is not toggled as described, after 5 seconds the Run LED goes off and the CPU remains in Stop/Fault mode. Faults stay in the fault table.

Configurable Memory Protection

Operation of the switch can be configured to prevent writing to program memory and configuration, and to prevent forcing or overriding discrete data.

Summary of CPU Switch Run/Stop Operation

Run/Stop Mode Configuration	I/O Scan Stop Configuration	Switch Position	CPU Operation
Off	has no effect	has no effect	All modes are allowed.
On	has no effect	Run/On	All modes are allowed.
On	has no effect	Stop/Off	CPU not allowed to go to Run mode.
Off	has no effect	Toggle Switch from Stop to Run	CPU goes to Run mode if no fatal faults are present; otherwise, the Run LED blinks for 5 seconds.
On	No	Toggle switch from Run to Stop	PLC goes to STOP–NO IO
On	Yes	Toggle switch from Run to Stop	PLC goes to STOP–IO

Flash Memory

A VersaMax PLC stores the current configuration and application in non-volatile battery-backed RAM. The programmer software can be used to store a copy of the current configuration, application program, and reference tables (excluding overrides) to Flash memory. The programmer can also be used to read a previously-stored configuration, application program, or reference tables from Flash into RAM, or to verify that Flash and RAM contain identical data.

By default, the PLC reads the configuration, program logic, and reference tables from RAM at powerup. However, it can be configured to read them from Flash. This is recommended, because data in Flash is non-volatile, even in the case of a battery failure.

Privilege Levels and Passwords

Passwords are an optional configurable feature of the VersaMax PLC. Passwords provide different levels of access privilege to the PLC when the programmer is in Online or Monitor mode. Passwords are not used if the programmer is in Offline mode. Passwords can restrict:

- Changing I/O and PLC configuration data
- Changing programs
- Reading PLC data
- Reading programs

There is one password for each privilege level in the PLC. Each password may be unique or the same password can be used for more than one level. Passwords are one to seven ASCII characters in length.

By default, there is no password protection. Passwords are set up, changed, or removed using the programming software. After passwords have been set up, access to the PLC is restricted unless the proper password is entered. Entering a correct password allows access to the requested level and to all lower levels. For example, the password for level 3 allows access to levels 0, 1, 2, and 3. If PLC communications are suspended, protection automatically returns to the highest unprotected level. For example: If a password is set at levels 2 & 3, but none at level 4, if the software disconnects and reconnects, the access level is 4. Privilege level 1 is always available because no password can be set for this level.

Level	Access Description
4 Least Protected	▪ Write to all configuration or logic. Configuration may only be written in Stop mode; logic may be written in Stop or Run mode (if run-mode store is supported). ▪ Set or delete passwords for any level. ▪ Plus all access from levels 3,2 and 1. ▪ NOTE: This is the default if no passwords are defined.
3	▪ Write to all configuration and logic when the CPU is in Stop mode, including word-for-word changes (when supported), the addition/deletion of program logic, and the overriding of discrete I/O. ▪ Read/Write/Verify user flash. ▪ Store reference/override tables. ▪ Change sweep mode. ▪ Plus all access from levels 2 and 1.
2	▪ Write to any data memory, but this does not include storing tables. ▪ This includes the toggle/force of reference values but does not include overriding discrete I/O. ▪ The PLC can be started or stopped. ▪ PLC and I/O fault tables can be cleared. ▪ Plus all access from level 1.
1 Most Protected	Read any PLC data except for passwords. This includes reading fault tables, current status, performing datagrams, verifying logic/config, and loading program and configuration from the PLC. No PLC memory may be changed.

Protection Level Request from Programmer

Upon connection to the CPU, the programming software automatically requests the CPU to move to the highest unprotected level. That gives the programmer access to the highest unprotected level without having to specifically request a particular level.

A privilege change may be to a lower level or to a higher level. The privilege level is changed from the programmer by entering the new level and the correct password for that level. If the wrong password is entered, the change is denied and a fault is logged in the PLC fault table. A request to change to a privilege level that is not password-protected is made by supplying the new level and an empty password.

Notes on Using Passwords

- To re-enable passwords after passwords have been disabled, the PLC must be power-cycled with the battery removed for long enough to completely discharge the super-capacitor and erase the PLC's memory.
- If the passwords prevent changing the run/stop mode, firmware upgrades cannot be performed if the PLC is in run mode.
- The Run/Stop switch (if configured) will place the PLC in run or stop mode regardless of the passwords.

The OEM Protection Feature

The OEM protection feature is similar to the passwords and privilege levels and provides an even higher level of security. The feature is enabled or disabled using a 1 to 7 character password called the *OEM key*. When OEM protection is enabled, no write-access to the PLC program and configuration is permitted. Reading the configuration from the PLC is permitted. In this mode, no user flash operations are allowed.

When the OEM key password has been created, the OEM key can be locked in two ways: by choosing the locked setting from the programming software or by power-cycling the PLC. (The OEM key locked status does not change when PLC communications are suspended.)

Clearing Logic/Configuration, and References

It is possible to clear logic, configuration, and references from the programmer with the CPU at any privilege level, even with the OEM key locked. Operators can clear logic, configuration, and references, and store a new application program to the CPU without knowing passwords.

If passwords and/or the OEM key have been set and written to flash, a read from flash updates the protection level. In this case, it is not necessary to reenter the password to gain access to a particular level. A Clear All does not clear user flash.

Chapter

8

Elements of an Application Program

This chapter provides basic information about the application program for a VersaMax® PLC.

- Structure of an application program
- Subroutines
- Program languages
- The Instruction Set

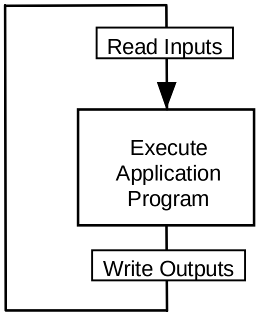
Structure of an Application Program

The application program consists of all the logic needed to control the operations of the PLC CPU and the modules in the system.

Application programs are created using the programming software and transferred to the PLC. Programs are stored in the CPU's non-volatile memory.

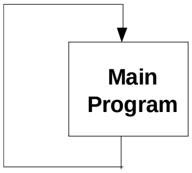
During the CPU Sweep (described in the previous chapter), the CPU reads input data from the modules in the system and stores the data in its configured input memory locations. The CPU then executes the entire application program once, utilizing this fresh input data. Executing the application program creates new output data that is placed in the configured output memory locations.

After completing the end of the application program, the CPU writes the output data to modules in the system.



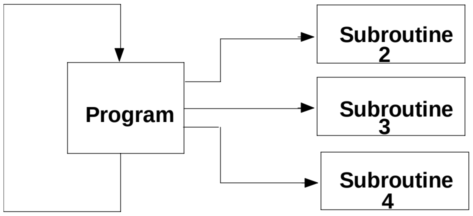
Subroutines

The program can consist of one Main program that executes completely during each CPU sweep.

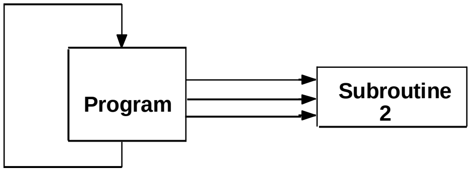


Or a program can be divided into subroutines. The maximum size of a main program or subroutine block is 64kB. The program can contain up to 255 subroutines.

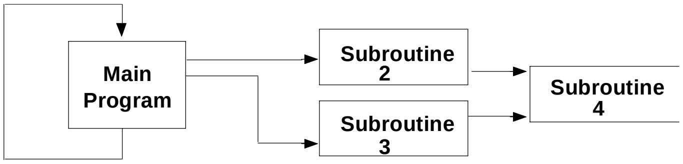
Subroutines can simplify programming and reduce the overall amount of logic. Each subroutine can be called as needed. The main program might serve primarily to sequence the subroutine blocks.



A subroutine block can be called many times as the program executes. Logic that should be repeated can be placed in a subroutine block, reducing total program size.



In addition to being called from the program, subroutine blocks can also be called by other subroutine blocks. A subroutine block can even call itself.



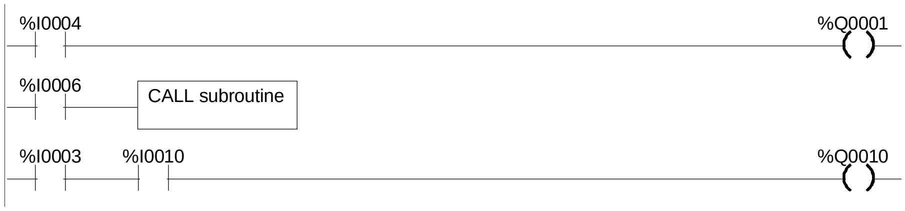
The main program is level 1. The program can include up to eight additional nested call levels.

Declaring a Subroutine

A subroutine must be declared through the block declaration editor of the programming software.

Calling a Subroutine

A subroutine invoked in the program is using a CALL instruction. Up to 64 subroutine block declarations and 64 CALL instructions are allowed for each block in the program.



Program Languages

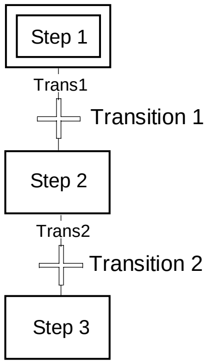
Programs can be created in Ladder Diagram or Instruction List format. The main program or subroutines within the program can also be created in Sequential Function Chart format. The PLC programming software can be used to create both types of logic.

Sequential Function Chart

Sequential Function Chart (SFC) is a graphic method of representing the functions of a sequential automated system as a sequence of steps and transitions. Each step represents commands or actions that are either active or inactive.

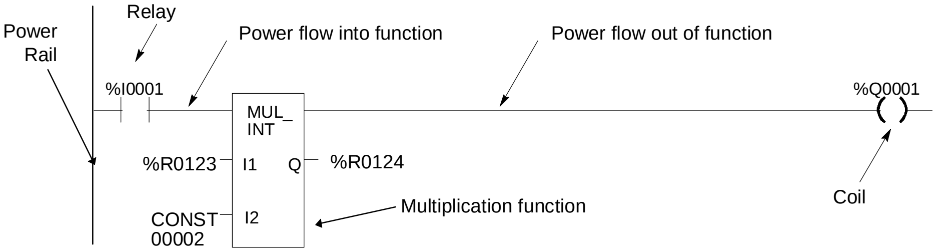
The flow of control passes from one step to the next through a conditional transition that is either true (1) or false (0). If the transition condition is true (1), control passes from the current step (which becomes inactive) to the next step, which then becomes active.

The logic associated with a step is executed when the step is active. This logic is programmed in Ladder Diagram format. The transitions between steps are also programmed as Ladder Diagram logic.



Ladder Diagram

This traditional PLC programming language, with its rung-like structure, executes from top to bottom. The logic execution is thought of as “power flow”, which proceeds down along the left “rail” of the ladder, and from left to right along each rung in sequence.



The flow of logical power through each rung is controlled by a set of simple program functions that work like mechanical relays and output coils. Whether or not a relay passes logical power flow along the rung depends on the content of a memory location with which the relay has been associated in the program. For instance, a relay might pass power flow if its associated memory location contained the value 1. The same relay would not pass power flow if the memory location contained the value 0.

If a relay or other function in a rung does not pass logical power flow, the rest of that rung is not executed. Power then flows down along the left rail to the next rung.

Within a rung, there are many complex functions that can be used for operations like moving data stored in memory, performing math operations, and controlling communications between the CPU and other devices in the system.

Some program functions, such as the Jump function and Master Control Relay, can be used to control the execution of the program itself.

Together, this large group of Ladder Diagram relays, coils, and functions is called the “Instruction Set” of the CPU.

The Instruction Set

The VersaMax PLC CPU provides a powerful Instruction Set for building application programs.

As a guide to the programming capabilities of the VersaMax PLC, all of the relays, coils, functions, and other elements of the Instruction Set are summarized on the following pages. Complete reference information is included in the documentation and online help for the programming software.

Contacts

–| |–	**Normally Open**	Passes power if the associated reference is ON.
–|/|–	**Normally Closed**	Passes power if the associated reference is OFF.
<+>–––	**Continuation**	Passes power to the right if the preceding continuation coil is set ON.

Coils

–( )–	**Normally Open**	Sets the associated reference ON if the coil receives power. Otherwise OFF.
–(/)–	**Negated**	Sets the associated discrete reference ON if the coil does not receive power. Otherwise OFF.
–(▯)–	**Positive Transition**	If power flow was OFF to this coil the last time it was executed and is ON this time, then the coil is turned ON. Otherwise, the coil is turned OFF.
–(▯)–	**Negative Transition**	If power flow was ON to this coil the last time it was executed and is OFF this time, then the coil is turned ON. Otherwise, the coil is turned OFF.
–(S)–	**SET**	Sets the associated discrete reference ON if the coil receives power. It remains set until reset by an –(R)– coil.
–(R)–	**RESET**	Sets the associated discrete reference OFF if the coil receives power. It remains reset until set by an –(S)– coil.
–(SM)–	**Retentive SET**	Sets the associated reference is set ON if the coil receives power. The reference remains set until reset by an –(RM)– coil. Its state is retained through power failure and **STOP-TO-RUN** transition.
–(RM)–	**Retentive RESET**	Resets the associated discrete reference OFF if the coil receives power. The reference remains reset until set by an –(SM)– coil. Its state is retained through power failure and **STOP-TO-RUN** transition.
–(/M)–	**Negated Retentive**	Sets the associated discrete reference ON if the coil does not receive power. The state is retained through power failure and **STOP-TO-RUN** transition. Otherwise OFF.
–(M)–	**Retentive**	Sets the associated discrete reference ON if the coil receives power. The state is retained through power failure and **STOP-TO-RUN** transition. Otherwise OFF.
–––<+>	**Continuation**	If power to the coil is ON, the continuation coil sets the next continuation contact ON. If power is OFF, the continuation coil sets the next continuation contact OFF.

Timers and Counters

ondtr	**On-Delay Stopwatch Timer**	Accumulates time while receiving power The current value is reset to zero when the Reset input receives power.
oftd	**Off-Delay Timer**	Accumulates time while NOT receiving power.
tmr	**On-Delay Timer**	Accumulates time while receiving power The current value is reset to zero when there is no power flow.
upctr	**Up Counter**	Increments by 1 each time the function receives transitional power.
dnctr	**Down Counter**	Counts down from a preset value every time the function receives transitional power.

Math Functions

add	**Addition**	Adds two numbers.
sub	**Subtraction**	Subtracts one number from another.
mul	**Multiplication**	Multiplies two numbers.
div	**Division**	Divides one number by another, yielding a quotient.
mod	**Modulo Division**	Divides one number by another, yielding a remainder.
expt	**Power of X**	Raises X to the power specified by IN and places the result in Q.
sin	**Trigonometric Sine**	Finds the trigonometric sine of a real number.
cos	**Trigonometric Cosine**	Finds the trigonometric cosine of a real number.
tan	**Trigonometric Tangent**	Finds the trigonometric tangent of a real number.
asin	**Inverse Sine**	Finds the inverse sine of a real number.
acos	**Inverse Cosine**	Finds the inverse cosine of a real number.
atan	**Inverse Tangent**	Finds the inverse tangent of a real number.
deg	**Convert to Degrees**	Performs a RAD_TO_DEG conversion on a real radian value.
rad	**Convert to Radians**	Performs a DEG_TO_RAD conversion on a real degree value.
scale	**Scaling**	Scales an input constant or word value.
sqroot	**Square Root**	Finds the square root of an integer or real value.
Log	**Base 10 Logarithm**	Finds the base 10 logarithm of a real value.
ln	**Natural Logarithm**	Finds the natural logarithm base of a real number.
exp	**Power of e**	Raises the natural logarithm base to the power specified by input.

Relational Functions

eq	**Equal**	Tests for equality between two numbers.
ne	**Not Equal**	Tests for nonequality between two numbers.
gt	**Greater Than**	Tests whether one number is greater than another. Passes power if the first number is greater than the second.
ge	**Greater Than or Equal To**	Tests whether one number is greater than or equal to another
lt	**Less Than**	Tests whether one number is less than another.
le	**Less Than or Equal To**	Test whether one number is greater than or equal to another.
range	**Range**	Test the input value against a range of two numbers.

Bit Operation Functions

and	**Logical AND**	Performs Logical AND of two bit strings.
or	**Logical OR**	Performs Logical OR of two bit strings.
xor	**Logical Exclusive OR**	performs Logical Exclusive OR of two bit strings.
not	**Logical Invert**	Performs a logical inversion of a bit string.
shl	**Shift Left**	Shifts a bit string left.
shr	**Shift Right**	Shifts a bit string right.
rol	**Rotate Left**	Rotates a bit string left.
ror	**Rotate Right**	Rotates a bit string right.
bittst	**Bit Test**	Test a bit within a bit string.
bitset	**Bit Set**	Sets one bit within a string to true.
bitclr	**Bit Clear**	Sets one bit within a string to false.
bitpos	**Bit Position**	Locates a bit set to true within a bit string.
mskcmp	**Masked Compare**	Performs a masked compare of two arrays.

Data Move Functions

move	**Move**	Moves one or more bits of data.
blkmov	**Block Move**	Moves a block of up to 7 constants.
blkclr	**Block Clear**	Clears to zero one or more bytes/words of memory.
shfreg	**Shift Register**	Shifts one or more words or bits of data through a block of memory.
bitseq	**Bit Sequencer**	Sequences a 1 through a group of bits in PLC memory.
comreq	**Communication Request**	Sends a communications request.

Table Functions

arrmov	**Array Move**	Copies a specified number of data elements from a source array to a destination array.
srh eq	**Search Equal**	Searches array for values equal to a specified value.
srh ne	**Search Not Equal**	Searches array for values not equal to a specified value.
srh gt	**Search Greater Than**	Searches array for values greater than a specified value.
srh ge	**Search Greater Than or Equal**	Searches array for values greater than or equal to a specified value.
srh lt	**Search Less Than**	Searches array for values less than a specified value.
srh le	**Search Less Than or Equal**	Searches array for values less than or equal to a specified value.

Conversion Functions

→bcd-4	**Convert to BCD4 (From INT)**	Converts a number to 4-digit BCD format.
→word	**Convert to Word (From REAL)**	Converts a Real value to Word format.
→int	**Convert to INT (From BCD4 or REAL)**	Converts a number to signed integer format.
→tdint	**Convert to DINT (From BCD4 or REAL)**	Converts a number to double precision integer format.
→real	**Convert to Real (From INT, DINT, BCD4 or WORD)**	Converts a value to real value format.
→→int	**Truncate to INT (from REAL)**	Truncates to a 16-bit signed number. The range is –32,768 to +32,767.
→→dint	**Truncate to Double Precision INT (from REAL)**	Truncates to a 32-bit signed number. The range is -2,147,483,648 to +2,147,483,647.

Control Functions

call	**Call**	Causes a program execution to go to a specified subroutine block.
do io	**Do I/O**	Services a specified range of inputs or outputs immediately (all inputs or outputs on a module will be serviced if any addresses on that module are included in the function – partial I/O module updates are not performed
pidind	**Independent PID Algorithm**	Selects the non-interacting independent PID algorithm.
pidisa	**ISA PID Algorithm**	Selects the ISA PID algorithm.
end	**Temporary End of Logic**	The program executes from the first rung to the last rung or the END instruction, whichever is encountered first. This instruction is useful for debugging purposes.
commnt	**Comment**	A rung explanation.
svcreq	**Service Request**	A special PLC service function.
mcr	**Master Control Relay**	Starts a master control relay range. An MCR causes all rungs between the MCR and its subsequent ENDMCR to be executed with no power flow. Up to 8 MCRs can be nested.
endmcr	**End Master Control Relay**	Ends a master control relay range.
jump	**Jump**	Jumps to a specified location indicated by a LABEL in the logic.
label	**Label**	The target location of a JUMP instruction. Multiple Jump instructions can reference the same label.
drumseq	**Drum Sequencer**	(future) Operates like a mechanical drum sequencer, selecting a 16-bit output pattern from an array of stored patterns, and sending it to a set of outputs.

Chapter

9

Program Data

This chapter describes the types of data that can be used in an application program, and explains how that data is stored in the VersaMax® PLC's memory.

- Data memory references
- Retentiveness of data
- Using names and descriptions for program references
- System status references
- Time tick contacts
- How program functions handle numerical data

Data Memory References

The PLC stores program data in both bit memory and word memory. Both bit memory and word memory are divided into different types with specific characteristics.

By convention, each type is normally used for a specific type of data, as explained below. However, there is great flexibility in actual memory assignment.

Individual memory locations are indexed using alphanumeric identifiers called references. The reference's letter prefix identifies the memory area. The numerical value is the offset within that memory area.

Word Memory References

Each word memory address (reference) is on a 16-bit word boundary. The PLC uses three types of references for data stored in word memory.

%AI	Normally used for analog inputs.
%AQ	Normally used for analog outputs.
%R	Registers are normally used to store program data in word format.

Word memory is represented below. The example below shows ten addresses. Each has 16 bits that together contain one value. The PLC cannot access individual bits in word memory.

addresses	**1**	**12467**
	2	**12004**
	3	**231**
	4	**359**
	5	**14**
	6	**882**
	7	**24**
	8	**771**
	9	**735**
	10	**000**

Bit Memory References

Each bit memory address (reference) is on a bit boundary. Data is stored in bit memory as represented below. The illustration shows160 individually-addressed bits, with address 1 in the upper left and address 160 in the lower right.

addresses

1	2	3	4	5	6	7	8								
0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0
0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0
1	1	1	1	0	0	0	1	1	0	0	1	0	0	0	0
1	1	0	0	0	0	0	1	1	1	0	0	1	0	1	0
0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0
1	1	0	0	0	0	0	1	1	1	0	0	1	0	1	0
1	1	0	1	0	0	0	1	1	1	0	1	0	0	0	0
1	1	0	0	0	0	0	1	1	0	1	1	1	0	1	1
1	0	0	1	0	0	0	1	1	0	1	1	1	0	0	1
0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1

... 160

The PLC uses six types of references for data stored in bit memory.

%I	Normally used for discrete inputs, and viewable in the Input Status Table.
%Q	Normally used for physical output references, and viewable in the Output Status Table. A %Q reference may be either retentive or non-retentive, depending on its use in the program.
%M	Normally used to represent internal references. A specific %M reference may be either retentive or non-retentive, depending on its use in the program.
%T	Used for temporary references that can be used many times in a program. Data with %T references is not retained through loss of power or RUN-TO-STOP-TO-RUN transitions. %T references cannot be used with retentive coils.
%S	System status references, which have specific predefinitions. ■ %S, %SA, %SB, and %SC can be used for any type of logic contact. ■ %SA, %SB, and %SC can be used for retentive coils. ■ %S can be used as inputs to functions or function blocks. ■ %SA, %SB, and %SC can be used as inputs or outputs of functions and function blocks.
%G	Used for Global Data. Data in %G references is retained through power loss. %G references can be used with contacts and retentive coils, but not on non-retentive coils.

Transition Bits and Override Bits

%I, %Q, %M, and %G references have associated transition and override bits.

%T, %S, %SA, %SB, and %SC references have associated transition bits only.

The CPU uses transition bits for transitional coils. When override bits are set, the associated references can only be changed from the programmer.

Retentiveness of Data

Data is retentive if it is automatically saved when the PLC is stopped or power cycled. The following data is retentive:

- Program logic
- Fault tables and diagnostics
- Overrides
- Word data (%R, %AI, %AQ)
- Bit data (%I, %SC, %G, fault bits and reserved bits)
- Word data stored in %Q and %M.
- Data in %Q or %M references that are used as function block outputs or with retentive coils:

  -(M)- retentive coils
  -(/M)- negated retentive coils
  -(SM)- retentive SET coils
  -(RM)- retentive RESET coils

  The last time a %Q or %M reference is used with a coil, the coil type determines whether the data is retentive or non-retentive. For example, if %Q0001 was last programmed as the reference of a retentive coil, the %Q0001 data is retentive. However, if %Q0001 was last programmed on a non-retentive coil, then the %Q0001 data is non-retentive.
- %Q or %M references that have been made retentive by specifically declaring them to be retentive. %Q and %M references default to non-retentive.

The following data is non-retentive:

- The states of transition coils.
- %T data
- %S, %SA, and %SB data (but %SC bit data IS retentive).
- %Q and %M references that have not been declared to be retentive.
- %Q and %M references that are used with non-retentive coils:

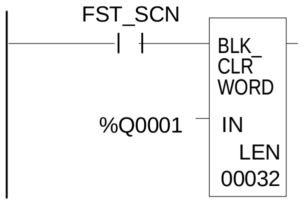
  -( )- coils
  -(/)- negated coils
  -(S)- SET coils
  -(R)- RESET coils

System Status References

The PLC stores system status data in predefined references in %S, %SA, %SB, and %SC memory. Each system status reference has a descriptive name. For example, time tick references are named T_10MS, T_100MS, T_SEC, and T_MIN. Examples of convenience references include FST_SCN, ALW_ON, and ALW_OFF.

Using the System Status References

System status references can be used as needed in application programs. For example, the following function block uses the FST_SCN (first scan) status reference to control power flow to a Block Clear function. In this example, at powerup, 32 words of %Q memory (512 points) beginning at %Q0001 are filled with zeros.



%S References

References in %S memory are read only.

Reference	Name	Definition
%S0001	FST_SCN	Set to 1 when the current sweep is the first sweep.
%S0002	LST_SCN	Reset from 1 to 0 when the current sweep is the last sweep.
%S0003	T_10MS	0.01 second timer contact.
%S0004	T_100MS	0.1 second timer contact.
%S0005	T_SEC	1.0 second timer contact.
%S0006	T_MIN	1.0 minute timer contact.
%S0007	ALW_ON	Always ON.
%S0008	ALW_OFF	Always OFF.
%S0009	SY_FULL	Set when the PLC fault table fills up. Cleared when an entry is removed and when the PLC fault table is cleared.
%S0010	IO_FULL	Set when the I/O fault table fills up. Cleared when an entry is removed from the I/O fault table and when the I/O fault table is cleared.
%S0011	OVR_PRE	Set when an override exists in %I, %Q, %M, or %G memory.
%S0012		reserved
%S0013	PRG_CHK	Set when background program check is active.
%S0014	PLC_BAT	Set to indicate a bad battery in the CPU. The contact reference is updated once per sweep.
%S0015, 16		reserved
%S0017	SNPXACT	SNP-X host is actively attached to CPU port 1. (Port 2 defaults to disabled, and must be activated with a CRQ).
%S0018	SNPX_RD	SNP-X host has read data from CPU port 1.
%S0019	SNPX_WT	SNP-X host has written data to CPU port 1.
%S0020		Set ON when a relational function using REAL data executes successfully. It is cleared when either input is NaN (Not a Number).
%S0021	FF_OVR	Set to report a Fatal Fault Overide.
%S0022	USR_SW	Set to reflect the state of the CPU mode switch. 1 = Run/On 0 = Stop/Off
%S0023-32		reserved

%SA, %SB, and %SC References

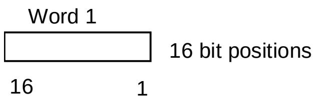
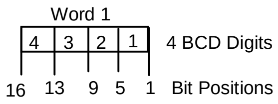
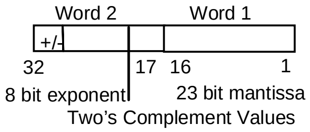
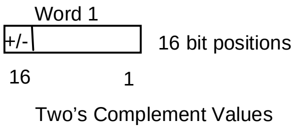
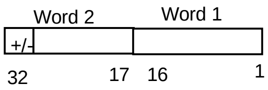
References in %SA, %SB, and %SC memory can be both read and written to.

Reference	Name	Definition
%SA0001	PB_SUM	Set when a checksum calculated on the application program does not match the reference checksum. If the fault was due to a temporary failure, the discrete bit can be cleared by again storing the program to the CPU. If the fault was due to a hard RAM failure, the CPU must be replaced.
%SA0002	OV_SWP	Set when a PLC in CONSTANT SWEEP mode detects that the previous sweep took longer than the time specified. Cleared when the PLC detects that the previous sweep did not take longer than specified. Also cleared during transition from STOP to RUN mode.
%SA0003	APL_FLT	Set when an application fault occurs. Cleared when the PLC transitions from STOP to RUN mode.
%SA0004-8		reserved
%SA0009	CFG_MM	Set when a configuration mismatch is detected during power-up or a configuration store. Cleared by powering up the PLC after correcting the condition.
%SA0010	HRD_CPU	Set when the diagnostics detects a problem with the CPU hardware. Cleared by replacing the CPU module.
%SA0011	LOW_BAT	Set when a low battery fault occurs. Cleared by replacing the battery then powering up the PLC.
%SA0012,13		reserved
%SA0014	LOS_IOM	Set when an I/O module stops communicating with the CPU. Cleared by replacing the module and cycling system power.
%SA0015	LOS_SIO	Set when an option module stops communicating with the CPU. Cleared by replacing the module and cycling power on the main rack.
%SA0016-18		reserved
%SA0019	ADD_IOM	Set when an I/O module is added. Cleared by cycling PLC power and when the configuration matches the hardware after a store.
%SA0020	ADD_SIO	Set when an option module is added. Cleared by cycling PLC power and when the configuration matches the hardware after a store.
%SA0021-26		reserved
%SA0027	HRD_SIO	Set when a hardware failure is detected in an option module. Cleared by replacing the module and cycling PLC power.
%SA0028-30		reserved
%SA0031	SFT_SIO	Set when an unrecoverable software fault is detected in an option module. Cleared by cycling PLC power and when the configuration matches the hardware.

Reference	Name	Definition
%SB0001-9		reserved
%SB0010	BAD_RAM	Set when the CPU detects corrupted RAM memory at powerup. Cleared when RAM memory is valid at powerup.
%SB0011	BAD_PWD	Set when a password access violation occurs. Cleared when the PLC fault table is cleared.
%SB0012		reserved
%SB0013	SFT_CPU	Set when the CPU detects an unrecoverable error in the software. Cleared by clearing the PLC fault table.
%SB0014	STOR_ER	Set when an error occurs during a programmer store operation. Cleared when a store operation is completed successfully.
%SC0001-8		reserved
%SC0009	ANY_FLT	Set when any fault occurs. Cleared when both fault tables have no entries.
%SC0010	SY_FLT	Set when any fault occurs that causes an entry to be placed in the PLC fault table. Cleared when the PLC fault table has no entries.
%SC0011	IO_FLT	Set when any fault occurs that causes an entry to be placed in the I/O fault table. Cleared when the I/O fault table has no entries.
%SC0012	SY_PRES	Set as long as there is at least one entry in the PLC fault table. Cleared when the PLC fault table has no entries.
%SC0013	IO_PRES	Set as long as there is at least one entry in the I/O fault table. Cleared when the I/O fault table has no entries.
%SC0014	HRD_FLT	Set when a hardware fault occurs. Cleared when both fault tables have no entries.
%SC0015	SFT_FLT	Set when a software fault occurs. Cleared when both fault tables have no entries.

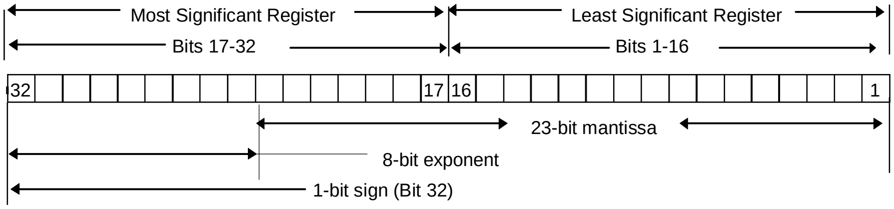
How Program Functions Handle Numerical Data

Regardless of where data is stored in memory—in one of the bit memories or one of the word memories--the application program can handle it as different data types.

Type	Name	Description	Data Format
BIT	Bit	A Bit data type is the smallest unit of memory. It has two states, 1 or 0. The programmer functions use the term BOOL for bit-type data.	
BYTE	Byte	A Byte data type has an 8-bit value. The valid range is 0 to 255 (0 to FF in hexadecimal).	
WORD		A Word data type uses 16 consecutive bits of data memory; but, instead of the bits in the data location representing a number, the bits are independent of each other. Each bit represents its own binary state (1 or 0). The valid range of word values is 0 to +65,535 (FFFF).	
BCD-4	Four-Digit Binary Coded Decimal	Four-digit BCD numbers use 16-bit data memory locations. Each BCD digit uses four bits and can represent numbers between 0 and 9. BCD coding of the 16 bits has a value range of 0 to 9999.	
REAL	Floating-Point	Real numbers use two consecutive 16-bit memory locations. The range of numbers that can be stored in this format is ± 1.401298E-45 to ± 3.402823E+38. See the next page for more information.	
INT	Signed Integer	Signed integer data uses 16-bit memory locations. Signed integers are represented in 2's complement notation. Bit 16 is the sign bit, (0 = positive, 1 = negative). Their range is -32,768 to +32,767.	
DINT	Double Precision Signed Integer	Double precision signed integers data uses two consecutive 16-bit memory locations. They are represented in 2's complement notation. Bit 32 is the sign bit, (0 = positive, 1 = negative). Their range is -2,147,483,648 to +2,147,483,867.	

Real Numbers

The REAL data type, which can be used for some Math functions and Numerical functions, is actually floating point data. Floating-point numbers are stored in single precision IEEE-standard format. This format requires 32 bits, which occupy two (adjacent) 16-bit PLC words.



For example, if the floating-point number occupies registers %R0005 and %R0006, then %R0005 is the least significant register and %R0006 is the most significant register.

The range of numbers that can be stored in this format is from ± 1.401298E–45 to ± 3.402823E+38 and the number zero.

Errors in Real Numbers and Operations

Overflow occurs when a number greater than 3.402823E+38 or less than -3.402823E+38 is generated by a REAL function. The ok output of the function is set OFF; and the result is set to positive infinity (for a number greater than 3.402823E+38) or negative infinity (for a number less than –3.402823E+38). You can determine where this occurs by testing the sense of the ok output.

POS_INF = 7F800000h – IEEE positive infinity representation in hex.
NEG_INF = FF800000h – IEEE negative infinity representation in hex.

If the infinities produced by overflow are used as operands to other REAL functions, they may cause an undefined result. This result is referred to as NaN (Not a Number). For example, the result of adding positive infinity to negative infinity is undefined. When the ADD_REAL function is invoked with positive infinity and negative infinity as its operands, it produces NaN for its result.

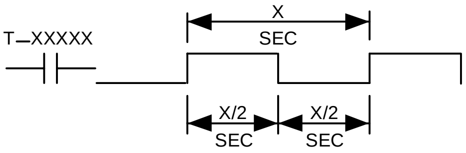
Time-Tick Contacts

There are four time-tick contacts. They can be used to provide regular pulses of power flow to other program functions. The four time-tick contacts have time durations of 0.01 second, 0.1 second, 1.0 second, and 1 minute.

The state of these contacts does not change during the execution of the sweep. These contacts provide a pulse having an equal on and off time duration.

The contacts are referenced as T_10MS (0.01 second), T_100MS (0.1 second), T_SEC (1.0 second), and T_MIN (1 minute).

The following timing diagram represents the on/off time duration of these contacts.



These time-tick contacts represent specific locations in %S memory.

Chapter 10

Instruction Set Reference

This section is a reference to the functions in the VersaMax® PLC Instruction Set:

Bit Operation Functions Logical AND, Logical OR Exclusive OR, Logical Invert (NOT) Shift Right/Shift Left Rotate Right/Rotate Left Bit Test Bit Set, Bit Clear Masked Compare Bit Position Bit Sequencer	**Math and Numerical Functions** Add, Subtract, Multiply, Divide Modulo Division Scaling Square Root Trigonometric Functions Logarithmic/Exponential Functions Convert Radians / Degrees
Control Functions Do I/O Call End Comment Master Control Relay Drum Sequencer Service Request (see chapter 11) PID (see chapter 14)	**Relational Functions** Equal Not Equal Greater Than Less Than Greater or Equal Less or Equal Range
Data Move Functions Move Block Move Block Clear Shift Register Communication Request	**Relay Functions** Contacts, Coils Fault and No Fault Contacts Alarm Contacts **Table Functions** Array Move Search
Data Type Conversion Functions Convert to BCD-4 Convert to Signed Integer Convert to Double Precision Signed Integer Convert to Real Convert Real to Word Truncate Real Number PID (see chapter 14)	**Timer and Counter Functions** Time-tick Contacts On Delay Stopwatch Timer On Delay Timer Off Delay Timer Up Counter Down Counter

Bit Operation Functions

The Bit Operation functions perform comparison, logical, and move operations on bit strings. The Bit Operation functions are:

- Logical AND
- Logical OR
- Exclusive OR
- Logical Invert (NOT)
- Shift Right/Shift Left
- Rotate Right/Rotate Left
- Bit Test
- Bit Set, Bit Clear
- Masked Compare
- Bit Position
- Bit Sequencer

Data Lengths for the Bit Operation Functions

The Logical AND, OR, XOR, and NOT (Invert) functions operate on a single word of data. The other Bit Operation functions may operate on up to 256 words.

All Bit Operation functions require Word-type data. However, they operate on data as a continuous string of bits, with bit 1 of the first word being the Least Significant Bit (LSB). The last bit of the last word is the Most Significant Bit (MSB). For example, if you specified three words of data beginning at reference %R0100, it would be operated on as 48 contiguous bits.

%R0100	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	← bit 1 (LSB)
%R0101	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	
%R0102	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	
	↑ (MSB)																

Overlapping input and output reference address ranges in multi-word functions is not recommended, it can produce unexpected results.

Bit Operation Functions
Logical AND, Logical OR

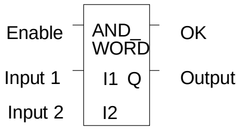
Each scan that power is received, a Logical AND or Logical OR function examines each bit in bit string I1 and the corresponding bit in bit string I2, beginning at the least significant bit in each. A string length of 256 words can be selected.

Logical AND

If both bits examined by the Logical AND function are 1, a 1 is placed in the corresponding location in output string Q. If either or both bits are 0, a 0 is placed in string Q in that location. The Logical AND function can be used to build masks or screens, where only certain bits are passed through (bits opposite a 1 in the mask), and all other bits are set to 0. The Logical AND function can also be used to clear an area of word memory by ANDing the bits with another bit string known to contain all 0s. The I1 and I2 bit strings specified may overlap.

Logical OR

If either or both bits examined by the Logical OR function is 1, a 1 is placed in the corresponding location in output string Q. If both bits are 0, a 0 is placed in string Q in that location. The Logical OR function can be used to combine strings or to control many outputs with one simple logical structure. The Logical OR function is the equivalent of two relay contacts in parallel multiplied by the number of bits in the string. It can be used to drive indicator lamps directly from input states, or to superimpose blinking conditions on status lights.



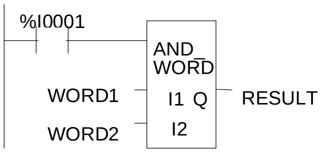
Bit Operation Functions
Logical AND, Logical OR

Parameters of the Logical AND and Logical OR Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
I1	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the first word of the first string.
I2	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the first word of the second string.
ok	flow, none	The OK output is energized whenever enable is energized.
Q	I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ	Output Q contains the result of the operation.

Example of the Logical AND Function

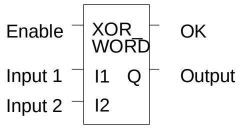
In the example, when input %I0001 is set, the 16-bit strings represented by nicknames WORD1 and WORD2 are examined. The results of the Logical AND are placed in output string RESULT.



WORD1	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0
WORD2	1	1	0	1	1	1	0	0	0	0	0	0	1	1	1	1
RESULT	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0

Bit Operation Functions
Exclusive OR

The Exclusive OR function compares each bit in bit string I1 with the corresponding bit in string I2. If the bits are different, a 1 is placed in the corresponding position in the output bit string.



Each scan that power is received, the Exclusive OR function examines each bit in string I1 and the corresponding bit in string I2, beginning at the least significant bit in each. For each two bits examined, if only one is 1, then a 1 is placed in the corresponding location in bit string Q. The Exclusive OR function passes power flow to the right whenever power is received.

If string I2 and output string Q begin at the same reference, a 1 placed in string I1 will cause the corresponding bit in string I2 to alternate between 0 and 1, changing state with each scan as long as power is received. Longer cycles can be programmed by pulsing the power flow to the function at twice the desired rate of flashing; the power flow pulse should be one scan long (one-shot type coil or self-resetting timer).

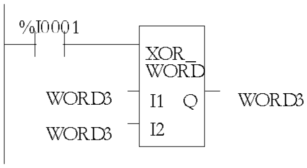
The Exclusive OR function is useful for quickly comparing two bit strings, or to blink a group of bits at the rate of one ON state per two scans.

Parameters of the Exclusive OR Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
I1	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the first word to be XORed.
I2	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the second word to be XORed.
ok	flow, none	The OK output is energized whenever enable is energized.
Q	I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ	Output Q contains the result of the operation.

Example

In the example, whenever %I0001 is set, the bit string represented by the nickname WORD3 is cleared (set to all zeros).



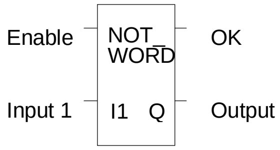
I1 (WORD3)	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0
I2 (WORD3)	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0

Q (WORD3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Bit Operation Functions
Logical Invert (NOT)

The Logical Invert (NOT) function sets the state of each bit in the output bit string Q to the opposite of the state of the corresponding bit in bit string I1.

All bits are altered on each scan that power is received, making output string Q the logical complement of I1. The function passes power flow to the right whenever power is received. A length of 256 words can be selected.

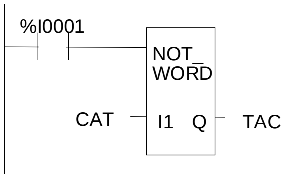


Parameters of the Logical Invert Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
I1	I, Q, M, T, S, G, R, AI, AQ, constant	Constant or reference for the word to be negated.
ok	flow, none	The OK output is energized whenever enable is energized.
Q	I, Q, M, T, SA, SB, SC (not S), G, R, AI, AQ	Output Q contains the result of the operation.

Example

In the example, whenever input %I0001 is set, the bit string represented by the nickname TAC is set to the inverse of bit string CAT.



Bit Operation Functions
Shift Bits Right, Shift Bits Left

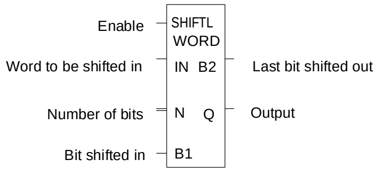
The Shift Left function shifts all the bits in a word or group of words to the left by a specified number of places. When the shift occurs, the specified number of bits is shifted out of the output string to the left. As bits are shifted out of the high end of the string, the same number of bits is shifted in at the low end.

	MSB															LSB	
B2 ←	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	←B1

The Shift Right function is used to shift all the bits in a word or group of words a specified number of places to the right. When the shift occurs, the specified number of bits is shifted out of the output string to the right. As bits are shifted out of the low end of the string, the same number of bits is shifted in at the high end.

	MSB															LSB	
B1 →	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	→B2

A string length of 1 to 256 words can be selected for either function.



If the number of bits to be shifted (N) is greater than the number of bits in the array * 16, the array (Q) is filled with copies of the input bit (B1), and the input bit is copied to the output power flow (B2). If the number of bits to be shifted is zero, then no shifting is performed; the input array is copied into the output array; and input bit (B1) is copied into the power flow.

The bits being shifted into the beginning of the string are specified via input parameter B1. If a length greater than 1 has been specified as the number of bits to be shifted, each of the bits is filled with the same value (0 or 1). This can be:

- The boolean output of another program function.
- All 1s. To do this, use the special reference nickname ALW_ON as a permissive to input B1.
- All 0s. To do this, use the special reference nickname ALW_OFF as a permissive to input B1.

The function passes power flow to the right, unless the number of bits specified to be shifted is zero. Output Q is the shifted copy of the input string. If you want the input string to be shifted, the output parameter Q must use the same memory location as the input parameter IN. The entire shifted string is written on each scan that power is received. Output B2 is the last bit shifted out. For example, if four bits were shifted, B2 would be the fourth bit shifted out.

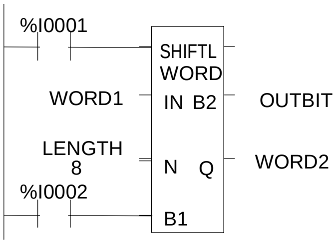
Bit Operation Functions
Shift Bits Right, Shift Bits Left

Parameters of the Shift Right / Left Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the shift is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word to be shifted.
N	I, Q, M, T, G, R, AI, AQ, constant	N contains the number of places (bits) that the array is to be shifted.
B1	flow	B1 contains the bit value to be shifted into the array.
B2	flow, none	B2 contains the bit value of the last bit shifted out of the array.
Q	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	Output Q contains the first word of the shifted array.

Example

In the example, whenever input %I0001 is set, the output bit string contained in the memory location represented by the nickname WORD2 is made a copy of of the bits in location WORD1. The output string is left-shifted by 8 bits, as specified by the input LENGTH. The resulting open bits at the beginning of the output string are set to the value of %I0002.



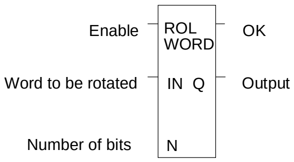
Bit Operation Functions
Rotate Bits Right, Rotate Bits Left

The Rotate Left function rotates all the bits in a string a specified number of places to the left. When rotation occurs, the specified number of bits is rotated out of the input string to the left and back into the string on the right.

The Rotate Right function rotates the bits in the string to the right. When rotation occurs, the specified number of bits is rotated out of the input string to the right and back into the string on the left.

A length of 1 to 256 words can be selected for either function. The number of places to rotate must be more than zero and less than the number of bits in the string.

The Rotate Bits function passes power flow to the right, unless the number of bits specified to be rotated is greater than the total length of the string or is less than zero. The result is placed in output string Q. If you want the input string to be rotated, the output parameter Q must use the same memory location as the input parameter IN. The entire rotated string is written on each scan that power is received.

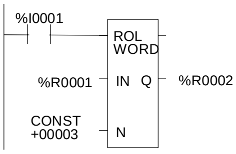


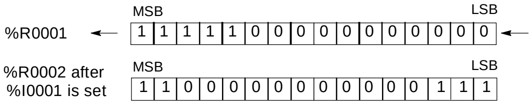
Parameters of the Rotate Bits Right / Left Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the rotation is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word to be rotated.
N	I, Q, M, T, G, R, AI, AQ, constant	N contains the number of places the array is to be rotated.
ok	flow, none	The OK output is energized when the rotation is energized and the rotation length is not greater than the array size.
Q	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	Output Q contains the first word of the rotated array.

Example

In the example, whenever input %I0001 is set, the input bit string in location %R0001 is rotated 3 bits. The result is placed in %R0002. The input bit string %R0001 is not changed by the function. If the same reference is used for IN and Q, a rotation will occur in place.



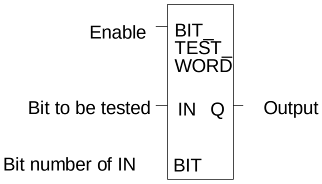


Bit Operation Functions
Bit Test

The Bit Test function tests a bit within a bit string to determine whether that bit is currently 1 or 0. The result of the test is placed in output Q.

Each sweep power is received, the Bit Test function sets its output Q to the same state as the specified bit. If a register rather than a constant is used to specify the bit number, the same function block can test different bits on successive sweeps. If the value of BIT is outside the range (1 ≤ BIT ≤ (16 * length)), then Q is set OFF.

A string length of 1 to 256 words can be selected.



Parameters of the Bit Test Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the bit test is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word of the data to be operated on.
BIT	I, Q, M, T, G, R, AI, AQ, constant	BIT contains the bit number of IN that should be tested. Valid range is (1 ≤ BIT ≤ (16 * length)).
Q	flow, none	Output Q is energized if the bit tested was a 1.

Example

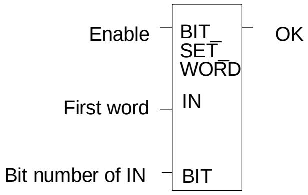
In the example, whenever input %I0001 is set, the bit at the location contained in reference PICKBIT is tested. The bit is part of string PRD_CDE. If it is 1, output Q passes power flow and the coil %Q0001 is turned on.

Bit Operation Functions
Bit Set and Bit Clear

The Bit Set function sets a bit in a bit string to 1. The Bit Clear function sets a bit in a string to 0.

Each sweep that power is received, the function sets the specified bit. If a variable (register) rather than a constant is used to specify the bit number, the same function block can set different bits on successive sweeps.

A string length of 1 to 256 words can be selected. The function passes power flow to the right, unless the value for BIT is outside the range (1 ≤ BIT ≤ (16 * length)). Then, OK is set OFF.

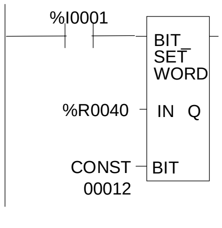


Parameters of the Bit Set and Bit Clear Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the bit operation is performed.
IN	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	IN contains the first word of the data to be operated on.
BIT	I, Q, M, T, G, R, AI, AQ, constant	BIT contains the bit number of IN that should be set or cleared. Valid range is (1 ≤ BIT ≤ (16 * length)).
ok	flow, none	The OK output is energized whenever the bit input is valid and enable is energized.

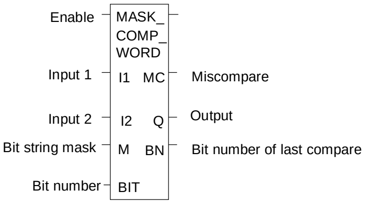
Example

In the example, whenever input %I0001 is set, bit 12 of the string beginning at reference %R0040 is set to 1.



Bit Operation Functions
Masked Compare

The Masked Compare function compares the contents of two separate bit strings. It provides the ability to mask selected bits. Input string 1 might contain the states of outputs such as solenoids or motor starters. Input string 2 might contain their input state feedback, such as limit switches or contacts.



When the function receives power flow, it begins comparing the bits in the first string with the corresponding bits in the second string. Comparison continues until a miscompare is found or until the end of the string is reached.

The BIT input stores the bit number where the next comparison should start (a *0* indicates the first bit in the string). The BN output stores the bit number where the last comparison occurred (where a *1* indicates the first bit in the string). Using the same reference for BIT and BN causes the compare to start at the next bit position after a miscompare; or, if all bits compared successfully upon the next invocation of the function block, the compare starts at the beginning.

If you want to start the next comparison at some other location in the string, you can enter different references for BIT and BN. If the value of BIT is a location that is beyond the end of the string, BIT is reset to 0 before starting the next comparison.

Parameters of the Masked Compare Function

Input/ Output	Choices	Description
enable	flow	Permissive logic to enable the function.
I1	R, AI, AQ For WORD only: I, Q, M, T, S, G	Reference for the first bit string to be compared.
I2	R, AI, AQ For WORD only: I, Q, M, T, S, G	Reference for the second bit string to be compared.
M	R, AI, AQ For WORD only: I, Q, M, T, SS, SB, SC, G	Reference for the bit string mask.
BIT	I, Q, M, T, S, G, R, AI, AQ, constant	Reference for the bit number where the next comparison should start.
MC	flow, none	User logic to determine if a miscompare has occurred.
Q	R, AI, AQ For WORD only: I, Q, M, T, SA, SB, SC, G	Output copy of the mask (M) bit string.
BN	I, Q, M, T, S, G, R, AI, AQ	Bit number where the last miscompare occurred.
length	Constant	The number of words in the bit string. Max. is 4095 for WORD and 2047 for DWORD.

Bit Operation Functions
Masked Compare

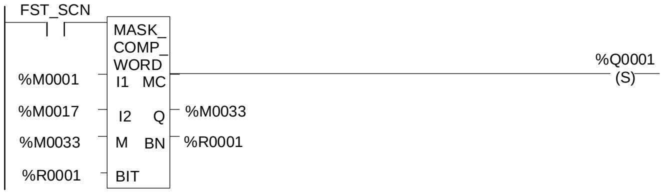
Operation of the Masked Compare

If all corresponding bits in strings I1 and I2 match, the function sets the “miscompare” output MC to 0 and BN to the highest bit number in the input strings. The comparison then stops. On the next invocation of a Masked Compare Word, it is reset to 0. When the two bits currently being compared are not the same, the function checks the correspondingly numbered bit in string M (the mask). If the mask bit is a *1*, the comparison continues until it reaches another miscompare or the end of the input strings. If a miscompare is detected and the corresponding mask bit is a 0, the function does the following:

1. Sets the corresponding mask bit in M to 1.
2. Sets the miscompare (MC) output to 1.
3. Updates the output bit string Q to match the new content of mask string M
4. Sets the bit number output (BN) to the number of the miscompared bit.
5. Stops the comparison.

Example

In the example, after first scan the Masked Compare Word function executes. It compares %M0001–16 with %M0017–32. %M0033–48 contain the mask. The value in %R0001 determines the bit position in the two input strings where the comparison starts.



Before the function block is executed, the contents of the above references are:

(I1) – %M0001	= 6C6Ch	=	0	1	1	0	1	1	0	0	0	1	1	0	1	1	0	0
(I2) – %M0017	= 606Fh	=	0	1	1	0	1	1	0	1	0	1	1	0	1	1	1	1
(M/Q) – %M0033	= 000Fh	=	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
(BIT/BN) – %R0001		=	0															
(MC) – %Q0001		=	OFF															

The contents of these references after the function block is executed are:

(I1) – %M0001	= (same)	=	0	1	1	0	1	1	0	0	0	1	1	0	1	1	0	0
(I2) – %M0017	= (same)	=	0	1	1	0	1	1	0	1	0	1	1	0	1	1	1	1
(M/Q) – %M0033		=	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1
(BIT/BN) – %R0001		=	8															
(MC) – %Q0001		=	ON															

In this example, contact %T1 and coil %M100 force one and only one execution; otherwise the function would repeat with possibly unexpected results.

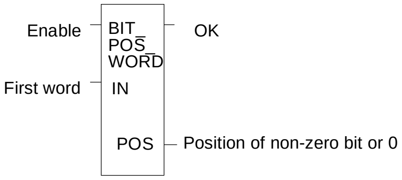
Bit Operation Functions
Bit Position

The Bit Position function locates a bit set to 1 in a bit string.

Each sweep that power is received, the function scans the bit string starting at IN. When the function stops scanning, either a bit equal to 1 has been found or the entire length of the string has been scanned.

POS is set to the position within the bit string of the first non-zero bit; POS is set to zero if no non-zero bit is found.

A string length of 1 to 256 words can be selected. The function passes power flow to the right whenever enable is ON.

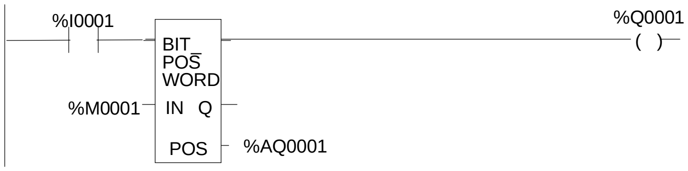


Parameters for the Bit Position Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, a bit search operation is performed.
IN	I, Q, M, T, S, G, R, AI, AQ	IN contains the first word of the data to be operated on.
ok	flow, none	The OK output is energized whenever enable is energized.
POS	I, Q, M, T, G, R, AI, AQ	The position of the first non-zero bit found, or zero if a non-zero bit is not found.

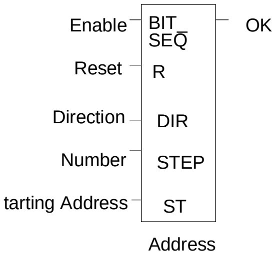
Example

In the example, if %I0001 is set, the bit string starting at %M0001 is searched until a bit equal to 1 is found. Coil %Q0001 is turned on. If a bit equal to 1 is found, its location within the bit string is written to %AQ001. If %I0001 is set, bit %M0001 is 0, and bit %M0002 is 1, then the value written to %AQ001 is 2



Bit Operation Functions
Bit Sequencer

The Bit Sequencer function performs a bit sequence shift through an array of bits.



The operation of the function depends on the previous value of the parameter EN:

R Current Execution	EN Previous Execution	EN Current Execution	Bit Sequencer Execution
OFF	OFF	OFF	Bit sequencer does not execute.
OFF	OFF	ON	Bit sequencer increments/decrements by 1.
OFF	ON	OFF	Bit sequencer does not execute.
OFF	ON	ON	Bit sequencer does not execute.
ON	ON/OFF	ON/OFF	Bit sequencer resets.

The reset input (R) overrides the enable (EN) and always resets the sequencer. When R is active, the current step number is set to the value passed in via the step number parameter. If no step number is passed in, step is set to 1. All of the bits in the sequencer are set to 0, except for the bit pointed to by the current step, which is set to 1.

When Enable is active and Reset is not active, the bit pointed to by the current step number is cleared. The current step number is incremented or decremented, based on the direction parameter. Then, the bit pointed to by the new step number is set to 1.

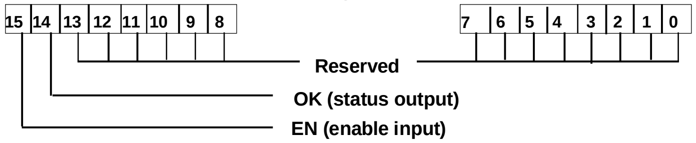
The parameter ST is optional. If it is not used, the Bit Seqencer function operates as described above, except that no bits are set or cleared. The function just cycles the current step number through its legal range.

Memory Required for a Bit Sequencer

Each bit sequencer uses three words (registers) of %R memory to store the information:

word 1	current step number
word 2	length of sequence (in bits)
word 3	control word

Word 3 (the control word) stores the state of the boolean inputs and outputs of its associated function block, in the following format:



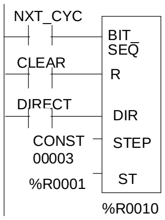
Parameters for the Bit Sequencer Function

Input/ Output	Choices	Description
address	R	Address is the location of the bit sequencer's current step, length, and the last enable and OK status.
enable	flow	When the function is enabled, if it was not enabled on the previous sweep and if R is not energized, the bit sequence shift is performed.
R	flow	When R is energized, the bit sequencer's step number is set to the value in STEP (default = 1), and the bit sequencer is filled with zeros, except for the current step number bit.
DIR	flow	When DIR is energized, the bit sequencer's step number is incremented prior to the shift. Otherwise, it is decremented.
STEP	I, Q, M, T, G, R, AI, AQ, constant, none	When R is energized, the step number is set to this value.
ST	I, Q, M, T, SA, SB, SC, G, R, AI, AQ, none	ST contains the first word of the bit sequencer. Optional.
ok	flow, none	The OK output is energized whenever the function is enabled.

Example

In the example, the Bit Sequencer operates on register memory %R0001. Its static data is stored in registers %R0010–12. When CLEAR is active, the sequencer is reset and the current step is set to step number 3. The first 8 bits of %R0001 are set to zero.

When NXT_SEQ is active and CLEAR is not active, the bit for step number 3 is cleared and the bit for step number 2 or 4 (depending on whether DIR is energized) is set.



Control Functions

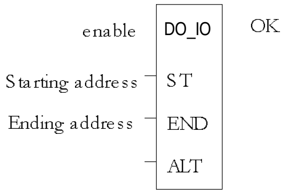
This section describes the control functions, which may be used to limit program execution and to change the way the CPU executes the application program.

- Service specified I/O: DO IO
- Go to a subroutine block: CALL
- Temporary program end: END
- Execute a group of logic rungs without power flow: MCR
- Go to a specified location in the program: JUMP, LABEL
- Place a text explanation in the program logic: COMMENT
- Provide predefined On/Off patterns to a set of 16 discrete outputs in the manner of a mechanical DRUM SEQUENCER.

The more complex Control Functions; Service Request and the PID algorithms, are described in other chapters of this manual.

Control Functions
Do I/O

The Do I/O function updates inputs or outputs for one scan while the program is running. The Do I/O function can also be used to update selected I/O during the program in addition to the normal I/O scan. I/O is serviced in increments of entire I/O modules; the PLC adjusts the references, if necessary, while the function executes.



Execution of the function continues until all inputs in the selected range have reported or all outputs have been serviced on the I/O modules. Program execution then returns to the next function.

If the range of references includes an option module, all the input data (%I and %AI) or all the output data (%Q and %AQ) for that module will be scanned. The ALT parameter is ignored while scanning intelligent I/O modules or the Ethernet interface.

The function passes power to the right whenever power is received, unless:

- Not all references of the type specified are present within the selected range.
- The CPU is not able to properly handle the temporary list of I/O created by the function.
- The range specified includes modules that are associated with a “Loss of I/O" fault.

Parameters of the Do I/O Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, a limited input or output scan is performed.
ST	I, Q, AI, AQ	The starting address of the I/O to be serviced.
END	I, Q, AI, AQ	The ending address of the I/O to be serviced.
ALT	I, Q, M, T, G, R, AI, AQ, constant, none	For the input scan, ALT specifies the address to store scanned input point/word values. For the output scan, ALT specifies the address to get output point/word values from to send to the I/O modules.
ok	flow, none	OK is energized when the scan completes normally.

Do I/O for Inputs

If input references are specified, when the function receives power flow, the PLC scans input points from the starting reference (ST) to the END reference. If a reference is specified for ALT, copies of the new input values are placed in memory beginning at that reference, and the real input values are not updated. ALT must be the same size as the reference type scanned. If a discrete reference is used for ST and END, ALT must also be discrete. If no reference is specified for ALT, the real input values are updated. This allows inputs to be scanned one or more times during the program execution portion of the CPU sweep.

Example Do I/O for Inputs:

In this example, when the function receives power flow, the PLC scans references %I0001-64 and %Q0001 is turned on. Copies of the scanned inputs are placed in internal memory from %M0001-64. Because a reference is specified for ALT, the real inputs are not updated. This allows the current values of inputs to be compared with their values at the beginning of the scan.

Do I/O for Outputs

If output references are specified, when the function receives power flow, the PLC writes the latest output values from the starting reference (ST) to the END reference to the output modules. If outputs should be written to the output modules from internal memory other than %Q or %AQ, the beginning reference can be specified for ALT.

Example Do I/O For Outputs:

In the next example, when the function receives power flow, the PLC writes values from references %R0001-0004 to analog output channels %AQ001-004 and %Q0001 is turned on. Because a reference is entered for ALT, the values at %AQ001-004 are not written to output modules.

If no reference were specified for ALT, the PLC would write values at references %AQ001-004 to analog output channels.

Control Functions
Do I/O

Do I/O to One Module (Enhanced Do I/O)

The Do I/O function can be used on a single discrete input or discrete output module located in the main PLC. Execution of the function is much faster when just one module is read or written to.

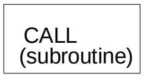
The module to be read/written is specified in the ALT parameter. For example, a constant value of 2 in this parameter indicates to the CPU that it is to execute the Do I/O function block for the module in location 2. The start and end references must be either %I or %Q. These references specify the first and last reference the module is configured for.

Example Do I/O for One Module

In this example, the Do I/O function is executed only to a 16-point input module which is configured at %I0001 through %I0016 in location 2.

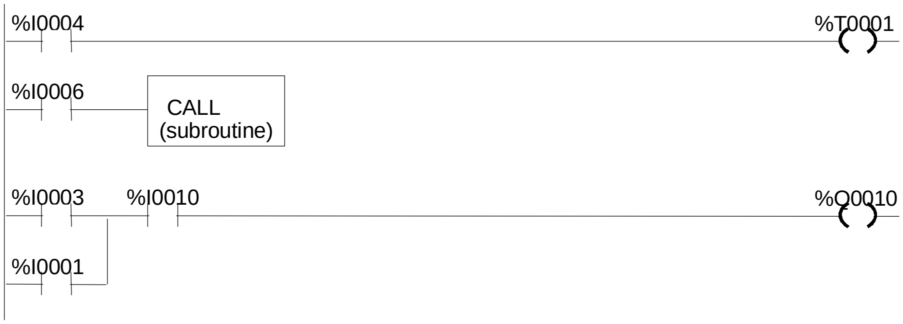
Control Functions
Call

The Call function causes program execution to go to a specified subroutine block.



When the Call function receives power flow, it causes the scan to go immediately to the designated subroutine block and execute it. After the subroutine block execution is complete, control returns to the point in the logic immediately following the Call instruction.

Example



Control Functions
End of Logic

The End of Logic function provides a temporary end of logic. The program executes from the first rung to the last rung or the End of Logic function, whichever is encountered first.

The End of Logic function unconditionally terminates program execution. There can be nothing after the end function in the rung. No logic beyond the End of Logic function is executed, and control is transferred to the beginning of the program for the next sweep.

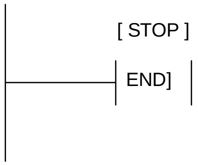
The End of Logic function is useful for debugging purposes because it prevents any logic which follows from being executed.

The programming software provides an [END OF PROGRAM LOGIC] marker to indicate the end of program execution. This marker is used if no End of Logic function is programmed in the logic.

[END]

Example

In the example, an End of Logic function is programmed to terminate the end of the current sweep.



Control Functions
Master Control Relay (MCR) / End MCR

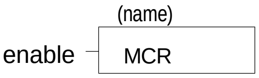
All rungs between an active Master Control Relay (MCRN) and its corresponding End Master Control Relay (ENDMCRN) function are executed without power flow to coils. The ENDMCRN associated with the Master Control Relay is used to resume normal program execution. Unlike Jump functions, Master Control Relays can only move forward; the ENDMCRN must appear after its corresponding Master Control Relay instruction in a program.

Nested MCR

A Nested Master Control Relay function can be nested completely within another MCRN/ENDMCRN pair.

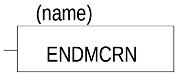
There can be multiple Master Control Relay functions with a single ENDMCRN.

The Master Control Relay function has an enable input and a name. This name is used again with the ENDMCRN. The Master Control Relay has no outputs; there can be nothing after it in a rung.



With a Master Control Relay, function blocks within the scope of the Master Control Relay are executed *without power flow*, and coils *are turned off*.

The ENDMCRN function must be tied to power rail; there can be no logic before it in the rung. The name of the ENDMCRN associates it with the corresponding Master Control Relay(s). The ENDMCRN function has no outputs; there can be nothing after it in a rung.

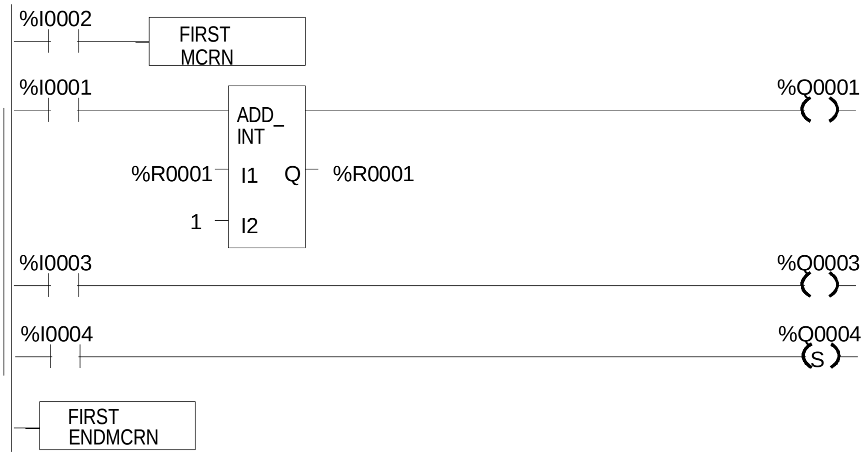


Control Functions
Master Control Relay (MCR) / End MCR

Example Master Control Relay and ENDMCRN Functions

In the example, when %I0002 is ON, the Master Control Relay is enabled. When the Master Control Relay is enabled--even if %I0001 is ON--the Addition function block is executed *without* power flow (i.e., it does not add 1 to %R0001), and %Q0001 is turned OFF.

If %I0003 and %I0004 are ON, %Q0003 is turned OFF and %Q0004 remains ON.



Control Functions
Jump, Label

The Nested Jump instruction causes a portion of the program logic to be bypassed. Program execution continues at the Label specified. When the Jump is active, all coils within its scope are left at their previous states. This includes coils associated with timers, counters, latches, and relays.

The Nested Jump instruction has the form ----->>LABEL01, where LABEL01 is the name of the corresponding nested Label instruction.

A nested Jump can be placed anywhere in a program.

There can be multiple nested Jump instructions corresponding to a single nested Label. Nested Jumps can be either forward or backward Jumps.

There can be nothing after the Jump instruction in the rung. Power flow jumps directly from the instruction to the rung with the named label.

Caution

To avoid creating an endless loop with forward and backward Jump instructions, a backward Jump must contain a way to make it conditional.

Label

The Label instruction is the target of a Jump. Use the Label instruction to resume normal program execution. There can be only one Label with a particular name in a program.

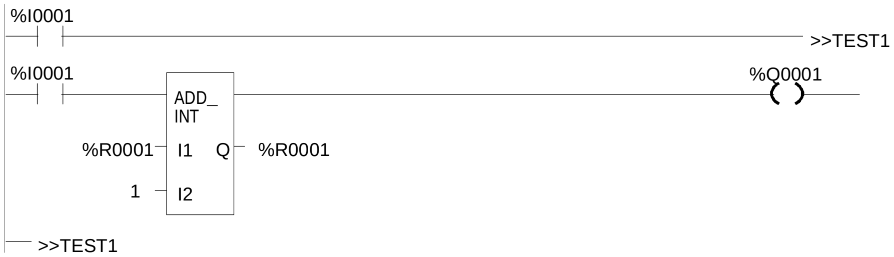
The Label instruction has no inputs and no outputs; there can be nothing either before or after a Label in a rung.

Control Functions
Jump, Label

Example Jump and Label Instructions

In the example, whenever Jump TEST1 is active, power flow is transferred to Label TEST1.

With a Jump, any function blocks between the Jump and the Label *are not* executed, and coils *are not affected*. In the example, when %I0002 is ON, the Jump is taken. Since the logic between the Jump and the Label is skipped, %Q0001 is unaffected (if it was ON, it remains ON; if it was OFF, it remains OFF).



Control Functions
Comment

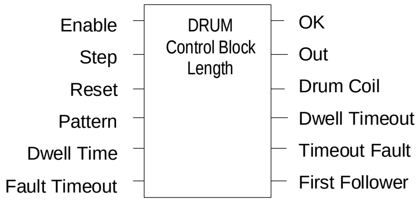
The Comment function is used to enter a comment (rung explanation) in the program. A comment can have up to 2048 characters of text. Longer text can be included in printouts using an annotation text file.

It is represented in the ladder logic like this:

(* COMMENT *)

Control Functions
Drum Sequencer

The Drum Sequencer function is a program instruction that operates like a mechanical drum sequencer. The Drum Sequencer steps through a set of potential output bit patterns and selects one based on inputs to the function block. The selected value is copied to a group of 16 discrete output references.



Power flow to the Enable input causes the Drum Sequencer to copy the content of a selected reference to the Out reference.

Power flow to the Reset input or to the Step input selects the reference to be copied.

The Control Block input is the beginning reference for the Drum Sequencer function's parameter block, which includes information used by the function.

Control Functions
Drum Sequencer

Parameters of the Drum Sequencer Function

Input/ Output	Choices	Description
enable	flow	The Enable input controls execution of the function.
Step	flow	The Step input can be used to go one step forward in the sequence. When the Enable input receives power flow and the Step input makes an Off to On transition, the Drum Sequencer moves one step. When Reset is active, the function ignores the Step input.
Reset	flow	The Reset input can be used to select a specific step in the sequence. When Enable and Reset both receive power flow, the function copies the Preset Step value in the Control Block to the Active Step reference, also in the Control Block. Then the function block copies the value in the Preset Step reference to the Out reference bits. When Reset is active, the function ignores the Step input.
Pattern	R, AI, AQ	The starting address of an array of words, each representing one step of the Drum Sequencer. The value of each word represents the desired combination of outputs for a particular value of Active Step. The number of elements in the array is equal to the length input.
Dwell Time	R, AI, AQ, none	This optional input array of words has one element for each element in the Pattern array. Each value in the array represents the dwell time for the corresponding step of the Drum Sequencer in 0.1 second units. When the dwell time expires for a given step the Dwell Timeout bit is set. If a Dwell Time is specified the drum cannot sequence into its next step until the Dwell Time has expired.
Fault Timeout	R, AI, AQ, none	This optional input array of words has one element for each element in the Pattern array. Each value in the array represents the fault timeout for the corresponding step of the Drum Sequencer in 0.1 second units. When the fault timeout has expired the Fault Timeout bit is set.
Control Block	R	The beginning reference address of the function's parameter block. The length of the Control Block is 5 words. A more complete description of what is contained within this block is listed below.
Length	CONST	Value between 1 and 128 that specifies the number of steps.
ok	flow, none	OK is energized if Enable is On and no error condition is detected. If Enable is Off, this output will always be Off.
OUT	I, Q, M, T, G, R, AI, AQ	A word of memory containing the element of the Pattern Array that corresponds to the current Active Step.
Drum Coil	I, Q, M, T, G, none	This optional bit reference is set whenever the function block is enabled and Active Step is not equal to Preset Step.
Dwell Timeout	I, Q, M, T, G, none	This optional bit reference is set if the dwell time for the current step has expired.
Timeout Fault	I, Q, M, T, G, none	This optional bit reference is set if the drum has been in a particular step longer than the step's specified Fault Timeout.
First Follower	I, Q, M, T, G, none	This optional array of bits has one element for each step of the Drum Sequencer. No more than one bit in the array is On at any time and that bit corresponds to the value of the Active Step

Control Functions
Drum Sequencer

Parameter Block for the Drum Sequencer Function

The parameter block (control block) for the Drum Sequencer function contains information needed to operate the Drum Sequencer.

address	Active Step
address + 1	Preset Step
address + 2	Step Control
address + 3	Timer Control

Active Step The active step value specifies the element in the Pattern array to copy to the Out output memory location. This is used as the array index into the Pattern, Dwell Time, Fault Timeout, and First Follower arrays.

Preset Step A word input that is copied to the Active Step output when the Reset is On.

Step Control A word that is used to detect Off to On transitions on both the Step input and the Enable input. The Step Control word is reserved for use by the function block, and must not be written to.

Timer Control Two words of data that hold values needed to run the timer. These values are reserved for use by the function block and must not be written to.

Notes on Using the Drum Sequencer Function

1. The Dwell Timeout Output bit is cleared the first time the drum is in a new step. This is true:
    - Whether the drum is introduced to a new step by changing the Active Step or by using the Step Input.
    - Regardless of the Dwell Time Array value associated with the step (even if it is 0).
    - During the first sweep the Active Step is initialized.
2. The Active and Preset Step of the Drum Sequencer's control block must be initialized for the Drum Sequencer to work or to pass power flow. Even if the Active Step is in the correct range (between 1 and length of the Pattern array) and the Preset Step is not used, the drum will not function if the Preset Step is not in the proper range.

Data Move Functions

The Data Move functions of the Instruction Set provide basic data move capabilities.

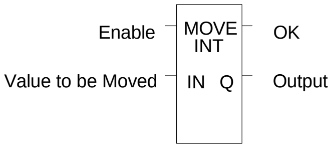
- Move Data. This function copies data as individual bits, so the new location does not have to be the same data type.
- Block Move. This function places constants into seven specified memory locations.
- Block Clear. This function fills an area of memory with zeros.
- Shift Register. This function shifts one or more data words or data bits from a reference location into a specified area of memory. Data already in the area is shifted out.
- Communication Request (COMMREQ). This important function allows the CPU to communicate with intelligent modules in the system, for example, communications modules. The basic format of the COMMREQ function is shown in this chapter. The detailed parameters needed to program specific communications tasks are provided in the documentation for each module.

Data Move Functions

Move Data

The Move function copies data as individual bits from one location to another. Because the data is copied in bit format, the new location does not need to be the same data type as the original.

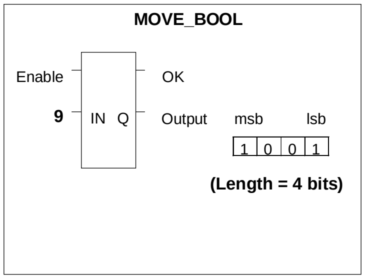
When the Move function receives power flow, it copies data from input parameter IN to output parameter Q as bits. If data is moved from one location in discrete memory to another, (for example, from %I memory to %T memory), the transition information associated with the discrete memory elements is updated to indicate whether or not the Move operation caused any discrete memory elements to change state. Data at the input parameter does not change unless there is an overlap in the source and destination.

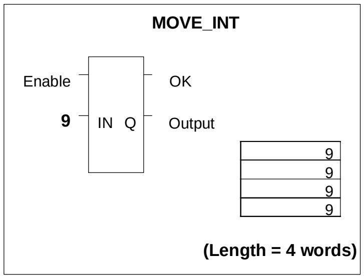


Note that if an array of Bit-type data specified in the Q parameter does not include all the bits in a byte, the transition bits associated with that byte (which are not in the array) are cleared when the Move function receives power flow.

The input IN can be either a reference for the data to be moved or a constant. If a constant is specified, then the constant value is placed in the location specified by the output reference. For example, if a constant value of 4 is specified for IN, then 4 is placed in the memory location specified by Q. If the length is greater than 1 and a constant is specified, then the constant is placed in the memory location specified by Q and the locations following, up to the length specified. Do not allow overlapping of IN and Q parameters.

The result of the Move depends on the data type selected for the function, as shown below. For example, if the constant value 9 is specified for IN and the length is 4, then 9 is placed in the bit memory location specified by Q and the three locations following:





The function passes power to the right whenever power is received.

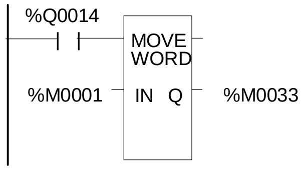
Data Move Functions
Move Data

Parameters for the Move Data Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the move is performed.
Length		The number of bits, words, or double words of data to be copied. This is the length of IN. Length must be from 1 to 256 for all types except BIT. If IN is a constant and Q is type BIT, the length must be between 1 and 16. If IN is type Bit, the length must be between 1 and 256 bits.
IN	I, Q, M, T, G, R, AI, AQ, constant For bit or word data only: S For real data: R, AI, AQ	IN contains the value to be moved. For MOVE_BOOL, any discrete reference may be used; it does not need to be byte aligned. However, 16 bits, beginning with the reference address specified, are displayed online.
ok	flow, none	The OK output is energized whenever the function is enabled.
Q	I, Q, M, T, G, R, AI, AQ, For bit/ word data: SA, SB, SC For real data: R, AI, AQ	When the move is performed, the value at IN is written to Q. For MOVE_BOOL, any discrete reference may be used; it does not need to be byte aligned. However, 16 bits, beginning with the reference address specified, are displayed online.

Example 1

When enabling input %Q0014 is ON, 48 bits are moved from memory location %M0001 to memory location %M0033. (%M0001 and %M0003 are defined as WORD types if length 3.)



Even though the destination overlaps the source for 16 bits, the move is done correctly.

Before using the Move function:

INPUT (%M0001 through %M0048)

%M0016	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
%M0032	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
%M0048	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

After using the Move function:

INPUT (%M0033 through %M0080)

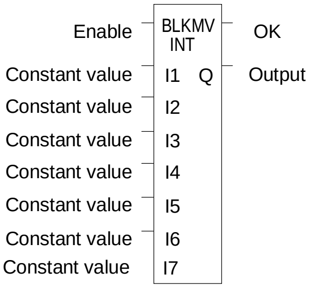
1

%M0048	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
%M0064	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
%M0080	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

33

Data Move Functions
Block Move

The Block Move function copies a block of seven constants to a specified location. When the Block Move function receives power flow, it copies the constant values into consecutive locations beginning at the destination specified in output Q. The function passes power to the right whenever power is received.

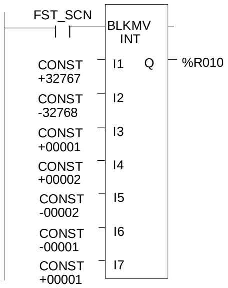


Parameters of the Block Move Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the block move is performed.
I1 to I7	constant	I1 through I7 contain seven constant values.
ok	flow, none	The OK output is energized whenever the function is enabled.
Q	I, Q, M, T, G, R, AI, AQ For Word data: SA, SB, SC For Real data: R, AI, AQ	Output Q contains the first element of the moved array. I1 is moved to Q.

Example

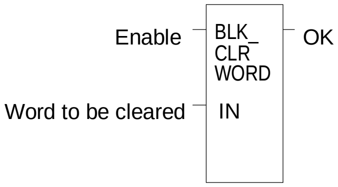
In the example, when the enabling input represented by the nickname FST_SCN is ON, the Block Move function copies the input constants into memory locations %R0010–16.



Data Move Functions
Block Clear

The Block Clear function fills a specified block of data with zeros. When the function receives power flow, it writes zeros into the memory location beginning at the reference specified by IN. When the data to be cleared is from discrete memory (%I, %Q, %M, %G, or %T), the transition information associated with the references is also cleared.

The function passes power to the right whenever power is received.

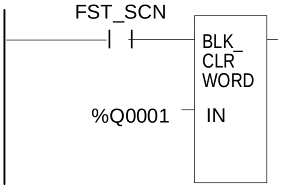


Parameters of the Block Clear Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the array is cleared.
IN	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	IN contains the first word of the array to be cleared. The length of IN must be between 1 and 256 words.
Length		The number of words that will be cleared. This is the length of IN.
ok	flow, none	The OK output is energized whenever the function is enabled.

Example

In the example, at powerup, 32 words of %Q memory (512 points) beginning at %Q0001 are filled with zeros. %Q is defined as WORD of length 32.

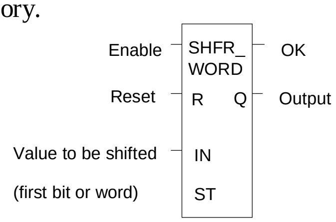


Data Move Functions
Shift Register

The Shift Register function shifts one or more data words or data bits from a reference location into a specified area of memory. For example, one word might be shifted into an area of memory with a specified length of five words. As a result of this shift, another word of data would be shifted out of the end of the memory area.

The reset input (R) takes precedence over the function enable input. When the reset is active, all references beginning at the shift register (ST) up to the length specified for LEN, are filled with zeros.

If the function receives power flow and reset is not active, each bit or word of the shift register is moved to the next highest reference. The last element in the shift register is shifted into Q. The highest reference of the shift register element of IN is shifted into the vacated element starting at ST. The contents of the shift register are accessible throughout the program because they are overlaid on absolute locations in logic addressable memory.



Parameters of the Shift Register Function

Input/ Output	Choices	Description
enable	flow	When enable is energized and R is not, the shift is performed.
Length	1 to 256 bits or words.	The length of the shift register in bits or words. Length is defined as the length of IN.
R	flow	When R is energized, the shift register located at ST is filled with zeros.
IN	I, Q, M, T, S, G, R, AI, AQ, constant	IN contains the value to be shifted into the first bit or word of the shift register. For SHFR_BIT, any discrete reference may be used; it does not need to be byte aligned.
ST	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	ST contains the first bit or word of the shift register. For SHFR_BIT, any discrete reference may be used; it does not need to be byte aligned.
ok	flow, none	OK is energized whenever the function is enabled and R is not enabled.
Q	I, Q, M, T, SA, SB, SC, G, R, AI, AQ	Output Q contains the bit or word shifted out of the shift register. For SHFR_BIT, any discrete reference may be used; it does not need to be byte aligned.

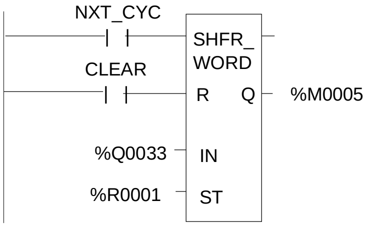
CAUTION: the use of overlapping input and output reference address ranges in multi-word functions is not recommended; it may produce unexpected results.

Data Move Functions
Shift Register

Example 1:

In the example, the shift register operates on register memory locations %R0001 through %R0100. (%R0001 is defined as type Word of length 100). When the reset reference CLEAR is active, the Shift Register words are set to zero.

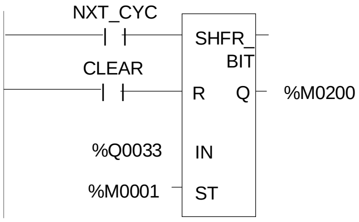
When the NXT_CYC reference is active and CLEAR is not active, the word from output status table location %Q0033 is shifted into the Shift Register at %R0001. The word shifted out of the Shift Register from %R0100 is stored in output %M0005.



Example 2:

In this example, the Shift Register operates on memory locations %M0001 through %M0100. (%M0001 is defined as type Boolean of length 100). When the reset reference CLEAR is active, the Shift Register function fills %M0001 through %M0100 with zeros.

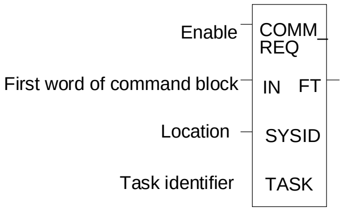
When NXT_CYC is active and CLEAR is not, the Shift Register function shifts the data in %M0001 to %M0100 down by one bit. The bit in %Q0033 is shifted into %M0001 while the bit shifted out of %M0100 is written to %M0200.



Data Move Functions
Communication Request

The Communication Request (COMMREQ) function communicates with an intelligent module. Many types of COMM REQs have been defined. The information below describes only the basic format of the function.

When the function receives power flow, a command block of data is sent to the specified module. After sending the COMMREQ, the program can either suspend execution and wait for a reply for a maximum waiting period specified in the command, or resume immediately.



Parameters of the COMMREQ Function

Input/ Output	Choices	Description
enable	flow	When the function is energized, the communications request is performed.
IN	R, AI, AQ	IN contains the first word of the command block.
SYSID	I, Q, M, T, G, R, AI, AQ, constant	SYSID contains the rack number (most significant byte) and slot number (least significant byte) of the target device.
TASK	R AI, AQ, constant	TASK contains the task ID of the process on the target device.
FT	flow, none	FT is energized if an error is detected processing the COMM REQ: 1. The specified target address is not present (SYSID). 2. The specified task is not valid for the device (TASK). 3. The data length is 0. 4. The device's status pointer address (in the command block) does not exist.

Data Move Functions
Communication Request

Command Block for the COMMREQ Function

The Command Block starts at the reference specified in COMMREQ parameter IN. The length of the Command Block depends on the amount of data sent to the device.

The Command Block contains the data to be communicated to the other device, plus information related to the execution of the COMM REQ. The Command Block has the following structure:

address	Length (in words)
address + 1	Wait/No Wait Flag
address + 2	Status Pointer Memory
address + 3	Status Pointer Offset
address + 4	Idle Timeout Value
address + 5	Maximum Communication Time
address + 6 to address + 133	Data Block

Example

In the example, when enabling input %M0020 is ON, a Command Block starting at %R0016 is sent to communications task 1 in the device located at rack 1, slot 2 of the PLC. If an error occurs processing the COMMREQ, %Q0100 is set.

Data Type Conversion Functions

The Data Type Conversion functions are used to change a data item from one number type to another. Many programming instructions, such as math functions, must be used with data of one type.

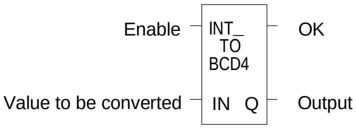
- Convert data to BDC-4
- Convert data to signed integer
- Convert data to double-precision integer
- Convert data to Real
- Convert data to Word
- Round a Real number toward zero (TRUN)

Data Type Conversion Functions
Convert Signed Integer Data to BCD-4

The Convert to BCD-4 function outputs the four-digit BCD equivalent of signed integer data. The original data is not changed by this function.

Data can be converted to BCD format to drive BCD-encoded LED displays or presets to external devices such as high-speed counters.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to 9999.



Parameters of the Convert to BCD-4 Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	I, Q, M, T, G, R, AI, AQ, constant	IN contains a reference for the integer value to be converted to BCD-4.
OK	flow, none	The OK output is energized when the function is performed without error.
Q	I, Q, M, T, G, R, AI, AQ	Output Q contains the BCD-4 form of the original value in IN.

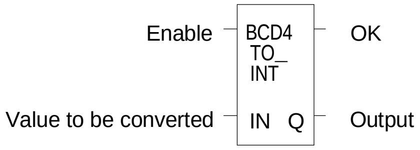
Example

In the example, whenever input %I0002 is set and no errors exist, the integer at input location %I0017 through %I0032 is converted to four BCD digits, and the result is stored in memory locations %Q0033 through %Q0048. Coil %Q1432 is used to check for successful conversion.

Data Type Conversion Functions
Convert to Signed Integer

The Convert to Signed Integer function outputs the integer equivalent of BCD-4 or Real data. The original data is not changed by this function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function always passes power flow when power is received, unless the data is out of range.

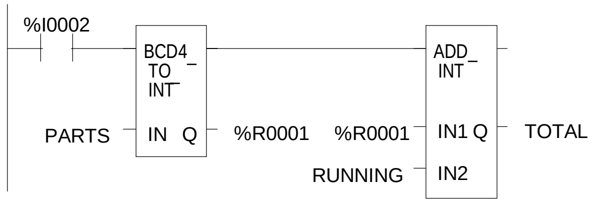


Parameters of the Convert to Signed Integer Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	For BCD-4: I, Q, M, T, G, R, AI, AQ, constant For REAL: R, AI, AQ	IN contains a reference for the BCD-4, REAL, or Constant value to be converted to integer.
ok	flow, none	The OK output is energized whenever enable is energized, unless the data is out of range or NaN (Not a Number).
Q	I, Q, M, T, G, R, AI, AQ	Output Q contains the integer form of the original value in IN.

Example

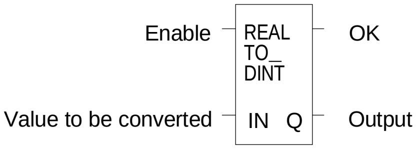
In the example, whenever input %I0002 is set, the BCD-4 value in PARTS is converted to a signed integer and passed to the Addition function, where it is added to the signed integer value represented by the reference RUNNING. The sum is output by the Addition function to the reference TOTAL.



Data Type Conversion Functions
Convert to Double Precision Signed Integer

The Convert to Double Precision Signed Integer function outputs the double precision signed integer equivalent of real data. The original data is not changed by this function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function always passes power flow when power is received, unless the real value is out of range.



Note that loss of precision can occur when converting from Real-type data to Double-Precision Integer, because Real data has 24 significant bits.

Parameters of the Convert to Double Precision Signed Integer Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	I, Q, M, T, G, R, AI, AQ, constant	Constant or reference for the value to be converted
ok	flow, none	OK is energized whenever enable is energized, unless the real value is out of range.
Q	R, AI, AQ	Reference that contains the double precision signed integer form of the original value.

Example

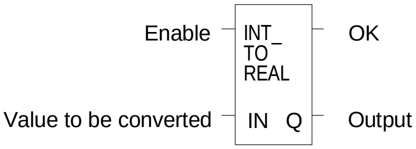
In the example, whenever input %I0002 is set, the integer value at input location %I0017 is converted to a double precision signed integer and the result is placed in location %R0001. The output %Q1001 is set whenever the function executes successfully.

Data Type Conversion Functions
Convert to Real Data

The Convert to Real function outputs the real value equivalent of the input data. The original data is not changed by this function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is out of range.

Note that loss of precision can occur when converting from Double-Precision Integer to Real data, because since the number of significant bits is reduced to 24.

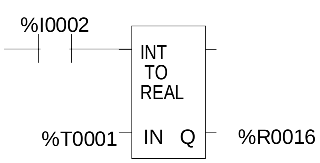


Parameters of the Convert to Real Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	R, AI, AQ, constant For INT only: I, Q, M, T, G	IN contains a reference for the integer value to be converted to Real.
ok	flow, none	OK is energized when the function is performed without error.
Q	R, AI, AQ	The Real form of the original value in IN.

Example

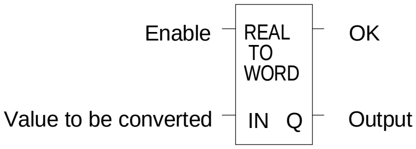
In the example, the integer value of input IN is 678. The result value placed in %T0016 is 678.000.



Data Type Conversion Functions
Convert Real Data to Word Data

The Convert to Word function outputs the Word equivalent of Real data. The original data is not changed by this function.

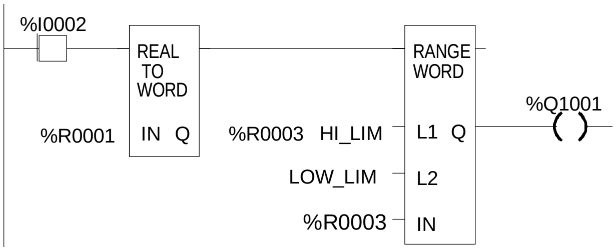
When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to FFFFh.



Parameters of the Convert to Word Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	R, AI, AQ, constant	IN contains a reference for the value to be converted to Word type.
ok	flow, none	OK is energized when the function is performed without error.
Q	I, Q, M, T, G, R, AI, AQ	Contains the word form of the original value in IN.

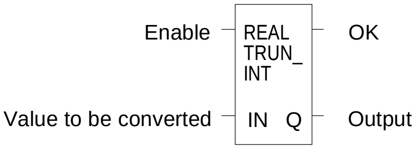
Example



Data Type Conversion Functions
Truncate Real Number

The Truncate function copies a Real number and rounds the copied number down to an integer or double precision integer. The original data is not changed by this function.

When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is out of range or unless IN is not a number.

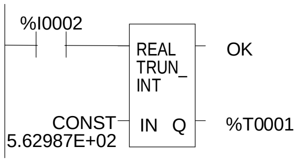


Parameters of the Truncate Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the conversion is performed.
IN	R, AI, AQ, constant	IN contains a reference for the real value to be truncated.
ok	flow, none	The OK output is energized when the function is performed without error, unless the value is out of range or IN is NaN.
Q	R, AI, AQ For integer only: I, Q, M, T, G	Q contains the truncated INT or DINT value of the original value in IN.

Example

In the example, the displayed constant is truncated and the integer result 562 is placed in %T0001.



Math and Numerical Functions

This section describes the Math and Numerical functions of the Instruction Set:

- Standard Math Functions: Addition, Subtraction, Multiplication, Division
- Modulo Division
- Scaling Function
- Square Root
- Trigonometric functions
- Logarithmic/Expontial functions
- Convert to Degrees
- Convert to Radians

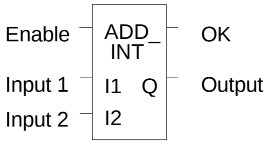
Converting Data for the Math and Numerical Functions

The program may need to include logic to convert data to a different type before using a Math or Numerical function. The description of each function includes information about appropriate data types. The section *Data Type Conversion Functions* explains how to convert data to a different type.

Math and Numerical Functions Add, Subtract, Multiply, Divide

The standard math functions are Addition, Subtraction, Multiplication, and Division. The Division function rounds down; it does not round to the closest integer. (For example, 24 DIV 5 = 4.)

When a math function receives power flow, the operation is performed on input parameters I1 and I2. Parameters I1, I2, and output Q must be the same data type.



The math functions pass power if there is no math overflow. If an overflow occurs, the result is the largest value with the proper sign and no power flow.

Parameters of the Standard Math Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
I1	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	I1 contains a constant or reference for the first value used in the operation. (I1 is on the left side of the mathematical expression, as in I1 + I2). Range for constants in double-precision signed integer operations is minimum/maximum DINT.
I2	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	I2 contains a constant or reference for the second value used in the operation. (I2 is on the right side of the mathematical expression, as in I1 + I2). Range for constants in double-precision signed integer operations is minimum/maximum DINT.
ok	flow, none	The OK output is energized when the function is performed without overflow, unless an invalid operation occurs.
Q	All data types: R, AI, AQ INT only: I, Q, M, T, G	Output Q contains the result of the operation.

Data Types for Standard Math Functions

Standard math functions operate on these types of data:

INT	Signed integer
DINT	Double precision signed integer
REAL	Floating Point

The input and output parameter data types must be the same (16 bits or 32 bits).

Math and Numerical Functions
Add, Subtract, Multiply, Divide

Avoiding Overflows

Be careful to avoid overflows when using Multiplication and Division functions.

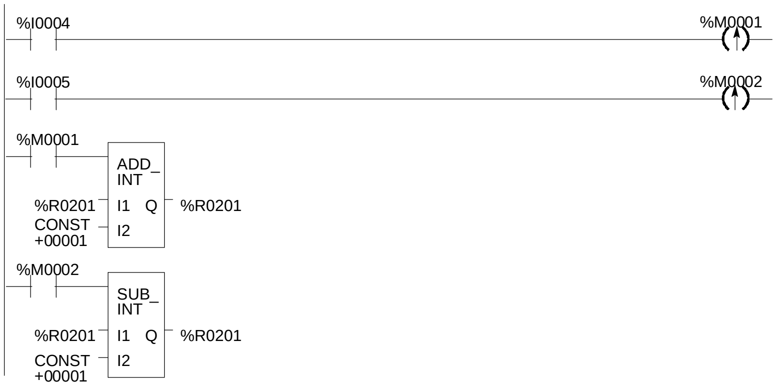
If you have to convert Integer to Double-Precision Integer values, remember that the CPU uses standard 2's complement with the sign extended to the highest bit of the second word. You must check the sign of the low 16-bit word and extend it into the second 16 bit word. If the most significant bit in a 16-bit INT word is 0 (positive), move a 0 to the second word. If the most significant bit in a 16-bit word is –1 (negative), move a –1 or hex 0FFFFh to the second word.

Converting from Double-Precision Integer to Integer data is easier, because the low 16-bit word (first register) is the integer portion of a Double-Precision Integer 32-bit word. The upper 16 bits or second word should be either a 0 (positive) or –1 (negative) value or the Double-Precision Integer number will be too big to convert to 16 bits.

Example

This example uses the Addition and Subtraction functions to keep track of the number of parts in a temporary storage area. Each time a part enters the storage area, power flows through relay %I0004 to a positive transition coil with reference %M0001. Relay %M0001 then enables the Addition function, adding the (constant) value 1 to the current total value in %R0201.

Each time a part leaves the storage area, power flows through relay %I0005 to a positive transition coil with reference %M0002. Relay %M0002 then enables the Subtraction function, subtracting the (constant) value 1 from the current total value in %R0201.



Math and Numerical Functions
Modulo Division

The Modulo Division function divides one value by another of the same data type, to obtain the remainder. The sign of the result is always the same as the sign of input parameter I1. The Modulo function operates on these types of data:

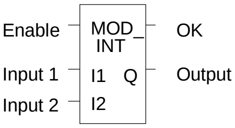
INT	Signed integer
DINT	Double precision signed integer

When the function receives power flow, it divides input I1 by input I2. These parameters must be the same data type. Output Q is calculated using the formula:

Q = I1-((I1 DIV I2) * I2)

The division produces an integer. Q is the same data type as inputs I1 and I2.

OK is always ON when the function receives power flow, unless there is an attempt to divide by zero. In that case, it is set OFF.

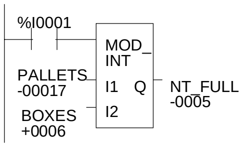


Parameters of the Modulo Division Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
I1	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	I1 contains a constant or reference for the value to be divided by I2. Range for constants in double precision signed integer operations is minimum/maximum DINT.
I2	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	I2 contains a constant or reference for the value to be divided into I1. Range for constants in double precision signed integer operations is minimum/maximum DINT.
ok	flow, none	The OK output is energized when the function is performed without overflow.
Q	All data types: R, AI, AQ INT data type only: I, Q, M, T, G	Output Q contains the result of dividing I1 by I2 to obtain a remainder.

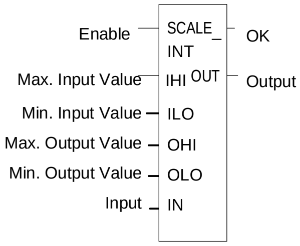
Example

In the example, the remainder of the integer division of BOXES into PALLETS is placed into NT_FULL whenever %I0001 is ON.



Math and Numerical Functions
Scaling

The Scaling function scales an input parameter and places the result in an output location. For integer-type data, all parameters must be integer-based (signed). For word-type data, all parameters must be word-based (unsigned).

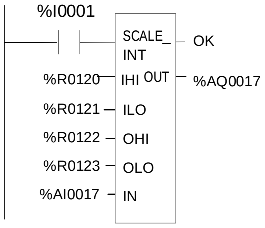


Parameters of the Scaling Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IHI ILO	R ,AI, AQ, constant	IHI and ILO contain a constant or reference for the upper and lower limits of the unscaled data. These limits, together with the values for OHI and OLO, are used to calculate the scaling factor that will be applied to the input value IN.
OHI OLO	R ,AI, AQ, constant	OHI and OLO contain a constant or reference for the upper and lower limits of the scaled data.
IN	R, AI, AQ, constant	IN contains a constant or reference for the actual value to be scaled.
ok	flow, none	The OK output is energized when the function is performed without overflow.
OUT	R, AI, AQ	Output OUTcontains the scaled equivalent of the input value.

Example

In the example, the registers %R0120 through %R0123 are used to store the high and low scaling values. The input value to be scaled is analog input %AI0017. The scaled output data is used to control analog output %AQ0017. The scaling is performed whenever %I0001 is ON.



Math and Numerical Functions
Square Root

The Square Root function finds the square root of a value. When the function receives power flow, the value of output Q is set to the integer portion of the square root of the input IN. The output Q must be the same data type as IN.

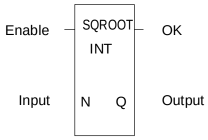
The Square Root function operates on these types of data:

INT	Signed integer
DINT	Double precision signed integer
REAL	Floating Point

OK is set ON if the function is performed without overflow, unless one of these invalid REAL operations occurs:

- IN < 0
- IN is NaN (Not a Number)

Otherwise, OK is set OFF.

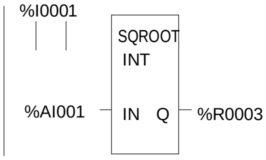


Parameters of the Square Root Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN	All data types: R, AI, AQ, constant INT data type only: I, Q, M, T, G	A constant or reference for the value whose square root is to be calculated. If IN is less than zero, the function will not pass power flow. Range for constants is minimum/maximum DINT for double-precision signed integer operations.
ok	flow, none	The OK output is energized when the function is performed without overflow, unless an invalid operation occurs.
Q	All data types: R, AI, AQ INT data type only: I, Q, M, T, G	Output Q contains the square root of IN.

Example

In the example, the square root of the integer number located at %AI001 is placed into the result located at %R0003 whenever %I0001 is ON.

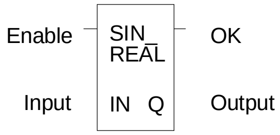


Math and Numerical Functions
Trigonometric Functions

There are six Trigonometric functions: Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent.

Sine, Cosine, and Tangent

When a Sine, Cosine, or Tangent function receives power flow, it operates on IN, whose units are radians, and stores the result in output Q. Both IN and Q are floating-point values.



The Sine, Cosine, and Tangent functions accept a broad range of input values, where

$$-2^{63} < IN < +2^{63}, (2^{63} = 9.22x10^{18})$$

Inverse Sine, Cosine, and Tangent

When an Inverse Sine, Cosine, or Tangent function receives power flow, it operates on IN and stores the result in output Q, whose units are radians. Both IN and Q are floating-point values.

The Inverse Sine and Cosine functions accept a narrow range of input values, where

$$-1 \le IN \le 1.$$

Given a valid value for the IN parameter, the Inverse Sine Real function produces a result Q such that:

$$ASIN (IN) = \frac{\pi}{2} \le Q \le \frac{\pi}{2}$$

The Inverse Cosine Real function produces a result Q such that:

$$ACOS (IN) = 0 \le Q \le \pi$$

The Inverse Tangent function accepts the broadest range of input values, where

$$-\infty \le IN \le +\infty.$$

Given a valid value for the IN parameter, the Inverse Tangent Real function produces a result Q such that:

$$ATAN (IN) = \frac{\pi}{2} \le Q \le \frac{\pi}{2}$$

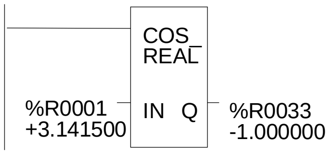
Math and Numerical Functions
Trigonometric Functions

Parameters of the Trigonometric Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN	R, AI, AQ, constant	IN contains the constant or reference real value to be operated on.
ok	flow, none	OK is energized when the function is performed without overflow, unless an invalid operation occurs and/or IN is NaN.
Q	R, AI, AQ	Output Q contains the trigonometric value of IN.

Example

In the example, the Cosine of the value in %R0001 is placed in %R0033.

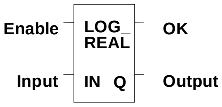


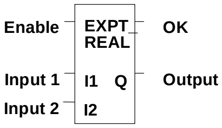
Math and Numerical Functions
Logarithmic / Exponential Functions

When a Logarithmic or Exponential function receives power flow, it performs the appropriate logarithmic/exponential operation on the Real value in input IN and places the result in output Q.

- For the Base 10 Logarithm (LOG) function, the base 10 logarithm of IN is placed in Q.
- For the Natural Logarithm (LN) function, the natural logarithm of IN is placed in Q.
- For the Power of E (EXP) function, ***e*** is raised to the power specified by IN and the result is placed in Q.
- For the Power of X (EXPT) function, the value of input I1 is raised to the power specified by the value I2 and the result is placed in output Q. (The EXPT function has three input parameters and two output parameters.)

The OK output receives power flow unless the input is NaN (Not a Number) or is negative.



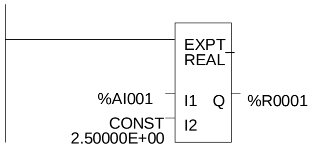


Parameters of the Logarithmic/Exponential Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN or I1, I2	R, AI, AQ, constant	For EXP, LOG, and LN, IN contains the real value to be operated on. The EXPT function has two inputs, I1 and I2. For EXPT, I1 is the base value and I2 is the exponent.
ok	flow, none	OK is energized when the function is performed without overflow, unless an invalid operation occurs and/or IN is NaN or is negative.
Q	R, AI, AQ	Output Q contains the logarithmic/exponential value of IN.

Example of the EXPT Function

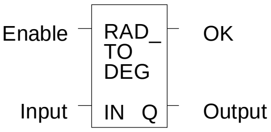
In the example, the value of %AI001 is raised to the power of 2.5 and the result is placed in %R0001.



Math and Numerical Functions
Radian Conversion Functions

When Degree/Radian Conversion function receives power flow, the appropriate conversion (radians to degrees or degrees to radians) is performed on the Real value in input IN and the result is placed in output Q.

The OK output will receive power flow unless IN is NaN (Not a Number).

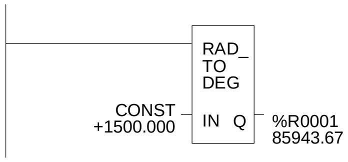


Parameters of the Radian Conversion Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN	R, AI, AQ, constant	IN contains the real value to be operated on.
ok	flow, none	The OK output is energized when the function is performed without overflow, unless IN is NaN.
Q	R, AI, AQ	Output Q contains the converted value of IN.

Example

In the example, +1500 is converted to DEG and is placed in %R0001.

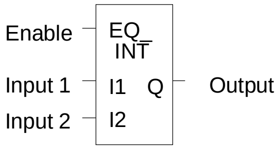


Relational Functions

The Relational functions can be used to compare two numbers and to determine whether a number lies within a specified range.

Equal	Test two numbers for equality
Not Equal	Test two numbers for non-equality
Greater Than	Test whether one number is greater than another
Greater Than or Equal	Test whether one number is greater than or equal to another
Less Than	Test whether one number is less than another
Less Than or Equal	Test whether one number is less than or equal to another
Range	Tests whether one number lies between two other numbers

When the function receives power flow, it compares input IN1 to input IN2. These parameters must be the same data type.



If inputs IN1 and IN2 match the specified relational condition, output Q receives power flow and is set ON (1); otherwise, it is set OFF (0).

Data Types for Relational Functions

Relational functions operate on these types of data:

INT	Signed integer
DINT	Double precision signed integer
REAL	Floating Point

The %S0020 bit is set ON when a relational function using Real data executes successfully. It is cleared when either input is NaN (Not a Number).

Relational Functions
Equal, Not Equal, Less Than, Less/Equal, Greater Than, Greater/Equal

Parameters for the Relational Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
IN1	R, AI, AQ, constant For INT data only: I, Q, M, T, G	IN1 contains a constant or reference for the first value to be compared. IN1 must be a valid number. Constants must be integers for double precision signed integer operations. IN1 is on the left side of the relational equation, as in IN1 < IN2.
IN2	R, AI, AQ, constant For INT data only: I, Q, M, T, G	IN2 contains a constant or reference for the second value to be compared. IN2 must be a valid number. Constants must be integers for double precision signed integer operations. IN2 is on the right side of the relational equation, as in IN1 < IN2.
Q	flow, none	Output Q is energized when IN1 and IN2 match the specified relation.

Example

In the example, two double precision signed integers are tested for equality. When the relay %I0001 passes power flow to the LE (Less or Equal) function, the value presently in the reference nicknamed PWR_MDE is compared to the value presently in the reference BIN_FUL. If the value in PWR_MDE is less than or equal to the value in BIN_FUL, coil %Q0002 is turned on.

Relational Functions
Range

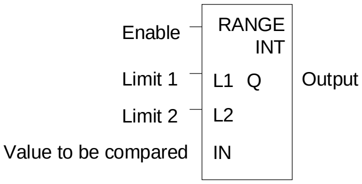
The Range function determines if a value is within the range of two numbers.

Data Types for the Range Function

The Range function operates on these types of data:

INT	Signed integer (default).
DINT	Double precision signed integer.
WORD	Word data type.

When the Range function is enabled, it compares the value of input IN against the range specified by limits L1 and L2. Either L1 or L2 can be the high or low limit. When the value is within the range specified by L1 and L2, inclusive, output parameter Q is set ON (1). Otherwise, Q is set OFF (0).



Parameters for the Range Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
L1	R, AI, AQ, constant INT and WORD only: I, Q, M, T, G	L1 contains the start point of the range. Constants must be integer values for double precision signed integer operations.
L2	R, AI, AQ, constant INT and WORD only: I, Q, M, T, G	L2 contains the end point of the range. Constants must be integer values for double precision signed integer operations.
IN	R, AI, AQ INT and WORD only: I, Q, M, T, G	IN contains the value to be compared against the range specified by L1 and L2.
Q	flow, none	Output Q is energized when the value in IN is within the range specified by L1 and L2, inclusive.

Relational Functions
Range

Example

In this example, when the Range function receives power flow from relay %I0001, the function determines whether the value in %AI001 is within the range 0 to 100.

%R0001 contains the value 100. %R2 contains the value 0.

Output coil %Q0001 is On only if the value presently in %AI0001 is within the range 0 to 100.

IN Value %AI001	Q State %Q0001
< 0	OFF
0 — 100	ON
> 100	OFF

Relay Functions

- Normally Open Contact –| |–
- Normally Closed Contact –|/|–
- Normally Open Coil –( )–
- Retentive SET Coil –(SM)–
- Retentive RESET Coil –(RM)–
- Negated Retentive Coil –(/M)–
- Negated Coil –(/)–
- Retentive Coil –(M)–
- SET Coil –(S)–
- RESET Coil –(R)–
- Positive Transition Coil –(↑)–
- Negative Transition Coil –(↓)–
- Vertical Link vert |
- Horizontal Link horz –
- Continuation Coil ——<+>
- Continuation Contact <+>——

Each relay contact and coil has one input and one output. Together, they provide logic flow through the contact or coil.

Input→ —–| |—– ← *Output*

Relay Functions
Normally-open, Normally-closed, Continuation Contacts

A contact is used to monitor the state of a reference. Whether the contact passes power flow depends on the state or status of the reference being monitored and on the contact type. A reference is ON if its state is 1; it is OFF if its state is 0.

Type of Contact	Display	Contact Passes Power to Right:
Normally Open	-| |-	When reference is ON.
Normally Closed	-|/|-	When reference is OFF.
Continuation Contact	<+>---	If the preceding continuation coil is set ON.

Normally Open Contact -| |-

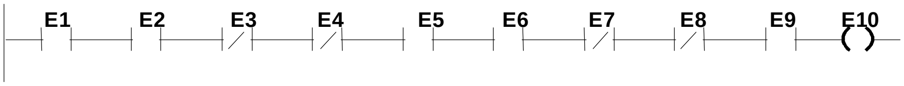
A normally open contact acts as a switch that passes power flow if the associated reference is ON (1).

Normally Closed Contact -|/|-

A normally closed contact acts as a switch that passes power flow if the associated reference is OFF (0).

Example

The example shows a rung with 10 elements having nicknames from E1 to E10. Coil E10 is ON when reference E1, E2, E5, E6, and E9 are ON and references E3, E4, E7, and E8 are OFF.



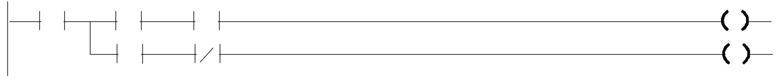
Continuation Coils and Contacts

Continuation coils and continuation contacts are used to continue relay ladder rung logic beyond the last column. The state of the last executed continuation coil is the flow state used on the next executed continuation contact. If the flow of logic does not execute a continuation coil before it executes a continuation contact, the state of the contact is no flow. There can be only one continuation coil and contact per rung; the continuation contact must be in column 1, and the continuation coil must be in the last column.

Relay Functions

Coils

Coils are used to control discrete references. Conditional logic must be used to control the flow of power to a coil. Coils cause action directly; they do not pass power flow to the right. If additional logic in the program should be executed as a result of the coil condition, an internal reference for the coil, or a continuation coil/contact combination may be used. Coils are always located at the rightmost position of a line of logic:



References and Coil Checking

When the level of coil checking is set to “single”, you can use a specific %M or %Q reference with only one Coil, but you can use it with one Set Coil and one Reset Coil simultaneously. When the level of coil checking is “warn multiple” or “multiple”, each reference can be used with multiple Coils, Set Coils, and Reset Coils. With multiple usage, a reference could be turned On by either a Set Coil or a normal Coil and could be turned Off by a Reset Coil or by a normal Coil.

Power Flow and Retentiveness

The following table summarizes how power flow to different types of coils affects their reference. The states of retentive coils are saved when power is cycled or when the PLC goes from Stop to Run mode. The states of non-retentive coils are set to zero when power is cycled or the PLC goes from Stop to Run mode.

Type of Coil	Symbol	Power to Coil	Result
Normally Open	-( )-	ON OFF	Sets reference ON, non-retentive. Sets reference OFF, non-retentive.
Negated	-(/)-	ON OFF	Sets reference OFF, non-retentive. Sets reference ON, non-retentive.
Retentive	-(M)-	ON OFF	Sets reference ON, retentive. Sets reference OFF, retentive.
Negated Retentive	-(/M)-	ON OFF	Sets reference OFF, retentive. Sets reference ON, retentive.
Positive Transition	-(P)-	OFF→ON	If power flow into the coil was OFF the previous sweep and is ON this sweep, sets the coil ON.
Negative Transition	-(N)-	ON→OFF	If power flow into the coil was ON the previous sweep and is OFF this sweep, sets the coil ON.
SET	-(S)-	ON OFF	Sets reference ON until reset OFF by (R), non-retentive. Does not change the coil state, non-retentive.
RESET	-(R)-	ON OFF	Sets reference OFF until set ON by (S), non-retentive. Does not change the coil state, non-retentive.
Retentive SET	-(SM)-	ON OFF	Sets reference ON until reset OFF by (RM), retentive. Does not change the coil state.
Retentive RESET	-(RM)-	ON OFF	Sets reference OFF until set ON by (SM)-, retentive. Does not change the coil state.
Continuation Coil	----<+>	ON OFF	Sets next continuation contact ON. Sets next continuation contact OFF.

Relay Functions
Coils

A coil sets a discrete reference ON while it receives power flow. It is non-retentive; therefore, it cannot be used with system status references (%SA, %SB, %SC, or %G).

Example

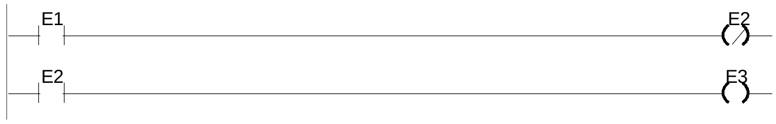
In the example, coil E3 is ON when reference E1 is ON and reference E2 is OFF.

Negated Coil

A negated coil sets a discrete reference ON when it does not receive power flow. It is not retentive, so it cannot be used with system status references (%SA, %SB, %SC, or %G).

Example

In the example, coil E3 is ON when reference E1 is OFF.



Retentive Coil

Like a normally open coil, the retentive coil sets a discrete reference ON while it receives power flow. The state of the retentive coil is retained across power failure. Therefore, it cannot be used with references from strictly non-retentive memory (%T).

Negated Retentive Coil

The negated retentive coil sets a discrete reference ON when it does not receive power flow. The state of the negated retentive coil is retained across power failure. Therefore, it cannot be used with references from strictly non-retentive memory (%T).

Positive Transition Coil

If the reference associated with a positive transition coil was OFF , when the coil receives power flow it is set to ON until the next time the coil is executed. (If the rung containing the coil is skipped on subsequent sweeps, it will remain ON.) This coil can be used as a one-shot.

Do not write from external devices (e.g., PCM, programmer, ADS, etc.) to references used on positive transition coils since it will destroy the one-shot nature of these coils.

Transitional coils can be used with references from either retentive or non-retentive memory (%Q, %M, %T, %G, %SA, %SB, or %SC).

Negative Transition Coil

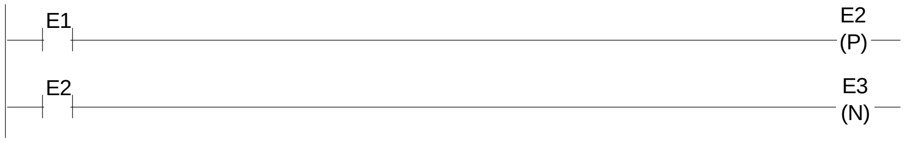
If the reference associated with this coil is OFF, when the coil stops receiving power flow the reference is set to ON until the next time the coil is executed.

Do not write from external devices to references used on negative transition coils since it will destroy the one-shot nature of these coils.

Transitional coils can be used with references from either retentive or non-retentive memory (%Q, %M, %T, %G, %SA, %SB, or %SC).

Example

In the example, when reference E1 goes from OFF to ON, coils E2 and E3 receive power flow, turning E2 ON for one logic sweep. When E2 goes from ON to OFF, power flow is removed from E2 and E3, turning coil E3 ON for one sweep.



Relay Functions
Coils

SET Coil

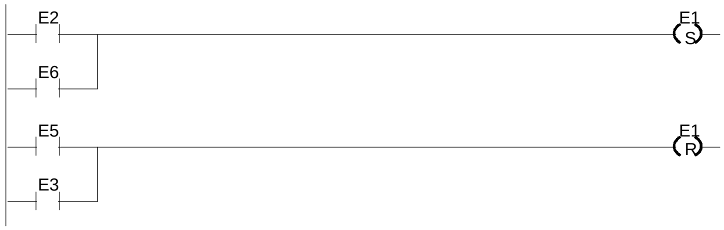
SET and RESET are non-retentive coils that can be used to keep ("latch") the state of a reference either ON or OFF. When a SET coil receives power flow, its reference stays ON (whether or not the coil itself receives power flow) until the reference is reset by another coil.

RESET Coil

The RESET coil sets a discrete reference OFF if the coil receives power flow. The reference remains OFF until the reference is set by another coil. The last-solved SET coil or RESET coil of a pair takes precedence.

Example

In the example, the coil represented by E1 is turned ON whenever reference E2 or E6 is ON. The coil represented by E1 is turned OFF whenever reference E5 or E3 is ON.



Retentive SET Coil

Retentive SET and RESET coils are similar to SET and RESET coils, but they are retained across power failure or when the PLC transitions from to Run mode. A retentive SET coil sets a discrete reference ON if the coil receives power flow. The reference remains ON until reset by a retentive RESET coil.

Retentive RESET Coil

This coil sets a discrete reference OFF if it receives power flow. The reference remains OFF until set by a retentive SET coil. The state of this coil is retained across power failure or when the PLC transitions from Stop to Run mode.

Table Functions

The Table functions are used to:

- Copy array data: ARRAY MOVE
- Search for values in an array

The maximum length allowed for these functions is 32,767 for any type.

Data Types for the Table Functions

Table functions operate on these types of data:

INT	Signed integer
DINT	Double precision signed integer
BOOL *	Bit data type
BYTE	Byte data type
WORD	Word data type

* Applies to Array Move only.

Table Functions
Array Move

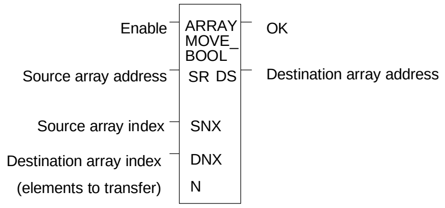
The Array Move function copies a specified number of elements from a source array to a destination array. When the function receives power flow, it copies the number of elements specified from the input array, starting at the indexed location. The function then writes the copied elements to the output array starting with the indexed location.

For bit data, when word-oriented memory is selected for the parameters of the source array and/or destination array starting address, the least significant bit of the specified word is the first bit of the array.

The indices in an Array Move instruction are 1-based. In using an Array Move, no element outside either the source or destination arrays (as specified by their starting address and length) may be referenced.

The OK output receives power flow unless one of the following occurs:

- Enable is OFF.
- (N + SNX – 1) is greater than (length).
- (N + DNX – 1) is greater than (length).



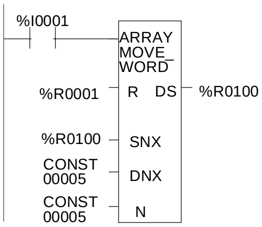
Parameters for the Array Move Function

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the operation is performed.
SR	For all: R, AI, AQ For INT, BIT, BYTE, WORD: I, Q, M, T, G, For BIT, BYTE, WORD: SA, SB, SC	SR contains the starting address of the source array. For ARRAY_MOVE_ BOOL, any reference may be used; it does not need to be byte aligned.
SNX	I, Q, M, T, G, R, AI, AQ, constant	SNX contains the index of the source array.
DNX	I, Q, M, T, G, R, AI, AQ, constant	DNX contains the index of the destination array.
N	I, Q, M, T, G, R, AI, AQ, constant	N provides a count indicator.
ok	flow, none	OK is energized whenever enable is energized.
DS	For all: SA, SB, SC, R, AI, AQ For INT, BIT, BYTE, WORD: I, Q, M, T, G	The starting address of the destination array. For ARRAY_MOVE_ BOOL, any reference may be used; it does not need to be byte aligned.
length		The number of elements starting at SR and DS that make up each array. It is defined as the length of SR+DS.

Table Functions
Array Move

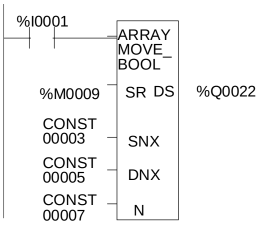
Example 1:

In this example, if %R100=3 then %R0003 -%R0007 of the array %R0001 - %R0016 is read and is written into %R0104 - %R0108 of the array %R0100 - %R0115. (%R001 and %R0100 are declared as type WORD of length 16.)



Example 2:

Using bit memory for SR and DS, %M0011 - %M0017 of the array %M0009 - %M0024 is read and then written to %Q0026 - %Q0032 of the array %Q0022 - %Q0037. (%M009 and %Q0022 are declared as type BOOL of length 16).



Example 3:

Using word memory, for SR and DS, the third least significant bit of %R0001 through the second least significant bit of %R0002 of the array containing all 16 bits of %R0001 and four bits of %R0002 is read and then written into the fifth least significant bit of %R0100 through the fourth least significant bit of %R0101 of the array containing all 16 bits of %R0100 and four bits of %R0101. 0001 and %R0100 are declared as type BOOL of length 20).

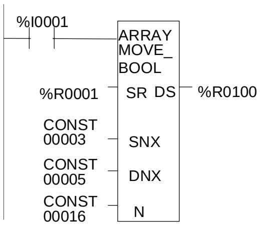
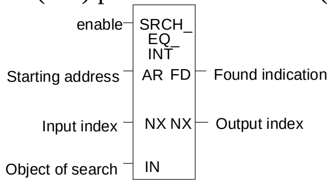


Table Functions
Search for Array Values

Use the Search functions listed below to search for values in an array.

▪ Search Equal	▪ Equal to a specified value.
▪ Search Not Equal	▪ Not equal to a specified value.
▪ Search Greater Than	▪ Greater than a specified value.
▪ Search Greater Than or Equal	▪ Greater than or equal to a specified value.
▪ Search Less Than	▪ Less than a specified value.
▪ Search Less Than or Equal	▪ Less than or equal to a specified value.

When the Search function receives power, it searches the specified array. Searching begins at the starting address (AR) plus the index value (NX).



The search continues until the array element of the search object (IN) is found or until the end of the array is reached. If an array element is found, the Found Indication (FD) is set ON and the Output Index (output NX) is set to the relative position of this element within the array. If no array element is found before the end of the array is reached, the Found Indication (FD) is set OFF and the Output Index (output NX) is set to zero.

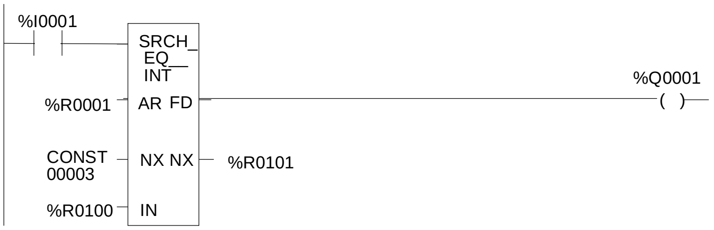
Valid values for input NX are 0 to (length)- 1. NX should be set to zero to begin searching at the first element. This value increments by one at the time of execution. Therefore, the values of output NX are 1 to (length). If the value of input NX is out-of-range, (< 0 or ≥ length), its value defaults to zero.

Parameters of the Search Functions

Input/ Output	Choices	Description
enable	flow	When the function is enabled, the search is performed.
AR	For all: R, AI, AQ For INT, BYTE, WORD: I, Q, M, T, G, For BYTE, WORD: S	Contains the starting address of the array.
Input NX	I, Q, M, T, G, R, AI, AQ, constant	Contains the zero-based index into the array at which to begin the search.
IN	For all: R, AI, AQ, constant For INT, BYTE, WORD: I, Q, M, T, G, For BYTE, WORD: S	IN contains the object of the search.
Output NX	I, Q, M, T, G, R, AI, AQ	Holds the one-based position within the array of the search target.
FD	flow, none	FD indicates that an array element has been found and the function was successful.
length	1 to 32,767 bytes or words.	The number of elements starting at AR that make up the array to be searched.

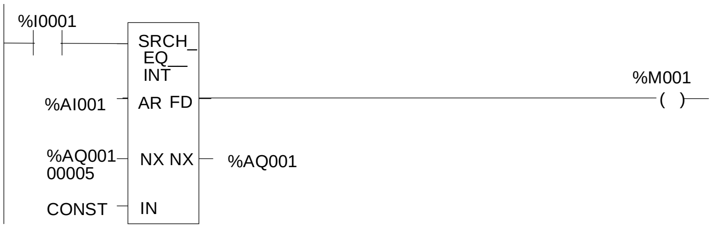
Example 1:

The array AR is defined as memory addresses %R0001 - %R0005. When EN is ON, the portion of the array between %R0004 and %R0005 is searched for an element whose value is equal to IN. If %R0001 = 7, %R0002 = 9, %R0003 = 6, %R0004 = 7, %R0005 = 7, and %R0100 = 7, then the search will begin at %R0004 and conclude at %R0004 when FD is set ON and a 4 is written to %R0101.



Example 2:

Array AR is defined as memory addresses %AI001 - %AI016. The values of the array elements are 100, 20, 0, 5, 90, 200, 0, 79, 102, 80, 24, 34, 987, 8, 0, and 500. Initially, %AQ001 is 5. When EN is ON, each sweep will search the array looking for a match to the IN value of 0. The first sweep will start searching at %AI006 and find a match at %AI007, so FD is ON and %AQ001 is 7. The second sweep will start searching at %AI008 and find a match at %AI015, so FD remains ON and %AQ001 is 15. The next sweep will start at %AI016. Since the end of the array is reached without a match, FD is set OFF and %AQ001 is set to zero. The next sweep will start searching at the beginning of the array.



Timer and Counter Functions

This section describes the timing and counting functions of the Instruction Set. The data associated with these functions is retentive through power cycles.

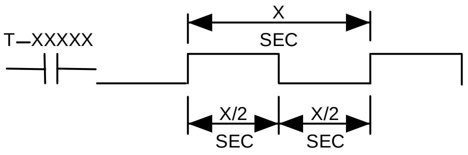
- On-Delay Stopwatch Timer
- Off-Delay Timer
- On-Delay Timer
- Up Counter
- Down Counter

Time-Tick Contacts

In addition to the Timer functions of the Instruction Set, the VersaMax PLC has four time-tick contacts. These contacts can be used to provide regular pulses of power flow to other program functions. The four time-tick contacts have time durations of 0.01 second, 0.1 second, 1.0 second, and 1 minute.

The state of these contacts does not change during the execution of the sweep. These contacts provide a pulse having an equal on and off time duration.

The contacts are referenced as T_10MS (0.01 second), T_100MS (0.1 second), T_SEC (1.0 second), and T_MIN (1 minute).
The following timing diagram represents the on/off time duration of these contacts.



These time-tick contacts represent specific locations in %S memory.

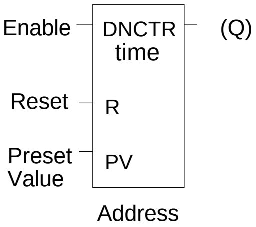
Timer and Counter Functions

Function Block Data Required for Timers and Counters

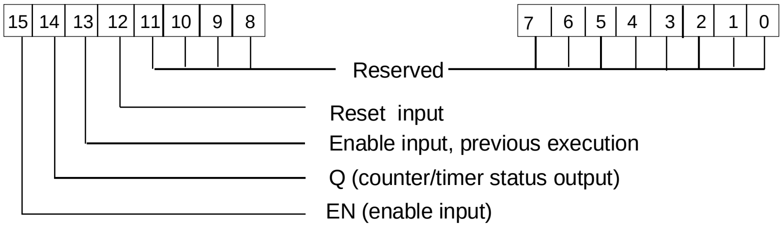
Each timer or counter uses three words (registers) of %R memory to store the following information:

current value (CV)	word 1
preset value (PV)	word 2
control word	word 3

When you enter a timer or counter, you must enter a beginning address for these three words (registers). Do not use consecutive registers for the 3 word timer/counter blocks. Timers and counters will not work if you place the current value of a block on top of the preset for the previous block.



The control word stores the state of the boolean inputs and outputs of its associated function block in the following format:



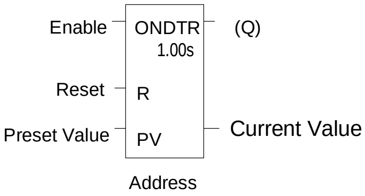
Bits 0 through 11 are used for timer accuracy; not for counters.

If the Preset Value (PV) is not a constant, PV is normally set to a different location than the second word. Some applications use the second word address for the PV, such as using %R0102 when the bottom data block starts at %R0101. It is then possible to change the Preset Value while the timer or counter is running. The first (CV) and third (Control) words can be read but should not be written, or the function will not work.

Timer and Counter Functions
On Delay Stopwatch Timer

A retentive On-Delay Stopwatch Timer (ONDTR) increments while it receives power flow and holds its value when power flow stops. Time may be counted in tenths (0.1), hundredths (0.01), or thousandths (0.001) of a second. The range is 0 to +32,767 time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.

When this function first receives power flow, it starts accumulating time (current value). When this timer is encountered in the ladder logic, its Current Value is updated.



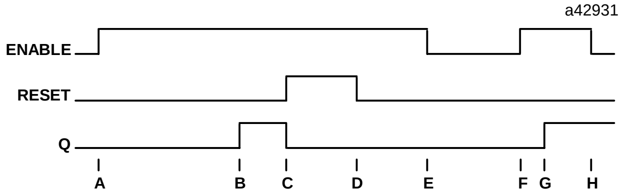
When the Current Value equals or exceeds the Preset Value PV, output Q is energized. As long as the timer continues to receive power flow, it continues accumulating until the maximum value is reached. Once the maximum value is reached, it is retained and output Q remains energized regardless of the state of the enable input.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the current values of the timers will be the same.

Parameters of the On Delay Stopwatch Timer Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) =word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with other instructions. **Careful:** Overlapping references cause erratic timer operation.
enable	flow	When enable receives power flow, the timer's Current Value increments.
R	flow	When R receives power flow, it resets the Current Value to zero.
PV	I ,Q, M, T, G, R, AI, AQ, constant, none	The Preset Value, which is used when the timer is enabled or reset.
Q	flow, none	Output Q is energized when the current value of the timer is greater than or equal to the Preset Value.
time	tenths, hundredths, or thousandths of seconds	Time increment for the low bit of the PV preset and CV current value.

Operation of the On Delay Timer Function



A. ENABLE goes high; timer starts accumulating
B. Current value reaches preset value PV; Q goes high
C. RESET goes high; Q goes low, accumulated time is reset (CV=0)
D. RESET goes low; timer then starts accumulating again
E. ENABLE goes low; timer stops accumulating. Accumulated time stays the same
F. ENABLE goes high again; timer continues accumulating time
G. Current value becomes equal to preset value PV; Q goes high. Timer continues to accumulate time until ENABLE goes low, RESET goes high or current value becomes equal to the maximum time
H. ENABLE goes low; timer stops accumulating time.

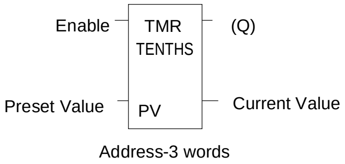
When power flow to the timer stops, the current value stops incrementing and is retained. Output Q, if energized, will remain energized. When the function receives power flow again, the current value again increments, beginning at the retained value. When reset R receives power flow, the current value is set back to zero and output Q is de-energized unless PV equals zero.

Example

In the example, a retentive on-delay timer is used to create a signal (%Q0011) that turns on 8.0 seconds after %Q0010 turns on, and turns off when %Q0010 turns off.

Timer and Counter Functions
On Delay Timer

The On-Delay Timer (TMR) increments while it receives power flow and resets to zero when power flow stops. Time may be counted in tenths of a second (the default selection), hundredths of a second, or thousandths of a second. The range is 0 to +32,767 time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.



When the On Delay Timer function receives power flow, the timer starts accumulating time (Current Value). The Current Value is updated when it is encountered in the logic to reflect the total elapsed time the timer has been enabled since it was last reset.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the Current Values of the timers will be the same.

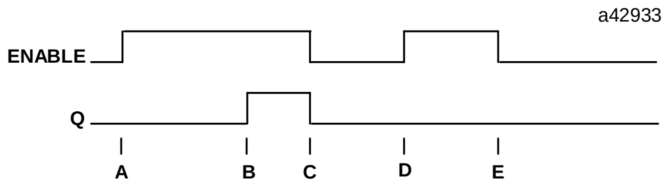
This update occurs as long as the enabling logic remains ON. When the current value equals or exceeds the Preset Value PV, the function begins passing power flow to the right. The timer continues accumulating time until the maximum value is reached. When the enabling parameter transitions from ON to OFF, the timer stops accumulating time and the Current Value is reset to zero.

Parameters for the On Delay Timer Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with other instructions. **Careful:** Overlapping references cause erratic operation of the timer.
enable	flow	When enable receives power flow, the timer's current value is incremented. When the TMR is not enabled, the current value is reset to zero and Q is turned off.
PV	I Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the timer's preset value when the timer is enabled or reset.
Q	flow, none	Output Q is energized when TMR is enabled and the current value is greater than or equal to the preset value.
time	tenths (0.1), hundredths (0.01), or thousandths (0.001) of seconds	Time increment for the low bit of the PV preset and CV current value.

Timer and Counter Functions
On Delay Timer

Operation of the On-Delay Timer Function



A. ENABLE goes high; timer begins accumulating time.

B. Current value reaches preset value PV; Q goes high, and timer continues accumulating time.

C. ENABLE goes low; Q goes low; timer stops accumulating time and current time is cleared.

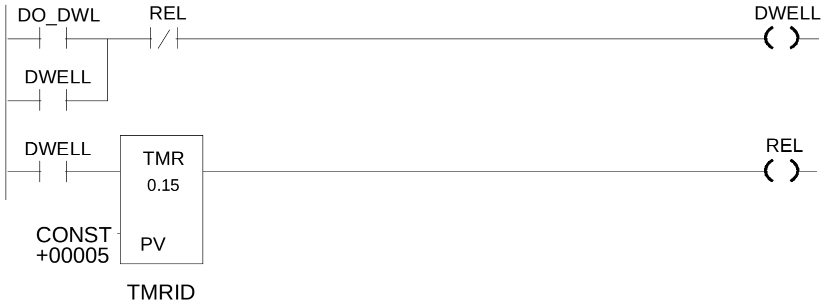
D. ENABLE goes high; timer starts accumulating time.

E. ENABLE goes low before current value reaches preset value PV; Q remains low; timer stops accumulating time and is cleared to zero (CV=0).

Example

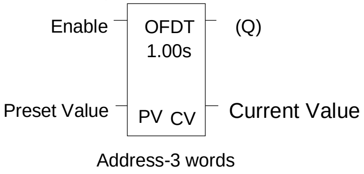
In the example, a delay timer (with address) TMRID is used to control the length of time that coil is on. This coil has been assigned the Nickname DWELL . When the normally open (momentary) contact with the Nickname DO_DWL is on, coil DWELL is energized.

The contact of coil DWELL keeps coil DWELL energized (when contact DO_DWL is released), and also starts the timer TMRID. When TMRID reaches its preset value of one-half second, coil REL energizes, interrupting the latched-on condition of coil DWELL. The contact DWELL interrupts power flow to TMRID, resetting its current value and de-energizing coil REL. The circuit is then ready for another momentary activation of contact DO_DWL.



Timer and Counter Functions
Off Delay Timer

The Off-Delay Timer increments while power flow is off and resets to zero when power flow is on. Time may be counted in tenths (0.1), hundredths (0.01), or thousandths (0.001) of a second. Range is 0 to +32,767 time units. The state of this timer is retentive on power failure; no automatic initialization occurs at power-up.



When the Off-Delay Timer first receives power flow, it passes power to the right, and the Current Value (CV) is set to zero. The function uses word 1 [register] as its CV storage location. The output remains on as long as the function receives power flow. If the function stops receiving power flow from the left, it continues to pass power to the right, and the timer starts accumulating time in the Current Value. The Off-Delay Timer does not pass power flow if the Preset Value is zero or negative.

If multiple occurrences of the same timer with the same reference address are enabled during a CPU sweep, the Current Values of the timers will be the same.

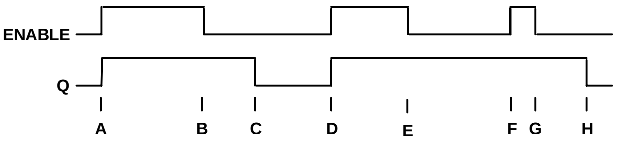
Each time the function is invoked with the enabling logic set to OFF, the Current Value is updated to reflect the elapsed time since the timer was turned off. When the Current Value (CV) is equal to the Preset Value (PV), the function stops passing power flow to the right and the timer stops accumulating. When the function receives power flow again, the current value resets to zero. When this timer is used in a program block that is *not* called every sweep, it accumulates time between calls to the program block unless it is reset. That means it functions like a timer in a program with a much slower sweep than the timer in the main program block. For program blocks that are inactive for a long time, the timer should be programmed to allow for this catch-up. For example, if a timer in a program block is reset and the program block is inactive for four minutes, when the program block is called, four minutes of time will have accumulated. This time is applied to the timer when enabled unless the timer is first reset.

Example

In the example, an Off-Delay Timer is used to turn off an output (%Q00001) whenever an input (%I00001) turns on. The output is turned on again 0.3 seconds after the input goes off.

Timer and Counter Functions
Off Delay Timer

Operation of the Off-Delay Timer Function



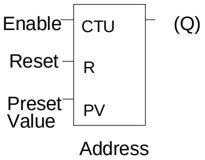
A. ENABLE and Q both go high; timer is reset (CV = 0).
B. ENABLE goes low; timer starts accumulating time.
C. CV reaches PV; Q goes low, and timer stops accumulating time.
D. ENABLE goes high; timer is reset (CV = 0).
E. ENABLE goes low; timer starts accumulating time.
F. ENABLE goes high; timer is reset (CV = 0).
G. ENABLE goes low; timer begins accumulating time.
H. V reaches PV; Q goes low, and timer stops accumulating time.

Parameters of the Off-Delay Timer Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with other instructions. **Careful:** Overlapping references cause erratic operation of the timer.
enable	flow	When enable receives power flow, the timer's current value is incremented.
PV	I Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the timer's preset value when the timer is enabled or reset. For a register (%R) OV reference, the PV parameter is specified as the second word of the address parameter. For example, an address parameter of %R0001 would use %R0002 as the PV parameter.
Q	flow, none	Output Q is energized when the current value is less than the preset value. The Q state is retentive on power failure; no automatic initialization occurs at power-up.
time	tenths, hundredths, or thousandths of seconds	Time increment for the low bit of the PV preset and CV current value.

Timer and Counter Functions
Up Counter

The Up Counter function counts up to a designated value. The range is 0 to +32,767 counts. When the Up Counter reset is ON, the Current Value of the counter resets to 0. Each time the enable input transitions from OFF to ON, the Current Value increments by 1. The current value can be incremented past the Preset Value PV. The output is ON whenever the Current Value is greater than or equal to the Preset Value. The state of the CTU is retentive on power failure; no automatic initialization occurs at power-up.



Parameters of the Up Counter Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with another up counter, down counter, or any other instruction or improper operation will result. **Careful:** Overlapping references cause erratic operation of the counter.
enable	flow	On a positive transition of enable, the current count is incremented by one.
R	flow	When R receives power flow, it resets the current value back to zero.
PV	I, Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the counter's preset value when the counter is enabled or reset.
Q	flow, none	Output Q is energized when the Current Value is greater than or equal to the Preset Value.

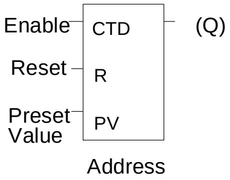
Example of the Up Counter Function

In the example, every time input %I0012 transitions from OFF to ON, up counter PRT_CNT counts up by 1; internal coil %M0001 is energized when 100 parts have been counted. When %M0001 is ON, the accumulated count is reset to zero.

Timer and Counter Functions
Down Counter

The Down Counter function counts down from a preset value. The minimum Preset Value is zero; the maximum present value is +32,767 counts. The minimum Current Value is –32,768. When reset, the Current Value of the counter is set to the Preset Value PV. When the enable input transitions from OFF to ON, the Current Value is decremented by one. The output is ON whenever the Current Value is less than or equal to zero.

The Current Value of the Down Counter is retentive on power failure; no automatic initialization occurs at power-up.



Parameters of the Down Counter Function

Input/ Output	Choices	Description
address	R	The function uses three consecutive words (registers) of %R memory to store the following: • Current value (CV) = word 1. • Preset value (PV) = word 2. • Control word = word 3. Do not use this address with another down counter, up counter, or any other instruction or improper operation will result. **Careful:** Overlapping references will result in erratic counter operation.
enable	flow	On a positive transition of enable, the Current Value is decremented by one.
R	flow	When R receives power flow, it resets the Current Value to the Preset Value.
PV	I, Q, M, T, G, R, AI, AQ, constant, none	PV is the value to copy into the counter's Preset Value when the counter is enabled or reset.
Q	flow, none	Output Q is energized when the Current Value is less than or equal to zero.

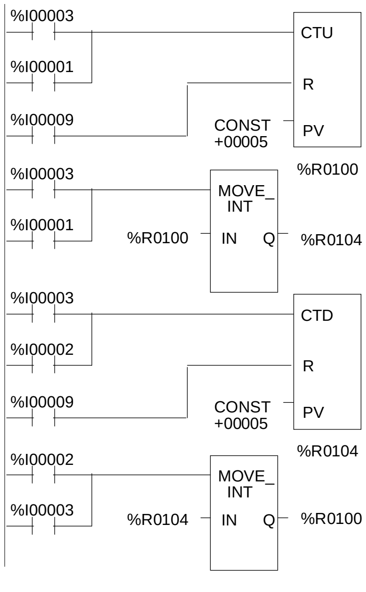
Timer and Counter Functions
Down Counter

Example 1:

In the example, the down counter identified as COUNTP counts 500 new parts before energizing output %Q0005.

Example 2: Keeping Track of Parts in a Temporary Storage Area

The following example shows how the PLC can keep track of the number of parts in a temporary storage area. It uses an up/down counter pair with a shared register for the accumulated or current value. When parts enter the storage area, the up counter increases the current value of the parts in storage by 1. When a part leaves the storage area, the down counter decrements by 1, decreasing the inventory storage value by 1. The two counters use different register addresses. When a register counts, its current value must be moved to the current value register of the other counter.



See the pages on Math functions for an example of using the Addition and Subtraction functions to provide storage tracking.

Chapter

11

The Service Request Function

This chapter explains the Service Request (SVCREQ) function, which requests a special PLC service. It describes SVCREQ parameters for the VersaMax® CPU.

- SVCREQ Function Numbers
- Format of the SVCREQ Function
- SVCREQ 1: Change/Read Constant Sweep Timer
- SVCREQ 2: Read Window Times
- SVCREQ 3: Change Programmer Communications Window Mode
- SVCREQ 4: Change System Communications Window Mode
- SVCREQ 6: Change/Read Number of Words to Checksum
- SVCREQ 7: Read or Change the Time-of-Day Clock
- SVCREQ 8: Reset Watchdog Timer
- SVCREQ 9: Read Sweep Time from Beginning of Sweep
- SVCREQ 10: Read Folder Name
- SVCREQ 11: Read PLC ID
- SVCREQ 13: Shut Down (Stop) PLC
- SVCREQ 14: Clear Fault
- SVCREQ 15: Read Last-Logged Fault Table Entry
- SVCREQ 16: Read Elapsed Time Clock
- SVCREQ 18: Read I/O Override Status
- SVCREQ 23: Read Master Checksum
- SVCREQ 26/30: Interrogate I/O

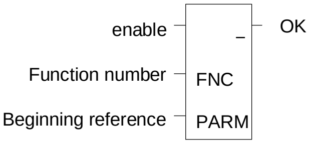
SVCREQ Function Numbers

Each Service Request has its own function number, as listed in the following table.

Function #	Description
1	Change/Read Constant Sweep Timer
2	Read Window Times
3	Change Programmer Communications Window Mode and Time
4	Change System Communications Window Mode and Time
5	reserved
6	Change/Read Number of Words to Checksum
7	Change/Read Time-of-Day Clock
8	Reset Watchdog Timer
9	Read Sweep Time from Beginning of Sweep
10	Read Folder Name
11	Read PLC ID
12	reserved
13	Shut Down the PLC
14	Clear Fault Tables
15	Read Last-Logged Fault Table Entry
16	Read Elapsed Time Clock
17	reserved
18	Read I/O Override Status
19-22	reserved
23	Read Master Checksum
26/30	Interrogate I/O
27, 28	reserved
29	Read Elapsed Power Down Time
31-255	reserved

Format of the SVCREQ Function

The SVCREQ function has three inputs and one output.



When the SVCREQ receives power flow, the PLC is requested to perform the function number FNC indicated. Parameters for the function are located beginning at the reference given for PARM. This is the beginning of the “parameter block" for the function. The number of 16-bit references required depends on the SVCREQ function being used.

Parameter blocks may be used as both inputs for the function and the location where data may be output after the function executes. Therefore, data returned by the function is accessed at the same location specified for PARM.

The SVCREQ function passes power flow unless an incorrect function number, incorrect parameters, or out-of-range references are specified. Specific SVCREQ functions have additional causes for failure.

Parameters of the SVCREQ Function

Input/Output	Choices	Description
enable	flow	When enable is energized, the service request is performed.
FNC	I, Q M, T, G, R, AI, AQ, constant	Contains the constant or reference for the requested service.
PARM	I, Q M, T, G, R, AI, AQ	Contains the beginning reference for the parameter block for the requested service.
ok	flow, none	OK is energized when the function is performed without error.

Example of the SVCREQ Function

In the example, when the enabling input %I0001 is ON, SVCREQ function number 7 is called, with the parameter block located starting at %R0001. Output coil %Q0001 is set ON if the operation succeeds.

SVCREQ 1: Change/Read Constant Sweep Timer

Use SVCREQ 1 to enable or disable Constant Sweep Time mode, change the length of the Constant Sweep Time, read whether Constant Sweep Time is currently enabled, or read the Constant Sweep Time length.

Input Parameter Block for SCVREQ 1

For this function, the parameter block has a length of two words.

Disable Constant Sweep Mode

To disable Constant Sweep mode, enter SVCREQ function #1 with this parameter block:

address	0
address + 1	ignored

Enable Constant Sweep Mode

To enable Constant Sweep mode, enter SVCREQ function #1 with this parameter block:

address	1
address + 1	0 or timer value

Note: If the timer should use a new value, enter it in the second word. If the timer value should not be changed, enter 0 in the second word. If the timer value does not already exist, entering 0 causes the function to set the OK output to OFF.

Change the Constant Sweep Time

To change the timer value **without** changing the selection for sweep mode state, enter SVCREQ function #1 with this parameter block:

address	2
address + 1	new timer value

Read the Constant Sweep State and Time

To read the current timer state and value without changing either, enter SVCREQ function #1 with this parameter block:

address	3
address + 1	ignored

Successful execution will occur, unless:

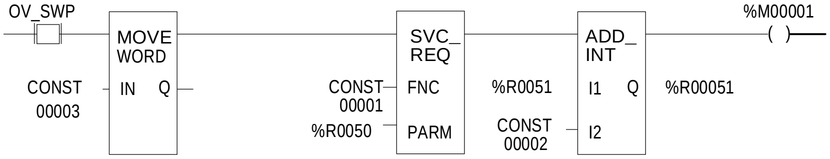
1. A number other than 0, 1, 2, or 3 is entered as the requested operation:
2. The sweep time value is greater than 500ms (0.5 seconds).
3. Constant sweep time is enabled with no timer value programmed or with an old value of 0 for the timer.

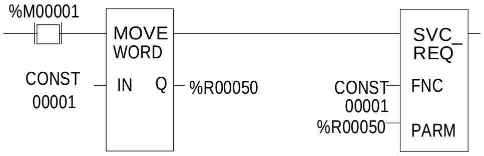
After the function executes, the function returns the timer state and value in the same parameter block references:

	0 = disabled
address	1 = enabled
address + 1	current timer value

Example of SVCREQ 1

In this example, if contact OV_SWP is set, the Constant SweepTimer is read, the timer is increased by two milliseconds, and the new timer value is sent back to the PLC. The parameter block is in local memory at location %R0050. Because the MOVE and ADD functions require three horizontal contact positions, the example logic uses discrete internal coil %M00001 as a temporary location to hold the successful result of the first rung line. On any sweep in which OV_SWP is not set, %M00001 is turned off.





SVCREQ 2: Read Window Times

SVCREQ 2 can be used to read the times of the programmer communications window and the system communications window. These windows can operate in Limited or Run to Completion Mode.

Mode Name	Value	Description
Limited Mode	0	The execution time of the window is limited to 6ms. The window terminates when it has no more tasks to complete or after 6ms elapses.
Run to Completion Mode	2	Regardless of the time assigned to a window, it runs until all tasks within that window are completed (up to 400ms).

A window is disabled when the time value is zero.

Output Parameter Block for SVCREQ 2

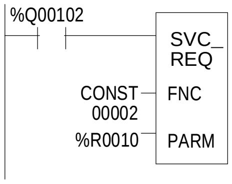
The parameter block has a length of three words:

	High Byte	Low Byte	
address	Mode	Value in ms	Programmer Window
address + 1	Mode	Value in ms	System Communications Window
address + 2	must be zero	must be zero	reserved

All parameters are output parameters. It is not necessary to enter values in the parameter block to program this function.

Example of SVCREQ 2

In the following example, when enabling output %Q00102 is set, the CPU places the current time values of the windows in the parameter block starting at location %R0010.



SVCREQ 3: Change Programmer Communications Window Mode

Use SVCREQ 3 to change the programmer communications window mode (Limited or Run-to-Completion). The change occurs during the next CPU sweep after the function is called. The time of the window cannot be changed; it is always 6ms.

SVCREQ 3 passes power flow to the right unless a mode other than 0 (Limited) or 2 (Run-to-Completion) is selected.

The parameter block has a length of one word.

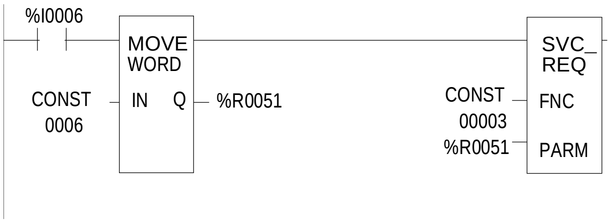
Changing the Programmer Communications Window Mode

To change the programmer window, enter SVCREQ 3 with this parameter block:

	High Byte	Low Byte
address	Mode	6

Example of SVCREQ 3

In the following example, when enabling input %I006 goes ON, the programmer communications window is enabled and assigned a value of 6ms. The parameter block is in reference memory location %R0051.



SVCREQ 4: Change System Communications Window Mode

Use SVCREQ 4 to change the system communications window mode (Limited or Run-to-Completion). The change occurs during the next CPU sweep after the function is called. The time of the window cannot be changed; it is always 6ms.

SVCREQ 4 passes power flow to the right unless a mode other than 0 (Limited) or 2 (Run-to-Completion) is selected.

The parameter block has a length of one word.

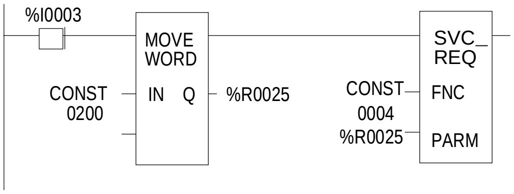
Changing the System Communications Window Mode

To change the programmer window, enter SVCREQ 4 with this parameter block:

	High Byte	Low Byte
address	Mode	6

Example of SVCREQ 4

In the following example, when enabling input %I0003 is ON the system communications window is changed to Run-to-Completion mode. The parameter block is at location %R0025.



SVCREQ 6: Change/Read Number of Words to Checksum

Use SVCREQ 6 to read or change the number of words in the program to be checksummed. The function is successful unless some number other than 0 or 1 is entered as the requested operation.

Parameter Block Formats for SVCREQ 6

The parameter block has a length of 2 words.

To read the word count, the first word of the parameter block must contain a zero:

address	0 (read word count)
address + 1	ignored

The function returns the current word count in the second word of the parameter block.

address	0
address + 1	current word count

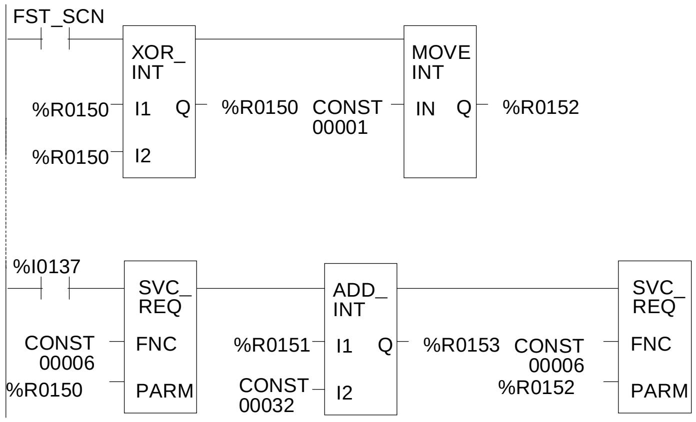
To change the word count, the first word of the parameter block must contain a one:

address	1 (change word count)
address + 1	new word count (0 or 32)

The PLC will change the number of words to be checksummed to the new value.

Example of SVCREQ 6

In the example, when enabling contact FST_SCN is set, the parameter blocks for the checksum function are built. Later in the program, if input %I0137 turns on, the SVCREQ reads the number of words being checksummed. The parameter block for the Read function is located at %R0150-151. The ADD function adds 32 to the current word count in %R0151 and places the result in %R0153. The parameter block for the Change function is located at %R00152-153. The second SVCREQ then changes to the new word count specified in %R0153.



SVCREQ 7: Read or Change the Time-of-Day Clock

Use SVCREQ 7 to read or change the time of day clock in the PLC. The data can be either BCD or ASCII. Either 2-digit-year or 4-digit-year format is available. The function is successful unless some number other than 0 (read) or 1 (change) is entered for the requested operation, or an invalid data format is specified, or data is provided in an unexpected format.

Parameter Block Format for SVCREQ 7

For the date/time functions, the length of the parameter block depends on the data format. The data block is either BCD or ASCII. BCD format requires 6 words; packed ASCII requires 12 words (13 words for 4-digit year). For both data types:

- Hours are stored in 24-hour format.
- Day of the week is a numeric value from 1 (Sunday) to 7 (Saturday).

	2-Digit Year Format	**4-Digit Year Format**
address	0 = read time and date 1 = set time and date	0 = read time and date 1 = set time and date
address + 1	1 = BCD format 3 = packed ASCII format	81h = BCD format 83h = packed ASCII format
address + 2 to end	data	data

Words 3 to the end of the parameter block contain output data returned by a read function, or new data being supplied by a change function. In both cases, format of these data words is the same. When reading the date and time, words (address + 2) to the end of the parameter block are ignored on input.

SVCREQ 7 Parameter Block Content: BCD Format

In BCD format, each time and date item occupies one byte, so the parameter block has six words.

2-Digit Year

The last byte of the sixth word is not used. When setting the date and time, this byte is ignored; when reading date and time, the function returns 00.

Parameter Block Format:

Example:
Read Date and Time in BCD format
(Sun., July 3, 1998, at 2:45:30 p.m.)

High Byte:	**Low Byte**			
1 = change or 0 = read		address	0 (read)	
1 (BCD format)		address + 1	1 (BCD format)	
month	year	address + 2	07 (July)	98 (year)
hours	day of month	address + 3	14 (hours)	03 (day)
seconds	minutes	address + 4	30 (seconds)	45 (minutes)
(null)	day of week	address + 5	00	06 (Friday)

4-Digit Year

The parameter block has six words. All bytes are used.

Parameter Block Format:

Example:
Read Date and Time in BCD format
(Sun., July 3, 1998, at 2:45:30 p.m.)

High Byte:	**Low Byte**			
1 = change or 0 = read		address	00	00 (read)
81h (BCD format, 4-digit)		address + 1	00	81h (BCD, 4-digit)
year	year	address + 2	19 (year)	98 (year)
day of month	month	address + 3	03 (day)	07 (July)
minutes	hours	address + 4	45 (minutes)	14 (hours)
day of week	seconds	address + 5	06 (Friday)	30 (seconds)

SVCREQ 7 Parameter Block Content: Packed ASCII Format

In Packed ASCII format, each digit of the time and date items is an ASCII formatted byte. Spaces and colons are embedded into the data to format it for printing or display. ASCII format requires 12 words in the parameter block (13 words for 4-digit year).

2-Digit Year

Parameter Block Format:

Example: Read Date and Time in Packed ASCII Format (Mon, Oct. 5, 1998 at 11:13:00pm)

High Byte	Low Byte		Example	
1 = change or 0 = read		address	0 (read)	
3 (ASCII format)		address + 1	3 (ASCII format)	
year	year	address + 2	38 (8)	39 (9)
month	(space)	address + 3	31 (1)	20 (space)
(space)	month	address + 4	20 (space)	30 (0)
day of month	day of month	address + 5	35 (5)	30 (leading 0)
hours	(space)	address + 6	31 (1)	20 (space)
:	hours	address + 7	3A (:)	31 (1)
minutes	minutes	address + 8	33 (3)	31 (1)
seconds	:	address + 9	30 (0)	3A (:)
(space)	seconds	address + 10	20 (space)	30 (0)
day of week	day of week	address + 11	32 (2: Mon.)	30 (leading 0)

4-Digit Year

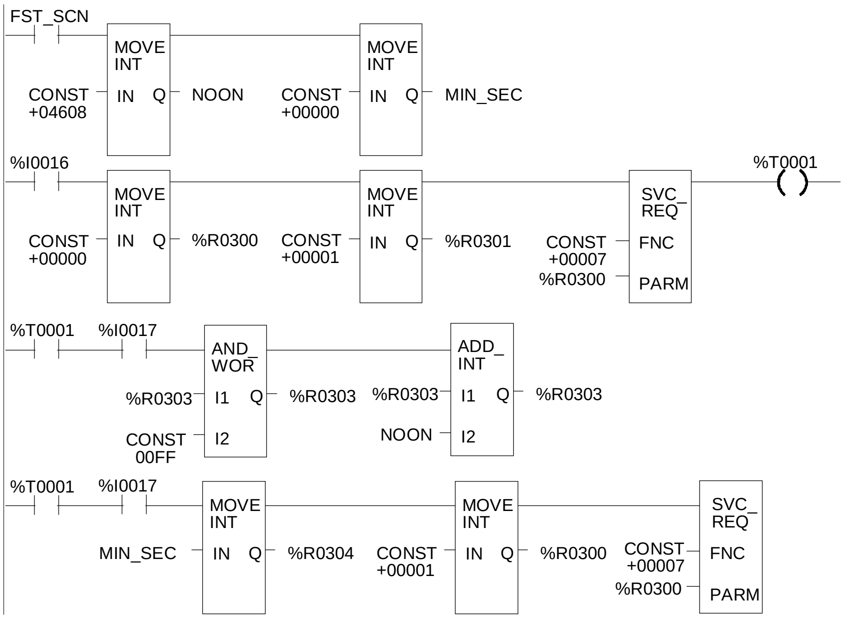
Parameter Block Format:

Example: Read Date and Time in Packed ASCII Format (Mon, Oct. 5, 1998 at 11:13:00pm)

High Byte	Low Byte		Example	
1 = change or 0 = read		address	0 (read)	
83h (ASCII 4 digit)		address + 1	83h (ASCII 4 digit)	
year (hundreds)	year (thousands)	address + 2	39 (9)	31 (1)
year (ones)	year (tens)	address + 3	38 (8)	39 (9)
month (tens)	(space)	address + 4	31 (1)	20 (space)
(space)	month (ones)	address + 5	20 (space)	30 (0)
day of month (ones)	day of month (tens)	address + 6	35 (5)	30 (leading 0)
hours (tens)	(space)	address + 7	31 (1)	20 (space)
: (colon)	hours (ones)	address + 8	3A (:)	31 (1)
minutes (ones)	minutes (tens)	address + 9	33 (3)	31 (1)
seconds (tens)	: (colon)	address + 10	30 (0)	3A (:)
(space)	seconds (ones)	address + 11	20 (space)	30 (0)
day of week (ones)	day of week (tens)	address + 12	32 (2: Mon.)	30 (leading 0)

Example of SVCREQ 7

In the example, when called for by previous logic, a parameter block for the time-of-day clock is built. It requests the current date and time, then sets the clock to 12 noon using BCD format. The parameter block is located at location %R0300. Array NOON has been set up elsewhere in the program to contain the values 12, 0, and 0. (Array NOON must also contain the data at %R0300.) BCD format requires six contiguous memory locations for the parameter block.



SVCREQ 8: Reset Watchdog Timer

Use SVCREQ 8 to reset the watchdog timer during the sweep. Ordinarily, when the watchdog timer expires, the PLC shuts down without warning. SVCREQ 8 allows the timer to keep going during a time-consuming task (for example, while waiting for a response from a communications line).

Caution

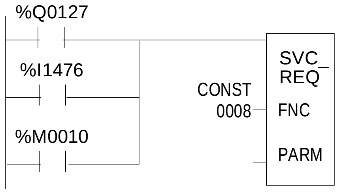
Be sure that resetting the watchdog timer does not adversely affect the controlled process.

Parameter Block Format for SVCREQ 8

This function has no associated parameter block.

Example of SVCREQ 8

In this example, power flow through enabling output %Q0027 or input %I1476 or internal coil %M00010 causes the watchdog timer to be reset.



SVCREQ 9: Read Sweep Time from Beginning of Sweep

Use SVCREQ 9 to read the time in milliseconds since the start of the sweep. The data format is unsigned 16-bit integer.

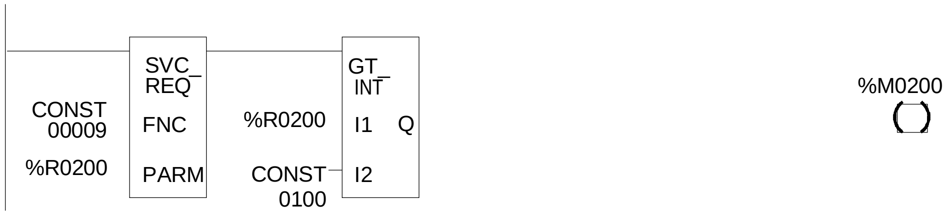
Output Parameter Block Format for SVCREQ 9

The parameter block is an output parameter block only; it has a length of one word.

address	time since start of sweep

Example of SVCREQ 9

In the following example, the elapsed time from the start of the sweep is always read into location %R0200. If it is greater than 100ms, internal coil %M0200 is turned on.



SVCREQ 10: Read Folder Name

Use SVCREQ 10 to read the name of the currently-executing folder.

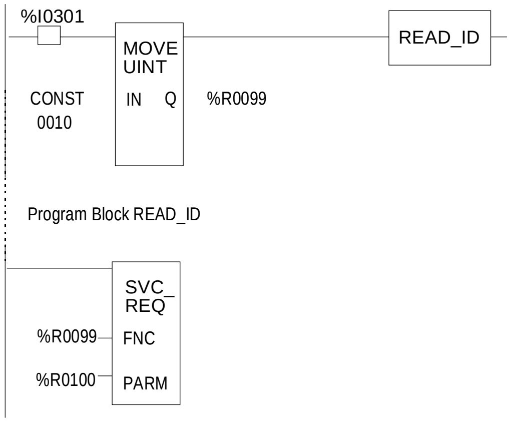
Output Parameter Block Format for SVCREQ 10

The output parameter block has a length of four words. It returns eight ASCII characters; the last is a null character (00h). If the program name has fewer than seven characters, null characters are added to the end.

	Low Byte	High Byte
address	character 1	character 2
address + 1	character 3	character 4
address + 2	character 5	character 6
address + 3	character 7	00

Example of SVCREQ 10

In this example, when enabling input %I0301 goes OFF, register location %R0099 is loaded with the value 10, which is the function code for the Read Folder Name function. The Program Block READ_ID is then called to retrieve the folder name. The parameter block is located at address %R0100.



SVCREQ 11: Read PLC ID

Use SVCREQ 11 to read the name of the PLC executing the program.

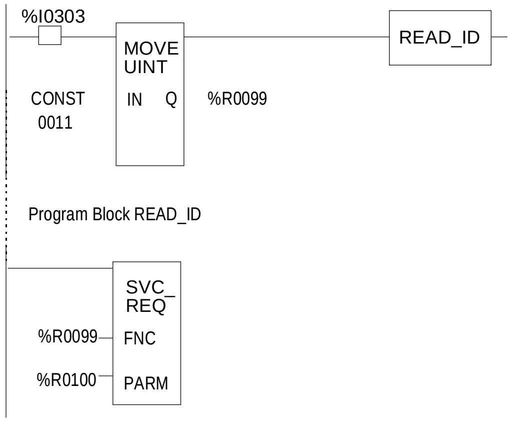
Output Parameter Block Format for SVCREQ 11

The output parameter block has a length of four words. It returns eight ASCII characters; the last is a null character (00h). If the PLC ID has fewer than seven characters, null characters are added to the end.

	Low Byte	High Byte
address	character 1	character 2
address + 1	character 3	character 4
address + 2	character 5	character 6
address + 3	character 7	00

Example of SVCREQ 11

In this example, when enabling input %I0302 goes OFF, register location %R0099 is loaded with the value 11, which is the function code for the Read PLC ID function. The program block READ_ID is then called to retrieve the ID. The parameter block is located at address %R0100.



SVCREQ 13: Shut Down (Stop) PLC

Use SVCREQ 13 to stop the PLC *at the end of the next sweep*. All outputs go to their designated default states at the start of the next PLC sweep. An informational "Shut Down PLC" fault is placed in the PLC Fault Table. The I/O scan continues as configured.

Parameter Block for SVCREQ 13

This function has no parameter block.

Example of SVCREQ 13

In the example, when a "Loss of I/O Module" fault occurs, SVCREQ 13 executes. The PARM input is not used.

This example uses a JUMP to the end of the program to force a shutdown if the Shutdown PLC function executes successfully. This JUMP and LABEL are needed because the transition to Stop mode does not occur until the end of the sweep in which the function executes.

SVCREQ 14: Clear Fault

Use SVCREQ 14 to clear either the PLC fault table or the I/O fault table. The SVCREQ output is set ON unless some number other than 0 or 1 is entered as the requested operation.

Input Parameter Block for SVCREQ 14

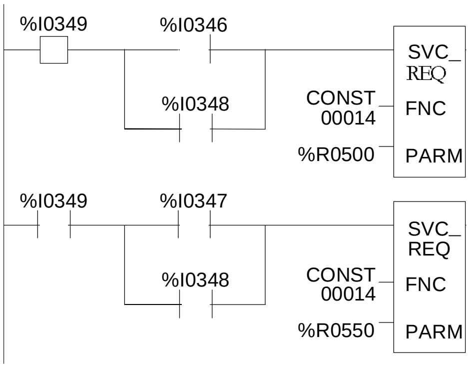
For this function, the parameter block has a length of 1 word. It is an input parameter block only. There is no output parameter block.

0 = clear PLC fault table.
1 = clear I/O fault table.

Example of SVCREQ 14

In the example, when input %I0346 is on and input %I0349 is on, the PLC fault table is cleared. When input %I0347 is on and input %I0349 is on, the I/O fault table is cleared. When input %I0348 is on and input %I0349 is on, both are cleared.

The parameter block for the PLC fault table is located at %R0500; for the I/O fault table the parameter block is located at %R0550. Both parameter blocks are set up elsewhere in the program.



SVCREQ 15: Read Last-Logged Fault Table Entry

Use SVCREQ 15 to read the last entry logged in either the PLC fault table or the I/O fault table. The SVCREQ output is set ON unless some number other than 0 or 1 is entered as the requested operation or the fault table is empty.

Input Parameter Block for SVCREQ 15

For this function, the parameter block has a length of 22 words. The input parameter block has this format:

	2-Digit Year Format	4-Digit Year Format
address	0 = Read PLC fault table. 1 = Read I/O fault table.	8 = Read PLC fault table. 9 = Read I/O fault table.

The format of the output parameter block depends on whether the function reads data from the PLC fault table or the I/O fault table.

PLC Fault Table Output Format / **I/O Fault Table Output Format**

	High Byte	Low Byte		High Byte	Low Byte
	0			1	
	spare	long/short	address + 1	memory type	long/short
	spare	spare	address + 2		offset
	slot	rack	address + 3	slot	rack
		task	address + 4	block	bus
	fault action	fault group	address + 5		point
		error code	address + 6	fault action	fault group
		fault specific data	address + 7	fault type	fault category
			address + 8	fault specific data	fault description
			to		
			address + 18		
	minutes	seconds	address + 19	minutes	seconds
	day of month	hour	address + 20	day of month	hour
2-Digit Year Format	year	month	address + 21	year	month
or					
4-Digit Year Format	spare	month	address + 21	spare	month
	year		address + 22	year	

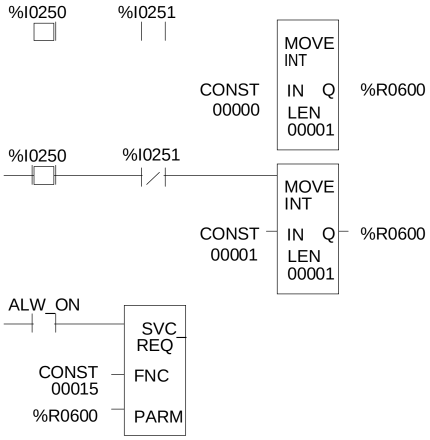
Long/Short Value

The first byte of word address +1 contains a number that indicates the length of the fault-specific data in the fault entry. These possible values are:

PLC fault table	00 = 8 bytes (short) 01 = 24 bytes (long)
I/O fault table	02 = 5 bytes (short) 03 = 21 bytes (long)

Example of SVCREQ 15

When inputs %I0250 and %I0251 are both on, the first Move function places a zero (read PLC fault table) into the parameter block for SVCREQ 15. When input %I0250 is on and input %I0251 is off, the Move instruction instead places a one (read I/O fault table) in the SVCREQ parameter block. The parameter block is located at location %R0600.



SVCREQ 16: Read Elapsed Time Clock

Use SVCREQ 16 to read the system's elapsed time clock. The elapsed time clock measures the time in seconds since the PLC was powered on.

Output Parameter Block for SVCREQ 16

This function has an output parameter block only. Its length is 3 words.

address	seconds from power on (low order)
address + 1	seconds from power on (high order)
address + 2	100 microsecond ticks

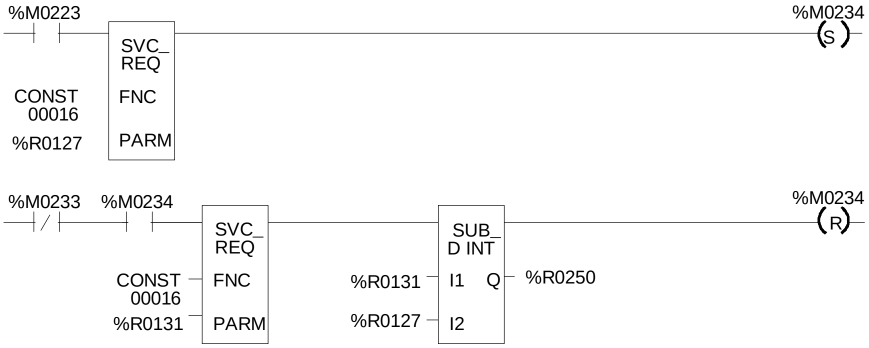
The first two words are the elapsed time in seconds. The last word is the number of 100 microsecond ticks in the current second.

Example of SVCREQ 16

In the example, when internal coil %M0233 is on, the SVCREQ with a parameter block located at %R0127 reads the system's elapsed time clock and sets internal coil %M0234. When coil %M0233 is off, the SVCREQ with a parameter block at %R0131 reads the elapsed time clock again.

The subtraction function finds the difference between the first and second readings, which have been stored in the SVCREQ parameter blocks. The subtraction ignores the hundred microsecond ticks.

The difference between the two readings is placed in memory location %R0250.



SVCREQ 18: Read I/O Override Status

Use SVCREQ 18 to check for any overrides in the CPU's %I and %Q memories.

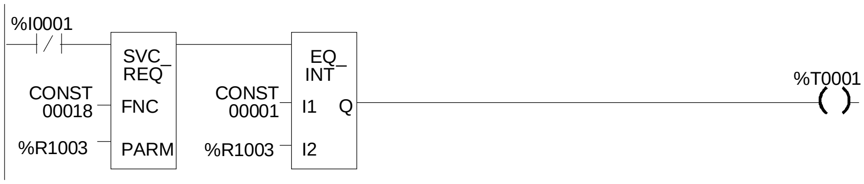
Output Parameter Block for SVCREQ 18

This function has an output parameter block only. Its length is 1 word.

address	0 = No overrides are set. 1 = Overrides are set.

Example of SVCREQ 18

The following SVCREQ reads the status of I/O overrides memory into location %R1003. The equality function checks %R1003 to see if it is equal to (the constant) 1. If it is, the equality function turns on output %T0001.



SVCREQ 23: Read Master Checksum

Use SVCREQ 23 to read the master checksums of the application program and the configuration. The SVCREQ output is always ON if the function is enabled.

Output Parameter Block for SVCREQ 23

For this function, the output parameter block has a length of 12 words with this format:

The first two items in the output parameter block indicate when the program and configuration checksums are valid. (Program checksums may not be valid during a Run Mode Store.)

address	Master Program Checksum Valid (0 = not valid, 1 = valid)
address + 1	Master Configuration Checksum Valid (0 = not valid, 1 = valid)
address + 2	Number of Program Blocks (including _MAIN)
address + 3	Size of User Program in Bytes (DWORD data type)
address + 5	Program Additive Checksum
address + 6	Program CRC Checksum (DWORD data type)
address + 8	Size of Configuration Data in Bytes
address + 9	Configuration Additive Checksum
address + 10	Configuration CRC Checksum (DWORD data type)

Example of SVCREQ 23

In the example, when input %I0251 is ON, the master checksum information is placed into the parameter block at %R0050 and the output coil (%Q0001) is turned on.

SVCREQ 26/30: Interrogate I/O

Use SVCREQs 26 and 30 to check whether the installed modules match the software configuration. If not, these SVCREQs place appropriate addition, loss, and mismatch faults in the PLC and/or I/O fault tables. SVCREQs 26 and 30 both perform the same function.

The more configuration faults there are, the longer it takes these SVCREQs longer to execute.

These SVCREQs have no parameter block. They always output power flow.

Example of SVCREQ 26

In the example, when input %I0251 is ON, the SVCREQ checks the installed modules and compares them to the software configuration. Output %Q0001 is turned on after the SVCREQ is complete.

SVCREQ 29: Read Elapsed Power Down Time

Use SVCREQ 29 to read the amount of time elapsed between the last power-down and the most recent powerup. If the watchdog timer expired before power-down, the PLC is not able to calculate the power down elapsed time, so the time is set to 0.

The SVCREQ output is always ON.

Output Parameter Block for SVCREQ 29

This function has an output parameter block only. The parameter block has a length of 3 words.

address	Power-Down Elapsed Seconds (low order)
address + 1	Power-Down Elapsed Seconds (high order)
address + 2	zero

The first two words are the power-down elapsed time in seconds. The last word is always 0.

Example of SVCREQ 29

In the example, when input %I0251 is ON, the Elapsed Power-Down Time is placed into the parameter block that starts at %R0050. The output coil (%Q0001) is turned on.

Chapter 12

Serial I/O / SNP / RTU Protocols

This chapter describes the VersaMax® CPU's Serial I/O feature, which can be used to control the read/write activities of one of the CPU ports directly from the application program.

This chapter also contains instructions for using COMMREQs to configure the CPU serial ports for SNP, RTU, or Serial I/O protocol.

- Format of the COMMREQ Function
- Configuring Serial Ports Using the COMMREQ Function
  - RTU Slave/SNP Slave Operation with a Programmer Attached
  - COMMREQ Command Block for Configuring SNP Protocol
  - COMMREQ Data Block for Configuring RTU Protocol
  - COMMREQ Data Block for Configuring Serial I/O
- Serial I/O COMMREQ Commands
  - Initialize Port
  - Set Up Input Buffer
  - Flush Input Buffer
  - Read Port Status
  - Write Port Control
  - Cancel Operation
  - Autodial
  - Write Bytes
  - Read Bytes
  - Read String

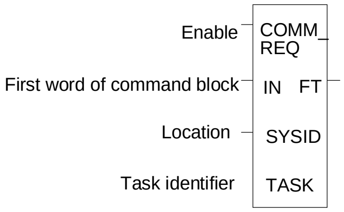
Details of RTU and SNP protocol are described in the *Serial Communications User's Manual* (GFK-0582).

Format of the Communication Request Function

Serial I/O is implemented through the use of Communication Request (COMMREQ) functions. The operations of the protocol, such as transmitting a character through the serial port or waiting for an input character, are implemented through the COMMREQ function block. In CPUE05, Serial I/O is not available for Port 1 when that port is configured or forced for Station Manager operation.

The COMMREQ requires that all its command data be placed in the correct order (in a *command block*) in the CPU memory before it is executed. The COMMREQ should then be executed by a contact of a one-shot coil to prevent sending the data multiple times. A series of Block Move (BLKMV) commands should be used to move the words to create a command block in the Register tables.

The COMMREQ function has three inputs and one output. When the function receives power flow, a command block of data is sent to the specified module.



Parameters of the COMMREQ Function

Input/ Output	Choices	Description
enable	flow	When the function is energized, the communications request is performed.
IN	R, AI, AQ	IN contains the first word of the command block.
SYSID	I, Q, M, T, G, R, AI, AQ, constant	SYSID contains the rack number (most significant byte) and slot number (least significant byte) of the target device. For the CPU, SYSID must specify rack/slot 0.
TASK	R AI, AQ, constant	TASK specifies the port for which the operation is intended: task 19 for port 1 task 20 for port 2
FT	flow, none	FT is energized if an error is detected processing the COMMREQ: • The specified target address is not present (SYSID). • The specified task is not valid for the device (TASK). • The data length is 0. • The device’s status pointer address (in the command block) does not exist.

Command Block for the COMMREQ Function

The Command Block starts at the reference specified in COMMREQ parameter IN. The length of the Command Block depends on the amount of data sent to the device.

The Command Block contains the data to be communicated to the other device, plus information related to the execution of the COMMREQ. The Command Block has the following structure:

address	Length (in words)
address + 1	Wait/No Wait Flag
address + 2	Status Pointer Memory
address + 3	Status Pointer Offset
address + 4	Idle Timeout Value
address + 5	Maximum Communication Time
address + 6 to address + 133	Data Block

Example of the COMMREQ Function

In the example, when %M0021 is ON, a Command Block located starting at %R0032 is sent to port 2 (communications task 20) of the CPU (rack 0, slot 0). If an error occurs processing the COMMREQ, %Q0110 is set.

Configuring Serial Ports Using the COMMREQ Function

The following tables list the command block values required for setting up a Serial Port for SNP, RTU, and Serial I/O. All values are in hexadecimal unless otherwise indicated. The BLKMV commands that are used to create the command block are described in the example.

It is important to note that 2 parameters have been added to the RTU and Serial IO port configuration COMMREQ, receive to transmit delay and RTS drop delay. When these parameters are included in a COMMREQ the data block length must be set to 12H. If a value of 10H is used, the COMMREQ will still be processed however the receive to transmit and RTS drop delays would not be recognized. It is also important to note that if a COMMREQ containing the receive to transmit delay and RTS drop delay is sent to a CPU that does not support these delay features the CPU will accept and process the COMMREQ but will ignore the receive to transmit, RTS drop delay, and turnaround delay (i.e. turn around delay will be ignored only for the RTU and Serial IO protocols in this case).

Note: Either the old form (length 10H) or the new form (length 12H) of the COMMREQ can be used. Only the new form supports the new parameters.

Timing

If a port configuration COMMREQ is sent to a serial port that currently has an SNP/SNPX master (for example, the programmer) connected to it, the serial port configuration specified by the COMMREQ does not take effect until the CPU detects a loss of the SNP/SNPX master. This occurs the configured T3' time after the master disconnects. The COMMREQ status word for the port configuration COMMREQ is updated as soon as the CPU verifies that the specified configuration is valid. That means a COMMREQ Successful value may be returned by the Port Configuration COMMREQ before the specified configuration is actually installed.

Sending Another COMMREQ to the Same Port

The application program must wait at least 2 seconds plus the configured T3' time after a new serial port protocol is installed before sending any COMMREQs specific to that protocol to the port. This applies to a new protocol installed by Storing a new hardware configuration or by a port configuration COMMREQ. If the port is configured for Serial I/O, this waiting period must also follow any Stop to Run mode transition of the CPU.

Invalid Port Configuration Combinations

The configurations of both ports must be compatible. One port must be available for PLC programmer connection.

The CPU rejects the following combinations:

Port 1	Port 2
Disabled	Disabled
Disabled	Serial I/O (CPU Run/Stop switch disabled)
Serial I/O (CPU Run/Stop switch disabled)	Disabled
Serial I/O (CPU Run/Stop switch disabled)	Serial I/O (CPU Run/Stop switch disabled)
Station Manager	Disabled
Station Manager	Serial I/O (CPU Run/Stop switch disabled)

RTU Slave/SNP Slave Operation With Programmer Attached

A programmer (an SNP/SNPX device) can be attached to port 1 or port 2 while RTU Slave mode is active on the port. For multi-drop connections, the CPU must have been configured to use an appropriate PLC ID. Note that for a multi-drop SNP connection with the port currently configured for RTU, the SNP ID associated with the CPU settings must match the multi-drop ID.

The programmer must use the same serial communications parameters (baud rate, parity, stop bits, etc…) as the currently-active RTU Slave protocol for it to be recognized.

When the CPU recognizes the programmer, the CPU removes the RTU Slave protocol from the port and installs SNP Slave as the currently-active protocol. The SNP ID, modem turnaround time, and default idletime for this new SNP Slave session are obtained from the configured CPU settings, not the port 1 or port 2 configurations. Connection should be established within 12 seconds. When the programmer connection has been enabled, normal programmer communications can take place. (Failure of the programmer to establish communications within 12 seconds is treated as a Loss of Programmer Communications).

The programmer may send a new protocol via configuration or a Serial Port Setup COMMREQ. (COMMREQs not supported by SNP Slave protocol are rejected). If a new protocol is received, it will not take effect until the programmer is disconnected.

After the programmer is removed, there is a slight delay (equal to the configured SNP T3’ timeout) before the CPU recognizes its absence. During this time, no messages are processed on the port. The CPU detects removal of the programmer as an SNP Slave protocol timeout. Therefore, it is important to be careful when disabling timeouts used by the SNP Slave protocol.

When the CPU recognizes the disconnect, it reinstalls RTU Slave protocol unless a new protocol has been received. In that case, the CPU installs the new protocol instead.

Example

1. Port 1 is running RTU Slave protocol at 9600 baud.
2. A programmer is attached to port 1. The programmer is using 9600 baud.
3. The CPU installs SNP Slave on port 1 and the programmer communicates normally.
4. The programmer stores a new configuration to port 1. The new configuration sets the port for SNP Slave at 4800 baud (it will not take effect until the port loses communications with the programmer).
5. When the CPU loses communications with the programmer, the new configuration takes effect.

Example COMMREQ Command Block for Configuring SNP Protocol

	Values	Meaning
Address	10H	Data Block Length
Address + 1	0 = No Wait	WAIT/NOWAIT Flag
Address + 2	0008 = %R, register memory	Status Word Pointer Memory Type
Address + 3	Zero-based number that gives the address of the COMMREQ status word (for example, a value of 99 gives an address of 100 for the status word)	Status Word Pointer Offset
Address + 4	0 (Only used in Wait/No Wait mode)	Idle Timeout Value
Address + 5	0 (Only used in Wait/No Wait mode)	Maximum Communication Time
Address + 6	FFF0H	Command Word (serial port setup)
Address + 7	0001	Protocol: 1=SNP
Address + 8	0000=Slave	Port Mode
Address + 9	7=38400, 6=19200, 5=9600, 4=4800	Data Rate
Address + 10	0 = None, 1 = Odd, 2 = Even	Parity
Address + 11	1 = None	Flow Control
Address + 12	0 = None, 1 = 10ms, 2 = 100ms, 3 = 500ms	Turnaround Delay
Address + 13	0 = Long, 1 = Medium, 2 = Short, 3 = None	Timeout
Address + 14	1 = 8 bits	Bits Per Character
Address + 15	0 = 1 Stop Bit, 1 = 2 Stop bits	Stop Bits
Address + 16	not used	Interface
Address + 17	not used	Duplex Mode
Address + 18	user-provided*	Device identifier bytes 1 and 2
Address + 19	user-provided*	Device identifier bytes 3 and 4
Address + 20	user-provided*	Device identifier bytes 5 and 6
Address + 21	user-provided*	Device identifier bytes 7 and 8

* The device identifier for SNP Slave ports is packed into words with the least significant character in the least significant byte of the word. For example, if the first two characters are “A” and “B,” the Address + 18 will contain the hex value 4241.

Example COMMREQ Data Block for Configuring RTU Protocol

	Values	Meaning
First 6 words		Reserved for COMMREQ use.
Address + 6	FFF0H	Command
Address + 7	0003	Protocol: 0003=RTU
Address + 8	0000	Port Mode: 0000=Slave
Address + 9	2=1200, 3-2400, 4=4800, 5=9600, 6=19200,7=38400*, 8=57600** *CPU models IC200CPU005 and CPUE05 only	Data Rate
Address + 10	0 = None, 1 = Odd, 2 = Even	Parity
Address + 11	0 = Hardware, 1 = None	Flow Control
Address + 12	0-255 (units of 10ms,e.g. 10=100ms)	Turnaround delay
Address + 13	not used	Timeout
Address + 14	not used	Bits per Character
Address + 15	not used	Stop Bits
Address + 16	not used	Interface
Address + 17	0 = 2-wire, 1 = 4-wire	Duplex Mode
Address + 18	Station Address (1-247)	Device Identifier
Address + 19—21	not used	Device Identifier
Address + 22*	0-255 (units of 10ms,e.g. 10=100ms)	Receive to transmit delay
Address + 22*	0-255 (units of 10ms,e.g. 10=100ms)	RTS drop delay

Notes

The data block length (Address + 0) for a COMMREQ that includes the Receive to transmit delay and RTS drop delay should be 12H not 10H. Both forms (Length 10H and 12H) are supported

If RTU is configured for 115.2K baud. a major error code 12 (0cH) and a minor error code 2 (02H) is returned in the COMMREQ status word. This will occur for any unsupported baud rate.

Example COMMREQ Data Block for Configuring Serial I/O Protocol

	Values	Meaning
First 6 words		Reserved for COMMREQ use.
Address + 6	FFF0H	Command
Address + 7	0005	Protocol: 0005=Serial IO
Address + 8	0 = Slave	Port Mode
Address + 9	4=4800, 5=9600, 6=19200, 7=38400*, 8=57600** *CPU models IC200CPU005 and CPUE05 only	Data Rate
Address + 10	0 = None, 1 = Odd, 2 = Even	Parity
Address + 11	0 = Hardware, 1 = None	Flow Control
Address + 12	0-255 (units of 10ms,e.g. 10=100ms)	Turnaround Delay
Address + 13	0 = Long	Timeout
Address + 14	0=7 bits, 1=8 bits	Bits per Character
Address + 15	0 = 1 stop bit, 1 = 2 stop bits	Stop Bits
Address + 16	not used	Interface
Address + 17	0 = 2-wire, 1 = 4-wire	Duplex Mode
Address + 18—21	not used	Device Identifier
Address + 22*	0-255 (units of 10ms,e.g. 10=100ms)	Receive to transmit delay
Address + 22*	0-255 (units of 10ms,e.g. 10=100ms)	RTS drop delay

Notes

The data block length (Address + 0) for a COMMREQ that includes the Receive to transmit delay and RTS drop delay should be 12H not 10H. Both forms (Length 10H and 12H) are supported.

If Serial I/O is configured for 115.2K baud. a major error code 12 (0cH) and a minor error code 2 (02H) is returned in the COMMREQ status word. This will occur for any unsupported baud rate.

Calling Serial I/O COMMREQs from the PLC Sweep

Implementing a serial protocol using Serial I/O COMMREQs may be restricted by the PLC sweep time. For example, if the protocol requires that a reply to a certain message from the remote device be initiated within 5mS of receiving the message, this method may not be successful if the PLC sweep time is 5mS or longer, since timely response is not guaranteed.

Since the Serial I/O is completely driven by the application program, in STOP mode a port configured as Serial I/O automatically reverts to SNP slave, to facilitate programmer communication. Therefore, while in Stop mode, Serial I/O protocol is not active; it is only active when the PLC is in Run mode.

When the port reverts back to SNP Slave, the same serial communications parameters (baud rate, parity, stop bits …) as the currently-active Serial I/O protocol are used. Therefore the programmer must use the same parameters for it to be recognized. If any of the parameter values associated with the Serial I/O protocol are not supported by the SNP Slave protocol, the programmer will not be able to communicate with the PLC via that port.

Compatibility

The COMMREQ function blocks supported by Serial I/O are not supported by other currently-existing protocols (such as SNP slave, SNP master, and RTU slave). Errors are returned if they are attempted for a port configured for one of those protocols.

Status Word for Serial I/O COMMREQs

A value of 1 is returned in the COMMREQ status word upon successful completion of the COMMREQ. Any other value returned is an error code where the low byte is a major error code and the high byte is a minor error code.

Major Error Code	Description	
1 (01h)	Successful Completion (this is the expected completion value in the COMMREQ status word).	
12 (0Ch)	Local error —Error processing a local command. The minor error code identifies the specific error.	
	1 (01h)	Wait-type command is not permitted. Use No-Wait command.
	2 (02h)	COMMREQ command is not supported.
	5 (05h)	Error writing COMMREQ status word to PLC memory.
	6 (06h)	Invalid PLC memory type specified.
	7 (07h)	Invalid PLC memory offset specified.
	8 (08h)	Unable to access PLC memory.
	9 (09h)	Data length exceeded.
	12 (0Ch)	COMMREQ data block length too small.
	14 (0Eh)	COMMREQ data is invalid.
	15 (0Fh)	Could not allocate system resources to complete COMMREQ.
13 (0Dh)	Remote error — Error processing a remote command. The minor error code identifies the error.	
	2 (02h)	Number of bytes requested to read is greater than input buffer size OR number bytes requested to write is zero or greater than 250 bytes.
	3 (03h)	COMMREQ data block length is too small. String data is missing or incomplete.
	4 (04h)	Receive timeout awaiting serial reception of data
	8 (08h)	Unable to access PLC memory.
	12 (0Ch)	COMMREQ data block length too small.
	48 (30h)	Serial output timeout. The serial port was unable to transmit the string. (Could be due to missing CTS signal when the serial port is configured to use hardware flow control.)
	50 (32h)	COMMREQ timeout. The COMMREQ did not complete within a 20-second time limit.
14 (0Eh)	Autodial Error — An error occurred while attempting to send a command string to an attached external modem. The minor error code identifies the specific error.	
	1 (01h)	Not used.
	2 (02h)	The modem command string length exceeds end of reference memory type.
	3 (03h)	COMMREQ Data Block Length too small. Output command string data missing or incomplete.
	4 (04h)	Serial output timeout. The serial port was unable to transmit the modem autodial output.
	5 (05h)	Response was not received from modem. Check modem and cable.
	6 (06h)	Modem responded with BUSY. Modem is unable to complete the requested connection. The remote modem is already in use; retry the connection request later.
	7 (07h)	Modem responded with NO CARRIER. Modem is unable to complete the requested connection. Check the local and remote modems and the telephone line.
	8 (08h)	Modem responded with NO DIALTONE. Modem is unable to complete the requested connection. Check the modem connections and the telephone line.
	9 (09h)	Modem responded with ERROR. Modem is unable to complete the requested command. Check the modem command string and modem.
	10 (0Ah)	Modem responded with RING, indicating that the modem is being called by another modem. Modem is unable to complete the requested command. Retry the modem command later.
	11 (0Bh)	Unknown response received from the modem. Modem unable to complete the request. Check the modem command string and modem. Response should be CONNECT or OK.
	50 (32h)	COMMREQ timeout. The COMMREQ did not complete within a 20-second time limit.

Serial I/O COMMREQ Commands

The following COMMREQs are used to implement Serial I/O:

- Local COMMREQs - do not receive or transmit data through the serial port.
    - ☐ Initialize Port (4300)
    - ☐ Set Up Input Buffer (4301)
    - ☐ Flush Input Buffer (4302)
    - ☐ Read Port Status (4303)
    - ☐ Write Port Control (4304)
    - ☐ Cancel Operation (4399)
- Remote COMMREQs - receive and/or transmit data through the serial port.
    - ☐ Autodial (4400)
    - ☐ Write Bytes (4401)
    - ☐ Read Bytes (4402)
    - ☐ Read String (4403)

Overlapping COMMREQs

Some of the Serial I/O COMMREQs must complete execution before another COMMREQ can be processed. Others can be left pending while others are executed.

COMMREQS that Must Complete Execution

- Autodial (4400)
- Initialize Port (4300)
- Set Up Input Buffer (4301)
- Flush Input Buffer (4302)
- Read Port Status (4303)
- Write Port Control (4304)
- Cancel Operation (4399)
- Serial Port Setup (FFF0)

COMMREQs that Can be Pending While Others Execute

The table below shows whether Write Bytes, Read Bytes and Read String COMMREQs can be pending when other COMMREQs are executed.

	NEW COMMREQ										
Currently-pending COMMREQs	Autodial (4400)	Write Bytes (4401)	Initialize Port (4300)	Set Up Input Buffer (4301)	Flush Input Buffer (4302)	Read Port Status (4303)	Write Port Control (4304	Read Bytes (4402)	Read String (4403)	Cancel Operation (4399)	Serial Port Setup (FFF0)
Write Bytes (4401)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Read Bytes (4402)	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No
Read String (4403)	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No

Initialize Port Function (4300)

This function causes a reset command to be sent to the specified port. It also cancels any COMMREQ currently in progress and flushes the internal input buffer. RTS is set to inactive.

Example Command Block for the Initialize Port Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0001	0001	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4300	10CC	Initialize port command

Operating Notes

Note: COMMREQs that are cancelled due to this command executing do not have their respective COMMREQ status words updated.

Caution: If this COMMREQ is sent when a Write Bytes (4401) COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the CPU is sending to is also indeterminate.

Set Up Input Buffer Function (4301)

This function can be used to change the size of the internal memory buffer where input data will be placed as it is received. By default, the buffer is set to a maximum of 2K *bytes.* As data is received from the serial port it is placed in the input buffer. If the buffer becomes full, any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

Retrieving Data from the Buffer

Data can be retrieved from the buffer using the Read String or Read Bytes function. It is not directly accessible from the application program.

If data is not retrieved from the buffer in a timely fashion, some characters may be lost.

Example Command Block for the Set Up Input Buffer Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0002	0002	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4301	10CD	Setup input buffer command
address +7	0064	0040	Buffer length (in words)

Operating Notes

It is not possible to set the buffer length to zero. If zero is entered as the buffer length, the buffer size will be set to the 2K bytes default.

If a length greater than 2K bytes is specified, an error is generated.

Flush Input Buffer Function (4302)

This operation empties the input buffer of any characters received through the serial port but not yet retrieved using a read command. All such characters are lost.

Example Command Block for the Flush Input Buffer Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0001	0001	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4302	10CE	Flush input buffer command

Read Port Status Function (4303)

This function returns the current status of the port. The following events can be detected:

1. A read request was initiated previously and the required number of characters has now been received or the specified time-out has elapsed.
2. A write request was initiated previously and transmission of the specified number of characters is complete or a time-out has elapsed.

The status returned by the function indicates the event or events that have completed. More than one condition can occur simultaneously, if both a read and a write were initiated previously.

Example Command Block for the Read Port Status Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0003	0003	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4303	10CF	Read port status command
address +7	0076	004C	Port status memory type (%M)
address +8	0101	0065	Port status memory offset (%M101)

Port Status

The port status consists of a status word and the number of characters in the input buffer that have not been retrieved by the application (characters which have been received and are available).

word 1	Port status word (see below)
word 2	Characters available in the input buffer

The Port Status Word can be:

Bit	Name	Definition	Meaning	
15	RI	Read In progress	Set	Read Bytes or Read String invoked
			Cleared	Previous Read bytes or String has timed out, been canceled, or finished
14	RS	Read Success	Set	Read Bytes or Read String has successfully completed
			Cleared	New Read Bytes or Read String invoked
13	RT	Read Time-out	Set	Receive timeout occurred during Read Bytes or Read String
			Cleared	New Read Bytes or Read String invoked
12	WI	Write In progress	Set	New Write Bytes invoked
			Cleared	Previously-invoked Write Bytes has timed out, been canceled, or finished
11	WS	Write Success	Set	Previously-invoked Write Bytes has successfully completed
			Cleared	New Write Bytes invoked
10	WT	Write Time-out	Set	Transmit timeout occurred during Write Bytes
			Cleared	New Write Bytes invoked
9	CA	Character Available	Set	Unread characters are in the buffer
			Cleared	No unread characters in the buffer
8	OF	OverFlow error	Set	Overflow error occurred on the serial port or internal buffer
			Cleared	Read Port Status invoked
7	FE	Framing Error	Set	Framing error occurred on the serial port
			Cleared	Read Port Status invoked
6	PE	Parity Error	Set	Parity error occurred on the serial port
			Cleared	Read Port Status invoked
5	CT	CTS is active	Set	CTS line on the serial port is active or the serial port does not have a CTS line
			Cleared	CTS line on the serial port is not active
4 - 0	U	not used, should be 0		

Write Port Control Function (4304)

This function forces RTS for the specified port:

Example Command Block for the Write Port Control Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0002	0002	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4304	10D0	Write port control command
address +7	xxxx	xxxx	Port control word

Port Control Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RTS	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

The Port Control Word can be:

15	**RTS**	Commanded state of the **RTS** output 1 = Activates RTS 0 = Deactivates RTS
0-14	**U**	**U**nused (should be zero)

Operating Note

For CPU port 2 (RS-485), the RTS signal is also controlled by the transmit driver. Therefore, control of RTS is dependent on the current state of the transmit driver. If the transmit driver is not enabled, asserting RTS with the Write Port Control COMMREQ will not cause RTS to be asserted on the serial line. The state of the transmit driver is controlled by the protocol and is dependent on the current Duplex Mode of the port. For 2-wire and 4-wire Duplex Mode, the transmit driver is only enabled during transmitting. Therefore, RTS on the serial line will only be seen active on port 2 (configured for 2-wire or 4-wire Duplex Mode) when data is being transmitted. For point-to-point Duplex Mode, the transmit driver is always enabled. Therefore, in point-to-point Duplex Mode, RTS on the serial line will always reflect what is chosen with the Write Port Control COMMREQ.

Cancel Commreq Function (4399)

This function cancels the current operations in progress. It can be used to cancel both read operations and write operations.

If a read operation is in progress and there are unprocessed characters in the input buffer, those characters are left in the input buffer and available for future reads. The serial port is not reset.

Example Command Block for the Cancel Operation Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0002	0002	Data block length (2)
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4399	112F	Cancel operation command
address +7	0001	0001	Transaction type to cancel 1 All operations 2 Read operations 3 Write operations

Operating Notes

This function does not update the status of words of the cancelled COMMREQs.

Caution: If this COMMREQ is sent in either Cancel All or Cancel Write mode when a Write Bytes (4401) COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the CPU is sending to is also indeterminate.

Autodial Function (4400)

This feature allows the VersaMax CPU to automatically dial a modem and send a specified byte string.

To implement this feature, the port must be configured for Serial I/O.

For example, pager enunciation can be implemented by three commands, requiring three COMMREQ command blocks:

Autodial: 04400 (1130h) Dials the modem.

Write Bytes: 04401 (1131h) Specifies an ASCII string, from 1 to 250 bytes in length, to send from the serial port.

Autodial: 04400 (1130h) It is the responsibility of the PLC application program to hang up the phone connection. This is accomplished by reissuing the autodial command and sending the hang up command string.

Autodial Command Block

The Autodial command automatically transmits an Escape sequence that follows the Hayes convention. If you are using a modem that does not support the Hayes convention, you may be able to use the Write Bytes command to dial the modem.

Examples of commonly used command strings for Hayes-compatible modems are listed below:

Command String	Length	Function
ATDP15035559999<CR>	16 (10h)	Pulse dial the number 1-503-555-9999
ATDT15035559999<CR>	16 (10h)	Tone dial the number 1-503-555-9999
ATDT9,15035559999<CR>	18 (12h)	Tone dial using outside line with pause
ATH0<CR>	5 (05h)	Hang up the phone
ATZ <CR>	4 (04h)	Restore modem configuration to internally saved values

Example Autodial Command Block

This example COMMREQ command block dials the number 234-5678 using a Hayes-compatible modem.

Word	Definition	Values
1	0009h	CUSTOM data block length (includes command string)
2	0000h	NOWAIT mode
3	0008h	Status word memory type (%R)
4	0000h	Status word address minus 1 (Register 1)
5	0000h	not used
6	0000h	not used
7	04400 (1130h)	Autodial command number
8	00030 (001Eh)	Modem response timeout (30 seconds)
9	0012 (000Ch)	Number of bytes in command string
10	5441h	A (41h), T (54h)
11	5444h	D (44h), T (54h)
12	3332h	Phone number: 2 (32h), 3 (33h)
13	3534h	4 (34h), 5 (35h)
14	3736h	6 (36h), 7 (37h)
15	0D38h	8 (38h) <CR> (0Dh)

Write Bytes Function (4401)

This operation can be used to transmit one or more characters to the remote device through the specified serial port. The character(s) to be transmitted must be in a word reference memory . They should not be changed until the operation is complete.

Up to 250 characters can be transmitted with a single invocation of this operation. The status of the operation is not complete until all of the characters have been transmitted or until a timeout occurs (for example, if hardware flow control is being used and the remote device never enables the transmission).

Example Command Block for the Write Bytes Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0006	0006	Data block length (includes characters to send)
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4401	1131	Write bytes command
address +7	0030	001E	Transmit time-out (30 seconds). See note below.
address +8	0005	0005	Number of bytes to write
address +9	25960	6568	‘h’ (68h), ‘e’ (65h)
address +10	27756	6C6C	‘l’ (6Ch), ‘l’ (6Ch)
address +11	0111	006F	‘o’ (6Fh)

Although printable ASCII characters are used in this example, there is no restriction on the values of the characters which can be transmitted.

Operating Notes

Note: Specifying zero as the Transmit time-out sets the time-out value to the amount of time actually needed to transmit the data, plus 4 seconds.

Caution: If an Initialize Port (4300) COMMEQ is sent or a Cancel Operation (4399) COMMREQ is sent in either Cancel All or Cancel Write mode while this COMMREQ is transmitting a string from a serial port, transmission is halted. The position within the string where the transmission is halted is indeterminate. In addition, the final character received by the device the CPU is sending to is also indeterminate.

Read Bytes Function (4402)

This function causes one or more characters to be read from the specified port. The characters are read from the internal input buffer and placed in the specified input data area.

The function returns both the number of characters retrieved and the number of unprocessed characters still in the input buffer. If zero characters of input are requested, only the number of unprocessed characters in the input buffer is returned.

If insufficient characters are available to satisfy the request and a non-zero value is specified for the number of characters to read, the status of the operation is not complete until either sufficient characters have been received or the time-out interval expires. In either of those conditions, the port status indicates the reason for completion of the read operation. The status word is not updated until the read operation is complete (either due to timeout or when all the data has been received).

If the time-out interval is set to zero, the COMMREQ remains pending until it has received the requested amount of data, or until it is cancelled.

If this COMMREQ fails for any reason, no data is returned to the buffer. Any data that was already in the buffer remains, and can be retrieved with a subsequent read request.

Example Command Block for the Read Bytes Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0005	0005	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4402	1132	Read bytes command
address +7	0030	001E	Read time-out (30 seconds)
address +8	0005	0005	Number of bytes to read
address +9	0008	0008	Input data memory type (%R).
address +10	0100	0064	Input data memory address (%R0100)

Return Data Format for the Read Bytes Function

The return data consists of the number of characters actually read, the number of characters still available in the input buffer after the read is complete (if any), and the actual input characters.

Address	Number of characters actually read
Address + 1	Number of characters still available in the input buffer, if any
Address + 2	first two characters (first character is in the low byte)
Address + 3	third and fourth characters (third character is in the low byte)
Address + n	subsequent characters

Operating Note

If the input data memory type parameter is specified to be a word memory type, and if an odd number of bytes are actually received, then the high byte of the last word to be written with the received data is set to zero.

As data is received from the serial port it is placed in the internal input buffer. If the buffer becomes full, then any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

Read String Function (4403)

This function causes characters to be read from the specified port until a specified terminating character is received. The characters are read from the internal input buffer and placed in the specified input data area.

The function returns both the number of characters retrieved and the number of unprocessed characters still in the input buffer. If zero characters of input are requested, only the number of unprocessed characters in the input buffer are returned.

If the terminating character is not in the input buffer, the status of the operation is not complete until either the terminating character has been received or the time-out interval expires. In either of those conditions, the port status indicates the reason for completion of the read operation.

If the time-out interval is set to zero, the COMMREQ remains pending until it has received the requested string, terminated by the specified end character.

If this COMMREQ fails for any reason, no data is returned to the buffer. Any data that was already in the buffer remains, and can be retrieved with a subsequent read request.

Example Command Block for the Read String Function

	VALUE (decimal)	VALUE (hexadecimal)	MEANING
address	0005	0005	Data block length
address +1	0000	0000	NOWAIT mode
address +2	0008	0008	Status word memory type (%R)
address +3	0000	0000	Status word address minus 1 (%R0001)
address +4	0000	0000	Not used
address +5	0000	0000	Not used
address +6	4403	1133	Read string command
address +7	0030	001E	Read time-out (30 seconds)
address +8	0013	000D	Terminating character (carriage return): must be between 0 and 255 (0xFF), inclusive
address +9	0008	0008	Input data memory type (%R)
address +10	0100	0064	Input data memory address (%R0100)

Return Data Format for the Read String Function

The return data consists of the number of characters actually read, the number of characters still available in the input buffer after the read is complete (if any), and the actual input characters:

Address	Number of characters actually read
Address + 1	Number of characters still available in the input buffer, if any
Address + 2	first two characters (first character is in the low byte)
Address + 3	third and fourth characters (third character is in the low byte)
Address + n	subsequent characters

Operating Note

If the input data memory type parameter is specified to be a word memory type, and if an odd number of bytes are actually received, then the high byte of the last word to be written with the received data is set to zero.

As data is received from the serial port it is placed in the internal input buffer. If the buffer becomes full, then any additional data received from the serial port is discarded and the Overflow Error bit in the Port Status word (See Read Port Status Function) is set.

Chapter 13

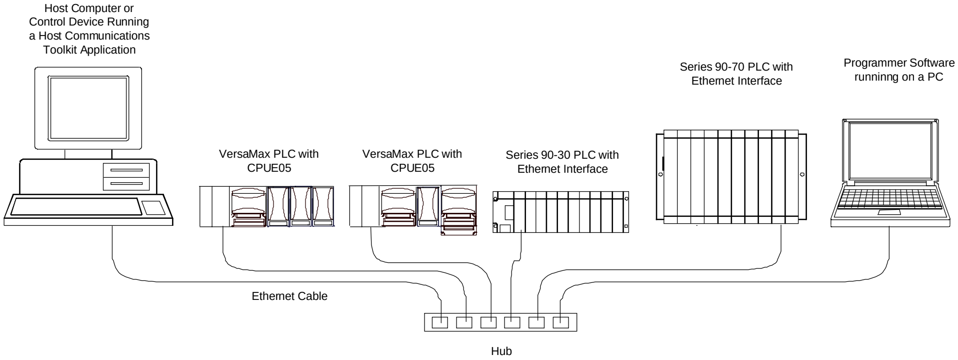
Ethernet Communications

This chapter describes the Ethernet communications features of VersaMax® CPU model IC200CPUE05.

- Overview of the Ethernet interface
- IP Addressing
- Routers
- Ethernet Global Data
- Checking the status of an Ethernet Global Data exchange
- Diagnostic Tools
- Troubleshooting Common Ethernet Difficulties

Overview of the Ethernet Interface

VersaMax CPU model IC200CPUE05 has a built-in Ethernet interface that makes it possible to communicate on a 10BaseT network in either half-duplex or full-duplex mode. Using 10/100 hubs allows CPUE05 to communicate on a network containing 100Mb devices.-



Use the Ethernet interface to:

- ***Send and receive Ethernet Global Data.*** Ethernet Global Data can be used for highly efficient periodic data transfer on the LAN.
- ***Access data from CPUE05 using a Host computer.*** Computer applications can access data from CPUE05 through its SRTP server capability.
- ***Communicate simultaneously to multiple devices.*** The multiplexing capabilities of Ethernet interface, along with Ethernet network's high capacity, allow CPUE05 to communicate with several other devices at the same time.
- ***Indirectly attach to other Local Area Networks and/or wide area networks via third party IP routers.*** CPUE05 can communicate with remote PLCs and other nodes via an IP Router.
- ***Communicate with remote computers via Serial Line Protocol (SLIP) using modems and/or serial lines.*** Using third party SLIP devices, a remote host computer can be attached to a TCP/IP network. Once attached, the serial communications can be routed over the Ethernet interface to the CPUE05.
- ***Maintain compatibility with other devices.*** CPUE05 is compatible with the GE Fanuc Series 90-30 Ethernet Interface, Series 90-30 CPU364 Embedded Ethernet Interface, and Series 90-70 Ethernet Interface (Type 2). It is also compatible with GE Fanuc programming packages supporting TCP/IP Ethernet communications.

Ethernet Global Data

CPUE05 also supports up to 32 simultaneous Ethernet Global Data exchanges. Ethernet Global Data exchanges are configured using the PLC programming software, then stored to the PLC. Both Produced and Consumed exchanges may be configured. CPUE05 supports up to 1200 data ranges across all Ethernet Global Data exchanges, and can be configured for selective consumption of Ethernet Global Data exchanges.

SRTP Server

CPUE05 supports up to eight simultaneous SRTP Server connections for use by other devices on the Ethernet network, such as the PLC programmer, CIMPLICITY HMI, SRTP channels for Series 90 PLCs, and Host Communications Toolkit applications. No PLC programming is required for server operation.

SRTP Channels

SRTP Channels can be used by a Series 90-30 or Series 90-70 PLC to communicate with CPUE05. The CPUE05 cannot initiate SRTP channels.

Attachment to the Ethernet LAN

The Ethernet port uses a twisted pair cable of up to 100 meters in length between each node and a hub or repeater. Typical hubs or repeaters support 4 to 12 nodes connected in a star wiring topology.

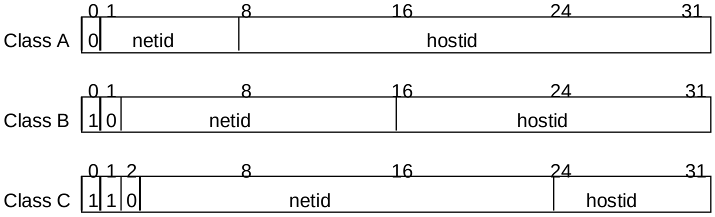
The Station Manager Software

CPUE05 provides built-in Station Manager support. It accommodates on-line diagnostic and supervisory access through either the Station Manager port or via Ethernet. Station Manager services include:

- An interactive set of commands for interrogating and controlling the station.
- Unrestricted access to observe internal statistics, an exception log, and configuration parameters.
- Password security for commands that change station parameters or operation.
- Access to the Station Manager requires a user-provided computer terminal or terminal emulator.

IP Addressing

The CPUE05 must have a unique IP address that identifies it on the Ethernet network. The IP Address is assigned using the configuration software, as described in chapter 6. The IP address is 32 bits long and has a *netid* part and a *hostid* part. The format of the IP address depends on the network class:



Each IP address on a network has:

- The same class. Each network is a Class A, Class B or Class C network. A Class A network can support 16,777,214 hosts, Class B: 65,534 hosts, and Class C: 254 hosts.
- The same *netid*, which is generally assigned by the Internet authorities
- A different *hostid*, giving it a unique IP address. The *hostid* is generally assigned by your local network administrator.

IP addresses are written in “dotted-decimal” format as four decimal integers (0-255) separated by periods. Each integer represents one byte of the IP address. For example, the 32-bit IP address

00001010 00000000 00000000 00000001

is written as

10.0.0.1

The class of an IP address is indicated by the first decimal integer:

Range of first integer	Class
0 - 127	A
128 - 191	B
192 - 223	C
224-239	D (Reserved for Multicast Use)
240 - 255	E (Reserved for Experimental Use)

RFC 1918 reserves IP addresses in the following ranges for private networks.

10.0.0.0 – 10.255.255.255	(Class A)
172.16.0.0 – 172.31.255.255	(Class B)
192.168.0.0 – 192.168.255.255	(Class C)

x.y.z.1 is reserved for gateways.

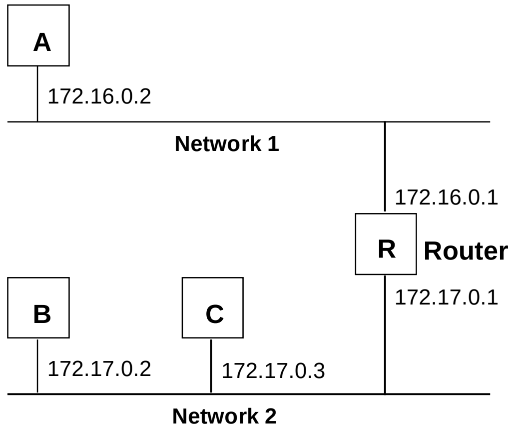
x.y.z.255 is reserved for subnet broadcast

Routers

Routers connect individual physical networks into a system of networks. When a node on one network needs to communicate with a node on another network, a Router transfers the data between the two networks.

Example: Networks Connected by a Router

The following figure shows Network 1 and Network 2 connected by Router R.



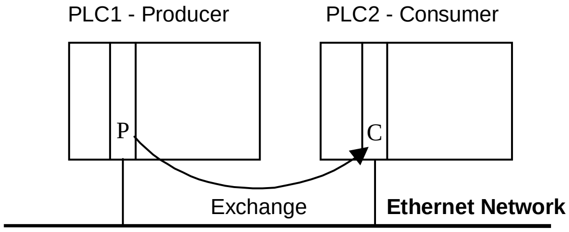
Host B can communicate with host C directly because they are on the same network. Their IP addresses have the same *netid.*

However, to send data to host A, which is on another network (it has a different *netid,*) host B must send it via the router. The router has two IP addresses (172.16.0.1 and 172.17.0.1). The first is used by hosts on Network 1 and the second is used by hosts on Network 2. In this example, the router's IP address on Network 2 is 172.17.0.1. This address would be configured in host B as its default "gateway" address.

Ethernet Global Data

Ethernet Global Data is data that is automatically sent from one Ethernet device to one or more others. Once Ethernet Global Data has been configured, the data is sent automatically during system operation. No program interaction is necessary to produce or consume the global data.

The device that sends the Ethernet Global Data is called the *producer*. Each device that receives Ethernet Global Data is called a *consumer*. Each unique Ethernet Global Data message is called an *exchange*.



Ethernet Global Data provides simple, regular communication of data between devices. It should not be used for event notification if possible loss of data would be significant.

VersaMax CPU IC200CPUE05 can be configured for up to 32 produced Ethernet Global Data exchanges (total of Produced and Consumed) s. Each Ethernet Global Data exchange must be configured individually for each PLC and consists of one or more data ranges. See chapter 6 for configuration information.

The Frequency of Sending/Receiving an Exchange

During configuration, the repetition period of each Ethernet Global Data exchange is set up for the producer. The range is 10 milliseconds to 1 hour, which is selectable in increments of 10 mS. It is not necessary to produce and consume data faster than the application requires. This reduces the load on the network and on the devices, providing capacity for other transfers.

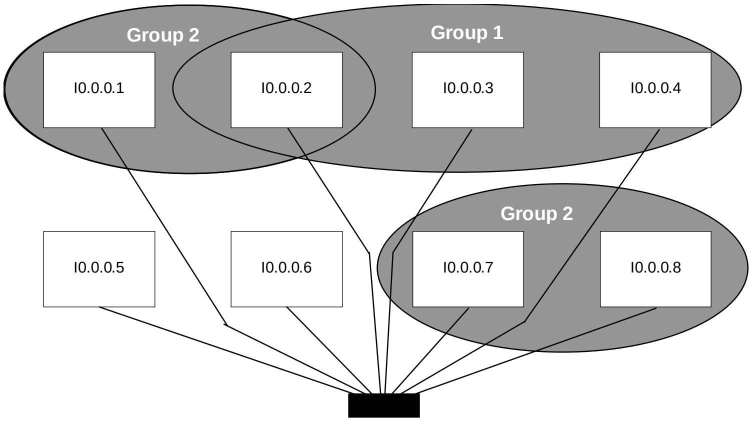
The Consumer Update Timeout Period

As part of the configuration for each consumed exchange, a “timeout period” can be set up for the exchange. The CPU reports an error if the first or subsequent packet of data has not arrived within the specified time. The range is 0 for no timeout detection, or 10 to 3,600,000 milliseconds. The consumer’s timeout period should be greater than the producer’s repetition period. GE Fanuc recommends that the consumer timeout be set to no lower than twice the production period,

Ethernet Global Data Groups

If more than one device on the network should consume a Global Data exchange, those devices can be set up as a group. The network can include up to 32 numbered groups. Groups allow each sample from the producer to be seen simultaneously by all consumers in the group.

A device can belong to more than one group, as illustrated below.



Each device in a group responds to the group’s assigned ID number. For CPUE05, the Group IDs are 1 to 32.

Each Group ID corresponds to a Multicast (Class D) IP address reserved by the Internet authorities. The default Multicast IP addresses used by Ethernet Global Data are:

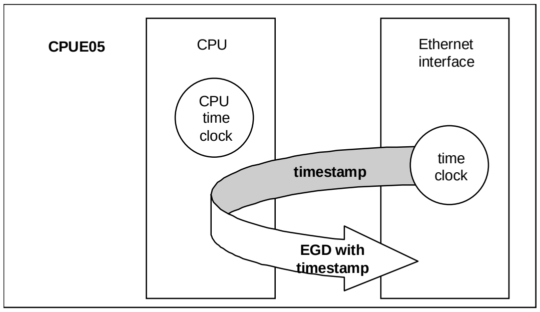
Group ID	IP Address
1	224.0.7.1
2	224.0.7.2
.	.
.	.
.	.
32	224.0.7.32

Group Multicast IP Addresses used by Ethernet Global Data should not be changed unless the defaults would cause a network conflict. If necessary, they can be changed within the reserved range of multicast IP addresses (224.0.0.0 through 239.255.255.255). The change must be made using an Advanced User Parameter File.

Timestamping of Ethernet Global Data Exchanges

The PLC CPU adds a timestamp to each Ethernet Global Data Message it produces. The timestamp indicates when the data was transferred from the producing PLC's CPU to its Ethernet interface for transmission over the network.

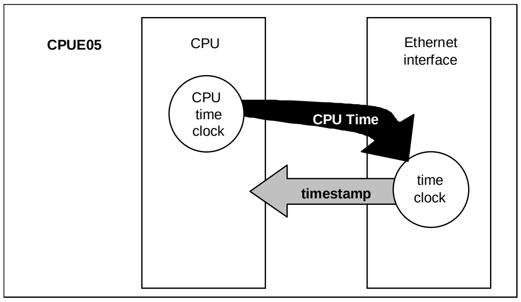
The PLC CPU obtains the timestamp data from the time clock in the Ethernet interface. The CPU only uses this timestamp for Ethernet Global Data exchanges. The timestamp from the Ethernet interface does not affect the time of the CPU's internal time clock.



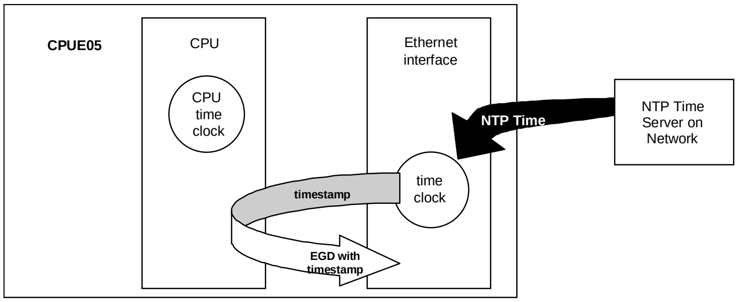
Synchronizing the Timestamp

The timestamp clock in the Ethernet interface is synchronized to either the clock in the CPU or an external Network Time Protocol (NTP) server.

- **The CPU Time Clock:** If no NTP servers are configured, the Ethernet interface's built-in time clock is synchronized once, at power-up or restart, to the clock in the CPU. Because the clocks in the other devices on the network are not synchronized with the CPUE05, their timestamps cannot be compared accurately.



- **NTP Server's Time Clock:** If time servers are configured and present on the network (see chapter 6 for configuration details), the Ethernet interface's built-in clock is periodically synchronized to the clock from one to three NTP servers on the network. The Ethernet interface periodically requests time from the servers and uses the time from the most accurate server (based on NTP stratum number).



All Ethernet interfaces that have been configured to use Network Time Protocol will have updated, synchronized timestamps because they are all controlled by the NTP server clock. Therefore, accurate timing comparisons between exchanged data can be made. For example, if several PLCs sent alarm data, it might be helpful to know the order in which the alarms occurred.

Multiple NTP servers can be used to improve the availability of time servers.

When the time is obtained from an NTP server, dates from January 1, 1970 are supported by the Ethernet Interface.

Configuring NTP for the CPUE05 Ethernet Interface

To implement Network Time Protocol in the Ethernet interface in CPUE05, the IP address of one to three NTP Time Servers are specified in the PLC Ethernet configuration. See "Configuring the Ethernet Interface" in chapter 6 for details. CPUE05 does not support multicast NTP operation; multiple NTP servers may be specified individually.

The Ethernet interface in CPUE05 always operates in "client" mode. It will synchronize to an NTP time server, but it will not synchronize other devices on the network.

Time synchronization takes multiple message exchanges to reach maximum precision. Based on the default configuration of poll times, NTP synchronization should occur approximately 2 minutes after a time server has been established.

The Content of an Ethernet Global Data Exchange

Each Ethernet Global Data exchange is composed of one or more data ranges transmitted as a sequence of 1 to 1400 bytes of data. The content of the data is defined for both the producer and consumers of the data. In this example, a producer sends an 11-byte exchange consisting of the current contents of %R00100 through %R00104 followed by the current contents of %I00257 through %I00264:

Address	Length	Type	Description
%R00100	5	WORD	Conveyor1 in PLC1
%I00257	1	BYTE	Conveyor1 limit switch in PLC1

The same exchange can be configured for each consumer to suit the needs of the application. The size of the exchange must be consistent on all nodes.

Data Types for Ethernet Global Data

The table below lists memory types that can be configured for produced and/or consumed Ethernet Global Data.

Type	Description	Producer, Consumer
%R	Register memory in word mode	P/C
%AI	Analog input memory in word mode	P/C
%AQ	Analog output memory in word mode	P/C
%I	Discrete input memory in byte mode	P/C
%Q	Discrete output memory in byte mode	P/C
%T	Discrete temporary memory in byte mode	P/C
%M	Discrete momentary memory in byte mode	P/C
%SA	Discrete system memory group A in byte mode	P/C
%SB	Discrete system memory group B in byte mode	P/C
%SC	Discrete system memory group C in byte mode	P/C
%G	Discrete global data table in byte mode	P/C

The Data Ranges in a Global Data Exchange

The variable ranges in an exchange are defined in the Ethernet Global Data configuration in hardware configuration. There can be:

- Up to 1200 data ranges for all EGD exchanges for one CPUE05.
- Up to 100 data ranges per exchange.
- A length of 1 byte to 1400 bytes per exchange. The total size of an exchange is the sum of the data lengths of all of the data ranges configured for that exchange.

Different exchanges may share some or all of the same data ranges even if the exchanges are produced at different rates. A consumer does not have to consume all of the data from a produced exchange. A consumed exchange may be configured to ignore specified data ranges. (See “Selective Consumption” in chapter 6.)

Effect of PLC Modes and Actions on Ethernet Global Data

The usual PLC mode for Ethernet Global Data operation is Run with I/O enabled. In that mode, Ethernet Global Data remains configured and exchanges are both produced and consumed. If the PLC mode is set to Stop with I/O disabled, the Producer ID remains configured, but production and consumption stops. The samples of the consumed exchanges received while the PLC is stopped continue to be processed by the Ethernet interface. The latest received data from the network will be available to the application when the PLC returns to an I/O enabled state.

The table below summarizes what happens to the configuration and operation of Ethernet Global Data in different PLC modes.

	Exchanges continue to be...	
PLC Mode or Action	**Produced**	**Consumed**
RUN-Outputs Enabled	YES	YES
STOP-I/O Enabled	YES	YES
STOP-I/O Disabled	NO	NO *

* The latest data from the network is available to the application when the PLC transitions from Stop to Run mode.

EGD Synchronization

Ethernet Global Data attempts to provide the most up-to-date process data, consistent with the configured schedule. The Ethernet interface maintains a timer for each produced exchange. When the timer for the exchange expires, the Ethernet interface requests that the data for the exchange be transferred from reference memory during the output scan portion of the next CPU sweep. Once the data has been transferred by the CPU sweep, the Ethernet interface immediately formulates a sample and transfers the sample on the network. As soon as a sample for a consumed exchange is received, it is transferred to the CPU during the next input scan portion of the CPU sweep.

The result of this scheduling method for Ethernet Global Data is a variability of up to one producer CPU sweep time in the interval between samples produced on the network. This variability in the time between samples is present to assure that the most up-to-date data is being transferred.

In general, it is not useful or necessary to configure the production period to be less than the CPU sweep time. If the producer period for an exchange is set lower than the CPU sweep time, the Ethernet interface will send a “stale” sample (a sample containing the same data as previously sent) at the configured interval. When the fresh CPU data becomes available at the end of the sweep, the Ethernet interface will immediately send another sample with the fresh data. The timer of the produced exchange is not reset when this sample is sent. This can result in more samples in the network than would be expected from the configured period.

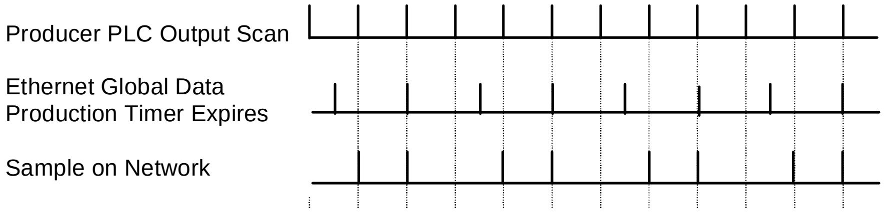
Timing Examples

The following illustrations show the relationship between the PLC output scan time, the produced exchange timer, and data samples on the network.

Example 1

Only one sample is produced on the network per producer period expiration. The variability between samples can be up to producer CPU sweep time.

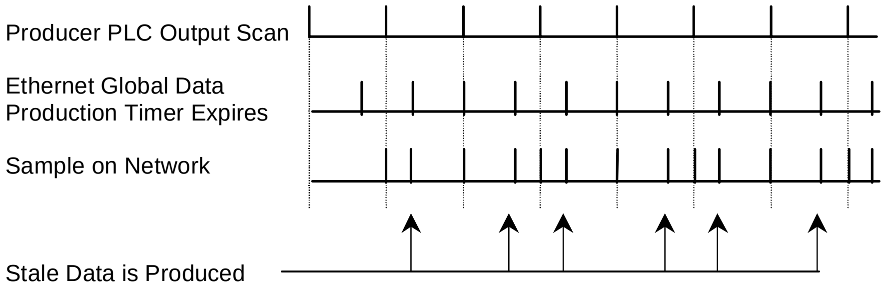
Producer Period = 1.5 Times CPU Sweep



Example 2

More than one sample can be produced per producer period expiration and stale samples are produced to the network.

Producer Period = 2/3 Time of CPU Sweep



Diagnostic Tools

There are several tools to assist you in diagnosing problems that may occur with Ethernet operations and Ethernet Global Data.

- Check the ***Ethernet LEDs***, as detailed on the following pages, to troubleshoot a problem on power-up of the Ethernet Interface. The LEDs provide an immediate visual summary of the operating state of the Interface.
- Use the ***PLC Fault Table***, also explained in this chapter. The PLC Fault Table records exceptions logged by the PLC, the Ethernet interface, and other modules. The PLC Fault Table is accessed through the PLC programming software.
- The application program can use special status data to monitor Ethernet operations.
  - ☐ The Ethernet interface status address, selected during PLC configuration, contains information about the operating status of the Ethernet interface.
  - ☐ The Exchange Status words, selected during Ethernet Global Data configuration, contain information about the status of exchange operations.
- Use the ***Station Manager*** function to troubleshoot a problem with the Ethernet Interface, with the network, with PLC backplane communication, or with your application. The LOG, TALLY, and STAT Station Manager commands are especially useful. Refer to the *VersaMax PLC Ethernet Station Manager Manual*, for information on how to access and use the Station Manager.

What to do if you Cannot Solve the Problem

If you still cannot solve your problem, call GE Fanuc Automation – NA, 1-800-GE FANUC. Please have the following information available when you call.

- The Name and Catalog Number marked on the product.
- Description of symptoms of problem. *Depending on the problem, you may also be asked for the following information:*
  1. The ladder logic application program and the PLC sweep length at the time the problem occurred.
  2. A listing of the configuration parameters for the Ethernet Interface that failed.
  3. A description of the network configuration. This should include the number of PLCs and host computers accessing the network, the type of network cable used (e.g. twisted pair, fiber optic, etc.), length of network cable, and the number and manufacturer of transceivers, hubs, and network switches used.

Checking the Ethernet LEDs

After configuring the Interface, follow the steps below to verify that the Ethernet Interface is operating correctly.

1. Turn power OFF to the PLC for 3–5 seconds, then turn the power back ON. This starts a series of diagnostic tests. During powerup diagnostics, after a brief delay the STAT LED on the Ethernet side of the CPU module blinks. Both the LAN and PORT1 LEDs are off. If a fatal diagnostic failure occurs, the failure is indicated by a two-digit pattern in amber on the STAT LED.
2. After successful power-up, all three LEDs on the Ethernet side turn on briefly. Then the STAT and LAN LEDs should be green. The LAN LED blinks when there is traffic.
3. If the STAT LED is amber, check the PLC Fault Table. With the Station Manager feature, you can also use the LOG command as explained in GFK-1876, *The VersaMax PLC Ethernet Station Manager Manual*.

If a problem occurs during power-up, the Ethernet interface may not begin operating. Check the Ethernet LEDs, as explained below.

Ethernet LEDs	Indications	Actions
LAN ○ Off STAT ○ Off PORT 1 ○ Off	Off	▪ Make sure the PLC has power ▪ Look in the PLC Fault Table for problems ▪ Recheck configuration ▪ Check module installation ▪ If the problem persists, replace PLC CPU
LAN ○ Off STAT ◐ Fast blink green PORT 1 ○ Off	Performing powerup diagnostics	No action necessary; diagnostics will complete within 3 to 10 seconds.
LAN ○ Off STAT ◐ Blinking amber PORT 1 ○ Off	Hardware failure mode. STAT: Blinks 2-digit error code: 1 – 2 unexpected interrupt 1 – 3 timer failure 1 – 4 DMA failure 2 – 1 RAM failure 2 – 2 stack error 2 – 3 shared memory interface error 2 – 4 firmware CRC error 3 - 1 unidentified instruction, or divide by 0 3 – 2 unexpected SWI interrupt 3 – 3 prefetch abort error 3 - 4 data abort error 3 – 5 unexpected IRQ request 3 – 6 unexpected FIQ interrupt 3 - 7 reserved exception error 4 - 1 fatal operating system startup or EEPROM error	▪ Note error code ▪ Power cycle or restart Ethernet interface ▪ If problem persists, replace the PLC hardware.

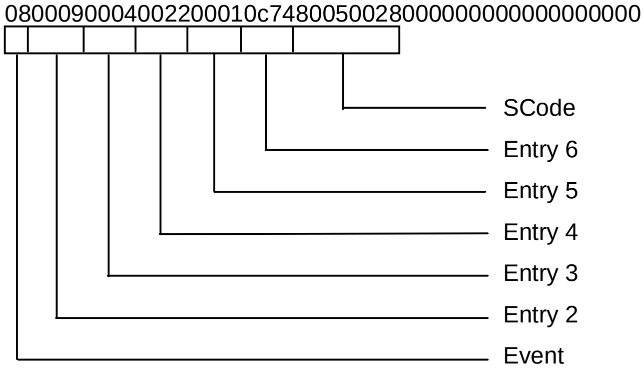
Ethernet LEDs	Indications	Actions
LAN ○ Off STAT ◑ Slow blink green PORT 1 ○ Off	Waiting for Ethernet configuration data from CPU. PORT 1: PLC CPU is controlling Port 1.	▪ Use the PLC programmer to update the configuration, then store the configuration to the PLC. ▪ Power cycle the PLC. ▪ Clear faults and press the Restart pushbutton for less than 5 seconds to restart the Ethernet interface.
LAN ● Green / flickering STAT ◑ Slow blink green PORT 1 ○ Off	Waiting for IP Address LAN: Ethernet interface is online. Flickers during activity. STAT: IP Address has not been configured. PORT 1: PLC CPU is controlling Port 1.	IP address has not been configured, or has been configured as 0.0.0.0 ▪ Use the PLC programmer to configure a non-zero IP address.
LAN ● Green / flickering STAT ◑ Slow blink green PORT 1 ◍ Amber	Waiting for IP Address LAN: Ethernet interface is online. Flickers during activity. STAT: IP Address has not been configured. PORT 1: Available for Station Manager use	
LAN ◍ Amber STAT ◑ Slow blink green PORT 1 ○ Amber	Waiting for IP Address LAN: Ethernet interface is offline. Attempting to recover if possible. STAT: IP Address has not been configured. PORT 1: PLC CPU is controlling Port 1.	
LAN ◍ Amber STAT ◑ Slow blink green PORT 1 ◍ Amber	Waiting for IP Address LAN: Ethernet interface is offline. Attempting to recover if possible. STAT: IP Address has not been configured. PORT 1: Available for Station Manager use	
LAN ● Green / flickering STAT ● Green PORT 1 ○ Off	Operational LAN: Ethernet interface is online. Flickers during activity. STAT: No “exception” detected PORT 1: PLC CPU is controlling Port 1.	If LAN is off, the problem may be: ▪ Network cable not connected either at the PLC or at the hub. ▪ Hub disconnected/failed. ▪ Network cable not properly terminated. If STAT is amber, an “exception” condition has occurred.
LAN ● Green / flickering STAT ● Green PORT 1 ◍ Amber	Operational LAN: Ethernet interface is online. Flickers during activity. STAT: No “exception” detected PORT 1: Forced to Station Manager use	
LAN ◍ Amber STAT ● Green PORT 1 ○ Off	Operational LAN: Ethernet interface is offline. Attempting to recover if possible. STAT: No “exception” detected PORT 1: PLC CPU is controlling Port 1.	
LAN ◍ Amber STAT ● Green PORT 1 ◍ Amber	Operational LAN: Ethernet interface is offline. Attempting to recover if possible. STAT: No “exception” detected PORT 1: Forced to Station Manager use	
LAN ◑ STAT ◑ PORT 1 ◑ Slow blink green, all LEDS blink in unison	Software Load Loading new firmware (via CPU serial port)	No action necessary; the Ethernet interface restarts automatically after loading is complete

Using the PLC Fault Table

Most error conditions involving the Ethernet interface generate faults in the PLC Fault table. The table on the next page lists Ethernet interface faults and corrective actions.

To display fault text for the Ethernet interface, access the PLC Fault Table from the programmer. For the Ethernet interface the leftmost 14 digits of extra fault data show the corresponding log Events (2 digits) and Entries 2, 3, 4, 5, and 6 (in that order, 4 digits each), and other optional data.

The following example reports an Event 8, Entry 2=9, Entry 3=4, Entry 4 = 22H, Entry 5 = 1, Entry 6=c74H, and SCode = 80050028H.



This information can be used to refer directly to detailed fault descriptions included in the Log event table under the LOG command in the *VersaMax PLC Station Manager Manual.*

Please note some internal system errors display error messages as ASCII text in the fault extra data.

PLC Fault Table Descriptions

PLC Fault	User Action
Backplane communications with PLC fault; lost request	Check that PLC CPU is running normally (usually in Run mode) * Check to make sure you are not sending COMMREQs faster than the Ethernet interface can process them. *
Bad local application request; discarded request	Check for valid COMMREQ command code. *
Bad remote application request; discarded request	Try to validate the operation of the remote node. *
Can't locate remote node; discarded request	Error reported when message received where IP address cannot be resolved. Error may indicate that remote host is not operational on the network. Check that remote host is operational on network and its addresses are correct.
Comm_req – Bad task ID programmed	Message from PLC for unknown Ethernet interface task. Check COMMREQ function block.
Comm_req – Wait mode not allowed	Check COMMREQ to make sure sent in no-wait mode.
LAN data memory exhausted – check parms; resuming	The Ethernet interface does not have free memory to process communications. *
LAN I/F capacity exceeded; discarded request	Verify that connection limits are not being exceeded.
LAN transceiver fault; Off network until fixed	Ethernet interface is not properly connected to the network. Check the connection to the network hub or switch.
LAN system-software fault; aborted connection resuming	Internal system error. *
LAN system-software fault; restarted LAN IF	
LAN system-software fault; resuming	
Module software corrupted; requesting reload	Catastrophic internal system error. Contact GE Fanuc Automation – NA.
Module state doesn't permit Comm_Req; discarded	COMMREQ received when Ethernet interface cannot process COMMREQ. Make sure Ethernet interface is configured and online.
Unsupported feature in configuration	Attempt has been made to configure a feature not supported by the Ethernet interface. Check CPU revision; order upgrade kit for CPU and/or Ethernet interface.

* If the problem persists, contact GE Fanuc Automation – NA.

Checking the Status of the Ethernet Interface

The application program can monitor the status of the Ethernet interface using the status bits described below. The beginning address of the data is the *Status Address* entered when configuring the CPU. See "Configuring the Ethernet Interface" in chapter 6 for details.

The Ethernet interface updates these status bits every PLC I/O scan. The Ethernet status bits normally occupy a single block of memory. Most of these bits are reserved. Five are of interest for checking the status of the Ethernet interface:

Status Bits	Brief Description
1–2	Reserved, always 0
3	Full-duplex
4-12	Reserved, always 0
13	LAN OK
14	Resource problem
15	Reserved, always 0
16	LAN Interface OK
17-80	Reserved

Bit 3: Full Duplex	If this bit 3 is 1, CPUE05 is operating in full-duplex Ethernet mode. Full-duplex or half-duplex operation is automatically negotiated between the CPUE05 and its immediately-connected network device, usually a network hub. If this bit is 0, CPUE05 is operating in half-duplex Ethernet mode. This bit is only valid if bit 13 (LAN OK) is 1.
Bit 13: LAN OK	This bit is 1 while the Ethernet interface is able to communicate on the network. If the network is not accessible due to local or network problems, this bit is 0. When communication resumes, it is automatically set to 1.
Bit 14: Resource Problem	This bit is 1 whenever the Ethernet interface has a resource problem (i.e., lack of data memory). The bit is reset to 0 on a subsequent PLC sweep. The Ethernet interface may or may not be able to continue functioning, depending on the severity of the problem. Use the PLC Fault Table to identify the problem. The Station Manager STAT B and LOG commands can also provide more information.
Bit 16: LAN Interface OK	When this bit is 1, the Ethernet interface is properly initialized. When this bit is 0, all other Ethernet status bits are invalid.

Checking the Status of an Ethernet Global Data Exchange

To check the status of any Ethernet Global Data exchange, monitor the value in the Exchange Status word (selected during Ethernet Global Data configuration). The PLC automatically writes exchange status information in this location when:

- a producer/consumer period expires (the value is set for the entire period).
- an Ethernet Global Data configuration is stored to the PLC.
- the PLC powers up and it has an Ethernet Global Data configuration.
- the Ethernet interface configured for Ethernet Global Data is restarted.

If the application program uses the Exchange Status word to check exchange status, it must clear this word to 0 once a non-zero value is written to it. That allows the application program to detect a new exchange status in subsequent sweeps.

The Exchange Status word uses the error codes below to report exchange status. See also the *Troubleshooting Common Ethernet Difficulties* section later in this chapter.

Value (Decimal)	Error	Description
0	Exchange status has not been updated	Produced: Initial value until the first producer period refresh occurs. Consumed: The data has not been refreshed and timeout has not expired.
1	No error	Produced: The produced exchange is producing data. Consumed: The data has been refreshed on schedule.
3	NTP error	Consumed only: The CPU is configured for network time synchronization, but is not synchronized.
4	Specification error	Produced and Consumed: Error configuring the exchange. For CPUE05, this error does NOT indicate a consumed exchange size miscomparison.
6	Refresh timeout without data.	Consumed only: The timeout period has expired but data has not been refreshed from the network.
7	Data after refresh timeout	Consumed only: The data has been refreshed since the previous consumption, but was not refreshed within the timeout period.
10	IP connection not available	Produced and Consumed: The IP network connection is not available.
12	Lack of resource error	Produced and Consumed: Local resources are not available to establish the exchange. Look in the PLC Fault Table for details.
14	Length error	Consumed only: The packet received did not match the length expected.
18	Loss of Ethernet interface error	Produced and Consumed: The Ethernet interface is not communicating with the CPU. A loss of module or reset of module PLC Fault Table entry may also be present. If the failure is transient in nature, the status of the exchange may change at a later time. That indicates subsequent transfers on the exchange were successful.
22	EGD not supported	This error cannot occur with CPUE05.
26	No response	Produced and Consumed: Ethernet interface failed to establish exchange.
28	Other error	Produced and Consumed: Error other than 12, 14, 18, or 26 when establishing an exchange. Look in the PLC Fault Table for information.
30	Exchange deleted	Produced And Consumed: Exchange has been deleted and will no longer be scanned.

Using the Ethernet Station Manager Function

CPUE05 provides local Station Manager operation via Port 1. This port can be configured for either CPU serial communications (SNP, RTU, Serial I/O) or local Station Manager use. While Port 1 is configured as a local Station Manager, it cannot be used for CPU serial communications or firmware loading. However, if the port is configured as a CPU port instead (the default setting), it can temporarily be forced to local Station Manager operation using the Restart pushbutton (or using the "chport1" Station Manager command).

The CPUE05 also supports remote Station Manager operation over the Ethernet network via UDP protocol. With UDP protocol, the remote station is addressed via an IP address. Unlike some Series 90 Ethernet products, CPUE05 cannot send or receive remote Station Manager messages that have been sent to a specified MAC address.

For a detailed description of Station Manager functions, please refer to GFK-1876, the *VersaMax PLC Ethernet Station Manager User's Manual.*

Troubleshooting Common Ethernet Difficulties

Some common Ethernet errors are described below. Ethernet errors are generally indicated in the PLC Fault Table and the Ethernet exception log. As previously explained in *Using the PLC Fault Table*, PLC Faults generated by the Ethernet interface contain Ethernet exception events within the extra fault data. See the *VersaMax Station Manager Manual*, GFK-1876 for detailed descriptions of Ethernet exception events.

PLC Timeout Errors

When the SRTP traffic to the CPUE05 exceeds the PLC's ability to process the requests, PLC Timeout errors may occur. PLC Timeout errors will take down an SRTP Server connection; in this case, the remote SRTP client must reestablish a new SRTP connection to the CPUE05.

This error is indicated in the PLC Fault Table as:

> "Backplane communication with PLC fault; lost request"
> with exception Event = 8, Entry 2 = 8
>
> "Backplane communication with PLC fault; lost request"
> (no exception Event)

These errors may also be accompanied by either of the following:

> "Backplane communication with PLC fault; lost request"
> with exception Event = 8, Entry 2 = 6
>
> "LAN system-software fault; resuming"
> with exception Event = 8, Entry 2 = 16

The PLC Timeout condition occurs when the CPUE05 cannot process requests within a specified timeout period. The remedy is to reduce the requests, or increase the processing capacity in the PLC.

Cause	Corrective Action
Heavy SRTP traffic.	Reduce the size, number, or frequency of SRTP requests at the remote SRTP client.
Long PLC sweep time.	Modify the PLC application to reduce the PLC sweep time.
PLC Communication Window set to LIMITED mode.	Change to RUN-TO-COMPLETION mode.

If none of the above corrective actions is feasible, the timeout interval may be lengthened. The timeout interval is specified by the "crsp_tmot" Advanced User Parameter. The default timeout value is 15 seconds. See *Configuring Advanced User Parameters* in chapter 6 to change Advanced User Parameter values.

Note that changing this timeout value does not reduce the actual time for the PLC to process the requests.

Unexpected Ethernet Restart or Runtime Errors

Sustained heavy EGD and/or SRTP operation can exceed the data transfer and processing capacity of the CPUE05. This can result in missed EGD exchanges, unexpected automatic restarts of the Ethernet interface within the CPUE05, or runtime fatal errors at the Ethernet interface.

Restart errors are indicated in the PLC Fault Table as one or more of the following:

“Loss of daughterboard” (no exception Event)
“Reset of daughterboard” (no exception Event)
“LAN system-software fault; restarted LAN I/F”
with exception Event = 3, Entry 2 = 1, Entry 3 = 5f0fH

After any of the above errors, the Ethernet interface restarts itself automatically without manual intervention.

The above Ethernet restarts may be accompanied by one or more of the following in the PLC Fault Table:

“Backplane communications with PC fault; lost request” (no exception event)
“LAN system-software fault; resuming”
with exception Event = 28, Entry 2 = 1, SCode = 95255037H

Runtime errors suspend normal operation and a blink fatal error code in amber at the STAT LED. To recover, manually restart the Ethernet interface. Runtime error codes “31” and “33” have been observed under heavy load. See *Checking the Ethernet LEDs* section earlier in this chapter for descriptions of runtime diagnostic fatal error codes.

All Ethernet Global Data (EGD) exchanges default to status code 18 (0012H) during a loss or reset of the Ethernet interface. EGD operation will resume after the restart is complete.

These restart and runtime errors occur when the CPUE05 cannot process the attempted volume of EGD and/or SRTP requests. As these errors have been observed only when the CPUE05 is connected to a repeater-type network hub, the primary remedy is to replace the repeater-type hub with a switching-type network hub. A secondary remedy is to reduce the number, size, or frequency of the EGD exchanges and/or transfers over SRTP connections.

EGD Configuration Mismatch Errors

When using Ethernet Global Data, the produced exchange (defined at the producer) must agree with the consumed exchange (defined at the consumer). The consumer generates an error when the size of an exchange received from the network differs from the configured size for that consumed exchange.

This error is indicated in the PLC Fault Table as:

> "LAN system-software fault; resuming"
> with exception Event = 28, Entry 2 = 1d

As this error is generated each time the mismatched exchange is received, the Ethernet exception log can quickly fill up with mismatch error events.

Cause	Corrective Action
Producer and Consumer exchange definitions are of different size.	Review the conflicting exchange definitions at the producer and at the consumer. Change the incorrect exchange definition so that produced and consumed definitions are the same size.

If the consumer wishes to ignore certain portions of a consumed exchange, be sure that the length of the ignored portions is correct. The ignored portion is specified as a byte count.

Receive Resource Exhaustion Errors

Heavy network traffic can exhaust available memory in the Ethernet interface used for network communications. This most often occurs under heavy Ethernet Global Data (EGD) traffic on a busy network. Since the traffic on the network is unpredictable, this error condition may always occur.

This error is indicated in the PLC Fault Table as:

> "LAN system-software fault; resuming"
> with exception Event = 28, Entry 2 = 1

Cause	Corrective Action
Heavy EGD traffic exhausts network data buffers.	Modify the application to reduce the number, size, or frequency of produced and consumed EGD exchanges.
Bursts of heavy network traffic are received at the CPUE05.	Analyze the broadcast and multicast network traffic received at the CPUE05. Reduce such traffic if possible.

Station Manager Lockout under Heavy Load

Sustained heavy EGD and/or SRTP Server load can utilize all processing resources within the Ethernet interface, effectively locking out the Station Manager function. The Station Manager appears inoperative under either local or remote operation. The Ethernet interface always gives higher priority to data communication functions than to the Station Manager. When the processing load is reduced, the Station Manager becomes operative once again.

This condition is not reported to the PLC Fault Table or Ethernet exception log.

PING Restrictions

To conserve network data buffer resources, the CPUE05 process only one ICMP control message at a time. An ICMP Echo (ping) request that arrives while the CPUE05 is processing another ICMP control message is discarded. When multiple remote hosts attempt to ping the CPUE05 at the same time, some individual ping requests may be ignored depending upon the timing of the ping requests on the network.

The CPUE05 may initiate ping requests to another host on the network via the “ping” Station Manager command. The ping request sequence is restricted to one remote host at a time.

Discarded ping requests are not reported to the PLC Fault Table or Ethernet exception log.

SRTP Connection Timeout

When a remote SRTP client is abruptly disconnected from a CPUE05 (for example, by disconnecting the Ethernet cable), the underlying TCP connection attempts to re-establish communication. The SRTP connection in the CPUE05 remains open for approximately 5 minutes while TCP attempt to reconnect; during this interval, the SRTP connection is unavailable. If all the SRTP connections in the CPUE05 are in use or otherwise unavailable, a new SRTP client connection must wait until the TCP reconnect time expires on an existing connection.

The SRTP connection timeout is normal expected behavior, and is consistent with other GE Fanuc PLC products.

Chapter 14

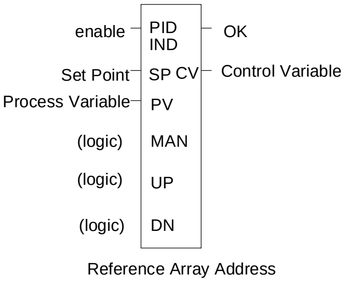
The PID Function

This chapter describes the PID (Proportional plus Integral plus Derivative) function, which is used for closed-loop process control. The PID function compares feedback from a process variable with a desired process Set Point and updates a Control Variable based on the error.

- Format of the PID Function
- Operation of the PID Function
- Parameter Block for the PID Function
- PID Algorithm Selection
- Determining the Process Characteristics
- Setting Parameters Including Tuning Loop Gains
- Sample PID Call

Format of the PID Function

The PID function uses PID loop gains and other parameters stored in an array of 40 16 bit words to solve the PID algorithm at the desired time interval. All parameters are 16 bit integer words. This allows %AI memory to be used for input Process Variables and %AQ to be used for output Control Variables.



The PID function does not pass power flow if there is an error in the configurable parameters. It can be monitored using a temporary coil while modifying data.

Parameters of the PID Function

Input/ Output	Choices	Description
enable	flow	When enabled through a contact, the PID algorithm is performed.
SP	I, Q, M, T, G, R, AI, AQ, constant	The control loop or process Set Point. Set using Process Variable counts, the PID function adjusts the output Control Variable so that the Process Variable matches the Set Point (zero error).
PV	I, Q, M, T, G, R, AI, AQ	Process Variable input from the process being controlled, often a %AI input.
MAN	flow	When energized to 1 (through a contact), the PID block is in manual mode. If the PID block is on manual off, the PID block is in automatic mode.
UP	flow	If energized along with MAN, it adjusts the Control Variable up by 1 CV per solution.*
DN	flow	If energized along with MAN, it adjusts the Control Variable down by 1 CV per solution.*
Address	R	Location of the PID control block information (user and internal parameters). Uses 40 %R words that cannot be shared.
ok	flow, none	OK is energized when the function is performed without error. It is Off if errors exist.
CV	I, Q, M, T, G, R, AI, AQ	The Control Variable output to the process, often a %AQ output.

* Incremented (UP parameter) or decremented (DN parameter) by one (1) per access of the PID function.

As scaled 16 integer numbers, many parameters must be defined in either Process Variable (PV) counts or units or Control Variable (CV) counts or units. For example, the Set Point (SP) input must be scaled over the same range as the Process Variable as the PID block calculates the error by subtracting these two inputs. The Process Variable and Control Variable Counts may be –32000 or 0 to 32000 matching analog scaling or from 0 to 10000 to display variables as 0.00% to 100.00%. The Process Variable and Control Variable Counts do not have to have the same scaling, in which case there will be scale factors included in the PID gains.

Operation of the PID Function

Automatic Operation

The PID function can be called every sweep by providing power flow to Enable and no power flow to Manual input contacts. The block compares the current PLC elapsed time clock with the last PID solution time stored in the internal RefArray. If the difference is greater than the sample period defined in the third word (%Ref+2) of the RefArray, the PID algorithm is solved using the time difference. Both the last solution time and Control Variable output are updated. In Automatic mode, the output Control Variable is placed in the Manual Command parameter %Ref+13.

Manual Operation

The PID block is placed in Manual mode by providing power flow to both the Enable and Manual input contacts. The output Control Variable is set from the Manual Command parameter %Ref+13. If either the UP or DN inputs have power flow, the Manual Command word is incremented or decremented by one CV count every PID solution. For faster manual changes of the output Control Variable, it is also possible to add or subtract any CV count value directly to/from the Manual Command word

The PID block uses the CV Upper and CV Lower Clamp parameters to limit the CV output. If a positive Minimum Slew Time is defined, it is used to limit the rate of change of the CV output. If either the CV amplitude or rate limit is exceeded, the value stored in the integrator is adjusted so that CV is at the limit. This anti-reset windup feature means that even if the error tried to drive CV above (or below) the clamps for a long period of time, the CV output will move off the clamp as soon as the error term changes sign.

This operation, with the Manual Command tracking CV in Automatic mode and setting CV in Manual mode, provides a bumpless transfer between Automatic and Manual modes. The CV Upper and Lower Clamps and the Minimum Slew Time still apply to the CV output in Manual mode and the internal value stored in the integrator is updated. This means that if you were to step the Manual Command in Manual mode, the CV output will not change any faster that the Minimum Slew Time (Inverse) rate limit and will not go above or below the CV Upper or CV Lower Clamp limits.

Time Interval for the PID Function

The PID will not execute more often than once every 10 milliseconds. If it is set up to execute every sweep and the sweep is under 10 milliseconds, the PID function will not run until enough sweeps have occurred to accumulate an elapsed time of 10 milliseconds. For example, if the sweep time is 9 milliseconds, the PID function executes every other sweep, so the overall elapsed time between executions is 18 milliseconds. A specific PID function should not be called more than once per sweep.

The longest possible interval between executions is 10.9 minutes. The PID function compensates for the actual time elapsed since the last execution within 100 microseconds.

The PID algorithm is solved only if the current PLC elapsed time clock is at or later than the last PID solution time plus the sample period. If the sample period is set to 0, the function executes each time it is enabled; however, it is restricted to a minimum of 10 milliseconds as noted above.

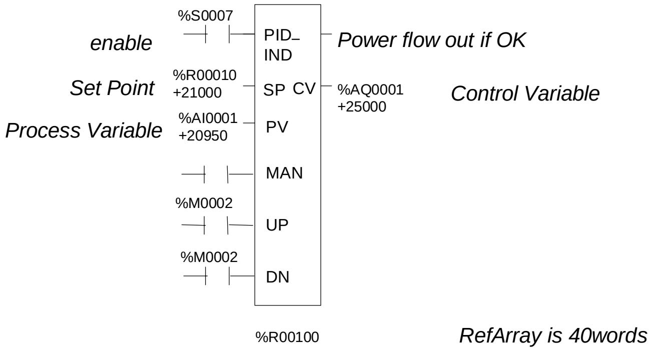
Scaling Input and Outputs

All parameters of the PID function are 16 bit integer words for compatibility with 16 bit analog process variables. Some parameters must be defined in either process variable counts or units or control variable counts or units.

The set point input must be scaled over the same range as process variable, because the PID function calculates error by subtracting these two inputs. The process variable and control variable counts do not have to use the same scaling. Either may be -32000 or 0 to 32000 to match analog scaling, or from 0 to 10000 to display variables as 0.00% to 100.00%. If the process and control variables do not use the same scaling, scale factors are included in the PID gains.

Example of the PID Function

The example shown below includes typical inputs.



Parameter Block for the PID Function

The parameter block for the PID function occupies 40 words of %R memory. Many of the 40 words are used by the PLC and not configurable. Every PID function call must use a different 40-word memory area even if all 13 configurable parameters are the same.

The first 13 words of the parameter block must be specified before executing the PID function. Zeros can be used for most default values. Once suitable PID values have been chosen, they can be defined as constants in a BLKMOV so they can be changed by the program as needed.

Internal Parameters in RefArray

The PID function reads 13 parameters and uses the rest of the 40-word RefArray for internal PID storage. Normally you would not change these values. If you call the PID block in Auto mode after a long delay, you may want to use SVC_REQ 16 to load the current PLC elapsed time clock into %Ref+23 to update the last PID solution time to avoid a step change on the integrator. If you have set the Override low bit of the Control Word (%Ref+14) to 1, the next four bits of the Control Word must be set to control the PID block input contacts, and the Internal SP and PV must be set as you have taken control of the PID block away from the ladder logic.

	Parameter	Low Bit Units	Range	Description
Address	Loop Number	Integer	0 to 255.	Optional number of the PID block. It provides a common identification in the PLC with the loop number defined by an operator interface device.
Address +1	Algorithm	-	Set by the PLC	1 = ISA algorithm 2 = independent algorithm
Address+2	Sample Period	10ms	0 (every sweep) to 65535 (10.9 Min) At least 10ms.	The shortest time, in 10mS increments, between solutions of the PID algorithm. For example, use a 10 for a 100mS sample period.
Address+3 Address+4	Dead Band + and Dead Band -	PV Counts	0 to 32000 (+ never negative) (- never positive)	INT values defining the upper (+) and lower (-) Dead Band limits in PV Counts. If no Dead Band is required, these values must be 0. If the PID Error (SP - PV) or (PV - SP) is above the (-) value and below the (+) value, the PID calculations are solved with an Error of 0. If non-zero, the (+) value must greater than 0 and the (-) value less than 0 or the PID block will not function. Leave these at 0 until the PID loop gains are set up or tuned. A Dead Band might be added to avoid small CV output changes due to variations in error.
Address+5	Proportional Gain -Kp (Controller gain, Kc, in the ISA version)	0.01 CV%/PV%	0 to 327.67%	Change in the Control Variable in CV Counts for a 100 PV Count change in the Error term. A Kp entered as 450 is displayed as 4.50 and results in a Kp*Error/100 or 450*Error/100 contribution to the PID Output. Kp is generally the first gain set when adjusting a PID loop.

	Parameter	Low Bit Units	Range	Description
Address+6	Derivative Gain-Kd	0.01 seconds	0 to 327.67 sec	Change in the Control Variable in CV Counts if the Error or PV changes 1 PV Count every 10ms. Entered as a time with the low bit indicating 10ms. For example, a Kd entered as 120 is displayed as 1.20 Sec and results in a Kd * delta Error/delta time or 120*4/3 contribution to the PID Output if Error was changing by 4 PV Counts every 30ms. Kd can be used to speed up a slow loop response, but is very sensitive to PV input noise.
Address+7	Integral Rate-Ki	Repeat/1000 Sec	0 to 32.767 repeat/sec	Change in the Control Variable in CV Counts if the Error were a constant 1 PV Count. Displayed as 0.000 Repeats/Sec with an implied decimal point of 3. For example, a Ki entered as 1400 is displayed as 1.400 Repeats/Sec and results in a Ki * Error *dt or 1400 * 20 * 50/1000 contribution to PID Output for an Error of 20 PV Counts and a 50ms PLC sweep time (Sample Period of 0). Ki is usually the second gain set after Kp.
Address+8	CV Bias/Output Offset	CV Counts	-32000 to 32000 (add to integrator output)	Number of CV Counts added to the PID Output before the rate and amplitude clamps. It can be used to set non-zero CV values if only Kp Proportional gains are used, or for feed forward control of this PID loop output from another control loop.
Address+9 Address+10	CV Upper and Lower Clamps	CV Counts	-32000 to 32000 (>%Ref+10)	Number of CV Counts that define the highest and lowest value for CV. These values are required. The Upper Clamp must have a more positive value than the Lower Clamp, or the PID block will not work. These are usually used to define limits based on physical limits for a CV output. They are also used to scale the Bar Graph display for CV. The block has anti-reset windup to modify the integrator value when a CV clamp is reached.
Address+11	Minimum Slew Time	Second/Full Travel	0 (none) to 32000 sec to move 32000 CV	Minimum number of seconds for the CV output to move from 0 to full travel of 100% or 32000 CV Counts. It is an inverse rate limit on how fast the CV output can be changed. If positive, CV cannot change more than 32000 CV Counts times Delta Time (seconds) divided by Minimum Slew Time. For example, if the Sample Period is 2.5 seconds and the Minimum Slew Time is 500 seconds, CV cannot change more than 32000*2.5/500 or 160 CV Counts per PID solution. The integrator value is adjusted if the CV rate limit is exceeded. If Minimum Slew Time is 0, there is no CV rate limit. Set Minimum Slew Time to 0 while tuning or adjusting PID loop gains.

	Parameter	Low Bit Units	Range	Description
Address+12	Config Word	Low 5 bits used	Bit 0 to 2 for Error+/-, OutPolarity, Deriv.	The low 5 bits of this word are used to modify three standard PID settings. The other bits should be set to 0. Set the low bit to 1 to modify the standard PID Error Term from the normal (SP – PV) to (PV – SP), reversing the sign of the feedback term. This is for Reverse Acting controls where the CV must go down when the PV goes up. Set the second bit to a 1 to invert the Output Polarity so that CV is the negative of the PID output rather than the normal positive value. Set the fourth bit to 1 to modify the Derivative Action from using the normal change in the Error term to the change in the PV feedback term. The low 5 bits in the Config Word are defined in detail below: Bit 0: Error Term. When this bit is 0, the error term is SP - PV. When this bit is 1, the error term is PV - SP. Bit 1: Output Polarity. When this bit is 0, the CV output represents the output of the PID calculation. When it is set to 1, the CV output represents the negative of output of the PID calculation. Bit 2: Derivative action on PV. When this bit is 0, the derivative action is applied to the error term. When it is set to 1, the derivative action is applied to PV. All remaining bits should be zero. Bit 3: Deadband action. When the Deadband action bit is 0, then no deadband action is chosen. If the error is within the deadband limits, then the error is to be zero. Otherwise the error is not affected by the deadband limits. If the Deadband action bit is 1, then deadband action is chosen. If the error is within the deadband limits, then the error is forced to be zero. If, however, the error is outside the deadband limits, then the error is reduced by the deadband limit (error = error – deadband limit). Bit 4:Anti-reset windup action. When this bit is 0, the anti-reset windup action uses a reset back calculation. When the output is clamped, this replaces the accumulated Y remainder value with whatever value is necessary to produce the clamped output exactly. When the bit is 1, this replaces accumulated Y term with the value of the Y term at the start of the calculation. In this way, the pre-clamp Y value is held as long as the output is clamped. Remember that the bits are set in powers of 2. For example, to set Config Word to 0 for default PID configuration, you would add 1 to change the Error Term from SP–PV to PV–SP, or add 2 to change the Output Polarity from CV = PID Output to CV = – PID Output, or add 4 to change Derivative Action from Error rate of change to PV rate of change, etc.
Address+13	Manual Command	CV Counts	Tracks CV in Auto or Sets CV in Manual	Set to the current CV output while the PID block is in Automatic mode. When the block is switched to Manual mode, this value is used to set the CV output and the internal value of the integrator within the Upper and Lower Clamp and Slew Time limits.

<table>
<tr><th></th><th>Parameter</th><th>Low Bit Units</th><th>Range</th><th>Description</th></tr>
<tr><td>Address+14</td><td>Control Word</td><td>Maintained by the PLC, unless Bit 1 is set.</td><td>PLC maintained unless set otherwise: low bit sets Override if 1.</td><td>If the Override low bit is set to 1, this word and other internal SP, PV and CV parameters must be used for remote operation of this PID block (see below). This allows remote operator interface devices, such as a computer, to take control away from the PLC program. Caution: if you do not want this to happen, make sure the Control Word is set to 0. If the low bit is 0, the next 4 bits can be read to track the status of the PID input contacts as long as the PID Enable contact has power.
A discrete data structure with the first five bit positions in the following format:
<table>
<tr><td>Bit:</td><td>Word Value:</td><td>Function:</td><td>Status or External Action if Override bit set to 1:</td></tr>
<tr><td>0</td><td>1</td><td>Override</td><td>If 0, monitor block contacts below. If 1, set them externally.</td></tr>
<tr><td>1</td><td>2</td><td>Manual /Auto</td><td>If 1, block is in Manual mode; other numbers it is in Automatic mode.</td></tr>
<tr><td>2</td><td>4</td><td>Enable</td><td>Should normally be 1; otherwise block is never called.</td></tr>
<tr><td>3</td><td>8</td><td>UP /Raise</td><td>If 1 and Manual (Bit 1) is 1, CV is being incremented every solution.</td></tr>
<tr><td>4</td><td>16</td><td>DN /Lower</td><td>If 1 and Manual (Bit 1) is 1, CV is being incremented every solution.</td></tr>
</table>
</td></tr>
<tr><td>Address+15</td><td>Internal SP</td><td>Set and maintained by the PLC</td><td>Non-configurable</td><td>Tracks SP in; must be set externally if Override = 1.</td></tr>
<tr><td>Address+16</td><td>Internal CV</td><td>“</td><td>“</td><td>Tracks CV out.</td></tr>
<tr><td>Address+17</td><td>Internal PV</td><td>“</td><td>“</td><td>Tracks PV in; must be set externally if Override bit = 1.</td></tr>
<tr><td>Address+18</td><td>Output</td><td>“</td><td>“</td><td>Signed word value representing the output of the function block before the optional inversion. If no output inversion is configured and the output polarity bit in the control word is set to 0, this value equals the CV output. If inversion is selected and the output polarity bit is set to 1, this value equals the negative of the CV output.</td></tr>
<tr><td>Address+19</td><td>Diff Term Storage</td><td></td><td></td><td></td></tr>
<tr><td>Address+20
Address+21</td><td>Int Term Storage</td><td></td><td></td><td>Used internally for storage of intermediate values. Do not write to these locations</td></tr>
<tr><td>Address+22</td><td>Slew Term Storage</td><td></td><td></td><td></td></tr>
<tr><td>Address+23 to Address+25</td><td>Clock</td><td></td><td></td><td>Internal elapsed time storage (time last PID executed). Do not write to these locations</td></tr>
<tr><td>Address+26</td><td>Y Remainder Storage</td><td></td><td></td><td>Holds remainder for integrator division scaling for 0 steady state error.</td></tr>
<tr><td>Address+27
Address+28</td><td>SP, PV Lower and Upper Range</td><td>PV Counts</td><td>-32000 to 32000</td><td>Optional INT values in PV Counts that define high and low display values.(Ref +27 must be lower than Ref+28)</td></tr>
<tr><td>Address+29 to Address+39</td><td>Reserved</td><td>N/A</td><td>Non-configurable</td><td>29-34 are reserved for internal use; 35-39 are reserved for external use. Do not use these references.</td></tr>
</table>

PID Algorithm Selection (PIDISA or PIDIND) and Gains

The PID block can be programmed selecting either the Independent (PID_IND) term or standard ISA (PID_ISA) versions of the PID algorithm. The only difference in the algorithms is how the Integral and Derivative gains are defined.

Both PID types calculate the Error term as SP - PV, which can be changed to Reverse Acting mode PV - SP by setting the Error Term (low bit 0 in the Config Word %Ref+12) to 1.

Reverse-Acting mode may be used if you want the CV output to move in the opposite direction from PV input changes (CV down for PV up) rather than the normal CV up for PV up.

Error = (SP - PV) or (PV - SP) if low bit of Config Word set to 1

The Derivative is normally based on the change of the Error term since the last PID solution, which may cause a large change in the output if the SP value is changed. If this is not desired, the third bit of the Config Word can be set to 1 to calculate the Derivative based on the change of the PV. The dt (or Delta Time) is determined by subtracting the last PID solution clock time for this block from the current PLC elapsed time clock.

dt = Current PLC Elapsed Time clock - PLC Elapsed Time Clock at Last PID solution

Derivative = (Error - previous Error)/dt

or (PV - previous PV)/dt if 3rd bit of Config Word set to 1

The Independent term PID (PID_IND) algorithm calculates the output as:

PID Output = Kp * Error + Ki * Error * dt + Kd * Derivative + CV Bias

The standard ISA (PID_ISA) algorithm has a different form:

PID Output = Kc * (Error + Error * dt/Ti + Td * Derivative) + CV Bias

where Kc is the controller gain, and Ti is the Integral time and Td is the Derivative time. The advantage of ISA is that adjusting the Kc changes the contribution for the integral and derivative terms as well as the proportional one, which may make loop tuning easier. If you have PID gains in terms or Ti and Td, use

Kp = Kc Ki = Kc/Ti and Kd = Kc/Td

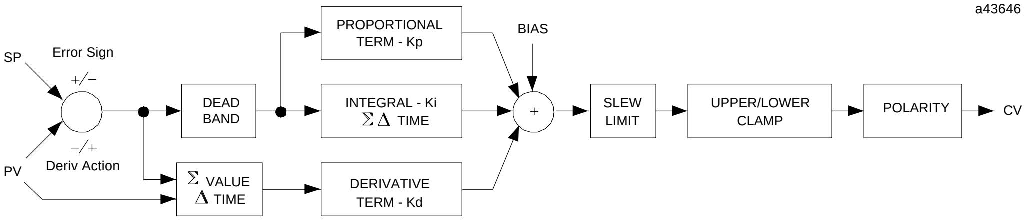
to convert them to use as PID User Parameter inputs.

The CV Bias term above is an additive term separate from the PID components. It may be required if you are using only Proportional Kp gain and you want the CV to be a non?zero value when the PV equals the SP and the Error is 0. In this case, set the CV Bias to the desired CV when the PV is at the SP. CV Bias can also be used for feed forward control where another PID loop or control algorithm is used to adjust the CV output of this PID loop.

If an Integral Ki gain is used, the CV Bias would normally be 0 as the integrator acts as an automatic bias. Just start up in Manual mode and use the Manual Command word (%Ref+13) to set the integrator to the desired CV, then switch to Automatic mode. This also works if Ki is 0, except the integrator will not be adjusted based on the Error after going into Automatic mode.

Independent Term Algorithm (PIDIND)

The following diagram shows how the PID algorithms work:



The ISA Algorithm (PIDISA) is similar except the Kp gain is factored out of Ki and Kd so that the integral gain is Kp * Ki and derivative gain is Kp * Kd. The Error sign, DerivAction and Polarity are set by bits in the Config Word user parameter.

CV Amplitude and Rate Limits

The block does not send the calculated PID Output directly to CV. Both PID algorithms can impose amplitude and rate of change limits on the output Control Variable. The maximum rate of change is determined by dividing the maximum 100% CV value (32000) by the Minimum Slew Time, if specified as greater than 0. For example, if the Minimum Slew Time is 100 seconds, the rate limit will be 320 CV counts per second. If the dt solution time was 50 milliseconds, the new CV output can not change more than 320*50/1000 or 16 CV counts from the previous CV output.

The CV output is then compared to the CV Upper and CV Lower Clamp values. If either limit is exceeded, the CV output is set to the clamped value. If either rate or amplitude limits are exceeded modifying CV, the internal integrator value is adjusted to match the limited value to avoid reset windup.

Finally, the block checks the Output Polarity (2nd bit of the Config Word %Ref+12) and changes the sign of the output if the bit is 1.

CV = Clamped PID Output or
- Clamped PID Output if Output Polarity bit set

If the block is in Automatic mode, the final CV is placed in the Manual Command %Ref+13. If the block is in Manual mode, the PID equation is skipped as CV is set by the Manual Command, but all the rate and amplitude limits are still checked. That means that the Manual Command can not change the output above the CV Upper Clamp or below the CV Lower Clamps and the output can not change faster than the Minimum Slew Time allowed.

Sample Period and PID Block Scheduling

The PID block is a digital implementation of an analog control function, so the dt sample time in the PID Output equation is not the infinitesimally small sample time available with analog controls. The majority of processes being controlled can be approximated as a gain with a first or second order lag, possibly with a pure time delay. The PID block sets a CV output to the process and uses the process feedback PV to determine an Error to adjust the next CV output. A key process parameter is the total time constant, which is how fast does the PV respond when the CV is changed. As discussed in the Setting Loop Gains section below, the total time constant, Tp+Tc, for a first order system is the time required for PV to reach 63% of its final value when CV is stepped. The PID block will not be able to control a process unless its Sample Period is well under half the total time constant. Larger Sample Periods will make it unstable.

The Sample Period should be no bigger than the total time constant divided by 10 (or down to 5 worst case). For example, if PV seems to reach about 2/3 of its final value in 2 seconds, the Sample Period should be less than 0.2 seconds, or 0.4 seconds worst case. On the other hand, the Sample Period should not be too small, such as less than the total time constant divided by 1000, or the Ki * Error * dt term for the PID integrator will round down to 0. For example, a very slow process that takes 10 hours or 36000 seconds to reach the 63% level should have a Sample Period of 40 seconds or longer.

Unless the process is very fast, it is not usually necessary to use a Sample Period of 0 to solve the PID algorithm every PID sweep. If many PID loops are used with a Sample Period greater than the sweep time, there may be wide variations in PLC sweep time if many loops end up solving the algorithm at the same time. The simple solution is to sequence a one or more 1 bits through an array of bits set to 0 that is being used to enable power flow to individual PID blocks.

Determining the Process Characteristics

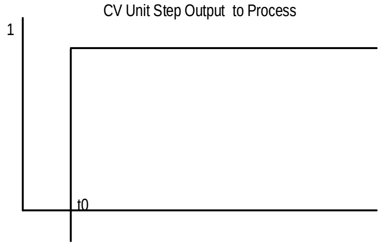
The PID loop gains, Kp, Ki and Kd, are determined by the characteristics of the process being controlled. Two key questions when setting up a PID loop are:

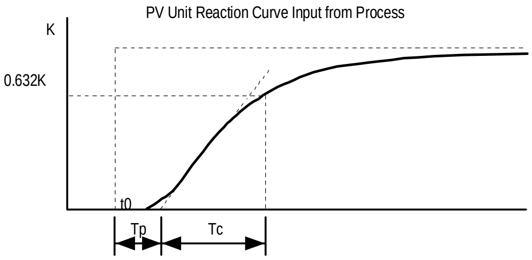
1. How big is the change in PV when we change CV by a fixed amount, or what is the open loop gain?
2. How fast does the system respond, or how quickly does PV change after the CV output is stepped?

Many processes can be approximated by a process gain, first or second order lag and a pure time delay. In the frequency domain, the transfer function for a first order lag system with a pure time delay is:

PV(s)/CV(s) = G(s) = K * e **(-Tp s)/(1 + Tc s)

Plotting a step response at time t0 in the time domain provides an open loop unit reaction curve:





The following process model parameters can be determined from the PV unit reaction curve:

K	Process open loop gain = final change in PV/change in CV at time t0 (Note no subscript on K)
Tp	Process or pipeline time delay or dead time after t0 before the process output PV starts moving
Tc	First order Process time constant, time required after Tp for PV to reach 63.2% of the final PV

Usually the quickest way to measure these parameters is by putting the PID block in Manual mode and making a small step in CV output, by changing the Manual Command %Ref+13, and plotting the PV response over time. For slow processes, this can be done manually, but for faster processes a chart recorder or computer graphic data logging package will help. The CV step size should be large enough to cause an observable change in PV, but not so large that it disrupts the process being measured. A good size may be from 2 to 10% of the difference between the CV Upper and CV Lower Clamp values.

Setting Parameters Including Tuning Loop Gains

As all PID parameters are totally dependent on the process being controlled, there are no predetermined values that will work; however, it is usually simple to find acceptable loop gain.

1. Set all the User Parameters to 0, then set the CV Upper and CV Lower Clamps to the highest and lowest CV expected. Set the Sample Period to the estimated process time constant(above)/10 to 100.
2. Put block in Manual mode and set Manual Command (%Ref+13) at different values to check if CV can be moved to Upper and Lower Clamp. Record PV value at some CV point and load it into SP.
3. Set a small gain, such as 100 * Maximum CV/Maximum PV, into Kp and turn off Manual mode. Step SP by 2 to 10% of the Maximum PV range and observe PV response. Increase Kp if PV step response is too slow or reduce Kp if PV overshoots and oscillates without reaching a steady value.
4. Once a Kp is found, start increasing Ki to get overshooting that dampens out to a steady value in 2 to 3 cycles. This may required reducing Kp. Also try different step sizes and CV operating points.
5. After suitable Kp and Ki gains are found, try adding Kd to get quicker responses to input changes providing it doesn't cause oscillations. Kd is often not needed and will not work with noisy PV.
6. Check gains over different SP operating points and add Dead Band and Minimum Slew Time if needed. Some Reverse Acting processes may need setting Config Word Error Sign or Polarity bits.

Setting Loop Gains Using the Ziegler and Nichols Tuning Approach

Once the three process model parameters, K, Tp and Tc, are determined, they can be used to estimate initial PID loop gains. The following approach provides good response to system disturbances with gains producing an amplitude ratio of 1/4. The amplitude ratio is the ratio of the second peak over the first peak in the closed loop response.

1. Calculate the Reaction rate:

   R = K/Tc

2. For Proportional control only, calculate Kp as:

   Kp = 1/(R * Tp) = Tc/(K * Tp)

   For Proportional and Integral control, use:

   Kp = 0.9/(R * Tp) = 0.9 * Tc/(K * Tp) Ki = 0.3 * Kp/Tp

   For Proportional, Integral and Derivative control, use:

   Kp = G/(R * Tp) where G is from 1.2 to 2.0
   Ki = 0.5 * Kp/Tp
   Kd = 0.5 * Kp * Tp

3. Check that the Sample Period is in the range

   (Tp + Tc)/10 to (Tp + Tc)/1000

The Ideal Tuning Method

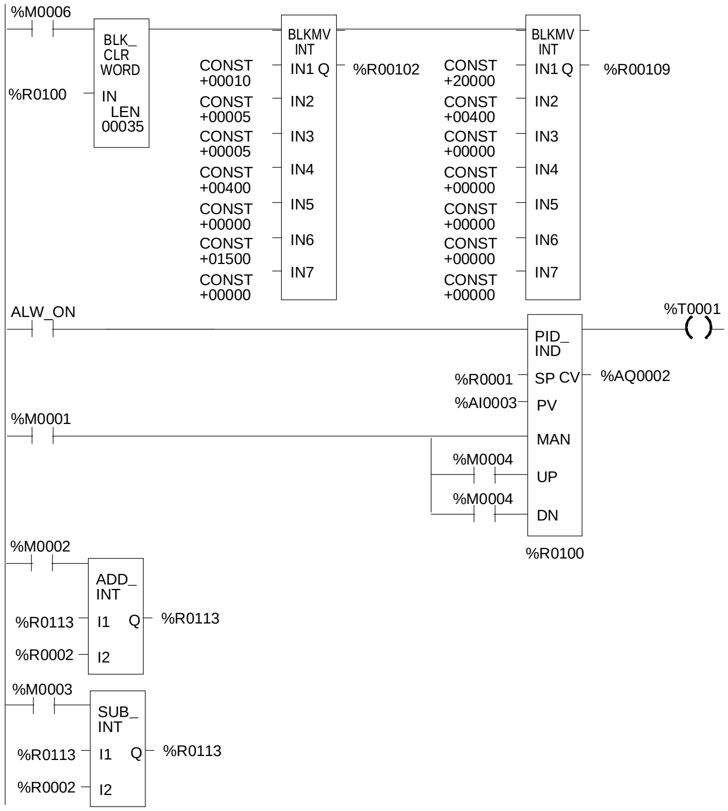
The “Ideal Tuning" procedure provides the best response to SP changes, delayed only by the Tp process delay or dead time.

Kp = 2 * Tc/(3 * K * Tp)
Ki = Tc
Kd = Ki/4 if Derivative term is used

Once initial gains are determined, convert them to integers. Calculate the Process gain K as a change in input PV Counts divided by the output step change in CV Counts and not in process PV or CV engineering units. Specify all times in seconds. Once Kp, Ki and Kd are determined, Kp and Kd can be multiplied by 100 and entered as integer while Ki can be multiplied by 1000 and entered into the User Parameter %RefArray.

Sample PID Call

The following PID example has a sample period of 100Ms, a Kp gain of .4.00 and a Ki gain of 1.500. The set point is stored in %R0001, the control variable output in %AQ0002, and the process variable is returned in %AI0003. CV Upper and CV Lower Clamps must be set, in this case to 20000 and 4000, and an optional small Dead Band of +5 and -5 has been included. The 40-word RefArray starts in %R0100. Normally User Parameters are set in the RefArray, but %M0006 can be set to reinitialize the 14 words starting at %R0102 (%Ref+2) from constants stored in logic (a useful technique).

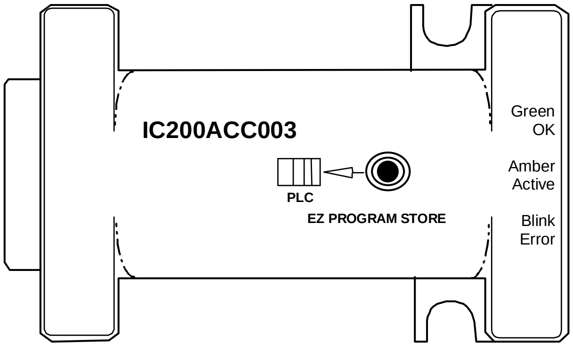


The block can be switched to Manual mode with %M1 so that the Manual Command, %R113, can be adjusted. Bits %M4 or %M5 can be used to increase or decrease %R113 and the PID CV and integrator by 1 every 100 MSec solution. For faster manual operation, bits %M2 and %M3 can be used to add or subtract the value in %R2 to/from %R113 every PLC sweep. The %T1 output is on when the PID is OK.

Chapter 15

The EZ Program Store Device

This chapter describes the VersaMax® EZ Program Store device, which can be used to transfer program, configuration, and reference tables data from one PLC to one or more others of the same type.



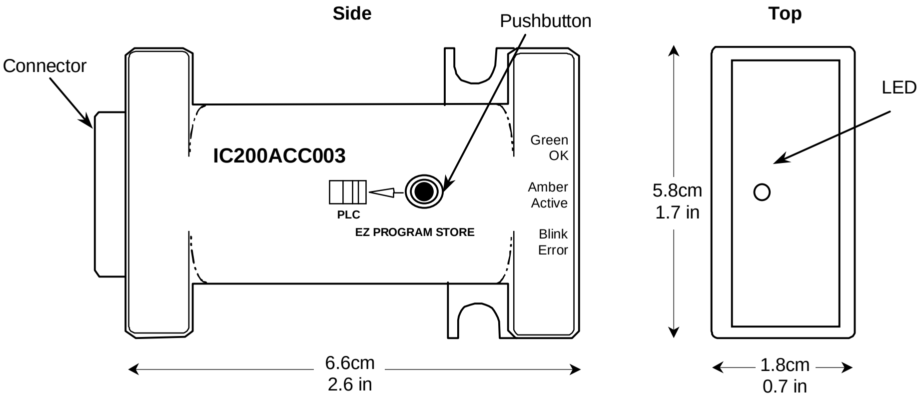
Contents of this chapter:

- Description of the EZ Program Store device
- Details of Using the EZ Program Store device
- Read/Write/Verify Data with a Programmer Present
- Write Data to a PLC CPU without a Programmer Present

IC200ACC003: EZ Program Store Device

The EZ Program Store device (IC200ACC003) can be used to store and update the configuration, application program, and reference tables data of a VersaMax PLC. The update can include Ethernet Global Data and Advanced User Parameters for Ethernet. A programmer and PLC CPU are used to initially write data to the device. In addition to writing data to the device, the programmer can read data already stored on an EZ Program Store device, and compare that data with similar files already present in the programmer.

Once the data is written to the EZ Program Store device, the data can be written to one or more other PLC CPUs of the same type, with no programmer needed.



The EZ Program Store device and PLC must both have no OEM key password or the same OEM key password for an update to occur. The EZ Program Store device does not perform special processing for other types of passwords.

The EZ Program Store device plugs directly into port 2 on a VersaMax PLC. No cables or connectors are required. Power for the device comes from port 2. Because the EZ Program Store device is not used during normal operation, it does not need to be screwed down to the PLC. The device can be hot inserted and hot removed without disrupting the system.

Features

- 2-Megabit Serial Data Flash for non-volatile storage
- Pushbutton initiates update from the device to a PLC
- Dual color status LED
- Configurable OEM key password protection
- Compatible with all VersaMax CPU models, release 2.10 and later.

Read/Write/Verify Data with a Programmer Present

With a programmer present, the PLC CPU can read, write, or verify a program, configuration and tables in the EZ Program Store device. When reading or verifying data, it is possible to select hardware configuration, logic, and/or reference tables data. However, when writing data to the EZ Program Store device, all three data types must be written. If the hardware configuration includes Ethernet Global Data and/or a file of Advanced User Parameters for Ethernet communications, they will also be included.

The programmer must be using version 1.5 or later of the VersaPro programming software.

WARNING

Do not use the pushbutton on the EZ Program Store device to invoke an update while:

1. Loading program logic, configuration data, and/or reference tables from the PLC to the programmer.
2. Verifying program logic, configuration data, and/or reference tables in the PLC with the programmer.

Doing so may corrupt the data being loaded or verified and produce unexpected results. You should power-cycle the PLC to restore normal operation.

Including All the Necessary Information

When the EZ Program Store device updates a PLC, it writes over existing configuration, program files and data in the target PLC. Therefore, it is important to be sure that the information placed on the EZ Program Store device is complete for proper operation of the PLC system. For example, if the EZ Program Store device contains an application program, but instead of a customized hardware configuration it contains the default PLC configuration, the update will overwrite any existing configuration data in a PLC being updated. If that happens, the modules in the PLC system will then use their default configuration, which may cause unexpected operation.

EZ Program Store Device: IC200ACC003

Matching OEM Protection

If the PLC(s) that will be updated by the EZ Program Store device are protected by an OEM key password, be sure the same OEM key password is present in the configuration stored to the EZ Program Store device, otherwise no update will be possible. If the PLC(s) being updated had no OEM key password assigned, the EZ Program Store device must also not have an OEM key password. The device does not use other system passwords. (See chapter 7, CPU Operation, for information about passwords and the OEM key).

Adjusting the Configuration Timeouts

Reading and writing large programs, hardware configurations, and reference tables to or from the EZ Program Store device may take 30 seconds or more to complete. To avoid possible disconnect errors or read/write errors, adjust the request timeouts in the configuration to 30 - 63 seconds (30,000 - 63,000mS).

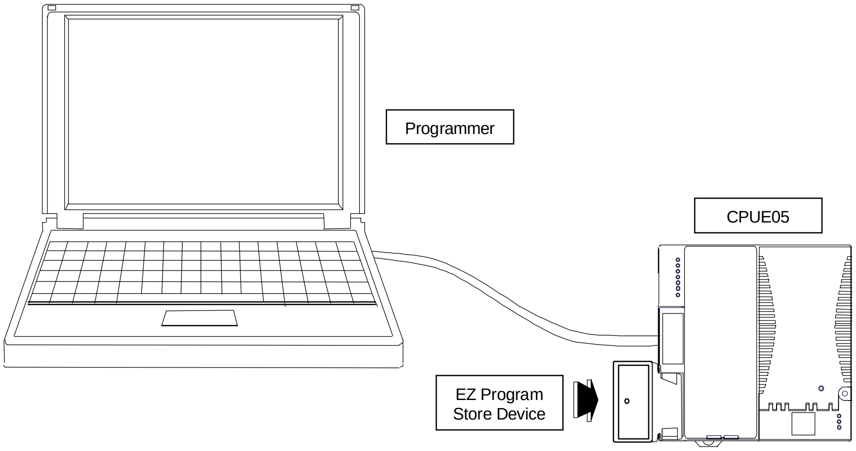
Writing Data to RAM or Flash

Folder data is stored from the programmer to the EZ Program Store device in the same way data is stored to Flash memory. Writing to either Flash or to the EZ Program Store device always writes all folder data (regardless of what types are selected). Data stored to the EZ Program Store device is verified in the same manner as data stored in Flash memory is verified. Data can also be read from the device in the same manner as reading from Flash.

The EZ Program Store device can be used to update data in a PLC’s RAM memory only, or in both RAM and Flash memory. In the configuration data stored to the EZ Program Store device, be sure to specify which type of memory should be updated. Select “RAM only” to update only RAM memory in the target PLC. Select “RAM & FLASH” to update both.

IC200ACC003: EZ Program Store Device

Using the EZ Program Store Device with the Programmer

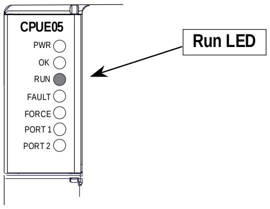


To read/write or verify some or all of the data, follow these steps:

1. Plug the EZ Program Store device into port 2 of the VersaMax PLC CPU. The device's LED turns green after about 2 seconds. The delay allows time for proper seating of the device.

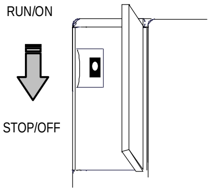
EZ Program Store Device: IC200ACC003

2. If the PLC is in Run mode when the EZ Program Store device is connected, the Run LED on the PLC blinks at a 1 Hz rate.



   This blinking indicates that the Run/Stop switch is enabled, regardless of the configuration of the switch.

3. If the EZ Program Store device's LED is green and the PLC's Run LED is blinking, stop the PLC by moving the Run/Stop switch from the On/Run position to the Stop/Off position.



   If the switch is already on the Stop/Off position, move it to Run then back to Stop to affirm the change. After the mode is changed to Stop No I/O, the Run LED goes off.

   Note that to change the PLC mode from Run to Stop or from Stop to Run mode when an EZ Program Store device is attached, the PLC's Run/Stop switch must be used. If a programmer (computer) is also connected to the PLC at the same time, the programmer cannot be used to change the PLC mode.

4. Start the programming software and change the request timeout values as needed.
5. Connect the programmer to the PLC CPU.
6. Use the programming software to read, write, or verify the data.

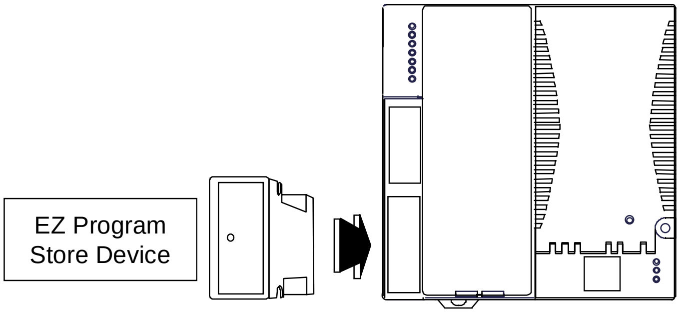
   When performing an update with the programmer present, the pushbutton on the EZ Program Store device is not used.

Update a PLC CPU without a Programmer Present

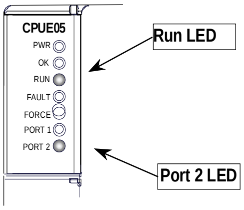
With a program, configuration, tables, Ethernet Global Data, and Advanced User Parameters (if any) already stored in an EZ Program Store device, it can be used to update one or more other PLC CPUs of the same type. All the data stored in the EZ Program Store device will be updated in the PLC CPU.

To update all of the data in a VersaMax PLC CPU, follow these steps:

1. Plug the EZ Program Store device into port 2 of the VersaMax PLC CPU.

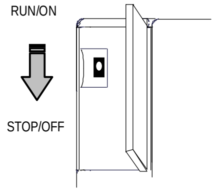


If the PLC is in Run mode when the EZ Program Store device is connected, the Run LED on the PLC blinks at a 1 Hz rate. This blinking indicates that the Run/Stop switch is enabled, regardless of the configuration of the switch.



EZ Program Store Device: IC200ACC003

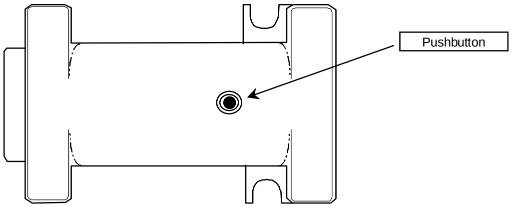
2. If the PLC's Run LED is blinking and the LED on the device is green, stop the PLC by moving the Run/Stop switch from Run/On to Stop/Off position.



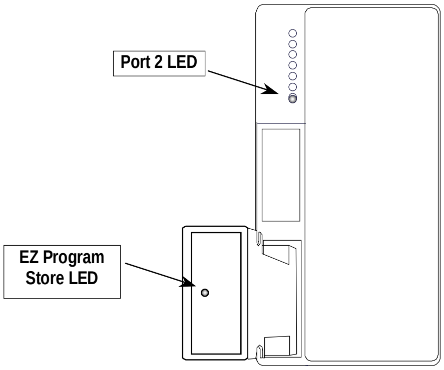
If the switch is already on the Stop/Off position, move it from Run then back to Stop to affirm the change.

After the mode is changed to Stop No I/O, the PLC Run LED goes off.

3. To start the update, press the pushbutton on the EZ Program Store device.

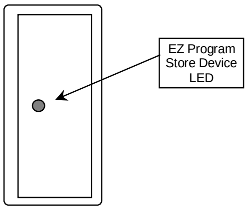


The LED on the EZ Program Store device turns amber and the Port 2 LED on the PLC blinks.



4. Wait for the update to complete. Reading and writing large programs, hardware configurations, and reference tables to or from the EZ Program Store device may take 30 seconds or more to complete.

When the device’s LED turns solid green and the CPU’s Run LED starts blinking, the update has completed successfully.



When the PLC is placed into Run mode (by moving the Run/Stop switch from Stop/Off to Run/On position) it uses the new data immediately.

Error During Update

If the EZ Program Store device’s LED is blinking green/amber and the CPU’s Run LED is blinking, an error was detected before the old data was erased. When the PLC is placed into Run mode, it continues using the old data.

If the device’s LED is blinking green/amber and the CPU’s Run LED is off, an error occurred during the transfer after the data in the PLC was erased. Try the update again by disconnecting and reconnecting the device and pressing the pushbutton. If the second update fails, contact the update provider for service.

Update errors are reported as USD Flash Read faults in the PLC Fault Table. The first two bytes of extra fault data describe the fault.

Appendix A

Performance Data

This section presents performance data collected on the VersaMax CPUs IC200CPU001, CPU002, CPU005, and CPUE05. The data includes base sweep time, sweep impact of boolean instructions, function block sweep impact times, function block sizes, and I/O module scan time data.

Base Sweep Time

The table below shows the base sweep time with the default program in Run mode, no I/O modules present or configured, and no serial connections to either serial port.

Model	Time (in milliseconds)
CPU001/002	1.605
CPU005	1.039
CPUE05	1.910

Boolean Instruction Time

This table shows the typical sweep impact time for boolean instructions:

Model	Typical Time (in microseconds)
CPU001/002	1.7
CPU005/E05	0.8

Function Block Timing

The following tables show the sweep impact times and size information for all supported function blocks of the CPU.

Sweep Impact Times

The tables show two sweep impact times are shown for each function. An Increment time is shown for functions that can have variable length inputs (table functions):

Enabled	Sweep impact time (in microseconds) when a function block has been enabled; power flow to the function block.
Disabled	Sweep impact time (in microseconds) when a function block has been disabled; no power-flow to function block and/or power-flow to reset of function block.
Increment	Incremental time (in microseconds/input unit) to add to the base function time for each addition to the length of an input parameter. Only applies to table functions that can have varying input lengths (i.e. Search, Array Moves, etc.).

All timings represent typical execution time. Timings may vary with input and error conditions. Each timing includes the time to execute one contact, and normal overhead including a connection with a programmer. (**Note**: timings listed in previous versions of this manual did not include this overhead.)

- For table functions, increment is in units of length specified.
- For bit operation functions, microseconds/bit.
- For data move functions, microseconds/number of bits or words.
- For functions that have an increment value, multiply the increment by (Length –1) and add that value to the base time to get total instruction time.

Sizes of Timers, Counters, Math Functions, Trig Functions, Log Functions

The size of a function is the number of bytes consumed in user logic space for each instance of the function in a ladder diagram application program.

Group	Function	CPU001/002		CPU005/E05		Increment	Size
		Enabled	Disabled	Enabled	Disabled		
Timers	On-Delay Timer	119	90	90	69	–	15
	Timer	110	80	81	60	–	15
	Off-Delay Timer	110	80	81	60	–	15
Counters	Up Counter	90	90	70	70	–	13
	Down Counter	93	90	70	70	–	13
Math	Addition (INT)	62	12	50	10	–	13
	Addition (DINT)	60	12	50	10	–	19
	Addition (REAL)	139	12	99	10	–	17
	Subtraction (INT)	62	12	50	10	–	13
	Subtraction (DINT)	60	12	50	10	–	19
	Subtraction (REAL)	139	12	100	10	–	17
	Multiplication (INT)	70	12	50	10	–	13
	Multiplication (DINT)	99	12	50	10	–	19
	Multiplication (REAL)	155	12	108	10	–	17
	Division (INT)	80	12	60	10	–	13
	Division (DINT)	70	12	51	10	–	19
	Division (REAL)	244	12	160	10	–	17
	Modulo Division (INT)	84	12	60	10	–	13
	Modulo Division (DINT)	80	12	60	10	–	19
	Square Root (INT)	85	12	60	10	–	10
	Square Root (DINT)	126	12	70	10	–	13
	Square Root (REAL)	514	12	340	10	–	11
	Scale (INT)	112	12	78	10	–	22
	Scale (WORD)	110	12	73	10	–	22
Trigonometric	SIN (REAL)	1432	12	945	10	–	11
	COS (REAL)	1437	12	945	10	–	11
	TAN (REAL)	2135	20	1400	20	–	11
	ASIN (REAL)	1838	12	1200	10	–	11
	ACOS (REAL)	1793	12	1200	10	–	11
	ATAN (REAL)	820	12	542	10	–	11
Logarithmic	LOG (REAL)	878	12	577	10	–	11
	LN (REAL)	821	12	542	10	–	11

Sizes of Exponential Functions, Radian Conversion, Relational Functions

The size of a function is the number of bytes consumed in user logic space for each instance of the function in a ladder diagram application program.

Group	Function	CPU001/002		CPU005/E05		Increment	Size
		Enabled	Disabled	Enabled	Disabled		
Exponential	Power of e	592	12	393	10	–	11
	Power of X	365	12	249	10	–	17
Radian	Convert RAD to DEG	328	12	214	10	–	11
Conversion	Convert DEG to RAD	106	12	70	10	–	11
Relational	Equal (INT)	43	12	30	10	–	10
	Equal (DINT)	50	12	37	10	–	16
	Equal (REAL)	60	12	41	10	–	14
	Not Equal (INT)	40	12	30	10	–	10
	Not Equal (DINT)	45	12	30	10	–	16
	Not Equal (REAL)	60	12	40	10	–	14
	Greater Than (INT)	40	12	30	10	–	10
	Greater Than (DINT)	45	12	30	10	–	16
	Greater Than (REAL)	60	12	40	10	–	14
	Greater Than/Equal (INT)	40	12	30	10	–	10
	Greater Than/Equal (DINT)	46	12	30	10	–	10
	Greater Than/Equal (REAL)	60	12	40	10	–	14
	Less Than (INT)	40	12	30	10	–	10
	Less Than (DINT)	46	12	30	10	–	16
	Less Than (REAL)	60	12	40	10	–	14
	Less Than/Equal (INT)	40	12	30	10	–	10
	Less Than/Equal (DINT)	46	12	30	10	–	16
	Less Than/Equal (REAL)	60	12	40	10	–	14
	Range (INT)	50	12	33	10	–	13
	Range (DINT)	55	12	40	10	–	22
	Range (WORD)	50	12	33	10	–	13

Sizes of Bit Operations, Data Move Functions

The size of a function is the number of bytes consumed in user logic space for each instance of the function in a ladder diagram application program.

Group	Function	CPU001/002		CPU005/E05		Increment	Size
		Enabled	Disabled	Enabled	Disabled		
Bit Operation	Logical AND	60	12	50	10	–	13
	Logical OR	60	12	50	10	–	13
	Logical Exclusive OR	60	12	50	10	–	13
	Logical Invert, NOT	50	12	40	10	–	10
	Shift Bit Left	134	12	80	10	14.78	16
	Shift Bit Right	129	12	80	10	16.31	16
	Rotate Bit Left	110	12	70	10	18.45	16
	Rotate Bit Right	111	12	70	10	18.41	16
	Bit Position	76	12	57	10	–	13
	Bit Clear	70	12	56	10	–	13
	Bit Test	60	12	44	10	–	13
	Bit Set	70	12	56	10	–	13
	Mask Compare (WORD)	158	12	110	10	–	25
	Mask Compare (DWORD)	150	12	100	10	–	25
	Bit Sequencer	150	109	101	77	0.24	16
Data Move	Move (INT)	45	12	32	10	2.83	10
	Move (BIT)	80	12	60	10	10.76	13
	Move (WORD)	46	12	32	10	2.82	10
	Move (REAL)	60	12	47	10	2.75	13
	Block Move (INT)	60	12	50	10	–	28
	Block Move (WORD)	60	12	50	10	–	28
	Block Move (REAL)	113	12	94	10	–	13
	Block Clear	100	12	83	10	4.63	11
	Shift Register (BIT)	130	12	94	10	0.45	16
	Shift Register (WORD)	120	12	100	10	2.76	16
	COMM_REQ *	175	175	120	120	–	13

* Commreq sent to HSC module.

Sizes of Table Functions

The size of a function is the number of bytes consumed in user logic space for each instance of the function in a ladder diagram application program.

Group	Function	CPU001/002		CPU005/E05		Increment	Size
		Enabled	Disabled	Enabled	Disabled		
Table	Array Move						
	INT	110	12	90	10	5.50	22
	DINT	100	12	80	10	2.76	22
	BIT	129	12	92	10	1.08	22
	BYTE	109	12	80	10	4.75	22
	WORD	110	12	90	10	5.50	22
	Search Equal						
	INT	90	12	70	10	6.59	19
	DINT	90	12	60	10	7.14	22
	BYTE	81	12	60	10	2.58	19
	WORD	90	12	70	10	6.59	19
	Search Not Equal						
	INT	100	12	78	10	6.66	19
	DINT	110	12	81	10	7.14	22
	BYTE	74	12	57	10	2.56	19
	WORD	100	12	78	10	6.66	19
	Search Greater Than						
	INT	100	12	80	10	6.69	19
	DINT	94	12	70	10	7.12	22
	BYTE	90	12	69	10	2.58	19
	WORD	100	12	76	10	6.69	19
	Search Greater Than/Equal						
	INT	90	12	70	10	6.79	19
	DINT	90	12	60	10	7.15	22
	BYTE	81	12	60	10	2.56	19
	WORD	90	12	70	10	6.79	19
	Search Less Than						
	INT	80	12	60	10	6.59	19
	DINT	110	12	80	10	7.13	22
	BYTE	73	12	56	10	2.58	19
	WORD	80	12	60	10	6.66	19
	Search Less Than/Equal						
	INT	80	12	60	10	6.66	19
	DINT	90	12	60	10	7.13	22
	BYTE	72	12	54	10	2.59	19
	WORD	80	12	60	10	6.66	19

Sizes of Conversion and Control Functions

The size of a function is the number of bytes consumed in user logic space for each instance of the function in a ladder diagram application program.

Group	Function	CPU001/002		CPU005/E05		Increment	Size
		Enabled	Disabled	Enabled	Disabled		
Conversion	Convert INT to REAL	60	12	40	10	–	10
	Convert REAL to INT	683	12	455	10	–	13
	Convert DINT to REAL	60	12	40	10	–	13
	Convert REAL to DINT	673	12	451	10	–	13
	Convert WORD to REAL	60	12	40	10	–	10
	Convert REAL to WORD	642	12	429	10	–	13
	Convert BCD to INT	57	12	40	10	–	10
	Convert INT to BCD	167	12	120	10	–	10
	Convert BCD to REAL	70	12	50	10		10
	Truncate to INT	188	12	130	10	–	13
	Truncate to DINT	179	12	128	10	–	13
Control	Call a Subroutine	60	12	40	10	–	7
	Do I/O *	130	12	130	10	–	13
	PID – ISA Algorithm	231	85	150	57	–	16
	PID – IND Algorithm	231	85	150	57	–	16
	Service Request						
	#6	77	12	60	10	–	10
	#7 (Read)	221	12	173	10	–	10
	#7 (Set)	2610	12	2211	10	–	10
	#14 **	169	12	139	10	–	10
	#15	100	12	72	10	–	10
	#16	110	12	80	10	–	10
	#18	346	12	251	10	–	10
	#23	377	12	361	10	–	10
	#26//30 ***	912	12	912	10	–	10
	#29	72	12	60	10	–	10
	Nested MCR/ENDMCR Combined	31	33	31	33	–	4
	Drum Sequencer	267	222	184	152	–	34

* DO I/O timing is the time to output values to discrete output module.

** Service Request #14 (Clear Fault Table) timing was done when fault table contained no faults.

*** Service Request #26/30 (Interrogate I/O) timing was done when I/O configuration was empty and both an MDL740 (16pt out) and MDL640 (16pt in) were physically present.

I/O Module Scan Times

The tables that follow show typical scan times for modules in a VersaMax PLC. Each module was configured with its default settings and user power was applied when applicable.

Four tables are included:

- Modules Located in Main Rack
- Modules Located in Local Single Rack
- Modules Located in Multiple Remote Rack
- Modules Located in Isolated Rack

Reference to Discrete Module Types in the Scan Time Tables

In the scan time tables, discrete modules are grouped by type:

Module Type	Module Catalog Number, IC200:					
Discrete Input Type 1	MDL140	MDL141	MDL143	MDL144	MDL631	MDL635
	MDL640	MDL643	MDD842	MDD843	MDD844	MDD845
	MDD846	MDD847	MDD848	MDD849	MDD850	MDL930
Discrete Input Type 2	MDL240	MDL241	MDL243	MDL244	MDL632	MDL636
	MDL644	MDL650	MDD840			
Discrete Output Type 1	MDL329	MDL331	MDL740	MDL741	MDL743	MDD842
	MDD843	MDD844	MDD845	MDD846	MDD847	MDD848
	MDD849	MDD850				
Discrete Output Type 2	MDL330	MDL742	MD744	MDL750	MDL840	MDL940
Discrete Output w/ ESCP Per Point Fault Reporting	MDL730					

For additional information on VersaMax I/O Modules, please refer to *VersaMax Modules, Power Supplies, and Carrier User's Manual GFK-1504*.

Modules Located in Main PLC Rack

Module Type	CPU005/CPUE05		CPU001/CPU002	
	Main Rack		*Main Rack*	
	Input	***Output***	***Input***	***Output***
Discrete Input Type 1 *	95	---	158	---
Discrete Input Type 2 *	117	---	189	---
Discrete Output Type 1 *	---	84	---	132
Discrete Output Type 2 *	---	101	---	152
Discrete Output w/ ESCP Per Point Fault Reporting	---	116	---	190
Intelligent Discrete Input 20 Points	349	---	389	---
Intelligent Discrete Output 12 Points	---	294	---	369
Analog Input 4 Channels	160	---	190	---
Analog Input 8 Channels	239	---	312	---
Analog Input 15 Channels	377	---	526	---
Analog Output 2 Channels	---	109	---	161
Analog Output 4 Channels	---	145	---	202
Analog Output 8 Channels	---	217	---	285
Analog Output 12 Channels	---	289	---	367
Intelligent Analog Input 4 Channels	237	---	281	---
Intelligent Analog Input 7 Channels	261	---	305	---
Intelligent Analog Input 8 Channels	272	---	313	---
Intelligent Analog Output 4 Channels	---	212	---	264
PLC Network Comm Profibus-DP Slave	**	**	**	**
DeviceNet Network Master/Slave	**	**	**	**

*   Mixed modules have both and input and output scan time values.

**   Network Communications Modules (NCM) Scan Impact Times vary depending upon the network configuration.

Modules Located in Single-ended Expansion Rack

The table below shows timing for modules located in a single-ended expansion rack with a non-isolated Expansion Receiver module ((C200ERM002). This type of system does NOT have an Expansion Transmitter module (IC200ETM001) in the main rack.

Module Type	**CPU005/CPUE05**		**CPU001/CPU002**	
	Local Single Rack		***Local Single Rack***	
	Input	***Output***	***Input***	***Output***
Discrete Input Type 1 *	127	---	191	---
Discrete Input Type 2 *	179	---	262	---
Discrete Output Type 1 *	---	116	---	167
Discrete Output Type 2 *	---	167	---	222
Discrete Output w/ ESCP Per Point Fault Reporting	---	176	---	260
Intelligent Discrete Input 20 Points	643	---	763	---
Intelligent Discrete Output 12 Points	---	714	---	756
Analog Input 4 Channels	317	---	389	---
Analog Input 8 Channels	527	---	631	---
Analog Input 15 Channels	896	---	1054	---
Analog Output 2 Channels	---	204	---	266
Analog Output 4 Channels	---	296	---	374
Analog Output 8 Channels	---	480	---	592
Analog Output 12 Channels	---	664	---	809
Intelligent Analog Input 4 Channels	438	---	533	---
Intelligent Analog Input 7 Channels	479	---	580	---
Intelligent Analog Input 8 Channels	493	---	596	---
Intelligent Analog Output 4 Channels	---	484	---	613
PLC Network Comm Profibus-DP Slave	**	**	**	**
DeviceNet Network Master/Slave	**	**	**	**

* Mixed modules have both and input and output scan time values.

** Network Communications Modules (NCM) Scan Impact Times vary depending upon the network configuration.

Modules Located in Multiple Remote Expansion Rack

The table below shows timing for modules located in the expansion racks of a multiple-rack expansion system that uses only Isolated Expansion Receiver Modules (IC200ERM001). In this type of system, there is an Expansion Transmitter module (IC200ETM001) in the CPU rack.

Module Type	CPU005/CPUE05		CPU001/CPU002	
	Multiple Remote Rack		*Multiple Remote Rack*	
	Input	***Output***	***Input***	***Output***
Discrete Input Type 1 *	130	---	193	---
Discrete Input Type 2 *	181	---	258	---
Discrete Output Type 1 *	---	118	---	167
Discrete Output Type 2 *	---	165	---	223
Discrete Output w/ ESCP Per Point Fault Reporting	---	177	---	261
Intelligent Discrete Input 20 Points	651	---	766	---
Intelligent Discrete Output 12 Points	---	728	---	757
Analog Input 4 Channels	324	---	393	---
Analog Input 8 Channels	541	---	646	---
Analog Input 15 Channels	920	---	1087	---
Analog Output 2 Channels	---	206	---	267
Analog Output 4 Channels	---	300	---	377
Analog Output 8 Channels	---	489	---	596
Analog Output 12 Channels	---	678	---	815
Intelligent Analog Input 4 Channels	442	---	535	---
Intelligent Analog Input 7 Channels	484	---	582	---
Intelligent Analog Input 8 Channels	497	---	598	---
Intelligent Analog Output 4 Channels	---	490	---	615
PLC Network Comm Profibus-DP Slave	**	**	**	**
DeviceNet Network Master/Slave	**	**	**	**

* Mixed modules have both and input and output scan time values.

** Network Communications Modules (NCM) Scan Impact Times vary depending upon the network configuration.

Modules Located in Single-ended Isolated Expansion Rack

The table below shows timing for modules located in an expansion rack in a single-ended expansion system that has an Isolated Expansion Receiver Module (IC200ERM001) in the expansion rack and an Expansion Transmitter module (IC200ETM001) in the CPU rack.

Module Type	CPU005/CPUE05		CPU001/CPU002	
	Isolated Rack		*Isolated Rack*	
	Input	*Output*	*Input*	*Output*
Discrete Input Type 1 *	466	---	524	---
Discrete Input Type 2 *	869	---	913	---
Discrete Output Type 1 *	---	452	---	496
Discrete Output Type 2 *	---	837	---	875
Discrete Output w/ ESCP Per Point Fault Reporting	---	850	---	914
Intelligent Discrete Input 20 Points	4050	---	4086	---
Intelligent Discrete Output 12 Points	---	5135	---	5135
Analog Input 4 Channels	2054	---	2093	---
Analog Input 8 Channels	3660	---	3660	---
Analog Input 15 Channels	6471	---	6471	---
Analog Output 2 Channels	---	1221	---	1251
Analog Output 4 Channels	---	1991	---	2021
Analog Output 8 Channels	---	3531	---	3560
Analog Output 12 Channels	---	5071	---	5099
Intelligent Analog Input 4 Channels	3155	---	3196	---
Intelligent Analog Input 7 Channels	3401	---	3444	---
Intelligent Analog Input 8 Channels	3483	---	3526	---
Intelligent Analog Output 4 Channels	---	2751	---	2811
PLC Network Comm Profibus-DP Slave	**	**	**	**
DeviceNet Network Master/Slave	**	**	**	**

* Mixed modules have both and input and output scan time values.

** Network Communications Modules (NCM) Scan Impact Times vary depending upon the network configuration.

Ethernet Global Data Sweep Impact

Depending on the relationship between the CPU sweep time and Ethernet Global Data (EGD) exchange's period, the exchange data may be transferred every sweep or periodically after some number of sweeps. Therefore, the sweep impact will vary based on the number of exchanges that are scheduled to be transferred during the sweep. However, at some point during the operation of the PLC, all of the exchanges will be scheduled to transfer data during the same sweep. Therefore, all exchanges must be considered when computing the worst case sweep impact.

The Ethernet Global Data (EGD) sweep impact has two parts, Consumption Scan and Production Scan:

EGD Sweep Impact = Consumption Scan Time + Production Scan Time

Where the Consumption and Production Scans consist of two parts, exchange overhead and byte transfer time:

Scan Time = Exchange Overhead + Byte Transfer Time

Exchange Overhead

Exchange overhead includes the setup time for each exchange that will be transferred during the sweep. This overhead varies depending on whether the exchange is consumed or produced and if the time-stamp for the exchange originates from the PLC itself or from a remote Network Time Protocol (NTP) server. When computing the sweep impact, include overhead time for each exchange.

	Consumed Exchange	**Produced Exchange**
Exchange Overhead*	80	110 (304**)

* Times are in microseconds.

** Represents overhead if the exchange is time-stamped with the PLC clock instead of a remote NTP server.

Byte Transfer Time

This is the time required to transfer data between the PLC CPU module and the Ethernet module. The byte transfer time is slightly greater if the PLC memory being written to could contain overrides due to additional overhead. The times shown in the following table represent the time to transfer one data byte.

	Consumed Exchange	**Produced Exchange**
Byte Transfer Time*	1 (3.6**)	1

* Times are in microseconds.

** Represents transfer time if memory type supports overrides.

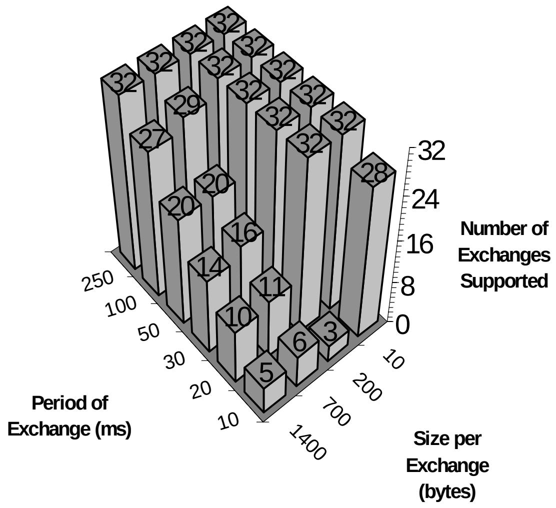
Support for Large Ethernet Global Data Configurations

The VersaMax CPUE05 Ethernet Global Data (EGD) feature supports a configuration of up to 32 exchanges, at periods as short as 10 ms, with data sizes as large as 1400 bytes. However, the CPUE05 cannot support a configuration in which every aspect of EGD is maximized. The chart below indicates the maximum number of EGD exchanges that the CPUE05 can realistically support of a certain size and data refresh period under "Best-Case" conditions. These numbers will scale downwards based on the size of the user program, the presence of other Ethernet traffic, etc.

The term "Best-Case" indicates the following setup parameters apply:

- No user logic is present, so the logic sweep time is nearly 0
- There are no modules present in the system.
- No other Ethernet traffic present on the network.
- Assumed data refresh timeout is $2 \times refresh\ period + 10ms$

CPUE05 System Best-Case EGD Capacity



Index

Index

Index

RH2B-ULCAC110-120V

[Compact 10A ice-cube relays with SPDT up to 4PDT including blade or PCB type.]

Key Features

RH2B-ULCAC110-120V

Product Specifications

Status	Active
Switching Current	10A
Contact Configuration	DPDT
Special Contacts	None
Input Voltage	120VAC
Options	Indicator Light, Momentary Checkbutton
Minimum Applicable Load (ref. value)	30mA @ 24VDC; 100mA @ 5VDC
Contact Material	AgCdO
Motor Load HP Rating	1/3 HP (at 240VAC), 1/6 HP (at 120VAC)
Base Terminal Type	Blade Plug-In
Base Terminal Size	0.187"
Weight	37g
Socket: DIN Rail Mount (Standard)	SH2B-05
Socket: DIN Rail Mount (Finger-safe)	SH2B-05C
Socket: Through Panel Mount	SH2B-51
Socket: PCB Mount	SH2B-62
Product Series Name	RH Series
Relay Type	General Purpose Relay
Switching Current Range	3A to 10A

Industrial Automation Catalog Section - U906

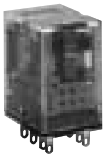
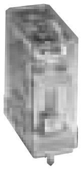
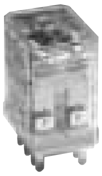
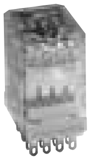
Selection Guides

General Purpose Relays

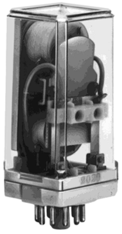
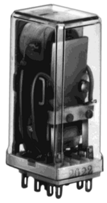
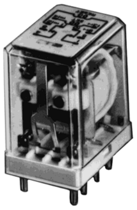
- RH Series
- ~~RM Series~~
- ~~RY Series~~

Selection Guides

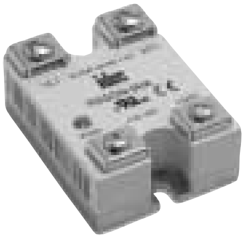
General Purpose Relays

	RU Series	RR Series	RH Series	RM Series	RY Series
Appearance					
Page	E-3	E-6	E-10	E-16	E-19
Contact Configuration	2, 4 Form C	1, 2, 3 Form C	1, 2, 3, 4 Form C	2 Form C	2, 4 Form C
Contact Rating (resistive)	DPDT: 10A, 30V DC 10A, 250V AC 4PDT: 6A, 30V DC 6A, 250V AC	10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/4HP, 120V AC	10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/6HP, 120V AC	5A, 30V DC 5A, 120V AC, 240V AC	DPDT: 3A, 30V DC; 3A, 120V AC, 240V AC 4PDT: 5A, 30V DC; 5A, 120V AC, 240V AC
Contact Material	DPDT: AuSnOIn (silver tin oxide indium) 4PDT: AuAg/Ag (gold-silver alloy on silver)	Silver	Silver-cadmium oxide	Silver	Standard: Silver, gold-plated Bifurcated: Silver-paladium alloy (Ag-PD Alloy)

General Purpose Latching Relays

	RR2KP Series	RH2L Series	RY2KS Series	RY2L Series
Appearance				
Page	E-23	E-26	E-29	E-32
Contact Configuration	2 Form C	2 Form C	2 Form C	2 Form C
Contact Rating (resistive)	10A, 30V DC 10A, 120V AC	10A, 30V DC 7.5A, 240V AC 10A, 120V AC	3A, 30V DC 3A, 120V AC	3A, 30V DC 3A, 120V AC 3A, 240V AC
Contact Material	Silver	Silver-cadmium oxide	Silver, gold-plated	Silver, gold-flashed

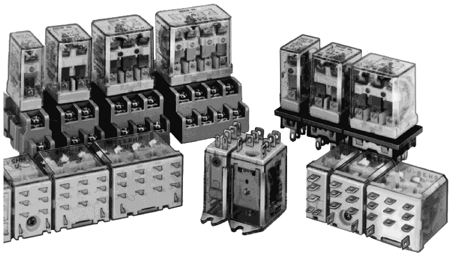
Solid State Relays

	RSS Series
Appearance	
Page	E-35
Contact Configuration	1 Form A (SPST-NO)
Contact Rating	10, 25, 50, 75, 90A 48V AC to 660V AC Output Ratings
Output	Dual SCR (zero crossing)

RH Series — General Purpose Midget Relays

Key features of the RH series include:

- **Compact midget size saves space**
- **High switching capacity (10A)**
- **Choice of blade or PCB style terminals**
- **Relay options include indicator light, check button, and top mounting bracket**
- **DIN rail, surface, panel, and PCB type sockets available for a wide range of mounting applications**



UL Recognized
Files No. E67770
E59804

CSA Certified
File No.LR35144

File No. BL951113332319

Specifications

Contact Material	Silver cadmium oxide
Contact Resistance	50mΩ maximum (initial value)
Minimum Applicable Load	24V DC/30mA, 5V DC/100mA (reference value)
Operating Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
Release Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
Maximum Continuous Applied Voltage (AC/DC) at 20°C	110% of the rated voltage
Minimum Operating Voltage (AC/DC) at 20°C	80% of the rated voltage
Drop-Out Voltage (AC)	30% or more of the rated voltage
Drop-Out Voltage (DC)	10% or more of the rated voltage
Power Consumption	**SPDT** (RH1): DC: 0.8W AC: 1.1VA (50Hz), 1VA (60Hz) **DPDT** (RH2): DC: 0.9W AC: 1.4VA (50Hz), 1.2VA (60Hz) **3PDT** (RH3): DC: 1.5W AC: 2VA (50Hz), 1.7VA (60Hz) **4PDT** (RH4): DC: 1.5W AC: 2.5VA (50Hz), 2VA (60Hz)
Insulation Resistance	100MΩ min (measured with a 500V DC megger)
Dielectric Strength	**SPDT** (RH1) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
	DPDT (RH2), **3PDT** (RH3), **4PDT** (RH4) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contact circuits: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
Frequency Response	1,800 operations/hour
Temperature Rise	Coil: 85°C maximum Contact: 65°C maximum
Vibration Resistance	0 to 6G (55Hz maximum)
Shock Resistance	SPDT/DPDT: 200N (approximately 20G) 3PDT/4PDT: 100N (approximately 10G)
Life Expectancy	Electrical: over 500,000 operations at 120V AC, 10A; (over 200,000 operations at 120V AC, 10A for SPDT [RH1], 3PDT [RH3], 4PDT [RH4]) Mechanical: 50,000,000 operations
Operating Temperature	–30 to +70°C
Weight	SPDT: 24g, DPDT: 37g (approximately) 3PDT: 50g, 4PDT: 74g (approximately)

Ordering Information

Order standard voltages for fastest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No.		*Coil Voltage:*
RH2B-U	–	*AC110-120V*

Part Numbers

Part Numbers: RH Series with Options

Termination	Contact Configuration	Basic Part No.	Indicator Light	Check Button	Indicator Light and Check Button	Top Bracket
B (blade)	SPDT	RH1B-U	RH1B-L*	—	—	RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-ULC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	RH3B-ULC	RH3B-UT
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-ULC	RH4B-UT
V2 (PCB 0.078" [2mm] wide)	SPDT	RH1V2-U	RH1V2-L*	—	—	—
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	RH2V2-ULC	—
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	RH3V2-ULC	—
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	RH4V2-ULC	—

** RH1B(V2)-L is* **not** *UL recognized.*

Ratings

Coil Ratings

Rated Voltage		Rated Current ±15% at 20°C								Coil Resistance ±15% at 20°C			
		60Hz				50Hz							
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	150mA	200mA	280mA	330mA	170mA	238mA	330mA	387mA	18.8Ω	9.4Ω	6.0Ω	5.4Ω
	12V	75mA	100mA	140mA	165mA	86mA	118mA	165mA	196mA	76.8Ω	39.3Ω	25.3Ω	21.2Ω
	24V	37mA	50mA	70mA	83mA	42mA	59.7mA	81mA	98mA	300Ω	153Ω	103Ω	84.5Ω
	120V*	7.5mA	11mA	14.2mA	16.5mA	8.6mA	12.9mA	16.4mA	19.5mA	7,680Ω	4,170Ω	2770Ω	2220Ω
	240V†	3.2mA	5.5mA	7.1mA	8.3mA	3.7mA	6.5mA	8.2mA	9.8mA	3,1200Ω	15,210Ω	12,100Ω	9120Ω
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	128mA		150mA		240mA		250mA		47Ω	40Ω	25Ω	24Ω
	12V	64mA		75mA		120mA		125mA		188Ω	160Ω	100Ω	96Ω
	24V	32mA		36.9mA		60mA		62mA		750Ω	650Ω	400Ω	388Ω
	48V	18mA		18.5mA		30mA		31mA		2,660Ω	2,600Ω	1,600Ω	1550Ω
	110V‡	8mA		9.1mA		12.8mA		15mA		13,800Ω	12,100Ω	8,600Ω	7,340Ω

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Rated Voltage		Coil Inrush				Coil Inductance							
						Energizing				De-Energizing			
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	250mA	340mA	520mA	620mA	0.09H	0.08H	0.05H	0.05H	0.06H	0.04H	0.03H	0.02H
	12V	120mA	170mA	260mA	310mA	0.037H	0.30H	0.22H	0.18H	0.22H	0.16H	0.12H	0.10H
	24V	56mA	85mA	130mA	165mA	1.5H	1.2H	0.9H	0.73H	0.9H	0.63H	0.5H	0.36H
	120V*	12mA	16mA	26mA	33mA	37H	33H	21H	18H	22H	15H	12H	9H
	240V†	7mA	8mA	12mA	16mA	130H	130H	84H	73H	77H	62H	47H	36H
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	N/A		N/A		N/A		N/A		N/A	N/A	N/A	N/A
	12V												
	24V												
	48V												
	110V‡												

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Ratings con't

Contact Ratings

Voltage	Rating	Resistive				Inductive				Motor Load		
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT
28V DC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	—	—	—
30V DC	UL	10A	10A	10A	—	7A	7A	—	—	—	—	—
	CSA				10A		7.5A			—	—	—
	Nominal							7.5A	7.5A	—	—	—
110V DC	Nominal	0.5A	0.5A	0.5A	0.5A	0.3A	0.3A	0.3A	0.3A	—	—	—
120V AC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	1/6	1/6	1/6
	CSA						7.5A			—	—	—
	Nominal					7A		7.5A				
240V AC	UL	10A	10A	—	7.5A	7A	7A	*	5A	1/3	1/3	1/3
	CSA							7A		—	—	—
	Nominal	7A	7.5A	7.5A	4.5A	5A	5A	5A				

*1. * 6.5A/pole, 20A total.*
2. Inductive load cos ø = 0.3, L/R = 7ms.

Applicable Sockets

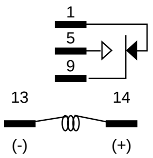
Part Numbers: Sockets

Relay	Standard DIN Rail Mount	Finger-Safe DIN Rail Mount	Surface Mount	Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	—	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-02	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	—	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C		SH4B-51	SH4B-62

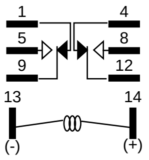
Spring & Clips (optional)	
Part Number	Use With
SY2S-02F1 SFA-101 SFA-202	SH1B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH1B-51, 62
SY4S-02F1 SFA-101 SFA-202	SH2B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH2B-51, 62
SH3B-05F1 SFA-101, -202	SH3B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH3B-51, 62
SH4B-02F1 SFA-101, -202	SH4B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH4B-51, 62

See Section F for details on sockets. All DIN rail mount sockets shown above can be mounted using DIN rail BNDN1000.

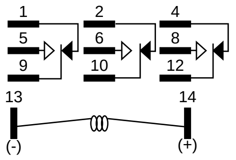
Internal Circuits



RH1



RH2



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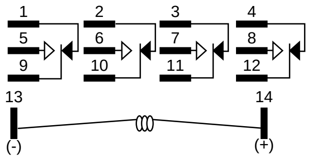
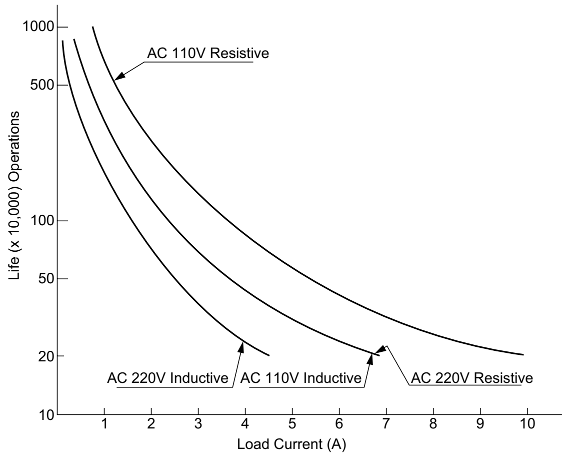
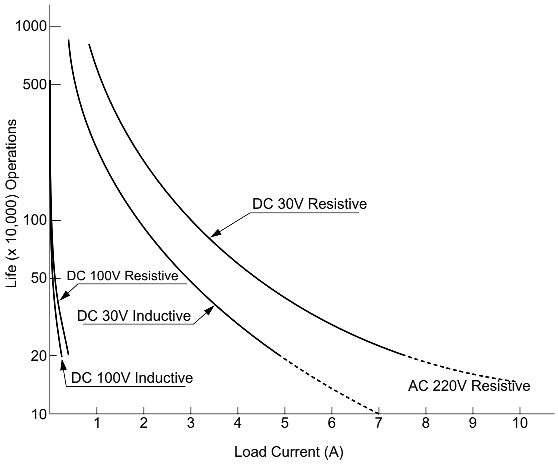


RH4

Electrical Life Curves

RH1





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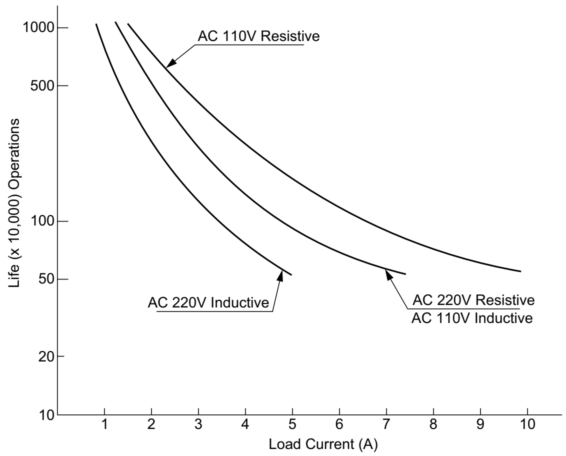
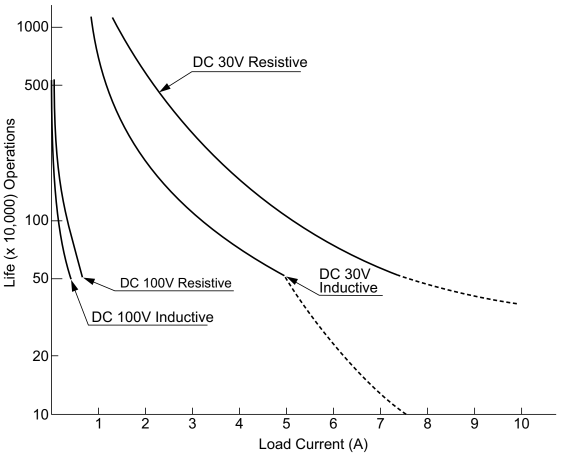
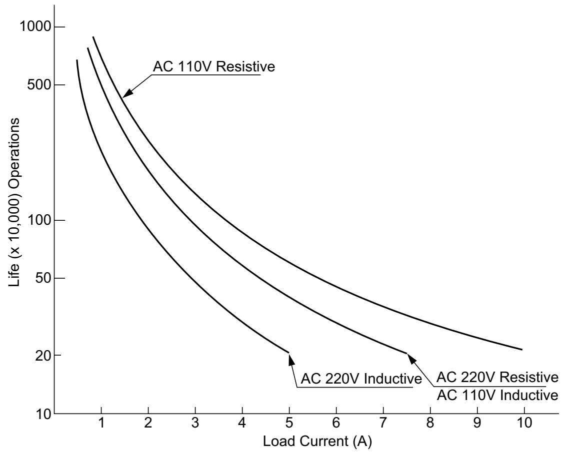
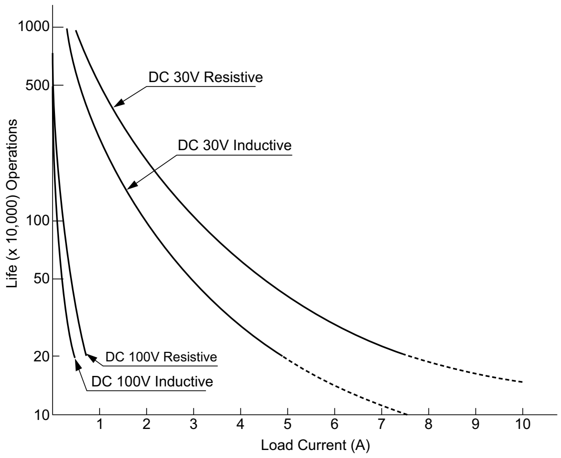




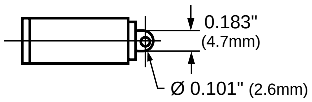
RH3 and 4

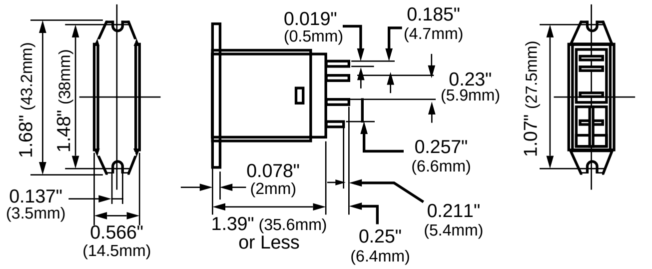




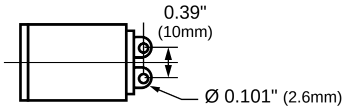
Dimensions

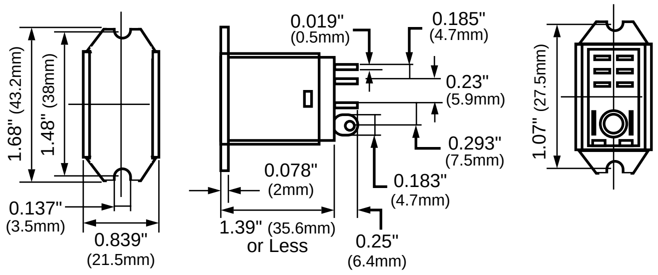
Top Bracket Mounting Blade Terminal RH1B-UT





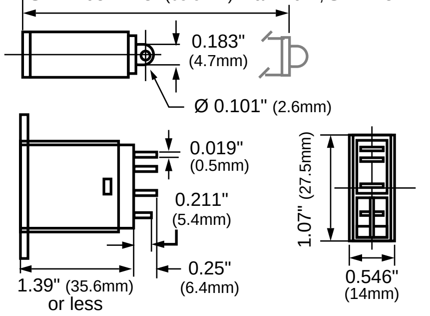
RH2B-UT





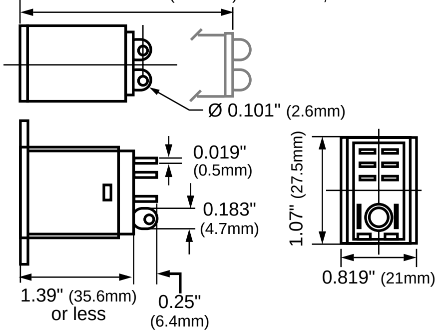
Plug-in Blade Terminal RH1B

Total length from panel surface including socket:
SH1B-05: 2.40" (61.5mm) maximum; ***SH1B-51:*** 1.54" (39mm) maximum
Total length from panel surface including hold-down spring:
SH1B-05: 2.48" (63.5mm) maximum; ***SH1B-51:*** 1.62" (41.6mm) maximum



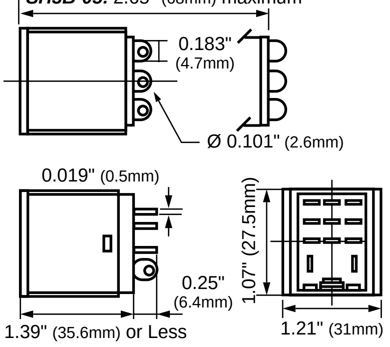
RH2B

Total length from panel surface including socket:
SH2B-05: 2.40" (61.5mm) maximum; ***SH2B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH2B-05: 2.48" (63.5mm) maximum; ***SH2B-51:*** 1.62" (41.6mm)



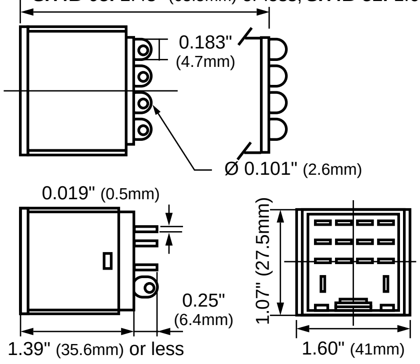
Plug-in Blade Terminal RH3B

Total length from panel surface including socket:
SH3B-05: 2.57" (66mm) maximum
Total length from panel surface including hold-down spring:
SH3B-05: 2.65" (68mm) maximum



RH4B

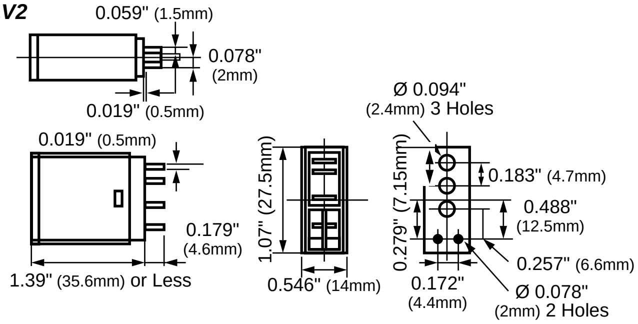
Total length from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41.6mm)



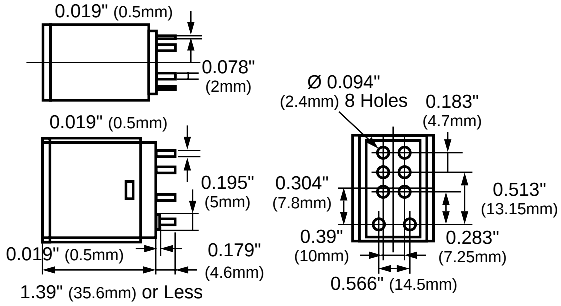
Dimensions

PCB Terminal

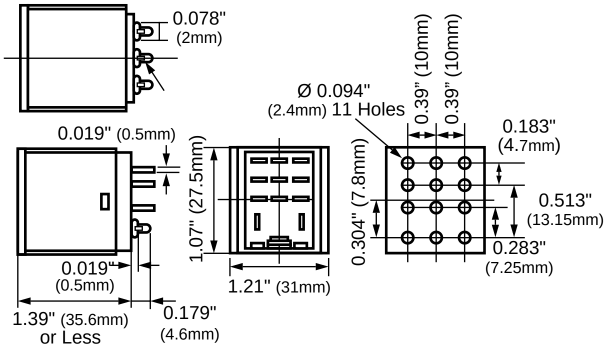
RH1V2



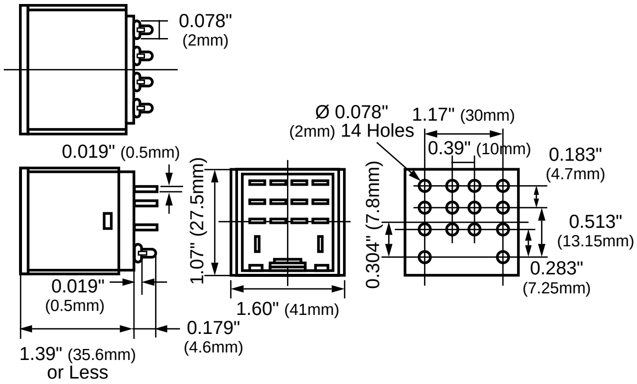
RH2V2



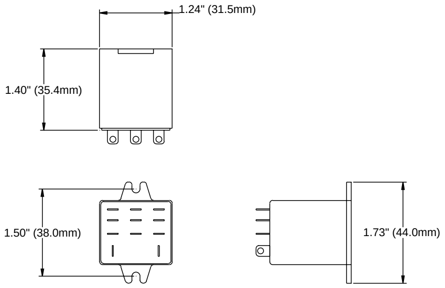
RH3V2



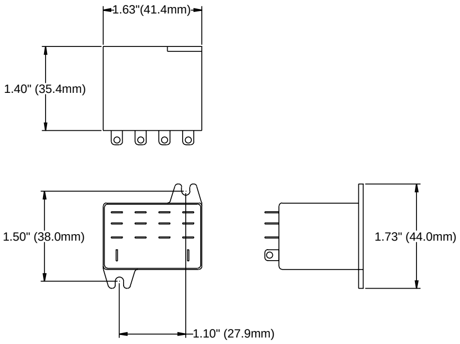
RH4V2



RH3B-UT



RH4B-UT

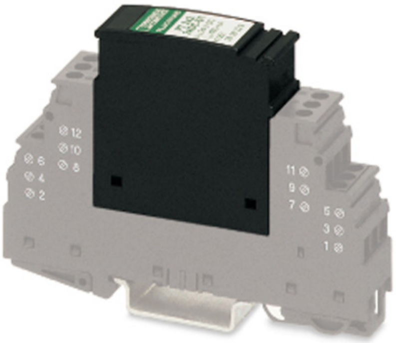


Extract from the online catalog

PT 2X2-24DC-ST

Order No.: 2838228

The illustration shows version PT 2x2- 5DC-ST



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2838228

Protective plug PT with protective circuit for two 2-core floating signal circuits. Nominal voltage: 24 V DC

Commercial data	
EAN	4017918182649
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.02511 KG
Catalog page information	Page 86 (TT-2009)

Product notes

WEEE/RoHS-compliant since: 06/01/2006

Technical data

General

Housing material	PA 6.6
Inflammability class acc. to UL 94	V0
Color	black

Standards for air and creepage distances	VDE 0110-1
	IEC 60664-1: 1992-10
Total surge current (8/20) µs	20 kA
Ambient temperature (operation)	-40 °C ... 85 °C
Mounting type	On base element
Design	DIN rail module, two-section, divisible
Degree of protection	IP20
Direction of action	Line-Line & Line-Signal Ground/Shield & optional Signal Ground/ Shield-Earth Ground
Arrester can be tested with CHECKMASTER from software version:	From SW rev. 1.00
Width	17.70 mm
Height	52.00 mm
Length	45.00 mm
Pitch unit	1 Div.

Protective circuit

IEC category	C1
	C2
	C3
	D1
VDE requirement class	C1
	C2
	C3
	D1
Nominal voltage U_N	24 V DC
Max. operating voltage U_{max}	26 V DC
Arrester rated voltage U_C	28 V DC
	20 V AC
Arrester rated voltage U_C (Core-Core)	28 V DC
	20 V AC
Arrester rated voltage U_C (Core-Earth)	28 V DC
	20 V AC
Nominal current I_N	450 mA (45°C)
Operating effective current I_C at U_C	≤ 5 µA
Discharge current to PE at U_C	≤ 1 µA (BE: 2x2+F)
	≤ 4 µA

Nominal discharge surge current In (8/20) µs (Core-Core)	10 kA
Nominal discharge surge current I_n (8/20) µs (Core-Earth)	10 kA
Total surge current (8/20) µs	20 kA
Max. discharge surge current Imax (8/20) µs maximum (Core-Core)	10 kA
Max. discharge surge current Imax (8/20) µs maximum (Core-Earth)	10 kA
Lightning test current (10/350) µs, peak value I_{imp}	2.5 kA (per path)
Output voltage limitation at 1 kV/µs (Core-Core) spike	≤ 40 V
Output voltage limitation at 1 kV/µs (Core-Earth) spike	≤ 450 V
Output voltage limitation at 1 kV/µs (Core-Core) static	≤ 40 V
Output voltage limitation at 1 kV/µs (Core-Earth) static	≤ 450 V
Residual voltage at I_n, (conductor-conductor)	≤ 40 V
Residual voltage at In, (conductor-GND)	≤ 450 V
Residual voltage with Ian (10/1000)µs (conductor-conductor)	≤ 50 V
Response time tA (Core-Core)	≤ 1 ns
Response time tA (Core-Earth)	≤ 100 ns
Input attenuation aE, sym.	0.5 dB (≤ 1 MHz)
Cut-off frequency fg (3 dB), sym. in 50 Ohm system	Typ. 6 MHz
Capacity (Core-Core)	1.4 nF
Resistance in series	2.2 Ω (Path 1-2/5-6)
	2.2 Ω (Path 7-8, 11-12)
Surge carrying capacity in acc. with IEC 61643-21 (Core-Core)	C2 (10 kV/5 kA)
Surge carrying capacity in acc. with IEC 61643-21 (Core-Earth)	C2 (10 kV/5 kA)
	D1 (2.5 kA)

Connection data

Type of connection	Screw connection (in connection with the base element)
Connection type IN	PLUGTRAB plug-in system
Connection type OUT	PLUGTRAB plug-in system

Screw thread	M3
Tightening torque, min	0.8 Nm
Stripping length	8 mm
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	2.5 mm²
Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12

Connection, protective circuit

Standards/regulations	IEC 61643-21
	DIN EN 61643-21
	UL 497B

Certificates / Approvals

Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

Accessories

Item	Designation	Description
Marking		
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm
0814717	ZBF 15:SO/CMS	Zack strip, flat, 10-section, divisible, special printing, marking according to customer requirements
0808671	ZBF 5,LGS:FORTL.ZAHLEN	Zack strip, flat, printed horizontally: 10-section, with the numbers, 1-10, 11-20 etc. up to 991-1000, color: White
0810821	ZBF 5,LGS:GERADE ZAHLEN	Zack marker strip, flat, printed horizontally: 10-section, with even numbers, printed with the numbers: 2-20, 22-40, etc. up to 82-100
0810863	ZBF 5,LGS:UNGERADE ZAHLEN	Zack strip, flat, printed horizontally: 10-section, with odd numbers, printed with the numbers: 1-19, 21-39 etc. up to 81-99
0808697	ZBF 5,QR:FORTL.ZAHLEN	Flat Zack marker strip, printed vertically: 10-section, with the numbers 1-10, 11-20, etc. up to 151-160, color: White

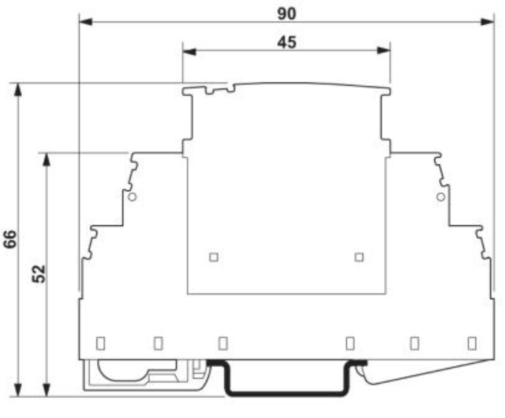
0808668	ZBF 5/WH-100:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, large batch, sufficient for labeling 1000 terminal blocks, color: white
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, sufficient for 100 terminal blocks, color: white
0800763	ZBN 18:SO/CMS	Marker labels, 5-section, special printing, labeled according to customer requirements (Please specify the required marking with order), for terminal width: 17.5 mm, color: White
2809128	ZBN 18:UNBEDRUCKT	Unprinted marker labels, strips with 5 labels for individual labeling with M-PEN or CMS system, for terminal block width: 17.5 mm, color: White

Additional products

Item	Designation	Description
Assembly		
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black
General		
2839224	PT 2X2+F-BE	Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, gas-filled surge arrester between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm
2839208	PT 2X2-BE	Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, bridge between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm

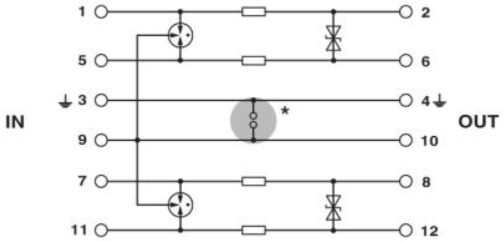
Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Circuit diagram



Approbationslogos (EX-Bereich)

Address

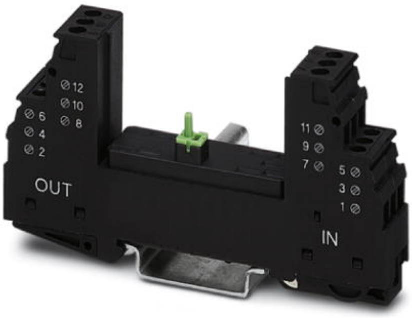
PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

PT 2X2+F-BE

Order No.: 2839224

The illustration shows version PT 2x2-BE



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2839224

Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, gas-filled surge arrester between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm

Product notes

WEEE/RoHS-compliant since: 05/10/2006

Commercial data

EAN	4017918182762
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.0573 KG
Catalog page information	Page 86 (TT-2009)

Technical data

General

Inflammability class acc. to UL 94	V0
Color	black
Ambient temperature (operation)	-40 °C ... 85 °C

Mounting type	DIN rail 35 mm
Design	DIN rail module, two-section, divisible
Degree of protection	IP20
Direction of action	Signal Ground/Shield-Earth Ground
Width	17.70 mm
Height	52.00 mm
Length	89.80 mm
Pitch unit	1 Div.

Protective circuit

Nominal current I_N	450 mA
Output voltage limitation at 1 kV/μs (Core-Earth) spike	$\leq$ 600 V

Connection data

Type of connection	Screw connection
Connection type IN	Screw terminal blocks
Connection type OUT	Screw terminal blocks
Screw thread	M3
Tightening torque, min	0.8 Nm
Stripping length	8 mm
Conductor cross section stranded min.	0.2 mm^2
Conductor cross section stranded max.	2.5 mm^2
Conductor cross section solid min.	0.2 mm^2
Conductor cross section solid max.	4 mm^2
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12

Certificates / Approvals

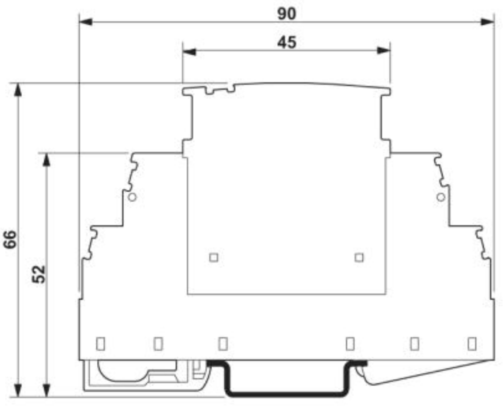
Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

Accessories

Item	Designation	Description
Assembly		
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black
Marking		
1051993	B-STIFT	Marker pen, for manual labeling of unprinted Zack strips, smear-proof and waterproof, line thickness 0.5 mm
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm
1050004	ZB 5 :UNBEDRUCKT	Zack strip, unprinted, 10-section, for individual labeling with M-PEN, ZB-T or CMS system, pack is sufficient for 100 terminal blocks, for a terminal width of 5.2 mm, color: White
2715212	ZB 5,8,LGS:FORTL.ZAHLEN	Zack marker strip, 10-section, printed horizontally: with consecutive numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1050305	ZB 5,8:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
2715209	ZB 5,8:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 5.8 mm, color: White
1050295	ZB 5:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, sufficient for 100 terminal blocks, color: white

Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Approbationslogos (EX-Bereich)

Address

PHOENIX CONTACT Inc., USA
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Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

MODEL DSP – DATA STATION PLUS

C UL US LISTED
IND. CONT. EQ.
34AD

C UL US LISTED
3PWL
PROGRAMMABLE
CONTROLLERS

FOR USE IN HAZARDOUS LOCATIONS:
Class I, Division 2, Groups A, B, C, and D

- *PROTOCOL CONVERSION FEATURE CONVERTS NUMEROUS PROTOCOLS SIMULTANEOUSLY*
- *COMPACTFLASH® SLOT ALLOWS PROCESS DATA TO BE LOGGED DIRECTLY TO CSV FILES*
- *VIRTUAL HMI OFFERS BUILT-IN PC-BASED SCADA FUNCTIONALITY*
- *WEBSERVER PROVIDES WORLDWIDE ACCESS TO DATA LOGS AND VIRTUAL HMI*
- *EXTENSIVE BUILT-IN DRIVER LIST ALLOWS EASY DATA MAPPING TO PLCs, PCs, AND SCADA SYSTEMS*
- *ALARM NOTIFICATIONS CAN BE SENT VIA EMAIL OR TEXT MESSAGES*
- *10 BASE-T/100 BASE-TX ETHERNET CONNECTION CAN CONNECT TO AN UNLIMITED NUMBER OF DEVICES VIA FOUR PROTOCOLS SIMULTANEOUSLY*

CE

GENERAL DESCRIPTION

The Data Station Plus was designed to act as a nexus for industrial data collection and management. The unit offers multiple protocol conversion, data logging and remote machine access. With three built in serial ports and a 10 Base-T/100 Base-TX Ethernet port, the unit performs protocol conversion, allowing disparate devices to communicate seamlessly with one another. The Ethernet port supports up to four protocols simultaneously so even Ethernet to Ethernet protocols can be converted.

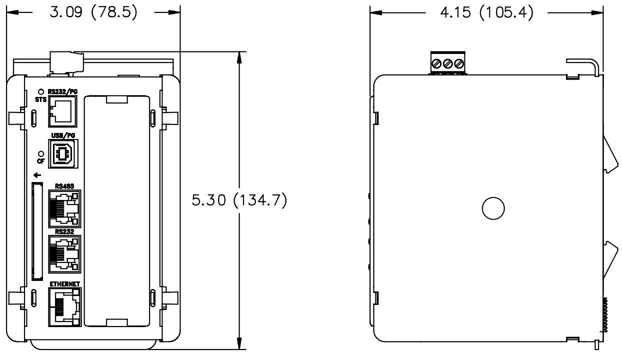
The CompactFlash card allows data to be collected and stored for later review. The files are stored in simple CSV file format allowing common applications, such as Microsoft Excel and Access, to view and manage the data. The free Websync utility provides a means to synchronize the files with a PC's hard drive for permanent storage. The CompactFlash card may also be used to load new configuration files into the Data Station.

The built-in web server allows log files to be retrieved manually, and also provides access to the unique "virtual HMI". The virtual HMI is programmed just like Red Lion's G3 series of HMI. Any standard web browser such as Internet Explorer or Netscape may be used to monitor or control the HMI from a PC anywhere in the world.

The USB port may be used for blazing fast file downloads, or to mount the Data Station's CompactFlash card as an external drive to your PC.

The Data Station's DIN rail mounting saves time and panel space and snaps easily onto standard top hat (T) profile DIN rail.

DIMENSIONS In inches (mm)



SOFTWARE

The Data Station is programmed with Crimson® 2.0 software for Windows® 2000 or later platforms. The software is an easy to use graphical interface which can be purchased as part of a kit that includes a manual and cables, or downloaded free of charge from www.redlion.net.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.

⚠ **CAUTION: Risk of Danger.**
Read complete instructions prior to installation and operation of the unit.

⚠ WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2

⚠ THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D, OR NON-HAZARDOUS LOCATIONS ONLY

CompactFlash is a registered trademark of CompactFlash Association.

SPECIFICATIONS

1. **POWER**: 24 VDC ± 10%
   200 mA min., without expansion card
   1 Amp maximum with expansion card fitted
   Must use Class 2 or SELV rated power supply.
2. **COMMUNICATIONS**:
   USB/PG Port: Adheres to USB specification 1.1. Device only using Type B connection.

   WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

   Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud.
   RS232/PG Port: RS232 port via RJ12
   COMMS Ports: RS422/485 port via RJ45, and RS232 port via RJ12
   DH485 TXEN: Transmit enable; open collector, V_{OH} = 15 VDC, V_{OL} = 0.5 V @ 25 mA max.
   Ethernet Port: 10 BASE-T / 100 BASE-TX
   RJ45 jack is wired as a NIC (Network Interface Card).
3. **LEDs**:
   STS – Status LED indicates condition of Data Station.
   TX/RX – Transmit/Receive LEDs show serial activity.
   Ethernet – Link and activity LEDs.
   CF – CompactFlash LED indicates card status and read/write activity
4. **MEMORY**:
   On-board User Memory: 4 Mbytes of non-volatile Flash memory.
   On-board SDRAM:
   DSPSX: 2 Mbytes
   DSPGT: 8 Mbytes
   Memory Card: CompactFlash Type II slot for Type I and Type II cards.
5. **REAL-TIME CLOCK**: Typical accuracy is less than one minute per month drift. Crimson 2.0's SNTP facility allows synchronization with external servers.
   Battery: Lithium Coin Cell. Typical lifetime of 10 years at 25 ºC.
   A "Battery Low" system variable is available so that the programmer can choose specific action(s) to occur when the battery voltage drops below its nominal voltage.
6. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0 to 50°C
   Storage Temperature Range: -30 to +70°C
   Operating and Storage Humidity: 80% max relative humidity, non-condensing, from 0 to 50°C
   Vibration According to IEC 68-2-6: Operational 5 to 150 Hz, in X, Y, Z direction for 1.5 hours, 2 g's.
   Shock According to IEC 68-2-27: Operational 30 g, 11 msec in 3 directions.
   Altitude: Up to 2000 meters
7. **CONSTRUCTION**: Case body is burgundy high impact plastic and stainless steel. Installation Category I, Pollution Degree 2.
8. **POWER CONNECTION**: Removable wire clamp screw terminal block.
   Wire Gage Capacity: 24 AWG to 12 AWG
   Torque: 4.45 to 5.34 in/lb (0.5 to 0.6 N-m)
9. **MOUNTING**: Snaps onto standard DIN style top hat (T) profile mounting rails according to EN50022 -35 x 7.5 and -35 x 15.
10. **CERTIFICATIONS AND COMPLIANCES**:
    SAFETY
    UL Listed, File #E302106, UL508, CSA 22.2 No. 14-M05
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    UL Listed, File #E317425, ANSI/ISA 12.12.01-2007, CSA 22.2 No. 213-M1987
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
    ELECTROMAGNETIC COMPATIBILITY
    Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

Immunity to Industrial Locations:

Electrostatic discharge	EN 61000-4-2	Criterion A [2] 4 kV contact discharge 8 kV air discharge
Electromagnetic RF fields	EN 61000-4-3	Criterion A 10 V/m
Fast transients (burst)	EN 61000-4-4	Criterion A 2 kV power 2 kV signal
Surge	EN 61000-4-5	Criterion A 1kV L-L,2 kV L&N-E power
RF conducted interference	EN 61000-4-6	Criterion A 3 V/rms

Emissions:

Emissions	EN 55011	Class A

Notes:

1. Criterion A: Normal operation within specified limits.

2. This device was designed for installation in an enclosure. To avoid electrostatic discharge to the unit in environments with static levels above 4 kV precautions should be taken when the device is mounted outside an enclosure. When working in an enclosure (ex. making adjustments, setting jumpers etc.) typical anti-static precautions should be observed before touching the unit.

11. **WEIGHT**: 15.1 oz (456.4 g)

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR AREA IS KNOWN TO BE NON-HAZARDOUS.

HARDWARE

INSTALLATION

DIN rail should be mounted horizontally so that the unit's ventilation holes are vertical in relation to cabinet orientation. A minimum clearance of 1 inch (25.4 mm) should be maintained above and below the unit in order to ensure proper thermal regulation.

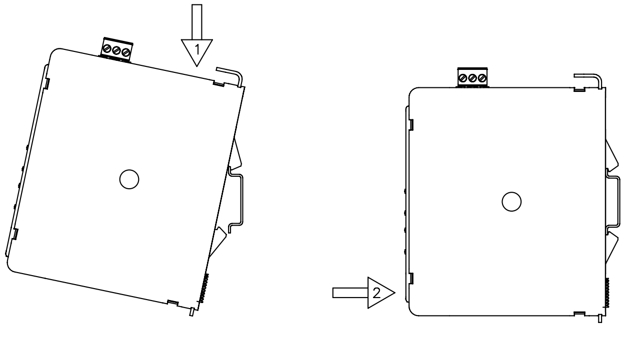
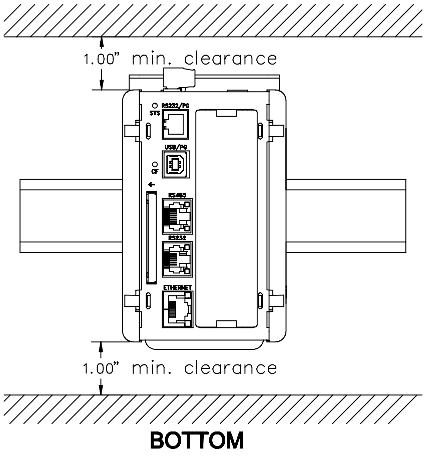


Figure 1 - Attach Data Station To DIN Rail



LEDS

STS – STATUS LED

The green Status LED provides information regarding the state of the Data Station. This includes indication of the various stages of the start-up routine (power-up), and any errors that may occur.

Startup Routine

	INDICATION
Rapidly Flashing	Data Station is currently running the boot loader and/or being flash upgraded by Crimson.
Steady	Data Station is operating properly.

CF – COMPACTFLASH LED

LED	INDICATION
Off	No CompactFlash Card is present.
Steady	Valid CompactFlash card is present.
Flashing Rapidly	CompactFlash card is being checked.
Flickering	Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive. [1]
Flashing Slowly	Incorrectly formatted CompactFlash card present.

1. *Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to “Mounting the CompactFlash” in the Crimson 2.0 User Manual.*

USER COMMUNICATION PORTS - TX/RX LEDS

LED	INDICATION
GREEN	Transmitting
RED	Receiving

Note: LEDs are not available on the Programming Port: RS232/PG.

ETHERNET LEDS

LED	INDICATION
YELLOW (Solid)	Link Established
YELLOW (Flashing)	Network Activity
GREEN	10 BASE-T Communications
AMBER	100 BASE-TX Communications

ORDERING INFORMATION

TYPE	MODEL NO.	DESCRIPTION	PART NUMBER
Data Station Plus	DSP	Data Station with multiple protocol converter, data logger, web server with Virtual HMI up to QVGA (320 x 240) and expansion slot.	DSPSX000
		Data Station with multiple protocol converter, data logger, web server with Virtual HMI up to VGA (640 x 480) size and expansion slot with increased SDRAM.	DSPGT000
Communications Cables (10 feet)	CBL	RS-232 Programming Cable	CBLPROG0
		USB Cable	CBLUSB00
		Communications Cables [1]	CBLxxxxx
Software	SFCRM2	Crimson® 2.0 [2], Manual and Download Cable	SFCRM200
Power Supply	PSDR	DIN Rail Power Supply	PSDRxxxx
Accessories	XCCN	CANopen option card for Modular Controller or Data Station Plus	XCCN0000
	XCDN	DeviceNet option card for Modular Controller or Data Station Plus	XCDN0000
	XCPB	PROFIBUS option card for Modular Controller or Data Station Plus	XCPBDP00
	XCRS	RS232/485 option card for Modular Controller or Data Station Plus	XCRS0000
	G3CF	64 MB CompactFlash Card [4]	G3CF064M
		256 MB CompactFlash Card [4]	G3CF256M
		512 MB CompactFlash Card [4]	G3CF512M
	DR	DIN Rail Mountable Adapter Products [3]	DRxxxxxx

[2] Use this part number to purchase the Crimson® software on CD with a printed manual, USB cable, and RS-232 cable.

[3] Red Lion offers RJ modular jack adapters. Refer to the DR literature for complete details.

[4] Industrial grade two million write cycles.

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www.redlion.net

Bulletin No. XCRS- A
Drawing No. LP0669
Released 01/10

MODEL XCRS - RS232/485 OPTION CARD FOR DATA STATION PLUS AND MODULAR CONTROLLER

- *CONFIGURED USING CRIMSON SOFTWARE (VERSION 2.0 OR LATER)*
- *ISOLATED RS232 AND RS485 MULTIPLEXED PORTS CAPABLE OF COMMUNICATING WITH RS232, RS422, RS485 AND DH485 DEVICES AT UP TO 115,200 BAUD*
- *EASY INSTALLATION*

GENERAL DESCRIPTION

Both the Modular Controller Master (enhanced models) and Data Station Plus contain a proprietary expansion port which provides a high speed, parallel architecture that extends the functionality and flexibility of the platform. This approach allows these products to evolve concurrently with the latest advances in communications and standards, without sacrificing performance. This high bandwidth channel has significantly greater throughput when compared to the traditional (external) serial gateway approach.

The XCRS option card adds an additional RS232 and RS422/485 port to the series. This isolated card protects user equipment from potentially harmful ground loops while providing high-speed RS232, RS422, RS485, and DH485 communication options to the end user.

The XCRS communication card is easily installed by removing the blank expansion port cover of your Modular Controller or Data Station Plus, and plugging the XCRS card into the expansion port. Configuration is simple using Red Lion's free Crimson 2.0 software.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.

⚠ **CAUTION: Risk of Danger.**
Read complete instructions prior to installation and operation of the unit.

CONTENTS OF PACKAGE

- XCRS option card
- This hardware bulletin

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
XCRS	RS232/485 option card for Modular Controller or Data Station Plus	XCRS0000
CBL	Communication Cables [1]	CBLxxxxx
DR	DIN Rail Mountable Adapter Products [2]	DRxxxxxx
SFCRM2	Crimson 2.0 with G3/Data Station Manual [3]	SFCRM200
SFCRM2	Crimson 2.0 with Modular Controller Manual [3]	SFCRM2MC

[1] Contact your Red Lion distributor or visit www.redlion.net for complete selection.

[2] Red Lion offers RJ modular jack adapters. Refer to DR literature for complete details.

[3] Use these part numbers to purchase Crimson 2.0 on CD with a printed manual, USB cable and RS-232 cable. Otherwise, download free of charge from www.redlion.net.

SPECIFICATIONS

1. **POWER REQUIREMENTS:** 24 V @ 50 mA max. Power is supplied to the option card from the main board of the Modular Controller Master or Data Station Plus.
2. **COMMUNICATIONS:**

   Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud and are isolated to help prevent ground loops. The RS422/485 and DH485 port via RJ45 and the RS232 port via RJ12 share the same hardware. The XCRS option card multiplexes the ports to communicate via two protocols. These ports may be used to configure different master protocols, but only one port may be used if configuring a slave protocol or AB DH485.

   DH485 TXEN: Transmit enable; open collector, V_{OH} = 15 VDC, V_{OL} = 0.5 VDC

   Isolation from XCRS Communication ports to the Modular Controller Master or Data Station Plus: 1000 VDC for 1 minute.
3. **CERTIFICATIONS AND COMPLIANCES:**

   Refer to main unit manual or “Agency Approvals” section of Red Lion’s website for agency certifications.

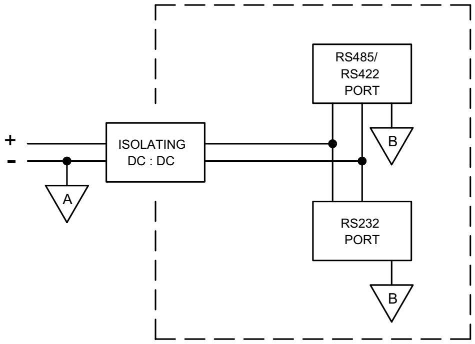
   ELECTROMAGNETIC COMPATIBILITY

   Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

   Reference Modular Controller Master or Data Station Plus unit for EMC specifications

4. **ENVIRONMENTAL CONDITIONS:**
Refer to the specifications of the Modular Controller Master or Data Station Plus you are installing this card in.
5. **CONSTRUCTION:** For indoor use only. Installation Category II, Pollution Degree 2.
6. **INSTALLATION REQUIREMENTS:** See “Installing the XCRS Option card” for more details.
7. **WEIGHT**: 1.9 oz (53.9 g)

BLOCK DIAGRAM



INSTALLING THE XCRS OPTION CARD

1. Remove power from the unit
2. Insert a flat-bladed screwdriver into the slot at the top of the expansion port cover. Gently apply pressure on the screwdriver in an upward direction until the expansion port cover disengages from the unit as shown in Figure 1.
3. Verify that the option card knobs are in the “unlocked” position as shown in Figure 2.
4. Carefully insert the option card into the expansion port opening while aligning the card-edge connector on the option card with the main board's header, as shown in Figure 3. Once aligned, gently press on the front of the card until it is flush with the front of the case.
5. Turn the option card knobs to the locked position as shown in Figure 4.

Caution: The expansion and main circuit boards contain static sensitive components. Before handling the cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the cards at a static controlled clean workstation. Also, handle the cards by the edges only. Dirt, oil, or other contaminants that may contact the cards can adversely affect circuit operation.

Warning: Risk of Danger: Be sure to remove all power before removing the expansion port cover.

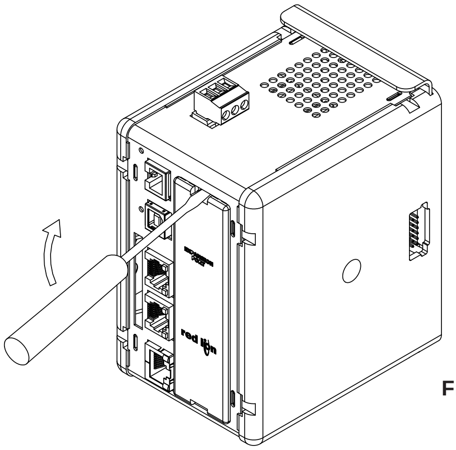


Figure 1

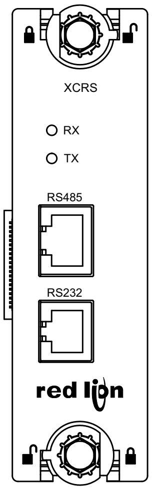


Figure 2

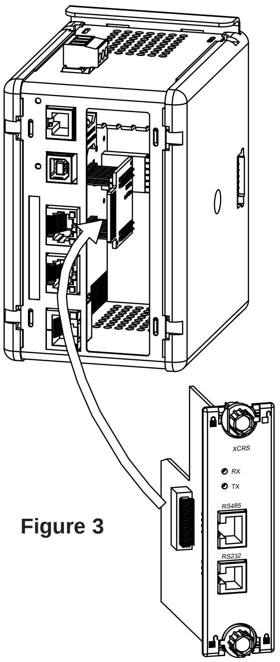


Figure 3

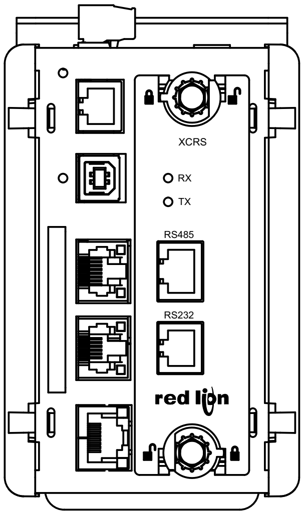


Figure 4

POWER SUPPLY REQUIREMENTS

NEW AND EXISTING INSTALLATIONS

The XCRS option card draws all of its power from the main board of the Modular Controller Master or Data Station Plus. The specifications of the Modular Controller Master or Data Station Plus account for the power needs of an option card.

COMMUNICATING WITH THE XCRS OPTION CARD

CONFIGURING A XCRS OPTION CARD

The XCRS is configured using Crimson software. Crimson is available as a free download from www.redlion.net, or it can be ordered on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the XCRS using the latest version of Crimson, you are assured that your unit has the most up-to-date feature set. Crimson software can configure the XCRS through the RS232 PGM port, USB port, Ethernet port, or CompactFlash socket on your Modular Controller Master or Data Station Plus. Additional information can be found in your Modular Controller Master or Data Station Plus hardware bulletin and the Crimson user manual.

CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from www.redlion.net. New cables and drivers are added on a regular basis. If making your own cable, refer to the “XCRS Port Pin Outs” for wiring information.

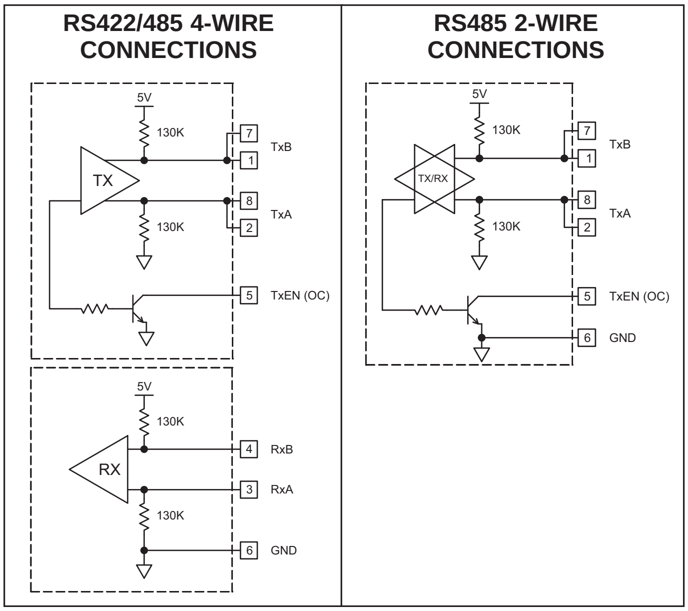
RS232 PORTS

The XCRS option card has one RS232 port. The port can be used for either master or slave protocols with any Modular Controller Master or Data Station Plus configuration. The RS232 port and RS422/485 port on the XCRS option card are multiplexed because they share the same hardware. Both ports can be used with master protocols. However, when the RS232 port is used with a slave protocol, the RS422/485 port is not available. For examples of RS232 communications refer to your Modular Controller Master or Data Station Plus literature.

RS422/485 COMMS PORT

The XCRS option card has one RS422/485 port. This port can be configured to act as either RS422 or RS485.

The RS422/485 port and RS232 port are multiplexed because they share the same hardware. Both ports can be used with master protocols. However, when the RS422/485 port is used with a slave protocol, the RS232 port is not available.



RS422/485 4-WIRE CONNECTIONS

RS485 2-WIRE CONNECTIONS

Note: All Red Lion devices connect A to A and B to B, except for Paradigm devices. Refer to www.redlion.net for additional information.

For examples of RS422/485 communications refer to your Modular Controller Master or Data Station Plus literature.

DH485 COMMUNICATIONS

The XCRS option card’s RS422/485 port can also be used for Allen Bradley DH485 communications. When this port is configured to communicate DH485, the RS232 port can not be used because the ports share the same hardware and the XCRS option card multiplexes the ports to communicate via two protocols.

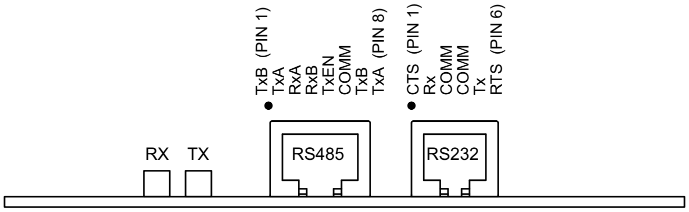
WARNING: DO NOT use a standard DH485 cable to connect this port to Allen Bradley equipment doing so may cause irreparable damage to the equipment connected. A cable and wiring diagram are available from Red Lion.

Modular Controller Master or Data Station Plus to AB SLC 500 (CBLAB003)

Connections			
RJ45: RLC	Name	RJ45: A-B	Name
1	TxB	1	A
2	TxA	2	B
3, 8	RxA	-	24V
4, 7	RxB	-	COMM
5	TxEN	5	TxEN
6	COMM	4	SHIELD
4, 7	TxB	-	COMM
3, 8	TxA	-	24V

SOFTWARE/UNIT OPERATIONS

XCRS PORT PIN OUTS



LEDS

The transmit LED(TX) will flash when information is transmitted from the XCRS card. The receive LED(RX) will flash when information is received.

CRIMSON SOFTWARE

Crimson 2.0 software is available as a free download from www.redlion.net or it can be purchased on a CD, see “Ordering Information” for part number. The latest version of the software is always available from the web site, and updating your copy is free.

TROUBLESHOOTING YOUR XCRS OPTION CARD

If for any reason you have trouble operating, connecting, or simply have questions concerning your new XCRS option card, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsupport@redlion.net

Web Site: http://www.redlion.net

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

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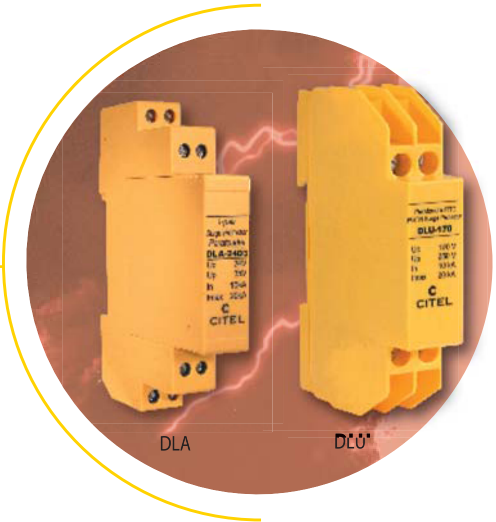
DIN Rail Surge Protector for Dataline/Telecom

DLA & DLU



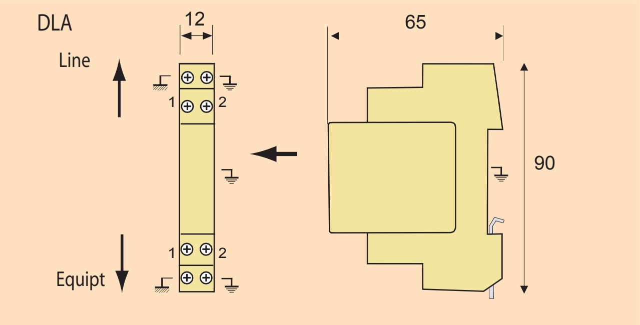
DLA and DLU surge protectors are designed to protect, against surge voltages due to lightning, terminals equipment connected to industrial buses, telecom lines or datalines.
These surge protectors must be installed on symmetrical DIN rail and are available for most of the transmission lines : line voltage from 6 to 170 V, bitrate up to 10 Mbit/s.
Electrical diagrams of DLA and DLU models are built with gas tubes and fast clamping diodes in order to provide high discharge current capability and fast operation.
The different models offer protection for 1 pair (DLA, DLU) and 2 pairs (DLU2).

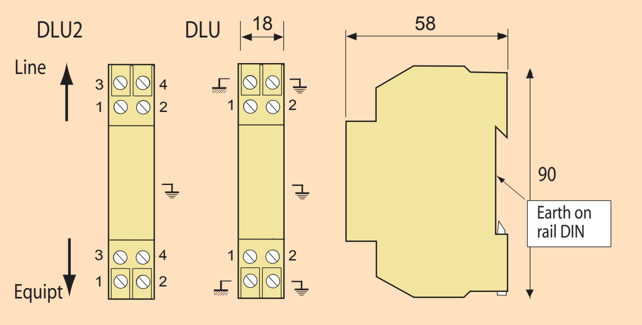
DLA
1-pair DIN rail surge protector with removable module for easy maintenance (ref. DLM...). Transmission and protection of the shield wire by gas tube. Direct earthing through Din rail. Line continuity in case of plug-in module removed.

DLU
1-pair (DLU) or 2-pair (DLU2) DIN rail surge protector. Monobloc enclosure. Transmission and protection of the shield wire (DLU). Earth through DIN rail.

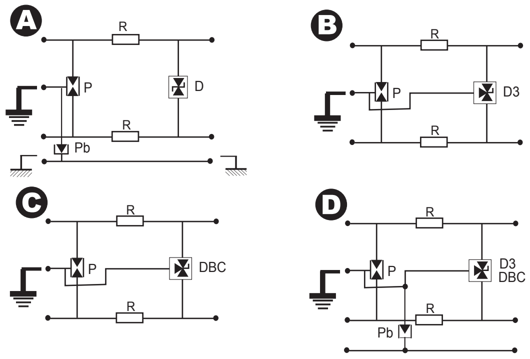
- For «DIN» rail mounting
- All types of Telephone and Data lines
- Pluggable version (DLA)
- 2-pair version (DLU2)

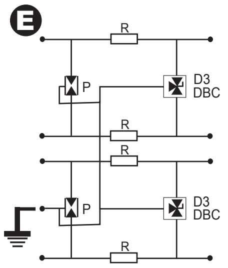
Dimensions (in mm)





Electrical diagrams





P : 3-electrode gas tube
Pb : : 2-electrode gas tube
R : Resistor
D : Clamping diode
D3 : 3-pole clamping diode
DBC : 3-pole low capacitance diode
V : varistor

F050414B - Document could be modified without notice

CITEL 2CP

DIN Rail Surge Protector for Dataline/Telecom

DLA & DLU

Characteristics

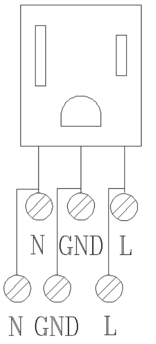
CITEL part number	DLA-170	DLA-48D3	DLA-24D3	DLA-12D3	DLA-06D3	DLA-06DBC
Application	Telephone line ADSL	ISDN-T0 48 V line	Leased line 4-20 mA	RS232	RS422 RS485	T2 - T1 10BaseT
Configuration	1 pair+shield	1 pair+shield	1 pair+shield	1 pair+shield	1 pair+shield	1 pair+shield
Max. line voltage (Uc)	170 V	48 V	24 V	15 V	6 V	6 V
Max. line current	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA
Protection level (Up) 8/20µs impulse - 5 kA	220 V	70 V	40 V	30 V	20 V	25 V
Nominal discharge current (In) 8/20µs impulse - 10 times	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA
Max. discharge current (Imax) 8/20µs impulse - 1 time	10 kA	10 kA	10 kA	10 kA	10 kA	10 kA
Type of diagram	A	B	B	B	B	C
End of life	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit
Mechanical characteristics	Modular shape and Symmetrical Din rail mounting Direct earthing on Din rail and shield wire protected by GDT Dimensions : see drawing Connection by screw - max. cross section 1.5 mm² Removable module for DLA series : ref DLAM-xxx Housing material : Thermoplastic UL94-V0					

CITEL part number	DLU-170	DLU2-48D3	DLU-48DBC	DLU-24D3	DLU2-12D3	DLU-12D3	DLU-12DBC	DLU2-06D3	DLU2-06DBC
Application	Telephone line ADSL	ISDN-T0 Profibus-PA Liaison 48 V	Fipway WorldFIP Fieldbus-H2	4-20 mA 24 V line	RS232	Profibus-FMS Interbus Fieldbus-H1 Batibus	Profibus-DP LONwork	RS422	T2 - T1 10BaseT
Configuration	1 pair	2 pairs	1 pair + shield	1 pair	4 wires	1 pair + shield	1 pair + shield	2 pairs	2 pairs
Max. line voltage(Uc)	170 V	48 V	48 V	24 V	15 V	15 V	15 V	6 V	6 V
Max. line current	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA
Protection level (Up) 8/20µs impulse - 5 kA	220 V	70 V	75 V	40 V	30 V	30 V	35 V	20 V	25 V
Nominal discharge current (In) 8/20µs impulse - 10 times	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA
Max. discharge current (Imax) 8/20µs impulse - 1 time	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA
Type of diagram	D	E	D	D	E	D	D	E	E
End of life	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circui
Mechanical characterisitics	Modular shape Symmetrical DIN rail mounting Dimensions : see drawing connection by screw - max. cross section 1.5 mm² Housing material : Thermoplastic UL94-V0 Earth connection via DIN rail (DLU, DLU2) or screw terminal (DLU).								

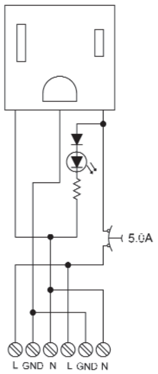
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- Compact and easily snaps onto 35mm DIN-rail
- CSA, UL508A and cULus approved
- Available with ground fault current interrupt (GFCI) or standard simplex and duplex outlets
- Option for visual indication of power included with GFCI versions
- Enclosed versions feature NEMA rated enclosure with UL94 VO flammability rating

Schematic diagram



Schematic diagram



Rated data

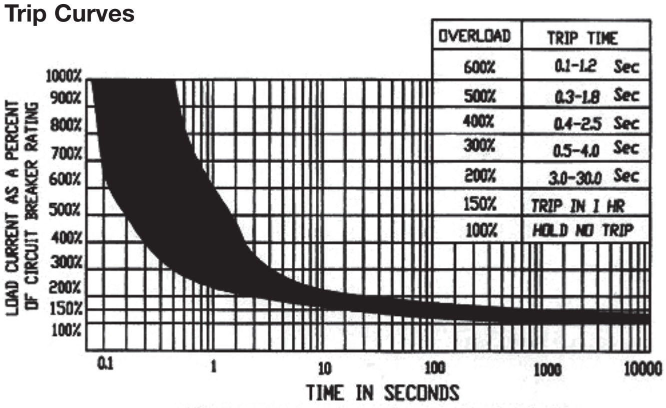
Input voltage		
Rated current	120Vac	120Vac
	5A max via outlet	5A max via outlet
	10A via redundant terminals	10A via redundant terminals
Wire range	26 - 12 AWG (0.14 0 4.0mm²)	26 - 12 AWG (0.14 0 4.0mm²)

Ordering data	Type	Part No.	Type	Part No.
TS32 / TS35 mounting (⊔ / ⎍)	Single outlet without circuit breaker	**9915480000**	Single outlet with circuit breaker	**9915480001**
			(supplemental protector with manual reset via push button)	

Dimensions		
Width	35mm	35mm
Length	70mm	70mm
Height	55mm	55mm

Approvals		
	SP LR-229352, UL E252394	SP LR-229352, UL E252394

Trip Curves



OVERLOAD	TRIP TIME
600%	0.1-1.2 Sec
500%	0.3-1.8 Sec
400%	0.4-2.5 Sec
300%	0.5-4.0 Sec
200%	3.0-30.0 Sec
150%	TRIP IN 1 HR
100%	HOLD NO TRIP

TRIP CURVES ARE SPECIFIED OF 25°C/77°F

Extract from the online catalog

UK 6,3-HESILA 250

Order No.: 3004249

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004249

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Commercial data	
EAN	4017918090739
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.034648 KG
Catalog page information	Page 370 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 09/11/2006

http://www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

Technical data

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

Connection data

Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Certificates / Approvals

Certification	ABS, CSA, GL, GOST, LR, UL

CSA

Nominal voltage U_N	600 V
Nominal current I_N	25 A
AWG/kcmil	26-8

UL

Nominal voltage U_N	600 V
Nominal current I_N	10 A
AWG/kcmil	26-8

Accessories

Item	Designation	Description
Assembly		
3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
3004207	VS	Connection pin, Length: 1000 mm, Color: white
Bridges		
0203153	EB 2-10	Cross connector/bridge, Number of positions: 2, Color: gray
0203137	EB 10-10	Cross connector/bridge, Number of positions: 10, Color: gray
Marking		
1007248	SBS10:UNBEDRUCKT	Marker cards, unprinted, for individual labeling with the M-PEN, 250-section, perforated, white plastic

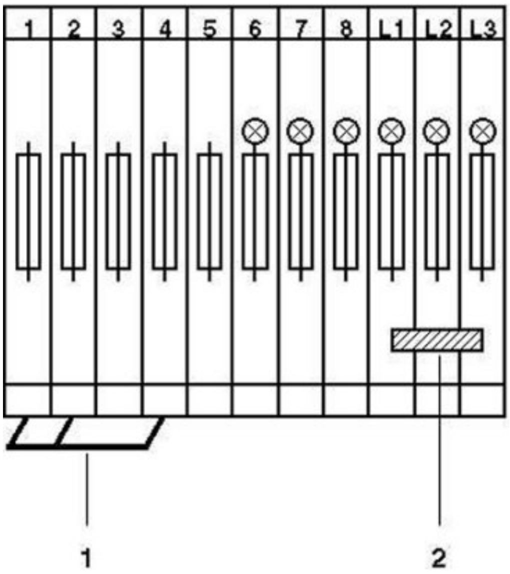
1050525	ZB10:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Tools

1205066	SZS 1,0X4,0	Screwdriver, bladed, matches all screw terminal blocks with 10 mm² and 16 mm² connection cross section, blade: 1.0 x 4.0 mm

Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

UK 6,3-HESILED 24

Order No.: 3004265

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004265

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Product notes

WEEE/RoHS-compliant since: 09/01/2006

Commercial data	
EAN	4017918090753
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.03542 KG
Catalog page information	Page 370 (CL-2009)

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

Technical data

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

Connection data

Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Certificates / Approvals

Certification	CSA, GL, GOST, LR, UL

CSA

Nominal voltage U_N	600 V
Nominal current I_N	25 A
AWG/kcmil	26-8

UL

Nominal voltage U_N	600 V
Nominal current I_N	10 A
AWG/kcmil	26-8

Accessories

Item	Designation	Description
Assembly		
3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
3004207	VS	Connection pin, Length: 1000 mm, Color: white
Bridges		
0203153	EB 2-10	Cross connector/bridge, Number of positions: 2, Color: gray
0203137	EB 10-10	Cross connector/bridge, Number of positions: 10, Color: gray
Marking		
1007248	SBS10:UNBEDRUCKT	Marker cards, unprinted, for individual labeling with the M-PEN, 250-section, perforated, white plastic

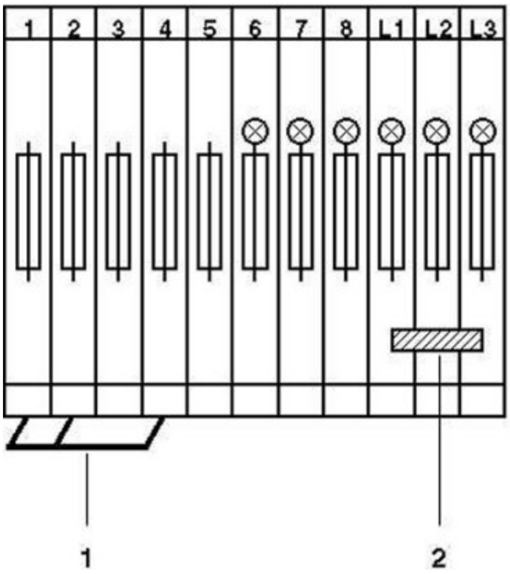
1050525	ZB10:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Tools

1205066	SZS 1,0X4,0	Screwdriver, bladed, matches all screw terminal blocks with 10 mm² and 16 mm² connection cross section, blade: 1.0 x 4.0 mm

Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

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http://www.phoenixcon.com

Extract from the online catalog

UK 5 N YE

Order No.: 3003952

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003952

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Commercial data	
EAN	4017918282172
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00917 KG

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Certificates / Approvals

Certification Ex: FM, GL-EX, IECEx, KEMA-EX, UL-EX

CSA

Nominal voltage U_N	600 V
Nominal current I_N	40 A
AWG/kcmil	28-10

CUL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

UL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

Accessories

Assembly

Item	Designation	Description
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray
3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover for modular terminal blocks, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for supporting the electronic base. If mounted vertically, 2 end clamps are required in each case
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m

1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/jumper for modular terminal block, Color: aluminum
0204107	STL 35/ 5	Cross connector/jumper for modular terminal block, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/jumper for modular terminal block, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/jumper for modular terminal block, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/jumper for modular terminal block, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/jumper for modular terminal block, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/jumper for modular terminal block, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: aluminum

0201281	FB 10- 6-EX	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/jumper for modular terminal block, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/jumper for modular terminal block, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/jumper for modular terminal block, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/jumper for modular terminal block, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Isolator bridge bar, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/jumper for modular terminal block, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/jumper for modular terminal block, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/jumper for modular terminal block, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/jumper for modular terminal block, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/jumper for modular terminal block, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/jumper for modular terminal block, Color: silver
2305538	USBRJ 2-7	Cross connector/jumper for modular terminal block, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit plug, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit plug, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part for test connector
3000214	PAD-LOE/ 5N GY	Connector, color: gray
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Address

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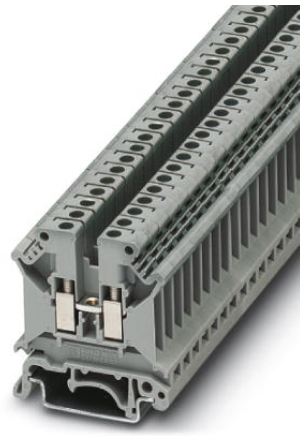
Extract from the online catalog

UK 5 N

Order No.: 3004362



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004362

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Commercial data	
EAN	4017918090760
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG
Catalog page information	Page 343 (CL-2009)

Technical data

General

Number of levels	1
Number of connections	2
Color	gray

Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Maximum load current	41 A (with 6 mm^2 conductor cross section)
Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-1
Nominal current I_N	32 A
Nominal voltage U_N	800 V
Open side panel	ja

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²

2 conductors with same cross section, stranded min.	0.2 mm²
2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Cross-section with insertion bridge, solid max.	4 mm²
Cross-section with insertion bridge, stranded max.	4 mm²
Type of connection	Screw connection
Stripping length	8 mm
Internal cylindrical gage	A4
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Certificates / Approvals

Certification	ABS, BV, CB, CCA, CSA, CUL, DNV, GL, GOST, KEMA, KR, LR, NK, PRS, RS, UL
Certification Ex:	CUL-EX, FM, GL-EX, IECEx, KEMA-EX, UL-EX

CSA

Nominal voltage U_N	600 V
Nominal current I_N	40 A
AWG/kcmil	28-10

CUL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

UL	
Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray
3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover for modular terminal blocks, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m

1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red

2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Kurzschlussstecker, Polzahl: 3, Farbe: schwarz
0301547	KSS 6	Kurzschlussstecker, Polzahl: 2, Farbe: schwarz
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Drawings

Circuit diagram

Approbationslogos (EX-Bereich)

Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

UK 5 N GN

Order No.: 3003965

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003965

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green, Mounting type: NS 35/7,5, NS 35/15, NS 32

Commercial data	
EAN	4017918282189
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.009305 KG

Product notes

WEEE/RoHS-compliant since:
01/01/2003

http://www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Certificates / Approvals

Certification	CB, CCA, CSA, CUL, DNV, GL, GOST, KEMA, UL

Certification Ex:	FM, GL-EX, IECEx, KEMA-EX, UL-EX

CSA

Nominal voltage U_N	600 V
Nominal current I_N	40 A
AWG/kcmil	28-10

CUL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

UL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray
3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover for modular terminal blocks, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m

1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver

0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Kurzschlussstecker, Polzahl: 3, Farbe: schwarz
0301547	KSS 6	Kurzschlussstecker, Polzahl: 2, Farbe: schwarz
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Drawings

Approbationslogos (EX-Bereich)


FM
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GL

Address

PHOENIX CONTACT Inc., USA
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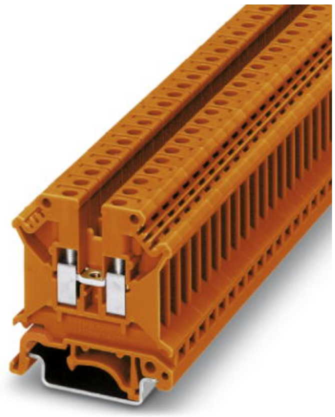
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

UK 5 N OG

Order No.: 3002908



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3002908

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: orange, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Commercial data	
EAN	4017918117498
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG

http://www.download.phoenixcontact.com

Certificates / Approvals

Certification	CB, CCA, CSA, CUL, DNV, GL, GOST, KEMA, UL

Certification Ex:	FM, GL-EX, IECEx, KEMA-EX, UL-EX

CSA

Nominal voltage U_N	600 V
Nominal current I_N	40 A
AWG/kcmil	28-10

CUL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

UL

Nominal voltage U_N	600 V
Nominal current I_N	30 A
AWG/kcmil	30-10

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray
3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover for modular terminal blocks, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m

1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver

0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Kurzschlussstecker, Polzahl: 3, Farbe: schwarz
0301547	KSS 6	Kurzschlussstecker, Polzahl: 2, Farbe: schwarz
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Drawings

Approbationslogos (EX-Bereich)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GL

Address

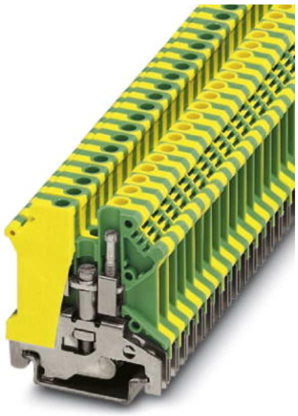
PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

PHOENIX CONTACT

Extract from the online catalog

USLKG 5

Order No.: 0441504



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0441504

Ground modular terminal block, Type of connection: Screw connection, Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green-yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/15/2005

Commercial data

EAN	4017918002190
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.02081 KG
Catalog page information	Page 347 (CL-2009)

http://www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

Note	When aligning with a feed-through terminal block with the same shape, an end cover must be interposed with insulation voltages of > 690 V
Number of levels	1

Number of connections	2
Color	green-yellow
Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-2
Open side panel	nein

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²
2 conductors with same cross section, stranded min.	0.2 mm²

2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Type of connection	Screw connection
Stripping length	8 mm
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Certificates / Approvals

Certification	ABS, BV, CCA, CSA, CUL, GOST, KEMA, KR, LR, PRS, RS, UL
Certification Ex:	IECEx, KEMA-EX

CSA

AWG/kcmil	28-10

CUL

AWG/kcmil	26-10

UL

AWG/kcmil	26-10

Accessories

Item	Designation	Description
Assembly		
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m

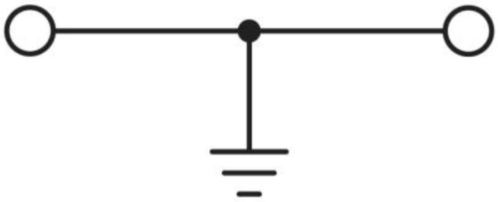
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Drawings

Circuit diagram



Approbationslogos (EX-Bereich)

Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

D-UK 4/10

Order No.: 3003020

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003020

End cover for modular terminal blocks, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray

Commercial data	
EAN	4017918090425
Pack	50 pcs.
Customs tariff	85472000
Weight/Piece	0.002536 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 01/01/2003

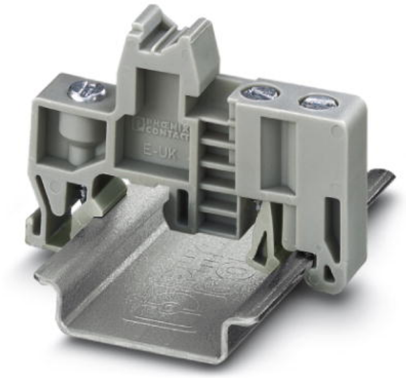
Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

E/UK

Order No.: 1201442



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=1201442

End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail

Product notes
WEEE/RoHS-compliant since: 07/01/2005

Commercial data	
EAN	4017918017323
Pack	50 pcs.
Customs tariff	39269097
Weight/Piece	0.009354 KG
Catalog page information	Page 696 (CL-2009)

Technical data

General

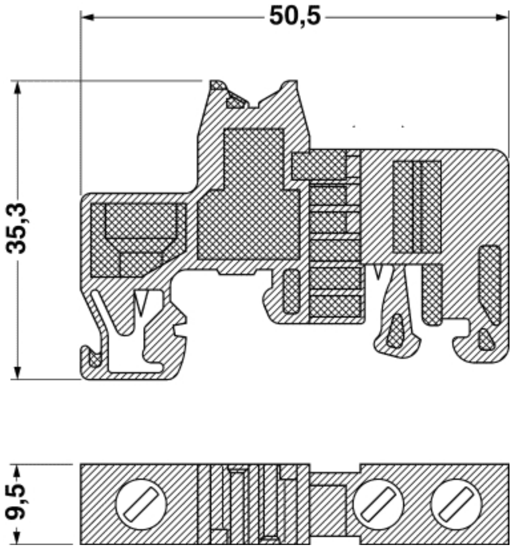
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

Accessories

Item	Designation	Description
Assembly		
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
Marking		
1004089	UBE + ES/KMK 3	Marker carrier, color: Gray for marking groups of terminals, for end clamp E/UK or end clamp E/U, with perforated insert strips, 40 x 17 mm, can be labeled with CMS system
1051003	ZB 6:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 6.2 mm, color: white

Drawings

Dimensioned drawing



Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

FBI 10- 6

Order No.: 0203250

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203250

Cross connector/bridge, Number of positions: 10, Color: silver

Commercial data	
EAN	4017918098070
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.01615 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

http://
www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

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http://www.phoenixcon.com

K2A25U : TWO:14 STR-1/0 STR DUAL

ACTIVE

RoHS compatible

www.fci.com

BURNDY® PRODUCTS

Specifications

General

Number of Conductors	2
Number of Screws	1
Number of Stud Holes	1 Hole

Dimensional

Stud Hole (Size)	1/4 in.

Physical

Conductor Size	14 AWG 2 AWG 1 AWG 4 AWG 1/0 AWG 8 AWG 12 AWG 10 AWG 6 AWG
Installation Torque	50 in. lb.
Conductor Size (Range)	14 AWG to 1/0 AWG

Approvals / Certifications

UL Listed	Yes
CSA Certified	Yes

Other Features

Set Screw Type	Slot
UPC	78181060004
Keyword	kau

T1-E Duct Series

Contact your local representative or the IBOCO sales office for more information.

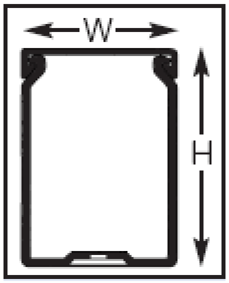
MATERIAL:
Rigid PVC,
self-extinguishing

COLOR:
light GREY RAL 7030
WHITE

STANDARD LENGTH:
6 Feet 6 3/4 Inches

STANDARD UNIT:
Duct complete with cover

Catalog Number	Nominal Size (WxH)	Dimensions inches (Actual)				Dimensions W x H (millimeters)	Standard Carton Length (1)	(QTY) Feet
		W	H	E	F			
T1E-1015 *	1 x 1 1/2	1.00	1.57	.16	.24	25 x 40	18	108
T1E-1022 *	1 x 2 1/4	1.00	2.36	.16	24	25 x 60	24	144
T1E-1030 *	1 x 3	1.00	3.15	16	.24	25 x 80	24	144
T1E-1040 *	1 x 4		.			25 x 100	8	48
T1E-1515 *	1 1/2 x 1 1/2	1.57	1.57	.16	.24	40 x 40	20	120
T1E-1522 *	1 1/2 x 2 1/4	1.57	2.36	.16	.24	40 x 60	18	108
T1E-1530 *	1 1/2 x 3	1.57	3.15	.16	24	40 x 80	16	96
T1E-1540 *	1 1/2 x 4	1.57	3.94	.16	.24	40 x 100	8	48
T1E-2222 *	2 1/4 x 2 1/4	2.36	2.36	.16	.24	60 x 60	12	72
T1E-2230 *	2 1/4 x 3	2.36	3.15	.16	.24	60 x 80	12	72
T1E-2240 *	2 1/4 x 4	2.36	3.94	.16	.24	60 x 100	4	24
T1E-3015G	3 x 1 1/2	3.15	1.57	.16	.24	80 x 40	12	72
T1E-3022 *	3 x 2 1/4	3.15	2.36	.16	.24	80 x 60	12	72
T1E-3030 *	3 x 3	3.15	3.15	.16	.24	80 x 80	12	72
T1E-3040 *	3 x 4	3.15	3.94	.16	.24	80 x 100	4	24
T1E-4015G	4 x 1 1/2	3.94	1.57	.16	.24	100 x 40	8	48
T1E-4022G	4 x 2 1/4	3.94	2.36	.16	.24	100 x 60	8	48
T1E-4030 *	4 x 3	3.94	3.15	.16	.24	100 x 80	8	48
T1E-4040 *	4 x 4	3.94	3.94	.31	.47	100 x 100	4	24



Example: T1E-1015G = 1" x 1 1/2" light GREY duct with cover

(1) Each standard length is actually 6'6 3/4" but is counted as 6 feet for packaging and pricing

* Color - add suffix "G" fro light GREY, "W" for WHITE

ADHESIVE BACKING - add suffix "A" to catalog number - contact sales office for pricing

Technical Characteristics

IBOCO Wiring products respond to all installation needs, coping with different uses and environment applications. They are manufactured with high quality materials that undergo severe quality controls and performance tests under extreme operating and duration conditions witha constant control of quality standards.

Wiring Ducts T1, T1E, SEP-E and CL are manufactured in rigid Self-Extinguishing PVC.

Those components for which high bending resilience is required are in polyamide 6 and polypropylene.

Spiralite is manufactured in natural polyethylene and self-extinguishing polyethylene.

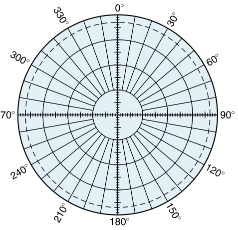
Materials Technical Characteristics	Unit of Measure	Standard	PVC Duct Value	PVC Moulded Components Value	Polyamide 6 Value	Polyethylene Value	Flame Retardant Polyethylene Value
CHEMICAL-PHYSICAL PROPERTIES							
Specific gravity	g/cm^3	ASTM D792	1.55	1.32	1.14	0.92	0.97
H2O 73,4° F absorbtion	%	ISO 62	<0,1	2,5	2,5	<0,1	<0,1
Formaldehyde	ppm	-	absent	absent	absent	absent	absent
Cadmium	ppm	-	absent	absent	absent	absent	absent
MECHANICAL PROPERTIES							
Tensile stress at break	MPa	ASTM D638	39	30	45	17	15
Traction strength	MPa	ASTM D638	44	27	55	9,5	9
Elongation at break	%	ASTM D638	130	97	250	400	600
Modulus of elasticity at traction	MPa	ASTM D638	4400	-	950	-	240
Modulus of elasticity at flexion	MPa	ASTM D790	3200	-	1100	210	130
THERMAL PROPERTIES							
Temperature VICAT	°C	ASTM D1525	84	70	198	89	-
HDT	°C	ASTM D648	72	60	185	-	-
Coefficient of expansion	K^-1	ASTM D696	6 10^-5	8 10^-5	8-10 10^-5	22 10^-5	10^-5
Specific heat	kJ/kgK	ASTM C351	0,94	1,24	1,7	-	-
Thermal conductivity	W/mK	ASTM C177	0,14	0,14	0,29	0,32	0,32
ELECTRICAL PROPERTIES							
Dielectric constant	-	ASTM D150	3,2 - 4,0	3,2	5,0	2,4	2,3
Dielectric strength	kV/mm	IEC 243	70	60	35	90	90
Surface resistance	Ohm	IEC 93	10^13	10^13	5 10^11	10^13	10^13
SELF-EXTINGUISING							
Self-extinguising 1,6 millimeters	-	UL 94	V0	V0	V2	HB	V2
Self-extinguishing 3,2 millimeters	-	UL 94	V0	V0	V2	HB	V2
Glow wire test (2 mm)	°C	IEC 695-2-1	960	960	650	650	850
Oxygen number	%	ASTM D2863	43	34	25	-	25

K7515641

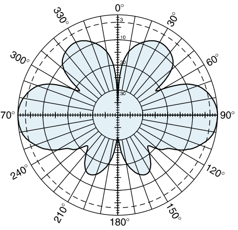
Omnidirectional Antenna

Kathrein's omnidirectional antennas for wireless, paging, SMR and mobile applications are extremely robust, using the finest fiberglass, brass, and aluminum. Applicable mounting hardware is fabricated from stainless steel. Many models may be mounted inverted. Higher gain antennas can be provided with downtilt, as well.

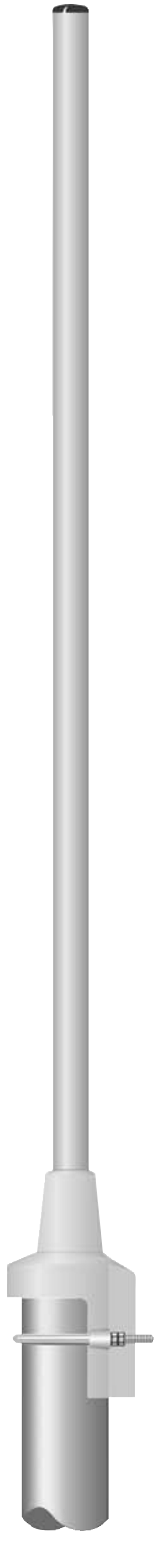
- Wireless
- Paging
- SMR
- Land Mobile
- ISM



H-plane
Horizontal pattern
V-polarization



E-plane
Vertical pattern
V-polarization



Specifications:

Frequency range	890–960 MHz
Gain	5 dBi
Impedance	50 ohms
VSWR	< 1.5:1
Intermodulation (2x5w)	IM3: <-150dBc
Polarization	Vertical
Maximum input power	250 watts (at 50°C)
H-plane beamwidth	Omni
E-plane beamwidth	30 degrees (half power)
Connector	N female
Weight	2.0 lb (0.9 kg)
Height	28.1 inches (715 mm)
Radome diameter	0.83 inches (21 mm)
Equivalent flat plate area	0.194 ft^2 (0.018 m^2)
Wind survival rating	120 mph (200 kph)
Shipping dimensions	32.5 x 4.4 x 3.8 inches (825 x 112 x 97 mm)
Shipping weight	5.0 lb (2.3 kg)
Mounting	For masts of 0.8 to 2.1 inch (20 to 54 mm) OD.

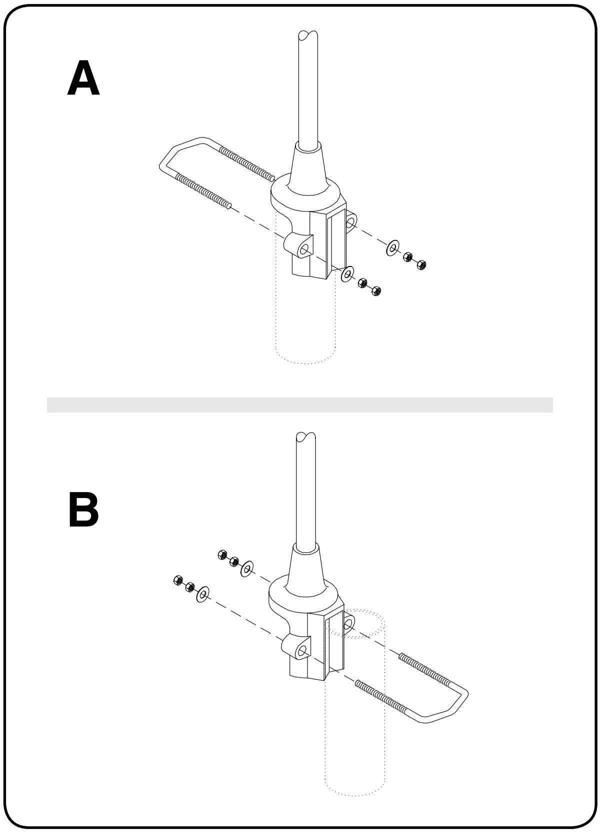
See reverse for order information.

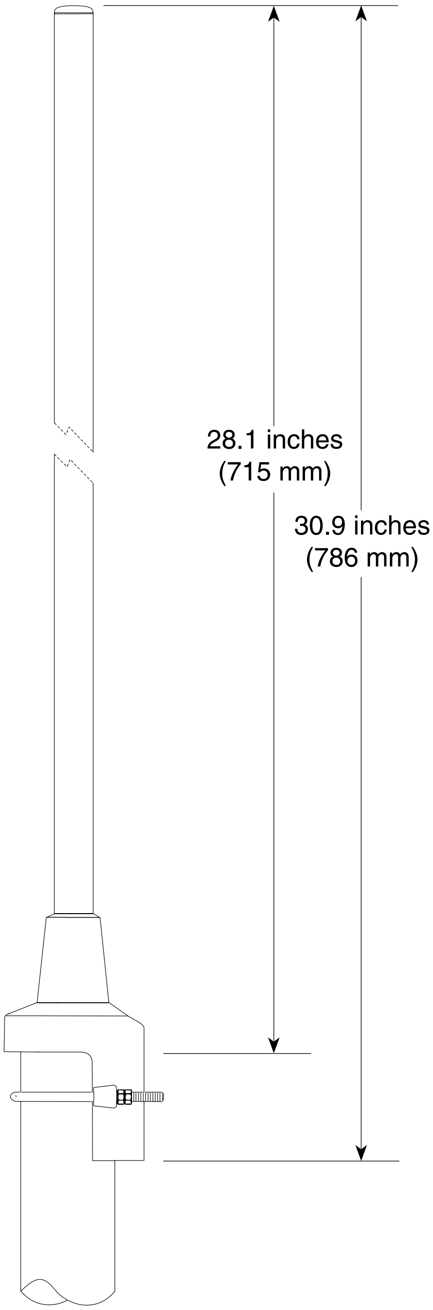
* Mechanical design is based on environmental conditions as stipulated in EIA-222-F (June 1996) and/or ETS 300 019-1-4 which include the static mechanical load imposed on an antenna by wind at maximum velocity. See the Engineering Section of the catalog for further details.

10046-J
936.376/i

K7515641

Omnidirectional Antenna





Mounting Options:

	Description
A	Mounting for 1.6 to 2.1 inch (40 to 54 mm) OD mast
B	Mounting for 0.8 to 2.1 inch (20 to 54 mm) OD mast

Order Information:

Model	Description
K7515641	Antenna with N connector 0° electrical downtilt

All specifications are subject to change without notice. The latest specifications are available at www.kathrein-scala.com.

System Controls & Instrumentation, Ltd

11218 IH-10 E.
Converse, TX 78109
Phone: 210-661-9901
Fax: 210-666-5575

1108 Quail Hollow
Laredo, TX 78045
Phone: 956-725-1239
Fax: 956-726-1774

TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-1

DRAWINGS

SCI FILE 3079

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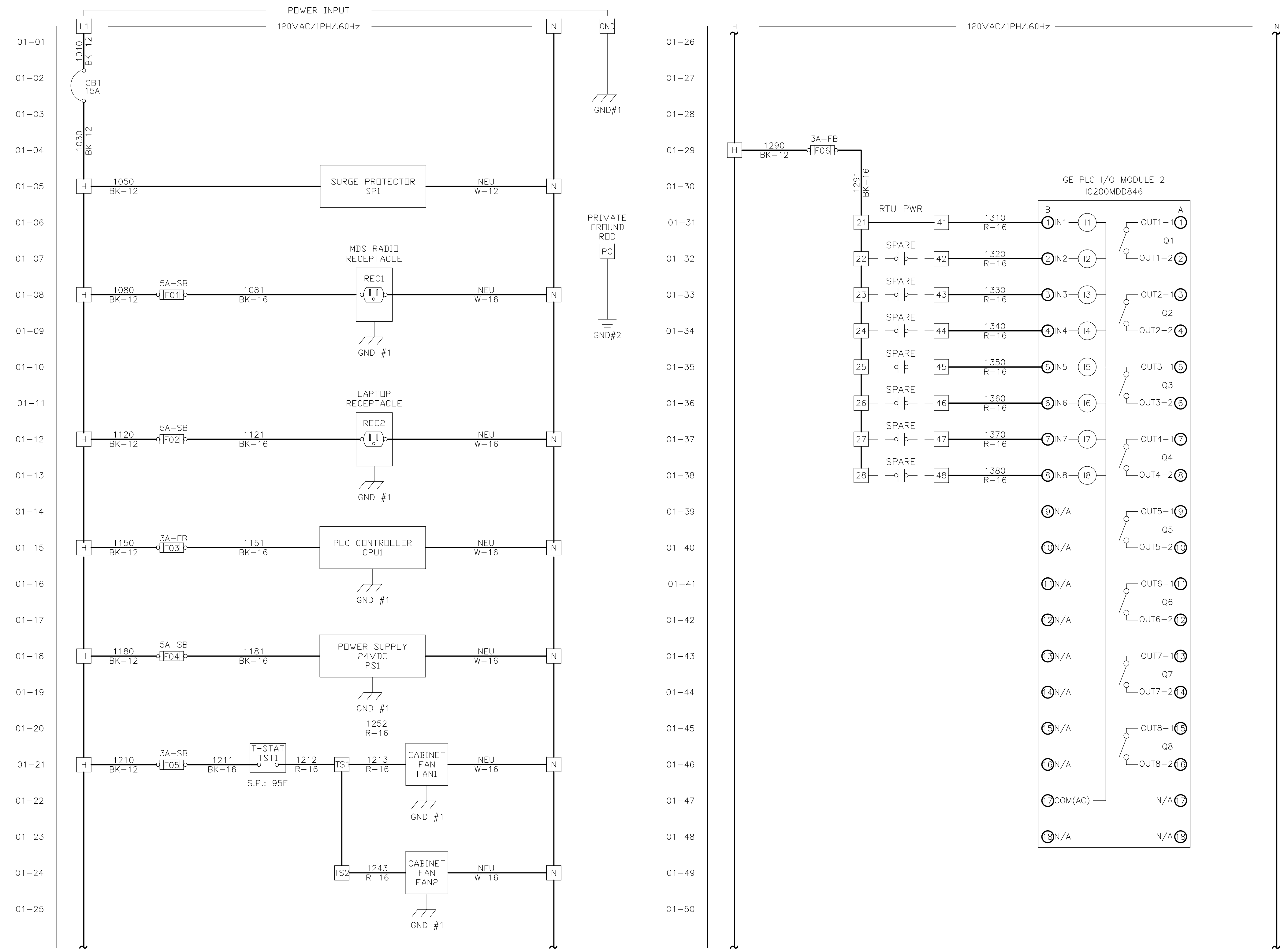


COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

WIRE MARKER LEGEND

COLOR SIZE

Y-18

NOTE 1: DASHED LINES INDICATE FIELD WIRING

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

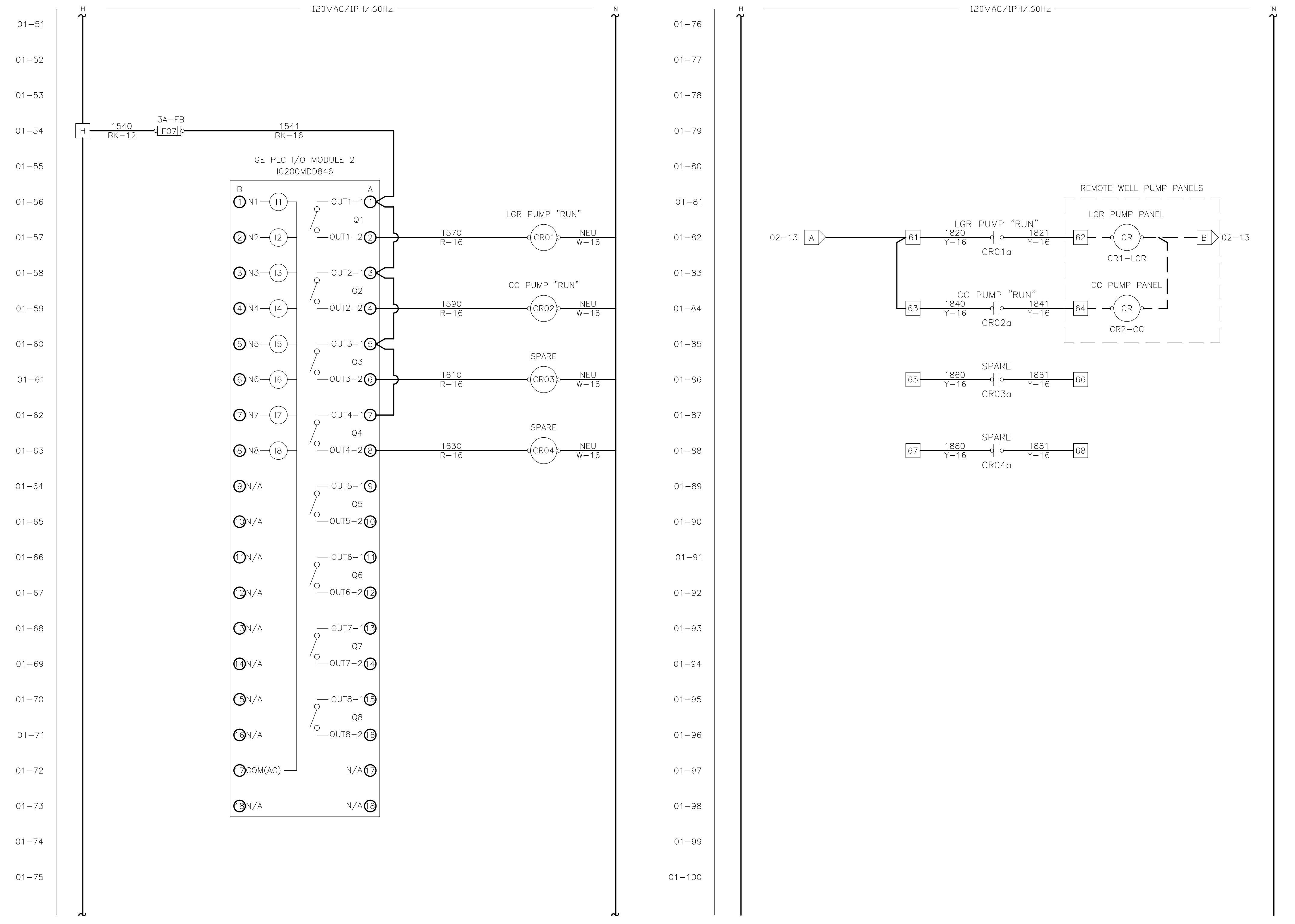
PROJECT TITLE

CAMP STANLEY
BIOREACTOR

SHEET TITLE

RTU 903-1
LINE-TO-LINE
WIRING DIAGRAM

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 1
OF 12



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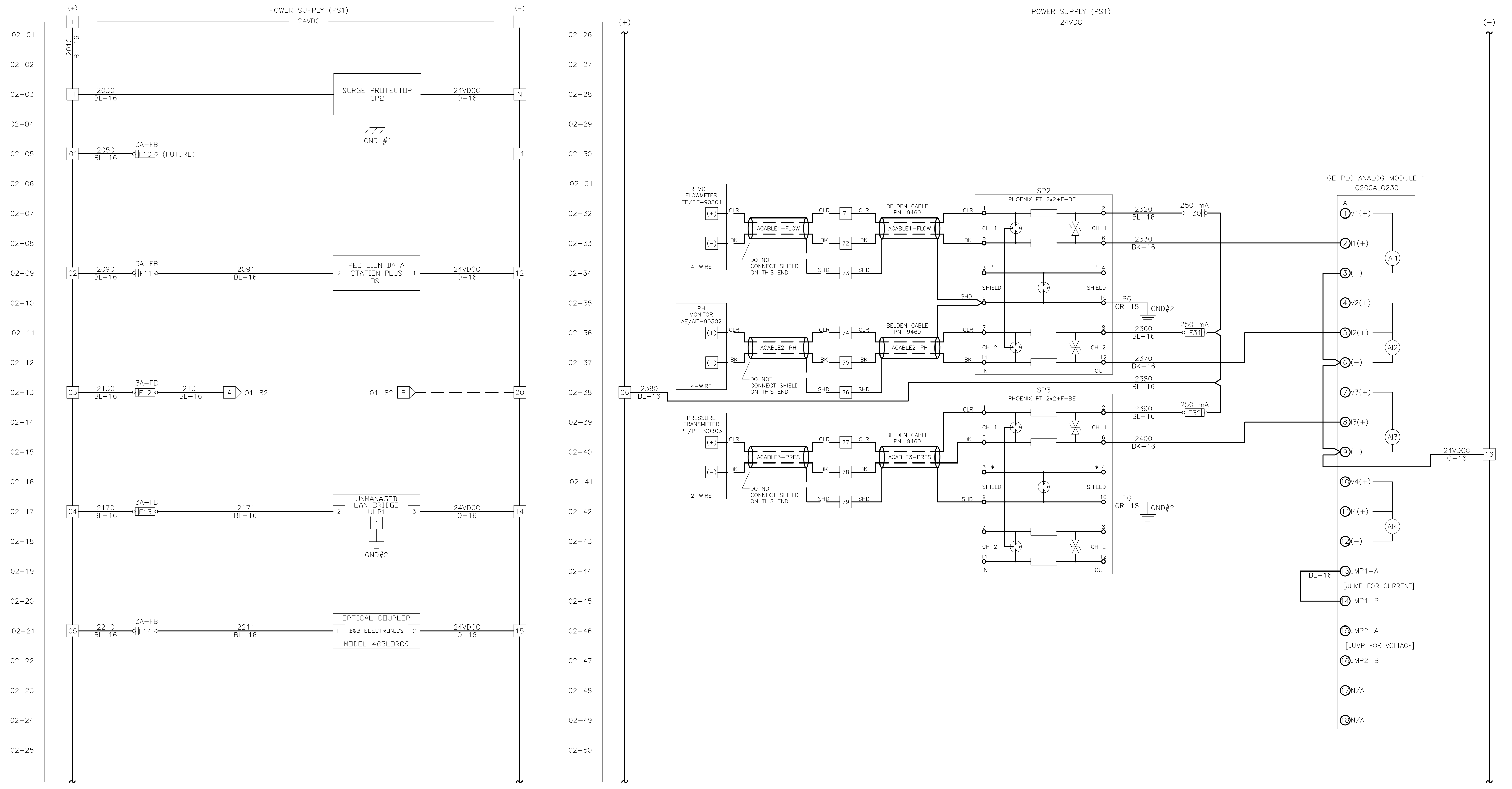
SH 2
OF 12



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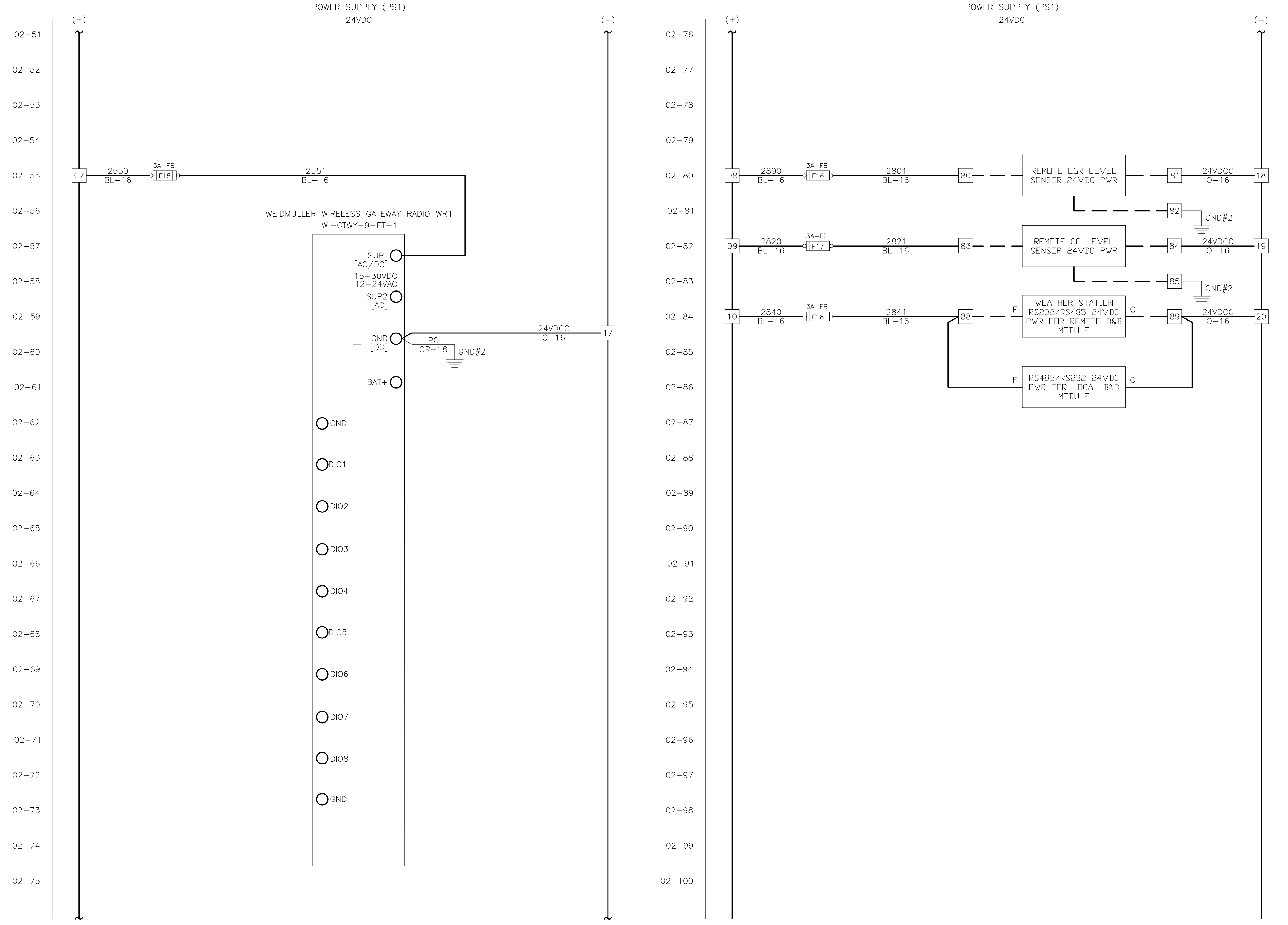

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WIRE MARKER LEGEND

COLOR SIZE

Y-18

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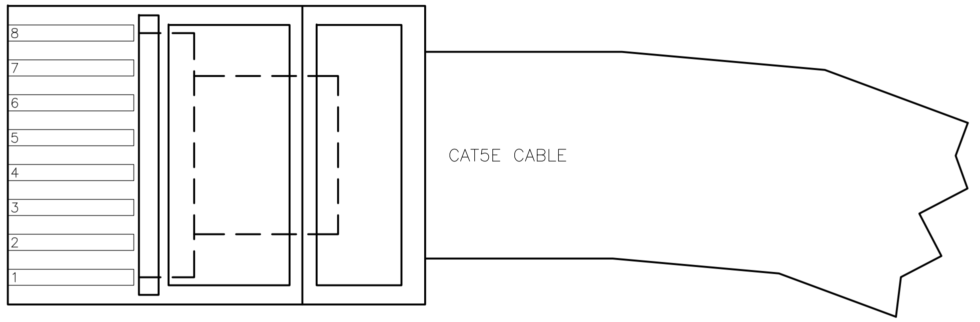
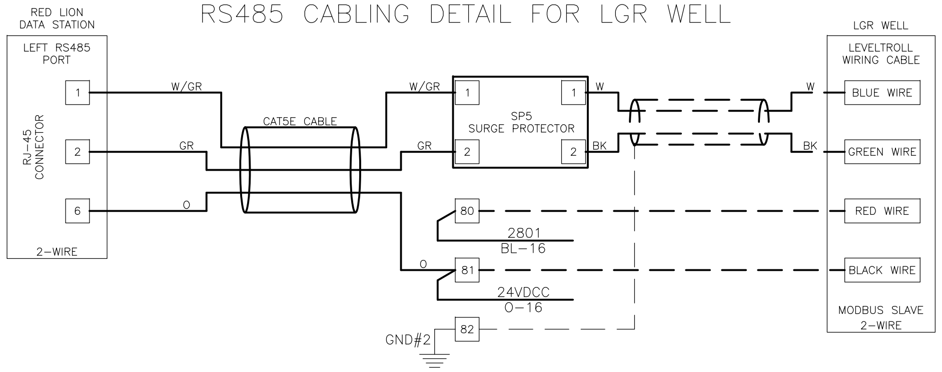
SH 4
OF 12

RED LION USING USING RJ-45 CONNECTOR FOR RS485 SIGNAL

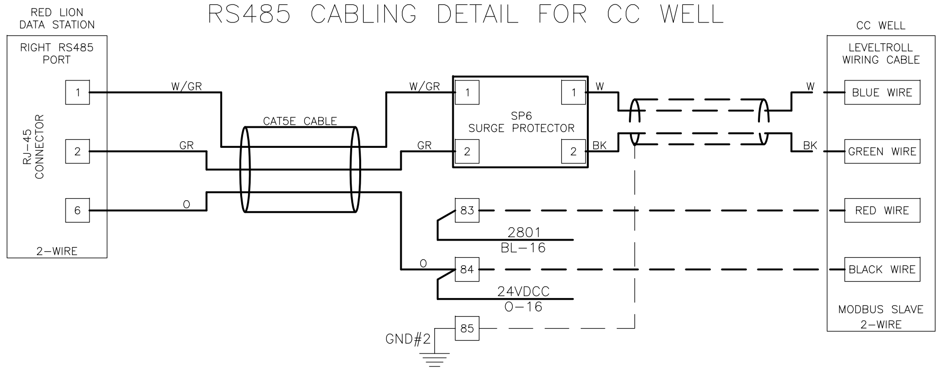


STANDARD ETHERNET WIRE COLOR CABLE USING RJ-45 PIN-OUT DETAIL				
RJ-45 PIN	WIRE COLOR	RED LION SIGNAL PIN OUT	RED LION RS485 2-WIRE	RJ-45 PIN
1	WHITE-GREEN	TxB	YES	1
2	GREEN	TxA	YES	2
3	WHITE-ORANGE	RxA		3
4	BLUE	RxB		4
5	WHITE-BLUE	TxEN		5
6	ORANGE	COM	YES	6
7	WHITE-BROWN	TxB		7
8	BROWN	TxA		8

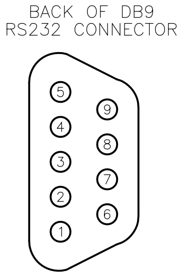
RS485 CABLING DETAIL FOR LGR WELL

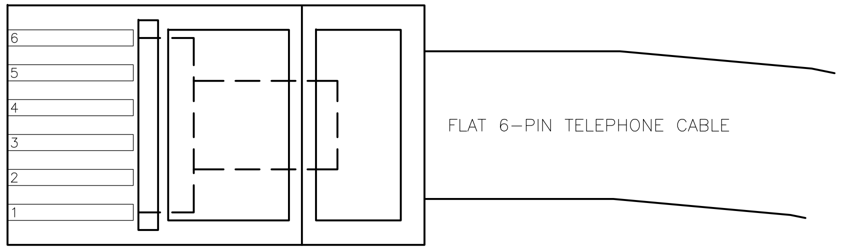


RS485 CABLING DETAIL FOR CC WELL

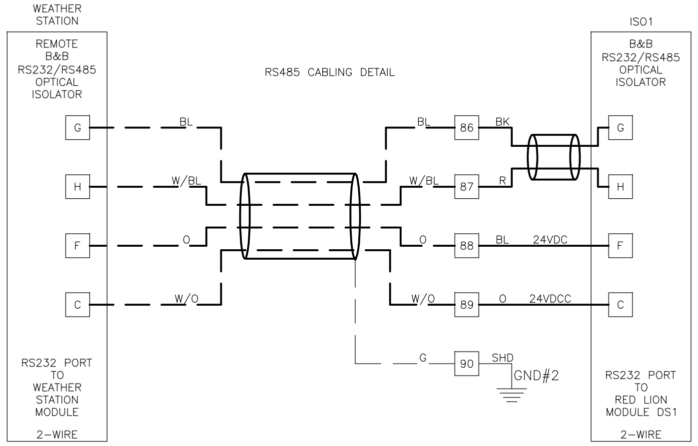


RED LION USING USING 6-PIN CONNECTOR FOR RS232 SIGNAL





DB9 RS232 CUSTOM CONNECTOR TO 6-PIN TELEPHONE CONNECTOR PIN OUT				
DB9 RS232 CONNECTOR	JUMPER WIRE COLOR	RED LION SIGNAL PIN OUT	RED LION RS232	6-PIN TELE CONNECTOR
8	<-- ORANGE	CTS	YES	1
2	<-- BLACK	Rx	YES	2
-	<-- RED	COM		3
5	<-- GREEN	COM	YES	4
3	<-- YELLOW	Tx	YES	5
7	<-- BROWN	RTS	YES	6



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COLOR SIZE
Y-18

NOTE 1: DASHED LINES INDICATE FIELD WIRING

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CONVERSE, TEXAS 78109
PHONE (210) 661-9901

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CAMP STANLEY
BIOREACTOR

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SH 5
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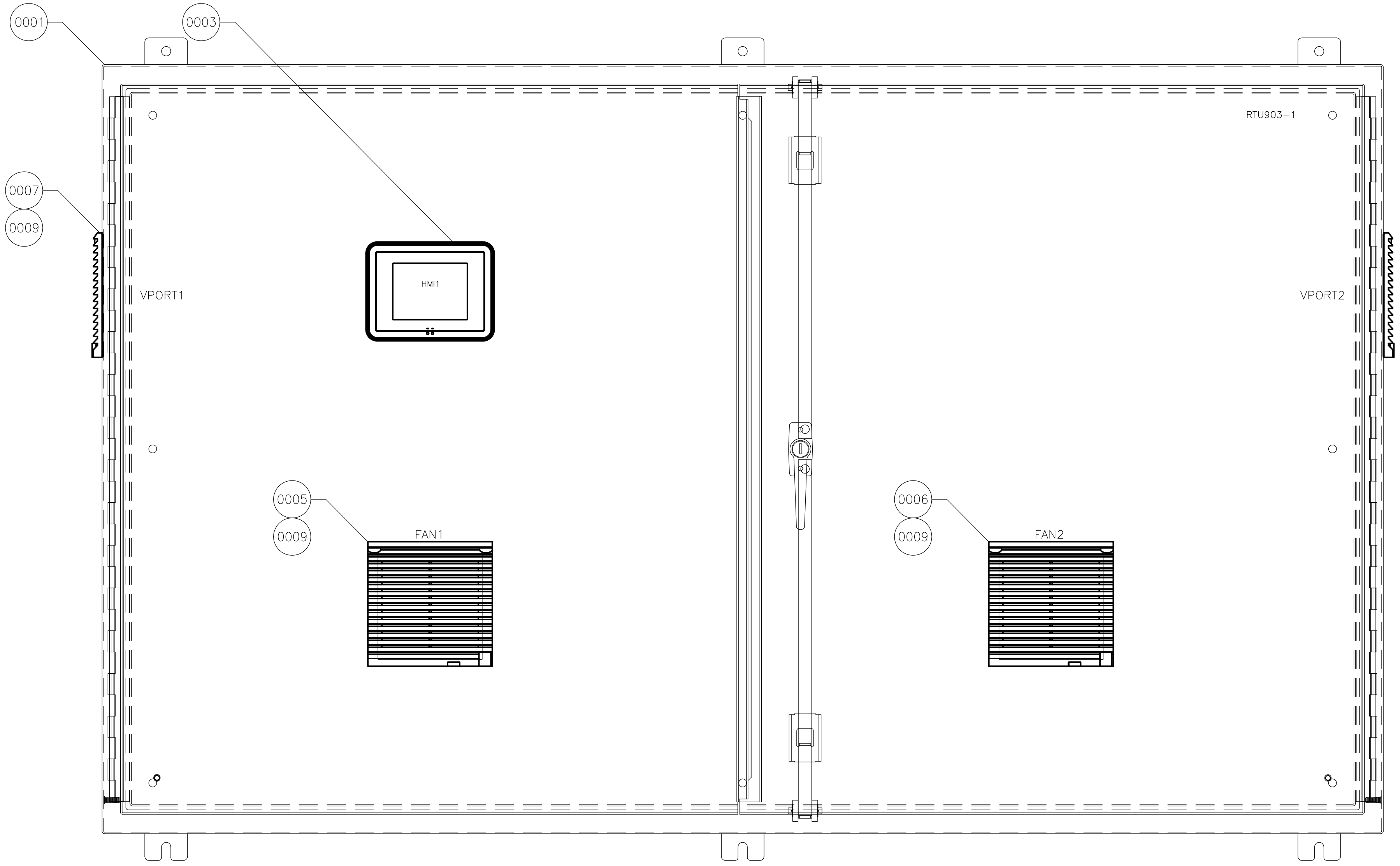

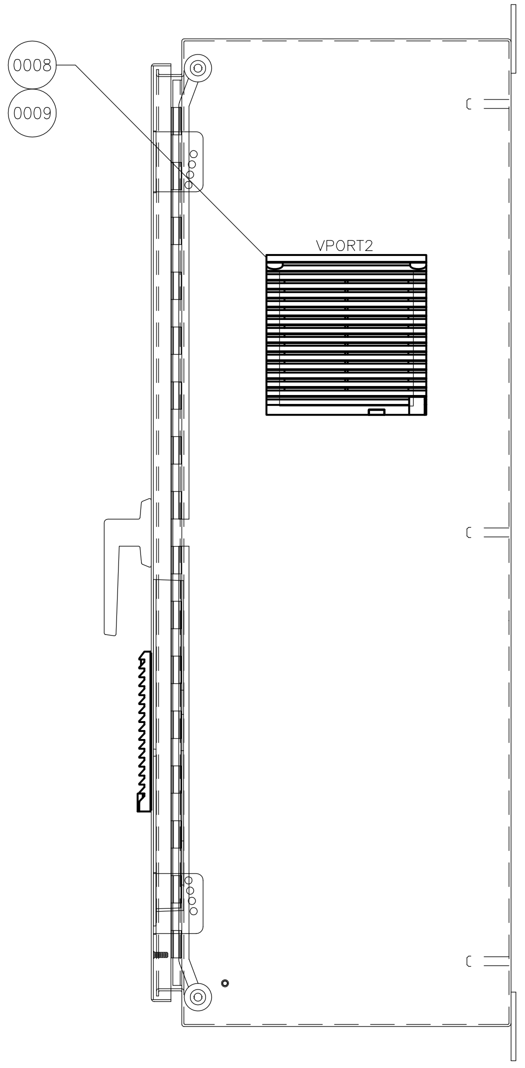

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CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
ENCLOSURE LAYOUT

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CAD FILE	SCI3079_RTU903-1

DWG. NO.	SH	OF
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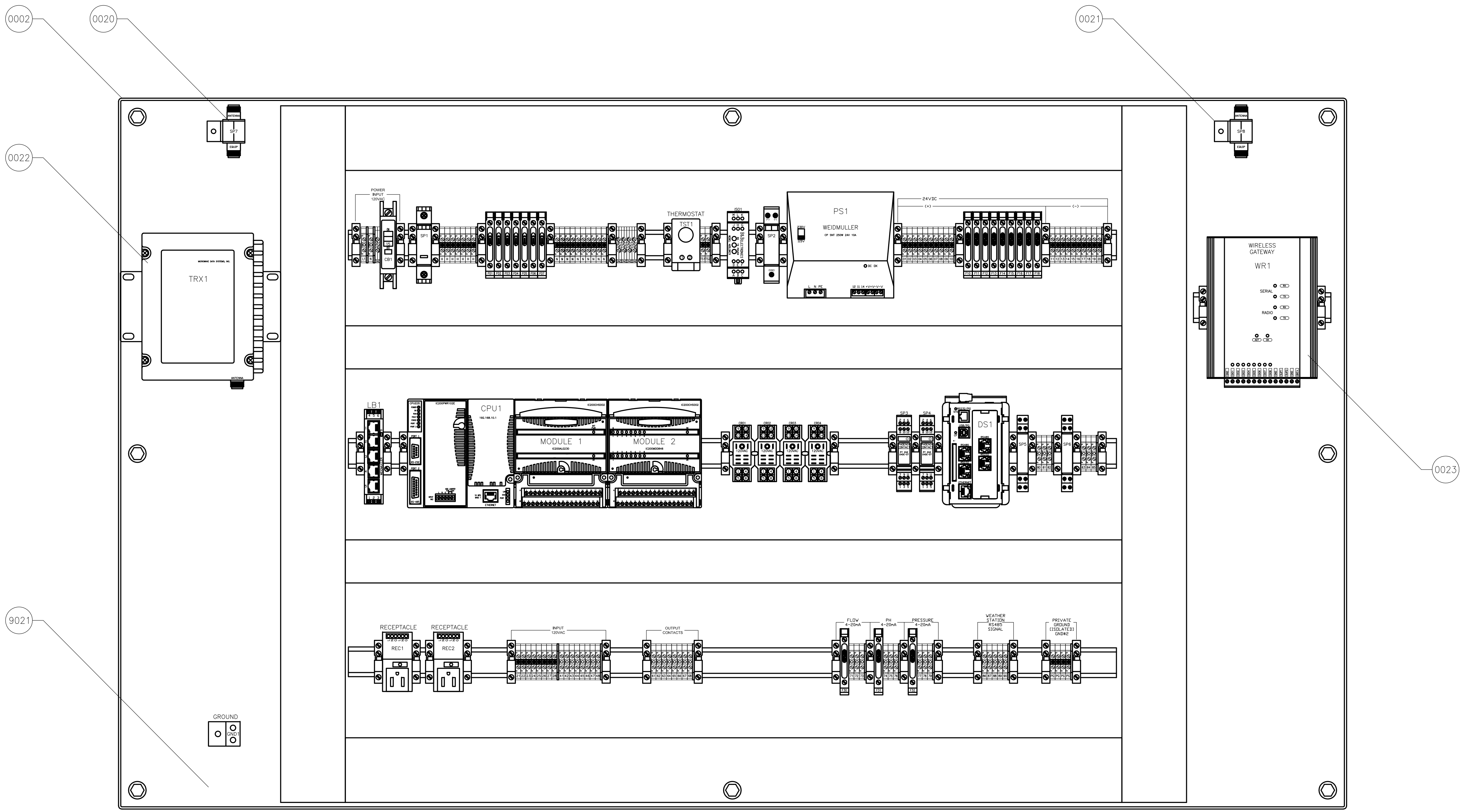

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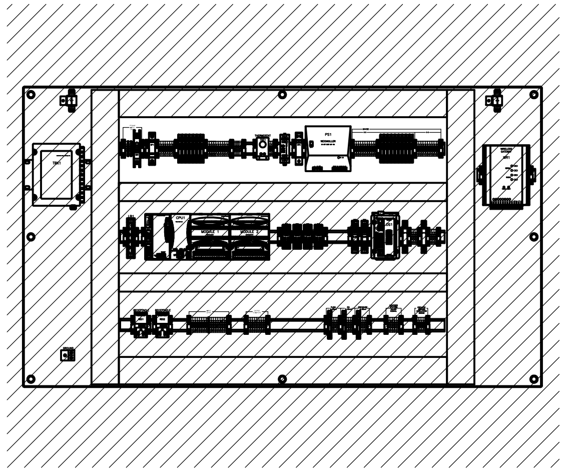
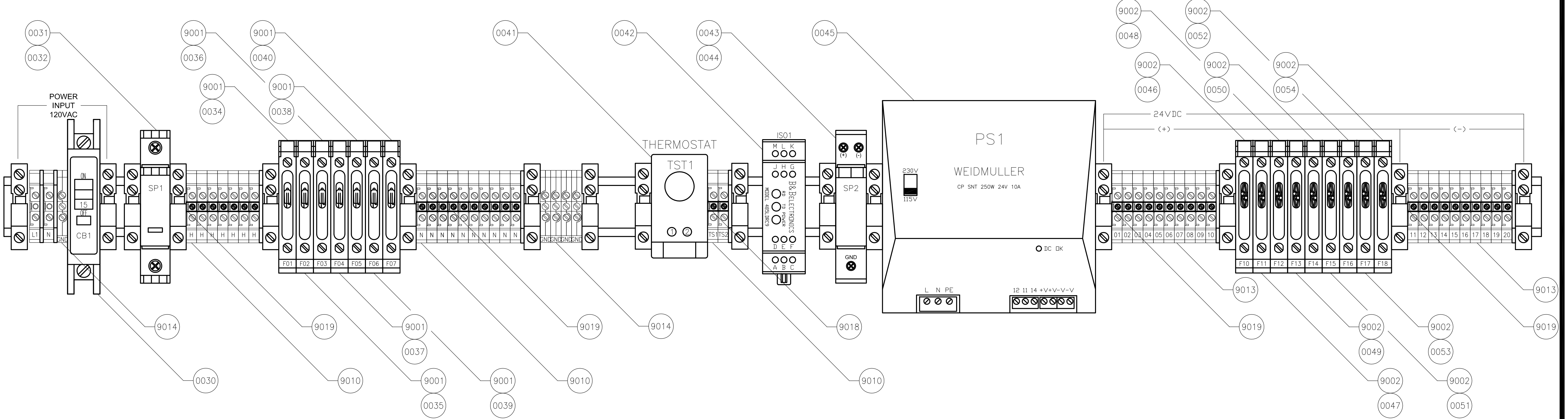
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BACK PANEL
LAYOUT

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 7
OF 12





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PHONE (210) 661-9901

ENGINEER

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BACK PANEL LAYOUT

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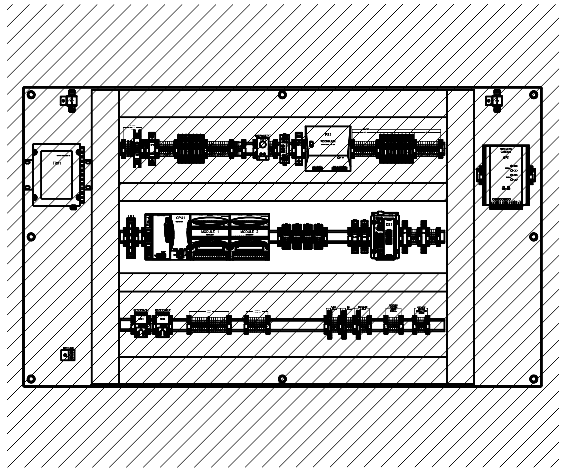
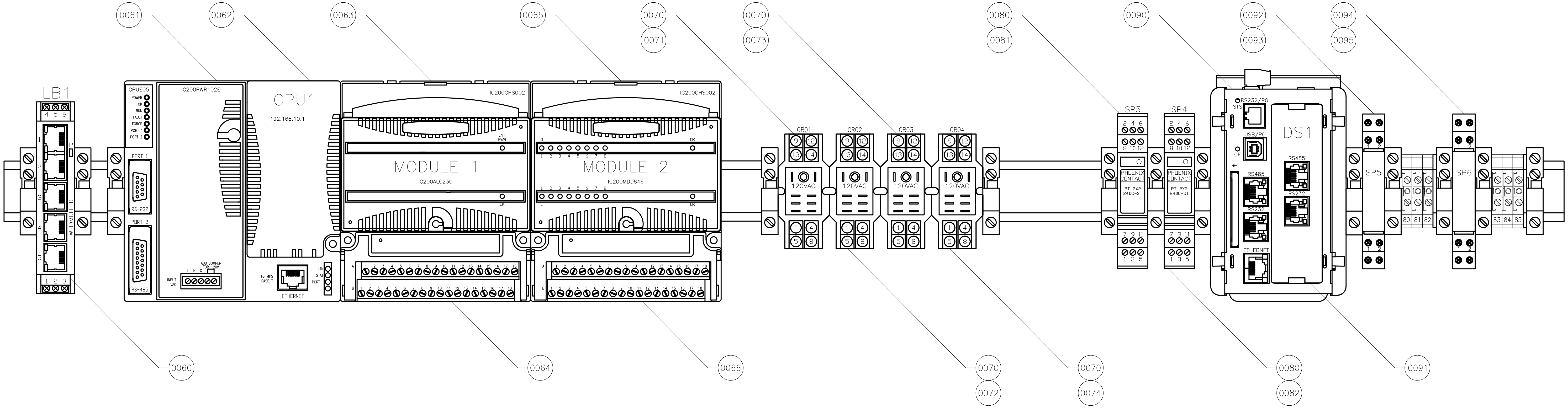
SH 8
OF 12





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

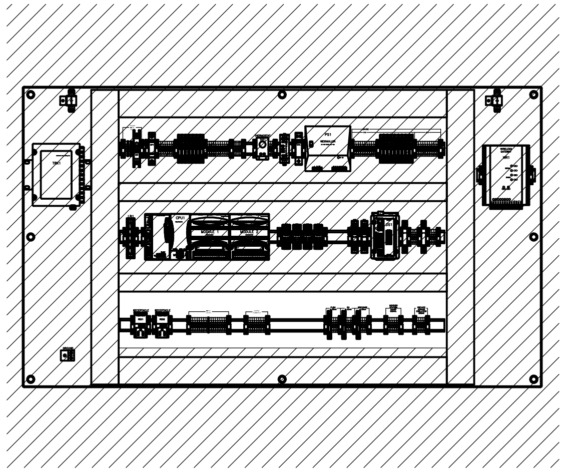
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

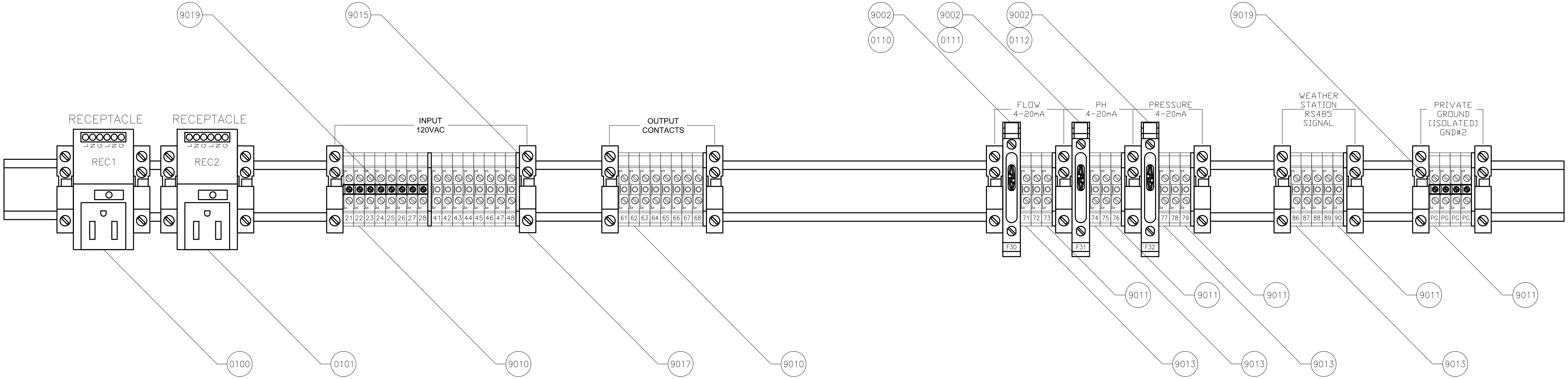
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BACK PANEL LAYOUT

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 9
OF 12





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DATE: 8/10/2009
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CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 10
OF 12

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-1	1	ENCLOSURE, 36"HX60"WX12"D, NEMA12	A366012WFLP	HOFFMAN
0002	RTU903-1	1	BACK PANEL, 36"HX60"W, STEEL	A60P36	HOFFMAN
0003	HMI1	1	HMI 6" COLOR TOUCH SCREEN, 24VDC, LAN PORT	IC754VSI06STD	GE FANUC
0005	FAN1	1	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), CUTOUT 124MM SQUARE	3322.117	RITTAL
0006	FAN2	1	FAN, FILTER UNIT, 39CFM, 115VAC, 0.24A, 50/60HZ, 19W, NEMA 12, LIGHT GREY, 13F-131F, 49DB(A), CUTOUT 124MM SQUARE	3322.117	RITTAL
0007	VPORT1	1	FILTER UNIT, HOLDER ONLY, 124MM	SK3322-207	RITTAL
0008	VPORT2	1	FILTER UNIT, HOLDER ONLY, 124MM	SK3322-207	RITTAL
0009		4	REPLACEMENT FILTER PADS, FOR 5.8"SQ FANS	3322.700	RITTAL
0020	SP7	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0021	SP8	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0022	TRX1	1	DATA TRANSCEIVER, 173MHZ, RS232 INPUT, 13.8VDC	MDS 1710A	MICROWAVE DATA SYSTEMS
0023	WR1	1	WIRELESS GATEWAY RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS/OUTPUTS, ETHERNET, RS485	WI-GTWY-9-ET1	WEIDMULLER
0030	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0031	SP1	1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	PU II 1	WEIDMULLER
0032		1	HOLDER, SURGE PROTECTION	PU II 1S	WEIDMULLER
0034		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0035		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0036		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0037		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0038		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0039		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0040		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0041	TST1	1	THERMOSTAT, DIN-RAIL MOUNT, 30-140F, HYSTERESIS +/-4F, 15A, 120VAC	SKT011419NO	HAMMOND
0042		1	OPTICAL ISOLATOR, RS-232 TO RS-422/485 CONVERTER	485LDRC9	B&B ELECTRONICS
0043	SP2	1	SURGE PROTECTION MODULE, 24VDC, IMAX:2KA, VMAX: 30V	DS210-24DC	CITEL
0044		1	HOLDER, SURGE PROTECTION	DS210-24DC	CITEL
0045	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3.6A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 10.0A, 250W	CP SNT 250W 24V 10A	WEIDMULLER
0046		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0047		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0048		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0049		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0050		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0051		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0052		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0053		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0054		1	FUSE, FAST ACTING FURRULE, 3A, 250VAC, 1/4"X1.25"	AGC-3	BUSSMANN
0060	LB1	1	UNMANAGED LAN BRIDGE, 5-PORT, 4W/ 10-35VDC, 6VA 10-24VAC, 32-140F, CLASS 1 DIV 2	IE-SW5-WAVE	WEIDMULLER
0061		1	POWER SUPPLY, 120/240VAC. 27VA, 50/60HZ, EXPANDED 3.3VDC	IC200PWR102E	GE FANUC
0062	CPU1	1	PLC CPU MODULE	CPUE05	GE FANUC
0063		1	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	IC200CHS002	GE FANUC
0064	MODULE 1	1	ANALOG MODULE, 4-CH, 12 BIT, VOLTAGE/CURRENT	IC200ALG230	GE FANUC
0065		1	BOX STYLE I/O CARRIER, AWG: 22-14, 2A/ POINT, 8A/ POWER OR GND, 264VAC MAX	IC200CHS002	GE FANUC
0066	MODULE 2	1	MIXED MODULE, 8-INPUT, 8-OUTPUT, 120VAC INPUT, RELAY OUTPUT	IC200MDD846	GE FANUC
0070		4	RELAY, 2PDT, COIL: 120VAC/ 9.2MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-AC120V	IDEC
0071		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0072		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0073		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0074		1	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0080		2	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PT 2X2-24DC-ST	PHOENIX
0081		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0082		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0090	DS1	1	DATA STATION PLUS, PROTOCOL CONVERTER, 24VDC@200MA, 1A MAX, W/ WEB SERVER & DATA LOGGER	DSPSX000	RED LION
0091		1	DATA STATION PLUS, RS-232/RS-485 ADD-ON MODULE	XCRS0000	RED LION
0092	SP5	1	SURGE PROTECTION MODULE, RS232/RS485, IMAX:20KA, VMAX: 8VDC, 1PAIR SHIELD	DLA-06D3	CITEL
0093		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-06D3	CITEL
0094	SP6	1	SURGE PROTECTION MODULE, RS232/RS485, IMAX:20KA, VMAX: 8VDC, 1PAIR SHIELD	DLA-06D3	CITEL
0095		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-06D3	CITEL
0100	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0101	REC2	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0110		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0111		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0112		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		7	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		12	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9009		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9010		40	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		10	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9013		34	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		5	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		17	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		47	END CLAMP, GRAY	E/UK	PHOENIX
9018		1	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	FBI 2-6	PHOENIX
9019		5	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9020		1	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

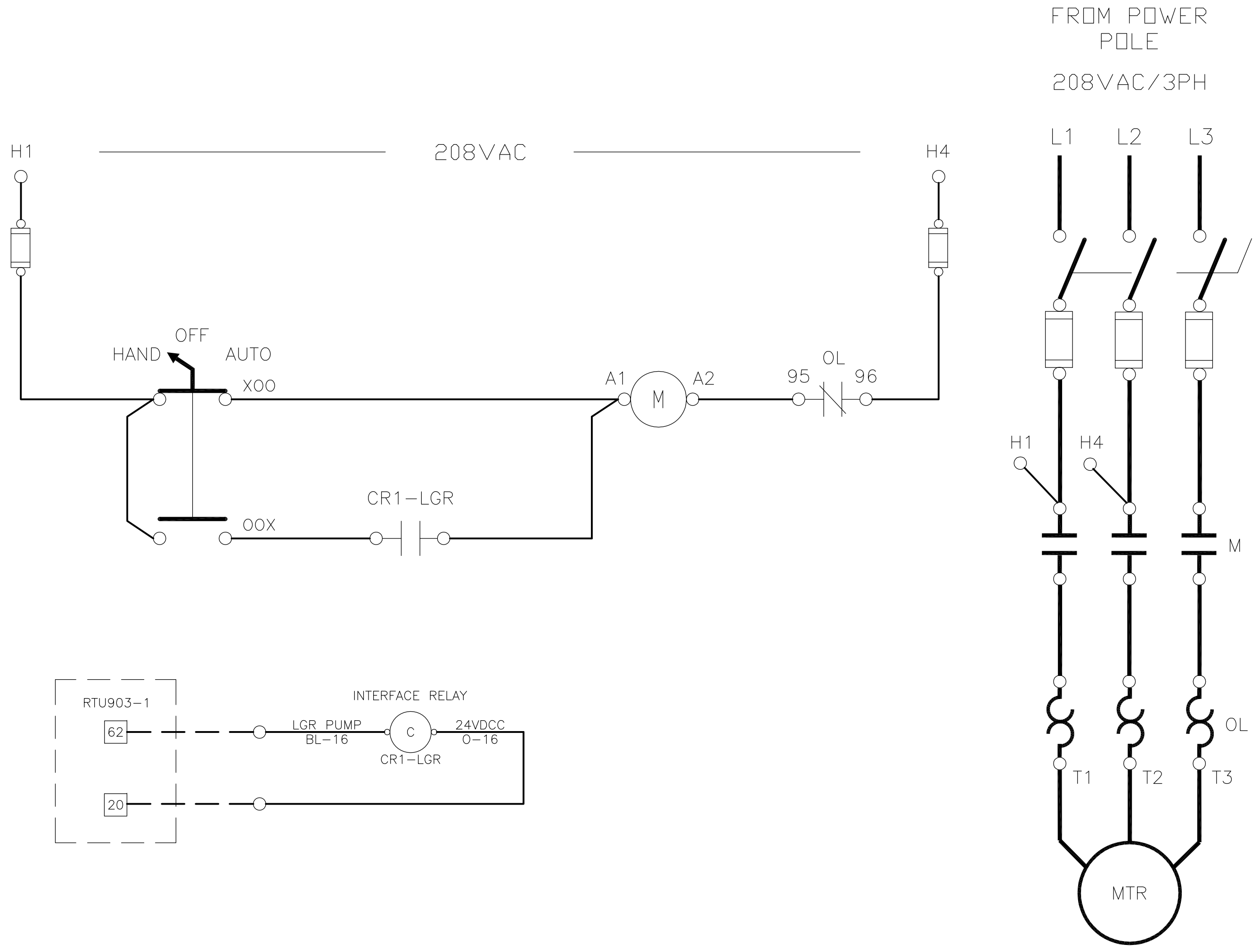
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

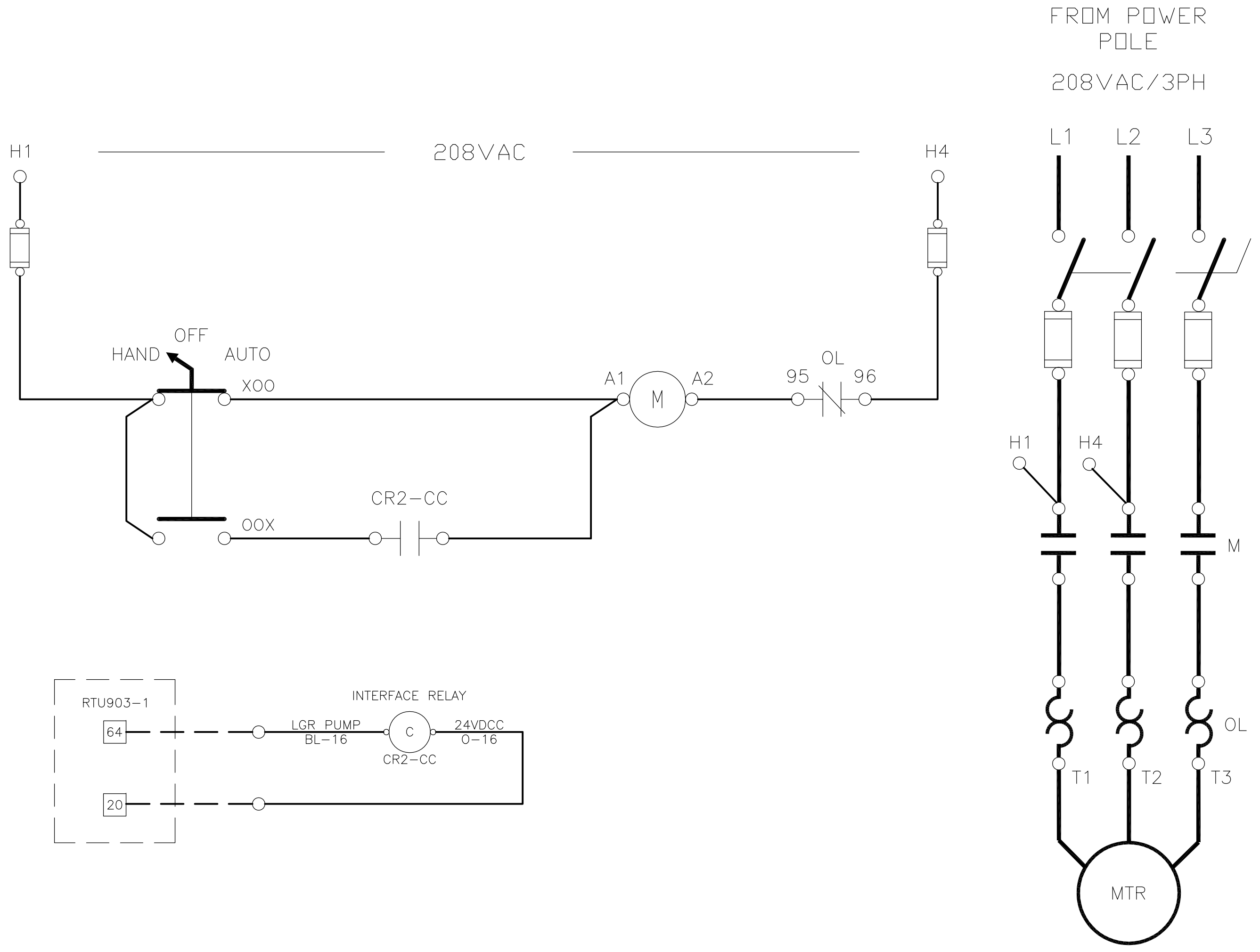
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-1
BILL OF MATERIALS

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 11 OF 12



CS-16 LGR WELL PUMP



CS-MW 16CC WELL PUMP

NOTE 1: DASHED LINES INDICATE FIELD WIRING

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

WIRE MARKER LEGEND
COLOR SIZE
Y-18

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
LGR / CC PUMP PANELS
LINE-TO-LINE
FIELD WIRING DIAGRAM

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-1
DWG. NO. 3079
SH 12 OF 12

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REMOTE RTU903-2

System Controls &
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1108 Quail Hollow
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Fax: 956-726-1774

TECL # 18461

April 29, 2010

Operating & Maintenance Manual

FOR

REMOTE RTU903-2

AT

Camp Stanley Storage Bioreactor Facility

Bldg. 903

Instrumentations & Controls

SCI FILE 3079

System Controls & Instrumentation, Ltd

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29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-2

Table of Contents

SCI FILE 3079

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TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-2

BILL OF MATERIAL

SCI FILE 3079

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BILL OF MATERIAL

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-2	1	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	CSD242410SS	HOFFMAN
0002	RTU903-2	1	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	CP2424	HOFFMAN
0003	PL1	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0004	PL1	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0005	PL2	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0006	PL2	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0007	PB1	1	PUSH BUTTON OPERATOR, METAL, 30.5MM, FLUSH HEAD, BLUE W/WHITE LETTERING, 1-NO / 1-NC	800T-A707WA	AB
0008	PB1	1	PUSH BUTTON LABEL, PLASTIC, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0010	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0011	SP1	1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	PU II 1	WEIDMULLER
0012		1	HOLDER, SURGE PROTECTION	PU II 1S	WEIDMULLER
0013		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0014		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0015	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	CP SNT 120W 24V 5A	WEIDMULLER
0016	WR1	1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WI-I/O 9-1	WEIDMULLER
0017	WR2	1	EXPANSION I/O MODULE, 10.8-30VDC, 16 I/O INPUT/OUTPUTS, DIN RAIL MOUNTING	WI-I/O-EX-S-11	WEIDMULLER
0018	SP3	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0020		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0021		1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	AGC-1	BUSSMANN
0022		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0023		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0024		4	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0025		4	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-DC24V	IDEC
0026		2	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0027		2	RELAY, 2PDT, COIL: 120VAC, 1/6HP, W/INDICATOR	RH2B-ULC-AC120V	IDEC
0028		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0029		1	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PT 2X2-24DC-ST	PHOENIX
0040	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0041		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0042		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		4	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		6	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9010		12	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		6	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9012		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9013		36	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		3	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		14	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		24	END CLAMP, GRAY	E/UK	PHOENIX
9018		2	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9019		4	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

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29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-2

PRODUCT DATA
OPERATION MANUAL

SCI FILE 3079

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CONCEPT® Wall-Mount Enclosures

CONCEPT®, Type 4X

Industry Standards

Mounting brackets required to meet UL/CSA external mounting requirements.

UL 508A Listed; Type 3R, 4, 4X, 12; File No. E61997
cUL Listed per CSA C22.2 No 94; Type 3R, 4, 4X, 12; File No. E61997

NEMA/EEMAC Type 3R, 4, 4X, 12, 13
CSA File No. 42186: Type 4, 4X, 12
VDE IP66
IEC 60529, IP66
Meets NEMA Type 3RX requirements

Application

For indoor or outdoor applications that require corrosion protection from chemicals and water. CONCEPT® Enclosures feature streamlined styling with an attractive stroked finish and flush quarter-turn latches for secure closure. Available in solid- and window-door models.

Specifications

- Manufactured from 16 and 14 gauge Type 304 or Type 316L stainless steel
- Minimum-width body flange provides maximum body opening
- External formed body flange trough
- Panel mounting studs fit optional CONCEPT panels and other accessories
- Mounting holes in back of body for direct mounting or for optional external mounting brackets
- Type 304 stainless steel hidden hinges promote clean aesthetic appearance
- Doors are interchangeable and easily removed by pulling clip-style hinge pins
- Provision on door (except window-door style and when B = 12 in.) for thermoplastic data pocket
- Provision on door (except window-door style and when B = 12 in.) for optional doorstop kit
- Quarter-turn latches furnished with flush slotted insert
- Seamless foam-in-place gasket
- Self-grounding latch system with double seal
- Bonding provision on door; grounding stud on body
- Furnished hardware kit consists of panel-mounting nuts, panel-grounding hardware and sealing washers for wall-mounting holes
- Installation instructions
- Window doors have a clear polycarbonate window

Finish

Door and body have smooth #4 brushed finish.

Patents

This product is covered by the following patents:
US 360,345
DE 9405854.7
US 5,509,703
US 5,666,695
Other patents pending.

Accessories

See also Accessories.
Type 316 Stainless Steel Door Stop Kit
CONCEPT® Panels
H_2OMIT™ Vent Drains, Type 4X
H_2OMIT™ Thermoelectric Dehumidifier
Handles
Lock Inserts

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

Bulletin: CWS

CONCEPT® Wall-Mount Enclosures

Standard Product **One-Door**

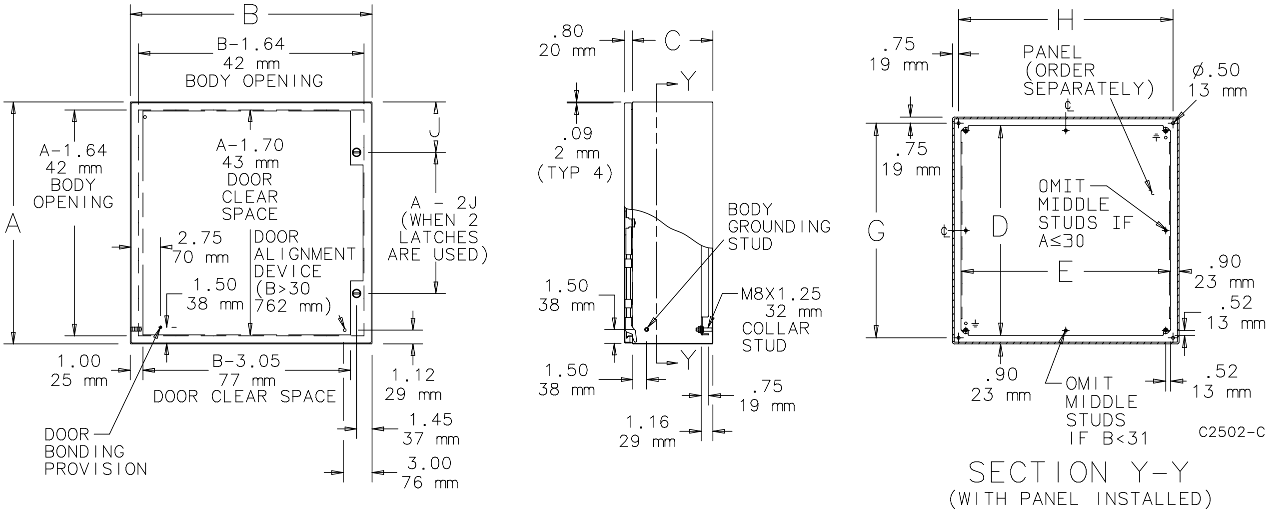
Catalog Number	AxBxC in.	AxBxC mm	Door Gauge	Body Gauge	Panel	Conductive Panel	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Latches Qty.	Style	J (in.)	J (mm)
CSD12126SS	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	Quarter-turn	6.00	152
CSD12126SS6	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	Quarter-turn	6.00	152
CSD16126SS	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16126SS6	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16166SS	16.00 x 16.00 x 6.00	406 x 406 x 152	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16166SS6	16.00 x 16.00 x 6.00	406 x 406 x 152	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD20166SS	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20166SS6	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20206SS	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD20206SS6	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD16128SS	16.00 x 12.00 x 8.00	406 x 305 x 203	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16128SS6	16.00 x 12.00 x 8.00	406 x 305 x 203	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16168SS	16.00 x 16.00 x 8.00	406 x 406 x 203	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16168SS6	16.00 x 16.00 x 8.00	406 x 406 x 203	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16208SS	16.00 x 20.00 x 8.00	406 x 508 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD16208SS6	16.00 x 20.00 x 8.00	406 x 508 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD20168SS	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20168SS6	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20208SS	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD20208SS6	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD24168SS	24.00 x 16.00 x 8.00	610 x 406 x 203	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD24168SS6	24.00 x 16.00 x 8.00	610 x 406 x 203	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD24208SS	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD24208SS6	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD24248SS	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD24248SS6	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD30248SS	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD30248SS6	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD30308SS	30.00 x 30.00 x 8.00	762 x 762 x 203	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD30308SS6	30.00 x 30.00 x 8.00	762 x 762 x 203	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD36248SS	36.00 x 24.00 x 8.00	914 x 610 x 203	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD36248SS6	36.00 x 24.00 x 8.00	914 x 610 x 203	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD36308SS	36.00 x 30.00 x 8.00	914 x 762 x 203	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD36308SS6	36.00 x 30.00 x 8.00	914 x 762 x 203	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD161210SS	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD161210SS6	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD161610SS	16.00 x 16.00 x 10.00	406 x 406 x 254	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD161610SS6	16.00 x 16.00 x 10.00	406 x 406 x 254	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD162010SS	16.00 x 20.00 x 10.00	406 x 508 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD162010SS6	16.00 x 20.00 x 10.00	406 x 508 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD201610SS	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD201610SS6	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD202010SS	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202010SS6	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202410SS	20.00 x 24.00 x 10.00	508 x 610 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	464 x 462	18.50 x 22.50	470 x 572	1	Quarter-turn	10.00	254
CSD202410SS6	20.00 x 24.00 x 10.00	508 x 610 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	464 x 462	18.50 x 22.50	470 x 572	1	Quarter-turn	10.00	254
CSD241610SS	24.00 x 16.00 x 10.00	610 x 406 x 254	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD241610SS6	24.00 x 16.00 x 10.00	610 x 406 x 254	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD242010SS	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD242010SS6	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD242410SS	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD242410SS6	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD243010SS	24.00 x 30.00 x 10.00	610 x 762 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	22.50 x 28.50	572 x 724	2	Quarter-turn	5.00	127
CSD243010SS6	24.00 x 30.00 x 10.00	610 x 762 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	22.50 x 28.50	572 x 724	2	Quarter-turn	5.00	127
CSD302010SS	30.00 x 20.00 x 10.00	762 x 508 x 254	14	16	CP3020	CP3020G	28.20 x 18.20	716 x 462	28.50 x 18.50	724 x 470	2	Quarter-turn	5.00	127
CSD302010SS6	30.00 x 20.00 x 10.00	762 x 508 x 254	14	16	CP3020	CP3020G	28.20 x 18.20	716 x 462	28.50 x 18.50	724 x 470	2	Quarter-turn	5.00	127
CSD302410SS	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD302410SS6	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD303010SS	30.00 x 30.00 x 10.00	762 x 762 x 254	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD303010SS6	30.00 x 30.00 x 10.00	762 x 762 x 254	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD362410SS	36.00 x 24.00 x 10.00	914 x 610 x 254	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD362410SS6	36.00 x 24.00 x 10.00	914 x 610 x 254	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD363010SS	36.00 x 30.00 x 10.00	914 x 762 x 254	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD363010SS6	36.00 x 30.00 x 10.00	914 x 762 x 254	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD482410SS	48.00 x 24.00 x 10.00	1220 x 610 x 254	14	14	CP4824	CP4824G	46.20 x 22.20	1173 x 564	46.50 x 22.50	1181 x 572	1	3-point	24.00	610
CSD482410SS6	48.00 x 24.00 x 10.00	1220 x 610 x 254	14	14	CP4824	CP4824G	46.20 x 22.20	1173 x 564	46.50 x 22.50	1181 x 572	1	3-point	24.00	610
CSD202012SS	20.00 x 20.00 x 12.00	508 x 508 x 305	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202012SS6	20.00 x 20.00 x 12.00	508 x 508 x 305	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD242412SS	24.00 x 24.00 x 12.00	610 x 610 x 305	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD242412SS6	24.00 x 24.00 x 12.00	610 x 610 x 305	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD302412SS	30.00 x 24.00 x 12.00	762 x 610 x 305	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD302412SS6	30.00 x 24.00 x 12.00	762 x 610 x 305	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD362412SS	36.00 x 24.00 x 12.00	914 x 610 x 305	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD362412SS6	36.00 x 24.00 x 12.00	914 x 610 x 305	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD363012SS	36.00 x 30.00 x 12.00	914 x 762 x 305	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD363012SS6	36.00 x 30.00 x 12.00	914 x 762 x 305	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127

Catalog numbers ending in 6 are Type 316L stainless steel.

Purchase panels separately. Optional stainless steel, composite and aluminum panels are also available for most sizes.

Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.

CONCEPT® Wall-Mount Enclosures



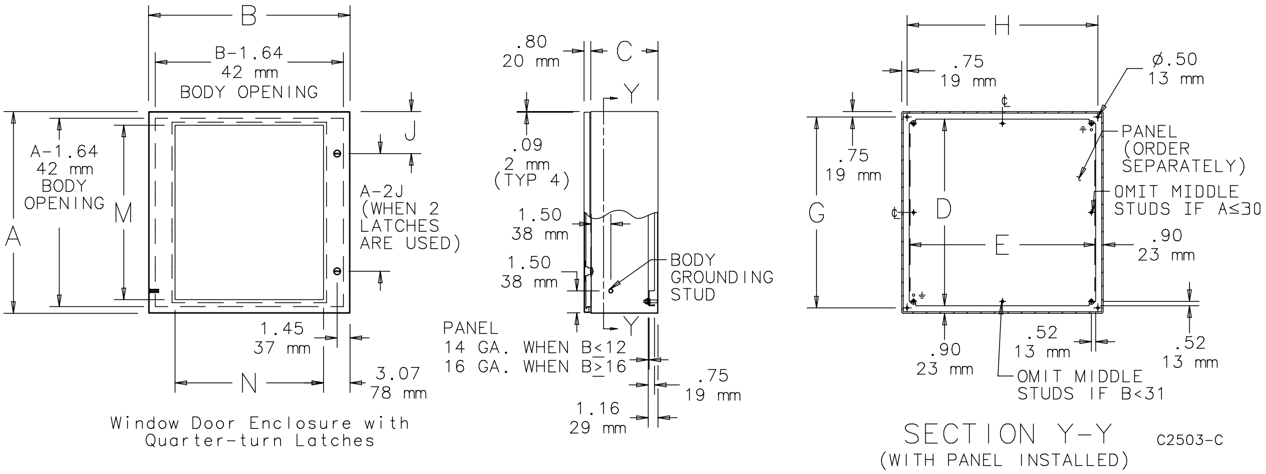
CONCEPT® Wall-Mount Enclosures

Standard Product **One-Door with Window**

Catalog Number	AxBxC in.	AxBxC mm	Door Ga.	Body Ga.	Panel	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Window Size M x N (in.)	Window Size M x N (mm)	Latch Qty.	Style	J (in.)	J (mm)
CSD12126WSS	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	8.74 x 7.10	222 x 180	1	Quarter-turn	6.00	152
CSD16126WSS	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	12.74 x 7.10	324 x 180	1	Quarter-turn	8.00	203
CSD20166WSS	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD20206WSS	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD20168WSS	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD20208WSS	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD24208WSS	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	20.74 x 15.10	527 x 384	1	Quarter-turn	12.00	305
CSD24248WSS	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	20.74 x 17.68	527 x 449	2	Quarter-turn	5.00	127
CSD30248WSS	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127
CSD161210WSS	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	12.74 x 7.10	324 x 180	1	Quarter-turn	8.00	203
CSD201610WSS	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD202010WSS	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD242010WSS	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	20.74 x 15.10	527 x 384	1	Quarter-turn	12.00	305
CSD242410WSS	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	20.74 x 17.68	527 x 449	2	Quarter-turn	5.00	127
CSD302410WSS	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127
CSD202012WSS	20.00 x 20.00 x 12.00	508 x 508 x 305	14	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD302412WSS	30.00 x 24.00 x 12.00	762 x 610 x 305	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127

Purchase panels separately.
Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.
Material is stainless steel Type 304.
For Conductive Panels, add a "G" to the panel catalog number.

CONCEPT Single-Door Wall-Mounted Enclosures with Windows

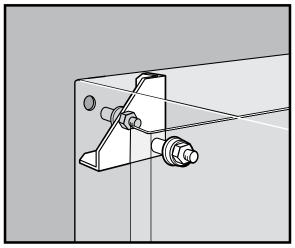


Window Door Enclosure with Quarter-turn Latches

SECTION Y-Y
(WITH PANEL INSTALLED)

CONCEPT® Accessories

CONCEPT® Panel Conversion Kit



Panel Conversion Kit adapts enclosure for mounting standard NEMA-style panels in CONCEPT® enclosures. Bracket attaches to rear collar stud. Kit includes four adapter plates and hardware for mounting panel.

Bulletin: CWY

Catalog Number	Material	Fits CONCEPT Enclosure
CCPM4	Steel	When A x B is equal to or less than 30.00 x 30.00 in. (762 x 762 mm)

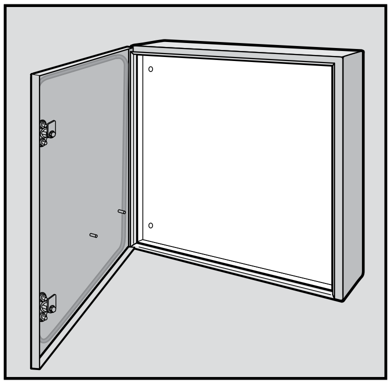
Swing-Out Rack Frame

Swing-Out Rack Frames provide 120-degree swing-out access for 19-in. rack equipment. Welded rack frame mounts to front flange. Distance from frame to door surface is 1.32 in. (33 mm) for solid doors and 1.07 in. (27 mm) for window doors. Frame is painted steel ANSI 61 gray. Mounting hinge and latching hardware provided.
Order separately clip nut package catalog number XNM5 and screws XSM5 (metric) or AN1032 and screws AS1032 (English).
Swing-Out Rack Frame cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Material	Fits Enclosure A x B
CSF2424	Painted steel	24.00 x 24.00 in. (610 x 610 mm)
CSF3024	Painted steel	30.00 x 24.00 in. (762 x 610 mm)
CSF3624	Painted steel	36.00 x 24.00 in. (914 x 610 mm)

Dead Front Kits



Dead Front Kits provide a NEMA Type 1 safety barrier and mounting surface close to the front of the enclosure. Enables convenient mounting of equipment while controlling access to the interior of the enclosure. The depth from the mounting surface to the door is 1.33 in. (34 mm) for solid doors and 1.15 in. (29 mm) for window doors. Kit includes mounting brackets, grounding hardware and a steel panel painted ANSI 61 gray.
Dead Front Kit cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure A x B
CDF1212	12.00 x 12.00 in. (305 x 305 mm)
CDF1612	16.00 x 12.00 in. (406 x 305 mm)
CDF2016	20.00 x 16.00 in. (508 x 406 mm)
CDF2020	20.00 x 20.00 in. (508 x 508 mm)
CDF2420	24.00 x 20.00 in. (610 x 508 mm)
CDF2424	24.00 x 24.00 in. (610 x 610 mm)
CDF3024	30.00 x 24.00 in. (762 x 610 mm)

CONCEPT® Adjustable-Depth Mounting Kits

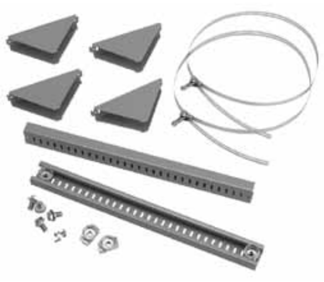
Adjustable-Depth Mounting Kits provide mounting means for installing panels, swing-out panels, DIN rails, rack angles, mounting channels or grid straps at any depth from front to rear of enclosure. Kits include slide mechanisms and hardware. Use two kits when enclosure has 6 collar studs for mounting panel.
Dead Front Panel and Swing-Out Rack Frame cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure (in.)	Fits CONCEPT Enclosure (mm)
CAM64	when C = 6.00	when C = 152
CAM82	when C = 8.00	when C = 203
CAM84	when C = 8.00	when C = 203
CAM102	when C = 10.00	when C = 254
CAM104	when C = 10.00	when C = 254
CAM122	when C = 12.00	when C = 305
CAM124	when C = 12.00	when C = 305
CAM162	when C = 16.00	when C = 406
CAM164	when C = 16.00	when C = 406
CAM202	when C = 20.00	when C = 508
CAM204	when C = 20.00	when C = 508

CONCEPT® Accessories

Pole-Mount Kit

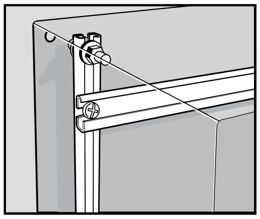


Use to mount CONCEPT®, Networking and wall-mount enclosures to poles of various sizes and shapes. Simply attach the plated steel channel bar to the mounting holes at the back of the enclosure and wrap the stainless steel strap around the pole and through the bar. Kit includes two mounting channels, two straps suitable for 3-in. (76-mm) to 12-in. (30-mm) diameter pole and mounting hardware.

Bulletin: CWY

Catalog Number	Fits Enclosure (in.)	Fits Enclosure (mm)
CPMK12	when B = 12.00	when B = 305
CPMK16	when B = 16.00	when B = 406
CPMK20	when B = 20.00	when B = 508
CPMK24	when B = 24.00	when B = 610
CPMK30	when B = 30.00	when B = 762

Mounting Channels

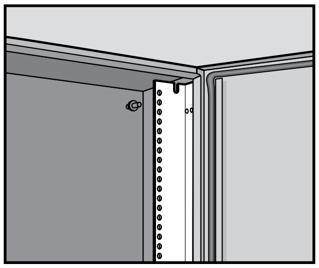


Mounting Channels provide mounting framework for installing DIN rails and grid straps at various positions within the enclosure. Channels can be mounted vertically or horizontally to collar studs or to the slide mechanisms of the adjustable-depth mounting kit. Kit includes two channels.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CMC12	when A or B = 12.00 in. (305 mm)
CMC16	when A or B = 16.00 in. (406 mm)
CMC20	when A or B = 20.00 in. (508 mm)
CMC24	when A or B = 24.00 in. (610 mm)
CMC30	when A or B = 30.00 in. (762 mm)
CMC36	when A or B = 36.00 in. (914 mm)
CMC42	when A or B = 42.00 in. (1067 mm)
CMC48	when A or B = 48.00 in. (1219 mm)
CMC60	when A or B = 60.00 in. (1524 mm)

Rack-Mount Angles



Rack-Mount Angles are a mounting means for 19-in. rack equipment in 24-in. wide enclosures. L-shaped through-hole angles attach to enclosure flange or the adjustable-depth mounting kit. Holes are .281 in. (7 mm) in diameter. Clear plated 14 gauge steel construction. Mounting hardware included.

Order separately clip nut package catalog number XNM5 and screws XSM5 (metric) or AN1032 and screws AS1032 (English).

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure	Rack Units
CRA10TH	when A = 20.00 in. (508 mm)	10
CRA12TH	when A = 24.00 in. (610 mm)	12
CRA16TH	when A = 30.00 in. (762 mm)	16
CRA19TH	when A = 36.00 in. (914 mm)	19
CRA26TH	when A = 48.00 in. (1219 mm)	26

DIN3 Rail Kits

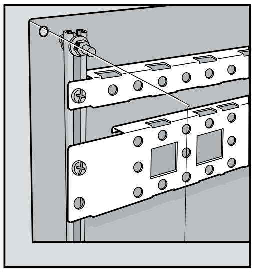
DIN3 Rail Kits supply mounting surfaces for DIN mount snap-on devices in either DIN 1, DIN 3 or CENELEC styles. Rails attach vertically or horizontally to rear collar stud or to mounting channels. Kit includes three rails and mounting hardware.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CDR3P12	when A or B = 12.00 in. (305 mm)
CDR3P16	when A or B = 16.00 in. (406 mm)
CDR3P20	when A or B = 20.00 in. (508 mm)
CDR3P24	when A or B = 24.00 in. (610 mm)

CONCEPT® Accessories

Grid Straps



Grid Straps provide flexible mounting inside the enclosure. Available in one-hole or three-hole widths. Straps mount vertically or horizontally on rear collar studs or to mounting channels in any front-to-back position. Two straps and mounting hardware included in kit. (Order separate grid fastener package catalog number XGFM6, consisting of 20 metric M6 clip nuts and 20 metric M6 Phillips washer head bolts, for mounting equipment to grid straps.)

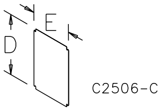
Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CGS112	when A or B = 12.00 in. (305 mm)
CGS116	when A or B = 16.00 in. (406 mm)
CGS120	when A or B = 20.00 in. (508 mm)
CGS124	when A or B = 24.00 in. (610 mm)
CGS130	when A or B = 30.00 in. (762 mm)
CGS336	when A or B = 36.00 in. (914 mm)
CGS348	when A or B = 48.00 in. (1219 mm)

CONCEPT® Panels

These panels are taller and wider than corresponding NEMA-size panels. Panels are 14 or 12 gauge steel and painted white or have a conductive finish.
Panels have a formed flange along any side that is longer than 22.20 in. (564 mm). CP2420 and CP2424 have a flange on all four sides.

Bulletin: CWP



Catalog Number	Panel Type	Panel Size D x E (in.)	Panel Size D x E (mm)	Gauge
CP1212	Painted steel	10.20 x 10.20	259 x 259	14
CP1212G	Conductive	10.20 x 10.20	259 x 259	14
CP1612	Painted steel	14.20 x 10.20	361 x 259	14
CP1612G	Conductive	14.20 x 10.20	361 x 259	14
CP1616	Painted steel	14.20 x 14.20	361 x 361	12
CP1616G	Conductive	14.20 x 14.20	361 x 361	12
CP2016	Painted steel	18.20 x 14.20	462 x 361	12
CP2014	Painted steel	18.20 x 12.20	462 x 310	14
CP2016G	Conductive	18.20 x 14.20	462 x 361	12
CP2416	Painted steel	22.20 x 14.20	564 x 361	12
CP2416G	Conductive	22.20 x 14.20	564 x 361	12
CP2020	Painted steel	18.20 x 18.20	462 x 462	12
CP2020G	Conductive	18.20 x 18.20	462 x 462	12
CP2420	Painted steel	22.20 x 18.20	564 x 462	12
CP2420G	Conductive	22.20 x 18.20	564 x 462	12
CP3020	Painted steel	28.20 x 18.20	716 x 462	12
CP3020G	Conductive	28.20 x 18.20	716 x 462	12
CP2424	Painted steel	22.20 x 22.20	564 x 564	12
CP2424G	Conductive	22.20 x 22.20	564 x 564	12
CP3024	Painted steel	28.20 x 22.20	716 x 564	12
CP3024G	Conductive	28.20 x 22.20	716 x 564	12
CP3624	Painted steel	34.20 x 22.20	869 x 564	12
CP3624G	Conductive	34.20 x 22.20	869 x 564	12
CP4824	Painted steel	46.20 x 22.20	1173 x 564	12
CP4824G	Conductive	46.20 x 22.20	1173 x 564	12
CP3030	Painted steel	28.20 x 28.20	716 x 716	12
CP3030G	Conductive	28.20 x 28.20	716 x 716	12
CP3630	Painted steel	34.20 x 28.20	869 x 716	12
CP3630G	Conductive	34.20 x 28.20	869 x 716	12
CP4230	Painted steel	40.20 x 28.20	1021 x 716	12
CP4230G	Conductive	40.20 x 28.20	1021 x 716	12
CP3636	Painted steel	34.20 x 34.20	869 x 869	12
CP3636G	Conductive	34.20 x 34.20	869 x 869	12
CP4236	Painted steel	40.20 x 34.20	1021 x 869	12
CP4236G	Conductive	40.20 x 34.20	1021 x 869	12
CP4836	Painted steel	46.20 x 34.20	1173 x 869	12
CP4836G	Conductive	46.20 x 34.20	1173 x 869	12
CP6036	Painted steel	58.20 x 34.20	1478 x 869	12
CP6036G	Conductive	58.20 x 34.20	1478 x 869	12
CP2442	Painted steel	22.20 x 40.20	564 x 1021	12
CP2442G	Conductive	22.20 x 40.20	564 x 1021	12
CP3048	Painted steel	28.20 x 46.20	716 x 1173	12
CP3048G	Conductive	28.20 x 46.20	716 x 1173	12
CP3060	Painted steel	28.20 x 58.20	716 x 1478	12
CP3060G	Conductive	28.20 x 58.20	716 x 1478	12

Catalog number CP4230 is used on CONCEPT disconnect enclosures.

CONCEPT® Accessories

CONCEPT® Swing-Out Panels

CSPB panels

CSP panels

Panels swing clear from the front of the enclosure to provide access to mounted internal equipment. For CSPB panels, maximum swing is 94 degrees. For CSP panels, maximum panel swing is 106 degrees. Distance from panel surface to door when in the latched position is 1.71 in. (43 mm) for solid doors and 1.45 in. (37 mm) for window doors. Kits include panel, brackets and hardware to mount to the front flange.

Swing-out panels also can be mounted on front-to-back adjustable rails. CSPB panels require adapter CSPBADB and front-to-back adjustable rails for front-to-back adjustment.

Bulletin: CWY

CSPB Panels

Catalog Number	Fits Enclosure Size (in.)	Fits Enclosure Size (mm)	Panel Size (in.)	Panel Size (mm)
CSPB1212	12.00 x 12.00	305 x 305	9.72 x 9.75	247 x 248
CSPB1612	16.00 x 12.00	406 x 305	13.72 x 9.75	349 x 248
CSPB1616	16.00 x 16.00	406 x 406	13.72 x 13.75	349 x 349
CSPB1620	16.00 x 20.00	406 x 508	13.72 x 17.75	349 x 451
CSPB2016	20.00 x 16.00	508 x 406	17.72 x 13.75	450 x 349
CSPB2020	20.00 x 20.00	508 x 508	17.72 x 17.75	450 x 451
CSPB2024	20.00 x 24.00	508 x 610	17.72 x 21.75	450 x 553
CSPB2416	24.00 x 16.00	610 x 406	21.72 x 13.73	552 x 349
CSPB2420	24.00 x 20.00	610 x 508	21.72 x 17.75	552.452
CSPB2424	24.00 x 24.00	610 x 610	21.72 x 21.75	552 x 553
CSPB2430	24.00 x 30.00	610 x 762	21.72 x 27.75	552 x 705
CSPB3020	30.00 x 20.00	762 x 508	27.72 x 17.75	704 x 451
CSPB3024	30.00 x 24.00	762 x 610	27.72 x 21.75	704 x 553
CSPB3030	30.00 x 30.00	762 x 762	27.72 x 27.75	704 x 705
CSPB3624	36.00 x 24.00	914 x 610	33.72 x 21.75	857 x 553
CSPB3630	36.00 x 30.00	914 x 762	33.72 x 27.75	857 x 705
CSPB3636	36.00 x 36.00	914 x 914	33.72 x 33.75	857 x 857
CSPB4236	42.00 x 36.00	1067 x 914	39.72 x 33.75	1009 x 857
CSPB4824	48.00 x 24.00	1219 x 610	45.72 x 21.75	1161 x 553
CSPB4836	48.00 x 36.00	1219 x 914	45.72 x 33.75	1161 x 857
CSPB6036	60.00 x 36.00	1542 x 914	57.72 x 33.75	1466 x 857

CSP Panels

Catalog Number	Fits Enclosure (in.)	Fits Enclosure (mm)	Panel Size (in.)	Panel Size (mm)
CSP1212	12.00 x 12.00	305 x 305	9.78 x 9.84	248 x 250
CSP1612	16.00 x 12.00	406 x 305	13.78 x 9.84	350 x 250
CSP1616	16.00 x 16.00	406 x 406	13.78 x 13.84	350 x 352
CSP1620	16.00 x 20.00	406 x 508	13.78 x 17.84	350 x 453
CSP2016	20.00 x 16.00	508 x 406	17.78 x 13.84	452 x 352
CSP2020	20.00 x 20.00	508 x 508	17.78 x 17.84	452 x 453
CSP2024	20.00 x 24.00	508 x 610	17.78 x 21.84	452 x 555
CSP2416	24.00 x 16.00	610 x 406	21.78 x 13.84	553 x 352
CSP2420	24.00 x 20.00	610 x 508	21.78 x 17.84	553 x 453
CSP2424	24.00 x 24.00	610 x 610	21.78 x 21.84	553 x 555
CSP3020	30.00 x 20.00	762 x 508	27.78 x 17.84	706 x 453
CSP3024	30.00 x 24.00	762 x 610	27.78 x 21.84	706 x 555
CSP3030	30.00 x 30.00	762 x 762	27.78 x 27.84	706 x 707
CSP3624	36.00 x 24.00	914 x 610	33.78 x 21.84	858 x 555
CSP3630	36.00 x 30.00	914 x 762	33.78 x 27.84	858 x 707
CSP3636	36.00 x 36.00	914 x 914	33.78 x 33.84	858 x 860

CONCEPT® Adapter Bracket

Adapter bracket for use with CONCEPT® B-style Swing-Out Panels and Adjustable-Depth Mounting Kits. Bracket enables the B-style swing-out panels to be mounted in infinite front-to-back positions within a CONCEPT enclosure.

Bulletin: CWY

Catalog Number	Material
CSPBADB	Steel

Handles

Handles can replace the standard slotted insert on all CONCEPT® wall-mount enclosures. The CONCEPT non-locking handle provides quick and easy access to the enclosure contents. Handle is black plastic. A zinc die-cast keylock handle is available for applications requiring quick access and security. A padlocking handle, also zinc die-cast, accommodates a padlock with up to a 5/16-in. locking bar. Each latch system can be converted from clockwise to counter-clockwise opening. Kit includes all hardware.

Patents:
US 360,345,
DE M9405854.7.

Bulletin: CWY

Catalog Number	UL Rating	Description
CWHK	Maintains UL/CSA Type 12 when properly installed	Keylock handle
CWHNL	Maintains UL Type 3, 4, 4X, 12 when properly installed	Non-locking handle
CWHPTO	Maintains UL/CSA Type 3, 4, 12 when properly installed	Padlock handle

CWHNL is not suitable for 3-point latch operation.

CONCEPT® Accessories

Door Stop Kit

Door Stop Kit secures the door in the open position. Kit can be installed at the top or bottom of a door which opens horizontally. Door opening angle can be easily adjusted by means of a wing nut. Stop arm slides neatly out of the way when the door is closed. All parts are plated. Mounting hardware included.

- *Door stop kits should not be installed on enclosures configured with a swing-out panel or swing-out rack frame*
- *Door stop kits cannot be used with CONCEPT window doors*

Bulletin: A80

Catalog Number	Finish
ADSTOPK	Plated Steel

Data Pockets

Data Pockets provide convenient storage for wiring diagrams, operation manuals and other documentation inside an enclosure. Pocket mounts on studs located on the inside of a solid-door enclosure. Constructed of high-impact thermoplastic, pockets are dark gray and have cutout areas for easy access and visibility to contents. Mounting hardware included.

Bulletin: UX1Y

Catalog Number	Length x Width in./mm	Fits CONCEPT Enclosure
ADP1	6.00 x 6.00 152 x 152	when A is less than or equal to 24 and B is less than or equal to 24
ADP2	12.00 x 12.00 305 x 305	when A is greater than or equal to 30 and B is greater than or equal to 20

Use ADP2 when A = 24 and B = 30

Lock Inserts

Lock inserts can be substituted for the standard slot/screwdriver insert latch. Inserts have a chrome finish. Matching key is zinc die-cast.

Bulletin: CWY

Catalog Number	Description
CLKTM7	Triangular 7-mm insert with key
CLKSM7	Square 7-mm insert with key
CLKDBM3	Double bit with key

Mounting-Bracket Kits

Mounting-Bracket Kits are field installable. Composite and stainless steel brackets are rated to Type 4X. Set of four (4) brackets can support 500 lb. maximum load. All hardware is included. Four brackets per kit.

Mounting brackets are required to maintain UL/CSA external mounting requirement.

Bulletin: A80

Catalog Number	Description
CMFK	Steel
CMFKSS	Stainless Steel
CMTGFT	Composite

CONCEPT® Accessories

Hinge Pins

Contact Customer Service to order new mild steel hinge pins for an existing product.

Bulletin: VM3

Catalog Number	Description	Qty.
GHPINMS	Hinge Pin	2

Door Bars

Non-metallic door bar includes pressure-sensitive adhesive. Contact Customer Service to order new door bars for an existing product.

Bulletin: CWY

Catalog Number	Description	Length	Qty.
ADB305MM	Door Bar	8 in. (203 mm)	4

Momentary Contact Push Button Units, Illuminated

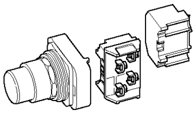
Extended Head Without Guard
Cat. No. 800T-PB16R

Extended Head without Guard
Cat. No. 800H-PRB16R

				Type 4/13		Type 4/4X/13	
				Extended Head Without Guard∗	Extended Head With Guard∗	Extended Head without Guard∗	Extended Head with Guard∗
Type	Lamp Type	Volts	Color	Cat. No.	Cat. No.	Cat. No.	Cat. No.
Operator Only†				800T-SB00XX	800T-SA00XX	800H-SRB00XX	800H-SRA00XX
Full Voltage	Incandescent	24V AC/DC	Red	800T-QB24R	800T-QA24R	800H-QRB24R	800H-QRA24R
			Green	800T-QB24G	800T-QA24G	800H-QRB24G	800H-QRA24G
			Amber	800T-QB24A	800T-QA24A	800H-QRB24A	800H-QRA24A
	LED	120V AC	Red	800T-QBH10R	800T-QAH10R	800H-QRBH10R	800H-QRAH10R
			Green	800T-QBH10G	800T-QAH10G	800H-QRBH10G	800H-QRAH10G
			Amber	800T-QBH10A	800T-QAH10A	800H-QRBH10A	800H-QRAH10A
		24V AC/DC	Red	800T-QBH24R	800T-QAH24R	800H-QRBH24R	800H-QRAH24R
			Green	800T-QBH24G	800T-QAH24G	800H-QRBH24G	800H-QRAH24G
			Amber	800T-QBH24A	800T-QAH24A	800H-QRBH24A	800H-QRAH24A
	No Lamp	0…250V AC/DC	No Lens	800T-QBN25	800T-QAN25	800H-QRBN25	800H-QRAN25
Transformer	Incandescent	120V AC 50/60 Hz	Red	800T-PB16R	800T-PA16R	800H-PRB16R	800H-PRA16R
			Green	800T-PB16G	800T-PA16G	800H-PRB16G	800H-PRA16G
			Amber	800T-PB16A	800T-PA16A	800H-PRB16A	800H-PRA16A
	LED		Red	800T-PBH16R	800T-PAH16R	800H-PRBH16R	800H-PRAH16R
			Green	800T-PBH16G	800T-PAH16G	800H-PRBH16G	800H-PRAH16G
			Amber	800T-PBH16A	800T-PAH16A	800H-PRBH16A	800H-PRAH16A
	No Lamp		No Lens	800T-PBN16	800T-PAN16	800H-PRBN16	800H-PRAN16

∗ Includes as standard one 800T-XA (1 N.O. - 1 N.C.) contact block.
† Operator only supplied without power module, lamp, lens cap, or contact blocks.

800	T		– P	B	H	16	R	
	a	b	c	d	e	f	g	h



a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Power Module Type		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
P	Transformer (or Dual Input)	PR
Q	Full Voltage (or Resistor)	QR
R	Neon∗	RR

d

Head Type	
Code	Description
A	Extended Head with Guard
B	Extended Head without Guard
M	Mushroom
MJ	Jumbo Mushroom

e

Illumination Options	
Transformer/Full Voltage	
Code	Description
Blank	Incandescent
H	LED†
Resistor/Neon	
Blank	No Options
Dual Input	
D	Diode Type‡
DH	Diode Type LED†‡
T	Transformer — Relay Type
TH	Transformer — Relay Type LED†

f

Voltage	
Transformer	
Code	Description
36	48V AC 50/60 Hz
16	120V AC 50/60 Hz
26	240V AC 50/60 Hz
76	277V AC 50/60 Hz
46	480V AC 50/60 Hz
56	600V AC 50/60 Hz
Full Voltage	
06	6V AC/DC
12	12V AC/DC
24	24V AC/DC
32	32V AC/DC§
48	48V AC/DC
10	120V AC/DC♣
13	130V AC/DC§
20	240V AC/DC§
Resistor	
11	120V AC/DC Resistor

f (cont'd)

Neon	
Code	Description
10	120V AC/DC
20	240V AC/DC
Dual Input	
16	120V AC
24	24V AC/DC➤

g

Lens Color	
Code	Description
Blank	No Lens with standard contacts 1 N.O. - 1 N.C.
X	No Lens if ordering any contacts other than standard 1 N.O. - 1 N.C.
A	Amber
B	Blue
C	Clear
G	Green
R	Red
W	White

h

Contact Block(s)	
Code	Description
X	No Contacts
Standard	
Blank	1 N.O. - 1 N.C.
D1	1 N.O.
Pen*TUFF* (Low Voltage)	
AV	1 N.O. - 1 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C.
Sealed Switch	
AP	1 N.O. - 1 N.C.
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C.

∗ Neon is only available in amber or clear.
† LEDs available in red, green, amber, blue, and white. White LEDs only in 6/24/120/130V and all transformer units. LED color matches lens color, except clear lens supplied with white LED and white lens with amber LED. All LEDs except 120V, have an internal shunt resistor for use with solid-state outputs.
‡ Diode type dual input provides circuit isolation via opposing diodes. Not recommended for use with solid-state outputs and neon indicators.
§ 32V and 130V are LED only. 240V is incandescent only.
♣ 120V LED is AC only and does not contain internal shunt resistor. For AC/DC and internal shunt resistor, order 130V AC/DC LED (Code 13).
➤ Dual input diode only.

Product Data Sheet

QOU115

MINIATURE CIRCUIT BREAKER 120/240V 15A

List Price	$40.20 USD
Availability	**Stock Item:** This item is normally stocked in our distribution facility.

Technical Characteristics

Wire Size	#14-2 AWG(Al/Cu)
Depth	2.98 Inches
Height	4.05 Inches
Number of Poles	1-Pole
Switching Duty Rated	Yes
Short Circuit Current Rating	5kA@277VAC - 10kA@120/240VAC
Type	QOU
Marketing Trade Name	QOU
Mounting Type	Flush, Surface or DIN Rail (35mm)
Voltage Rating	120/240VAC
Terminal Type	Line: Box Lug - Load: Box Lug
Approvals	UL489 Listed - CSA 22.2 #5.1 Certified - IEC Rated 60947-2
Ampere Rating	15A
Circuit Breaker Type	Standard
Width	0.75 Inches
For Use With	OEM Panels and Enclosures
HACR Rated	Yes

Shipping and Ordering

Category	00900 - Circuit Breakers, 1 Pole: 10 - 100 Amp, 2 Pole: 10 - 125 Amp, 3 Pole: 10 -125 Amp, Type QOU
Discount Schedule	DE2
Article Number	785901418504
Package Quantity	40
Weight	0.36 lbs.
Availability Code	S
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

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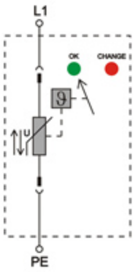


General ordering data

Order No.	8859950000
Part designation	PU II 1 130V/40kA
Version	Surge protection for low-voltage supply, 120 V, without telecomm. contact
EAN	4032248583843
Qty.	1 pc(s).

Dimensions

Clamping range, nom.	25 mm²
Clamping range, min.	4 mm²
Clamping range, max.	25 mm²

temperature

Ambient temperature (operational)	-40...+80°C
Storage temperature	-40 ... +85°C

Product notes

Note, technical data	* This product also fulfils the requirements for Class III with Uoc: 6 kV
Note, accessories	Pluggable spare arrester PU II 0 130V / 40kA - 8860030000
Product description	Class II surge protectionwith Uc: 130 V

Clamped conductors

Conductor cross-section, flexible, AEH (DIN 46228-1), max.	25 mm²
Conductor cross-section, flexible, AEH (DIN 46228-1), min.	4 mm²
Cross-section	25 mm²
Stranded, max.	25 mm²
Stranded, min.	4 mm²
Type of connection	Screw connection

Discharge surge current of top part	
Limiting discharge current (8/20 µs) I	40 kA

General data	
Signalling contact	250 V 1A 1CO at PU II 1 R
Optical function display	green = OK; red = arrester is defective - replace
Design	Installation housing; 1TE
Protection class	IP 20
Type of connection	Screw connection
Cross-section	25 mm²

Interference voltage	
Protection level at 5kA (Up)	< 500 V
Protection level at In (Up)	< 850 V

Protective elements	
Optical function display	green = OK; red = arrester is defective - replace

Technical data	
Rated voltage	120 V
Rated voltage (AC)	130 V
Max. continuous voltage, Uc (AC)	130 V
max. continuous voltage, Uc (DC)	170 V
Requirements class, acc. to IEC 61643-1	Class II
Highest continuous current AC	130 V
Requirements class, acc. to EN 61643-11	T2
Limiting discharge current (8/20 µs) I	40 kA
Discharge current, max. (8/20 µs)	40 kA
Sparkover time / Drop-out time	≤ 25 ns
Fuse, max.	125 A gL
Protection level at In (Up)	< 850 V
Protection level at 5kA (Up)	< 500 V
Temporary surge - U	150 V
AC/DC/UC	AC

Technical data, signal line	
Sparkover time / Drop-out time	≤ 25 ns

Approvals	
Approvals institutes	OEVE; UR; CE

Downloads	
EPLAN	EPLAN4.zip

Classifications	
ETIM30	EC000941
eClass 5.1	27-13-08-01
eClass 6.0	27-13-08-02

Similar products

Order No.	Part designation	Version
8859960000	PU II 1R 130V/40kA	Surge protection for low-voltage supply, 120 V, with telecomm. contact
8859970000	PU II 2 130V/40kA	Surge protection for low-voltage supply, 120 V, without telecomm. contact
8859980000	PU II 2 R 130V/40kA	Surge protection for low-voltage supply, 120 V, with telecomm. contact
8859990000	PU II 3 130V/40kA	Surge protection for low-voltage supply, without telecomm. contact
8860000000	PU II 3 R 130V/40kA	Surge protection for low-voltage supply, with telecomm. contact
8860010000	PU II 4 130V/40kA	Surge protection for low-voltage supply, without telecomm. contact
8860020000	PU II 4 R 130V/40kA	Surge protection for low-voltage supply, with telecomm. contact

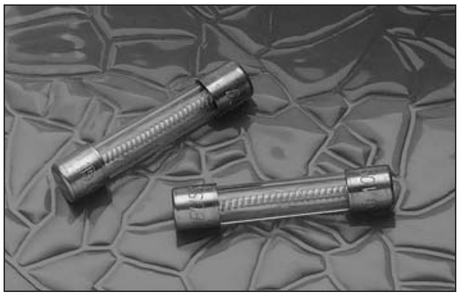
¼″ x 1 ¼″ Time-Delay, Glass Tube Fuses

MDL Series

Description

RoHS
2002/95/EC

- Time-delay
- Optional axial leads available
- ¼ x 1 ¼ (6.4 x 31.7mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14



Electrical Characteristics		
Rated Current	**% of Amp Rating**	**Opening Time**
1/16 - 30A	100%	None
	135%	60 minutes maximum
	200%	120 seconds maximum
1/16 - 3A	200%	5 seconds minimum
3-2/10 - 8A	200%	12 seconds minimum

Agency Information

- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDL 1/16 - 8A (Class No. 1422-01)
- CSA Component Acceptance: MDL 9-30A (Class No. 1422-30)
- CE

Environmental Data

- Shock: 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/4A thru 30A – MIL-STD-202, Method 204, Test Condition C (Except 5g, 500HZ)

Ordering

Specify packaging code

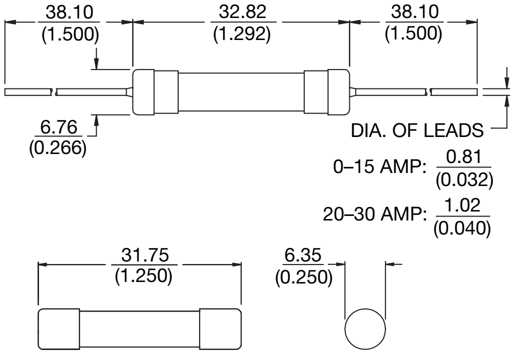
- Insert packaging code prefix before part number. E.g., BK (or BK1)-MDL-5-R

Specify option codes if desired

- For axial leads, insert “V” between catalog series and amp rating. E.g., BK-MDL-V-5-R
- For board washable, insert “B” between catalog series and amp rating. E.g., BK-MDL-B-5-R
- For axial leads and board washable, insert “B” then “V” between catalog series and amp rating. E.g., BK-MDL-BV-5-R

Dimensions - mm (in)

Drawing Not to Scale



Specifications

Part Number	Voltage Rating Vac	AC Interrupting Rating* (amps)@			Typical DC Cold Resistance** (Ω)	Typical Melting I²t† AC	Typical Voltage Drop‡
		250Vac	125Vac	32Vac			
MDL-1/16-R	250	35	10000	-	45.6	0.0046	2.79
MDL-1/10-R	250	35	10000	-	15.68	0.0420	1.95
MDL-1/8-R	250	35	10000	-	12.238	0.0422	1.52
MDL-3/16-R	250	35	10000	-	4.81	0.116	1.05
MDL-2/10-R	250	35	10000	-	5.234	0.314	0.972
MDL-1/4-R	250	35	10000	-	3.208	0.447	0.965
MDL-3/10-R	250	35	10000	-	2.046	0.412	0.808
MDL-3/8-R	250	35	10000	-	1.567	0.982	1.46
MDL-1/2-R	250	35	10000	-	0.943	1.656	1.27
MDL-3/4-R	250	35	10000	-	0.397	4.343	1.01
MDL-1-R	250	35	10000	-	0.273	11.498	0.995
MDL-1-1/4-R	250	100	10000	-	0.205	86.2	0.722
MDL-1-1/2-R	250	100	10000	-	0.156	22.7	0.721
MDL-2-R	250	100	10000	-	0.116	62.3	0.644
MDL-2-1/4-R	250	100	10000	-	0.096	49.6	0.535
MDL-2-1/2-R	250	100	10000	-	0.081	63.1	0.410
MDL-3-R	250	100	10000	-	0.057	67.5	0.345
MDL-4-R	250	200	10000	-	0.038	19.3	0.187
MDL-5-R	250	200	10000	-	0.025	32.0	0.160
MDL-6-R	250	200	10000	-	0.022	37.4	0.155
MDL-6-1/4-R	250	200	10000	-	0.02	38.7	0.152
MDL-7-R	250	200	10000	-	0.018	42.7	0.140
MDL-8-R	250	200	10000	-	0.015	47.8	0.119
MDL-9-R	32	-	-	1000	0.012	51.5	0.124
MDL-10-R	32	-	-	1000	0.01	64.4	0.114
MDL-15-R	32	-	-	1000	0.005	354.0	0.130
MDL-20-R	32	-	-	1000	0.004	2914.0	0.530
MDL-25††	32	-	-	1000	0.01225	15221.0	0.30
MDL-30††	32	-	-	1000	0.0011	15581.0	0.40

* Interrupting Ratings (Interrupting ratings were measured at 70% - 80% power factor on AC)

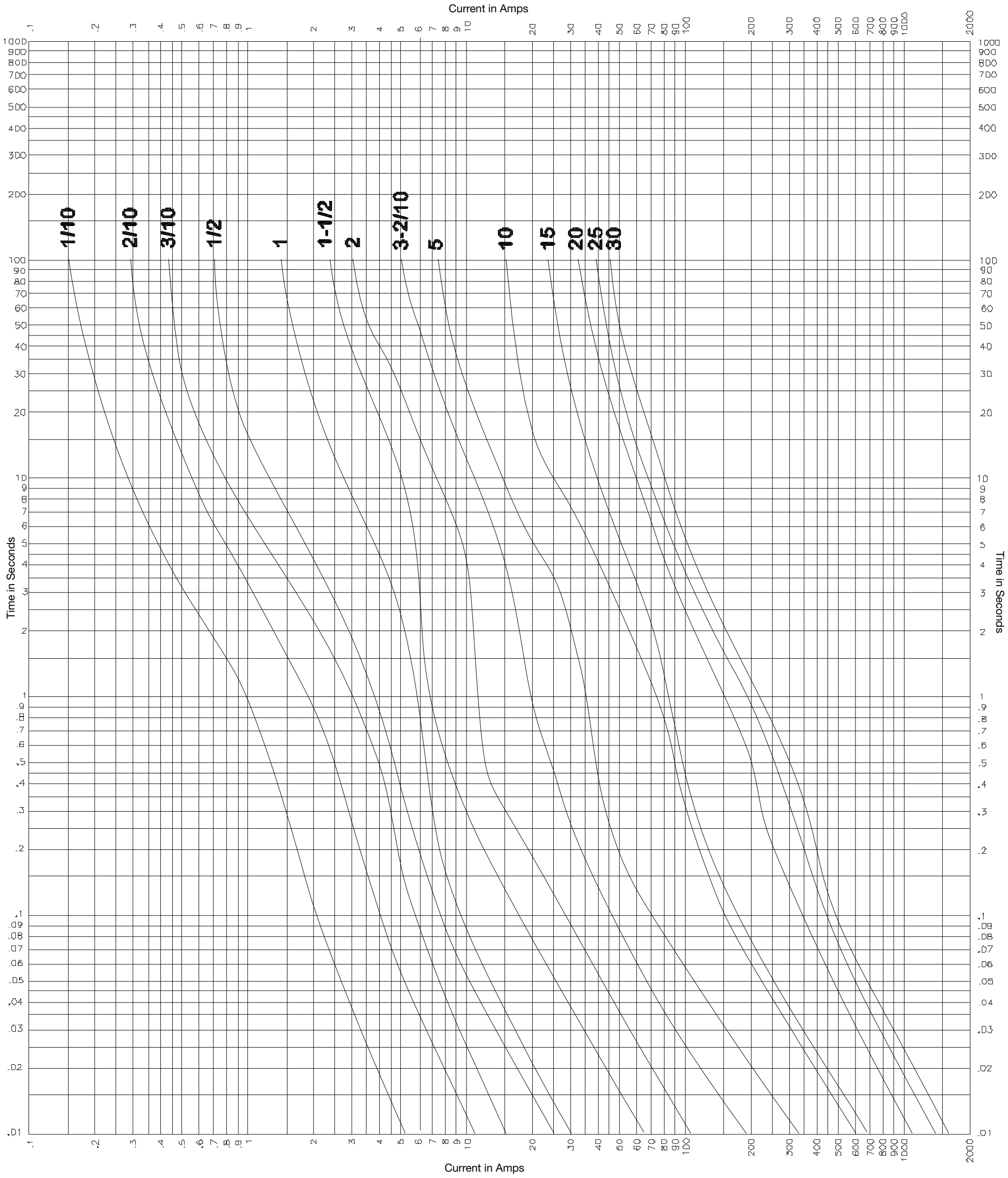
** DC Cold Resistance (Measured at ≤10% of rated current)

† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C±3°C ambient temperature at rated current)

†† MDL-25 & MDL-30 not available in RoHS compliant construction.

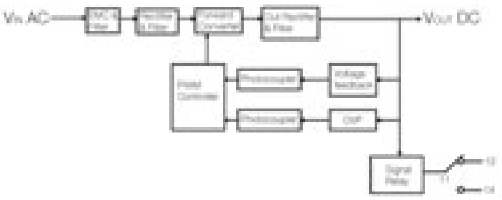
Time-Current Curve



Packaging Code	
Packaging Code	**Description**
BK	100 fuses packed into a cardboard carton
BK1	1,000 fuses packed into a cardboard carton
BK8	8,000 fuses packed into a cardboard carton

	Option Code
Option Code	**Description**
B	Sealed to withstand aqueous cleaning (Board Washable)
V	Axial leads - copper tinned wire with nickel plated brass overcaps

St. Louis, MO 63178
www.cooperbussmann.com



General ordering data	
Order No.	8708670000
Part designation	CP SNT 120W 24V 5A
Version	Switched-mode power supplies
EAN	4032248380831
Qty.	1 pc(s).

Dimensions	
Clamping range, nom.	2.5 mm²
Clamping range, min.	0.13 mm²
Clamping range, max.	4 mm²

temperature	
Ambient temperature (operational)	
Storage temperature	-20 °C...+85 °C
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Input	
Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Input current	3 A @ 115 V AC / 2 A @ 230 V AC
Input frequency, max.	50/ 60 Hz
Input fuse	Fusible link 4 A (T) / 250 V
Input voltage (voltage mode input)	88...132 V AC/176...264 V AC selectable; 250...370 V DC
Surge protection [input]	Varistor

output	
Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Control at 10...100% load	< 2 %
Control at input voltage	0.5 %
Mains failure bridge-over time	20 ms @ 115 V AC / 20 ms @ 230 V AC
Mains failure bridge-over time for 115 V AC	20 ms
Mains failure bridge-over time for 230 V AC	20 ms

output	
Max. capacitance at output	40000 µF
Max. residual ripple	< 100 mV / bandwidth 20 MHz
Output current	5 A
Output power, max.	120 W
Output voltage	24...28 V DC (adjustable with potentiometer)
Output voltage type	DC
Output voltage, max.	28 V
Output voltage, min.	24 V
Overload protection	105 %..130 % I of max. output load; automatic reset
Parallel connection option	Recommended with diode module
Status relay / CO contact	250 V AC (max. 30 V DC) / 1 A
Surge protection [output]	29...34 V

General data	
Ambient temperature (operational)	
DIN Rail compatibility	TS 35
Degree of efficiency at max. load	84 %
Depth	100 mm
EMC standards	EN 55011 EN 55022 EN 55024 EN 61000-6-2, 3
Installation advice	Clearance: above/below ≥ 3 cm
Low Voltage Directive	73/ 23/ EWG
Mounting position, installation notice	horizontally on terminal rail TS 35
Power factor correction	No
Standards	EN 60950 (SELV)
Status indication	Green LED
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Insulation coordination	
Protection class	IP 20
electrical isolation, input-earth	1.5 kV
electrical isolation, input-output	3 kV
electrical isolation, output-earth	0.5 kV

Approvals	
Approvals institutes	CULUS; CURUS; GERMLLOYD; GOSTME25; CE

Classifications	
ETIM20	EC001039
ETIM30	EC001039
eClass 4.1	27-24-04-10
eClass 5.0	27-24-22-13
eClass 5.1	27-04-90-02
eClass 6.0	27-04-90-04

Similar products

Order No.	Part designation	Version
8862780000	CP SNT 1000W 24V 40A	Switched-mode power supplies

8708660000	CP SNT 70W 24V 3A	Switched-mode power supplies
8708680000	CP SNT 250W 24V 10A	Switched-mode power supplies
8778870000	CP SNT 500W 24V 20A	Switched-mode power supplies

WI-I/O 9 Multi I/O Units

- Large I/O capability with I/O expansion
- Two-way communications
- Use where communications is required in both directions or for large I/O requirements. Each network can handle multiple I/O applications.
- Frequency hopping spread spectrum
- 902-928 MHz 1W license-free USA/Canada
- Configurable sub-bands license-free
- Up to 95 wireless units per network
- Support up to 31 I/O expansion modules (WI-I/O-EX-1-S-XX) per wireless unit. See table below.
- Multi-hop repeater functions – up to 5 intermediate units
- Four I/O versions available:

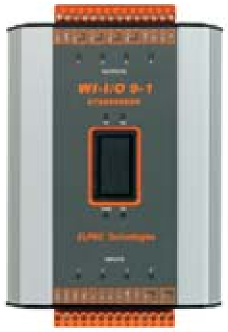
WI-I/O 9	**-1**	**-2**	**-3**	**-4**
Digital inputs	4	4	0 Voltage-free contacts	4 – 16
Digital outputs	1 + 3 Relay + FET	1 FET	8 FET	4 - 16 FET
Analog inputs	2 4-20mA	6 0-20mA/0-10V	0	0
Analog outputs	2 4-20mA	0	8 0-20mA/0-10V	0
Pulse inputs	1 100Hz	4 1 x 1KHz, 3 x 100Hz	0	4 1 x 1KHz, 3 x 100Hz
Pulse outputs	1 100Hz	0	4 1 x 1KHz, 3 x 100Hz	4 1 x 1KHz, 3 x 100Hz

Note: Pulse and digital inputs are same connection point.

- Pulse inputs generate separate pulse count and rate value; pulse rates treated as internal analog registers with configurable maximum value.
- Wide voltage power supply, with integral UPS battery charger and solar regulator
- Power supply generates transmittable internal I/O values
- Multiple communication-failure diagnostics with output status
- Class 1 Div 2 approval
- Radio receive signal and background RF noise measurement / logging diagnostics
- Input measurement display and output “forcing” diagnostics
- Communication logging diagnostics
- Easy-to-use E-Series Windows configuration available at www.weidmuller.ca or weidmuller.com

C US **C1D2**

WI-I/O 9-1



WI-I/O 9-2

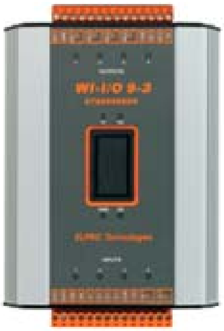
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA	four inputs	four inputs
Analog: “floating” differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.	two 4-20mA resolution 15 bit, accuracy 0.1%	six 0-20mA/0-10V resolution 12 bit, accuracy 0.1%
Pulse: as per digital inputs, Max pulse rate 100Hz, pulse width min 5ms	one input (DI1)	four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
Outputs		
Digital	four relay contacts, Form A, AC, 50V 5A/ DC 30V 2A	one FET output 30VDC 500mA
Analog: current sink to common, max loop voltage 27V, max loop resistance 1000 ohms	two 4-20 mA resolution 15 bit, accuracy 0.1%	
Pulse: FET 30VDC 500mA max 100Hz	one	
Power Supply		
Battery supply	11.5-15.0 VDC	11.5-15.0 VDC
Normal supply	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected
Battery charging circuit	included for 1.2-12 AHr sealed battery	included for 1.2-12 AHr sealed battery
Solar regulator	for direct connection of solar panel (up to 30W) and solar battery (100AHr)	for direct connection of solar panel (up to 30W) and solar battery (100AHr)
Internal monitoring	power fail, solar charge status, and battery voltage	power fail, solar charge status, and battery voltage
Notes	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS232/RS485	serial port 9600 baud, 8 bits, no parity, 1 stop bit	serial port 9600 baud, 8 bits, no parity, 1 stop bit
RS232 connection	9pin DB9 female connector	9pin DB9 female connector
RS485 connection	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections

General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99%RH	0-99%RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC, EN 301 489	FCC Part 15, AS3548, 89/336/EEC, EN 301 489
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting	DIN rail mounting
LED indication	For power supply, WDT, digital I/O	For power supply, WDT, digital I/O
Antenna connector	SMA female coaxial	SMA female coaxial
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)

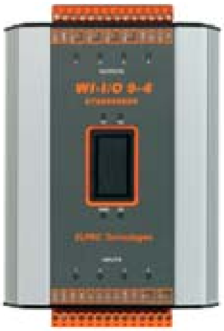
Ordering Data	Type	Part No.	Type	Part No.
	WI-I/O 9-1	**6720005000**	WI-I/O 9-2	**6720005001**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

C US C1D2

WI-I/O 9-3



WI-I/O 9-4



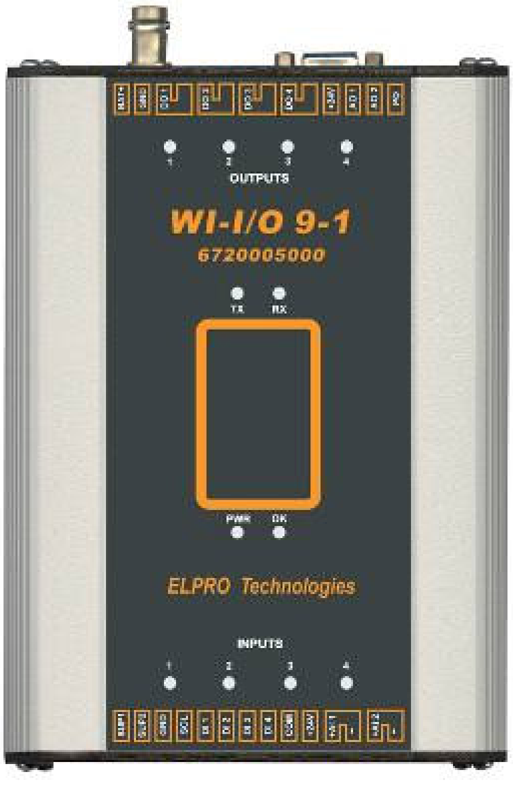
Technical Data	WI-I/O 9-3	WI-I/O 9-4
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA		up to 16 inputs (4 inputs + 12 selectable I/O) the 12 selectable inputs are surge protected but not isolated
Analog: "floating" differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.		
Pulse: as per digital inputs, Max pulse rate 100Hz, pulse width min 5ms		four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
Outputs		
Digital	eight FET output 30VDC 500mA	up to 16 FET output (4 outputs + 12 selectable I/O)
Analog: current sink to common, max loop voltage 27V, max loop resistance 1000 ohms	eight 0-20 mA resolution 12 bit, accuracy 0.1%	
Pulse: FET 30VDC 500mA max 100Hz	four (DO1-4)	four (DO1-4)
Power Supply		
Battery supply	11.5-15.0 VDC	11.5-15.0 VDC
Normal supply	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected
Battery charging circuit	included for 1.2-12 AHr sealed battery	included for 1.2-12 AHr sealed battery
Solar regulator	for direct connection of solar panel (up to 30W) and solar battery (100AHr)	for direct connection of solar panel (up to 30W) and solar battery (100AHr)
Internal monitoring	power fail, solar charge status, and battery voltage	power fail, solar charge status, and battery voltage
Notes	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS232/RS485	serial port 9600 baud, 8 bits, no parity, 1 stop bit	serial port 9600 baud, 8 bits, no parity, 1 stop bit
RS232 connector	9pin DB9 female connector	9pin DB9 female connector
RS485 connector	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections
General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99%RH	0-99%RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC, EN 301 489	FCC Part 15, AS3548, 89/336/EEC, EN 301 489
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting	DIN rail mounting
LED indication	For power supply, WDT, digital I/O	For power supply, WDT, digital I/O
Antenna Connector	SMA female coaxial	SMA female coaxial
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)

Ordering Data	Type	Part No.	Type	Part No.
	WI-I/O 9-3	**6720005002**	WI-I/O 9-4	**6720005003**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

User Manual

WI-I/O 9-x Wireless Module

WI-I/O-EX-1-S-x Serial Module



W Interconnections Inc., 821 Southlake Boulevard, Richmond, VA 23236

Tel: (804) 794-2877 Fax: (804) 379-2593

Thank you for your selection of the WI-I/O-9-x_WI-I/O-EX-1-S-x module for your I/O needs. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may
cause internal damage and will void warranty.
To ensure this product enjoys a long life,
double check ALL your connections with
the user's manual
before turning the power on.

Caution! For continued protection against risk of fire, replace the module fuse F1 only with the same type and rating.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to **provide a separation distance of at least 33 cm from all persons** to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 33 cm of the antenna
- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.
- operate the equipment near electrical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

FCC Notice: WI-I/O 9-x Wireless I/O Module

This user's manual is for the W INTERCONNECTIONS WI-I/O 9-x wireless I/O module. This device complies with Part 15.247 of the FCC Rules.

Operation is subject to the following two conditions:

1) This device may not cause harmful interference and

2) This device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by W INTERCONNECTIONS Technologies. Any changes or modifications made to the device without the written consent of W INTERCONNECTIONS Technologies may void the user's authority to operate the device.

End user products that have this device embedded must be installed by experienced radio and antenna personnel, or supplied with non-standard antenna connectors, and antennas available from vendors specified by W INTERCONNECTIONS Technologies. Please contact W INTERCONNECTIONS Technologies for end user antenna and connector recommendations.

Notices: Safety

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in Docket 93-62 and OET Bulletin 65 Edition 97-01.

FCC Notice: WI-I/O-EX-1-S-x Wireless I/O Module

Part 15 – This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part15 of the FCC rules (Code of Federal Regulations 47CFR Part 15). Operation is subject to the condition that this device does not cause harmful interference.

Part 90 – This device has been type accepted for operation by the FCC in accordance with Part90 of the FCC rules (47CFR Part 90). See the label on the unit for the specific FCC ID and any other certification designations.

Industry Canada: WI-I/O-EX-1-S-x Wireless I/O Module

RSS-119 - This device has been type accepted for operation by Industry Canada in accordance with RSS-119 of the Industry Canada rules. See the label on the unit for the specific Industry Canada certification number and any other certification designations.

Notice Any changes or modifications not expressly approved by W INTERCONNECTIONS could void the user's authority to operate this equipment.

To operate this equipment legally the user must obtain a radio operating license from the government agency. This is done so the government can coordinate radio users in order to minimize interference.

Important Notice

W INTERCONNECTIONS products are designed to be used in industrial environments, by experienced industrial engineering personnel with adequate knowledge of safety design considerations.

W INTERCONNECTIONS radio products are used on unprotected license-free radio bands with radio noise and interference. The products are designed to operate in the presence of noise and interference, however in an extreme case, radio noise and interference could cause product operation delays or operation failure. Like all industrial electronic products, W INTERCONNECTIONS products can fail in a variety of modes due to misuse, age, or malfunction. We recommend that users and designers design systems using design techniques intended to prevent personal injury or damage during product operation, and provide failure tolerant systems to prevent personal injury or damage in the event of product failure. Designers must warn users of the equipment or systems if adequate protection against failure has not been included in the system design. Designers must include this Important Notice in operating procedures and system manuals.

These products should not be used in non-industrial applications, or life-support systems, without consulting W INTERCONNECTIONS Technologies first.

1. For WI-I/O 9-x modules, a radio licence is not required in many countries, provided the module is installed using the antenna and equipment configuration complying with the country's regulations.. Check with your local distributor for further information on regulations.
2. For WI-I/O 9-x modules, operation is authorised by the radio frequency regulatory authority in your country on a non-protection basis. Although all care is taken in the design of these units, there is no responsibility taken for sources of external interference. The WI-I/O 9-x intelligent communications protocol aims to correct communication errors due to interference and to retransmit the required output conditions regularly. However some delay in the operation of outputs may occur during periods of interference. Systems should be designed to be tolerant of these delays.
3. To avoid the risk of electrocution, the antenna, antenna cable, serial cables and all terminals of the WI-I/O 9-x_WI-I/O-EX-1-S-x module should be electrically protected. To provide maximum surge and lightning protection, the module should be connected to a suitable earth and the antenna, antenna cable, serial cables and the module should be installed as recommended in the Installation Guide.
4. To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the WI-I/O 9-x_WI-I/O-EX-1-S-x module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. E.g. "This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments."
5. The WI-I/O 9-x_WI-I/O-EX-1-S-x module is not suitable for use in explosive environments without additional protection. These modules are approved for use in Class 1 Division 2 areas

in North America.

Limited Lifetime Warranty, Disclaimer and Limitation of Remedies

W INTERCONNECTIONS products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W INTERCONNECTIONS, W INTERCONNECTIONS will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W INTERCONNECTIONS' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W INTERCONNECTIONS is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W INTERCONNECTIONS is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W INTERCONNECTIONS or its representatives or by any other party, except as expressed solely in this document..

How to Use This Manual

To receive the maximum benefit from your WI-I/O 9-x_WI-I/O-EX-1-S-x product, please read the **Introduction**, **Installation** and **Operation** chapters of this manual thoroughly before putting the product to work.

Chapter Four **Configuration** explains how to configure the modules using the Configuration Software available.

Chapter Five **Specifications** details the features of the product and lists the standards to which the product is approved.

Chapter Six **Troubleshooting** will help if your system has problems and Chapter Seven specifies the **Warranty and Service** conditions.

The foldout sheet *Installation Guide* is an installation drawing appropriate for most applications.

CONTENTS

Chapter One INTRODUCTION

1.1 General

The WI-I/O 9-x & WI-I/O-EX-1-S-x range of I/O modules has been designed to provide standard "off-the-shelf" telemetry functions, for an economical price. *Telemetry* is the transmission of signals over a long distance via a medium such as radio or twisted-pair wire. Although the WI-I/O 9-x_WI-I/O-EX-1-S-x is intended to be simple in its application, it also provides many sophisticated features. This manual should be read carefully to ensure that the modules are configured and installed to give reliable performance.

The unit can monitor and control the following types of signals:

Digital on/off signals

Example outputs - motor run, siren on
Example inputs - motor fault, tank overflow, intruder alarm

Analog continuously variable signals (0-20mA)

Example outputs - tank level indication, required motor speed
Example inputs - measured tank level, actual motor speed

Pulse frequency signals

Examples - electricity metering, fluid flow

Internal Status signals

Examples - analog battery voltage, power status, solar panel status and low battery status.

The unit will monitor the input signals and transmit the signal information by radio or RS485 twisted pair to another module or modules. At the remote unit, the signals will be reproduced as digital, analog or pulse output signals. The modules also provide analog set points, so that a digital output may be configured to turn on and off depending on the value of an analog input. The pulse I/O transmits an accumulated value and the pulses are reliably recreated at the remote unit regardless of 'missed' transmissions. The actual pulse rate is also calculated and is available as a remote analog output.

This manual covers the WI-I/O 9-x and WI-I/O-EX-1-S-x modules. We have provided a summary on all products available in the range, below.

- **WI-I/O 9-1, WI-I/O 9-2, WI-I/O 9-3 and WI-I/O 9-4** modules have radio **and** serial communications. The modules differ only in their input/output (I/O) design, and are compatible, i.e. they can be used to communicate signals to each other in the same network. The WI-I/O 9-x has a frequency hopping spread spectrum 900MHz radio which is license-free in many countries.
-

- **WI-I/O-EX-1-S-1, WI-I/O-EX-1-S-2, WI-I/O-EX-1-S-3 and WI-I/O-EX-1-S-4** modules have **only** serial communications. All other specifications are as per the WI-I/O 9-1, 2, 3 & 4 modules. The WI-I/O-EX-1-S-x modules are compatible with WI-I/O 9-x modules. WI-I/O-EX-1-S-x modules may be used for serial I/O applications, or as I/O expansion for WI-I/O 9-x modules.
- The **WI-GTWY-9-xxx** modules provides an interface between host devices such as PLC's or SCADA computers, and a wireless I/O system comprising WI-I/O 9-x modules. The WI-GTWY-9-xxx allows WI-I/O 9-x modules to act as remote wireless I/O for the host devices. For more information, refer to the **WI-GTWY-9-xxx User Manual**.

The WI-I/O 9-x radio has been designed to meet the requirements of unlicensed operation for remote monitoring and control of equipment. That is, a radio licence is not required for the WI-I/O 9-x modules in many countries. See Chapter Five **Specifications** for details. A radio license is not required to use the WI-I/O 9-x products.

I/O Types

	WI-I/O 9-1	WI-I/O-EX-1-S-1	WI-I/O 9-2	WI-I/O-EX-1-S-2	WI-I/O 9-3	WI-I/O-EX-1-S-3	WI-I/O 9-4	WI-I/O-EX-1-S-4
Radio	✓		✓		✓		✓	
Serial	✓	✓	✓	✓	✓	✓	✓	✓
Digital Inputs (DI)	4		4				4 to 16	
Digital Outputs (DO)	4 (relay)		1 (FET)		8 (FET)		4 to 16 (FET)	
Analog Inputs (AI)	2 (4-20mA)		6 (0-20mA)					
Analog Outputs (AO)	2 (4-20mA)				8 (0-20mA)			
Pulse Inputs (PI)	1 (100Hz)		4 (1x1KHz, 3x100Hz)				4 (1x1KHz, 3x100Hz)	
Pulse Outputs (PO)	1 (100Hz)				4 (100 Hz)		4 (100 Hz)	
Comments	PI is DI 1. PO is separate to DO.		PI's are the same as DI's.		PO's are the same as DO's .		PI/ PO's are the same as DI/ DO's.	

Note regarding -4 modules. The WI-I/O 9-x_WI-I/O-EX-1-S-4 has a total of 20 digital I/O. Four are fixed inputs (also PI's) and four are fixed outputs (also PO's). The other 12 are selectable individually as DI or DO. The I/O range can vary from 16DI + 4DO to 4DI + 16DO or any combination in between.

Input signals connected to a module are transmitted to another module and appear as output signals. These input signals may also be configured to appear as "inverted" signals on the output. A

transmission occurs whenever a "change-of-state" occurs on an input signal. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa. A "change-of-state" for an analog input, internal analog input or pulse input rate is a change in value of the signal of 3% (configurable from 0.8 to 75 %).

In addition to change-of-state messages, update messages are automatically transmitted on a regular basis. The time period may be configured by the user for each input. This update ensures the integrity of the system.

Pulse inputs are accumulated as a pulse count and the accumulated pulse count is transmitted regularly according to the configured update time.

The I/O modules transmit the input/output data as a data frame using radio or serial RS485 as the communications medium. The data frame includes the "address" of the transmitting module and the receiving module, so that each transmitted message is acted on only by the correct receiving unit. Each transmitted message also includes error checking to ensure that no corruption of the data frame has occurred due to noise or interference. The module with the correct receiving "address" will acknowledge the message with a return transmission. If the original module does not receive a correct acknowledgement to a transmission, it will retry up to five times before setting the communications fail status of that path. In critical paths, this status can be reflected on an output on the module for alert purposes. The module will continue to try to establish communications and retry, if required, each time an update or change-of-state occurs.

A system may be a complex network or a simple pair of modules. An easy-to-use configuration procedure allows the user to specify any output destination for each input.

The maximum number of modules in one system is 95 modules communicating by radio. Each of these modules may have up to 31 other modules connected by RS485 twisted pair. Modules may communicate by radio only, by RS485 only or by both RS485 and radio. Any input signal at any module may be configured to appear at any output on any module in the entire system.

Systems with a WI-I/O 9-C or WI-GTWY-9-xxx module and host device can have more than 95 radio modules.

Modules can be used as repeaters to re-transmit messages on to the destination module. Repeaters can repeat messages on the radio channel, or from the radio channel to the serial channel (and serial to radio). Up to five repeater addresses may be configured for each input-to-output link.

The units may be configured by using a PC connected to the RS232 port. The default configuration and software configuration is defined in Section 4 **Configuration**.

Chapter Two INSTALLATION

2.1 General

The WI-I/O 9-x_WI-I/O-EX-1-S-x module is housed in a rugged aluminium case, suitable for DIN-rail mounting. Terminals are suitable for cables up to 2.5 sqmm in size.

All connections to the module should be SELV only. Normal 110/220/240V mains supply should not be connected to any input terminal of the module. Refer to Section 2.3 **Power Supply**.

Each module should be effectively earthed/grounded via a "GND" terminal on the module - this is to ensure that the surge protection circuits inside the module are effective. The earth/ground wire should be connected to the same earth/ground point as the enclosure "earth" and the antenna mast "earth".

Before installing a new system, it is preferable to bench test the complete system. Configuration common problem is poor communications on the radio channel or the serial channel. For radio modules, problems are caused by incorrectly installed antennas, or radio interference on the same channel, or the radio path being inadequate. If the radio path is a problem (i.e. path too long, or obstructions in the way), then higher performance antennas or a higher mounting point for the antenna may fix the problem. Alternately, use an intermediate module as a repeater.

For serial modules, poorly installed serial cable, or interference on the serial cable is a common problem.

The foldout sheet Installation Guide provides an installation drawing appropriate to most applications. Refer to Appendix B of this manual for terminal layout drawings of the modules.

2.2 Antenna Installation *(WI-I/O 9-x units only)*

The WI-I/O 9-x module will operate reliably over large distances. The distance which may be reliably achieved will vary with each application - depending on the type and location of antennas, the degree of radio interference, and obstructions (such as hills or trees) to the radio path. Typical reliable distances are :

USA/Canada	15 miles	6dB net gain antenna configuration permitted (4W ERP)
Australia/NZ	12 km	unity gain antenna configuration (1W ERP)

Longer distances can be achieved if one antenna is mounted on top of a hill.

To achieve the maximum transmission distance, the antennas should be raised above intermediate obstructions so the radio path is true "line of sight". Because of the curvature of the earth, the antennas will need to be elevated at least 15 feet (5 metres) above ground for paths greater than 3 miles (5 km). The modules will operate reliably with some obstruction of the radio path, although the reliable distance will be reduced. Obstructions which are close to either antenna will have more of a blocking affect than obstructions in the middle of the radio path. For example, a group of trees around the antenna is a larger obstruction than a group of trees further away from the antenna. The WI-I/O 9-x modules provide a test feature which displays the radio signal strength.

Line-of-sight paths are only necessary to obtain the maximum range. Obstructions will reduce the range however, but may not prevent a reliable path. A larger amount of obstruction can be tolerated for shorter distances. For very short distances, it is possible to mount the antennas inside buildings. An obstructed path requires testing to determine if the path will be reliable (refer the section 6 of this manual).

Where it is not possible to achieve reliable communications between two modules, then a third module may be used to receive the message and re-transmit it. This module is referred to as a repeater. This module may also have input/output (I/O) signals connected to it and form part of the I/O network - refer to Chapter 4 **Configuration** of this manual.

An antenna should be connected to the module via 50 ohm coaxial cable (eg RG58, RG213 or Cellfoil) terminated with a male SMA coaxial connector. The higher the antenna is mounted, the greater the transmission range will be, however as the length of coaxial cable increases so do cable losses. For use on unlicensed frequency channels, there are several types of antennas suitable for use. It is important antenna are chosen carefully to avoid contravening the maximum power limit on the unlicensed channel (if in doubt refer to an authorised service provider).

The net gain of an antenna/cable configuration is the gain of the antenna (in dBi) less the loss in the coaxial cable (in dB).

The maximum net gain of the antenna/cable configuration permitted for WI-I/O 9-x is

Country	**Max. gain (dB)**
USA / Canada	6
Australia / New Zealand	0

The gains and losses of typical antennas for WI-I/O 9-x are

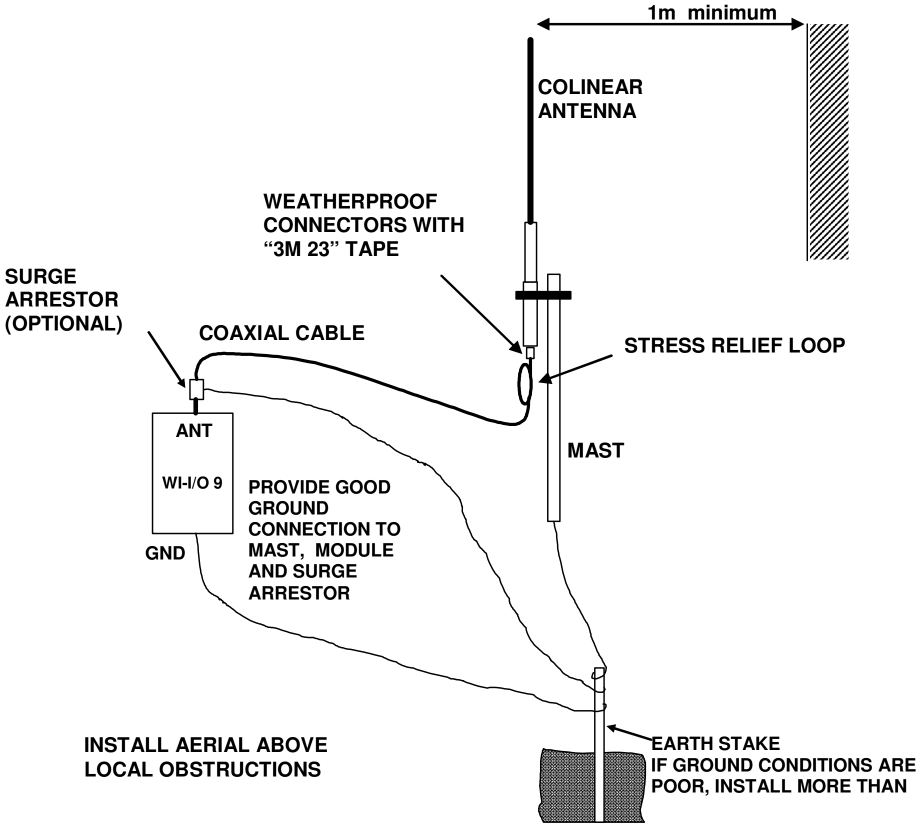
Standard Antennas	**Gain (dB)**	**Part Numbers**
Dipole with integral 15’ cable	0	6720005080
5dBi Collinear(3dBd)	5	6720005081
8dBi Collinear (6dBd)	8	6720005082
6 element Yagi	10	6720005084
16 element Yagi	15	6720005085

Cable type	Loss (dB per 30 ft / 10 m)
RG58	-5
RG213	-2.5
Cellfoil	-3

The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6 element Yagi with 70 feet (20 metres) of Cellfoil has a net gain of 4dB (10dB – 6dB).

Connections between the antenna and coaxial cable should be carefully taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems, as it greatly increases the radio losses. We recommend that the connection be taped, firstly with a layer of PVC Tape, then with a vulcanising tape such as “3M 23 tape”, and finally with another layer of PVC UV Stabilised insulating tape. The first layer of tape allows the joint to be easily inspected when trouble shooting as the vulcanising seal can be easily removed.

Where antennas are mounted on elevated masts, the masts should be effectively earthed to avoid lightning surges. For high lightning risk areas, surge suppression devices between the module and the antenna are recommended. If the antenna is not already shielded from lightning strike by an adjacent earthed structure, a lightning rod may be installed above the antenna to provide shielding.



2.2.1 Dipole and Collinear antennas.

A collinear antenna transmits the same amount of radio power in all directions - as such that are easy to install and use. The dipole antenna with integral 15 feet cable does not require any additional coaxial cable, however a cable must be used with the collinear antennas.

Collinear and dipole antennas should be mounted vertically, preferably 1 metre away from a wall or mast to obtain maximum range.

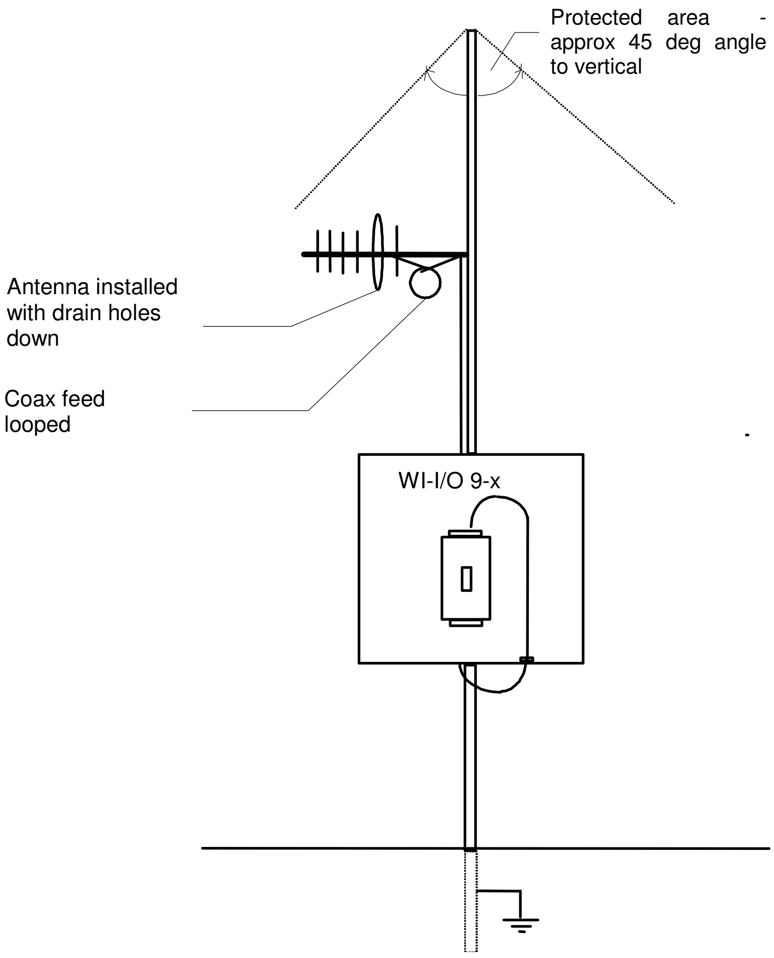
2.2.2 Yagi antennas.

A Yagi antenna provides high gain in the forward direction, but lower gain in other directions. This may be used to compensate for coaxial cable loss for installations with marginal radio path.

The Yagi gain also acts on the receiver, so adding Yagi antennas at both ends of a link provides a double improvement.

Yagi antennas are directional. That is, they have positive gain to the front of the antenna, but negative gain in other directions. Hence Yagi antennas should be installed with the central beam horizontal and must be pointed exactly in the direction of transmission to benefit from the gain of the antenna. The Yagi antennas may be installed with the elements in a vertical plane (vertically polarised) or in a horizontal plane (horizontally polarised). For a two station installation, with both modules using Yagi antennas, horizontal polarisation is recommended. If there are more than two stations transmitting to a common station, then the Yagi antennas should have vertical polarisation, and the common (or "central" station should have a collinear (non-directional) antenna.

Note that Yagi antennas normally have a drain hole on the folded element. The drain hole should be located on the bottom of the installed antenna.



2.3 Power Supply

The WI-I/O 9-x_WI-I/O-EX-1-S-x power supply is a switch-mode design which will accept either AC or DC supply. The module may also be powered from a solar panel without an external solar regulator.

The module accepts supply voltages in the following ranges :

12 - 24 volts AC RMS or 15 - 30 volts DC at the “supply” terminals, or

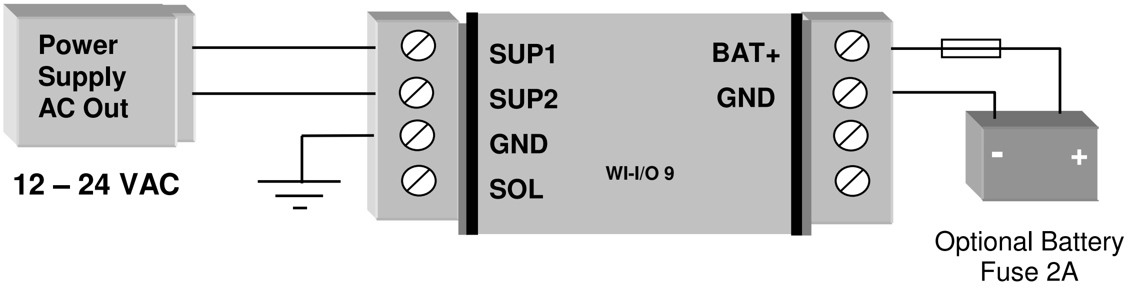
11.5 -15 volts DC at the “battery” terminals.

The power supply should be rated at 1.5 Amps and be CSA Certified Class 2. For use in Class 1 Div 2 explosive areas, the power supply must be approved for Class 1 Div 2 use.

Note: Connect module to the same ground/earth point as the antenna mounting to avoid differences in earth potential during voltage surges. The modules need an earth connection for the internal surge protection to be effective.

2.3.1 AC Supply

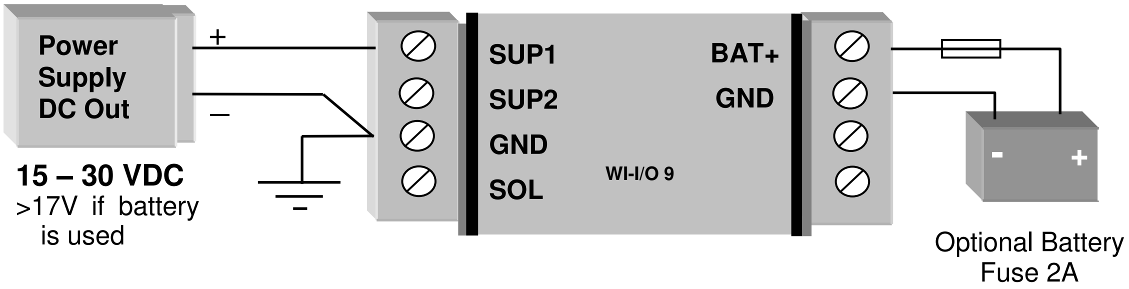
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below.



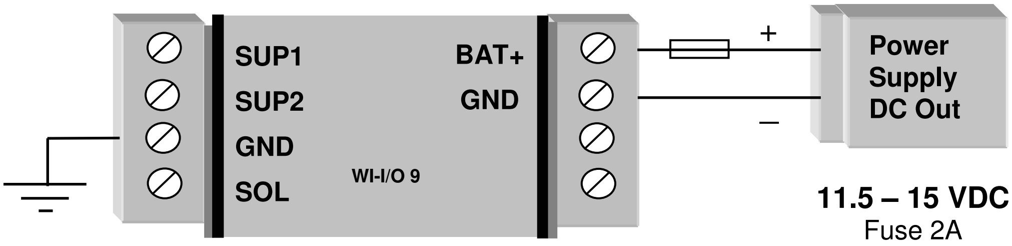
The AC supply should be "floating" relative to earth. AC transformers with grounded/earthed secondary windings should **not** be used.

2.3.2 DC Supply

For DC supplies, the positive lead is connected to "SUP1" and the negative to "GND". The positive side of the supply **<u>must not be connected to earth.</u>** The DC supply may be a floating supply or negatively grounded.



The module may also be powered from an external 11.5 - 15 VDC battery supply without the need for a "normal" supply connected to "SUP1". This external battery supply is connected to "BAT+" and "GND" terminals. The positive lead of the external supply should be protected by a 2A fuse.



Upon failure of the normal supply, the module may continue to operate for several hours from a backup battery. The module includes battery charging circuits for charging up to a 12 AHr sealed lead acid battery. The battery is connected to the "BAT+" (positive) and "GND" (negative) terminals. The positive lead from the battery should be protected with a 2A fuse, installed as near to the battery terminal as possible. On return of main supply, the unit will switch back to mains operation, and recharge the battery. To provide adequate current to recharge the backup battery, an AC supply of 15V minimum or a DC supply of 17V minimum must be used. Typically, a 6 AHr battery will supply the WI-I/O 9-x for 1 - 3 days, depending on I/O loads.

2.3.3 Solar Supply

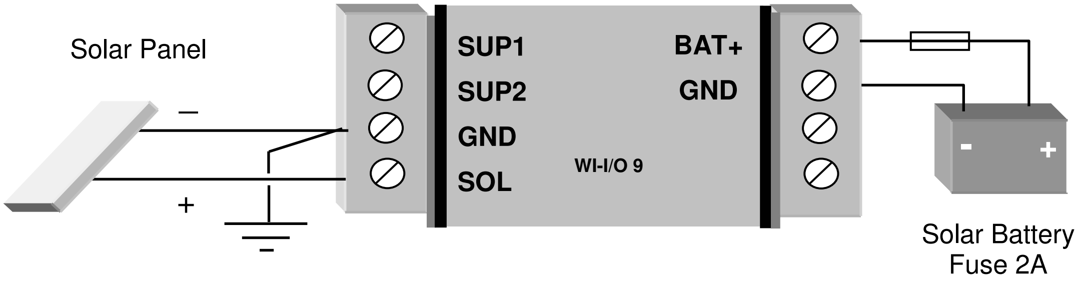
The power supply also includes a 12 V solar regulator for connecting 12V solar panels of up to 30W, and solar batteries of up to 100AHr. **The unit must not be powered from a solar panel without a battery.** A 20W solar panel is sufficient for most solar applications. The size of the solar battery required depends on the I/O used. Batteries are sized for a number of sunless days with 50% battery capacity remaining as follows:

$$\text{No. of sunless days} = \frac{\text{Battery capacity (AHr)} \times 0.5}{\text{Module load (A)} \times 1.2 \times 24}$$

The Module load depends on the I/O connected and can be calculated as follows:

Module Load(mA) = (85 for WI-I/O 9-x or 45 for WI-I/O-EX-1-S-x) + (10 x No. of active DI’s) +
(25 x No. of active DO’s) + (2 x Analog loop load).

The analog loop load is the total signal current for the AI’s and AO’s which are powered from the internal 24V supply. Externally powered loops are not included in this.



The solar panel is connected to the "SOL" (positive) and "GND" (negative) terminals and the battery connected to the "BAT+" (positive) and "GND" (negative) terminals. Solar panels must be installed and

connected as per the panel manufacturer's instructions. The positive lead of the battery should be protected by a 2A fuse installed as near as possible to the battery terminal.

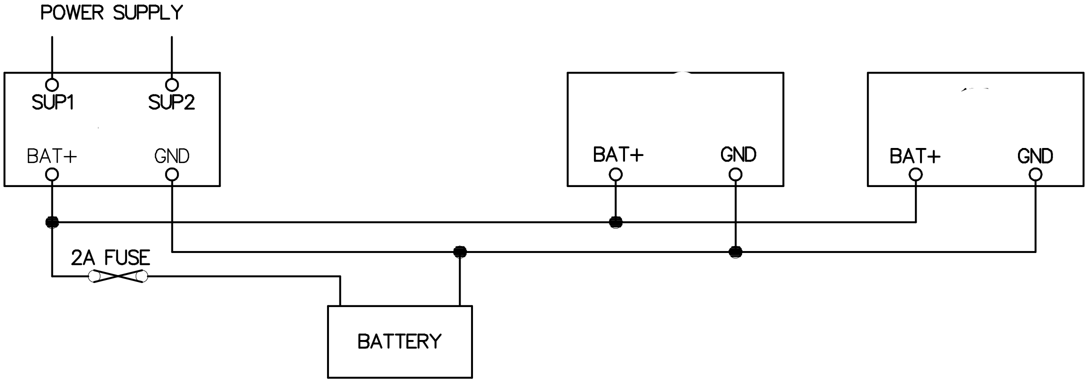
Where a panel larger than 30W is required, an external solar regulator should be used.

For maintenance, disconnect the solar panel first before disconnecting the battery.

2.3.4 Multiple Modules

Where more than one module is installed at the one location, a shared power supply and battery may be used, provided the total load does not exceed the power supply.

The internal power supply of the module can supply a maximum 12V load of 700mA. In order to achieve this, the input power supply must be above 15VAC or 17VDC. Using these figures, it can be determined whether there is enough supply for more than one module - allow 100mA for recharging a battery.



For example, assume there is a WI-I/O 9-1 module and a WI-I/O-EX-1-S-1 module at the same location. The total I/O at the location is 3 analog inputs, 6 digital inputs and 4 digital outputs. The total load will be :-

TYPE OF LOAD	LOAD mA
WI-I/O 9-1 quiescent	85
WI-I/O-EX-1-S-1 quiescent	45
6 DI @ 10 mA	60
3 AI @ 20mA x 2	120
4 DO @ 25mA	100
Battery charging	100
TOTAL	510

So both modules could be powered from one power supply and one battery, provided the external supply voltage is more than 15VAC or 17VDC.

2.3.5 24V Regulated Supply

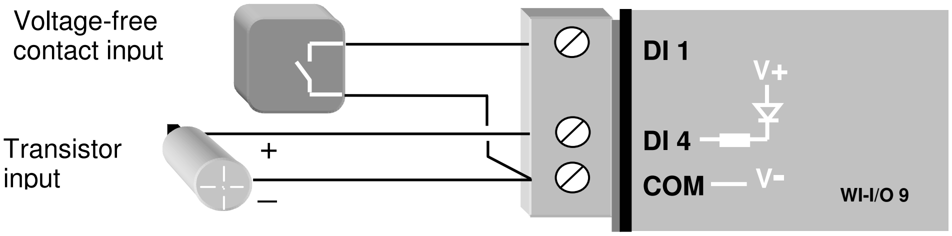
Each module provides a 24V DC regulated supply for analog loop power, except for WI-I/O 9-4_WI-I/O-EX-1-S-4. The supply is rated at 150mA, and should **only** be used for powering analog loops.

2.4 Input / Output

2.4.1 Digital Inputs (WI-I/O 9-1, WI-I/O 9-2 and WI-I/O 9-4)

The ”-1” and ”-2” modules each provide four digital inputs with 5000 volt opto-isolation, and the ”-4” provides 4 to 16 inputs with 3000 volt surge protection. All inputs are suitable for voltage free contacts (such as mechanical switches) or NPN transistor devices (such as electronic proximity switches). PNP transistor devices are not suitable. Contact wetting current of approximately 5mA is provided to maintain reliable operation of driving relays.

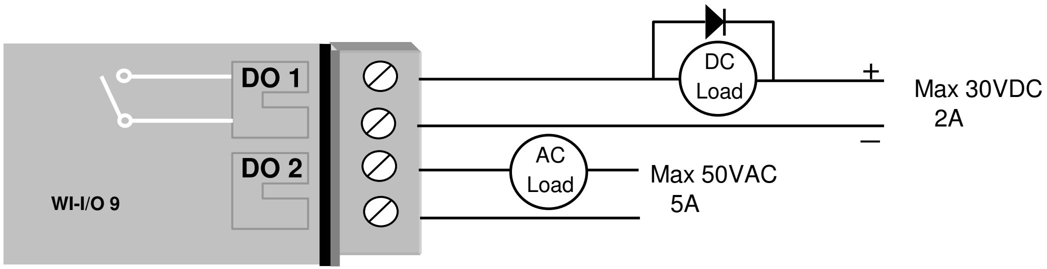
Each digital input is connected between the appropriate "DI" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200 ohms, the device will be able to activate the digital input.



For pulse inputs, refer to Section 2.4.6.

2.4.2 Digital Outputs (WI-I/O 9-1)

The ”-1” module provides four normally open voltage-free relay contacts, rated at AC 50V/5A, DC 30V/2A, 20V/5A. These outputs may be used to directly control low-powered equipment, or to power larger relays for higher powered equipment. When driving inductive loads such as AC relays, good installation should include capacitors (e.g. 10nf 250V) across the external circuit to prevent arcing across the relay contacts. For DC inductive loads, flyback diodes should be used across DC relays.

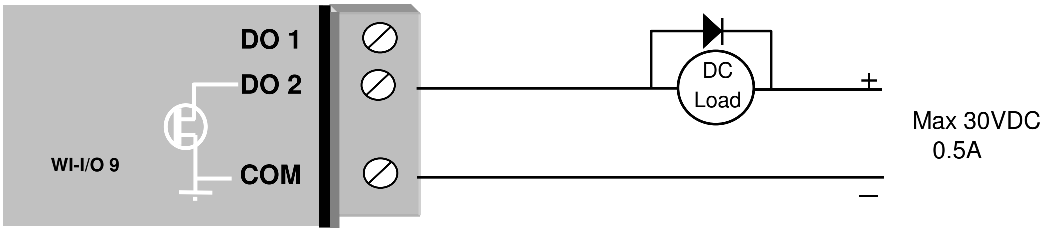


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See section 4.4 Changing User Options for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.3 Digital Outputs (WI-I/O 9-2, WI-I/O 9-3 and WI-I/O 9-4)

The digital outputs on the “-2”, “-3” and “-4” modules are transistor switched DC signals, FET output to common rated at 30VDC 500 mA. The ”-2” provides one digital output; the ”-3” provides eight digital outputs and the ”-4” provides 4 – 16 outputs. The first four DO’s on the ”-3” and ”-4” modules are also the pulse outputs - that is, the first four DO's can be either digital outputs or pulse outputs. The function of each of these outputs may be configured individually. For a description of pulse outputs, refer to Section 2.4.7.



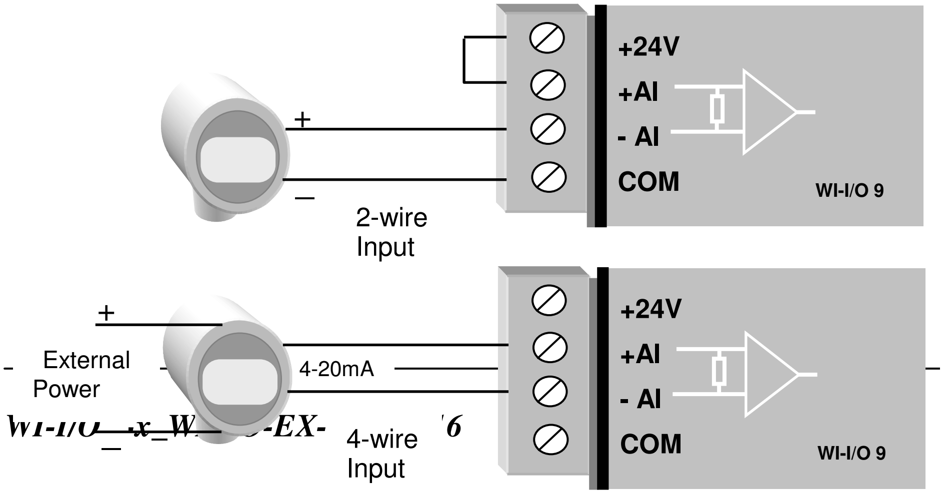
Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 4 Configuration for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.4 Analog Inputs (WI-I/O 9-1 and WI-I/O 9-2)

The ”-1” module provides two 4 - 20 mA DC analog inputs for connecting to instrument transducers such as level, moisture, pressure transducers, etc. The ”-2” module provides six 0 - 20 mA DC analog inputs. Note that the inputs on the ”-2” module will measure down to 0mA, so they can also be used for zero based signals such as 0 - 10 mA. The modules transmit the “mA value” of the input, not a “% of range”, so the output value is set to the correct mA signal.

Each analog input has a positive and negative terminal, and may be placed at any point in the current



Note:
AI must be within 27V of COM. If terminal voltages exceed this, a loop isolator must be used.

loop, as long as neither input rises above the 24 volt supply level. Each input has a loop resistance of less than 250 ohms and zener diode protection is provided against over-voltage and reverse voltage, however additional protection may be required in high voltage or noisy environments or for very long wiring runs.

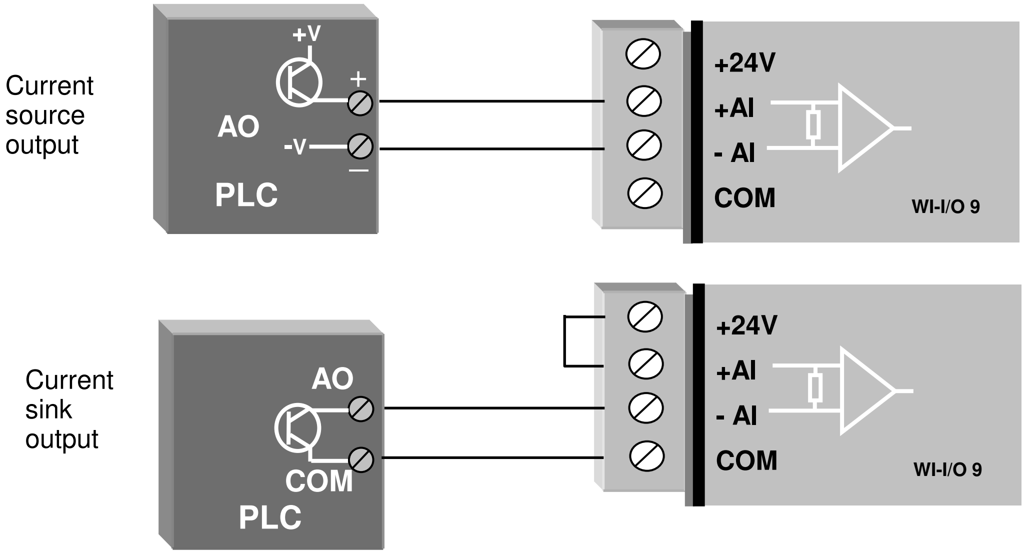
A 24VDC loop supply is available on the module for powering the analog transducer loops. In this case, the analog loop should be connected between a "AI 1-" terminal and "COM" (for the first analog input) or "AI 2-" (for the second analog input), and so on for other inputs.

The positive terminal ("AI 1+" or "AI 2+", etc) should be connected to "+24V".

Externally powered loops may be connected by connecting the input between "AI 1+" and "AI 1-" for analog input 1 or "AI 2+" and "AI 2-" for analog input 2, and so on for other inputs. Common mode voltage may be -0.5V to 27V.

Shielded cable is recommended for analog I/O loops to minimise induced noise and Radio Frequency Interference (RFI). The shield of the cable should be connected to earth at one of the cable only. The use of shielded wiring inside an enclosure containing a module is also recommended.

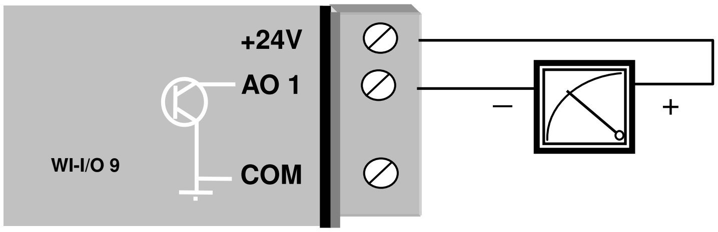
To connect an AI on the WI-I/O 9-x to an analog signal from a PLC or DCS output, check the internal circuit of the output carefully as different devices use different ways to create an analog signal. The following diagram shows two ways of connecting.



Note:
1. AI must be within 27V of COM. If terminal voltages exceed this, a loop isolator must be used.
2. COM on the WI-I/O is connected to ground/earth. If the COM of the PLC cannot be grounded, then a loop isolator must be used.

2.4.5 Analog Outputs (WI-I/O 9-1 and WI-I/O 9-3)

The "-1" module provides two 4 - 20 mA DC analog outputs for connecting to instrument indicators for the display of remote analog measurements. The "-3" module provides eight 0 - 20 mA DC analog outputs. Each analog output is a "sink" to common.

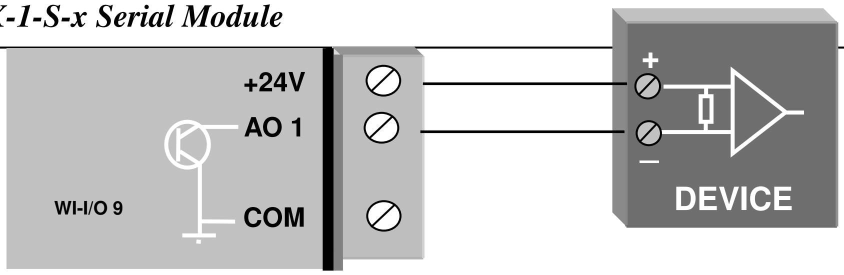


A 24VDC supply is available on the module for powering the analog output loop (max external loop resistance 1000 ohms). In this case, the analog loop is connected between a "+24V" terminal and "AO 1" (for the first analog output) or "AO 2" (for the second analog output), and so on for the other output signals.

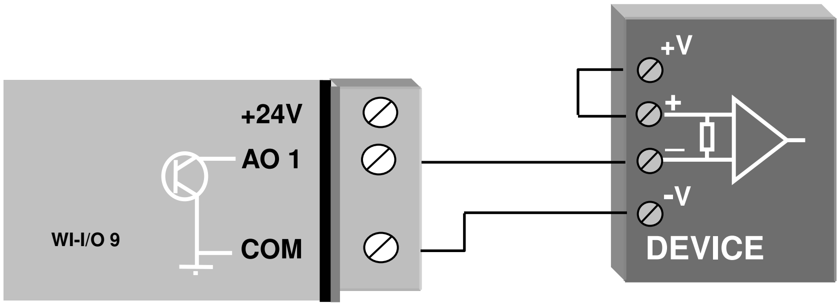
If connecting to an external device such as an electronic indicator, recorder or PLC / DCS input, the loop can be powered by either the WI-I/O 9-x or the device. Externally powered loops to 27 VDC may be connected by connecting the output between the "AO" terminal (positive) and the "COM" terminal (negative). Zener protection of analog outputs provides protection against short periods of over-voltage but longer periods **may result in module damage**.

Note that the common is connected internally to ground and no other point in the analog loop should be grounded. If the external device has single-ended grounded inputs, then a signal isolator must be used.

Analog outputs may also be configured to individually turn off (0 mA) if no command message is received to that output for a certain period. . See Chapter 4 **Configuration** for further details.

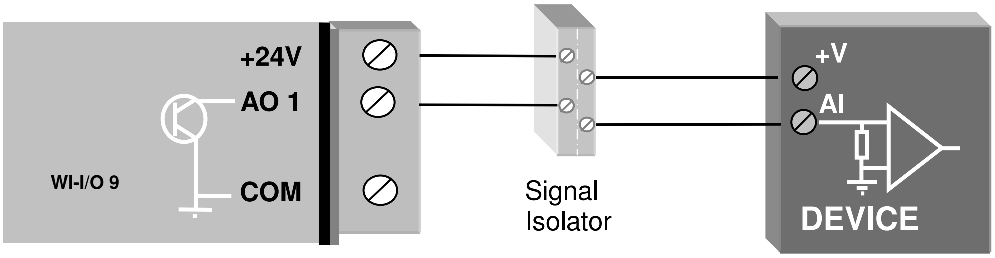


Connecting to a floating input device, powered from the WI-I/O 9-x



Note:
COM on WI-I/O 9-x is connected to ground/earth. If the external power supply cannot be grounded, a loop isolator must be used.

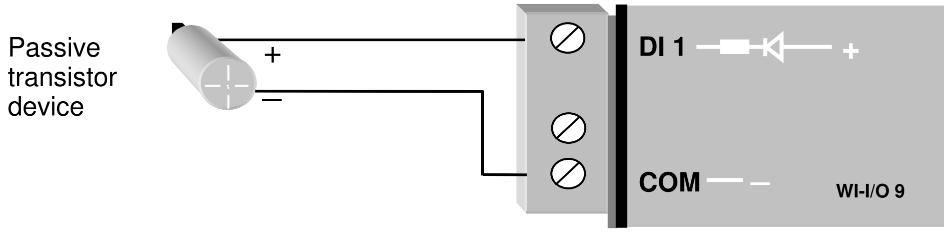
Connecting to an externally powered floating-input device

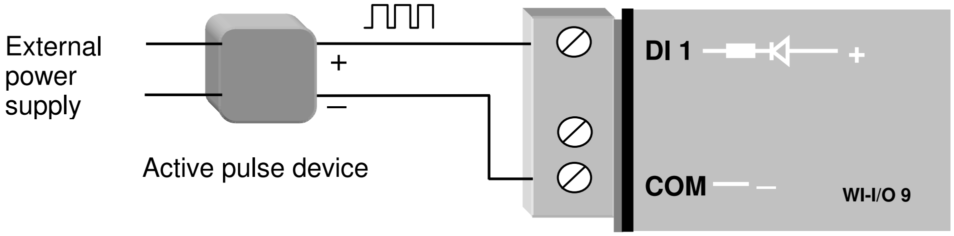


Connecting to a grounded input device via a signal isolator

2.4.6 Pulse Input (WI-I/O 9-1)

For the ”-1” module, digital input 1 may be configured as a pulse input (max rate 100 Hz, min. off time 5 ms). In this mode, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analog output on the remote unit, while the pulse count can appear at a Pulse Output on another ”-1” or Digital/Pulse Output on a ”-3” or “-4” unit. The pulse input should be connected in the same way as a digital input.





Note:
Use a solid state relay if the voltage range is not suitable.

Active pulse signals can be connected directly provided the peak voltage is between 3.5–13V and the low voltage is less than 1.5V. Note that the WI-I/O 9-x will ground the negative of the pulse signal. If the voltages are not compatible, use a solid state relay to isolate the two devices.

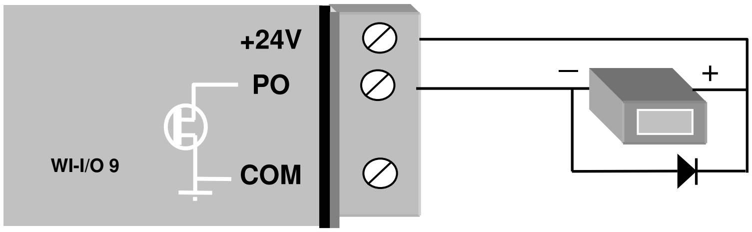
2.4.7 Pulse Inputs (WI-I/O 9-2 and WI-I/O 9-4)

For the ”-2” and ”-4” modules, the four digital inputs (DI 1-4) may be configured as pulse inputs. The first digital/pulse input DI 1 has a maximum rate of 1000 Hz (min. off time 0.5 ms), while DI 2-4 have a maximum rate of 100 Hz (min. off time 5 ms). When using DI 1 at high pulse rates (more than 100 Hz), a divide by 10 function may be configured to reduce the pulse count at the output, as Pulse Outputs have a maximum rate of 100 Hz.

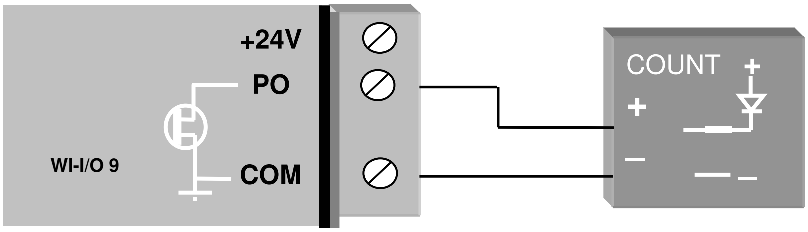
For each pulse input, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analog output on the remote unit, while the pulse count can appear at a Pulse Output. The default update time for pulse counts is 1 minute. This can be changed by changing the update time configuration (refer Chapter 4 **Configuration** for further details). The pulse count is a 16 bit value - “roll over” of the count when it exceeds the maximum value is automatically handled by the modules.

2.4.8 Pulse Output (WI-I/O 9-1)

A single FET output to common rated at 30VDC, 500 mA is provide for the pulse output "PO". This output accurately recreates the pulses counted at a pulse input at another module.



Use by-pass diode if counter is inductive.



Use solid-state relay isolator if voltages are not compatible

If the counter device requires a voltage pulse signal (such as electronic or elector-mechanical counters), use the 24V analog loop supply, or the 12V BAT supply for the voltage source. Use a by-pass diode if the counter is inductive.

Some devices such as PLC counter modules power the pulse loop. For these devices, connect to the PO and COM terminals of the WI-I/O 9-x. The COM terminal will connect a ground/earth to the external device. If this is not suitable, use a solid state relay to isolate the external device.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analog output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred. The maximum output rate is 100 Hz.

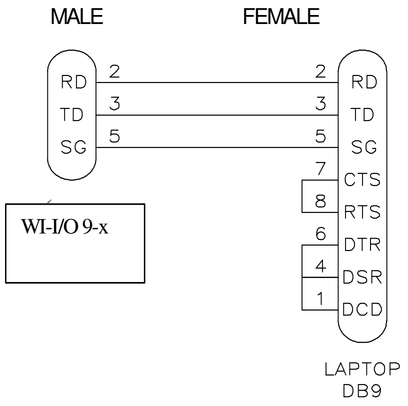
2.4.9 Pulse Output (WI-I/O 9-3 and WI-I/O 9-4)

The first four digital outputs on the ”-3” and ”-4” modules may also be used as pulse outputs. The outputs are FET output to common rated at 30VDC, 500 mA. The outputs will provide a pulse signal of up to 100 Hz. The outputs accurately recreate the pulses counted at pulse inputs at a ”-1”, ”-2” or “-4” module.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analog output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred.

2.4.10 RS232 Serial Port

The serial port is a 9 pin DB9 female and provides for connection to a terminal or to a PC for configuration, field testing and for factory testing. This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS-232 signals. The WI-I/O 9-x_WI-I/O-EX-1-S-x is configured as DCE equipment with the pin-out detailed below. The serial port communicates at a baud rate of 9600 baud, 8 bits, no parity, one stop bit. An example cable drawing for connection to a laptop is detailed below:



Pin	Name	Dirn	Function
1	DCD	Out	Data carrier detect - not used
2	RD	Out	Transmit Data - Serial Data Input (High = 0, Low = 1)
3	TD	In	Receive Data - Serial Data Output (High = 0, Low = 1)
4	DTR	In	Data Terminal Ready - not used
5	SG	-	Signal Ground
6	DSR	Out	Data Set Ready - not used
7	RTS	In	Request to Send - not used
8	CTS	Out	Clear to send - not used
9	RI	-	Ring indicator - not used.

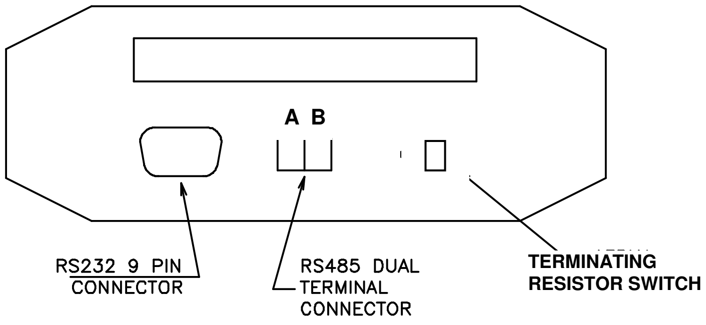
2.4.11 RS485 Serial Port

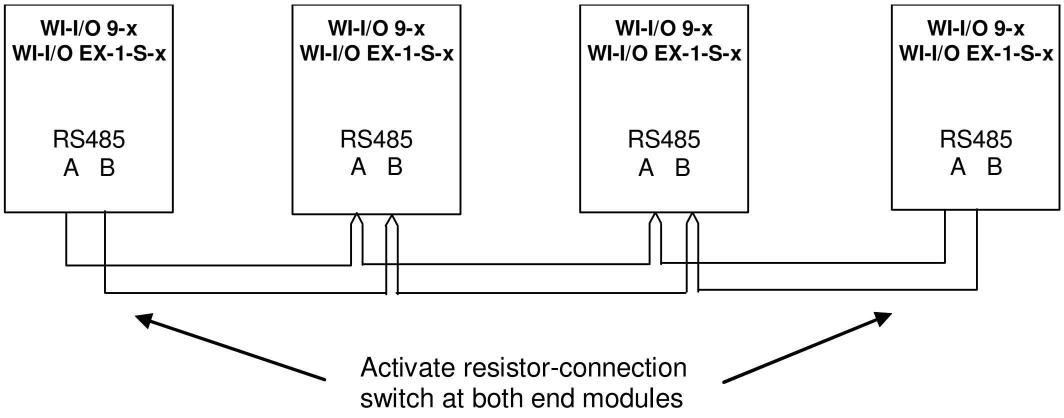
The RS485 port provides for communication between multiple units using a multi-drop cable. Up to 32 units may be connected in each multi-drop network. Each multi-drop network may have one unit providing radio communications with other units in the system. The RS485 feature allows local hubs of control to operate without occupying radio bandwidth required for communication between remotely sited units.

The RS485 Communications format is 9600 baud, 8 data bits, one stop bit, no parity. Note that the RS485 port is shared internally with the RS232 port - disconnect the RS232 cable after configuration is complete.

RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential Radio Frequency Interference (RFI). An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120 ohm resistor.

The modules include a terminating resistor on-board. If the WI-I/O 9-x module is the first or last module in the RS485 chain, then the terminating resistor may be connected by operating the single DIP switch in the end-plate next to the RS485 terminals. “On” or “down” means that the resistor is connected.





2.4.12 Connecting WI-I/O-EX-1-S-x Modules to WI-I/O 9-x Modules

WI-I/O-EX-1-S-x modules connect to a WI-I/O 9-x via the RS485 port on each module (refer to section 2.4.11). Up to 31 x WI-I/O-EX-1-S-x modules can be connected to a WI-I/O 9-x module. This number is reduced for WI-I/O-EX-1-S-3 and –4 modules, as these modules use two unit addresses (refer to chapter 4 of this manual).

The WI-I/O-EX-1-S-x modules can be mounted next to the WI-I/O 9-x module, or they can be remote from the WI-I/O 9-x. The reliable distance for a RS485 multi-drop line depends on the shielding of the wire and how close it is installed to electrical noise sources - distances of more than ½ mile (1 km) can be achieved by good installation methods. External RS485 isolators are recommended if the earth potential difference between modules is greater than 7V.

3.1 Power-up and Normal Operation

When power is initially connected to the module, the module will perform internal diagnostics to check its functions. The following table details the status of the indicating LED's on the front panel under **normal** operating conditions.

LED Indicator	Condition	Meaning
OK	On	Normal Operation
RX	Occasional flash	Radio Receiving, or Activity on serial ports
RX	Flashes continuously	Configuration Mode
RX	On	Button press when entering Configuration Mode
TX (only on WI-I/O 9-x units)	Occasional flash	Radio Transmitting
PWR	On	Supply voltage available from Solar Panel or SUP1/SUP2
OK	Flashes every 5 seconds	+24V Supply overloaded

Additional LED's provide indication of the status of digital inputs and outputs. LED's display the status of each digital input (lit for active), and LED's display the status of each digital output (lit for active). Other conditions indicating a fault are described in Chapter Six **Troubleshooting**.

The module monitors the power supply and provides status of supply failure and battery low voltage for "mapping" to one of the module's own outputs or transmitting to a remote output. When the module is powered from a normal supply (i.e. via either of the "SUP" terminals), the *PWR* LED indicator is lit. When the module is powered from a solar panel and battery, the *PWR* LED indicator is lit only when the charge current is available (i.e. when the solar panel is receiving light).

If a backup battery is connected, the module will generate a low battery voltage status when the voltage has dropped to 11.3V for approx 45 seconds. This status may be transmitted to another module. In the event of excessively low battery voltage (10.8V), the *OK* LED will go off, the unit will automatically set all outputs off, and disable the +24V analog loop supply. The *OK* LED will turn on again after the battery voltage exceeds 11.8V. This enables installations to be configured so that the battery current drain is minimised in the event of extended mains failure, reducing the possibility of deep discharge of batteries.

3.1.1 Communications

Before each transmission, the WI-I/O 9-x radio will "listen-before-transmit" to make sure that another module is not already transmitting - if there is another transmission, the WI-I/O 9-x will wait until the transmission is complete. When the WI-I/O 9-x transmits, it will wait for a return "acknowledgement" message from the destination module, indicating a successful message. If transmissions are not

successful (radio or serial), then the module will re-try up to four times at random intervals to transmit the message.

Example of Successful Communications

Local Unit		**Remote Unit**
• Listen to ensure channel is clear		
• If clear, transmit message	→	• Receive message
TX LED flashes if radio		RX LED flashes
RX LED flashes if RS485		Check message for integrity
• RX LED flashes	←	• If message okay, transmit it back as acknowledgement
• Acknowledgement received okay – communication complete		TX LED flashes if radio
		RX LED flashes if RS485
		Outputs updated as per message received.

Example of unsuccessful communications

Local Unit		**Remote Unit**
• Listen to ensure channel is clear		
• If clear, transmit message		• Receive message
TX LED flashes if radio	→	RX LED flashes
RX LED flashes if RS485		Check message for integrity
		Message corrupted - do nothing
• No acknowledgement received		
• Retry up to four times		
• Still no acknowledgement	(4) →	• If no update received for an output within watchdog timeout, check to see if the output is configured to reset
"Comms fail" status to remote unit set		
If status is mapped to an output, set output		• Reset outputs if configured

If communications is still not successful, the "Comms Fail" internal status will be set. In the default configuration, this will have no consequence and the module will continue to attempt to transmit to the remote module every ten minutes. For critical applications, the "comms fail" status can be configured to be reflected to an output on the module for alert purposes. The outputs on the module may also be configured to reset after a specified timeout (digital outputs reset to "off", analog outputs reset to 0 mA)

allowing the system to turn off in a controlled manner e.g. a pump will never be left running because of a system failure.

> Note: The WI-I/O 9-x will hop frequencies for each re-try transmission - each re-try will follow at approx 0.5 sec after the last. So a WI-I/O 9-x will complete all re-tries in less than 3 seconds.

Repeaters can be used in a system to increase range. Each WI-I/O 9 unit can be configured to act as a repeater. When configuring an input to be mapped to an output, the communications path to the output unit, including the repeater addresses is specified. The WI-I/O 9-x acts as a *store&forward repeater*, that is, the signal is decoded and then retransmitted "as new".

Example Repeater Communications

Unit A DI 1 mapped to Unit D DO1 via Units B & C

Unit A	Unit B Repeater	Unit C Repeater	Unit D
• DI 1 is turned on			
• Transmit →	• Receive		
• Receive Acknowledge ←	• Transmit on with Acknowledge →	• Receive	
	• Receive Acknowledge ←	• Transmit on with Acknowledge →	• Receive
		• Receive Acknowledge ←	• Transmit acknowledge
			• DO 1 is turned on

3.1.2 Change of state conditions

The module transmits a data message whenever it detects a "change-of-state" on one of its input signals. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa provided the change is sustained for 0.5 second (i.e. 0.5 second debounce). The debounce delay is configurable.

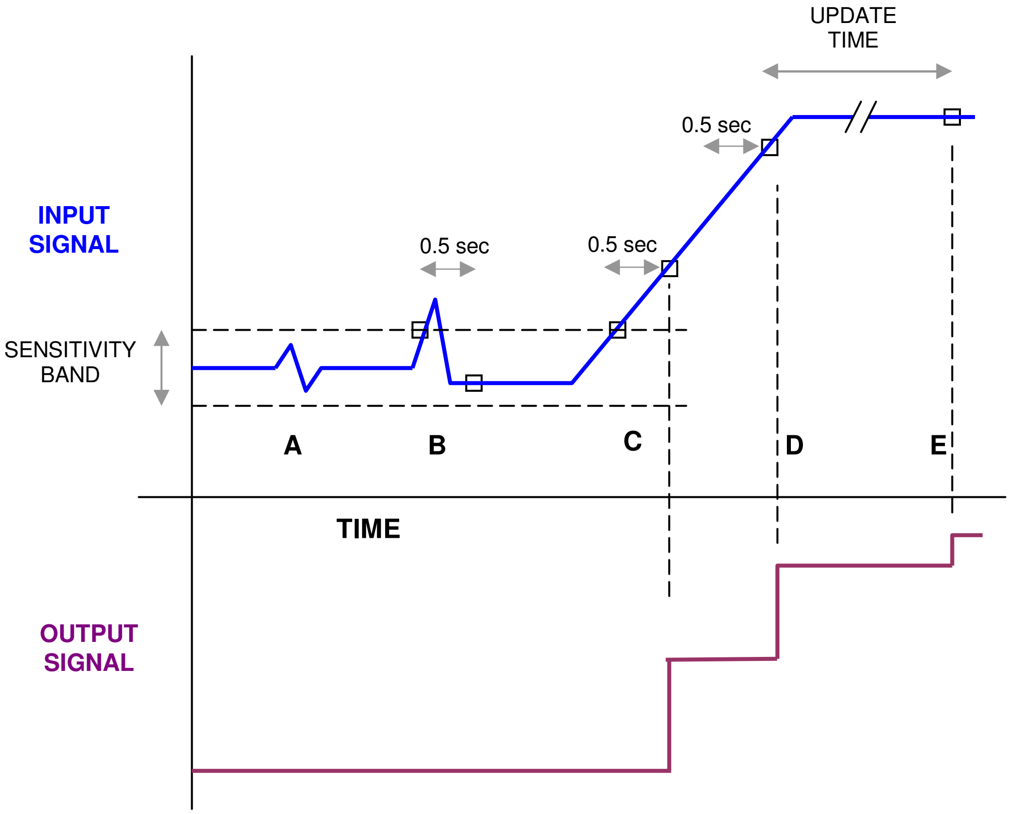
In addition to "change-of-state" transmissions, each module will transmit the status of each input to its corresponding output every ten minutes (configurable). These **updates** mean that the outputs are set to the current input values regularly, even where no "change-of-state" has occurred. These update transmissions increase the accuracy of the output and give extra system reliability.

Analog Change-of-state

A "change-of-state" for an analog input, battery voltage or pulse input rate is a change in value of the signal of 3% (configurable) since the last transmission. Note that the sensitivity of 3% refers to 3% of the analog range, not 3% of the instantaneous analog value. That is, if an analog input changes from 64% (14.24 mA) to 67% (14.72 mA), a "change-of-state" will be detected. This "change-of-state"

sensitivity is configurable between 0.8% and 75%.

Analog inputs are digitally filtered to prevent multiple transmissions on continually varying or "noisy" signals. The input is filtered with a 1 second time constant and a 1 second debounce. The analog outputs are filtered with a 1 second time constant. An **example** of an **analog** input and how the output follows it is shown below:



A No transmission as the sensitivity band was not exceeded

B The sensitivity band was exceeded, however the input returned to within the sensitivity band before the 0.5 sec debounce time - no transmission

C Transmission occurs 0.5 sec after the sensitivity band is exceeded.

D Another transmission 0.5 sec later as the input has changed by more than the sensitivity band

E The input has not changed by more than the sensitivity, however the update time has elapsed since D.

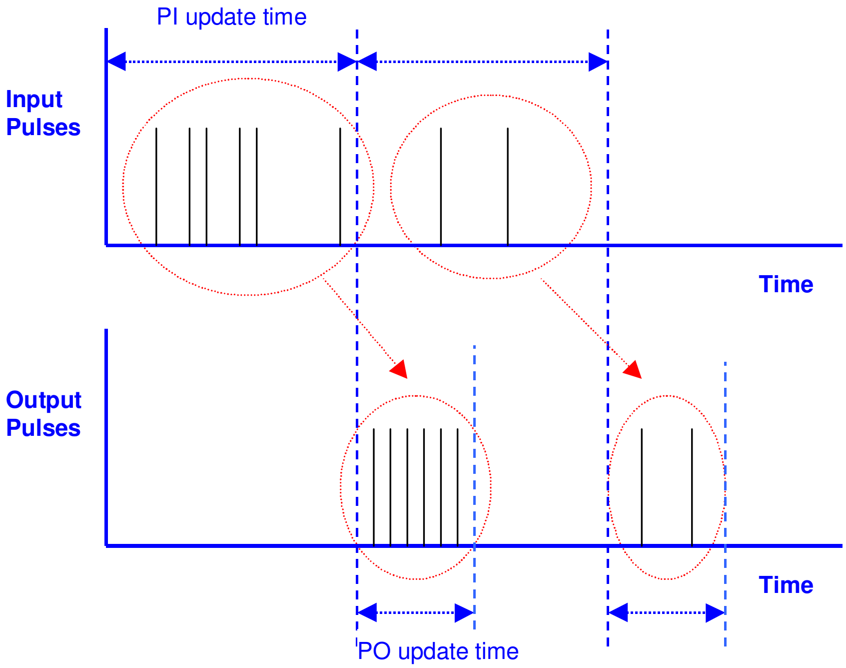
In general, the following may be used as a rule of thumb for calculating the appropriate sensitivity required for a given application:
Instantaneous change of 2 x sensitivity on input → 3 second output response
Instantaneous change of 10 x sensitivity on input → 5 second output response

The analog inputs have 15 bit resolution and 0.016mA accuracy.

Pulse input change of state

Pulse input counts do not use "change-of-state" transmissions. Instead, accumulated pulse input counts are transmitted at set intervals. The default period is 1 minute and is configurable. The absolute pulse count is transmitted. If the PI is transmitted to a PO on a WI-I/O 9-x_WI-I/O-EX-1-S-x module, then the pulse outputs are re-created from the *accumulated* pulse count. Rollovers of the pulse count thru zero are catered for. If a transmission is missed, the pulse output will still be re-created when the next accumulated value is transmitted. This ensures that no pulses are lost due to communications failures. If the PI is transmitted to a WI-I/O 9-C interface module, then the accumulated pulse count is stored in the WI-I/O 9-C for interfacing to the host device.

The following diagram shows how pulse inputs are re-created as pulse outputs. For pulse outputs, the module keeps two counters in memory - the pulse input count received from the remote module, and the count of output pulses. When the module receives an update of the input pulse count, it will output pulses until the output pulse count is the same as the input pulse count. The output pulse will be output evenly over the pulse output update time which is configured in the module. For example, assume that module receives a pulse input update message from the remote module, and the difference between the pulse input count and the pulse output count is 12 pulses. The module will then output the 12 pulses evenly over the next minute (if the pulse output update time is 1 minute).



The default values for the pulse input update time and pulse output update time is 1 minute. In this case, the output pulses are effectively 1 minute behind the input pulses. These update times may be changed by the user. The pulse output update time should not be set to be more than the pulse input update time. Note that the maximum pulse rate for both inputs and outputs is 100Hz.

As well as accumulating the pulse input, the module will also calculate the rate of pulses. **Pulse rates** are treated as an "internal" analog input and are configured with analog sensitivities for change-of-state transmissions. The maximum pulse rate corresponding to 20mA output may be configured by the user.

3.1.3 Analog Set-points

On "-1" modules, the "AI 1" input may be used to trigger the analog set-point status. High set point and low set point levels are configurable. This set-point status turns ON when the analog input moves below the low level, and turns OFF when it moves above the high level. The high level must always be greater than, or equal to, the low level set point. This set-point status may be mapped (inverted, if required) to any output in the network. The set-point status is effectively an internal digital input.

On "-2" modules, AI 1 - 4 have set-point values for controlling digital outputs. The set-point operation works as for the "-1" module.

3.1.4 Start-up Poll

After a module has completed its initial diagnostics following power up, it will transmit update messages to remote modules based on the values of the module's inputs. The module's outputs will remain in the reset/off/zero condition until it receives update or "change-of-state" messages from the remote modules.

The module can transmit a special "start-up poll" message to another module. The remote module will then immediately send update messages to this module such that its outputs can be set to the correct value. Start-up polls will only occur if they are configured. It is necessary to configure a start-up poll to each remote module which controls the module's outputs. For further information (refer to Chapter 4 Configuration).

3.1.5 Communications Failure (CF)

The internal communications failure (CF) status is set if a module does not receive an acknowledgement message after five attempts at transmitting a message. The CF status may be configured to set a local digital output for an external alarm.

Although the CF status can set an output, it will not reset the output. That is, once communications is re-established (and the CF status is reset), the output will stay "on". The Reset Output feature (see below) is used to reset the output.

The output will reset only when no communications failures occur within the configured "Reset Output Time" for the output that CF status is mapped to. Note that if the reset output time is not enabled, the CF status will remain set forever, once an unsuccessful transmission occurs. See Chapter 4 **Configuration** for further details.

For a link with one or more repeaters, the internal CF status will only set for a failure between the transmitting module (the source module) and the first repeater. If the communications failure occurs after the first repeater, then the source module CF status will not set. To indicate comms status on this type of link, the "Reset Output" function should be used.

3.1.6 Resetting Outputs

Each digital and analog output may be individually configured to reset if that output has not received a change-of-state or an update message within a certain time period. Generally this time is set to twice the update period, so at least one update can be missed before an output is reset.

In most cases it is desirable to reset outputs which are controlling equipment if there is a system failure, however alarm or indication outputs are not reset so the last valid indication remains shown. See Chapter 4 **Configuration** for further details.

3.2 System Design Tips

The following tips will help to ensure that your system operates reliably.

3.2.1 System Dynamics

It is important to be aware of the dynamics of the system. Inputs have a configurable “debounce” delay (default 0.5 sec) - that is, a change message will not be sent for 0.5 sec after a change has occurred. This avoids transmitting spurious noise on the input signal. If you require faster (or slower) operation, change the debounce setting.

Messages transmitted via serial link are received in less than 20 m/sec., however a message sent by radio takes approx 60 m/sec.

These delays are not significant is most applications, however if your application requires faster responses, then the above delays need to be considered.

3.2.2 Radio Channel Capacity

Messages sent on a cable link are much faster than on a radio channel, and the capacity of the radio channel must be considered when designing a system. This becomes more important as the I/O size of a system increases.

The modules are designed to provide “real-time” operation. When an input signal changes, a change message is sent to change the output. The system does not require continuous messages to provide fast operation (as in a polling system). Update messages are intended to check the integrity of the system, not to provide fast operation. Update times should be selected based on this principle. The default update time is 10 minutes - we recommend that you leave these times as 10 minutes unless particular inputs are very important and deserve a smaller update time.

It is important that radio paths be reliable. For large systems, we recommend a maximum radio channel density of 100 messages per minute, including change messages and update messages. We suggest that you do not design for an average transmission rate of greater than 40 per minute - this will give a peak rate of approx 100 per minute. Note that this peak rate assumes that all radio paths are reliable - poor radio paths will require re-try transmissions and will reduce the peak channel density. If there are other users on the radio channel, then this peak figure will also decrease.

Dual Band Operation

The WI-I/O 9-x radio band is split into two sub-bands, 902-915 MHz and 915 – 928 MHz . In America

and Canada, the WI-I/O 9-x uses both sub-bands - but in other countries, only the high sub-band. In America and Canada, it is possible to restrict the frequency hopping of the WI-I/O 9-x to only the high or low band. If there are many WI-I/O 9-x systems in the same area, this technique will help to separate systems to avoid radio interference. Note that this technique is only possible in America / Canada.

The radio sub-band can be selected by the "system address" - refer section 4 of this manual. An odd system address selects the low band, and an even system address selects the high band.

3.2.3 Radio Path Reliability

Radio paths over short distances can operate reliably with a large amount of obstruction in the path. As the path distance increases, the amount of obstruction which can be tolerated decreases. At the maximum reliable distance, "line-of-sight" is required for reliable operation. If the path is over several kilometres (or miles), then the curvature of the earth is also an obstacle and must be allowed for. For example, the earth curvature over 5 miles (8km) is approx 10 feet (3m), requiring antennas to be elevated at least 13 feet (4m) to achieve "line-of-sight" even if the path is flat.

A radio path may act reliably in good weather, but poorly in bad weather - this is called a "marginal" radio path. If the radio path is more than 20% of the maximum reliable distance (see Specification section for these distances), we recommend that you test the radio path before installation. Each WI-I/O 9-x module has a radio path testing feature - refer to section 6.2 and 6.3 of this manual.

There are several ways of improving a marginal path :-

- Relocate the antenna to a better position. If there is an obvious obstruction causing the problem, then locating the antenna to the side or higher will improve the path. If the radio path has a large distance, then increasing the height of the antenna will improve the path.
- Use an antenna with a higher gain. Before you do this, make sure that the radiated power from the new antenna is still within the regulations of your country. If you have a long length of coaxial cable, you can use a higher gain antenna to cancel the losses in the coaxial cable.
- If it is not practical to improve a marginal path, then the last method is to use another module as a repeater. A repeater does not have to be between the two modules (although often it is). If possible, use an existing module in the system which has good radio path to both modules. The repeater module can be to the side of the two modules, or even behind one of the modules, if the repeater module is installed at a high location (for example, a tower or mast). Repeater modules can have their own I/O and act as a "normal" WI-I/O 9-x module in the system.

3.2.4 Design for Failures

All well designed systems consider system failure. I/O systems operating on a wire link will fail eventually, and a radio system is the same. Failures could be short-term (interference on the radio channel or power supply failure) or long-term (equipment failure).

The modules provide the following features for system failure :-

- Outputs can reset if they do not receive a message within a configured time. If an output should

receive an update or change message every 10 minutes, and it has not received a message within this time, then some form of failure is likely. If the output is controlling some machinery, then it is good design to switch off this equipment until communications has been re-established.

The modules provide a "drop outputs on comms fail" time. This is a configurable time value for each output. If a message has not been received for this output within this time, then the output will reset (off, in-active, "0"). We suggest that this reset time be a little more than twice the update time of the input. It is possible to miss one update message because of short-term radio interference, however if two successive update messages are missed, then long term failure is likely and the output should be reset. For example, if the input update time is 3 minutes, set the output reset time to 7 minutes.

- A module can provide an output which activates on communication failure to another module. This can be used to provide an external alarm that there is a system fault.

3.2.5 Indicating a Communications Problem

There are two ways to provide an indication of communications problems.

Fail-to-transmit alarm. The first is to map the internal CF status to a local output, to generate a "fail-to-transmit" alarm. The configured output will activate when a comms fail occurs - that is, when the module attempts to transmit a message five times without an acknowledgement. This method provides an indication immediately an attempt to transmit a message fails. If you want the radio path to be "tested" regularly, then you need to configure the update times such that transmissions occur regularly (however do not overload the radio channel).

Notes regarding this method:

1. Each CF mapping corresponds to only one remote address - you need to make separate mappings for each remote address. You can map the CF for each remote module to a separate output, or to the same output.
2. You need to reset the comms fail output using the "reset output" parameter. Select a reset time which is greater than the effective update time period. For example, if there are four inputs mapped from module #1 to module #2, each with a 10 minute update, then you would expect at least four transmissions in each 10 minute period. At module #1, a comms fail for #2 is mapped to DO1. If you set the "reset time" for DO1 to 10 minutes, then there will be at least four transmissions made during the reset period - that is, the output will only reset when the communications has been successful four times.
3. This method will not work for radio links with repeaters. If a repeater is used, you will need to use the second method described below.

Fail-to-receive alarm. The second method is to set up a "comms OK" output using the "Reset Outputs" function. The output is normally on, indicating "comms OK", and will reset if the module does not receive a message from the remote module within the configured reset time.

Consider a link between module #1 and #2, and assume that you want a "comms OK" output at #1. At #2, map an unused input to an output at #1 such that the output is normally active ('on"). If there is no spare inputs at #2, you can use an internal input such as "low voltage status". You will need to invert the mappings such that the output is normally on (because the input is normally off).

At #1, configure a reset time for the output. The reset time should be greater than the update time for the mapping at #2. If #1 fails to receive update messages from #2, then the output will reset, indicating a communications failure. Notes regarding this method:

1. This method will work with repeaters in the link.
2. The "comms OK" output is fail-safe - if module #1 fails, then the output will reset indicating a problem.
3. You should use separate outputs to indicate "comms OK" of different remote modules.
4. It is recommended that you set the reset time at #1 to more than twice the update time of the mapping at #2. This means that the comms OK output will only reset if #1 misses two consecutive updates from #2.

3.2.6 Testing and Commissioning

We recommend that you set-up and test the system with all of the modules together **before** you install the modules. It is much easier to find a configuration problem.

When the system is configured, record the radio signal strength and background noise level for each radio link. If there are future communications problems, you can compare the present measurements to the as-commissioned values. This is an effective way of finding problems with antennas, cables and also changes in the radio path (for example, the erection of new buildings).

3.3 Security Considerations

There are three dimensions of security considerations:

1. Failure to operate when required - or "operational reliability".

   The features discussed above optimize operating reliability. Using an acknowledgement and re-try protocol ensures that the transmitting module is aware whether the transmitted message has been transmitted reliably. The "fail to transmit" and "fail to receive" alarms provide indication if the radio link has failed to operate.

2. Mal-operation, or operating when not requested.

   This problem occurs when an output is "triggered" by the wrong radio device. The WI-I/O 9-x modules use frequency encoding and a very secure addressing system to ensure this does not occur. An additional security level using data encryption can also be selected.

3. Malicious operation, or "hacking"

   This is the problem most associated with security concerns - the ability for someone to access information from a radio system by "listening-in", or to cause damage by transmitting radio messages to force outputs.

A security option can be selected during the module configuration to protect against this. The security option (if selected) adds data encryption to radio messages. Modules in the same system are

automatically configured with the encryption key, such that only these modules can understand each other. “Foreign” modules will hear the messages, but cannot decrypt the messages. For more information, refer to section 4.3.7.

Chapter Four CONFIGURATION

4.1 Introduction

The modules are configured by connecting a computer (PC) using the Configuration Software program. The same software program is used to configure WI-I/O 9-x and WI-GTWY-9-xxx modules - for more information, refer to the separate User Manuals for these products.

Each module is configured with a system address and a unit address. The system address is common to every module in the same system, and is used to prevent "cross-talk" between modules in different systems. Separate networks with different system addresses may operate independently in the same area without affecting each other. The system address may be any number between 1 and 32 767. The actual value of the system address is not important, provided all modules in the same system have the same system address value. **A system address of zero should not be used.** The configuration program automatically offers a random number for the system address - you can change this to any number in the valid range but we recommend that you use the random number.

Each module must have a unique unit address within the one system. A valid unit address is 1 to 127. A network may have up to 95 addresses communicating via radio (unit addresses 1 to 95), each with up to 31 modules communicating via RS485 (unit addresses 96 to 127). In the network, any individual input signal may be "mapped" to one or more outputs anywhere in the system. The unit address determines the method of communication to a module. Any module with a unit address between 96 and 127 will communicate by RS485 only. Other units with a unit address below 95 may communicate by radio *or* RS485 - the unit will determine which way to communicate depending upon the unit address of the destination module. For example, Unit 31 will talk to Unit 97 by RS485 only, but will talk to unit 59 by radio only. WI-I/O-EX-1-S-x units must always have a unit address between 96 and 127 as serial communication is the only method of communication available. **A unit address of zero should not be used.**

The four different I/O versions in the range can be used together in the same system. WI-I/O 9-x and WI-GTWY-9-xxx modules can also be part of a system. Inputs to one product type can be transmitted to outputs of another product type. For example, an analog input to a ”-2” may be transmitted to an analog output of a ”-1” or ”-3”. Repeaters may be any product type.

The ”-1” and ”-2” modules require only one unit address. The ”-3” and ”-4” modules use two addresses, however only one unit address has to be entered. The ”-3” and ”-4” modules require two addresses because of the large number of output channels. If the “entered" unit address is an even number, then the second address is the next number. If the "entered" address is an odd number, then the second address is the previous number. So the two addresses are two subsequent numbers, starting with an even number. If a ”-3” module is given a unit address of 10, then it will also take up the unit address 11 and will accept messages addressed to either 10 or 11. It is important to remember this when allocating unit addresses to other modules in the system.

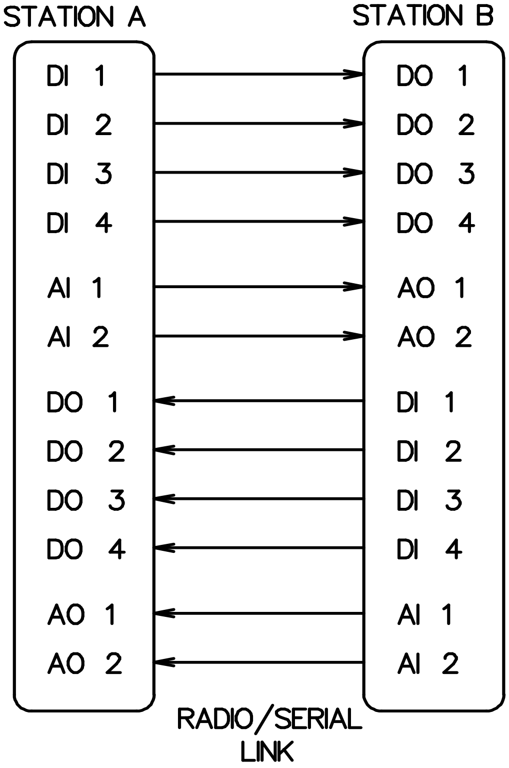
Warning - do not allocate the address number 1 to a “-3” or “-4” module.

In addition to these network configurations, operational parameters called **User Options** may be configured to change the features of the operation.

4.2 Easy Configuration Using Default Settings

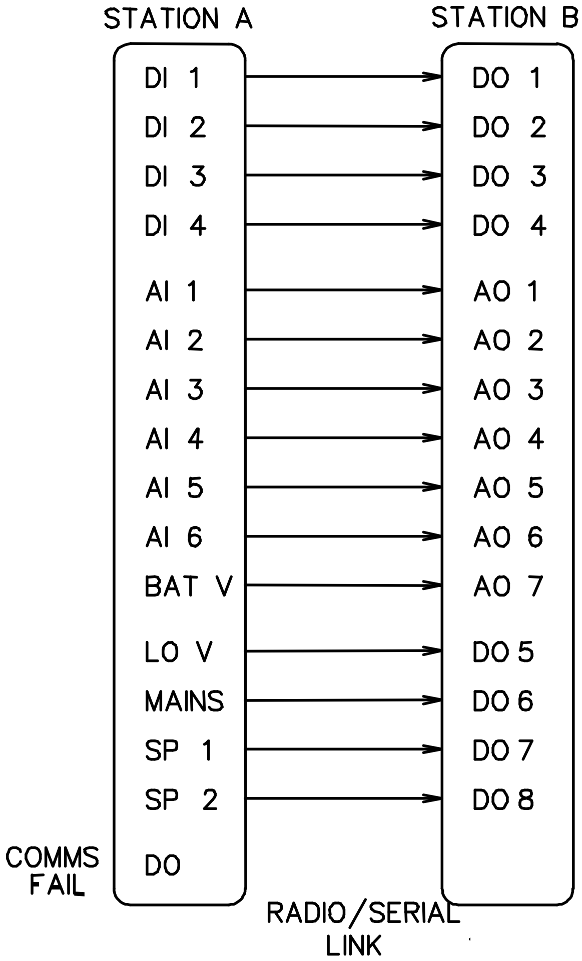
If your application requires only a single pair of modules, communicating via radio or serial link, default settings may satisfy your needs. If so, no configuration is required. Essentially, all inputs at Module A are reflected at the corresponding outputs at Module B. All inputs at Module B are reflected at the corresponding outputs at Module A.

For "-1" modules, the default configuration is as follows :-



In this configuration, the "PO" Pulse output is inactive and no special action is taken on "Comms fail", "Mains fail" or "Battery Low". "DI 1" is configured as a digital and not a pulse input.

For "-2" and "-3" modules, the default configuration is as follows :-



Note that there is no default configuration for the "-4" modules.

The following table details the default values for **User Options**:

Option	Factory Set Value
Update transmissions	Every 10 minutes
Analog Change-of-state sensitivity	3%
Reset outputs on Comms fail	No
Analog Setpoints (if mapped)	Low Set point = 30% High Set point = 75%
Pulse Output Rate Scaling (if Pulse Rate is mapped)	100 Hz
Digital Input Debounce Time	0.5 seconds

If any of the above values are not appropriate to your system, Section 4.4 below will detail how to change one or all of the above variables.

This chapter describes installation and operation of configuration software for the radio and serial telemetry modules. The configuration software runs on a conventional PC as a Windows application. The software creates a configuration file which can be loaded into a module via RS232. The configuration software also allows the configuration of a module to be loaded for display and modification. Configuration files are created and stored in project directories.

Configuration of modules consists of entering I/O mappings, and selecting User Options. An I/O mapping is a link between an input on the module being configured and an output on another module. A mapping has the form :-

DI3 → Out2 at 4 via 3, 11

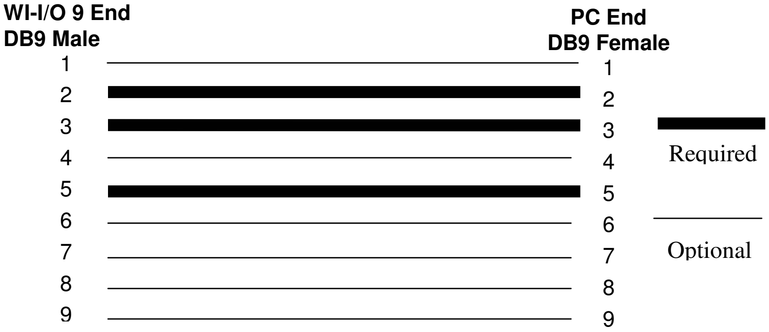
This mapping links DI3 on this module to output channel 2 on the module with address 4, and modules 3 and 11 are repeaters.

User Options may be selected to change the configuration of specific features.

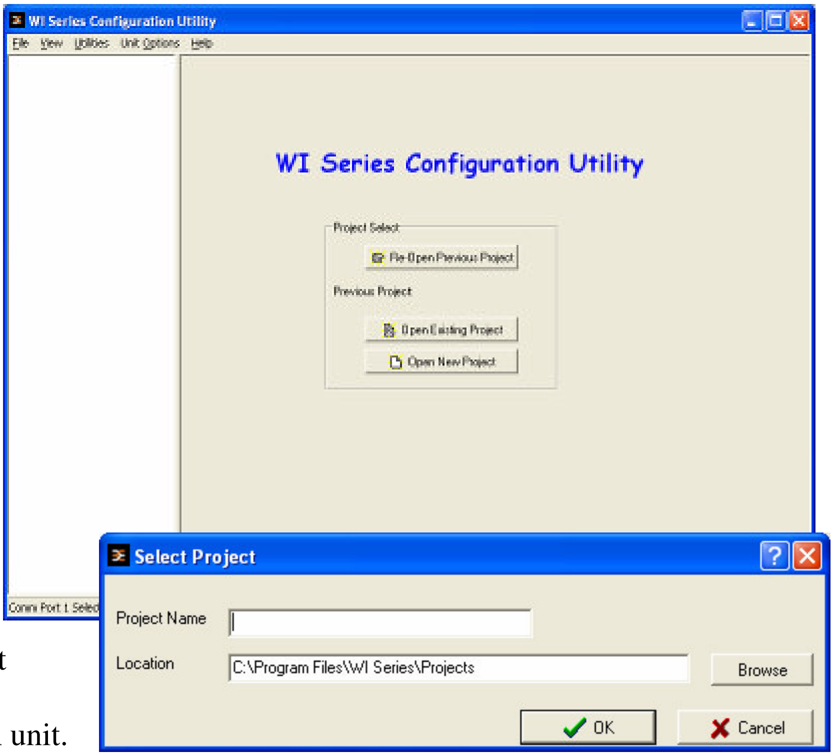
Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

4.3.1 Hardware and Software Requirements

The configuration software is available on a CD, and needs to be installed on your PC before you can use it. The CD contains a setup file called *setup.exe*. Select the configuration software window on the Product CD and an installation Wizard will guide you through the installation procedure. To upload and download configuration files to a module, you will need a RS-232 serial cable as shown below.



4.3.2 Program Operation



Project Name

Location C:\Program Files\WI Series\Projects

Start the software by either clicking on the start bar and navigating to the Configuration menu or by running WISeries.exe in the directory selected in the setup stage.

The Initial screen will appear. The configuration is performed for a complete system. The necessary configuration stages are:

- select system name and system address
- select individual units and unit addresses
- configure I/O mappings for each unit
- configure user options for each unit
- load the configuration files into each unit.

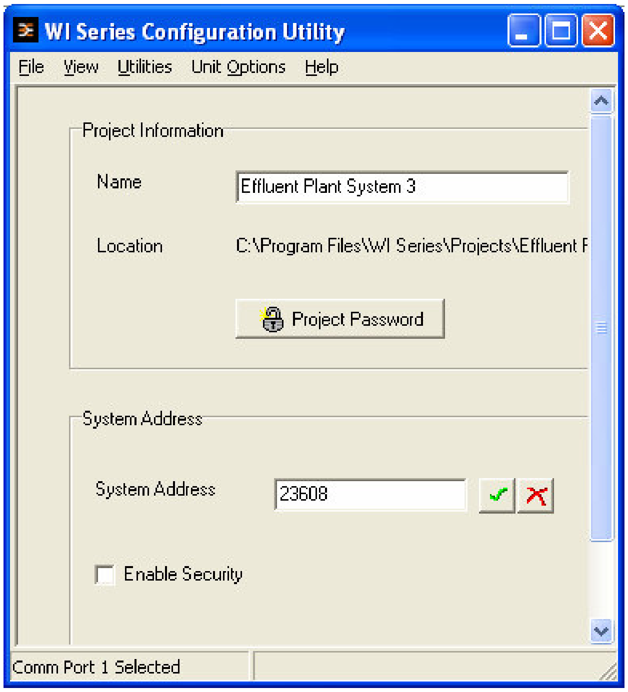
From the initial screen, you can select an existing project, or start a new project. The name of the project will create a new directory which will eventually contain the configuration files for the modules in this system.

When you have selected the project, a screen will appear where you may enter the system address.

If you are editting an existing project, the system address will already have been entered. Do not change the system address unless you are going to re-program all of the modules in the system.

Password. You have the option of entering a password to protect the configuration files against unauthorized changes. When you open a new project, you will be asked to enter a password - if you do not enter any text - that is, press "ESC" or "Enter", then password protection is disabled. If you do enter a password, then you will need to enter this password to make changes to the configuration or download or upload configuration. You only need to enter the password each time you enter the project. Without the passowrd, you are able to view the configuration details but you cannot make changes.

The password can be between 6 and 256 characters. You can also change password by selecting this option from the "Utilities" menu.



Name Effluent Plant System 3

Location C:\Program Files\WI Series\Projects\Effluent F

System Address 23608

☐ Enable Security

Comm Port 1 Selected

If you are starting a new project, you have the option of "Enabling Security" - please read Section 4.3.7 and the associated warnings before using this option.

To proceed with the configuration, double-click on the project name on the menu on the left side of the screen. "Units" will appear. You can now enter the types of units which will be used in the system. If you double-click on "Units", then the modules that have already been selected will appear.

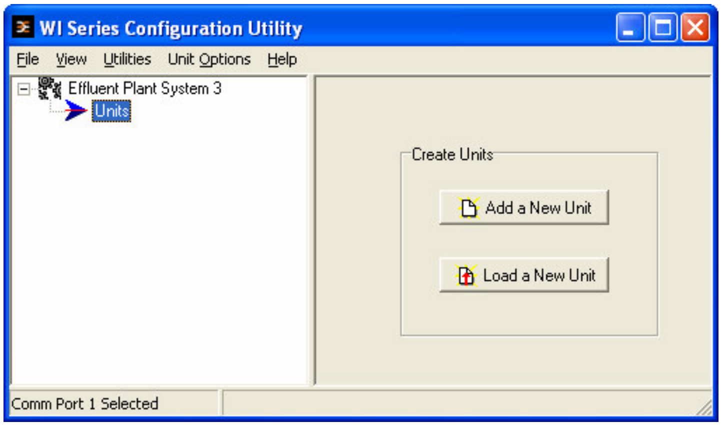
Loading configuration from an existing module

To load the configuration from a module, connect the module to the PC via the RS232 cable and click on "Load Unit". This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3.3 for more information.

Adding a new module to the system configuration

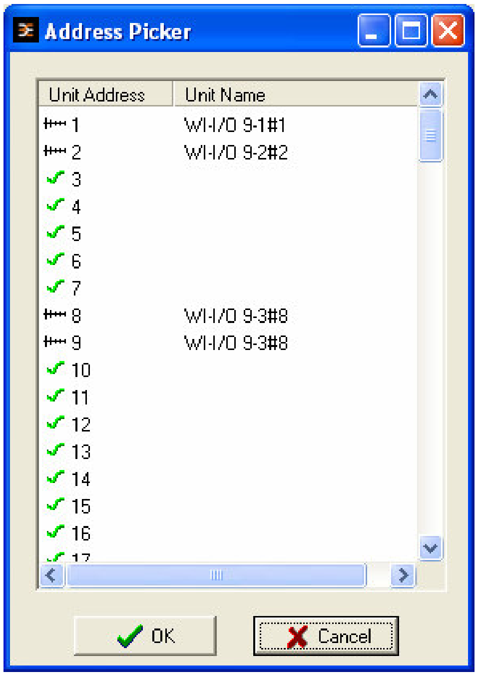
To add a new module to the system configuration, click on "Units" on the left-hand menu and then "Add Unit". Select the type of module from the list.

Note that this program covers WI-I/O-EX-1-S-x and WI-I/O 9-x modules. These modules are essentially the same as far as configuration is concerned. That is, a WI-I/O 9-1 selection will configure a WI-I/O-EX-1-S-1 or a WI-I/O 9-1.



The program will ask to select the unit address and will display the list of available addresses for you to select. For WI-I/O 9-x modules, select an address between 1 and 95. For WI-I/O-EX-1-S-x modules, select an address between 96 and 127.

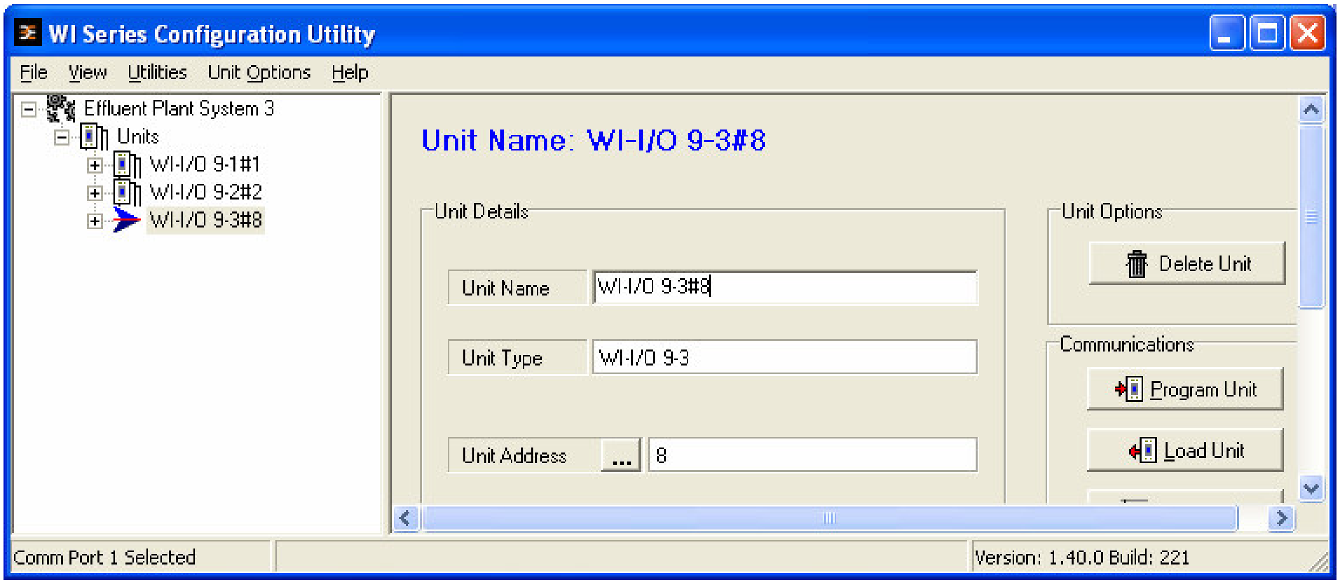
The default name for a unit will include the unit address. For example, "WI-I/O 9-3#8" is a WI-I/O 9-3 module with unit address 8 (and also 9, as a -3 takes two unit addresses). You can change the name of a unit - for example, you could replace the default name with "Pump Station 14".



Unit Address	Unit Name
1	WI-I/O 9-1#1
2	WI-I/O 9-2#2
✓ 3	
✓ 4	
✓ 5	
✓ 6	
✓ 7	
8	WI-I/O 9-3#8
9	WI-I/O 9-3#8
✓ 10	
✓ 11	
✓ 12	
✓ 13	
✓ 14	
✓ 15	
✓ 16	

Deleting a Unit

A module can be deleted from the configuration by highlighting the unit and selecting "Delete Unit".



Unit Name: WI-I/O 9-3#8

Unit Name: WI-I/O 9-3#8

Unit Type: WI-I/O 9-3

Unit Address: 8

Comm Port 1 Selected

Version: 1.40.0 Build: 221

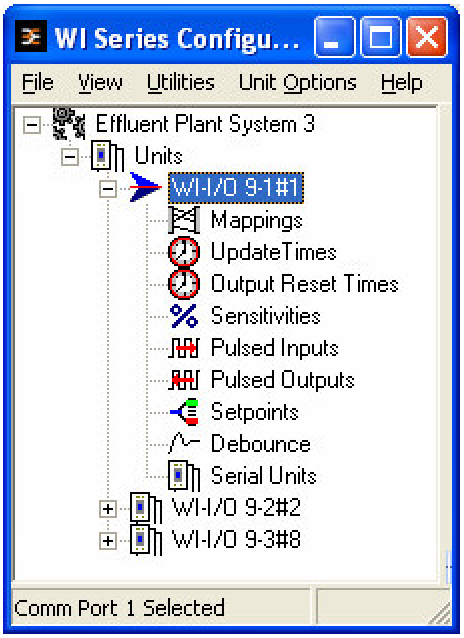
Configuring an individual module

Double-click on a unit shown on the left-hand menu. The configuration options for each unit will appear. We recommend that you configure I/O mappings first, and then other options.

Select "Mappings" and the following screen appears. There are three types of mappings:

- I/O mappings which link inputs to outputs
- Poll mappings, which enables a module on start-up to request set its outputs quickly

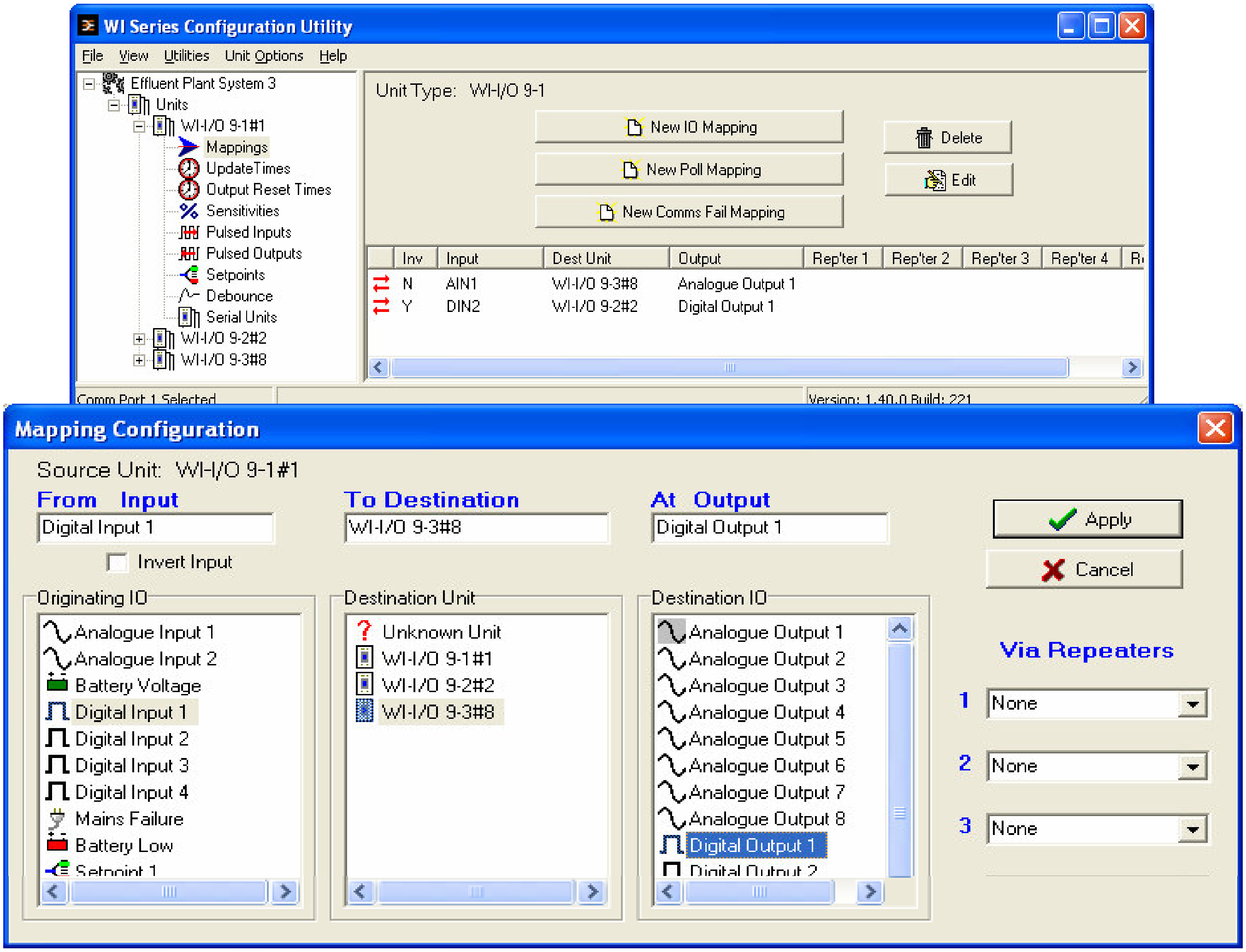
Comms Fail mappings, which maps communication failure status to an output on the local module.



Comm Port 1 Selected

I/O Mapping To enter an I/O mapping, select "New I/O Mapping".

1. The I/O mapping display will show all inputs at the selected module - both physical inputs and internal inputs. Select the input to be mapped.
2. If you wish to invert the mapping, select the "Invert Input" box. If you invert an input, then the output will be the reverse of the input. Analog I/O can also be reversed - 4mA will be 20mA etc. **Do not invert pulse inputs.**
3. The invert function is not available on -2 modules - only inverted digital inputs are available (as internal inputs on the input list).
4. To select the destination module, you can either select the module from the "Destination Unit" list, or enter the unit address in the "To Destination" box. You can enter an address that has not yet been allocated to another unit.
5. You can select the output by entering the output number (1 – 8) in the "output" box, or select an output from the displayed list. There will only be a list of possible outputs displayed if at step 2 you selected a desrtination until that has already been configured in the system. The output numbering



Unit Type: WI-I/O 9-1

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'ter 4	R
N	AIN1	WI-I/O 9-3#8	Analogue Output 1					
Y	DIN2	WI-I/O 9-2#2	Digital Output 1					

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Mapping Configuration

Source Unit: WI-I/O 9-1#1

From Input: Digital Input 1

☐ Invert Input

To Destination: WI-I/O 9-3#8

At Output: Digital Output 1

Via Repeaters

1 None

2 None

3 None

	WI-I/O 9-1	**WI-I/O 9-2**	**WI-I/O 9-3 First addr (Even)**	**WI-I/O 9-3 Second addr (Odd)**	**WI-I/O 9-4 First addr (Even)**	**WI-I/O 9-4 Second addr (Odd)**
Output 1	DO 1	DO 1	D/P O 1	AO 1	D/P O 1	DIO 5
Output 2	DO 2	None	D/P O 2	AO 2	D/P O 2	DIO 6
Output 3	DO 3	None	D/P O 3	AO 3	D/P O 3	DIO 7
Output 4	DO 4	None	D/P O 4	AO 4	D/P O 4	DIO 8
Output 5	AO 1	None	DO 5	AO 5	DIO 1	DIO 9
Output 6	AO 2	None	DO 6	AO 6	DIO 2	DIO 10
Output 7	PO	None	DO 7	AO 7	DIO 3	DIO 11
Output 8	None	None	DO 8	AO 8	DIO 4	DIO 12

6. If you select a WI-GTWY-9-xxx as the destination module, you will be asked to select a I/O Register as the destination “output”. Note that the grey-shaded I/O registers have already been allocated.
7. Select any intermediate repeater units needed to reach the destination address (entered in order of nearest to furthermost repeater). You can either select from the list of configured units or enter the unit address in the “Repeater” box. If no repeaters are required, do not enter anything in the repeater boxes. If only one repeater address is required, enter the address in box 1 and leave the other repeater boxes empty.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

It is possible to configure multiple mappings for an input - each mapping will generate separate transmissions. We recommend that you do not configure multiple mappings to the same output as the output will have the value of the last message that it receives. Each output should have only one mapped input.

It is possible to map a digital input to an analog output - the output will be maximum value when the input is on and minimum value when the input is off. It is also possible to map a analog input to an digital output - the output will be on when the input is equal or greater than 12mA and off when the input is less than 12mA.

For more information on using WI-I/O-EX-1-S-x modules, refer to Section 4.3.8.

Edit existing mappings

To edit an existing mapping, double-click on the mapping line, or select the mapping line and “Edit”.

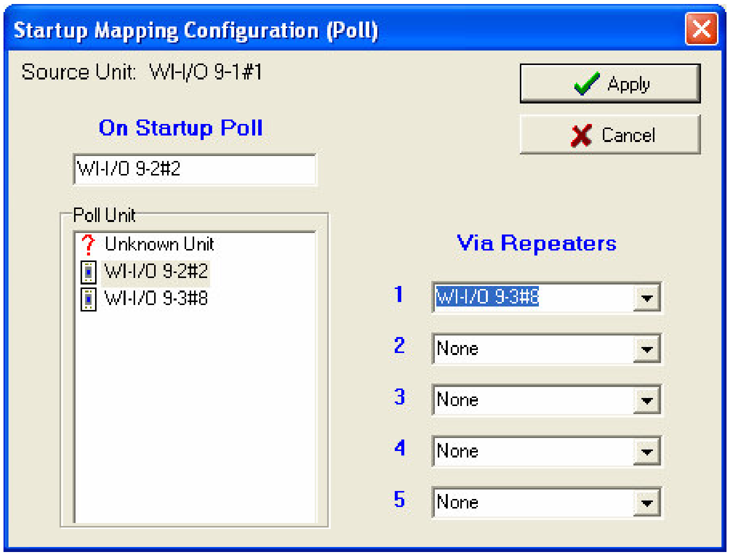
To delete an existing mapping

To delete a mapping, select the mapping and delete or right-mouse click and select Delete.

Configuring Start-Up Polls

When a unit is first turned on, its outputs will not be set until it receives update messages from other units in the system. To that outputs are set as soon as possible after start-up the unit may be configured to "Poll" any other units with mapping s to its o utputs.

Select the remote unit to be polled from the unit list, or enter the unit address in the box. If the remote unit communicates via repeaters, select the repeater units or enter the repeater addresses.



Source Unit: WI-I/O 9-1#1

On Startup Poll: WI-I/O 9-2#2

Poll Unit:
- Unknown Unit
- WI-I/O 9-2#2
- WI-I/O 9-3#8

Via Repeaters:
1 WI-I/O 9-3#8
2 None
3 None
4 None
5 None

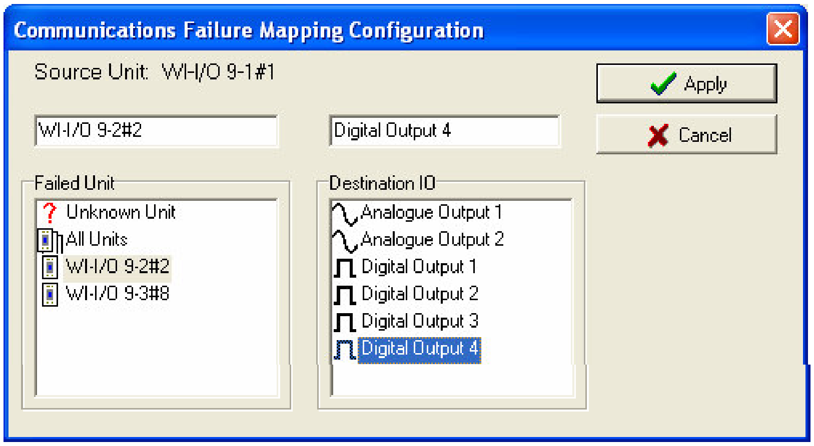
Remember that if more than one remote unit is controlling the local outputs, then more than one start-up poll should be configured.

Configuring Comms Fail Mappings

Each module has a "comms fail" status which may be mapped to a local output. The comms fail status is active (on) if the module is transmitting a message and does not receive an acknowledgement after five tries. By setting the comms fail status to a local output, you can provide a communications alarm. The local output can be digital or analog - if analog, the output will go to maximum value.

Although communication failure will activate the output, successful comms does not reset the output. You must use the "Reset outputs on comms fail" option (Refer to User Options section).

different remote addresses. You can configure several comms fail mappings to the same output - the output will be active if there is comms fail to any of the remote addresses. Configuring a "Comms Fail Address" of zero causes communication failure to any destination module to be indicated on the selected output.



Source Unit: WI-I/O 9-1#1

WI-I/O 9-2#2

Digital Output 4

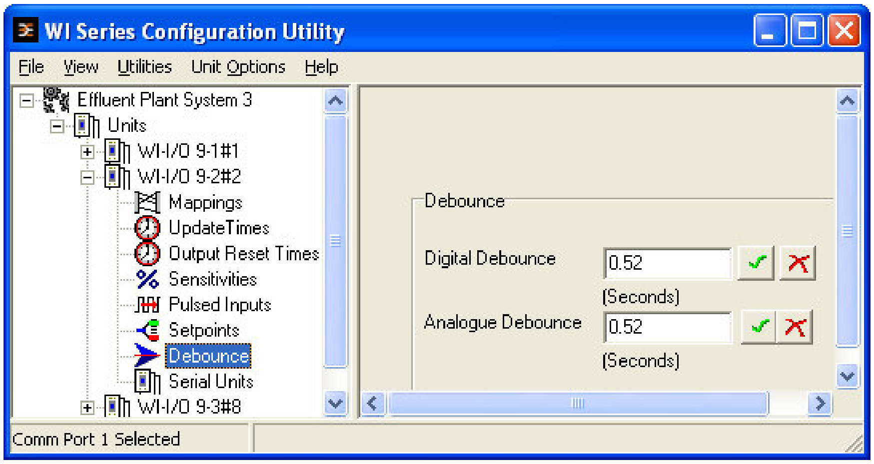
Failed Unit:
- Unknown Unit
- All Units
- WI-I/O 9-2#2
- WI-I/O 9-3#8

Destination IO:
- Analogue Output 1
- Analogue Output 2
- Digital Output 1
- Digital Output 2
- Digital Output 3
- Digital Output 4

For example, if "Comms fail to unit 12" is configured to DO1, then the module will set (or activate) DO1 each time communications to unit 12 is not successful. If DO1 has a "Reset output" time of 10 minutes configured for DO1, then DO1 will reset (de-activate) 10 minutes after the last comms fail to unit 12.

Debounce Configuration

Debounce is the time which an input must stay stable before the module decides that a change of state has occurred. If a digital input changes (say 0 → 1) and changes again (1 → 0) in less than the debounce time, then the module will ignore both changes. Debounce may be configured for digital inputs on the –1, -2 and -4 modules (0.5 - 8 seconds) and the analog inputs on the -2 module (0.5 - 8 seconds). The default value of 0.5 seconds is suitable for most applications. In applications where a digital input may turn on and off several times slowly (for example, security switches or float switches) a debounce time of up to 8 seconds may be configured. *The configured debounce time has no affect on pulse inputs.*



Debounce

Digital Debounce 0.52 (Seconds)

Analogue Debounce 0.52 (Seconds)

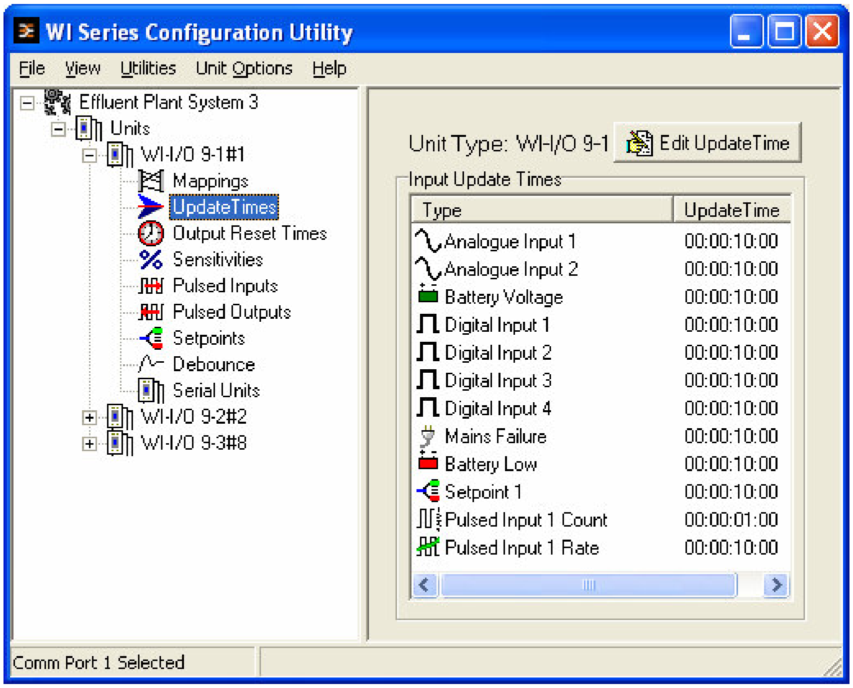
Comm Port 1 Selected

Note that the analog debounce is not configurable for the -1 , but is configurable in the -2.

Update Time Configuration

Update messages are sent if a change message has not occurred within the update time period. The update time may be set for each input - both physical and internal inputs.

The default period is 10 minutes for all inputs, except for pulse inputs (1 minute). Short update times should only be used in special circumstances. It is important to remember the principle - “Less radio traffic means better communications”. Frequent updates from multiple units causes congestion of the radio channel, which results in increased communication failures and poorer performance of the system. To change an update time, select “Update Times” on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values. For the -1, -2 and –3 modules, the maximum update time is 16 minutes, however the update



Unit Type: WI-I/O 9-1

Input Update Times

Type	UpdateTime
Analogue Input 1	00:00:10:00
Analogue Input 2	00:00:10:00
Battery Voltage	00:00:10:00
Digital Input 1	00:00:10:00
Digital Input 2	00:00:10:00
Digital Input 3	00:00:10:00
Digital Input 4	00:00:10:00
Mains Failure	00:00:10:00
Battery Low	00:00:10:00
Setpoint 1	00:00:10:00
Pulsed Input 1 Count	00:00:01:00
Pulsed Input 1 Rate	00:00:10:00

Comm Port 1 Selected

time for -4 inputs can be up to 5 days.

If a zero value is entered as an update time, then the input will not update at all.

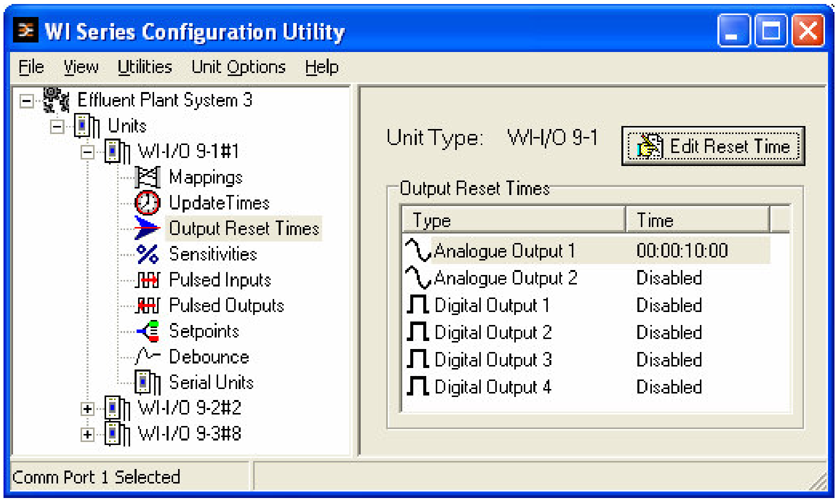
Changing Multiple Settings

You can change the Update Times of several inputs simultaneously by using the <Shift> Select feature. For example, if you want to change all digital inputs to 1 minute update, you could change each individually, or you could "block" the four digital inputs using the "Shift" Select feature and select "Edit". You only need to enter the change once to change all of the inputs selected. This feature is also available with the other configurable parameters.

Output Reset Time Configuration

This allows the **Comms Fail Time** to be selected - this is the time for an output to reset if it has not received an update or change message.

Each output on the unit, either analog or digital, may be configured to reset (off or 0mA) when no update transmission has been received for a certain time. This option can be used to ensure that communications failure will not result in loss of control. For example, outputs connected to pumps should be configured to reset on communications failure so that the pump will turn off. The default condition is zero (no reset).



Unit Type: WI-I/O 9-1

Type	Time
Analogue Output 1	00:00:10:00
Analogue Output 2	Disabled
Digital Output 1	Disabled
Digital Output 2	Disabled
Digital Output 3	Disabled
Digital Output 4	Disabled

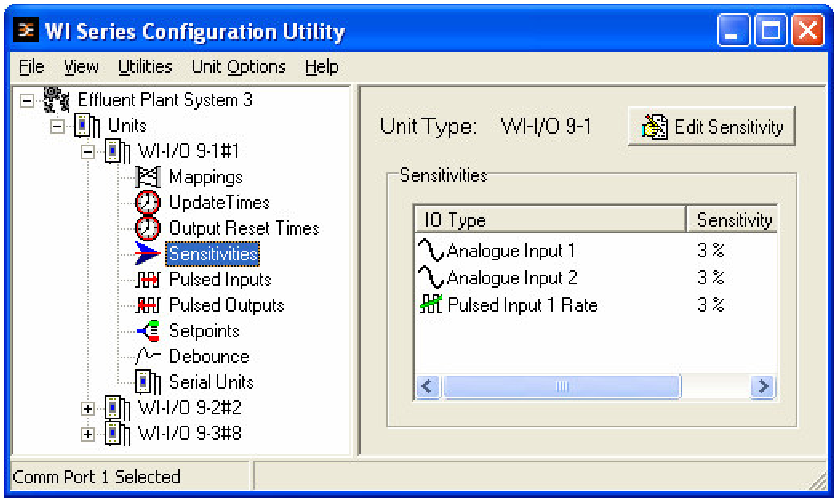
Comm Port 1 Selected

If the reset time is less than the update time, then the output will reset when the reset time expires, and then set again when the update message is received. We recommend that the reset time be a little more than twice the update time.

To set an output reset time, select "Output Reset Times" on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values.

Analog Sensitivity Configuration

The analog sensitivity is the change required in an analog input before a “Change Of State” is detected, and the new analog value is transmitted. For input signals which vary widely over a short period of time or have a normal oscillation, the analog sensitivity should be set to an appropriately large value. This ensures that many change messages are not transmitted in too short a time. This will result in channel congestion, as described in the preceding section.



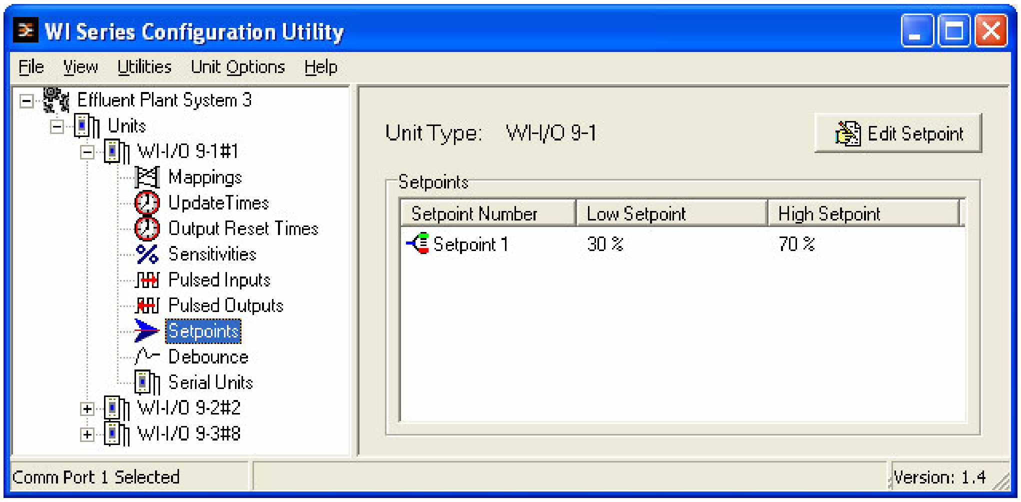
Unit Type: WI-I/O 9-1

IO Type	Sensitivity
Analogue Input 1	3 %
Analogue Input 2	3 %
Pulsed Input 1 Rate	3 %

Comm Port 1 Selected

To change an analog sensitivity, select “Sensitivities” on the left-hand menu and double-click the selected input. The sensitivity for physical inputs is shown in mA and internal input is shown as %.

SetPoint Configuration



Unit Type: WI-I/O 9-1

Setpoint Number	Low Setpoint	High Setpoint
Setpoint 1	30 %	70 %

Comm Port 1 Selected
Version: 1.4

Setpoints allow a remote digital output to be turned on and off depending on the value of an analog input. The “set-point status” internal input must be mapped to an output for this option to have effect. When the AI is less than the Low Set-point (LSP), the set-point status will be active (on, “1”) - when the AI is more than the High Set Point (HSP), the set-point status will be reset (off, “0”). Note that the High Set Point (HSP) must always be higher than the Low Set Point (LSP). For the -1 module, only AI1 has set-point values. For -2 modules, the first four analog inputs (AI 1 – 4) have set-points.

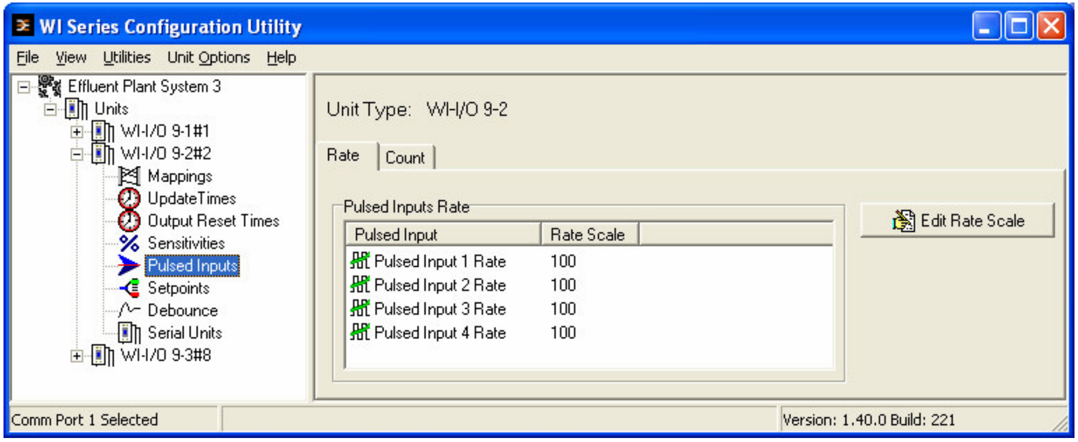
Debounce time operates on the set-point status in the same way as digital inputs.

To change a setpoint values, select “SetPoints” on the left-hand menu and double-click the selected Setpoint Status.

Pulse Input Count Configuration

PI1 of the -2 and -4 modules normally count up to 100Hz (as for the other PI's), however can be configured to count up to 1000Hz. This configuration actually divides the input count by 10 - each count in the PI1 register is then equivalent to 10 input pulses. If PI1 is mapped to a PO, then the maximum output pulse rate is 100Hz, however each output pulse is equivalent to 10 input pulses.

To configure the "divide by 10" feature, select "Pulse Inputs" on the left-hand menu and select the "Count" page - double-click "Pulse Input 1 Count" and enable "divide by 10" counting.



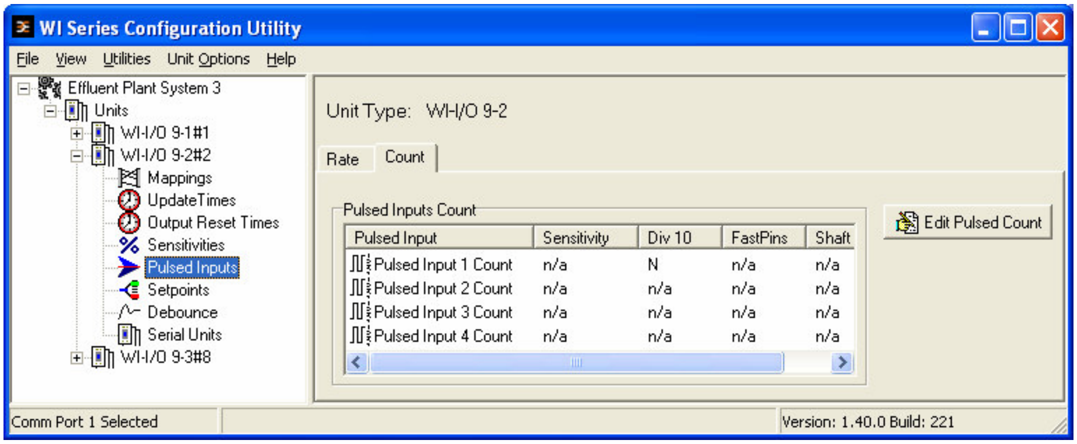
Unit Type: WI-I/O 9-2

Pulsed Input	Rate Scale
Pulsed Input 1 Rate	100
Pulsed Input 2 Rate	100
Pulsed Input 3 Rate	100
Pulsed Input 4 Rate	100

Pulse Input Rate Scale Configuration

When a pulse rate is mapped to an analog output, the rate must be scaled to the 4-20mA output. The pulse rate scale is the rate (in Hz) corresponding 20 mA.

To configure the pulse rate scale, select "Pulse Inputs" on the left-hand menu and select the "Rate" page - double-click the pulse input rate and enter the scale value.

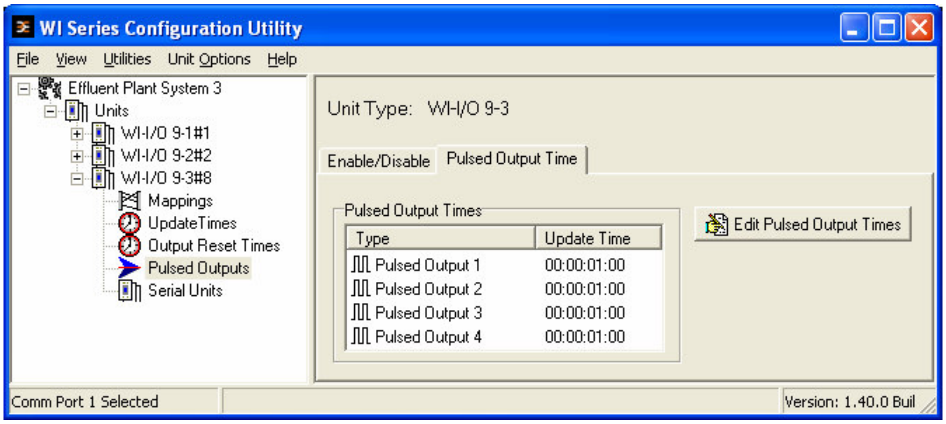


Unit Type: WI-I/O 9-2

Pulsed Input	Sensitivity	Div 10	FastPins	Shaft
Pulsed Input 1 Count	n/a	N	n/a	n/a
Pulsed Input 2 Count	n/a	n/a	n/a	n/a
Pulsed Input 3 Count	n/a	n/a	n/a	n/a
Pulsed Input 4 Count	n/a	n/a	n/a	n/a

Pulse Output Update Time Configuration

The pulse output update time is the time period over which pulses are output after a PI update is received. It should be configured to correspond to the pulse input update time for the corresponding pulse input. This ensures that the pulse output rate matches as closely as possible the pulse input rate which it is reflecting.



Unit Type: WI-I/O 9-3

Type	Update Time
Pulsed Output 1	00:00:01:00
Pulsed Output 2	00:00:01:00
Pulsed Output 3	00:00:01:00
Pulsed Output 4	00:00:01:00

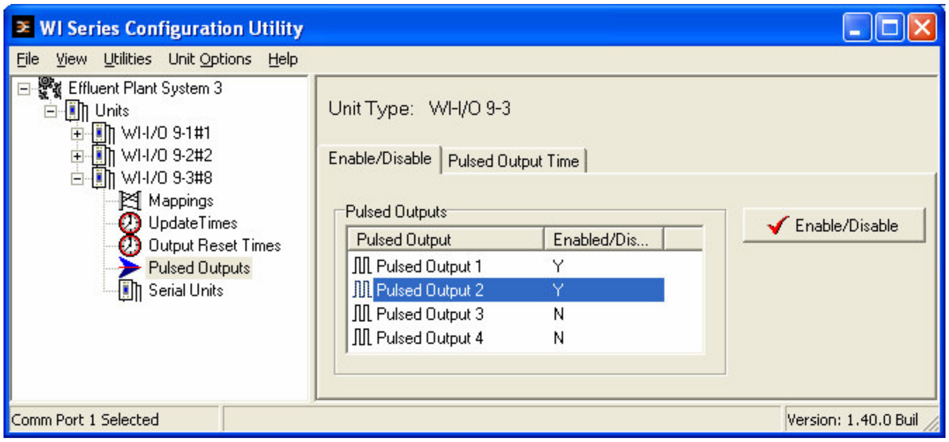
For example, if the PI update time is 1 minute, then the PO update time should also be 1 minute. If the PI update time is changed, then the PO update time at the remote module should be also changed. The PO will still operate if the time is not changed, however pulses may be output faster or slower than the input pulses.

To configure the pulse output time, select “Pulse Outputs” on the left-hand menu and select the “Pulsed Output Time” page - double-click the pulse output and enter the new time.

Pulse Output Enable

The PO’s for the -2 and -4 modules are also DO1-4. To use as pulse outputs, you need to enable them as pulse outputs.

To enable pulse outputs, select “Pulse Outputs” on the left-hand menu and select the “Enable/Disable” page - double-click the pulse output to enable.



Unit Type: WI-I/O 9-3

Pulsed Output	Enabled/Dis...
Pulsed Output 1	Y
Pulsed Output 2	Y
Pulsed Output 3	N
Pulsed Output 4	N

Compiling a System

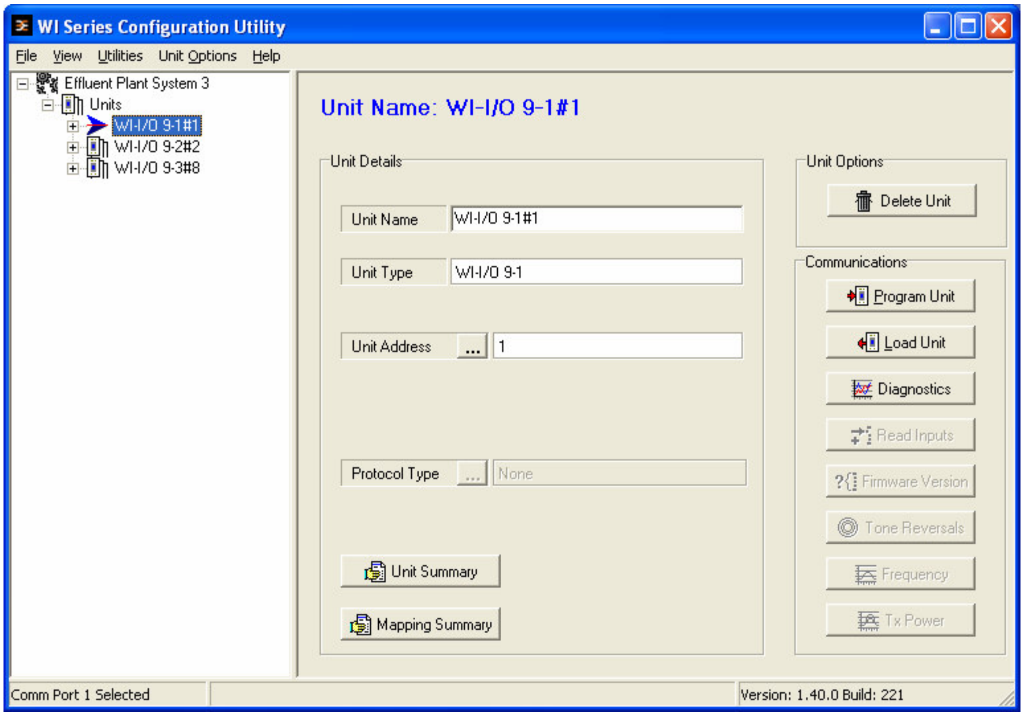
When you have finished configuring the modules, you should compile the system. The compile function scans the configuration and reports any detected errors. To compile the system, select “Compile System” from the “Utilities” menu. Select the “Compile” button. The system will compile - the display will show if there are any compile errors or warnings.

4.3.3 Programming Configurations to Modules

To program a module :

- Connect the cable from the PC's serial port to the module serial port (see 2.4.10 for cable connections)
- From the Utilities menu, select "Serial Port Setup"
- Select the appropriate serial port (COM1 - COM4)
- Select the unit to be configured from the left-hand menu
- Double-click "Program Unit".

Each module will need to be programmed individually.



Unit Name: WI-I/O 9-1#1

Unit Name: WI-I/O 9-1#1

Unit Type: WI-I/O 9-1

Unit Address: 1

Protocol Type: None

Comm Port 1 Selected

Version: 1.40.0 Build: 221

4.3.4 Loading Configuration from a Module

Care should be taken when loading a configuration from a module. It is easy to lose the system address and unit address. We suggest that you first view the system address and unit address - you can do this via the "Unit Options" menu. Note these addresses before loading the configuration.

When you upload the configuration, the program will check if you want to load the addresses from the module. **If you do not, then the system address and unit address will change.**

You are able to upload the configuration from a module into a new "project", to view the configuration and modify it. Note that as the "project" will not have the details of the other modules in the system, the other modules and outputs will be shown as unit addresses and output numbers. Don't forget to download the configuration into the module after you modify it.

If security has been enabled for the system, please read section 4.3.7.

If you are adding additional mappings to a WI-I/O 9-C or WI-GTWY-9-xxx module, then you need to change the archived configuration files first so you can download the modified configuration details into the WI-I/O 9-C or WI-GTWY-9-xxx.

4.3.5 Modifying and Archiving Configuration Files

As you build a system configuration, it is automatically saved in the "Project" directory. We recommend that all system additions and changes be made to the archived configuration files first, and

then downloaded to the module/s. This ensures that the archived files are always maintained and accurate. If you modify the configuration of a module by uploading and then downloading, then the module configuration will be different then the archived files.

If you lose the configuration files for a system, then you can rebuild the configuration by uploading the configuration file from every module in the system.

4.3.6 Print Options

You can obtain a print-out of each module configuration. On each unit display, there are “Unit Summary” and “Mapping Summary” windows. Each of these will display a printable information page about that module. The Unit Summary page will display the user options configured, and the Mapping Summary will display the mappings entered for that unit.

The printer may be selected from the Printer Setup option in the File menu.

4.3.7 Security

There are two security features available. You can enter a password to protect the configuration files, and you can enable security encryption of the radio transmissions.

The password can be between 6 and 256 characters. The password is case sensitive and any ASCII characters can be used. If you have entered a password, then this password will need to be entered if the configuration is to be changed later. You can view the configuration, but you will not be able to make any changes. You are able to change the password from the “Utilities” menu. If unauthorised access to the files is a concern, we recommend that you change the password regularly or whenever there is a change of staff.

Security Encryption is an additional level of security. The security option uses an 8-character security key to provide 64-bit data encryption of the radio messages. All modules in the same system will be configured with the same security key used to encrypt and decrypt the messages. This feature is available for modules with serial numbers with the middle three numbers greater than 210 - that is xxxx210xxxx, or xxxx220xxxx etc. If you are adding modules to an old system which does not have the security encryption feature, then you cannot use security encryption on the new modules.

Note that the security key is different than the password.

- To enable the security encryption, select the “Enable Security” box on the project display. An 8-character security key is entered and you will be prompted to enter the security code a second time to confirm. The security key can be any characters or numbers. Characters are case sensitive. The security key will never be displayed.
- If you do not enable security, there will be no data encryption of the radio messages. This is the default setting.
- If a security key has been entered, this key is downloaded into each module as part of the configuration download process. You can download another configuration at any time - if the security key is different, or if there is no security key in the new configuration, the old key will be over-written.

- You can change the security key in the configuration files simply by entering a new security key in the security key window. You will be prompted to confirm the new security key. If the configuration files are password-protected, you will be asked for the password. Note that if you change the security key, it will not match the security key previously loaded into existing modules.

- If you want to change a configuration, we recommend that you change the archived configuration, and then download the configuration onto the module. The archived configuration already has the valid security key.

- If you lose the archived configuration, you can upload the configuration from a module, but you cannot upload a security key. That is, you can upload the module configuration, view it, change it - but if you don't know the original security key, the old key will be over-written when you download the new configuration. This module will no longer communicate with other modules in the system as the security key is different.

The security options provide security against a "hacker" in the following way:

- ☐ A hacker cannot listen-in to radio messages without the security key to decrypt the radio messages. Similarly, a hacker cannot force outputs by transmitting a radio message to a module without the security key.
- ☐ A hacker cannot access the security key from an installed module or from the configuration files.
- ☐ The archived configuration files cannot be changed, downloaded or uploaded without the password.

Warning!!

These security options provide a high level of security, but no data-security system can provide "100% protection". But it does make it very difficult for someone to interfere with the WI-I/O 9-x system - difficult to the point where there would be many easier alternate ways to cause malicious damage.

The password must be kept in a secure place. Security procedures need to be adopted. If staff with access to the password leaves your organization, we recommend that the password be changed.

We recommend that you use a random 8-character string for the security key and that you do not record the key. It is not necessary to know what the security key is. The key will be recorded in the archived configuration files, and therefore the configuration files should be held in a secure place and backed up.

The security key does not prevent a hacker uploading a configuration from a module and downloading with a new security key. This module will no longer operate with other modules in the system. To prevent this, unauthorized access to modules must be prevented.

If you lose the configuration files, you can regenerate these by uploading the configuration from every module in the system into a new project with a new security key. After uploading each module, download the configuration with the new security key.

If you wish to change the security key, simply enter a new key in the configuration program, and download the new configuration to all modules in the system.

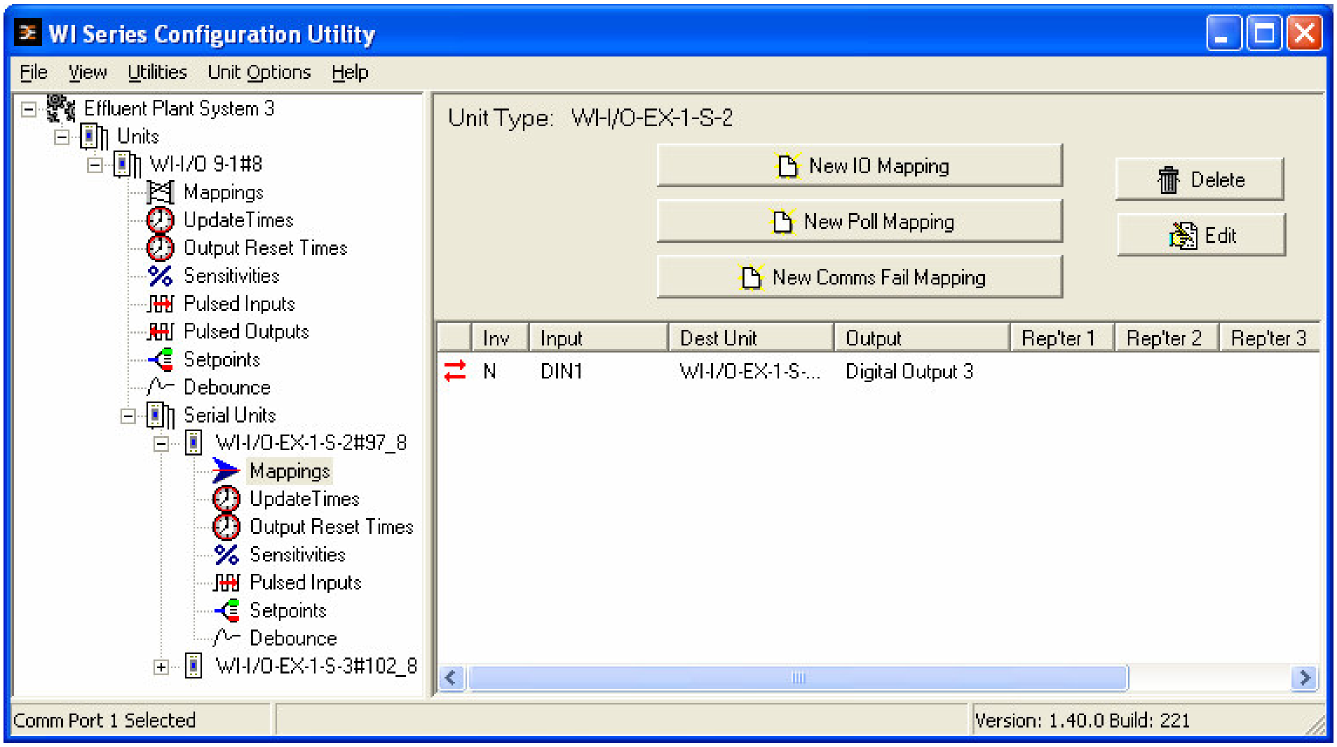
4.3.8 Using WI-I/O-EX-1-S-x Modules

WI-I/O-EX-1-S-x modules can be used by themselves, as “line telemetry” or “wired I/O”, or they can be used as I/O expansion for WI-I/O 9-x modules. As the WI-I/O-EX-1-S-x modules are connected by RS485, the WI-I/O-EX-1-S-x modules can be separated from the WI-I/O 9 modules by some distance. There can be up to 32 addresses on the one RS485 multi-drop link. Note that each –3 and –4 module takes up 2 addresses. For example, you could have up to 32 modules sharing a multi-drop link if they are all –1 or -2 modules - if they are all –3 or –4, then you could only have 16 modules on the link.

WI-I/O-EX-1-S-x modules are configured with unit addresses in the range 96 – 127.

Example 1 - Mapping to another WI-I/O-EX-1-S-x module on the same link.

The I/O mapping is done in the same way as for WI-I/O 9-x modules.



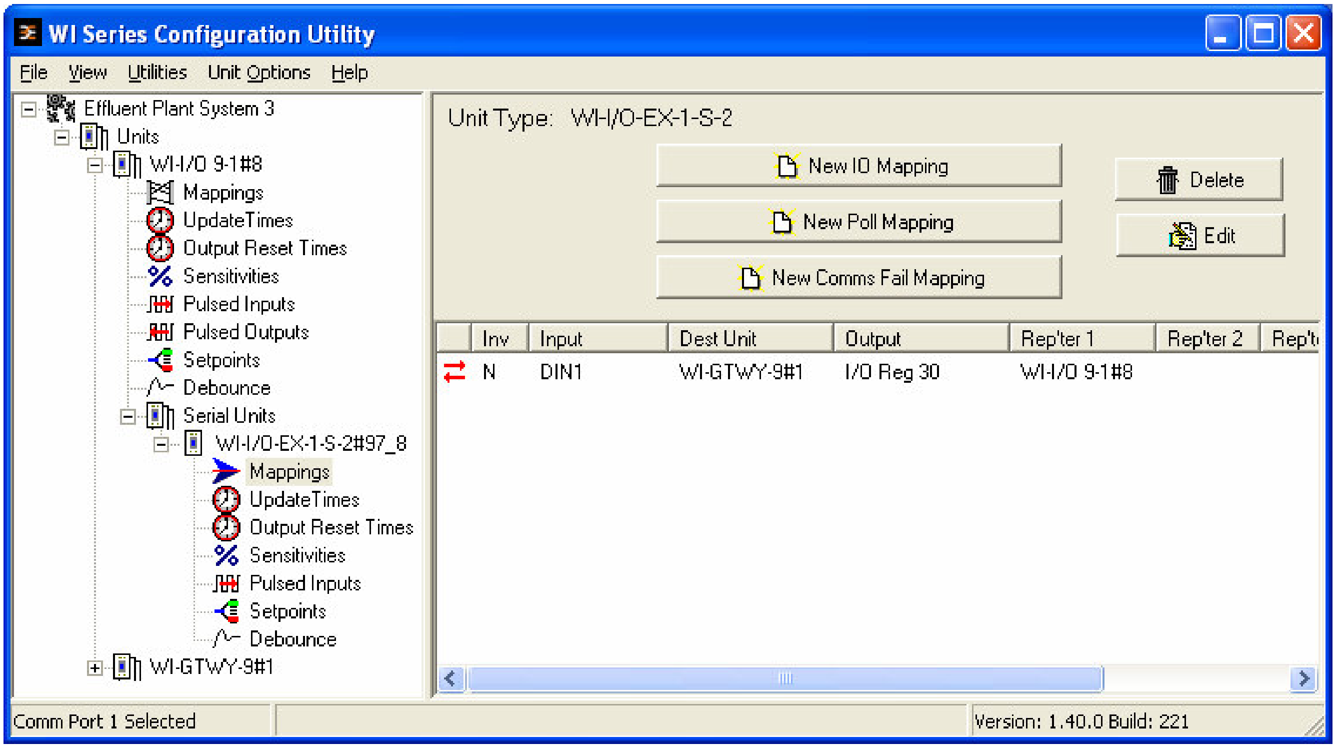
Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
⇄	N	DIN1	WI-I/O-EX-1-S-...	Digital Output 3			

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Example 2 - Mapping to a remote WI-I/O 9-x.



Unit Type: WI-I/O-EX-1-S-2

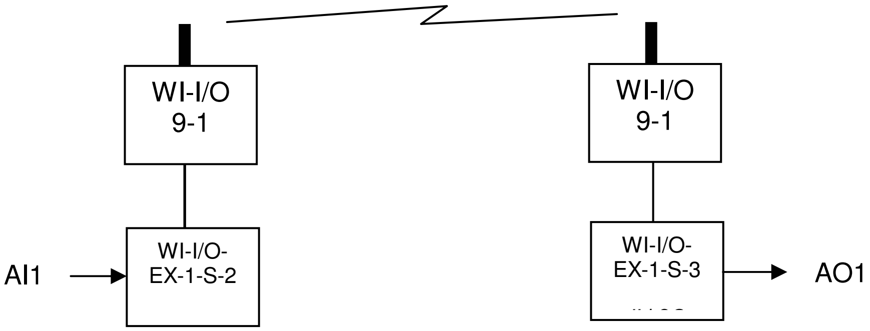
	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep't
⇄	N	DIN1	WI-GTWY-9#1	I/O Reg 30	WI-I/O 9-1#8		

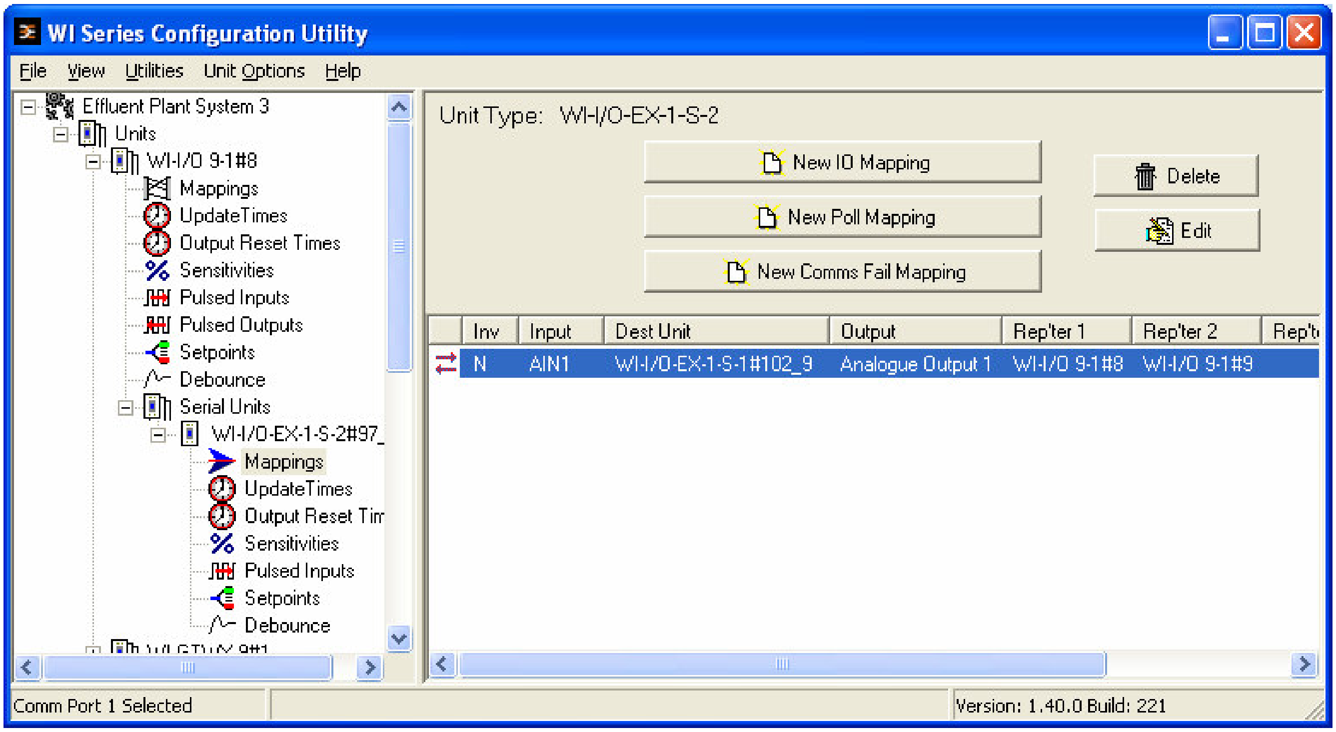
In this example, a WI-I/O-EX-1-S-x-2 is connected to WI-I/O 9-1#8. DI1 is mapped to a remote WI-GTWY-9-MD1 module. The WI-I/O 9-x that is connected to the WI-I/O-EX-1-S-x module acts as a repeater - a serial-to-radio repeater.

When DI1 changes, the WI-I/O-EX-1-S-x will send a message via the serial link to WI-I/O 9-1#8.

Example 3 - Mapping to another WI-I/O-EX-1-S-x which is connected to a different WI-I/O 9-x

In this example, both WI-I/O 9-x modules act as repeaters. The first is a “serial-to-radio” repeater and the second is a “radio-to-serial” repeater.





Unit Type: WI-I/O-EX-1-S-2

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep't
N	AIN1	WI-I/O-EX-1-S-1#102_9	Analogue Output 1	WI-I/O 9-1#8	WI-I/O 9-1#9	

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Chapter Five SPECIFICATIONS

General		
WI-I/O 9-x Radio standards	FCC Part 15A, Part 15.247	902 – 928 MHz, 1W
Housing	130 x 185 x 60mm DIN rail mount Refer section 5.1 for dimensioned drawing	Powder-coated, extruded aluminium
Terminal blocks	Removable	Suitable for 2.5 mm^2 conductors
LED indication	Power supply, OK operation, digital I/O, RX and TX	
Operating Temperature	WI-I/O 9-x, WI-I/O-EX-1-S-x	-40 to 60 degrees C / -40 to 140 degrees F -30 to 60 degrees C / -20 to 140 degrees F
Humidity	0 – 99% RH non-condensing	
Power Supply		
Battery supply	11.3 - 15.0 VDC	
AC supply	12 - 24 VAC, 50/60 Hz	Overvoltage protected
DC supply	15 - 30 VDC	Overvoltage and reverse voltage protected > 17VDC required for charging battery
Battery Charging circuit	Included	for 1.2-12 AHr sealed lead acid battery
Solar regulator	Included	Direct connection of solar panel (up to 30W) and solar battery (100 Ahr)
Current Drain at 12VDC	85 mA quiescent for 'U' 45 mA quiescent for 'S'	+ 10 mA/active digital input + 25 mA/active digital output + 2 x analog I/O loop (mA)
Radio transmitter inrush	WI-I/O 9-x	350mA @ 13.8VDC; 250mA @ 24VDC 450mA @ 13.8VDC (0.5W) 600mA @ 13.8VDC (1W) 800mA @ 13.8VDC (2W) 1.25A @ 13.8VDC (5W)
Analog loop supply	Included, except -4	24V DC 150 mA
Mains fail status	Monitored	Can be transmitted to remote modules
Battery voltage	Monitored	As above

Radio Transceiver (WI-I/O 9-x)		
Spread spectrum	Frequency hopping	
Frequency	USA/Canada Australia New Zealand	902 – 928 MHz 915 – 928 MHz 922 – 928 MHz
Transmission Power	1W	
Signal detect / RSSI	-120 to –50 dBm	
Expected line-of-sight range (subject to local conditions)	20 miles + @ 4W ERP 15 km + @ 1W ERP depending on local conditions	USA / Canada Australia / New Zealand Range may be extended by up to 5 intermediate modules as repeaters
Antenna Connector	Female SMA coaxial	
Data transmission rate	19200 baud	
Serial Ports		
RS232 Port	DB9 female DCE	9600 baud, no parity, 8 data bits, 1 stop bit
RS485 Port	2 pin terminal block	9600 baud, no parity, 8 data bits, 1 stop bit, Typical distance 1 mile / 2km
Data transmission	On change-of-state + integrity update	Update time configurable
Protocol - serial - radio	asynchronous ARQ, with 16 bit CRC synchronous ARQ	Automatic acknowledgements with up to 4 retries
Communications fail status	May be mapped to local or remote output	Resetting of outputs on comms fail configurable
Inputs and Outputs		
Digital Inputs	WI-I/O 9-x_WI-I/O-EX-1-S-1 Four WI-I/O 9-x_WI-I/O-EX-1-S-2 Four WI-I/O 9-x_WI-I/O-EX-1-	Opto-isolated (5000V)inputs, suitable for voltage free contacts or NPN transistor, contact wetting current 5mA, input debounce 0.5 second For –4 modules, as above, but with 3000V surge protection instead of opto-isolation

	S-3 None WI-I/O 9-x_WI-I/O-EX-1-S-4 Four plus 12 selectable I/O	
Digital Outputs Digital Outputs	WI-I/O 9-1_WI-I/O-EX-1-S-1 Four WI-I/O 9-2_WI-I/O-EX-1-S-2 One WI-I/O 9-3_WI-I/O-EX-1-S-3 Eight WI-I/O 9-4_WI-I/O-EX-1-S-4 Four plus 12 selectable I/O	Relay output contacts, normally open, AC 5A 50V DC 2A 30V, 5A 20V
Pulse Inputs	WI-I/O 9-1_WI-I/O-EX-1-S-1 One WI-I/O 9-2_WI-I/O-EX-1-S-2 Four WI-I/O 9-3_WI-I/O-EX-1-S-3 None WI-I/O 9-4_WI-I/O-EX-1-S-4 Four	Uses DI1. Max rate 100Hz, min. off-time 5msec. Uses DI1-4. Max rate of DI1 is 1000Hz, min. off-time 0.5msec Max rate of DI2-4 is 100Hz, min. off-time 5msec.
Pulse Output	WI-I/O 9-1_WI-I/O-EX-1-S-1 One WI-I/O 9-2_WI-I/O-EX-1-S-2 None WI-I/O 9-3_WI-I/O-EX-1-S-3 Four WI-I/O 9-4_WI-I/O-EX-1-S-4 Four	FET output, 30 VDC 500mA max Max rate for WI-I/O-EX-11 is100 Hz. Max rate for WI-I/O-EX-1-S-13 is 1000 Hz. Pulse signal recreated, pulse rate avail. on analog output, (scaling configurable). Divide-by-10 available for 1000Hz inputs.
Analog Inputs	“floating” differential input, common mode voltage -0.5V to 27V WI-I/O 9-1_WI-I/O-EX-1-S-1 Two 4-20 mA WI-I/O 9-2_WI-I/O-EX-1-S-2 Six 0-20mA	24 VDC for powering external loops provided, 150 mA max. Digital filter time constant 1 second (config.) Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%

Analog Input Setpoints	WI-I/O 9-1_WI-I/O-EX-1-S-1 AI 1 only WI-I/O 9-2_WI-I/O-EX-1-S-2 AI 1-4	Configurable high & low set-points, allowing set/reset of remote digital outputs
Analog Outputs	current sink to common WI-I/O 9-1_WI-I/O-EX-1-S-1 Two 4-20mA WI-I/O 9-3_WI-I/O-EX-1-S-3 Eight 0-20mA	max loop voltage 27V, Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%
System Parameters		
Network Configurations	Communications via radio or RS485 or network of both	Up to 95 radio units with up to 32 serial units off each radio unit
User Configuration	Any input to any output in system	RS232 PC or laptop
Diagnostics		
On board diagnostics	Automatic check on start-up Via RS232 terminal or laptop	Input status Output test Incoming radio signal level Simple radio path testing

Chapter Six TROUBLESHOOTING

6.1 Diagnostics Chart

INDICATOR	CONDITION	MEANING
OK LED OFF	Continuously	• Battery Voltage low • CPU failure • +24V supply failure/overload
OK LED ON	Continuously	• Normal Operation
PWR LED ON	Continuously	• Supply available from SUP1/SUP2 • Supply available from solar panel
TX LED ON	Flashes briefly	• Radio transmitting
RX LED ON	Flashes briefly	• Radio Receiving • Serial port communicating
RX LED ON	Flashes continuously	• Module in Configuration Mode
RX LED ON	Continuously	• Test Button press in Configuration Mode
No transmission on change of state		• Unit not configured correctly - re-configure and check operation

The green OK LED on the front panel indicates correct operation of the unit. This LED extinguishes on failure as described above. When the OK LED extinguishes shutdown state is indicated. In this state, all digital outputs turn OFF and the +24V supply turns off.

On processor failure, or on failure during start-up diagnostics, the unit shuts down, and remains in shutdown until the fault is rectified. The unit also shuts down if the battery voltage falls below 10.8 volts. This is a protection feature designed to protect the battery from deep discharge in case of extended period without supply voltage.

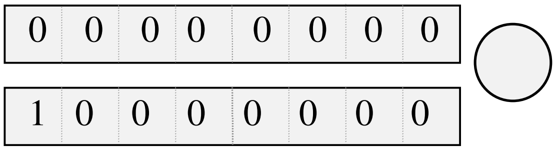
Note: During diagnostic testing, it is likely that the module will reset and restart. This will affect the output signals.

6.2 Self Test Functions

6.2.1 Input to Output Reflection (WI-I/O 9-1_WI-I/O-EX-1-S-1 only)

The unit will require re-configuration after SELF TEST. Ensure you know the required operational configuration including system and unit addresses so that the network can be restored after testing.

Remove the cover in the front panel, and set the DIP switches as shown below. Hold down the red button for five seconds, or until the Rx LED glows yellow, release the Red button (the Rx LED now flashes), then press and release the Red button (the flashing Rx LED extinguishes).



Input signals may now be connected to the input terminals of the module. If the module is operating correctly, then the input signals will be reflected to the corresponding output on the same module. For example, if DI 1 is connected to common - i.e. the first digital input is turned "ON" - then DO 1 will activate, if the module is functional. Similarly, if a 12mA signal is connected to AI 2, then a 12mA signal should be able to be measured from AO 2, if the module is functioning correctly.

If a module does not pass its self test function, then it should be returned to an authorised service agent for attention

6.2.2 Radio Testing using Tone Reversals (WI-I/O 9-x modules only)

This function allows the unit to be configured to continuously transmit a sequence of alternate zeros and ones on the radio. This function provides the facility to check VSWR of antennas during installation, as well as checking the fade margin of the path between two units (see below - received signal strength indication).

The tone reversals function is initiated by setting all of the DIL switches to ON, and holding down the red button for approximately 5 seconds(until the RX LED lights continuously). On releasing the button, the RX LED will flash continuously, and the TX LED will light, indicating that the radio transmitter is on.

To finish the test, push the red button again or re-power the module.

6.2.3 Diagnostics menu

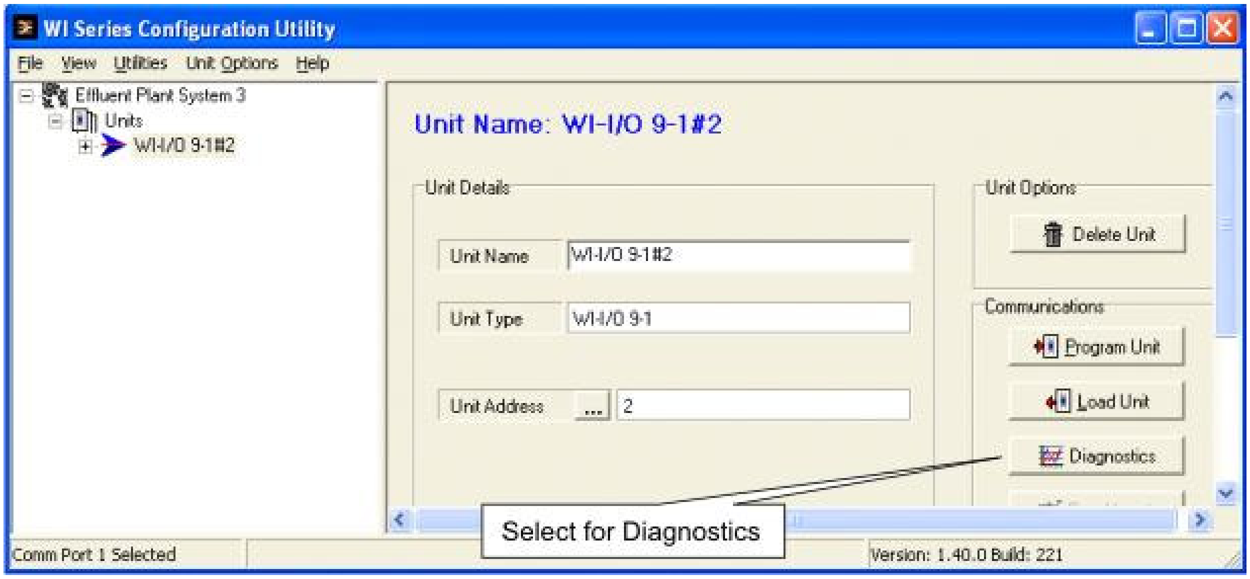
To aid in the checking and set-up of the module, a user friendly menu provides access to diagnostic

functions. Use of the diagnostics menu does not affect module configuration.

The diagnostics functions can be accessed from the E Series Config software - the same software package used to configure the modules. Connect the laptop or PC to the module using a configuration RS232 cable.

Either open the archived project containing the module, or start a New Project and select "Load a New Unit" - select the correct type of module. After the unit has loaded, select the Diagnostics box.

A "Terminal" screen will appear. Select the "Terminal" box.



WI Series Configuration Utility

Unit Name: WI-I/O 9-1#2

Unit Name: WI-I/O 9-1#2

Unit Type: WI-I/O 9-1

Unit Address: 2

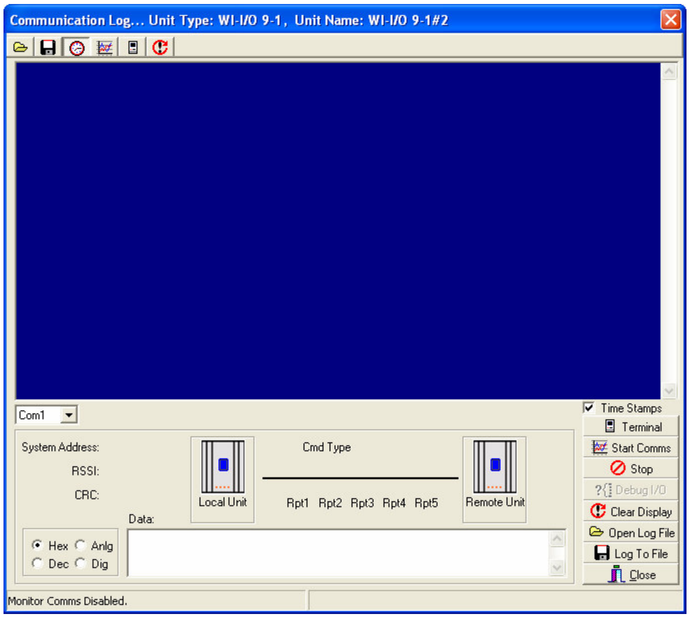
Comm Port 1 Selected

Version: 1.40.0 Build: 221

Select for Diagnostics

Connect the module (ensure the RS485 port is disconnected first) to the PC using the same serial cable used for configuration.

The diagnostics menu is accessed by removing the blue "plug" from the front of the module and setting all switches to '0' or "Open", and holding down the red button for approximately 5 seconds, until the RX LED lights continuously. One of the following menus will be displayed on the terminal :



Communication Log... Unit Type: WI-I/O 9-1, Unit Name: WI-I/O 9-1#2

☑ Time Stamps

● Hex ○ Anlg ○ Dec ○ Dig

Monitor Comms Disabled.

WI-I/O 9-1

a) Ins

b) Tones

c) Comms

d) DO1

e) DO2

```
f)      DO3
g)      DO4
h)      AO1
i)      AO2
j)      Switch
k)      Signal
>
```

```
WI-I/O 9-2
a)      Digital Ins
b)      Analog Ins
c)      Tones
d)      Comms
e)      DO1
f)      Switch
g)      Signal
>
```

```
WI-I/O 9-3
a)      Ins
b)      Tones
c)      Comms
d)      DO1
e)      DO2
f)      DO3
g)      DO4
h)      DO5
i)      DO6
j)      DO7
k)      DO8
l)      AO1
m)      AO2
n)      AO3
o)      AO4
p)      AO5
q)      AO6
r)      AO7
s)      AO8
t)      Switch
u)      Signal
>
```

```
WI-I/O 9-4
a)      D Ins
b)      A Ins
c)      Tones
d)      Comms
e)      DO1
f)      DO2
g)      DO3
h)      DO4
i)      DIO1
j)      DIO2
k)      DIO3
l)      DIO4
m)      DIO5
n)      DIO6
o)      DIO7
p)      DIO8
q)      DIO9
r)      DIO10
s)      DIO11
t)      DIO12
u)      Signal
>
```

Choose an item from the menu by entering the letter before that item. For example, to select the "Signal" function from the WI-I/O-EX-1-S-11 Menu, enter :- k

During the diagnostics session, if you press Enter or Space while the menu is displayed, the module will restart in normal operating mode. To re-enter diagnostics mode, hold the red button for 5 seconds etc.

After the diagnostics session is over, force the module to restart, then select “Stop Terminal”, then “Close”.

Inputs

This option provides a dynamic display of the status of all of the inputs in the WI-I/O 9-x, both internal and external.

WI-I/O 9-1/WI-I/O-EX-1-S-1 Modules

```
1234MLS      P CNT  AI1   AI2    PRATE  VBATT
0101001      00F6   C000  4000   8000    9C00
```

The first 7 values (1234MLS) each represent a single digital input. A ‘1’ indicates that that input is ON, and a ‘0’ indicates that the corresponding input is OFF. "1234" represents the four physical digital

inputs, DI1 to DI4. "M" is the mains fail status ('1' for mains fail, '0' for mains OK). "L" is the battery low volts status ('1' for low volts '0' for OK). "S" is the set-point status.

P CNT, AI1, AI2, P RATE, and VBATT each represent 16 bit values, displayed as four hexadecimal digits.

P CNT is the current value of the pulsed input counter. This value should increment each time 'DI 1' turns from OFF to ON. P RATE displays the current pulse rate at DI1. This value is scaled according to the MAXRATE value configured (0 Hertz is displayed as 4000, and the maximum rate is displayed as C000).

AI1 and AI2 represent the value for the two analog inputs. Full scale input (20 mA) is displayed as C000, 4mA is displayed as 4000, and 0ma is displayed as 2000. Analog inputs are filtered digitally with a time constant of 1 second, so a sudden change in the analog input current will result in a slower change in displayed analog value, finally settling at the new value.

A guide to translate the displayed value to the analog input current is provided below.

	Add together the figures corresponding to each digit in each position to determine the current (mA) e.g. displayed value 3456 = 2.000+0.500+0.039+0.003 = 2.542mA			
Digit	**Leftmost position**	**Next position**	**Next position**	**Rightmost position**
0	-	0.000	0.000	0.000
1	-	0.125	0.008	0.000
2	0.000	0.250	0.016	0.001
3	2.000	0.375	0.023	0.001
4	4.000	0.500	0.031	0.002
5	6.000	0.625	0.039	0.002
6	8.000	0.750	0.047	0.003
7	10.000	0.875	0.055	0.003
8	12.000	1.000	0.063	0.004
9	14.000	1.125	0.070	0.004
A	16.000	1.250	0.078	0.005
B	18.000	1.375	0.086	0.005
C	20.000	1.500	0.094	0.006
D	22.000	1.625	0.102	0.006
E	-	1.750	0.109	0.007
F	-	1.875	0.117	0.007

VBATT is the current internally derived battery voltage. 4000 corresponds to 8 Volts, C000 represents 16 volts. A quicker method is use the calculation :

Battery voltage (volts) = ½ I + 6, where I is the mA value determined from the above table using VBATT. For example, a value of VBATT of A000 gives an I value of 16mA from the above table. The battery voltage corresponding to this is 14V (or ½ x 16 + 6).

WI-I/O 9-2_WI-I/O-EX-1-S-2 Modules

Digital Inputs

```
DIN       SETPNT            PULSED
1234MSL123456        PIN1        PIN2        PIN3        PIN4
0000100111111        0000        0000        0000        0000
```

Analog Inputs

```
VBAT     PR1      PR2    PR3      PR4      AI1      AI2      AI3      AI4      AI5    AI6
8138     4000     4000   4000     4000     0D3A     0CD2     0CC7     0CC7     0CD4   0CC7
```

WI-I/O 9-3_WI-I/O-EX-1-S-3 Modules

```
ML     VBAT   VSLR
00     9FA2   0000
```

WI-I/O 9-4_WI-I/O-EX-1-S-4 Modules

Digital Inputs

```
DIN  DIO                      PULSED
1234 123456789ABC MLS   PIN1 PIN2 PIN3 PIN4
1001 010101010 001   101     0001 0001 0001  0001
```

Analog Inputs

```
VBAT PR1     PR2     PR3     PR4
8DBE  0000    0000    0000    0000
```

Tones (WI-I/O 9-x modules only)

This provides the same function as described above in 6.2.2. Tone Reversals. This function may be used to check VSWR of antennas, and may be used in conjunction with the Signal option (described below) to check the path between two units.

Comms

This function allows monitoring of all messages transmitted and received over the radio. A better comms display function is available using the “Comms Logging” feature in the configuration software - refer to section 6.2.4.

Transmitted messages are displayed starting in the leftmost column of the display. Received messages are displayed with the received signal strength preceding the message. The first four hexadecimal digits are the system address attached to the message, and must match for units to communicate successfully.

The received signal strength is in negative dBm - the lower the measurement, the stronger the radio signal. A measurement larger than 95 indicates a weak radio signal.

Example:

```
>c
Comms
TX: 01FA8106008005C6727D44    Command message transmitted by this unit.
84   01FA8186C6E0E3           Acknowledge received from remote.
81  01FA860100800100009286    Message received from remote unit.
TX:  01FA868100FCE4           Acknowledge message from this unit to remote.
<INVALID> 01FA860000800100009286  Corrupted message received.
```

DO1 to DO8, DIO1 to DIO12

These options allow the user to set and clear digital outputs. To set an output, select the corresponding menu item, at the prompt, type the value FFFF to turn the output ON, or 0000 to turn the output OFF. For example, to set DO1 ON,

```
>e
DO1
>FFFF
```

AO1 to AO8

These options allow the user to set analog outputs to any value. To set the output, select the corresponding menu item. At the prompt type the value required for the analog output as a four digit hexadecimal value. Refer to the table above for analog current/expected value relationship. To set AO2 on WI-I/O-EX-1-13 to 19 mA :

```
>m
AO2
>B800
```

Switch

This option allows testing of the DIL (Dual In Line) switches. The diagram below indicates the layout of the switches of which there are two sets of eight, with an “Enter” button located to the right of the pair. the display indicates the current switch settings with the digit ‘1’ corresponding to ‘On’ and the digit ‘O’ corresponding to ‘Off’. Changing the switch settings in this mode will change the display. Test each switch and check to ensure the display changes accordingly.

Switches

1	1	1	0	0	0	1	0

0	1	0	1	0	1	0	1

Displayed

`1110001001010101`

Signal

This option provides for testing the radio path between two units for a suitable reliability margin. Although a pair of units may communicate successfully, radio communication may be affected by a range of influences, including atmospheric conditions, changing landscape, degradation of antennas or co-axial cable, low battery voltage etc. “Fade margin” is an indication of how far a radio path can deteriorate before communication becomes unreliable.

When using the Signal feature, the current received radio signal level is displayed in negative dBm (dBm is relative to 1mW of RF power). A display of 100 means –100dBm. This means that a stronger signal will have a lower measured value.

To check the radio path between two units, select the signal option at the local unit. The display will initially show the background noise of the radio band. Determine the approximate average of the noise level. The remote unit may then be set up for tone reversals (refer 1 above). Determine the approximate average of the received signal strength. It is normal for the measured values to continually change - the radios are continually changing frequency. Calculate the best average for both the noise and signal. For a reliable radio path, the signal strength must be at least 10dB lower than the noise level, or 98, whichever is less.

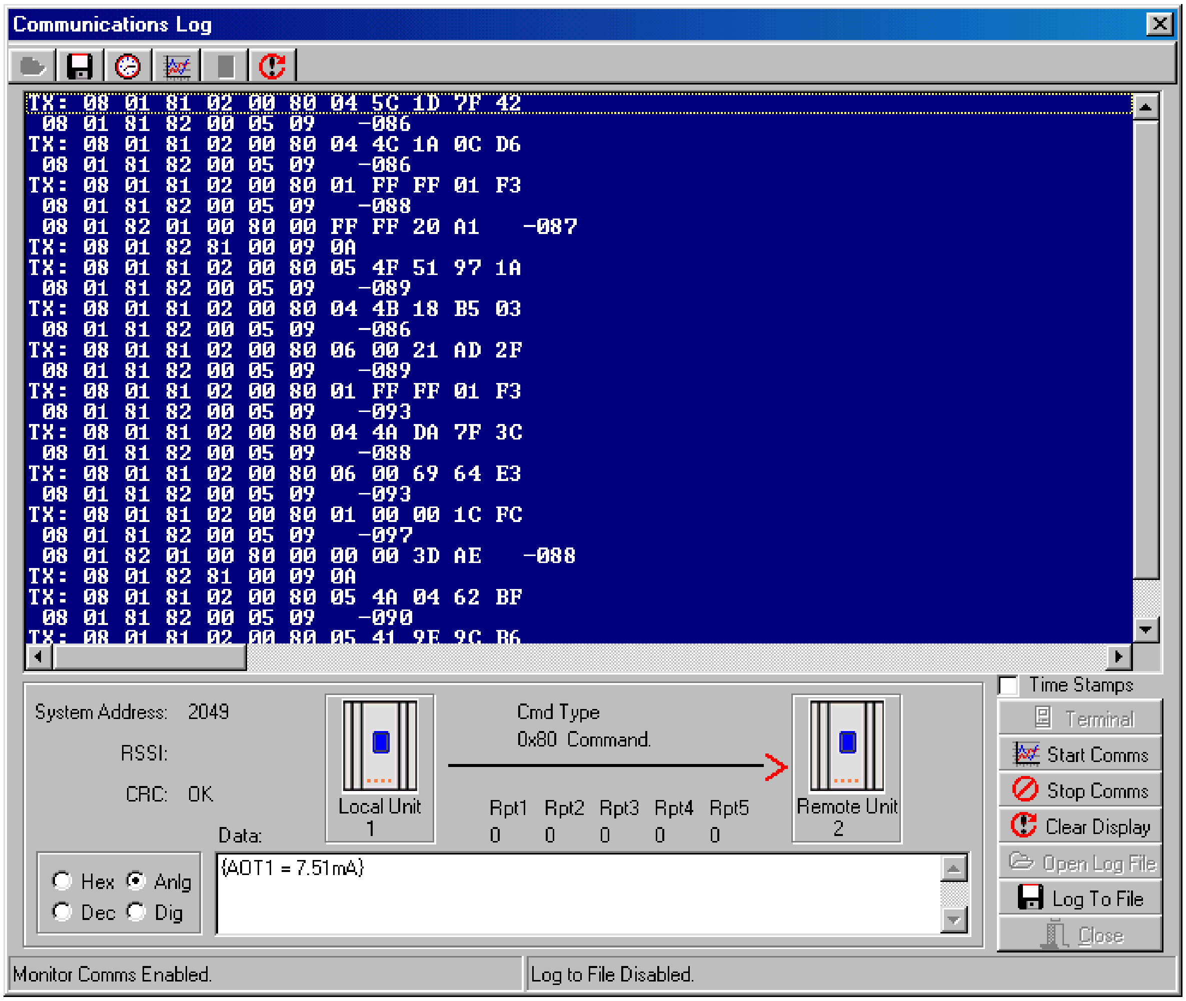
For example, if the noise level is 120, then the radio signal must be 98 or lower for a reliable path. If the noise level is 100, then the radio signal must be 90 or lower.

A simpler method when remote units are not easily accessible is to cause a transmission from the local unit to the remote unit (by setting a digital input which maps to the remote unit, for example). The meter will latch the received signal from the remote unit for half a second, allowing the received level to be read.

If any obstructions in the radio path are likely to change, then this should be allowed for. For example, if the radio test is done during winter and the radio path is through trees without leaves, then another 10dB of margin should be allowed for to cover summer conditions when the trees have leaves.

When using directional antennas (i.e. YAGI antennas) this feature may be used to peak the received signal level. Set-up the remote unit to transmit tone reversals as described above, and observe the signal indication while adjusting the orientation of the antenna. A peak in signal level indicates optimum orientation of the antenna.

6.2.4 Comms Logging



```
TX: 08 01 81 02 00 80 04 5C 1D 7F 42
 08 01 81 82 00 05 09   -086
TX: 08 01 81 02 00 80 04 4C 1A 0C D6
 08 01 81 82 00 05 09   -086
TX: 08 01 81 02 00 80 01 FF FF 01 F3
 08 01 81 82 00 05 09   -088
 08 01 82 01 00 80 00 FF FF 20 A1   -087
TX: 08 01 82 81 00 09 0A
TX: 08 01 81 02 00 80 05 4F 51 97 1A
 08 01 81 82 00 05 09   -089
TX: 08 01 81 02 00 80 04 4B 18 B5 03
 08 01 81 82 00 05 09   -086
TX: 08 01 81 02 00 80 06 00 21 AD 2F
 08 01 81 82 00 05 09   -089
TX: 08 01 81 02 00 80 01 FF FF 01 F3
 08 01 81 82 00 05 09   -093
TX: 08 01 81 02 00 80 04 4A DA 7F 3C
 08 01 81 82 00 05 09   -088
TX: 08 01 81 02 00 80 06 00 69 64 E3
 08 01 81 82 00 05 09   -093
TX: 08 01 81 02 00 80 01 00 00 1C FC
 08 01 81 82 00 05 09   -097
 08 01 82 01 00 80 00 00 00 3D AE   -088
TX: 08 01 82 81 00 09 0A
TX: 08 01 81 02 00 80 05 4A 04 62 BF
 08 01 81 82 00 05 09   -090
TX: 08 01 81 02 00 80 05 41 9E 9C B6
```

System Address: 2049
RSSI:
CRC: OK
Cmd Type
0x80 Command
Rpt1 0 Rpt2 0 Rpt3 0 Rpt4 0 Rpt5 0
Data: (AOT1 = 7.51mA)
○ Hex ● Anlg
○ Dec ○ Dig
☐ Time Stamps
Monitor Comms Enabled.
Log to File Disabled.

These options allow logging and display of radio communications. To start “Comms logging”:

- select option the “Comms” option from the diagnostics menu (see section 6.2.3),
- select ‘Stop Terminal’ and then
- select ‘Start Comms’.

The display will show radio messages transmitted and received. Messages starting with TX are transmitted messages, and received messages start with a small line indent. At the end of each received message is the RSSI (radio signal strength) in dBm.

If you select any message line with the mouse, information about the message will be displayed at the bottom of the screen - the system address, RSSI and CRC (error-check) status. The “text box” at the bottom middle of the screen decodes the message - that is, it decodes the message to display I/O channel and value.

You can display the register values in Decimal by selecting “Dec” at the bottom of the screen. If you select “Dig”, the values will be displayed as a 0 or 1 digital value (1 if the 16-bit value is greater than 50% - that is, the most significant bit is 1). If you select “Anlg”, the value will be displayed as a 4-20mA range.

To stop “comms logging”, select the “Stop Comms” box. You can then shut down the diagnostics

screen, or select “Terminal” to go back to the diagnostics menu.

Add Time Stamps

Time stamps can be added by selecting the “Time Stamps” box. This will allow the current time and date to be displayed with each message. The “Comms log” can be saved to a file for future reference by selecting “Log to File”.

6.3 Radio Path Testing

To carry out a radio path test, you will need two WI-I/O 9-x modules. One module will be “fixed” and the other “mobile”. Both units will need power supplies and antennas. The power supply for the mobile unit is normally a 12V battery, but make sure that the battery is fully charged - batteries with low voltage will lead to low radio power which will affect the test result.

The object of the test is to determine whether radio paths are reliable, marginal or unreliable. A reliable path will have a margin of at least 10dB above the background noise level in good weather - this margin is enough to ensure that the radio path remains reliable in poor conditions. A marginal path will work reliably in good conditions, however will fail during poor conditions. If the test is carried out during rainy or foggy weather, then a margin of only 5dB is required.

Procedure:

- ☐ Configure the modules to the same system address, and on each module, configure DI1 to DO1 on the other module. At the fixed module, wire DO1 to DI1 such that DI1 will turn ON when DO1 turns ON. Connect a switch to DI1 on the mobile unit.
- ☐ When the modules are close to each other, test the system - close the switch, forcing the mobile unit to transmit. The mobile unit will transmit to the fixed unit, and the fixed unit will transmit back to the mobile unit, activating DO1. Turning off the switch will result in two radio transmissions, turning off DO1. Each time the switch is changed, there should be two radio messages (two sets of TX/RX flashes) at the mobile unit. Note that when the modules are within a couple of metres, they may not work well with antennas connected - in this case, test without antennas.
- ☐ Set up the fixed module in one of the test positions - this is normally at a control centre or repeater site. Fix the antenna in a temporary fashion. You will need to make an initial assessment on how high the antenna should be mounted.
- ☐ Take the mobile module to the other end of the radio path. The antenna at this end can be either held by the tester, or fixed in a temporary fashion. Note that a person’s body will affect the radiation pattern of an antenna, so if the antenna is hand-held and the test is not successful, try again with the antenna fixed to a 1 metre length of plastic pipe or timber. The tester holds the length of pipe or timber with the antenna above head height.
- ☐ Test the radio path by operating the switch. If the radio path is short, and there is a high level of confidence that the radio path will be reliable, the result can be checked by simply looking at the

TX/RX leds on the mobile unit. If each TX flash is followed immediately by a RX flash (that is, the TX flash does not flash twice or more times before the RX flashes), then the radio path is likely to be reliable. Operate the switch several times - do not rely on one test. If the test is being done outside, the leds will need to be shaded to view the flashes.

- ☐ If the radio path is uncertain, then the result should be measured by connecting a laptop computer, following the procedure outlined in this manual for measuring the radio signal strength. Before the switch is operated, the background noise level should be measured and recorded. This measurement is likely to "jump around" or oscillate, to determine an average measurement. Now operate the switch several times - take the average measurement of the signal transmitted from the fixed unit.
- ☐ The radio path is reliable if the transmitted signal is 10dB above the noise level, or better than –98dBm. For example, if the noise level is –115dBm, then the minimum level for reliability is –98dBm. If the noise level is –100dBm, then you need –90dBm for a reliable path. If the laptop displays a scale measurement instead of a numerical measurement, then the transmitted signal should be at least 3 divisions, and at least 2 divisions above the noise level.
- ☐ If the weather is poor during the test, then the transmitted signal needs to be 5dB above noise, or 1 division. It is best not to do radio tests during poor weather.
- ☐ Record these measurements for comparison later during commissioning or if the system has problems later.

If the radio path test is not successful:

1. Increasing the height of the antenna at either module, or at both modules can significantly improve the result. Sometimes moving the antenna to the side helps, if there is an obvious obstruction in the radio path.
2. Change one or both antennas to a higher gain if regulations allow.
3. Use a shorter coaxial cable between the antenna and the WI-I/O 9-x.(this may involve moving WI-I/O 9-x nearer to antenna mounting), or use a different coaxial cable with lower loss.
4. If a reliable radio path is not possible because of distance or path obstructions, you will need to consider using a repeater module. The ideal repeater is another module in the system, in a good location to act as a repeater. If this is not the case, you need to consider installing a module to act specifically as a repeater.

Chapter Seven WARRANTY & SERVICE

We are pleased that you have purchased this product.

W INTERCONNECTIONS products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W INTERCONNECTIONS, W INTERCONNECTIONS will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W INTERCONNECTIONS' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W INTERCONNECTIONS is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W INTERCONNECTIONS is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W INTERCONNECTIONS or its representatives or by any other party, except as expressed solely in this document..

Full product specifications and maintenance instructions are available from your Service Agent, your source of purchase, or from the master distributor in your country upon request and should be noted if you are in any doubt about the operating environment for your equipment purchase

In the unlikely event of your purchase being faulty, your warranty extends to free repair or replacement of the faulty unit, after its receipt at the master distributor in your country. Our warranty does not include transport or insurance charges relating to a warranty claim.

Should you wish to make a warranty claim, or obtain service, please forward the module to the nearest authorised Service Agent along with proof of purchase. For details of authorised Service Agents, contact your sales distributor.

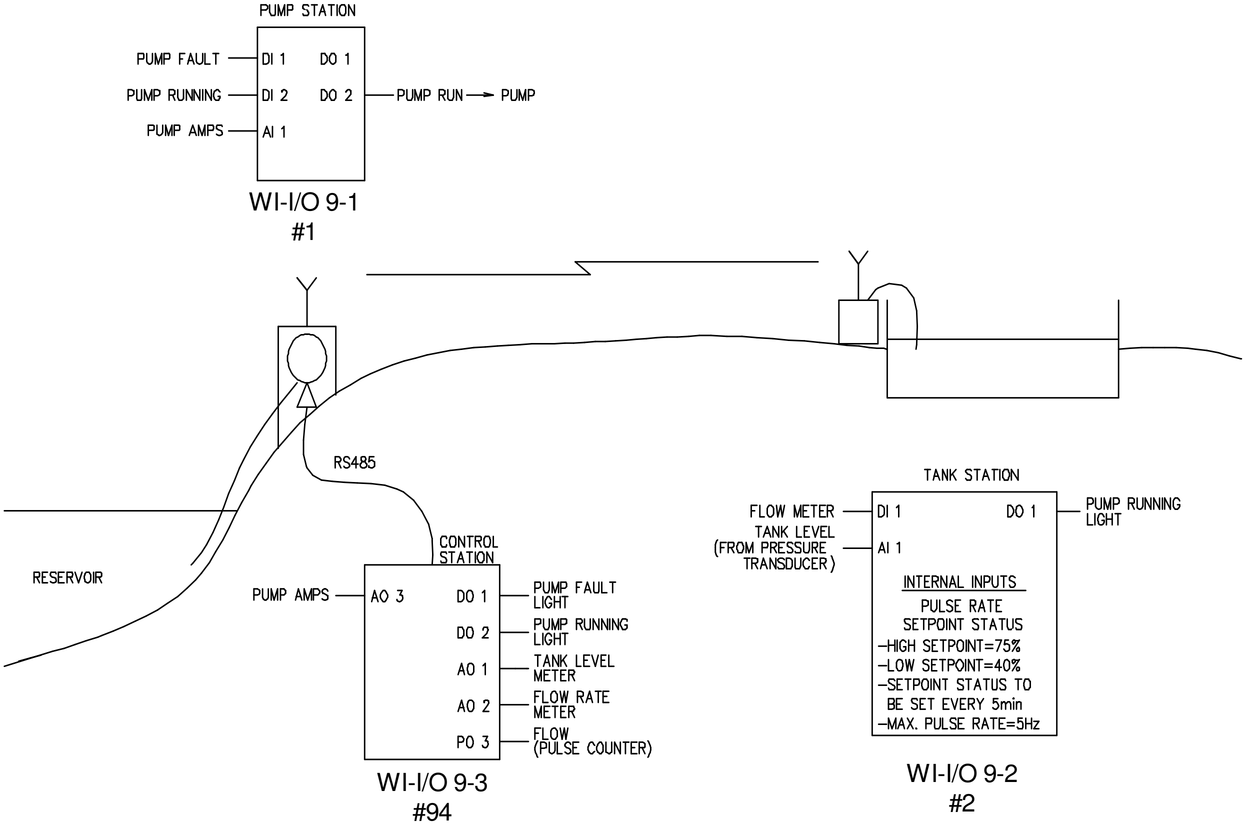
Appendix A SYSTEM EXAMPLE

The following example of a system is a comprehensive guide to using some of the features of the range and design of system.

The example application is a pump station which supplies water from a reservoir to a tank station. Signals are transferred between the pump station and tank station by radio - the distance between the two stations is 10 km (6 mile), and the radio path is heavily obstructed by buildings and trees. A control station is located near the pump station, and there is an existing signal cable between the control station and the pump station.

A WI-I/O 9-1 module is installed at the pump station (with address 1) and a WI-I/O 9-2 module is installed at the tank station (with address 2). Because the signal cable to the control station does not have enough cores for all of the signals required, the signal cable is used as a RS485 cable and a WI-I/O-EX-1-S-x-3 module is installed at the control station (with address 96). As this module has an address greater than 95, the WI-I/O 9-1 at the pump station will communicate to it via its serial port.

The following diagram represents the system:-



The following design points should be noted :-

- A test of the radio path between the pump station and the tank station indicated that the radio path

would be reliable provided antennas were installed at 6 m above the ground. At each site, the coaxial cable would be approx 30 feet in length, so it was decided to use 6 element Yagi antennas with RG58 coaxial cable - the Yagi antennas would compensate for the loss in the cable.

- At the tank station, there was an existing light pole with a mains power supply - the light pole was 10m high. Permission was obtained to mount the antenna from the pole and to use the power supply for the radio telemetry module.

  As there was no existing electrical panel at this station, a small steel enclosure was installed on the light pole. A 2 Amp-Hour sealed battery was installed to provide power during any mains failure. The flow and level transducer were powered from the 24VDC loop supply provided by the module.

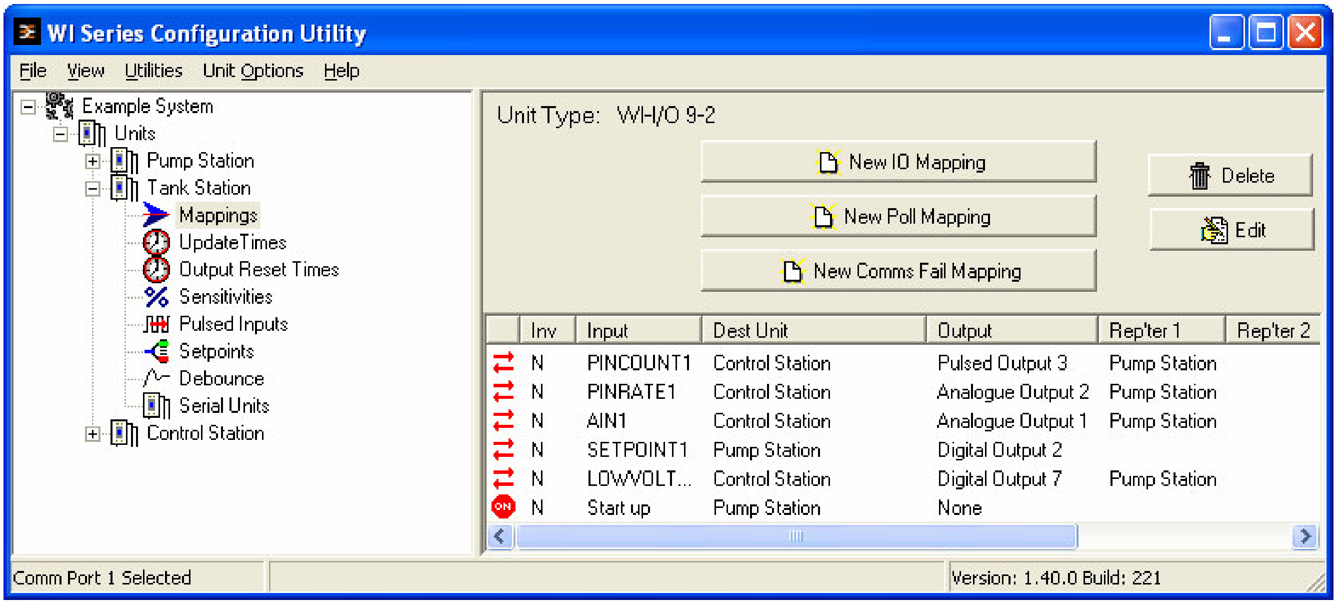
- At the pump station, the antenna was mounted on a 10' J-bracket installed on the roof of the pump station building. The final height of the antenna was approx 20 feet. Care was taken to align the Yagi antennas so they pointed at each other. The Yagi antennas were installed with horizontal polarity - that is, with the elements horizontal. These antennas will not "hear" other radio users on the same radio channel which generally use vertical polarity.

  There was an existing electrical enclosure at the pump station, and the WI-I/O 9-x module was installed inside this enclosure. The module was powered from a 24VDC supply with a 2 Amp Hour sealed battery as backup.

- At the control station, the WI-I/O-EX-1-S-x module was installed inside the existing control panel enclosure. The module was powered from an existing 24VDC power supply.

Tank Station Configuration

The WI-I/O 9-2 module has the following configuration :-



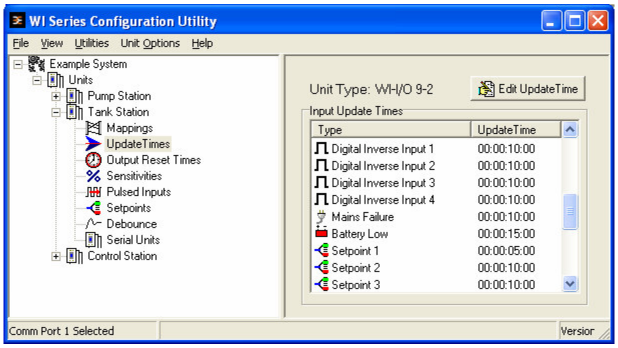
Unit Type: WI-I/O 9-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2
⇄	N	PINCOUNT1	Control Station	Pulsed Output 3	Pump Station	
⇄	N	PINRATE1	Control Station	Analogue Output 2	Pump Station	
⇄	N	AIN1	Control Station	Analogue Output 1	Pump Station	
⇄	N	SETPOINT1	Pump Station	Digital Output 2		
⇄	N	LOWVOLT...	Control Station	Digital Output 7	Pump Station	
ON	N	Start up	Pump Station	None		

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Note the following points in the configuration:

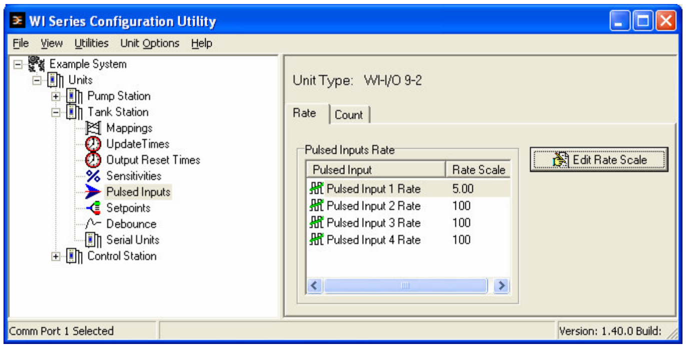


Unit Type: WI-I/O 9-2

Input Update Times

Type	UpdateTime
Digital Inverse Input 1	00:00:10:00
Digital Inverse Input 2	00:00:10:00
Digital Inverse Input 3	00:00:10:00
Digital Inverse Input 4	00:00:10:00
Mains Failure	00:00:10:00
Battery Low	00:00:15:00
Setpoint 1	00:00:05:00
Setpoint 2	00:00:10:00
Setpoint 3	00:00:10:00

Comm Port 1 Selected



Unit Type: WI-I/O 9-2

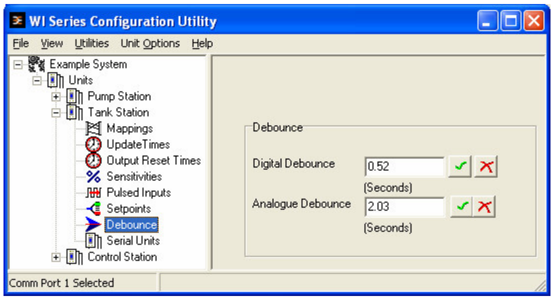
Pulsed Inputs Rate

Pulsed Input	Rate Scale
Pulsed Input 1 Rate	5.00
Pulsed Input 2 Rate	100
Pulsed Input 3 Rate	100
Pulsed Input 4 Rate	100

Comm Port 1 Selected

Version: 1.40.0 Build:

- #1 is a repeater for communications between #2 and #94
- The pulse rate scaling for PIN1 has been set to 5 Hz to match the maximum flow rate of the flow meter. Note that PIN1 has not been configured for "divide by 10" (for 1000 Hz pulse signals).



Debounce

Digital Debounce 0.52 (Seconds)

Analogue Debounce 2.03 (Seconds)

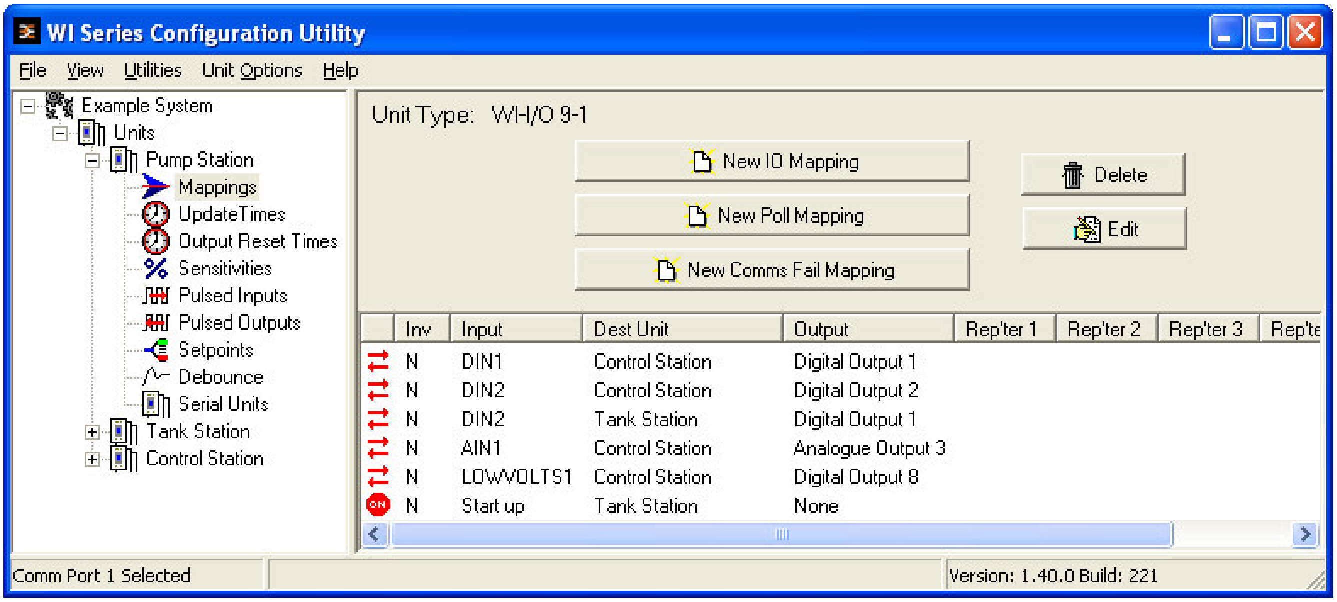
Comm Port 1 Selected

- AIN1 (the level transducer) is mapped to AO1 at the WI-I/O 9-3. The analog debounce has been set to 2 sec. This is because of concern of wave action on the surface of the tank causing un-necessary change transmissions. This debounce time will also operate on the Pulse Rate value, but as the flow rate changes slowly, this will not affect the performance of this signal.

- SETPOINT1 (the set-point status for AI1) is mapped to DO2 of #1 (pump station). The set-point values for this setpoint have been set to 40% and 75%. When the tank level drops to 40%, DO2 at the pump station will activate to start the pump. When the level rises above 75%, DO2 will reset to stop the pump.
- The update time for SETPOINT1 has been changed to 5 minute, as required.
- An additional mapping has been entered - LOW VOLT has been mapped to DO7 at #94 via #1 (DO7 at the control station). This mapping is for future use - it will provide a low battery voltage alarm for the tank station. The update time for this mapping has been set to the maximum time of 15 minutes to reduce loading of the radio channel.
- A Start-up poll has been configured for #1, as DO1 at the tank station is controlled from the pump station. Note that no comms fail reset time has been configured for DO1. As this output drives an indication only, the indication will show the last correct status even during communication failures.

Pump Station Configuration

The WI-I/O 9-1 module has the following configuration :-



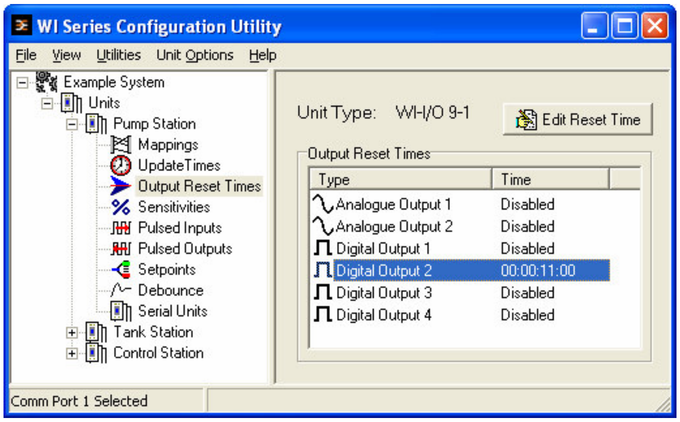
Unit Type: WI-I/O 9-1

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'te
⇄	N	DIN1	Control Station	Digital Output 1				
⇄	N	DIN2	Control Station	Digital Output 2				
⇄	N	DIN2	Tank Station	Digital Output 1				
⇄	N	AIN1	Control Station	Analogue Output 3				
⇄	N	LOWVOLTS1	Control Station	Digital Output 8				
ON	N	Start up	Tank Station	None				

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Note the following points in the configuration:



Unit Type: WI-I/O 9-1

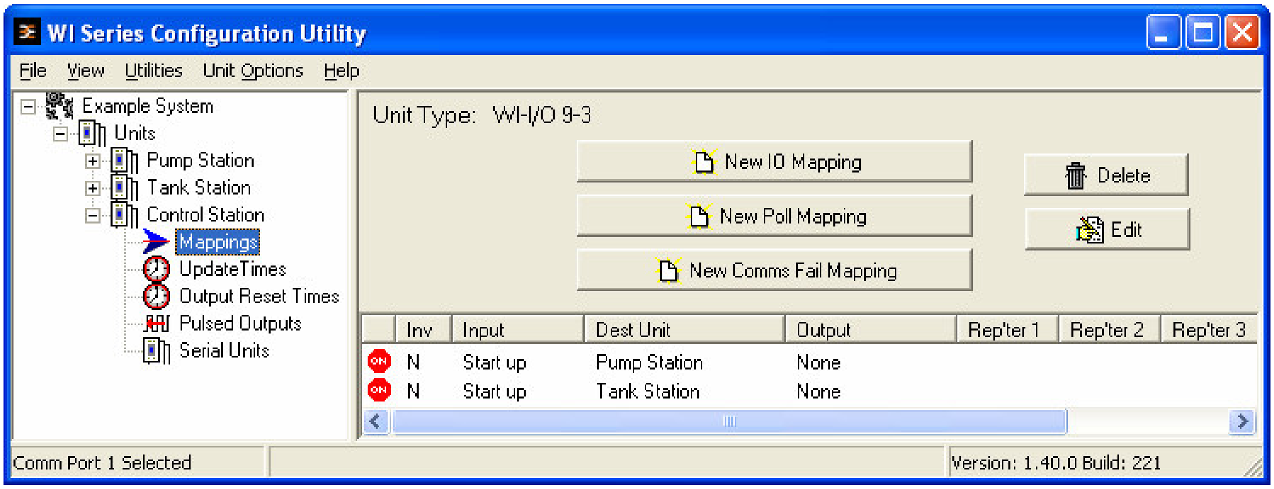
Output Reset Times

Type	Time
Analogue Output 1	Disabled
Analogue Output 2	Disabled
Digital Output 1	Disabled
Digital Output 2	00:00:11:00
Digital Output 3	Disabled
Digital Output 4	Disabled

- Note that no repeater address is necessary between #1 and #94.
- DIN2 (pump running signal) has two mappings - a mapping to DO1 at #2 (tank station) and DO2 at #94 (control station). When DIN2 changes, there will be two separate change messages transmitted - one by radio to #2 and one by serial link to #96.
- AIN1 (pump amps) is mapped to AO3 at #94 (control station).
- An additional mapping has been entered - LOW VOLT has been mapped to DO8 at the control station. This mapping is for future use - it will provide a low battery voltage alarm for the pump station.
- A Start-up poll has been configured for #2, as DO2 at the pump station is controlled from the tank station. Note that a comms fail reset time of 11 minutes has been configured for DO2. This means that if a message has not been received for DO2 within 11 minutes, DO2 will reset and switch off the pump. The 11 min time was chosen as it means that two successive update messages have to be missed before the pump is reset, and there is no problems if the pump runs for 11 minutes during a system failure (the tank will not overflow during this time).

Control Station Configuration

The WI-I/O-EX-1-S-3 module has the following configuration :-

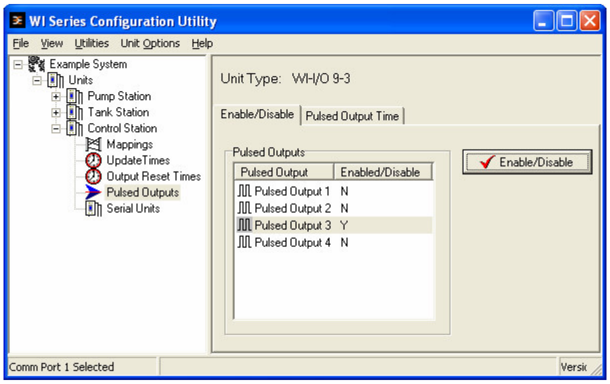


Unit Type: WI-I/O 9-3

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
ON	N	Start up	Pump Station	None			
ON	N	Start up	Tank Station	None			

Note the following points in the configuration:

- The only mappings are Start-up polls. Note that there are two separate polls, one for each remote module.
- PO 3 has been configured as a PO. Its pulse output update time is the same as the PI update time at the remote module (both have been left at their default value of 1 minute).
- Reset times have been selected for the analog outputs (21 minutes) but not the digital outputs. In the event of a system failure, the digital outputs will stay at their last correct status, but the analog outputs will reset to 0 mA.



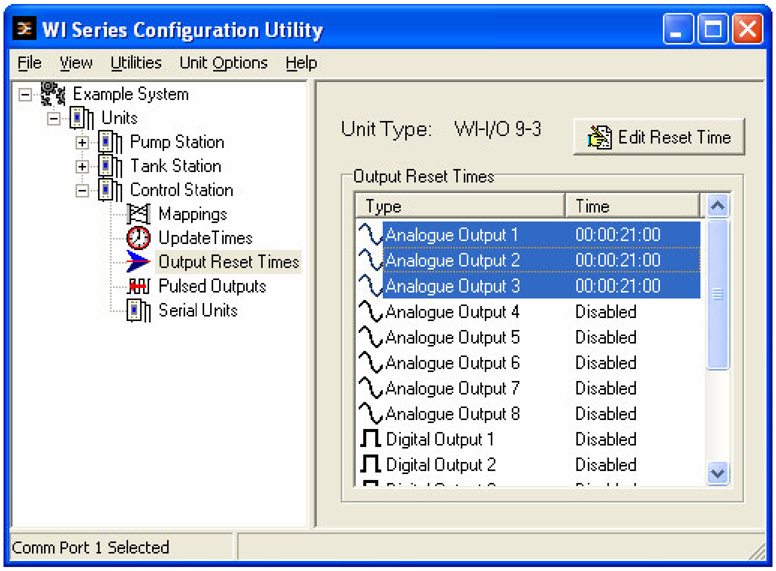
Unit Type: WI-I/O 9-3

Pulsed Outputs

Pulsed Output	Enabled/Disable
Pulsed Output 1	N
Pulsed Output 2	N
Pulsed Output 3	Y
Pulsed Output 4	N

System Failure Alarm

After the system had been running for some time, the operators wanted a "system failure" output at the control station, to warn the operators that there was a fault with the system.



Unit Type: WI-I/O 9-3

Output Reset Times

Type	Time
Analogue Output 1	00:00:21:00
Analogue Output 2	00:00:21:00
Analogue Output 3	00:00:21:00
Analogue Output 4	Disabled
Analogue Output 5	Disabled
Analogue Output 6	Disabled
Analogue Output 7	Disabled
Analogue Output 8	Disabled
Digital Output 1	Disabled
Digital Output 2	Disabled

The following configuration was added :

At #2 (tank station), Inverse DI4 → DO4 at #94 via 1 ; DI4 Update time = 1 minute

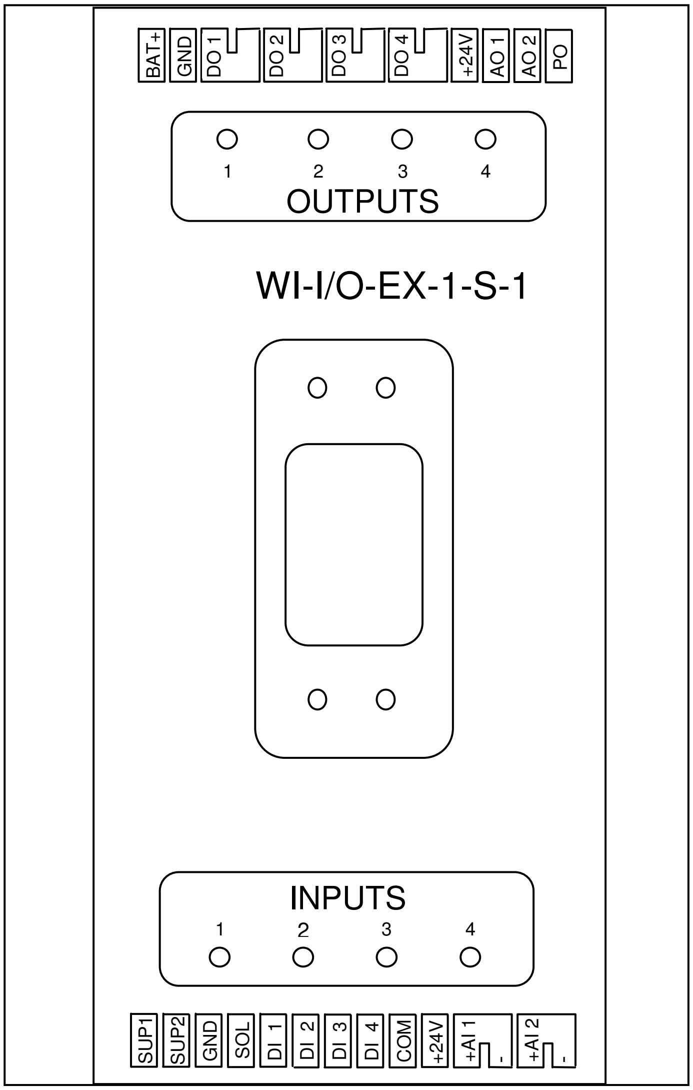
At #94 (control station), DO4 Comms fail reset time = 3.5 min

At the control station, DO4 was a "system OK" signal. It was normally active - if the signal reset, then this represented a system failure. At the tank station, there is no signal wired to DI4. By mapping Inv DI4 to DO4 at the control station, a message is transmitted every minute to this output to activate it. The message is transmitted via the radio link to #1, and then by the serial link to #94. If anything happened to either module #2 or module #1, or the radio link, or the serial link, then the update messages for DO4 will not be received at the control station module. After 3.5 Minutes, DO4 will reset indicating a problem.

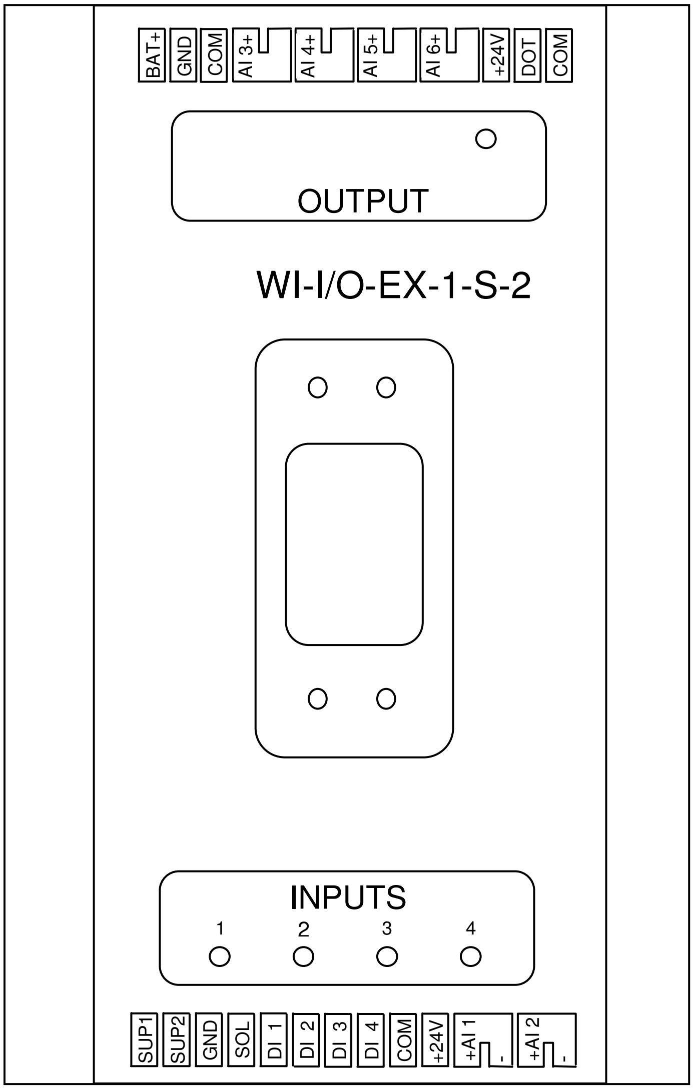
The time of 3.5 minutes was selected as this means that 3 successive update messages have to be missed before a system alarm occurs. Also note, that if module #94 fails, DO4 will reset and give an alarm signal.

Appendix B TERMINAL LAYOUTS

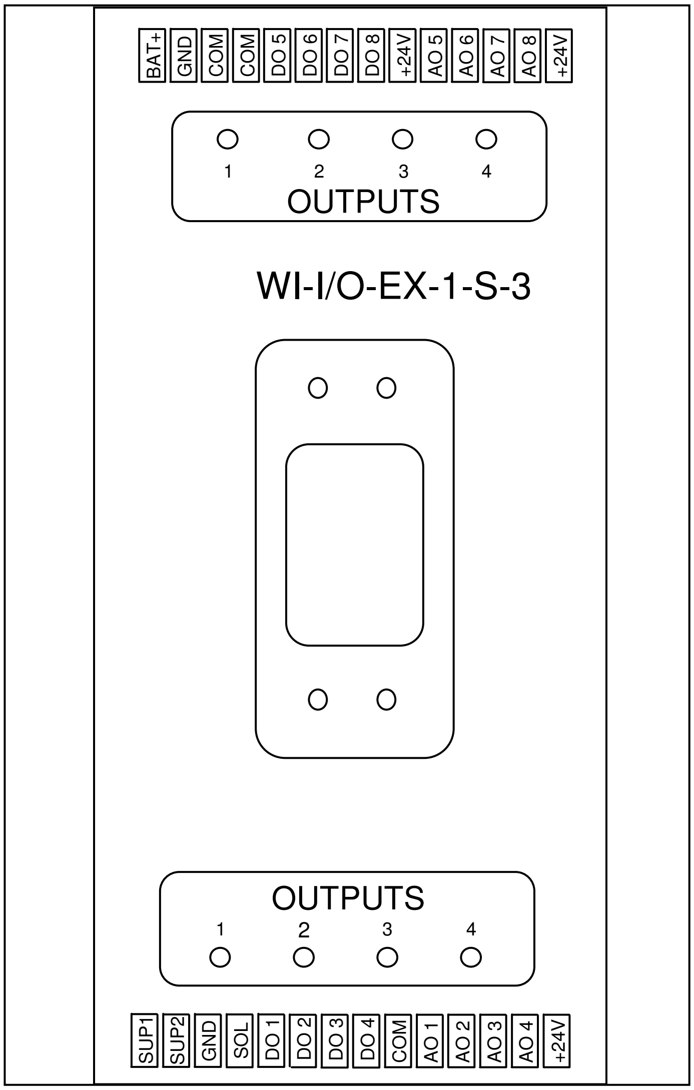
WIRING DRAWING -WI-I/O 9-1 WI-I/O-EX-1-S-1



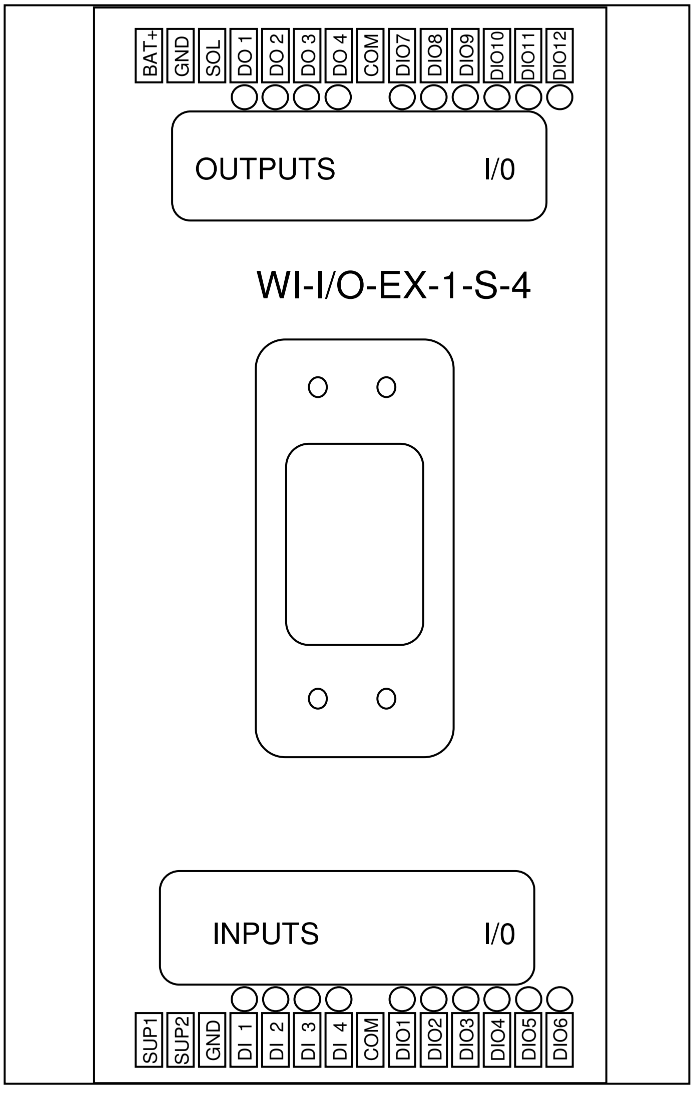
WIRING DRAWING - WI-I/O 9-2 WI-I/O-EX-1-S-2



WIRING DRAWING - WI-I/O 9-3, WI-I/O-EX-1-S-3



WIRING DRAWING -WI-I/O 9-4, WI-I/O-EX-1-S-4



WI-I/O 9-1
Installation Guide

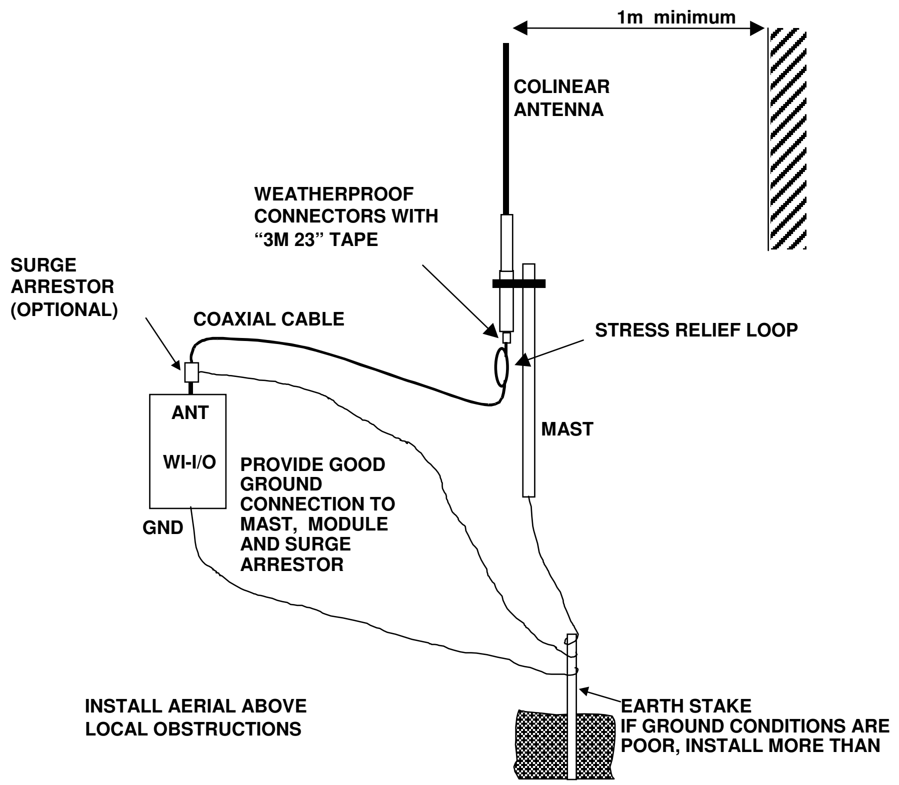
FCC Notice

This device complies with Part 15.247 of the FCC Rules.
Operation is subject to the following two conditions:

1) This device may not cause harmful interference and
2) This device must accept any interference received, including interference that may cause undesired operation

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS 1 DIVISION 2 GROUPS ABC AND D OR NON HAZARDOUS LOCATIONS ONLY

Aerial Installation



ANTENNA INSTALLATION
Antennas should be installed by experienced contractors.

WI-I/O 9-1 Installation

Power supply: (A) 12-24VAC 1.5 Amp CSA Certified Class 2

(B) 15-30VDC 1.5 Amp CSA Certified Class 2

(C) Supply battery or 11-15VDC

(D) Solar panel with solar battery

Choose option and wire as shown

WARNING!

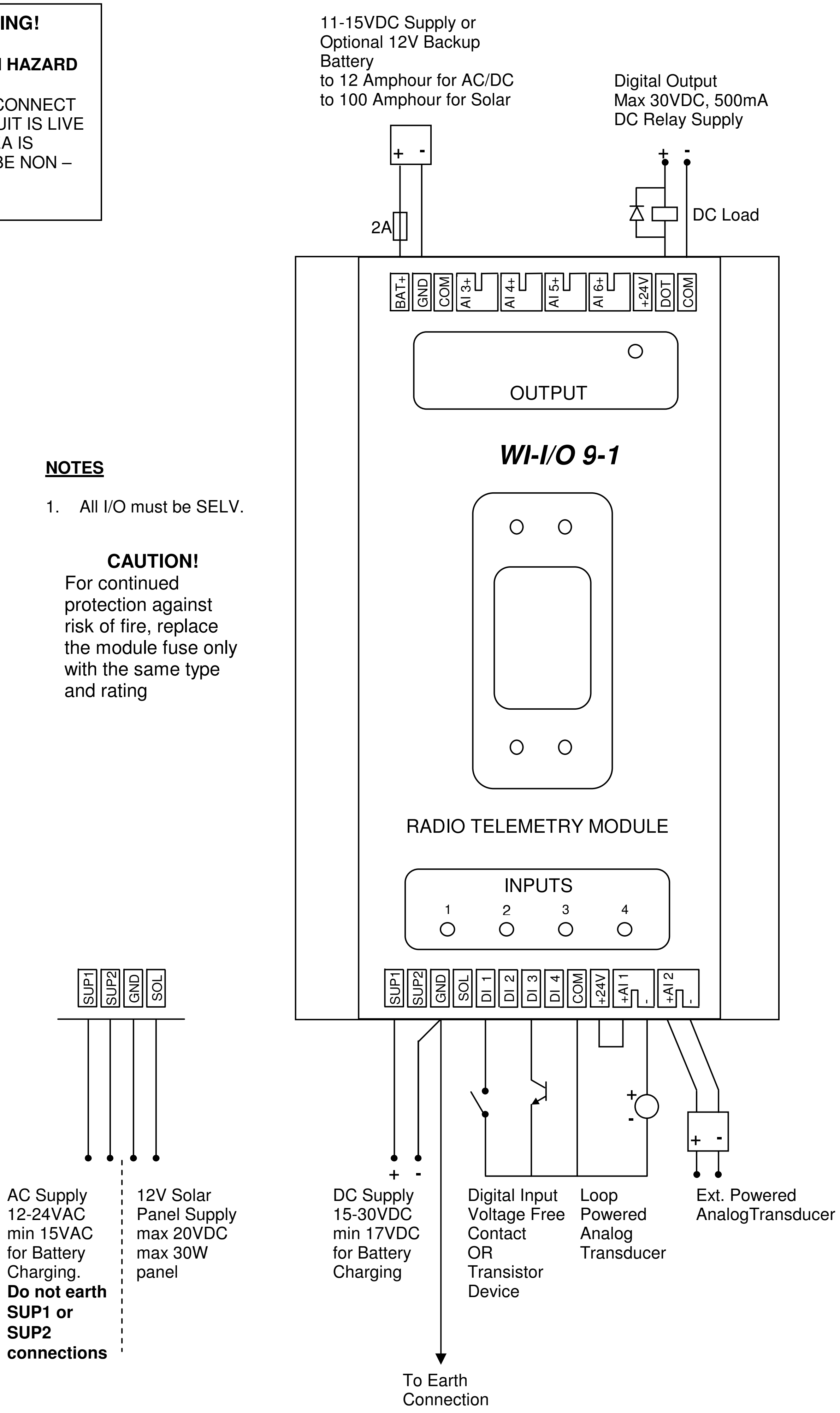
EXPLOSION HAZARD

DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON – HAZARDOUS

NOTES

1. All I/O must be SELV.

CAUTION!
For continued protection against risk of fire, replace the module fuse only with the same type and rating



WI-I/O–EX Expansion I/O Units (Serial I/O)

The WI-I/O-EX is a wired device capable of interfacing with other Weidmuller wireless radios to increase the number of signals radios can monitor/control. They can also be used as a slave to any Modbus control system.

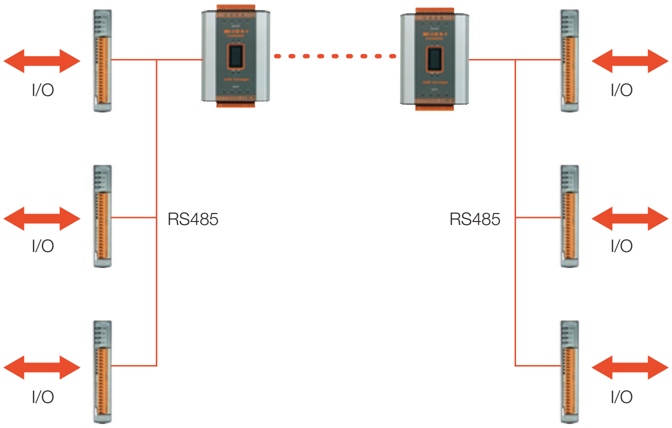
Typical Applications

Expansion I/O for WI-I/O 9 wireless units and WI-MOD units

- up to 31 x WI-I/O-EX units can be connected to each wireless unit via RS485 (up to 2 km long). Serial I/O multiplexer
- transfer I/O via RS485— up to 32 units per multi-drop link.

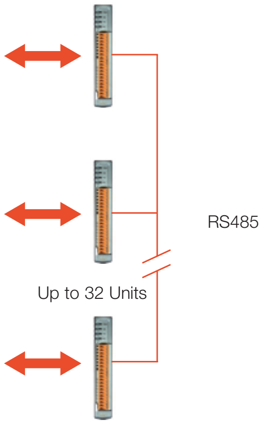
Expansion I/O for Modbus devices

- up to 31 x WI-I/O-EX units can be connected to each Modbus master via RS485 (up to 2 km long).

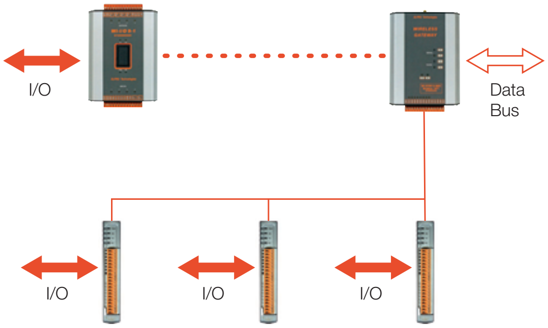


Features

- Multi I/O channels— monitoring and control functions
- Connected via RS485 multi-drop
- Selectable communications via WIB-net or Modbus protocol (both RTU and ASCII formats)
- Sensor signals connected at one module (input signals) are transmitted to another module where the signals are re-created as output signals, or passed via serial to a host device such as a PLC or SCADA system
- Connect to WI-I/O 9 wireless I/O units for up to 31 serial addresses per wireless unit



- Connect WI-I/O-EX units together to form a serial multi-drop I/O system - up to 32 serial addresses per multi-drop link— no Master device is required to control communications
- Connect up to 99 x WI-I/O-EX units as multi-drop Modbus I/O (RS485 extenders/isolators required for more than 31 units per single multi-drop length)
- RS485 multi-drop up to 2 km (1 mile) depending on installation environment
- Three I/O versions available
- Peer-to-peer communications; Exception reporting; Reliable self-checking messages; Any input on any unit can be linked to any output on any unit. Inputs can be linked to multiple outputs; Serial communications 9.6Kb/s
- Alternate Modbus RTU or Modbus ASCII slave protocol, serial communications configurable up to 115.2Kb/s, 7 or 8 data bit format
- External I/O plus internally calculated values - analog setpoint status, pulse rate and pulse total, power supply voltage, power supply alarm
- Setpoint status generated by comparing analog inputs to high and low setpoints



- Analog inputs selectable as "floating" dual-terminal inputs or commoned single-terminal inputs; Configurable current (0-10/0-20/4-20mA) or voltage (0-5/0-10/1-5V).
- Analog outputs selectable as single-terminal source or sink outputs. Configurable current (0-10/0-20/4-20mA) or voltage (0-5/0-10/1-5V). Configurable scaling, zero and span parameters.
- Pulse inputs generate separate pulse count value and a pulse rate value. Pulse rates are treated as internal analog registers with a configurable maximum value.

Wireless I/O Expansion I/O Units—Introduction 900 MHz/2.4GHz

- Multiple communication-failure diagnostics with output status. Fail-to-transmit alarm and fail-to-receive alarm status.
- Class 1 Div 2 hazardous areas approval
- Input measurement display and output “forcing” diagnostics.
- Communication logging diagnostics.
- Easy-to-use E-Series Windows configuration available at **www.weidmuller.ca** or **weidmuller.com**

Serial Unit Ordering Information

WI-I/O-EX	**67200005038 -11**	**67200005039 -12**	**67200005040 -13**
Digital inputs	up to 16	up to 8 Voltage-free contacts	up to 8
Digital outputs	up to 16	up to 8	up to 8
Analog inputs	0	4 “floating”/ 8 commoned 0-20mA / 0-10V	0
Analog outputs	0	0	8 sink / source 0-20mA / 0-10V
Pulse inputs	4 1KHz	0	0
Pulse outputs	8 100Hz	8 100Hz	8 100Hz

Note: Digital inputs and outputs are combined channels. When a channel is used as an output, it is not available as an input. Pulse and digital I/O are same connection.

Dimensions

General Specifications

- **Temperature:** -40 to 60ºC / -40 to 140 ºF
- **Humidity:** 0-99% RH
- **Regulatory Approvals:** EMC FCC Part 15, AS3548, 89/336/EEC
- **Certifications:** CSA Class I, Division 2 hazardous areas (USA/Canada)
- **Housing:** high density thermo-plastic, 5.91” x 6.97” x 1.38” (150 X 177 x 35mm) with DIN rail mounting
- **Removable terminals** up to 12 gauge (2.5 mm^2) wires
- **LED indication** for power supply, processor OK, serial TX and RX, digital I/O

Inputs and Outputs

Digital Inputs

- Suitable for voltage-free contacts or NPN transistor, contact wetting current 5mA, inputs are surge protected
- **Type -11 -** up to 16 selectable I/O
- **Type -12, -13, -** up to 8 selectable I/O

Digital Outputs

- Field Effect Transistor (FET) outputs, 30VDC 200mA
- **Type -11** - up to 16 selectable I/O
- **Type -12, -13,** - up to 8 selectable I/O

Analog Inputs

- “Floating” differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, 0-20mA/0-10V, resolution 12-bit, accuracy 0.1%
- **Type-12** - 8 input channels, selectable as 4 dual-terminal floating inputs or 8 single-terminal commoned inputs

Analog Outputs

- Selectable as current/voltage source or current sink to common, max. loop voltage 27V, max. loop resistance 1000 ohms, 0 – 20mA/0 – 10V, 12-bit, accuracy 0.1%
- **Type -13** - 8 channels

Pulse Inputs

- Specifications as per digital inputs, max. pulse rate1kHz, pulse width min. 0.5 ms
- **Type -11**- 4 inputs (DIO1-4)

Pulse Outputs

- Specifications as per digital outputs, max. pulse rate100Hz, pulse width min. 5ms
- **Type -11,-12,-13,** - 8 outputs (DIO1-8)

Power Supply

- **Battery Supply:** 9 - 30VDC, over-voltage and reverse power protected
- Internal monitoring of supply voltage. These values may be transmitted to remote modules for monitoring.
- Internal DC/DC converter provides 24VDC 250mA for analog loop supply

Serial Port

- RS485 serial port configurable up to 115.2Kb/s, 7 or 8 data bits, none/even/odd parity, 1 or 2 stop bits
- RS232 configuration port 9 pin DB9 female connector, 9.6Kb/s, 8/n/1
- RS485 max cable distance 2000 m terminal connections

C US **C1D2**

WI-I/O-EX-1-S-11

WI-I/O-EX-1-S-12

Technical Data	WI-I/O-EX-1-S-11	WI-I/O-EX-1-S-12
Inputs:		
Digital: suitable for voltage free contacts or NPN transistor, contact wetting current 5mA, inputs are surge protected	up to 16 selectable I/O	up to 8 selectable I/O
Analog: “floating” differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, 0-20mA/ 0-10V resolution 12 bit, accuracy 0.1%		8 input channels, selectable as 4 dual-terminal floating inputs or 8 single-terminal commoned inputs.
Pulse: specifications as per digital inputs Max pulse rate 1kHz, pulse width min 0.5ms	4 inputs (DIO1-4)	
Outputs		
Digital: FET outputs, 30VDC 200mA	up to 16 selectable I/O	up to 8 selectable I/O
Pulse: specifications as per digital outputs Max pulse rate 100Hz, pulse width min 5ms	8 outputs (DIO1-8)	8 outputs (DIO1-8)
Power Supply	10.8 - 30VDC, over-voltage and reverse power protected Internal monitoring of supply voltage. These values may be transmitted to remote modules for monitoring. An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	10.8 - 30VDC, over-voltage and reverse power protected Internal monitoring of supply voltage. These values may be transmitted to remote modules for monitoring. An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS485	serial port configurable up to 115.2Kb/s, 7/8 data bits, n/e/o parity, 1 / 2 stop bits	serial port configurable up to 115.2Kb/s, 7/8 data bits, n/e/o parity, 1 / 2 stop bits
RS232 connector	configuration port 9pin DB9 female connector, 9.6Kb/s, 8/n/1	configuration port 9pin DB9 female connector, 9.6Kb/s, 8/n/1
RS485 connector	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections
General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99% RH	0-99% RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC	FCC Part 15, AS3548, 89/336/EEC
Approvals	Class 1 Div 2 hazardous areas	Class 1 Div 2 hazardous areas
Mounting	DIN rail mounting	DIN rail mounting
LED indication	power supply, processor OK, serial TX and RX, digital I/O	power supply, processor OK, serial TX and RX, digital I/O
Dimensions mm (in)	150 x 177 x 35 (5.91 x 6.97 x 1.38)	150 x 177 x 35 (5.91 x 6.97 x 1.38)

Ordering Data	**Type**	**Part No.**	**Type**	**Part No.**
	WI-I/O-EX-1-S-11	**6720005038**	WI-I/O-EX-1-S-12	**6720005039**

WI-I/O-EX-1-S-13

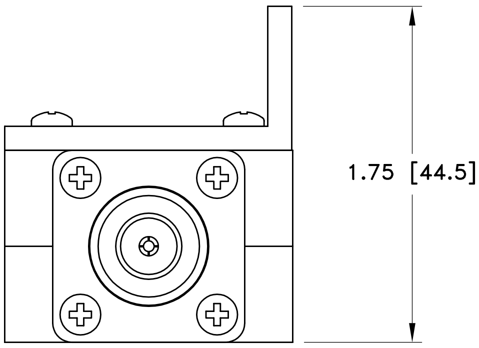
Technical Data	
Inputs:	
Digital: suitable for voltage free contacts or NPN transistor, contact wetting current 5mA, inputs are surge protected	up to 8 selectable I/O
Outputs	
Digital: FET outputs, 30VDC 200mA	up to 8 selectable I/O
Analog: selectable as current/voltage source or current sink to common, max loop voltage 27V, max loop resistance 1000 ohms, 0 – 20mA/ 0 – 10V, 12 bit, accuracy 0.1%	8 channels
Pulse: specifications as per digital outputs Max pulse rate 100Hz, pulse width min 5ms	8 outputs (DIO1-8)
Power Supply	10.8 - 30VDC, over-voltage and reverse power protected Internal monitoring of supply voltage. These values may be transmitted to remote modules for monitoring. An internal DC/DC converter provides 20VDC 150mA for analog loop supply.
Serial Port	
RS485	serial port configurable up to 115.2Kb/s, 7/8 data bits, n/e/o parity, 1 / 2 stop bits
RS232 connector	configuration port 9pin DB9 female connector, 9.6Kb/s, 8/n/1
RS485 connector	max cable distance 2000 m terminal connections

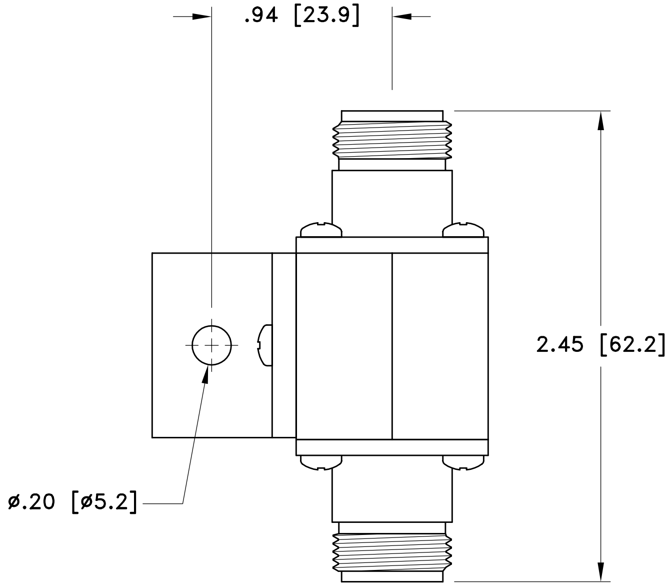
General Data	
Operating Temperature	-40 to 60°C (-40 to 140°F)
Humidity	0-99% RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC
Approvals	Class 1 Div 2 hazardous areas
Mounting	DIN rail mounting
LED indication	power supply, processor OK, serial TX and RX, digital I/O
Dimensions mm (in)	150 x 177 x 35 (5.91 x 6.97 x 1.38)

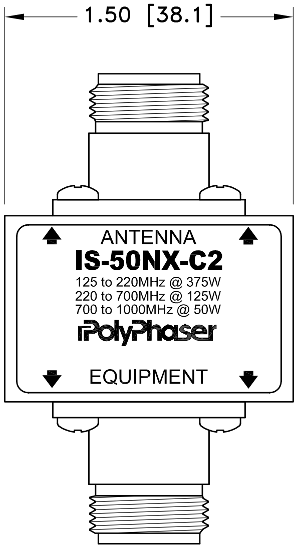
Ordering Data	Type	Part No.
	WI-I/O-EX-1-S-13	**6720005040**

REVISIONS

REV LTR	DATE	ENG	MKTG	Q.A.
A	01/30/96 PJP	T. K.	– –	R. M.
B	06/30/99 JCG	K.C.B.	T.G.F.	R. M.
C	01/16/01 SH	KCB	PH	RM
D	11/18/02 SH	LC	SD	LJ







MAXIMUM CHARACTERISTICS

SURGE:
50kA IEC 1000–4–5 8/20μs WAVEFORM 500 JOULES

TURN ON:
600Vdc ±20%

TURN ON TIME:
2.5ns FOR 2kV/ns

FREQUENCY RANGE:
125MHz TO 1GHz

VSWR:
≤1.1:1 OVER FREQUENCY RANGE

INSERTION LOSS:
≤0.1dB OVER FREQUENCY RANGE

TEMPERATURE:
–45°C TO +85°C STORAGE/OPERATING +50°C

CUSTOMER APPROVAL:____________________ DATE:__________

ALL DIMENSIONS SHOWN ABOVE ARE FOR REFERENCE ONLY.

DRAFTER J. CALLISTER	DATE 09/21/93
MECH ENGINEER – – – –	DATE – – –
ELEC ENGINEER J. JONES	DATE 04/12/95
MARKETING – – – –	DATE – – –
QUALITY DEPT R. MATHEUS	DATE 04/12/95

PolyPhaser® CORPORATION
P.O. BOX 9000, MINDEN, NV 89423–9000 (775) 782–2511 FAX (775) 782–4476

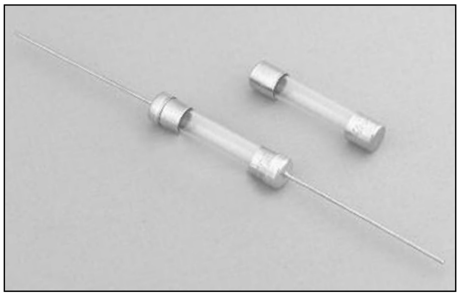
DWG NO/PART NO/DESCRIPTION
IS–50NX–C2
CUSTOMER PRINT

CAGE CODE	FILE NAME	SCALE	SHEET
61114	–C1	1/1	1 OF 1

1/4" x 1-1/4" Fuses
AGC Series, Fast Acting, Glass Tube

Description
- Fast-acting, glass tube
- Optional axial leads available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

RoHS
2002/95/EC



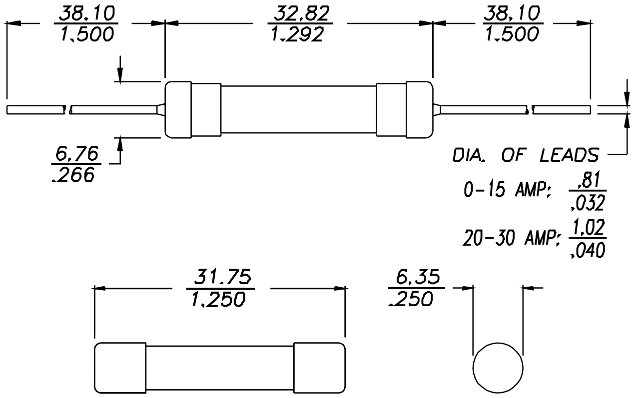
ELECTRICAL CHARACTERISTICS	
% of Amp Rating	**Opening Time**
100%	None
135%	60 Minutes Maximum
200%	120 Seconds Maximum

Agency Information
- UL Listed Card: AGC 1/500-10
- UL Recognition Card: AGC 11-45
- CSA Component Acceptance Card (Class No. 1422 30)
- CSA Certification Card (Class No. 1422 01)

Environmental Data
- Shock: 1/100A thru 3/4A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A thru 30A – MIL-STD-202, Method 204, Test Condition A (Except 5g, 500HZ)

Ordering
- Specify packaging, product, and option code

Dimensions (mm/in)
Drawing Not to Scale



SPECIFICATIONS

Product Code	Voltage Rating AC	AC Interrupting Rating			Typical DC Cold Resistance** (ohms)	Typical Melting I²t† AC	Typical Voltage Drop‡
		250V	125V	32V			
AGC-1/20	250V	35A	10000A	-	4.500	0.00773	0.67
AGC-1/16	250V	35A	10000A	-	29.000	0.000181	10.41
AGC-1/10	250V	35A	10000A	-	12.565	0.000787	6.00
AGC-1/8	250V	35A	10000A	-	6.800	0.00131	4.67
AGC-3/16	250V	35A	10000A	-	4.900	0.00637	4.12
AGC-2/10	250V	35A	10000A	-	3.360	0.00435	4.51
AGC-1/4	250V	35A	10000A	-	2.300	0.0148	0.89
AGC-3/10	250V	35A	10000A	-	1.670	0.0208	2.88
AGC-3/8	250V	35A	10000A	-	1.203	0.0321	4.59
AGC-1/2	250V	35A	10000A	-	0.615	0.269	0.59
AGC-3/4	250V	35A	10000A	-	0.312	0.815	0.37
AGC-1	250V	35A	10000A	-	0.190	1.615	0.31
AGC-1-1/4	250V	100A	10000A	-	0.145	0.018	0.35
AGC-1-1/2	250V	100A	10000A	-	0.115	0.0149	0.27
AGC-2	250V	100A	10000A	-	0.078	0.00509	0.28
AGC-2-1/4	250V	100A	10000A	-	0.067	0.00588	0.26
AGC-2-1/2	250V	100A	10000A	-	0.057	0.00879	0.31
AGC-3	250V	100A	10000A	-	0.045	0.0167	0.25
AGC-4	250V	200A	10000A	-	0.030	0.0305	0.22
AGC-5	250V	200A	10000A	-	0.024	0.045	0.23
AGC-6	250V	200A	10000A	-	0.020	0.071	0.23
AGC-7	250V	200A	10000A	-	0.017	0.105	0.23
AGC-7-1/2	250V	200A	10000A	-	0.0146	-	-
AGC-8	250V	200A	10000A	-	0.014	0.152	0.19
AGC-9	250V	200A	10000A	-	0.012	0.21	0.18
AGC-10	250V	200A	10000A	-	0.008	0.492	0.20
AGC-12	32V	-	-	1000A	0.0070	-	-
AGC-14	32V	-	-	1000A	0.0062	-	-
AGC-15	32V	-	-	1000A	0.006	0.566	0.14
AGC-20	32V	-	-	1000A	0.004	1.438	0.12
AGC-25	32V	-	-	1000A	0.003	2.109	0.11
AGC-30	32V	-	-	1000A	0.002	3.807	0.12
AGC-35	32V	-	-	70A	0.0014	-	-
AGC-40	32V	-	-	80A	0.0019	-	-

** DC Cold Resistance (Measured at ≤10% of rated current)

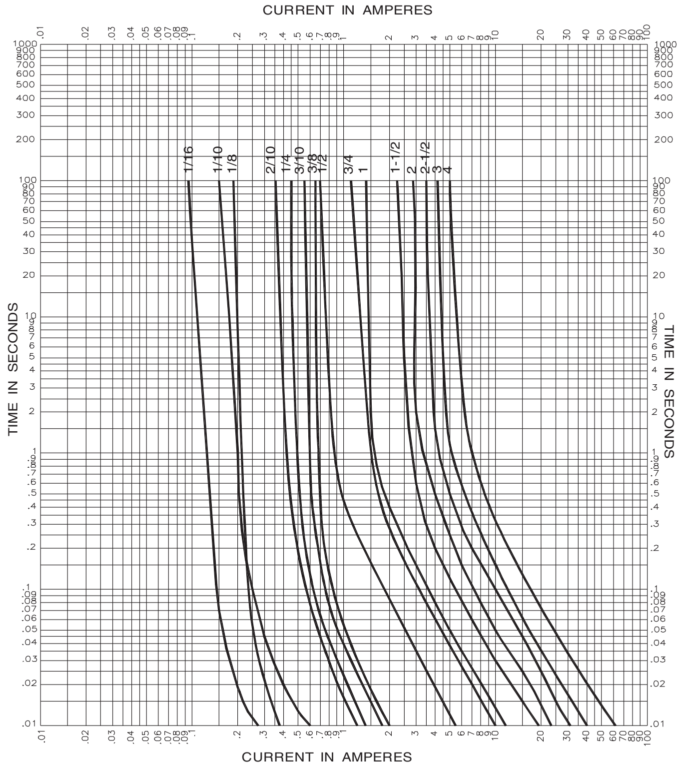
† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

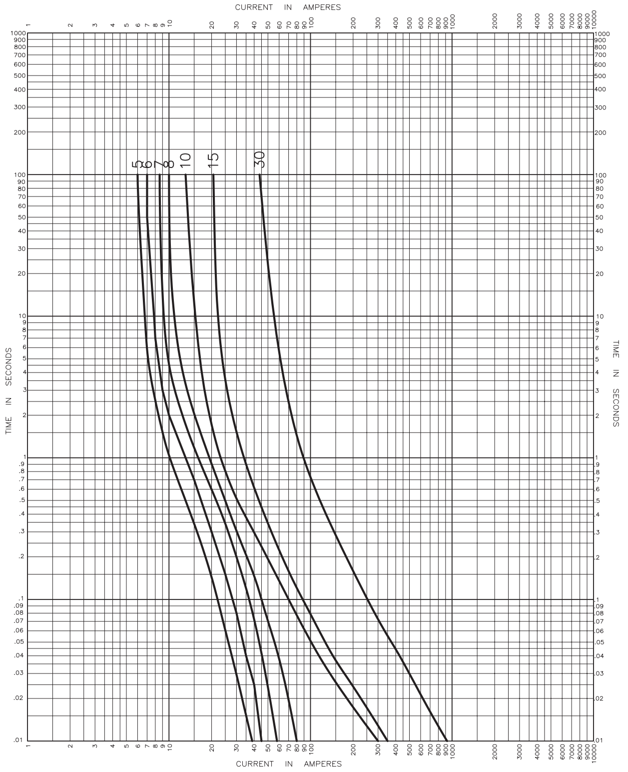
‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

1/4" x 1-1/4" Fuses

AGC Series, Fast Acting, Glass Tube

TIME CURRENT CURVE





	PACKAGING CODE
Packaging Code	**Description**
BK	100 pieces of fuses packed into a cardboard carton with flaps folded
BK1	1,000 pieces of fuses packed into a cardboard carton with flaps folded
BK8	8,000 pieces of fuses packed into a cardboard carton with flaps folded

	OPTION CODE
Option Code	**Description**
B	Board Washable - Hermetically sealed to withstand aqueous cleaning
V	Axial leads - copper tinned wire with nickel plated brass overcaps
-R	RoHS compliant version

COOPER Bussmann

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www.cooperbussmann.com

OC-2543 3/07

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Technologies 2007

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Industrial Automation Catalog Section - U906

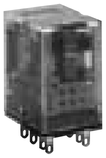
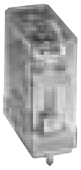
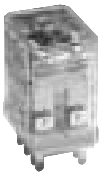
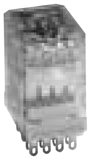
Selection Guides

General Purpose Relays

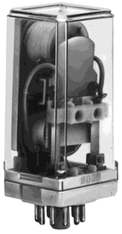
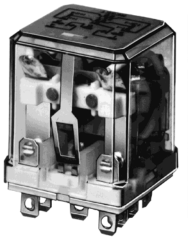
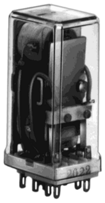
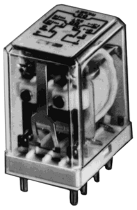
- RH Series
- ~~RM Series~~
- ~~RY Series~~

Selection Guides

General Purpose Relays

	RU Series		RR Series	RH Series	RM Series	RY Series	
Appearance							
Page	E-3		E-6	E-10	E-16	E-19	
Contact Configuration	2, 4 Form C		1, 2, 3 Form C	1, 2, 3, 4 Form C	2 Form C	2, 4 Form C	
Contact Rating (resistive)	DPDT: 10A, 30V DC 10A, 250V AC 4PDT: 6A, 30V DC 6A, 250V AC		10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/4HP, 120V AC	10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/6HP, 120V AC	5A, 30V DC 5A, 120V AC, 240V AC	DPDT: 3A, 30V DC; 3A, 120V AC, 240V AC 4PDT: 5A, 30V DC; 5A, 120V AC, 240V AC	
Contact Material	DPDT	AuSnOIn (silver tin oxide indium)	Silver	Silver-cadmium oxide	Silver	Standard	Silver, gold-plated
	4PDT	AuAg/Ag (gold-silver alloy on silver)				Bifurcated	Silver-paladium alloy (Ag-PD Alloy)

General Purpose Latching Relays

	RR2KP Series	RH2L Series	RY2KS Series	RY2L Series
Appearance				
Page	E-23	E-26	E-29	E-32
Contact Configuration	2 Form C	2 Form C	2 Form C	2 Form C
Contact Rating (resistive)	10A, 30V DC 10A, 120V AC	10A, 30V DC 7.5A, 240V AC 10A, 120V AC	3A, 30V DC 3A, 120V AC	3A, 30V DC 3A, 120V AC 3A, 240V AC
Contact Material	Silver	Silver-cadmium oxide	Silver, gold-plated	Silver, gold-flashed

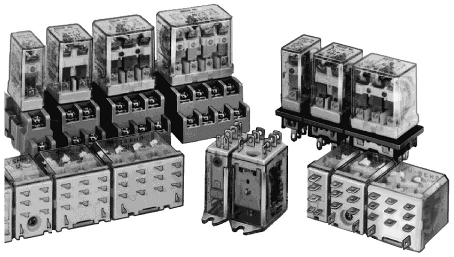
Solid State Relays

	RSS Series
Appearance	
Page	E-35
Contact Configuration	1 Form A (SPST-NO)
Contact Rating	10, 25, 50, 75, 90A 48V AC to 660V AC Output Ratings
Output	Dual SCR (zero crossing)

RH Series — General Purpose Midget Relays

Key features of the RH series include:

- **Compact midget size saves space**
- **High switching capacity (10A)**
- **Choice of blade or PCB style terminals**
- **Relay options include indicator light, check button, and top mounting bracket**
- **DIN rail, surface, panel, and PCB type sockets available for a wide range of mounting applications**



UL Recognized
Files No. E67770
E59804

CSA Certified
File No.LR35144

File No. BL951113332319

Specifications

Contact Material	Silver cadmium oxide
Contact Resistance	50mΩ maximum (initial value)
Minimum Applicable Load	24V DC/30mA, 5V DC/100mA (reference value)
Operating Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
Release Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
Maximum Continuous Applied Voltage (AC/DC) at 20°C	110% of the rated voltage
Minimum Operating Voltage (AC/DC) at 20°C	80% of the rated voltage
Drop-Out Voltage (AC)	30% or more of the rated voltage
Drop-Out Voltage (DC)	10% or more of the rated voltage
Power Consumption	**SPDT** (RH1): DC: 0.8W AC: 1.1VA (50Hz), 1VA (60Hz) **DPDT** (RH2): DC: 0.9W AC: 1.4VA (50Hz), 1.2VA (60Hz) **3PDT** (RH3): DC: 1.5W AC: 2VA (50Hz), 1.7VA (60Hz) **4PDT** (RH4): DC: 1.5W AC: 2.5VA (50Hz), 2VA (60Hz)
Insulation Resistance	100MΩ min (measured with a 500V DC megger)
Dielectric Strength	**SPDT** (RH1) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
	DPDT (RH2), **3PDT** (RH3), **4PDT** (RH4) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contact circuits: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
Frequency Response	1,800 operations/hour
Temperature Rise	Coil: 85°C maximum Contact: 65°C maximum
Vibration Resistance	0 to 6G (55Hz maximum)
Shock Resistance	SPDT/DPDT: 200N (approximately 20G) 3PDT/4PDT: 100N (approximately 10G)
Life Expectancy	Electrical: over 500,000 operations at 120V AC, 10A; (over 200,000 operations at 120V AC, 10A for SPDT [RH1], 3PDT [RH3], 4PDT [RH4]) Mechanical: 50,000,000 operations
Operating Temperature	–30 to +70°C
Weight	SPDT: 24g, DPDT: 37g (approximately) 3PDT: 50g, 4PDT: 74g (approximately)

Ordering Information

Order standard voltages for fastest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No.		*Coil Voltage:*
RH2B-U	–	*AC110-120V*

Part Numbers

Part Numbers: RH Series with Options

Termination	Contact Configuration	Basic Part No.	Indicator Light	Check Button	Indicator Light and Check Button	Top Bracket
B (blade)	SPDT	RH1B-U	RH1B-L*	—	—	RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-ULC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	RH3B-ULC	RH3B-UT
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-ULC	RH4B-UT
V2 (PCB 0.078" [2mm] wide)	SPDT	RH1V2-U	RH1V2-L*	—	—	—
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	RH2V2-ULC	—
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	RH3V2-ULC	—
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	RH4V2-ULC	—

** RH1B(V2)-L is* ***not*** *UL recognized.*

Ratings

Coil Ratings

Rated Voltage		Rated Current ±15% at 20°C								Coil Resistance ±15% at 20°C			
		60Hz				50Hz							
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	150mA	200mA	280mA	330mA	170mA	238mA	330mA	387mA	18.8Ω	9.4Ω	6.0Ω	5.4Ω
	12V	75mA	100mA	140mA	165mA	86mA	118mA	165mA	196mA	76.8Ω	39.3Ω	25.3Ω	21.2Ω
	24V	37mA	50mA	70mA	83mA	42mA	59.7mA	81mA	98mA	300Ω	153Ω	103Ω	84.5Ω
	120V*	7.5mA	11mA	14.2mA	16.5mA	8.6mA	12.9mA	16.4mA	19.5mA	7,680Ω	4,170Ω	2770Ω	2220Ω
	240V†	3.2mA	5.5mA	7.1mA	8.3mA	3.7mA	6.5mA	8.2mA	9.8mA	3,1200Ω	15,210Ω	12,100Ω	9120Ω
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	128mA		150mA		240mA		250mA		47Ω	40Ω	25Ω	24Ω
	12V	64mA		75mA		120mA		125mA		188Ω	160Ω	100Ω	96Ω
	24V	32mA		36.9mA		60mA		62mA		750Ω	650Ω	400Ω	388Ω
	48V	18mA		18.5mA		30mA		31mA		2,660Ω	2,600Ω	1,600Ω	1550Ω
	110V‡	8mA		9.1mA		12.8mA		15mA		13,800Ω	12,100Ω	8,600Ω	7,340Ω

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Rated Voltage		Coil Inrush				Coil Inductance							
						Energizing				De-Energizing			
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	250mA	340mA	520mA	620mA	0.09H	0.08H	0.05H	0.05H	0.06H	0.04H	0.03H	0.02H
	12V	120mA	170mA	260mA	310mA	0.037H	0.30H	0.22H	0.18H	0.22H	0.16H	0.12H	0.10H
	24V	56mA	85mA	130mA	165mA	1.5H	1.2H	0.9H	0.73H	0.9H	0.63H	0.5H	0.36H
	120V*	12mA	16mA	26mA	33mA	37H	33H	21H	18H	22H	15H	12H	9H
	240V†	7mA	8mA	12mA	16mA	130H	130H	84H	73H	77H	62H	47H	36H
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	N/A		N/A		N/A		N/A		N/A	N/A	N/A	N/A
	12V												
	24V												
	48V												
	110V‡												

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Ratings con't

Contact Ratings

Voltage	Rating	Resistive				Inductive				Motor Load		
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT
28V DC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	—	—	—
30V DC	UL	10A	10A	10A	—	7A	7A	—	—	—	—	—
	CSA				10A		7.5A			—	—	—
	Nominal							7.5A	7.5A	—	—	—
110V DC	Nominal	0.5A	0.5A	0.5A	0.5A	0.3A	0.3A	0.3A	0.3A	—	—	—
120V AC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	1/6	1/6	1/6
	CSA						7.5A			—	—	—
	Nominal					7A		7.5A				
240V AC	UL	10A	10A	—	7.5A	7A	7A	*	5A	1/3	1/3	1/3
	CSA							7A		—	—	—
	Nominal	7A	7.5A	7.5A	4.5A	5A	5A	5A				

1. ** 6.5A/pole, 20A total.*
2. *Inductive load cos ø = 0.3, L/R = 7ms.*

Applicable Sockets

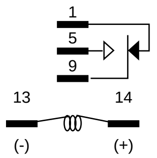
Part Numbers: Sockets

Relay	Standard DIN Rail Mount	Finger-Safe DIN Rail Mount	Surface Mount	Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	—	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-02	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	—	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C		SH4B-51	SH4B-62

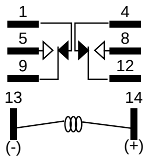
Spring & Clips (optional)	
Part Number	Use With
SY2S-02F1 SFA-101 SFA-202	SH1B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH1B-51, 62
SY4S-02F1 SFA-101 SFA-202	SH2B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH2B-51, 62
SH3B-05F1 SFA-101, -202	SH3B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH3B-51, 62
SH4B-02F1 SFA-101, -202	SH4B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH4B-51, 62

See Section F for details on sockets. All DIN rail mount sockets shown above can be mounted using DIN rail BNDN1000.

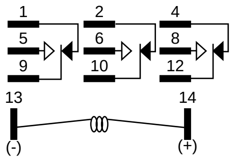
Internal Circuits



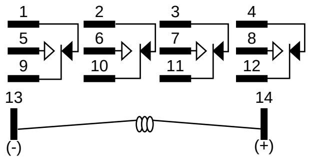
RH1



RH2



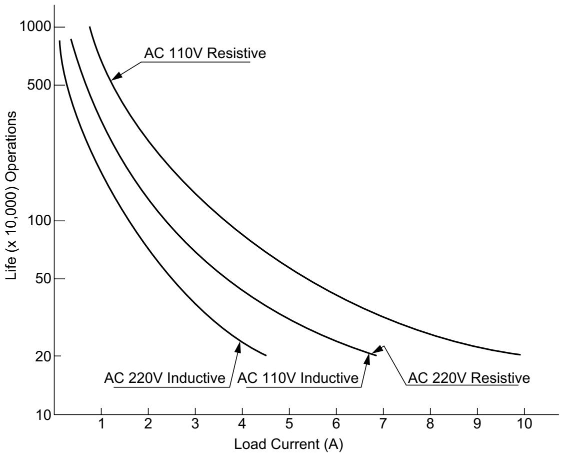
RH3

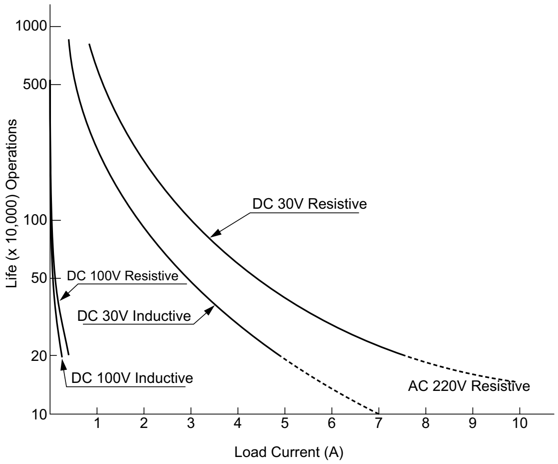


RH4

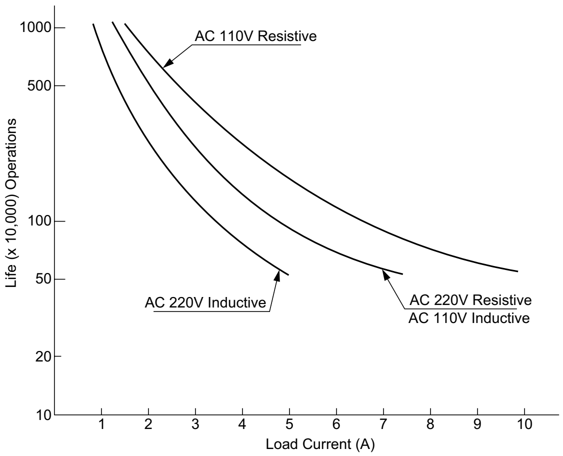
Electrical Life Curves

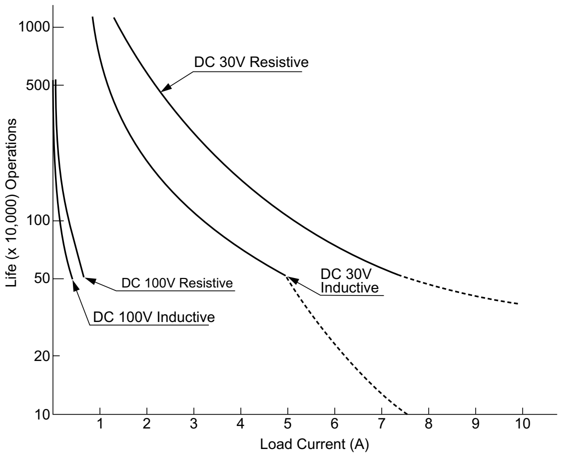
RH1



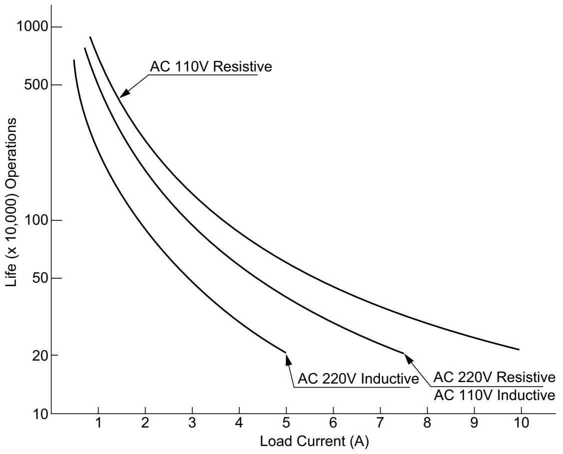


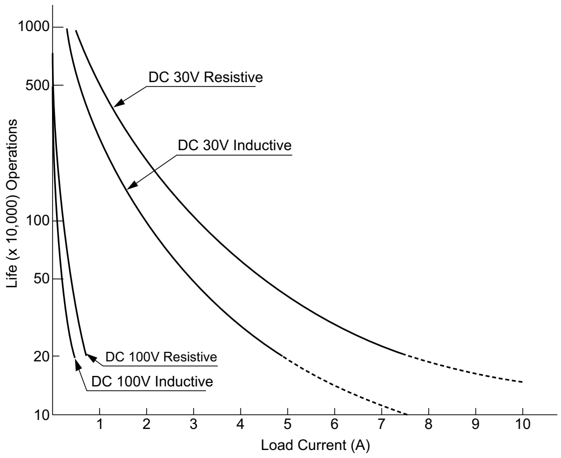
RH2





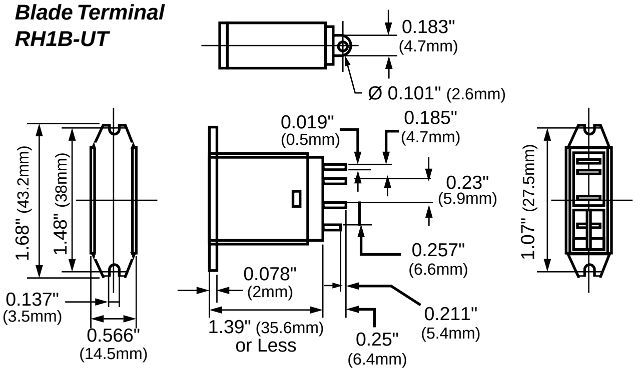
RH3 and 4



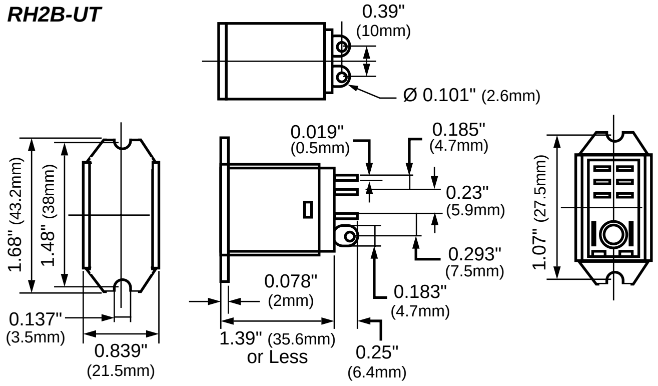


Dimensions

Top Bracket Mounting
Blade Terminal
RH1B-UT

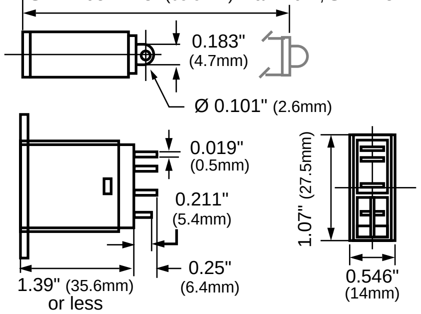


RH2B-UT



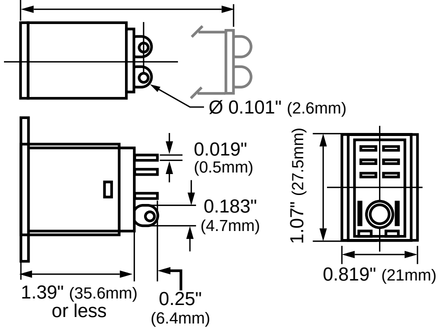
Plug-in
Blade Terminal
RH1B

Total length from panel surface including socket:
SH1B-05: 2.40" (61.5mm) maximum; ***SH1B-51:*** 1.54" (39mm) maximum
Total length from panel surface including hold-down spring:
SH1B-05: 2.48" (63.5mm) maximum; ***SH1B-51:*** 1.62" (41.6mm) maximum



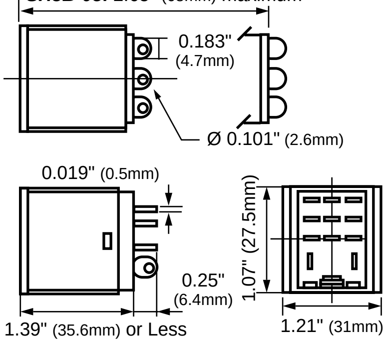
RH2B

Total length from panel surface including socket:
SH2B-05: 2.40" (61.5mm) maximum; ***SH2B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH2B-05: 2.48" (63.5mm) maximum; ***SH2B-51:*** 1.62" (41.6mm)



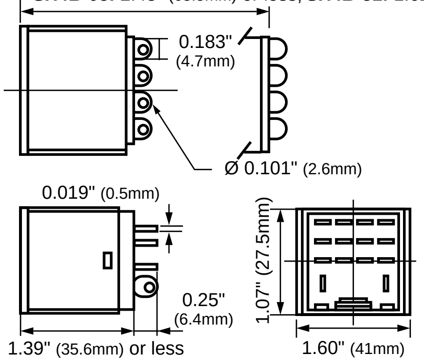
Plug-in
Blade Terminal
RH3B

Total length from panel surface including socket:
SH3B-05: 2.57" (66mm) maximum
Total length from panel surface including hold-down spring:
SH3B-05: 2.65" (68mm) maximum



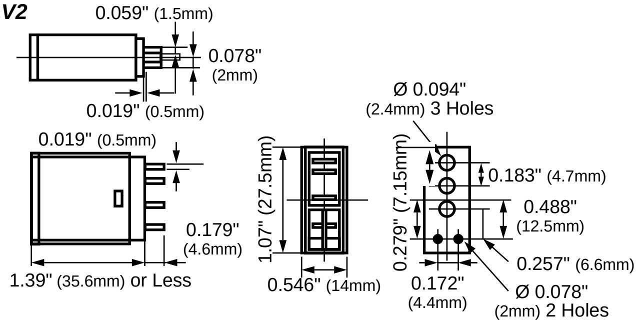
RH4B

Total length from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41.6mm)

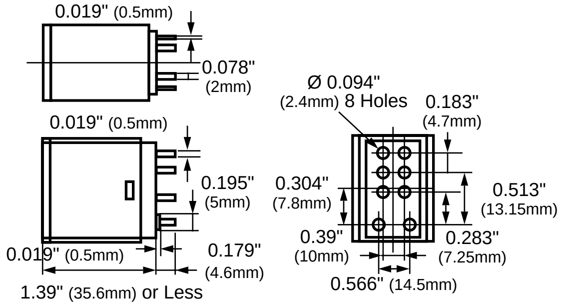


Dimensions

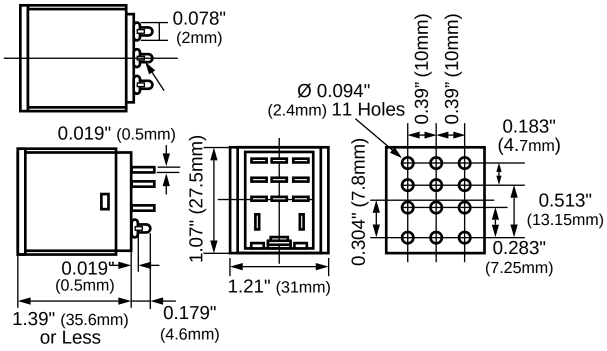
PCB Terminal
RH1V2



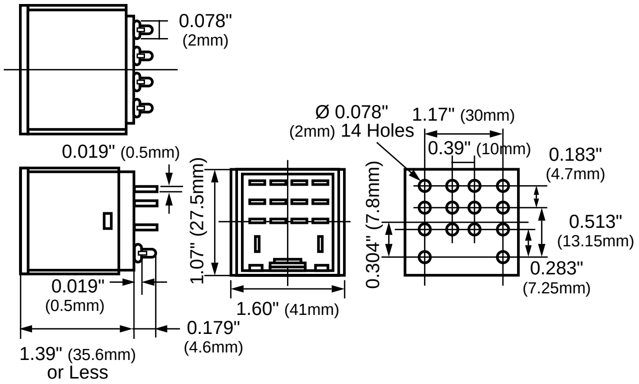
RH2V2



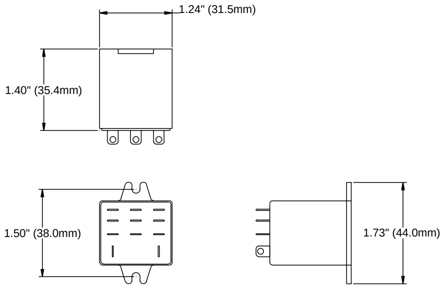
RH3V2



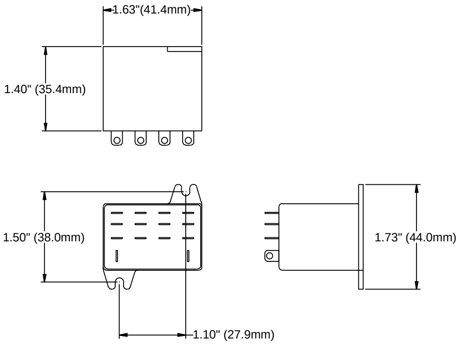
RH4V2



RH3B-UT



RH4B-UT

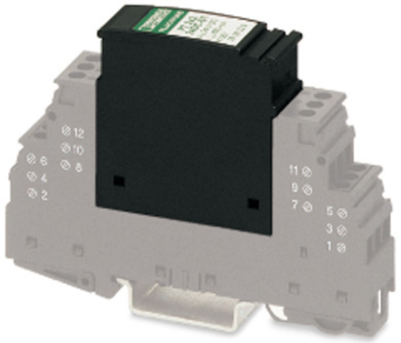


Extract from the online catalog

PT 2X2-24DC-ST

Order No.: 2838228

The illustration shows version PT 2x2- 5DC-ST



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2838228

Protective plug PT with protective circuit for two 2-core floating signal circuits. Nominal voltage: 24 V DC

Commercial data	
EAN	4017918182649
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.02511 KG
Catalog page information	Page 86 (TT-2009)

Product notes

WEEE/RoHS-compliant since:
06/01/2006

http://
www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

Housing material	PA 6.6
Inflammability class acc. to UL 94	V0
Color	black

Standards for air and creepage distances	VDE 0110-1
	IEC 60664-1: 1992-10
Total surge current (8/20) µs	20 kA
Ambient temperature (operation)	-40 °C ... 85 °C
Mounting type	On base element
Design	DIN rail module, two-section, divisible
Degree of protection	IP20
Direction of action	Line-Line & Line-Signal Ground/Shield & optional Signal Ground/ Shield-Earth Ground
Arrester can be tested with CHECKMASTER from software version:	From SW rev. 1.00
Width	17.70 mm
Height	52.00 mm
Length	45.00 mm
Pitch unit	1 Div.

Protective circuit

IEC category	C1
	C2
	C3
	D1
VDE requirement class	C1
	C2
	C3
	D1
Nominal voltage U_N	24 V DC
Max. operating voltage U_{max}	26 V DC
Arrester rated voltage U_C	28 V DC
	20 V AC
Arrester rated voltage U_C (Core-Core)	28 V DC
	20 V AC
Arrester rated voltage U_C (Core-Earth)	28 V DC
	20 V AC
Nominal current I_N	450 mA (45°C)
Operating effective current I_C at U_C	≤ 5 µA
Discharge current to PE at U_C	≤ 1 µA (BE: 2x2+F)
	≤ 4 µA

Nominal discharge surge current In (8/20) µs (Core-Core)	10 kA
Nominal discharge surge current I_n (8/20) µs (Core-Earth)	10 kA
Total surge current (8/20) µs	20 kA
Max. discharge surge current Imax (8/20) µs maximum (Core-Core)	10 kA
Max. discharge surge current Imax (8/20) µs maximum (Core-Earth)	10 kA
Lightning test current (10/350) µs, peak value I_{imp}	2.5 kA (per path)
Output voltage limitation at 1 kV/µs (Core-Core) spike	≤ 40 V
Output voltage limitation at 1 kV/µs (Core-Earth) spike	≤ 450 V
Output voltage limitation at 1 kV/µs (Core-Core) static	≤ 40 V
Output voltage limitation at 1 kV/µs (Core-Earth) static	≤ 450 V
Residual voltage at I_n, (conductor-conductor)	≤ 40 V
Residual voltage at In, (conductor-GND)	≤ 450 V
Residual voltage with Ian (10/1000)µs (conductor-conductor)	≤ 50 V
Response time tA (Core-Core)	≤ 1 ns
Response time tA (Core-Earth)	≤ 100 ns
Input attenuation aE, sym.	0.5 dB (≤ 1 MHz)
Cut-off frequency fg (3 dB), sym. in 50 Ohm system	Typ. 6 MHz
Capacity (Core-Core)	1.4 nF
Resistance in series	2.2 Ω (Path 1-2/5-6)
	2.2 Ω (Path 7-8, 11-12)
Surge carrying capacity in acc. with IEC 61643-21 (Core-Core)	C2 (10 kV/5 kA)
Surge carrying capacity in acc. with IEC 61643-21 (Core-Earth)	C2 (10 kV/5 kA)
	D1 (2.5 kA)

Connection data

Type of connection	Screw connection (in connection with the base element)
Connection type IN	PLUGTRAB plug-in system
Connection type OUT	PLUGTRAB plug-in system

Screw thread	M3
Tightening torque, min	0.8 Nm
Stripping length	8 mm
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	2.5 mm²
Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12

Connection, protective circuit

Standards/regulations	IEC 61643-21
	DIN EN 61643-21
	UL 497B

Certificates / Approvals

Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

Accessories

Item	Designation	Description
Marking		
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm
0814717	ZBF 15:SO/CMS	Zack strip, flat, 10-section, divisible, special printing, marking according to customer requirements
0808671	ZBF 5,LGS:FORTL.ZAHLEN	Zack strip, flat, printed horizontally: 10-section, with the numbers, 1-10, 11-20 etc. up to 991-1000, color: White
0810821	ZBF 5,LGS:GERADE ZAHLEN	Zack marker strip, flat, printed horizontally: 10-section, with even numbers, printed with the numbers: 2-20, 22-40, etc. up to 82-100
0810863	ZBF 5,LGS:UNGERADE ZAHLEN	Zack strip, flat, printed horizontally: 10-section, with odd numbers, printed with the numbers: 1-19, 21-39 etc. up to 81-99
0808697	ZBF 5,QR:FORTL.ZAHLEN	Flat Zack marker strip, printed vertically: 10-section, with the numbers 1-10, 11-20, etc. up to 151-160, color: White

0808668	ZBF 5/WH-100:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, large batch, sufficient for labeling 1000 terminal blocks, color: white
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, sufficient for 100 terminal blocks, color: white
0800763	ZBN 18:SO/CMS	Marker labels, 5-section, special printing, labeled according to customer requirements (Please specify the required marking with order), for terminal width: 17.5 mm, color: White
2809128	ZBN 18:UNBEDRUCKT	Unprinted marker labels, strips with 5 labels for individual labeling with M-PEN or CMS system, for terminal block width: 17.5 mm, color: White

Additional products

Assembly

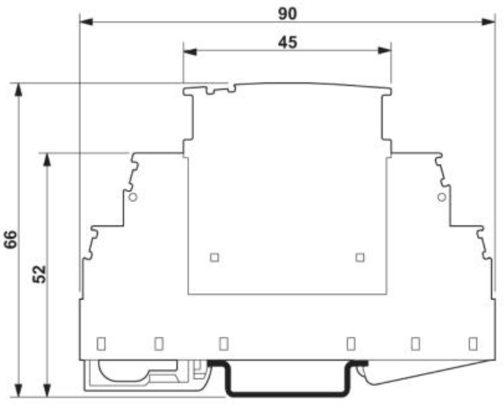
Item	Designation	Description
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black

General

Item	Designation	Description
2839224	PT 2X2+F-BE	Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, gas-filled surge arrester between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm
2839208	PT 2X2-BE	Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, bridge between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm

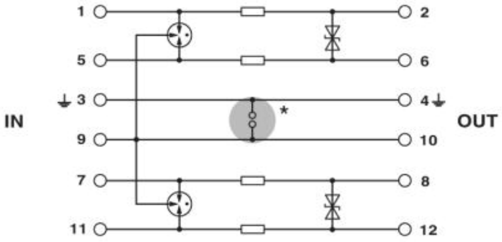
Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Circuit diagram



Approbationslogos (EX-Bereich)

c UL US

UL

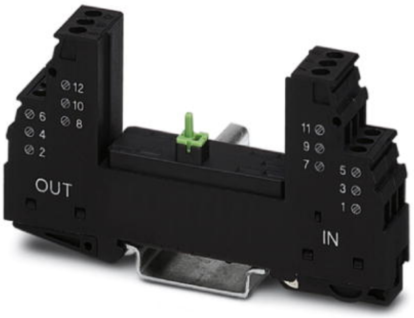
Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

PT 2X2+F-BE

Order No.: 2839224

The illustration shows version PT 2x2-BE



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2839224

Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, gas-filled surge arrester between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm

Commercial data	
EAN	4017918182762
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.0573 KG
Catalog page information	Page 86 (TT-2009)

Product notes

WEEE/RoHS-compliant since:
05/10/2006

Technical data

General

Inflammability class acc. to UL 94	V0
Color	black
Ambient temperature (operation)	-40 °C ... 85 °C

Mounting type	DIN rail 35 mm
Design	DIN rail module, two-section, divisible
Degree of protection	IP20
Direction of action	Signal Ground/Shield-Earth Ground
Width	17.70 mm
Height	52.00 mm
Length	89.80 mm
Pitch unit	1 Div.

Protective circuit

Nominal current I_N	450 mA
Output voltage limitation at 1 kV/μs (Core-Earth) spike	≤ 600 V

Connection data

Type of connection	Screw connection
Connection type IN	Screw terminal blocks
Connection type OUT	Screw terminal blocks
Screw thread	M3
Tightening torque, min	0.8 Nm
Stripping length	8 mm
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	2.5 mm²
Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12

Certificates / Approvals

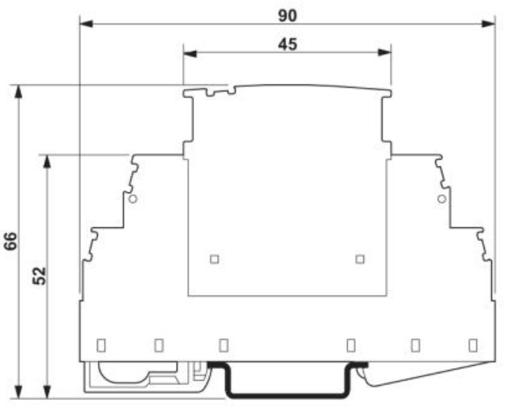
Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

Accessories

Item	Designation	Description
Assembly		
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black
Marking		
1051993	B-STIFT	Marker pen, for manual labeling of unprinted Zack strips, smear-proof and waterproof, line thickness 0.5 mm
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm
1050004	ZB 5 :UNBEDRUCKT	Zack strip, unprinted, 10-section, for individual labeling with M-PEN, ZB-T or CMS system, pack is sufficient for 100 terminal blocks, for a terminal width of 5.2 mm, color: White
2715212	ZB 5,8,LGS:FORTL.ZAHLEN	Zack marker strip, 10-section, printed horizontally: with consecutive numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1050305	ZB 5,8:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
2715209	ZB 5,8:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 5.8 mm, color: White
1050295	ZB 5:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, sufficient for 100 terminal blocks, color: white

Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Approbationslogos (EX-Bereich)

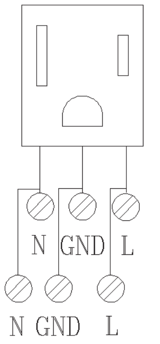
Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

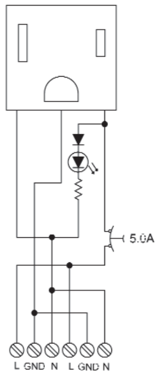
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- Compact and easily snaps onto 35mm DIN-rail
- CSA, UL508A and cULus approved
- Available with ground fault current interrupt (GFCI) or standard simplex and duplex outlets
- Option for visual indication of power included with GFCI versions
- Enclosed versions feature NEMA rated enclosure with UL94 VO flammability rating

Schematic diagram



Schematic diagram



Rated data

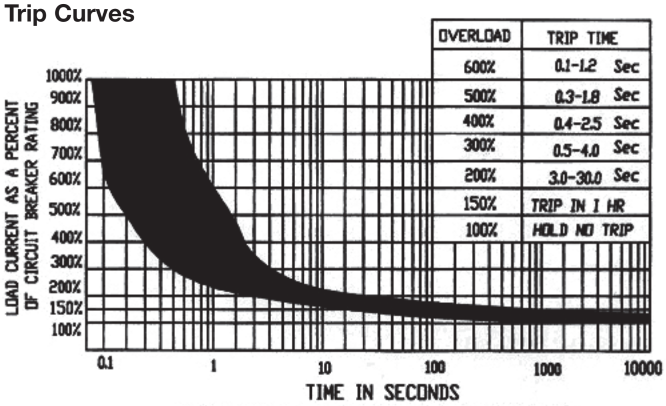
Input voltage		
Rated current	120Vac	120Vac
	5A max via outlet	5A max via outlet
	10A via redundant terminals	10A via redundant terminals
Wire range	26 - 12 AWG (0.14 0 4.0mm²)	26 - 12 AWG (0.14 0 4.0mm²)

Ordering data	Type	Part No.	Type	Part No.
TS32 / TS35 mounting (⊔ / ⊔)	Single outlet without circuit breaker	**9915480000**	Single outlet with circuit breaker	**9915480001**
			(supplemental protector with manual reset via push button)	

Dimensions		
Width	35mm	35mm
Length	70mm	70mm
Height	55mm	55mm

Approvals		
	LR-229352, E252394	LR-229352, E252394

Trip Curves



OVERLOAD	TRIP TIME
600%	0.1-1.2 Sec
500%	0.3-1.8 Sec
400%	0.4-2.5 Sec
300%	0.5-4.0 Sec
200%	3.0-30.0 Sec
150%	TRIP IN 1 HR
100%	HOLD NO TRIP

TRIP CURVES ARE SPECIFIED OF 25°C/77°F

Extract from the online catalog

UK 6,3-HESILA 250

Order No.: 3004249

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004249

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Commercial data

EAN	4017918090739
sales group	A040
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.034648 KG
Catalog page information	Page 370 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 09/11/2006

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

Technical data

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

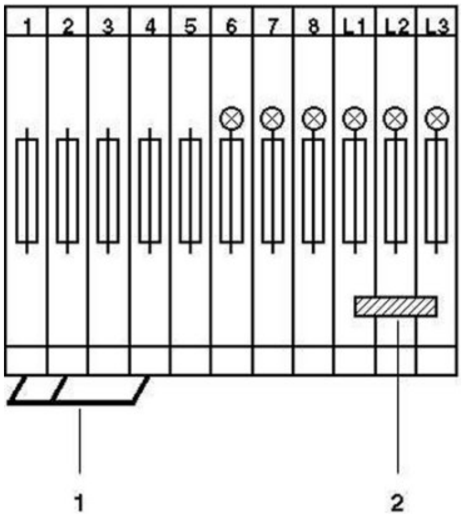
Connection data

Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Diagrams/Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

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Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

UK 6,3-HESILED 24

Order No.: 3004265

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004265

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Product notes

WEEE/RoHS-compliant since: 09/01/2006

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Commercial data

EAN	4017918090753
sales group	A040
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.03542 KG
Catalog page information	Page 370 (CL-2009)

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

Technical data

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

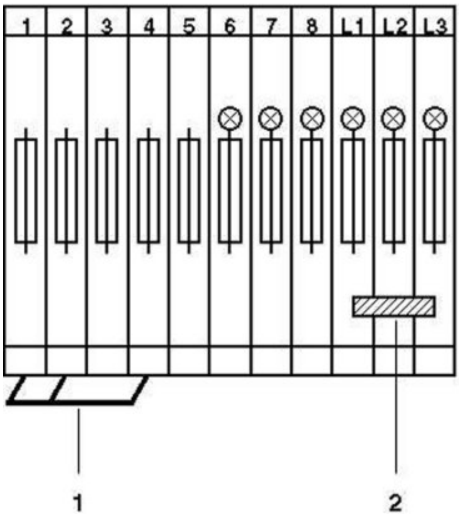
Connection data

Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Diagrams/Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

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Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

UK 5 N

Order No.: 3004362

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004362

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15, NS 32

Commercial data	
EAN	4017918090760
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 01/01/2003

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Technical data

General

Number of levels	1
Number of connections	2
Color	gray

Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Maximum load current	41 A (with 6 mm^2 conductor cross section)
Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-1
Nominal current I_N	32 A
Nominal voltage U_N	800 V
Open side panel	ja

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²

2 conductors with same cross section, stranded min.	0.2 mm²
2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Cross-section with insertion bridge, solid max.	4 mm²
Cross-section with insertion bridge, stranded max.	4 mm²
Type of connection	Screw connection
Stripping length	8 mm
Internal cylindrical gage	A4
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Diagrams/Drawings

Circuit diagram

Approbationslogos (EX-Bereich)

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UK 5 N GN

Order No.: 3003965

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003965

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data	
EAN	4017918282189
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.009305 KG

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Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


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Extract from the online catalog

UK 5 N YE

Order No.: 3003952

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003952

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data	
EAN	4017918282172
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00917 KG

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


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UK 5 N OG

Order No.: 3002908

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3002908

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: orange, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data

EAN	4017918117498
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG

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Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


FM
APPROVED


GL

Address

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586 Fulling Mill Road
Middletown, PA 17057,USA
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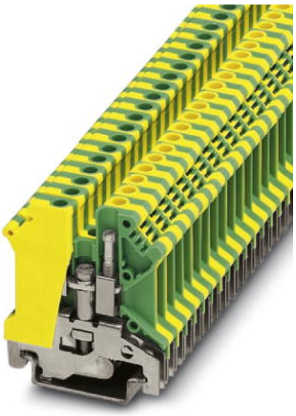
http://www.phoenixcon.com

Extract from the online catalog

USLKG 5

Order No.: 0441504



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0441504

Ground modular terminal block, Type of connection: Screw connection, Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green-yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes
WEEE/RoHS-compliant since: 01/15/2005

Commercial data	
EAN	4017918002190
sales group	A020
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.020842 KG
Catalog page information	Page 347 (CL-2009)

Technical data

General

Note	When aligning with a feed-through terminal block with the same shape, an end cover must be interposed with insulation voltages of > 690 V
Number of levels	1

Number of connections	2
Color	green-yellow
Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-2
Open side panel	nein

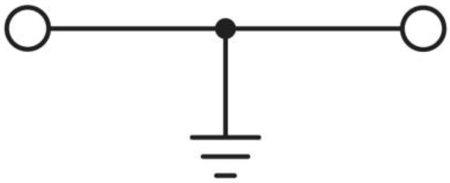
Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²
2 conductors with same cross section, stranded min.	0.2 mm²

2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Type of connection	Screw connection
Stripping length	8 mm
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Diagrams/Drawings

Circuit diagram



Approbationslogos (EX-Bereich)

Address

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Extract from the online catalog

D-UK 4/10

Order No.: 3003020

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003020

End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray

Commercial data	
EAN	4017918090425
sales group	A090
Pack	50 pcs.
Customs tariff	85389099
Weight/Piece	0.002536 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 01/01/2003

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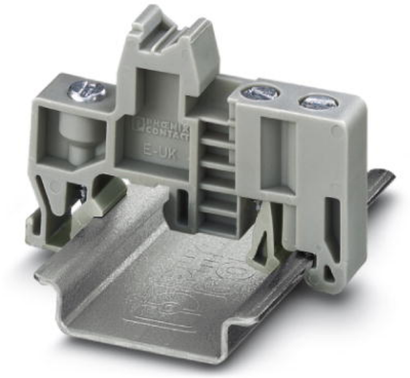
Extract from the online catalog

E/UK

Order No.: 1201442



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=1201442

End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail

Commercial data	
EAN	4017918017323
sales group	B220
Pack	50 pcs.
Customs tariff	39269097
Weight/Piece	0.009354 KG
Catalog page information	Page 696 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
07/01/2005

http://
www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

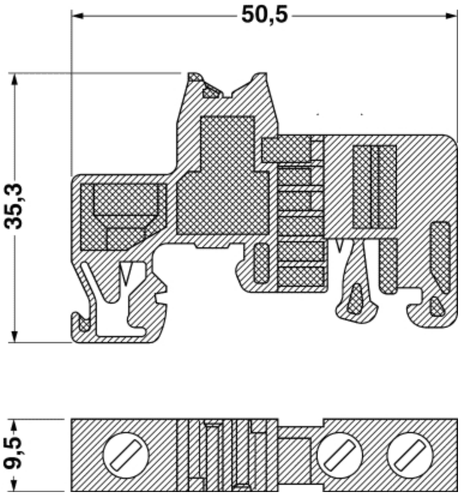
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

Accessories

Item	Designation	Description
Assembly		
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
Marking		
1004089	UBE + ES/KMK 3	Marker carrier, color: Gray for marking groups of terminals, for end clamp E/UK or end clamp E/U, with perforated insert strips, 40 x 17 mm, can be labeled with CMS system
1051003	ZB 6:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 6.2 mm, color: white

Diagrams/Drawings

Dimensioned drawing



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Extract from the online catalog

FBI 2- 6

Order No.: 0203438

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203438

Cross connector/bridge, Number of positions: 2, Color: aluminum

Commercial data	
EAN	4017918104122
sales group	A900
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.00349 KG

Product notes

WEEE/RoHS-compliant since:
01/01/2003

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Extract from the online catalog

FBI 10- 6

Order No.: 0203250

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203250

Cross connector/bridge, Number of positions: 10, Color: silver

Commercial data	
EAN	4017918098070
sales group	A900
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.01615 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Address

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http://www.phoenixcon.com

K2A25U : TWO:14 STR-1/0 STR DUAL

ACTIVE

RoHS compatible

www.fci.com

BURNDY® PRODUCTS

Specifications

General

Number of Conductors	2
Number of Screws	1
Number of Stud Holes	1 Hole

Dimensional

Stud Hole (Size)	1/4 in.

Physical

Conductor Size	14 AWG 2 AWG 1 AWG 4 AWG 1/0 AWG 8 AWG 12 AWG 10 AWG 6 AWG
Installation Torque	50 in. lb.
Conductor Size (Range)	14 AWG to 1/0 AWG

Approvals / Certifications

UL Listed	Yes
CSA Certified	Yes

Other Features

Set Screw Type	Slot
UPC	78181060004
Keyword	kau

T1-E Duct Series

Contact your local representative or the IBOCO sales office for more information.

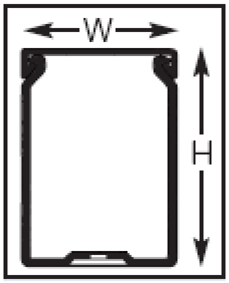
MATERIAL:
Rigid PVC,
self-extinguishing

COLOR:
light GREY RAL 7030
WHITE

STANDARD LENGTH:
6 Feet 6 3/4 Inches

STANDARD UNIT:
Duct complete with cover

Catalog Number	Nominal Size (WxH)	Dimensions inches (Actual)				Dimensions W x H (millimeters)	Standard Carton Length (1)	(QTY) Feet
		W	H	E	F			
T1E-1015 *	1 x 1 1/2	1.00	1.57	.16	.24	25 x 40	18	108
T1E-1022 *	1 x 2 1/4	1.00	2.36	.16	24	25 x 60	24	144
T1E-1030 *	1 x 3	1.00	3.15	16	.24	25 x 80	24	144
T1E-1040 *	1 x 4		.			25 x 100	8	48
T1E-1515 *	1 1/2 x 1 1/2	1.57	1.57	.16	.24	40 x 40	20	120
T1E-1522 *	1 1/2 x 2 1/4	1.57	2.36	.16	.24	40 x 60	18	108
T1E-1530 *	1 1/2 x 3	1.57	3.15	.16	24	40 x 80	16	96
T1E-1540 *	1 1/2 x 4	1.57	3.94	.16	.24	40 x 100	8	48
T1E-2222 *	2 1/4 x 2 1/4	2.36	2.36	.16	.24	60 x 60	12	72
T1E-2230 *	2 1/4 x 3	2.36	3.15	.16	.24	60 x 80	12	72
T1E-2240 *	2 1/4 x 4	2.36	3.94	.16	.24	60 x 100	4	24
T1E-3015G	3 x 1 1/2	3.15	1.57	.16	.24	80 x 40	12	72
T1E-3022 *	3 x 2 1/4	3.15	2.36	.16	.24	80 x 60	12	72
T1E-3030 *	3 x 3	3.15	3.15	.16	.24	80 x 80	12	72
T1E-3040 *	3 x 4	3.15	3.94	.16	.24	80 x 100	4	24
T1E-4015G	4 x 1 1/2	3.94	1.57	.16	.24	100 x 40	8	48
T1E-4022G	4 x 2 1/4	3.94	2.36	.16	.24	100 x 60	8	48
T1E-4030 *	4 x 3	3.94	3.15	.16	.24	100 x 80	8	48
T1E-4040 *	4 x 4	3.94	3.94	.31	.47	100 x 100	4	24



Example: T1E-1015G = 1" x 1 1/2" light GREY duct with cover

(1) Each standard length is actually 6'6 3/4" but is counted as 6 feet for packaging and pricing

* Color - add suffix "G" fro light GREY, "W" for WHITE

ADHESIVE BACKING - add suffix "A" to catalog number - contact sales office for pricing

Technical Characteristics

IBOCO Wiring products respond to all installation needs, coping with different uses and environment applications. They are manufactured with high quality materials that undergo severe quality controls and performance tests under extreme operating and duration conditions witha constant control of quality standards.

Wiring Ducts T1, T1E, SEP-E and CL are manufactured in rigid Self-Extinguishing PVC.

Those components for which high bending resilience is required are in polyamide 6 and polypropylene.

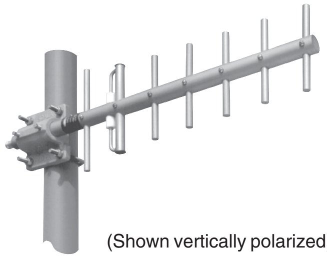
Spiralite is manufactured in natural polyethylene and self-extinguishing polyethylene.

Materials Technical Characteristics	Unit of Measure	Standard	PVC Duct Value	PVC Moulded Components Value	Polyamide 6 Value	Polyethylene Value	Flame Retardant Polyethylene Value
CHEMICAL-PHYSICAL PROPERTIES							
Specific gravity	g/cm^3	ASTM D792	1.55	1.32	1.14	0.92	0.97
H2O 73,4° F absorbtion	%	ISO 62	<0,1	2,5	2,5	<0,1	<0,1
Formaldehyde	ppm	-	absent	absent	absent	absent	absent
Cadmium	ppm	-	absent	absent	absent	absent	absent
MECHANICAL PROPERTIES							
Tensile stress at break	MPa	ASTM D638	39	30	45	17	15
Traction strength	MPa	ASTM D638	44	27	55	9,5	9
Elongation at break	%	ASTM D638	130	97	250	400	600
Modulus of elasticity at traction	MPa	ASTM D638	4400	-	950	-	240
Modulus of elasticity at flexion	MPa	ASTM D790	3200	-	1100	210	130
THERMAL PROPERTIES							
Temperature VICAT	°C	ASTM D1525	84	70	198	89	-
HDT	°C	ASTM D648	72	60	185	-	-
Coefficient of expansion	K^-1	ASTM D696	6 10^-5	8 10^-5	8-10 10^-5	22 10^-5	10^-5
Specific heat	kJ/kgK	ASTM C351	0,94	1,24	1,7	-	-
Thermal conductivity	W/mK	ASTM C177	0,14	0,14	0,29	0,32	0,32
ELECTRICAL PROPERTIES							
Dielectric constant	-	ASTM D150	3,2 - 4,0	3,2	5,0	2,4	2,3
Dielectric strength	kV/mm	IEC 243	70	60	35	90	90
Surface resistance	Ohm	IEC 93	10^13	10^13	5 10^11	10^13	10^13
SELF-EXTINGUISING							
Self-extinguising 1,6 millimeters	-	UL 94	V0	V0	V2	HB	V2
Self-extinguishing 3,2 millimeters	-	UL 94	V0	V0	V2	HB	V2
Glow wire test (2 mm)	°C	IEC 695-2-1	960	960	650	650	850
Oxygen number	%	ASTM D2863	43	34	25	-	25

TY-900
Yagi Antenna

The Kathrein-Scala TY series are rugged broadband yagi antennas fabricated of 6061/T6 aluminum rod and seamless drawn pipe, anodized for maximum reliability and corrosion resistance. The hardware and fastenings are stainless steel. The internal balun, coax feed and connector are sealed in a foam potting system to prevent moisture penetration and assure long service life in severe environmental conditions. The heavy aluminum mounting casting allows installation for V or H polarization.

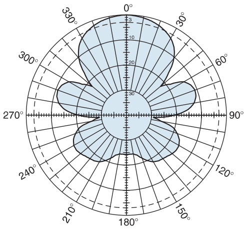
- The TY-900 is specifically designed for professional fixed-station applications in the 890–960 MHz band.


(Shown vertically polarized)

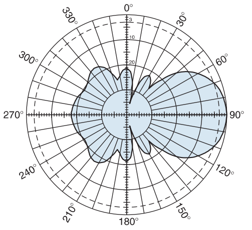
Specifications:

Frequency range	890–960 MHz (broadband)
Gain	10 dBd
Impedance	50 ohms
VSWR	< 1.5:1 maximum (1.35:1 typical)
Polarization	Horizontal or vertical
Front-to-back ratio	>20 dB
Maximum input power	100 watts (at 50°C)
H-plane beamwidth	48 degrees (half-power)
E-plane beamwidth	40 degrees (half-power)
Connector	N female
Weight	3 lb (1.4 kg)
Dimensions	23 x 7 inches (584 x 178 mm)
Equivalent flat plate area	0.24 ft^2 (0.022 m^2)
Wind survival rating*	150 mph (240 kph)
Shipping dimensions	28 x 10 x 4.5 inches (710 x 254 x 114 mm)
Shipping weight	5.0 lb (2.3 kg)
Mounting	For masts of 1.25 to 2.375 inch (32 to 60 mm) OD.

See reverse for order information.



H-plane
Horizontal pattern – V-polarization
Vertical pattern – H-polarization



E-plane
Horizontal pattern – H-polarization
Vertical pattern – V-polarization

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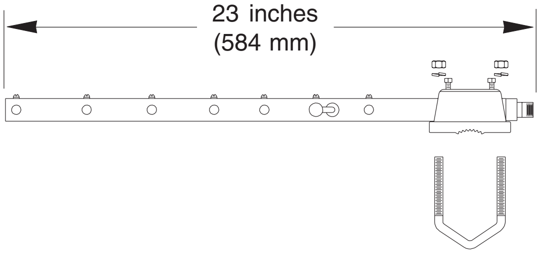
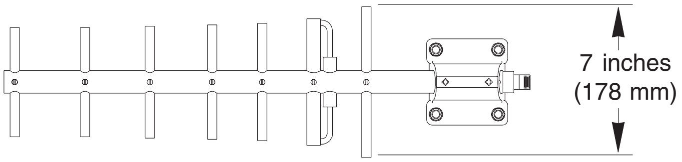
* Mechanical design is based on environmental conditions as stipulated in EIA-222-F (June 1996) and/or ETS 300 019-1-4 which include the static mechanical load imposed on an antenna by wind at maximum velocity. See the Engineering Section of the catalog for further details.

10065-D

TY-900
Yagi Antenna





Order Information:

Model	Description
TY-900	Yagi antenna with N connector

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System Controls & Instrumentation, Ltd

11218 IH-10 E.
Converse, TX 78109
Phone: 210-661-9901
Fax: 210-666-5575

1108 Quail Hollow
Laredo, TX 78045
Phone: 956-725-1239
Fax: 956-726-1774

TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-2

DRAWINGS

SCI FILE 3079

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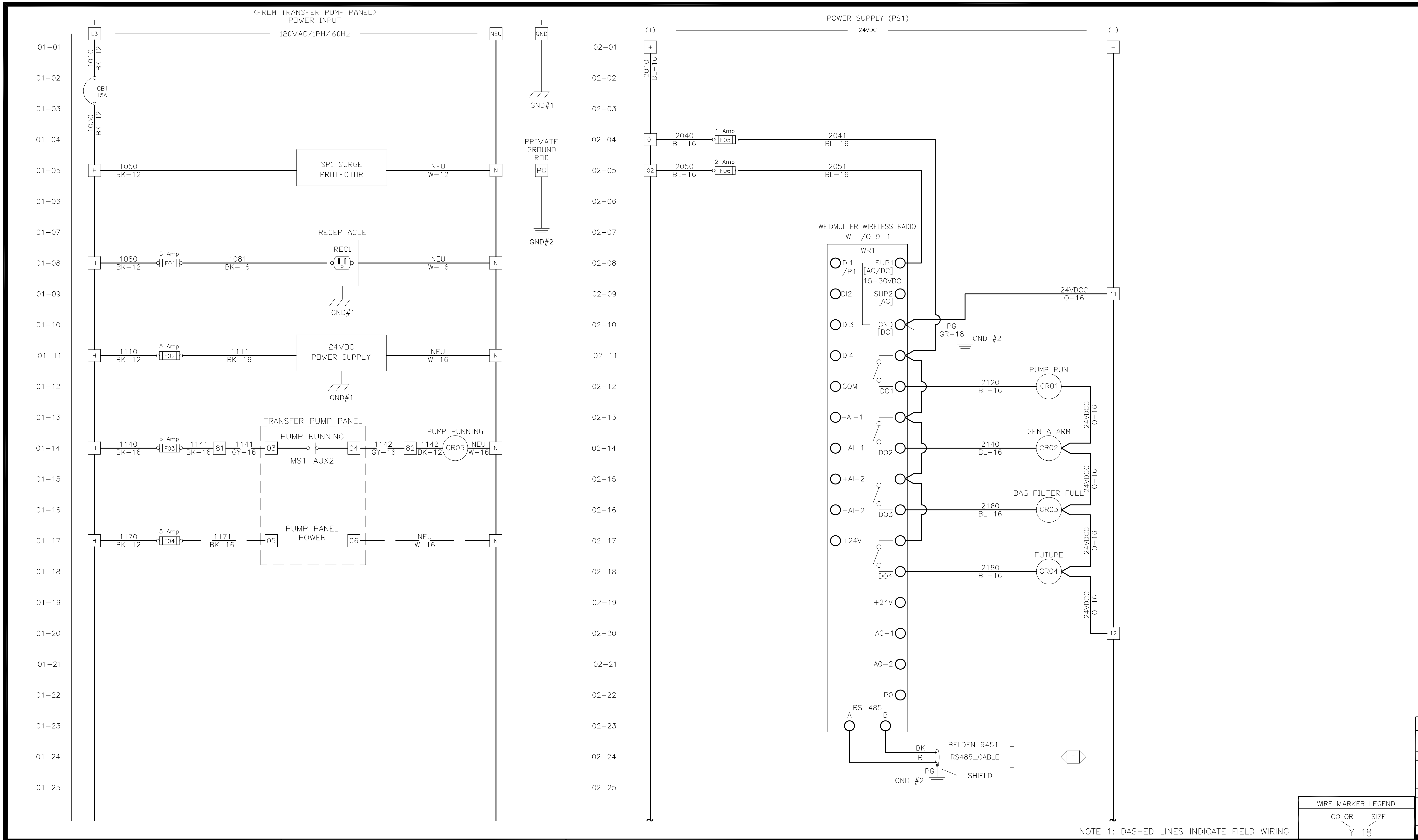


WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

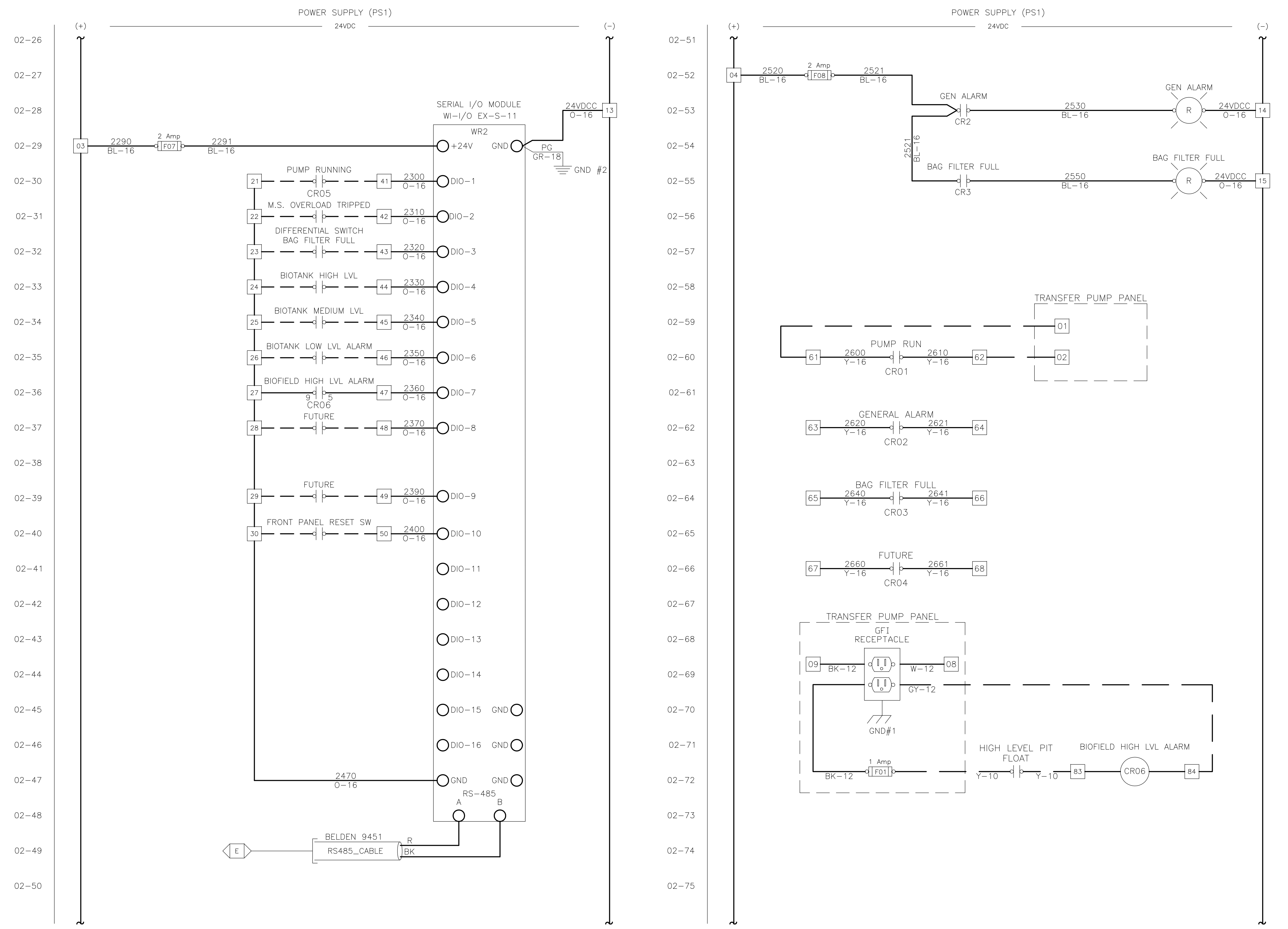
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK WIRING DIAGRAM

DATE: *8/10/2009*
SCALE: *N/A*
DRAWN BY: *RMF*
CAD FILE *SCI3079_RTU903-2*
DWG. NO. *3079*
SH *1*
OF *8*



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

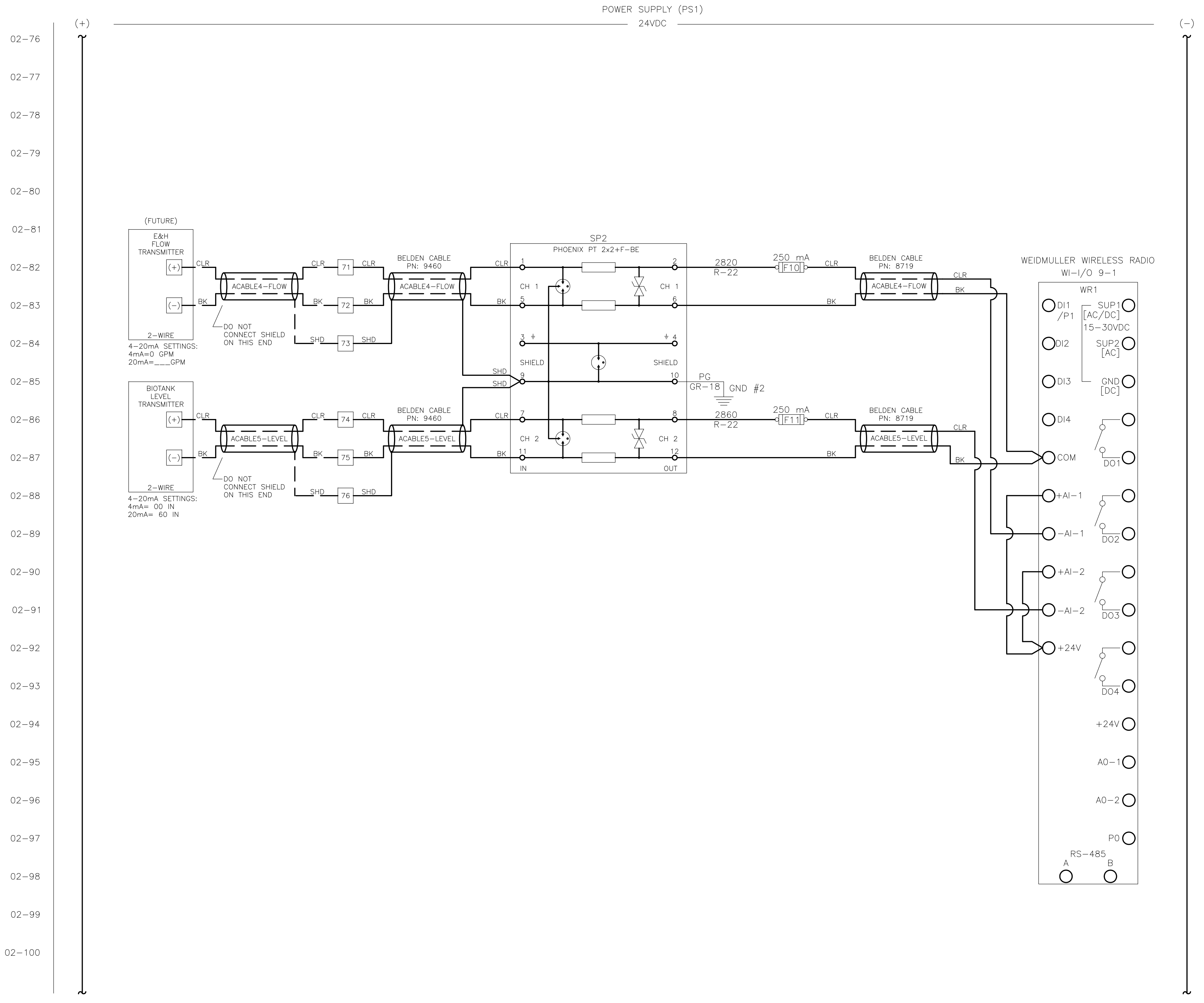
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK WIRING DIAGRAM

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 2
OF 8



COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

WIRE MARKER LEGEND
COLOR SIZE
Y−18

NOTE 1: DASHED LINES INDICATE FIELD WIRING

REV #	DATE	REVISION

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11218 IH−10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661−9901

ENGINEER

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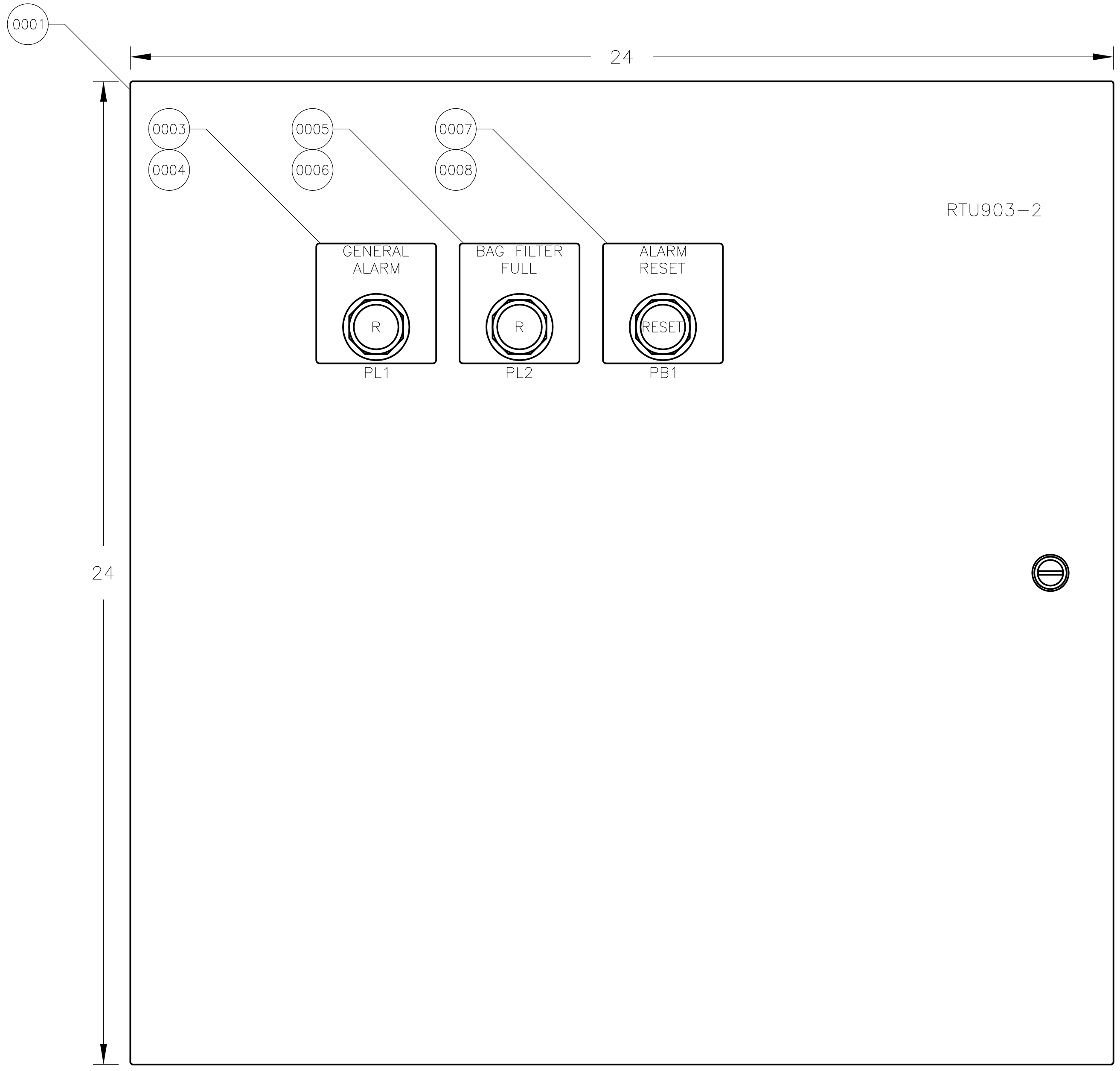
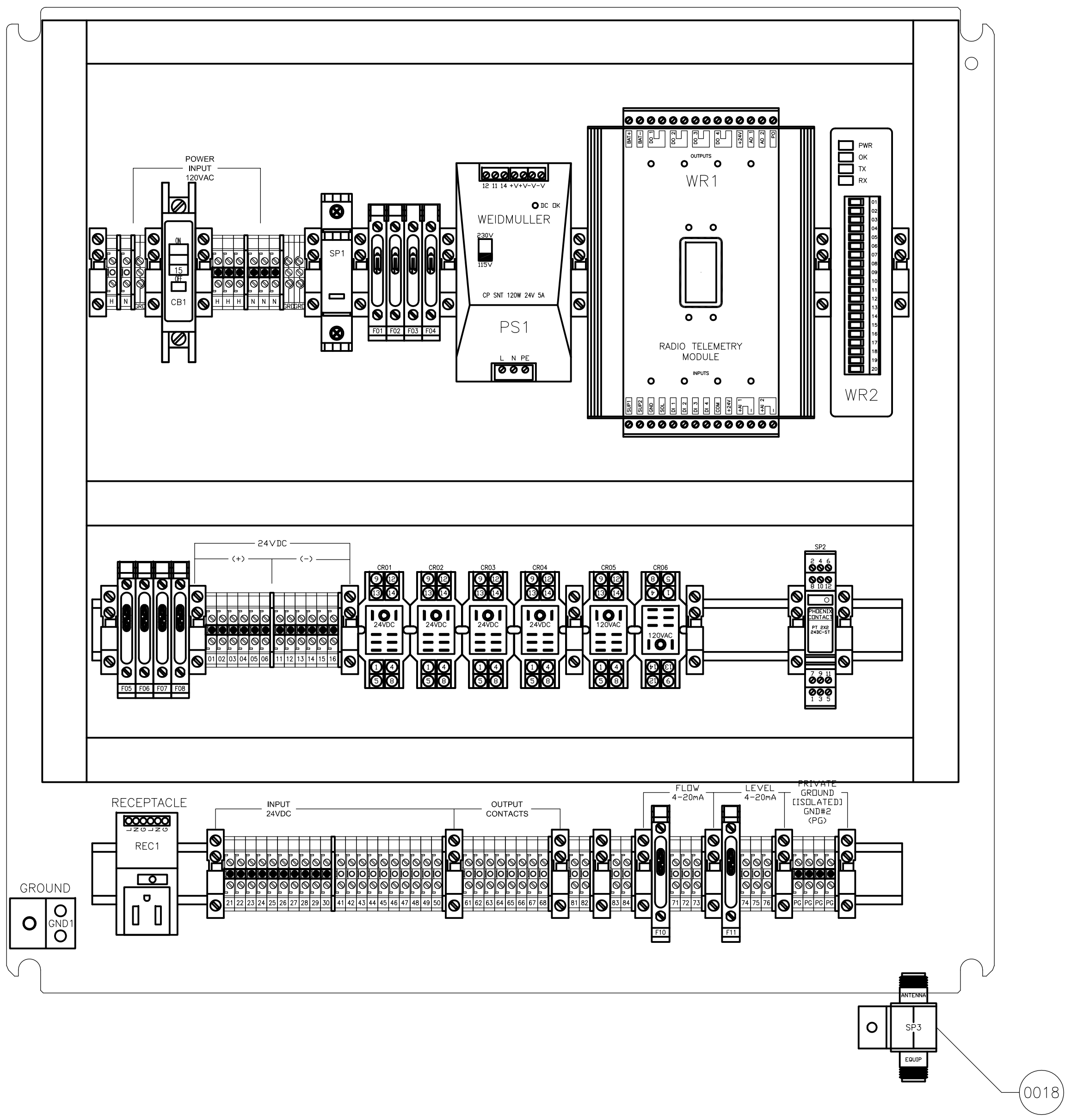
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903−2
PROCESS TANK WIRING DIAGRAM

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903−2

DWG. NO. 3079
SH 3
OF 8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

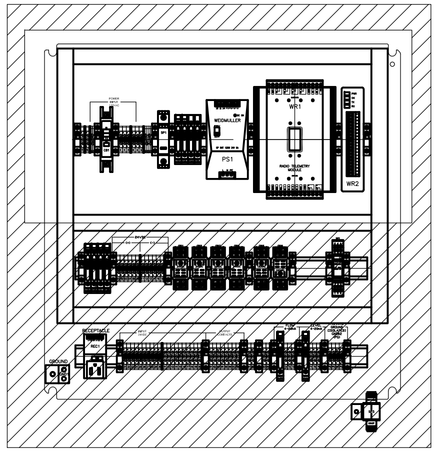
ENGINEER

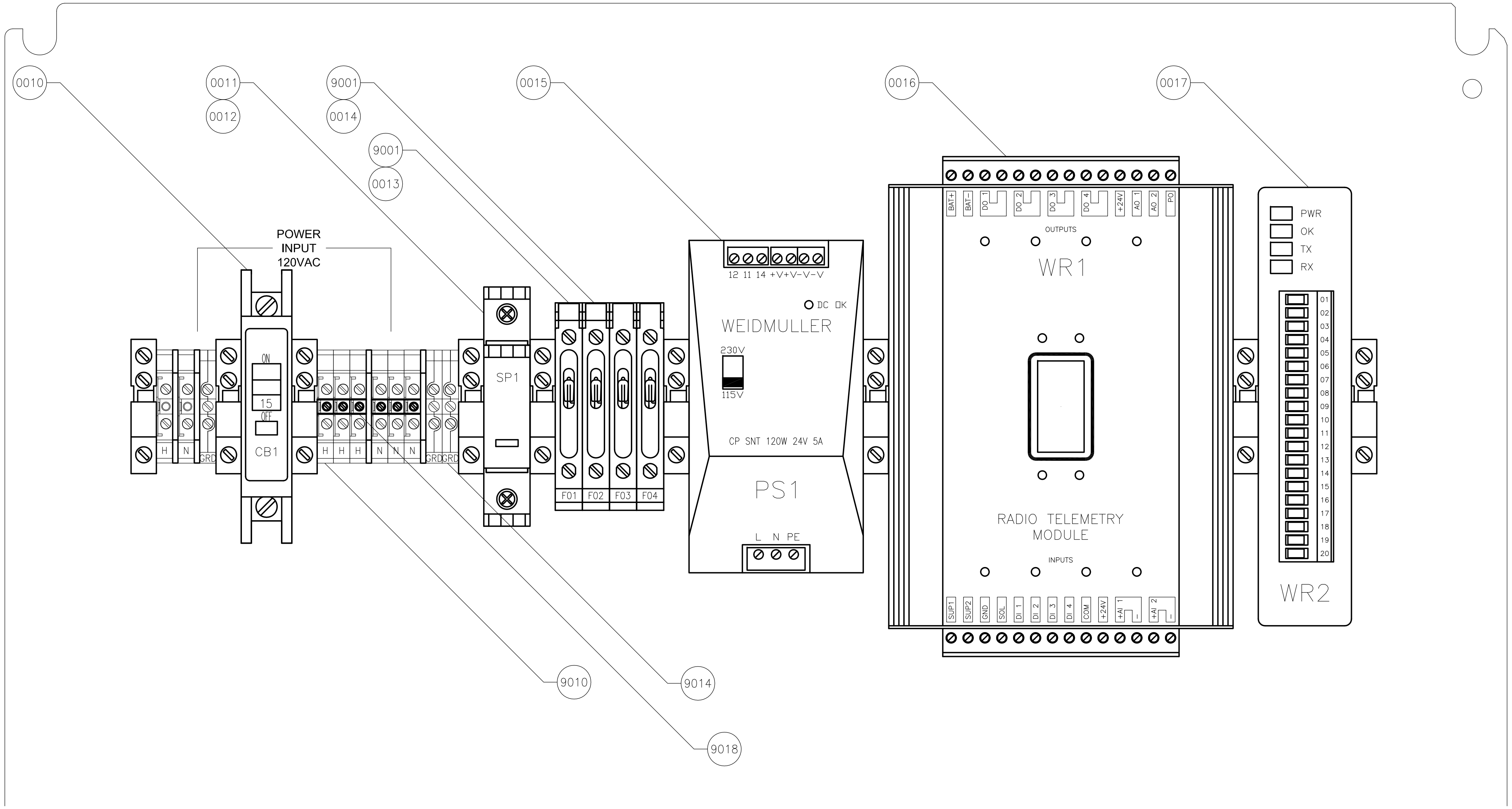
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK FRONT PANEL
& BACK PANEL LAYOUT

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-2

DWG. NO.	SH	OF
3079	4	8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

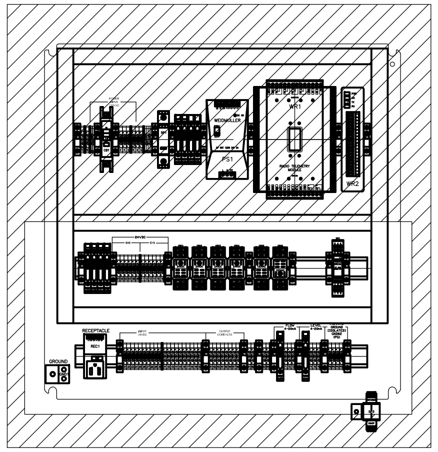
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

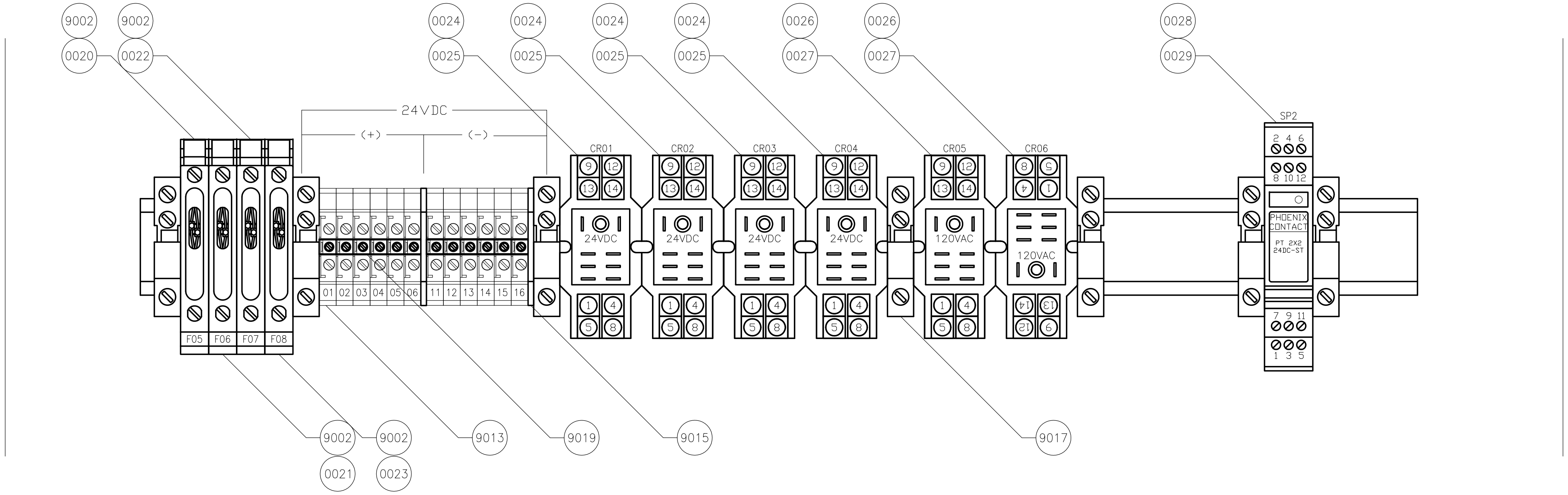
ENGINEER

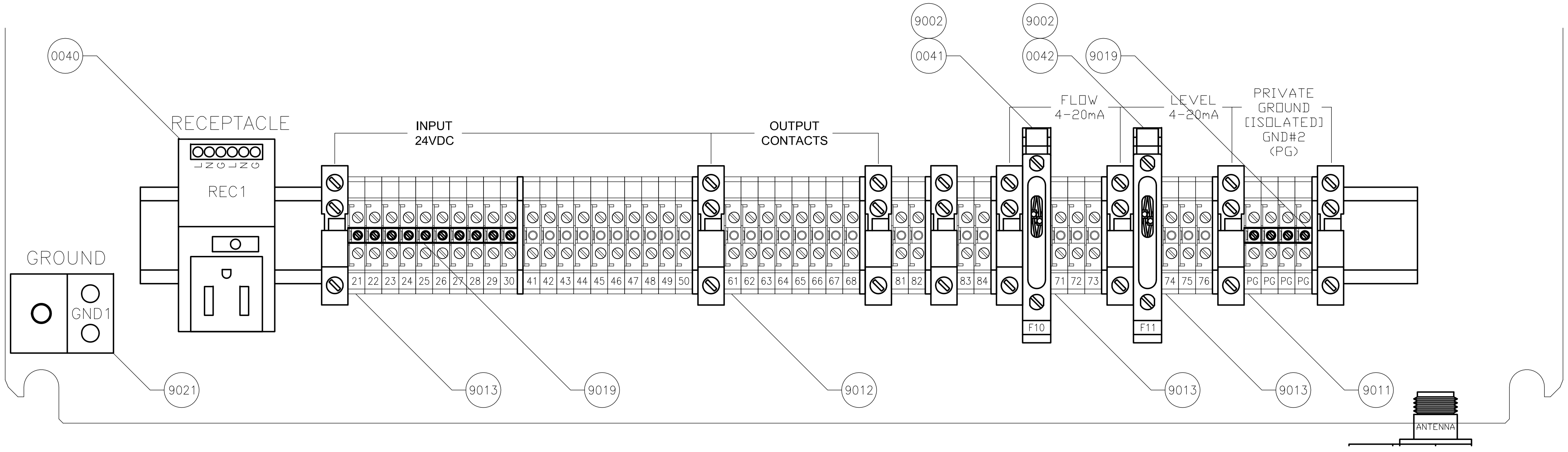
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK PARTS LAYOUT

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 5
OF 8







REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK PARTS LAYOUT

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-2
DWG. NO.	3079
SH	6
OF	8

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-2	1	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	CSD242410SS	HOFFMAN
0002	RTU903-2	1	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	CP2424	HOFFMAN
0003	PL1	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0004	PL1	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0005	PL2	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0006	PL2	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0007	PB1	1	PUSH BUTTON OPERATOR, METAL, 30.5MM, FLUSH HEAD, BLUE W/WHITE LETTERING, 1-NO / 1-NC	800T-A707WA	AB
0008	PB1	1	PUSH BUTTON LABEL, PLASTIC, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0010	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0011	SP1	1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	PU II 1	WEIDMULLER
0012		1	HOLDER, SURGE PROTECTION	PU II 1S	WEIDMULLER
0013		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0014		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0015	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	CP SNT 120W 24V 5A	WEIDMULLER
0016	WR1	1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WI-I/O 9-1	WEIDMULLER
0017	WR2	1	EXPANSION I/O MODULE, 10.8-30VDC, 16 I/O INPUT/OUTPUTS, DIN RAIL MOUNTING	WI-I/O-EX-S-11	WEIDMULLER
0018	SP3	1	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	IS-50NX-C2	POLYPHASER
0020		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0021		1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	AGC-1	BUSSMANN
0022		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0023		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0024		4	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0025		4	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-DC24V	IDEC
0026		2	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0027		2	RELAY, 2PDT, COIL: 120VAC, 1/6HP, W/INDICATOR	RH2B-ULC-AC120V	IDEC
0028		1	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PT 2X2+F-BE	PHOENIX
0029		1	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PT 2X2-24DC-ST	PHOENIX
0040	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0041		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0042		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		4	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		6	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9010		12	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		6	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9012		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9013		36	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		3	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		14	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		24	END CLAMP, GRAY	E/UK	PHOENIX
9018		2	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9019		4	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

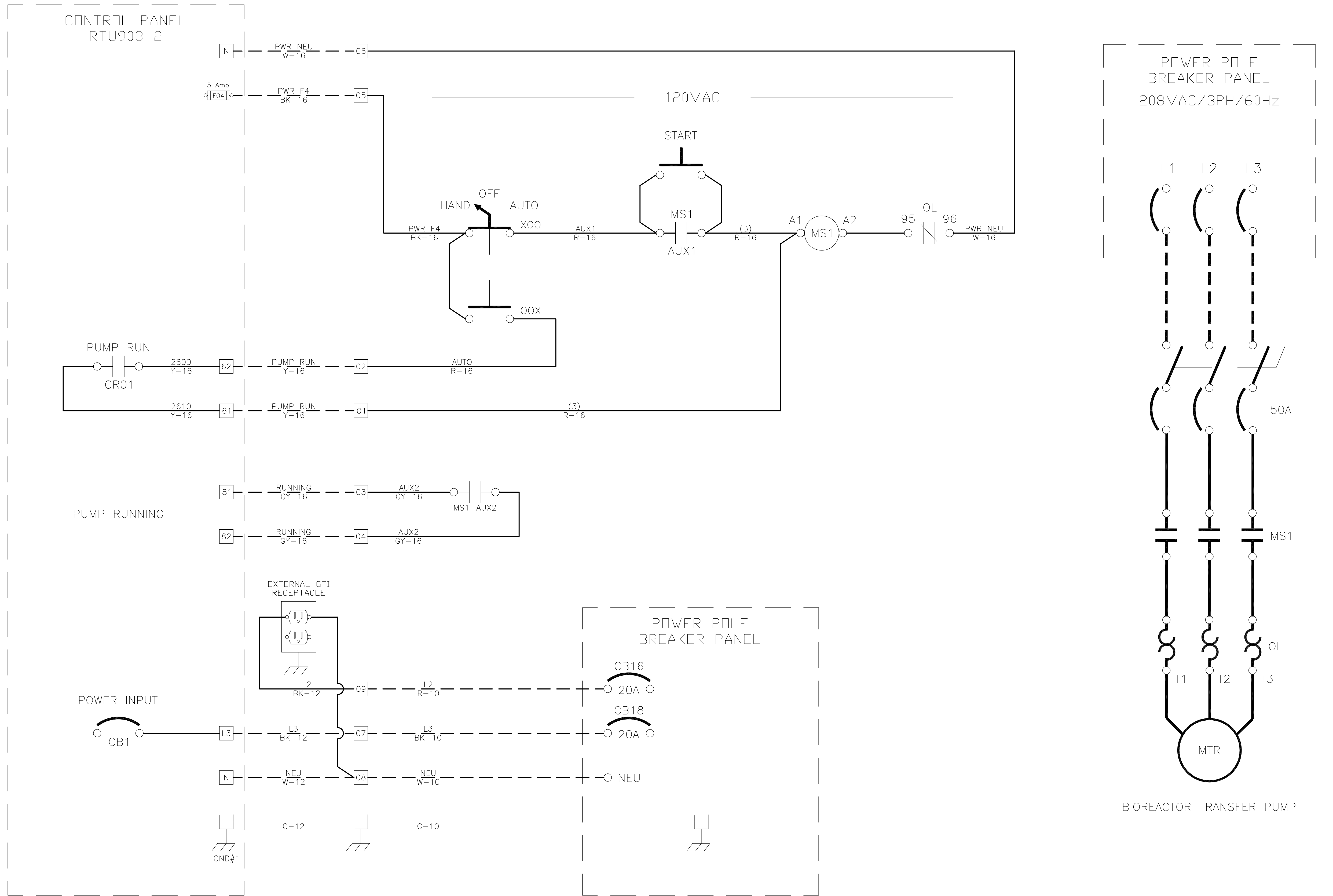
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-2
PROCESS TANK BILL OF MATERIALS

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 7
OF 8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SCI
SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
TRANSFER PUMP PANEL
FIELD WIRING DIAGRAM

DATE: 4/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-2
DWG. NO. 3079
SH 8
OF 8

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CALIBRATION NOTES

JOB:	CSSA	DATE:	12/22/2009
JOB NO:	3079	BY:	RMF

PNL NO: 903-2

ANALOG CH:	**1**		Arbitrary (R1099)
MA	**OHMS**	**DEC**	**GPM**
4mA	6470	0	0
12mA	1970	16362	49.97
20mA	1086	32735	99.95

ANALOG CH:	**2**		Arbitrary (R1101)
MA	**OHMS**	**DEC**	**GPM**
4mA	6407	0	0ft
12mA	1970	16306	4.000ft
20mA	1086	32681	8.019ft

REMOTE RTU903-3

System Controls &
Instrumentation, Ltd

11218 IH-10 E.
Converse, TX 78109
Phone: 210-661-9901
Fax: 210-666-5575

1108 Quail Hollow
Laredo, TX 78045
Phone: 956-725-1239
Fax: 956-726-1774

TECL # 18461

April 29, 2010

Operating & Maintenance Manual

FOR

REMOTE RTU903-3

AT

Camp Stanley Storage
Bioreactor Facility

Bldg. 903

Instrumentations & Controls

SCI FILE 3079

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System Controls & Instrumentation, Ltd

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Laredo, TX 78045
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TECL # 18461

30-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-3

Table of Contents

SCI FILE 3079

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System Controls & Instrumentation, Ltd

11218 IH-10 E. | **1108 Quail Hollow**
Converse, TX 78109 | **Laredo, TX 78045**
Phone: 210-661-9901 | **Phone: 956-725-1239**
Fax: 210-666-5575 | **Fax: 956-726-1774**
TECL # 18461

30-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-3

BILL OF MATERIAL

SCI FILE 3079

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BILL OF MATERIAL

ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-3	1	CSD242410SS	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	HOFFMAN	
0002	RTU903-3	1	CP2424	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	HOFFMAN	
0003	PL1	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0004	PL1	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0010	CB1	1	QOU115	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0011		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0012	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0013		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0014		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0015	PS1	1	CP SNT 120W 24V 5A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	WEIDMULLER	
0016	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	8708670000
0017	SP3	1	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021		1	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0024		4	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0025		4	RH2B-ULC-DC24V	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0026		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0027		1	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0040	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0041		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0042		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		2	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		6	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		4	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		6	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9012		8	UK 5 N YE	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	PHOENIX	3003952
9013		24	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		10	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		21	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9018		2	FBI 2-6	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	PHOENIX	0203438
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

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System Controls &
Instrumentation, Ltd

11218 IH-10 E.	**1108 Quail Hollow**
Converse, TX 78109	**Laredo, TX 78045**
Phone: 210-661-9901	**Phone: 956-725-1239**
Fax: 210-666-5575	**Fax: 956-726-1774**

TECL # 18461

30-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-3

PRODUCT DATA
OPERATION MANUAL

SCI FILE 3079

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CONCEPT® Wall-Mount Enclosures

CONCEPT®, Type 4X

Industry Standards

Mounting brackets required to meet UL/CSA external mounting requirements.

UL 508A Listed; Type 3R, 4, 4X, 12; File No. E61997
cUL Listed per CSA C22.2 No 94; Type 3R, 4, 4X, 12; File No. E61997

NEMA/EEMAC Type 3R, 4, 4X, 12, 13
CSA File No. 42186: Type 4, 4X, 12
VDE IP66
IEC 60529, IP66
Meets NEMA Type 3RX requirements

Application

For indoor or outdoor applications that require corrosion protection from chemicals and water. CONCEPT® Enclosures feature streamlined styling with an attractive stroked finish and flush quarter-turn latches for secure closure. Available in solid- and window-door models.

Specifications

- Manufactured from 16 and 14 gauge Type 304 or Type 316L stainless steel
- Minimum-width body flange provides maximum body opening
- External formed body flange trough
- Panel mounting studs fit optional CONCEPT panels and other accessories
- Mounting holes in back of body for direct mounting or for optional external mounting brackets
- Type 304 stainless steel hidden hinges promote clean aesthetic appearance
- Doors are interchangeable and easily removed by pulling clip-style hinge pins
- Provision on door (except window-door style and when B = 12 in.) for thermoplastic data pocket
- Provision on door (except window-door style and when B = 12 in.) for optional doorstop kit
- Quarter-turn latches furnished with flush slotted insert
- Seamless foam-in-place gasket
- Self-grounding latch system with double seal
- Bonding provision on door; grounding stud on body
- Furnished hardware kit consists of panel-mounting nuts, panel-grounding hardware and sealing washers for wall-mounting holes
- Installation instructions
- Window doors have a clear polycarbonate window

Finish

Door and body have smooth #4 brushed finish.

Patents

This product is covered by the following patents:
US 360,345
DE 9405854.7
US 5,509,703
US 5,666,695
Other patents pending.

Accessories

See also Accessories.
Type 316 Stainless Steel Door Stop Kit
CONCEPT® Panels
H_2OMIT™ Vent Drains, Type 4X
H_2OMIT™ Thermoelectric Dehumidifier
Handles
Lock Inserts

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

Bulletin: CWS

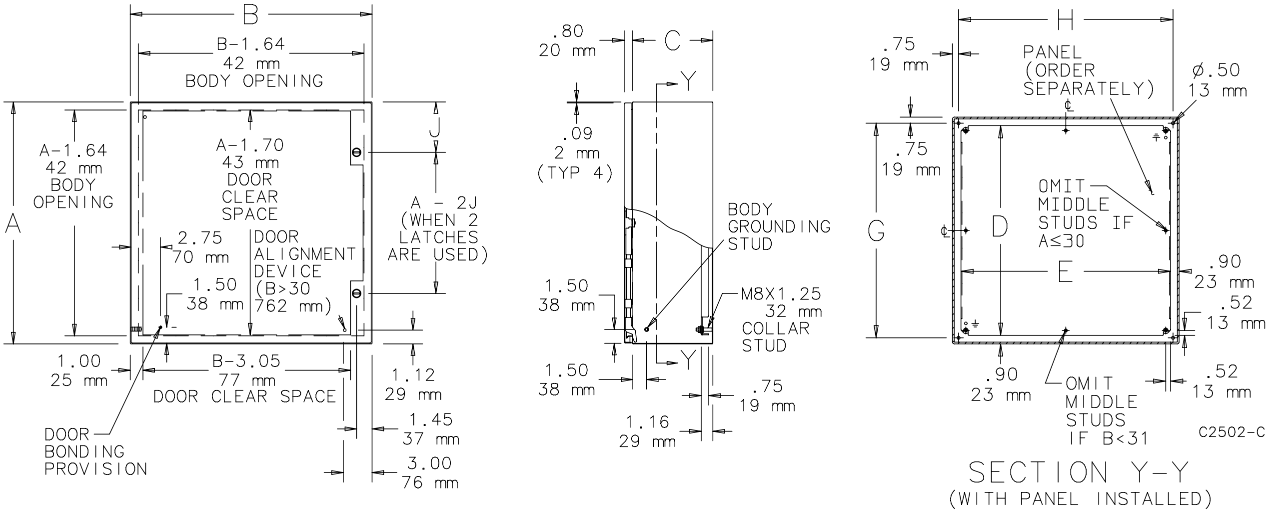
CONCEPT® Wall-Mount Enclosures

Standard Product **One-Door**

Catalog Number	AxBxC in.	AxBxC mm	Door Gauge	Body Gauge	Panel	Conductive Panel	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Latches Qty.	Style	J (in.)	J (mm)
CSD12126SS	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	Quarter-turn	6.00	152
CSD12126SS6	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	Quarter-turn	6.00	152
CSD16126SS	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16126SS6	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16166SS	16.00 x 16.00 x 6.00	406 x 406 x 152	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16166SS6	16.00 x 16.00 x 6.00	406 x 406 x 152	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD20166SS	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20166SS6	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20206SS	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD20206SS6	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD16128SS	16.00 x 12.00 x 8.00	406 x 305 x 203	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16128SS6	16.00 x 12.00 x 8.00	406 x 305 x 203	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16168SS	16.00 x 16.00 x 8.00	406 x 406 x 203	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16168SS6	16.00 x 16.00 x 8.00	406 x 406 x 203	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16208SS	16.00 x 20.00 x 8.00	406 x 508 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD16208SS6	16.00 x 20.00 x 8.00	406 x 508 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD20168SS	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20168SS6	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20208SS	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD20208SS6	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD24168SS	24.00 x 16.00 x 8.00	610 x 406 x 203	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD24168SS6	24.00 x 16.00 x 8.00	610 x 406 x 203	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD24208SS	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD24208SS6	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD24248SS	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD24248SS6	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD30248SS	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD30248SS6	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD30308SS	30.00 x 30.00 x 8.00	762 x 762 x 203	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD30308SS6	30.00 x 30.00 x 8.00	762 x 762 x 203	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD36248SS	36.00 x 24.00 x 8.00	914 x 610 x 203	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD36248SS6	36.00 x 24.00 x 8.00	914 x 610 x 203	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD36308SS	36.00 x 30.00 x 8.00	914 x 762 x 203	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD36308SS6	36.00 x 30.00 x 8.00	914 x 762 x 203	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD161210SS	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD161210SS6	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD161610SS	16.00 x 16.00 x 10.00	406 x 406 x 254	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD161610SS6	16.00 x 16.00 x 10.00	406 x 406 x 254	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD162010SS	16.00 x 20.00 x 10.00	406 x 508 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD162010SS6	16.00 x 20.00 x 10.00	406 x 508 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD201610SS	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD201610SS6	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD202010SS	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202010SS6	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202410SS	20.00 x 24.00 x 10.00	508 x 610 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	464 x 462	18.50 x 22.50	470 x 572	1	Quarter-turn	10.00	254
CSD202410SS6	20.00 x 24.00 x 10.00	508 x 610 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	464 x 462	18.50 x 22.50	470 x 572	1	Quarter-turn	10.00	254
CSD241610SS	24.00 x 16.00 x 10.00	610 x 406 x 254	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD241610SS6	24.00 x 16.00 x 10.00	610 x 406 x 254	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD242010SS	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD242010SS6	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD242410SS	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD242410SS6	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD243010SS	24.00 x 30.00 x 10.00	610 x 762 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	22.50 x 28.50	572 x 724	2	Quarter-turn	5.00	127
CSD243010SS6	24.00 x 30.00 x 10.00	610 x 762 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	22.50 x 28.50	572 x 724	2	Quarter-turn	5.00	127
CSD302010SS	30.00 x 20.00 x 10.00	762 x 508 x 254	14	16	CP3020	CP3020G	28.20 x 18.20	716 x 462	28.50 x 18.50	724 x 470	2	Quarter-turn	5.00	127
CSD302010SS6	30.00 x 20.00 x 10.00	762 x 508 x 254	14	16	CP3020	CP3020G	28.20 x 18.20	716 x 462	28.50 x 18.50	724 x 470	2	Quarter-turn	5.00	127
CSD302410SS	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD302410SS6	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD303010SS	30.00 x 30.00 x 10.00	762 x 762 x 254	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD303010SS6	30.00 x 30.00 x 10.00	762 x 762 x 254	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD362410SS	36.00 x 24.00 x 10.00	914 x 610 x 254	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD362410SS6	36.00 x 24.00 x 10.00	914 x 610 x 254	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD363010SS	36.00 x 30.00 x 10.00	914 x 762 x 254	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD363010SS6	36.00 x 30.00 x 10.00	914 x 762 x 254	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD482410SS	48.00 x 24.00 x 10.00	1220 x 610 x 254	14	14	CP4824	CP4824G	46.20 x 22.20	1173 x 564	46.50 x 22.50	1181 x 572	1	3-point	24.00	610
CSD482410SS6	48.00 x 24.00 x 10.00	1220 x 610 x 254	14	14	CP4824	CP4824G	46.20 x 22.20	1173 x 564	46.50 x 22.50	1181 x 572	1	3-point	24.00	610
CSD202012SS	20.00 x 20.00 x 12.00	508 x 508 x 305	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202012SS6	20.00 x 20.00 x 12.00	508 x 508 x 305	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD242412SS	24.00 x 24.00 x 12.00	610 x 610 x 305	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD242412SS6	24.00 x 24.00 x 12.00	610 x 610 x 305	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD302412SS	30.00 x 24.00 x 12.00	762 x 610 x 305	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD302412SS6	30.00 x 24.00 x 12.00	762 x 610 x 305	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD362412SS	36.00 x 24.00 x 12.00	914 x 610 x 305	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD362412SS6	36.00 x 24.00 x 12.00	914 x 610 x 305	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD363012SS	36.00 x 30.00 x 12.00	914 x 762 x 305	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD363012SS6	36.00 x 30.00 x 12.00	914 x 762 x 305	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127

Catalog numbers ending in 6 are Type 316L stainless steel.
Purchase panels separately. Optional stainless steel, composite and aluminum panels are also available for most sizes.
Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.

CONCEPT® Wall-Mount Enclosures



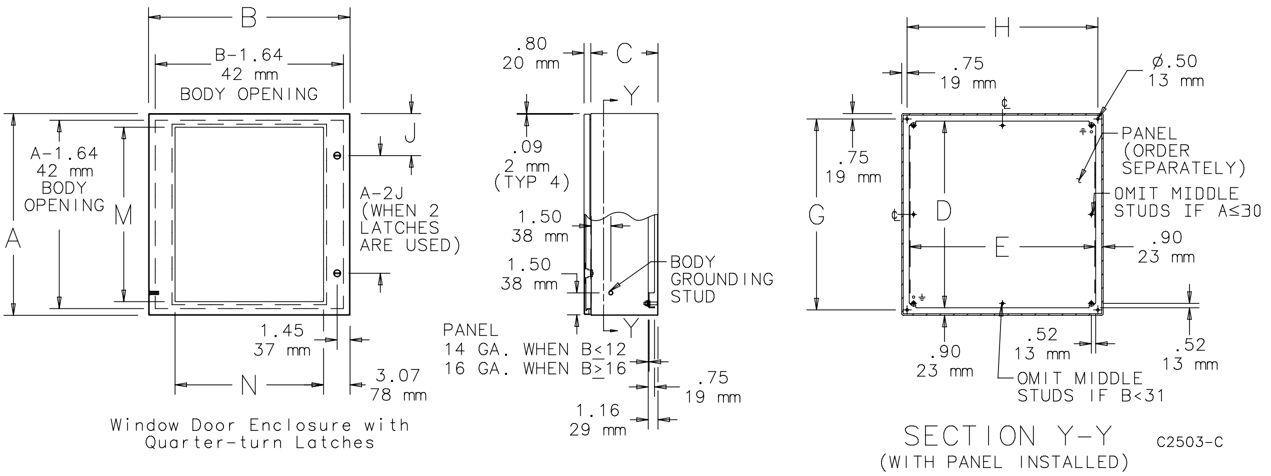
CONCEPT® Wall-Mount Enclosures

Standard Product **One-Door with Window**

Catalog Number	AxBxC in.	AxBxC mm	Door Ga.	Body Ga.	Panel	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Window Size M x N (in.)	Window Size M x N (mm)	Latch Qty.	Style	J (in.)	J (mm)
CSD12126WSS	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	8.74 x 7.10	222 x 180	1	Quarter-turn	6.00	152
CSD16126WSS	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	12.74 x 7.10	324 x 180	1	Quarter-turn	8.00	203
CSD20166WSS	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD20206WSS	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD20168WSS	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD20208WSS	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD24208WSS	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	20.74 x 15.10	527 x 384	1	Quarter-turn	12.00	305
CSD24248WSS	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	20.74 x 17.68	527 x 449	2	Quarter-turn	5.00	127
CSD30248WSS	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127
CSD161210WSS	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	12.74 x 7.10	324 x 180	1	Quarter-turn	8.00	203
CSD201610WSS	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD202010WSS	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD242010WSS	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	20.74 x 15.10	527 x 384	1	Quarter-turn	12.00	305
CSD242410WSS	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	20.74 x 17.68	527 x 449	2	Quarter-turn	5.00	127
CSD302410WSS	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127
CSD202012WSS	20.00 x 20.00 x 12.00	508 x 508 x 305	14	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD302412WSS	30.00 x 24.00 x 12.00	762 x 610 x 305	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127

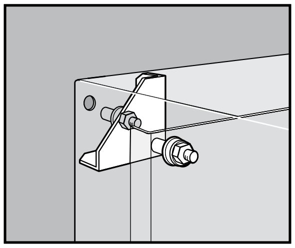
Purchase panels separately.
Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.
Material is stainless steel Type 304.
For Conductive Panels, add a “G” to the panel catalog number.

CONCEPT Single-Door Wall-Mounted Enclosures with Windows



CONCEPT® Accessories

CONCEPT® Panel Conversion Kit



Panel Conversion Kit adapts enclosure for mounting standard NEMA-style panels in CONCEPT® enclosures. Bracket attaches to rear collar stud. Kit includes four adapter plates and hardware for mounting panel.

Bulletin: CWY

Catalog Number	Material	Fits CONCEPT Enclosure
CCPM4	Steel	When A x B is equal to or less than 30.00 x 30.00 in. (762 x 762 mm)

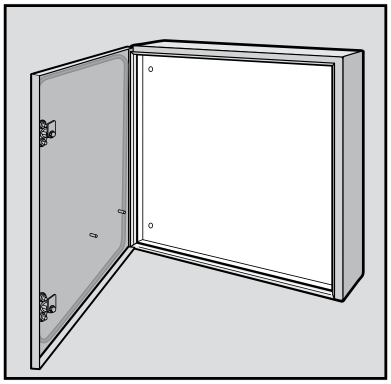
Swing-Out Rack Frame

Swing-Out Rack Frames provide 120-degree swing-out access for 19-in. rack equipment. Welded rack frame mounts to front flange. Distance from frame to door surface is 1.32 in. (33 mm) for solid doors and 1.07 in. (27 mm) for window doors. Frame is painted steel ANSI 61 gray. Mounting hinge and latching hardware provided.
Order separately clip nut package catalog number XNM5 and screws XSM5 (metric) or AN1032 and screws AS1032 (English).
Swing-Out Rack Frame cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Material	Fits Enclosure A x B
CSF2424	Painted steel	24.00 x 24.00 in. (610 x 610 mm)
CSF3024	Painted steel	30.00 x 24.00 in. (762 x 610 mm)
CSF3624	Painted steel	36.00 x 24.00 in. (914 x 610 mm)

Dead Front Kits



Dead Front Kits provide a NEMA Type 1 safety barrier and mounting surface close to the front of the enclosure. Enables convenient mounting of equipment while controlling access to the interior of the enclosure. The depth from the mounting surface to the door is 1.33 in. (34 mm) for solid doors and 1.15 in. (29 mm) for window doors. Kit includes mounting brackets, grounding hardware and a steel panel painted ANSI 61 gray.
Dead Front Kit cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure A x B
CDF1212	12.00 x 12.00 in. (305 x 305 mm)
CDF1612	16.00 x 12.00 in. (406 x 305 mm)
CDF2016	20.00 x 16.00 in. (508 x 406 mm)
CDF2020	20.00 x 20.00 in. (508 x 508 mm)
CDF2420	24.00 x 20.00 in. (610 x 508 mm)
CDF2424	24.00 x 24.00 in. (610 x 610 mm)
CDF3024	30.00 x 24.00 in. (762 x 610 mm)

CONCEPT® Adjustable-Depth Mounting Kits

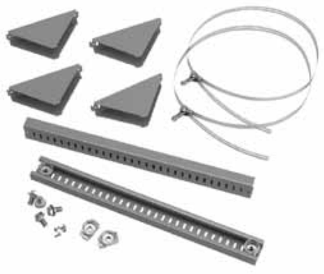
Adjustable-Depth Mounting Kits provide mounting means for installing panels, swing-out panels, DIN rails, rack angles, mounting channels or grid straps at any depth from front to rear of enclosure. Kits include slide mechanisms and hardware. Use two kits when enclosure has 6 collar studs for mounting panel.
Dead Front Panel and Swing-Out Rack Frame cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure (in.)	Fits CONCEPT Enclosure (mm)
CAM64	when C = 6.00	when C = 152
CAM82	when C = 8.00	when C = 203
CAM84	when C = 8.00	when C = 203
CAM102	when C = 10.00	when C = 254
CAM104	when C = 10.00	when C = 254
CAM122	when C = 12.00	when C = 305
CAM124	when C = 12.00	when C = 305
CAM162	when C = 16.00	when C = 406
CAM164	when C = 16.00	when C = 406
CAM202	when C = 20.00	when C = 508
CAM204	when C = 20.00	when C = 508

CONCEPT® Accessories

Pole-Mount Kit

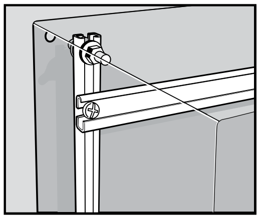


Use to mount CONCEPT®, Networking and wall-mount enclosures to poles of various sizes and shapes. Simply attach the plated steel channel bar to the mounting holes at the back of the enclosure and wrap the stainless steel strap around the pole and through the bar. Kit includes two mounting channels, two straps suitable for 3-in. (76-mm) to 12-in. (30-mm) diameter pole and mounting hardware.

Bulletin: CWY

Catalog Number	Fits Enclosure (in.)	Fits Enclosure (mm)
CPMK12	when B = 12.00	when B = 305
CPMK16	when B = 16.00	when B = 406
CPMK20	when B = 20.00	when B = 508
CPMK24	when B = 24.00	when B = 610
CPMK30	when B = 30.00	when B = 762

Mounting Channels

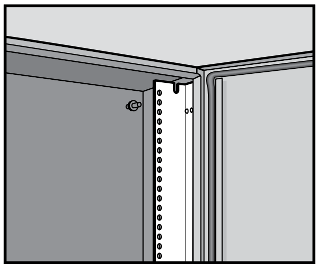


Mounting Channels provide mounting framework for installing DIN rails and grid straps at various positions within the enclosure. Channels can be mounted vertically or horizontally to collar studs or to the slide mechanisms of the adjustable-depth mounting kit. Kit includes two channels.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CMC12	when A or B = 12.00 in. (305 mm)
CMC16	when A or B = 16.00 in. (406 mm)
CMC20	when A or B = 20.00 in. (508 mm)
CMC24	when A or B = 24.00 in. (610 mm)
CMC30	when A or B = 30.00 in. (762 mm)
CMC36	when A or B = 36.00 in. (914 mm)
CMC42	when A or B = 42.00 in. (1067 mm)
CMC48	when A or B = 48.00 in. (1219 mm)
CMC60	when A or B = 60.00 in. (1524 mm)

Rack-Mount Angles



Rack-Mount Angles are a mounting means for 19-in. rack equipment in 24-in. wide enclosures. L-shaped through-hole angles attach to enclosure flange or the adjustable-depth mounting kit. Holes are .281 in. (7 mm) in diameter. Clear plated 14 gauge steel construction. Mounting hardware included.

Order separately clip nut package catalog number XNM5 and screws XSM5 (metric) or AN1032 and screws AS1032 (English).

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure	Rack Units
CRA10TH	when A = 20.00 in. (508 mm)	10
CRA12TH	when A = 24.00 in. (610 mm)	12
CRA16TH	when A = 30.00 in. (762 mm)	16
CRA19TH	when A = 36.00 in. (914 mm)	19
CRA26TH	when A = 48.00 in. (1219 mm)	26

DIN3 Rail Kits

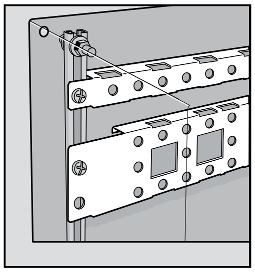
DIN3 Rail Kits supply mounting surfaces for DIN mount snap-on devices in either DIN 1, DIN 3 or CENELEC styles. Rails attach vertically or horizontally to rear collar stud or to mounting channels. Kit includes three rails and mounting hardware.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CDR3P12	when A or B = 12.00 in. (305 mm)
CDR3P16	when A or B = 16.00 in. (406 mm)
CDR3P20	when A or B = 20.00 in. (508 mm)
CDR3P24	when A or B = 24.00 in. (610 mm)

CONCEPT® Accessories

Grid Straps



Grid Straps provide flexible mounting inside the enclosure. Available in one-hole or three-hole widths. Straps mount vertically or horizontally on rear collar studs or to mounting channels in any front-to-back position. Two straps and mounting hardware included in kit. (Order separate grid fastener package catalog number XGFM6, consisting of 20 metric M6 clip nuts and 20 metric M6 Phillips washer head bolts, for mounting equipment to grid straps.)

Bulletin: CWY

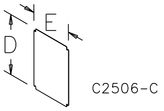
Catalog Number	Fits CONCEPT Enclosure
CGS112	when A or B = 12.00 in. (305 mm)
CGS116	when A or B = 16.00 in. (406 mm)
CGS120	when A or B = 20.00 in. (508 mm)
CGS124	when A or B = 24.00 in. (610 mm)
CGS130	when A or B = 30.00 in. (762 mm)
CGS336	when A or B = 36.00 in. (914 mm)
CGS348	when A or B = 48.00 in. (1219 mm)

CONCEPT® Panels

Bulletin: CWP

These panels are taller and wider than corresponding NEMA-size panels. Panels are 14 or 12 gauge steel and painted white or have a conductive finish.

Panels have a formed flange along any side that is longer than 22.20 in. (564 mm). CP2420 and CP2424 have a flange on all four sides.

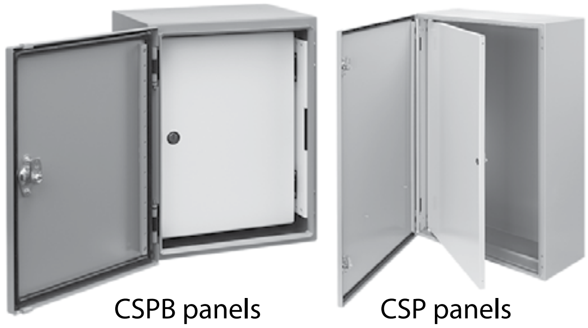


Catalog Number	Panel Type	Panel Size D x E (in.)	Panel Size D x E (mm)	Gauge
CP1212	Painted steel	10.20 x 10.20	259 x 259	14
CP1212G	Conductive	10.20 x 10.20	259 x 259	14
CP1612	Painted steel	14.20 x 10.20	361 x 259	14
CP1612G	Conductive	14.20 x 10.20	361 x 259	14
CP1616	Painted steel	14.20 x 14.20	361 x 361	12
CP1616G	Conductive	14.20 x 14.20	361 x 361	12
CP2016	Painted steel	18.20 x 14.20	462 x 361	12
CP2014	Painted steel	18.20 x 12.20	462 x 310	14
CP2016G	Conductive	18.20 x 14.20	462 x 361	12
CP2416	Painted steel	22.20 x 14.20	564 x 361	12
CP2416G	Conductive	22.20 x 14.20	564 x 361	12
CP2020	Painted steel	18.20 x 18.20	462 x 462	12
CP2020G	Conductive	18.20 x 18.20	462 x 462	12
CP2420	Painted steel	22.20 x 18.20	564 x 462	12
CP2420G	Conductive	22.20 x 18.20	564 x 462	12
CP3020	Painted steel	28.20 x 18.20	716 x 462	12
CP3020G	Conductive	28.20 x 18.20	716 x 462	12
CP2424	Painted steel	22.20 x 22.20	564 x 564	12
CP2424G	Conductive	22.20 x 22.20	564 x 564	12
CP3024	Painted steel	28.20 x 22.20	716 x 564	12
CP3024G	Conductive	28.20 x 22.20	716 x 564	12
CP3624	Painted steel	34.20 x 22.20	869 x 564	12
CP3624G	Conductive	34.20 x 22.20	869 x 564	12
CP4824	Painted steel	46.20 x 22.20	1173 x 564	12
CP4824G	Conductive	46.20 x 22.20	1173 x 564	12
CP3030	Painted steel	28.20 x 28.20	716 x 716	12
CP3030G	Conductive	28.20 x 28.20	716 x 716	12
CP3630	Painted steel	34.20 x 28.20	869 x 716	12
CP3630G	Conductive	34.20 x 28.20	869 x 716	12
CP4230	Painted steel	40.20 x 28.20	1021 x 716	12
CP4230G	Conductive	40.20 x 28.20	1021 x 716	12
CP3636	Painted steel	34.20 x 34.20	869 x 869	12
CP3636G	Conductive	34.20 x 34.20	869 x 869	12
CP4236	Painted steel	40.20 x 34.20	1021 x 869	12
CP4236G	Conductive	40.20 x 34.20	1021 x 869	12
CP4836	Painted steel	46.20 x 34.20	1173 x 869	12
CP4836G	Conductive	46.20 x 34.20	1173 x 869	12
CP6036	Painted steel	58.20 x 34.20	1478 x 869	12
CP6036G	Conductive	58.20 x 34.20	1478 x 869	12
CP2442	Painted steel	22.20 x 40.20	564 x 1021	12
CP2442G	Conductive	22.20 x 40.20	564 x 1021	12
CP3048	Painted steel	28.20 x 46.20	716 x 1173	12
CP3048G	Conductive	28.20 x 46.20	716 x 1173	12
CP3060	Painted steel	28.20 x 58.20	716 x 1478	12
CP3060G	Conductive	28.20 x 58.20	716 x 1478	12

Catalog number CP4230 is used on CONCEPT disconnect enclosures.

CONCEPT® Accessories

CONCEPT® Swing-Out Panels



CSPB panels CSP panels

Panels swing clear from the front of the enclosure to provide access to mounted internal equipment. For CSPB panels, maximum swing is 94 degrees. For CSP panels, maximum panel swing is 106 degrees. Distance from panel surface to door when in the latched position is 1.71 in. (43 mm) for solid doors and 1.45 in. (37 mm) for window doors. Kits include panel, brackets and hardware to mount to the front flange.

Swing-out panels also can be mounted on front-to-back adjustable rails. CSPB panels require adapter CSPBADB and front-to-back adjustable rails for front-to-back adjustment.

Bulletin: CWY

CSPB Panels

Catalog Number	Fits Enclosure Size (in.)	Fits Enclosure Size (mm)	Panel Size (in.)	Panel Size (mm)
CSPB1212	12.00 x 12.00	305 x 305	9.72 x 9.75	247 x 248
CSPB1612	16.00 x 12.00	406 x 305	13.72 x 9.75	349 x 248
CSPB1616	16.00 x 16.00	406 x 406	13.72 x 13.75	349 x 349
CSPB1620	16.00 x 20.00	406 x 508	13.72 x 17.75	349 x 451
CSPB2016	20.00 x 16.00	508 x 406	17.72 x 13.75	450 x 349
CSPB2020	20.00 x 20.00	508 x 508	17.72 x 17.75	450 x 451
CSPB2024	20.00 x 24.00	508 x 610	17.72 x 21.75	450 x 553
CSPB2416	24.00 x 16.00	610 x 406	21.72 x 13.73	552 x 349
CSPB2420	24.00 x 20.00	610 x 508	21.72 x 17.75	552.452
CSPB2424	24.00 x 24.00	610 x 610	21.72 x 21.75	552 x 553
CSPB2430	24.00 x 30.00	610 x 762	21.72 x 27.75	552 x 705
CSPB3020	30.00 x 20.00	762 x 508	27.72 x 17.75	704 x 451
CSPB3024	30.00 x 24.00	762 x 610	27.72 x 21.75	704 x 553
CSPB3030	30.00 x 30.00	762 x 762	27.72 x 27.75	704 x 705
CSPB3624	36.00 x 24.00	914 x 610	33.72 x 21.75	857 x 553
CSPB3630	36.00 x 30.00	914 x 762	33.72 x 27.75	857 x 705
CSPB3636	36.00 x 36.00	914 x 914	33.72 x 33.75	857 x 857
CSPB4236	42.00 x 36.00	1067 x 914	39.72 x 33.75	1009 x 857
CSPB4824	48.00 x 24.00	1219 x 610	45.72 x 21.75	1161 x 553
CSPB4836	48.00 x 36.00	1219 x 914	45.72 x 33.75	1161 x 857
CSPB6036	60.00 x 36.00	1542 x 914	57.72 x 33.75	1466 x 857

CSP Panels

Catalog Number	Fits Enclosure (in.)	Fits Enclosure (mm)	Panel Size (in.)	Panel Size (mm)
CSP1212	12.00 x 12.00	305 x 305	9.78 x 9.84	248 x 250
CSP1612	16.00 x 12.00	406 x 305	13.78 x 9.84	350 x 250
CSP1616	16.00 x 16.00	406 x 406	13.78 x 13.84	350 x 352
CSP1620	16.00 x 20.00	406 x 508	13.78 x 17.84	350 x 453
CSP2016	20.00 x 16.00	508 x 406	17.78 x 13.84	452 x 352
CSP2020	20.00 x 20.00	508 x 508	17.78 x 17.84	452 x 453
CSP2024	20.00 x 24.00	508 x 610	17.78 x 21.84	452 x 555
CSP2416	24.00 x 16.00	610 x 406	21.78 x 13.84	553 x 352
CSP2420	24.00 x 20.00	610 x 508	21.78 x 17.84	553 x 453
CSP2424	24.00 x 24.00	610 x 610	21.78 x 21.84	553 x 555
CSP3020	30.00 x 20.00	762 x 508	27.78 x 17.84	706 x 453
CSP3024	30.00 x 24.00	762 x 610	27.78 x 21.84	706 x 555
CSP3030	30.00 x 30.00	762 x 762	27.78 x 27.84	706 x 707
CSP3624	36.00 x 24.00	914 x 610	33.78 x 21.84	858 x 555
CSP3630	36.00 x 30.00	914 x 762	33.78 x 27.84	858 x 707
CSP3636	36.00 x 36.00	914 x 914	33.78 x 33.84	858 x 860

CONCEPT® Adapter Bracket

Adapter bracket for use with CONCEPT® B-style Swing-Out Panels and Adjustable-Depth Mounting Kits. Bracket enables the B-style swing-out panels to be mounted in infinite front-to-back positions within a CONCEPT enclosure.

Bulletin: CWY

Catalog Number	Material
CSPBADB	Steel

Handles

Handles can replace the standard slotted insert on all CONCEPT® wall-mount enclosures. The CONCEPT non-locking handle provides quick and easy access to the enclosure contents. Handle is black plastic. A zinc die-cast keylock handle is available for applications requiring quick access and security. A padlocking handle, also zinc die-cast, accommodates a padlock with up to a 5/16-in. locking bar. Each latch system can be converted from clockwise to counter-clockwise opening. Kit includes all hardware.

Patents:

US 360,345,

DE M9405854.7.

Bulletin: CWY

Catalog Number	UL Rating	Description
CWHK	Maintains UL/CSA Type 12 when properly installed	Keylock handle
CWHNL	Maintains UL Type 3, 4, 4X, 12 when properly installed	Non-locking handle
CWHPTO	Maintains UL/CSA Type 3, 4, 12 when properly installed	Padlock handle

CWHNL is not suitable for 3-point latch operation.

CONCEPT® Accessories

Door Stop Kit

Door Stop Kit secures the door in the open position. Kit can be installed at the top or bottom of a door which opens horizontally. Door opening angle can be easily adjusted by means of a wing nut. Stop arm slides neatly out of the way when the door is closed. All parts are plated. Mounting hardware included.

- *Door stop kits should not be installed on enclosures configured with a swing-out panel or swing-out rack frame*
- *Door stop kits cannot be used with CONCEPT window doors*

Bulletin: A80

Catalog Number	Finish
ADSTOPK	Plated Steel

Data Pockets

Data Pockets provide convenient storage for wiring diagrams, operation manuals and other documentation inside an enclosure. Pocket mounts on studs located on the inside of a solid-door enclosure. Constructed of high-impact thermoplastic, pockets are dark gray and have cutout areas for easy access and visibility to contents. Mounting hardware included.

Bulletin: UX1Y

Catalog Number	Length x Width in./mm	Fits CONCEPT Enclosure
ADP1	6.00 x 6.00 152 x 152	when A is less than or equal to 24 and B is less than or equal to 24
ADP2	12.00 x 12.00 305 x 305	when A is greater than or equal to 30 and B is greater than or equal to 20

Use ADP2 when A = 24 and B = 30

Lock Inserts

Lock inserts can be substituted for the standard slot/screwdriver insert latch. Inserts have a chrome finish. Matching key is zinc die-cast.

Bulletin: CWY

Catalog Number	Description
CLKTM7	Triangular 7-mm insert with key
CLKSM7	Square 7-mm insert with key
CLKDBM3	Double bit with key

Mounting-Bracket Kits

Mounting-Bracket Kits are field installable. Composite and stainless steel brackets are rated to Type 4X. Set of four (4) brackets can support 500 lb. maximum load. All hardware is included. Four brackets per kit.

Mounting brackets are required to maintain UL/CSA external mounting requirement.

Bulletin: A80

Catalog Number	Description
CMFK	Steel
CMFKSS	Stainless Steel
CMTGFT	Composite

CONCEPT® Accessories

Hinge Pins

Contact Customer Service to order new mild steel hinge pins for an existing product.

Bulletin: VM3

Catalog Number	Description	Qty.
GHPINMS	Hinge Pin	2

Door Bars

Non-metallic door bar includes pressure-sensitive adhesive. Contact Customer Service to order new door bars for an existing product.

Bulletin: CWY

Catalog Number	Description	Length	Qty.
ADB305MM	Door Bar	8 in. (203 mm)	4

30.5 mm Push Buttons

Push Button Operators, Continued

Momentary Contact Push Button Units, Illuminated

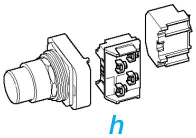
Extended Head Without Guard
Cat. No. 800T-PB16R

Extended Head without Guard
Cat. No. 800H-PRB16R

Type	Lamp Type	Volts	Color	Type 4/13		Type 4/4X/13	
				Extended Head Without Guard∗	Extended Head With Guard∗	Extended Head without Guard∗	Extended Head with Guard∗
				Cat. No.	Cat. No.	Cat. No.	Cat. No.
Operator Only†				800T-SB00XX	800T-SA00XX	800H-SRB00XX	800H-SRA00XX
Full Voltage	Incandescent	24V AC/DC	Red	800T-QB24R	800T-QA24R	800H-QRB24R	800H-QRA24R
			Green	800T-QB24G	800T-QA24G	800H-QRB24G	800H-QRA24G
			Amber	800T-QB24A	800T-QA24A	800H-QRB24A	800H-QRA24A
	LED	120V AC	Red	800T-QBH10R	800T-QAH10R	800H-QRBH10R	800H-QRAH10R
			Green	800T-QBH10G	800T-QAH10G	800H-QRBH10G	800H-QRAH10G
			Amber	800T-QBH10A	800T-QAH10A	800H-QRBH10A	800H-QRAH10A
		24V AC/DC	Red	800T-QBH24R	800T-QAH24R	800H-QRBH24R	800H-QRAH24R
			Green	800T-QBH24G	800T-QAH24G	800H-QRBH24G	800H-QRAH24G
			Amber	800T-QBH24A	800T-QAH24A	800H-QRBH24A	800H-QRAH24A
	No Lamp	0…250V AC/DC	No Lens	800T-QBN25	800T-QAN25	800H-QRBN25	800H-QRAN25
Transformer	Incandescent	120V AC 50/60 Hz	Red	800T-PB16R	800T-PA16R	800H-PRB16R	800H-PRA16R
			Green	800T-PB16G	800T-PA16G	800H-PRB16G	800H-PRA16G
			Amber	800T-PB16A	800T-PA16A	800H-PRB16A	800H-PRA16A
	LED		Red	800T-PBH16R	800T-PAH16R	800H-PRBH16R	800H-PRAH16R
			Green	800T-PBH16G	800T-PAH16G	800H-PRBH16G	800H-PRAH16G
			Amber	800T-PBH16A	800T-PAH16A	800H-PRBH16A	800H-PRAH16A
	No Lamp		No Lens	800T-PBN16	800T-PAN16	800H-PRBN16	800H-PRAN16

∗ Includes as standard one 800T-XA (1 N.O. - 1 N.C.) contact block.
† Operator only supplied without power module, lamp, lens cap, or contact blocks.

800	T		–	P	B	H	16	R	
	a	b		c	d	e	f	g	h



a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Power Module Type		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
P	Transformer (or Dual Input)	PR
Q	Full Voltage (or Resistor)	QR
R	Neon∗	RR

d

Head Type	
Code	Description
A	Extended Head with Guard
B	Extended Head without Guard
M	Mushroom
MJ	Jumbo Mushroom

e

Illumination Options	
Transformer/Full Voltage	
Code	Description
Blank	Incandescent
H	LED†
Resistor/Neon	
Blank	No Options
Dual Input	
D	Diode Type‡
DH	Diode Type LED†‡
T	Transformer — Relay Type
TH	Transformer — Relay Type LED†

f

Voltage	
Transformer	
Code	Description
36	48V AC 50/60 Hz
16	120V AC 50/60 Hz
26	240V AC 50/60 Hz
76	277V AC 50/60 Hz
46	480V AC 50/60 Hz
56	600V AC 50/60 Hz
Full Voltage	
06	6V AC/DC
12	12V AC/DC
24	24V AC/DC
32	32V AC/DC§
48	48V AC/DC
10	120V AC/DC♣
13	130V AC/DC§
20	240V AC/DC§
Resistor	
11	120V AC/DC Resistor

f (cont'd)

Neon	
Code	Description
10	120V AC/DC
20	240V AC/DC
Dual Input	
16	120V AC
24	24V AC/DC➤

g

Lens Color	
Code	Description
Blank	No Lens with standard contacts 1 N.O. - 1 N.C.
X	No Lens if ordering any contacts other than standard 1 N.O. - 1 N.C.
A	Amber
B	Blue
C	Clear
G	Green
R	Red
W	White

h

Contact Block(s)	
Code	Description
X	No Contacts
Standard	
Blank	1 N.O. - 1 N.C.
D1	1 N.O.
Pen*TUFF* (Low Voltage)	
AV	1 N.O. - 1 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C.
Sealed Switch	
AP	1 N.O. - 1 N.C.
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C.

∗ Neon is only available in amber or clear.
† LEDs available in red, green, amber, blue, and white. White LEDs only in 6/24/120/130V and all transformer units. LED color matches lens color, except clear lens supplied with white LED and white lens with amber LED. All LEDs except 120V, have an internal shunt resistor for use with solid-state outputs.
‡ Diode type dual input provides circuit isolation via opposing diodes. Not recommended for use with solid-state outputs and neon indicators.
§ 32V and 130V are LED only. 240V is incandescent only.
♣ 120V LED is AC only and does not contain internal shunt resistor. For AC/DC and internal shunt resistor, order 130V AC/DC LED (Code 13).
➤ Dual input diode only.

Product Data Sheet

QOU115

MINIATURE CIRCUIT BREAKER 120/240V 15A

SQUARE D

by Schneider Electric

List Price	$40.20 USD
Availability	**Stock Item:** This item is normally stocked in our distribution facility.

Technical Characteristics

Wire Size	#14-2 AWG(Al/Cu)
Depth	2.98 Inches
Height	4.05 Inches
Number of Poles	1-Pole
Switching Duty Rated	Yes
Short Circuit Current Rating	5kA@277VAC - 10kA@120/240VAC
Type	QOU
Marketing Trade Name	QOU
Mounting Type	Flush, Surface or DIN Rail (35mm)
Voltage Rating	120/240VAC
Terminal Type	Line: Box Lug - Load: Box Lug
Approvals	UL489 Listed - CSA 22.2 #5.1 Certified - IEC Rated 60947-2
Ampere Rating	15A
Circuit Breaker Type	Standard
Width	0.75 Inches
For Use With	OEM Panels and Enclosures
HACR Rated	Yes

Shipping and Ordering

Category	00900 - Circuit Breakers, 1 Pole: 10 - 100 Amp, 2 Pole: 10 - 125 Amp, 3 Pole: 10 -125 Amp, Type QOU
Discount Schedule	DE2
Article Number	785901418504
Package Quantity	40
Weight	0.36 lbs.
Availability Code	S
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

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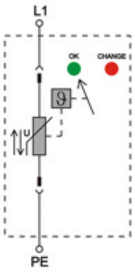


General ordering data	
Order No.	8859950000
Part designation	PU II 1 130V/40kA
Version	Surge protection for low-voltage supply, 120 V, without telecomm. contact
EAN	4032248583843
Qty.	1 pc(s).

Dimensions	
Clamping range, nom.	25 mm²
Clamping range, min.	4 mm²
Clamping range, max.	25 mm²

temperature	
Ambient temperature (operational)	-40...+80°C
Storage temperature	-40 ... +85°C

Product notes	
Note, technical data	* This product also fulfils the requirements for Class III with Uoc: 6 kV
Note, accessories	Pluggable spare arrester PU II 0 130V / 40kA - 8860030000
Product description	Class II surge protectionwith Uc: 130 V

Clamped conductors	
Conductor cross-section, flexible, AEH (DIN 46228-1), max.	25 mm²
Conductor cross-section, flexible, AEH (DIN 46228-1), min.	4 mm²
Cross-section	25 mm²
Stranded, max.	25 mm²
Stranded, min.	4 mm²
Type of connection	Screw connection

Discharge surge current of top part

Limiting discharge current (8/20 µs) I	40 kA

General data

Signalling contact	250 V 1A 1CO at PU II 1 R
Optical function display	green = OK; red = arrester is defective - replace
Design	Installation housing; 1TE
Protection class	IP 20
Type of connection	Screw connection
Cross-section	25 mm²

Interference voltage

Protection level at 5kA (Up)	< 500 V
Protection level at In (Up)	< 850 V

Protective elements

Optical function display	green = OK; red = arrester is defective - replace

Technical data

Rated voltage	120 V
Rated voltage (AC)	130 V
Max. continuous voltage, Uc (AC)	130 V
max. continuous voltage, Uc (DC)	170 V
Requirements class, acc. to IEC 61643-1	Class II
Highest continuous current AC	130 V
Requirements class, acc. to EN 61643-11	T2
Limiting discharge current (8/20 µs) I	40 kA
Discharge current, max. (8/20 µs)	40 kA
Sparkover time / Drop-out time	≤ 25 ns
Fuse, max.	125 A gL
Protection level at In (Up)	< 850 V
Protection level at 5kA (Up)	< 500 V
Temporary surge - U	150 V
AC/DC/UC	AC

Technical data, signal line

Sparkover time / Drop-out time	≤ 25 ns

Approvals

Approvals institutes	OEVE; UR; CE

Downloads

EPLAN	EPLAN4.zip

Classifications

ETIM30	EC000941
eClass 5.1	27-13-08-01
eClass 6.0	27-13-08-02

Similar products

Order No.	Part designation	Version
8859960000	PU II 1R 130V/40kA	Surge protection for low-voltage supply, 120 V, with telecomm. contact
8859970000	PU II 2 130V/40kA	Surge protection for low-voltage supply, 120 V, without telecomm. contact
8859980000	PU II 2 R 130V/40kA	Surge protection for low-voltage supply, 120 V, with telecomm. contact
8859990000	PU II 3 130V/40kA	Surge protection for low-voltage supply, without telecomm. contact
8860000000	PU II 3 R 130V/40kA	Surge protection for low-voltage supply, with telecomm. contact
8860010000	PU II 4 130V/40kA	Surge protection for low-voltage supply, without telecomm. contact
8860020000	PU II 4 R 130V/40kA	Surge protection for low-voltage supply, with telecomm. contact

¼″ x 1 ¼″ Time-Delay, Glass Tube Fuses

MDL Series

Description

RoHS 2002/95/EC

- Time-delay
- Optional axial leads available
- ¼ x 1 ¼ (6.4 x 31.7mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

Electrical Characteristics

Rated Current	% of Amp Rating	Opening Time
1/16 - 30A	100%	None
	135%	60 minutes maximum
	200%	120 seconds maximum
1/16 - 3A	200%	5 seconds minimum
3-2/10 - 8A	200%	12 seconds minimum

Agency Information

- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDL 1/16 - 8A (Class No. 1422-01)
- CSA Component Acceptance: MDL 9-30A (Class No. 1422-30)
- CE

Environmental Data

- Shock: 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/4A thru 30A – MIL-STD-202, Method 204, Test Condition C (Except 5g, 500HZ)

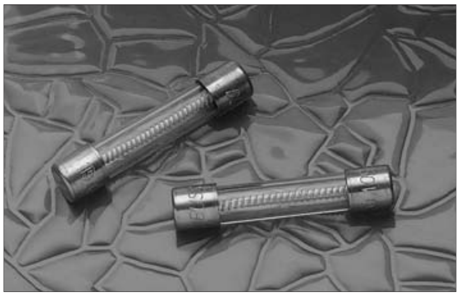
Ordering

Specify packaging code

- Insert packaging code prefix before part number. E.g., BK (or BK1)-MDL-5-R

Specify option codes if desired

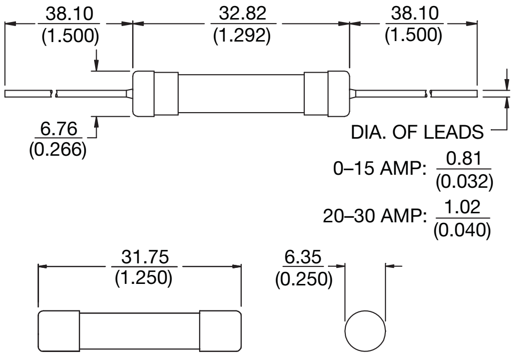
- For axial leads, insert "V" between catalog series and amp rating. E.g., BK-MDL-V-5-R



- For board washable, insert "B" between catalog series and amp rating. E.g., BK-MDL-B-5-R
- For axial leads and board washable, insert "B" then "V" between catalog series and amp rating. E.g., BK-MDL-BV-5-R

Dimensions - mm (in)

Drawing Not to Scale



Specifications

Part Number	Voltage Rating Vac	AC Interrupting Rating* (amps)@			Typical DC Cold Resistance** (Ω)	Typical Melting I²t† AC	Typical Voltage Drop‡
		250Vac	125Vac	32Vac			
MDL-1/16-R	250	35	10000		45.6	0.0046	2.79
MDL-1/10-R	250	35	10000		15.68	0.0420	1.95
MDL-1/8-R	250	35	10000		12.238	0.0422	1.52
MDL-3/16-R	250	35	10000		4.81	0.116	1.05
MDL-2/10-R	250	35	10000		5.234	0.314	0.972
MDL-1/4-R	250	35	10000		3.208	0.447	0.965
MDL-3/10-R	250	35	10000		2.046	0.412	0.808
MDL-3/8-R	250	35	10000		1.567	0.982	1.46
MDL-1/2-R	250	35	10000		0.943	1.656	1.27
MDL-3/4-R	250	35	10000		0.397	4.343	1.01
MDL-1-R	250	35	10000		0.273	11.498	0.995
MDL-1-1/4-R	250	100	10000		0.205	86.2	0.722
MDL-1-1/2-R	250	100	10000		0.156	22.7	0.721
MDL-2-R	250	100	10000		0.116	62.3	0.644
MDL-2-1/4-R	250	100	10000		0.096	49.6	0.535
MDL-2-1/2-R	250	100	10000		0.081	63.1	0.410
MDL-3-R	250	100	10000		0.057	67.5	0.345
MDL-4-R	250	200	10000		0.038	19.3	0.187
MDL-5-R	250	200	10000		0.025	32.0	0.160
MDL-6-R	250	200	10000		0.022	37.4	0.155
MDL-6-1/4-R	250	200	10000		0.02	38.7	0.152
MDL-7-R	250	200	10000		0.018	42.7	0.140
MDL-8-R	250	200	10000		0.015	47.8	0.119
MDL-9-R	32			1000	0.012	51.5	0.124
MDL-10-R	32			1000	0.01	64.4	0.114
MDL-15-R	32			1000	0.005	354.0	0.130
MDL-20-R	32			1000	0.004	2914.0	0.530
MDL-25††	32			1000	0.01225	15221.0	0.30
MDL-30††	32			1000	0.0011	15581.0	0.40

* Interrupting Ratings (Interrupting ratings were measured at 70%   80% power factor on AC)

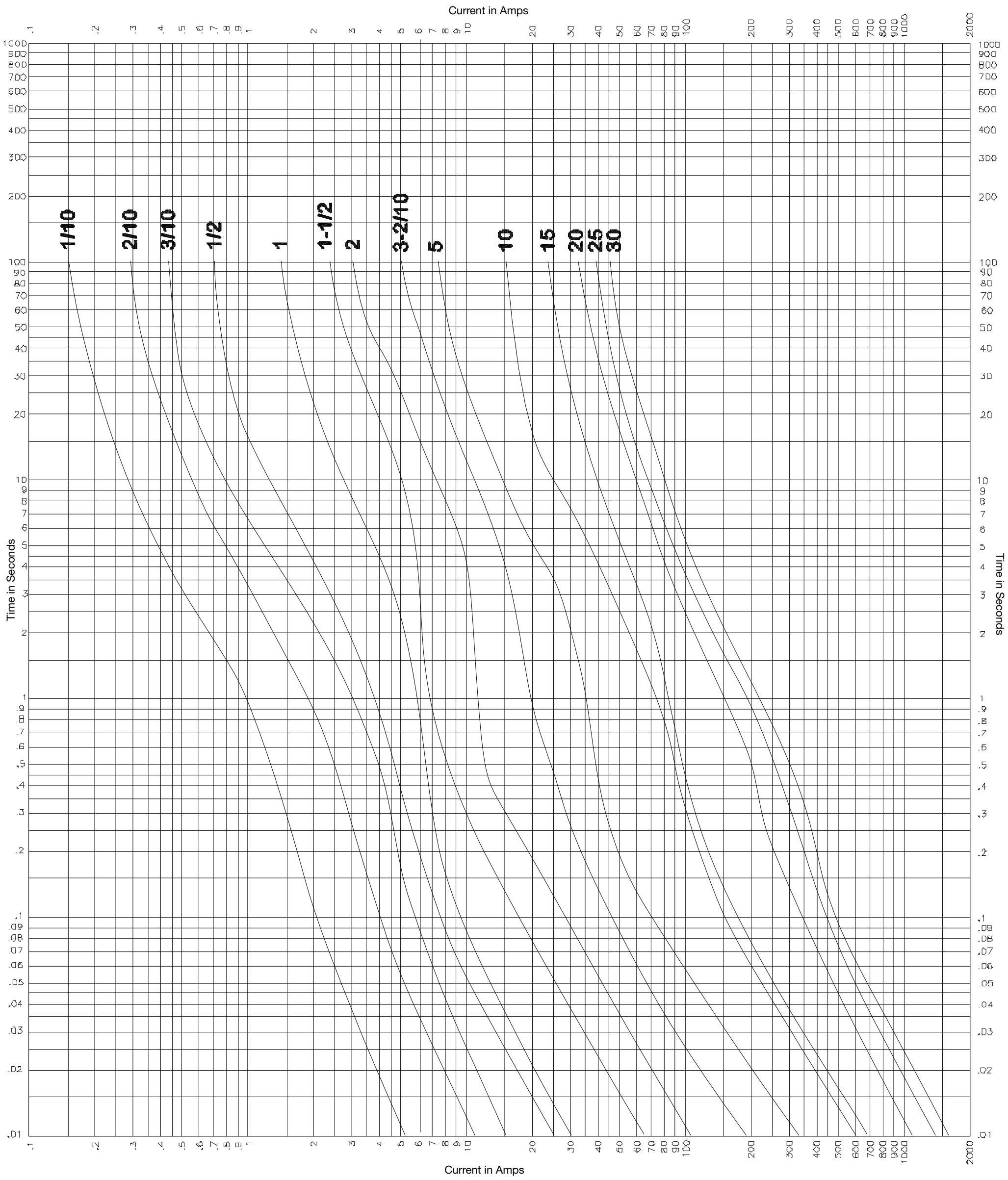
** DC Cold Resistance (Measured at ≤10% of rated current)

† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C±3°C ambient temperature at rated current)

†† MDL 25 & MDL 30 not available in RoHS compliant construction.

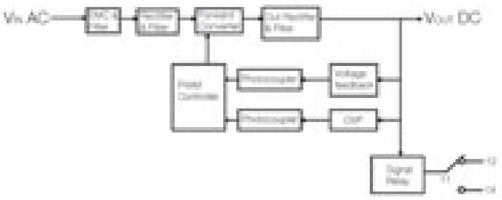
Time-Current Curve



Packaging Code	
Packaging Code	**Description**
BK	100 fuses packed into a cardboard carton
BK1	1,000 fuses packed into a cardboard carton
BK8	8,000 fuses packed into a cardboard carton

	Option Code
Option Code	**Description**
B	Sealed to withstand aqueous cleaning (Board Washable)
V	Axial leads - copper tinned wire with nickel plated brass overcaps

St. Louis, MO 63178
www.cooperbussmann.com



General ordering data

Order No.	8708670000
Part designation	CP SNT 120W 24V 5A
Version	Switched-mode power supplies
EAN	4032248380831
Qty.	1 pc(s).

Dimensions

Clamping range, nom.	2.5 mm²
Clamping range, min.	0.13 mm²
Clamping range, max.	4 mm²

temperature

Ambient temperature (operational)	
Storage temperature	-20 °C...+85 °C
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Input

Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Input current	3 A @ 115 V AC / 2 A @ 230 V AC
Input frequency, max.	50/ 60 Hz
Input fuse	Fusible link 4 A (T) / 250 V
Input voltage (voltage mode input)	88...132 V AC/176...264 V AC selectable; 250...370 V DC
Surge protection [input]	Varistor

output

Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Control at 10...100% load	< 2 %
Control at input voltage	0.5 %
Mains failure bridge-over time	20 ms @ 115 V AC / 20 ms @ 230 V AC
Mains failure bridge-over time for 115 V AC	20 ms
Mains failure bridge-over time for 230 V AC	20 ms

output	
Max. capacitance at output	40000 µF
Max. residual ripple	< 100 mV / bandwidth 20 MHz
Output current	5 A
Output power, max.	120 W
Output voltage	24...28 V DC (adjustable with potentiometer)
Output voltage type	DC
Output voltage, max.	28 V
Output voltage, min.	24 V
Overload protection	105 %..130 % I of max. output load; automatic reset
Parallel connection option	Recommended with diode module
Status relay / CO contact	250 V AC (max. 30 V DC) / 1 A
Surge protection [output]	29...34 V

General data	
Ambient temperature (operational)	
DIN Rail compatibility	TS 35
Degree of efficiency at max. load	84 %
Depth	100 mm
EMC standards	EN 55011 EN 55022 EN 55024 EN 61000-6-2, 3
Installation advice	Clearance: above/below ≥ 3 cm
Low Voltage Directive	73/ 23/ EWG
Mounting position, installation notice	horizontally on terminal rail TS 35
Power factor correction	No
Standards	EN 60950 (SELV)
Status indication	Green LED
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Insulation coordination	
Protection class	IP 20
electrical isolation, input-earth	1.5 kV
electrical isolation, input-output	3 kV
electrical isolation, output-earth	0.5 kV

Approvals	
Approvals institutes	CULUS; CURUS; GERMLLOYD; GOSTME25; CE

Classifications	
ETIM20	EC001039
ETIM30	EC001039
eClass 4.1	27-24-04-10
eClass 5.0	27-24-22-13
eClass 5.1	27-04-90-02
eClass 6.0	27-04-90-04

Similar products

Order No.	Part designation	Version
8862780000	CP SNT 1000W 24V 40A	Switched-mode power supplies

8708660000	CP SNT 70W 24V 3A	Switched-mode power supplies
8708680000	CP SNT 250W 24V 10A	Switched-mode power supplies
8778870000	CP SNT 500W 24V 20A	Switched-mode power supplies

WI-I/O 9 Multi I/O Units

- Large I/O capability with I/O expansion
- Two-way communications
- Use where communications is required in both directions or for large I/O requirements. Each network can handle multiple I/O applications.
- Frequency hopping spread spectrum
- 902-928 MHz 1W license-free USA/Canada
- Configurable sub-bands license-free
- Up to 95 wireless units per network
- Support up to 31 I/O expansion modules (WI-I/O-EX-1-S-XX) per wireless unit. See table below.
- Multi-hop repeater functions – up to 5 intermediate units
- Four I/O versions available:

WI-I/O 9	**-1**	**-2**	**-3**	**-4**
Digital inputs	4	4	0 Voltage-free contacts	4 – 16
Digital outputs	1 + 3 Relay + FET	1 FET	8 FET	4 - 16 FET
Analog inputs	2 4-20mA	6 0-20mA/0-10V	0	0
Analog outputs	2 4-20mA	0	8 0-20mA/0-10V	0
Pulse inputs	1 100Hz	4 1 x 1KHz, 3 x 100Hz	0	4 1 x 1KHz, 3 x 100Hz
Pulse outputs	1 100Hz	0	4 1 x 1KHz, 3 x 100Hz	4 1 x 1KHz, 3 x 100Hz

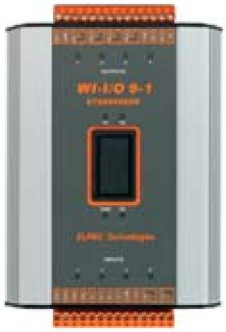
Note: Pulse and digital inputs are same connection point.

- Pulse inputs generate separate pulse count and rate value; pulse rates treated as internal analog registers with configurable maximum value.
- Wide voltage power supply, with integral UPS battery charger and solar regulator
- Power supply generates transmittable internal I/O values
- Multiple communication-failure diagnostics with output status
- Class 1 Div 2 approval
- Radio receive signal and background RF noise measurement / logging diagnostics
- Input measurement display and output "forcing" diagnostics
- Communication logging diagnostics
- Easy-to-use E-Series Windows configuration available at www.weidmuller.ca or weidmuller.com

Multi-I/O Units—Product Data 900 MHz

C US **C1D2**

WI-I/O 9-1



WI-I/O 9-2

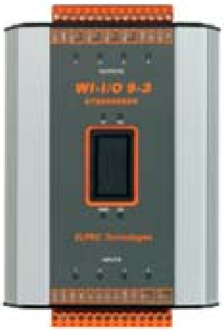
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA	four inputs	four inputs
Analog: "floating" differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.	two 4-20mA resolution 15 bit, accuracy 0.1%	six 0-20mA/0-10V resolution 12 bit, accuracy 0.1%
Pulse: as per digital inputs, Max pulse rate 100Hz, pulse width min 5ms	one input (DI1)	four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
Outputs		
Digital	four relay contacts, Form A, AC, 50V 5A/ DC 30V 2A	one FET output 30VDC 500mA
Analog: current sink to common, max loop voltage 27V, max loop resistance 1000 ohms	two 4-20 mA resolution 15 bit, accuracy 0.1%	
Pulse: FET 30VDC 500mA max 100Hz	one	
Power Supply		
Battery supply	11.5-15.0 VDC	11.5-15.0 VDC
Normal supply	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected
Battery charging circuit	included for 1.2-12 AHr sealed battery	included for 1.2-12 AHr sealed battery
Solar regulator	for direct connection of solar panel (up to 30W) and solar battery (100AHr)	for direct connection of solar panel (up to 30W) and solar battery (100AHr)
Internal monitoring	power fail, solar charge status, and battery voltage	power fail, solar charge status, and battery voltage
Notes	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS232/RS485	serial port 9600 baud, 8 bits, no parity, 1 stop bit	serial port 9600 baud, 8 bits, no parity, 1 stop bit
RS232 connection	9pin DB9 female connector	9pin DB9 female connector
RS485 connection	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections

General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99%RH	0-99%RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC, EN 301 489	FCC Part 15, AS3548, 89/336/EEC, EN 301 489
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting	DIN rail mounting
LED indication	For power supply, WDT, digital I/O	For power supply, WDT, digital I/O
Antenna connector	SMA female coaxial	SMA female coaxial
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)

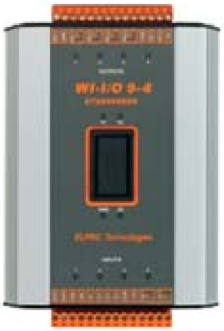
Ordering Data	Type	Part No.	Type	Part No.
	WI-I/O 9-1	**6720005000**	WI-I/O 9-2	**6720005001**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

C1D2

WI-I/O 9-3



WI-I/O 9-4



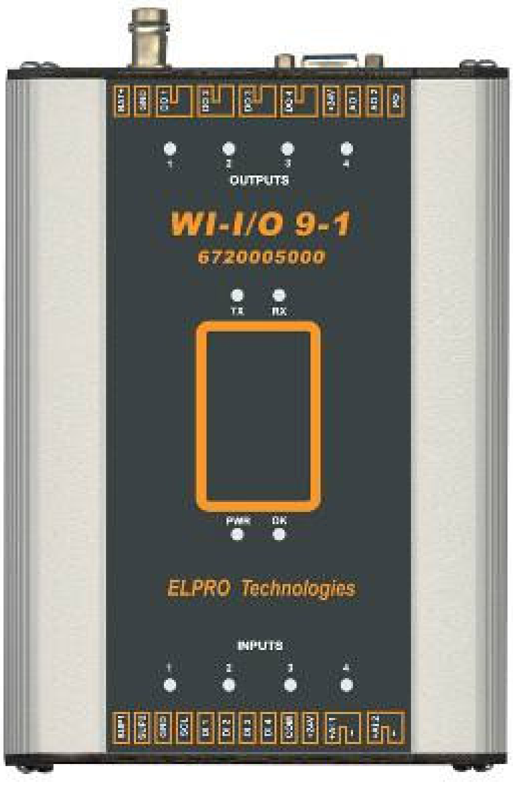
Technical Data	WI-I/O 9-3	WI-I/O 9-4
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA		up to 16 inputs (4 inputs + 12 selectable I/O) the 12 selectable inputs are surge protected but not isolated
Analog: "floating" differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.		
Pulse: as per digital inputs, Max pulse rate 100Hz, pulse width min 5ms		four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
Outputs		
Digital	eight FET output 30VDC 500mA	up to 16 FET output (4 outputs + 12 selectable I/O)
Analog: current sink to common, max loop voltage 27V, max loop resistance 1000 ohms	eight 0-20 mA resolution 12 bit, accuracy 0.1%	
Pulse: FET 30VDC 500mA max 100Hz	four (DO1-4)	four (DO1-4)
Power Supply		
Battery supply	11.5-15.0 VDC	11.5-15.0 VDC
Normal supply	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected
Battery charging circuit	included for 1.2-12 AHr sealed battery	included for 1.2-12 AHr sealed battery
Solar regulator	for direct connection of solar panel (up to 30W) and solar battery (100AHr)	for direct connection of solar panel (up to 30W) and solar battery (100AHr)
Internal monitoring	power fail, solar charge status, and battery voltage	power fail, solar charge status, and battery voltage
Notes	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS232/RS485	serial port 9600 baud, 8 bits, no parity, 1 stop bit	serial port 9600 baud, 8 bits, no parity, 1 stop bit
RS232 connector	9pin DB9 female connector	9pin DB9 female connector
RS485 connector	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections
General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99%RH	0-99%RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC, EN 301 489	FCC Part 15, AS3548, 89/336/EEC, EN 301 489
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting	DIN rail mounting
LED indication	For power supply, WDT, digital I/O	For power supply, WDT, digital I/O
Antenna Connector	SMA female coaxial	SMA female coaxial
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)

Ordering Data	Type	Part No.	Type	Part No.
	WI-I/O 9-3	**6720005002**	WI-I/O 9-4	**6720005003**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

User Manual

WI-I/O 9-x Wireless Module

WI-I/O-EX-1-S-x Serial Module



W Interconnections Inc., 821 Southlake Boulevard, Richmond, VA 23236
Tel: (804) 794-2877 Fax: (804) 379-2593

Thank you for your selection of the WI-I/O-9-x_WI-I/O-EX-1-S-x module for your I/O needs. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may
cause internal damage and will void warranty.
To ensure this product enjoys a long life,
double check ALL your connections with
the user's manual
before turning the power on.

Caution! For continued protection against risk of fire, replace the module fuse F1 only with the same type and rating.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to **provide a separation distance of at least 33 cm from all persons** to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 33 cm of the antenna
- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.
- operate the equipment near electrical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

FCC Notice: WI-I/O 9-x Wireless I/O Module

This user's manual is for the W INTERCONNECTIONS WI-I/O 9-x wireless I/O module. This device complies with Part 15.247 of the FCC Rules.

Operation is subject to the following two conditions:

1) This device may not cause harmful interference and

2) This device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by W INTERCONNECTIONS Technologies. Any changes or modifications made to the device without the written consent of W INTERCONNECTIONS Technologies may void the user's authority to operate the device.

End user products that have this device embedded must be installed by experienced radio and antenna personnel, or supplied with non-standard antenna connectors, and antennas available from vendors specified by W INTERCONNECTIONS Technologies. Please contact W INTERCONNECTIONS Technologies for end user antenna and connector recommendations.

Notices: Safety

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in Docket 93-62 and OET Bulletin 65 Edition 97-01.

FCC Notice: WI-I/O-EX-1-S-x Wireless I/O Module

Part 15 – This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part15 of the FCC rules (Code of Federal Regulations 47CFR Part 15). Operation is subject to the condition that this device does not cause harmful interference.

Part 90 – This device has been type accepted for operation by the FCC in accordance with Part90 of the FCC rules (47CFR Part 90). See the label on the unit for the specific FCC ID and any other certification designations.

Industry Canada: WI-I/O-EX-1-S-x Wireless I/O Module

RSS-119 - This device has been type accepted for operation by Industry Canada in accordance with RSS-119 of the Industry Canada rules. See the label on the unit for the specific Industry Canada certification number and any other certification designations.

Notice Any changes or modifications not expressly approved by W INTERCONNECTIONS could void the user's authority to operate this equipment.

To operate this equipment legally the user must obtain a radio operating license from the government agency. This is done so the government can coordinate radio users in order to minimize interference.

Important Notice

W INTERCONNECTIONS products are designed to be used in industrial environments, by experienced industrial engineering personnel with adequate knowledge of safety design considerations.

W INTERCONNECTIONS radio products are used on unprotected license-free radio bands with radio noise and interference. The products are designed to operate in the presence of noise and interference, however in an extreme case, radio noise and interference could cause product operation delays or operation failure. Like all industrial electronic products, W INTERCONNECTIONS products can fail in a variety of modes due to misuse, age, or malfunction. We recommend that users and designers design systems using design techniques intended to prevent personal injury or damage during product operation, and provide failure tolerant systems to prevent personal injury or damage in the event of product failure. Designers must warn users of the equipment or systems if adequate protection against failure has not been included in the system design. Designers must include this Important Notice in operating procedures and system manuals.

These products should not be used in non-industrial applications, or life-support systems, without consulting W INTERCONNECTIONS Technologies first.

1. For WI-I/O 9-x modules, a radio licence is not required in many countries, provided the module is installed using the antenna and equipment configuration complying with the country's regulations.. Check with your local distributor for further information on regulations.
2. For WI-I/O 9-x modules, operation is authorised by the radio frequency regulatory authority in your country on a non-protection basis. Although all care is taken in the design of these units, there is no responsibility taken for sources of external interference. The WI-I/O 9-x intelligent communications protocol aims to correct communication errors due to interference and to retransmit the required output conditions regularly. However some delay in the operation of outputs may occur during periods of interference. Systems should be designed to be tolerant of these delays.
3. To avoid the risk of electrocution, the antenna, antenna cable, serial cables and all terminals of the WI-I/O 9-x_WI-I/O-EX-1-S-x module should be electrically protected. To provide maximum surge and lightning protection, the module should be connected to a suitable earth and the antenna, antenna cable, serial cables and the module should be installed as recommended in the Installation Guide.
4. To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the WI-I/O 9-x_WI-I/O-EX-1-S-x module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. E.g. "This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments."
5. The WI-I/O 9-x_WI-I/O-EX-1-S-x module is not suitable for use in explosive environments without additional protection. These modules are approved for use in Class 1 Division 2 areas

in North America.

Limited Lifetime Warranty, Disclaimer and Limitation of Remedies

W INTERCONNECTIONS products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W INTERCONNECTIONS, W INTERCONNECTIONS will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W INTERCONNECTIONS' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W INTERCONNECTIONS is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W INTERCONNECTIONS is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W INTERCONNECTIONS or its representatives or by any other party, except as expressed solely in this document..

How to Use This Manual

To receive the maximum benefit from your WI-I/O 9-x_WI-I/O-EX-1-S-x product, please read the **Introduction**, **Installation** and **Operation** chapters of this manual thoroughly before putting the product to work.

Chapter Four **Configuration** explains how to configure the modules using the Configuration Software available.

Chapter Five **Specifications** details the features of the product and lists the standards to which the product is approved.

Chapter Six **Troubleshooting** will help if your system has problems and Chapter Seven specifies the **Warranty and Service** conditions.

The foldout sheet *Installation Guide* is an installation drawing appropriate for most applications.

CONTENTS

Chapter One INTRODUCTION

1.1 General

The WI-I/O 9-x & WI-I/O-EX-1-S-x range of I/O modules has been designed to provide standard "off-the-shelf" telemetry functions, for an economical price. *Telemetry* is the transmission of signals over a long distance via a medium such as radio or twisted-pair wire. Although the WI-I/O 9-x_WI-I/O-EX-1-S-x is intended to be simple in its application, it also provides many sophisticated features. This manual should be read carefully to ensure that the modules are configured and installed to give reliable performance.

The unit can monitor and control the following types of signals:

Digital on/off signals

Example outputs - motor run, siren on
Example inputs - motor fault, tank overflow, intruder alarm

Analog continuously variable signals (0-20mA)

Example outputs - tank level indication, required motor speed
Example inputs - measured tank level, actual motor speed

Pulse frequency signals

Examples - electricity metering, fluid flow

Internal Status signals

Examples - analog battery voltage, power status, solar panel status and low battery status.

The unit will monitor the input signals and transmit the signal information by radio or RS485 twisted pair to another module or modules. At the remote unit, the signals will be reproduced as digital, analog or pulse output signals. The modules also provide analog set points, so that a digital output may be configured to turn on and off depending on the value of an analog input. The pulse I/O transmits an accumulated value and the pulses are reliably recreated at the remote unit regardless of 'missed' transmissions. The actual pulse rate is also calculated and is available as a remote analog output.

This manual covers the WI-I/O 9-x and WI-I/O-EX-1-S-x modules. We have provided a summary on all products available in the range, below.

- **WI-I/O 9-1, WI-I/O 9-2, WI-I/O 9-3 and WI-I/O 9-4** modules have radio **and** serial communications. The modules differ only in their input/output (I/O) design, and are compatible, i.e. they can be used to communicate signals to each other in the same network. The WI-I/O 9-x has a frequency hopping spread spectrum 900MHz radio which is license-free in many countries.
-

- **WI-I/O-EX-1-S-1, WI-I/O-EX-1-S-2, WI-I/O-EX-1-S-3 and WI-I/O-EX-1-S-4** modules have **only** serial communications. All other specifications are as per the WI-I/O 9-1, 2, 3 & 4 modules. The WI-I/O-EX-1-S-x modules are compatible with WI-I/O 9-x modules. WI-I/O-EX-1-S-x modules may be used for serial I/O applications, or as I/O expansion for WI-I/O 9-x modules.
- The **WI-GTWY-9-xxx** modules provides an interface between host devices such as PLC's or SCADA computers, and a wireless I/O system comprising WI-I/O 9-x modules. The WI-GTWY-9-xxx allows WI-I/O 9-x modules to act as remote wireless I/O for the host devices. For more information, refer to the **WI-GTWY-9-xxx User Manual**.

The WI-I/O 9-x radio has been designed to meet the requirements of unlicensed operation for remote monitoring and control of equipment. That is, a radio licence is not required for the WI-I/O 9-x modules in many countries. See Chapter Five **Specifications** for details. A radio license is not required to use the WI-I/O 9-x products.

I/O Types

	WI-I/O 9-1	WI-I/O-EX-1-S-1	WI-I/O 9-2	WI-I/O-EX-1-S-2	WI-I/O 9-3	WI-I/O-EX-1-S-3	WI-I/O 9-4	WI-I/O-EX-1-S-4
Radio	✓		✓		✓		✓	
Serial	✓	✓	✓	✓	✓	✓	✓	✓
Digital Inputs (DI)	4		4				4 to 16	
Digital Outputs (DO)	4 (relay)		1 (FET)		8 (FET)		4 to 16 (FET)	
Analog Inputs (AI)	2 (4-20mA)		6 (0-20mA)					
Analog Outputs (AO)	2 (4-20mA)				8 (0-20mA)			
Pulse Inputs (PI)	1 (100Hz)		4 (1x1KHz, 3x100Hz)				4 (1x1KHz, 3x100Hz)	
Pulse Outputs (PO)	1 (100Hz)				4 (100 Hz)		4 (100 Hz)	
Comments	PI is DI 1. PO is separate to DO.		PI's are the same as DI's.		PO's are the same as DO's .		PI/ PO's are the same as DI/ DO's.	

Note regarding -4 modules. The WI-I/O 9-x_WI-I/O-EX-1-S-4 has a total of 20 digital I/O. Four are fixed inputs (also PI's) and four are fixed outputs (also PO's). The other 12 are selectable individually as DI or DO. The I/O range can vary from 16DI + 4DO to 4DI + 16DO or any combination in between.

Input signals connected to a module are transmitted to another module and appear as output signals. These input signals may also be configured to appear as "inverted" signals on the output. A

transmission occurs whenever a "change-of-state" occurs on an input signal. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa. A "change-of-state" for an analog input, internal analog input or pulse input rate is a change in value of the signal of 3% (configurable from 0.8 to 75 %).

In addition to change-of-state messages, update messages are automatically transmitted on a regular basis. The time period may be configured by the user for each input. This update ensures the integrity of the system.

Pulse inputs are accumulated as a pulse count and the accumulated pulse count is transmitted regularly according to the configured update time.

The I/O modules transmit the input/output data as a data frame using radio or serial RS485 as the communications medium. The data frame includes the "address" of the transmitting module and the receiving module, so that each transmitted message is acted on only by the correct receiving unit. Each transmitted message also includes error checking to ensure that no corruption of the data frame has occurred due to noise or interference. The module with the correct receiving "address" will acknowledge the message with a return transmission. If the original module does not receive a correct acknowledgement to a transmission, it will retry up to five times before setting the communications fail status of that path. In critical paths, this status can be reflected on an output on the module for alert purposes. The module will continue to try to establish communications and retry, if required, each time an update or change-of-state occurs.

A system may be a complex network or a simple pair of modules. An easy-to-use configuration procedure allows the user to specify any output destination for each input.

The maximum number of modules in one system is 95 modules communicating by radio. Each of these modules may have up to 31 other modules connected by RS485 twisted pair. Modules may communicate by radio only, by RS485 only or by both RS485 and radio. Any input signal at any module may be configured to appear at any output on any module in the entire system.

Systems with a WI-I/O 9-C or WI-GTWY-9-xxx module and host device can have more than 95 radio modules.

Modules can be used as repeaters to re-transmit messages on to the destination module. Repeaters can repeat messages on the radio channel, or from the radio channel to the serial channel (and serial to radio). Up to five repeater addresses may be configured for each input-to-output link.

The units may be configured by using a PC connected to the RS232 port. The default configuration and software configuration is defined in Section 4 **Configuration**.

Chapter Two INSTALLATION

2.1 General

The WI-I/O 9-x_WI-I/O-EX-1-S-x module is housed in a rugged aluminium case, suitable for DIN-rail mounting. Terminals are suitable for cables up to 2.5 sqmm in size.

All connections to the module should be SELV only. Normal 110/220/240V mains supply should not be connected to any input terminal of the module. Refer to Section 2.3 **Power Supply**.

Each module should be effectively earthed/grounded via a "GND" terminal on the module - this is to ensure that the surge protection circuits inside the module are effective. The earth/ground wire should be connected to the same earth/ground point as the enclosure "earth" and the antenna mast "earth".

Before installing a new system, it is preferable to bench test the complete system. Configuration common problem is poor communications on the radio channel or the serial channel. For radio modules, problems are caused by incorrectly installed antennas, or radio interference on the same channel, or the radio path being inadequate. If the radio path is a problem (i.e. path too long, or obstructions in the way), then higher performance antennas or a higher mounting point for the antenna may fix the problem. Alternately, use an intermediate module as a repeater.

For serial modules, poorly installed serial cable, or interference on the serial cable is a common problem.

The foldout sheet Installation Guide provides an installation drawing appropriate to most applications. Refer to Appendix B of this manual for terminal layout drawings of the modules.

2.2 Antenna Installation *(WI-I/O 9-x units only)*

The WI-I/O 9-x module will operate reliably over large distances. The distance which may be reliably achieved will vary with each application - depending on the type and location of antennas, the degree of radio interference, and obstructions (such as hills or trees) to the radio path. Typical reliable distances are :

USA/Canada	15 miles	6dB net gain antenna configuration permitted (4W ERP)
Australia/NZ	12 km	unity gain antenna configuration (1W ERP)

Longer distances can be achieved if one antenna is mounted on top of a hill.

To achieve the maximum transmission distance, the antennas should be raised above intermediate obstructions so the radio path is true "line of sight". Because of the curvature of the earth, the antennas will need to be elevated at least 15 feet (5 metres) above ground for paths greater than 3 miles (5 km). The modules will operate reliably with some obstruction of the radio path, although the reliable distance will be reduced. Obstructions which are close to either antenna will have more of a blocking affect than obstructions in the middle of the radio path. For example, a group of trees around the antenna is a larger obstruction than a group of trees further away from the antenna. The WI-I/O 9-x modules provide a test feature which displays the radio signal strength.

Line-of-sight paths are only necessary to obtain the maximum range. Obstructions will reduce the range however, but may not prevent a reliable path. A larger amount of obstruction can be tolerated for shorter distances. For very short distances, it is possible to mount the antennas inside buildings. An obstructed path requires testing to determine if the path will be reliable (refer the section 6 of this manual).

Where it is not possible to achieve reliable communications between two modules, then a third module may be used to receive the message and re-transmit it. This module is referred to as a repeater. This module may also have input/output (I/O) signals connected to it and form part of the I/O network - refer to Chapter 4 **Configuration** of this manual.

An antenna should be connected to the module via 50 ohm coaxial cable (eg RG58, RG213 or Cellfoil) terminated with a male SMA coaxial connector. The higher the antenna is mounted, the greater the transmission range will be, however as the length of coaxial cable increases so do cable losses. For use on unlicensed frequency channels, there are several types of antennas suitable for use. It is important antenna are chosen carefully to avoid contravening the maximum power limit on the unlicensed channel (if in doubt refer to an authorised service provider).

The net gain of an antenna/cable configuration is the gain of the antenna (in dBi) less the loss in the coaxial cable (in dB).

The maximum net gain of the antenna/cable configuration permitted for WI-I/O 9-x is

Country	**Max. gain (dB)**
USA / Canada	6
Australia / New Zealand	0

The gains and losses of typical antennas for WI-I/O 9-x are

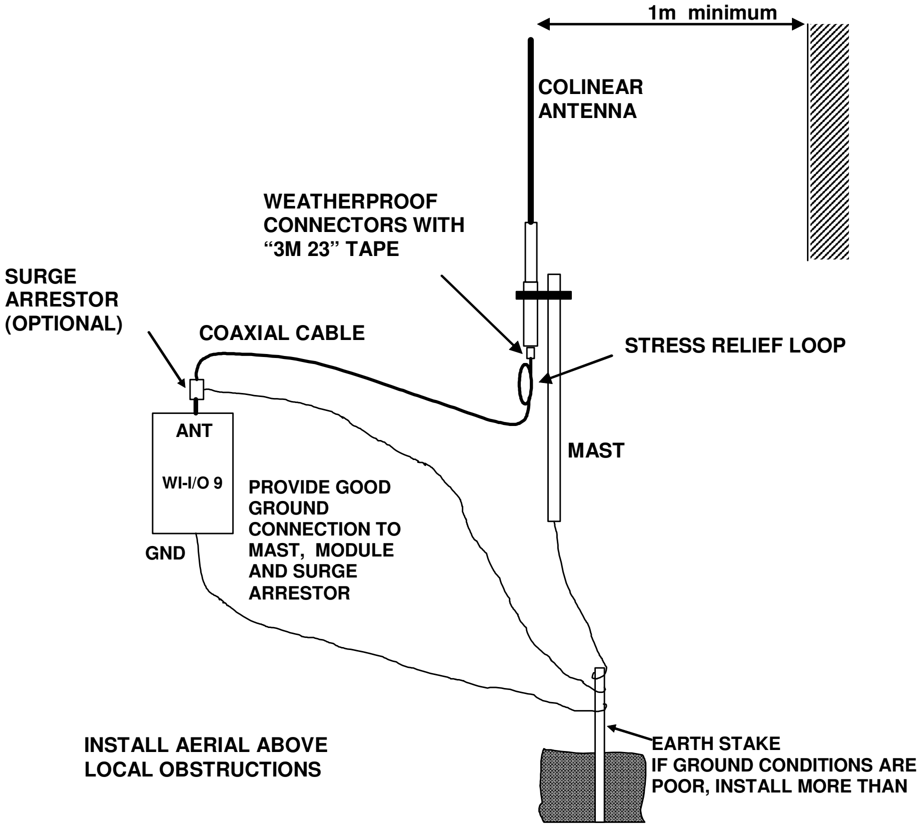
Standard Antennas	**Gain (dB)**	**Part Numbers**
Dipole with integral 15’ cable	0	6720005080
5dBi Collinear(3dBd)	5	6720005081
8dBi Collinear (6dBd)	8	6720005082
6 element Yagi	10	6720005084
16 element Yagi	15	6720005085

Cable type	Loss (dB per 30 ft / 10 m)
RG58	-5
RG213	-2.5
Cellfoil	-3

The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6 element Yagi with 70 feet (20 metres) of Cellfoil has a net gain of 4dB (10dB – 6dB).

Connections between the antenna and coaxial cable should be carefully taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems, as it greatly increases the radio losses. We recommend that the connection be taped, firstly with a layer of PVC Tape, then with a vulcanising tape such as “3M 23 tape”, and finally with another layer of PVC UV Stabilised insulating tape. The first layer of tape allows the joint to be easily inspected when trouble shooting as the vulcanising seal can be easily removed.

Where antennas are mounted on elevated masts, the masts should be effectively earthed to avoid lightning surges. For high lightning risk areas, surge suppression devices between the module and the antenna are recommended. If the antenna is not already shielded from lightning strike by an adjacent earthed structure, a lightning rod may be installed above the antenna to provide shielding.



2.2.1 Dipole and Collinear antennas.

A collinear antenna transmits the same amount of radio power in all directions - as such that are easy to install and use. The dipole antenna with integral 15 feet cable does not require any additional coaxial cable, however a cable must be used with the collinear antennas.

Collinear and dipole antennas should be mounted vertically, preferably 1 metre away from a wall or mast to obtain maximum range.

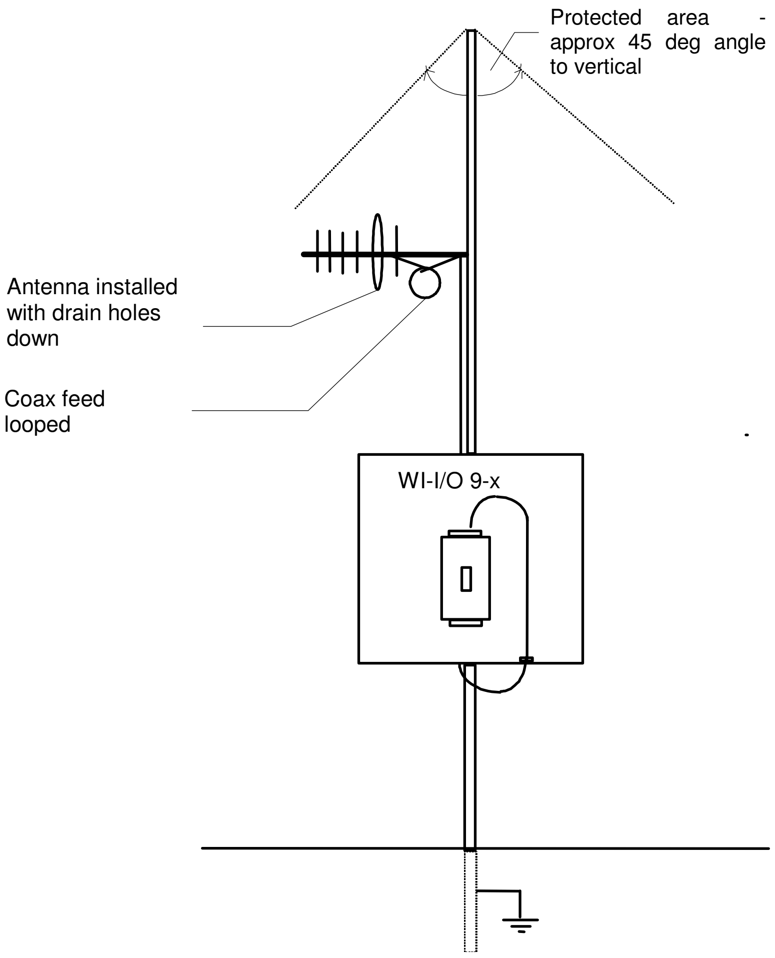
2.2.2 Yagi antennas.

A Yagi antenna provides high gain in the forward direction, but lower gain in other directions. This may be used to compensate for coaxial cable loss for installations with marginal radio path.

The Yagi gain also acts on the receiver, so adding Yagi antennas at both ends of a link provides a double improvement.

Yagi antennas are directional. That is, they have positive gain to the front of the antenna, but negative gain in other directions. Hence Yagi antennas should be installed with the central beam horizontal and must be pointed exactly in the direction of transmission to benefit from the gain of the antenna. The Yagi antennas may be installed with the elements in a vertical plane (vertically polarised) or in a horizontal plane (horizontally polarised). For a two station installation, with both modules using Yagi antennas, horizontal polarisation is recommended. If there are more than two stations transmitting to a common station, then the Yagi antennas should have vertical polarisation, and the common (or "central" station should have a collinear (non-directional) antenna.

Note that Yagi antennas normally have a drain hole on the folded element. The drain hole should be located on the bottom of the installed antenna.



2.3 Power Supply

The WI-I/O 9-x_WI-I/O-EX-1-S-x power supply is a switch-mode design which will accept either AC or DC supply. The module may also be powered from a solar panel without an external solar regulator.

The module accepts supply voltages in the following ranges :

12 - 24 volts AC RMS   or   15 - 30 volts DC at the “supply” terminals, or

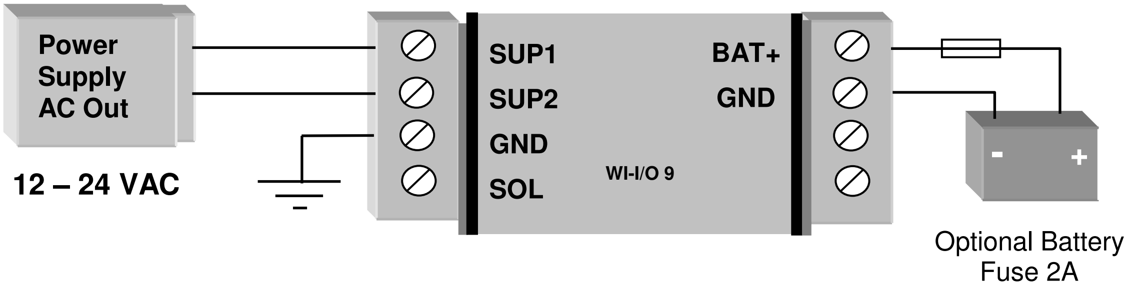
11.5 -15 volts DC at the “battery” terminals.

The power supply should be rated at 1.5 Amps and be CSA Certified Class 2. For use in Class 1 Div 2 explosive areas, the power supply must be approved for Class 1 Div 2 use.

Note: Connect module to the same ground/earth point as the antenna mounting to avoid differences in earth potential during voltage surges. The modules need an earth connection for the internal surge protection to be effective.

2.3.1 AC Supply

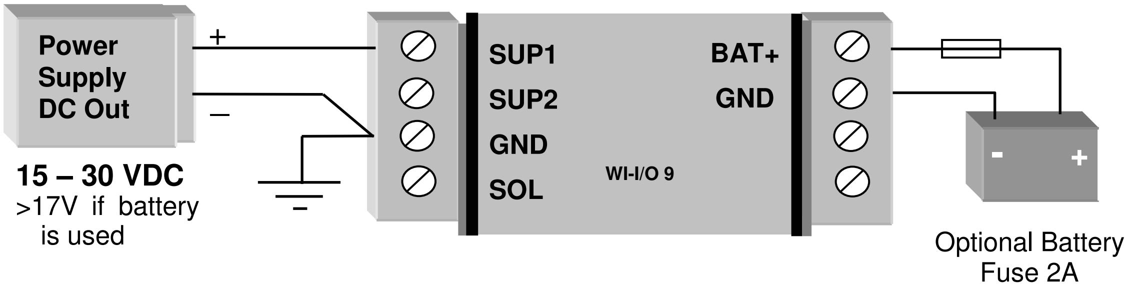
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below.



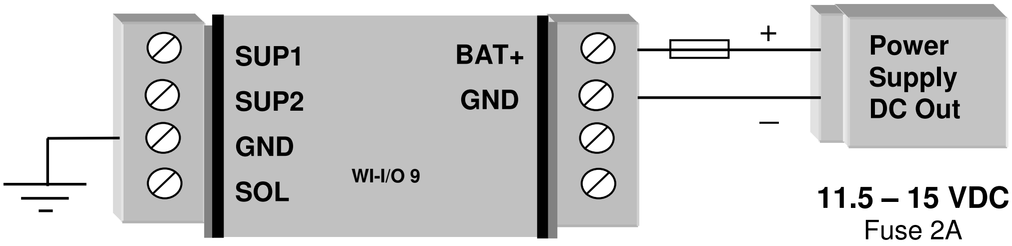
The AC supply should be "floating" relative to earth. AC transformers with grounded/earthed secondary windings should **not** be used.

2.3.2 DC Supply

For DC supplies, the positive lead is connected to "SUP1" and the negative to "GND". The positive side of the supply **<u>must not be connected to earth.</u>** The DC supply may be a floating supply or negatively grounded.



The module may also be powered from an external 11.5 - 15 VDC battery supply without the need for a "normal" supply connected to "SUP1". This external battery supply is connected to "BAT+" and "GND" terminals. The positive lead of the external supply should be protected by a 2A fuse.



Upon failure of the normal supply, the module may continue to operate for several hours from a backup battery. The module includes battery charging circuits for charging up to a 12 AHr sealed lead acid battery. The battery is connected to the "BAT+" (positive) and "GND" (negative) terminals. The positive lead from the battery should be protected with a 2A fuse, installed as near to the battery terminal as possible. On return of main supply, the unit will switch back to mains operation, and recharge the battery. To provide adequate current to recharge the backup battery, an AC supply of 15V minimum or a DC supply of 17V minimum must be used. Typically, a 6 AHr battery will supply the WI-I/O 9-x for 1 - 3 days, depending on I/O loads.

2.3.3 Solar Supply

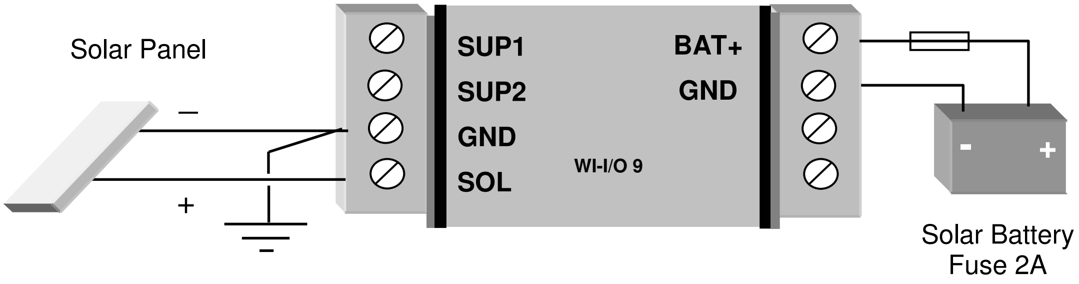
The power supply also includes a 12 V solar regulator for connecting 12V solar panels of up to 30W, and solar batteries of up to 100AHr. **The unit must not be powered from a solar panel without a battery.** A 20W solar panel is sufficient for most solar applications. The size of the solar battery required depends on the I/O used. Batteries are sized for a number of sunless days with 50% battery capacity remaining as follows:

$$\text{No. of sunless days} = \frac{\text{Battery capacity (AHr)} \times 0.5}{\text{Module load (A)} \times 1.2 \times 24}$$

The Module load depends on the I/O connected and can be calculated as follows:

Module Load(mA) = (85 for WI-I/O 9-x or 45 for WI-I/O-EX-1-S-x) + (10 x No. of active DI’s) +
(25 x No. of active DO’s) + (2 x Analog loop load).

The analog loop load is the total signal current for the AI’s and AO’s which are powered from the internal 24V supply. Externally powered loops are not included in this.



The solar panel is connected to the "SOL" (positive) and "GND" (negative) terminals and the battery connected to the "BAT+" (positive) and "GND" (negative) terminals. Solar panels must be installed and

connected as per the panel manufacturer's instructions. The positive lead of the battery should be protected by a 2A fuse installed as near as possible to the battery terminal.

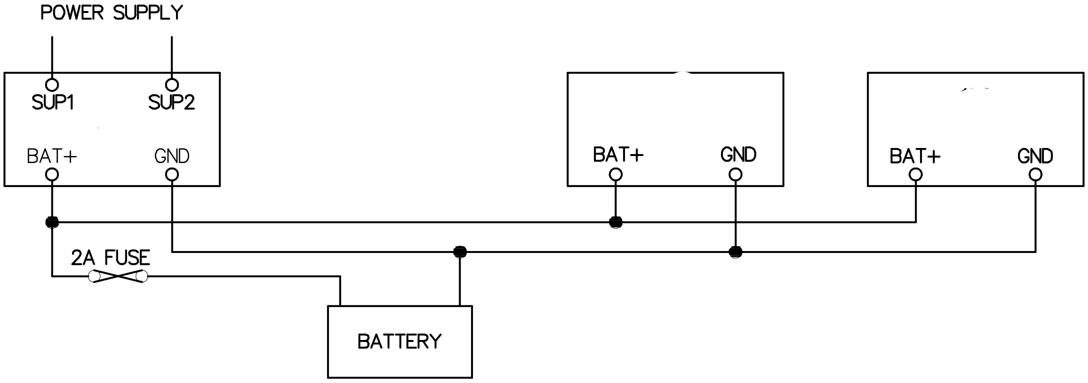
Where a panel larger than 30W is required, an external solar regulator should be used.

For maintenance, disconnect the solar panel first before disconnecting the battery.

2.3.4 Multiple Modules

Where more than one module is installed at the one location, a shared power supply and battery may be used, provided the total load does not exceed the power supply.

The internal power supply of the module can supply a maximum 12V load of 700mA. In order to achieve this, the input power supply must be above 15VAC or 17VDC. Using these figures, it can be determined whether there is enough supply for more than one module - allow 100mA for recharging a battery.



For example, assume there is a WI-I/O 9-1 module and a WI-I/O-EX-1-S-1 module at the same location. The total I/O at the location is 3 analog inputs, 6 digital inputs and 4 digital outputs. The total load will be :-

TYPE OF LOAD	LOAD mA
WI-I/O 9-1 quiescent	85
WI-I/O-EX-1-S-1 quiescent	45
6 DI @ 10 mA	60
3 AI @ 20mA x 2	120
4 DO @ 25mA	100
Battery charging	100
TOTAL	510

So both modules could be powered from one power supply and one battery, provided the external supply voltage is more than 15VAC or 17VDC.

2.3.5 24V Regulated Supply

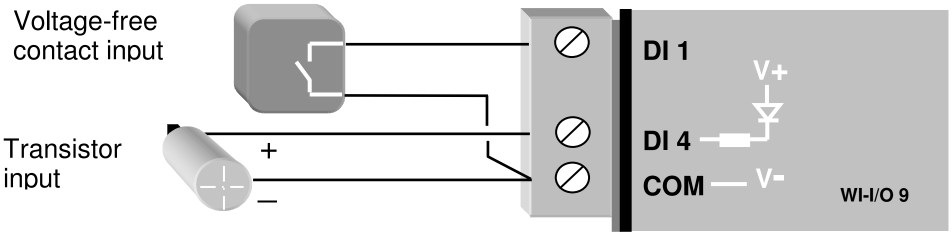
Each module provides a 24V DC regulated supply for analog loop power, except for WI-I/O 9-4_WI-I/O-EX-1-S-4. The supply is rated at 150mA, and should **only** be used for powering analog loops.

2.4 Input / Output

2.4.1 Digital Inputs (WI-I/O 9-1, WI-I/O 9-2 and WI-I/O 9-4)

The ”-1” and ”-2” modules each provide four digital inputs with 5000 volt opto-isolation, and the ”-4” provides 4 to 16 inputs with 3000 volt surge protection. All inputs are suitable for voltage free contacts (such as mechanical switches) or NPN transistor devices (such as electronic proximity switches). PNP transistor devices are not suitable. Contact wetting current of approximately 5mA is provided to maintain reliable operation of driving relays.

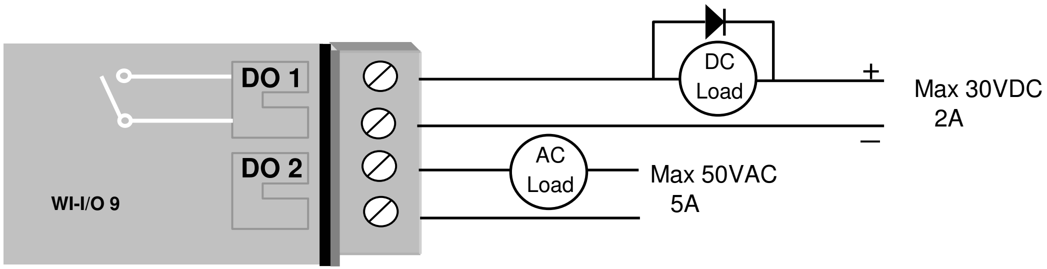
Each digital input is connected between the appropriate "DI" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200 ohms, the device will be able to activate the digital input.



For pulse inputs, refer to Section 2.4.6.

2.4.2 Digital Outputs (WI-I/O 9-1)

The ”-1” module provides four normally open voltage-free relay contacts, rated at AC 50V/5A, DC 30V/2A, 20V/5A. These outputs may be used to directly control low-powered equipment, or to power larger relays for higher powered equipment. When driving inductive loads such as AC relays, good installation should include capacitors (e.g. 10nf 250V) across the external circuit to prevent arcing across the relay contacts. For DC inductive loads, flyback diodes should be used across DC relays.

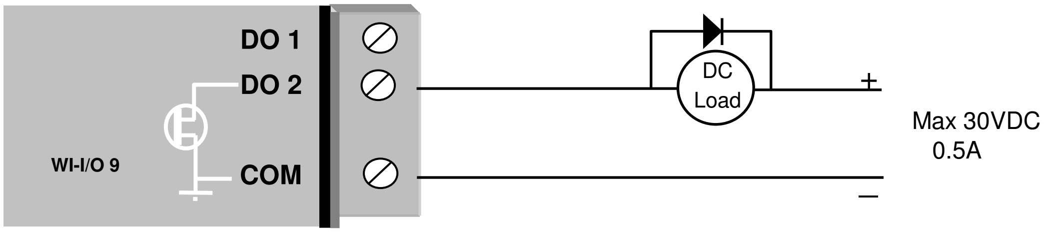


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See section 4.4 Changing User Options for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.3 Digital Outputs (WI-I/O 9-2, WI-I/O 9-3 and WI-I/O 9-4)

The digital outputs on the “-2”, “-3” and “-4” modules are transistor switched DC signals, FET output to common rated at 30VDC 500 mA. The ”-2” provides one digital output; the ”-3” provides eight digital outputs and the ”-4” provides 4 – 16 outputs. The first four DO’s on the ”-3” and ”-4” modules are also the pulse outputs - that is, the first four DO's can be either digital outputs or pulse outputs. The function of each of these outputs may be configured individually. For a description of pulse outputs, refer to Section 2.4.7.



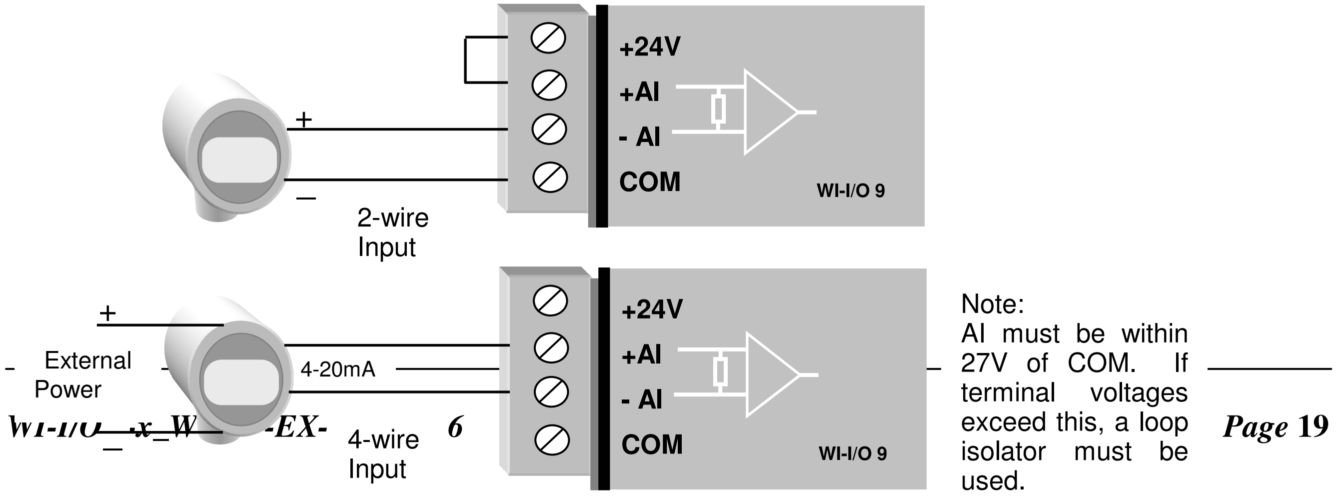
Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 4 Configuration for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.4 Analog Inputs (WI-I/O 9-1 and WI-I/O 9-2)

The ”-1” module provides two 4 - 20 mA DC analog inputs for connecting to instrument transducers such as level, moisture, pressure transducers, etc. The ”-2” module provides six 0 - 20 mA DC analog inputs. Note that the inputs on the ”-2” module will measure down to 0mA, so they can also be used for zero based signals such as 0 - 10 mA. The modules transmit the “mA value” of the input, not a “% of range”, so the output value is set to the correct mA signal.

Each analog input has a positive and negative terminal, and may be placed at any point in the current



Note:
AI must be within 27V of COM. If terminal voltages exceed this, a loop isolator must be used.

loop, as long as neither input rises above the 24 volt supply level. Each input has a loop resistance of less than 250 ohms and zener diode protection is provided against over-voltage and reverse voltage, however additional protection may be required in high voltage or noisy environments or for very long wiring runs.

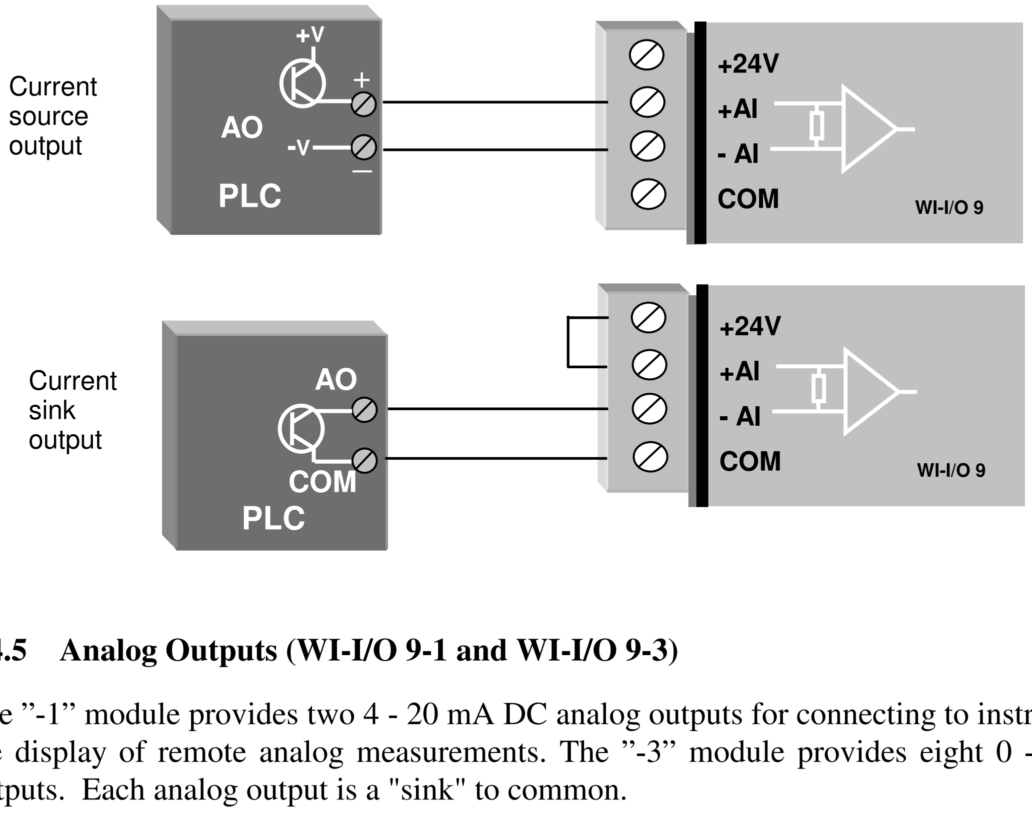
A 24VDC loop supply is available on the module for powering the analog transducer loops. In this case, the analog loop should be connected between a "AI 1-" terminal and "COM" (for the first analog input) or "AI 2-" (for the second analog input), and so on for other inputs.

The positive terminal ("AI 1+" or "AI 2+", etc) should be connected to "+24V".

Externally powered loops may be connected by connecting the input between "AI 1+" and “AI 1-” for analog input 1 or "AI 2+" and “AI 2-” for analog input 2, and so on for other inputs. Common mode voltage may be -0.5V to 27V.

Shielded cable is recommended for analog I/O loops to minimise induced noise and Radio Frequency Interference (RFI). The shield of the cable should be connected to earth at one of the cable only. The use of shielded wiring inside an enclosure containing a module is also recommended.

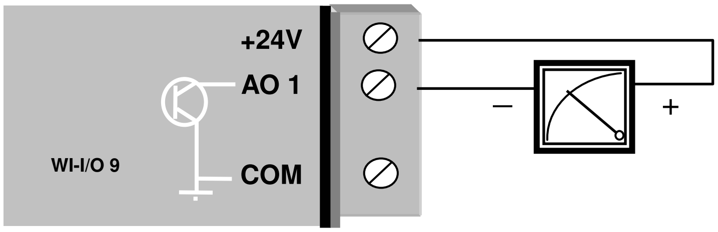
To connect an AI on the WI-I/O 9-x to an analog signal from a PLC or DCS output, check the internal circuit of the output carefully as different devices use different ways to create an analog signal. The following diagram shows two ways of connecting.



Note:
1. AI must be within 27V of COM. If terminal voltages exceed this, a loop isolator must be used.
2. COM on the WI-I/O is connected to ground/earth. If the COM of the PLC cannot be grounded, then a loop isolator must be used.

2.4.5 Analog Outputs (WI-I/O 9-1 and WI-I/O 9-3)

The ”-1” module provides two 4 - 20 mA DC analog outputs for connecting to instrument indicators for the display of remote analog measurements. The ”-3” module provides eight 0 - 20 mA DC analog outputs. Each analog output is a "sink" to common.

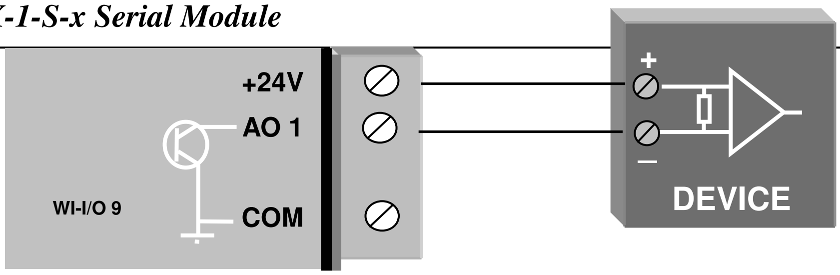


A 24VDC supply is available on the module for powering the analog output loop (max external loop resistance 1000 ohms). In this case, the analog loop is connected between a "+24V" terminal and "AO 1" (for the first analog output) or "AO 2" (for the second analog output), and so on for the other output signals.

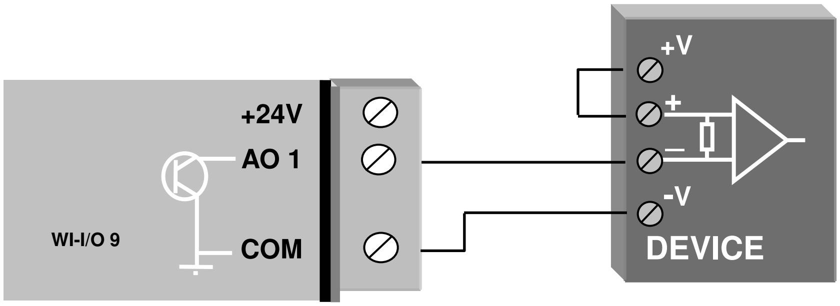
If connecting to an external device such as an electronic indicator, recorder or PLC / DCS input, the loop can be powered by either the WI-I/O 9-x or the device. Externally powered loops to 27 VDC may be connected by connecting the output between the "AO" terminal (positive) and the "COM" terminal (negative). Zener protection of analog outputs provides protection against short periods of over-voltage but longer periods **may result in module damage**.

Note that the common is connected internally to ground and no other point in the analog loop should be grounded. If the external device has single-ended grounded inputs, then a signal isolator must be used.

Analog outputs may also be configured to individually turn off (0 mA) if no command message is received to that output for a certain period. . See Chapter 4 **Configuration** for further details.

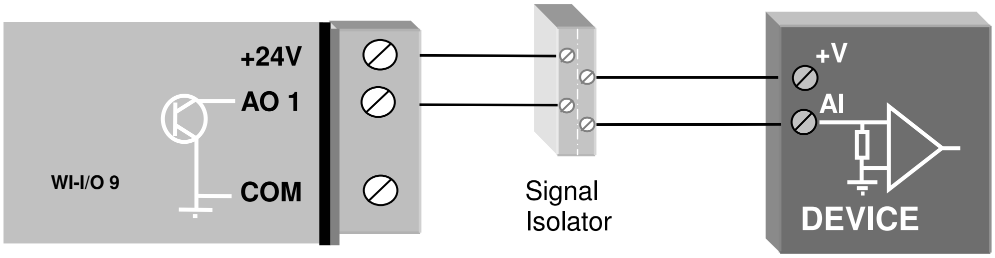


Connecting to a floating input device, powered from the WI-I/O 9-x



Note:
COM on WI-I/O 9-x is connected to ground/earth. If the external power supply cannot be grounded, a loop isolator must be used.

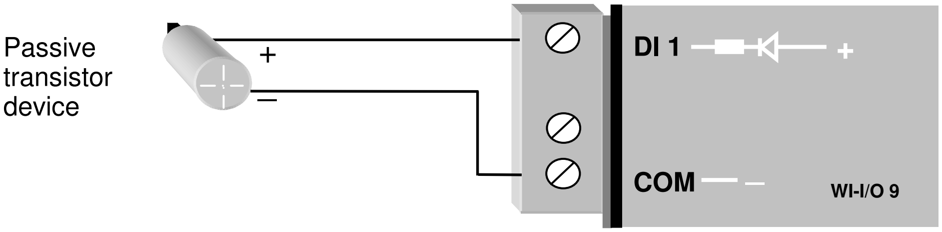
Connecting to an externally powered floating-input device

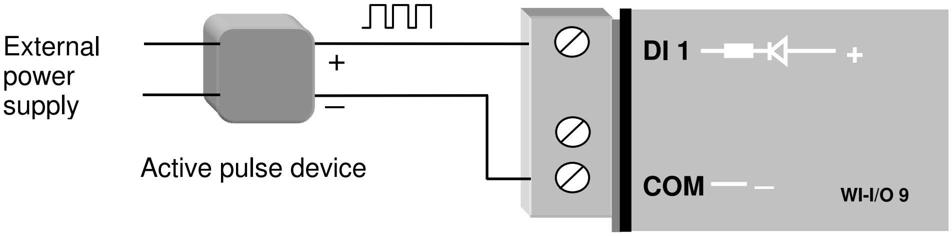


Connecting to a grounded input device via a signal isolator

2.4.6 Pulse Input (WI-I/O 9-1)

For the ”-1” module, digital input 1 may be configured as a pulse input (max rate 100 Hz, min. off time 5 ms). In this mode, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analog output on the remote unit, while the pulse count can appear at a Pulse Output on another ”-1” or Digital/Pulse Output on a ”-3” or “-4” unit. The pulse input should be connected in the same way as a digital input.





Note:
Use a solid state relay if the voltage range is not suitable.

Active pulse signals can be connected directly provided the peak voltage is between 3.5–13V and the low voltage is less than 1.5V. Note that the WI-I/O 9-x will ground the negative of the pulse signal. If the voltages are not compatible, use a solid state relay to isolate the two devices.

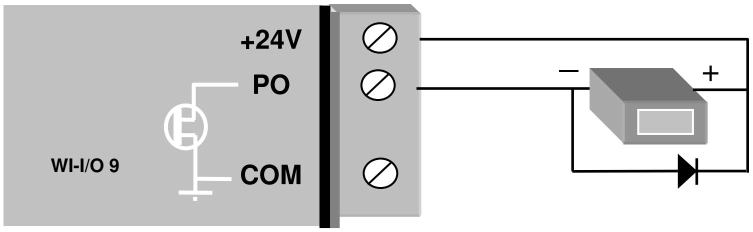
2.4.7 Pulse Inputs (WI-I/O 9-2 and WI-I/O 9-4)

For the ”-2” and ”-4” modules, the four digital inputs (DI 1-4) may be configured as pulse inputs. The first digital/pulse input DI 1 has a maximum rate of 1000 Hz (min. off time 0.5 ms), while DI 2-4 have a maximum rate of 100 Hz (min. off time 5 ms). When using DI 1 at high pulse rates (more than 100 Hz), a divide by 10 function may be configured to reduce the pulse count at the output, as Pulse Outputs have a maximum rate of 100 Hz.

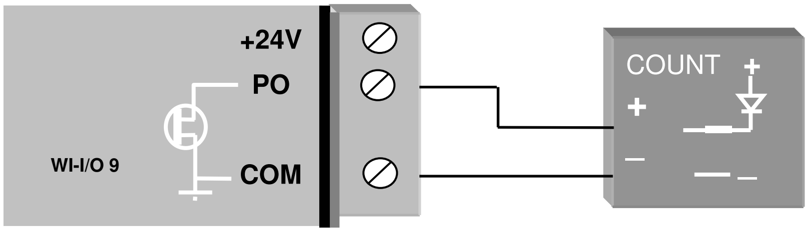
For each pulse input, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analog output on the remote unit, while the pulse count can appear at a Pulse Output. The default update time for pulse counts is 1 minute. This can be changed by changing the update time configuration (refer Chapter 4 **Configuration** for further details). The pulse count is a 16 bit value - “roll over” of the count when it exceeds the maximum value is automatically handled by the modules.

2.4.8 Pulse Output (WI-I/O 9-1)

A single FET output to common rated at 30VDC, 500 mA is provide for the pulse output "PO". This output accurately recreates the pulses counted at a pulse input at another module.



Use by-pass diode if counter is inductive.



Use solid-state relay isolator if voltages are not compatible

If the counter device requires a voltage pulse signal (such as electronic or elector-mechanical counters), use the 24V analog loop supply, or the 12V BAT supply for the voltage source. Use a by-pass diode if the counter is inductive.

Some devices such as PLC counter modules power the pulse loop. For these devices, connect to the PO and COM terminals of the WI-I/O 9-x. The COM terminal will connect a ground/earth to the external device. If this is not suitable, use a solid state relay to isolate the external device.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analog output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred. The maximum output rate is 100 Hz.

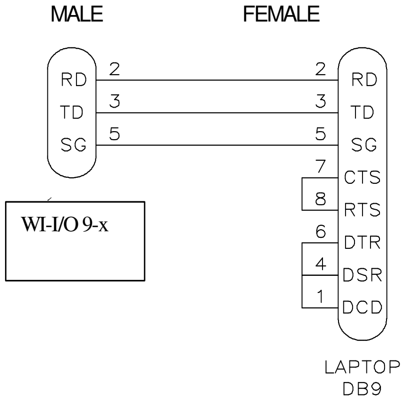
2.4.9 Pulse Output (WI-I/O 9-3 and WI-I/O 9-4)

The first four digital outputs on the ”-3” and ”-4” modules may also be used as pulse outputs. The outputs are FET output to common rated at 30VDC, 500 mA. The outputs will provide a pulse signal of up to 100 Hz. The outputs accurately recreate the pulses counted at pulse inputs at a ”-1”, ”-2” or “-4” module.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analog output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred.

2.4.10 RS232 Serial Port

The serial port is a 9 pin DB9 female and provides for connection to a terminal or to a PC for configuration, field testing and for factory testing. This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS-232 signals. The WI-I/O 9-x_WI-I/O-EX-1-S-x is configured as DCE equipment with the pin-out detailed below. The serial port communicates at a baud rate of 9600 baud, 8 bits, no parity, one stop bit. An example cable drawing for connection to a laptop is detailed below:



Pin	Name	Dirn	Function
1	DCD	Out	Data carrier detect - not used
2	RD	Out	Transmit Data - Serial Data Input (High = 0, Low = 1)
3	TD	In	Receive Data - Serial Data Output (High = 0, Low = 1)
4	DTR	In	Data Terminal Ready - not used
5	SG	-	Signal Ground
6	DSR	Out	Data Set Ready - not used
7	RTS	In	Request to Send - not used
8	CTS	Out	Clear to send - not used
9	RI	-	Ring indicator - not used.

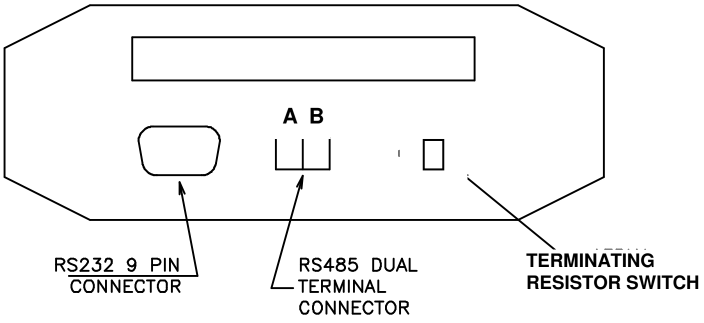
2.4.11 RS485 Serial Port

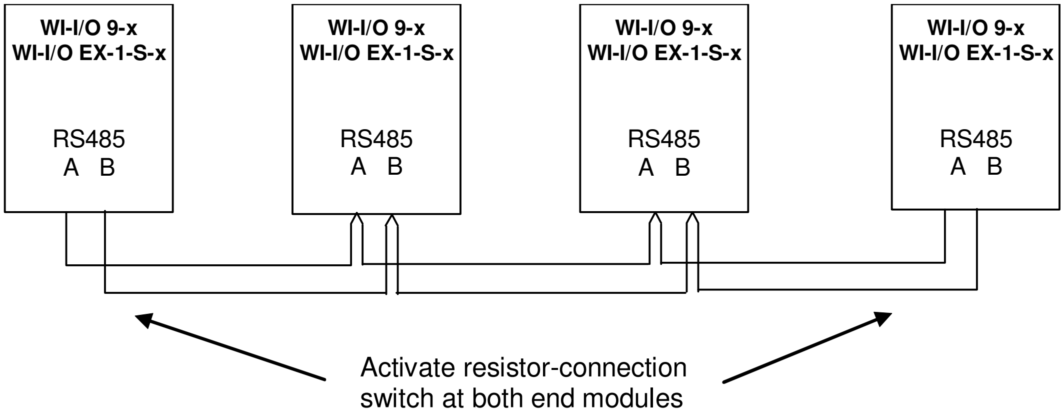
The RS485 port provides for communication between multiple units using a multi-drop cable. Up to 32 units may be connected in each multi-drop network. Each multi-drop network may have one unit providing radio communications with other units in the system. The RS485 feature allows local hubs of control to operate without occupying radio bandwidth required for communication between remotely sited units.

The RS485 Communications format is 9600 baud, 8 data bits, one stop bit, no parity. Note that the RS485 port is shared internally with the RS232 port - disconnect the RS232 cable after configuration is complete.

RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential Radio Frequency Interference (RFI). An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120 ohm resistor.

The modules include a terminating resistor on-board. If the WI-I/O 9-x module is the first or last module in the RS485 chain, then the terminating resistor may be connected by operating the single DIP switch in the end-plate next to the RS485 terminals. “On” or “down” means that the resistor is connected.





2.4.12 Connecting WI-I/O-EX-1-S-x Modules to WI-I/O 9-x Modules

WI-I/O-EX-1-S-x modules connect to a WI-I/O 9-x via the RS485 port on each module (refer to section 2.4.11). Up to 31 x WI-I/O-EX-1-S-x modules can be connected to a WI-I/O 9-x module. This number is reduced for WI-I/O-EX-1-S-3 and –4 modules, as these modules use two unit addresses (refer to chapter 4 of this manual).

The WI-I/O-EX-1-S-x modules can be mounted next to the WI-I/O 9-x module, or they can be remote from the WI-I/O 9-x. The reliable distance for a RS485 multi-drop line depends on the shielding of the wire and how close it is installed to electrical noise sources - distances of more than ½ mile (1 km) can be achieved by good installation methods. External RS485 isolators are recommended if the earth potential difference between modules is greater than 7V.

3.1 Power-up and Normal Operation

When power is initially connected to the module, the module will perform internal diagnostics to check its functions. The following table details the status of the indicating LED's on the front panel under **normal** operating conditions.

LED Indicator	Condition	Meaning
OK	On	Normal Operation
RX	Occasional flash	Radio Receiving, or Activity on serial ports
RX	Flashes continuously	Configuration Mode
RX	On	Button press when entering Configuration Mode
TX (only on WI-I/O 9-x units)	Occasional flash	Radio Transmitting
PWR	On	Supply voltage available from Solar Panel or SUP1/SUP2
OK	Flashes every 5 seconds	+24V Supply overloaded

Additional LED's provide indication of the status of digital inputs and outputs. LED's display the status of each digital input (lit for active), and LED's display the status of each digital output (lit for active). Other conditions indicating a fault are described in Chapter Six **Troubleshooting**.

The module monitors the power supply and provides status of supply failure and battery low voltage for "mapping" to one of the module's own outputs or transmitting to a remote output. When the module is powered from a normal supply (i.e. via either of the "SUP" terminals), the *PWR* LED indicator is lit. When the module is powered from a solar panel and battery, the *PWR* LED indicator is lit only when the charge current is available (i.e. when the solar panel is receiving light).

If a backup battery is connected, the module will generate a low battery voltage status when the voltage has dropped to 11.3V for approx 45 seconds. This status may be transmitted to another module. In the event of excessively low battery voltage (10.8V), the *OK* LED will go off, the unit will automatically set all outputs off, and disable the +24V analog loop supply. The *OK* LED will turn on again after the battery voltage exceeds 11.8V. This enables installations to be configured so that the battery current drain is minimised in the event of extended mains failure, reducing the possibility of deep discharge of batteries.

3.1.1 Communications

Before each transmission, the WI-I/O 9-x radio will "listen-before-transmit" to make sure that another module is not already transmitting - if there is another transmission, the WI-I/O 9-x will wait until the transmission is complete. When the WI-I/O 9-x transmits, it will wait for a return "acknowledgement" message from the destination module, indicating a successful message. If transmissions are not

successful (radio or serial), then the module will re-try up to four times at random intervals to transmit the message.

<u>Example of Successful Communications</u>

Local Unit		**Remote Unit**
• Listen to ensure channel is clear		
• If clear, transmit message TX LED flashes if radio RX LED flashes if RS485	→	• Receive message RX LED flashes Check message for integrity
• RX LED flashes • Acknowledgement received okay – communication complete	←	• If message okay, transmit it back as acknowledgement TX LED flashes if radio RX LED flashes if RS485 Outputs updated as per message received.

<u>Example of unsuccessful communications</u>

Local Unit		**Remote Unit**
• Listen to ensure channel is clear		
• If clear, transmit message TX LED flashes if radio RX LED flashes if RS485	→	• Receive message RX LED flashes Check message for integrity Message corrupted - do nothing
• No acknowledgement received • Retry up to four times • Still no acknowledgement “Comms fail” status to remote unit set If status is mapped to an output, set output	(4) →	• If no update received for an output within watchdog timeout, check to see if the output is configured to reset • Reset outputs if configured

If communications is still not successful, the “Comms Fail” internal status will be set. In the default configuration, this will have no consequence and the module will continue to attempt to transmit to the remote module every ten minutes. For critical applications, the “comms fail” status can be configured to be reflected to an output on the module for alert purposes. The outputs on the module may also be configured to reset after a specified timeout (digital outputs reset to “off”, analog outputs reset to 0 mA)

allowing the system to turn off in a controlled manner e.g. a pump will never be left running because of a system failure.

> Note: The WI-I/O 9-x will hop frequencies for each re-try transmission - each re-try will follow at approx 0.5 sec after the last. So a WI-I/O 9-x will complete all re-tries in less than 3 seconds.

Repeaters can be used in a system to increase range. Each WI-I/O 9 unit can be configured to act as a repeater. When configuring an input to be mapped to an output, the communications path to the output unit, including the repeater addresses is specified. The WI-I/O 9-x acts as a *store&forward repeater*, that is, the signal is decoded and then retransmitted "as new".

Example Repeater Communications

Unit A DI 1 mapped to Unit D DO1 via Units B & C

Unit A		**Unit B Repeater**		**Unit C Repeater**		**Unit D**
• DI 1 is turned on						
• Transmit	→	• Receive				
• Receive Acknowledge	←	• Transmit on with Acknowledge	→	• Receive		
		• Receive Acknowledge	←	• Transmit on with Acknowledge	→	• Receive
				• Receive Acknowledge	←	• Transmit acknowledge
						• DO 1 is turned on

3.1.2 Change of state conditions

The module transmits a data message whenever it detects a "change-of-state" on one of its input signals. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa provided the change is sustained for 0.5 second (i.e. 0.5 second debounce). The debounce delay is configurable.

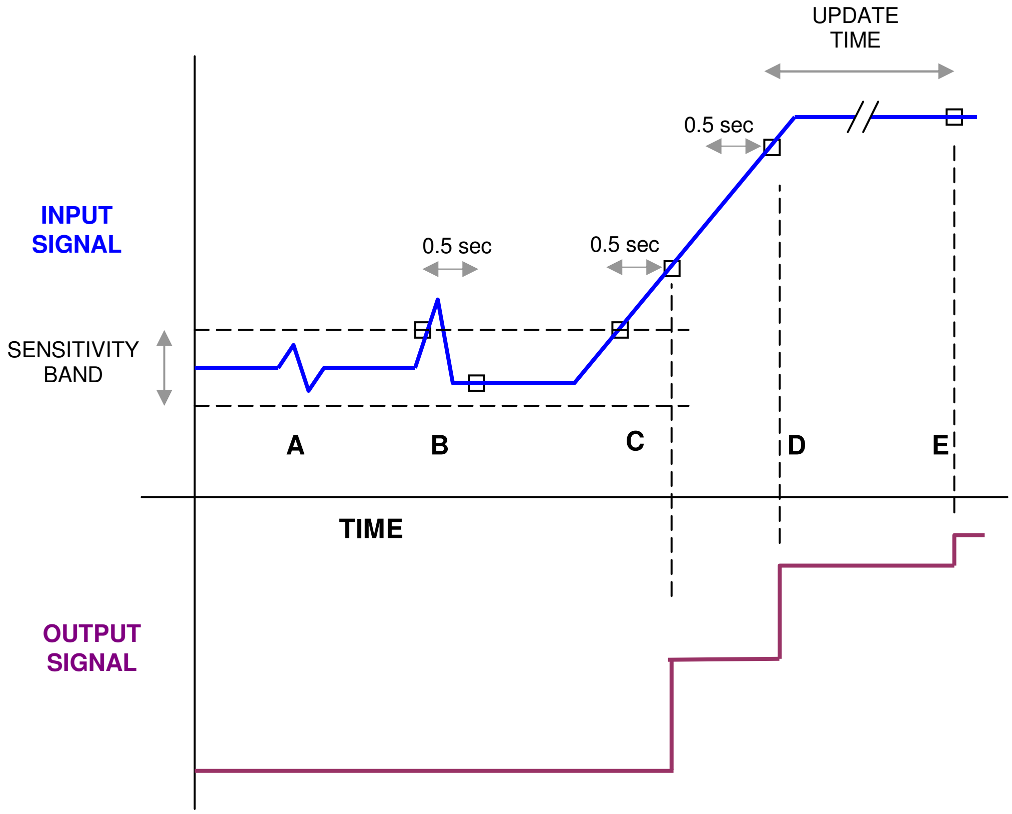
In addition to "change-of-state" transmissions, each module will transmit the status of each input to its corresponding output every ten minutes (configurable). These **updates** mean that the outputs are set to the current input values regularly, even where no "change-of-state" has occurred. These update transmissions increase the accuracy of the output and give extra system reliability.

Analog Change-of-state

A "change-of-state" for an analog input, battery voltage or pulse input rate is a change in value of the signal of 3% (configurable) since the last transmission. Note that the sensitivity of 3% refers to 3% of the analog range, not 3% of the instantaneous analog value. That is, if an analog input changes from 64% (14.24 mA) to 67% (14.72 mA), a "change-of-state" will be detected. This "change-of-state"

sensitivity is configurable between 0.8% and 75%.

Analog inputs are digitally filtered to prevent multiple transmissions on continually varying or "noisy" signals. The input is filtered with a 1 second time constant and a 1 second debounce. The analog outputs are filtered with a 1 second time constant. An **example** of an **analog** input and how the output follows it is shown below:



A	No transmission as the sensitivity band was not exceeded
B	The sensitivity band was exceeded, however the input returned to within the sensitivity band before the 0.5 sec debounce time - no transmission
C	Transmission occurs 0.5 sec after the sensitivity band is exceeded.
D	Another transmission 0.5 sec later as the input has changed by more than the sensitivity band
E	The input has not changed by more than the sensitivity, however the update time has elapsed since D.

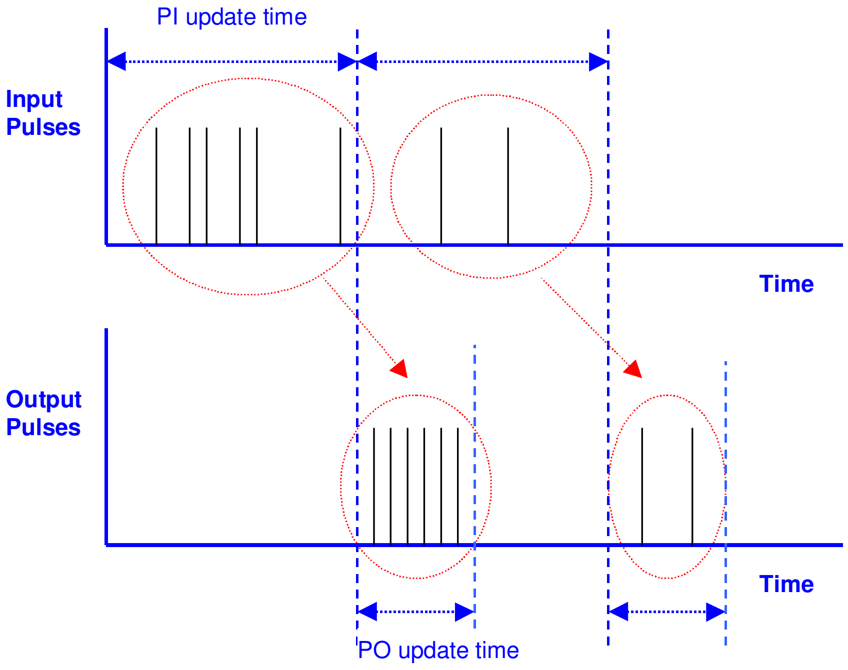
In general, the following may be used as a rule of thumb for calculating the appropriate sensitivity required for a given application:
Instantaneous change of 2 x sensitivity on input → 3 second output response
Instantaneous change of 10 x sensitivity on input → 5 second output response

The analog inputs have 15 bit resolution and 0.016mA accuracy.

Pulse input change of state

Pulse input counts do not use "change-of-state" transmissions. Instead, accumulated pulse input counts are transmitted at set intervals. The default period is 1 minute and is configurable. The absolute pulse count is transmitted. If the PI is transmitted to a PO on a WI-I/O 9-x_WI-I/O-EX-1-S-x module, then the pulse outputs are re-created from the *accumulated* pulse count. Rollovers of the pulse count thru zero are catered for. If a transmission is missed, the pulse output will still be re-created when the next accumulated value is transmitted. This ensures that no pulses are lost due to communications failures. If the PI is transmitted to a WI-I/O 9-C interface module, then the accumulated pulse count is stored in the WI-I/O 9-C for interfacing to the host device.

The following diagram shows how pulse inputs are re-created as pulse outputs. For pulse outputs, the module keeps two counters in memory - the pulse input count received from the remote module, and the count of output pulses. When the module receives an update of the input pulse count, it will output pulses until the output pulse count is the same as the input pulse count. The output pulse will be output evenly over the pulse output update time which is configured in the module. For example, assume that module receives a pulse input update message from the remote module, and the difference between the pulse input count and the pulse output count is 12 pulses. The module will then output the 12 pulses evenly over the next minute (if the pulse output update time is 1 minute).



The default values for the pulse input update time and pulse output update time is 1 minute. In this case, the output pulses are effectively 1 minute behind the input pulses. These update times may be changed by the user. The pulse output update time should not be set to be more than the pulse input update time. Note that the maximum pulse rate for both inputs and outputs is 100Hz.

As well as accumulating the pulse input, the module will also calculate the rate of pulses. **Pulse rates** are treated as an "internal" analog input and are configured with analog sensitivities for change-of-state transmissions. The maximum pulse rate corresponding to 20mA output may be configured by the user.

3.1.3 Analog Set-points

On "-1" modules, the "AI 1" input may be used to trigger the analog set-point status. High set point and low set point levels are configurable. This set-point status turns ON when the analog input moves below the low level, and turns OFF when it moves above the high level. The high level must always be greater than, or equal to, the low level set point. This set-point status may be mapped (inverted, if required) to any output in the network. The set-point status is effectively an internal digital input.

On "-2" modules, AI 1 - 4 have set-point values for controlling digital outputs. The set-point operation works as for the "-1" module.

3.1.4 Start-up Poll

After a module has completed its initial diagnostics following power up, it will transmit update messages to remote modules based on the values of the module's inputs. The module's outputs will remain in the reset/off/zero condition until it receives update or "change-of-state" messages from the remote modules.

The module can transmit a special "start-up poll" message to another module. The remote module will then immediately send update messages to this module such that its outputs can be set to the correct value. Start-up polls will only occur if they are configured. It is necessary to configure a start-up poll to each remote module which controls the module's outputs. For further information (refer to Chapter 4 Configuration).

3.1.5 Communications Failure (CF)

The internal communications failure (CF) status is set if a module does not receive an acknowledgement message after five attempts at transmitting a message. The CF status may be configured to set a local digital output for an external alarm.

Although the CF status can set an output, it will not reset the output. That is, once communications is re-established (and the CF status is reset), the output will stay "on". The Reset Output feature (see below) is used to reset the output.

The output will reset only when no communications failures occur within the configured "Reset Output Time" for the output that CF status is mapped to. Note that if the reset output time is not enabled, the CF status will remain set forever, once an unsuccessful transmission occurs. See Chapter 4 **Configuration** for further details.

For a link with one or more repeaters, the internal CF status will only set for a failure between the transmitting module (the source module) and the first repeater. If the communications failure occurs after the first repeater, then the source module CF status will not set. To indicate comms status on this type of link, the "Reset Output" function should be used.

3.1.6 Resetting Outputs

Each digital and analog output may be individually configured to reset if that output has not received a change-of-state or an update message within a certain time period. Generally this time is set to twice the update period, so at least one update can be missed before an output is reset.

In most cases it is desirable to reset outputs which are controlling equipment if there is a system failure, however alarm or indication outputs are not reset so the last valid indication remains shown. See Chapter 4 **Configuration** for further details.

3.2 System Design Tips

The following tips will help to ensure that your system operates reliably.

3.2.1 System Dynamics

It is important to be aware of the dynamics of the system. Inputs have a configurable "debounce" delay (default 0.5 sec) - that is, a change message will not be sent for 0.5 sec after a change has occurred. This avoids transmitting spurious noise on the input signal. If you require faster (or slower) operation, change the debounce setting.

Messages transmitted via serial link are received in less than 20 m/sec., however a message sent by radio takes approx 60 m/sec.

These delays are not significant is most applications, however if your application requires faster responses, then the above delays need to be considered.

3.2.2 Radio Channel Capacity

Messages sent on a cable link are much faster than on a radio channel, and the capacity of the radio channel must be considered when designing a system. This becomes more important as the I/O size of a system increases.

The modules are designed to provide "real-time" operation. When an input signal changes, a change message is sent to change the output. The system does not require continuous messages to provide fast operation (as in a polling system). Update messages are intended to check the integrity of the system, not to provide fast operation. Update times should be selected based on this principle. The default update time is 10 minutes - we recommend that you leave these times as 10 minutes unless particular inputs are very important and deserve a smaller update time.

It is important that radio paths be reliable. For large systems, we recommend a maximum radio channel density of 100 messages per minute, including change messages and update messages. We suggest that you do not design for an average transmission rate of greater than 40 per minute - this will give a peak rate of approx 100 per minute. Note that this peak rate assumes that all radio paths are reliable - poor radio paths will require re-try transmissions and will reduce the peak channel density. If there are other users on the radio channel, then this peak figure will also decrease.

Dual Band Operation

The WI-I/O 9-x radio band is split into two sub-bands, 902-915 MHz and 915 – 928 MHz . In America

and Canada, the WI-I/O 9-x uses both sub-bands - but in other countries, only the high sub-band. In America and Canada, it is possible to restrict the frequency hopping of the WI-I/O 9-x to only the high or low band. If there are many WI-I/O 9-x systems in the same area, this technique will help to separate systems to avoid radio interference. Note that this technique is only possible in America / Canada.

The radio sub-band can be selected by the "system address" - refer section 4 of this manual. An odd system address selects the low band, and an even system address selects the high band.

3.2.3 Radio Path Reliability

Radio paths over short distances can operate reliably with a large amount of obstruction in the path. As the path distance increases, the amount of obstruction which can be tolerated decreases. At the maximum reliable distance, "line-of-sight" is required for reliable operation. If the path is over several kilometres (or miles), then the curvature of the earth is also an obstacle and must be allowed for. For example, the earth curvature over 5 miles (8km) is approx 10 feet (3m), requiring antennas to be elevated at least 13 feet (4m) to achieve "line-of-sight" even if the path is flat.

A radio path may act reliably in good weather, but poorly in bad weather - this is called a "marginal" radio path. If the radio path is more than 20% of the maximum reliable distance (see Specification section for these distances), we recommend that you test the radio path before installation. Each WI-I/O 9-x module has a radio path testing feature - refer to section 6.2 and 6.3 of this manual.

There are several ways of improving a marginal path :-

- Relocate the antenna to a better position. If there is an obvious obstruction causing the problem, then locating the antenna to the side or higher will improve the path. If the radio path has a large distance, then increasing the height of the antenna will improve the path.
- Use an antenna with a higher gain. Before you do this, make sure that the radiated power from the new antenna is still within the regulations of your country. If you have a long length of coaxial cable, you can use a higher gain antenna to cancel the losses in the coaxial cable.
- If it is not practical to improve a marginal path, then the last method is to use another module as a repeater. A repeater does not have to be between the two modules (although often it is). If possible, use an existing module in the system which has good radio path to both modules. The repeater module can be to the side of the two modules, or even behind one of the modules, if the repeater module is installed at a high location (for example, a tower or mast). Repeater modules can have their own I/O and act as a "normal" WI-I/O 9-x module in the system.

3.2.4 Design for Failures

All well designed systems consider system failure. I/O systems operating on a wire link will fail eventually, and a radio system is the same. Failures could be short-term (interference on the radio channel or power supply failure) or long-term (equipment failure).

The modules provide the following features for system failure :-

- Outputs can reset if they do not receive a message within a configured time. If an output should

receive an update or change message every 10 minutes, and it has not received a message within this time, then some form of failure is likely. If the output is controlling some machinery, then it is good design to switch off this equipment until communications has been re-established.

The modules provide a "drop outputs on comms fail" time. This is a configurable time value for each output. If a message has not been received for this output within this time, then the output will reset (off, in-active, "0"). We suggest that this reset time be a little more than twice the update time of the input. It is possible to miss one update message because of short-term radio interference, however if two successive update messages are missed, then long term failure is likely and the output should be reset. For example, if the input update time is 3 minutes, set the output reset time to 7 minutes.

- A module can provide an output which activates on communication failure to another module. This can be used to provide an external alarm that there is a system fault.

3.2.5 Indicating a Communications Problem

There are two ways to provide an indication of communications problems.

Fail-to-transmit alarm. The first is to map the internal CF status to a local output, to generate a "fail-to-transmit" alarm. The configured output will activate when a comms fail occurs - that is, when the module attempts to transmit a message five times without an acknowledgement. This method provides an indication immediately an attempt to transmit a message fails. If you want the radio path to be "tested" regularly, then you need to configure the update times such that transmissions occur regularly (however do not overload the radio channel).

Notes regarding this method:

1. Each CF mapping corresponds to only one remote address - you need to make separate mappings for each remote address. You can map the CF for each remote module to a separate output, or to the same output.
2. You need to reset the comms fail output using the "reset output" parameter. Select a reset time which is greater than the effective update time period. For example, if there are four inputs mapped from module #1 to module #2, each with a 10 minute update, then you would expect at least four transmissions in each 10 minute period. At module #1, a comms fail for #2 is mapped to DO1. If you set the "reset time" for DO1 to 10 minutes, then there will be at least four transmissions made during the reset period - that is, the output will only reset when the communications has been successful four times.
3. This method will not work for radio links with repeaters. If a repeater is used, you will need to use the second method described below.

Fail-to-receive alarm. The second method is to set up a "comms OK" output using the "Reset Outputs" function. The output is normally on, indicating "comms OK", and will reset if the module does not receive a message from the remote module within the configured reset time.

Consider a link between module #1 and #2, and assume that you want a "comms OK" output at #1. At #2, map an unused input to an output at #1 such that the output is normally active ('on"). If there is no spare inputs at #2, you can use an internal input such as "low voltage status". You will need to invert the mappings such that the output is normally on (because the input is normally off).

At #1, configure a reset time for the output. The reset time should be greater than the update time for the mapping at #2. If #1 fails to receive update messages from #2, then the output will reset, indicating a communications failure. Notes regarding this method:

1. This method will work with repeaters in the link.
2. The "comms OK" output is fail-safe - if module #1 fails, then the output will reset indicating a problem.
3. You should use separate outputs to indicate "comms OK" of different remote modules.
4. It is recommended that you set the reset time at #1 to more than twice the update time of the mapping at #2. This means that the comms OK output will only reset if #1 misses two consecutive updates from #2.

3.2.6 Testing and Commissioning

We recommend that you set-up and test the system with all of the modules together **before** you install the modules. It is much easier to find a configuration problem.

When the system is configured, record the radio signal strength and background noise level for each radio link. If there are future communications problems, you can compare the present measurements to the as-commissioned values. This is an effective way of finding problems with antennas, cables and also changes in the radio path (for example, the erection of new buildings).

3.3 Security Considerations

There are three dimensions of security considerations:

1. Failure to operate when required - or "operational reliability".

   The features discussed above optimize operating reliability. Using an acknowledgement and re-try protocol ensures that the transmitting module is aware whether the transmitted message has been transmitted reliably. The "fail to transmit" and "fail to receive" alarms provide indication if the radio link has failed to operate.

2. Mal-operation, or operating when not requested.

   This problem occurs when an output is "triggered" by the wrong radio device. The WI-I/O 9-x modules use frequency encoding and a very secure addressing system to ensure this does not occur. An additional security level using data encryption can also be selected.

3. Malicious operation, or "hacking"

   This is the problem most associated with security concerns - the ability for someone to access information from a radio system by "listening-in", or to cause damage by transmitting radio messages to force outputs.

A security option can be selected during the module configuration to protect against this. The security option (if selected) adds data encryption to radio messages. Modules in the same system are

automatically configured with the encryption key, such that only these modules can understand each other. “Foreign” modules will hear the messages, but cannot decrypt the messages. For more information, refer to section 4.3.7.

Chapter Four CONFIGURATION

4.1 Introduction

The modules are configured by connecting a computer (PC) using the Configuration Software program. The same software program is used to configure WI-I/O 9-x and WI-GTWY-9-xxx modules - for more information, refer to the separate User Manuals for these products.

Each module is configured with a system address and a unit address. The system address is common to every module in the same system, and is used to prevent "cross-talk" between modules in different systems. Separate networks with different system addresses may operate independently in the same area without affecting each other. The system address may be any number between 1 and 32 767. The actual value of the system address is not important, provided all modules in the same system have the same system address value. **A system address of zero should not be used.** The configuration program automatically offers a random number for the system address - you can change this to any number in the valid range but we recommend that you use the random number.

Each module must have a unique unit address within the one system. A valid unit address is 1 to 127. A network may have up to 95 addresses communicating via radio (unit addresses 1 to 95), each with up to 31 modules communicating via RS485 (unit addresses 96 to 127). In the network, any individual input signal may be "mapped" to one or more outputs anywhere in the system. The unit address determines the method of communication to a module. Any module with a unit address between 96 and 127 will communicate by RS485 only. Other units with a unit address below 95 may communicate by radio *or* RS485 - the unit will determine which way to communicate depending upon the unit address of the destination module. For example, Unit 31 will talk to Unit 97 by RS485 only, but will talk to unit 59 by radio only. WI-I/O-EX-1-S-x units must always have a unit address between 96 and 127 as serial communication is the only method of communication available. **A unit address of zero should not be used.**

The four different I/O versions in the range can be used together in the same system. WI-I/O 9-x and WI-GTWY-9-xxx modules can also be part of a system. Inputs to one product type can be transmitted to outputs of another product type. For example, an analog input to a ”-2” may be transmitted to an analog output of a ”-1” or ”-3”. Repeaters may be any product type.

The ”-1” and ”-2” modules require only one unit address. The ”-3” and ”-4” modules use two addresses, however only one unit address has to be entered. The ”-3” and ”-4” modules require two addresses because of the large number of output channels. If the “entered" unit address is an even number, then the second address is the next number. If the "entered" address is an odd number, then the second address is the previous number. So the two addresses are two subsequent numbers, starting with an even number. If a ”-3” module is given a unit address of 10, then it will also take up the unit address 11 and will accept messages addressed to either 10 or 11. It is important to remember this when allocating unit addresses to other modules in the system.

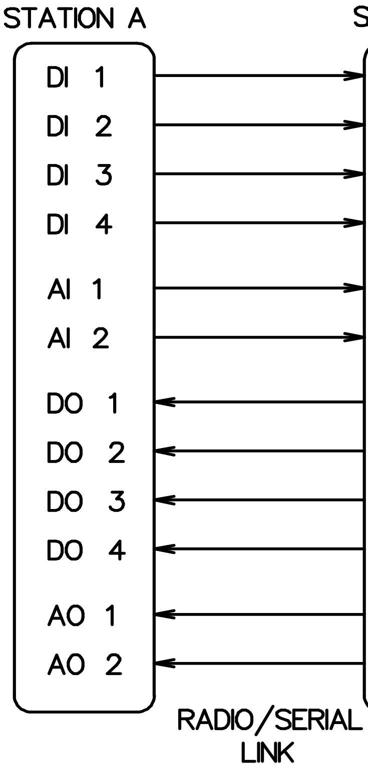
Warning - do not allocate the address number 1 to a “-3” or “-4” module.

In addition to these network configurations, operational parameters called **User Options** may be configured to change the features of the operation.

4.2 Easy Configuration Using Default Settings

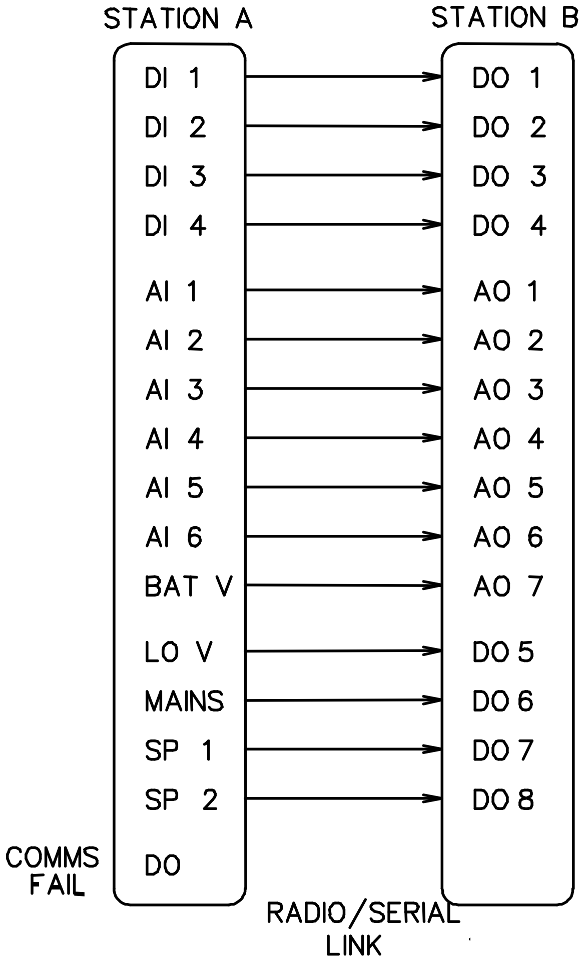
If your application requires only a single pair of modules, communicating via radio or serial link, default settings may satisfy your needs. If so, no configuration is required. Essentially, all inputs at Module A are reflected at the corresponding outputs at Module B. All inputs at Module B are reflected at the corresponding outputs at Module A.

For “-1” modules, the default configuration is as follows :-



In this configuration, the “PO” Pulse output is inactive and no special action is taken on “Comms fail”, “Mains fail” or “Battery Low”. “DI 1” is configured as a digital and not a pulse input.

For "-2" and "-3" modules, the default configuration is as follows :-



Note that there is no default configuration for the "-4" modules.

The following table details the default values for **User Options**:

Option	Factory Set Value
Update transmissions	Every 10 minutes
Analog Change-of-state sensitivity	3%
Reset outputs on Comms fail	No
Analog Setpoints (if mapped)	Low Set point = 30% High Set point = 75%
Pulse Output Rate Scaling (if Pulse Rate is mapped)	100 Hz
Digital Input Debounce Time	0.5 seconds

If any of the above values are not appropriate to your system, Section 4.4 below will detail how to change one or all of the above variables.

4.3 Configuration Software

This chapter describes installation and operation of configuration software for the radio and serial telemetry modules. The configuration software runs on a conventional PC as a Windows application. The software creates a configuration file which can be loaded into a module via RS232. The configuration software also allows the configuration of a module to be loaded for display and modification. Configuration files are created and stored in project directories.

Configuration of modules consists of entering I/O mappings, and selecting User Options. An I/O mapping is a link between an input on the module being configured and an output on another module. A mapping has the form :-

DI3 → Out2 at 4 via 3, 11

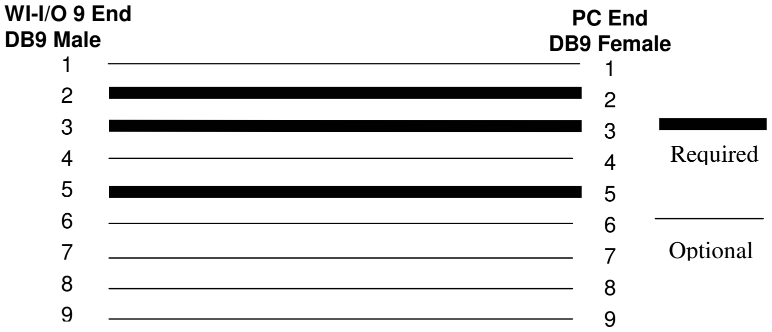
This mapping links DI3 on this module to output channel 2 on the module with address 4, and modules 3 and 11 are repeaters.

User Options may be selected to change the configuration of specific features.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

4.3.1 Hardware and Software Requirements

The configuration software is available on a CD, and needs to be installed on your PC before you can use it. The CD contains a setup file called *setup.exe*. Select the configuration software window on the Product CD and an installation Wizard will guide you through the installation procedure. To upload and download configuration files to a module, you will need a RS-232 serial cable as shown below.

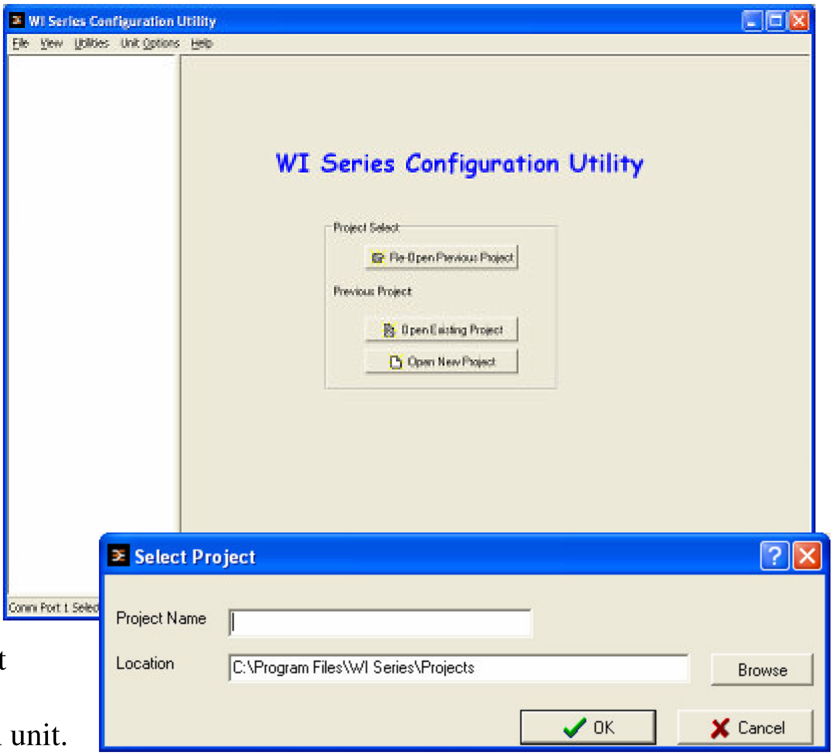


4.3.2 Program Operation

Start the software by either clicking on the start bar and navigating to the Configuration menu or by running WISeries.exe in the directory selected in the setup stage.

The Initial screen will appear. The configuration is performed for a complete system. The necessary configuration stages are:

- select system name and system address
- select individual units and unit addresses
- configure I/O mappings for each unit
- configure user options for each unit
- load the configuration files into each unit.



Project Name

Location C:\Program Files\WI Series\Projects

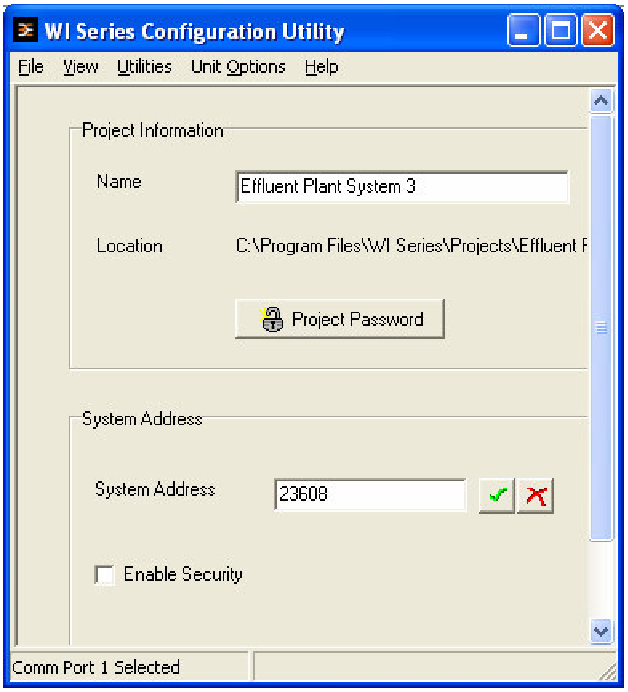
From the initial screen, you can select an existing project, or start a new project. The name of the project will create a new directory which will eventually contain the configuration files for the modules in this system.

When you have selected the project, a screen will appear where you may enter the system address.

If you are editting an existing project, the system address will already have been entered. Do not change the system address unless you are going to re-program all of the modules in the system.

Password. You have the option of entering a password to protect the configuration files against unauthorized changes. When you open a new project, you will be asked to enter a password - if you do not enter any text - that is, press "ESC" or "Enter", then password protection is disabled. If you do enter a password, then you will need to enter this password to make changes to the configuration or download or upload configuration. You only need to enter the password each time you enter the project. Without the passowrd, you are able to view the configuration details but you cannot make changes.

The password can be between 6 and 256 characters. You can also change password by selecting this option from the "Utilities" menu.



Name Effluent Plant System 3

Location C:\Program Files\WI Series\Projects\Effluent F

System Address 23608

☐ Enable Security

Comm Port 1 Selected

If you are starting a new project, you have the option of "Enabling Security" - please read Section 4.3.7 and the associated warnings before using this option.

To proceed with the configuration, double-click on the project name on the menu on the left side of the screen. "Units" will appear. You can now enter the types of units which will be used in the system. If you double-click on "Units", then the modules that have already been selected will appear.

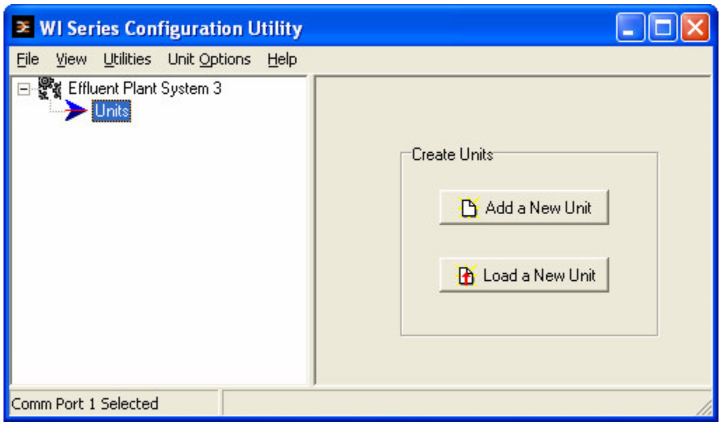
Loading configuration from an existing module

To load the configuration from a module, connect the module to the PC via the RS232 cable and click on "Load Unit". This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3.3 for more information.

Adding a new module to the system configuration

To add a new module to the system configuration, click on "Units" on the left-hand menu and then "Add Unit". Select the type of module from the list.

Note that this program covers WI-I/O-EX-1-S-x and WI-I/O 9-x modules. These modules are essentially the same as far as configuration is concerned. That is, a WI-I/O 9-1 selection will configure a WI-I/O-EX-1-S-1 or a WI-I/O 9-1.

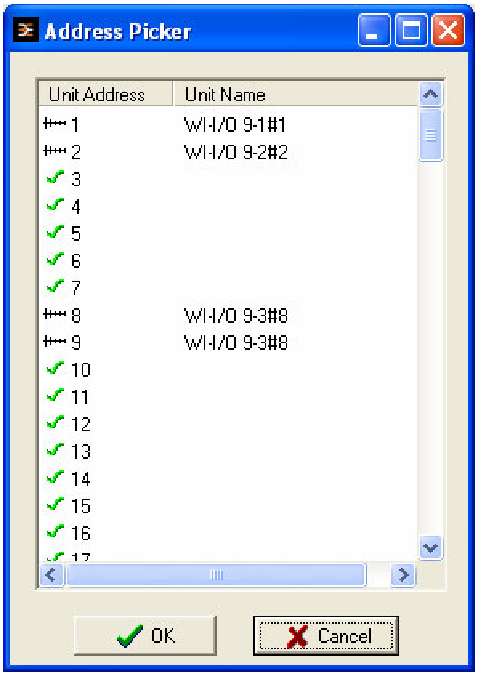


The program will ask to select the unit address and will display the list of available addresses for you to select. For WI-I/O 9-x modules, select an address between 1 and 95. For WI-I/O-EX-1-S-x modules, select an address between 96 and 127.

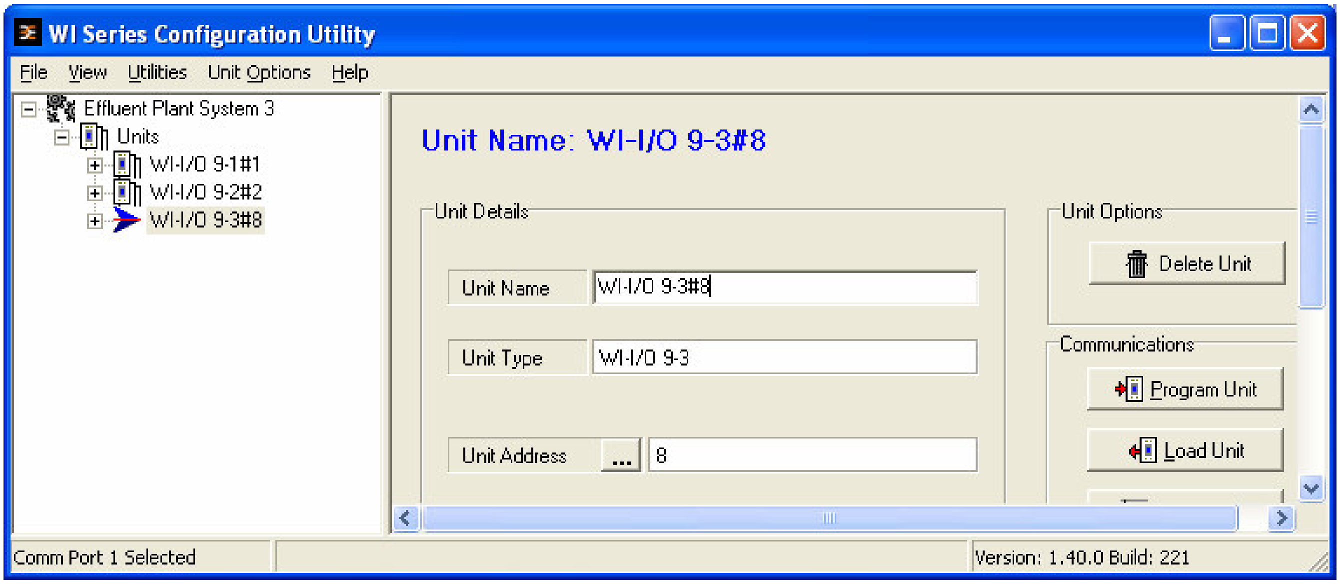
The default name for a unit will include the unit address. For example, "WI-I/O 9-3#8" is a WI-I/O 9-3 module with unit address 8 (and also 9, as a -3 takes two unit addresses). You can change the name of a unit - for example, you could replace the default name with "Pump Station 14".

Deleting a Unit

A module can be deleted from the configuration by highlighting the unit and selecting "Delete Unit".



Unit Address	Unit Name
1	WI-I/O 9-1#1
2	WI-I/O 9-2#2
✓ 3	
✓ 4	
✓ 5	
✓ 6	
✓ 7	
8	WI-I/O 9-3#8
9	WI-I/O 9-3#8
✓ 10	
✓ 11	
✓ 12	
✓ 13	
✓ 14	
✓ 15	
✓ 16	



Unit Name: WI-I/O 9-3#8

Unit Details

Unit Name: WI-I/O 9-3#8

Unit Type: WI-I/O 9-3

Unit Address: 8

Comm Port 1 Selected

Version: 1.40.0 Build: 221

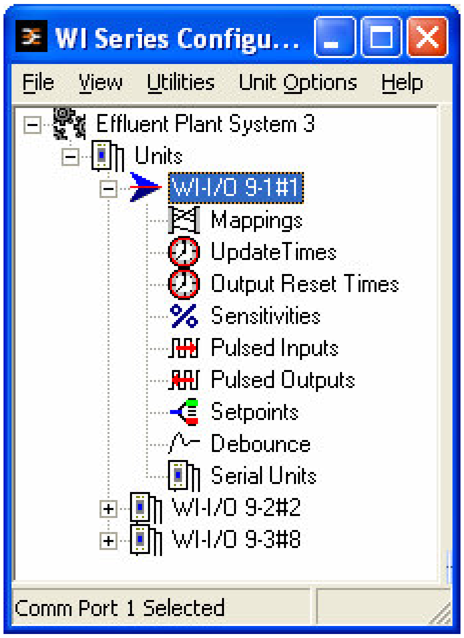
Configuring an individual module

Double-click on a unit shown on the left-hand menu. The configuration options for each unit will appear. We recommend that you configure I/O mappings first, and then other options.

Select "Mappings" and the following screen appears. There are three types of mappings:

- I/O mappings which link inputs to outputs
- Poll mappings, which enables a module on start-up to request set its outputs quickly

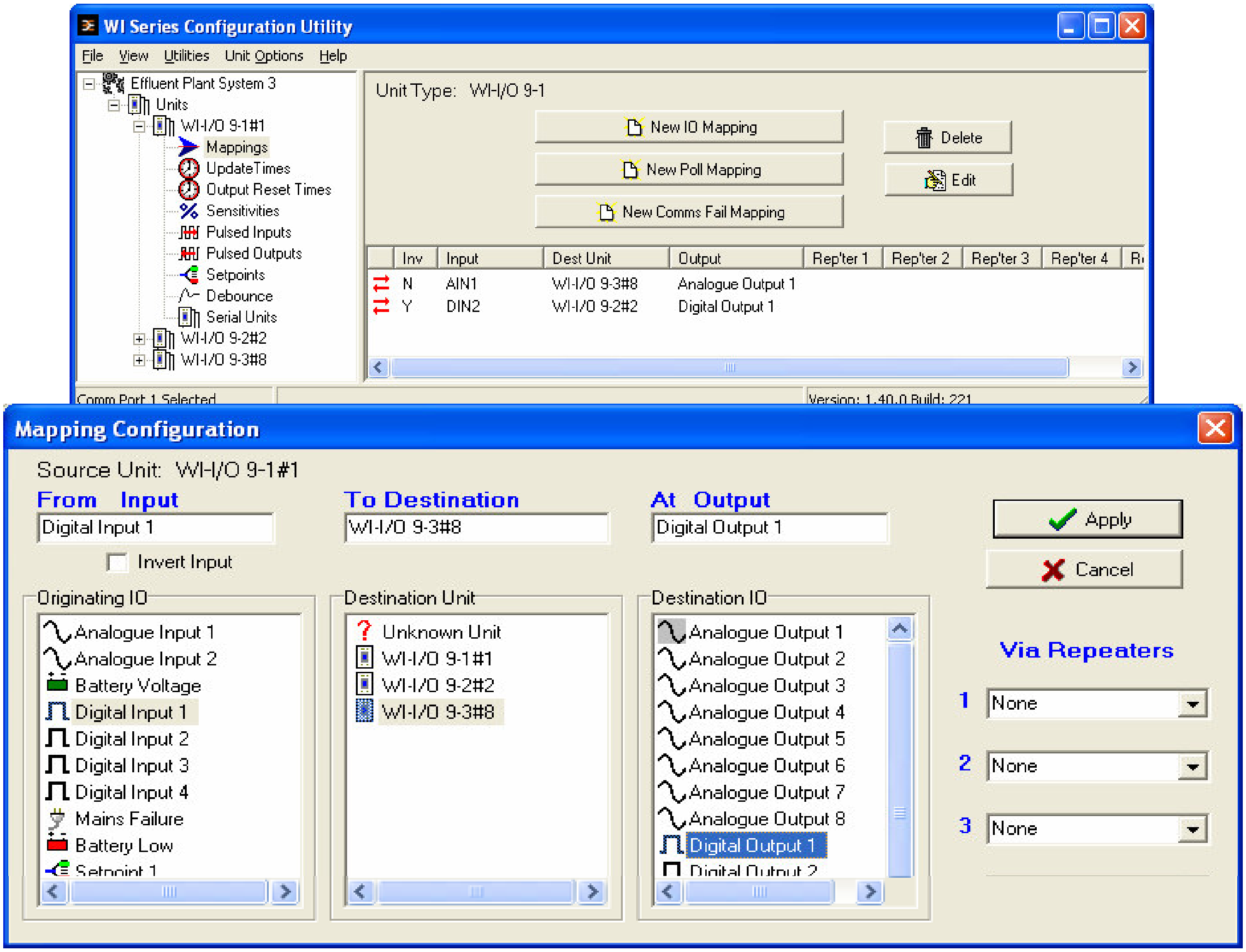
Comms Fail mappings, which maps communication failure status to an output on the local module.



Comm Port 1 Selected

I/O Mapping To enter an I/O mapping, select “New I/O Mapping”.

1. The I/O mapping display will show all inputs at the selected module - both physical inputs and internal inputs. Select the input to be mapped.
2. If you wish to invert the mapping, select the “Invert Input” box. If you invert an input, then the output will be the reverse of the input. Analog I/O can also be reversed - 4mA will be 20mA etc. **Do not invert pulse inputs.**
3. The invert function is not available on -2 modules - only inverted digital inputs are available (as internal inputs on the input list).
4. To select the destination module, you can either select the module from the “Destination Unit” list, or enter the unit address in the “To Destination” box. You can enter an address that has not yet been allocated to another unit.
5. You can select the output by entering the output number (1 – 8) in the “output” box, or select an output from the displayed list. There will only be a list of possible outputs displayed if at step 2 you selected a desrtination until that has already been configured in the system. The output numbering



Unit Type: WI-I/O 9-1

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'ter 4	R
⇄	N	AIN1	WI-I/O 9-3#8	Analogue Output 1					
⇄	Y	DIN2	WI-I/O 9-2#2	Digital Output 1					

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Source Unit: WI-I/O 9-1#1

From Input: Digital Input 1

To Destination: WI-I/O 9-3#8

At Output: Digital Output 1

☐ Invert Input

Via Repeaters

1 None

2 None

3 None

	WI-I/O 9-1	**WI-I/O 9-2**	**WI-I/O 9-3 First addr (Even)**	**WI-I/O 9-3 Second addr (Odd)**	**WI-I/O 9-4 First addr (Even)**	**WI-I/O 9-4 Second addr (Odd)**
Output 1	DO 1	DO 1	D/P O 1	AO 1	D/P O 1	DIO 5
Output 2	DO 2	None	D/P O 2	AO 2	D/P O 2	DIO 6
Output 3	DO 3	None	D/P O 3	AO 3	D/P O 3	DIO 7
Output 4	DO 4	None	D/P O 4	AO 4	D/P O 4	DIO 8
Output 5	AO 1	None	DO 5	AO 5	DIO 1	DIO 9
Output 6	AO 2	None	DO 6	AO 6	DIO 2	DIO 10
Output 7	PO	None	DO 7	AO 7	DIO 3	DIO 11
Output 8	None	None	DO 8	AO 8	DIO 4	DIO 12

6. If you select a WI-GTWY-9-xxx as the destination module, you will be asked to select a I/O Register as the destination "output". Note that the grey-shaded I/O registers have already been allocated.
7. Select any intermediate repeater units needed to reach the destination address (entered in order of nearest to furthermost repeater). You can either select from the list of configured units or enter the unit address in the "Repeater" box. If no repeaters are required, do not enter anything in the repeater boxes. If only one repeater address is required, enter the address in box 1 and leave the other repeater boxes empty.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

It is possible to configure multiple mappings for an input - each mapping will generate separate transmissions. We recommend that you do not configure multiple mappings to the same output as the output will have the value of the last message that it receives. Each output should have only one mapped input.

It is possible to map a digital input to an analog output - the output will be maximum value when the input is on and minimum value when the input is off. It is also possible to map a analog input to an digital output - the output will be on when the input is equal or greater than 12mA and off when the input is less than 12mA.

For more information on using WI-I/O-EX-1-S-x modules, refer to Section 4.3.8.

Edit existing mappings

To edit an existing mapping, double-click on the mapping line, or select the mapping line and "Edit".

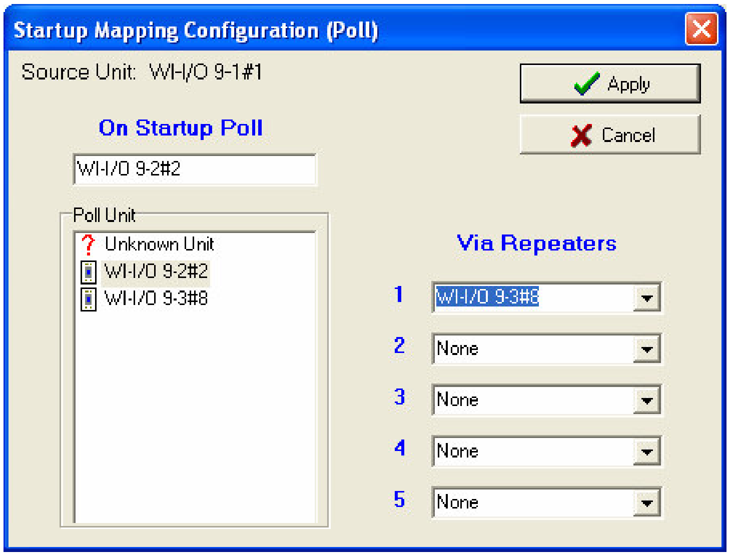
To delete an existing mapping

To delete a mapping, select the mapping and delete or right-mouse click and select Delete.

Configuring Start-Up Polls

When a unit is first turned on, its outputs will not be set until it receives update messages from other units in the system. To that outputs are set as soon as possible after start-up the unit may be configured to “Poll” any other units with mapping s to its o utputs.

Select the remote unit to be polled from the unit list, or enter the unit address in the box. If the remote unit communicates via repeaters, select the repeater units or enter the repeater addresses.



Startup Mapping Configuration (Poll)

Source Unit: WI-I/O 9-1#1

On Startup Poll

WI-I/O 9-2#2

Poll Unit
- Unknown Unit
- WI-I/O 9-2#2
- WI-I/O 9-3#8

Via Repeaters
1 WI-I/O 9-3#8
2 None
3 None
4 None
5 None

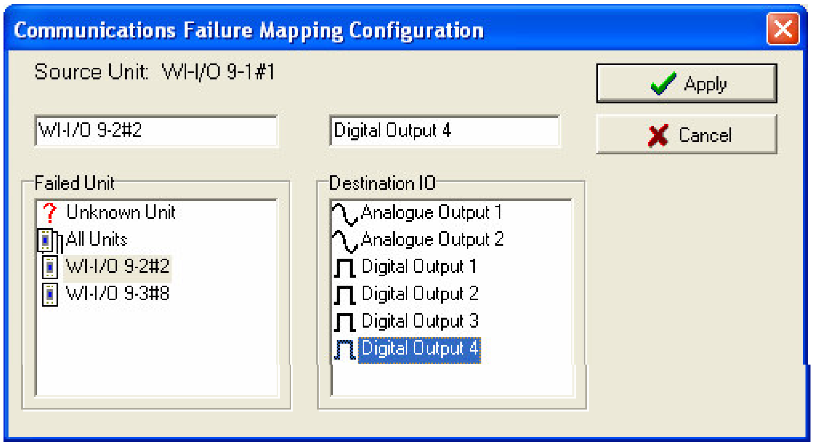
Remember that if more than one remote unit is controlling the local outputs, then more than one start-up poll should be configured.

Configuring Comms Fail Mappings

Each module has a “comms fail” status which may be mapped to a local output. The comms fail status is active (on) if the module is transmitting a message and does not receive an acknowledgement after five tries. By setting the comms fail status to a local output, you can provide a communications alarm. The local output can be digital or analog - if analog, the output will go to maximum value.

Although communication failure will activate the output, successful comms does not reset the output. You must use the “Reset outputs on comms fail” option (Refer to User Options section).

different remote addresses. You can configure several comms fail mappings to the same output - the output will be active if there is comms fail to any of the remote addresses. Configuring a “Comms Fail Address” of zero causes communication failure to any destination module to be indicated on the selected output.



Communications Failure Mapping Configuration

Source Unit: WI-I/O 9-1#1

WI-I/O 9-2#2

Digital Output 4

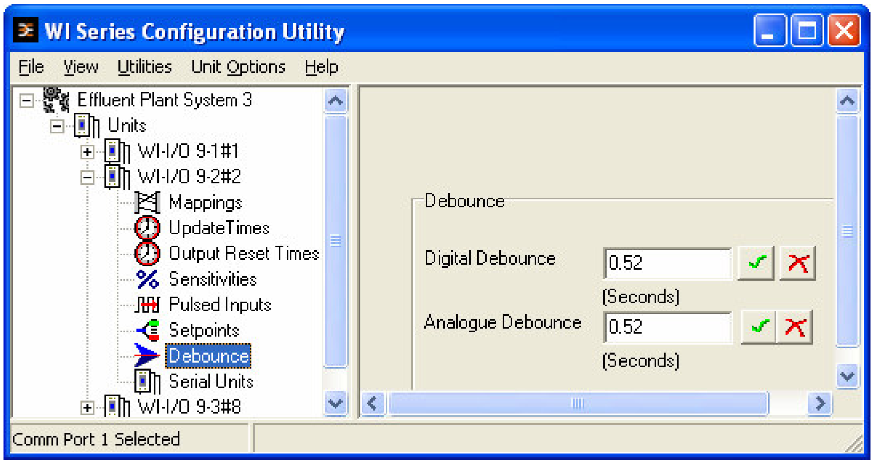
Failed Unit
- Unknown Unit
- All Units
- WI-I/O 9-2#2
- WI-I/O 9-3#8

Destination IO
- Analogue Output 1
- Analogue Output 2
- Digital Output 1
- Digital Output 2
- Digital Output 3
- Digital Output 4

For example, if “Comms fail to unit 12” is configured to DO1, then the module will set (or activate) DO1 each time communications to unit 12 is not successful. If DO1 has a “Reset output” time of 10 minutes configured for DO1, then DO1 will reset (de-activate) 10 minutes after the last comms fail to unit 12.

Debounce Configuration

Debounce is the time which an input must stay stable before the module decides that a change of state has occurred. If a digital input changes (say 0 → 1) and changes again (1 → 0) in less than the debounce time, then the module will ignore both changes. Debounce may be configured for digital inputs on the –1, -2 and -4 modules (0.5 - 8 seconds) and the analog inputs on the -2 module (0.5 - 8 seconds). The default value of 0.5 seconds is suitable for most applications. In applications where a digital input may turn on and off several times slowly (for example, security switches or float switches) a debounce time of up to 8 seconds may be configured. *The configured debounce time has no affect on pulse inputs.*



Digital Debounce 0.52 (Seconds)

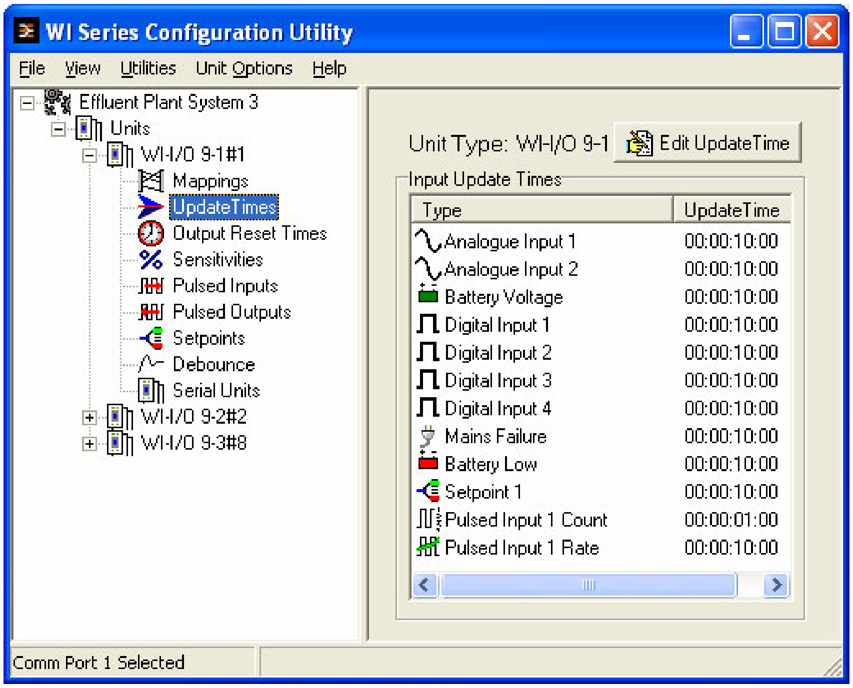
Analogue Debounce 0.52 (Seconds)

Note that the analog debounce is not configurable for the -1 , but is configurable in the -2.

Update Time Configuration

Update messages are sent if a change message has not occurred within the update time period. The update time may be set for each input - both physical and internal inputs.

The default period is 10 minutes for all inputs, except for pulse inputs (1 minute). Short update times should only be used in special circumstances. It is important to remember the principle - “Less radio traffic means better communications”. Frequent updates from multiple units causes congestion of the radio channel, which results in increased communication failures and poorer performance of the system. To change an update time, select “Update Times” on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values. For the -1, -2 and –3 modules, the maximum update time is 16 minutes, however the update



Unit Type: WI-I/O 9-1

Type	UpdateTime
Analogue Input 1	00:00:10:00
Analogue Input 2	00:00:10:00
Battery Voltage	00:00:10:00
Digital Input 1	00:00:10:00
Digital Input 2	00:00:10:00
Digital Input 3	00:00:10:00
Digital Input 4	00:00:10:00
Mains Failure	00:00:10:00
Battery Low	00:00:10:00
Setpoint 1	00:00:10:00
Pulsed Input 1 Count	00:00:01:00
Pulsed Input 1 Rate	00:00:10:00

time for -4 inputs can be up to 5 days.

If a zero value is entered as an update time, then the input will not update at all.

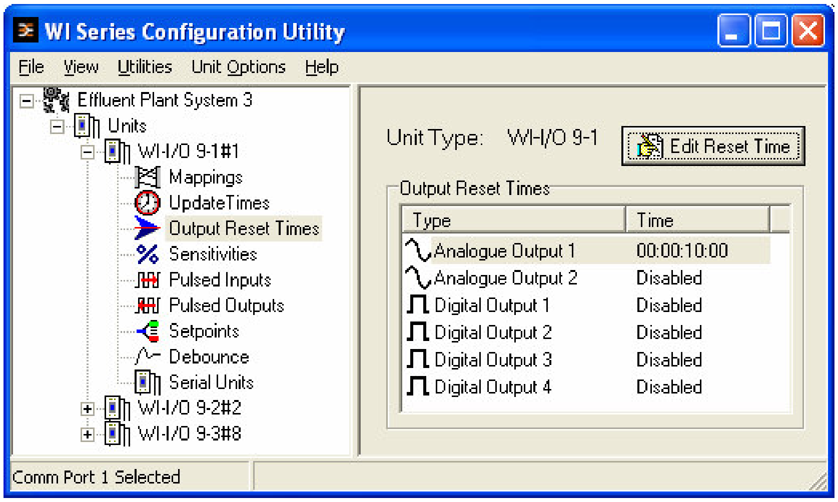
Changing Multiple Settings

You can change the Update Times of several inputs simultaneously by using the <Shift> Select feature. For example, if you want to change all digital inputs to 1 minute update, you could change each individually, or you could "block" the four digital inputs using the "Shift" Select feature and select "Edit". You only need to enter the change once to change all of the inputs selected. This feature is also available with the other configurable parameters.

Output Reset Time Configuration

This allows the **Comms Fail Time** to be selected - this is the time for an output to reset if it has not received an update or change message.

Each output on the unit, either analog or digital, may be configured to reset (off or 0mA) when no update transmission has been received for a certain time. This option can be used to ensure that communications failure will not result in loss of control. For example, outputs connected to pumps should be configured to reset on communications failure so that the pump will turn off. The default condition is zero (no reset).



Unit Type: WI-I/O 9-1

Type	Time
Analogue Output 1	00:00:10:00
Analogue Output 2	Disabled
Digital Output 1	Disabled
Digital Output 2	Disabled
Digital Output 3	Disabled
Digital Output 4	Disabled

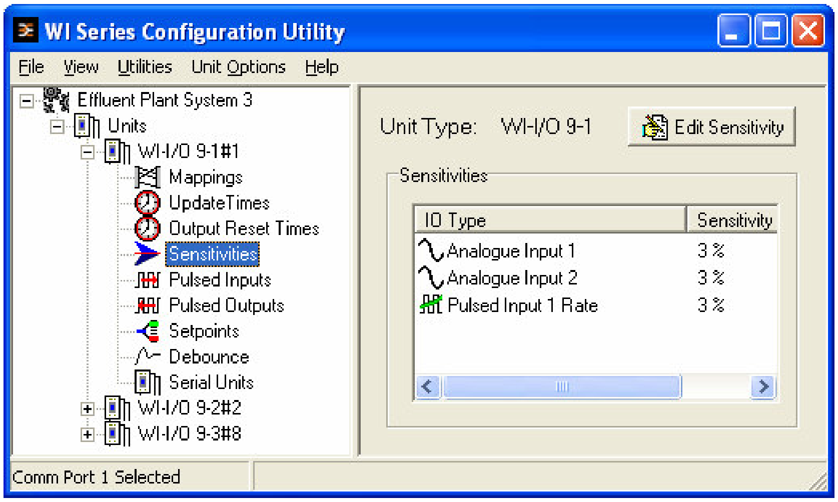
Comm Port 1 Selected

If the reset time is less than the update time, then the output will reset when the reset time expires, and then set again when the update message is received. We recommend that the reset time be a little more than twice the update time.

To set an output reset time, select "Output Reset Times" on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values.

Analog Sensitivity Configuration

The analog sensitivity is the change required in an analog input before a “Change Of State” is detected, and the new analog value is transmitted. For input signals which vary widely over a short period of time or have a normal oscillation, the analog sensitivity should be set to an appropriately large value. This ensures that many change messages are not transmitted in too short a time. This will result in channel congestion, as described in the preceding section.



Unit Type: WI-I/O 9-1

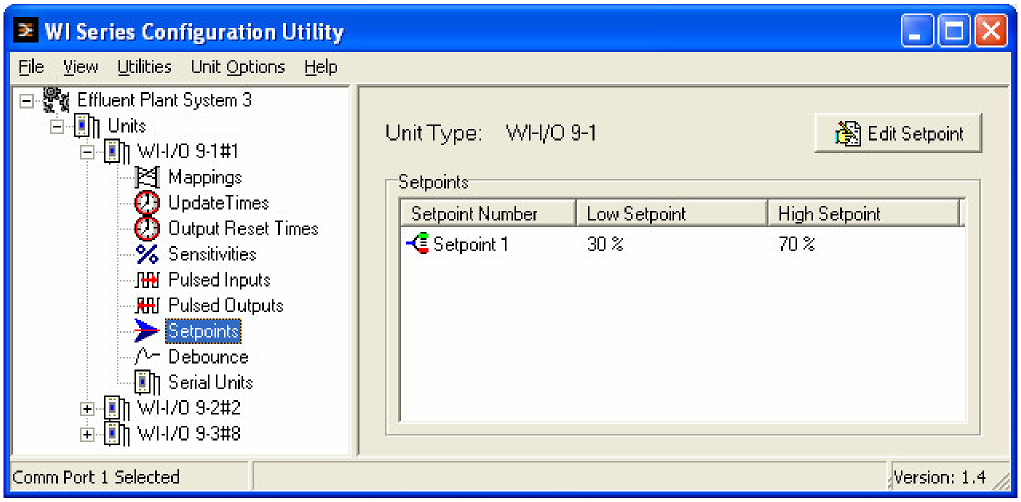
IO Type	Sensitivity
Analogue Input 1	3 %
Analogue Input 2	3 %
Pulsed Input 1 Rate	3 %

Comm Port 1 Selected

To change an analog sensitivity, select “Sensitivities” on the left-hand menu and double-click the selected input. The sensitivity for physical inputs is shown in mA and internal input is shown as %.

SetPoint Configuration

Setpoints allow a remote digital output to be turned on and off depending on the value of an analog input. The “set-point status” internal input must be mapped to an output for this option to have effect. When the AI is less than the Low Set-point (LSP), the set-point status will be active (on, “1”) - when the AI is more than the High Set Point (HSP), the set-point status will be reset (off, “0”). Note that the High Set Point (HSP) must always be higher than the Low Set Point (LSP). For the -1 module, only AI1 has set-point values. For -2 modules, the first four analog inputs (AI 1 – 4) have set-points.



Unit Type: WI-I/O 9-1

Setpoint Number	Low Setpoint	High Setpoint
Setpoint 1	30 %	70 %

Comm Port 1 Selected

Version: 1.4

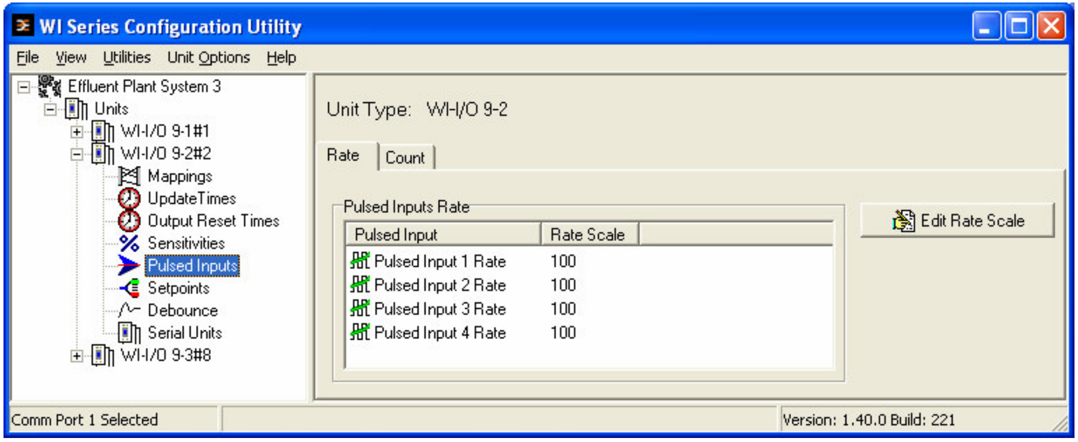
Debounce time operates on the set-point status in the same way as digital inputs.

To change a setpoint values, select “SetPoints” on the left-hand menu and double-click the selected Setpoint Status.

Pulse Input Count Configuration

PI1 of the -2 and -4 modules normally count up to 100Hz (as for the other PI's), however can be configured to count up to 1000Hz. This configuration actually divides the input count by 10 - each count in the PI1 register is then equivalent to 10 input pulses. If PI1 is mapped to a PO, then the maximum output pulse rate is 100Hz, however each output pulse is equivalent to 10 input pulses.

To configure the "divide by 10" feature, select "Pulse Inputs" on the left-hand menu and select the "Count" page - double-click "Pulse Input 1 Count" and enable "divide by 10" counting.



Unit Type: WI-I/O 9-2

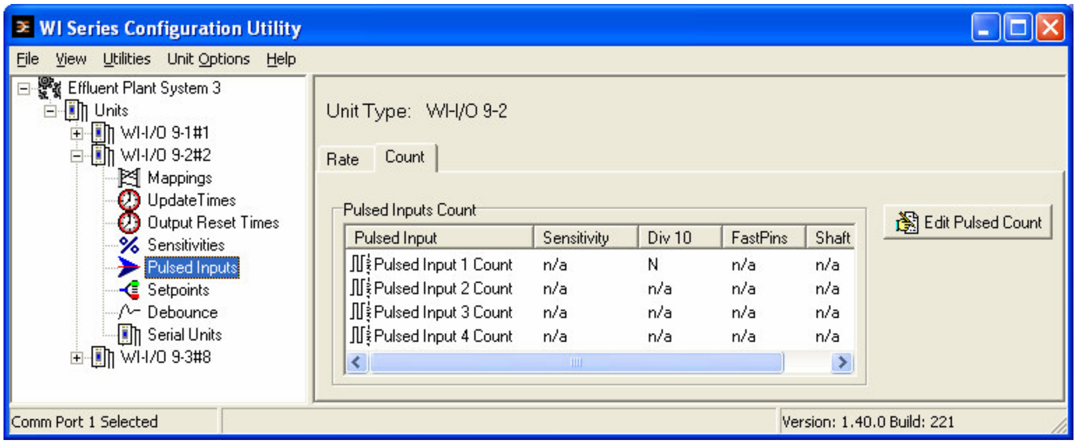
Pulsed Inputs Rate

Pulsed Input	Rate Scale
Pulsed Input 1 Rate	100
Pulsed Input 2 Rate	100
Pulsed Input 3 Rate	100
Pulsed Input 4 Rate	100

Pulse Input Rate Scale Configuration

When a pulse rate is mapped to an analog output, the rate must be scaled to the 4-20mA output. The pulse rate scale is the rate (in Hz) corresponding 20 mA.

To configure the pulse rate scale, select "Pulse Inputs" on the left-hand menu and select the "Rate" page - double-click the pulse input rate and enter the scale value.

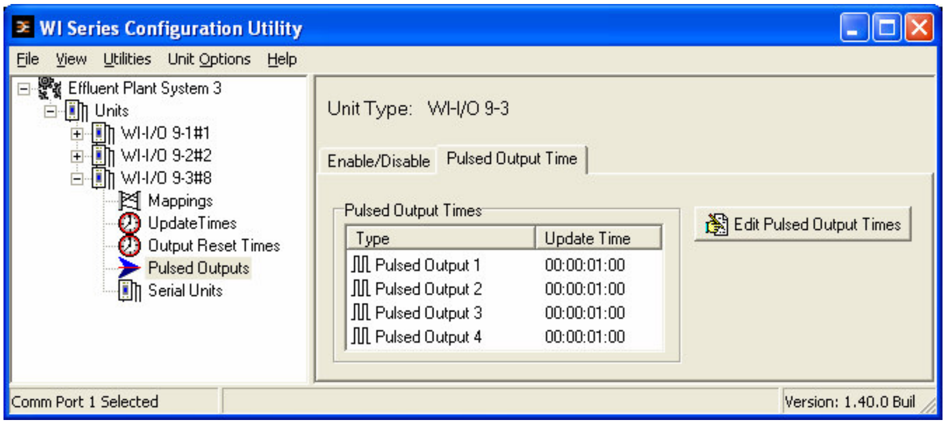


Unit Type: WI-I/O 9-2

Pulsed Inputs Count

Pulsed Input	Sensitivity	Div 10	FastPins	Shaft
Pulsed Input 1 Count	n/a	N	n/a	n/a
Pulsed Input 2 Count	n/a	n/a	n/a	n/a
Pulsed Input 3 Count	n/a	n/a	n/a	n/a
Pulsed Input 4 Count	n/a	n/a	n/a	n/a

Pulse Output Update Time Configuration



Unit Type: WI-I/O 9-3

Type	Update Time
Pulsed Output 1	00:00:01:00
Pulsed Output 2	00:00:01:00
Pulsed Output 3	00:00:01:00
Pulsed Output 4	00:00:01:00

Comm Port 1 Selected

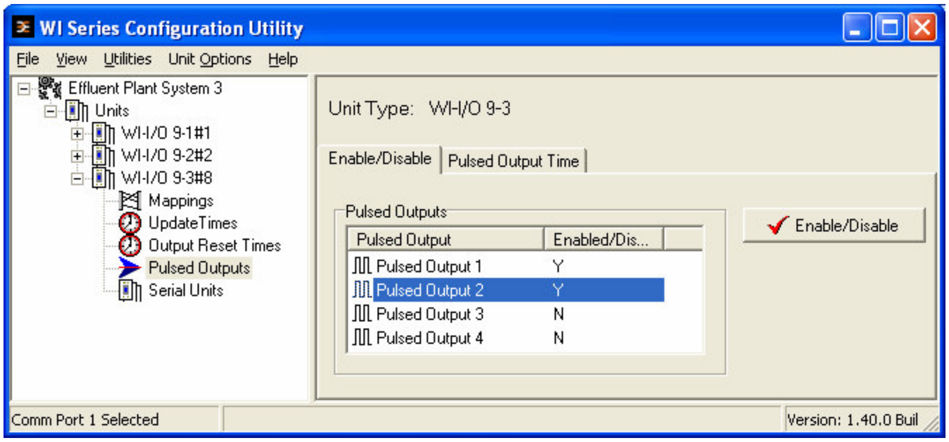
Version: 1.40.0 Buil

The pulse output update time is the time period over which pulses are output after a PI update is received. It should be configured to correspond to the pulse input update time for the corresponding pulse input. This ensures that the pulse output rate matches as closely as possible the pulse input rate which it is reflecting.

For example, if the PI update time is 1 minute, then the PO update time should also be 1 minute. If the PI update time is changed, then the PO update time at the remote module should be also changed. The PO will still operate if the time is not changed, however pulses may be output faster or slower than the input pulses.

To configure the pulse output time, select “Pulse Outputs” on the left-hand menu and select the “Pulsed Output Time” page - double-click the pulse output and enter the new time.

Pulse Output Enable



Unit Type: WI-I/O 9-3

Pulsed Output	Enabled/Dis...
Pulsed Output 1	Y
Pulsed Output 2	Y
Pulsed Output 3	N
Pulsed Output 4	N

Comm Port 1 Selected

Version: 1.40.0 Buil

The PO’s for the -2 and -4 modules are also DO1-4. To use as pulse outputs, you need to enable them as pulse outputs.

To enable pulse outputs, select “Pulse Outputs” on the left-hand menu and select the “Enable/Disable” page - double-click the pulse output to enable.

Compiling a System

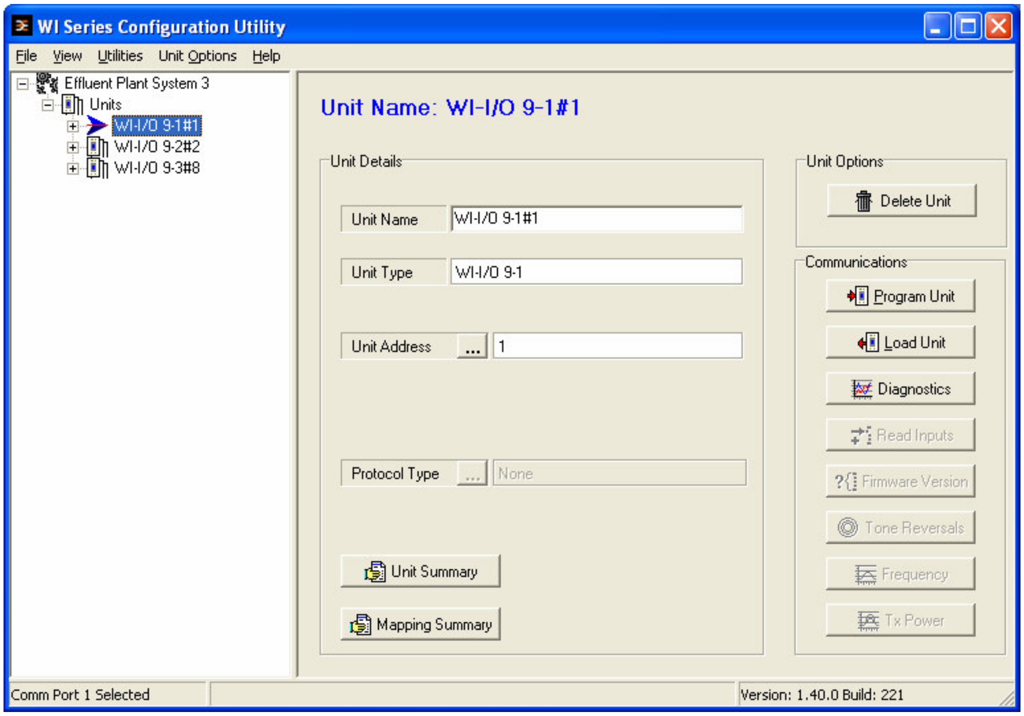
When you have finished configuring the modules, you should compile the system. The compile function scans the configuration and reports any detected errors. To compile the system, select “Compile System” from the “Utilities” menu. Select the “Compile” button. The system will compile - the display will show if there are any compile errors or warnings.

4.3.3 Programming Configurations to Modules

To program a module :

- Connect the cable from the PC's serial port to the module serial port (see 2.4.10 for cable connections)
- From the Utilities menu, select "Serial Port Setup"
- Select the appropriate serial port (COM1 - COM4)
- Select the unit to be configured from the left-hand menu
- Double-click "Program Unit".

Each module will need to be programmed individually.



Unit Name: WI-I/O 9-1#1

Unit Name: WI-I/O 9-1#1

Unit Type: WI-I/O 9-1

Unit Address: 1

Protocol Type: None

Comm Port 1 Selected

Version: 1.40.0 Build: 221

4.3.4 Loading Configuration from a Module

Care should be taken when loading a configuration from a module. It is easy to lose the system address and unit address. We suggest that you first view the system address and unit address - you can do this via the "Unit Options" menu. Note these addresses before loading the configuration.

When you upload the configuration, the program will check if you want to load the addresses from the module. **If you do not, then the system address and unit address will change.**

You are able to upload the configuration from a module into a new "project", to view the configuration and modify it. Note that as the "project" will not have the details of the other modules in the system, the other modules and outputs will be shown as unit addresses and output numbers. Don't forget to download the configuration into the module after you modify it.

If security has been enabled for the system, please read section 4.3.7.

If you are adding additional mappings to a WI-I/O 9-C or WI-GTWY-9-xxx module, then you need to change the archived configuration files first so you can download the modified configuration details into the WI-I/O 9-C or WI-GTWY-9-xxx.

4.3.5 Modifying and Archiving Configuration Files

As you build a system configuration, it is automatically saved in the "Project" directory. We recommend that all system additions and changes be made to the archived configuration files first, and

then downloaded to the module/s. This ensures that the archived files are always maintained and accurate. If you modify the configuration of a module by uploading and then downloading, then the module configuration will be different then the archived files.

If you lose the configuration files for a system, then you can rebuild the configuration by uploading the configuration file from every module in the system.

4.3.6 Print Options

You can obtain a print-out of each module configuration. On each unit display, there are “Unit Summary” and “Mapping Summary” windows. Each of these will display a printable information page about that module. The Unit Summary page will display the user options configured, and the Mapping Summary will display the mappings entered for that unit.

The printer may be selected from the Printer Setup option in the File menu.

4.3.7 Security

There are two security features available. You can enter a password to protect the configuration files, and you can enable security encryption of the radio transmissions.

The password can be between 6 and 256 characters. The password is case sensitive and any ASCII characters can be used. If you have entered a password, then this password will need to be entered if the configuration is to be changed later. You can view the configuration, but you will not be able to make any changes. You are able to change the password from the “Utilities” menu. If unauthorised access to the files is a concern, we recommend that you change the password regularly or whenever there is a change of staff.

Security Encryption is an additional level of security. The security option uses an 8-character security key to provide 64-bit data encryption of the radio messages. All modules in the same system will be configured with the same security key used to encrypt and decrypt the messages. This feature is available for modules with serial numbers with the middle three numbers greater than 210 - that is xxxx210xxxx, or xxxx220xxxx etc. If you are adding modules to an old system which does not have the security encryption feature, then you cannot use security encryption on the new modules.

Note that the security key is different than the password.

- To enable the security encryption, select the “Enable Security” box on the project display. An 8-character security key is entered and you will be prompted to enter the security code a second time to confirm. The security key can be any characters or numbers. Characters are case sensitive. The security key will never be displayed.
- If you do not enable security, there will be no data encryption of the radio messages. This is the default setting.
- If a security key has been entered, this key is downloaded into each module as part of the configuration download process. You can download another configuration at any time - if the security key is different, or if there is no security key in the new configuration, the old key will be over-written.

- You can change the security key in the configuration files simply by entering a new security key in the security key window. You will be prompted to confirm the new security key. If the configuration files are password-protected, you will be asked for the password. Note that if you change the security key, it will not match the security key previously loaded into existing modules.
- If you want to change a configuration, we recommend that you change the archived configuration, and then download the configuration onto the module. The archived configuration already has the valid security key.
- If you lose the archived configuration, you can upload the configuration from a module, but you cannot upload a security key. That is, you can upload the module configuration, view it, change it - but if you don't know the original security key, the old key will be over-written when you download the new configuration. This module will no longer communicate with other modules in the system as the security key is different.

The security options provide security against a "hacker" in the following way:

- ☐ A hacker cannot listen-in to radio messages without the security key to decrypt the radio messages. Similarly, a hacker cannot force outputs by transmitting a radio message to a module without the security key.
- ☐ A hacker cannot access the security key from an installed module or from the configuration files.
- ☐ The archived configuration files cannot be changed, downloaded or uploaded without the password.

Warning!!

These security options provide a high level of security, but no data-security system can provide "100% protection". But it does make it very difficult for someone to interfere with the WI-I/O 9-x system - difficult to the point where there would be many easier alternate ways to cause malicious damage.

The password must be kept in a secure place. Security procedures need to be adopted. If staff with access to the password leaves your organization, we recommend that the password be changed.

We recommend that you use a random 8-character string for the security key and that you do not record the key. It is not necessary to know what the security key is. The key will be recorded in the archived configuration files, and therefore the configuration files should be held in a secure place and backed up.

The security key does not prevent a hacker uploading a configuration from a module and downloading with a new security key. This module will no longer operate with other modules in the system. To prevent this, unauthorized access to modules must be prevented.

If you lose the configuration files, you can regenerate these by uploading the configuration from every module in the system into a new project with a new security key. After uploading each module, download the configuration with the new security key.

If you wish to change the security key, simply enter a new key in the configuration program, and download the new configuration to all modules in the system.

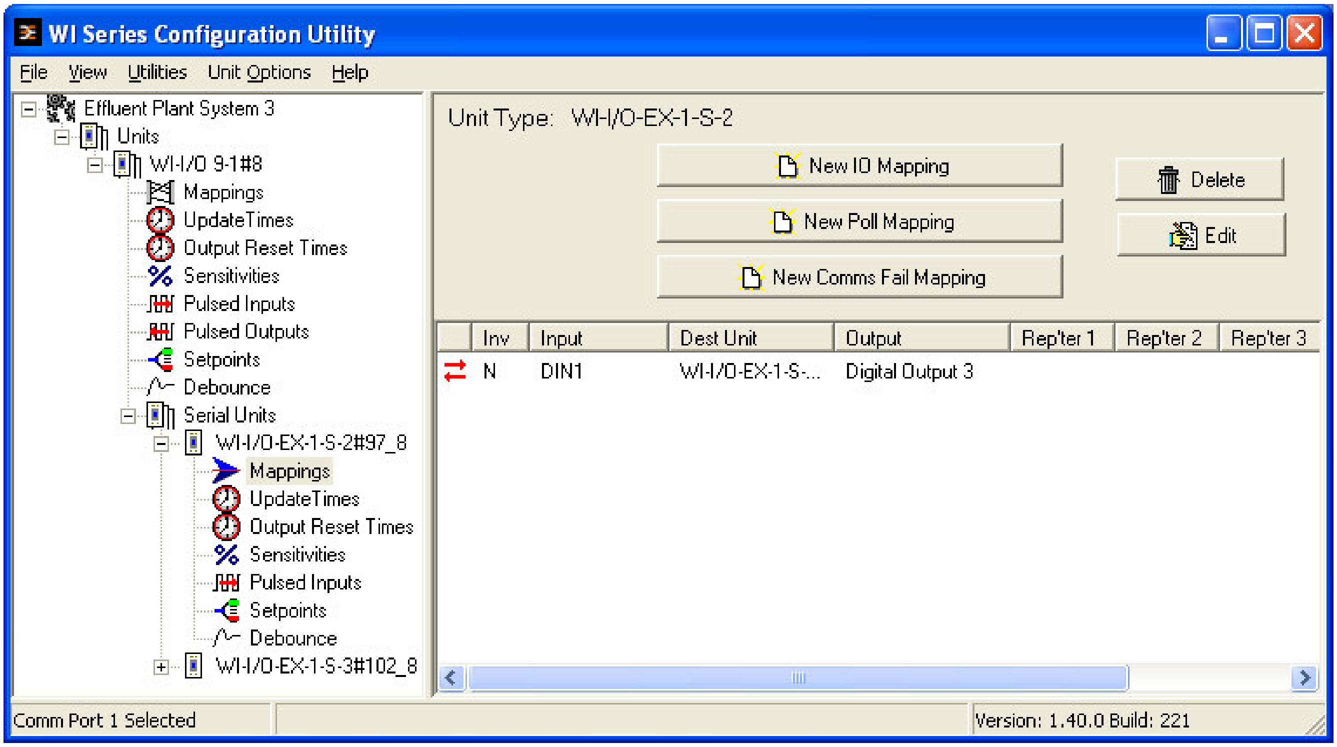
4.3.8 Using WI-I/O-EX-1-S-x Modules

WI-I/O-EX-1-S-x modules can be used by themselves, as "line telemetry" or "wired I/O", or they can be used as I/O expansion for WI-I/O 9-x modules. As the WI-I/O-EX-1-S-x modules are connected by RS485, the WI-I/O-EX-1-S-x modules can be separated from the WI-I/O 9 modules by some distance. There can be up to 32 addresses on the one RS485 multi-drop link. Note that each –3 and –4 module takes up 2 addresses. For example, you could have up to 32 modules sharing a multi-drop link if they are all –1 or -2 modules - if they are all –3 or –4, then you could only have 16 modules on the link.

WI-I/O-EX-1-S-x modules are configured with unit addresses in the range 96 – 127.

Example 1 - Mapping to another WI-I/O-EX-1-S-x module on the same link.

The I/O mapping is done in the same way as for WI-I/O 9-x modules.



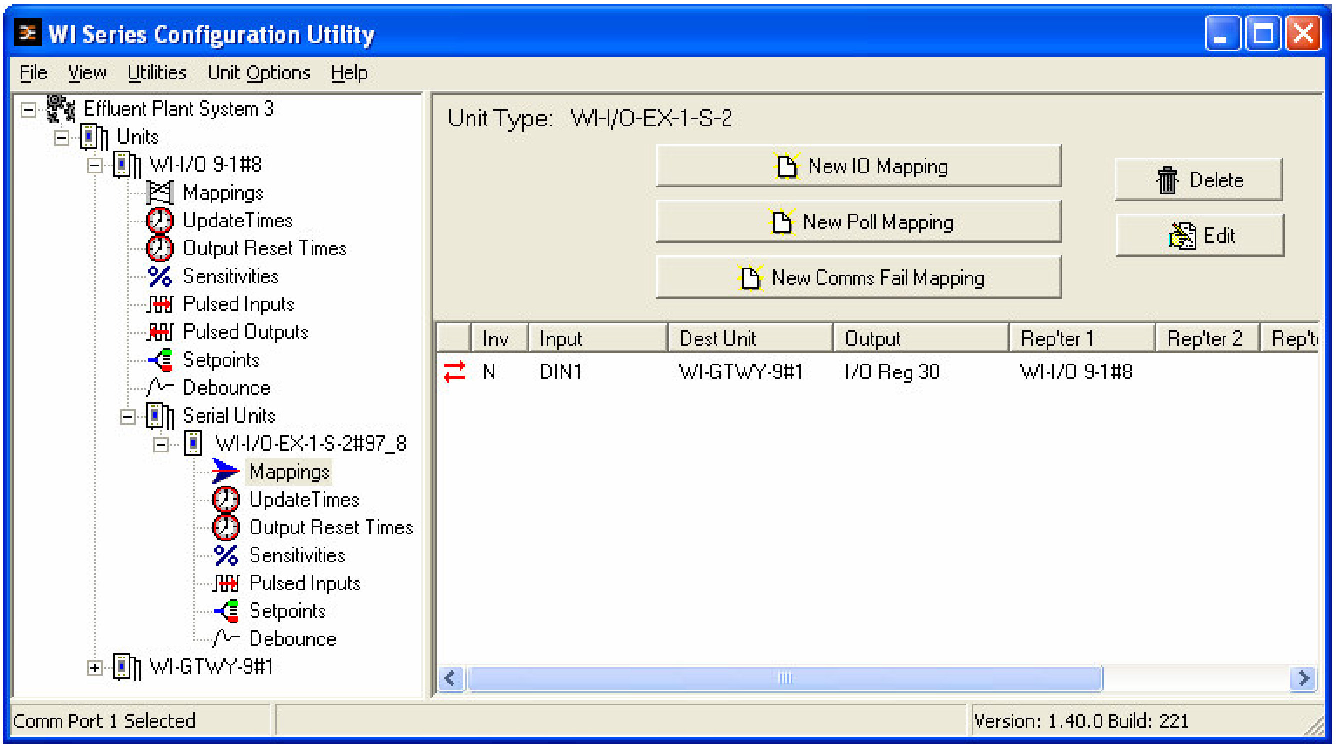
Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
⇄	N	DIN1	WI-I/O-EX-1-S-...	Digital Output 3			

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Example 2 - Mapping to a remote WI-I/O 9-x.



Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep't
⇄	N	DIN1	WI-GTWY-9#1	I/O Reg 30	WI-I/O 9-1#8		

Comm Port 1 Selected

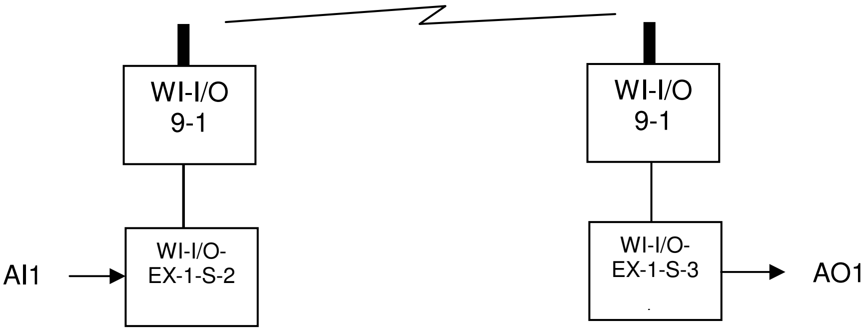
Version: 1.40.0 Build: 221

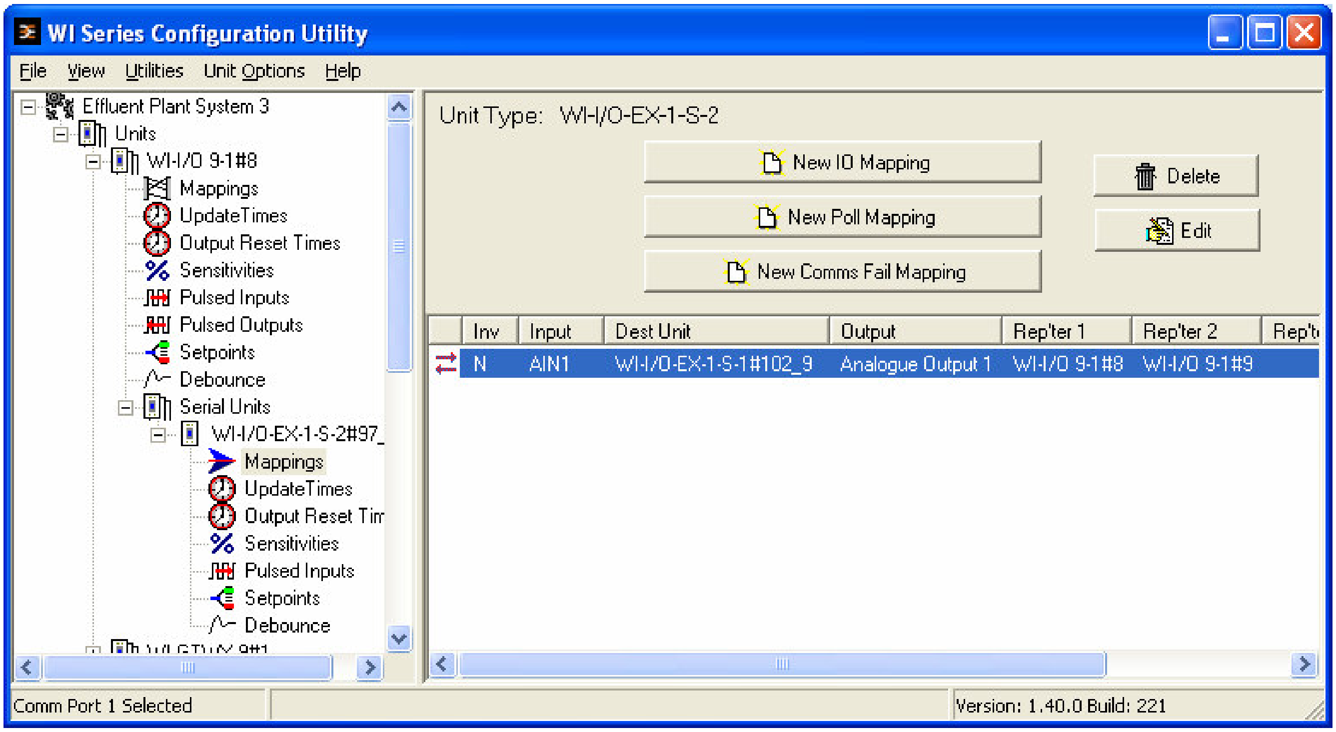
In this example, a WI-I/O-EX-1-S-x-2 is connected to WI-I/O 9-1#8. DI1 is mapped to a remote WI-GTWY-9-MD1 module. The WI-I/O 9-x that is connected to the WI-I/O-EX-1-S-x module acts as a repeater - a serial-to-radio repeater.

When DI1 changes, the WI-I/O-EX-1-S-x will send a message via the serial link to WI-I/O 9-1#8.

Example 3 - Mapping to another WI-I/O-EX-1-S-x which is connected to a different WI-I/O 9-x

In this example, both WI-I/O 9-x modules act as repeaters. The first is a "serial-to-radio" repeater and the second is a "radio-to-serial" repeater.





Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep't
⇄	N	AIN1	WI-I/O-EX-1-S-1#102_9	Analogue Output 1	WI-I/O 9-1#8	WI-I/O 9-1#9	

Chapter Five SPECIFICATIONS

General		
WI-I/O 9-x Radio standards	FCC Part 15A, Part 15.247	902 – 928 MHz, 1W
Housing	130 x 185 x 60mm DIN rail mount Refer section 5.1 for dimensioned drawing	Powder-coated, extruded aluminium
Terminal blocks	Removable	Suitable for 2.5 mm^2 conductors
LED indication	Power supply, OK operation, digital I/O, RX and TX	
Operating Temperature	WI-I/O 9-x, WI-I/O-EX-1-S-x	-40 to 60 degrees C / -40 to 140 degrees F -30 to 60 degrees C / -20 to 140 degrees F
Humidity	0 – 99% RH non-condensing	
Power Supply		
Battery supply	11.3 - 15.0 VDC	
AC supply	12 - 24 VAC, 50/60 Hz	Overvoltage protected
DC supply	15 - 30 VDC	Overvoltage and reverse voltage protected > 17VDC required for charging battery
Battery Charging circuit	Included	for 1.2-12 AHr sealed lead acid battery
Solar regulator	Included	Direct connection of solar panel (up to 30W) and solar battery (100 Ahr)
Current Drain at 12VDC	85 mA quiescent for ‘U’ 45 mA quiescent for ‘S’	+ 10 mA/active digital input + 25 mA/active digital output + 2 x analog I/O loop (mA)
Radio transmitter inrush	WI-I/O 9-x	350mA @ 13.8VDC; 250mA @ 24VDC 450mA @ 13.8VDC (0.5W) 600mA @ 13.8VDC (1W) 800mA @ 13.8VDC (2W) 1.25A @ 13.8VDC (5W)
Analog loop supply	Included, except -4	24V DC 150 mA
Mains fail status	Monitored	Can be transmitted to remote modules
Battery voltage	Monitored	As above

Radio Transceiver (WI-I/O 9-x)		
Spread spectrum	Frequency hopping	
Frequency	USA/Canada Australia New Zealand	902 – 928 MHz 915 – 928 MHz 922 – 928 MHz
Transmission Power	1W	
Signal detect / RSSI	-120 to –50 dBm	
Expected line-of-sight range (subject to local conditions)	20 miles + @ 4W ERP 15 km + @ 1W ERP depending on local conditions	USA / Canada Australia / New Zealand Range may be extended by up to 5 intermediate modules as repeaters
Antenna Connector	Female SMA coaxial	
Data transmission rate	19200 baud	
Serial Ports		
RS232 Port	DB9 female DCE	9600 baud, no parity, 8 data bits, 1 stop bit
RS485 Port	2 pin terminal block	9600 baud, no parity, 8 data bits, 1 stop bit, Typical distance 1 mile / 2km
Data transmission	On change-of-state + integrity update	Update time configurable
Protocol - serial - radio	asynchronous ARQ, with 16 bit CRC synchronous ARQ	Automatic acknowledgements with up to 4 retries
Communications fail status	May be mapped to local or remote output	Resetting of outputs on comms fail configurable
Inputs and Outputs		
Digital Inputs	WI-I/O 9-x_WI-I/O-EX-1-S-1 Four WI-I/O 9-x_WI-I/O-EX-1-S-2 Four WI-I/O 9-x_WI-I/O-EX-1-	Opto-isolated (5000V)inputs, suitable for voltage free contacts or NPN transistor, contact wetting current 5mA, input debounce 0.5 second For –4 modules, as above, but with 3000V surge protection instead of opto-isolation

	S-3 None WI-I/O 9-x_WI-I/O-EX-1-S-4 Four plus 12 selectable I/O	
Digital Outputs Digital Outputs	WI-I/O 9-1_WI-I/O-EX-1-S-1 Four WI-I/O 9-2_WI-I/O-EX-1-S-2 One WI-I/O 9-3_WI-I/O-EX-1-S-3 Eight WI-I/O 9-4_WI-I/O-EX-1-S-4 Four plus 12 selectable I/O	Relay output contacts, normally open, AC 5A 50V DC 2A 30V, 5A 20V
Pulse Inputs	WI-I/O 9-1_WI-I/O-EX-1-S-1 One WI-I/O 9-2_WI-I/O-EX-1-S-2 Four WI-I/O 9-3_WI-I/O-EX-1-S-3 None WI-I/O 9-4_WI-I/O-EX-1-S-4 Four	Uses DI1. Max rate 100Hz, min. off-time 5msec. Uses DI1-4. Max rate of DI1 is 1000Hz, min. off-time 0.5msec Max rate of DI2-4 is 100Hz, min. off-time 5msec.
Pulse Output	WI-I/O 9-1_WI-I/O-EX-1-S-1 One WI-I/O 9-2_WI-I/O-EX-1-S-2 None WI-I/O 9-3_WI-I/O-EX-1-S-3 Four WI-I/O 9-4_WI-I/O-EX-1-S-4 Four	FET output, 30 VDC 500mA max Max rate for WI-I/O-EX-11 is100 Hz. Max rate for WI-I/O-EX-1-S-13 is 1000 Hz. Pulse signal recreated, pulse rate avail. on analog output, (scaling configurable). Divide-by-10 available for 1000Hz inputs.
Analog Inputs	“floating” differential input, common mode voltage -0.5V to 27V WI-I/O 9-1_WI-I/O-EX-1-S-1 Two 4-20 mA WI-I/O 9-2_WI-I/O-EX-1-S-2 Six 0-20mA	24 VDC for powering external loops provided, 150 mA max. Digital filter time constant 1 second (config.) Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%

Analog Input Setpoints	WI-I/O 9-1_WI-I/O-EX-1-S-1 AI 1 only WI-I/O 9-2_WI-I/O-EX-1-S-2 AI 1-4	Configurable high & low set-points, allowing set/reset of remote digital outputs
Analog Outputs	current sink to common WI-I/O 9-1_WI-I/O-EX-1-S-1 Two 4-20mA WI-I/O 9-3_WI-I/O-EX-1-S-3 Eight 0-20mA	max loop voltage 27V, Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%
System Parameters		
Network Configurations	Communications via radio or RS485 or network of both	Up to 95 radio units with up to 32 serial units off each radio unit
User Configuration	Any input to any output in system	RS232 PC or laptop
Diagnostics		
On board diagnostics	Automatic check on start-up Via RS232 terminal or laptop	Input status Output test Incoming radio signal level Simple radio path testing

Chapter Six TROUBLESHOOTING

6.1 Diagnostics Chart

INDICATOR	CONDITION	MEANING
OK LED OFF	Continuously	• Battery Voltage low • CPU failure • +24V supply failure/overload
OK LED ON	Continuously	• Normal Operation
PWR LED ON	Continuously	• Supply available from SUP1/SUP2 • Supply available from solar panel
TX LED ON	Flashes briefly	• Radio transmitting
RX LED ON	Flashes briefly	• Radio Receiving • Serial port communicating
RX LED ON	Flashes continuously	• Module in Configuration Mode
RX LED ON	Continuously	• Test Button press in Configuration Mode
No transmission on change of state		• Unit not configured correctly - re-configure and check operation

The green OK LED on the front panel indicates correct operation of the unit. This LED extinguishes on failure as described above. When the OK LED extinguishes shutdown state is indicated. In this state, all digital outputs turn OFF and the +24V supply turns off.

On processor failure, or on failure during start-up diagnostics, the unit shuts down, and remains in shutdown until the fault is rectified. The unit also shuts down if the battery voltage falls below 10.8 volts. This is a protection feature designed to protect the battery from deep discharge in case of extended period without supply voltage.

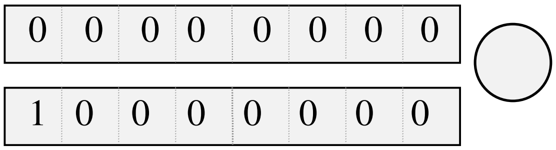
Note: During diagnostic testing, it is likely that the module will reset and restart. This will affect the output signals.

6.2 Self Test Functions

6.2.1 Input to Output Reflection (WI-I/O 9-1_WI-I/O-EX-1-S-1 only)

The unit will require re-configuration after SELF TEST. Ensure you know the required operational configuration including system and unit addresses so that the network can be restored after testing.

Remove the cover in the front panel, and set the DIP switches as shown below. Hold down the red button for five seconds, or until the Rx LED glows yellow, release the Red button (the Rx LED now flashes), then press and release the Red button (the flashing Rx LED extinguishes).



Input signals may now be connected to the input terminals of the module. If the module is operating correctly, then the input signals will be reflected to the corresponding output on the same module. For example, if DI 1 is connected to common - i.e. the first digital input is turned "ON" - then DO 1 will activate, if the module is functional. Similarly, if a 12mA signal is connected to AI 2, then a 12mA signal should be able to be measured from AO 2, if the module is functioning correctly.

If a module does not pass its self test function, then it should be returned to an authorised service agent for attention

6.2.2 Radio Testing using Tone Reversals (WI-I/O 9-x modules only)

This function allows the unit to be configured to continuously transmit a sequence of alternate zeros and ones on the radio. This function provides the facility to check VSWR of antennas during installation, as well as checking the fade margin of the path between two units (see below - received signal strength indication).

The tone reversals function is initiated by setting all of the DIL switches to ON, and holding down the red button for approximately 5 seconds(until the RX LED lights continuously). On releasing the button, the RX LED will flash continuously, and the TX LED will light, indicating that the radio transmitter is on.

To finish the test, push the red button again or re-power the module.

6.2.3 Diagnostics menu

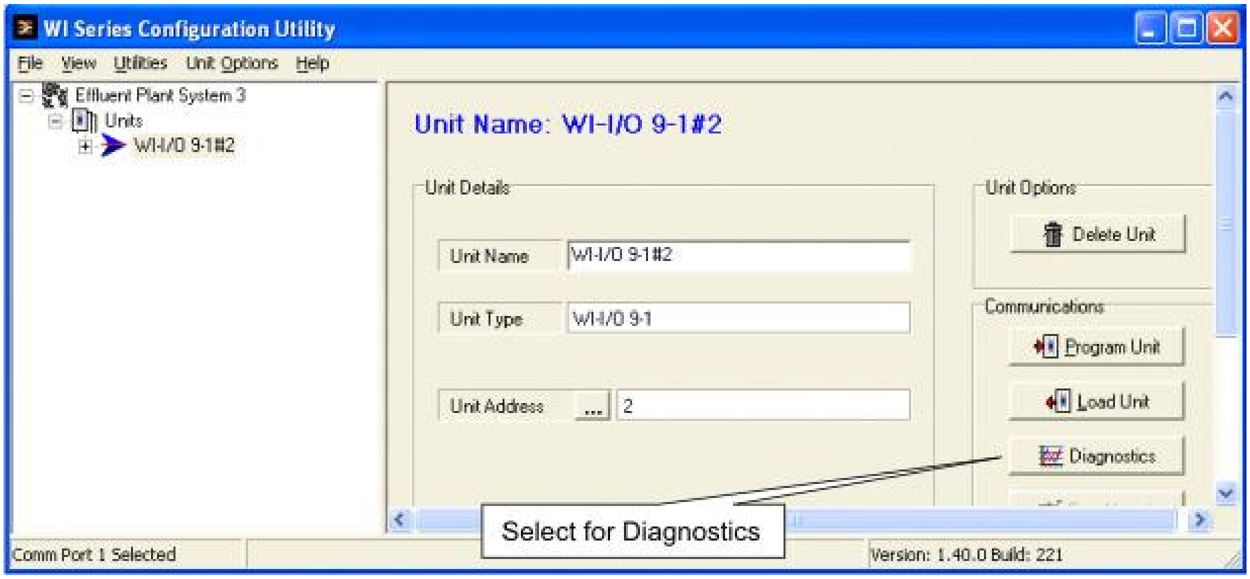
To aid in the checking and set-up of the module, a user friendly menu provides access to diagnostic

functions. Use of the diagnostics menu does not affect module configuration.

The diagnostics functions can be accessed from the E Series Config software - the same software package used to configure the modules. Connect the laptop or PC to the module using a configuration RS232 cable.

Either open the archived project containing the module, or start a New Project and select “Load a New Unit” - select the correct type of module. After the unit has loaded, select the Diagnostics box.

A “Terminal” screen will appear. Select the “Terminal” box.



Unit Name: WI-I/O 9-1#2

Unit Name: WI-I/O 9-1#2

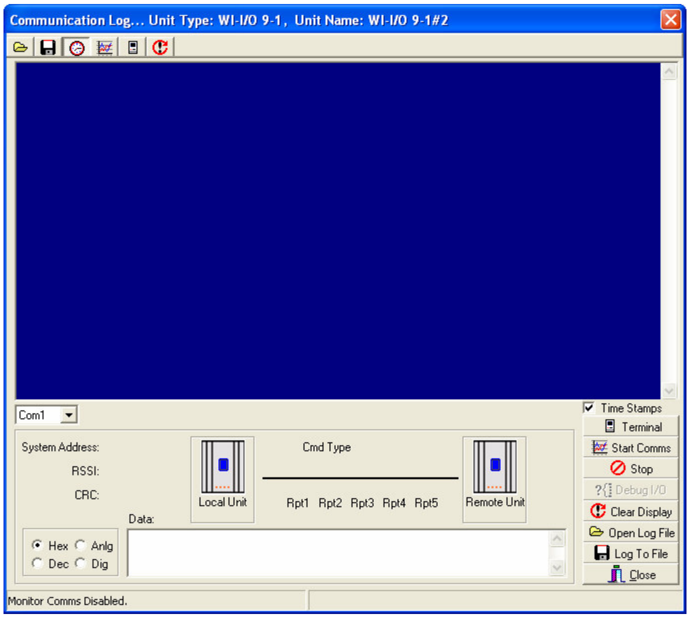
Unit Type: WI-I/O 9-1

Unit Address: 2

Select for Diagnostics

Connect the module (ensure the RS485 port is disconnected first) to the PC using the same serial cable used for configuration.

The diagnostics menu is accessed by removing the blue “plug” from the front of the module and setting all switches to ‘0’ or “Open”, and holding down the red button for approximately 5 seconds, until the RX LED lights continuously. One of the following menus will be displayed on the terminal :



Monitor Comms Disabled.

WI-I/O 9-1

a) Ins

b) Tones

c) Comms

d) DO1

e) DO2

```
f)      DO3
g)      DO4
h)      AO1
i)      AO2
j)      Switch
k)      Signal
>
```

```
WI-I/O 9-2
a)      Digital Ins
b)      Analog Ins
c)      Tones
d)      Comms
e)      DO1
f)      Switch
g)      Signal
>
```

```
WI-I/O 9-3
a)      Ins
b)      Tones
c)      Comms
d)      DO1
e)      DO2
f)      DO3
g)      DO4
h)      DO5
i)      DO6
j)      DO7
k)      DO8
l)      AO1
m)      AO2
n)      AO3
o)      AO4
p)      AO5
q)      AO6
r)      AO7
s)      AO8
t)      Switch
u)      Signal
>
```

```
WI-I/O 9-4
a)      D Ins
b)      A Ins
c)      Tones
d)      Comms
e)      DO1
f)      DO2
g)      DO3
h)      DO4
i)      DIO1
j)      DIO2
k)      DIO3
l)      DIO4
m)      DIO5
n)      DIO6
o)      DIO7
p)      DIO8
q)      DIO9
r)      DIO10
s)      DIO11
t)      DIO12
u)      Signal
>
```

Choose an item from the menu by entering the letter before that item. For example, to select the "Signal" function from the WI-I/O-EX-1-S-11 Menu, enter :- k

During the diagnostics session, if you press Enter or Space while the menu is displayed, the module will restart in normal operating mode. To re-enter diagnostics mode, hold the red button for 5 seconds etc.

After the diagnostics session is over, force the module to restart, then select “Stop Terminal”, then “Close”.

Inputs

This option provides a dynamic display of the status of all of the inputs in the WI-I/O 9-x, both internal and external.

WI-I/O 9-1/WI-I/O-EX-1-S-1 Modules

```
1234MLS    P CNT  AI1   AI2   PRATE  VBATT
0101001    00F6   C000  4000  8000   9C00
```

The first 7 values (1234MLS) each represent a single digital input. A ‘1’ indicates that that input is ON, and a ‘0’ indicates that the corresponding input is OFF. "1234" represents the four physical digital

inputs, DI1 to DI4. "M" is the mains fail status (‘1’ for mains fail, ‘0’ for mains OK). "L" is the battery low volts status (‘1’ for low volts ‘0’ for OK). "S" is the set-point status.

P CNT, AI1, AI2, P RATE, and VBATT each represent 16 bit values, displayed as four hexadecimal digits.

P CNT is the current value of the pulsed input counter. This value should increment each time ‘DI 1’ turns from OFF to ON. P RATE displays the current pulse rate at DI1. This value is scaled according to the MAXRATE value configured (0 Hertz is displayed as 4000, and the maximum rate is displayed as C000).

AI1 and AI2 represent the value for the two analog inputs. Full scale input (20 mA) is displayed as C000, 4mA is displayed as 4000, and 0ma is displayed as 2000. Analog inputs are filtered digitally with a time constant of 1 second, so a sudden change in the analog input current will result in a slower change in displayed analog value, finally settling at the new value.

A guide to translate the displayed value to the analog input current is provided below.

	Add together the figures corresponding to each digit in each position to determine the current (mA) e.g. displayed value 3456 = 2.000+0.500+0.039+0.003 = 2.542mA			
Digit	**Leftmost position**	**Next position**	**Next position**	**Rightmost position**
0	-	0.000	0.000	0.000
1	-	0.125	0.008	0.000
2	0.000	0.250	0.016	0.001
3	2.000	0.375	0.023	0.001
4	4.000	0.500	0.031	0.002
5	6.000	0.625	0.039	0.002
6	8.000	0.750	0.047	0.003
7	10.000	0.875	0.055	0.003
8	12.000	1.000	0.063	0.004
9	14.000	1.125	0.070	0.004
A	16.000	1.250	0.078	0.005
B	18.000	1.375	0.086	0.005
C	20.000	1.500	0.094	0.006
D	22.000	1.625	0.102	0.006
E	-	1.750	0.109	0.007
F	-	1.875	0.117	0.007

VBATT is the current internally derived battery voltage. 4000 corresponds to 8 Volts, C000 represents 16 volts. A quicker method is use the calculation :

Battery voltage (volts) = ½ I + 6, where I is the mA value determined from the above table using VBATT. For example, a value of VBATT of A000 gives an I value of 16mA from the above table. The battery voltage corresponding to this is 14V (or ½ x 16 + 6).

WI-I/O 9-2_WI-I/O-EX-1-S-2 Modules

Digital Inputs

```
DIN     SETPNT          PULSED
1234MSL123456      PIN1      PIN2      PIN3      PIN4
0000100111111      0000      0000      0000      0000
```

Analog Inputs

```
VBAT    PR1     PR2    PR3     PR4     AI1     AI2     AI3     AI4     AI5    AI6
8138    4000    4000   4000    4000    0D3A    0CD2    0CC7    0CC7    0CD4   0CC7
```

WI-I/O 9-3_WI-I/O-EX-1-S-3 Modules

```
ML     VBAT   VSLR
00    9FA2   0000
```

WI-I/O 9-4_WI-I/O-EX-1-S-4 Modules

Digital Inputs

```
DIN  DIO                  PULSED
1234 123456789ABC MLS   PIN1 PIN2 PIN3 PIN4
1001 010101010 001   101    0001 0001 0001  0001
```

Analog Inputs

```
VBAT PR1     PR2     PR3     PR4
8DBE  0000    0000    0000    0000
```

Tones (WI-I/O 9-x modules only)

This provides the same function as described above in 6.2.2. Tone Reversals. This function may be used to check VSWR of antennas, and may be used in conjunction with the Signal option (described below) to check the path between two units.

Comms

This function allows monitoring of all messages transmitted and received over the radio. A better comms display function is available using the “Comms Logging” feature in the configuration software - refer to section 6.2.4.

Transmitted messages are displayed starting in the leftmost column of the display. Received messages are displayed with the received signal strength preceding the message. The first four hexadecimal digits are the system address attached to the message, and must match for units to communicate successfully.

The received signal strength is in negative dBm - the lower the measurement, the stronger the radio signal. A measurement larger than 95 indicates a weak radio signal.

Example:

```
>c
Comms
TX: 01FA8106008005C6727D44     Command message transmitted by this unit.
84   01FA8186C6E0E3            Acknowledge received from remote.
81  01FA860100800100009286     Message received from remote unit.
TX:  01FA868100FCE4            Acknowledge message from this unit to remote.
<INVALID> 01FA860000800100009286  Corrupted message received.
```

DO1 to DO8, DIO1 to DIO12

These options allow the user to set and clear digital outputs. To set an output, select the corresponding menu item, at the prompt, type the value FFFF to turn the output ON, or 0000 to turn the output OFF. For example, to set DO1 ON,

```
>e
DO1
>FFFF
```

AO1 to AO8

These options allow the user to set analog outputs to any value. To set the output, select the corresponding menu item. At the prompt type the value required for the analog output as a four digit hexadecimal value. Refer to the table above for analog current/expected value relationship. To set AO2 on WI-I/O-EX-1-13 to 19 mA :

```
>m
AO2
>B800
```

Switch

This option allows testing of the DIL (Dual In Line) switches. The diagram below indicates the layout of the switches of which there are two sets of eight, with an “Enter” button located to the right of the pair. the display indicates the current switch settings with the digit ‘1’ corresponding to ‘On’ and the digit ‘O’ corresponding to ‘Off’. Changing the switch settings in this mode will change the display. Test each switch and check to ensure the display changes accordingly.

Switches

1	1	1	0	0	0	1	0

0	1	0	1	0	1	0	1

Displayed

`1110001001010101`

Signal

This option provides for testing the radio path between two units for a suitable reliability margin. Although a pair of units may communicate successfully, radio communication may be affected by a range of influences, including atmospheric conditions, changing landscape, degradation of antennas or co-axial cable, low battery voltage etc. “Fade margin” is an indication of how far a radio path can deteriorate before communication becomes unreliable.

When using the Signal feature, the current received radio signal level is displayed in negative dBm (dBm is relative to 1mW of RF power). A display of 100 means –100dBm. This means that a stronger signal will have a lower measured value.

To check the radio path between two units, select the signal option at the local unit. The display will initially show the background noise of the radio band. Determine the approximate average of the noise level. The remote unit may then be set up for tone reversals (refer 1 above). Determine the approximate average of the received signal strength. It is normal for the measured values to continually change - the radios are continually changing frequency. Calculate the best average for both the noise and signal. For a reliable radio path, the signal strength must be at least 10dB lower than the noise level, or 98, whichever is less.

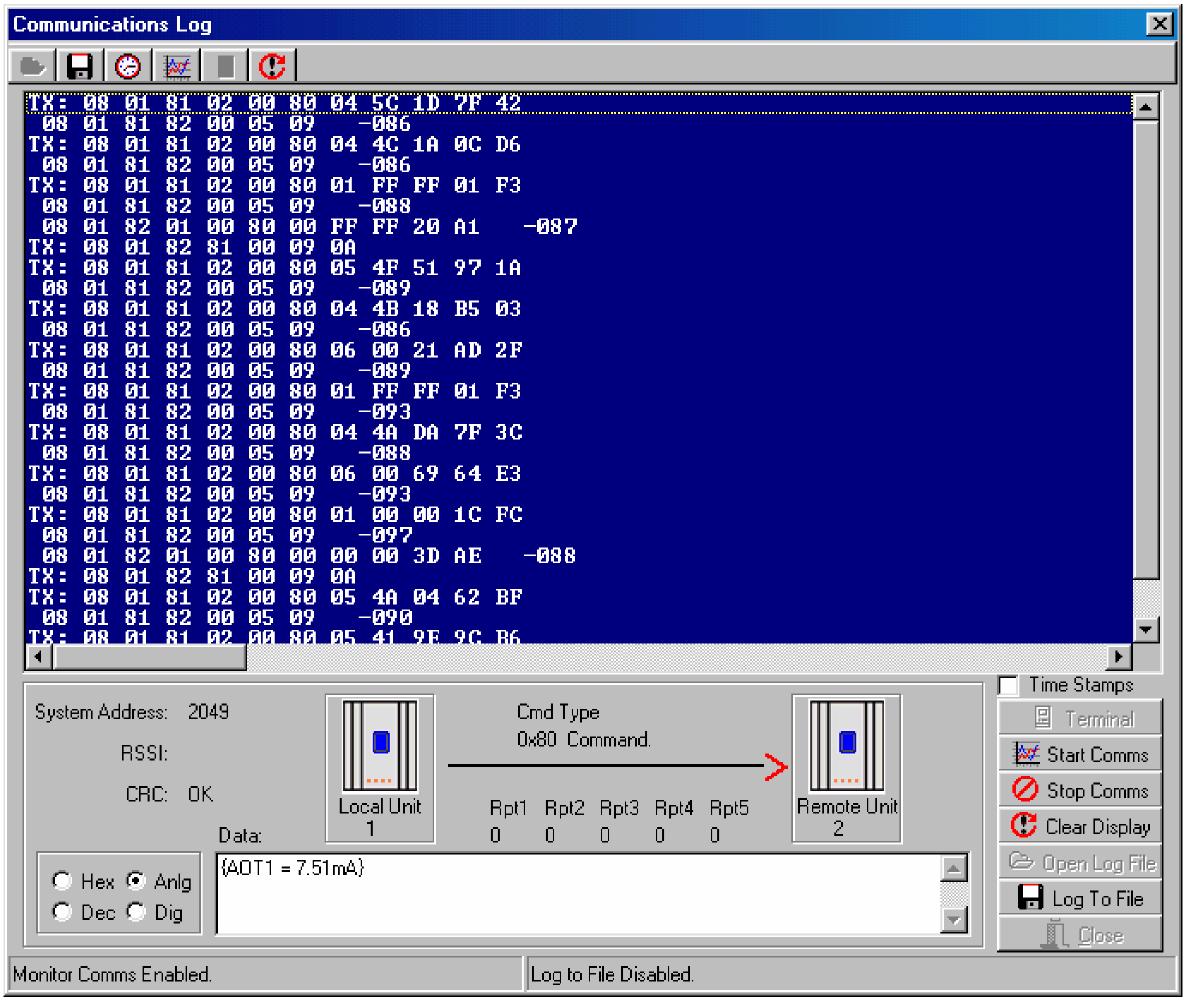
For example, if the noise level is 120, then the radio signal must be 98 or lower for a reliable path. If the noise level is 100, then the radio signal must be 90 or lower.

A simpler method when remote units are not easily accessible is to cause a transmission from the local unit to the remote unit (by setting a digital input which maps to the remote unit, for example). The meter will latch the received signal from the remote unit for half a second, allowing the received level to be read.

If any obstructions in the radio path are likely to change, then this should be allowed for. For example, if the radio test is done during winter and the radio path is through trees without leaves, then another 10dB of margin should be allowed for to cover summer conditions when the trees have leaves.

When using directional antennas (i.e. YAGI antennas) this feature may be used to peak the received signal level. Set-up the remote unit to transmit tone reversals as described above, and observe the signal indication while adjusting the orientation of the antenna. A peak in signal level indicates optimum orientation of the antenna.

6.2.4 Comms Logging



```
TX: 08 01 81 02 00 80 04 5C 1D 7F 42
 08 01 81 82 00 05 09   -086
TX: 08 01 81 02 00 80 04 4C 1A 0C D6
 08 01 81 82 00 05 09   -086
TX: 08 01 81 02 00 80 01 FF FF 01 F3
 08 01 81 82 00 05 09   -088
 08 01 82 01 00 80 00 FF FF 20 A1   -087
TX: 08 01 82 81 00 09 0A
TX: 08 01 81 02 00 80 05 4F 51 97 1A
 08 01 81 82 00 05 09   -089
TX: 08 01 81 02 00 80 04 4B 18 B5 03
 08 01 81 82 00 05 09   -086
TX: 08 01 81 02 00 80 06 00 21 AD 2F
 08 01 81 82 00 05 09   -089
TX: 08 01 81 02 00 80 01 FF FF 01 F3
 08 01 81 82 00 05 09   -093
TX: 08 01 81 02 00 80 04 4A DA 7F 3C
 08 01 81 82 00 05 09   -088
TX: 08 01 81 02 00 80 06 00 69 64 E3
 08 01 81 82 00 05 09   -093
TX: 08 01 81 02 00 80 01 00 00 1C FC
 08 01 81 82 00 05 09   -097
 08 01 82 01 00 80 00 00 00 3D AE   -088
TX: 08 01 82 81 00 09 0A
TX: 08 01 81 02 00 80 05 4A 04 62 BF
 08 01 81 82 00 05 09   -090
TX: 08 01 81 02 00 80 05 41 9E 9C B6
```

System Address: 2049

RSSI:

CRC: OK

Cmd Type

0x80 Command.

Data:

(AOT1 = 7.51mA)

○ Hex ● Anlg

○ Dec ○ Dig

☐ Time Stamps

Monitor Comms Enabled.

Log to File Disabled.

These options allow logging and display of radio communications. To start "Comms logging":

- select option the "Comms" option from the diagnostics menu (see section 6.2.3),
- select 'Stop Terminal' and then
- select 'Start Comms'.

The display will show radio messages transmitted and received. Messages starting with TX are transmitted messages, and received messages start with a small line indent. At the end of each received message is the RSSI (radio signal strength) in dBm.

If you select any message line with the mouse, information about the message will be displayed at the bottom of the screen - the system address, RSSI and CRC (error-check) status. The "text box" at the bottom middle of the screen decodes the message - that is, it decodes the message to display I/O channel and value.

You can display the register values in Decimal by selecting "Dec" at the bottom of the screen. If you select "Dig", the values will be displayed as a 0 or 1 digital value (1 if the 16-bit value is greater than 50% - that is, the most significant bit is 1). If you select "Anlg", the value will be displayed as a 4-20mA range.

To stop "comms logging", select the "Stop Comms" box. You can then shut down the diagnostics

screen, or select “Terminal” to go back to the diagnostics menu.

Add Time Stamps

Time stamps can be added by selecting the “Time Stamps” box. This will allow the current time and date to be displayed with each message. The “Comms log” can be saved to a file for future reference by selecting “Log to File”.

6.3 Radio Path Testing

To carry out a radio path test, you will need two WI-I/O 9-x modules. One module will be “fixed” and the other “mobile”. Both units will need power supplies and antennas. The power supply for the mobile unit is normally a 12V battery, but make sure that the battery is fully charged - batteries with low voltage will lead to low radio power which will affect the test result.

The object of the test is to determine whether radio paths are reliable, marginal or unreliable. A reliable path will have a margin of at least 10dB above the background noise level in good weather - this margin is enough to ensure that the radio path remains reliable in poor conditions. A marginal path will work reliably in good conditions, however will fail during poor conditions. If the test is carried out during rainy or foggy weather, then a margin of only 5dB is required.

Procedure:

- ☐ Configure the modules to the same system address, and on each module, configure DI1 to DO1 on the other module. At the fixed module, wire DO1 to DI1 such that DI1 will turn ON when DO1 turns ON. Connect a switch to DI1 on the mobile unit.
- ☐ When the modules are close to each other, test the system - close the switch, forcing the mobile unit to transmit. The mobile unit will transmit to the fixed unit, and the fixed unit will transmit back to the mobile unit, activating DO1. Turning off the switch will result in two radio transmissions, turning off DO1. Each time the switch is changed, there should be two radio messages (two sets of TX/RX flashes) at the mobile unit. Note that when the modules are within a couple of metres, they may not work well with antennas connected - in this case, test without antennas.
- ☐ Set up the fixed module in one of the test positions - this is normally at a control centre or repeater site. Fix the antenna in a temporary fashion. You will need to make an initial assessment on how high the antenna should be mounted.
- ☐ Take the mobile module to the other end of the radio path. The antenna at this end can be either held by the tester, or fixed in a temporary fashion. Note that a person’s body will affect the radiation pattern of an antenna, so if the antenna is hand-held and the test is not successful, try again with the antenna fixed to a 1 metre length of plastic pipe or timber. The tester holds the length of pipe or timber with the antenna above head height.
- ☐ Test the radio path by operating the switch. If the radio path is short, and there is a high level of confidence that the radio path will be reliable, the result can be checked by simply looking at the

TX/RX leds on the mobile unit. If each TX flash is followed immediately by a RX flash (that is, the TX flash does not flash twice or more times before the RX flashes), then the radio path is likely to be reliable. Operate the switch several times - do not rely on one test. If the test is being done outside, the leds will need to be shaded to view the flashes.

- ☐ If the radio path is uncertain, then the result should be measured by connecting a laptop computer, following the procedure outlined in this manual for measuring the radio signal strength. Before the switch is operated, the background noise level should be measured and recorded. This measurement is likely to "jump around" or oscillate, to determine an average measurement. Now operate the switch several times - take the average measurement of the signal transmitted from the fixed unit.
- ☐ The radio path is reliable if the transmitted signal is 10dB above the noise level, or better than –98dBm. For example, if the noise level is –115dBm, then the minimum level for reliability is –98dBm. If the noise level is –100dBm, then you need –90dBm for a reliable path. If the laptop displays a scale measurement instead of a numerical measurement, then the transmitted signal should be at least 3 divisions, and at least 2 divisions above the noise level.
- ☐ If the weather is poor during the test, then the transmitted signal needs to be 5dB above noise, or 1 division. It is best not to do radio tests during poor weather.
- ☐ Record these measurements for comparison later during commissioning or if the system has problems later.

If the radio path test is not successful:

1. Increasing the height of the antenna at either module, or at both modules can significantly improve the result. Sometimes moving the antenna to the side helps, if there is an obvious obstruction in the radio path.
2. Change one or both antennas to a higher gain if regulations allow.
3. Use a shorter coaxial cable between the antenna and the WI-I/O 9-x.(this may involve moving WI-I/O 9-x nearer to antenna mounting), or use a different coaxial cable with lower loss.
4. If a reliable radio path is not possible because of distance or path obstructions, you will need to consider using a repeater module. The ideal repeater is another module in the system, in a good location to act as a repeater. If this is not the case, you need to consider installing a module to act specifically as a repeater.

Chapter Seven WARRANTY & SERVICE

We are pleased that you have purchased this product.

W INTERCONNECTIONS products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W INTERCONNECTIONS, W INTERCONNECTIONS will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W INTERCONNECTIONS' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W INTERCONNECTIONS is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W INTERCONNECTIONS is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W INTERCONNECTIONS or its representatives or by any other party, except as expressed solely in this document..

Full product specifications and maintenance instructions are available from your Service Agent, your source of purchase, or from the master distributor in your country upon request and should be noted if you are in any doubt about the operating environment for your equipment purchase

In the unlikely event of your purchase being faulty, your warranty extends to free repair or replacement of the faulty unit, after its receipt at the master distributor in your country. Our warranty does not include transport or insurance charges relating to a warranty claim.

Should you wish to make a warranty claim, or obtain service, please forward the module to the nearest authorised Service Agent along with proof of purchase. For details of authorised Service Agents, contact your sales distributor.

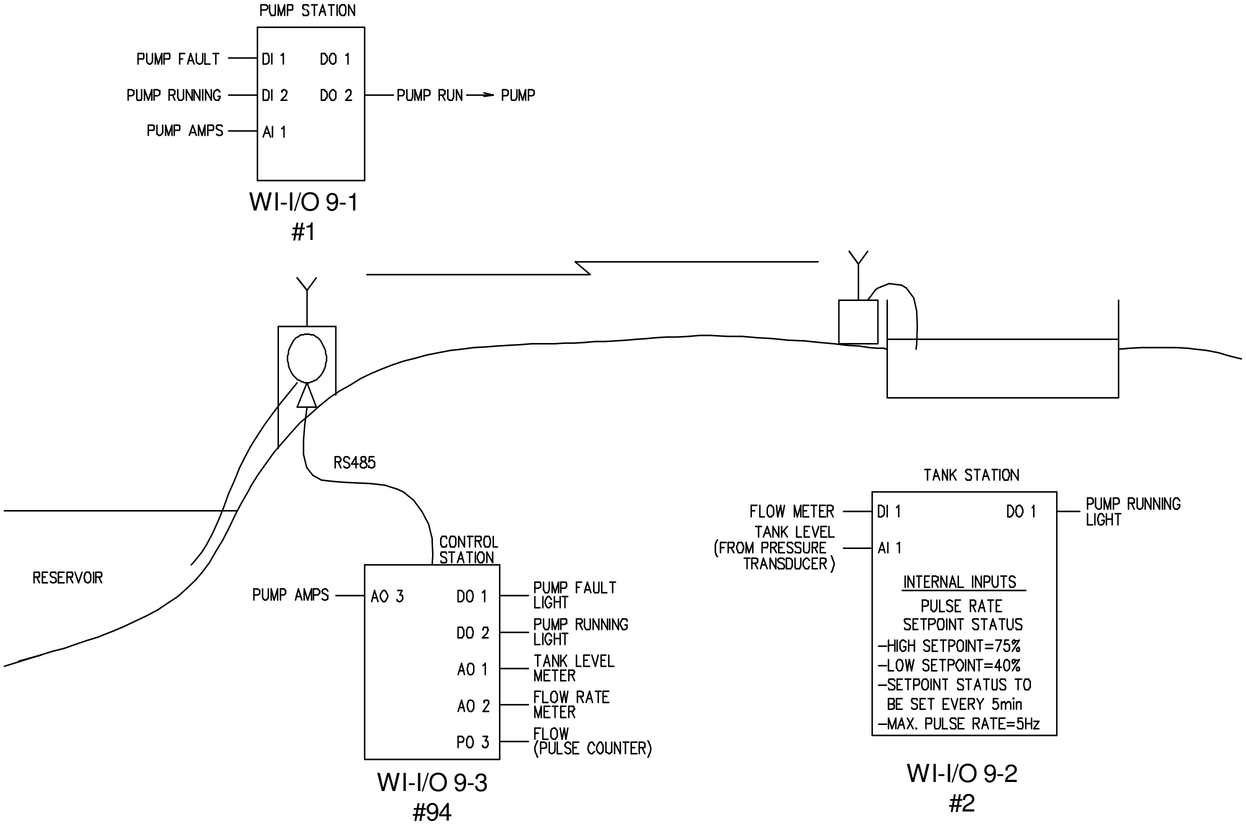
Appendix A SYSTEM EXAMPLE

The following example of a system is a comprehensive guide to using some of the features of the range and design of system.

The example application is a pump station which supplies water from a reservoir to a tank station. Signals are transferred between the pump station and tank station by radio - the distance between the two stations is 10 km (6 mile), and the radio path is heavily obstructed by buildings and trees. A control station is located near the pump station, and there is an existing signal cable between the control station and the pump station.

A WI-I/O 9-1 module is installed at the pump station (with address 1) and a WI-I/O 9-2 module is installed at the tank station (with address 2). Because the signal cable to the control station does not have enough cores for all of the signals required, the signal cable is used as a RS485 cable and a WI-I/O-EX-1-S-x-3 module is installed at the control station (with address 96). As this module has an address greater than 95, the WI-I/O 9-1 at the pump station will communicate to it via its serial port.

The following diagram represents the system:-



The following design points should be noted :-

- A test of the radio path between the pump station and the tank station indicated that the radio path

would be reliable provided antennas were installed at 6 m above the ground. At each site, the coaxial cable would be approx 30 feet in length, so it was decided to use 6 element Yagi antennas with RG58 coaxial cable - the Yagi antennas would compensate for the loss in the cable.

- At the tank station, there was an existing light pole with a mains power supply - the light pole was 10m high. Permission was obtained to mount the antenna from the pole and to use the power supply for the radio telemetry module.

  As there was no existing electrical panel at this station, a small steel enclosure was installed on the light pole. A 2 Amp-Hour sealed battery was installed to provide power during any mains failure. The flow and level transducer were powered from the 24VDC loop supply provided by the module.

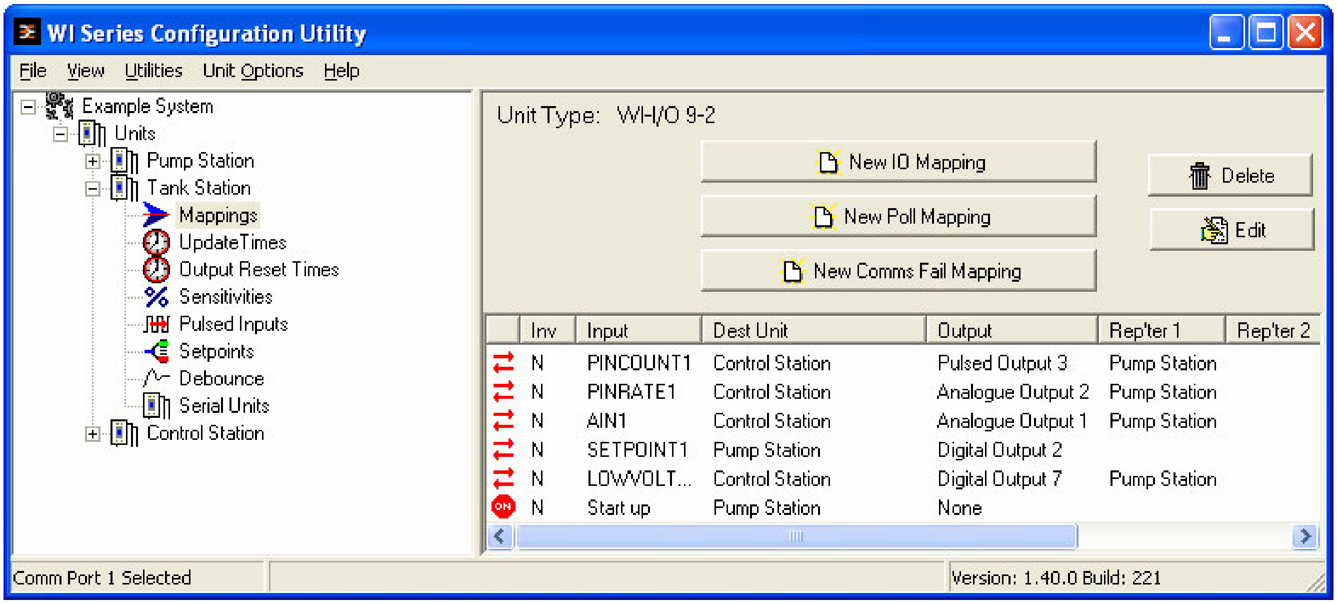
- At the pump station, the antenna was mounted on a 10' J-bracket installed on the roof of the pump station building. The final height of the antenna was approx 20 feet. Care was taken to align the Yagi antennas so they pointed at each other. The Yagi antennas were installed with horizontal polarity - that is, with the elements horizontal. These antennas will not "hear" other radio users on the same radio channel which generally use vertical polarity.

  There was an existing electrical enclosure at the pump station, and the WI-I/O 9-x module was installed inside this enclosure. The module was powered from a 24VDC supply with a 2 Amp Hour sealed battery as backup.

- At the control station, the WI-I/O-EX-1-S-x module was installed inside the existing control panel enclosure. The module was powered from an existing 24VDC power supply.

Tank Station Configuration

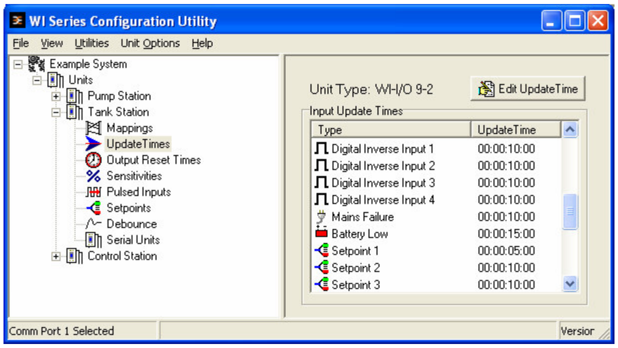
The WI-I/O 9-2 module has the following configuration :-



Unit Type: WI-I/O 9-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2
⇄	N	PINCOUNT1	Control Station	Pulsed Output 3	Pump Station	
⇄	N	PINRATE1	Control Station	Analogue Output 2	Pump Station	
⇄	N	AIN1	Control Station	Analogue Output 1	Pump Station	
⇄	N	SETPOINT1	Pump Station	Digital Output 2		
⇄	N	LOWVOLT...	Control Station	Digital Output 7	Pump Station	
ON	N	Start up	Pump Station	None		

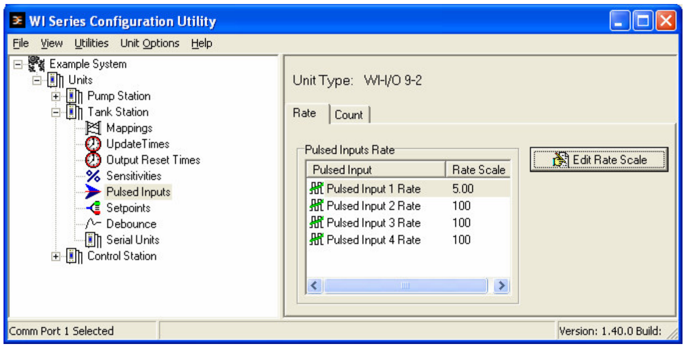
Note the following points in the configuration:



Unit Type: WI-I/O 9-2

Input Update Times

Type	UpdateTime
Digital Inverse Input 1	00:00:10:00
Digital Inverse Input 2	00:00:10:00
Digital Inverse Input 3	00:00:10:00
Digital Inverse Input 4	00:00:10:00
Mains Failure	00:00:10:00
Battery Low	00:00:15:00
Setpoint 1	00:00:05:00
Setpoint 2	00:00:10:00
Setpoint 3	00:00:10:00

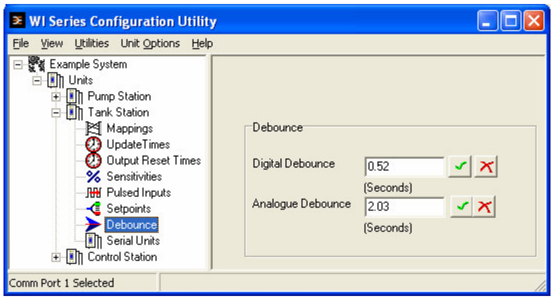


Unit Type: WI-I/O 9-2

Pulsed Inputs Rate

Pulsed Input	Rate Scale
Pulsed Input 1 Rate	5.00
Pulsed Input 2 Rate	100
Pulsed Input 3 Rate	100
Pulsed Input 4 Rate	100

- #1 is a repeater for communications between #2 and #94



Debounce

Digital Debounce 0.52 (Seconds)

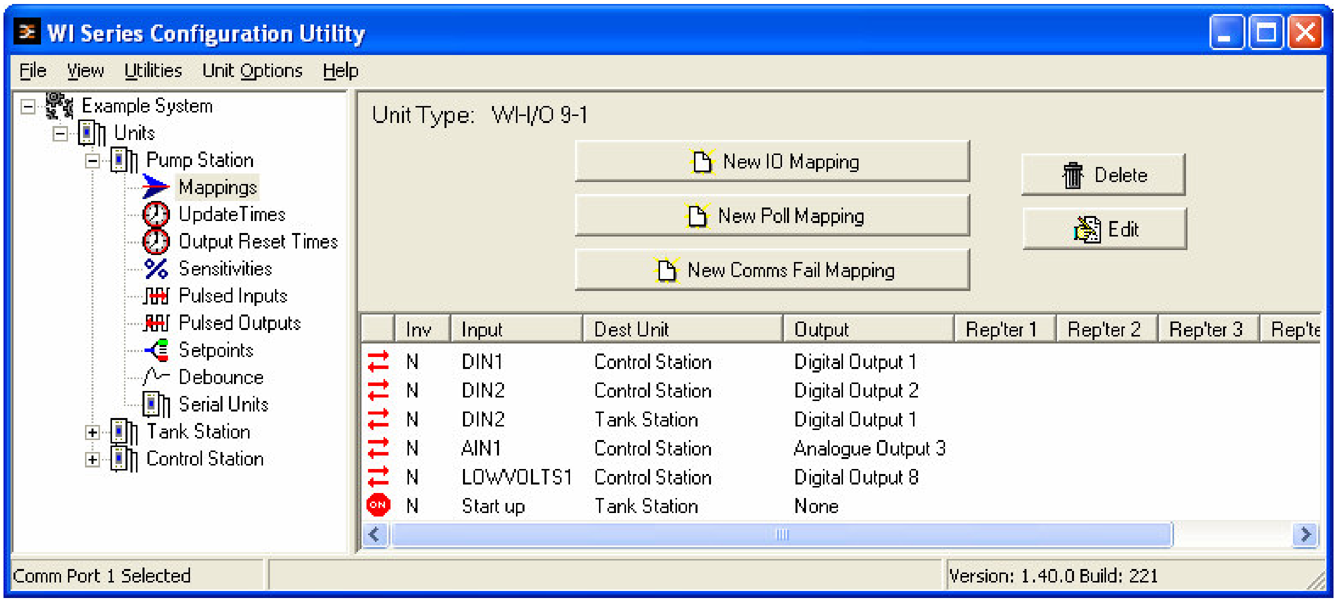
Analogue Debounce 2.03 (Seconds)

- The pulse rate scaling for PIN1 has been set to 5 Hz to match the maximum flow rate of the flow meter. Note that PIN1 has not been configured for "divide by 10" (for 1000 Hz pulse signals).
- AIN1 (the level transducer) is mapped to AO1 at the WI-I/O 9-3. The analog debounce has been set to 2 sec. This is because of concern of wave action on the surface of the tank causing un-necessary change transmissions. This debounce time will also operate on the Pulse Rate value, but as the flow rate changes slowly, this will not affect the performance of this signal.

- SETPOINT1 (the set-point status for AI1) is mapped to DO2 of #1 (pump station). The set-point values for this setpoint have been set to 40% and 75%. When the tank level drops to 40%, DO2 at the pump station will activate to start the pump. When the level rises above 75%, DO2 will reset to stop the pump.
- The update time for SETPOINT1 has been changed to 5 minute, as required.
- An additional mapping has been entered - LOW VOLT has been mapped to DO7 at #94 via #1 (DO7 at the control station). This mapping is for future use - it will provide a low battery voltage alarm for the tank station. The update time for this mapping has been set to the maximum time of 15 minutes to reduce loading of the radio channel.
- A Start-up poll has been configured for #1, as DO1 at the tank station is controlled from the pump station. Note that no comms fail reset time has been configured for DO1. As this output drives an indication only, the indication will show the last correct status even during communication failures.

Pump Station Configuration

The WI-I/O 9-1 module has the following configuration :-



Unit Type: WI-I/O 9-1

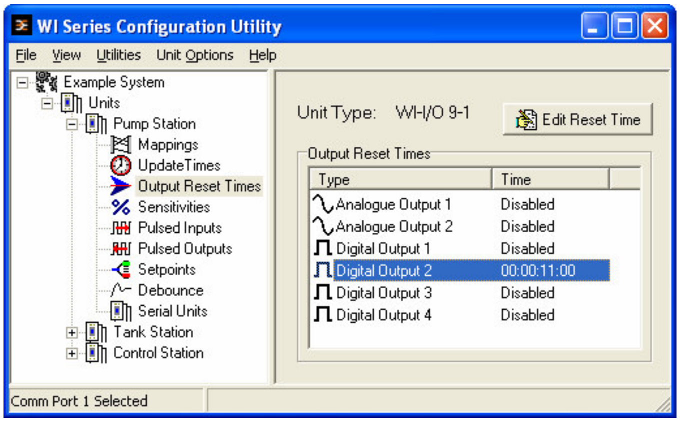
	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'te
⇄	N	DIN1	Control Station	Digital Output 1				
⇄	N	DIN2	Control Station	Digital Output 2				
⇄	N	DIN2	Tank Station	Digital Output 1				
⇄	N	AIN1	Control Station	Analogue Output 3				
⇄	N	LOWVOLTS1	Control Station	Digital Output 8				
ON	N	Start up	Tank Station	None				

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Note the following points in the configuration:

- Note that no repeater address is necessary between #1 and #94.
- DIN2 (pump running signal) has two mappings - a mapping to DO1 at #2 (tank station) and DO2 at #94 (control station). When DIN2 changes, there will be two separate change messages transmitted - one by radio to #2 and one by serial link to #96.
- AIN1 (pump amps) is mapped to AO3 at #94 (control station).



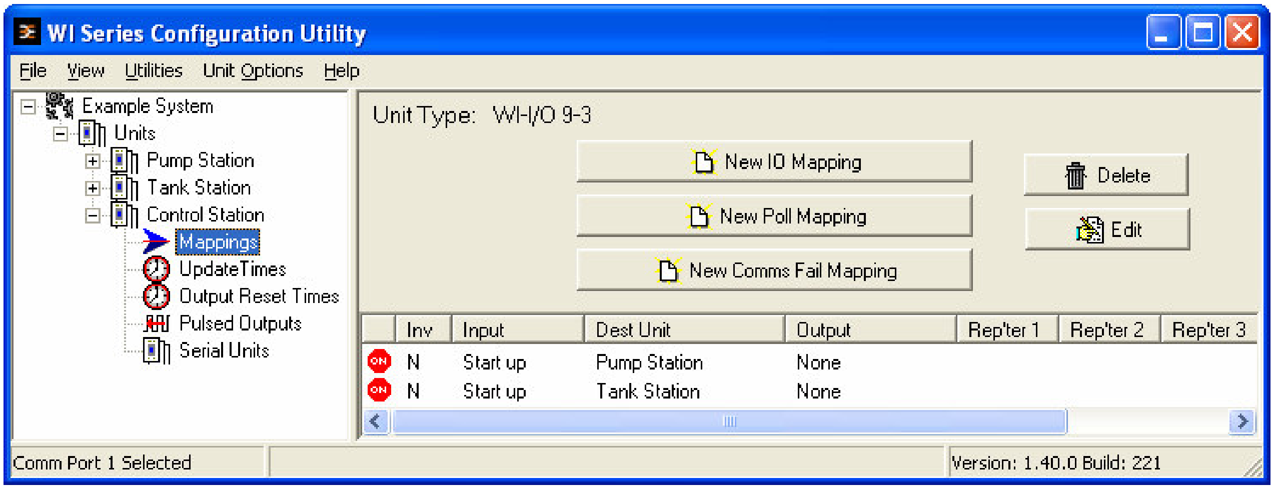
Unit Type: WI-I/O 9-1

Type	Time
Analogue Output 1	Disabled
Analogue Output 2	Disabled
Digital Output 1	Disabled
Digital Output 2	00:00:11:00
Digital Output 3	Disabled
Digital Output 4	Disabled

- An additional mapping has been entered - LOW VOLT has been mapped to DO8 at the control station. This mapping is for future use - it will provide a low battery voltage alarm for the pump station.
- A Start-up poll has been configured for #2, as DO2 at the pump station is controlled from the tank station. Note that a comms fail reset time of 11 minutes has been configured for DO2. This means that if a message has not been received for DO2 within 11 minutes, DO2 will reset and switch off the pump. The 11 min time was chosen as it means that two successive update messages have to be missed before the pump is reset, and there is no problems if the pump runs for 11 minutes during a system failure (the tank will not overflow during this time).

Control Station Configuration

The WI-I/O-EX-1-S-3 module has the following configuration :-

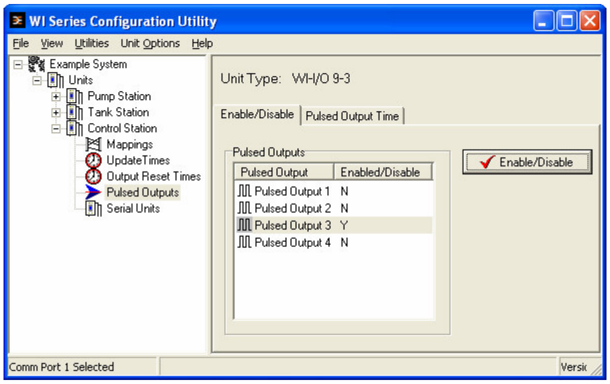


Unit Type: WI-I/O 9-3

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
ON	N	Start up	Pump Station	None			
ON	N	Start up	Tank Station	None			

Note the following points in the configuration:

- The only mappings are Start-up polls. Note that there are two separate polls, one for each remote module.
- PO 3 has been configured as a PO. Its pulse output update time is the same as the PI update time at the remote module (both have been left at their default value of 1 minute).



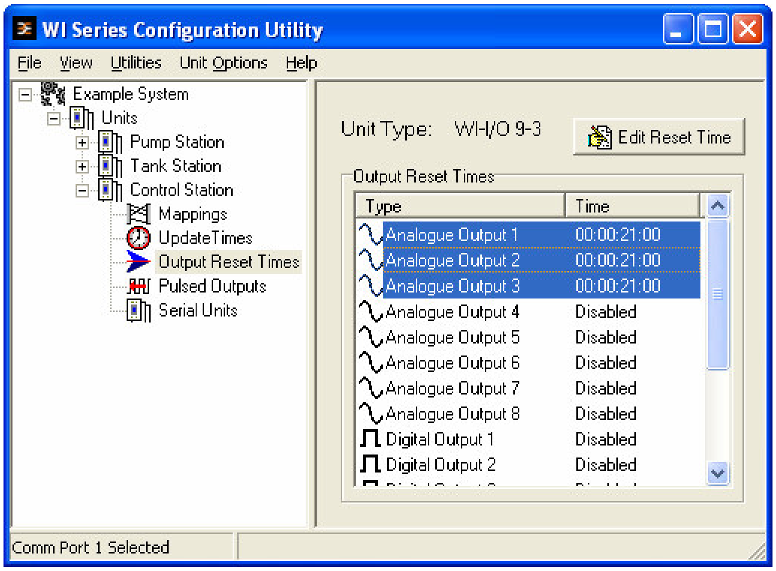
Unit Type: WI-I/O 9-3

Pulsed Output	Enabled/Disable
Pulsed Output 1	N
Pulsed Output 2	N
Pulsed Output 3	Y
Pulsed Output 4	N

- Reset times have been selected for the analog outputs (21 minutes) but not the digital outputs. In the event of a system failure, the digital outputs will stay at their last correct status, but the analog outputs will reset to 0 mA.

System Failure Alarm

After the system had been running for some time, the operators wanted a "system failure" output at the control station, to warn the operators that there was a fault with the system.



Unit Type: WI-I/O 9-3

Type	Time
Analogue Output 1	00:00:21:00
Analogue Output 2	00:00:21:00
Analogue Output 3	00:00:21:00
Analogue Output 4	Disabled
Analogue Output 5	Disabled
Analogue Output 6	Disabled
Analogue Output 7	Disabled
Analogue Output 8	Disabled
Digital Output 1	Disabled
Digital Output 2	Disabled

The following configuration was added :

At #2 (tank station), Inverse DI4 → DO4 at #94 via 1 ; DI4 Update time = 1 minute

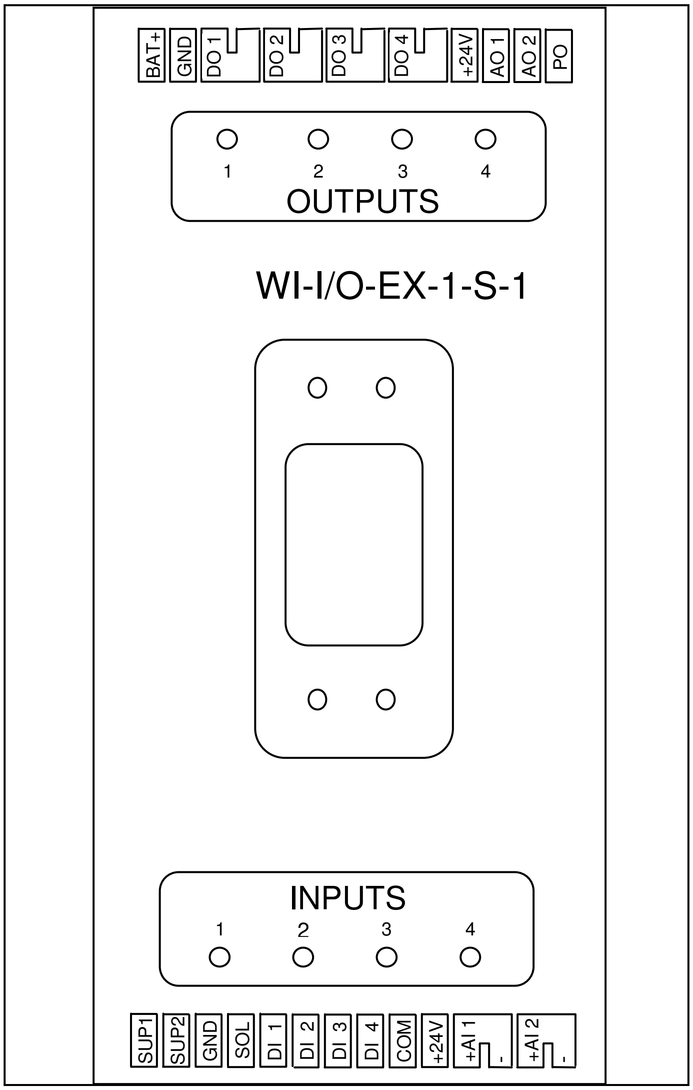
At #94 (control station), DO4 Comms fail reset time = 3.5 min

At the control station, DO4 was a "system OK" signal. It was normally active - if the signal reset, then this represented a system failure. At the tank station, there is no signal wired to DI4. By mapping Inv DI4 to DO4 at the control station, a message is transmitted every minute to this output to activate it. The message is transmitted via the radio link to #1, and then by the serial link to #94. If anything happened to either module #2 or module #1, or the radio link, or the serial link, then the update messages for DO4 will not be received at the control station module. After 3.5 Minutes, DO4 will reset indicating a problem.

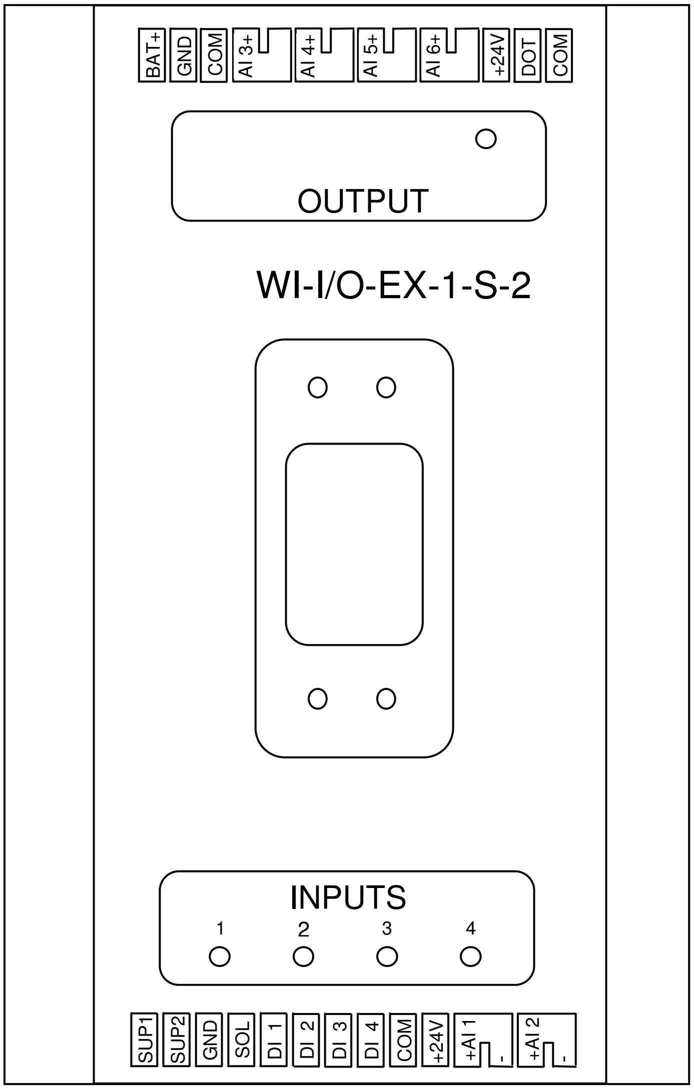
The time of 3.5 minutes was selected as this means that 3 successive update messages have to be missed before a system alarm occurs. Also note, that if module #94 fails, DO4 will reset and give an alarm signal.

Appendix B TERMINAL LAYOUTS

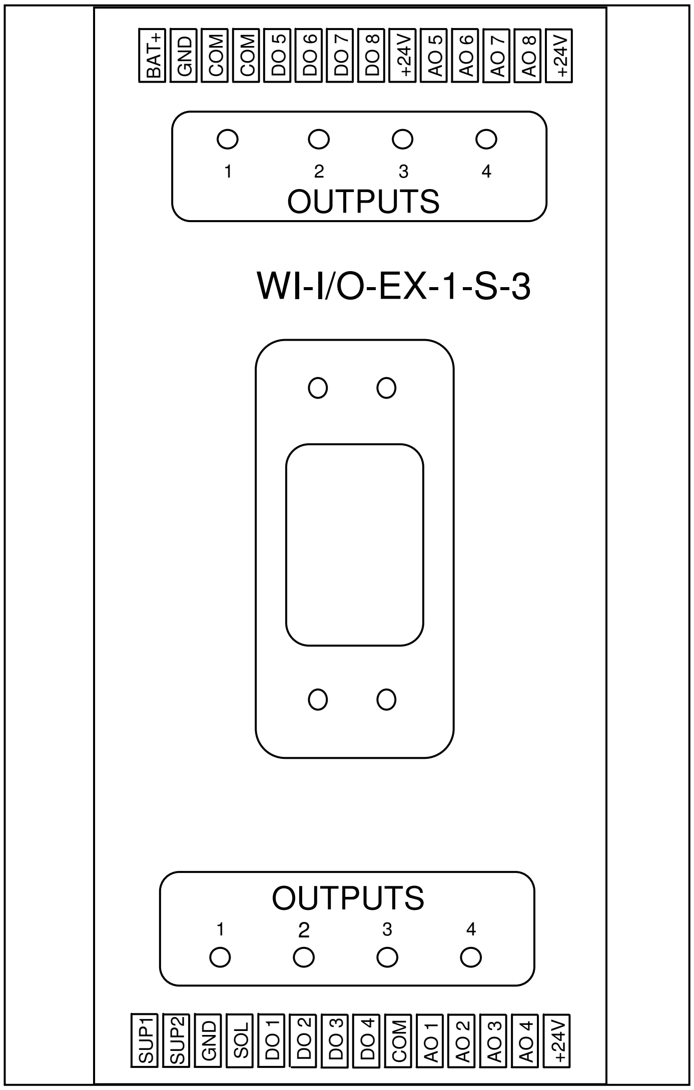
WIRING DRAWING -WI-I/O 9-1 WI-I/O-EX-1-S-1



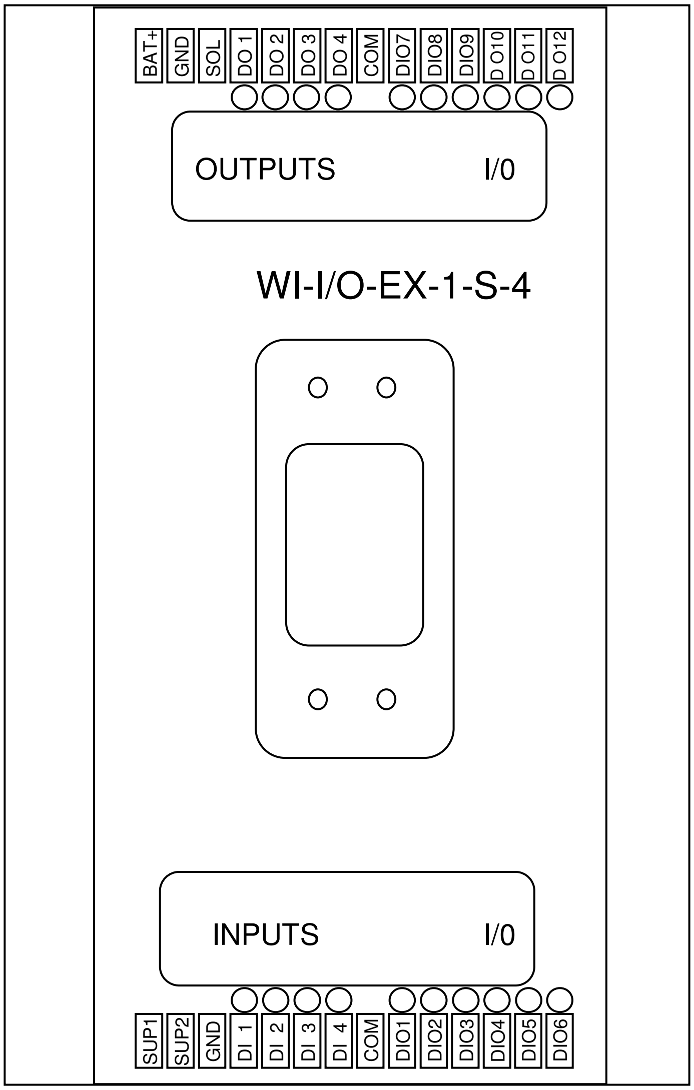
WIRING DRAWING - WI-I/O 9-2 WI-I/O-EX-1-S-2



WIRING DRAWING - WI-I/O 9-3, WI-I/O-EX-1-S-3



WIRING DRAWING -WI-I/O 9-4, WI-I/O-EX-1-S-4



WI-I/O 9-1
Installation Guide

WARNING!

EXPLOSION HAZARD

DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON – HAZARDOUS

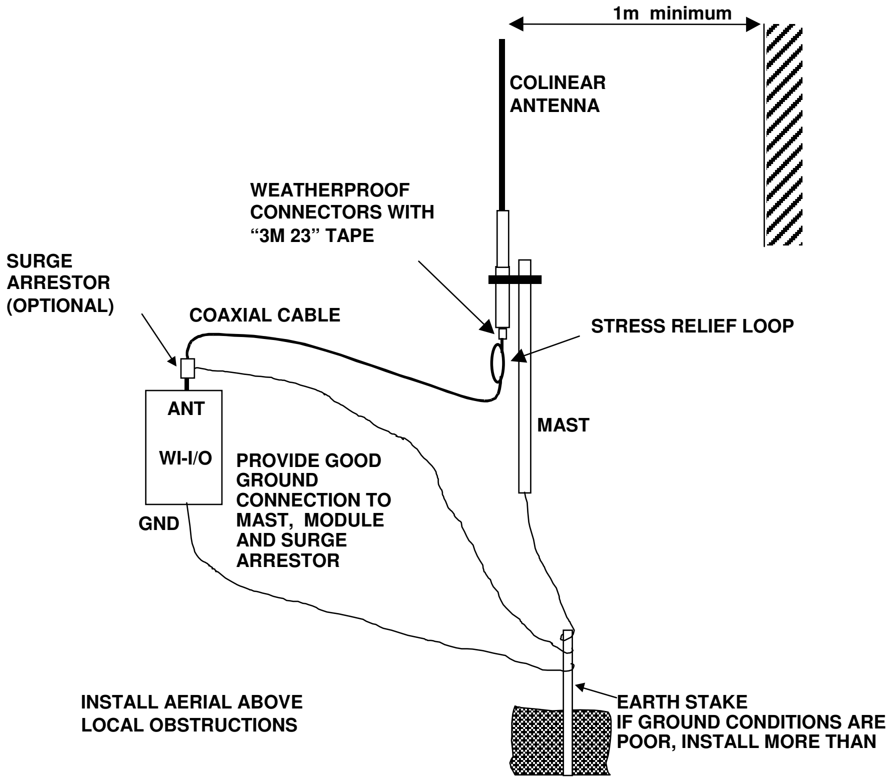
FCC Notice

This device complies with Part 15.247 of the FCC Rules.
Operation is subject to the following two conditions:

1) This device may not cause harmful interference and
2) This device must accept any interference received, including interference that may cause undesired operation

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS 1 DIVISION 2 GROUPS ABC AND D OR NON HAZARDOUS LOCATIONS ONLY

Aerial Installation



ANTENNA INSTALLATION
Antennas should be installed by experienced contractors.

WI-I/O 9-1 Installation

Power supply: (A) 12-24VAC 1.5 Amp CSA Certified Class 2

(B) 15-30VDC 1.5 Amp CSA Certified Class 2

(C) Supply battery or 11-15VDC

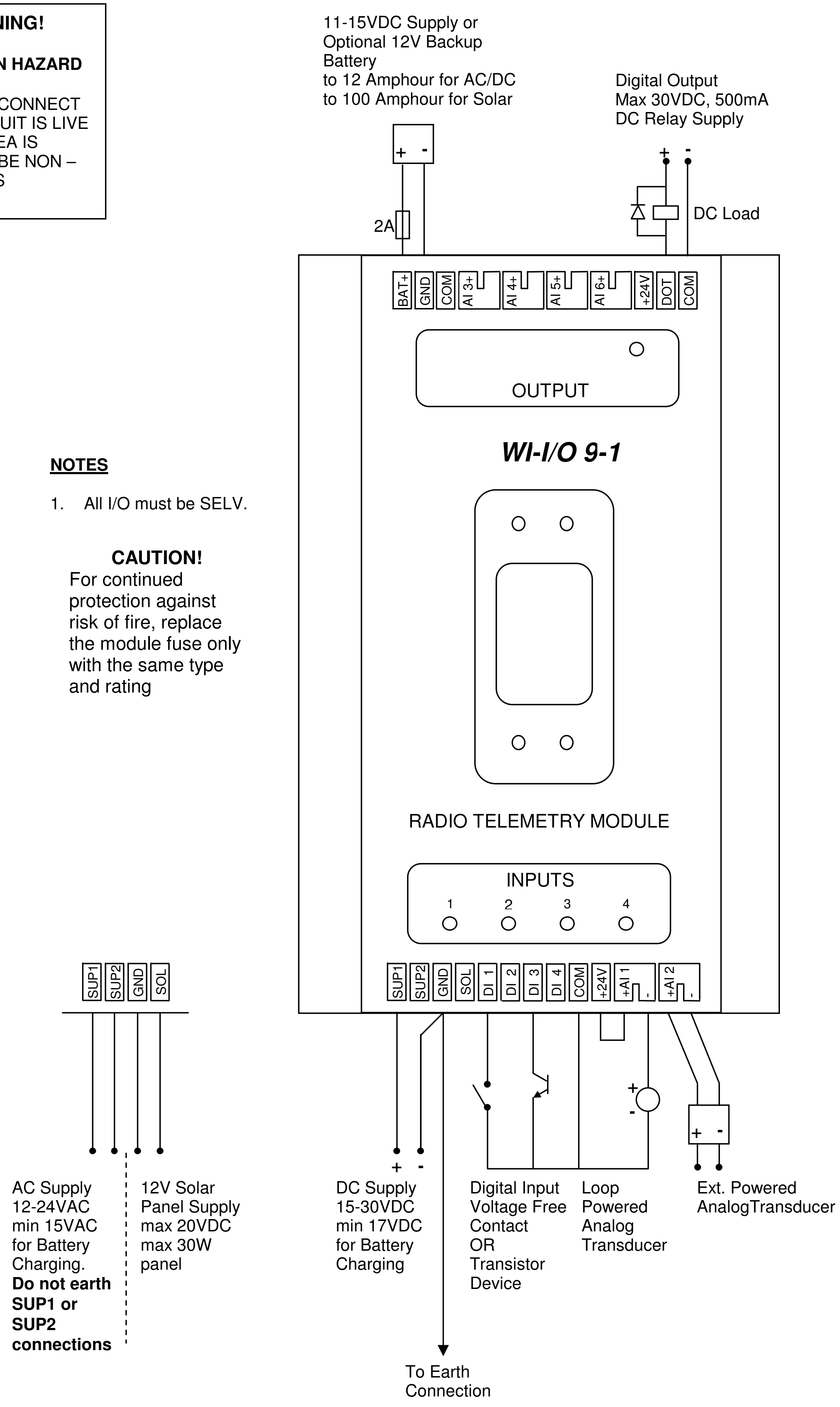
(D) Solar panel with solar battery

Choose option and wire as shown

NOTES

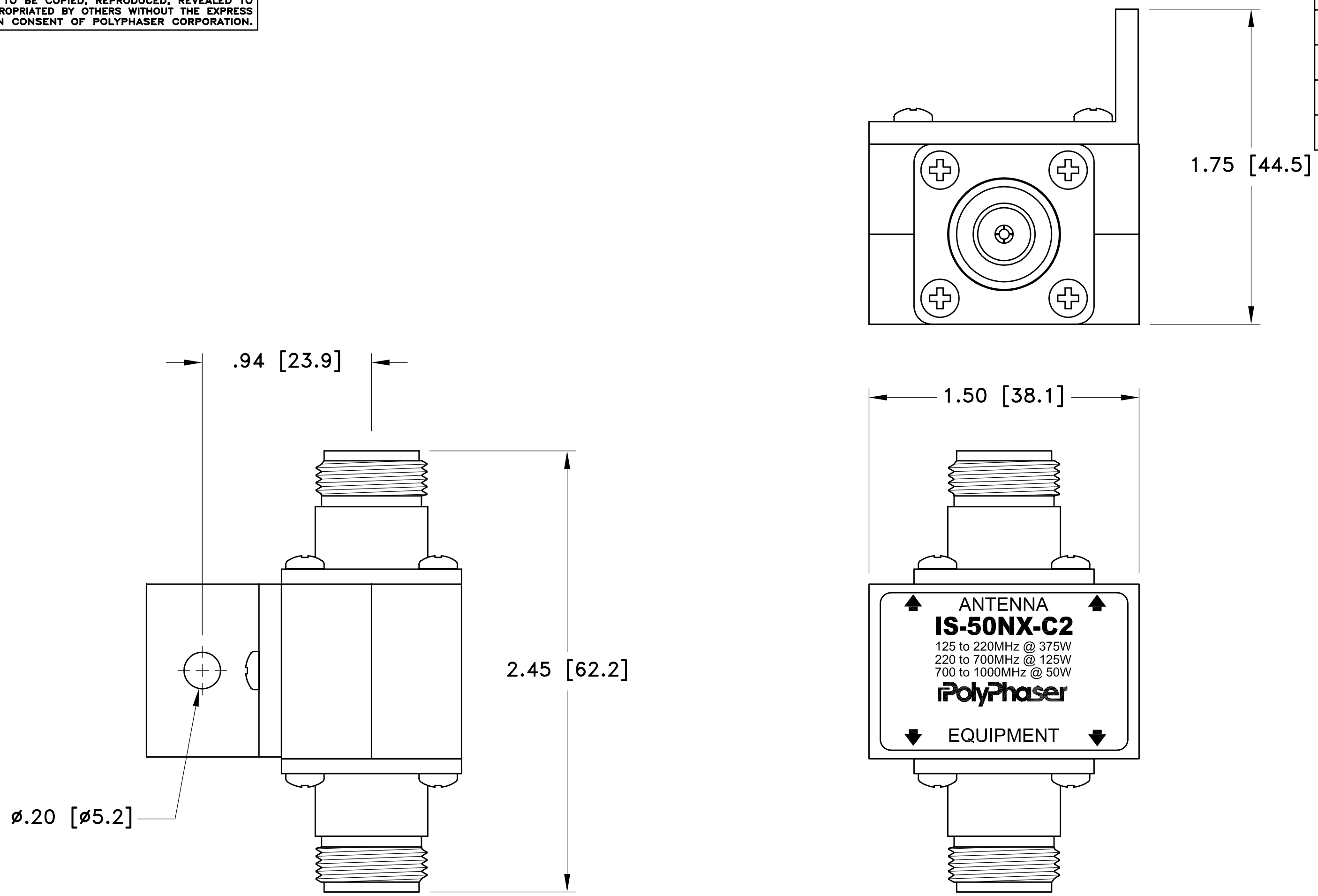
1. All I/O must be SELV.

CAUTION!
For continued protection against risk of fire, replace the module fuse only with the same type and rating



REVISIONS

REV LTR	DATE	ENG	MKTG	Q.A.
A	01/30/96 PJP	T. K.	– –	R. M.
B	06/30/99 JCG	K.C.B.	T.G.F.	R. M.
C	01/16/01 SH	KCB	PH	RM
D	11/18/02 SH	LC	SD	LJ



MAXIMUM CHARACTERISTICS

SURGE:
50kA IEC 1000–4–5 8/20µs WAVEFORM 500 JOULES

TURN ON:
600Vdc ±20%

TURN ON TIME:
2.5ns FOR 2kV/ns

FREQUENCY RANGE:
125MHz TO 1GHz

VSWR:
≤1.1:1 OVER FREQUENCY RANGE

INSERTION LOSS:
≤0.1dB OVER FREQUENCY RANGE

TEMPERATURE:
–45°C TO +85°C STORAGE/OPERATING +50°C

CUSTOMER APPROVAL:________________ DATE:________

ALL DIMENSIONS SHOWN ABOVE ARE FOR REFERENCE ONLY.

DRAFTER J. CALLISTER	DATE 09/21/93	PolyPhaser CORPORATION P.O. BOX 9000, MINDEN, NV 89423–9000 (775) 782–2511 FAX (775) 782–4476
MECH ENGINEER – – – –	DATE – – –	DWG NO/PART NO/DESCRIPTION
ELEC ENGINEER J. JONES	DATE 04/12/95	IS–50NX–C2 CUSTOMER PRINT
MARKETING – – – –	DATE – – –	
QUALITY DEPT R. MATHEUS	DATE 04/12/95	CAGE CODE 61114 · FILE NAME –C1 · SCALE 1/1 · SHEET 1 OF 1

COOPER Bussmann

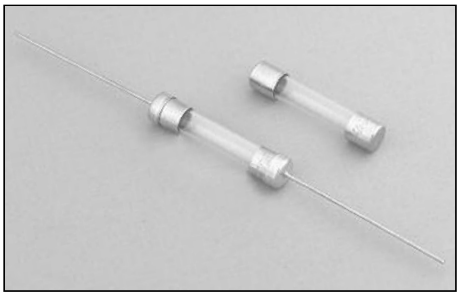
1/4" x 1-1/4" Fuses

AGC Series, Fast Acting, Glass Tube

Description

- Fast-acting, glass tube
- Optional axial leads available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

RoHS 2002/95/EC



ELECTRICAL CHARACTERISTICS	
% of Amp Rating	**Opening Time**
100%	None
135%	60 Minutes Maximum
200%	120 Seconds Maximum

Agency Information

- UL Listed Card: AGC 1/500-10
- UL Recognition Card: AGC 11-45
- CSA Component Acceptance Card (Class No. 1422 30)
- CSA Certification Card (Class No. 1422 01)

Environmental Data

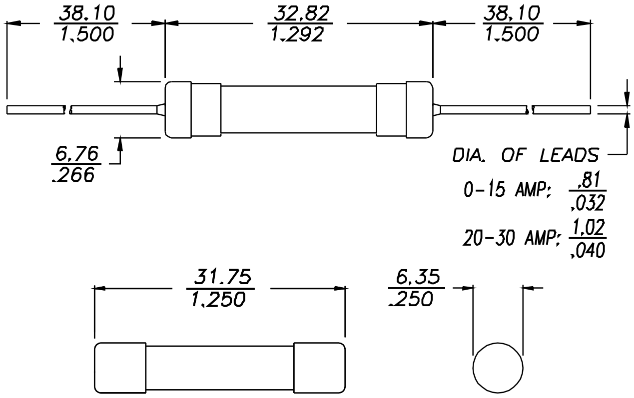
- Shock: 1/100A thru 3/4A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A thru 30A – MIL-STD-202, Method 204, Test Condition A (Except 5g, 500HZ)

Ordering

- Specify packaging, product, and option code

Dimensions ($^{mm}/_{in}$)

Drawing Not to Scale



SPECIFICATIONS

Product Code	Voltage Rating AC	AC Interrupting Rating			Typical DC Cold Resistance** (ohms)	Typical Melting I²t† AC	Typical Voltage Drop‡
		250V	125V	32V			
AGC-1/20	250V	35A	10000A	-	4.500	0.00773	0.67
AGC-1/16	250V	35A	10000A	-	29.000	0.000181	10.41
AGC-1/10	250V	35A	10000A	-	12.565	0.000787	6.00
AGC-1/8	250V	35A	10000A	-	6.800	0.00131	4.67
AGC-3/16	250V	35A	10000A	-	4.900	0.00637	4.12
AGC-2/10	250V	35A	10000A	-	3.360	0.00435	4.51
AGC-1/4	250V	35A	10000A	-	2.300	0.0148	0.89
AGC-3/10	250V	35A	10000A	-	1.670	0.0208	2.88
AGC-3/8	250V	35A	10000A	-	1.203	0.0321	4.59
AGC-1/2	250V	35A	10000A	-	0.615	0.269	0.59
AGC-3/4	250V	35A	10000A	-	0.312	0.815	0.37
AGC-1	250V	35A	10000A	-	0.190	1.615	0.31
AGC-1-1/4	250V	100A	10000A	-	0.145	0.018	0.35
AGC-1-1/2	250V	100A	10000A	-	0.115	0.0149	0.27
AGC-2	250V	100A	10000A	-	0.078	0.00509	0.28
AGC-2-1/4	250V	100A	10000A	-	0.067	0.00588	0.26
AGC-2-1/2	250V	100A	10000A	-	0.057	0.00879	0.31
AGC-3	250V	100A	10000A	-	0.045	0.0167	0.25
AGC-4	250V	200A	10000A	-	0.030	0.0305	0.22
AGC-5	250V	200A	10000A	-	0.024	0.045	0.23
AGC-6	250V	200A	10000A	-	0.020	0.071	0.23
AGC-7	250V	200A	10000A	-	0.017	0.105	0.23
AGC-7-1/2	250V	200A	10000A	-	0.0146	-	-
AGC-8	250V	200A	10000A	-	0.014	0.152	0.19
AGC-9	250V	200A	10000A	-	0.012	0.21	0.18
AGC-10	250V	200A	10000A	-	0.008	0.492	0.20
AGC-12	32V	-	-	1000A	0.0070	-	-
AGC-14	32V	-	-	1000A	0.0062	-	-
AGC-15	32V	-	-	1000A	0.006	0.566	0.14
AGC-20	32V	-	-	1000A	0.004	1.438	0.12
AGC-25	32V	-	-	1000A	0.003	2.109	0.11
AGC-30	32V	-	-	1000A	0.002	3.807	0.12
AGC-35	32V	-	-	70A	0.0014	-	-
AGC-40	32V	-	-	80A	0.0019	-	-

** DC Cold Resistance (Measured at ≤10% of rated current)

† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

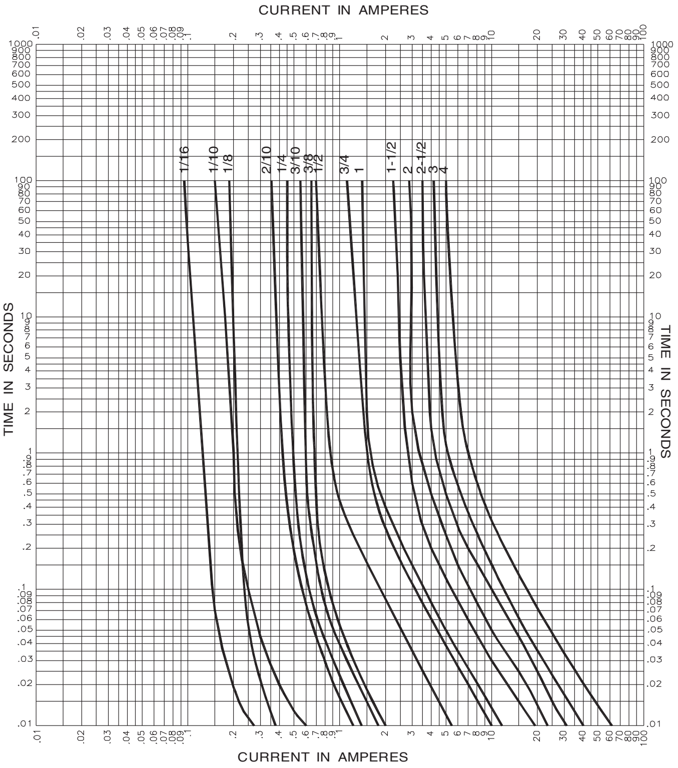
‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

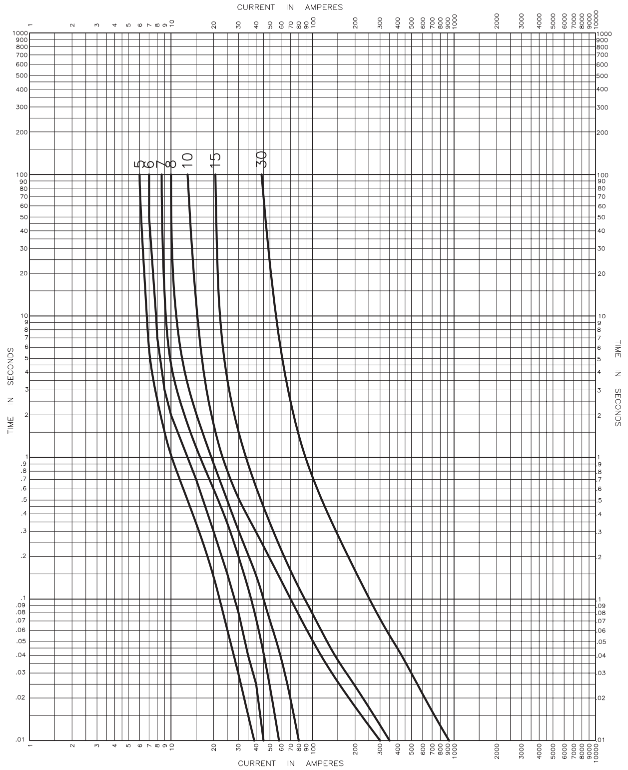
COOPER Bussmann

1/4" x 1-1/4" Fuses

AGC Series, Fast Acting, Glass Tube

TIME CURRENT CURVE





	PACKAGING CODE
Packaging Code	**Description**
BK	100 pieces of fuses packed into a cardboard carton with flaps folded
BK1	1,000 pieces of fuses packed into a cardboard carton with flaps folded
BK8	8,000 pieces of fuses packed into a cardboard carton with flaps folded

OPTION CODE	
Option Code	**Description**
B	Board Washable - Hermetically sealed to withstand aqueous cleaning
V	Axial leads - copper tinned wire with nickel plated brass overcaps
-R	RoHS compliant version

COOPER Bussmann

Visit us on the web at:
www.cooperbussmann.com

OC-2543 3/07

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+34 937 362 813
Fax: +34 937 362 719

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1 Jalan Kilang Timor
#06-01 Pacific Tech Centre
Singapore 159303
Tel: +65 278 6151
Fax: +65 270 4160

Industrial Automation Catalog Section - U906

Selection Guides

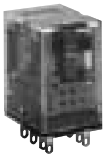
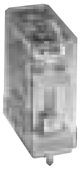
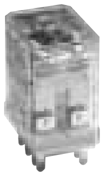
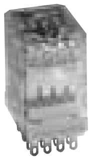
General Purpose Relays

- RH Series
- RM Series
- RY Series

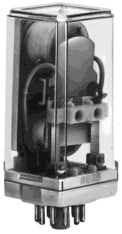
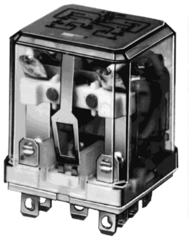
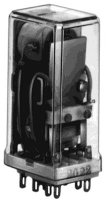
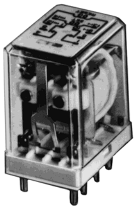
idec

Selection Guides

General Purpose Relays

	RU Series	RR Series	RH Series	RM Series	RY Series
Appearance					
Page	E-3	E-6	E-10	E-16	E-19
Contact Configuration	2, 4 Form C	1, 2, 3 Form C	1, 2, 3, 4 Form C	2 Form C	2, 4 Form C
Contact Rating (resistive)	DPDT: 10A, 30V DC 10A, 250V AC 4PDT: 6A, 30V DC 6A, 250V AC	10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/4HP, 120V AC	10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/6HP, 120V AC	5A, 30V DC 5A, 120V AC, 240V AC	DPDT: 3A, 30V DC; 3A, 120V AC, 240V AC 4PDT: 5A, 30V DC; 5A, 120V AC, 240V AC
Contact Material	DPDT: AuSnOIn (silver tin oxide indium) 4PDT: AuAg/Ag (gold-silver alloy on silver)	Silver	Silver-cadmium oxide	Silver	Standard: Silver, gold-plated Bifurcated: Silver-paladium alloy (Ag-PD Alloy)

General Purpose Latching Relays

	RR2KP Series	RH2L Series	RY2KS Series	RY2L Series
Appearance				
Page	E-23	E-26	E-29	E-32
Contact Configuration	2 Form C	2 Form C	2 Form C	2 Form C
Contact Rating (resistive)	10A, 30V DC 10A, 120V AC	10A, 30V DC 7.5A, 240V AC 10A, 120V AC	3A, 30V DC 3A, 120V AC	3A, 30V DC 3A, 120V AC 3A, 240V AC
Contact Material	Silver	Silver-cadmium oxide	Silver, gold-plated	Silver, gold-flashed

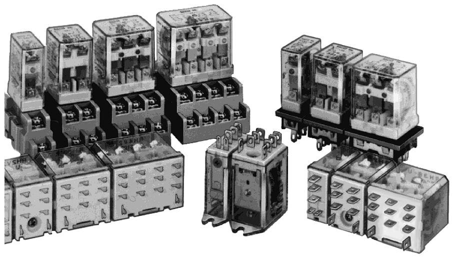
Solid State Relays

	RSS Series
Appearance	
Page	E-35
Contact Configuration	1 Form A (SPST-NO)
Contact Rating	10, 25, 50, 75, 90A 48V AC to 660V AC Output Ratings
Output	Dual SCR (zero crossing)

RH Series — General Purpose Midget Relays

Key features of the RH series include:

- Compact midget size saves space
- High switching capacity (10A)
- Choice of blade or PCB style terminals
- Relay options include indicator light, check button, and top mounting bracket
- DIN rail, surface, panel, and PCB type sockets available for a wide range of mounting applications



UL Recognized
Files No. E67770
E59804

CSA Certified
File No.LR35144

File No. BL951113332319

Specifications	**Contact Material**	Silver cadmium oxide
	Contact Resistance	50mΩ maximum (initial value)
	Minimum Applicable Load	24V DC/30mA, 5V DC/100mA (reference value)
	Operating Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
	Release Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
	Maximum Continuous Applied Voltage (AC/DC) at 20°C	110% of the rated voltage
	Minimum Operating Voltage (AC/DC) at 20°C	80% of the rated voltage
	Drop-Out Voltage (AC)	30% or more of the rated voltage
	Drop-Out Voltage (DC)	10% or more of the rated voltage
	Power Consumption	**SPDT** (RH1): DC: 0.8W AC: 1.1VA (50Hz), 1VA (60Hz) **DPDT** (RH2): DC: 0.9W AC: 1.4VA (50Hz), 1.2VA (60Hz) **3PDT** (RH3): DC: 1.5W AC: 2VA (50Hz), 1.7VA (60Hz) **4PDT** (RH4): DC: 1.5W AC: 2.5VA (50Hz), 2VA (60Hz)
	Insulation Resistance	100MΩ min (measured with a 500V DC megger)
	Dielectric Strength	**SPDT** (RH1) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
		DPDT (RH2), **3PDT** (RH3), **4PDT** (RH4) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contact circuits: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
	Frequency Response	1,800 operations/hour
	Temperature Rise	Coil: 85°C maximum Contact: 65°C maximum
	Vibration Resistance	0 to 6G (55Hz maximum)
	Shock Resistance	SPDT/DPDT: 200N (approximately 20G) 3PDT/4PDT: 100N (approximately 10G)
	Life Expectancy	Electrical: over 500,000 operations at 120V AC, 10A; (over 200,000 operations at 120V AC, 10A for SPDT [RH1], 3PDT [RH3], 4PDT [RH4]) Mechanical: 50,000,000 operations
	Operating Temperature	–30 to +70°C
	Weight	SPDT: 24g, DPDT: 37g (approximately) 3PDT: 50g, 4PDT: 74g (approximately)

Ordering Information

Order standard voltages for fastest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No.		*Coil Voltage:*
RH2B-U	–	*AC110-120V*

Part Numbers

Part Numbers: RH Series with Options

Termination	Contact Configuration	Basic Part No.	Indicator Light	Check Button	Indicator Light and Check Button	Top Bracket
B (blade)	SPDT	RH1B-U	RH1B-L*	—	—	RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-ULC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	RH3B-ULC	RH3B-UT
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-ULC	RH4B-UT
V2 (PCB 0.078" [2mm] wide)	SPDT	RH1V2-U	RH1V2-L*	—	—	—
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	RH2V2-ULC	—
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	RH3V2-ULC	—
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	RH4V2-ULC	—

** RH1B(V2)-L is* **not** *UL recognized.*

Ratings

Coil Ratings

Rated Voltage		Rated Current ±15% at 20°C								Coil Resistance ±15% at 20°C			
		60Hz				50Hz							
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	150mA	200mA	280mA	330mA	170mA	238mA	330mA	387mA	18.8Ω	9.4Ω	6.0Ω	5.4Ω
	12V	75mA	100mA	140mA	165mA	86mA	118mA	165mA	196mA	76.8Ω	39.3Ω	25.3Ω	21.2Ω
	24V	37mA	50mA	70mA	83mA	42mA	59.7mA	81mA	98mA	300Ω	153Ω	103Ω	84.5Ω
	120V*	7.5mA	11mA	14.2mA	16.5mA	8.6mA	12.9mA	16.4mA	19.5mA	7,680Ω	4,170Ω	2770Ω	2220Ω
	240V†	3.2mA	5.5mA	7.1mA	8.3mA	3.7mA	6.5mA	8.2mA	9.8mA	3,1200Ω	15,210Ω	12,100Ω	9120Ω
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	128mA		150mA		240mA		250mA		47Ω	40Ω	25Ω	24Ω
	12V	64mA		75mA		120mA		125mA		188Ω	160Ω	100Ω	96Ω
	24V	32mA		36.9mA		60mA		62mA		750Ω	650Ω	400Ω	388Ω
	48V	18mA		18.5mA		30mA		31mA		2,660Ω	2,600Ω	1,600Ω	1550Ω
	110V‡	8mA		9.1mA		12.8mA		15mA		13,800Ω	12,100Ω	8,600Ω	7,340Ω

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Rated Voltage		Coil Inrush				Coil Inductance							
						Energizing				De-Energizing			
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	250mA	340mA	520mA	620mA	0.09H	0.08H	0.05H	0.05H	0.06H	0.04H	0.03H	0.02H
	12V	120mA	170mA	260mA	310mA	0.037H	0.30H	0.22H	0.18H	0.22H	0.16H	0.12H	0.10H
	24V	56mA	85mA	130mA	165mA	1.5H	1.2H	0.9H	0.73H	0.9H	0.63H	0.5H	0.36H
	120V*	12mA	16mA	26mA	33mA	37H	33H	21H	18H	22H	15H	12H	9H
	240V†	7mA	8mA	12mA	16mA	130H	130H	84H	73H	77H	62H	47H	36H
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	N/A		N/A		N/A		N/A		N/A	N/A	N/A	N/A
	12V												
	24V												
	48V												
	110V‡												

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Ratings con't

Contact Ratings

Voltage	Rating	Resistive				Inductive				Motor Load		
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT
28V DC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	—	—	—
30V DC	UL	10A	10A	10A	—	7A	7A	—	—	—	—	—
	CSA				10A		7.5A			—	—	—
	Nominal							7.5A	7.5A	—	—	—
110V DC	Nominal	0.5A	0.5A	0.5A	0.5A	0.3A	0.3A	0.3A	0.3A	—	—	—
120V AC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	1/6	1/6	1/6
	CSA						7.5A			—	—	—
	Nominal					7A		7.5A				
240V AC	UL	10A	10A	—	7.5A	7A	7A	*	5A	1/3	1/3	1/3
	CSA							7A		—	—	—
	Nominal	7A	7.5A	7.5A	4.5A	5A	5A	5A				

1. * 6.5A/pole, 20A total.
2. Inductive load cos ø = 0.3, L/R = 7ms.

Applicable Sockets

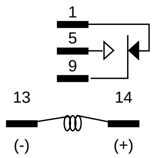
Part Numbers: Sockets

Relay	Standard DIN Rail Mount	Finger-Safe DIN Rail Mount	Surface Mount	Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	—	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-02	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	—	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C		SH4B-51	SH4B-62

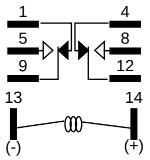
Spring & Clips (optional)	
Part Number	Use With
SY2S-02F1 SFA-101 SFA-202	SH1B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH1B-51, 62
SY4S-02F1 SFA-101 SFA-202	SH2B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH2B-51, 62
SH3B-05F1 SFA-101, -202	SH3B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH3B-51, 62
SH4B-02F1 SFA-101, -202	SH4B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH4B-51, 62

See Section F for details on sockets. All DIN rail mount sockets shown above can be mounted using DIN rail BNDN1000.

Internal Circuits



RH1



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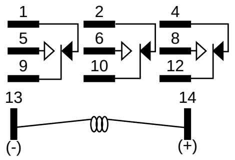

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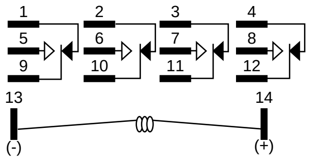
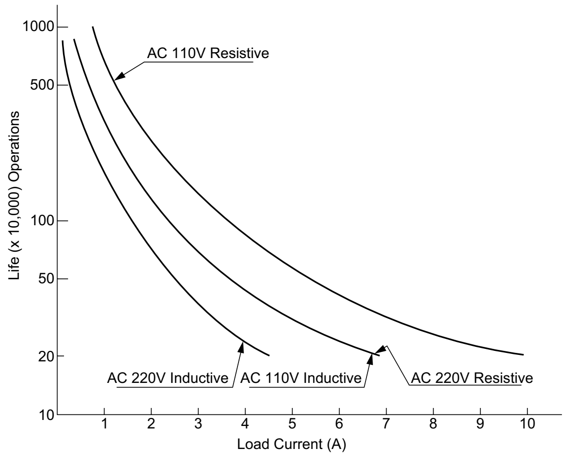
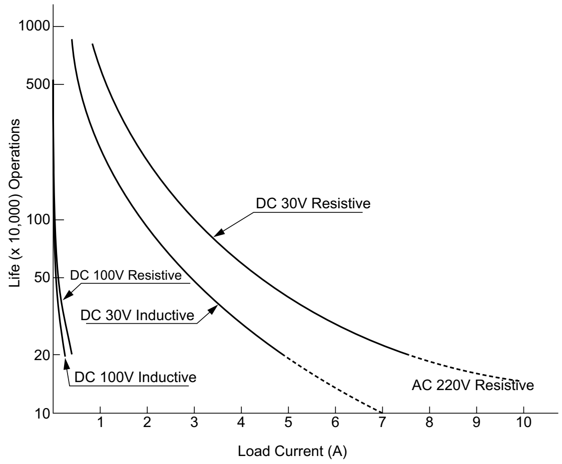


RH4

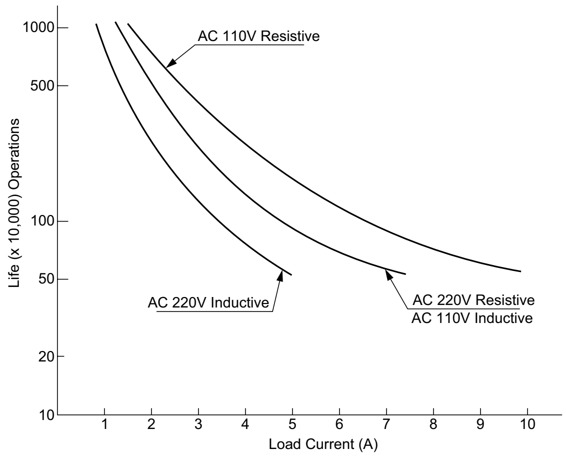
Electrical Life Curves

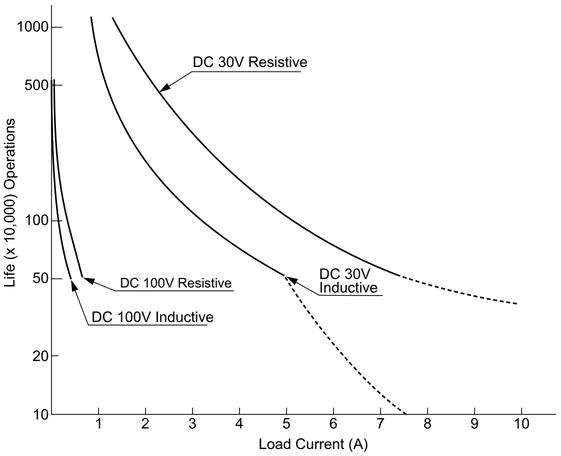
RH1



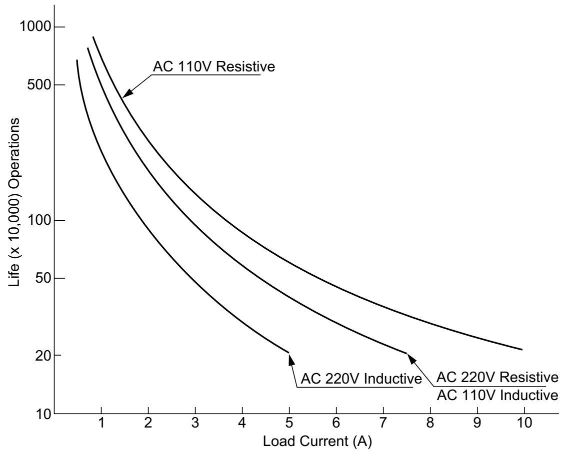


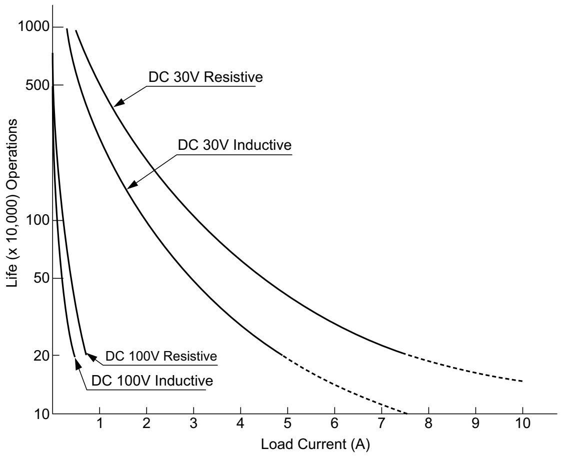
RH2





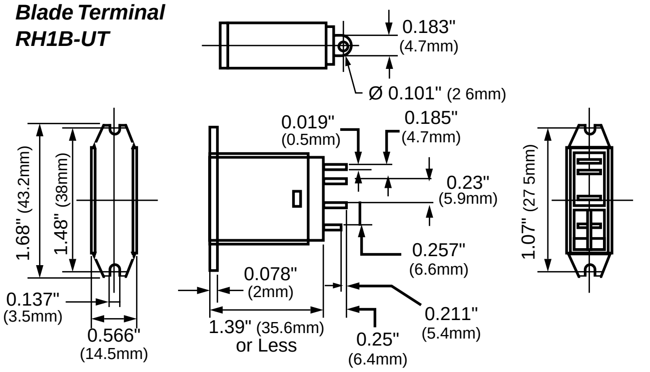
RH3 and 4



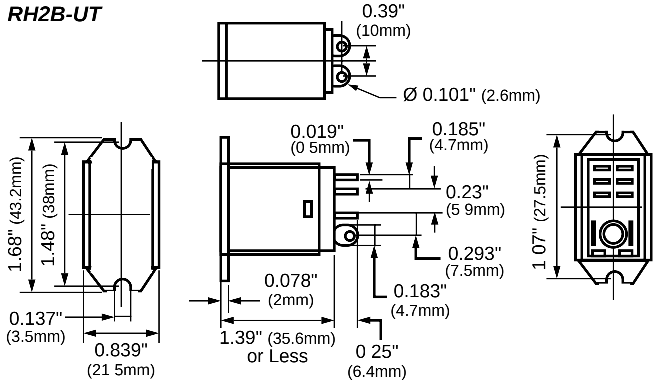


Dimensions

Top Bracket Mounting
Blade Terminal
RH1B-UT

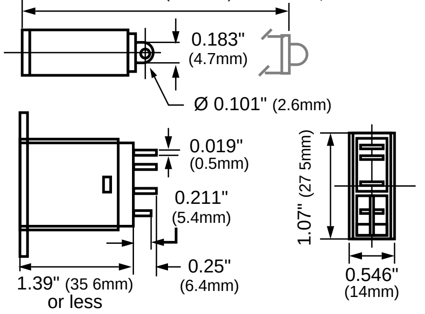


RH2B-UT



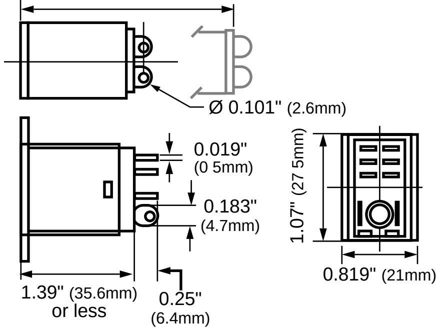
Plug-in
Blade Terminal
RH1B

Total length from panel surface including socket:
SH1B-05: 2.40" (61.5mm) maximum; ***SH1B-51:*** 1.54" (39mm) maximum
Total length from panel surface including hold-down spring:
SH1B-05: 2.48" (63.5mm) maximum; ***SH1B-51:*** 1.62" (41.6mm) maximum



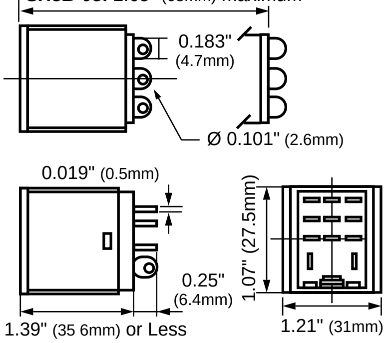
RH2B

Total length from panel surface including socket:
SH2B-05: 2.40" (61.5mm) maximum; ***SH2B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH2B-05: 2.48" (63.5mm) maximum; ***SH2B-51:*** 1.62" (41.6mm)



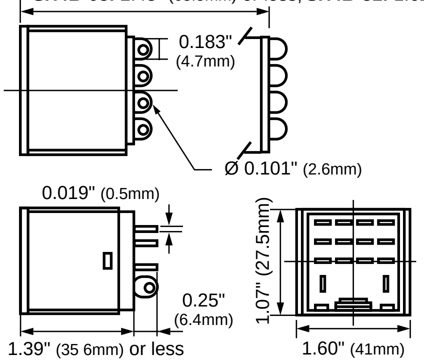
Plug-in
Blade Terminal
RH3B

Total length from panel surface including socket:
SH3B-05: 2.57" (66mm) maximum
Total length from panel surface including hold-down spring:
SH3B-05: 2.65" (68mm) maximum



RH4B

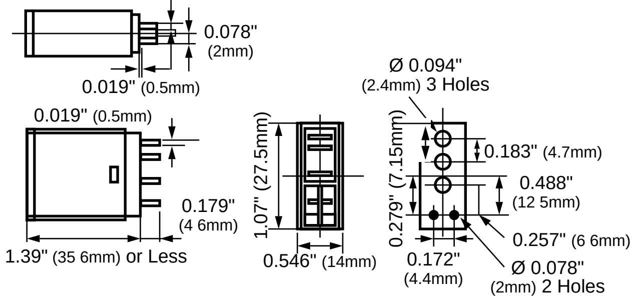
Total length from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39 6mm)
Total length from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41 6mm)



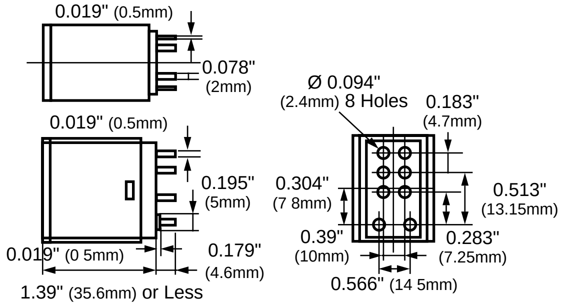
Dimensions

PCB Terminal

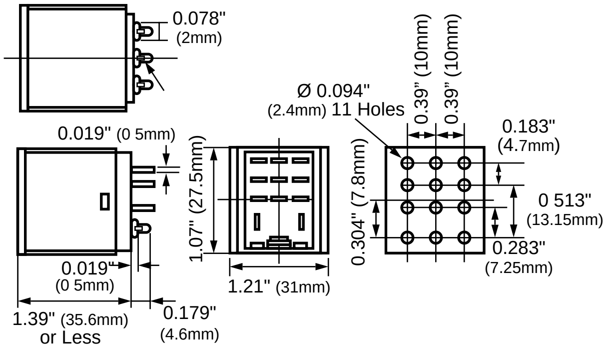
RH1V2



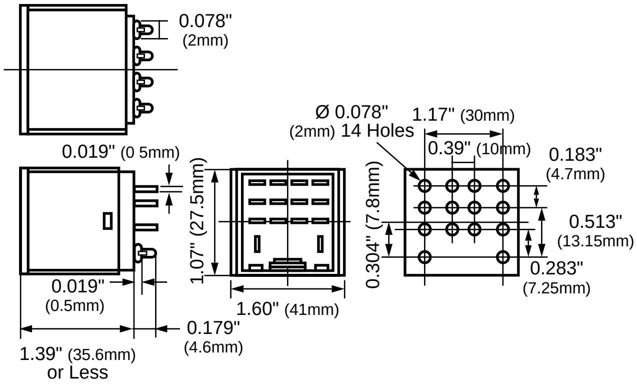
RH2V2



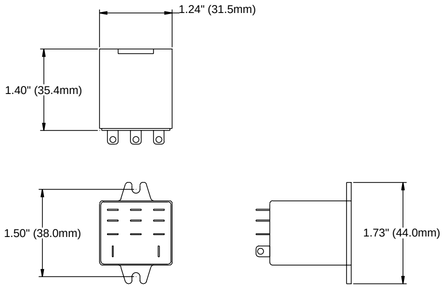
RH3V2



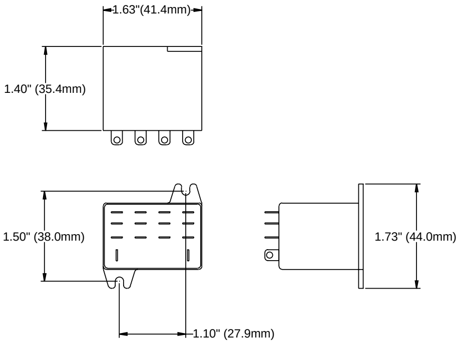
RH4V2



RH3B-UT



RH4B-UT



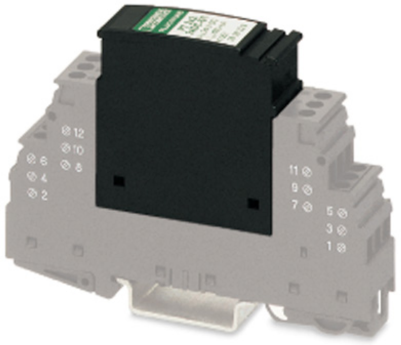
E

Extract from the online catalog

PT 2X2-24DC-ST

Order No.: 2838228

The illustration shows version PT 2x2- 5DC-ST



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2838228

Protective plug PT with protective circuit for two 2-core floating signal circuits. Nominal voltage: 24 V DC

Commercial data	
EAN	4017918182649
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.02511 KG
Catalog page information	Page 86 (TT-2009)

Product notes

WEEE/RoHS-compliant since:
06/01/2006

http://www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

Housing material	PA 6.6
Inflammability class acc. to UL 94	V0
Color	black

Standards for air and creepage distances	VDE 0110-1
	IEC 60664-1: 1992-10
Total surge current (8/20) µs	20 kA
Ambient temperature (operation)	-40 °C ... 85 °C
Mounting type	On base element
Design	DIN rail module, two-section, divisible
Degree of protection	IP20
Direction of action	Line-Line & Line-Signal Ground/Shield & optional Signal Ground/ Shield-Earth Ground
Arrester can be tested with CHECKMASTER from software version:	From SW rev. 1.00
Width	17.70 mm
Height	52.00 mm
Length	45.00 mm
Pitch unit	1 Div.

Protective circuit

IEC category	C1
	C2
	C3
	D1
VDE requirement class	C1
	C2
	C3
	D1
Nominal voltage U_N	24 V DC
Max. operating voltage U_{max}	26 V DC
Arrester rated voltage U_C	28 V DC
	20 V AC
Arrester rated voltage U_C (Core-Core)	28 V DC
	20 V AC
Arrester rated voltage U_C (Core-Earth)	28 V DC
	20 V AC
Nominal current I_N	450 mA (45°C)
Operating effective current I_C at U_C	≤ 5 µA
Discharge current to PE at U_C	≤ 1 µA (BE: 2x2+F)
	≤ 4 µA

Nominal discharge surge current In (8/20) µs (Core-Core)	10 kA
Nominal discharge surge current I_n (8/20) µs (Core-Earth)	10 kA
Total surge current (8/20) µs	20 kA
Max. discharge surge current Imax (8/20) µs maximum (Core-Core)	10 kA
Max. discharge surge current Imax (8/20) µs maximum (Core-Earth)	10 kA
Lightning test current (10/350) µs, peak value I_{imp}	2.5 kA (per path)
Output voltage limitation at 1 kV/µs (Core-Core) spike	≤ 40 V
Output voltage limitation at 1 kV/µs (Core-Earth) spike	≤ 450 V
Output voltage limitation at 1 kV/µs (Core-Core) static	≤ 40 V
Output voltage limitation at 1 kV/µs (Core-Earth) static	≤ 450 V
Residual voltage at I_n, (conductor-conductor)	≤ 40 V
Residual voltage at In, (conductor-GND)	≤ 450 V
Residual voltage with Ian (10/1000)µs (conductor-conductor)	≤ 50 V
Response time tA (Core-Core)	≤ 1 ns
Response time tA (Core-Earth)	≤ 100 ns
Input attenuation aE, sym.	0.5 dB (≤ 1 MHz)
Cut-off frequency fg (3 dB), sym. in 50 Ohm system	Typ. 6 MHz
Capacity (Core-Core)	1.4 nF
Resistance in series	2.2 Ω (Path 1-2/5-6)
	2.2 Ω (Path 7-8, 11-12)
Surge carrying capacity in acc. with IEC 61643-21 (Core-Core)	C2 (10 kV/5 kA)
Surge carrying capacity in acc. with IEC 61643-21 (Core-Earth)	C2 (10 kV/5 kA)
	D1 (2.5 kA)

Connection data

Type of connection	Screw connection (in connection with the base element)
Connection type IN	PLUGTRAB plug-in system
Connection type OUT	PLUGTRAB plug-in system

Screw thread	M3
Tightening torque, min	0.8 Nm
Stripping length	8 mm
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	2.5 mm²
Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12

Connection, protective circuit

Standards/regulations	IEC 61643-21
	DIN EN 61643-21
	UL 497B

Certificates / Approvals

Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

Accessories

Marking

Item	Designation	Description
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm
0814717	ZBF 15:SO/CMS	Zack strip, flat, 10-section, divisible, special printing, marking according to customer requirements
0808671	ZBF 5,LGS:FORTL.ZAHLEN	Zack strip, flat, printed horizontally: 10-section, with the numbers, 1-10, 11-20 etc. up to 991-1000, color: White
0810821	ZBF 5,LGS:GERADE ZAHLEN	Zack marker strip, flat, printed horizontally: 10-section, with even numbers, printed with the numbers: 2-20, 22-40, etc. up to 82-100
0810863	ZBF 5,LGS:UNGERADE ZAHLEN	Zack strip, flat, printed horizontally: 10-section, with odd numbers, printed with the numbers: 1-19, 21-39 etc. up to 81-99
0808697	ZBF 5,QR:FORTL.ZAHLEN	Flat Zack marker strip, printed vertically: 10-section, with the numbers 1-10, 11-20, etc. up to 151-160, color: White

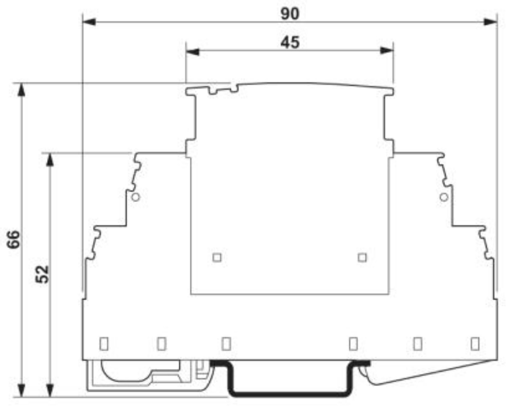
0808668	ZBF 5/WH-100:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, large batch, sufficient for labeling 1000 terminal blocks, color: white
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, sufficient for 100 terminal blocks, color: white
0800763	ZBN 18:SO/CMS	Marker labels, 5-section, special printing, labeled according to customer requirements (Please specify the required marking with order), for terminal width: 17.5 mm, color: White
2809128	ZBN 18:UNBEDRUCKT	Unprinted marker labels, strips with 5 labels for individual labeling with M-PEN or CMS system, for terminal block width: 17.5 mm, color: White

Additional products

Item	Designation	Description
Assembly		
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black
General		
2839224	PT 2X2+F-BE	Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, gas-filled surge arrester between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm
2839208	PT 2X2-BE	Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, bridge between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm

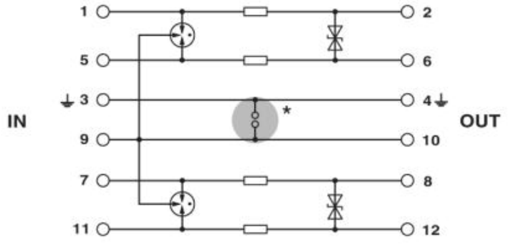
Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Circuit diagram



Approbationslogos (EX-Bereich)

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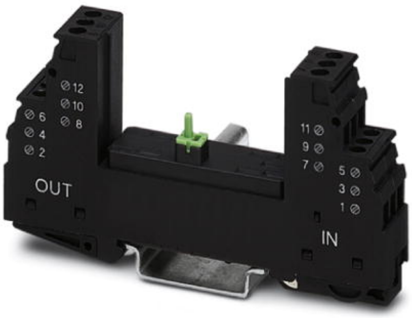
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

PT 2X2+F-BE

Order No.: 2839224

The illustration shows version PT 2x2-BE



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2839224

Base element for protective plug PT with protective circuit for two 2-wire floating signal circuit, gas-filled surge arrester between the connections 3-4 (GND) and 9-10, for mounting on NS 35/7.5 and NS 35/15, housing width: 17.5 mm

Commercial data

EAN	4017918182762
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.0573 KG
Catalog page information	Page 86 (TT-2009)

Product notes

WEEE/RoHS-compliant since:
05/10/2006

Technical data

General

Inflammability class acc. to UL 94	V0
Color	black
Ambient temperature (operation)	-40 °C ... 85 °C

Mounting type	DIN rail 35 mm
Design	DIN rail module, two-section, divisible
Degree of protection	IP20
Direction of action	Signal Ground/Shield-Earth Ground
Width	17.70 mm
Height	52.00 mm
Length	89.80 mm
Pitch unit	1 Div.

Protective circuit

Nominal current I_N	450 mA
Output voltage limitation at 1 kV/μs (Core-Earth) spike	$\leq$ 600 V

Connection data

Type of connection	Screw connection
Connection type IN	Screw terminal blocks
Connection type OUT	Screw terminal blocks
Screw thread	M3
Tightening torque, min	0.8 Nm
Stripping length	8 mm
Conductor cross section stranded min.	0.2 mm^2
Conductor cross section stranded max.	2.5 mm^2
Conductor cross section solid min.	0.2 mm^2
Conductor cross section solid max.	4 mm^2
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	12

Certificates / Approvals

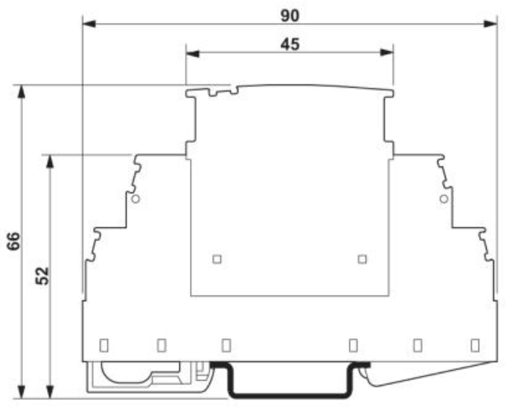
Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

Accessories

Item	Designation	Description
Assembly		
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black
Marking		
1051993	B-STIFT	Marker pen, for manual labeling of unprinted Zack strips, smear-proof and waterproof, line thickness 0.5 mm
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm
1050004	ZB 5 :UNBEDRUCKT	Zack strip, unprinted, 10-section, for individual labeling with M-PEN, ZB-T or CMS system, pack is sufficient for 100 terminal blocks, for a terminal width of 5.2 mm, color: White
2715212	ZB 5,8,LGS:FORTL.ZAHLEN	Zack marker strip, 10-section, printed horizontally: with consecutive numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1050305	ZB 5,8:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
2715209	ZB 5,8:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 5.8 mm, color: White
1050295	ZB 5:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, sufficient for 100 terminal blocks, color: white

Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Approbationslogos (EX-Bereich)

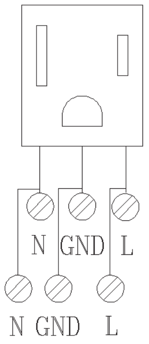
Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

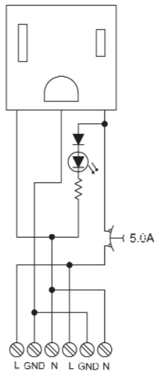
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- Compact and easily snaps onto 35mm DIN-rail
- CSA, UL508A and cULus approved
- Available with ground fault current interrupt (GFCI) or standard simplex and duplex outlets
- Option for visual indication of power included with GFCI versions
- Enclosed versions feature NEMA rated enclosure with UL94 VO flammability rating

Schematic diagram



Schematic diagram



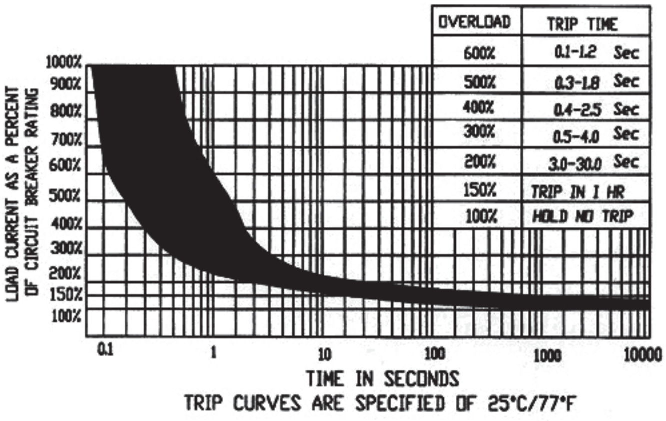
Rated data

Input voltage		
Rated current	120Vac	120Vac
	5A max via outlet	5A max via outlet
	10A via redundant terminals	10A via redundant terminals
Wire range	26 - 12 AWG (0.14 0 4.0mm^2)	26 - 12 AWG (0.14 0 4.0mm^2)

Ordering data	**Type**	**Part No.**	**Type**	**Part No.**
TS32 / TS35 mounting (⊔ / ⊔)	Single outlet without circuit breaker	**9915480000**	Single outlet with circuit breaker	**9915480001**
			(supplemental protector with manual reset via push button)	

Dimensions		
Width	35mm	35mm
Length	70mm	70mm
Height	55mm	55mm

Approvals		
	LR-229352, E252394	LR-229352, E252394



OVERLOAD	TRIP TIME
600%	0.1-1.2 Sec
500%	0.3-1.8 Sec
400%	0.4-2.5 Sec
300%	0.5-4.0 Sec
200%	3.0-30.0 Sec
150%	TRIP IN 1 HR
100%	HOLD NO TRIP

Extract from the online catalog

UK 6,3-HESILA 250

Order No.: 3004249

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004249

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Product notes

WEEE/RoHS-compliant since: 09/11/2006

http://www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Commercial data

EAN	4017918090739
sales group	A040
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.034648 KG
Catalog page information	Page 370 (CL-2009)

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

Technical data

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

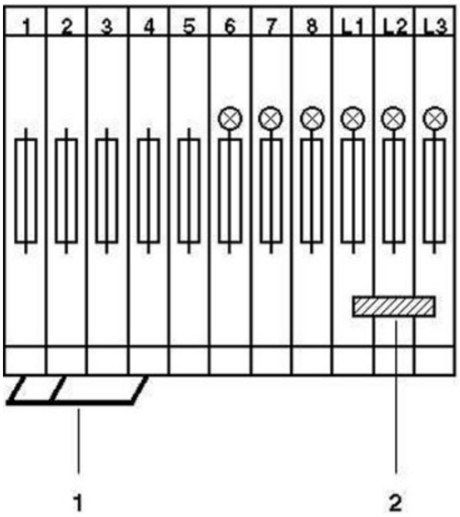
Connection data

Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Diagrams/Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

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Extract from the online catalog

UK 6,3-HESILED 24

Order No.: 3004265

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004265

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Commercial data

EAN	4017918090753
sales group	A040
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.03542 KG
Catalog page information	Page 370 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 09/01/2006

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions	
Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

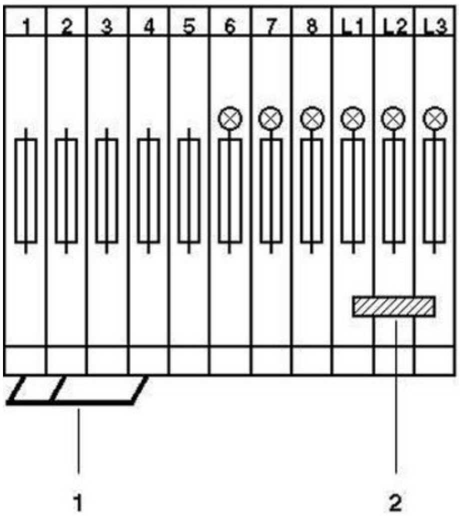
Technical data	
Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

Connection data	
Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Diagrams/Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

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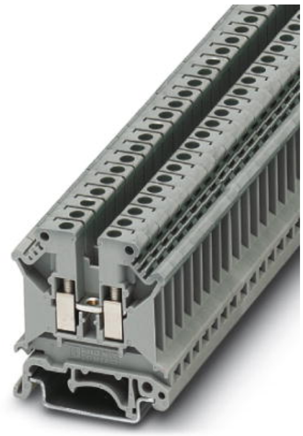
PHOENIX CONTACT

Extract from the online catalog

UK 5 N

Order No.: 3004362



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004362

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data

EAN	4017918090760
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG
Catalog page information	Page 343 (CL-2009)

Technical data

General

Number of levels	1
Number of connections	2
Color	gray

Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Maximum load current	41 A (with 6 mm^2 conductor cross section)
Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-1
Nominal current I_N	32 A
Nominal voltage U_N	800 V
Open side panel	ja

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²

2 conductors with same cross section, stranded min.	0.2 mm²
2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Cross-section with insertion bridge, solid max.	4 mm²
Cross-section with insertion bridge, stranded max.	4 mm²
Type of connection	Screw connection
Stripping length	8 mm
Internal cylindrical gage	A4
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Diagrams/Drawings

Circuit diagram

Approbationslogos (EX-Bereich)

Address

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Fax (717) 944-1625
http://www.phoenixcon.com

UK 5 N GN

Order No.: 3003965

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003965

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data	
EAN	4017918282189
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.009305 KG

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


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Extract from the online catalog

UK 5 N YE

Order No.: 3003952

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003952

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Commercial data	
EAN	4017918282172
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00917 KG

Product notes

WEEE/RoHS-compliant since: 01/01/2003

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Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


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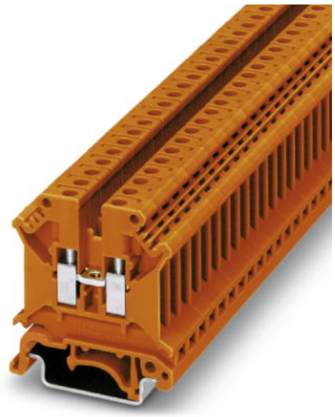
UK 5 N OG

Order No.: 3002908



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3002908

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: orange, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data

EAN	4017918117498
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)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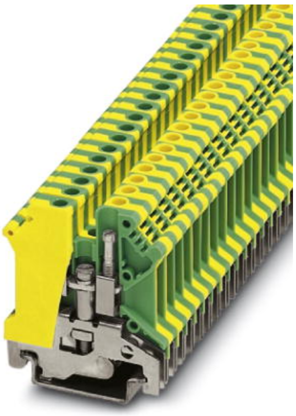
USLKG 5

Order No.: 0441504



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0441504

Ground modular terminal block, Type of connection: Screw connection, Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green-yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/15/2005

Commercial data

EAN	4017918002190
sales group	A020
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.020842 KG
Catalog page information	Page 347 (CL-2009)

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Technical data

General

Note	When aligning with a feed-through terminal block with the same shape, an end cover must be interposed with insulation voltages of > 690 V
Number of levels	1

Number of connections	2
Color	green-yellow
Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-2
Open side panel	nein

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²
2 conductors with same cross section, stranded min.	0.2 mm²

2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Type of connection	Screw connection
Stripping length	8 mm
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Diagrams/Drawings

Circuit diagram

Approbationslogos (EX-Bereich)

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Extract from the online catalog

D-UK 4/10

Order No.: 3003020

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003020

End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm,
Color: gray

Commercial data	
EAN	4017918090425
sales group	A090
Pack	50 pcs.
Customs tariff	85389099
Weight/Piece	0.002536 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Address

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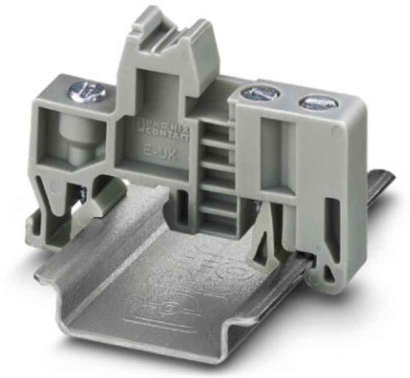
http://www.phoenixcon.com

Extract from the online catalog

E/UK

Order No.: 1201442



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=1201442

End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail

Commercial data	
EAN	4017918017323
sales group	B220
Pack	50 pcs.
Customs tariff	39269097
Weight/Piece	0.009354 KG
Catalog page information	Page 696 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
07/01/2005

Technical data

General

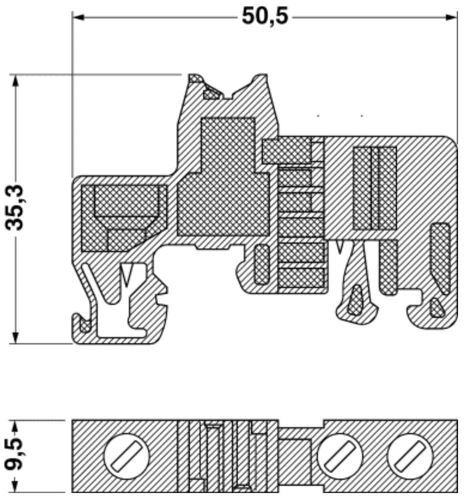
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

Accessories

Item	Designation	Description
Assembly		
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
Marking		
1004089	UBE + ES/KMK 3	Marker carrier, color: Gray for marking groups of terminals, for end clamp E/UK or end clamp E/U, with perforated insert strips, 40 x 17 mm, can be labeled with CMS system
1051003	ZB 6:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 6.2 mm, color: white

Diagrams/Drawings

Dimensioned drawing



Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

FBI 2- 6

Order No.: 0203438

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203438

Cross connector/bridge, Number of positions: 2, Color: aluminum

Commercial data	
EAN	4017918104122
sales group	A900
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.00349 KG

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Address

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586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

FBI 10- 6

Order No.: 0203250

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203250

Cross connector/bridge, Number of positions: 10, Color: silver

Commercial data	
EAN	4017918098070
sales group	A900
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.01615 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

http://
www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Address

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586 Fulling Mill Road
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Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

K2A25U : TWO:14 STR-1/0 STR DUAL

ACTIVE

RoHS compatible

www.fci.com

BURNDY® PRODUCTS

Specifications

General

Number of Conductors	2
Number of Screws	1
Number of Stud Holes	1 Hole

Dimensional

Stud Hole (Size)	1/4 in.

Physical

Conductor Size	14 AWG 2 AWG 1 AWG 4 AWG 1/0 AWG 8 AWG 12 AWG 10 AWG 6 AWG
Installation Torque	50 in. lb.
Conductor Size (Range)	14 AWG to 1/0 AWG

Approvals / Certifications

UL Listed	Yes
CSA Certified	Yes

Other Features

Set Screw Type	Slot
UPC	78181060004
Keyword	kau

T1-E Duct Series

Contact your local representative or the IBOCO sales office for more information.

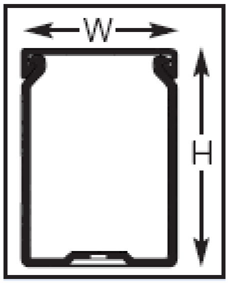
MATERIAL:
Rigid PVC,
self-extinguishing

COLOR:
light GREY RAL 7030
WHITE

STANDARD LENGTH:
6 Feet 6 3/4 Inches

STANDARD UNIT:
Duct complete with cover

Catalog Number	Nominal Size (WxH)	Dimensions inches (Actual) W	H	E	F	Dimensions W x H (millimeters)	Standard Carton Length (1)	(QTY) Feet
T1E-1015 *	1 x 1 1/2	1.00	1.57	.16	.24	25 x 40	18	108
T1E-1022 *	1 x 2 1/4	1.00	2.36	.16	24	25 x 60	24	144
T1E-1030 *	1 x 3	1.00	3.15	16	.24	25 x 80	24	144
T1E-1040 *	1 x 4		.			25 x 100	8	48
T1E-1515 *	1 1/2 x 1 1/2	1.57	1.57	.16	.24	40 x 40	20	120
T1E-1522 *	1 1/2 x 2 1/4	1.57	2.36	.16	.24	40 x 60	18	108
T1E-1530 *	1 1/2 x 3	1.57	3.15	.16	24	40 x 80	16	96
T1E-1540 *	1 1/2 x 4	1.57	3.94	.16	.24	40 x 100	8	48
T1E-2222 *	2 1/4 x 2 1/4	2.36	2.36	.16	.24	60 x 60	12	72
T1E-2230 *	2 1/4 x 3	2.36	3.15	.16	.24	60 x 80	12	72
T1E-2240 *	2 1/4 x 4	2.36	3.94	.16	.24	60 x 100	4	24
T1E-3015G	3 x 1 1/2	3.15	1.57	.16	.24	80 x 40	12	72
T1E-3022 *	3 x 2 1/4	3.15	2.36	.16	.24	80 x 60	12	72
T1E-3030 *	3 x 3	3.15	3.15	.16	.24	80 x 80	12	72
T1E-3040 *	3 x 4	3.15	3.94	.16	.24	80 x 100	4	24
T1E-4015G	4 x 1 1/2	3.94	1.57	.16	.24	100 x 40	8	48
T1E-4022G	4 x 2 1/4	3.94	2.36	.16	.24	100 x 60	8	48
T1E-4030 *	4 x 3	3.94	3.15	.16	.24	100 x 80	8	48
T1E-4040 *	4 x 4	3.94	3.94	.31	.47	100 x 100	4	24



Example: T1E-1015G = 1" x 1 1/2" light GREY duct with cover

(1) Each standard length is actually 6'6 3/4" but is counted as 6 feet for packaging and pricing

* Color - add suffix "G" fro light GREY, "W" for WHITE

ADHESIVE BACKING - add suffix "A" to catalog number - contact sales office for pricing

Technical Characteristics

IBOCO Wiring products respond to all installation needs, coping with different uses and environment applications. They are manufactured with high quality materials that undergo severe quality controls and performance tests under extreme operating and duration conditions witha constant control of quality standards.

Wiring Ducts T1, T1E, SEP-E and CL are manufactured in rigid Self-Extinguishing PVC.

Those components for which high bending resilience is required are in polyamide 6 and polypropylene.

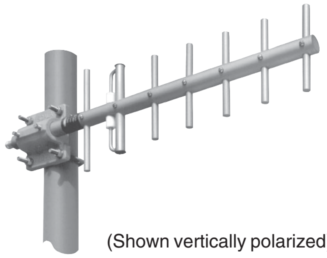
Spiralite is manufactured in natural polyethylene and self-extinguishing polyethylene.

Materials Technical Characteristics	Unit of Measure	Standard	PVC Duct Value	PVC Moulded Components Value	Polyamide 6 Value	Polyethylene Value	Flame Retardant Polyethylene Value
CHEMICAL-PHYSICAL PROPERTIES							
Specific gravity	g/cm^3	ASTM D792	1.55	1.32	1.14	0.92	0.97
H2O 73,4 F absorbtion	%	ISO 62	<0,1	2,5	2,5	<0,1	<0,1
Formaldehyde	ppm	-	absent	absent	absent	absent	absent
Cadmium	ppm	-	absent	absent	absent	absent	absent
MECHANICAL PROPERTIES							
Tensile stress at break	MPa	ASTM D638	39	30	45	17	15
Traction strength	MPa	ASTM D638	44	27	55	9,5	9
Elongation at break	%	ASTM D638	130	97	250	400	600
Modulus of elasticity at traction	MPa	ASTM D638	4400	-	950	-	240
Modulus of elasticity at flexion	MPa	ASTM D790	3200	-	1100	210	130
THERMAL PROPERTIES							
Temperature VICAT	C	ASTM D1525	84	70	198	89	-
HDT	C	ASTM D648	72	60	185	-	-
Coefficient of expansion	K^-1	ASTM D696	6 10^-5	8 10^-5	8-10 10^-5	22 10^-5	10^-5
Specific heat	kJ/kgK	ASTM C351	0,94	1,24	1,7	-	-
Thermal conductivity	W/mK	ASTM C177	0,14	0,14	0,29	0,32	0,32
ELECTRICAL PROPERTIES							
Dielectric constant	-	ASTM D150	3,2 - 4,0	3,2	5,0	2,4	2,3
Dielectric strength	kV/mm	IEC 243	70	60	35	90	90
Surface resistance	Ohm	IEC 93	10^13	10^13	5 10^11	10^13	10^13
SELF-EXTINGUISING							
Self-extinguising 1,6 millimeters	-	UL 94	V0	V0	V2	HB	V2
Self-extinguishing 3,2 millimeters	-	UL 94	V0	V0	V2	HB	V2
Glow wire test (2 mm)	C	IEC 695-2-1	960	960	650	650	850
Oxygen number	%	ASTM D2863	43	34	25	-	25

TY-900
Yagi Antenna

The Kathrein-Scala TY series are rugged broadband yagi antennas fabricated of 6061/T6 aluminum rod and seamless drawn pipe, anodized for maximum reliability and corrosion resistance. The hardware and fastenings are stainless steel. The internal balun, coax feed and connector are sealed in a foam potting system to prevent moisture penetration and assure long service life in severe environmental conditions. The heavy aluminum mounting casting allows installation for V or H polarization.

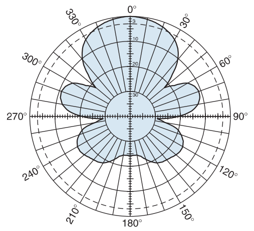
- The TY-900 is specifically designed for professional fixed-station applications in the 890–960 MHz band.


(Shown vertically polarized)

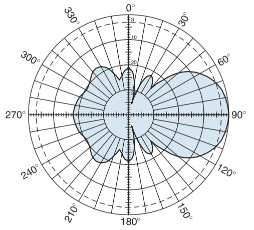
Specifications:

Frequency range	890–960 MHz (broadband)
Gain	10 dBd
Impedance	50 ohms
VSWR	< 1.5:1 maximum (1.35:1 typical)
Polarization	Horizontal or vertical
Front-to-back ratio	>20 dB
Maximum input power	100 watts (at 50°C)
H-plane beamwidth	48 degrees (half-power)
E-plane beamwidth	40 degrees (half-power)
Connector	N female
Weight	3 lb (1.4 kg)
Dimensions	23 x 7 inches (584 x 178 mm)
Equivalent flat plate area	0.24 ft^2 (0.022 m^2)
Wind survival rating*	150 mph (240 kph)
Shipping dimensions	28 x 10 x 4.5 inches (710 x 254 x 114 mm)
Shipping weight	5.0 lb (2.3 kg)
Mounting	For masts of 1.25 to 2.375 inch (32 to 60 mm) OD.

See reverse for order information.



H-plane
Horizontal pattern – V-polarization
Vertical pattern – H-polarization



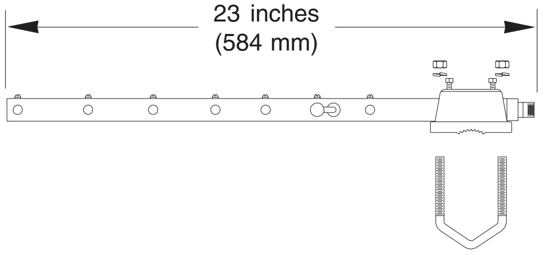
E-plane
Horizontal pattern – H-polarization
Vertical pattern – V-polarization

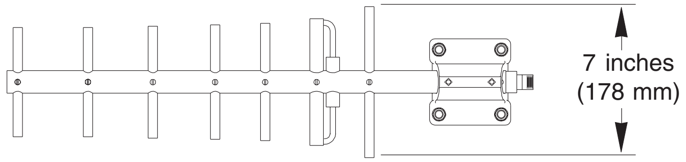
* Mechanical design is based on environmental conditions as stipulated in EIA-222-F (June 1996) and/or ETS 300 019-1-4 which include the static mechanical load imposed on an antenna by wind at maximum velocity. See the Engineering Section of the catalog for further details.

10065-D

KATHREIN
SCALA DIVISION

TY-900
Yagi Antenna





Order Information:

Model	Description
TY-900	Yagi antenna with N connector

All specifications are subject to change without notice

Endress+Hauser GmbH+Co. KG
Postfach/P.O. Box 1262
D-79690 Maulburg

Final Inspection Report
Endprüfprotokoll

The manufacturer confirms that all measuring equipment used to assure the quality of the products has been calibrated and is traceable to national and international standards.

Der Hersteller bestätigt, dass die zu Qualitätsprüfungen des Erzeugnisses eingesetzten Messmittel gültig kalibriert waren und auf nationale bzw. internationale Normale rückführbar sind.

Waterpilot

TAG number	Messstellen-Nummer	
Device type	Gerätetyp	FMX167-A2AFK2G7
Serial number	Seriennummer	D202610108E
Sensor limits	Sensor-Messgrenzen	0...600 ftH2O
Adjusted measuring range	Eingestellter Messbereich	0...600 ftH2O
Maximum linearity error	Maximal zulässiger Linearitätsfehler	±0.2 %
Electronic type	Elektronik-Typ	4...20mA

SYSTEM CONTROLS & INSTRUMENTATION ATTN: ACCTS. PAYABLES

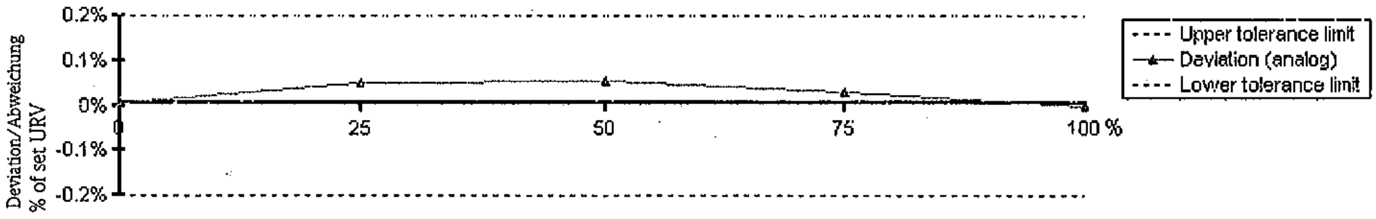
Customer number	Kundennummer	
Customer order number	Auftragsnummer des Kunden	3079-1
Sales order number	Kommissionsnummer	10992723000010
Order confirmation no.	Auftragsbestätigungsnr.	41890795/0010

Ambient temperature	Umgebungs-Temperatur	25 °C (± 5 °C)
Ambient humidity	Umgebungs-Luftfeuchte	45...75 %rel.F (± 10 %rel.F)
Ambient pressure	Umgebungs-Luftdruck	860...1060 mbar

Inspection according to fix point method IEC 60770. Prüfung nach Grenzpunktmethode gemäß IEC 60770.

Measuring results Messergebnisse

Measuring point Messpunkt	Reference pressure ($p_{Ref.}$) Druck des Vergleichsnormales ($p_{Ref.}$)	Current pressure (p calculated) Istdruck (p berechnet)	Current nominal value (I_{Out} calculated) Sollwert Stromausgang (I_{Out} berechnet)	Current output (analog) Istwert Stromausgang (analog)	Deviation current output (analog) Abweichung Stromausgang (analog)
%	ftH2O	ftH2O	mA	mA	%
0	0.01200	0.0424	4.0003	4.0011	0.0051
25	152.910	153.21	8.0776	8.0857	0.0504
50	297.186	297.51	11.925	11.933	0.0533
75	441.864	442.04	15.783	15.788	0.0290
100	589.101	589.08	19.709	19.709	-0.0036



Measuring point in % of adjusted measuring range/
Messpunkt in % vom eingestellten Messbereich

At the time of verification, the measuring points of the device indicated above were within tolerance and in compliance to the published specification of the referenced Operating Instructions (KA ...).

Das Gerät entsprach zum Zeitpunkt der Prüfung unter den angegebenen Bedingungen an den aufgeführten Messpunkten den Vorgaben der genannten Betriebsanleitung (KA ...).

BA231
71096102

Geprüft durch/Operator 105696
Prüfdatum/Date of inspection 18. Feb 2010

Endress+Hauser
People for Process Automation

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System Controls & Instrumentation, Ltd

11218 IH-10 E.
Converse, TX 78109
Phone: 210-661-9901
Fax: 210-666-5575

1108 Quail Hollow
Laredo, TX 78045
Phone: 956-725-1239
Fax: 956-726-1774

TECL # 18461

30-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-3

DRAWINGS

SCI FILE 3079

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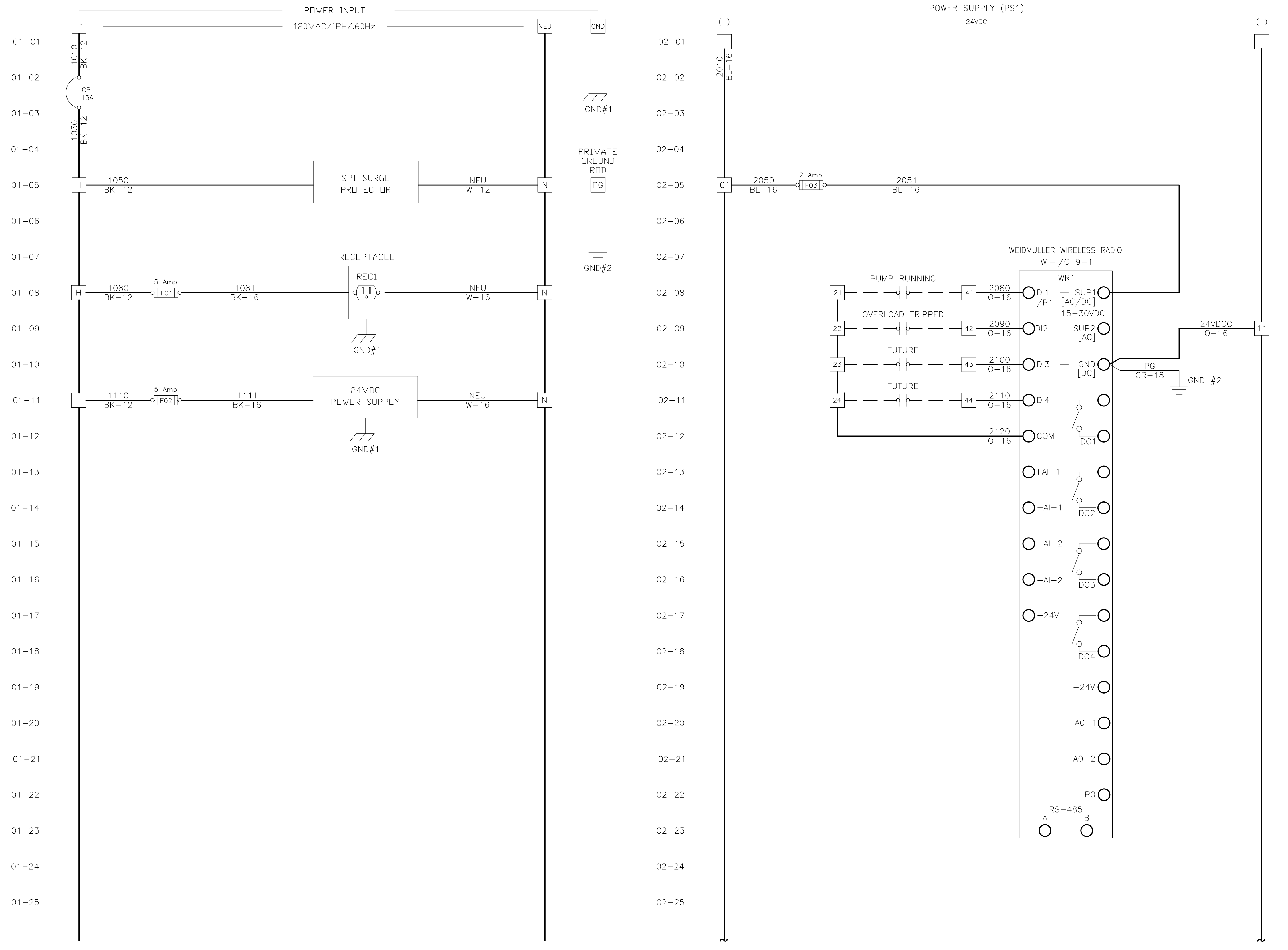


NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

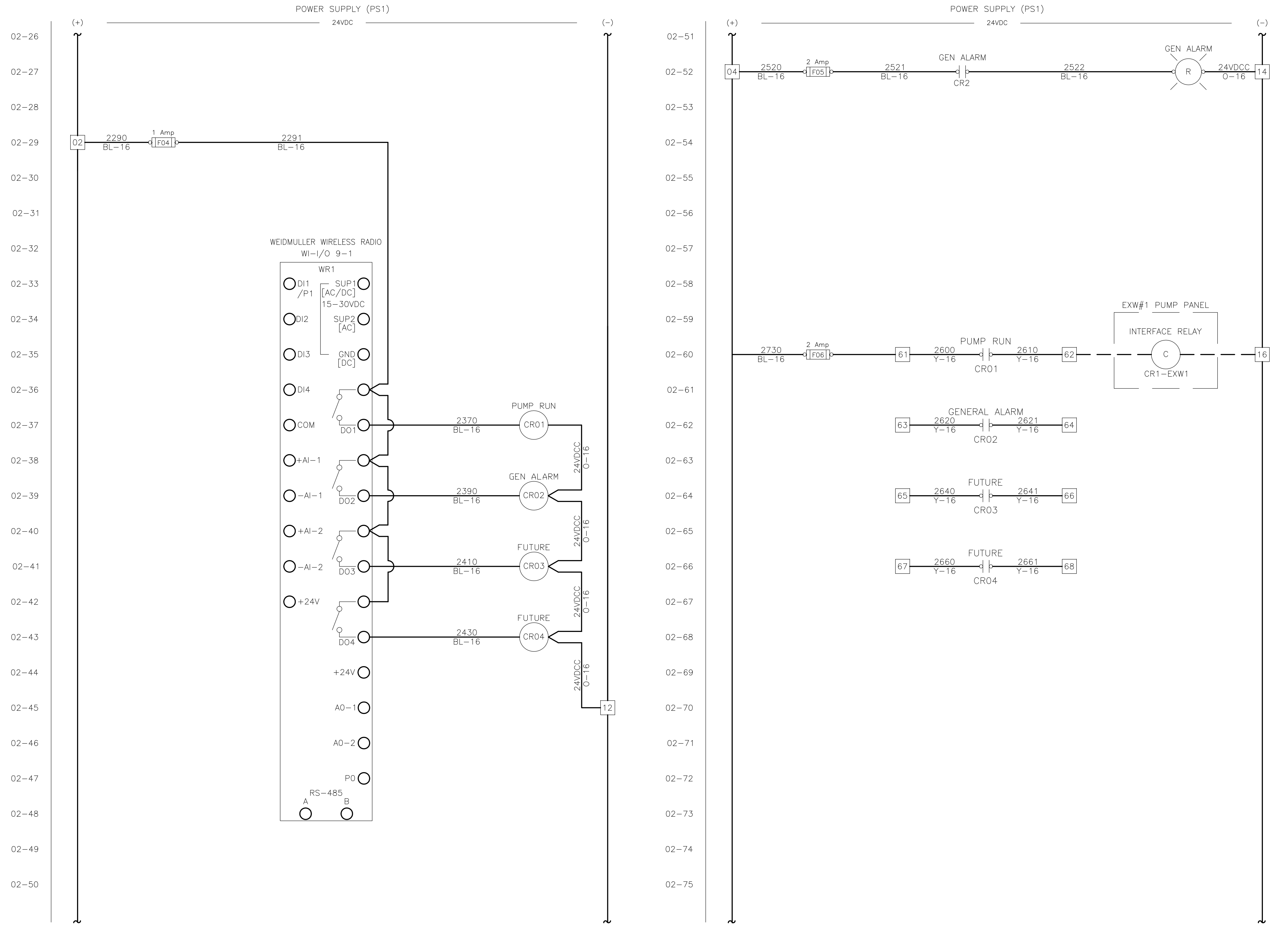
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL FOR
EXTRACTION WELL #1

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-3

DWG. NO.	SH	OF
3079	1	8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

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REV #	DATE	REVISION

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CONVERSE, TEXAS 78109
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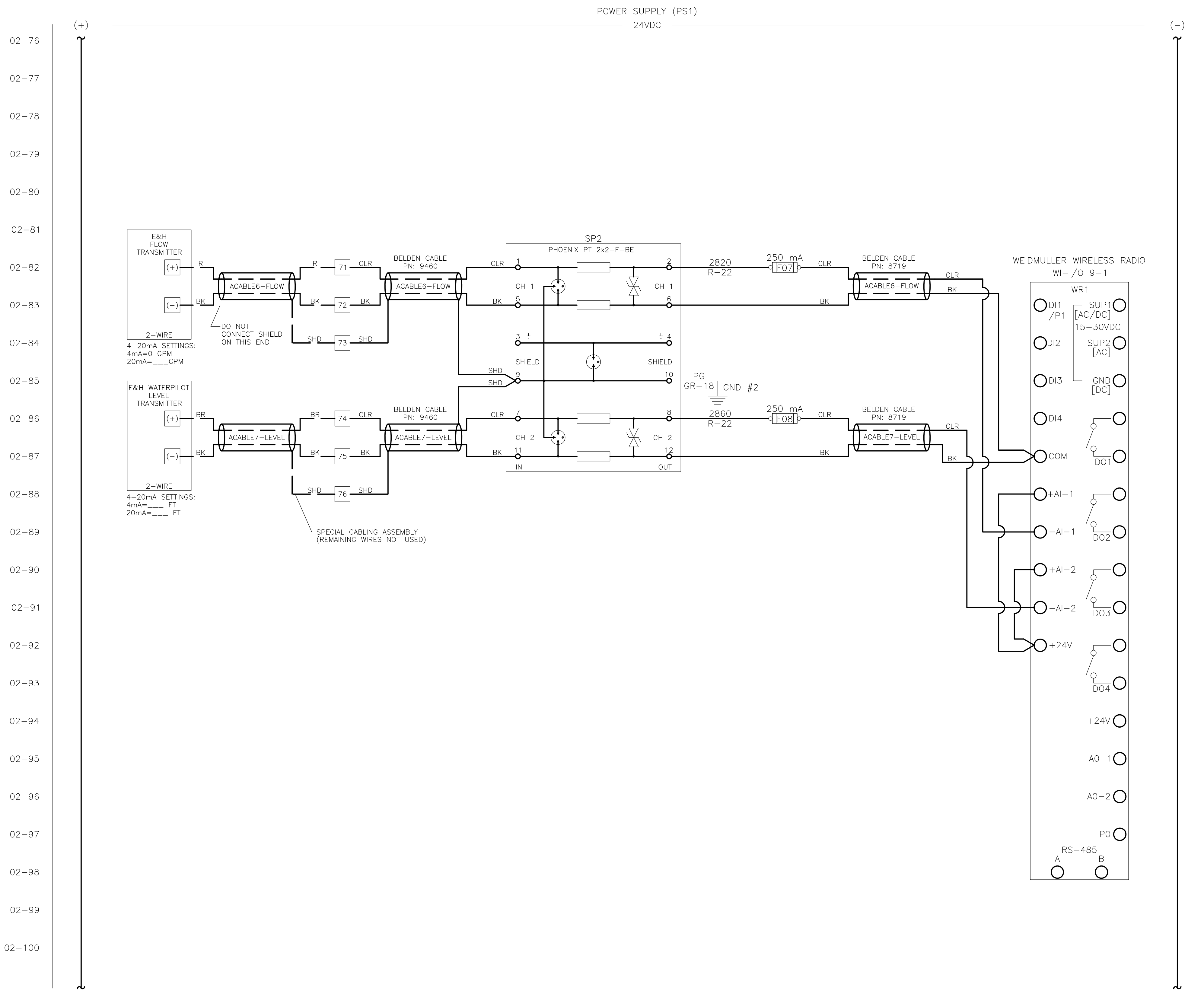
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903−3
CONTROL PANEL FOR
EXTRACCTION WELL #1

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903−3

DWG. NO.	SH	OF
3079	2	8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND

COLOR SIZE
Y−18

COLOR CODE	
CLR	CLEAR
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BR	BROWN
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REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

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PHONE (210) 661-9901

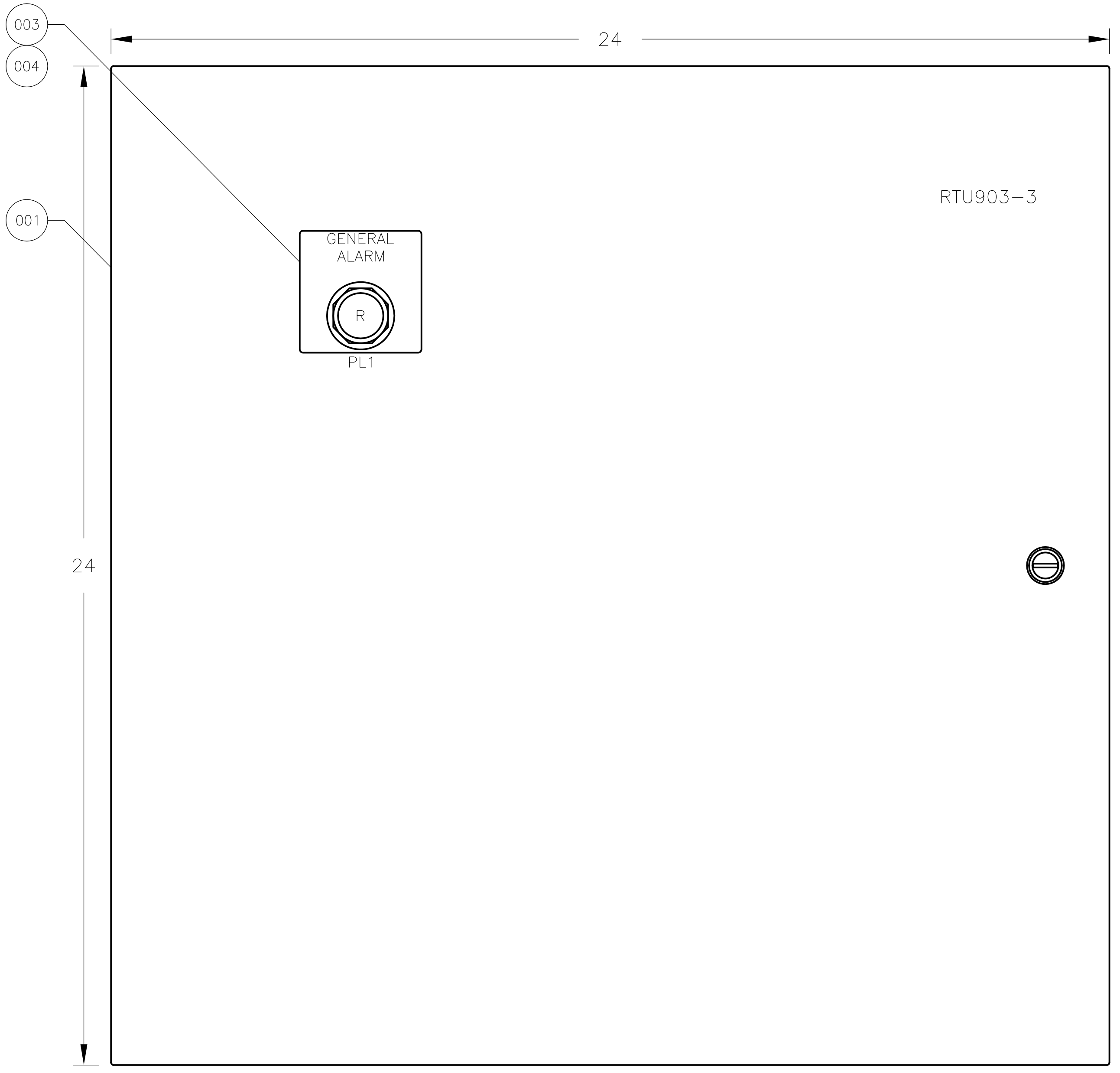
ENGINEER

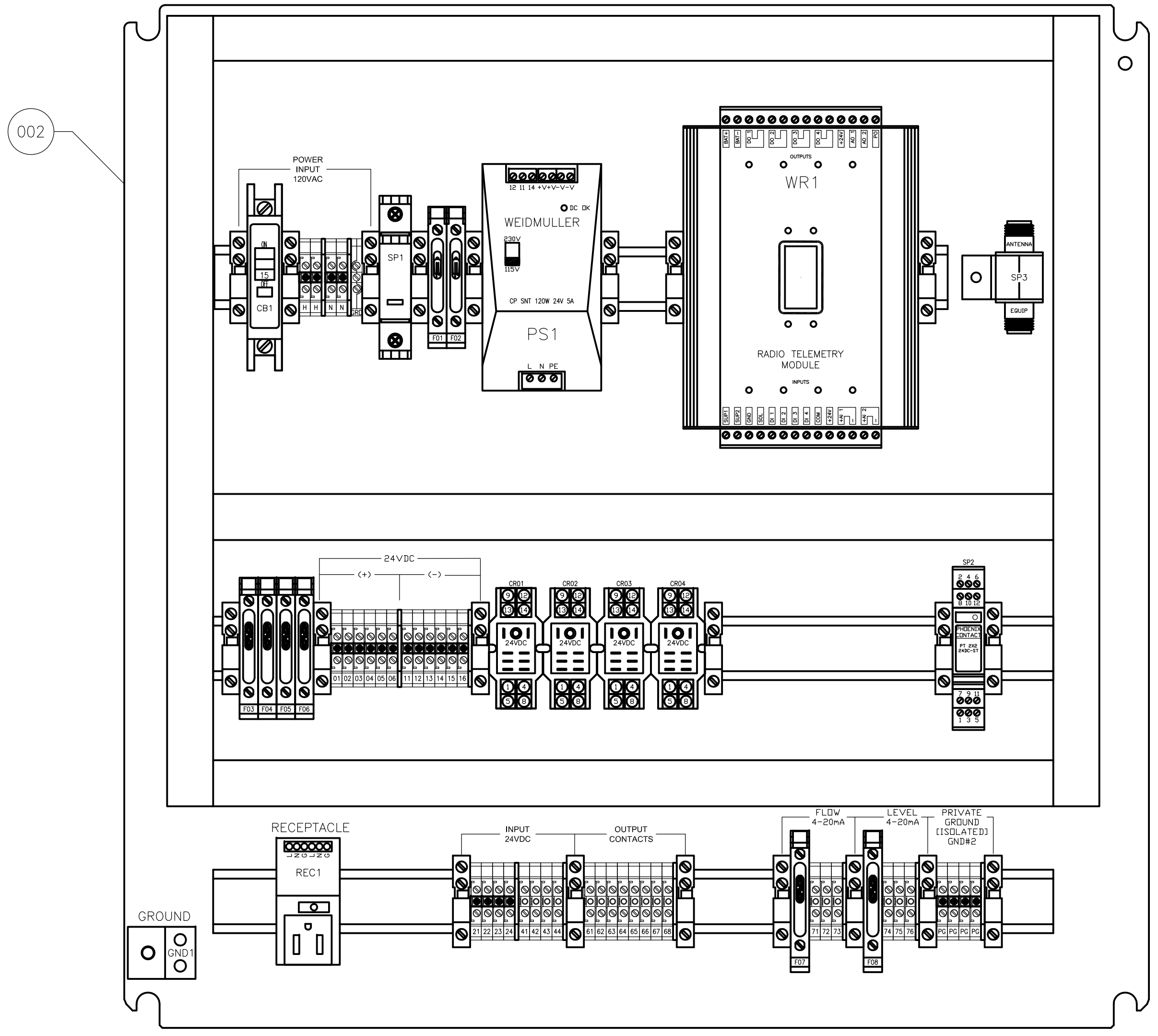
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903−3
CONTROL PANEL FOR
EXTRACTION WELL #1

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903−3

DWG. NO.	SH	OF
3079	3	8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

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CONVERSE, TEXAS 78109
PHONE (210) 661-9901

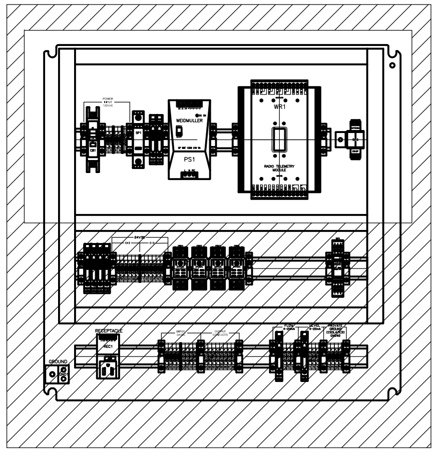
ENGINEER

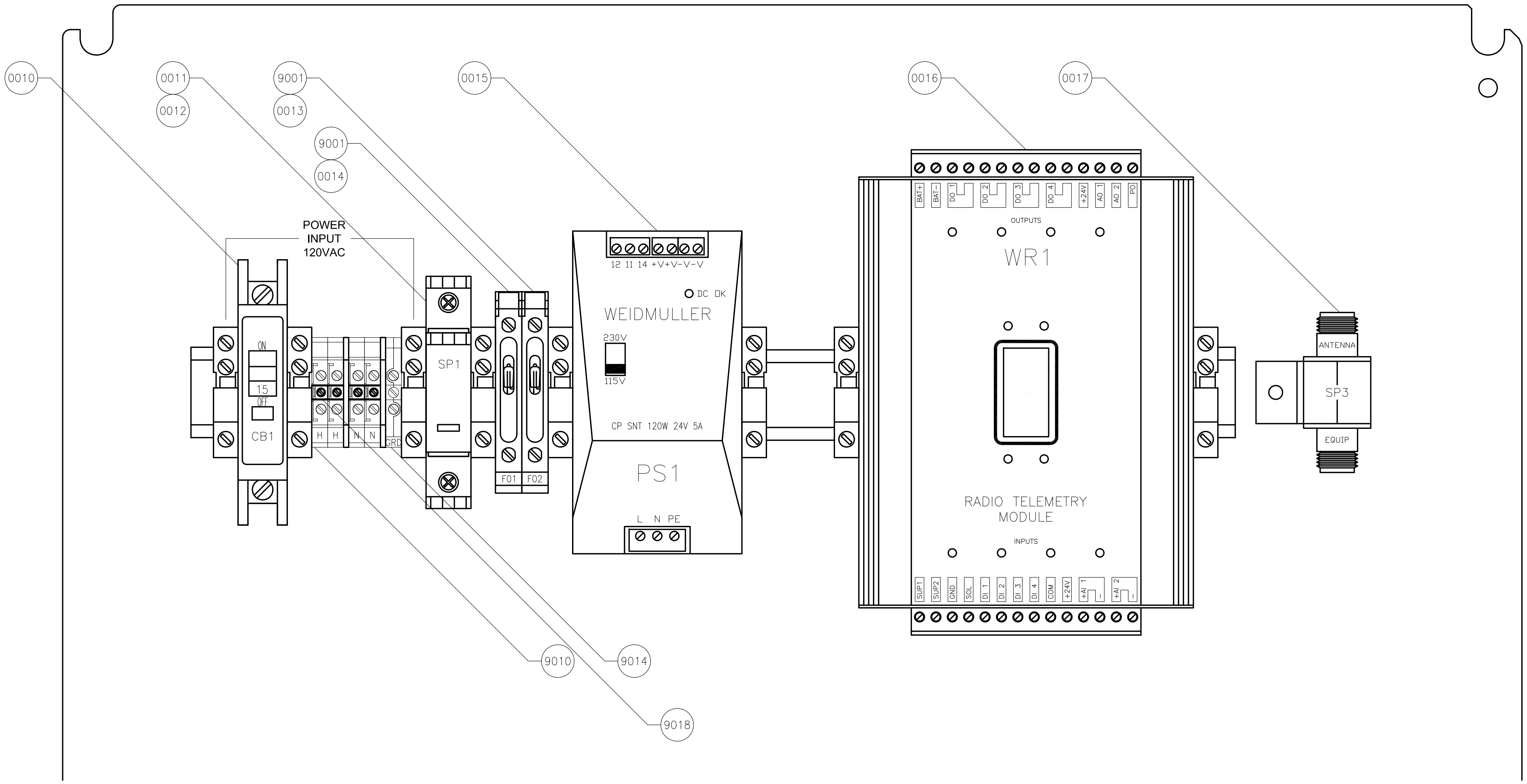
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL BACK PANEL
FOR EXTRACTION WELL #1

DATE:	8/10/2009
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-3

DWG. NO.	SH	OF
3079	4	8





REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

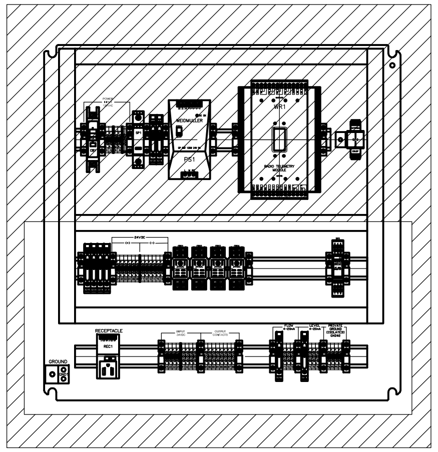
ENGINEER

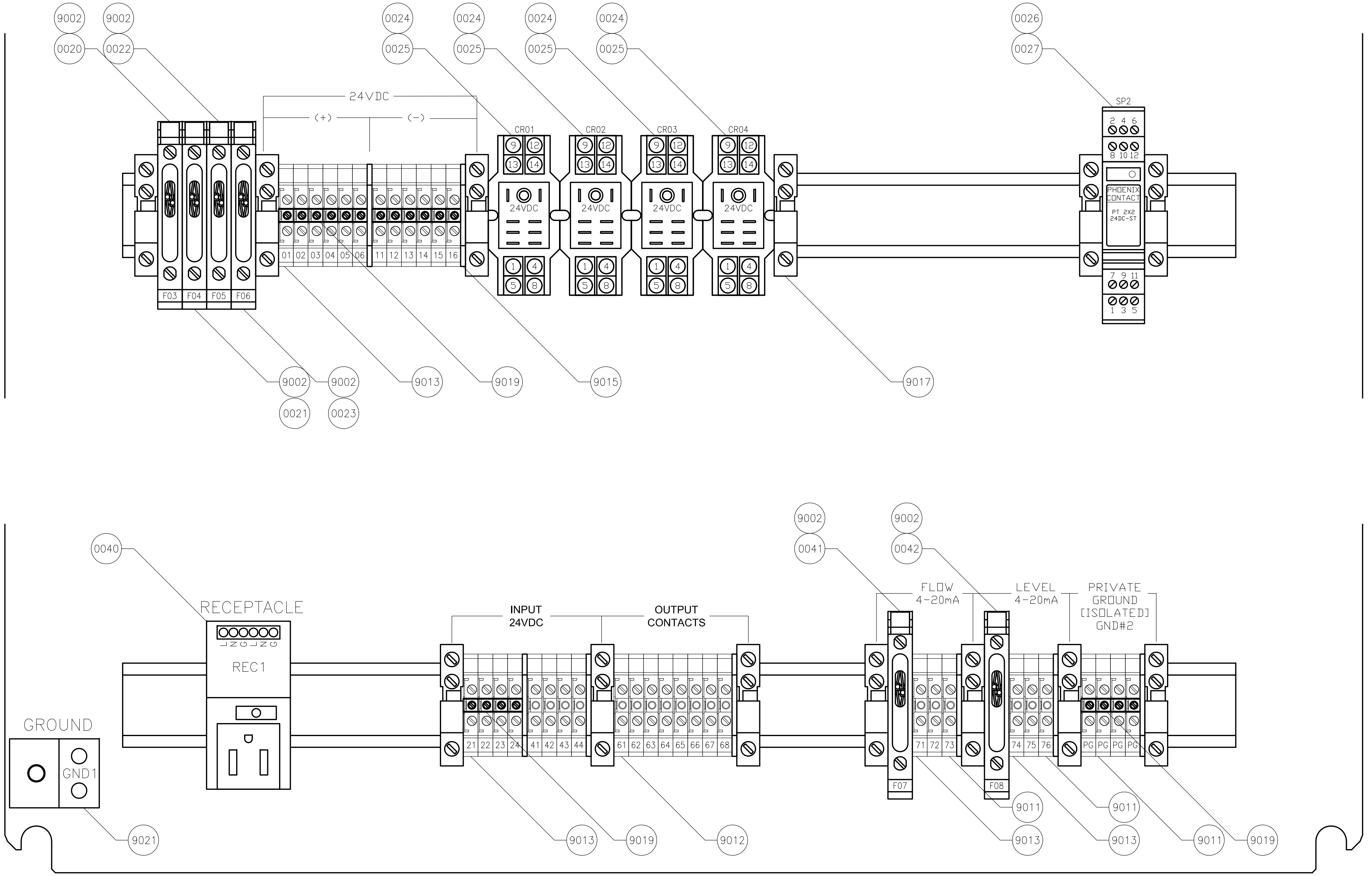
PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL PARTS LAYOUT
EXTRACTION WELL #1

DATE:	8/10/09
SCALE:	1:2
DRAWN BY:	RMF
CAD FILE	SCI3079_RTU903-3

DWG. NO.	SH	OF
3079	5	8





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BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL PARTS LAYOUT
EXTRACTION WELL #1

DATE: 8/10/09
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 6
OF 8

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	COUNT	MFG_#	DESCRIPTION	MFG_NAME	PART_KEY_#
0001	RTU903-3	1	CSD242410SS	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	HOFFMAN	
0002	RTU903-3	1	CP2424	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	HOFFMAN	
0003	PL1	1	800T-QBH24R	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	AB	
0004	PL1	1		PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H	SCI	999999
0010	CB1	1	QOU115	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	SQD	
0011		1	PU II 1S	HOLDER, SURGE PROTECTION	WEIDMULLER	
0012	SP1	1	PU II 1	SURGE PROTECTION MODULE, 130VAC, IN:20KA, IMAX:40KA, L-N	WEIDMULLER	8859950000
0013		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0014		1	MDL-5	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	BUSSMANN	
0015	PS1	1	CP SNT 120W 24V 5A	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	WEIDMULLER	
0016	WR1	1	WI-I/O 9-1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WEIDMULLER	8708670000
0017	SP3	1	IS-50NX-C2	BROADBAND DC BLOCKED PROTECTOR, 125-1000MHZ, 50 OHM, 50-375W, VSWR: 1.1:1, SURGE 50KA, N-FEMALE X N-FEMALE	POLYPHASER	
0020		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0021		1	AGC-1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	BUSSMANN	
0022		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0023		1	AGC-2	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	BUSSMANN	
0024		4	SH2B-05	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	IDEC	
0025		4	RH2B-ULC-DC24V	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	IDEC	
0026		1	PT 2X2+F-BE	BASE, GAS-FILLED SURGE ARRESTOR, 2 2-WIRE FLOATING SIGNALS, 600V/ 450MA, DIN RAIL	PHOENIX	2839224
0027		1	PT 2X2-24DC-ST	PROTECTIVE PLUG, 2 2-CORE FLOATING SIGNALS, 24VDC, MAX CORE SURGE 10KA @ (8-20US)	PHOENIX	2838228
0040	REC1	1	991548	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	WEIDMULLER	991548
0041		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
0042		1	AGC-1/4	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	BUSSMANN	
9001		2	UK 6,3-HESILA 250	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	3004249
9002		6	UK 6,3-HESILED 24	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	3004265
9010		4	UK 5 N	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	PHOENIX	3004362
9011		6	UK 5 N GN	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	PHOENIX	3003965
9012		8	UK 5 N YE	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	PHOENIX	3003952
9013		24	UK 5 N OG	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	PHOENIX	3002908
9014		1	UKLKG 5	GROUND TERMINAL, 26-10AWG	PHOENIX	0441504
9015		10	D-UK 4/10	END COVER PLATE, GRAY	PHOENIX	3003020
9017		21	E/UK	END CLAMP, GRAY	PHOENIX	1201442
9018		2	FBI 2-6	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	PHOENIX	0203438
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9019		2	FBI 10-6	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	PHOENIX	0203250
9021	GND1	1	K2A25U	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	BURNDY	

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

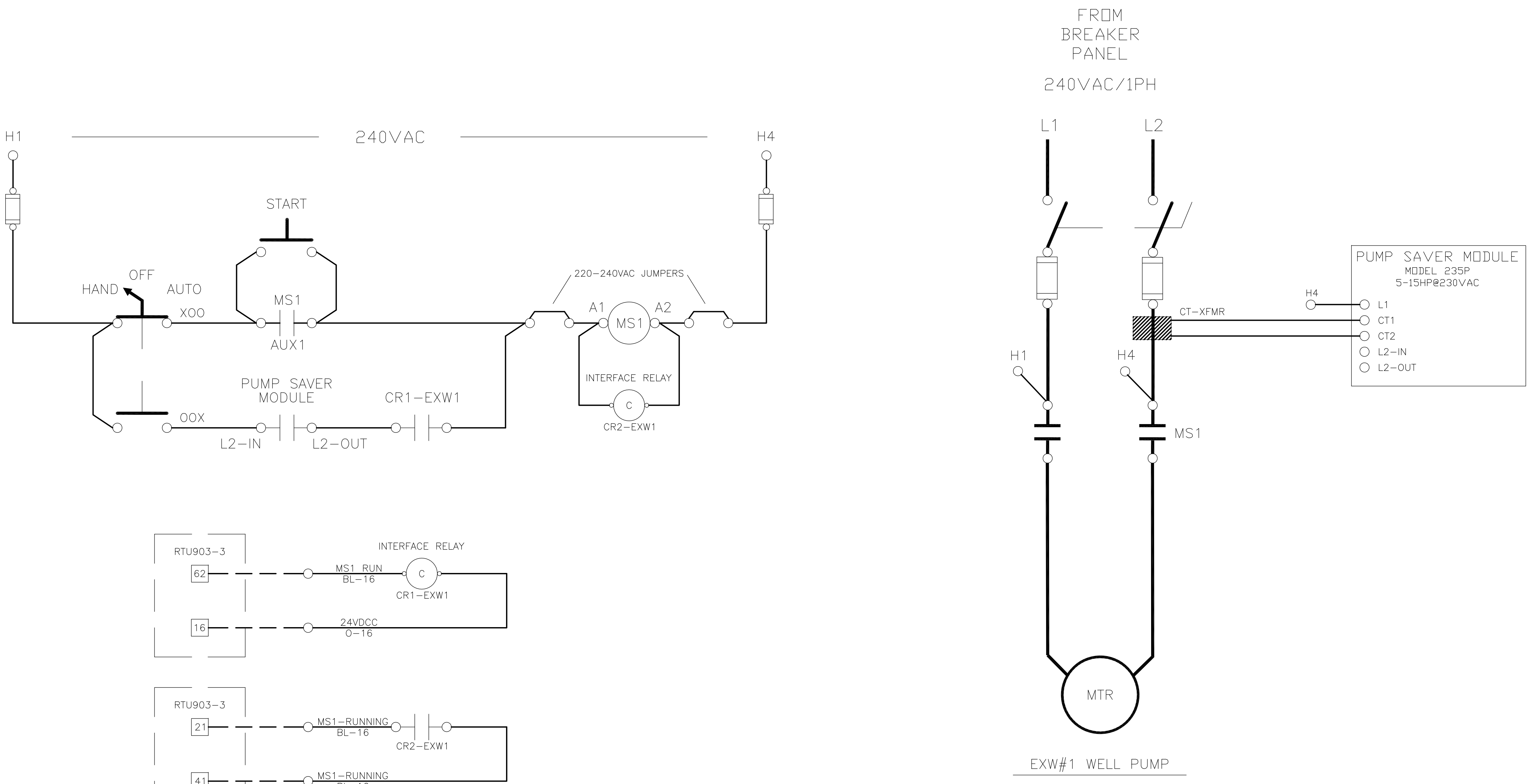
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-3
CONTROL PANEL BILL OF MATERIALS
FOR EXTRACTION WELL #1

DATE: 8/10/2009
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 7
OF 8



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND

COLOR SIZE
Y-18

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
PUMP CONTROL PANEL
FIELD WIRING DIAGRAM
FOR EXTRACTION WELL #1

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI3079_RTU903-3
DWG. NO. 3079
SH 8
OF 8

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CALIBRATION NOTES

JOB:	CSSA	DATE:	1/13/2010
JOB NO:	3079	BY:	RMF
PNL NO:	903-3		
ANALOG CH:	**1**		Arbitrary
			(R3030)
MA	**OHMS**	**DEC**	**FLOW (GPM)**
4mA	6470	0	0.00
12mA	1990	16375	50.00
20mA	1100	32739	99.96
ANALOG CH:	**2**		Arbitrary
			(R3031)
MA	**OHMS**	**DEC**	**DEPTH (ft)**
4mA	6460	0	0.0
12mA	1990	16356	150.0
20mA	1099	32754	300.4

REMOTE RTU903-4

System Controls & Instrumentation, Ltd

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Converse, TX 78109	**Laredo, TX 78045**
Phone: 210-661-9901	**Phone: 956-725-1239**
Fax: 210-666-5575	**Fax: 956-726-1774**

TECL # 18461

April 29, 2010

Operating & Maintenance Manual

FOR

REMOTE RTU903-4

AT

Camp Stanley Storage Bioreactor Facility

Bldg. 903

Instrumentations & Controls

SCI FILE 2829

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TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-4

Table of Contents

SCI FILE 2829

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TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-4

BILL OF MATERIAL

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BILL OF MATERIALS

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-4	1	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	CSD242410SS	HOFFMAN
0002	RTU903-4	1	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	CP2424	HOFFMAN
0003	PL1	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0004	PL1	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0010	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0011	SP1	1	SURGE PROTECTION MODULE, 120VAC, IMAX:40KA, VMAX: 150V	DS41-120	CITEL
0012		1	HOLDER, SURGE PROTECTION	DS41-120	CITEL
0013		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0014		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0015	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	CP SNT 120W 24V 5A	WEIDMULLER
0016	SP2	1	SURGE PROTECTION MODULE, 24VDC, IMAX:2KA, VMAX: 30V	DS220-24DC	CITEL
0017		1	HOLDER, SURGE PROTECTION	DS220-24DC	CITEL
0018	WR1	1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WI-I/O 9-1	WEIDMULLER
0019	SP3	1	SURGE PROTECTOR, GAS TUBE, DC-5GHZ, 50 OHM, MAX POWER: 25W, VSWR: 1.2:1, SURGE 20KA, N-FEMALE X N-FEMALE, BULKHEAD MOUNT	P8AX09-N/FF	CITEL
0020		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0021		1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	AGC-1	BUSSMANN
0022		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0023		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0024		4	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0025		4	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-DC24V	IDEC
0026	SP4	1	SURGE PROTECTION MODULE, 4-20MA, IMAX:20KA, VMAX: 28VDC	DLA-24D3	CITEL
0027		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-24D3	CITEL
0028	SP5	1	SURGE PROTECTION MODULE, 4-20MA, IMAX:20KA, VMAX: 28VDC	DLA-24D3	CITEL
0029		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-24D3	CITEL
0040	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0041		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0042		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		2	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		6	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9010		4	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		6	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9012		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9013		24	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		1	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		10	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		23	END CLAMP, GRAY	E/UK	PHOENIX
9018		2	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	FBI 2-6	PHOENIX
9019		4	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

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TECL # 18461

29-Apr-10

Camp Stanley Storage

Bioreactor Facility
Bldg. 903

REMOTE RTU903-4

PRODUCT DATA
Operation Manual

SCI FILE 2829

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CONCEPT® Wall-Mount Enclosures

CONCEPT®, Type 4X

Industry Standards

Mounting brackets required to meet UL/CSA external mounting requirements.

UL 508A Listed; Type 3R, 4, 4X, 12; File No. E61997
cUL Listed per CSA C22.2 No 94; Type 3R, 4, 4X, 12; File No. E61997

NEMA/EEMAC Type 3R, 4, 4X, 12, 13
CSA File No. 42186: Type 4, 4X, 12
VDE IP66
IEC 60529, IP66
Meets NEMA Type 3RX requirements

Application

For indoor or outdoor applications that require corrosion protection from chemicals and water. CONCEPT® Enclosures feature streamlined styling with an attractive stroked finish and flush quarter-turn latches for secure closure. Available in solid- and window-door models.

Specifications

- Manufactured from 16 and 14 gauge Type 304 or Type 316L stainless steel
- Minimum-width body flange provides maximum body opening
- External formed body flange trough
- Panel mounting studs fit optional CONCEPT panels and other accessories
- Mounting holes in back of body for direct mounting or for optional external mounting brackets
- Type 304 stainless steel hidden hinges promote clean aesthetic appearance
- Doors are interchangeable and easily removed by pulling clip-style hinge pins
- Provision on door (except window-door style and when B = 12 in.) for thermoplastic data pocket
- Provision on door (except window-door style and when B = 12 in.) for optional doorstop kit
- Quarter-turn latches furnished with flush slotted insert
- Seamless foam-in-place gasket
- Self-grounding latch system with double seal
- Bonding provision on door; grounding stud on body
- Furnished hardware kit consists of panel-mounting nuts, panel-grounding hardware and sealing washers for wall-mounting holes
- Installation instructions
- Window doors have a clear polycarbonate window

Finish

Door and body have smooth #4 brushed finish.

Patents

This product is covered by the following patents:
US 360,345
DE 9405854.7
US 5,509,703
US 5,666,695
Other patents pending.

Accessories

See also Accessories.
Type 316 Stainless Steel Door Stop Kit
CONCEPT® Panels
H_2OMIT™ Vent Drains, Type 4X
H_2OMIT™ Thermoelectric Dehumidifier
Handles
Lock Inserts

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

Bulletin: CWS

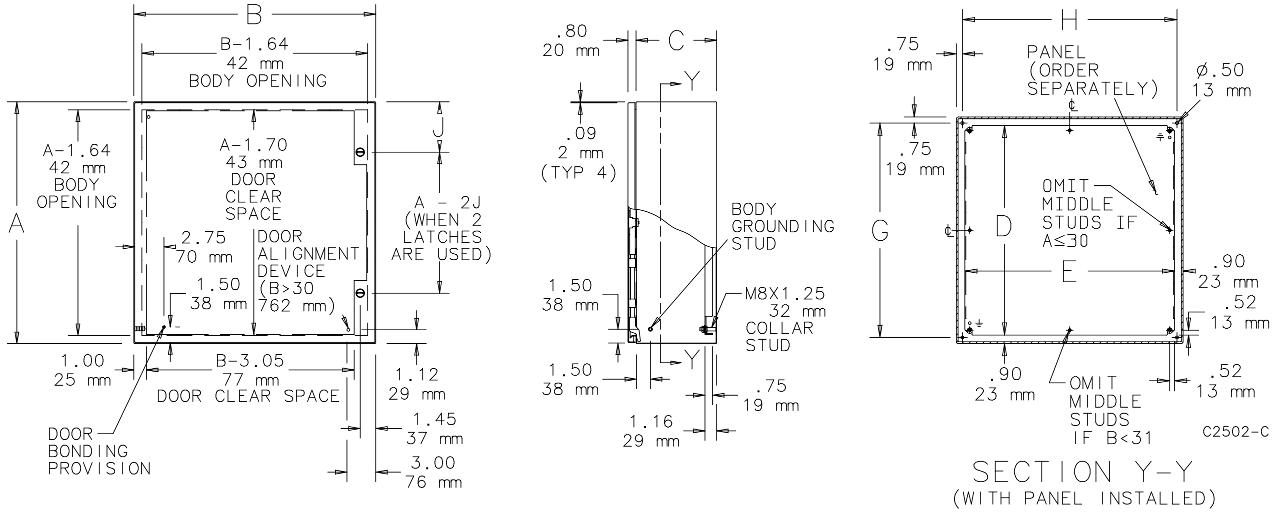
CONCEPT® Wall-Mount Enclosures

Standard Product **One-Door**

Catalog Number	AxBxC in.	AxBxC mm	Door Gauge	Body Gauge	Panel	Conductive Panel	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Latches Qty.	Style	J (in.)	J (mm)
CSD12126SS	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	Quarter-turn	6.00	152
CSD12126SS6	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	Quarter-turn	6.00	152
CSD16126SS	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16126SS6	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16166SS	16.00 x 16.00 x 6.00	406 x 406 x 152	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16166SS6	16.00 x 16.00 x 6.00	406 x 406 x 152	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD20166SS	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20166SS6	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20206SS	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD20206SS6	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD16128SS	16.00 x 12.00 x 8.00	406 x 305 x 203	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16128SS6	16.00 x 12.00 x 8.00	406 x 305 x 203	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD16168SS	16.00 x 16.00 x 8.00	406 x 406 x 203	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16168SS6	16.00 x 16.00 x 8.00	406 x 406 x 203	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD16208SS	16.00 x 20.00 x 8.00	406 x 508 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD16208SS6	16.00 x 20.00 x 8.00	406 x 508 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD20168SS	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20168SS6	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD20208SS	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD20208SS6	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD24168SS	24.00 x 16.00 x 8.00	610 x 406 x 203	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD24168SS6	24.00 x 16.00 x 8.00	610 x 406 x 203	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD24208SS	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD24208SS6	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD24248SS	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD24248SS6	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD30248SS	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD30248SS6	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD30308SS	30.00 x 30.00 x 8.00	762 x 762 x 203	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD30308SS6	30.00 x 30.00 x 8.00	762 x 762 x 203	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD36248SS	36.00 x 24.00 x 8.00	914 x 610 x 203	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD36248SS6	36.00 x 24.00 x 8.00	914 x 610 x 203	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD36308SS	36.00 x 30.00 x 8.00	914 x 762 x 203	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD36308SS6	36.00 x 30.00 x 8.00	914 x 762 x 203	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD161210SS	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD161210SS6	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	Quarter-turn	8.00	203
CSD161610SS	16.00 x 16.00 x 10.00	406 x 406 x 254	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD161610SS6	16.00 x 16.00 x 10.00	406 x 406 x 254	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	Quarter-turn	8.00	203
CSD162010SS	16.00 x 20.00 x 10.00	406 x 508 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD162010SS6	16.00 x 20.00 x 10.00	406 x 508 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	Quarter-turn	8.00	203
CSD201610SS	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD201610SS6	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	Quarter-turn	10.00	254
CSD202010SS	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202010SS6	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202410SS	20.00 x 24.00 x 10.00	508 x 610 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	464 x 462	18.50 x 22.50	470 x 572	1	Quarter-turn	10.00	254
CSD202410SS6	20.00 x 24.00 x 10.00	508 x 610 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	464 x 462	18.50 x 22.50	470 x 572	1	Quarter-turn	10.00	254
CSD241610SS	24.00 x 16.00 x 10.00	610 x 406 x 254	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD241610SS6	24.00 x 16.00 x 10.00	610 x 406 x 254	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	Quarter-turn	12.00	305
CSD242010SS	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD242010SS6	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	Quarter-turn	12.00	305
CSD242410SS	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD242410SS6	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD243010SS	24.00 x 30.00 x 10.00	610 x 762 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	22.50 x 28.50	572 x 724	2	Quarter-turn	5.00	127
CSD243010SS6	24.00 x 30.00 x 10.00	610 x 762 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	22.50 x 28.50	572 x 724	2	Quarter-turn	5.00	127
CSD302010SS	30.00 x 20.00 x 10.00	762 x 508 x 254	14	16	CP3020	CP3020G	28.20 x 18.20	716 x 462	28.50 x 18.50	724 x 470	2	Quarter-turn	5.00	127
CSD302010SS6	30.00 x 20.00 x 10.00	762 x 508 x 254	14	16	CP3020	CP3020G	28.20 x 18.20	716 x 462	28.50 x 18.50	724 x 470	2	Quarter-turn	5.00	127
CSD302410SS	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD302410SS6	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD303010SS	30.00 x 30.00 x 10.00	762 x 762 x 254	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD303010SS6	30.00 x 30.00 x 10.00	762 x 762 x 254	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	Quarter-turn	5.00	127
CSD362410SS	36.00 x 24.00 x 10.00	914 x 610 x 254	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD362410SS6	36.00 x 24.00 x 10.00	914 x 610 x 254	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD363010SS	36.00 x 30.00 x 10.00	914 x 762 x 254	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD363010SS6	36.00 x 30.00 x 10.00	914 x 762 x 254	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD482410SS	48.00 x 24.00 x 10.00	1220 x 610 x 254	14	14	CP4824	CP4824G	46.20 x 22.20	1173 x 564	46.50 x 22.50	1181 x 572	1	3-point	24.00	610
CSD482410SS6	48.00 x 24.00 x 10.00	1220 x 610 x 254	14	14	CP4824	CP4824G	46.20 x 22.20	1173 x 564	46.50 x 22.50	1181 x 572	1	3-point	24.00	610
CSD202012SS	20.00 x 20.00 x 12.00	508 x 508 x 305	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD202012SS6	20.00 x 20.00 x 12.00	508 x 508 x 305	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	Quarter-turn	10.00	254
CSD242412SS	24.00 x 24.00 x 12.00	610 x 610 x 305	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD242412SS6	24.00 x 24.00 x 12.00	610 x 610 x 305	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	Quarter-turn	5.00	127
CSD302412SS	30.00 x 24.00 x 12.00	762 x 610 x 305	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD302412SS6	30.00 x 24.00 x 12.00	762 x 610 x 305	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	Quarter-turn	5.00	127
CSD362412SS	36.00 x 24.00 x 12.00	914 x 610 x 305	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD362412SS6	36.00 x 24.00 x 12.00	914 x 610 x 305	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	Quarter-turn	5.00	127
CSD363012SS	36.00 x 30.00 x 12.00	914 x 762 x 305	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127
CSD363012SS6	36.00 x 30.00 x 12.00	914 x 762 x 305	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	Quarter-turn	5.00	127

Catalog numbers ending in 6 are Type 316L stainless steel.
Purchase panels separately. Optional stainless steel, composite and aluminum panels are also available for most sizes.
Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.

CONCEPT® Wall-Mount Enclosures



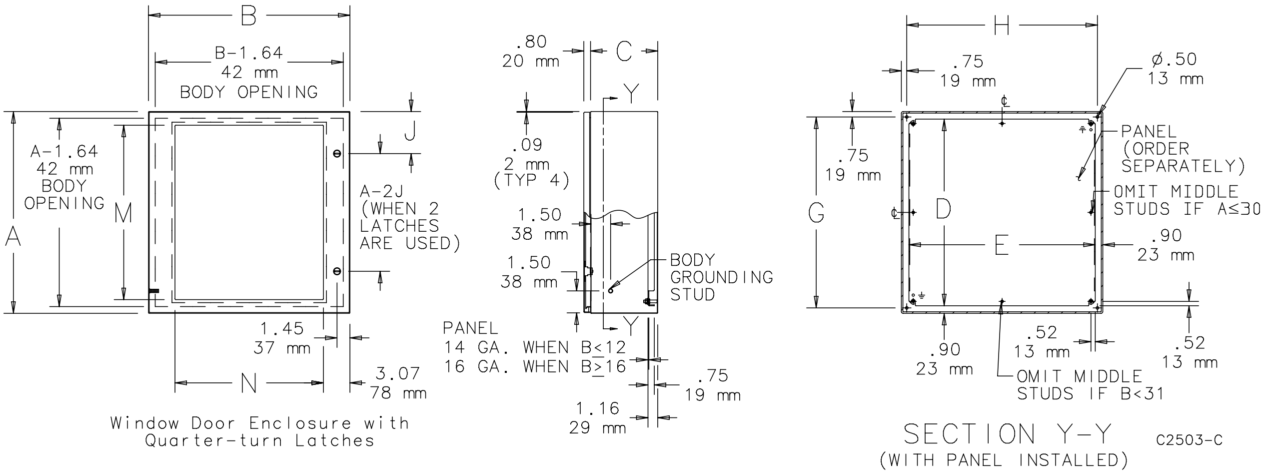
CONCEPT® Wall-Mount Enclosures

Standard Product **One-Door with Window**

Catalog Number	AxBxC in.	AxBxC mm	Door Ga.	Body Ga.	Panel	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Window Size M x N (in.)	Window Size M x N (mm)	Latch Qty.	Style	J (in.)	J (mm)
CSD12126WSS	12.00 x 12.00 x 6.00	305 x 305 x 152	16	16	CP1212	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	8.74 x 7.10	222 x 180	1	Quarter-turn	6.00	152
CSD16126WSS	16.00 x 12.00 x 6.00	406 x 305 x 152	16	16	CP1612	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	12.74 x 7.10	324 x 180	1	Quarter-turn	8.00	203
CSD20166WSS	20.00 x 16.00 x 6.00	508 x 406 x 152	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD20206WSS	20.00 x 20.00 x 6.00	508 x 508 x 152	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD20168WSS	20.00 x 16.00 x 8.00	508 x 406 x 203	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD20208WSS	20.00 x 20.00 x 8.00	508 x 508 x 203	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD24208WSS	24.00 x 20.00 x 8.00	610 x 508 x 203	16	16	CP2420	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	20.74 x 15.10	527 x 384	1	Quarter-turn	12.00	305
CSD24248WSS	24.00 x 24.00 x 8.00	610 x 610 x 203	14	16	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	20.74 x 17.68	527 x 449	2	Quarter-turn	5.00	127
CSD30248WSS	30.00 x 24.00 x 8.00	762 x 610 x 203	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127
CSD161210WSS	16.00 x 12.00 x 10.00	406 x 305 x 254	16	16	CP1612	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	12.74 x 7.10	324 x 180	1	Quarter-turn	8.00	203
CSD201610WSS	20.00 x 16.00 x 10.00	508 x 406 x 254	16	16	CP2016	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	16.74 x 11.10	425 x 282	1	Quarter-turn	10.00	254
CSD202010WSS	20.00 x 20.00 x 10.00	508 x 508 x 254	16	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD242010WSS	24.00 x 20.00 x 10.00	610 x 508 x 254	16	16	CP2420	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	20.74 x 15.10	527 x 384	1	Quarter-turn	12.00	305
CSD242410WSS	24.00 x 24.00 x 10.00	610 x 610 x 254	14	16	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	20.74 x 17.68	527 x 449	2	Quarter-turn	5.00	127
CSD302410WSS	30.00 x 24.00 x 10.00	762 x 610 x 254	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127
CSD202012WSS	20.00 x 20.00 x 12.00	508 x 508 x 305	14	16	CP2020	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	16.74 x 15.10	425 x 384	1	Quarter-turn	10.00	254
CSD302412WSS	30.00 x 24.00 x 12.00	762 x 610 x 305	14	16	CP3024	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	26.74 x 17.68	679 x 449	2	Quarter-turn	5.00	127

Purchase panels separately.
Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.
Material is stainless steel Type 304.
For Conductive Panels, add a "G" to the panel catalog number.

CONCEPT Single-Door Wall-Mounted Enclosures with Windows

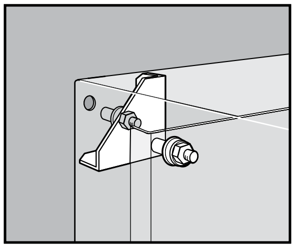


Window Door Enclosure with Quarter-turn Latches

SECTION Y-Y
(WITH PANEL INSTALLED)

CONCEPT® Accessories

CONCEPT® Panel Conversion Kit



Panel Conversion Kit adapts enclosure for mounting standard NEMA-style panels in CONCEPT® enclosures. Bracket attaches to rear collar stud. Kit includes four adapter plates and hardware for mounting panel.

Bulletin: CWY

Catalog Number	Material	Fits CONCEPT Enclosure
CCPM4	Steel	When A x B is equal to or less than 30.00 x 30.00 in. (762 x 762 mm)

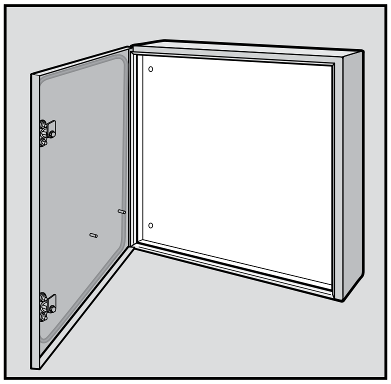
Swing-Out Rack Frame

Swing-Out Rack Frames provide 120-degree swing-out access for 19-in. rack equipment. Welded rack frame mounts to front flange. Distance from frame to door surface is 1.32 in. (33 mm) for solid doors and 1.07 in. (27 mm) for window doors. Frame is painted steel ANSI 61 gray. Mounting hinge and latching hardware provided.
Order separately clip nut package catalog number XNM5 and screws XSM5 (metric) or AN1032 and screws AS1032 (English).
Swing-Out Rack Frame cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Material	Fits Enclosure A x B
CSF2424	Painted steel	24.00 x 24.00 in. (610 x 610 mm)
CSF3024	Painted steel	30.00 x 24.00 in. (762 x 610 mm)
CSF3624	Painted steel	36.00 x 24.00 in. (914 x 610 mm)

Dead Front Kits



Dead Front Kits provide a NEMA Type 1 safety barrier and mounting surface close to the front of the enclosure. Enables convenient mounting of equipment while controlling access to the interior of the enclosure. The depth from the mounting surface to the door is 1.33 in. (34 mm) for solid doors and 1.15 in. (29 mm) for window doors. Kit includes mounting brackets, grounding hardware and a steel panel painted ANSI 61 gray.
Dead Front Kit cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure A x B
CDF1212	12.00 x 12.00 in. (305 x 305 mm)
CDF1612	16.00 x 12.00 in. (406 x 305 mm)
CDF2016	20.00 x 16.00 in. (508 x 406 mm)
CDF2020	20.00 x 20.00 in. (508 x 508 mm)
CDF2420	24.00 x 20.00 in. (610 x 508 mm)
CDF2424	24.00 x 24.00 in. (610 x 610 mm)
CDF3024	30.00 x 24.00 in. (762 x 610 mm)

CONCEPT® Adjustable-Depth Mounting Kits

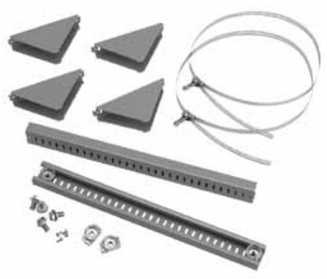
Adjustable-Depth Mounting Kits provide mounting means for installing panels, swing-out panels, DIN rails, rack angles, mounting channels or grid straps at any depth from front to rear of enclosure. Kits include slide mechanisms and hardware. Use two kits when enclosure has 6 collar studs for mounting panel.
Dead Front Panel and Swing-Out Rack Frame cannot be mounted on adjustable mounting kit.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure (in.)	Fits CONCEPT Enclosure (mm)
CAM64	when C = 6.00	when C = 152
CAM82	when C = 8.00	when C = 203
CAM84	when C = 8.00	when C = 203
CAM102	when C = 10.00	when C = 254
CAM104	when C = 10.00	when C = 254
CAM122	when C = 12.00	when C = 305
CAM124	when C = 12.00	when C = 305
CAM162	when C = 16.00	when C = 406
CAM164	when C = 16.00	when C = 406
CAM202	when C = 20.00	when C = 508
CAM204	when C = 20.00	when C = 508

CONCEPT® Accessories

Pole-Mount Kit

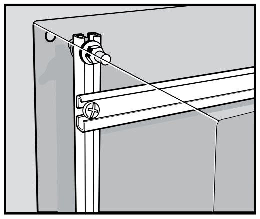


Use to mount CONCEPT®, Networking and wall-mount enclosures to poles of various sizes and shapes. Simply attach the plated steel channel bar to the mounting holes at the back of the enclosure and wrap the stainless steel strap around the pole and through the bar. Kit includes two mounting channels, two straps suitable for 3-in. (76-mm) to 12-in. (30-mm) diameter pole and mounting hardware.

Bulletin: CWY

Catalog Number	Fits Enclosure (in.)	Fits Enclosure (mm)
CPMK12	when B = 12.00	when B = 305
CPMK16	when B = 16.00	when B = 406
CPMK20	when B = 20.00	when B = 508
CPMK24	when B = 24.00	when B = 610
CPMK30	when B = 30.00	when B = 762

Mounting Channels

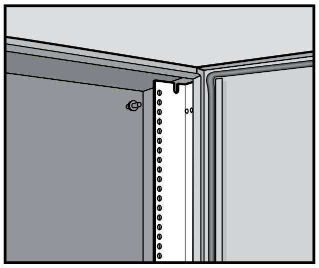


Mounting Channels provide mounting framework for installing DIN rails and grid straps at various positions within the enclosure. Channels can be mounted vertically or horizontally to collar studs or to the slide mechanisms of the adjustable-depth mounting kit. Kit includes two channels.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CMC12	when A or B = 12.00 in. (305 mm)
CMC16	when A or B = 16.00 in. (406 mm)
CMC20	when A or B = 20.00 in. (508 mm)
CMC24	when A or B = 24.00 in. (610 mm)
CMC30	when A or B = 30.00 in. (762 mm)
CMC36	when A or B = 36.00 in. (914 mm)
CMC42	when A or B = 42.00 in. (1067 mm)
CMC48	when A or B = 48.00 in. (1219 mm)
CMC60	when A or B = 60.00 in. (1524 mm)

Rack-Mount Angles



Rack-Mount Angles are a mounting means for 19-in. rack equipment in 24-in. wide enclosures. L-shaped through-hole angles attach to enclosure flange or the adjustable-depth mounting kit. Holes are .281 in. (7 mm) in diameter. Clear plated 14 gauge steel construction. Mounting hardware included.

Order separately clip nut package catalog number XNM5 and screws XSM5 (metric) or AN1032 and screws AS1032 (English).

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure	Rack Units
CRA10TH	when A = 20.00 in. (508 mm)	10
CRA12TH	when A = 24.00 in. (610 mm)	12
CRA16TH	when A = 30.00 in. (762 mm)	16
CRA19TH	when A = 36.00 in. (914 mm)	19
CRA26TH	when A = 48.00 in. (1219 mm)	26

DIN3 Rail Kits

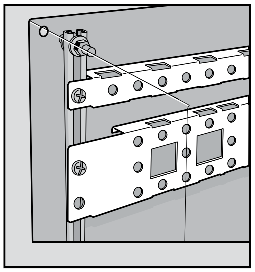
DIN3 Rail Kits supply mounting surfaces for DIN mount snap-on devices in either DIN 1, DIN 3 or CENELEC styles. Rails attach vertically or horizontally to rear collar stud or to mounting channels. Kit includes three rails and mounting hardware.

Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CDR3P12	when A or B = 12.00 in. (305 mm)
CDR3P16	when A or B = 16.00 in. (406 mm)
CDR3P20	when A or B = 20.00 in. (508 mm)
CDR3P24	when A or B = 24.00 in. (610 mm)

CONCEPT® Accessories

Grid Straps



Grid Straps provide flexible mounting inside the enclosure. Available in one-hole or three-hole widths. Straps mount vertically or horizontally on rear collar studs or to mounting channels in any front-to-back position. Two straps and mounting hardware included in kit. (Order separate grid fastener package catalog number XGFM6, consisting of 20 metric M6 clip nuts and 20 metric M6 Phillips washer head bolts, for mounting equipment to grid straps.)

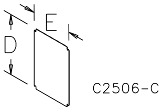
Bulletin: CWY

Catalog Number	Fits CONCEPT Enclosure
CGS112	when A or B = 12.00 in. (305 mm)
CGS116	when A or B = 16.00 in. (406 mm)
CGS120	when A or B = 20.00 in. (508 mm)
CGS124	when A or B = 24.00 in. (610 mm)
CGS130	when A or B = 30.00 in. (762 mm)
CGS336	when A or B = 36.00 in. (914 mm)
CGS348	when A or B = 48.00 in. (1219 mm)

CONCEPT® Panels

These panels are taller and wider than corresponding NEMA-size panels. Panels are 14 or 12 gauge steel and painted white or have a conductive finish.
Panels have a formed flange along any side that is longer than 22.20 in. (564 mm). CP2420 and CP2424 have a flange on all four sides.

Bulletin: CWP



Catalog Number	Panel Type	Panel Size D x E (in.)	Panel Size D x E (mm)	Gauge
CP1212	Painted steel	10.20 x 10.20	259 x 259	14
CP1212G	Conductive	10.20 x 10.20	259 x 259	14
CP1612	Painted steel	14.20 x 10.20	361 x 259	14
CP1612G	Conductive	14.20 x 10.20	361 x 259	14
CP1616	Painted steel	14.20 x 14.20	361 x 361	12
CP1616G	Conductive	14.20 x 14.20	361 x 361	12
CP2016	Painted steel	18.20 x 14.20	462 x 361	12
CP2014	Painted steel	18.20 x 12.20	462 x 310	14
CP2016G	Conductive	18.20 x 14.20	462 x 361	12
CP2416	Painted steel	22.20 x 14.20	564 x 361	12
CP2416G	Conductive	22.20 x 14.20	564 x 361	12
CP2020	Painted steel	18.20 x 18.20	462 x 462	12
CP2020G	Conductive	18.20 x 18.20	462 x 462	12
CP2420	Painted steel	22.20 x 18.20	564 x 462	12
CP2420G	Conductive	22.20 x 18.20	564 x 462	12
CP3020	Painted steel	28.20 x 18.20	716 x 462	12
CP3020G	Conductive	28.20 x 18.20	716 x 462	12
CP2424	Painted steel	22.20 x 22.20	564 x 564	12
CP2424G	Conductive	22.20 x 22.20	564 x 564	12
CP3024	Painted steel	28.20 x 22.20	716 x 564	12
CP3024G	Conductive	28.20 x 22.20	716 x 564	12
CP3624	Painted steel	34.20 x 22.20	869 x 564	12
CP3624G	Conductive	34.20 x 22.20	869 x 564	12
CP4824	Painted steel	46.20 x 22.20	1173 x 564	12
CP4824G	Conductive	46.20 x 22.20	1173 x 564	12
CP3030	Painted steel	28.20 x 28.20	716 x 716	12
CP3030G	Conductive	28.20 x 28.20	716 x 716	12
CP3630	Painted steel	34.20 x 28.20	869 x 716	12
CP3630G	Conductive	34.20 x 28.20	869 x 716	12
CP4230	Painted steel	40.20 x 28.20	1021 x 716	12
CP4230G	Conductive	40.20 x 28.20	1021 x 716	12
CP3636	Painted steel	34.20 x 34.20	869 x 869	12
CP3636G	Conductive	34.20 x 34.20	869 x 869	12
CP4236	Painted steel	40.20 x 34.20	1021 x 869	12
CP4236G	Conductive	40.20 x 34.20	1021 x 869	12
CP4836	Painted steel	46.20 x 34.20	1173 x 869	12
CP4836G	Conductive	46.20 x 34.20	1173 x 869	12
CP6036	Painted steel	58.20 x 34.20	1478 x 869	12
CP6036G	Conductive	58.20 x 34.20	1478 x 869	12
CP2442	Painted steel	22.20 x 40.20	564 x 1021	12
CP2442G	Conductive	22.20 x 40.20	564 x 1021	12
CP3048	Painted steel	28.20 x 46.20	716 x 1173	12
CP3048G	Conductive	28.20 x 46.20	716 x 1173	12
CP3060	Painted steel	28.20 x 58.20	716 x 1478	12
CP3060G	Conductive	28.20 x 58.20	716 x 1478	12

Catalog number CP4230 is used on CONCEPT disconnect enclosures.

CONCEPT® Accessories

CONCEPT® Swing-Out Panels

CSPB panels

CSP panels

Panels swing clear from the front of the enclosure to provide access to mounted internal equipment. For CSPB panels, maximum swing is 94 degrees. For CSP panels, maximum panel swing is 106 degrees. Distance from panel surface to door when in the latched position is 1.71 in. (43 mm) for solid doors and 1.45 in. (37 mm) for window doors. Kits include panel, brackets and hardware to mount to the front flange.

Swing-out panels also can be mounted on front-to-back adjustable rails. CSPB panels require adapter CSPBADB and front-to-back adjustable rails for front-to-back adjustment.

Bulletin: CWY

CSPB Panels

Catalog Number	Fits Enclosure Size (in.)	Fits Enclosure Size (mm)	Panel Size (in.)	Panel Size (mm)
CSPB1212	12.00 x 12.00	305 x 305	9.72 x 9.75	247 x 248
CSPB1612	16.00 x 12.00	406 x 305	13.72 x 9.75	349 x 248
CSPB1616	16.00 x 16.00	406 x 406	13.72 x 13.75	349 x 349
CSPB1620	16.00 x 20.00	406 x 508	13.72 x 17.75	349 x 451
CSPB2016	20.00 x 16.00	508 x 406	17.72 x 13.75	450 x 349
CSPB2020	20.00 x 20.00	508 x 508	17.72 x 17.75	450 x 451
CSPB2024	20.00 x 24.00	508 x 610	17.72 x 21.75	450 x 553
CSPB2416	24.00 x 16.00	610 x 406	21.72 x 13.73	552 x 349
CSPB2420	24.00 x 20.00	610 x 508	21.72 x 17.75	552.452
CSPB2424	24.00 x 24.00	610 x 610	21.72 x 21.75	552 x 553
CSPB2430	24.00 x 30.00	610 x 762	21.72 x 27.75	552 x 705
CSPB3020	30.00 x 20.00	762 x 508	27.72 x 17.75	704 x 451
CSPB3024	30.00 x 24.00	762 x 610	27.72 x 21.75	704 x 553
CSPB3030	30.00 x 30.00	762 x 762	27.72 x 27.75	704 x 705
CSPB3624	36.00 x 24.00	914 x 610	33.72 x 21.75	857 x 553
CSPB3630	36.00 x 30.00	914 x 762	33.72 x 27.75	857 x 705
CSPB3636	36.00 x 36.00	914 x 914	33.72 x 33.75	857 x 857
CSPB4236	42.00 x 36.00	1067 x 914	39.72 x 33.75	1009 x 857
CSPB4824	48.00 x 24.00	1219 x 610	45.72 x 21.75	1161 x 553
CSPB4836	48.00 x 36.00	1219 x 914	45.72 x 33.75	1161 x 857
CSPB6036	60.00 x 36.00	1542 x 914	57.72 x 33.75	1466 x 857

CSP Panels

Catalog Number	Fits Enclosure (in.)	Fits Enclosure (mm)	Panel Size (in.)	Panel Size (mm)
CSP1212	12.00 x 12.00	305 x 305	9.78 x 9.84	248 x 250
CSP1612	16.00 x 12.00	406 x 305	13.78 x 9.84	350 x 250
CSP1616	16.00 x 16.00	406 x 406	13.78 x 13.84	350 x 352
CSP1620	16.00 x 20.00	406 x 508	13.78 x 17.84	350 x 453
CSP2016	20.00 x 16.00	508 x 406	17.78 x 13.84	452 x 352
CSP2020	20.00 x 20.00	508 x 508	17.78 x 17.84	452 x 453
CSP2024	20.00 x 24.00	508 x 610	17.78 x 21.84	452 x 555
CSP2416	24.00 x 16.00	610 x 406	21.78 x 13.84	553 x 352
CSP2420	24.00 x 20.00	610 x 508	21.78 x 17.84	553 x 453
CSP2424	24.00 x 24.00	610 x 610	21.78 x 21.84	553 x 555
CSP3020	30.00 x 20.00	762 x 508	27.78 x 17.84	706 x 453
CSP3024	30.00 x 24.00	762 x 610	27.78 x 21.84	706 x 555
CSP3030	30.00 x 30.00	762 x 762	27.78 x 27.84	706 x 707
CSP3624	36.00 x 24.00	914 x 610	33.78 x 21.84	858 x 555
CSP3630	36.00 x 30.00	914 x 762	33.78 x 27.84	858 x 707
CSP3636	36.00 x 36.00	914 x 914	33.78 x 33.84	858 x 860

CONCEPT® Adapter Bracket

Adapter bracket for use with CONCEPT® B-style Swing-Out Panels and Adjustable-Depth Mounting Kits. Bracket enables the B-style swing-out panels to be mounted in infinite front-to-back positions within a CONCEPT enclosure.

Bulletin: CWY

Catalog Number	Material
CSPBADB	Steel

Handles

Handles can replace the standard slotted insert on all CONCEPT® wall-mount enclosures. The CONCEPT non-locking handle provides quick and easy access to the enclosure contents. Handle is black plastic. A zinc die-cast keylock handle is available for applications requiring quick access and security. A padlocking handle, also zinc die-cast, accommodates a padlock with up to a 5/16-in. locking bar. Each latch system can be converted from clockwise to counter-clockwise opening. Kit includes all hardware.

Patents:
US 360,345,
DE M9405854.7.

Bulletin: CWY

Catalog Number	UL Rating	Description
CWHK	Maintains UL/CSA Type 12 when properly installed	Keylock handle
CWHNL	Maintains UL Type 3, 4, 4X, 12 when properly installed	Non-locking handle
CWHPTO	Maintains UL/CSA Type 3, 4, 12 when properly installed	Padlock handle

CWHNL is not suitable for 3-point latch operation.

CONCEPT® Accessories

Door Stop Kit

Door Stop Kit secures the door in the open position. Kit can be installed at the top or bottom of a door which opens horizontally. Door opening angle can be easily adjusted by means of a wing nut. Stop arm slides neatly out of the way when the door is closed. All parts are plated. Mounting hardware included.

- *Door stop kits should not be installed on enclosures configured with a swing-out panel or swing-out rack frame*
- *Door stop kits cannot be used with CONCEPT window doors*

Bulletin: A80

Catalog Number	Finish
ADSTOPK	Plated Steel

Data Pockets

Data Pockets provide convenient storage for wiring diagrams, operation manuals and other documentation inside an enclosure. Pocket mounts on studs located on the inside of a solid-door enclosure. Constructed of high-impact thermoplastic, pockets are dark gray and have cutout areas for easy access and visibility to contents. Mounting hardware included.

Bulletin: UX1Y

Catalog Number	Length x Width in./mm	Fits CONCEPT Enclosure
ADP1	6.00 x 6.00 152 x 152	when A is less than or equal to 24 and B is less than or equal to 24
ADP2	12.00 x 12.00 305 x 305	when A is greater than or equal to 30 and B is greater than or equal to 20

Use ADP2 when A = 24 and B = 30

Lock Inserts

Lock inserts can be substituted for the standard slot/screwdriver insert latch. Inserts have a chrome finish. Matching key is zinc die-cast.

Bulletin: CWY

Catalog Number	Description
CLKTM7	Triangular 7-mm insert with key
CLKSM7	Square 7-mm insert with key
CLKDBM3	Double bit with key

Mounting-Bracket Kits

Mounting-Bracket Kits are field installable. Composite and stainless steel brackets are rated to Type 4X. Set of four (4) brackets can support 500 lb. maximum load. All hardware is included. Four brackets per kit.

Mounting brackets are required to maintain UL/CSA external mounting requirement.

Bulletin: A80

Catalog Number	Description
CMFK	Steel
CMFKSS	Stainless Steel
CMTGFT	Composite

CONCEPT® Accessories

Hinge Pins

Contact Customer Service to order new mild steel hinge pins for an existing product.

Bulletin: VM3

Catalog Number	Description	Qty.
GHPINMS	Hinge Pin	2

Door Bars

Non-metallic door bar includes pressure-sensitive adhesive. Contact Customer Service to order new door bars for an existing product.

Bulletin: CWY

Catalog Number	Description	Length	Qty.
ADB305MM	Door Bar	8 in. (203 mm)	4

30.5 mm Push Buttons

Push Button Operators, Continued

Momentary Contact Push Button Units, Illuminated

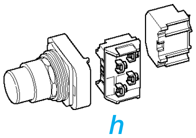
Extended Head Without Guard
Cat. No. 800T-PB16R

Extended Head without Guard
Cat. No. 800H-PRB16R

				Type 4/13		Type 4/4X/13	
				Extended Head Without Guard∗	Extended Head With Guard∗	Extended Head without Guard∗	Extended Head with Guard∗
Type	Lamp Type	Volts	Color	Cat. No.	Cat. No.	Cat. No.	Cat. No.
Operator Only†				800T-SB00XX	800T-SA00XX	800H-SRB00XX	800H-SRA00XX
Full Voltage	Incandescent	24V AC/DC	Red	800T-QB24R	800T-QA24R	800H-QRB24R	800H-QRA24R
			Green	800T-QB24G	800T-QA24G	800H-QRB24G	800H-QRA24G
			Amber	800T-QB24A	800T-QA24A	800H-QRB24A	800H-QRA24A
	LED	120V AC	Red	800T-QBH10R	800T-QAH10R	800H-QRBH10R	800H-QRAH10R
			Green	800T-QBH10G	800T-QAH10G	800H-QRBH10G	800H-QRAH10G
			Amber	800T-QBH10A	800T-QAH10A	800H-QRBH10A	800H-QRAH10A
		24V AC/DC	Red	800T-QBH24R	800T-QAH24R	800H-QRBH24R	800H-QRAH24R
			Green	800T-QBH24G	800T-QAH24G	800H-QRBH24G	800H-QRAH24G
			Amber	800T-QBH24A	800T-QAH24A	800H-QRBH24A	800H-QRAH24A
	No Lamp	0…250V AC/DC	No Lens	800T-QBN25	800T-QAN25	800H-QRBN25	800H-QRAN25
Transformer	Incandescent	120V AC 50/60 Hz	Red	800T-PB16R	800T-PA16R	800H-PRB16R	800H-PRA16R
			Green	800T-PB16G	800T-PA16G	800H-PRB16G	800H-PRA16G
			Amber	800T-PB16A	800T-PA16A	800H-PRB16A	800H-PRA16A
	LED		Red	800T-PBH16R	800T-PAH16R	800H-PRBH16R	800H-PRAH16R
			Green	800T-PBH16G	800T-PAH16G	800H-PRBH16G	800H-PRAH16G
			Amber	800T-PBH16A	800T-PAH16A	800H-PRBH16A	800H-PRAH16A
	No Lamp		No Lens	800T-PBN16	800T-PAN16	800H-PRBN16	800H-PRAN16

∗ Includes as standard one 800T-XA (1 N.O. - 1 N.C.) contact block.
† Operator only supplied without power module, lamp, lens cap, or contact blocks.

800	T		– P	B	H	16	R	
	a	b	c	d	e	f	g	h



a

Protection Rating	
Code	Description
T	Metal, Type 4/13
H	Plastic, Type 4/4X/13

b

Finger-Safe Guards	
Code	Description
Blank	No Guards
C	Guards on Terminals

c

Power Module Type		
800T Type 4/13 Code	Description	800H Type 4/4X/13 Code
P	Transformer (or Dual Input)	PR
Q	Full Voltage (or Resistor)	QR
R	Neon∗	RR

d

Head Type	
Code	Description
A	Extended Head with Guard
B	Extended Head without Guard
M	Mushroom
MJ	Jumbo Mushroom

e

Illumination Options	
Transformer/Full Voltage	
Code	Description
Blank	Incandescent
H	LED†
Resistor/Neon	
Blank	No Options
Dual Input	
D	Diode Type‡
DH	Diode Type LED†‡
T	Transformer — Relay Type
TH	Transformer — Relay Type LED†

f

Voltage	
Transformer	
Code	Description
36	48V AC 50/60 Hz
16	120V AC 50/60 Hz
26	240V AC 50/60 Hz
76	277V AC 50/60 Hz
46	480V AC 50/60 Hz
56	600V AC 50/60 Hz
Full Voltage	
06	6V AC/DC
12	12V AC/DC
24	24V AC/DC
32	32V AC/DC§
48	48V AC/DC
10	120V AC/DC♣
13	130V AC/DC§
20	240V AC/DC§
Resistor	
11	120V AC/DC Resistor

f (cont'd)

Neon	
Code	Description
10	120V AC/DC
20	240V AC/DC
Dual Input	
16	120V AC
24	24V AC/DC➤

g

Lens Color	
Code	Description
Blank	No Lens with standard contacts 1 N.O. - 1 N.C.
X	No Lens if ordering any contacts other than standard 1 N.O. - 1 N.C.
A	Amber
B	Blue
C	Clear
G	Green
R	Red
W	White

h

Contact Block(s)	
Code	Description
X	No Contacts
Standard	
Blank	1 N.O. - 1 N.C.
D1	1 N.O.
Pen*TUFF* (Low Voltage)	
AV	1 N.O. - 1 N.C.
Class 1, Div. 2/Zone 2	
Logic Reed	
AR	1 N.O. - 1 N.C.
Sealed Switch	
AP	1 N.O. - 1 N.C.
Stackable Sealed Switch	
AY	1 N.O. - 1 N.C.

∗ Neon is only available in amber or clear.
† LEDs available in red, green, amber, blue, and white. White LEDs only in 6/24/120/130V and all transformer units. LED color matches lens color, except clear lens supplied with white LED and white lens with amber LED. All LEDs except 120V, have an internal shunt resistor for use with solid-state outputs.
‡ Diode type dual input provides circuit isolation via opposing diodes. Not recommended for use with solid-state outputs and neon indicators.
§ 32V and 130V are LED only. 240V is incandescent only.
♣ 120V LED is AC only and does not contain internal shunt resistor. For AC/DC and internal shunt resistor, order 130V AC/DC LED (Code 13).
➤ Dual input diode only.

Product Data Sheet

QOU115

MINIATURE CIRCUIT BREAKER 120/240V 15A

List Price	$40.20 USD
Availability	**Stock Item:** This item is normally stocked in our distribution facility.

Technical Characteristics

Wire Size	#14-2 AWG(Al/Cu)
Depth	2.98 Inches
Height	4.05 Inches
Number of Poles	1-Pole
Switching Duty Rated	Yes
Short Circuit Current Rating	5kA@277VAC - 10kA@120/240VAC
Type	QOU
Marketing Trade Name	QOU
Mounting Type	Flush, Surface or DIN Rail (35mm)
Voltage Rating	120/240VAC
Terminal Type	Line: Box Lug - Load: Box Lug
Approvals	UL489 Listed - CSA 22.2 #5.1 Certified - IEC Rated 60947-2
Ampere Rating	15A
Circuit Breaker Type	Standard
Width	0.75 Inches
For Use With	OEM Panels and Enclosures
HACR Rated	Yes

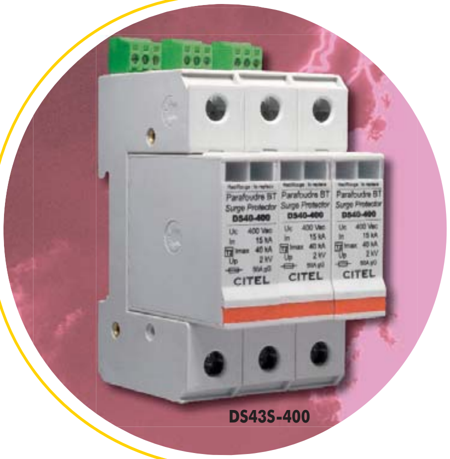
Shipping and Ordering

Category	00900 - Circuit Breakers, 1 Pole: 10 - 100 Amp, 2 Pole: 10 - 125 Amp, 3 Pole: 10 -125 Amp, Type QOU
Discount Schedule	DE2
Article Number	785901418504
Package Quantity	40
Weight	0.36 lbs.
Availability Code	S
Returnability	Y

Imax 40 kA

Type 2 AC power Surge Protector

DS40


DS43S-400

DS40 Type 2 AC Surge Protectors are used mainly for primary protection of single and 3 Phase networks at the main electrical panel. They provide common mode (between L and PE) or common and differential mode (L/PE and L/N) when associated with DS40G (DS4x xxx/G version). They are available in one phase, single phase, three phase, and three phase+neutral versions.

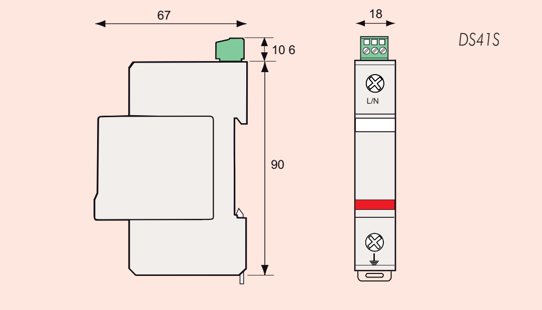
The DS40 impulse discharge capability classifies this SPD as regular Type 2, useful in case of medium lightning density areas. IEC60364 standard requests Type 2 SPD at the entrance of installation if the keraunic level Nk > 25.

*This SPD is based on high energy varistor equipped with thermal disconnector and failure indicator, to comply with standards. Version with a remote signaling for disconnection indication is also available (DS4*S).*

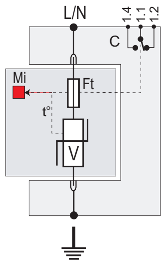
The DS40 is available for a large range of AC voltages.
The DS40 is DIN rail compatible and is built with a plug in module (DSM40 xxx) and a fixed base, which allows an easy and fast maintenance.

- **Type 2 AC Surge Protector**
- **Discharge currents : In : 20 kA/Imax : 40 kA**
- **Pluggable module for each phase**
- **Remote signaling option**
- **IEC 61643-1 and EN 61643-11 compliance**

Dimensions (in mm)



Electrical diagram



DS41S (1 pole)

V: High-energy varistor
Ft: Thermal fuse
C: Remote signaling contact
t°: Thermal disconnection system
Mi : Disconnection indicator

Characteristics

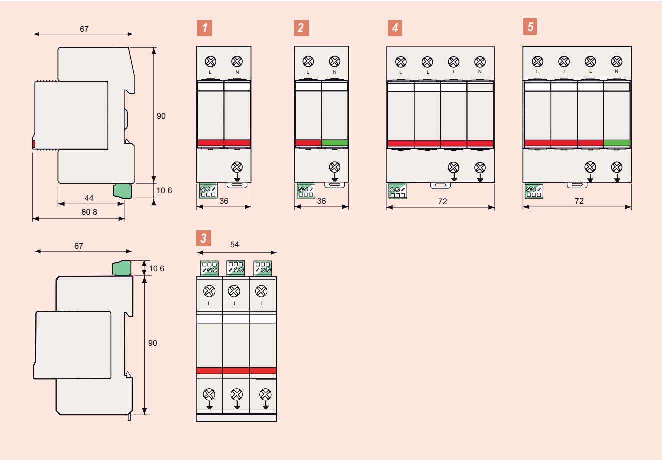
CITEL part number	**DS41-400**	**DS41-230**	**DS41-120**
Network	230/400V	230/400V	120/208V
Max. operating voltage Uc	400 Vac	255 Vac	150 Vac
Temporary overvoltage withstand U_T	400 Vac	255 Vac	150 Vac
Operating current Ic *Leakage current at Uc*	< 1 mA	< 1 mA	< 1 mA
Follow current If	none	none	none
Nominal discharge current In *15 x 8/20 µs impulse*	20 kA	20 kA	20 kA
Maximum discharge current Imax *max. withstand 8/20 µs*	40 kA	40 kA	40 kA
Protection level (at In) Up	1.8 kV	1.25 kV	0.9 kV
Residual voltage at 10 kA	1.5 kV	1.1 kV	0.7 kV
Residual voltage at 5 kA	1.3 kV	0.9 kV	0.6 kV
Admissible short-circuit current	25000 A	25000 A	25000 A
Associated disconnection devices			
Thermal disconnector	internal		
Fuses	Fuses type gG - 50 A max. *(see Note 1)*		
Installation ground fault breaker	Type «S» or delayed		
Mechanical characteristics			
Dimensions	see diagram		
Connection	by screw terminals : 4-25 mm² / by bus		
Disconnection indicator	1 mechanical indicator		
Remote signaling of disconnection	Option DS40S - output on changeover contact		
Mounting	symmetrical rail 35 mm		
Operating temperature	-40/+85 °C		
Protection class	IP20		
Housing material	Thermoplastic UL94-V0		
Standards compliance			
EN 61643-11 Europe	Low Voltage SPD - Class II Test		
IEC 61643-1 International	Low Voltage SPD - Class II Test		
NF EN 61643-11 France	Parafoudre Basse Tension - Essais Classe II		
UL1449 ed.2 USA	Low Voltage TVSS		

Note 1: Rating in compliance with nominal discharge current. In order to increase service continuity, higher rating can be used (up to 125 A). For further information, please consult product instructions..

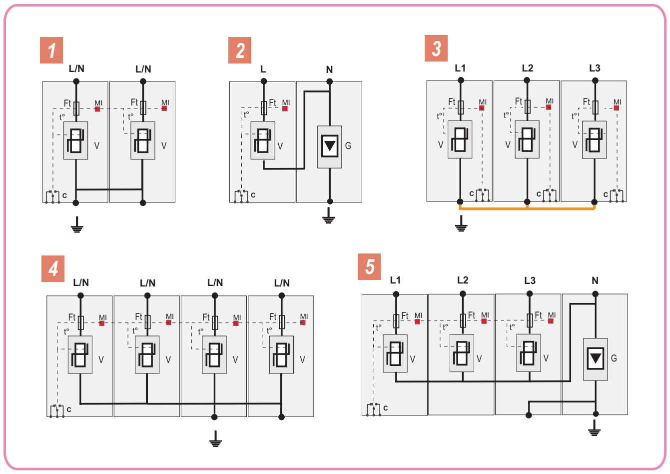
Type 2 AC power Multipolar Surge Protector

DS42
DS43
DS44

Dimensions and Diagram



DS42S-230/G



The DS40 surge protectors are designed to be used in a multipolar configuration to protect single phase, 3 phase or 3 phase+neutral AC networks. They are sometimes associated with dedicated N/PE surge protector based on gas tube technology (DS40G).

2 possible configurations :

> ***Common mode : CT1 configuration***
>
> *DS40 surge protectors are connected between line(s), Neutral and protective wire (PE).*
>
> ***Common and Differential mode : CT2 configuration***
>
> *DS40 surge protectors are connected between line(s) and Neutral to provide differential mode protection. A specific surge protector DS40G is connected between Neutral and Protective wire (PE) for common mode protection. This configuration provides the highest efficiency.*

Part Number	Network	AC system	Protection mode		Imax total	Up L/PE	Up L/N	Diagram
			common	differential				
DS44 230/G	230/400 V 3 phase+N	TT TN	●	●	40 kA	1.5 kV	1.25 kV	5
DS44 120/G	120/208 V 3 phase+N	TT TN	●	●	40 kA	1.5 kV	0.9 kV	
DS44 400	230/400 V 3 phase+N	IT	●		160 kA	1.8 kV		4
DS44 230	230/400 V 3 phase+N	TN	●		160 kA	1.25 kV		
DS44 120	120/208 V 3 phase+N	TN	●		160 kA	0.9 kV		
DS43 400	400 V 3 phase	IT TT TNC	●		120 kA	1.8 kV		3
DS43 230	400 V 3 phase	TNC	●		120 kA	1.25 kV		
DS43 120	208 V 3 phase	TNC	●		120 kA	0.9 kV		
DS42 230/G	230 V Single phase	TT TN	●	●	40 kA	1.5 kV	1.25 kV	2
DS42 120/G	120 V Single phase	TN	●	●	40 kA	1.5 kV	0.9 kV	
DS42 400	230V Single phase	IT	●		80 kA	1.8 kV		1
DS42 230	230V Single phase	TN	●		80 kA	1.25 kV		
DS42 120	120 V Single phase	TN	●		80 kA	0.9 kV		

**) or DS4x 320x (e.g: DS44 320/G) in case of possible temporary voltages (bad quality AC voltage or supply by AC generator set).*

¼″ x 1 ¼″ Time-Delay, Glass Tube Fuses

MDL Series

Description

RoHS 2002/95/EC

- Time-delay
- Optional axial leads available
- ¼ x 1 ¼ (6.4 x 31.7mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

Electrical Characteristics

Rated Current	% of Amp Rating	Opening Time
1/16 - 30A	100%	None
	135%	60 minutes maximum
	200%	120 seconds maximum
1/16 - 3A	200%	5 seconds minimum
3-2/10 - 8A	200%	12 seconds minimum

Agency Information

- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDL 1/16 - 8A (Class No. 1422-01)
- CSA Component Acceptance: MDL 9-30A (Class No. 1422-30)
- CE

Environmental Data

- Shock: 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/4A thru 30A – MIL-STD-202, Method 204, Test Condition C (Except 5g, 500HZ)

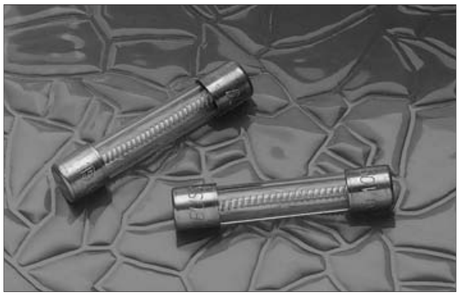
Ordering

Specify packaging code

- Insert packaging code prefix before part number. E.g., BK (or BK1)-MDL-5-R

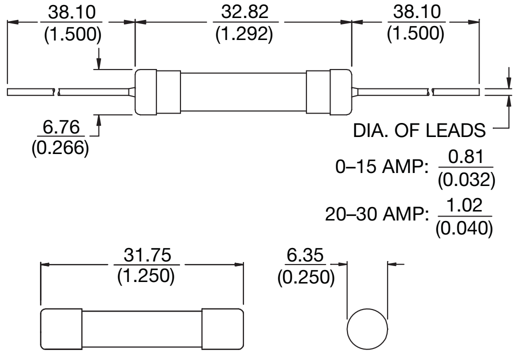
Specify option codes if desired

- For axial leads, insert "V" between catalog series and amp rating. E.g., BK-MDL-V-5-R
- For board washable, insert "B" between catalog series and amp rating. E.g., BK-MDL-B-5-R
- For axial leads and board washable, insert "B" then "V" between catalog series and amp rating. E.g., BK-MDL-BV-5-R



Dimensions - mm (in)

Drawing Not to Scale



Specifications

Part Number	Voltage Rating Vac	AC Interrupting Rating* (amps)@			Typical DC Cold Resistance** (Ω)	Typical Melting I²t† AC	Typical Voltage Drop‡
		250Vac	125Vac	32Vac			
MDL-1/16-R	250	35	10000		45.6	0.0046	2.79
MDL-1/10-R	250	35	10000		15.68	0.0420	1.95
MDL-1/8-R	250	35	10000		12.238	0.0422	1.52
MDL-3/16-R	250	35	10000		4.81	0.116	1.05
MDL-2/10-R	250	35	10000		5.234	0.314	0.972
MDL-1/4-R	250	35	10000		3.208	0.447	0.965
MDL-3/10-R	250	35	10000		2.046	0.412	0.808
MDL-3/8-R	250	35	10000		1.567	0.982	1.46
MDL-1/2-R	250	35	10000		0.943	1.656	1.27
MDL-3/4-R	250	35	10000		0.397	4.343	1.01
MDL-1-R	250	35	10000		0.273	11.498	0.995
MDL-1-1/4-R	250	100	10000		0.205	86.2	0.722
MDL-1-1/2-R	250	100	10000		0.156	22.7	0.721
MDL-2-R	250	100	10000		0.116	62.3	0.644
MDL-2-1/4-R	250	100	10000		0.096	49.6	0.535
MDL-2-1/2-R	250	100	10000		0.081	63.1	0.410
MDL-3-R	250	100	10000		0.057	67.5	0.345
MDL-4-R	250	200	10000		0.038	19.3	0.187
MDL-5-R	250	200	10000		0.025	32.0	0.160
MDL-6-R	250	200	10000		0.022	37.4	0.155
MDL-6-1/4-R	250	200	10000		0.02	38.7	0.152
MDL-7-R	250	200	10000		0.018	42.7	0.140
MDL-8-R	250	200	10000		0.015	47.8	0.119
MDL-9-R	32			1000	0.012	51.5	0.124
MDL-10-R	32			1000	0.01	64.4	0.114
MDL-15-R	32			1000	0.005	354.0	0.130
MDL-20-R	32			1000	0.004	2914.0	0.530
MDL-25††	32			1000	0.01225	15221.0	0.30
MDL-30††	32			1000	0.0011	15581.0	0.40

* Interrupting Ratings (Interrupting ratings were measured at 70% 80% power factor on AC)

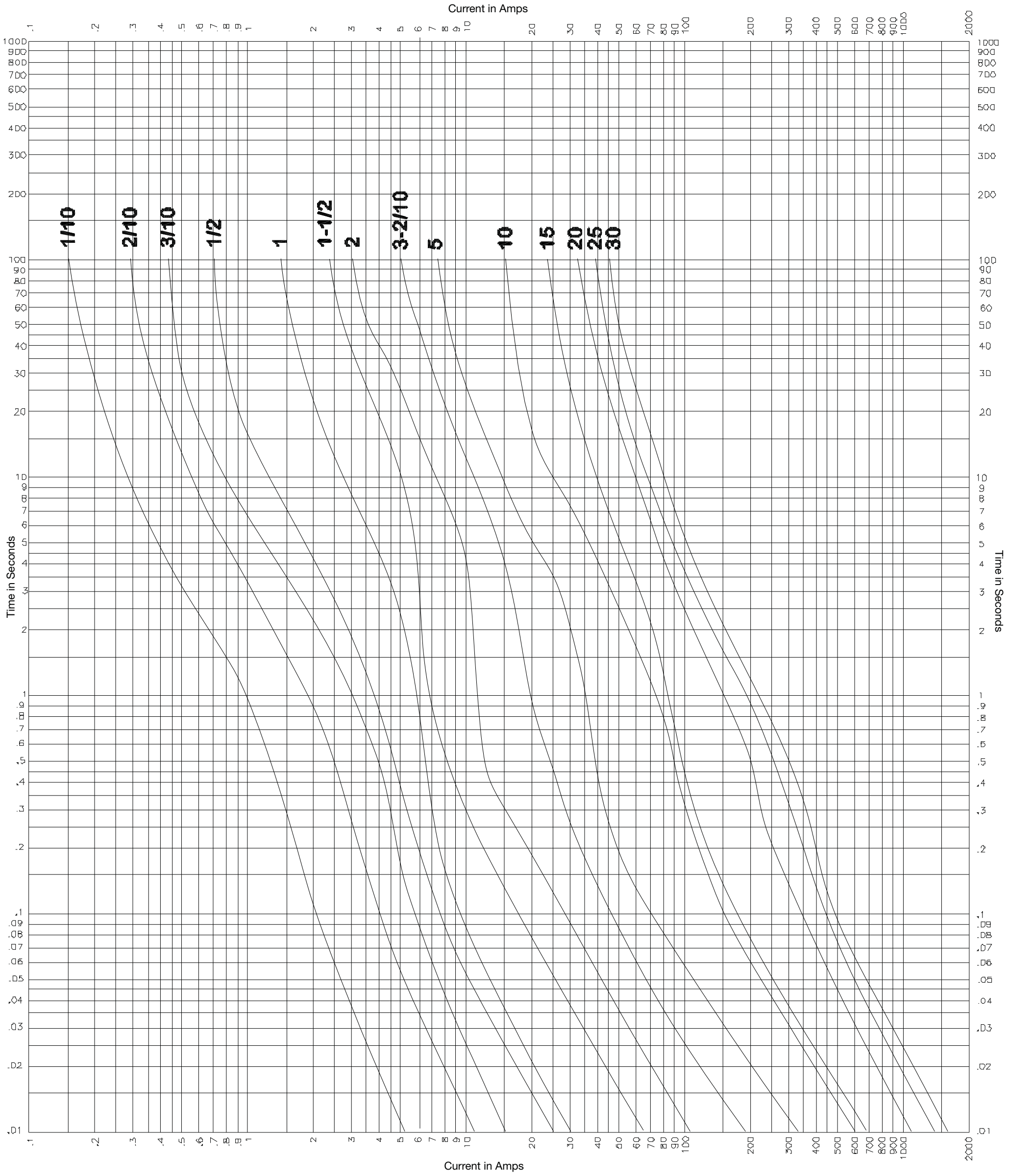
** DC Cold Resistance (Measured at ≤10% of rated current)

† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C±3°C ambient temperature at rated current)

†† MDL 25 & MDL 30 not available in RoHS compliant construction.

Time-Current Curve



Packaging Code

Packaging Code	Description
BK	100 fuses packed into a cardboard carton
BK1	1,000 fuses packed into a cardboard carton
BK8	8,000 fuses packed into a cardboard carton

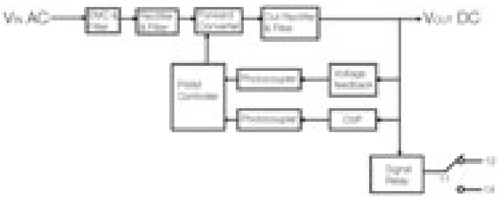
Option Code

Option Code	Description
B	Sealed to withstand aqueous cleaning (Board Washable)
V	Axial leads - copper tinned wire with nickel plated brass overcaps

The only controlled copy of this Data Sheet is the electronic read-only version located on the Cooper Bussmann Network Drive. All other copies of this document are by definition uncontrolled. This bulletin is intended to clearly present comprehensive product data and provide technical information that will help the end user with design applications. Cooper Bussmann reserves the right, without notice, to change design or construction of any products and to discontinue or limit distribution of any products. Cooper Bussmann also reserves the right to change or update, without notice, any technical information contained in this bulletin. Once a product has been selected, it should be tested by the user in all possible applications.

Life Support Policy: Cooper Bussmann does not authorize the use of any of its products for use in life support devices or systems without the express written approval of an officer of the Company. Life support systems are devices which support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

St. Louis, MO 63178
www.cooperbussmann.com



General ordering data	
Order No.	8708670000
Part designation	CP SNT 120W 24V 5A
Version	Switched-mode power supplies
EAN	4032248380831
Qty.	1 pc(s).

Dimensions	
Clamping range, nom.	2.5 mm²
Clamping range, min.	0.13 mm²
Clamping range, max.	4 mm²

temperature	
Ambient temperature (operational)	
Storage temperature	-20 °C...+85 °C
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Input	
Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Input current	3 A @ 115 V AC / 2 A @ 230 V AC
Input frequency, max.	50/ 60 Hz
Input fuse	Fusible link 4 A (T) / 250 V
Input voltage (voltage mode input)	88...132 V AC/176...264 V AC selectable; 250...370 V DC
Surge protection [input]	Varistor

output	
Conductor connection system	Screw connection
Connection range	AWG26-12 (0.1-4.0 mm²)
Control at 10...100% load	< 2 %
Control at input voltage	0.5 %
Mains failure bridge-over time	20 ms @ 115 V AC / 20 ms @ 230 V AC
Mains failure bridge-over time for 115 V AC	20 ms
Mains failure bridge-over time for 230 V AC	20 ms

output	
Max. capacitance at output	40000 µF
Max. residual ripple	< 100 mV / bandwidth 20 MHz
Output current	5 A
Output power, max.	120 W
Output voltage	24...28 V DC (adjustable with potentiometer)
Output voltage type	DC
Output voltage, max.	28 V
Output voltage, min.	24 V
Overload protection	105 %..130 % I of max. output load; automatic reset
Parallel connection option	Recommended with diode module
Status relay / CO contact	250 V AC (max. 30 V DC) / 1 A
Surge protection [output]	29...34 V

General data	
Ambient temperature (operational)	
DIN Rail compatibility	TS 35
Degree of efficiency at max. load	84 %
Depth	100 mm
EMC standards	EN 55011 EN 55022 EN 55024 EN 61000-6-2, 3
Installation advice	Clearance: above/below ≥ 3 cm
Low Voltage Directive	73/ 23/ EWG
Mounting position, installation notice	horizontally on terminal rail TS 35
Power factor correction	No
Standards	EN 60950 (SELV)
Status indication	Green LED
Ambient temperature (operational)	-10 °C...+70 °C (derating from 55 °C)

Insulation coordination	
Protection class	IP 20
electrical isolation, input-earth	1.5 kV
electrical isolation, input-output	3 kV
electrical isolation, output-earth	0.5 kV

Approvals	
Approvals institutes	CULUS; CURUS; GERMLLOYD; GOSTME25; CE

Classifications	
ETIM20	EC001039
ETIM30	EC001039
eClass 4.1	27-24-04-10
eClass 5.0	27-24-22-13
eClass 5.1	27-04-90-02
eClass 6.0	27-04-90-04

Similar products

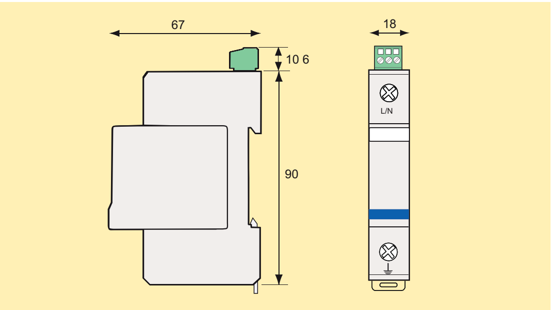
Order No.	Part designation	Version
8862780000	CP SNT 1000W 24V 40A	Switched-mode power supplies

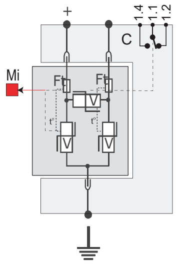
8708660000	CP SNT 70W 24V 3A	Switched-mode power supplies
8708680000	CP SNT 250W 24V 10A	Switched-mode power supplies
8778870000	CP SNT 500W 24V 20A	Switched-mode power supplies

DC Power Surge Protector

DS220..DC

Dimensions and Diagram





DS220..DC

V: High energy varistor
Ft: Thermal fuse
C: Remote signaling contact
t°: Thermal disconnection system
Mi : Disconnection indicator

The DS220 24DC surge protector is designed to protect equiptment connected to DC (and AC) power supplies from lightning surges.

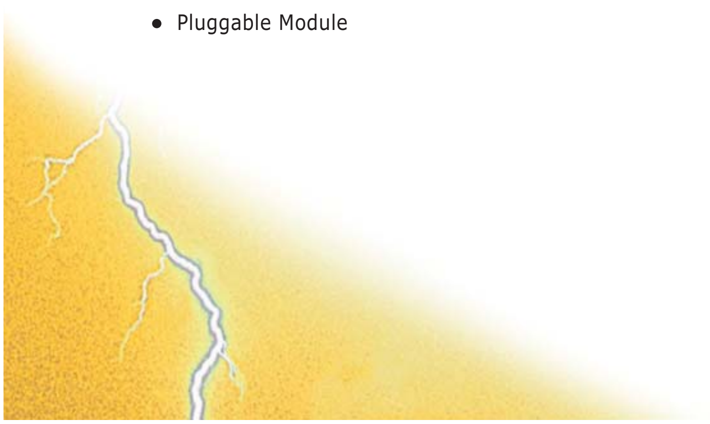
It is based on varistors matched to the network voltage. This SPD is based on varistors equipped with thermal disconnector and failure indicators. Version with remote signaling for disconnection indication is also available. (DS220S 24DC).

In addition, the surge protection function is pluggable to make replacement simple and rapid (spare module: DSM220 DC). The DS220 24DC is DIN rail compatible and is connected in parallel on the line to be protected.

- Surge Protector for DC Supplies
- Remote Signal Contact
- Discharge Currents: 20kA
- Visual Fault Indicator
- Pluggable Module

Characteristics

CITEL part number		DS220-24DC
Nominal DC voltage	Un-dc	24 Vdc
Maximal AC voltage	Uc	40 Vac
Maximal DC voltage	Uc-dc	56 Vdc
Nominal discharge current *15 x 8/20 µs impulses*	In	5 kA
Maximum discharge current 1 impulse 8/20µs	Imax	20 kA
Protection level (at In)	Up	180 V
Thermal disconnect or internal		
Fuses		Fuses - 50 A time delay
Dimensions		see diagram
Connection		by screw terminals : #8 AWG MAX
Disconnection indicator		Mechanical Indicator
Mounting		symmetrical rail 35 mm
Operating temperature		-40/+85 °C
Protection class		IP20
Housing material		Thermoplastic UL94-V0



WI-I/O 9 Multi I/O Units

- Large I/O capability with I/O expansion
- Two-way communications
- Use where communications is required in both directions or for large I/O requirements. Each network can handle multiple I/O applications.
- Frequency hopping spread spectrum
- 902-928 MHz 1W license-free USA/Canada
- Configurable sub-bands license-free
- Up to 95 wireless units per network
- Support up to 31 I/O expansion modules (WI-I/O-EX-1-S-XX) per wireless unit. See table below.
- Multi-hop repeater functions – up to 5 intermediate units
- Four I/O versions available:

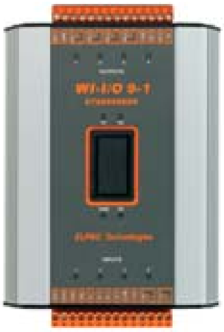
WI-I/O 9	**-1**	**-2**	**-3**	**-4**
Digital inputs	4	4	0 Voltage-free contacts	4 – 16
Digital outputs	1 + 3 Relay + FET	1 FET	8 FET	4 - 16 FET
Analog inputs	2 4-20mA	6 0-20mA/0-10V	0	0
Analog outputs	2 4-20mA	0	8 0-20mA/0-10V	0
Pulse inputs	1 100Hz	4 1 x 1KHz, 3 x 100Hz	0	4 1 x 1KHz, 3 x 100Hz
Pulse outputs	1 100Hz	0	4 1 x 1KHz, 3 x 100Hz	4 1 x 1KHz, 3 x 100Hz

Note: Pulse and digital inputs are same connection point.

- Pulse inputs generate separate pulse count and rate value; pulse rates treated as internal analog registers with configurable maximum value.
- Wide voltage power supply, with integral UPS battery charger and solar regulator
- Power supply generates transmittable internal I/O values
- Multiple communication-failure diagnostics with output status
- Class 1 Div 2 approval
- Radio receive signal and background RF noise measurement / logging diagnostics
- Input measurement display and output “forcing” diagnostics
- Communication logging diagnostics
- Easy-to-use E-Series Windows configuration available at www.weidmuller.ca or weidmuller.com

C US **C1D2**

WI-I/O 9-1



WI-I/O 9-2

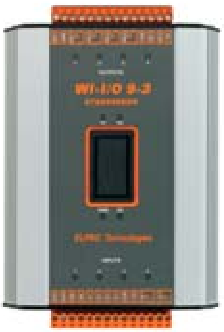
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA	four inputs	four inputs
Analog: “floating” differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.	two 4-20mA resolution 15 bit, accuracy 0.1%	six 0-20mA/0-10V resolution 12 bit, accuracy 0.1%
Pulse: as per digital inputs, Max pulse rate 100Hz, pulse width min 5ms	one input (DI1)	four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
Outputs		
Digital	four relay contacts, Form A, AC, 50V 5A/ DC 30V 2A	one FET output 30VDC 500mA
Analog: current sink to common, max loop voltage 27V, max loop resistance 1000 ohms	two 4-20 mA resolution 15 bit, accuracy 0.1%	
Pulse: FET 30VDC 500mA max 100Hz	one	
Power Supply		
Battery supply	11.5-15.0 VDC	11.5-15.0 VDC
Normal supply	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected
Battery charging circuit	included for 1.2-12 AHr sealed battery	included for 1.2-12 AHr sealed battery
Solar regulator	for direct connection of solar panel (up to 30W) and solar battery (100AHr)	for direct connection of solar panel (up to 30W) and solar battery (100AHr)
Internal monitoring	power fail, solar charge status, and battery voltage	power fail, solar charge status, and battery voltage
Notes	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS232/RS485	serial port 9600 baud, 8 bits, no parity, 1 stop bit	serial port 9600 baud, 8 bits, no parity, 1 stop bit
RS232 connection	9pin DB9 female connector	9pin DB9 female connector
RS485 connection	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections

General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99%RH	0-99%RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC, EN 301 489	FCC Part 15, AS3548, 89/336/EEC, EN 301 489
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting	DIN rail mounting
LED indication	For power supply, WDT, digital I/O	For power supply, WDT, digital I/O
Antenna connector	SMA female coaxial	SMA female coaxial
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)

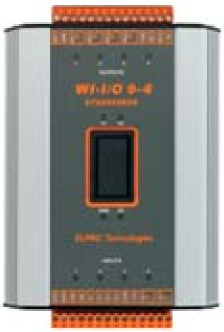
Ordering Data	Type	Part No.	Type	Part No.
	WI-I/O 9-1	**6720005000**	WI-I/O 9-2	**6720005001**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

C US **C1D2**

WI-I/O 9-3



WI-I/O 9-4



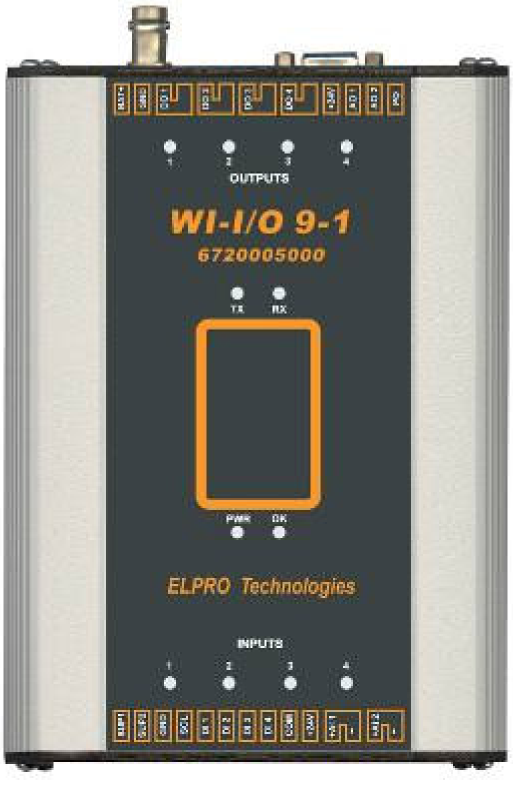
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA		up to 16 inputs (4 inputs + 12 selectable I/O) the 12 selectable inputs are surge protected but not isolated
Analog: "floating" differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, digital filtering 1 sec.		
Pulse: as per digital inputs, Max pulse rate 100Hz, pulse width min 5ms		four input(DI1-4) - first pulse input (DI1) max 1000Hz, pulse width min 0.5ms
Outputs		
Digital	eight FET output 30VDC 500mA	up to 16 FET output (4 outputs + 12 selectable I/O)
Analog: current sink to common, max loop voltage 27V, max loop resistance 1000 ohms	eight 0-20 mA resolution 12 bit, accuracy 0.1%	
Pulse: FET 30VDC 500mA max 100Hz	four (DO1-4)	four (DO1-4)
Power Supply		
Battery supply	11.5-15.0 VDC	11.5-15.0 VDC
Normal supply	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected	12-24 VAC or 15-30 VDC, over-voltage and reverse power protected
Battery charging circuit	included for 1.2-12 AHr sealed battery	included for 1.2-12 AHr sealed battery
Solar regulator	for direct connection of solar panel (up to 30W) and solar battery (100AHr)	for direct connection of solar panel (up to 30W) and solar battery (100AHr)
Internal monitoring	power fail, solar charge status, and battery voltage	power fail, solar charge status, and battery voltage
Notes	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.	An internal DC/DC converter provides 24VDC 150mA for analog loop supply.
Serial Port		
RS232/RS485	serial port 9600 baud, 8 bits, no parity, 1 stop bit	serial port 9600 baud, 8 bits, no parity, 1 stop bit
RS232 connector	9pin DB9 female connector	9pin DB9 female connector
RS485 connector	max cable distance 2000 m terminal connections	max cable distance 2000 m terminal connections
General Data		
Operating Temperature	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Humidity	0-99%RH	0-99%RH
EMC Standards	FCC Part 15, AS3548, 89/336/EEC, EN 301 489	FCC Part 15, AS3548, 89/336/EEC, EN 301 489
Approvals	Class 1 Div 2	Class 1 Div 2
Mounting	DIN rail mounting	DIN rail mounting
LED indication	For power supply, WDT, digital I/O	For power supply, WDT, digital I/O
Antenna Connector	SMA female coaxial	SMA female coaxial
Dimensions mm (in)	130 x 185 x 60 (5.1 x 7.3 x 2.4)	130 x 185 x 60 (5.1 x 7.3 x 2.4)

Ordering Data	**Type**	**Part No.**	**Type**	**Part No.**
	WI-I/O 9-3	**6720005002**	WI-I/O 9-4	**6720005003**
Accessories: DB9 Male - DB9 Female Serial config. cable	WI-CSER-905-9	**6720005105**	WI-CSER-905-9	**6720005105**

User Manual

WI-I/O 9-x Wireless Module

WI-I/O-EX-1-S-x Serial Module



W Interconnections Inc., 821 Southlake Boulevard, Richmond, VA 23236

Tel: (804) 794-2877 Fax: (804) 379-2593

Thank you for your selection of the WI-I/O-9-x_WI-I/O-EX-1-S-x module for your I/O needs. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may
cause internal damage and will void warranty.
To ensure this product enjoys a long life,
double check ALL your connections with
the user's manual
before turning the power on.

Caution! For continued protection against risk of fire, replace the module fuse F1 only with the same type and rating.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to **provide a separation distance of at least 33 cm from all persons** to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 33 cm of the antenna
- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.
- operate the equipment near electrical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

FCC Notice: WI-I/O 9-x Wireless I/O Module

This user's manual is for the W INTERCONNECTIONS WI-I/O 9-x wireless I/O module. This device complies with Part 15.247 of the FCC Rules.

Operation is subject to the following two conditions:

1) This device may not cause harmful interference and

2) This device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by W INTERCONNECTIONS Technologies. Any changes or modifications made to the device without the written consent of W INTERCONNECTIONS Technologies may void the user's authority to operate the device.

End user products that have this device embedded must be installed by experienced radio and antenna personnel, or supplied with non-standard antenna connectors, and antennas available from vendors specified by W INTERCONNECTIONS Technologies. Please contact W INTERCONNECTIONS Technologies for end user antenna and connector recommendations.

Notices: Safety

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in Docket 93-62 and OET Bulletin 65 Edition 97-01.

FCC Notice: WI-I/O-EX-1-S-x Wireless I/O Module

Part 15 – This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part15 of the FCC rules (Code of Federal Regulations 47CFR Part 15). Operation is subject to the condition that this device does not cause harmful interference.

Part 90 – This device has been type accepted for operation by the FCC in accordance with Part90 of the FCC rules (47CFR Part 90). See the label on the unit for the specific FCC ID and any other certification designations.

Industry Canada: WI-I/O-EX-1-S-x Wireless I/O Module

RSS-119 - This device has been type accepted for operation by Industry Canada in accordance with RSS-119 of the Industry Canada rules. See the label on the unit for the specific Industry Canada certification number and any other certification designations.

Notice Any changes or modifications not expressly approved by W INTERCONNECTIONS could void the user's authority to operate this equipment.

To operate this equipment legally the user must obtain a radio operating license from the government agency. This is done so the government can coordinate radio users in order to minimize interference.

Important Notice

W INTERCONNECTIONS products are designed to be used in industrial environments, by experienced industrial engineering personnel with adequate knowledge of safety design considerations.

W INTERCONNECTIONS radio products are used on unprotected license-free radio bands with radio noise and interference. The products are designed to operate in the presence of noise and interference, however in an extreme case, radio noise and interference could cause product operation delays or operation failure. Like all industrial electronic products, W INTERCONNECTIONS products can fail in a variety of modes due to misuse, age, or malfunction. We recommend that users and designers design systems using design techniques intended to prevent personal injury or damage during product operation, and provide failure tolerant systems to prevent personal injury or damage in the event of product failure. Designers must warn users of the equipment or systems if adequate protection against failure has not been included in the system design. Designers must include this Important Notice in operating procedures and system manuals.

These products should not be used in non-industrial applications, or life-support systems, without consulting W INTERCONNECTIONS Technologies first.

1. For WI-I/O 9-x modules, a radio licence is not required in many countries, provided the module is installed using the antenna and equipment configuration complying with the country's regulations.. Check with your local distributor for further information on regulations.
2. For WI-I/O 9-x modules, operation is authorised by the radio frequency regulatory authority in your country on a non-protection basis. Although all care is taken in the design of these units, there is no responsibility taken for sources of external interference. The WI-I/O 9-x intelligent communications protocol aims to correct communication errors due to interference and to retransmit the required output conditions regularly. However some delay in the operation of outputs may occur during periods of interference. Systems should be designed to be tolerant of these delays.
3. To avoid the risk of electrocution, the antenna, antenna cable, serial cables and all terminals of the WI-I/O 9-x_WI-I/O-EX-1-S-x module should be electrically protected. To provide maximum surge and lightning protection, the module should be connected to a suitable earth and the antenna, antenna cable, serial cables and the module should be installed as recommended in the Installation Guide.
4. To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the WI-I/O 9-x_WI-I/O-EX-1-S-x module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. E.g. "This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments."
5. The WI-I/O 9-x_WI-I/O-EX-1-S-x module is not suitable for use in explosive environments without additional protection. These modules are approved for use in Class 1 Division 2 areas

in North America.

Limited Lifetime Warranty, Disclaimer and Limitation of Remedies

W INTERCONNECTIONS products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W INTERCONNECTIONS, W INTERCONNECTIONS will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W INTERCONNECTIONS' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W INTERCONNECTIONS is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W INTERCONNECTIONS is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W INTERCONNECTIONS or its representatives or by any other party, except as expressed solely in this document..

How to Use This Manual

To receive the maximum benefit from your WI-I/O 9-x_WI-I/O-EX-1-S-x product, please read the **Introduction**, **Installation** and **Operation** chapters of this manual thoroughly before putting the product to work.

Chapter Four **Configuration** explains how to configure the modules using the Configuration Software available.

Chapter Five **Specifications** details the features of the product and lists the standards to which the product is approved.

Chapter Six **Troubleshooting** will help if your system has problems and Chapter Seven specifies the **Warranty and Service** conditions.

The foldout sheet *Installation Guide* is an installation drawing appropriate for most applications.

CONTENTS

Chapter One INTRODUCTION

1.1 General

The WI-I/O 9-x & WI-I/O-EX-1-S-x range of I/O modules has been designed to provide standard "off-the-shelf" telemetry functions, for an economical price. *Telemetry* is the transmission of signals over a long distance via a medium such as radio or twisted-pair wire. Although the WI-I/O 9-x_WI-I/O-EX-1-S-x is intended to be simple in its application, it also provides many sophisticated features. This manual should be read carefully to ensure that the modules are configured and installed to give reliable performance.

The unit can monitor and control the following types of signals:

Digital on/off signals

Example outputs - motor run, siren on
Example inputs - motor fault, tank overflow, intruder alarm

Analog continuously variable signals (0-20mA)

Example outputs - tank level indication, required motor speed
Example inputs - measured tank level, actual motor speed

Pulse frequency signals

Examples - electricity metering, fluid flow

Internal Status signals

Examples - analog battery voltage, power status, solar panel status and low battery status.

The unit will monitor the input signals and transmit the signal information by radio or RS485 twisted pair to another module or modules. At the remote unit, the signals will be reproduced as digital, analog or pulse output signals. The modules also provide analog set points, so that a digital output may be configured to turn on and off depending on the value of an analog input. The pulse I/O transmits an accumulated value and the pulses are reliably recreated at the remote unit regardless of 'missed' transmissions. The actual pulse rate is also calculated and is available as a remote analog output.

This manual covers the WI-I/O 9-x and WI-I/O-EX-1-S-x modules. We have provided a summary on all products available in the range, below.

- **WI-I/O 9-1, WI-I/O 9-2, WI-I/O 9-3 and WI-I/O 9-4** modules have radio **and** serial communications. The modules differ only in their input/output (I/O) design, and are compatible, i.e. they can be used to communicate signals to each other in the same network. The WI-I/O 9-x has a frequency hopping spread spectrum 900MHz radio which is license-free in many countries.
-

- **WI-I/O-EX-1-S-1, WI-I/O-EX-1-S-2, WI-I/O-EX-1-S-3 and WI-I/O-EX-1-S-4** modules have **only** serial communications. All other specifications are as per the WI-I/O 9-1, 2, 3 & 4 modules. The WI-I/O-EX-1-S-x modules are compatible with WI-I/O 9-x modules. WI-I/O-EX-1-S-x modules may be used for serial I/O applications, or as I/O expansion for WI-I/O 9-x modules.
- The **WI-GTWY-9-xxx** modules provides an interface between host devices such as PLC's or SCADA computers, and a wireless I/O system comprising WI-I/O 9-x modules. The WI-GTWY-9-xxx allows WI-I/O 9-x modules to act as remote wireless I/O for the host devices. For more information, refer to the **WI-GTWY-9-xxx User Manual**.

The WI-I/O 9-x radio has been designed to meet the requirements of unlicensed operation for remote monitoring and control of equipment. That is, a radio licence is not required for the WI-I/O 9-x modules in many countries. See Chapter Five **Specifications** for details. A radio license is not required to use the WI-I/O 9-x products.

I/O Types

	WI-I/O 9-1	WI-I/O-EX-1-S-1	WI-I/O 9-2	WI-I/O-EX-1-S-2	WI-I/O 9-3	WI-I/O-EX-1-S-3	WI-I/O 9-4	WI-I/O-EX-1-S-4
Radio	✓		✓		✓		✓	
Serial	✓	✓	✓	✓	✓	✓	✓	✓
Digital Inputs (DI)	4		4				4 to 16	
Digital Outputs (DO)	4 (relay)		1 (FET)		8 (FET)		4 to 16 (FET)	
Analog Inputs (AI)	2 (4-20mA)		6 (0-20mA)					
Analog Outputs (AO)	2 (4-20mA)				8 (0-20mA)			
Pulse Inputs (PI)	1 (100Hz)		4 (1x1KHz, 3x100Hz)				4 (1x1KHz, 3x100Hz)	
Pulse Outputs (PO)	1 (100Hz)				4 (100 Hz)		4 (100 Hz)	
Comments	PI is DI 1. PO is separate to DO.		PI's are the same as DI's.		PO's are the same as DO's .		PI/ PO's are the same as DI/ DO's.	

Note regarding -4 modules. The WI-I/O 9-x_WI-I/O-EX-1-S-4 has a total of 20 digital I/O. Four are fixed inputs (also PI's) and four are fixed outputs (also PO's). The other 12 are selectable individually as DI or DO. The I/O range can vary from 16DI + 4DO to 4DI + 16DO or any combination in between.

Input signals connected to a module are transmitted to another module and appear as output signals. These input signals may also be configured to appear as "inverted" signals on the output. A

transmission occurs whenever a "change-of-state" occurs on an input signal. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa. A "change-of-state" for an analog input, internal analog input or pulse input rate is a change in value of the signal of 3% (configurable from 0.8 to 75 %).

In addition to change-of-state messages, update messages are automatically transmitted on a regular basis. The time period may be configured by the user for each input. This update ensures the integrity of the system.

Pulse inputs are accumulated as a pulse count and the accumulated pulse count is transmitted regularly according to the configured update time.

The I/O modules transmit the input/output data as a data frame using radio or serial RS485 as the communications medium. The data frame includes the "address" of the transmitting module and the receiving module, so that each transmitted message is acted on only by the correct receiving unit. Each transmitted message also includes error checking to ensure that no corruption of the data frame has occurred due to noise or interference. The module with the correct receiving "address" will acknowledge the message with a return transmission. If the original module does not receive a correct acknowledgement to a transmission, it will retry up to five times before setting the communications fail status of that path. In critical paths, this status can be reflected on an output on the module for alert purposes. The module will continue to try to establish communications and retry, if required, each time an update or change-of-state occurs.

A system may be a complex network or a simple pair of modules. An easy-to-use configuration procedure allows the user to specify any output destination for each input.

The maximum number of modules in one system is 95 modules communicating by radio. Each of these modules may have up to 31 other modules connected by RS485 twisted pair. Modules may communicate by radio only, by RS485 only or by both RS485 and radio. Any input signal at any module may be configured to appear at any output on any module in the entire system.

Systems with a WI-I/O 9-C or WI-GTWY-9-xxx module and host device can have more than 95 radio modules.

Modules can be used as repeaters to re-transmit messages on to the destination module. Repeaters can repeat messages on the radio channel, or from the radio channel to the serial channel (and serial to radio). Up to five repeater addresses may be configured for each input-to-output link.

The units may be configured by using a PC connected to the RS232 port. The default configuration and software configuration is defined in Section 4 **Configuration**.

Chapter Two INSTALLATION

2.1 General

The WI-I/O 9-x_WI-I/O-EX-1-S-x module is housed in a rugged aluminium case, suitable for DIN-rail mounting. Terminals are suitable for cables up to 2.5 sqmm in size.

All connections to the module should be SELV only. Normal 110/220/240V mains supply should not be connected to any input terminal of the module. Refer to Section 2.3 **Power Supply**.

Each module should be effectively earthed/grounded via a "GND" terminal on the module - this is to ensure that the surge protection circuits inside the module are effective. The earth/ground wire should be connected to the same earth/ground point as the enclosure "earth" and the antenna mast "earth".

Before installing a new system, it is preferable to bench test the complete system. Configuration common problem is poor communications on the radio channel or the serial channel. For radio modules, problems are caused by incorrectly installed antennas, or radio interference on the same channel, or the radio path being inadequate. If the radio path is a problem (i.e. path too long, or obstructions in the way), then higher performance antennas or a higher mounting point for the antenna may fix the problem. Alternately, use an intermediate module as a repeater.

For serial modules, poorly installed serial cable, or interference on the serial cable is a common problem.

The foldout sheet Installation Guide provides an installation drawing appropriate to most applications. Refer to Appendix B of this manual for terminal layout drawings of the modules.

2.2 Antenna Installation *(WI-I/O 9-x units only)*

The WI-I/O 9-x module will operate reliably over large distances. The distance which may be reliably achieved will vary with each application - depending on the type and location of antennas, the degree of radio interference, and obstructions (such as hills or trees) to the radio path. Typical reliable distances are :

USA/Canada	15 miles	6dB net gain antenna configuration permitted (4W ERP)
Australia/NZ	12 km	unity gain antenna configuration (1W ERP)

Longer distances can be achieved if one antenna is mounted on top of a hill.

To achieve the maximum transmission distance, the antennas should be raised above intermediate obstructions so the radio path is true "line of sight". Because of the curvature of the earth, the antennas will need to be elevated at least 15 feet (5 metres) above ground for paths greater than 3 miles (5 km). The modules will operate reliably with some obstruction of the radio path, although the reliable distance will be reduced. Obstructions which are close to either antenna will have more of a blocking affect than obstructions in the middle of the radio path. For example, a group of trees around the antenna is a larger obstruction than a group of trees further away from the antenna. The WI-I/O 9-x modules provide a test feature which displays the radio signal strength.

Line-of-sight paths are only necessary to obtain the maximum range. Obstructions will reduce the range however, but may not prevent a reliable path. A larger amount of obstruction can be tolerated for shorter distances. For very short distances, it is possible to mount the antennas inside buildings. An obstructed path requires testing to determine if the path will be reliable (refer the section 6 of this manual).

Where it is not possible to achieve reliable communications between two modules, then a third module may be used to receive the message and re-transmit it. This module is referred to as a repeater. This module may also have input/output (I/O) signals connected to it and form part of the I/O network - refer to Chapter 4 **Configuration** of this manual.

An antenna should be connected to the module via 50 ohm coaxial cable (eg RG58, RG213 or Cellfoil) terminated with a male SMA coaxial connector. The higher the antenna is mounted, the greater the transmission range will be, however as the length of coaxial cable increases so do cable losses. For use on unlicensed frequency channels, there are several types of antennas suitable for use. It is important antenna are chosen carefully to avoid contravening the maximum power limit on the unlicensed channel (if in doubt refer to an authorised service provider).

The net gain of an antenna/cable configuration is the gain of the antenna (in dBi) less the loss in the coaxial cable (in dB).

The maximum net gain of the antenna/cable configuration permitted for WI-I/O 9-x is

Country	**Max. gain (dB)**
USA / Canada	6
Australia / New Zealand	0

The gains and losses of typical antennas for WI-I/O 9-x are

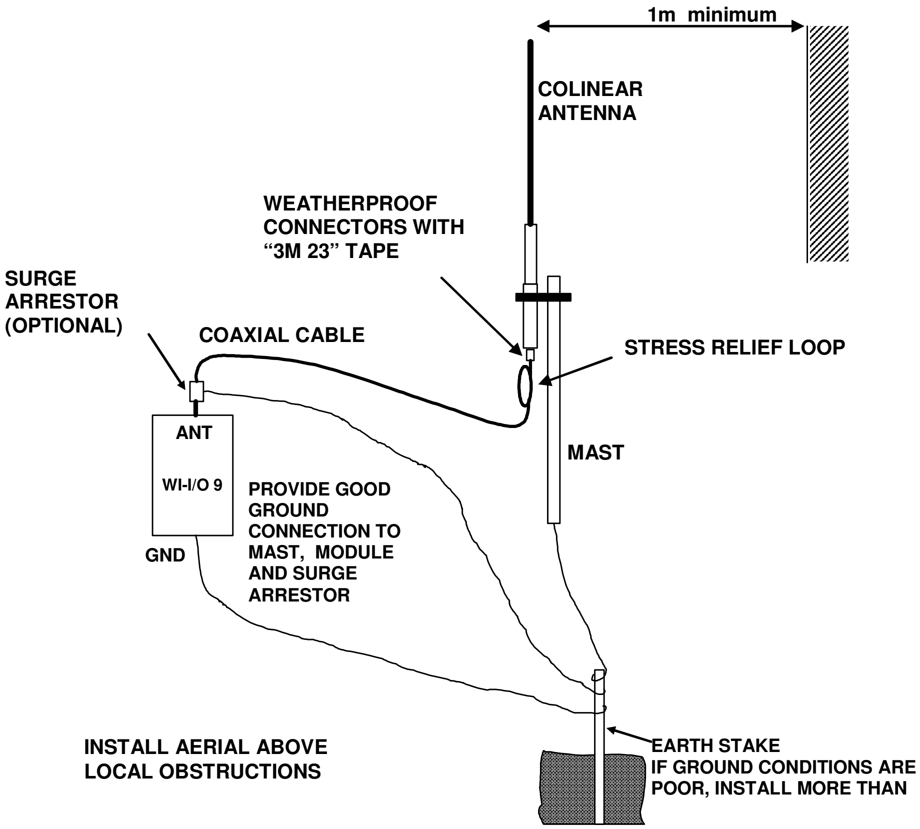
Standard Antennas	**Gain (dB)**	**Part Numbers**
Dipole with integral 15' cable	0	6720005080
5dBi Collinear(3dBd)	5	6720005081
8dBi Collinear (6dBd)	8	6720005082
6 element Yagi	10	6720005084
16 element Yagi	15	6720005085

Cable type	Loss (dB per 30 ft / 10 m)
RG58	-5
RG213	-2.5
Cellfoil	-3

The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6 element Yagi with 70 feet (20 metres) of Cellfoil has a net gain of 4dB (10dB – 6dB).

Connections between the antenna and coaxial cable should be carefully taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems, as it greatly increases the radio losses. We recommend that the connection be taped, firstly with a layer of PVC Tape, then with a vulcanising tape such as "3M 23 tape", and finally with another layer of PVC UV Stabilised insulating tape. The first layer of tape allows the joint to be easily inspected when trouble shooting as the vulcanising seal can be easily removed.

Where antennas are mounted on elevated masts, the masts should be effectively earthed to avoid lightning surges. For high lightning risk areas, surge suppression devices between the module and the antenna are recommended. If the antenna is not already shielded from lightning strike by an adjacent earthed structure, a lightning rod may be installed above the antenna to provide shielding.



2.2.1 Dipole and Collinear antennas.

A collinear antenna transmits the same amount of radio power in all directions - as such that are easy to install and use. The dipole antenna with integral 15 feet cable does not require any additional coaxial cable, however a cable must be used with the collinear antennas.

Collinear and dipole antennas should be mounted vertically, preferably 1 metre away from a wall or mast to obtain maximum range.

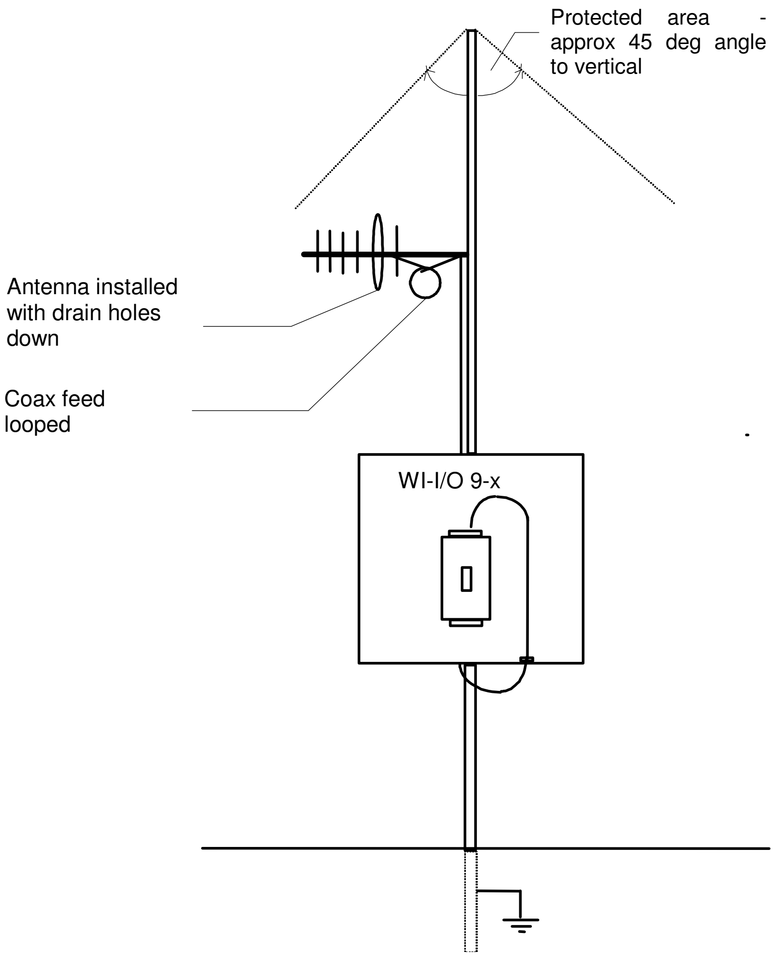
2.2.2 Yagi antennas.

A Yagi antenna provides high gain in the forward direction, but lower gain in other directions. This may be used to compensate for coaxial cable loss for installations with marginal radio path.

The Yagi gain also acts on the receiver, so adding Yagi antennas at both ends of a link provides a double improvement.

Yagi antennas are directional. That is, they have positive gain to the front of the antenna, but negative gain in other directions. Hence Yagi antennas should be installed with the central beam horizontal and must be pointed exactly in the direction of transmission to benefit from the gain of the antenna. The Yagi antennas may be installed with the elements in a vertical plane (vertically polarised) or in a horizontal plane (horizontally polarised). For a two station installation, with both modules using Yagi antennas, horizontal polarisation is recommended. If there are more than two stations transmitting to a common station, then the Yagi antennas should have vertical polarisation, and the common (or "central" station should have a collinear (non-directional) antenna.

Note that Yagi antennas normally have a drain hole on the folded element. The drain hole should be located on the bottom of the installed antenna.



The WI-I/O 9-x_WI-I/O-EX-1-S-x power supply is a switch-mode design which will accept either AC or DC supply. The module may also be powered from a solar panel without an external solar regulator.

The module accepts supply voltages in the following ranges :

12 - 24 volts AC RMS or 15 - 30 volts DC at the “supply” terminals, or

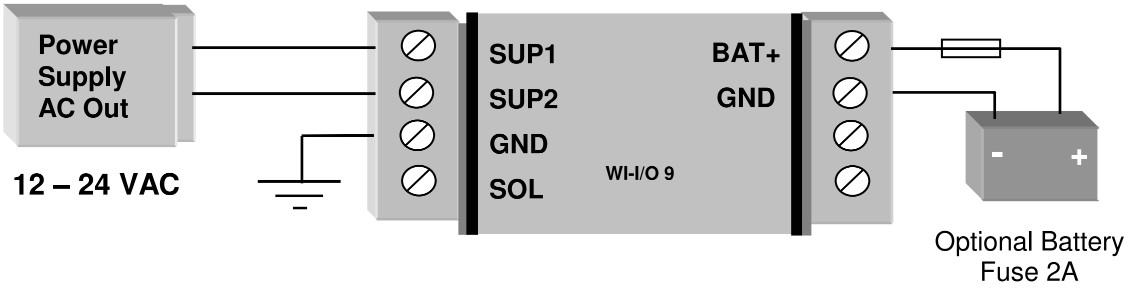
11.5 -15 volts DC at the “battery” terminals.

The power supply should be rated at 1.5 Amps and be CSA Certified Class 2. For use in Class 1 Div 2 explosive areas, the power supply must be approved for Class 1 Div 2 use.

Note: Connect module to the same ground/earth point as the antenna mounting to avoid differences in earth potential during voltage surges. The modules need an earth connection for the internal surge protection to be effective.

2.3.1 AC Supply

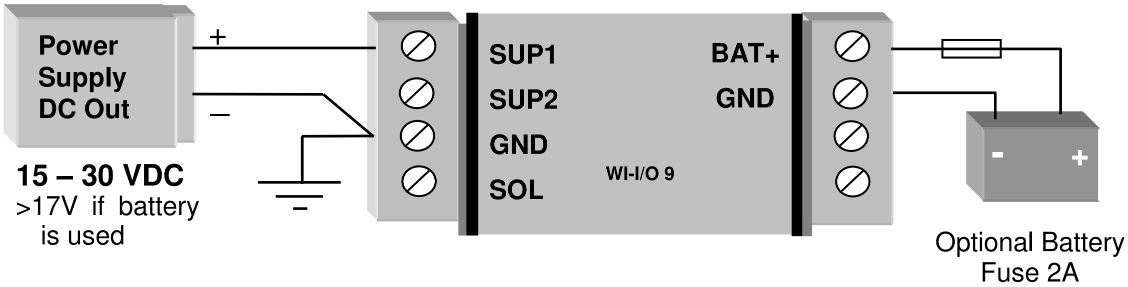
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below.



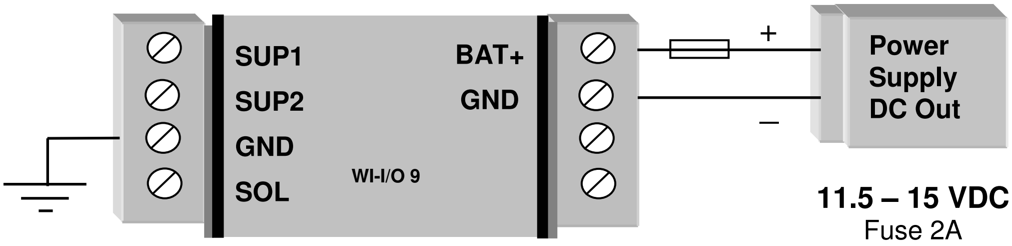
The AC supply should be "floating" relative to earth. AC transformers with grounded/earthed secondary windings should **not** be used.

2.3.2 DC Supply

For DC supplies, the positive lead is connected to "SUP1" and the negative to "GND". The positive side of the supply **must not be connected to earth.** The DC supply may be a floating supply or negatively grounded.



The module may also be powered from an external 11.5 - 15 VDC battery supply without the need for a "normal" supply connected to "SUP1". This external battery supply is connected to "BAT+" and "GND" terminals. The positive lead of the external supply should be protected by a 2A fuse.



Upon failure of the normal supply, the module may continue to operate for several hours from a backup battery. The module includes battery charging circuits for charging up to a 12 AHr sealed lead acid battery. The battery is connected to the "BAT+" (positive) and "GND" (negative) terminals. The positive lead from the battery should be protected with a 2A fuse, installed as near to the battery terminal as possible. On return of main supply, the unit will switch back to mains operation, and recharge the battery. To provide adequate current to recharge the backup battery, an AC supply of 15V minimum or a DC supply of 17V minimum must be used. Typically, a 6 AHr battery will supply the WI-I/O 9-x for 1 - 3 days, depending on I/O loads.

2.3.3 Solar Supply

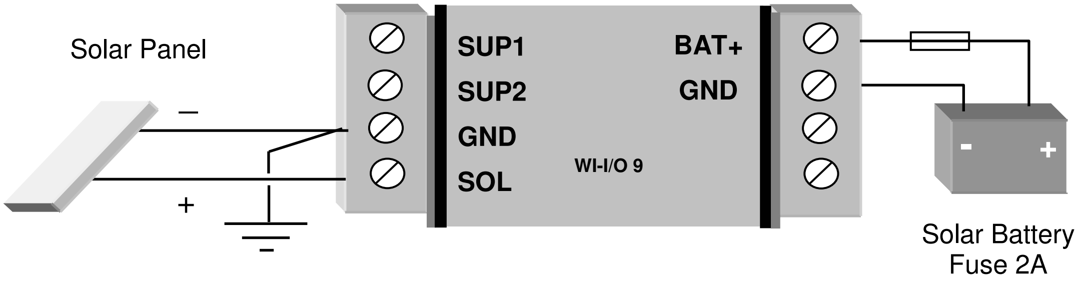
The power supply also includes a 12 V solar regulator for connecting 12V solar panels of up to 30W, and solar batteries of up to 100AHr. **The unit must not be powered from a solar panel without a battery.** A 20W solar panel is sufficient for most solar applications. The size of the solar battery required depends on the I/O used. Batteries are sized for a number of sunless days with 50% battery capacity remaining as follows:

$$\text{No. of sunless days} = \frac{\text{Battery capacity (AHr)} \times 0.5}{\text{Module load (A)} \times 1.2 \times 24}$$

The Module load depends on the I/O connected and can be calculated as follows:

Module Load(mA) = (85 for WI-I/O 9-x or 45 for WI-I/O-EX-1-S-x) + (10 x No. of active DI’s) +
(25 x No. of active DO’s) + (2 x Analog loop load).

The analog loop load is the total signal current for the AI’s and AO’s which are powered from the internal 24V supply. Externally powered loops are not included in this.



The solar panel is connected to the "SOL" (positive) and "GND" (negative) terminals and the battery connected to the "BAT+" (positive) and "GND" (negative) terminals. Solar panels must be installed and

connected as per the panel manufacturer's instructions. The positive lead of the battery should be protected by a 2A fuse installed as near as possible to the battery terminal.

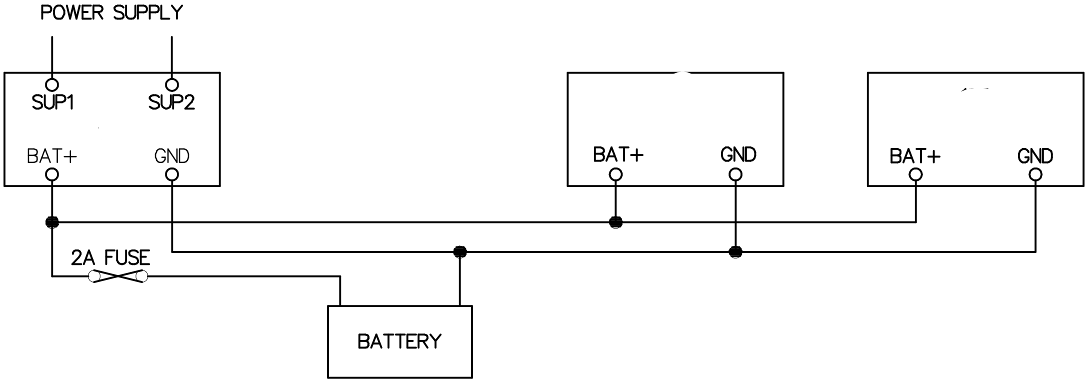
Where a panel larger than 30W is required, an external solar regulator should be used.

For maintenance, disconnect the solar panel first before disconnecting the battery.

2.3.4 Multiple Modules

Where more than one module is installed at the one location, a shared power supply and battery may be used, provided the total load does not exceed the power supply.

The internal power supply of the module can supply a maximum 12V load of 700mA. In order to achieve this, the input power supply must be above 15VAC or 17VDC. Using these figures, it can be determined whether there is enough supply for more than one module - allow 100mA for recharging a battery.



For example, assume there is a WI-I/O 9-1 module and a WI-I/O-EX-1-S-1 module at the same location. The total I/O at the location is 3 analog inputs, 6 digital inputs and 4 digital outputs. The total load will be :-

TYPE OF LOAD	LOAD mA
WI-I/O 9-1 quiescent	85
WI-I/O-EX-1-S-1 quiescent	45
6 DI @ 10 mA	60
3 AI @ 20mA x 2	120
4 DO @ 25mA	100
Battery charging	100
TOTAL	510

So both modules could be powered from one power supply and one battery, provided the external supply voltage is more than 15VAC or 17VDC.

2.3.5 24V Regulated Supply

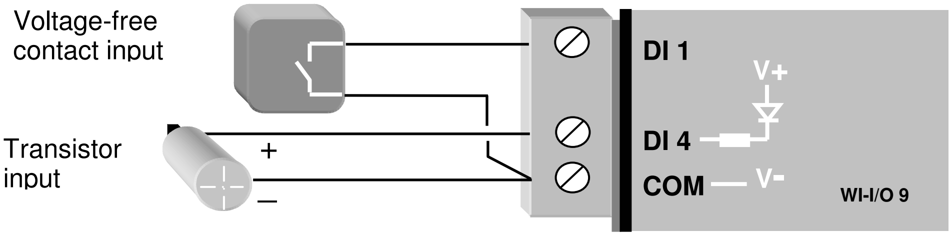
Each module provides a 24V DC regulated supply for analog loop power, except for WI-I/O 9-4_WI-I/O-EX-1-S-4. The supply is rated at 150mA, and should **only** be used for powering analog loops.

2.4 Input / Output

2.4.1 Digital Inputs (WI-I/O 9-1, WI-I/O 9-2 and WI-I/O 9-4)

The ”-1” and ”-2” modules each provide four digital inputs with 5000 volt opto-isolation, and the ”-4” provides 4 to 16 inputs with 3000 volt surge protection. All inputs are suitable for voltage free contacts (such as mechanical switches) or NPN transistor devices (such as electronic proximity switches). PNP transistor devices are not suitable. Contact wetting current of approximately 5mA is provided to maintain reliable operation of driving relays.

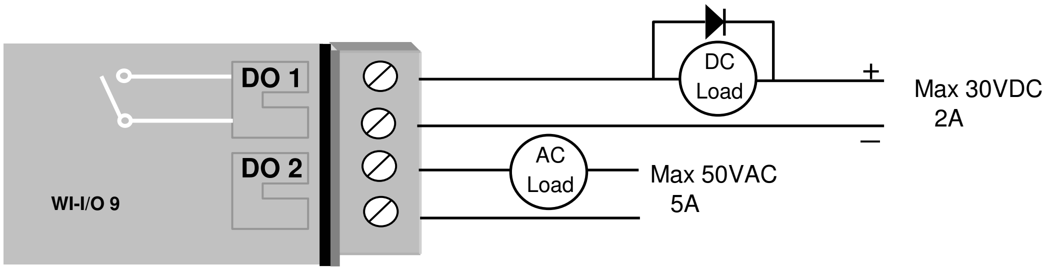
Each digital input is connected between the appropriate "DI" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200 ohms, the device will be able to activate the digital input.



For pulse inputs, refer to Section 2.4.6.

2.4.2 Digital Outputs (WI-I/O 9-1)

The ”-1” module provides four normally open voltage-free relay contacts, rated at AC 50V/5A, DC 30V/2A, 20V/5A. These outputs may be used to directly control low-powered equipment, or to power larger relays for higher powered equipment. When driving inductive loads such as AC relays, good installation should include capacitors (e.g. 10nf 250V) across the external circuit to prevent arcing across the relay contacts. For DC inductive loads, flyback diodes should be used across DC relays.

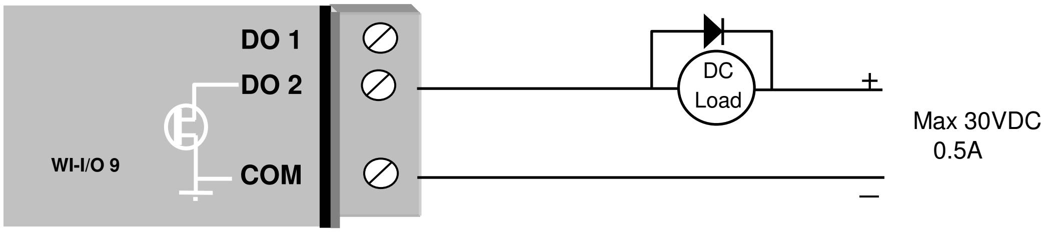


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See section 4.4 Changing User Options for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.3 Digital Outputs (WI-I/O 9-2, WI-I/O 9-3 and WI-I/O 9-4)

The digital outputs on the “-2”, “-3” and “-4” modules are transistor switched DC signals, FET output to common rated at 30VDC 500 mA. The ”-2” provides one digital output; the ”-3” provides eight digital outputs and the ”-4” provides 4 – 16 outputs. The first four DO’s on the ”-3” and ”-4” modules are also the pulse outputs - that is, the first four DO's can be either digital outputs or pulse outputs. The function of each of these outputs may be configured individually. For a description of pulse outputs, refer to Section 2.4.7.



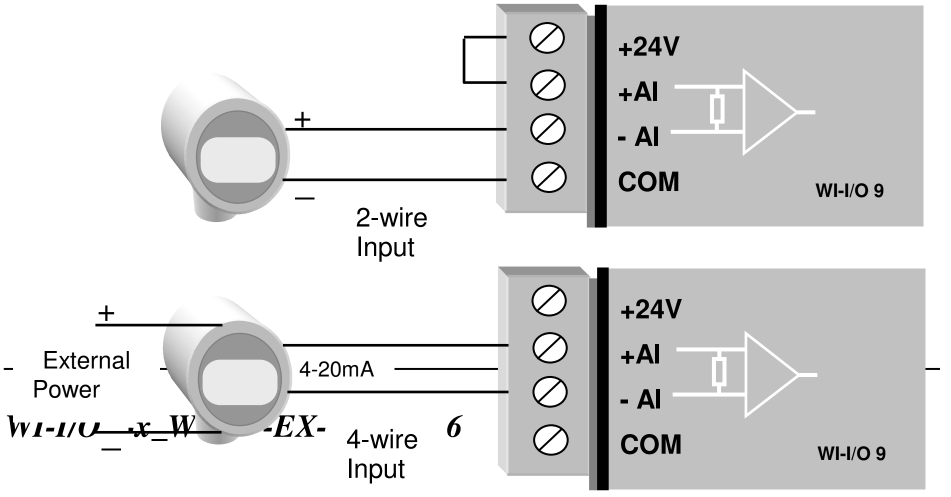
Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 4 Configuration for further details.

The output circuit is connected to the appropriate pair of "DO" terminals. Each digital output circuit includes a LED indicator which is lit when the digital output is active.

2.4.4 Analog Inputs (WI-I/O 9-1 and WI-I/O 9-2)

The ”-1” module provides two 4 - 20 mA DC analog inputs for connecting to instrument transducers such as level, moisture, pressure transducers, etc. The ”-2” module provides six 0 - 20 mA DC analog inputs. Note that the inputs on the ”-2” module will measure down to 0mA, so they can also be used for zero based signals such as 0 - 10 mA. The modules transmit the “mA value” of the input, not a “% of range”, so the output value is set to the correct mA signal.

Each analog input has a positive and negative terminal, and may be placed at any point in the current



Note:
AI must be within 27V of COM. If terminal voltages exceed this, a loop isolator must be used.

loop, as long as neither input rises above the 24 volt supply level. Each input has a loop resistance of less than 250 ohms and zener diode protection is provided against over-voltage and reverse voltage, however additional protection may be required in high voltage or noisy environments or for very long wiring runs.

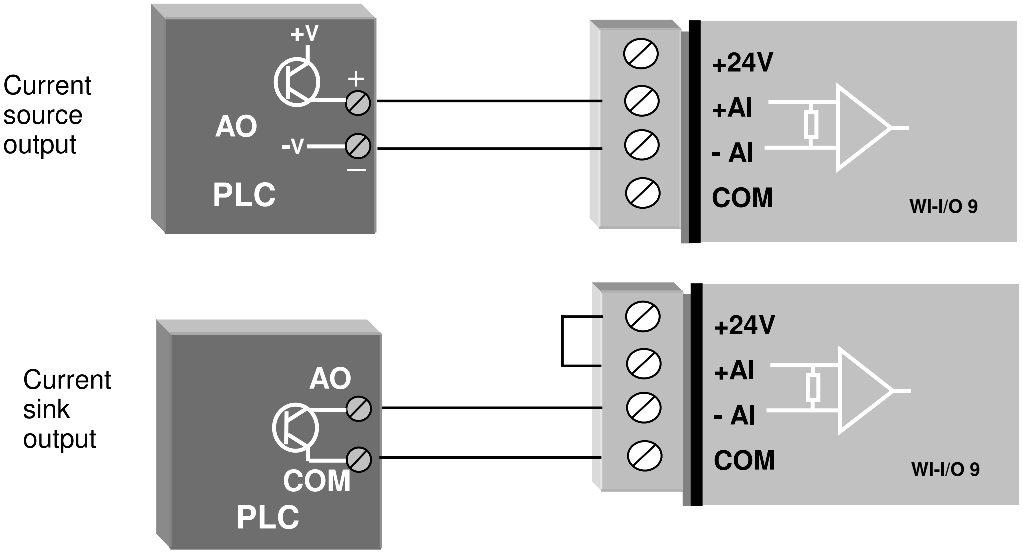
A 24VDC loop supply is available on the module for powering the analog transducer loops. In this case, the analog loop should be connected between a "AI 1-" terminal and "COM" (for the first analog input) or "AI 2-" (for the second analog input), and so on for other inputs.

The positive terminal ("AI 1+" or "AI 2+", etc) should be connected to "+24V".

Externally powered loops may be connected by connecting the input between "AI 1+" and “AI 1-” for analog input 1 or "AI 2+" and “AI 2-” for analog input 2, and so on for other inputs. Common mode voltage may be -0.5V to 27V.

Shielded cable is recommended for analog I/O loops to minimise induced noise and Radio Frequency Interference (RFI). The shield of the cable should be connected to earth at one of the cable only. The use of shielded wiring inside an enclosure containing a module is also recommended.

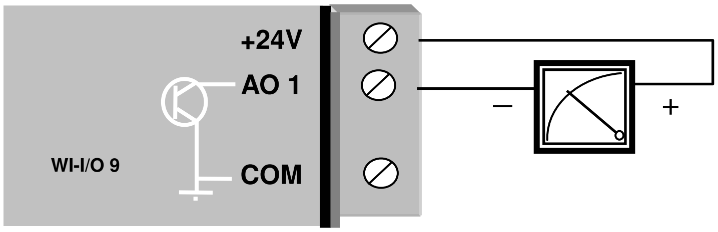
To connect an AI on the WI-I/O 9-x to an analog signal from a PLC or DCS output, check the internal circuit of the output carefully as different devices use different ways to create an analog signal. The following diagram shows two ways of connecting.



Note:
1. AI must be within 27V of COM. If terminal voltages exceed this, a loop isolator must be used.
2. COM on the WI-I/O is connected to ground/earth. If the COM of the PLC cannot be grounded, then a loop isolator must be used.

2.4.5 Analog Outputs (WI-I/O 9-1 and WI-I/O 9-3)

The ”-1” module provides two 4 - 20 mA DC analog outputs for connecting to instrument indicators for the display of remote analog measurements. The ”-3” module provides eight 0 - 20 mA DC analog outputs. Each analog output is a "sink" to common.

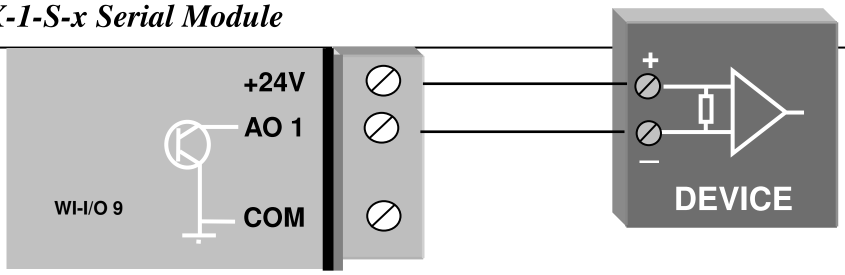


A 24VDC supply is available on the module for powering the analog output loop (max external loop resistance 1000 ohms). In this case, the analog loop is connected between a "+24V" terminal and "AO 1" (for the first analog output) or "AO 2" (for the second analog output), and so on for the other output signals.

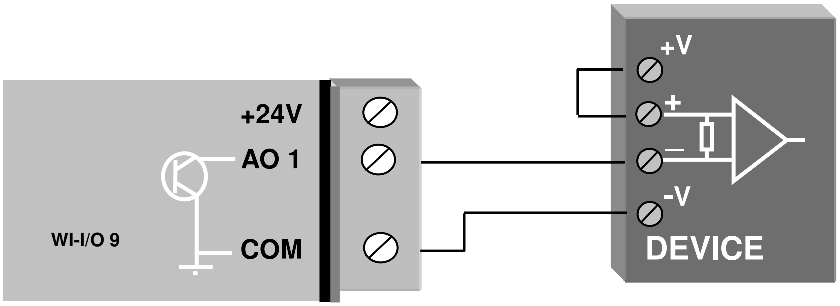
If connecting to an external device such as an electronic indicator, recorder or PLC / DCS input, the loop can be powered by either the WI-I/O 9-x or the device. Externally powered loops to 27 VDC may be connected by connecting the output between the "AO” terminal (positive) and the "COM" terminal (negative). Zener protection of analog outputs provides protection against short periods of over-voltage but longer periods **may result in module damage**.

Note that the common is connected internally to ground and no other point in the analog loop should be grounded. If the external device has single-ended grounded inputs, then a signal isolator must be used.

Analog outputs may also be configured to individually turn off (0 mA) if no command message is received to that output for a certain period. . See Chapter 4 **Configuration** for further details.

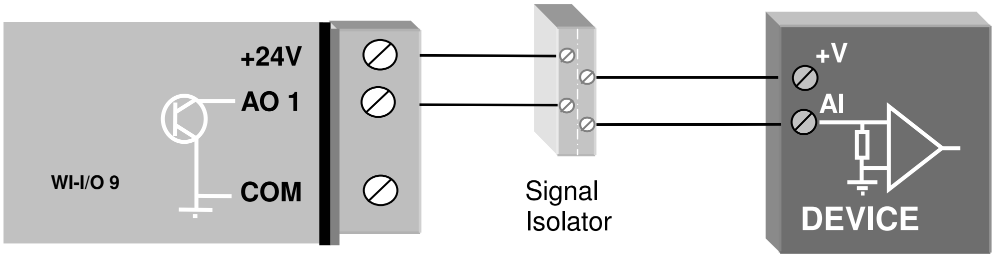


Connecting to a floating input device, powered from the WI-I/O 9-x



Note:
COM on WI-I/O 9-x is connected to ground/earth. If the external power supply cannot be grounded, a loop isolator must be used.

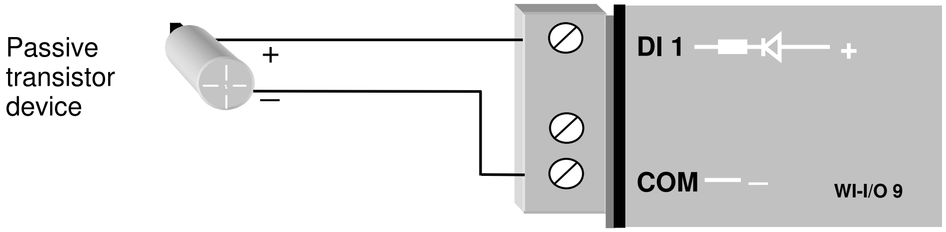
Connecting to an externally powered floating-input device

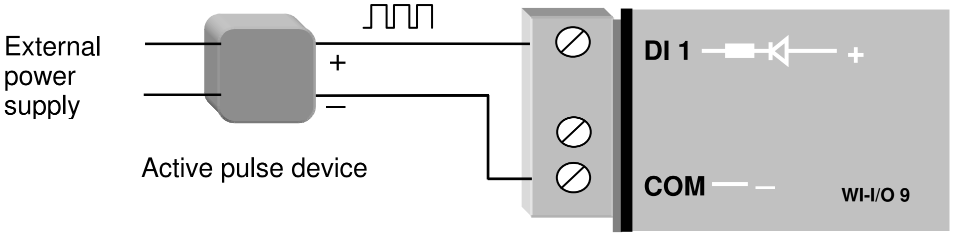


Connecting to a grounded input device via a signal isolator

2.4.6 Pulse Input (WI-I/O 9-1)

For the ”-1” module, digital input 1 may be configured as a pulse input (max rate 100 Hz, min. off time 5 ms). In this mode, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analog output on the remote unit, while the pulse count can appear at a Pulse Output on another ”-1” or Digital/Pulse Output on a ”-3” or “-4” unit. The pulse input should be connected in the same way as a digital input.





Note:
Use a solid state relay if the voltage range is not suitable.

Active pulse signals can be connected directly provided the peak voltage is between 3.5–13V and the low voltage is less than 1.5V. Note that the WI-I/O 9-x will ground the negative of the pulse signal. If the voltages are not compatible, use a solid state relay to isolate the two devices.

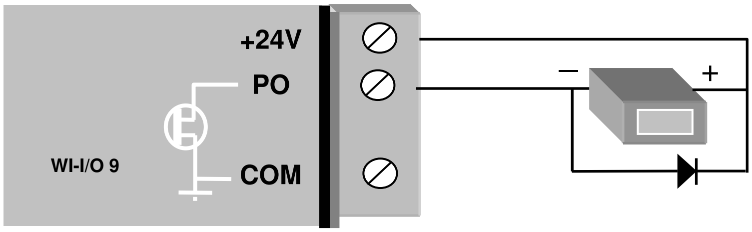
2.4.7 Pulse Inputs (WI-I/O 9-2 and WI-I/O 9-4)

For the ”-2” and ”-4” modules, the four digital inputs (DI 1-4) may be configured as pulse inputs. The first digital/pulse input DI 1 has a maximum rate of 1000 Hz (min. off time 0.5 ms), while DI 2-4 have a maximum rate of 100 Hz (min. off time 5 ms). When using DI 1 at high pulse rates (more than 100 Hz), a divide by 10 function may be configured to reduce the pulse count at the output, as Pulse Outputs have a maximum rate of 100 Hz.

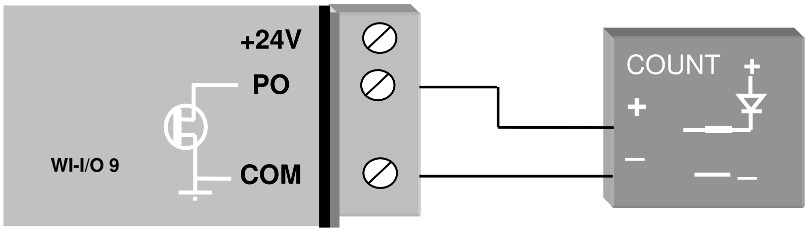
For each pulse input, both the pulse **rate** and the pulse **count** are available for mapping to a remote output. The pulse rate may appear at any analog output on the remote unit, while the pulse count can appear at a Pulse Output. The default update time for pulse counts is 1 minute. This can be changed by changing the update time configuration (refer Chapter 4 **Configuration** for further details). The pulse count is a 16 bit value - “roll over” of the count when it exceeds the maximum value is automatically handled by the modules.

2.4.8 Pulse Output (WI-I/O 9-1)

A single FET output to common rated at 30VDC, 500 mA is provide for the pulse output "PO". This output accurately recreates the pulses counted at a pulse input at another module.



Use by-pass diode if counter is inductive.



Use solid-state relay isolator if voltages are not compatible

If the counter device requires a voltage pulse signal (such as electronic or elector-mechanical counters), use the 24V analog loop supply, or the 12V BAT supply for the voltage source. Use a by-pass diode if the counter is inductive.

Some devices such as PLC counter modules power the pulse loop. For these devices, connect to the PO and COM terminals of the WI-I/O 9-x. The COM terminal will connect a ground/earth to the external device. If this is not suitable, use a solid state relay to isolate the external device.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analog output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred. The maximum output rate is 100 Hz.

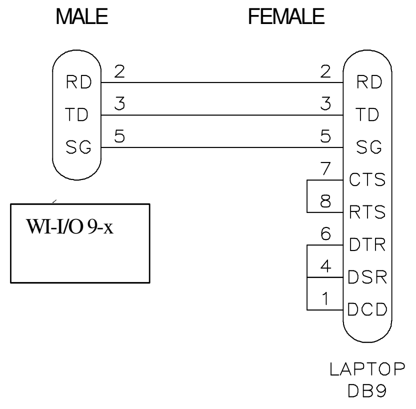
2.4.9 Pulse Output (WI-I/O 9-3 and WI-I/O 9-4)

The first four digital outputs on the ”-3” and ”-4” modules may also be used as pulse outputs. The outputs are FET output to common rated at 30VDC, 500 mA. The outputs will provide a pulse signal of up to 100 Hz. The outputs accurately recreate the pulses counted at pulse inputs at a ”-1”, ”-2” or “-4” module.

Although the count is accurately re-created, the rate of output pulses may not accurately reflect the input rate. The actual input pulse rate may be configured to appear at an analog output if required. Note that the pulse rate and accumulated value will remain accurate even if a period of communications failure has occurred.

2.4.10 RS232 Serial Port

The serial port is a 9 pin DB9 female and provides for connection to a terminal or to a PC for configuration, field testing and for factory testing. This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS-232 signals. The WI-I/O 9-x_WI-I/O-EX-1-S-x is configured as DCE equipment with the pin-out detailed below. The serial port communicates at a baud rate of 9600 baud, 8 bits, no parity, one stop bit. An example cable drawing for connection to a laptop is detailed below:



Pin	Name	Dirn	Function
1	DCD	Out	Data carrier detect - not used
2	RD	Out	Transmit Data - Serial Data Input (High = 0, Low = 1)
3	TD	In	Receive Data - Serial Data Output (High = 0, Low = 1)
4	DTR	In	Data Terminal Ready - not used
5	SG	-	Signal Ground
6	DSR	Out	Data Set Ready - not used
7	RTS	In	Request to Send - not used
8	CTS	Out	Clear to send - not used
9	RI	-	Ring indicator - not used.

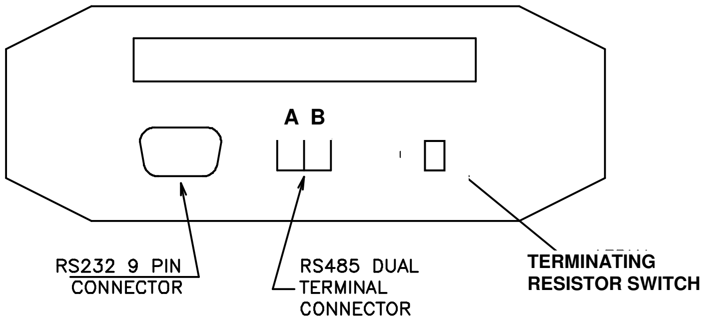
2.4.11 RS485 Serial Port

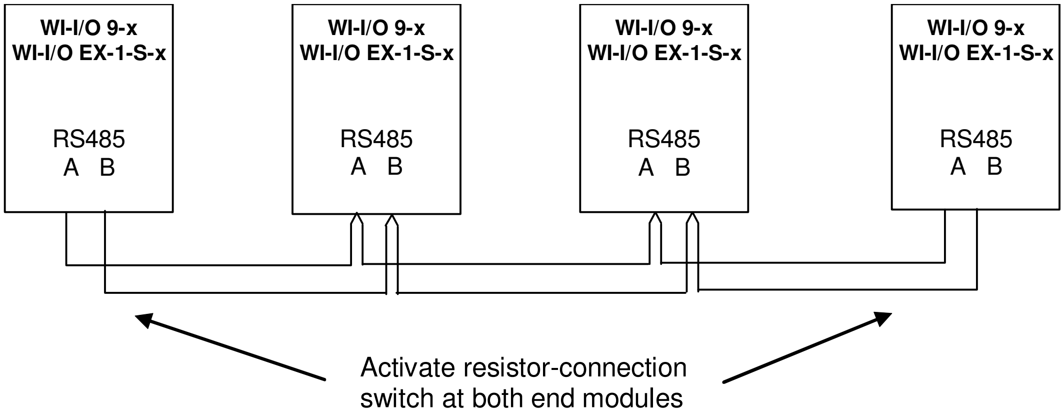
The RS485 port provides for communication between multiple units using a multi-drop cable. Up to 32 units may be connected in each multi-drop network. Each multi-drop network may have one unit providing radio communications with other units in the system. The RS485 feature allows local hubs of control to operate without occupying radio bandwidth required for communication between remotely sited units.

The RS485 Communications format is 9600 baud, 8 data bits, one stop bit, no parity. Note that the RS485 port is shared internally with the RS232 port - disconnect the RS232 cable after configuration is complete.

RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential Radio Frequency Interference (RFI). An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120 ohm resistor.

The modules include a terminating resistor on-board. If the WI-I/O 9-x module is the first or last module in the RS485 chain, then the terminating resistor may be connected by operating the single DIP switch in the end-plate next to the RS485 terminals. “On” or “down” means that the resistor is connected.





2.4.12 Connecting WI-I/O-EX-1-S-x Modules to WI-I/O 9-x Modules

WI-I/O-EX-1-S-x modules connect to a WI-I/O 9-x via the RS485 port on each module (refer to section 2.4.11). Up to 31 x WI-I/O-EX-1-S-x modules can be connected to a WI-I/O 9-x module. This number is reduced for WI-I/O-EX-1-S-3 and –4 modules, as these modules use two unit addresses (refer to chapter 4 of this manual).

The WI-I/O-EX-1-S-x modules can be mounted next to the WI-I/O 9-x module, or they can be remote from the WI-I/O 9-x. The reliable distance for a RS485 multi-drop line depends on the shielding of the wire and how close it is installed to electrical noise sources - distances of more than ½ mile (1 km) can be achieved by good installation methods. External RS485 isolators are recommended if the earth potential difference between modules is greater than 7V.

3.1 Power-up and Normal Operation

When power is initially connected to the module, the module will perform internal diagnostics to check its functions. The following table details the status of the indicating LED's on the front panel under **normal** operating conditions.

LED Indicator	Condition	Meaning
OK	On	Normal Operation
RX	Occasional flash	Radio Receiving, or Activity on serial ports
RX	Flashes continuously	Configuration Mode
RX	On	Button press when entering Configuration Mode
TX (only on WI-I/O 9-x units)	Occasional flash	Radio Transmitting
PWR	On	Supply voltage available from Solar Panel or SUP1/SUP2
OK	Flashes every 5 seconds	+24V Supply overloaded

Additional LED's provide indication of the status of digital inputs and outputs. LED's display the status of each digital input (lit for active), and LED's display the status of each digital output (lit for active). Other conditions indicating a fault are described in Chapter Six **Troubleshooting**.

The module monitors the power supply and provides status of supply failure and battery low voltage for "mapping" to one of the module's own outputs or transmitting to a remote output. When the module is powered from a normal supply (i.e. via either of the "SUP" terminals), the *PWR* LED indicator is lit. When the module is powered from a solar panel and battery, the *PWR* LED indicator is lit only when the charge current is available (i.e. when the solar panel is receiving light).

If a backup battery is connected, the module will generate a low battery voltage status when the voltage has dropped to 11.3V for approx 45 seconds. This status may be transmitted to another module. In the event of excessively low battery voltage (10.8V), the *OK* LED will go off, the unit will automatically set all outputs off, and disable the +24V analog loop supply. The *OK* LED will turn on again after the battery voltage exceeds 11.8V. This enables installations to be configured so that the battery current drain is minimised in the event of extended mains failure, reducing the possibility of deep discharge of batteries.

3.1.1 Communications

Before each transmission, the WI-I/O 9-x radio will "listen-before-transmit" to make sure that another module is not already transmitting - if there is another transmission, the WI-I/O 9-x will wait until the transmission is complete. When the WI-I/O 9-x transmits, it will wait for a return "acknowledgement" message from the destination module, indicating a successful message. If transmissions are not

successful (radio or serial), then the module will re-try up to four times at random intervals to transmit the message.

Example of Successful Communications

Local Unit		**Remote Unit**
• Listen to ensure channel is clear		
• If clear, transmit message TX LED flashes if radio RX LED flashes if RS485	→	• Receive message RX LED flashes Check message for integrity
• RX LED flashes • Acknowledgement received okay – communication complete	←	• If message okay, transmit it back as acknowledgement TX LED flashes if radio RX LED flashes if RS485 Outputs updated as per message received.

Example of unsuccessful communications

Local Unit		**Remote Unit**
• Listen to ensure channel is clear		
• If clear, transmit message TX LED flashes if radio RX LED flashes if RS485	→	• Receive message RX LED flashes Check message for integrity Message corrupted - do nothing
• No acknowledgement received		
• Retry up to four times		
• Still no acknowledgement “Comms fail” status to remote unit set If status is mapped to an output, set output	(4) →	• If no update received for an output within watchdog timeout, check to see if the output is configured to reset • Reset outputs if configured

If communications is still not successful, the “Comms Fail” internal status will be set. In the default configuration, this will have no consequence and the module will continue to attempt to transmit to the remote module every ten minutes. For critical applications, the “comms fail” status can be configured to be reflected to an output on the module for alert purposes. The outputs on the module may also be configured to reset after a specified timeout (digital outputs reset to “off”, analog outputs reset to 0 mA)

allowing the system to turn off in a controlled manner e.g. a pump will never be left running because of a system failure.

> Note: The WI-I/O 9-x will hop frequencies for each re-try transmission - each re-try will follow at approx 0.5 sec after the last. So a WI-I/O 9-x will complete all re-tries in less than 3 seconds.

Repeaters can be used in a system to increase range. Each WI-I/O 9 unit can be configured to act as a repeater. When configuring an input to be mapped to an output, the communications path to the output unit, including the repeater addresses is specified. The WI-I/O 9-x acts as a *store&forward repeater*, that is, the signal is decoded and then retransmitted "as new".

Example Repeater Communications

Unit A DI 1 mapped to Unit D DO1 via Units B & C

Unit A	Unit B Repeater	Unit C Repeater	Unit D
• DI 1 is turned on			
• Transmit →	• Receive		
• Receive Acknowledge ←	• Transmit on with Acknowledge →	• Receive	
	• Receive Acknowledge ←	• Transmit on with Acknowledge →	• Receive
		• Receive Acknowledge ←	• Transmit acknowledge
			• DO 1 is turned on

3.1.2 Change of state conditions

The module transmits a data message whenever it detects a "change-of-state" on one of its input signals. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa provided the change is sustained for 0.5 second (i.e. 0.5 second debounce). The debounce delay is configurable.

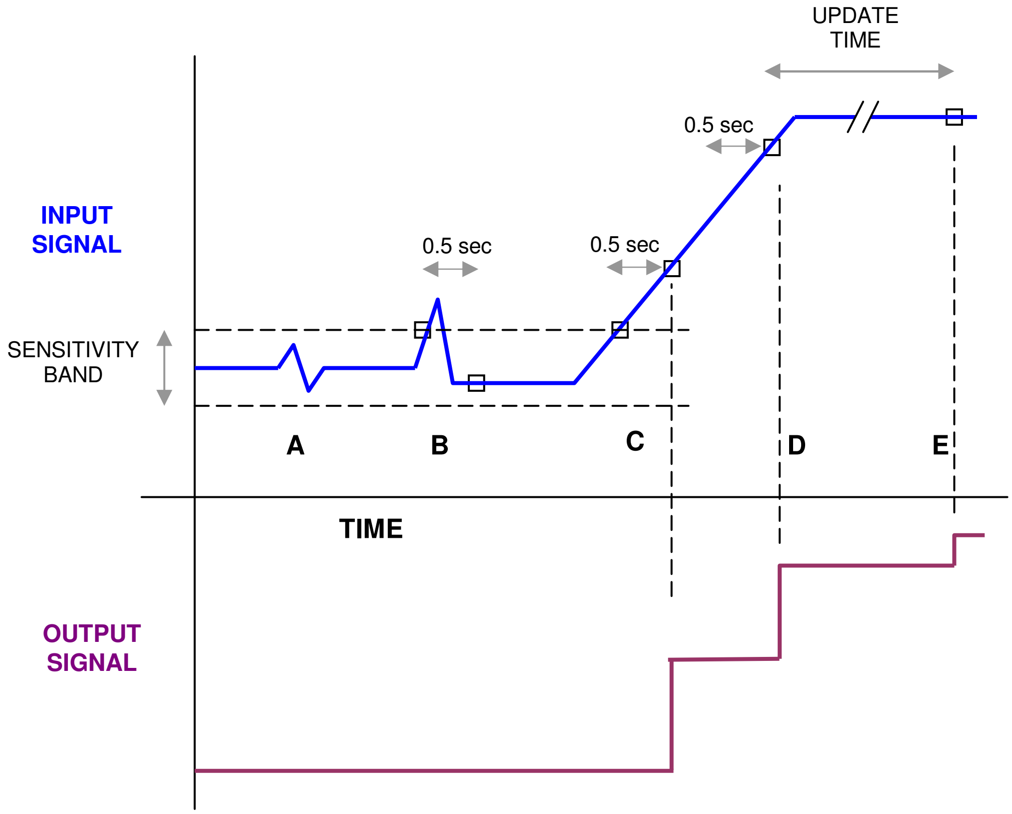
In addition to "change-of-state" transmissions, each module will transmit the status of each input to its corresponding output every ten minutes (configurable). These **updates** mean that the outputs are set to the current input values regularly, even where no "change-of-state" has occurred. These update transmissions increase the accuracy of the output and give extra system reliability.

Analog Change-of-state

A "change-of-state" for an analog input, battery voltage or pulse input rate is a change in value of the signal of 3% (configurable) since the last transmission. Note that the sensitivity of 3% refers to 3% of the analog range, not 3% of the instantaneous analog value. That is, if an analog input changes from 64% (14.24 mA) to 67% (14.72 mA), a "change-of-state" will be detected. This "change-of-state"

sensitivity is configurable between 0.8% and 75%.

Analog inputs are digitally filtered to prevent multiple transmissions on continually varying or "noisy" signals. The input is filtered with a 1 second time constant and a 1 second debounce. The analog outputs are filtered with a 1 second time constant. An **example** of an **analog** input and how the output follows it is shown below:



A No transmission as the sensitivity band was not exceeded

B The sensitivity band was exceeded, however the input returned to within the sensitivity band before the 0.5 sec debounce time - no transmission

C Transmission occurs 0.5 sec after the sensitivity band is exceeded.

D Another transmission 0.5 sec later as the input has changed by more than the sensitivity band

E The input has not changed by more than the sensitivity, however the update time has elapsed since D.

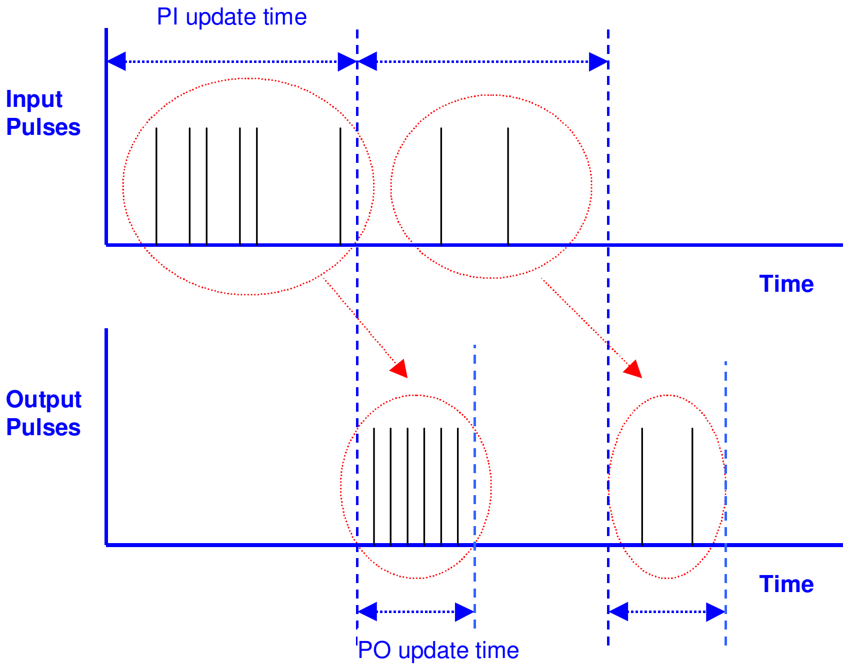
In general, the following may be used as a rule of thumb for calculating the appropriate sensitivity required for a given application:
Instantaneous change of 2 x sensitivity on input → 3 second output response
Instantaneous change of 10 x sensitivity on input → 5 second output response

The analog inputs have 15 bit resolution and 0.016mA accuracy.

Pulse input change of state

Pulse input counts do not use “change-of-state” transmissions. Instead, accumulated pulse input counts are transmitted at set intervals. The default period is 1 minute and is configurable. The absolute pulse count is transmitted. If the PI is transmitted to a PO on a WI-I/O 9-x_WI-I/O-EX-1-S-x module, then the pulse outputs are re-created from the *accumulated* pulse count. Rollovers of the pulse count thru zero are catered for. If a transmission is missed, the pulse output will still be re-created when the next accumulated value is transmitted. This ensures that no pulses are lost due to communications failures. If the PI is transmitted to a WI-I/O 9-C interface module, then the accumulated pulse count is stored in the WI-I/O 9-C for interfacing to the host device.

The following diagram shows how pulse inputs are re-created as pulse outputs. For pulse outputs, the module keeps two counters in memory - the pulse input count received from the remote module, and the count of output pulses. When the module receives an update of the input pulse count, it will output pulses until the output pulse count is the same as the input pulse count. The output pulse will be output evenly over the pulse output update time which is configured in the module. For example, assume that module receives a pulse input update message from the remote module, and the difference between the pulse input count and the pulse output count is 12 pulses. The module will then output the 12 pulses evenly over the next minute (if the pulse output update time is 1 minute).



The default values for the pulse input update time and pulse output update time is 1 minute. In this case, the output pulses are effectively 1 minute behind the input pulses. These update times may be changed by the user. The pulse output update time should not be set to be more than the pulse input update time. Note that the maximum pulse rate for both inputs and outputs is 100Hz.

As well as accumulating the pulse input, the module will also calculate the rate of pulses. **Pulse rates** are treated as an "internal" analog input and are configured with analog sensitivities for change-of-state transmissions. The maximum pulse rate corresponding to 20mA output may be configured by the user.

3.1.3 Analog Set-points

On "-1" modules, the "AI 1" input may be used to trigger the analog set-point status. High set point and low set point levels are configurable. This set-point status turns ON when the analog input moves below the low level, and turns OFF when it moves above the high level. The high level must always be greater than, or equal to, the low level set point. This set-point status may be mapped (inverted, if required) to any output in the network. The set-point status is effectively an internal digital input.

On "-2" modules, AI 1 - 4 have set-point values for controlling digital outputs. The set-point operation works as for the "-1" module.

3.1.4 Start-up Poll

After a module has completed its initial diagnostics following power up, it will transmit update messages to remote modules based on the values of the module's inputs. The module's outputs will remain in the reset/off/zero condition until it receives update or "change-of-state" messages from the remote modules.

The module can transmit a special "start-up poll" message to another module. The remote module will then immediately send update messages to this module such that its outputs can be set to the correct value. Start-up polls will only occur if they are configured. It is necessary to configure a start-up poll to each remote module which controls the module's outputs. For further information (refer to Chapter 4 Configuration).

3.1.5 Communications Failure (CF)

The internal communications failure (CF) status is set if a module does not receive an acknowledgement message after five attempts at transmitting a message. The CF status may be configured to set a local digital output for an external alarm.

Although the CF status can set an output, it will not reset the output. That is, once communications is re-established (and the CF status is reset), the output will stay "on". The Reset Output feature (see below) is used to reset the output.

The output will reset only when no communications failures occur within the configured "Reset Output Time" for the output that CF status is mapped to. Note that if the reset output time is not enabled, the CF status will remain set forever, once an unsuccessful transmission occurs. See Chapter 4 **Configuration** for further details.

For a link with one or more repeaters, the internal CF status will only set for a failure between the transmitting module (the source module) and the first repeater. If the communications failure occurs after the first repeater, then the source module CF status will not set. To indicate comms status on this type of link, the "Reset Output" function should be used.

3.1.6 Resetting Outputs

Each digital and analog output may be individually configured to reset if that output has not received a change-of-state or an update message within a certain time period. Generally this time is set to twice the update period, so at least one update can be missed before an output is reset.

In most cases it is desirable to reset outputs which are controlling equipment if there is a system failure, however alarm or indication outputs are not reset so the last valid indication remains shown. See Chapter 4 **Configuration** for further details.

3.2 System Design Tips

The following tips will help to ensure that your system operates reliably.

3.2.1 System Dynamics

It is important to be aware of the dynamics of the system. Inputs have a configurable "debounce" delay (default 0.5 sec) - that is, a change message will not be sent for 0.5 sec after a change has occurred. This avoids transmitting spurious noise on the input signal. If you require faster (or slower) operation, change the debounce setting.

Messages transmitted via serial link are received in less than 20 m/sec., however a message sent by radio takes approx 60 m/sec.

These delays are not significant is most applications, however if your application requires faster responses, then the above delays need to be considered.

3.2.2 Radio Channel Capacity

Messages sent on a cable link are much faster than on a radio channel, and the capacity of the radio channel must be considered when designing a system. This becomes more important as the I/O size of a system increases.

The modules are designed to provide "real-time" operation. When an input signal changes, a change message is sent to change the output. The system does not require continuous messages to provide fast operation (as in a polling system). Update messages are intended to check the integrity of the system, not to provide fast operation. Update times should be selected based on this principle. The default update time is 10 minutes - we recommend that you leave these times as 10 minutes unless particular inputs are very important and deserve a smaller update time.

It is important that radio paths be reliable. For large systems, we recommend a maximum radio channel density of 100 messages per minute, including change messages and update messages. We suggest that you do not design for an average transmission rate of greater than 40 per minute - this will give a peak rate of approx 100 per minute. Note that this peak rate assumes that all radio paths are reliable - poor radio paths will require re-try transmissions and will reduce the peak channel density. If there are other users on the radio channel, then this peak figure will also decrease.

Dual Band Operation

The WI-I/O 9-x radio band is split into two sub-bands, 902-915 MHz and 915 – 928 MHz . In America

and Canada, the WI-I/O 9-x uses both sub-bands - but in other countries, only the high sub-band. In America and Canada, it is possible to restrict the frequency hopping of the WI-I/O 9-x to only the high or low band. If there are many WI-I/O 9-x systems in the same area, this technique will help to separate systems to avoid radio interference. Note that this technique is only possible in America / Canada.

The radio sub-band can be selected by the "system address" - refer section 4 of this manual. An odd system address selects the low band, and an even system address selects the high band.

3.2.3 Radio Path Reliability

Radio paths over short distances can operate reliably with a large amount of obstruction in the path. As the path distance increases, the amount of obstruction which can be tolerated decreases. At the maximum reliable distance, "line-of-sight" is required for reliable operation. If the path is over several kilometres (or miles), then the curvature of the earth is also an obstacle and must be allowed for. For example, the earth curvature over 5 miles (8km) is approx 10 feet (3m), requiring antennas to be elevated at least 13 feet (4m) to achieve "line-of-sight" even if the path is flat.

A radio path may act reliably in good weather, but poorly in bad weather - this is called a "marginal" radio path. If the radio path is more than 20% of the maximum reliable distance (see Specification section for these distances), we recommend that you test the radio path before installation. Each WI-I/O 9-x module has a radio path testing feature - refer to section 6.2 and 6.3 of this manual.

There are several ways of improving a marginal path :-

- Relocate the antenna to a better position. If there is an obvious obstruction causing the problem, then locating the antenna to the side or higher will improve the path. If the radio path has a large distance, then increasing the height of the antenna will improve the path.
- Use an antenna with a higher gain. Before you do this, make sure that the radiated power from the new antenna is still within the regulations of your country. If you have a long length of coaxial cable, you can use a higher gain antenna to cancel the losses in the coaxial cable.
- If it is not practical to improve a marginal path, then the last method is to use another module as a repeater. A repeater does not have to be between the two modules (although often it is). If possible, use an existing module in the system which has good radio path to both modules. The repeater module can be to the side of the two modules, or even behind one of the modules, if the repeater module is installed at a high location (for example, a tower or mast). Repeater modules can have their own I/O and act as a "normal" WI-I/O 9-x module in the system.

3.2.4 Design for Failures

All well designed systems consider system failure. I/O systems operating on a wire link will fail eventually, and a radio system is the same. Failures could be short-term (interference on the radio channel or power supply failure) or long-term (equipment failure).

The modules provide the following features for system failure :-

- Outputs can reset if they do not receive a message within a configured time. If an output should

receive an update or change message every 10 minutes, and it has not received a message within this time, then some form of failure is likely. If the output is controlling some machinery, then it is good design to switch off this equipment until communications has been re-established.

The modules provide a "drop outputs on comms fail" time. This is a configurable time value for each output. If a message has not been received for this output within this time, then the output will reset (off, in-active, "0"). We suggest that this reset time be a little more than twice the update time of the input. It is possible to miss one update message because of short-term radio interference, however if two successive update messages are missed, then long term failure is likely and the output should be reset. For example, if the input update time is 3 minutes, set the output reset time to 7 minutes.

- A module can provide an output which activates on communication failure to another module. This can be used to provide an external alarm that there is a system fault.

3.2.5 Indicating a Communications Problem

There are two ways to provide an indication of communications problems.

Fail-to-transmit alarm. The first is to map the internal CF status to a local output, to generate a "fail-to-transmit" alarm. The configured output will activate when a comms fail occurs - that is, when the module attempts to transmit a message five times without an acknowledgement. This method provides an indication immediately an attempt to transmit a message fails. If you want the radio path to be "tested" regularly, then you need to configure the update times such that transmissions occur regularly (however do not overload the radio channel).

Notes regarding this method:

1. Each CF mapping corresponds to only one remote address - you need to make separate mappings for each remote address. You can map the CF for each remote module to a separate output, or to the same output.
2. You need to reset the comms fail output using the "reset output" parameter. Select a reset time which is greater than the effective update time period. For example, if there are four inputs mapped from module #1 to module #2, each with a 10 minute update, then you would expect at least four transmissions in each 10 minute period. At module #1, a comms fail for #2 is mapped to DO1. If you set the "reset time" for DO1 to 10 minutes, then there will be at least four transmissions made during the reset period - that is, the output will only reset when the communications has been successful four times.
3. This method will not work for radio links with repeaters. If a repeater is used, you will need to use the second method described below.

Fail-to-receive alarm. The second method is to set up a "comms OK" output using the "Reset Outputs" function. The output is normally on, indicating "comms OK", and will reset if the module does not receive a message from the remote module within the configured reset time.

Consider a link between module #1 and #2, and assume that you want a "comms OK" output at #1. At #2, map an unused input to an output at #1 such that the output is normally active ('on"). If there is no spare inputs at #2, you can use an internal input such as "low voltage status". You will need to invert the mappings such that the output is normally on (because the input is normally off).

At #1, configure a reset time for the output. The reset time should be greater than the update time for the mapping at #2. If #1 fails to receive update messages from #2, then the output will reset, indicating a communications failure. Notes regarding this method:

1. This method will work with repeaters in the link.
2. The "comms OK" output is fail-safe - if module #1 fails, then the output will reset indicating a problem.
3. You should use separate outputs to indicate "comms OK" of different remote modules.
4. It is recommended that you set the reset time at #1 to more than twice the update time of the mapping at #2. This means that the comms OK output will only reset if #1 misses two consecutive updates from #2.

3.2.6 Testing and Commissioning

We recommend that you set-up and test the system with all of the modules together **before** you install the modules. It is much easier to find a configuration problem.

When the system is configured, record the radio signal strength and background noise level for each radio link. If there are future communications problems, you can compare the present measurements to the as-commissioned values. This is an effective way of finding problems with antennas, cables and also changes in the radio path (for example, the erection of new buildings).

3.3 Security Considerations

There are three dimensions of security considerations:

1. Failure to operate when required - or "operational reliability".

   The features discussed above optimize operating reliability. Using an acknowledgement and re-try protocol ensures that the transmitting module is aware whether the transmitted message has been transmitted reliably. The "fail to transmit" and "fail to receive" alarms provide indication if the radio link has failed to operate.

2. Mal-operation, or operating when not requested.

   This problem occurs when an output is "triggered" by the wrong radio device. The WI-I/O 9-x modules use frequency encoding and a very secure addressing system to ensure this does not occur. An additional security level using data encryption can also be selected.

3. Malicious operation, or "hacking"

   This is the problem most associated with security concerns - the ability for someone to access information from a radio system by "listening-in", or to cause damage by transmitting radio messages to force outputs.

A security option can be selected during the module configuration to protect against this. The security option (if selected) adds data encryption to radio messages. Modules in the same system are

automatically configured with the encryption key, such that only these modules can understand each other. “Foreign” modules will hear the messages, but cannot decrypt the messages. For more information, refer to section 4.3.7.

Chapter Four CONFIGURATION

4.1 Introduction

The modules are configured by connecting a computer (PC) using the Configuration Software program. The same software program is used to configure WI-I/O 9-x and WI-GTWY-9-xxx modules - for more information, refer to the separate User Manuals for these products.

Each module is configured with a system address and a unit address. The system address is common to every module in the same system, and is used to prevent "cross-talk" between modules in different systems. Separate networks with different system addresses may operate independently in the same area without affecting each other. The system address may be any number between 1 and 32 767. The actual value of the system address is not important, provided all modules in the same system have the same system address value. **A system address of zero should not be used.** The configuration program automatically offers a random number for the system address - you can change this to any number in the valid range but we recommend that you use the random number.

Each module must have a unique unit address within the one system. A valid unit address is 1 to 127. A network may have up to 95 addresses communicating via radio (unit addresses 1 to 95), each with up to 31 modules communicating via RS485 (unit addresses 96 to 127). In the network, any individual input signal may be "mapped" to one or more outputs anywhere in the system. The unit address determines the method of communication to a module. Any module with a unit address between 96 and 127 will communicate by RS485 only. Other units with a unit address below 95 may communicate by radio *or* RS485 - the unit will determine which way to communicate depending upon the unit address of the destination module. For example, Unit 31 will talk to Unit 97 by RS485 only, but will talk to unit 59 by radio only. WI-I/O-EX-1-S-x units must always have a unit address between 96 and 127 as serial communication is the only method of communication available. **A unit address of zero should not be used.**

The four different I/O versions in the range can be used together in the same system. WI-I/O 9-x and WI-GTWY-9-xxx modules can also be part of a system. Inputs to one product type can be transmitted to outputs of another product type. For example, an analog input to a ”-2” may be transmitted to an analog output of a ”-1” or ”-3”. Repeaters may be any product type.

The ”-1” and ”-2” modules require only one unit address. The ”-3” and ”-4” modules use two addresses, however only one unit address has to be entered. The ”-3” and ”-4” modules require two addresses because of the large number of output channels. If the “entered" unit address is an even number, then the second address is the next number. If the "entered" address is an odd number, then the second address is the previous number. So the two addresses are two subsequent numbers, starting with an even number. If a ”-3” module is given a unit address of 10, then it will also take up the unit address 11 and will accept messages addressed to either 10 or 11. It is important to remember this when allocating unit addresses to other modules in the system.

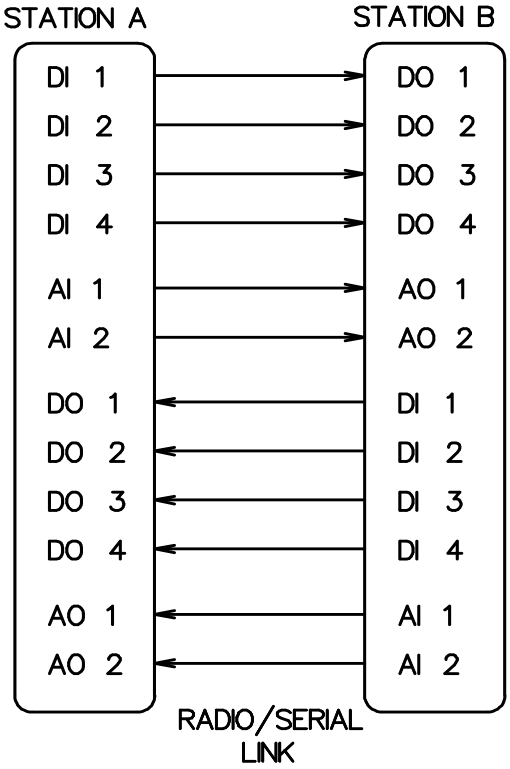
Warning - do not allocate the address number 1 to a “-3” or “-4” module.

In addition to these network configurations, operational parameters called **User Options** may be configured to change the features of the operation.

4.2 Easy Configuration Using Default Settings

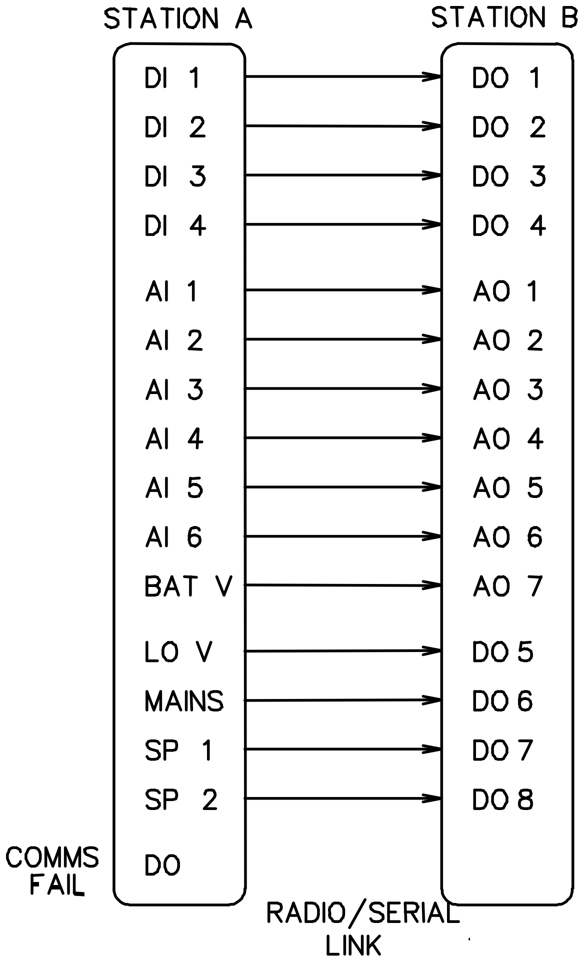
If your application requires only a single pair of modules, communicating via radio or serial link, default settings may satisfy your needs. If so, no configuration is required. Essentially, all inputs at Module A are reflected at the corresponding outputs at Module B. All inputs at Module B are reflected at the corresponding outputs at Module A.

For "-1" modules, the default configuration is as follows :-



In this configuration, the "PO" Pulse output is inactive and no special action is taken on "Comms fail", "Mains fail" or "Battery Low". "DI 1" is configured as a digital and not a pulse input.

For "-2" and "-3" modules, the default configuration is as follows :-



Note that there is no default configuration for the "-4" modules.

The following table details the default values for **User Options**:

Option	Factory Set Value
Update transmissions	Every 10 minutes
Analog Change-of-state sensitivity	3%
Reset outputs on Comms fail	No
Analog Setpoints (if mapped)	Low Set point = 30% High Set point = 75%
Pulse Output Rate Scaling (if Pulse Rate is mapped)	100 Hz
Digital Input Debounce Time	0.5 seconds

If any of the above values are not appropriate to your system, Section 4.4 below will detail how to change one or all of the above variables.

4.3 Configuration Software

This chapter describes installation and operation of configuration software for the radio and serial telemetry modules. The configuration software runs on a conventional PC as a Windows application. The software creates a configuration file which can be loaded into a module via RS232. The configuration software also allows the configuration of a module to be loaded for display and modification. Configuration files are created and stored in project directories.

Configuration of modules consists of entering I/O mappings, and selecting User Options. An I/O mapping is a link between an input on the module being configured and an output on another module. A mapping has the form :-

DI3 → Out2 at 4 via 3, 11

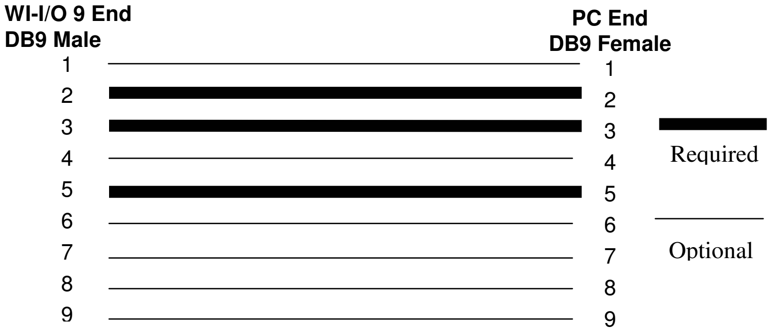
This mapping links DI3 on this module to output channel 2 on the module with address 4, and modules 3 and 11 are repeaters.

User Options may be selected to change the configuration of specific features.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

4.3.1 Hardware and Software Requirements

The configuration software is available on a CD, and needs to be installed on your PC before you can use it. The CD contains a setup file called *setup.exe*. Select the configuration software window on the Product CD and an installation Wizard will guide you through the installation procedure. To upload and download configuration files to a module, you will need a RS-232 serial cable as shown below.

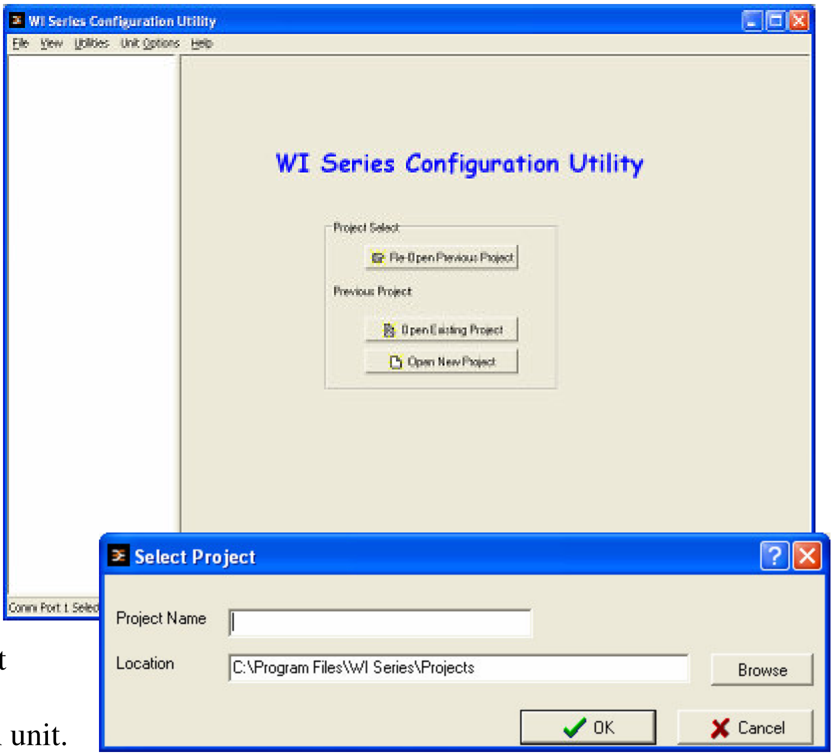


4.3.2 Program Operation

Start the software by either clicking on the start bar and navigating to the Configuration menu or by running WISeries.exe in the directory selected in the setup stage.

The Initial screen will appear. The configuration is performed for a complete system. The necessary configuration stages are:

- select system name and system address
- select individual units and unit addresses
- configure I/O mappings for each unit
- configure user options for each unit
- load the configuration files into each unit.



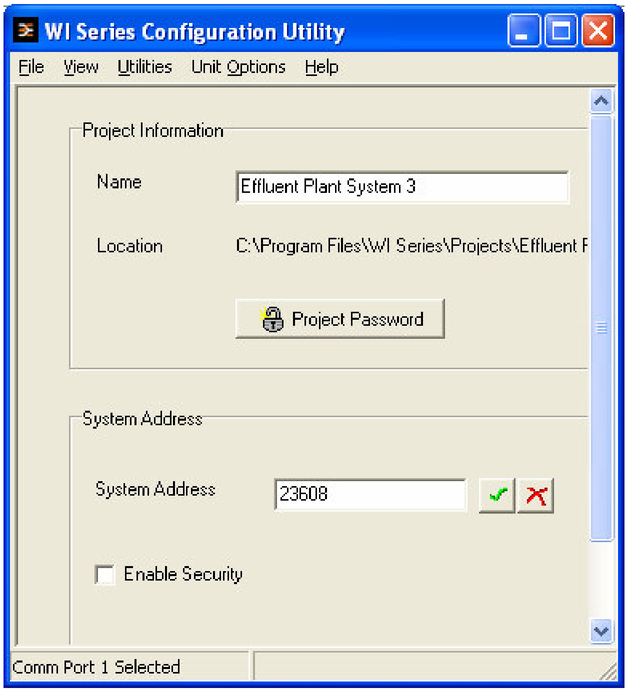
Project Name

Location C:\Program Files\WI Series\Projects

From the initial screen, you can select an existing project, or start a new project. The name of the project will create a new directory which will eventually contain the configuration files for the modules in this system.

When you have selected the project, a screen will appear where you may enter the system address.

If you are editting an existing project, the system address will already have been entered. Do not change the system address unless you are going to re-program all of the modules in the system.



Name Effluent Plant System 3

Location C:\Program Files\WI Series\Projects\Effluent F

System Address 23608

☐ Enable Security

Comm Port 1 Selected

Password. You have the option of entering a password to protect the configuration files against unauthorized changes. When you open a new project, you will be asked to enter a password - if you do not enter any text - that is, press "ESC" or "Enter", then password protection is disabled. If you do enter a password, then you will need to enter this password to make changes to the configuration or download or upload configuration. You only need to enter the password each time you enter the project. Without the passowrd, you are able to view the configuration details but you cannot make changes.

The password can be between 6 and 256 characters. You can also change password by selecting this option from the "Utilities" menu.

If you are starting a new project, you have the option of "Enabling Security" - please read Section 4.3.7 and the associated warnings before using this option.

To proceed with the configuration, double-click on the project name on the menu on the left side of the screen. "Units" will appear. You can now enter the types of units which will be used in the system. If you double-click on "Units", then the modules that have already been selected will appear.

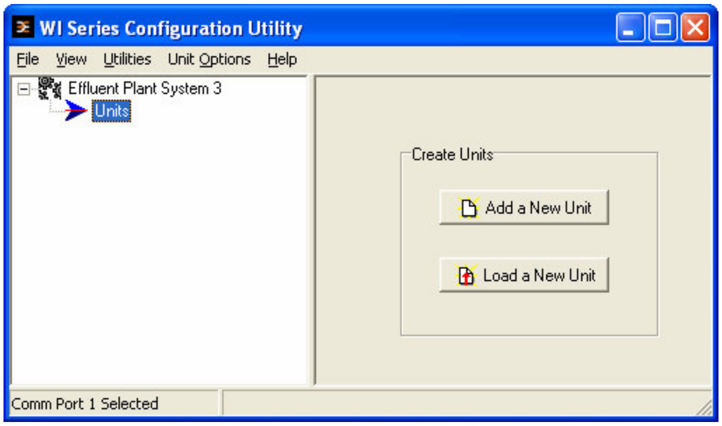
Loading configuration from an existing module

To load the configuration from a module, connect the module to the PC via the RS232 cable and click on "Load Unit". This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3.3 for more information.

Adding a new module to the system configuration

To add a new module to the system configuration, click on "Units" on the left-hand menu and then "Add Unit". Select the type of module from the list.

Note that this program covers WI-I/O-EX-1-S-x and WI-I/O 9-x modules. These modules are essentially the same as far as configuration is concerned. That is, a WI-I/O 9-1 selection will configure a WI-I/O-EX-1-S-1 or a WI-I/O 9-1.

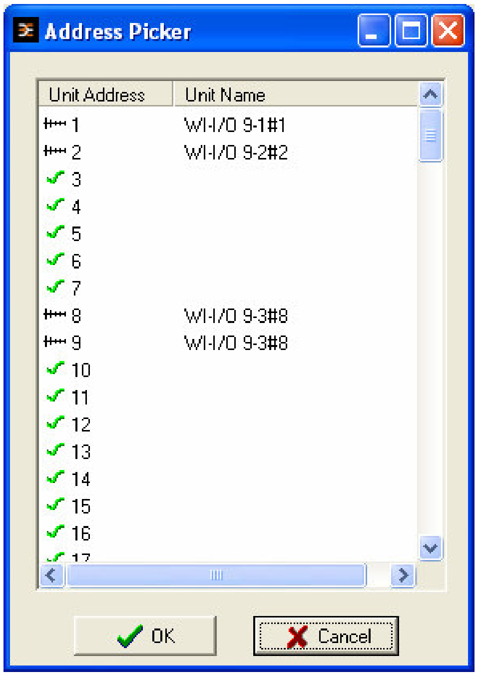


The program will ask to select the unit address and will display the list of available addresses for you to select. For WI-I/O 9-x modules, select an address between 1 and 95. For WI-I/O-EX-1-S-x modules, select an address between 96 and 127.

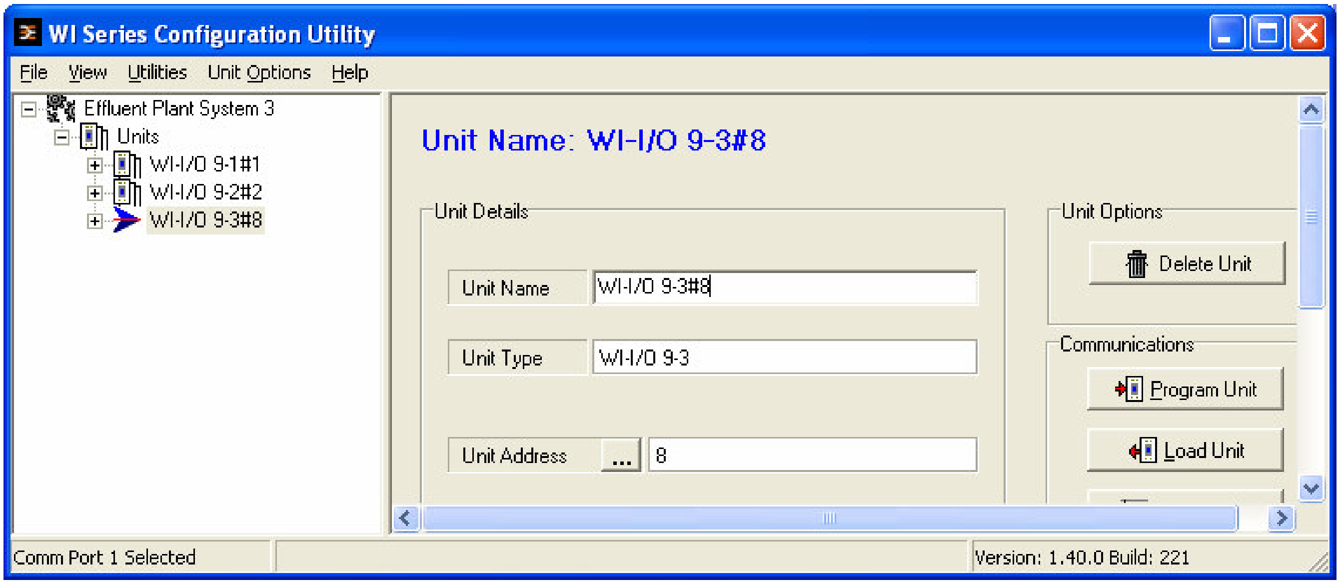
The default name for a unit will include the unit address. For example, "WI-I/O 9-3#8" is a WI-I/O 9-3 module with unit address 8 (and also 9, as a -3 takes two unit addresses). You can change the name of a unit - for example, you could replace the default name with "Pump Station 14".

Deleting a Unit

A module can be deleted from the configuration by highlighting the unit and selecting "Delete Unit".



Unit Address	Unit Name
1	WI-I/O 9-1#1
2	WI-I/O 9-2#2
✓ 3	
✓ 4	
✓ 5	
✓ 6	
✓ 7	
8	WI-I/O 9-3#8
9	WI-I/O 9-3#8
✓ 10	
✓ 11	
✓ 12	
✓ 13	
✓ 14	
✓ 15	
✓ 16	



Unit Name: WI-I/O 9-3#8

Unit Name: WI-I/O 9-3#8

Unit Type: WI-I/O 9-3

Unit Address: 8

Comm Port 1 Selected

Version: 1.40.0 Build: 221

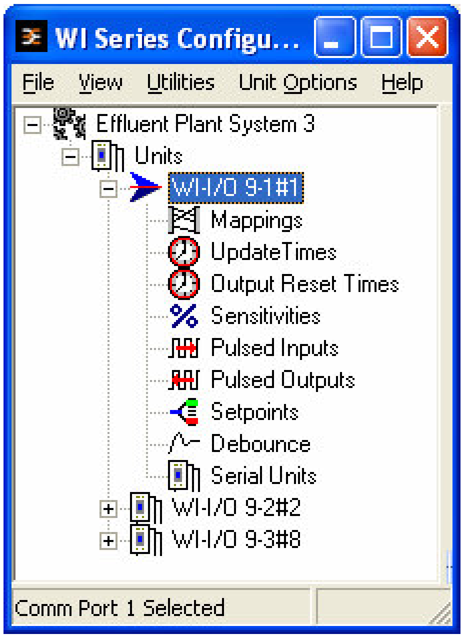
Configuring an individual module

Double-click on a unit shown on the left-han d menu. The configuration options for each unit will appear. We recommend that you configure I/O mappings first, and then other options.

Select “Mappings” and the following screen appears. There are three types of mappings:

- I/O mappings which link inputs to outputs
- Poll mappings, which enables a module on start-up to request set its outputs quickly

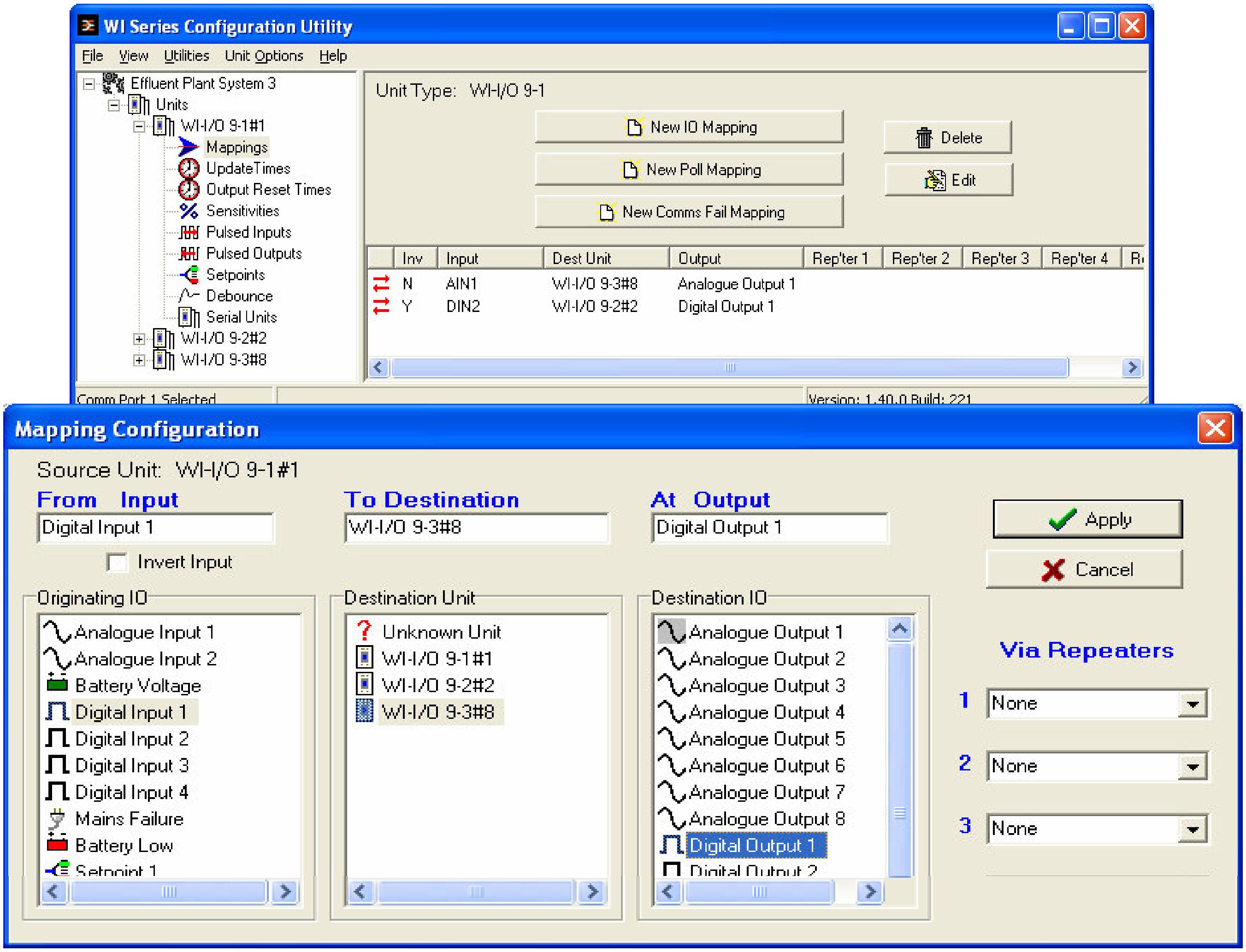
Comms Fail mappings, which maps communication failure status to an output on the local module.



Comm Port 1 Selected

I/O Mapping To enter an I/O mapping, select “New I/O Mapping”.

1. The I/O mapping display will show all inputs at the selected module - both physical inputs and internal inputs. Select the input to be mapped.
2. If you wish to invert the mapping, select the “Invert Input” box. If you invert an input, then the output will be the reverse of the input. Analog I/O can also be reversed - 4mA will be 20mA etc. **Do not invert pulse inputs.**
3. The invert function is not available on -2 modules - only inverted digital inputs are available (as internal inputs on the input list).
4. To select the destination module, you can either select the module from the “Destination Unit” list, or enter the unit address in the “To Destination” box. You can enter an address that has not yet been allocated to another unit.
5. You can select the output by entering the output number (1 – 8) in the “output” box, or select an output from the displayed list. There will only be a list of possible outputs displayed if at step 2 you selected a desrtination until that has already been configured in the system. The output numbering



Unit Type: WI-I/O 9-1

Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'ter 4	R
N	AIN1	WI-I/O 9-3#8	Analogue Output 1					
Y	DIN2	WI-I/O 9-2#2	Digital Output 1					

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Source Unit: WI-I/O 9-1#1

From Input: Digital Input 1

To Destination: WI-I/O 9-3#8

At Output: Digital Output 1

☐ Invert Input

Via Repeaters

1 None

2 None

3 None

	WI-I/O 9-1	**WI-I/O 9-2**	**WI-I/O 9-3 First addr (Even)**	**WI-I/O 9-3 Second addr (Odd)**	**WI-I/O 9-4 First addr (Even)**	**WI-I/O 9-4 Second addr (Odd)**
Output 1	DO 1	DO 1	D/P O 1	AO 1	D/P O 1	DIO 5
Output 2	DO 2	None	D/P O 2	AO 2	D/P O 2	DIO 6
Output 3	DO 3	None	D/P O 3	AO 3	D/P O 3	DIO 7
Output 4	DO 4	None	D/P O 4	AO 4	D/P O 4	DIO 8
Output 5	AO 1	None	DO 5	AO 5	DIO 1	DIO 9
Output 6	AO 2	None	DO 6	AO 6	DIO 2	DIO 10
Output 7	PO	None	DO 7	AO 7	DIO 3	DIO 11
Output 8	None	None	DO 8	AO 8	DIO 4	DIO 12

6. If you select a WI-GTWY-9-xxx as the destination module, you will be asked to select a I/O Register as the destination "output". Note that the grey-shaded I/O registers have already been allocated.
7. Select any intermediate repeater units needed to reach the destination address (entered in order of nearest to furthermost repeater). You can either select from the list of configured units or enter the unit address in the "Repeater" box. If no repeaters are required, do not enter anything in the repeater boxes. If only one repeater address is required, enter the address in box 1 and leave the other repeater boxes empty.

Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

It is possible to configure multiple mappings for an input - each mapping will generate separate transmissions. We recommend that you do not configure multiple mappings to the same output as the output will have the value of the last message that it receives. Each output should have only one mapped input.

It is possible to map a digital input to an analog output - the output will be maximum value when the input is on and minimum value when the input is off. It is also possible to map a analog input to an digital output - the output will be on when the input is equal or greater than 12mA and off when the input is less than 12mA.

For more information on using WI-I/O-EX-1-S-x modules, refer to Section 4.3.8.

Edit existing mappings

To edit an existing mapping, double-click on the mapping line, or select the mapping line and "Edit".

To delete an existing mapping

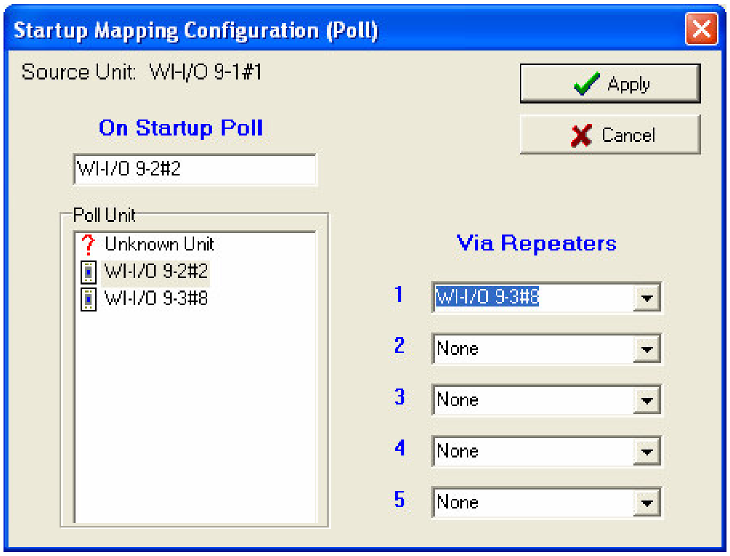
To delete a mapping, select the mapping and delete or right-mouse click and select Delete.

Configuring Start-Up Polls

When a unit is first turned on, its outputs will not be set until it receives update messages from other units in the system. To that outputs are set as soon as possible after start-up the unit may be configured to "Poll" any other units with mapping s to its o utputs.

Select the remote unit to be polled from the unit list, or enter the unit address in the box. If the remote unit communicates via repeaters, select the repeater units or enter the repeater addresses.

Remember that if more than one remote unit is controlling the local outputs, then more than one start-up poll should be configured.



Source Unit: WI-I/O 9-1#1

On Startup Poll: WI-I/O 9-2#2

Via Repeaters:

1 WI-I/O 9-3#8

2 None

3 None

4 None

5 None

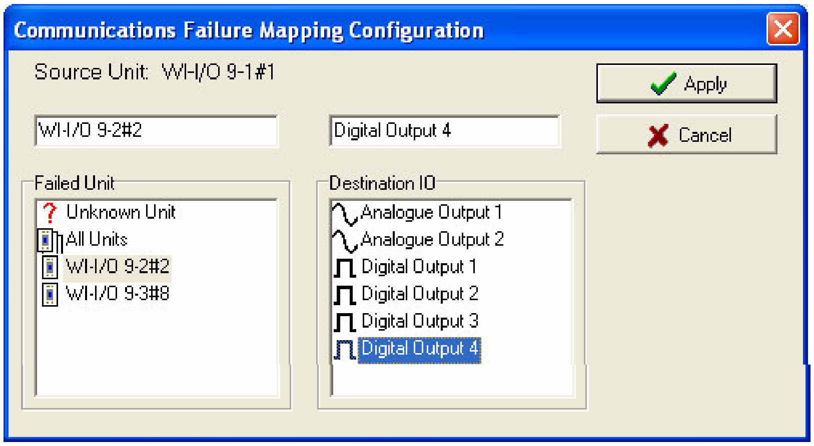
Configuring Comms Fail Mappings

Each module has a "comms fail" status which may be mapped to a local output. The comms fail status is active (on) if the module is transmitting a message and does not receive an acknowledgement after five tries. By setting the comms fail status to a local output, you can provide a communications alarm. The local output can be digital or analog - if analog, the output will go to maximum value.

Although communication failure will activate the output, successful comms does not reset the output. You must use the "Reset outputs on comms fail" option (Refer to User Options section).

different remote addresses. You can configure several comms fail mappings to the same output - the output will be active if there is comms fail to any of the remote addresses. Configuring a "Comms Fail Address" of zero causes communication failure to any destination module to be indicated on the selected output.

For example, if "Comms fail to unit 12" is configured to DO1, then the module will set (or activate) DO1 each time communications to unit 12 is not successful. If DO1 has a "Reset output" time of 10 minutes configured for DO1, then DO1 will reset (de-activate) 10 minutes after the last comms fail to unit 12.



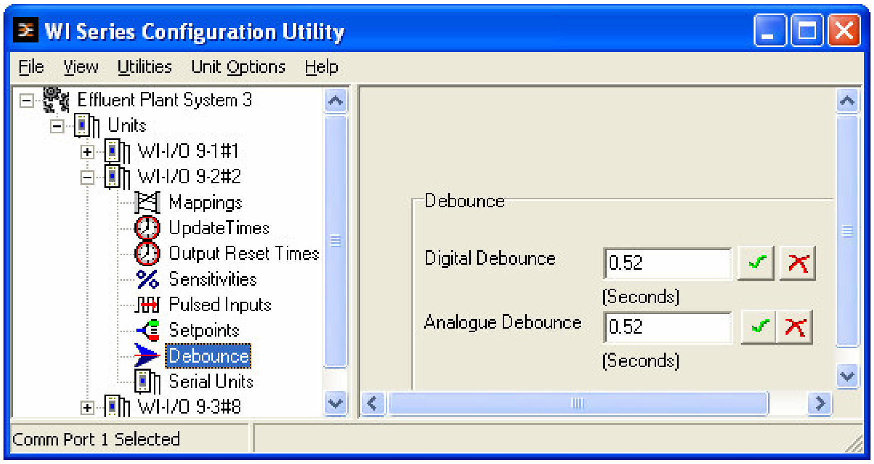
Source Unit: WI-I/O 9-1#1

WI-I/O 9-2#2

Digital Output 4

Debounce Configuration

Debounce is the time which an input must stay stable before the module decides that a change of state has occurred. If a digital input changes (say 0 → 1) and changes again (1 → 0) in less than the debounce time, then the module will ignore both changes. Debounce may be configured for digital inputs on the –1, -2 and -4 modules (0.5 - 8 seconds) and the analog inputs on the -2 module (0.5 - 8 seconds). The default value of 0.5 seconds is suitable for most applications. In applications where a digital input may turn on and off several times slowly (for example, security switches or float switches) a debounce time of up to 8 seconds may be configured. *The configured debounce time has no affect on pulse inputs.*



Debounce

Digital Debounce 0.52 (Seconds)

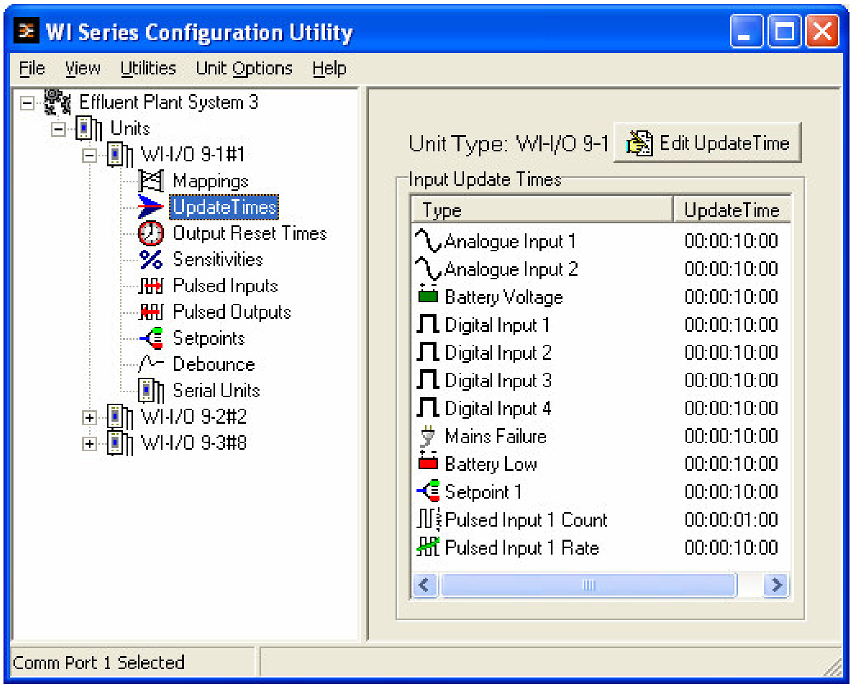
Analogue Debounce 0.52 (Seconds)

Note that the analog debounce is not configurable for the -1 , but is configurable in the -2.

Update Time Configuration

Update messages are sent if a change message has not occurred within the update time period. The update time may be set for each input - both physical and internal inputs.

The default period is 10 minutes for all inputs, except for pulse inputs (1 minute). Short update times should only be used in special circumstances. It is important to remember the principle - “Less radio traffic means better communications”. Frequent updates from multiple units causes congestion of the radio channel, which results in increased communication failures and poorer performance of the system. To change an update time, select “Update Times” on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values. For the -1, -2 and –3 modules, the maximum update time is 16 minutes, however the update



Unit Type: WI-I/O 9-1

Input Update Times

Type	UpdateTime
Analogue Input 1	00:00:10:00
Analogue Input 2	00:00:10:00
Battery Voltage	00:00:10:00
Digital Input 1	00:00:10:00
Digital Input 2	00:00:10:00
Digital Input 3	00:00:10:00
Digital Input 4	00:00:10:00
Mains Failure	00:00:10:00
Battery Low	00:00:10:00
Setpoint 1	00:00:10:00
Pulsed Input 1 Count	00:00:01:00
Pulsed Input 1 Rate	00:00:10:00

time for -4 inputs can be up to 5 days.

If a zero value is entered as an update time, then the input will not update at all.

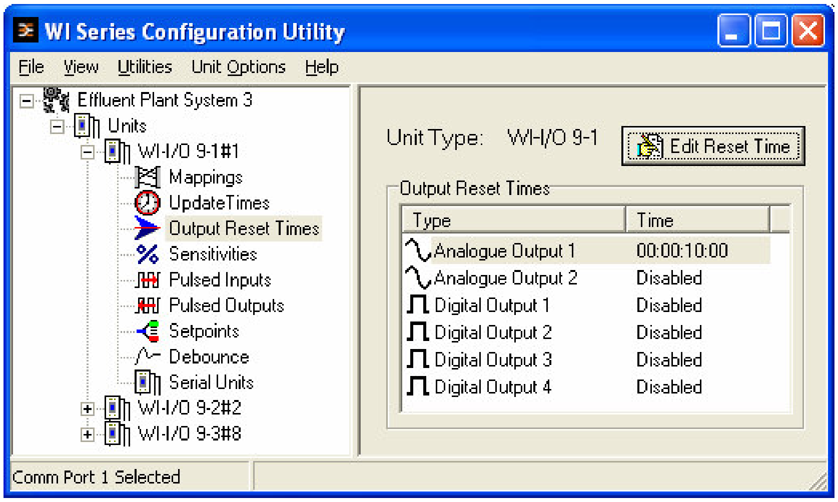
Changing Multiple Settings

You can change the Update Times of several inputs simultaneously by using the <Shift> Select feature. For example, if you want to change all digital inputs to 1 minute update, you could change each individually, or you could “block” the four digital inputs using the “Shift” Select feature and select “Edit”. You only need to enter the change once to change all of the inputs selected. This feature is also available with the other configurable parameters.

Output Reset Time Configuration

This allows the **Comms Fail Time** to be selected - this is the time for an output to reset if it has not received an update or change message.

Each output on the unit, either analog or digital, may be configured to reset (off or 0mA) when no update transmission has been received for a certain time. This option can be used to ensure that communications failure will not result in loss of control. For example, outputs connected to pumps should be configured to reset on communications failure so that the pump will turn off. The default condition is zero (no reset).



Unit Type: WI-I/O 9-1

Output Reset Times

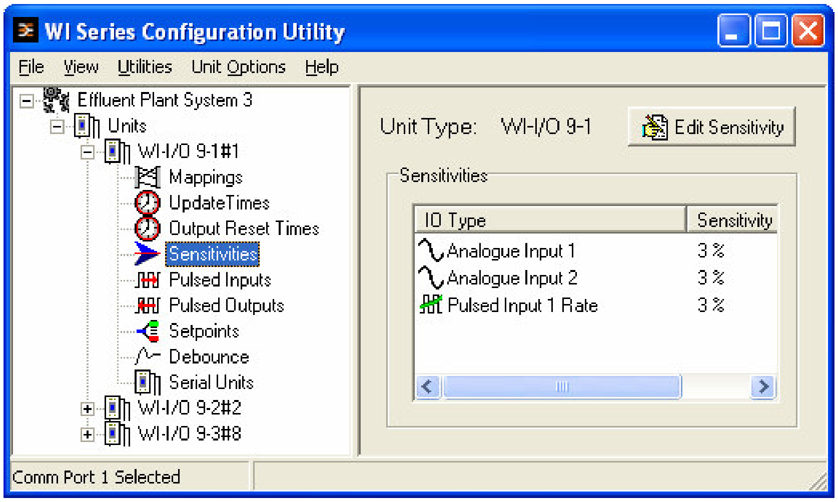
Type	Time
Analogue Output 1	00:00:10:00
Analogue Output 2	Disabled
Digital Output 1	Disabled
Digital Output 2	Disabled
Digital Output 3	Disabled
Digital Output 4	Disabled

Comm Port 1 Selected

If the reset time is less than the update time, then the output will reset when the reset time expires, and then set again when the update message is received. We recommend that the reset time be a little more than twice the update time.

To set an output reset time, select “Output Reset Times” on the left-hand menu and double-click the selected input. The update time will be shown in days:hours:minutes:seconds. Change the values in each field. The display also shows the maximum and minimum values.

Analog Sensitivity Configuration



Unit Type: WI-I/O 9-1

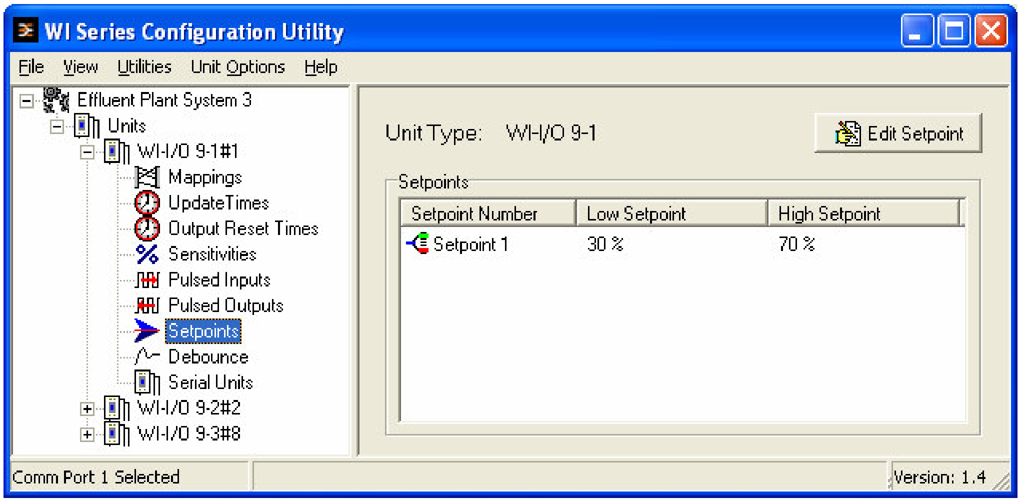
Sensitivities

IO Type	Sensitivity
Analogue Input 1	3 %
Analogue Input 2	3 %
Pulsed Input 1 Rate	3 %

The analog sensitivity is the change required in an analog input before a "Change Of State" is detected, and the new analog value is transmitted. For input signals which vary widely over a short period of time or have a normal oscillation, the analog sensitivity should be set to an appropriately large value. This ensures that many change messages are not transmitted in too short a time. This will result in channel congestion, as described in the preceding section.

To change an analog sensitivity, select "Sensitivities" on the left-hand menu and double-click the selected input. The sensitivity for physical inputs is shown in mA and internal input is shown as %.

SetPoint Configuration



Unit Type: WI-I/O 9-1

Setpoints

Setpoint Number	Low Setpoint	High Setpoint
Setpoint 1	30 %	70 %

Setpoints allow a remote digital output to be turned on and off depending on the value of an analog input. The "set-point status" internal input must be mapped to an output for this option to have effect. When the AI is less than the Low Set-point (LSP), the set-point status will be active (on, "1") - when the AI is more than the High Set Point (HSP), the set-point status will be reset (off, "0"). Note that the High Set Point (HSP) must always be higher than the Low Set Point (LSP). For the -1 module, only AI1 has set-point values. For -2 modules, the first four analog inputs (AI 1 – 4) have set-points.

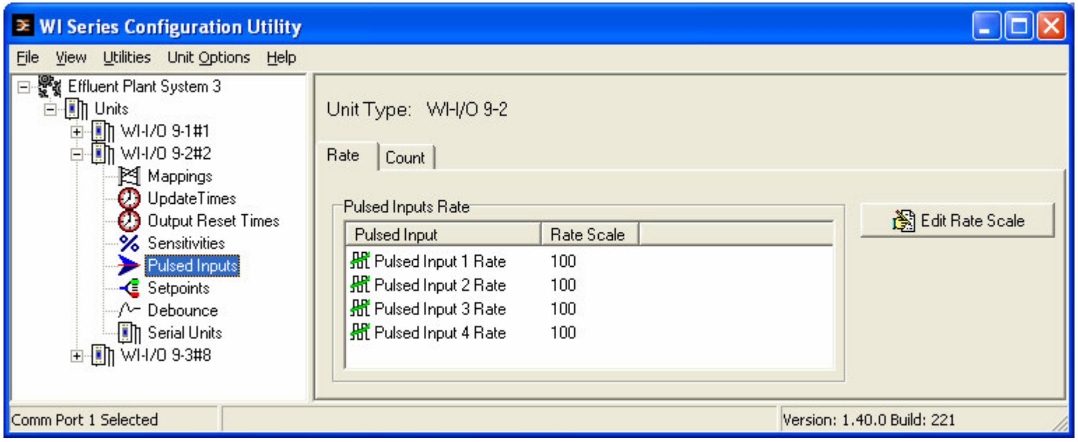
Debounce time operates on the set-point status in the same way as digital inputs.

To change a setpoint values, select "SetPoints" on the left-hand menu and double-click the selected Setpoint Status.

Pulse Input Count Configuration

PI1 of the -2 and -4 modules normally count up to 100Hz (as for the other PI’s), however can be configured to count up to 1000Hz. This configuration actually divides the input count by 10 - each count in the PI1 register is then equivalent to 10 input pulses. If PI1 is mapped to a PO, then the maximum output pulse rate is 100Hz, however each output pulse is equivalent to 10 input pulses.

To configure the “divide by 10” feature, select “Pulse Inputs” on the left-hand menu and select the “Count” page - double-click “Pulse Input 1 Count” and enable “divide by 10” counting.



Unit Type: WI-I/O 9-2

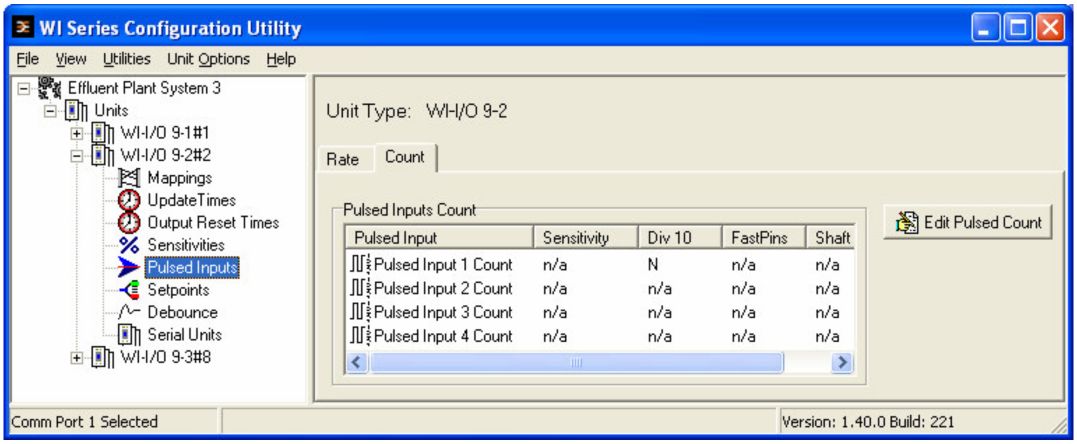
Pulsed Inputs Rate

Pulsed Input	Rate Scale
Pulsed Input 1 Rate	100
Pulsed Input 2 Rate	100
Pulsed Input 3 Rate	100
Pulsed Input 4 Rate	100

Pulse Input Rate Scale Configuration

When a pulse rate is mapped to an analog output, the rate must be scaled to the 4-20mA output. The pulse rate scale is the rate (in Hz) corresponding 20 mA.

To configure the pulse rate scale, select “Pulse Inputs” on the left-hand menu and select the “Rate” page - double-click the pulse input rate and enter the scale value.



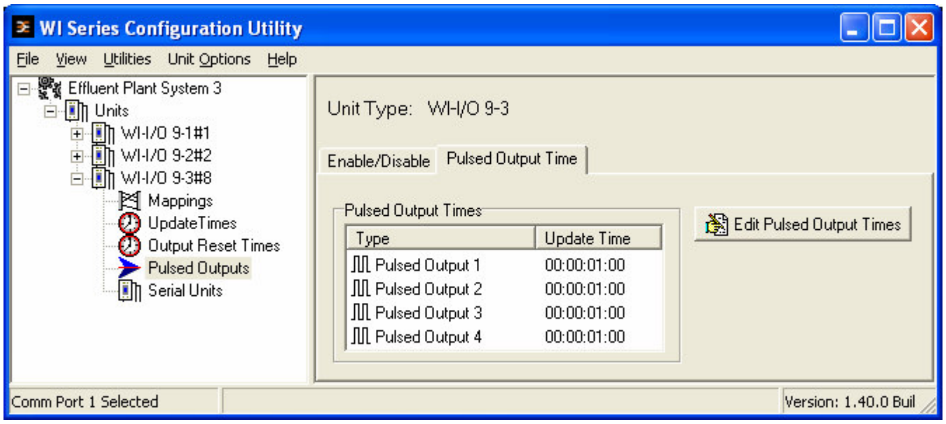
Unit Type: WI-I/O 9-2

Pulsed Inputs Count

Pulsed Input	Sensitivity	Div 10	FastPins	Shaft
Pulsed Input 1 Count	n/a	N	n/a	n/a
Pulsed Input 2 Count	n/a	n/a	n/a	n/a
Pulsed Input 3 Count	n/a	n/a	n/a	n/a
Pulsed Input 4 Count	n/a	n/a	n/a	n/a

Pulse Output Update Time Configuration

The pulse output update time is the time period over which pulses are output after a PI update is received. It should be configured to correspond to the pulse input update time for the corresponding pulse input. This ensures that the pulse output rate matches as closely as possible the pulse input rate which it is reflecting.



Unit Type: WI-I/O 9-3

Pulsed Output Times

Type	Update Time
Pulsed Output 1	00:00:01:00
Pulsed Output 2	00:00:01:00
Pulsed Output 3	00:00:01:00
Pulsed Output 4	00:00:01:00

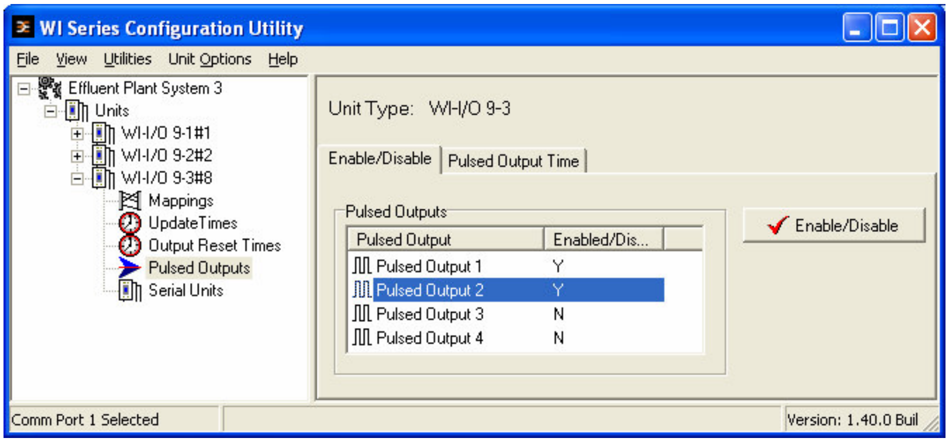
For example, if the PI update time is 1 minute, then the PO update time should also be 1 minute. If the PI update time is changed, then the PO update time at the remote module should be also changed. The PO will still operate if the time is not changed, however pulses may be output faster or slower than the input pulses.

To configure the pulse output time, select “Pulse Outputs” on the left-hand menu and select the “Pulsed Output Time” page - double-click the pulse output and enter the new time.

Pulse Output Enable

The PO’s for the -2 and -4 modules are also DO1-4. To use as pulse outputs, you need to enable them as pulse outputs.

To enable pulse outputs, select “Pulse Outputs” on the left-hand menu and select the “Enable/Disable” page - double-click the pulse output to enable.



Unit Type: WI-I/O 9-3

Pulsed Outputs

Pulsed Output	Enabled/Dis...
Pulsed Output 1	Y
Pulsed Output 2	Y
Pulsed Output 3	N
Pulsed Output 4	N

Compiling a System

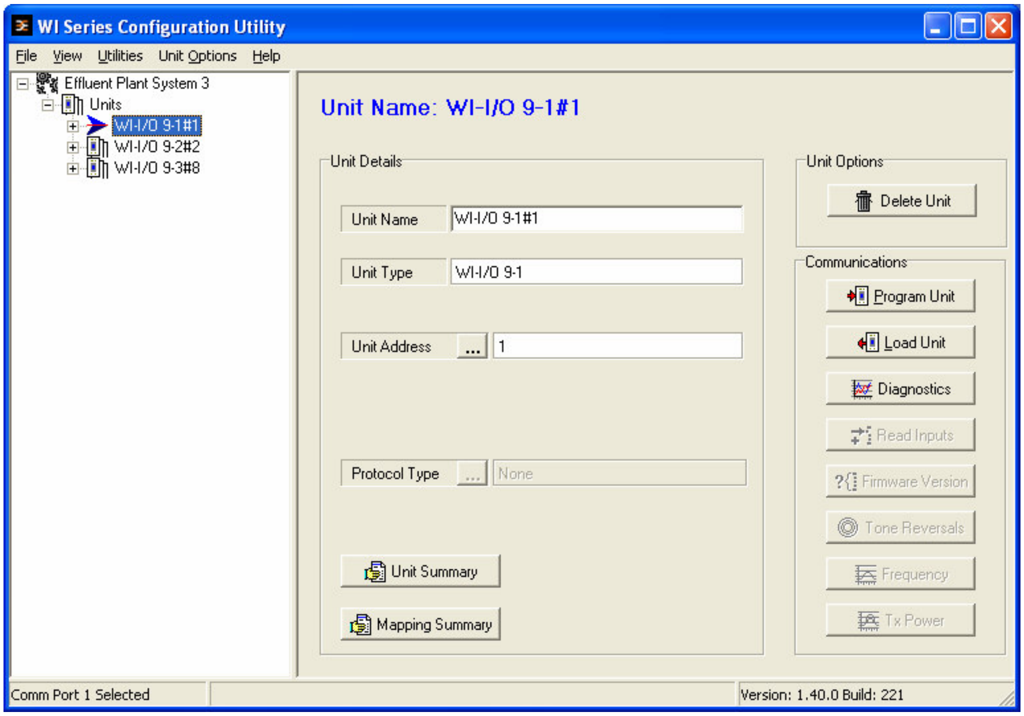
When you have finished configuring the modules, you should compile the system. The compile function scans the configuration and reports any detected errors. To compile the system, select “Compile System” from the “Utilities” menu. Select the “Compile” button. The system will compile - the display will show if there are any compile errors or warnings.

4.3.3 Programming Configurations to Modules

To program a module :

- Connect the cable from the PC’s serial port to the module serial port (see 2.4.10 for cable connections)
- From the Utilities menu, select “Serial Port Setup”
- Select the appropriate serial port (COM1 - COM4)
- Select the unit to be configured from the left-hand menu
- Double-click “Program Unit”.

Each module will need to be programmed individually.



Effluent Plant System 3
Units
WI-I/O 9-1#1
WI-I/O 9-2#2
WI-I/O 9-3#8

Unit Name: WI-I/O 9-1#1

Unit Name: WI-I/O 9-1#1
Unit Type: WI-I/O 9-1
Unit Address: 1
Protocol Type: None

Comm Port 1 Selected
Version: 1.40.0 Build: 221

4.3.4 Loading Configuration from a Module

Care should be taken when loading a configuration from a module. It is easy to lose the system address and unit address. We suggest that you first view the system address and unit address - you can do this via the “Unit Options” menu. Note these addresses before loading the configuration.

When you upload the configuration, the program will check if you want to load the addresses from the module. **If you do not, then the system address and unit address will change.**

You are able to upload the configuration from a module into a new “project”, to view the configuration and modify it. Note that as the “project” will not have the details of the other modules in the system, the other modules and outputs will be shown as unit addresses and output numbers. Don’t forget to download the configuration into the module after you modify it.

If security has been enabled for the system, please read section 4.3.7.

If you are adding additional mappings to a WI-I/O 9-C or WI-GTWY-9-xxx module, then you need to change the archived configuration files first so you can download the modified configuration details into the WI-I/O 9-C or WI-GTWY-9-xxx.

4.3.5 Modifying and Archiving Configuration Files

As you build a system configuration, it is automatically saved in the “Project” directory. We recommend that all system additions and changes be made to the archived configuration files first, and

then downloaded to the module/s. This ensures that the archived files are always maintained and accurate. If you modify the configuration of a module by uploading and then downloading, then the module configuration will be different then the archived files.

If you lose the configuration files for a system, then you can rebuild the configuration by uploading the configuration file from every module in the system.

4.3.6 Print Options

You can obtain a print-out of each module configuration. On each unit display, there are “Unit Summary” and “Mapping Summary” windows. Each of these will display a printable information page about that module. The Unit Summary page will display the user options configured, and the Mapping Summary will display the mappings entered for that unit.

The printer may be selected from the Printer Setup option in the File menu.

4.3.7 Security

There are two security features available. You can enter a password to protect the configuration files, and you can enable security encryption of the radio transmissions.

The password can be between 6 and 256 characters. The password is case sensitive and any ASCII characters can be used. If you have entered a password, then this password will need to be entered if the configuration is to be changed later. You can view the configuration, but you will not be able to make any changes. You are able to change the password from the “Utilities” menu. If unauthorised access to the files is a concern, we recommend that you change the password regularly or whenever there is a change of staff.

Security Encryption is an additional level of security. The security option uses an 8-character security key to provide 64-bit data encryption of the radio messages. All modules in the same system will be configured with the same security key used to encrypt and decrypt the messages. This feature is available for modules with serial numbers with the middle three numbers greater than 210 - that is xxxx210xxxx, or xxxx220xxxx etc. If you are adding modules to an old system which does not have the security encryption feature, then you cannot use security encryption on the new modules.

Note that the security key is different than the password.

- To enable the security encryption, select the “Enable Security” box on the project display. An 8-character security key is entered and you will be prompted to enter the security code a second time to confirm. The security key can be any characters or numbers. Characters are case sensitive. The security key will never be displayed.
- If you do not enable security, there will be no data encryption of the radio messages. This is the default setting.
- If a security key has been entered, this key is downloaded into each module as part of the configuration download process. You can download another configuration at any time - if the security key is different, or if there is no security key in the new configuration, the old key will be over-written.

- You can change the security key in the configuration files simply by entering a new security key in the security key window. You will be prompted to confirm the new security key. If the configuration files are password-protected, you will be asked for the password. Note that if you change the security key, it will not match the security key previously loaded into existing modules.
- If you want to change a configuration, we recommend that you change the archived configuration, and then download the configuration onto the module. The archived configuration already has the valid security key.
- If you lose the archived configuration, you can upload the configuration from a module, but you cannot upload a security key. That is, you can upload the module configuration, view it, change it - but if you don't know the original security key, the old key will be over-written when you download the new configuration. This module will no longer communicate with other modules in the system as the security key is different.

The security options provide security against a "hacker" in the following way:

- ☐ A hacker cannot listen-in to radio messages without the security key to decrypt the radio messages. Similarly, a hacker cannot force outputs by transmitting a radio message to a module without the security key.
- ☐ A hacker cannot access the security key from an installed module or from the configuration files.
- ☐ The archived configuration files cannot be changed, downloaded or uploaded without the password.

Warning!!

These security options provide a high level of security, but no data-security system can provide "100% protection". But it does make it very difficult for someone to interfere with the WI-I/O 9-x system - difficult to the point where there would be many easier alternate ways to cause malicious damage.

The password must be kept in a secure place. Security procedures need to be adopted. If staff with access to the password leaves your organization, we recommend that the password be changed.

We recommend that you use a random 8-character string for the security key and that you do not record the key. It is not necessary to know what the security key is. The key will be recorded in the archived configuration files, and therefore the configuration files should be held in a secure place and backed up.

The security key does not prevent a hacker uploading a configuration from a module and downloading with a new security key. This module will no longer operate with other modules in the system. To prevent this, unauthorized access to modules must be prevented.

If you lose the configuration files, you can regenerate these by uploading the configuration from every module in the system into a new project with a new security key. After uploading each module, download the configuration with the new security key.

If you wish to change the security key, simply enter a new key in the configuration program, and download the new configuration to all modules in the system.

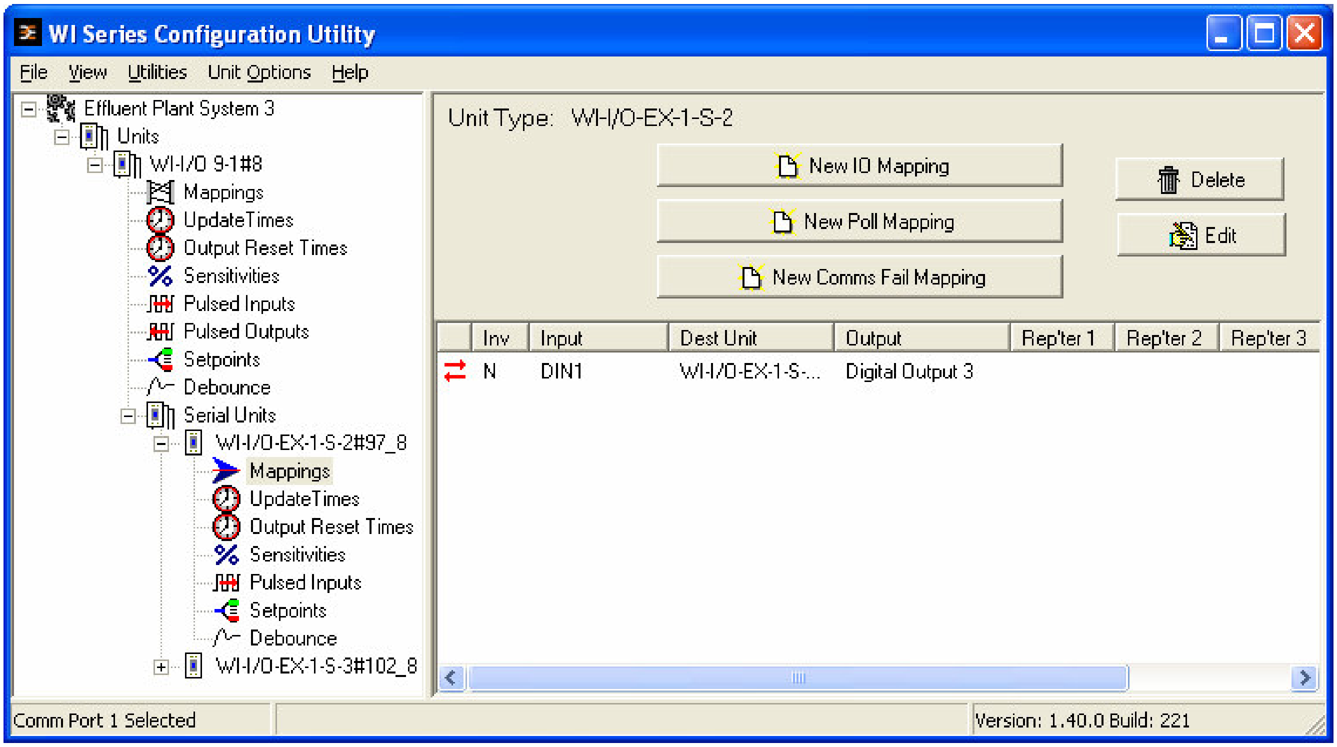
4.3.8 Using WI-I/O-EX-1-S-x Modules

WI-I/O-EX-1-S-x modules can be used by themselves, as “line telemetry” or “wired I/O”, or they can be used as I/O expansion for WI-I/O 9-x modules. As the WI-I/O-EX-1-S-x modules are connected by RS485, the WI-I/O-EX-1-S-x modules can be separated from the WI-I/O 9 modules by some distance. There can be up to 32 addresses on the one RS485 multi-drop link. Note that each –3 and –4 module takes up 2 addresses. For example, you could have up to 32 modules sharing a multi-drop link if they are all –1 or -2 modules - if they are all –3 or –4, then you could only have 16 modules on the link.

WI-I/O-EX-1-S-x modules are configured with unit addresses in the range 96 – 127.

Example 1 - Mapping to another WI-I/O-EX-1-S-x module on the same link.

The I/O mapping is done in the same way as for WI-I/O 9-x modules.



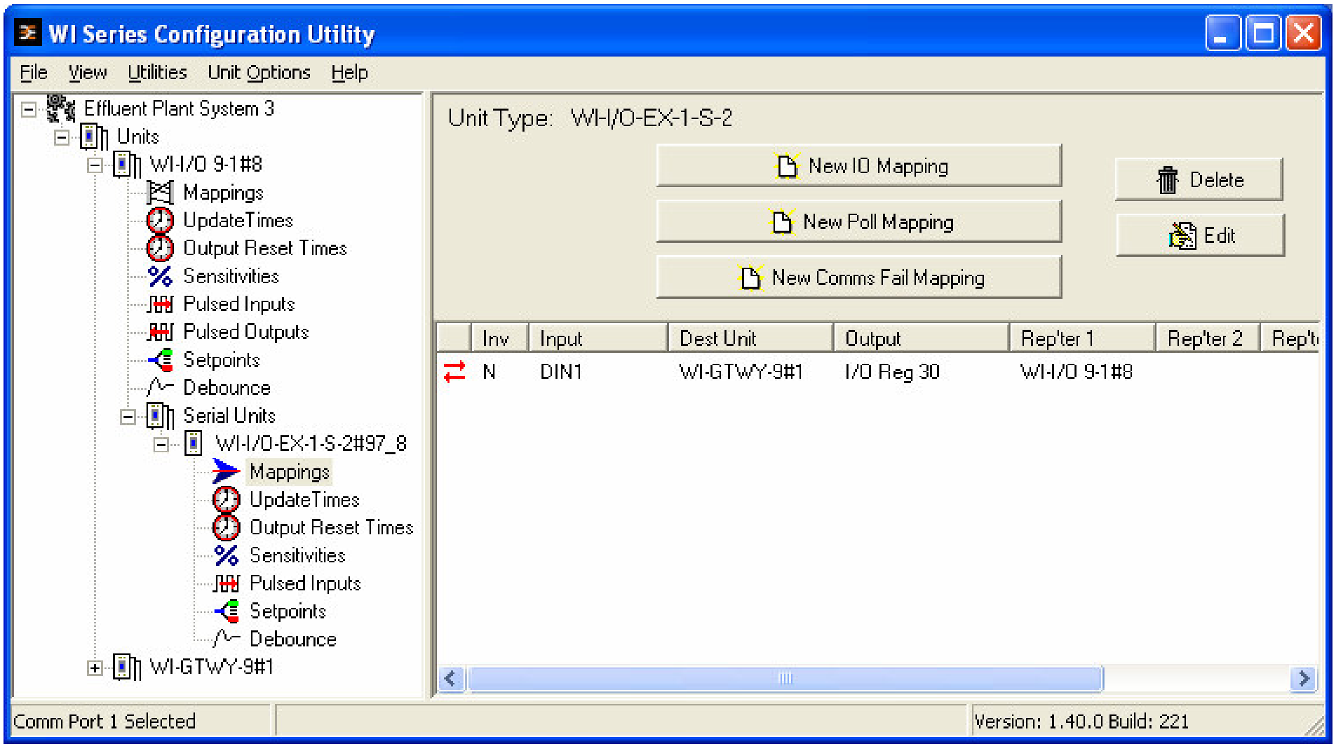
Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
⇄	N	DIN1	WI-I/O-EX-1-S-...	Digital Output 3			

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Example 2 - Mapping to a remote WI-I/O 9-x.



Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep't
⇄	N	DIN1	WI-GTWY-9#1	I/O Reg 30	WI-I/O 9-1#8		

Comm Port 1 Selected

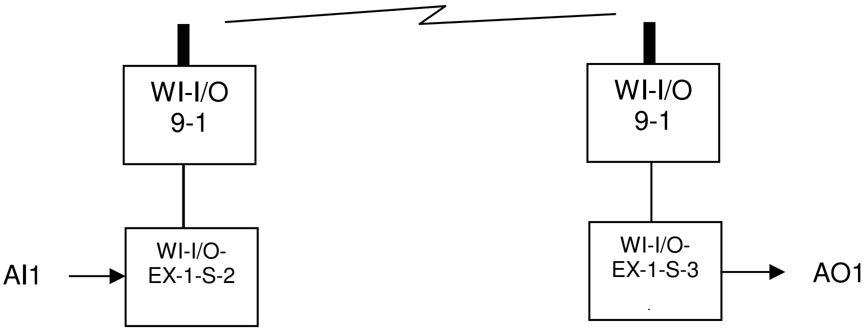
Version: 1.40.0 Build: 221

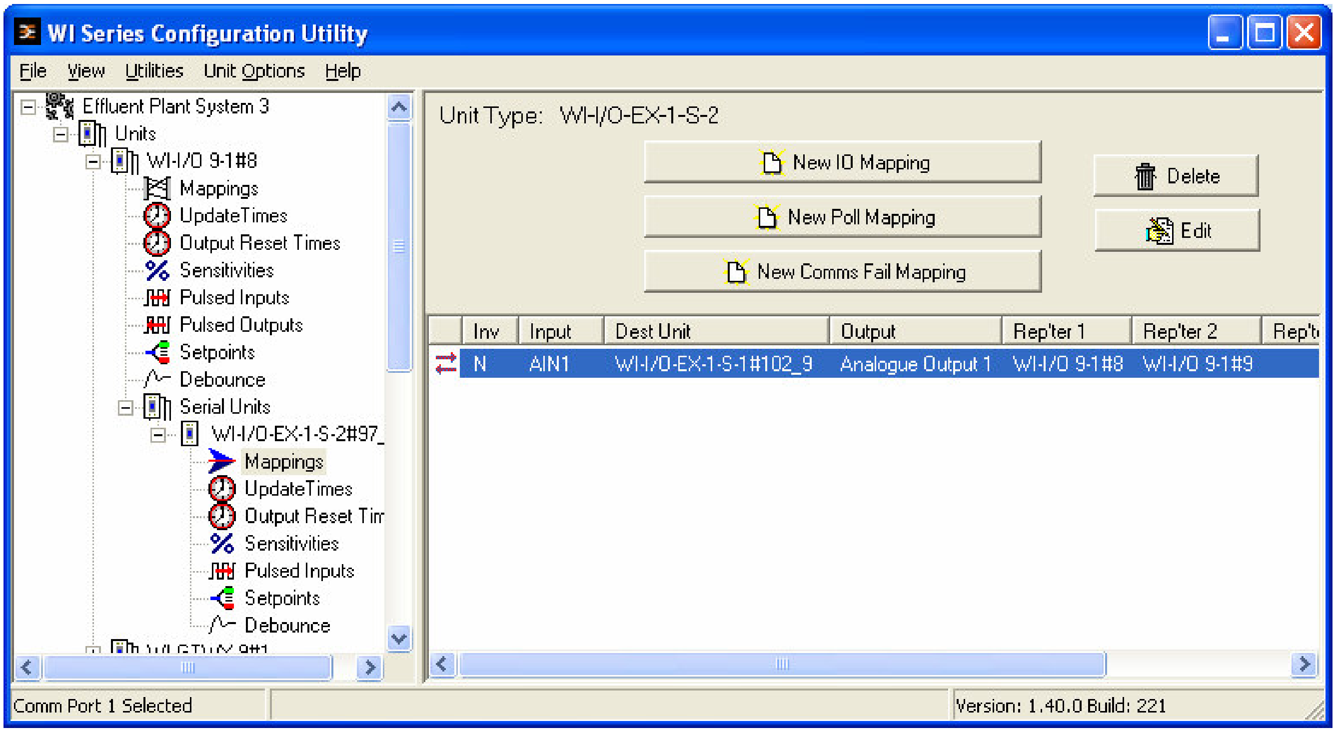
In this example, a WI-I/O-EX-1-S-x-2 is connected to WI-I/O 9-1#8. DI1 is mapped to a remote WI-GTWY-9-MD1 module. The WI-I/O 9-x that is connected to the WI-I/O-EX-1-S-x module acts as a repeater - a serial-to-radio repeater.

When DI1 changes, the WI-I/O-EX-1-S-x will send a message via the serial link to WI-I/O 9-1#8.

Example 3 - Mapping to another WI-I/O-EX-1-S-x which is connected to a different WI-I/O 9-x

In this example, both WI-I/O 9-x modules act as repeaters. The first is a “serial-to-radio” repeater and the second is a “radio-to-serial” repeater.





Unit Type: WI-I/O-EX-1-S-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep't
⇄	N	AIN1	WI-I/O-EX-1-S-1#102_9	Analogue Output 1	WI-I/O 9-1#8	WI-I/O 9-1#9	

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Chapter Five SPECIFICATIONS

General		
WI-I/O 9-x Radio standards	FCC Part 15A, Part 15.247	902 – 928 MHz, 1W
Housing	130 x 185 x 60mm DIN rail mount Refer section 5.1 for dimensioned drawing	Powder-coated, extruded aluminium
Terminal blocks	Removable	Suitable for 2.5 mm^2 conductors
LED indication	Power supply, OK operation, digital I/O, RX and TX	
Operating Temperature	WI-I/O 9-x, WI-I/O-EX-1-S-x	-40 to 60 degrees C / -40 to 140 degrees F -30 to 60 degrees C / -20 to 140 degrees F
Humidity	0 – 99% RH non-condensing	
Power Supply		
Battery supply	11.3 - 15.0 VDC	
AC supply	12 - 24 VAC, 50/60 Hz	Overvoltage protected
DC supply	15 - 30 VDC	Overvoltage and reverse voltage protected > 17VDC required for charging battery
Battery Charging circuit	Included	for 1.2-12 AHr sealed lead acid battery
Solar regulator	Included	Direct connection of solar panel (up to 30W) and solar battery (100 Ahr)
Current Drain at 12VDC	85 mA quiescent for ‘U’ 45 mA quiescent for ‘S’	+ 10 mA/active digital input + 25 mA/active digital output + 2 x analog I/O loop (mA)
Radio transmitter inrush	WI-I/O 9-x	350mA @ 13.8VDC; 250mA @ 24VDC 450mA @ 13.8VDC (0.5W) 600mA @ 13.8VDC (1W) 800mA @ 13.8VDC (2W) 1.25A @ 13.8VDC (5W)
Analog loop supply	Included, except -4	24V DC 150 mA
Mains fail status	Monitored	Can be transmitted to remote modules
Battery voltage	Monitored	As above

Radio Transceiver (WI-I/O 9-x)		
Spread spectrum	Frequency hopping	
Frequency	USA/Canada Australia New Zealand	902 – 928 MHz 915 – 928 MHz 922 – 928 MHz
Transmission Power	1W	
Signal detect / RSSI	-120 to –50 dBm	
Expected line-of-sight range (subject to local conditions)	20 miles + @ 4W ERP 15 km + @ 1W ERP depending on local conditions	USA / Canada Australia / New Zealand Range may be extended by up to 5 intermediate modules as repeaters
Antenna Connector	Female SMA coaxial	
Data transmission rate	19200 baud	
Serial Ports		
RS232 Port	DB9 female DCE	9600 baud, no parity, 8 data bits, 1 stop bit
RS485 Port	2 pin terminal block	9600 baud, no parity, 8 data bits, 1 stop bit, Typical distance 1 mile / 2km
Data transmission	On change-of-state + integrity update	Update time configurable
Protocol - serial - radio	asynchronous ARQ, with 16 bit CRC synchronous ARQ	Automatic acknowledgements with up to 4 retries
Communications fail status	May be mapped to local or remote output	Resetting of outputs on comms fail configurable
Inputs and Outputs		
Digital Inputs	WI-I/O 9-x_WI-I/O-EX-1-S-1 Four WI-I/O 9-x_WI-I/O-EX-1-S-2 Four WI-I/O 9-x_WI-I/O-EX-1-	Opto-isolated (5000V)inputs, suitable for voltage free contacts or NPN transistor, contact wetting current 5mA, input debounce 0.5 second For –4 modules, as above, but with 3000V surge protection instead of opto-isolation

	S-3 None WI-I/O 9-x_WI-I/O-EX-1-S-4 Four plus 12 selectable I/O	
Digital Outputs Digital Outputs	WI-I/O 9-1_WI-I/O-EX-1-S-1 Four WI-I/O 9-2_WI-I/O-EX-1-S-2 One WI-I/O 9-3_WI-I/O-EX-1-S-3 Eight WI-I/O 9-4_WI-I/O-EX-1-S-4 Four plus 12 selectable I/O	Relay output contacts, normally open, AC 5A 50V DC 2A 30V, 5A 20V
Pulse Inputs	WI-I/O 9-1_WI-I/O-EX-1-S-1 One WI-I/O 9-2_WI-I/O-EX-1-S-2 Four WI-I/O 9-3_WI-I/O-EX-1-S-3 None WI-I/O 9-4_WI-I/O-EX-1-S-4 Four	Uses DI1. Max rate 100Hz, min. off-time 5msec. Uses DI1-4. Max rate of DI1 is 1000Hz, min. off-time 0.5msec Max rate of DI2-4 is 100Hz, min. off-time 5msec.
Pulse Output	WI-I/O 9-1_WI-I/O-EX-1-S-1 One WI-I/O 9-2_WI-I/O-EX-1-S-2 None WI-I/O 9-3_WI-I/O-EX-1-S-3 Four WI-I/O 9-4_WI-I/O-EX-1-S-4 Four	FET output, 30 VDC 500mA max Max rate for WI-I/O-EX-11 is100 Hz. Max rate for WI-I/O-EX-1-S-13 is 1000 Hz. Pulse signal recreated, pulse rate avail. on analog output, (scaling configurable). Divide-by-10 available for 1000Hz inputs.
Analog Inputs	“floating” differential input, common mode voltage -0.5V to 27V WI-I/O 9-1_WI-I/O-EX-1-S-1 Two 4-20 mA WI-I/O 9-2_WI-I/O-EX-1-S-2 Six 0-20mA	24 VDC for powering external loops provided, 150 mA max. Digital filter time constant 1 second (config.) Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%

Analog Input Setpoints	WI-I/O 9-1_WI-I/O-EX-1-S-1 AI 1 only WI-I/O 9-2_WI-I/O-EX-1-S-2 AI 1-4	Configurable high & low set-points, allowing set/reset of remote digital outputs
Analog Outputs	current sink to common WI-I/O 9-1_WI-I/O-EX-1-S-1 Two 4-20mA WI-I/O 9-3_WI-I/O-EX-1-S-3 Eight 0-20mA	max loop voltage 27V, Resolution 15 bit, Accuracy 0.1% Resolution 12 bit, Accuracy 0.1%
System Parameters		
Network Configurations	Communications via radio or RS485 or network of both	Up to 95 radio units with up to 32 serial units off each radio unit
User Configuration	Any input to any output in system	RS232 PC or laptop
Diagnostics		
On board diagnostics	Automatic check on start-up Via RS232 terminal or laptop	Input status Output test Incoming radio signal level Simple radio path testing

Chapter Six TROUBLESHOOTING

6.1 Diagnostics Chart

INDICATOR	CONDITION	MEANING
OK LED OFF	Continuously	• Battery Voltage low • CPU failure • +24V supply failure/overload
OK LED ON	Continuously	• Normal Operation
PWR LED ON	Continuously	• Supply available from SUP1/SUP2 • Supply available from solar panel
TX LED ON	Flashes briefly	• Radio transmitting
RX LED ON	Flashes briefly	• Radio Receiving • Serial port communicating
RX LED ON	Flashes continuously	• Module in Configuration Mode
RX LED ON	Continuously	• Test Button press in Configuration Mode
No transmission on change of state		• Unit not configured correctly - re-configure and check operation

The green OK LED on the front panel indicates correct operation of the unit. This LED extinguishes on failure as described above. When the OK LED extinguishes shutdown state is indicated. In this state, all digital outputs turn OFF and the +24V supply turns off.

On processor failure, or on failure during start-up diagnostics, the unit shuts down, and remains in shutdown until the fault is rectified. The unit also shuts down if the battery voltage falls below 10.8 volts. This is a protection feature designed to protect the battery from deep discharge in case of extended period without supply voltage.

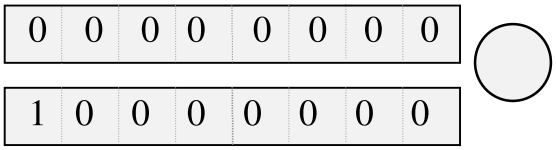
Note: During diagnostic testing, it is likely that the module will reset and restart. This will affect the output signals.

6.2 Self Test Functions

6.2.1 Input to Output Reflection (WI-I/O 9-1_WI-I/O-EX-1-S-1 only)

The unit will require re-configuration after SELF TEST. Ensure you know the required operational configuration including system and unit addresses so that the network can be restored after testing.

Remove the cover in the front panel, and set the DIP switches as shown below. Hold down the red button for five seconds, or until the Rx LED glows yellow, release the Red button (the Rx LED now flashes), then press and release the Red button (the flashing Rx LED extinguishes).



0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0

Input signals may now be connected to the input terminals of the module. If the module is operating correctly, then the input signals will be reflected to the corresponding output on the same module. For example, if DI 1 is connected to common - i.e. the first digital input is turned "ON" - then DO 1 will activate, if the module is functional. Similarly, if a 12mA signal is connected to AI 2, then a 12mA signal should be able to be measured from AO 2, if the module is functioning correctly.

If a module does not pass its self test function, then it should be returned to an authorised service agent for attention

6.2.2 Radio Testing using Tone Reversals (WI-I/O 9-x modules only)

This function allows the unit to be configured to continuously transmit a sequence of alternate zeros and ones on the radio. This function provides the facility to check VSWR of antennas during installation, as well as checking the fade margin of the path between two units (see below - received signal strength indication).

The tone reversals function is initiated by setting all of the DIL switches to ON, and holding down the red button for approximately 5 seconds(until the RX LED lights continuously). On releasing the button, the RX LED will flash continuously, and the TX LED will light, indicating that the radio transmitter is on.

To finish the test, push the red button again or re-power the module.

6.2.3 Diagnostics menu

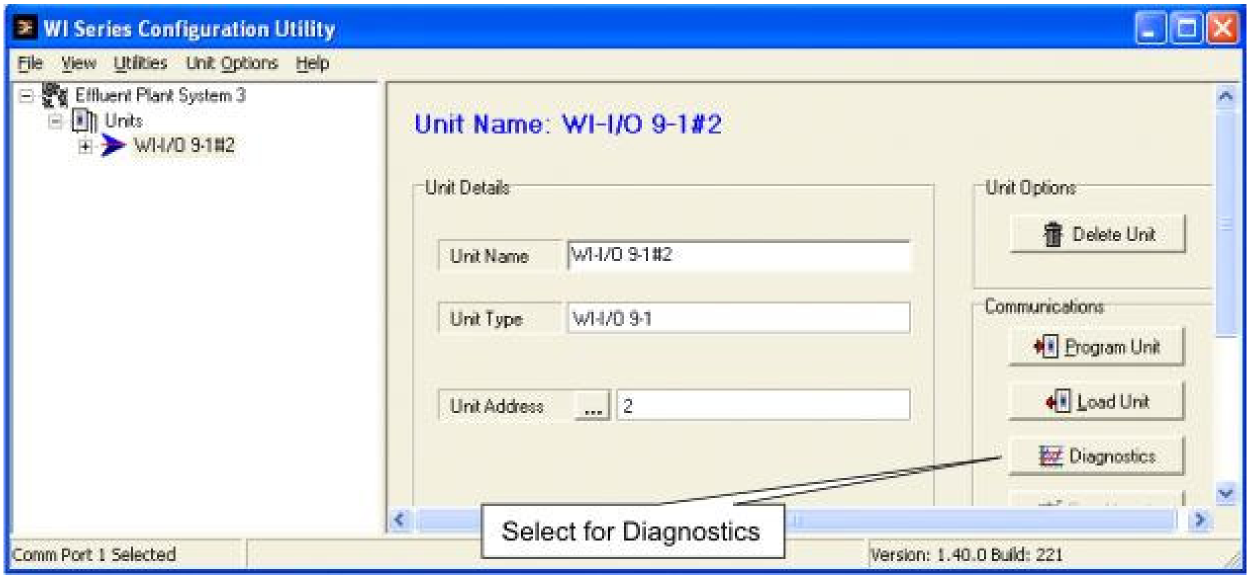
To aid in the checking and set-up of the module, a user friendly menu provides access to diagnostic

functions. Use of the diagnostics menu does not affect module configuration.

The diagnostics functions can be accessed from the E Series Config software - the same software package used to configure the modules. Connect the laptop or PC to the module using a configuration RS232 cable.

Either open the archived project containing the module, or start a New Project and select “Load a New Unit” - select the correct type of module. After the unit has loaded, select the Diagnostics box.

A “Terminal” screen will appear. Select the “Terminal” box.



Unit Name: WI-I/O 9-1#2

Unit Name: WI-I/O 9-1#2

Unit Type: WI-I/O 9-1

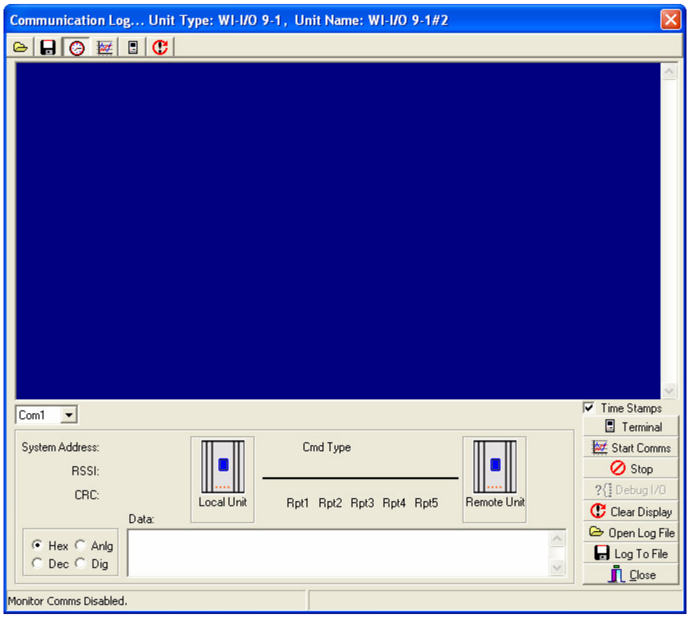
Unit Address: 2

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Connect the module (ensure the RS485 port is disconnected first) to the PC using the same serial cable used for configuration.

The diagnostics menu is accessed by removing the blue “plug” from the front of the module and setting all switches to ‘0’ or “Open”, and holding down the red button for approximately 5 seconds, until the RX LED lights continuously. One of the following menus will be displayed on the terminal :



Communication Log... Unit Type: WI-I/O 9-1, Unit Name: WI-I/O 9-1#2

☑ Time Stamps

● Hex ○ Anlg

○ Dec ○ Dig

Monitor Comms Disabled.

WI-I/O 9-1

a) Ins

b) Tones

c) Comms

d) DO1

e) DO2

```
f)      DO3
g)      DO4
h)      AO1
i)      AO2
j)      Switch
k)      Signal
>
```

```
WI-I/O 9-2
a)      Digital Ins
b)      Analog Ins
c)      Tones
d)      Comms
e)      DO1
f)      Switch
g)      Signal
>
```

```
WI-I/O 9-3
a)      Ins
b)      Tones
c)      Comms
d)      DO1
e)      DO2
f)      DO3
g)      DO4
h)      DO5
i)      DO6
j)      DO7
k)      DO8
l)      AO1
m)      AO2
n)      AO3
o)      AO4
p)      AO5
q)      AO6
r)      AO7
s)      AO8
t)      Switch
u)      Signal
>
```

```
WI-I/O 9-4
a)      D Ins
b)      A Ins
c)      Tones
d)      Comms
e)      DO1
f)      DO2
g)      DO3
h)      DO4
i)      DIO1
j)      DIO2
k)      DIO3
l)      DIO4
m)      DIO5
n)      DIO6
o)      DIO7
p)      DIO8
q)      DIO9
r)      DIO10
s)      DIO11
t)      DIO12
u)      Signal
>
```

Choose an item from the menu by entering the letter before that item. For example, to select the "Signal" function from the WI-I/O-EX-1-S-11 Menu, enter :- k

During the diagnostics session, if you press Enter or Space while the menu is displayed, the module will restart in normal operating mode. To re-enter diagnostics mode, hold the red button for 5 seconds etc.

After the diagnostics session is over, force the module to restart, then select “Stop Terminal”, then “Close”.

Inputs

This option provides a dynamic display of the status of all of the inputs in the WI-I/O 9-x, both internal and external.

WI-I/O 9-1/WI-I/O-EX-1-S-1 Modules

```
1234MLS     P CNT  AI1    AI2    PRATE  VBATT
0101001     00F6   C000   4000   8000    9C00
```

The first 7 values (1234MLS) each represent a single digital input. A ‘1’ indicates that that input is ON, and a ‘0’ indicates that the corresponding input is OFF. "1234" represents the four physical digital

inputs, DI1 to DI4. "M" is the mains fail status (‘1’ for mains fail, ‘0’ for mains OK). "L" is the battery low volts status (‘1’ for low volts ‘0’ for OK). "S" is the set-point status.

P CNT, AI1, AI2, P RATE, and VBATT each represent 16 bit values, displayed as four hexadecimal digits.

P CNT is the current value of the pulsed input counter. This value should increment each time ‘DI 1’ turns from OFF to ON. P RATE displays the current pulse rate at DI1. This value is scaled according to the MAXRATE value configured (0 Hertz is displayed as 4000, and the maximum rate is displayed as C000).

AI1 and AI2 represent the value for the two analog inputs. Full scale input (20 mA) is displayed as C000, 4mA is displayed as 4000, and 0ma is displayed as 2000. Analog inputs are filtered digitally with a time constant of 1 second, so a sudden change in the analog input current will result in a slower change in displayed analog value, finally settling at the new value.

A guide to translate the displayed value to the analog input current is provided below.

	Add together the figures corresponding to each digit in each position to determine the current (mA) e.g. displayed value 3456 = 2.000+0.500+0.039+0.003 = 2.542mA			
Digit	**Leftmost position**	**Next position**	**Next position**	**Rightmost position**
0	-	0.000	0.000	0.000
1	-	0.125	0.008	0.000
2	0.000	0.250	0.016	0.001
3	2.000	0.375	0.023	0.001
4	4.000	0.500	0.031	0.002
5	6.000	0.625	0.039	0.002
6	8.000	0.750	0.047	0.003
7	10.000	0.875	0.055	0.003
8	12.000	1.000	0.063	0.004
9	14.000	1.125	0.070	0.004
A	16.000	1.250	0.078	0.005
B	18.000	1.375	0.086	0.005
C	20.000	1.500	0.094	0.006
D	22.000	1.625	0.102	0.006
E	-	1.750	0.109	0.007
F	-	1.875	0.117	0.007

VBATT is the current internally derived battery voltage. 4000 corresponds to 8 Volts, C000 represents 16 volts. A quicker method is use the calculation :

Battery voltage (volts) = ½ I + 6, where I is the mA value determined from the above table using VBATT. For example, a value of VBATT of A000 gives an I value of 16mA from the above table. The battery voltage corresponding to this is 14V (or ½ x 16 + 6).

Digital Inputs

```
DIN     SETPNT          PULSED
1234MSL123456       PIN1      PIN2      PIN3      PIN4
0000100111111       0000      0000      0000      0000
```

Analog Inputs

```
VBAT   PR1    PR2   PR3    PR4    AI1    AI2    AI3    AI4    AI5   AI6
8138   4000   4000  4000   4000   0D3A   0CD2   0CC7   0CC7   0CD4  0CC7
```

WI-I/O 9-3_WI-I/O-EX-1-S-3 Modules

```
ML    VBAT   VSLR
00   9FA2   0000
```

WI-I/O 9-4_WI-I/O-EX-1-S-4 Modules

Digital Inputs

```
DIN  DIO                  PULSED
1234 123456789ABC MLS   PIN1 PIN2 PIN3 PIN4
1001 010101010 001   101    0001 0001 0001  0001
```

Analog Inputs

```
VBAT PR1    PR2    PR3    PR4
8DBE  0000   0000   0000   0000
```

Tones (WI-I/O 9-x modules only)

This provides the same function as described above in 6.2.2. Tone Reversals. This function may be used to check VSWR of antennas, and may be used in conjunction with the Signal option (described below) to check the path between two units.

Comms

This function allows monitoring of all messages transmitted and received over the radio. A better comms display function is available using the "Comms Logging" feature in the configuration software - refer to section 6.2.4.

Transmitted messages are displayed starting in the leftmost column of the display. Received messages are displayed with the received signal strength preceding the message. The first four hexadecimal digits are the system address attached to the message, and must match for units to communicate successfully.

The received signal strength is in negative dBm - the lower the measurement, the stronger the radio signal. A measurement larger than 95 indicates a weak radio signal.

Example:

```
>c
Comms
TX: 01FA8106008005C6727D44    Command message transmitted by this unit.
84   01FA8186C6E0E3           Acknowledge received from remote.
81  01FA860100800100009286    Message received from remote unit.
TX:  01FA868100FCE4           Acknowledge message from this unit to remote.
<INVALID> 01FA860000800100009286  Corrupted message received.
```

DO1 to DO8, DIO1 to DIO12

These options allow the user to set and clear digital outputs. To set an output, select the corresponding menu item, at the prompt, type the value FFFF to turn the output ON, or 0000 to turn the output OFF. For example, to set DO1 ON,

```
>e
DO1
>FFFF
```

AO1 to AO8

These options allow the user to set analog outputs to any value. To set the output, select the corresponding menu item. At the prompt type the value required for the analog output as a four digit hexadecimal value. Refer to the table above for analog current/expected value relationship. To set AO2 on WI-I/O-EX-1-13 to 19 mA :

```
>m
AO2
>B800
```

Switch

This option allows testing of the DIL (Dual In Line) switches. The diagram below indicates the layout of the switches of which there are two sets of eight, with an "Enter" button located to the right of the pair. the display indicates the current switch settings with the digit '1' corresponding to 'On' and the digit 'O' corresponding to 'Off'. Changing the switch settings in this mode will change the display. Test each switch and check to ensure the display changes accordingly.

Switches

1	1	1	0	0	0	1	0

0	1	0	1	0	1	0	1

Displayed

`1110001001010101`

Signal

This option provides for testing the radio path between two units for a suitable reliability margin. Although a pair of units may communicate successfully, radio communication may be affected by a range of influences, including atmospheric conditions, changing landscape, degradation of antennas or co-axial cable, low battery voltage etc. “Fade margin” is an indication of how far a radio path can deteriorate before communication becomes unreliable.

When using the Signal feature, the current received radio signal level is displayed in negative dBm (dBm is relative to 1mW of RF power). A display of 100 means –100dBm. This means that a stronger signal will have a lower measured value.

To check the radio path between two units, select the signal option at the local unit. The display will initially show the background noise of the radio band. Determine the approximate average of the noise level. The remote unit may then be set up for tone reversals (refer 1 above). Determine the approximate average of the received signal strength. It is normal for the measured values to continually change - the radios are continually changing frequency. Calculate the best average for both the noise and signal. For a reliable radio path, the signal strength must be at least 10dB lower than the noise level, or 98, whichever is less.

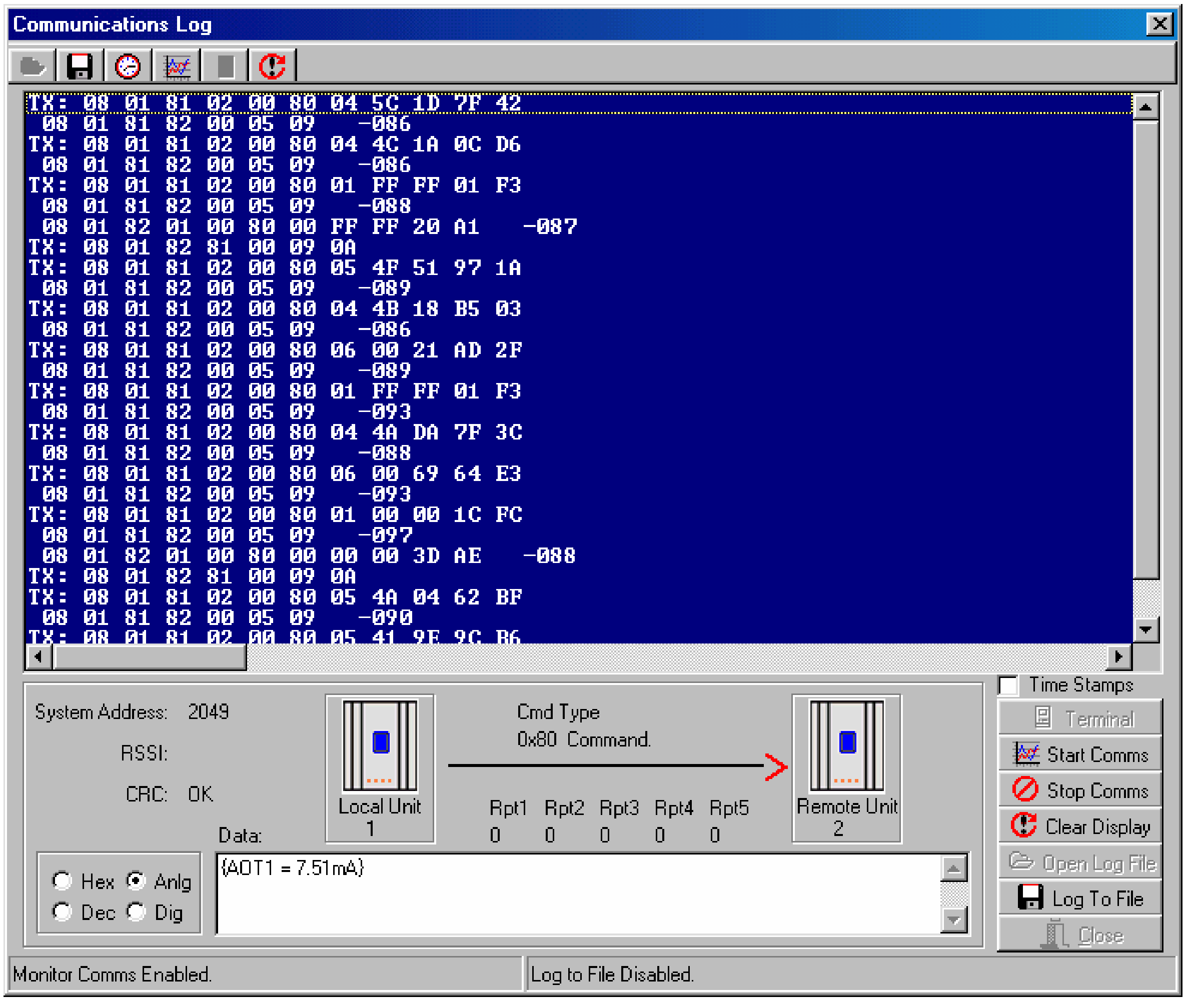
For example, if the noise level is 120, then the radio signal must be 98 or lower for a reliable path. If the noise level is 100, then the radio signal must be 90 or lower.

A simpler method when remote units are not easily accessible is to cause a transmission from the local unit to the remote unit (by setting a digital input which maps to the remote unit, for example). The meter will latch the received signal from the remote unit for half a second, allowing the received level to be read.

If any obstructions in the radio path are likely to change, then this should be allowed for. For example, if the radio test is done during winter and the radio path is through trees without leaves, then another 10dB of margin should be allowed for to cover summer conditions when the trees have leaves.

When using directional antennas (i.e. YAGI antennas) this feature may be used to peak the received signal level. Set-up the remote unit to transmit tone reversals as described above, and observe the signal indication while adjusting the orientation of the antenna. A peak in signal level indicates optimum orientation of the antenna.

6.2.4 Comms Logging



```
TX: 08 01 81 02 00 80 04 5C 1D 7F 42
 08 01 81 82 00 05 09    -086
TX: 08 01 81 02 00 80 04 4C 1A 0C D6
 08 01 81 82 00 05 09    -086
TX: 08 01 81 02 00 80 01 FF FF 01 F3
 08 01 81 82 00 05 09    -088
 08 01 82 01 00 80 00 FF FF 20 A1    -087
TX: 08 01 82 81 00 09 0A
TX: 08 01 81 02 00 80 05 4F 51 97 1A
 08 01 81 82 00 05 09    -089
TX: 08 01 81 02 00 80 04 4B 18 B5 03
 08 01 81 82 00 05 09    -086
TX: 08 01 81 02 00 80 06 00 21 AD 2F
 08 01 81 82 00 05 09    -089
TX: 08 01 81 02 00 80 01 FF FF 01 F3
 08 01 81 82 00 05 09    -093
TX: 08 01 81 02 00 80 04 4A DA 7F 3C
 08 01 81 82 00 05 09    -088
TX: 08 01 81 02 00 80 06 00 69 64 E3
 08 01 81 82 00 05 09    -093
TX: 08 01 81 02 00 80 01 00 00 1C FC
 08 01 81 82 00 05 09    -097
 08 01 82 01 00 80 00 00 00 3D AE    -088
TX: 08 01 82 81 00 09 0A
TX: 08 01 81 02 00 80 05 4A 04 62 BF
 08 01 81 82 00 05 09    -090
TX: 08 01 81 02 00 80 05 41 9E 9C B6
```

System Address: 2049
RSSI:
CRC: OK

Local Unit
1

Cmd Type
0x80 Command

Rpt1	Rpt2	Rpt3	Rpt4	Rpt5
0	0	0	0	0

Remote Unit
2

○ Hex ● Anlg
○ Dec ○ Dig

Data:
(AOT1 = 7.51mA)

Monitor Comms Enabled. | Log to File Disabled.

These options allow logging and display of radio communications. To start "Comms logging":

- select option the "Comms" option from the diagnostics menu (see section 6.2.3),
- select 'Stop Terminal' and then
- select 'Start Comms'.

The display will show radio messages transmitted and received. Messages starting with TX are transmitted messages, and received messages start with a small line indent. At the end of each received message is the RSSI (radio signal strength) in dBm.

If you select any message line with the mouse, information about the message will be displayed at the bottom of the screen - the system address, RSSI and CRC (error-check) status. The "text box" at the bottom middle of the screen decodes the message - that is, it decodes the message to display I/O channel and value.

You can display the register values in Decimal by selecting "Dec" at the bottom of the screen. If you select "Dig", the values will be displayed as a 0 or 1 digital value (1 if the 16-bit value is greater than 50% - that is, the most significant bit is 1). If you select "Anlg", the value will be displayed as a 4-20mA range.

To stop "comms logging", select the "Stop Comms" box. You can then shut down the diagnostics

screen, or select “Terminal” to go back to the diagnostics menu.

Add Time Stamps

Time stamps can be added by selecting the “Time Stamps” box. This will allow the current time and date to be displayed with each message. The “Comms log” can be saved to a file for future reference by selecting “Log to File”.

6.3 Radio Path Testing

To carry out a radio path test, you will need two WI-I/O 9-x modules. One module will be “fixed” and the other “mobile”. Both units will need power supplies and antennas. The power supply for the mobile unit is normally a 12V battery, but make sure that the battery is fully charged - batteries with low voltage will lead to low radio power which will affect the test result.

The object of the test is to determine whether radio paths are reliable, marginal or unreliable. A reliable path will have a margin of at least 10dB above the background noise level in good weather - this margin is enough to ensure that the radio path remains reliable in poor conditions. A marginal path will work reliably in good conditions, however will fail during poor conditions. If the test is carried out during rainy or foggy weather, then a margin of only 5dB is required.

Procedure:

- ☐ Configure the modules to the same system address, and on each module, configure DI1 to DO1 on the other module. At the fixed module, wire DO1 to DI1 such that DI1 will turn ON when DO1 turns ON. Connect a switch to DI1 on the mobile unit.
- ☐ When the modules are close to each other, test the system - close the switch, forcing the mobile unit to transmit. The mobile unit will transmit to the fixed unit, and the fixed unit will transmit back to the mobile unit, activating DO1. Turning off the switch will result in two radio transmissions, turning off DO1. Each time the switch is changed, there should be two radio messages (two sets of TX/RX flashes) at the mobile unit. Note that when the modules are within a couple of metres, they may not work well with antennas connected - in this case, test without antennas.
- ☐ Set up the fixed module in one of the test positions - this is normally at a control centre or repeater site. Fix the antenna in a temporary fashion. You will need to make an initial assessment on how high the antenna should be mounted.
- ☐ Take the mobile module to the other end of the radio path. The antenna at this end can be either held by the tester, or fixed in a temporary fashion. Note that a person’s body will affect the radiation pattern of an antenna, so if the antenna is hand-held and the test is not successful, try again with the antenna fixed to a 1 metre length of plastic pipe or timber. The tester holds the length of pipe or timber with the antenna above head height.
- ☐ Test the radio path by operating the switch. If the radio path is short, and there is a high level of confidence that the radio path will be reliable, the result can be checked by simply looking at the

TX/RX leds on the mobile unit. If each TX flash is followed immediately by a RX flash (that is, the TX flash does not flash twice or more times before the RX flashes), then the radio path is likely to be reliable. Operate the switch several times - do not rely on one test. If the test is being done outside, the leds will need to be shaded to view the flashes.

- ☐ If the radio path is uncertain, then the result should be measured by connecting a laptop computer, following the procedure outlined in this manual for measuring the radio signal strength. Before the switch is operated, the background noise level should be measured and recorded. This measurement is likely to "jump around" or oscillate, to determine an average measurement. Now operate the switch several times - take the average measurement of the signal transmitted from the fixed unit.
- ☐ The radio path is reliable if the transmitted signal is 10dB above the noise level, or better than –98dBm. For example, if the noise level is –115dBm, then the minimum level for reliability is –98dBm. If the noise level is –100dBm, then you need –90dBm for a reliable path. If the laptop displays a scale measurement instead of a numerical measurement, then the transmitted signal should be at least 3 divisions, and at least 2 divisions above the noise level.
- ☐ If the weather is poor during the test, then the transmitted signal needs to be 5dB above noise, or 1 division. It is best not to do radio tests during poor weather.
- ☐ Record these measurements for comparison later during commissioning or if the system has problems later.

If the radio path test is not successful:

1. Increasing the height of the antenna at either module, or at both modules can significantly improve the result. Sometimes moving the antenna to the side helps, if there is an obvious obstruction in the radio path.
2. Change one or both antennas to a higher gain if regulations allow.
3. Use a shorter coaxial cable between the antenna and the WI-I/O 9-x.(this may involve moving WI-I/O 9-x nearer to antenna mounting), or use a different coaxial cable with lower loss.
4. If a reliable radio path is not possible because of distance or path obstructions, you will need to consider using a repeater module. The ideal repeater is another module in the system, in a good location to act as a repeater. If this is not the case, you need to consider installing a module to act specifically as a repeater.

Chapter Seven WARRANTY & SERVICE

We are pleased that you have purchased this product.

W INTERCONNECTIONS products are warranted to be free from manufacturing defects for the "serviceable lifetime" of the product. The "serviceable lifetime" is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from W INTERCONNECTIONS, W INTERCONNECTIONS will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by the operation of the equipment outside the particular product's specification, or
- use of the module not in accordance with this User Manual, or
- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

W INTERCONNECTIONS' liability under this warranty is limited to the replacement or repair of the product. This warranty is in lieu of and exclusive of all other warranties. This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits and W INTERCONNECTIONS is not liable for any consequential damages or loss of operations or profits resulting from the use of these products. W INTERCONNECTIONS is not liable for damages, losses, costs, injury or harm incurred as a consequence of any representations, warranties or conditions made by W INTERCONNECTIONS or its representatives or by any other party, except as expressed solely in this document..

Full product specifications and maintenance instructions are available from your Service Agent, your source of purchase, or from the master distributor in your country upon request and should be noted if you are in any doubt about the operating environment for your equipment purchase

In the unlikely event of your purchase being faulty, your warranty extends to free repair or replacement of the faulty unit, after its receipt at the master distributor in your country. Our warranty does not include transport or insurance charges relating to a warranty claim.

Should you wish to make a warranty claim, or obtain service, please forward the module to the nearest authorised Service Agent along with proof of purchase. For details of authorised Service Agents, contact your sales distributor.

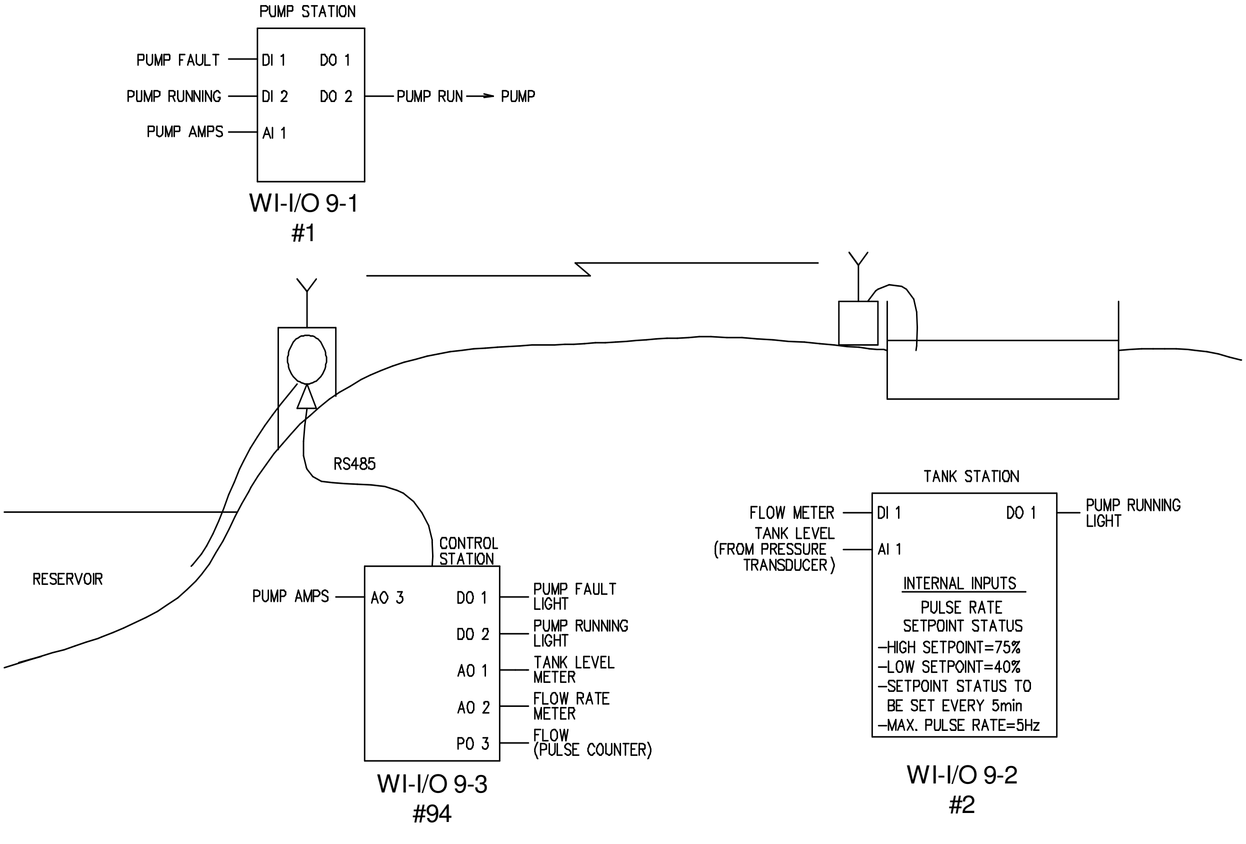
Appendix A SYSTEM EXAMPLE

The following example of a system is a comprehensive guide to using some of the features of the range and design of system.

The example application is a pump station which supplies water from a reservoir to a tank station. Signals are transferred between the pump station and tank station by radio - the distance between the two stations is 10 km (6 mile), and the radio path is heavily obstructed by buildings and trees. A control station is located near the pump station, and there is an existing signal cable between the control station and the pump station.

A WI-I/O 9-1 module is installed at the pump station (with address 1) and a WI-I/O 9-2 module is installed at the tank station (with address 2). Because the signal cable to the control station does not have enough cores for all of the signals required, the signal cable is used as a RS485 cable and a WI-I/O-EX-1-S-x-3 module is installed at the control station (with address 96). As this module has an address greater than 95, the WI-I/O 9-1 at the pump station will communicate to it via its serial port.

The following diagram represents the system:-



The following design points should be noted :-

- A test of the radio path between the pump station and the tank station indicated that the radio path

would be reliable provided antennas were installed at 6 m above the ground. At each site, the coaxial cable would be approx 30 feet in length, so it was decided to use 6 element Yagi antennas with RG58 coaxial cable - the Yagi antennas would compensate for the loss in the cable.

- At the tank station, there was an existing light pole with a mains power supply - the light pole was 10m high. Permission was obtained to mount the antenna from the pole and to use the power supply for the radio telemetry module.

  As there was no existing electrical panel at this station, a small steel enclosure was installed on the light pole. A 2 Amp-Hour sealed battery was installed to provide power during any mains failure. The flow and level transducer were powered from the 24VDC loop supply provided by the module.

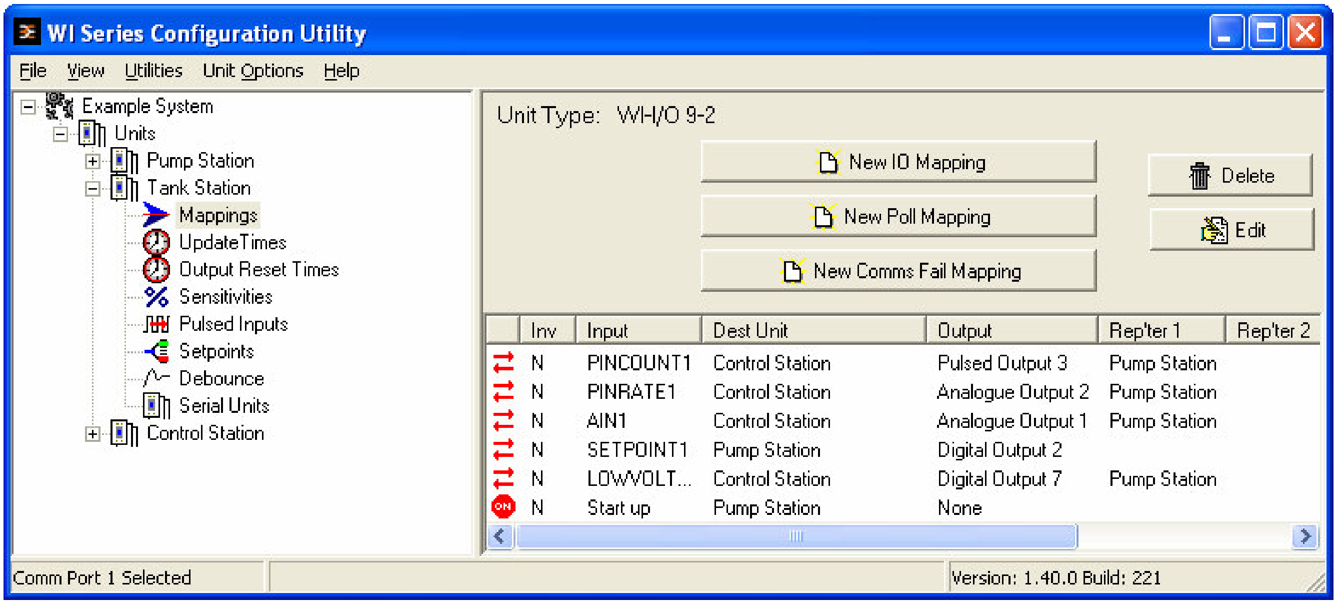
- At the pump station, the antenna was mounted on a 10' J-bracket installed on the roof of the pump station building. The final height of the antenna was approx 20 feet. Care was taken to align the Yagi antennas so they pointed at each other. The Yagi antennas were installed with horizontal polarity - that is, with the elements horizontal. These antennas will not "hear" other radio users on the same radio channel which generally use vertical polarity.

  There was an existing electrical enclosure at the pump station, and the WI-I/O 9-x module was installed inside this enclosure. The module was powered from a 24VDC supply with a 2 Amp Hour sealed battery as backup.

- At the control station, the WI-I/O-EX-1-S-x module was installed inside the existing control panel enclosure. The module was powered from an existing 24VDC power supply.

Tank Station Configuration

The WI-I/O 9-2 module has the following configuration :-



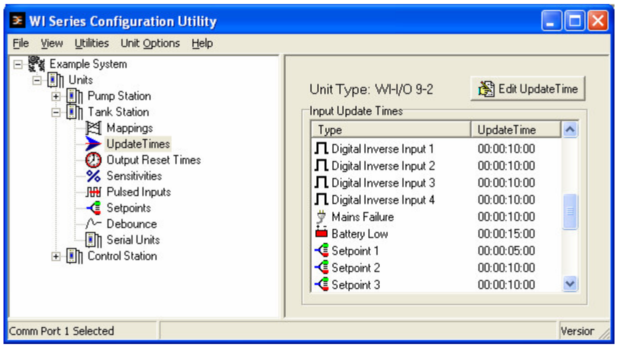
Unit Type: WI-I/O 9-2

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2
⇄	N	PINCOUNT1	Control Station	Pulsed Output 3	Pump Station	
⇄	N	PINRATE1	Control Station	Analogue Output 2	Pump Station	
⇄	N	AIN1	Control Station	Analogue Output 1	Pump Station	
⇄	N	SETPOINT1	Pump Station	Digital Output 2		
⇄	N	LOWVOLT...	Control Station	Digital Output 7	Pump Station	
ON	N	Start up	Pump Station	None		

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Note the following points in the configuration:

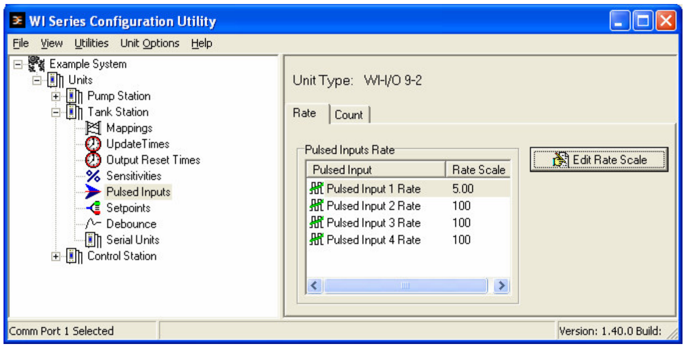


Unit Type: WI-I/O 9-2

Input Update Times

Type	UpdateTime
Digital Inverse Input 1	00:00:10:00
Digital Inverse Input 2	00:00:10:00
Digital Inverse Input 3	00:00:10:00
Digital Inverse Input 4	00:00:10:00
Mains Failure	00:00:10:00
Battery Low	00:00:15:00
Setpoint 1	00:00:05:00
Setpoint 2	00:00:10:00
Setpoint 3	00:00:10:00

Comm Port 1 Selected



Unit Type: WI-I/O 9-2

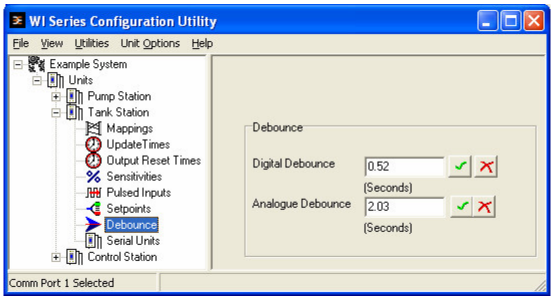
Pulsed Inputs Rate

Pulsed Input	Rate Scale
Pulsed Input 1 Rate	5.00
Pulsed Input 2 Rate	100
Pulsed Input 3 Rate	100
Pulsed Input 4 Rate	100

Comm Port 1 Selected

Version: 1.40.0 Build:

- #1 is a repeater for communications between #2 and #94
- The pulse rate scaling for PIN1 has been set to 5 Hz to match the maximum flow rate of the flow meter. Note that PIN1 has not been configured for "divide by 10" (for 1000 Hz pulse signals).
- AIN1 (the level transducer) is mapped to AO1 at the WI-I/O 9-3. The analog debounce has been set to 2 sec. This is because of concern of wave action on the surface of the tank causing un-necessary change transmissions. This debounce time will also operate on the Pulse Rate value, but as the flow rate changes slowly, this will not affect the performance of this signal.



Debounce

Digital Debounce 0.52 (Seconds)

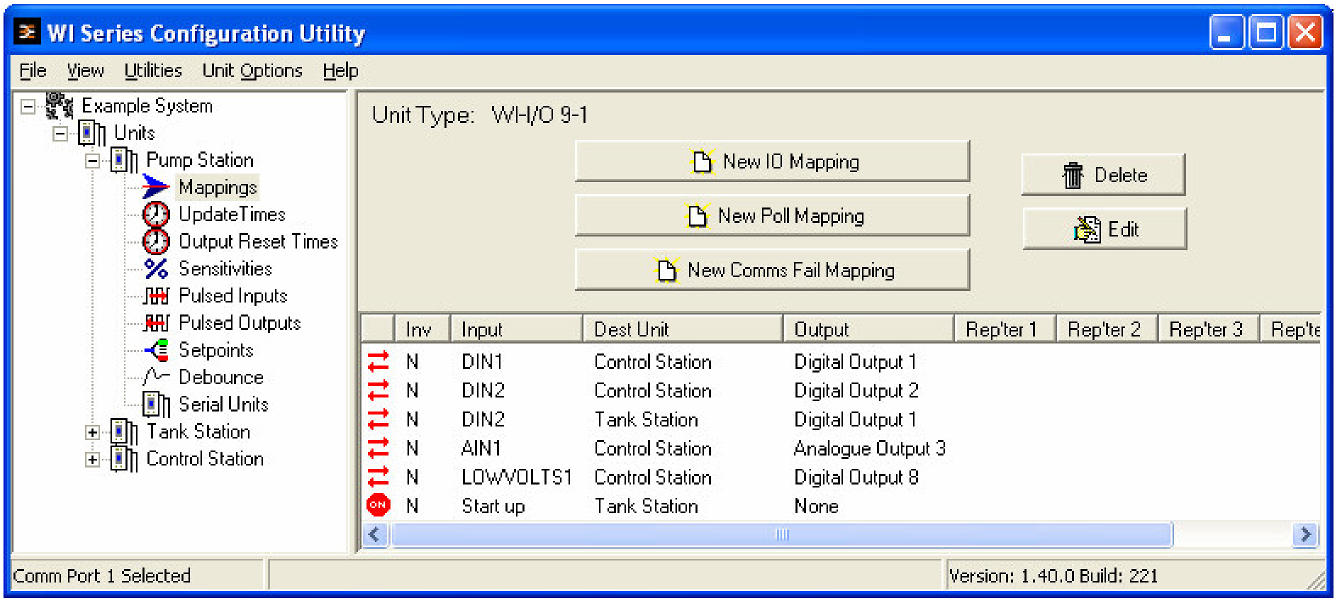
Analogue Debounce 2.03 (Seconds)

Comm Port 1 Selected

- SETPOINT1 (the set-point status for AI1) is mapped to DO2 of #1 (pump station). The set-point values for this setpoint have been set to 40% and 75%. When the tank level drops to 40%, DO2 at the pump station will activate to start the pump. When the level rises above 75%, DO2 will reset to stop the pump.
- The update time for SETPOINT1 has been changed to 5 minute, as required.
- An additional mapping has been entered - LOW VOLT has been mapped to DO7 at #94 via #1 (DO7 at the control station). This mapping is for future use - it will provide a low battery voltage alarm for the tank station. The update time for this mapping has been set to the maximum time of 15 minutes to reduce loading of the radio channel.
- A Start-up poll has been configured for #1, as DO1 at the tank station is controlled from the pump station. Note that no comms fail reset time has been configured for DO1. As this output drives an indication only, the indication will show the last correct status even during communication failures.

Pump Station Configuration

The WI-I/O 9-1 module has the following configuration :-



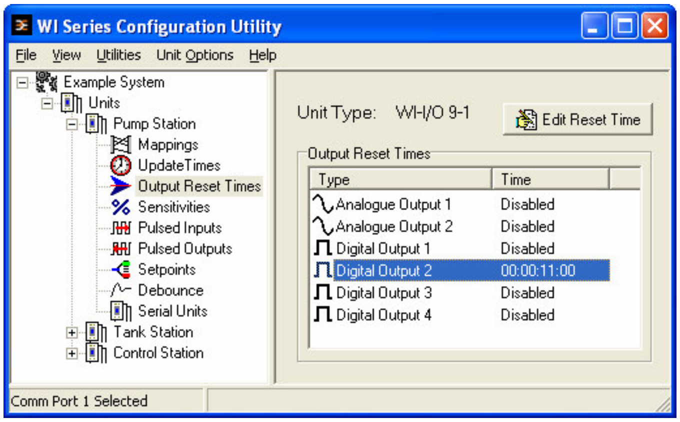
Unit Type: WI-I/O 9-1

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3	Rep'te
⇄	N	DIN1	Control Station	Digital Output 1				
⇄	N	DIN2	Control Station	Digital Output 2				
⇄	N	DIN2	Tank Station	Digital Output 1				
⇄	N	AIN1	Control Station	Analogue Output 3				
⇄	N	LOWVOLTS1	Control Station	Digital Output 8				
ON	N	Start up	Tank Station	None				

Comm Port 1 Selected

Version: 1.40.0 Build: 221

Note the following points in the configuration:



Unit Type: WI-I/O 9-1

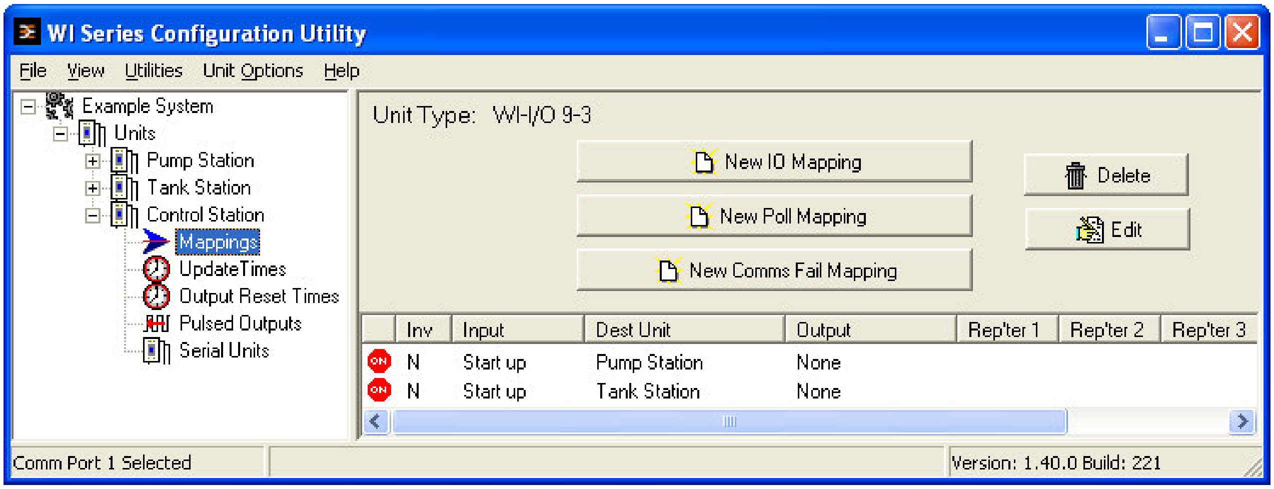
Output Reset Times

Type	Time
Analogue Output 1	Disabled
Analogue Output 2	Disabled
Digital Output 1	Disabled
Digital Output 2	00:00:11:00
Digital Output 3	Disabled
Digital Output 4	Disabled

- Note that no repeater address is necessary between #1 and #94.
- DIN2 (pump running signal) has two mappings - a mapping to DO1 at #2 (tank station) and DO2 at #94 (control station). When DIN2 changes, there will be two separate change messages transmitted - one by radio to #2 and one by serial link to #96.
- AIN1 (pump amps) is mapped to AO3 at #94 (control station).
- An additional mapping has been entered - LOW VOLT has been mapped to DO8 at the control station. This mapping is for future use - it will provide a low battery voltage alarm for the pump station.
- A Start-up poll has been configured for #2, as DO2 at the pump station is controlled from the tank station. Note that a comms fail reset time of 11 minutes has been configured for DO2. This means that if a message has not been received for DO2 within 11 minutes, DO2 will reset and switch off the pump. The 11 min time was chosen as it means that two successive update messages have to be missed before the pump is reset, and there is no problems if the pump runs for 11 minutes during a system failure (the tank will not overflow during this time).

Control Station Configuration

The WI-I/O-EX-1-S-3 module has the following configuration :-

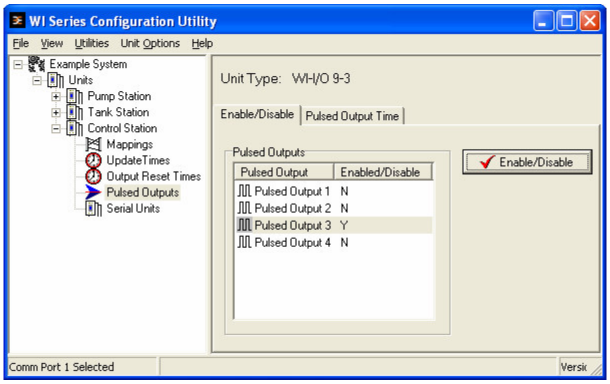


Unit Type: WI-I/O 9-3

	Inv	Input	Dest Unit	Output	Rep'ter 1	Rep'ter 2	Rep'ter 3
ON	N	Start up	Pump Station	None			
ON	N	Start up	Tank Station	None			

Note the following points in the configuration:

- The only mappings are Start-up polls. Note that there are two separate polls, one for each remote module.
- PO 3 has been configured as a PO. Its pulse output update time is the same as the PI update time at the remote module (both have been left at their default value of 1 minute).
- Reset times have been selected for the analog outputs (21 minutes) but not the digital outputs. In the event of a system failure, the digital outputs will stay at their last correct status, but the analog outputs will reset to 0 mA.

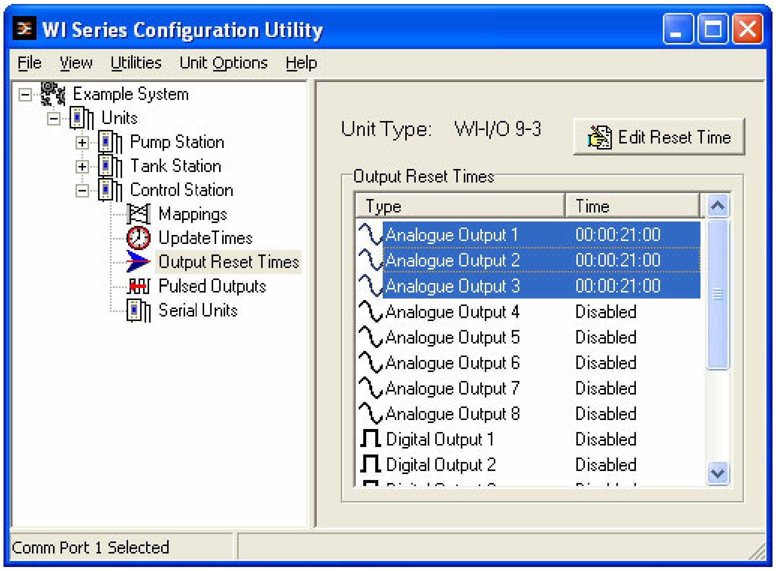


Unit Type: WI-I/O 9-3

Pulsed Output	Enabled/Disable
Pulsed Output 1	N
Pulsed Output 2	N
Pulsed Output 3	Y
Pulsed Output 4	N

System Failure Alarm

After the system had been running for some time, the operators wanted a "system failure" output at the control station, to warn the operators that there was a fault with the system.



Unit Type: WI-I/O 9-3

Type	Time
Analogue Output 1	00:00:21:00
Analogue Output 2	00:00:21:00
Analogue Output 3	00:00:21:00
Analogue Output 4	Disabled
Analogue Output 5	Disabled
Analogue Output 6	Disabled
Analogue Output 7	Disabled
Analogue Output 8	Disabled
Digital Output 1	Disabled
Digital Output 2	Disabled

The following configuration was added :

At #2 (tank station), Inverse DI4 → DO4 at #94 via 1 ; DI4 Update time = 1 minute

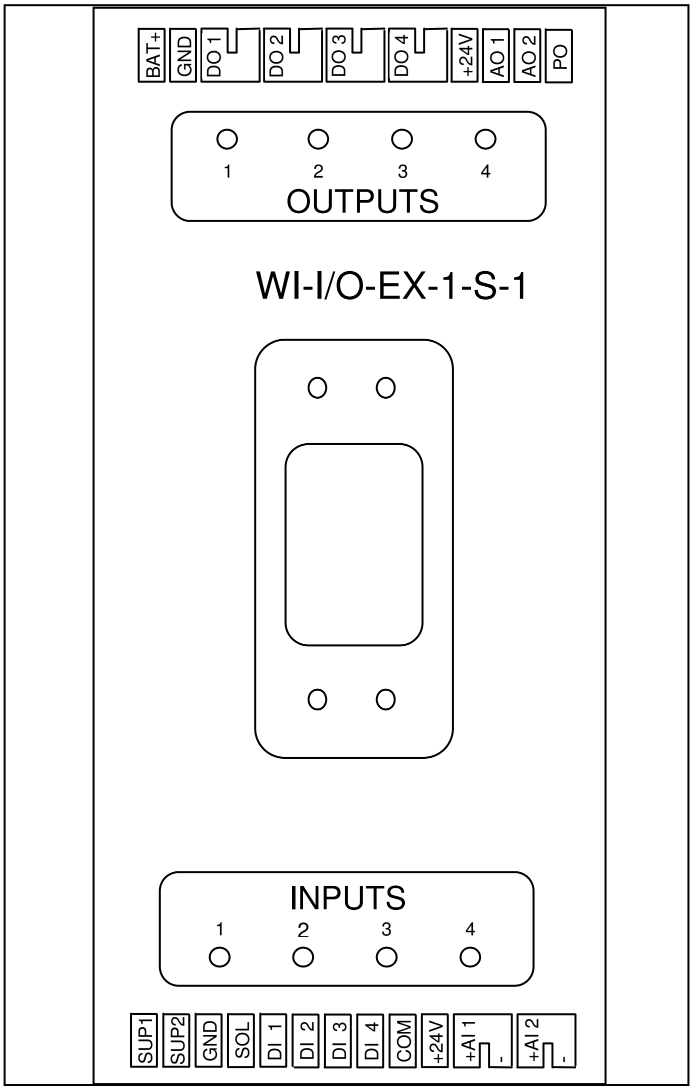
At #94 (control station), DO4 Comms fail reset time = 3.5 min

At the control station, DO4 was a "system OK" signal. It was normally active - if the signal reset, then this represented a system failure. At the tank station, there is no signal wired to DI4. By mapping Inv DI4 to DO4 at the control station, a message is transmitted every minute to this output to activate it. The message is transmitted via the radio link to #1, and then by the serial link to #94. If anything happened to either module #2 or module #1, or the radio link, or the serial link, then the update messages for DO4 will not be received at the control station module. After 3.5 Minutes, DO4 will reset indicating a problem.

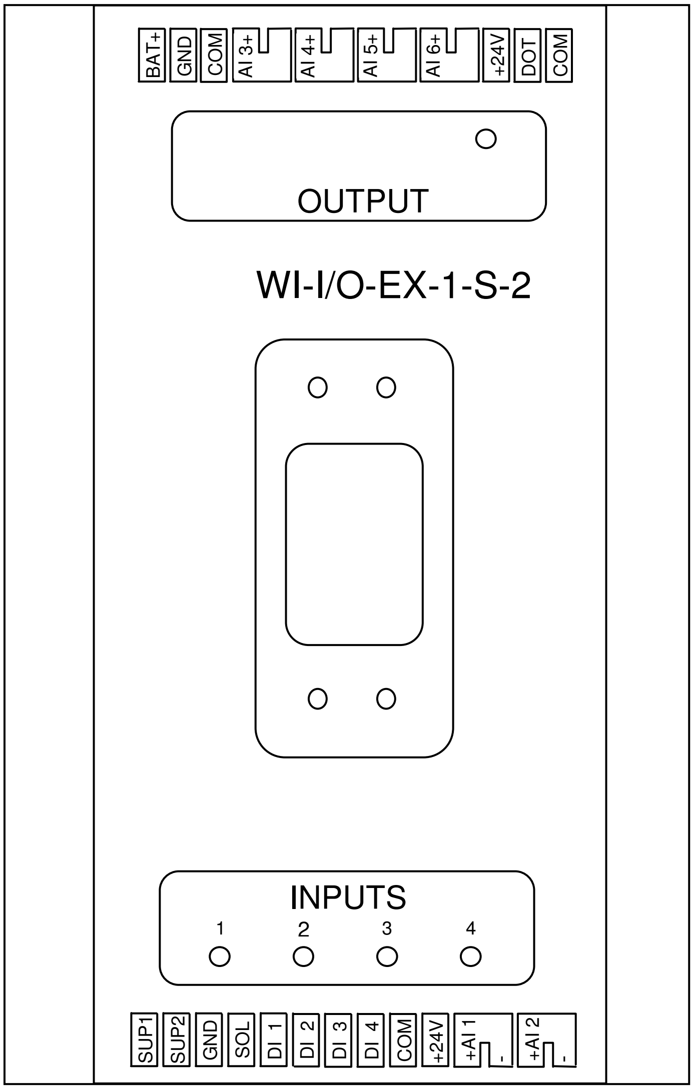
The time of 3.5 minutes was selected as this means that 3 successive update messages have to be missed before a system alarm occurs. Also note, that if module #94 fails, DO4 will reset and give an alarm signal.

Appendix B TERMINAL LAYOUTS

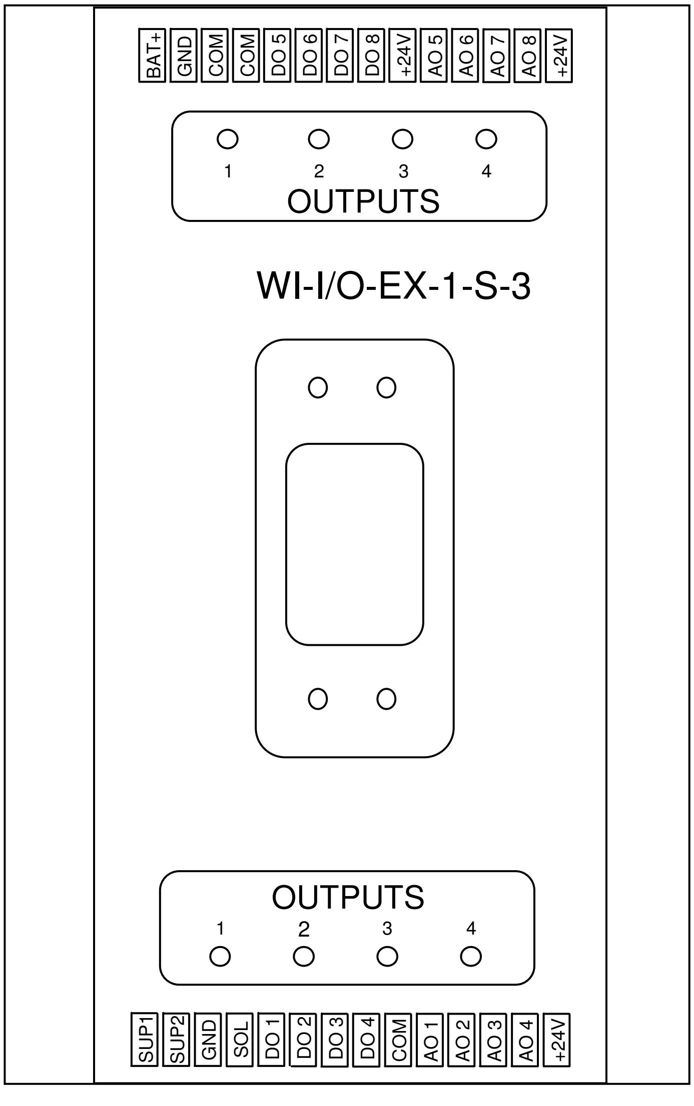
WIRING DRAWING -WI-I/O 9-1 WI-I/O-EX-1-S-1



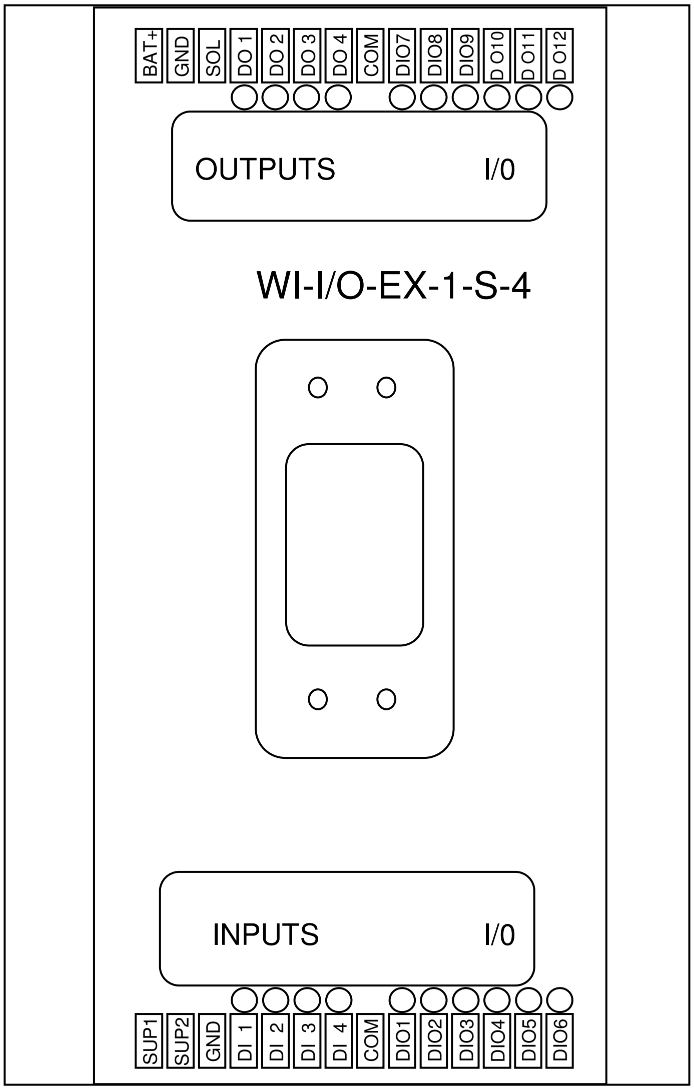
WIRING DRAWING - WI-I/O 9-2 WI-I/O-EX-1-S-2



WIRING DRAWING - WI-I/O 9-3, WI-I/O-EX-1-S-3



WIRING DRAWING -WI-I/O 9-4, WI-I/O-EX-1-S-4



WI-I/O 9-1
Installation Guide

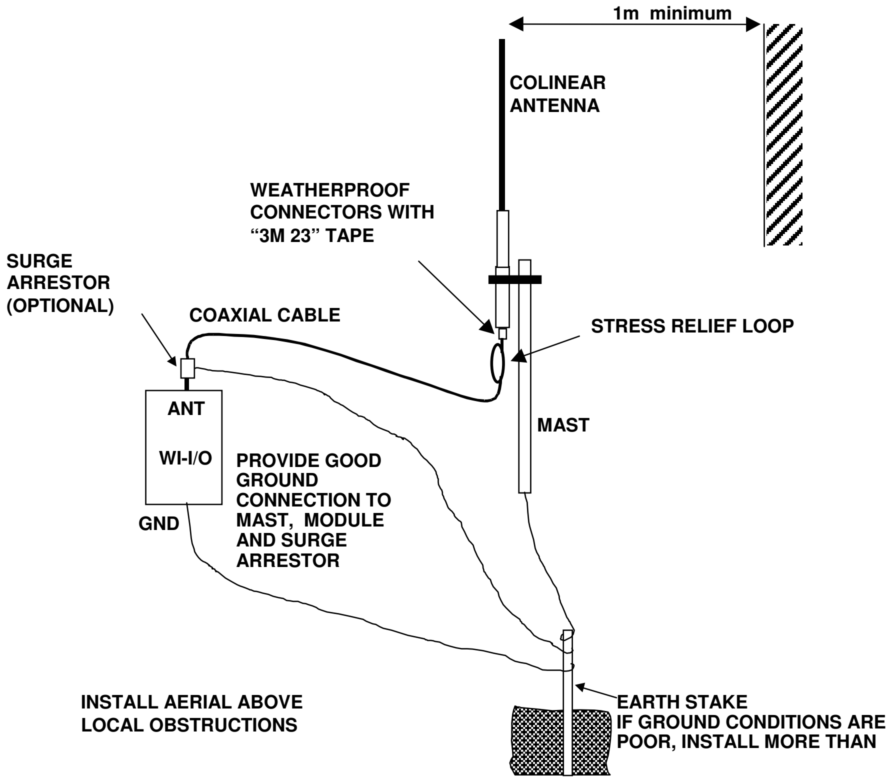
FCC Notice

This device complies with Part 15.247 of the FCC Rules.
Operation is subject to the following two conditions:

1) This device may not cause harmful interference and
2) This device must accept any interference received, including interference that may cause undesired operation

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS 1 DIVISION 2 GROUPS ABC AND D OR NON HAZARDOUS LOCATIONS ONLY

Aerial Installation



ANTENNA INSTALLATION
Antennas should be installed by experienced contractors.

WI-I/O 9-1 Installation

Power supply: (A) 12-24VAC 1.5 Amp CSA Certified Class 2

(B) 15-30VDC 1.5 Amp CSA Certified Class 2

(C) Supply battery or 11-15VDC

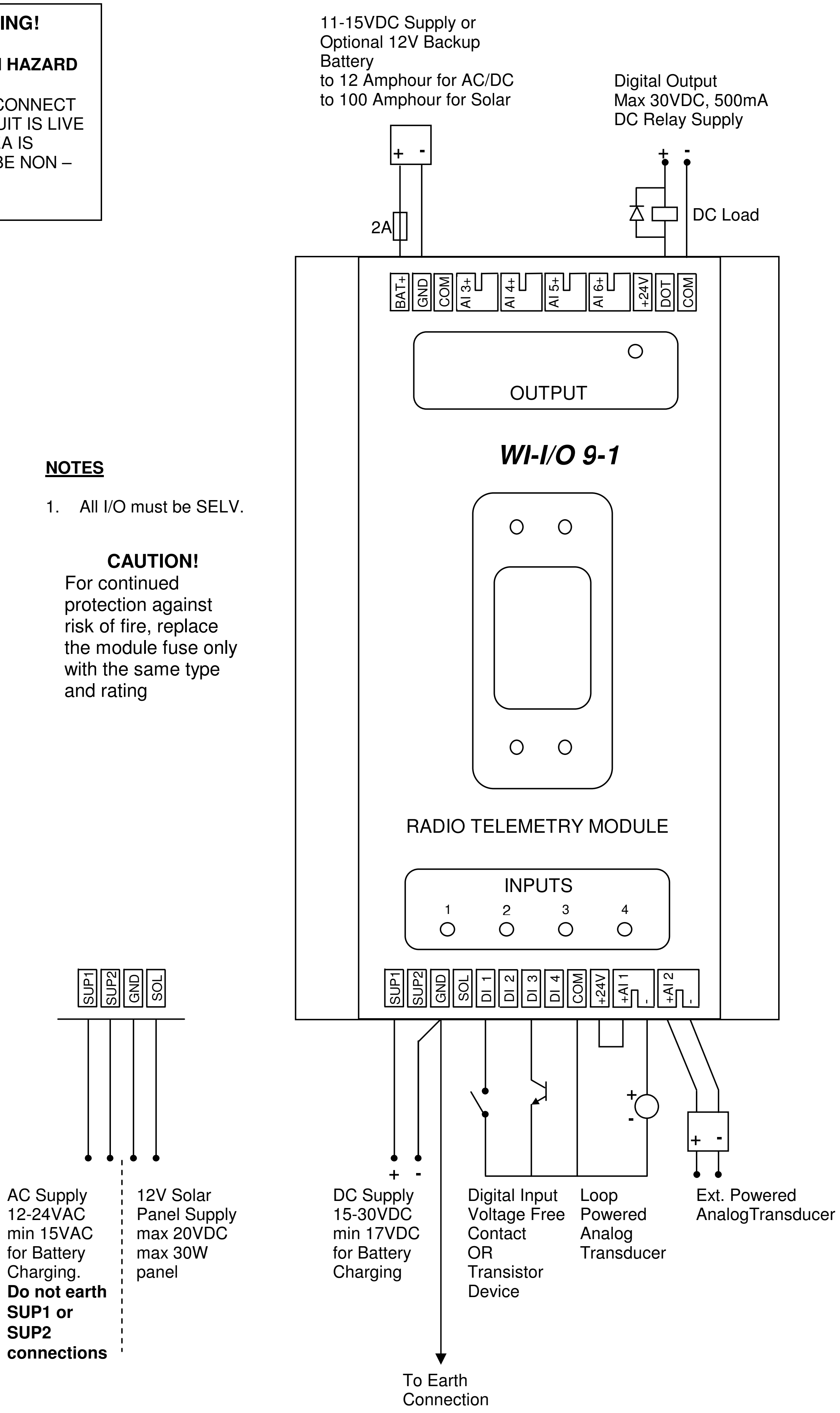
(D) Solar panel with solar battery

Choose option and wire as shown

WARNING!

EXPLOSION HAZARD

DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON – HAZARDOUS



NOTES

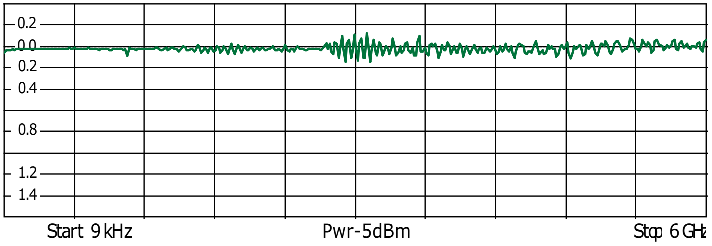
1. All I/O must be SELV.

CAUTION!
For continued protection against risk of fire, replace the module fuse only with the same type and rating

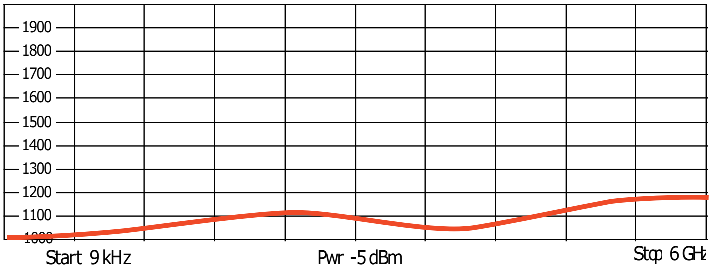
High Frequency Gas Tube Coaxial Surge Protectors

P8AX-6G Series

Insertion Loss 0.2 dB/div



VSWR 100 mV/div

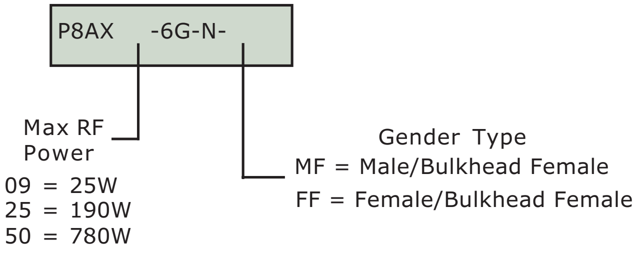


The P8AX 6G series coaxial surge protectors have been designed to protect multi point radios, backhaul bridges, antennas, microwaves, braodband applications, two way radios, and cellular equipment against lightning surges and electrical transients. They are a first line of defense for your sensitive equipment and have Multi Strike Capability.

The P8AX 6G series employs replacable gas tubes, are waterproof (IP65) and available with three grounding methods:
M6 ground screw, bulkhead or optional mounting bracket.

- Multi Point Radio & Backhaul Bridges
- Tower Mounted Amplifiers (TMA)
- Antenna Systems
- Tower Top Electronics (TTE)
- Transmitters and Recievers
- WiFi
- Wimax Broadband Wireless

Ordering information



Characteristics

CITEL Part Number	P8AX09 6G	P8AX25 6G	P8AX50 6G
Frequency Range	DC 6.9GHz	DC 6.9GHz	DC 6.9GHz
DC Turn On (Breakdown)	90 130V	200 300V	400 600V
Technology	Gas Discharge Tube	Gas Discharge Tube	Gas Discharge Tube
Insertion Loss	≤0.2db	≤0.2db	≤0.2db
Return Loss	≥19db	≥19db	≥19db
VSWR	<1.25:1	<1.25:1	<1.25:1
Ipeak (8/20 μs)	20kA	20kA	20kA
Max Power	25W	190W	780W
Max current	10A	10A	10A
Impedance	50 omhs	50 omhs	50 omhs
Connection Method	Series (bi directional)	Series (bi directional)	Series (bi directional)
Connectors	N	N	N
Grounding	M6 Screw, Bulkhead, Bracket	M6 Screw, Bulkhead, Bracket	M6 Screw, Bulkhead, Bracket
Enviromental Rating	IP65	IP65	IP65
Operating Temp	50˚C to +85˚C	50˚C to +85˚C	50˚C to +85˚C
Operating Altitude	13,000 ft (4,000m)	13,000 ft (4,000m)	13,000 ft (4,000m)
Relative Humidity	up to 5 to 95% non-condensing, up to 100%	up to 5 to 95% non-condensing, up to 100%	up to 5 to 95% non-condensing, up to 100%
Weight	5.3 oz	5.3 oz	5.3 oz

COOPER Bussmann

1/4" x 1-1/4" Fuses

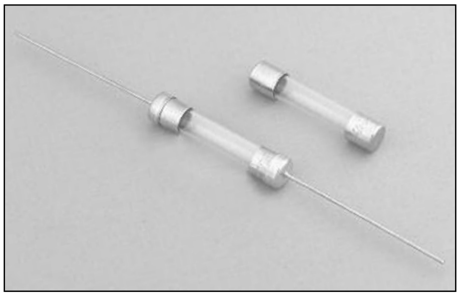
AGC Series, Fast Acting, Glass Tube

Description

- Fast-acting, glass tube
- Optional axial leads available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

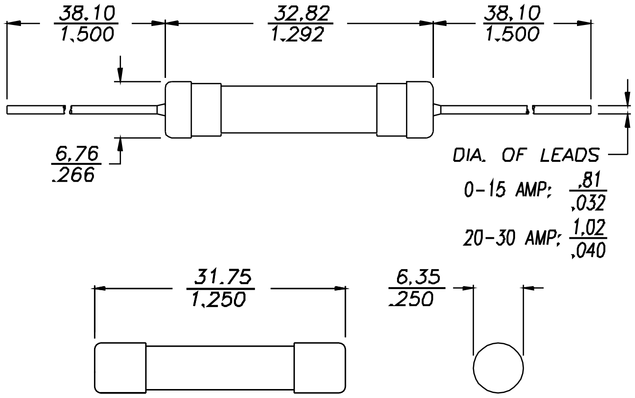
ELECTRICAL CHARACTERISTICS	
% of Amp Rating	**Opening Time**
100%	None
135%	60 Minutes Maximum
200%	120 Seconds Maximum

RoHS 2002/95/EC



Dimensions ($^{mm}/_{in}$)

Drawing Not to Scale



Agency Information

- UL Listed Card: AGC 1/500-10
- UL Recognition Card: AGC 11-45
- CSA Component Acceptance Card (Class No. 1422 30)
- CSA Certification Card (Class No. 1422 01)

Environmental Data

- Shock: 1/100A thru 3/4A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A thru 30A – MIL-STD-202, Method 204, Test Condition A (Except 5g, 500HZ)

Ordering

- Specify packaging, product, and option code

SPECIFICATIONS

Product Code	Voltage Rating AC	AC Interrupting Rating 250V	125V	32V	Typical DC Cold Resistance** (ohms)	Typical Melting I²t† AC	Typical Voltage Drop‡
AGC-1/20	250V	35A	10000A	-	4.500	0.00773	0.67
AGC-1/16	250V	35A	10000A	-	29.000	0.000181	10.41
AGC-1/10	250V	35A	10000A	-	12.565	0.000787	6.00
AGC-1/8	250V	35A	10000A	-	6.800	0.00131	4.67
AGC-3/16	250V	35A	10000A	-	4.900	0.00637	4.12
AGC-2/10	250V	35A	10000A	-	3.360	0.00435	4.51
AGC-1/4	250V	35A	10000A	-	2.300	0.0148	0.89
AGC-3/10	250V	35A	10000A	-	1.670	0.0208	2.88
AGC-3/8	250V	35A	10000A	-	1.203	0.0321	4.59
AGC-1/2	250V	35A	10000A	-	0.615	0.269	0.59
AGC-3/4	250V	35A	10000A	-	0.312	0.815	0.37
AGC-1	250V	35A	10000A	-	0.190	1.615	0.31
AGC-1-1/4	250V	100A	10000A	-	0.145	0.018	0.35
AGC-1-1/2	250V	100A	10000A	-	0.115	0.0149	0.27
AGC-2	250V	100A	10000A	-	0.078	0.00509	0.28
AGC-2-1/4	250V	100A	10000A	-	0.067	0.00588	0.26
AGC-2-1/2	250V	100A	10000A	-	0.057	0.00879	0.31
AGC-3	250V	100A	10000A	-	0.045	0.0167	0.25
AGC-4	250V	200A	10000A	-	0.030	0.0305	0.22
AGC-5	250V	200A	10000A	-	0.024	0.045	0.23
AGC-6	250V	200A	10000A	-	0.020	0.071	0.23
AGC-7	250V	200A	10000A	-	0.017	0.105	0.23
AGC-7-1/2	250V	200A	10000A	-	0.0146	-	-
AGC-8	250V	200A	10000A	-	0.014	0.152	0.19
AGC-9	250V	200A	10000A	-	0.012	0.21	0.18
AGC-10	250V	200A	10000A	-	0.008	0.492	0.20
AGC-12	32V	-	-	1000A	0.0070	-	-
AGC-14	32V	-	-	1000A	0.0062	-	-
AGC-15	32V	-	-	1000A	0.006	0.566	0.14
AGC-20	32V	-	-	1000A	0.004	1.438	0.12
AGC-25	32V	-	-	1000A	0.003	2.109	0.11
AGC-30	32V	-	-	1000A	0.002	3.807	0.12
AGC-35	32V	-	-	70A	0.0014	-	-
AGC-40	32V	-	-	80A	0.0019	-	-

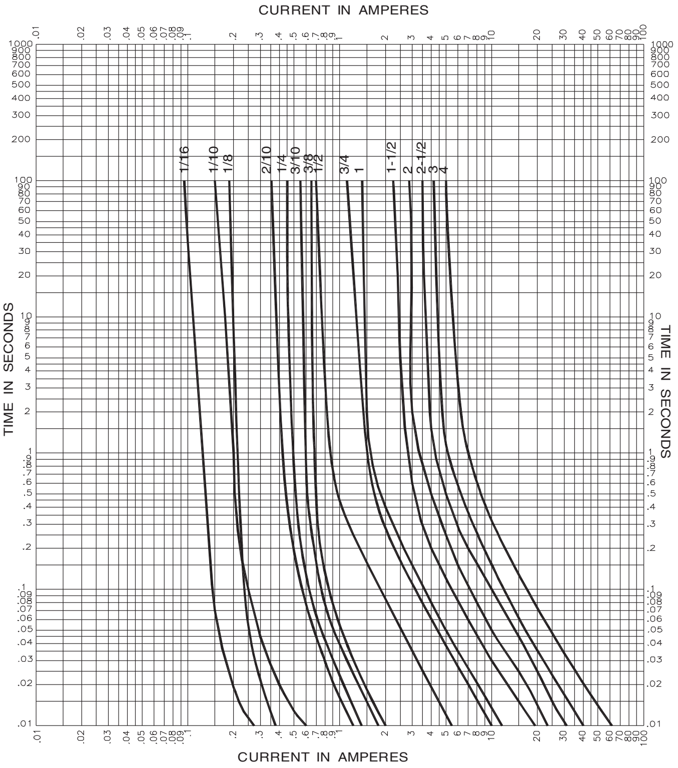
** DC Cold Resistance (Measured at ≤10% of rated current)

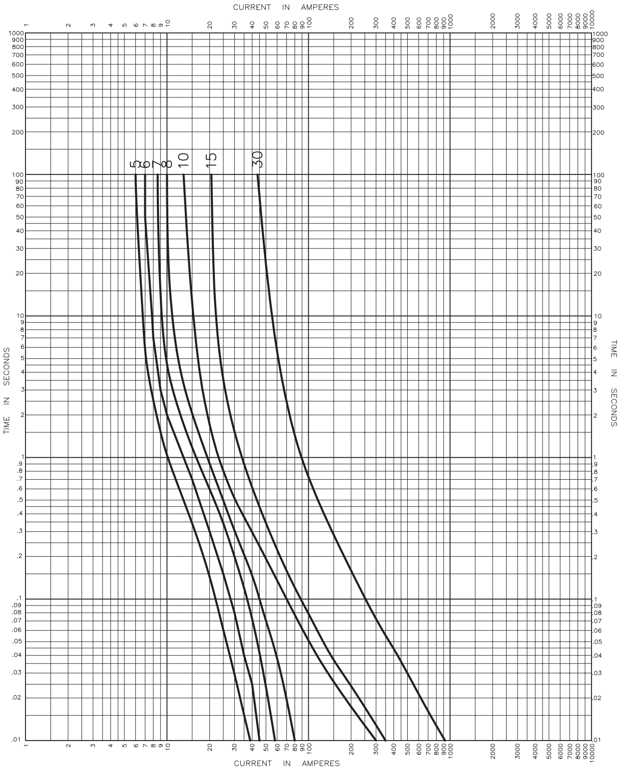
† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

1/4" x 1-1/4" Fuses
AGC Series, Fast Acting, Glass Tube

TIME CURRENT CURVE





	PACKAGING CODE
Packaging Code	**Description**
BK	100 pieces of fuses packed into a cardboard carton with flaps folded
BK1	1,000 pieces of fuses packed into a cardboard carton with flaps folded
BK8	8,000 pieces of fuses packed into a cardboard carton with flaps folded

	OPTION CODE
Option Code	**Description**
B	Board Washable - Hermetically sealed to withstand aqueous cleaning
V	Axial leads - copper tinned wire with nickel plated brass overcaps
-R	RoHS compliant version

Visit us on the web at:
www.cooperbussmann.com

OC-2543 3/07

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+34 937 362 813
Fax: +34 937 362 719

Asia Pacific

Cooper Electronic Technologies
1 Jalan Kilang Timor
#06-01 Pacific Tech Centre
Singapore 159303
Tel: +65 278 6151
Fax: +65 270 4160

Industrial Automation Catalog Section - U906

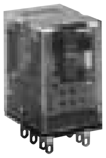
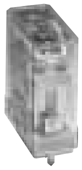
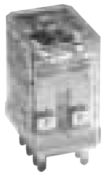
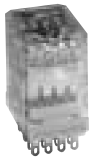
Selection Guides

General Purpose Relays

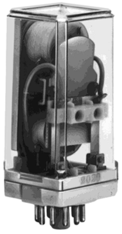
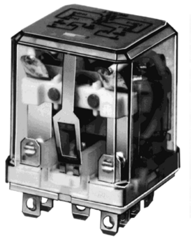
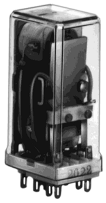
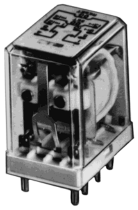
- RH Series
- RM Series
- RY Series

Selection Guides

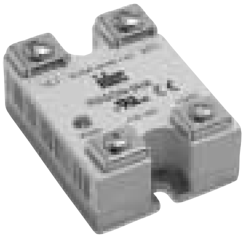
General Purpose Relays

	RU Series		RR Series	RH Series	RM Series	RY Series	
Appearance							
Page	E-3		E-6	E-10	E-16	E-19	
Contact Configuration	2, 4 Form C		1, 2, 3 Form C	1, 2, 3, 4 Form C	2 Form C	2, 4 Form C	
Contact Rating (resistive)	DPDT: 10A, 30V DC 10A, 250V AC 4PDT: 6A, 30V DC 6A, 250V AC		10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/4HP, 120V AC	10A, 30V DC 10A, 120V, 240V AC 1/3HP, 240V AC 1/6HP, 120V AC	5A, 30V DC 5A, 120V AC, 240V AC	DPDT: 3A, 30V DC; 3A, 120V AC, 240V AC 4PDT: 5A, 30V DC; 5A, 120V AC, 240V AC	
Contact Material	DPDT	AuSnOIn (silver tin oxide indium)	Silver	Silver-cadmium oxide	Silver	Standard	Silver, gold-plated
	4PDT	AuAg/Ag (gold-silver alloy on silver)				Bifurcated	Silver-paladium alloy (Ag-PD Alloy)

General Purpose Latching Relays

	RR2KP Series	RH2L Series	RY2KS Series	RY2L Series
Appearance				
Page	E-23	E-26	E-29	E-32
Contact Configuration	2 Form C	2 Form C	2 Form C	2 Form C
Contact Rating (resistive)	10A, 30V DC 10A, 120V AC	10A, 30V DC 7.5A, 240V AC 10A, 120V AC	3A, 30V DC 3A, 120V AC	3A, 30V DC 3A, 120V AC 3A, 240V AC
Contact Material	Silver	Silver-cadmium oxide	Silver, gold-plated	Silver, gold-flashed

Solid State Relays

	RSS Series
Appearance	
Page	E-35
Contact Configuration	1 Form A (SPST-NO)
Contact Rating	10, 25, 50, 75, 90A 48V AC to 660V AC Output Ratings
Output	Dual SCR (zero crossing)

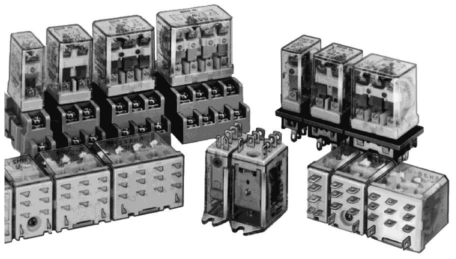
RH Series — General Purpose Midget Relays

Key features of the RH series include:

- **Compact midget size saves space**
- **High switching capacity (10A)**
- **Choice of blade or PCB style terminals**
- **Relay options include indicator light, check button, and top mounting bracket**
- **DIN rail, surface, panel, and PCB type sockets available for a wide range of mounting applications**

Specifications

Specifications	**Contact Material**	Silver cadmium oxide
	Contact Resistance	50mΩ maximum (initial value)
	Minimum Applicable Load	24V DC/30mA, 5V DC/100mA (reference value)
	Operating Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
	Release Time	SPDT (RH1), DPDT (RH2): 20ms maximum 3PDT (RH3), 4PDT (RH4): 25ms maximum
	Maximum Continuous Applied Voltage (AC/DC) at 20°C	110% of the rated voltage
	Minimum Operating Voltage (AC/DC) at 20°C	80% of the rated voltage
	Drop-Out Voltage (AC)	30% or more of the rated voltage
	Drop-Out Voltage (DC)	10% or more of the rated voltage
	Power Consumption	**SPDT** (RH1): DC: 0.8W AC: 1.1VA (50Hz), 1VA (60Hz) **DPDT** (RH2): DC: 0.9W AC: 1.4VA (50Hz), 1.2VA (60Hz) **3PDT** (RH3): DC: 1.5W AC: 2VA (50Hz), 1.7VA (60Hz) **4PDT** (RH4): DC: 1.5W AC: 2.5VA (50Hz), 2VA (60Hz)
	Insulation Resistance	100MΩ min (measured with a 500V DC megger)
	Dielectric Strength	**SPDT** (RH1) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
		DPDT (RH2), **3PDT** (RH3), **4PDT** (RH4) Between live and dead parts: 2,000V AC, 1 minute; Between contact circuit and operating coil: 2,000V AC, 1 minute; Between contact circuits: 2,000V AC, 1 minute; Between contacts of the same pole: 1,000V AC, 1 minute
	Frequency Response	1,800 operations/hour
	Temperature Rise	Coil: 85°C maximum Contact: 65°C maximum
	Vibration Resistance	0 to 6G (55Hz maximum)
	Shock Resistance	SPDT/DPDT: 200N (approximately 20G) 3PDT/4PDT: 100N (approximately 10G)
	Life Expectancy	Electrical: over 500,000 operations at 120V AC, 10A; (over 200,000 operations at 120V AC, 10A for SPDT [RH1], 3PDT [RH3], 4PDT [RH4]) Mechanical: 50,000,000 operations
	Operating Temperature	–30 to +70°C
	Weight	SPDT: 24g, DPDT: 37g (approximately) 3PDT: 50g, 4PDT: 74g (approximately)



UL Recognized
Files No. E67770
E59804

CSA Certified
File No.LR35144

File No. BL951113332319

Ordering Information

Order standard voltages for fastest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No.		*Coil Voltage:*
RH2B-U	–	*AC110-120V*

Part Numbers

Part Numbers: RH Series with Options

Termination	Contact Configuration	Basic Part No.	Indicator Light	Check Button	Indicator Light and Check Button	Top Bracket
B (blade)	SPDT	RH1B-U	RH1B-L*	—	—	RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-ULC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	RH3B-ULC	RH3B-UT
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-ULC	RH4B-UT
V2 (PCB 0.078" [2mm] wide)	SPDT	RH1V2-U	RH1V2-L*	—	—	—
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	RH2V2-ULC	—
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	RH3V2-ULC	—
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	RH4V2-ULC	—

** RH1B(V2)-L is* ***not*** *UL recognized.*

Ratings

Coil Ratings

Rated Voltage		Rated Current ±15% at 20°C								Coil Resistance ±15% at 20°C			
		60Hz				50Hz							
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	150mA	200mA	280mA	330mA	170mA	238mA	330mA	387mA	18.8Ω	9.4Ω	6.0Ω	5.4Ω
	12V	75mA	100mA	140mA	165mA	86mA	118mA	165mA	196mA	76.8Ω	39.3Ω	25.3Ω	21.2Ω
	24V	37mA	50mA	70mA	83mA	42mA	59.7mA	81mA	98mA	300Ω	153Ω	103Ω	84.5Ω
	120V*	7.5mA	11mA	14.2mA	16.5mA	8.6mA	12.9mA	16.4mA	19.5mA	7,680Ω	4,170Ω	2770Ω	2220Ω
	240V†	3.2mA	5.5mA	7.1mA	8.3mA	3.7mA	6.5mA	8.2mA	9.8mA	3,1200Ω	15,210Ω	12,100Ω	9120Ω
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	128mA		150mA		240mA		250mA		47Ω	40Ω	25Ω	24Ω
	12V	64mA		75mA		120mA		125mA		188Ω	160Ω	100Ω	96Ω
	24V	32mA		36.9mA		60mA		62mA		750Ω	650Ω	400Ω	388Ω
	48V	18mA		18.5mA		30mA		31mA		2,660Ω	2,600Ω	1,600Ω	1550Ω
	110V‡	8mA		9.1mA		12.8mA		15mA		13,800Ω	12,100Ω	8,600Ω	7,340Ω

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Rated Voltage		Coil Inrush				Coil Inductance							
						Energizing				De-Energizing			
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
AC	6V	250mA	340mA	520mA	620mA	0.09H	0.08H	0.05H	0.05H	0.06H	0.04H	0.03H	0.02H
	12V	120mA	170mA	260mA	310mA	0.037H	0.30H	0.22H	0.18H	0.22H	0.16H	0.12H	0.10H
	24V	56mA	85mA	130mA	165mA	1.5H	1.2H	0.9H	0.73H	0.9H	0.63H	0.5H	0.36H
	120V*	12mA	16mA	26mA	33mA	37H	33H	21H	18H	22H	15H	12H	9H
	240V†	7mA	8mA	12mA	16mA	130H	130H	84H	73H	77H	62H	47H	36H
		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
DC	6V	N/A		N/A		N/A		N/A		N/A	N/A	N/A	N/A
	12V												
	24V												
	48V												
	110V‡												

** For RH2 relays = 110/120V AC.*
† For RH2 relays = 220/240V AC.
‡ For RH2 relays = 100/110V DC.

Ratings con't

Contact Ratings

Voltage	Rating	Resistive				Inductive				Motor Load		
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT
28V DC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	—	—	—
30V DC	UL	10A	10A	10A	—	7A	7A	—	—	—	—	—
	CSA				10A		7.5A			—	—	—
	Nominal							7.5A	7.5A	—	—	—
110V DC	Nominal	0.5A	0.5A	0.5A	0.5A	0.3A	0.3A	0.3A	0.3A	—	—	—
120V AC	UL	10A	10A	10A	10A	7.5A	—	—	7.5A	1/6	1/6	1/6
	CSA						7.5A			—	—	—
	Nominal					7A		7.5A				
240V AC	UL	10A	10A	—	7.5A	7A	7A	*	5A	1/3	1/3	1/3
	CSA							7A		—	—	—
	Nominal	7A	7.5A	7.5A	4.5A	5A	5A	5A				

1. * 6.5A/pole, 20A total.
2. Inductive load cos ø = 0.3, L/R = 7ms.

Applicable Sockets

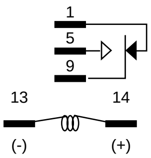
Part Numbers: Sockets

Relay	Standard DIN Rail Mount	Finger-Safe DIN Rail Mount	Surface Mount	Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	—	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-02	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	—	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C		SH4B-51	SH4B-62

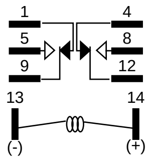
Spring & Clips (optional)	
Part Number	Use With
SY2S-02F1 SFA-101 SFA-202	SH1B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH1B-51, 62
SY4S-02F1 SFA-101 SFA-202	SH2B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH2B-51, 62
SH3B-05F1 SFA-101, -202	SH3B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH3B-51, 62
SH4B-02F1 SFA-101, -202	SH4B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH4B-51, 62

See Section F for details on sockets. All DIN rail mount sockets shown above can be mounted using DIN rail BNDN1000.

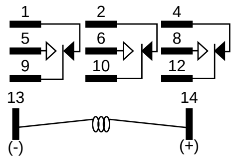
Internal Circuits



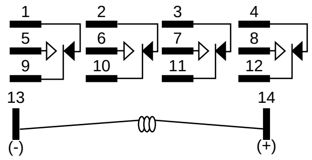
RH1



RH2



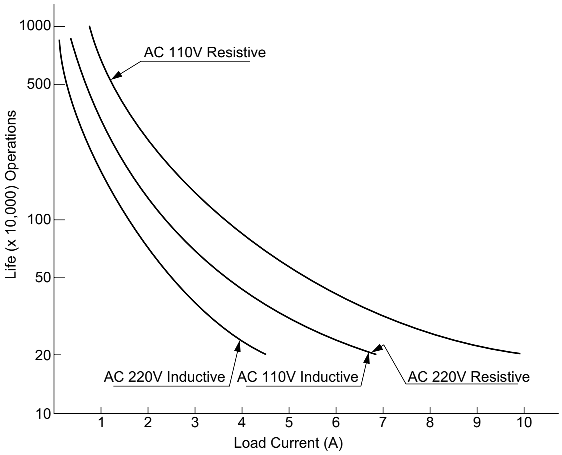
RH3

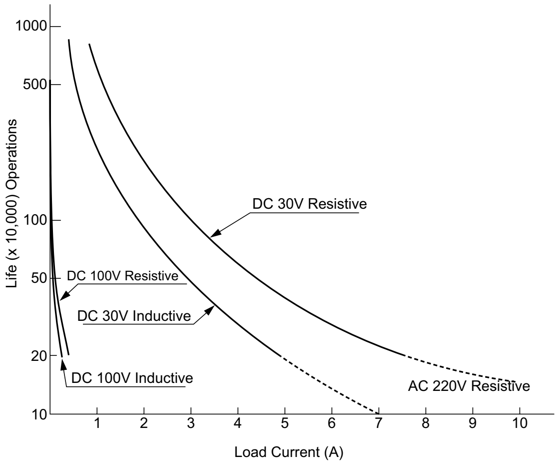


RH4

Electrical Life Curves

RH1





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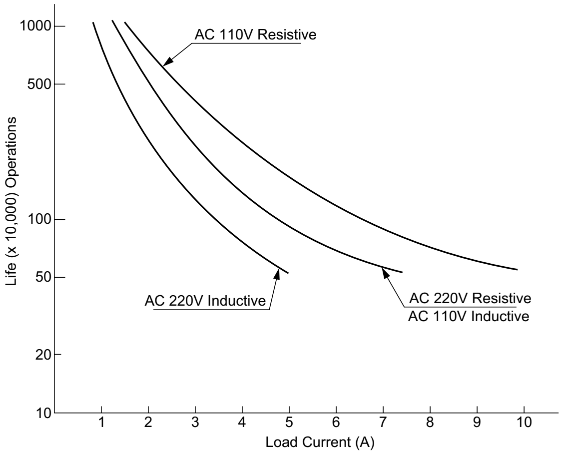
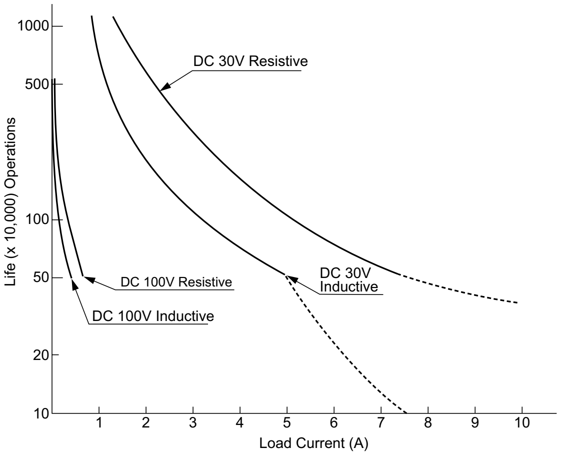
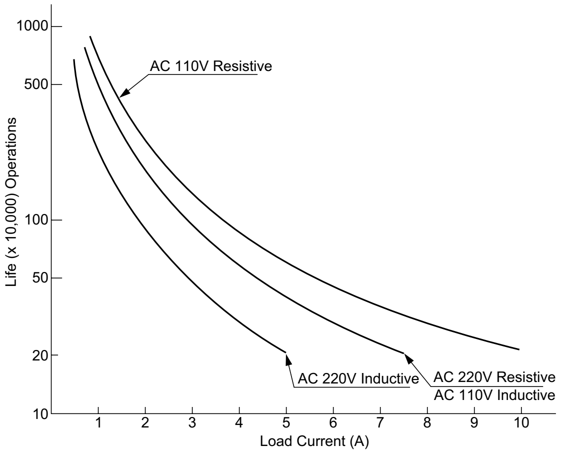
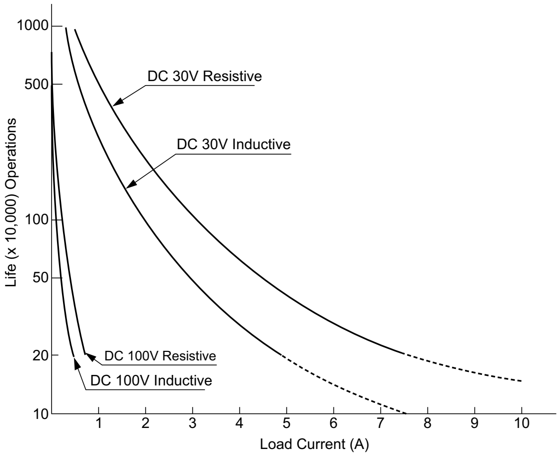




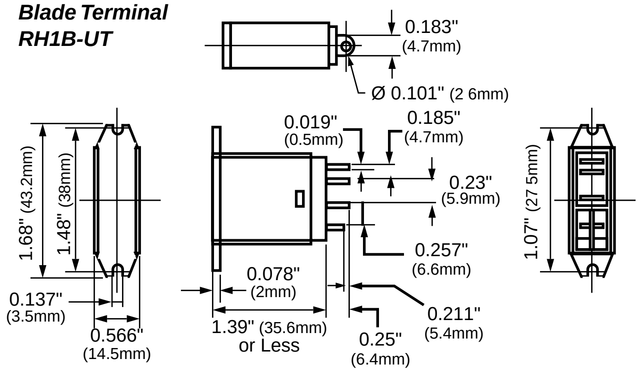
RH3 and 4



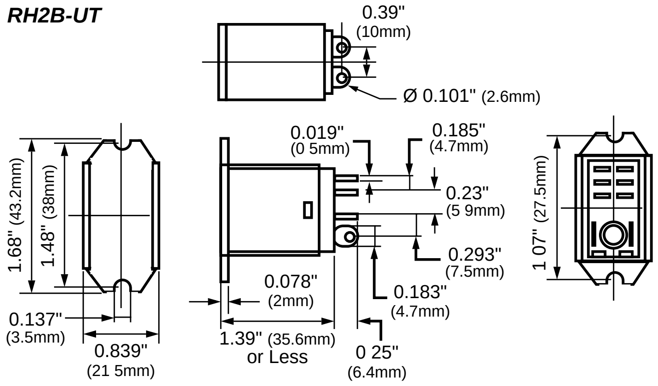


Dimensions

Top Bracket Mounting Blade Terminal RH1B-UT

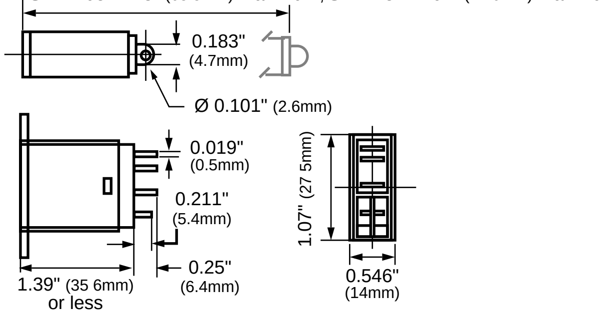


RH2B-UT



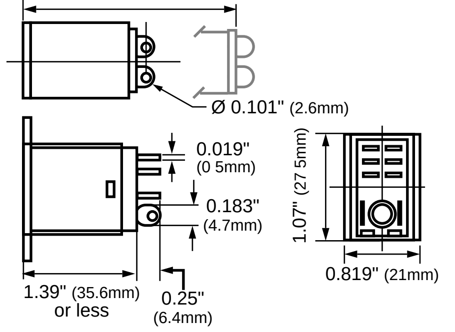
Plug-in Blade Terminal RH1B

Total length from panel surface including socket:
SH1B-05: 2.40" (61.5mm) maximum; ***SH1B-51:*** 1.54" (39mm) maximum
Total length from panel surface including hold-down spring:
SH1B-05: 2.48" (63.5mm) maximum; ***SH1B-51:*** 1.62" (41.6mm) maximum



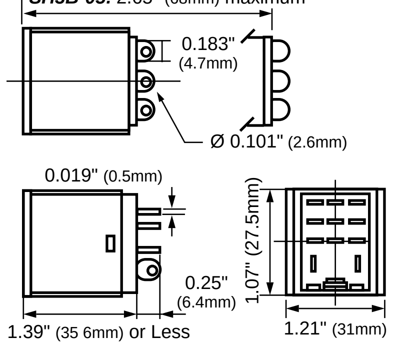
RH2B

Total length from panel surface including socket:
SH2B-05: 2.40" (61.5mm) maximum; ***SH2B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH2B-05: 2.48" (63.5mm) maximum; ***SH2B-51:*** 1.62" (41.6mm)



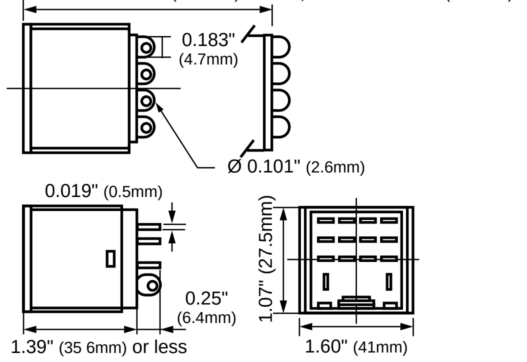
Plug-in Blade Terminal RH3B

Total length from panel surface including socket:
SH3B-05: 2.57" (66mm) maximum
Total length from panel surface including hold-down spring:
SH3B-05: 2.65" (68mm) maximum



RH4B

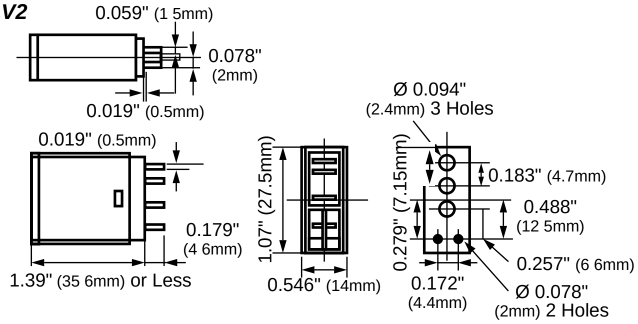
Total length from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39 6mm)
Total length from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41 6mm)



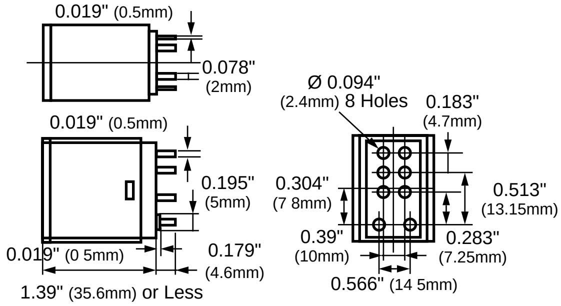
Dimensions

PCB Terminal

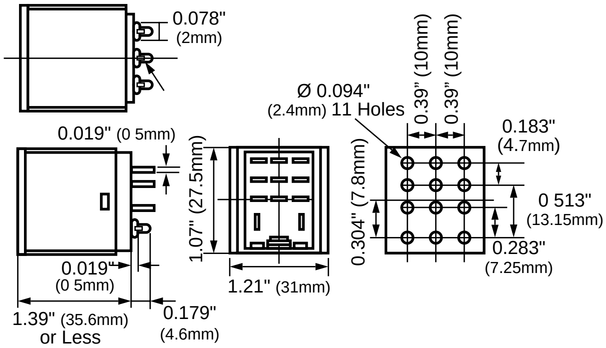
RH1V2



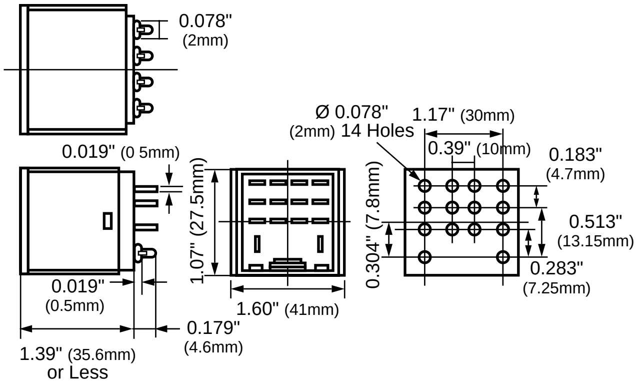
RH2V2



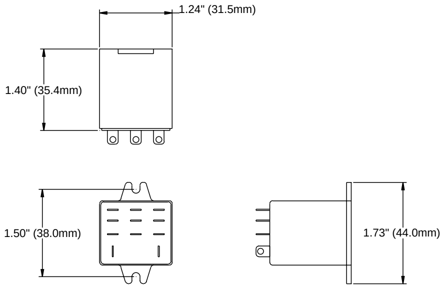
RH3V2



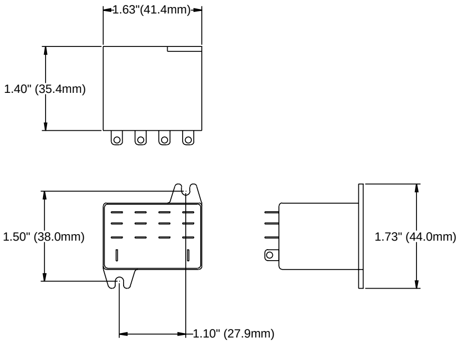
RH4V2



RH3B-UT

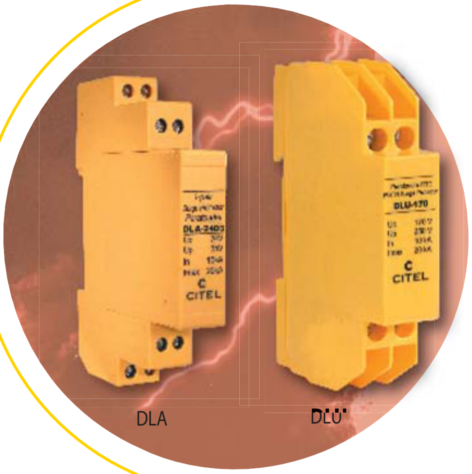


RH4B-UT



DIN Rail Surge Protector for Dataline/Telecom

DLA & DLU



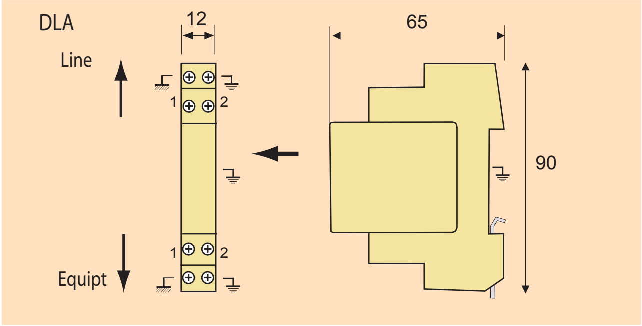
DLA and DLU surge protectors are designed to protect, against surge voltages due to lightning, terminals equipment connected to industrial buses, telecom lines or datalines.
These surge protectors must be installed on symmetrical DIN rail and are available for most of the transmission lines : line voltage from 6 to 170 V, bitrate up to 10 Mbit/s.
Electrical diagrams of DLA and DLU models are built with gas tubes and fast clamping diodes in order to provide high discharge current capability and fast operation.
The different models offer protection for 1 pair (DLA, DLU) and 2 pairs (DLU2).

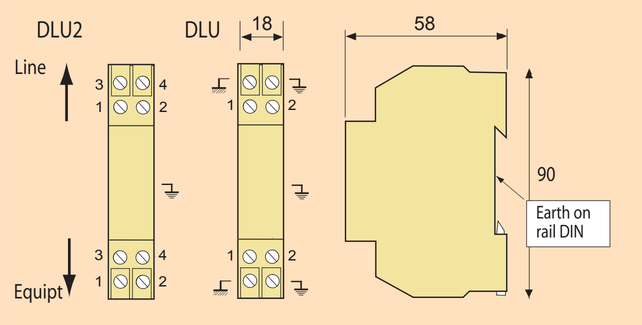
DLA
1-pair DIN rail surge protector with removable module for easy maintenance (ref. DLM...). Transmission and protection of the shield wire by gas tube. Direct earthing through Din rail. Line continuity in case of plug-in module removed.

DLU
1-pair (DLU) or 2-pair (DLU2) DIN rail surge protector. Monobloc enclosure. Transmission and protection of the shield wire (DLU). Earth through DIN rail.

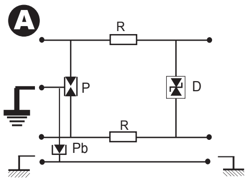
- For «DIN» rail mounting
- All types of Telephone and Data lines
- Pluggable version (DLA)
- 2-pair version (DLU2)

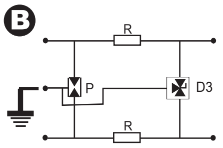
Dimensions (in mm)

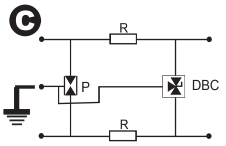


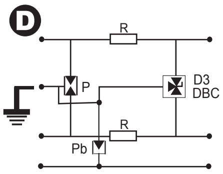


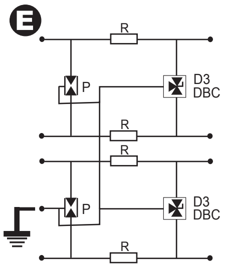
Electrical diagrams











P : 3-electrode gas tube
Pb : : 2-electrode gas tube
R : Resistor
D : Clamping diode
D3 : 3-pole clamping diode
DBC : 3-pole low capacitance diode
V : varistor

F050414B - Document could be modified without notice

DIN Rail Surge Protector for Dataline/Telecom

DLA & DLU

Characteristics

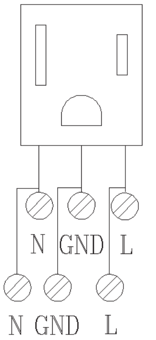
CITEL part number	DLA-170	DLA-48D3	DLA-24D3	DLA-12D3	DLA-06D3	DLA-06DBC
Application	Telephone line ADSL	ISDN-T0 48 V line	Leased line 4-20 mA	RS232	RS422 RS485	T2 - T1 10BaseT
Configuration	1 pair+shield	1 pair+shield	1 pair+shield	1 pair+shield	1 pair+shield	1 pair+shield
Max. line voltage (Uc)	170 V	48 V	24 V	15 V	6 V	6 V
Max. line current	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA
Protection level (Up) 8/20µs impulse - 5 kA	220 V	70 V	40 V	30 V	20 V	25 V
Nominal discharge current (In) 8/20µs impulse - 10 times	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA
Max. discharge current (Imax) 8/20µs impulse - 1 time	10 kA	10 kA	10 kA	10 kA	10 kA	10 kA
Type of diagram	A	B	B	B	B	C
End of life	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit
Mechanical characteristics	Modular shape and Symmetrical Din rail mounting Direct earthing on Din rail and shield wire protected by GDT Dimensions : see drawing Connection by screw - max. cross section 1.5 mm² Removable module for DLA series : ref DLAM-xxx Housing material : Thermoplastic UL94-V0					

CITEL part number	DLU-170	DLU2-48D3	DLU-48DBC	DLU-24D3	DLU2-12D3	DLU-12D3	DLU-12DBC	DLU2-06D3	DLU2-06DBC
Application	Telephone line ADSL	ISDN-T0 Profibus-PA Liaison 48 V	Fipway WorldFIP Fieldbus-H2	4-20 mA 24 V line	RS232	Profibus-FMS Interbus Fieldbus-H1 Batibus	Profibus-DP LONwork	RS422	T2 - T1 10BaseT
Configuration	1 pair	2 pairs	1 pair + shield	1 pair	4 wires	1 pair + shield	1 pair + shield	2 pairs	2 pairs
Max. line voltage(Uc)	170 V	48 V	48 V	24 V	15 V	15 V	15 V	6 V	6 V
Max. line current	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA	300 mA
Protection level (Up) 8/20µs impulse - 5 kA	220 V	70 V	75 V	40 V	30 V	30 V	35 V	20 V	25 V
Nominal discharge current (In) 8/20µs impulse - 10 times	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA	5 kA
Max. discharge current (Imax) 8/20µs impulse - 1 time	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA
Type of diagram	D	E	D	D	E	D	D	E	E
End of life	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circuit	short-circui
Mechanical characterisitics	Modular shape Symmetrical DIN rail mounting Dimensions : see drawing connection by screw - max. cross section 1.5 mm² Housing material : Thermoplastic UL94-V0 Earth connection via DIN rail (DLU, DLU2) or screw terminal (DLU).								

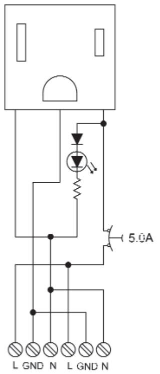
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- Compact and easily snaps onto 35mm DIN-rail
- CSA, UL508A and cULus approved
- Available with ground fault current interrupt (GFCI) or standard simplex and duplex outlets
- Option for visual indication of power included with GFCI versions
- Enclosed versions feature NEMA rated enclosure with UL94 VO flammability rating

Schematic diagram

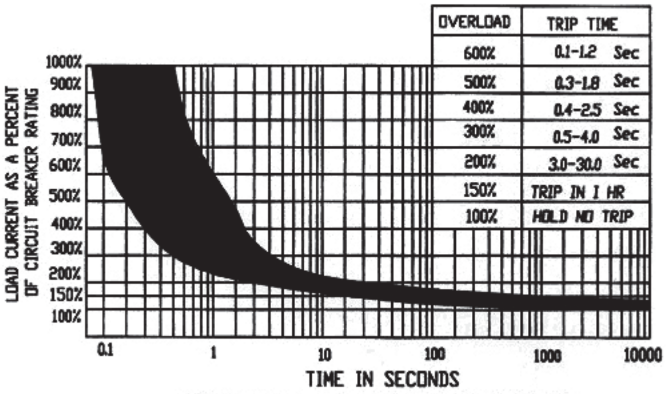


Schematic diagram



Rated data

Input voltage		
Rated current	120Vac	120Vac
	5A max via outlet	5A max via outlet
	10A via redundant terminals	10A via redundant terminals
Wire range	26 - 12 AWG (0.14 0 4.0mm²)	26 - 12 AWG (0.14 0 4.0mm²)
Ordering data	**Type** / **Part No.**	**Type** / **Part No.**
TS32 / TS35 mounting (⊔ / ⊓)	Single outlet without circuit breaker **9915480000**	Single outlet with circuit breaker **9915480001**
		(supplemental protector with manual reset via push button)
Dimensions		
Width	35mm	35mm
Length	70mm	70mm
Height	55mm	55mm
Approvals		
	LR-229352, E252394	LR-229352, E252394



TRIP CURVES ARE SPECIFIED OF 25°C/77°F

Extract from the online catalog

UK 6,3-HESILA 250

Order No.: 3004249

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004249

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Commercial data	
EAN	4017918090739
sales group	A040
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.034648 KG
Catalog page information	Page 370 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
09/11/2006

http://www.download.phoenixcontact.com Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions	
Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

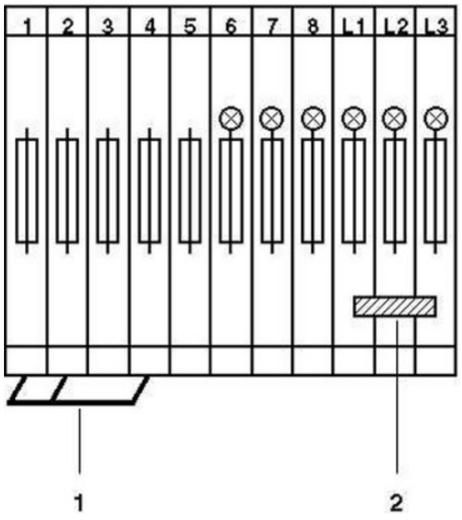
Technical data	
Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

Connection data	
Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Diagrams/Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

UK 6,3-HESILED 24

Order No.: 3004265

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004265

Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm², AWG: 26 - 8, width: 10.2 mm, color: black

Commercial data	
EAN	4017918090753
sales group	A040
Pack	50 pcs.
Customs tariff	85363010
Weight/Piece	0.03542 KG
Catalog page information	Page 370 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 09/01/2006

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Technical data

General

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

Dimensions

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

Technical data

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

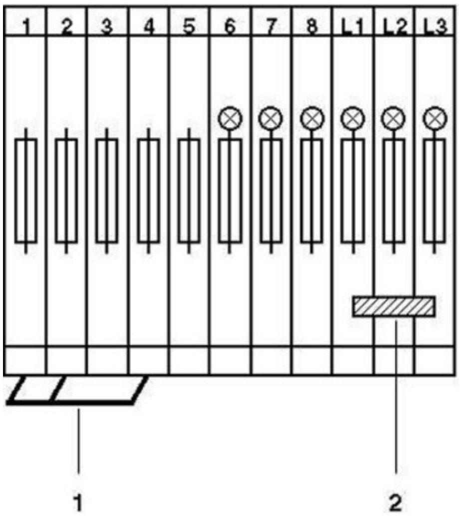
Connection data

Conductor cross section solid min.	0.5 mm²
Conductor cross section solid max.	16 mm²
Conductor cross section stranded min.	0.5 mm²
Conductor cross section stranded max.	16 mm²
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm²
2 conductors with same cross section, solid min.	0.5 mm²
2 conductors with same cross section, solid max.	4 mm²
2 conductors with same cross section, stranded min.	0.5 mm²
2 conductors with same cross section, stranded max.	4 mm²

2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm²
Cross-section with insertion bridge, solid max.	10 mm²
Cross-section with insertion bridge, stranded max.	10 mm²
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M4
Tightening torque, min	1.2 Nm
Tightening torque max	1.5 Nm

Diagrams/Drawings

Circuit diagram



1 = fixed bridge
2 = insertion bridge

Address

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Fax (717) 944-1625
http://www.phoenixcon.com

Extract from the online catalog

UK 5 N

Order No.: 3004362

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3004362

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: gray, Mounting type: NS 35/7,5, NS 35/15, NS 32

Commercial data	
EAN	4017918090760
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

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Technical data

General

Number of levels	1
Number of connections	2
Color	gray

Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Maximum load current	41 A (with 6 mm^2 conductor cross section)
Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-1
Nominal current I_N	32 A
Nominal voltage U_N	800 V
Open side panel	ja

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²

2 conductors with same cross section, stranded min.	0.2 mm²
2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Cross-section with insertion bridge, solid max.	4 mm²
Cross-section with insertion bridge, stranded max.	4 mm²
Type of connection	Screw connection
Stripping length	8 mm
Internal cylindrical gage	A4
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Diagrams/Drawings

Circuit diagram

Approbationslogos (EX-Bereich)

Address

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PHOENIX CONTACT

Extract from the online catalog

UK 5 N GN

Order No.: 3003965

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003965

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data

EAN	4017918282189
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.009305 KG

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


FM
APPROVED


GL

Address

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

UK 5 N YE

Order No.: 3003952

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003952

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/01/2003

Commercial data	
EAN	4017918282172
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00917 KG

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)


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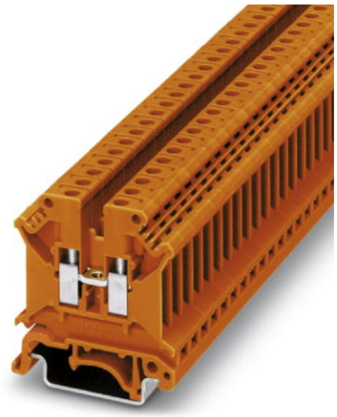
Extract from the online catalog

UK 5 N OG

Order No.: 3002908



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3002908

Feed-through modular terminal block, Type of connection: Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: orange, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Commercial data	
EAN	4017918117498
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 KG

http://www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Accessories

Item	Designation	Description
Assembly		
3003224	ATP-UK	Partition plate, Length: 56 mm, Width: 1.5 mm, Height: 59 mm, Color: gray

3022218	CLIPFIX 35	Snap-on end bracket, for 35 mm NS 35/7.5 or NS 35/15 DIN rail, can be fitted with Zack strip ZB 8 and ZB 8/27, terminal strip marker KLM 2 and KLM, width: 9.5 mm, color: gray
3003020	D-UK 4/10	End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray
1201442	E/UK	End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail
1024014	EA 5	Single covers, color: transparent
1024085	EA 5-WS	Single covers, for covering one terminal block, with black symbol (lightning flash) snap fit, color: transparent/yellow
0201595	FB-150 METER	Cross connection rail, for fixed bridging of identical inputs and outputs, made of Cu, nickel-plated, 1 m long
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
0204110	STL 10N/5N	Cross connector/bridge, Color: aluminum
0204107	STL 35/ 5	Cross connector/bridge, Color: white aluminum
1302215	TS-K	Separating plate, Length: 22.7 mm, Height: 30.5 mm, Color: gray
2303608	ZSR	Distance piece, metal, for branches of FB-150, with screw and thrust washer
0200017	ZSR-EX	Distance piece, metal, for branches of FB-150, with screw and thrust washer

Bridges

0201155	EB 2- 6	Cross connector/bridge, Number of positions: 2, Color: gray
0201142	EB 3- 6	Cross connector/bridge, Number of positions: 3, Color: gray
0201139	EB 10- 6	Cross connector/bridge, Number of positions: 10, Color: gray
0201456	FB 2- 6-EX	Cross connector/bridge, Number of positions: 2, Color: aluminum
0201469	FB 3- 6-EX	Cross connector/bridge, Number of positions: 3, Color: aluminum
0201029	FB 5- 6	Cross connector/bridge, Number of positions: 5, Color: aluminum
0201184	FB 10- 6	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201281	FB 10- 6-EX	Cross connector/bridge, Number of positions: 10, Color: aluminum
0201524	FB 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0203438	FBI 2- 6	Cross connector/bridge, Number of positions: 2, Color: aluminum
0203250	FBI 10- 6	Cross connector/bridge, Number of positions: 10, Color: silver
0201650	FBI 100- 6	Cross connector/bridge, Number of positions: 100, Color: aluminum
0201867	FBI 20- 6	Cross connector/bridge, Number of positions: 20, Color: aluminum
1302338	IS-K 4	Bridge bar isolator, Color: gray
0301505	ISSBI 10- 6	Switching jumper, Number of positions: 10, Color: silver
0201485	KB- 6-EX	Cross connector/bridge, Number of positions: 1, Color: silver
0202280	LB 10-6 BU	Cross connector/bridge, Number of positions: 10, Color: blue
0202358	LB 10-6 GY	Cross connector/bridge, Number of positions: 10, Color: gray
0202293	LB 10-6 RD	Cross connector/bridge, Number of positions: 10, Color: red
0202303	LB 100-6 BU	Cross connector/bridge, Number of positions: 100, Color: blue
0202345	LB 100-6 GY	Cross connector/bridge, Number of positions: 100, Color: gray
0202316	LB 100-6 RD	Cross connector/bridge, Number of positions: 100, Color: red
2303239	USBR 2-7	Cross connector/bridge, Color: silver
2305538	USBRJ 2-7	Cross connector/bridge, Number of positions: 2, Color: silver

Marking

1007222	SBS 6:UNBEDRUCKT	Marker cards for modular terminal blocks, color: white
1004115	WS 3- 6	Warning plate, with 2 plastic screws, across 3 terminal blocks, pitch 6 mm
1004209	WS 4- 6	Warning plate, with 2 plastic screws, across 4 terminal blocks, pitch 6 mm
1004403	WS 5- 6	Warning plate, with 2 plastic screws, across 5 terminal blocks, pitch 6 mm
1050499	ZB 6:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

Plug/Adapter

0309523	KSS 3- 6	Short circuit connector, Number of positions: 3, Color: black
0301547	KSS 6	Short circuit connector, Number of positions: 2, Color: black
0201744	MPS-MT	Metal part
3001132	PS-UK 2,5 B/E	Test plugs, Color: red
3001239	PS-UK 2,5 B/Z-6	Test plugs, Color: red
3001462	PS-UK 3-5/Z-6	Test plug
0601292	PSB 3/10/4	Female test connector, Color: silver
0201304	PSBJ 3/13/4	Female test connector, Color: silver
0201647	RPS	Reducing plug, Color: gray

Diagrams/Drawings

Approbationslogos (EX-Bereich)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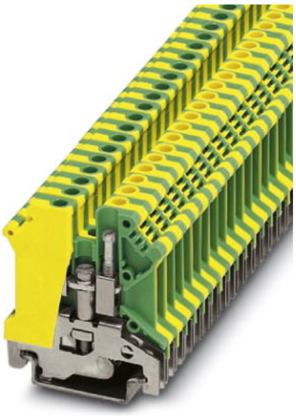
Extract from the online catalog

USLKG 5

Order No.: 0441504



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0441504

Ground modular terminal block, Type of connection: Screw connection, Screw connection, Cross section: 0.2 mm² - 6 mm², AWG 24 - 10, Width: 6.2 mm, Color: green-yellow, Mounting type: NS 35/7,5, NS 35/15, NS 32

Product notes

WEEE/RoHS-compliant since: 01/15/2005

Commercial data

EAN	4017918002190
sales group	A020
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.020842 KG
Catalog page information	Page 347 (CL-2009)

Technical data

General

Note	When aligning with a feed-through terminal block with the same shape, an end cover must be interposed with insulation voltages of > 690 V
Number of levels	1

Number of connections	2
Color	green-yellow
Insulating material	PA
Inflammability class acc. to UL 94	V0

Dimensions

Width	6.2 mm
Length	42.5 mm
Height NS 35/7,5	47 mm
Height NS 35/15	54.5 mm
Height NS 32	52 mm

Technical data

Rated surge voltage	8 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-2
Open side panel	nein

Connection data

Conductor cross section solid min.	0.2 mm²
Conductor cross section solid max.	6 mm²
Conductor cross section stranded min.	0.2 mm²
Conductor cross section stranded max.	4 mm²
Conductor cross section AWG/kcmil min.	24
Conductor cross section AWG/kcmil max	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm²
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm²
Conductor cross section stranded, with ferrule with plastic sleeve max.	2.5 mm²
2 conductors with same cross section, solid min.	0.2 mm²
2 conductors with same cross section, solid max.	1.5 mm²
2 conductors with same cross section, stranded min.	0.2 mm²

2 conductors with same cross section, stranded max.	1.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm²
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm²
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm²
Type of connection	Screw connection
Stripping length	8 mm
Screw thread	M3
Tightening torque, min	0.6 Nm
Tightening torque max	0.8 Nm

Diagrams/Drawings

Circuit diagram

Approbationslogos (EX-Bereich)

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Extract from the online catalog

D-UK 4/10

Order No.: 3003020

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=3003020

End cover, Length: 42.5 mm, Width: 1.8 mm, Height: 35.9 mm, Color: gray

Commercial data	
EAN	4017918090425
sales group	A090
Pack	50 pcs.
Customs tariff	85389099
Weight/Piece	0.002536 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

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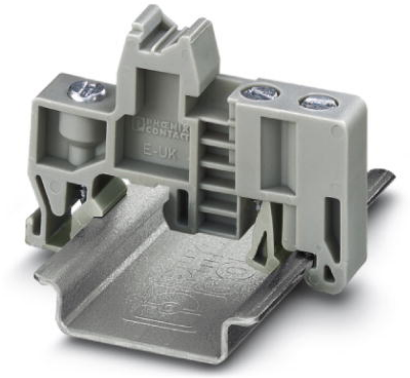
Extract from the online catalog

E/UK

Order No.: 1201442



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=1201442

End clamp, for assembly on NS 32 or NS 35/7,5 DIN rail

Product notes

WEEE/RoHS-compliant since:
07/01/2005

Commercial data	
EAN	4017918017323
sales group	B220
Pack	50 pcs.
Customs tariff	39269097
Weight/Piece	0.009354 KG
Catalog page information	Page 696 (CL-2009)

Technical data

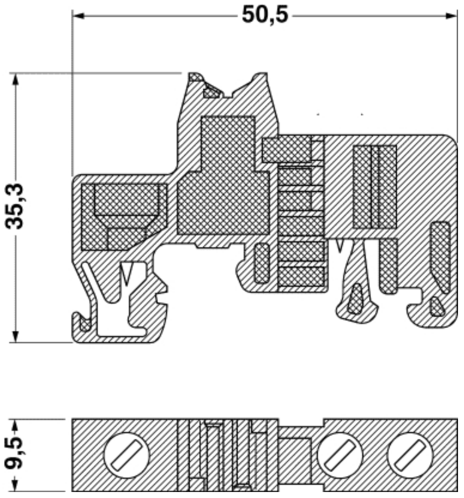
General	
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

Accessories

Item	Designation	Description
Assembly		
1201028	NS 32 AL UNPERF 2000MM	G rail 32 mm (NS 32)
1201280	NS 32 CU/120QMM UNPERF 2000MM	G-profile DIN rail, deep-drawn, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201358	NS 32 CU/35QMM UNPERF 2000MM	G-profile DIN rail, material: Copper, unperforated, height 15 mm, width 32 mm, length 2 m
1201002	NS 32 PERF 2000MM	G-profile DIN rail, material: Steel, perforated, height 15 mm, width 32 mm, length 2 m
1201015	NS 32 UNPERF 2000MM	G-profile DIN rail, material: Steel, unperforated, height 15 mm, width 32 mm, length 2 m
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
Marking		
1004089	UBE + ES/KMK 3	Marker carrier, color: Gray for marking groups of terminals, for end clamp E/UK or end clamp E/U, with perforated insert strips, 40 x 17 mm, can be labeled with CMS system
1051003	ZB 6:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 6.2 mm, color: white

Diagrams/Drawings

Dimensioned drawing



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Extract from the online catalog

FBI 2- 6

Order No.: 0203438

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203438

Cross connector/bridge, Number of positions: 2, Color: aluminum

Product notes

WEEE/RoHS-compliant since:
01/01/2003

Commercial data	
EAN	4017918104122
sales group	A900
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.00349 KG

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Extract from the online catalog

FBI 10- 6

Order No.: 0203250

http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=0203250

Cross connector/bridge, Number of positions: 10, Color: silver

Commercial data	
EAN	4017918098070
sales group	A900
Pack	10 pcs.
Customs tariff	85389099
Weight/Piece	0.01615 KG
Catalog page information	Page 343 (CL-2009)

Product notes

WEEE/RoHS-compliant since:
01/01/2003

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K2A25U : TWO:14 STR-1/0 STR DUAL

ACTIVE

RoHS compatible

www.fci.com

BURNDY® PRODUCTS

Specifications

General

Number of Conductors	2
Number of Screws	1
Number of Stud Holes	1 Hole

Dimensional

Stud Hole (Size)	1/4 in.

Physical

Conductor Size	14 AWG 2 AWG 1 AWG 4 AWG 1/0 AWG 8 AWG 12 AWG 10 AWG 6 AWG
Installation Torque	50 in. lb.
Conductor Size (Range)	14 AWG to 1/0 AWG

Approvals / Certifications

UL Listed	Yes
CSA Certified	Yes

Other Features

Set Screw Type	Slot
UPC	78181060004
Keyword	kau

T1-E Duct Series

Contact your local representative or the IBOCO sales office for more information.

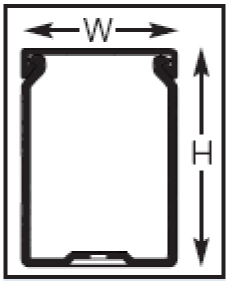
MATERIAL:
Rigid PVC,
self-extinguishing

COLOR:
light GREY RAL 7030
WHITE

STANDARD LENGTH:
6 Feet 6 3/4 Inches

STANDARD UNIT:
Duct complete with cover

Catalog Number	Nominal Size (WxH)	Dimensions inches (Actual)				Dimensions W x H (millimeters)	Standard Carton Length (1)	(QTY) Feet
		W	H	E	F			
T1E-1015 *	1 x 1 1/2	1.00	1.57	.16	.24	25 x 40	18	108
T1E-1022 *	1 x 2 1/4	1.00	2.36	.16	24	25 x 60	24	144
T1E-1030 *	1 x 3	1.00	3.15	16	.24	25 x 80	24	144
T1E-1040 *	1 x 4		.			25 x 100	8	48
T1E-1515 *	1 1/2 x 1 1/2	1.57	1.57	.16	.24	40 x 40	20	120
T1E-1522 *	1 1/2 x 2 1/4	1.57	2.36	.16	.24	40 x 60	18	108
T1E-1530 *	1 1/2 x 3	1.57	3.15	.16	24	40 x 80	16	96
T1E-1540 *	1 1/2 x 4	1.57	3.94	.16	.24	40 x 100	8	48
T1E-2222 *	2 1/4 x 2 1/4	2.36	2.36	.16	.24	60 x 60	12	72
T1E-2230 *	2 1/4 x 3	2.36	3.15	.16	.24	60 x 80	12	72
T1E-2240 *	2 1/4 x 4	2.36	3.94	.16	.24	60 x 100	4	24
T1E-3015G	3 x 1 1/2	3.15	1.57	.16	.24	80 x 40	12	72
T1E-3022 *	3 x 2 1/4	3.15	2.36	.16	.24	80 x 60	12	72
T1E-3030 *	3 x 3	3.15	3.15	.16	.24	80 x 80	12	72
T1E-3040 *	3 x 4	3.15	3.94	.16	.24	80 x 100	4	24
T1E-4015G	4 x 1 1/2	3.94	1.57	.16	.24	100 x 40	8	48
T1E-4022G	4 x 2 1/4	3.94	2.36	.16	.24	100 x 60	8	48
T1E-4030 *	4 x 3	3.94	3.15	.16	.24	100 x 80	8	48
T1E-4040 *	4 x 4	3.94	3.94	.31	.47	100 x 100	4	24



Example: T1E-1015G = 1" x 1 1/2" light GREY duct with cover

(1) Each standard length is actually 6'6 3/4" but is counted as 6 feet for packaging and pricing

* Color - add suffix "G" fro light GREY, "W" for WHITE

ADHESIVE BACKING - add suffix "A" to catalog number - contact sales office for pricing

Technical Characteristics

IBOCO Wiring products respond to all installation needs, coping with different uses and environment applications. They are manufactured with high quality materials that undergo severe quality controls and performance tests under extreme operating and duration conditions witha constant control of quality standards.

Wiring Ducts T1, T1E, SEP-E and CL are manufactured in rigid Self-Extinguishing PVC.

Those components for which high bending resilience is required are in polyamide 6 and polypropylene.

Spiralite is manufactured in natural polyethylene and self-extinguishing polyethylene.

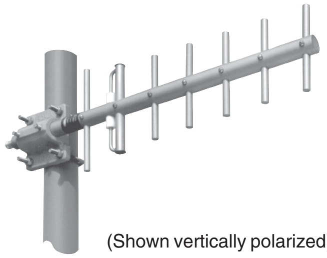
Materials Technical Characteristics	Unit of Measure	Standard	PVC Duct Value	PVC Moulded Components Value	Polyamide 6 Value	Polyethylene Value	Flame Retardant Polyethylene Value
CHEMICAL-PHYSICAL PROPERTIES							
Specific gravity	g/cm^3	ASTM D792	1.55	1.32	1.14	0.92	0.97
H2O 73,4 F absorbtion	%	ISO 62	<0,1	2,5	2,5	<0,1	<0,1
Formaldehyde	ppm	-	absent	absent	absent	absent	absent
Cadmium	ppm	-	absent	absent	absent	absent	absent
MECHANICAL PROPERTIES							
Tensile stress at break	MPa	ASTM D638	39	30	45	17	15
Traction strength	MPa	ASTM D638	44	27	55	9,5	9
Elongation at break	%	ASTM D638	130	97	250	400	600
Modulus of elasticity at traction	MPa	ASTM D638	4400	-	950	-	240
Modulus of elasticity at flexion	MPa	ASTM D790	3200	-	1100	210	130
THERMAL PROPERTIES							
Temperature VICAT	C	ASTM D1525	84	70	198	89	-
HDT	C	ASTM D648	72	60	185	-	-
Coefficient of expansion	K^-1	ASTM D696	6 10^-5	8 10^-5	8-10 10^-5	22 10^-5	10^-5
Specific heat	kJ/kgK	ASTM C351	0,94	1,24	1,7	-	-
Thermal conductivity	W/mK	ASTM C177	0,14	0,14	0,29	0,32	0,32
ELECTRICAL PROPERTIES							
Dielectric constant	-	ASTM D150	3,2 - 4,0	3,2	5,0	2,4	2,3
Dielectric strength	kV/mm	IEC 243	70	60	35	90	90
Surface resistance	Ohm	IEC 93	10^13	10^13	5 10^11	10^13	10^13
SELF-EXTINGUISING							
Self-extinguising 1,6 millimeters	-	UL 94	V0	V0	V2	HB	V2
Self-extinguishing 3,2 millimeters	-	UL 94	V0	V0	V2	HB	V2
Glow wire test (2 mm)	C	IEC 695-2-1	960	960	650	650	850
Oxygen number	%	ASTM D2863	43	34	25	-	25

KATHREIN
SCALA DIVISION

TY-900
Yagi Antenna

The Kathrein-Scala TY series are rugged broadband yagi antennas fabricated of 6061/T6 aluminum rod and seamless drawn pipe, anodized for maximum reliability and corrosion resistance. The hardware and fastenings are stainless steel. The internal balun, coax feed and connector are sealed in a foam potting system to prevent moisture penetration and assure long service life in severe environmental conditions. The heavy aluminum mounting casting allows installation for V or H polarization.

- The TY-900 is specifically designed for professional fixed-station applications in the 890–960 MHz band.

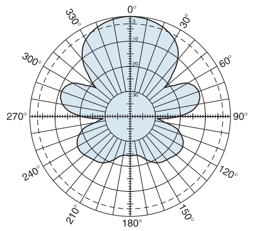

(Shown vertically polarized)

Specifications:

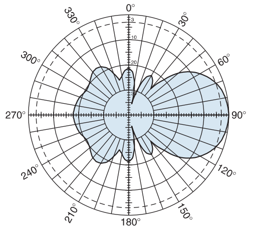
Frequency range	890–960 MHz (broadband)
Gain	10 dBd
Impedance	50 ohms
VSWR	< 1.5:1 maximum (1.35:1 typical)
Polarization	Horizontal or vertical
Front-to-back ratio	>20 dB
Maximum input power	100 watts (at 50°C)
H-plane beamwidth	48 degrees (half-power)
E-plane beamwidth	40 degrees (half-power)
Connector	N female
Weight	3 lb (1.4 kg)
Dimensions	23 x 7 inches (584 x 178 mm)
Equivalent flat plate area	0.24 ft^2 (0.022 m^2)
Wind survival rating*	150 mph (240 kph)
Shipping dimensions	28 x 10 x 4.5 inches (710 x 254 x 114 mm)
Shipping weight	5.0 lb (2.3 kg)
Mounting	For masts of 1.25 to 2.375 inch (32 to 60 mm) OD.

See reverse for order information.

* Mechanical design is based on environmental conditions as stipulated in EIA-222-F (June 1996) and/or ETS 300 019-1-4 which include the static mechanical load imposed on an antenna by wind at maximum velocity. See the Engineering Section of the catalog for further details.



H-plane
Horizontal pattern – V-polarization
Vertical pattern – H-polarization

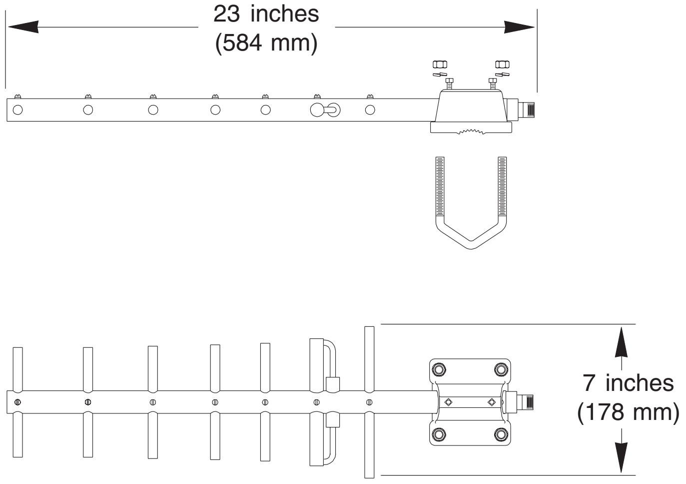


E-plane
Horizontal pattern – H-polarization
Vertical pattern – V-polarization

10065-D

KATHREIN
SCALA DIVISION

TY-900
Yagi Antenna



Order Information:

Model	Description
TY-900	Yagi antenna with N connector

All specifications are subject to change without notice

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System Controls & Instrumentation, Ltd

11218 IH-10 E.
Converse, TX 78109
Phone: 210-661-9901
Fax: 210-666-5575

1108 Quail Hollow
Laredo, TX 78045
Phone: 956-725-1239
Fax: 956-726-1774

TECL # 18461

29-Apr-10

Camp Stanley Storage
Bioreactor Facility
Bldg. 903

REMOTE RTU903-4

DRAWINGS

SCI FILE 2829

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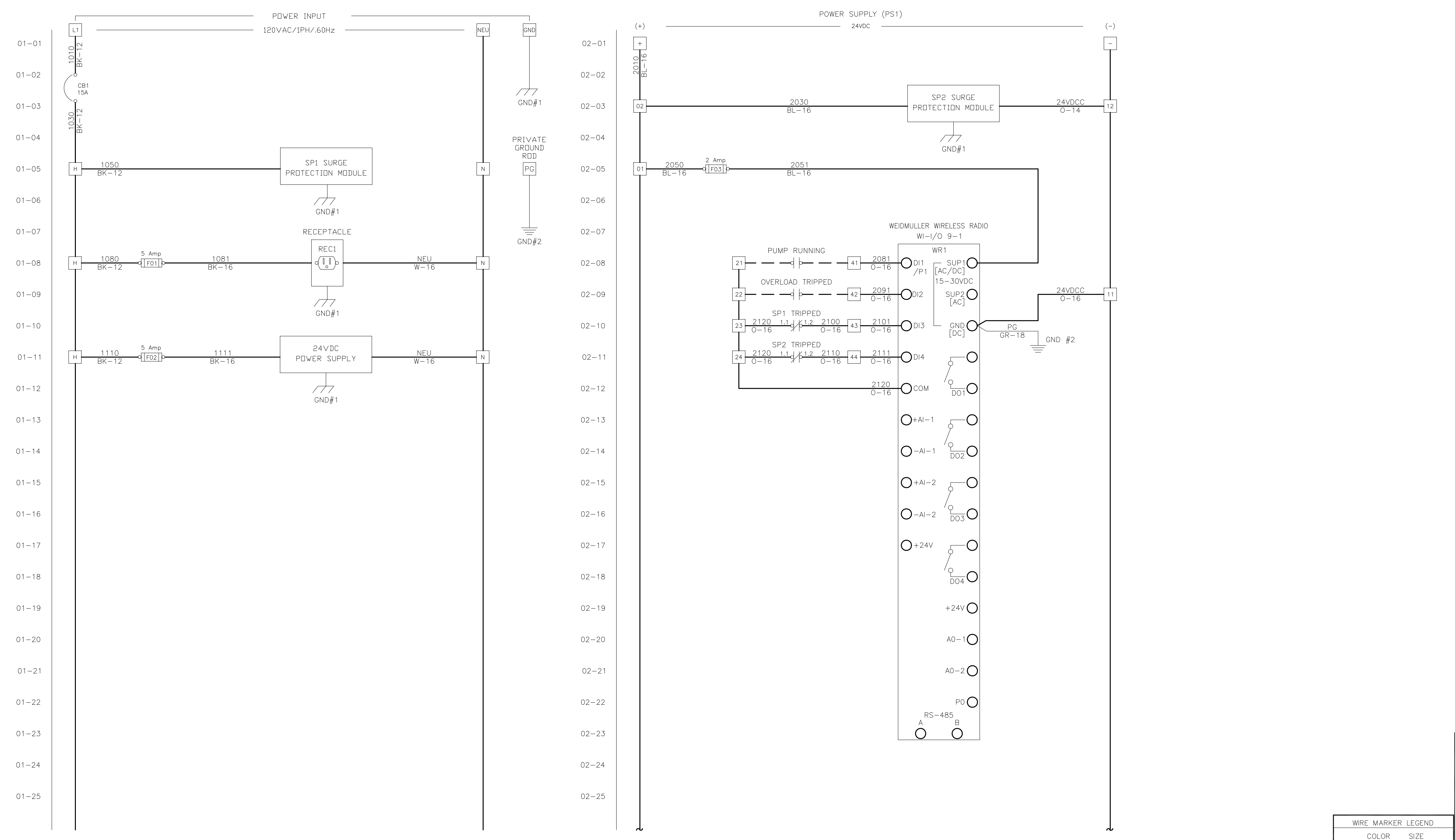


WIRE MARKER LEGEND

COLOR SIZE

Y-18

NOTE 1: DASHED LINES INDICATE FIELD WIRING

COLOR CODE	
CLR	CLEAR
BK	BLACK
BR	BROWN
R	RED
OR	ORANGE
Y	YELLOW
G	GREEN
BL	BLUE
PU	PURPLE
GY	GREY
W	WHITE

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

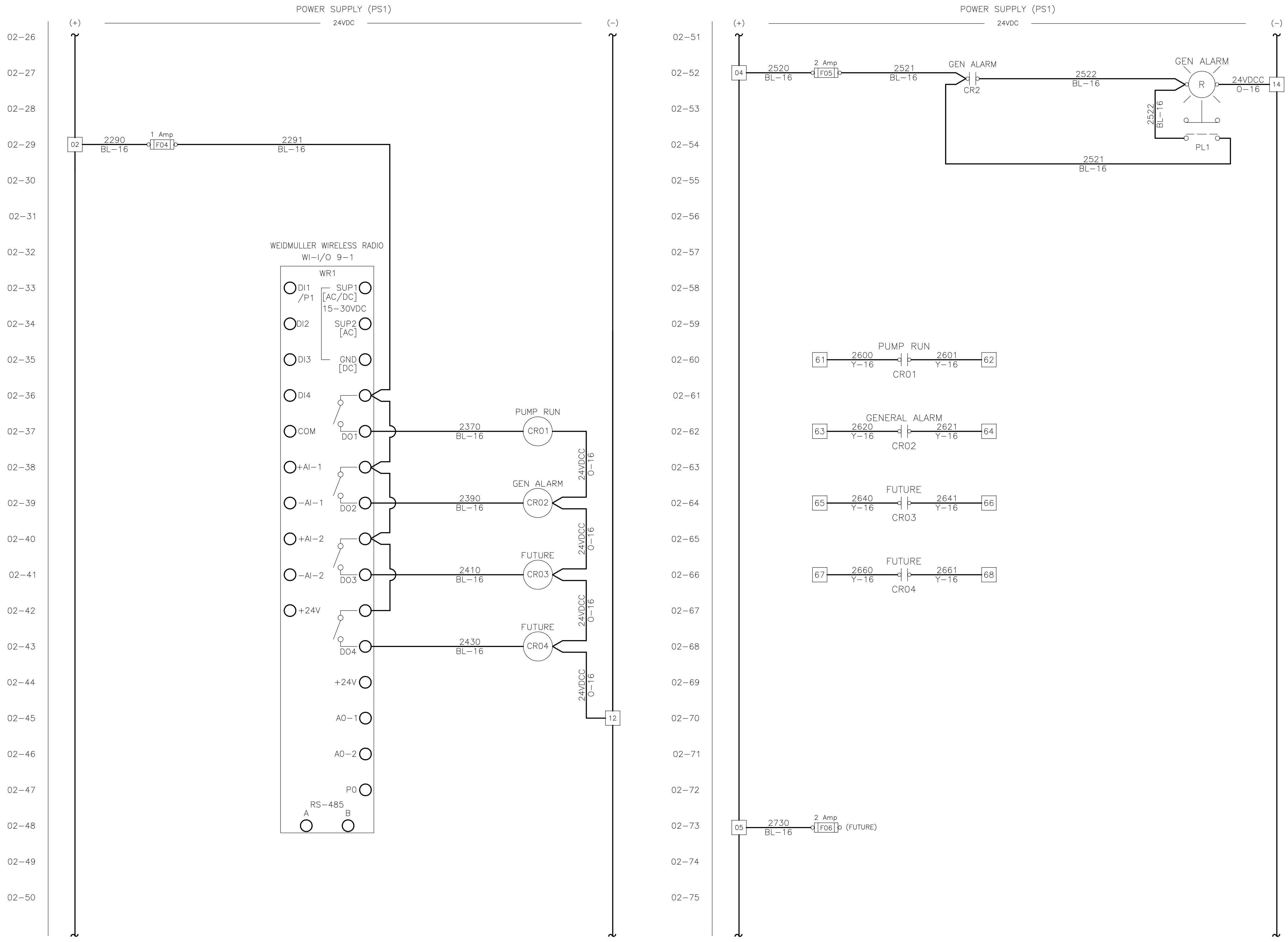
11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 WIRING DIAGRAM

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 1
OF 7



NOTE 1: DASHED LINES INDICATE FIELD WIRING

WIRE MARKER LEGEND
COLOR SIZE
Y−18

COLOR CODE	
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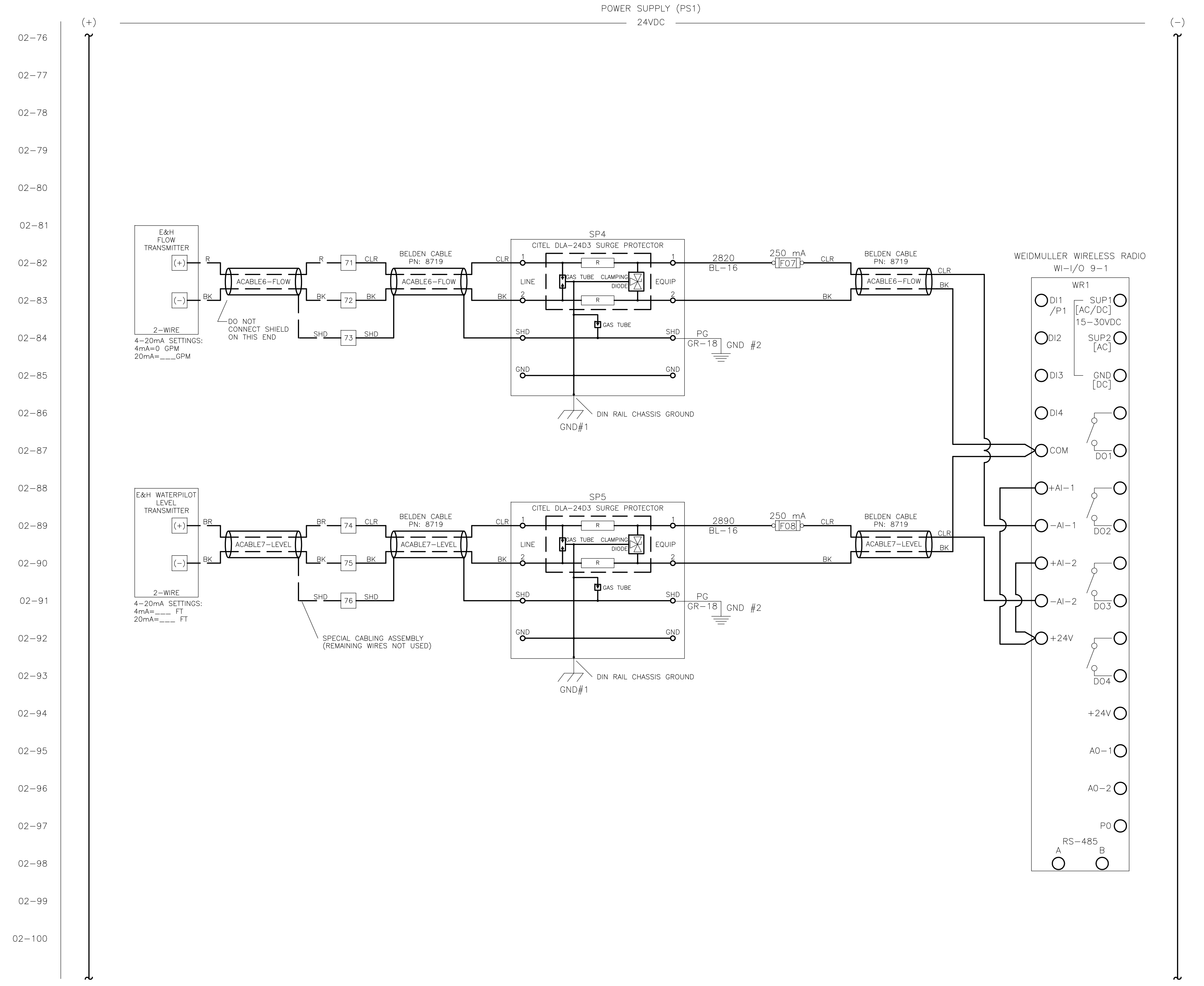
OF 7



NOTE 1: DASHED LINES INDICATE FIELD WIRING

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Y-18

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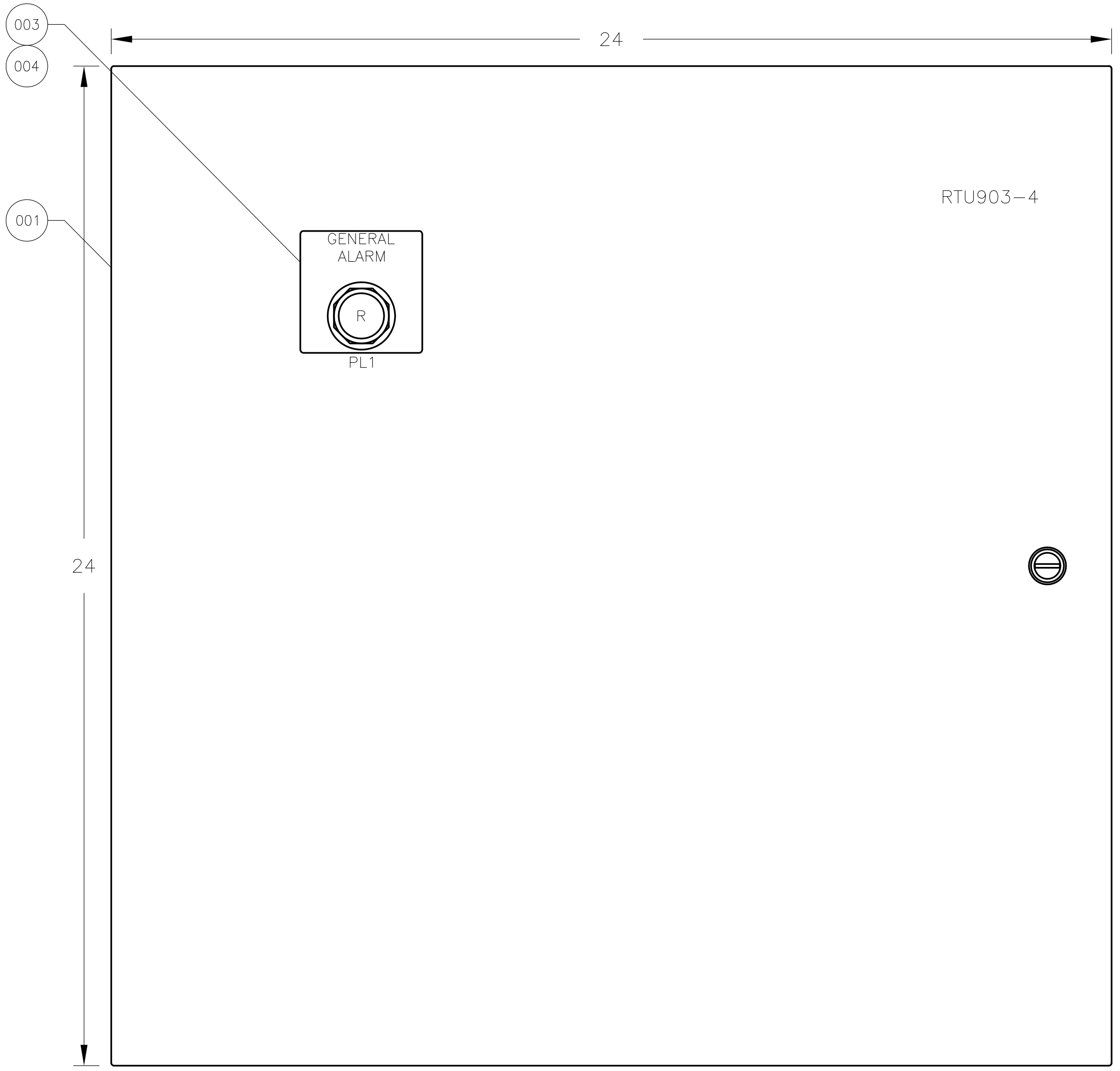

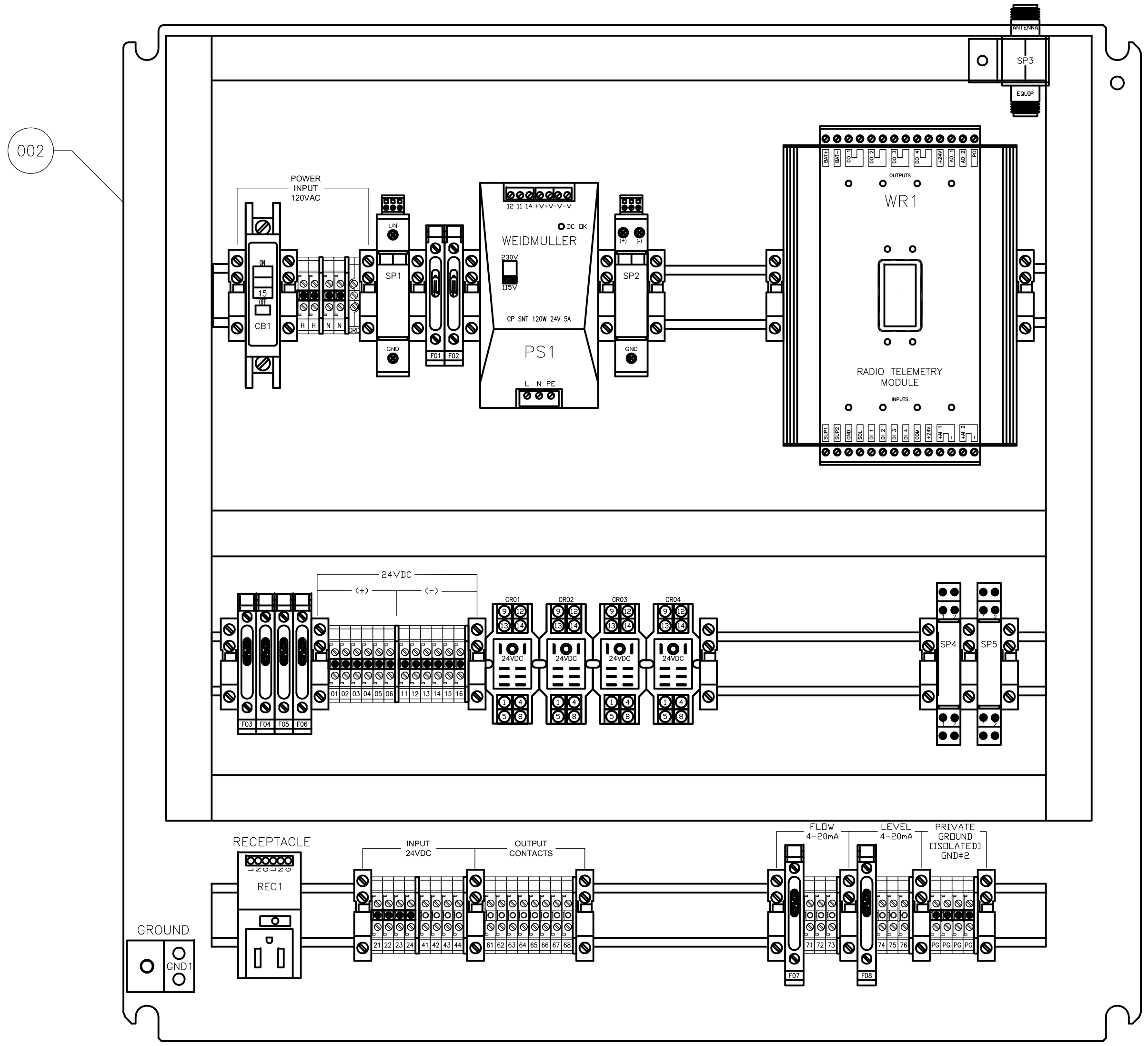

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11218 IH-10 EAST
CONVERSE, TEXAS 78109
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ENGINEER

PROJECT TITLE

CAMP STANLEY
BIOREACTOR

SHEET TITLE

RTU 903-4
WELL #2 BACK PANEL LAYOUT

DATE:	3/1/2010
SCALE:	N/A
DRAWN BY:	RMF
CAD FILE	SCI2829_RTU903-4

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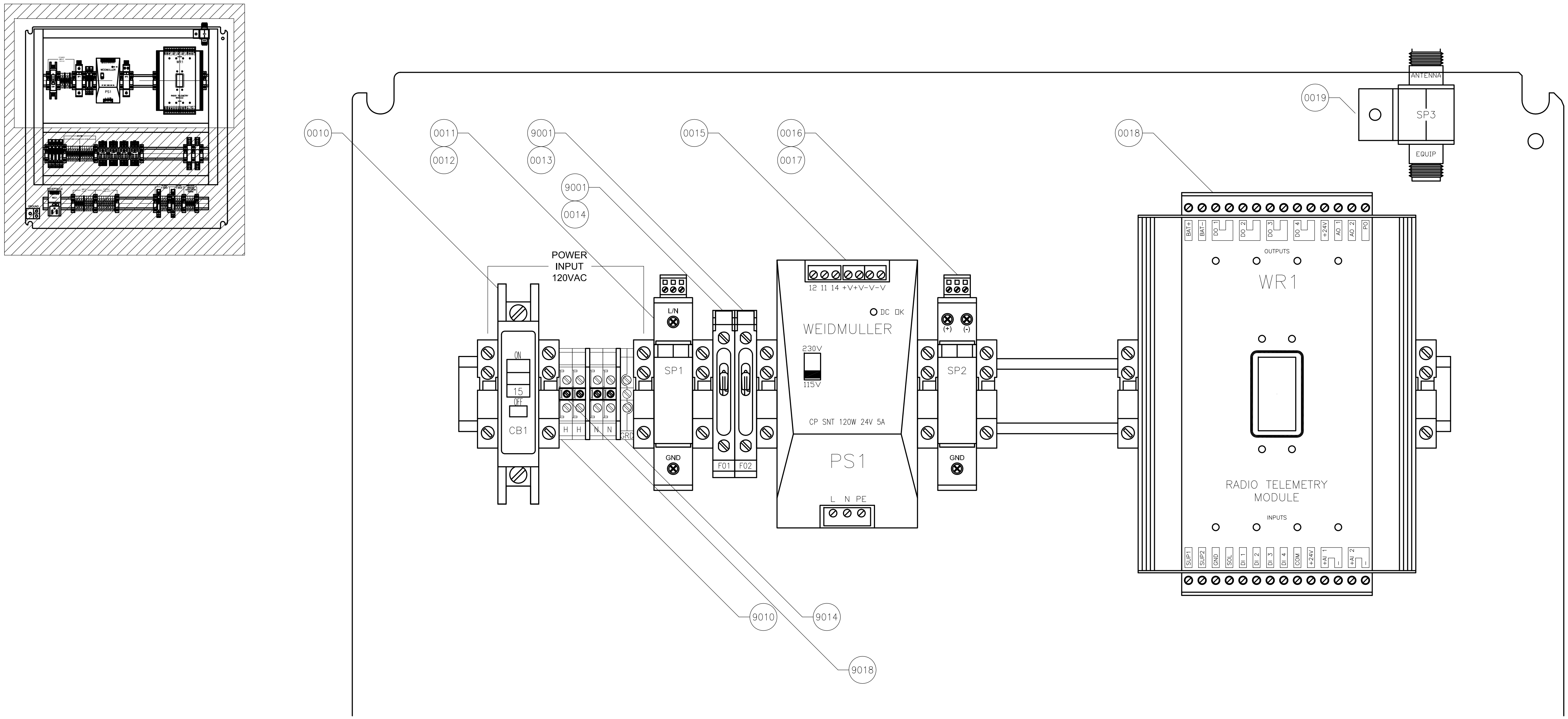

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CONVERSE, TEXAS 78109
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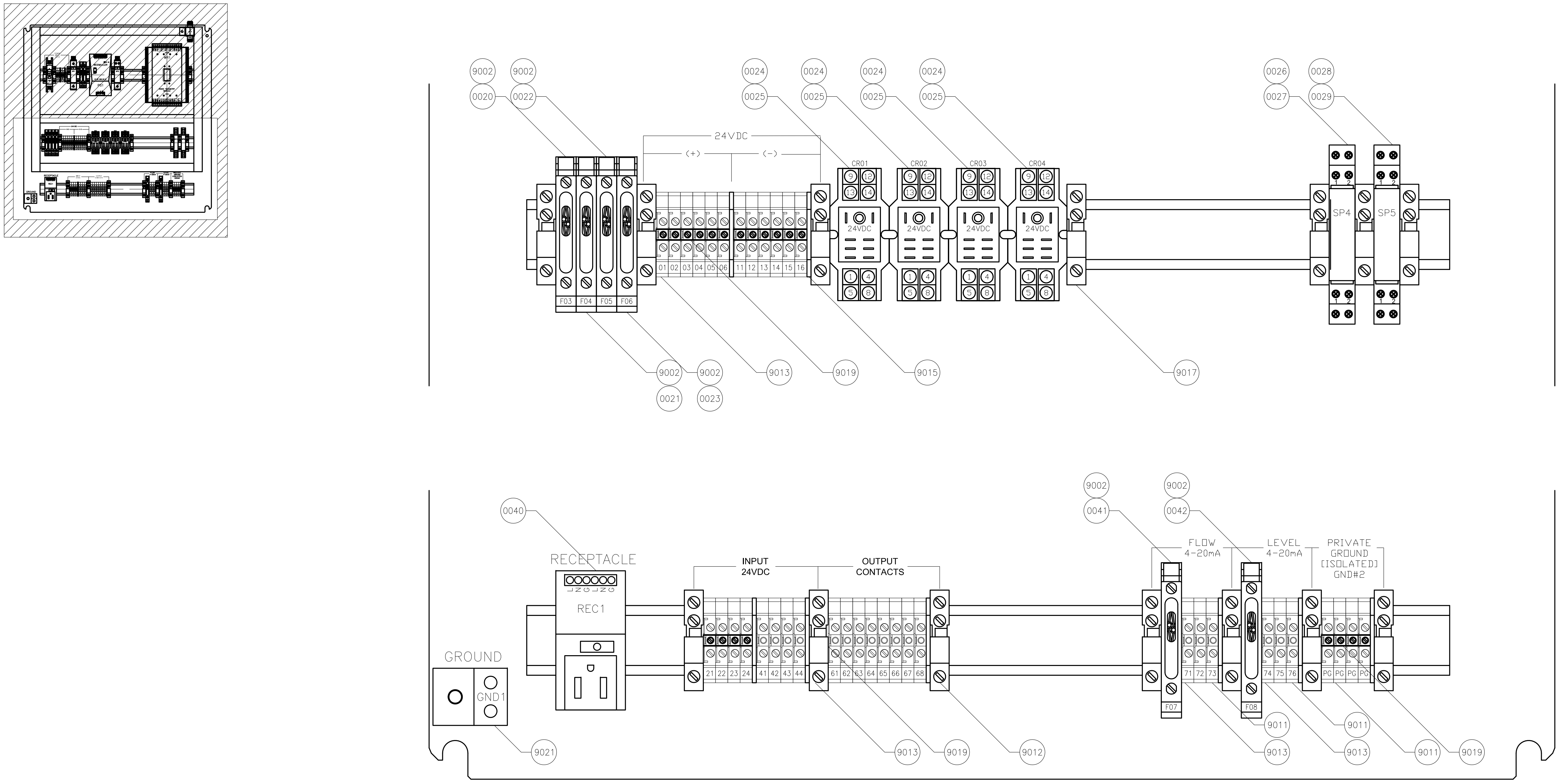
ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 PARTS LAYOUT

DATE: 3/1/2010
SCALE: 1:2
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 5
OF 7



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DRAWN BY: RMF
CAD FILE: SCI2829_RTU903-4
DWG. NO. 2829
SH 6 OF 7

BILL OF MATERIALS

ITEM_ID	DEVICE_ID	QUANTITY	DESCRIPTION	MFG_#	MFG_NAME
0001	RTU903-4	1	CONCEPT ENCLOSURE, 24"HX24"WX10"D NEMA 4, 304SS	CSD242410SS	HOFFMAN
0002	RTU903-4	1	CONCEPT ENCLOSURE BACK PANEL, 24"X24"	CP2424	HOFFMAN
0003	PL1	1	PUSH BUTTON PILOT LED, 30.5MM, 24VDC, RED LENS, 1NO / 1NC	800T-QBH24R	AB
0004	PL1	1	PLASTIC LABEL, 30.5MM PILOT LAMP, RED W/WHITE LETTERING, 2.4"WX2.4"H		SCI
0010	CB1	1	CIRCUIT BREAKER, 15A, UL489, 10K AIR, 1-#14-#2, CU OR AL	QOU115	SQD
0011	SP1	1	SURGE PROTECTION MODULE, 120VAC, IMAX:40KA, VMAX: 150V	DS41-120	CITEL
0012		1	HOLDER, SURGE PROTECTION	DS41-120	CITEL
0013		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0014		1	FUSE, TIME DELAY FURRULE, 5A, 250VAC, 1/4"X1.25"	MDL-5	BUSSMANN
0015	PS1	1	POWER SUPPLY, TS-35 DIN-RAIL MOUNT, 88-132VAC, 176-264VAC, 3A@115VAC/2A@230VAC, 50/60HZ, 24-28VDC, 5.0A, 120W	CP SNT 120W 24V 5A	WEIDMULLER
0016	SP2	1	SURGE PROTECTION MODULE, 24VDC, IMAX:2KA, VMAX: 30V	DS220-24DC	CITEL
0017		1	HOLDER, SURGE PROTECTION	DS220-24DC	CITEL
0018	WR1	1	WIRELESS RADIO, DIN-RAIL MOUNT, 15-30VDC, 4 INPUTS, 2- 4-20MA INPUTS, 4 OUTPUTS, 2- 4-20MA OUTPUTS, RS232/RS485	WI-I/O 9-1	WEIDMULLER
0019	SP3	1	SURGE PROTECTOR, GAS TUBE, DC-5GHZ, 50 OHM, MAX POWER: 25W, VSWR: 1.2:1, SURGE 20KA, N-FEMALE X N-FEMALE, BULKHEAD MOUNT	P8AX09-N/FF	CITEL
0020		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0021		1	FUSE, FAST ACTING FURRULE, 1A, 250VAC, 1/4"X1.25"	AGC-1	BUSSMANN
0022		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0023		1	FUSE, FAST ACTING FURRULE, 2A, 250VAC, 1/4"X1.25"	AGC-2	BUSSMANN
0024		4	RELAY MOUNTING SOCKET, DIN RAIL, 2PDT, 300V/10A, 2-#12	SH2B-05	IDEC
0025		4	RELAY, 2PDT, COIL: 24VDC/ 36.9MA, 1/6HP, W/INDICATOR & CHECK BUTTON	RH2B-ULC-DC24V	IDEC
0026	SP4	1	SURGE PROTECTION MODULE, 4-20MA, IMAX:20KA, VMAX: 28VDC	DLA-24D3	CITEL
0027		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-24D3	CITEL
0028	SP5	1	SURGE PROTECTION MODULE, 4-20MA, IMAX:20KA, VMAX: 28VDC	DLA-24D3	CITEL
0029		1	HOLDER, SURGE PROTECTION, DLA SERIES	DLA-24D3	CITEL
0040	REC1	1	RECEPTACLE, SIMPLEX 15A, 120VAC, UL, T35 DIN RAIL MOUNT	991548	WEIDMULLER
0041		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
0042		1	FUSE, FAST ACTING FURRULE, 250MA, 250VAC, 1/4"X1.25"	AGC-1/4	BUSSMANN
9001		2	FUSE BLOCK, ILL 110-250V, 600V/10A, 26-8AWG	UK 6,3-HESILA 250	PHOENIX
9002		6	FUSE BLOCK, ILL 15-30V, 600V/10A, 26-8AWG	UK 6,3-HESILED 24	PHOENIX
9010		4	TERMINAL BLOCK, GRAY, 600V/30A, 30-10AWG	UK 5 N	PHOENIX
9011		6	TERMINAL BLOCK, GREEN, 600V/30A, 30-10AWG	UK 5 N GN	PHOENIX
9012		8	TERMINAL BLOCK, YELLOW, 600V/30A, 30-10AWG	UK 5 N YE	PHOENIX
9013		24	TERMINAL BLOCK, ORANGE, 600V/30A, 30-10AWG	UK 5 N OG	PHOENIX
9014		1	GROUND TERMINAL, 26-10AWG	UKLKG 5	PHOENIX
9015		10	END COVER PLATE, GRAY	D-UK 4/10	PHOENIX
9017		23	END CLAMP, GRAY	E/UK	PHOENIX
9018		2	CROSS CONNECTOR/JUMPER, 2 POSITION, AL	FBI 2-6	PHOENIX
9019		4	CROSS CONNECTOR/JUMPER, 10 POSITION, AL	FBI 10-6	PHOENIX
9021	GND1	1	GROUNDING LUG, 2 CONDUCTOR, 1/0-14AWG	K2A25U	BURNDY

REV #	DATE	REVISION

SYSTEM CONTROLS & INSTRUMENTATION

11218 IH-10 EAST
CONVERSE, TEXAS 78109
PHONE (210) 661-9901

ENGINEER

PROJECT TITLE
CAMP STANLEY
BIOREACTOR

SHEET TITLE
RTU 903-4
WELL #2 BILL OF MATERIALS

DATE: 3/1/2010
SCALE: N/A
DRAWN BY: RMF
CAD FILE SCI2829_RTU903-4
DWG. NO. 2829
SH 7
OF 7

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CALIBRATION NOTES

JOB: CSSA DATE: 4/15/2010
JOB NO: 2829 BY: RMF

PNL NO: 903-4

ANALOG CH: 1

MA	OHMS	DEC	N/A
4mA	6383	0	
12mA	1960	16372	
20mA	1072	32720	

ANALOG CH: 2

MA	OHMS	DEC	N/A
4mA	6381	0	
12mA	1960	16316	
20mA	1071	32657	

Appendix J

Westbay® Monitoring Well Operations and Repair Manual

OPERATIONS MANUAL

Westbay MOSDAX Sampler Probe - Model 2531

Schlumberger
WATER SERVICES

NOTICE

Operation of Westbay System equipment should only be undertaken by qualified instrument technicians who have been trained by Westbay authorized personnel.

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DO NOT OPEN THE SAMPLER

All warranties expressed or implied will be void if, after examination by Westbay Instruments Inc. personnel, it is established that any of the instrument housings have been opened without prior authorization from Westbay Instruments Inc.

DO NOT LET THE SAMPLER FREEZE

Extreme care should be taken to avoid freezing the MOSDAX Sampler probe. Permanent transducer damage may result from freezing.

Manual Revision: 1.13 20 October 2006

Issued for Serial No.: ____________________

Date: ____________________

Signature: ____________________

Contents

1. DESCRIPTION

1.1 MOSDAX Sampler Probe, Model 2531

The MOSDAX Sampler is a downhole probe designed to collect fluid pressure information and fluid samples from Westbay System monitoring wells. Each MOSDAX pressure sensor is calibrated over its full pressure range for nonlinearity and temperature variation. MOSDAX Sampler probes are available in a variety of pressure ranges to permit operation to various depths. The shoe and valve motors can be operated from the surface. The power for the shoe and valve motors is supplied from the surface.

1.2 MOSDAX Automated Groundwater Interface (MAGI), Model 2536

The MOSDAX Sampler can be operated directly by the keypad on the MOSDAX Automated Groundwater Interface (MAGI), or by a Hand Held Controller (HHC) connected to the MAGI, or with a computer running Microsoft Windows (2000 or higher) and Westbay software connected to the MAGI. The MAGI translates the signals between the computer or HHC and the MOSDAX Sampler. The MAGI requires 12 volt DC power to operate.

Older versions of MOSDAX sampling equipment may incorporate a Model 2522 MOSDAX PC Interface (MPCI) and HHC rather than a MAGI. For such systems, reference to the MAGI in this document can be considered as reference to the MPCI and HHC.

1.3 Cable Reels

The manual cable reel can operate all Westbay probes and tools to a depth of 300m (1,000 ft) on a single-conductor cable. The manual reel is hand operated with an internal brake to control the speed of descent of the probe in the well. The two-pin cable connects the MAGI to the reel and the signals pass through a slipring located in the hub of the reel into the control cable. For maintenance information, see the appropriate cable reel manual.

Motorized cable reels are available for deeper applications.

1.4 Sample Containers

Sample containers can be used with the MOSDAX Sampler. The nonvented stainless steel sample containers maintain samples under formation pressure while the sampler and container are brought to the surface.

2. PRESSURE PROFILING

2.1 Items Required

- MOSDAX Sampler Probe, Model 2531
- MAGI, Model 2536 with:
    - one two-pin data cable
    - one three-pin power cable
    - hand held controller with cable and user’s guide (optional)
    - computer running Windows 2000 or higher with one nine-pin computer cable and MProfile software (optional)
- MOSDAX-compatible winch with cable
- Sheave with counter and tripod
- 12 VDC, 2 Amp power source (Battery pack, car/truck battery, or transformer)
- Water level measuring tape
- MProfile User's Guide for computer or the Handheld Controller Operations Manual
- Westbay Casing Log showing depths to ports and couplings in hole to be tested.

2.2 Surface Checks

1. Remove the MOSDAX Sampler from its storage case. Inspect the probe housing and body for any damage. Please contact Westbay for advice on any cover tube damage.
2. Assemble the tripod and counter over the well. Run the cable over the counter.
3. Connect the probe to the cable. Before attaching, inspect the O-ring at the top of the probe and lubricate with silicon. The O-ring should be clean and intact. Tighten the nut hand tight only.
4. Connect the two-pin cable from the MPCI to the cable reel. With the MPCI OFF connect the three-pin cable from the MPCI to the 12 v power supply.
5. Connect the 9 pin cable from computer or HHC to the MPCI and turn the MPCI ON.
6. Perform the following surface checks to ensure that the location arm and the shoe mechanisms are operating normally: Release the location arm. The location arm should extend smoothly. The number of revolutions used to release the location arm is displayed and should be 15 to 16 revolutions. If a smaller number of revolutions is reported, retract the arm and repeat. Place the probe in a piece of Westbay casing or coupling. Activate the shoe. The shoe should extend and hold the probe firmly in the coupling or casing. The display should indicate 16 to 19 revolutions. A reading of 23 revolutions indicates the probe is activated in open air. Retract the backing shoe.

7. Check that the face plate for sampling and the plastic plunger are installed on the sampler.
8. The probe is now ready to be lowered down the well.

2.3 Pressure Measurement Procedures

1. Obtain the completed Westbay Casing Log.
2. With the location arm retracted, lower the probe into the Westbay casing to immediately below the lowest measurement port coupling to be monitored. If magnetic collars have been installed on the well, the Collar Detect Command can be used to detect the collars. The Collar Detect Command is cancelled by pressing any key.
3. Release the location arm. The display should update and beep after the arm is released.
4. Raise the probe about 0.5 m (1.5 ft) above this measurement port. If the probe is accidentally lifted above the next higher coupling, it will be necessary to retract the location arm and lower the probe to below the measurement port and release the arm.
5. Lower the probe gently until the location arm rests in the measurement port.
6. Record the pressure and temperature inside the Westbay casing.
7. Optional: If a water level tape is available, measure and record the depth to water in the Westbay casing.
8. Activate the shoe. The pressure on the display should change to the formation pressure.
9. When the reading has stabilized, record the formation pressure.
10. Once the pressure has been recorded, retract the shoe.
11. Record the pressure of the fluid in the Westbay casing. This reading should be similar to that recorded in Step 6. If a large difference is noted between the readings, record the water level inside the Westbay casing again using the water level tape.
12. The three pressure readings plus the time and water level constitute a complete set of readings at a measurement port coupling.
13. Continue up the Westbay casing to obtain the pressure data from other measurement ports.
14. Take one last set of pressure and temperature readings at the surface. These readings should be similar to those recorded in Step 2.

CAUTION: **If a water level tape was used, remove the water level tape from the Westbay casing before removing the sampler probe from the well to prevent them from becoming jammed.**

3. FLUID SAMPLING

3.1 Items Required

- MOSDAX Sampler, Model 2531
- MAGI, Model 2536 with:
  - one two-pin data cable
  - one three-pin power cable
  - hand held controller with cable and user's guide (optional)
  - computer running Windows 2000 or higher with one nine-pin computer cable and MProfile software (optional)
- MOSDAX-compatible winch with cable
- Sample containers and connecting tubes
- Westbay Casing Log
- Groundwater Sampling Field Data Sheet
- 12 VDC, 2 amp power source (battery pack, car/truck, or transformer)
- Counter and tripod
- Westbay Sampling Kit including vacuum pump

3.2 Surface Checks and Preparation

1. Set up the MOSDAX Sampler probe following Steps 1 through 8 of Section 2.2.
2. Attach the sample containers.
3. Release the location arm. Locate the probe in the vacuum coupling.
4. Activate the shoe in the vacuum coupling.
5. Close the sampler valve. The motor should run about 5 seconds. The display should indicate one revolution.
6. Use the vacuum pump to apply a vacuum through the vacuum coupling. The vacuum should remain constant. If the vacuum is not maintained, inspect for leaks at the face seal of the probe, the connection to the pump and at the probe sampling valve.
7. Once a vacuum has been maintained, open the sampler valve. Apply a vacuum again to check that all connections are sealed.
8. Close the sampler valve. A vacuum has now been applied to the sample bottles.
9. Retract the shoe.

3.3 Drillhole Sampling

1. Check recent pressure logs of the hole and ensure that the head inside the Westbay casing is lower than the head outside the measurement port to be sampled.
2. After completing the surface checks, follow Steps 1 to 5 of Section 2.3 to locate the sampler at the measurement port in the monitoring zone to be sampled.
3. Record the pressure reading.
4. Activate the probe and record the formation pressure.
5. Open the sampler valve. The pressure should drop and then slowly increase as the bottles fill. When the pressure in the bottle equals the zone pressure from Step 4, the bottle is full. Wait a maximum of two minutes per sample bottle even if the pressures are not equal.
6. Close the sampler valve and retract the shoe.
7. Record the pressure reading. A reading the same as in Step 3 indicates that the sample is OK.
8. Reel the sampler to the surface and remove it from the Westbay casing.
9. **Do not open the sampler valve as damage to the probe or injury to the operator could occur.**
10. Remove the cap from the bottom sample bottle and open the valve on the bottle to release the pressure and to transfer the sample.
11. Open the sampler valve to allow the sample to flow from the bottles. Once the pressure in the sampler and bottles has decreased to atmospheric, the bottles may be disconnected to speed the process.
12. Take particular care in handling pressurized samples.

3.4 Rinsing Instructions

Rinse the sampler around the face seal and the bottom connector. With the sampler valve open, flush the interior of the sampler from the bottom connector. Rinse the sample bottles and connectors.

Note: Project specific procedures for decontaminating the sampler and sample bottles are the responsibility of the project manager and are not covered in this manual.

4. Care and Maintenance

The MOSDAX Sampler System must be routinely maintained for optimum performance. The procedures outlined here are required to keep the instrument operating properly. For any additional information or advice, please contact Westbay Instruments Inc.

4.1 MAGI

The MAGI should be cleaned to remove dirt and dust and inspected for damage or wear. If any part requires replacement, contact Westbay for information.

4.2 Cable Reels and Control Cable

The cable reels should be kept clean and protected from damage. The cable and cable head should be inspected for kinks and corrosion. Rehead the cable if necessary. For more information concerning cable reels and the control cable, refer to the appropriate reel manual.

4.3 MOSDAX Sampler Probe

1. Never allow the probe to freeze or the pressure transducer may be damaged.
2. Clean and inspect the probe for dents and scratches on the cover tube. Clean the threads with a nylon brush, such as a toothbrush. DO NOT use a wire brush. Protect the O-rings from damage and dirt.

4.3.1 Face Seal

Inspect the face seal and replace if damaged or worn.

1. Remove the two screws holding the face plate to the probe body and lift the face plate off.
2. Remove the face seal and plunger. Set the location arm assembly aside. Clean the plunger and probe body.
3. When reinstalling the face plate hold the face seal, plunger and location arm assembly in place. Replace the two screws the hold the face plate on the probe.

4.3.2 Location Arm

Release the location arm. Check that the arm moves smoothly and freely and check for damage and sharp edges due to wear. Replace the location arm if necessary.

1. Release the location arm. Remove the two screws and face plate (Section 4.3.1).
2. Remove the location arm with its spring and pivot pin. Clean and inspect all parts and replace if needed.
3. Insert the spring and pivot in the location arm and place the assembly in the probe body. Place the face plate over the face seal and location arm and tighten the two screws.

SECTION 4.3.2 SUPPLEMENT

WESTBAY Probe Location Arm replacement

a) It is easier when the arm is first extended to the "out" position (Fig. A). Do this before powering down and disconnecting the probe.

b) Remove the face seal slowly and stabilize the arm as it is under tension from the spring (Section 4.3.2.2) and may suddenly pop out. Observe the position and orientation of the parts as they are removed (Fig. B).

c) Insert the hook of bent leg of the spring into the tiny hole on the neck of the new arm and align the spring coil opening alongside the larger hole in the arm with the spring leg positioned directly against the arm and over the pivot facing out (Fig. C-1). The metal pivot pin goes through the hole in the arm and through the spring coil (Fig. C-2). The straight leg of the spring leads under the pivot into the smaller side slot on the side of the main arm aperture, parallel with the probe. Place the assembly into its space in the probe body (Fig. C-3). The arm assembly has to be held in place while replacing the face seal to counter the force of the slightly compacted spring (Fig.C-4).

d) Replace the face seal by sliding it toward the top of the probe and sliding the top edge into the slot while at the same time allowing the arm to protrude through the face seal. The arm should remain in the extended position while screwing down the face seal.

e) Check to see that the arm can be freely, manually pushed in and that it pops back out when released. Attach the probe to the cable and mechanically retract the arm using the MAGI commands.

Figure **A -** Arm is extended out at start of replacement operation.

Figure **B** - Disassembled face seal and location arm.

Figure **C-1 -** Orientation of spring relative to arm.

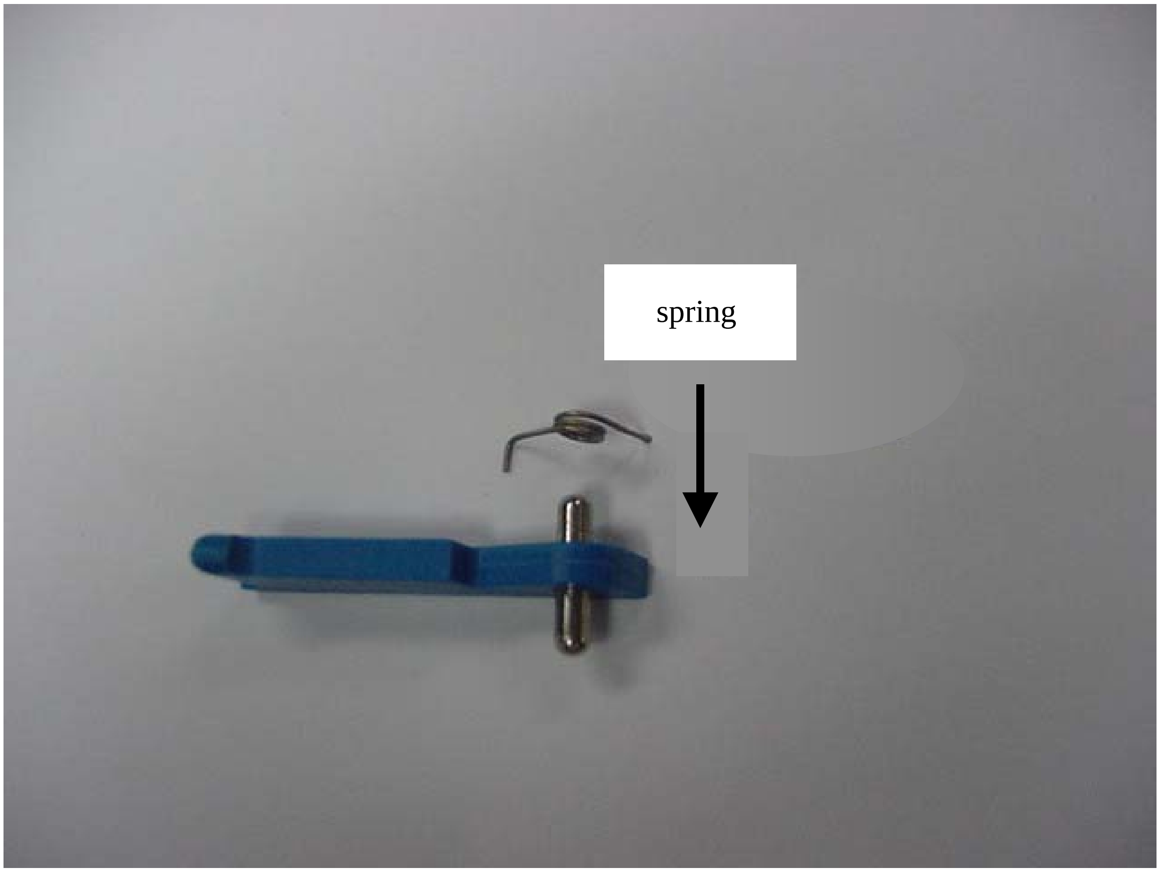


Figure **C-2 -** Position of spring and pivot in the arm.

Figure **C-3 -** Placement of arm assembly.

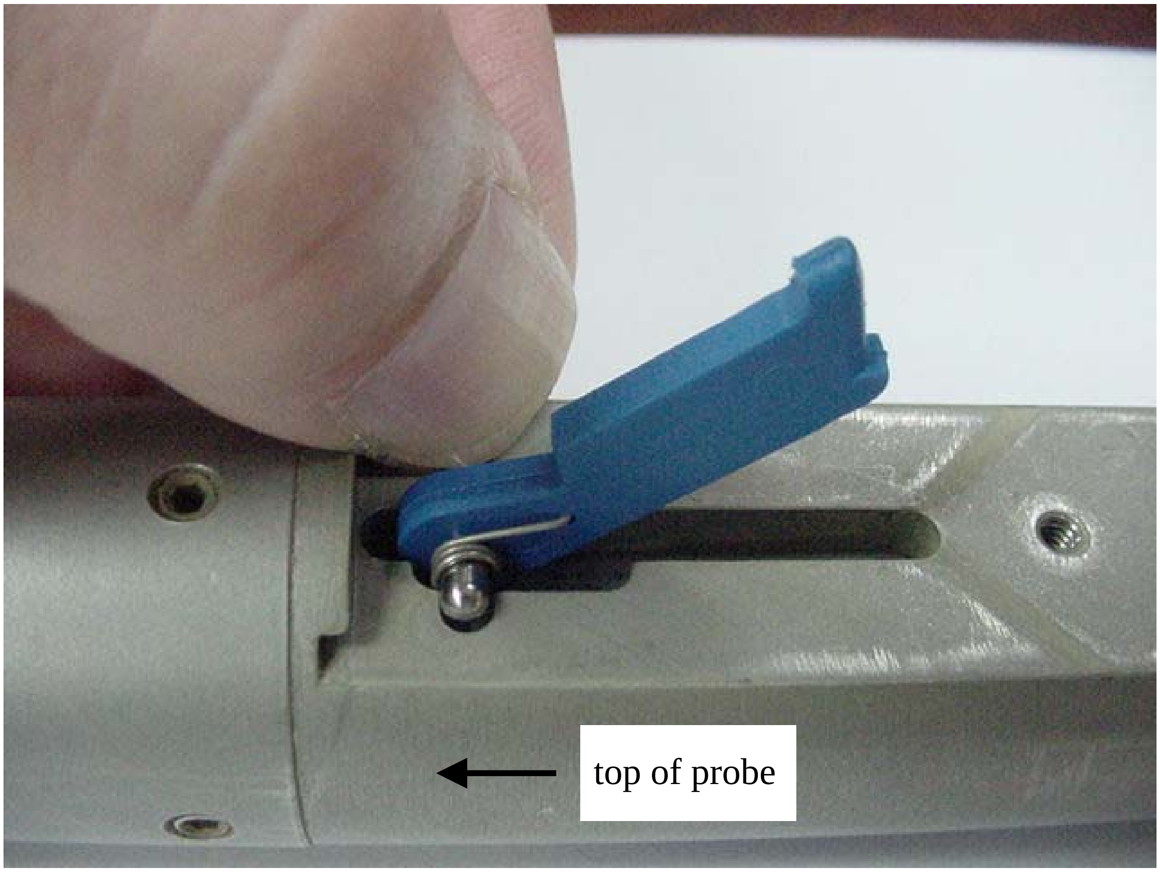
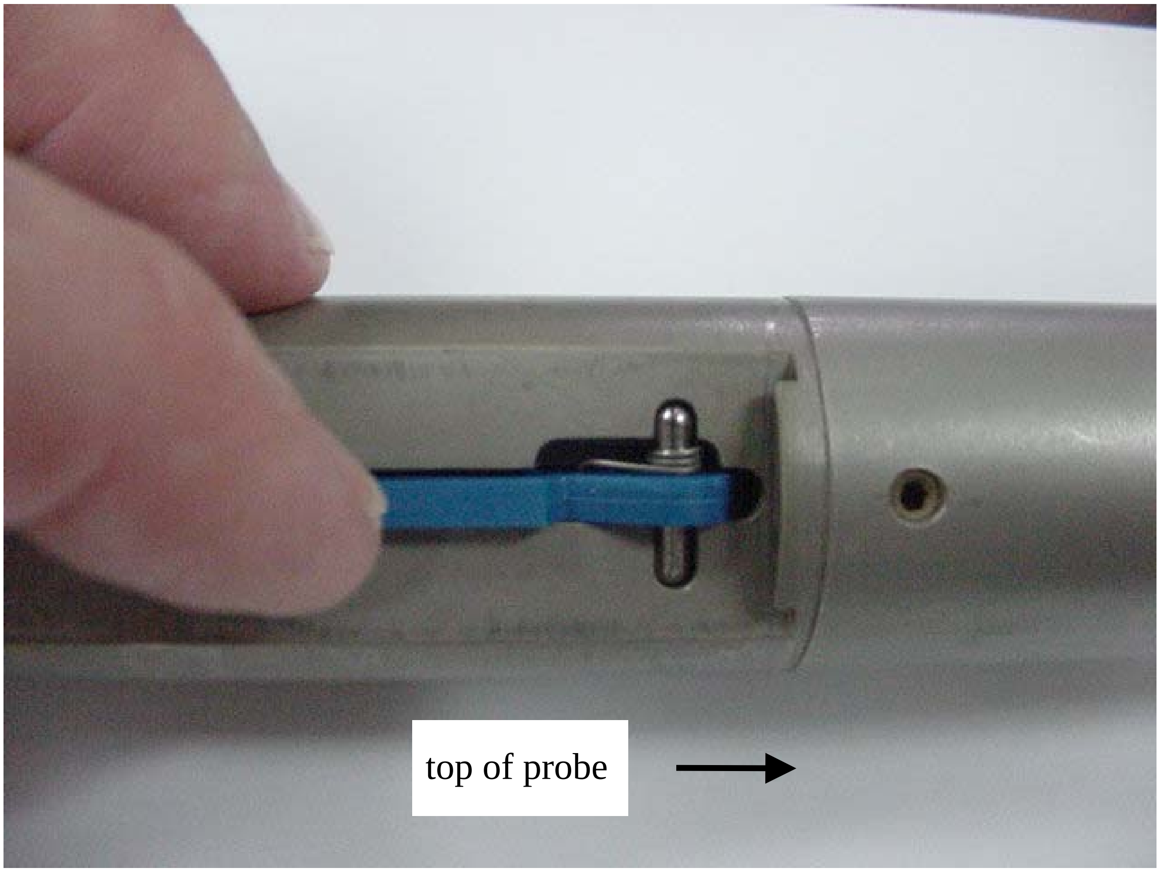


Figure **C-4 -** Top view of arm and spring placement.



Check that the arm is moving freely and the face seal insert and plunger are held securely in place.

4.3.3 Shoe Replacement

Activate the shoe and inspect for damage or wear. The shoe should rotate freely about the pivot pin. When the shoe is retracted it should retract quickly and smoothly back into the probe. The shoe may be replaced in the following manner:

1. Release the location arm and extend the shoe to expose the pivot pin.
2. Unscrew the shoe pivot pin from the lever arm and remove the shoe.
3. Place a new shoe in the lever arm and install the shoe pivot pin.

4.3.4 Actuator Nut

The actuator nut needs to be routinely cleaned to remove particles of grit which can interfere with its movement. Remove the actuator nut in the following manner:

1. Remove the two set screws that hold in the lever arm pivot pin. Using the Allen key, push the lever pivot pin out of the probe body.
2. Remove the set screws on the side of the probe body that holds the plastic support block.
3. Remove the screw closest to the top of the probe.
4. Lift out the lever arm, guide plate, shoe, spring and plastic support block as one unit.
5. Use the Clean Nut Command to remove the actuator nut from the actuator screw. Turn off the MPCI and remove the nut from the probe.
6. Clean the actuator nut with the cleaning tap. Use the Clean Nut Command and clean the actuator screw with a nylon brush. DO NOT use a wire brush.
7. Apply a thin coating of silicone lubricant to the actuator screw. Place the actuator nut in the probe body against the actuator screw and retract the arm to thread the nut onto the actuator screw. Allow the nut to travel along the full length of the screw. YOU MAY HAVE TO REPEAT THIS OPERATION.
8. Install the single unit from Step 4 in the probe body. Install the lever arm pin through the probe body, lever arm, and spring. Lock the pin in position with two set screws.
9. Install the top screw into the guide plate and install the set screws to secure the support block.

5. CALIBRATION

The Westbay System permits frequent or periodic calibration of the transducers used for pressure measurement. Contact Westbay for details.

6. SPARE PARTS LIST

Item	Part No. or Size	Qty
Face Seal Insert	200302	5
Plunger	(see Note 1)	5
Location Arm	252112	5
Shoe	252313	5
Pin 3 (Location Arm)	252320	2
Spring 2 (Location Arm)	252319	2
Pin 1 (Shoe)	252316	2
Spring 1 (Shoe Lever)	252318	2
Pan Head Screw	# 4-40 x 1/4 - inch	2
Pan Head Screw	# 6-32 x 3/16 - inch	2
Pan Head Screw	# 6-32 x 1/2 - inch	2
Hex Socket Head Screw	# 8-32 x 1/8 - inch	4
Hex Socket Head Screw	# 10-32 x 3/16 - inch	4
Hex Socket Set Screw	# 8-32 x 5/16 - inch	2
Allen Key	5/64 - inch	1
Allen Key	3/32 - inch	1
Actuator Nut Tap	208001	1
Cablehead Parts:		
O-ring	# 111 B	2
Termination Sleeve	251805	1
Termination Insert	251806	1
Feedthru Connector	251814	1
Bushing 1	251812	1
Bushing 2	251813	1
O-Ring	# 108 V	1
O-Ring	# 010 V	1
O-Ring	# 004 V	1
Boot	JF0602CF	1
Contact	JF0603CF	1
Cable Heading Tool	208100	1

1. Plunger appropriate to type of measurement port to be accessed.

Schlumberger
WATER SERVICES

Groundwater Sampling

Field Data Sheet

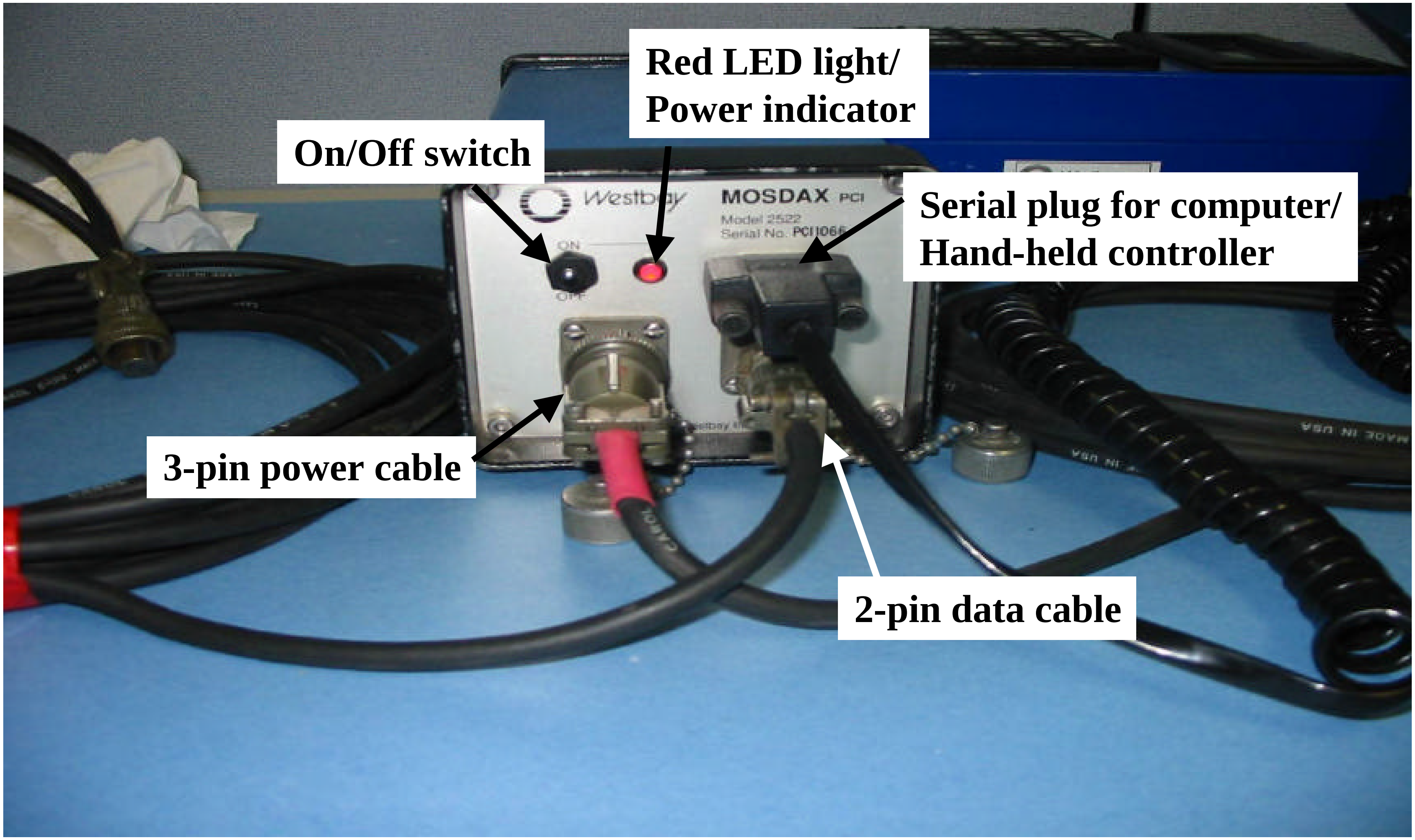
Project: ____________________
Monitoring Well No.: ____________________
Sampling Zone No(s).: ____________________

Date: ____________________
Start Time: __________ Atm. Rdg: __________
End Time: __________ Atm. Rdg: __________
Operators: ____________________

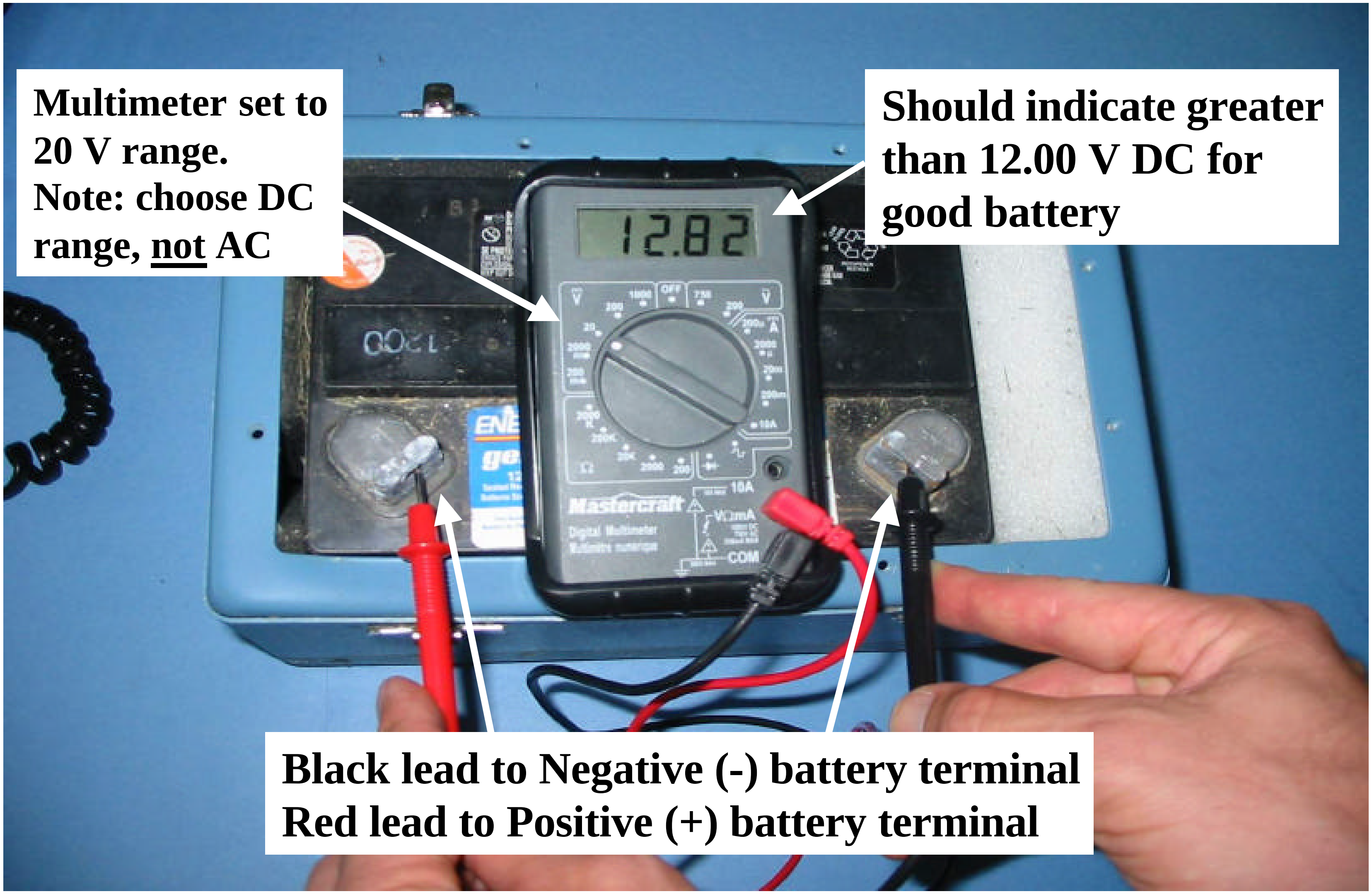
Port No.	Run No.	Surface Function Tests (probe in flushing collar)						Position Sampler			Sample Collection Checks (probe located at sampling zone in Westbay casing)								Comments (volume recovered)
		Shoe Out	Close Valve	Check Vacuum	Open Valve	Apply Vacuum	Close Valve	Locate Port	Arm Out	Land Probe	Pressure in Westbay ( )	Shoe Out	Zone Pressure ( )	Open Valve	Zone Pressure ( )	Close Valve	Shoe In	Pressure in Westbay ( )	

Additional Comments: (pH, turbidity, S.C., etc.)

Pic.1 Computer Interface Units, old and new:
MPCI model 2522 (left) and MAGI model 2536 (right)



Pic.2 MPCI unit showing typical set-up configuration

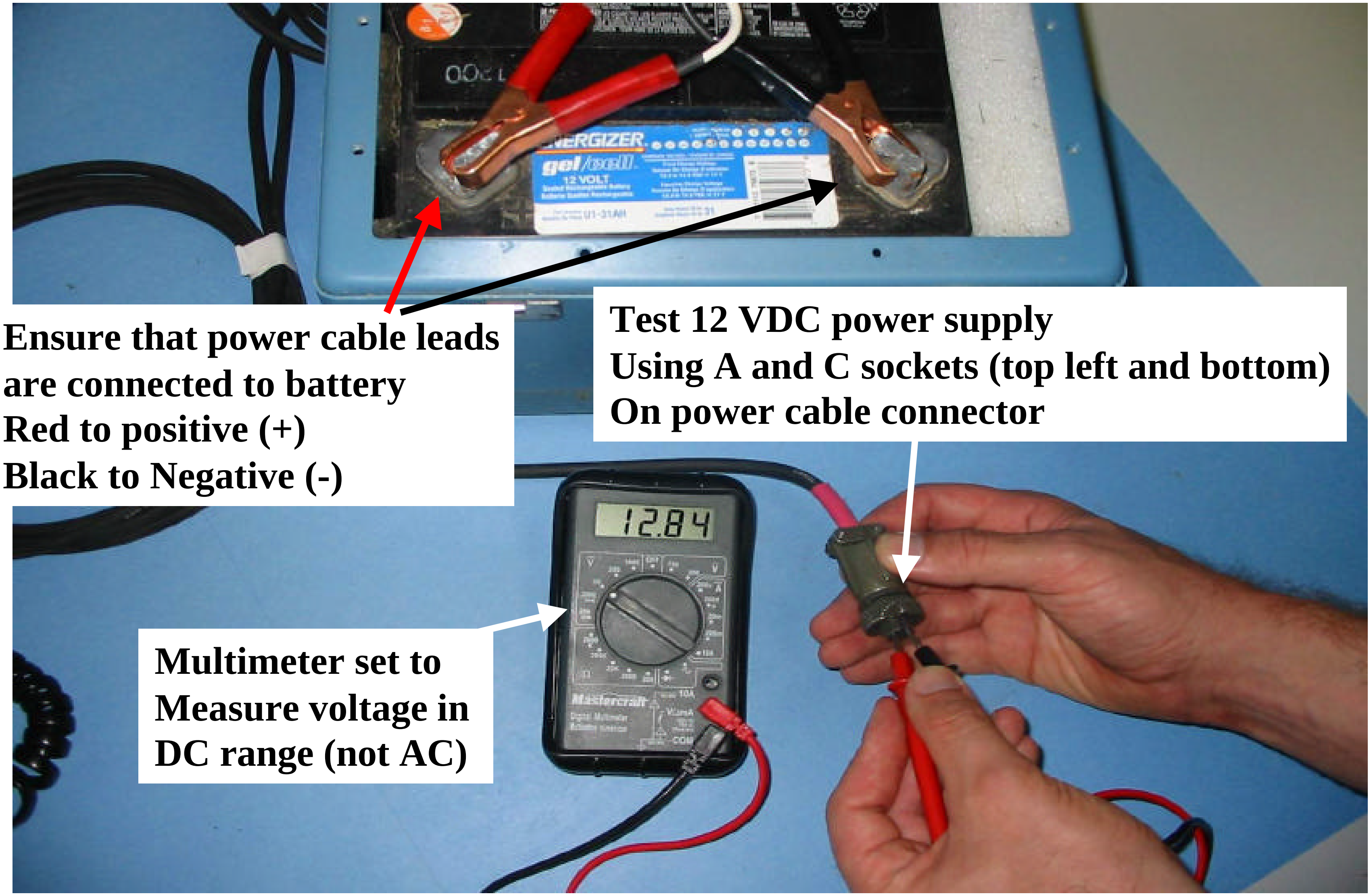


Multimeter set to 20 V range.
Note: choose DC range, <u>not</u> AC

Should indicate greater than 12.00 V DC for good battery

Black lead to Negative (-) battery terminal
Red lead to Positive (+) battery terminal

Pic.3 Testing 12 VDC Power Supply using Multimeter

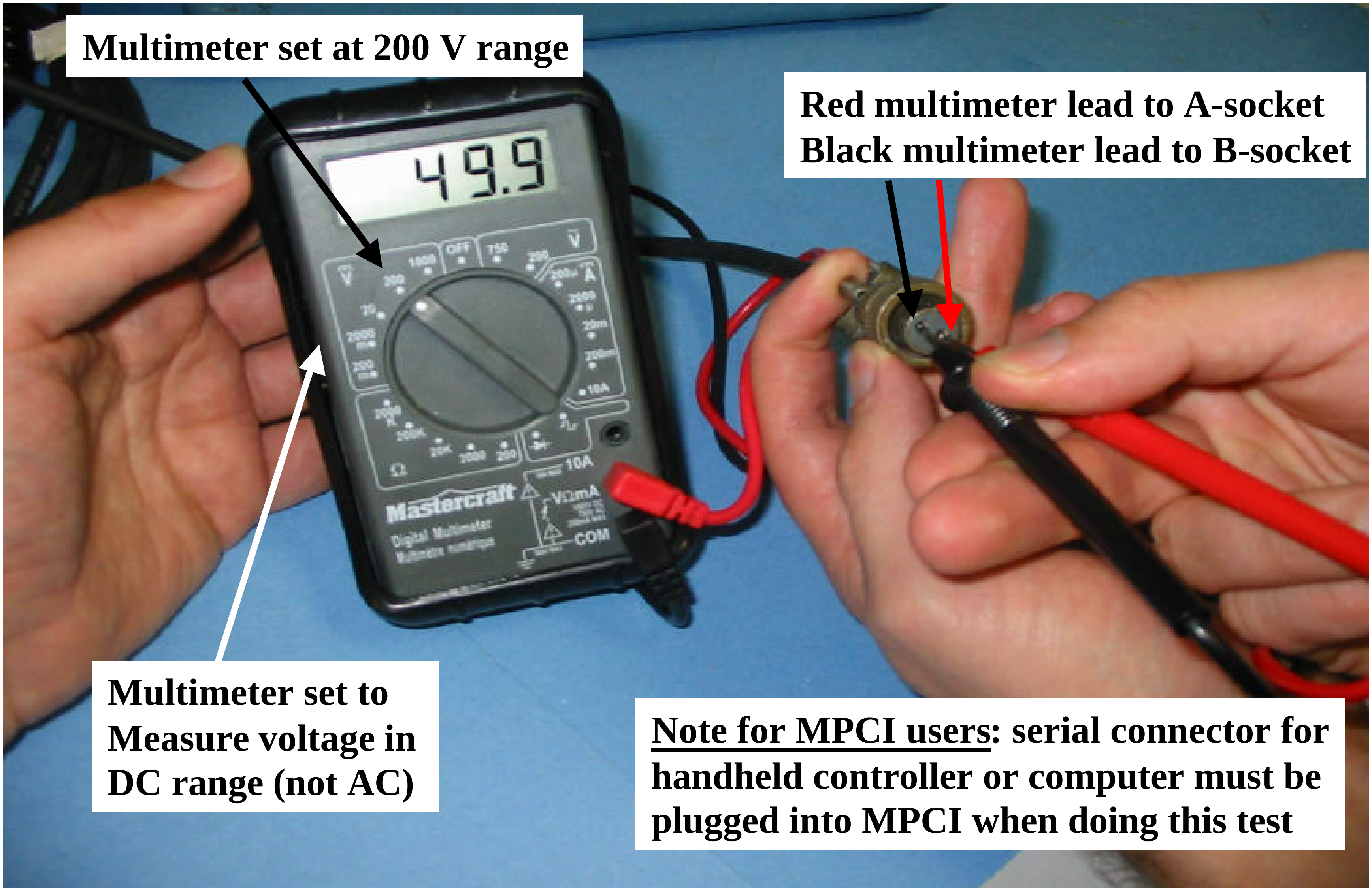


Ensure that power cable leads
are connected to battery
Red to positive (+)
Black to Negative (-)

Test 12 VDC power supply
Using A and C sockets (top left and bottom)
On power cable connector

Multimeter set to
Measure voltage in
DC range (not AC)

Pic.4 Testing Power Cable Voltage
(should indicate greater than 12.00 V DC for good battery and cable)



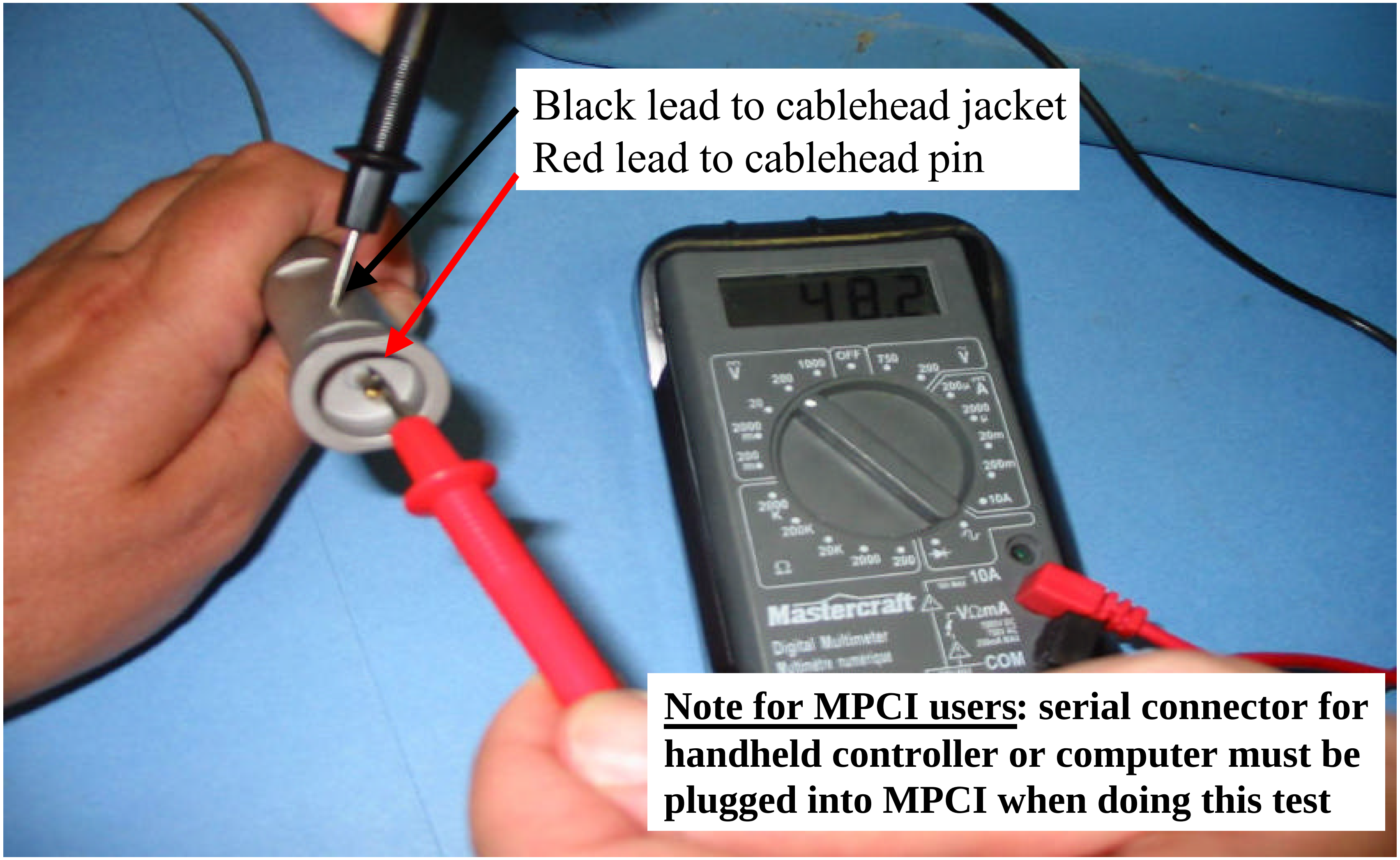
Multimeter set at 200 V range

Red multimeter lead to A-socket
Black multimeter lead to B-socket

Multimeter set to Measure voltage in DC range (not AC)

Note for MPCI users: serial connector for handheld controller or computer must be plugged into MPCI when doing this test

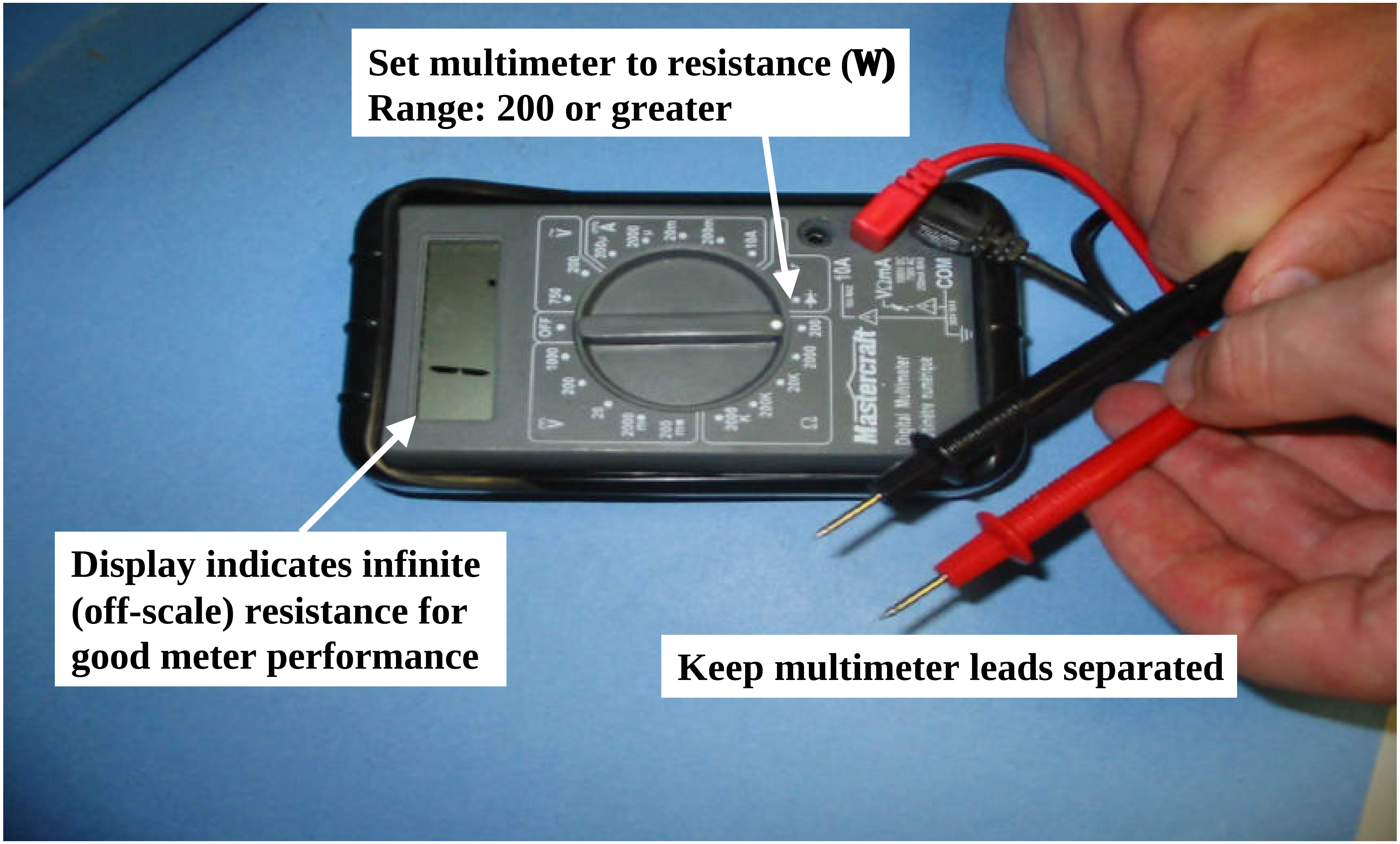
Pic.5 **Testing Power output from MPCI or MAGI using data cable (should be greater than 48 V)** ***Note: MPCI/MAGI must have power 'on' and be connected to power supply.***



Black lead to cablehead jacket
Red lead to cablehead pin

<u>**Note for MPCI users**</u>**: serial connector for handheld controller or computer must be plugged into MPCI when doing this test**

Pic.6 Checking power output at cablehead (should be greater than 48 V)
Note: MPCI/MAGI must have power 'on' and be connected to power supply.

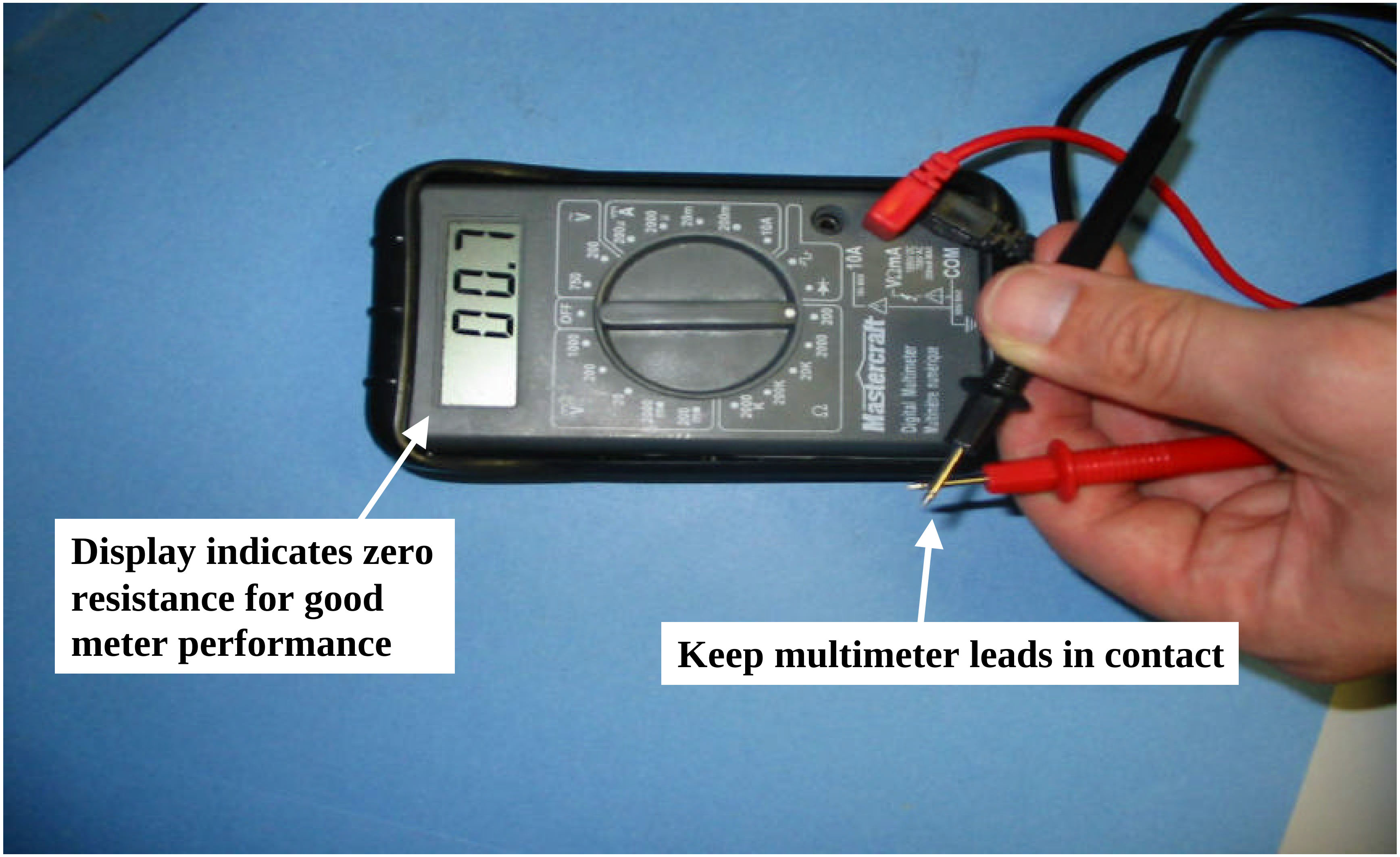


Set multimeter to resistance (W)
Range: 200 or greater

Display indicates infinite (off-scale) resistance for good meter performance

Keep multimeter leads separated

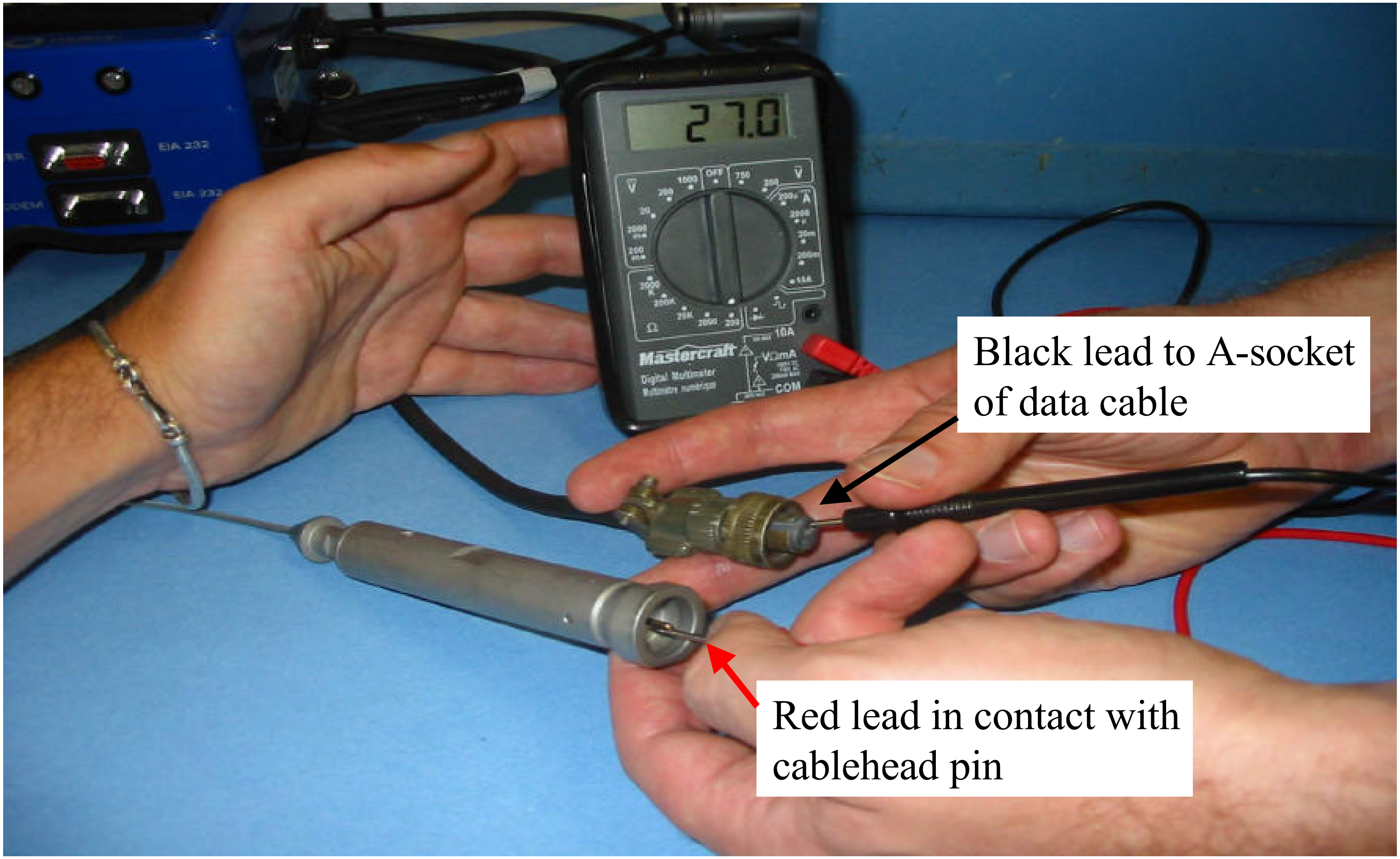
Pic.7 Test multimeter “open” resistence



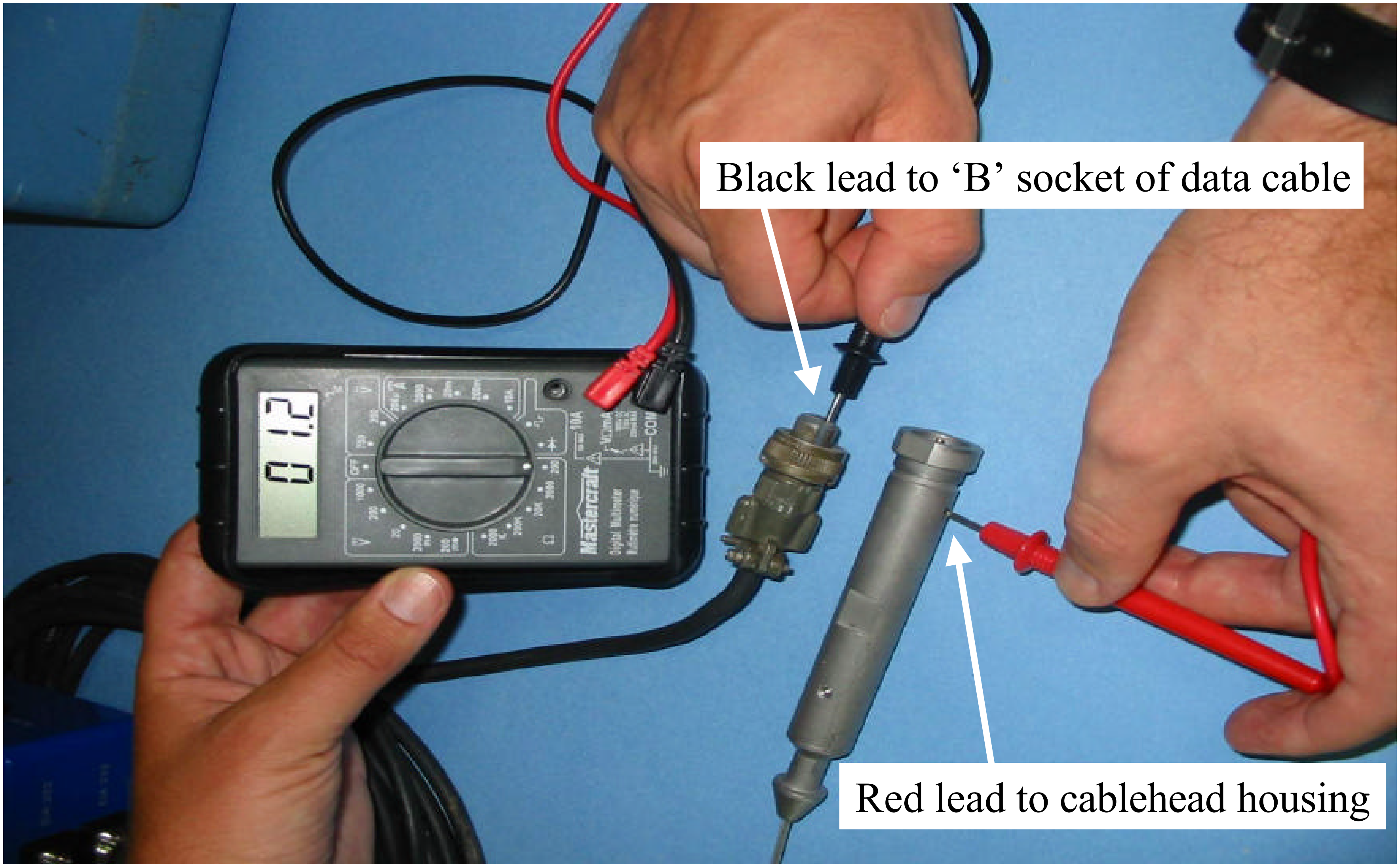
Display indicates zero resistance for good meter performance

Keep multimeter leads in contact

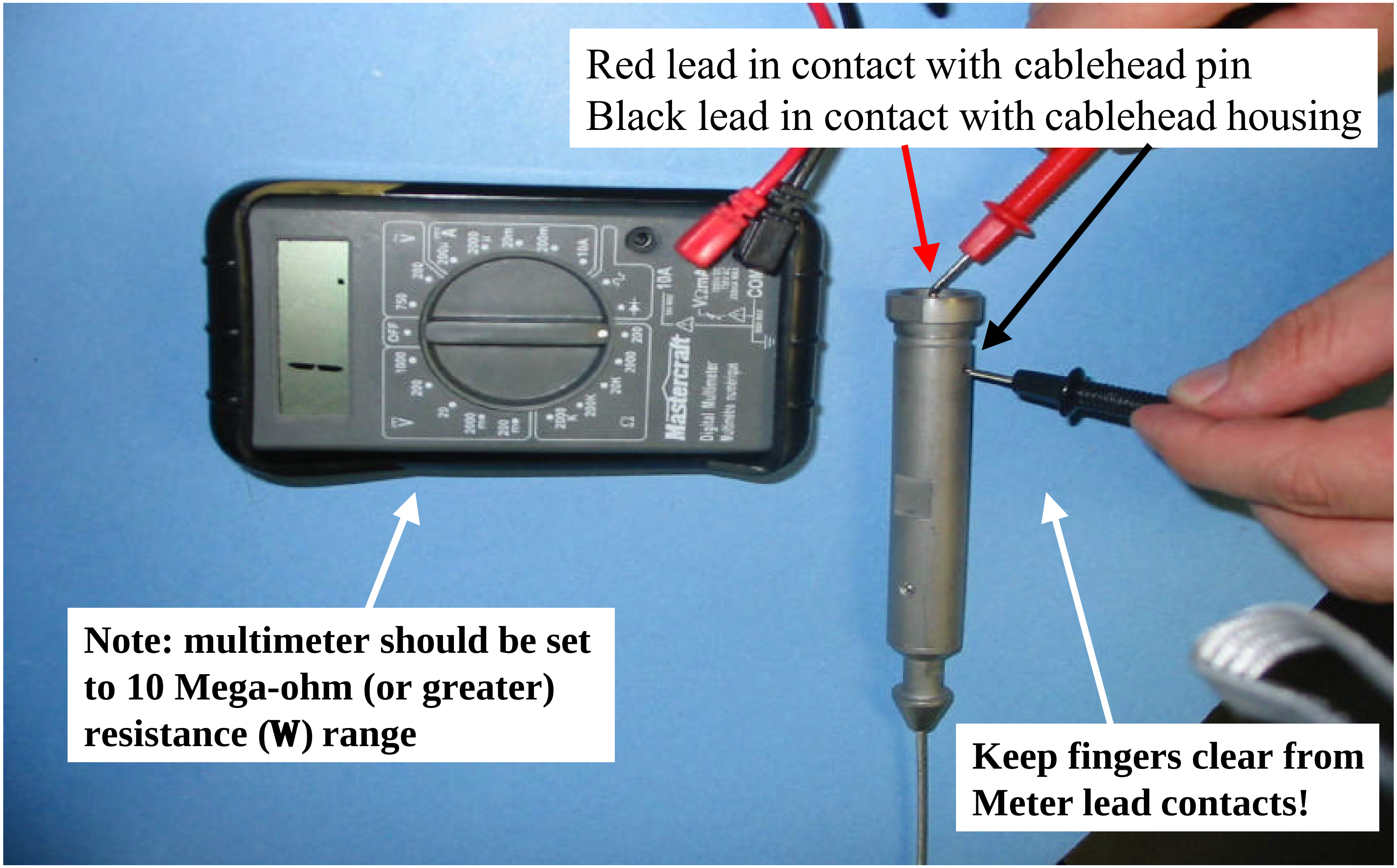
Pic.8 Test multimeter “closed” resistence



Pic.9 Test wireline ‘A-A’ resistance (approx. 27 W/1000 ft)



Pic.10 Test wireline 'B-B' resistance (should be less than 'A-A')

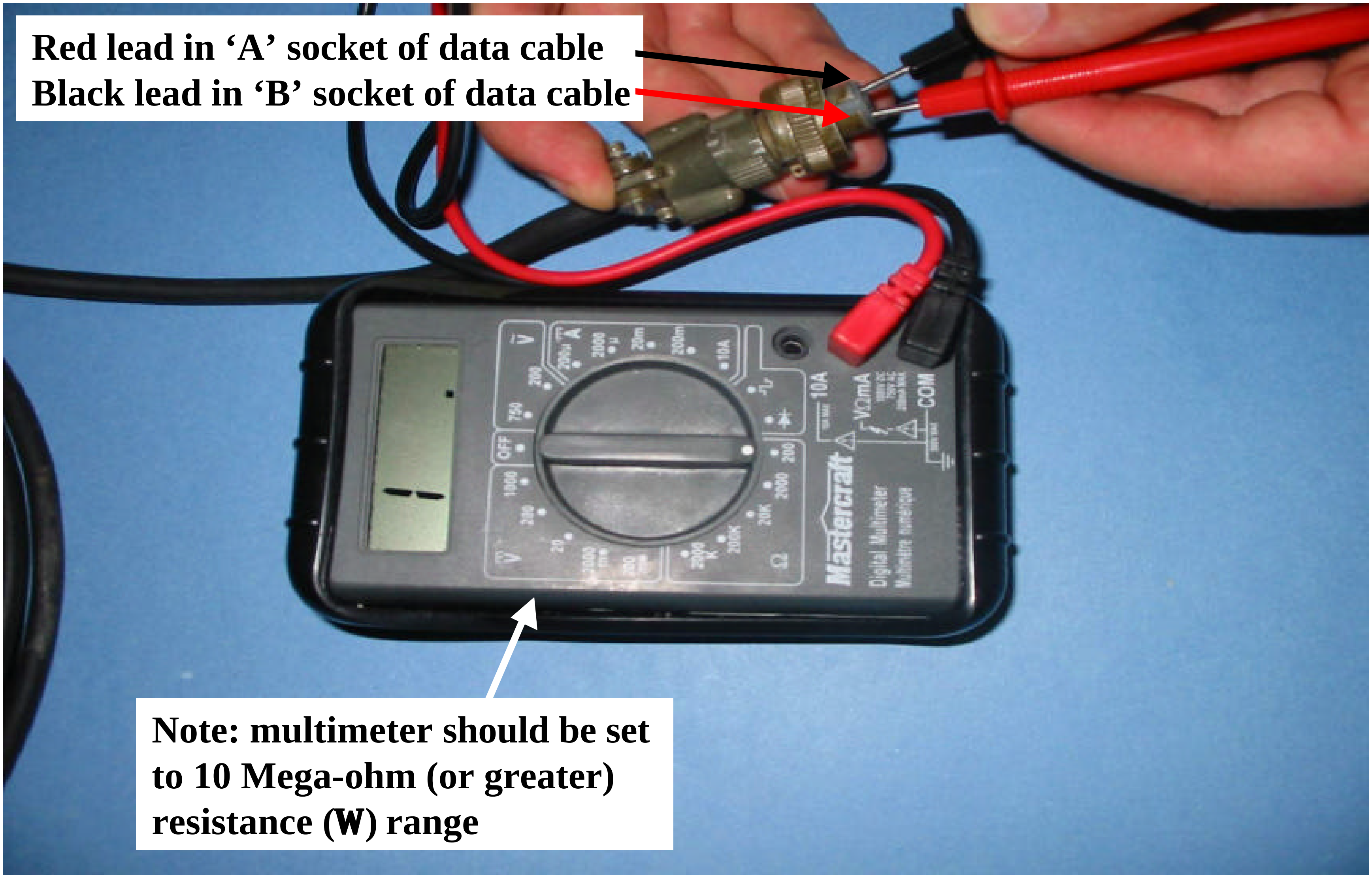


Red lead in contact with cablehead pin
Black lead in contact with cablehead housing

Note: multimeter should be set to 10 Mega-ohm (or greater) resistance (W) range

Keep fingers clear from Meter lead contacts!

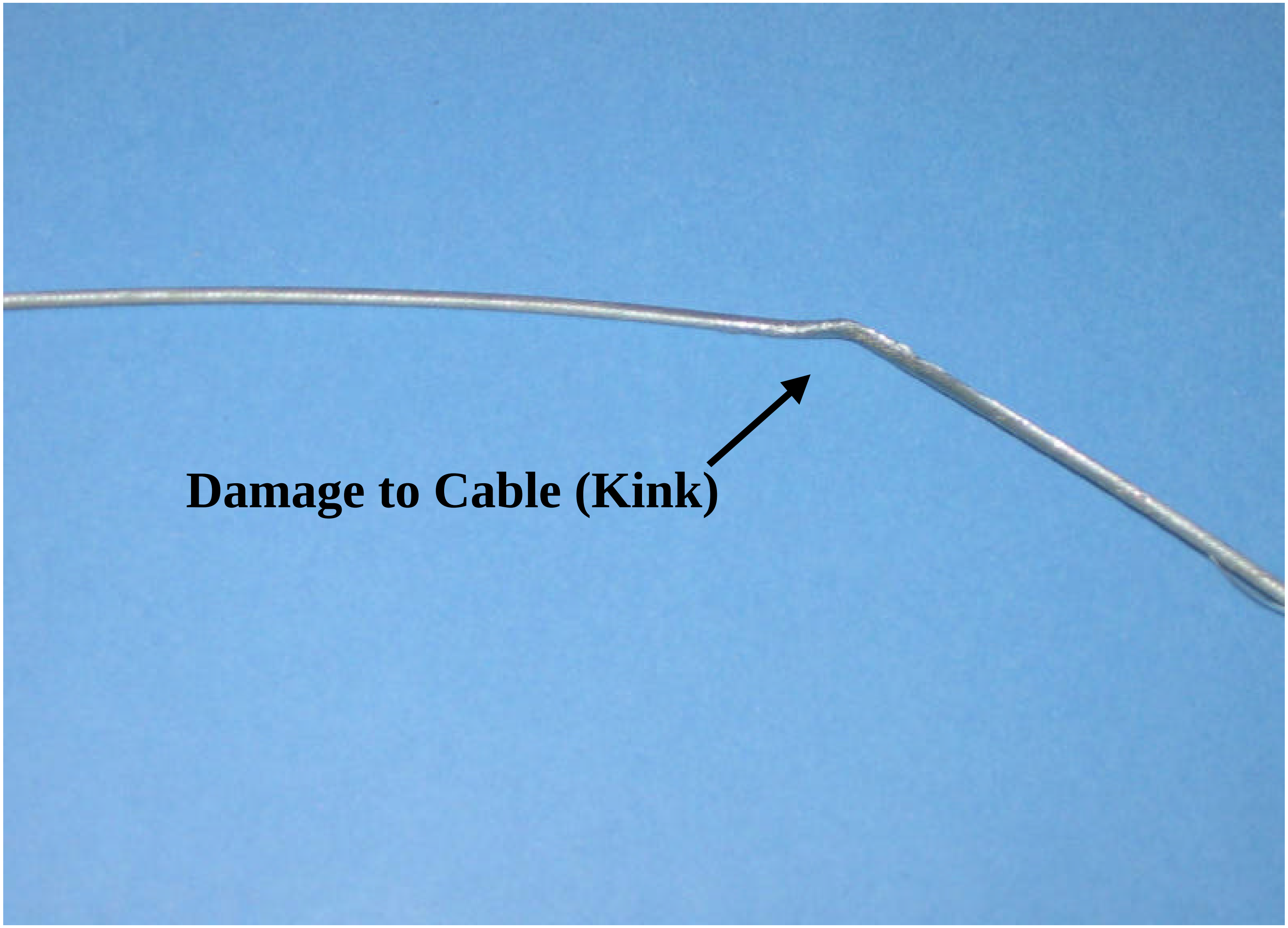
Pic.11 Test wireline 'A-B' resistance at cablehead (should be off-scale)



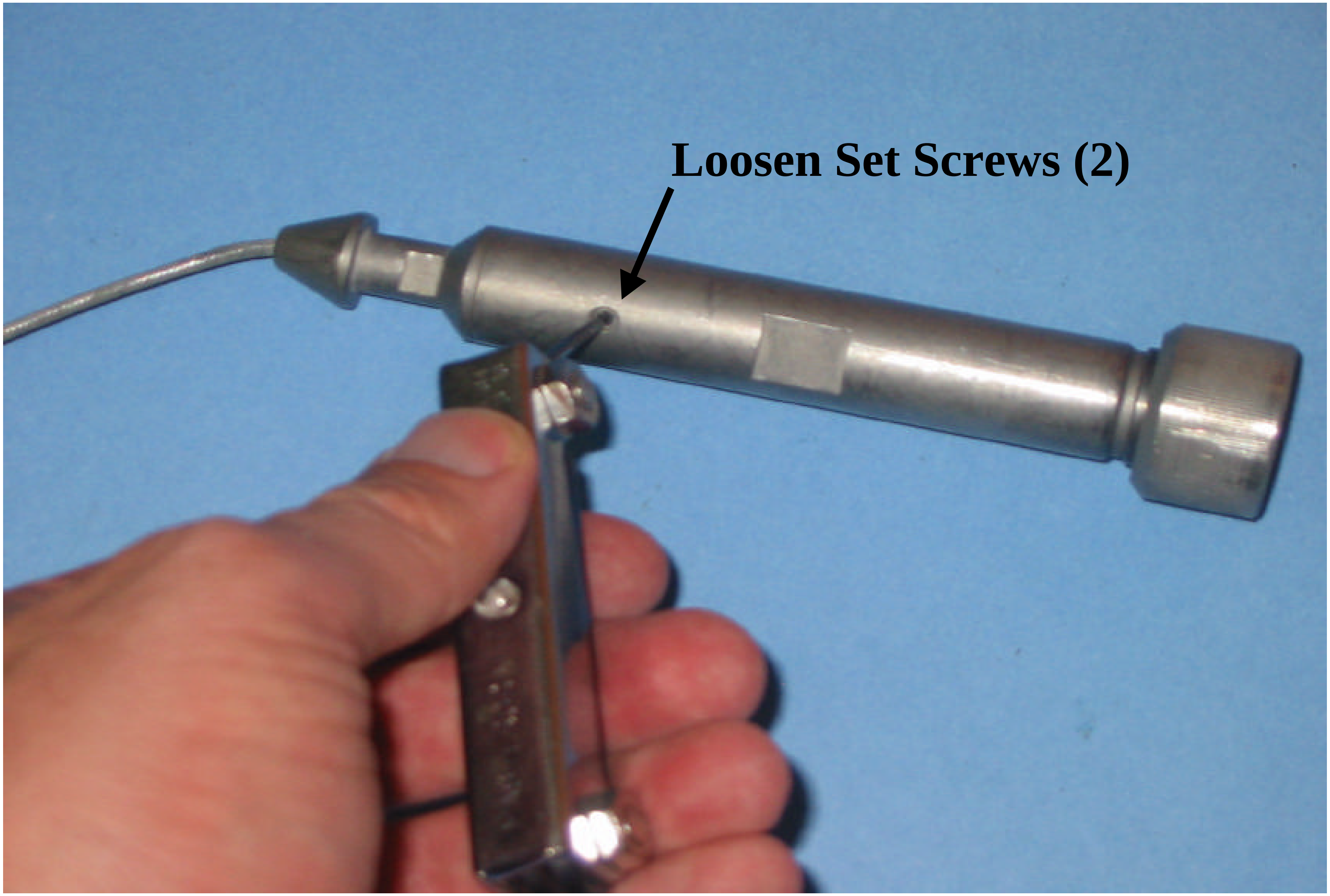
Red lead in ‘A’ socket of data cable
Black lead in ‘B’ socket of data cable

Note: multimeter should be set to 10 Mega-ohm (or greater) resistance (W) range

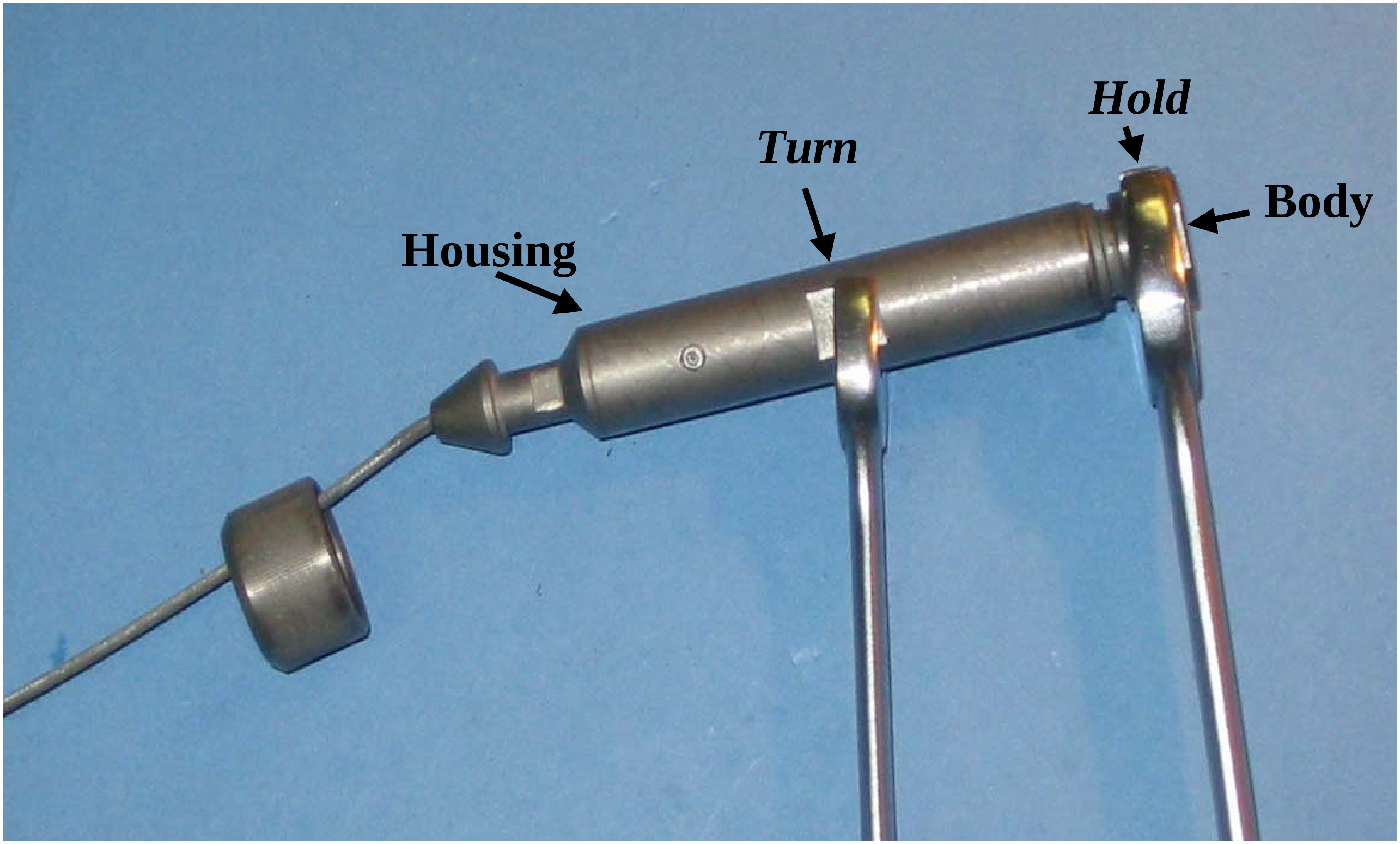
Pic.11 Test wireline ‘A-B’ resistance at data cable (should be off-scale)



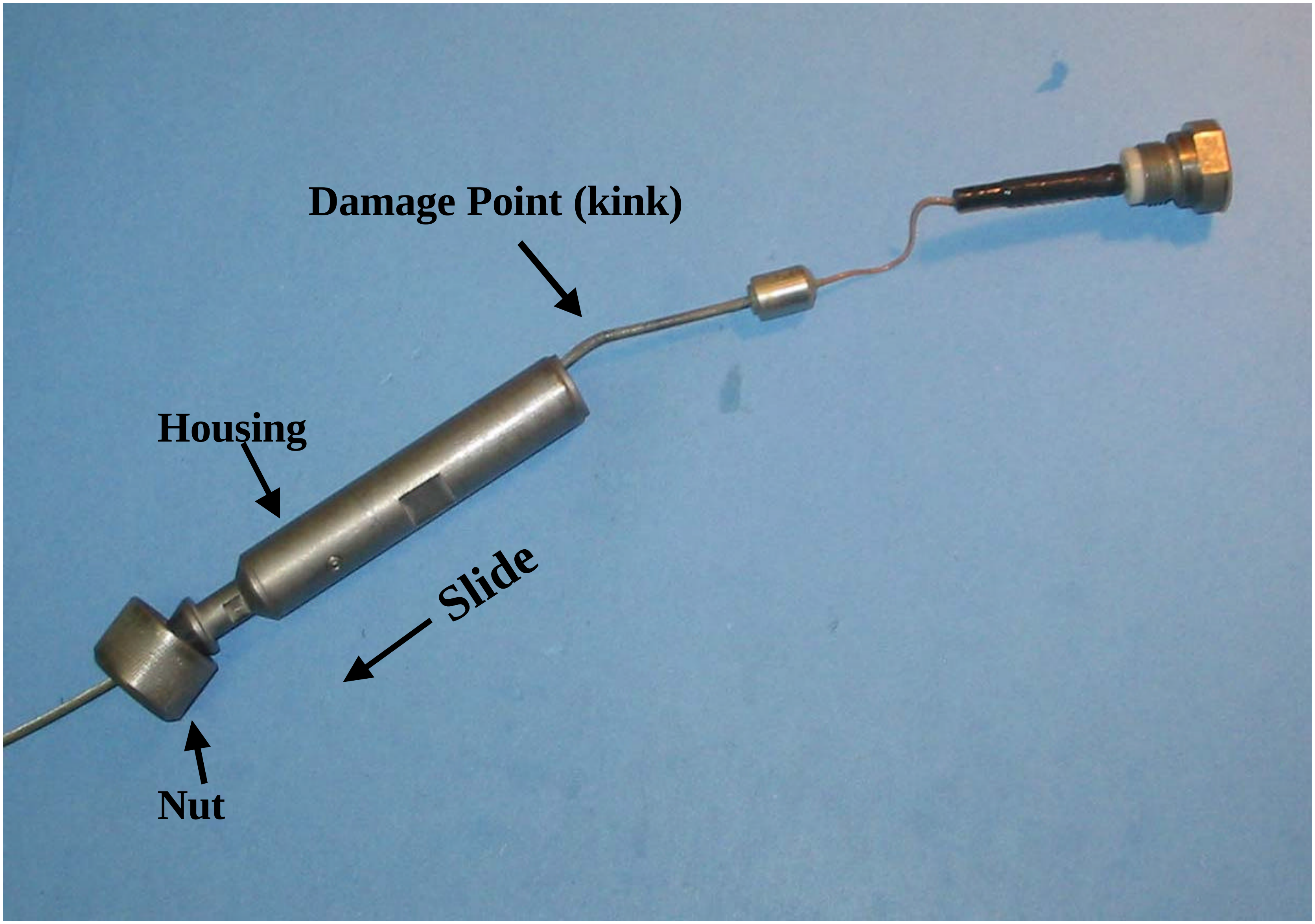
Pic.1 Identification of Cable Damage



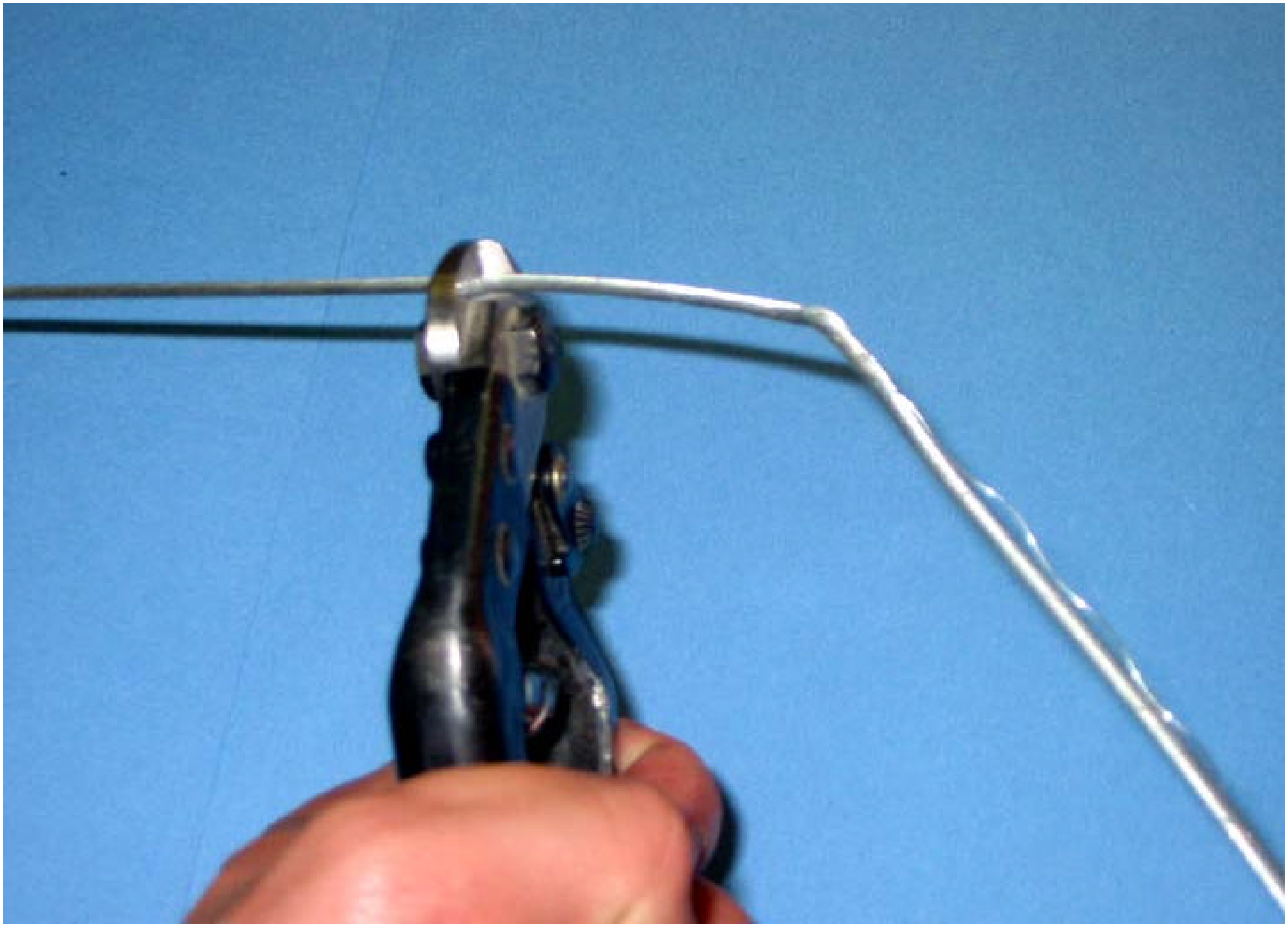
Pic.2 Cablehead Disassembly (1): Loosen set Screws



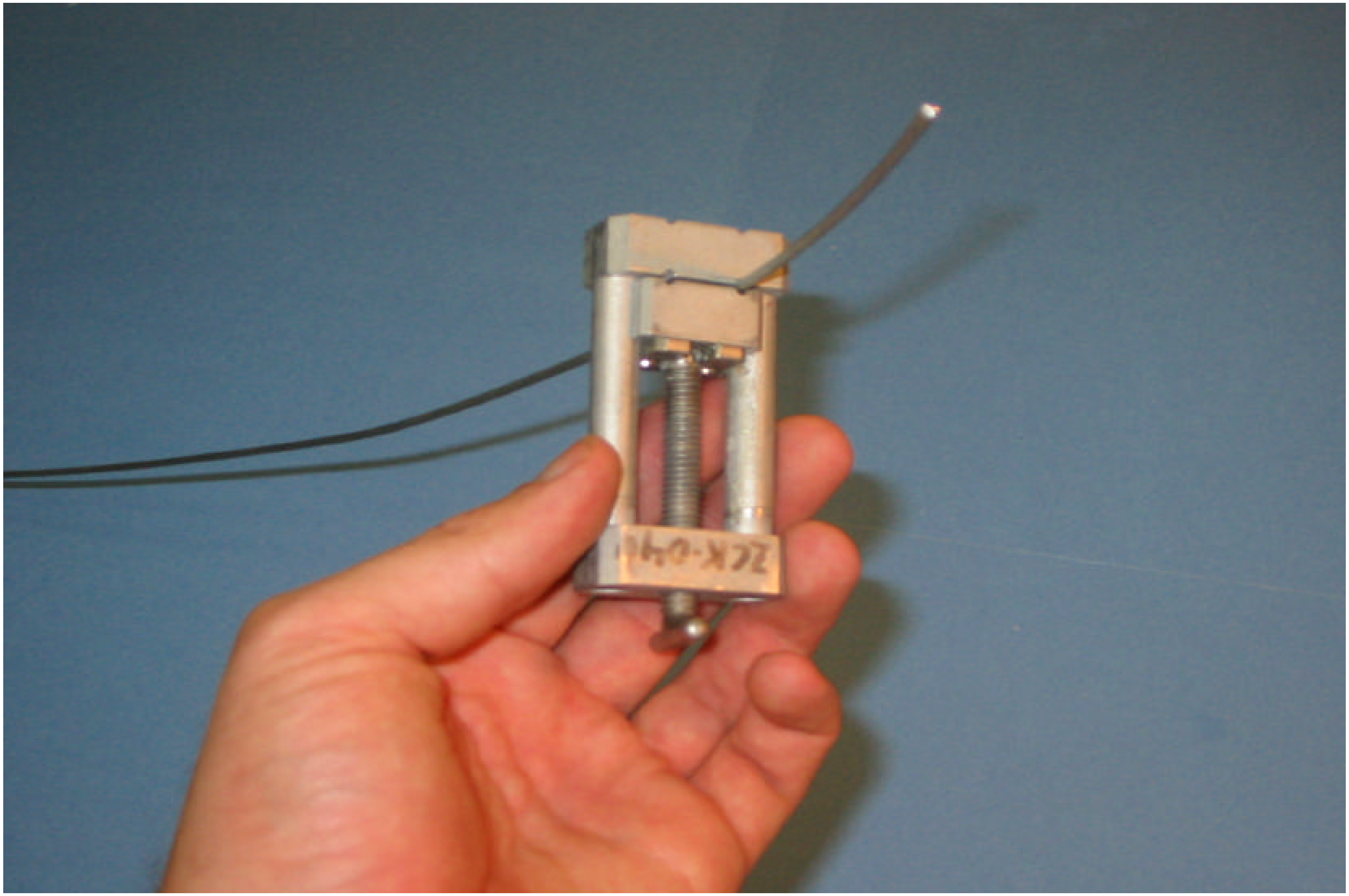
Pic.3 Cablehead Disassembly(2): Unscrew Housing From Body



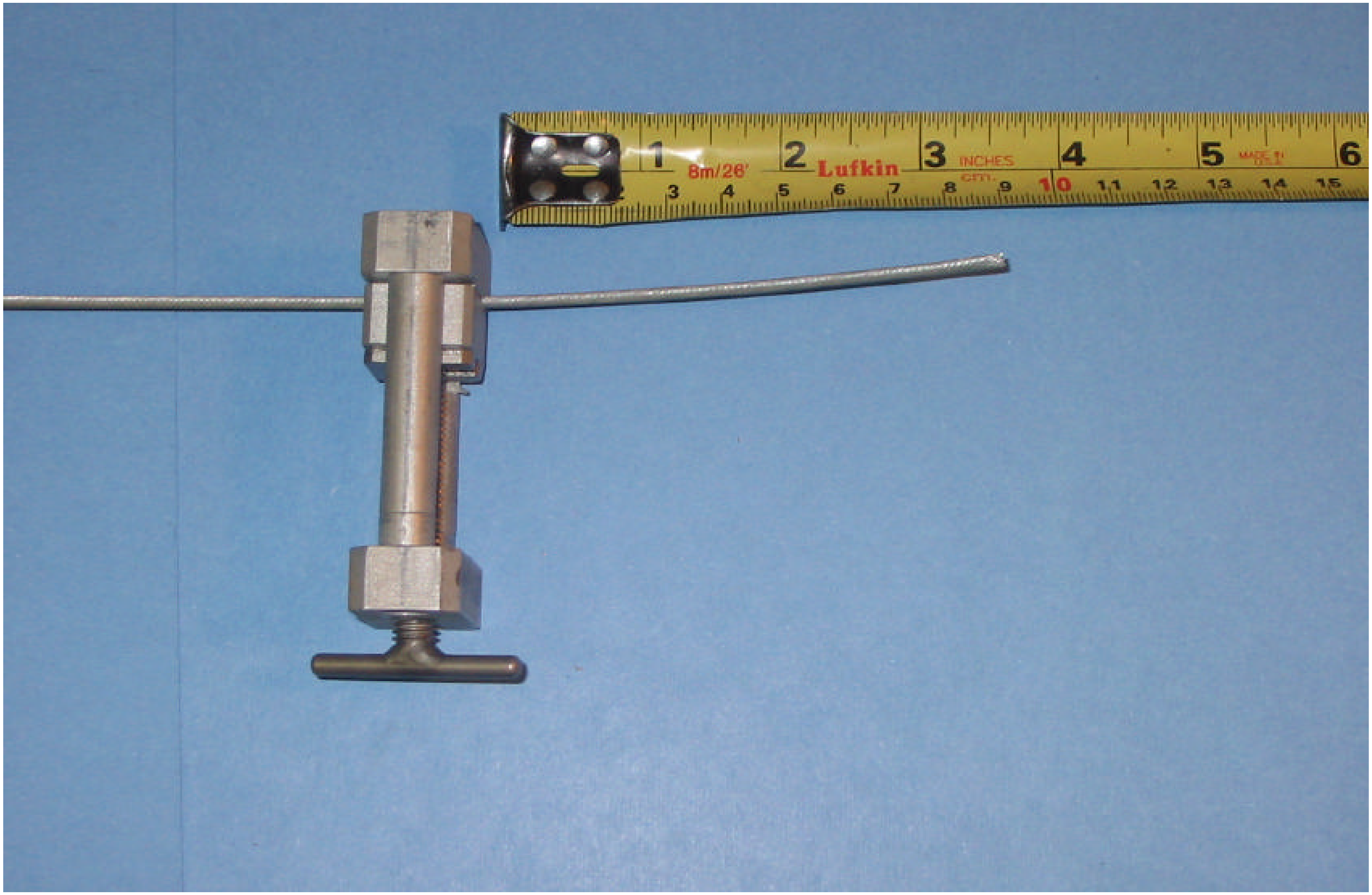
Pic.4 Cablehead Disassembly(3):
Slide Housing and Cablehead Nut Past Damage Point



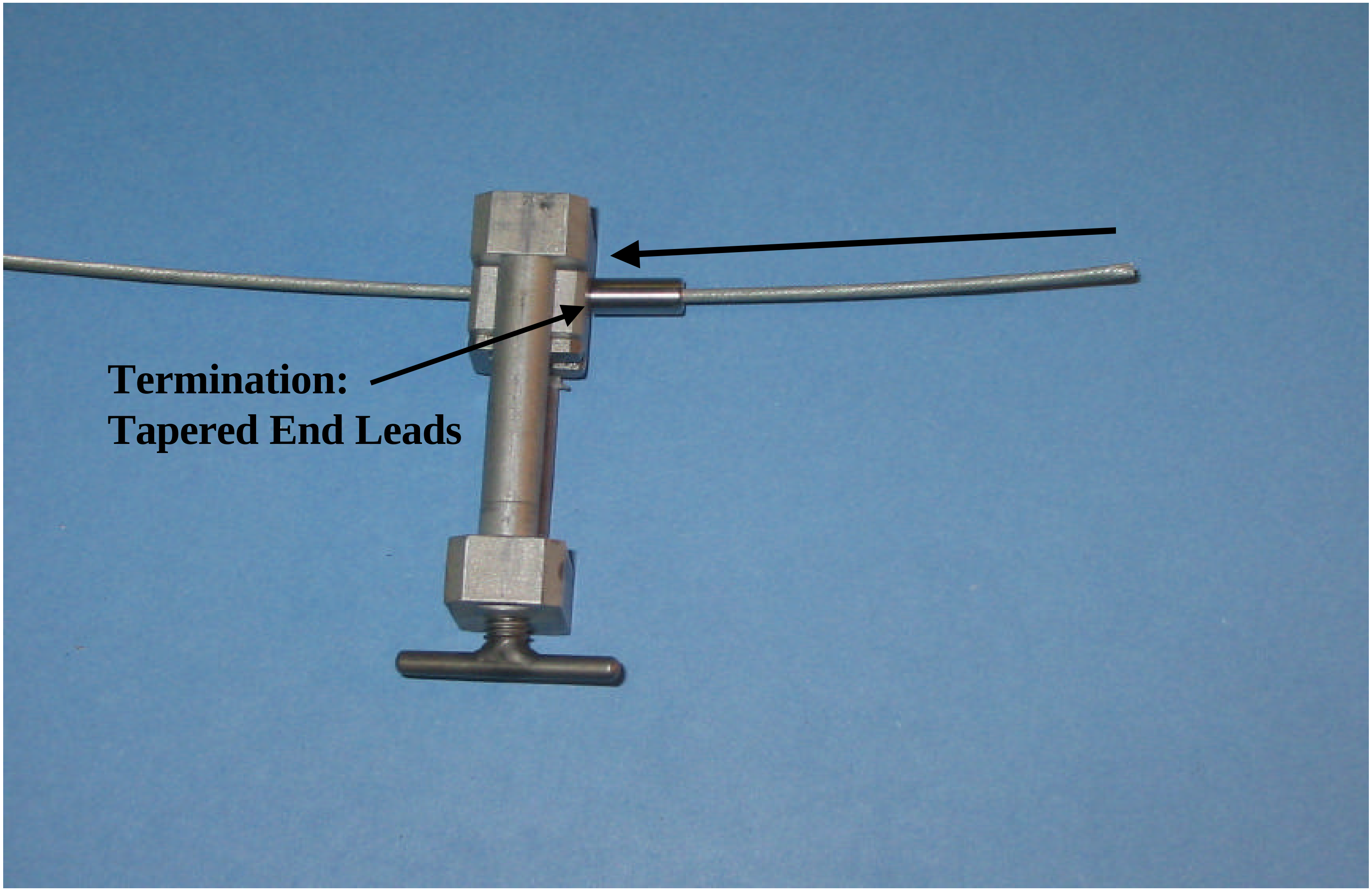
Pic.5 Cut Cable above Damage Point



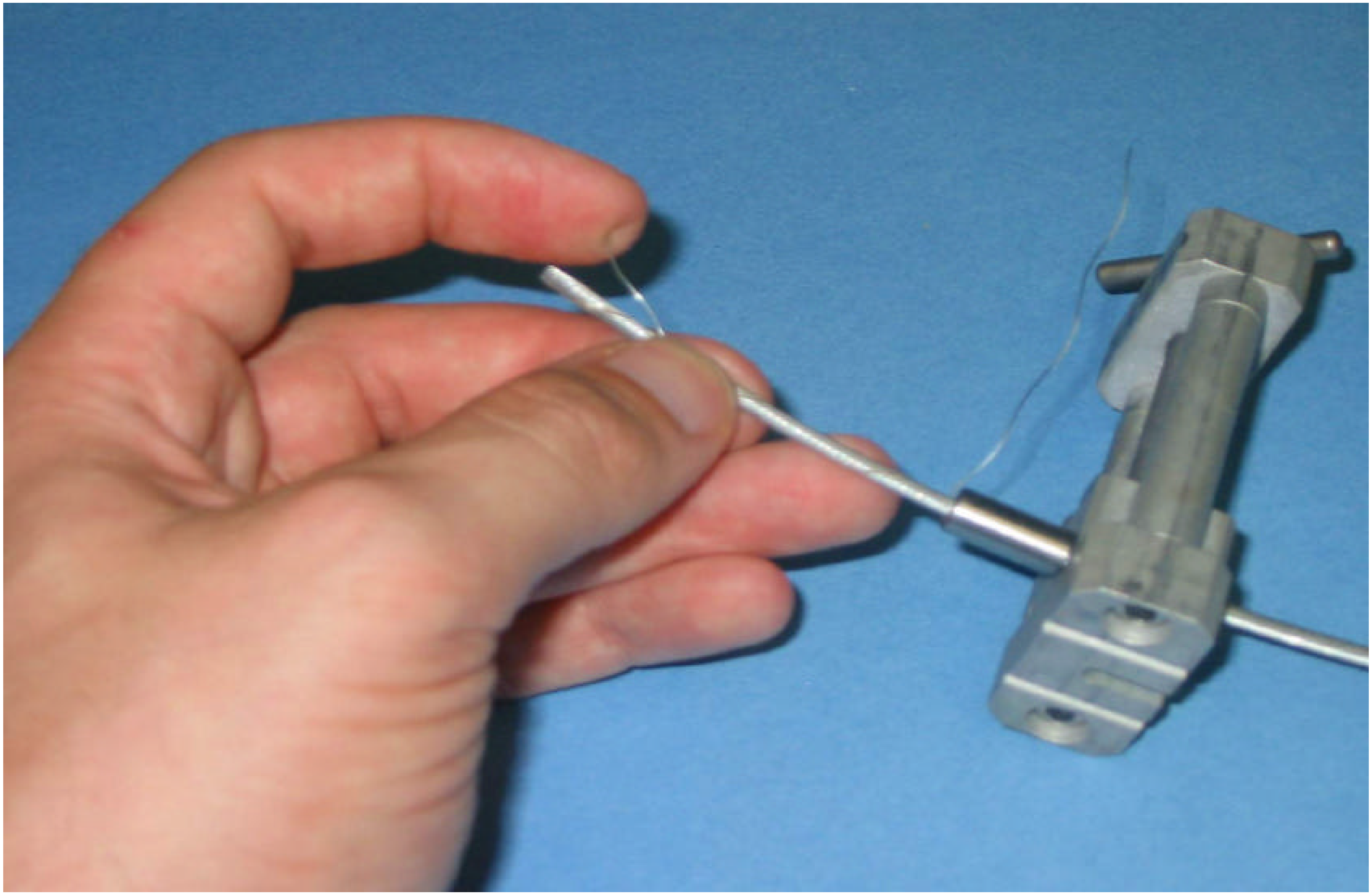
Pic.6a Clamp Cable in Termination Jig



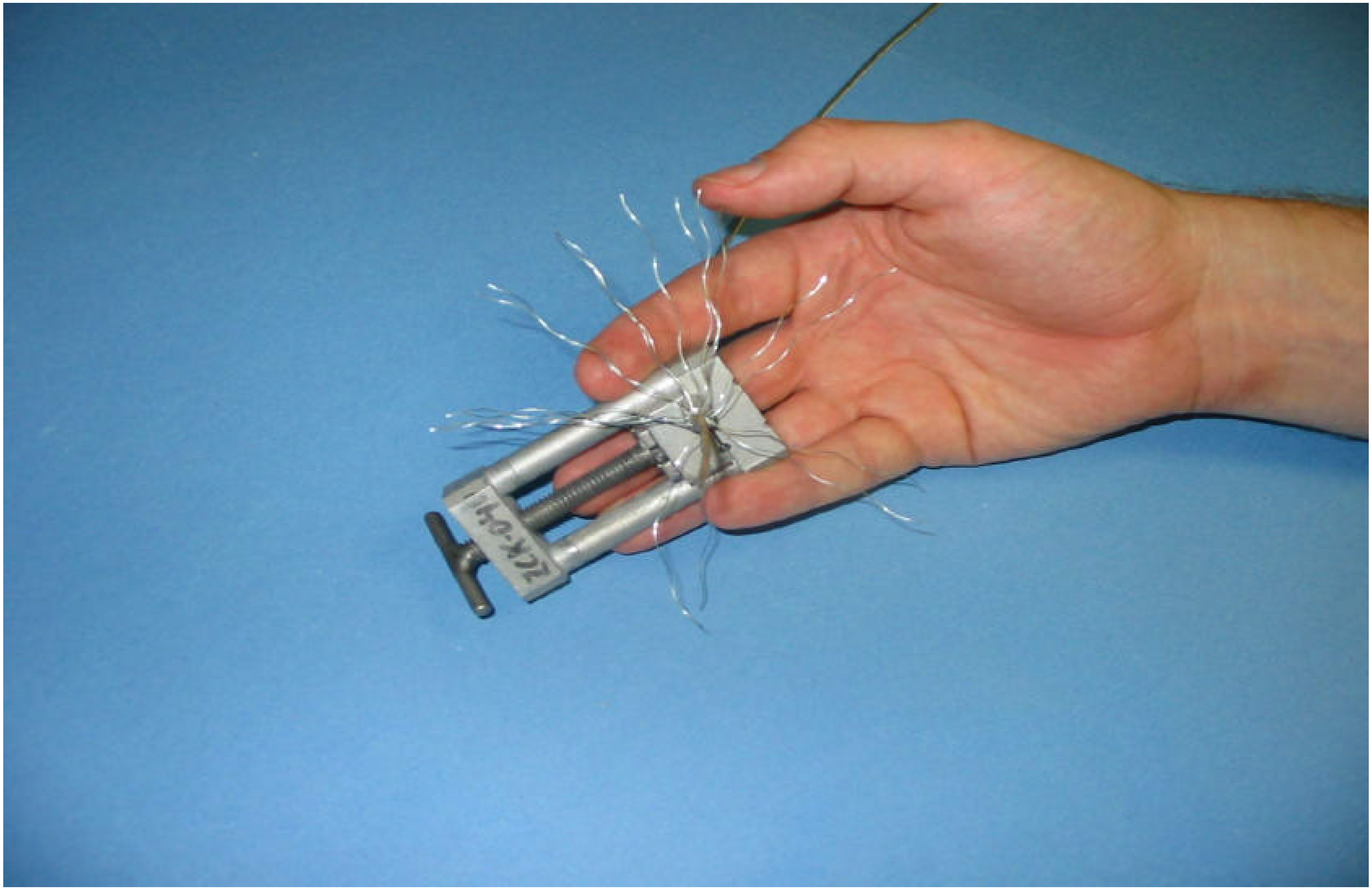
Pic.6b Leave 3.5 inches Cable Exposed



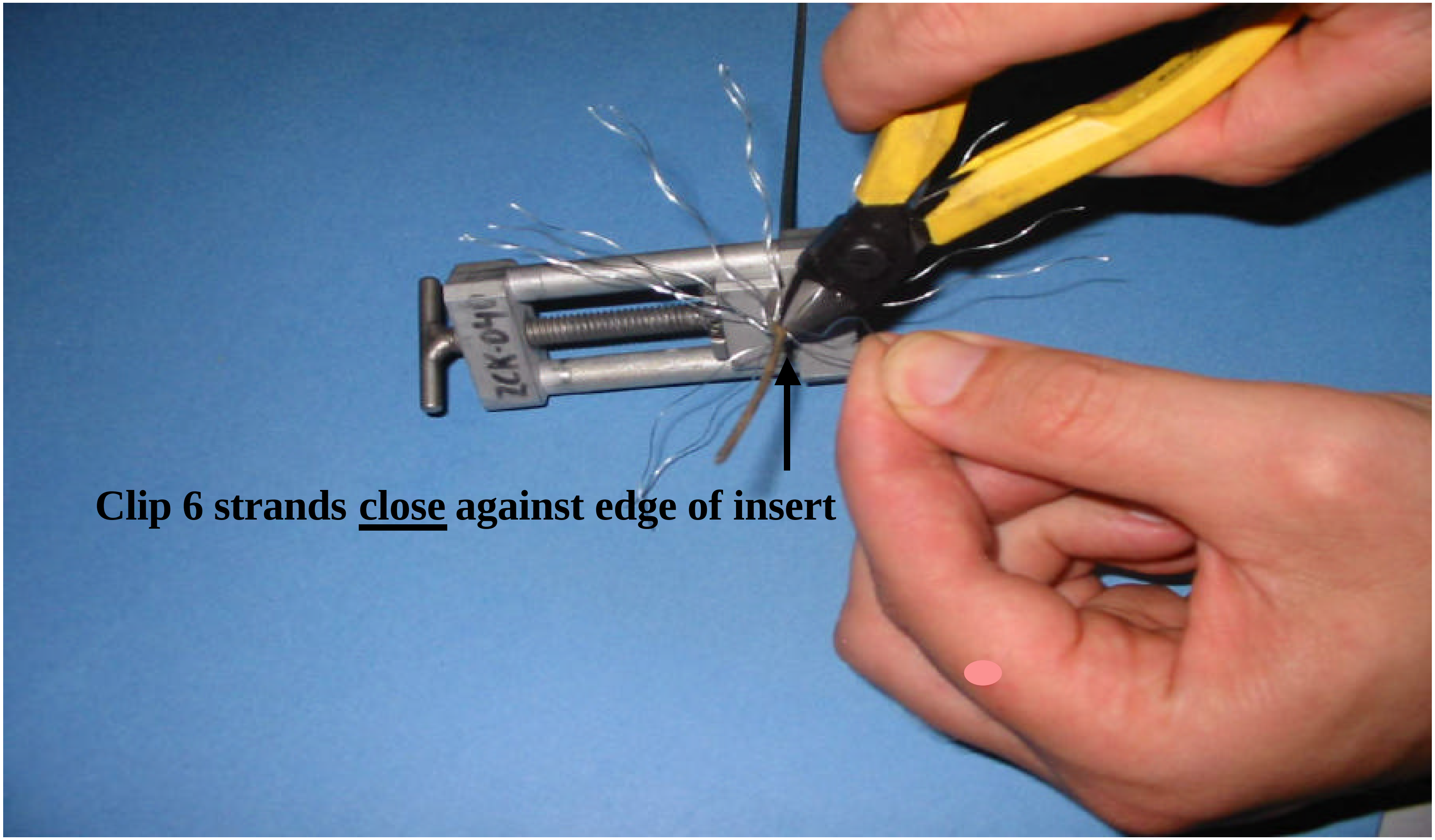
Pic.6c Slide Termination Insert Over Cable



Pic.7a Unwind Outer-layer Strands (start)

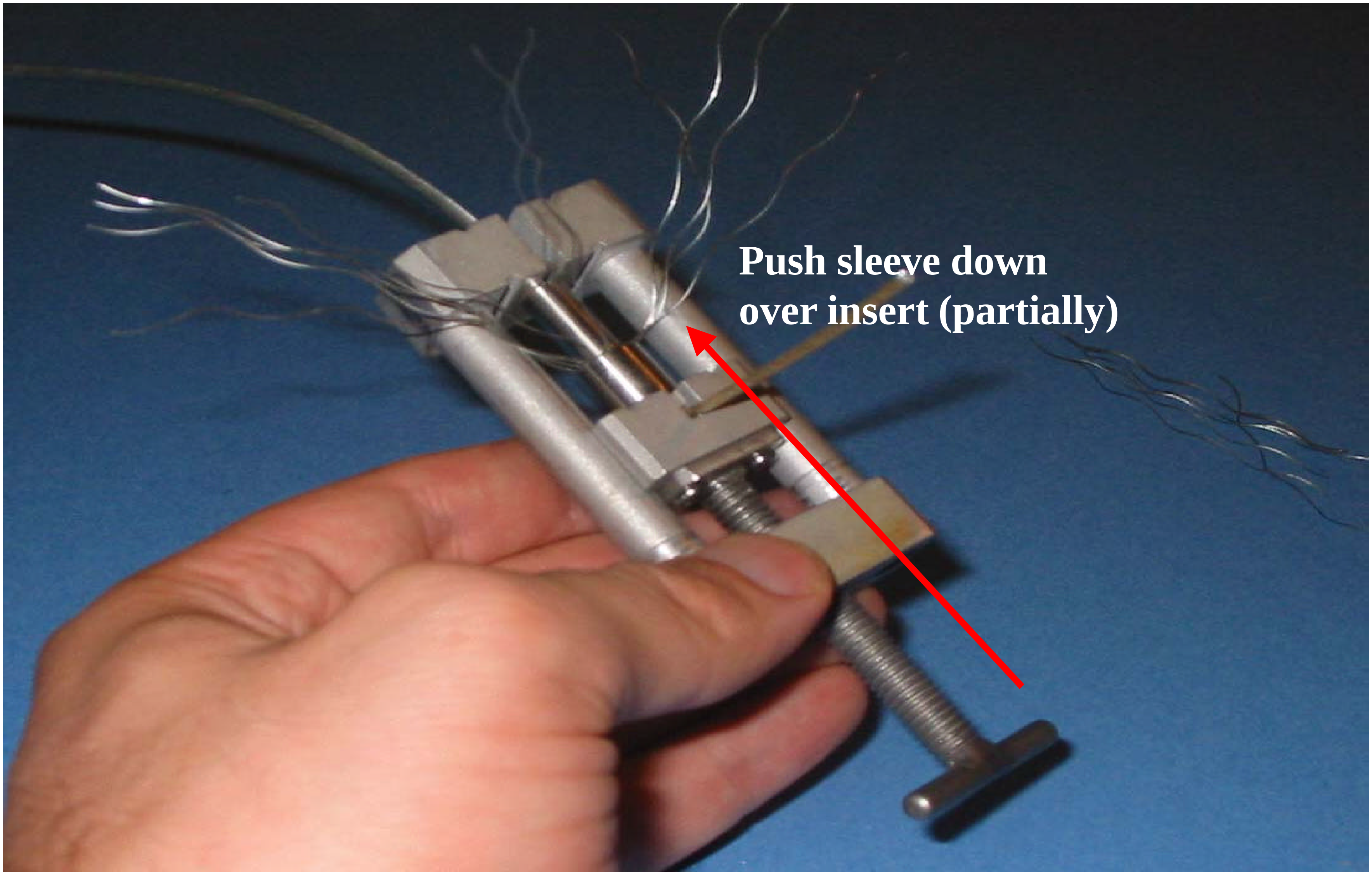


Pic.7b Unwind Outer Layer Strands (finish)

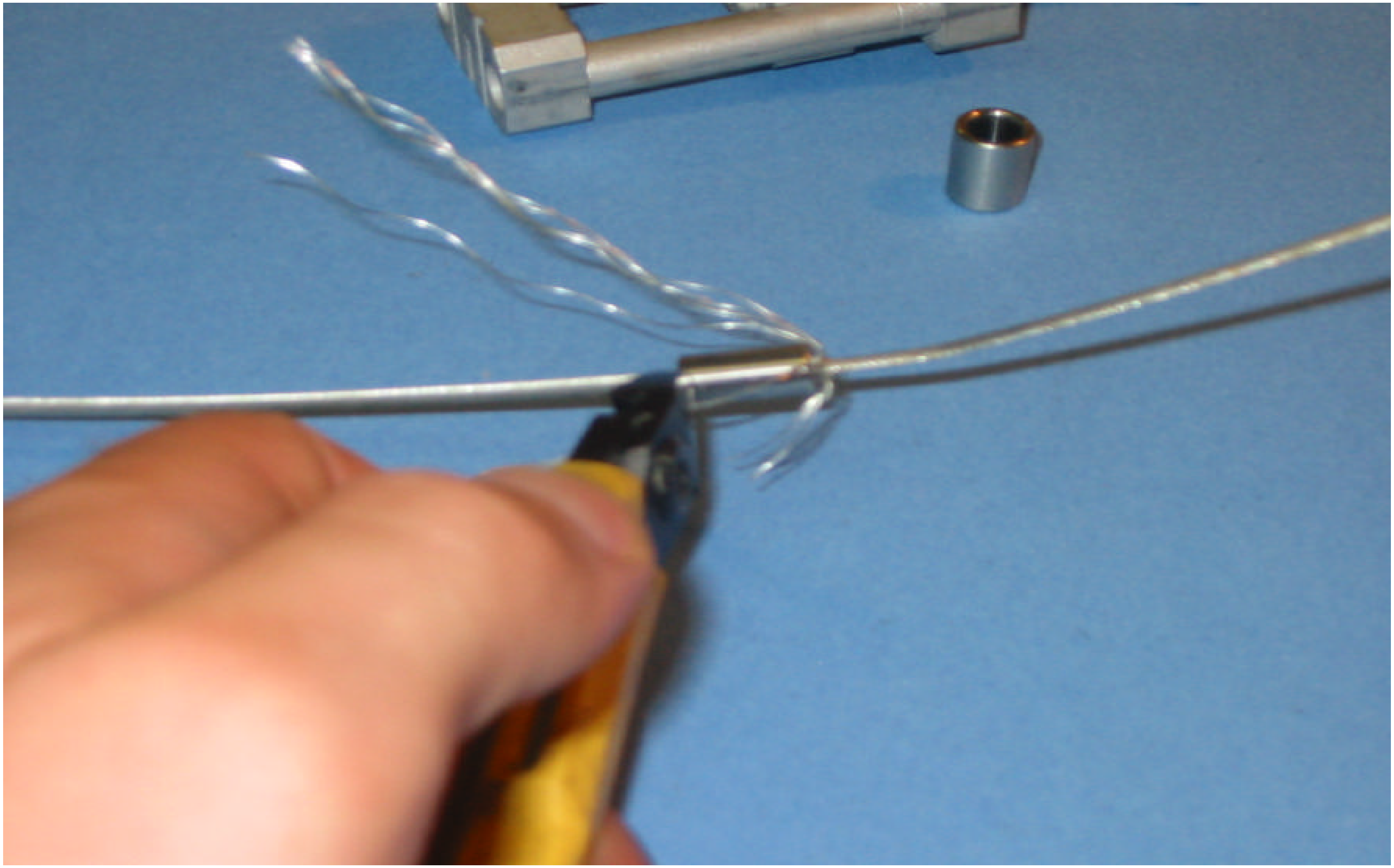


Clip 6 strands close against edge of insert

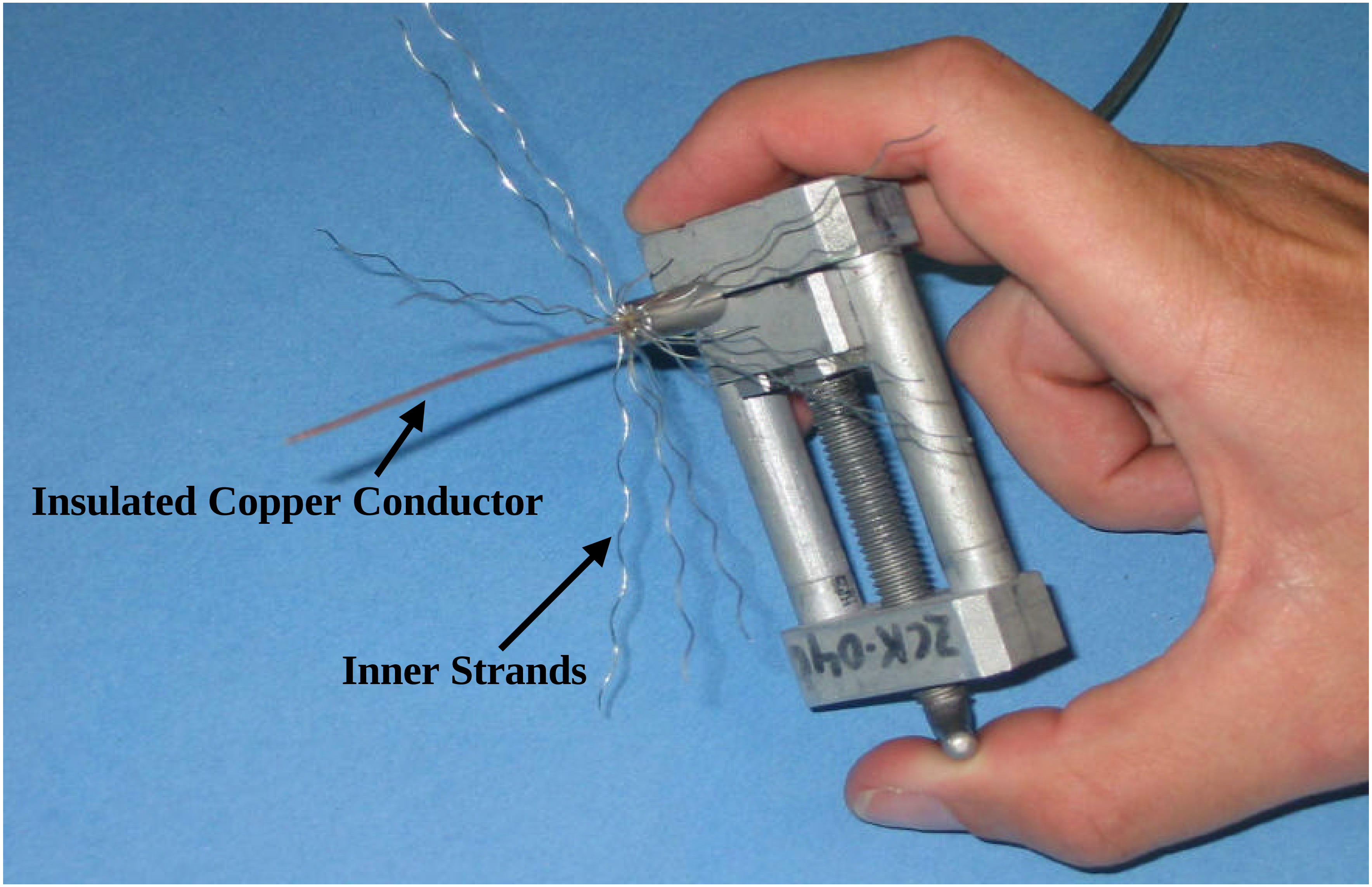
Pic.8 Clipping Outer Wire Strands (6 strands out of 18)



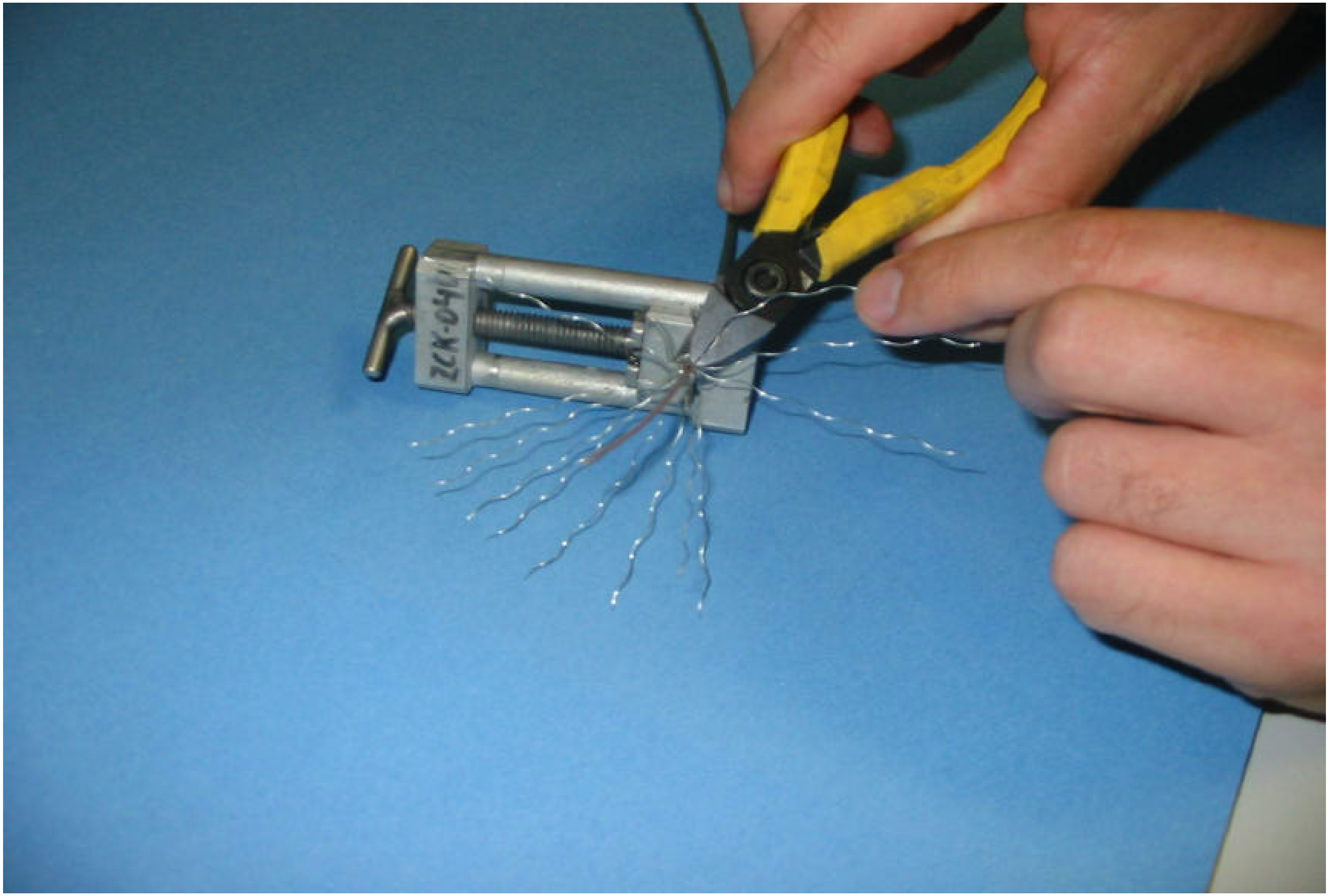
Pic.9 Partially Push Sleeve Down on Insert Using Jig
(enough to bend strands down along insert)



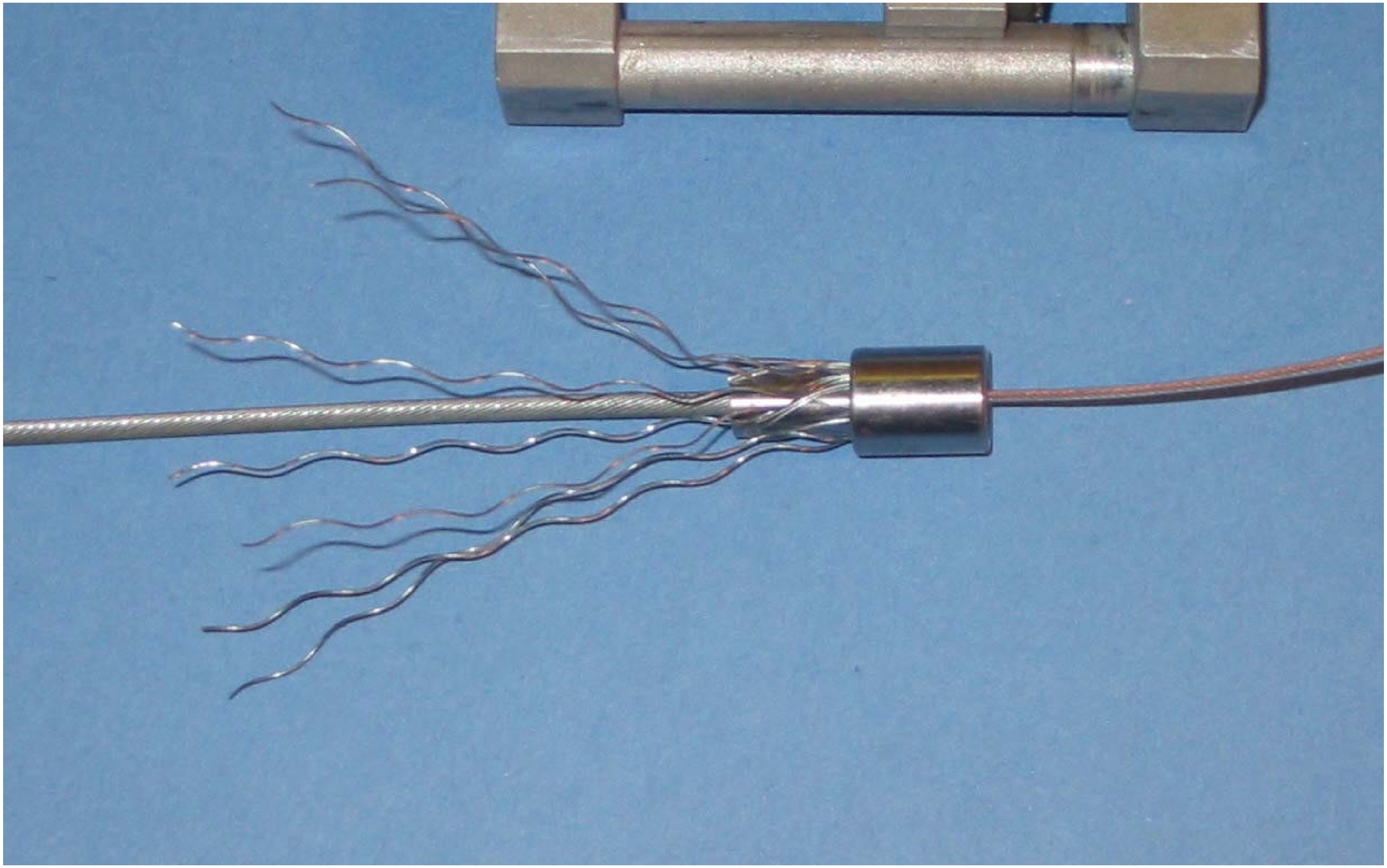
Pic.10 Trim Outer Wire Strands to Base of Insert.



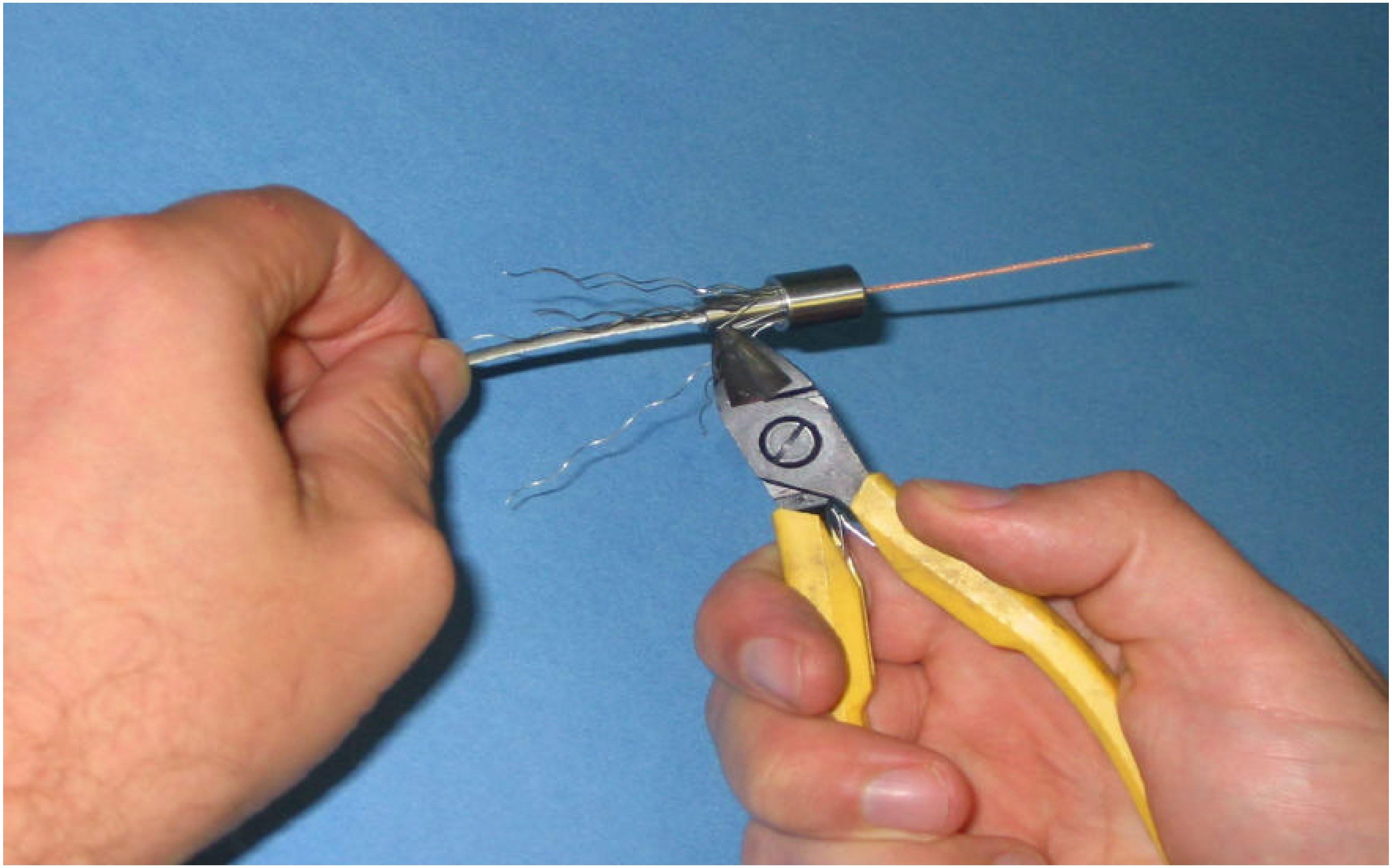
Pic.11 Unwind inner-layer strands of armor (exposing the insulated conductor wire)



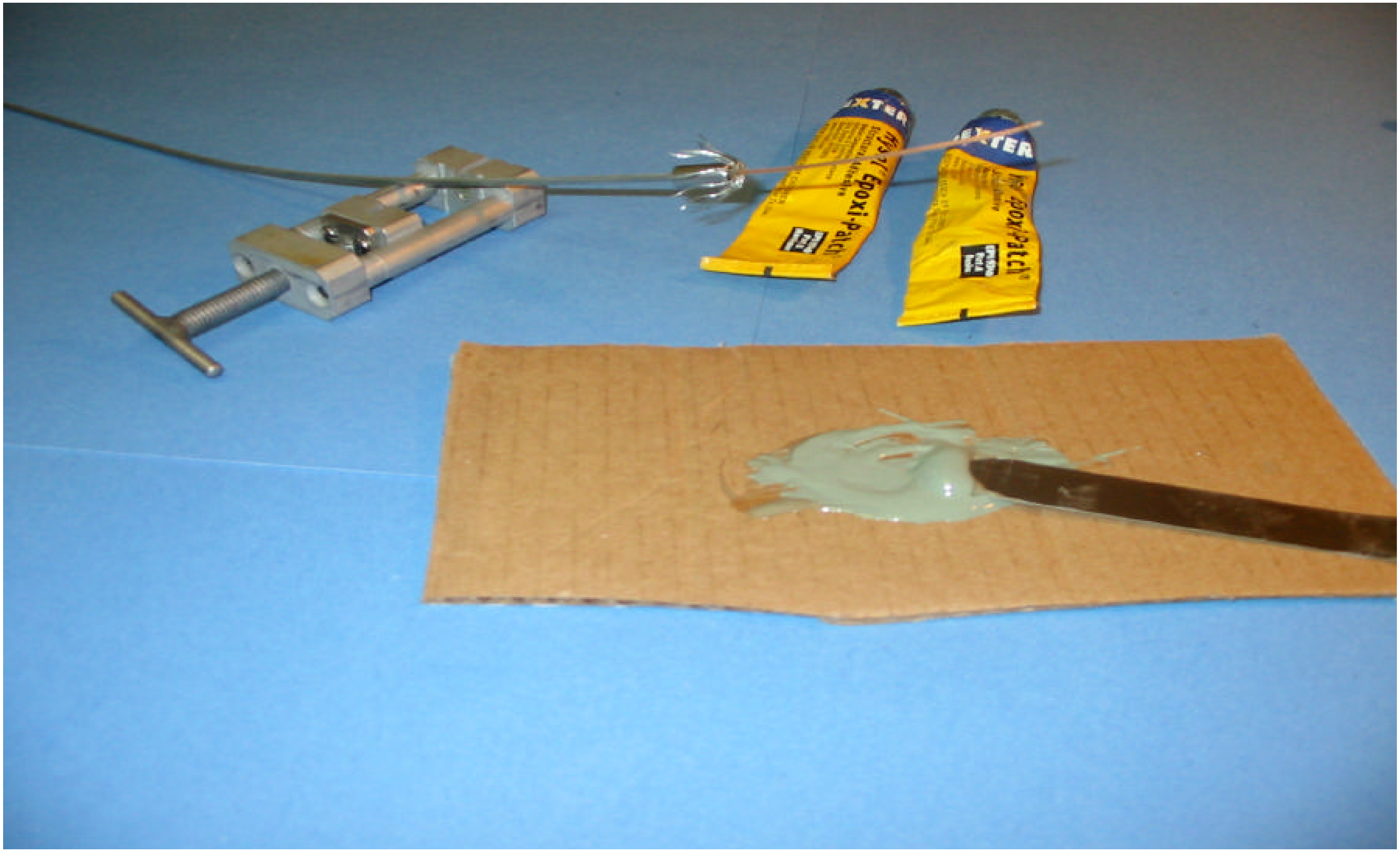
Pic.12 Clip 5 of the 12 inner armor strands close to the top of the insert



Pic.13 Bend down Remaining Inner Wire Strands
(Use jig and termination sleeve)

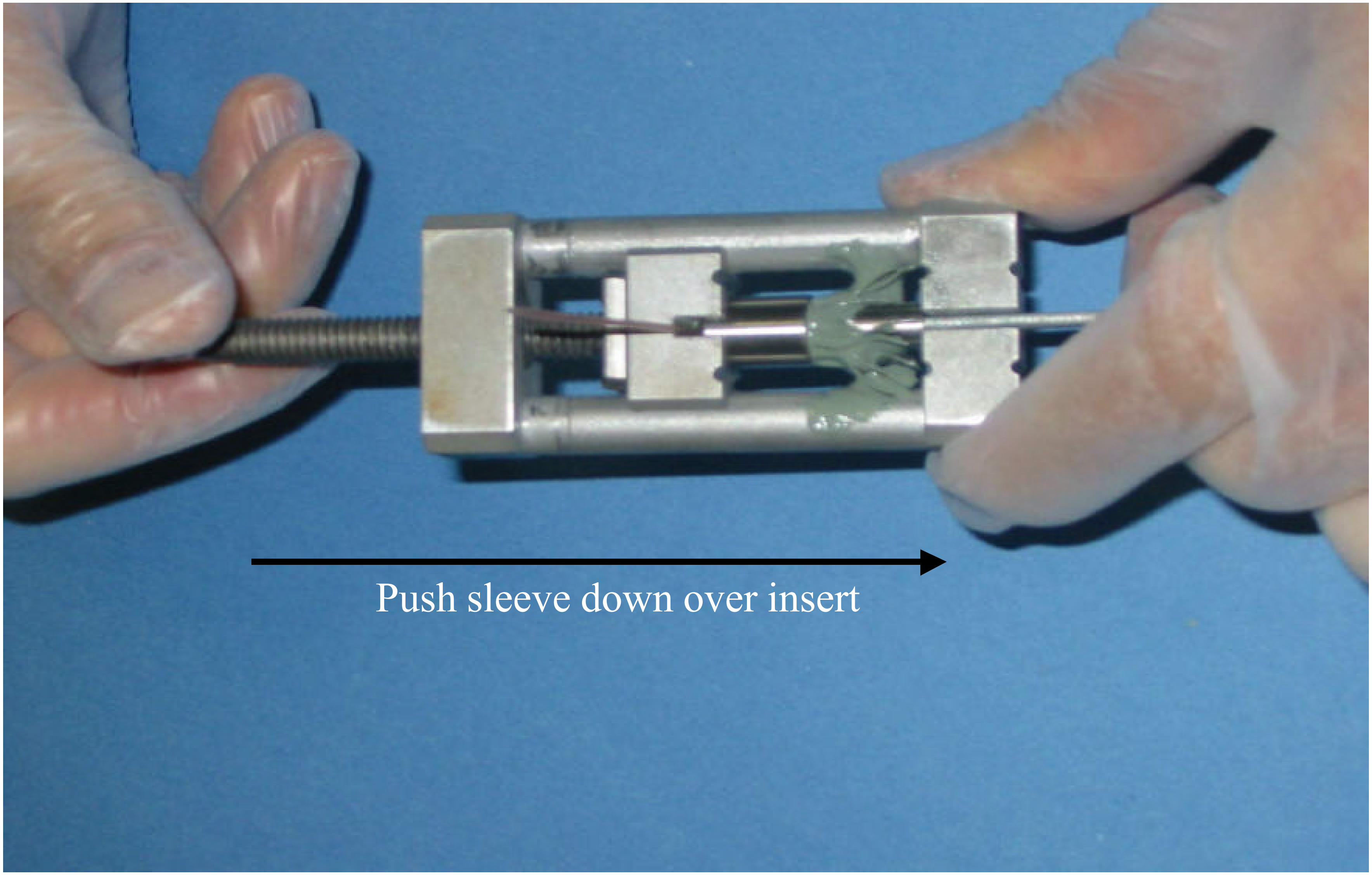


Pic.13 Trim Inner Wire Strands to Base of Insert

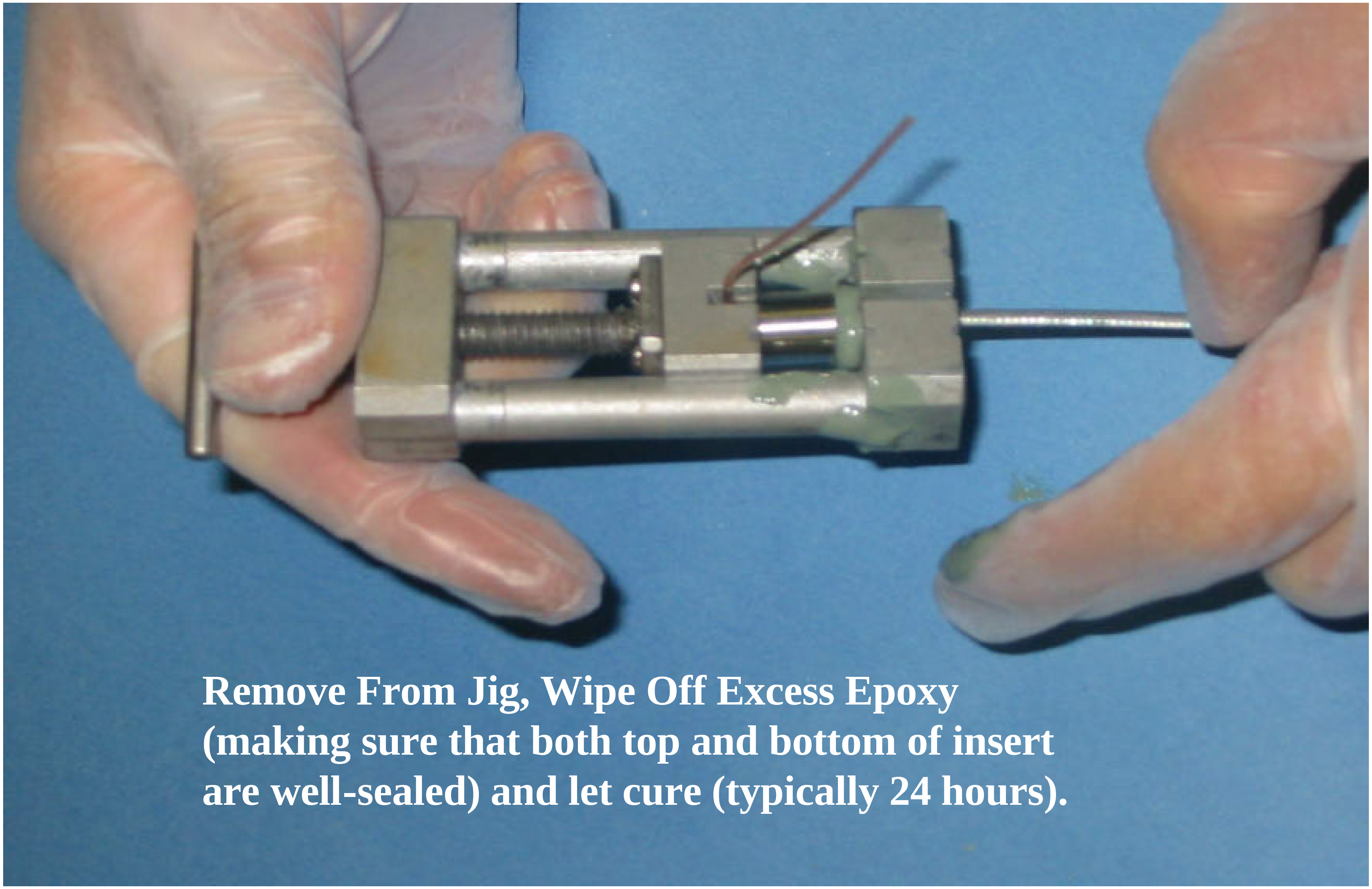


Pic.14 Mix epoxy

Pic.15 Apply epoxy. Cover the trimmed armor strands with epoxy



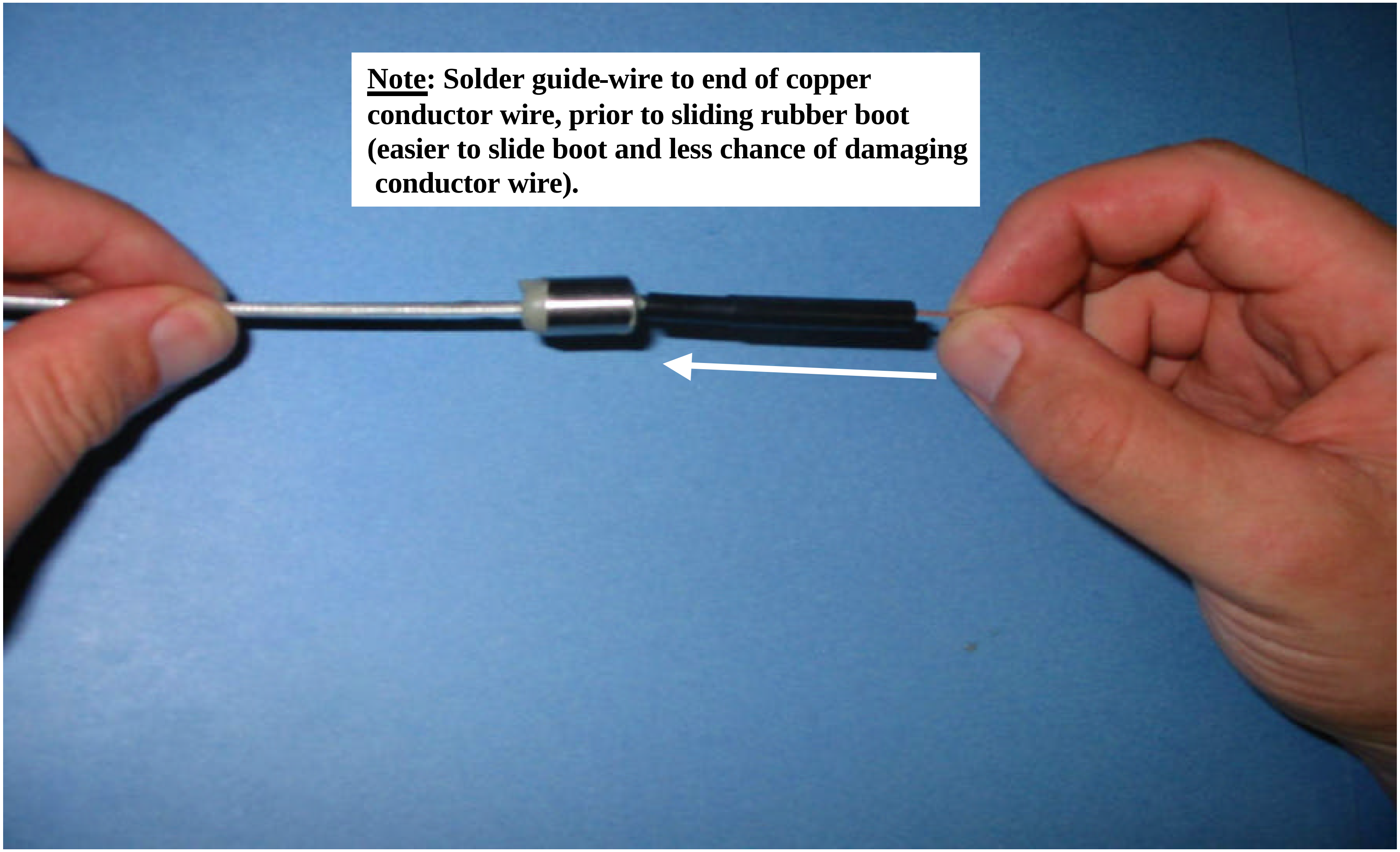
Pic.16 **Using the termination jig, push the termination sleeve completely down over the insert**



Remove From Jig, Wipe Off Excess Epoxy (making sure that both top and bottom of insert are well-sealed) and let cure (typically 24 hours).

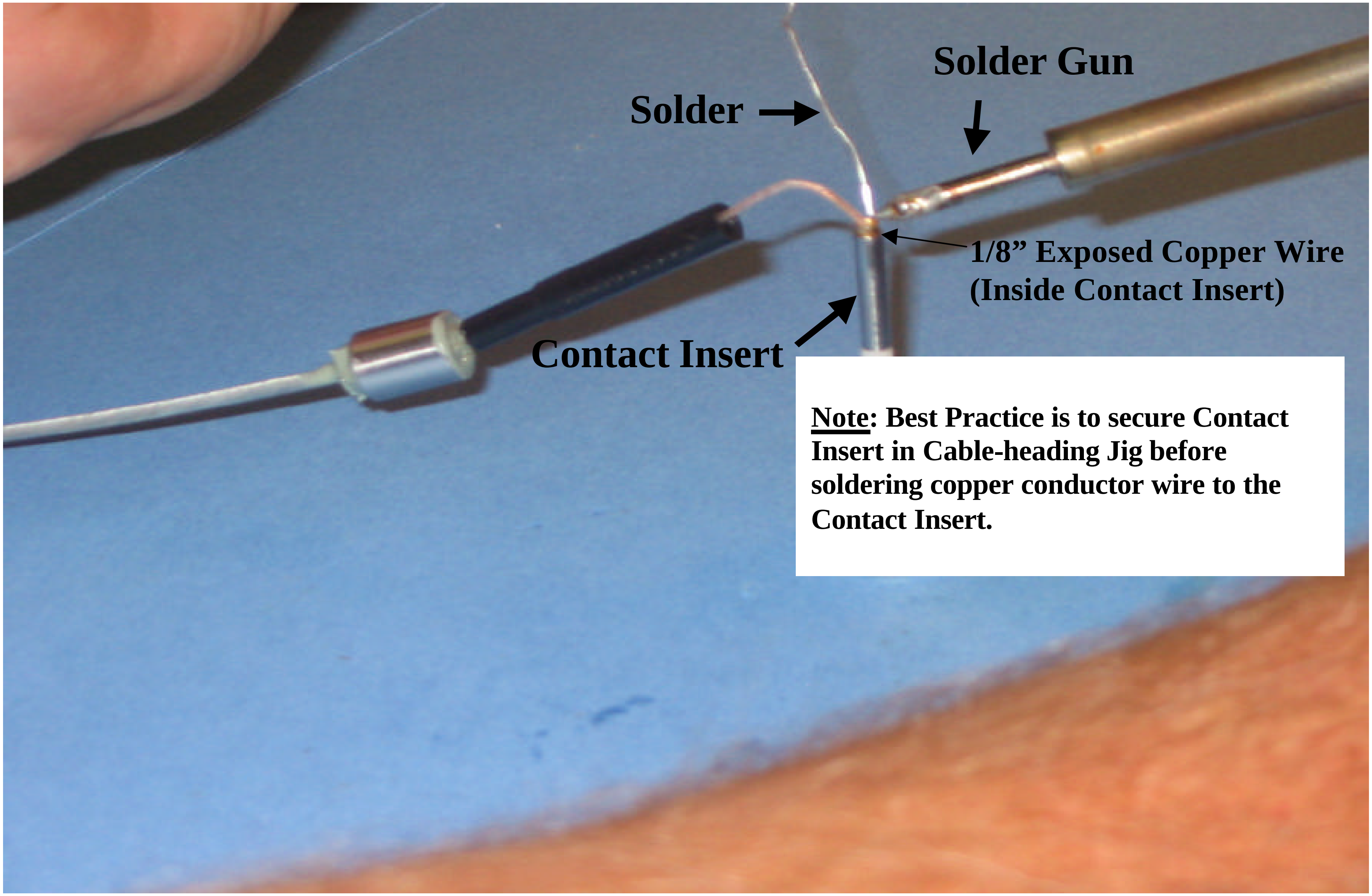
Pic.17 **Termination Sleeve completely pushed down over insert**

Pic.18 Apply silicon lubricant to the insulated conductor wire



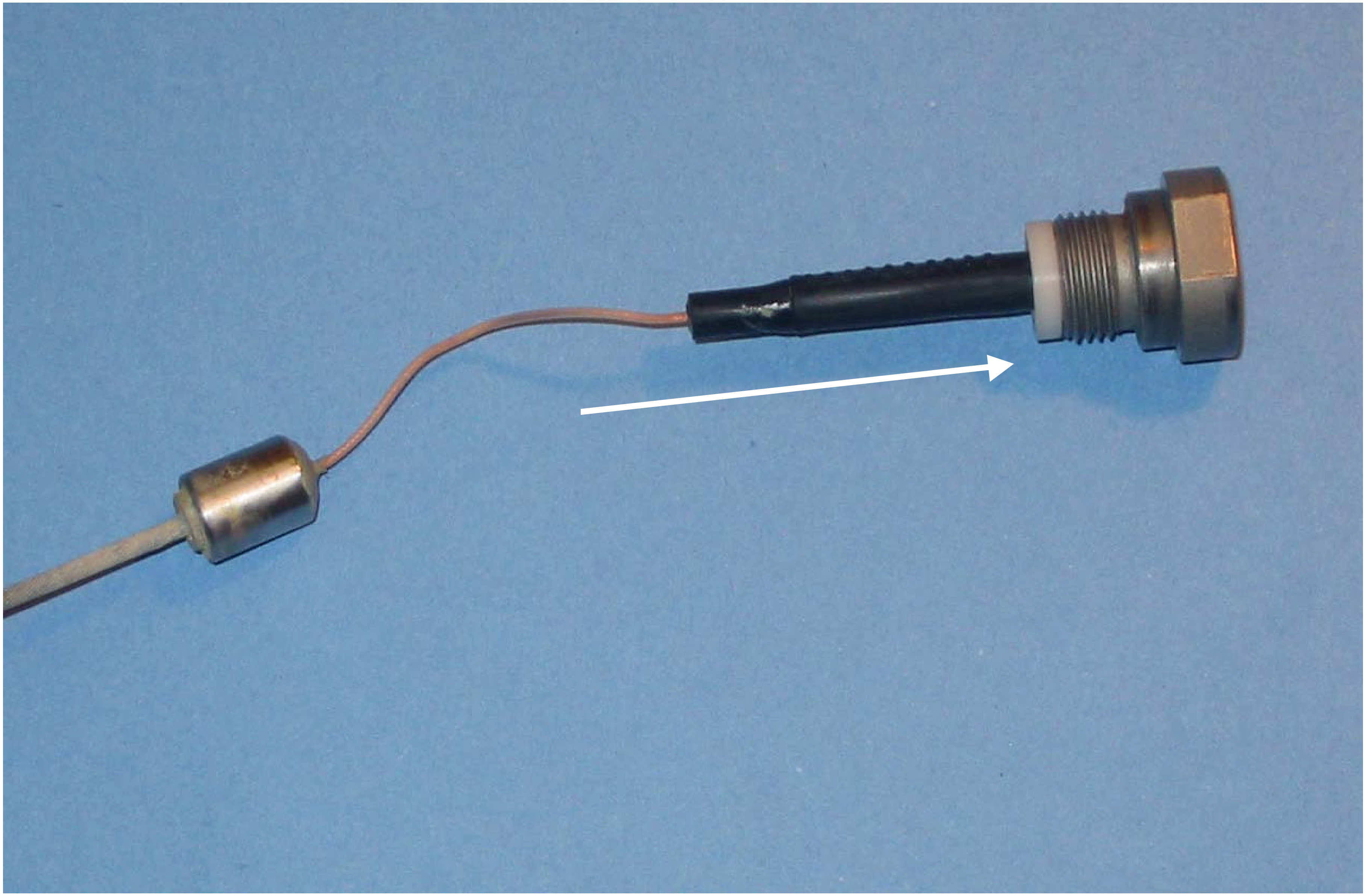
Note: Solder guide-wire to end of copper conductor wire, prior to sliding rubber boot (easier to slide boot and less chance of damaging conductor wire).

Pic.20 Slide the rubber boot towards the cablehead termination (final position)

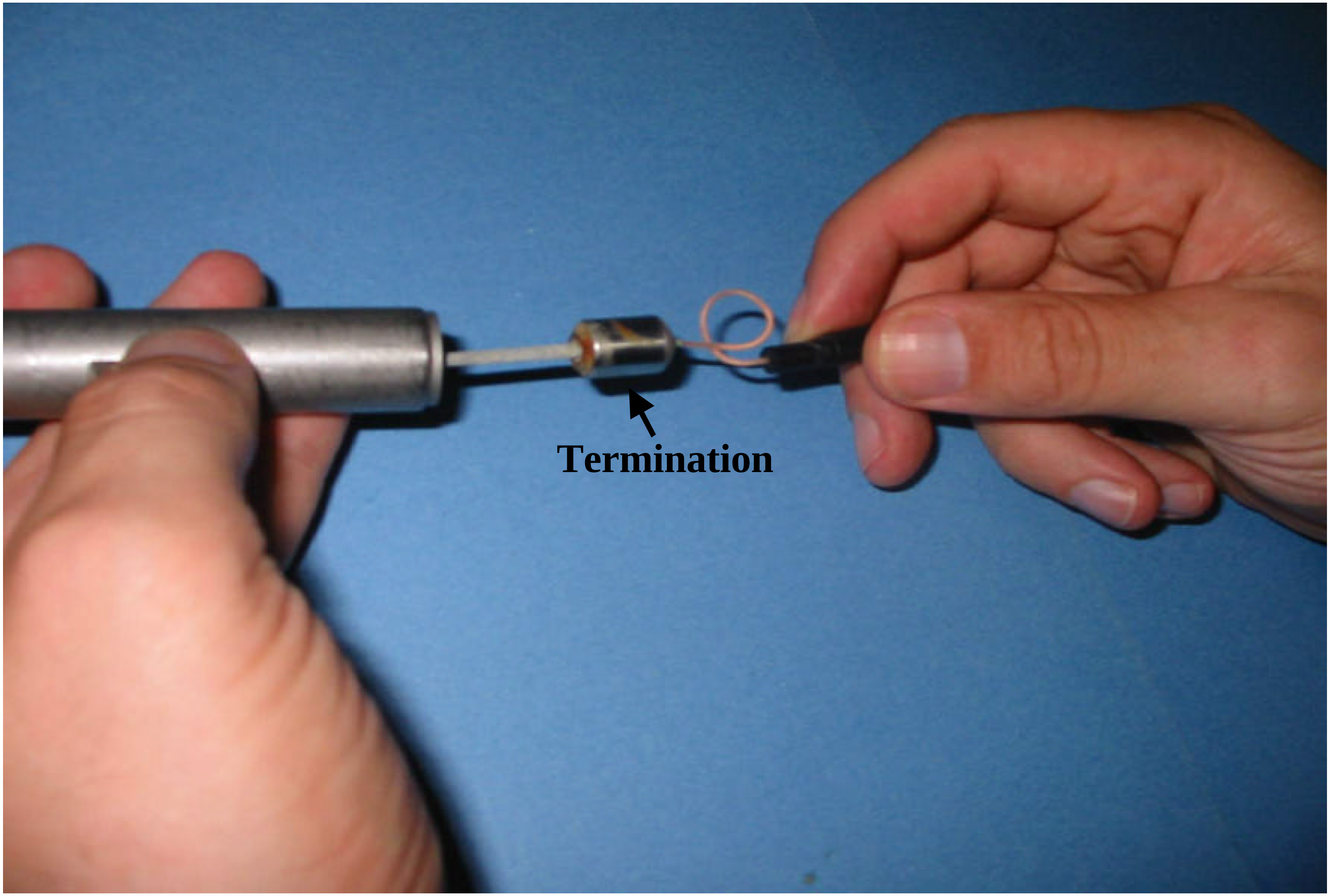


Note: Best Practice is to secure Contact Insert in Cable-heading Jig before soldering copper conductor wire to the Contact Insert.

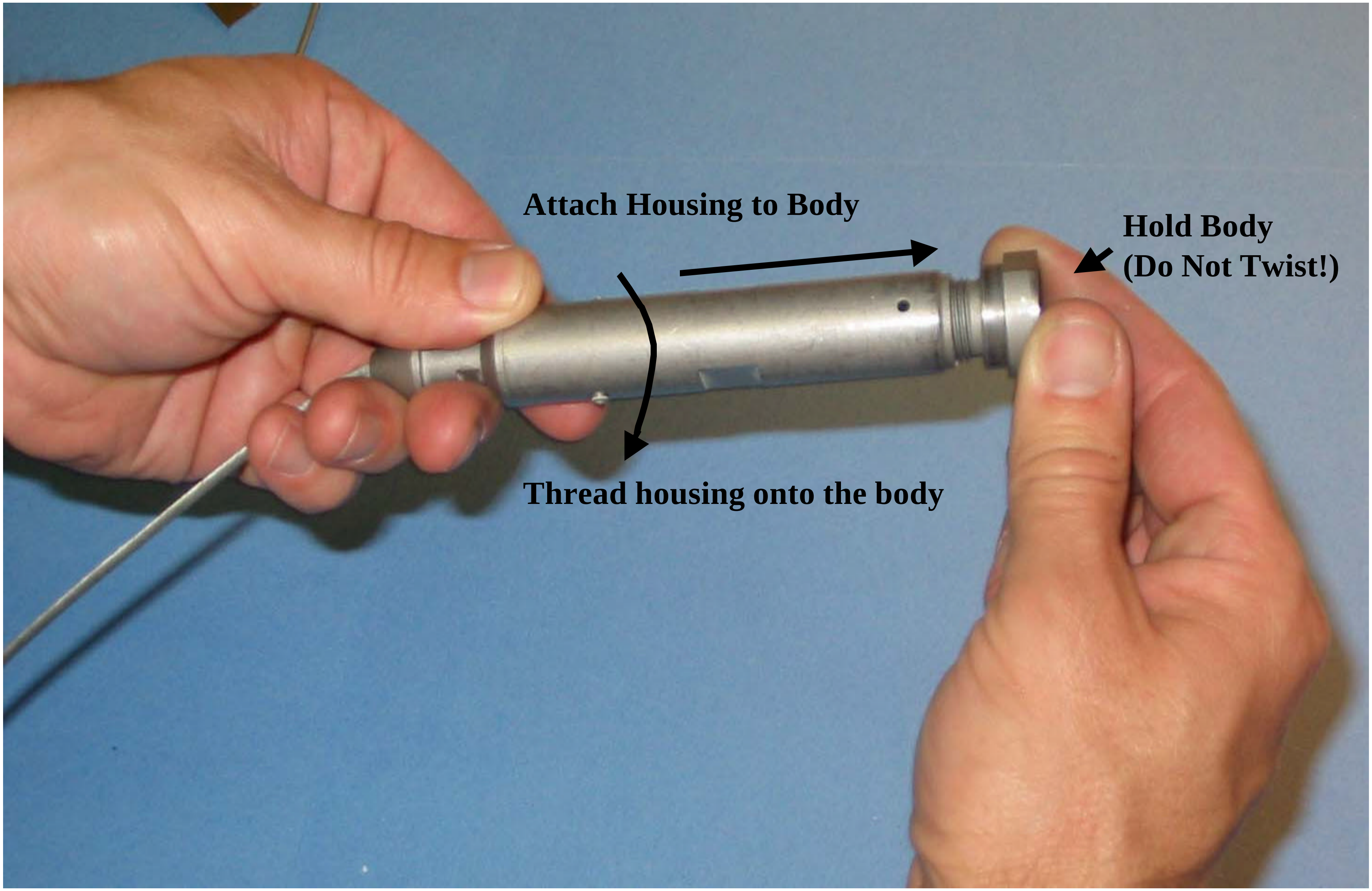
Pic.21 Solder 1/8 inch exposed copper wire (use wire strippers) into contact insert



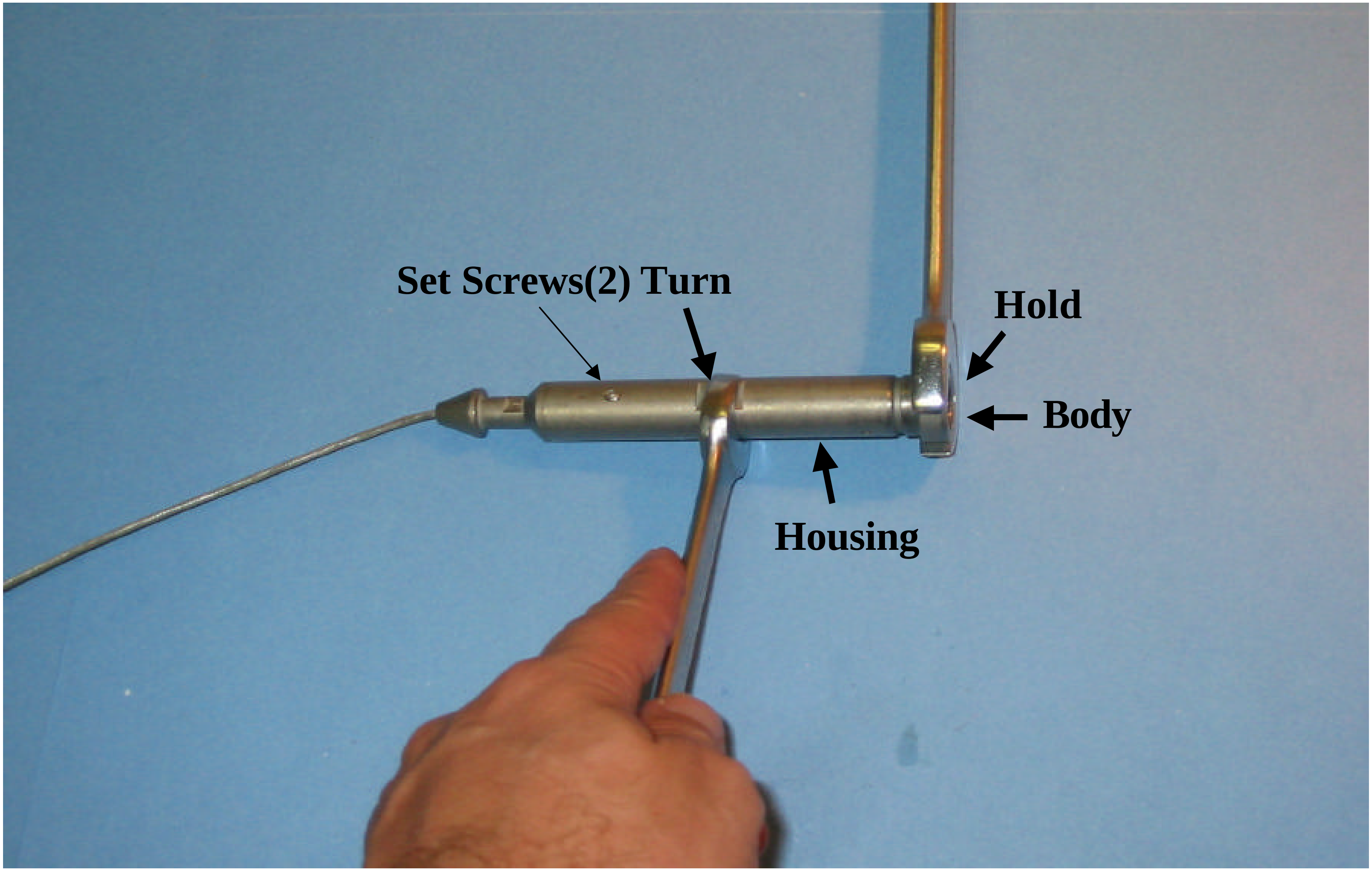
Pic.22 **Slide the rubber boot down over the contact insert (when the solder has cooled)**



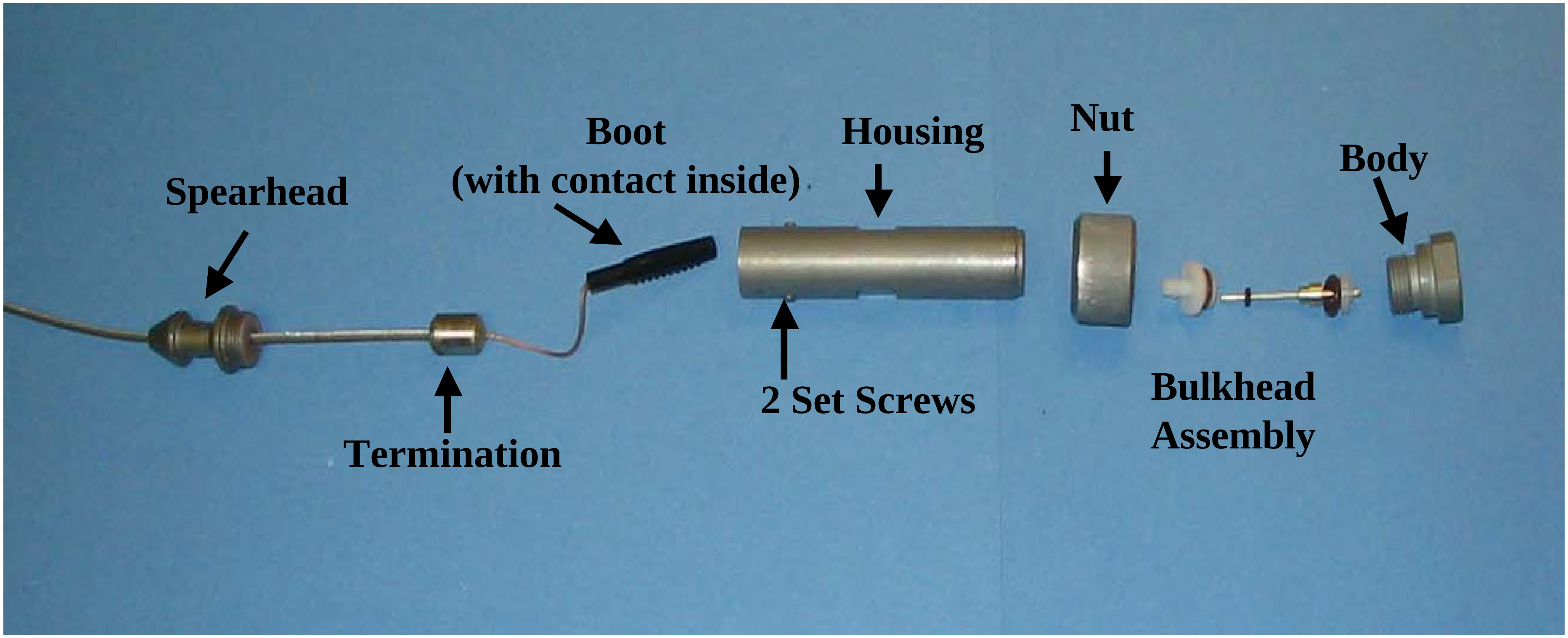
Pic.23 Create a loop in the conductor wire before sliding the cablehead housing down over the termination



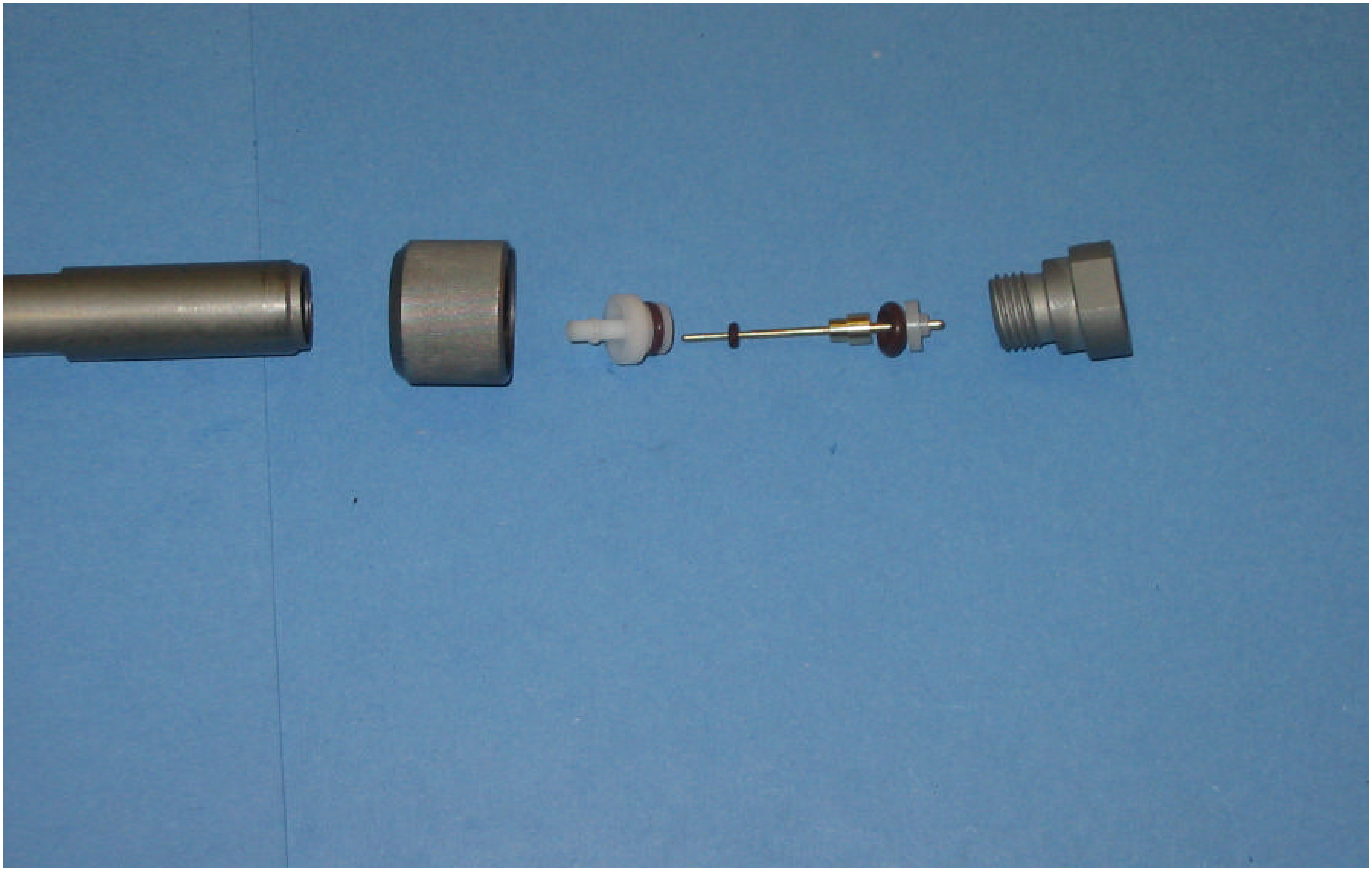
Pic.24 **Thread the cablehead housing onto the body**
(Do not twist the body! –this can damage the conductor wire)



Pic.25 Tighten the housing to the body
Tighten the set screws to complete re-assembly of the cablehead



Pic.26 Exploded view of cablehead assembly



Pic.27 Exploded view of bulkhead assembly

Appendix K

Field Monitoring Forms

Bioreactor Monitoring

Bioreactor Monitoring

Personnel:

Trench Sumps Water Levels ('BTOC)

Sump ID	Sump Depth (ft BTOC)	Sump Water Level (ft BTOC)	pH	Temp. (deg. C)	SpCond. (mS/cm)	ORP	DO (mg/L)	Trench Currently Being Used (√)	Notes
Date:		*Time:*							
B3-T1-1	**12.9**								
B3-T1-2	**12.4**								
B3-T1-3	**12.85**								
B3-T2-1	**9.67**								
B3-T2-2	**10.01**								
B3-T3-1	**9.96**								
B3-T3-2	**7.4**								
B3-T4-1	**6.32**								
B3-T5-1	**9.33**								
B3-T5-2	**7.98**								
B3-T6-1	**11.45**								
B3-T6-2	**12.34**								
B3-UIC									

B-3 Transfer System Monitoring

Flow Meters Readings

Meter	**Monday**		**Tuesday**		**Wednesday**		**Thursday**		**Friday**	
Date/Time:										
Rate (gpm) / Cumulative Total (gal)										
T-1										
T-2										
T-3										
T-4										
T-5										
T-6										
B-3 (Total)										
CS-MW16-LGR										
CS-MW16-CC										
B3-EXW01										

Bag Filter Pressure Reading (Pressure Drop (PB-1) - (PB-2)= *Note: If bag filter pressure drop is > or = 10 psi change fliter

PB-1 - PB-2 =	*PB-1 - PB-2 =*	*PB-1 - PB-2 =*	*PB-1 - PB-2 =*	*PB-1 - PB-2 =*

Notes:

Week___

Weekly Water Level Monitoring

Personnel

Weekly Water Level Monitoring

Well Interval	Sampling Port Depth (ft BTOC)	Sample Date	Sample Time	Pressure at TOC (psi)	Pressure in MP (psi)	Zone Pressure (psi)
CS-WB05-LGR-01	99				*14.07*	
CS-WB05-LGR-02	182				*14.11*	
CS-WB05-LGR-03A	216				*14.14*	
CS-WB05-LGR-03B	262				*16.17*	
CS-WB05-LGR-04A	277				*22.70*	
CS-WB05-LGR-04B	329				*45.33*	
CS-WB05-BS-01	362				*59.67*	
CS-WB05-CC-01	432				*90.08*	
CS-WB05-CC-02	460				*102.24*	
CS-WB06-UGR-01	20				*14.04*	
CS-WB06-LGR-01	93				*14.07*	
CS-WB06-LGR-02	174				*14.11*	
CS-WB06-LGR-03A	207				*14.14*	
CS-WB06-LGR-03B	260				*21.60*	
CS-WB06-LGR-04	320				*47.66*	
CS-WB07-UGR-01	14				*14.05*	
CS-WB07-LGR-01	90				*14.10*	
CS-WB07-LGR-02	175				*14.14*	
CS-WB07-LGR-03A	208				*14.17*	
CS-WB07-LGR-03B	257				*15.58*	
CS-WB07-LGR-04	318				*42.13*	
CS-WB08-UGR-01	38				*14.03*	
CS-WB08-LGR-01	115				*14.08*	
CS-WB08-LGR-02	193				*14.12*	
CS-WB08-LGR-03A	228				*14.14*	
CS-WB08-LGR-03B	273				*18.87*	
CS-WB08-LGR-04	341				*48.45*	

Week ___

Quarterly Monitoring

Personnel

Quarterly Monitoring

MPMWs	Sampling Port Depth (ft BTOC)	Sample Date	Sample Time	Inside Pressure	Zone Pressure
CS-WB05-LGR-01	99				
CS-WB05-LGR-02	182				
CS-WB05-LGR03A	216				
CS-WB05-LGR03B	262				
CS-WB05-LGR04A	277				
CS-WB05-LGR04B	329				
CS-WB05-BS-01	362				
CS-WB05-CC-01	432				
CS-WB05-CC-02	460				
CS-WB06-UGR-01	20				
CS-WB06-LGR-01	93				
CS-WB06-LGR-02	174				
CS-WB06-LGR03A	207				
CS-WB06-LGR03B	260				
CS-WB06-LGR-04	320				
CS-WB07-UGR-01	14				
CS-WB07-LGR-01	90				
CS-WB07-LGR-02	175				
CS-WB07-LGR03A	208				
CS-WB07-LGR03B	257				
CS-WB07-LGR-04	318				
CS-WB08-UGR-01	38				
CS-WB08-LGR-01	115				
CS-WB08-LGR-02	193				
CS-WB08-LGR03A	228				
CS-WB08-LGR03B	273				
CS-WB08-LGR-04	341				

Monitroing Wells	Sample Date	Sample Time	pH	Temp	SpCond	ORP	DO
B3-MW01							
CS-D							
CS-MW16-LGR							
CS-MW16-CC							
CS-MW1-LGR							
B3-EXW01							

Quarter ___