SWMU B-3 BIOREACTOR
OPERATION AND MAINTENANCE MANUAL

Prepared For:

Camp Stanley Storage Activity

Boerne, Texas

Prepared by

PARSONS

Austin, Texas

October 2012

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ACRONYMS AND ABBREVIATIONS

BTOC	below top of casing
BTS	Bioreactor Trench Sump
CC	Cow Creek
CO_2	carbon dioxide
CSSA	Camp Stanley Storage Activity
DCE	Dichloroethene
DO	Dissolved oxygen
DOC	Dissolved organic carbon
gpm	Gallons per minute
HDPE	High density polyethylene
HOA	Hand-Off-Auto
Hp	Horsepower
HSP	Health and Safety Plan
JSC	J. Sanchez Contractors, Inc.
LGR	Lower Glen Rose
MEE	Methane, Ethane, Ethene
MPMW	Multi-port monitoring well
MSL	Mean sea level
MW	Monitoring well
O&M	Operation and Maintenance
ORP	Oxidation reduction potential
Parsons	Parsons Government Services, Inc.
P&ID	Process and Instrumentation Diagram
PCE	Tetrachloroethene
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
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TOC	Total organic carbon

ACRONYMS AND ABBREVIATIONS *(continued)*

toc	top of casing
UIC	Underground Injection Control
USACE	US Army Corps of Engineers
VC	Vinyl Chloride
VOC	Volatile organic compound

SECTION 1
INTRODUCTION

This Operation and Maintenance (O&M) Plan documents the necessary activities to be performed during O&M of the Solid Waste Management Unit (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 also provides 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 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 Letters for the underground injection of VOC-impacted groundwater are included in **Appendix A**. Design drawings of the bioreactor facility and extraction wells are included in **Appendix B**. Product manuals and literature of system components are included in **Appendix C** through **K**. Field data forms to be used during O&M activities are included in **Appendix L**.

This 2012 update reflects major revisions to the bioreactor system, which was reconstructed in spring 2012 by J. Sanchez Contractors, Inc. (JSC) under separate contract with the US Army Corps of Engineers (USACE). The reconstruction included a new bioreactor building (Building 260) to centralize the control, collection, and injection of groundwater. Three new extraction wells, EXW03 through EXW05, were also integrated into the treatment system in 2012.

1.1 HEALTH AND SAFETY

CSSA and Parsons Government Services, Inc. (Parsons) are committed to performing the O&M activities at SWMU B-3 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 most current version of the HSP (revised May 2012) 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.

The new Building 260 includes safety features such as informational warning signage and a utility sink with eyewash to ensure the workplace is safe.

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.

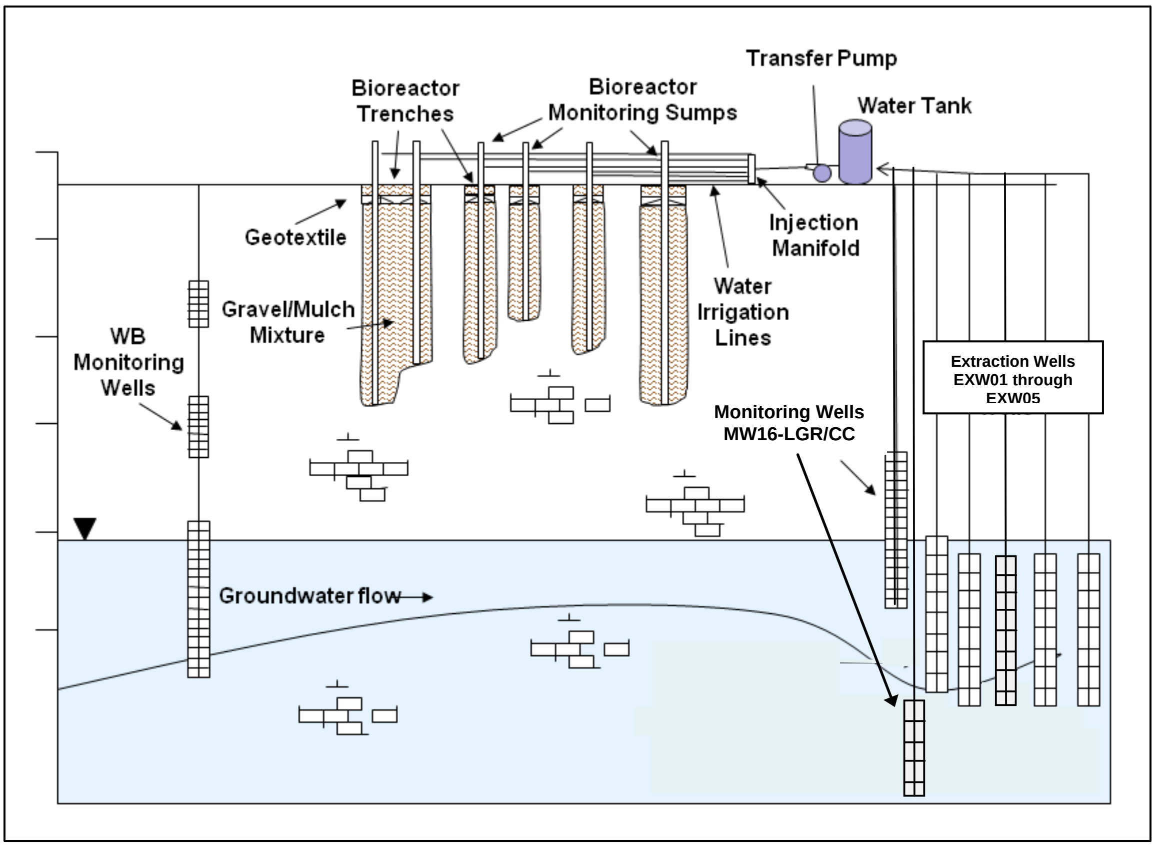
As part of the Resource Conservation and Recovery Act (RCRA) Administrative Consent Order, a pilot study using a bioreactor was conceptualized, designed, and constructed at SWMU B-3. The bioreactor is designed to remediate the affected groundwater and unsaturated zone underlying SWMU B-3. The design 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. That request was approved by the TCEQ on February 27, 2012. 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 seven recovery wells, CS-MW16-LGR, CS-MW16-CC, and B3-EXW01 through B3-EXW05, to 20,000-gallons of tank storage (two 10,000 gallon tanks); this water is then pumped into the bioreactor. Level sensors within the storage tanks are set to communicate directly with the extraction wells to maintain an available water supply in the tanks for subsequent injection into bioreactor trenches. A transfer pump pumps water from the storage tanks 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 tanks is trickled into the gravel/bark mulch mixture in each trench through equally-spaced perforations along 3-inch flexible high density polyethylene (HDPE) pipe.

Figure 2.1 General Components of the Bioreactor



To prevent the bioreactor from overfilling, a level transducer is installed in trench sump 1-1 which will signal and 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 sumps 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 the gravel mulch mixture backfill. The bioreactor capability to reduce contaminants from seven extraction wells 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 original construction of the bioreactor are provided in *"B-3 Bioreactor Construction Report"* (Parsons, February 2007). However, most of the details provided in that report have been superseded by the reconstruction efforts of 2012. Documentation of the reconstructed bioreactor by JSC in 2012 is available at the CSSA Environmental Office.

2.2 SYSTEM UPDATES

In 2012, several system updates have been incorporated at SWMU B-3 that significantly change the bioreactor O&M activities. In 2011-2012, Building 260 was constructed on the northeast side of the bioreactor that now houses system controls, storage tanks, the transfer pump, and bag filter. The repositioning of the injection equipment in this new building required the rerouting of water lines from extraction wells and utilities, and moving Supervisory Control and Data Acquisition (SCADA) controls. Two 10,000-gallon polyethylene storage tanks have been installed in the new Building 260, and they replace the 6,000-gallon trailer-mounted tank previously used. Design drawings for Building 260 and a typical extraction wellhead completion design is included as **Appendix B.**

Three new extraction wells have been incorporated into the system since the last revision of this O&M plan. These wells, B3-EXW03, B3-EXW04, and B3-EXW05, were drilled, cased, and equipped with pumps between May 2011 through June 2012. The area around B3-EXW03 and B3-EXW04 may be subject to periodic flooding. To minimize the potential for flood damage, the surface completions and control equipment were installed on additional fill material, thus elevating the wells above the flood-prone area. HDPE extraction lines were buried and routed to Building 260. Well construction and completion details for extraction wells B3-EXW03 and B3-EXW04 are provided in *"Final Well Installation Report"* (Parsons, 2011) and completion details for B3-EXW05 are provided in *"B3-EXW05 Well Installation Report"* (Parsons, 2012).

Finally, the bioreactor trenches 1, 2, and 6 have been recharged with deciduous tree mulch and 5/8 inch gravel. New injection piping was installed approximately 18 inches below the surface within each recharged trench and covered with new geotextile fabric. New injection piping was also installed within trenches 3, 4, and 5, and awaits the addition of mulch and gravel and geotextile fabric to complete the trench updates.

The overall layout of the bioreactor in its current configuration is presented in **Figure 2.2**. A schematic of the equipment layout inside Building 260 is shown in **Figure 2.3**.

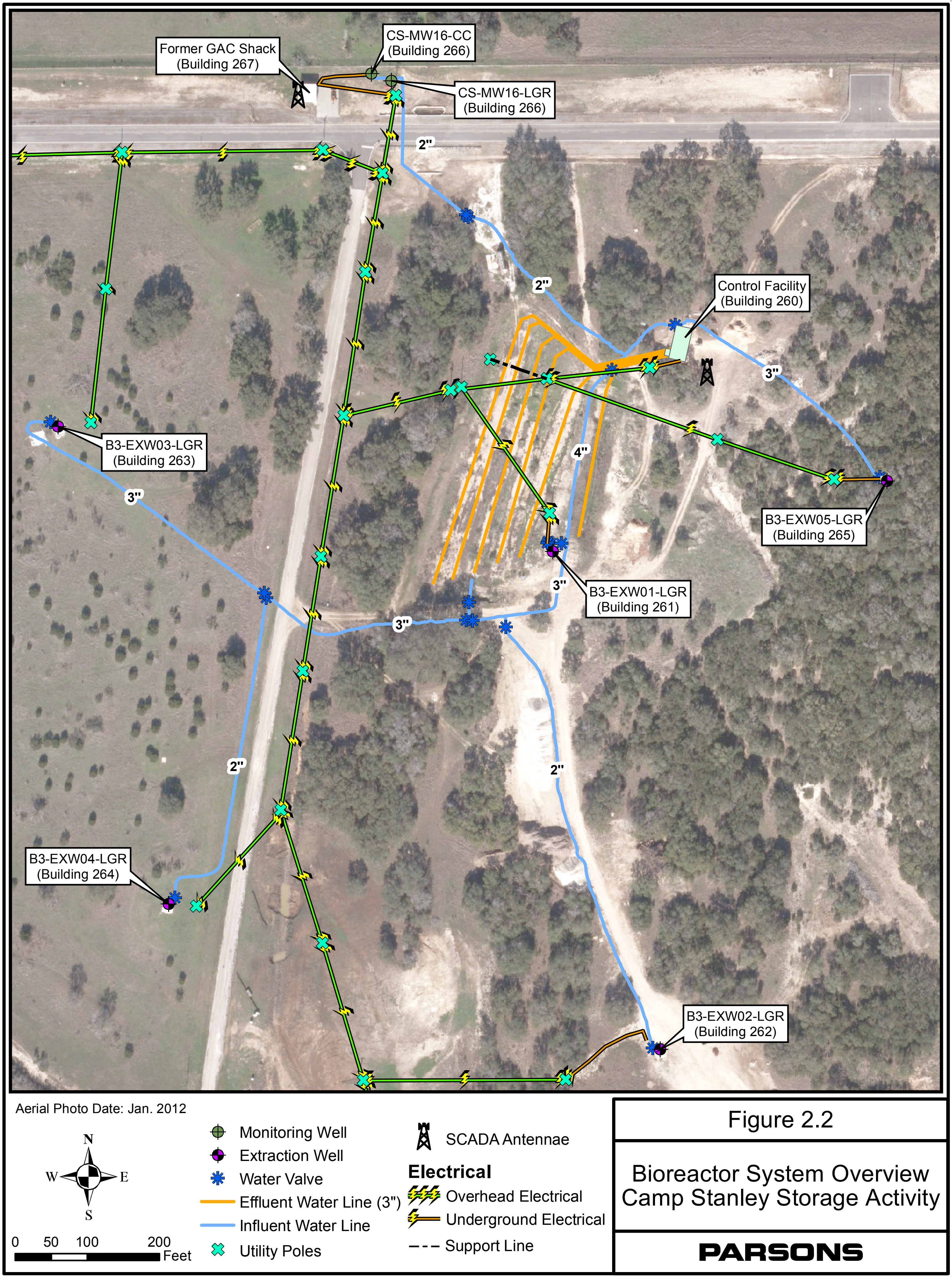


Figure 2.2

Bioreactor System Overview
Camp Stanley Storage Activity

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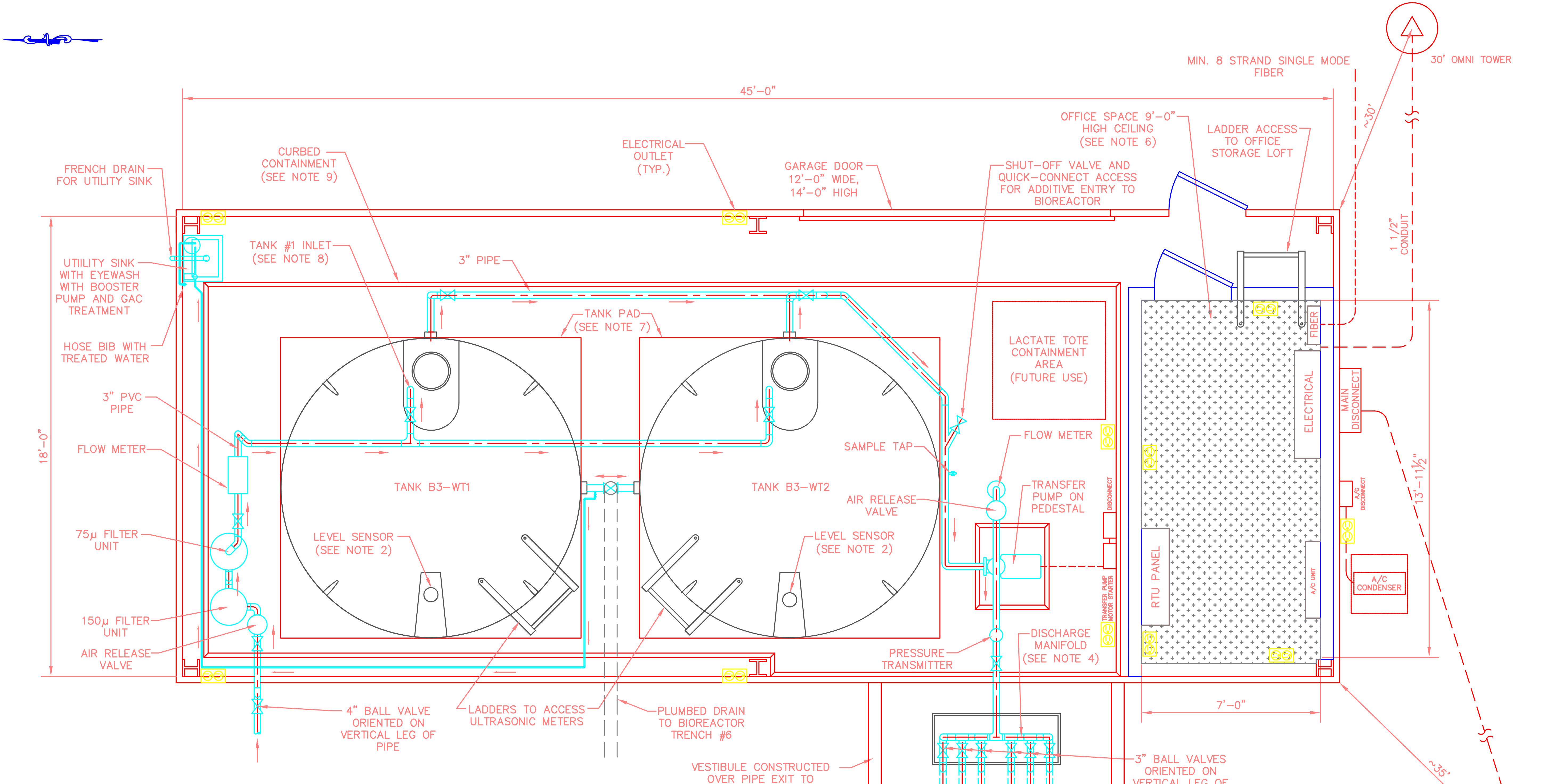

NOTES:

1. TANKS ARE 10,000–GALLON HDPE WITH DIMENSIONS OF 11'–9" DIAMETER BY 13'–4" HIGH.
2. ENDRESS+HAUSER PROSONIC M–FMU40 ULTRASONIC LEVEL METERS INSTALLED ON EACH TANK.
3. UTILITY SINK WITH EYEWASH. WATER FROM TANK #1 IS PRESSURIZED USING A SHURFLO PUMP (MODEL 2088–594) AND TREATED WITH GRANULAR ACTIVATED CARBON. A HOSE BIB IS ALSO INCLUDED AT THIS LOCATION.
4. DISCHARGE OUTLET MANIFOLD LOCATED OUTSIDE THE BUILDING. EACH LINE TO EACH TRENCH TO BE EQUIPPED WITH ONE 3–INCH VALVE FOR FLOW REGULATION OR ISOLATION. AN ENCLOSURE IS TO BE CONSTRUCTED AROUND THE MANIFOLD IN THE FUTURE.
5. DESIGN EAVE (WHERE ROOF MEETS WALLS) HEIGHT OF BUILDING 18–FEET
6. HATCHED AREA TO BE CLIMATE CONTROLLED BY A MITSUBISHI ELECTRIC MODEL A09WA–03 WALL–MOUNTED A/C UNIT.
7. TANK PAD IS CONSTRUCTED OF REINFORCED CONCRETE 2–INCHES IN HEIGHT AND WITH A 0.0% SURFACE SLOPE.
8. INLET INTO TANK #1 IS A 3–INCH TEE CONNECTION WITH A 3–INCH VALVE ON THE LEG LEADING INTO THE TANK.
9. CURBED CONTAINMENT AREA IS CONSTRUCTED OF CONCRETE 3–INCHES IN HEIGHT. FLOOR OF CONTAINMENT AREA IS SLOPED 0.50% TOWARDS CENTER DRAIN.

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Not To Scale

Figure 2.3

Building 260 Schematic Diagram

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2.3 MAJOR EQUIPMENT

Equipment was installed to provide control of water flow from the two CS-MW16 wells (-LGR and –CC), and extraction wells B3-EXW01 through B3-EXW05.

2.3.1 Extraction Wells

As shown in **Figure 2.2**, there are seven wells within and surrounding SWMU B-3 which supply water to the bioreactor. Wells CS-MW16-LGR and CS-MW16-CC (Building 266) were initially used to supply water to the bioreactor upon start-up in 2007. In 2009 B3-EXW01 (Building 261) was installed about 30 feet to the southwest of Trench 6. In late 2010 well B3-EXW02 (Building 262) was installed 600 feet to the south of the bioreactor at a location near SWMU O-1. In 2011, wells B3-EXW03 (Building 263) and B3-EXW04 (Building 264) were installed to the west of the bioreactor, across Moyer Road. A fifth extraction well, B3-EXW05 (Building 265), was installed in June 2012. All seven extraction wells are currently plumbed into the system.

2.3.2 Recovery Well Pumps

Each extraction well is equipped with an electric submersible pump to produce groundwater from the aquifer and transfer it to the storage/injection facility. **Table 2.1** lists the equipment specification for each of the pumps installed.

Table 2.1 Pump Equipment installed in Extraction Wells

Well ID	Location	Date Pump Installed	Model	Voltage	Phase	Horsepower
B3-EXW01-LGR	Building 261	May 2009	Grundfos 40S50-15	230	1 Phase	5
B3-EXW02-LGR	Building 262	June 2010	Grundfos 40S50-15	200	3 Phase	5
B3-EXW03-LGR	Building 263	July 2011	Grundfos 40S50-15	200	3 Phase	5
B3-EXW04-LGR	Building 264	July 2011	Grundfos 40S50-15	200	3 Phase	5
B3-EXW05-LGR	Building 265	June 2012	Grundfos 40S50-15	200	3 Phase	5
CS-MW16-LGR	Building 266	November 2007	Grundfos 25S30-15	230	3 Phase	3
CS-MW16-CC	Building 266	August 2005	Grundfos 25S50-26	230	3 Phase	5

Pump details, including O&M instructions and parts listing are provided in **Appendix C**.

Each well has 1-inch Schedule 40 polyvinyl chloride (PVC) guide tubes installed to facilitate water level probe and transducer access. Transducers were installed in all seven extraction wells to transmit water level data to the SCADA system. These values control the pump cycling in order to keep the 20,000 gallon tank storage full but not overflowing and provide well pump protection (automatic shut off) when water levels drop to 10-20 feet above the well pump.

Additional well pump protection was added to wells B3-EXW01 through B3-EXW05 with the installation of SymCom MotorSaver™ or PumpSaver™ protection devices. These sensing devices monitor the amperage being used by the pump motor. After an initial calibration by the Operator, if the PumpSaver detects an undercurrent or overcurrent condition (user settable), the well pump is disabled for a specified time period. This protects the motor from running dry (undercurrent) or pumping too hard (overcurrent). The single-phase motor in EXW01 is protected by model 235P PumpSaver. The three-phase motors in EXW2 through EXW05 utilize either 777 MotorSaver or PumpSaver protection. The use of these devices requires that they be calibrated by the Operator using the methods outlined in the product brochure included in **Appendix C**.

2.3.3 System Transfer Pump

An end suction centrifugal pump manufactured by Price® Pump Co. was installed to transfer water from the storage tanks 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 transfer pump is connected to the storage tanks with a 3-inch schedule 80 PVC suction line that is routed adjacent to the storage tanks. A 3-inch line installed from the pump to the 3-inch header connects the pump to the bioreactor distribution system. Additional information about the transfer pump and motor is provided in **Appendix D**.

2.3.4 Storage Tanks

Two 10,000 gallon tanks have been placed inside Building 260. They serve as temporary storage of groundwater from the extraction wells and are the on-demand water supply to the bioreactor. The tanks can be operated individually or simultaneously, based upon the positioning of the control valves. The northern tank is referred to as B3-WT1, whereas the southern tank is referred to as B3-WT2. Monthly inspections are conducted to examine the condition of the tanks and any deficiencies are noted in the field logbook and scheduled for repair.

2.3.5 Bag Filter System

To reduce the amount of silt being deposited within the storage tanks, it is necessary to remove as much sediment from the injection water as possible to reduce the potential for accumulation. As shown in **Figure 2.3**, the bag filter equipment is installed upstream of the storage tanks. The bag filter equipment, manufactured by Pentair Industrial (formerly Krystil Klear Filtration®) consists of two filter housings in series, each with a coarse mesh basket and a bag filter fitted inside the mesh basket (model number L88).

The first filter unit is fitted with a 150 micron bag filter, while the second unit is fitted with a 75 micron bag filter. 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 E**.

2.3.6 Eductor for Incorporation of Additive

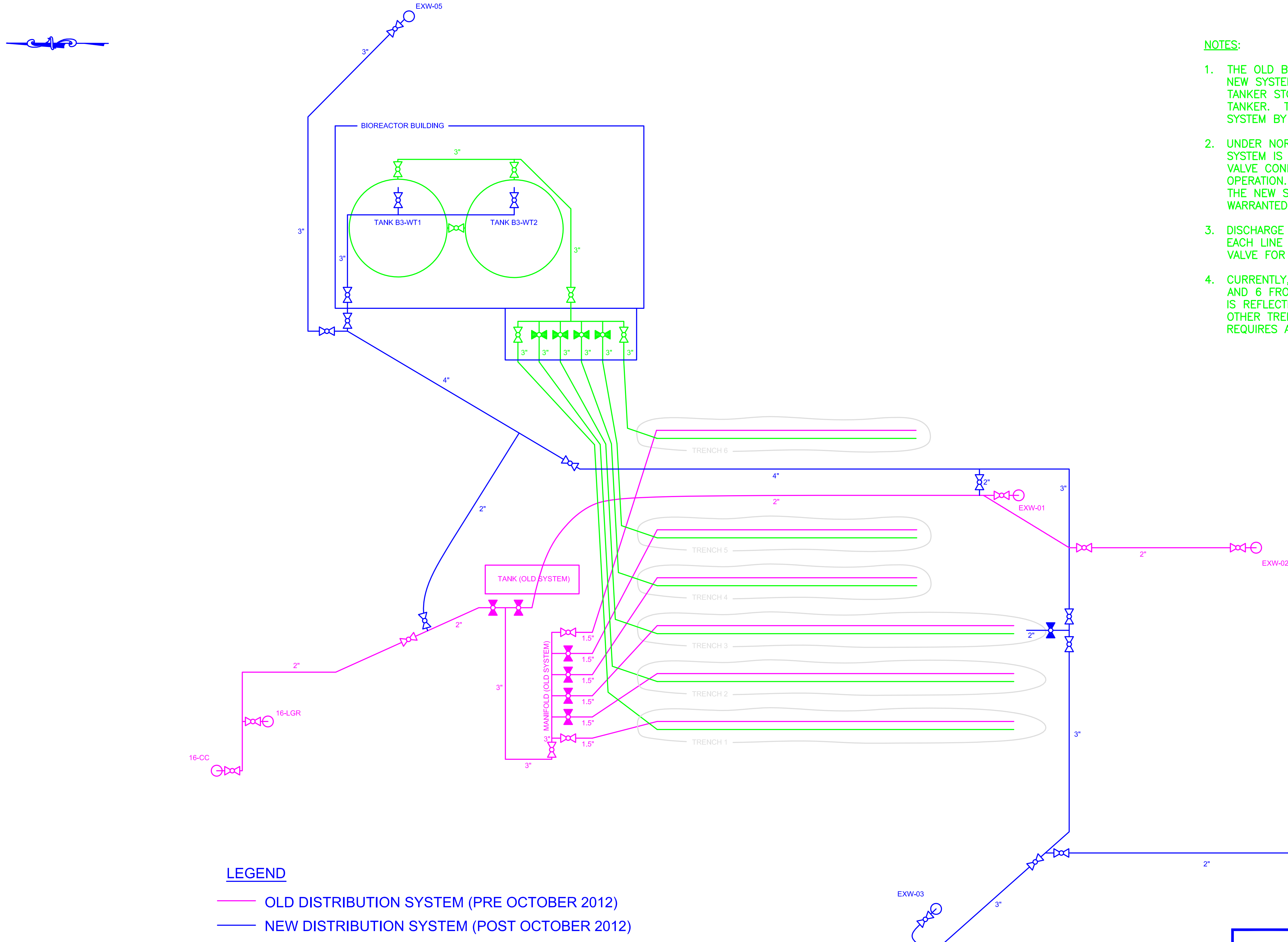
An eductor system is included upstream of the transfer pump for future use if it is deemed necessary to inject additional additive into the bioreactor. A container of vegetable oil, lactate, or similar microbial enhancement amendment can be placed within the containment near the eductor and an intake 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.

2.4 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 original infiltration gallery, installed in 2007, is still operational as needed. A new infiltration gallery with larger diameter pipe was installed in 2012. Within each trench, ½” holes have been drilled on 1-foot centers to serve as effluent orifices from the new 3” diameter HDPE injection pipe. This design has replaced the spray nozzles that were prone to clogging and biofouling.

Since both infiltration systems are still in place, they were designed with a cross-connect option to allow the operator to use the distribution systems either independently or simultaneously. The system is cross-connected at the well header located next to the former tanker storage unit. **Figure 2.4** shows how the two systems are cross-connected. If the two valves at the former well header are closed, all produced groundwater is diverted to Building 260. If either of those valves are opened, groundwater is available to be distributed to the trenches via the former discharge manifold.

At Building 260, groundwater is injected from the storage tanks into the trenches via the control manifold, located along the west outer wall of the building. The manifold includes separate lines and valving to direct and control the amount of flow to each of the six trenches. The trench piping from the manifold is logically ordered with Trench 1 on the left (northern end) of the manifold, and progressing to Trench 6 on the right (southern end) of the manifold (**Figure 2.5**). The operator will manipulate the ball valves to isolate or control the amount of water flow to each of the trenches.



NOTES:

1. THE OLD BIOREACTOR SYSTEM IS CROSS–CONNECTED WITH THE NEW SYSTEM AT WELL EXW–01, THE MANIFOLD AT THE FORMER TANKER STORAGE, AND BETWEEN MW16–LGR AND THE FORMER TANKER. THE OLD SYSTEM CAN BE ISOLATED FROM THE NEW SYSTEM BY CLOSING THE TWO VALVES AT THE TANKER MANIFOLD.
2. UNDER NORMAL CIRCUMSTANCES ONLY THE NEW DISTRIBUTION SYSTEM IS UTILIZED FOR DAILY BIOREACTOR OPERATIONS. THE VALVE CONFIGURATION IN THIS DRAWING REPRESENTS NORMAL OPERATION. THE OLD DISTRIBUTION SYSTEM IS USED TO BYPASS THE NEW SYSTEM FOR MAINTENANCE OR OTHER CONDITIONS AS WARRANTED.
3. DISCHARGE OUTLET MANIFOLD LOCATED OUTSIDE THE BUILDING. EACH LINE TO EACH TRENCH IS EQUIPPED WITH ONE 3–INCH VALVE FOR FLOW REGULATION OR ISOLATION.
4. CURRENTLY, GROUNDWATER IS ONLY DISCHARGED TO TRENCHES 1 AND 6 FROM EITHER THE NEW OR OLD DISTRIBUTION SYSTEM, AND IS REFLECTED AS SUCH IN THIS DRAWING. DISCHARGING TO THE OTHER TRENCHES HAS ADDITIONAL SAMPLING REQUIREMENTS, AND REQUIRES APPROVAL FROM CSSA AND PARSONS MANAGEMENT.

LEGEND

- OLD DISTRIBUTION SYSTEM (PRE OCTOBER 2012)
- NEW DISTRIBUTION SYSTEM (POST OCTOBER 2012)
- OLD TRENCH DISTRIBUTION SYSTEM (PRE- OCTOBER 2012)
- NEW TRENCH DISTRIBUTION SYSTEM (POST- OCTOBER 2012)
- 16-LGR WELL LOCATION
- ISOLATION VALVE (NORMALLY OPEN)
- ISOLATION VALVE (NORMALLY CLOSED)

Not To Scale

Figure 2.4

Bioreactor Distribution Configuration Showing Old and New Distribution Lines

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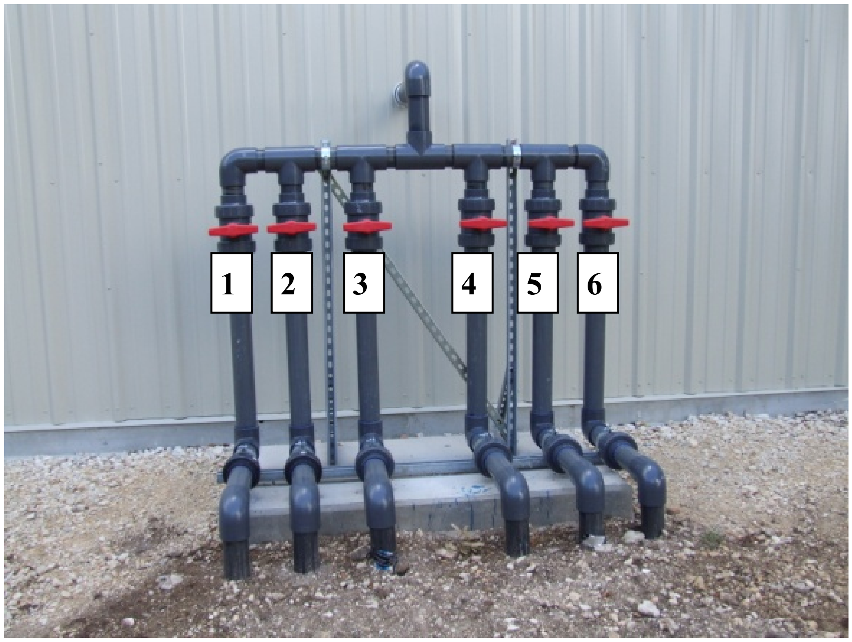
Figure 2.5 Trench Control Manifold



2.5 INSTRUMENTS AND CONTROL

The bioreactor has been automated to operate with minimal supervision since it was first installed. In fall 2012, the bioreactor automation system will be upgraded to provide additional controls and provide connectivity to the CSSA SCADA system. The system uses seven Remote Telemetry Units (RTU) to control the operation of the Bioreactor System. The RTUs are located at Building 260, Building 267 (former GAC Shack next to MW16-LGR/CC), and extraction wells B3-EXW01 through B3-EXW05 (Buildings 261 through 265).

The RTUs use wireless radios (900 MHz) to communicate commands, status, and data among the bioreactor components. Ultimately, the data is transferred (fiber optic network) back to the SCADA system for viewing at the SCADA workstations located in Buildings 1, 36, 38, 73, and 606. The bioreactor can be operated from either the control screen located in Building 260 or any SCADA workstation by an operator with the proper credentials. Process and Instrumentation Diagrams (P&ID) that detail the monitoring and control systems as well as the design drawings for each RTU are included with **Appendix F**.

Each RTU is comprised of a myriad of components from various manufacturers. The individual components are consolidated into a single enclosure to comprise an RTU. In general, the RTUs feature General Electric VersaMax Programmable Logic Controllers (PLCs), Weidmuller 900 MHz radios, and Red Lion protocol converters. Product information for the SCADA control components is provided in **Appendix G**.

The main RTU (903-1) is located inside Building 260, and serves as the hub for the bioreactor controls. To control bioreactor operations, the main RTU communicates directly with the slave RTUs at CS-MW16-LGR/CC (RTU 903-2), B3-EXW01

(RTU 903-3), B3-EXW02 (RTU 903-4), B3-EXW03 (RTU 903-5), B3-EXW04 (RTU 903-6), and B3-EXW05 (RTU 903-7). In addition, the Building 260 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.

Master RTU 903-1 (Building 260) controls the functions at the storage tanks and transfer pump. The storage tanks are equipped with ultrasonic level meters to provide accurate readings of the water level in the tanks and dictate when the wells are activated to fill the tanks. The ultrasonic level measurements are evaluated against programmed setpoints to also control the operation of the transfer pump to convey water from the tank to the trenches. The tank is also equipped with redundant mechanical switches in the event the ultrasonic meters fail.

Slave RTU 903-2 (Building 267) communicates directly with Master RTU 903-1 via fiber optic communication, and controls the operation of extraction wells CS-MW16-LGR and CS-MW16-CC. This location is equipped with pump controls, pressure transducers, and a water flowmeters for each well. Based on commands given by the Master RTU 903-1, this RTU operates the well pumps and communicates the groundwater level and flowrate back to the Master RTU 903-1.

Slave RTU 903-3 (Building 261) communicates directly with Master RTU 903-1 via fiber optic communication, and controls the operation of extraction well B3-EXW01 and reports data collected by the weather station. 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 903-3 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. Future expansion plans for this RTU may include monitoring of water levels in individual sumps completed within the trenches.

Slave RTUs 903-4, 903-5, 903-6, and 903-7 (Buildings 262 through 265) communicate directly with Master RTU 903-1 via 900 MHz radio frequency, and controls the operation of extraction wells B3-EXW02, EXW03, EXW04, and EXW05, respectively. Each location is equipped with a pump control, pressure transducer, and a water flowmeter. Based on commands given by the Master RTU 903-1, these RTUs operate the well pumps and communicate the groundwater levels and flowrates back to the Master RTU 903-1.

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 through B3-EXW05 and the Transfer Pump are switched to **"AUTO"**. The control equipment for each of these pumps is located at their respective locations.

2.5.1 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 (annual) Underground Injection Control (UIC) Operational Data reports. Instruments to monitor line pressures and volume of injection water are provided for the B-3 Bioreactor System. Specifically, pressure gauges are located at the bag filtration unit on the influent side of the system, and before the trench header on the effluent side of the system (after the transfer pump). In addition, flowmeters are installed to provide the injection volume from the transfer pump, as well as extraction volumes from each of the extraction wells.

An Endress+Hauser Promag 53P flowmeter with SCADA connectivity is installed on the injection line between the transfer pump and injection manifold containing the six trench injection lines. All seven of the extraction wells are equipped with an Endress+Hauser Prowirl 72F flowmeter with SCADA connectivity. Product information for the various flow meters is provided in **Appendix H.**

2.5.2 Liquid Level Switches and Meters

Multiple sets of water level indicators are required for the automation system to operate effectively. One set of indicators is installed within the storage tanks (B3-WT1 and B3-WT2) and is comprised of two Endress+Hauser FMU40 ultrasonic level meters. Each meter reports an instantaneous water level in each storage tank back to the RTU. The PLCs within the RTU controls the operation of the extraction wells and transfer pump based upon user-defined operational setpoints.

Each extraction well is equipped with an Endress+Hauser FMX167 WaterPilot pressure transducer to monitor the groundwater level in the borehole. The transducer reports the extraction well water level back to the SCADA system via the RTUs. Additionally, the PLCs within each RTU protect the well from pumping dry based upon the water level above the pump intake.

Similar transducers are also installed in selected trench monitoring sumps to report the level of water present in the trenches. The PLCs evaluate the data from the monitoring sumps, and will turn off the bioreactor injection system if the height of groundwater rises to within 1 foot of the ground surface. Telemetry from the sump transducers is relayed to the 903-3 RTU (B3-EXW01) via wireless 900 MHz radio equipment manufactured by Banner Engineering (**Appendix G**). Each wireless transmitter equipped at the trench sumps is operated by a solar-charged battery system.

Product information for the liquid level switches and level transducers is provided in **Appendix I**.

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 operations 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 southwest 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 seven wells, CS-MW16-LGR, CS-MW16-CC, and B3-EXW01 through B3-EXW05. The extracted groundwater is pumped into the storage tanks which are pre-treated by a bag filter unit to remove suspended solids. All of the filtration, storage, and transferring activities occur within Building 260 located on the northeast corner of SWMU B-3. 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 (two, 10,000 gallon storage tanks) 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, CS-B3-EXW01 through -EXW05 are expected to pump water at a combined, sustainable flowrate ranging between 70 gallons per minute (gpm) and 350 gpm to the storage tanks. 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 operational and aquifer groundwater availability. The operator can adjust the ball valve located at each well discharge to control the flowrate to achieve the desired production of groundwater from each well.

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 storage tanks) are identified in **Table 3.1**.

In addition to the RTU controllers for the extraction wells, there is a master RTU controller connected to ultrasonic level meters located in each of the two 10,000-gallon storage tanks. There is an HOA switch at each pump that should be kept in the automatic mode such that the individual well transducer and the storage tank level sensors control the activation of the well pump.

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

Water Level in Well	Water Level in 10.000-gallon Storage Tanks	Activation of All or One Extraction Well Based on Water Levels in Well and Storage Tanks
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 level sensors with PLC software 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 two 10,000 gallon storage tanks.

3.2.2 Pumping Water from Storage Tanks to the Bioreactor

Extracted water stored in the storage tanks is pumped to the bioreactor with an end-suction centrifugal transfer pump located between the storage tanks and the bioreactor trench manifold. The operation of the transfer pump is controlled by the ultrasonic level sensors in the storage tanks as well as a level transducer switch 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 10,000-Gallon Storage Tanks	Response of Transfer Pump Based on Signal from a Sump or Tank Level Sensors
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 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

Note: Controllers are level sensors with PLC software switches that start or stop operations under certain conditions.

Generally, the controllers at the 10,000 gallon storage tanks will operate the transfer pump when there is sufficient volume of water in the storage tanks 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. 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 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-EXW05; 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 user settable high level setpoint installed in Sump 1-1. If the level transducer measures a water level above this setpoint, 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 setpoint.
2. The operation of the transfer pump and supply wells are interlocked with the capacity of the storage tanks. The storage tanks are equipped with level measurements from ultrasonic level meters with redundant mechanical floats to prevent overfilling or run dry conditions. The measurements from the ultrasonic meters are used to simulate programmable **HIGH-MEDIUM-LOW** setpoints which trigger the action of the wells and transfer pump. The **HIGH-MEDIUM-LOW** setpoints for the storage tanks are definable by the Operator via the SCADA interface:
   a. The **HIGH** setpoint is used to turn off the supply wells (**Table 3.1**). If the water level in the tanks is below the **HIGH** 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** setpoint is used to turn off the transfer pump. This setpoint prevents the transfer pump from running dry (**Table 3.2**).
   c. The **MEDIUM** setpoint is used to turn on the transfer pump once the tanks have 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** setpoint. The **MEDIUM** 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 prevent the well pump from running dry, and also dictate 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 RTU 903-1 located in Building 260. 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 Building 260, or remotely from any of the SCADA workstations (B1, B36, B38, B73, or B606). The following are descriptions on how to interface with the bioreactor SCADA Controls.

3.3.2 Local SCADA Control from Building 260

The operational programming functions reside in the local PLC located at the Building 260 building RTU. Most functions are internal and have been programmed by the on-site SCADA Engineer (Richard Fincke, 210-793-0413). However, limited operational functionality resides with the bioreactor operator and includes:

- ***OFF/AUTO Pump Status*** (CS-MW16-LGR, CS-MW16-CC, B3-EXW01, through EXW05, and Transfer Pump);
- ***Water Level Operational Setpoints*** (CS-MW16-LGR, CS-MW16-CC, B3-EXW01 through B3-EXW05, sump shut-off level).

The Building 260 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:

- ***Administrative Rights:*** Richard Finke
- ***Operator Rights:*** Gabriel Moreno-Fergusson, Julie Bouch, Samantha Elliott, Adrien Lindley, and Scott Pearson.

To add additional users to the system, the user will need to contact Richard Fincke (210-793-0413) 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 (seven groundwater supply wells and transfer pump) are set to **"AUTO"**. It is important to note that not all wells are required to operate the 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 Building 260 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 on-site SCADA Engineer (Richard Fincke) 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***.

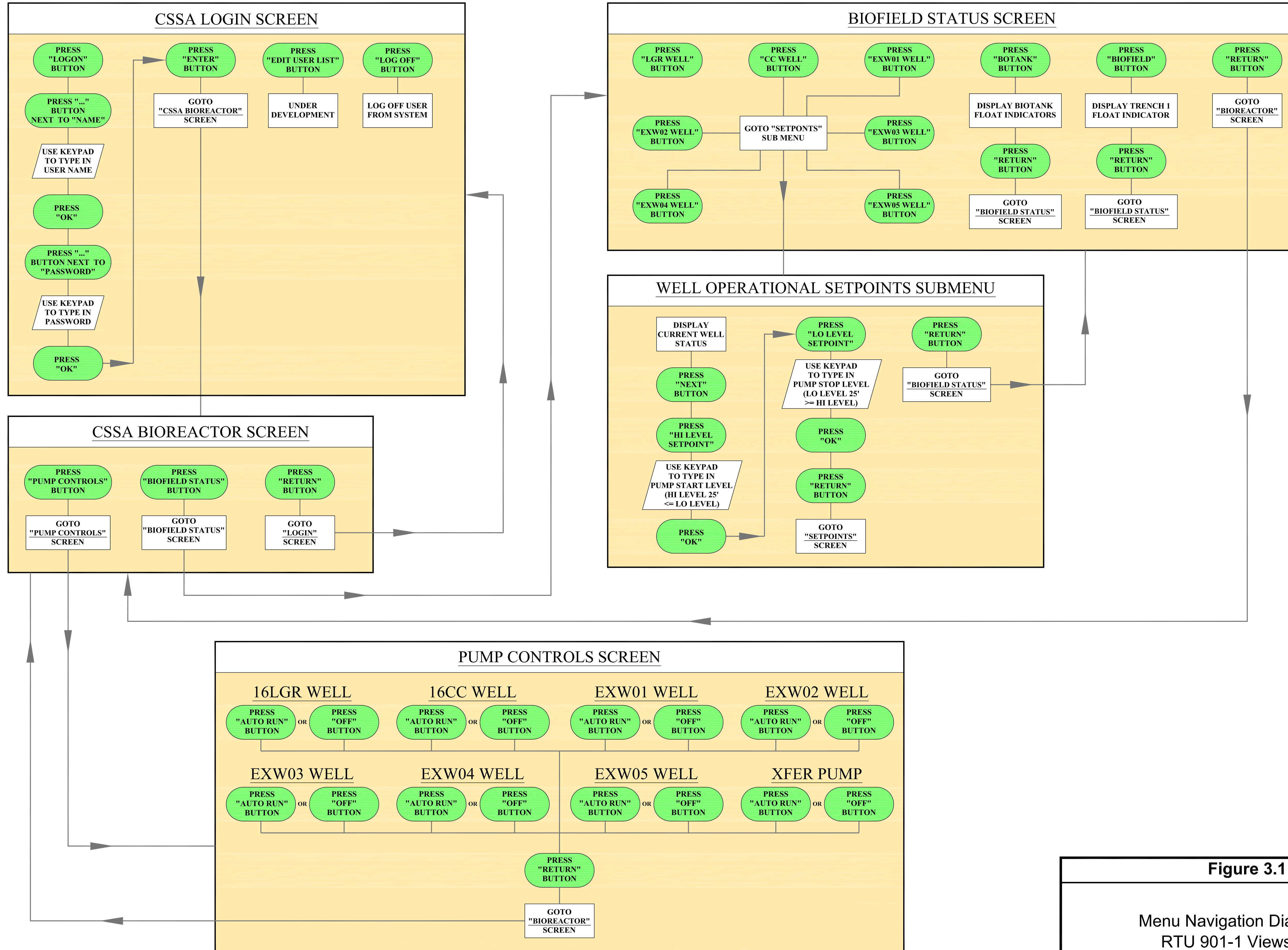


Figure 3.1

Menu Navigation Diagram for RTU 901-1 Viewscreen

746545 B3 SCADA CONTROL CHART2.DWG 8/30/12

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 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*** < 335 feet BTOC

  - B3-EXW04 ***STOP*** < 330 feet BTOC
  - B3-EXW05 ***STOP*** < 365 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***.

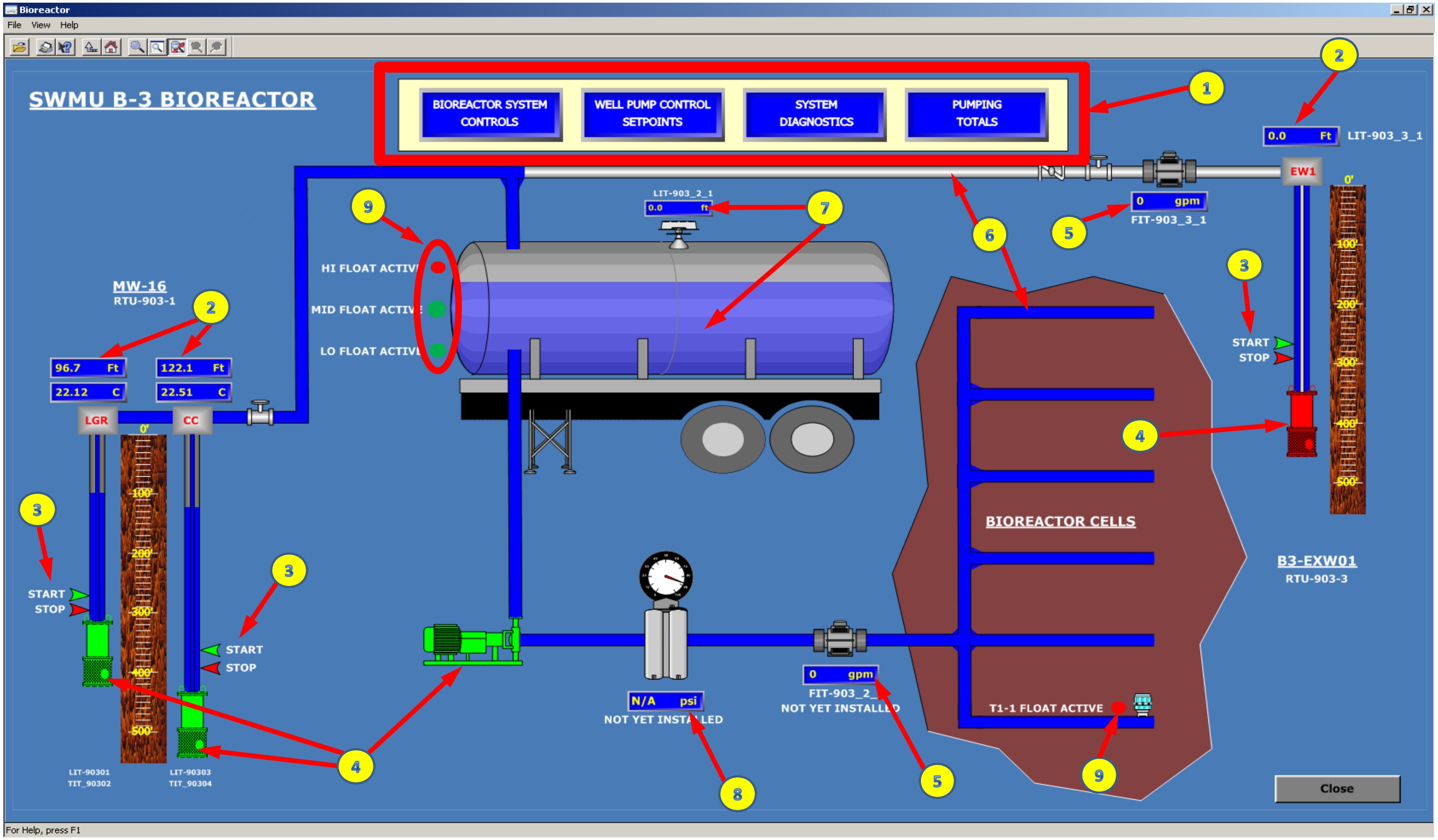
3.3.3 Remote SCADA Control from Workstations

The Operator can also display the bioreactor status and access controls from any of the SCADA workstations at CSSA (B1, B36, B38, B73, and B606). The Operator must have login and password credentials already established by the SCADA Engineer (Richard Fincke). 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 fifteen seconds due to the polling cycle of the 900 MHZ radio communications utilized between the wells and Building 260. Feedback on commands issued to the bioreactor from a workstation may take as long as one minute to indicate on the workstation screen because of the established 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 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 from wells and the Transfer Pump are displayed.

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 Tanks***: The status of water storage tanks is displayed. The height of the water in the tanks as measured by the ultrasonic level meter is displayed at the top of the tanks. 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***: Differential pressure across the Bag Filtration Unit is displayed.

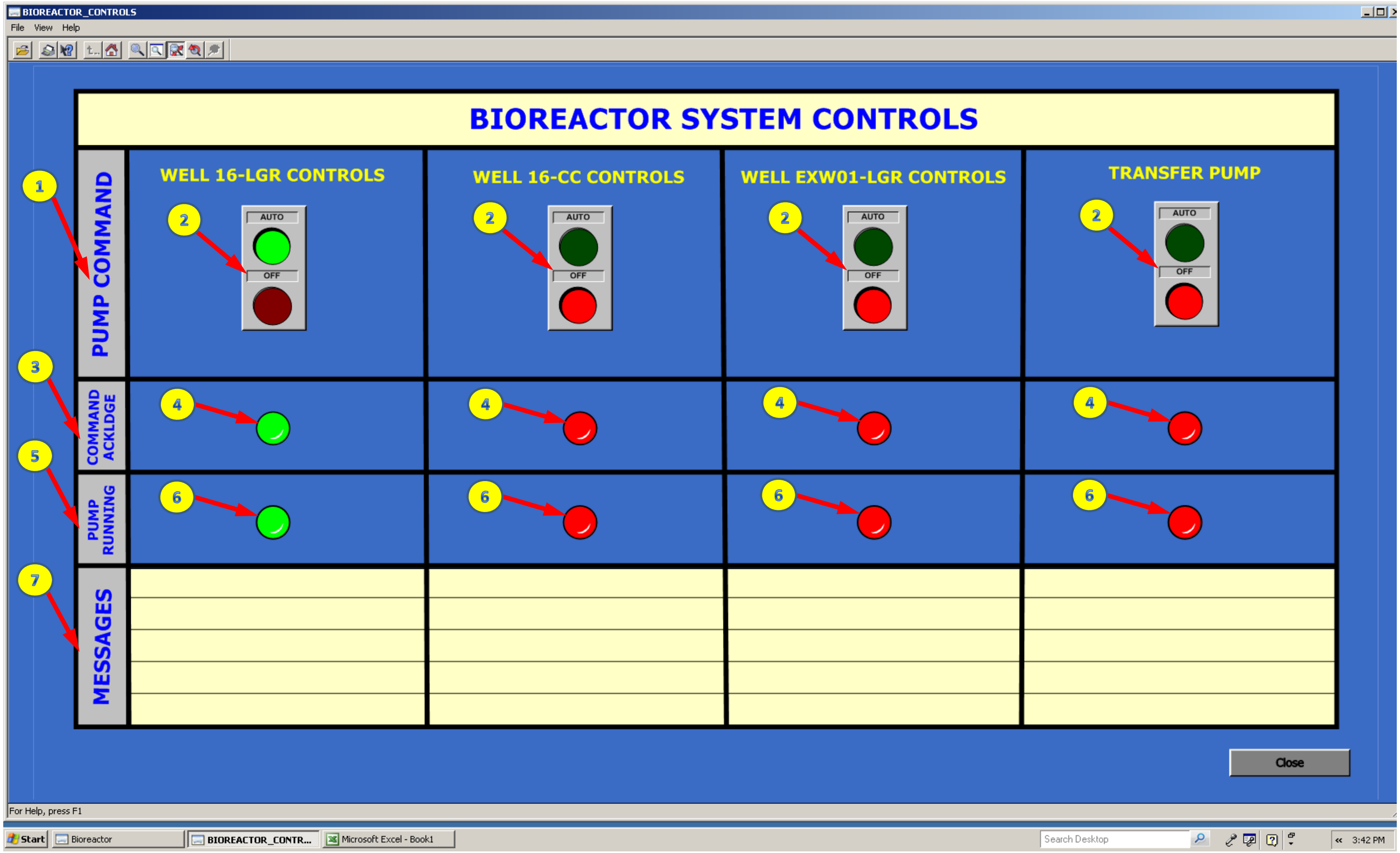
9 ***Float Switch Indicators***: The status of the mechanical float meters in the storage tanks and Sump 1-1 are graphically displayed. If a switch is activated by the current level of the water, it is displayed in the color "**GREEN**". If the switch is not activated by the water level, the color is "**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 Building 260 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 Building 260 RTU. If a pump is toggled to **"AUTO"**, a receipt of this command results in a change of color from "**RED**" to "**GREEN**", indicating that system is ready to pump if the level setpoint 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 Building 260 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 one minute, this indicates that there is a problem at the Building 260 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 running. 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 tanks are full.

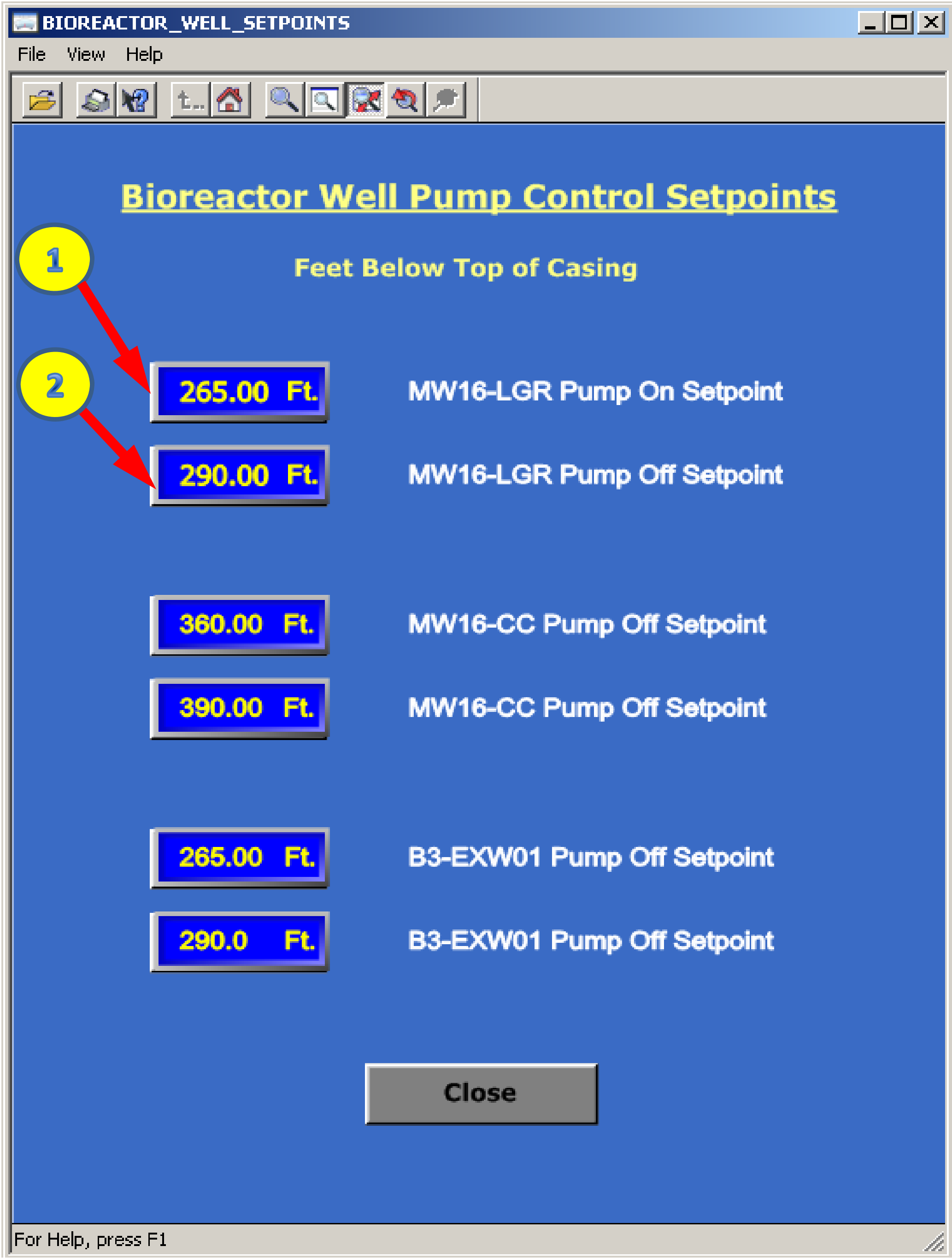
7 ***Messages***: Status messages for each pump will display in this section. Messages may include "Low Level", "Loss of Power", or Pump Fail".

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 3.4**). The functionality of this screen is very similar to the ***WELL OPERATIONAL SETPOINTS SUBMENU*** at the Building 260 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



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 $\boxed{\textit{START}}$: 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*** < 335 feet BTOC

f. B3-EXW04 ***STOP*** < 330 feet BTOC

g. B3-EXW05 ***STOP*** < 365 feet BTOC

Pressing the $\boxed{\text{CLOSE}}$ button will return you to the Bioreactor Main Screen.

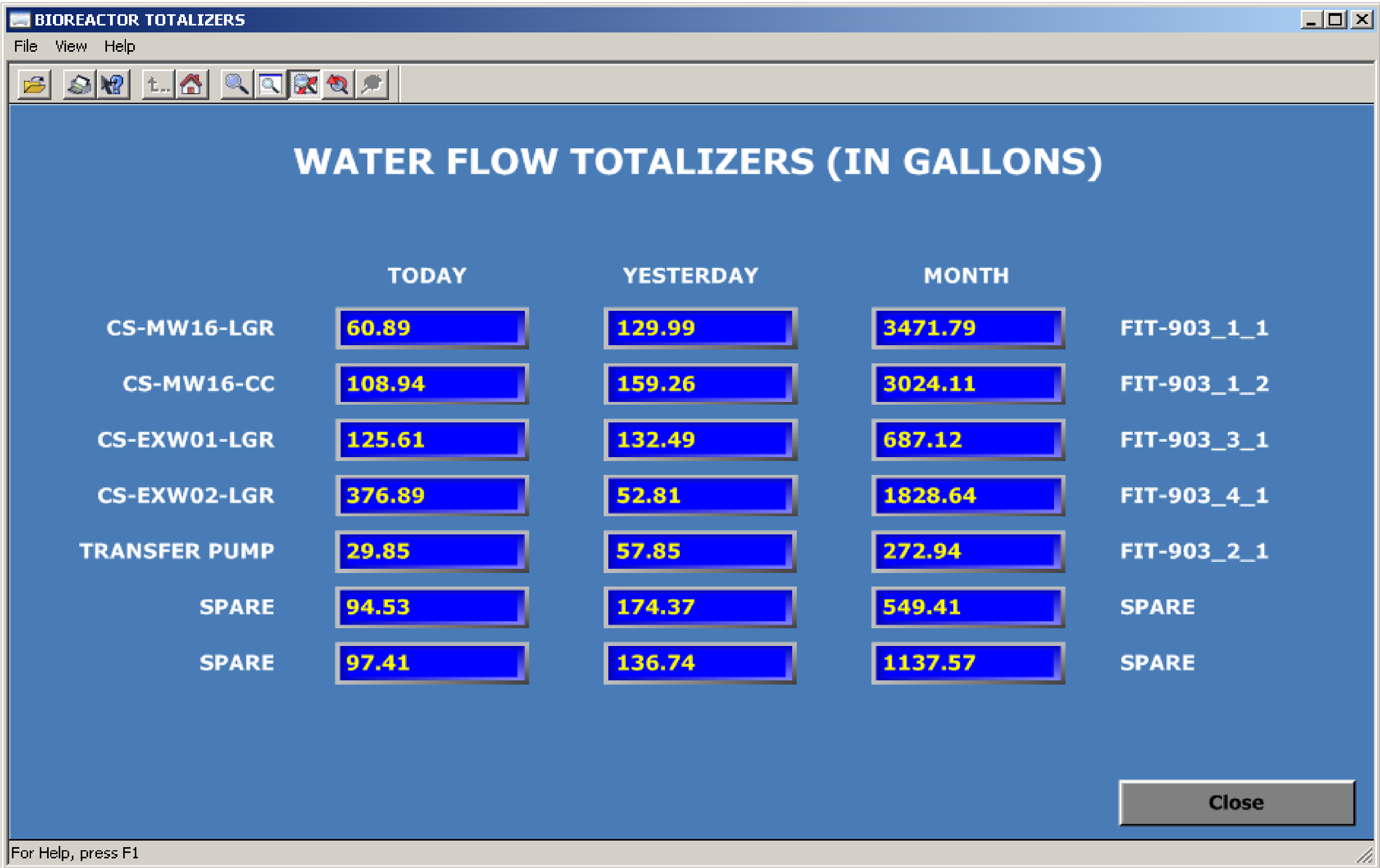
3.3.3.4 SYSTEM DIAGNOSITCS SCREEN

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.

Figure 3.5
Bioreactor Flowmeter Totals on CSSA SCADA



J:\747\747144_747145\07000 Bioreactor\Bioreactor O&M Update 2010\Bioreactor Screens.xls

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

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 tanks, 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; and
- system pressure readings.

Data to be collected quarterly (4 quarters per year) for compliance with UIC requirements of the groundwater recovery and bioreactor operations include:

- contaminant concentrations from the injected water, including:
  - ✓ VOCs, tetrachloroethene [PCE], trichloroethene [TCE], cis-1,2-dichloroethene [*cis*-1,2-DCE], *trans*-1-2-DCE, and vinyl chloride [VC]);
  - ✓ Total Dissolved Solids (TDS); and
  - ✓ and pH.

Data to be collected semi-annually (twice per year) for compliance with UIC requirements of the groundwater recovery and bioreactor operations include:

- contaminant concentrations within active trench sumps and uppermost saturated zone of 4 MPMWs (LGR-03B zone), including:
  - ✓ (VOCs, PCE, TCE, *cis*-1,2-DCE, *trans*-1-2 DCE, and VC);
  - ✓ TDS; and
  - ✓ and pH.

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

<u>Water Quality Analyses:</u> conducted monthly at all trench sumps with saturated thicknesses exceeding 1 foot, UGR wells monitored semi-annually.

- Temperature
- Specific Conductivity
- Oxidation Reduction Potential (ORP)

- Dissolved Oxygen (DO)
- pH

Full Analytical Suite: collected from active trench sumps, all MPMW zones (27 total), seven extraction wells, four monitoring wells, and nine shallow UGR wells during the semi-annual events (2 per year).

- VOCs
- TDS
- Ferrous Iron, Manganese
- Methane, Ethane, Ethene (MEE)
- Carbon Dioxide (CO_2)
- Arsenic
- Dissolved Organic Carbon (DOC)
- Total Organic Carbon (TOC)
- Anions (Sulfate and Chloride)
- Sulfide

Additional Analyses: 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 tanks), 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 semi-annually in accordance with this O&M plan's monitoring schedule. Water levels and water quality measurements will be recorded bi-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**.

Table 3.3
Class V Aquifer Remediation Injection Well Permit #5X2600431
Sampling and Monitoring Schedule for the B-3 Bioreactor - Boerne, Texas

	Sampling or Monitoring Location	Parameter(s)		Sampling Frequency	Reporting Frequency
Current Regulatory Req.	Flow meter (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
	MPMWs (4 – LGR-03B zone) (b)	- TDS (lab) - VOCs (a)		Semi-Annual	Annual
Performance sampling	Trench sumps (7) (b) MPMWs (4 – LGR-03B zone)	- MEE + CO2 - Ferrous Iron - Manganese - Arsenic	- TOC - DOC - Sulfide - Anions (sulfate and chloride)	Semi-Annual	Annual
	MPMWs (23 – *excluding* LGR-03B zone) UGR wells (9) Extraction Wells (7) Monitoring Wells (4)	- VOCs (a) - TDS (lab) - MEE + CO2 - Ferrous Iron - Manganese	- Arsenic - TOC - DOC - Sulfide - Anions (sulfate and chloride)	Semi-Annual	Annual
	Trench sumps (2), one per active trench Monitoring wells (TBD)	- Dehalococcoides populations (DNA)	- Dissolved Hydrogen	Semi-Annual	Annual
Performance monitoring	Trench sumps (7) (b)	- Temperature - Specific Conductivity - pH	- DO - ORP	Quarterly	Annual
	UGR wells (9)	- Water Level - Temperature - Specific Conductivity - pH	- DO - ORP	Quarterly	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 -05 groundwater.
MPMWs 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-05.
Surrounding UGR wells include: B3-MW26-UGR through B3-MW34-UGR.

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 MPMW or Westbay® wells were installed around SWMU B-3 to monitor the groundwater infiltrating through the underlying formations. The multi-port wells allow collection of discrete samples from distinct hydrostratigraphic zones at 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:

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

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 3.5**. **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 (UGR) 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 3.6**.

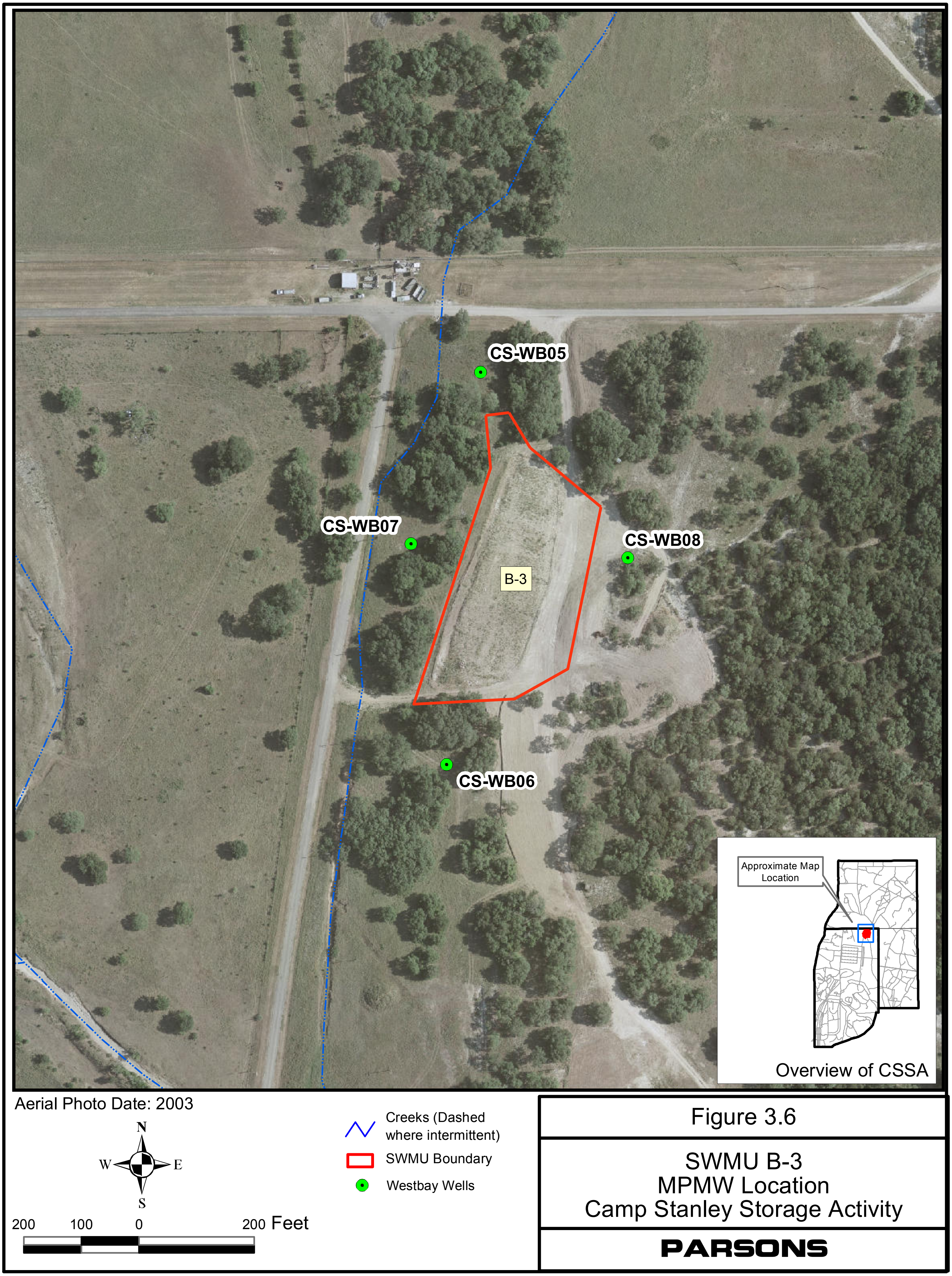


Figure 3.6

SWMU B-3
MPMW Location
Camp Stanley Storage Activity

PARSONS

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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.

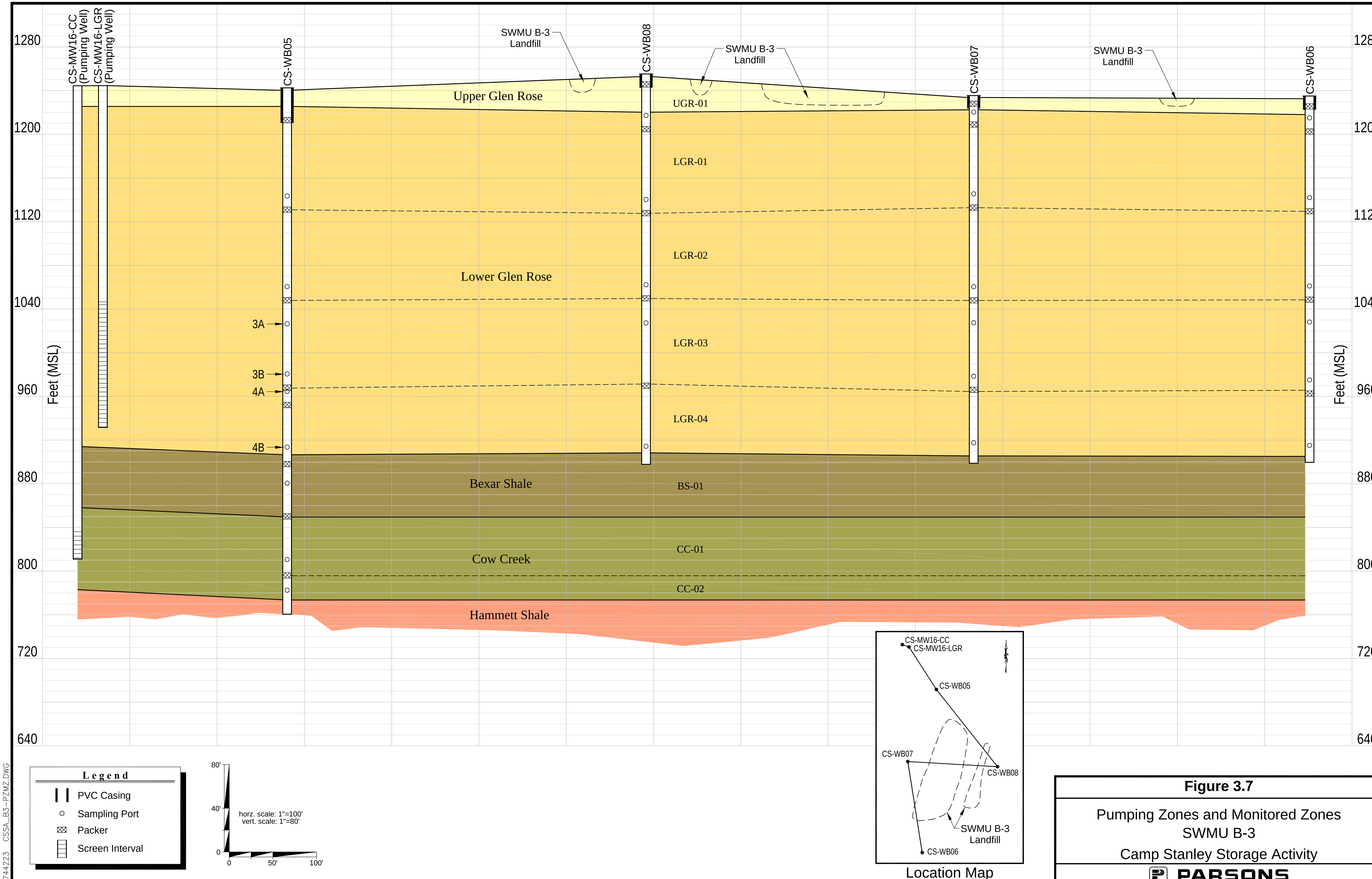

Figure 3.7

Pumping Zones and Monitored Zones
SWMU B-3
Camp Stanley Storage Activity

PARSONS

Table 3.5
B-3 O&M Monitoring Schedule

Quarter 21	May, 2012	Month 61	Annual UIC Permit Letter Submittal
	June, 2012	Month 62	
	July, 2012	Month 63	Collect UIC sample Annual Bioreactor Performance Report
Quarter 22	August, 2012	Month 64	
	September, 2012	Month 65	
	October, 2012	Month 66	Semi-Annual Sampling Event Collect UIC sample
Quarter 23	November, 2012	Month 67	
	December, 2012	Month 68	
	January, 2013	Month 69	Collect UIC sample
Quarter 24	February, 2013	Month 70	
	March, 2013	Month 71	
	April, 2013	Month 72	Semi-Annual Sampling Event Collect UIC sample
Quarter 25	May, 2013	Month 73	Annual UIC Permit Letter Submittal
	June, 2013	Month 74	
	July, 2013	Month 75	Collect UIC sample Annual Bioreactor Performance Report
Quarter 26	August, 2013	Month 76	
	September, 2013	Month 77	
	October, 2013	Month 78	Semi-Annual Sampling Event Collect UIC sample

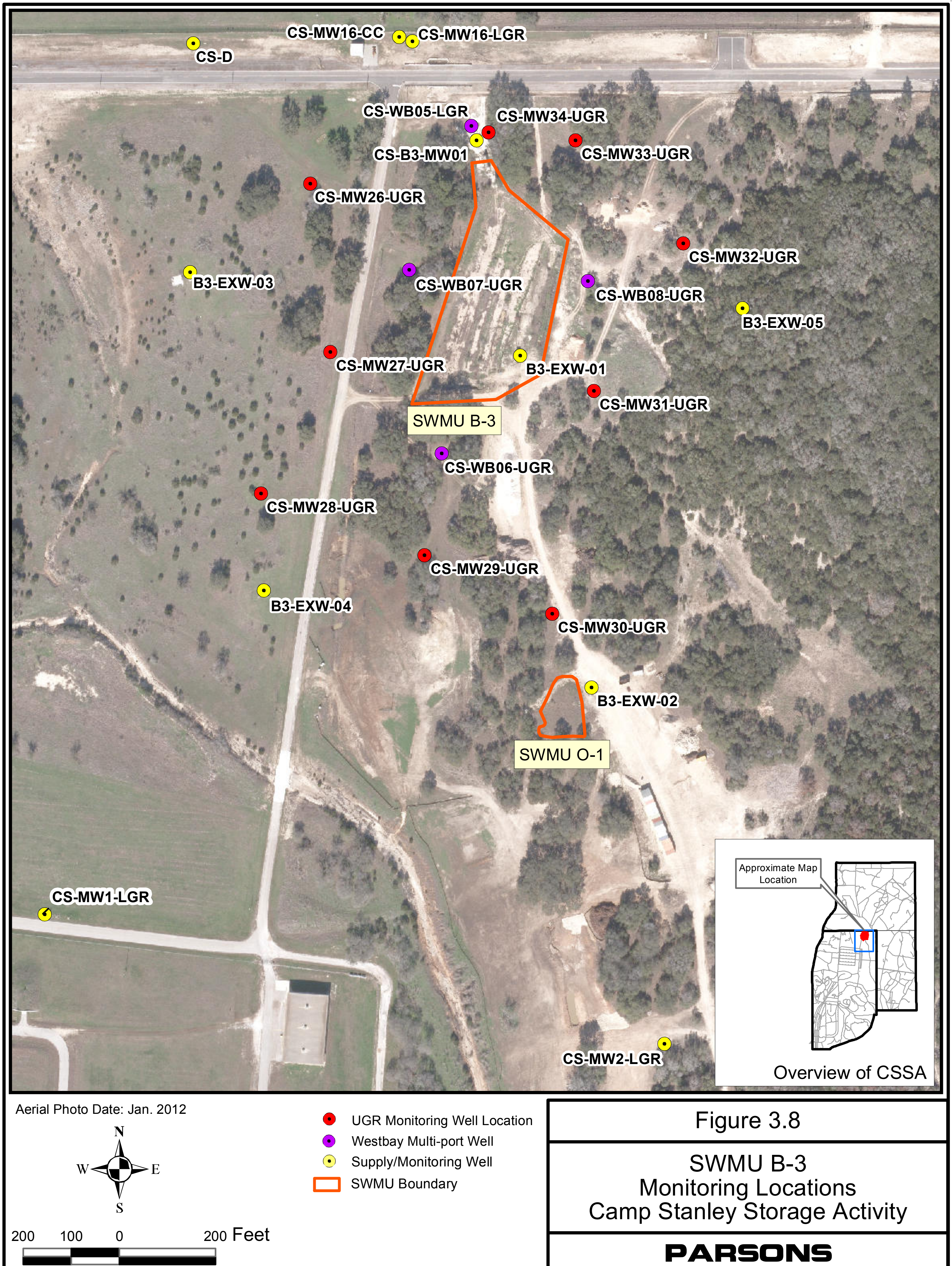

Figure 3.8

SWMU B-3
Monitoring Locations
Camp Stanley Storage Activity

PARSONS

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N
W E
S

80 40 0 80 Feet

Westbay Well
Bioreactor Trench Sumps
Irrigation Nozzles
Berm Location
B3 Boundary
Tank
Former Trench Locations

Figure 3.9

B-3 Site Survey Map

Camp Stanley Storage Activity

PARSONS

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Table 3.6
List of Surrounding Monitoring Wells

Well ID	Top of Casing Elev. (Ft MSL)	Screen Interval Depth below Top of Casing (Ft bgs)	Pump Depth (Ft bgs)	Pump Elevation (Ft MSL)	Planned Performance Monitoring Frequency
CS-MW1-LGR	1220.73	288 – 313	300	920.73	Semi-Annually
CS-MW2-LGR	1237.08	318 – 343	330	907.08	Semi-Annually
CS-D-LGR	1236.03	205 – 263 (open hole)	252	984.03	Semi-Annually
CS-B3-MW01	1242.84	277 - 287	284	958.84	Semi-Annually

bgs = below ground surface
MSL = mean sea level
NP = not penetrated (well not deep enough to encounter contact)

3.5.4 Monitoring the Upper Glen Rose

Nine shallow (less than 45 foot) piezometers installed in the UGR formation around the bioreactor provide sample locations to monitor the lateral influence from bioreactor activities (**Table 3.7**). 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 3.7
List of SMWU B-3 UGR Monitoring Wells

Well ID	Top of Casing Elev. (Ft MSL)	Screen Interval Depth (Ft bgs)	Planned Performance Monitoring Frequency
B3-MW26-UGR	1,238.49	7.5 - 17.5	Semi-Annually
B3-MW26-UGR	1,233.42	7.0 - 17.0	Semi-Annually
B3-MW26-UGR	1,226.67	5.5 - 15.5	Semi-Annually
B3-MW26-UGR	1,233.25	7.5 - 17.5	Semi-Annually
B3-MW26-UGR	1,246.01	10.8 - 20.8	Semi-Annually
B3-MW26-UGR	1,257.20	16.0 - 36.0	Semi-Annually
B3-MW26-UGR	1,266.98	26.0 - 56.0	Semi-Annually
B3-MW26-UGR	1,249.55	6.0 - 26.0	Semi-Annually
B3-MW26-UGR	1,244.51	12.0 - 22.0	Semi-Annually

bgs = below ground surface
MSL = mean sea level

SECTION 4
SYSTEM MAINTENANCE

4.1 BIOREACTOR INSPECTION

The bioreactor will be inspected periodically to determine if the components are operating properly. 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 monthly;
- Conditions of the storage tanks;
- Replacement of bag filter, as necessary.

A System O&M logbook will be maintained documenting all maintenance activities associated with bioreactor system operations, as well as documenting 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 well 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 20 pounds per square inch (psi) or greater during site visits. Spare filters will be stored in Building 260. 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 vents on the top of the filter vessels. Think Safety!
4. Loosen the retaining lugs and remove the lids from the top of the filter vessels.
5. Replace used filters with new ones and place used filters in 55-gal container.
6. Realign the vessel lids and tighten the retaining lugs.
7. Open the butterfly 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 L**) to reflect the replacement date of the filters, new filter sizes, and condition of the old filters. Used filters are considered non-hazardous and shall be disposed of within CSSA general trash.

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. Because of the depth and weight of the submersible pumps and column pipe, a well service contractor is required for pump maintenance and repair. Pump service and replacement requires specialized hoisting equipment and State of Texas license to perform these services. Historically, GeoProjects International of Austin, TX (512-288-3777) has been the licensed pump installer that has provided all well installation and service at the bioreactor.

During the pump maintenance, worn or malfunctioning components will be repaired or replaced. This includes column pipe, check valves, electrical cables, and motor control boxes. In the event that a pump malfunctions, it will be pulled for service and repaired, as necessary, and a spare/new pump will be installed in its place.

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

1. Turn off power and initiate lockout/tagout procedures per Subsection 3.3.
2. Remove the level transducer from the PVC guide tube and store away from the work area (transducer does not need to be disconnected from the junction box). 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.
3. Open the electrical junction box and un-splice the pump motor cable from the electrical service.
4. Disconnect the pipe coupling in the discharge pipe within the wellhead.
5. 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.
6. Using a truck-mounted hydraulic hoist (Smeal or other), lift the pump from the well until the first pipe connection is observed in the discharge pipe.
7. One crew member will secure the discharge pipe below the pipe joint using elevators. Using pipe wrenches, the crew loosens and removes the top section of pipe.

8. Care must be taken to secure and manage the electrical cables and PVC guide tubes. These wires/tubes are to be secured to the discharge pipe by industrial electrical tape which must be cut and removed to manage the wiring and cable.
9. 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. Each joint of pipe must be visually inspected for holes, leaks, and corrosion that affect the integrity of the pipe. Likewise, the entire length of the pump motor cable must be inspected for nicks, cuts, abrasions on the insulation jacket, or bad splices.
10. Make necessary repairs to pump or replacement.
11. Carefully reinsert the pump in the well.
12. Reinstall the pump assembly in the well by reversing the removal instructions. New cable ties and wrapping tape should be used to re-secure the PVC guide tubes and pump lead wires to the discharge pipe as it reinserted into the well. CAUTION:
13. Secure the well seal by tightening the bolts. Replace all vent lines and seal access tubes per state guidelines.
14. Re-make the connections with the wellhead distribution piping.
15. Re-splice the pump motor lead to the electrical distribution inside the junction box.
16. Carefully insert the level transducer into the well without pinching or kinking the transducer cable which could block the internal vent tube.
17. 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, may 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 O&M Form in **Appendix L** 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 B-3 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 TDSs) in the injected groundwater shall be sampled quarterly 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 an annual basis. The concentration of contaminants in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled quarterly and submitted to the UIC Permits Team, Industrial and Hazardous Waste Permits Section, at mail code MC-130 on an annual basis. The monitoring and sampling program is presented in Section 4. The sampling and monitoring program will adhere to Requirement 4.

Appendix A

TCEQ Authorization Letter and Amendments

July 20, 2006 Transmittal

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

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

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

February 17, 2012 Transmittal

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

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

February 17, 2012

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

Re: Amendment to Class V Authorization
TCEQ Authorization No. 5X2600431
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 August 29, 2011 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 quarterly at the point of reinjection (prior to fluids being released into the trenches). The concentration of contaminates in the trench bioreactor monitoring sumps and the surrounding monitoring wells shall be sampled semiannually. All monitoring and sampling data shall be submitted to the UIC Permits Team, Radioactive Materials Divisions, at mail code MC 233 on an annual basis. All other requirements of the above mentioned authorization remain in effect.

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 233.

Sincerely,

Bryan S. Smith

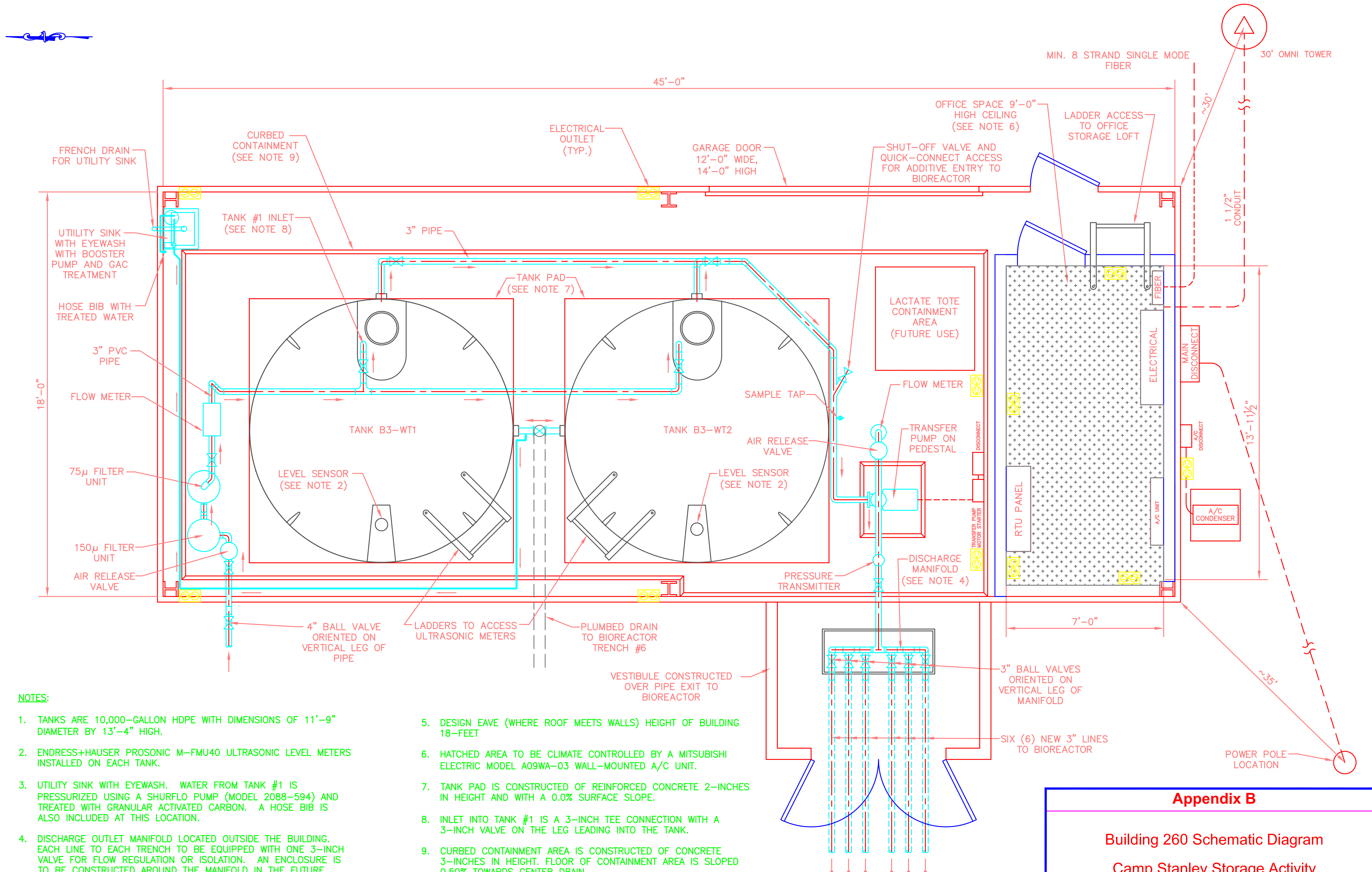
Bryan S. Smith
Underground Injection Control Permits Team
Radioactive Materials Division

BSS/nlc

cc: Mr. Ken Rice, Parsons, 8000 Centre Park Drive, Suite 200, Austin, TX 78754

Appendix B
Bioreactor Design Drawings

BUILDING 260 SCHEMATIC DIAGRAM



NOTES:

1. TANKS ARE 10,000–GALLON HDPE WITH DIMENSIONS OF 11'–9" DIAMETER BY 13'–4" HIGH.
2. ENDRESS+HAUSER PROSONIC M–FMU40 ULTRASONIC LEVEL METERS INSTALLED ON EACH TANK.
3. UTILITY SINK WITH EYEWASH. WATER FROM TANK #1 IS PRESSURIZED USING A SHURFLO PUMP (MODEL 2088–594) AND TREATED WITH GRANULAR ACTIVATED CARBON. A HOSE BIB IS ALSO INCLUDED AT THIS LOCATION.
4. DISCHARGE OUTLET MANIFOLD LOCATED OUTSIDE THE BUILDING. EACH LINE TO EACH TRENCH TO BE EQUIPPED WITH ONE 3–INCH VALVE FOR FLOW REGULATION OR ISOLATION. AN ENCLOSURE IS TO BE CONSTRUCTED AROUND THE MANIFOLD IN THE FUTURE.
5. DESIGN EAVE (WHERE ROOF MEETS WALLS) HEIGHT OF BUILDING 18–FEET
6. HATCHED AREA TO BE CLIMATE CONTROLLED BY A MITSUBISHI ELECTRIC MODEL A09WA–03 WALL–MOUNTED A/C UNIT.
7. TANK PAD IS CONSTRUCTED OF REINFORCED CONCRETE 2–INCHES IN HEIGHT AND WITH A 0.0% SURFACE SLOPE.
8. INLET INTO TANK #1 IS A 3–INCH TEE CONNECTION WITH A 3–INCH VALVE ON THE LEG LEADING INTO THE TANK.
9. CURBED CONTAINMENT AREA IS CONSTRUCTED OF CONCRETE 3–INCHES IN HEIGHT. FLOOR OF CONTAINMENT AREA IS SLOPED 0.50% TOWARDS CENTER DRAIN.

Not To Scale

Appendix B

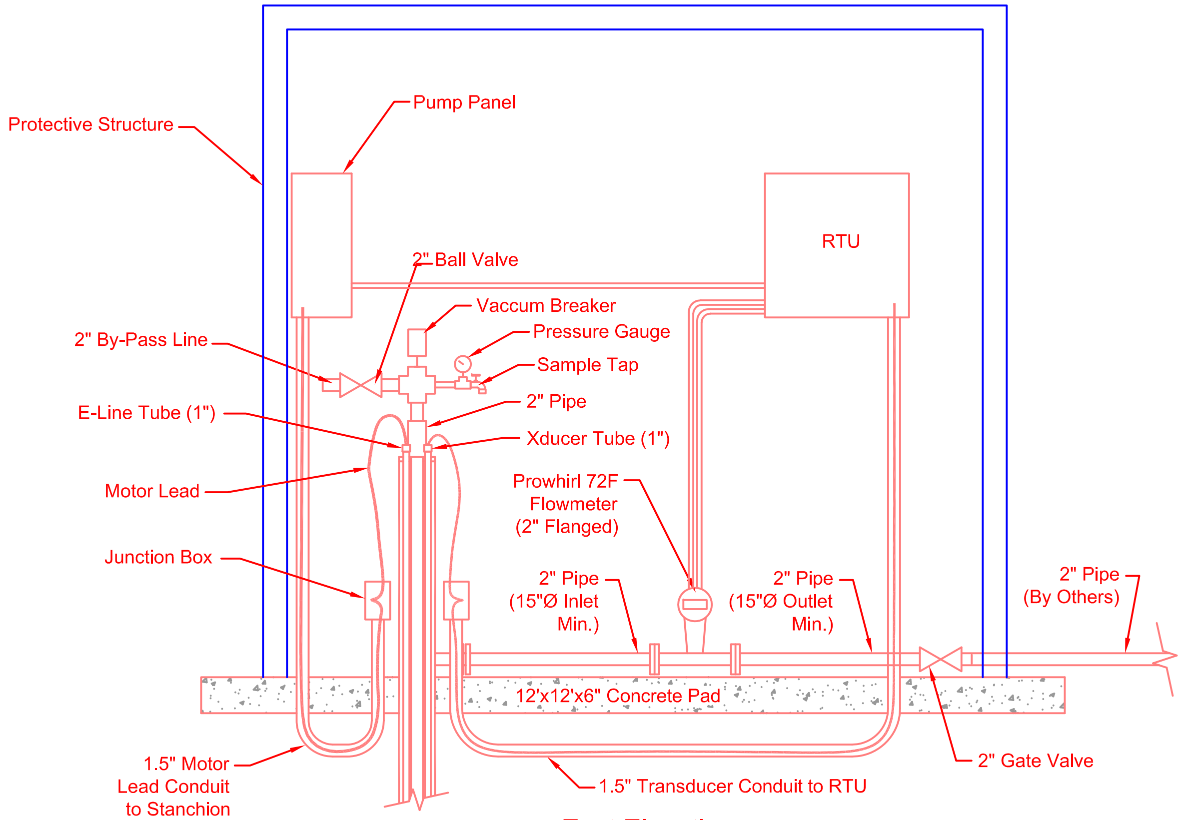
Building 260 Schematic Diagram

Camp Stanley Storage Activity

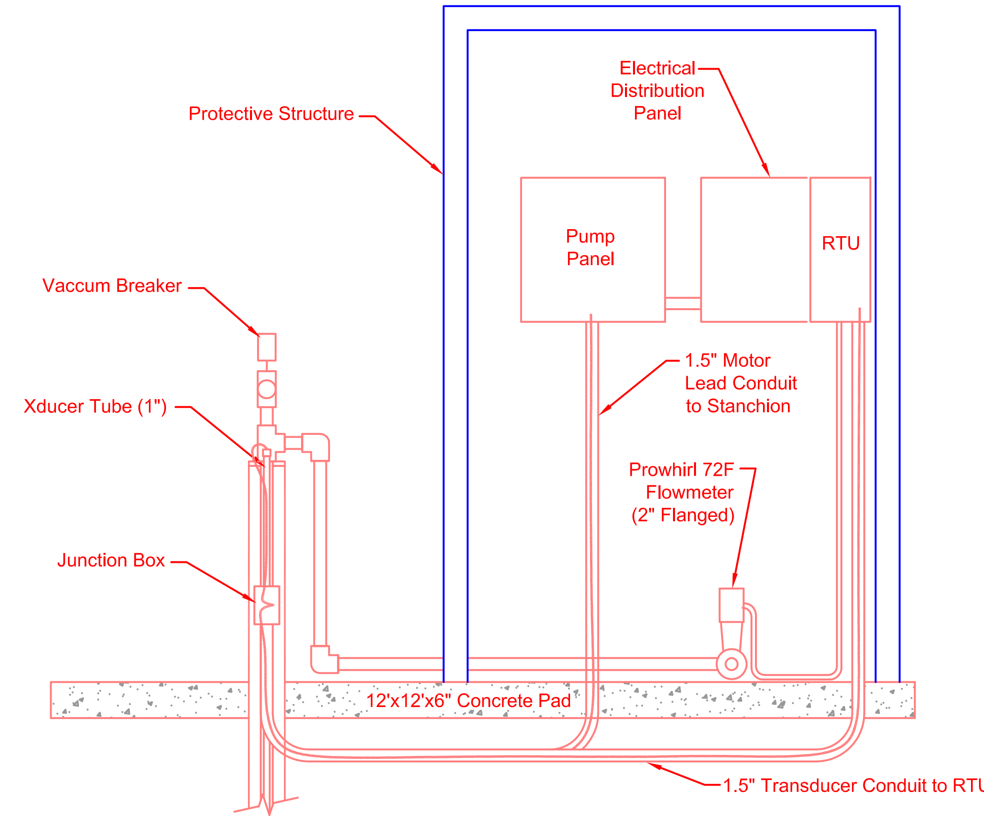
PARSONS

748402 CSSA-BIOBLDG_AS BUILT.DWG 1/16/13

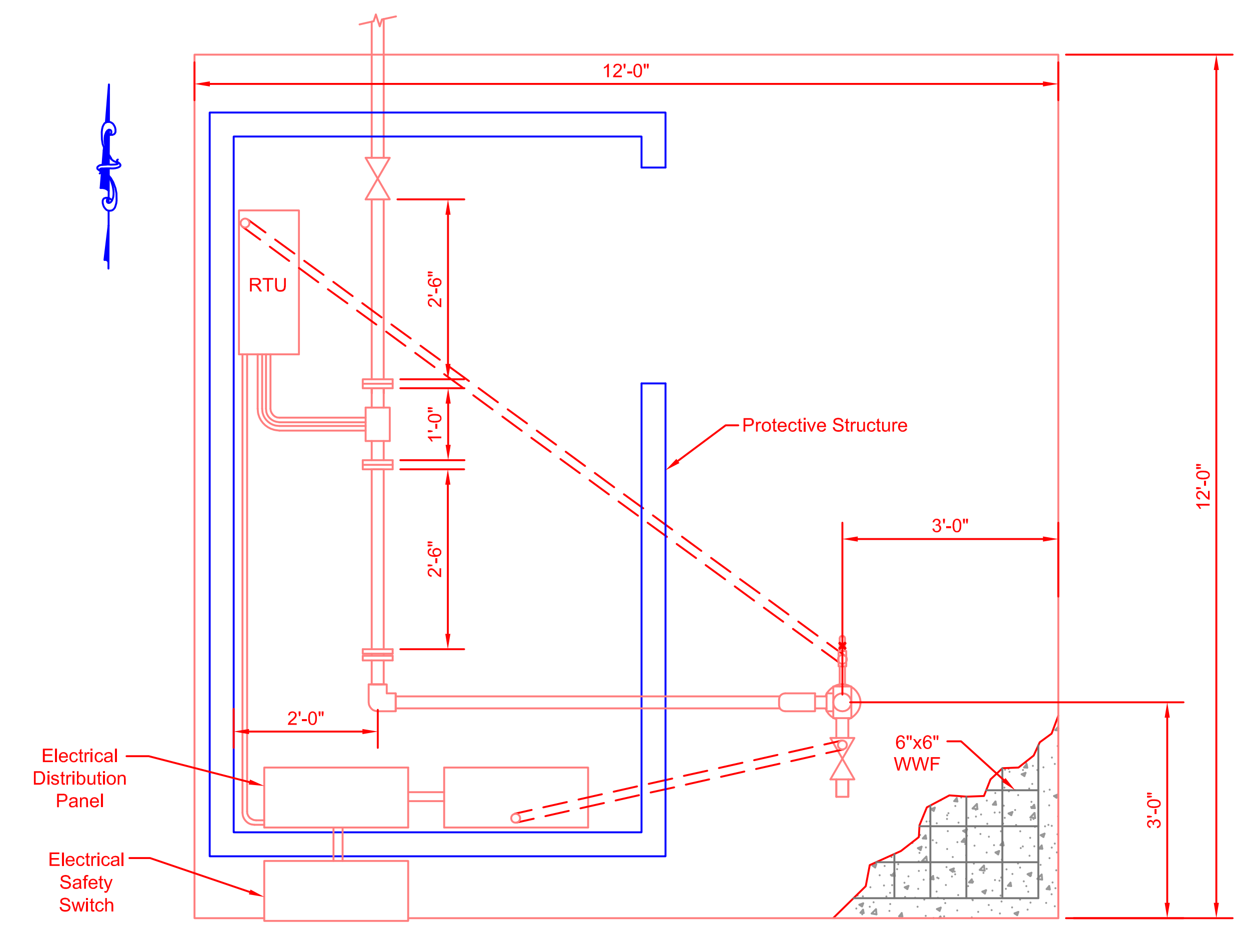
WELLHEAD COMPLETION
B3-EXW01



East Elevation
Scale: 3/8"=1'-0"



North Elevation
Scale: 3/8"=1'-0"



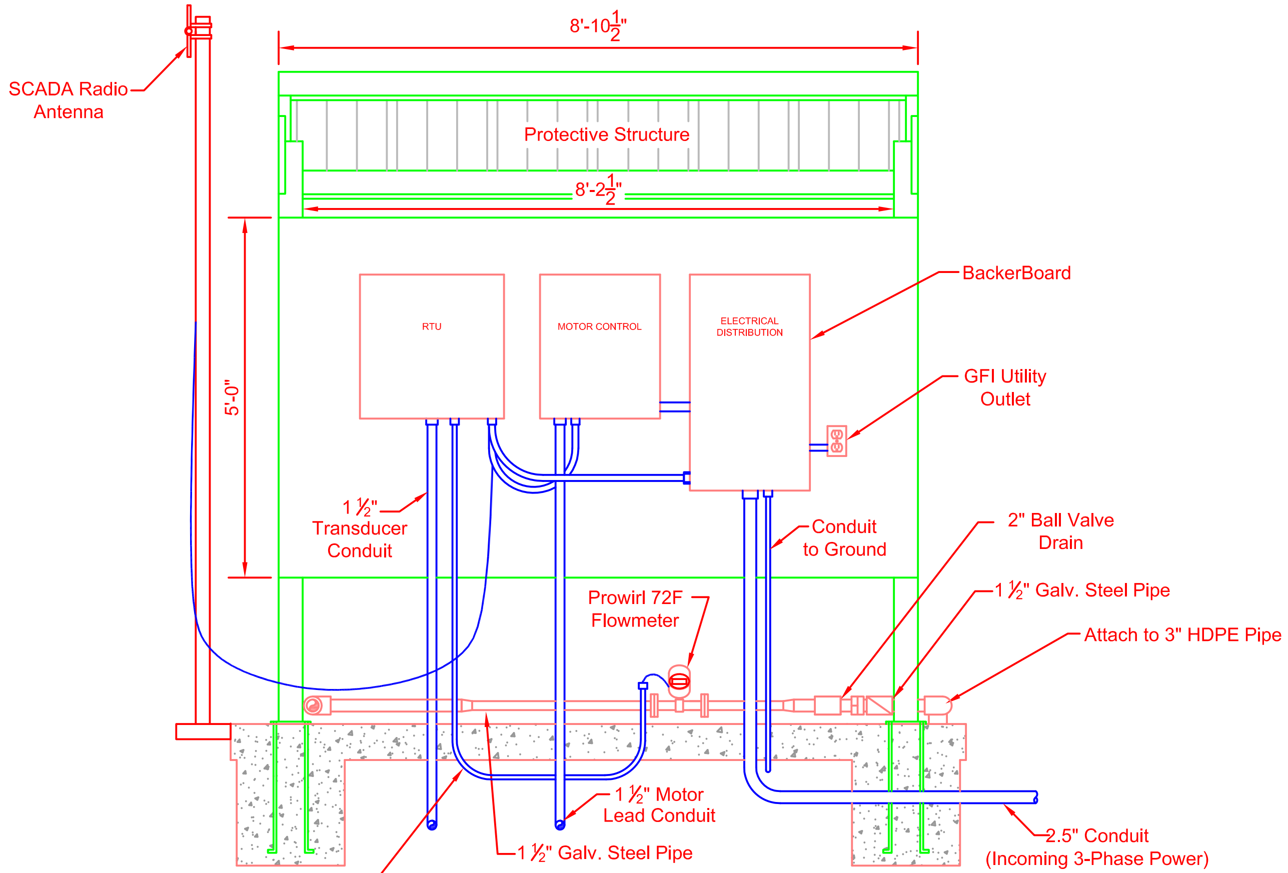
Plan
Scale: 3/8"=1'-0"

J:\CSSA PROGRAM\RESTORATION\TREATABILITY STUDIES\SWMU B-3\BIOREACTOR PROJECT DOCUMENTS\O&M UPDATE 2012 - BIOREACTOR\CAD\EXW01 WELLHEAD PLAN.DWG 1/16/13

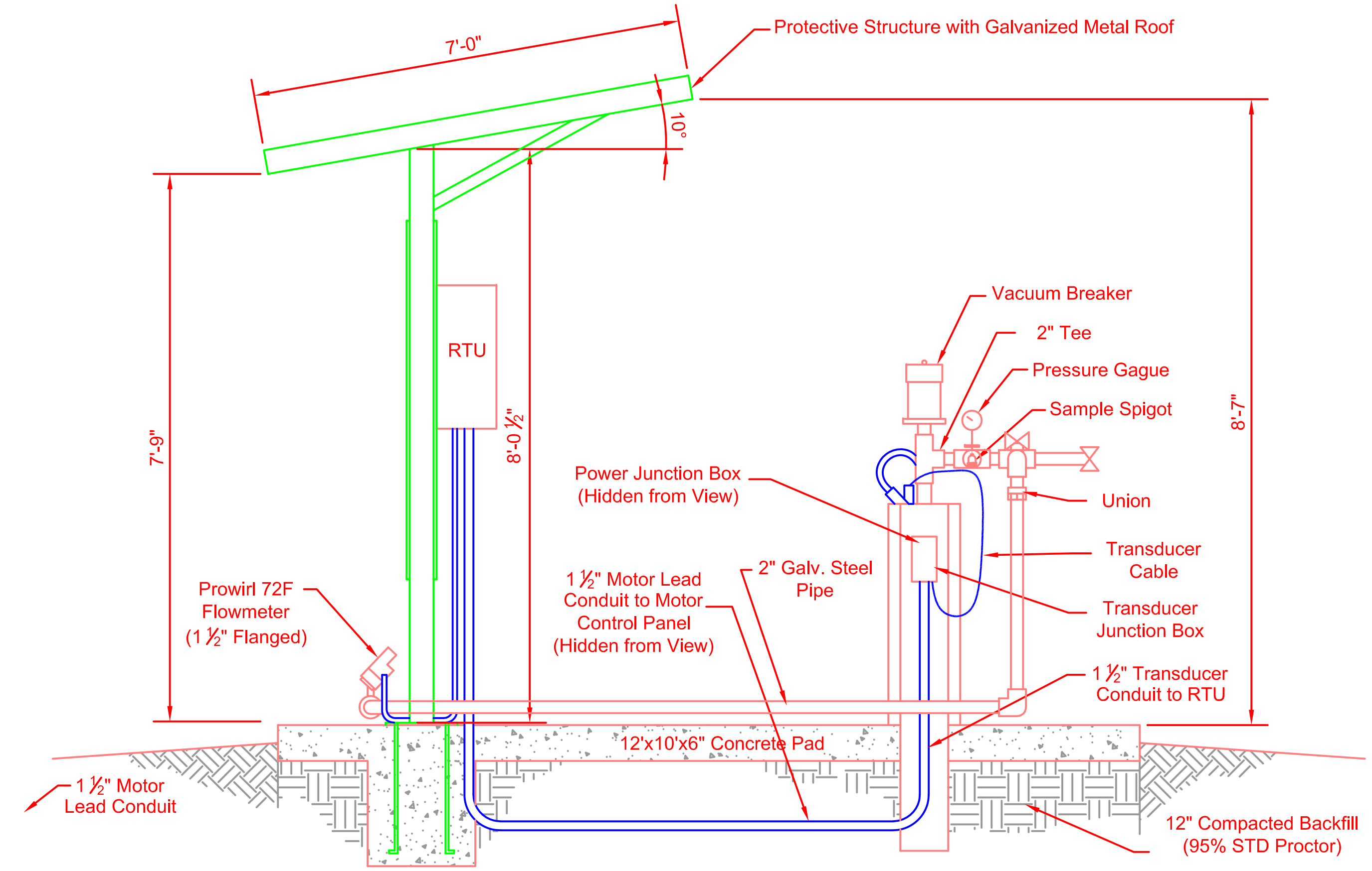
Appendix B

SWMU B3-EXW01 Surface Completion Design

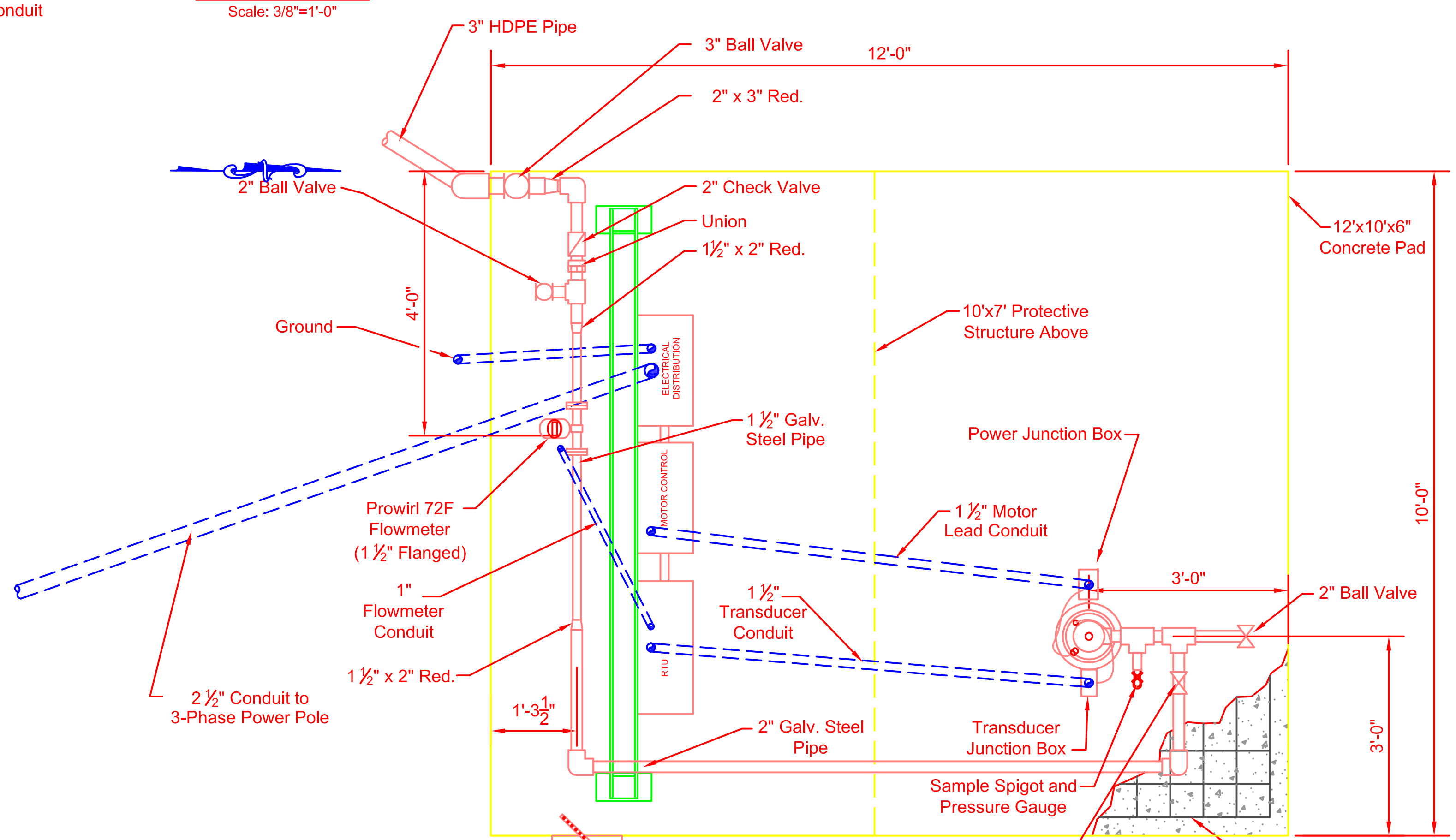
Camp Stanley Storage Activity



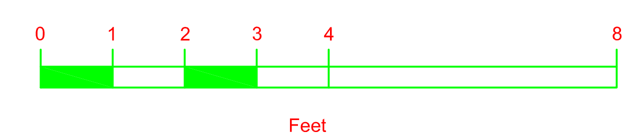
Panel Elevation
Scale: 3/8"=1'-0"



North Elevation
Scale: 3/8"=1'-0"



Plan
Scale: 3/8"=1'-0"



Scale: 3/8"=1'-0" at 11"x17"

Appendix B

Typical SWMU B-3 Extraction Well (B3-EXW05 Shown)
Surface Completion Design
Buildings 261 through 265

Camp Stanley Storage Activity

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Appendix C
Product Information
Recovery Well Pumps and SymCom PumpSavers

PUMP (FLUID END) SPECIFICATIONS (GRUNDFOS)

MW16-LGR

MW16-CC

B3-EXW01

B3-EXW02

B3-EXW03

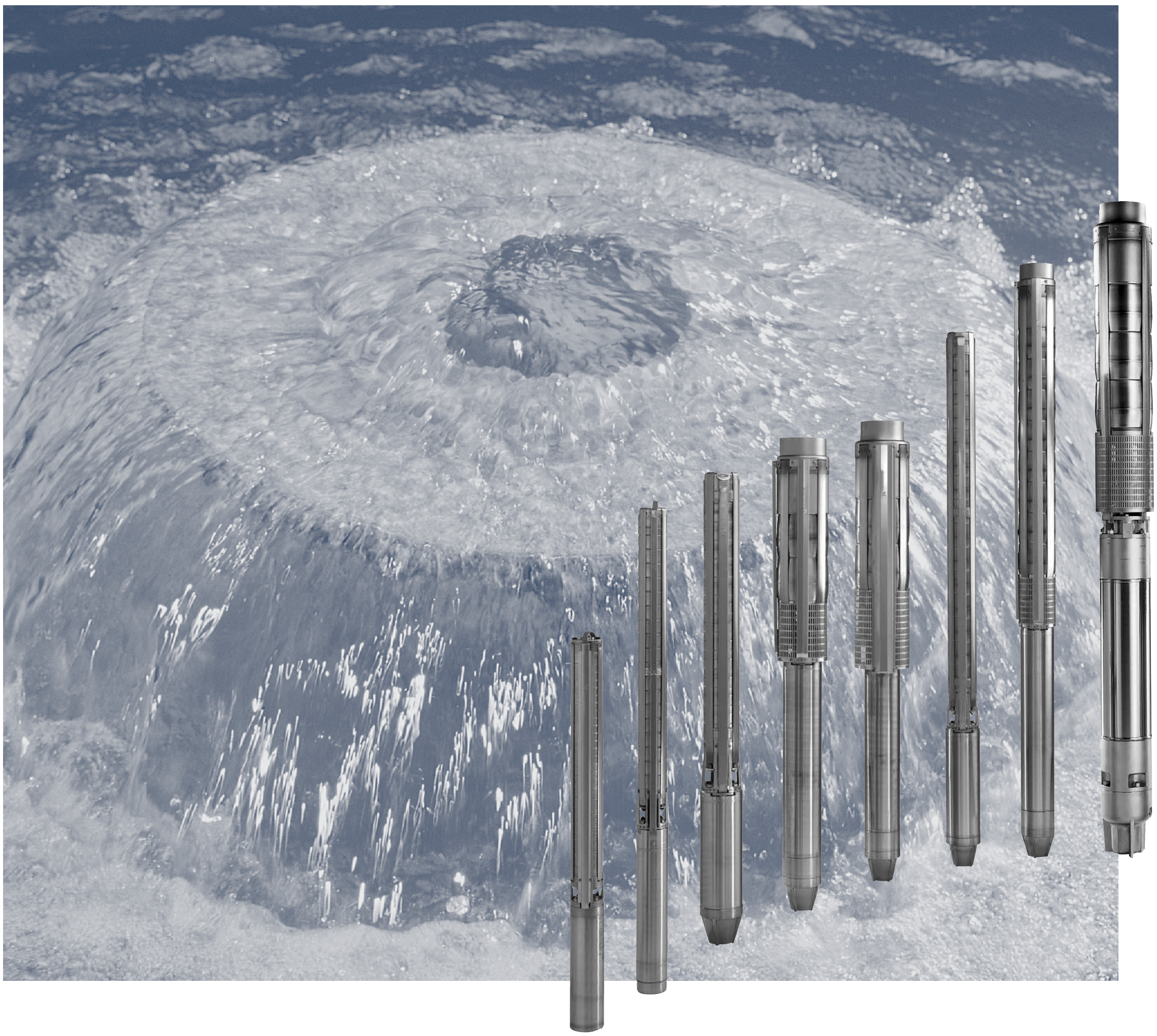
B3-EXW04

B3-EXW05

GRUNDFOS **PRODUCT GUIDE**

SP

Submersible pumps, motors, and accessories
60 Hz



BE > THINK > INNOVATE >

1. Product introduction

Introduction

The Grundfos SP range of submersible pumps is renowned for high efficiency and reliability. Made entirely of corrosion resistant stainless steel, SP pumps are ideal for a wide variety of applications.

Grundfos SP pumps represent state-of-the-art hydraulic design. Built to deliver optimum efficiency during periods of high demand, SP pumps provide low long-term costs and high operating reliability regardless of the application.

The SP range offers high efficiency, high resistance to sand and other abrasives, motor burnout protection, and easy maintenance. A complete monitoring and control system is available for constant optimization of the pumping system.

TM05 0051 0611

Fig. 1 Grundfos SP pumps

Applications

Grundfos Large SP submersible pumps are suitable for:

- Groundwater supply to waterworks
- Irrigation in horticulture and agriculture
- Groundwater lowering (dewatering)
- Pressure boosting
- Industrial applications
- Domestic water supply.

Pumped liquids

Grundfos SP pumps are suitable for pumping clean, thin, non-aggressive liquids without solid particles or fibers.

SP offers stainless steel construction which ensures good wear resistance and a reduced risk of corrosion where the water has minor chloride content.

Optional, upgraded stainless steel construction is available for pumping more aggressive liquids:

A complete range of zinc anodes for cathodic protection is available; see p. 97 for applications (for example, sea water applications).

For slightly polluted liquids (for example, containing oil), Grundfos offers a complete range of stainless steel SP NE pumps with all rubber parts made of FKM.

Features and benefits

Grundfos SP submersible pumps offer these features and benefits:

- State-of-the-art hydraulics provide high efficiency and low operating costs
- 100 % stainless steel components inside and outside for long service life
- Sand resistant
- Resistant to aggressive water
- Dry-running protection
- Monitoring, protection and communication via protection unit MP204, and remote control, R100.

A wide pump range

Grundfos offers energy-efficient SP submersible pumps with a performance range of up to 1,400 gpm and 2,100 ft of head.

The pump range consists of many pump sizes, and each pump size is available with an optional number of stages to match any duty point.

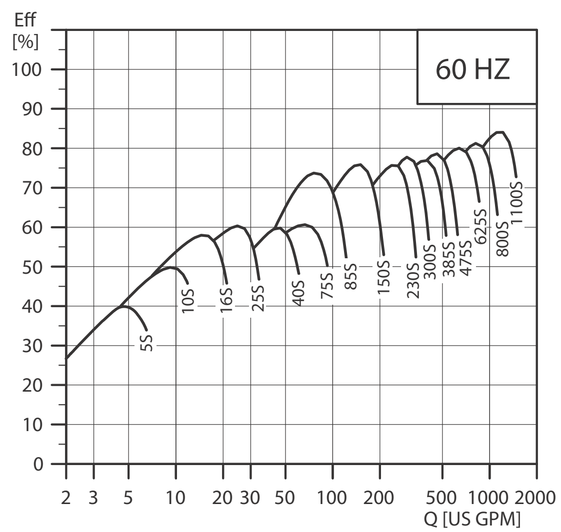
High pump efficiency

Often pump efficiency is given less consideration than the price of a pump; however, owners who choose efficiency will find substantial savings in energy costs over time. See fig. 2 for an illustration of SP efficiencies in relation to flow.

Example

For example, a pump and motor with a 10 % higher efficiency than a cheaper, less efficient pump, can save its owner more than $80,000.00 over 10 years*.

* If producing 880 gpm at 325 ft of head for 10 years @ 13.8 cents per kWh. U.S. kWh costs range from 6 cents to more than 20 cents, depending on region.



TM05 0057 0711

Fig. 2 SP pump/motor efficiencies in relation to flow

Pump design

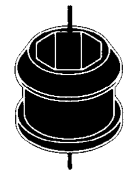
Grundfos SP submersible pumps feature components that contribute to the superior performance and durability of the range.

Lower installation costs

Stainless steel means low weight for ease in the handling of pumps, resulting in lower equipment costs and reduced installation and service time.

Bearings with sand channels

All bearings are water-lubricated and have a squared shape enabling sand particles, if any, to leave the pump together with the pumped liquid.

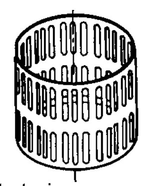


TM00 7301 1096

Fig. 3 Bearing

Inlet strainer

The inlet strainer prevents particles over a certain size from entering the pump.



TM00 7302 1096

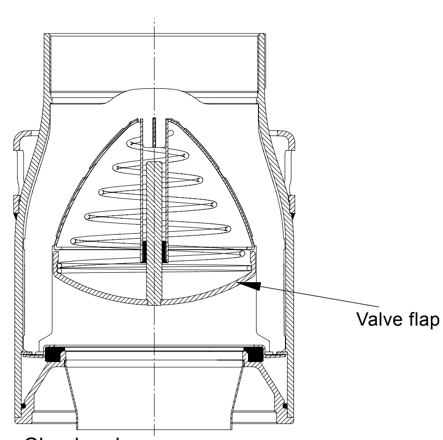
Fig. 4 Fig. Inlet strainer

Non-return valve

All pumps are equipped with a reliable check valve in the valve casing preventing back flow in connection with pump stoppage.

Furthermore, the short closing time of the check valve means that the risk of destructive water hammer is reduced to a minimum.

The valve casing is designed for optimum hydraulic properties to minimize the pressure loss across the valve and thus to contribute to the high efficiency of the pump.



TM01 2499 1798

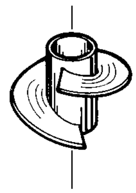
Fig. 5 Check valve

Priming screw

All Grundfos 4" pumps are fitted with a priming screw. Consequently, dry running is prevented, because the priming screw will make sure that pump bearings are always lubricated.

Due to the semi-axial impellers of large SP pumps this priming is provided automatically.

However, it applies to all pump types that if the water table is lowered to a level below the pump inlet neither pump nor motor will be protected against dry running.



TM00 7304 1096

Fig. 6 Priming screw

Stop ring

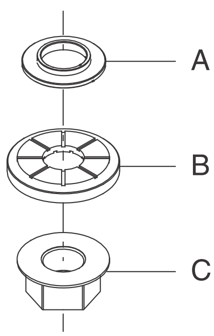
The stop ring prevents damage to the pump during transport and in case of up-thrust in connection with start-up.

The stop ring, which is designed as a thrust bearing, limits axial movements of the pump shaft.

Example: SP 385S

The stationary part of the stop ring (A) is secured in the upper intermediate chamber.

The rotating part (B) is fitted above the split cone (C).



TM01 3327 0412

Fig. 7 Stop ring (rotating and stationary part) and the split cone

Grundfos submersible motors

A complete motor range

Grundfos offers a complete submersible motor range in different voltages. For an overview of motor types, sizes and voltages, see page 85.

MS 402 is designed for the domestic ground water market and covers outputs. The MS 4000 and MS6 series are designed for use in a variety of applications in water supply. When equipped with features like oversized motor, temperature measurement, cooling jacket, and SiC/SiC mechanical shaft seals, these motors are suitable for heavy-duty industrial applications such as dewatering operations.

As a standard, all external surfaces of the Grundfos MS motors in contact with water are made of AISI 304 stainless steel. For aggressive water, such as seawater or brackish water, R-versions made of AISI 904 are available.

Grundfos rewindable MMS motor range

Grundfos MMS motors are suitable for any submersible installation, including heavy-duty industrial applications and dewatering operations (when equipped with temperature control, oversized motor, cooling jacket, and SiC/ SiC mechanical shaft seals).

As a standard the MMS motors are supplied with black cast-iron end-bells. Optionally, the range is available in all-stainless steel AISI 316 or AISI 904 versions.

The 2-pole Grundfos MMS submersible motors are all easy to rewind. The windings of the stator are made of a special water-proof wire of pure electrolytic copper sheathed with special non-hydroscopic thermoplastic material. The fine dielectric properties of this material allow direct contact between the windings and the liquid for efficient cooling of the windings.

TM00 7305 1096 - GrA4011 - GrA4013

Fig. 8 Grundfos MS motors

Fig. 9 Grundfos MMS motors

Industrial submersible motors and MS6 T60-versions

For heavy-duty applications Grundfos offers a complete motor range of industrial motors with up to 5 % higher efficiency than that of Grundfos' standard motors. The industrial motors are available in sizes as from 3 Hp up to 30 Hp.

The cooling of the motor is very efficient due to the large motor surface. The efficient cooling makes it possible to increase the liquid temperature to 140 °F (60 °C) at a minimum flow of 0.49 ft/s (0.15 m/s) past the motor.

The industrial motors are for customers who value low operating costs and long life higher than price.

Grundfos industrial motors are developed for difficult operating conditions. These motors will stand a higher thermal load than standard motors and thus have a longer life when subjected to high load. This applies whether the high load is caused by bad power supply, hot water, bad cooling conditions, high pump load etc.

Please note that heavy duty motors are longer than motors for standard conditions.

Overtemperature protection

Accessories for protection against overtemperature are available for both Grundfos MS and MMS submersible motors. When the temperature becomes too high, the protection device will cut out and damage to the pump and motor be avoided.

Restart of the motor after cut-out can be achieved in two ways:

- manual restart
- automatic restart.

Automatic restart means that the MP 204 attempts to restart the motor after 15 minutes. If the first attempt is not successful, restarting will be reattempted at 30-minute intervals.

MS

The Grundfos MS submersible motors (with the exception of MS 402) are available with a built-in Tempcon temperature transmitter for protection against overtemperature. By means of the transmitter, it is possible to read out and/or monitor the motor temperature via an MP 204 or a PR 5714 relay.

The Grundfos MS6 submersible motors can be fitted with a Pt100. The Pt100 is fitted in the motor and connected directly to the MP 204 or monitored by the PR 5714 relay.

MMS

For the protection of the Grundfos MMS submersible motors against overtemperature Grundfos offers the Pt100 temperature sensor as an optional extra.

The Pt100 is fitted in the motor and connected directly to the MP 204 or monitored by the PR 5714 relay.

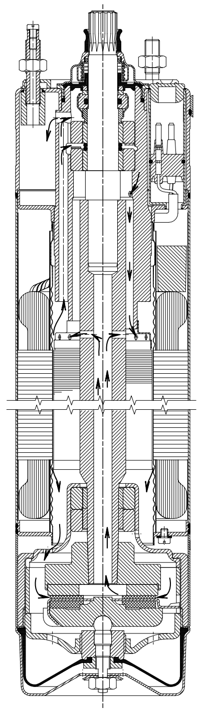
Protection against upthrust

In case of a very low counter pressure in connection with start-up there is a risk that the entire chamber stack may rise. This is called upthrust. Upthrust may damage both pump and motor. Both Grundfos pumps and motors are protected against upthrust as standard, preventing upthrust from occurring during the critical start-up phase. The protection consists of either a built-in stop ring or hydraulic balancing.

Built-in cooling chambers

In all Grundfos MS submersible motors, efficient cooling is ensured by cooling chambers at the top and at the bottom of the motor, and by an internal circulation of motor liquid.

See fig. 10. As long as the required flow velocity past the motor is maintained, cooling of the motor will be efficient.



TM00 5698 0996

Fig. 10 MS 4000

Lightning protection

The smallest Grundfos submersible motors, such as the MS 402, are all insulated in order to minimize the risk of motor burnout caused by lightning strike.

Reduced risk of short-circuit

The embedded stator winding in the Grundfos MS submersible motor is hermetically enclosed in stainless steel. The result is high mechanical stability and optimum cooling. Also, this eliminates the risk of short-circuit of the windings caused by water condensation.

Shaft seal

MS 402

The shaft seal is of the lip seal type characterized by low friction against the rotor shaft.

The rubber material offers good wear resistance, good elasticity and resistance to particles, and it is approved for use in drinking water.

MS 4000, MS6

The material is ceramic/tungsten carbide providing optimum sealing, optimum wear resistance and long life.

The spring loaded shaft seal is designed with a large surface and a sand shield. The result is a minimum exchange of pumped and motor liquids and no penetration of particles.

Motors, version R, are supplied with a SiC/SiC shaft seal. Other combinations are available request. See fig. 11 and fig. 12 for an illustration of shaft seal components and configuration.

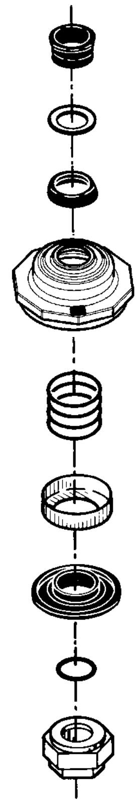
MMS rewindable motors

The standard shaft seal is a ceramic/carbon mechanical shaft seal. The shaft seal is replaceable.

The material features good wear resistance and resistance to particles.

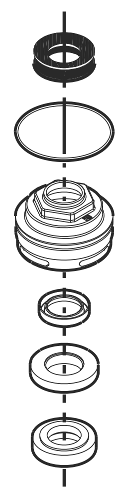
Together with the shaft seal housing, the sand shield forms a labyrinth seal, which during normal operating conditions prevents penetration of sand particles into the shaft seal.

On request, motors can be supplied with a SiC/SiC seal.



TM00 7306 0412

Fig. 11 Shaft seal, MS 4000



TM03 9225 3607

Fig. 12 Shaft seal, MS6

Identification

Type key, SP pumps

Example	475	S	500	-	5	-	A	B

- 475: Rated flow rate in gpm
- S: Type range. Stainless steel parts of material: S= AISI 304, N= AISI 316, R= AISI 904L
- 500: Hp of motor
- 5: Number of impellers
- A: First reduced-diameter impeller (A, B or C)
- B: Second reduced-diameter impeller (A, B or C)

Type key, MS 4000 motors

Example	MS	4	000	R

- MS: Motor submersible
- 4: Min. borehole diameter in inches
- 000: Generation
- R:
  - \- = Stainless steel AISI 304
  - R = Stainless steel AISI 904L
  - I = Stainless steel AISI 304 + De-rated
  - RE = Stainless steel AISI 904 L + FKM
  - EI = Stainless steel AISI 304 + De-rated + FKM

Type key, MS 402 motors

Example	MS	4	02	

- MS: Motor submersible
- 4: Min. borehole diameter in inches
- 02: Generation
- \- = Stainless steel AISI 304

Type key, MMS motors

Example	MMS	6	000	N

- MMS: Type range
- 6: Min. borehole diameter in inches
- 000: Generation
- N: Material:
  - = Cast iron EN-JL1040
  - N = DIN/EN 1.4401 (AISI 316)

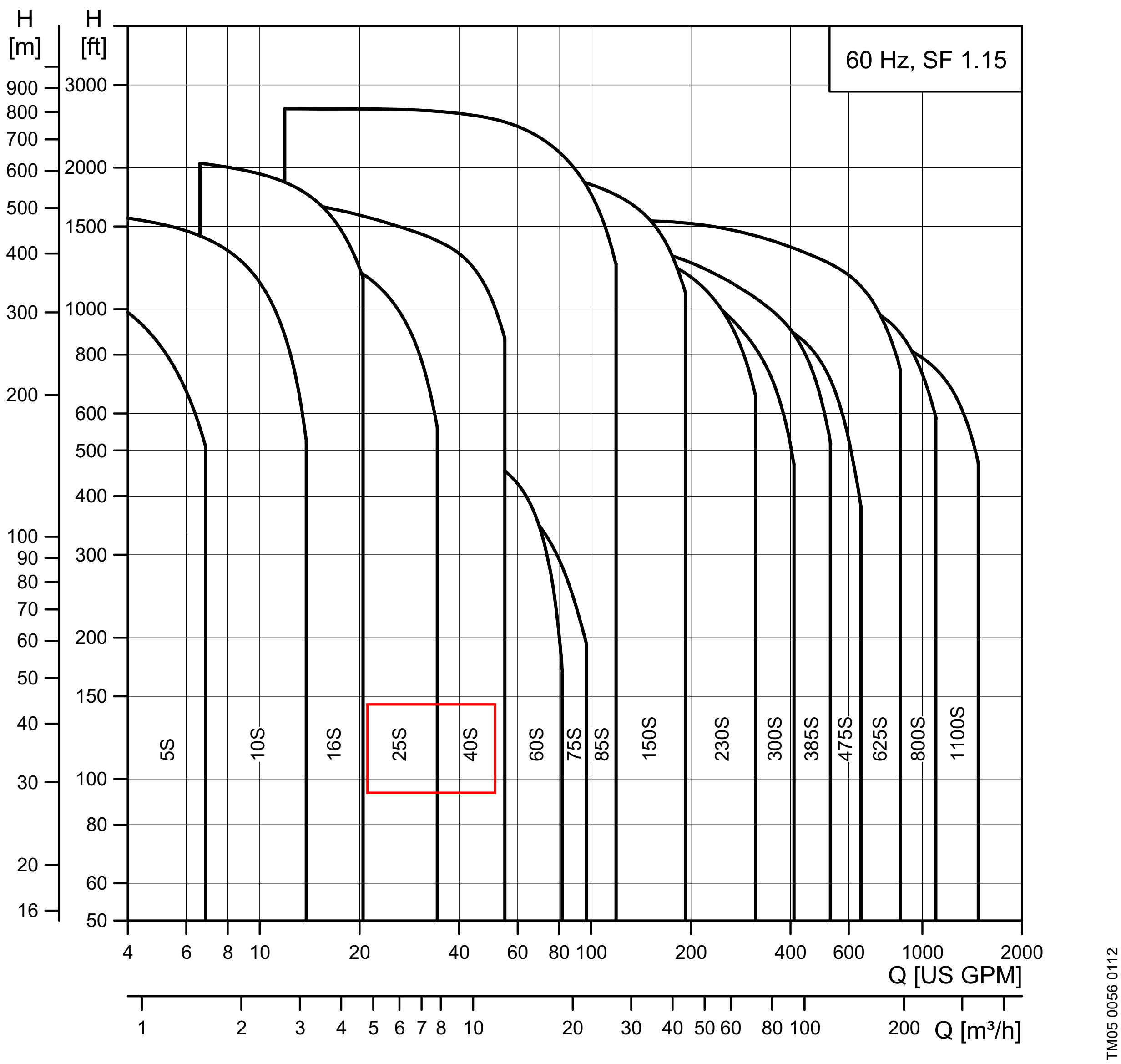
Type key, MS6 motors

Example	MS	6	R	E	S	W	D	T60

- MS: Type range (**M**otor **S**ubmersible)
- 6: **Motor diameter in inches**
- R: **Material**
  - Blank = stainless steel EN 1.4301 (AISI 304)
  - R = stainless steel EN 1.4539 (AISI 904L)
- E: **Rubber parts**
  - Blank = NBR
  - E = FKM
- S: **Shaft seal**
  - Blank = ceramics/carbon
  - S = SiC/SiC
- W: **Radial bearings**
  - Blank = carbon/stainless steel
  - W = SiC/tungsten carbide
- D: **Motor liquid**
  - Blank = SML-3
  - D = demineralized water
- T60: **Maximum liquid temperature**
  - T30 = 86 °F (30 °C)
  - T60 = 140 °F (60 °C)

2. Product overview

Performance range 60 Hz



Pump range

Type		5S	10S	16S	25S	40S	60S	75S	85S	150S	230S	300S	385S	475S	625S	800S	1100S
AISI 304 stainless steel		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
AISI 316 stainless steel				●	●	●		●	●	●	●	●	●	●	●	●	●
AISI 904L stainless steel					●	●			●	●	●	●	●	●	●	●	●
Connection ★	NPT	1"	1.25"	1.25"	1.5"	2"	2"	2"	(3")	(3")	3" (4")	3" 4"	5"	5"	6"	6"	6"
Flange connection: Grundfos flange													5"	5"	6"	6"	6"

★ Figures in brackets ( ) indicate connection for pumps with sleeve.

Motor range

Motor output [hp]	0.5	0.75	1.0	1.5	1.5	3.0	5.0	7.5	10.0	15	20	25	30	40	50	60	75	100	125	150	175	200	250
Single-phase	●	●	●	●	●	●																	
Three-phase	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Industrial motor and MS6 T60-versions						●	●	●	●	●	●	●	●										
Rewindable motor							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 304	●	●	●	●	●	●	●	●	●	●	●	●	●	●									
Steel: AISI 304 and cast iron							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 316							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steel: AISI 904L			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			
Built-in temperature transmitter in motor			●	●	●	●	●	●	●	●	●	●	●	●									

Direct-on-line starting is recommended up to 100 hp.
Soft starter or autotransformer is recommended above 100 hp.
Motors with star/delta are available from 7.5 hp.

Motor protection and controllers

Motor output [hp]	0.5	0.75	1.0	1.5	1.5	3.0	5.0	7.5	10.0	15	20	25	30	40	50	60	75	100	125	150	175	200	250
MP 204	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pt100							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Zinc anode				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Vertical flow sleeve	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Horizontal flow sleeve	●	●	●	●	●	●		●	●	●	●	●	●	●									
SA-SPM	●	●	●	●	●	●	●																
R100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RS-485 communication module	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
G100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Motor protection of single-phase motors, see page 85.

3. Construction

Sectional drawing, SP pump, 4"

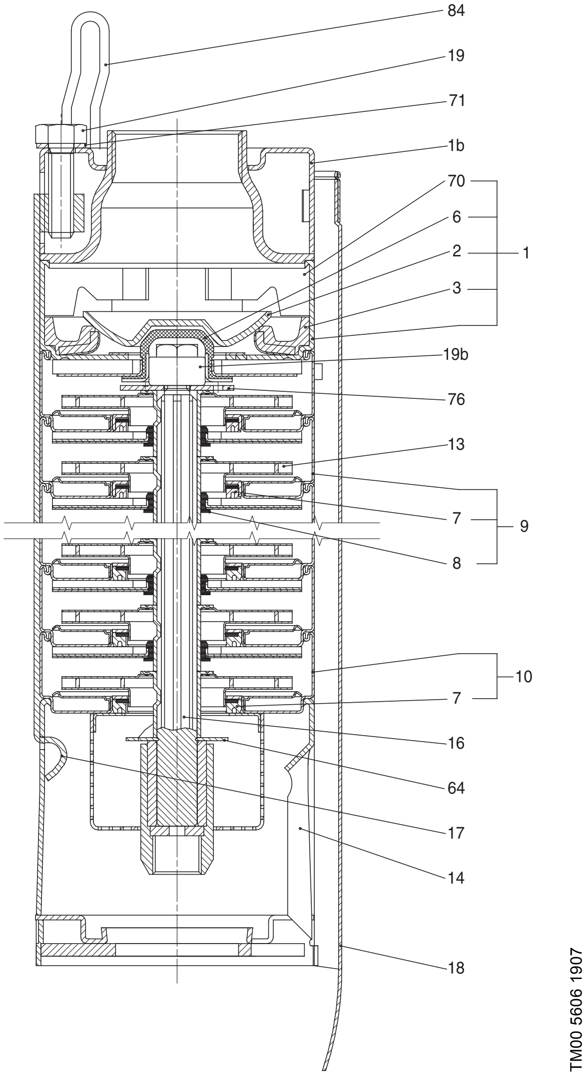


Fig. 13 SP pump, 4"

Material specification, SP pump, 4"

Pos.	Component	Materials	Standard AISI
1	Valve casing	Stainless steel	304
1b	Discharge piece	Stainless steel	304
2	Valve cup	Stainless steel	304
3	Valve seat	Stainless steel/NBR	304
6	Top bearing	NBR	
7	Neck ring	NBR/PBT	
8	Intermediate ring	NBR	
9	Intermediate chamber	Stainless steel	304
10	Bottom intermediate chamber	Stainless steel	304
13	Impeller	Stainless steel	304
14	Suction interconnector	Stainless steel	304
16	Shaft	Stainless steel	304
17	Strap	Stainless steel	304
18	Cable guard	Stainless steel	304
19	Hexagon screw	Stainless steel	304
19a	Nut	Stainless steel	316
19b	Nut	Stainless steel	304
20	Motor cable		
64	Priming disc	Stainless steel	304
70	Valve guide	Stainless steel	304
71	Washer for pos. 19	Stainless steel	316
76	Washer	Stainless steel	304
78	Nameplate	Stainless steel	316
84	Hook	Stainless steel	304

Sectional drawing, SP pump, 6"

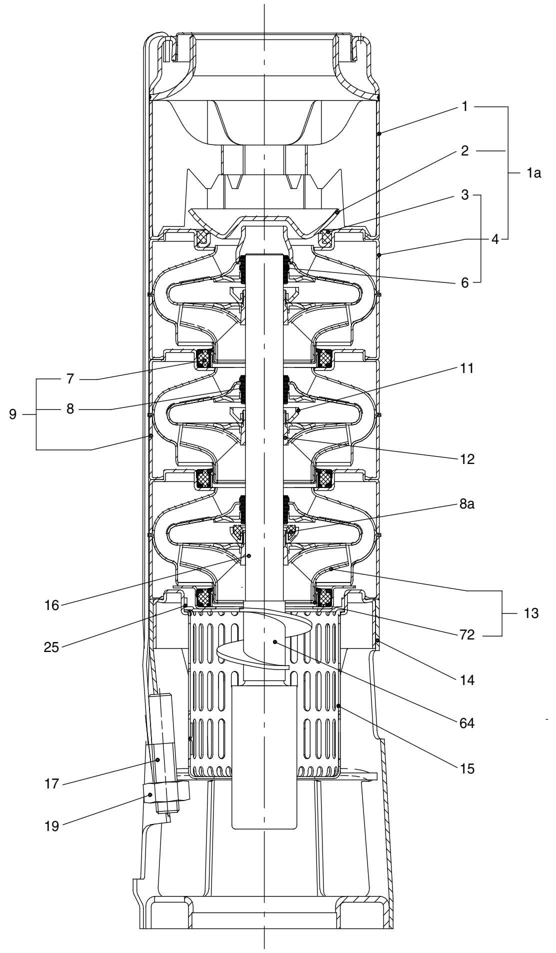


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Fig. 14 SP pump, 6"

Material specification, SP pump, 6"

Pos.	Component	Materials	Standard	N-version	R-version
			AISI		
		Valve casing			
1	Valve casing	Stainless steel	304	316	904 L
2	Valve cup	Stainless steel	304	316	904 L
3	Valve seat	Stainless steel	304	316	904 L
4	Top chamber	Stainless steel	304	316	904 L
		Chamber stack			
7	Neck ring	NBR/PPS			
8	Bearing	NBR			
8a	Spacing washer	Carbon/ graphite HY22 in PTFE mass			
9	Chamber	Stainless steel	304	316	904 L
11	Nut for split cone	Stainless steel	304	316	904 L
12	Split cone	Stainless steel	304	316	904 L
13	Impeller	Stainless steel	304	316	904 L
16	Shaft with coupling	Stainless steel	431	329	Si 31 803
18	Cable guard	Stainless steel	304	316	904 L
23	Rubber guard	NBR			
25	Neck ring retainer	Stainless steel	304	316	904 L
64	Priming screw	Stainless steel	304	316	904 L
72	Wear ring	Stainless steel	304	316	904 L
		Suction interconnector			
14	Suction interconnector	Stainless steel	304	316	904 L
	Intermediate piece for 6" motor over 40 Hp	Stainless steel	316	316	316
15	Strainer	Stainless steel	304	316	904 L
17	Strap	Stainless steel	304	316	904 L
19	Nut for strap	Stainless steel	304	316	904 L
19a	Nut	Stainless steel	316	316	316
20	Motor cable				
78	Nameplate	Stainless steel	316	316	316
		Pumps in sleeve			
	Clamping flange (counter)	Stainless steel	304	316	904 L
	Clamping flange	Stainless steel	304	316	904 L
	Connecting piece	Stainless steel	304	316	904 L
	Sleeve	Stainless steel	304	316	904 L
	Stay bolt	Stainless steel	304	316	904 L
	Hexagon socket head screw	Stainless steel	304	316	904 L

Sectional drawing, SP pump, 8"

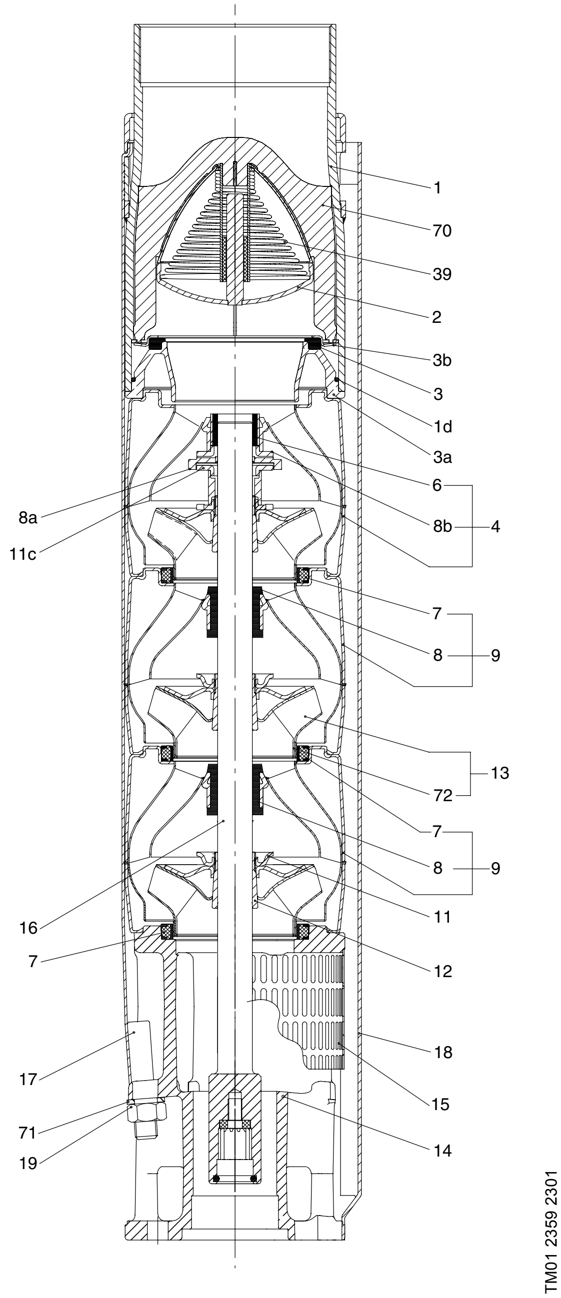


Fig. 15 SP pump, 8"

Material specification, SP pump, 8"

Pos.	Component	Materials	Standard	N-version	R-version
				AISI	
1	Valve casing	Stainless steel	304	316	904L
1d	O-ring	NBR			
2	Valve cup	Stainless steel	304	316	904L
3	Valve seat	Standard/ N- version: NBR R-version: FKM			
3a	Lower valve seat retainer	Stainless steel	316	316	(DIN 1.4517)
3b	Upper valve seat retainer	Stainless steel	304	316	904L
4	Top chamber	Stainless steel	304	316	904L
6	Upper bearing	Stainless steel/NBR	304	316	904L
7	Neck ring	NBR/PPS			
8	Bearing	NBR			
8a	Washer for stop ring	Carbon/ graphite HY22 in PTFE mass			
8b	Stop ring	Stainless steel	316	316	904L
9	Chamber	Stainless steel	304	316	904L
11	Split cone nut	Stainless steel	304	316	904L
11c	Nut for stop ring	Stainless steel	316	316	904L
12	Split cone	Stainless steel	304	316	904L
13	Impeller	Stainless steel	304	316	904L
14	Suction inter-connector	Stainless steel	CF8M	A744 CD4-MCu	(DIN 1.4517)
15	Strainer	Stainless steel	304	316	904L
16	Shaft complete	Stainless steel	431	329	329
17	Strap	Stainless steel	304	316	904L
18	Cable guard	Stainless steel	304	316	904L
19	Nut for strap	Stainless steel	304	316	904L
39	Spring for valve cup	Stainless steel	304	316	SAF 2205
70	Valve guide	Stainless steel	304	316	904L
71	Washer	Stainless steel	316	316	904L
72	Wear ring	Stainless steel	304	316	904L

Sectional drawing, SP pump, 10"

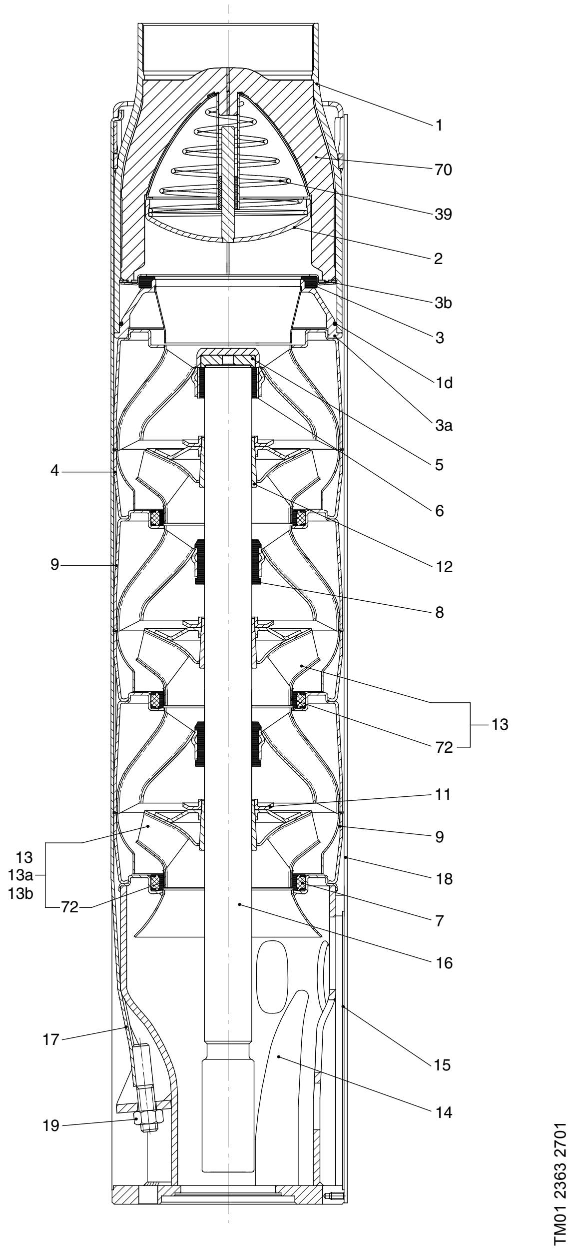


Fig. 16 SP pump, 10"

Material specification, SP pump, 10"

Pos.	Description	Material	Standard	N version
			AISI	
		Valve casing		
1	Valve casing	Stainless steel	304	316
1d	O-ring	NBR		
2	Valve cup	Stainless steel	304	316
3	Valve seat	Stainless steel	304	316
3a	Lower valve seat retainer	Stainless steel	304	316
3b	Upper valve seat retainer	Stainless steel	304	316
39	Spring for valve cup	Stainless steel	301	316
70	Valve guide	Stainless steel	304	316
78	Nameplate	Stainless steel	304	316
79	Rivet	Stainless steel	304	316
63	Connecting piece	Stainless steel	304	316
		Chamber stack		
4	Top chamber	Stainless steel	304	316
5	Upthrust disc	Carbon/ graphite HY22 in PTFE mass		
6	Top bearing	Stainless steel/ NBR	304	316
7	Neck ring	NBR/PPS		
8	Bearing	NBR		
9	Chamber	Stainless steel	304	316
11	Nut for split cone	Stainless steel	304	316
12	Split cone	Stainless steel	304	316
13	Impeller	Stainless steel	304	316
16	Shaft with coupling	Stainless steel	431	329
18	Cable guard	Stainless steel	304	316
18a, 18b	Screw for cable guard	Stainless steel	304	316
23	Rubber guard	NBR		
72	Wear ring	Stainless steel	304	316
		Suction interconnector		
14	Suction interconnector	Stainless steel	304	316
15	Strainer	Stainless steel	304	316
17	Strap	Stainless steel	304	316
19	Nut for strap	Stainless steel	304	316
19a	Nut	Stainless steel	316	316
20	Motor cable			
22	Bolts	Stainless steel	316	316
28, 28a	Lock for strainer	Stainless steel	329	329

Sectional drawing - MS motors

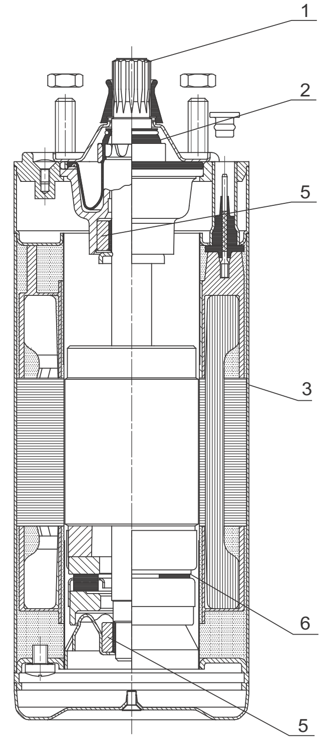


Fig. 17 MS 402 motor

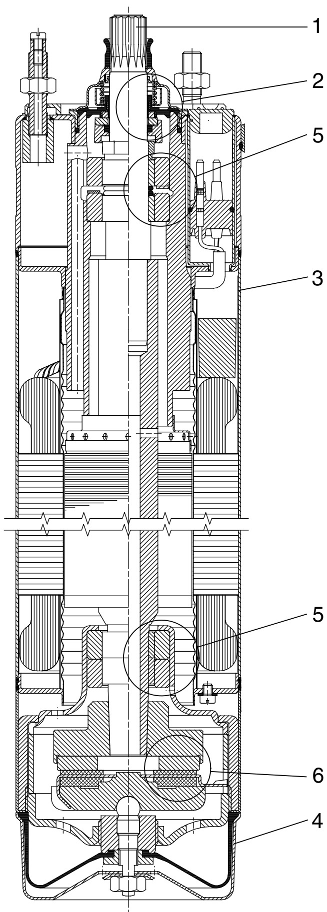


Fig. 18 MS 4000 motor

Material specification, MS 402 and MS 4000 motors

Pos.	Part	MS 402	MS 4000
		AISI	
1	Shaft	431	431
2	Shaft seal	NBR	Tungsten carbide/ ceramic
3	Motor sleeve	304	304
4	Motor end shield		304
5	Radial bearing	Ceramic	Ceramic/ tungsten carbide
6	Axial bearing	Ceramic/carbon	Ceramic/carbon
	Rubber parts	NBR	NBR

R-version motor

Pos.	Part	MS 4000
1	Shaft	318 LN
2	Shaft seal	NBR/ceramic
3	Motor sleeve	904L
4	Motor end shield	904L
5	Radial bearing	Ceramic/tungsten carbide
6	Thrust bearing	Ceramic/carbon
	Rubber parts	NBR

Sectional drawing - MS6 motors

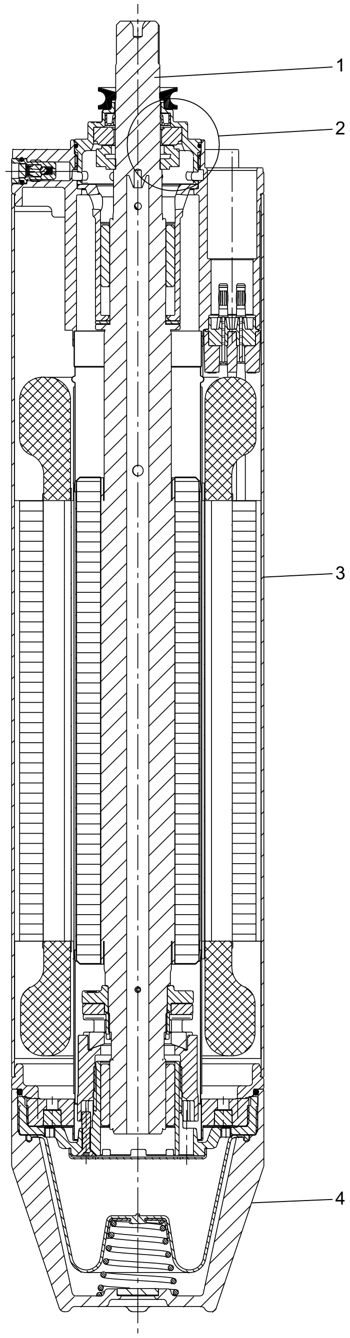


Fig. 19 MS6 motor

Material specification - MS6 motors

Pos.	Part	MS6
202	Shaft with rotor	318LN
2	Shaft seal	Ceramic/carbon
3	Motor sleeve	304
4	Motor end cover	304
	Rubber parts	NBR/FKM

R-version motor

Pos.	Part	MS6
1	Shaft	318LN
2	Shaft seal	SiC/SiC
3	Motor sleeve	904L
4	Motor end cover	(DIN 1.4517)
	Rubber parts	FKM

Sectional drawing - MMS motors

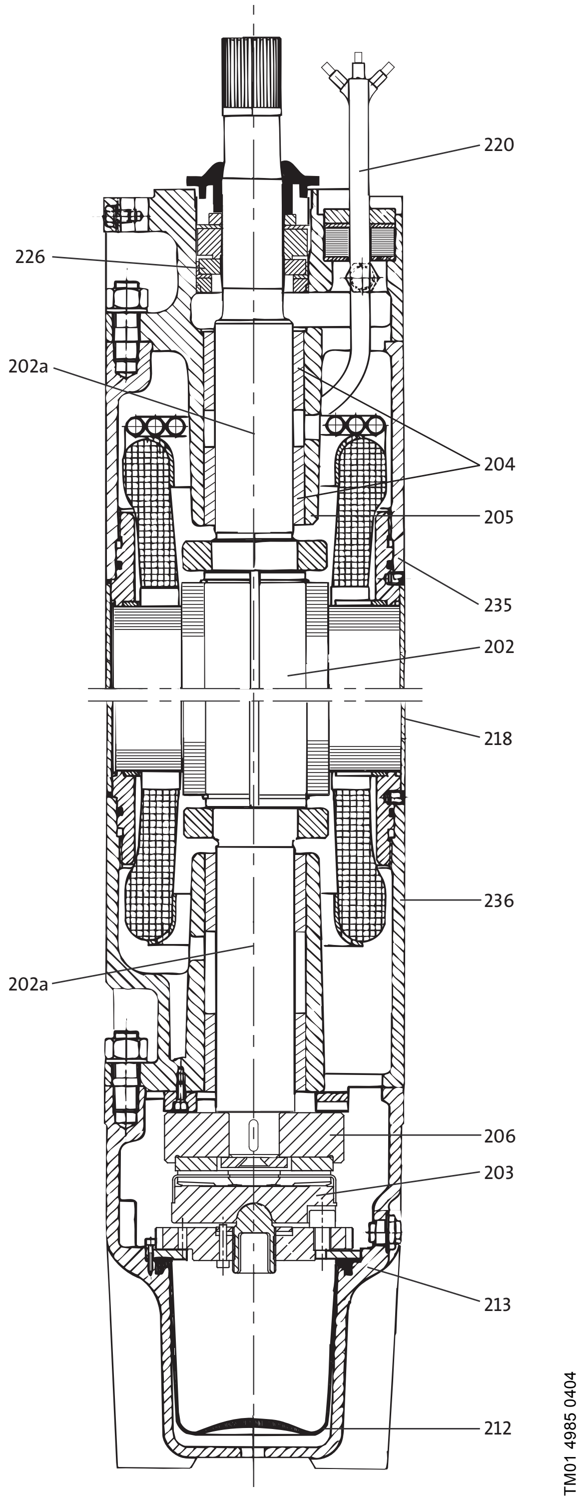


Fig. 20 MMS 10000

Material specification

MMS motors, submersible rewindable versions

Pos.	Component		Material	AISI
202	Shaft		Steel	(EN 1.0533)
202a	Shaft ends		Stainless steel	316/329
203/ 206	Thrust bearing Stationary/ rotating part	6", 0.5 - 20 Hp	Hardened steel/ EPDM	
		6", 25 - 50 Hp	Ceramic/ carbon	
		8" - 10"		
204	Bearing bush	6" - 10"	Carbon	
205	Bearing housing, upper		Cast iron	A126 Class B
212	Diaphragm		CR	
213	Motor end shield		Cast iron	A126 Class B
218	Motor sleeve		Stainless steel	304
220	Motor cable		EPDM	
226	Shaft seal		Ceramic/ carbon	
235	Intermediate housing		Cast iron	A126 Class B
236	Bearing housing, lower		Cast iron	A126 Class B

MMS motors, N- and R-versions

Pos.	Component		Material	Version	
				N	R*
				AISI	
202	Shaft		Steel	(EN 1.0533)	(EN 1.0533)
202a	Shaft ends		Stainless steel	316/329	318LN
203/ 206	Thrust bearing Stationary/ rotating part	6", 0.5 - 20 Hp	Hardened steel/EPDM		
		6", 25 - 50 Hp	Ceramic/ carbon		
		8"-10"			
204	Bearing bush	6"-10"	Carbon		
205	Bearing housing, upper		Stainless steel	316	904L
212	Diaphragm		CR		
213	Motor end shield		Stainless steel	316	904L
218	Motor sleeve		Stainless steel	316	904L
220	Motor cable		EPDM		
226	Shaft seal		Ceramic/ carbon		
235	Intermediate housing		Stainless steel	316	904L
236	Bearing housing, lower		Stainless steel	316	904L

* Only MMS 6000 and MMS 8000 are available in R-versions

4. Operating conditions

Operating conditions

Flow rate, Q: 0.44 - 1475 gpm (0.1-335 m^3/h).

Head, H: Maximum 2657 ft (810 m).

Maximum liquid temperature

Motor	Installation		
	Flow velocity past motor	Vertical [°F (°C)]	Horizontal [°F (°C)]
Grundfos MS 4"and MS6 T30-versions	0.49 ft/s (0.15 m/s)	86 (30)	86 (30)
Grundfos 4" MS industry versions	0.49 ft/s (0.15 m/s)	140 (60)	140 (60)
Grundfos MS6 T60-versions	3.28 ft/s (1.0 m/s)	140 (60)	140 (60)
Grundfos MMS 6" to 12" rewindable with PVC in the windings	0.49 ft/s (0.15 m/s)	77 (25)	77 (25)
	1.64 ft/s (0.50 m/s)	86 (30)	86 (30)
Grundfos MMS 6" to 12" rewindable with PE/PA in the windings	0.49 ft/s (0.15 m/s)	104 (40)	104 (40)
	1.64 ft/s (0.50 m/s)	113 (45)	113 (45)

Note: Note: For MMS 6000, 0.5 hp; MMS 8000, 150 hp; the maximum liquid temperature is 9 °F (5 °C) lower than the values stated in the table. For MMS 10000, 250 hp, the temperature is 18 °F (10 °C) lower.

Operating pressure

Motor	Maximum operating pressure
Grundfos MS 4" and 6"	870 psi (6 Mpa) (60 bar)
Grundfos MMS 6" to 10" rewindable	

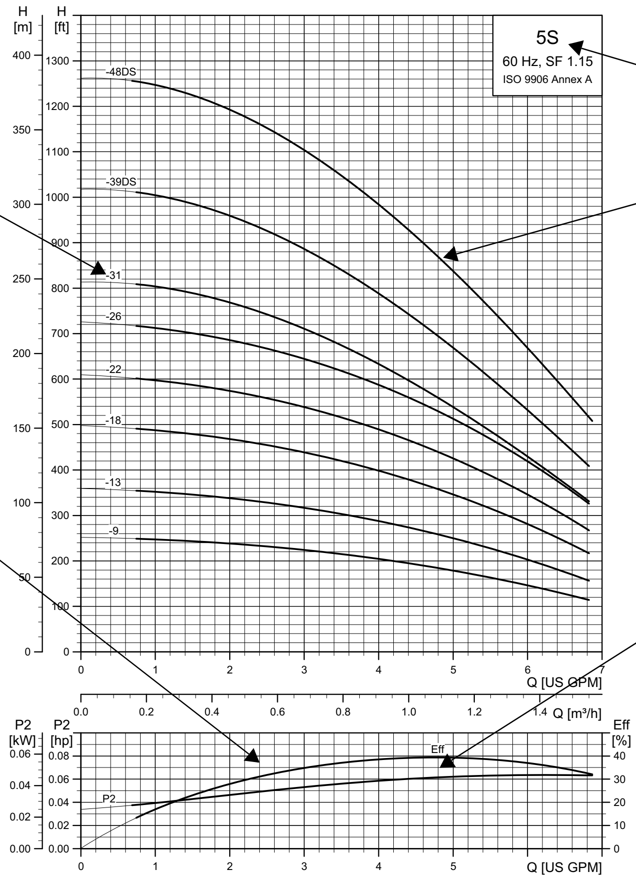
Curve conditions

The conditions below apply to the curves shown on pages 20 - 84:

General

- Curve tolerances according to ISO 9906, Annex A.
- The performance curves show pump performance at actual speed, cf. standard motor range.
  The speeds of the motors are approximately these:
  4" motors: n = 3470 min^{-1}
  6" motors: n = 3460 min^{-1}
  8" to 10" motors: n = 3525 min^{-1}
- The measurements were made with airless water at a temperature of 68 °F (20 °C). The curves apply to a kinematic viscosity of 1 mm^2/s (1 cSt). When pumping liquids with a density higher than that of water, use motors with correspondingly higher outputs.
- The **bold** curves indicate the recommended performance range.
- The performance curves are inclusive of possible losses such as non-return valve loss.
- **Q/H:** The curves are inclusive of valve and inlet losses at the actual speed.
  Operation without non-return valve will increase the actual head at rated performance by 0.5 to 1.0 m.
- **NPSH:** The curve is inclusive of pressure loss in the suction interconnector and shows required inlet pressure.
- **Power curve:** P_2 shows pump power input at the actual speed of each individual pump size.
- **Efficiency curve:** Eta shows pump stage efficiency. If Eta for the actual pump size is needed, please consult WinCAPS or WebCAPS.

5. How to read the curve charts



Pump type, number of poles and frequency.

Number of stages.
First figure: number of stages; second figure: number of reduced-diameter impellers.

QH curve for the individual pump. The **bold** curves indicate the **recommended** performance range for best efficiency.

The efficiency curve shows the efficiency of the pump. The efficiency curve is an average curve of all the pump types shown in the chart. The efficiency of pumps with reduced-diameter impellers is approx. 2 % lower than the efficiency curve shown in the chart.

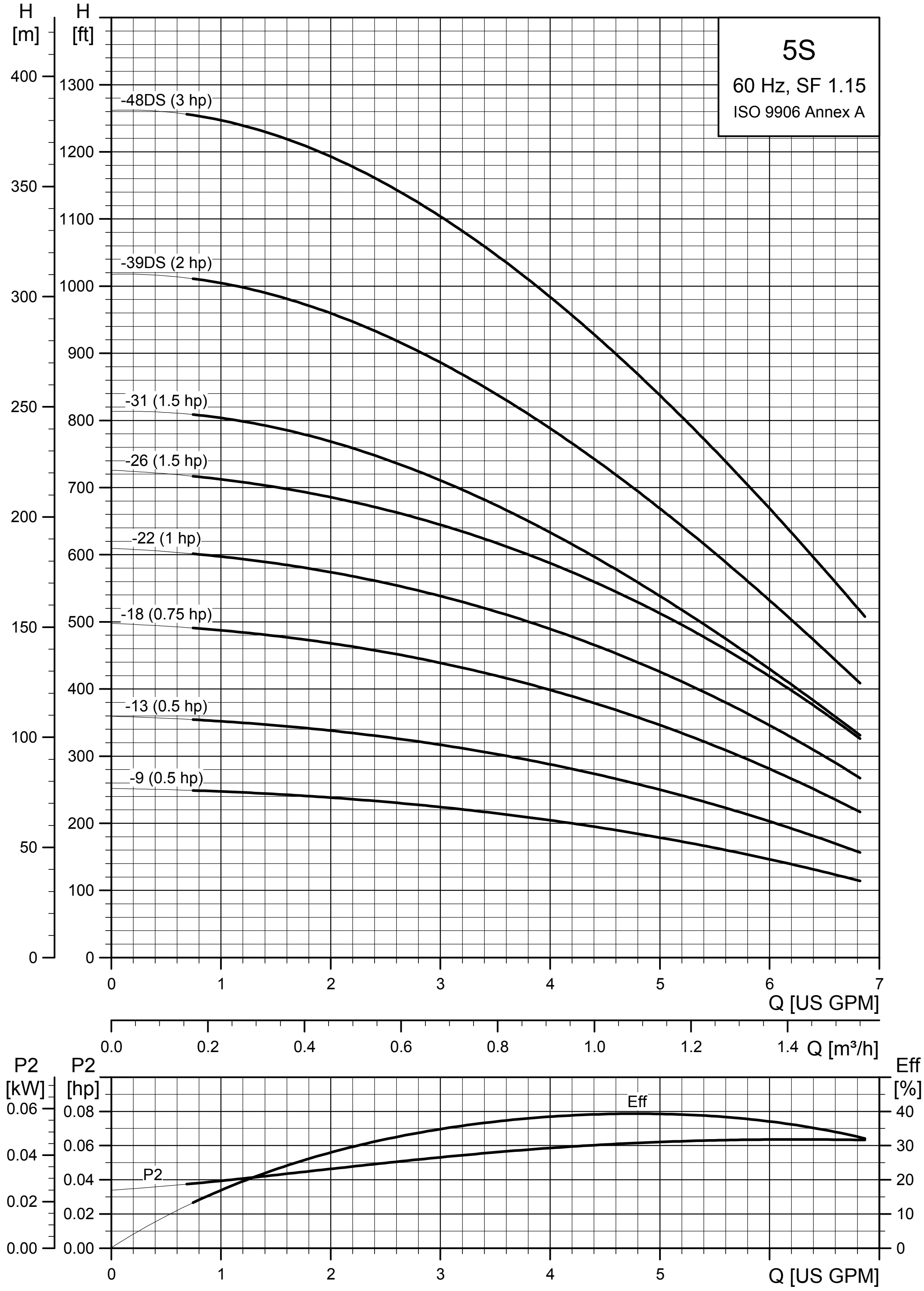
The power curves indicate pump input power **per stage**. Curves are shown for complete (1/1) and for reduced-diameter (2/3) impellers.

TM05 0229 10112

Curve charts and technical data

6. Curve charts and technical data

5S (5 gpm)



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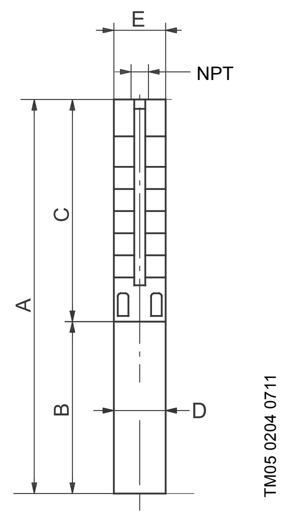
5S (5 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	Dimensions B [in (mm)]	Dimensions C [in (mm)]	Dimensions D [in (mm)]	Dimensions E [in (mm)]	Net weight (complete) [lb]
5S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 5 gpm (1" NPT)											
5S05-9	171	1	230	0.5	■	24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.97 (101)	21.6
5S05-13	247	1	115	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.9
			230	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.1
5S07-18	343	1	230	0.75	■	32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.97 (101)	29.7
5S10-22	419	1	230	1	■	36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.97 (101)	32.4
5S15-26	495	1	230	1.5	■	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	41.4
5S15-31	527	1	230	1.5	■	47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.97 (101)	47.7
5S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 5 gpm (1" NPT)											
5S05-9	171	1	230	0.5	■	24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.97 (101)	22.5
5S05-13	247	1	115	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	26.9
			230	0.5	■	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.97 (101)	25.2
5S07-18	343	1	230	0.75	■	32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.97 (101)	28.8
5S10-22	419	1	230	1	■	36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.97 (101)	32.4
5S15-26	495	1	230	1.5	■	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	37.8
		3	230	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
			460	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
5S15-31	527	1	230	1.5	■	47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.97 (101)	47.7
		3	230	1.5	■	45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.97 (101)	45.0
			460	1.5	■	45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.97 (101)	45.0
5S20-39DS	663	1	230	2	●	59.61 (1514)	19.49 (495)	40.12 (1019)	3.74 (95)	3.97 (101)	57.6
		3	230	2	■	53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	3.97 (101)	54.0
			460	2	■	53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	3.97 (101)	54.0
5S30-48DS	816	1	230	3	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4
		3	230	3	●	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4
			460	3	●	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	3.97 (101)	77.4

5S

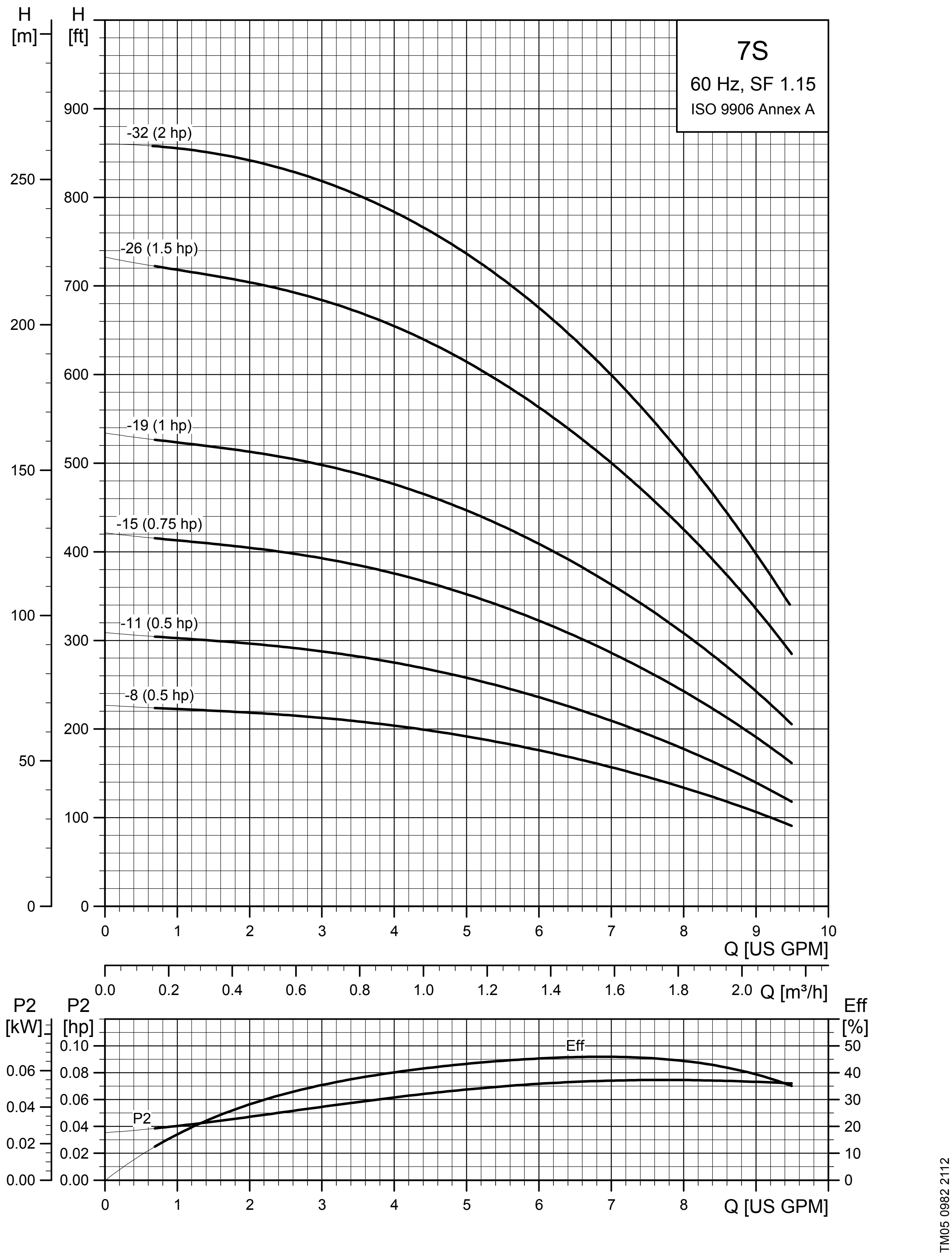


E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

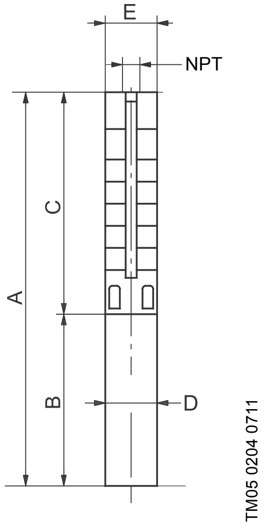
7S (7 gpm)


7S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-32 (2 hp)
-26 (1.5 hp)
-19 (1 hp)
-15 (0.75 hp)
-11 (0.5 hp)
-8 (0.5 hp)
Q [US GPM]
Q [m³/h]
P2 [kW]
P2 [hp]
Eff [%]
Eff
P2
TM05 0982 2112

7S (7 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
7S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 7 gpm (1" NPT)											
7S05-8	151	1	230	.5	■	23.75 (603)	11.03 (280)	12.72 (323)	3.74 (95)	3.97 (101)	21.6
7S05-11	208	1	115	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	29.7
			230	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	24.3
7S07-15	283	1	230	.75	■	30.12 (765)	11.62 (295)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
7S10-19	358	1	230	1	■	34.02 (864)	12.21 (310)	21.82 (554)	3.74 (95)	3.97 (101)	32.4
7S15-26	491	1	230	1.5	■	41.3 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	41.4
7S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 7 gpm (1" NPT)											
7S05-8	151	1	230	.5	■	23.75 (603)	11.03 (280)	12.72 (323)	3.74 (95)	3.97 (101)	21.6
7S05-11	208	1	115	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.97 (101)	30.6
7S07-15	283	1	230	.75	■	30.12 (765)	11.62 (295)	18.51 (470)	3.74 (95)	3.97 (101)	27.9
7S10-19	358	1	230	1	■	34.02 (864)	12.21 (310)	21.82 (554)	3.74 (95)	3.97 (101)	39.6
7S15-26	491	1	230	1.5	■	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
		3	230	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
			460	1.5	■	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.97 (101)	38.7
7S20-32	604	1	230	2	●	52.05 (1322)	19.49 (495)	32.56 (827)	3.74 (95)	3.97 (101)	48.5
		3	230	2	■	46.26 (1175)	13.71 (348)	32.56 (827)	3.74 (95)	3.97 (101)	48.5
			460	2	■	46.26 (1175)	13.71 (348)	32.56 (827)	3.74 (95)	3.97 (101)	48.5

7S

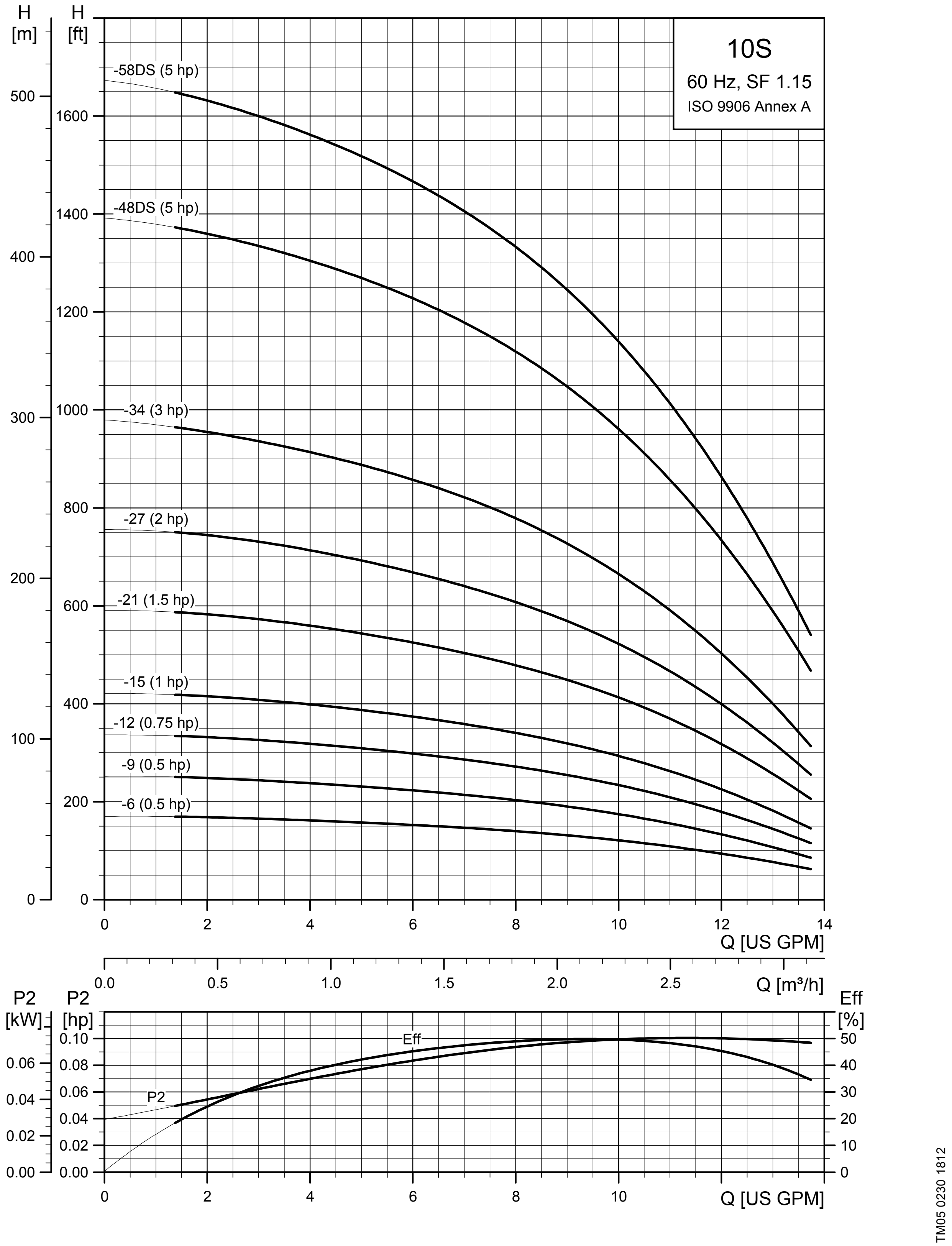


E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

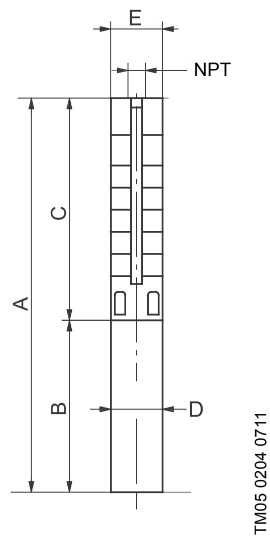
10S (10 gpm)


10S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-58DS (5 hp)
-48DS (5 hp)
-34 (3 hp)
-27 (2 hp)
-21 (1.5 hp)
-15 (1 hp)
-12 (0.75 hp)
-9 (0.5 hp)
-6 (0.5 hp)
Q [US GPM]
Q [m³/h]
P2 [kW]
P2 [hp]
Eff [%]
Eff
P2
TM05 0230 1812

10S (10 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
10S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 10 gpm (1.25" NPT)											
10S05-6	116	1	230	.5	■	22.05 (560)	10.99 (279)	11.07 (281)	3.74 (95)	3.97 (101)	20.7
10S05-9	174	1	115	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	24.3
			230	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	23.4
10S07-12	233	1	230	.75	■	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.97 (101)	24.3
10S10-15	291	1	230	1	■	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
10S15-21	407	1	230	1.5	■	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.97 (101)	35.1
10S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 10 gpm (1.25" NPT)											
10S05-6	116	1	230	.5	■	24.77 (629)	13.71 (348)	11.07 (281)	3.74 (95)	3.97 (101)	21.6
10S05-9	174	1	115	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	25.4
			230	.5	■	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.97 (101)	24.3
10S07-12	233	1	230	.75	■	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.97 (101)	28.8
10S10-15	291	1	230	1	■	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.97 (101)	29.7
10S15-21	407	1	230	1.5	■	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.97 (101)	35.1
		3	230	1.5	■	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.97 (101)	32.4
			460	1.5	■	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.97 (101)	36.0
10S20-27	524	1	230	2	●	47.92 (1217)	19.49 (495)	28.43 (722)	3.74 (95)	3.97 (101)	45.9
		3	230	2	■	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.97 (101)	44.1
			460	2	■	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.97 (101)	44.1
10S30-34	659	1	230	3	●	58.59 (1488)	22.6 (574)	35.99 (914)	3.74 (95)	3.97 (101)	81.9
		3	230	3	●	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.97 (101)	74.7
			460	3	●	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.97 (101)	74.7
10S50-48DS	931	1	230	5	●	74.18 (1884)	26.62 (676)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
		3	230	5	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
			460	5	●	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	3.97 (101)	103.5
10S50-58DS	1124	1	230	5	●	89.49 (2272)	26.62 (676)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
		3	230	5	●	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
			460	5	●	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3

10S

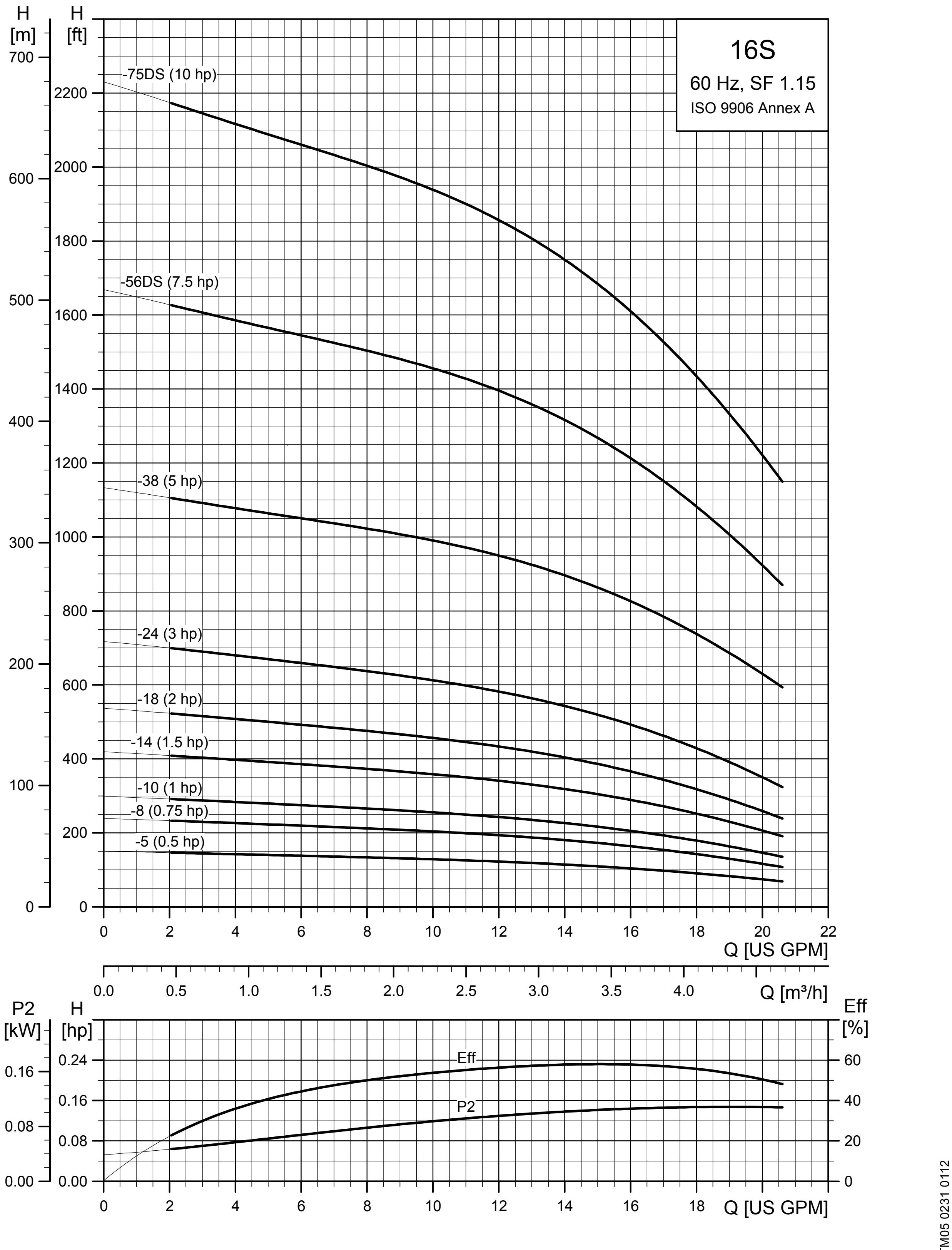


E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

16S (16 gpm)

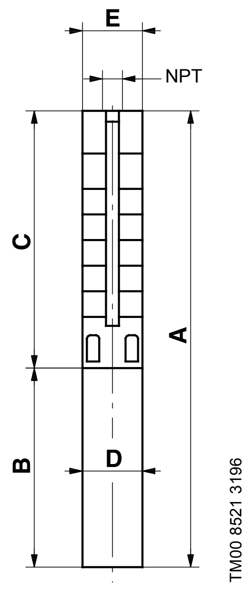

16S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-75DS (10 hp)
-56DS (7.5 hp)
-38 (5 hp)
-24 (3 hp)
-18 (2 hp)
-14 (1.5 hp)
-10 (1 hp)
-8 (0.75 hp)
-5 (0.5 hp)
Q [US GPM]
Q [m³/h]
P2 [kW]
H [hp]
Eff [%]
Eff
P2
TM05 0231 0112

16S (16 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
16S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 16 gpm (1.25" NPT)											
16S05-5	102	1	115	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	23.4
16S07-8	162	1	230	.75	■	24.34 (618)	11.62 (295)	12.72 (323)	3.74 (95)	3.97 (101)	24.3
16S10-10	203	1	230	1	■	26.58 (675)	12.21 (310)	14.38 (365)	3.74 (95)	3.97 (101)	27.9
16S15-14	284	1	230	1.5	■	31.38 (797)	13.71 (348)	17.68 (449)	3.74 (95)	3.97 (101)	36.0
16S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 16 gpm (1.25" NPT)											
16S05-5	102	1	115	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.97 (101)	21.6
16S07-8	162	1	230	.75	■	24.34 (618)	11.62 (295)	12.72 (323)	3.74 (95)	3.97 (101)	27.0
16S10-10	203	1	230	1	■	26.58 (675)	12.21 (310)	14.38 (365)	3.74 (95)	3.97 (101)	27.9
16S15-14	284	1	230	1.5	●	31.38 (797)	13.71 (348)	17.68 (449)	3.74 (95)	3.97 (101)	32.4
		3	230	1.5	■	29.89 (759)	12.21 (310)	17.68 (449)	3.74 (95)	3.97 (101)	28.8
			460	1.5	■	29.89 (759)	12.21 (310)	17.68 (449)	3.74 (95)	3.97 (101)	28.8
16S20-18	366	1	230	2	●	40.48 (1028)	19.49 (495)	20.99 (533)	3.74 (95)	3.97 (101)	36.0
		3	230	2	■	34.69 (881)	13.71 (348)	20.99 (533)	3.74 (95)	3.97 (101)	36.0
			460	2	■	34.69 (881)	13.71 (348)	20.99 (533)	3.74 (95)	3.97 (101)	36.0
16S30-24	487	1	230	3	●	48.55 (1233)	22.60 (574)	25.95 (659)	3.74 (95)	3.97 (101)	62.1
		3	230	3	●	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.97 (101)	57.6
			460	3	●	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.97 (101)	57.6
16S50-38	814	1	230	5	●	65.91 (1674)	26.62 (676)	39.30 (998)	3.74 (95)	3.97 (101)	97.2
		3	230	5	●	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.97 (101)	90.0
			460	5	●	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.97 (101)	90.0
SP 16S, motor dia. 6 inch, 3 wire motor, 60 Hz - rated flow 16 gpm (1.25" NPT)											
16S75-56DS	1200	3	230	7.5	▲	95.40 (2423)	26.62 (676)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
			460	7.5	▲	95.40 (2423)	26.62 (676)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
16S100-75DS	1607	3	460	10	▲	115.08 (2923)	30.60 (777)	84.49 (2146)	5.63 (143)	5.51 (140)	190.0

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/4" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.
■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
∧ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.
† Takes MMS10000 motor; not available as complete.

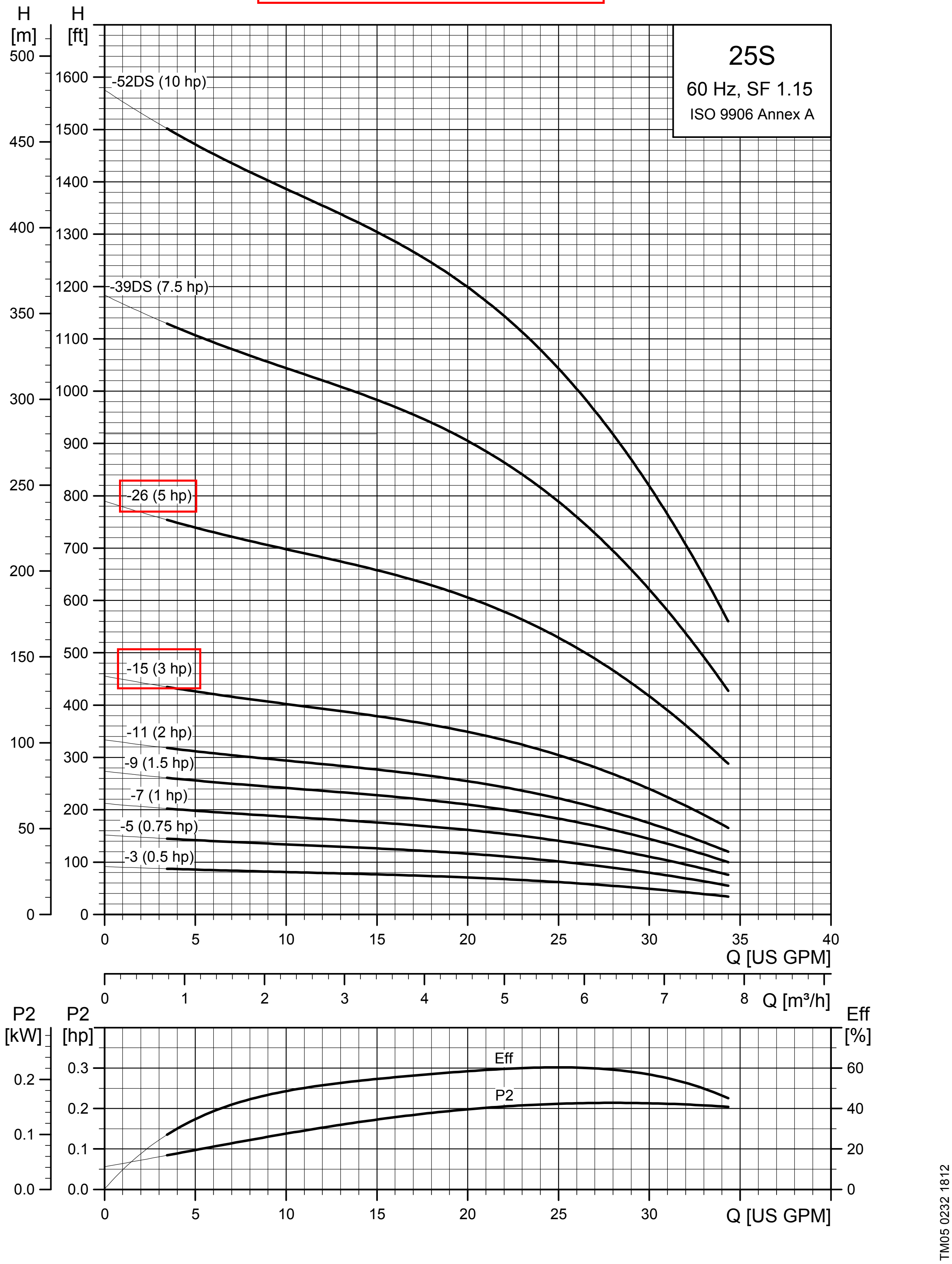
16S



E = Maximum diameter of pump including cable guard and motor.

25S (25 gpm)

MW16-LGR: 25S30-15
MW16-CC: 25S30-26



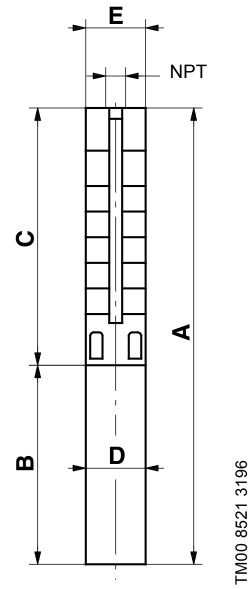
25S (25 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
25S, motor dia. 4 inch, 2 wire motor, 60 Hz - rated flow 25 gpm (1.5" NPT)											
25S05-3	60	1	115	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
25S07-5	99	1	230	.75	■	21.86 (555)	11.62 (295)	10.24 (260)	3.74 (95)	3.97 (101)	23.4
25S10-7	139	1	230	1	■	24.10 (612)	12.21 (310)	11.89 (302)	3.74 (95)	3.97 (101)	25.2
25S15-9	179	1	230	1.5	■	27.25 (692)	13.71 (348)	13.55 (344)	3.74 (95)	3.97 (101)	28.8
25S, motor dia. 4 inch, 3 wire motor, 60 Hz - rated flow 25 gpm (1.5" NPT)											
25S05-3	60	1	115	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
			230	.5	■	19.61 (498)	11.03 (280)	8.59 (218)	3.74 (95)	3.97 (101)	21.6
25S07-5	99	1	230	.75	■	21.86 (555)	11.62 (295)	10.24 (260)	3.74 (95)	3.97 (101)	23.4
25S10-7	139	1	230	1	■	24.10 (612)	12.21 (310)	11.89 (302)	3.74 (95)	3.97 (101)	25.2
25S15-9	179	1	230	1.5	■	27.25 (692)	13.71 (348)	13.55 (344)	3.74 (95)	3.97 (101)	29.7
		3	230	1.5	■	25.75 (654)	12.21 (310)	13.55 (344)	3.74 (95)	3.97 (101)	27.0
			460	1.5	■	25.75 (654)	12.21 (310)	13.55 (344)	3.74 (95)	3.97 (101)	28.8
25S20-11	219	1	230	2	●	34.69 (881)	19.49 (495)	15.20 (386)	3.74 (95)	3.97 (101)	33.1
		3	230	2	■	28.90 (734)	13.71 (348)	15.20 (386)	3.74 (95)	3.97 (101)	37.0
			460	2	■	28.90 (734)	13.71 (348)	15.20 (386)	3.74 (95)	3.97 (101)	33.3
25S30-15	298	1	230	3	●	41.11 (1044)	22.60 (574)	18.51 (470)	3.74 (95)	3.97 (101)	61.2
		3	230	3	●	36.50 (927)	18.00 (457)	18.51 (470)	3.74 (95)	3.97 (101)	53.1
			460	3	●	36.50 (927)	18.00 (457)	18.51 (470)	3.74 (95)	3.97 (101)	53.1
25S50-26	517	1	230	5	●	54.22 (1377)	26.62 (676)	27.60 (701)	3.74 (95)	3.97 (101)	72.9
		3	230	5	●	50.32 (1278)	22.72 (577)	27.60 (701)	3.74 (95)	3.97 (101)	72.9
			460	5	●	50.32 (1278)	22.72 (577)	27.60 (701)	3.74 (95)	3.97 (101)	72.9
SP 25S, motor dia. 6 inch, 3 wire motor, 60 Hz - rated flow 25 gpm (1.5" NPT)											
25S75-39DS	775	3	230	7.5	▲	64.81 (1646)	22.25 (565)	42.56 (1081)	5.63 (143)	5.43 (138)	122.1
			460	7.5	▲	64.81 (1646)	22.25 (565)	42.56 (1081)	5.63 (143)	5.43 (138)	122.1
25S100-52DS	1034	3	460	10	▲	88.71 (2253)	23.23 (590)	65.48 (1663)	5.63 (143)	5.51 (140)	163.1

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1-1/2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

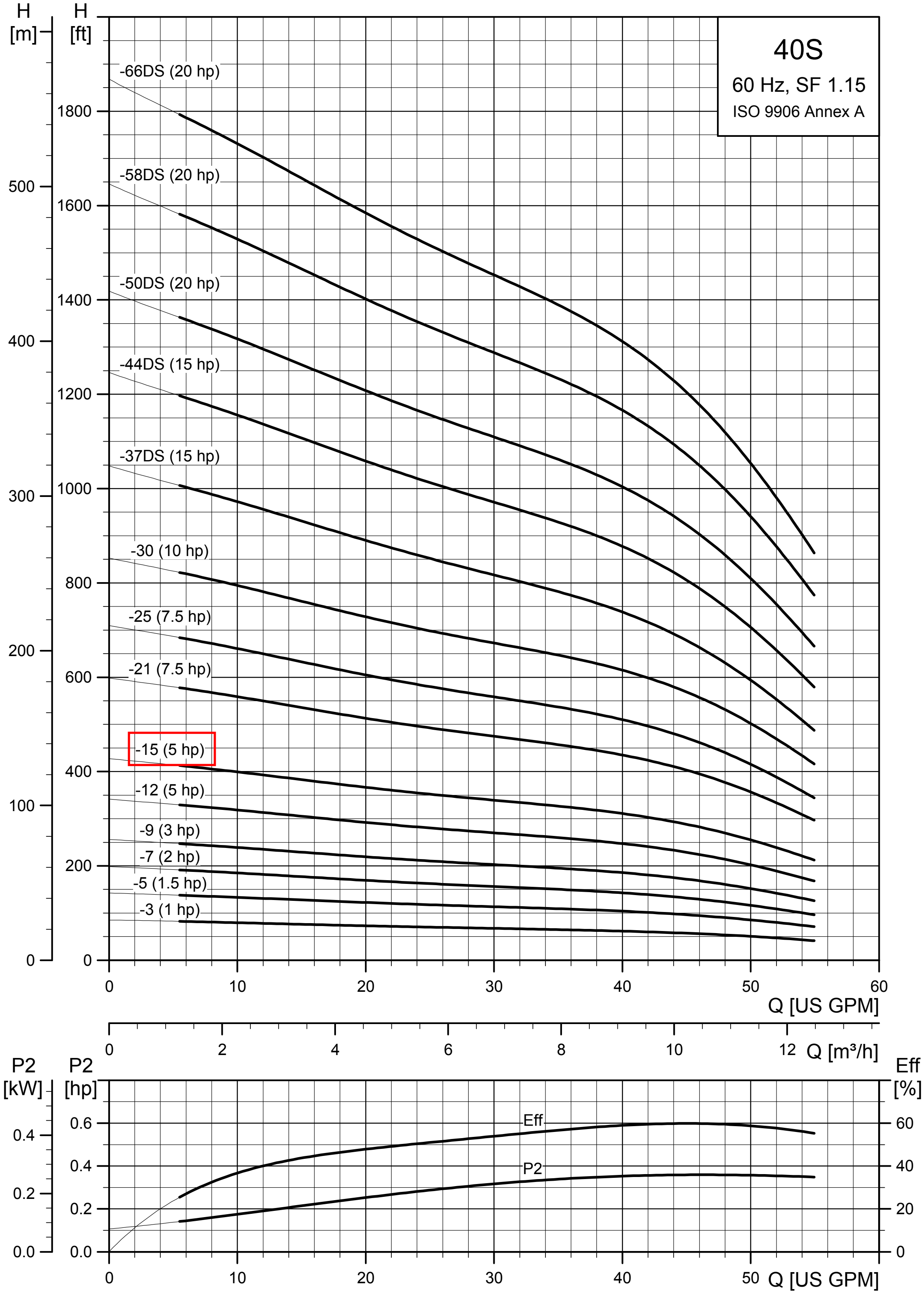
25S



E = Maximum diameter of pump including cable guard and motor.

40S (40 gpm)

40S50-15: EXW01, EXW02, EXW03, EXW04, EXW05



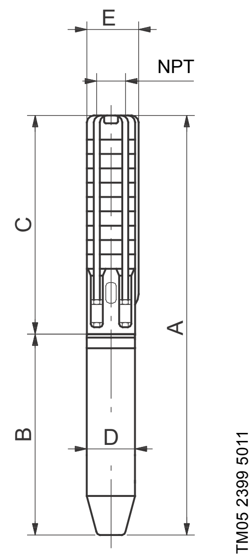
40S (40 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
40S - Motor dia. 4 inch, 2 wire motor, 60 Hz, rated flow 40 gpm (2" NPT)											
40S10-3	60	1	230	1	■	25.00 (635)	12.21 (310)	12.80 (325)	3.74 (95)	3.97 (101)	26.1
40S10-5	102	1	230	1.5	■	29.81 (757)	13.71 (348)	16.11 (409)	3.74 (95)	3.97 (101)	30.6
40S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 40 gpm (2" NPT)											
40S10-3	61	1	230	1	■	25.00 (635)	12.21 (310)	12.8 (325)	3.74 (95)	3.97 (101)	26.1
40S15-5	102	1	230	1.5	■	29.81 (757)	13.71 (348)	16.11 (409)	3.74 (95)	3.97 (101)	30.6
		3	230	1.5	■	28.31 (719)	12.21 (310)	16.11 (409)	3.74 (95)	3.97 (101)	30.6
			460	1.5	■	28.31 (719)	12.21 (310)	16.11 (409)	3.74 (95)	3.97 (101)	30.6
40S20-7	143	1	230	2	●	38.90 (988)	19.49 (495)	19.41 (493)	3.74 (95)	3.97 (101)	36.9
		3	230	2	■	33.12 (841)	13.71 (348)	19.41 (493)	3.74 (95)	3.97 (101)	36.9
			460	2	■	33.12 (841)	13.71 (348)	19.41 (493)	3.74 (95)	3.97 (101)	36.9
40S30-9	184	1	230	3	●	45.32 (1151)	22.60 (574)	22.72 (577)	3.74 (95)	3.97 (101)	74.1
		3	230	3	●	40.71 (1034)	18.00 (457)	22.72 (577)	3.74 (95)	3.97 (101)	81.0
			460	3	●	40.71 (1034)	18.00 (457)	22.72 (577)	3.74 (95)	3.97 (101)	74.7
40S50-12	245	1	230	5	●	54.30 (1379)	26.62 (676)	27.68 (703)	3.74 (95)	3.97 (101)	81.0
		3	230	5	●	50.40 (1280)	22.72 (577)	27.68 (703)	3.74 (95)	3.97 (101)	74.7
			460	5	●	50.40 (1280)	22.72 (577)	27.68 (703)	3.74 (95)	3.97 (101)	74.7
40S50-15	307	1	230	5	●	59.26 (1505)	26.62 (676)	32.64 (829)	3.74 (95)	3.97 (101)	80.1
		3	230	5	●	55.36 (1406)	22.72 (577)	32.64 (829)	3.74 (95)	3.97 (101)	80.1
			460	5	●	55.36 (1406)	22.72 (577)	32.64 (829)	3.74 (95)	3.97 (101)	80.1
40S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 40 gpm (2" NPT)											
40S75-21	429	3	230	7.5	●	69.22 (1758)	26.66 (677)	42.56 (1081)	3.74 (95)	3.97 (101)	113.3
			460	7.5	●	69.22 (1758)	26.66 (677)	42.56 (1081)	3.74 (95)	3.97 (101)	113.3
40S75-25	511	3	230	7.5	●	75.83 (1926)	26.66 (677)	49.18 (1249)	3.74 (95)	3.97 (101)	92.4
			460	7.5	●	75.83 (1926)	26.66 (677)	49.18 (1249)	3.74 (95)	3.97 (101)	92.4
40S100-30	613	3	460	10	●	88.04 (2236)	30.60 (777)	57.45 (1459)	3.74 (95)	3.97 (101)	166.0
40S150-37DS	756	3	230	15	▲	99.34 (2523)	27.88 (708)	71.46 (1815)	5.63 (143)	5.43 (138)	151.9
			460	15	▲	99.34 (2523)	27.88 (708)	71.46 (1815)	5.63 (143)	5.43 (138)	151.9
40S150-44DS	899	3	230	15	▲	110.91 (2817)	27.88 (708)	83.04 (2109)	5.63 (143)	5.43 (138)	165.1
			460	15	▲	110.91 (2817)	27.88 (708)	83.04 (2109)	5.63 (143)	5.43 (138)	151.9
40S200-50DS	1022	3	230	20	▲	136.23 (3460)	30.83 (783)	105.4 (2677)	5.63 (143)	5.51 (140)	226.9
			460	20	▲	136.23 (3460)	30.83 (783)	105.4 (2677)	5.63 (143)	5.51 (140)	226.9
40S200-58DS	1186	3	230	20	▲	149.45 (3796)	30.83 (783)	118.63 (3013)	5.63 (143)	5.51 (140)	251.1
			460	20	▲	149.45 (3796)	30.83 (783)	118.63 (3013)	5.63 (143)	5.51 (140)	251.1
40S200-66DS	1349	3	230	20	▲	162.68 (4132)	30.83 (783)	131.86 (3349)	5.63 (143)	5.51 (140)	266.5
			460	20	▲	162.68 (4132)	30.83 (783)	131.86 (3349)	5.63 (143)	5.51 (140)	266.5

EXW01

200 VOLT: EXW02, EXW03, EXW04, EXW05

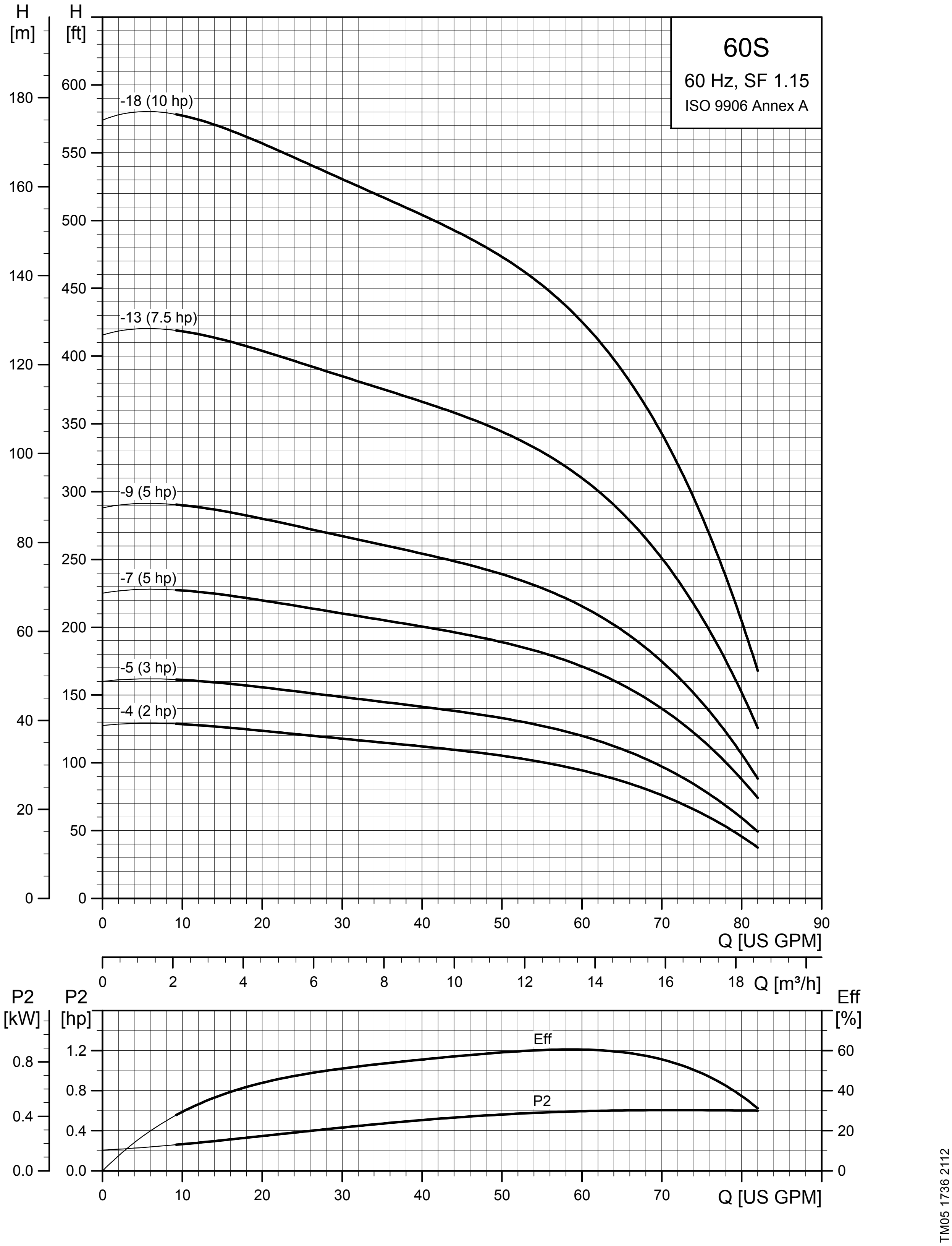
40S



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 5 feet.
■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
ʌ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.

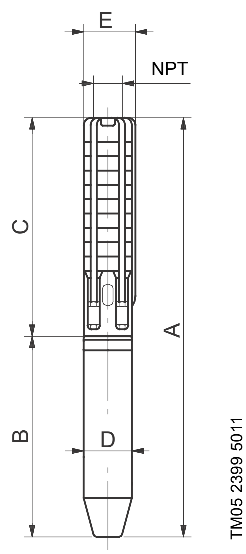
60S (60 gpm)


60S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-18 (10 hp)
-13 (7.5 hp)
-9 (5 hp)
-7 (5 hp)
-5 (3 hp)
-4 (2 hp)
Q [US GPM]
Q [m³/h]
P2 [kW]
P2 [hp]
Eff [%]
Eff
P2
TM05 1736 2112

60S (60 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
60S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 60 gpm (2" NPT)											
60S20-4	93	1	230	2	●	37.01 (940)	19.49 (495)	17.52 (445)	3.74 (95)	3.97 (101)	36.0
		3	230	2	■	31.23 (793)	13.71 (348)	17.52 (445)	3.74 (95)	3.97 (101)	36.0
			460	2	■	31.23 (793)	13.71 (348)	17.52 (445)	3.74 (95)	3.97 (101)	36.0
60S30-5	117	1	230	3	●	42.68 (1084)	22.60 (574)	20.08 (510)	3.74 (95)	3.97 (101)	61.2
		3	230	3	●	38.08 (967)	18.00 (457)	20.08 (510)	3.74 (95)	3.97 (101)	49.5
			460	3	●	38.08 (967)	18.00 (457)	20.08 (510)	3.74 (95)	3.97 (101)	58.5
60S50-7	164	1	230	5	●	51.82 (1316)	26.62 (676)	25.20 (640)	3.74 (95)	3.97 (101)	81.0
		3	230	5	●	47.92 (1217)	22.72 (577)	25.20 (640)	3.74 (95)	3.97 (101)	49.5
			460	5	●	47.92 (1217)	22.72 (577)	25.20 (640)	3.74 (95)	3.97 (101)	72.0
60S50-9	210	1	230	5	●	56.93 (1446)	26.62 (676)	30.32 (770)	3.74 (95)	3.97 (101)	85.5
		3	230	5	●	53.04 (1347)	22.72 (577)	30.32 (770)	3.74 (95)	3.97 (101)	76.5
			460	5	●	53.04 (1347)	22.72 (577)	30.32 (770)	3.74 (95)	3.97 (101)	76.5
60S75-13	304	3	230	7.5	●	67.21 (1707)	26.66 (677)	40.56 (1030)	3.74 (95)	3.97 (101)	83.3
			460	7.5	●	67.21 (1707)	26.66 (677)	40.56 (1030)	3.74 (95)	3.97 (101)	136.8
60S100-18	420	3	460	10	●	83.94 (2132)	30.60 (777)	53.35 (1355)	3.74 (95)	3.97 (101)	175.5
60S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 60 gpm (2" NPT)											
60S75-13	304	3	230	7.5	▲	65.24 (1657)	22.25 (565)	43.00 (1092)	5.63 (143)	5.43 (138)	136.8
			460	7.5	▲	65.24 (1657)	22.25 (565)	43.00 (1092)	5.63 (143)	5.43 (138)	136.8
60S100-18	420	3	230	10	▲	79.02 (2007)	23.23 (590)	55.79 (1417)	5.63 (143)	5.43 (138)	207.0
			460	10	▲	79.02 (2007)	23.23 (590)	55.79 (1417)	5.63 (143)	5.43 (138)	207.0

60S

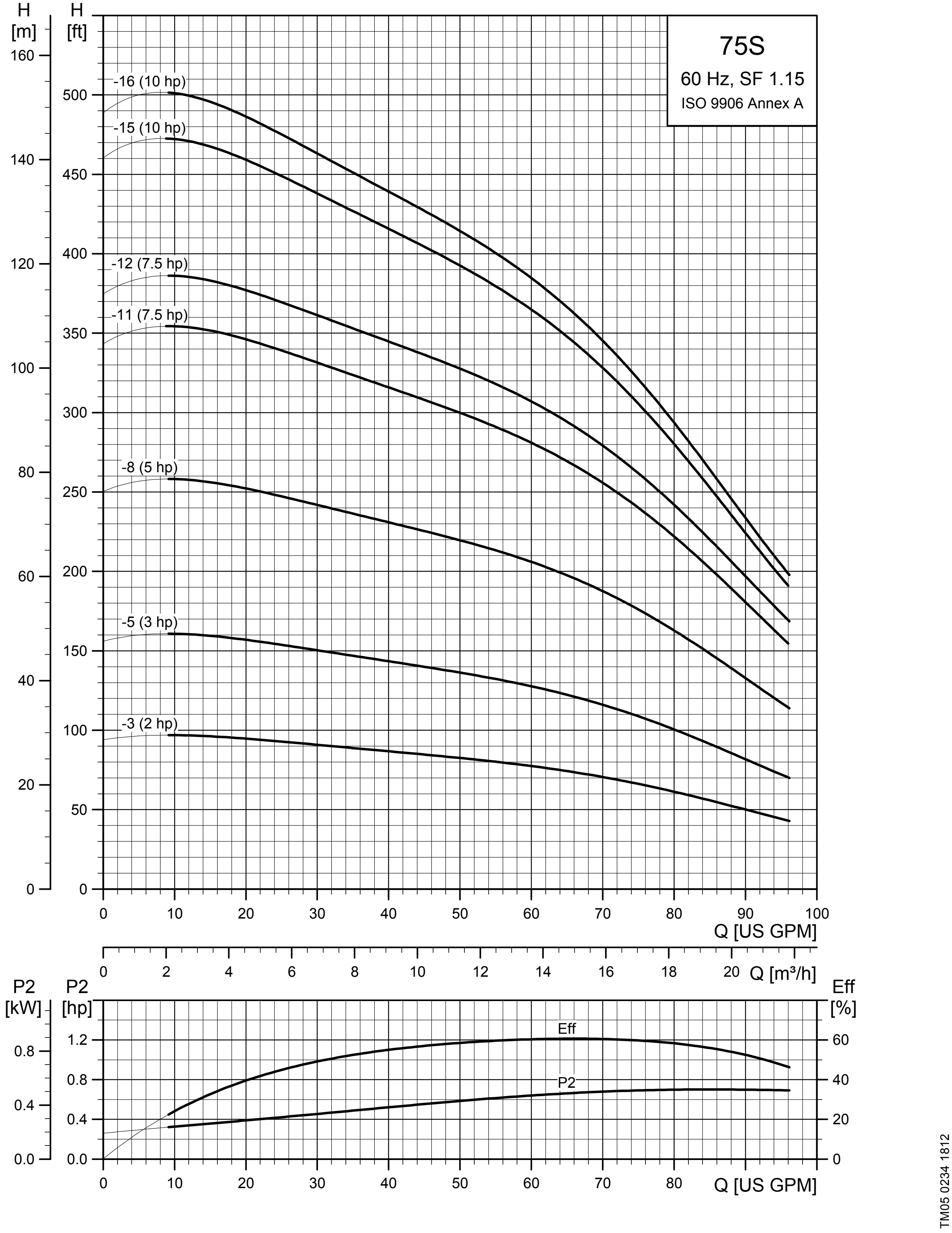


E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 5 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

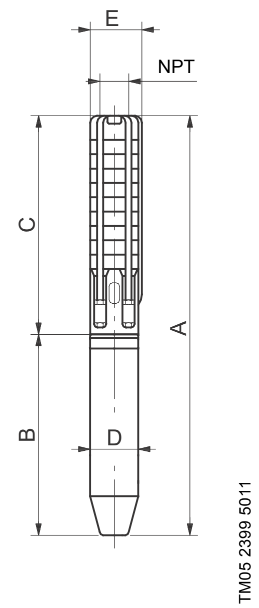
75S (75 gpm)


75S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-16 (10 hp)
-15 (10 hp)
-12 (7.5 hp)
-11 (7.5 hp)
-8 (5 hp)
-5 (3 hp)
-3 (2 hp)
Q [US GPM]
Q [m³/h]
P2 [kW]
P2 [hp]
Eff [%]
Eff
P2
TM05 0234 1812

75S (75 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
75S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 75 gpm (2" NPT)											
75S20-3	68	1	230	2	●	34.45 (875)	19.49 (495)	14.97 (380)	3.74 (95)	3.97 (101)	36.9
		3	230	2	■	28.67 (728)	13.71 (348)	14.97 (380)	3.74 (95)	3.97 (101)	34.2
			460	2	■	28.67 (728)	13.71 (348)	14.97 (380)	3.74 (95)	3.97 (101)	34.2
75S30-5	114	1	230	3	●	42.68 (1084)	22.60 (574)	20.08 (510)	3.74 (95)	3.97 (101)	69.3
		3	230	3	●	38.08 (967)	18.00 (457)	20.08 (510)	3.74 (95)	3.97 (101)	57.6
			460	3	●	38.08 (967)	18.00 (457)	20.08 (510)	3.74 (95)	3.97 (101)	57.6
75S50-8	182	1	230	5	●	54.38 (1381)	26.62 (676)	27.76 (705)	3.74 (95)	3.97 (101)	87.3
		3	230	5	●	50.48 (1282)	22.72 (577)	27.76 (705)	3.74 (95)	3.97 (101)	74.7
			460	5	●	50.48 (1282)	22.72 (577)	27.76 (705)	3.74 (95)	3.97 (101)	74.7
75S75-12	273	3	230	7.5	●	64.65 (1642)	26.66 (677)	38.00 (965)	3.74 (95)	3.97 (101)	81.4
			460	7.5	●	64.65 (1642)	26.66 (677)	38.00 (965)	3.74 (95)	3.97 (101)	81.4
75S100-16	364	3	460	10	●	78.82 (2002)	30.60 (777)	48.23 (1225)	3.74 (95)	3.97 (101)	138.0
75S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 75 gpm (2" NPT)											
75S75-11	250	3	230	7.5	▲	60.12 (1527)	22.25 (565)	37.88 (962)	5.63 (143)	5.43 (138)	130.5
			460	7.5	▲	60.12 (1527)	22.25 (565)	37.88 (962)	5.63 (143)	5.43 (138)	130.5
75S100-15	341	3	230	10	▲	70.16 (1782)	23.23 (590)	46.93 (1192)	5.63 (143)	5.43 (138)	175.5
			460	10	▲	70.16 (1782)	23.23 (590)	46.93 (1192)	5.63 (143)	5.43 (138)	175.5

75S

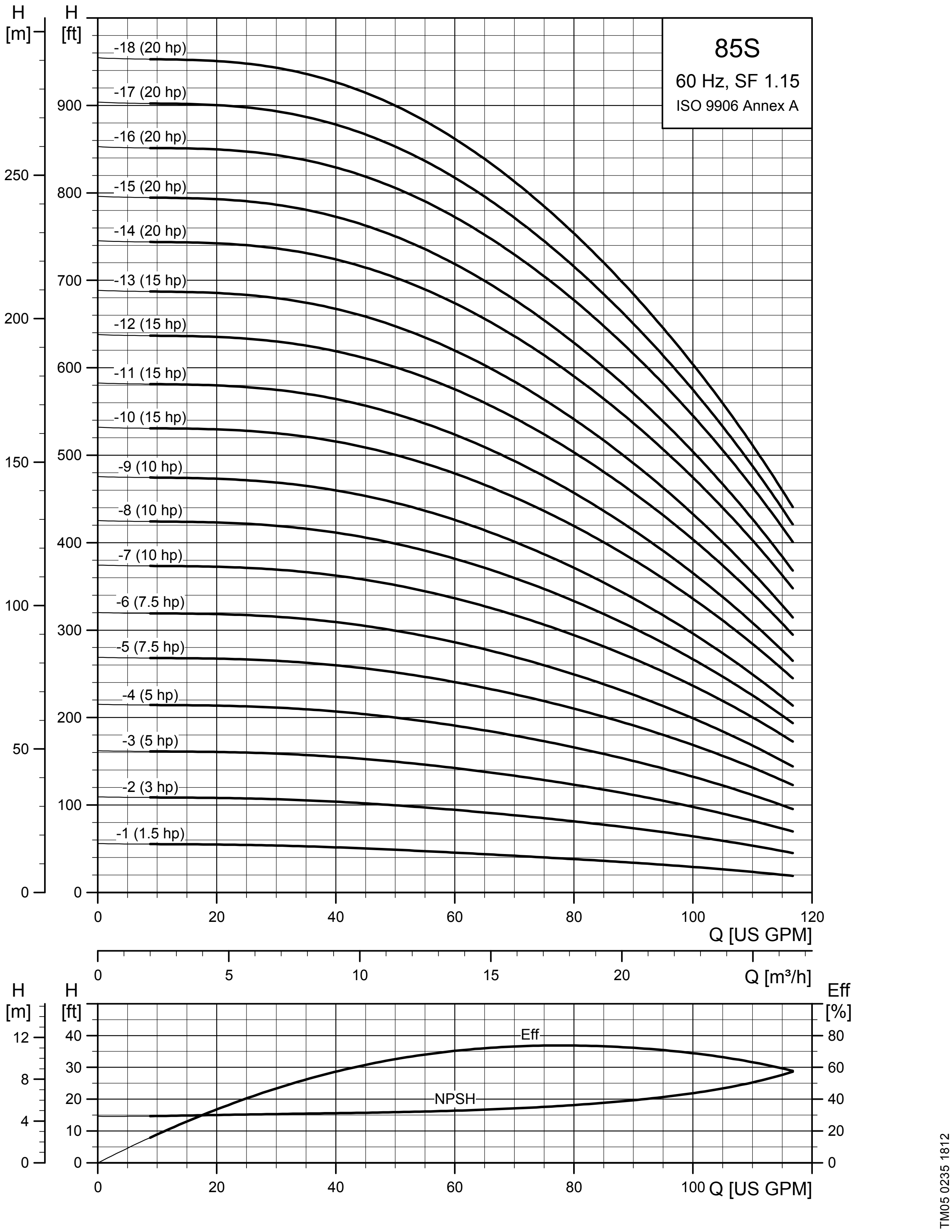


E = Maximum diameter of pump including cable guard and motor.

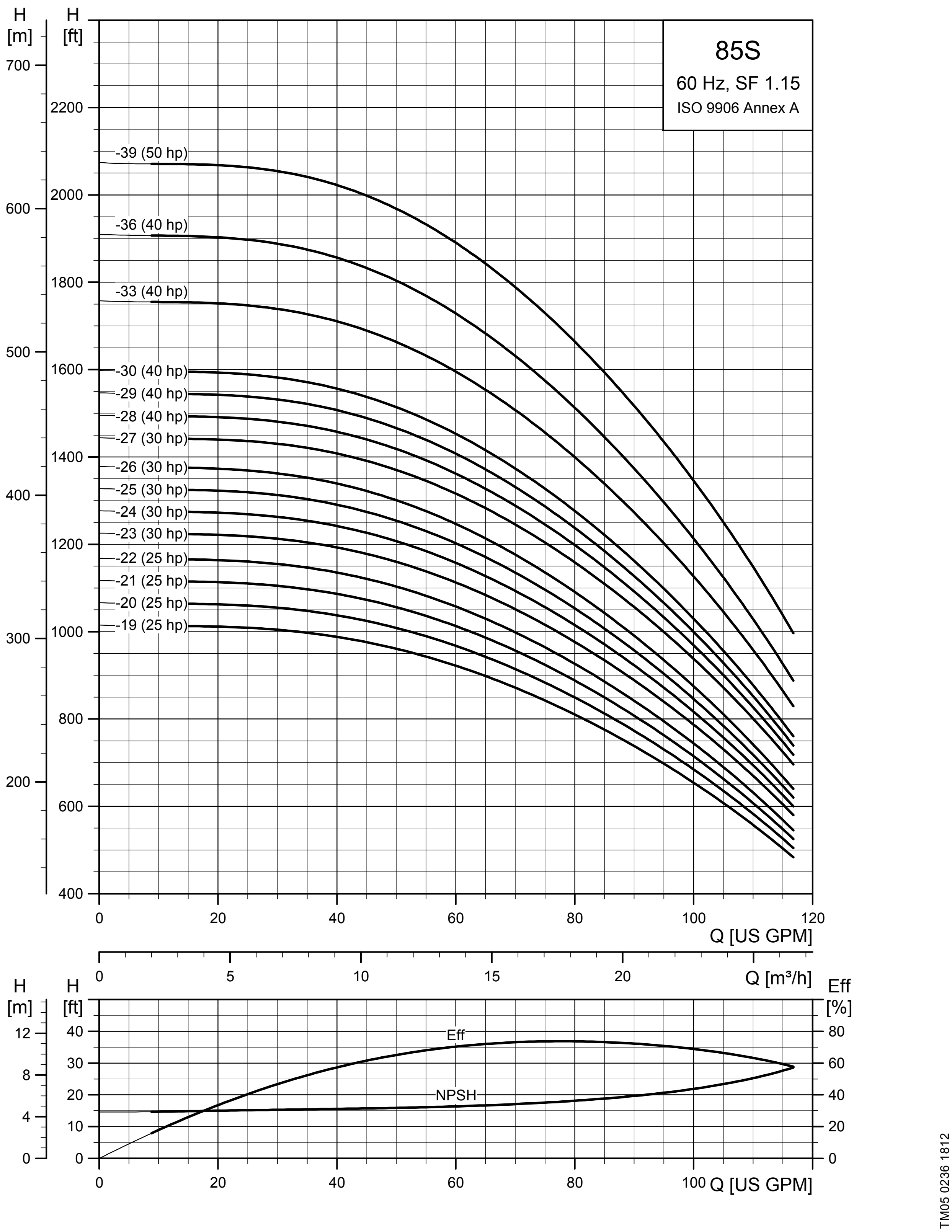
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 5 feet.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

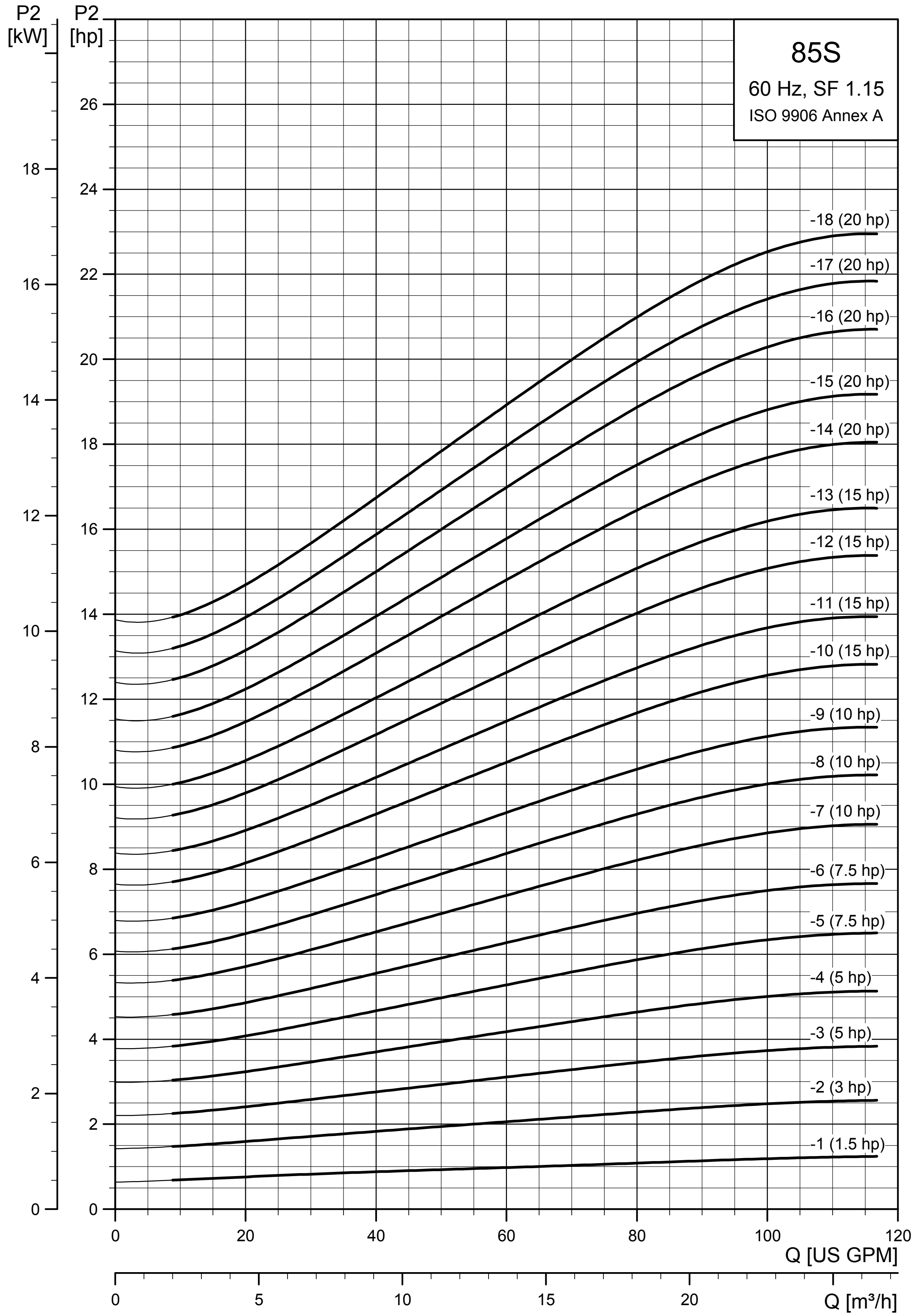
85S (85 gpm)


85S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-18 (20 hp)
-17 (20 hp)
-16 (20 hp)
-15 (20 hp)
-14 (20 hp)
-13 (15 hp)
-12 (15 hp)
-11 (15 hp)
-10 (15 hp)
-9 (10 hp)
-8 (10 hp)
-7 (10 hp)
-6 (7.5 hp)
-5 (7.5 hp)
-4 (5 hp)
-3 (5 hp)
-2 (3 hp)
-1 (1.5 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0235 1812

85S (85 gpm)

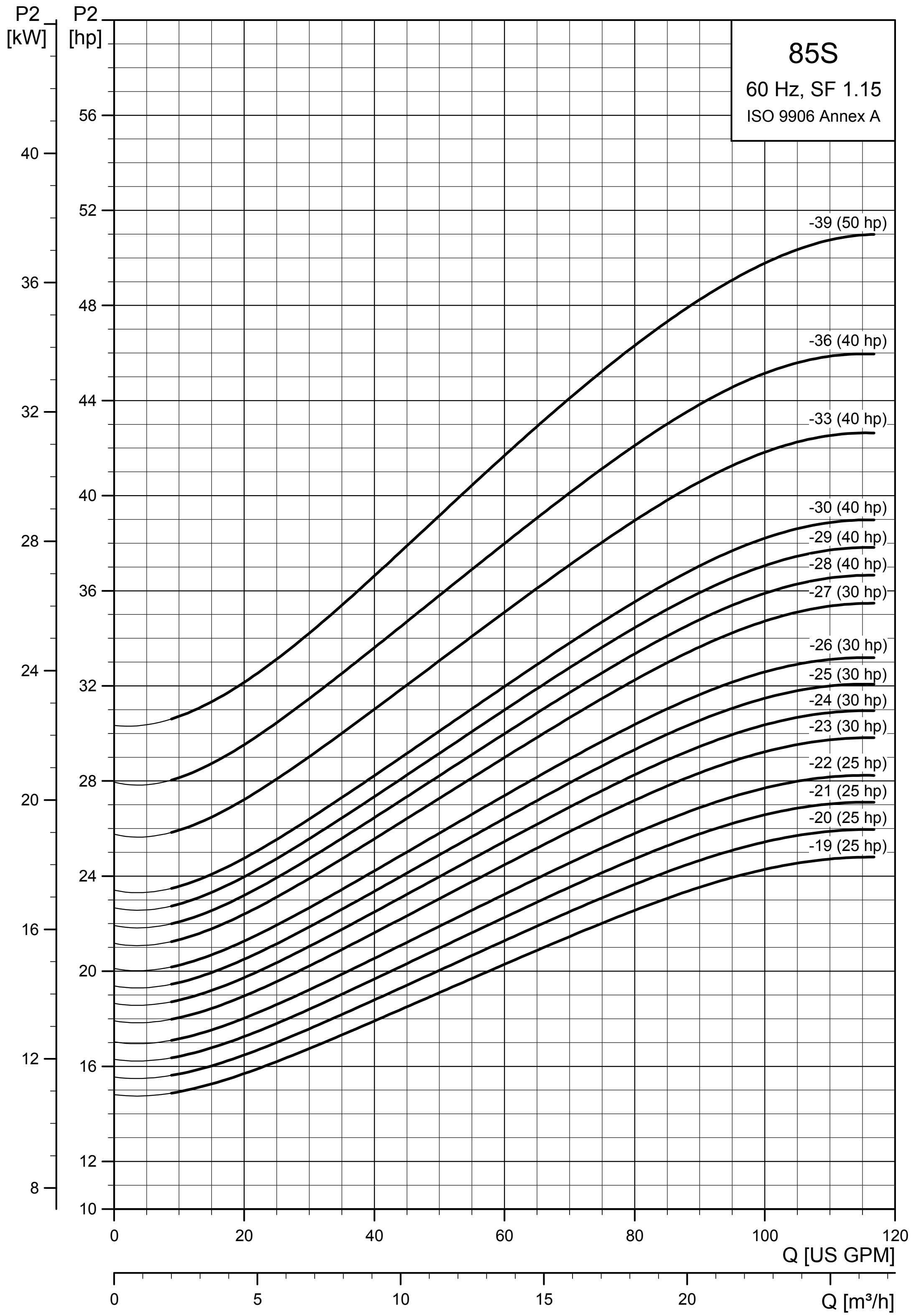

85S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-39 (50 hp)
-36 (40 hp)
-33 (40 hp)
-30 (40 hp)
-29 (40 hp)
-28 (40 hp)
-27 (30 hp)
-26 (30 hp)
-25 (30 hp)
-24 (30 hp)
-23 (30 hp)
-22 (25 hp)
-21 (25 hp)
-20 (25 hp)
-19 (25 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0236 1812

85S (85 gpm) pump power requirement (P2)



TM05 0237 1812

85S (85 gpm) pump power requirement (P2)

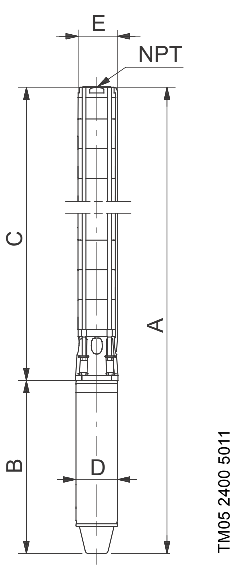


TM05 0238 1812

85S (85 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
						85S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 85 gpm (3" NPT)					
85S15-1	35	1	230	1.5	■	27.60 (701)	15.24 (387)	12.36 (314)	3.74 (95)	5.16 (131)	29.7
		3	230	1.5	■	26.02 (661)	13.66 (347)	12.36 (314)	3.74 (95)	5.16 (131)	29.7
		3	460	1.5	■	26.02 (661)	13.66 (347)	12.36 (314)	3.74 (95)	5.16 (131)	29.7
85S30-2	74	1	230	3	●	32.69 (951)	22.72 (577)	14.72 (374)	3.74 (95)	5.16 (131)	55.8
		3	230	3	●	32.69 (830)	17.96 (456)	14.72 (374)	3.74 (95)	5.16 (131)	47.7
		3	460	3	●	32.69 (830)	17.96 (456)	14.72 (374)	3.74 (95)	5.16 (131)	47.7
85S50-3	114	1	230	5	●	43.78 (1112)	26.65 (677)	17.13 (435)	3.74 (95)	5.16 (131)	67.5
		3	230	5	●	39.80 (1011)	22.69 (576)	17.13 (435)	3.74 (95)	5.16 (131)	51.3
		3	460	5	●	39.80 (1011)	22.69 (576)	17.13 (435)	3.74 (95)	5.16 (131)	51.3
85S50-4	154	1	230	5	●	43.78 (1112)	26.65 (677)	17.13 (435)	3.74 (95)	5.16 (131)	69.3
		3	230	5	●	39.80 (1011)	22.69 (576)	17.13 (435)	3.74 (95)	5.16 (131)	61.2
		3	460	5	●	39.80 (1011)	22.69 (576)	17.13 (435)	3.74 (95)	5.16 (131)	61.2
85S75-5	194	3	230	7.5	●	48.50 (1232)	26.62 (676)	21.89 (556)	3.74 (95)	5.16 (131)	73.8
		3	460	7.5	●	48.50 (1232)	26.62 (676)	21.89 (556)	3.74 (95)	5.16 (131)	73.8
85S75-6	234	3	230	7.5	●	50.87 (1292)	26.62 (676)	24.25 (616)	3.74 (95)	5.16 (131)	85.5
		3	460	7.5	●	50.87 (1292)	26.62 (676)	24.25 (616)	3.74 (95)	5.16 (131)	76.5
85S100-7	274	3	460	10	●	57.21 (1453)	30.56 (776)	26.65 (677)	3.74 (95)	5.16 (131)	136.8
85S100-8	314	3	460	10	●	59.57 (1513)	30.56 (776)	29.02 (737)	3.74 (95)	5.16 (131)	138.6
85S100-9	353	3	460	10	●	61.98 (1574)	30.56 (776)	31.42 (798)	3.74 (95)	5.16 (131)	140.4
						85S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 85 gpm (3" NPT)					
85S75-5	194	3	230	7.5	▲	44.76 (1137)	22.52 (565)	22.52 (572)	5.63 (143)	5.59 (142)	98.1
		3	460	7.5	▲	44.76 (1137)	22.52 (565)	22.52 (572)	5.63 (143)	5.59 (142)	98.1
85S75-6	234	3	230	7.5	▲	47.12 (1197)	22.24 (565)	24.88 (632)	5.63 (143)	5.59 (142)	99.9
		3	460	7.5	▲	47.12 (1197)	22.24 (565)	24.88 (632)	5.63 (143)	5.59 (142)	99.9
85S100-7	274	3	230	10	▲	50.51 (1283)	23.23 (590)	27.28 (693)	5.63 (143)	5.59 (142)	103.5
		3	460	10	▲	50.51 (1283)	23.23 (590)	27.28 (693)	5.63 (143)	5.59 (142)	103.5
85S100-8	314	3	230	10	▲	52.87 (1343)	23.23 (590)	29.65 (753)	5.63 (143)	5.59 (142)	105.3
		3	460	10	▲	52.87 (1343)	23.23 (590)	29.65 (753)	5.63 (143)	5.59 (142)	105.3
85S100-9	353	3	230	10	▲	55.28 (1404)	23.23 (590)	32.05 (814)	5.63 (143)	5.60 (142)	108.0
		3	460	10	▲	55.28 (1404)	23.23 (590)	32.05 (814)	5.63 (143)	5.60 (142)	108.0
85S150-10	393	3	230	15	▲	62.29 (1582)	27.88 (708)	34.41 (874)	5.63 (143)	5.60 (142)	122.4
		3	460	15	▲	62.29 (1582)	27.88 (708)	34.41 (874)	5.63 (143)	5.60 (142)	122.4
85S150-11	433	3	230	15	▲	64.69 (1643)	27.88 (708)	36.82 (935)	5.63 (143)	5.60 (142)	126.0
		3	460	15	▲	64.69 (1643)	27.88 (708)	36.82 (935)	5.63 (143)	5.60 (142)	126.0
85S150-12	473	3	230	15	▲	67.05 (1703)	27.88 (708)	39.18 (995)	5.63 (143)	5.60 (142)	133.2
		3	460	15	▲	67.05 (1703)	27.88 (708)	39.18 (995)	5.63 (143)	5.60 (142)	133.2
85S150-13	513	3	230	15	▲	69.45 (1764)	27.88 (708)	41.58 (1056)	5.63 (143)	5.60 (142)	135.0
		3	460	15	▲	69.45 (1764)	27.88 (708)	41.58 (1056)	5.63 (143)	5.60 (142)	135.0

85S



E = Maximum diameter of pump including cable guard and motor.

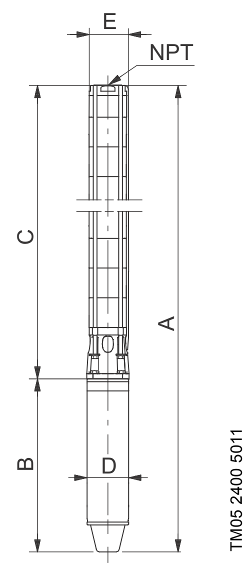
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 5 ft. minimum submergence.

■ MS402 motor.
● MS4000 motor.
▲ MS6 motor.
∧ MMS6000 motor.
★ MMS8000 motor.
♦ Takes MS6 motor; not available as complete.
☼ Takes MMS6000 motor; not available as complete.
* Takes MMS8000 motor; not available as complete.
† Takes MMS10000 motor; not available as complete.

85S (85 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
85S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 85 gpm (3" NPT)											
85S200-14	533	3	230	20	▲	74.77 (1899)	30.83 (783)	43.94 (1116)	5.63 (143)	5.60 (142)	143.1
		3	460	20	▲	74.77 (1899)	30.83 (783)	43.94 (1116)	5.63 (143)	5.60 (142)	143.1
85S200-15	593	3	230	20	▲	77.17 (1960)	30.83 (783)	46.34 (1177)	5.63 (143)	5.60 (142)	147.6
		3	460	20	▲	77.17 (1960)	30.83 (783)	46.34 (1177)	5.63 (143)	5.60 (142)	147.6
85S200-16	633	3	230	20	▲	79.53 (2020)	30.83 (783)	48.71 (1237)	5.63 (143)	5.60 (142)	157.5
		3	460	20	▲	79.53 (2020)	30.83 (783)	48.71 (1237)	5.63 (143)	5.60 (142)	157.5
85S200-17	672	3	230	20	▲	81.93 (2081)	30.83 (783)	51.11 (1298)	5.63 (143)	5.60 (142)	160.2
		3	460	20	▲	81.93 (2081)	30.83 (783)	51.11 (1298)	5.63 (143)	5.60 (142)	160.2
85S200-18	712	3	230	20	▲	84.30 (2141)	30.83 (783)	53.47 (1358)	5.63 (143)	5.60 (142)	161.1
		3	460	20	▲	84.30 (2141)	30.83 (783)	53.47 (1358)	5.63 (143)	5.60 (142)	179.0
85S250-19	752	3	230	25	▲	88.86 (2257)	33.00 (838)	55.87 (1419)	5.63 (143)	5.60 (142)	191.7
		3	460	25	▲	88.86 (2257)	33.00 (838)	55.87 (1419)	5.63 (143)	5.60 (142)	191.7
85S250-20	792	3	230	25	▲	91.86 (2333)	33.00 (838)	58.86 (1495)	5.63 (143)	5.60 (142)	195.3
		3	460	25	▲	91.86 (2333)	33.00 (838)	58.86 (1495)	5.63 (143)	5.60 (142)	195.3
85S250-21	832	3	230	25	▲	94.26 (2394)	33.00 (838)	61.26 (1556)	5.63 (143)	5.60 (142)	198.0
		3	460	25	▲	94.26 (2394)	33.00 (838)	61.26 (1556)	5.63 (143)	5.60 (142)	198.0
85S250-22	872	3	230	25	▲	96.62 (2454)	33.00 (838)	63.63 (1616)	5.63 (143)	5.60 (142)	199.8
		3	460	25	▲	96.62 (2454)	33.00 (838)	63.63 (1616)	5.63 (143)	5.60 (142)	199.8
85S300-23	912	3	230	30	▲	101.54 (2579)	35.56 (903)	65.99 (1676)	5.63 (143)	5.60 (142)	199.8
		3	460	30	▲	101.54 (2579)	35.56 (903)	65.99 (1676)	5.63 (143)	5.60 (142)	199.8
85S300-24	952	3	230	30	▲	103.94 (2640)	35.56 (903)	68.39 (1737)	5.63 (143)	5.60 (142)	216.0
		3	460	30	▲	103.94 (2640)	35.56 (903)	68.39 (1737)	5.63 (143)	5.60 (142)	216.0
85S300-25	991	3	230	30	▲	106.34 (2701)	35.56 (903)	70.79 (1798)	5.63 (143)	5.60 (142)	219.6
		3	460	30	▲	106.34 (2701)	35.56 (903)	70.79 (1798)	5.63 (143)	5.60 (142)	219.6
85S300-26	1031	3	230	30	▲	108.71 (2761)	35.56 (903)	73.15 (1858)	5.63 (143)	5.60 (142)	221.4
		3	460	30	▲	108.71 (2761)	35.56 (903)	73.15 (1858)	5.63 (143)	5.60 (142)	221.4
85S300-27	1071	3	230	30	▲	111.11 (2822)	35.56 (903)	75.56 (1919)	5.63 (143)	5.60 (142)	234.9
		3	460	30	▲	111.11 (2822)	35.56 (903)	75.56 (1919)	5.63 (143)	5.60 (142)	234.9
85S400-28	1111	3	460	40	▲	118.19 (3002)	40.28 (1023)	77.92 (1979)	5.63 (143)	5.60 (142)	246.6
85S400-29	1151	3	460	40	▲	120.6 (3063)	40.28 (1023)	80.32 (2040)	5.63 (143)	5.60 (142)	248.4
85S400-30	1191	3	460	40	▲	122.96 (3123)	40.28 (1023)	82.68 (2100)	5.63 (143)	5.60 (142)	270.0
85S400-33DS	1310	3	460	40	▲	139.22 (3536)	40.28 (1023)	98.94 (2513)	5.63 (143)	6.90 (176)	515.5
85S400-36DS	1430	3	460	40	▲	146.34 (3717)	40.28 (1023)	106.07 (2694)	5.63 (143)	6.90 (176)	454.8
85S500-39DS	1510	3	460	50	▲	169.26 (4299)	56.03 (1423)	113.23 (2876)	5.63 (143)	6.90 (176)	469.0
85S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 85 gpm (3" NPT)											
85S400-33DS	1310	3	460	40	★	140.87 (3578)	43.71 (1110)	97.17 (2468)	7.56 (192)	7.56 (192)	652.7
85S400-36DS	1310	3	460	40	★	147.96 (3758)	43.71 (1110)	104.26 (2648)	7.56 (192)	7.56 (192)	592.0
85S400-39DS	1510	3	460	50	★	155.04 (3938)	43.71 (1110)	111.34 (2828)	7.56 (192)	7.56 (192)	537.2

85S

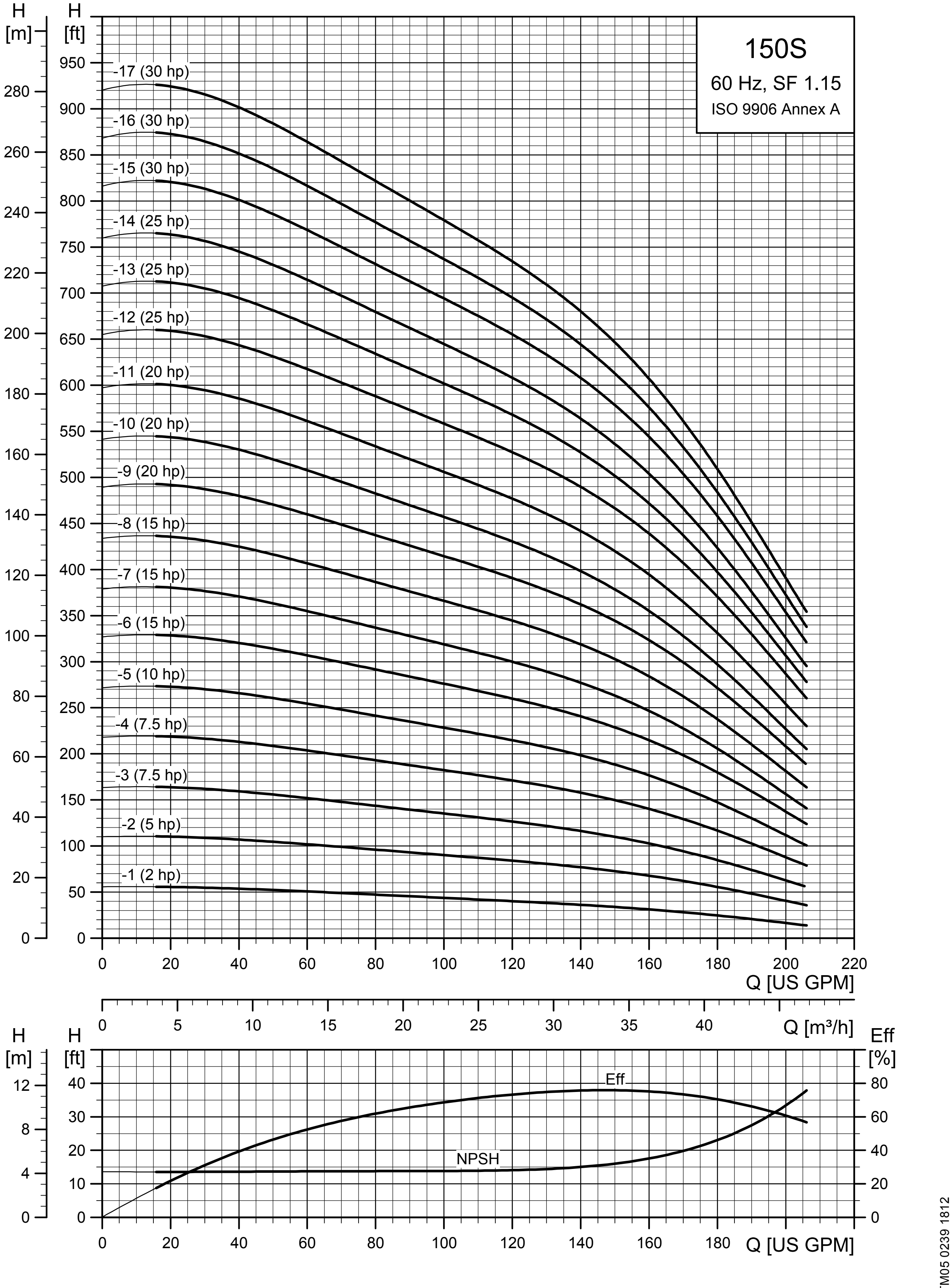


E = Maximum diameter of pump including cable guard and motor.

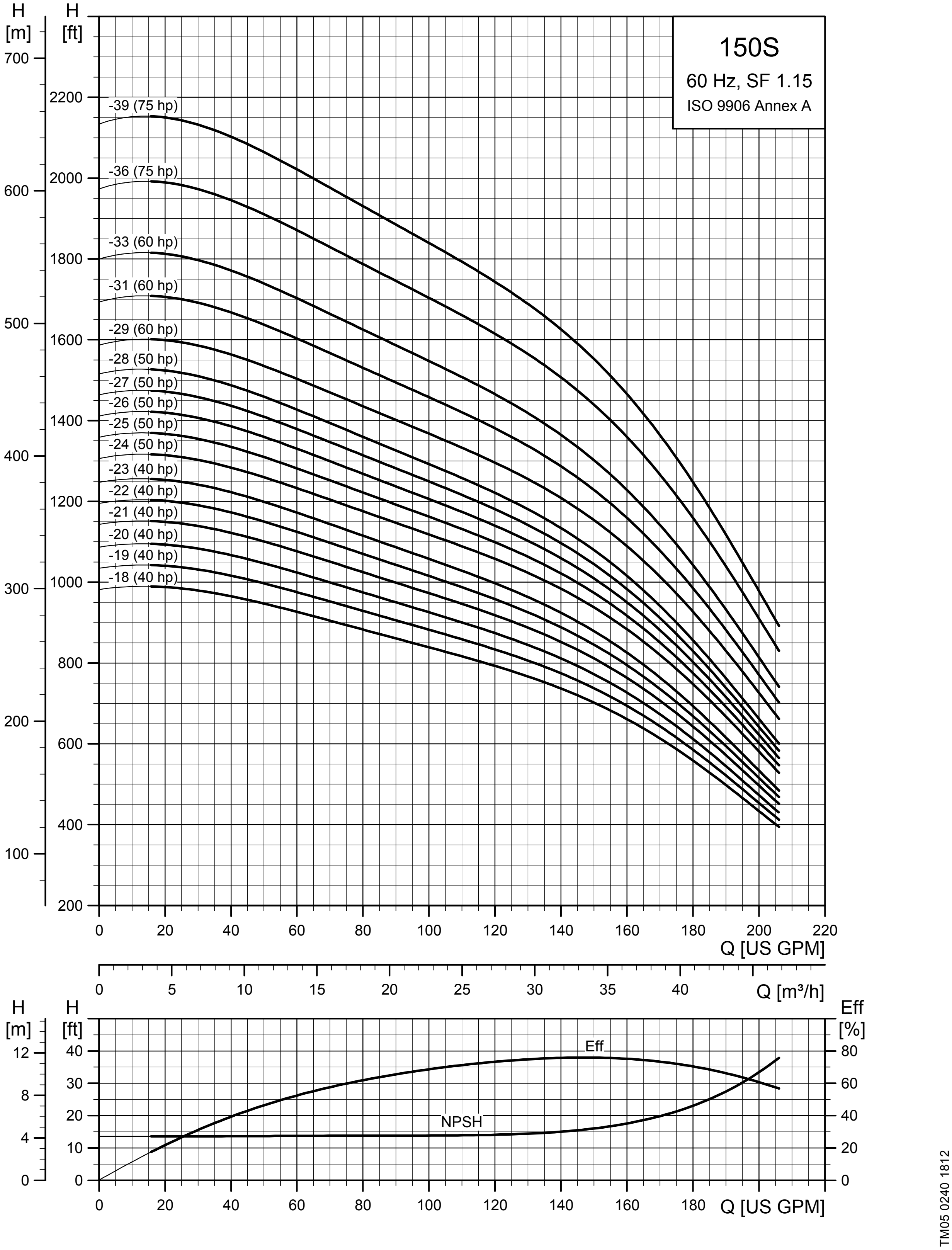
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 3" NPT, 8" minimum well diameter.
Performance conforms to ISO 9906 Annex A @ 5 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

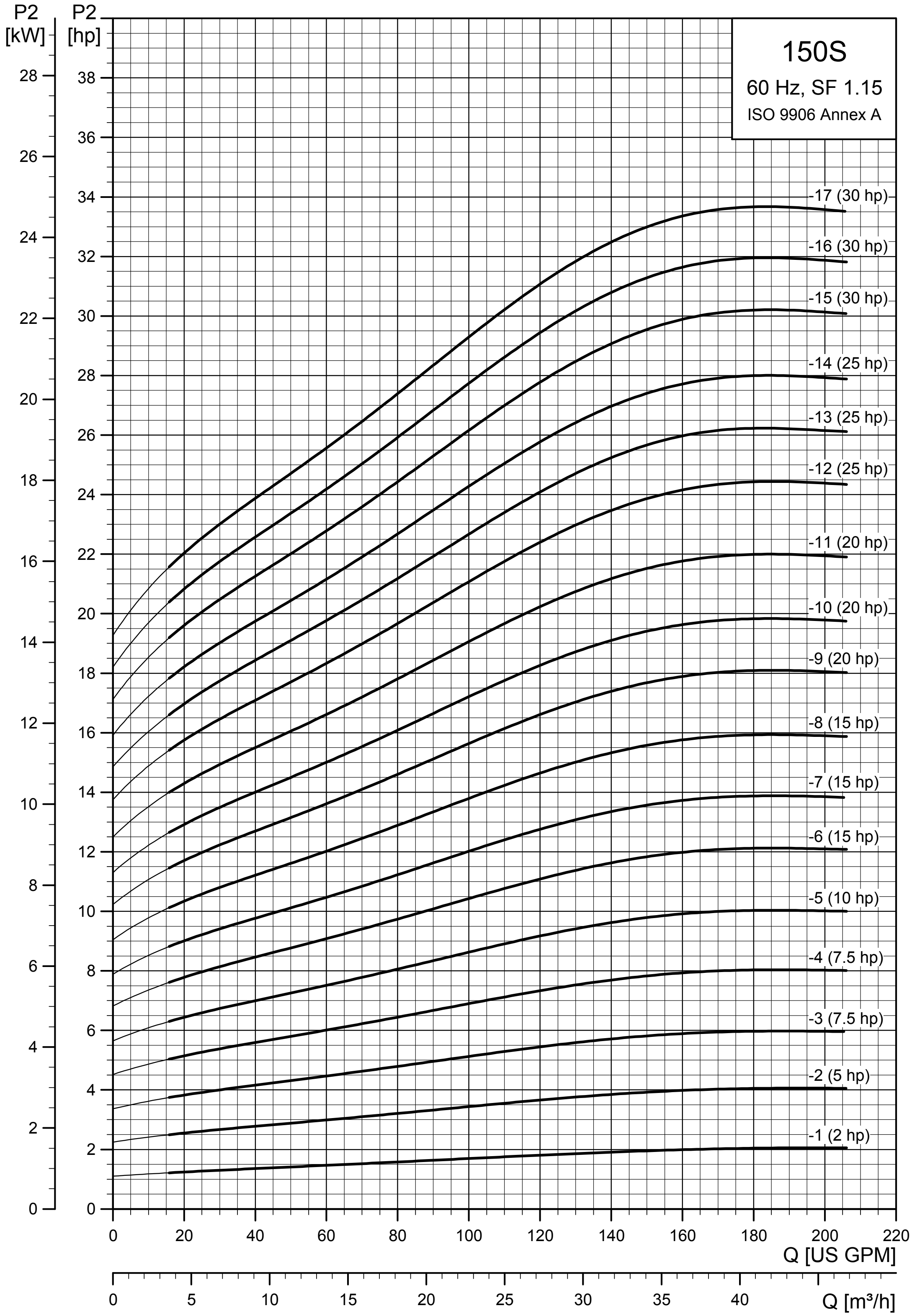
150S (150 gpm)


150S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-17 (30 hp)
-16 (30 hp)
-15 (30 hp)
-14 (25 hp)
-13 (25 hp)
-12 (25 hp)
-11 (20 hp)
-10 (20 hp)
-9 (20 hp)
-8 (15 hp)
-7 (15 hp)
-6 (15 hp)
-5 (10 hp)
-4 (7.5 hp)
-3 (7.5 hp)
-2 (5 hp)
-1 (2 hp)
Q [US GPM]
Q [m³/h]
Eff
[%]
NPSH
TM05 0239 1812

150S (150 gpm)

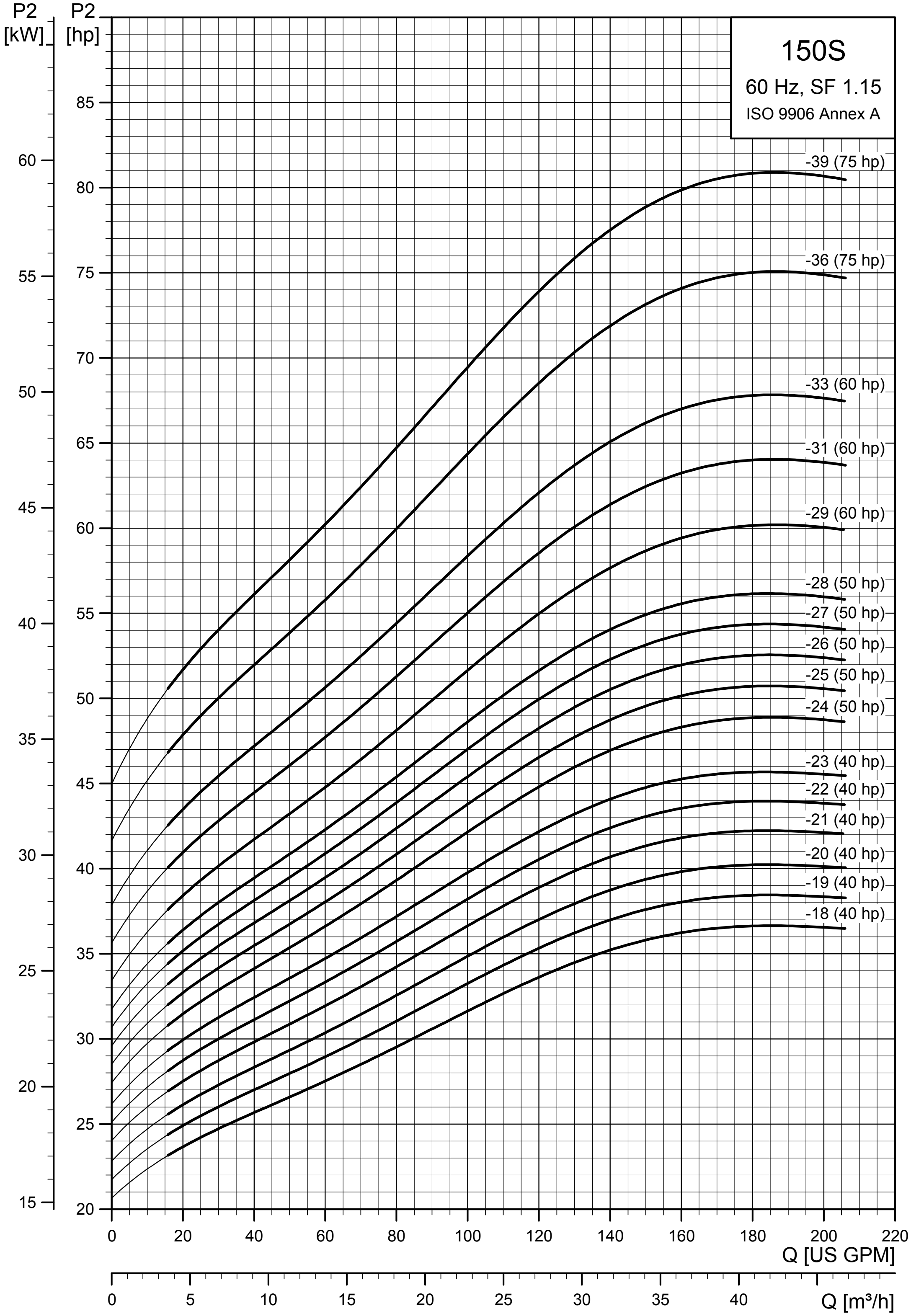

150S
60 Hz, SF 1.15
ISO 9906 Annex A
-39 (75 hp)
-36 (75 hp)
-33 (60 hp)
-31 (60 hp)
-29 (60 hp)
-28 (50 hp)
-27 (50 hp)
-26 (50 hp)
-25 (50 hp)
-24 (50 hp)
-23 (40 hp)
-22 (40 hp)
-21 (40 hp)
-20 (40 hp)
-19 (40 hp)
-18 (40 hp)
H [m]
H [ft]
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0240 1812

150S (150 gpm) pump power requirement (P2)



TM05 0241 1812

150S (150 gpm) pump power requirement (P2)

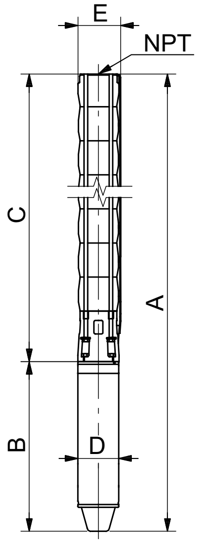


TM05 0242 1812

150S (150 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
150S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 150 gpm (3" NPT)											
150S20-1	33	1	230	2	●	33.30 (846)	19.57 (497)	13.75 (349)	3.75 (95)	5.16 (131)	49.5
		3	230	2	■	28.98 (736)	15.23 (387)	13.75 (349)	3.75 (95)	5.16 (131)	45.0
		3	460	2	■	28.98 (736)	15.23 (387)	13.75 (349)	3.75 (95)	5.16 (131)	45.0
150S50-2	71	1	230	5	●	44.17 (1122)	26.65 (677)	17.52 (445)	3.75 (95)	5.16 (131)	67.5
		3	230	5	●	40.20 (1021)	22.69 (576)	17.52 (445)	3.75 (95)	5.16 (131)	42.3
		3	460	5	●	40.20 (1021)	22.69 (576)	17.52 (445)	3.75 (95)	5.16 (131)	42.3
150S75-3	108	3	230	7.5	●	47.91 (1217)	26.63 (676)	21.3 (541)	3.75 (95)	5.16 (131)	51.3
		3	460	7.5	●	47.91 (1217)	26.63 (676)	21.3 (541)	3.75 (95)	5.16 (131)	82.8
150S75-4	146	3	230	7.5	●	51.71 (1313)	26.63 (676)	25.08 (637)	3.75 (95)	5.16 (131)	85.5
		3	460	7.5	●	51.71 (1313)	26.63 (676)	25.08 (637)	3.75 (95)	5.16 (131)	85.5
150S100-5	184	3	460	10	●	59.42 (1509)	30.56 (776)	28.86 (733)	3.75 (95)	5.16 (131)	135.9
150S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 150 gpm (3" NPT)											
150S75-4	146	3	230	7.5	▲	47.96 (1218)	22.25 (565)	25.71 (653)	5.63 (143)	5.60 (142)	99.9
		3	460	7.5	▲	47.96 (1218)	22.25 (565)	25.71 (653)	5.63 (143)	5.60 (142)	99.9
150S100-5	184	3	230	10	▲	52.72 (1339)	23.23 (590)	29.49 (749)	5.63 (143)	5.60 (142)	73.8
		3	460	10	▲	52.72 (1339)	23.23 (590)	29.49 (749)	5.63 (143)	5.60 (142)	73.8
150S150-6	222	3	230	15	▲	61.15 (1553)	27.88 (708)	33.27 (845)	5.63 (143)	5.60 (142)	119.7
		3	460	15	▲	61.15 (1553)	27.88 (708)	33.27 (845)	5.63 (143)	5.60 (142)	119.7
150S150-7	260	3	230	15	▲	64.93 (1649)	27.88 (708)	37.05 (941)	5.63 (143)	5.60 (142)	127.8
		3	460	15	▲	64.93 (1649)	27.88 (708)	37.05 (941)	5.63 (143)	5.60 (142)	127.8
150S150-8	297	3	230	15	▲	68.71 (1745)	27.88 (708)	40.83 (1037)	5.63 (143)	5.60 (142)	137.7
		3	460	15	▲	68.71 (1745)	27.88 (708)	40.83 (1037)	5.63 (143)	5.60 (142)	137.7
150S200-9	335	3	230	20	▲	75.44 (1916)	30.83 (783)	44.61 (1133)	5.63 (143)	5.60 (142)	141.3
		3	460	20	▲	75.44 (1916)	30.83 (783)	44.61 (1133)	5.63 (143)	5.60 (142)	141.3
150S200-10	373	3	230	20	▲	79.22 (2012)	30.83 (783)	48.39 (1229)	5.63 (143)	5.60 (142)	151.2
		3	460	20	▲	79.22 (2012)	30.83 (783)	48.39 (1229)	5.63 (143)	5.60 (142)	151.2
150S200-11	411	3	230	20	▲	83.00 (2108)	30.83 (783)	52.17 (1325)	5.63 (143)	5.60 (142)	166.5
		3	460	20	▲	83.00 (2108)	30.83 (783)	52.17 (1325)	5.63 (143)	5.60 (142)	166.5
150S250-12	448	3	230	25	▲	88.86 (2257)	32.92 (836)	55.95 (1421)	5.63 (143)	5.60 (142)	188.1
		3	460	25	▲	88.86 (2257)	32.92 (836)	55.95 (1421)	5.63 (143)	5.60 (142)	188.1
150S250-13	486	3	230	25	▲	92.64 (2353)	32.92 (836)	59.73 (1517)	5.63 (143)	5.60 (142)	201.6
		3	460	25	▲	92.64 (2353)	32.92 (836)	59.73 (1517)	5.63 (143)	5.60 (142)	201.6
150S250-14	524	3	230	25	▲	96.42 (2449)	32.92 (836)	63.51 (1613)	5.63 (143)	5.60 (142)	206.1
		3	460	25	▲	96.42 (2449)	32.92 (836)	63.51 (1613)	5.63 (143)	5.60 (142)	206.1

150S



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 5 ft. minimum submergence.

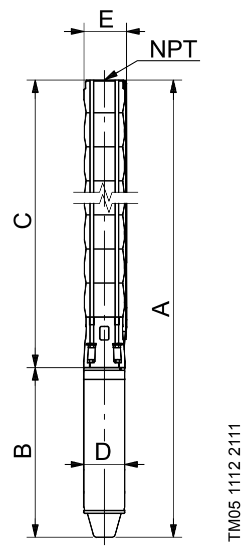
- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

150S (150 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	Dimensions B [in (mm)]	Dimensions C [in (mm)]	Dimensions D [in (mm)]	Dimensions E [in (mm)]	Net weight (complete) [lb]
150S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 150 gpm (3" NPT)											
150S300-15	562	3	230	30	▲	102.84 (2612)	35.56 (903)	67.29 (1709)	5.63 (143)	5.60 (142)	209.7
		3	460	30	▲	102.84 (2612)	35.56 (903)	67.29 (1709)	5.63 (143)	5.60 (142)	209.7
150S300-16	600	3	230	30	▲	106.62 (2708)	35.56 (903)	71.07 (1805)	5.63 (143)	5.60 (142)	211.5
		3	460	30	▲	106.62 (2708)	35.56 (903)	71.07 (1805)	5.63 (143)	5.60 (142)	211.5
150S300-17	637	3	230	30	▲	110.4 (2804)	35.56 (903)	74.85 (1901)	5.63 (143)	5.60 (142)	216.0
		3	460	30	▲	110.4 (2804)	35.56 (903)	74.85 (1901)	5.63 (143)	5.60 (142)	246.6
150S400-18	675	3	460	40	▲	118.9 (3020)	40.28 (1023)	78.63 (1997)	5.63 (143)	5.60 (142)	246.6
150S400-19	713	3	460	40	▲	122.68 (3116)	40.28 (1023)	82.41 (2093)	5.63 (143)	5.60 (142)	248.4
150S400-20	751	3	460	40	▲	126.46 (3212)	40.28 (1023)	86.19 (2189)	5.63 (143)	5.60 (142)	291.0
150S400-21	789	3	460	40	▲	130.24 (3308)	40.28 (1023)	89.97 (2285)	5.63 (143)	5.67 (144)	271.8
150S400-22	826	3	460	40	▲	134.02 (3404)	40.28 (1023)	93.75 (2381)	5.63 (143)	5.67 (144)	305.9
150S400-23	864	3	460	40	▲	137.8 (3500)	40.28 (1023)	97.52 (2477)	5.63 (143)	5.67 (144)	277.2
150S500-24	902	3	460	50	☼	157.41 (3998)	56.11 (1425)	101.3 (2573)	5.67 (144)	5.60 (142)	411.8
150S500-25	940	3	460	50	☼	161.19 (4094)	56.11 (1425)	105.08 (2669)	5.67 (144)	5.60 (142)	419.0
150S500-26	977	3	460	50	☼	164.97 (4190)	56.11 (1425)	108.86 (2765)	5.67 (144)	5.60 (142)	426.2
150S500-27	1015	3	460	50	☼	168.75 (4286)	56.11 (1425)	112.64 (2861)	5.67 (144)	5.60 (142)	433.4
150S500-28	1053	3	460	50	☼	172.52 (4382)	56.11 (1425)	116.42 (2957)	5.67 (144)	5.60 (142)	440.6
150S600-29DS	1091	3	460	60	-	—	—	129.05 (3278)	—	7.10 (181)	—
150S600-31DS	1166	3	460	60	-	—	—	136.61 (3470)	—	7.10 (181)	—
150S600-33DS	1242	3	460	60	-	—	—	144.17 (3662)	—	7.10 (181)	—

150S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 150 gpm (3" NPT)											
150S500-24	902	3	460	50	*	148.12 (3762)	45.67 (1160)	102.45 (2602)	7.56 (192)	7.56 (192)	484.5
150S500-25	940	3	460	50	*	151.89 (3858)	45.67 (1160)	106.23 (2698)	7.56 (192)	7.56 (192)	491.7
150S500-26	977	3	460	50	*	155.67 (3954)	45.67 (1160)	110.00 (2794)	7.56 (192)	7.56 (192)	498.9
150S500-27	1015	3	460	50	*	159.45 (4050)	45.67 (1160)	113.78 (2890)	7.56 (192)	7.56 (192)	506.1
150S500-28	1053	3	460	50	*	163.23 (4146)	45.67 (1160)	117.56 (2986)	7.56 (192)	7.56 (192)	513.3
150S600-29DS	1091	3	460	60	*	177.92 (4519)	50.00 (1270)	127.92 (3249)	7.56 (192)	7.56 (192)	612.7
150S600-31DS	1166	3	460	60	*	185.48 (4711)	50.00 (1270)	135.48 (3441)	7.56 (192)	7.56 (192)	623.7
150S600-33DS	1242	3	460	60	*	193.04 (4903)	50.00 (1270)	143.04 (3633)	7.56 (192)	7.56 (192)	639.1
150S750-36DS	1355	3	460	75	*	207.52 (5271)	53.15 (1350)	154.38 (3921)	7.56 (192)	7.56 (192)	689.2
150S750-39DS	1469	3	460	75	*	218.86 (5559)	53.15 (1350)	165.71 (4209)	7.56 (192)	7.56 (192)	704.6

150S

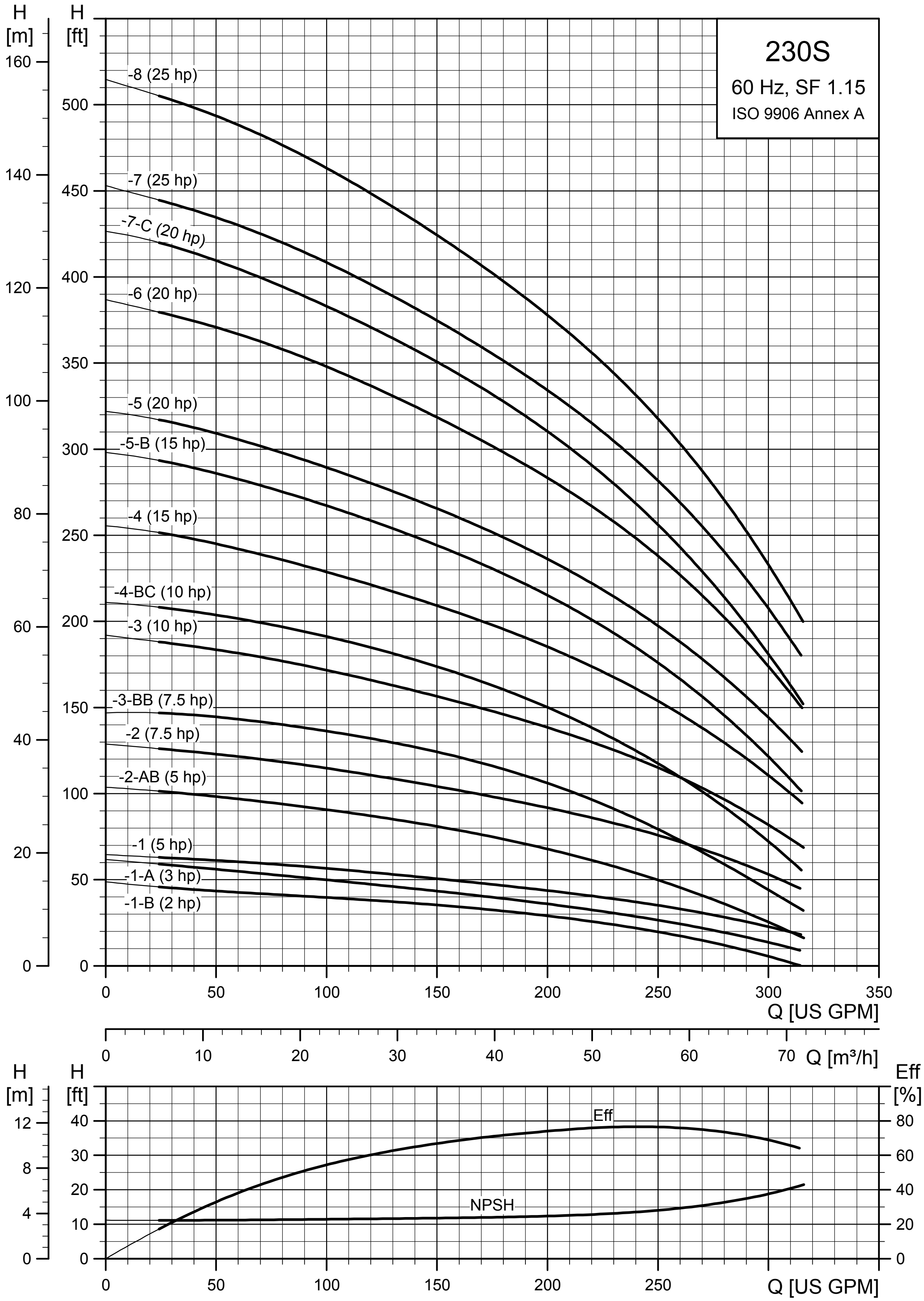


E = Maximum diameter of pump including cable guard and motor.

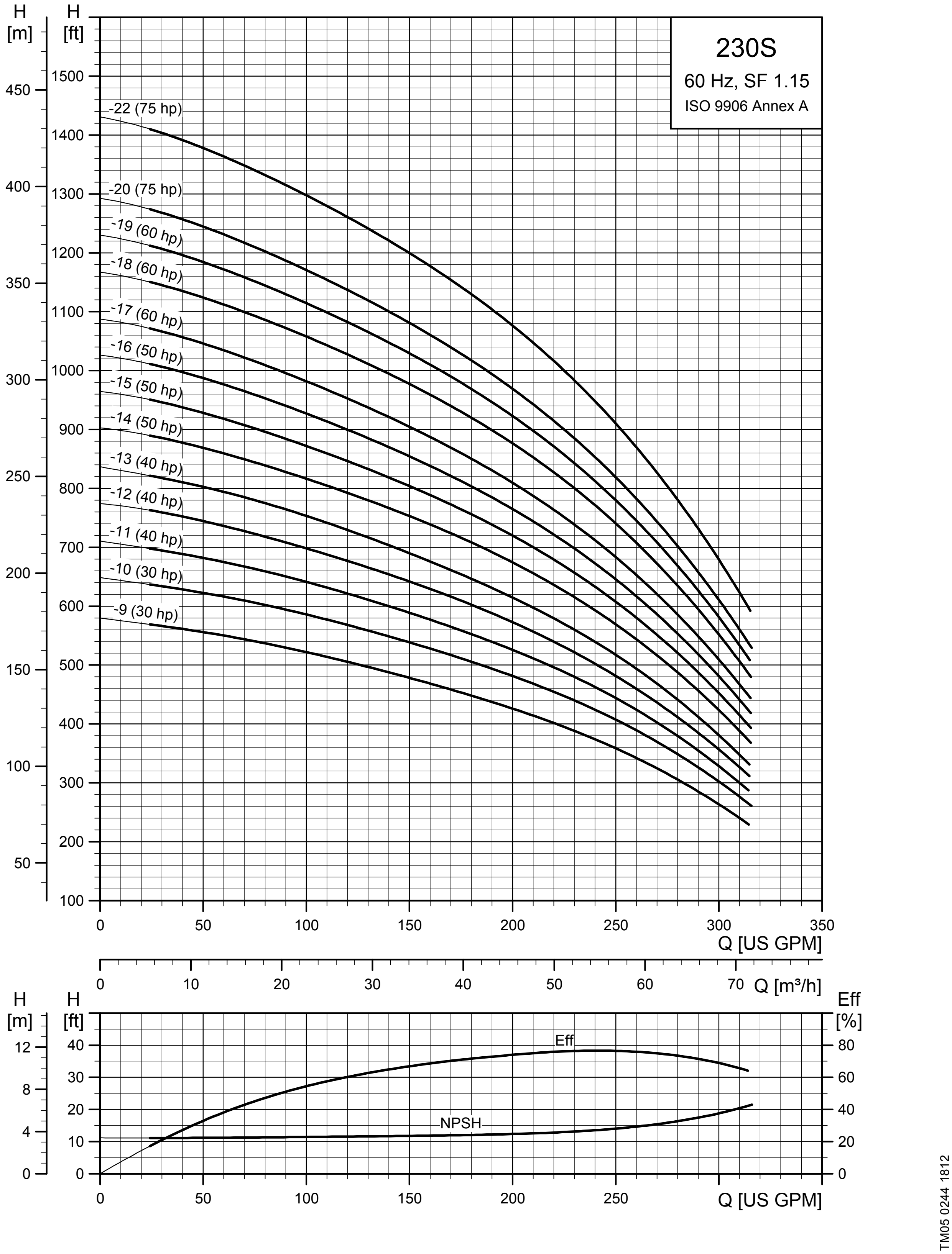
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 3" NPT, 8" minimum well diameter.
Performance conforms to ISO 9906 Annex A @ 5 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

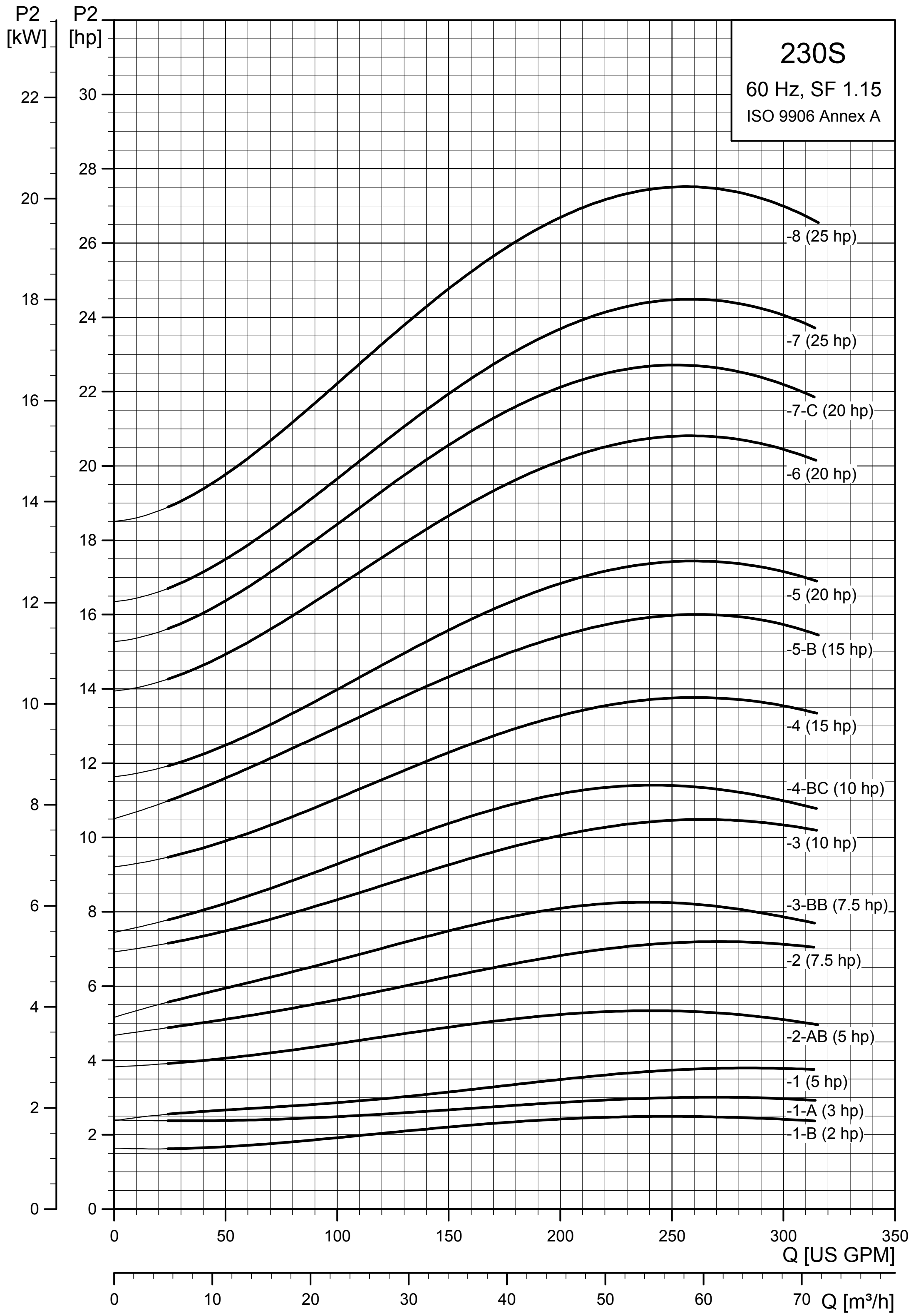
230S (230 gpm)


230S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-8 (25 hp)
-7 (25 hp)
-7-C (20 hp)
-6 (20 hp)
-5 (20 hp)
-5-B (15 hp)
-4 (15 hp)
-4-BC (10 hp)
-3 (10 hp)
-3-BB (7.5 hp)
-2 (7.5 hp)
-2-AB (5 hp)
-1 (5 hp)
-1-A (3 hp)
-1-B (2 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0243 1812

230S (230 gpm)

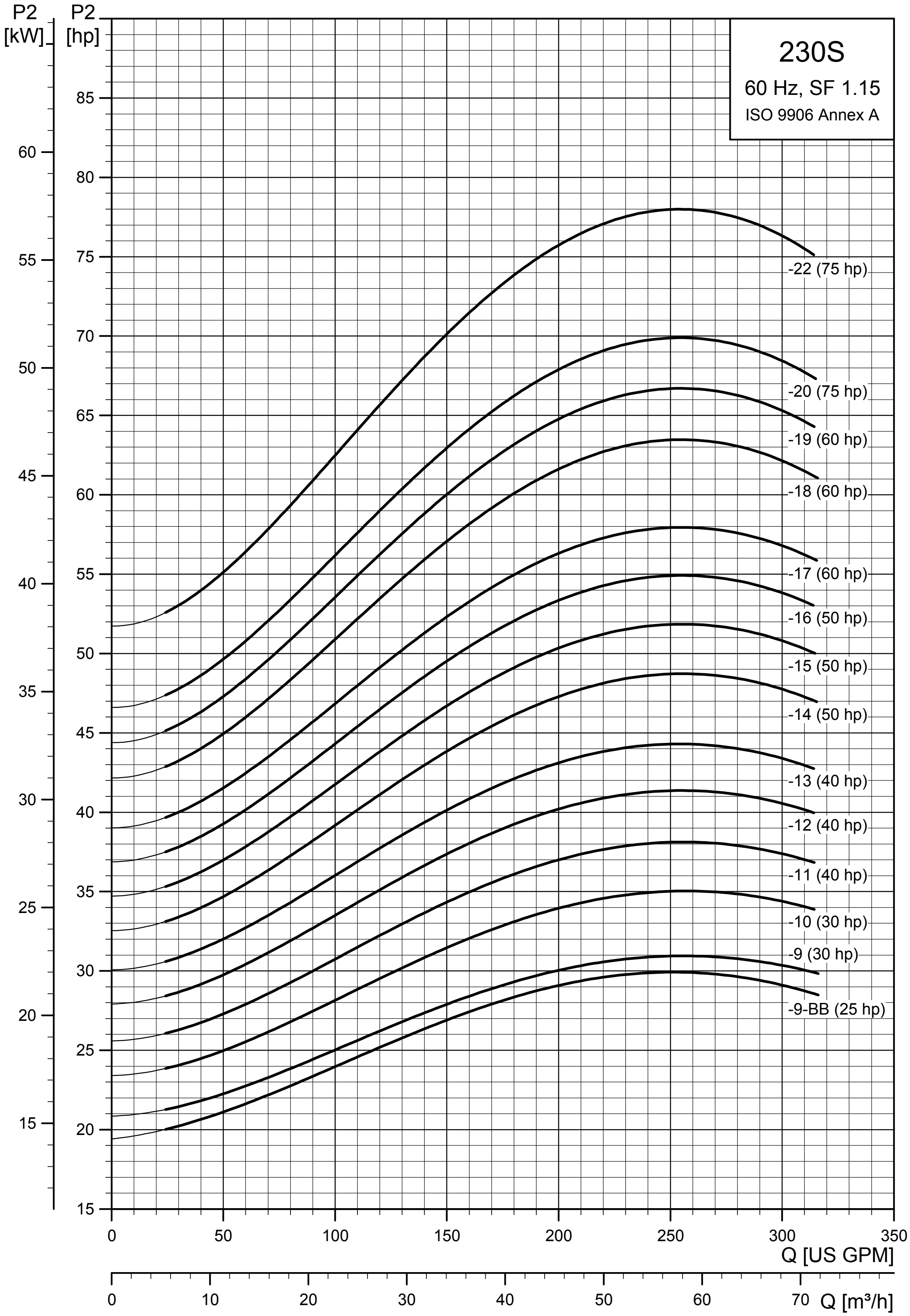

230S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-22 (75 hp)
-20 (75 hp)
-19 (60 hp)
-18 (60 hp)
-17 (60 hp)
-16 (50 hp)
-15 (50 hp)
-14 (50 hp)
-13 (40 hp)
-12 (40 hp)
-11 (40 hp)
-10 (30 hp)
-9 (30 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0244 1812

230S (230 gpm) pump power requirement (P2)



TM05 0245 1812

230S (230 gpm) pump power requirement (P2)



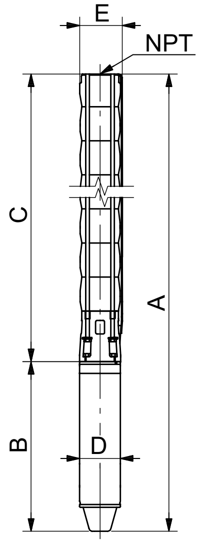
230S (230 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	Dimensions B [in (mm)]	Dimensions C [in (mm)]	Dimensions D [in (mm)]	Dimensions E [in (mm)]	Net weight (complete) [lb]
230S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 230 gpm (3" NPT)											
230S20-1B	24	1	230	2	●	33.90 (861)	19.57 (497)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
		3	230	2	●	25.67 (751)	15.24 (387)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
		3	460	2	■	25.67 (751)	15.24 (387)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
230S30-1A	30	1	230	3	●	37.05 (941)	22.72 (577)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
		3	230	3	●	46.65 (1185)	17.96 (456)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
		3	460	3	●	46.65 (1185)	17.96 (456)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
230S50-1	37	1	230	5	●	40.98 (1041)	26.65 (677)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
		3	230	5	●	37.01 (940)	22.69 (576)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
		3	460	5	●	37.01 (940)	22.69 (576)	14.34 (364)	3.75 (95)	5.75 (146)	49.5
230S50-2AB	56	1	230	5	●	45.43 (1154)	26.65 (677)	18.78 (477)	3.75 (95)	5.75 (146)	49.5
		3	230	5	●	41.46 (1053)	22.69 (576)	18.78 (477)	3.75 (95)	5.75 (146)	79.2
		3	460	5	●	41.46 (1053)	22.69 (576)	18.78 (477)	3.75 (95)	5.75 (146)	79.2
230S75-2	80	3	230	7.5	●	45.39 (1153)	26.63 (676)	23.23 (590)	3.75 (95)	5.75 (146)	79.2
		3	460	7.5	●	45.39 (1153)	26.63 (676)	23.23 (590)	3.75 (95)	5.75 (146)	79.2
230S75-3BB	90	3	230	7.5	●	49.84 (1266)	26.63 (676)	23.23 (590)	3.75 (95)	5.75 (146)	126.0
		3	460	7.5	●	49.84 (1266)	26.63 (676)	23.23 (590)	3.75 (95)	5.75 (146)	126.0
230S100-3	123	3	460	10	●	53.78 (1366)	30.56 (776)	23.23 (590)	3.75 (95)	5.75 (146)	126.0
230S100-4BC	131	3	460	10	●	53.78 (1366)	30.56 (776)	23.23 (590)	3.75 (95)	5.75 (146)	144.9
230S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 230 gpm (3" NPT)											
230S75-2	80	3	230	7.5	▲	41.65 (1058)	22.25 (565)	19.41 (493)	5.63 (143)	5.99 (152)	111.6
		3	460	7.5	▲	41.65 (1058)	22.25 (565)	19.41 (493)	5.63 (143)	5.99 (152)	111.6
230S75-3BB	90	3	230	7.5	▲	46.10 (1171)	22.25 (565)	23.86 (606)	5.63 (143)	5.99 (152)	131.4
		3	460	7.5	▲	46.10 (1171)	22.25 (565)	23.86 (606)	5.63 (143)	5.99 (152)	131.4
230S100-3	123	3	230	10	▲	47.09 (1196)	23.23 (590)	23.86 (606)	5.63 (143)	5.99 (152)	126.0
		3	460	10	▲	47.09 (1196)	23.23 (590)	23.86 (606)	5.63 (143)	5.99 (152)	126.0
230S100-4BC	131	3	230	10	▲	51.54 (1309)	23.23 (590)	28.31 (719)	5.63 (143)	5.99 (152)	144.9
		3	460	10	▲	51.54 (1309)	23.23 (590)	28.31 (719)	5.63 (143)	5.99 (152)	144.9
230S150-4	166	3	230	15	▲	56.19 (1427)	27.88 (708)	28.31 (719)	5.63 (143)	5.99 (152)	144.9
		3	460	15	▲	56.19 (1427)	27.88 (708)	28.31 (719)	5.63 (143)	5.99 (152)	144.9
230S150-5B	195	3	230	15	▲	60.63 (1540)	27.88 (708)	32.76 (832)	5.63 (143)	5.99 (152)	161.1
		3	460	15	▲	60.63 (1540)	27.88 (708)	32.76 (832)	5.63 (143)	5.99 (152)	161.1
230S200-5	208	3	230	20	▲	63.59 (1615)	30.83 (783)	32.76 (832)	5.63 (143)	5.99 (152)	161.1
		3	460	20	▲	63.59 (1615)	30.83 (783)	32.76 (832)	5.63 (143)	5.99 (152)	161.1
230S200-6	251	3	230	20	▲	68.04 (1728)	30.83 (783)	37.21 (945)	5.63 (143)	5.99 (152)	167.4
		3	460	20	▲	68.04 (1728)	30.83 (783)	37.21 (945)	5.63 (143)	5.99 (152)	167.4
230S200-7C	276	3	230	20	▲	72.49 (1841)	30.83 (783)	41.66 (1058)	5.63 (143)	5.99 (152)	181.8
		3	460	20	▲	72.49 (1841)	30.83 (783)	41.66 (1058)	5.63 (143)	5.99 (152)	181.8

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

230S

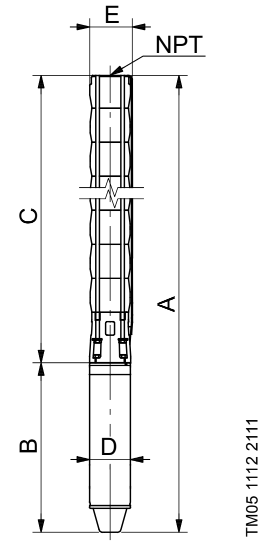


E = Maximum diameter of pump including cable guard and motor.

230S (230 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	Dimensions B [in (mm)]	Dimensions C [in (mm)]	Dimensions D [in (mm)]	Dimensions E [in (mm)]	Net weight (complete) [lb]
230S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 230 gpm (3" NPT)											
230S250-7	294	3	230	25	▲	74.65 (1896)	33.00 (838)	41.66 (1058)	5.63 (143)	5.99 (152)	149.9
		3	460	25	▲	74.65 (1896)	33.00 (838)	41.66 (1058)	5.63 (143)	5.99 (152)	181.8
230S250-8B	329	3	230	25	▲	79.10 (2009)	33.00 (838)	46.11 (1171)	5.63 (143)	5.99 (152)	188.1
		3	460	25	▲	79.10 (2009)	33.00 (838)	46.11 (1171)	5.63 (143)	5.99 (152)	188.1
230S250-8	336	3	230	25	▲	79.10 (2009)	33.00 (838)	46.11 (1171)	5.63 (143)	5.99 (152)	188.1
		3	460	25	▲	79.10 (2009)	33.00 (838)	46.11 (1171)	5.63 (143)	5.99 (152)	188.1
230S250-9BB	352	3	230	25	▲	83.55 (2122)	33.00 (838)	50.56 (1284)	5.63 (143)	5.99 (152)	205.2
		3	460	25	▲	83.55 (2122)	33.00 (838)	50.56 (1284)	5.63 (143)	5.99 (152)	205.2
230S300-9	379	3	230	30	▲	86.11 (2187)	35.56 (903)	50.56 (1284)	5.63 (143)	5.99 (152)	205.2
		3	460	30	▲	86.11 (2187)	35.56 (903)	50.56 (1284)	5.63 (143)	5.99 (152)	205.2
230S400-10	422	3	460	30	▲	95.28 (2420)	40.28 (1023)	55.00 (1397)	5.63 (143)	5.99 (152)	241.2
230S400-11	465	3	460	40	▲	99.73 (2533)	40.28 (1023)	59.45 (1510)	5.63 (143)	5.99 (152)	245.7
230S400-12	507	3	460	40	▲	104.18 (2646)	40.28 (1023)	63.9 (1623)	5.63 (143)	5.99 (152)	251.1
230S400-13	550	3	460	40	▲	108.63 (2759)	40.28 (1023)	68.35 (1736)	5.63 (143)	5.99 (152)	255.6
230S500-14	593	3	460	50	ʌ	132.17 (3357)	56.11 (1425)	76.07 (1932)	5.67 (144)	5.99 (152)	356.0
230S500-15	635	3	460	50	ʌ	136.62 (3470)	56.11 (1425)	80.52 (2045)	5.67 (144)	5.99 (152)	360.5
230S500-16	678	3	460	50	ʌ	141.07 (3583)	56.11 (1425)	84.97 (2158)	5.67 (144)	5.99 (152)	365.0
230S600-17	721	3	460	60	▲	—	—	88.54 (2249)	—	5.99 (152)	—
230S600-18	763	3	460	60	▲	—	—	92.99 (2362)	—	5.99 (152)	—
230S600-19	806	3	460	60	▲	—	—	97.44 (2475)	—	7.56 (192)	—
230S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 230 gpm (3" NPT)											
230S600-17	721	3	460	60	★	137.41 (3490)	50.00 (1270)	87.41 (2220)	7.56 (192)	7.56 (192)	546.0
230S600-18	763	3	460	60	★	141.86 (3690)	50.00 (1270)	91.86 (2333)	7.56 (192)	7.56 (192)	568.5
230S600-19	806	3	460	60	★	146.3 (3716)	50.00 (1270)	96.3 (2446)	7.56 (192)	7.56 (192)	591.0
230S750-20DS	849	3	460	75	★	153.9 (3909)	53.15 (1350)	100.75 (2559)	7.56 (192)	7.56 (192)	549.9
230S750-22DS	934	3	460	75	★	169.22 (4298)	53.15 (1350)	116.07 (2948)	7.56 (192)	7.56 (192)	620.4

230S

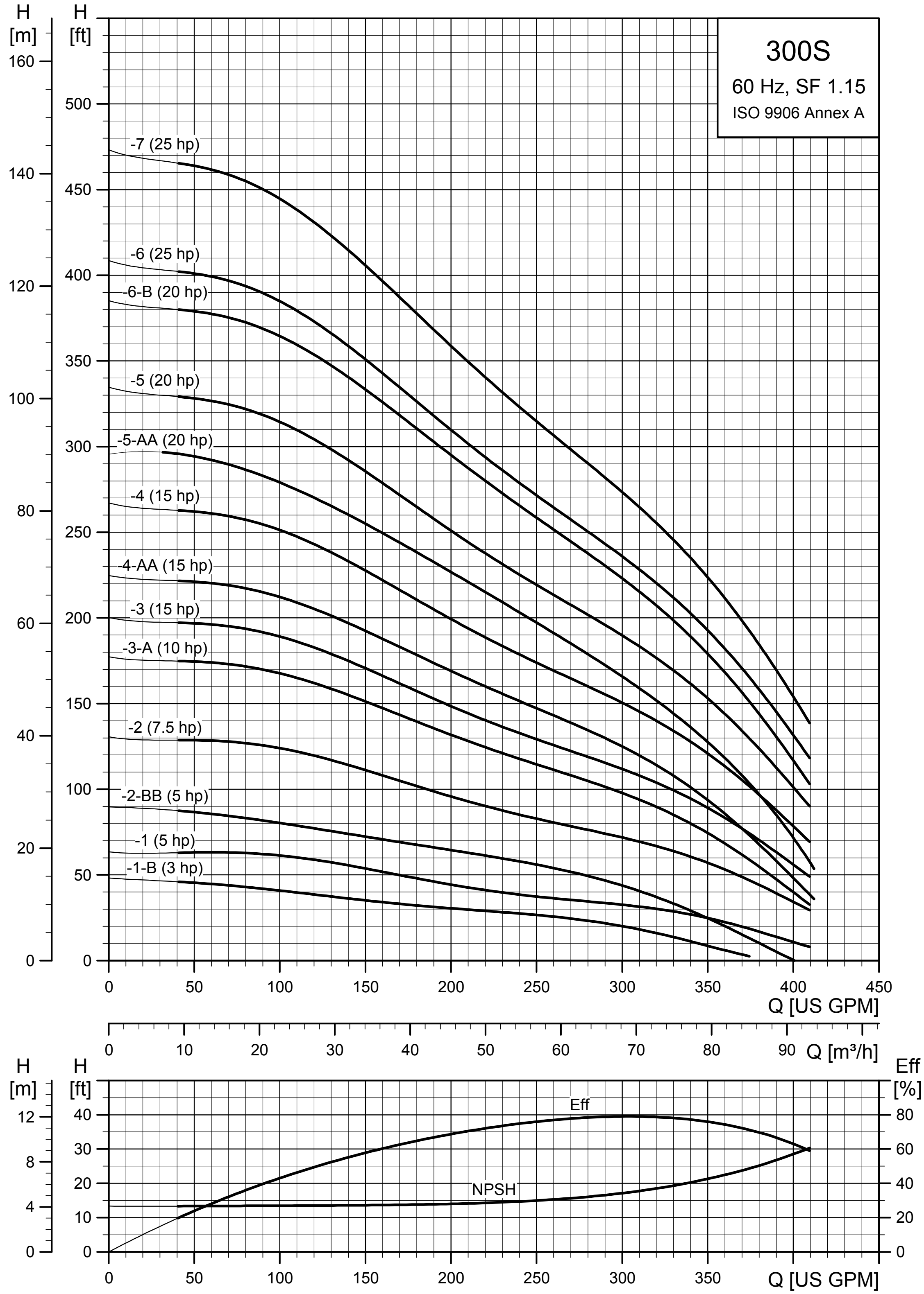


E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 4" NPT, 10" minimum well diameter.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

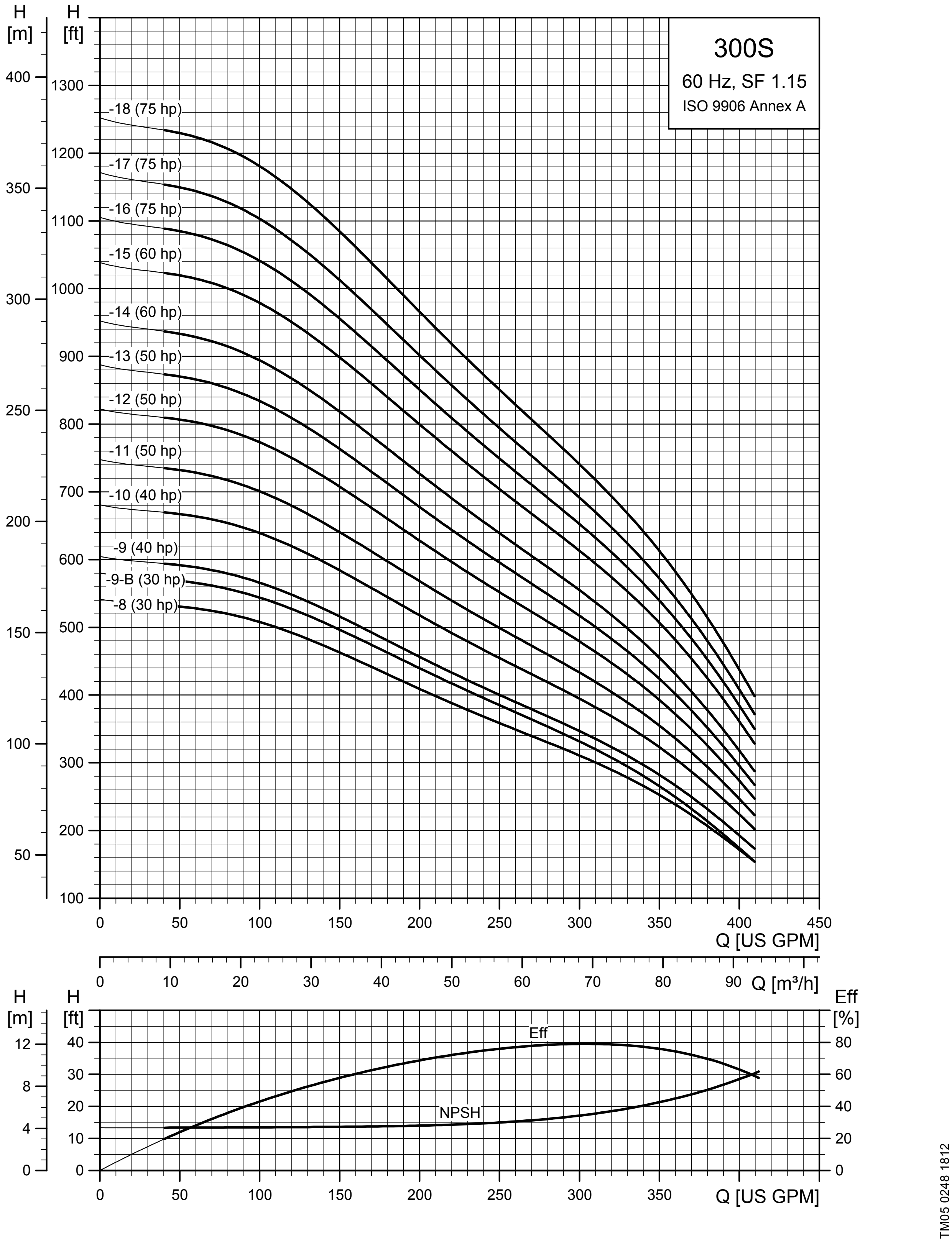
- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

300S (300 gpm)

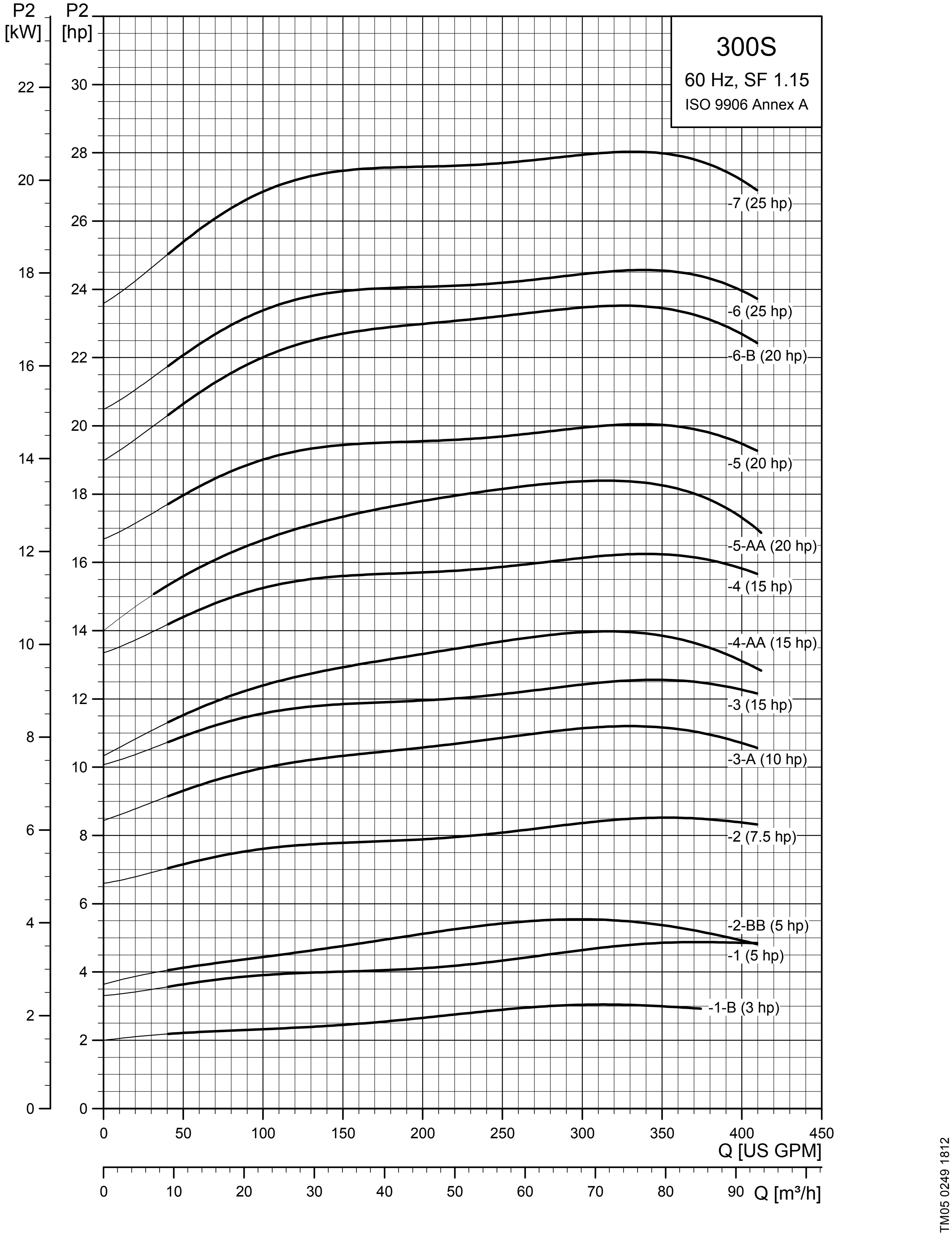


TM05 0247 1812

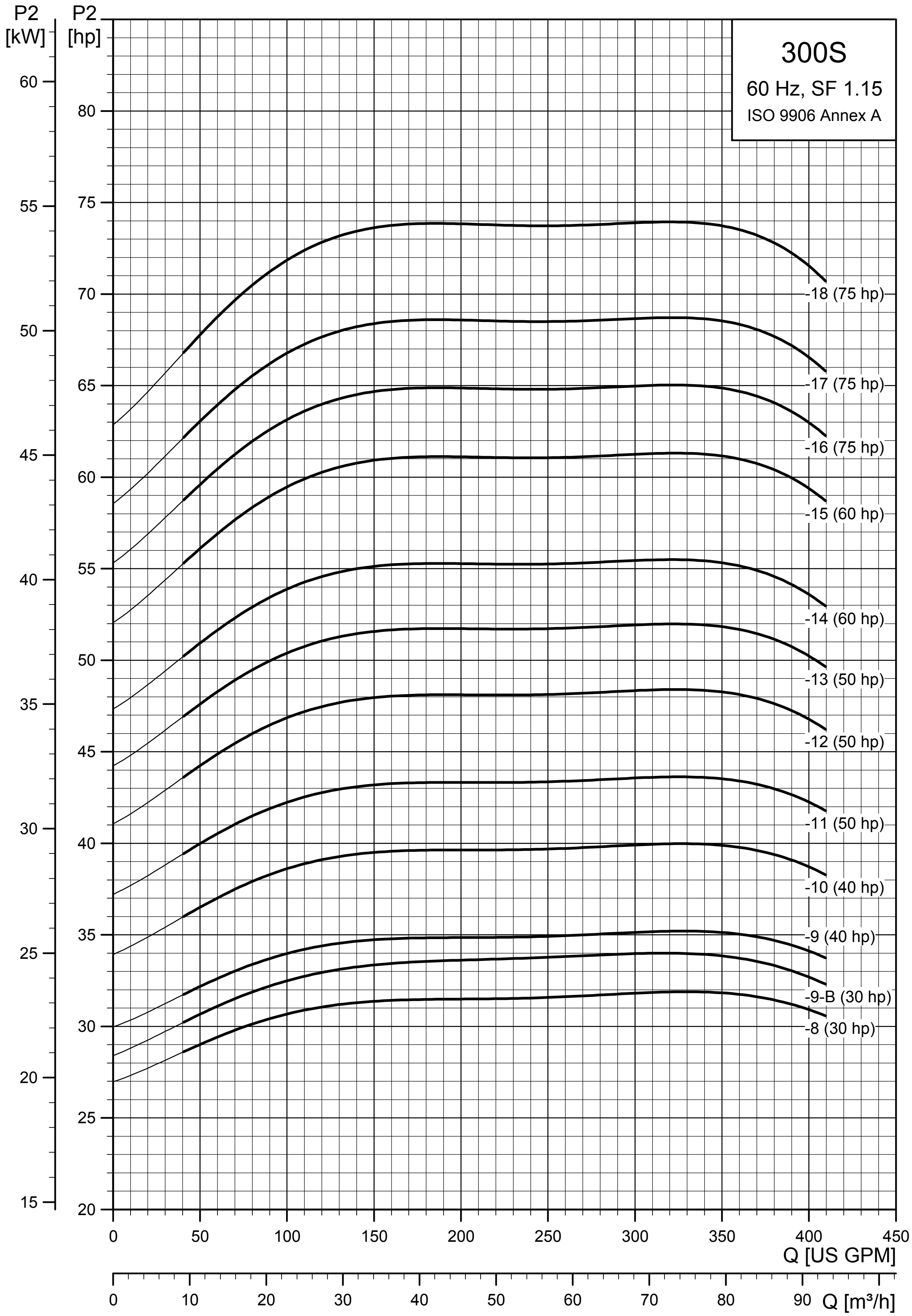
300S (300 gpm)


300S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-18 (75 hp)
-17 (75 hp)
-16 (75 hp)
-15 (60 hp)
-14 (60 hp)
-13 (50 hp)
-12 (50 hp)
-11 (50 hp)
-10 (40 hp)
-9 (40 hp)
-9-B (30 hp)
-8 (30 hp)
Q [US GPM]
Q [m³/h]
Eff
Eff [%]
NPSH
TM05 0248 1812

300S (300 gpm) pump power requirement (P2)



300S (300 gpm) pump power requirement (P2)

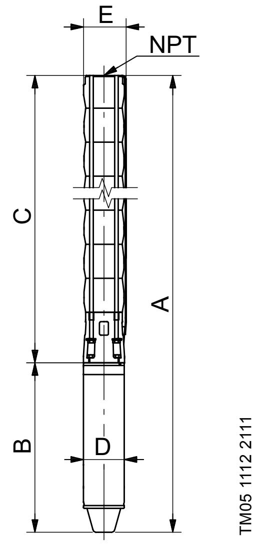


TM05 0250 1812

300S (300 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
300S - Motor dia. 4 inch, 3 wire motor, 60 Hz, rated flow 300 gpm (3" NPT)											
300S30-1B	19	1	230	3	●	37.17 (944)	22.72 (577)	14.45 (367)	3.75 (95)	5.83 (148)	72.0
		3	230	3	●	32.41 (823)	17.96 (456)	14.45 (367)	3.75 (95)	5.83 (148)	72.0
		3	460	3	●	32.41 (823)	17.96 (456)	14.45 (367)	3.75 (95)	5.83 (148)	72.0
300S50-1	31	1	230	5	●	41.11 (1044)	26.65 (677)	14.45 (367)	3.75 (95)	5.83 (148)	74.7
		3	230	5	●	37.13 (943)	22.69 (576)	14.45 (367)	3.75 (95)	5.83 (148)	74.7
		3	460	5	●	37.13 (943)	22.69 (576)	14.45 (367)	3.75 (95)	5.83 (148)	74.7
300S50-2BB	42	1	230	5	●	45.56 (1157)	26.65 (677)	18.90 (480)	3.75 (95)	5.83 (148)	135.0
		3	230	5	●	41.58 (1056)	22.69 (576)	18.90 (480)	3.75 (95)	5.83 (148)	135.0
		3	460	5	●	41.58 (1056)	22.69 (576)	18.90 (480)	3.75 (95)	5.83 (148)	135.0
300S75-2	70	3	230	7.5	●	45.52 (1156)	26.62 (676)	18.90 (480)	3.75 (95)	5.83 (148)	101.7
		3	460	7.5	●	45.52 (1156)	26.62 (676)	18.90 (480)	3.75 (95)	5.83 (148)	101.7
300S100-3A	97	3	460	10	●	53.90 (1369)	30.56 (776)	23.35 (593)	3.75 (95)	5.83 (148)	145.8
300S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 300 gpm (3" NPT)											
300S75-2	70	3	230	7.5	▲	41.78 (1061)	22.25 (565)	19.53 (496)	5.63 (143)	6.15 (156)	167.4
		3	460	7.5	▲	41.78 (1061)	22.25 (565)	19.53 (496)	5.63 (143)	6.15 (156)	167.4
300S100-3A	97	3	230	10	▲	47.21 (1199)	23.23 (590)	23.98 (609)	5.63 (143)	6.15 (156)	216.0
		3	460	10	▲	47.21 (1199)	23.23 (590)	23.98 (609)	5.63 (143)	6.15 (156)	216.0
300S150-3	110	3	230	15	▲	51.86 (1317)	27.88 (708)	23.98 (609)	5.63 (143)	6.15 (156)	216.0
		3	460	15	▲	51.86 (1317)	27.88 (708)	23.98 (609)	5.63 (143)	6.15 (156)	216.0
300S150-4AA	123	3	230	15	▲	56.30 (1430)	27.88 (708)	28.43 (722)	5.63 (143)	6.15 (156)	222.3
		3	460	15	▲	56.30 (1430)	27.88 (708)	28.43 (722)	5.63 (143)	6.15 (156)	222.3
300S150-4	149	3	230	15	▲	56.30 (1430)	27.88 (708)	28.43 (722)	5.63 (143)	6.15 (156)	222.3
		3	460	15	▲	56.30 (1430)	27.88 (708)	28.43 (722)	5.63 (143)	6.15 (156)	222.3
300S200-5AA	170	3	230	20	▲	63.71 (1618)	30.83 (783)	32.88 (835)	5.63 (143)	6.15 (156)	194.4
		3	460	20	▲	63.71 (1618)	30.83 (783)	32.88 (835)	5.63 (143)	6.15 (156)	194.4
300S200-5	188	3	230	20	▲	63.71 (1618)	30.83 (783)	32.88 (835)	5.63 (143)	6.15 (156)	194.4
		3	460	20	▲	63.71 (1618)	30.83 (783)	32.88 (835)	5.63 (143)	6.15 (156)	194.4
300S200-6B	211	3	230	20	▲	68.15 (1731)	30.83 (783)	37.33 (948)	5.63 (143)	6.15 (156)	198.0
		3	460	20	▲	68.15 (1731)	30.83 (783)	37.33 (948)	5.63 (143)	6.15 (156)	198.0
300S250-6	228	3	230	25	▲	70.32 (1786)	33.00 (838)	37.33 (948)	5.63 (143)	6.15 (156)	198.0
		3	460	25	▲	70.32 (1786)	33.00 (838)	37.33 (948)	5.63 (143)	6.15 (156)	198.0

300S



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

300S (300 gpm)

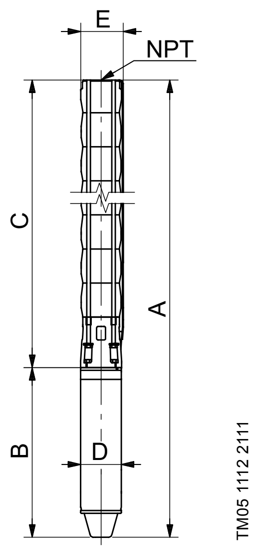
Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]	A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
300S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 300 gpm (4" NPT)										
300S250-7AA	249	3	230	25 ▲	74.77 (1899)	33.00 (838)	41.78 (1061)	5.63 (143)	6.15 (156)	217.8
		3	460	25 ▲	74.77 (1899)	33.00 (838)	41.78 (1061)	5.63 (143)	6.15 (156)	217.8
300S300-7	267	3	230	25 ▲	77.33 (1964)	35.56 (903)	41.78 (1061)	5.63 (143)	6.15 (156)	217.8
		3	460	25 ▲	77.33 (1964)	35.56 (903)	41.78 (1061)	5.63 (143)	6.15 (156)	217.8
300S300-8	307	3	230	30 ▲	81.78 (2077)	35.56 (903)	46.23 (1174)	5.63 (143)	6.15 (156)	224.1
		3	460	30 ▲	81.78 (2077)	35.56 (903)	46.23 (1174)	5.63 (143)	6.15 (156)	224.1
300S300-9B	329	3	230	30 ▲	86.23 (2190)	35.56 (903)	50.67 (1287)	5.63 (143)	6.15 (156)	261.0
		3	460	30 ▲	86.23 (2190)	35.56 (903)	50.67 (1287)	5.63 (143)	6.15 (156)	261.0
300S400-9	346	3	460	40 ▲	90.95 (2310)	40.28 (1023)	50.67 (1287)	5.63 (143)	6.15 (156)	296.0
300S400-10	385	3	460	40 ▲	95.40 (2423)	40.28 (1023)	55.12 (1400)	5.63 (143)	6.15 (156)	300.5
300S500-11	425	3	460	50 ☼	115.67 (2938)	56.11 (1425)	59.57 (1513)	5.67 (144)	6.15 (156)	352.0
300S500-12	464	3	460	50 ☼	120.12 (3051)	56.11 (1425)	64.02 (1626)	5.67 (144)	6.15 (156)	348.8
300S500-13	504	3	460	50 ☼	124.57 (3164)	56.11 (1425)	68.47 (1739)	5.67 (144)	6.15 (156)	355.1
300S600-14	543	3	460	60 ☼	—	—	74.06 (1881)	—	6.15 (156)	—
300S600-15	582	3	460	60 ☼	—	—	74.06 (1881)	—	6.15 (156)	—

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]	A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
SP 300S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 230 gpm (4" NPT)										
300S600-14	543	3	460	60 *	124.06 (3151)	50.00 (1270)	74.06 (1881)	7.56 (192)	7.56 (192)	479.4
300S600-15	582	3	460	60 *	128.51 (3264)	50.00 (1270)	78.51 (1994)	7.56 (192)	7.56 (192)	519.4
300S750-16	622	3	460	75 *	136.11 (3457)	53.15 (1350)	82.96 (2107)	7.56 (192)	7.56 (192)	569.1
300S750-17	661	3	460	75 *	140.56 (3570)	53.15 (1350)	87.41 (2220)	7.56 (192)	7.56 (192)	575.4
300S750-18	701	3	460	75 *	145.00 (3683)	53.15 (1350)	91.86 (2333)	7.56 (192)	7.56 (192)	581.7

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

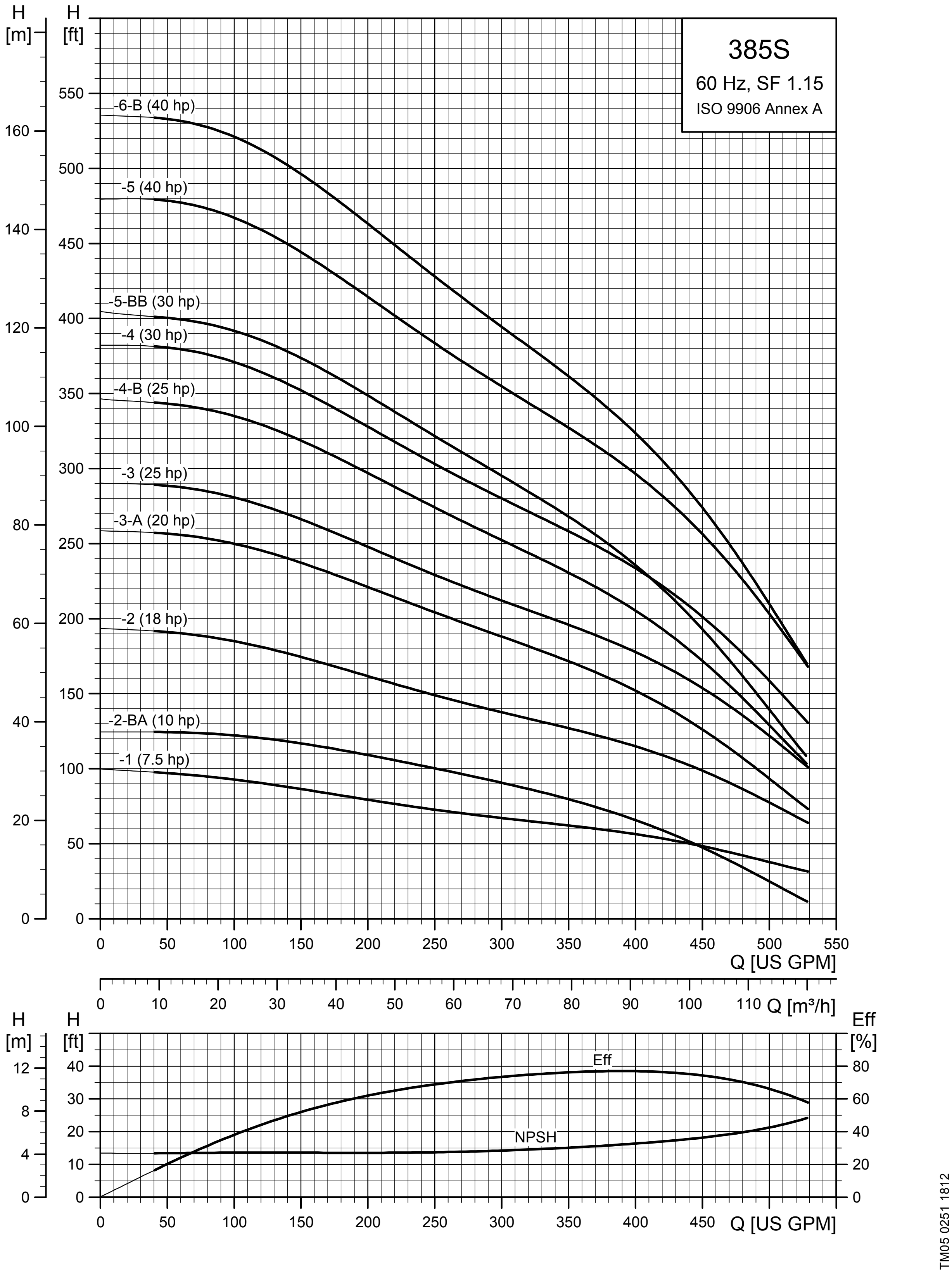
- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- †Takes MMS10000 motor; not available as complete.

300S

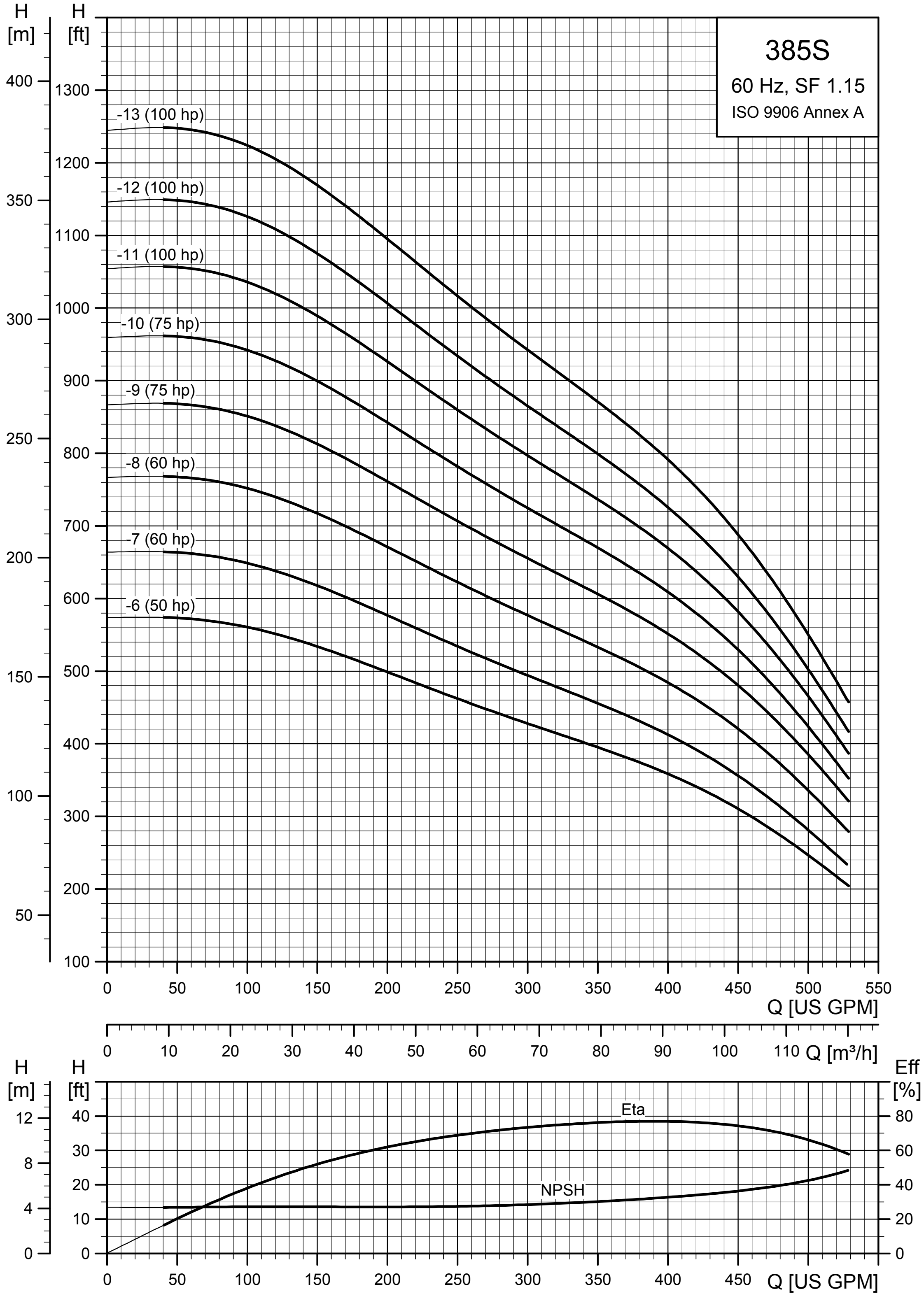


E = Maximum diameter of pump including cable guard and motor.

385S (385 gpm)

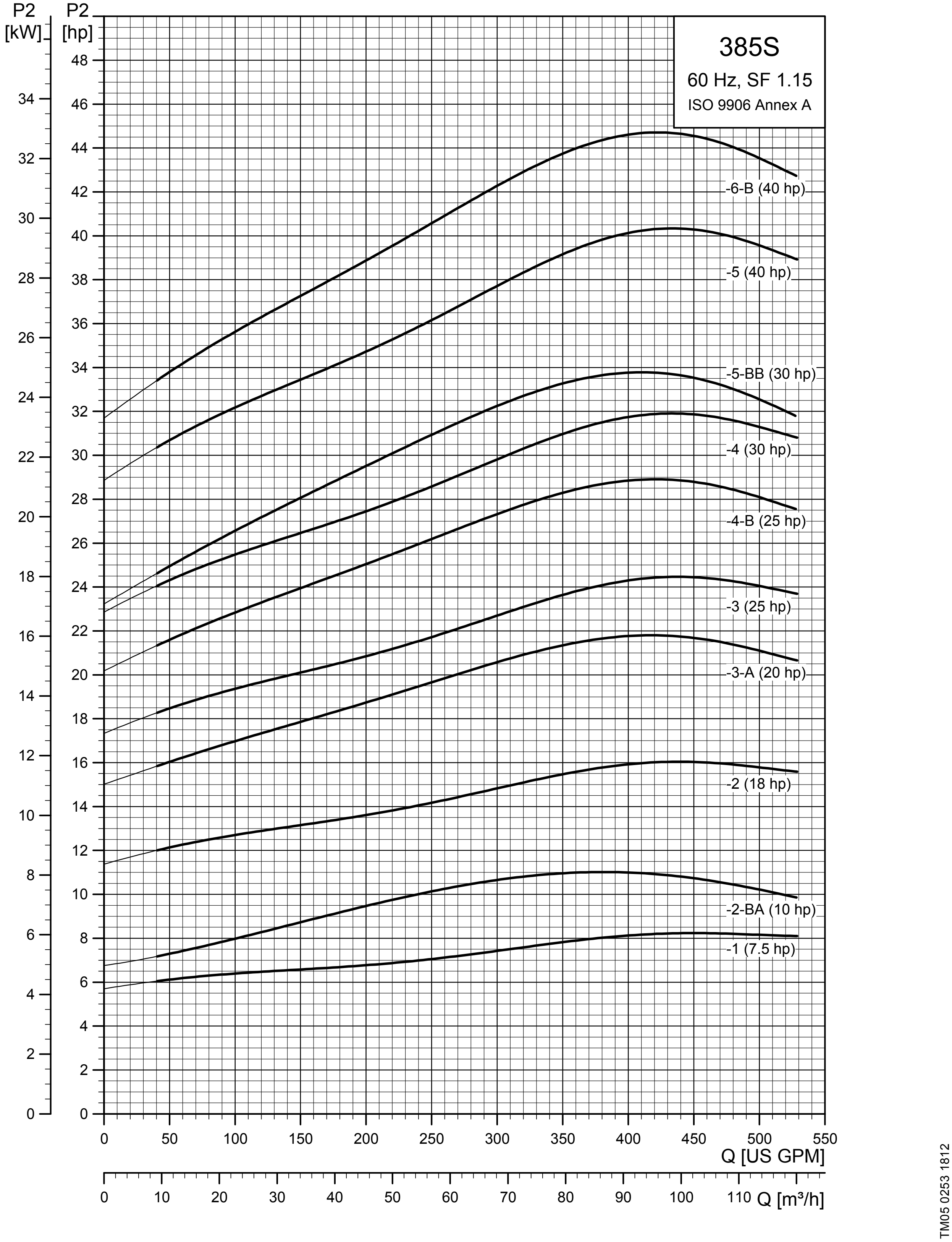

385S
60 Hz, SF 1.15
ISO 9906 Annex A
-6-B (40 hp)
-5 (40 hp)
-5-BB (30 hp)
-4 (30 hp)
-4-B (25 hp)
-3 (25 hp)
-3-A (20 hp)
-2 (18 hp)
-2-BA (10 hp)
-1 (7.5 hp)
H [m]
H [ft]
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0251 1812

385S (385 gpm)

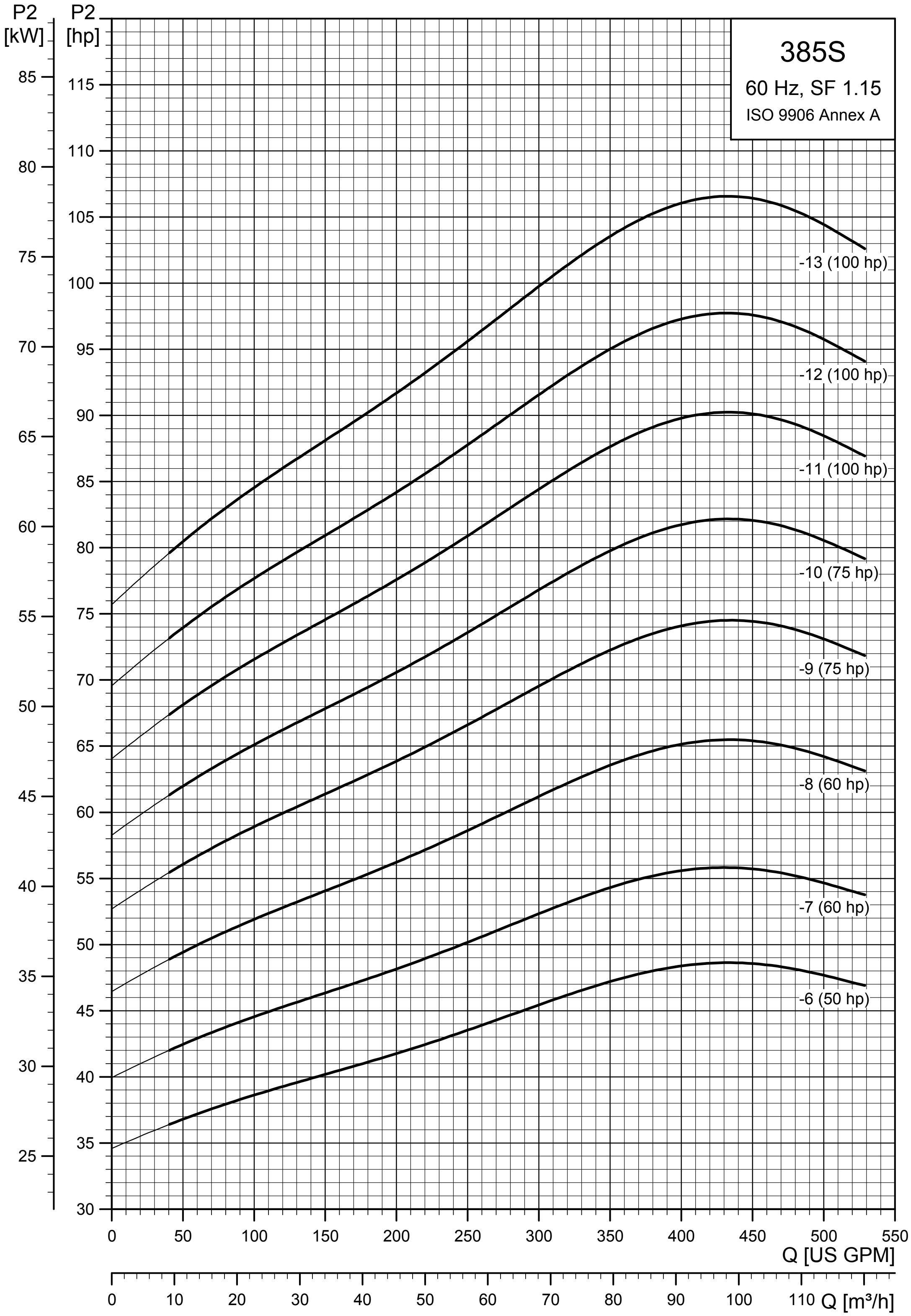

385S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-13 (100 hp)
-12 (100 hp)
-11 (100 hp)
-10 (75 hp)
-9 (75 hp)
-8 (60 hp)
-7 (60 hp)
-6 (50 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eta
NPSH
TM05 0252 1812

Curve charts and technical data

385S (385 gpm) pump power requirement (P2)



385S (385 gpm) pump power requirement (P2)

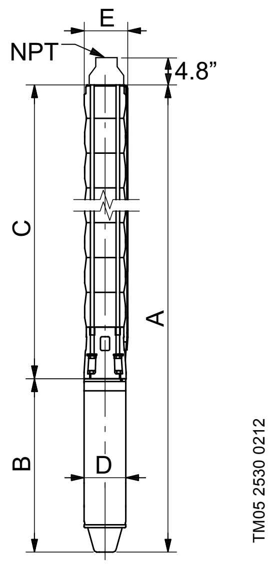


TM05 0254 1812

385S (385 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
385S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 385 gpm (4" NPT)											
385S75-1	57	3	230	7.5	▲	46.58 (1183)	22.25 (565)	24.34 (618)	5.63 (143)	7.01 (178)	135.9
		3	460	7.5	▲	46.58 (1183)	22.25 (565)	24.34 (618)	5.63 (143)	7.01 (178)	135.9
385S100-2BA	69	3	230	10	▲	52.6 (1336)	23.23 (590)	29.38 (746)	5.63 (143)	7.01 (178)	169.2
		3	460	10	▲	52.6 (1336)	23.23 (590)	29.38 (746)	5.63 (143)	7.01 (178)	169.2
385S150-2	117	3	230	18	▲	57.25 (1454)	27.88 (708)	29.38 (746)	5.63 (143)	7.01 (178)	169.2
		3	460	18	▲	57.25 (1454)	27.88 (708)	29.38 (746)	5.63 (143)	7.01 (178)	169.2
385S200-3A	155	3	230	20	▲	65.24 (1657)	30.83 (783)	34.41 (874)	5.63 (143)	7.01 (178)	188.1
		3	460	20	▲	65.24 (1657)	30.83 (783)	34.41 (874)	5.63 (143)	7.01 (178)	188.1
385S250-3	177	3	230	25	▲	67.41 (1712)	33.00 (838)	34.41 (874)	5.63 (143)	7.01 (178)	188.1
		3	460	25	▲	67.41 (1712)	33.00 (838)	34.41 (874)	5.63 (143)	7.01 (178)	188.1
385S250-4B	210	3	230	25	▲	72.45 (1840)	33.00 (838)	39.45 (1002)	5.63 (143)	7.01 (178)	239.4
		3	460	25	▲	72.45 (1840)	33.00 (838)	39.45 (1002)	5.63 (143)	7.01 (178)	239.4
385S300-4	237	3	230	30	▲	75.00 (1905)	35.56 (903)	39.45 (1002)	5.63 (143)	7.01 (178)	239.4
		3	460	30	▲	75.00 (1905)	35.56 (903)	39.45 (1002)	5.63 (143)	7.01 (178)	239.4
385S300-5BB	343	3	230	30	▲	80.04 (2033)	35.56 (903)	44.49 (1130)	5.63 (143)	7.01 (178)	247.5
		3	460	30	▲	80.04 (2033)	35.56 (903)	44.49 (1130)	5.63 (143)	7.01 (178)	247.5
385S400-5	297	3	460	40	▲	84.77 (2153)	40.28 (1023)	44.49 (1130)	5.63 (143)	7.01 (178)	247.5
385S400-6B	330	3	460	40	▲	89.81 (2281)	40.28 (1023)	49.53 (1258)	5.63 (143)	7.01 (178)	252.0
385S500-6	357	3	460	50	☼	110.99 (2825)	56.11 (1425)	54.88 (1394)	5.67 (144)	7.88 (200)	—
385S500-7A	400	3	460	50	☼	110.99 (2825)	56.11 (1425)	54.88 (1394)	5.67 (144)	7.88 (200)	—
385S600-7	416	3	460	60	♦	—	—	55.12 (1400)	—	7.88 (200)	—
385S600-8	476	3	460	60	♦	—	—	55.12 (1400)	—	7.88 (200)	—
385S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 385 gpm (4" NPT)											
385S400-6B	330	3	460	40	*	93.78 (2382)	43.71 (1110)	50.08 (1272)	7.56 (192)	7.88 (200)	428.3
385S500-6	357	3	460	50	*	95.75 (2432)	45.67 (1160)	50.08 (1272)	7.56 (192)	7.88 (200)	451.2
385S500-7A	400	3	460	50	*	100.79 (2560)	45.67 (1160)	55.12 (1400)	7.56 (192)	7.88 (200)	461.1
385S600-7	416	3	460	60	*	105.12 (2670)	50.00 (1270)	55.12 (1400)	7.56 (192)	7.88 (200)	507.3
385S600-8	476	3	460	60	*	110.16 (2798)	50.00 (1270)	60.16 (1528)	7.56 (192)	7.88 (200)	517.2
385S750-9	536	3	460	75	*	118.35 (3006)	53.15 (1350)	65.2 (1656)	7.56 (192)	7.88 (200)	558.7
385S750-10	596	3	460	75	*	123.39 (3134)	53.15 (1350)	70.24 (1784)	7.56 (192)	7.88 (200)	568.6
385S1000-11	656	3	460	100	*	137.88 (3502)	62.60 (1590)	75.28 (1912)	7.56 (192)	7.88 (200)	677.5
385S1000-12	716	3	460	100	*	142.92 (3630)	62.60 (1590)	80.32 (2040)	7.56 (192)	7.88 (200)	687.4
385S1000-13	776	3	460	100	*	147.96 (3758)	62.60 (1590)	85.36 (2168)	7.56 (192)	7.88 (200)	697.3

385S

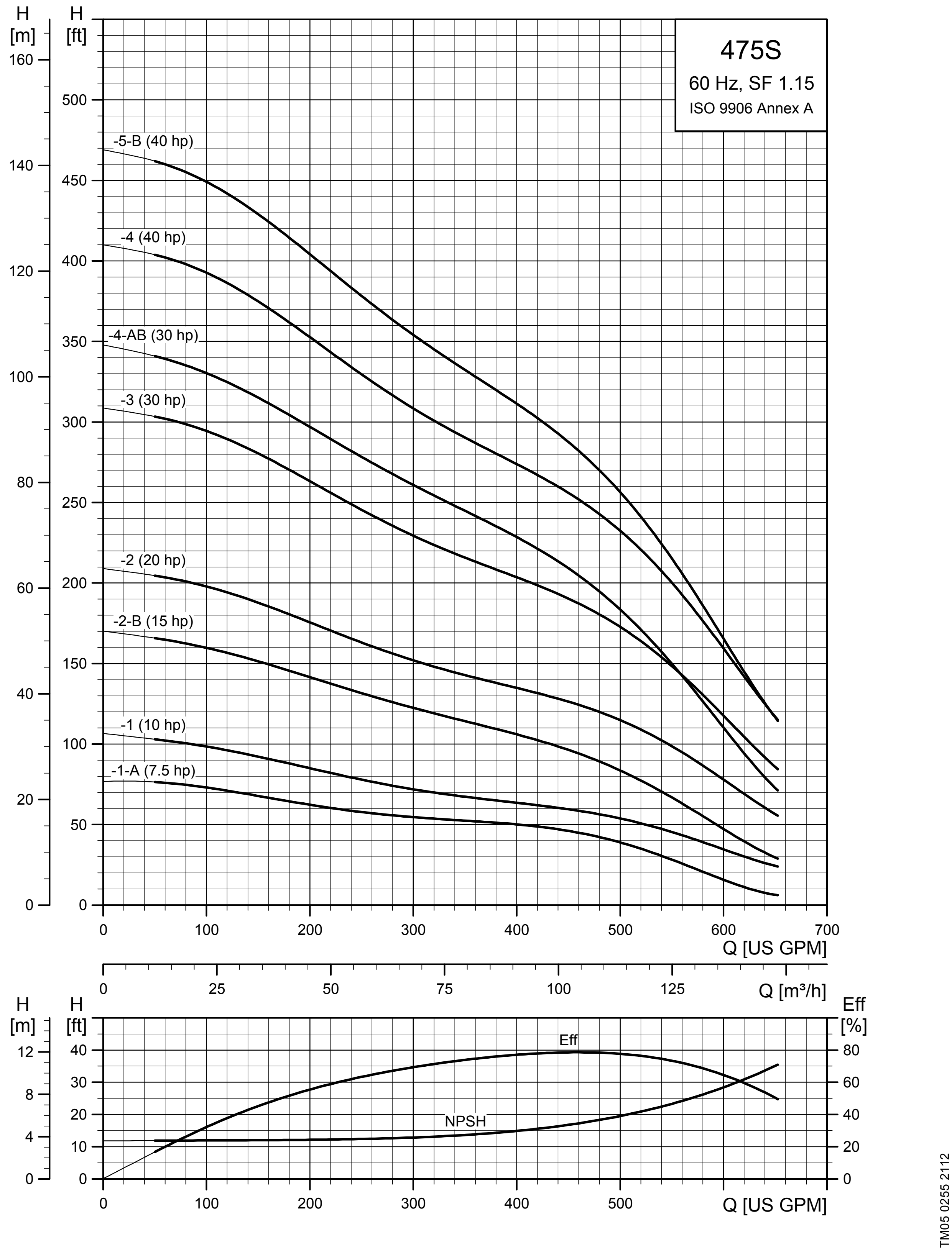


E = Maximum diameter of pump including cable guard and motor.

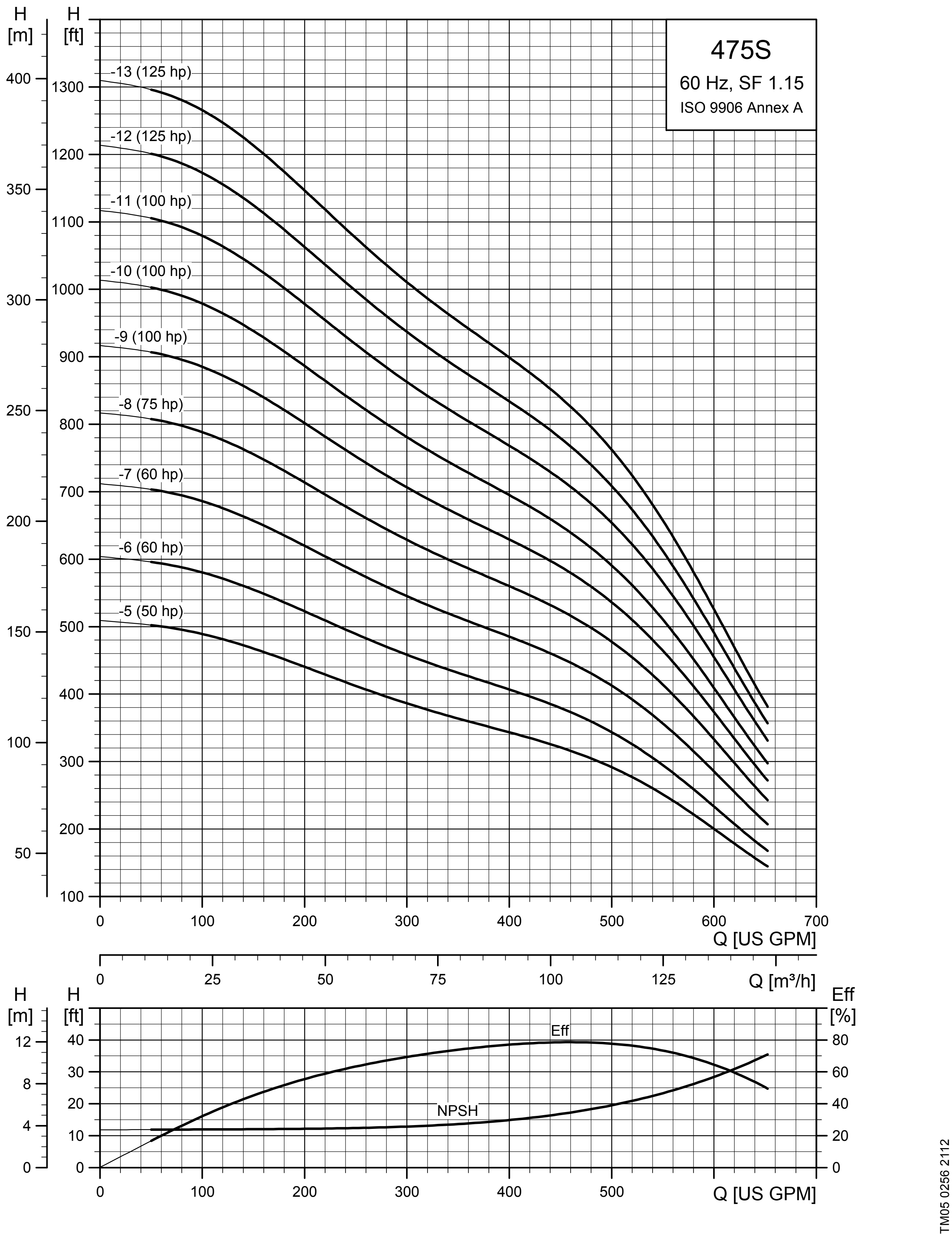
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

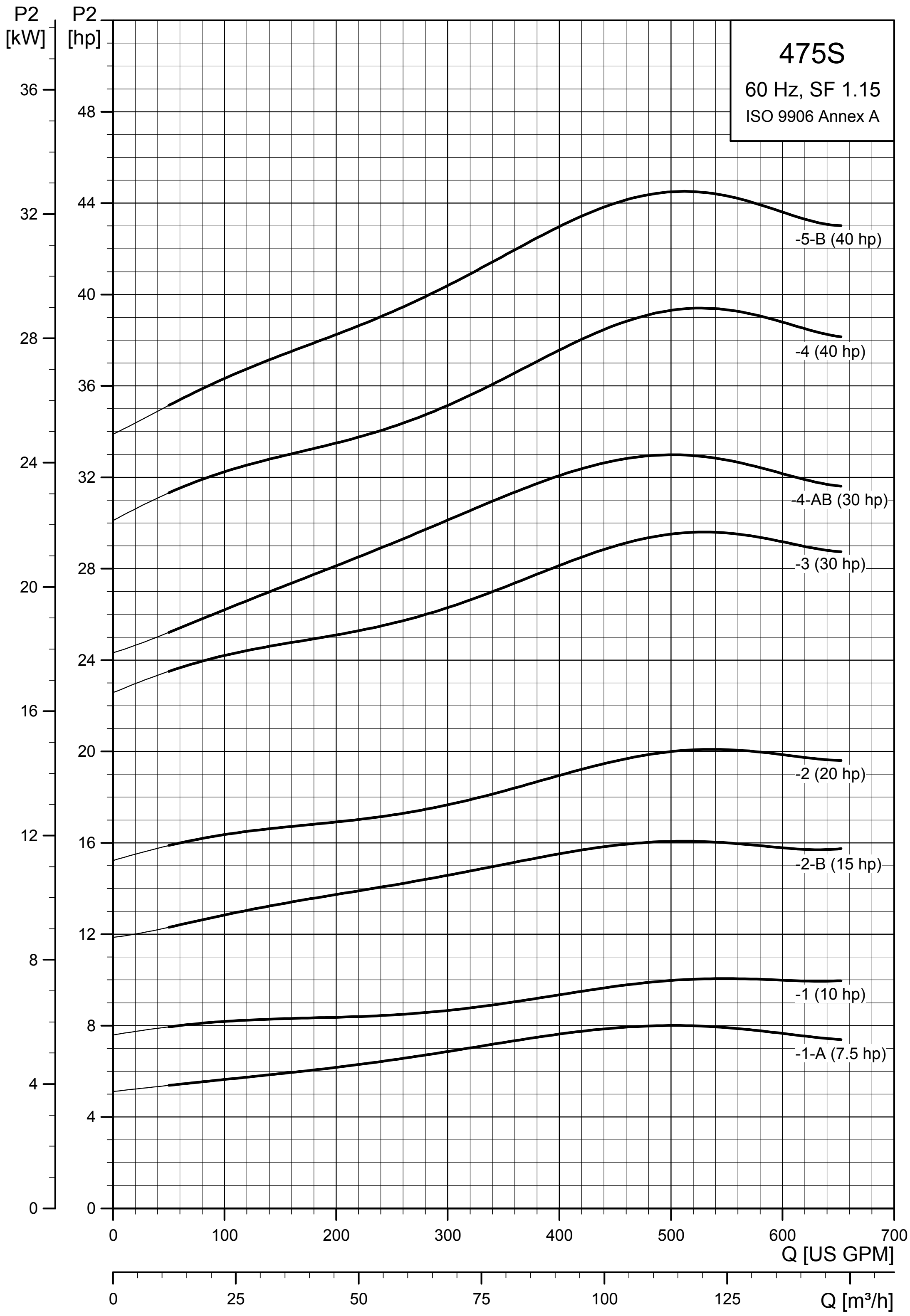
475S (475 gpm)


475S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-5-B (40 hp)
-4 (40 hp)
-4-AB (30 hp)
-3 (30 hp)
-2 (20 hp)
-2-B (15 hp)
-1 (10 hp)
-1-A (7.5 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0255 2112

475S (475 gpm)

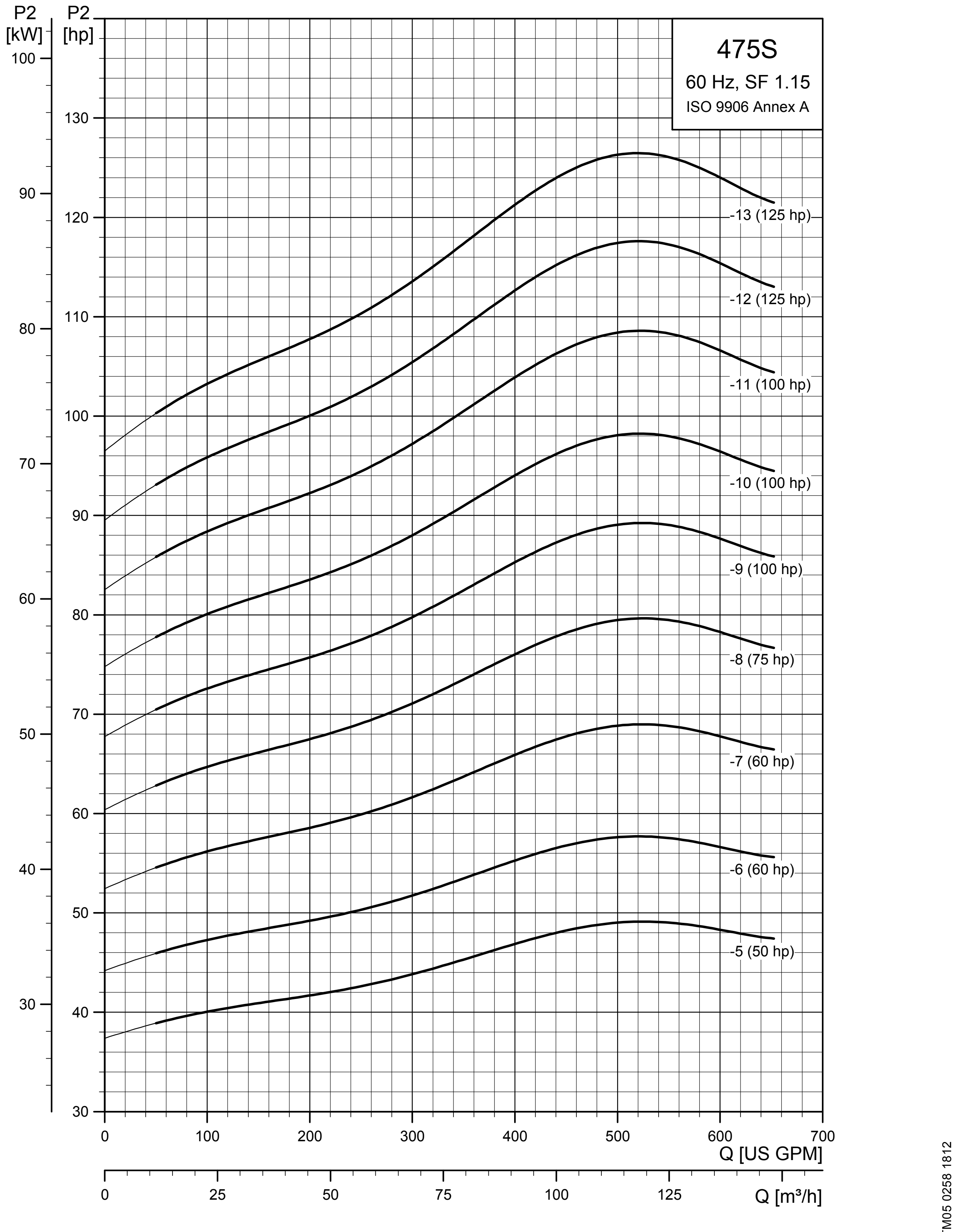

475S
60 Hz, SF 1.15
ISO 9906 Annex A
-13 (125 hp)
-12 (125 hp)
-11 (100 hp)
-10 (100 hp)
-9 (100 hp)
-8 (75 hp)
-7 (60 hp)
-6 (60 hp)
-5 (50 hp)
H [m]
H [ft]
Q [US GPM]
Q [m³/h]
Eff
NPSH
Eff [%]
TM05 0256 2112

475S (475 gpm) pump power requirement (P2)



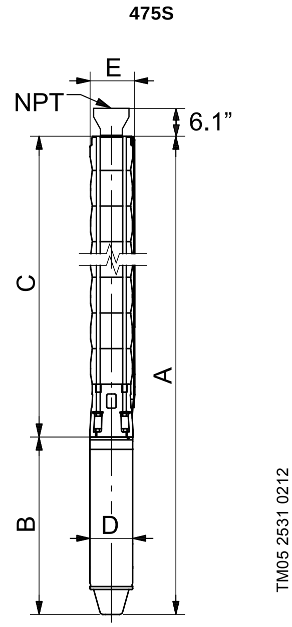
TM05 0257 1812

475S (475 gpm) pump power requirement (P2)



475S (475 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
475S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 475 gpm (5" NPT)											
475S75-1A	42	3	230	7.5	▲	46.58 (1183)	22.25 (565)	24.34 (618)	5.63 (143)	7.05 (179)	132.3
		3	460	7.5	▲	46.58 (1183)	22.25 (565)	24.34 (618)	5.63 (143)	7.05 (179)	132.3
475S100-1	58	3	230	10	▲	47.56 (1208)	23.23 (590)	24.34 (618)	5.63 (143)	7.05 (179)	132.3
		3	460	10	▲	47.56 (1208)	23.23 (590)	24.34 (618)	5.63 (143)	7.05 (179)	132.3
475S150-2B	89	3	230	15	▲	57.25 (1454)	27.88 (708)	29.38 (746)	5.63 (143)	7.05 (179)	170.1
		3	460	15	▲	57.25 (1454)	27.88 (708)	29.38 (746)	5.63 (143)	7.05 (179)	170.1
475S200-2	117	3	230	20	▲	60.20 (1529)	30.83 (783)	29.38 (746)	5.63 (143)	7.05 (179)	198.7
		3	460	20	▲	60.20 (1529)	30.83 (783)	29.38 (746)	5.63 (143)	7.05 (179)	198.7
475S250-3A	166	3	230	25	▲	67.41 (1712)	33.00 (838)	34.41 (874)	5.63 (143)	7.05 (179)	218.2
		3	460	25	▲	67.41 (1712)	33.00 (838)	34.41 (874)	5.63 (143)	7.05 (179)	218.2
475S300-3	177	3	230	30	▲	69.97 (1777)	35.56 (903)	34.41 (874)	5.63 (143)	7.05 (179)	233.6
		3	460	30	▲	69.97 (1777)	35.56 (903)	34.41 (874)	5.63 (143)	7.05 (179)	233.6
475S300-4AB	168	3	230	30	▲	75.00 (1905)	35.56 (903)	39.45 (1002)	5.63 (143)	7.05 (179)	239.9
		3	460	30	▲	75.00 (1905)	35.56 (903)	39.45 (1002)	5.63 (143)	7.05 (179)	239.9
475S400-4	236	3	460	40	▲	79.73 (2025)	40.28 (1023)	39.45 (1002)	5.63 (143)	7.05 (179)	268.5
475S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 475 gpm (6" NPT)											
475S400-5B	268	3	460	40	▲	84.77 (2153)	40.28 (1023)	44.49 (1130)	5.63 (143)	7.05 (179)	356.0
475S500-5	296	3	460	50	☼	100.6 (2555)	56.11 (1425)	44.49 (1130)	5.67 (144)	7.05 (179)	384.0
475S500-6A	344	3	460	50	☼	105.63 (2683)	56.11 (1425)	49.53 (1258)	5.67 (144)	7.05 (179)	385.0
475S600-6	355	3	460	60	♦	—	—	50.08 (1272)	—	7.05 (179)	—
475S600-7	415	3	460	60	♦	—	—	55.12 (1400)	—	7.05 (179)	—
475S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 475 gpm (6" NPT)											
475S400-4	236	3	460	40	*	83.71 (2126)	43.71 (1110)	40.00 (1016)	7.56 (192)	8.08 (205)	406.5
475S400-5B	268	3	460	40	*	88.75 (2254)	43.71 (1110)	45.04 (1144)	7.56 (192)	8.08 (205)	—
475S500-5	296	3	460	50	*	90.71 (2304)	45.67 (1160)	45.04 (1144)	7.56 (192)	8.08 (205)	420.4
475S500-6A	344	3	460	50	*	95.75 (2432)	45.67 (1160)	50.08 (1272)	7.56 (192)	8.08 (205)	—
475S600-6	355	3	460	60	*	100.08 (2542)	50.00 (1270)	50.08 (1272)	7.56 (192)	8.08 (205)	476.0
475S600-7	415	3	460	60	*	105.12 (2670)	50.00 (1270)	55.12 (1400)	7.56 (192)	8.08 (205)	482.6
475S750-8	534	3	460	75	*	113.31 (2878)	53.15 (1350)	60.16 (1528)	7.56 (192)	8.08 (205)	524.4
475S1000-9	534	3	460	100	*	127.8 (3246)	62.60 (1590)	65.20 (1656)	7.56 (192)	8.08 (205)	631.0
475S1000-10	593	3	460	100	*	132.84 (3374)	62.60 (1590)	70.24 (1784)	7.56 (192)	8.08 (205)	637.6
475S1000-11	653	3	460	100	*	137.88 (3502)	62.60 (1590)	75.28 (1912)	7.56 (192)	8.08 (205)	644.3
475S1250-12	712	3	460	125	*	152.37 (3870)	72.05 (1830)	80.32 (2040)	7.56 (192)	8.08 (205)	754.1
475S1250-13	772	3	460	125	*	157.41 (3998)	72.05 (1830)	85.36 (2168)	7.56 (192)	8.08 (205)	760.7

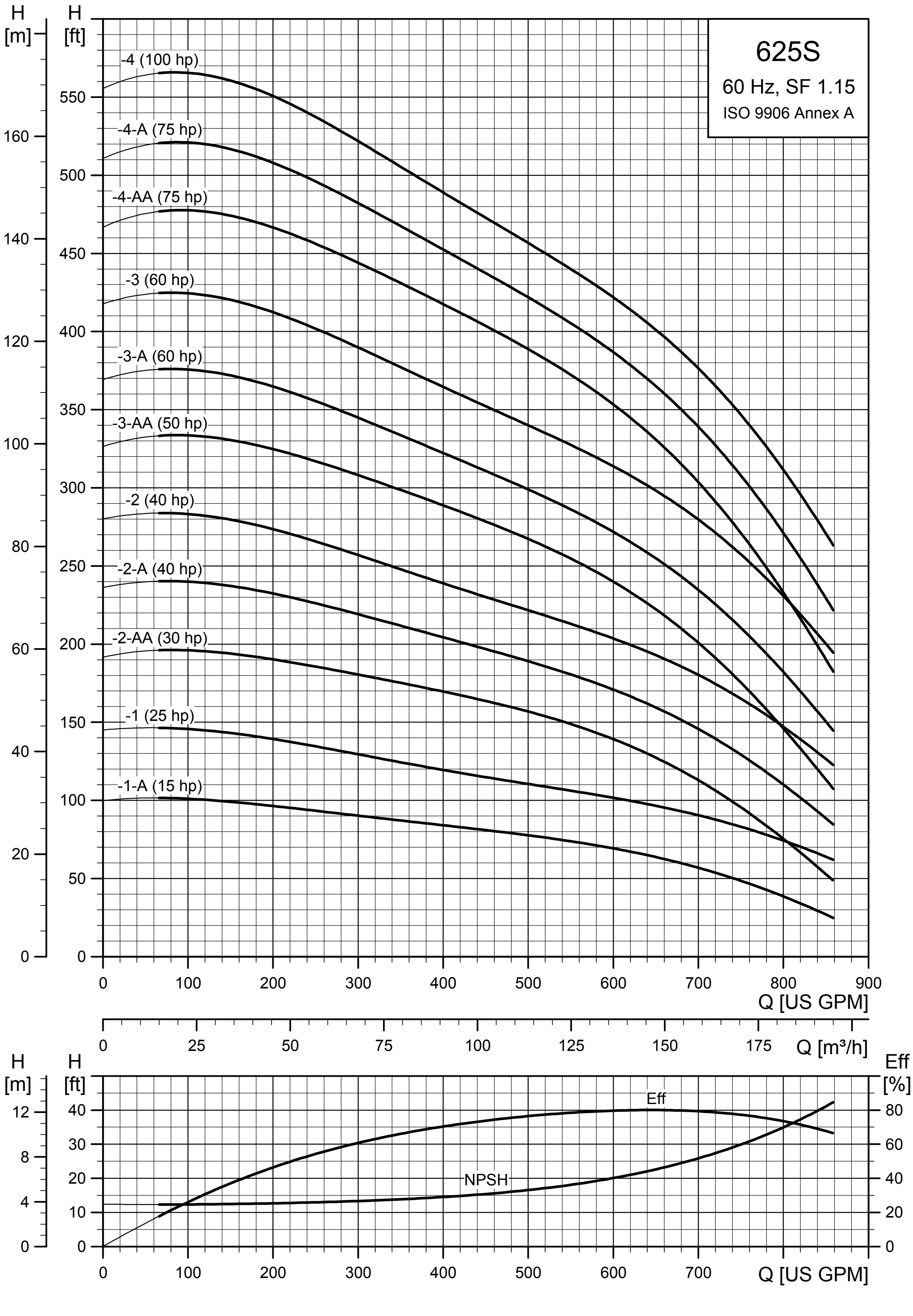


E = Maximum diameter of pump including cable guard and motor.

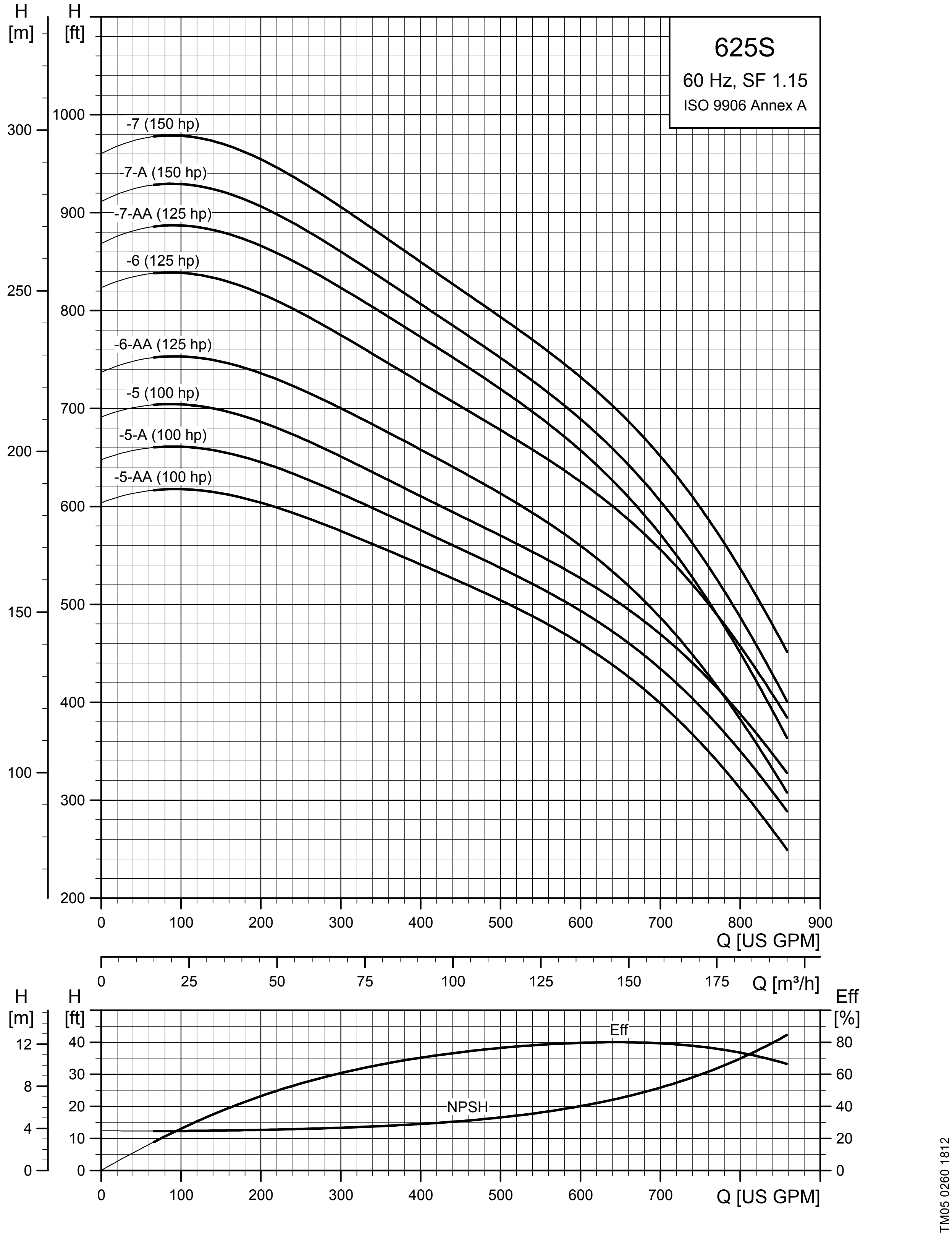
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

625S (625 gpm)

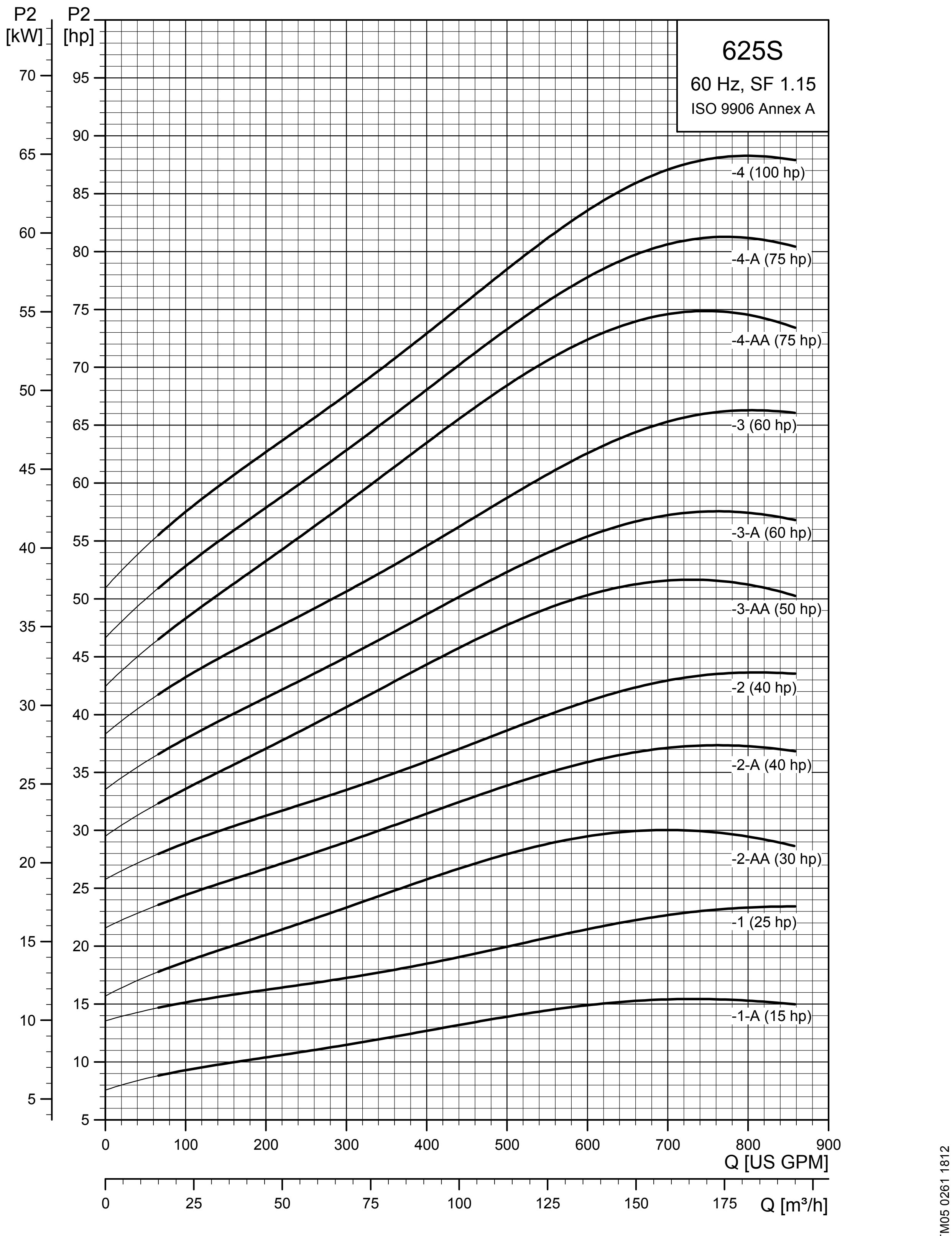

625S
60 Hz, SF 1.15
ISO 9906 Annex A
-4 (100 hp)
-4-A (75 hp)
-4-AA (75 hp)
-3 (60 hp)
-3-A (60 hp)
-3-AA (50 hp)
-2 (40 hp)
-2-A (40 hp)
-2-AA (30 hp)
-1 (25 hp)
-1-A (15 hp)
H [m]
H [ft]
Q [US GPM]
Q [m³/h]
Eff
NPSH
Eff [%]
TM05 0259 1812

625S (625 gpm)

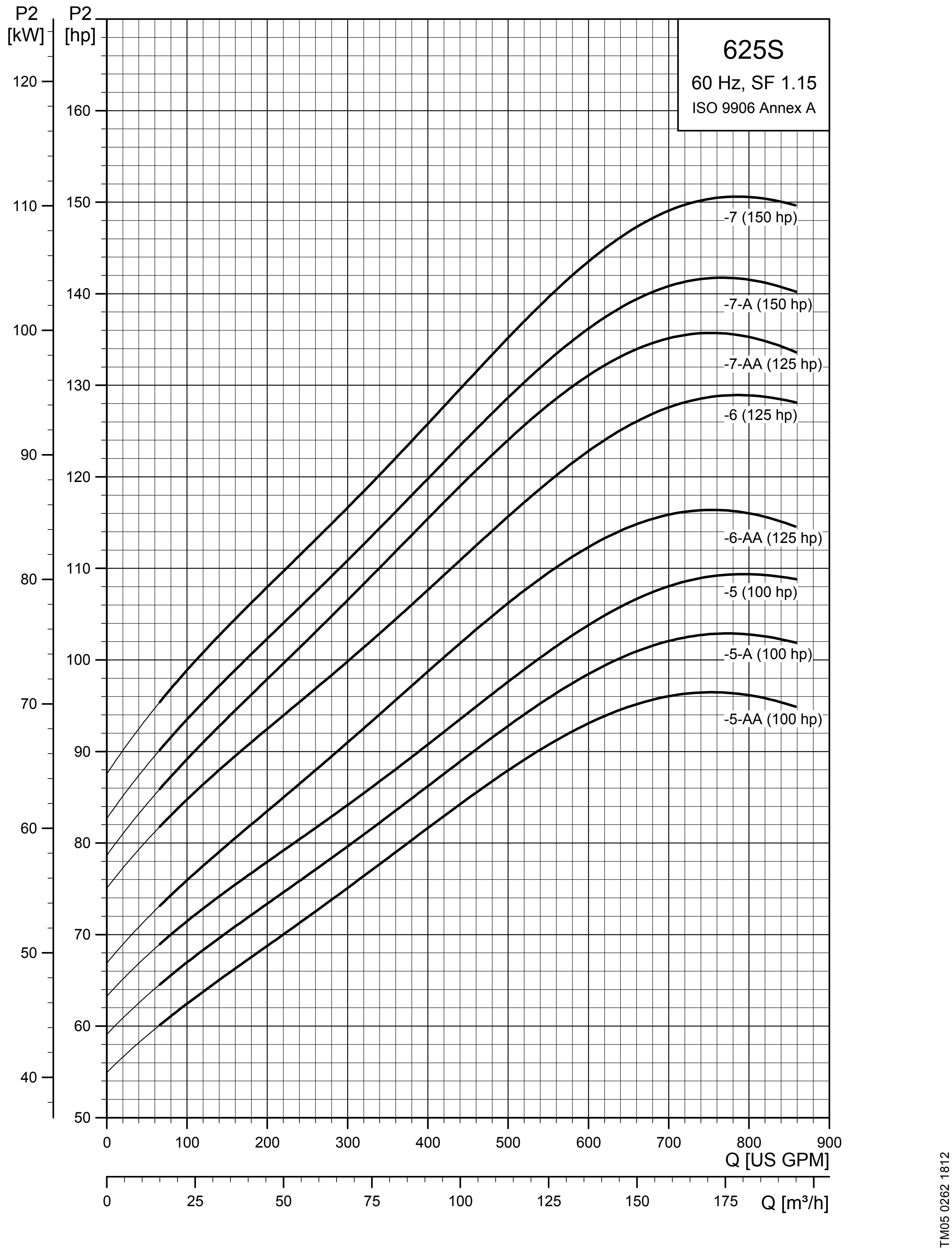


625S
60 Hz, SF 1.15
ISO 9906 Annex A
H [m]
H [ft]
-7 (150 hp)
-7-A (150 hp)
-7-AA (125 hp)
-6 (125 hp)
-6-AA (125 hp)
-5 (100 hp)
-5-A (100 hp)
-5-AA (100 hp)
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0260 1812

625S (625 gpm) pump power requirement (P2)



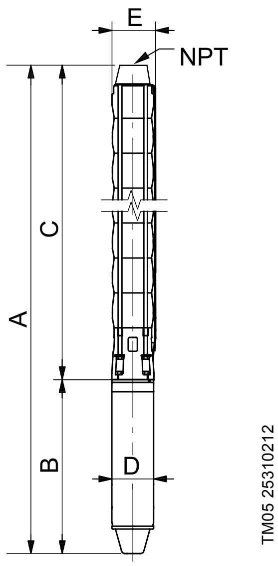
625S (625 gpm) pump power requirement (P2)



625S (625 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
625S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 625 gpm (6" NPT)											
625S150-1A	65	3	230	15	▲	53.51 (1359)	27.88 (708)	25.63 (651)	5.63 (143)	8.31 (211)	193.0
		3	460	15	▲	53.51 (1359)	27.88 (708)	25.63 (651)	5.63 (143)	8.31 (211)	193.0
625S250-1	95	3	230	25	▲	58.63 (1489)	33.00 (838)	25.63 (651)	5.63 (143)	8.31 (211)	189.9
		3	460	25	▲	58.63 (1489)	33.00 (838)	25.63 (651)	5.63 (143)	8.31 (211)	198.9
625S300-2AA	130	3	230	30	▲	67.33 (1710)	35.56 (903)	31.78 (807)	5.63 (143)	8.31 (211)	213.0
		3	460	30	▲	67.33 (1710)	35.56 (903)	31.78 (807)	5.63 (143)	8.31 (211)	222.3
625S400-2A	159	3	460	40	▲	72.05 (1830)	40.28 (1023)	31.78 (807)	5.63 (143)	8.31 (211)	333.8
625S400-2	194	3	460	40	▲	72.05 (1830)	40.28 (1023)	31.78 (807)	5.63 (143)	8.31 (211)	333.8
625S500-3AA	224	3	460	50	♦	94.02 (2388)	56.11 (1425)	37.94 (963)	5.63 (143)	8.31 (211)	376.4
625S600-3A	258	3	460	60	♦	—	—	37.92 (963)	—	8.31 (211)	—
625S600-3	292	3	460	60	♦	—	—	37.92 (963)	—	8.31 (211)	—
625S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 625 gpm (6" NPT)											
625S400-2	194	3	460	40	*	76.03 (1931)	43.71 (1110)	32.33 (821)	7.56 (192)	8.39 (213)	409.4
625S500-3AA	224	3	460	50	*	83.59 (2123)	45.67 (1160)	37.92 (963)	7.56 (192)	8.39 (213)	444.6
625S600-3A	258	3	460	60	*	87.92 (2233)	50.00 (1270)	37.92 (963)	7.56 (192)	8.39 (213)	490.8
625S600-3	292	3	460	60	*	87.92 (2233)	50.00 (1270)	37.92 (963)	7.56 (192)	8.39 (213)	490.8
625S750-4AA	322	3	460	75	*	97.21 (2469)	53.15 (1350)	44.06 (1119)	7.56 (192)	8.39 (213)	534.8
625S750-4A	357	3	460	75	*	97.21 (2469)	53.15 (1350)	44.06 (1119)	7.56 (192)	8.39 (213)	534.8
625S1000-4	391	3	460	100	*	106.66 (2709)	62.60 (1590)	44.06 (1119)	7.56 (192)	8.39 (213)	633.8
6251000-5AA	421	3	460	100	*	112.76 (2864)	62.60 (1590)	50.16 (1274)	7.56 (192)	8.39 (213)	649.3
625S1000-5A	455	3	460	100	*	112.76 (2864)	62.60 (1590)	50.16 (1274)	7.56 (192)	8.39 (213)	649.3
625S1000-5	490	3	460	100	*	112.76 (2864)	62.60 (1590)	50.16 (1274)	7.56 (192)	8.39 (213)	649.3
625S1250-6AA	520	3	460	125	*	128.31 (3259)	72.05 (1830)	56.26 (1429)	7.56 (192)	8.39 (213)	761.5
625S1250-6	554	3	460	125	*	128.31 (3259)	72.05 (1830)	56.26 (1429)	7.56 (192)	8.39 (213)	761.5
625S1250-7AA	618	3	460	125	*	134.45 (3415)	72.05 (1830)	62.41 (1585)	7.56 (192)	8.39 (213)	774.7
625S1500-7A	653	3	460	150	*	143.51 (3645)	81.11 (2060)	62.41 (1585)	7.56 (192)	8.39 (213)	884.7
625S1500-7	687	3	460	150	*	143.51 (3645)	81.11 (2060)	62.41 (1585)	7.56 (192)	8.39 (213)	884.7

625S

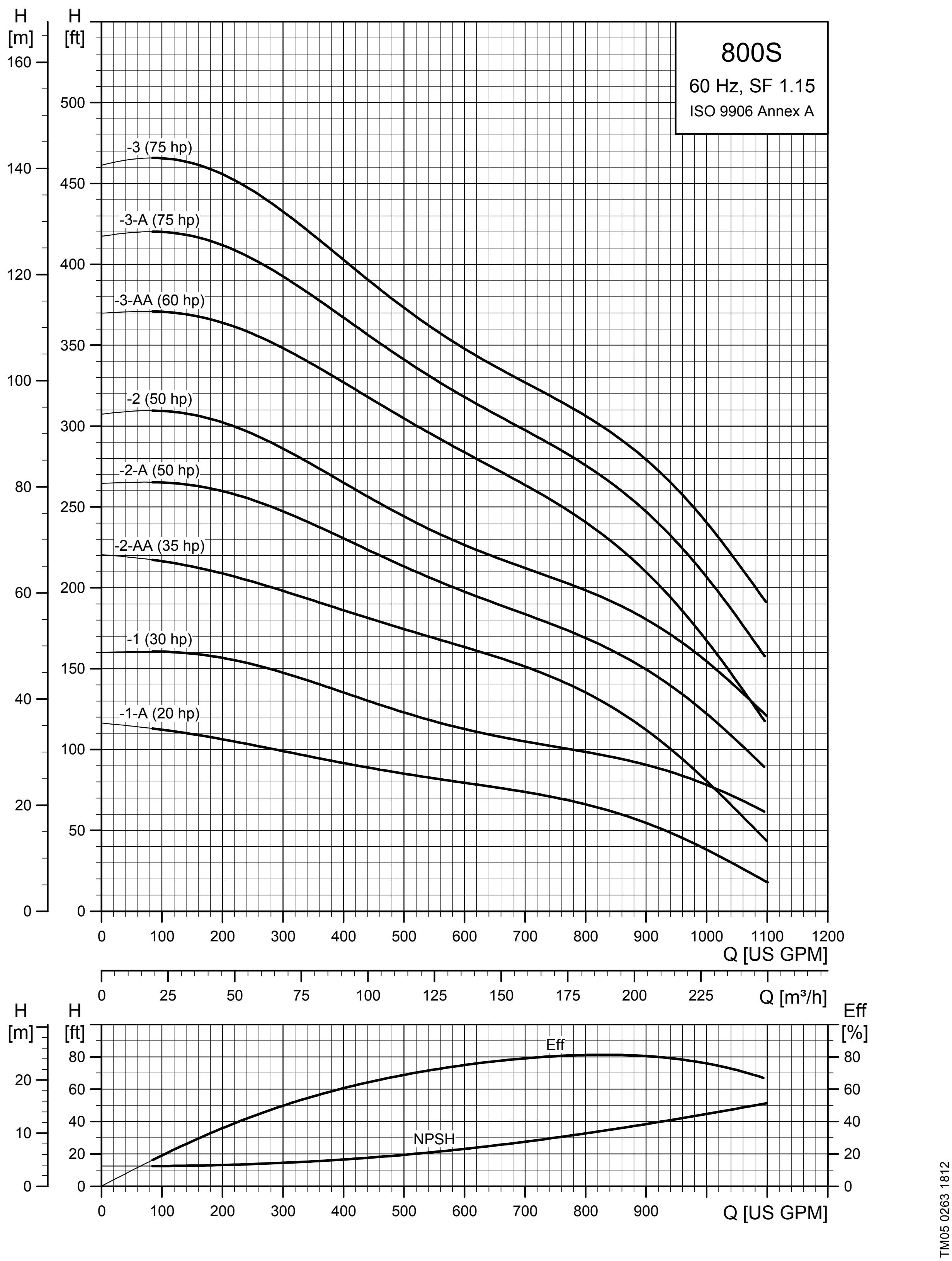


E = Maximum diameter of pump including cable guard and motor.

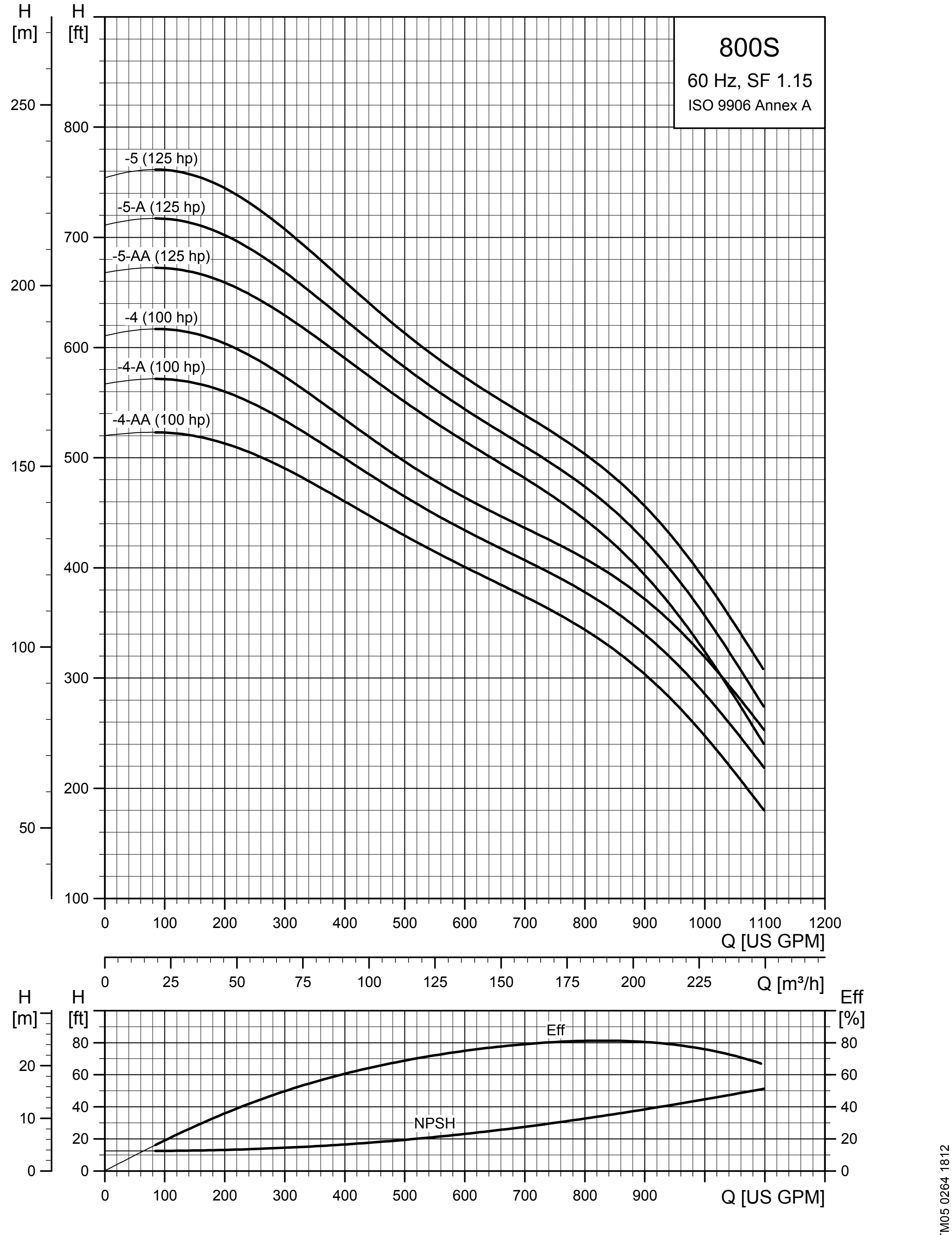
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 10 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ʌ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

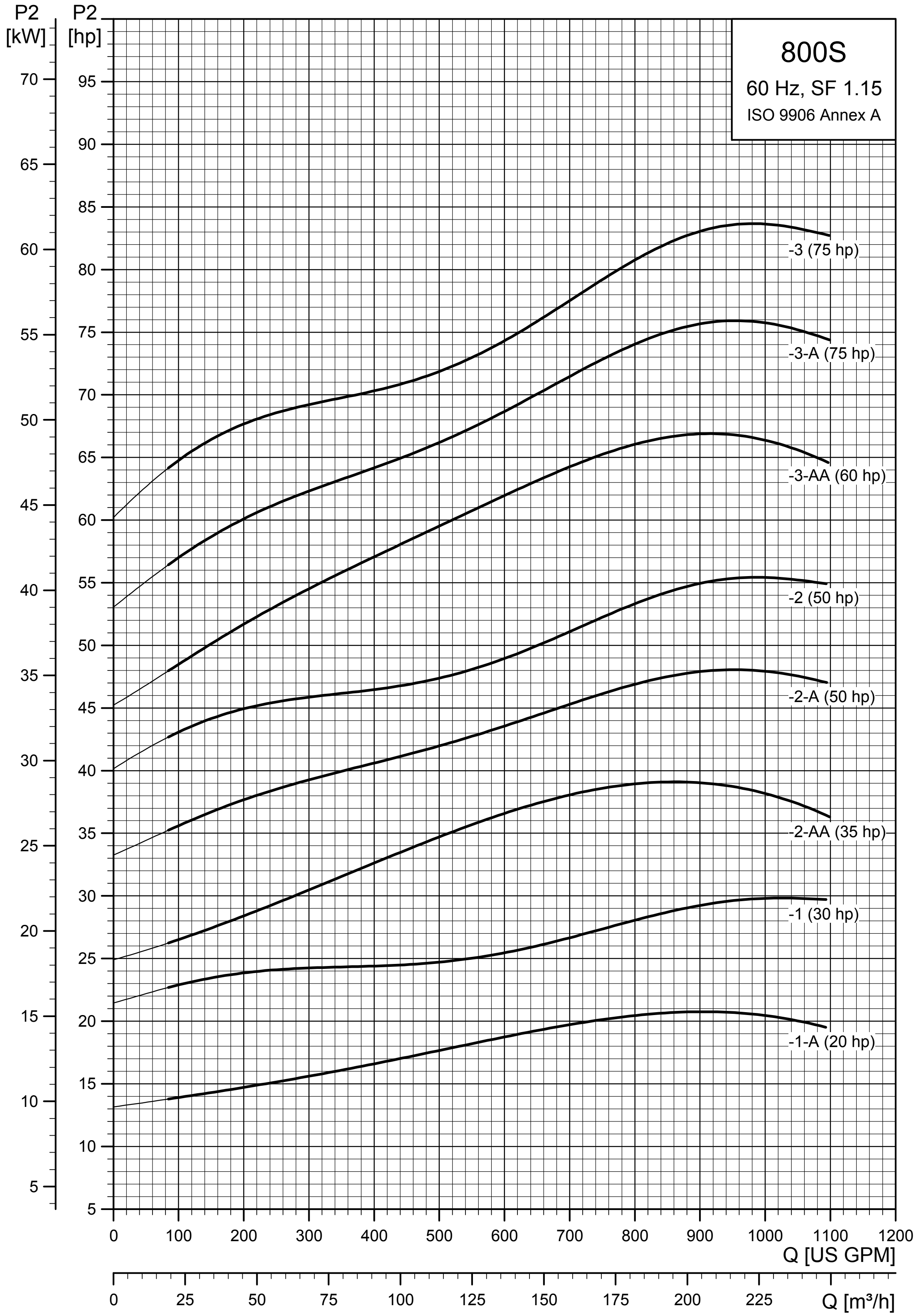
800S (800 gpm)


800S
60 Hz, SF 1.15
ISO 9906 Annex A
-3 (75 hp)
-3-A (75 hp)
-3-AA (60 hp)
-2 (50 hp)
-2-A (50 hp)
-2-AA (35 hp)
-1 (30 hp)
-1-A (20 hp)
H [m]
H [ft]
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0263 1812

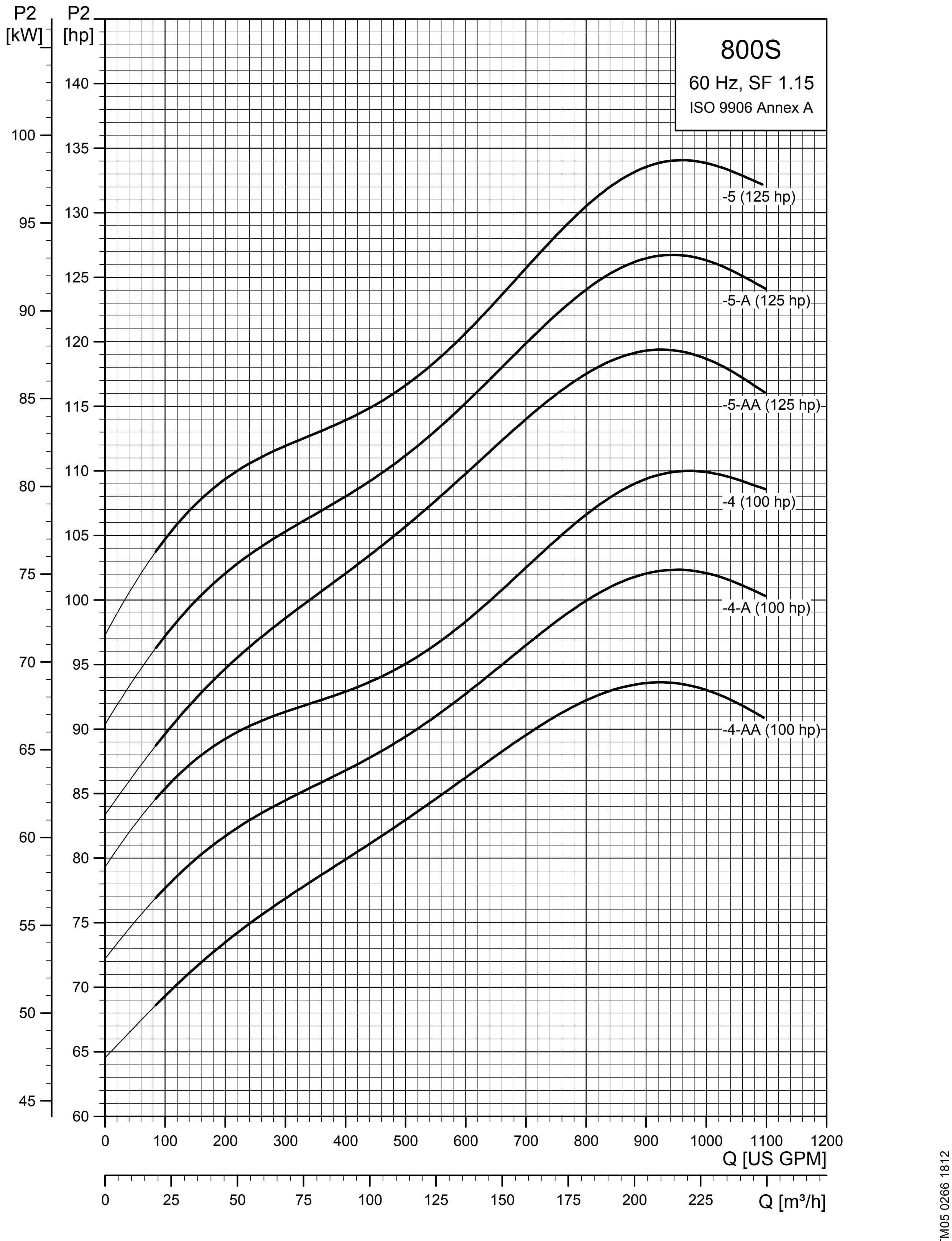
800S (800 gpm)


800S
60 Hz, SF 1.15
ISO 9906 Annex A
-5 (125 hp)
-5-A (125 hp)
-5-AA (125 hp)
-4 (100 hp)
-4-A (100 hp)
-4-AA (100 hp)
H [m]
H [ft]
Q [US GPM]
Q [m³/h]
Eff [%]
Eff
NPSH
TM05 0264 1812

800S (800 gpm) pump power requirement (P2)



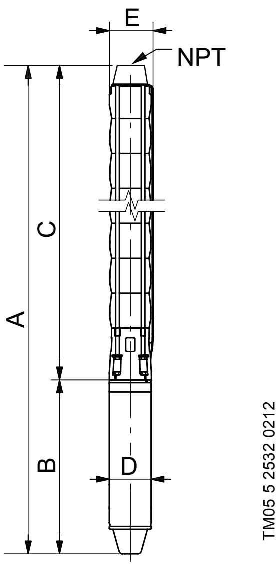
800S (800 gpm) pump power requirement (P2)



800S (800 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	Dimensions B [in (mm)]	Dimensions C [in (mm)]	Dimensions D [in (mm)]	Dimensions E [in (mm)]	Net weight (complete) [lb]
800S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 800 gpm (6" NPT)											
800S200-1A	64	3	230	20	▲	56.50 (1435)	30.83 (783)	25.67 (652)	5.63 (143)	8.31 (211)	180.0
		3	460	20	▲	56.50 (1435)	30.83 (783)	25.67 (652)	5.63 (143)	8.31 (211)	180.0
800S300-1	96	3	230	30	▲	61.23 (1555)	35.56 (903)	25.67 (652)	5.63 (143)	8.31 (211)	202.5
		3	460	30	▲	61.23 (1555)	35.56 (903)	25.67 (652)	5.63 (143)	8.31 (211)	202.5
800S400-2AA	131	3	460	35	▲	72.05 (1830)	40.28 (1023)	31.78 (807)	5.63 (143)	8.31 (211)	257.4
800S500-2A	162	3	460	50	☼	88.00 (2235)	56.11 (1425)	31.87 (810)	7.56 (192)	8.39 (213)	363.2
800S500-2	194	3	460	50	☼	88.00 (2235)	56.11 (1425)	31.87 (810)	7.56 (192)	8.39 (213)	363.2
800S600-3AA	197	3	460	60	♦	—	—	37.92 (963)	—	8.39 (213)	—
800S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 800 gpm (6" NPT)											
800S400-2AA	131	3	460	40	*	75.48 (1917)	43.71 (1110)	31.78 (807)	7.56 (192)	8.39 (213)	409.4
800S500-2A	162	3	460	50	*	77.45 (1967)	45.67 (1160)	31.78 (807)	7.56 (192)	8.39 (213)	431.4
800S500-2	187	3	460	50	*	77.45 (1967)	45.67 (1160)	31.78 (807)	7.56 (192)	8.39 (213)	438.0
800S600-3AA	229	3	460	60	*	87.92 (2233)	50.00 (1270)	37.92 (963)	7.56 (192)	8.39 (213)	490.8
800S750-3A	260	3	460	75	*	91.07 (2313)	53.15 (1350)	37.92 (963)	7.56 (192)	8.39 (213)	523.8
800S750-3	292	3	460	75	*	91.07 (2313)	53.15 (1350)	37.92 (963)	7.56 (192)	8.39 (213)	523.8
800S1000-4AA	327	3	460	100	*	106.62 (2708)	62.60 (1590)	44.02 (1118)	7.56 (192)	8.39 (213)	633.8
800S1000-4A	358	3	460	100	*	106.62 (2708)	62.60 (1590)	44.02 (1118)	7.56 (192)	8.39 (213)	633.8
800S1000-4	389	3	460	100	*	106.62 (2708)	62.60 (1590)	44.02 (1118)	7.56 (192)	8.39 (213)	633.8
800S1250-5AA	426	3	460	125	*	122.21 (3104)	72.05 (1830)	50.16 (1274)	7.56 (192)	8.39 (213)	748.3
800S1250-5A	456	3	460	125	*	122.21 (3104)	72.05 (1830)	50.16 (1274)	7.56 (192)	8.39 (213)	748.3
800S1250-5	487	3	460	125	*	122.21 (3104)	72.05 (1830)	50.16 (1274)	7.56 (192)	8.39 (213)	746.6

800S

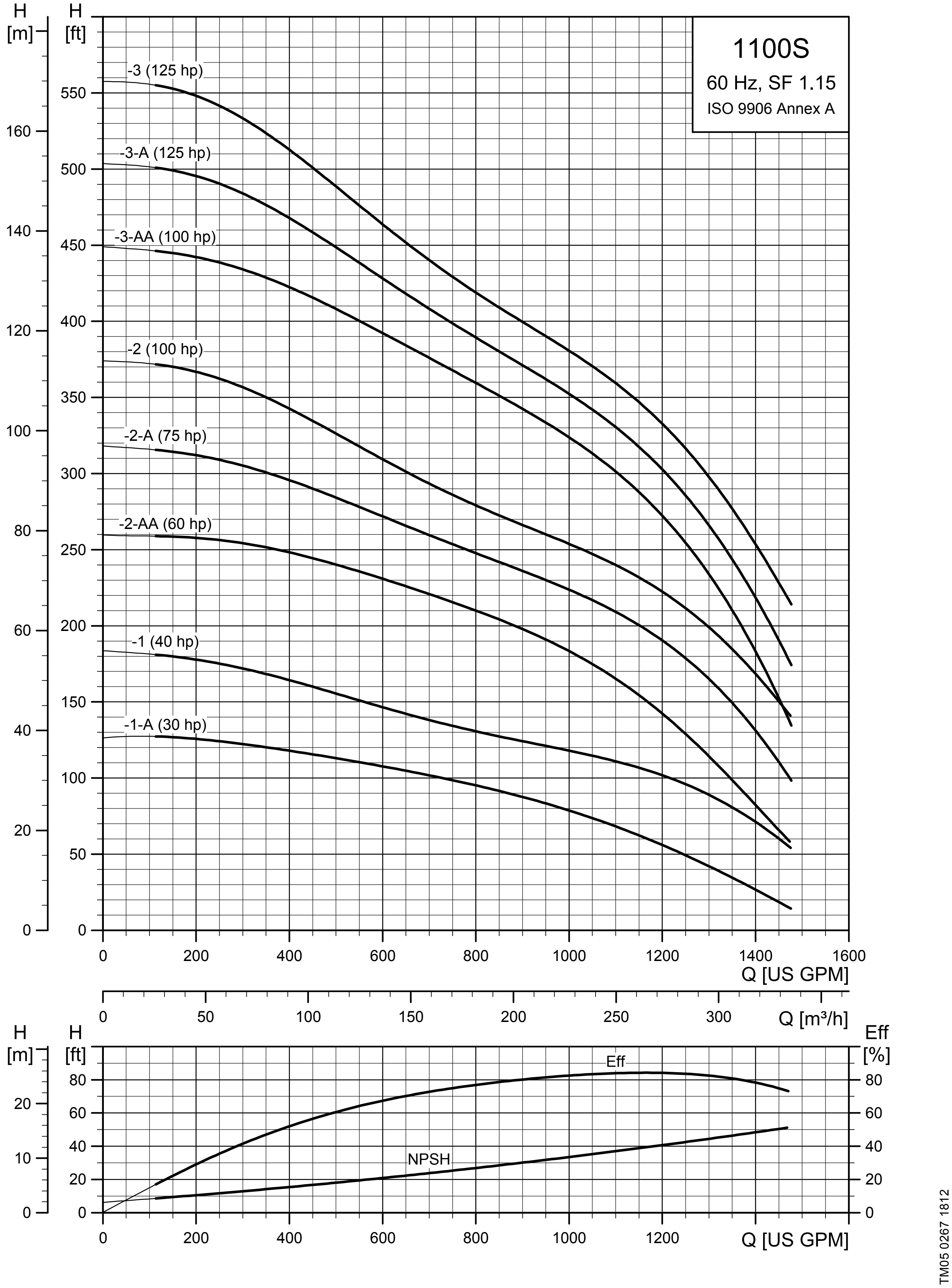


E = Maximum diameter of pump including cable guard and motor.

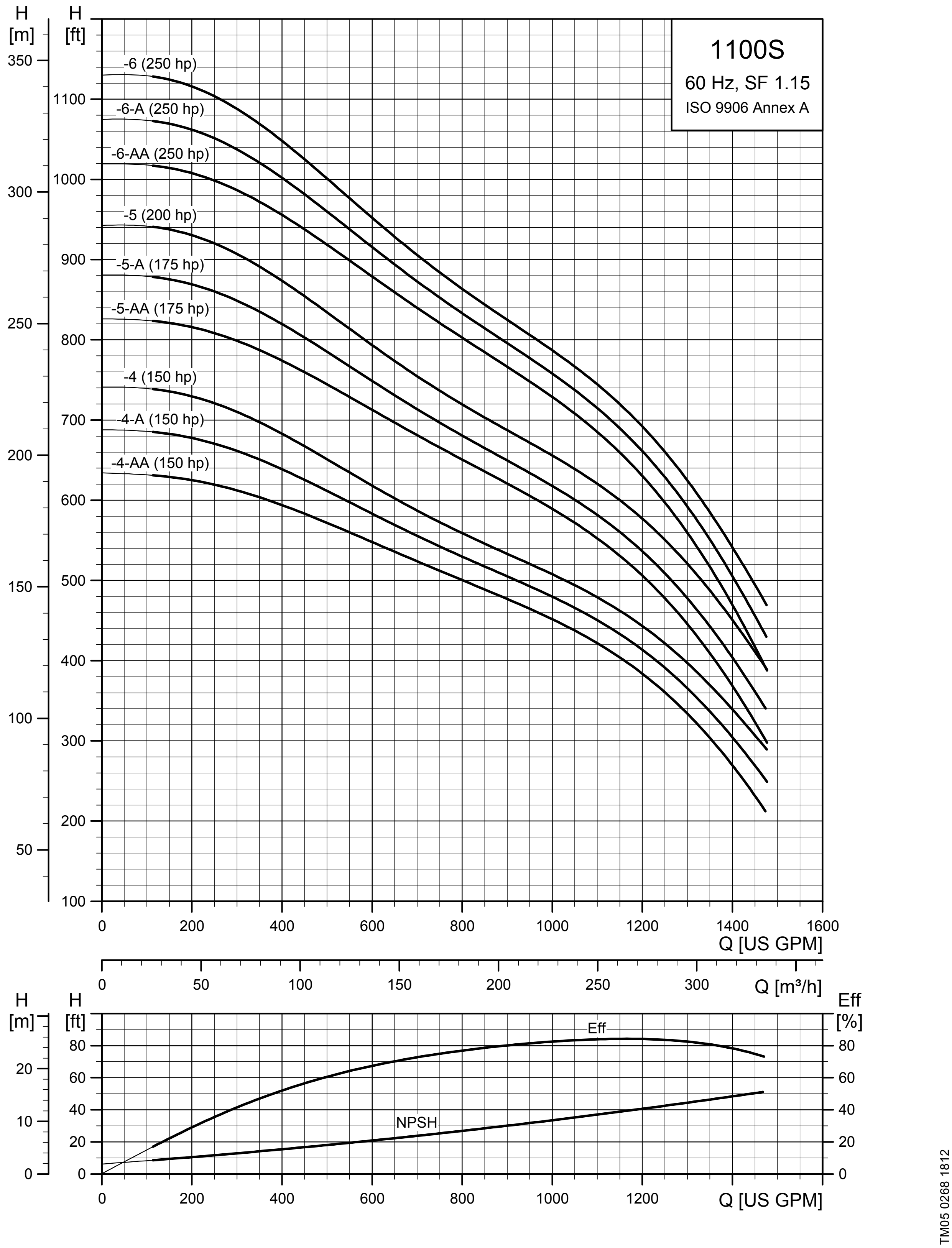
Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 10 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

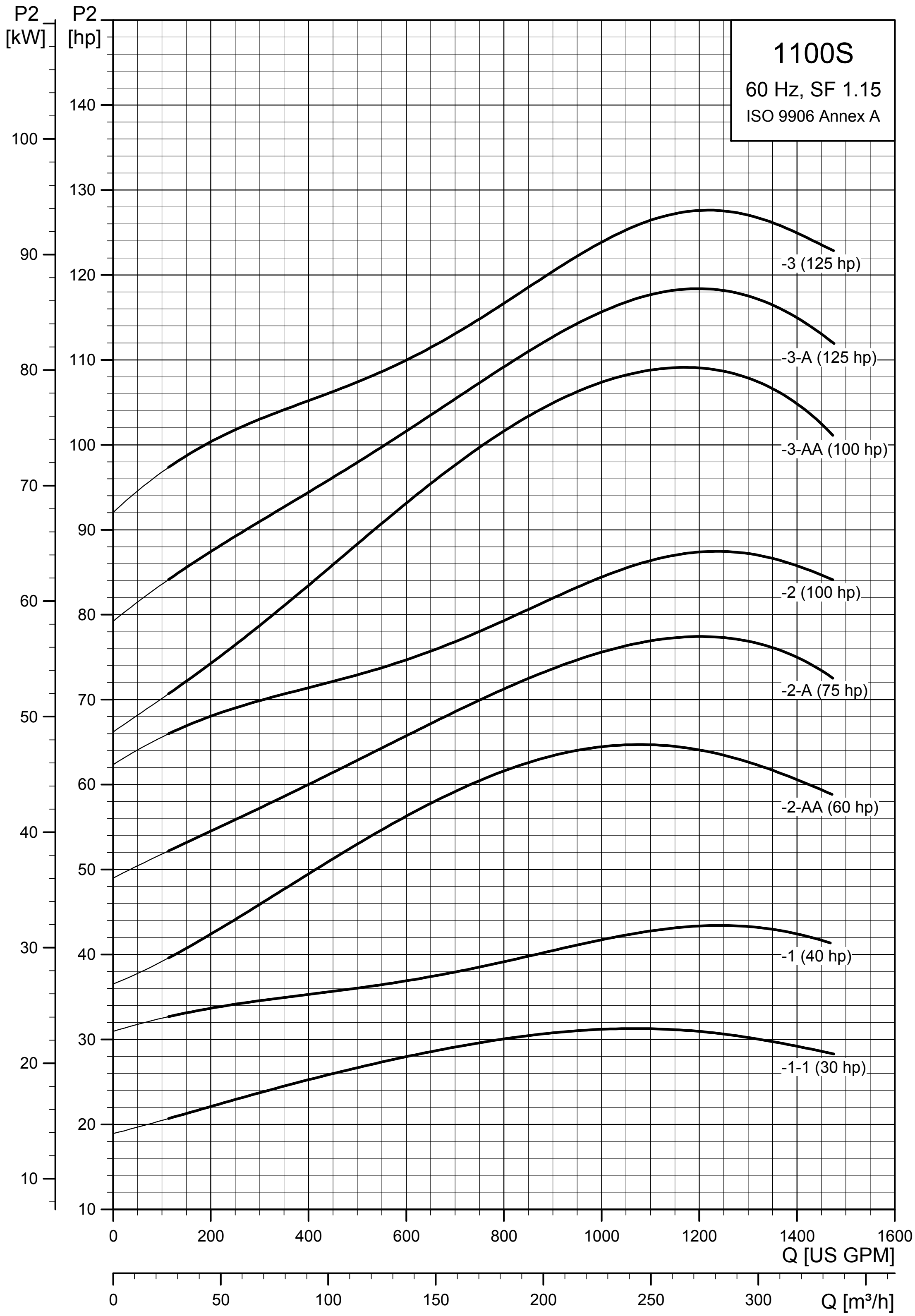
1100S (1100 gpm)



1100S (1100 gpm)

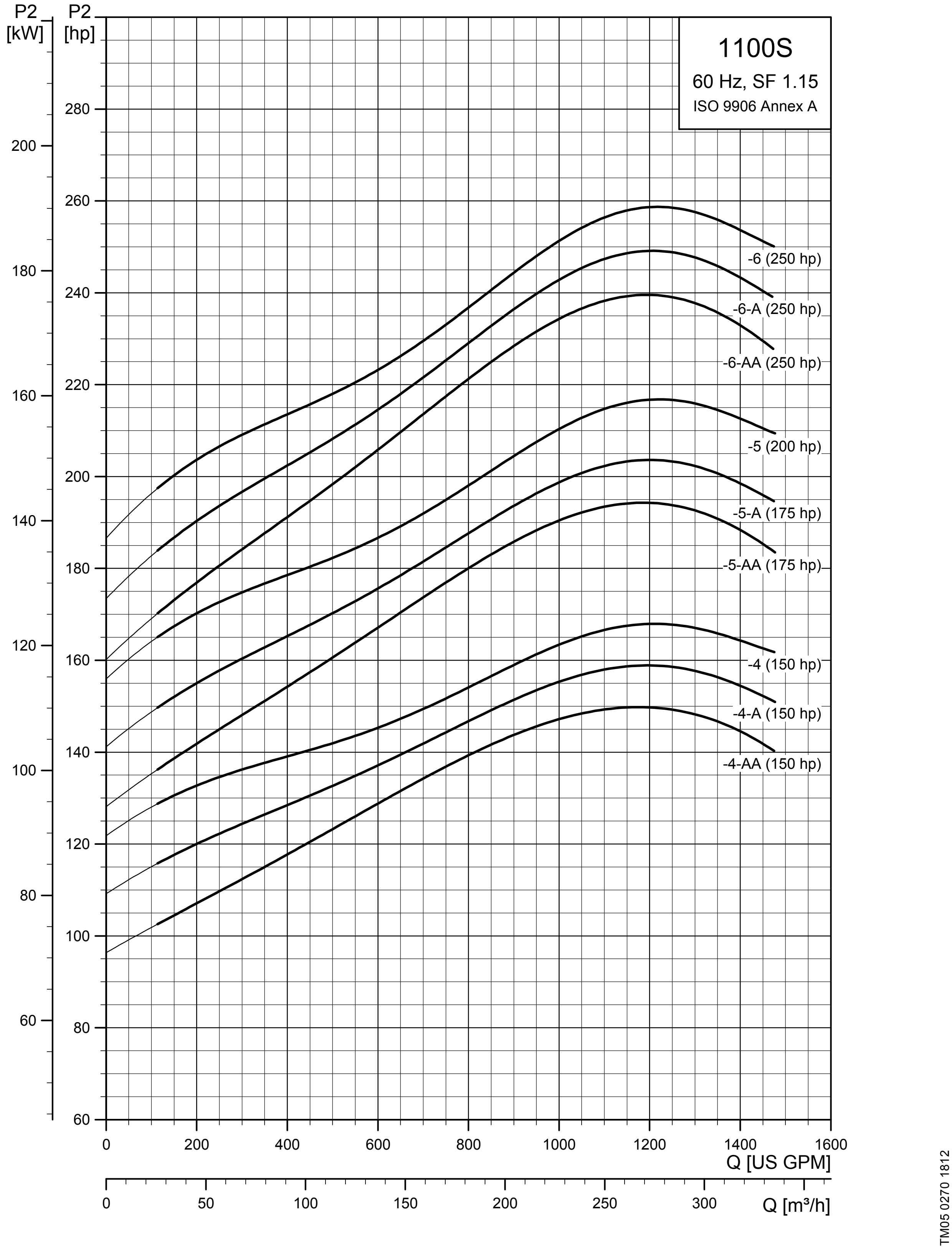


1100S (1100 gpm) pump power requirement (P2)



TM05 0269 1812

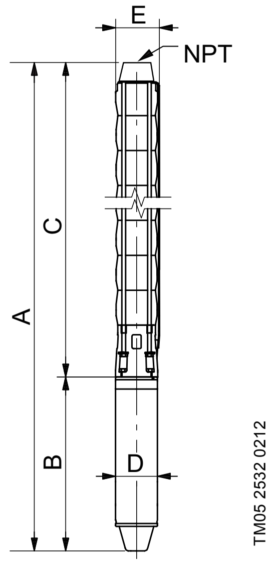
1100S (1100 gpm) pump power requirement (P2)



1100S (1100 gpm)

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in (mm)]	B [in (mm)]	C [in (mm)]	D [in (mm)]	E [in (mm)]	Net weight (complete) [lb]
1100S - Motor dia. 6 inch, 3 wire motor, 60 Hz, rated flow 1100 gpm (6" NPT)											
1100S300-1A	67	3	230	30	▲	66.66 (1693)	35.56 (903)	31.11 (790)	5.63 (143)	9.30 (236)	261.0
		3	460	30	▲	66.66 (1693)	35.56 (903)	31.11 (790)	5.63 (143)	9.30 (236)	261.0
1100S400-1	108	3	460	40	▲	71.38 (1813)	40.28 (1023)	31.11 (790)	5.63 (143)	9.30 (236)	290.6
1100S600-2AA	155	3	460	60	♦	—	—	38.04 (966)	—	9.30 (236)	—
1100S - Motor dia. 8 inch, 3 wire motor, 60 Hz, rated flow 1100 gpm (6" NPT)											
1100S400-1	108	3	460	40	*	74.81 (1900)	43.71 (1110)	31.11 (790)	7.56 (192)	9.41 (239)	407.2
1100S600-2AA	155	3	460	60	*	88.04 (2236)	50.00 (1270)	38.04 (966)	7.56 (192)	9.41 (239)	501.8
1100S750-2A	197	3	460	75	*	91.19 (2316)	53.15 (1350)	38.04 (966)	7.56 (192)	9.41 (239)	534.8
1100S1000-2	227	3	460	100	*	100.63 (2556)	62.60 (1590)	38.04 (966)	7.56 (192)	9.41 (239)	633.8
1100S1000-3AA	286	3	460	100	*	107.56 (2732)	62.60 (1590)	44.97 (1142)	7.56 (192)	9.41 (239)	655.9
1100S1250-3A	316	3	460	125	*	117.01 (2972)	72.05 (1830)	44.97 (1142)	7.56 (192)	9.41 (239)	757.1
1100S1250-3	346	3	460	125	*	117.01 (2972)	72.05 (1830)	44.97 (1142)	7.56 (192)	9.41 (239)	757.1
1100S1500-4AA	405	3	460	150	*	133.00 (3378)	81.11 (2060)	51.89 (1318)	7.56 (192)	9.41 (239)	889.1
1100S1500-4A	435	3	460	150	*	133.00 (3378)	81.11 (2060)	51.89 (1318)	7.56 (192)	9.41 (239)	889.1
1100S1500-4	465	3	460	150	*	133.00 (3378)	81.11 (2060)	51.89 (1318)	7.56 (192)	9.41 (239)	889.1
1100S1750-5AA	524	3	460	175	*	—	—	58.82 (1494)	—	9.41 (239)	—
1100S1750-5A	554	3	460	175	*	—	—	58.82 (1494)	—	9.41 (239)	—
1100S2000-5	584	3	460	200	*	—	—	58.82 (1494)	—	9.41 (239)	—
1100S - Motor dia. 10 inch, 3 wire motor, 60 Hz, rated flow 1100 gpm (6" NPT)											
1100S1750-5AA	524	3	460	175	†	132.45 (3364)	73.63 (1870)	58.82 (1494)	9.34 (237)	9.85 (250)	1142.2
1100S1750-5A -1800	554	3	460	175	†	132.45 (3364)	73.63 (1870)	58.82 (1494)	9.34 (237)	9.85 (250)	1137.0
1100S2000-5	584	3	460	200	†	140.32 (3564)	81.5 (2070)	58.82 (1494)	9.34 (237)	9.85 (250)	1285.2
1100S2500-6AA -2600	703	3	460	250	†	160.24 (4070)	94.49 (2400)	65.75 (1670)	9.34 (237)	9.85 (250)	1478.0
1100S2500-6A-2600	673	3	460	250	†	160.24 (4070)	94.49 (2400)	65.75 (1670)	9.34 (237)	9.85 (250)	1483.2
1100S2500-6-2600	703	3	460	250	†	160.24 (4070)	94.49 (2400)	65.75 (1670)	9.34 (237)	9.85 (250)	1483.2

1100S



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 10 ft. minimum submergence.

- ■ MS402 motor.
- ● MS4000 motor.
- ▲ MS6 motor.
- ∧ MMS6000 motor.
- ★ MMS8000 motor.
- ♦ Takes MS6 motor; not available as complete.
- ☼ Takes MMS6000 motor; not available as complete.
- * Takes MMS8000 motor; not available as complete.
- † Takes MMS10000 motor; not available as complete.

Electrical data

Grundfos submersible pump motors - 60 Hz

Grundfos submersible pump motors - 60 Hz												
Hp	Ph	Volt [V]	S.F.	Circuit breaker		Amperage		Full load		Max. thrust [lbs]	Nameplate number	Product number
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	PF [%]			
4-inch, single-phase, 2-wire motors (control box not required)												
.5	1	115	1.60	35	15	55.0	12.0	62	76	900	79922102	96465574
.5			1.60	15	7	34.5	6.0	62	76	900	79952102	96465616
.75			1.50	20	9	40.5	8.4	62	75	900	79952103	96465618
1	1	230	1.40	25	12	48.4	9.8	63	82	900	79952104	96465620
1.5			1.30	35	15	62.0	13.1	64	85	900	79952105	96465622
4-inch, single-phase, 3-wire motors												
.5	1	115	1.60	35	15	42.5	12.0	61	76	900	79423102	96023039
.5			1.60	15	7	21.5	6.0	62	76	900	79453102	96465606
.75			1.50	20	9	31.4	8.4	62	75	900	79453103	96465608
1			1.40	25	12	37.0	9.8	63	82	900	79453104	96465610
1.5	1	230	1.30	35	15	45.9	11.6	69	89	900	79453105	96465612
2			1.25	35	20	57.0	13.2	72	86	1500	79454506	96449947
3			1.15	45	30	77.0	17.0	74	93	1500	79454507	96449948
5			1.15	70	45	110.0	27.5	77	92	1500	79454509	96449949
4-inch, three-phase, 3-wire motors												
		230	1.30	15	8	40.3	7.3	75	72	900	79302005	96465629
1.5	3	460	1.30	10	4	20.1	3.7	75	72	900	79362005	96465651
		575	1.30	10	4	16.1	2.9	75	72	900	79392005	96785912
		230	1.25	20	10	48	8.7	76	75	900	79302006	96465630
2	3	460	1.25	10	5	24	4.4	76	75	900	79362006	96465652
		575	1.25	10	4	19.2	3.5	76	75	900	79392006	96785917
		230	1.15	30	15	56	12.2	77	75	1500	79304507	96405801
3	3	460	1.15	15	7	28	6.1	77	75	1500	79354507	96405810
		575	1.15	15	6	22	4.8	77	75	1500	79394507	96405815
		230	1.15	40	25	108	19.8	80	82	1500	79304509	96405802
5	3	460	1.15	20	12	54	9.9	80	82	1500	79354509	96405811
		575	1.15	15	9	54	7.9	80	82	1500	79394509	96405816
		230	1.15	60	30	130	25.0	81	82	1500	79305511	96405805
7.5	3	460	1.15	35	15	67	13.2	81	82	1500	79355511	96405814
		575	1.15	30	15	67	10.6	81	82	1500	79395511	96405819
10	3	460	1.15	50	30	90	18	81	80	1500	79355512	96440318
6-inch, three-phase, 3-wire motors												
7.5	3	208-230	1.15	65	40	102-116	27-23.6	82-23	85	1686	78285541	96168843
		460	1.15	30	17	54	11.8	83	85	1686	78355541	96168823
10	3	208-230	1.15	90	50	142-162	35.5-32	82-84	86-84	1686	78285542	96168844
		460	1.15	40	25	75	16.0	84	85	1686	78355542	96168824
15	3	208-230	1.15	130	75	390-500	52-47	83-84	86-84	6182	78285544	96168846
		460	1.15	60	35	112	23.6	85	84	6182	78355544	96168826
20	3	208-230	1.15	175	100	265-305	70-63.5	83-85	86-84	6182	78285546	96168848
		460	1.15	80	45	154	32.0	85	84	6182	78355546	96168828
25	3	208-230	1.15	200	125	410-520	86-78	84-85	87-84	6182	78285547	96168849
		460	1.15	100	60	196	39	85	84	6182	78355547	96168829
30	3	208-230	1.15	250	150	405-475	102-92.5	84-85	87-85	6182	78285548	96168850
		460	1.15	125	70	238	46.0	85	85	6182	78355548	96168830
40	3	460	1.15	170	90	330	63.5	86	84	6182	78355550	96168832
50	3	460	1.15	225	125	470	68.7	84	83	6182	96476890	96023200
8-inch, three-phase, 3-wire motors												
40	3	460	1.15	175	100	380	55.7	83	85	13000	96530180	96023204
50	3	460	1.15	225	125	550	67.8	84	85	13000	96530182	96023205
60	3	460	1.15	250	150	640	80.4	86	85	13000	96476891	96023206
75	3	460	1.15	300	175	580	97.4	86	86	13000	96476892	96023207
100	3	460	1.15	400	225	570	130.4	87	86	13000	96476893	96023208
125	3	460	1.15	500	300	600	160.0	87	87	13000	96476894	96023209
150	3	460	1.15	600	350	580	191.3	86	87	13000	96511375	96023210
10-inch, three-phase, 3-wire motors												
175	3	460	1.15	700	400	570	230.4	88	85	13000	96521619	96937300
200	3	460	1.15	800	500	620	265.2	87	82	13000	96540302	96937302
250	3	460	1.15	1100	600	610	352.2	87	79	13000	96463669	96937316

.Other motor manufacturers

- Hitachi motors: Refer to the Hitachi submersible motors application maintenance manual.
- Franklin motors: Refer to the Franklin submersible motors application maintenance manual.

7. Accessories

MP 204

The MP 204 is an electronic motor protector, designed for the protection of an asynchronous motor or a pump.

The motor protector consists of:

- a cabinet incorporating transformers and electronics
- a control panel with operating buttons and display for reading of data.

The MP 204 operates with two sets of limits:

- a set of warning limits and
- a set of trip limits.

If one or more of the warning limits are exceeded, the motor continues to run, but the warnings will appear in the MP 204 display.

Some values only have a warning limit.

The warning can also be read out by means of the Grundfos R100 remote control.

If one of the trip limits is exceeded, the trip relay will stop the motor. At the same time, the signal relay is operating to indicate that the limit has been exceeded.

Applications

The MP 204 can be used as a stand-alone motor protector.

The MP 204 can be monitored via a Grundfos GENIbus.

The power supply to the MP 204 is in parallel with the supply to the motor. Motor currents up to 120 A are passed directly through the MP 204. The MP 204 protects the motor primarily by measuring the motor current by means of a true RMS measurement. The MP 204 disconnects the contactor if, for example, the current exceeds the preset value.

Secondarily, the motor is protected via temperature measuring by a Tempcon sensor, a Pt100/Pt1000 sensor and a PTC sensor/thermal switch.

The MP 204 is designed for single- and three-phase motors. In single-phase motors, the starting and run capacitors are also measured. Cos φ is measured in both single- and three-phase systems.

Benefits

The MP 204 offers these benefits:

- Suitable for both single- and three-phase motors
- Dry-running protection
- Overload protection
- Very high accuracy
- Made for submersible pumps.

Many monitoring options

The MP 204 monitors the following parameters:

- Insulation resistance before start-up
- Temperature (Tempcon, Pt sensor and PTC/thermal switch)
- Overload/underload
- Overvoltage/undervoltage
- Phase sequence
- Phase failure
- Power factor
- Power consumption
- Harmonic distortion
- Operating hours and number of starts.

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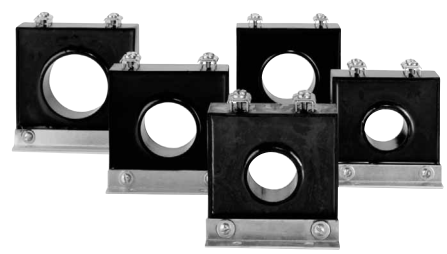
Fig. 21 MP 204

Five sizes of single-turn transformers, 120-999 A.
Note: Monitoring of motor temperature is not possible when single-turn transformers are used.



TM03 2033 3505

Fig. 22 Single-turn transformers

Product numbers

Product	Product number
MP 204	96079927
R100	625333

Functions

- Phase-sequence monitoring
- Indication of current or temperature (user selection)
- Indication of temperature in °F or °C (user selection)
- 4-digit, 7-segment display
- Setting and status reading with the R100
- Setting and status reading via the GENIbus.

Tripping conditions

- Overload
- Underload (dry running)
- Temperature (Tempcon sensor, PTC/thermal switch and Pt sensor)
- Phase failure
- Phase sequence
- Overvoltage
- Undervoltage
- Power factor (cos φ)
- Current unbalance.

Warnings

- Overload
- Underload
- Temperature (Tempcon and Pt sensor)
- Overvoltage
- Undervoltage
- Power factor (cos φ)
  Note: In connection with single- and three-phase connection.
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Loss of communication in network
- Harmonic distortion.

Learning function

- Phase sequence (three-phase operation)
- Run capacitor (single-phase operation)
- Starting capacitor (single-phase operation)
- Identification and measurement of Pt100/Pt1000 sensor circuit.

External current transformers

When fitted with external current transformers, the MP 204 unit can handle currents from 120 to 999 A. Grundfos can supply approved current transformers from stock (200/5A, 300/5A, 500/5A, 750/5A, 1000/5A).

Remote control R100

The R100 remote control from Grundfos allows for wireless infrared remote control of your MP 204 unit.

With the R100, you get access to a full range of options such as factory setting adjustment, service and fault finding.

Ready for bus communication

The MP 204 allows for monitoring and communication via GENIbus — a Grundfos-designed bus for exchange of pump data, alarms, status information, and setpoints. This enables users to connect the MP 204 to, for instance, SCADA systems.

Technical data - MP 204

Enclosure class	IP 20
Ambient temperature	–4 °F to +140 °F (–20 °C to +60 °C)
Relative air humidity	99%
Voltage range	100-480 VAC
Current range	3-999 A
Frequency	50 to 60 Hz
IEC trip class	1-45
Special Grundfos trip class	0.1 to 30 s
Voltage variation	–25 %/+15 % of nominal voltage
Approvals	EN 60947, EN 60335, UL/CSA 508
Marking	CE, cUL, C-tick
Consumption	Max. 5 W
Plastic type	Black PC / ABS

	Measuring range	Accuracy	Resolution
Current without external current transformers	3-120 A	±1 %	0.1 A
Current with external current transformers	120-999 A	±1 %	1 A
Phase-to-phase voltage	80-610 VAC	±1 %	1 V
Frequency	47-63 Hz	±1 %	0.5 Hz
Power	0-1 MW	±2 %	1 W
Power factor	0-0.99	±2 %	0.01
Energy consumption	0-4x10^{9} kWh	±5 %	1 kWh

IO 112	Description	Product number
	The IO 112 is a measuring module and a 1-channel protection unit for use in connection with the MP 204 motor protection unit. The module can be used for protection of pump against other factors than the electrical conditions, for instance dry-running. It can also be used as a stand-alone protection module. The IO 112 interface has three inputs for measured values one potentiometer for setting of limits indicator lights indicating the • measured value of the input • value of the limit set • alarm source • pump status. **Electrical data:** • Supply voltage: 24 VAC ±10% 50/60 Hz or 24 VDC ±10% • Supply current: Min. 2.4 A; max. 8 A • Power consumption:Max. 5 W Ambient temperature: –13 °F to+149 °F (–25 °C to +65 °C) • Enclosure class: IP 20	96651601

Control functions

This table describes the protection provided by MP 204.

Control parameters	Function	Problem	Advantages
Temperature	**MS** The motor temperature is measured by means of the built-in Tempcon temperature transmitter and a signal is sent to MP 204 via the phase leads. In MP 204 the measured temperature is compared with the factory-set value (167 °F (75 °C)). **MMS** The motor temperature is measured by means of the Pt100. The signal is sent to the MP 204 where the measured temperature is compared with the factory-set value. Temperature protection requires a submersible motor with a Pt100. The motor temperature must be monitored during frequency converter operation.	Overload, frequent starts/stops, operation against blocked discharge pipe, insufficient flow velocity past the motor.	Longer motor life, safe operating conditions, service indication.
Overvoltage/ undervoltage	If the set trip value is exceeded, the motor will stop.	The installation is close to a transformer. The mains do not absorb load variations.	Important installation parameter, possibility of improving operating conditions.
Overload	The motor power input is measured on each of the three phases. The registered power input is an average of these three values. If the factory-set value is exceeded, the motor will stop.	Incorrect sizing of pump/motor, voltage supply failure, defective cable, blocking, wear or corrosion.	Longer pump life, safe operating conditions, service indication.
Underload (dry running)	The motor power input is measured on each of the three phases. The registered power input is an average of these three values. If the average value is lower than the factory-set value, the motor will stop.	Pump exposed to dry running or underload, for example caused by wear.	Traditional dry-running protection is no longer necessary, no extra cables.
Current unbalance	The power input of the motor is measured on each of the three phases.	Mains load is uneven, incipient motor defect, phase voltages diverging.	Motor protection against overload, service indication.
Phase sequence	MP 204 and motor are installed so that the phase sequence corresponds to correct direction of rotation. MP 204 monitors changes in the phase sequence.	Two phases are wrongly connected.	Ensures correct pump performance.
Phase failure	MP 204 checks the phases connected, phase failure will cause an alarm.	Phase failure	Indication of phase failure, and alarm.

R100 menus

0. GENERAL

See the operating instructions for the R100.

1. OPERATION

- Operating mode
- Actual trip
- Actual warning 1
- Actual warning 2
- Alarm log 1
- Alarm log 2
- Alarm log 3
- Alarm log 4
- Alarm log 5.

2. STATUS

Display of

- Supply overview
- Average current
- Average voltage
- Tempcon sensor
- Pt100/Pt1000 sensor
- *Power input and energy consumption* (described in the following)
- Energy trip counter
- Phase sequence
- Current unbalance
- Operating hours and number of starts
- Trip counter of hours and starts
- Starting capacitor
- Run capacitor
- Insulation resistance
- Cos φ
- Harmonic distortion.

3. LIMITS

Display and setting of warning and trip limits.

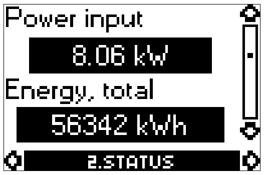
- Tempcon sensor
- Pt sensor
- Tripping current
- Current warning
- Nominal voltage
- Voltage limits
- Current unbalance
- Starting capacitor
- Run capacitor
- Insulation resistance
- Cos φ trip
- Cos φ warning.

4. INSTALLATION

Setting and display of

- Supply mains
- Trip class (described in the following)
- Trip delay
- External current transformers
- Power-on delay
- Restarting (described in the following)
- Automatic restarting (described in the following)
- Tempcon sensor
- Pt sensor
- Insulation resistance measurement
- PTC/thermal switch
- Resetting of trip counters
- Service interval
- Number of automatic restarts
- Units/display
- MP 204 display
- GENIbus ID number
- Learning function.

Power input and energy consumption



Actual input power and motor energy consumption.

The energy consumption is an accumulated value which cannot be reset.

The power is calculated like this:

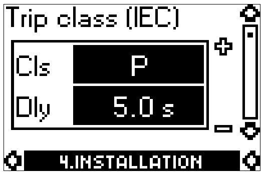
$$U_{average} = \frac{U_{L1-L2} + U_{L2-L3} + U_{L3-L1}}{3} [V]$$

$$I_{average} = \frac{I_{L1} + I_{L2} + I_{L3}}{3} [A]$$

$$\cos\varphi_{average} = \frac{\cos\varphi_{L1} + \cos\varphi_{L2} + \cos\varphi_{L3}}{3} [-]$$

$$P = (U_{average} \times I_{average} \times \sqrt{3} \times \cos\varphi_{average}) [W]$$

Trip class



Line 1: Select IEC trip class (1 to 45).

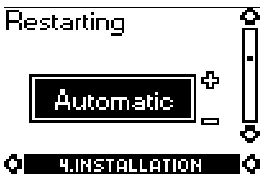
If manual indication of trip delay in the case of overload is required, select trip class "P".

Factory setting:
- Cls (trip class): P.

Line 2: Select trip delay.

Factory setting:
- Dly (trip delay): 10 s.

Restarting



Set whether restarting after tripping is to be

- *Automatic* (factory setting)
- *Manual*.

Setting of time, see section "Automatic restarting".

Automatic restarting

Set the time after which the MP 204 is to attempt automatic restarting of motor after cut-out.

The time runs from the moment when the value which triggered the fault has returned to normal.

Factory setting:
- 300 s.

G100 gateway for communication with Grundfos products

The G100 offers a wide selection of options for integration of Grundfos products provided with GENIbus interface into main control and monitoring systems.

The G100 enables a pump installation to meet future demands for optimum pump operation in terms of reliability, operating costs, centralization and automation.

GR5940

Fig. 23 G100

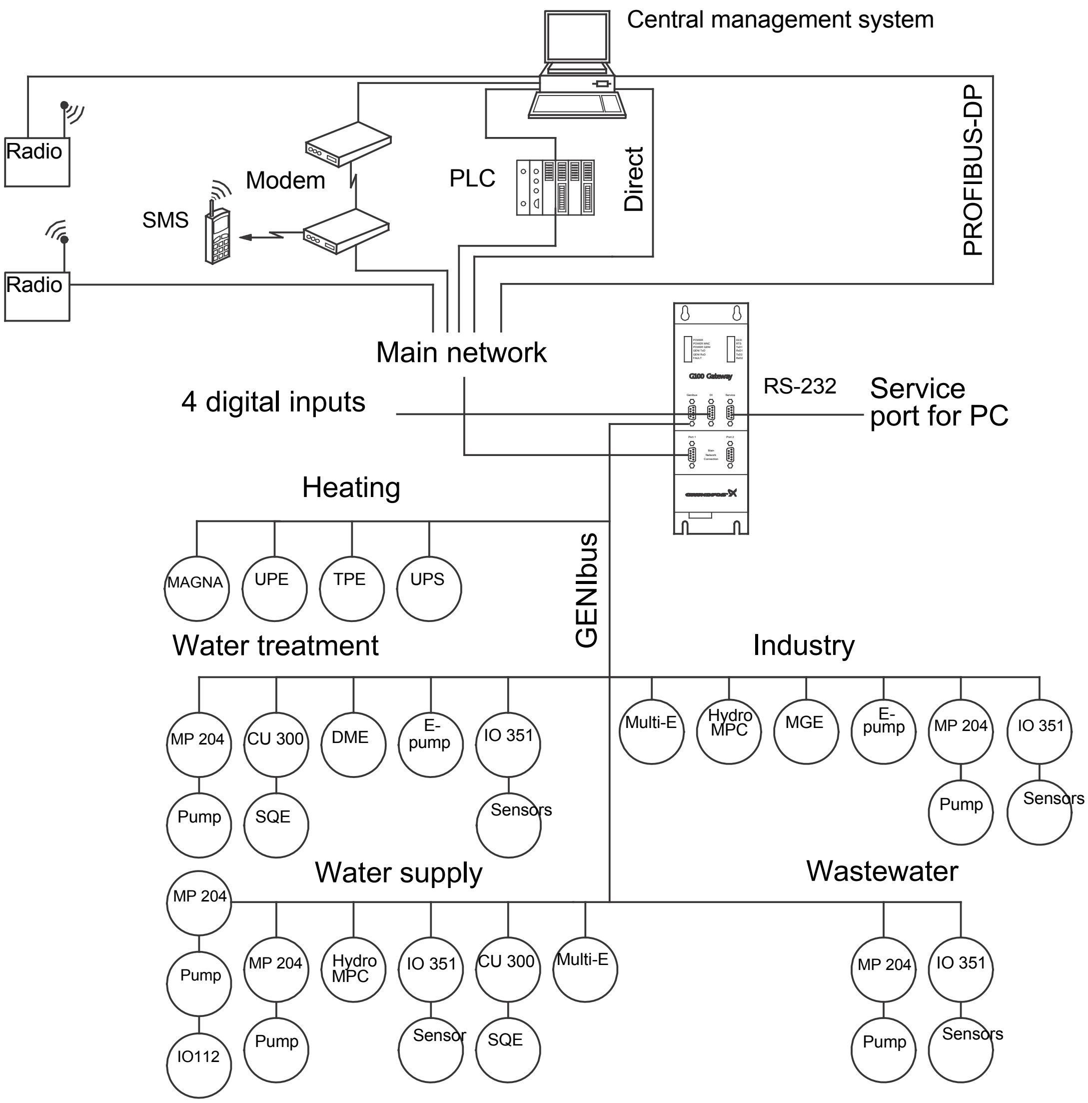


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Fig. 24 Examples of G100 applications

Product description

The G100 Gateway enables communication of operating data, such as measured values and setpoints, between Grundfos products with GENIbus interface and a main network for control and monitoring.

As indicated in the illustration on page 92, the G100 is suitable for use in applications such as water supply, water treatment, wastewater, building automation and industry.

Common to above applications is that downtime is usually costly, and extra investments are therefore often made to achieve maximum reliability by monitoring selected operating variables.

The day-to-day operation, such as starting and stopping of pumps and changing of setpoints, can also be effected from the main system by communication with the G100. In addition, the G100 can be set up to send event-controlled status indications such as alarms via the SMS to mobile phones, and to make automatic alarm call-backs to a central management system.

Data logging

Besides the possibility of data communication, the G100 offers logging of up to 350,000 time-stamped data. The logged data can be transmitted to the main system or a PC for further analysis in a spreadsheet or similar program.

For the data logging, the "PC Tool G100 Data Log" software tool is used. The tool is part of the PC Tool G100 package, which is supplied with the G100.

Other features

- Four digital inputs.
- Stop of all pumps in case of failing communication with the management system (optional).
- Access code for modem communication (optional).
- Alarm log.

Installation

Installation of the G100 is effected by the system integrator. The G100 is connected to the GENIbus as well as to the main network. All units on the GENIbus can thus be controlled from a central management system on the main network.

The "G100 Support Files" CD-ROM supplied with the G100 contains examples of programs to be used when the G100 is connected to the various main network systems. Included is also a description of the data points available in Grundfos products with GENIbus interface.

The "PC Tool G100" software tool included can be used for the installation and use of G100.

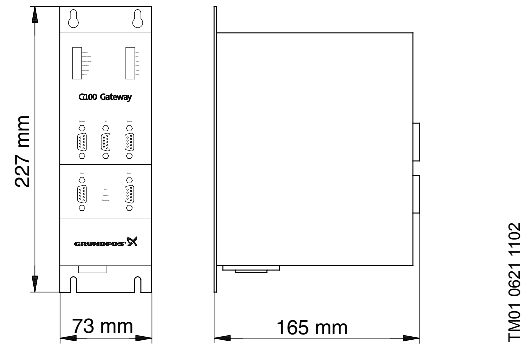


Fig. 25 Dimensional sketch

Technical data

Overview of protocols

Main system	Software protocol
PROFIBUS-DP	DP
Radio	Satt Control COMLI/Modbus
Modem	Satt Control COMLI/Modbus
PLC	Satt Control COMLI/Modbus
GSM mobile phone	SMS, UCP

Other possible connections

GENIbus RS-485:	Connection of up to 32 units.
Service port RS-232:	For direct connection to a PC or via radio modem.
Digital inputs:	4.
Voltage supply:	1 x 110-240 V, 50/60 Hz.
Ambient temperature:	In operation: –4 °F to +140 °F (–20 °C to +60 °C).
Enclosure class:	IP 20.
Weight:	1.8 kg.

Accessories

- PC Tool G100 package (supplied with the product)
- G100 Support Files CD-ROM (supplied with product)

Product numbers

Product	Product number
G100 with Profibus-DP expansion board*	96411135
G100 with Radio/Modem/PLC expansion board*	96411136
G100 Basic Version*	96411137
PC Tool G100 package	96415783

* CD-ROM with G100 Support Files included.

Connecting pieces

The tables below show the range of connecting pieces for connection of thread-to-flange and thread-to-thread.

Thread-to- thread

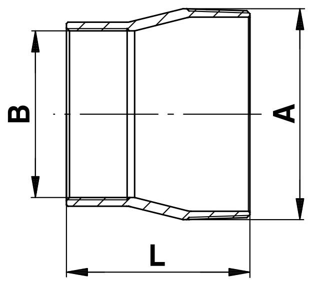


Fig. 26 Dimensional sketch and photo of connecting piece thread-to-thread

Type	Connecting piece	Dimensions			Product number	
		Thread-to-thread		L [in (mm)]		
		A	B		304 stainless steel	316 stainless steel
385S 475S	NPT 5→ NPT 4	NPT 5	NPT 4	4.76 (121)	190064	190586
	NPT 5→ NPT 6	NPT 5	NPT 6	5.91 (150)	190070	190592
625S 800S 1100S	NPT 6→ NPT 5	NPT 6	NPT 5	5.91 (150)	200135	200645

Zinc anodes

Application

Cathodic protection by means of zinc can be used for corrosion protection of SP pumps in chloride-containing liquids such as brackish water and seawater.

Sacrificial anodes are placed on the outside of the pump and motor as protection against corrosion.

The number of anodes required depends on the pump and motor in question.

Please contact Grundfos for further details.

Liquid temperatures

- Seawater:
  Up to 95 °F (35 °C).
- Brackish water (min. 1500 ppm (g/m^3) chloride):
  Up to 95 °F (35 °C).

Anode life

The zinc anodes have a life of one to four years, depending on operating conditions (temperature, flow and chloride content).

SA-SPM 5 control boxes

Application

SA-SPM 5 control boxes are used as starting units for single-phase, 3-wire motors, types MS 402B with power input lower than or equal to 1.5 hp (1.1 kW).

SA-SPM 5 is available in two versions, standard and DeLuxe. The standard version incorporates a motor -protective circuit breaker and thus protects the motor against overload. The DeLuxe version is identical to the standard version with the following addition a motor contactor is included for connection and disconnection of the power supply.

Technical data

Enclosure class:	IP 42.
Ambient temperature:	–4 °F to +140 °F (–20 °C to +60 °C).
Relative humidity:	Maximum 95 %, normal non-aggressive atmosphere.

Product numbers

Product numbers of zinc anodes

Zinc anodes for pumps										
Product number	Used for pump type									
	SP 5S to 75S	85S	150S	230S	300S	385S	475S	625S	800S	1100S
96421444	●	-	-	-	-	-	-	-	-	-
96421445	-	●	●	●	●	-	-	-	-	-
96421447	-	-	-	-	-	●	●	-	-	-
96421448	-	-	-	-	-	-	●	-	-	-
96421449	-	-	-	-	-	-	-	●	-	-
96421450	-	-	-	-	-	-	-	●	●	●

Zinc anodes for motors			
4" motors	6" motors	8" motors	10" motors
96421444	96421446	96421450	96564808

TM03 8150 0607

Fig. 27 SA-SPM 5 control box

Product	Description					Product number
	1 x 220-230 V	1.5 hp	2.0 hp	3.0 hp	5.0 hp	
SA-SPM 5 (Standard version)	●	●	-	-	-	91126212
SA-SPM 5 (DeLuxe version)	●	●	-	-	-	91126213
SA-SPM 5 (Standard version)	●	-	●	-	-	91126214
SA-SPM 5 (DeLuxe version)	●	-	●	-	-	91126215
SA-SPM 5 (Standard version)	●	-	-	●	-	91126216
SA-SPM 5 (DeLuxe version)	●	-	-	●	-	91126217
SA-SPM 5 (Standard version)	●	-	-	-	●	91126218
SA-SPM 5 (DeLuxe version)	●	-	-	-	●	91126219

Pt100

The Pt100 sensor offers these features:

- Continuous monitoring of the motor temperature
- Protection against too high motor temperature.

Protecting the motor against too high motor temperature is the simplest and cheapest way of avoiding that motor lifetime is reduced. Pt100 ensures that operating conditions are not exceeded and indicates when it is time for service of the motor.

Monitoring and protection by means of Pt100 require the following parts:

- Pt100 sensor
- Relay, type PR 5714
- Cable.

The PR 5714 relay is fitted with a Pt100 module. For both relays the following temperature limits are preset on delivery:

- +60 °C (+140 °F) warning limit
- +75 °C (+167 °F) stop limit.

Technical data

	Relay type
	PR 5714
Enclosure class	IP 65 (mounted in a control panel)
Ambient temperature	–4 °F to +140 °F (–20 °C to +60 °C)
Relative humidity	95 % (condensating)
Voltage variation	• 1 x 24-230 VAC ±10 %, 50 - 60 Hz. • 24-250 VDC ±20 %.
Approvals	UL, DNV
Mark	CE

Pt100 sensor with/without PR 5714 relay and cable	Cable length [ft (m)]	PR 5714	Product number		
			MS6	MMS 6000, MMS 8000	MMS 10000, MMS 12000
	65.6 (20)	Yes	96408953	96494596	96437287
	131.2 (40)	Yes	96408681	96494597	96437288
	196.9 (60)	Yes	96408954	96494598	96437289
	262.5 (80)	Yes	96408955	96494599	96437290
	328.1 (100)	Yes	96408956	96494610	96437291
	65.6 (20)	No	96658626	96658629	96658633
	131.2 (40)	No	96658627	96658630	96658634
	196.9 (60)	No	96658628	96658631	96658635
	262.5 (80)	No	96658637	96658632	96658636
	328.1 (100)	No	96658638	96658639	96658640

PR 5714 relay	Voltage	Product number
	24-230 VAC, 50/60 Hz / 24-250 VDC	96621274

Pt100 sensor including cable	Cable length [ft (m)]	Product number	
		MS6, MMS 6000, MMS 8000	MMS 10000 MMS 12000
	65.6 (20)	96408957	96437784
	131.2 (40)	96408684	96437785
	196.9 (60)	96408958	96437786
	262.5 (80)	96408959	96437787
	328.1 (100)	96408960	96437788

Staybolts for Pt100	Description	Product number
	Bolt KIT for Pt100 (for MS6)	96611899

8. Energy consumption

Energy consumption of submersible pumps

The percentage distribution of service life costs of a submersible pump for water supply is:

5 % initial costs (pump)
85 % operating costs / energy consumption
10 % maintenance costs.

It is obvious that the highest savings can be achieved within energy consumption!

The annual energy consumption, E, of a submersible pump can be calculated as follows:

E = c x h x P_1 (USD)

c = specific energy price (USD/kWh)

h = operating hours/year (hours)

P_1 = power input of the submersible pump (hp).

Example: Calculation of the annual energy consumption of the submersible pump, type 625S-3.

625S-3 with MS 8000, 60 hp, 3 x 460 V, 60 Hz.

Duty point:

Flow rate: Q = 528 GPM

Total head: H = 335 ft

Specific energy price: c = USD 0.15/kWh (consisting of day and night rate)

Operating hours/year: h = 3200.

$$P_1 = \frac{Q \times H \times \rho}{367 \times \eta_{pump} \times \eta_{motor}} \text{ in kW}$$

Q = GPM

H = ft

Density ρ = lb/ft^3 (assumed 1)

367 = conversion factor

η_{motor} = (example 84.5 %, in equation 0.845)

η_{pump} = (not to be confused with the stage efficiency curve).

By showing the P_2/Q curve we make it easier for you to calculate the energy consumption.

$$P_1 = \frac{P_2}{\eta_{motor}}$$

P_2 = 35 hp (power requirement of 625S-3 pump at 88 GPM, from curve P_2 / Q.

Calculation of motor efficiency at duty point

As standard the SP 625S-3 is equipped with a 60 hp (45 kW for P1) MS6 motor.

At duty point (Q = 528 GPM) the pump requires 59 hp (44 kW for P1), thus:

a motor load of 87 % (44 kw / 45 kw) and a power reserve of 2 %.

From the table on page 72 the motor efficiency can be read as:

84.6 % at a load of 75 %. ($\eta_{75\%}$)
85.6 % at a load of 100 %. ($\eta_{100\%}$)
The interpolated value in this example is
η_{motor} = 85.1 %, η_{motor} = 0.851.

$$P_1 = \frac{44}{0.851} = 51.7 \text{ kW}$$

E = 0.15 USD/kWh x 3200 h x 51.7 kW.

The annual energy costs amount to USD 24816.

The pay-off time, A, (months) is calculated as follows:

$$A = \frac{\text{Purchase price of energy} - \text{efficiency pump}}{\text{Energy savings/year}} \times 12$$

Cable sizing

In order to obtain an economical duty of the pump the voltage drop should be low.

Today large water works already size cables for a maximum voltage drop of 1 %).

The hydraulic resistance in the discharge pipe should be as low as possible.

9. Cables

Grundfos offers submersible drop cables for all applications: 3-core cable, 4-core cable, single leads.

Cables for Grundfos 4" submersible motors are available with or without plugs. The submersible drop cable is chosen according to application and type of installation.

Standard version:	Max. liquid temperature +140 °F +60 °C).
Hot water version:	Max. liquid temperature +158 °F (+70 °C), for short periods up to 194 °F (+90 °C) (for MS only).

Tables indicating cable dimension in borehole

The tables indicate the maximum length of drop cables in meters from motor starter to pump at direct-on-line starting at different cable dimensions.

If star/delta starting is used the current will be reduced by $\sqrt{3}$ (I x 0.58), meaning that the cable length may be $\sqrt{3}$ longer (L x 1.73) than indicated in the tables.

If for example the operating current is 10 % lower than the full-load current, the cable may be 10 % longer than indicated in the tables.

The calculation of the cable length is based on a maximum voltage drop of 1 % to 3 % of the rated voltage and a water temperature of maximum +86 °F (30 °C).

In order to minimize operating losses the cable cross section may be increased compared to what is indicated in the tables. This is economical only if the borehole provides the necessary space, and if the operational time of the pump is long, especially if the operating voltage is below the rated voltage.

The table values are calculated on the basis of the formula:

Max. cable length of a single-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)} [\mathrm{ft}]$$

Max. cable length of a three-phase submersible pump:

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)} [\mathrm{ft}]$$

where

U = Rated voltage [V]

ΔU = Voltage drop [%]

I = Rated current of the motor [A]

q = Cross-section of submersible drop cable [in^2]

X_L = Inductive resistance: 0.024 x 10^{-3} [Ω/ft]

$\cos\varphi$ = Power factor

$\sin\varphi = \sqrt{1 - \cos^2\varphi}$

ρ = Specific resistance: 9.5 X 10^{-6} [Ω in^2/ft]

Example

Motor size:	40 hp, MMS 8000
Rated current:	64.0 A
Rated voltage:	3 x 460 V, 60 Hz
Starting method:	Direct-on-line
Power factor:	$\cos\varphi$ = 0.85
Voltage drop:	3 %
Cross-section:	0.025 in^2
$\sin\varphi$:	0.53

$$= \frac{460 \times 3}{64.0 \times 1.73 \times 100 \times \left(0.85 \times \frac{0.0000095}{0.025} + 0.53 \times 0.024 \times 10^{-3}\right)}$$

L = 370 ft

Cable dimensions at 1 x 220 V, 60 Hz

Motor	hp	I_n [A]	0.002 in^2	0.004 in^2	0.006 in^2	0.009 in^2	0.016 in^2
4"	0.33	3.3	315	522	833	1243	2047
	0.50	4.4	239	397	630	938	1548
	0.75	6.6	157	262	417	620	1020
	1.00	7.7	121	203	321	482	797
	1.50	9.0	98	164	259	387	643

Maximum cable length in feet from motor starter to pump.

Cable sizing chart

1 phase, 60 Hz

Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
115	0.33	130 (40)	210 (64)	340 (104)	540 (165)	840 (256)	1300 (396)	1960 (597)	2910 (887)					
	0.5	100 (30)	160 (49)	250 (76)	390 (119)	620 (189)	960 (293)	1460 (445)	2160 (658)					
	0.33	550 (168)	880 (268)	1390 (424)	2190 (668)	3400 (1036)	5250 (1600)	7960 (2426)						
	0.5	400 (122)	650 (198)	1020 (311)	1610 (491)	2510 (765)	3880 (1183)	5880 (1792)						
	0.75	300 (91)	480 (146)	760 (232)	1200 (366)	1870 (570)	2890 (881)	4370 (1332)	6470 (1972)					
	1	250 (76)	400 (122)	630 (192)	990 (302)	1540 (469)	2380 (725)	3610 (1100)	5360 (1634)	6520 (1987)				
	1.5	190 (58)	310 (94)	480 (146)	770 (235)	1200 (366)	1870 (570)	2850 (869)	4280 (1305)	5240 (1597)				
	2	150 (46)	250 (76)	390 (119)	620 (189)	970 (296)	1530 (466)	2360 (719)	3620 (1103)	4480 (1366)				
	3	120 (37)	190 (58)	300 (91)	470 (143)	750 (229)	1190 (363)	1850 (564)	2890 (881)	3610 (1100)				
	5			180 (55)	280 (85)	450 (137)	710 (216)	1110 (338)	1740 (530)	2170 (661)				
	7.5				200 (61)	310 (94)	490 (149)	750 (229)	1140 (347)	1410 (430)				
	10					250 (76)	390 (119)	600 (183)	930 (283)	1160 (354)				

3 phase, 60 Hz

Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
208	1.5	310 (94)	500 (152)	790 (241)	1260 (384)									
	2	240 (73)	390 (119)	610 (186)	970 (296)	1520 (463)								
	3	180 (55)	290 (88)	470 (143)	740 (226)	1160 (354)	1810 (552)							
	5		170 (52)	280 (85)	440 (134)	690 (210)	1080 (329)	1660 (506)						
	7.5			200 (61)	310 (94)	490 (149)	770 (235)	1180 (360)	1770 (539)					
	10				230 (70)	370 (113)	570 (174)	880 (268)	1330 (405)	1640 (500)				
	15					250 (76)	390 (119)	600 (183)	910 (277)	1110 (338)	1340 (408)			
	20						300 (91)	460 (140)	700 (213)	860 (262)	1050 (320)	1270 (387)		
	25							370 (113)	570 (174)	700 (213)	840 (256)	1030 (314)	1170 (357)	
	30							310 (94)	470 (143)	580 (177)	700 (213)	850 (259)	970 (296)	1110 (338)
230	1.5	360 (110)	580 (177)	920 (280)	1450 (442)									
	2	280 (85)	450 (137)	700 (213)	1110 (338)	1740 (530)								
	3	210 (64)	340 (104)	540 (165)	860 (262)	1340 (408)	2080 (634)							
	5		200 (61)	320 (98)	510 (155)	800 (244)	1240 (378)	1900 (579)						
	7.5			230 (70)	360 (110)	570 (174)	890 (271)	1350 (411)	2030 (619)					
	10				270 (82)	420 (128)	660 (201)	1010 (308)	1520 (463)	1870 (570)				
	15					290 (88)	450 (137)	690 (210)	1040 (317)	1280 (390)	1540 (469)			
	20						350 (107)	530 (162)	810 (247)	990 (302)	1200 (366)	1450 (442)		
	25						280 (85)	430 (131)	650 (198)	800 (244)	970 (296)	1170 (357)	1340 (408)	
	30							350 (107)	540 (165)	660 (201)	800 (244)	970 (296)	1110 (338)	1270 (387)
460	1.5	1700 (518)												
	2	1300 (396)	2070 (631)											
	3	1000 (305)	1600 (488)	2520 (768)										
	5	590 (180)	950 (290)	1500 (457)	2360 (719)									
	7.5	420 (128)	680 (207)	1070 (326)	1690 (515)	2640 (805)								
	10	310 (94)	500 (152)	790 (241)	1250 (381)	1960 (597)	3050 (930)							
	15			540 (165)	850 (259)	1340 (408)	2090 (637)	3200 (975)						
	20			410 (125)	650 (198)	1030 (314)	1610 (491)	2470 (753)	3730 (1137)					
	25				530 (162)	830 (253)	1300 (396)	1990 (607)	3010 (917)	3700 (1128)				
	30				430 (131)	680 (207)	1070 (326)	1640 (500)	2490 (759)	3060 (933)	3700 (1128)			
	40						790 (241)	1210 (369)	1830 (558)	2250 (686)	2710 (826)	3290 (1003)		
	50						640 (195)	980 (299)	1480 (451)	1810 (552)	2190 (668)	2650 (808)	3010 (917)	
	60							830 (253)	1250 (381)	1540 (469)	1850 (564)	2240 (683)	2540 (774)	2890 (881)
	75								1030 (314)	1260 (384)	1520 (463)	1850 (564)	2100 (640)	2400 (732)
	100									940 (287)	1130 (344)	1380 (421)	1560 (475)	1790 (546)
	125											1080 (329)	1220 (372)	1390 (424)
	150												1050 (320)	1190 (363)
	200												1080 (329)	1300 (396)
	250													1080 (329)

3 phase, 60 Hz														
Motor rating		Copper wire size												
Volts	Hp	14	12	10	8	6	4	2	0	00	000	0000	250	300
		Maximum motor cable length (motor service to entrance) [ft/m]												
575	1.5	2620 (799)												
	2	2030 (619)												
	3	1580 (482)	2530 (771)											
	5	920 (280)	1480 (451)	2330 (710)										
	7.5	660 (201)	1060 (323)	1680 (512)	2650 (808)									
	10	490 (149)	780 (238)	1240 (378)	1950 (594)									
	15		530 (162)	850 (259)	1340 (408)	2090 (637)								
	20			650 (198)	1030 (314)	1610 (491)	2520 (768)							
	25			520 (158)	830 (253)	1300 (396)	2030 (619)	3110 (948)						
	30				680 (207)	1070 (326)	1670 (509)	2560 (780)	3880 (1183)					
	40					790 (241)	1240 (378)	1900 (579)	2860 (872)	3510 (1070)				
	50						1000 (305)	1540 (469)	2310 (704)	2840 (866)	3420 (1042)			
	60						850 (259)	1300 (396)	1960 (597)	2400 (732)	2890 (881)	3500 (1067)		
	75							1060 (323)	1600 (488)	1970 (600)	2380 (725)	2890 (881)	3290 (1003)	

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.

10. Friction loss tables

Friction loss table - SCH 40 steel pipe										
U.S. gpm	U.S. gph	.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
		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"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.8								
3	180	10.0	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	15.0	4.5						
9	540	78.3	18.8	5.7						
10	600	95.9	23.0	6.9						
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	2.0				
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			95.0	23.5	10.8	3.1	1.3		
45	2,700				29.4	13.5	3.9	1.6		
50	3,000				36.0	16.4	4.7	1.9		
60	3,600				51.0	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					51.0	14.2	5.8	2.0	
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						43.0	17.5	5.8	1.5
200	12,000						66.3	27.0	8.9	2.3
260	15,600							45.0	14.8	3.7
300	18,000							59.6	19.5	4.9

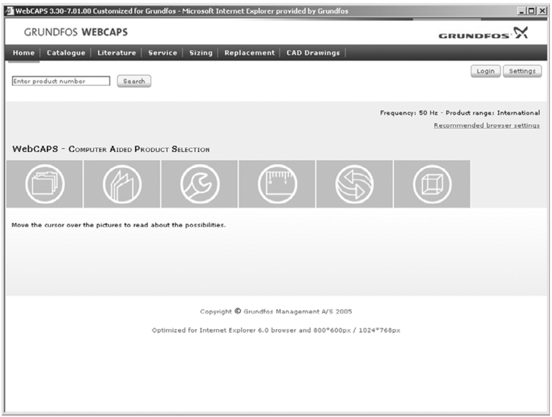
U.S. gpm	U.S. gph	.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
		Friction loss table - SCH 40 PVC pipe								
		ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.1								
3	180	8.7	2.2							
4	240	14.8	3.7							
5	300	22.2	5.7	1.8						
6	360	31.2	8.0	2.5						
7	420	41.5	10.6	3.3						
8	480	53.0	13.5	4.2						
9	540	66.0	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		38.0	11.8	3.1	1.4				
16	960		48.6	15.1	4.0	1.9				
20	1,200		60.5	22.8	6.0	2.8				
25	1,500			38.7	9.1	4.3	1.3			
30	1,800				12.7	6.0	1.8			
35	2,100				16.9	8.0	2.4			
40	2,400				21.6	10.2	3.0	1.1		
45	2,700				28.0	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	3.0	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	8.0	3.0	
140	8,400						30.6	10.5	4.0	1.1
160	9,600						39.3	13.4	5.0	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

Type of fitting and application	Pipe and fitting	Nominal size of fitting and pipe						
		1/2"	3/4"	1"	1.25"	1.5"	2"	2.5"
		Friction loss in equivalent length of straight 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
[1]Friction loss figures are for screwed valves and are based on equivalent lengths of steel pipe.

11. Further product documentation

WebCAPS



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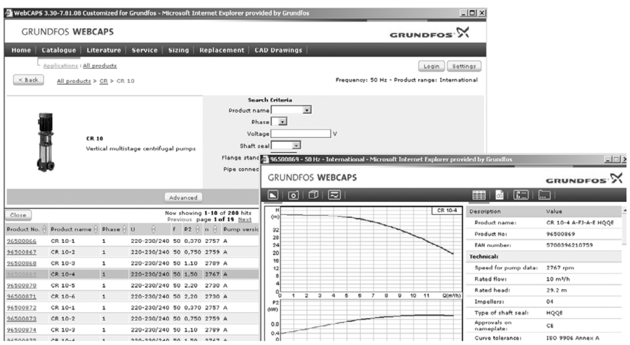
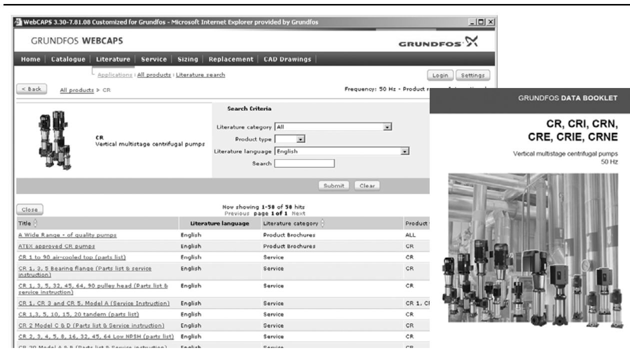
In WebCAPS, all information is divided into 6 sections:

- Catalog
- Literature
- Service
- Sizing
- Replacement
- CAD drawings.



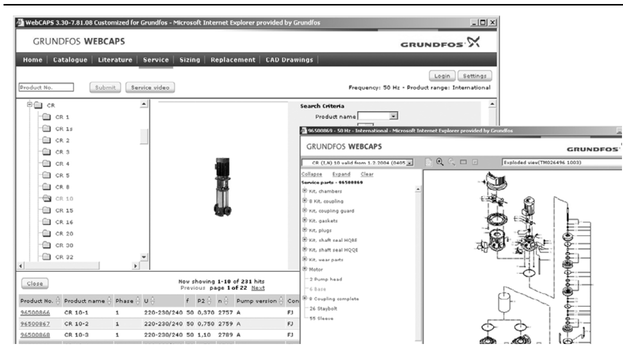
Catalog

This section is based on fields of application and pump types, and contains
- technical data
- curves (QH, Eta, P1, P2, etc) which can be adapted to the density and viscosity of the pumped liquid and show the number of pumps in operation
- product photos
- dimensional drawings
- wiring diagrams
- quotation texts, etc.



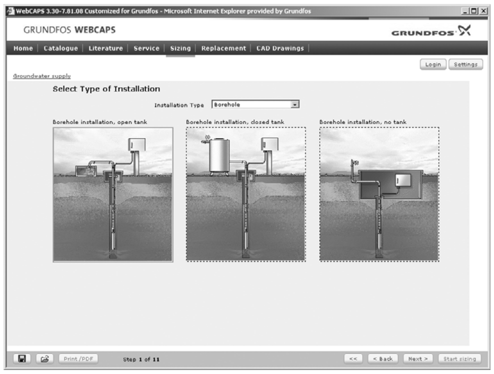
Literature

In this section you can access all the latest documents of a given pump, such as
- product guides
- installation and operating instructions
- service documentation, such as Service kit catalog and Service kit instructions
- quick guides
- product brochures, etc.



Service

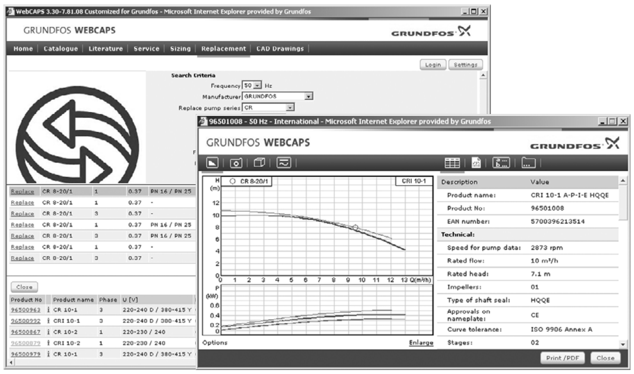
This section contains an easy-to-use interactive service catalog. Here you can find and identify service parts of both existing and discontinued Grundfos pumps.
Furthermore, this section contains service videos showing you how to replace service parts.



Sizing

This section is based on different fields of application and installation examples, and gives easy step-by-step instructions in how to

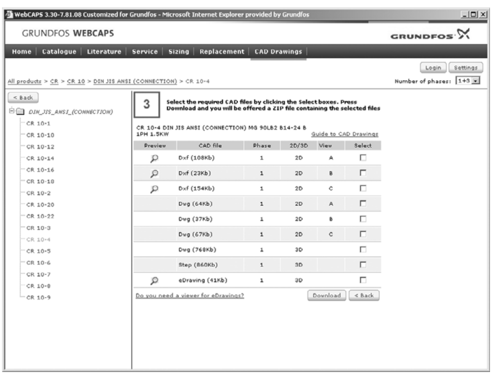
- select the most suitable and efficient pump for your installation
- carry out advanced calculations based on energy consumption, payback periods, load profiles, life cycle costs, etc.
- analyse your selected pump via the built-in life cycle cost tool
- determine the flow velocity in wastewater applications, etc.



Replacement

In this section you find a guide to selecting and comparing replacement data of an installed pump in order to replace the pump with a more efficient Grundfos pump.
The section contains replacement data of a wide range of pumps produced by other manufacturers than Grundfos.

Based on an easy step-by-step guide, you can compare Grundfos pumps with the one you have installed on your site. When you have specified the installed pump, the guide will suggest a number of Grundfos pumps which can improve both comfort and efficiency.



CAD drawings

In this section it is possible to download 2-dimensional (2D) and 3-dimensional (3D) CAD drawings of most Grundfos pumps.

These formats are available in WebCAPS:

2-dimensional drawings:

- .dxf, wireframe drawings
- .dwg, wireframe drawings.

3-dimensional drawings:

- .dwg, wireframe drawings (without surfaces)
- .stp, solid drawings (with surfaces)
- .eprt, E-drawings.

WinCAPS

Fig. 28 WinCAPS CD-ROM

WinCAPS is a **Win**dows-based **C**omputer **A**ided **P**roduct **S**election program containing detailed information on more than 185,000 Grundfos products in more than 20 languages.

The program contains the same features and functions as WebCAPS, but is an ideal solution if no Internet connection is available.

WinCAPS is available on CD-ROM and updated once a year.

BE > THINK > INNOVATE >

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

L-SP-PG-001 0612

US

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GRUNDFOS®

PUMP (MOTOR END) SPECIFICATIONS (FRANKLIN ELECTRIC)

MW16-LGR

MW16-CC

B3-EXW01

B3-EXW02

B3-EXW03

B3-EXW04

B3-EXW05

FRANKLIN ELECTRIC
2011 AIM MANUAL

SUBMERSIBLE MOTORS

Application • Installation • Maintenance

60 Hz, Single-Phase and Three-Phase Motors

System Solutions

Franklin Electric

ATTENTION!
IMPORTANT INFORMATION FOR INSTALLERS OF THIS EQUIPMENT!

THIS EQUIPMENT IS INTENDED FOR INSTALLATION BY TECHNICALLY QUALIFIED PERSONNEL. FAILURE TO INSTALL IT IN COMPLIANCE WITH NATIONAL AND LOCAL ELECTRICAL CODES, AND WITHIN FRANKLIN ELECTRIC RECOMMENDATIONS, MAY RESULT IN ELECTRICAL SHOCK OR FIRE HAZARD, UNSATISFACTORY PERFORMANCE, AND EQUIPMENT FAILURE. FRANKLIN INSTALLATION INFORMATION IS AVAILABLE FROM PUMP MANUFACTURERS AND DISTRIBUTORS, AND DIRECTLY FROM FRANKLIN ELECTRIC. CALL FRANKLIN TOLL FREE 800-348-2420 FOR INFORMATION.

WARNING

SERIOUS OR FATAL ELECTRICAL SHOCK MAY RESULT FROM FAILURE TO CONNECT THE MOTOR, CONTROL ENCLOSURES, METAL PLUMBING, AND ALL OTHER METAL NEAR THE MOTOR OR CABLE, TO THE POWER SUPPLY GROUND TERMINAL USING WIRE NO SMALLER THAN MOTOR CABLE WIRES. TO REDUCE RISK OF ELECTRICAL SHOCK, DISCONNECT POWER BEFORE WORKING ON OR AROUND THE WATER SYSTEM. DO NOT USE MOTOR IN SWIMMING AREAS.

ATTENTION!
INFORMATIONS IMPORTANTES POUR L'INSTALLATEUR DE CET EQUIPEMENT.

CET EQUIPEMENT DOIT ETRE INTALLE PAR UN TECHNICIEN QUALIFIE. SI L'INSTALLATION N'EST PAS CONFORME AUX LOIS NATIONALES OU LOCALES AINSI QU'AUX RECOMMANDATIONS DE FRANKLIN ELECTRIC, UN CHOC ELECTRIQUE, LE FEU, UNE PERFORMANCE NON ACCEPTABLE, VOIRE MEME LE NON-FONCTIONNEMENT PEUVENT SURVENIR. UN GUIDE D'INSTALLATION DE FRANKLIN ELECTRIC EST DISPONIBLE CHEZ LES MANUFACTURIERS DE POMPES, LES DISTRIBUTEURS, OU DIRECTEMENT CHEZ FRANKLIN. POUR DE PLUS AMPLES RENSEIGNEMENTS, APPELEZ SANS FRAIS LE 800-348-2420.

AVERTISSEMENT

UN CHOC ELECTRIQUE SERIEUX OU MEME MORTEL EST POSSIBLE, SI L'ON NEGLIGE DE CONNECTER LE MOTEUR, LA PLOMBERIE METALLIQUE, BOITES DE CONTROLE ET TOUT METAL PROCHE DU MOTEUR A UN CABLE ALLANT VERS UNE ALIMENTATION D'ENERGIE AVEC BORNE DE MISE A LA TERRE UTILISANT AU MOINS LE MEME CALIBRE QUE LES FILS DU MOTEUR. POUR REDUIRE LE RISQUE DE CHOC ELECTRIQUE. COUPER LE COURANT AVANT DE TRAVAILLER PRES OU SUR LE SYSTEM D'EAU. NE PAS UTILISER CE MOTEUR DANS UNE ZONE DE BAIGNADE.

ATENCION!
INFORMACION PARA EL INSTALADOR DE ESTE EQUIPO.

PARA LA INSTALACION DE ESTE EQUIPO, SE REQUIERE DE PERSONAL TECNICO CALIFICADO. EL NO CUMPLIR CON LAS NORMAS ELECTRICAS NACIONALES Y LOCALES, ASI COMO CON LAS RECOMENDACIONES DE FRANKLIN ELECTRIC DURANTE SU INSTALACION, PUEDE OCASIONAR, UN CHOQUE ELECTRICO, PELIGRO DE UN INCENDIO, OPERACION DEFECTUOSA E INCLUSO LA DESCOMPOSTURA DEL EQUIPO. LOS MANUALES DE INSTALACION Y PUESTA EN MARCHA DE LOS EQUIPOS, ESTAN DISPONIBLES CON LOS DISTRIBUIDORES, FABRICANTES DE BOMBAS O DIRECTAMENTE CON FRANKLIN ELECTRIC. PUEDE LLAMAR GRATUITAMENTE PARA MAYOR INFORMACION AL TELEFONO 800-348-2420.

ADVERTENCIA

PUEDE OCURRIR UN CHOQUE ELECTRICO, SERIO O FATAL DEBIDO A UNA ERRONEA CONECCION DEL MOTOR, DE LOS TABLEROS ELECTRICOS, DE LA TUBERIA, DE CUALQUIER OTRA PARTE METALICA QUE ESTA CERCA DEL MOTOR O POR NO UTILIZAR UN CABLE PARA TIERRA DE CALIBRE IGUAL O MAYOR AL DE LA ALIMENTACION. PARA REDUCIR EL RIESGO DE CHOQUE ELECTRIC, DESCONECTAR LA ALIMENTACION ELECTRICA ANTES DE INICIAR A TRABAJAR EN EL SISTEMA HIDRAULICO. NO UTILIZAR ESTE MOTOR EN ALBERCAS O AREAS EN DONDE SE PRACTIQUE NATACION.

Commitment to Quality

Franklin Electric is committed to provide customers with defect free products through our program of continuous improvement. Quality shall, in every case, take precedence over quantity.

Franklin Electric

Pump Equipment installed in Extraction Wells

Well ID	Date Pump Installed	Model	Voltage	Phase	Horsepower
CS-MW16-LGR	November 2007	Grundfos 25S30-15	230	3 Phase	3
CS-MW16-CC	2007	Grundfos 25S50-26	230	3 Phase	5
B3-EXW01-LGR	May 2009	Grundfos 40S50-15	230	1 Phase	5
B3-EXW02-LGR	June 2010	Grundfos 40S50-15	200	3 Phase	5
B3-EXW03-LGR	July 2011	Grundfos 40S50-15	200	3 Phase	5
B3-EXW04-LGR	July 2011	Grundfos 40S50-15	200	3 Phase	5
B3-EXW05-LGR	June 2012	Grundfos 40S50-15	200	3 Phase	5

SUBMERSIBLE MOTORS

60 Hz, Single-Phase and Three-Phase

Application • Installation • Maintenance Manual

The submersible motor is a reliable, efficient and trouble-free means of powering a pump. Its needs for a long operational life are simple. They are:

1. A suitable operating environment
2. An adequate supply of electricity
3. An adequate flow of cooling water over the motor
4. An appropriate pump load

All considerations of application, installation, and maintenance of submersible motors relating to these four areas are presented in this manual. Franklin Electric's web page, www.franklin-electric.com, should be checked for the latest updates.

Contents

Storage

Franklin Electric submersible motors are a water-lubricated design. The fill solution consists of a mixture of deionized water and Propylene Glycol (a non-toxic antifreeze). The solution will prevent damage from freezing in temperatures to -40 °F (-40 °C); motors should be stored in areas that do not go below this temperature. The solution will partially freeze below 27 °F (-3 °C), but no damage occurs. Repeated freezing and thawing should be avoided to prevent possible loss of fill solution.

There may be an interchange of fill solution with well water during operation. Care must be taken with motors removed from wells during freezing conditions to prevent damage.

When the storage temperature does not exceed 100 °F (37 °C), storage time should be limited to two years. Where temperatures reach 100° to 130 °F, storage time should be limited to one year.

Loss of a few drops of liquid will not damage the motor as an excess amount is provided, and the filter check valve will allow lost liquid to be replaced by filtered well water upon installation. If there is reason to believe there has been a considerable amount of leakage, consult the factory for checking procedures.

Frequency of Starts

The average number of starts per day over a period of months or years influences the life of a submersible pumping system. Excessive cycling affects the life of control components such as pressure switches, starters, relays and capacitors. Rapid cycling can also cause motor spline damage, bearing damage, and motor overheating. All these conditions can lead to reduced motor life.

The pump size, tank size and other controls should be selected to keep the starts per day as low as practical for longest life. The maximum number of starts per 24-hour period is shown in table 3.

Motors should run a minimum of one minute to dissipate heat build up from starting current. Six inch and larger motors should have a minimum of 15 minutes between starts or starting attempts.

Table 3 Number of Starts

MOTOR RATING		MAXIMUM STARTS PER 24 HR PERIOD	
HP	KW	SINGLE-PHASE	THREE-PHASE
Up to 0.75	Up to 0.55	300	300
1 thru 5.5	0.75 thru 4	100	300
7.5 thru 30	5.5 thru 22	50	100*
40 and over	30 and over	-	100

* Keeping starts per day within the recommended numbers provides the best system life. However, when used with a properly configured Reduced Voltage Starter (RVS) or Variable Frequency Drive (VFD), 7.5 thru 30 hp three-phase motors can be started up to 200 times per 24 hour period.

Mounting Position

Franklin submersible motors are designed primarily for operation in the vertical, shaft-up position.

During acceleration, the pump thrust increases as its output head increases. In cases where the pump head stays below its normal operating range during startup and full speed condition, the pump may create upward thrust. This creates upward thrust on the motor upthrust bearing. This is an acceptable operation for short periods at each start, but running continuously with upthrust will cause excessive wear on the upthrust bearing.

With certain additional restrictions as listed in this section and the Inline Booster Pump Systems sections of this manual, motors are also suitable for operation in positions from shaft-up to shaft-horizontal. As the mounting position becomes further from vertical and closer to horizontal, the probability of shortened thrust bearing life increases. For normal motor life expectancy with motor positions other than shaft-up, follow these recommendations:

1. Minimize the frequency of starts, preferably to fewer than **10** per 24-hour period. Six and eight inch motors should have a minimum of 20 minutes between starts or starting attempts
2. Do not use in systems which can run even for short periods at full speed without thrust toward the motor.

Transformer Capacity - Single-Phase or Three-Phase

Distribution transformers must be adequately sized to satisfy the kVA requirements of the submersible motor. When transformers are too small to supply the load, there is a reduction in voltage to the motor.

Table 4 references the motor horsepower rating, single-phase and three-phase, total effective kVA required, and the smallest transformer required for open or closed three-phase systems. Open systems require larger transformers since only two transformers are used.

Other loads would add directly to the kVA sizing requirements of the transformer bank.

Table 4 Transformer Capacity

MOTOR RATING		TOTAL EFFECTIVE KVA REQUIRED	SMALLEST KVA RATING-EACH TRANSFORMER	
HP	KW		OPEN WYE OR DELTA 2- TRANSFORMERS	CLOSED WYE OR DELTA 3- TRANSFORMERS
1.5	1.1	3	2	1
2	1.5	4	2	1.5
3	2.2	5	3	2
5	3.7	7.5	5	3
7.5	5.5	10	7.5	5
10	7.5	15	10	5
15	11	20	15	7.5
20	15	25	15	10
25	18.5	30	20	10
30	22	40	25	15
40	30	50	30	20
50	37	60	35	20
60	45	75	40	25
75	55	90	50	30
100	75	120	65	40
125	93	150	85	50
150	110	175	100	60
175	130	200	115	70
200	150	230	130	75

NOTE: Standard kVA ratings are shown. If power company experience and practice allows transformer loading higher than standard, higher loading values may be used to meet total effective kVA required, provided correct voltage and balance is maintained.

Effects of Torque

During starting of a submersible pump, the torque developed by the motor must be supported through the pump, delivery pipe or other supports. Most pumps rotate in the direction which causes unscrewing torque on right-handed threaded pipe or pump stages. All threaded joints, pumps and other parts of the pump support system must be capable of withstanding the maximum torque repeatedly without loosening or breaking. Unscrewing joints will break electrical cable and may cause loss of the pump-motor unit.

To safely withstand maximum unscrewing torques with a minimum safety factor of 1.5, tightening all threaded joints to at least 10 lb-ft per motor horsepower is recommended (table 4A). It may be necessary to tack or strap weld pipe joints on high horsepower pumps, especially at shallower settings.

Table 4A Torque Required (Examples)

MOTOR RATING		MINIMUM SAFE TORQUE-LOAD
HP	KW	
1 hp & Less	0.75 kW & Less	10 lb-ft
20 hp	15 kW	200 lb-ft
75 hp	55 kW	750 lb-ft
200 hp	150 kW	2000 lb-ft

Use of Engine Driven Generators - Single-Phase or Three-Phase

Table 5 lists minimum generator sizes based on typical 80 °C rise continuous duty generators, with 35% maximum voltage dip during starting, for Franklin's three-wire motors, single- or three-phase.

This is a general chart. The generator manufacturer should be consulted whenever possible, especially on larger sizes.

There are two types of generators available: externally and internally regulated. Most are externally regulated. They use an external voltage regulator that senses the output voltage. As the voltage dips at motor start-up, the regulator increases the output voltage of the generator.

Internally regulated (self-excited) generators have an extra winding in the generator stator. The extra winding senses the output current to automatically adjust the output voltage.

Generators must be sized to deliver at least 65% of the rated voltage during starting to ensure adequate starting torque. Besides sizing, generator frequency is important as the motor speed varies with the frequency (Hz). Due to pump affinity laws, a pump running at 1 to 2 Hz below motor nameplate frequency design will not meet its performance curve. Conversely, a pump running at 1 to 2 Hz above may trip overloads.

Generator Operation

Always start the generator before the motor is started and always stop the motor before the generator is shut down. The motor thrust bearing may be damaged if the generator is allowed to coast down with the motor running. This same condition occurs when the generator is allowed to run out of fuel.

Follow generator manufacturer's recommendations for de-rating at higher elevations or using natural gas.

Table 5 Engine Driven Generators

NOTE: This chart applies to 3-wire or 3-phase motors. For best starting of 2-wire motors, the minimum generator rating is 50% higher than shown.

MOTOR RATING		MINIMUM RATING OF GENERATOR			
		EXTERNALLY REGULATED		INTERNALLY REGULATED	
HP	KW	KW	KVA	KW	KVA
1/3	0.25	1.5	1.9	1.2	1.5
1/2	0.37	2	2.5	1.5	1.9
3/4	0.55	3	3.8	2	2.5
1	0.75	4	5.0	2.5	3.13
1.5	1.1	5	6.25	3	3.8
2	1.5	7.5	9.4	4	5
3	2.2	10	12.5	5	6.25
5	3.7	15	18.75	7.5	9.4
7.5	5.5	20	25.0	10	12.5
10	7.5	30	37.5	15	18.75
15	11	40	50	20	25
20	15	60	75	25	31
25	18.5	75	94	30	37.50
30	22	100	125	40	50
40	30	100	125	50	62.5
50	37	150	188	60	75
60	45	175	220	75	94
75	55	250	313	100	125
100	75	300	375	150	188
125	93	375	469	175	219
150	110	450	563	200	250
175	130	525	656	250	313
200	150	600	750	275	344

WARNING: To prevent accidental electrocution, automatic or manual transfer switches must be used any time a generator is used as standby or back up on power lines. Contact power company for use and approval.

Use of Check Valves

It is recommended that one or more check valves always be used in submersible pump installations. If the pump does not have a built-in check valve, a line check valve should be installed in the discharge line within 25 feet of the pump and below the draw down level of the water supply. For deeper settings, check valves should be installed per the manufacturer's recommendations. More than one check valve may be required, but more than the recommended number of check valves should not be used.

Swing type check valves are **not** acceptable and should never be used with submersible motors/pumps. Swing type check valves have a slower reaction time which can cause water hammer (see next page). Internal pump check valves or spring loaded check valves close quickly and help eliminate water hammer.

Check valves are used to hold pressure in the system when the pump stops. They also prevent backspin, water hammer and upthrust. Any of these can lead to early pump or motor failure.

NOTE: Only positive sealing check valves should be used in submersible installations. Although drilling the check valves or using drain-back check valves may prevent back spinning, they create upthrust and water hammer problems.

A. Backspin - With no check valve or a failed check valve, the water in the drop pipe and the water in the system can flow down the discharge pipe when the motor stops. This can cause the pump to rotate in a reverse direction. If the motor is started while it is backspinning, an excessive force is placed across the pump-motor assembly that can cause impeller damage, motor or pump shaft breakage, excessive bearing wear, etc.

B. Upthrust - With no check valve, a leaking check valve, or drilled check valve, the unit starts under a zero head condition. This causes an uplifting or upthrust on the impeller-shaft assembly in the pump. This upward movement carries across the pump-motor coupling and creates an upthrust condition in the motor. Repeated upthrust can cause premature failure of both the pump and the motor.

C. **Water Hammer -** If the lowest check valve is more than 30 feet above the standing (lowest static) water level, or a lower check valve leaks and the check valve above holds, a vacuum is created in the discharge piping. On the next pump start, water moving at very high velocity fills the void and strikes the closed check valve and the stationary water in the pipe above it, causing a hydraulic shock. This shock can split pipes, break joints and damage the pump and/or motor. Water hammer can often be heard or felt. When discovered, the system should be shut down and the pump installer contacted to correct the problem.

Wells – Large Diameter, Uncased, Top Feeding and Screened Sections

Franklin Electric submersible motors are designed to operate with a cooling flow of water over and around the full length of the motor.

If the pump installation does not provide the minimum flow shown in table 6, a flow inducer sleeve (flow sleeve) must be used. The conditions requiring a flow sleeve are:

- Well diameter is too large to meet table 6 flow requirements.
- Pump is in an open body of water.
- Pump is in a rock well or below the well casing.
- The well is “top-feeding” (a.k.a. cascading)
- Pump is set in or below screens or perforations.

Water Temperature and Flow

Franklin Electric’s standard submersible motors, except Hi-Temp designs (see note below), are designed to operate up to maximum service factor horsepower in water up to 86 °F (30 °C). A flow of 0.25 ft/s for 4" motors rated 3 hp and higher, and 0.5 ft/s for 6" and 8" motors is required for proper cooling. Table 6 shows minimum flow rates, in gpm, for various well diameters and motor sizes.

If a standard motor is operated in water over 86 °F (30 °C), water flow past the motor must be increased to maintain safe motor operating temperatures. See HOT WATER APPLICATIONS on page 7.

NOTE: Franklin Electric offers a line of Hi-Temp motors designed to operate in water at higher temperatures or lower flow conditions. Consult factory for details.

Table 6 Required Cooling Flow

MINIMUM GPM REQUIRED FOR MOTOR COOLING IN WATER UP TO 86 °F (30 °C).			
CASING OR SLEEVE ID INCHES (MM)	4" MOTOR (3-10 HP) 0.25 FT/S GPM (L/M)	6" MOTOR 0.50 FT/S GPM (L/M)	8" MOTOR 0.50 FT/S GPM (L/M)
4 (102)	1.2 (4.5)	-	-
5 (127)	7 (26.5)	-	-
6 (152)	13 (49)	9 (34)	-
7 (178)	20 (76)	25 (95)	-
8 (203)	30 (114)	45 (170)	10 (40)
10 (254)	50 (189)	90 (340)	55 (210)
12 (305)	80 (303)	140 (530)	110 (420)
14 (356)	110 (416)	200 (760)	170 (645)
16 (406)	150 (568)	280 (1060)	245 (930)

0.25 ft/s = 7.62 cm/sec 0.50 ft/s = 15.24 cm/sec
1 inch = 2.54 cm

Flow Inducer Sleeve

If the flow rate is less than specified, then a flow inducer sleeve must be used. A flow sleeve is always required in an open body of water. FIG. 1 shows a typical flow inducer sleeve construction.

EXAMPLE: A 6" motor and pump that delivers 60 gpm will be installed in a 10" well.

From table 6, 90 gpm would be required to maintain proper cooling. In this case adding an 8" or smaller flow sleeve provides the required cooling.

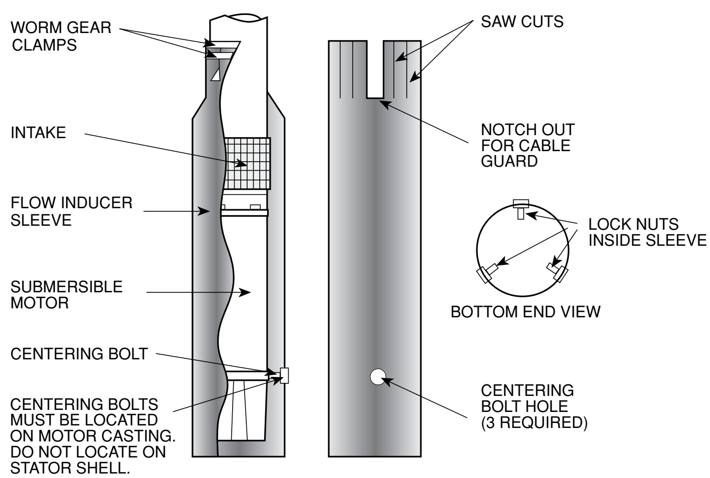

FIG. 1

Head Loss From Flow Past Motor

Table 7 lists the approximate head loss due to flow between an average length motor and smooth casing or flow inducer sleeve.

Table 7 Head Loss in Feet (Meters) at Various Flow Rates

MOTOR DIAMETER		4"	4"	4"	6"	6"	6"	8"	8"
CASING ID IN INCHES (MM)		4 (102)	5 (127)	6 (152)	6 (152)	7 (178)	8 (203)	8.1 (206)	10 (254)
Flow Rate in gpm (l/m)	25 (95)	0.3 (.09)							
	50 (189)	1.2 (.37)							
	100 (378)	4.7 (1.4)	0.3 (.09)		1.7 (.52)				
	150 (568)	10.2 (3.1)	0.6 (.18)	0.2 (.06)	3.7 (1.1)				
	200 (757)		1.1 (.34)	0.4 (.12)	6.3 (1.9)	0.5 (.15)		6.8 (2.1)	
	250 (946)		1.8 (.55)	0.7 (.21)	9.6 (2.9)	0.8 (.24)		10.4 (3.2)	
	300 (1136)		2.5 (.75)	1.0 (.30)	13.6 (4.1)	1.2 (.37)	0.2 (.06)	14.6 (4.5)	
	400 (1514)				23.7 (7.2)	2.0 (.61)	0.4 (.12)	24.6 (7.5)	
	500 (1893)					3.1 (.94)	0.7 (.21)	37.3 (11.4)	0.6 (0.2)
	600 (2271)					4.4 (1.3)	1.0 (.30)	52.2 (15.9)	0.8 (0.3)
	800 (3028)								1.5 (0.5)
	1000 (3785)								2.4 (0.7)

Hot Water Applications (Standard Motors)

Franklin Electric offers a line of Hi-Temp motors which are designed to operate in water with various temperatures up to 194 °F (90 °C) without increased flow. When a standard pump-motor operates in water hotter than 86 °F (30 °C), a flow rate of at least 3 ft/s is required. When selecting the motor to drive a pump in over 86 °F (30 °C) water, the motor horsepower must be de-rated per the following procedure.

1. Using table 7A, determine pump gpm required for different well or sleeve diameters. If necessary, add a flow sleeve to obtain at least 3 ft/s flow rate.

Table 7A Minimum gpm (l/m) Required for 3 ft/s (.91 m/sec) Flow Rate

CASING OR SLEEVE ID		4" HIGH THRUST MOTOR		6" MOTOR		8" MOTOR	
INCHES	(MM)	GPM	(L/M)	GPM	(L/M)	GPM	(L/M)
4	(102)	15	(57)				
5	(127)	80	(303)				
6	(152)	160	(606)	52	(197)		
7	(178)			150	(568)		
8	(203)			260	(984)	60	(227)
10	(254)			520	(1970)	330	(1250)
12	(305)					650	(2460)
14	(356)					1020	(3860)
16	(406)					1460	(5530)

Continued on next page

2. Determine pump horsepower required from the pump manufacturer's curve.

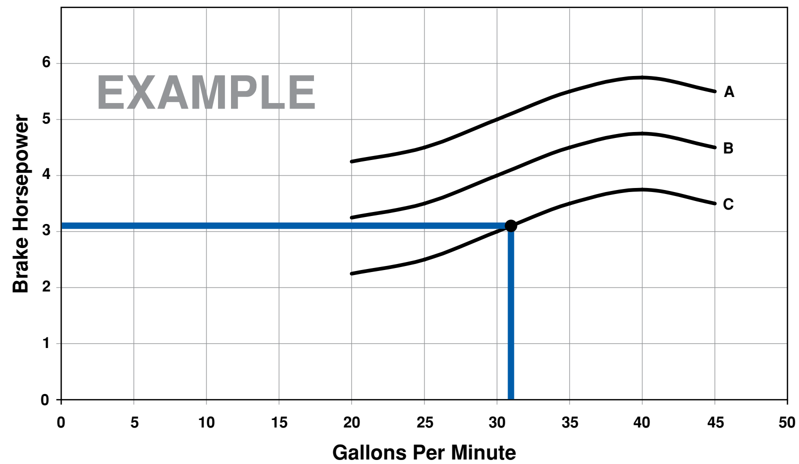

FIG. 2 MANUFACTURER'S PUMP CURVE

3. Multiply the pump horsepower required by the heat factor multiplier from table 8.

Table 8 Heat Factor Multiplier at 3 ft/s (.91 m/sec) Flow Rate

MAXIMUM WATER TEMPERATURE	1/3 - 5 HP .25 - 3.7 KW	7 1/2 - 30 HP 5.5 - 22 KW	OVER 30 HP OVER 22 KW
140 °F (60 °C)	1.25	1.62	2.00
131 °F (55 °C)	1.11	1.32	1.62
122 °F (50 °C)	1.00	1.14	1.32
113 °F (45 °C)	1.00	1.00	1.14
104 °F (40 °C)	1.00	1.00	1.00
95 °F (35 °C)	1.00	1.00	1.00

4. Select a rated hp motor on table 8A whose Service Factor Horsepower is at least the value calculated in Item 3.

Table 8A Service Factor Horsepower

HP	KW	SFHP	HP	KW	SFHP	HP	KW	SFHP	HP	KW	SFHP
1/3	0.25	0.58	3	2.2	3.45	25	18.5	28.75	100	75	115.00
1/2	0.37	0.80	5	3.7	5.75	30	22.0	34.50	125	93	143.75
3/4	0.55	1.12	7.5	5.5	8.62	40	30.0	46.00	150	110	172.50
1	0.75	1.40	10	7.5	11.50	50	37.0	57.50	175	130	201.25
1.5	1.10	1.95	15	11.0	17.25	60	45.0	69.00	200	150	230.00
2	1.50	2.50	20	15.0	23.00	75	55.0	86.25			

Hot Water Applications - Example

EXAMPLE: A 6" pump end requiring 39 hp input will pump 124 °F water in an 8" well at a delivery rate of 140 gpm. From table 7A, a 6" flow sleeve will be required to increase the flow rate to at least 3 ft/s.

Using table 8, the 1.62 heat factor multiplier is selected because the hp required is over 30 hp and water temperature is above 122 °F. Multiply 39 hp x 1.62 (multiplier), which equals 63.2 hp. This is the minimum rated service factor horsepower usable at 39 hp in 124 °F. Using table 8A, select a motor with a rated service factor horsepower above 63.2 hp. A 60 hp motor has a service factor horsepower of 69, so a 60 hp motor may be used.

Drawdown Seals

Allowable motor temperature is based on atmospheric pressure or higher surrounding the motor. "Drawdown seals," which seal the well to the pump above its intake to maximize delivery, are not recommended, since the suction created can be lower than atmospheric pressure.

Grounding Control Boxes and Panels

The National Electrical Code requires that the control box or panel-grounding terminal always be connected to supply ground. If the circuit has no grounding conductor and no metal conduit from the box to supply panel, use a wire at least as large as line conductors and connect as required by the National Electrical Code, from the grounding terminal to the electrical supply ground.

WARNING: Failure to ground the control frame can result in a serious or fatal electrical shock hazard.

Grounding Surge Arrestors

An above ground surge arrestor must be grounded, metal to metal, all the way to the lowest draw down water strata for the surge arrestor to be effective. GROUNDING THE ARRESTOR TO THE SUPPLY GROUND OR TO A DRIVEN GROUND ROD PROVIDES LITTLE OR NO SURGE PROTECTION FOR THE MOTOR.

Control Box, Pumptec Products and Panel Environment

Franklin Electric control boxes, Pumptec products and three-phase panels meet UL requirements for NEMA Type 3R enclosures. They are suitable for indoor and outdoor applications within temperatures of +14 °F (-10 °C) to 122 °F (50 °C). Operating control boxes below +14 °F can cause reduced starting torque and loss of overload protection when overloads are located in control boxes.

Control boxes, Pumptec products and three-phase panels should never be mounted in direct sunlight or high temperature locations. This will cause shortened capacitor life (where applicable) and unnecessary tripping of overload protectors. A ventilated enclosure painted white to reflect heat is recommended for an outdoor, high temperature location.

A damp well pit, or other humid location, accelerates component failure from corrosion.

Control boxes with voltage relays are designed for vertical upright mounting only. Mounting in other positions will affect the operation of the relay.

Equipment Grounding

WARNING: Serious or fatal electrical shock may result from failure to connect the motor, control enclosures, metal plumbing and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires.

The primary purpose of grounding the metal drop pipe and/or metal well casing in an installation is safety. It is done to limit the voltage between nonelectrical (exposed metal) parts of the system and ground, thus minimizing dangerous shock hazards. Using wire at least the size of the motor cable wires provides adequate current-carrying capability for any ground fault that might occur. It also provides a low resistance path to ground, ensuring that the current to ground will be large enough to trip any overcurrent device designed to detect faults (such as a ground fault circuit interrupter, or GFCI).

Normally, the ground wire to the motor would provide the primary path back to the power supply ground for any ground fault. There are conditions, however, where the ground wire connection could become compromised. One such example would be the case where the water in the well is abnormally corrosive or aggressive. In this example, a grounded metal drop pipe or casing would then become the primary path to ground. However, the many installations that now use plastic drop pipes and/or casings require further steps to be taken for safety purposes, so that the water column itself does not become the conductive path to ground.

When an installation has abnormally corrosive water AND the drop pipe or casing is plastic, Franklin Electric recommends the use of a GFCI with a 10 mA set-point. In this case, the motor ground wire should be routed through the current-sensing device along with the motor power leads. Wired this way, the GFCI will trip only when a ground fault has occurred AND the motor ground wire is no longer functional.

3-Wire Control Boxes

Single-phase three-wire submersible motors require the use of control boxes. Operation of motors without control boxes or with incorrect boxes can result in motor failure and voids warranty.

Control boxes contain starting capacitors, a starting relay, and, in some sizes, overload protectors, running capacitors and contactors.

Ratings through 1 hp may use either a Franklin Electric solid state QD or a potential (voltage) type starting relay, while larger ratings use potential relays.

Potential (Voltage) Relays

Potential relays have normally closed contacts. When power is applied, both start and main motor windings are energized, and the motor starts. At this instant, the voltage across the start winding is relatively low and not enough to open the contacts of the relay.

As the motor accelerates, the increasing voltage across the start winding (and the relay coil) opens the relay contacts. This opens the starting circuit and the motor continues to run on the main winding alone, or the main plus run capacitor circuit. After the motor is started the relay contacts remain open.

CAUTION: The control box and motor are two pieces of one assembly. Be certain that the control box and motor hp and voltage match. Since a motor is designed to operate with a control box from the same manufacturer, we can promise warranty coverage only when a Franklin control box is used with a Franklin motor.

2-Wire Motor Solid State Controls

BIAC Switch Operation

When power is applied the bi-metal switch contacts are closed, so the triac is conducting and energizes the start winding. As rpm increases, the voltage in the sensor coil generates heat in the bi-metal strip, causing the bi-metal strip to bend and open the switch circuit. This removes the starting winding and the motor continues to run on the main winding alone.

Approximately 5 seconds after power is removed from the motor, the bi-metal strip cools sufficiently to return to its closed position and the motor is ready for the next start cycle.

Rapid Cycling

The BIAC starting switch will reset within approximately 5 seconds after the motor is stopped. If an attempt is made to restart the motor before the starting switch has reset, the motor may not start; however, there will be current in the main winding until the overload protector interrupts the circuit. The time for the protector to reset is longer than the reset of the starting switch. Therefore, the start switch will have closed and the motor will operate.

CAUTION: Restarting the motor within 5 seconds after power is removed may cause the motor overload to trip.

A waterlogged tank will cause fast cycling. When a waterlogged condition does occur, the user will be alerted to the problem during the off time (overload reset time) since the pressure will drop drastically. When the waterlogged tank condition is detected, the condition should be corrected to prevent nuisance tripping of the overload protector.

Bound Pump (Sandlocked)

When the motor is not free to turn, as with a sandlocked pump, the BIAC switch creates a "reverse impact torque" in the motor in either direction. When the sand is dislodged, the motor will start and operate in the correct direction.

QD Relays (Solid State)

There are two elements in the relay: a reed switch and a triac. The reed switch consists of two tiny rectangular blade-type contacts, which bend under magnetic flux. It is hermetically sealed in glass and is located within a coil, which conducts line current. When power is supplied to the control box, the main winding current passing through the coil immediately closes the reed switch contacts. This turns on the triac, which supplies voltage to the start winding, thus starting the motor.

Once the motor is started, the operation of the QD relay is an interaction between the triac, the reed switch and the motor windings. The solid state switch senses motor speed through the changing phase relationship between start winding current and line current. As the motor approaches running speed, the phase angle between the start current and the line current becomes nearly in phase. At this point, the reed switch contacts open, turning off the triac. This removes voltage from the start winding and the motor continues to run on the main winding only. With the reed switch contacts open and the triac turned off, the QD relay is ready for the next starting cycle.

2- or 3-Wire Cable, 60 Hz (Service Entrance to Motor - Maximum Length In Feet)

Table 11

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE												
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	1/2	.37	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230	1/2	.37	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
	3/4	.55	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870		
	1	.75	250	400	630	990	1540	2380	2960	3610	4410	5360	6520		
	1.5	1.1	190	310	480	770	1200	1870	2320	2850	3500	4280	5240		
	2	1.5	150	250	390	620	970	1530	1910	2360	2930	3620	4480		
	3	2.2	**120**	190	300	470	750	1190	1490	1850	2320	2890	3610		
	5	3.7	0	0	**180**	280	450	710	890	1110	1390	1740	2170	2680	
	7.5	5.5	0	0	0	**200**	310	490	610	750	930	1140	1410	1720	
	10	7.5	0	0	0	0	**250**	390	490	600	750	930	1160	1430	1760
	15	11	0	0	0	0	**170**	**270**	340	430	530	660	820	1020	1260

Table 11A

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE												
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	1/2	.37	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230	1/2	.37	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
	3/4	.55	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870	9380	
	1	.75	250	400	630	990	1540	2380	2960	3610	4410	5360	6520	7780	9350
	1.5	1.1	190	310	480	770	1200	1870	2320	2850	3500	4280	5240	6300	7620
	2	1.5	150	250	390	620	970	1530	1910	2360	2930	3620	4480	5470	6700
	3	2.2	**120**	190	300	470	750	1190	1490	1850	2320	2890	3610	4470	5550
	5	3.7	0	**110**	180	280	450	710	890	1110	1390	1740	2170	2680	3330
	7.5	5.5	0	0	**120**	200	310	490	610	750	930	1140	1410	1720	2100
	10	7.5	0	0	0	**160**	250	390	490	600	750	930	1160	1430	1760
	15	11	0	0	0	0	**170**	270	340	430	530	660	820	1020	1260

EXW01

1 Foot = .3048 Meter

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors 60 °C or 75 °C in free air or water, not in magnetic enclosures, conduit or direct buried.

Lengths NOT in bold meet the NEC ampacity requirements for either individual conductors or jacketed 60 °C or 75 °C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable.

If any other cable is used, the NEC and local codes should be observed.

Cable lengths in tables 11 & 11A allow for a 5% voltage drop running at maximum nameplate amperes. If 3% voltage drop is desired, multiply table 11 and 11A lengths by 0.6 to get maximum cable length.

The portion of the total cable length, which is between the supply and single-phase control box with a line contactor, should not exceed 25% of total maximum allowable to ensure reliable contactor operation. Single-phase control boxes without line contactors may be connected at any point in the total cable length.

Tables 11 & 11A are based on copper wire. If aluminum wire is used, it must be two sizes larger than copper wire and oxidation inhibitors must be used on connections.

EXAMPLE: If tables 11 & 11A call for #12 copper wire, #10 aluminum wire would be required.

Contact Franklin Electric for 90 °C cable lengths. See pages 15, 49, and 50 for applications using 230 V motors on 208 V power systems.

Two or More Different Cable Sizes Can Be Used

Depending on the installation, any number of combinations of cable may be used.

For example, in a replacement/upgrade installation, the well already has 160 feet of buried #10 cable between the service entrance and the wellhead. A new 3 hp, 230-volt, single-phase motor is being installed to replace a smaller motor. The question is: Since there is already 160 feet of #10 AWG installed, what size cable is required in the well with a 3 hp, 230-volt, single-phase motor setting at 310 feet?

From tables 11 & 11A, a 3 hp motor can use up to 300 feet of #10 AWG cable.

The application has 160 feet of #10 AWG copper wire installed.

Using the formula below, 160 feet (actual) ÷ 300 feet (max allowable) is equal to 0.533. This means 53.3% (0.533 x 100) of the allowable voltage drop or loss, which is allowed between the service entrance and the motor, occurs in this wire. This leaves us 46.7% (1.00 - 0.533 = 0.467) of some other wire size to use in the remaining 310 feet "down hole" wire run.

The table shows #8 AWG copper wire is good for 470 feet. Using the formula again, 310 feet (used) ÷ 470 feet (allowed) = 0.660; adding this to the 0.533 determined earlier; 0.533 + 0.660 = 1.193. This combination is greater than 1.00, so the voltage drop will not meet US National Electrical Code recommendations.

Tables 11 & 11A show #6 AWG copper wire is good for 750 feet. Using the formula, 310 ÷ 750 = 0.413, and using these numbers, 0.533 + 0.413 = 0.946, we find this is less than 1.00 and will meet the NEC recommended voltage drop.

This works for two, three or more combinations of wire and it does not matter which size wire comes first in the installation.

$$\textbf{Formula: } \frac{\text{Actual Length}}{\text{Max Allowed}} + \frac{\text{Actual Length}}{\text{Max Allowed}} = 1.00$$

EXAMPLE: 3 hp, 230-Volt, Single-Phase Motor

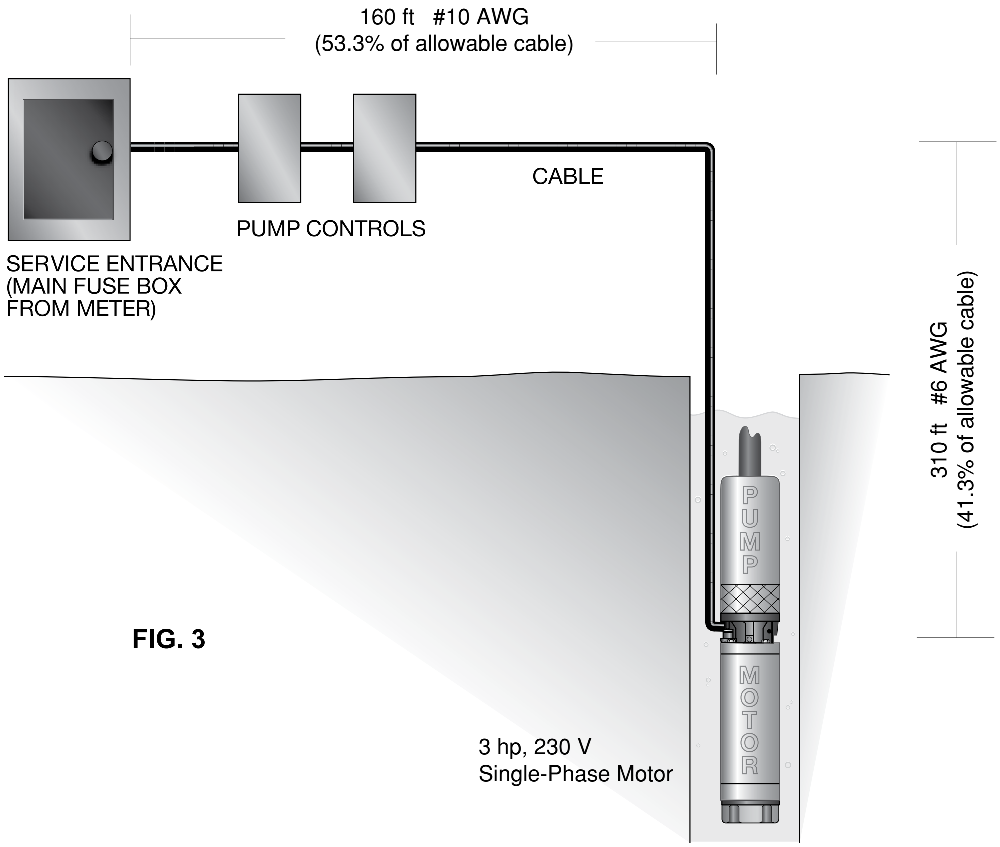

FIG. 3

Table 13 Single-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		WINDING (1) RES. IN OHMS	EFFICIENCY %		POWER FACTOR %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	(2) AMPS	WATTS	(2) AMPS	WATTS	M=MAIN RES. S=START RES.	S.F.	F.L.	S.F.	F.L.		
4" 2-WIRE	244504	1/2	0.37	115	60	1.6	10.0	670	12.0	960	1.0-1.3	62	56	73	58	64.4	R
	244505	1/2	0.37	230	60	1.6	5.0	670	6.0	960	4.2-5.2	62	56	73	58	32.2	R
	244507	3/4	0.55	230	60	1.5	6.8	940	8.0	1310	3.0-3.6	64	59	74	62	40.7	N
	244508	1	0.75	230	60	1.4	8.2	1210	10.4	1600	2.2-2.7	65	62	74	63	48.7	N
	244309	1.5	1.1	230	60	1.3	10.6	1770	13.1	2280	1.5-2.1	64	63	83	76	66.2	M
4" 3-WIRE	214504	1/2	0.37	115	60	1.6	Y10.0 B10.0 R0	670	Y12.0 B12.0 R0	960	M1.0-1.3 S4.1-5.1	62	56	73	58	50.5	M
	214505	1/2	0.37	230	60	1.6	Y5.0 B5.0 R0	670	Y6.0 B6.0 R0	960	M4.2-5.2 S16.7-20.5	62	56	73	58	23	M
	214507	3/4	0.55	230	60	1.5	Y6.8 B6.8 R0	940	Y8.0 B8.0 R0	1310	M3.0-3.6 S10.7-13.1	64	59	74	62	34.2	M
	214508	1	0.75	230	60	1.4	Y8.2 B8.2 R0	1210	10.4 10.4 R0	1600	M2.2-2.7 S9.9-12.1	65	62	74	63	41.8	L
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	60	1.6	Y3.6 B3.7 R2.0	655	Y4.3 B4.0 R2.0	890	M4.2-5.2 S16.7-20.5	67	57	90	81	23	M
	214507	3/4	0.55	230	60	1.5	Y4.9 B5.0 R3.2	925	Y5.7 B5.2 R3.1	1220	M3.0-3.6 S10.7-13.1	69	60	92	84	34.2	M
	214508	1	0.75	230	60	1.4	Y6.0 B5.7 R3.4	1160	Y7.1 B6.2 R3.3	1490	M2.2-2.7 S9.9-12.1	70	64	92	86	41.8	L
4" 3-WIRE	214508 W/1- 1.5 CB	1	0.75	230	60	1.4	Y6.6 B6.6 R1.3	1130	Y8.0 B7.9 R1.3	1500	M2.2-2.7 S9.9-12.1	70	66	82	72	43	L
	224300	1.5	1.1	230	60	1.3	Y10.0 B9.9 R1.3	1620	Y11.5 B11.0 R1.3	2080	M1.7-2.1 S7.5-9.2	70	69	85	79	51.4	J
	224301	2	1.5	230	60	1.25	Y10.0 B9.3 R2.6	2025	Y13.2 B11.9 R2.6	2555	M1.8-2.3 S5.5-7.2	73	74	95	94	53.1	G
	224302 (3)	3	2.2	230	60	1.15	Y14.0 B11.2 R6.1	3000	Y17.0 B12.6 R6.0	3400	M1.1-1.4 S4.0-4.8	75	75	99	99	83.4	H
	224303 (4)	5	3.7	230	60	1.15	Y23.0 B15.9 R11.0	4830	Y27.5 B19.1 R10.8	5500	M.71-.82 S1.8-2.2	78	77	100	100	129	G
6"	226110 (5)	5	3.7	230	60	1.15	Y23.0 B14.3 R10.8	4910	Y27.5 B17.4 R10.5	5570	M.55-.68 S1.3-1.7	77	76	100	99	99	E
	226111	7.5	5.5	230	60	1.15	Y36.5 B34.4 R5.5	7300	Y42.1 B40.5 R5.4	8800	M.36-.50 S.88-1.1	73	74	91	90	165	F
	226112	10	7.5	230	60	1.15	Y44.0 B39.5 R9.3	9800	Y51.0 B47.5 R8.9	11300	M.27-.33 S.80-.99	76	77	96	96	204	E
	226113	15	11	230	60	1.15	Y62.0 B52.0 R17.5	13900	Y75.0 B62.5 R16.9	16200	M.17-.22 S.68-.93	79	80	97	98	303	E

EXW01

(1) Main winding - yellow to black
Start winding - yellow to red

(2) Y = Yellow lead - line amps
B = Black lead - main winding amps
R = Red lead - start or auxiliary winding amps

(3) Control Boxes date coded 02C and older have **35 MFD** run capacitors. Current values should be Y14.0 @ FL and Y17.0 @ Max Load.
B12.2 B14.5
R4.7 R4.5

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

(5) Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 6" motor will be Y23.0 @ FL -Y27.5 @ Max Load.
B18.2 B23.2
R8.0 R7.8

Performance is typical, not guaranteed, at specified voltages and specified capacitor values. Performance at voltage ratings not shown is similar, except amps vary inversely with voltage.

Table 14 Single-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
4" 2-WIRE	244504	1/2	0.37	115	35	20	30	30	15	30
	244505	1/2	0.37	230	20	10	15	15	8	15
	244507	3/4	0.55	230	25	15	20	20	10	20
	244508	1	0.75	230	30	20	25	25	11	25
	244309	1.5	1.1	230	35	20	30	35	15	30
4" 3-WIRE	214504	1/2	0.37	115	35	20	30	30	15	30
	214505	1/2	0.37	230	20	10	15	15	8	15
	214507	3/4	0.55	230	25	15	20	20	10	20
	214508	1	0.75	230	30	20	25	25	11	25
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	20	10	15	15	8	15
	214507	3/4	0.55	230	25	15	20	20	10	20
	214508	1	0.75	230	30	20	25	25	11	25
4" 3-WIRE	214508 W/ 1-1.5 CB	1	0.75	230	30	20	25	25	11	25
	224300	1.5	1.1	230	35	20	30	30	15	30
	224301	2	1.5	230	30	20	25	30	15	25
	224302	3	2.2	230	45	30	40	45	20	40
	224303	5	3.7	230	80	45	60	70	30	60
6"	226110	5	3.7	230	80	45	60	70	30	60
	226111	7.5	5.5	230	125	70	100	110	50	100
	226112	10	7.5	230	150	80	125	150	60	125
	226113	15	11	230	200	125	175	200	90	175

EXW01

Auxiliary Running Capacitors

Added capacitors must be connected across "Red" and "Black" control box terminals, in parallel with any existing running capacitors. The additional capacitor(s) should be mounted in an auxiliary box. The values of additional running capacitors most likely to reduce noise are given below. The tabulation gives the **max.** S.F. amps normally in each lead with the added capacitor.

Although motor amps decrease when auxiliary run capacitance is added, the load on the motor does not. If a motor is overloaded with normal capacitance, it still will be overloaded with auxiliary run capacitance, even though motor amps may be within nameplate values.

Table 15 Auxiliary Capacitor Sizing

MOTOR RATING		NORMAL RUNNING CAPACITOR(S)	AUXILIARY RUNNING CAPACITORS FOR NOISE REDUCTION			MAXIMUM AMPS WITH RUN CAP		
HP	VOLTS	MFD	MFD	MIN. VOLTS	FRANKLIN PART	YELLOW	BLACK	RED
1/2	115	0	60(1)	370	TWO 155327101	8.4	7.0	4.0
1/2	230	0	15(1)	370	ONE 155328101	4.2	3.5	2.0
3/4	230	0	20(1)	370	ONE 155328103	5.8	5.0	2.5
1	230	0	25(1)	370	ONE EA. 155328101 155328102	7.1	5.6	3.4
1.5	230	10	20	370	ONE 155328103	9.3	7.5	4.4
2	230	20	10	370	ONE 155328102	11.2	9.2	3.8
3	230	45	NONE	370		17.0	12.6	6.0
5	230	80	NONE	370		27.5	19.1	10.8
7.5	230	45	45	370	ONE EA. 155327101 155328101	37.0	32.0	11.3
10	230	70	30	370	ONE 155327101	49.0	42.0	13.0
15	230	135	NONE			75.0	62.5	16.9

(1) Do not add running capacitors to 1/3 through 1 hp control boxes, which use solid state switches or QD relays. Adding capacitors will cause switch failure. If the control box is converted to use a voltage relay, the specified running capacitance can be added.

Buck-Boost Transformers

When the available power supply voltage is not within the proper range, a buck-boost transformer is often used to adjust voltage to match the motor. The most common usage on submersible motors is boosting a 208 volt supply to use a standard 230 volt single-phase submersible motor and control. While tables to give a wide range of voltage boost or buck are published by transformer manufacturers, the following table shows Franklin's recommendations. The table, based on boosting the voltage 10%, shows the minimum rated transformer kVA needed and the common standard transformer kVA.

Table 15A Buck-Boost Transformer Sizing

MOTOR HP	1/3	1/2	3/4	1	1.5	2	3	5	7.5	10	15
LOAD KVA	1.02	1.36	1.84	2.21	2.65	3.04	3.91	6.33	9.66	11.70	16.60
MINIMUM XFMR KVA	0.11	0.14	0.19	0.22	0.27	0.31	0.40	0.64	0.97	1.20	1.70
STANDARD XFMR KVA	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.75	1.00	1.50	2.00

Buck-Boost transformers are power transformers, not control transformers. They may also be used to lower voltage when the available power supply voltage is too high.

Table 16 Three-Phase 60 °C Cable, 60 Hz (Service Entrance to Motor) Maximum Length in Feet

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	710	1140	1800	2840	4420													
	3/4	0.55	510	810	1280	2030	3160													
	1	0.75	430	690	1080	1710	2670	4140	5140											
	1.5	1.1	310	500	790	1260	1960	3050	3780											
	2	1.5	240	390	610	970	1520	2360	2940	3610	4430	5420								
	3	2.2	180	290	470	740	1160	1810	2250	2760	3390	4130								
	5	3.7	**110**	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030				
	7.5	5.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560				
	10	7.5	0	0	0	**230**	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420
	15	11	0	0	0	**160**	**250**	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980
	20	15	0	0	0	0	**190**	**300**	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360
	25	18.5	0	0	0	0	0	**240**	**300**	**370**	460	570	700	840	1030	1170	1330	1500	1640	1900
	30	22	0	0	0	0	0	0	**250**	**310**	**380**	470	580	700	850	970	1110	1250	1360	1590
230 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	930	1490	2350	3700	5760	8910												
	3/4	0.55	670	1080	1700	2580	4190	6490	8060	9860										
	1	0.75	560	910	1430	2260	3520	5460	6780	8290										
	1.5	1.1	420	670	1060	1670	2610	4050	5030	6160	7530	9170								
	2	1.5	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780							
	3	2.2	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680					
	5	3.7	**140**	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220	
	7.5	5.5	0	**160**	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510
	10	7.5	0	0	**190**	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840
	15	11	0	0	0	**210**	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940
	20	15	0	0	0	0	**250**	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120
	25	18.5	0	0	0	0	0	**320**	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520
	30	22	0	0	0	0	0	**260**	**330**	**410**	510	620	760	930	1130	1280	1470	1650	1800	2110
380 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	2690	4290	6730															
	3/4	0.55	2000	3190	5010	7860														
	1	0.75	1620	2580	4060	6390	9980													
	1.5	1.1	1230	1970	3100	4890	7630													
	2	1.5	870	1390	2180	3450	5400	8380												
	3	2.2	680	1090	1710	2690	4200	6500	8020	9830										
	5	3.7	400	640	1010	1590	2490	3870	4780	5870	7230	8830								
	7.5	5.5	270	440	690	1090	1710	2640	3260	4000	4930	6010	7290	8780						
	10	7.5	**200**	**320**	510	800	1250	1930	2380	2910	3570	4330	5230	6260	7390	8280	9340			
	15	11	0	0	**370**	590	920	1430	1770	2170	2690	3290	4000	4840	5770	6520	7430	8250	8990	
	20	15	0	0	0	**440**	700	1090	1350	1670	2060	2530	3090	3760	4500	5110	5840	6510	7120	8190
	25	18.5	0	0	0	**360**	570	880	1100	1350	1670	2050	2510	3040	3640	4130	4720	5250	5740	6590
	30	22	0	0	0	0	**470**	730	910	1120	1380	1700	2080	2520	3020	3430	3920	4360	4770	5490
	40	30	0	0	0	0	0	**530**	660	820	1010	1240	1520	1840	2200	2500	2850	3170	3470	3990
	50	37	0	0	0	0	0	0	**540**	**660**	820	1000	1220	1480	1770	2010	2290	2550	2780	3190
	60	45	0	0	0	0	0	0	0	**560**	**690**	850	1030	1250	1500	1700	1940	2150	2350	2700
	75	55	0	0	0	0	0	0	0	0	**570**	**700**	**860**	1050	1270	1440	1660	1850	2030	2350
	100	75	0	0	0	0	0	0	0	0	0	**510**	**630**	**760**	910	1030	1180	1310	1430	1650
	125	93	0	0	0	0	0	0	0	0	0	0	0	**620**	**740**	**840**	**950**	1060	1160	1330
	150	110	0	0	0	0	0	0	0	0	0	0	0	0	**620**	**700**	**790**	**880**	**960**	1090
	175	130	0	0	0	0	0	0	0	0	0	0	0	0	0	**650**	**750**	**840**	**920**	1070
	200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**630**	**700**	**760**	**880**

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

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Table 17 Three-Phase 60 °C Cable (Continued)

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
460 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	3770	6020	9460															
	3/4	0.55	2730	4350	6850															
	1	0.75	2300	3670	5770	9070														
	1.5	1.1	1700	2710	4270	6730														
	2	1.5	1300	2070	3270	5150	8050													
	3	2.2	1000	1600	2520	3970	6200													
	5	3.7	590	950	1500	2360	3700	5750												
	7.5	5.5	420	680	1070	1690	2640	4100	5100	6260	7680									
	10	7.5	310	500	790	1250	1960	3050	3800	4680	5750	7050								
	15	11	0	**340**	540	850	1340	2090	2600	3200	3930	4810	5900	7110						
	20	15	0	0	**410**	650	1030	1610	2000	2470	3040	3730	4580	5530						
	25	18.5	0	0	0	**530**	830	1300	1620	1990	2450	3010	3700	4470	5430					
	30	22	0	0	0	**430**	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860			
	40	30	0	0	0	0	**500**	790	980	1210	1490	1830	2250	2710	3290	3730	4250			
	50	37	0	0	0	0	0	**640**	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850
	60	45	0	0	0	0	0	**540**	**670**	**830**	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100
	75	55	0	0	0	0	0	0	0	**680**	**840**	1030	1260	1520	1850	2100	2400	2700	2950	3440
	100	75	0	0	0	0	0	0	0	0	**620**	**760**	**940**	1130	1380	1560	1790	2010	2190	2550
	125	93	0	0	0	0	0	0	0	0	0	0	**740**	**890**	**1000**	1220	1390	1560	1700	1960
	150	110	0	0	0	0	0	0	0	0	0	0	0	**760**	**920**	**1050**	**1190**	1340	1460	1690
	175	130	0	0	0	0	0	0	0	0	0	0	0	0	**810**	**930**	**1060**	**1190**	1300	1510
	200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	**810**	**920**	**1030**	**1130**	1310
575 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	5900	9410																
	3/4	0.55	4270	6810																
	1	0.75	3630	5800	9120															
	1.5	1.1	2620	4180	6580															
	2	1.5	2030	3250	5110	8060														
	3	2.2	1580	2530	3980	6270														
	5	3.7	920	1480	2330	3680	5750													
	7.5	5.5	660	1060	1680	2650	4150													
	10	7.5	490	780	1240	1950	3060	4770	5940											
	15	11	**330**	530	850	1340	2090	3260	4060											
	20	15	0	**410**	650	1030	1610	2520	3140	3860	4760	5830								
	25	18.5	0	0	**520**	830	1300	2030	2530	3110	3840	4710								
	30	22	0	0	**430**	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000				
	40	30	0	0	0	**500**	790	1240	1540	1900	2330	2860	3510	4230	5140	5830				
	50	37	0	0	0	0	**640**	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580
	60	45	0	0	0	0	0	**850**	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410
	75	55	0	0	0	0	0	**690**	**860**	**1060**	1310	1600	1970	2380	2890	3290	3750	5220	4610	5370
	100	75	0	0	0	0	0	0	0	**790**	**970**	**1190**	1460	1770	2150	2440	2790	3140	3430	3990
	125	93	0	0	0	0	0	0	0	0	**770**	**950**	**1160**	1400	1690	1920	2180	2440	2650	3070
	150	110	0	0	0	0	0	0	0	0	0	**800**	**990**	**1190**	1440	1630	1860	2080	2270	2640
	175	130	0	0	0	0	0	0	0	0	0	0	**870**	**1050**	**1270**	**1450**	1650	1860	2030	2360
	200	150	0	0	0	0	0	0	0	0	0	0	0	**920**	**1110**	**1260**	**1440**	1620	1760	2050

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See 11 for additional details.

Continued on next page

Table 18 Three-Phase 60 °C Cable (Continued)

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	160	250	420	660	1030	1620	2020	2490	3060	3730	4570	5500	6660	7540				
	7.5	5.5	110	180	300	460	730	1150	1440	1770	2170	2650	3250	3900	4720	5340				
	10	7.5	**80**	130	210	340	550	850	1080	1320	1630	1990	2460	2950	3580	4080	4650	5220	5700	6630
	15	11	0	0	**140**	240	370	580	730	900	1110	1360	1660	2010	2440	2770	3150	3520	3850	4470
	20	15	0	0	0	**170**	280	450	570	690	850	1050	1290	1570	1900	2160	2470	2770	3030	3540
	25	18.5	0	0	0	**140**	**220**	360	450	550	690	850	1050	1260	1540	1750	1990	2250	2460	2850
	30	22	0	0	0	0	**180**	294	370	460	570	700	870	1050	1270	1450	1660	1870	2040	2380
230 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	210	340	550	880	1380	2140	2680	3280	4030	4930	6040	7270	8800	9970				
	7.5	5.5	150	240	390	630	970	1530	1900	2340	2880	3510	4300	5160	6240	7060	8010	8950	9750	
	10	7.5	**110**	180	280	460	730	1140	1420	1750	2160	2640	3240	3910	4740	5380	6150	6900	7530	8760
	15	11	0	0	**190**	310	490	780	970	1200	1470	1800	2200	2670	3220	3660	4170	4660	5100	5910
	20	15	0	0	**140**	230	370	600	750	910	1140	1390	1710	2070	2520	2860	3270	3670	4020	4680
	25	18.5	0	0	0	**190**	300	480	600	750	910	1120	1380	1680	2040	2310	2640	2970	3240	3780
	30	22	0	0	0	**150**	**240**	390	490	610	760	930	1140	1390	1690	1920	2200	2470	2700	3160
380 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	600	960	1510	2380	3730	5800	7170	8800										
	7.5	5.5	400	660	1030	1630	2560	3960	4890	6000	7390	9010								
	10	7.5	300	480	760	1200	1870	2890	3570	4360	5350	6490	7840	9390						
	15	11	210	340	550	880	1380	2140	2650	3250	4030	4930	6000	7260	8650	9780				
	20	15	**160**	260	410	660	1050	1630	2020	2500	3090	3790	4630	5640	6750	7660	4260	9760		
	25	18.5	0	**210**	330	540	850	1320	1650	2020	2500	3070	3760	4560	5460	6190	7080	7870	8610	9880
	30	22	0	0	**270**	430	700	1090	1360	1680	2070	2550	3120	3780	4530	5140	5880	6540	7150	8230
	40	30	0	0	0	**320**	510	790	990	1230	1510	1860	2280	2760	3300	3750	4270	4750	5200	5980
	50	37	0	0	0	**250**	**400**	630	810	990	1230	1500	1830	2220	2650	3010	3430	3820	4170	4780
	60	45	0	0	0	0	**340**	540	660	840	1030	1270	1540	1870	2250	2550	2910	3220	3520	4050
	75	55	0	0	0	0	0	**450**	550	690	855	1050	1290	1570	1900	2160	2490	2770	3040	3520
	100	75	0	0	0	0	0	0	**420**	**520**	640	760	940	1140	1360	1540	1770	1960	2140	2470
	125	93	0	0	0	0	0	0	0	**400**	**490**	**600**	730	930	1110	1260	1420	1590	1740	1990
	150	110	0	0	0	0	0	0	0	0	**420**	**510**	**620**	750	930	1050	1180	1320	1440	1630
	175	130	0	0	0	0	0	0	0	0	**360**	**440**	**540**	660	780	970	1120	1260	1380	1600
	200	150	0	0	0	0	0	0	0	0	0	0	**480**	**580**	**690**	790	940	1050	1140	1320
460 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	880	1420	2250	3540	5550	8620												
	7.5	5.5	630	1020	1600	2530	3960	6150	7650	9390										
	10	7.5	460	750	1180	1870	2940	4570	5700	7020	8620									
	15	11	310	510	810	1270	2010	3130	3900	4800	5890	7210	8850							
	20	15	**230**	380	610	970	1540	2410	3000	3700	4560	5590	6870	8290						
	25	18.5	**190**	310	490	790	1240	1950	2430	2980	3670	4510	5550	6700	8140					
	30	22	0	**250**	410	640	1020	1600	1990	2460	3040	3730	4590	5550	6750	7690	8790			
	40	30	0	0	**300**	480	750	1180	1470	1810	2230	2740	3370	4060	4930	5590	6370			
	50	37	0	0	0	**370**	590	960	1200	1470	1810	2220	2710	3280	3970	4510	5130	5740	6270	7270
	60	45	0	0	0	**320**	**500**	810	1000	1240	1530	1870	2310	2770	3360	3810	4330	4860	5310	6150
	75	55	0	0	0	0	**420**	660	810	1020	1260	1540	1890	2280	2770	3150	3600	4050	4420	5160
	100	75	0	0	0	0	0	**500**	**610**	760	930	1140	1410	1690	2070	2340	2680	3010	3280	3820
	125	93	0	0	0	0	0	0	**470**	**590**	**730**	880	1110	1330	1500	1830	2080	2340	2550	2940
	150	110	0	0	0	0	0	0	0	**510**	**630**	**770**	950	1140	1380	1570	1790	2000	2180	2530
	175	130	0	0	0	0	0	0	0	0	**550**	**680**	**830**	1000	1220	1390	1580	1780	1950	2270
	200	150	0	0	0	0	0	0	0	0	0	**590**	**730**	**880**	1070	1210	1380	1550	1690	1970
575 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	1380	2220	3490	5520	8620													
	7.5	5.5	990	1590	2520	3970	6220													
	10	7.5	730	1170	1860	2920	4590	7150	8910											
	15	11	490	790	1270	2010	3130	4890	6090											
	20	15	370	610	970	1540	2410	3780	4710	5790	7140	8740								
	25	18.5	**300**	490	780	1240	1950	3040	3790	4660	5760	7060								
	30	22	**240**	400	645	1020	1600	2500	3120	3840	4740	5820	7150	8670						
	40	30	0	**300**	480	750	1180	1860	2310	2850	3490	4290	5260	6340	7710	8740				
	50	37	0	0	**380**	590	960	1500	1870	2310	2830	3460	4260	5130	6210	7050	8010	8980	9790	
	60	45	0	0	0	**500**	**790**	1270	1590	1950	2400	2940	3600	4330	5250	5950	6780	7600	8290	9610
	75	55	0	0	0	**420**	**660**	1030	1290	1590	1960	2400	2950	3570	4330	4930	5620	6330	6910	8050
	100	75	0	0	0	0	**400**	**780**	960	1180	1450	1780	2190	2650	3220	3660	4180	4710	5140	5980
	125	93	0	0	0	0	0	**600**	**740**	920	1150	1420	1740	2100	2530	2880	3270	3660	3970	4600
	150	110	0	0	0	0	0	0	**650**	**800**	**990**	1210	1480	1780	2160	2450	2790	3120	3410	3950
	175	130	0	0	0	0	0	0	0	**700**	**860**	1060	1300	1570	1910	2170	2480	2780	3040	3540
	200	150	0	0	0	0	0	0	0	0	**760**	**930**	1140	1370	1670	1890	2160	2420	2640	3070

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

Table 19 Three-Phase 75 °C Cable, 60 Hz (Service Entrance to Motor) Maximum Length in Feet

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE					
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
200 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	710	1140	1800	2840	4420														
	3/4	0.55	510	810	1280	2030	3160														
	1	0.75	430	690	1080	1710	2670	4140	5140												
	1.5	1.1	310	500	790	1260	1960	3050	3780												
	2	1.5	240	390	610	970	1520	2360	2940	3610	4430	5420									
	3	2.2	180	290	470	740	1160	1810	2250	2760	3390	4130									
	5	3.7	**110**	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030					EXW02 EXW03 EXW04 EXW05
	7.5	5.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560					
	10	7.5	0	0	**150**	230	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420	
	15	11	0	0	0	**160**	250	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980	
	20	15	0	0	0	0	**190**	300	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360	
	25	18.5	0	0	0	0	0	**240**	300	370	460	570	700	840	1030	1170	1330	1500	1640	1900	
	30	22	0	0	0	0	0	**200**	**250**	310	380	470	580	700	850	970	1110	1250	1360	1590	
230 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	930	1490	2350	3700	5760	8910													
	3/4	0.55	670	1080	1700	2580	4190	6490	8060	9860											
	1	0.75	560	910	1430	2260	3520	5460	6780	8290											
	1.5	1.1	420	670	1060	1670	2610	4050	5030	6160	7530	9170									
	2	1.5	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780								
	3	2.2	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680						16LGR
	5	3.7	**140**	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220		16CC
	7.5	5.5	0	**160**	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510	
	10	7.5	0	0	**190**	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840	
	15	11	0	0	0	**210**	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940	
	20	15	0	0	0	**160**	**250**	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120	
	25	18.5	0	0	0	0	**200**	320	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520	
	30	22	0	0	0	0	0	**260**	330	410	510	620	760	930	1130	1280	1470	1650	1800	2110	
380 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	2690	4290	6730																
	3/4	0.55	2000	3190	5010	7860															
	1	0.75	1620	2580	4060	6390	9980														
	1.5	1.1	1230	1970	3100	4890	7630														
	2	1.5	870	1390	2180	3450	5400	8380													
	3	2.2	680	1090	1710	2690	4200	6500	8020	9830											
	5	3.7	400	640	1010	1590	2490	3870	4780	5870	7230	8830									
	7.5	5.5	270	440	690	1090	1710	2640	3260	4000	4930	6010	7290	8780							
	10	7.5	**200**	320	510	800	1250	1930	2380	2910	3570	4330	5230	6260	7390	8280	9340				
	15	11	0	0	370	590	920	1430	1770	2170	2690	3290	4000	4840	5770	6520	7430	8250	8990		
	20	15	0	0	**280**	440	700	1090	1350	1670	2060	2530	3090	3760	4500	5110	2840	6510	7120	8190	
	25	18.5	0	0	0	**360**	570	880	1100	1350	1670	2050	2510	3040	3640	4130	4720	5250	5740	6590	
	30	22	0	0	0	**290**	470	730	910	1120	1380	1700	2080	2520	3020	3430	3920	4360	4770	5490	
	40	30	0	0	0	0	0	**530**	660	820	1010	1240	1520	1840	2200	2500	2850	3170	3470	3990	
	50	37	0	0	0	0	0	**440**	**540**	660	820	1000	1220	1480	1770	2010	2290	2550	2780	3190	
	60	45	0	0	0	0	0	**370**	**460**	**560**	690	850	1030	1250	1500	1700	1940	2150	2350	2700	
	75	55	0	0	0	0	0	0	0	**460**	**570**	700	860	1050	1270	1440	1660	1850	2030	2350	
	100	75	0	0	0	0	0	0	0	0	**420**	**510**	**630**	760	910	1030	1180	1310	1430	1650	
	125	93	0	0	0	0	0	0	0	0	0	0	**510**	**620**	**740**	840	950	1060	1160	1330	
	150	110	0	0	0	0	0	0	0	0	0	0	0	**520**	**620**	**700**	**790**	880	960	1090	
	175	130	0	0	0	0	0	0	0	0	0	0	0	0	**560**	**650**	**750**	**840**	920	1070	
	200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	**550**	**630**	**700**	**760**	880	

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

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Table 20 Three-Phase 75 °C Cable (Continued)

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
460 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	3770	6020	9460															
	3/4	0.55	2730	4350	6850															
	1	0.75	2300	3670	5770	9070														
	1.5	1.1	1700	2710	4270	6730														
	2	1.5	1300	2070	3270	5150	8050													
	3	2.2	1000	1600	2520	3970	6200													
	5	3.7	590	950	1500	2360	3700	5750												
	7.5	5.5	420	680	1070	1690	2640	4100	5100	6260	7680									
	10	7.5	310	500	790	1250	1960	3050	3800	4680	5750	7050								
	15	11	0	**340**	540	850	1340	2090	2600	3200	3930	4810	5900	7110						
	20	15	0	0	410	650	1030	1610	2000	2470	3040	3730	4580	5530						
	25	18.5	0	0	**330**	530	830	1300	1620	1990	2450	3010	3700	4470	5430					
	30	22	0	0	**270**	430	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860			
	40	30	0	0	0	**320**	**500**	790	980	1210	1490	1830	2250	2710	3290	3730	4250			
	50	37	0	0	0	0	**410**	640	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850
	60	45	0	0	0	0	0	**540**	**670**	830	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100
	75	55	0	0	0	0	0	**440**	**550**	**680**	840	1030	1260	1520	1850	2100	2400	2700	2950	3440
	100	75	0	0	0	0	0	0	0	**500**	**620**	**760**	940	1130	1380	1560	1790	2010	2190	2550
	125	93	0	0	0	0	0	0	0	0	0	**600**	**740**	**890**	1000	1220	1390	1560	1700	1960
	150	110	0	0	0	0	0	0	0	0	0	0	**630**	**760**	**920**	1050	1190	1340	1460	1690
	175	130	0	0	0	0	0	0	0	0	0	0	0	**670**	**810**	**930**	1060	1190	1300	1510
	200	150	0	0	0	0	0	0	0	0	0	0	0	**590**	**710**	**810**	**920**	1030	1130	1310
575 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	5900	9410																
	3/4	0.55	4270	6810																
	1	0.75	3630	5800	9120															
	1.5	1.1	2620	4180	6580															
	2	1.5	2030	3250	5110	8060														
	3	2.2	1580	2530	3980	6270														
	5	3.7	920	1480	2330	3680	5750													
	7.5	5.5	660	1060	1680	2650	4150													
	10	7.5	490	780	1240	1950	3060	4770	5940											
	15	11	**330**	530	850	1340	2090	3260	4060											
	20	15	0	**410**	650	1030	1610	2520	3140	3860	4760	5830								
	25	18.5	0	0	520	830	1300	2030	2530	3110	3840	4710								
	30	22	0	0	**430**	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000				
	40	30	0	0	0	**500**	790	1240	1540	1900	2330	2860	3510	4230	5140	5830				
	50	37	0	0	0	**410**	**640**	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580
	60	45	0	0	0	0	**540**	850	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410
	75	55	0	0	0	0	0	**690**	860	1060	1310	1600	1970	2380	2890	3290	3750	5220	4610	5370
	100	75	0	0	0	0	0	0	**640**	**790**	970	1190	1460	1770	2150	2440	2790	3140	3430	3990
	125	93	0	0	0	0	0	0	0	**630**	**770**	**950**	1160	1400	1690	1920	2180	2440	2650	3070
	150	110	0	0	0	0	0	0	0	0	**660**	**800**	**990**	1190	1440	1630	1860	2080	2270	2640
	175	130	0	0	0	0	0	0	0	0	0	**700**	**870**	**1050**	1270	1450	1650	1860	2030	2360
	200	150	0	0	0	0	0	0	0	0	0	0	**760**	**920**	**1110**	1260	1440	1620	1760	2050

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

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Table 21 Three-Phase 75 °C Cable (Continued)

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	160	250	420	660	1030	1620	2020	2490	3060	3730	4570	5500	6660	7540				
	7.5	5.5	110	180	300	460	730	1150	1440	1770	2170	2650	3250	3900	4720	5340				
	10	7.5	**80**	130	210	340	550	850	1080	1320	1630	1990	2460	2950	3580	4080	4650	5220	5700	6630
	15	11	0	0	140	240	370	580	730	900	1110	1360	1660	2010	2440	2770	3150	3520	3850	4470
	20	15	0	0	**120**	170	280	450	570	690	850	1050	1290	1570	1900	2160	2470	2770	3030	3540
	25	18.5	0	0	0	**140**	220	360	450	550	690	850	1050	1260	1540	1750	1990	2250	2460	2850
	30	22	0	0	0	**120**	**180**	294	370	460	570	700	870	1050	1270	1450	1660	1870	2040	2380
230 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	210	340	550	880	1380	2140	2680	3280	4030	4930	6040	7270	8800	9970				
	7.5	5.5	150	240	390	630	970	1530	1900	2340	2880	3510	4300	5160	6240	7060	8010	8950	9750	
	10	7.5	**110**	180	280	460	730	1140	1420	1750	2160	2640	3240	3910	4740	5380	6150	6900	7530	8760
	15	11	0	**130**	190	310	490	780	970	1200	1470	1800	2200	2670	3220	3660	4170	4660	5100	5910
	20	15	0	0	**140**	230	370	600	750	910	1140	1390	1710	2070	2520	2860	3270	3670	4020	4680
	25	18.5	0	0	**120**	190	300	480	600	750	910	1120	1380	1680	2040	2310	2640	2970	3240	3780
	30	22	0	0	0	**150**	240	390	490	610	760	930	1140	1390	1690	1920	2200	2470	2700	3160
380 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	600	960	1510	2380	3730	5800	7170	8800										
	7.5	5.5	400	660	1030	1630	2560	3960	4890	6000	7390	9010								
	10	7.5	300	480	760	1200	1870	2890	3570	4360	5350	6490	7840	9390						
	15	11	210	340	550	880	1380	2140	2650	3250	4030	4930	6000	7260	8650	9780				
	20	15	**160**	260	410	660	1050	1630	2020	2500	3090	3790	4630	5640	6750	7660	4260	9760		
	25	18.5	0	**210**	330	540	850	1320	1650	2020	2500	3070	3760	4560	5460	6190	7080	7870	8610	9880
	30	22	0	0	**270**	430	700	1090	1360	1680	2070	2550	3120	3780	4530	5140	5880	6540	7150	8230
	40	30	0	0	**210**	320	510	790	990	1230	1510	1860	2280	2760	3300	3750	4270	4750	5200	5980
	50	37	0	0	0	**250**	400	630	810	990	1230	1500	1830	2220	2650	3010	3430	3820	4170	4780
	60	45	0	0	0	0	**340**	540	660	840	1030	1270	1540	1870	2250	2550	2910	3220	3520	4050
	75	55	0	0	0	0	**290**	450	550	690	855	1050	1290	1570	1900	2160	2490	2770	3040	3520
	100	75	0	0	0	0	0	**340**	**420**	520	640	760	940	1140	1360	1540	1770	1960	2140	2470
	125	93	0	0	0	0	0	0	**340**	**400**	**490**	600	730	930	1110	1260	1420	1590	1740	1990
	150	110	0	0	0	0	0	0	0	**350**	**420**	**510**	620	750	930	1050	1180	1320	1440	1630
	175	130	0	0	0	0	0	0	0	0	**360**	**440**	**540**	660	780	970	1120	1260	1380	1600
	200	150	0	0	0	0	0	0	0	0	0	**410**	**480**	**580**	690	790	940	1050	1140	1320
460 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	880	1420	2250	3540	5550	8620												
	7.5	5.5	630	1020	1600	2530	3960	6150	7650	9390										
	10	7.5	460	750	1180	1870	2940	4570	5700	7020	8620									
	15	11	310	510	810	1270	2010	3130	3900	4800	5890	7210	8850							
	20	15	230	380	610	970	1540	2410	3000	3700	4560	5590	6870	8290						
	25	18.5	**190**	310	490	790	1240	1950	2430	2980	3670	4510	5550	6700	8140					
	30	22	0	**250**	410	640	1020	1600	1990	2460	3040	3730	4590	5550	6750	7690	8790			
	40	30	0	0	**300**	480	750	1180	1470	1810	2230	2740	3370	4060	4930	5590	6370			
	50	37	0	0	**250**	370	590	960	1200	1470	1810	2220	2710	3280	3970	4510	5130	5740	6270	7270
	60	45	0	0	0	**320**	500	810	1000	1240	1530	1870	2310	2770	3360	3810	4330	4860	5310	6150
	75	55	0	0	0	0	**420**	660	810	1020	1260	1540	1890	2280	2770	3150	3600	4050	4420	5160
	100	75	0	0	0	0	**310**	**500**	610	760	930	1140	1410	1690	2070	2340	2680	3010	3280	3820
	125	93	0	0	0	0	0	**390**	**470**	**590**	730	880	1110	1330	1500	1830	2080	2340	2550	2940
	150	110	0	0	0	0	0	0	**420**	**510**	**630**	770	950	1140	1380	1570	1790	2000	2180	2530
	175	130	0	0	0	0	0	0	0	**450**	**550**	**680**	830	1000	1220	1390	1580	1780	1950	2270
	200	150	0	0	0	0	0	0	0	0	**480**	**590**	**730**	880	1070	1210	1380	1550	1690	1970
575 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	1380	2220	3490	5520	8620													
	7.5	5.5	990	1590	2520	3970	6220													
	10	7.5	730	1170	1860	2920	4590	7150	8910											
	15	11	490	790	1270	2010	3130	4890	6090											
	20	15	370	610	970	1540	2410	3780	4710	5790	7140	8740								
	25	18.5	**300**	490	780	1240	1950	3040	3790	4660	5760	7060								
	30	22	**240**	400	645	1020	1600	2500	3120	3840	4740	5820	7150	8670						
	40	30	0	**300**	480	750	1180	1860	2310	2850	3490	4290	5260	6340	7710	8740				
	50	37	0	0	**380**	590	960	1500	1870	2310	2830	3460	4260	5130	6210	7050	8010	8980	9790	
	60	45	0	0	**330**	500	790	1270	1590	1950	2400	2940	3600	4330	5250	5950	6780	7600	8290	9610
	75	55	0	0	0	**420**	660	1030	1290	1590	1960	2400	2950	3570	4330	4930	5620	6330	6910	8050
	100	75	0	0	0	0	**400**	780	960	1180	1450	1780	2190	2650	3220	3660	4180	4710	5140	5980
	125	93	0	0	0	0	0	**600**	740	920	1150	1420	1740	2100	2530	2880	3270	3660	3970	4600
	150	110	0	0	0	0	0	**520**	**650**	800	990	1210	1480	1780	2160	2450	2790	3120	3410	3950
	175	130	0	0	0	0	0	0	**570**	**700**	860	1060	1300	1570	1910	2170	2480	2780	3040	3540
	200	150	0	0	0	0	0	0	**500**	**610**	**760**	930	1140	1370	1670	1890	2160	2420	2640	3070

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

Table 22 Three-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE	
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.			
4"	234501	1/2	0.37	200	60	1.6	2.8	585	3.4	860	6.6-8.4	70	64	17.5	N	
	234511			230	60	1.6	2.4	585	2.9	860	9.5-10.9	70	64	15.2	N	
	234541			380	60	1.6	1.4	585	2.1	860	23.2-28.6	70	64	9.2	N	
	234521			460	60	1.6	1.2	585	1.5	860	38.4-44.1	70	64	7.6	N	
	234531			575	60	1.6	1.0	585	1.2	860	58.0-71.0	70	64	6.1	N	
	234502	3/4	0.55	200	60	1.5	3.6	810	4.4	1150	4.6-5.9	73	69	24.6	N	
	234512			230	60	1.5	3.1	810	3.8	1150	6.8-7.8	73	69	21.4	N	
	234542			380	60	1.5	1.9	810	2.5	1150	16.6-20.3	73	69	13	N	
	234522			460	60	1.5	1.6	810	1.9	1150	27.2-30.9	73	69	10.7	N	
	234532			575	60	1.5	1.3	810	1.6	1150	41.5-50.7	73	69	8.6	N	
	234503	1	0.75	200	60	1.4	4.5	1070	5.4	1440	3.8-4.5	72	70	30.9	M	
	234513			230	60	1.4	3.9	1070	4.7	1440	4.9-5.6	72	70	26.9	M	
	234543			380	60	1.4	2.3	1070	2.8	1440	12.2-14.9	72	70	16.3	M	
	234523			460	60	1.4	2	1070	2.4	1440	19.9-23.0	72	70	13.5	M	
	234533			575	60	1.4	1.6	1070	1.9	1440	30.1-36.7	72	70	10.8	M	
	234504	1.5	1.1	200	60	1.3	5.8	1460	6.8	1890	2.5-3.0	76	76	38.2	K	
	234514			230	60	1.3	5	1460	5.9	1890	3.2-4.0	76	76	33.2	K	
	234544			380	60	1.3	3	1460	3.6	1890	8.5-10.4	76	76	20.1	K	
	234524			460	60	1.3	2.5	1460	3.1	1890	13.0-16.0	76	76	16.6	K	
	234534			575	60	1.3	2	1460	2.4	1890	20.3-25.0	76	76	13.3	K	
	234305	2	1.5	200	60	1.25	7.7	1960	9.3	2430	1.8-2.4	76	76	50.3	K	
	234315			230	60	1.25	6.7	1960	8.1	2430	2.3-3.0	76	76	45.0	K	
	234345			380	60	1.25	4.1	1960	4.9	2430	6.6-8.2	76	76	26.6	K	
	234325			460	60	1.25	3.4	1960	4.1	2430	9.2-12.0	76	76	22.5	K	
	234335			575	60	1.25	2.7	1960	3.2	2430	14.6-18.7	76	76	17.8	K	
	234306	3	2.2	200	60	1.15	10.9	2920	12.5	3360	1.3-1.7	77	77	69.5	K	
	234316			230	60	1.15	9.5	2920	10.9	3360	1.8-2.2	77	77	60.3	K	16CC
	234346			380	60	1.15	5.8	2920	6.6	3360	4.7-6.0	77	77	37.5	K	
	234326			460	60	1.15	4.8	2920	5.5	3360	7.2-8.8	77	77	31.0	K	
	234336			575	60	1.15	3.8	2920	4.4	3360	11.4-13.9	77	77	25.1	K	
	234307	5	3.7	200	60	1.15	18.3	4800	20.5	5500	.68-.83	78	78	116	K	
	234317			230	60	1.15	15.9	4800	17.8	5500	.91-1.1	78	78	102	K	16LGR
	234347			380	60	1.15	9.6	4800	10.8	5500	2.6-3.2	78	78	60.2	K	
	234327			460	60	1.15	8.0	4800	8.9	5500	3.6-4.4	78	78	53.7	K	
	234337			575	60	1.15	6.4	4800	7.1	5500	5.6-6.9	78	78	41.8	K	EXW02
	234308	7.5	5.5	200	60	1.15	26.5	7150	30.5	8200	.43-.53	78	78	177	K	
	234318			230	60	1.15	23.0	7150	26.4	8200	.60-.73	78	78	152	K	EXW03
	234348			380	60	1.15	13.9	7150	16.0	8200	1.6-2.0	78	78	92.7	K	EXW04
	234328			460	60	1.15	11.5	7150	13.2	8200	2.3-2.8	78	78	83.8	K	EXW05
	234338			575	60	1.15	9.2	7150	10.6	8200	3.6-4.5	78	78	64.6	K	
	234549	10	7.5	380	60	1.15	19.3	10000	21.0	11400	1.2-1.6	75	75	140	L	
	234595			460	60	1.15	15.9	10000	17.3	11400	1.8-2.3	75	75	116.0	L	
	234598			575	60	1.15	12.5	10000	13.6	11400	2.8-3.5	75	75	92.8	L	

Table 23 Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)			
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	
4"	234501	1/2	0.37	200	10	5	8	10	4	15	
	234511			230	8	4.5	6	8	4	15	
	234541			380	5	2.5	4	5	2	15	
	234521			460	4	2.25	3	4	2	15	
	234531			575	3	1.8	3	3	1.4	15	
	234502	3/4	0.55	200	15	7	10	12	5	15	
	234512			230	10	5.6	8	10	5	15	
	234542			380	6	3.5	5	6	3	15	
	234522			460	5	2.8	4	5	3	15	
	234532			575	4	2.5	4	4	1.8	15	
	234503	1	0.75	200	15	8	15	15	6	15	
	234513			230	15	7	10	12	6	15	
	234543			380	8	4.5	8	8	4	15	
	234523			460	6	3.5	5	6	3	15	
	234533			575	5	2.8	4	5	2.5	15	
	234504	1.5	1.1	200	20	12	15	20	8	15	
	234514			230	15	9	15	15	8	15	
	234544			380	10	5.6	8	10	4	15	
	234524			460	8	4.5	8	8	4	15	
	234534			575	6	3.5	5	6	3	15	
	234305	2	1.5	200	25	15	20	25	11	20	
	234315			230	25	12	20	25	10	20	
	234345			380	15	8	15	15	6	15	
	234325			460	15	6	10	11	5	15	
	234335			575	10	5	8	10	4	15	
	234306	3	2.2	200	35	20	30	35	15	30	16CC
	234316			230	30	17.5	25	30	12	25	
	234346			380	20	12	15	20	8	15	
	234326			460	15	9	15	15	6	15	
	234336			575	15	7	10	11	5	15	
	234307	5	3.7	200	60	35	50	60	25	50	
	234317			230	50	30	40	45	20	40	16LGR
	234347			380	30	17.5	25	30	12	25	
	234327			460	25	15	20	25	10	20	
	234337			575	20	12	20	20	8	20	EXW02
	234308	7.5	5.5	200	90	50	70	80	35	70	EXW03
	234318			230	80	45	60	70	30	60	EXW04
	234348			380	45	25	40	40	20	40	EXW05
	234328			460	40	25	30	35	15	30	
	234338			575	30	17.5	25	30	12	25	
	234349	10	7.5	380	70	40	60	60	25	60	
	234329			460	60	30	45	50	25	45	
	234339			575	45	25	35	40	20	35	
	234549			380	70	35	60	60	25	60	
	234595			460	60	30	45	50	25	45	
	234598			575	45	25	35	40	20	35	

Table 24 Three-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.		
6" STD.	236650	5	3.7	200	60	1.15	17.5	4700	20.0	5400	.77-.93	79	79	99	H
	236600			230	60	1.15	15	4700	17.6	5400	1.0-1.2	79	79	86	H
	236660			380	60	1.15	9.1	4700	10.7	5400	2.6-3.2	79	79	52	H
	236610			460	60	1.15	7.5	4700	8.8	5400	3.9-4.8	79	79	43	H
	236620			575	60	1.15	6	4700	7.1	5400	6.3-7.7	79	79	34	H
	236651	7.5	5.5	200	60	1.15	25.1	7000	28.3	8000	.43-.53	80	80	150	H
	236601			230	60	1.15	21.8	7000	24.6	8000	.64-.78	80	80	130	H
	236661			380	60	1.15	13.4	7000	15	8000	1.6-2.1	80	80	79	H
	236611			460	60	1.15	10.9	7000	12.3	8000	2.4-2.9	80	80	65	H
	236621			575	60	1.15	8.7	7000	9.8	8000	3.7-4.6	80	80	52	H
	236652	10	7.5	200	60	1.15	32.7	9400	37	10800	.37-.45	79	79	198	H
	236602			230	60	1.15	28.4	9400	32.2	10800	.47-.57	79	79	172	H
	236662			380	60	1.15	17.6	9400	19.6	10800	1.2-1.5	79	79	104	H
	236612			460	60	1.15	14.2	9400	16.1	10800	1.9-2.4	79	79	86	H
	236622			575	60	1.15	11.4	9400	12.9	10800	3.0-3.7	79	79	69	H
	236653	15	11	200	60	1.15	47.8	13700	54.4	15800	.24-.29	81	81	306	H
	236603			230	60	1.15	41.6	13700	47.4	15800	.28-.35	81	81	266	H
	236663			380	60	1.15	25.8	13700	28.9	15800	.77-.95	81	81	161	H
	236613			460	60	1.15	20.8	13700	23.7	15800	1.1-1.4	81	81	133	H
	236623			575	60	1.15	16.6	13700	19	15800	1.8-2.3	81	81	106	H
	236654	20	15	200	60	1.15	61.9	18100	69.7	20900	.16-.20	82	82	416	J
	236604			230	60	1.15	53.8	18100	60.6	20900	.22-.26	82	82	362	J
	236664			380	60	1.15	33	18100	37.3	20900	.55-.68	82	82	219	J
	236614			460	60	1.15	26.9	18100	30.3	20900	.8-1.0	82	82	181	J
	236624			575	60	1.15	21.5	18100	24.2	20900	1.3-1.6	82	82	145	J
	236655	25	18.5	200	60	1.15	77.1	22500	86.3	25700	.12-.15	83	83	552	J
	236605			230	60	1.15	67	22500	75	25700	.15-.19	83	83	480	J
	236665			380	60	1.15	41	22500	46	25700	.46-.56	83	83	291	J
	236615			460	60	1.15	33.5	22500	37.5	25700	.63-.77	83	83	240	J
	236625			575	60	1.15	26.8	22500	30	25700	1.0-1.3	83	83	192	J
	236656	30	22	200	60	1.15	90.9	26900	104	31100	.09-.11	83	83	653	J
	236606			230	60	1.15	79	26900	90.4	31100	.14-.17	83	83	568	J
	236666			380	60	1.15	48.8	26900	55.4	31100	.35-.43	83	83	317	J
	236616			460	60	1.15	39.5	26900	45.2	31100	.52-.64	83	83	284	J
	236626			575	60	1.15	31.6	26900	36.2	31100	.78-.95	83	83	227	J
	236667	40	30	380	60	1.15	66.5	35600	74.6	42400	.26-.33	83	83	481	J
	236617			460	60	1.15	54.9	35600	61.6	42400	.34-.42	83	83	397	J
	236627			575	60	1.15	42.8	35600	49.6	42400	.52-.64	83	83	318	H
	236668	50	37	380	60	1.15	83.5	45100	95	52200	.21-.25	82	83	501	H
	236618			460	60	1.15	67.7	45100	77	52200	.25-.32	82	83	414	H
	236628			575	60	1.15	54.2	45100	61.6	52200	.40-.49	82	83	331	H
	276668			380	60	1.15	82.4	45100	94.5	52200	.21 - .25	82	83	501	H
	276618			460	60	1.15	68.1	45100	78.1	52200	.25 - .32	82	83	414	H
	276628			575	60	1.15	54.5	45100	62.5	52200	.40 - .49	82	83	331	H
	236669	60	45	380	60	1.15	98.7	53500	111	61700	.15-.18	84	84	627	H
	236619			460	60	1.15	80.5	53500	91	61700	.22-.27	84	84	518	H
	236629			575	60	1.15	64.4	53500	72.8	61700	.35-.39	84	84	414	H
	276669			380	60	1.15	98.1	53500	111.8	61700	.15 - .18	84	84	627	H
	276619			460	60	1.15	81.0	53500	92.3	61700	.22 - .27	84	84	518	H
	276629			575	60	1.15	64.8	53500	73.9	61700	.35 - .39	84	84	414	H

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

Table 25 6” Three-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.		
6" HI-TEMP 90 °C	276650	5	3.7	200	60	1.15	17.2	5200	19.8	5800	.53 - .65	73	72	124	K
	276600			230	60	1.15	15.0	5200	17.2	5800	.68 - .84	73	72	108	K
	276660			380	60	1.15	9.1	5200	10.4	5800	2.0 - 2.4	73	72	66.0	K
	276610			460	60	1.15	7.5	5200	8.6	5800	2.8 - 3.4	73	72	54.0	K
	276620			575	60	1.15	6.0	5200	6.9	5800	4.7 - 5.7	73	72	43.0	K
	276651	7.5	5.5	200	60	1.15	24.8	7400	28.3	8400	.30 - .37	77	76	193	K
	276601			230	60	1.15	21.6	7400	24.6	8400	.41 - .50	77	76	168	K
	276661			380	60	1.15	13.1	7400	14.9	8400	1.1 - 1.4	77	76	102	K
	276611			460	60	1.15	10.8	7400	12.3	8400	1.7 - 2.0	77	76	84.0	K
	276621			575	60	1.15	8.6	7400	9.9	8400	2.6 - 3.2	77	76	67.0	K
	276652	10	7.5	200	60	1.15	32.0	9400	36.3	10700	.21 - .26	80	79	274	L
	276602			230	60	1.15	27.8	9400	31.6	10700	.28 - .35	80	79	238	L
	276662			380	60	1.15	16.8	9400	19.2	10700	.80 - .98	80	79	144	L
	276612			460	60	1.15	13.9	9400	15.8	10700	1.2 - 1.4	80	79	119	L
	276622			575	60	1.15	11.1	9400	12.7	10700	1.8 - 2.2	80	79	95.0	L
	276653	15	11	200	60	1.15	48.5	14000	54.5	15900	.15 - .19	81	80	407	L
	276603			230	60	1.15	42.2	14000	47.4	15900	.19 - .24	81	80	354	L
	276663			380	60	1.15	25.5	14000	28.7	15900	.52 - .65	81	80	214	L
	276613			460	60	1.15	21.1	14000	23.7	15900	.78 - .96	81	80	177	L
	276623			575	60	1.15	16.9	14000	19.0	15900	1.2 - 1.4	81	80	142	L
	276654	20	15	200	60	1.15	64.9	18600	73.6	21300	.10 - .12	80	80	481	K
	276604			230	60	1.15	56.4	18600	64.0	21300	.14 - .18	80	80	418	K
	276664			380	60	1.15	34.1	18600	38.8	21300	.41 - .51	80	80	253	K
	276614			460	60	1.15	28.2	18600	32.0	21300	.58 - .72	80	80	209	K
	276624			575	60	1.15	22.6	18600	25.6	21300	.93 - 1.15	80	80	167	K
	276655	25	18.5	200	60	1.15	80.0	22600	90.6	25800	.09 - .11	83	82	665	L
	276605			230	60	1.15	69.6	22600	78.8	25800	.11 - .14	83	82	578	L
	276665			380	60	1.15	42.1	22600	47.7	25800	.27 - .34	83	82	350	L
	276615			460	60	1.15	34.8	22600	39.4	25800	.41 - .51	83	82	289	L
	276625			575	60	1.15	27.8	22600	31.6	25800	.70 - .86	83	82	231	L
	276656	30	22	200	60	1.15	95.0	28000	108.6	31900	.07 - .09	81	80	736	K
	276606			230	60	1.15	82.6	28000	94.4	31900	.09 - .12	81	80	640	K
	276666			380	60	1.15	50.0	28000	57.2	31900	.23 - .29	81	80	387	K
	276616			460	60	1.15	41.3	28000	47.2	31900	.34 - .42	81	80	320	K
	276626			575	60	1.15	33.0	28000	37.8	31900	.52 - .65	81	80	256	K
	276667	40	30	380	60	1.15	67.2	35900	76.0	42400	.18 - .23	84	83	545	L
	276617			460	60	1.15	55.4	35900	62.8	42400	.23 - .29	84	83	450	L
	276627			575	60	1.15	45.2	35900	50.2	42400	.34 - .43	84	83	360	L

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

Table 26 Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX		RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
			HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
6" STD. & HI-TEMP	236650	276650	5	3.7	200	60	35	45	50	25	45
	236600	276600			230	45	30	40	45	20	40
	236660	276660			380	30	17.5	25	30	12	25
	236610	276610			460	25	15	20	25	10	20
	236620	276620			575	20	12	15	20	8	15
	236651	276651	7.5	5.5	200	80	45	70	80	35	70
	236601	276601			230	70	40	60	70	30	60
	236661	276661			380	45	25	35	40	20	35
	236611	276611			460	35	20	30	35	15	30
	236621	276621			575	30	17.5	25	25	11	25
	236652	276652	10	7.5	200	100	60	90	100	45	90
	236602	276602			230	90	50	80	90	40	80
	236662	276662			380	60	35	45	50	25	45
	236612	276612			460	45	25	40	45	20	40
	236622	276622			575	35	20	30	35	15	30
	236653	276653	15	11	200	150	90	125	150	60	125
	236603	276603			230	150	80	110	125	60	110
	236663	276663			380	80	50	70	80	35	70
	236613	276613			460	70	40	60	60	30	60
	236623	276623			575	60	30	45	50	25	45
	236654	276654	20	15	200	200	110	175	175	80	175
	236604	276604			230	175	100	150	175	70	150
	236664	276664			380	100	60	90	100	45	90
	236614	276614			460	90	50	70	80	35	70
	236624	276624			575	70	40	60	70	30	60
	236655	276655	25	18.5	200	250	150	200	225	100	200
	236605	276605			230	225	125	175	200	90	175
	236665	276665			380	125	80	110	125	50	110
	236615	276615			460	110	60	90	100	45	90
	236625	276625			575	90	50	70	80	35	70
	236656	276656	30	22	200	300	175	250	300	125	250
	236606	276606			230	250	150	225	250	100	200
	236666	276666			380	150	90	125	150	60	125
	236616	276616			460	125	70	110	125	50	100
	236626	276626			575	100	60	90	100	40	80
	236667	276667	40	30	380	200	125	175	200	90	175
	236617	276617			460	175	100	150	175	70	150
	236627	276627			575	150	80	110	125	60	110
	236668	276668	50	37	380	250	150	225	250	110	225
	236618	276618			460	225	125	175	200	90	175
	236628	276628			575	175	100	150	175	70	150
	236669	276669	60	45	380	300	175	250	300	125	250
	236619	276619			460	250	150	225	250	100	225
	236629	276629			575	200	125	175	200	80	175

Table 27 Three-Phase Motor Specifications (60 Hz) 3525 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	KILOWATTS	AMPS	KILOWATTS		S.F.	F.L.		
8" STD.	239660	40	30	380	60	1.15	64	35	72	40	.16-.20	86	86	479	J
	239600			460	60	1.15	53	35	60	40	.24-.30	86	86	396	J
	239610			575	60	1.15	42	35	48	40	.39-.49	86	86	317	J
	239661	50	37	380	60	1.15	79	43	88	49	.12-.16	87	87	656	K
	239601			460	60	1.15	64	43	73	49	.18-.22	87	87	542	K
	239611			575	60	1.15	51	43	59	49	.28-.34	87	87	434	K
	239662	60	45	380	60	1.15	92	52	104	60	.09-.11	88	87	797	K
	239602			460	60	1.15	76	52	86	60	.14-.17	88	87	658	K
	239612			575	60	1.15	61	52	69	60	.22-.28	88	87	526	K
	239663	75	55	380	60	1.15	114	64	130	73.5	.06-.09	88	88	1046	L
	239603			460	60	1.15	94	64	107	73.5	.10-.13	88	88	864	L
	239613			575	60	1.15	76	64	86	73.5	.16-.21	88	88	691	L
	239664	100	75	380	60	1.15	153	85	172	97.5	.05-.06	89	89	1466	L
	239604			460	60	1.15	126	85	142	97.5	.07-.09	89	89	1211	L
	239614			575	60	1.15	101	85	114	97.5	.11-.13	89	89	969	L
	239165	125	93	380	60	1.15	202	109	228	125	.03-.04	87	86	1596	K
	239105			460	60	1.15	167	109	188	125	.05-.07	87	86	1318	K
	239115			575	60	1.15	134	109	151	125	.08-.11	87	86	1054	K
	239166	150	110	380	60	1.15	235	128	266	146	.02-.03	88	87	1961	K
	239106			460	60	1.15	194	128	219	146	.04-.05	88	87	1620	K
	239116			575	60	1.15	155	128	176	146	.06-.08	88	87	1296	K
	239167	175	130	380	60	1.15	265	150	302	173	.02-.04	88	88	1991	J
	239107			460	60	1.15	219	150	249	173	.04-.05	88	88	1645	J
	239117			575	60	1.15	175	150	200	173	.06-.08	88	88	1316	J
	239168	200	150	380	60	1.15	298	169	342	194	.02-.03	88	88	2270	J
	239108			460	60	1.15	246	169	282	194	.03-.05	88	88	1875	J
	239118			575	60	1.15	197	169	226	194	.05-.07	88	88	1500	J

Table 27A 8" Three-Phase Motor Specifications (60 Hz) 3525 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	KILOWATTS	AMPS	KILOWATTS		S.F.	F.L.		
8" HI-TEMP	279160	40	30	380	60	1.15	69.6	38	78.7	43	.11 - .14	79	78	616	M
	279100			460	60	1.15	57.5	38	65.0	43	.16 - .19	79	78	509	M
	279110			575	60	1.15	46.0	38	52.0	43	.25 - .31	79	78	407	M
	279161	50	37	380	60	1.15	84.3	47	95.4	53	.07 - .09	81	80	832	M
	279101			460	60	1.15	69.6	47	78.8	53	.11 - .14	81	80	687	M
	279111			575	60	1.15	55.7	47	63.0	53	.18 - .22	81	80	550	M
	279162	60	45	380	60	1.15	98.4	55	112	62	.06 - .07	83	82	1081	N
	279102			460	60	1.15	81.3	55	92.1	62	.09 - .11	83	82	893	N
	279112			575	60	1.15	65.0	55	73.7	62	.13 - .16	83	82	715	N
	279163	75	56	380	60	1.15	125	68	141	77	.05 - .06	83	82	1175	L
	279103			460	60	1.15	100	68	114	77	.07 - .09	83	82	922	L
	279113			575	60	1.15	80	68	92	77	.11 - .14	83	82	738	L
	279164	100	75	380	60	1.15	159	88	181	100	.04 - .05	86	85	1508	M
	279104			460	60	1.15	131	88	149	100	.05 - .07	86	85	1246	M
	279114			575	60	1.15	105	88	119	100	.08 - .10	86	85	997	M
	279165	125	93	380	60	1.15	195	109	223	125	.03 - .04	86	85	1793	L
	279105			460	60	1.15	161	109	184	125	.04 - .06	86	85	1481	L
	279115			575	60	1.15	129	109	148	125	.07 - .09	86	85	1185	L
	279166	150	110	380	60	1.15	235	133	269	151	.02 - .03	85	84	2012	K
	279106			460	60	1.15	194	133	222	151	.03 - .05	85	84	1662	K
	279116			575	60	1.15	155	133	178	151	.05 - .07	85	84	1330	K

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

Table 28 Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
8" STD.	239660			380	200	125	175	200	80	175
	239600	40	30	460	175	100	150	175	70	150
	239610			575	150	80	110	125	60	110
	239661			380	250	150	200	225	100	200
	239601	50	37	460	200	125	175	200	80	175
	239611			575	175	90	150	150	70	150
	239662			380	300	175	250	300	125	250
	239602	60	45	460	250	150	200	225	100	200
	239612			575	200	110	175	175	80	175
	239663			380	350	200	300	350	150	300
	239603	75	55	460	300	175	250	300	125	250
	239613			575	250	150	200	225	100	200
	239664			380	500	275	400	450	200	400
	239604	100	75	460	400	225	350	400	175	350
	239614			575	350	200	300	300	125	300
	239165			380	700	400	600	600	250	600
	239105	125	93	460	500	300	450	500	225	450
	239115			575	450	250	350	400	175	350
	239166			380	800	450	600	700	300	600
	239106	150	110	460	600	350	500	600	250	500
	239116			575	500	300	400	450	200	400
	239167			380	800	500	700	800	350	700
	239107	175	130	460	700	400	600	700	300	600
	239117			575	600	350	450	600	225	450
	239168			380	1000	600	800	1000	400	800
	239108	200	150	460	800	450	700	800	350	700
	239118			575	600	350	500	600	250	500

Table 28A 8" Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
8" HI-TEMP	279160			380	225	125	175	200	90	175
	279100	40	30	460	175	110	150	175	70	150
	279110			575	150	90	125	125	60	125
	279161			380	250	150	225	225	110	225
	279101	50	37	460	200	125	175	200	90	175
	279111			575	175	100	150	150	70	150
	279162			380	300	175	250	300	125	250
	279102	60	45	460	275	150	225	250	100	225
	279112			575	200	125	175	175	80	175
	279163			380	400	200	350	350	150	350
	279103	75	56	460	300	175	275	300	125	275
	279113			575	275	150	225	225	100	225
	279164			380	500	300	450	450	200	450
	279104	100	75	460	400	250	350	400	175	350
	279114			575	350	200	300	300	125	300
	279165			380	700	400	600	600	250	600
	279105	125	93	460	500	300	450	500	225	450
	279115			575	450	250	350	400	175	350
	279166			380	800	450	600	700	300	600
	279106	150	110	460	600	350	500	600	250	500
	279116			575	500	300	400	450	200	400

Overload Protection of Three-Phase Submersible Motors **Class 10 Protection Required**

The characteristics of submersible motors are different than standard motors and special overload protection is required.

If the motor is locked, the overload protection must trip within 10 seconds to protect the motor windings. Subtrol/ SubMonitor, a Franklin-approved adjustable overload relay, or a Franklin-approved fixed heater must be used.

Fixed heater overloads must be the ambient-compensated quick-trip type to maintain protection at high and low air temperatures.

All heaters and amp settings shown are based on total line amps. When determining amperage settings or making heater selections for a six-lead motor with a Wye-Delta starter, divide motor amps by 1.732.

Pages 29, 30 and 31 list the correct selection and settings for some manufacturers. Approval for other manufacturers' types not listed may be requested by calling Franklin's Submersible Service Hotline at 800-348-2420.

Refer to notes on page 30.

Table 29 - 60 Hz 4" Motors

HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
				FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
1/2	0.37	200	00	K31	L380A	3.2	3.4
		230	00	K28	L343A	2.7	2.9
		380	00	K22	L211A	1.7	1.8
		460	00	-	L174A	1.4	1.5
		575	00	-	-	1.2	1.3
3/4	0.55	200	00	K34	L510A	4.1	4.4
		230	00	K32	L420A	3.5	3.8
		380	00	K27	L282A	2.3	2.5
		460	00	K23	L211A	1.8	1.9
		575	00	K21	L193A	1.5	1.6
1	0.75	200	00	K37	L618A	5.0	5.4
		230	00	K36	L561A	4.4	4.7
		380	00	K28	L310A	2.6	2.8
		460	00	K26	L282A	2.2	2.4
		575	00	K23	L211A	1.8	1.9
1.5	1.1	200	00	K42	L750A	6.3	6.8
		230	00	K39	L680A	5.5	5.9
		380	00	K32	L420A	3.3	3.6
		460	00	K29	L343A	2.8	3.0
		575	00	K26	L282A	2.2	2.4
2	1.5	200	0	K50	L111B	8.6	9.3
		230	0	K49	L910A	7.5	8.1
		380	0	K36	L561A	4.6	4.9
		460	00	K33	L463A	3.8	4.1
		575	00	K29	L380A	3.0	3.2
3	2.2	200	0	K55	L147B	11.6	12.5
		230	0	K52	L122B	10.1	10.9
		380	0	K41	L750A	6.1	6.6
		460	0	K37	L618A	5.1	5.5
		575	0	K34	L510A	4.1	4.4
5	3.7	200	1	K62	L241B	19.1	20.5
		230	1	K61	L199B	16.6	17.8
		380	0	K52	L122B	10.0	10.8
		460	0	K49	L100B	8.3	8.9
		575	0	K42	L825A	6.6	7.1
7.5	5.5	200	1	K68	L332B	28.4	30.5
		230	1	K67	L293B	24.6	26.4
		380	1	K58	L181B	14.9	16.0
		460	1	K55	L147B	12.3	13.2
		575	1	K52	L122B	9.9	10.6
10	7.5	380	1	K62	L241B	19.5	21.0
		460	1	K60	L199B	16.1	17.3
		575	1	K56	L165B	12.9	13.6

16CC

16LGR

EXW02
EXW03
EXW04
EXW05

Table 30 - 60 Hz 6" Standard & Hi-Temp Motors

HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
				FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
5	3.7	200	1	K61	L220B	17.6	19.1
		230	1	K61	L199B	15.4	16.6
		380	0	K52	L122B	9.4	10.1
		460	0	K49	L100B	7.7	8.3
		575	0	K42	L825A	6.1	6.6
7.5	5.5	200	1	K67	L322B	26.3	28.3
		230	1	K64	L293B	22.9	24.6
		380	1	K57	L165B	13.9	14.9
		460	1	K54	L147B	11.4	12.3
		575	1	K52	L111B	9.1	9.8
10	7.5	200	2(1)	K72	L426B	34.4	37.0
		230	2(1)	K70	L390B	29.9	32.2
		380	1	K61	L220B	18.1	19.5
		460	1	K58	L181B	15.0	16.1
		575	1	K55	L147B	12.0	12.9
15	11	200	3(1)	K76	L650B	50.7	54.5
		230	2	K75	L520B	44.1	47.4
		380	2(1)	K68	L322B	26.7	28.7
		460	2(1)	K64	L265B	22.0	23.7
		575	2(1)	K61	L220B	17.7	19.0
20	15	200	3	K78	L787B	64.8	69.7
		230	3(1)	K77	L710B	56.4	60.6
		380	2	K72	L426B	34.1	36.7
		460	2	K69	L352B	28.2	30.3
		575	2	K64	L393B	22.7	24.4
25	18.5	200	3	K86	L107C	80.3	86.3
		230	3	K83	L866B	69.8	75.0
		380	2	K74	L520B	42.2	45.4
		460	2	K72	L426B	34.9	37.5
		575	2	K69	L352B	27.9	30.0
30	22	200	4(1)	K88	L126C	96.7	104.0
		230	3	K87	L107C	84.1	90.4
		380	3(1)	K76	L650B	50.9	54.7
		460	3(1)	K74	L520B	42.0	45.2
		575	3(1)	K72	L390B	33.7	36.2
40	30	380	3	K83	L866B	69.8	75.0
		460	3	K77	L710B	57.7	62.0
		575	3	K74	L593B	46.1	49.6
50	37	380	3	K87	L107C	86.7	93.2
		460	3	K83	L950B	71.6	77.0
		575	3	K77	L710B	57.3	61.6
60	45	380	4(1)	K89	L126C	102.5	110.2
		460	4(1)	K87	L107C	84.6	91.0
		575	4(1)	K78	L866B	67.7	72.8

Footnotes for Tables 29, 30, and 31

NOTE 1: Furnas intermediate sizes between NEMA starter sizes apply where (1) is shown in tables, size 1.75 replacing 2, 2.5 replacing 3, 3.5 replacing 4, and 4.5 replacing 5. Heaters were selected from Catalog 294, table 332 and table 632 (starter size 00, size B). Size 4 starters are heater type 4 (JG). Starters using these heater tables include classes 14, 17 and 18 (inNOVA), classes 36 and 37 (reduced voltage), and classes 87, 88 and 89 (pump and motor control centers). Overload relay adjustments should be set no higher than 100% unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum. Heater selections for class 16 starters (Magnetic Definite Purpose) will be furnished upon request.

NOTE 2: General Electric heaters are type CR123 usable only on type CR124 overload relays and were selected from Catalog GEP-126OJ, page 184. Adjustment should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum.

NOTE 3: Adjustable overload relay amp settings apply to approved types listed. Relay adjustment should be set at the specified SET amps. Only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, not to exceed the MAX value shown.

NOTE 4: Heaters shown for ratings requiring NEMA size 5 or 6 starters are all used with current transformers per manufacturer standards. Adjustable relays may or may not use current transformers depending on design.

Table 31 - 60 Hz 8" Motors

MOTOR MODEL PREFIX	HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS FURNAS (NOTE 1)	HEATERS FOR OVERLOAD RELAYS G.E. (NOTE 2)	ADJUSTABLE RELAYS (NOTE 3) SET	ADJUSTABLE RELAYS (NOTE 3) MAX.
239660	40	30	380	3	K78	L866B	68	73
239600			460	3	K77	L710B	56	60
239610			575	3	K73	L520B	45	48
239661	50	37	380	3	K86	L107C	81	87
239601			460	3	K78	L866B	68	73
239611			575	3	K77	L710B	56	60
239662	60	45	380	4(1)	K89	L126C	101	108
239602			460	4(1)	K86	L107C	83	89
239612			575	4(1)	K78	L787B	64	69
239663	75	55	380	4	K92	L142C	121	130
239603			460	4(1)	K89	L126C	100	107
239613			575	4(1)	K85	L950C	79	85
239664	100	75	380	5(1)	K28	L100B	168	181
239604			460	4	K92	L155C	134	144
239614			575	4	K90	L142C	108	116
239165	125	93	380	5	K32	L135B	207	223
239105			460	5(1)	K29	L111B	176	189
239115			575	5(1)	K26	L825A	140	150
239166	150	110	380	5	-	L147B	248	267
239106			460	5(1)	K32	L122B	206	221
239116			575	5(1)	K28	L100B	165	177
239167	175	130	380	6	K26	-	270	290
239107			460	5	K33	L147B	233	250
239117			575	5	K31	L111B	186	200
239168	200	150	380	6	K27	-	316	340
239108			460	5	K33	L165B	266	286
239118			575	5	K32	L135B	213	229

Table 31A - 60 Hz 8" Hi-Temp 75°C Motors

MOTOR MODEL PREFIX	HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS FURNAS (NOTE 1)	HEATERS FOR OVERLOAD RELAYS G.E. (NOTE 2)	ADJUSTABLE RELAYS (NOTE 3) SET	ADJUSTABLE RELAYS (NOTE 3) MAX.
279160	40	30	380	3	K83	L866B	73	79
279100			460	3	K77	L710B	60	65
279110			575	3	K74	L593B	48	52
279161	50	37	380	3	K87	L107C	89	95
279101			460	3	K83	L866B	73	79
279111			575	3	K77	L710B	59	63
279162	60	45	380	4(1)	K89	L126C	104	112
279102			460	4(1)	K87	L107C	86	92
279112			575	4(1)	K78	L866B	69	74
279163	75	56	380	4	K92	L155C	131	141
279103			460	4(1)	K89	L126C	106	114
279113			575	4(1)	K87	L950C	86	92
279164	100	75	380	5(1)	K28	L100B	168	181
279104			460	5(1)	K26	L825A	139	149
279114			575	4	K90	L142C	111	119
279165	125	93	380	5	K32	L135B	207	223
279105			460	5(1)	K29	L111B	171	184
279115			575	5(1)	K26	L825A	138	148
279166	150	110	380	5	-	L147B	250	269
279106			460	5(1)	K32	L122B	206	222
279116			575	5(1)	K28	L100B	166	178

Note: Other relay types from these and other manufacturers may or may not provide acceptable protection, and they should not be used without approval of Franklin Electric.

Some approved types may only be available for part of the listed motor ratings. When relays are used with current transformers, relay setting is the specified amps divided by the transformer ratio.

Recommended Adjustable Overload Relays

Advance Controls: MDR3 Overload

AEG Series: B17S, B27S, B27-2

ABB Type: RVH 40, RVH65, RVP160, T25DU, T25CT, TA25DU

AGUT: MT03, R1K1, R1L0, R1L3, TE set Class 5

Allen Bradley: Bulletin 193, SMP-Class 10 only

Automatic Switch Types: DQ, LR1-D, LR1-F, LR2 Class 10

Benshaw: RSD6 (Class 10) Soft Start

Bharita C-H: MC 305 ANA 3

Clipsal: 6CTR, 6MTR

Cutler-Hammer: C316F, C316P, C316S, C310-set at 6 sec max, Advantage Class10

Fanal Types: K7 or K7D through K400

Franklin Electric: Subtrol-Plus, SubMonitor

Fuji Types: TR-OQ, TR-OQH, TR-2NQ, TR- 3NQ, TR-4NQ, TR-6NQ, RCa 3737-ICQ & ICQH

Furnas Types: US15 48AG & 48BG, 958L, ESP100-Class 10 only, 3RB10-Class 10

General Electric: CR4G, CR7G, RT*1, RT*2, RTF3, RT*4, CR324X-Class 10 only

Kasuga: RU Set Operating Time Code = 10 & time setting 6 sec max

Klockner-Moeller Types: ZOO, Z1, Z4, PKZM1, PKZM3 & PKZ2

Lovato: RC9, RC22, RC80, RF9, RF25 & RF95

Matsushita: FKT-15N, 15GN, 15E, 15GE, FT-15N, FHT-15N

Mitsubishi: ET, TH-K12ABKP, TH-K20KF, TH-K20KP, TH-K20TAKF, TH-K60KF, TH-K60TAKF

Omron: K2CM Set Operating Timing Code = 10 & time setting 6 sec max, SE-KP24E time setting 6 sec max

Riken: PM1, PM3

Samwha: EOCRS Set for Class 5, EOCR-ST, EOCR-SE, EOCR-AT time setting 6 sec max

Siemens Types: 3UA50, -52, -54, -55, -58, -59, -60, -61, -62, -66, -68, -70, 3VUI3, 3VE, 3UB (Class 5)

Sprecher and Schuh Types: CT, CT1, CTA 1, CT3K, CT3-12 thru CT3-42, KTA3, CEF1 & CET3 set at 6 sec max, CEP 7 Class 10, CT4, 6, & 7, CT3, KT7

Square D/Telemecanique: Class 9065 Types: TD, TE, TF, TG, TJ, TK, TR, TJE &TJF (Class 10), LR1-D, LR1-F, LR2 Class 10, Types 18A, 32A, SS-Class 10, SR-Class 10 and 63-A-LB Series. Integral 18,32,63, GV2-L, GV2-M, GV2-P, GV3-M (1.6-10 amp only) LR9D, SF Class 10, ST Class 10, LT6 (Class 5 or 10), LRD (Class 10), Motor Logic (Class10)

Toshiba Type: 2E RC820, set at 8 sec max.

WEG: RW2

Westinghouse Types: FT13, FT23, FT33, FT43, K7D, K27D, K67D, Advantage (Class 10), MOR, IQ500 (Class 5)

Westmaster: OLWROO and OLWTOO suffix D thru P

SUBMERSIBLE PUMP

Installation Check List

1. Motor Inspection

- [ ] A. Verify that the model, hp or kW, voltage, phase and hertz on the motor nameplate match the installation requirements.
- [ ] B. Check that the motor lead assembly is not damaged.
- [ ] C. Measure insulation resistance using a 500 or 1000 volt DC megohmmeter from each lead wire to the motor frame. Resistance should be at least 200 megohms without drop cable.
- [ ] D. Keep a record of motor model number, hp or kW, voltage, and serial number (S/N). (S/N is stamped in shell above the nameplate. A typical example, S/N 07A18 01-0123)

2. Pump Inspection

- [ ] A. Check that the pump rating matches the motor.
- [ ] B. Check for pump damage and verify that the pump shaft turns freely.

3. Pump/Motor Assembly

- [ ] A. If not yet assembled, check that pump and motor mounting faces are free from dirt, debris and uneven paint thickness.
- [ ] B. Pumps and motors over 5 hp should be assembled in the vertical position to prevent stress on pump brackets and shafts. Assemble the pump and motor together so their mounting faces are in contact and then tighten assembly bolts or nuts evenly to manufacturer specifications.
- [ ] C. If accessible, check that the pump shaft turns freely.
- [ ] D. Assemble the pump lead guard over the motor leads. Do not cut or pinch lead wires during assembly or installation.

4. Power Supply and Controls

- [ ] A. Verify that the power supply voltage, Hertz, and kVA capacity match motor requirements.
- [ ] B. Verify control box hp and voltage matches motor (3-wire only).
- [ ] C. Check that the electrical installation and controls meet all safety regulations and match the motor requirements, including fuse or circuit breaker size and motor overload protection. Connect all metal plumbing and electrical enclosures to the power supply ground to prevent shock hazard. Comply with national and local codes.

5. Lightning and Surge Protection

- [ ] A. Use properly rated surge (lightning) arrestors on all submersible pump installations. Motors 5 hp and smaller, which are marked “Equipped with Lightning Arrestors”, contain internal arrestors.
- [ ] B. Ground all above ground arrestors with copper wire directly to the motor frame, or to metal drop pipe or casing which reaches below the well pumping level. Connecting to a ground rod does not provide good surge protection.

6. Electrical Drop Cable

- [ ] A. Use submersible cable sized in accordance with local regulations and the cable charts. See pages 11 and 16-21. Ground motor per national and local codes.
- [ ] B. Include a ground wire to the motor and surge protection, connected to the power supply ground if required by codes. Always ground any pump operated outside a drilled well.

7. Motor Cooling

- [ ] A. Ensure at all times that the installation provides adequate motor cooling; see page 6 for details.

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8. Pump/Motor Installation

- ☐ A. Splice motor leads to supply cable using electrical grade solder or compression connectors, and carefully insulate each splice with watertight tape or adhesive-lined shrink tubing, as shown in motor or pump installation data.
- ☐ B. Support the cable to the delivery pipe every 10 feet (3 meters) with straps or tape strong enough to prevent sagging. Use padding between cable and any metal straps.
- ☐ C. A check valve in the delivery pipe is recommended. More than one check valve may be required, depending on valve rating and pump setting; see page 5 for details.
- ☐ D. Assemble all pipe joints as tightly as practical, to prevent unscrewing from motor torque. Torque should be at least 10 pound feet per hp (2 meter-KG per kW).
- ☐ E. Set the pump far enough below the lowest pumping level to assure the pump inlet will always have at least the Net Positive Suction Head (NPSH) specified by the pump manufacturer. Pump should be at least 10 feet (3 meters) from the bottom of the well to allow for sediment build up.
- ☐ F. Check insulation resistance as pump/motor assembly is lowered into the well. Resistance may drop gradually as more cable enters the water, but any sudden drop indicates possible cable, splice or motor lead damage; see page 45.

9. After Installation

- ☐ A. Check all electrical and water line connections and parts before starting the pump.
- ☐ B. Start the pump and check motor amps and pump delivery. If normal, continue to run the pump until delivery is clear. If three-phase pump delivery is low, it may be running backward. Rotation may be reversed (with power off) by interchanging any two motor lead connections to the power supply.
- ☐ C. Check three-phase motors for current balance within 5% of average, using motor manufacturer instructions Imbalance over 5% will cause higher motor temperatures and may cause overload trip, vibration, and reduced life.
- ☐ D. Verify that starting, running and stopping cause no significant vibration or hydraulic shocks.
- ☐ E. After at least 15 minutes running time, verify that pump output, electrical input, pumping level, and other characteristics are stable and as specified.

Date ______________________ Filled In By ____

Notes ____

____

____

____

____

____

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SUBMERSIBLE MOTOR INSTALLATION RECORD
Form 2207 - Page 1

RMA Number ____________

KEY DEALER # ____________

DISTRIBUTOR	INSTALLER	END USER
Name: ____________	Name: ____________	Name: ____________
City: ____________	City: ____________	City: ____________
State: ______ Zip: ______	State: ______ Zip: ______	State: ______ Zip: ______

Well ID or GPS: ______ ______ ____________ Water Temperature: ______ ☐ °F ☐ °C

Application/Water Use (e.g. potable water, irrigation, municipal, fountain, etc.): ____________

Date Installed (mm/yy): ______ Date Failed (mm/yy): ______ Motor Position Shaft-Up: ☐ Yes ☐ No

Operating Cycle: ON Time Per Start ______ ☐ Hrs. ☐ Mins. Time OFF Between Stop & Restart ______ ☐ Hrs. ☐ Mins.

MOTOR

Model: ____________ Serial Number: ____________ Date Code (if updated): ______

MOTOR OVERLOAD

System Typical Operating Current: ______ Amps @ ______ Volts

Overload: ☐ FE SubMonitor Input Amps ______ D3 Attached ☐ Yes ☐ No Fault Settings Attached ☐ Yes ☐ No

☐ Other Manufacturer Model: ____________ Dial Set at: ______ or Heater# ______

NEMA Class: ☐ 10 ☐ 20 ☐ 30 Ambient Compensated: ☐ Yes ☐ No

Power to Motor by: ☐ Full Volt Starter ☐ VFD ☐ Soft Starter VFD or Soft Starter Mfr. & Model: ____________

PUMP

Manufacturer: ____________

Model: ____________

Stages: ____________

Design Rating: ______ gpm @ ______ ft TDH

Horsepower Required by Pump End: ______

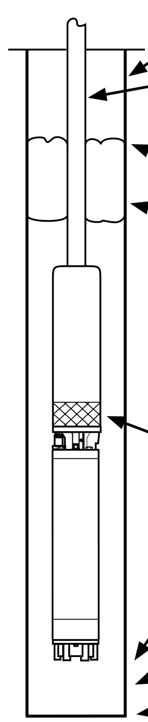
Actual Pump Delivery: ______ gpm @ ______ psi

What Controls When System Runs & Stops:

____

(e.g. pressure, level, flow, manual on/off, timer, time clock etc.)

WELL DATA (All measurements from well head down.)



Casing Diameter ____________ in

Drop Pipe Diameter ____________ in

Number of Sticks of Drop Pipe ____________

Static Water Level ____________ ft

Drawdown (pumping) Water Level ____________ ft

Spring Assist Check Valves:
(Measured from Well Head Down)

#1 ______ #2 ______ #3 ______ #4 ______ ft

☐ Solid ☐ Drilled Poppet ☐ Break-Off Plug

Pump Inlet Setting ____________ ft

Flow Sleeve ☐ No ☐ Yes, Dia. ______ in

Case Ends ____________ ft

☐ Well Screen ☐ Perforated Casing

#1 from ____ to ____ ft & #2 from ____ to ____ ft

Well Depth ____________ ft

YOUR NAME / DATE

____________ / ______

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SUBMERSIBLE MOTOR INSTALLATION RECORD
Form 2207 - Page 2

RMA Number

TRANSFORMERS

Number of Transformers: ☐ Two ☐ Three   Transformers Supply Motor Only: ☐ Yes ☐ No ☐ Unsure

Transformer #1: __________ kVA   Transformer #2: __________ kVA   Transformer #3: __________ kVA

POWER CABLES & GROUND WIRE

1 **Service Entrance to Pump Control Panel:**

Length: __________ ft. & Gauge: __________ AWG/MCM

Material: ☐ Copper ☐ Aluminum   Construction: ☐ Jacketed ☐ Individual Conductors ☐ Web ☐ Twisted

Temperature Rating of Cable: ☐ 60C ☐ 75C ☐ 90C ☐ 125C or Insulation Type: ________________ (e.g. THHN)

2 **Pump Control Panel to Motor:**

Length: __________ ft. & Gauge: __________ AWG/MCM

Material: ☐ Copper ☐ Aluminum   Construction: ☐ Jacketed ☐ Individual Conductors ☐ Web ☐ Twisted

Temperature Rating of Cable: ☐ 60C ☐ 75C ☐ 90C ☐ 125C or Insulation Type: ________________ (e.g. THHN)

3 **Ground Wire Size:** From Control Panel to Motor: __________ AWG/MCM

Control Grounded to (mark all that apply):

☐ Well Head ☐ Metal Casing ☐ Motor ☐ Driven Rod ☐ Power Supply

INCOMING VOLTAGE

No Load   L1-L2 ______ L2-L3 ______ L1-L3 ______

Full Load   L1-L2 ______ L2-L3 ______ L1-L3 ______

RUNNING AMPS & CURRENT BALANCE

Full Load   L1 ________ L2 ________ L3 ________

% Unbalance: ______

CONTROL PANEL

1 **Pump Panel Manufacturer/Fabricator:** ______________________________

2 **Short Circuit Protection - Fuses or Circuit Breaker**

Option #1 - Fuse

Manufacturer: ________________ Model: ________________ Rating: ____________ Amps

Type: ☐ Time-Delay ☐ Standard

Option #2 - Circuit Breaker

Manufacturer: ________________ Model: ________________ Rating: ___________ Amps Setting: _________

3 **Starter - Full Voltage, Reduced Voltage, Soft-Starter or VFD (Variable Frequency Drive)**

Option #1 - Full Voltage

Manufacturer: ________________ Model: ________________ Size: ____________ Contacts: ☐ NEMA ☐ IEC

Option #2 - Reduced Voltage

Manufacturer: ________________ Model: ________________ Ramp Time to Full Voltage: _____________ sec.

Option #3 - Soft-Starter or VFD

Manufacturer: ________________ Model: ________________ Max. Continuous Amp Output Rating: _________

Min. Setting: ____________ Hz & GPM: ____________ Max. Setting: ____________ Hz & GPM: ____________

Start Ramp Time to 30 Hz: ________ sec.   Stop Mode: ☐ Power Off Coast ☐ 30-0 Hz Ramp ________ sec.

Special Output Filter Purchased: ☐ Yes ☐ No

Output Filter Manufacturer: ______________________ Model: ______________________ % Reactance: _________

4 **Surge Arrestor:** ☐ No ☐ Yes, Manufacturer: ____________________ Model: ____________________

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SUBMERSIBLE MOTOR

Booster Installation Record

RMA Number

Date ______ /______ /_______ Filled In By ______________________________

INSTALLATION

Owner/User ______________________________ Telephone (______) ______________

Address ______________________________ City ______________ State ______ Zip __________

Installation Site, If Different ______________________________

Contact ______________________________ Telephone (______) ______________

System Application ______________________________

____

____

System Manufactured By ______________________ Model ______________ Serial No. ______________

System Supplied By ______________________ City ______________ State ______ Zip __________

Is this a "HERO" system (10.0 - 10.5 PH)? ☐ Yes ☐ No

MOTOR

Model No. ______________ Serial No. ______________ Date Code ______

Horsepower ______ Voltage ______ ☐ Single-Phase ☐ Three-Phase Diameter ______ in.

Slinger Removed? ☐ Yes ☐ No Check Valve Plug Removed? ☐ Yes ☐ No

Motor Fill Solution ☐ Standard ☐ DI Water Model No. ______________ Serial No. ______________ Date Code ______

PUMP

Manufacturer ______________ Model ______________ Serial No. ______________

Stages ______ Diameter ________ Flow Rate Of ________ gpm At ______ TDH

Booster Case Internal Diameter ________ Material ______________

CONTROLS AND PROTECTIVE DEVICES

SubMonitor? ☐ Yes ☐ No If Yes, Warranty Registration No. ______________________________

If Yes, Overload Set? ☐ Yes ☐ No ______ Set At ______________________

Underload Sets? ☐ Yes ☐ No ______ Set At ______________________

VFD or Reduced Voltage Starter? ☐ Yes ☐ No If Yes, Type ______________________________

Mfr. ______________ Setting ________ % Full Voltage In ________ sec

Pump Panel? ☐ Yes ☐ No If Yes, Mfr. ______________________ Size ______________________

Magnetic Starter/Contactor Mfr. ______________________ Model ______________ Size ______________

Heaters Mfr. ______________________ No. ____________ If Adjustable Set At ______________________

Fuses Mfr. ______________________ Size ____________ Type ______________________________

Lightning/Surge Arrestor Mfr. ______________________ Model ______________________________

Controls Are Grounded to ______________________ with No. ________ Wire

Inlet Pressure Control ☐ Yes ☐ No If Yes, Mfr. ________ Model ________ Setting _____ psi Delay ____ sec

Inlet Flow Control ☐ Yes ☐ No If Yes, Mfr. ________ Model ________ Setting _____ gpm Delay ____ sec

Outlet Pressure Control ☐ Yes ☐ No If Yes, Mfr. ________ Model ________ Setting _____ psi Delay ____ sec

Outlet Flow Control ☐ Yes ☐ No If Yes, Mfr. ________ Model ________ Setting _____ gpm Delay ____ sec

Water Temperature Control ☐ Yes ☐ No If Yes, Mfr. ________ Model ______________________ Delay ____ sec

Set At ________ °F or ______ °C Located ______________________________

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SUBMERSIBLE MOTOR

Booster Installation Record

INSULATION CHECK

Initial Megs: Motor & Lead Only — Black (T1/U1)________ Yellow (T2/V1)________ Red (T3/W1)________

Installed Megs: Motor, Lead, & Cable — Black (T1/U1)________ Yellow (T2/V1)________ Red (T3/W1)________

VOLTAGE TO MOTOR

Non-Operating: — B-Y (T1/U1 - T2/V1)_____ Y-R (T2/V1 - T3/W1)_____ R-B (T3/W1 - T1/U1)_____

At Rated Flow of __________gpm — B-Y (T1/U1 - T2/V1)_____ Y-R (T2/V1 - T3/W1)_____ R-B (T3/W1 - T1/U1)_____

At Open Flow ____________gpm — B-Y (T1/U1 - T2/V1)_____ Y-R (T2/V1 - T3/W1)_____ R-B (T3/W1 - T1/U1)_____

AMPS TO MOTOR

At Rated Flow of __________gpm — Black (T1/U1)________ Yellow (T2/V1)________ Red (T3/W1)________

At Open Flow ____________gpm — Black (T1/U1)________ Yellow (T2/V1)________ Red (T3/W1)________

At Shut Off* — Black (T1/U1)________ Yellow (T2/V1)________ Red (T3/W1)________

*Do **NOT** run at Shut Off more than two (2) minutes.

Inlet Pressure __________psi Outlet Pressure __________psi Water Temperature _______ °F or _______ °C

If you have any questions or problems, call the Franklin Electric Toll-Free Hot Line: 1-800-348-2420

Comments: ____

____

____

____

PLEASE SKETCH THE SYSTEM

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SubMonitor Three-Phase Protection

Applications

SubMonitor is designed to protect 3-phase pumps/motors with service factor amp ratings (SFA) from 5 to 350 A (approx. 3 to 200 hp). Current, voltage, and motor temperature are monitored using all three legs and allows the user to set up the SubMonitor quickly and easily.

Protects Against

- Under/Overload
- Under/Overvoltage
- Current Unbalance
- Overheated Motor
  (if equipped with Subtrol Heat Sensor)
- False Start (Chattering)
- Phase Reversal

Power Factor Correction

In some installations, power supply limitations make it necessary or desirable to increase the power factor of a submersible motor. The table lists the capacitive kVAR required to increase the power factor of large Franklin three-phase submersible motors to the approximate values shown at maximum input loading.

Capacitors must be connected on the line side of the overload relay, or overload protection will be lost.

Table 32 kVAR Required 60 Hz

MOTOR		KVAR REQUIRED FOR PF OF:		
HP	KW	0.90	0.95	1.00
5	3.7	1.2	2.1	4.0
7.5	5.5	1.7	3.1	6.0
10	7.5	1.5	3.3	7.0
15	11	2.2	4.7	10.0
20	15	1.7	5.0	12.0
25	18.5	2.1	6.2	15.0
30	22	2.5	7.4	18.0
40	30	4.5	11.0	24.0
50	37	7.1	15.0	32.0
60	45	8.4	18.0	38.0
75	55	6.3	18.0	43.0
100	75	11.0	27.0	60.0
125	93	17.0	36.0	77.0
150	110	20.0	42.0	90.0
175	130	9.6	36.0	93.0
200	150	16.0	46.0	110.0

Values listed are total required (not per phase).

Three-Phase Starter Diagrams

Three-phase combination magnetic starters have two distinct circuits: a power circuit and a control circuit.

The power circuit consists of a circuit breaker or fused line switch, contacts, and overload heaters connecting incoming power lines L1, L2, L3 and the three-phase motor.

The control circuit consists of the magnetic coil, overload contacts and a control device such as a pressure switch. When the control device contacts are closed, current flows through the magnetic contactor coil, the contacts close, and power is applied to the motor. Hand-Off-Auto switches, start timers, level controls and other control devices may also be in series in the control circuit.

Line Voltage Control

This is the most common type of control encountered. Since the coil is connected directly across the power lines L1 and L2, the coil must match the line voltage.

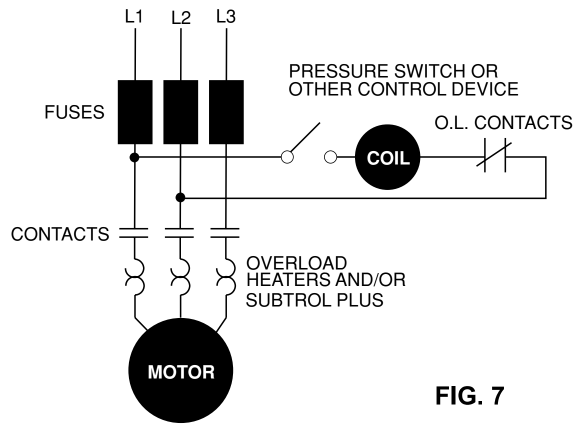


FIG. 7

Low Voltage Transformer Control

This control is used when it is desirable to operate push buttons or other control devices at some voltage lower than the motor voltage. The transformer primary must match the line voltage and the coil voltage must match the secondary voltage of the transformer.

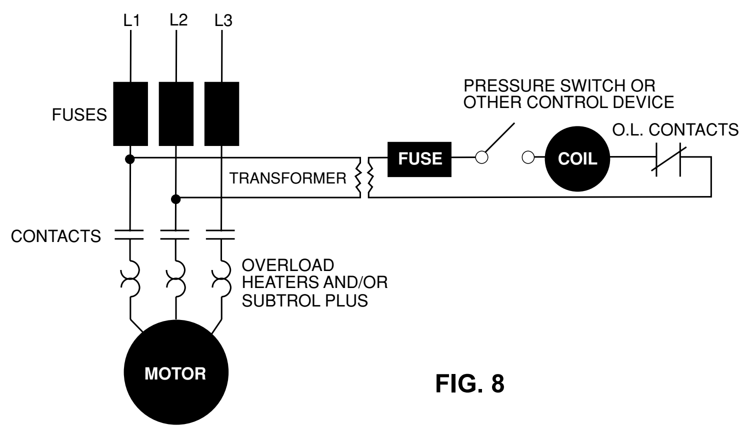


FIG. 8

External Voltage Controls

Control of a power circuit by a lower circuit voltage can also be obtained by connecting to a separate control voltage source. The coil rating must match the control voltage source, such as 115 or 24 volts.

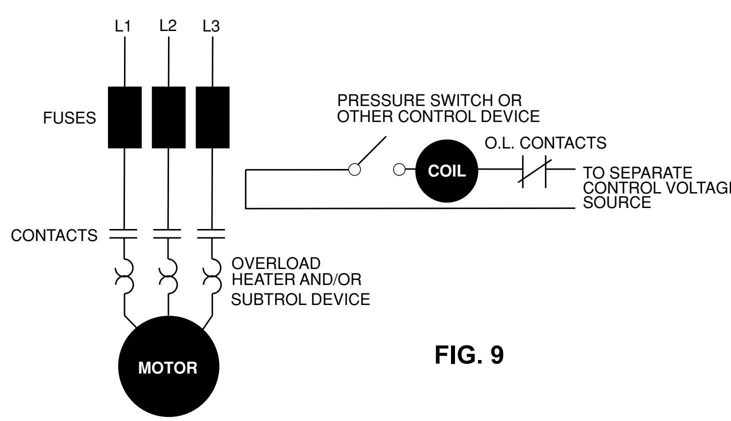


FIG. 9

Three-Phase Power Unbalance

A full three-phase supply is recommended for all three-phase motors, consisting of three individual transformers or one three-phase transformer. So-called "open" delta or Wye connections using only two transformers can be used, but are more likely to cause problems, such as poor performance, overload tripping or early motor failure due to current unbalance.

Transformer rating should be no smaller than listed in table 4 for supply power to the motor alone.

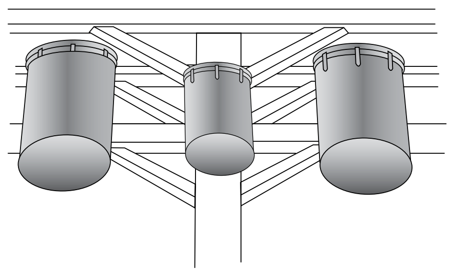


FIG. 10
FULL THREE-PHASE

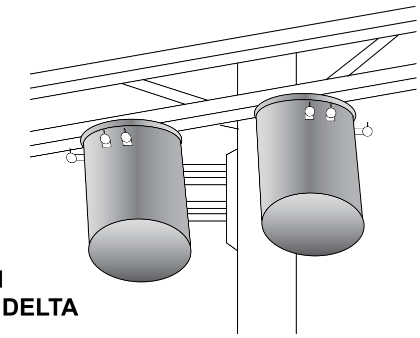


FIG. 11
OPEN DELTA

Checking and Correcting Rotation and Current Unbalance

1. Establish correct motor rotation by running the motor in both directions. Normal rotation is CCW viewing the shaft end. Rotation can be changed by interchanging any two of the three motor leads. The rotation that gives the most water flow is typically the correct rotation.
2. After correct rotation has been established, check the current in each of the three motor leads and calculate the current unbalance as explained in 3 below.

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

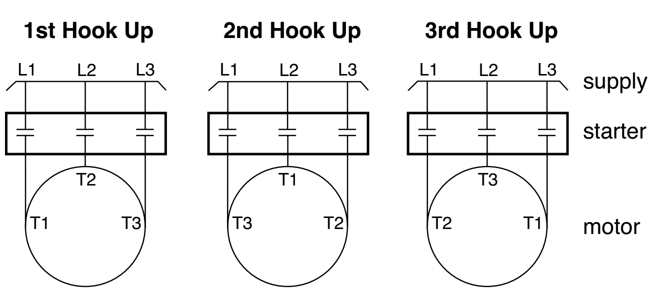
   If the current unbalance is more than 2%, current readings should be checked on each leg using each of three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.
3. To calculate percent of current unbalance:
   A. Add the three line amps values together.
   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.
4. Current unbalance should not exceed 5% at max amp 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 side" of the system. If the reading farthest from average moves with the same motor lead, the primary source of unbalance is on the "motor side" of the starter. In this instance, consider a damaged cable, leaking splice, poor connection, or faulty motor winding.

Phase designation of leads for CCW rotation viewing shaft end.

To reverse rotation, interchange any two leads.

Phase 1 or "A" - Black, T1, or U1
Phase 2 or "B" - Yellow, T2, or V1
Phase 3 or "C" - Red, T3, or W1

NOTICE: Phase 1, 2 and 3 may not be L1, L2 and L3.



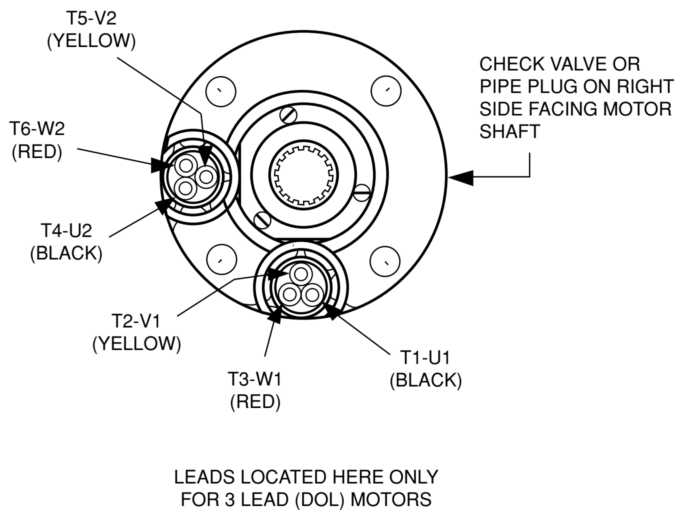
EXAMPLE:

T1 = 51 amps	T3 = 50 amps	T2 = 50 amps
T2 = 46 amps	T1 = 49 amps	T3 = 48 amps
+ T3 = 53 amps	+ T2 = 51 amps	+ T1 = 52 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
$\frac{150}{3}$ = 50 amps	$\frac{150}{3}$ = 50 amps	$\frac{150}{3}$ = 50 amps
50 - 46 = 4 amps	50 - 49 = 1 amp	50 - 48 = 2 amps
$\frac{4}{50}$ = 0.08 or 8%	$\frac{1}{50}$ = 0.02 or 2%	$\frac{2}{50}$ = 0.04 or 4%

Three-Phase Motor Lead Identification

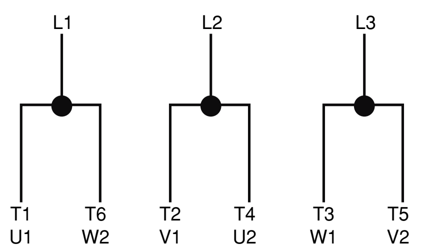
WARNING: When installing 6-lead motors extra care must be used to ensure lead identification at the surface. Leads must be marked and connected per diagram. Motor leads are not connected red to red, yellow to yellow, etc.

Line Connections — Six-Lead Motors

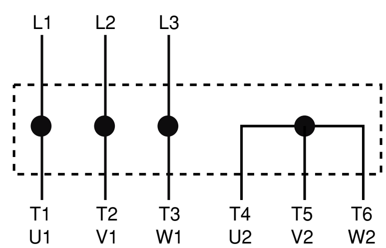


90° Lead Spacing

Connections for across-the-line starting, running, and any reduced voltage starting except WYE-DELTA type starters.



WYE-DELTA starters connect the motor as shown below during starting, then change to the running connection shown at the left.



Each motor lead is numbered with two markers, one near each end. To reverse rotation, interchange any two line connections.

Phase Converters

There are a number of different types of phase converters available. Each generates three-phase power from a single-phase power line.

In all phase converters, the voltage balance is critical to current balance. Although some phase converters may be well balanced at one point on the system-operating curve, submersible pumping systems often operate at differing points on the curve as water levels and operating pressures fluctuate. Other converters may be well balanced at varying loads, but their output may vary widely with fluctuations in the input voltage.

The following guidelines have been established for submersible installations to be warrantable when used with a phase converter.

1. Limit pump loading to rated horsepower. Do not load into motor service factor.
2. Maintain at least 3 ft/s flow past the motor. Use a flow sleeve when necessary.
3. Use time delay fuses or circuit breakers in pump panel. Standard fuses or circuit breakers do not provide secondary motor protection.
4. SubMonitor may be used with electro mechanical type phase converters, however special connections are required. Consult SubMonitor Manual for connections of receiver and lightning arrestor.
5. SubMonitor will not work with electronic solid state phase converters.
6. Current unbalance must not exceed 10%.

Reduced Voltage Starters

All Franklin three-phase submersible motors are suitable for full-voltage starting. Under this condition the motor speed goes from zero to full speed within a half second or less. The motor current goes from zero to locked rotor amps, then drops to running amps at full speed. This may dim lights, cause momentary voltage dips to other electrical equipment, and shock power distribution transformers.

In some cases the power companies may require reduced-voltage starters to limit this voltage dip. There are also times when reduced-voltage starters may be desirable to reduce motor starting torque thus reducing the stress on shafts, couplings, and discharge piping. Reduced-voltage starters also slow the rapid acceleration of the water on start-up to help control upthrust and water hammer.

Reduced-voltage starters may not be required if the maximum recommended cable length is used. With maximum recommended cable length there is a 5% voltage drop in the cable at running amps, resulting in about 20% reduction in starting current and about 36% reduction in starting torque compared to having rated voltage at the motor. This may be enough reduction in starting current so that reduced-voltage starters are not required.

Three-Lead Motors: Autotransformer or solid-state reduced-voltage starters may be used for soft-starting standard three-phase motors.

When autotransformer starters are used, the motor should be supplied with at least 55% of rated voltage to ensure adequate starting torque. Most autotransformer starters have 65% and 80% taps. Setting the taps on these starters depends on the percentage of the maximum allowable cable length used in the system. If the cable length is less than 50% of the maximum allowable, either the 65% or the 80% taps may be used. When the cable length is more than 50% of allowable, the 80% tap should be used.

Six-Lead Motors: Wye-Delta starters are used with six-lead Wye-Delta motors. All Franklin 6" and 8" three-phase motors are available in six-lead Wye-Delta construction. Consult the factory for details and availability. Part winding starters are not compatible with Franklin Electric submersible motors and should not be used.

Wye-Delta starters of the open-transition type, which momentarily interrupt power during the starting cycle, are not recommended. Closed-transition starters have no interruption of power during the start cycle and can be used with satisfactory results.

Reduced-voltage starters have adjustable settings for acceleration ramp time, typically preset at 30 seconds. They must be adjusted so the motor is at full voltage within THREE SECONDS MAXIMUM to prevent excessive radial and thrust bearing wear.

If Subtrol-Plus or SubMonitor is used the acceleration time must be set to TWO SECONDS MAXIMUM due to the 3 second reaction time of the Subtrol-Plus or SubMonitor.

Solid-state starters AKA soft starts may not be compatible with Subtrol-Plus/SubMonitor. However, in some cases a bypass contactor has been used. Consult the factory for details.

During shutdown, Franklin Electric's recommendation is for the power to be removed, allowing the pump/motor to coast down. Stopping the motor by ramping down the voltage is possible, but should be limited to three (3) seconds maximum.

Inline Booster Pump Systems

Franklin Electric offers three different types of motors for non-vertical applications.

1. The **Booster** motors are specifically designed for booster applications. They are the **"Best Choice" for sealed Reverse Osmosis applications.** These motors are the result of two years of focused development and bring additional value and durability to booster module systems. These motors are only available to OEMs or Distributors who have demonstrated capability in Booster Module systems design and operation and adhere to Franklin's Application Manual requirements.

2. The **Hi-Temp** motors have many of the internal design features of the Booster motor. It's additional length allows for higher temperature handling and the Sand Fighter sealing system provides greater abrasion resistance. One or both of these conditions are often experienced in open atmosphere applications such as lakes, ponds, etc.

3. The **Standard Vertical Water Well** (40-125 hp) motors can be adapted to non-vertical applications when applied per the below guidelines. However, they will be more sensitive to application variances than the other two designs.

All of the above motors must be applied per the guidelines listed below. In addition, for all applications where the motor is applied in a sealed system, a Submersible Motor Booster Installation Record (Form 3655) or its equivalent must be completed at startup and received by Franklin Electric within 60 days. A sealed system is one where the motor and pump intake are mounted in a sleeve and the water feeding the pump intake is not open to the atmosphere.

Continued on next page

Inline Booster Pump Systems (continued)

Design And Operational Requirements

1. **Non-Vertical Operation:** Vertical Shaft-up (0°) to Horizontal (90°) operation is acceptable as long as the pump transmits "down-thrust" to the motor within 3 seconds after start-up and continuously during operation. However, it is best practice to provide a positive slope whenever it is possible, even if it is only a few degrees.

2. **Motor, Sleeve, and Pump Support System:** The booster sleeve ID must be sized according to the motor cooling and pump NPSHR requirements. The support system must support the motor's weight, prevent motor rotation and keep the motor and pump aligned. The support system must also allow for thermal axial expansion of the motor without creating binding forces.

3. **Motor Support Points:** A minimum of two support points are required on the motor. One in the motor/pump flange connection area and one in the bottom end of the motor area. The motor castings, not the shell area, are recommended as support points. If the support is a full length support and/or has bands in the shell area, they must not restrict heat transfer or deform the shell.

4. **Motor Support Material and Design:** The support system shall not create any areas of cavitation or other areas of reduced flow less than the minimum rate required by this manual. They should also be designed to minimize turbulence and vibration and provide stable alignment. The support materials and locations must not inhibit the heat transfer away from the motor.

5. **Motor and Pump Alignment:** The maximum allowable misalignment between the motor, pump, and pump discharge is 0.025 inch per 12 inches of length (2 mm per 1000 mm of length). This must be measured in both directions along the assembly using the motor/pump flange connection as the starting point. The booster sleeve and support system must be rigid enough to maintain this alignment during assembly, shipping, operation and maintenance.

6. The best motor lubrication and heat resistance is obtained with the factory based propylene glycol fill solution. Only when an application MUST HAVE deionized (DI) water should the factory fill solution be replaced. When a deionized water fill is required, the motor must be derated as indicated on the below chart. The exchange of the motor fill solution to DI water must be done by an approved Franklin service shop or representative using a vacuum fill system per Franklin's Motor Service Manual instruction. The motor shell then must be permanently stamped with a D closely behind the Serial Number.

   The maximum pressure that can be applied to the motor internal components during the removal of the factory fill solution is 7 psi (0.5 bar.)

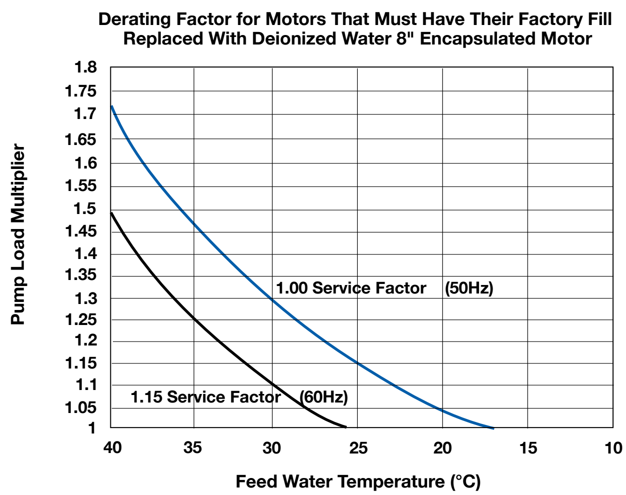


FIG. 12

First: Determine maximum Feed Water Temperature that will be experienced in this application. If the feed water exceeds the maximum ambient of the motor, both the DI water derating and a hot water application derating must be applied.

Second: Determine the Pump Load Multiplier from the appropriate Service Factor curve. (Typical 1.15 Service Factor is for 60 Hz ratings &1.00 Service Factor for 50 Hz ratings).

Third: Multiply the Pump Load Requirement times the pump load multiplier number indicated on the vertical axis to determine the Minimum Motor Nameplate Rating.

Fourth: Select a motor with a nameplate equal or higher than the above calculated value.

7. **Motor Alterations - Sand Slinger & Check Valve Plug:** On 6" and 8" motors, the rubber sand slinger located on the shaft must be removed. If a pipe plug is covering the check valve, it must be removed. The special Booster motor already has these modifications.

8. **Frequency of Starts:** Fewer than 10 starts per 24-hour period are recommended. Allow at least 20 minutes between shutdown and start-up of the motor.

Continued on next page

Inline Booster Pump Systems (continued)

9. **Controls-Soft Starters and VFDs:** Reduced voltage starters and variable speed drives (inverter drives) may be used with Franklin three-phase submersible motors to reduce starting current, upthrust, and mechanical stress during start-up. The guidelines for their use with submersible motors are different than with normal air cooled motor applications. Refer to the Franklin Electric Application, Installation and Maintenance (AIM) Manual Reduced Voltage Starters section or Variable Speed Submersible Pump Operation, Inverter Drives sections for specific details including required filtering.

10. **Motor Overload Protection:** Submersible motors require properly sized ambient compensated Class 10 quick-trip overloads per Franklin's AIM Manual guidelines to protect the motor. Class 20 or higher overloads are NOT acceptable. Franklin's SubMonitor is strongly recommended for all large submersibles since it is capable of sensing motor heat without any additional wiring to the motor. Applications using Soft Starters with a SubMonitor require a start-up bypass - consult the factory for details. SubMonitor can not be used in applications using a VFD control.

11. **Motor Surge Protection:** Properly sized, grounded and dedicated motor surge arrestors must be installed in the supply line of the booster module as close to the motor as possible. This is required on all systems including those using soft-starters and variable speed drives (inverter drives).

12. **Wiring:** Franklin's lead assemblies are only sized for submerged operation in water to the motor nameplate maximum ambient temperature and may overheat and cause failure or serious injury if operated in air. Any wiring not submerged must meet applicable national and local wiring codes and Franklin Cable Chart tables 16-21. (Notice: wire size, wire rating and insulation temperature rating must be known when determining its suitability to operate in air or conduit. Typically, for a given size and rating, as the insulation temperature rating increases its ability to operate in air or conduit also increases.)

13. **Check Valves:** Spring-loaded check valves must be used on start-up to minimize motor upthrusting, water hammer, or in multiple booster (parallel) applications to prevent reverse flow.

14. **Pressure Relief Valves:** A pressure relief valve is required and must be selected to ensure that, as the pump approaches shut-off, it never reaches the point that the motor will not have adequate cooling flow past it.

15. **System Purge (Can Flooding):** An air bleeder valve must be installed on the booster sleeve so that flooding may be accomplished prior to booster start-up. Once flooding is complete, the booster should be started and brought up to operating pressure as quickly as possible to minimize the duration of an upthrust condition. At no time should air be allowed to gather in the booster sleeve because this will prevent proper cooling of the motor and permanently damage it.

16. **System Flush – Must Not Spin Pump:** Applications may utilize a low flow flushing operation. Flow through the booster sleeve must not spin the pump impellers and the motor shaft. If spinning takes place, the bearing system will be permanently damaged and the motor life shortened. Consult the booster pump manufacturer for maximum flow rate through the pump when the motor is not energized.

Table 38 Franklin Cable chart (See 12. Wiring)

CABLE TEMP. RATING (°C)	MOTOR NAMEPLATE RATED AMPS FULL LOAD	#10 AWG		#8 AWG		#6 AWG		#4 AWG		#2 AWG	
		IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT
75	3-LEAD (DOL)	40A	28A	56A	40A	76A	52A	100A	68A	136A	92A
	6-LEAD (Y-Δ)	69A	48A	97A	69A	132A	90A	173A	118A	236A	159A
90	3-LEAD (DOL)	44A	32A	64A	44A	84A	60A	112A	76A	152A	104A
	6-LEAD (Y-Δ)	76A	55A	111A	76A	145A	104A	194A	132A	263A	180A
125	3-LEAD (DOL)	66A	46A	77A	53A	109A	75A	153A	105A	195A	134A
	6-LEAD (Y-Δ)	114A	80A	133A	91A	188A	130A	265A	181A	337A	232A

Based on 30 °C maximum ambient with cable length of 100 feet or less.

Continued on next page

Inline Booster Pump Systems (continued)

17. **Open Atmosphere Booster Pump Systems:** When an open booster is placed in a lake, tank, etc. that is open to atmospheric pressure, the water level must provide sufficient head pressure to allow the pump to operate above its NPSHR requirement at all times and all seasons. Adequate inlet pressure must be provided prior to booster start-up.

Four Continuous Monitoring System Requirements for Sealed Booster Systems.

1. **Water Temperature:** Feed water on each booster must be continuously monitored and not allowed to exceed the motor nameplate maximum ambient temperature at any time. IF THE INLET TEMPERATURE EXCEEDS THE MOTOR NAMEPLATE MAXIMUM AMBIENT TEMPERATURE, THE SYSTEM MUST SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE. If feed water temperatures are expected to be above the allowable temperature, the motor must be derated. See Franklin's AIM Manual Hot Water Applications section for derating guidelines. (The high temperature feed water derating is in addition to the exchange to DI water derating if the motor factory fill solution was exchanged to DI water.)

2. **Inlet Pressure:** The inlet pressure on each booster module must be continuously monitored. It must always be positive and higher than the NPSHR (Net Positive Suction Head Requirement) of the pump. A minimum of 20 PSIG (1.38 Bar) is required at all times, except for 10 seconds or less when the motor is starting and the system is coming up to pressure. Even during these 10 seconds the pressure must remain positive and be higher than the NPSHR (Net Positive Suction Head Requirement) of the pump.

   PSIG is the actual value displayed on a pressure gauge in the system piping. PSIG is the pressure above the atmospheric conditions. If at any time these pressure requirements are not being met, the motor must be de-energized immediately to prevent permanent damage to the motor. Once the motor is damaged, it is usually not immediately noticeable, but progresses and results in a premature motor failure weeks or months after the damage occurred.

   Motors that will be exposed to pressure in excess of 500 psi (34.47 Bar) must undergo special high pressure testing. Consult factory for details and availability.

3. **Discharge Flow:** The flow rate for each pump must not be allowed to drop below the motor minimum cooling flow requirement. IF THE MOTOR MINIMUM COOLING FLOW REQUIREMENT IS NOT BEING MET FOR MORE THAN 10 SECONDS, THE SYSTEM MUST BE SHUT DOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.

4. **Discharge Pressure:** The discharge pressure must be monitored to ensure that a downthrust load toward the motor is present within 3 seconds after start-up and continuously during operation.
   IF THE MOTOR DISCHARGE PRESSURE IS NOT ADEQUATE TO MEET THIS REQUIREMENT, THE SYSTEM MUST BE SHUT DOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.

Variable Frequency Drive Submersible Motor Requirements

Franklin Electric's three-phase, encapsulated submersible motors can be used with variable frequency drives (VFD) when applied within the guidelines below.

All three-phase, encapsulated submersible motors must have the VFD sized based on the motor's nameplate maximum amps, not horsepower. The continuous rated amps of the VFD must be equal to or greater than the motor's nameplate maximum amps or warranty will be void.

Franklin Electric's single-phase, 2- and 3-wire, encapsulated submersible motors can only be used with the appropriate Franklin constant pressure controller.

Franklin Electric's submersible motor Application Installation Maintenance (AIM) manual should be checked for the latest guidelines and can be found online at www.franklin-electric.com.

WARNING: There is a potential shock hazard from contact with and/or touching the insulated cables connected to the variable frequency drive output anytime the motor has energy applied.

Output Filter Requirement Test:

NOTICE: An incoming power supply or line-side filter for the drive does not replace the need for additional output filters.

An output filter is required if the answer is yes to one or both of the items below:
#1 - Is the VFD's pulse width modulation (PWM) voltage rise-time (dV/dt) more than 500 Volts per micro-second (500 V/µ-second)?

#2 - Is the motor nameplate voltage more than 379 Volts and is the cable from drive-to-motor more than 50 ft (15.2 m)?

NOTICE:
More than 99% of the drives applied on water well submersible motors will require the purchase of additional output filtering based on question #1.

Output filters can be expensive. However, when needed, it is required for the motor to be considered for warranty. Make sure this item is not overlooked when quoting a job.

PWM dV/dt value can be defined as: the rate at which voltage is changing with time or how fast the voltage is accelerating. This information can be supplied by the drive manufacturer or the manufacturer's drive specification sheet. The dV/dt value cannot be measured with typical field equipment, even when using a true-RMS voltage/amperage multi-meter.

Franklin Electric has a line of VFDs that are specifically designed for Franklin application systems. These VFDs are used in the MonoDrive and SubDrive constant pressure systems. Franklin drive systems have the required additional output filtering installed; however, the SubDrive HPX does not.

Types of Output Filters:

A resistor-inductor-capacitor (RLC) filter has both a high pass filter & a low pass filter section and are considered the best practice, but a high pass reactor filter is also acceptable.

Filters should be recommended by the drive manufacturer; for the correct recommendations provide them with answers to all five of the items below.

REQUIRED ITEMS FOR PROPER VFD FILTER SIZING:
(1) VFD model (2) Carrier frequency setting (3) Motor nameplate voltage (4) Motor nameplate max amps (5) Cable length from the drive output terminals to the motor

Input Current & Motor Overload Protection:

- Motor input current should be set at the system's typical operating current when running at nameplate rated voltage and frequency (Hz).
- Motor overload protection should be set to trip at 115% of the system's typical operating current.
- Motor overload protection must trip equal to or faster than NEMA Class 10 motor overload curve requirements.

Motor Maximum Load Limits:

- The system must never operate in excess of the motor nameplate maximum amps.
- On 50 Hz motors, nameplate amps are maximum amps as these motors have a 1.0 service factor.

Variable Frequency Drive Submersible Motor Requirements

Motor Operating Hertz, Cooling Requirements & Underload Settings:

- Standard practice for large VFD installations is to limit the operation to 60 Hz max. Operating at greater than 60 Hz requires special system design considerations.
- The motor must never operate below 30 Hz. This is the minimum speed required to provide correct bearing lubrication.
- The motor's operating speed must always operate so the minimum water flow requirements of 0.5 ft/sec for 6-inch & 8-inch motors and 0.25 ft/sec for 4-inch motors is supplied.
- The motor underload protection is normally set to trip at 80% of the system's typical operating current. However, the underload trip point must be selected so that minimum flow requirements are always met.

Starting & Stopping Ramp Settings:

- The motor must reach or pass the 30 Hz operating speed within 1 second of the motor being energized. If this does not occur, the motor bearings will be damaged and the motor life reduced.
- The best stopping method is to turn power off followed by a natural coast to stop.
- A controlled stop from 30 Hz to 0 Hz is allowed if the time does not exceed 1 second.

Drive Carrier Frequency:

- The carrier frequency is set in the field. The drive typically has a selectable range between 2k and 12k Hz. The higher the carrier wave frequency setting, the greater the voltage spikes; the lower the carrier wave frequency setting, the rougher/poorer the shape of the power curve.
- The carrier frequency should be set within the range of 4k to 5k Hz for encapsulated submersible motors.

Application Function Setting:

- If the VFD has a setting of centrifugal pump or propeller fan it should be used.
- Centrifugal pumps and fans have similar load characteristics.

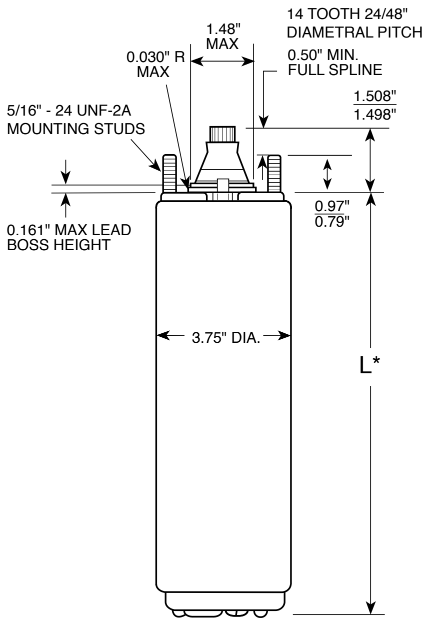
VFD Frequency of Starts:

- Keeping the starts per day within the recommended numbers shown in the frequency of starts section of the AIM manual provides the best system life. However, since in-rush current is typically reduced when used with a properly configured VFD, large 3-phase submersible motors can be started more frequently. In all cases a minimum of 7 minutes must be allowed between a power off and the next restart attempt or consecutive restart attempts.

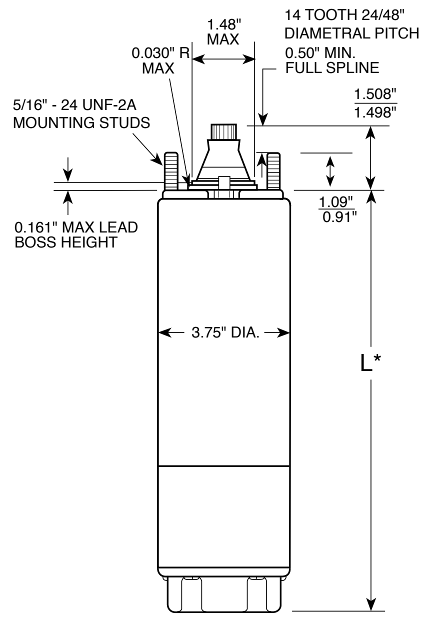
NEMA MG1 Above Ground Motor Standard Comments:

- Franklin Electric encapsulated submersible motors are not declared inverter duty motors by NEMA MG1 standards. The reason is NEMA MG1 standard part 31 does not include a section covering encapsulated winding designs.
- Franklin submersible motors can be used with VFDs without problems or warranty concerns providing Franklin's Application Installation Maintenance (AIM) manual guidelines are followed. See Franklin's on-line AIM manual for the latest guidelines.

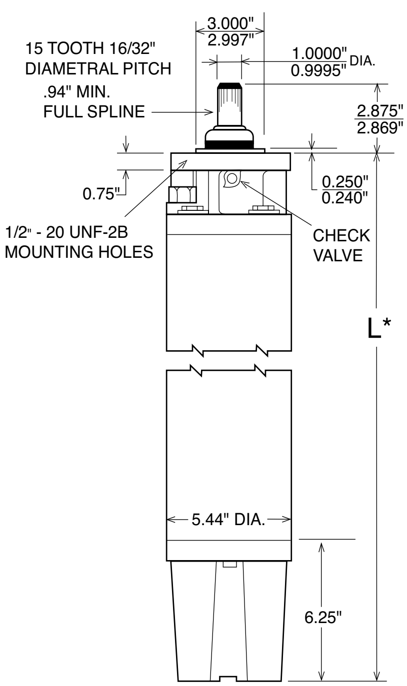
4" Super Stainless — Dimensions
(Standard Water Well)



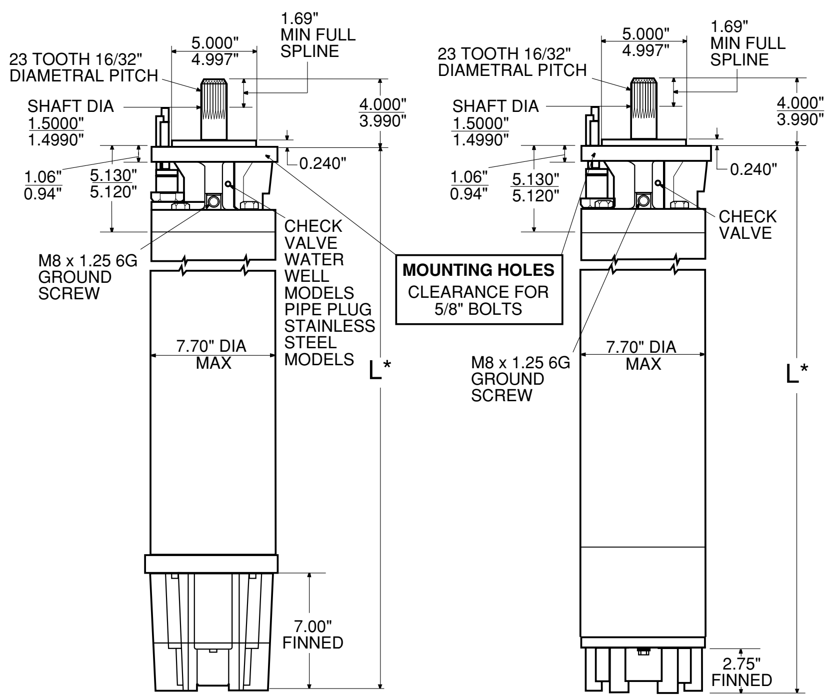
4" High Thrust — Dimensions
(Standard Water Well)



6" — Dimensions
(Standard Water Well)



8" — Dimensions
(Standard Water Well)



40 to 100 hp　　125 to 200 hp

*** Motor lengths and shipping weights are available on Franklin Electric's web site (www.franklin-electric.com) or by calling Franklin's submersible hotline (800-348-2420).**

Tightening Motor Lead Connector Jam Nut

4" Motors with Jam Nut:
15 to 20 ft-lb (20 to 27 Nm)

4" Motors with 2 Screw Clamp Plate:
35 to 45 in-lb (4.0 to 5.1 Nm)

6" Motors:
40 to 50 ft-lb (54 to 68 Nm)

8" Motors with 1-3/16" to 1-5/8" Jam Nut:
50 to 60 ft-lb (68 to 81 Nm)

8" Motors with 4 Screw Clamp Plate:
Apply increasing torque to the screws equally in a criss-cross pattern until 80 to 90 in-lb (9.0 to 10.2 Nm) is reached.

Jam nut tightening torques recommended for field assembly are shown. Rubber compression set within the first few hours after assembly may reduce the jam nut torque. This is a normal condition which does not indicate reduced seal effectiveness. Retightening is not required, but is permissible and recommended if original torque was questionable.

A motor lead assembly should not be reused. A new lead assembly should be used whenever one is removed from the motor, because rubber set and possible damage from removal may prevent proper resealing of the old lead.

All motors returned for warranty consideration must have the lead returned with the motor.

Pump to Motor Coupling

Assemble coupling with non-toxic FDA approved waterproof grease such as Mobile FM102, Texaco CYGNUS2661, or approved equivalent. This prevents abrasives from entering the spline area and prolongs spline life.

Pump to Motor Assembly

After assembling the motor to the pump, torque mounting fasteners to the following:

4" Pump and Motor: 10 lb-ft (14 Nm)

6" Pump and Motor: 50 lb-ft (68 Nm)

8" Pump and Motor: 120 lb-ft (163 Nm)

Shaft Height and Free End Play

Table 42

MOTOR	NORMAL SHAFT HEIGHT		DIMENSION SHAFT HEIGHT		FREE END PLAY	
					MIN.	MAX.
4"	1 1/2"	38.1 mm	1.508" 1.498"	38.30 38.05 mm	0.010" 0.25 mm	0.045" 1.14 mm
6"	2 7/8"	73.0 mm	2.875" 2.869"	73.02 72.88 mm	0.030" 0.76 mm	0.050" 1.27 mm
8" TYPE 1	4"	101.6 mm	4.000" 3.990"	101.60 101.35 mm	0.008" 0.20 mm	0.032" 0.81 mm
8" TYPE 2.1	4"	101.6 mm	4.000" 3.990"	101.60 101.35 mm	0.030" 0.76 mm	0.080" 2.03 mm

If the height, measured from the pump-mounting surface of the motor, is low and/or end play exceeds the limit, the motor thrust bearing is possibly damaged, and should be replaced.

Submersible Leads and Cables

A common question is why motor leads are smaller than specified in Franklin's cable charts.

The leads are considered a part of the motor and actually are a connection between the large supply wire and the motor winding. The motor leads are short and there is virtually no voltage drop across the lead.

In addition, the lead assemblies **operate under water**, while at least part of the supply cable must **operate in air.** Lead assemblies running under water operate cooler.

CAUTION: Lead assemblies on submersible motors are suitable only for use in water and may overheat and cause failure if operated in air.

System Troubleshooting

Motor Does Not Start

POSSIBLE CAUSE	CHECKING PROCEDURES	CORRECTIVE ACTION
A. No power or incorrect voltage.	Check voltage at line terminals. The voltage must be ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Fuses blown or circuit breakers tripped.	Check fuses for recommended size and check for loose, dirty or corroded connections in fuse receptacle. Check for tripped circuit breakers.	Replace with proper fuse or reset circuit breakers.
C. Defective pressure switch.	Check voltage at contact points. Improper contact of switch points can cause voltage less than line voltage.	Replace pressure switch or clean points.
D. Control box malfunction.	For detailed procedure, see pages 48-56.	Repair or replace.
E. Defective wiring.	Check for loose or corroded connections or defective wiring	Correct faulty wiring or connections.
F. Bound pump.	Check for misalignment between pump and motor or a sand bound pump. Amp readings will be 3 to 6 times higher than normal until the overload trips	Pull pump and correct problem. Run new installation until the water clears
G. Defective cable or motor.	For detailed procedure, see pages 46 & 47.	Repair or replace.

Motor Starts Too Often

A. Pressure switch.	Check setting on pressure switch and examine for defects.	Reset limit or replace switch.
B. Check valve - stuck open.	Damaged or defective check valve will not hold pressure.	Replace if defective.
C. Waterlogged tank.	Check air charge	Clean or replace.
D. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.

System Troubleshooting

Motor Runs Continuously

POSSIBLE CAUSE	CHECKING PROCEDURES	CORRECTIVE ACTION
A. Pressure switch.	Check switch for welded contacts. Check switch adjustments.	Clean contacts, replace switch, or adjust setting.
B. Low water level in well.	Pump may exceed well capacity. Shut off pump, wait for well to recover. Check static and drawdown level from well head.	Throttle pump output or reset pump to lower level. Do not lower if sand may clog pump.
C. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.
D. Worn pump.	Symptoms of worn pump are similar to those of drop pipe leak or low water level in well. Reduce pressure switch setting, if pump shuts off worn parts may be the fault.	Pull pump and replace worn parts.
E. Loose coupling or broken motor shaft.	Check for loose coupling or damaged shaft.	Replace worn or damaged parts.
F. Pump screen blocked.	Check for clogged intake screen.	Clean screen and reset pump depth.
G. Check valve stuck closed.	Check operation of check valve.	Replace if defective.
H. Control box malfunction.	See pages 47-55 for single-phase.	Repair or replace.

Motor Runs But Overload Protector Trips

A. Incorrect voltage.	Using voltmeter, check the line terminals. Voltage must be within ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Overheated protectors.	Direct sunlight or other heat source can raise control box temperature causing protectors to trip. The box must not be hot to touch.	Shade box, provide ventilation or move box away from source.
C. Defective control box.	For detailed procedures, see pages 47-55.	Repair or replace.
D. Defective motor or cable.	For detailed procedures, see pages 45 & 46.	Repair or replace.
E. Worn pump or motor.	Check running current, see tables 13, 22, 24 & 27.	Replace pump and/or motor.

Table 45 Preliminary Tests - All Sizes Single- and Three-Phase

TEST	PROCEDURE	WHAT IT MEANS
Insulation Resistance	1. Open master breaker and disconnect all leads from control box or pressure switch (QD type control, remove lid) to avoid electric shock hazard and damage to the meter. 2. Use a megohmmeter or set the scale lever to R X 100K on an ohmmeter. Zero the meter. 3. Connect one meter lead to any one of the motor leads and the other lead to the metal drop pipe. If the drop pipe is plastic, connect the meter lead to ground.	1. If the ohms value is normal (table 46), the motor is not grounded and the cable insulation is not damaged. 2. If the ohms value is below normal, either the windings are grounded or the cable insulation is damaged. Check the cable at the well seal as the insulation is sometimes damaged by being pinched.
Winding Resistance	1. Open master breaker and disconnect all leads from control box or pressure switch (QD type control, remove lid) to avoid electric shock hazard and damage to the meter. 2. Set the scale lever to R X 1 for values under 10 ohms. For values over 10 ohms, set the scale lever to R X 10. "zero" the ohmmeter. 3. On 3-wire motors measure the resistance of yellow to black (main winding) and yellow to red (start winding). On 2-wire motors: measure the resistance from line-to-line. Three-phase motors: measure the resistance line-to-line for all three combinations.	1. If all ohms values are normal (tables 13, 22, 24 & 27), the motor windings are neither shorted nor open, and the cable colors are correct 2. If any one value is less than normal, the motor is shorted. 3. If any one ohm value is greater than normal, the winding or the cable is open, or there is a poor cable joint or connection. 4. If some ohms values are greater than normal and some less on single-phase motors, the leads are mixed. See page 46 to verify cable colors.

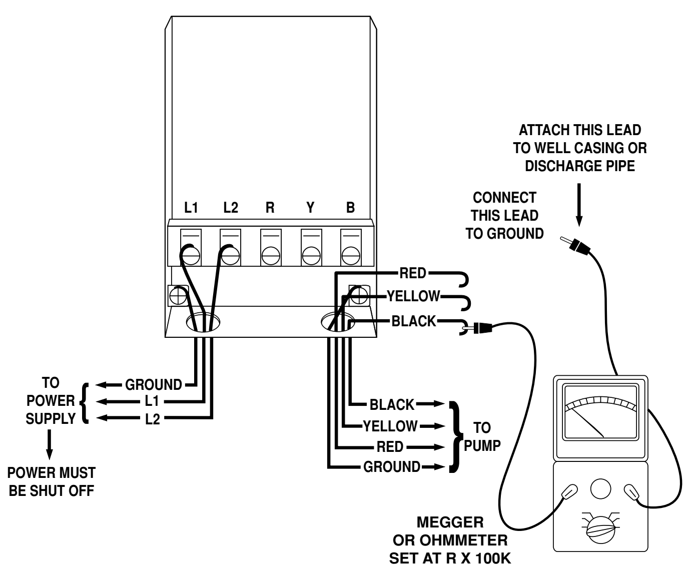


FIG. 13

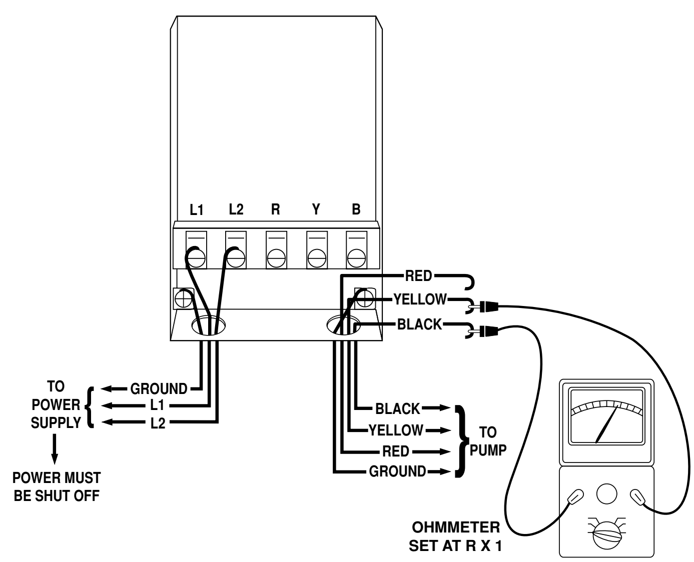


FIG. 14

Insulation Resistance Readings

Table 46 Normal ohm and Megohm Values Between All Leads and Ground

CONDITION OF MOTOR AND LEADS	OHMS VALUE	MEGOHM VALUE
A new motor (without drop cable).	200,000,000 (or more)	200.0 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10.0 (or more)
MOTOR IN WELL. READINGS ARE FOR DROP CABLE PLUS MOTOR.		
New motor.	2,000,000 (or more)	2.0 (or more)
Motor in good condition.	500,000 - 2,000,000	0.50 - 2.0
Insulation damage, locate and repair.	Less than 500,000	Less than .50

Insulation resistance varies very little with rating. Motors of all hp, voltage, and phase rating have similar values of insulation resistance.

The table above is based on readings taken with a megohm meter with a 500 VDC output. Readings may vary using a lower voltage ohmmeter, consult Franklin Electric if readings are in question.

Resistance of Drop Cable (ohms)

The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher. To determine the actual resistance of the aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control to motor and back.

Winding Resistance Measuring

The winding resistance measured at the motor should fall within the values in tables 13, 22, 24 & 27. When measured through the drop cable, the resistance of the drop cable must be subtracted from the ohmmeter readings to get the winding resistance of the motor. See table below.

Table 46A DC Resistance in ohms per 100 ft of Wire (Two conductors) @ 50 °F

AWG OR MCM WIRE SIZE (COPPER)	14	12	10	8	6	4	3	2
OHMS	0.544	0.338	0.214	0.135	0.082	0.052	0.041	0.032

1	1/0	2/0	3/0	4/0	250	300	350	400	500	600	700
0.026	0.021	0.017	0.013	0.010	0.0088	0.0073	0.0063	0.0056	0.0044	0.0037	0.0032

Identification Of Cables When Color Code Is Unknown (Single-Phase 3-Wire Units)

If the colors on the individual drop cables cannot be found with an ohmmeter, measure:

Cable 1 to Cable 2
Cable 2 to Cable 3
Cable 3 to Cable 1

Find the highest resistance reading.

The lead not used in the highest reading is the yellow lead.

Use the yellow lead and each of the other two leads to get two readings:

Highest is the red lead.
Lowest is the black lead.

EXAMPLE:
The ohmmeter readings were:

Cable 1 to Cable 2 - 6 ohms
Cable 2 to Cable 3 - 2 ohms
Cable 3 to Cable 1 - 4 ohms

The lead not used in the highest reading (6 ohms) was

Cable 3—Yellow

From the yellow lead, the highest reading (4 ohms) was

To Cable 1—Red

From the yellow lead, the lowest reading (2 ohms) was

To Cable 2—Black

Single-Phase Control Boxes

Checking and Repairing Procedures (Power On)

WARNING: Power must be on for these tests. Do not touch any live parts.

A. VOLTAGE MEASUREMENTS

Step 1. Motor Off

1. Measure voltage at L1 and L2 of pressure switch or line contactor.
2. Voltage Reading: Should be ± 10% of motor rating.

Step 2. Motor Running

1. Measure voltage at load side of pressure switch or line contactor with pump running.
2. Voltage Reading: Should remain the same except for slight dip on starting. Excessive voltage drop can be caused by loose connections, bad contacts, ground faults, or inadequate power supply.
3. Relay chatter is caused by low voltage or ground faults.

B. CURRENT (AMP) MEASUREMENTS

1. Measure current on all motor leads.
2. Amp Reading: Current in red lead should momentarily be high, then drop within one second to values in table 13. This verifies relay or solid state relay operation. Current in black and yellow leads should not exceed values in table 13.
3. Relay or switch failures will cause red lead current to remain high and overload tripping.
4. Open run capacitor(s) will cause amps to be higher than normal in the black and yellow motor leads and lower than normal in the red motor lead.
5. A bound pump will cause locked rotor amps and overloading tripping.
6. Low amps may be caused by pump running at shutoff, worn pump, or stripped splines.
7. Failed start capacitor or open switch/relay are indicated if the red lead current is not momentarily high at starting.

CAUTION: The tests in this manual for components such as capacitors, relays, and QD switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but may have lost some of its capacitance and may no longer be able to perform its function.

Ohmmeter Tests

QD, Solid State Control Box (Power Off)

A. START CAPACITOR AND RUN CAPACITOR IF APPLICABLE (CRC)

1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then back to infinity.

B. Q.D. (BLUE) RELAY

Step 1. Triac Test

1. Meter setting: R x 1,000.
2. Connections: Cap and B terminal.
3. Correct meter reading: Infinity for all models.

Step 2. Coil Test

1. Meter Setting: R x 1.
2. Connections: L1 and B.
3. Correct meter reading: Zero ohms for all models.

C. POTENTIAL (VOLTAGE) RELAY

Step 1. Coil Test

1. Meter setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings:

   For 115 Volt Boxes:
   0.7-1.8 (700 to 1,800 ohms).

   For 230 Volt Boxes:
   4.5-7.0 (4,500 to 7,000 ohms).

Step 2. Contact Test

1. Meter setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading: Zero for all models.

Ohmmeter Tests

Integral Horsepower Control Box (Power Off)

A. OVERLOADS (Push Reset Buttons to make sure contacts are closed.)

1. Meter Setting: R x 1.
2. Connections: Overload terminals.
3. Correct meter reading: Less than 0.5 ohms.

B. CAPACITOR (Disconnect leads from one side of each capacitor before checking.)

1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then drift back to infinity, except for capacitors with resistors which will drift back to 15,000 ohms.

C. POTENTIAL (VOLTAGE) RELAY

Step 1. Coil Test

1. Meter setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings: 4.5-7.0 (4,500 to 7,000 ohms) for all models.

Step 2. Contact Test

1. Meter Setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading: Zero ohms for all models.

D. CONTACTOR

Step 1. Coil

1. Meter setting: R x 100
2. Connections: Coil terminals
3. Correct meter reading: 1.8-14.0 (180 to 1,400 ohms)

Step 2. Contacts

1. Meter Setting: R X 1
2. Connections: L1 & T1 or L2 & T2
3. Manually close contacts
4. Correct meter reading: Zero ohms

CAUTION: The tests in this manual for components such as capacitors, relays, and QD switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but may have lost some of its capacitance and may no longer be able to perform its function.

Table 49 QD Control Box Parts 60 Hz

HP	VOLTS	CONTROL BOX MODEL NUMBER	QD (BLUE) RELAY	START CAPACITOR	MFD	VOLTS	RUN CAPACITOR	MFD	VOLTS
1/3	115	280 102 4915	223 415 905	275 464 125	159-191	110			
	230	280 103 4915	223 415 901	275 464 126	43-53	220			
1/2	115	280 104 4915	223 415 906	275 464 201	250-300	125			
	230	280 105 4915	223 415 902	275 464 105	59-71	220			
	230	282 405 5015 (CRC)	223 415 912	275 464 126	43-53	220	156 362 101	15	370
3/4	230	280 107 4915	223 415 903	275 464 118	86-103	220			
	230	282 407 5015 (CRC)	223 415 913	275 464 105	59-71	220	156 362 102	23	370
1	230	280 108 4915	223 415 904	275 464 113	105-126	220			
	230	282 408 5015 (CRC)	223 415 914	275 464 118	86-103	220	156 362 102	23	370

Table 49A QD Capacitor Replacement Kits

CAPACITOR NUMBER	KIT
275 464 105	305 207 905
275 464 113	305 207 913
275 464 118	305 207 918
275 464 125	305 207 925
275 464 126	305 207 926
275 464 201	305 207 951
156 362 101	305 203 907
156 362 102	305 203 908

Table 49B Overload Kits 60 Hz

HP	VOLTS	KIT (1)
1/3	115	305 100 901
1/3	230	305 100 902
1/2	115	305 100 903
1/2	230	305 100 904
3/4	230	305 100 905
1	230	305 100 906

(1) For Control Boxes with model numbers that end with 4915.

Table 49C QD Relay Replacement Kits

QD RELAY NUMBER	KIT
223 415 901	305 101 901
223 415 902	305 101 902
223 415 903	305 101 903
223 415 904	305 101 904
223 415 905	305 101 905
223 415 906	305 101 906
223 415 912 (CRC)	305 105 901
223 415 913 (CRC)	305 105 902
223 415 914 (CRC)	305 105 903

FOOTNOTES:

(1) Control boxes supplied with QD Relays are designed to operate on 230-volt systems. For 208-volt systems or where line voltage is between 200 volts and 210 volts use the next larger cable size, or use a boost transformer to raise the voltage.

(2) Voltage relays kits for 115-volts (305 102 901) and 230-volts (305 102 902) will replace current, voltage or QD Relays, and solid state switches.

Table 50 Integral Horsepower Control Box Parts 60 Hz

MOTOR SIZE	MOTOR RATING HP	CONTROL BOX (1) MODEL NO.	CAPACITORS				OVERLOAD (2) PART NO.	RELAY (3) PART NO.	CONTACTOR (2) PART NO.
			PART NO. (2)	MFD.	VOLTS	QTY.			
4"	1 - 1.5 STANDARD	282 300 8110 (See Note 5)	275 464 113 S 155 328 102 R	105-126 10	220 370	1 1	275 411 107	155 031 102	
		282 300 8110 (See Note 5)	275 464 113 S 155 328 101 R	105-126 15	220 370	1 1	275 411 114 S 275 411 113 M	155 031 102	
		282 300 8610	275 464 113 S 155 328 101 R	105-126 15	220 370	1 1	None (See Note 4)	155 031 102	
4"	2 STANDARD	282 301 8110	275 464 113 S 155 328 103 R	105-126 20	220 370	1 1	275 411 117 S 275 411 113 M	155 031 102	
4"	2 DELUXE	282 301 8310	275 464 113 S 155 328 103 R	105-126 20	220 370	1 1	275 411 117 S 275 411 113 M	155 031 102	155 325 102 L
4"	3 STANDARD	282 302 8110	275 463 123 S 155 327 109 R	208-250 45	220 370	1 1	275 411 118 S 275 411 115 M	155 031 102	
4"	3 DELUXE	282 302 8310	275 463 123 S 155 327 109 R	208-250 45	220 370	1 1	275 411 118 S 275 411 115 M	155 031 102	155 325 102 L
4" & 6"	5 STANDARD	282 113 8110	275 468 119 S 155 327 114 R	270-324 40	330 370	1 2	275 411 119 S 275 406 102 M	155 031 601	
4" & 6"	5 DELUXE	282 113 9310	275 468 119 S 155 327 114 R	270-324 40	330 370	1 2	275 411 119 S 275 406 102 M	155 031 601	155 326 101 L
6"	7.5 STANDARD	282 201 9210	275 468 119 S 275 468 118 S 155 327 109 R	270-324 216-259 45	330 330 370	1 1 1	275 411 102 S 275 406 122 M	155 031 601	
6"	7.5 DELUXE	282 201 9310	275 468 119 S 275 468 118 S 155 327 109 R	270-324 216-259 45	330 330 370	1 1 1	275 411 102 S 275 406 121 M	155 031 601	155 326 102 L
6"	10 STANDARD	282 202 9210	275 468 119 S 275468 120 S 155 327 102 R	270-324 350-420 35	330 330 370	1 1 2	275 406 103 S 155 409 101 M	155 031 601	
6"	10 STANDARD	282 202 9230	275 463 120 S 275 468 118 S 275 468 119 S 155 327 102 R	130-154 216-259 270-324 35	330 330 330 370	1 1 1 2	275 406 103 S 155 409 101 M	155 031 601	
6"	10 DELUXE	282 202 9310	275 468 119 S 275468 120 S 155 327 102 R	270-324 350-420 35	330 330 370	1 1 2	275 406 103 S 155 409 101 M	155 031 601	155 326 102 L
6"	10 DELUXE	282 202 9330	275 463 120 S 275 468 118 S 275 468 119 S 155 327 102 R	130-154 216-259 270-324 35	330 330 330 370	1 1 1 2	275 406 103 S 155 409 101 M	155 031 601	155 326 102 L
6"	15 DELUXE	282 203 9310	275 468 120 S 155 327 109 R	350-420 45	330 370	2 3	275 406 103 S 155 409 102 M	155 031 601	155 429 101 L
6"	15 DELUXE	282 203 9330	275 463 122 S 275 468 119 S 155 327 109 R	161-193 270-324 45	330 330 370	1 2 3	275 406 103 S 155 409 102 M	155 031 601	155 429 101 L
6"	15 X-LARGE	282 203 9621	275 468 120 S 155 327 109 R	350-420 45	330 370	2 3	275 406 103 S 155 409 102 M	155 031 601 2 required	155 429 101 L

FOOTNOTES:

(1) Lightning arrestors 150 814 902 are suitable for all control boxes.

(2) S = Start, M = Main, L = Line, R = Run
Deluxe = Control box with line contactor.

(3) For 208-volt systems or where line voltage is between 200 volts and 210 volts, a low voltage relay is required. On 3 hp and smaller control boxes use relay part 155 031 103 in place of 155 031 102 and use the next larger cable size than specified in the 230-volt table. On 5 hp and larger use relay 155 031 602 in place of 155 031 601 and next larger wire. Boost transformers per page 15 are an alternative to special relays and cable.

(4) Control box model 282 300 8610 is designed for use with motors having internal overload protectors. If used with a 1.5 hp motor manufactured prior to date code 06H18, Overload/Capacitor Kit 305 388 901 is required.

(5) Control box model 282 300 8110 with date code 11C19 (March 2011) and newer contain 15 MFD run capacitor and both start and run overloads. This box is designed for use with any Franklin 1.5 hp motor.

Table 51 Integral hp Capacitor Replacement Kits

CAPACITOR NUMBER	KIT
275 463 120	305 206 920
275 463 122	305 206 922
275 463 123	305 206 923
275 464 113	305 207 913
275 468 118	305 208 918
275 468 119	305 208 919
275 468 120	305 208 920
155 327 101	305 203 901
155 327 102	305 203 902
155 327 109	305 203 909
155 327 114	305 203 914
155 328 101	305 204 901
155 328 102	305 204 902
155 328 103	305 204 903

Table 51A Integral hp Overload Replacement Kits

OVERLOAD NUMBER	KIT
275 406 102	305 214 902
275 406 103	305 214 903
275 406 121	305 214 921
275 406 122	305 214 922
275 411 102	305 215 902
275 411 107	305 215 907
275 411 108	305 215 908
275 411 113	305 215 913
275 411 114	305 215 914
275 411 115	305 215 915
275 411 117	305 215 917
275 411 118	305 215 918
275 411 119	305 215 919

Table 51B Integral hp Voltage Relay Replacement Kits

RELAY NUMBER	KIT
155 031 102	305 213 902
155 031 103	305 213 903
155 031 601	305 213 961
155 031 602	305 213 962

Table 51C Integral hp Contactor Replacement Kits

CONTACTOR	KIT
155 325 102	305 226 902
155 326 101	305 347 903
155 326 102	305 347 902
155 429 101	305 347 901

FOOTNOTES:

(1) The following kit number changes were made for number consistency purposes only. Parts in the kit did not change.

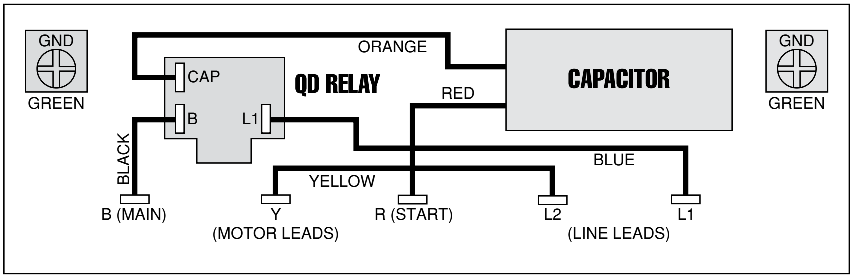
305 206 922 was 305 206 912

305 206 923 was 305 206 911

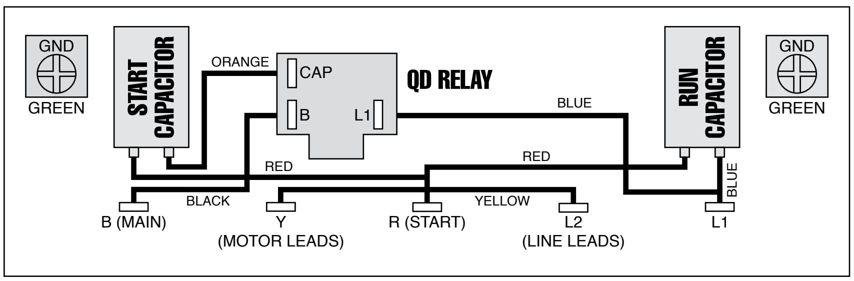
305 213 962 was 305 213 904

305 226 902 was 305 226 901

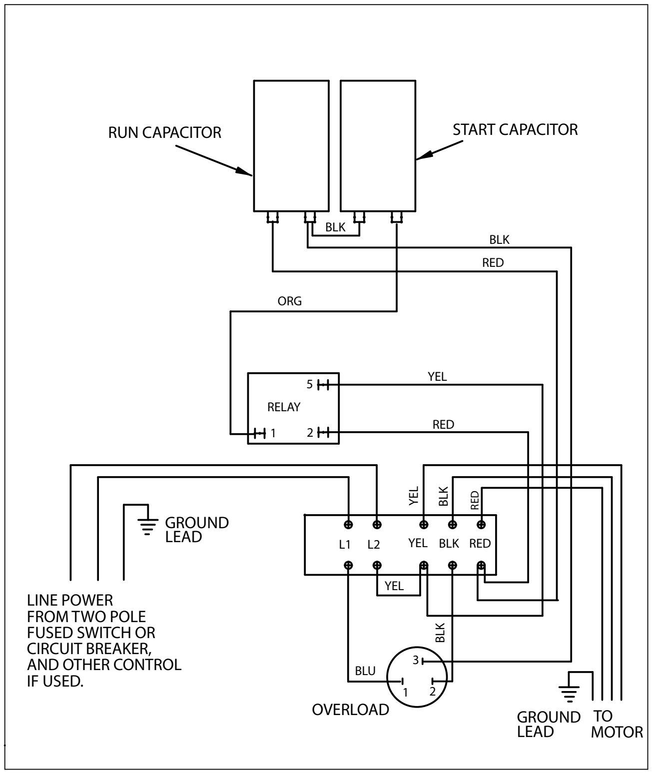
Control Box Wiring Diagrams



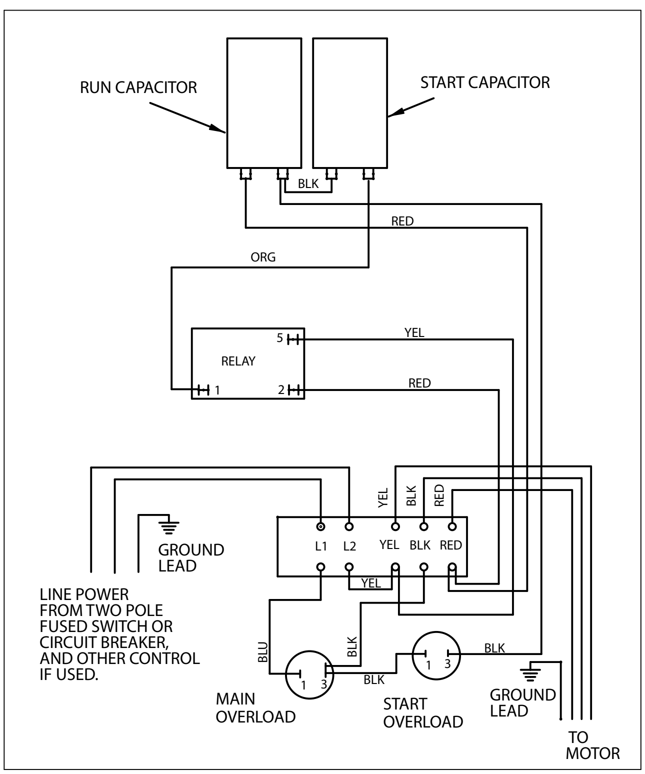
1/3 - 1 hp QD RELAY
280 10_ 4915
Sixth digit depends on hp



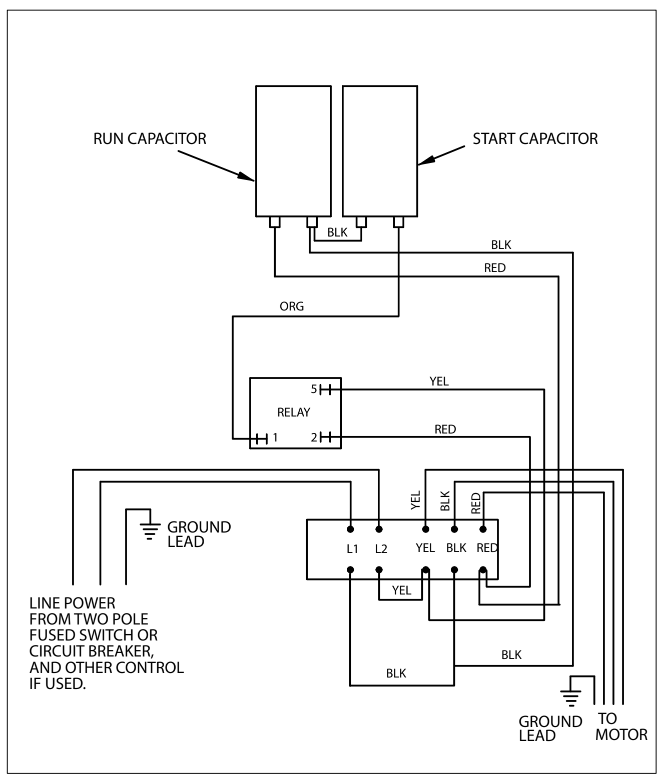
1/2 - 1 hp CRC QD RELAY
282 40_ 5015
Sixth digit depends on hp



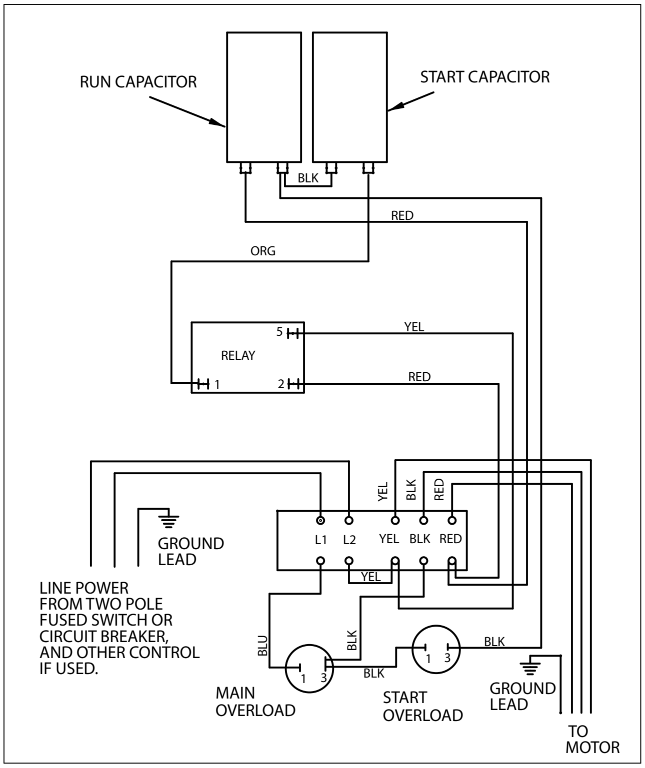
1 - 1.5 hp
282 300 8110
(Date Codes 11C19 & Older)



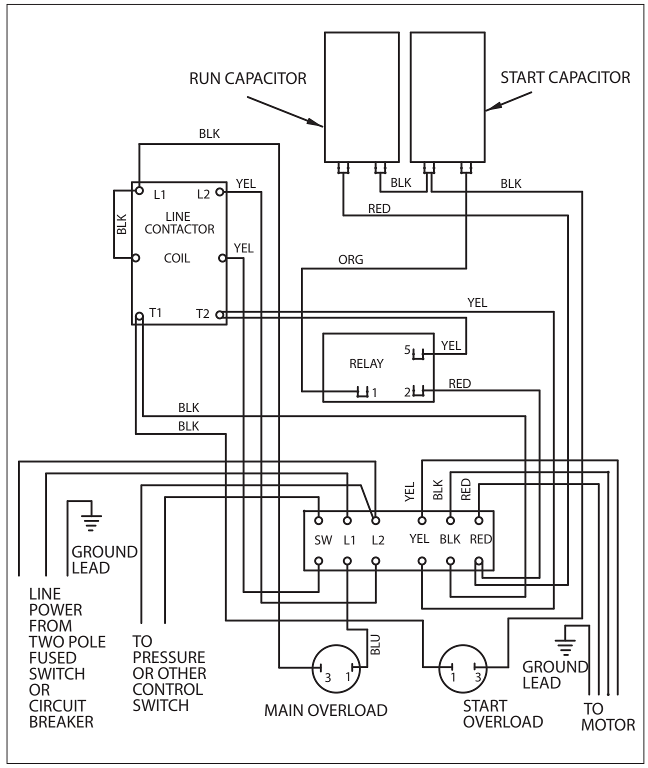
1 - 1.5 hp
282 300 8110
(Date Codes 11C19 & Newer)



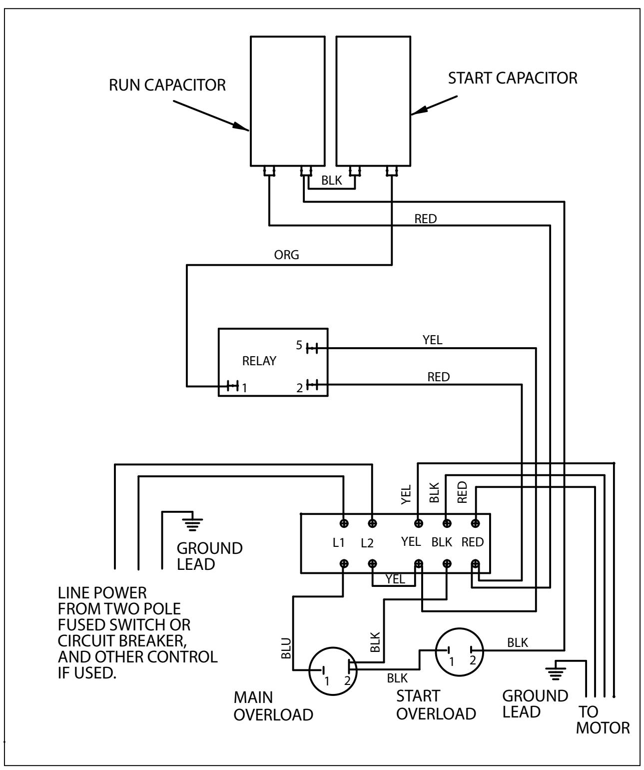
1 - 1.5 hp
282 300 8610



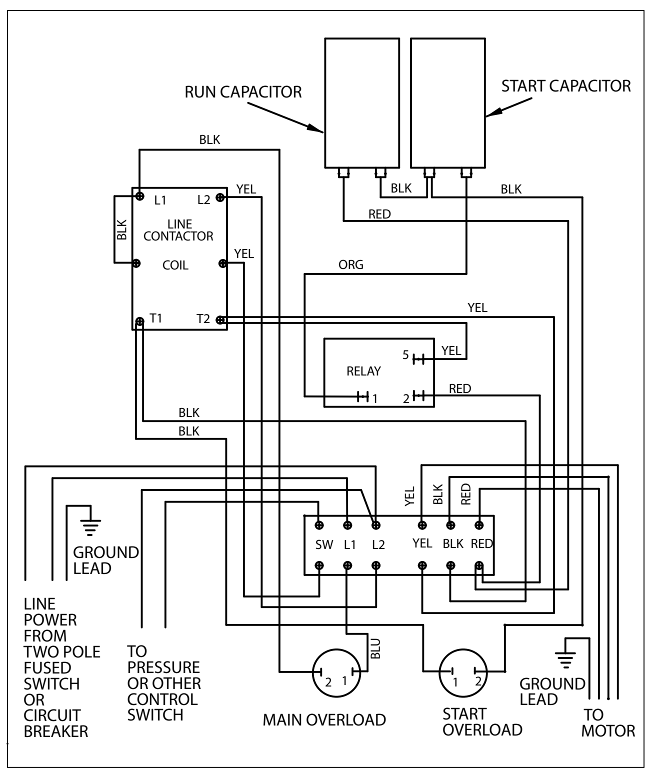
2 hp STANDARD
282 301 8110



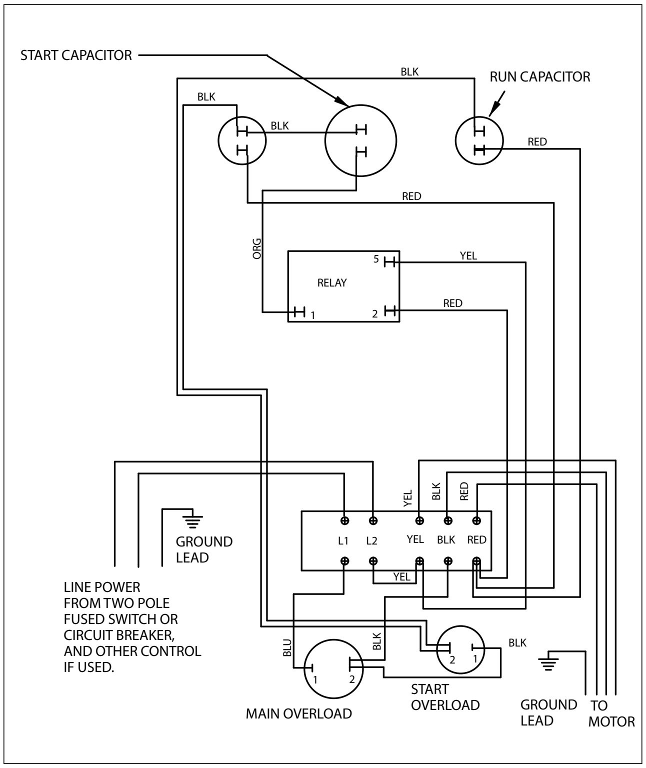
2 hp DELUXE
282 301 8310



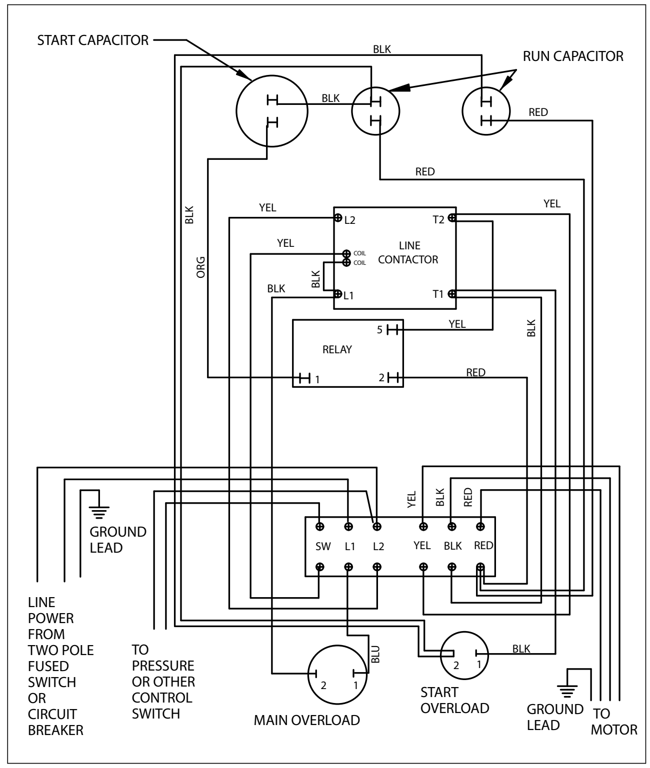
3 hp STANDARD
282 302 8110



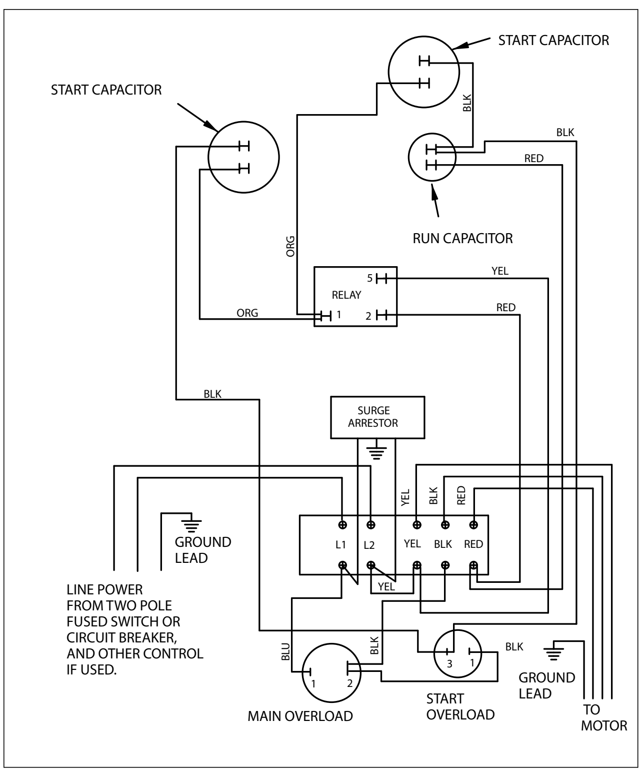
3 hp DELUXE
282 302 8310



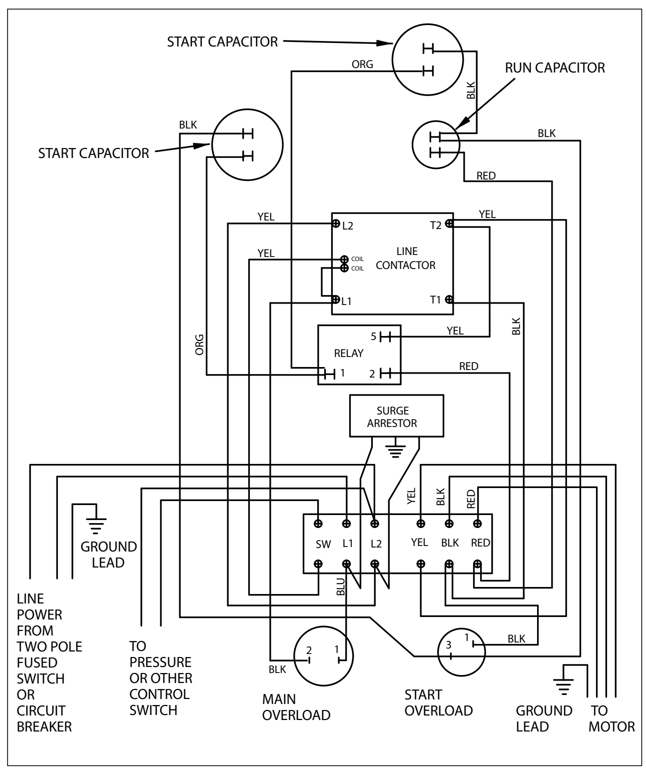
5 hp STANDARD
282 113 8110



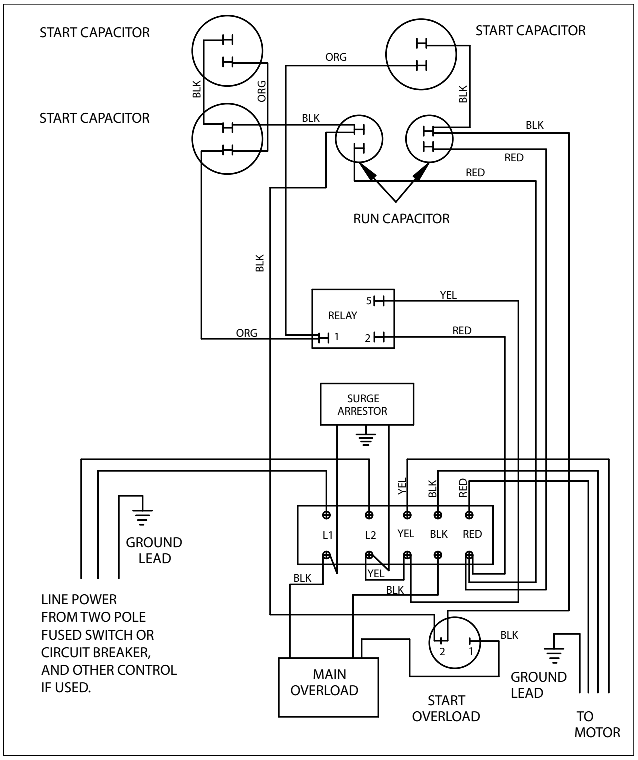
5 hp DELUXE
282 113 8310 or 282 113 9310



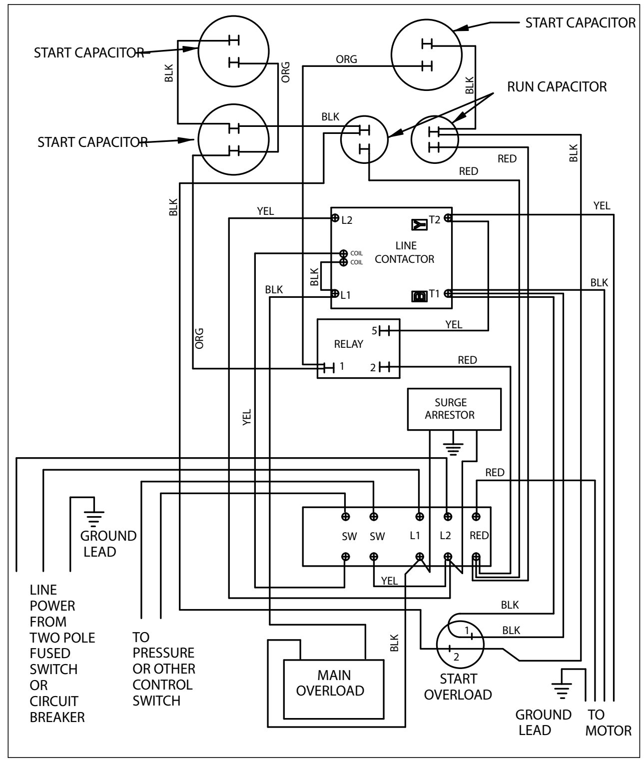
7.5 hp STANDARD
282 201 9210



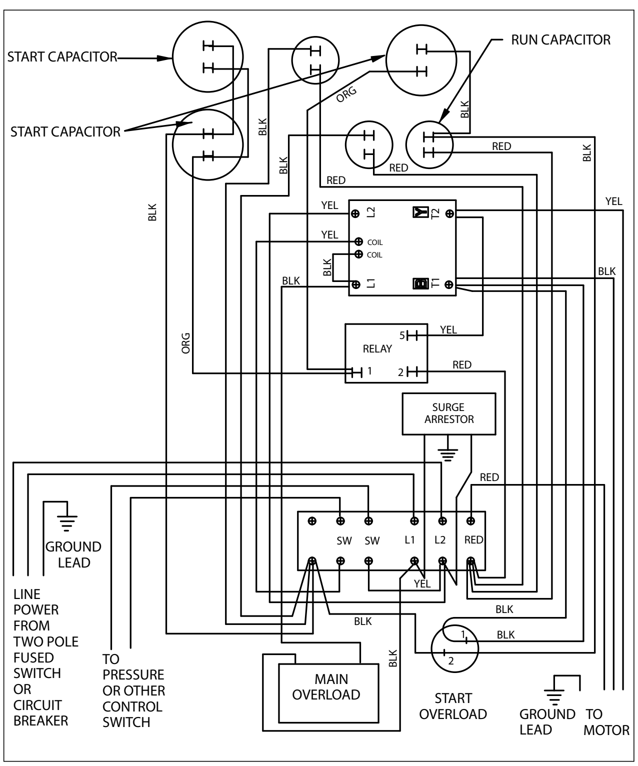
7.5 hp DELUXE
282 201 9310



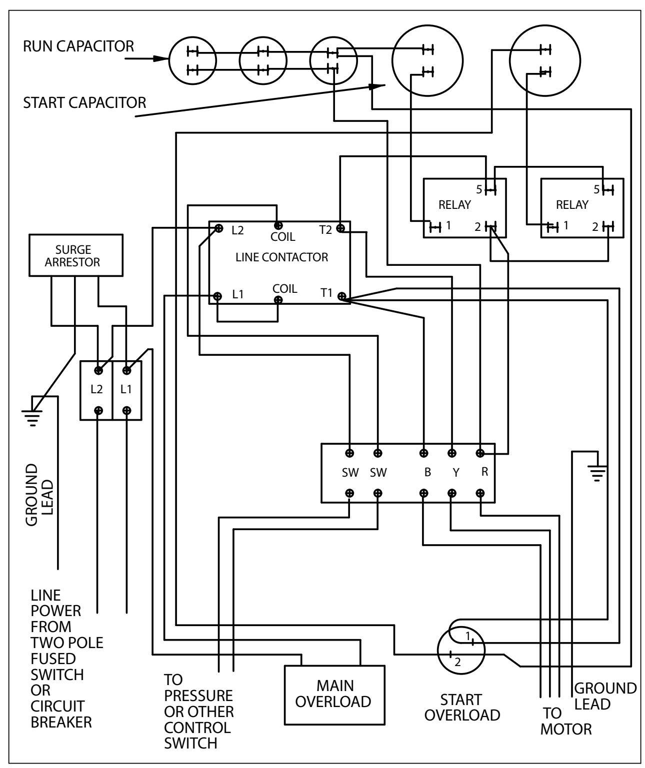
10 hp STANDARD
282 202 9210 or 282 202 9230



10 hp DELUXE
282 202 9230 or 282 202 9330



15 hp DELUXE
282 203 9310 or 282 203 9330



15 hp X-LARGE
282 203 9621

Pumptec-Plus

Pumptec-Plus is a pump/motor protection device designed to work on any 230 V single-phase induction motor (PSC, CSCR, CSIR, and split phase) ranging in size from 1/2 to 5 horsepower. Pumptec-Plus uses a micro-computer to continuously monitor motor power and line voltage to provide protection against dry well, water logged tank, high and low voltage and mud or sand clogging.

Pumptec-Plus – Troubleshooting During Installation

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Unit Appears Dead (No Lights)	No Power to Unit	Check wiring. Power supply voltage should be applied to L1 and L2 terminals of the Pumptec-Plus. In some installations the pressure switch or other control devices is wired to the input of the Pumptec-Plus. Make sure this switch is closed.
Flashing Yellow Light	Unit Needs to Be Calibrated	Pumptec-Plus is calibrated at the factory so that it will overload on most pump systems when the unit is first installed. This overload condition is a reminder that the Pumptec-Plus unit requires calibration before use. See step 7 of the installation instructions.
	Miscalibrated	Pumptec-Plus should be calibrated on a full recovery well with the maximum water flow. Flow restrictors are not recommended.
Flashing Yellow Light During Calibration	2-Wire Motor	Step C of the calibration instructions indicate that a flashing green light condition will occur 2 to 3 seconds after taking the SNAPSHOT of the motor load. On some two-wire motors the yellow light will flash instead of the green light. Press and release the reset button. The green should start flashing.
Flashing Red and Yellow Lights	Power Interruption	During the installation of Pumptec-Plus power may be switched on and off several times. If power is cycled more than four times within a minute Pumptec-Plus will trip on rapid cycle. Press and release the reset button to restart the unit.
	Float Switch	A bobbing float switch may cause the unit to detect a rapid cycle condition on any motor or an overload condition on two-wire motors. Try to reduce water splashing or use a different switch.
Flashing Red Light	High Line Voltage	The line voltage is over 253 volts. Check line voltage. Report high line voltage to the power company.
	Unloaded Generator	If you are using a generator the line voltage may become too high when the generator unloads. Pumptec-Plus will not allow the motor to turn on again until the line voltage returns to normal. Overvoltage trips will also occur if line frequency drops too far below 60 Hz.
Solid Red Light	Low Line Voltage	The line voltage is below 207 volts. Check line voltage.
	Loose Connections	Check for loose connections which may cause voltage drops.
	Loaded Generator	If you are using a generator the line voltage may become too low when the generator loads. Pumptec-Plus will trip on undervoltage if the generator voltage drops below 207 volts for more than 2.5 seconds. Undervoltage trips will also occur if the line frequency rises too far above 60 Hz.

Pumptec-Plus

Pumptec-Plus - Troubleshooting After Installation

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Solid Yellow Light	Dry Well	Wait for the automatic restart timer to time out. During the time out period the well should recover and fill with water. If the automatic reset timer is set to the manual position, then the reset button must be pressed to reactivate the unit.
	Blocked Intake	Clear or replace pump intake screen.
	Blocked Discharge	Remove blockage in plumbing.
	Check Valve Stuck	Replace check valve.
	Broken Shaft	Replace broken parts.
	Severe Rapid Cycling	Machine gun rapid cycling can cause an underload condition. See flashing red and yellow lights section below.
	Worn Pump	Replace worn pump parts and recalibrate.
Yellow Flashing Light	Stalled Motor	Repair or replace motor. Pump may be sand or mud locked.
	Float Switch	A bobbing float switch can cause two-wire motors to stall. Arrange plumbing to avoid splashing water. Replace float switch.
	Ground Fault	Check insulation resistance on motor and control box cable.
Solid Red Light	Low Line Voltage	The line voltage is below 207 volts. Pumptec-Plus will try to restart the motor every two minutes until line voltage is normal.
	Loose Connections	Check for excessive voltage drops in the system electrical connections (i.e. circuit breakers, fuse clips, pressure switch, and Pumptec-Plus L1 and L2 terminals). Repair connections.
Flashing Red Light	High Line Voltage	The line voltage is over 253 volts. Check line voltage. Report high line voltage to the power company.
Flashing Red and Yellow Lights	Rapid Cycle	The most common cause for the rapid cycle condition is a waterlogged tank. Check for a ruptured bladder in the water tank. Check the air volume control or snifter valve for proper operation. Check setting on the pressure switch and examine for defects.
	Leaky Well System	Replace damaged pipes or repair leaks.
	Stuck Check Valve	Failed valve will not hold pressure. Replace valve.
	Float Switch	Press and release the reset button to restart the unit. A bobbing float switch may cause the unit to detect a rapid cycle condition on any motor or an overload condition on 2-wire motors. Try to reduce water splashing or use a different switch.

QD Pumptec and Pumptec

QD Pumptec and Pumptec are load sensing devices that monitor the load on submersible pumps/motors. If the load drops below a preset level for a minimum of 4 seconds the QD Pumptec or the Pumptec will shut off the motor.

The QD Pumptec is designed and calibrated expressly for use on Franklin Electric 230 V 3-wire motors (1/3 to 1 hp.) The QD Pumptec must be installed in QD relay boxes.

The Pumptec is designed for use on Franklin Electric 2- and 3-wire motors (1/3 to 1.5 hp) 115 and 230 V. The Pumptec is not designed for jet pumps.

QD Pumptec & Pumptec – Troubleshooting

SYMPTOM	CHECKS OR SOLUTION
If the QD Pumptec or Pumptec trips in about 4 seconds with some water delivery.	A. Is the voltage less than 90% of nameplate rating? B. Are the pump and motor correctly matched? C. Is the **QD Pumptec** or **Pumptec** wired correctly? For the **Pumptec** check the wiring diagram and pay special attention to the positioning of the power lead (230 V or 115 V). D. For **QD Pumptec** is your system 230 V 60 Hz or 220 V 50 Hz?
If the QD Pumptec or Pumptec trips in about 4 seconds with no water delivery.	A. The pump may be airlocked. If there ia a check valve on top of the pump, put another section of pipe between the pump and the check valve. B. The pump may be out of water. C. Check the valve settings. The pump may be dead-heading. D. Pump or motor shaft may be broken. E. Motor overload may be tripped. Check the motor current (amperage).
If the QD Pumptec or Pumptec will not timeout and reset.	A. Check switch position on side of circuit board on **Pumptec**. **QD Pumptec** check timer position on top/front of unit. Make sure the switch is not between settings. B. If the reset time switch is set to manual reset (position 0), **QD Pumptec** and **Pumptec** will not reset (turn power off for 5 sec. then back on to reset).
If your pump/motor will not run at all.	A. Check voltage. B. Check wiring. C. Remove the **QD Pumptec** from the control box. Reconnect wires in box to original state. If motor does not run the problem is not **QD Pumptec**. Bypass **Pumptec** by connecting L2 and motor lead with jumper. Motor should run. If not, the problem is not **Pumptec**. D. On **Pumptec** only check that **Pumptec** is installed between the control switch and the motor.
If your QD Pumptec or Pumptec will not trip when the pump breaks suction.	A. Be sure you have a Franklin motor. B. Check wiring connections. On **Pumptec** is lead power (230 V or 115 V) connected to correct terminal? Is motor lead connected to correct terminal? C. Check for ground fault in the motor and excessive friction in the pump. D. The well may be “gulping” enough water to keep **QD Pumptec** or **Pumptec** from tripping. It may be necessary to adjust the **QD Pumptec** or the **Pumptec** for these extreme applications. Call the Franklin Electric Service Hotline at 800-348-2420 for information. E. On **Pumptec** applications does the control box have a run capacitor? If so, **Pumptec** will not trip. (Except for Franklin 1.5 hp motors).
If your QD Pumptec or Pumptec chatters when running.	A. Check for low voltage. B. Check for waterlogged tank. Rapid cycling for any reason can cause the **QD Pumptec** or the **Pumptec** relay to chatter. C. On **Pumptec** make sure the L2 and motor wires are installed correctly. If they are reversed, the unit can chatter.

SubDrive2W, 75, 100, 150, 300, MonoDrive, & MonoDrive XT

The Franklin Electric SubDrive/MonoDrive Constant Pressure controller is a variable-speed drive that delivers water at a constant pressure.

WARNING: Serious or fatal electrical shock may result from failure to connect the motor, SubDrive/MonoDrive Controller, metal plumbing and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires. To reduce the risk of electrical shock, disconnect power before working on or around the water system. Capacitors inside the SubDrive/MonoDrive Controller can still hold a lethal voltage even after power has been removed. Allow 10 minutes for dangerous internal voltage to discharge. Do not use motor in swimming areas.

SubDrive2W, 75, 100, 150, 300, MonoDrive, & MonoDrive XT

SubDrive/MonoDrive Troubleshooting

Should an application or system problem occur, built-in diagnostics will protect the system. The "FAULT" light or digital display on the front of the SubDrive/MonoDrive Controller will flash a given number of times or display a number indicating the nature of the fault. In some cases, the system will shut itself off until corrective action is taken. Fault codes and their corrective actions are listed below. See SubDrive/MonoDrive Installation Manual for installation data.

NUMBER OF FLASHES OR DIGITAL DISPLAY	FAULT	POSSIBLE CAUSE	CORRECTIVE ACTION
1	MOTOR UNDERLOAD	- Overpumped well - Broken shaft or coupling - Blocked screen, worn pump - Air/gas locked pump - SubDrive not set properly for pump end	- Frequency near maximum with less than 65% of expected load, 42% if DIP #3 is "on" - System is drawing down to pump inlet (out of water) - High static, light loading pump - reset DIP switch #3 to "on" for less sensitivity if not out of water - Check pump rotation (SubDrive only) reconnect if necessary for proper rotation - Air/gas locked pump - if possible, set deeper in well to reduce - Verify DIP switches are set properly
2	UNDERVOLTAGE	- Low line voltage - Misconnected input leads	- Line voltage low, less than approximately 150 VAC (normal operating range = 190 to 260 VAC) - Check incoming power connections and correct or tighten if necessary - Correct incoming voltage - check circuit breaker or fuses, contact power company
3	LOCKED PUMP	- Motor and/or pump misalignment - Dragging motor and/or pump - Abrasives in pump	- Amperage above SFL at 10 Hz - Remove and repair or replace as required
4 (MonoDrive & MonoDriveXT only)	INCORRECTLY WIRED	- MonoDrive only - Wrong resistance values on main and start	- Wrong resistance on DC test at start - Check wiring, check motor size and DIP switch setting, adjust or repair as needed
5	OPEN CIRCUIT	- Loose connection - Defective motor or drop cable - Wrong motor	- Open reading on DC test at start. - Check drop cable and motor resistance, tighten output connections, repair or replace as necessary, use "dry" motor to check drive functions, if drive will not run and exhibits underload fault replace drive
6	SHORT CIRCUIT	- When fault is indicated immediately after power-up, short circuit due to loose connection, defective cable, splice or motor	- Amperage exceeded 50 amps on DC test at start or max amps during running - Incorrect output wiring, phase to phase short, phase to ground short in wiring or motor - If fault is present after resetting and removing motor leads, replace drive
	OVER CURRENT	- When fault is indicated while motor is running, over current due to loose debris trapped in pump	- Check pump
7	OVERHEATED DRIVE	- High ambient temperature - Direct sunlight - Obstruction of airflow	- Drive heat sink has exceeded max rated temperature, needs to drop below 85 °C to restart - Fan blocked or inoperable, ambient above 125 °F, direct sunlight, air flow blocked - Replace fan or relocate drive as necessary
8 (SubDrive300 only)	OVER PRESSURE	- Improper pre-charge - Valve closing too fast - Pressure setting too close to relief valve rating	- Reset the pre-charge pressure to 70% of sensor setting. Reduce pressure setting well below relief valve rating. Use next size larger pressure tank. - Verify valve operation is within manufacturer's specifications. - Reduce system pressure setting to a value less than pressure relief rating.
RAPID	INTERNAL FAULT	- A fault was found internal to drive	- Unit may require replacement. Contact your supplier.
9 (SubDrive2W only)	OVER RANGE (Values outside normal operating range)	- Wrong hp/voltage - Internal fault	- Verify motor hp and voltage - Unit may require replacement. Contact your supplier.

SubMonitor

SubMonitor Troubleshooting

FAULT MESSAGE	PROBLEM/CONDITION	POSSIBLE CAUSE
SF Amps Set Too High	SF Amps setting above 359 Amps.	Motor SF Amps not entered.
Phase Reversal	Reversed incoming voltage phase sequence.	Incoming power problem.
Underload	Normal line current.	Wrong SF Max Amps setting.
	Low line current.	Over pumping well. Clogged pump intake. Closed valve. Loose pump impeller. Broken shaft or coupling. Phase loss.
Overload	Normal line current.	Wrong SF Max Amps setting.
	High line current.	High or low line voltage. Ground fault. Pump or motor dragging. Motor stalled or bound pump.
Overheat	Motor temperature sensor has detected excess motor temperature.	High or low line voltage. Motor is overloaded. Excessive current unbalance. Poor motor cooling. High water temperature. Excessive electrical noise (VFD in close proximity).
Unbalance	Current difference between any two legs exceeds programmed setting.	Phase loss. Unbalanced power supply. Open Delta transformer.
Overvoltage	Line voltage exceeds programmed setting.	Unstable power supply.
Undervoltage	Line voltage below programmed setting.	Poor connection in motor power circuit. Unstable or weak power supply.
False Starts	Power has been interrupted too many times in a 10 second period.	Chattering contacts. Loose connections in motor power circuit. Arcing contacts.

Continued on next page

Subtrol-Plus (Obsolete - See SubMonitor)

Subtrol-Plus - Troubleshooting After Installation

SYMPTOM	POSSIBLE CAUSE OR SOLUTION
Subtrol-Plus Dead	When the Subtrol-Plus reset button is depressed and released, all indicator lights should flash. If line voltage is correct at the Subtrol-Plus L1, L2, L3 terminals and the reset button does not cause lights to flash, Subtrol-Plus receiver is malfunctioning.
Green Off Time Light Flashes	The green light will flash and not allow operation unless both sensor coils are plugged into the receiver. If both are properly connected and it still flashes, the sensor coil or the receiver is faulty. An ohmmeter check between the two center terminals of each sensor coil connected should read less than 1 ohm, or coil is faulty. If both coils check good, receiver is faulty.
Green Off Time Light On	The green light is on and the Subtrol-Plus requires the specified off time before the pump can be restarted after having been turned off. If the green light is on except as described, the receiver is faulty. Note that a power interruption when the motor is running will initiate the delay function.
Overheat Light On	This is a normal protective function which turns off the pump when the motor reaches maximum safe temperatures. Check that amps are within the nameplate maximum on all three lines, and that the motor has proper water flow past it. If overheat trip occurs without apparent motor overheating, it may be the result of an arcing connection somewhere in the circuit or extreme noise interference on the power lines. Check with the power company or Franklin Electric. A true motor overheat trip will require at least five minutes for a motor started cold. If trips do not conform to this characteristic, suspect arcing connections, power line noise, ground fault, or SCR variable speed control equipment.
Overload Light On	This is a normal protective function, protecting against an overload or locked pump. Check the amps in all lines through a complete pumping cycle, and monitor whether low or unbalanced voltage may be causing high amps at particular times. If overload trip occurs without high amps, it may be caused by a faulty rating insert, receiver, or sensor coil. Recheck that the insert rating matches the motor. If it is correct, carefully remove it from the receiver by alternately lifting sides with a knife blade or thin screwdriver, and make sure it has no pins bent over. If the insert is correct and its pins are okay, replace receiver and/or sensor coils.
Underload Light On	This is a normal protective function. A. Make sure the rating insert is correct for the motor. B. Adjusting the underload setting as described to allow the desired range of operating conditions. Note that a DECREASE in underload setting is required to allow loading without trip. C. Check for drop in amps and delivery just before trip, indicating pump breaking suction, and for unbalanced line current. D. With the power turned off, recheck motor lead resistance to ground. A grounded lead can cause underload trip.

Subtrol-Plus (Obsolete - See SubMonitor)

Subtrol-Plus - Troubleshooting After Installation (Continued)

SYMPTOM	POSSIBLE CAUSE OR SOLUTION
Tripped Light On	Whenever the pump is off as a result of Subtrol-Plus protective function, the red tripped light is on. A steady light indicates the Subtrol-Plus will automatically allow the pump to restart as described, and a flashing light indicates repeated trips, requiring manual reset before the pump can be restarted. Any other red light operation indicates a faulty receiver. One-half voltage on 460 V will cause tripped light on.
Control Circuit Fuse Blows	With power turned off, check for a shorted contactor coil or a grounded control circuit lead. The coil resistance should be at least 10 ohms and the circuit resistance to panel frame over 1 megohm. A standard or delay-type 2 amp fuse should be used.
Contactor Will Not Close	If proper voltage is at the control coil terminals when controls are operated to turn the pump on, but the contactor does not close, turn off power and replace the coil. If there is no voltage at the coil, trace the control circuit to determine if the fault is in the Subtrol-Plus receiver, fuse, wiring, or panel operating switches. This tracing can be done by first connecting a voltmeter at the coil terminals, and then moving the meter connections step by step along each circuit to the power source, to determine at which component the voltage is lost. With the Subtrol-Plus receiver powered up, with all leads disconnected from the control terminals and with an ohmmeter set at RX10, measure the resistance between the control terminals. It should measure 100 to 400 ohms. Depress and hold in the reset button. The resistance between the control terminals should measure close to infinity.
Contactor Hums or Chatters	Check that coil voltage is within 10% of rated voltage. If voltage is correct and matches line voltage, turn off power and remove the contactor magnetic assembly and check for wear, corrosion, and dirt. If voltage is erratic or lower than line voltage, trace the control circuit for faults similar to the previous item, but looking for a major drop in voltage rather than its complete loss.
Contactor Opens When Start Switch is Released	Check that the small interlocks switch on the side of the contactor closes when the contactor closes. If the switch or circuit is open, the contactor will not stay closed when the selector switch is in HAND position.
Contactor Closes But Motor Doesn't Run	Turn off power. Check the contactor contacts for dirt, corrosion, and proper closing when the contactor is closed by hand.
Signal Circuit Terminals Do Not Energize	With the Subtrol-Plus receiver powered up and all leads disconnected from the signal terminals, with an 0hmmeter set at RX10, measure the resistance between the signal terminals. Resistance should measure close to infinite. Depress and hold in the reset button. The resistance between the signal terminals should measure 100 to 400 ohms.

Abbreviations

A	Amp or amperage
AWG	American Wire Gauge
BJT	Bipolar Junction Transistor
°C	Degree Celsius
CB	Control Box
CRC	Capacitor Run Control
DI	Deionized
Dv/dt	Rise Time of the Voltage
EFF	Efficiency
°F	Degree Fahrenheit
FDA	Federal Drug Administration
FL	Full Load
ft	Foot
ft-lb	Foot Pound
ft/s	Feet per Second
GFCI	Ground Fault Circuit Interrupter
gpm	Gallon per Minute
HERO	High Efficiency Reverse Osmosis
hp	Horsepower
Hz	Hertz
ID	Inside Diameter
IGBT	Insulated Gate Bipolar Transistor
in	Inch
kVA	Kilovolt Amp
kVAR	Kilovolt Amp Rating
kW	Kilowatt (1000 watts)
L1, L2, L3	Line One, Line Two, Line Three
lb-ft	Pound Feet
L/min	Liter per Minute
mA	Milliamp
max	Maximum
MCM	Thousand Circular Mils
mm	Millimeter
MOV	Metal Oxide Varister
NEC	National Electrical Code
NEMA	National Electrical Manufacturer Association
Nm	Newton Meter
NPSH	Net Positive Suction Head
OD	Outside Diameter
OL	Overload
PF	Power Factor
psi	Pounds per Square Inch
PWM	Pulse Width Modulation
QD	Quick Disconnect
R	Resistance
RMA	Return Material Authorization
RMS	Root Mean Squared
rpm	Revolutions per Minute
SF	Service Factor
SFhp	Service Factor Horsepower
S/N	Serial Number
TDH	Total Dynamic Head
UNF	Fine Thread
V	Voltage
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VFD	Variable Frequency Drive
W	Watts
XFMR	Transformer
Y-D	Wye-Delta
Ω	ohms

TOLL FREE HELP FROM A FRIEND

800-348-2420 • 260-827-5102 (fax)

Phone Franklin's toll free SERVICE HOTLINE for answers to your pump and motor installation questions. When you call, a Franklin expert will offer assistance in troubleshooting and provide immediate answers to your system application questions. Technical support is also available online. Visit our website at:

www.franklin-electric.com

Franklin Electric
The Company You Trust Deep Down

M1311 07.11

PUMP INSTALLATION MANUAL (GRUNDFOS)

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

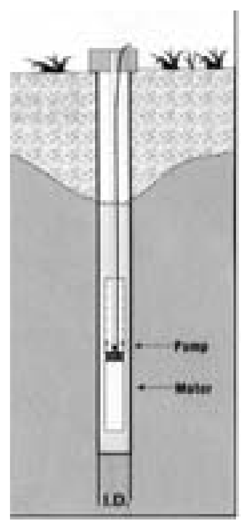
1. Well Preparation

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).

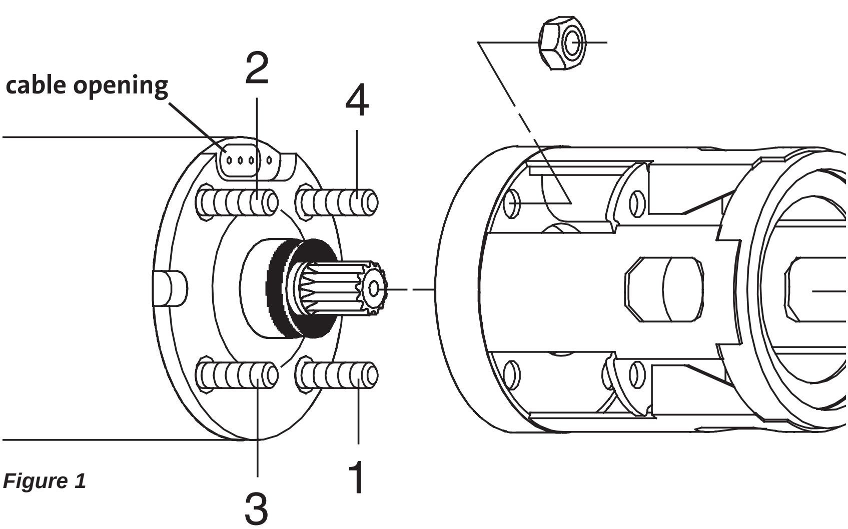


Figure 1

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.

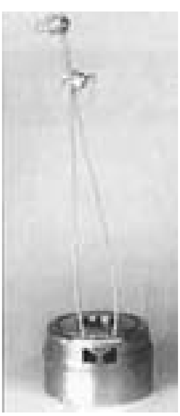


Figure 2

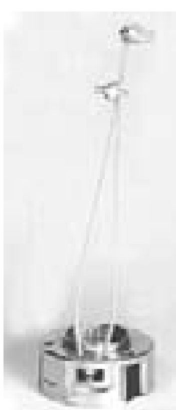


Figure 3

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

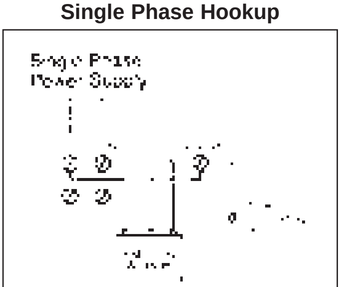


Figure 4a

Three Phase Hookup

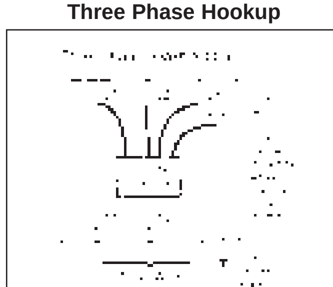
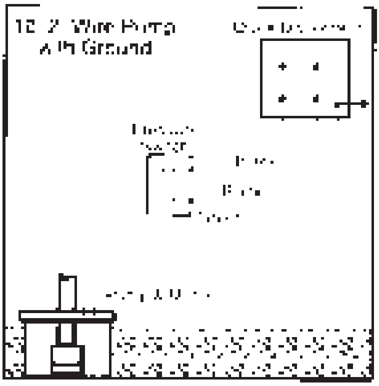


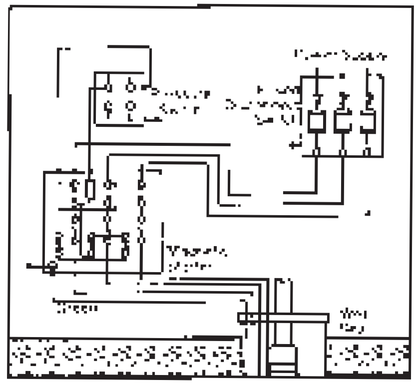
Figure 4b

INSTALLATION PROCEDURES

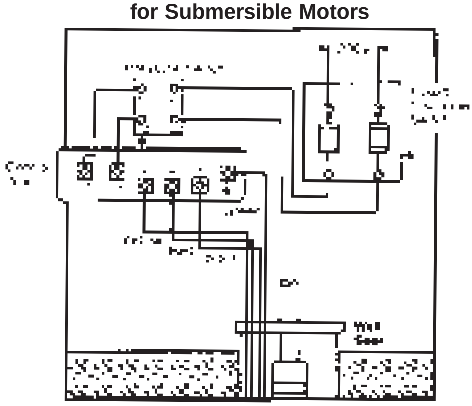
Single-Phase 2-Wire Wiring Diagram for Submersible Motors



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.

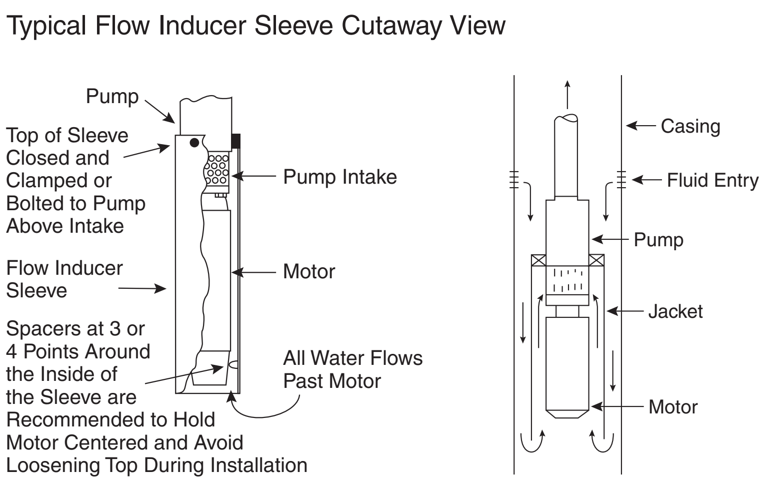
Typical Motor Jacket/Shroud Configurations.

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



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.

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. 3/09(US)

GRUNDFOS **INSTRUCTIONS**

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.

BE > THINK > INNOVATE >

GRUNDFOS

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

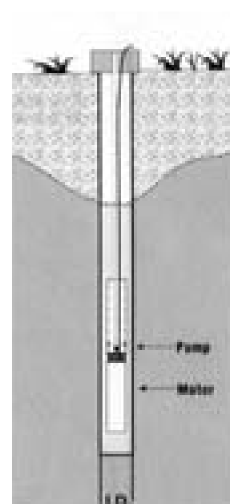
1. Well Preparation

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).

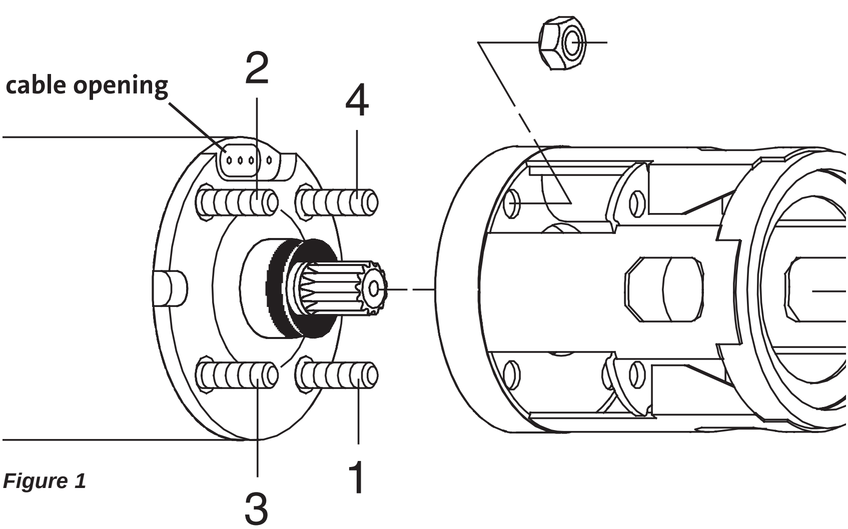


Figure 1

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.

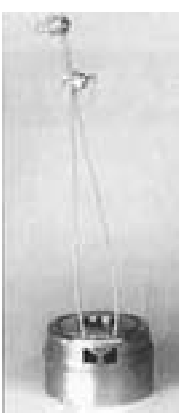


Figure 2

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

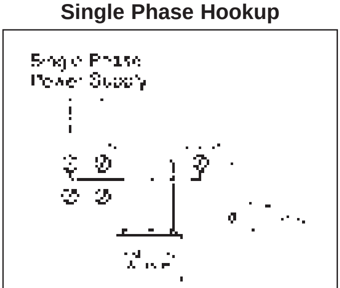


Figure 4a

Three Phase Hookup

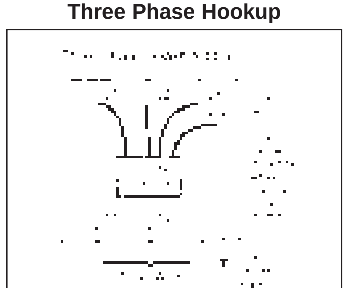
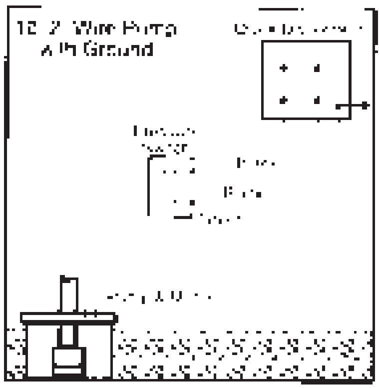


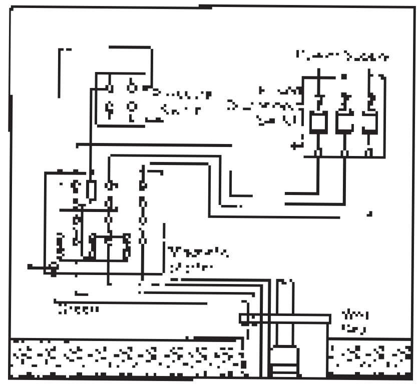
Figure 4b

INSTALLATION PROCEDURES

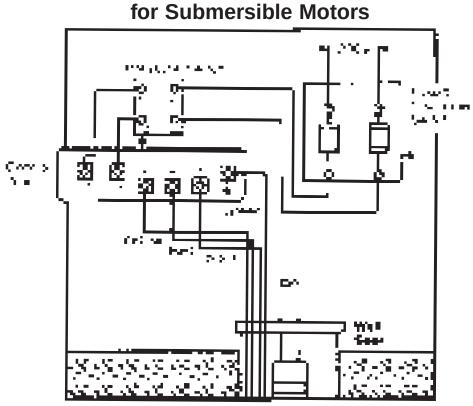
Single-Phase 2-Wire Wiring Diagram for Submersible Motors



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												
		230	1.30	7.3	40.3	75	72	900	3.9		K	79302005
1 1/2	3	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
		230	1.25	8.7	48	76	75	900	3.0		J	79302006
3	3	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
		230	1.15	12.2	56	77	75	900	2.2		H	79302006
3	3	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
		208/230	1.15	18.6/17.4	108	80	82	1500	1.2		H	79304509
5	3	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
		208/230	1.15	27.0/25.0	130	81	82	1500	0.84		H	79305511
7 1/2	3	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.

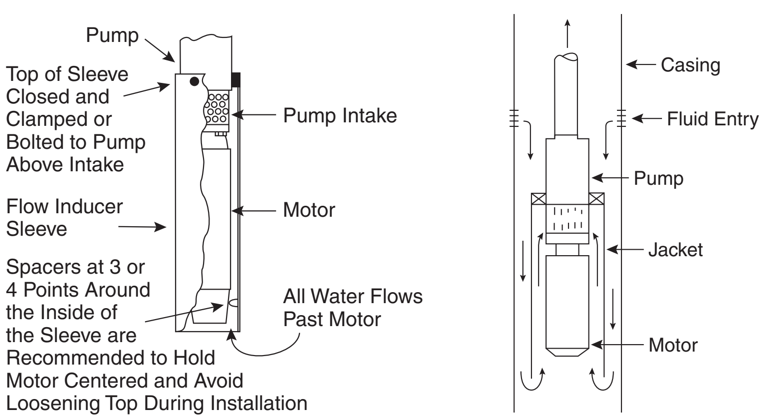
The motor shroud is generally of the next nominal diameter of standard pipe larger than the motor or the pump, depending on the shroud configuration used. The tubular/pipe material can be plastic or thin walled steel (corrosion resistant materials preferred). The cap/top must accommodate power cable 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.

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.

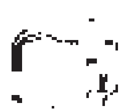
Zero-adjust the meter and measure the resistance between leads. Record the values. Motor resistance values can be found on page 6.

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. 3/09(US)

SIEMENS MOTOR CONTROL PANEL
MODEL 87DSD6FC

B3-EXW01

B3-EXW02

General

Features

- Fully Gasketed NEMA 3R Rainproof Enclosures
- 100,000 Amp Interrupting Capacity with Class R Fuses
- Heavy Duty NEMA Starters
- Solid State or Ambient Compensated Bimetal Overload Relays
- Heavy Duty Disconnect Handle
- Available in Reduced Voltage Versions
- Bold Pilot Legend on Front
- Generous Accessory Space
- Copper Grounding Lug For Three #6 Wires
- UL Listed for Outdoor Use and Service Equipment File #E14900

Application

Heavy duty pump control panels are designed to withstand the most demanding environments. Typical applications include irrigation, agriculture, petrochemical, wastewater treatment and wherever motor control is challenged by harsh elements.

Rugged pump control panels utilized cold forming "tox" process. They are more rainproof, sleet and ice resistant than in the past.

Installation is easy. Panels are factory wired to provide flexible control and protect against short circuits and overloads. Ample space is provided for field modifications and installation of accessories.

The pump control panels feature a full sized removable auxiliary panel for the mounting of accessories. The fusible version features fuse clips for full sized RK5 or compact class J fuses and accessory mounting space for the most commonly used accessories.

Class 87 pump panels become jockey pump panels with the addition of a pressure switch (see field modifications). The jockey pump's primary function is to maintain water pressure at a preset level and thus compensate for possible shortage of water in the pumping system. When the water pressure drops below the preset level, the pressure switch energizes the starter which in turn activates the jockey pump. The water pressure is then brought back up to the desired level. This insures the maintenance of proper water pressure at all times.

Features

Specified by Fortune 500 companies, ESP100 or thermal starters offer prolonged service under severe duty conditions. NEMA rated, these starters utilize large silver cadmium oxide contacts and wide copper heat sinks to ensure rapid heat dissipation and maximum electrical life.

ESP100 solid state overload relays provide phase loss protection for the motor by tripping within three seconds upon complete loss of one phase in a three phase circuit. Each overload has a 2:1 (4:1 in lower ranges) FLA adjustment range with an adjustment dial reading out in FLA. This feature allows for extreme fine tuning. Their heaterless construction minimizes energy costs and costs of cabinet ventilation or cooling. The class 87 pump panel comes with class 10 trip standard.

The ambient compensated bimetal overload relays are designed to parallel thermal characteristics of typical pump motors. They prevent nuisance trips that may result from operation of the control in a higher ambient temperature than that at the pump. These relays are trip-free, tamperproof and can be set to reset automatically or manually.

HOA and Start Pushbutton

Every pump panel comes with an HOA and a start pushbutton.

Half Size Starters

Siemens motor matched starters feature all the rugged performance characteristics of our NEMA rated starter sizes, but are fractionally sized to more closely match your exact motor rating. As a result, significant economic savings are made possible without sacrificing the reliability you expect from a heavy duty starter.

These additional starter sizes have the reserve capacity to handle occasional plugging and jogging without de-rating the device.

Siemens motor matched can save hundreds, even thousands of dollars per project.

Siemens motor matched starters comply with NEMA, UL and CSA standards.

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Panels are predrilled for easy repositioning of the fuse trailer block to accommodate 250 and 600 volt fuses and full sized RK or compact J fuses. Circuit breakers are also available.

New Heavy Duty Fusible Disconnect Switch

The disconnect switch has been made even better to give you greater advantages:

- Visible blades for the highest level of safety.
- Double Break Switching Action to reduce arcing, increase lifetime and eliminate the "electric hinge".
- Oversized lugs are standard.
- Line side shield to help guard personnel from contact with live parts.

Motor Circuit Protector

The motor circuit protector provides fast, accurate fault clearing that will minimize damage to the motor and control apparatus and protect branch circuit conductors. Continuous current ratings and adjustable trip ranges meet NEC requirements for full load and locked rotor currents. The adjustable instantaneous trip point can be set precisely to assure fault protection and eliminate nuisance tripping.

Removable Door

Enclosure door may be lifted off to make wiring easier.

Mounting Flanges

Convenient flanges at top and bottom of the enclosure provide easy mounting. They fit pole or flat surfaces using keyhole slots.

Quarter Turn Latches

Quarter turns are utilized to secure the door.

Wind Catches

A wind catch is provided to prevent the door from slamming shut (or open) due to high wind conditions.

Safety Disconnect Handle

Up to three padlocks can be used to lock the disconnect in the OFF position. Maintenance work can be performed without hazard to personnel.

External Reset

The overload relay may be quickly reset by means of a button on the front of the enclosure.

Bold Pilot Legend

Provides positive indication of the selector switch position for use to stop the pump motor.

Ground Lugs

Insures proper connecting of ground wires and lightning arresters.

UL Listed

Assures proper construction throughout control panel.

Reduced Voltage

Available in part winding, wye delta and auto transformer types, these controls may be necessary where the power company limits the amount of current drawn from its lines, or where starting torque must be reduced.

Fully gasketed NEMA 3/12 weather-proof enclosures are supplied with Class 88 reduced voltage starters.

Part Winding Starters apply starting current in timed steps to minimize voltage fluctuations.

Auto Transformer Starters maintain a closed circuit during transition and eliminate voltage or current surges. They draw less current than part winding starters and are well suited for starting motors over 20 Hp.

Wye Delta starters and motors are used in areas where the power supply is inadequate to supply full starting current without objectionable voltage drop or for applications where low starting torque is required. Centrifugal pumps and similar apparatus requiring a low starting torque are typical applications. Both ends of all three windings of the wye delta motor are brought out so that they may be accessible for reconnecting from wye to delta.

Auxiliary Equipment

Pilot Lights are easily installed on the enclosure. Oil Tight and Heavy Duty, they meet NEMA A600 requirements.

Lightning Arresters protect the control panel from lightning induced surges.

Undervoltage and Phase Sensing Relays protect the pump against low voltage, voltage imbalance, loss of phase and phase reversal.

Anti-Backspin Timers prevent the motor from starting during motor/shaft backspin.

The TOX Box

Siemens uses the TOX process to manufacture the enclosures for the pump panels.

Advantages of the TOX process:

- Joints are 50-70% stronger.
- Since the TOX process compresses the metal at the joint, it does not leave the high stresses in the metal.
- Increased corrosion resistance. The protective layer on the metal is not damaged in the process, but instead flows with the material.

Auto Transformer & Part winding [2 step] with Solid State Overload

Selection

Ordering Information	Coil and Control Voltage
► Technical Data see www.sea.siemens.com/controls. ► Field Modification Kits see page 8/79. ► Factory Modifications see page 8/93. ► Dimensions see page 8/110. ► Wiring Diagrams see page 8/137. ► Replacement Parts see pages 8/152.	The coil voltage on the contactors will be the motor voltage. A CPT will be supplied to provide the control voltage. The control voltage will be 120V. To change the control voltage to customer supplied (no CPT included), change the 9th character to the following: for 24V , use "J" for 120V, use "F"

Auto Transformer Type

					Fusible Disconnect			Circuit Breaker		
Motor Voltage	Max Hp	OL amp range	NEMA Size	Half Size	Fuse Clip Size	Catalog Number	List Price $	Circuit Breaker Amps	Catalog Number	List Price $
230	15	22-45	2	—	60A/250V	88FSHT2FG	6402.	50	88FSHT2MG	6487.
	20	30-60	—	2 1/2	100A/250V	88GSJT2FG	8659.	100	88GSJT2MG	8836.
	30	45-90	3	—	100A/250V	88HSKT2FG	9241.	100	88HSKT2MG	10123.
	40	57-115	—	3 1/2	200A/250V	88ISLT2FG	13128.	125	88ISLT2MG	14499.
	50	67-135	4	—	200A/250V	88JSMT2FG	13867.	150	88JSMT2MG	15239.
	75	100-210	5	—	—	—	—	250	88KSST2MG	23913.
	100	100-270	5	—	400A/250V	88KSUT2FG	24013.	400	88KSUT2MG	25670.
	200	200-540	6	—	—	—	—	600	88MSXT2MH	42954.
460	25	22-45	2	—	60A/600V	88FSHT4FH	6826.	50	88FSHT4MH	6937.
	30	22-45	—	2 1/2	60A/600V	88GSHT4FH	8983.	50	88GSHT4MH	9071.
	50	45-90	3	—	100A/600V	88HSKT4FH	9568.	100	88HSKT4MH	10042.
	75	57-115	—	3 1/2	200A/600V	88ISLT4FH	13574.	125	88ISLT4MH	14676.
	100	67-135	4	—	200A/600V	88JSMT4FH	15146.	150	88JSMT4MH	15601.
	150	100-210	5	—	—	—	—	250	88KSST4MH	24560.
	200	100-270	5	—	400A/600V	88KSUT4FH	26463.	400	88KSUT4MH	27750.
	400	200-540	6	—	600A/600V	88MSXT4FH	38713.	600	88MSXT4MH	42950.

Part Winding 2 Step

					Fusible Disconnect			Circuit Breaker		
Motor Voltage	Max Hp	OL amp range	NEMA Size	Half Size	Fuse Clip Size	Catalog Number	List Price $	Circuit Breaker Amps	Catalog Number	List Price $
230	20	20-40	—	1 3/4	100A/250V	88ESGP2FG	3829.	100	88ESGP2MG	3590.
	25	22-45	2	—	100A/250V	88FSHP2FG	4145.	100	88FSHP2MG	4014.
	40	30-60	—	2 1/2	200A/250V	88GSJP2FG	5855.	100	88GSJP2MG	5701.
	50	45-90	3	—	200A/250V	88HSKP2FG	6348.	150	88HSKP2MG	6194.
	60	57-115	—	3 1/2	200A/250V	88ISLP2FG	11248.	250	88ISLP2MG	12111.
	75	67-135	4	—	400A/250V	88JSMP2FG	11872.	250	88JSMP2MG	12727.
	125	100-210	5	—	—	—	—	400	88KSSP2MG	22426.
	150	100-270	5	—	600A/250V	88KSUP2FG	22958.	600	88KSUP2MG	23505.
460	30	13-27	—	1 3/4	100A/600V	88ESFP4FH	3829.	50	88ESFP4MH	3590.
	40	22-45	2	—	100A/600V	88FSHP4FH	4145.	100	88FSHP4MH	4014.
	60	30-60	—	2 1/2	200A/600V	88GSJP4FH	5855.	100	88GSJP4MH	5701.
	75	30-60	3	—	200A/600V	88HSJP4FH	6348.	125	88HSJP4MH	6194.
	100	57-115	—	3 1/2	200A/600V	88ISLP4FH	11248.	150	88ISLP4MH	12111.
	150	67-135	4	—	400A/600V	88JSMP4FH	11872.	250	88JSMP4MH	12727.
	250	100-210	5	—	—	—	—	400	88KSSP4MH	23505.
	350	100-270	5	—	600A/600V	88KSUP4FH	22958.	600	88KSUP4MH	42287.

Ordering Information	Coil and Control Voltage
► Technical Data see www.sea.siemens.com/controls. ► Field Modification Kits see page 8/79. ► Factory Modifications see page 8/93. ► Dimensions see page 8/110. ► Wiring Diagrams see page 8/137. ► Replacement Parts see pages 8/152.	The coil voltage on the contactors will be the motor voltage. A CPT will be supplied to provide the control voltage. The control voltage will be 120V. To change the control voltage to customer supplied (no CPT included), change the 9th character to the following: for 24V , use "J" for 120V, use "F"

Wye Delta

Motor Voltage	Max Hp	NEMA Size	Half Size	Fuse Clip Amps	MCP Amps	Open Transition – Fusible Disconnect – Catalog Number	List Price $	Open Transition – Circuit Breaker – Catalog Number	List Price $	Closed Transition – Fusible Disconnect – Catalog Number	List Price $	Closed Transition – Circuit Breaker – Catalog Number	List Price $
	10	1	—	60	50	88DSF06FD	4815.	88DSF06MD	5115.	88DSFC6FD	6209.	88DSFC6MD	6510.
	15	—	1 3⁄4	100	100	88ESG06FD	5408.	88ESG06MD	5385.	88ESGC6FD	6564.	88ESGC6MD	6818.
	20	2	—	100	100	88FSH06FD	6163.	88FSH06MD	5909.	88FSHC6FD	7303.	88FSHC6MD	7350.
	30	—	2 1⁄2	200	125	88GSJ06FD	7727.	88GSJ06MD	7820.	88GSJC6FD	9091.	88GSJC6MD	9491.
200V	40	3	—	200	150	88HSK06FD	8320.	88HSK06MD	8721.	88HSKC6FD	10077.	88HSKC6MD	10477.
	50	—	3 1⁄2	200	250	88ISL06FD	14622.	88ISL06MD	15616.	88ISLC6FD	16802.	88ISLC6MD	18181.
	60	4	—	400	250	88ISL06FD	15161.	88JSM06MD	16540.	88ISLC6FD	18097.	88JSMC6MD	19476.
	75	5	—	400	400	88KSS06FD	22808.	88KSS06MD	26667.	88KSSC6FD	30458.	88KSSC6MD	30381.
	150	5	—	600	600	88KSU06FD	27573.	88KSU06MD	27080.	88KSUC6FD	31425.	88KSUC6MD	30932.
	300	6	—	—	800	—	—	88MSX06MD	50276.	—	—	88MSXC6MD	59706.
	10	1	—	60	50	88DSF02FG	4815.	88DSF02MG	5115.	88DSFC2FG	6209.	88DSFC2MG	6510.
	15	—	1 3⁄4	60	50	88ESG02FG	5323.	88ESG02MG	5385.	88ESGC2FG	6479.	88ESGC2MG	6818.
	25	2	—	100	100	88FSH02FG	6163.	88FSH02MG	5909.	88FSHC2FG	7303.	88FSHC2MG	7350.
	30	—	2 1⁄2	200	100	88GSJ02FG	7727.	88GSJ02MG	7820.	88GSJC2FG	9091.	88GSJC2MG	9491.
230V	50	3	—	200	150	88HSK02FG	8320.	88HSK02MG	8721.	88HSKC2FG	10077.	88HSKC2MG	10477.
	60	—	3 1⁄2	200	250	88ISL02FG	14622.	88ISL02MG	15616.	88ISLC2FG	16802.	88ISLC2MG	18181.
	75	4	—	400	250	88JSM02FG	15161.	88JSM02MG	16540.	88JSMC2FG	18097.	88JSMC2MG	19476.
	100	5	—	400	400	88KSS02FG	22808.	88KSS02MG	26667	88KSSC2FG	30458.	88KSSC2MG	30381.
	150	5	—	600	600	88KSU02FG	27573.	88KSU02MG	27080.	88KSUC2FG	31425.	88KSUC2MG	30932.
	350	6	—	—	1200	—	—	88MSX02MG	50276.	—	—	88MSXC2MG	59706.
	15	1	—	60	30	88DSE04FH	4815.	88DSE04MH	5115.	88DSEC4FH	6209.	88DSEC4MH	6510.
	30	—	1 3⁄4	60	50	88ESF04FH	5339.	88ESF04MH	5385.	88ESFC4FH	6494.	88ESFC4MH	6818.
	40	2	—	100	100	88FSH04FH	5855.	88FSH04MH	5909.	88FSHC4FH	7465.	88FSHC4MH	7519.
	60	—	2 1⁄2	200	100	88GSJ04FH	7419.	88GSJ04MH	7820.	88GSJC4FH	9260.	88GSJC4MH	9661.
460V	75	3	—	200	125	88GSJ04FH	8320.	88HSK04MH	8721.	88GSJC4FH	10901.	88HSKC4MH	11302.
	100	—	3 1⁄2	200	150	88ISL04FH	12727.	88ISL04MH	15616.	88ISLC4FH	17373.	88ISLC4MH	19044.
	150	4	—	400	250	88JSM04FH	15161.	88JSM04MH	16540.	88JSMC4FH	18775.	88JSMC4MH	20154.
	200	5	—	400	400	88KSS04FH	22808.	88KSS04MH	26667.	88KSSC4FH	31151.	88KSSC4MH	31074.
	300	5	—	600	600	88KSU04FH	27573.	88KSU04MH	27080.	88KSUC4FH	33096.	88KSUC4MH	32603.
	700	6	—	—	1200	—	—	88MSX04MH	50276.	—	—	88MSXC4MH	59706.
	15	1	—	60	30	88DSE05FE	4815.	88DSE05ME	5115.	88DSEC5FE	6209.	88DSEC5ME	6510.
	30	—	1 3⁄4	60	50	88ESF05FE	5339.	88ESF05ME	5385.	88ESFC5FE	6494.	88ESFC5ME	6818.
	40	2	—	60	50	88FSF05FE	5855.	88FSF05ME	5909	88FSFC5FE	7465.	88FSFC5ME	7519.
	60	—	2 1⁄2	100	100	88GSH05FE	7419.	88GSH05ME	7820.	88GSHC5FE	9260.	88GSHC5ME	9661.
575V	75	3	—	200	125	88HSJ05FE	8320.	88HSJ05ME	8721.	88HSJC5FE	10901.	88HSJC5ME	11302.
	100	—	3 1⁄2	200	150	88ISK05FE	12727.	88ISK05ME	15616.	88ISKC5FE	17373.	88ISKC5ME	19044.
	150	4	—	400	250	88ISK05FE	15161.	88JSM05ME	16540	88ISKC5FE	18775.	88JSMC5ME	20154.
	200	5	—	400	400	88KSS05FE	22808.	88KSS05ME	26667.	88KSSC5FE	31151.	88KSSC5ME	31074.
	300	5	—	600	400	88KSU05FE	27573.	88KSU05ME	27080.	88KSUC5FE	33096.	88KSUC5ME	32603.
	700	6	—	—	1200	—	—	88MSX05ME	50276.	—	—	88MSXC5ME	59706.

Pump Control Panels

Standard Pump Panel with Solid State Overload

Selection

Ordering Information	Coil Table	
► Technical Data see www.sea.siemens.com/controls. ► Field Modification Kits see page 8/79. ► Factory Modifications see page 8/93. ► Dimensions see page 8/110. ► Wiring Diagrams see page 8/137. ► Replacement Parts see pages 8/152. ► Sizes 1-4 will be supplied standard with a 240/480 volt coil. To change the coil voltage, change the 8th character in the catalog number to the letter shown in the coil table. ► Sizes 5&6 will be supplied standard with a 480 volt coil. To change the coil voltage, change the 8th character in the catalog number to the letter shown in the coil table.	60Hz Voltage	Letter
	24 Separate Control	J
	120 Separate Control	F
	110–120/220–240	A[1]
	200–208	D
	220–240	G
	220–240/440–480	C[1]
	277	L
	440–480	H
	550–600	E

Fusible Disconnect

200V	230V	460V	575V	NEMA Size	Half Size	Overload Amp Range	Fuse Clip Amps	Catalog Number	List Price $
—	—	1	1	1	—	0.75-3[1]	30	**87DSB6FC**	**1017.**
—	—	5	5	1	—	2.5-10	30	**87DSD6FC**	**1017.**
—	—	7 1/2	10	1	—	9-18	30	**87DSE6FC**	**1017.**
—	—	7 1/2	10	1	—	9-18	60	**87DSE60C**	**1032.**
—	—	15	15	—	1 3/4	13-27	30	**87ESF6FC**	**1194.**
—	—	15	15	—	1 3/4	13-27	60	**87ESF60C**	**1210.**
—	—	15	20	2	—	13-27	60	**87FSF6FC**	**1371.**
—	—	25	25	2	—	22-45	60	**87FSH6FC**	**1371.**
—	—	25	25	2	—	22-45	100	**87FSH60C**	**1456.**
—	—	30	30	—	2 1/2	22-45	60	**87GSH6FC**	**1957.**
—	—	30	30	—	2 1/2	22-45	100	**87GSH60C**	**2042.**
—	—	50	50	3	—	45-90	100	**87HSK6FC**	**2211.**
—	—	50	50	3	—	45-90	200	**87HSK60C**	**2373.**
—	—	75	75	—	3 1/2	57-115	200	**87ISL6FC**	**3760.**
—	—	100	100	4	—	67-135	200	**87JSM6FC**	**4068.**
—	—	200	200	5	—	100-270	400	**87KSU6FH**	**8844.**
—	—	250	—	6	—	200-540	600	**87MSW6FH**	**22330.**
2	2	—	—	1	—	2.5-10	30	**87DSD6LC**	**1002.**
3	3	—	—	1	—	9-18	30	**87DSE6LC**	**1002.**
7 1/2	7 1/2	—	—	1	—	13-27	30	**87DSF6LC**	**1002.**
7 1/2	7 1/2	—	—	1	—	13-27	60	**87DSF6PC**	**1017.**
10	10	—	—	—	1 3/4	20-40	60	**87ESG6LC**	**1194.**
10	15	—	—	2	—	22-45	60	**87FSH6LC**	**1348.**
10	15	—	—	2	—	22-45	100	**87FSH6PC**	**1441.**
15	20	—	—	—	2 1/2	30-60	60	**87GSJ6LC**	**1903.**
15	20	—	—	—	2 1/2	30-60	100	**87GSJ6PC**	**1995.**
25	30	—	—	3	—	45-90	100	**87HSK6LC**	**2165.**
25	30	—	—	3	—	45-90	200	**87HSK6PC**	**2342.**
30	40	—	—	—	3 1/2	57-115	200	**87ISL6LC**	**3729.**
40	50	—	—	4	—	67-135	200	**87JSM6LC**	**4037.**
75	100	—	—	5	—	100-270	400	**87KSU6LH**	**8659.**

Circuit Breaker

200V	230V	460V	575V	NEMA Size	Half Size	Overload Amp Range	Motor Circuit Interrupter ETI Amps	Catalog Number	List Price $
1/2	1/2	1	1	1	—	0.75-3[1]	3	**87DSB6MC**	**1279.**
1	1	3	3	1	—	2.5-10	10	**87DSC6MC**	**1279.**
2	2	5	5	1	—	2.5-10	10	**87DSD6MC**	**1279.**
3	3	7 1/2	10	1	—	9-18	25	**87DSE6MC**	**1279.**
7 1/2	7 1/2	10	—	1	—	13-27	30	**87DSF6MC**	**1279.**
—	—	15	15	—	1 3/4	13-27	30	**87ESF6MC**	**1433.**
10	10	—	—	—	1 3/4	20-40	50	**87ESG6MC**	**1433.**
—	—	15	20	2	—	13-27	30	**87FSF6MC**	**1587.**
10	15	25	25	2	—	22-45	50	**87FSH6MC**	**1587.**
—	—	30	30	—	2 1/2	22-45	50	**87GSH6MC**	**2072.**
15	20	—	—	—	2 1/2	30-60	100	**87GSJ6MC**	**2072.**
25	30	50	50	3	—	45-90	100	**87HSK6MC**	**2242.**
30	40	75	75	—	3 1/2	57-115	125	**87ISL6MC**	**4438.**
40	50	100	100	4	—	67-135	150	**87JSM6MC**	**4746.**
50	75	150	200	5	—	100-270	250	**87KST6MH**	**10793.**
75	100	200	200	5	—	100-270	400	**87KSU6MH**	**10793.**
100	125	250	300	6	—	200-540	400	**87MSW6MH**	**23401.**
150	200	400	400	6	—	200-540	600	**87MSX6MH**	**26902.**

① Not available on Size 5 and larger.

② For an overload amp range of 0.25-1A, change the 5th character from a 'B' to an 'A'.

Discount Code: NEMA Control

Ordering Information

- Order 3 heater elements by code number at 11.60 each see page 8/145.
- Technical Data see www.sea.siemens.com/controls
- Field Modification Kits see page 8/79.
- Factory Modifications see page 8/93.
- Dimensions see page 8/110.
- Wiring Diagrams see page 8/137.
- Replacement Parts see pages 8/152.
- Sizes 1-4 will be supplied standard with a 230/480 volt coil. To change the coil voltage, change the 8th character in the catalog number to the letter shown in the coil table.
- Sizes 5&6 will be supplied standard with a 480 volt coil. To change the coil voltage, change the 8th character in the catalog number to the letter shown in the coil table.

Coil Table

60Hz Voltage	Letter
24 Separate Control	J
120 Separate Control	F
110–120/220–240	A①
200–208	D
220–240	G
220–240/440–480	C①
277	L
440–480	H
550–600	E

Fusible Disconnect

200V	230V	460V	575V	NEMA Size	Half Size	Fuse Clip Amps	Catalog Number	List Price $
—	—	10	10	1	—	30	**87DAE6FC**	**982.**
—	—	10	10	1	—	60	**87DAE60C**	**998.**
—	—	15	15	—	1 3/4	30	**87EAF6FC**	**1159.**
—	—	15	15	—	1 3/4	60	**87EAF60C**	**1175.**
—	—	25	25	2	—	60	**87FAJ6FC**	**1337.**
—	—	25	25	2	—	100	**87FAJ60C**	**1421.**
—	—	30	30	—	2 1/2	60	**87GAK6FC**	**1922.**
—	—	30	30	—	2 1/2	100	**87GAK60C**	**2007.**
—	—	50	50	3	—	100	**87HAN6FC**	**2176.**
—	—	50	50	3	—	200	**87HAN60C**	**2338.**
—	—	75	75	—	3 1/2	200	**87IAP6FC**	**3725.**
—	—	100	100	4	—	200	**87JAR6FC**	**4033.**
7 1/2	7 1/2	—	—	1	—	30	**87DAE6LC**	**967.**
7 1/2	7 1/2	—	—	1	—	60	**87DAE6PC**	**982.**
10	10	—	—	—	1 3/4	60	**87EAG6LC**	**1159.**
10	15	—	—	2	—	60	**87FAJ6LC**	**1314.**
10	15	—	—	2	—	100	**87FAJ6PC**	**1406.**
15	20	—	—	—	2 1/2	100	**87GAL6LC**	**1961.**
25	30	—	—	3	—	100	**87HAN6LC**	**2130.**
25	30	—	—	3	—	200	**87HAN6PC**	**2307.**
30	40	—	—	—	3 1/2	200	**87IAP6LC**	**3694.**
40	50	—	—	4	—	200	**87JAR6LC**	**4002.**

Circuit Breaker

200V	230V	460V	575V	NEMA Size	Half Size	Motor Circuit Interrupter ETI	Catalog Number	List Price $
1/2	1/2	1	1	1	—	3	**87DAA6MC**	**1244.**
1	1	3	3	1	—	10	**87DAB6MC**	**1244.**
3	3	7 1/2	7 1/2	1	—	25	**87DAD6MC**	**1244.**
7 1/2	7 1/2	10	10	1	—	30	**87DAE6MC**	**1244.**
7 1/2	7 1/2	15	15	—	1 3/4	30	**87EAF6MC**	**1398.**
10	10	—	—	—	1 3/4	50	**87EAG6MC**	**1538.**
—	—	15	20	2	—	40	**87FAH6MC**	**1552.**
10	15	25	25	2	—	50	**87FAJ6MC**	**1552.**
—	—	30	30	—	2 1/2	50	**87GAK6MC**	**2038.**
15	20	—	—	—	2 1/2	100	**87GAL6MC**	**2038.**
25	30	50	50	3	—	100	**87HAN6MC**	**2207.**
30	40	75	75	—	3 1/2	125	**87IAP6MC**	**4403.**
40	50	100	100	4	—	150	**87JAR6MC**	**4711.**

① Not available on Size 5 or larger.

Selection

Ordering Information	Coil Table	
► Technical Data see www.sea.siemens.com/controls. ► Field Modification Kits see page 8/79. ► Factory Modifications see page 8/93. ► Dimensions see page 8/110. ► Wiring Diagrams see page 8/137. ► Replacement Parts see pages 8/152. ► Sizes 1-4 will be supplied standard with a 240/480 volt coil. To change the coil voltage, change the 8th character in the catalog number to the letter shown in the coil table. ► Sizes 5&6 will be supplied standard with a 480 volt coil. To change the coil voltage, change the 8th character in the catalog number to the letter shown in the coil table.	60Hz Voltage	***
	024 Separate Control	024
	120	120
	208	208
	277	277
	480	480
	600	600

Fusible Disconnect

Max Hp						
460 Volts	575 Volts	NEMA Size	Overload Range	Fuse Clip Amps	Catalog Number	List Price $
100	100	4	55-250A	200A/600V	**87JCM4F**	**7059.**
200	200	5	55-250A	400A/600V	**87KCU4F***	**11363.**

Circuit Breaker

Max Hp						
460 Volts	575 Volts	NEMA Size	Overload Range	Circuit Breaker Rating	Catalog Number	List Price $
100	100	4	55-250A	250A	**87JCM4M***	**7810.**
200	200	5	55-250A	250A	**87KCT4M***	**13416.**
250	300	6	200-540A	400A	**87MCW4M***	**29928.**
400	400	6	200-540A	600A	**87MCX4M***	**29928.**

Pump Control Panels

Solid-State Overload Class 87

Ordering Instructions

- Use complete catalog number. Replace the (*) with letter from the coil table. Dual voltage coils are wired on high voltage unless specified on order.
- Contact Sales Office for 3 or 4 speed starters.
- For self-reset overload option on Sizes 0–5, change 4th character from "S" or "T" to "R". No price addition.

Coil Table①

60Hz Voltage	Letter
24 Separate Control	J
120 Separate Control	F
110–120/220–240	A
200–208	D
220–240	G
220–240/440–480	C
277	L
440–480	H
550–600	E

For other voltages and frequencies see page 124.

Additional References

- Field Modification Kits see page 454.
- Factory Modifications see page 455.
- Dimensions see page 456.
- Wiring Diagrams see page 458.

200/230V and 460/575V Max Hp 3 Phase

Max Hp								Fusible Disconnect		MCP	
								NEMA 3R		NEMA 3R	
200 Volts	230 Volts	460 Volts	575 Volts	NEMA Size	Half Size	Overload Amp Range	Fuse Clip Amps	Catalog No	Price $	Catalog No	Price $
½	½	—	—	1	—	0.75–3②	—	—	—	87DSB6M*	996.
—	—	1	1	1	—	0.75–3②	—	87DSB6F*	792.	87DSB6M*	996.
—	—	3	3	1	—	2.5–10	—	—	—	87DSC6M*	996.
1	1	—	—	1	—	2.5–10	30	87DSC6L*	780.	87DSC6M*	996.
2	2	—	—	1	—	2.5–10	30	87DSD6L*	780.	87DSD6M*	996.
—	—	5	5	1	—	2.5–10	30	87DSD6F*	792.	87DSD6M*	996.
3	3	—	—	1	—	9–18	30	87DSE6L*	780.	87DSE6M*	996.
—	—	7½	10	1	—	9–18	30	87DSE6F*	792.	87DSE6M*	996.
7½	7½	—	—	1	—	13–27	30	87DSF6L*	780.	87DSF6M*	996.
7½	7½	—	—	1	—	13–27	60	87DSF6P*	792.	—	—
—	—	7½	10	1	—	9–18	60	87DSE60*	804.	—	—
—	—	10	—	1	—	13–27	—	—	—	87DFS6M*	996.
—	—	15	15	—	1¾	13–27	30	87ESF6F*	930.	87ESF6M*	1116.
—	—	15	15	—	1¾	13–27	60	87ESF60*	942.	—	—
10	10	—	—	—	1¾	20–40	60	87ESG6L*	930.	87ESG6M*	1116.
—	—	15	20	2	—	13–27	60	87FSF6F*	1068.	87FSF6M*	1236.
10	15	—	—	2	—	22–45	60	87FSH6L*	1050.	87FSH6M*	1236.
—	—	25	25	2	—	22–45	60	87FSH6F*	1068.	87FSH6M*	1236.
10	15	—	—	2	—	22–45	100	87FSH6P*	1122.	—	—
—	—	25	25	2	—	22–45	100	87FSH60*	1134.	—	—
—	—	30	30	—	2½	22–45	60	87GSH6F*	1524.	87GSH6M*	1614.
15	20	—	—	—	2½	30–60	60	87GSJ6L*	1482.	87GSJ6M*	1614.
—	—	30	30	—	2½	22–45	100	87GSH60*	1590.	—	—
15	20	—	—	—	2½	30–60	100	87GSJ6P*	1554.	—	—
25	30	—	—	3	—	45–90	100	87HSK6L*	1686.	87HSK6M*	1746.
—	—	50	50	3	—	45–90	100	87HSK6F*	1722.	87HSK6M*	1746.
25	30	—	—	3	—	45–90	200	87HSK6P*	1824.	—	—
—	—	50	50	3	—	45–90	200	87HSK60*	1848.	—	—
30	40	—	—	—	3½	57–115	200	87ISL6L*	2904.	87ISL6M*	3456.
—	—	75	75	—	3½	57–115	200	87ISL6F*	2928.	87ISL6M*	3456.
—	—	75	75	—	3½	57–115	400	87ISL60*	3054.	—	—
40	50	—	—	4	—	67–135	200	87JSM6L*	3144.	87JSM6M*	3696.
—	—	100	100	4	—	67–135	200	87JSM6F*	3168.	87JSM6M*	3696.
40	50	—	—	Compact 4	—	67–135	200	87JSM6L*E6	3144.	87JSM6M*E6	3696.
—	—	100	100	Compact 4	—	67–135	200	87JSM6F*E6	3168.	87JSM6M*E6	3696.
50	75	—	—	—	4½	100–210	400	87RSS6L*	6324.	87RSS6M*	7986.
—	—	150	150	—	4½	100–210	400	87RSS6F*	6468.	87RSS6M*	7986.
75	100	—	—	5	—	100–270	400	87KSU6L*	6744.	87KSU6M*	8406.
—	—	150	200	5	—	100–270	—	—	—	87KST6M*	8406.
—	—	200	—	5	—	100–270	400	87KSU6F*	6888.	87KSU6M*	8406.
100	125	—	—	6	—	200–540	—	—	—	87MSW6M*	18225.
150	200	—	—	6	—	200–540	—	—	—	87MSX6M*	20952.
—	—	250	300③	6	—	200–540	600	87MSW6F*	17391.	87MSW6M*	18225.
—	—	400	400	6	—	200–540	—	—	—	87MSX6M*	20952.

①Pump panels are stocked with a "C" coil 220–240/440–480V 60Hz

②For overload amp ranges below 0.75 amps, change the 5th character in the Cat No to "A" for 0.25–1A range.

③300 Hp 575V rating applies to MCP only.

Ordering Instructions

- Catalog Number Suffixes indicate numbers or letters added to the end of a catalog number. Example: 14DP32BA becomes 14DP32BA**A1**.
- Multiple Modification Suffixes are added in numerical, alphabetical sequence.

Coil Options

Description			Catalog No Change	Class	Enclosure Type	Controller Size—Price Addition $							
						0–1¾	2, 2½	3, 3½	4	4½, 5	6	7	8
AC Coil①													
			8th char 9th char ESP100™	14, 17, 22, 25, 36, 37, 40, 43						Dual voltage coils not available.			
			9th char 9th char ESP100™	18, 26									
			10th char 12th char ESP100™	30									
			11th char 12th char ESP100™ 13th char ESP100™	32 32 Breaker 32 Disconnect									
Volts 60HZ	Volts 50HZ	Label Color	Coil Letter										
24 Separate Control	24	Black	J										
120 Separate Control	110	Black	F										
110–120/220–240	110/190–220	Blue	A										
200–208	—	Orange	D										
220–240	190–220	Blue	G	All	All	NC	NC	NC	NC	NC	NC	NC	NC
277	240	Orange	L										
220–240/440–480	190–220/380–440	Red	C										
440–480	380–440	Red	H										
550–600	550	Orange	E										
DC Coil		12V 24V 32V 48V 125V 250V	R S T U V W	All	All	102.	102.	198.	264.	330.	—	—	—
DC Coil and AC-DC Rectifier		120V AC 240V AC	VY WY	All Innova	All	228. 294.	228. 294.	240. 306.	240. 390.	456. 522.	— —	— —	— —

Control Options

Description			Catalog No Suffix	Class	Enclosure Type	Controller Size—Price Addition $							
						0–1¾	2, 2½	3, 3½	4	4½, 5	6	7	8
Surge Suppression for 120V AC Coil			SS		All	54.	54.	54.	—	66.	66.	66.	66.
Disconnect Switch Interlock	2 NO/2 NC	DPDT	GY	17, 25, 32, 36, 37, 87	1, 3, 4, 12	88.	88.	88.	88.	174.	174.	174.	174.
Motor Circuit Protector Interlock	NO/NC	SPDT	GY	18, 26, 32, 36, 37, 87	1, 3, 4, 12	174.	174.	174.	174.	174.	174.	174.	174.
Circuit Breaker Shunt Trip			L6	All	All	495.	495.	495.	495.	495.	495.	495.	495.
Circuit Breaker Undervoltage Trip			L7	All	All	495.	495.	495.	495.	495.	495.	495.	495.
Circuit Breaker Alarm Switch Trip			L8	All	All	495.	495.	495.	495.	495.	495.	495.	495.
1 Phase Combination Starter			X359U	17, 18	All	NC	NC	NC	—	—	—	—	—
Isolated Alarm Contact on Melting Alloy Overload			L9	All	All	75.	75.	75.	75.	75.	75.	75.	75.
Ground Lug – 1 Conductor			L10	All	All	12.	12.	12.	12.	12.	12.	12.	12.
Blown Fuse Indicator Lights			L11	All	All	300.	300.	300.	300.	300.	300.	300.	300.
Control Circuit Fuse and Holder (Transformer Primary Fusing)	1 Fuse		F1	All	1, 3, 4, 12	132.	132.	132.	132.	132.	—	—	—
	2 Fuses		F2			132.	132.	132.	132.	132.	—	—	—
Control Circuit Fused Disconnect Internally Operated			F3	All	1, 3, 4, 12	324.	324.	324.	324.	324.	324.	324.	324.
Control Circuit Circuit Breaker Internally Operated			F4	All	1, 3, 4, 12	522.	522.	522.	522.	522.	522.	522	522
Convenience Receptacle Mounted on Side of Enclosure			RE	All	1, 12	120.	120.	120.	120.	120.	120	120.	120.
Drip Hood			DP	All	1	108.	132.	396.	396.	528.	720.	720.	720.
Space Heater			SH		1, 3, 4, 12	420.	420.	420.	420.	420.	420.	420.	420.
Space Heater with Thermostat			ST		1, 3, 4, 12	450.	450.	450.	450.	450.	450.	450.	450.

Description	Catalog No Suffix	Product Class	Controller Size—Price Addition $								
			0	1	1¾	2	2½	3	3½	4	5
Reversing in one speed only 2 speed 1 winding	X439U	30, 32	720.	774.	877.	1032.	1275.	1500.	1721.	2025.	
Reversing in one speed only 2 speed 2 winding	X440U		696.	748.	894.	1052.	1316.	1548.	1776.	2090.	
Reversing in both speeds 2 speed 1 winding	X441U		972.	1056.	1418.	1668.	2111.	2484.	3274.	3852.	
Reversing in both speeds 2 speed 2 winding	X442U		1080.	1164.	1654.	1946.	2377.	2796.	3244.	3816.	

①Voltages and frequencies not listed, contact sales office.

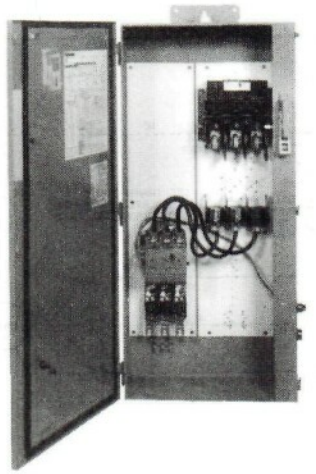
Pump Control Panels

Class 87, 88

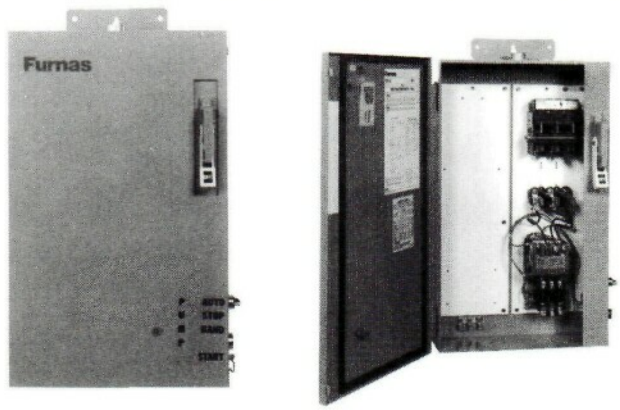
Features

- NEMA 3R Rainproof Enclosures
- 100,000 Amp Interrupting Capacity with Class R Fuses
- Heavy Duty NEMA Starters
- Solid State or Ambient Compensated Bimetal Overload Relays
- Heavy Duty Disconnect Handle
- Available in Reduced Voltage Versions
- Bold Pilot Legend on Front
- Generous Accessory Space
- Welded Corners and Pole Brackets
- Copper Grounding Bar For Three #6 Wires
- UL Listed for Outdoor Use and Service Equipment File #E14900
- CSA Certified File #LR6535

Class 87 Compact Size 4 Fusible Pump Panel



Class 87 Size 1 Fusible Pump Panel



Application

Heavy duty pump control panels are designed to withstand the most demanding environments. Typical applications include irrigation, agriculture, petrochemical, wastewater treatment and wherever motor control is challenged by harsh elements.

Rugged pump control panels are seam welded. Rainproof, sleet and ice resistant, there are no lapped surfaces to invite rust.

Installation is easy. Panels are factory wired to provide flexible control and protect against short circuits and overloads. Ample space is provided for field modifications and installation of accessories.

The exclusive **Compact NEMA Size 4** pump panels feature full sized NEMA starters in easy to "polemount" compact enclosures. The motor circuit protector panel features a full sized removable auxiliary panel for the mounting of accessories. The fusible version features fuse clips for full sized RK5 or compact class J fuses and accessory mounting space for the most commonly used accessories. A full sized Size 4 pump panel is also available for those applications that require an extra large auxiliary panel. See pages 456–457 for panel dimensions.

Class 87 pump panels become **jockey pump panels** with the addition of a pressure switch (see factory assembled modifications). The jockey pump's primary function is to maintain water pressure at a preset level and thus compensate for possible leakage of water in the pumping system.

When the water pressure drops below the preset level, the pressure switch energizes the starter which in turn activates the jockey pump. The water pressure is then brought back up to the desired level. This insures the maintenance of proper water pressure at all times.

Features

Specified by Fortune 500 companies, ESP100 or Innova Plus starters offer prolonged service under severe duty conditions. Made in the USA and NEMA rated, these starters utilize large silver cadmium oxide contacts and wide copper heat sinks to ensure rapid heat dissipation and maximum electrical life.

ESP100 solid state overload relays provide phase loss protection for the motor by tripping within three seconds upon complete loss of one phase in a three phase circuit. Each overload has a 2:1 (4:1 in lower ranges) FLA adjustment range with an adjustment dial reading out in FLA. This feature allows for extremely fine tuning. Their heaterless construction minimizes energy costs and costs of cabinet ventilation or cooling. (For more information see Section 8.

The **ambient compensated bimetal overload relays** are designed to parallel thermal characteristics of typical pump motors. They prevent nuisance trips that may result from operation of the control in a higher ambient temperature than that at the pump. These relays are trip free, tamperproof and can be set to reset automatically or manually.

Panels are predrilled for easy repositioning of the fuse trailer block to accommodate 250 and 600 volt fuses and full sized RK or compact J fuses. Fuse clips are replaceable. Thermal magnetic circuit breakers and motor circuit protectors are also available.

Heavy Duty Fusible Disconnect Switch

These versions offer visible blades that provide positive indication of switch status. Contacts operate with a snap action for a quick make and quick break. A shield guards personnel from contact with live parts.

Motor Circuit Protector

The motor circuit protector provides fast, accurate fault clearing that will minimize damage to the motor and control apparatus and protect branch circuit conductors. Continuous current ratings and adjustable trip ranges meet NEC requirements for full load and locked rotor currents. The adjustable instantaneous trip point can be set precisely to assure fault protection and eliminate nuisance tripping.

Large NEMA 3R Rainproof Enclosure

The control, disconnecting means and accessories are all assembled in a rainproof and sleet resistant enclosure. This enclosure is constructed of heavy gauge sheet metal and equipped with a threaded conduit hub and a full door gasket. A removable backplate allows for easy field installation of modifications.

Removable Door

Enclosure door may be lifted off to make wiring easier.

Mounting Flanges

Convenient flanges at top and bottom of the enclosure provide easy mounting. They fit pole or flat surfaces using keyhole slots.

Door Hasp

Sizes 1 thru 3½ have 2 over-center latches to secure door. Sizes 4–6 have spring catch and use quarter turn screws.

Safety Disconnect Handle

Up to three padlocks can be used to lock the safety handle in the OFF position. Maintenance work can be performed without hazard to personnel.

External Reset

The overload relay may be quickly reset by means of a button on the front of the enclosure.

Bold Pilot Legend

Provides positive indication of the selector switch position for use to stop the pump motor.

Welded Seams

Helps prevent rust.

Ground Bar

Insures proper connecting of ground wires and lightning arresters.

UL Listed

Assures proper construction throughout control panel.

Reduced Voltage

Available in part winding, Wye Delta and auto transformer types, these controls may be necessary where the power company limits the amount of current drawn from its lines, or where starting torque must be reduced.

Fully gasketed NEMA 3/12 weatherproof enclosures are supplied with Class 88 reduced voltage starters.

Part Winding Starters apply starting current in timed steps to minimize voltage fluctuations.

Auto Transformer Starters maintain a closed circuit during transition and eliminate voltage or current surges. They draw less current than part winding starters and are well suited for starting motors over 20 Hp.

Wye Delta starters and motors are used in areas where the power supply is inadequate to supply full starting current without objectionable voltage drop or for applications where low starting torque is required. Centrifugal pumps and similar apparatus requiring a low starting torque are typical applications. Both ends of all three windings of the Wye Delta motor are brought out so that they may be accessible for reconnecting from Wye to Delta.

Auxiliary Equipment

Pilot Lights easily installed on the enclosure, Oil Tight and Heavy Duty, they meet NEMA A600 requirements.

Lightning Arresters protect the control panel from lightning induced surges.

Undervoltage and Phase Sensing Relays protect the pump against low voltage, voltage imbalance, loss of phase and phase reversal.

Anti-Backspin Timers prevent the motor from starting during motor/shaft backspin.

Pressure Switches easy installation, inspection and adjustment characterize the 69ES Pro Control pressure switch. See the Pressure Switch Catalog Supplement for more information.

GARD-IT, for low water condition protection, see Pressure Switch Catalog supplement.

HI-GARD, used in conjunction with a standard pressure switch to protect against undesirable pressure rises in your system, see Pressure Switch Catalog supplement.

Panels are predrilled for easy repositioning of the fuse trailer block to accommodate 250 and 600 volt fuses and full sized RK or compact J fuses. Fuse clips are replaceable. Thermal magnetic circuit breakers and motor circuit protectors are also available.

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Outline

Figure 1

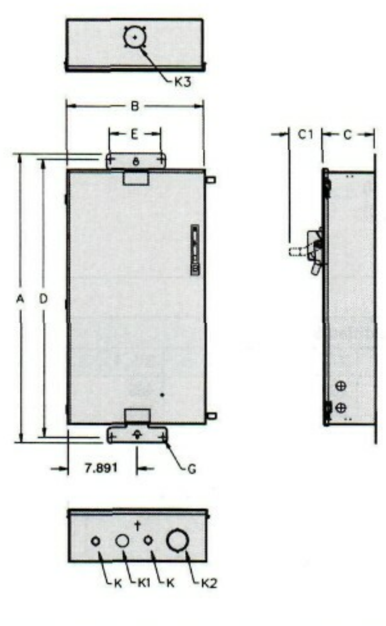


Figure 2

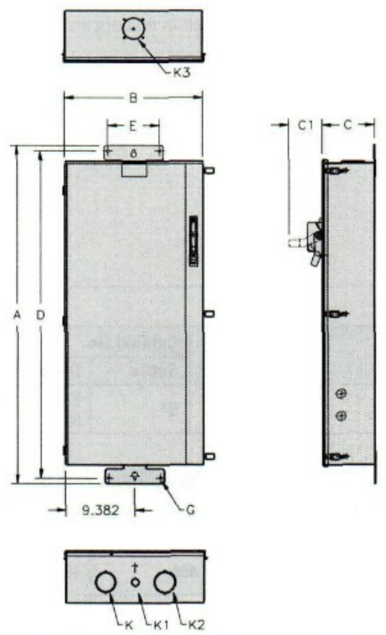
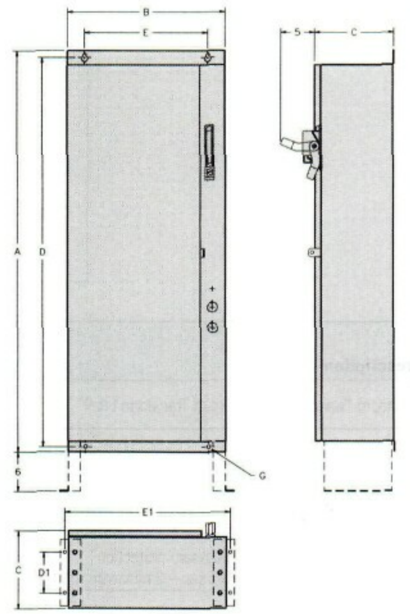
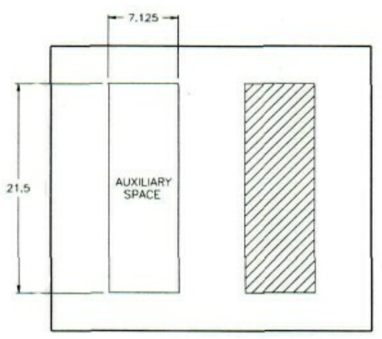
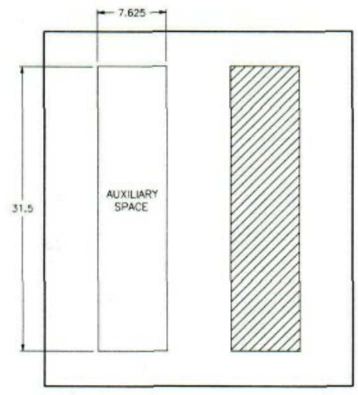


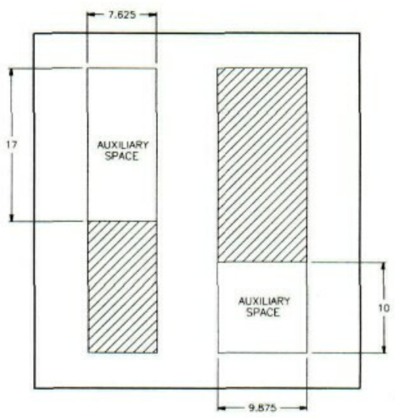
Figure 3



Layout







Fused or MCP

Size	Fig	Outline Dimensions A	B	C	C1	Mounting Dimensions D	D1	E	E1	Mtg Screw G	Conduit Size K1	K2	K3	Approx Ship Wt Lbs (Kg)	Ref Dwg
1–2½ (250V, 100 Amp Max) (600V, 60 Amp Max)	1	30⅝ (778)	15⅞ (403)	5⅛ (130)	5 (127)	29⅛ (740)	—	7 (178)	—	5/16	⅞–1⅛	1⅛–1²³⁄₆₄	1²³⁄₃₂–1³¹⁄₃₂	55 (25)	D68620-A
2–2½ (250V, 200 Amp Max) 3–3½, Compact 4 (600V, 200 Amp Max)	2	45⅝ (1159)	18⅞ (479)	6⅞ (175)	5 (127)	44⅛ (1121)	—	7 (178)	—	5/16 (10)	1³¹⁄₃₂–2¹⁵⁄₃₂	⅞–1⅛	2¹⁵⁄₃₂–3	105 (48)	D68620-A
4	3	49 (1245)	19⅛ (486)	9¹⁵⁄₁₆ (252)	—	47¹³⁄₁₆ (1214)	5 (127)	15 (381)	20¹⁵⁄₁₆ (532)	⅜	—	—	—	110 (50)	D56032
4½, 5	3	72³⁄₁₆ (1834)	20 (508)	9⁵⁄₁₆ (237)	—	71 (1803)	5 (127)	16 (406)	21⅞ (556)	⅜	—	—	—	—	D56032
6	3	79⅛ (2010)	22 (559)	12¹⁵⁄₁₆ (329)	—	78 (1981)	5 (127)	18 (457)	23⅞ (606)	⅜	—	—	—	—	D56032

All dimensions shown in inches (mm).
Dimensions for reference, not for construction.

Contact a Siemens & Furnas Controls Sales Office for dimensions not listed.

ALLEN BRADLEY MOTOR CONTROL PANEL
MODEL 1232X-BNA-AJ2-24

B3-EXW03

B3-EXW04

B3-EXW05

Rockwell Automation

BULLETIN 1232X PUMP CONTROL PANELS

Product Overview

Bulletin 1232X

- NEMA starter sizes 1…7
- Fusible disconnect switch
- Painted metal extra capacity enclosures: Type 3R
- Overload relays: Eutectic supplied as standard, solid-state available as an option
- Modifications — factory installed
- Accessories — field installed
- Service entrance rated

A Bulletin 1232X pump control panel (with fusible disconnect switch) consists of a Bulletin 509 starter mounted in an enclosure with extra panel space.

Standards Compliance

UL 508
CSA 22.2, No. 14

Certifications

cULus Listed (File No. E125316, Guide No. NKJH, NKJH7)

Configuration of a Basic Combination Starter

The information below is for reference purposes only. Not all combinations will produce a valid cat. no. Refer to the tables on the following pages for product selection.

Example Cat. No.

512	-	A	A	CD	-	A2E	-	1	-	24R	-	90
a		b	c	d		e				f		

a	
Bulletin No.	
Bulletin No.	Description
502	Combination contactor with disconnect switch
503	Combination contactor with circuit breaker

b	
Starter Size	
NEMA Size Code	NEMA Size
A	0
B	1

506	Reversing combination starter with disconnect switch
506X	Reversing combination starter with disconnect switch in a narrow enclosure
507	Reversing combination starter with circuit breaker
507X	Reversing combination starter with circuit breaker in a narrow enclosure
512	Non-reversing combination starter with disconnect switch
512H	Non-reversing combination starter with disconnect switch (Horizontal)
512M	Non-reversing combination starter with disconnect switch — extra panel space
512V	Non-reversing vacuum combination starter with disconnect switch
513	Non-reversing combination starter with circuit breaker
513H	Non-reversing combination starter with circuit breaker (Horizontal)
513M	Non-reversing combination starter with circuit breaker — extra panel space
513V	Non-reversing vacuum combination starter with circuit breaker
522E	2-speed, 2-winding, full voltage, multi-speed combination starter with disconnect switch
522F	2-speed, 1-winding, constant or variable torque, full voltage, multi-speed combination starter with disconnect switch
522G	2-speed, 1-winding, constant horsepower, full voltage, multi-speed combination starter with disconnect switch
523E	2-speed, 2-winding, full voltage, multi-speed combination starter with circuit breaker
523F	2-speed, 1-winding, constant or variable torque, full voltage, multi-speed combination starter with circuit breaker
523G	2-speed, 1-winding, constant horsepower, full voltage, multi-speed combination starter with circuit breaker
1232	Pump panel with disconnect switch (Narrow)
1232X	Pump panel with disconnect switch (Extra space)
1232V	Pump panel with vacuum contactor and disconnect switch (Extra space)
1233	Pump panel with circuit breaker (Narrow)
1233X	Pump panel with circuit breaker (Extra space)
1233V	Pump panel with vacuum contactor and circuit breaker (Extra space)

C	2
D	3
E	4
F	5
G	6
H	7

c

Enclosure Type

Code	Type
A	Type 1: General purpose, painted metal enclosure with spring latch door fastener, external overload relay reset, and non-metallic handle
F	Type 3R/4/12: Rainproof, watertight, dusttight, painted metal enclosure with screw fasteners, external overload relay reset, and non-metallic handle
J	Type 3R/4/12: Rainproof, watertight, dusttight, painted metal enclosure with door safety hardware, metal handle, and NO external overload relay reset
D	Type 3R/4/12: Rainproof, watertight, dusttight, painted metal enclosure with door safety hardware, external overload relay reset, and metal handle
N	Type 3R: Rainproof, painted metal enclosure with screw fasteners, external overload relay reset, and a non-metallic handle
C	Type 4/4X: Watertight corrosion-resistant stainless steel enclosure with screw fasteners, external overload relay reset, and a stainless steel handle
K	Type 12: Hazardous location (Class II, Division 2, Group F + G and Class III, Divisions 1 + 2) painted metal enclosure with screw fasteners, NO external overload relay reset, and a non-metallic handle.
L	Type 12: Hazardous location (Class II, Division 2, Group F + G and Class III, Divisions 1 + 2) painted metal enclosure with screw fasteners, external overload relay reset, and a non-metallic handle.
E	Type 7/9: Hazardous location bolted enclosure, metal handle.
H	Type 3R/7/9: Hazardous location bolted enclosure, rain proof, metal handle.
U	Type 3R/7/9: Hazardous location Unilock enclosure, rain proof, metal handle.

d

Coil Voltage

Voltage Code	Description	Line Voltage [V]	Coil Voltage [V]
H	Common Control (without transformer)	208	208
A		240	240
B		480	480
C		600	600
H	Transformer Control*	208	120
A		240	120
B		480	120
C		600	120
HD	Separate Control (without transformer)	208	120
AD		240	120
BD		480	120
CD		600	120

e		f
Overload Relay		Options
Code	Description	See **Modifications for Combination Devices**
None	Eutectic Alloy	
See **E1 Plus Solid-State Three-Phase Overload Relay (Selectable Class 10, 20, or 30) (Automatic/Manual Reset)**	Solid-State	

⋆ **Note:**
When selecting a factory-installed control circuit transformer use the Transformer Control Voltage Suffix Code to denote the transformer primary voltage. The transformer secondary voltage and starter coil will both be 120V AC by default. Example: **Cat. No. 512-BAB-6P-24R** will have a transformer with a 480V primary voltage, 120V secondary voltage, and a 120V starter coil voltage.

Build a Catalog Number

Heater Elements — Starters with eutectic alloy overload relays require 3 heater elements. Located on **Eutectic Alloy Overload Relay Heater Elements.**

NEMA Size	Continuous Ampere Rating [A]	Maximum Horsepower Rating *Full Load Current Must Not Exceed Continuous Ampere Rating*				Line Voltage [V]	Fuse Clip Rating Amperes [A] *Fuses not included. Select per NEC*	Type 3R Rainproof with Extra Panel Space
		Motor Voltage						
		60 Hz	60 Hz	50 Hz	60 Hz			
		200V	230V	380…415V	460…575V			Cat. No.
1	27	7-1/2	7-1/2	—	—	208…240	30	1232X-BN⊗-✪-24R
		—	—	10	10	480…600	30	1232X-BN⊗-✪-24R
		7-1/2	7-1/2	—	—	208…240	60	1232X-BN⊗-✪-25R
		—	—	10	10	480…600	60	1232X-BN⊗-✪-25R
2	45	10	15	—	—	208…240	60	1232X-CN⊗-✪-25R
		—	—	25	25	480…600	60	1232X-CN⊗-✪-25R
		10	15	—	—	208…240	100	1232X-CN⊗-✪-26J
		—	—	25	25	480…600	100	1232X-CN⊗-✪-26J
3	90	25	30	—	—	208…240	100	1232X-DN⊗-✪-26R
		—	—	50	50	480…600	100	1232X-DN⊗-✪-26R
		25	30	—	—	208…240	200	1232X-DN⊗-✪-27J
		—	—	50	50	480…600	200	1232X-DN⊗-✪-27J
4	135	40	50	—	—	208…240	200	1232X-EN⊗-✪-27R
		—	—	75	100	480…600	200	1232X-EN⊗-✪-27R
		40	50	—	—	208…240	400	1232X-EN⊗-✪-28J
		—	—	75	100	480…600	400	1232X-EN⊗-✪-28J
5	270	75	100	—	—	208…240	400	1232X-FN⊗-✪-28R
		—	—	150	200	480…600	400	1232X-FN⊗-✪-28R
6	540	150	200	300	400	208…600	600⋆	1232X-GN⊗-✪-29R
7	810	—	300	500	600	240…600	1200	1232X-HN⊗-✪-25L

⊗ Coil Voltage Code

The cat. no. as listed is incomplete. Select a coil voltage code from the table below to complete the cat. no. Example: **Cat. No. 1232X-BN⊗-✪-24** becomes **Cat. No. 1232X-BNA-✪-24**. For other voltages, consult your local Rockwell Automation sales office or Allen–Bradley distributor.

	[V]	208	230…240	460…480	575…600
Common Control	AC, 60 Hz	H	A	B	C
Transformer Control (See **Configuration of a Basic Combination Starter** Note)					
120V Separate Control (without transformer)		AD	AD	CD	CD

✪ Overload Relay Code

Use to order solid-state overload relay. Do not use when ordering eutectic alloy overload relay. The cat. no. as listed is incomplete. Select an overload relay code from E1 Plus Solid-State Three-Phase Overload Relay (Selectable Class 10, 20, or 30) (Automatic/Manual Reset) to complete the cat. no.
Example: **Cat. No. 1232X-BNA-✪-24** becomes **Cat. No. 1232X-BNA-A2E-24**.

⋆ For 230V and 460V Hp ratings, limit the maximum fuse sizing to 125% of motor full load current.

Modifications for Combination Devices

For Use on Bulletins 502, 502L, 503, 503L, 506, 506X, 507, 507X, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 522, 522E, 522F, 522G, 523, 523E, 523F, 523G, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1232X, 1232V, 1233X, and 1233V

Description of Modification			Suffix No.	Enclosure Type	NEMA Size							
					0	1	2	3	4	5	6	7
Pilot Devices in Cover or Flange												
Full Voltage Non-Reversing Single Speed Starters	START-STOP push button		1 1 1 1	1 3R/4/12, 4/4X Bolted Unilock	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	NA A NA NA	NA A NA NA
	ON-OFF push button		1E 1E 1E 1E	1 3R/4/12, 4/4X Bolted Unilock	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	NA A NA NA	NA A NA NA
	START-STOP illuminated push button		1L 1L	1 3R/4/12, 4/4X	A A	A A	A A	A A	A A	A A	NA NA	NA NA
	HAND-OFF-AUTO selector switch		3 3 3 3	1 3R/4/12, 4/4X Bolted Unilock	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	NA A NA NA	NA A NA NA
	OFF-ON selector switch		3E 3E 3E 3E	1 3R/4/12, 4/4X Bolted Unilock	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	NA A NA NA	NA A NA NA
	HAND-AUTO selector switch		3H 3H 3H 3H	1 3R/4/12, 4/4X Bolted Unilock	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	NA A NA NA	NA A NA NA
	PILOT LIGHT	Transformer Type — incandescent bulb	4⋆ ‡ 4⋆ ‡ 4⋆ ‡	1, 3R/4/12, 4/4X, 3R Bolted Unilock	A A A	A A A	A A A	A A A	A A A	A A A	A NA NA	A NA NA
		Transformer Type—LED bulb	4L⋆ ‡	1, 3R/4/12, 4/4X, 3R	A	A	A	A	A	A	A	A
	PUSH-TO-TEST PILOT LIGHT Transformer—incandescent bulb		5⋆ ‡ 5⋆ ‡	1, 3R/4/12, 4/4X, 3R Bolted	A A	A A	A A	A A	A A	A A	A A	A A
			5L⋆ ‡	1, 3R/4/12, 4/4X, 3R	A	A	A	A	A	A	A	A
	START-STOP push button and HAND-OFF-AUTO selector switch **(unwired)**		13 13	1 3R/4/12, 4/4X	A A	A A	A A	A A	A A	A A	A A	A A

Full Voltage Reversing and Multi-Speed Starters	FOR-REV-STOP push button	Bulletin 506…507	1	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
		Bulletin 507	1	Bolted (7 & 9)	A	A	A	A	A	A	NA	NA
	FOR-OFF-REV selector switch (Bulletin 506…507)		3 3 3	1, 3R/4X12, 4/4X, 3R Bolted Unilock	A A A	A A A	A A A	A A A	A A A	A A A	NA NA NA	NA NA NA
	HAND-AUTO		3H 3H 3H 3H	1 3R/4/12, 4/4X, Bolted Unilock	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	NA NA NA NA	NA NA NA NA
	HIGH-LOW-STOP push button	Bulletin 522…523	1	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
		Bulletin 523	1	Bolted	A	A	A	A	A	A	NA	NA
	HIGH-OFF-LOW selector switch	Bulletin 522…523	3	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
		Bulletin 523	3	Bolted	A	A	A	A	A	A	NA	NA
	HIGH-LOW-OFF-AUTO selector switch		3J	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
	PILOT LIGHT (2)	Transformer Type — Incandescent Bulb	4‡ §	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
		Transformer Type—LED Bulb	4L§	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
	PUSH-TO-TEST PILOT LIGHT	Transformer— Incandescent Bulb	5‡	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
		Transformer—LED Bulb	5L*	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA

A = Available
NA = Not Available

⋆ "OFF" pilot lights for non-reversing and non-multi-speed applications require a normally closed auxiliary contact (-91).

‡ The suffix number is incomplete. Specify the lens with the following letters: **A** = Amber; **B** = Blue; **C** = Clear; **G** = Green; **W** = White.

§ For multi-speed and reversing starters, one pilot light for each container. Add additional letter to identify two lens colors. The first letter specifies "FORWARD" or "HIGH", or "ON"; the second letter specifies "REVERSE" or "LOW" , or "OFF"; e.g. **4AG**.

Description of Modification			**Suffix No.**	**Enclosure Type**	**NEMA Size**							
					0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Control Circuit Transformers Includes 2 Primary Fuses and 1 Secondary Fuse	With standard capacity, 60 or 50 Hz With standard capacity with fuse covers With standard capacity, 60 or 50 Hz With standard capacity, 60 or 50 Hz		6P 6PC 6P 6P	1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 3R Bolted⋆ Unilock‡	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	A A NA NA	A A NA NA
	With 100 W extra capacity, 60 or 50 Hz With 100 W extra capacity with fuse covers With 100 W extra capacity, 60 or 50 Hz With 100 W extra capacity, 60 or 50 Hz		6XP 6XPC 6XP 6XP	1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 3R Bolted⋆ Unilock‡	A A A A	A A A A	A A A A	A A A A	A A A A	A A A A	A A NA NA	A A NA NA
	With 200VA capacity With 200VA capacity with fuse covers With 200 W extra capacity, 60 or 50 Hz With 200 W extra capacity with fuse covers		6XXP 6XXPC 6YP 6YPC	1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 3R	A A A A	A A A A	A A A A	NA NA A A	NA NA A A	NA NA A A	NA NA NA NA	NA NA NA NA
	With 300 W extra capacity, 60 or 50 Hz With 300 W extra capacity with fuse covers		6XYP 6XYPC	1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 3R	A A	A A	A A	A A	A A	A A	NA NA	NA NA
	With 400 W extra capacity, 60 or 50 Hz With 400 W extra capacity with fuse covers		6YYP 6YYPC	1, 3R/4X/12, 4/4X, 3R 1, 3R/4X/12, 4/4X, 4X	A A	A A	A A	A A	A A	A A	NA NA	NA NA
Auxiliary Contacts	Auxiliary contact installed on contactors	N.O. N.C.	90§ 91§	1, 3R/4X/12, 4/4X Bolted	A A	A A	A A	A A	A A	A A	A NA	A NA
	Auxiliary contact — contactor (four maximum) N.C. — late break		97	1, 3R/4/12, 4/4X, 3R	A	A	A	A	A	A	NA	NA
	Auxiliary contact installed on disconnect	N.O. N.C.	98 99	1, 3R/4/12, 4/4X, 3R 1, 3R/4/12, 4/4X, 3R	A A	A A	A A	A A	A A	A A	A A	A A

	Auxiliary contact installed on circuit breaker (external to breaker) to operate with handle (two maximum)	N.O. N.O. N.O.	98 98 98	1, 3R/4X/12, 4/4X, 3R Bolted* Unilock‡	A A A	A A A	A A A	A A A	A A A	A A A	A NA NA	A NA NA
		N.C. N.C. N.C.	99 99 99	1, 3R/4X/12, 4/4X, 3R Bolted* Unilock‡	A A A	A A A	A A A	A A A	A A A	A A A	A NA NA	A NA NA
Control Circuit	Control circuit fuse block less transformer	1 Fuse — Fuse Included	21	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	A	A
		1 Fuse with Protective Cover — Fuse Included	21C	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	A	A
		2 Fuses — Fuses Included	22	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	A	A
		2 Fuse with Protective Cover — Fuse Included	22C	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	A	A
	Surge suppression for 120V or 240V AC Coil		17	1, 3R/4X/12, 4/4X, 3R Bolted* Unilock‡	A	A	A	A	A	A	NA	NA
	Terminal blocks (**Cat No. 1492-HC6**)	6-Point Block	TB6	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	A	A
	Terminal blocks (**Cat No. 1492-HC12**)	12-Point Block	TB12	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	A	A
Overload Relays (Eutectic Alloy)	N.O. alarm contact adder (Bulletin 592)		9	1, 3R/4X/12, 4/4X, 3R Bolted* Unilock‡	A	A	A	A	A	A	NA	NA
	N.C. alarm contact adder (Bulletin 592)		9A		A	A	A	A	A	A	NA	NA
	Omit overload relays	For Bulletins 506, 506X, 507, 507X Deduct	23	1, 3R/4X/12, 4/4X, 3R Bolted* Unilock‡	A	A	A	A	A	A	NA	NA
		For Bulletins 522, 523 Deduct	23		A	A	A	A	A	A	NA	NA
Accessories	3-phase Powermonitor (Timemark Model 258)		400	1, 3R/4X/12, 4/4X, 3R Bolted (3R, 7 & 9) Unilock (7 & 9)	A	A	A	A	A	A	A	A
	Bulletin 596 (used on Bulletin 500…509), 3-pole maximum	On Delay Off Delay	87A 87B		A a	A A	A A	A A	A A	A A	NA NA	NA NA
	Form A compelling relay (used on Bulletin 522…523)		70	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
	Form B auto. seq. accelerating relay for each higher speed (used on Bulletin 522…523)		71	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA
	Form C auto. seq. decelerating relay for each higher speed (used on Bulletin 522…523)		72	1, 3R/4/12, 4/4X	A	A	A	A	A	A	NA	NA

A = Available
NA = Not Available

* Bolted suitable for Type 7 & 9 or Type 3R, 7 & 9.

‡ Unilock suitable for Type 7 & 9 or Type 3R, 7 & 9 with the addition of a drain or a breather and drain. White LED option not available, incandescent only.

§ For Bulletins 506, 507, 522 and 523 devices. One auxiliary contact is installed on each of the two contactors.

Description of Modification			Suffix No.	Enclosure Type	NEMA Size							
					0	1	2	3	4	5	6	7
Circuit Breakers	Marine Requirements		345	—	A	A	A	A	A	A	NA	NA
	Current Limiters	Add the letter "C" to the instantaneous circuit breaker no. code.	C	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	NA	NA
	Thermal Magnetic Circuit Breakers	Add the letter "T" to the circuit breaker no. code.	T	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	S	S
	Current Limiters	Add the letter "D" to the inverse time circuit breaker no. code.	D	1, 3R/4X/12, 4/4X, 3R	A	A	A	A	A	A	NA	NA
Accessories	Enclosure	Breather	136	Bolted*	A	A	A	A	A	A	NA	NA
		Breather and drain	137	Unilock and Bolted* ‡	A	A	A	A	A	A	NA	NA

		Drain	138	Bolted and Unilock* ‡	A	A	A	A	A	A	NA	NA
	Enclosure Door Viewing Window		203W	1, 3R/4/12, 3R	A	A	A	A	A	A	NA	NA
	Handles For Disconnect Switch or Circuit Breaker	Painted metal Stainless steel Molded plastic (deduct)	412 413 419	1, 3R/4/12, 3R 4/4X 1, 3R/4/12, 4/4X, 3R	A A A	A A A	A A A	A A A	A A A	S S NA	S S NA	S S NA
	Fuse Cover	Protective fuse cover for disconnect switch	414	1, 3R/4/12, 4/4X, 3R	A	A	A	A	A	A	NA	NA
	Control Relay (Plug-In)	2-Pole 3-Pole	415 416	1, 3R/4/12, 4/4X, 3R	A A	A A	A A	A A	A A	A A	A A	A A
	Timing Relay (Plug-In)	On-Delay Off-Delay	417 418	1, 3R/4/12, 4/4X, 3R	A A	A A	A A	A A	A A	A A	A A	A A
	Electrical Interlock	Early Break (1 N.O. and 1 N.C.) Early Break (2 N.O. and 2 N.C.)	420 421	1, 3R/4/12, 4/4X, 3R 1, 3R/4/12, 4/4X, 3R	A A	A A	A A	A A	A A	A A	NA NA	NA NA
	Bracket Mounting Feet for Pump Panels§		424	3R	NA	A	A	A	A	A	NA	NA
	Elapsed Time Meter (ENM - Series T50)		425	3R/4/4X/12	NA	A	A	A	A	A	A	A
	Protective Covers for Contactors and Starters		426	1, 3R/12, 4/4X, 4	NA	A	A	A	A	A	NA	NA

A = Available
NA = Not Available
S = Standard

* Bolted suitable for Type 7 & 9 or Type 3R, 7, & 9.

‡ Unilock suitable for Type 7 & 9 or Type 3R, 7, & 9 with the addition of a drain or a breather and drain.

§ Pump panel comes standard with pole mounting bracket.

Contactor Accessories

		
Bulletin	**500DC — Electronic DC Coil Controller**	
Features	• Compact size - NEMA sizes 0…3 • Versatility - Fully assembled unit or as a retro-fit kit • LED status indication - LED diagnostics determine if the controller is functioning correctly • Low power consumption - Draws 3.5 watts steady state • Built-in thermal protection - The controller is protected from over temperature • Reverse polarity protection - Should the wiring be reversed during installation or coil change, no damage will occur	
NEMA Size	0…1, 2, and 3	
DC Voltage	• 24V	• 125…250V
Min. DC Inrush Switching Requirement for Logic Control Device	• 6.7 A • 8.2 A • 16.5 A	• 4.9 A • 7.0 A • 14.3 A
Certifications	• cULus Listed (File No. E14840, Guide No. NKCR, NKCR7) • CE mark (per EN 60947-5-1)	
Example Cat. No.	An example of a factory-assembled contactor catalog number is **Cat. No. 500DC-BOVL930**. For further details visit the on-line catalog.	
For Use With	Bulletin 509 (See **Bulletin 509 Open Type Full Voltage Starter**). **For Bulletins 505 and 520, consult your local Rockwell Automation sales office or Allen-Bradley distributor.**	

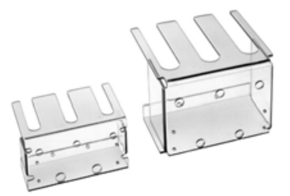
For use on Bulletins 500, 500F, 500L, 500FL, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1233X, and 1233V

Description		NEMA Size	Cat. No.
	**Coils (60 Hz)** 115…120V	0…1	CB-236
	200…208V		CB-249
	230…240V		CB-254
	460…480V		CB-273
	575…600V		CB-278
	115…120V	2	CC-236
	200…208V		CC-249
	230…240V		CC-254
	460…480V		CC-273
	575…600V		CC-278
	115…120V	3	CD-236
	200…208V		CD-249
	230…240V		CD-254
	460…480V		CD-273
	575…600V		CD-278
	115…120V	4	CE-236
	200…208V		CE-249
	230…240V		CE-254
	460…480V		CE-273
	575…600V		CE-278
	115…120V	5 (SER. L)	AF-236
	200…208V		AF-249
	230…240V		AF-254
Note: For complete listing of coils available, see Bulletin 500 Line of Contactors and Starters (excluding Modular Kits)	460…480V		AF-273
	575…600V	5	AF-278
Surge Suppressor — Made to be easily mounted directly across the coil terminals of contactors and starters with 120V or 240V AC coils. The purpose of the suppressor is to limit voltage transients for applications requiring interface with solid-state components. One suppressor is required per coil.			
	RC Module AC Operating Mechanism 24…48V AC, 50/60 Hz	00*	100-FSC48
	110…280V AC, 50/60 Hz		100-FSC280
	380…480V AC, 50/60 Hz		100-FSC480
	**Varistor Module** AC/DC Operating Mechanism 12…55V AC/ 12…77V DC	00*	100-FSV55
Cat. No. 100-FSC280	56…136V AC/ 78…180V DC		100-FSV136
	137…277V AC/ 181…350V DC		100-FSV277
	278…575V AC		100-FSV575
	12…120V AC	0…5	599-K04
	240…264V AC Varistor		599-KA04
	12…120V AC	6	199-FSMA1‡
	12…120V AC Varistor		199-GSMA1§
Cat. No. 599-K04	120V AC	7…8	700-N24

* For non-combination starters only.

‡ For use on the interposing relay.

§ For use on the contactor or starter.

Description		NEMA Size	Cat. No.
	**Terminal and Lug Covers** Line side terminal covers	0…1	599-TC01N
		2	599-TC2N
		3	599-TC3N
		4	599-TC4N
		5	599-TC5N
	Line side terminal covers (reversing)	0…1	599-TC01R
	Tie Point Terminal	0…2	599-TP02
		3…5	599-TP34

Description	For Use With	No. of Poles	NEMA Size	Cat. No.
Protective Covers	500/F/FL, 500L, 500LP, 505	3	0…1	599-PC01
	509, 505, 520E (2), 520F/G	3	0…1	599-PS01♦
	500L, 500LP	5	0…1	599-PC01-5♠
	520F/G	5	0…1	599-PS01-5♦
	500/F/FL, 500L, 500LP, 505	3	2	599-PC2
	509, 505, 520E (2), 520F/G	3	2	599-PS2♦
	500L, 500LP	5	2	599-PC2-5♠
	520F/G	5	2	599-PS2-5♦
	500/F/FL, 500L, 500LP, 505	3	3	599-PC3
	509, 505, 520E (2), 520F/G	3	3	599-PS3♦
	500L, 500LP	5	3	599-PC3-5♠
	520F/G	5	3	599-PS3-5♦
	500/F/FL, 500L, 500LP, 505	3	4	599-PC4
	509, 505, 520E (2), 520F/G	3	4	599-PS4♦
	500L, 500LP	5	4	599-PC4-5♠
	520F/G	5	4	599-PS4-5♦
	500/F/FL, 500L, 500LP	3	5	599-PC5
Cat. No. 599−PS01	509	3	5	599-PS5♦

♠ Used on 5-pole contactors and starters.

♦ Bul. 592 Eutectic alloy or solid-state overload relays.

Timer Attachment Kit — A pneumatic timer attachment may be field installed in the space of two adjacent auxiliary contact blocks. Timing units are available for either ON-Delay or OFF-Delay operation with a timed set of one (1) N.O. and one (1) N.C. snap-action contacts that are electrically isolated.
Repetitive accuracy within the timer range is approximately ±10% provided a minimum reset time of 75 ms is allowed.
Note:

- Sizes 0…5: Timers can be added to the left- or right-hand side of the contactor body. On Size 00 they can be mounted to the front of the contactor.
- Size 0, 1 and 2: Timers cannot be used on the same side as power pole adders.
- Size 2 Devices: The operating coil must be changed. See Bulletin 500 Line of Contactors and Starters (excluding Modular Kits) and refer to the size 2 operating coil listing. Order the coil listed for a 4−…5−pole device.
Note: These coils can also be factory installed.
- Enclosed Devices: Please contact your local Rockwell Automation sales office or Allen-Bradley distributor.
Contact Ratings: NEMA A600 (10 A, 600V AC max.)
NEMA P300 (5 A, 300V DC max.)

Description		NEMA Size	Cat. No.
	**On-Delay**	00♣	100-FPTA30
	On-Delay		100-FPTA180
	Off-Delay		100-FPTB30
	Off-Delay		100-FPTB180
	Left-hand ON Delay	0…5	596-TL32
	Left-hand OFF Delay		596-TL33
	Right-hand ON Delay		596-TR32
Cat No. 596-TR32	Right-hand OFF Delay		596-TR33

♣ For open type, non-combination starters only.

Description		NEMA Size	Cat. No.
Auxiliary Contact — Contactors	1 N.O.	0…5	595-A
	2 N.O.	0…5	595-AA
	1 N.C.	0…5	595-B
	2 N.C.	0…5	595-BB
	1 N.O. and N.C.	0…5	595-AB
	1 N.C.L.B.	0…5	595-BL
	1 N.O.	6	195-GA10
	1 N.O.	7	Δ 1495-J6
	2 N.O.	6	195-GA20
	2 N.O.	7…8	Δ 1495-K6
	2 N.O.	9	Δ 1495-K8
	1 N.C.	6	195-GB01
	1 N.C.	7…9	Δ 1495-J6
	2 N.C.	6	195-GB02
	2 N.C.	7…8	Δ 1495-K6
	2 N.C.	9	Δ 1495-K8
	1 N.O. and N.C.	6	195-GB11
	2 N.O.	7…8	Δ 1495-K6
	2 N.O.	9	Δ 1495-K8
	1 N.C.L.B.	6	195-GL01

Δ The normally open contacts can easily be changed to normally closed in the field.

Power Pole Adders — The 1 N.O. and 1 N.C. power poles may be field added to all size 0…4 Bulletin 500 line contactors and starters except the Bulletin 500L and 500FL. Two- and three-pole contactors will accept a maximum of two adder poles and four-pole devices will accept one adder pole. Each adder pole kit includes a mechanical load balancer to be used when only one power pole is added.
Note: When power poles are added to Size 2, 3, or 4 (2- or 3-pole devices) the operating coil must be changed. Refer to the listing for the size of your contactor or starter. Order the operating coil listed for a 4-…5-pole device.
Note: These coils can also be factory installed.

Description		NEMA Size	Cat. No.
	1 N.O.	0…1	599-P01A
	1 N.C.		599-P01B
	1 N.C. Late Break		599-P01BL
	1 N.O.	2	599-P2A

	1 N.C.		599-P2B
	1 N.C. Late Break		599-P2BL
	1 N.O.	3	599-P3A
	1 N.C.		599-P3B
Cat. No. 599-P01A (1 N.O.) Size 0…1, 27 Amps.	1 N.O.	4	599-P4A
	1 N.C.		599-P4B

Contactor Kick-off Springs — For horizontal mounting of 2- or 3-pole Bulletin 500 contactors and starters.
Note: When kick-off springs are added to Size 2, 3 or 4, the operating coil must be changed. Refer to the listing for the size of your contactor or starter. Order the operating coil listed for a 4-pole device.
Note: These coils can also be factory installed.

Description		NEMA Size	Cat. No.
	—	0…1	599-N11
		2	599-N12
		3	599-N13
		4…5	599-N14

	Wire Size	NEMA Size	Cat. No.
	**Lug Connectors (3 per package)**		
	#14…8 AWG Wire	0…1	*
	#14…4 AWG Wire	2	1494R-N1
	#8…1/0 AWG Wire	3	1494R-N2
	#6…4/0 AWG Wire	4	1494R-N3
Cat. No. 1494R-N3	2 of #1/0…350 MCM Wire	5	42450-804-01

* All terminals of the 30 A switches are furnished with self-lifting pressure plate connectors as standard.

Description			NEMA Size	Cat. No.
	Terminal Lug Kit	Two #1/0 150…500 MCM 1 required per terminal	6	199-LJ1
	Terminal Lug Kit	#4 AWG…500 MCM 3 required per terminal for Size 7 and 4 required per terminal for Size 8	7…8	199-LG1

Description		NEMA Size	Cat. No.
Auxiliary Contact Adder Decks — The same 2- and 4-pole auxiliary contact blocks in various combinations of normally open and normally closed will slide and snap on to the front of the contactor. Adder decks have convenient backed out wire clamps to make lugging of control wires unnecessary. **Fits on Open Type devices only.**			
	2 N.O.	00	100-FA20

	1 N.O. -1 N.C.		100-FA11
	2 N.C.		100-FA02
	4 N.O.		100-FA40
	3 N.O.-1 N.C.		100-FA31
	2 N.O. -2 N.C.		100-FA22
4-pole	4 N.C.		100-FA04
24V DC Interface Module — Mounts to the top of the contactor. It provides a 24V DC, 0.5 w input signal that can be used to operate the 24…240V AC coil of the contactor. **Fits on Open Type devices only.**			
	—	00	100-JE
Latch Attachment — On the front of the contactor. **Fits on Open Type devices only.**			
	—	00	100-FL11⊗
Interposing Contactor — For open type Bulletin 500 and 500L.	120V, 60 Hz	6	500-NX100D
	240V, 60 Hz	6	500-NX100A
Top Wiring Kit — Consists of (3) power lugs for the purpose of making extra connections to the load side of the contactor. A second set of overload relays can be wired to these lugs if two motors are being controlled by a single contactor.			
	—	0…1	599-TW01
	—	2	599-TW2
	—	3	599-TW3
	—	4	599-TW4
Cat No. 599-TW01	—	5	599-TW5P

⊗ Voltage Suffix Code

The cat. no. as listed is incomplete. Select a voltage suffix code from the table below to complete the Cat. No. Example: 120V, 60 Hz: **Cat. No. 100-FL11**⊗ becomes **Cat. No. 100-FL11D**. For other voltages, please consult your local Rockwell Automation sales office or Allen–Bradley distributor.

[V]	24	48	100	110	120	230… 240	240	277	380… 400	400… 415	400	480
50 Hz	K	Y	KP	D	—	VA	T	—	N	G	B	—
60 Hz	J	—	—	—	D	—	A	T	—	—	N	B

§ To complete cat. no., insert in the third position the desired numeric symbol (0…5) or one of the following letters — A, B, C, D, E, F, H, L, M, P, R, S, T, U, or W.

Description			Enclosure Type	NEMA Size	Cat. No.
		Adapter Plates — For replacement of: ● Allen-Bradley (Bulletin 709 Series K) ● Cutler Hammer (Citation & Freedom Series) ● Furnas (Class 14 and ESP 100) ● General Electric (Series 300) ● Joslyn-Clark (Type HP) ● Square D (Type S)	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0, 1	599-CP01
				2	599-CP2

		• Westinghouse (A200 and W200 Advantage)			

For use on Bulletins 512V, 513V, 1232V, 1233V

Contactors are supplied with one normally open and one normally closed auxiliary contact (A600 rating) as standard. Additional auxiliary contacts, two normally open and two normally closed, can be added in the field.

Description	Cat. No.
Auxiliary Contact (10 A @ 600V)	1195C-N3
Auxiliary Contact (10 mA @ 5V DC)	1195C-N4

Overload Accessories

For use on Bulletins 500, 500F, 500FL, 500L, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1233X, and 1233V

Description		NEMA Size	Cat. No.
	**Auxiliary Contact —** For eutectic alloy overload relays only⋆		
	1 N.O.	00, 3-phase‡	595-A00
	1 N.C.	00, 3-phase‡	595-B00
	1 N.O.	0…2, 5…9	595-A02
Auxillary Contact — For eutectic alloy overload relays only⋆ **Contact Ratings —** NEMA A600 (10 A, 600V AC max.) NEMA P300 (5 A, 300V DC max.)	1 N.C.		595-B02
	1 N.O.	3…4	595-A34§
	1 N.C.		595-B34♣

Description		Max. Continuous Current Rating [A]	Cat. No.
	**DIN Rail Mounting Adapter** for Bulletin 592 compact type 3-pole overload relays	40	599-MP1
	DIN Rail Mounting Adapter for Bulletin 592 compact type 1-pole overload relays	62	599-MP2

⋆ Auxiliary contact for solid-state overload relays is included in the product.
‡ Non-combination starters only.
§ Auxiliary contact mounted on right-hand side of overload relay provides N.O. contact function. Auxiliary contact mounted on left-hand side of overload relay provides N.C. contact function.
♣ To be mounted on right-hand side of overload to provide additional AC contact function.

Voltage Control Accessories

For use on Bulletins 500, 500F, 500L, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1233X, and 1233V; excluding Modular Kits

Control Circuit Transformer with Top-Mounted Fuse Block Kits (pre-wired)⋆‡

NEMA Size	Primary Voltage	Capacity – 120V Secondary Voltage									
		Standard		100 W Extra		200 W Extra		300 W Extra		400 W Extra	
		VA	Cat. No.	VA	Cat. No.	VA	Cat. No.	VA	Cat. No.	VA	Cat. No.
0…2	208V	80	1497-N1PK	130	1497-N15PK	250	1497-N7PK	350	1497-N10PK	500	1497-N18PK
	240V & 480V		1497-N2PK		1497-N16PK		1497-N8PK		1497-N11PK		1497-N19PK
	600V		1497-N3PK		1497-N17PK		1497-N9PK		1497-N12PK		1497-N20PK
3	208V	200	1497-N4PK	250	1497-N7PK	350	1497-N10PK	500	1497-N18PK	500	1497-N18PK
	240V & 480V		1497-N5PK		1497-N8PK		1497-N11PK		1497-N19PK		1497-N19PK
	600V		1497-N6PK		1497-N9PK		1497-N12PK		1497-N20PK		1497-N20PK
4	208V	250	1497-N7PK	350	1497-N10PK	500	1497-N18PK	–	–	–	–
	240V & 480V		1497-N8PK		1497-N11PK		1497-N19PK	–	–	–	–
	600V		1497-N9PK		1497-N12PK		1497-N20PK	–	–	–	–
5	208V	350	1497-N10PK	500	1497-N18PK	–	–	–	–	–	–
	240V & 480V		1497-N11PK		1497-N19PK	–	–	–	–	–	–
	600V		1497-N12PK		1497-N20PK	–	–	–	–	–	–
6	208V	500	1497-N18PK	–	–	–	–	–	–	–	–
	240V & 480V		1497-N19PK	–	–	–	–	–	–	–	–
	600V		1497-N20PK	–	–	–	–	–	–	–	–

⋆ Transformers for NEMA sizes 7…9 are included as standard.

‡ Type 4/4X non-metallic enclosures and Type 7 & 9 hazardous location enclosures require transformers with separately mounted fuse blocks. For a complete listing of transformers, see Control Transformers.

Control Circuit Transformers with Top Mounted Fuse Blocks§ ‡

NEMA Size	Primary Voltage/ 3 Pole Fuse Block	Capacity – 120V Secondary Voltage	
		Standard	
		VA	Cat. No.
0…2	208V	80	1497-B-HXDX-3-N
	240V & 480V		1497-B-BASX-3-N
	600V		1497-B-CXSX-3-N
3	208V	200	1497-D-HXDX-3-N
	240V & 480V		1497-D-BASX-3-N
	600V		1497-D-CXSX-3-N
4	208V	250	1497-E-HXDX-3-N
	240V & 480V		1497-E-BASX-3-N
	600V		1497-E-CXSX-3-N

	5	208V	350	1497-F-HXDX-3-N
		240V & 480V		1497-F-BASX-3-N
		600V		1497-F-CXSX-3-N

§ Transformers can be installed in Type 1, 3R, 3R/4/12 painted enclosures and Type 4/4X stainless steel enclosures.

‡ Type 4/4X non-metallic enclosures and Type 7 & 9 hazardous location enclosures require transformers with separately mounted fuse blocks. For a complete listing of transformers, see Control Transformers.

For use on Bulletins 500, 500F, 500L, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1232X, and 1233V; excluding Modular Kits

For Use When Fuse Block Is Not Integrated with the Transformers

Cat. No. 1491-R165
1-Pole Fuse Block

Cat. No. 1491-R167
2-Pole Fuse Block

Cat. No. 1491-R171
3-Pole Fuse Block

Cat. No. 1491-R169
3-Pole Fuse Block

Cat. No. 1491-R150
Fuse Cover without FuseΔ

These control circuit fusing kits are intended to be used for control circuit transformer protection and protection of control circuits capable of delivering no more than 200 000 RMS symmetrical amperes, 600V maximum. (Fuses not included.)

Description★	Cat. No.
One-pole kit — panel-mounted (midget fuse)‡	1491-R165
Control Circuit Fuse Block For Class CC rejection type fuses (fuses not included)‡	1491-R162
Two-pole kit — panel-mounted (two midget fuses)‡	1491-R167
Three-pole kit — panel-mounted (one midget fuse/two Class CC fuses)‡	1491-R169
Three-pole kit — panel-mounted (three Class CC fuses)	1491-R171
Single-pole kit — Bulletin 500 line controller mounted (Class CC fuses)§	599-FR04
One-pole kit — panel-mounted (31…60 A Class J fuse)	1491-R173
One-pole kit — panel-mounted (61…100 A Class J fuse)	1491-R175

★ For control circuit transformers with a 350 VA or larger rating, it is recommended that Bussmann Type FNQ-R, Ferraz-Shawmut Type ATDR, Littelfuse Type KLDR time delay fuses, or equivalent be used for primary fusing.

‡ These kits use only Class CC or midget fuses (rated 0.5…30 A) such as those offered by the following manufacturers:
- Bussmann KTK-R
- Ferraz-Shawmut ATM R
- Littelfuse KLK

§ **Cat. No. 599-FR04** is rated for 6 A fuse maximum. Controller mounting applies to size 0…5 devices only.

Δ One cover per pole is required. Example: transformer with top-mounted fuse block requires three covers. Fuse block kit for separate control requires two covers. Fuses not included.

Description		NEMA Size	Cat. No.
	Single-pole kit — Bulletin 500 line controller mounted (Class CC fuses)	0…5	599-FR04

Note: One cover per pole is required. Example: transformer with top-mounted fuse block requires three covers. Fuse block kit for separate control requires two covers.

Disconnect Switch Accessories

For use on Bulletins 502, 502L, 506, 506X, 512, 512H, 512M, 512V, 522, 532, 542, 572, 1242, 1272, 1282, 1232X, and 1232V

	Description	NEMA Size	Cat. No.
	**Fuse Clips**		
	0…30 A, 250V AC, Class H	0…2	1401-N41
	0…30 A, 250V AC, Class J 0…30 A, 600V AC, Class H 0…30 A, 600V AC, Class J 31…60 A, 250V AC, Class H	1…3	1401-N42
	31…60 A, 250V AC, Class J 31…60 A, 600V AC, Class H 31…60 A, 600V AC, Class J	1…3	1401-N43
	61…100 A, 250V AC, Class H 61…100 A, 250V AC, Class J 61…100 A, 600V AC, Class H 61…100 A, 600V AC, Class J	2…4	1401-N44
	101…200 A, 250V AC, Class H 101…200 A, 250V AC, Class J 101…200 A, 600V AC, Class H 101…200 A, 600V AC, Class J	3…5	1401-N45
	201…400 A, 250V AC, Class H 201…400 A, 250V AC, Class J 201…400 A, 600V AC, Class H 201…400 A, 600V AC, Class J	4…5	1401-N46
	0…30 A, 250V AC, Class R 0…30 A, 600V AC, Class R 31…60 A, 250V AC, Class R	0…2‡	1401-N50 1401-N51
	31…60 A, 600V AC, Class R	1…3	1401-N52
	61…100 A, 250V AC, Class R 61…100 A, 600V AC, Class R	2…4	1401-N53
	101…200 A, 250V AC, Class R 101…200 A, 600V AC, Class R	3…5	1401-N54
	201…400 A, 250V AC, Class R 201…400 A, 600V AC, Class R	5…6	1401-N55
	0…30 A, 250V AC HRC Form II Fusing⋆ 0…30 A, 600V AC HRC Form II Fusing⋆ 31…60 A, 250V AC HRC Form II Fusing⋆ 31…60 A, 600V AC HRC Form II Fusing⋆	0…2‡ 1…3	♠
	Auxiliary Contacts for Disconnect Switches 1 N.O.	0…5	1495-N8

	1 N.C.	0…5	1495-N9

⋆ HRC Form II fusing for Canada only.

‡ For 0…30 A only.

♠ Fuse clip not required. Fuse bolts directly to switch and trailer fuse block.

	Description		For Use With	Cat. No.	
	Lug Connectors (3 per package)		1494C, 1494F, 1494G, and 1494V Disconnect Switches		
	Disconnect Size [A]	Wire Size			
	30	#14…8 AWG Wire		⋆	
	60	#14…4 AWG Wire		♣	1494R-N1
	100	#8…1/0 AWG Wire		♣	1494R-N2
	200	#6…4/0 AWG Wire		♣	1494R-N3
	400	(2) #1/0…250 MCM AWG		1494R-N14	
	400	#4 AWG…500 MCM Wire (oversized)		1494R-N15	
	600	(2) of #1/0…350 MCM Wire		♣	1494R-N10
Cat. No. 1494R-N3	600	(2) of #1/0…350 MCM Wire	1491-N621 or 1491-R621 600 A fuse blocks	Δ	1494R-N11

	Protective Fuse Covers					
	Switch Rating [A]	Fuse Class	Fuse Clip Rating [A]		Cat. No.	
			250V	600V		
	30 30 60 30 60 60 100	Non-fusible H, R H, R J J Non-fusible Non-fusible	— 30 60 30 60 — —	— — — 30 60 — —	1495-N64	
	30 60 100	H, R H, R J	— — 100	30 60 100	1495-N65	
	100	H, R J	100 200	100 200	1495-N66	
	200 200	Non-fusible H, J, R J	— — 200 400	— — 200 400	♦	1495-N67
	200 200	Non-fusible H, J, R	— 200	— 200	♠	1495-N62
	400 400	Non-fusible H, J, R	— 400	— 400	♦	1495-N68
	400 400	Non-fusible H, J, R	— 400	— 400	♠	1495-N63
	600	Non-fusible J	— 600	— 600	♦	1495-N61

⋆ All terminals of the 30 A switches are furnished with self-lifting pressure plate connectors (N56, N57, and N58) as standard.

♣ Each kit contains three lugs.

Δ Each kits contains two lugs.

♦ Switch with right-hand mechanism.

♠ Switch with left-hand mechanism.

Circuit Breaker Accessories

For use on Bulletins 503, 503L, 507, 507X, 513, 513H, 513M, 513V, 523, 533, 543, 573, 1243, 1273, 1283, 1233X, and 1233V

Description		NEMA Size	Cat. No.
	**Circuit Breaker Kits**		
	3 A, 0…1/3 Hp @ 200 and 230V 3 A, 0…1 Hp @ 460 and 575V	0…1	1401-N60
	7 A, 0.5…1 Hp @ 200 and 230V 7 A, 1.5…3 Hp @ 460 and 575V	0…1	1401-N61
	15 A, 1.5…3 Hp @ 200 and 230V 15 A, 5…7.5 Hp @ 460 and 575V	0…1	1401-N62
	30 A, 5 Hp @ 200V 30 A, 5…7.5 Hp @ 230V 30 A, 10…15 Hp @ 460 and 575V	1…2	1401-N63
	50 A, 5…10 Hp @ 200V 50 A, 10 Hp @ 230V 50 A, 20…25 Hp @ 460V 50 A, 20…30 Hp @ 575V	1…3	1401-N64
	100 A, 15…25 Hp @ 200 and 230V 100 A, 30…50 Hp @ 460V 100 A, 40…50 Hp @ 575V	2…4	1401-N65
	150 A, 30 Hp @ 200V 150 A, 30…40 Hp @ 230V 150 A, 60…75 Hp @ 460V 150 A, 75…100 Hp @ 575 V	3…4	1401-N66
	250 A, 125 Hp @ 575V	5	1401-N68
	250 A, 50…60 Hp @ 200V 250 A, 60…75 Hp @ 230V		1401-N69
	**Auxiliary Contacts for Disconnect Switches**		1495-N8
	One normally open (1 N.O.) Adapter kit may be required. ⋆ Bolted — One normally open (1 N.O.)‡ Unilock — One normally open (1 N.O.)‡	0…5§ 4…5♣	
	One normally closed (1 N.C.) Adapter kit may be required.⋆ Bolted — One normally closed (1 N.C.)‡ Unilock — One normally closed (1 N.C.)‡	0…5	1495-N9
	Unilock — One normally open (1 N.O.)‡	0…2	1495-N14
	Unilock — One normally closed (1 N.C.)‡	0…2	1495-N15
	HMCP Circuit Breaker Adapter Kits (for mounting 1 or 2 auxiliary contacts) 400 A Frame‡	5	1495-N16
	150 A Frame	3…4	1495-N21
	250 A Frame - Enclosure Type 1, 3R/4/12, 3R and 4/4X (stainless steel) 250 A Frame - Enclosure Type 7 & 9 (bolted & Unilock) and 4/4X (non-metallic)	4…5∆ 0…5♦	1495-N22
	250 A Frame - Enclosure Type 1, 3R/4/12, 3R, and 4/4X (stainless steel)	4	1495-N23
	Unilock — 150 A Frame‡	3…4	1495-N21
	Unilock — 250 A Frame‡	4…5	1495-N22

⋆ Contact Ratings — NEMA B600 and NEMA P600.

‡ Not available on larger sizes 6…9.

§ For Bolted and 1 N.O.

♣ For Unilock 1 N.C.

∆ For Enclosure Type 1.

♦ For Enclosure Types 7 & 9.

Pilot Device Accessories

For use on Bulletins 500, 500F, 500L, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1233X, and 1233V

Description		Enclosure Type	NEMA Size	Cat. No.
	**Selector Switch Kits**			
	OFF-ON/HAND-OFF-AUTO* ‡	1 (lift-off)	00…2	599-SSL
				599-SS2L
	HAND-OFF-AUTO	1, 3R/4/12	0…5	599-SS09HJ
		4, 4X (stainless steel and non-metallic)		599-SS09HS
	OFF-ON	1, 3R/4/12		599-SS09OJ
		4, 4X (stainless steel and non-metallic)		599-SS09OS
	FOR-OFF-REV	1, 3R/4/12		599-SS09RJ
		4, 4X (stainless steel and non-metallic)		599-SS09RS
	TEST-OFF-AUTO (spring return from TEST)	1, 3R/4/12		599-SS09TJ
		4, 4X (stainless steel and non-metallic)		599-SS09TS
	FOR-OFF-REV (Unilock)	3R, 7 & 9	0…2	1481-N48
	OFF-ON (Unilock)			1481-N54
	HAND-OFF-AUTO (Unilock)			1481-N55
	OFF-ON (Unilock)		3…5	1481-N59
	HAND-OFF-AUTO (Unilock)			1481-N60
	FOR-OFF-REV (Unilock)			1481-N62
	**Push Button Kits**			
	START-STOP* ‡	1 (lift-off)	00…2	599-PBL
	START-STOP	1, 3R/4/12	0…5	599-PB09SJ
		4, 4X (stainless steel and non-metallic)		599-PB09SS
	FOR-REV-STOP	1, 3R/4/12		599-PB09RJ
		4, 4X (stainless steel and non-metallic)		599-PB09RS
	HIGH-LOW-STOP	1, 3R/4/12		599-PB09WJ
		4, 4X (stainless steel and non-metallic)		599-PB09WS
	START-STOP (Unilock)	7 & 9	0…2	1481-N53
			3…5	1481-N58
	START-STOP (bolted)		0…9	Use 800H-DPH16AAXX64

* Must order mounting bracket (**Cat. No. 599-BRL**) separately.

‡ For Type 1, lift-off, non-combination starters only (Bulletins 500, 500L, 505, and 509).

Description		Enclosure Type	NEMA Size	Cat. No.
	**Pilot Light Kits§** 120V	1, 3R/4/12	0…5	599-PL09DJ
	120V	4, 4X (stainless steel and non-metallic)		599-PL09DS
	240V	1, 3R/4/12		599-PL09AJ
	240V	4, 4X (stainless steel and non-metallic)		599-PL09AS
	480V	1, 3R/4/12		599-PL09BJ
	480V	4, 4X (stainless steel and non-metallic)		599-PL09BS
	600V	1, 3R/4/12		599-PL09CJ

	600V		4, 4X (stainless steel and non-metallic)		599-PL09CS
	ON* ‡ Δ	120V AC	1 (lift-off)	00…2	599-PLLD
		240V AC			599-PLLA
	Optional Pilot Light Lens Covers Red		All	0…5	800T-N26R
	Green				800T-N26G
	Amber				800T-N26A
	Blue				800T-N26B
	Clear				800T-N26C
	White				800T-N26W
	ON (Unilock 120V) — Red‡ ♣		3R, 7 & 9 (Unilock)	0…5	1481-N56A120R
	ON (Unilock 120V) — Green‡ ♣				1481-N56A120G
	**Push-to-Test Pilot Light Kits§** 120V		1, 3R/4/12	0…5	599-PT09DJ
	120V		4, 4X (stainless steel and non-metallic)		599-PT09DS
	240V		1, 3R/4/12		599-PT09AJ
	240V		4, 4X (stainless steel and non-metallic)		599-PT09AS
	480V		1, 3R/4/12		599-PT09BJ
	480V		4, 4X (stainless steel and non-metallic)		599-PT09BS
	600V		1, 3R/4/12		599-PT09CJ
	600V		4, 4X (stainless steel and non-metallic)		599-PT09CS
	Optional Push-to-Test Pilot Light Lens Covers Red		All	0…5	800T-N40
	Green				800T-N41
	Amber				800T-N42
	Blue				800T-N43
	Clear				800T-N45
	White				800T-N44
	Mounting bracket‡		All lift-off pilot devices, Type 1	00…2	599-BRL

* Must order mounting bracket (**Cat. No. 599-BRL**) separately.

‡ For Type 1, lift-off, non-combination starters only (Bulletins 500, 500L, 505, and 509).

§ Pilot light kits and push-to-test pilot light kits include one green and one red cover as standard.

♣ An adapter (**Cat. No. 1481-N61**) is required for each pilot light added to Size 3, 4, and 5 Unilock enclosures.

Δ Supplied with red lens only.

Note: Bulletins 505 and 520 with two pilot lights are supplied in hinged enclosures, with or without control circuit transformers.

Description		Enclosure Type	NEMA Size	Cat. No.
	ON ‡ (Unilock) — Red Lens (120V)	3R, 7 & 9 (Unilock)	0…5	1481-N56A120R
	ON ‡ (Unilock) — Green Lens (120V)			1481-N56A120G
	Transformers for pilot lights 240V, 60 Hz and 220V, 50 Hz*		00…5	1481-NX1
	480V, 60 Hz and 440V, 50 Hz			1481-NX2
	600V, 60 Hz and 550V, 50 Hz			1481-NX3
	Replacement Bulbs for all Pilot Lights 120V coil voltage - incandescent Amber, green, red, or blue lens color	—	—	800T-N169
	120V coil voltage - LED	—	—	800T-N320A

	Amber lens color			
	Green lens color	—	—	800T-N320G
	Red lens color	—	—	800T-N320R
	Blue lens color	—	—	800T-N320B
	240/480/600V coil voltage - incandescent Amber, green, red, or blue lens color	—	—	800T-N65
	240/480/600V coil voltage - LED Amber lens color	—	—	800T-N318A
	Green lens color	—	—	800T-N318G
	Red lens color	—	—	800T-N318R
	Blue lens color	—	—	800T-N318B
	Additional Pilot Devices Additional pilot devices	1, 3R/4/12	0…9	Use Bulletin 800T devices (See Bulletin 800T/800H 30.5 mm Push Buttons)
	Additional pilot devices	4/4X, 4X	0…9	Use Bulletin 800H Type 4X devices (See Bulletin 800T/800H 30.5 mm Push Buttons)
	Additional pilot devices (bolted)	3R, 7 & 9	0…9	Use Bulletin 800H Type 7 & 9 devices (See Bulletin 800H/Hazardous Location Push Buttons)

* When the control voltage is other than 120V, 60 Hz or 110V, 50 Hz it is necessary to also use one of the following transformers.

‡ An adaptor (**Cat. No. 1481-N61**) is required for each pilot light added to size 3, 4, and 5 Unilock enclosures.

Enclosure Accessories

For use on Bulletins 500, 500F, 500L, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1233X, and 1233V

Description		Enclosure Type	NEMA Size	Cat. No.
	**Non-metallic Conduit Connectors** 1/2 in. (12.7 mm)	4, 4X (stainless steel and non-metallic)	0…1	1490-N1
	3/4 in. (19 mm)			1490-N9
	1 in. (24.5 mm)			1490-N10
	1-1/4 in. (31.75 mm)		2	1490-N11
	1-1/2 in. (38.1 mm)		3	1490-N5
	2 in. (50.8 mm)		4	1490-N6
	2-1/2 in. (63.5 mm)			1490-N7
	3 in. (76.2 mm)		5	1490-N8
	**Grounding Adapters** 1/2 in. (12.7 mm), #14…10 AWG	4, 4X (stainless steel and non-metallic) ‡	0…1	1490-N19
	3/4 in. (19 mm), #14…8 AWG			1490-N20
	1 in. (24.5 mm), #14…8 AWG			1490-N21
	1-1/4 in. (31.75 mm), #14…4 AWG		2	1490-N22
	1-1/2 in. (38.1 mm), #8…1/0 AWG		3	1490-N23
	2 in. (50.8 mm), #8…1/0 AWG		4	1490-N24
	2-1/2 in. (63.5 mm), #6…2/0 AWG			1490-N25
	3 in. (76.2 mm), #6…4/0 AWG		5	1490-N26
	Handle Kits with Universal Link for Switch and Breaker Painted Metal 5-1/2 in. base	1, 3R, 3R/4/12*	0…4	1494F-M1
	Painted Metal		5	1494F-M2

	7-1/2 in. base			
	Stainless Steel 5-1/2 in. base	4/4X (stainless steel)	0…4	1494F-S1
	Stainless Steel 7-1/2 in. base		5	1494F-S2
	Nonmetallic Handle 5-1/2 in. base	1, 3R, 3R/4/12, 4/4X (non-metallic)	0…4	1494F-P1
	**Hole Plugs** 30.5 mm hole plug for pilot devices	All	0…5	800T-N1
	Enclosure Hole Plugs			598-N1

⋆ For combination starters only.

‡ Bulletin 1490 grounding adapters are available for use with these conduit hubs. These bushings provide a convenient method of connecting a ground wire to the conduit system. See conduit connector (hub) above proper size.

Description		Enclosure Type	NEMA Size	Cat. No.
	**Door Safety Hardware Kits Enclosure Size (H x W x D)** 27 x 10 x 8.2 in.	3R/4/12‡	0…2	1494F-V1
	30 x 20 x 9.7 in.		0…4	1494F-V2
	50 x 22 x 11.1 in.		3…4	1494F-V3
	56 x 30 x 14 in.		5	1494F-V4
	Breather Bulletin 505, 507, 509, and 513 — Unilock and bolted Class I, Groups C and D Class II, Groups E, F and GΔ §		0…5	1401-N1
	Drain Bulletin 505, 507, 509, and 513 — Unilock and bolted Class I, Groups C and D Class II, Groups E, F and GΔ §			1401-N2
	Breather Drain Combination♣ Bulletin 505, 507, 509, and 513 — Unilock and bolted Class I, Groups C and D Class II, Groups E, F and GΔ §			1401-N3
	**Ground Lug Kits**		0…2	599-GR1
			3…5	599-GR2
			6…7	599-GR3

Description of Accessory Kit	Size 0…2	Size 3	Size 4	Size 5	Size 6…9
	Cat. No.	Cat. No.	Cat. No.	Cat. No.	Cat. No.
Reset Buttons (Each Kit Contains One Reset)					
Type 1, 3R/12 Bulletin 506…507 — One Kit Required Per Starter Bulletin 512…513 — One Kit Required Per Starter Bulletin 522…523 — Two Kits Required Per Starter	1493-N21	1493-N21	1493-N31♠	—	—
				1493-N21♦	—

				—	—
Type 4/4X	—	—	1493-N32	—	—
Pneumatic Timer Mounting Plate Adapter (For Mtg. Bulletin 849A Timer) Bulletin 509 and 513 — Unilock∆	1401-N4	—	—	—	—

‡ Converts combination starter enclosure **F** to enclosure code **D** or **J** with door safety hardware.

§ Standard on bolted Type 3R, 7 & 9.

♣ The breather-drain combination can be in enclosure top as a breather or bottom as a drain. Specify (2) when both functions are required.

∆ Unilock suitable for Types 7 & 9 or Types 3R, 7 & 9 with the addition of a drain or a breather and drain.

♦ For Bulletins 512…513 only.

♠ Also use for NEMA sizes 0…2 lift-off enclosure.

System Accessories

For use on Bulletins 500, 500F, 500L, 500LP, 502, 502L, 503, 503L, 505, 505V, 506, 506X, 507, 507X, 509, 512, 512H, 512M, 512V, 513, 513H, 513M, 513V, 520, 520V, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1242, 1243, 1272, 1273, 1282, 1283, 1232X, 1232V, 1233X, and 1233V

Description		Enclosure Type	NEMA Size	Cat. No.
	**Power Monitor Kit★ ‡** 3-phase, 240V AC — (Time Mark Model A258)	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	599-PM1
	3-phase, 480V AC — (Time Mark Model A258B)			599-PM2
	**Terminal Block★** Panel Mount (6 point)§	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	1492-HC6
	**Timing Relays★** 120V AC, ON-Delay — 8-pin socket (Cat. No. 700-HN125) required 0.1…10 s	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	700-HT12AU120
	120V AC, ON-Delay — 8-pin socket (Cat. No. 700-HN125) required 1.0…180 s			700-HT12BU120
	120V AC, OFF-Delay — 11-pin socket (Cat. No. 700-HN126) required 0.1…10 s	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	700-HT22AU120
	120V AC, OFF-Delay — 11-pin socket (Cat. No. 700-HN126) required 1.0…180 s	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	700-HT22BU120
	**Control Relays★** DPDT 2-pole 2 Form C Single AgNi Contact	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	700-HA32A1
	3PDT 3-pole 3 Form C Single AgNi Contact	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	700-HA33A1
	Relay Sockets★ 8-pin socket	1 (hinged), 3R, 3R/4/12, 4/4X (stainless)	0…7	700-HN125

	11-pin socket		0…7	700-HN126

⋆ For combination starters only.

‡ 3-phase power monitor kit includes the time mark phase monitor and socket.

§ Up to two 6-point terminal blocks may be added to each combination starter.

Electrical Ratings

NEMA Size	Load Voltage [V]	Continuous Current Rating [A]	Service Limit Current Rating [A]⋆	Maximum Hp Rating (Non-plugging and non-jogging duty)		Maximum Hp Rating (Plugging and jogging duty)‡		Transformer Primary Switching kVa Rating (Inrush Current ≤ 20 times Continuous Current)		Transformer Primary Switching kVa Rating (Inrush Current = 20 to 40 times Continuous Current)		Capacitor Switching kVAR§	Maximum Circuit Closing Inrush Current [A] Peak Including Offset
				1Ø	3Ø	1Ø	3Ø	1Ø	3Ø	1Ø	3Ø	3Ø	3Ø
00	115 200 230 380 460 575	9	11	1/3 — 1 — — —	— 1-1/2 1-1/2 1-1/2 2 2	1/4 — 1/2 — — —	— 1 1 1 1-1/2 1-1/2	— — — — — —	— — — — — —	— — — — — —	— — — — — —	— — — — — —	87
0	115 200 230 380 460 575	18	21	1 — 2 — — —	— 3 3 5 5 5	1/2 — 1 — — —	— 1-1/2 1-1/2 1-1/2 2 2	0.6 — 1.2 — 2.4 3	— 1.8 2.1 — 4.2 5.2	0.3 — 0.6 — 1.2 1.5	— 0.9 1 — 2.1 2.6	— — — — — —	140
1	115 200 230 380 460 575	27	32	2 — 3 — — —	— 7-1/2 7-1/2 10 10 10	1 — 2 — — —	— 3 3 5 5 5	1.2 — 2.4 — 4.9 6.2	— 3.6 4.3 — 8.5 11	0.6 — 1.2 — 2.5 3.1	— 1.8 2.1 — 4.3 5.3	— — 6 — 13.5 17	288
1P	115 230	36	42	3 5	— —	1-1/2 3	— —	— —	— —	— —	— —	— —	— —
2	115 200 230 380 460 575	45	52	3 — 7-1/2 — — —	— 10 15 25 25 25	2 — 5 — — —	— 7-1/2 10 15 15 15	2.1 — 4.1 — 8.3 10	— 6.3 7.2 — 14 18	1 — 2.1 — 4.2 5.2	— 3.1 3.6 — 7.2 8.9	— — 12 — 25 31	483
3	115 200 230 380 460 575	90	104	7-1/2 — 15 — — —	— 25 30 50 50 50	7-1/2 — 15 — — —	— 15 20 30 30 30	4.1 — 8.1 — 16 20	— 12 14 — 28 35	2 — 4.1 — 8.1 10	— 6.1 7.0 — 14 18	— — 27 — 53 67	947
4	115 200 230 380 460 575	135	156	— — — — — —	— 40 50 75 100 100	— — — — — —	— 25 30 50 60 60	6.8 — 14 — 27 34	— 20 23 — 47 59	3.4 — 6.8 — 14 17	— 10 12 — 23 29	— — 40 — 80 100	1581
5	115 200 230 380 460 575	270	311	— — — — — —	— 75 100 150 200 200	— — — — — —	— 60 75 125 150 150	14 — 27 — 54 68	— 41 47 — 94 117	6.8 — 14 — 27 34	— 20 24 — 47 59	— — 80 — 160 200	3163
6	115 200 230 380 460 575	540	621	— — — — — —	— 150 200 300 400 400	— — — — — —	— 125 150 250 300 300	27 — 54 — 108 135	— 81 94 — 188 234	14 — 27 — 54 68	— 41 47 — 94 117	— — 160 — 320 400	6326
7	230 460 575	810	932	— — —	300 600 600	— — —	— — —	— — —	— — —	— — —	— — —	240 480 600	9470

8	230 460 575	1215	1400	— — —	450 900 900	— — —	— — —	— — —	— — —	— — —	— — —	360 720 900	14205
9	230 460 575	2250	2590	— — —	800 1600 1600	— — —	— — —	— — —	— — —	— — —	— — —	665 1325 1670	25380

⋆ **Service-Limit Current Ratings —** The service-limit current ratings shown represent the maximum rms current, in amperes, which the controller shall be permitted to carry for protracted periods in normal service. At service-limit current ratings, temperature rises shall be permitted to exceed those obtained by testing the controller at its continuous current rating. The current rating of overload relays or the trip current of other motor protective devices used shall not exceed the service-limit current rating of the controller.

‡ **Plugging or Jogging Service —** The listed horsepower ratings are recommended for those applications requiring repeated interruption of stalled motor current encountered in rapid motor reversal in excess of five openings or closings per minute and shall not be more than ten in a ten minute period.

§ If maximum available current (at capacitor terminals) is greater than 3000 A, please contact your local Rockwell Automation sales office, Allen-Bradley distributor, or NEMA ICS-2 Standard.

Mechanical Ratings

NEMA Size	Mechanical Life (Millions of Operations)	Maximum Number of Auxiliary Contacts	Operating Time [ms]	
			Pick-up (Average)	Drop-out (Average)
00	10	5	20	16
0	10	8	21	16
1	10	8	22	14
1P	10	8	22	14
2	10	8	27	13
3	5	8	37	20
4	5	8	27	20
5	5	8	25	18
6	5	4	25…79	10…22
7	—	8	88	40
8	—	8	88	45
9	—	8	118	84

Construction

NEMA Size	Wire Size for Power Terminals	Required Torque on Power Terminal Wire Clamps and Pressure Connectors or Lugs	Type of Power Terminal	Contact Material		Requirements for Sizing of Wire
				Power Contacts	Auxiliary Contacts	
00	#16…10 AWG	9 lb•in	Pressure terminals	Silver alloy	Silver	All wire rated 167 ˚F (75 ˚C) or higher must be sized per the local Electrical Code for 167˚F (75 ˚C) wire.
0	#14…10 AWG	20 lb•in	Saddle or wire clamps			
1	#14…8 AWG	20 lb•in				
2	#14…4 AWG	45 lb•in	Pressure terminals			
3	#8…1/0 AWG	150 lb•in				
4	#6…4/0 AWG	275 lb•in				
5	#4 AWG…500 MCM	375 lb•in				
6	Lugs sold separately. See Contactor Accessories .					
7						
8						
9	Direct bus connections only.					

Environmental

NEMA Size	Operating Position	Operating Temperature Range	Altitude	Corrosion-Resistance
00	Horizontal	Starters with eutectic alloy Overload relay -13…+149 °F (-25…+65 °C) Starters with SMP Overload relay -13…+131 °F (-25…+55 °C) (provided condensation is prevented)	10 000 feet before derating	All metal parts are treated for corrosion-resistance
0	Vertical			
1				
1P				
2				
3				
4				
5				
6	Horizontal			
7	Vertical			
8				
9				

Short Circuit Rating

Combination contactors and starters with disconnect switch: Bulletin 502, 506, 512, 522E, 522F, 522G, and 1232X

Combination Contactors and Starters with Disconnect Switch: Bulletin 502, 506, 512, 522E, 522F, 522G, and 1232X			
NEMA Size	**Fuse Type**	**Available Short Circuit Amperes RMS Symmetrical [A]**	**Maximum Voltage [V]**
0…3	H, K	5000	600
4…5	H, K	10 000	
0…5	J, R	100 000	
6	L	18 000	
7	L	18 000	
Combination Lighting Contactors with Disconnect Switch: Bulletin 502L			
Lighting Contactor Rating [A]	**Fuse Type**	**Available Short Circuit Amperes RMS Symmetrical [A]**	**Maximum Voltage [V]**
20…100	H, K	5000	600
200…300	H, K	10 000	
20…300	J, R	100 000	
Combination Contactors and Starters with Circuit Breaker: Bulletin 503, 507, 513, 523E, 523F, 523G, and 1233X*			
Enclosure Type	**NEMA Size**	**Available Short Circuit Amperes RMS Symmetrical [A]**	**Maximum Voltage [V]**
1, 3R, 3R/4/12, 4/4X (stainless)	0…5	65 000	480
Unilock 3R, 7, & 9	0…5	65 000	
Bolted 3R, 7, & 9	0…2	65 000	
1, 3R, 3R/4/12, 4/4X (stainless)	0…5	25 000	600
Unilock 3R, 7, & 9	0…3	5000	
Unilock 3R, 7, & 9	4…5	10 000	
Bolted 3R, 7, & 9	0…2	5000	
3R, 3R/4/12	6…7	10 000	
Combination Lighting Contactors with Circuit Breaker: Bulletin 503L*			
Enclosure Type	**Lighting Contactor Rating [A]**	**Available Short Circuit Amperes RMS Symmetrical [A]**	**Maximum Voltage [V]**

1, 3R, 3R/4/12, 4/4X (stainless)	20…300	65 000	480
Unilock 3R, 7, & 9	20…300	65 000	
Bolted 3R, 7, & 9	20…300	65 000	
1, 3R, 3R/4/12, 4/4X (stainless)	20…300	25 000	600
Unilock 3R, 7, & 9	20…100	5000	
Unilock 3R, 7, & 9	20…300	10 000	
Bolted 3R, 7, & 9	20…300	5000	

⋆ For the most up-to-date SCCRs, please see the on-line Industrial Controls catalog at www.ab.com/catalogs.

Combination Contactors and Starters with Disconnect Switch: Bulletin 502, 506, 512, 522E, 522F, 522G, and 1232X			
NEMA Size	**Fuse Type**	**Available Short Circuit Amperes RMS Symmetrical [A]**	**Maximum Voltage [V]**
0…3	H, K	5000	600
4…5	H, K	10 000	
0…5	J, R	100 000	
6	L	18 000	
7	L	18 000	

AC Coil Data

NEMA Size	Operating Volt Amperes Burden [VA]		Heat Dissipation [W]	Coil Operating Limits
	60 Hz Coils			
	Inrush	Sealed		
00	70	8	2.7	85…110%
0	192	29	5.9	
1 & 1P	192	29	5.9	
2 (2…3 poles)	240	29	5.9	
2 (4…5 poles)	315	38	5.9	
3 (2…3 poles)	660	45	10	
3 (4…5 poles)	840	58	10	
4 (2…3 poles)	1225	69	14.8	
4 (4…5 poles)	1490	96	14.8	
5 (Series L)	1490	96	19.8	
6⋆	4860	254	65.7	
6 (Interposing relay)	52.44	3.96	–	
7‡	Economized DC Coil		–	
7 (Interposing relay)	74.40	9.84	–	
8§	Economized DC Coil		–	
8 (Interposing relay)	74.40	9.84	–	
9♣	Economized DC Coil		–	
9 (Interposing relay)	144	19.20	–	

⋆ This rating is for the size 6 contactor coil only. All starters are shipped with an interposing relay as standard.

‡ Size 7 starters are shipped with a 250 VA control circuit transformer and an interposing relay with a 120V coil. Voltage is then rectified to DC for the contactor coil.

§ Size 8 starters are shipped with a 350 VA control circuit transformer and an interposing relay with a 120V coil. Voltage is then rectified to DC for the contactor coil.

♣ Size 9 starters are shipped with a 750 VA control circuit transformer and an interposing relay with a 120V coil. Voltage is then rectified to DC for the contactor coil.

Auxiliary Contacts (NEMA A600 and P300) — Bulletin 595, 596

Maximum AC Contact Rating Per Pole						
AC Rating Designation	Maximum Voltage 60 or 50 Hz	[A]		Continuous Carrying Current [A]	[VA]	
		Make	Break		Make	Break
A600	120	60	6	10	7200	720
	240	30	3	10	7200	720
	480	15	1.5	10	7200	720
	600	12	1.2	10	7200	720

Maximum DC Contact Rating Per Pole for 595, 596 Auxiliary Contacts (Maximum Continuous Carrying Current is 5 A)			
DC Rating Designation	125V DC	250V DC	600V DC
P300	0.55 A	0.55 A (Requires 2 Contacts in Series)	—
	1.1 A (Requires 2 Contacts in Series)		

Load-Life Curves

Bulletin 500 Line contactors and starters are designed to provide superior performance in a variety of applications. These load-life curves are based on Rockwell Automation tests according to the requirements defined in IEC 947-4. Actual contact life may vary based on the application, duty cycle, and environmental conditions from that indicated by the curves.
To find the contactor's estimated electrical life, follow these guidelines:

- Choose the appropriate graph that most closely approximates the utilization category of the application.
- Locate the intersection of the life-load curve of the appropriate contactor with the application's operational current (I_e) found on the horizontal axis.
- Read the estimated contact life in millions of operations along the vertical axis.

Contact Life for Mixed Utilization Categories AC3 and AC4

In many applications, the utilization category cannot be defined as either purely AC3 or AC4. In those applications, the electrical life of the contactor can be estimated from the following equation:

$$L_{mixed} = \frac{L_{AC3}}{1 + P_{AC4}\left(\frac{L_{AC3}}{L_{AC4}} - 1\right)}$$

Where:

$L_{\mathbf{mixed}}$ = Approximate contact life for a mixed AC3/AC4 utilization category application

L_{AC3} = Approximate contact life in operations for AC3 utilization category (from AC3 life-load curves below)

L_{AC4} = Approximate contact life in operations for AC4 utilization category (from AC4 life-load curves below)

P_{AC4} = Percentage of AC4 operations

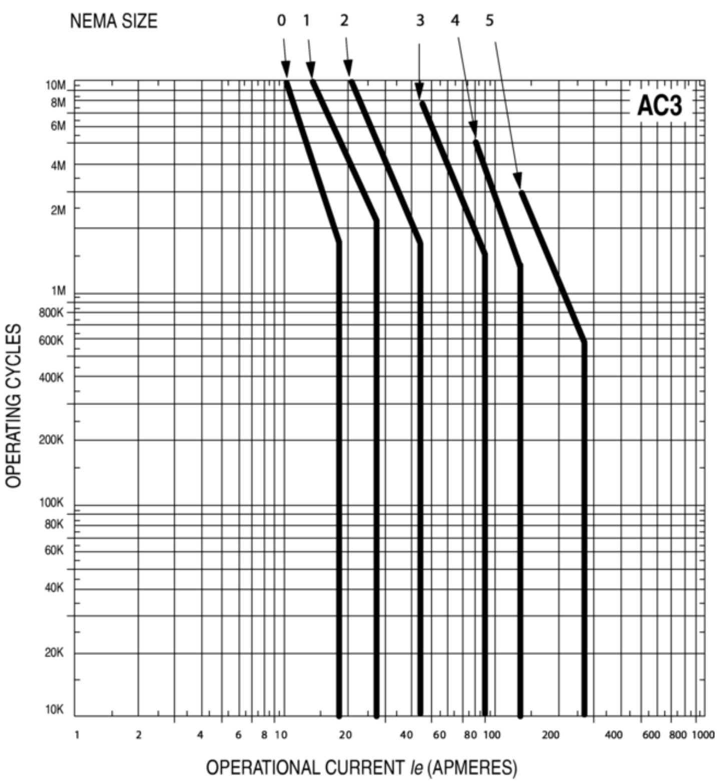
Utilization Categories

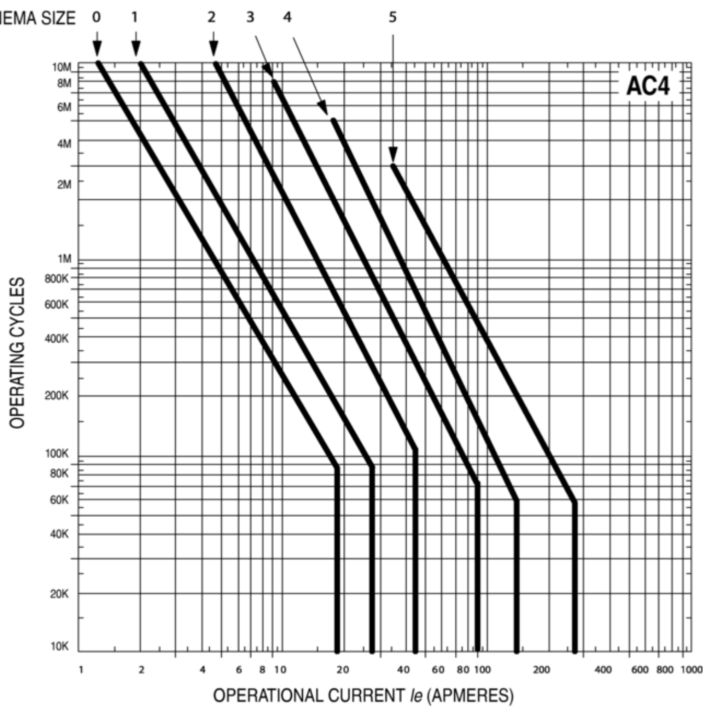
Category Typical Duty

AC3 Starting of squirrel cage motors and switching off only after the motor is up to speed.

AC4 Starting of squirrel cage motors with inching and plugging duty.

Bulletin 500 Load/ Life Curves — AC3 and AC4





Full Load Motor Currents

3-Phase Motor Currents

Full Load Currents of 3-Phase, 60 Hertz AC Induction Motors

The full load currents listed below are “average values” for horsepower rated motors of several manufacturers at the more common rated voltages and speeds. These “average values”, along with the similar values listed in the U. S. National Electrical Code (NEC), should be used only as a guide for selecting suitable components for the Motor Branch Circuit. The rated full load current, shown on the motor nameplate, may vary considerably from the listed value depending on the specific motor design.

ATTENTION: The motor nameplate full load current should always be used in determining the rating of the devices used for Motor Running Overcurrent Protection.

HP	RPM★	Full Load Current [A]					
		208V	240V	480V	600V	2200V	4000V
1/4	3600 1800 1200 900	1.20 1.39 1.62 —	1.04 1.20 1.40 —	0.52 0.60 0.70 —	0.42 0.48 0.56 —	— — — —	— — — —
1/3	3600 1800 1200 900	1.48 1.69 1.89 —	1.28 1.46 1.64 —	0.64 0.73 0.82 —	0.51 0.58 0.66 —	— — — —	— — — —
1/2	3600 1800 1200 900	2.08 2.54 2.89 —	1.80 2.20 2.50 —	0.90 1.10 1.25 —	0.72 0.88 1.00 —	— — — —	— — — —
3/4	3600 1800 1200 900	2.89 3.47 3.81 —	2.50 3.00 3.30 —	1.25 1.50 1.65 —	1.00 1.20 1.32 —	— — — —	— — — —
1	3600	3.51	3.04	1.52	1.22	—	—

	1800 **1200** **900**	4.25 4.60 —	3.68 3.98 —	1.84 1.99 —	1.47 1.59 —	— — —	— — —
1-1/2	**3600** **1800** **1200** **900**	5.04 5.80 6.49 —	4.36 5.02 5.62 —	2.18 2.51 2.81 —	1.74 2.01 2.25 —	— — — —	— — — —
2	**3600** **1800** **1200** **900**	6.51 7.18 8.20 —	5.64 6.22 7.10 —	2.82 3.11 3.55 —	2.26 2.49 2.84 —	— — — —	— — — —
3	**3600** **1800** **1200** **900**	9.24 10.4 11.6 —	8.00 9.04 10.1 —	4.00 4.52 5.04 —	3.20 3.62 4.03 —	— — — —	— — — —
5	**3600** **1800** **1200** **900**	15.7 15.9 18.6 —	13.6 13.8 16.1 —	6.80 6.88 8.07 —	5.44 5.50 6.46 —	— — — —	— — — —
7-1/2	**3600** **1800** **1200** **900**	22.1 25.0 26.6 —	19.1 21.7 23.1 —	9.57 10.8 11.5 —	7.66 8.66 9.22 —	— — — —	— — — —
10	**3600** **1800** **1200** **900**	29.7 31.5 32.9 —	25.7 27.3 28.4 —	12.9 13.7 14.2 —	10.3 10.9 11.4 —	— — — —	— — — —
15	**3600** **1800** **1200** **900** **600**	43.0 46.7 49.1 — —	37.2 40.4 42.5 — —	18.6 20.2 21.3 — —	14.9 16.2 17.0 — —	— — — — —	— — — — —
20	**3600** **1800** **1200** **900** **600**	59.2 59.6 61.7 — —	51.3 51.6 53.4 — —	25.6 25.8 26.7 — —	20.5 20.6 21.4 — —	5.2 5.3 5.4 5.8 6.4	2.9 3.0 3.1 3.2 3.5
25	**3600** **1800** **1200** **900** **600**	70.9 74.7 76.0 — —	61.4 64.7 65.8 — —	30.7 32.3 32.9 — —	24.6 25.9 26.3 — —	6.3 6.5 6.7 6.9 8.1	3.4 3.6 3.7 3.8 4.4

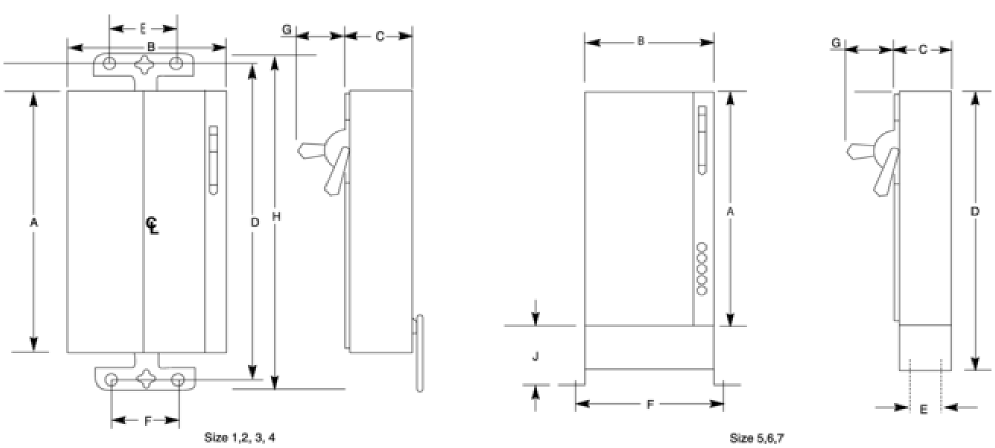
⋆ Synchronous speed nameplate is usually less due to slip.

HP	RPM⋆	Full Load Current [A]					
		208V	240V	480V	600V	2200V	4000V
50	**3600** **1800** **1200** **900** **600**	141 144 147 — —	122 125 127 — —	61.2 62.3 63.4 — —	49.0 49.8 50.7 — —	— 12.3 12.4 13.1 14.2	— 6.8 6.8 7.2 7.8
60	**3600** **1800** **1200** **900** **600**	165 172 173 — —	143 149 150 — —	71.6 74.3 74.9 — —	57.3 59.4 59.9 — —	— 14.6 14.9 15.4 16.7	— 8.0 8.2 8.5 9.2
75	**3600** **1800** **1200** **900** **600**	204 211 215 — —	177 183 186 — —	88.5 91.4 93.1 — —	70.8 73.1 74.5 — —	— 18.0 18.2 19.0 21.0	— 9.9 10.0 10.5 11.6
100	**3600** **1800** **1200** **900** **600** **450**	267 276 281 — — —	231 239 243 — — —	116 119 122 — — —	92.6 95.5 97.2 — — —	— 23.6 24.2 24.8 26.4 29.8	— 13.0 13.3 13.6 14.5 16.4
125	**3600** **1800** **1200** **900** **720** **600** **450**	333 340 347 — — — —	288 294 300 — — — —	144 147 150 — — — —	115 118 120 — — — —	— 29.2 29.9 30.9 31.3 32.8 36.0	— 16.1 16.4 17.0 17.2 18.0 19.8
150	**3600** **1800** **1200** **900**	397 404 414 —	344 350 358 —	172 175 179 —	138 140 143 —	— 34.8 35.5 37.0	— 19.1 19.5 20.4

	720 600 450	— — —	— — —	— — —	— — —	37.0 38.8 42.0	20.4 21.3 23.1
200	3600 1800 1200 900 720 600 450	524 531 538 — — — —	454 460 466 — — — —	227 230 233 — — — —	182 184 186 — — — —	— 46.7 47.0 49.4 49.0 50.9 53.7	— 25.7 25.9 27.2 27.0 28.0 29.5
250	3600 1800 1200 900 720 600 450 360	642 658 682 — — — — —	556 570 590 — — — — —	278 285 295 — — — — —	222 228 236 — — — — —	— 57.5 58.5 61.5 61.5 61.0 65.3 70.0	— 31.6 32.2 33.8 33.8 33.6 35.9 38.5
300	3600 1800 1200 900 600 450 360	774 790 804 — — — —	670 684 696 — — — —	335 342 348 — — — —	268 274 278 — — — —	— 69.0 70.0 73.5 72.3 76.0 82.8	— 38.0 38.5 40.4 39.8 41.8 45.5
350	3600 1800 1200	— — —	748 762 774	374 381 387	299 305 310	— — —	— — —
400	3600 1800 1200	— — —	874 892 902	437 446 451	350 357 361	— — —	— — —
450	3600 1800 1200	— — —	972 992 1004	486 496 502	389 397 402	— — —	— — —
500	3600 1800 1200	— — —	1074 1096 1108	537 548 554	430 438 443	— — —	— — —

Approximate dimensions are shown in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

Type 3R (Enclosure Code "N") Rainproof. Enclosures with Extra Panel Space Bulletins 1232X, 1233X, 1242, 1243, 1272, 1273, 1282, 1283



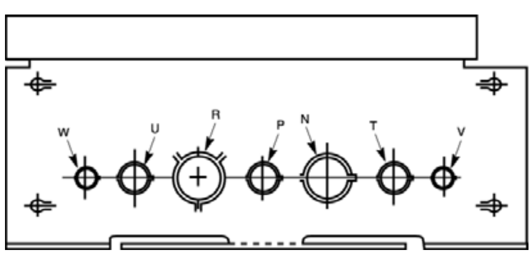
NEMA Size	Bulletin No.	Approximate Dimensions in Inches (Millimeters)									Approx. Shipping Weight [lb (kg)]
		A Height	B Width	C Depth	D Mounting	E Mounting	F Mounting	G Handle Depth	H	J	

1…2	1232X	30 (762)	20.5 (521)	8.72 (221)	34.88 (886)	10 (254)	10 (254)	5.56 (141)	36.38 (924)	—	90 (40.82)
1…2	1233X										
3…4	1232X, 1233X	50 (1270)	22 (559)	9.90 (251)	54.88 (1394)	15.25 (387)	15.25 (387)	5.56 (141)	56.38 (1432)	—	250 (113.4)
1PW, 2PW	1282, 1283										
1YD, 2YD	1242, 1243										
2	1272, 1273										
4	1232X										
3PW, 4PW	1282	56 (1422)	30.5 (775)	13.78 (350)	—	11 (279)	40.72 (1034)	7.62 (194)	—	—	360 (163.3)
3PW…5PW	1283										
3YD, 4YD	1242										
3YD…5YD	1243										
3, 4	1272										
3…5	1273										
5	1232X, 1233X	56 (1422)	30.5 (775)	13.78 (350)	65.68 (1668)	11 (279)	33.84 (860)	7.62 (194)	—	9.68 (246)	360 (163.3)
6	1233X										
5PW	1282										
5YD	1242										
5, 6	1272										
6	1273										
6	1232X*										
6	1232X‡	60 (1524)	37.38 (949)	16 (406)	69.68 (1769.9)	11 (279)	40.72 (1034)	7.62 (194)	—	9.68 (246)	420 (190.5)
7	1232X, 1233X	84 (2134)	39.5 (1003)	18 (457)	93.68 (2379.5)	11 (279)	42.84 (1088)	7.62 (194)	—	9.68 (246)	650 (294.8)

* Fusible disconnect switch with Class J fuses.

‡ Fusible disconnect switch with Class R fuses.

Type 3R (Enclosure Code "N") Rainproof Enclosures with Extra Panel Space — for Bulletins 1232X and 1233X



Bulletin No.	NEMA Size	Approximate Dimensions in Inches (Millimeters)							
		N		P		R		T	
		Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside
1232X 1233X	1	1-3/8 (35) 1 in. Hub	1-23/32 (44) 1-1/4 in. Hub	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub	1-23/32 (44) 1-1/4 in. Hub	1-31/32 (50) 1-1/2 in. Hub	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub
	2								
	3	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub	1-31/32 (50) 1-1/2 in. Hub	2-15/32 (63) 2 in. Hub	1-3/8 (35) 1 in. Hub	—	1-3/8 (35) 1 in. Hub	1-23/32 (44) 1-1/4 in. Hub
	4								

	5	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub	—	—	1-31/32 (50) 1-1/2 in. Hub	2-15/32 (63) 2 in. Hub	1-31/32 (50) 1-1/2 in. Hub	2-15/32 (63) 2 in. Hub

Bulletin No.	NEMA Size	Approximate Dimensions in Inches (Millimeters)					
		U		V		W	
		Inside	Outside	Inside	Outside	Inside	Outside
1232X 1233X	1	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub	—	—	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub
	2						
	3	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub	1-31/32 (50) 1-1/2 in. Hub	2-15/32 (63) 2 in. Hub	3 (76) 2-1/2 in. Hub	3 (76) 2-1/2 in. Hub
	4						
	5	7/8 (22) 1/2 in. Hub	1-1/8 (29) 3/4 in. Hub	3 (76) 2-1/2 in. Hub	3-5/8 (96) 3 in. Hub	3 (76) 2-1/2 in. Hub	3-5/8 (96) 3 in. Hub

Bulletin 500 Line of Contactors and Starters (excluding Modular Kits)

Used on Size 00, Series B

Used on Size 00, Series D

Used on Size 0…5

AC Operating Coils							
Voltage [V]	Frequency [Hz]	Size 00		Size 0…1 Size 15/20…30 A		Size 2 Size 60 A	
		Series B	Series D	2-…3-Pole★ ‡	4-Pole★ 4-…5-Pole‡	2-Pole★ 2-…3-Pole‡	3-…4-Pole★ 4-…5-Pole‡
		Part. No.					
24	50	GA407	TA407	—	—	—	—
	60	GA013	TA013	CB013		CC013	CC013C
110 120	50 60	GA473§	TA473	CB236		CC236	CC236C
		—					
200…208	60	GA049	TA049	CB249		CC249	CC249C
220 240	50 60	GA474♣	TA474♣	CB254		CC254	CC254C
277	60	GA060	TA480	CB260		CC260	CC260C
380	50	GA454	TA071	CB354	CB354C	CC354	CC354C
415	50	GA457	TA457	CB357	CB357C	CC357	CC357C
440 480	50 60	GA475	TA475	CB273		CC273	CC273C
		—	—				
550	50	—	TA476	CB278		CC278	CC278C
600	60	GA476					
Voltage [V]	Frequency [Hz]	Size 3 Size 100 A		Size 4 Size 200 A		Size 5 Size 300 A	

		2-Pole★ 2-…3-Pole‡	3-…4-Pole★ 4-…5-Pole‡	2-Pole★ 2-…3-Pole‡	3-…4-Pole★ 4-…5-Pole‡	Series L	
		Part. No.					
24	60	CD013	CD013C	—	—	—	—
110 120	50 60	CD236	CD236C	CE236	CE236C	AF236	
200…208	60	CD249	CD249C	CE249	CE249C	AF249	
220 240	50 60	CD254	CD254C	CE254	CE254C	AF254	
277	60	CD260	CD260C	CE260	CE260C	AF260	
380	50	CD354	CD354C	CE354	CE354C	AF354	
415	50	CD357	CD357C	CE357	CE357C	AF357	
440 480	50 60	CD273	CD273C	CE273	CE273C	AF273	
550 600	50 60	CD278	CD278C	CE278	CE278C	AF278	

★ For non-motor loads (Bulletin 500L).

‡ For motor rated contactors and starters.

§ Also for 120V, 60Hz.

♣ Also for 240V, 60Hz.

Single Pole Contact Kit — Sizes 00…5 (Includes Front and Rear Stationary Contact, Movable Contact and Contact Spring)

Motor Rated Contactors and Starters (Bulletin 500, 505, 509, and 520)			Non-Motor Rated Contactors (Bulletin 500L)			
Size	Part No.		Size	No. of Poles	Part No.	
0	§	40410-331-51	15/20 A	2…3	§	40410-331-53
1	§	40410-331-52	30 A	2…3	§	40410-331-54
1P	§	40410-331-55	60 A	2…3	§	40420-322-52
2	§	40420-322-51	100 A	2…3	40430-300-52	
				4	40430-300-53	
3	40430-300-51		200 A	2…3	40440-325-52	
4	40440-300-51			4	40440-325-53	
—			300 A (Series A)	2	Z-34119	
				3	Z-34120	
5 (Series L)	42450-805-01		300 A (Series L)	2…3	42450-805-02	
6 (Series B&C)	40783-802-02		540A (Series B&C)	3	40783-802-02	

Manual Reset (Eutectic Alloy) Overload Relays
Heater Elements — *Order heater elements as a separate item. See* ***Eutectic Alloy Overload Relay Heater Elements*** *for heater element selection tables.*

Size	Cat. No.
3-Phase or 1-Phase (3 elements)	
00 (Series B & D)	592-JOV16
0, 1	592-EUTB
2	592-EUTC
3	592-EUTD

4	592-EUTE	
5	592-BOV16	
1-Phase (1 element)		
Size	**Part No.**	
00 (Series B & D)	Cat. No. 592-BOV4	
0, 1	♦	42185-804-01
1P	♦	40185-803-01
2	♦	40185-804-01
3	♦	40185-805-01

Note: Auxiliary contacts on Size 3 and 4 overload relays are replaceable. Order Cat. No. 595-A34. See Overload Accessories for complete information.

§ Not for use on Power Pole Adders. Replace complete Power Pole Adder Kit with one selected from the listing on Contactor Accessories .

♦ Mounting plate is not included.

Power Pole Adder Kit (Used Only for 4- and 5-Pole Devices)

Motor Rated Contactors and Starters	
Size	**Cat. No.**
0…1	599-P01A
2	599-P2A
3	599-P3A
4	599-P4A
Non-Motor Rated Contactors	
Rating [A]	**Part No.**
15/20	40410-452-04
30	40410-452-08
60	40420-452-04
100	40430-453-51
200	40440-452-51
300	42450-600-01

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OVERLOAD RELAY CODE SELECTION

Overload Relay Code Selection

Starters Without Overload Relays for Field Assembly of Starters Using Bulletin 592 Overload Relays &

These products are intended for field installation of Bulletin 592 Eutectic, or 592 electronic overload relays (select Bulletin 592 overload relays from E1 Plus Electronic Overload Relays...Bulletin 592). The overload relays ship in a starter carton with provisions for mounting the overload relay (includes a starter mounting plate, screws/bolts, and instructions).

Eutectic Alloy Overload Relays — Overload relay codes do not apply. Use Cat. No. as listed in the product selection tables. Select heater elements from Eutectic Alloy Overload Relay Heater Elements.

& All Sizes — No overload relay.
Bulletins 520, 522, and 523 require two overload relays.
Bulletins 530, 1282, and 1283 require two overload relays. When selecting the proper electronic overload relay or heater, divide motor nameplate full load amperes by 2.00. Use this value to select the proper overload relays.
Bulletins 540, 1242, and 1243 have one overload relay. When selecting the proper electronic overload relay or heater, divide motor nameplate full load amperes by 1.73. Use this value to select the proper overload relays.

E1 Plus Solid-State Three-Phase Overload Relay (Selectable Class 10, 20, or 30) (Automatic/Manual Reset)

For use with Bulletins 505, 505V, 506, 507, 509, 512, 512M, 513, 520, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1232, 1232X, 1233, 1233X, 1242, 1243, 1272, 1273, 1282, and 1283.Δ ♦ ♠

NEMA Size	FLC Adjustment Range [A]	Overload Relay Code
00	0.1...0.5	A2A
	0.2...1.0	A2C
	1.0...5.0	A2E
	3.2...16	A2F
0, 1 1PW 1YD	0.2...1.0	A2C
	1.0...5.0	A2E
	3.2...16	A2F
	5.4...27	A2G
1	9...45	A2J
2 2PW 2YD	5.4...27	A2G
	9...45	A2J
3 3PW 3YD	9...45	A2J
	18...90	A2L
4 4PW 4YD	30...150	A2M
5 5PW 5YD	60...300	A2N
6 6PW	120...600	A2R

6YD		
7▸	256…810	A2T
8▸	384…1215	A2U
9▸	800…2250	A2V

▸ These overload relays have an interposing relay with a 120V AC coil.

Δ Bulletins 520, 522, and 523 require two overload relay codes to complete the Cat. No. The first code will denote the high speed overload relay and the second code will denote the low speed overload relay.

♦ Bulletins 530, 532, 533, 1282, and 1283 have two overload relays and require two overload relay codes to complete the Cat. No. When selecting the proper overload relay, divide motor nameplate full load amperes by 2.00. Use this value to select the proper overload relay codes.

♠ Bulletins 540, 542, 543, 1242, and 1243 have one overload relay. When selecting the proper overload relay, divide motor nameplate full load amperes by 1.73. Use this value to select the proper overload relay code.

E1 Plus Solid-State Single-Phase Overload Relay (Selectable Class 10, 20, or 30) (Automatic/Manual Reset)

For use with Bulletins 505, 505V, 506, 507, 509, 512, 512M, 513, 520, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1232, 1232X, 1233, 1233X, 1242, 1243, 1272, 1273, 1282, and 1283.Δ ♦ ♠

NEMA Size	FLC Adjustment Range [A]	Overload Relay Code
00	1.0…5.0	S2E
	3.2…16	S2F
	5.4…27	S2G
0…2	1.0…5.0	S2E
	3.2…16	S2F
	5.4…27	S2G
	9…45	S2J
3	18…90	S2L

▸ These overload relays have an interposing relay with a 120V AC coil.

Δ Bulletins 520, 522, and 523 require two overload relay codes to complete the Cat. No. The first code will denote the high speed overload relay and the second code will denote the low speed overload relay.

♦ Bulletins 530, 532, 533, 1282, and 1283 have two overload relays and require two overload relay codes to complete the Cat. No. When selecting the proper overload relay, divide motor nameplate full load amperes by 2.00. Use this value to select the proper overload relay codes.

♠ Bulletins 540, 542, 543, 1242, and 1243 have one overload relay. When selecting the proper overload relay, divide motor nameplate full load amperes by 1.73. Use this value to select the proper overload relay code.

E3 Solid-State Overload Relay: 2 Inputs/1 Output

For use with Bulletins 509, 512, 512M, 513, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1232, 1232X,1233, 1233X, 1242, 1243, 1272, 1273, 1282, and 1283.

NEMA Size	FLC Adjustment Range [A]	Overload Relay Code‡
00	1…5	EC1A
	3…15	EC1B
0…2	1…5	EC1A
	3…15	EC1B
	5…25	EC1C
	9…45	EC1D
3	9…45	EC1D
	18…90	EC1E

4	28…140	EC1F
5	60…302	EC1H
6	125…630	EC1K

E3 Plus Solid-State Overload Relay: 4 Inputs/2 Outputs, Built-In Ground Fault Sensor, PTC Thermistor Input

For use with Bulletins 505, 505V, 506, 507, 509, 512, 512M, 513, 520, 522, 523, 530, 532, 533, 540, 542, 543, 570, 572, 573, 1232, 1232X, 1233, 1233X, 1242, 1243, 1272, 1273, 1282, and 1283.⋆

NEMA Size	FLC Adjustment Range [A]	Overload Relay Code‡
00	1…5	EC2A
	3…15	EC2B
0…2	1…5	EC2A
	3…15	EC2B
	5…25	EC2C
	9…45	EC2D
3	9…45	EC2D
	18…90	EC2E
4	28…140	EC2F
5	60…302	EC2H

⋆ Bulletin 520 requires two overload relay codes to complete the cat. no. The first code will denote the high speed overload relay and the second code will denote the low speed overload relay.

‡ Rockwell Automation recommends using 120 or 240V AC coils on all NEMA Starters with E3 or E3 Plus electronic overload relays. When using coil voltages other than 120 or 240V AC, consult your local Rockwell Automation sales office or Allen-Bradley distributor.

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SYMCOM PUMPSAVER PLUS
MODEL 235P SPECIFICATIONS

B3-EXW01

www.SymCom.com
...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

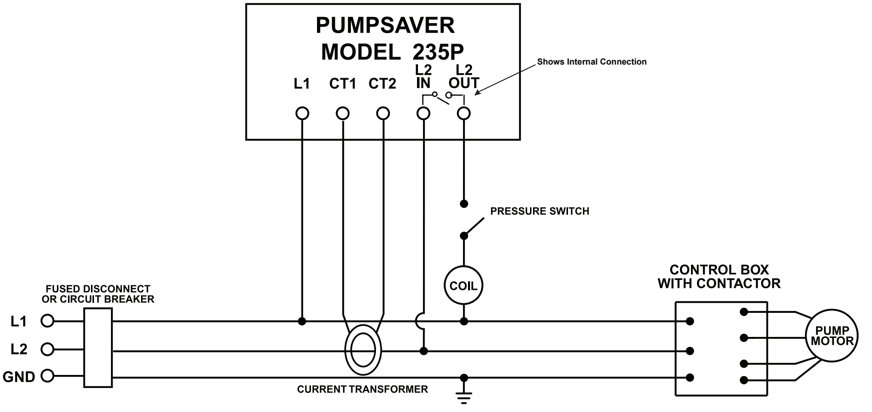
For a typical wiring diagram see page 35.
For installation instructions see page 36.
For product dimensions see page 54.

How to order:

235P* (5 - 15hp, 230VAC)

* current transformer sold separately

(605) 348.5580 / (800) 843.8848 / Fax (605) 348.5685
customerservice@symcom.com / technicalsupport@symcom.com



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 completely to the left (counter-clockwise) or completely 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.

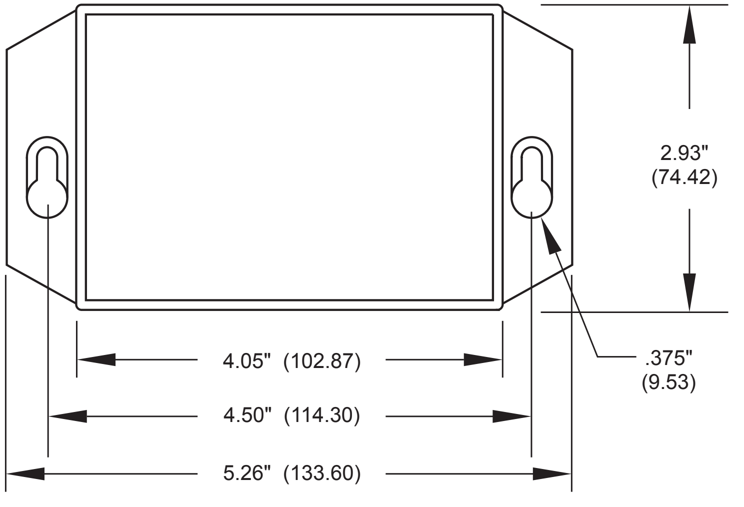
USING AN INFORMER

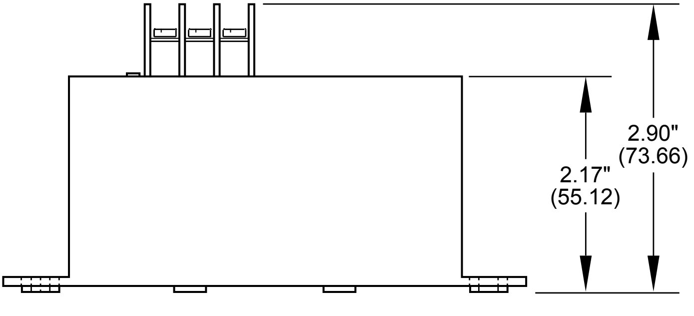
The PumpSaver®Plus units are equipped with an infrared LED that will communicate to a SymCom Informer—a hand-held, battery operated, diagnostic tool. An Informer IR Kit is required for the PumpSaver®Plus Insider units to communicate to the Informer. The Informer will display the model number; run time; 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
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customerservice@symcom.com • technicalsupport@symcom.com

SYMCOM PUMPSAVER
MODEL 777-KW/HP SPECIFICATIONS

B3-EXW02

Features

- Digital programmability permits precise customization.
- Sixteen setpoints can be programmed for maximum protection.
- Last fault memory provides instant troubleshooting diagnostics.
- Voltage, current, last 4 faults, kW, hp and power factor are recordable when using communications package.
- An RS485 communication port comes standard for use with computerized systems using Modbus protocol.
- UL and CSA listed as an overload relay.

Applications

The Model 777-KW/HP can be used on ANY 3-phase motor. It has advantages over current monitors in low speed motor applications (less than 1800 rpm), lower power applications and in lightly loaded applications. Some examples include **LOW SPEED MIXERS, CAN PUMPS, MAG DRIVE PUMPS, FRACTIONAL HORSEPOWER PUMPS and MOTORS, SUBMERSIBLE PUMPS AND COAL BED METHANE WELLS.**

Description

The Model 777-KW/HP is a fully-programmable motor and pump protection relay with power-monitoring capability. Voltage, current and power measurements are displayed on the three-digit display, as well as fault information and setpoints. The display simplifies troubleshooting and allows the user to easily and precisely configure setpoints. The Model 777-KW/HP has the following adjustable protection features:

1) Low voltage
2) High voltage
3) Voltage unbalance
4) UL listed/CSA approved overload
5) Trip class (5, 10, 15, 20, 30)
6) Current unbalance
7) Ground fault
8) Low power
9) High power (via network only)
10) Rapid-cycle timer
11) Fault/overload restart delay
12) Underload restart delay
13) Underpower/overpower trip delay

Other user adjustable features include:

1) CT/loop multiplier so overcurrent and power setpoints can be made in actual amps, kW or hp
2) Number of restarts after faults - manual, automatic and semiautomatic options
3) Number of restarts after underload - manual, automatic and semiautomatic options
4) Network address

Adding the optional RS485MS-2W communications module activates the built-in Modbus RTU bus capabilities. The 777-KW/HP can communicate with the SymCom RM-1000 and RM-2000 remote display modules, PLCs, RTUs, SCADA systems, PCs and other similar control devices. Real-time operating parameters can be gathered and setpoints can be viewed or modified via the RS-485 bus using Modbus RTU protocol.

PumpSaver®

SUBMERSIBLE PUMP PROTECTOR

777-KW/HP
777-LR-KW/HP
777-575-KW/HP
777-HVR-KW/HP
777-HVR-LR-KW/HP

Power Monitor Motor Protection Relay
•
Engineered Protection

Protects 3-Phase Motors and Pumps from:

- Underload (Low KW or HP)
- High power
- Overload (UL listed)
- Jams
- Undervoltage
- Overvoltage
- Single-phasing
- Unbalance (voltage & current)
- Ground fault (Class II)
- Rapid cycling
- Phase reversal

Additional Features

- Fully programmable
- UL and CSA listed
- CE marked
- Automatic or manual reset
- Tamper guard
- RS-485 communications port
- Surface or DIN rail mountable
- Alphanumeric LED diagnostic display
- Last fault memory
- Up to 99 individually programmable addresses
- 5-year warranty
- Made in USA

New Features

- Network programmable
- Ability to clear last fault
- Remote setup, Diagnostics and control
- Remote data logging

SymCom Inc
Motor Protection & Controls Since 1974

ELECTRIC MOTOR WHOLESALE.COM
(302) 653-1844
email: sales@electricmotorwholesale.com 11/05

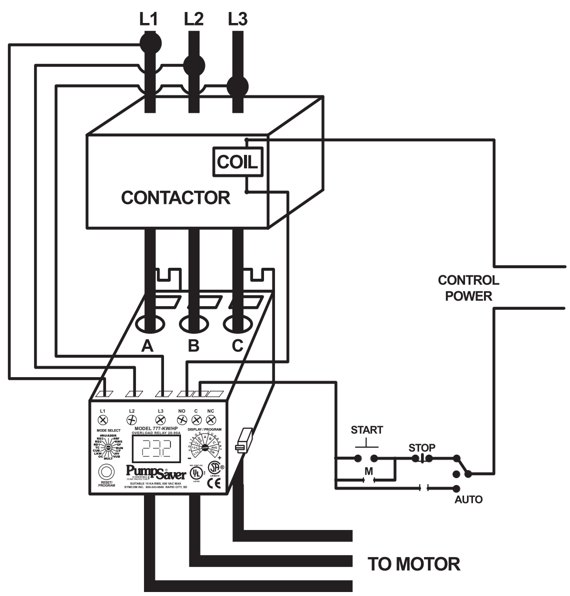
PumpSaver®
SUBMERSIBLE PUMP PROTECTOR

Specifications • Operating Points • Special Options

777-KW/HP
777-LR-KW/HP
777-575-KW/HP
777-HVR-KW/HP
777-HVR-LR-KW/HP

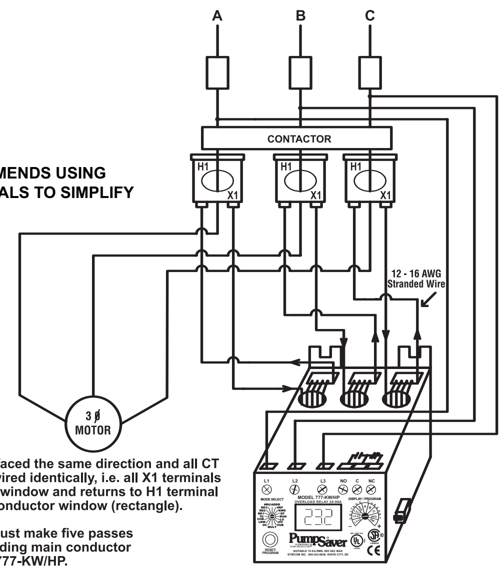
Power Monitor/Motor Protection Relay

TYPICAL WIRING DIAGRAM FOR
MODEL 777-KW/HP (20-90 AMPS)
& 777-LR-KW/HP (2-9 AMPS)



CURRENT TRANSFORMER WIRING DIAGRAM FOR
MODEL 777-KW/HP (80-800 AMPS)

SYMCOM RECOMMENDS USING CTs WITH TERMINALS TO SIMPLIFY INSTALLATION.



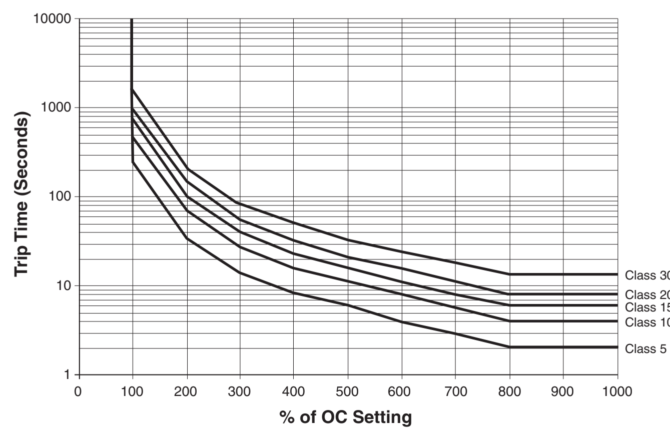
Note: All CTs must be faced the same direction and all CT secondaries must be wired identically, i.e. all X1 terminals enter the main (round) window and returns to H1 terminal after exiting the loop conductor window (rectangle).

Every CT secondary must make five passes through the corresponding main conductor window on the Model 777-KW/HP.

Wiring configuration based on motor amps.

Model	Full Load Amps	# of Loops	# of Conductors through A, B and C	MULT to Program (CT Ratio)
777-LR-KW/HP	1 - 2	1	2	2
	2 - 9	0	1	1
777-KW/HP	8 - 12	2	3	3
	12 - 25	1	2	2
	25 - 90	0	1	1
External CTs required. See wiring diagram for external CTs	80 - 110	4	5	100 (100:5)
	110 - 160	4	5	150 (150:5)
	160 - 220	4	5	200 (200:5)
	220 - 320	4	5	300 (300:5)
	320 - 420	4	5	400 (400:5)
	400 - 520	4	5	500 (500:5)
	480 - 600	4	5	600 (600:5)
	560 - 800	4	5	800 (800:5)

Overload Trip Classes



SymCom Inc
Motor Protection & Controls Since 1974

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PumpSaver®

SUBMERSIBLE PUMP PROTECTOR

Specifications • Operating Points • Special Options

777-KW/HP
777-LR-KW/HP
777-575-KW/HP
777-HVR-KW/HP
777-HVR-LR-KW/HP

Power Monitor/Motor Protection Relay

Advantages:

- Integrated UL Listed/CSA approved electronic overload relay
- Greater underload sensitivity than power factor or current monitors
- Built-in undervoltage, overvoltage and unbalance protection
- Digitally programmable
- Remote programmability
- Digital display
- Optional remote display
- Data logging capabilities

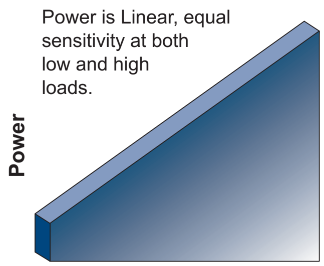
The Model 777-KW/HP has important advantages over current monitors in many protection applications. Any motor load that has a small or very non-linear change in current vs. load requires the use of a power monitor for underload, dry-run and dead-head protection. The change in power vs. load is more linear for most motor loads and is greater in magnitude than the change in current in all motor loads. This is because power measurements take into account both power factor (pf) and current.

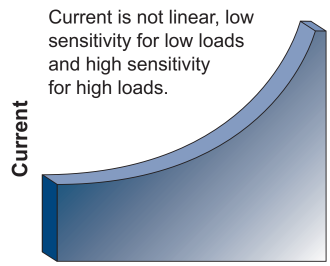
Small motors, those under 3 hp and especially fractional horsepower, exhibit small changes in current vs. load but the change in power is large. When larger motors are derated, run below their rated horsepower, the change in current is small vs. load, but again, the change in power is large and linear. Other typical applications include slower speed mixer or agitator motors up to 50 hp and beyond. These motors and others that run slower than around 3400 rpm usually have small current changes vs. load.

Magdrive and can pumps tend to be small horsepower, positive displacement-type pumps. These pumps need the high sensitivity of a power monitor to protect them from dry-run using the underpower feature and dead-head conditions using the underpower feature if the motor decouples from the pump and the overpower feature if the motor does not decouple.

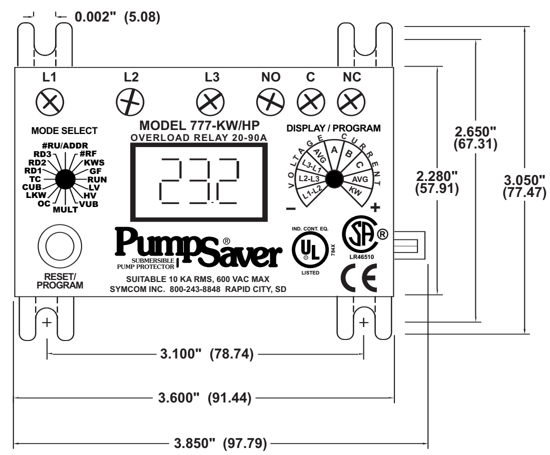
The built-in UL Listed/CSA approved overload, current unbalance, reverse-phase, single-phase and other protection features are significant benefits over similar products. The Modbus communications capability allows this device to be directly integrated with the SymCom RM-1000 and RM-2000 remote displays or other remote monitoring and control equipment.

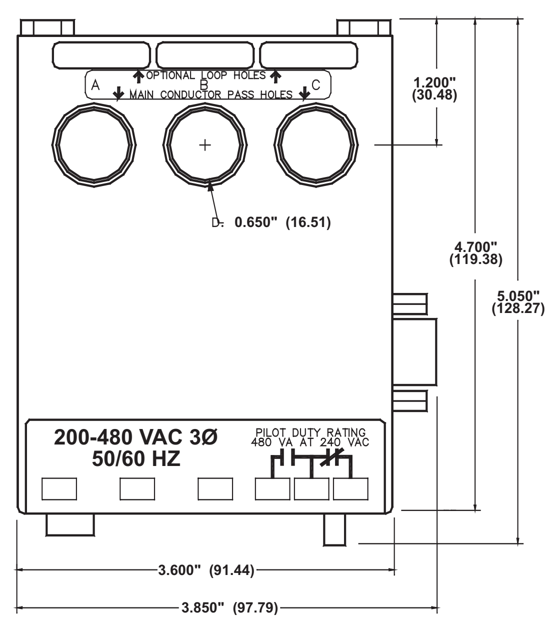
777-KW/HP uses power measurements for sensitive underload protection, while using current measurements for UL listed overload protection.





Dimensions for All 777-KW/HP Units





SymCom Inc

Motor Protection & Controls Since 1974

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Specifications

Electrical			
Input Voltage Ranges and Low and High Voltage Setpoints			
	Low Setpoint (LV)	Nominal Voltage Range	High Setpoint (HV)
777-KW/HP 777-LR-KW/HP	170-HV Setting	200-480 VAC	LV Setting - 528
777-HVR 777-HVR-LR	340-HV Setting	380-480 VAC	LV Setting - 528
777-575 777-575-LR	450-HV Setting	480-600 VAC	LV Setting - 660
Nominal Motor Full Load Current and Overcurrent Setpoint			
	Nom. Current Range	Overcurrent Setpoint (OC)	Ground Fault Setpoint (GF)
777, 777-HVR, 777-575	2-25A Looped	(20 to 100A)/MULT	OFF, (3 to 20A)/MULT
	25-90A Direct	20 to 100A	OFF, 3-20A
	80-800A Ext CTs	80-120% of CT Prim	OFF, 10-30% of CT Prim
777-LR, 777-HVR-LR, 777-575-LR	1-2.5A Looped	1-5A	0.15-1A
	2-9A Direct	2-10A	0.3-2A
Frequency	50/60 Hz		
Short Circuit	100 kA		
Power Consumption	10 Watts (max.)		
Output Contact Rating SPDT (Form C)			
All 777-XXX-XX KW/HP types except -HVR	Pilot duty rating: 480VA @ 240VAC		
	General purpose: 10A @ 240VAC		
	Max Voltage: 277VAC		
777-HVR-KW/HP 777-HVR-LR-KW/HP	Pilot duty rating: 480VA @ 600VAC		
Expected Life			
Mechanical	1 x 10^6 operations		
Electrical	1 x 10^5 operations at rated load		
Accuracy at 25° C (77° F)			
Voltage	±1%		
Current	±3%(<100 Amps Direct)		
GF Current	±15%		
Timing	5% ± 1 second		
Repeatability			
Voltage	± 0.5% of nominal voltage		
Current	± 1% (<100 amps direct)		
Safety Marks			
UL	UL508, UL1053		
CSA	LR46510		
CE	IEC 60947-1, IEC 60947-5-1		
Standards Passed			
Electrostatic Discharge (ESD)	IEC 1000-4-2, Level 3, 6kV contact, 8kV air		
Radio Frequency Immunity (RFI), Conducted	IEC 1000-4-6, Level 3 10V/m		
Radio Frequency Immunity (RFI), Radiated	IEC 1000-4-3, Level 3 10V/m		
Fast Transient Burst	IEC 1000-4-4, Level 3, 3.5 kV input power		
Surge			
IEC	1000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground		
ANSI/IEEE	C62.41 Surge and Ring Wave Compliance to 6kV line-line		
Hi-potential Test	Meets UL508 (2 x rated V +1000V for 1 minute)		
Vibration	IEC 68-2-6, 10-55Hz, 1mm peak-to-peak, 2 hours, 3 axis		
Shock	IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse		
Mechanical			
Dimensions	3.0"H x 5.1 " D x 3.6"W		
Terminal Torque	7 in.-lb.		
Enclosure Material	Polycarbonate		
Weight	1.2 lbs.		
Maximum Conductor Size Through 777-KW/HP	0.65" with insulation		
Environmental			
Temperature Range	Ambient Operating: -20° to 70° C (-4° to 158°F) Ambient Storage: -40° to 80° C (-40° to 176°F)		
Pollution Degree	3		
Class of Protection	IP20, NEMA 1		
Relative Humidity	10-95%, non-condensing per IEC 68-2-3		

Programmable Operating Points	**Range**	
LV, HV, OC, GF	See electrical specifications above	
UB- Voltage Unbalance Threshold	2 - 15% or 999%	
MULT- # of Loops or CT Ratio (XXX:5)	1-10 Loops or 100-800 Ratio	
LP- Low Power Setting	See Power Ranges Below or 0=off	
CUB- Current Unbalance Threshold	2 - 25% or 999%	
TC- Overcurrent Trip Class **	5, J5, 10, J10, 15, J15, 20, J20, 30, J30	
RD1- Rapid Cycle Timer	0, 2 - 500 Seconds	
RD2- Restart Delay After All Faults Except Underload (motor cool down timer)	2 - 500 Minutes	
RD3- Restart Delay After Underload (dry-well recovery timer)	2 - 500 Minutes	
#RU- Number of Restarts After Underload	0, 1, 2, 3, 4, A(Automatic)	
ADDR- RS485 Address	A01- A99	
#RF-Number of Restarts After All Faults Except Underload***	0, 1, oc1, 2, oc2, 3, oc3, 4, oc4, A, ocA	
Low Power (LP) / Power Range Setting (PWS)	1 = 0.01 - 0.99 KW	5 = 0.01 - 0.99 HP
	2 = 1.00 - 9.95 KW	6 = 1.00 - 9.95 HP
(PWS = LP Range)	3 = 10.0 - 99.5 KW	8 = 10.0 - 99.5 HP
	4 = 100 - 650 KW	9 = 100 - 650 HP

SymCom warrants its microcontroller based products against defects in material or workmanship for a period of five (5) years from the date of manufacture. All other products manufactured by SymCom shall be warranted against defects in material and workmanship for a period of two (2) years from the date of manufacture. For complete information on warranty, liability, terms returns, and cancellations, please refer to the SymCom Terms and Conditions of Sale document.

NOTES: SymCom's 777-KW/HP & 777-LR-KW/HP can be preprogrammed prior to installation by applying 120 VAC between the L1 and L2 terminals.

* 575 volt Model (MS 777-575-KW/HP)

** If J prefix is displayed in trip class setting, jam protection is enabled.

*** If "oc" is disabled in the #RF setting, the overcurrent will be included as a normal fault and the relay will automatically restart after RD2 expires, otherwise, manual reset is required after an overcurrent fault.

INSTALLATION INSTRUCTIONS FOR MODELS 777-KW/HP, 777-LR-KW/HP,777-575-KW/HP, 777-HVR-LR-KW/HP, 777-HVR-KW/HP POWER MONITOR/MOTOR PROTECTION RELAY

BE SURE POWER IS DISCONNECTED PRIOR TO INSTALLATION!
FOLLOW NATIONAL, STATE AND LOCAL CODES!
READ THESE INSTRUCTIONS ENTIRELY BEFORE INSTALLATION.

The Model 777-KW/HP is a solid-state power monitor/motor protection relay. It is fully-programmable for customized protection. It is designed to protect three phase systems operating on voltages from 190 to 480 VAC (500-600VAC for 777-575-KW/HP). The output relay is a Form C contact, which can control a contactor or other device within the output relay contact rating. The unit can be programmed prior to installation by applying 120VAC to terminals 'L1' and 'L2' (except 777-575-KW/HP and 777-HVR-KW/HP). The unit can NOT be tested for proper operation using this voltage. For testing purposes, three phase power needs to be used with a minimum voltage of 190VAC (450VAC for 777-575-KW/HP and 777-HVR-KW/HP).

DANGER!

HAZARDOUS VOLTAGES MAY BE PRESENT DURING INSTALLATION.
Electrical shock can cause death or serious injury.
Installation should be done by qualified personnel following all national, state and local electrical codes.

CONNECTIONS

1. Disconnect power and verify power is off.

2. Using the four corner tabs or the DIN rail mount, mount the 777 directly above or below the contactor. To use the DIN rail mount, hook the top clip first then apply downward pressure until the lower clip 'clicks' onto the rail.

3. A) For amperage ranging from 25-90 amps (2-9 Amps -LR types), insert the motor conductors through the holes marked 'A', 'B', and 'C'. Make certain that the conductor through each hole corresponds to the right motor conductor, i.e. the 'A' phase conductor should go through the 'A' round hole. See Figure 1 for a typical wiring diagram.
   B) For amperage less than 25 amps, loop the motor conductors according to Table 1. Figure 3 shows an example of the looping required for current ranging from 8.1 to 12 amps (MULT=3).
   C) For amperage greater than 90 amps, external CT's (current transformers) are required. SymCom recommends CT's with terminals be used for ease of installation. All CT secondaries must make five passes through the round holes on the PumpSaver. See Figure 2 for a typical wiring diagram using external CT's.
   NOTE: Pay close attention to this diagram to eliminate any power factor errors that will create errors in the horsepower measurements.

4. Connect the three phase power from the line side of the contactor to 'L1', 'L2', and 'L3' terminals using 12-18AWG copper wire (See Figure 1). Figure 1 is drawn for a power system wired in "ABC" phase sequence. For power systems with "ACB" phase sequence, switch L1 and L3 connections on 777-KW/HP input.

5. Connect the control circuit wires to the appropriate terminals. The relay is a fail safe design so the 'NO' contact should be in series with the coil on the contactor for motor control (see Figure 1). For alarm circuits, the 'NC' contact is in series with the alarm circuitry.

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SymCom Inc
Motor Protection & Controls Since 1974

ELECTRIC MOTOR WHOLESALE.COM

Model	Full Load Amps	# of Loops	# of Conductors through A, B and C	MULT to Program (CT Ratio)
777-XXX-LR-KW/HP	1 - 2	1	2	2
	2 - 9	0	1	1
777-KW/HP 777-HVR-KW/HP 777-575-KW/HP	2 - 2.5	9	10	10
	2.5 - 3	8	9	9
	3 - 3.5	7	8	8
	3.5 - 4	6	7	7
	4 - 5	5	6	6
	5 - 6	4	5	5
	6 - 8	3	4	4
	8 - 12	2	3	3
	12 - 25	1	2	2
	25 - 90	0	1	1
External CTs required. See wiring diagram for external CTs.	80 - 110	4	5	100 (100:5)
	110 - 160	4	5	150 (150:5)
	160 - 220	4	5	200 (200:5)
	220 - 320	4	5	300 (300:5)
	320 - 420	4	5	400 (400:5)
	400 - 520	4	5	500 (500:5)
	480 - 600	4	5	600 (600:5)
	560 - 800	4	5	800 (800:5)

Table 1: Wiring Configuration Based on Motor Full Load Amps

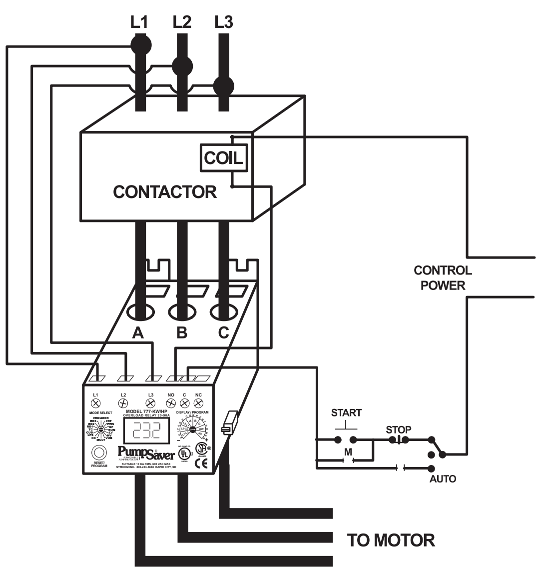


Figure 1: Typical Wiring Diagram for FLA of 26-90 ("ABC" phase sequence*)
***For input power configuration of "ACB" phase sequence, invert the L1 and L3 terminals on the 777-KW/HP.**

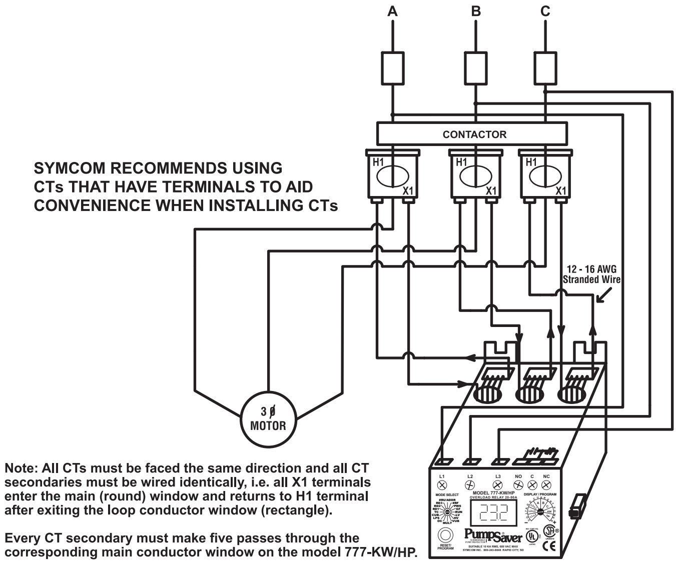


Figure 2: **Typical Wiring Diagram Using External CTs.**

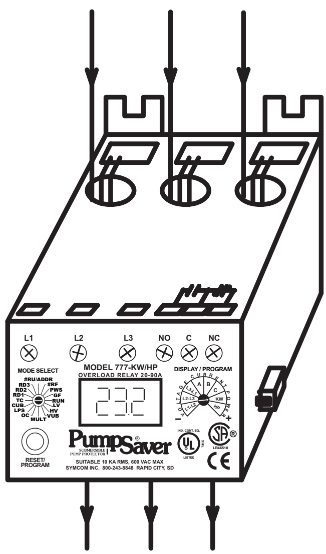


Figure 3: **Looping Example Showing Three Conductors (MULT=3 from Table 1)**
(No other necessary connections are shown.)

! WARNING !

UNEXPECTED OUTPUT ACTUATION CAN OCCUR.
Use hard-wired safety inerlocks where personnel and/or equipment hazards exist.
Failure to follow this instruction can result in death, injury or equipment damage.

PROGRAMMABLE PARAMETERS

The programmable parameters are the parameters which the user MUST program to provide the correct protection for the application. All parameters are actual values except for the “VUB” and the “CUB” settings. These are programmed as percentages. The range these parameters can be programmed to is found on the electrical specifications on page 11. See page 7 for programming examples.

LV/HV - The recommended settings for LV (low-voltage) and HV (high-voltage) according to the NEMA MG1 standard are ±10% of the motors nameplate voltage. For other settings the motor manufacturer should be contacted. Example: The motor nameplate voltage is 230 volts. If we take 90% and 110% of 230 we get 0.9 x 230= 207 volts for the LV setting and 230 x 1.1= 253 volts for the HV setting. These parameters are based on the average voltage going to the motor.

VUB - VUB (voltage unbalance) is factory set at 6%. The NEMA MG1 standard says a motor should not be operated above a 1% voltage unbalance without **DERATING** the motor. Most utility supplied power sources have a difficult time sustaining a 1% VUB. The motor manufacturer should be consulted for an exact VUB setting. A setting of 999 for VUB will disable the VUB protection and SP (single phase protection).

The VUB is calculated as follows:

%VUB = [(Maximum deviation from the average)/Average] x 100%

Example: Measured line-line voltages = 203, 210, and 212, so the average = (203+210+212)/3 = 208.3, the maximum deviation from the average is the biggest difference between the average voltage (208.3) and any one voltage reading, 212-208.3 = 3.7, 210-208.3 = 1.7 and 208.3-203 = 5.3, therefore the maximum deviation from the average is 5.3. The VUB is then = 5.3/208.3 x 100= 2.5%

MULT - MULT (multiplier) setting is found from table 1. The MULT setting is determined by the current the unit will be monitoring. This allows the unit to display the correct current. Changing this setting will also change the “OC”, and “GF” set points.

OC - OC (overcurrent) is usually set at the service factor amperage (typically 100-115% of motor FLA) of the motor, which is determined by the motor manufacturer. If any one leg of current exceeds the oc setting, the unit will follow its overload trip curve. (see Figure 4).

LP- LP (low power setting) is used to shut down the motor or pump on an underload condition. Setting LP to 0 disables the underload trip feature. LP is set in either kilowatts (KW) or horsepower (HP) depending on the PWS setting. NOTE: PWS must be set before setting LP.

HP- HP (high power setting) is used to shut down the motor or pump on an overpower condition. The High Power trip uses the underload trip delay and dry well recovery timer (RD3) to delay trips and restarts. The HP and underload trip delay settings can only be adjusted from the SymCom Solutions software or another software utility that can send Modbus write commands. The 777-KW/HP is shipped from the factory with this feature disabled.

CUB - CUB (current unbalance) is factory set to 7%. SymCom recommends the motor manufacturer be contacted for an exact setting. The CUB is calculated the same way the VUB is determined above. The CUB protection can be disabled by programming a 999 in this setting. This will disable current unbalance protection and current single phasing protection.

TC - TC (trip class) is the parameter used to determine when the unit will trip when an overload condition is detected. For standard motors, the TC is typically set at 20. The motor manufacturer should be contacted for exact TC settings. Table 2 and Figure 4 show the range of TC settings and trip times.

RD1 - RD1 (restart delay one) is the rapid cycle timer in seconds. This timer is initiated when power is first applied to the unit. If everything is okay (voltages are within the programmed limits and no SP or RP condition exists), after power is applied to the device and the RD1 time expires, the output relay will energize (the NO will close and the NC will open). Typically, this is set to 20-30 seconds. This will provide adequate protection for successive power outages or short cycling caused by other motor controls. This timer is also initiated when another control shuts the motor off (current goes to zero). If the user does not want the units' relay to de-energize when another control shuts the motor off, then RD1 should be set to zero. This will also assure that when an alarm circuit is used, an alarm will sound only when there is a true problem or when power is lost.

RD2 - RD2 (restart delay two) is the restart timer, in minutes, used when the unit has shut off due to a current unbalance, current single phasing, or an overload condition (if "oc" is the prefix to the number in #RF, see #RF description). This timer is known as a motor cool down timer. A setting of 5-10 minutes will give most motors adequate time to cool down after an overload condition. The motor manufacturer should be contacted for an exact value.

RD3- Restart Delay 3 (Dry Well Recovery Timer) RD3 can be set from 2-500 minutes or to 'A' to enable the Automatic Dry Well Recovery Calculator. The RD3 timer causes a restart delay after an under load (LP) trip.

The Automatic Dry Well Recovery Calculator allows the 777 to automatically select a restart delay based on the run time of the last run cycle. Table 2 shows the next restart delay vs. run time. In general a longer run time produces a shorter restart delay. This feature allows the 777 to optimize running and rest times automatically.

Run time	Next Restart Delay (min)	Starts/Hr
> 1hr	6	10
30 min - 59.99 min	15	4
15 min - 29.99 min	30	2
< 15 min	60	1

Table 2: State Table

#RU - The #RU/ADDR is a dual function setting. #RU can only be set to 0, 1, 2, 3, 4, or A. ADDR settings have the following format: Axx. The "xx" is any number combination from 01-99. This is how to identify which parameter is being programmed. The #RU settings cover from the 7 o'clock position to the 11 o'clock position. ADDR settings start after the 11 o'clock position. #RU (# of restarts after an underload) is the number of restarts after a low power trip condition before the unit locks and requires a manual restart. This counter will be cleared one minute after start-up if the unit does not trip again on LPR. A setting of zero means no automatic restarts after an under load. A setting of "A" means the unit will always automatically restart after an underload.

ADDR - ADDR (address) is the RS485 address of the particular device. This is only used when communicating with an RM-2000 (set ADDR=A01), RM-1000, a PLC, or PC. The ADDR can be programmed from A01-A99.

#RF - #RF (# of restarts after a fault) is the number of restarts allowed after a current unbalance, current single phasing, or an overload condition. A setting, which includes an "oc" prefix, will include over current in the number of successive restarts. If "oc" is not a prefix to the programmed setting, the unit will require a manual restart after an overcurrent. A setting of zero means the unit will not try to restart after a CUB, OC, or SP. A setting of "ocA" means the unit will always try to restart after a CUB, OC, or SP.

PWS - PWS (power scale) is the range setting for the LP setting.
1=0.01 - 0.99 KW; 2=1.00 - 9.95 KW; 3=10.0 - 99.5 KW; 4=100 - 650 KW
5=0.01 - 1.30 HP; 6=1.34 - 13.3 HP; 7=13.4 - 133.0 HP; 8=134 - 871 HP
Settings 1-4 will allow the LP setting to display in KW.
Settings 5-8 will allow the LP setting to display in HP.

GF - GF (ground fault) is the maximum allowable current, which can flow to ground before the unit de-energizes its relay. This is a residual, class II ground fault system and should not be used for personnel safety. A typical setting for this is 10%-20% of the motor full load current. The real GF current level is programmed into the unit. The GF test procedure on the last page of the installation instructions must be conducted before the device is brought online.

PROGRAMMING

1. Rotate the mode select switch to the parameter to be programmed. SymCom recommends that “LV” be programmed first and then move clockwise through the positions to complete the process.
2. Press and hold the “RESET/PROGRAM” button.
3. Rotate the “DISPLAY/PROGRAM” knob until the proper setting for the parameter that is being programmed is displayed in the LED display.
4. Release the “RESET/PROGRAM” button. This stores the new parameter in the nonvolatile memory. If the number changes back to what is was before programming, then the tamper guard is “on” and will need to be unlocked before programming can be completed.(See page 11 for tamper guard procedures.)
5. Continue steps 1-4 until all parameters are programmed.
6. The programming is now complete. Please see “Operations” section (p.6) for operating the unit.

Operation

The relay operation of the 777-KW/HP is a fail safe design. This means when everything is within the limits programmed into the unit, the relay will energize; the normally open (NO) contact will close and the normally closed (NC) contact will open. Once the unit has been wired and programmed, the unit is ready to operate. Turn the mode select to the “RUN” position. The display will show “RUN” alternating with some number (the numbers displayed will be the number corresponding to where the “DISPLAY/PROGRAM” knob is pointed). It will do this for the amount of time programmed into “RD1”. After this time has expired, the relay will energize (normally open will close and normally closed contact will open). If something else is in the display, see the troubleshooting section for more information. If the mode select is taken out of the “RUN” position, the unit’s relay will de-energize.

Trip Class	Application Description
5	Small fractional horsepower motors where acceleration times are almost instantaneous or where extremely quick trip times are required.
10	(Fast Trip) Hermetic refrigerant motors, compressors, submersible pumps and general purpose motors that reach rated speed in less than 4 seconds.
15	Specialized applications.
20	(Standard Trip) Most NEMA-rated general purpose motors will be protected by this setting.
30	(Slow Trip) Motors with long acceleration times (>10 seconds) or high inertia loads.
J Prefix	Programming any of the trip classes with the J Prefix will enable jam protection. This additional protection is enabled 1 minute after the motor starts and provides a 2 second trip time for motors exceeding 400% of the “OC” setting, regardless of trip class.

Table 3: Trip Class Descriptions

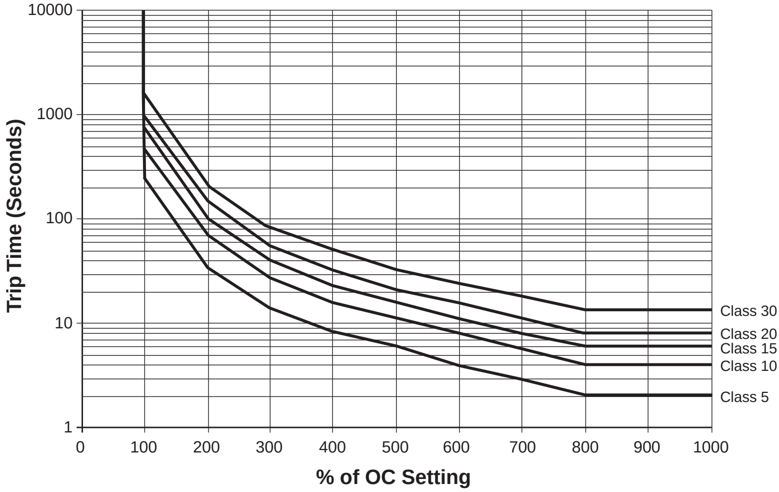


Figure 4: Overload Trip Curves

Programming Examples

Example

Pump To Be Protected: 3Ø, 460 Volt, 5 hp magnetic drive pump with a full load amperage rating of 7.1A and maximum service factor amps of 8.2. Use the following calculations and reasoning to determine the appropriate settings for this application. Use 777-LR-KW/HP from Table 1.

LV-	460 x 0.90 = 414
HV-	460 x 1.10 = 506
VUB-	Standard NEMA motor = 5
MULT-	From Table No. 1, Mult = 1 (777-LR-KW/HP)
OC-	Service Factor Amperage = 8.2
LP-	Normal pumping operation reads 2.86 KW Pump with a momentarily restricted flow (dead head) reads 1.8 KW Therefore setting is 2.0 KW (see PWS for proper range)
CUB-	Standard NEMA motor = 5
TC-	General purpose motor = 20
RD1-	To protect the pump from accidental rapid cycling, RD = 20 seconds.
RD2-	Because the motor may be hot from running in an unbalance or single phase condition, a motor cool down time of 10 minutes, RD2 = 10, should be appropriate.
RD3/#RU-	Because an underload (low power) would signal a serious problem in this application (dead head), #RU should be set = 0 for a manual reset. Therefore, RD3 does not have any function.
#RF-	Because an overload (overcurrent) fault signals a serious problem in this application (e.g., worn bearings), "oc" should not be included in the #RF setting so that a manual reset after an overload fault is required. A #RF=1 will give the system 1 chance to recover from an unbalance or single phasing problem before manual reset is required.
PWS-	LP setting is 2.0 KW: therefore range = 2 (1.0 - 9.95).
GF-	A ground fault setting of 15% of full load amps will be a significant indicator that the motor should be evaluated for repair or replacement. Therefore, GF = 7.1A x 0.15 = 1.0.

System Display

The output display can show one of the following parameters when the “MODE SELECT” switch is pointed at the “RUN” position: kilowatt or horsepower, each line current, or each individual line-line voltage. The display is also used for programming the operating parameters of the device. The display also identifies what caused the unit to de-energize its relay or what is keeping the unit from energizing its relay. The last fault, not the current fault, can be displayed by pressing and holding the “RUN/RESET” button while the “MODE SELECT” switch is in the “RUN” position. When the unit trips off or is holding the motor off, the current fault condition will be shown in the display without pressing the button. Table 3 below lists the fault codes the unit could display.

Displayed Message	Meaning
oc	Tripped on Overcurrent
SP	Tripped on current single phasing or unit won’t start because the voltage is sing phased.
ub	Tripped on current unbalance or unit won’t start because the voltage is unbalanced.
LPR	Tripped on Low Power
CF	Tripped on Contactor Failure
GrF	Tripped on Ground Fault
H I	A high voltage condition exists.
Lo	A low voltage condition exists.
rP	Incoming phases have been reversed. Your motor may run backward if started.
oFF	A stop command was issued from a remote source.

Table 4: Fault Codes and Their Meaning

Communications Port / Remote Reset

The unit comes with a 9-pin sub-D connector for remote communications and/or for using a remotely located reset button.

If communications are desired, a communication module (part number RS485MS-2W) needs to be plugged into this 9-pin connector (this is mandatory when communicating with the unit). This module provides isolation, signal conditioning for compatibility with Modbus RTU and RS485 networks, and provides terminals for terminating the shielded communications cable. Up to 99 units can be installed on one RS485 network. Further information can be obtained at http://www.symcominc.com or by calling in your request.

A remote reset button can be hooked up to the communications module (pn RS485MS-2W) or can be hooked directly to the 9-pin connector using a male sub-D connector. It should be wired as shown in Figure 5.

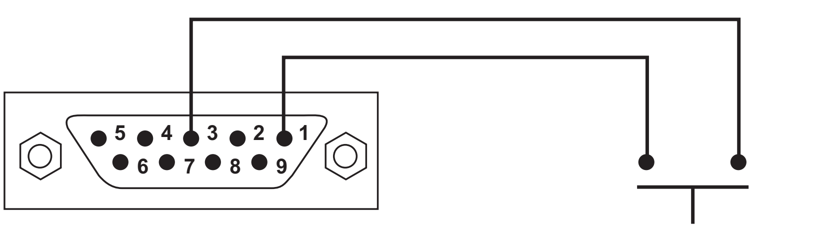


Figure 5: Remote Reset Button Wiring Diagram

Troubleshooting

The PumpSaver will display a fault code alternating with a number or with “run” when it is in a trip condition. If the unit is showing a fault code (see Table 5) alternating with the word “run”, then this indicates it has tripped on a current (amperage) condition. If the fault code is alternating with some number (voltage reading or zero) then the unit will not allow the motor to start because there is a problem with the incoming voltage. If the display is showing just a fault code, then the unit is in a mode that requires a manual reset. This could be because the number of restarts (#RF, #RU) has expired or is not allowed. If the display is showing ‘off’ then a stop command was issued through the communications network.

PROBLEM	SOLUTION
The unit will not start. Display alternates “rP” with the “DISPLAY / PROGRAM” switch parameter value.	The voltage inputs are reverse phased. If this is the initial start up, swap the leads connected to “L1” and “L3” on the 777-KW/HP to correct the problem. If the overload relay has been previously running, the power system has been reverse phased. Check the phase sequence of the incoming power lines. Note: “L1” must be tapped from conductor Phase A, “L2” from B, and “L3” from C for correct kilowatt measurements.
The unit will not start. Display alternates “SP”, “ub”, “HI”, or “Lo” with the “DISPLAY / PROGRAM” switch parameter value.	The incoming voltage is not within the limits programmed in the “VUB”, “HV”, and “LV” settings. Adjust the “DISPLAY / PROGRAM” switch to read the incoming line voltage values. Correct the incoming power problem and check programmed limits to verify they are correct.
Display alternates “SP”, “ub”, or “oc” with “RUN”	The overload relay has tripped on the fault shown on the LED display and is timing down “RD2” before restarting.
Display alternates “LPR” with “RUN”	The overload relay has tripped on low power (LPS) and is timing down “RD3” before restarting. If LPS is not a normal condition for this installation, check for loss of liquid, closed valves, broken belts, etc.
Display is showing a solid “SP”, “ub”, or “oc”	The unit has tripped on the fault shown and a manual reset is required because of the programmed setting in “#RF”. Check the system for problems that would produce the single phase, overload or current unbalance fault like a jam.
Display is showing a solid “LPR”	The unit has tripped on low power and a manual reset is required because of the setting in “#RU.” Check the system for problems that would produce a loss of load like a broken belt or a pump is out of liquid.
Display is showing a solid “CF”	The unit has tripped on a single phasing of the current, but was not single phased by the incoming voltage. Check for damaged contacts or loose wiring.
Display is showing a solid “GrF”	A ground fault current greater than the programmed “GF” value has been detected. A manual reset is required. Check the motor for insulation breakdown.
Unit displays currents when the motor starts but reads “0” KW or HP and trips on “LPR”after 4 seconds.	The unit is not wired properly to calculate correct power factor. See Figures 1, 2 & 3 (pages 2 & 3) for proper wiring and review step 4 in connection instructions (page 1).
Display alternates “HPR” with “RUN”	The overload has tripped on high power and is timing down RD3.
Display is showing solid “HPR”	The overload has tripped on high power and requires a manual reset.
Unable to change parameters	**See Tamper Guard Page 11**

<u>Table 5:</u> Troubleshooting

MODEL 777-KW/HP SPECIFICATIONS

Electrical			
Input Voltage Ranges and Low and High Voltage Setpoints			
	Low Setpoint (LV)	Nominal Voltage Range	High Setpoint (HV)
777-KW/HP 777-LR-KW/HP	170-HV Setting	200-480 VAC	LV Setting - 528
777-HVR 777-HVR-LR	340-HV Setting	380-480 VAC	LV Setting - 528
777-575 777-575-LR	450-HV Setting	480-600 VAC	LV Setting - 660
Nominal Motor Full Load Current and Overcurrent Setpoint			
	Nom. Current Range	Overcurrent Setpoint (OC)	Ground Fault Setpoint (GF)
777, 777-HVR, 777-575	2-25A Looped 25-90A Direct 80-800 A Ext CTs	(20 to 100A)/MULT 20 to 100A 80-120% of CT Prim	OFF, (3 to 20A)/MULT OFF, 3-20A OFF, 10-30% of CT Prim
777-LR, 777-HVR-LR, 777-575-LR	1-25A Looped 2-9A Direct	1-5A 2-10A	0.15-1A 0.3-2A
Frequency	50-60 Hz		
Short Circuit	100 kA		
Power Consumption	10W (Maximum)		
Output Contact Rating SPDT (Form C)			
All 777-XXX-XX KW/HP types except -HVR	Pilot duty rating: 480 VA @ 240 VAC General purpose: 10A @ 240 VAC Max Voltage: 277 VAC		
777-HVR-KW/HP 777-HVR-LR-KW/HP	Pilot duty rating: 480 VA @ 600 VAC		
Expected Life			
Mechanical	1 x 10^6 operations		
Electrical	1 x 10^5 operations at rated load		
Accuracy at 25° C (77° F)			
Voltage	±1%		
Current	±3%(<100 Amps Direct)		
GF Current	±15%		
Timing	5% ± 1 second		
Repeatability			
Voltage	± 0.5% of nominal voltage		
Current	± 1% (<100 amps direct)		
Ground Fault Trip Delay			
101%-200% of Setpoint	8 sec. +/- 1 sec		
201%-300% of Setpoint	4 sec. +/- 1 sec		
301%-400% of Setpoint	3 sec. +/- 1 sec		
401% or Greater	2 sec. +/- 1 sec		
Current Unbalance Trip Delay	(30 seconds) / (% over setpoint) see examples below		
% Over Setpoint — Trip Time	% Over Setpoint — Trip Time		
1% — 30 sec	5% — 6 sec		
2% — 15 sec	6% — 5 sec		
3% — 10 sec	10% — 3 sec		
Safety Marks			
UL	UL508, UL1053		
CSA	LR46510		
CE	IEC 60947-1, IEC 60947-5-1		
Standards Passed			
Electrostatic Discharge (ESD)	IEC 61000-4-2, Level 3, 6kv contact, 8kv air		
Radio Frequency Immunity (RFI), Conducted	IEC 61000-4-6, Level 3 10V/m		
Radio Frequency Immunity (RFI), Radiated	IEC 61000-4-3, Level 3 10V/m		
Fast Transient Burst	IEC 61000-4-4, Level 3, 3.5 kv input power		
Surge			
IEC	61000-4-5, Level 3, 2kv line-to-line; Level 4, 4kv line-to-ground		
ANSI/IEEE	C62.41 Surge and Ring Wave Compliance to 6kv line-line		
Hi-potential Test	Meets UL508 (2 x rated V +1000V for 1 minute)		
Vibration	IEC 68-2-6, 10-55Hz, 1mm peak-to-peak, 2 hours, 3 axis		
Shock	IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse		
Mechanical			
Dimensions	3.0"H x 5.1 " D x 3.6"W		
Terminal Torque	7 inch•lb		
Enclosure Material	Polycarbonate		
Weight	1.2 lbs		
Maximum Conductor Size Through 777-KW/HP	0.65" with insulation		
Environmental			
Temperature Range	Ambient Operating: -20° - 70° C (-4° - 158°F) Ambient Storage: -40° - 80° C (-40° - 176°F)		
Pollution Degree	3		
Class of Protection	IP20, NEMA 1		
Relative Humidity	10-95%, non-condensing per IEC 68-2-3		

MODEL 777-KW/HP SPECIFICATIONS CONTINUED

Programmable Operating Points	Range
LV, HV, OC, GF	See electrical specifications above
UB- Voltage Unbalance Threshold	2 - 15% or 999%
MULT- # of Loops or CT Ratio (XXX:5)	1-10 Loops or 100-800 Ratio
LP- Low Power Setting	See Power Ranges Below or 0=off
CUB- Current Unbalance Threshold	2 - 25% or 999%
TC- Overcurrent Trip Class **	5, J5, 10, J10, 15, J15, 20, J20, 30, J30
RD1- Rapid Cycle Timer	0, 2 - 500 Seconds
RD2- Restart Delay After All Faults Except Underload (motor cool down timer)	2 - 500 Minutes
RD3- Restart Delay After Underload (dry well recovery timer)	2 - 500 Minutes
#RU- Number of Restarts After Underload	0, 1, 2, 3, 4, A(Automatic)
ADDR- RS485 Address	A01- A99
#RF-Number of Restarts After All Faults Except Underload***	0, 1, oc1, 2, oc2, 3, oc3, 4, oc4, A, ocA
Low Power (LP) / Power Range Setting (PWS) (PWS = LP Range)	1 = 0.01 - 0.99 KW 5 = 0.01 - 0.99 HP 2 = 1.00 - 9.95 KW 6 = 1.00 - 9.95 HP 3 = 10.0 - 99.5 KW 8 = 10.0 - 99.5 HP 4 = 100 - 650 KW 9 = 100 - 650 HP

NOTES: SymCom's Power Monitor/Motor Protection Relay can be preprogrammed prior to installation by applying 120 VAC between the L1 and L2 terminals (except 575 Volt model). Power applied must be 110 VAC or greater.

* 575 Volt Model.

** If J Prefix is displayed in trip class setting, jam protection is enabled.

*** If "oc" is displayed in the #RF setting, then overcurrent will be included as a normal fault and the relay will automatically restart after RD2 expires, otherwise, manual reset is required after an overcurrent fault.

**** Given current range within nominal specified range and power factor must be > 60%

Clearing Last Fault

The last fault stored can be cleared on the PumpSaver.

This procedure is outline as follows:

1. Rotate the Mode Select Switch to 'GF'.
2. Press and hold the Reset/Program Button. Adjust the Display/Program adjustment until cLr appears on the display. Release the Reset/Program Button.

To verify the last fault was cleared, place the Mode Select switch in the Run position. Then press and hold the Reset/Program Button, cLr should be on the display.

Tamper Guard

The PumpSaver can be protected from unauthorized program changes by locking in the setpoints.

This procedure is outlines as follows:

1. Rotate the Mode Select switch to 'GF'.
2. Rotate Display/Program adjustment fully clockwise.
3. Press and hold the Reset Button. Adjust the Display/Program adjustment until 'Loc' appears in the display.
4. Release the Reset Button.
5. Turn Mode Select switch to 'run'.

The program is now locked, but all settings can be viewed. The unit can be unlocked by following the procedure above except step three. This step should say: Press and hold the Reset Button. Adjust the Display/Program adjustment until 'unL' appears in the display.

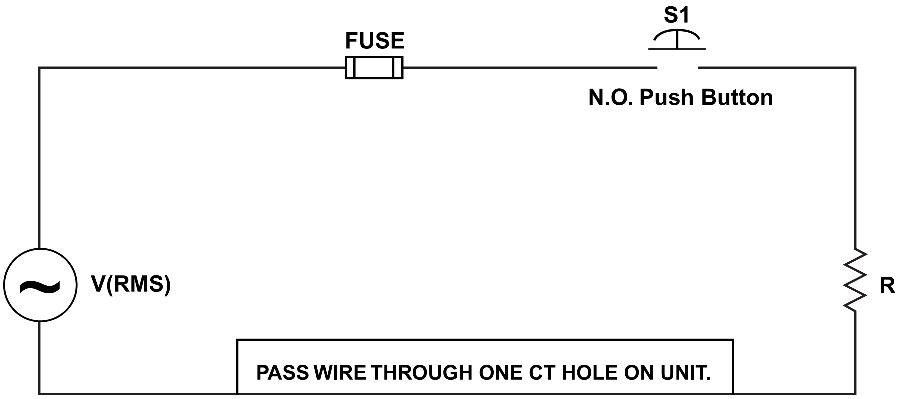
Network Tamper Guard

The PumpSaver can be protected from unauthorized program changes by locking each set point via the network. These set points can only be unlocked if the password is known. This feature is only available with SymCom Solutions software. For more information please call the factory.

The GF test must be performed before installing the PumpSaver as required by UL1053 and NEC, ANSI/NFPA 70.

Ground Fault Testing Procedure

1. Disconnect power
2. Hook up the three line voltages to L1, L2, and L3 as required by the installation instructions.
3. Program the desired parameters into the unit. For test purposes, set MULT to one and GF to the minimum allowed setting.
4. Construct the circuit below, using an AC power supply. This circuit simulates a ground fault condition by generating a current in one of the phases. Alternate test circuits may be used. The only requirement is the current through the current transformer must be between 115% and 150% of the GF setting and pass through only one CT window.



5. The values of V and R will be determined by the current required to generate a GF trip condition: I = Vrms/R, where I = 115% of GF setting.
6. Place the unit in the run position, apply three phase power and allow the N.O. contact to close.
7. Energize the test circuit by pushing and holding the test push-button until the unit trips (within 8.5 seconds). The display should show GrF and the N.O. contacts should be open. Release the N.O. push button.
8. The results of the test are to be recorded on the test form provided. The form should be kept by those in charge of the buildings electrical installation in order to be available to the authority having jurisdiction.
9. Confirm programmed parameters and proceed with installation instructions.

Ground Fault Test Results*

Date	Performed by	Results	Location

*A copy of this form should be retained by buildings electrical foreman.

SymCom warrants its microcontroller based products against defects in material or workmanship for a period of five (5) years from the date of manufacture. All other products manufactured by SymCom shall be warranted against defects in material and workmanship for a period of two (2) years from the date of manufacture. For complete information on warranty, liability, terms, returns, and cancellations, please refer to the SymCom Terms and Conditions of Sale document.

SYMCOM MOTORSAVER
MODEL MS777 SPECIFICATIONS

B3-EXW03

B3-EXW04

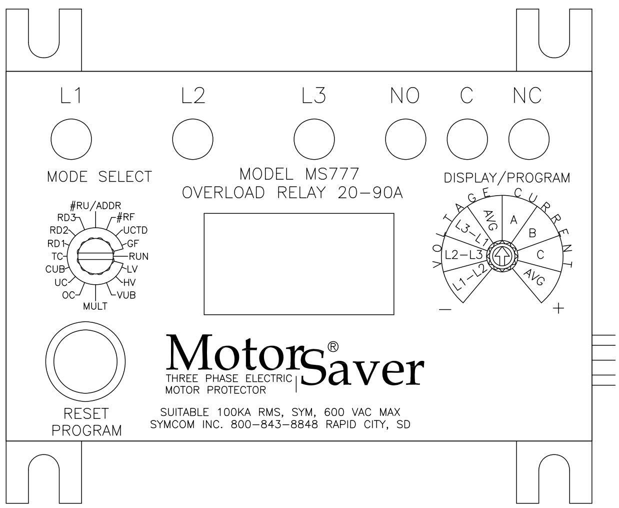
B3-EXW05

S&N PUMP CO.®

Engineered Offshore
Pumping Solutions

MotorSaver®

THREE PHASE ELECTRIC
MOTOR PROTECTOR



MODEL 777

Installation & Operation Manual

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PREFACE

Please read this manual thoroughly before putting into operation for the first time. By doing so, you will guarantee safe and economic operation of your Model 777 Electronic Overload Relay.

SAFETY REGULATIONS

DANGER!

HAZARDOUS VOLTAGES MAY BE PRESENT DURING INSTALLATION.
Electrical shock can cause death or serious injury.
Installation should be done by qualified personnel following all national, state, and local electrical codes.

TABLE 1: Wiring Configuration Based on Motor Full Load Amps

FULL LOAD AMPS	# OF LOOPS	# OF CONDUCTORS - A, B, C	MULT SETTING (CT RATIO)
2.0 - 2.5	9	10	10
2.6 - 3.0	8	9	9
3.1 - 3.5	7	8	7
3.6 - 4.0	6	7	7
4.1 - 5.0	5	6	6
5.1 - 6.0	4	5	5
6.1 - 8.0	3	4	4
8.1 - 12	2	3	3
13 - 25	1	2	2
26 - 90	0	1	1
EXTERNAL CTs REQUIRED. SEE FIGURE 2 FOR WIRING EXTERNAL CTs			
91 - 110	4	5	100 (100:5)
111 - 160	4	5	150 (150:5)
161 - 220	4	5	200 (200:5)
221 - 320	4	5	300 (300:5)
321 - 420	4	5	400 (400:5)
421 - 520	4	5	500 (500:5)
521 - 620	4	5	600 (600:5)
621 - 800	4	5	800 (800:5)

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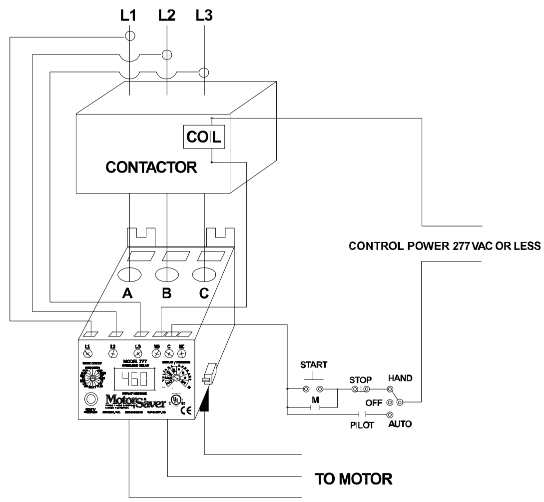


FIGURE 1: Typical Wiring Diagram for FLA of 26 - 90

SYMCOM RECOMMENDS USING CT's THAT HAVE TERMINALS TO MAKE CT INSTALLATION EASIER.

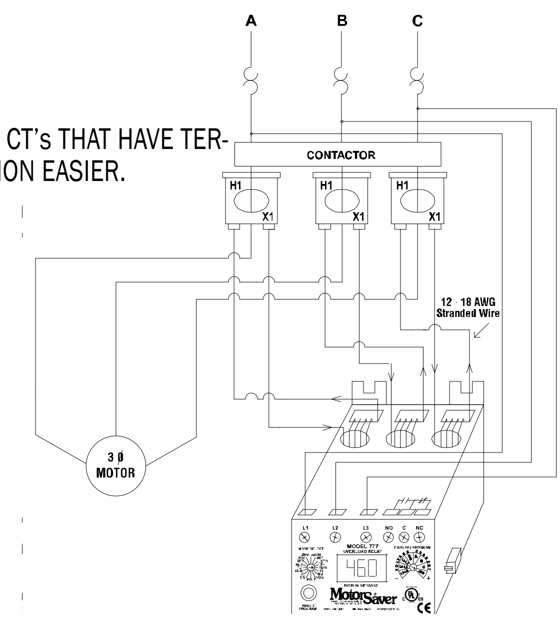


FIGURE 2: Typical Wiring Diagram Using External CTs

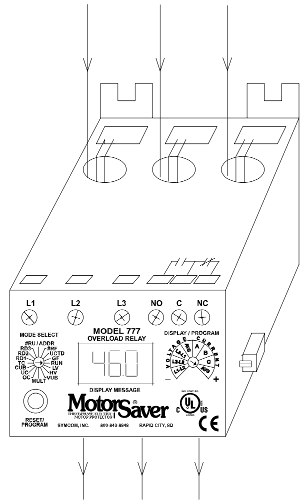


FIGURE 3: Looping Example Showing Three Conductors (MULT=3 from Table 1)
No other necessary connections are shown.

CONNECTIONS

1. Disconnect power and verify power is off.
2. Using the four corner tabs or the DIN rail mount, mount the 777 directly above or below the contactor. To use the DIN rail mount, hook the top clip first then apply downward pressure until the lower clip clicks onto the rail.
3. **A)** For amperages from 26-90 amps, insert the motor conductors through the holes marked A , B , and C . Make certain that the conductor through each hole corresponds to the right motor conductor, i.e. the A phase conductor should go through the A round hole.

   See Figure 1 for a typical wiring diagram.

   B) For amperages less than 26 amps, loop the motor conductors according to Table 1.
   Figure 3 shows an example of the looping required for current ranging from 8.1 to 12 amps (MULT=3).

   C) For amperages greater than 90 amps, external CT s (current transformers) are required. SymCom recommends CT s with terminals be used for ease of installation. All CT secondaries must make five passes through the round holes on the MotorSaver.

   See Figure 2 for a typical wiring diagram using external CT s.

   NOTE: Pay close attention to this diagram to eliminate any power factor errors when communicating with the device through the RS485 network.
4. Connect the three phase power from the line side of the contactor to L1 , L2 , and L3 terminals using 12-18AWG copper wire. These should be tightened to no more than 7 inch lbs.
5. Connect the control circuit wires to the appropriate terminals. The relay is a fail safe design so the NO contact should be in series with the coil on the contactor for motor control (see Figure 1). For alarm circuits, the NC contact is in series with the alarm circuitry.

PROGRAMMABLE PARAMETERS

The programmable parameters are the parameters which the user MUST program to provide the correct protection for the application. All parameters are actual values except for the VUB and the CUB settings. These are programmed as percentages.

LV/HV - The recommended settings for LV (low-voltage) and HV (high-voltage) according to the NEMA MG1 standard are –10% of the motors nameplate voltage. For other settings the motor manufacturer should be contacted. Example: The motor nameplate voltage is 230 volts. If we take 90% and 110% of 230 we get 0.9 x 230= 207 volts for the LV setting and 230 x 1.1= 253 volts for the HV setting. These parameters are based on the average voltage going to the motor.

VUB - VUB (voltage unbalance) is factory set at 6%. The NEMA MG1 standard says a motor should not be operated above a 1% voltage unbalance without DERATING the motor. Most utility supplied power sources have a difficult time sustaining a 1% VUB. The motor manufacturer should be consulted for an exact VUB setting. A setting of 999 for VUB will disable the VUB protection but will not disable SP (single phase protection).
The VUB is calculated as follows:

%VUB = [(Maximum deviation from the average)/Average] x 100%

Example: Measured line-line voltages = 203, 210, and 212, so the average = (203+210+212)/3 = 208.3, the maximum deviation from the average is the biggest difference between the average voltage (208.3) and any one voltage reading, 212-208.3 = 3.7, 210-208.3 = 1.7 and 208.3-203 = 5.3, therefore the maximum deviation from the average is 5.3. The VUB is then = 5.3/208.3 x 100= 2.5%

MULT - MULT (multiplier) setting is found in Table 1. The MULT setting is determined by the current the unit will be monitoring. This allows the unit to display the correct current. Changing this setting will also change the UC , OC , and GF set points.

OC- OC (overcurrent) is usually set at the service factor amperage (typically 100-115% of motor FLA) of the motor, which is determined by the motor manufacturer. If any one leg of current exceeds the oc setting, the unit will follow it s overload trip curve (see Figure 4).

UC - UC (undercurrent) is typically set at 80% of the full-load amperage of the motor. This is usually adequate for protection of loss of load for many pumps and motors, including submersibles. If the motor is not pulling near full load amperage then the UC may have to be set to something higher than 80% of FLA for adequate protection. UC can be set to 0 if UC protection is not desired. The UC trip point looks at the average current to determine if an under current trip condition exists.

CUB - CUB (current unbalance) is factory set to 7%. SymCom recommends the motor manufacturer be contacted for an exact setting. The CUB is calculated the same way the VUB is determined above. The CUB protection can be disabled by programming a 999 in this setting. This will disable current unbalance protection and current single phasing protection.

TC - TC (trip class) is the parameter used to determine when the unit will trip when an overload condition is detected. For standard motors, the TC is typically set at 20. The motor manufacturer should be contacted for exact TC settings. Table 2 and Figure 4 show the range of TC settings and trip times.

RD1 - RD1 (restart delay one) is the rapid cycle timer in seconds. This timer is initiated when power is first applied to the unit. If everything is okay (voltages are within the programmed limits and no SP or RP condition exists), after power is applied to the device and the RD1 time expires, the output relay will energize (the NO will close and the NC will open). Typically, this is set to 20-30 seconds. This will provide adequate protection for successive power outages or short cycling caused by other motor controls. This timer is also initiated when another control shuts the motor off (current goes to zero). If the user does not want the units relay to de-energize when another control shuts the motor off, then RD1 should be set to zero. This will also assure that when an alarm circuit is used, an alarm will sound only when there is a true problem or when power is lost.

RD2 - RD2 (restart delay two) is the restart timer, in minutes, used when the unit has shut off due to a current unbalance, current single phasing, or an overload condition (if oc is the prefix to the number in #RF, see #RF description). This timer is known as a motor cool down timer. A setting of 5-10 minutes will give most motors adequate time to cool down after an overload condition.The motor manufacturer should be contacted for an exact value.

RD3 - RD3 (restart delay three) is the restart timer, in minutes, used after an undercurrent trip. It is also known as a dry well recovery time in pumping applications. This would be the time it takes a well to recharge after pumping dry. This setting varies widely from application to application and there is no typical setting.

#RU - The #RU/ADDR is a dual function setting. #RU can only be set to 0, 1, 2, 3, 4, or A. ADDR settings have the following format: Axx. The xx is any number combination from 01-99. This is how to identify which parameter is being programmed. The #RU settings cover from the 7 o clock position to the 11 o clock position. ADDR settings start after the 11 o clock position. #RU (# of restarts after an undercurrent) is the number of restarts after an undercurrent trip condition before the unit locks and requires a manual restart. This counter will be cleared one minute after start-up if the unit does not trip again on UC. A setting of zero means no automatic restarts after an undercurrent. A setting of A means the unit will always automatically restart after an undercurrent.

ADDR - ADDR (address) is the RS485 address of the particular device. This is only used when communicating with an RM-2000 (set ADDR=A01), a PLC, or PC. The ADDR can be programmed from A01-A99

#RF - #RF (# of restarts after a fault) is the number of restarts allowed after a current unbalance, current single phasing, or an overload condition. A setting, which includes an oc prefix, will include over current in the number of successive restarts. If oc is not a prefix to the programmed setting, the unit will require a manual restart after an over current. A setting of zero means the unit will not try to restart after a CUB, OC, or SP. A setting of ocA means the unit will always try to restart after a CUB, OC, or SP.

UCTD - UCTD (undercurrent trip delay) is the amount of time, in seconds, the unit will allow the motor to run in an undercurrent situation before de-energizing it s relay. Typically, UCTD is set to 2-4 seconds.

GF - GF (ground fault) is the maximum allowable current, which can flow to ground before the unit de-energizes its relay. This is a residual, class II ground fault system and should not be used for personnel safety. A typical setting for this is 10%-20% of the motor full load current. The real GF current level is programmed into the unit. The GF test procedure on the last page of the installation instructions must be conducted before the device is brought online.

PROGRAMMING

1. Rotate the mode select switch to the parameter to be programmed. SymCom recommends that LV be programmed first and then move clockwise through the positions to complete the process.
2. Press and hold the RESET/PROGRAM button.
3. Rotate the DISPLAY/PROGRAM knob until the proper setting for the parameter that is being programmed is displayed in the LED window.
4. Release the RESET/PROGRAM button. This stores the new parameter in the nonvolatile memory. If the number changes back to what is was before programming, then the tamper guard is on and will need to be unlocked before programming can be completed.(See page 11 for tamper guard procedures.)

5. Continue steps 1-4 until all parameters are programmed.

6. The programming is now complete.

PROGRAMMING EXAMPLES

EXAMPLE #1

Motor To Be Protected: 3fl, 460 Volt, 25 Hp air compressor with a full load amperage rating of 34A and maximum service factor amps of 37.4. Use the following calculations and reasoning to determine the appropriate settings for this application.

LV - 460 x 0.90 = 414
HV - 460 x 1.10 = 506
VUB - Standard NEMA motor = 5
MULT - From Table No. 1 = 1
OC - Service Factor Amperage = 37.4
UC - FLA x 0.80 = 34A x 0.80 = 27.2
CUB - Standard NEMA motor = 5
TC - General purpose motor = 20
RD1 - Since this compressor takes about 10 seconds to bleed off excess pressure after a shutdown, setting RD1 = 20 will allow the compressor to unload before being restarted.
RD2 - Because the motor may be hot from running in an unbalance or single phase condition, a motor cool down time of 10 minutes, RD2 = 10, should be appropriate.
RD3/#RU - Because an undercurrent would signal a serious problem in this application (a broken shaft or belt), #RU should be set = 0 for a manual reset. Therefore, RD3 does not have any function
#RF - Because an overload (overcurrent) fault signals a serious problem in this application (e.g., worn bearings), “oc” should not be included in the #RF setting so that a manual reset after an overload fault is required. A #RF=1 will give the system 1 chance to recover from an unbalance or single phasing problem before manual reset is required.
UCTD - Setting UCTD = 5 will allow normal operation and not allow the motor to run too long in a failure mode.
GF - A ground fault setting of 15% of full load amps will be a significant indicator that the motor should be evaluated for repair or replacement. Therefore, GF = 34A x 0.15 = 5.1.

EXAMPLE #2

Motor To Be Protected: 3fl, 230 Volt, 5 Hp submersible pump with a full load amperage of 15.9 A and maximum service factor amps of 18.2. Use the following calculations and reasoning to determine the appropriate settings for this application.

LV - 230 x 0.90 = 207
HV - 230 x 1.10 = 253
VUB - Manufacturer suggests 5
MULT - From Table No. 1, MULT = 2, 1 loop of main conductor
OC - Service Factor Amperage = 18.2
UC - FLA x 0.80 = 15.9 x 0.80 = 12.7
CUB - Manufacturer suggests 5

TC - From Figure No. 3, for this (and most) submersible pumps, TC = 10 (fast trip)

RD1 - To protect the pump from rapid cycling, RD1 = 60

RD2 - Since the motor is small and submerged in water, the motor will generally cool down quickly. RD2=5

RD3 - The well history shows that it will fully recover in 2 hours. RD3 = 120

#RU - In this application, we know that the well will eventually recharge itself, #RU = A.

#RF - This well is known for sand to jam the impeller, therefore oc should be included so that the pump will attempt to automatically restart after an overloaded condition. History shows that 2 or 3 starts and stops usually clears the sand out of the impeller.
#RF = oc2 or oc3.

UCTD - This well may become airlocked on startup, but will usually re-prime itself in 5 seconds or less.
UCTD = 10

GF - Because this type of fault indicates the impending failure of the motor and it may take several days to get a new pump and schedule for a driller to remove and replace the pump, GF setting of 10% of full load amperage will give the well owner enough time to
prepare for pump replacement.
GF = 15.9A x 0.10 = 1.59

OPERATION

The relay operation of the 777 is a fail safe design. This means when everything is within the limits programmed into the unit, the relay will energize; the normally open (NO) contact will close and the normally closed (NC) contact will open. Once the unit has been wired and programmed, the unit is ready to operate. Turn the mode select to the RUN position. The display will show RUN alternating with some number (the numbers displayed will be the number corresponding to where the DISPLAY/PROGRAM knob is pointed). It will do this for the amount of time programmed into RD1 . After this time has expired, the relay will energize (normally open will close and normally closed contact will open). If something else is in the display, see the troubleshooting section for more

TABLE 2: Trip Class Descriptions

TRIP CLASS	APPLICATION DESCRIPTION
5	Small fractional horsepower motors where acceleration times are almost instantaneous or where extremely quick trip times are required.
10	(Fast Trip) Hermetic refrigerant motors, compressors, submersible pumps and general purpose motors that reach rated speed in less than 4 seconds.
15	Specialized applications.
20	(Standard Trip) Most NEMA-rated general purpose motors will be protected by this setting.
30	(Slow Trip) Motors with long acceleration times (>10 seconds) or high inertia loads.
J Prefix	Programming any of the trip classes with the J Prefix will enable jam protection. This additional protection is enabled 1 minute after the motor starts and provides a 2 second trip time for motors exceeding 400% of the OC setting, regardless of trip class.

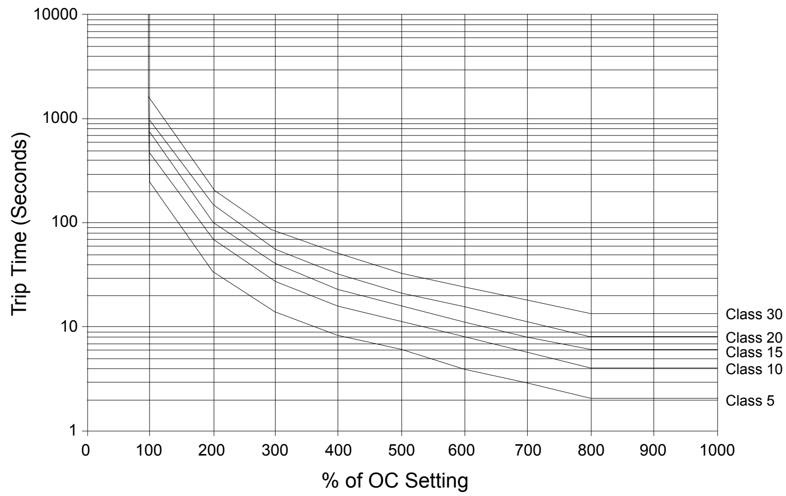


FIGURE 4: Overload Trip Curves

SYSTEM DISPLAY

The output display can show one of the following parameters when the MODE SELECT switch is pointed at he RUN position: average voltage or current, each line current, or each individual line-line voltage. The display is also used for programming the operating parameters of the device. The display also identifies what caused the unit to de-energize its relay or what is keeping the unit from energizing its relay. The last fault, not the current fault, can be displayed by pressing and holding the RUN/RESET button while the MODE SELECT switch is in the RUN position. When the unit trips off or is holding the motor off, the current fault condition will be shown in the display without pressing the button. Table 3 below lists the fault codes the unit could display.

TABLE 3: Fault Codes and Thier Meaning

DISPLAY MESSAGE	MEANING
oc	Tripped on Overcurrent
SP	Tripped on current single phasing or unit won t start because the voltage is sing phased.
ub	Tripped on current unbalance or unit won t start because the voltage is unbalanced.
uc	Tripped on Undercurrent
CF	Tripped on Contactor Failure
GrF	Tripped on Ground Fault
H I	A high voltage condition exists.
Lo	A low voltage condition exists.
rP	Incoming phases have been reversed. Your motor may run backward if started.
oFF	A stop command was issued from a remote source.

COMMUNICATIONS PORT/REMOTE RESET

The unit comes with a 9-pin sub-D connector for remote communications and/or for using a remotely located reset button.

If communications are desired, a communication module (part number RS485MS) needs to be plugged into this 9-pin connector (this is mandatory when communicating with the unit). This module provides isolation, signal conditioning for compatibility with Modbus RTU and RS485 networks, and provides terminals for terminating the shielded communications cable. Up to 99 units can be installed on one RS485 network. Further information can be obtained at http://www.symcominc.com or by calling in your request. A remote reset button can be hooked up to the communications module (pn RS485MS) or can be hooked directly to the 9-pin connector using a male sub-D connector. It should be wired as shown in Figure 5.

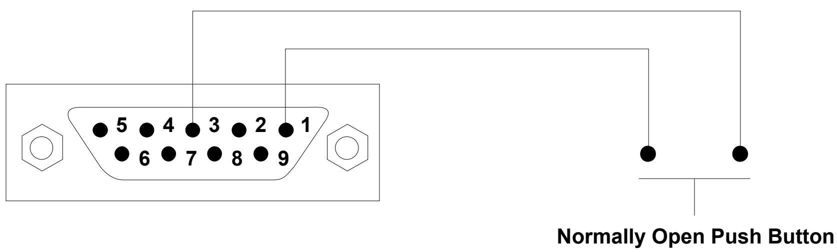


FIGURE 5: Remote Reset Button Wiring Diagram

TROUBLESHOOTING

The MotorSaver will display a fault code alternating with a number or with run when it is in a trip condition. If the unit is showing a fault code (see Table 4) alternating with the word run , then this indicates it has tripped on a current (amperage) condition. If the fault code is alternating with some number (voltage reading or zero) then the unit will not allow the motor to start because there is a problem with the incoming voltage. If the display is showing just a fault code, then the unit is in a mode that requires a manual reset. This could be because the number of restarts (#RF, #RU) has expired or is not allowed. If the display is showing off then a stop command was issued through the communications network.

TABLE 4: Troubleshooting

PROBLEM	SOLUTION
The unit will not start. Display alternates rP with the DISPLAY / PROGRAM switch parameter value.	The voltage inputs are reverse phased. If this is the initial start up, swap any two of the leads connected to L1 , L2 , or L3 on the 777 to correct the problem. If the overload relay has been previously running, the power system has been reverse phased. Check the phase sequence of the incoming power lines. Note: L1 must be tapped from conductor Phase A, L2 from B, and L3 from C for correct power factor measurements on remote communications.

The unit will not start. Display alternates SP , ub , HI , or Lo with the DISPLAY / PROGRAM switch parameter value.	The incoming voltage is not within the limits programmed in the VUB , HV , and LV settings. Adjust the DISPLAY / PROGRAM switch to read the incoming line voltage values. Correct the incoming power problem and check programmed limits to verify they are correct.
Display alternates SP , ub , or oc with RUN.	The overload relay has tripped on the fault shown on the LED display and is timing down RD2 before restarting.
Display alternates uc with RUN.	The overload relay has tripped on undercurrent and is timing down RD3 before restarting. If undercurrent is not a normal condition for this installation, check for broken shafts, broken belts, etc.
Display is showing a solid SP , ub , or oc.	The unit has tripped on the fault shown and a manual reset is required because of the programmed setting in #RF . Check the system for problems that would produce the single phase, overload or current unbalance fault like a jam.
Display is showing a solid uc.	The unit has tripped on undercurrent and a manual reset is required because of the setting in #RU. Check the system for problems that would produce a loss of load like a broken belt or a pump is out of liquid.
Display is showing a solid CF.	The unit has tripped on a single phasing of the current, but was not single phased by the incoming voltage. Check for damaged contacts or loose wiring.
Display is showing a solid GrF.	A ground fault current greater than the programmed GF value has been detected. A manual reset is required. Check the motor for insulation breakdown.

MODEL 777 SPECIFICATIONS

ELECTRICAL	
Input Voltage	200-480 VAC, 3fl(Standard) 500-600VAC for model 777-575

Motor Full Load Amp Range	2-25 Amps, 3fl(Loops Required) 25-90 Amps, 3fl(Direct) 80-800 Amps, 3fl(External CTs)
Power Consumption	10W (Maximum)
Output Contact Rating SPDT (Form C)	Pilot duty rating: 480 VA @ 240 VAC General purpose: 10A @ 240 VAC
Expected Life	
Mechanical	1 x 10 operations
Electrical	1 x 10 operations at rated load
Accuracy at 25¡ C (77¡ F)	
Voltage	–1%
Current	–3%(<100 Amps Direct)
GF Current	–15%
Timing	5% – 1 second
Repeatability	
Voltage	– 0.5% of nominal voltage
Current	– 1% (<100 amps direct)
Trip Times (Those not shown have user selectable trip times.)	
Ground Fault Trip Time 101%-200% of Setpoint 201%-300% of Setpoint 301%-400% of Setpoint 401% or Greater	**Trip time** 8 seconds – 1 second Setpoint 4 seconds – 1 second 3 seconds – 1 second 2 seconds – 1 second
Current Unbalance Trip Times **% Over Setpoint** 1% 2% 3% 4% 5% 6% 10% 15%	 **Trip time** 30 seconds 15 seconds 10 seconds 7.5 seconds 6 seconds 5 seconds 3 seconds 2 seconds
Safety Marks	
UL	UL508, UL1053
CE	IEC 60947-1, IEC 60947-5-1
StandardsPassed	
Electrostatic Discharge (ESD) Radio Frequency Immunity (RFI), Conducted Radio Frequency Immunity (RFI), Radiated	IEC 1000-4-2, Level 3, 6kV contact, 8kV air IEC 1000-4-6, Level 3 10V/m IEC 1000-4-3, Level 3 10V/m
Fast Transient Burst	IEC 1000-4-4, Level 3, 3.5 kV input power
Surge	

NOTE

SymCom's Overload Relay can be preprogrammed prior to installation by applying 120 VAC between the L1 and L2 terminals (except 575 Volt model). Power applied must be 110 VAC or greater.

* 575 Volt Model.
** If J Prefix is displayed in trip class setting, jam protection is enabled.
*** If "oc" is displayed in the #RF setting, then Over Current will be included as a normal fault and the relay will automatically restart after RD2 expires, otherwise, manual reset is required after an Over Current fault.

CLEARING LAST FAULT

The last fault stored can be cleared on the MotorSaver.

This procedure is outline as follows:

1. Rotate the Mode Select Switch to GF.
2. Press and hold the Reset/Program Button. Adjust the Display/Program adjustment until cLr appears on the display. Release the Reset/Program Button.

To verify the last fault was cleared, place the Mode Select switch in the Run position. Then press and hold the Reset/Program Button, cLr should be on the display.

TAMPER GUARD

The PumpSaver can be protected from unauthorized program changes by locking in the setpoints.

This procedure is outlines as follows:

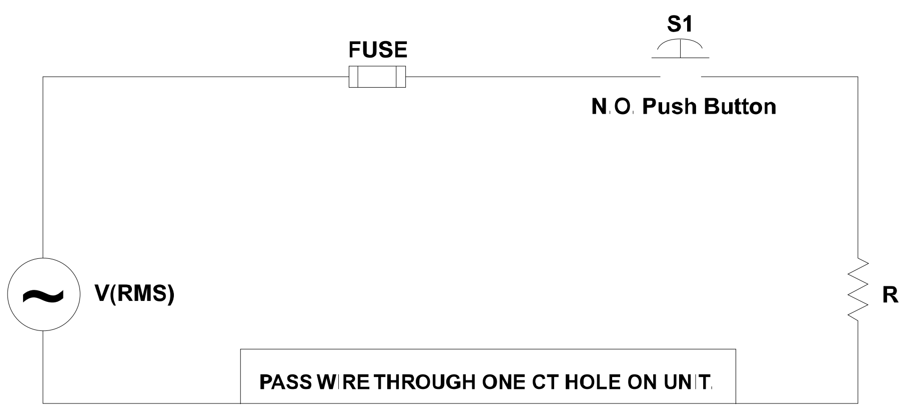
1. Rotate the Mode Select switch to GF.
2. Rotate Display/Program adjustment fully clockwise.
3. Press and hold the Reset Button. Adjust the Display/Program adjustment until Loc appears in the display.
4. Release the Reset Button.
5. Turn Mode Select switch to run.

The program is now locked, but all settings can be viewed. The unit can be unlocked by following the procedure above except step three. This step should say: Press and hold the Reset Button. Adjust the Display/Program adjustment until unL appears in the display.

GROUND FAULT TESTING PROCEDURE

1. Disconnect power
2. Hook up the three line voltages to L1, L2, and L3 as required by the installation instructions.

3. Program the desired parameters into the unit. For test purposes, set MULT to one and GF to the minimum allowed setting.
4. Construct the circuit below, using an AC power supply. This circuit simulates a ground fault condition by generating a current in one of the phases. Alternate test circuits may be used. The only requirement is the current through the current transformer must be between 115% and 150% of the GF setting and pass through only one CT window.
5. The values of V and R will be determined by the current required to generate a GF trip condition: I = Vrms/R, where I = 115% of GF setting.
6. Place the unit in the run position, apply three phase power and allow the N.O. contact to close.
7. Energize the test circuit by pushing and holding the test push-button until the unit trips (within 8.5 seconds). The display should show GrF and the N.O. contacts should be open. Release the N.O. push button.
8. The results of the test are to be recorded on the test form provided. The form should be kept by those in charge of the buildings electrical installation in order to be available to the authority having jurisdiction.
9. Confirm programmed parameters and proceed with installation instructions.



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Appendix D

Product Information

Price ® Pump Co. XL200SS Centrifugal Pump and Baldor Pump Motor

PRICE CENTRIFUGAL PUMP
MODEL XL200SS-575-21211(F)-1000-36-3W6

PRICE PUMP CO.

Centrifugal Pumps

XL100/150/200


XL200SS Shown

Features

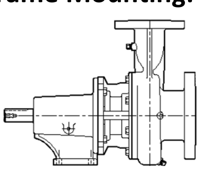
- **Pump Design** – Compact, close coupled
- **Double Seal** – Type 9 & 21 available
- **High Pressure Option** – 300 PSI maximum
- **Teflon Seal** – Type 9 available
- **Flush Options** – Recirculating & Quench available

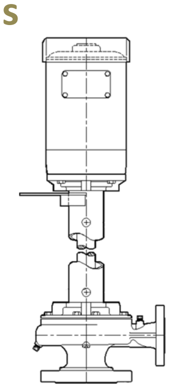
Applications

- Waste Water Treatment
- Hot Solvents
- Deionized Water
- Chemical Process
- Plating Equipment
- Agricultural Chemicals

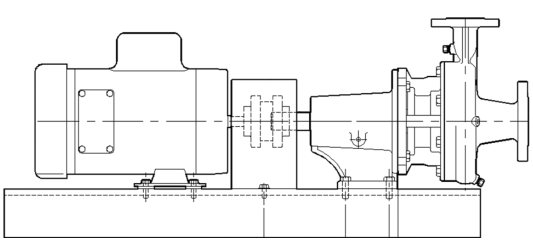
Optional Configurations

- **Air Motor:** Up to 2-1/2 HP
- **Vertical Mounting:**
- **Power Frame Mounting:**





- **Long-Coupled Mounting:**



Pump Volute / Impeller Materials

XL (SS) – 316SS / 316SS

Standard Specifications

- XL100 / XL100V Discharge 1", Suction 1-1/2" ANSI Flanges
- XL150 / XL150V Discharge 1-1/2", Suction 3" ANSI Flanges
- XL200 / XL200V Discharge 2", Suction 3" ANSI Flanges

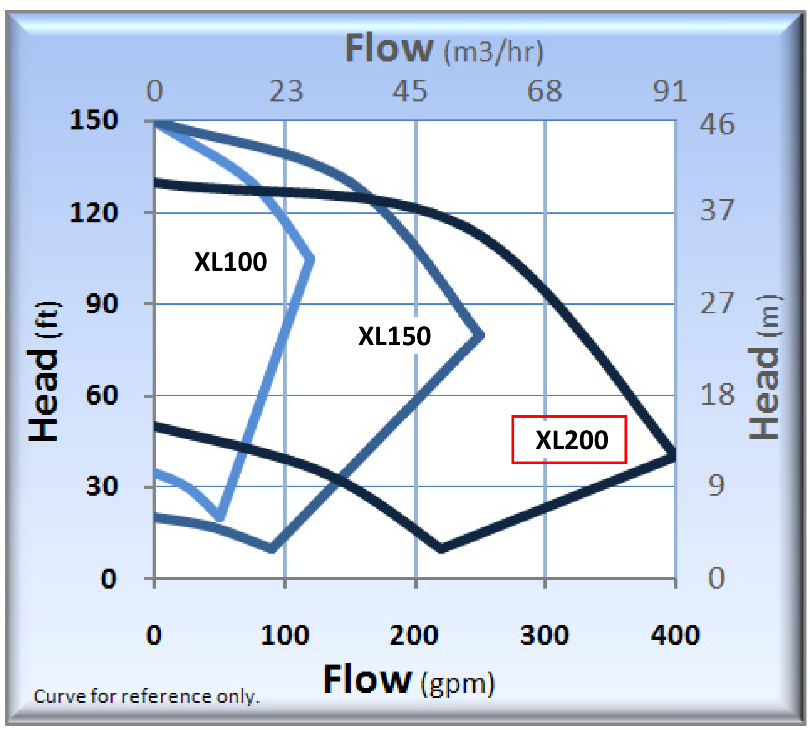
  Flanges: 150 lb. Centerline ANSI Dimensioned
- Maximum Impeller Diameter: 5.98"
- Shaft Sleeve: 316SS
- Motor: NEMA JM Face (Multiple enclosures available)
- Mechanical Seal:

  Single, 1-1/2" Type 21 Buna, Carbon vs. Ceramic (AI, BF, SF, AB)

  Single, 1-1/2" Type 21 Viton, Carbon vs. Ceramic (SS)

  Note: Additional seal options available
- Bracket Material: Stainless Steel, Bronze, & Cast Iron
- Gasket: Syn. Fiber (AI, BF, AB, SF) and PTFE (SS)

Performance Curve – 60 Hz



Rev. Date: May 2009

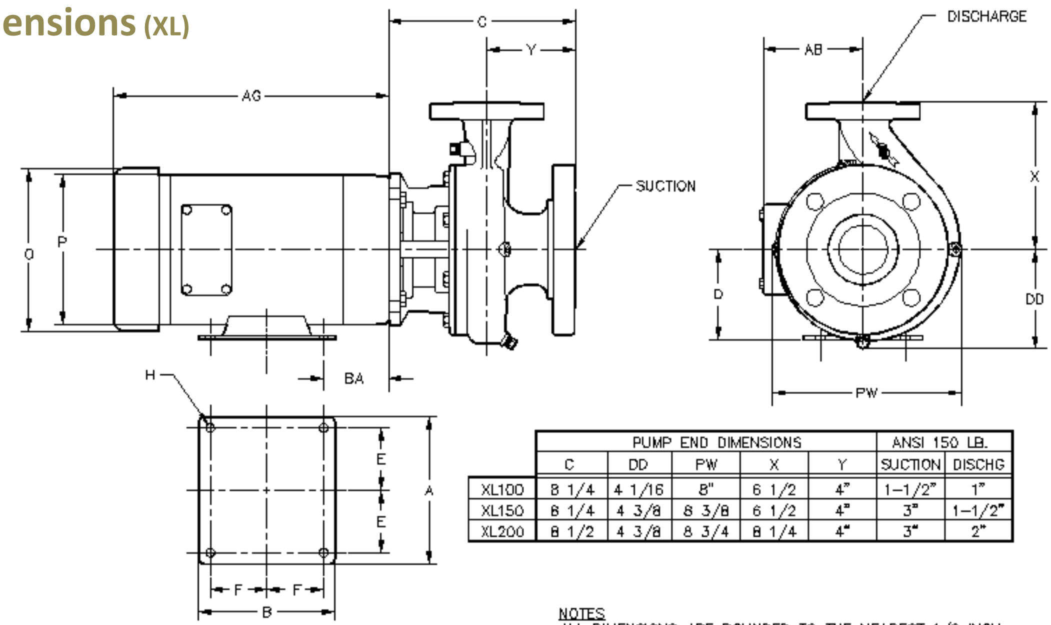
XL100/150/200

Technical Information		
Max Flow	(XL100)	**120 GPM** (27 m3/hr)
Max Flow	(XL150)	**250 GPM** (57 m3/hr)
Max Flow	(XL200)	**400 GPM** (95 m3/hr)
Max Head		**150 feet** (46 m)
Min. Flow	(XL100)	**10 GPM** (2.3 m3/hr)
Min. Flow	(XL150)	**35 GPM** (7.9 m3/hr)
Min. Flow	(XL200)	**50 GPM** (11.4 m3/hr)
Max Solid Size	(XL100)	**0.120"** (3.0 mm)
Max Solid Size	(XL150)	**0.190"** (4.8 mm)
Max Solid Size	(XL200)	**0.250"** (6.4 mm)
Max Working Pressure	(Type 8 Seal)	**325 PSI** (22.4 bar)
	(Type 9 Seal)	**350 PSI** (24.1 bar)
	(Type 21 Seal)	**150 PSI** (10.3 bar)
Max Temp.		**300°F** (149°C)*

Materials of Construction	
XL	**SS**
Volute	**316SS**
Impeller	**316SS**
Bracket	**316SS**
Gasket	**Teflon**
Fasteners	**316 SS**

* *Temperature limits are based on standard seal and gasket materials, and will vary according to the liquid being pumped.*

Dimensions (XL)



	PUMP END DIMENSIONS					ANSI 150 LB.	
	C	DD	PW	X	Y	SUCTION	DISCHG
XL100	8 1/4	4 1/16	8"	6 1/2	4"	1-1/2"	1"
XL150	8 1/4	4 3/8	8 3/8	6 1/2	4"	3"	1-1/2"
XL200	8 1/2	4 3/8	8 3/4	8 1/4	4"	3"	2"

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	AC	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	215JM	9-1/2	8	5-1/4	4-1/4	3-1/2	13/32	4-1/2	10-1/16	9-9/16	N/A		7-3/8	14-3/4
15	3600	215JM													

NOTE: MOTOR DIMENSIONS WILL VARY BY MODEL AND MAKE. DIMENSIONS ARE TO BE USED FOR REFERENCE ONLY.
10 AND 15 HP MOTORS ARE BALDOR 215 JM W/ 184 FACE.

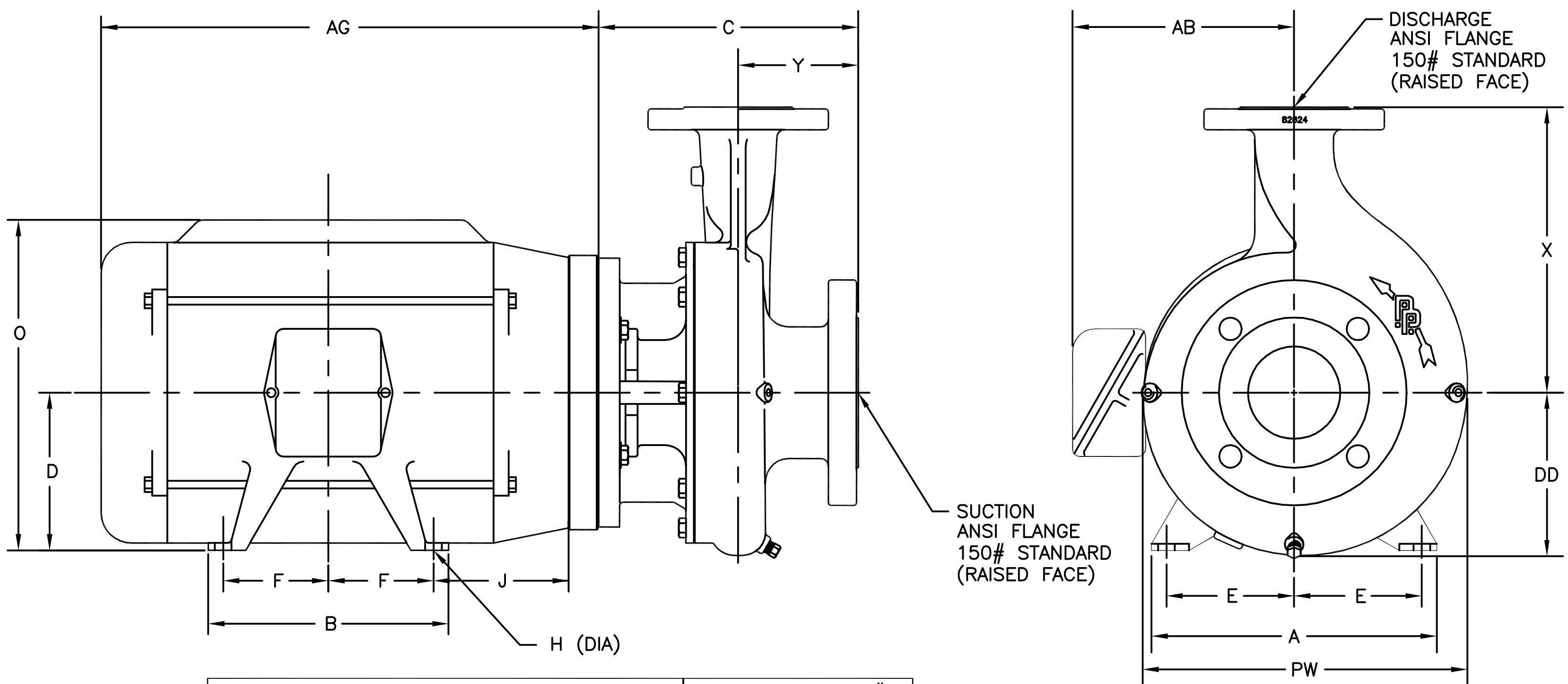
Contact factory for special pump configurations, same day, and next day delivery options.

PRICE PUMP CO.
21775 Eighth Street East
Sonoma, CA 95476-0329
MAIN (707) 938-8441
TOLL FREE (800) 345-7867
FAX (707) 938-0764
E-mail: sales@pricepump.com
Website: www.pricepump.com

Member of: Hydraulic Institute

Rev. Date: May 2009

DESCRIPTION	REF. NO.	DATE	REV.
XJSS & XLSS CLOSE COUPLED MOTOR PUMP ASSY	O-XJXL	10/28/92	C



	PUMP END DIMENSIONS					ANSI FLANGE 150#	
MODEL	C	DD	PW	X	Y	DISCHARGE	SUCTION
XL 1x1-1/2x6	8 1/4	4 1/16	8"	6 1/2	4"	1"	1-1/2
XL 1-1/2x3x6	8 1/4	4 3/8	8 3/8	6 1/2	4"	1-1/2	3"
XL 2x3x6	8 1/2	4 3/8	8 3/4	8 1/4	4"	2"	3"
XJ 1x1-1/2x8	8 9/16	5"	10 3/16	6 1/2	4"	1"	1-1/2
XJ 1-1/2x3x8	8 5/8	5 1/16	10 1/16	6 1/2	4"	1-1/2	3"
XJ 2x3x8	8 5/8	5 7/16	10 13/16	9 1/2	4"	2"	3"

DIMENSIONS 'X' AND 'Y', AND DISCHARGE AND SUCTION MEET ANSI CONFIGURATION.

	MOTOR END DIMENSIONS							DRIP-PROOF			TEFC & EXP. PROOF		
FRAME	A	B	D	E	F	H	J	AB	AG	O	AB	AG	O
143JM	6-1/2	6	3-1/2	2-3/4	2	11/32	1-5/8	5-1/4	8-3/4	6-7/8	6-3/4	11-1/4	6-7/8
145JM					2-1/2								
182JM	8-1/2	6-1/2	4-1/2	3-3/4	2-1/4	13/32	2-1/4	5-7/8	11-1/8	9	7-3/8	14-3/4	8-1/2
184JM					2-3/4								
213JM	9-1/2	8	5-1/4	4-1/4	2-3/4	13/32	3-1/4	7-3/8	12-3/4	10-1/16	9-3/4	15-1/2	10-3/8
215JM					3-1/2							17	
254JM	11-1/4	9-1/2	6-1/4	5	4-1/8	17/32	4-1/2	8-15/16	17	12	11	22	13
256JM		11-3/4			5				18-1/2				

NOTE: MOTOR DIMENSIONS WILL VARY BY MODEL AND MAKE. DIMENSIONS ARE TO BE USED FOR REFERENCE ONLY.

NOTE:
1. ALL DIMENSIONS ARE ROUNDED TO THE NEAREST 1/8".

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PRICE PUMP CO.

FACTORY PUMP FAX TRANSMITTAL DRAWING

#1 Pump Way P.O. Box Q
Sonoma, CA 95476 (707) 938-8441
707-FAX 938-0764

XL/XT Parts List

PRICE® PUMP CO.

XL/XT plist.doc rev. C

Key #	Description	Qty.	Part Numbers				
			Al Thd.	BF Thd.	AB Thd.	SS Thd.	SS Flanged
A.	Volute						
	1 x 1-1/2 - 6 (XT100 Threaded, XL100 Flanged)	1	2601	2601	2603	2629	2605
	1-1/2 x 2 - 6 (XT150 Threaded)	1	2607	2607	2609	2626	2611
	1-1/2 x 3 - 6 (XL150 Flanged)	1	-	-	-	-	2611
	2 x 3 - 6 (XT200 Threaded, XL200 Flanged)	1	2613	2613	2615	2627	2617
B.	Impeller - specify diameter **						
	1 x 1-1/2 - 6 (XT100 Threaded, XL100 Flanged)	1	2602-dia	2604-dia	2604-dia	2606-dia	2606-dia
	1-1/2 x 2 - 6 (XT150 Threaded)	1	2608-dia	2610-dia	2610-dia	2612-dia	
	1-1/2 x 3 - 6 (XL150 Flanged)	1					2612-dia
	2 x 3 - 6 (XT200 Threaded, XL200 Flanged)	1	2614-dia	2616-dia	2616-dia	2618-dia	2618-dia
Note:	For Dbl seal add DS (Sample: 2614**DS**-dia)						
C.	Bracket (standard)	1	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	1	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
	Flush w/ Quench		3405-5	3405-5	N/A	3388-5	3388-5
D^1.	Shaft Sleeve (for std. JM motor)	1	0127	0127	0127	0127	0127
D^2.	Stub Shaft 5/8" ID (56C) optional	1	0329-1	0329-1	0329-1	0329-1	0329-1
D^3.	Stub Shaft 7/8" ID (143TC/145TC/182C/184C)	1	0328-1	0328-1	0328-1	0328-1	0328-1
E.	Volute Gasket (Synthetic Fiber, std.)	1	0124	0124	0124	0301 (PTFE)	0301 (PTFE)
F.	Pipe Plug (2 rqd Threaded**,** 1 rqd Flanged)	*	0557	0557	0558	0559	0559
G.	Volute Bolts	8	0583	0583	0587	0724	0724
H^1.	T.21 Single Seal/Seat	1	0121 (std B*)	0121 (std B*)	0121 (std B*)	0122 (std V*)	0122 (std V*)
	B* = Buna						
	V* = Fluorocarbon						

All Models

Key #	Description	Qty.	Part Numbers
H^2.	T.9 PTFE Single Seal/Seat (opt)	1	0123
	Seat Pin T.9 (not shown)	1	0890
H^3.	T.21 Double Seal/Seat (opt)	1	Specify P/N
	Double Seal Plate	2	0309
	Plate Gasket, PTFE	2	0505
	Plate Bolts	6	0977
H^4.	Seal Quench (opt):		
	Buna Lip Seal	1	0756
	Fluorocarbon Lip Seal	1	0757
	PTFE Lip Seal	1	0758
	Lip Seal Plate	1	0309-2
	Plate Gasket, PTFE	1	0505
	Plate Bolts	3	0977
H^5.	T.9 PTFE Double Seal/Seat (opt)	1	0670
	Double Seal Plate	2	0309-1
	Plate Gasket, PTFE	2	0505
	Plate Bolts	6	0977
	Seat Pin T.9 (not shown)	2	0890
J.	Impeller Lockdown	1	0978
K.	Lockdown Gasket, PTFE	1	0245

Price® Pump Co.
21775 Eighth Street East * Sonoma, CA 95476-0329 * (707) 938-8441 * Fax (707) 938-0764

XL/XT Parts List

All Models

Key #	*Description*	*Qty.*	*Part Numbers*
L.	Motor Bolts		
	All Bronze pumps	4	0587
	Stainless Steel pumps	4	0593
	AI & BF pump	4	0593
	AI & BF pump Washers	4	1137
	Motor Bolts for 3405 & 3388 brackets		
	All Bronze pumps		N/A
	Stainless Steel pumps	4	1189
	AI & BF pumps	4	1189
	AI & BF pumps Washers	4	1199
	Motor Bolts for 5/8” & 7/8” Shaft Units		
	All pumps – all pumps require both		
	Top motor bolts	2	60-029-00
	Bottom motor bolts	2	60-024-00
	AI & BF need washers	4	1199
M.	Sleeve Gasket, PTFE	1	0245
N.	Impeller Shaft Key	1	0135
P1.	JM Motor	1	Specify P/N
P2.	‘C’ Face Motor (not shown)	1	Specify P/N
	Base Plate (not shown)	1	0199
P3.	Air Motor	1	Specify P/N
P4.	Power Frame	1	5480
Q.	12 Volt Clutch (opt)	1	1983
	Key for Clutch	2	0136
	Lock bolt for Clutch	1	0567
	Lock bolt Washer for Clutch	1	0564
R.	Ext. Plate for 5/8” & 7/8” Shafts	1	3690
S.	Base	1	0199

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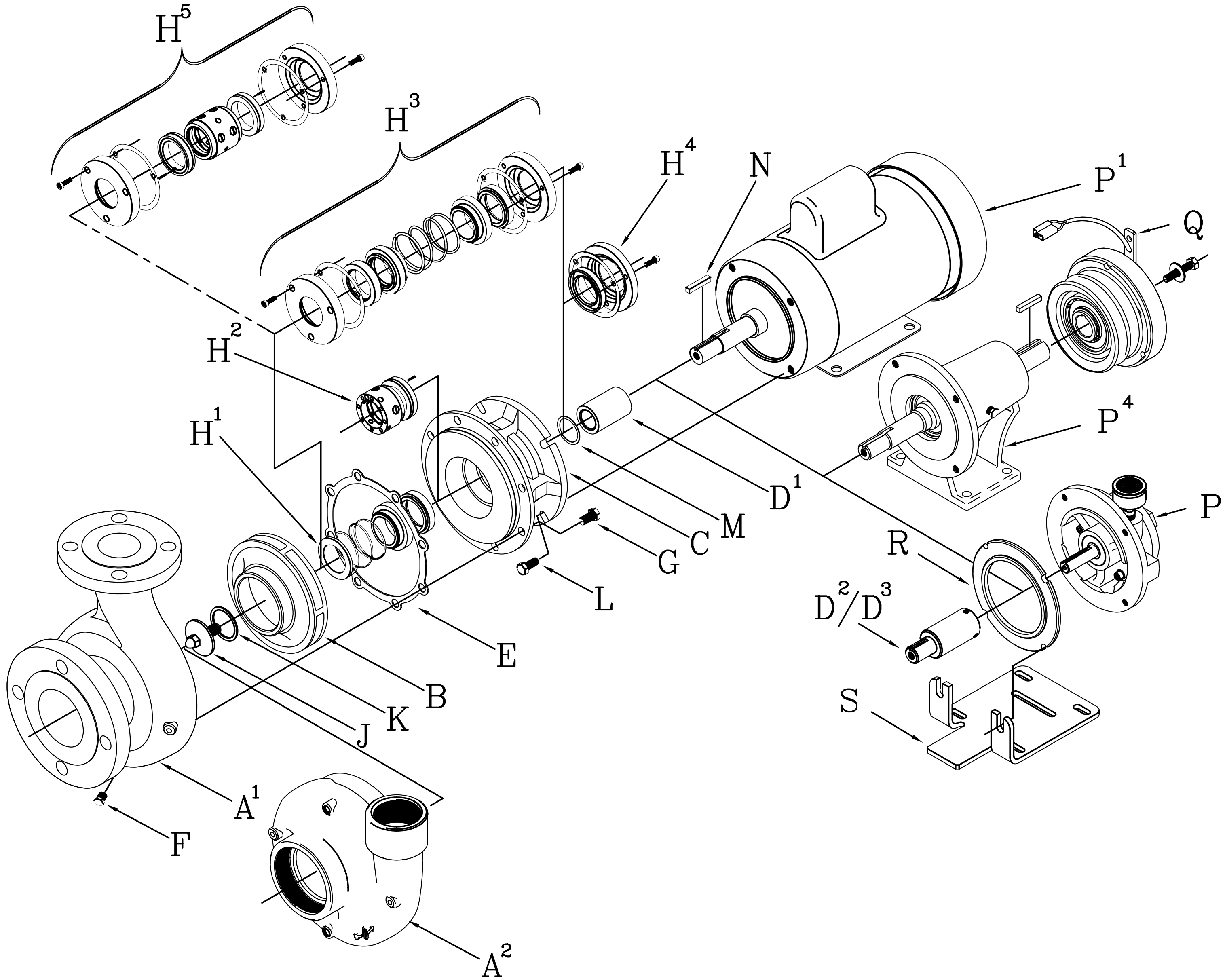

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Price® Pump Co.

INSTALLATION, OPERATING AND MAINTENANCE MANUAL

TYPE XL/XT CENTRIFUGAL PUMPS

MODELS: XL - 100, 150, 200
XT - 100, 150, 200

PLEASE FILL IN FROM PUMP NAMEPLATE

Pump Model_______________________

BOM. No.___________________________

Serial No.___________________________

RETAIN MANUAL FOR REFERENCE

Price® Pump Company
21775 8th. Street East
Sonoma, CA 95476
Tel: 707-938-8441
Fax 707-938-0764
Email: sales@pricepump.com

Congratulations

You are now the owner of a Price® Pump Co. Centrifugal Pump. This pump was carefully inspected and subjected to final performance tests before being released for shipment. In order to achieve maximum performance and reliability, please follow the simple instructions in this manual.

RECOMMENDED PRECAUTIONS

1. For satisfactory operation and safety, maximum system pressure must not exceed 350 psi* (24.6kg/sq cm).

2. For satisfactory operation and safety, maximum fluid temperature must not exceed 300°F* (121°C).

3. No modifications, additions or deletions should be made to the pump without prior approval of the factory.

4. Drain pump completely and flush with water before servicing a pump handling volatile or harmful liquids.

READ CAREFULLY THE CAUTION BELOW

The performance of your Price® Pump Co. Centrifugal Pump is based on clean, room temperature, water with suction conditions as shown on the performance curves. If used to pump liquids other than water, pump performance may differ from rated performance based on the different specific gravity, temperature, viscosity, etc. of the liquid being pumped. A standard pump, however, may not be safe for pumping all types of liquids, such as toxic, volatile or chemical liquids, or liquids under extreme temperatures or pressures.

Please consult Price® Pump Co. technical specifications as well as local codes and general references to determine the appropriate pump for your particular application. Since it is impossible for us to anticipate every application of a Price® Centrifugal pump, if you plan to use the pump for a non-water application, contact Price® Pump Co. beforehand to determine whether such application may be appropriate and safe under the operating conditions. Failure to do so could result in property damage or personal harm.

***** Depends on seal materials and seal type

Visit our website for product information and technical support

www.pricepump.com

INSTALLATION / OPERATING INSTRUCTIONS
CENTRIFUGAL PUMPS

Warning

Before installing, repairing or performing maintenance on this pump, read these instructions completely.

Disconnect power to pump before servicing to avoid dangerous or fatal electrical shock.

Match supply voltage and frequency to motor nameplate values. Incorrect voltage can cause fire or serious motor damage and void warranty.

Ground motor before connection to electrical power supply! Failure to ground motor can cause severe or fatal electrical shock!

Do not ground to gas supply line!

Before disassembling pump, be certain all liquid has been removed. If pump was used to pump hazardous or toxic fluid, it must be decontaminated prior to disassembly.

Close Coupled Motor Pumps

It is suggested that these pumps be firmly bolted to a level surface. Adequate air movement around motor will help prevent overheating.

Do not over tighten inlet and outlet piping or volute may be damaged.

Power Frame Mounted Pumps

Power Frame mounted pumps must be mounted on a rigid base that will not warp or flex. Each pump must be mounted such that the pump shaft centerline is in-line with the driver shaft centerline. Pads and/or shims will be required on the pump, the driver or both to insure proper alignment. The two shafts should not touch each other (end to end) and the distance between them depends on the coupling used to connect them.

Misalignment will cause vibration, 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 proper 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 as damage may result to the pump internal wear surfaces.

Plumbing

All piping needs to be supported independently of the pump. Piping connections should not exert any stress on the pump volute or fittings.

Suction Piping (Inlet)

(Horizontal Pumps)

Suction line must provide adequate suction pressure and even (Laminar) liquid flow for proper pump operation. Air, entrapped in the suction line due to leaks or improper piping design, may cause the pump to lose prime. Non-priming pumps must have their suction ‘flooded’ at start up (see datasheets for minimum NPSHR). Also, the suction line must provide sufficient pressure (NPSH) and even flow to pump inlet to prevent pump cavitation. The suction pipe entering the pump should be straight and a minimum length of 5 times and preferably 10 times the pump inlet diameter. Elbows, fittings or valves installed close to the pump inlet can disrupt liquid flow and cause cavitation. Suction lines must be at least the same diameter as the pump inlet or larger if possible.

Price Pump Company 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 vapor from being trapped in high spots in the piping. This condition may cause the pump to vapor lock.

Discharge Piping (Outlet)

To control flow and discharge head, it is advisable to install a valve (globe, ball, or other adjustable and non-leak type) in the discharge line adjacent 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

All centrifugal pumps must be filled with liquid prior to start up. It is suggested that during initial start up the discharge valve be closed and then opened as the motor reaches 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 pumps flow rate and head (pressure) will vary with the amount of resistance (pipe friction and flow restrictions) in the discharge line. As the valve on the discharge line opens, the flow rate and motor amperes draw will increase and head (pressure) will decrease. As the valve on the discharge line is closed, the flow rate and amperes draw will decrease and the head (pressure) will increase.

If resistance in the discharge line is not sufficient, the pump will operate at a condition of maximum flow, sometimes called "end of curve" performance. Maximum horse-power is required to operate at this point and motor overload may result. If excessive amperes draw and motor overload is occurring, reduce the system flow rate by installing a valve or orifice in the discharge line to control (restrict) the pumps flow rate. Alternatively, reduce pump head by trimming impeller to a smaller diameter.

Consult Price Pump or a local Price Pump distributor for assistance.

www.appsupport@pricepump.com

1. Pump fails to build head pressure:

Check for:

a. Pump not primed.

b. Incorrect pump 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 rate.

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 cavitation.

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 components.

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 overheating.

Check for:

a. Excessive flow and amp draw (Throttle discharge).

b. Low voltage or frequency.

c. Flow rate too low with resulting heat rise.

d. Bearing failure.

e. System temperature too high.

Before attempting any repairs under warranty, contact Price Pump to obtain factory authorization. Repairs carried out without authorization may void warranty. Many causes of pump failure are due to improper system design. Refer to the trouble shooting list in this manual before carrying out pump inspection or repair.

DISASSEMBLY

1. Disconnect power source to motor.

2. Disconnect electrical connections tagging wires carefully to preserve correct rotation. Loosen motor base.

3. Remove pump and motor assembly to repair area.

4. Remove volute bolts and remove volute from pump.

5. Unscrew and remove impeller lockdown bolt and lock washers. Slide impeller off shaft. (If 'keyed' shaft design, do not throw away the shaft key).

6. Remove seal head from the shaft. **Type 6A:** Remove seal head from bracket. **Type 21:** Slide seal head from the shaft. **Type 9:** Loosen set screws and slide seal head off shaft.

7. Remove four motor bolts and remove bracket from motor.

8. Remove seal seat from bracket. Use wooden or plastic dowel to remove the seat from the bracket.

9. Remove shaft or shaft sleeve. Heat shaft sleeve to approximately 300 °F and use a bearing puller to remove the sleeve.

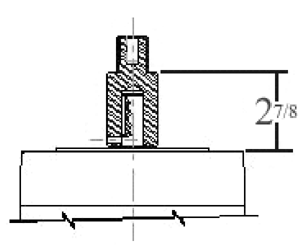
REASSEMBLY

If PEO (pump end only) go assembling PEO.

1. Thoroughly clean the seat cavity of the bracket.

2. Thoroughly clean pump shaft. Assure that the shaft is not grooved and that there is no evidence of pitting or scoring. If the shaft is grooved, scored or worn, replace it.

3a. 56C motors. (Stub shaft pumps only) Install the pump shaft onto the motor shaft, aligning set screws of the pump shaft with the keyway of the motor shaft. Set height – 2 7/8" (see diagram) and tighten all screws.



3b. JM 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 pump end. Remove excess Loctite. Ensure sleeve is seated against motor shaft shoulder.

4. **For Type 21, 8, 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 gently tap seat into place with a wooden dowel or plastic rod (2" outside diameter). To help insure that 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.

5a. On 56C face motors, place extension plate, bracket and base on motor. Secure plate, bracket and base to motor with four motor bolts and washers.

5b. On JM style motors, 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 hex 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.

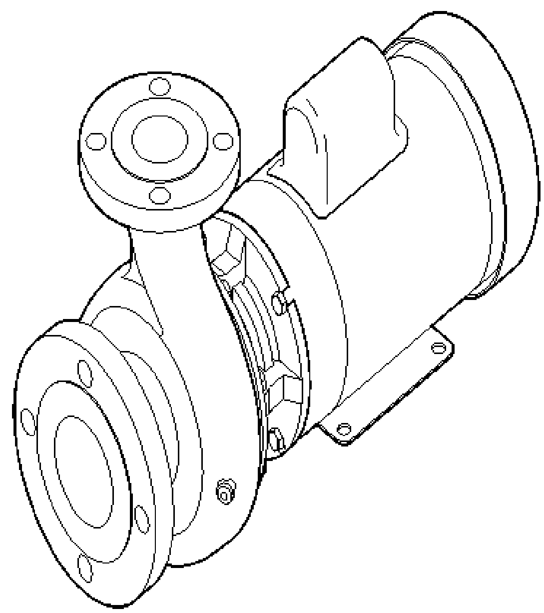
10. Return pump to installation, reconnect electric connections.

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.

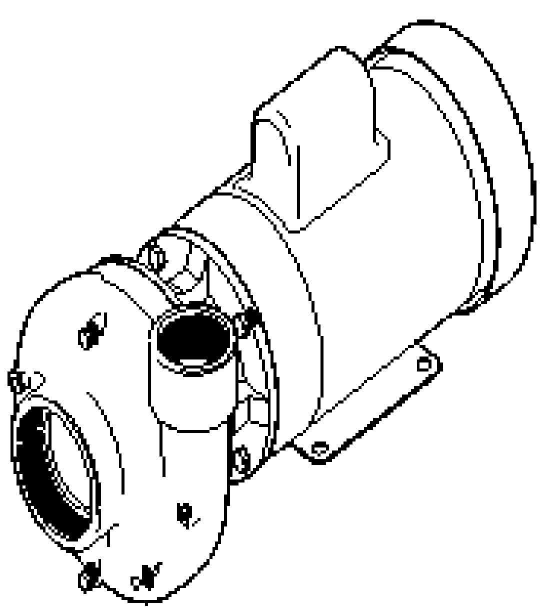
12. Remove top pipe plug (if applicable) from the front of volute and prime pump thoroughly, making sure all air is purged. Turn shaft one revolution and then refill. Replace the pipe plug.

13. Start pump allowing adequate time to purge all air from system. Observe any gauges, flow meters, etc., to see if pump performs properly.

XL – 316 Stainless Steel



XT - AI, BF, SF, AB, SS



INSTALLING A PEO (PUMP END ONLY) STUB SHAFT PUMPS

a. Place the bracket on a firm surface, loosen stub shaft setscrews and carefully remove shipping plug.

b. Place motor in an upright position with motor shaft pointing upward. Make sure motor shaft and end bell flange are free of burrs and surfaces are clean.

c. Align PEO stub shaft setscrews (if applicable) with motor shaft keyway and carefully slid the PEO onto the motor shaft until it sits firmly onto the motor end bell flange.

d. Oriented the PEO's discharge port or base to preferred motor configuration while referencing the motors electrical box position.

e. Install flange bolts and tighten. (Install pump base if applicable)

f. Reposition pump back onto motor base.

g. Refer to pump Reassembly Instructions and proceed to **setting the impeller clearance** (if applicable).

INSTALLING A PEO (PUMP END ONLY) NON-STUB SHAFT PUMPS

a. Carefully un-pack all components received with your shipment and remove any shipping plugs.

b. Place the bracket on a firm surface with the seat cavity (pump end) up. Follow reassembly instructions contained within the manual that accompanied your pump.

c. Make sure motor shaft and end bell flange are free of burrs and surfaces are clean.

d. Oriented the PEO's discharge port or base to preferred motor configuration while referencing the motors electrical box position.

e. Install flange bolts and tighten. (Install pump base if applicable)

f. Reposition pump back onto motor base (if applicable).

Type 21 JM Style Double Seal Installation

(For Type XJ/JB, XL/XT Series Pumps)

Double Seal pumps are generally used for one of these reasons:

1. To avoid seal damage when pumping abrasives.
2. To manage seal temperature when pumping hot liquids.
3. To prevent pump fluid from leaking to atmosphere when pumping toxic or other hazardous liquids.

A double seal must have pressure to the seal chamber at a minimum of 5 PSI preferable 10 PSI above pump pressure.

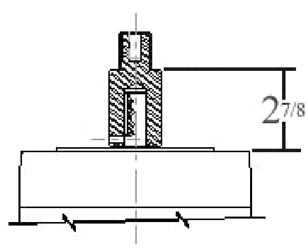
Flow rate through seal chamber will depend upon pump fluid temperature. Minimum flow rate should be **2 GPM** for XJ/JB, XT/XL Series Pumps. Flow rates may have to be increased with higher temperatures. Check the seal chamber discharge fluid temperature to be sure fluid is below boiling. We suggest a 140°F to 150°F temperature range. If seal cooling liquid flashes, seal may become damaged. Seal chamber fluid should enter at the bottom and discharge at the top to avoid entrapped air in the chamber. Be sure to prime the secondary pumping system properly as you would any other system.

CAUTION: Always Pressurize the Seal Chamber before starting the main pump!

In a pumping system that starts and stops automatically, insure that both pumps start at the same time.

REASSEMBLY:

1. Clean pump and motor shaft thoroughly.
2. Assure that the shaft is not grooved and that there is no evidence of pitting or fretting. If the shaft is grooved, fretted or worn, replace it.
3. 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.



4. 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 PTFE sleeve gasket is facing the pump end. Clean excess Loctite from shaft. Be sure sleeve is seated against motor shaft shoulder.
5. Place a small amount of vegetable oil on the seat cup or "O" ring seat. Install seats into seat plates with polished faces up. Evenly push seat into seat cavity with fingers, then gently tap seat into place with a wooden dowel or plastic pipe (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.

6. Install first seal plate onto rear of bracket with new gasket and tighten three Allen cap screws evenly (note: use PTFE pipe sealant on gasket surface and bolts).

7. Place bracket on motor (aligning the base if applicable). Secure bracket to motor with four motor bolts and washers.

8. Install seal head assembly:

For Type 21:

a. Lubricate shaft and elastomer with vegetable oil or equivalent.

b. Install first rotary seal head onto pump shaft and slide toward seat using a twisting motion until carbon face touches seal seat.

c. Install seal spring over shaft sleeve.

d. Install second rotary seal head onto shaft sleeve with carbon facing towards pump end.

9. Install second seal plate onto pump end of bracket with new gasket and tighten three Allen cap screws evenly (note: use PTFE pipe sealant on gasket surface and bolts).

10. 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.

11. Install impeller lockdown gasket and impeller lockdown. Tighten securely.

12. Install new volute gasket. Make sure that all of the mating surfaces of the gasket joint are cleaned to bare metal.

13. Install volute and secure with 8 bolts and tighten evenly.

14. Rotate pump shaft by hand to make sure impeller does not rub against volute.

15. Return pump to installation, reconnect electric connections.

16. 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.

17. 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.

18. Start pump allowing adequate time to purge all air from system. Observe any gauges, flow meters, etc., to see if pump performs properly.

Double Seal Flush Piping Installation

1. Piping of the double seal arrangement should be done in accordance with all governmental regulations and safety codes.

2. All double seals require a barrier flush between the seals for proper lubrication and cooling. The barrier liquid must be maintained at 10-15 PSIG above the discharge pressure of the pump and it must be chemically compatible with the pumped liquid, material construction of the pump, and seals (5/8" double seals have 18-8 parts).

3. The barrier flush shall have a minimum flow rate in accordance with the graph below. If water is used as a fluid, the inlet temperature should not exceed 140°F.

4. A positive pressure must be maintained to the barrier flush between the seal faces even when the pump is not running. To conserve the barrier liquid a solenoid valve (Item 1) may be installed and connected electrically in parallel with the motor so the barrier fluid flows only when the pump is running. Note: The maximum pressure of the barrier fluid at the inlet is 150 PSIG.

5. The inlet should be connected to the bottom and the outlet to the top of the seal cavity.

Procedures for Checking Double Seals for Internal Leakage

Option 1 - for use with 2 flow meters.

Install flow meters on the inlet and outlet lines. Normal operating conditions will be indicated by equal or near equal flow on both flow meters. If the inlet flow meter shows more flow than the outlet, this could indicate excessive leakage.

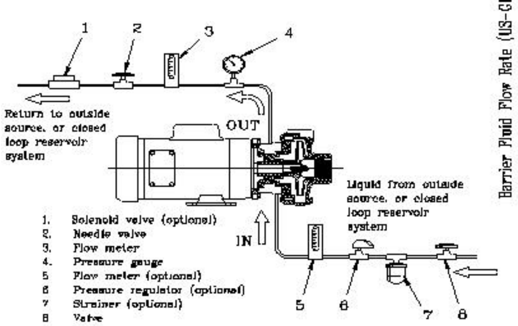
Option 2 - for use with 1 flow meter.

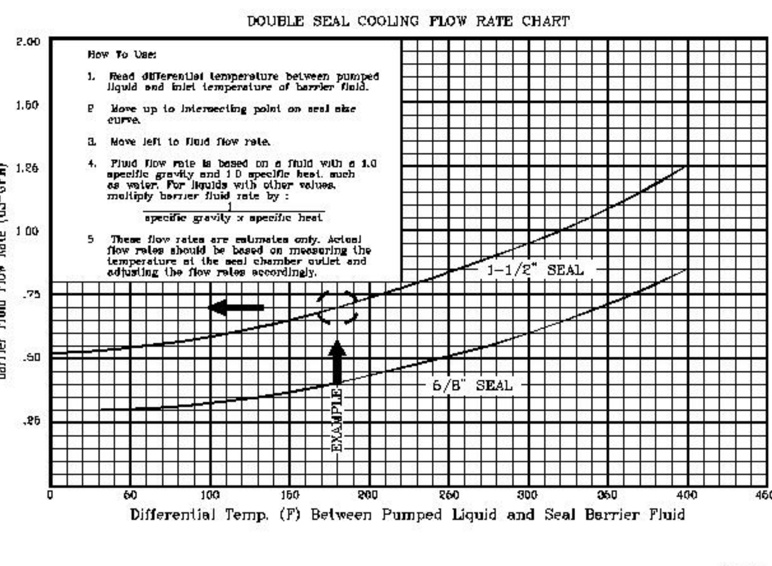
1. Shut off flow at outlet needle valve (Item 2).

2. Shut off inlet gate valve (Item 8) - for 15 seconds maximum.

3. If pressure in seal cavity drops rapidly rather than gradually while the gate valve is shut, the seal is leaking excessively.

4. To restart open gate valve first then reset valve on outlet.





XL/XT Parts List

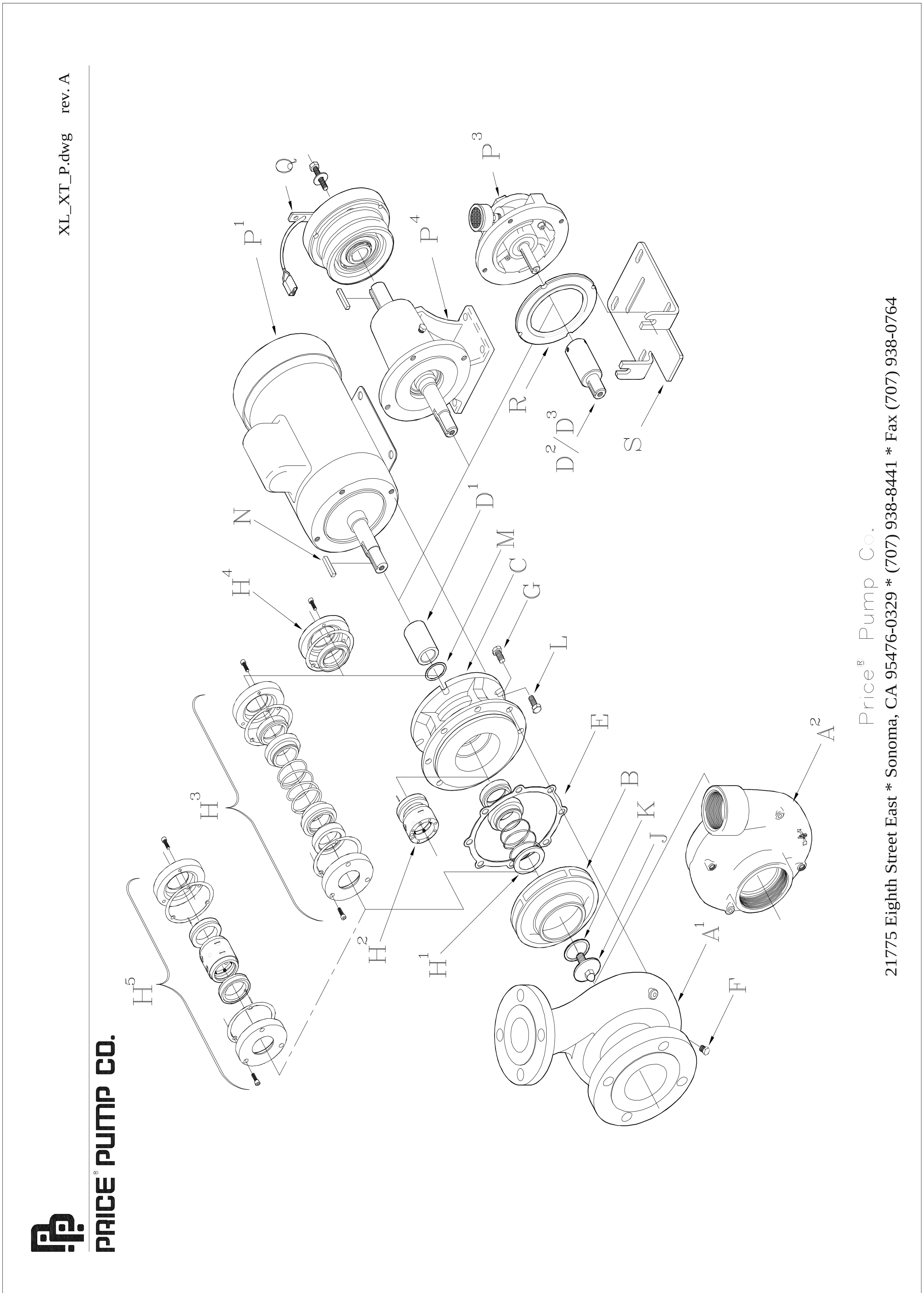
Key #	Description	Qty.	AI Thd.	BF Thd.	AB Thd.	SS Thd.	SS Flanged
A.	Volute						
	1 x 1-1/2 - 6 (XT100 Threaded, XL100 Flanged)	1	2601	2601	2603	2629	2605
	1-1/2 x 2 - 6 (XT150 Threaded)	1	2607	2607	2609	2626	2611
	1-1/2 x 3 - 6 (XL150 Flanged)	1	-	-	-	-	2611
	2 x 3 - 6 (XT200 Threaded, XL200 Flanged)	1	2613	2613	2615	2627	2617
B.	Impeller - specify diameter **						
	1 x 1-1/2 - 6 (XT100 Threaded, XL100 Flanged)	1	2602-dia	2604-dia	2604-dia	2606-dia	2606-dia
	1-1/2 x 2 - 6 (XT150 Threaded)	1	2608-dia	2610-dia	2610-dia	2612-dia	
	1-1/2 x 3 - 6 (XL150 Flanged)	1					2612-dia
	2 x 3 - 6 (XT200 Threaded, XL200 Flanged)	1	2614-dia	2616-dia	2616-dia	2618-dia	2618-dia
	Note: For Dbl seal add DS (Sample: 2614**DS**-dia)						
C.	Bracket (standard)	1	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	1	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
	Flush w/ Quench		3405-5	3405-5	N/A	3388-5	3388-5
D[1].	Shaft Sleeve (for std. JM motor)	1	0127	0127	0127	0127	0127
D[2].	Stub Shaft 5/8" ID (56C) optional	1	0329-1	0329-1	0329-1	0329-1	0329-1
D[3].	Stub Shaft 7/8" ID (143TC/145TC/182C/184C)	1	0328-1	0328-1	0328-1	0328-1	0328-1
E.	Volute Gasket (Synthetic Fiber, std.)	1	0124	0124	0124	0301 (PTFE)	0301 (PTFE)
F.	Pipe Plug (2 rqd Threaded**,** 1 rqd Flanged)	*	0557	0557	0558	0559	0559
G.	Volute Bolts	8	0583	0583	0587	0724	0724
H[1].	T.21 Single Seal/Seat	1	0121 (std B*)	0121 (std B*)	0121 (std B*)	0122 (std V*)	0122 (std V*)
	B* = Buna						
	V* = Fluorocarbon						

All Models

Key #	Description	Qty.	Part Numbers
H[2].	T.9 PTFE Single Seal/Seat (opt)	1	0123
	Seat Pin T.9 (not shown)	1	0890
H[3].	T.21 Double Seal/Seat (opt)	1	Specify P/N
	Double Seal Plate	2	0309
	Plate Gasket, PTFE	2	0505
	Plate Bolts	6	0977
H[4].	Seal Quench (opt):		
	Buna Lip Seal	1	0756
	Fluorocarbon Lip Seal	1	0757
	PTFE Lip Seal	1	0758
	Lip Seal Plate	1	0309-2
	Plate Gasket, PTFE	1	0505
	Plate Bolts	3	0977
H[5].	T.9 PTFE Double Seal/Seat (opt)	1	0670
	Double Seal Plate	2	0309-1
	Plate Gasket, PTFE	2	0505
	Plate Bolts	6	0977
	Seat Pin T.9 (not shown)	2	0890
J.	Impeller Lockdown	1	0978
K.	Lockdown Gasket, PTFE	1	0245

All Models

Key #	Description	Qty.	Part Numbers
L.	Motor Bolts		
	All Bronze pumps	4	0587
	Stainless Steel pumps	4	0593
	AI & BF pump	4	0593
	AI & BF pump Washers	4	1137
	Motor Bolts for 3405 & 3388 brackets		
	All Bronze pumps		N/A
	Stainless Steel pumps	4	1189
	AI & BF pumps	4	1189
	AI & BF pumps Washers	4	1199
	Motor Bolts for 5/8" & 7/8" Shaft Units		
	All pumps – all pumps require both		
	Top motor bolts	2	60-029-00
	Bottom motor bolts	2	60-024-00
	AI & BF need washers	4	1199
M.	Sleeve Gasket, PTFE	1	0245
N.	Impeller Shaft Key	1	0135
P1.	JM Motor	1	Specify P/N
P2.	'C' Face Motor (not shown)	1	Specify P/N
	Base Plate (not shown)	1	0199
P3.	Air Motor	1	Specify P/N
P4.	Power Frame	1	5480
Q.	12 Volt Clutch (opt)	1	1983
	Key for Clutch	2	0136
	Lock bolt for Clutch	1	0567
	Lock bolt Washer for Clutch	1	0564
R.	Ext. Plate for 5/8" & 7/8" Shafts	1	3690
S.	Base	1	0199


XL_XT_P.dwg rev. A
PRICE PUMP CO.
P1
Q
P4
P3
R
D2/D3
S
N
D1
M
H4
C
G
L
E
H3
B
K
J
A2
A1
H2
H1
H5
F
Price Pump Co.
21775 Eighth Street East * Sonoma, CA 95476-0329 * (707) 938-8441 * Fax (707) 938-0764

PRICE CENTRIFUGAL PUMP CAUTIONS & WARNINGS

- **CAUTION:** Price Pump centrifugal pumps must be operated above minimum flow rate to avoid damage.
- **CAUTION:** All Price Pump centrifugal pumps require the suction to be flooded.
- **CAUTION:** It is recommended that all piping connections to the pump be flexible.
- **WARNNING:** Verify chemical compatibility of the pump materials of construction with the fluid being pumped.
- **WARNNING:** Price centrifugal pumps are not designed for use in sanitary or food applications.
- **CAUTION:** Use only Price Pump original equipment factory replacement parts.
- **WARNNING:** Price pump fluid temperature limits must be observed. Maximum operating temperature is 300°F.
- **CAUTION:** The pump should be thoroughly flushed and drained before disassembly.
- **CAUTION:** For larger pump motor units, weight may exceed 65 1bs. (30 kg).

CAUTION: Maximum working pressure for seals:

- Type 6 Seal — **75 PSI** (5.2 bar)
- Type 6A Seal — **75 PSI** (5.2 bar)
- Type 8 Seal — **325 PSI** (22.4 bar)
- Type 9 Seal — **350 PSI** (24.1 bar)
- Type 21 Seal — **150 PSI** (10.3 bar)
- Type 2106 Seal — **150 PSI** (10.3 bar)

CAUTION: Maximum solid size by pump

- HP75 / MS50 — **0.030"** (0.76mm)
- SP150 — **0.060"** (1.50mm)
- LT25 — **0.120"** (3.05mm)
- F50/75/95 — **0.150"** (3.81mm)
- OH75 — **0.150"** (3.81mm)
- CD100/150 — **0.150"** (3.81mm)
- CL150 — **0.150"** (3.81mm)
- RC200/300 — **0.380"** (9.60mm)
- XJ-JB100 — **0.120"** (3.05mm)
- XJ-JB150 — **0.250"** (6.40mm)
- XJ-JB200 — **0.440"** (11.2mm)
- XL-XT100 — **0.120"** (3.05mm)
- XL-XT150 — **0.250"** (6.40mm)
- XL-XT200 — **0.440"** (11.2mm)

CAUTION: Minimum flow rate by pump

- HP75 / MS50 — **0.5 GPM** (1.9 LPM)
- SP150 — **10 GPM** (38 LPM)
- LT25 — **0.5 GPM** (1.9 LPM)
- F50/75/95 — **5.0 GPM** (19 LPM)
- OH75 — **7.0 GPM** (26 LPM)
- CD100 — **12 GPM** (45 LPM)
- CD150 — **25 GPM** (94 LPM)
- CL150 — **40 GPM** (150 LPM)
- RC200 — **10 GPM** (38 LPM)
- RC300 — **50 GPM** (189 LPM)
- XJ-JB150 — **20 GPM** (75 LPM)
- XJ-JB150 — **40 GPM** (150 LPM)
- XJ-JB200 — **90 GPM** (340 LPM)
- XL-XT100 — **10 GPM** (38 LPM)
- XL-XT150 — **35 GPM** (132 LPM)
- XL-XT200 — **50 GPM** (189 LPM)

GENERAL TERMS OF SALE

1. GENERAL

A. Seller's price is based on these sales terms and conditions. The agreement and inclusion of other or amended terms in this contract will result in a change (including increase) in Seller's price (as may be contained in any price books or quotations) to reflect such other or amended terms. 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 parole 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, similar pamphlets and information contained on websites 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 and/or any import or export duties or fees as may be assessed or imposed on or as a result of deliveries under 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. Where seller has responsibility for installation, construction or start-up 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) except 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, by way of example and not limitation, 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 those products, and parts, will meet any of Buyer's specifications and other specific product requirements which are a part of this agreement. Seller is a global supplier of products and utilizes parts and products obtained worldwide, and Seller's products supplied under this contract shall be subject to Seller's sole determination as to all manufacturing, sourcing, assembly and supply unless otherwise specifically agreed in writing.

E. The manufacture and inspection of products and parts shall be to Seller's Engineering and Quality Assurance standards, plus such other inspections or 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" as defined by Incoterms, 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 or for operation with any fluid or under any operating condition in variance with the specifications of this contract. 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. No product shall be deemed defective by reason of any effect on Seller's products of the action or results (such as vibration) of any goods or system (such as piping) not supplied by Seller.

6. BUYER'S RESPONSIBILITY

The design specifications of the equipment require the operation of the equipment within certain parameters and may call for the use of speed controls, safety devices, set points or other control devices to insure that the operation remains within design parameters. Buyer agrees and understands that the equipment must be operated and maintained within design specifications and operated within the specifications of the contract, irrespective of whether controls or devices are otherwise required.

7. 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. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within two (2) years of shipment by seller and all claims for defective work must be made in writing immediately upon discovery. Defective items must be held for Seller's inspection and returned to the sellers' point of original shipment upon request.

ANY UNAUTHORIZED DISSASSEMBLY, ALTERATION OF OR TAMPERING WITH ANY PRODUCT OR COMPONENT MAY "VOID" THE WARRANTY, IN THAT SUCH ACTION WILL RESULT IN SELLER BEING RELEASED AND RELIEVED FROM ITS OBLIGATIONS UNDER THIS WARRANTY AND FOR ANY FURTHER COSTS OR ACTIONS UNDER CLAUSE 7.C, FOLLOWING, AND THE BUYER ASSUMING SOLE RESPONSIBILITY FOR THE COSTS AND RESULTS OF SUCH ACTION. 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 ARE NOT MANUFACTURED BY SELLER ARE NOT WARRANTED BY SELLER and shall be covered only by the express warranty, if any, of the manufacturer thereof. 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 obtains from the manufacturer.

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 shipment, 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 THE 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 STRICT LIABILITY), INDEMNITY 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.

8. 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 Price Pump Co.

9. 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. Provided however, Seller will not defend any suit for infringement of a claimed patent where such alleged infringement is the result of following specific instruction furnished by Seller.

10. 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.

11. MANUFACTURING SOURCES

To maintain delivery schedules, Seller reserves the right to have all or any part of the Buyer's order manufactured at any of Sellers', sellers' licensees or sub contractors' plants, globally.

12. TERMS OF PAYMENT

Net 30 days from date of invoice.

13. ARBITRATION

In the event a dispute arises between the parties relating to or arising out of this agreement, the parties agree to attempt to have their senior management amicably settle the matter. In the event that the matter cannot be settled, the parties shall submit all disputes relating to this Agreement (whether contract, tort, products liability or otherwise) to binding Arbitration before a panel of arbitrators under the Commercial Dispute Resolution Procedures of the American Arbitration Association. Each party shall appoint an arbitrator and the third shall be selected in accordance with the rules of the American Arbitration Association. Judgment upon the award may be entered in any court having jurisdiction. The parties shall cooperate in providing reasonable disclosure of relevant documents. Each party shall bear its own expenses, and the costs and fees of the arbitration shall be borne as allocated by the Arbitrator.

BALDOR PUMP MOTOR

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- Parts List
- Drawings

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AC Motors | Washdown |

Product Overview: JMWDM3711T

* Click for Larger Image

Catalog Number:	JMWDM3711T
Description:	10HP,3500RPM,3PH,60HZ,215JM,3732M,TEFC,F
Ship Weight:	132 lbs.
List Price:	$2,149 USD
Multiplier Symbol:	WD

View Specifications | View Operation Manual

FEATURES

- Over-sized ball bearing with locked drive end construction for minimum shaft movement
- Moisture sealant on bolt heads, between frame and endplates
- Neopren gaskets, Forsheda running contact v-ring
- Stainless steel shaft
- Electrostatic epoxy coating (Tropicalized)

APPLICATIONS

Commercial and industrial water pumps, food processing and applications where motor is exposed to high pressure washdown.

* The image shown is representative only. Actual product may differ in appearance from image shown.

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Specifications: JMWDM3711T

CATALOG NUMBER:	JMWDM3711T
FL AMPS:	25-23/11.5
208V AMPS:	25
BEARING-DRIVE-END:	6309
BEARING-OPP-DRIVE-END:	6206
DESIGN CODE:	B
DOE-CODE:	010A
FL EFFICIENCY:	89.5
ENCLOSURE:	TEFC
FRAME:	215JM
HERTZ:	60
INSULATION-CLASS:	F
KVA-CODE:	H
SPEED [rpm]:	3500
OUTPUT [hp]:	10
PHASE:	3
POWER-FACTOR:	91
RATING:	40C AMB-CONT
SERIAL-NUMBER:	--
SERVICE FACTOR:	1.15
SPEC. NUMBER:	37H883T223H1
VOLTAGE:	208-230/460

* For certified information, contact your local Baldor office.

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Performance Data: JMWDM3711T

Product Nameplate Data :					
Rated Output	10 HP	Hertz	60	NEMA Nom. Eff.	89.5
Volts	208-230/460	Phase	3	Power Factor	91
Full Load Amps	25-23/11.5	NEMA Design Code	B	Service Factor	1.15
Speed	3500	LR KVA Code	H	Rating - Duty	40C AMB-CONT

* For certified information, contact your local Baldor office.

JMWDM3711T Replacement Parts List

Print Page | Close Window

Catalog Number	JMWDM3711T
Specification Number	37H883T223H1
Description	10HP,3500RPM,3PH,60HZ,215JM,3732M,TEFC,F
Plant	BALDOR/FT SMITH/REC WHSE #5

Replacement Parts

Material Number	Description	Qty.	List Price	Units
36FN3000C02	EXFN, PLASTIC, 5.25 OD, 1.175 ID	1	$ 19.00	EA
37CB3005A04W	CASTING W/.75 NPT@6(MACH WHITE)	1	$ 23.00	EA
37CB3005W	CASTING W/.922 LEAD HOLE .75 NPT@6(MACH	1	$ 26.00	EA
37GS1015	GASKET, FOR 37 WD KOBX'S (SANTOPRENE)	1	$ 10.00	EA
37EP3101A94MW	FRONT TEFC L&M 206 BRG W/O GRSR (WHITE)	1	$ 129.00	EA
37EP3101A94DW	FRONT TEFC L&M 206 BRG W/O GRSR	1	$ 161.00	EA
37EP3401T08MW	FACE MT EP, ENCL, 213TC-215TC, W/WHITE E	1	$ 117.00	EA
37EP3401T08DW	DRILLED EP W/WHITE EPOXY	1	$ 118.00	EA
07FH4011	WASHDOWN IEC FH W/AUTOPHORETIC PRIMER	1	$ 18.00	EA
37CB4512	CONDUIT BOX LID FOR WASHDOWN 37 FRAME	1	$ 3.00	EA

BALDOR • RELIANCE

Integral Horsepower
AC Induction Motors

Installation & Operating Manual

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Table of Contents

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

www.baldor.com/support/warranty_standard.asp

Safety Notice: This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

WARNING: **Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. When installing, protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.**

WARNING: **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

WARNING: **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

WARNING: **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

WARNING: **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

WARNING: **Thermostat contacts automatically reset when the motor has slightly cooled down. To prevent injury or damage, the control circuit should be designed so that automatic starting of the motor is not possible when the thermostat resets.**

Safety Notice Continued

WARNING: **UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.**

WARNING: **Pacemaker danger – Magnetic and electromagnetic fields in the vicinity of current carrying carrying conductors and permanent magnet motors can result result in a serious health hazard to persons with cardiac pacemakers, metal implants, and hearing aids. To avoid risk, stay way from the area surrounding a permanent magnet motor.**

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Use only UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust.**

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo. Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.**

WARNING: **Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not over–lubricate motor as this may cause premature bearing failure.**

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Handling The motor should be lifted using the lifting lugs or eye bolts provided.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed).
   The packing provides insulation from temperature changes during transportation.
3. When lifting a WPII (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only.
   A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.

4. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation.

   Do not lift the assembly using the motor lugs or eye bolts provided. Lugs or eye bolts are designed to lift motor only. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Storage

Storage requirements for motors and generators that will not be placed in service for at least six months from date of shipment.

Improper motor storage will result in seriously reduced reliability and failure. An electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to develop rust in the bearings or rust particles from surrounding surfaces may contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failure.

A wooden crate "shell" should be constructed to secure the motor during storage. This is similar to an export box but the sides & top must be secured to the wooden base with lag bolts (not nailed as export boxes are) to allow opening and reclosing many times without damage to the "shell".

Minimum resistance of motor winding insulation is 5 Meg ohms or the calculated minimum, which ever is greater. Minimum resistance is calculated as follows: **Rm = kV + 1**

where: (Rm is minimum resistance to ground in Meg−Ohms and
kV is rated nameplate voltage defined as Kilo−Volts.)

Example: For a 480VAC rated motor Rm =1.48 meg−ohms (use 5 MΩ).
For a 4160VAC rated motor Rm = 5.16 meg−ohms.

Preparation for Storage

1. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold the shaft firmly in place against the bearing before the motor is moved.
2. Store in a clean, dry, protected warehouse where control is maintained as follows:
   a. Shock or vibration must not exceed 2 mils maximum at 60 hertz, to prevent the bearings from brinelling. If shock or vibration exceeds this limit vibration isolation pads must be used.
   b. Storage temperatures of 10°C (50°F) to 49°C (120°F) must be maintained.
   c. Relative humidity must not exceed 60%.
   d. Motor space heaters (when present) are to be connected and energized whenever there is a possibility that the storage ambient conditions will reach the dew point. Space heaters are optional.

   Note: Remove motor from containers when heaters are energized, reprotect if necessary.
3. Measure and record the resistance of the winding insulation (dielectric withstand) every 30 days of storage.
   a. If motor insulation resistance decreases below the minimum resistance, contact your Baldor District office.
   b. Place new desiccant inside the vapor bag and re−seal by taping it closed.
   c. If a zipper−closing type bag is used instead of the heat−sealed type bag, zip the bag closed instead of taping it. Be sure to place new desiccant inside bag after each monthly inspection.
   d. Place the shell over the motor and secure with lag bolts.
4. Where motors are mounted to machinery, the mounting must be such that the drains and breathers are fully operable and are at the lowest point of the motor. Vertical motors must be stored in the vertical position. Storage environment must be maintained as stated in step 2.

5. Motors with anti−friction bearings are to be greased at the time of going into extended storage with periodic service as follows:
   a. Motors marked “Do Not Lubricate” on the nameplate do not need to be greased before or during storage.
   b. Ball and roller bearing (anti−friction) motor shafts are to be rotated manually every 3 months and greased every 6 months in accordance with the Maintenance section of this manual.
   c. Sleeve bearing (oil lube) motors are drained of oil prior to shipment.
      The oil reservoirs must be refilled to the indicated level with the specified lubricant, (see Maintenance). The shaft should be rotated monthly by hand at least 10 to 15 revolutions to distribute oil to bearing surfaces.
   d. “Provisions for oil mist lubrication” – These motors are packed with grease. Storage procedures are the same as paragraph 5b.
   e. “Oil Mist Lubricated” – These bearings are protected for temporary storage by a corrosion inhibitor. If stored for greater than 3 months or outdoor storage is anticipated, connected to the oil mist system while in storage. If this is not possible, add the amount of grease indicated under “Standard Condition” in Section 3, then rotate the shaft 15 times by hand.
6. All breather drains are to be fully operable while in storage (drain plugs removed). The motors must be stored so that the drain is at the lowest point. All breathers and automatic “T” drains must be operable to allow breathing and draining at points other than through the bearings around the shaft. Vertical motors should be stored in a safe stable vertical position.
7. Coat all external machined surfaces with a rust preventing material.
   An acceptable product for this purpose is Exxon Rust Ban # 392.

Non−Regreaseable Motors

Non−regreasable motors with “Do Not Lubricate” on the nameplate should have the motor shaft rotated 15 times to redistribute the grease within the bearing every 3 months or more often.

All Other Motor Types

Before storage, the following procedure must be performed.

1. Remove the grease drain plug, if supplied, (opposite the grease fitting) on the bottom of each bracket prior to lubricating the motor.
2. The motor with regreasable bearing must be greased as instructed in Section 3 of this manual.
3. Replace the grease drain plug after greasing.
4. The motor shaft must be rotated a minimum of 15 times after greasing.
5. Motor Shafts are to be rotated at least 15 revolutions manually every 3 months and additional grease added every nine months (see Section 3) to each bearing.
6. Bearings are to be greased at the time of removal from storage.

Removal From Storage

1. Remove all packing material.
2. Measure and record the electrical resistance of the winding insulation resistance meter at the time of removal from storage. The insulation resistance must not be less than 50% from the initial reading recorded when the motor was placed into storage. A decrease in resistance indicates moisture in the windings and necessitates electrical or mechanical drying before the motor can be placed into service. If resistance is low, contact your Baldor District office.
3. Regrease the bearings as instructed in Section 3 of this manual.
4. Reinstall the original shipping brace if motor is to be moved. This will hold the shaft firmly against the bearing and prevent damage during movement.

Section 2
Installation & Operation

Overview Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip−Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non−corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

Hazardous Locations are those where there is a risk of ignition or explosion due to the presence of combustible gases, vapors, dust, fibers, or flyings. Facilities requiring special equipment for hazardous locations are typically classified in accordance with local requirements. In the US market, guidance is provided by the National Electric Code.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Mounting The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment Accurate alignment of the motor with the driven equipment is extremely important. The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible.
It is recommended to heat the pulley, sprocket, or gear before installing on the motor shaft.
Forcibly driving a unit on the motor shaft will damage the bearings.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.
5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

WARNING: Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.

Guarding

Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions. This is particularly important where the parts have surface irregularities such as keys, key ways or set screws. Some satisfactory methods of guarding are:

1. Covering the machine and associated rotating parts with structural or decorative parts of the driven equipment.
2. Providing covers for the rotating parts. Covers should be sufficiently rigid to maintain adequate guarding during normal service.

Power Connection Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices. Flying leads must be insulated with two full wraps of electrical grade insulating tape or heat shrink tubing.

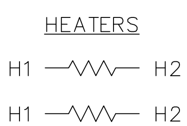
Conduit Box For ease of making connections, an oversize conduit box is provided.
The box can be rotated 360° in 90° increments.
Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

AC Power Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

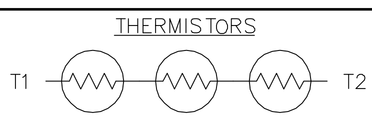
1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
OR
2. AC power is within ±5% of rated frequency with rated voltage.
OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

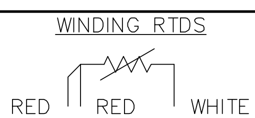
Figure 2-1 Accessory Connections



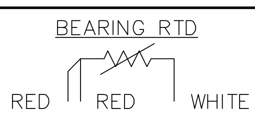
One heater is installed in each end of motor.
Leads for each heater are labeled H1 & H2.
(Like numbers should be tied together).



Three thermistors are installed in windings and tied in series.
Leads are labeled T1 & T2.

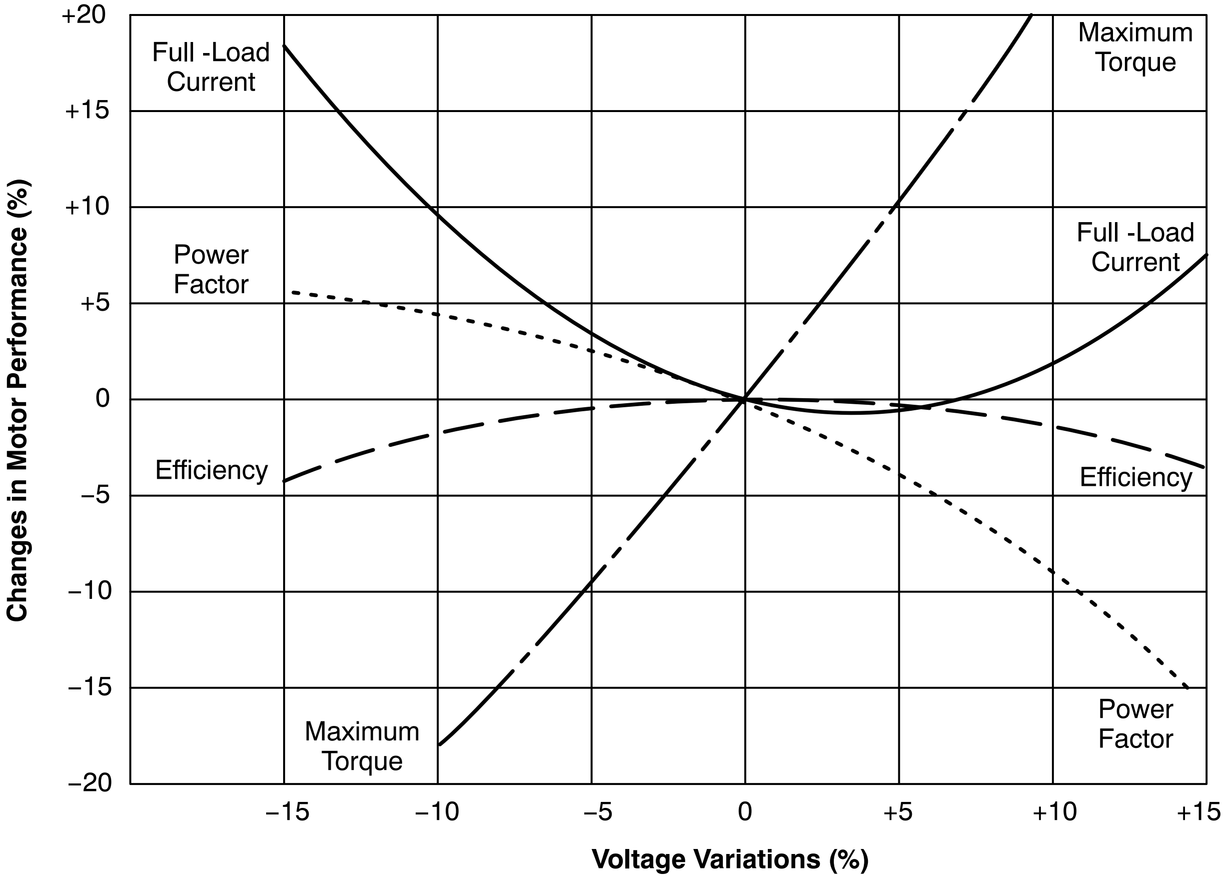


Winding RTDs are installed in windings (2) per phase.
Each set of leads is labeled W1, W2, W3, W4, W5, & W6.



* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE.
* One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE.
* Note RTD may have 2–Red/1–White leads; or 2–White/1–Red Lead.

Figure 2-2 Typical Motor Performance VS Voltage Variations



Rotation All three phase motors are reversible. To reverse the direction of rotation, disconnect and lock out power and interchange any two of the three line leads for three phase motors. For single phase motors, check the connection diagram to determine if the motor is reversible and follow the connection instructions for lead numbers to be interchanged. Not all single phase motors are reversible.

Adjustable Frequency Power Inverters used to supply adjustable frequency power to induction motors produce wave forms with lower order harmonics with voltage spikes superimposed. Turn−to−turn, phase−to−phase, and ground insulation of stator windings are subject to the resulting dielectric stresses. Suitable precautions should be taken in the design of these drive systems to minimize the magnitude of these voltage spikes. Consult the drive instructions for maximum acceptable motor lead lengths, and proper grounding.

First Time Start Up Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor District Office or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

General Inspection Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Relubrication & Bearings Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is **Polyrex EM (Mobil)**. Do not mix greases unless compatibility has been checked and verified.

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

Relubrication Intervals Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

Table 3-1 Relubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3-2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<−29° C **	

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Relubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100−112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315−450)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315−450)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225−280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

Relubrication Procedure Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: Do not over−lubricate motor as this may cause premature bearing failure.

With Grease Outlet Plug

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

Caution: Over−lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed.
   This allows excess grease to purge.
5. Re-install grease outlet plug.

Without Grease Provisions

Note: Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

Sample Relubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten "Thru Bolts".
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note:
- Winding RTDs are factory production installed, not from Mod–Express.
- When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

Bearing RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Bearing Type Oil or Grease	Anti–Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as "standard" lubricants) include the following:

- Texaco Polystar
- Rykon Premium #2
- Chevron SRI #2
- Mobilith SHC–100
- Pennzoil Pennzlube EM–2
- Chevron Black Pearl
- Darmex 707
- Darmex 711
- Petro–Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.
Contact Baldor application engineering for special lubricants or further clarifications.

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EATON MOTOR STARTER
MODEL ECN0522AHA

February 2, 1998
Supersedes TIP AN16, AN56, CN15, CN55
Pages 1-20, Dated 1/1/94

ECN01, ECN02, ECN05, ECN06, ECN07
AN16, AN56, CN15 & CN55
Sizes 00-9, 600V Max.
Non-Reversing & Reversing
NEMA Type Enclosures 1, 3R, 4X & 12
Details On UL & cUL Listing and CSA Certified Included In This TIP

NEMA Contactors & Starters (Freedom)

SIZE 1
NON-REVERSING STARTER

SIZE 3
NON-REVERSING STARTER

DESIGN CHARACTERISTICS

- **Overload Relays —** Bimetallic Ambient Compensated

  Features include:
  – Selectable Manual or Automatic Reset operation.
  – Interchangeable Heater Packs ± 24% to match motor FLA and calibrated for 1.0 and 1.15 service factors.
  – Heater packs for Size 00-0 overload relays will mount in larger Size 1 and 2 overload relays — useful in derating applications such as jogging.
  – Single phase protection – Class 20 or 10 trip time.
  – Electrically isolated NO - NC contacts (pull RESET button to test).
  – Visual trip indication
  – Integral load lugs allows field wiring prior to heater pack installation.
  – NEMA Sizes 5-9 use Current Transformer with 32 Amp overload. Size 5 uses 300:5 CT, Size 6 uses 600:5 CT, Size 7 uses 1000:5 CT, Size 8 uses 1500:5 CT, and Size 9 uses 3000:5 CT.

- **Magnet Coil —** Encapsulated dual voltage/frequency – color coded and permanently marked with voltage, frequency and part number.

  A two-piece spring latch contactor design makes coil removal or replacement fast and simple for Sizes 00-2.

  The NEMA Size 3-5 features a quick change coil assembly which makes coil removal and replacement fast and simple.

  Coil terminals are located on top for easy accessibility. The Size 00 and 0 contactor magnet coils have three terminals, permitting either top or diagonal wiring — European or U. S. style starters can be replaced without changing wiring layout.

  The NEMA Sizes 6-8 features a special DC feeder group for coil feeding. This system allows AC or DC applied voltage, low noise and low inrush and holding consumption.

  The NEMA Size 9 coil is 110V dc/120V ac (Rectified).

  AC or DC magnet coils.

- **Contacts —** Long life twin break contacts provide excellent conductivity and superior resistance to welding and arc erosion. Generously sized for low resistance resulting in extended life.

NEMA, Contactors & Starters, (Freedom)

DESIGN CHARACTERISTICS (Continued)

- **Terminals — Size 00 through 1** ± screw type with captive, backed-out self-lifting pressure plates. Finger proof covers, to reduce electrical shock, are available. Size 2-9:
  Control: Back-out saddle clamp with ± screws
  Power: Box lugs, pressure type
- **Mounting Position —** Sizes 00-5: Horizontal or vertical on upright panel. Sizes 6-8: 25° from vertical maximum. Size 9: Vertical only.
- **Connections —** Straight through wiring — Line lugs at top, load lugs at bottom.
- **Standards —**
  UL listed (Size 00-8):
  Open — File #E1491, Guide #NLDX
  Enclosed — File #E19224, Guide #NLDX
  UL listed (Size 9):
  Open and Enclosed — File #E19224, Guide #NLDX
  Except Size 9 Reverser Not UL Listed.
  cUL listed (Size 00-8):
  Enclosed — File #E19224, Guide #NLDX
  CSA certified — (Size 00-8):
  Open — File #LR353, Class #3211-04
  Designed to meet or exceed NEMA standards.
- **Ambient Temperature —** –5°C to + 65°C
- **Enclosures —** Open or NEMA 1, 3R, 4X, and 12 enclosed. Snap-on cover control kits Size 00-4 NEMA 1; flange mount all other enclosure types.
- **Construction —** Designed specifically for use in applications requiring NEMA ratings. Starters meet or exceed NEMA standards ICS 2-1988.
- **Mechanical/Electrical Life —** Designed to 30 million mechanical operations at maximum HP ratings for Sizes 00 & 0, 10 million for Sizes 1& 2, 5 million for Sizes 3-8. Designed to 3 million electrical operations for Sizes 00-3 and 500 thousand for Sizes 4-8. Size 9 mechanical life in excess of 24K operations and electrical life AC-3 (N/A); AC-4 in excess of 50 operations.
- **Wiring —** Wired for separate or common control.
- **Holding Circuit Interlock —** NEMA Starters Sizes 0-3 are supplied with 1 NO auxiliary contact mounted on the right hand side. On Size 00, interlock occupies 4th power pole position — no increase in width. Sizes 4 and 5 have NO interlock on left side, Sizes 6 and 7 have a 2NO/2NC auxiliary mounted on top between arc-chutes and Size 8 has NO/NC auxiliary on left side and a NO on the right. Size 9 supplied with 2 auxiliary contacts. Each with 1 NO & 1 NC.
- **Mounting —** Supplied with steel mounting plate as standard.

OPTIONAL FEATURES

- **Auxiliary Contacts —** Open type starters will accept up to 8 NO or NC auxiliary contacts (4 for Size 8) — includes holding circuit interlock. Enclosed contactors and starters will accept up to 4 NO or NC auxiliary contacts up to Size 1 in NEMA 1 enclosures. For larger sizes and other NEMA type enclosures, up to 8 NO or NC auxiliary contacts can be added.
- **Mechanical Interlock & Reversing Kits —** Available for field assembly of reversing contactors/starters up to Size 7.
- **Timer —** Two types – Side mounted five function Solid-State timer with timing ranges up to 5 minutes for use with open or enclosed starters/contactors, and top mounted pneumatic timers convertible from OFF to ON delay with timing ranges up to 3 minutes for use with open starters/contactors. Sizes 00-5 only.
- **Transient Suppressor Kit —** Limit high voltage transients produced in the control circuit when power is removed from the coil. For Sizes 00 through 2 there are three separate panel-mounted suppressors for use on 120, 240 or 480 volt coils. For Sizes 3 through 5 there is one separate side mounted suppressor for use on 120 volt coils.
- **Control Circuit Fuse Block —** Sizes 00-2 panel mounted and Sizes 3-5 side mounted fuse holder for control circuit protection. Uses Class CC rejection type fuses, 30 ampere, 600 volt ac maximum.
- **Locking Cover for Overload Relay —** Snaps over top of overload relays to prevent accidental turning of trip or reset adjustments.
- **Branch Circuit Fuse Block Kits —** Sizes 00 through 2, 3-pole, top-mounted. Provide short circuit protection for branch circuits.
- **Phase Monitor Relays —** Designed to monitor phase voltage unbalance, incorrect phase sequence and line undervoltage of a 3 phase system. Sizes 00-5 only.
- **Cover Controls for Enclosures —** Numerous pushbuttons, selector switches and indicating lights are available either factory installed or as kits to be installed by others. These local control devices are available for NEMA 1, 3R, 4X and 12 enclosures.
- **Other Options for Enclosures —** Many other optional features such as meters, terminal strips, relays timers, control power transformers, fuse blocks and other accessories are available for installation in enclosed contactors and starters.

DESCRIPTION

Non-Reversing Starters

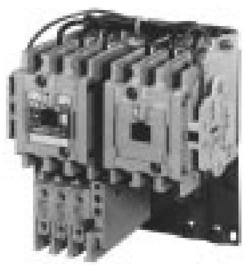
Line voltage magnetic starters are used for starting polyphase squirrel cage motors when full starting torque and the resulting inrush current are acceptable. These starters also provide protection to the motor against running or stalled overcurrents.

NEMA, Contactors & Starters, (Freedom)

The “Freedom Series” starters feature a compact space saving design using state-of-the-art technology and the latest in high strength, impact and temperature resistant insulating materials.

Reversing Starters

Three phase, full voltage magnetic starters are used primarily for reversing of polyphase squirrel cage motors. They consist of two contactors and a single overload relay assembled together. The contactors are mechanically and electrically interlocked to prevent line shorts and energization of both contactors simultaneously.



SIZE 1 REVERSING STARTER

SIZE 0 REVERSING STARTER

GENERAL

Magnet Coil — Magnet coils are encapsulated dual voltage/frequency coils which are color coded and permanently marked with voltage, frequency and part number. Coil terminals are located on top for easy accessibility.

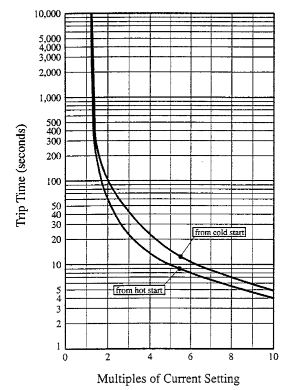
Overload and Heater Packs — Overload relays used on “Freedom Series” starters come in four sizes — 32 amperes, 75 amperes, 105 amperes and 144 amperes. They can be attached directly to contactors (panel mount or common mounting plate) or, with a panel mounting adapter, as a stand alone panel mounted 32 ampere or 75 ampere overload relay. The panel mounting adapter also provides a terminal block for line side wiring to the stand alone overload relay. Sizes 5-9 use 32 amps with CT’s.

The overload relay houses an adjustable, trip-free mechanism and provides mounting for three heater packs. The mechanism is bimetallic with ambient compensated operation. Single phase protection is built in. The reset mechanism can be set for AUTO or MANUAL operation. It has ± 24% adjustability to match motor full load ampere rating with calibration for 1.0 or 1.15 service factor motors. Two isolated contacts, one NC and one NO can be tested by pulling the RESET button. The NC and NO contacts are rated B600 and C600 (refer to Ratings tables on Page 8) respectively. Like the contactor, the overload relay has “finger proof” terminals to reduce the possibility of electrical shock.

Tamper proof overload relay adjustment locking covers snap over the top of overload relays to prevent accidental turning of trip or reset adjustments. Consult the Industrial Control Catalog for information on the variety of covers available.

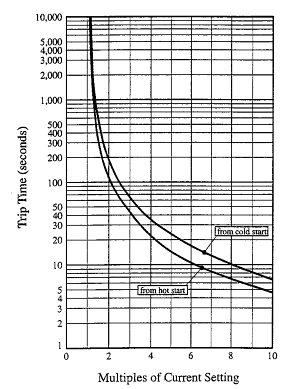
Visual trip indication is provided on all overload relays. The indicator window is located on the lower right-hand corner of the switch unit, just below the reset button. Upon an overload trip (or by pulling up on the reset button), a fluorescent orange indicating flag will appear in the window. Trip indication is only present when using Manual Reset.

CLASS 10 TYPE C306 OVERLOAD RELAY



TRIP CURVE
TYPE C306 BIMETALLIC COMPENSATED
OVERLOAD RELAY 25°C OPEN RATING

CLASS 20 TYPE C306 OVERLOAD RELAY



TRIP CURVE
TYPE C306 BIMETALLIC COMPENSATED
OVERLOAD RELAY 25°C OPEN RATING

The heater packs are securely held in the overload relay by two captive screws. Three Class 20 (Class 10 optional) heater packs are installed in the overload relay. The 32 ampere heater packs will mount in the 75 ampere overload relay for applications where the contactor is derated such as for jogging.

The overload relay is adjustable within the FLA range of the heater pack and will ultimately trip at 125% motor current. After the heater packs are selected and installed in the overload relay, the FLA adjustment dial should be rotated to the dial position corresponding to the motor FLA.

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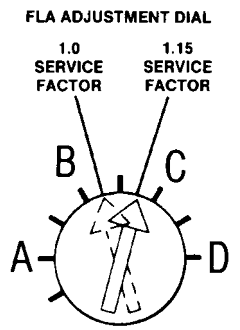


Diagram	Heater Pack Selection Table ❶				
	Motor FLA Rating				Heater Pack Number
	FLA Dial Positions				
	A	B	C	D	
	18.0	20.2	22.3	24.5	H2018-3
	24.6	27.6	30.5	33.4	H2019-3
	33.5	37.5	41.5	45.6	H2020-3
	45.7	51.2	56.7	62.1	H2021-3
	62.2	69.7	77.1	84.6	H2022-3
	84.7	95.0	105.0	115.0	H2023-3
	106.0	118.0	131.0	144.0	H2024-3

❶ Example of Heater Pack Selection Table only. Refer to catalog for complete table.

For example, if the FLA rating is 75.2 amperes, heater packs number H2022-3 should be selected from the above listed Heater Pack Selection Table. For a 1.15 service factor motor the FLA adjustment dial should be set at the location shown in the above diagram by interpolating between the B position of 69.7 amperes and the C position of 77.1 amperes. If a 1.0 service factor motor would be involved, the dial should be rotated counterclockwise one graduation (one half position) to the dotted location in the diagram.

Power Poles — Power poles are available for the Sizes 00, 0, 1 and 2 contactors and starters only. The 00 & 0 power pole is rated 12 amps (20 amp thermal) and the 1 & 2 is rated the same as the basic devices.

A maximum of two power poles can be used per contactor or starter. They cannot be field or factory installed. The power poles have been designed to accept mechanical interlocks and side mounted auxiliary contacts.

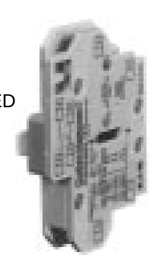
General Auxiliary Contacts Information — Auxiliary contact blocks are designed for snap-on installation — fast, easy installation (no tools required). Side mounted contact blocks are available in 8 different circuit configurations — top mounted contact blocks are offered in 21 different combinations. Enclosed type starters will accept side-mounted auxiliaries only when mounted in standard enclosures. In larger enclosures, top mounted contacts can be added.

All auxiliary contacts are of the bifurcated design with parallel circuit paths. This redundant path provides very high reliability.

For rating information, refer to the “Auxiliary Contact Ratings” table in this publication on Page 8.

TOP MOUNTED

SIDE MOUNTED



Side Auxiliary Contacts — All starters are supplied as standard with one normally open (1 NO) auxiliary contact for use as a holding circuit contact. Reversing starters have in addition, one normally closed (1 NC) auxiliary contact for electrical interlocking purposes.

On Size 00, the holding contact occupies the 4th power pole position (no additional space required). Up to two additional contacts may be added to each side of a Size 00 starter. On Sizes 0-2, the NO holding contact is located on the right side of the contactor. Up to two additional contacts may be added to the left side.

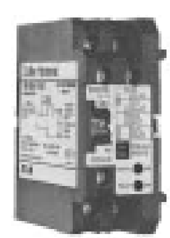
On Sizes 3-5, the NO holding contact is a base contact (on the right on Size 3 and on the left on Sizes 4 & 5). Up to 2 additional contacts can be mounted on the base interlock. On the opposite side, up to 4 additional auxiliary contacts can be added.

On Sizes 6 & 7, there is 2NO/2NC contact block mounted on the top-left position. An additional 2NO/2NC block may be added to the top-right position. On Size 8, there is a NO/NC block on the left back and a NO on the right back. Additional NO/NC blocks may be added on the left and right front positions.

On Size 9, 2 auxiliary contacts are provided, each with 1 NO and 1 NC.

Top Auxiliary Contacts — Open type starters, Sizes 00-2, will accept top auxiliary contacts (up to four circuits possible). This allows a total of up to 8 extra auxiliaries on Size 00 (6 extra auxiliaries on Sizes 00-2).

Electronic Timer — The side mounted, five-function Electronic Timer attachment has a 1 NO - 1 NC relay output and is designed for easy installation to any Freedom Series starter. It is available in three different timing ranges from 0.3 to 300 seconds. Additional auxiliary contacts cannot be installed on same side of starter when timer is used. For Sizes 3-5 a separate mounting bracket is required.



ELECTRONIC TIMER MODULE

- Timing Modes
  - ON DELAY - Timing begins when timer is energized.
  - OFF DELAY - Timing begins when timer is deenergized.
  - ONE SHOT - A single pulsed output occurs when timer is energized.

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- ON DELAY/OFF DELAY - Timer delay occurs on both energization and deenergization of timer.
- CYCLE MODE - Dual delay with external connections to the NC output contact, cycles ON and OFF continuously.

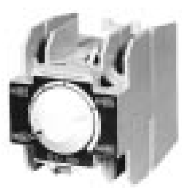
Delay mode is selectable with two switches on the face of the timer. The time is set by a serrated dial on the module face. Timer can also be mounted directly on 35 mm DIN rail.

- Specifications
  - Repeat Accuracy – within ± 1%
  - Setting Accuracy – ± 10% of scale setting

Maximum Current Rating, Amperes			
Description	Volts, ac		Volts, dc (Resistive)
	120	240	30
Make	30	15	5
Break	3	1.5	5
Continuous	3	1.5	5

Pneumatic Timer — The Pneumatic Timer attachment is designed for snap-on installation to top of any Size 00-2 starter (top mounted auxiliary contacts cannot be installed on device when timer is used). It is available in two ranges from 0.1 to 180 seconds. Timer unit has D.P.D.T. timed contacts – circuits in each pole must be the same polarity. Units are convertible from OFF to ON delay or vice-versa. Contacts are rated A600. Repeat accuracy is ±10%.

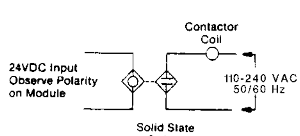
PNEUMATIC TIMER ATTACHMENT



DC/AC Interface Module — The Interface Module is an optically isolated solid state switch which provides a means of operating ac coils with a 24 volt dc control signal. It acts as a space saving interposing relay which can switch a 110-240 volt, 50/60 Hz source to the contactor or starter coil.

The module may be directly attached to the coil terminals of any Freedom Series contactor or starter - Size 00-2. It also has provisions for DIN rail mounting.

INTERFACE MODULE



TYPICAL APPLICATION

DC Magnet Coils — Dc Magnet Coils are available either factory installed or as field conversion kits.

Transient Suppressor Kit — Sizes 00-2 device connects across terminals on any 120 V, 240 V or 480 V starter magnet coil and Sizes 3-5 side mounted device connects across terminals on a 120 volt starter magnet coil. Suppressors are designed to limit the high voltage transients produced in the circuit when power is removed from the coil.

TRANSIENT SUPPRESSOR KITS

FOR SIZES 00-2

FOR SIZES 3-5

Control Circuit Fuse Block — Size 00-2 panel mounted and Size 3-5 side mounted fuse holders, designed for control circuit protection or other similar low current requirements, have extractor type fuse caps.

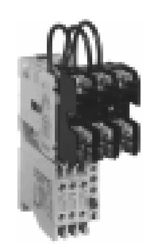
The Class CC rejection type fuses (KTK-R) used in these holders are intended for use with equipment designated as being suitable for use on systems having high available fault currents.

If branch circuit protective device is 45 amperes or greater, C320FBR1 fuse kit may be required for control circuit protection per NEC 430-72.

CONTROL CIRCUIT FUSE BLOCK

3-Pole Top Mounted Branch Circuit Fuse Block Kits — Designed to save space and reduce installation time, these top mounted fuse block kits field mount to any Size 00-2 starter and provide short circuit protection for branch circuits. Available for Class H, R, G or T fuses rated 15 through 60 amperes and Class J fuses rated 15 through 100 amperes, 250 through 600 volts.

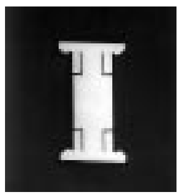
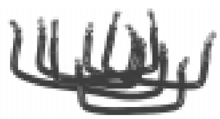
MOUNTED FUSE BLOCK



NEMA, Contactors & Starters, (Freedom)

Mechanical Interlock and Reversing Kits — These kits are available for field assembly of reversing starters using components. The Reversing Kits include a mechanical interlock, stabilizer bar and a pre-cut, trimmed and formed wire set. Auxiliary contacts are not supplied but can be ordered separately. The snap-fit mechanical interlock and stabilizer bar do not require tools for assembly. Installation instructions are included with the device.

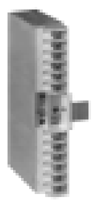
STABILIZER BAR

MECHANICAL INTERLOCK

WIRE SET

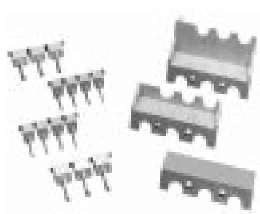
Phase Monitor Relay — Phase Monitor Relays are designed to monitor phase voltage unbalance, incorrect phase sequence and line undervoltage of a 3 phase system.



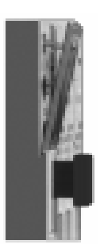
PHASE MONITOR RELAY

Finger Protection Shields — Snap-on shields for both contactors and starters, reversing and non-reversing provides type IP20 Finger Protection. Prevents accidental contact with line load terminals.

FINGER PROTECTION SHIELDS



Overload Locking Covers — Snap-on transparent or opaque plastic panel for covering access port to the overload relay trip setting dials. Helps prevent accidental or unauthorized changes to trip reset setting. Five varieties offers maximum application flexibility.



OVERLOAD LOCKING COVER

Short Circuit Protection — Fuses and Inverse-Time Circuit Breakers may be selected per Article 430, Part D of the National Electrical Code to protect motor branch circuits from fault conditions. If higher ratings or settings are required to start the motor, do not exceed the maximum as listed in Exception No. 2, Article 430-52.

ENCLOSURES

NEMA Definitions

Type	Definition
1	Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.
3R	Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet, and damage from external ice formation.
4X	Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage form external ice formation.
12	Enclosures are intended for indoor use primarily to provide a degree of protection agains circulating dust, falling dirt, and dripping noncorrosive liquids.


NEMA 1

NEMA 3R

ENCLOSED STARTERS

Cover Control Kits for Enclosures — These kits are available for NEMA 1 enclosures in versions such as Start/Stop, Hand-Auto, Hand-Off-Auto, Test-Off-Auto — all available with and without pilot light options. For reversing applications, Forward-Stop-Reverse, Up-Stop-Down and Open-Stop-Close with and without pilot lights are available. For other NEMA types, these and other versions such as On-Off are available. The kits are complete with wires and instructions. Assembly is fast and easy, requiring only a screwdriver in most cases. NEMA 1 enclosures have removable blank plates or knockouts and NEMA 3R, 4X and 12 enclosures have removable hole plugs that cover the pre-punched holes.


ISLAND & 10250T TYPE COVER CONTROL WITH ACCOMPANYING ENCLOSURES

NEMA, Contactors & Starters, (Freedom)

REFERENCE DATA

NEMA AN16 Starters — High Fault Current Circuit Ratings — UL508

SCPD	Max Rating SCPD (A)	Cir Bkr Intrp Rating (KA)	Short Circuit Volt (V)	Withstand Current (KA)	Typical Disconnect
Size 00					
Data To Be Available Later					
Size 0					
Class R, J Fuse ❶	60	100	600	100	C361
Mag Bkr — HMCP ❶	30	100	480	100	HMCP
Thrml Mag — FDC ❶	35	100	480	100	FDC
Size 1					
Class R, J Fuse ❶	60	100	600	100	C361
Mag Bkr — HMCP ❶	30	100	480	100	HMCP
Thrml Mag — FDC ❶	90	100	480	100	FDC
Size 2					
Class R, J Fuse ❶	100	100	600	100	C361
Mag Bkr — HMCP ❶	50	100	480	100	HMCP
Thrml Mag — FDC ❶	150	100	480	100	FDC
Size 3					
Class R, J Fuse ❶	200	100	600	100	C361
Mag Bkr — HMCP ❶	150	100	480	100	HMCP
Thrml Mag — FDC ❶	150	100	480	100	FDC
Size 4					
Class R, J Fuse ❶	400	100	600	100	400 A K SW
Mag Bkr — HMCP ❶	150	100	480	100	HMCP
Thrml Mag — JDC ❷	250	100	480	100	JDC
Size 5					
Class R, J Fuse ❶	600	100	600	100	600 A K SW
Mag Bkr — HMCP ❷	600	100	480	100	HMCP
Thrml Mag — KDC ❷	400	100	480	100	FDC
Size 6					
Class L Fuse ❶	1200	- - -	600	100	800 A K SW
Class L Fuse ❶	1200	- - -	600	100	Mld Case N Fr
Thrml Mag — HLD ❷	800	65	480	65	HLD

❶ UL File E39943 — Issue Date 2/15/89.
❷ UL File E47048 — Issue Date 11/23/87.

NOTE:
UL 508 STANDARD FAULT CURRENT RATINGS: All devices are UL Listed with fuses and inverse time circuit breakers to standard low level fault currents based on horsepower. All AN16 starters conform. Sizes 00-3 to 5kA. Sizes 4-5 to 10kA. Size 6 to 18kA. Size 7 to 30kA. Size 8 to 42kA and Size 9 to 85kA.

Electrical Data

NEMA Size / Frame Width	Ampere Rating, Continuous	Maximum Horsepower		
		Motor Voltage 60 Hz	1 ϕ	3 ϕ
00 / 45 mm	9	115 200 230 460 575	1/3 - - - 1 - - - - - -	- - - 1½ 1½ 2 2
0 / 45 mm	18	115 200 230 460 575	1 - - - 2 - - - - - -	- - - 3 3 5 5
1 / 65 mm	27	115 200 230 460 575	2 - - - 3 - - - - - -	- - - 7½ 7½ 10 10
2 / 65 mm	45	115 200 230 460 575	3 - - - 7½ - - - - - -	- - - 10 15 25 25
3 / 90 mm	90	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - 25 30 50 50
4 / 180 mm	135	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - 40 50 100 100
5 / 180 mm	270	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - 75 100 200 200
6 / 220 mm	540	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - 150 200 400 400
7 / 280 mm	810	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - 200 300 600 600
8 / 334 mm	1215	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - 400 450 900 900
9 / 813 mm	2250	115 200 230 460 575	- - - - - - - - - - - - - - -	- - - - - - 800 1600 1600

NEMA, Contactors & Starters, (Freedom)

Auxiliary Contact Ratings

NEMA Electrical Rating Designation	Volts	Amperes Make	Amperes Break	Amperes Continuous
A600	120 240 480 600	60 30 15 12	6 3 1.5 1.2	10
B600	120 240 480 600	30 15 7.5 6	3 1.5 0.75 0.60	5
C600	120 240 480 600	15 7.5 3.75 3.00	1.5 0.75 0.38 0.30	2.5

Wire (75°C) Sizes — AWG or kcmil – Open and Enclosed

NEMA Size	Cu Only
Power Terminals — Contactors	
00	#12 – #16 Stranded, #12 – #14 Solid
0	#8 – #16 Stranded, #10 – #14 Solid
1	#8 – #14 Stranded or Solid
2	#3 – #14 (upper) and/or #6 – #14 (lower) Stranded or Solid ❷
Power Terminals — Load (Overload Relay)	
Heater Pack Cat. Nos.	**❶ Min. — Cu Only (Stranded or Solid)**
H2001B-H2010B H2101B-H2110B	#14
H2011B & H2111B	#12
H2012B & H2112B	#10
H2013B-H2014B H2113B-H2114B	#8
H2015B & H2115B	#6
H2016B & H2116B	#4
H2017B & H2117B	#3
H2015A-H2017A H2114-H2117	#14-#2
Power Terminals – Line and Load	
3	#1/0 – #14 Al Cu
4	#3/0 – #8 Al Cu
5	750 kcmil – #2 or (2) 250 kcmil – #3/0 Al Cu
6	(2) 750 kcmil — #3/0 Al Cu
7	(3) 750 kcmil — #3/0 Al Cu
8	(4) 750 kcmil — #1/0 Al Cu
9	(8) 500 kcmil
Control Terminals — Cu Only	
All	#12 – #16 Stranded or #12 – #14 Solid

❶ Minimum per NEC.
Maximum Wire Size: Sizes 00 & 0 — #8 and Sizes 1 & 2 — #2.
❷ Two compartment box lug.

Torque Requirements — Line/Load and Heaters (in-lbs)

NEMA Size	AN16/56 Starters Line Lug ❹ Torque in-lbs	Line Lug ❹ Wire Range	Load Lug Torque in-lbs	Load Lug Wire Range	Heater Packs in-lbs
00	7	❸	20	❸	9
0	15	❸	20	❸	9
1	20	❸	35 40 45 50	#14-10 #8 #6-4 #3	9 9 9 9
2	40 45 50	#14-8 #6-4 #3	35 40 45 50	#14-10 #8 #6-4 #3	9 9 9 9
3	35 40 45 50	#14-10 #8 #6-4 #3-1/0	35 40 45 50	#14-10 #8 #6-4 #3-1/0	24-30 24-30 24-30 24-30
4	200	❸	200	❸	24-30
5-7	550	❸	550	❸	9
8	500	❸	500	❸	9
9	400	4/0- 500 MCM	400	4/0- 500 MCM	9

❸ See "Wire Sizes" Table adjacent.
❹ For contactors this is "Line and Load Lug" data.

Plugging and Jogging Service Horsepower Rating

NEMA Size	200 Volts	230 Volts	460 Volts	575 Volts
Maximum horsepower where operation is interrupted more than 5 times per minute, or more than 10 times in a 10 minute period.				
00	- - -	½	½	½
0	1½	1½	2	2
1	3	3	5	5
2	7½	10	15	15
3	15	20	30	30
4	25	30	60	60
5	60	75	150	150
6	125	150	300	300

NEMA, Contactors & Starters, (Freedom)

AC COIL DATA

NEMA Sizes	P.U. Volts		P.U.			Sealed			D.O. Volts		Mech. Max. Operation Rate Ops/Hour	P.U. Time mS	D.O. Time mS
	Cold	Hot	VAR	VA	Watts	VAR	VA	Watts	Cold	Hot			
00	74.0%	78%	64	80	49	7.1	7.5	2.4	45%	46%	10,800	12	12
0	74.0%	78%	78	100	65	9.2	10	3.1	45%	46%	10,800	12	12
1-2	74.0%	78%	210	230	95	27	28	7.8	49%	50%	7,200	20	14
3	72.0%	76%	374	390	112	48	49.8	13	50%	52%	7,200	14	11
4	72.5%	76%	1132	1158	240	96	100	27.2	54%	56%	4,800	28	14
5	75.0%	77%	1132	1158	240	96	100	27.2	63%	64%	4,800	25	13
6	75.0%	75%	516	890	798	- - -	11	10	❶	❶	2,400	100	150-1000 ❷
7	75.0%	75%	868	1000	1345	11	25	20	❶	❶	1,200	100	150-1000
8	75.0%	75%	1262	2400	- - -	- - -	70	- - -	❶	❶	600	100	25-50
9	50.0%	65%	- - -	- - -	2100	- - -	- - -	350	40%	50%	- - -	18	20

❶ 20-30% of rated coil voltage.

❷ Adjustable drop out time.

DC COIL DATA

NEMA Sizes	Volts	P.U.			Sealed		D.O. Volts (Hot)	P.U. Time mS	D.O. Time mS	Max. Operation Rate Ops/Hour	Mech. Life Millions
		Amps	Watts	Volts (Hot)	Amps	Watts					
00/0	12	6.4	76.8	80%	0.28	3.36	60%	22	17	3,600	5
	24	3.2	76.8	80%	0.14	3.36	60%	22	17	3,600	5
	48	1.6	76.8	80%	0.07	3.36	60%	22	17	3,600	5
	120	0.64	76.8	80%	0.028	3.36	60%	22	17	3,600	5
1/2	12	15.4	126	68%	0.42	4.98	30%	21	12	3,600	2
	24	6.2	88.4	60%	0.21	4.96	29%	20	13	3,600	2
	48	2.9	76.2	56%	0.11	5.04	28%	20	14	3,600	2
	120	1.1	67.3	53%	0.041	4.87	29%	20	16	3,600	2
3	12	24	293	65%	0.40	4.84	23%	39	14	3,600	2
	24	12	288	61%	0.20	4.75	22%	38	14	3,600	2
	48	6.1	295	62%	0.097	4.67	22%	37	14	3,600	2
	120	2.5	298	61%	0.038	4.57	22%	37	16	3,600	2
4/5	24	18	400	67%	0.22	5.3	25%	53	14	2,400	2
	48	9.0	400	67%	0.11	5.2	25%	49	16	2,400	2
	120	3.3	450	65%	0.05	5.4	28%	56	19	2,400	2
	240	1.7	440	64%	0.02	4.9	26%	49	21	2,400	2
6	106	8.25	775	N/A	0.085	9	N/A	N/A	N/A	2,400	5
	214	4.09	775	N/A	0.042	9	N/A	N/A	N/A	2,400	5
	340	2.57	775	N/A	0.026	9	N/A	N/A	N/A	2,400	5
	430	2.03	775	N/A	0.021	9	N/A	N/A	N/A	2,400	5
7	106	13.92	1425	N/A	0.184	19.5	N/A	N/A	N/A	1,200	5 ❸
	214	6.89	1425	N/A	0.091	19.5	N/A	N/A	N/A	1,200	5 ❸
	340	4.34	1425	N/A	0.057	19.5	N/A	N/A	N/A	1,200	5 ❸
	430	3.43	1425	N/A	0.045	19.5	N/A	N/A	N/A	1,200	5 ❸
8	106	19.81	2100	N/A	0.566	60	N/A	N/A	N/A	600	5 ❸
	214	9.81	2100	N/A	0.280	60	N/A	N/A	N/A	600	5 ❸
	340	6.18	2100	N/A	0.176	60	N/A	N/A	N/A	600	5 ❸
	430	4.88	2100	N/A	0.139	60	N/A	N/A	N/A	600	5 ❸

❸ Change armature, magnet and armature interlock after 1 x 10^4 operations.

GENERAL COIL DATA

Coil Offering — Encapsulated – NEMA Sizes 00-9 (Except Size 6 is tape)

UL Insulation Rating — Encapsulated – Class 130 (B) – 105 degree C temp. rise

Operational Limits — 85% to 110% of Rated Voltage

Coil Data Notes

P.U. = Pick up time is the average time taken from closing of the coil circuit to main contact touch.

D.O. = Drop out time is the average time taken from opening of the coil circuit to main contact separation.

Cold = Coil data with a cold coil.

Hot = Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 VAC or 24 VDC magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

NEMA, Contactors & Starters, (Freedom)

RENEWAL PARTS

Magnet Coils					
Coil Volts and Hertz	**Size 00 ❶**	**Size 0 ❶**	**Size 1-2**	**Size 3**	**Size 4-5**
120/60 or 110/50	9-2823-1	9-2824-1	9-2703-1	9-2756-1	9-1891-1
240/60 or 220/50	9-2823-2	9-2824-2	9-2703-2	9-2756-2	9-1891-2
480/60 or 440/50	9-2823-3	9-2824-3	9-2703-3	9-2756-3	9-1891-3
600/60 or 550/50	9-2823-4	9-2824-4	9-2703-4	9-2756-4	9-1891-4
24/60 or 24/50	9-2823-18	9-2824-18	9-2703-16	9-2756-16	– – –
24/60	9-2823-7	9-2824-7	9-2703-6	9-2756-6	9-1891-15
48/60	9-2823-8	9-2824-8	9-2703-11	9-2756-15	– – –
208/60	9-2823-5	9-2824-5	9-2703-9	9-2756-5	9-1891-13
277/60	9-2823-12	9-2824-14	9-2703-7	9-2756-9	9-1891-26
24/50	9-2823-13	9-2824-13	9-2703-12	9-2756-11	9-1891-16
208-240/60	9-2823-17	9-2824-17	– – –	– – –	– – –
32/50	– – –	– – –	9-2703-10	9-2756-10	9-1891-27
48/50	9-2823-9	9-2824-9	9-2703-13	9-2756-7	9-1891-18
240/50	9-2823-11	9-2824-11	9-2703-14	9-2756-13	9-1891-20
380/50	– – –	– – –	– – –	9-2756-12	9-1891-14
415/50	– – –	– – –	– – –	9-2756-8	9-1891-21
380-415/50	9-2823-6	9-2824-6	9-2703-8	– – –	– – –
550/50	– – –	– – –	– – –	9-2756-14	9-1891-8

Coil Volts and Hertz	**Size 6**	
	Main Coil	**Feeder Group**
120/60 or 110/50	9-3006	9-3007
240/60 or 220/50	9-3006-2	9-3007-2
480/60 or 440/50	9-3006-3	9-3007-3
600/60 or 550/50	9-3006-4	9-3007-4
218/60 or 200/50	9-3006-5	9-3007-5
277/60 or 254/50	9-3006-6	9-3007-6
415/60 or 380/50	9-3006-7	9-3007-7
52/60 or 48/50	– – –	– – –
110/50-60	– – –	– – –
120/50-60	– – –	– – –
208/50-60	– – –	– – –
220/50-60	– – –	– – –
240/50-60	– – –	– – –
380/50-60	– – –	– – –
415/50-60	– – –	– – –
440/50-60	– – –	– – –
480/50-60	– – –	– – –
550/50-60	– – –	– – –
600/60-50	– – –	– – –

Coil Volts and Hertz	**Size 7**	
	Main Coil	**Feeder Group**
120/60 or 110/50	9-2698	9-2705
240/60 or 220/50	9-2698-2	9-2705-2
480/60 or 440/50	9-2698-3	9-2705-3
600/60 or 550/50	9-2698-4	9-2705-4
415/60 or 380/50	9-2698-6	9-2705-6
48/60 or 44/50	9-2698-8	9-2705-8
208/50-60	9-2698-5	9-2705-5

❶ These are the only renewal parts available. Series B1/C1 only.

NEMA, Contactors & Starters, (Freedom)

RENEWAL PARTS

Magnet Coils (Continued)

Coil Volts and Hertz	Size 8			
	Common Control		Separate Control	
	Main Coils	Feeder Group	Main Coils	Feeder Group
120/50-60	9-2654	9-2664	9-2654	9-2664
208/50-60	9-2654-6	9-2664-6		
240/50-60	9-2654-2	9-2664-2		
380/50-60	9-2654-5	9-2664-5		
480/50-60	9-2654-3	9-2664-3		
550/50-60	9-2654-10	9-2664-10		
600/50-60	9-2654-4	9-2664-4		

Coil Volts and Hertz	Size 9	
	Common Control	Separate Control
120/50-60	5264C34G01	5264C34G01

Dc Coil Kits

NEMA Contactor or Starter Size	Volts	Catalog Number
00-0	12	**C335KD3R1**
	24	**KD3T1**
	48	**KD3W1**
	120	**KD3A1**
1-2	12	**C335KD4R4**
	24	**KD4T4**
	48	**KD4W4**
	120	**KD4A4**
3	12	**C335KD5R1**
	24	**KD5T1**
	48	**KD5W1**
	120	**KD5A1**
4-5	24	**C335KA3T1**
	48	**KA3W1**
	120	**KA3A1**
	240	**KA3B1**

Contact Kits

Contactor or Starter NEMA Size	Part Numbers	
	2 Pole	3 Pole
1	6-65	6-65-2
2	6-65-7	6-65-8
3	6-43	6-43-2
4	6-44	6-44-2
5	6-45	6-45-2
6 ❶	– – –	6-648
7	– – –	6-613
8	– – –	6-571
9	(2) — 5264C42G01	(3) — 5264C42G01

Publications

NEMA Size Starter	Publication Numbers
1-2	22177
3	20426
4	20428
5	20429
6	23349
7	20848
8	20849
9	IL 16978

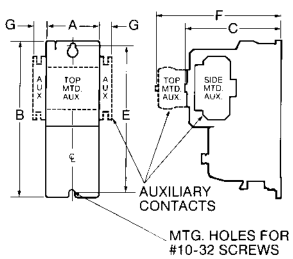
❶ Series B1 contactor, Series C1 starter.

NEMA, Contactors & Starters, (Freedom)

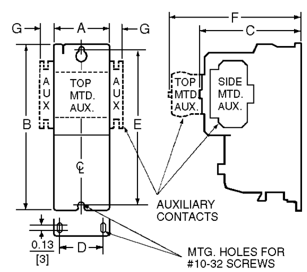
APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS

Do not use for construction.

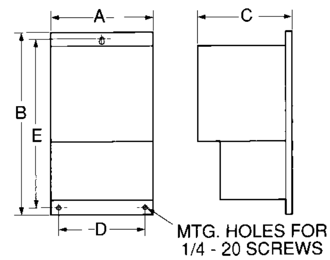
NON-REVERSING OPEN TYPE



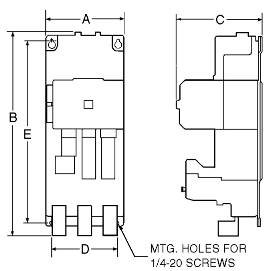
SIZE 00 & 0



SIZE 1 & 2



SIZE 3 & 4



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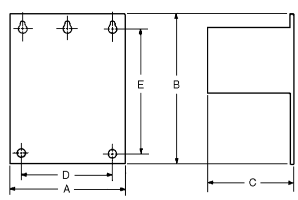
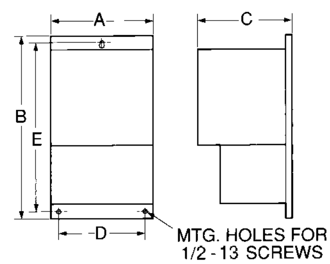


MOUNTING SCREWS — #1/2 - 13
SIZES 6 THROUGH 8



SIZE 9

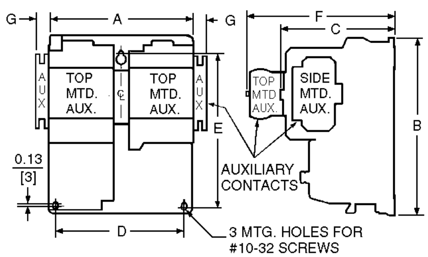
NEMA Size	Dimensions in Inches [mm]							Shipping Weight Lbs.
	Wide A	High B	Deep C	Mounting		F	G	
				D	E			
00-0	1.80 [45.5]	6.60 [168]	3.52 [89.5]	– – –	6.07 [154]	4.90 [124.5]	0.54 [13.7]	2.2
1	2.56 [65]	7.08 [180]	4.44 [113]	2.00 [51]	6.63 [168]	5.80 [147.5]	0.54 [13.7]	4.5
2	2.56 [65]	8.08 [205]	4.44 [113]	2.00 [51]	7.63 [194]	5.80 [147.5]	0.54 [13.7]	4.7
3	4.08 [104]	11.35 [288]	5.94 [151]	3.00 [76]	10.81 [275]	– – –	– – –	11.
4	7.05 [179]	12.06 [306]	7.25 [184]	6.00 [152]	8.50 [216]	– – –	– – –	23.
5	7.00 [178]	17.77 [451]	7.76 [197]	6.00 [152]	16.00 [406]	– – –	– – –	36.
6	9.47 [241]	21.69 [551]	9.90 [251]	3.10 [79]	18.00 [457]	– – –	– – –	75.
7	15.13 [384]	29.13 [740]	12.64 [321]	13.25 [337]	21.25 [540]	– – –	– – –	120.
8	15.13 [384]	34.50 [876]	15.00 [381]	13.75 [337]	16.75 [425]	– – –	– – –	210.
9	33.00 [838]	30.00 [762]	12.94 [329]	30.75 [781]	8.00 [203]	– – –	– – –	315.

NEMA, Contactors & Starters, (Freedom)

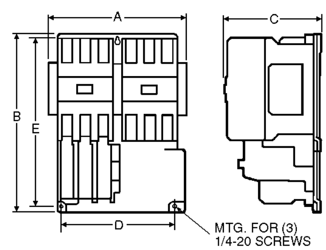
APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS (Continued)

Do not use for construction.

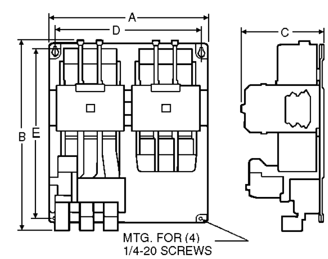
REVERSING OPEN TYPE



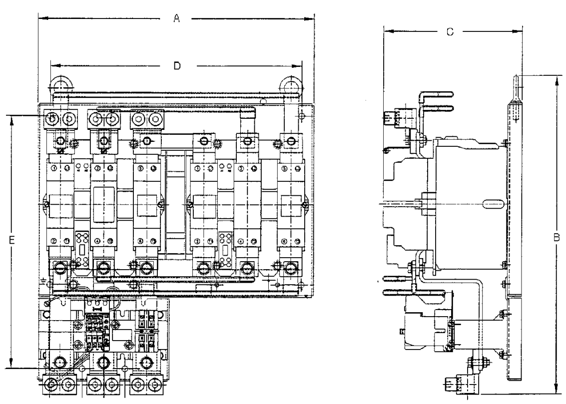
SIZE 00-2



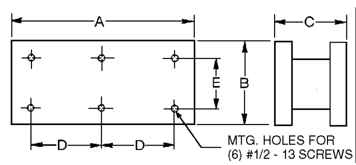
SIZE 3



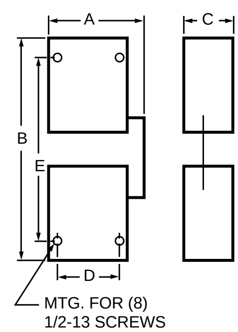
SIZE 4-5



SIZE 6



MOUNTING SCREWS #1/2 - 13
OPEN TYPE — SIZE 7-8 HORIZONTAL



SIZE 9
OPEN TYPE — VERTICAL

NEMA Size	Dimensions in Inches [mm]							Shipping Weight Lbs.
	Wide A	High B	Deep C	Mounting		F	G	
				D	E			
00-0	4.20 [106.5]	7.38 [187.5]	3.52 [89.5]	3.50 [89]	6.87 [174.5]	4.90 [124.5]	0.54 [13.7]	3.6
1	5.71 [145]	7.08 [180]	4.44 [113]	5.25 [133.5]	5.75 [146]	5.80 [147]	0.54 [13.7]	8.25
2	5.71 [145]	8.08 [205]	4.44 [113]	5.25 [133.5]	6.75 [171.5]	5.80 [147]	0.54 [13.7]	8.5
3	8.70 [221]	11.35 [288]	5.94 [151]	7.00 [178]	10.81 [275]	– – –	– – –	20.
4	14.68 [373]	12.06 [306]	7.25 [184]	13.50 [343]	8.50 [216]	– – –	– – –	49.
5	14.50 [368]	17.77 [451]	7.76 [197]	13.50 [343]	16.00 [406]	– – –	– – –	68.
6	19.77 [502]	22.63 [575]	9.90 [251]	18.00 [457]	18.00 [457]	– – –	– – –	130.
7	28.06 [713]	32.13 [816] ❶	12.70 [322]	12.75 [324]	21.25 [540]	– – –	– – –	175.
8	30.38 [772]	41.50 [1054] ❶	14.70 [373]	14.13 [359]	16.75 [425]	– – –	– – –	430.
9	33.00 [838]	63.12 [1603]	12.94 [329]	30.75 [781]	41.00 [1041]	– – –	– – –	640.

❶ Includes cross wiring overhang.

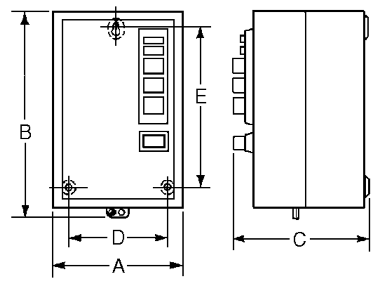
NEMA, Contactors & Starters, (Freedom)

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS (Continued)

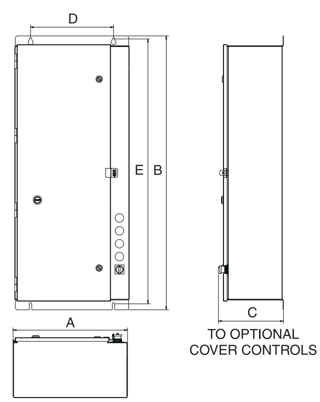
Do not use for construction.

NON-REVERSING & REVERSING CONTACTORS — ENCLOSED TYPE NEMA 1

NEMA Size (poles)	Box No.	Dimensions in Inches [mm]					Ship Wt. Lbs.
		Wide A	High B	Deep C	Mounting		
					Wide D	High E	
NON-REVERSING CONTACTORS - without Control Power Transformers							
00 (2P, 3P, 4P)	1	5.62 [143]	10.09 [256]	5.71 [145]	4.50 [114]	8.00 [203]	5.25
00 (2P, 3P, 4P) with top adders	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	7.3
0 (2P, 3P, 4P)	1	5.62 [143]	10.09 [256]	5.71 [145]	4.50 [114]	8.00 [203]	5.25
0 (2P, 3P, 4P) with top adders	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	7.3
0 (5P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	7.3
1 (2P, 3P)	1	5.62 [143]	10.09 [256]	5.71 [145]	4.50 [114]	8.00 [203]	7.9
1 (2P, 3P) with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	11
1 (4P, 5P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	8.5
2 (2P, 3P, 4P, 5P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	8.5
3 (2P, 3P)	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	35
4 (2P, 3P)	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	47
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	113
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
NON-REVERSING CONTACTORS - with Control Power Transformers							
00 (2P, 3P, 4P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	12
00 (2P, 3P, 4P, 5P) with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
0 (2P, 3P, 4P, 5P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	12
0 (2P, 3P, 4P, 5P) with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
1 (2P, 3P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	12.2
1 (2P, 3P) with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	12.5
1 (4P, 5P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	12.6
2 (2P, 3P, 4P, 5P)	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	12.8
3 (2P, 3P)	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	40
4 (2P, 3P)	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	52
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	120
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
3 POLE REVERSING CONTACTORS - without Control Power Transformers							
00	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	7.8
0	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	8
1	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	11
2	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	12
3	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	67
4	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	154
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	170
6		Consult Cutler-Hammer for Availability					
7							
8							
9							



BOXES 1-4



BOX 10

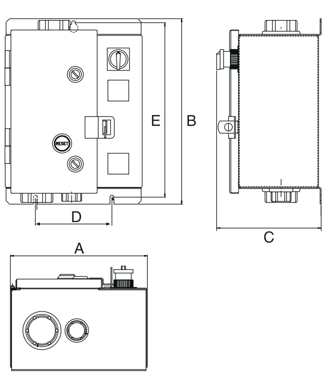
NEMA, Contactors & Starters, (Freedom)

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS (Continued)

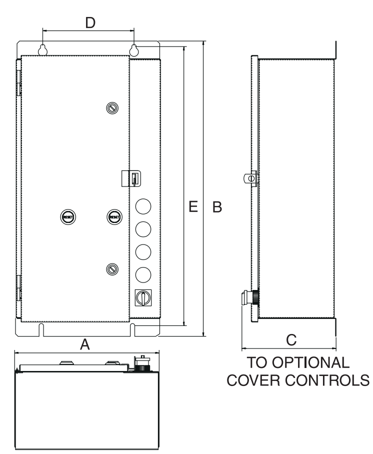
Do not use for construction.

NON-REVERSING & REVERSING CONTACTORS — ENCLOSED TYPE NEMA 3R, 4/4X & 12

NEMA Size (poles)	Box No.	Dimensions in Inches [mm] Wide A	High B	Deep C	Mounting Wide D	Mounting High E	Ship Wt. Lbs.
NON-REVERSING CONTACTORS - without Control Power Transformers							
0 (2P, 3P, 4P)	5	9.84 [250]	13.31 [338]	7.51 [191]	5.50 [140]	12.50 [3.18]	14
1 (2P, 3P, 4P, 5P)	5	9.84 [250]	13.31 [338]	7.51 [191]	5.50 [140]	12.50 [3.18]	15
2 (2P, 3P, 4P, 5P)	5	9.84 [250]	13.31 [338]	7.51 [191]	5.50 [140]	12.50 [3.18]	15.5
3 (2P, 3P)	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	45
4 (2P, 3P)	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	56
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	140
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
NON-REVERSING CONTACTORS - with Control Power Transformers							
0 (2P, 3P, 4P)	5	9.84 [250]	13.31 [338]	7.51 [191]	5.50 [140]	12.50 [3.18]	18
1 (2P, 3P, 4P, 5P)	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	19
2 (2P, 3P, 4P, 5P)	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	19.5
3 (2P, 3P)	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	52
4 (2P, 3P)	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	63
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	147
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
3 POLE REVERSING CONTACTORS - with or without Control Power Transformers							
0	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	18
1	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	19
2	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	19
3	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	47
4	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	69
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	170
6		Consult Cutler-Hammer for Availability					
7							
8							
9							



BOXES 5, 6



BOXES 8, 10

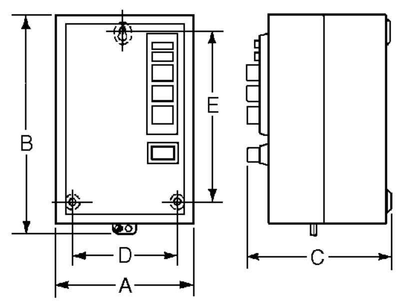
NEMA, Contactors & Starters, (Freedom)

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS (Continued)

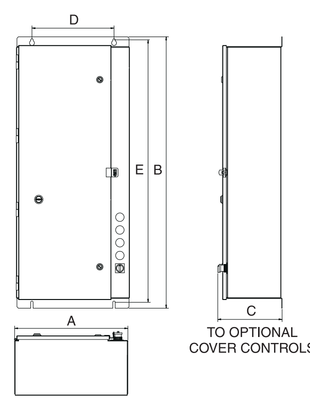
Do not use for construction.

NON-REVERSING & REVERSING STARTERS — ENCLOSED TYPE NEMA 1

NEMA Size (poles)	Box No.	Dimensions in Inches [mm] Wide A	High B	Deep C	Mounting Wide D	Mounting High E	Ship Wt. Lbs.
NON-REVERSING STARTERS Without Control Power Transformers							
00	1	5.62 [143]	10.09 [256]	5.71 [145]	4.50 [114]	8.00 [203]	7
00 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	10
0	1	5.62 [143]	10.09 [256]	5.71 [145]	4.50 [114]	8.00 [203]	7.1
0 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	10
1	1	5.62 [143]	10.09 [256]	5.71 [145]	4.50 [114]	8.00 [203]	7.9
1 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	11.5
2	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	8.5
3	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	35
4	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	47
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	139
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
NON-REVERSING STARTERS With Control Power Transformers							
00	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
0	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
1	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	16
2	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	16.2
3	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	42
4	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	54
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	146
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
REVERSING STARTERS Without Control Power Transformers							
00	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	8
0	2	7.73 [196]	13.21 [336]	6.75 [172]	6.00 [152]	10.75 [273]	8
0 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	11
1	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	13
1 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	13.4
2	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
3	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	43
4	9	25.50 [648]	29.10 [739]	9.31 [237]	20.00 [508]	27.50 [699]	65
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	165
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
REVERSING STARTERS With Control Power Transformers							
00 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
0	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	15
1 with top adders	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	17
2	3	12.65 [321]	14.40 [366]	7.31 [186]	9.75 [248]	11.25 [286]	19
3	4	11.66 [296]	26.51 [673]	8.89 [226]	9.00 [229]	23.38 [594]	50
4	9	25.50 [648]	29.10 [739]	9.31 [237]	20.00 [508]	27.50 [699]	72
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	172
6		Consult Cutler-Hammer for Availability					
7							
8							
9							



BOXES 1-4



BOXES 9-10

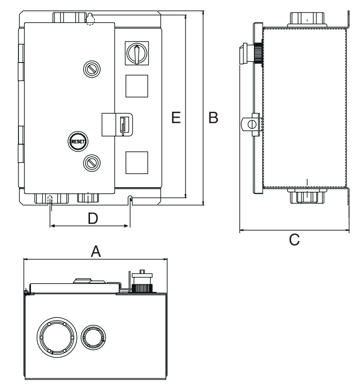
NEMA, Contactors & Starters, (Freedom)

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS (Continued)

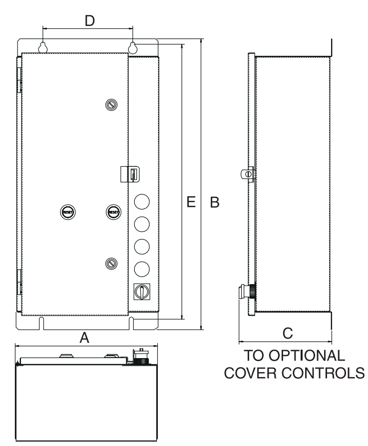
Do not use for construction.

NON-REVERSING & REVERSING STARTERS — ENCLOSED TYPE NEMA 3R, 4/4X & 12

NEMA Size (poles)	Box No.	Dimensions in Inches [mm] Wide A	High B	Deep C	Mounting Wide D	Mounting High E	Ship Wt. Lbs.
NON-REVERSING STARTERS - without Control Power Transformers							
0	5	9.84 [250]	13.31 [338]	7.51 [191]	5.50 [140]	12.50 [318]	14.3
1	5	9.84 [250]	13.31 [338]	7.51 [191]	5.50 [140]	12.50 [318]	15.3
2	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	16
3	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	46
4	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	60
4	9	25.50 [648]	29.10 [739]	9.31 [237]	20.00 [508]	27.50 [699]	60
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	150
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
NON-REVERSING STARTERS - with Control Power Transformers							
0	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	18
1	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	19
2	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	20
3	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	53
4	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	67
4	9	25.50 [648]	29.10 [739]	9.31 [237]	20.00 [508]	27.50 [699]	67
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	157
6		Consult Cutler-Hammer for Availability					
7							
8							
9							
REVERSING STARTERS - with or without Control Power Transformers							
0	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	18.5
1	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	19.5
2	6	12.01 [305]	14.39 [366]	7.51 [191]	8.00 [203]	13.50 [343]	21
1-2	7	16.26 [413]	14.37 [365]	7.51 [191]	11.00 [279]	13.50 [343]	24
3	8	14.25 [362]	29.10 [739]	9.29 [234]	9.00 [229]	27.50 [699]	48
4	9	25.50 [648]	29.10 [739]	9.31 [237]	20.00 [508]	27.50 [699]	72
5	10	20.00 [508]	47.85 [1215]	11.36 [289]	14.50 [368]	46.25 [1175]	175
6		Consult Cutler-Hammer for Availability					
7							
8							
9							



BOXES 5, 6, 7, 9

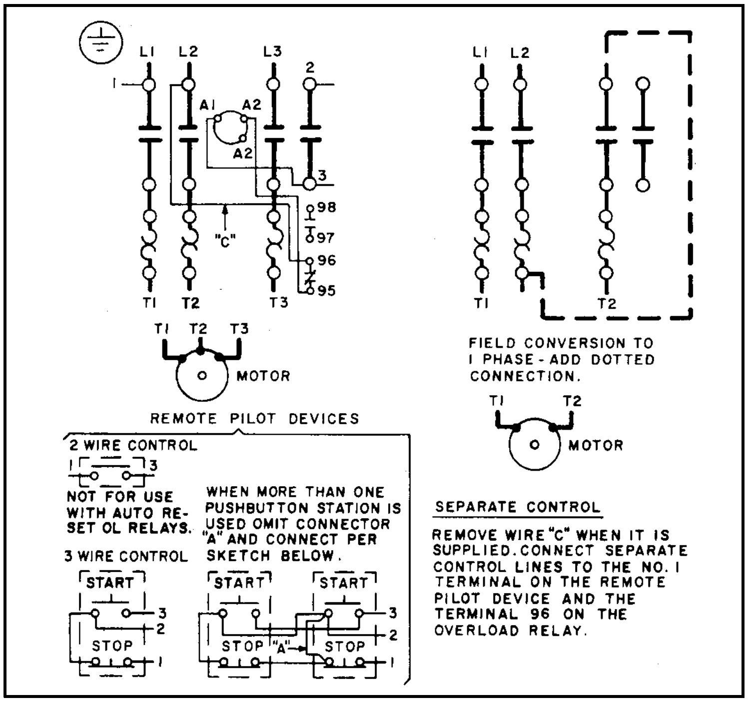


BOXES 8, 10

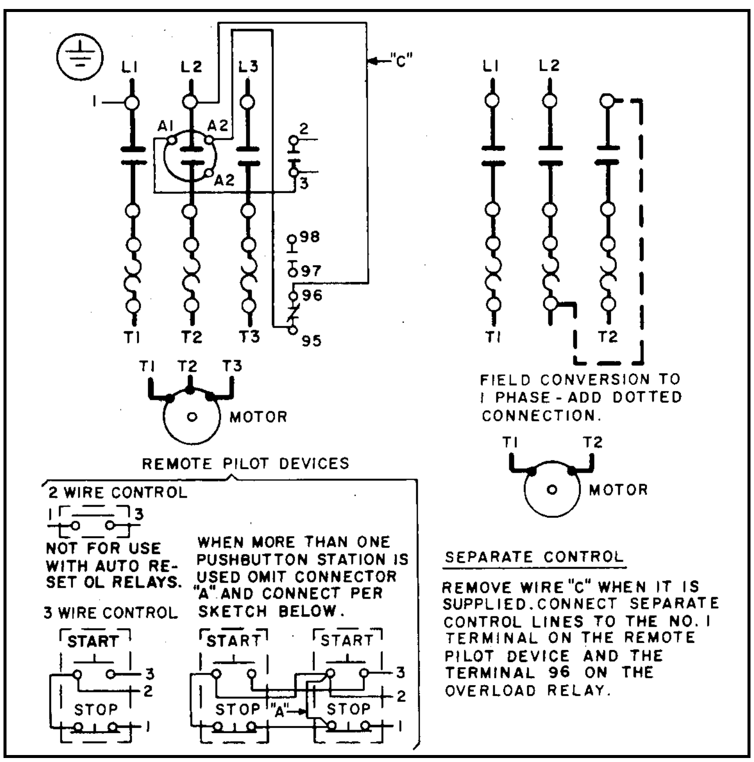
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS

NON-REVERSING STARTERS



SIZE 00

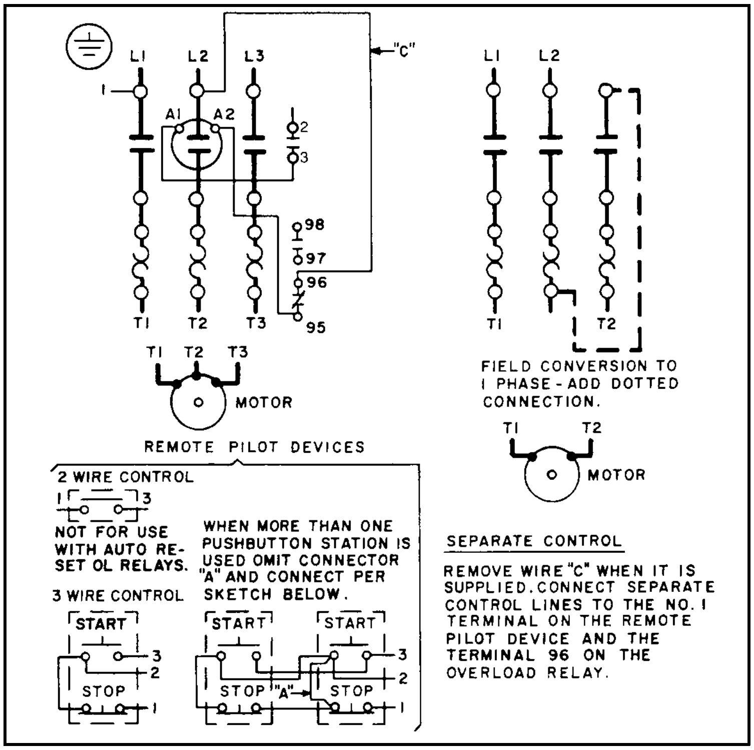


SIZE 0

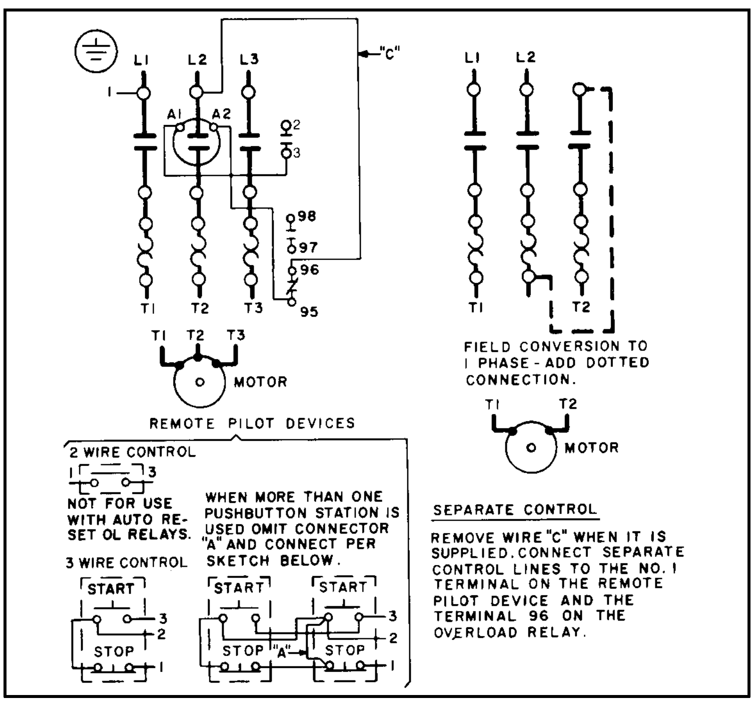
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

NON-REVERSING STARTERS (Continued)



SIZES 1 & 2

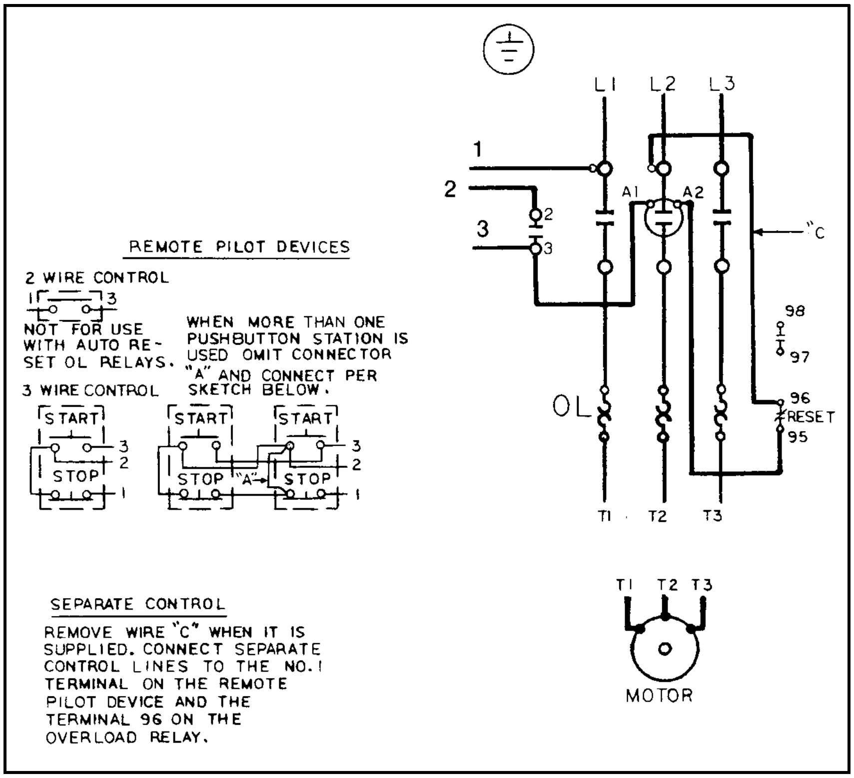


SIZE 3

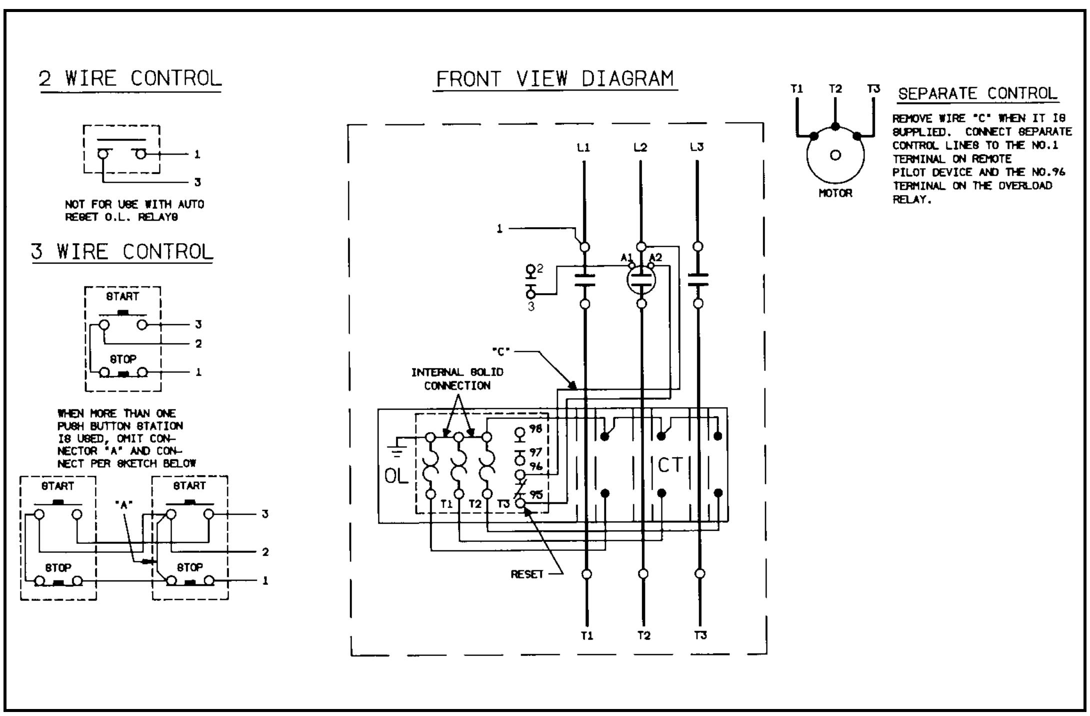
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

NON-REVERSING STARTERS (Continued)



SIZE 4

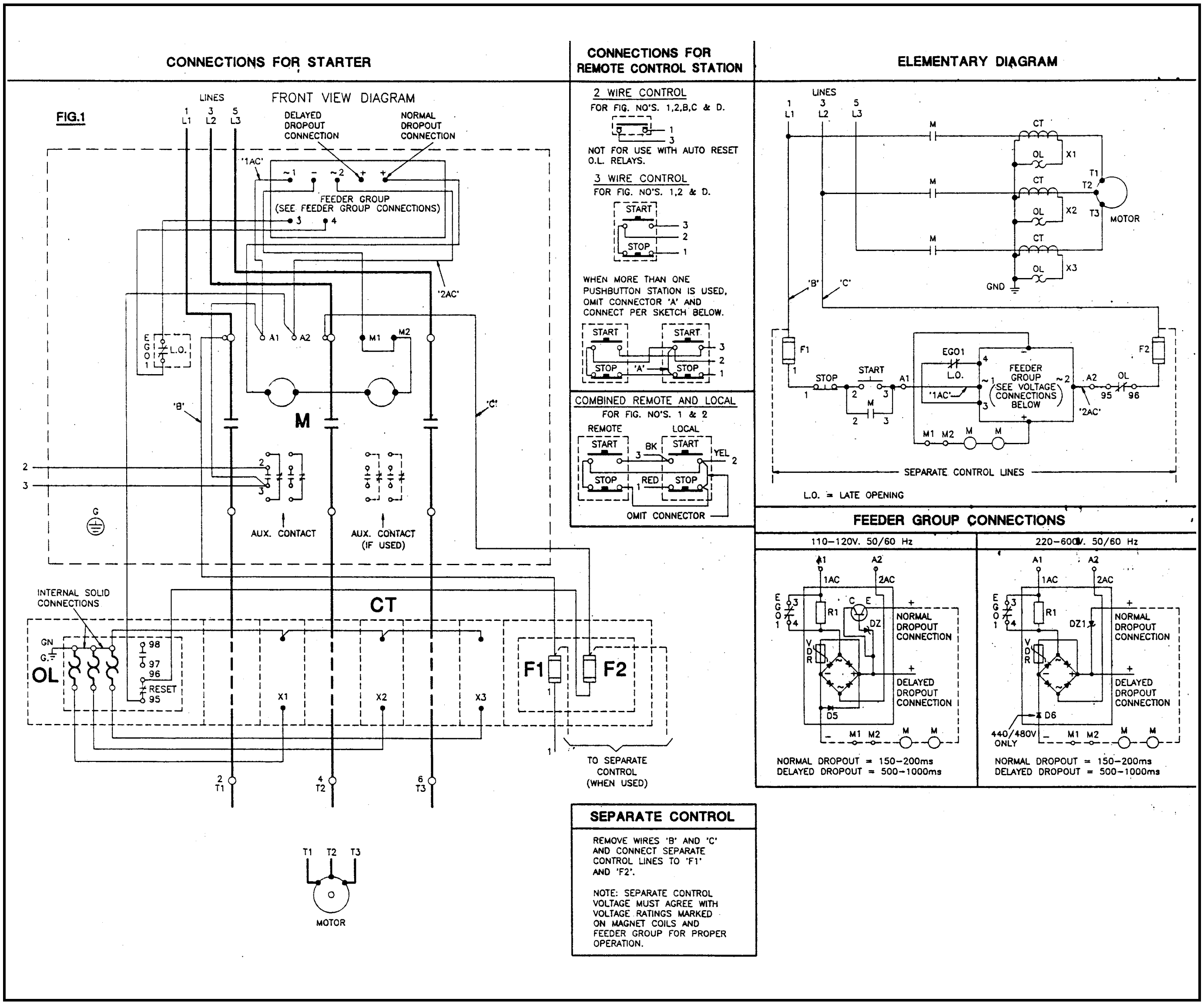


SIZE 5

NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

NON-REVERSING STARTERS (Continued)

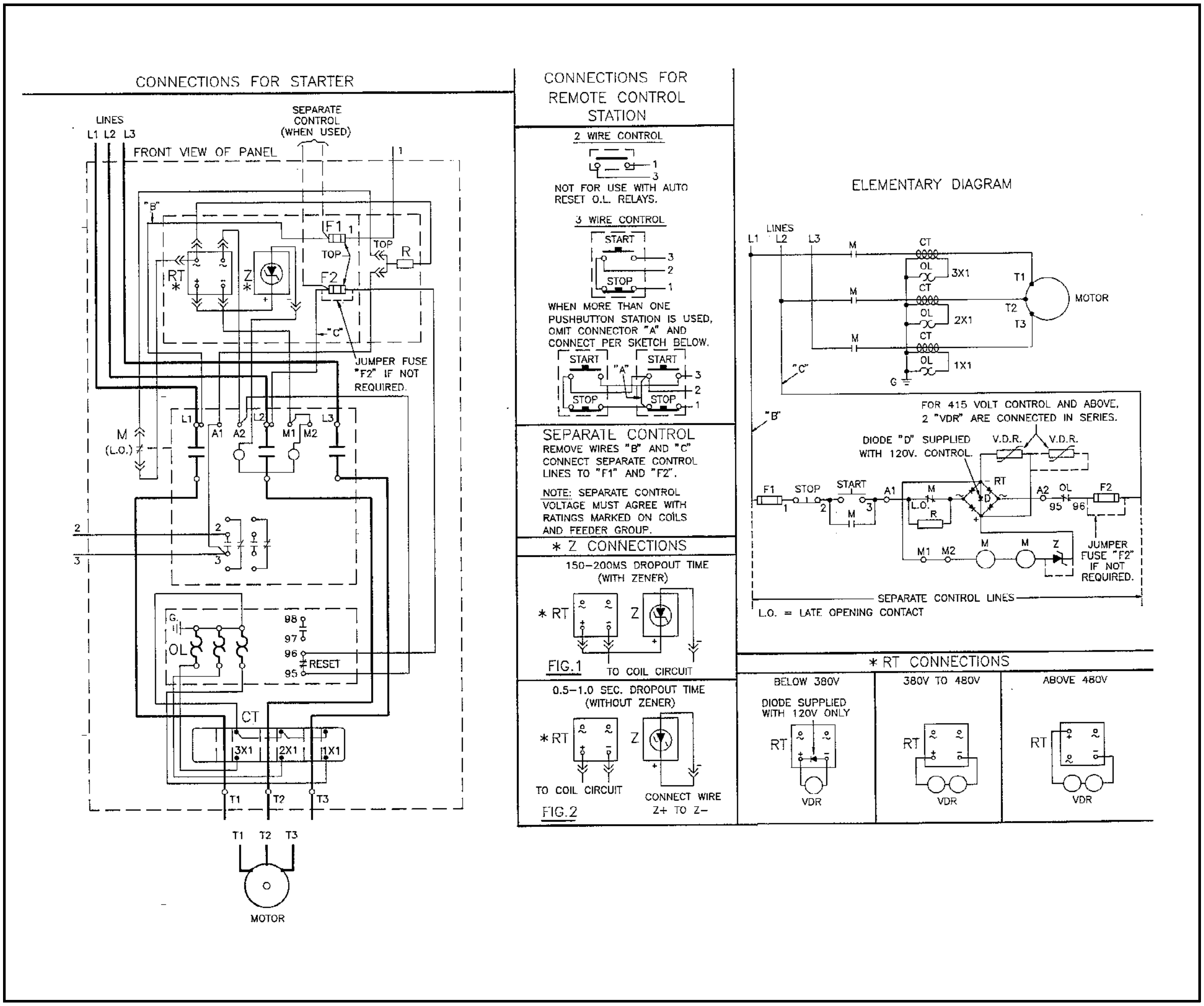


SIZE 6

NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

NON-REVERSING STARTERS (Continued)

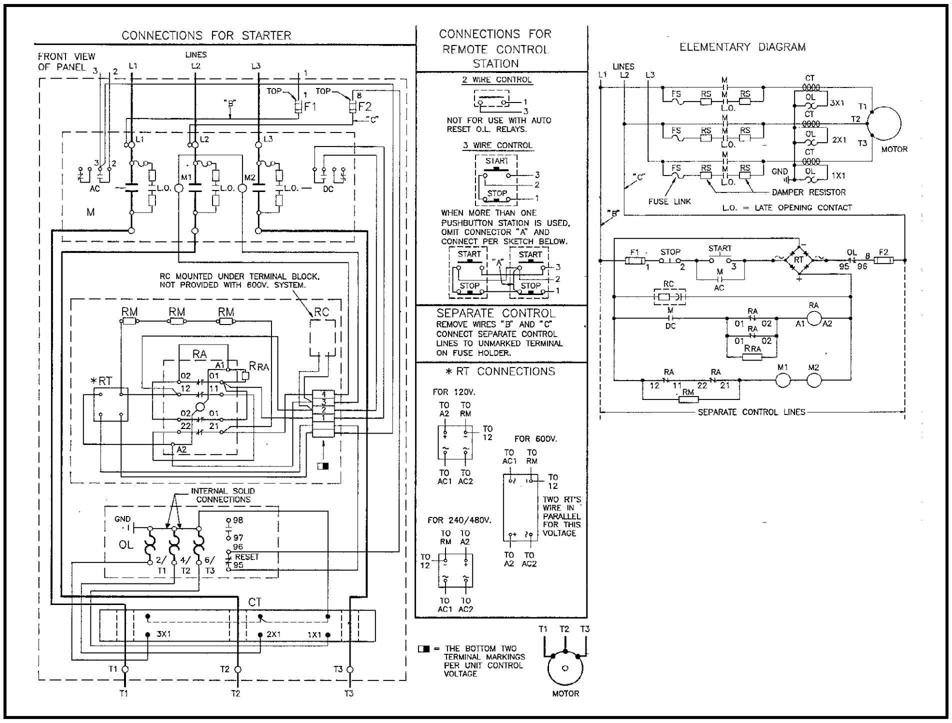


SIZE 7

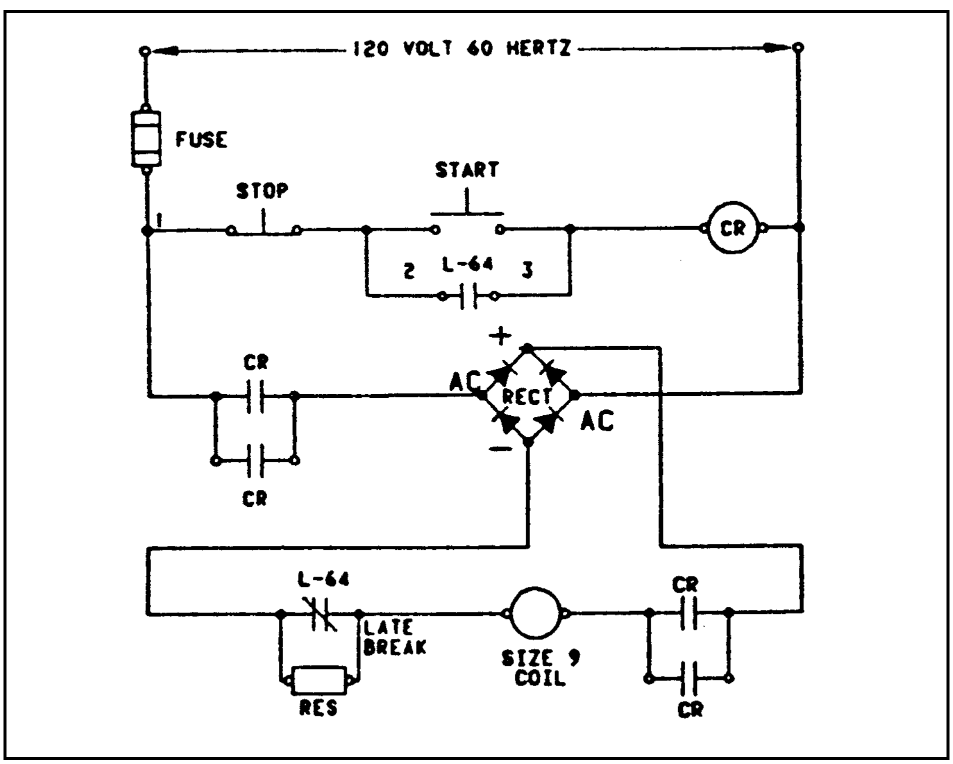
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

NON-REVERSING STARTERS (Continued)



SIZE 8



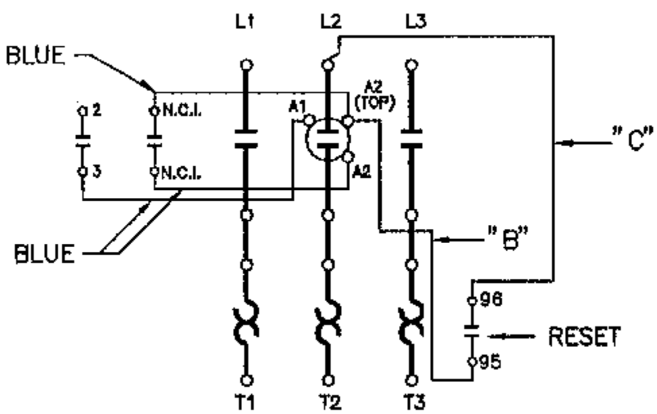
SIZE 9
CONTROL CIRCUIT

NEMA, Contactors & Starters, (Freedom)

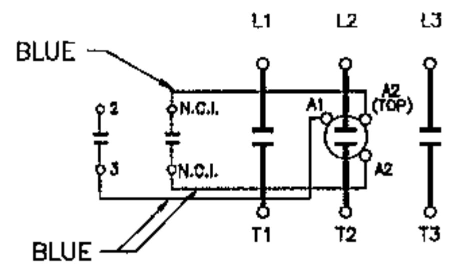
WIRING DIAGRAMS (Continued)

TYPICAL DC CONTROL WIRING DIAGRAM

TYPICAL STARTER DIAGRAM



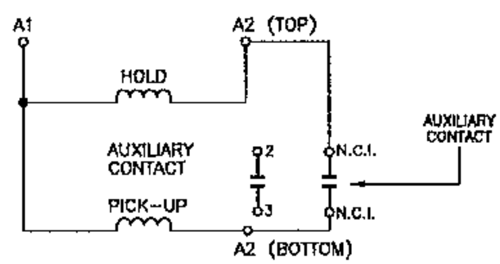
TYPICAL CONTACTOR DIAGRAM



SEPARATE CONTROL

1. REMOVE WIRE "C" (WHEN SUPPLIED).
2. REMOVE RED CONTROL WIRE FROM TERMINAL NO.A2 (BOTTOM) TO TERMINAL NO.95 OF OVERLOAD RELAY.
3. CONNECT RED CONTROL WIRE "B" FROM TERMINAL NO.A2 (TOP) TO TERMINAL NO.95 OF THE OVERLOAD RELAY.
4. CONNECT SEPARATE CONTROL LINES TO THE NO.1 TERMINAL OF THE REMOTE PILOT DEVICE AND TO THE NO.96 TERMINAL OF THE OVERLOAD RELAY.

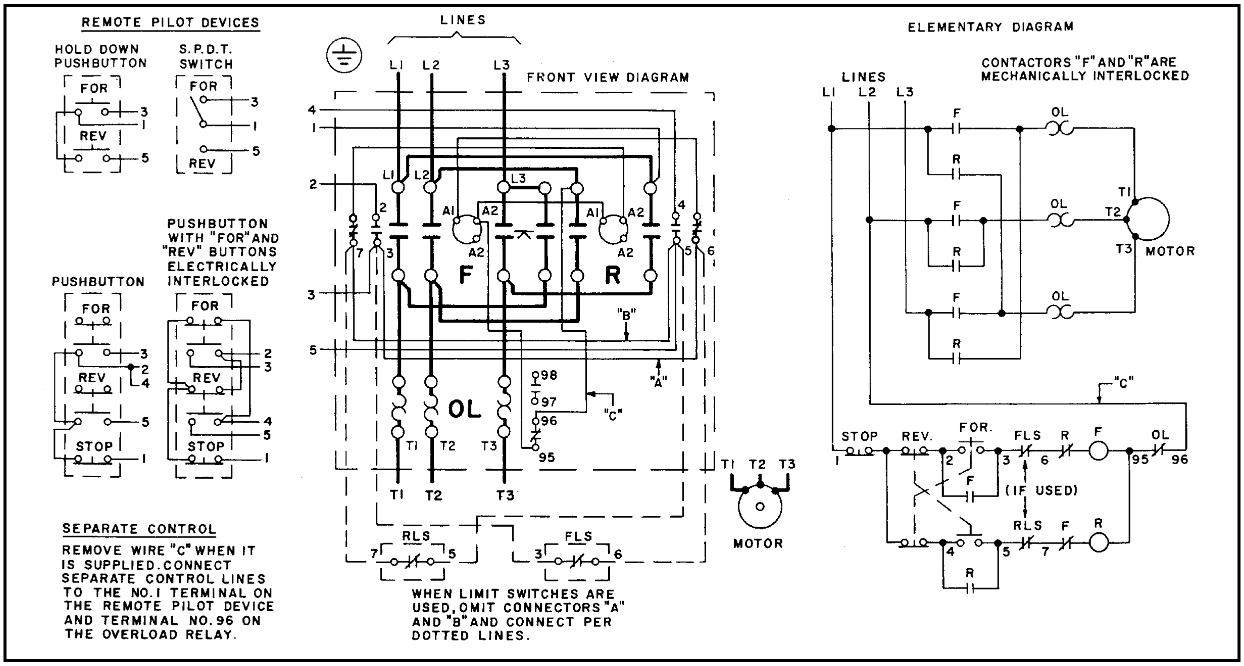
D.C. COIL ELEMENTARY DIAGRAM



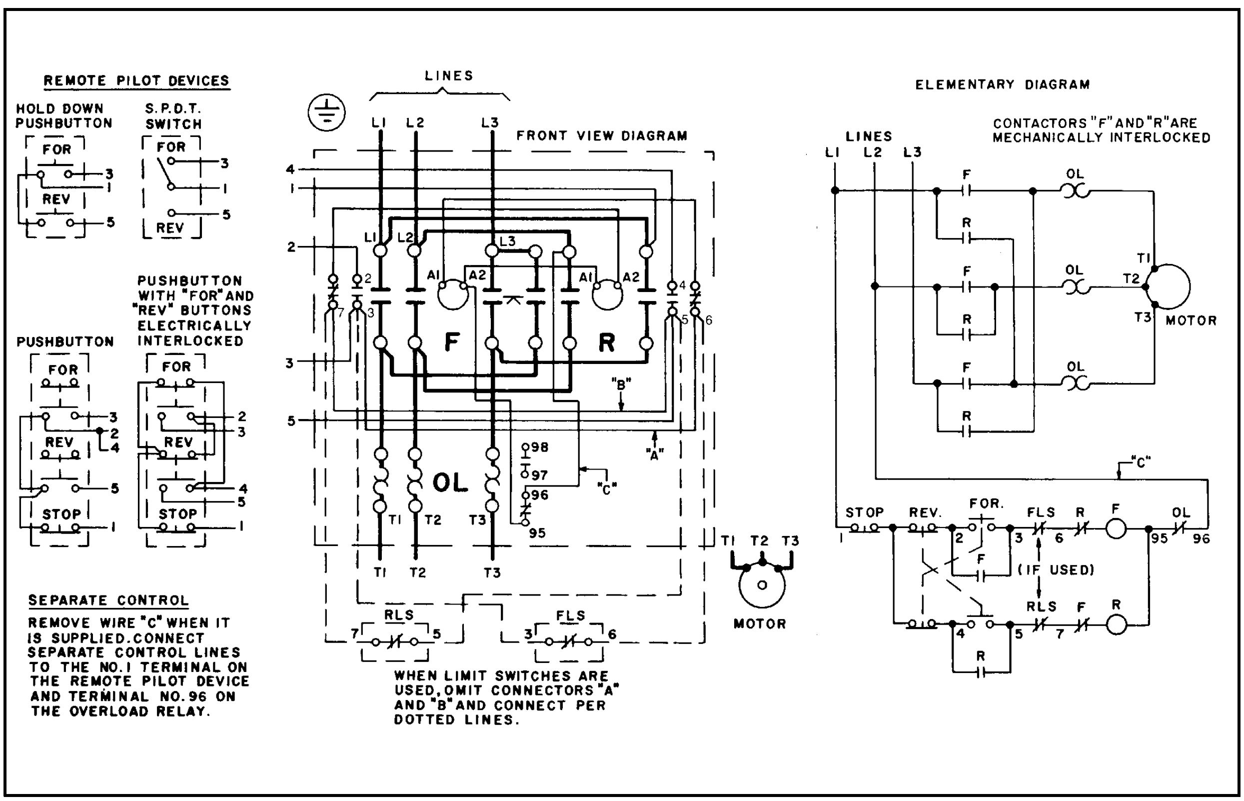
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

REVERSING STARTERS



SIZES 00 & 0

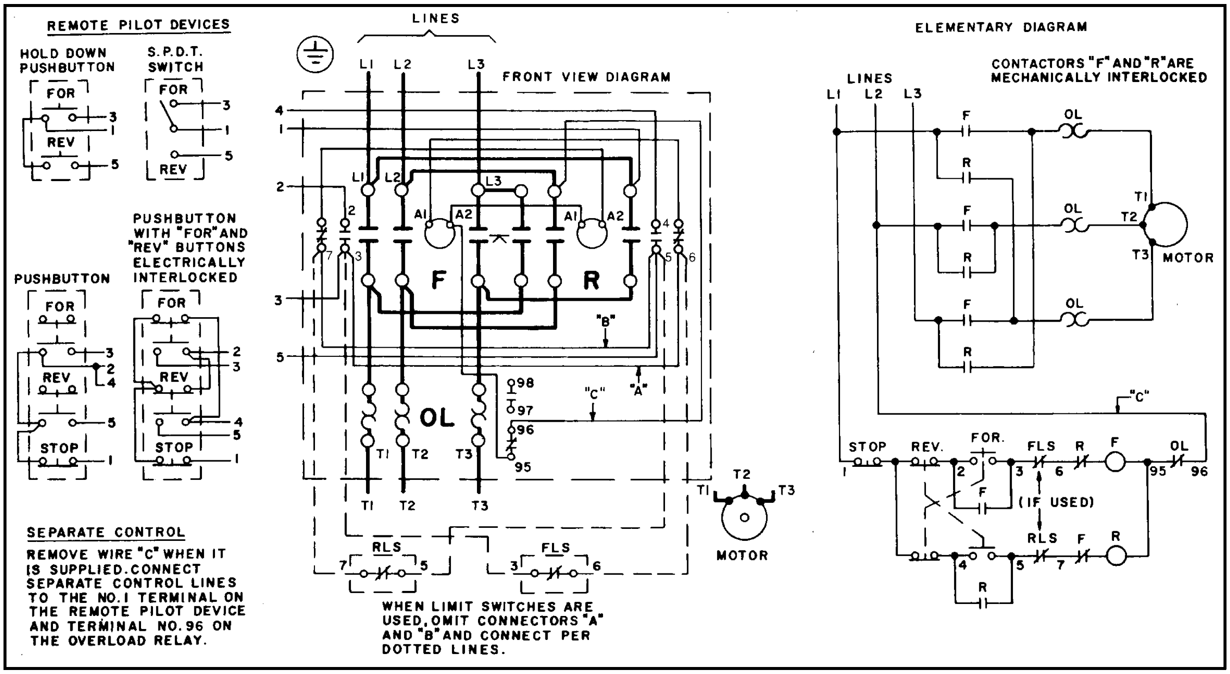


SIZES 1 & 2

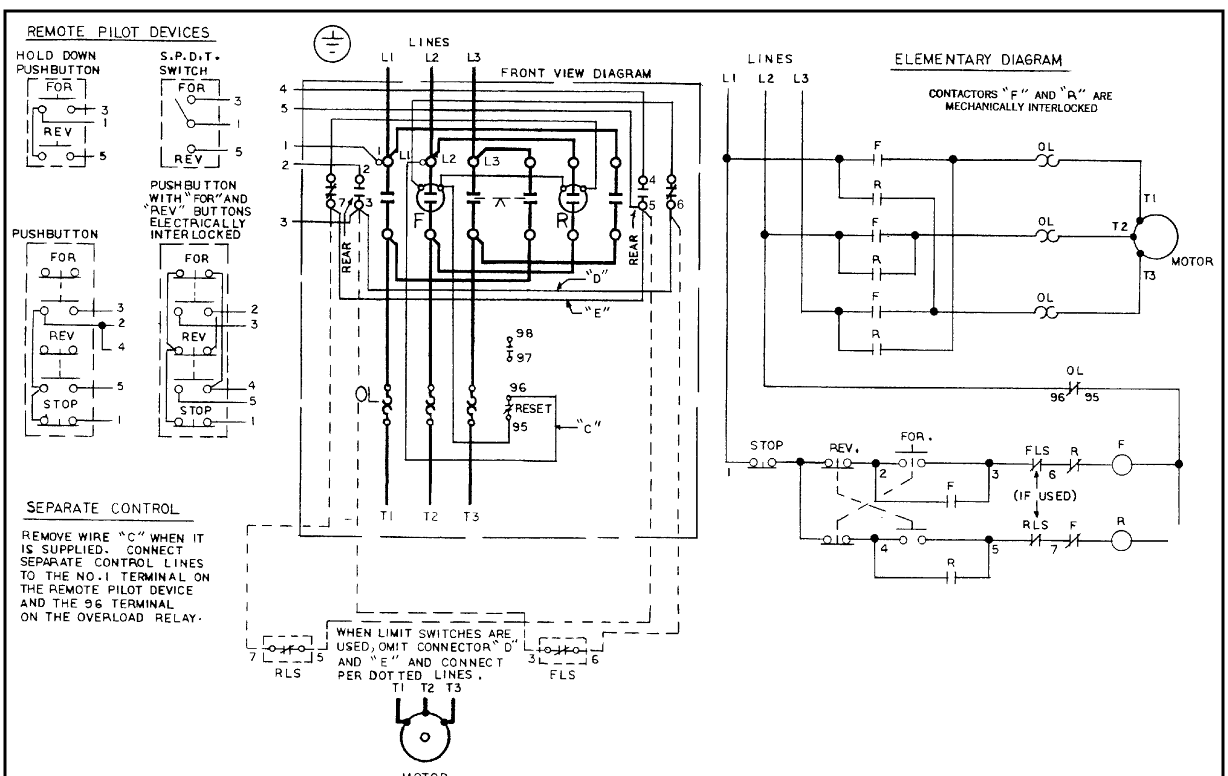
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

REVERSING STARTERS (Continued)



SIZE 3



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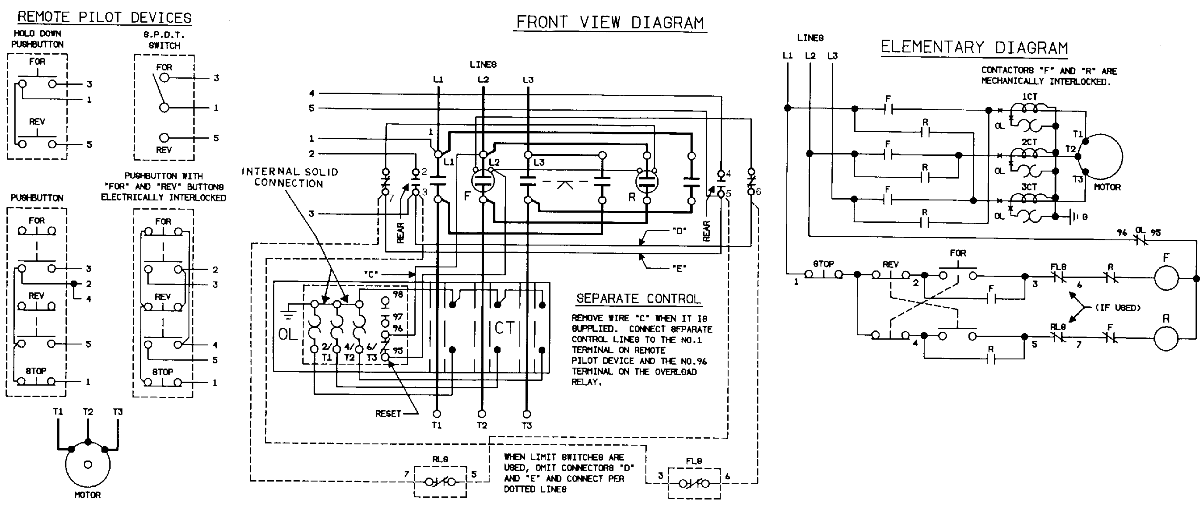
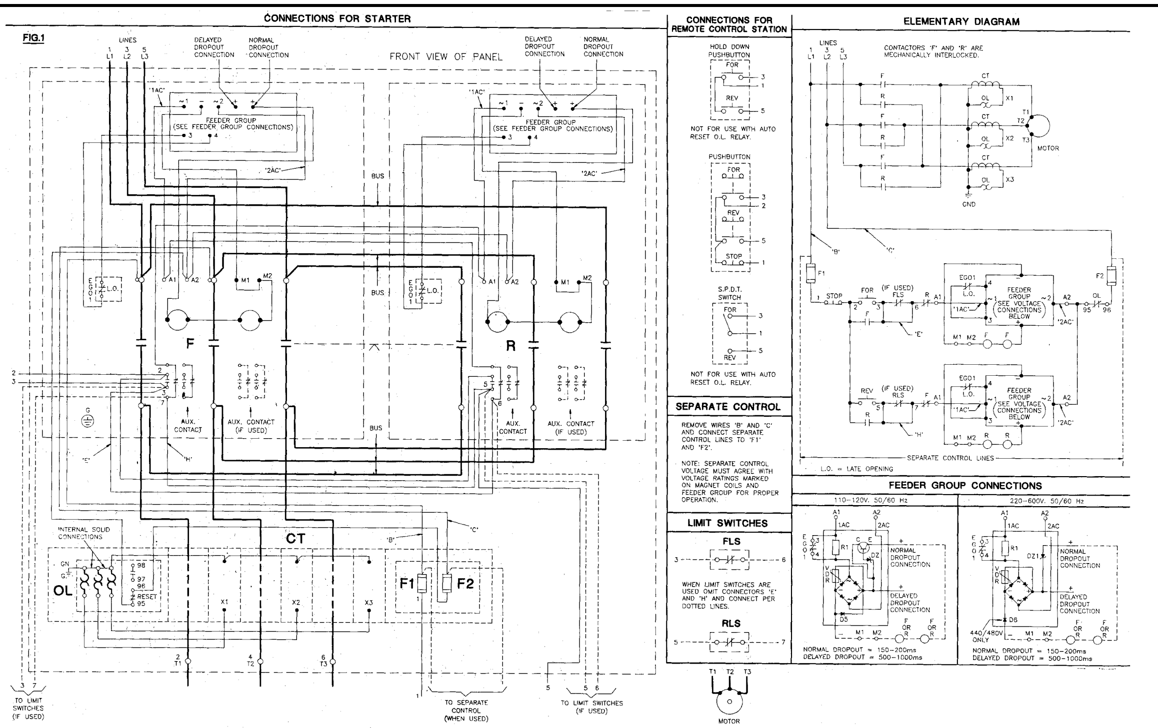
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

REVERSING STARTERS (Continued)



SIZE 5

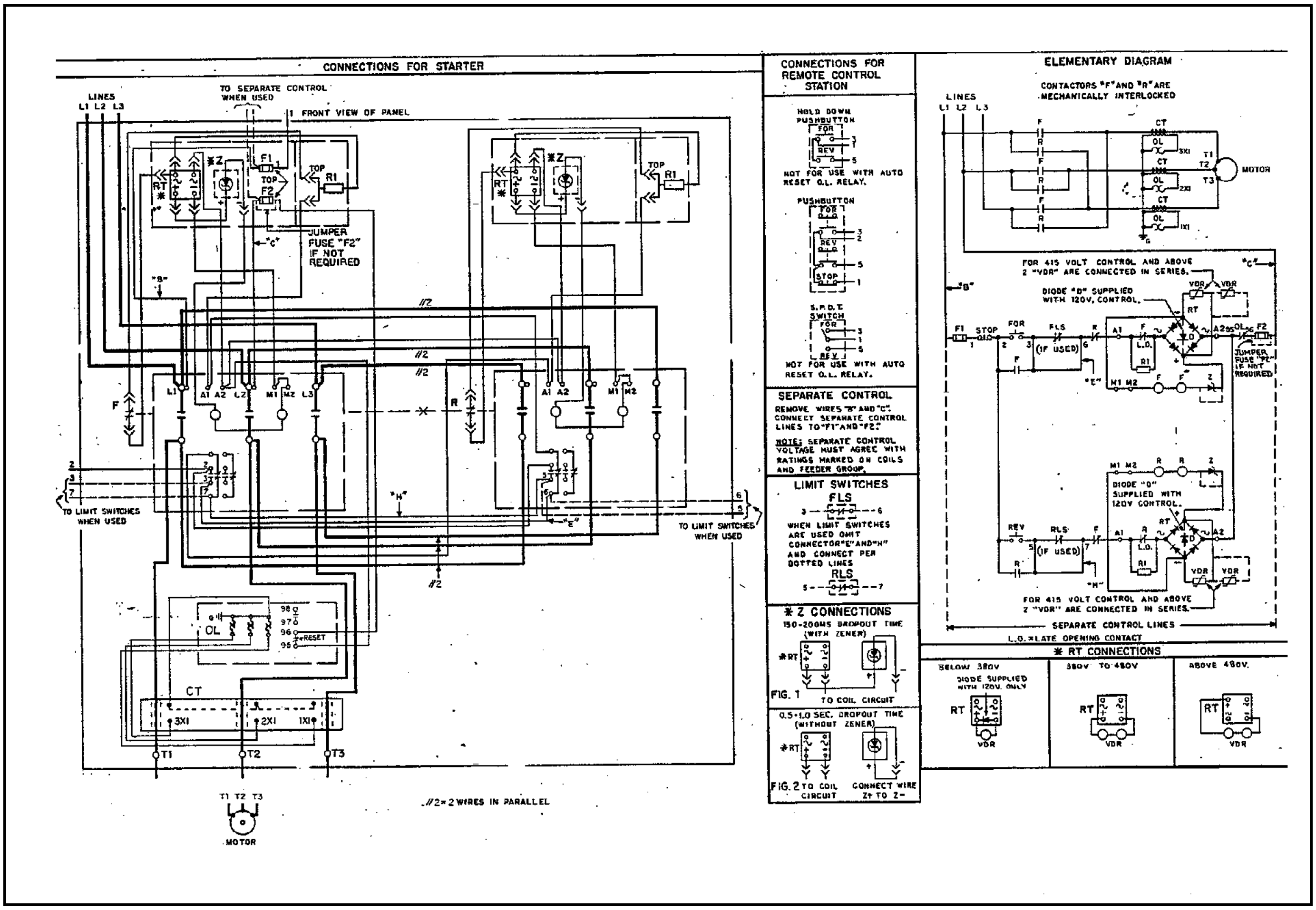


SIZE 6

NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

REVERSING STARTERS (Continued)

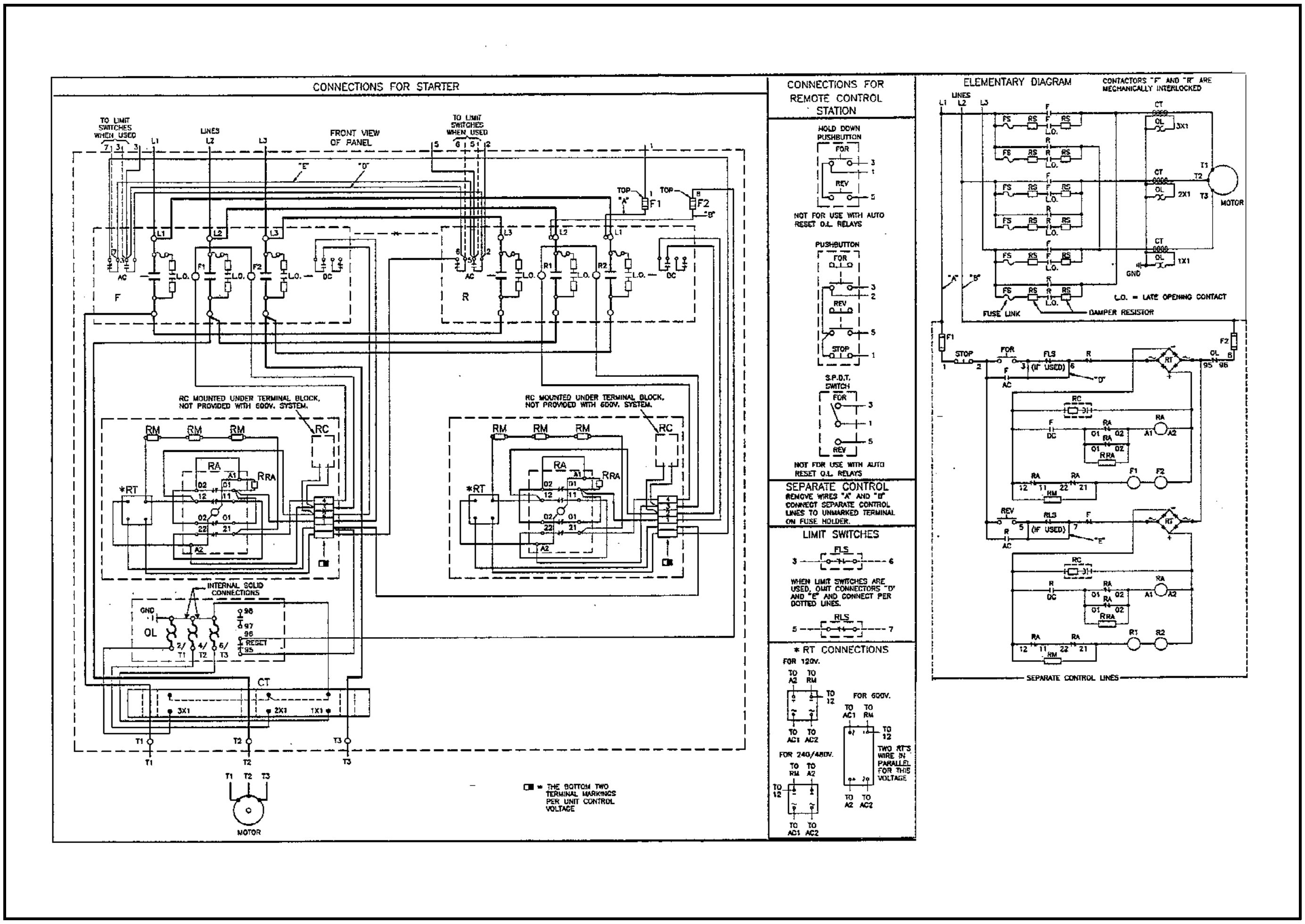


SIZE 7

NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

REVERSING STARTERS (Continued)

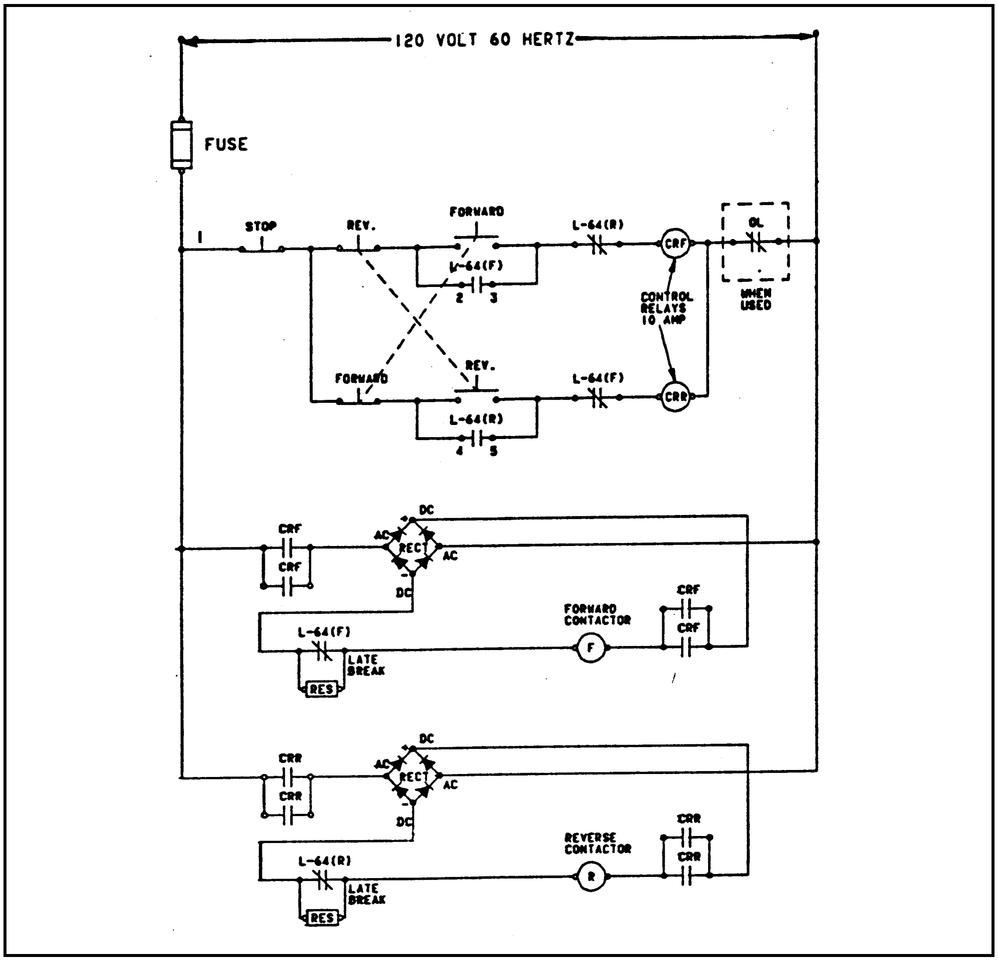


SIZE 8

NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

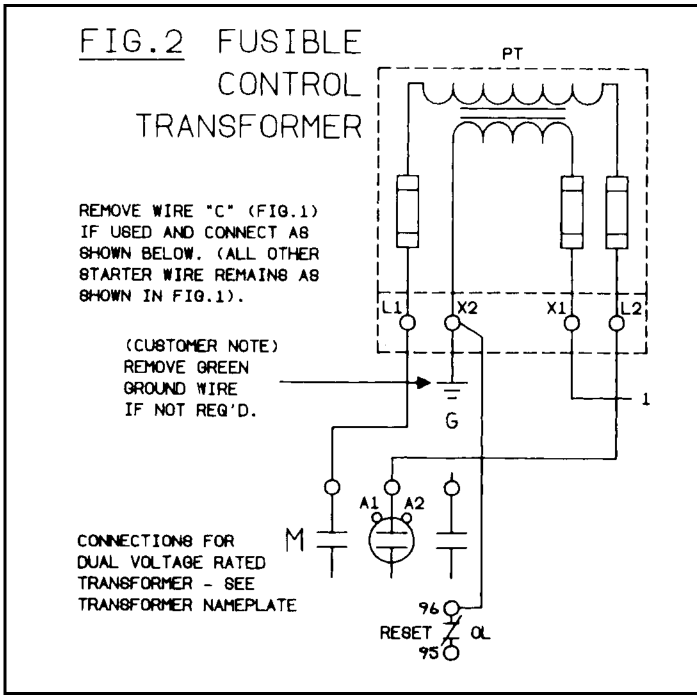
REVERSING STARTERS (Continued)

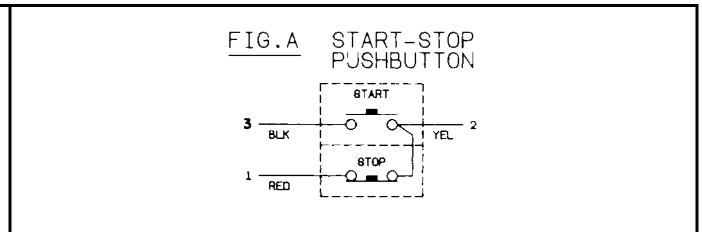


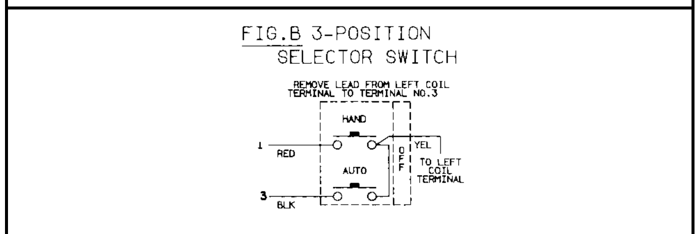
SIZE 9 — CONTROL CIRCUIT

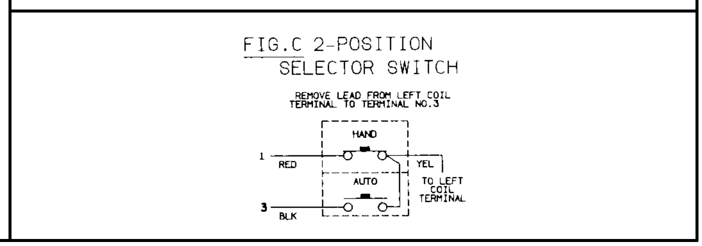
NEMA, Contactors & Starters, (Freedom)

WIRING DIAGRAMS (Continued)

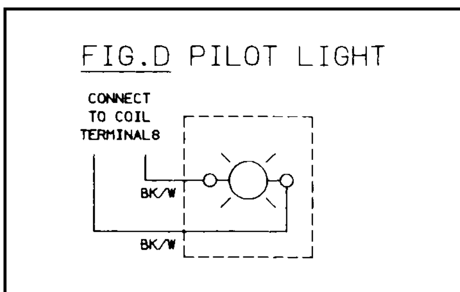


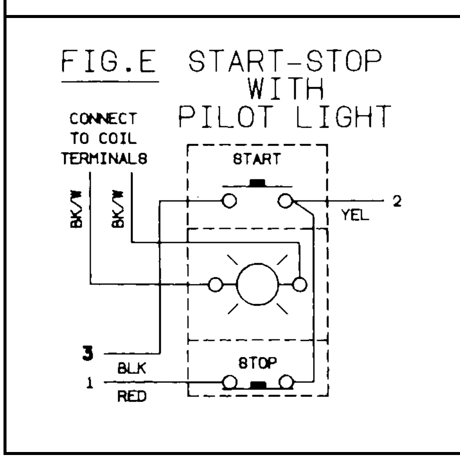


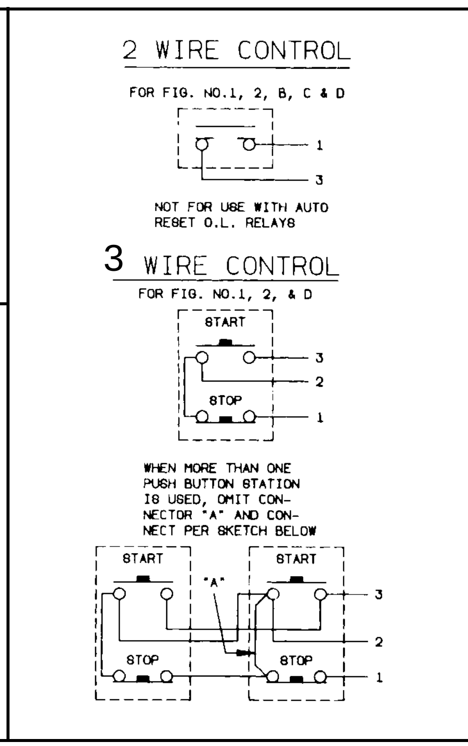


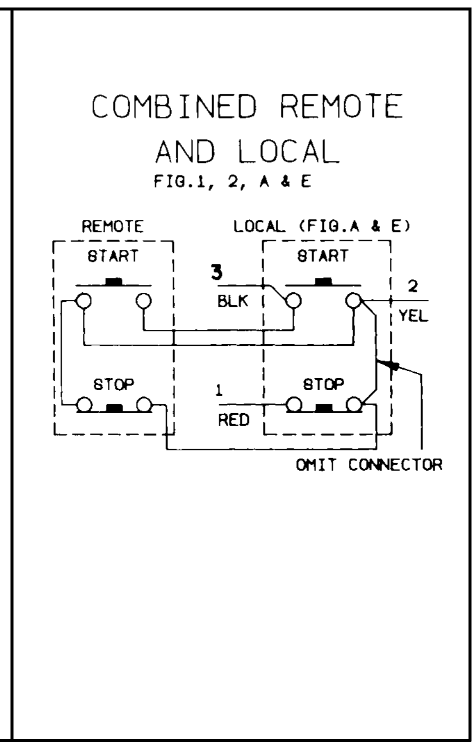


ACCESSORIES









ACCESSORIES

Appendix E
Product Information
Pentair Industrial Model L88 Bag Filters

PRODUCT INFORMATION: PENTAIL INDUSTRIAL BAG FILTER
MODEL L88303NA415

L88
Single Liquid BAG HOUSINGS

L88 Single Liquid Bag Housings effectively remove dirt, pipe scale, and other contaminants from process liquids. Quality construction and design assure clean effluent and protection for all downstream equipment.

APPLICATIONS

- Chemical
- General Industrial
- Oil and Gas
- Water

HOUSING OPERATION

Unfiltered liquid enters the housing above the filter bag or strainer basket, fills the interior of the housing and continues through the bag or strainer basket. Solids are trapped inside the filter bag or strainer and easily removed when the housing is serviced. The standard o-ring seal between the basket and the housing ensures a positive seal to prevent bypass.

HOUSING OPTIONS

- 300 PSI pressure rating
- Mesh-lined strainer baskets
- Alternative o-ring materials
- Adjustable support legs
- ASME code U or UM

FEATURES

- Flow rates up to 220 gpm
- Two lengths available, a 15- or a 30-inch housing, depending upon the required surface area and volume of fluid to be filtered
- Carbon steel and 304 or 316 Stainless Steel material
- Each vessel is factory hydro-tested
- Low pressure drop
- Quick-swing closure with eye nuts
- Viton® seals — lid & basket
- Differential, drain, and vent ports
- 316 Stainless Steel strainer basket
- Accepts #1-size and #2-size bag filters
- Two-part epoxy paint finish on carbon vessels

SPECIFICATIONS

Pressure Rating	150 PSI at 300˚F (up to 300 PSI optional)
Connections	2-, 3- or 4-inch (NPT)(FLG)
Housing Lid	3-bolt swing closure with 0.25-inch NPT vent port
Lid & Basket Seat	Viton® o-ring
Inlets/Outlets	Side inlet/bottom outlet; side inlet/side outlet; side inlet/90˚ bottom outlet
Pressure Ports	Two differential ports measure pressure across filter bag
Construction/Finish	Carbon steel w/two-part epoxy finish; 304 or 316 Stainless Steel w/satin finish
Basket Material	316 Stainless Steel with 9/64-inch perforations
Bags Sizes	#1 and #2 liquid bags accepted
Base	Adjustable tripod leg assembly

Pentair Industrial

L88 Single Bag Housings

ORDERING INFORMATION

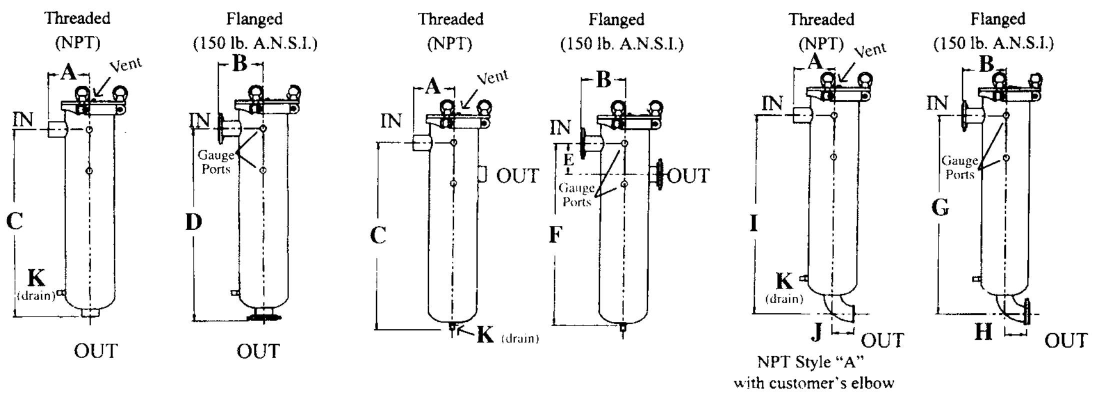
Custom configurations available; please contact Customer Service.

L88 | 15 | 2 | N | A | C | 15

HOUSING	BASKET SIZE (IN.)	CONNECTION SIZE (IN.)	CONNECTION TYPE	OUTLET LOCATION	MATERIAL	PRESSURE RATING (PSI)
L88	15 (#1)	2	NPT = N	Bottom = A	Carbon = C	150 = 15
	30 (#2)	3	Flange = F	Opposite = AB	304 SS = 4	300 = 30
		4		Bottom, Angle 90˚ = C	306 SS = 6	

DIMENSIONS

STYLE A BOTTOM OUTLET | STYLE B SIDE OUTLET | STYLE C BOTTOM OUTLET 90˚



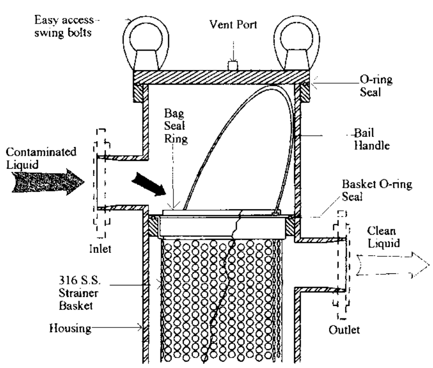
L88-15 (IN.)

Pipe Size	A	B	C	D	E	F	G	H	I	J	K	wt.
2	5.3	6.7	23.2	24.5	7.0	24.7	26.2	3.4	25.7	2.3		105-125# skid wt.
3	5.4	7.1	23.2	24.5	7.0	24.7	26.5	5.0	26.3	3.1	1	
4	5.4	7.1	23.2	24.5	7.0	24.7	29.1	6.3	26.9	3.8		

All dimensions are approximate.

L88-30 (IN.)

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	34.7	36.2	3.4	35.7	2.3		125-145# skid wt.
3	5.4	7.1	36.2	38.0	7.0	34.7	37.7	5.0	37.2	3.1.	1	
4	5.4	7.1	36.2	38.1	7.0	34.7	39.1	6.3	37.4	3.8		



BASKET DATA

Depth Nominal (in.)	Diameter (in.)	Surface Area (sq. ft.)	Volume (cu. in.)
15	6.7	2.3	500
30	6.7	4.4	1000

Pentair Industrial

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PENTAIR INDUSTRIAL	Department: Engineering		Document Number:
Krystil Klear Winamac	Status:	Rev 0	Issue Date: 11/08/08
Instructions	Written By: L.Junk		Page: of
Operating Instructions for Liquid Bag Models - L44-66-88			

WARNING-SAFETY INFORMATION

1. The housings in this catalog, if improperly used, can cause serious injury or death
2. Always wear proper protective clothing for the liquid being filtered. Check your M.S.D.S. for any instructions or suggestions.
3. Do not run housing in excess of the rated pressure or temperature found on the housing tank label.
4. Check chemical compatibility of selected o-ring and housing material before housing installation.
5. Do not open housing when the system is under pressure; always relieve all pressure through housing before opening of housing lid.
6. *Stop all flow of liquid before opening of lid*.
7. Bolt housing to floor, as tipping may occur when lid is opened.

MODEL L44: maximum of 300 PSI working pressure
maximum flow rate of 50 gallons per minute
MODEL L66: maximum of 150 PSI working pressure
maximum flow rate of 100 gallons per minute
MODEL L88: maximum of 150 PSI working pressure
maximum flow rate of 220 gallons per minute

RECEIVING INSTRUCTIONS:

1. Unpack the housing(s) and discard any shipping materials
2. Place housing in the desired location on a flat surface, securing support legs to base if applicable.

INSTALLATION INSTRUCTIONS:

*** flow to the housing should be turned off***

1. Place housing on pipe connections
   a. N.P.T./Coupling style – Pentair does not recommend using any type of liquid sealant due to contamination of the pipe that may occur.
   b. Flange style – put a small amount of clean, heavy oil on one side of the gaskets, place oiled side down onto existing flanges to hold gaskets.
2. Please note the labeling of the inlet and outlet connections for proper installation. Tighten housing with proper tension to seal housing onto existing pipe or flange. Note: housing has been factory pressure tested to assure a leak proof vessel. If leaking occurs, check for improper connections.
3. Remove lid from housing by turning 2 eye nuts until loosened and swing them down. Swing the lid out of the way until full view of the inner housing area is gained.
4. Check inner housing and pipe connections for foreign material and discard any items that have entered during shipping or unpacking.
5. Make sure that the strainer baskets are pushed fully into housing grooves. If using a filter bag, seat bag fully into strainer basket to assure a leak-proof seal between bag and basket. For best results, bag should be fully extended into the basket.
6. Close lid and alternately tighten the eye nuts until lid is fully seated onto the O-ring gasket. DO NOT OVERTIGHTEN.
7. Housing is now ready for start-up.

START-UP OF HOUSING

1. Loosen vent plug to allow air to escape from housing.
2. Slowly open the inlet to gradually fill the housing body.
3. When housing body is full (liquid escapes from top vent), close the vent.
4. Open the outlet connection and fully open the inlet connection. Housing is now operating properly.

REMOVAL OF SPENT ELEMENT:

1. When the housing reaches your pre-determined differential pressure, stop flow to the housing and relieve housing pressure through housing drain. Remove enough liquid to show top of basket flange.
2. Loosen eye nuts on housing and swing the lid to gain full access to the inside of housing.
3. If using a liquid bag, pull the bags out and discard per the liquid MSDS or State and Federal regulations for the handling of all items in contact with such liquid.
4. Remove filter baskets and clean thoroughly.
5. Housing debris and sludge should be removed to prolong filter efficiencies.
6. Replace filter baskets and bags into housings as noted in Installation Instructions above.

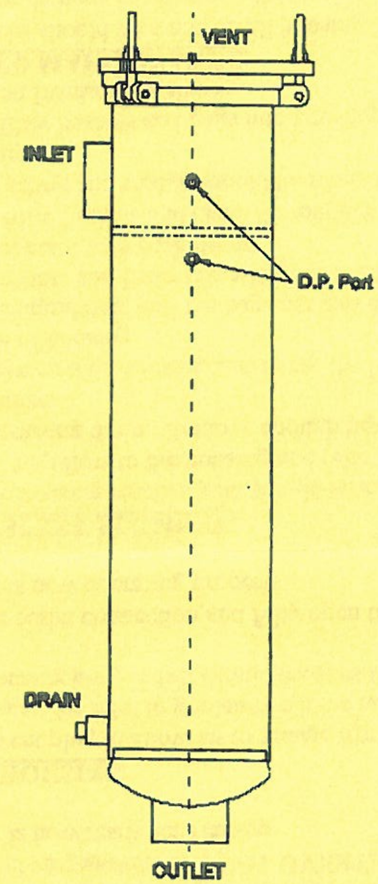
RECOMMENDED MAINTENANCE:

Periodic checks should be made on all housing lid and basket o-rings to ensure no cuts or damage has incurred that would cause the housing not to seal. If housing parts become damaged or worn, replace immediately.

REPLACEMENT PARTS LISTING

PART NUMBER	DESCRIPTION
*LV	Viton Lid O-ring
88BV	Viton Basket O-ring
*LGCA	18" Tri-pod Leg Assembly Carbon Steel
*LG22	18" Tri-Pod Leg Assembly Stainless Steel
EN	Eye Nut
RE	Rod End
CBA	Clevis Bolt Assembly
*LDCA	Lid Cover Carbon Steel
*LDSS304	Lid Cover Stainless Steel
PER APPLICATION **	Filter Bags
PER APPLICATION **	Filter Basket

* Insert first two digits of housing model # (18,22,24,30,36,42,48)
** Full line of replacement bags and baskets are available



PRODUCT INFORMATION: PENTAIR INDUSTRIAL BAG FILTERS
#2 BAG SIZE: KEM75K2S AND KEM150K2S

FILTER BAGS

Liquid
FILTER BAGS

Economical filtration for a wide array of applications. Highly controlled manufacturing procedures ensure consistent quality and no contamination. The unique bag designs provide added strength and avoids risk of bypass. Our filter bags will fit all industry-standard bag housings.

APPLICATIONS

- Automotive
- Commercial
- General Industrial
- Paints, Inks, Coatings
- Water

REPLACEMENT BAGS AVAILABLE FOR:

American Felt™
Commercial™
Cuno®
Filter Specialists™ (FSI)
Filtration Systems™
GAF Filter Systems™
Plenty™
Ronnigen-Petter™
Rosedale™
Strainrite™

FEATURES

- Available medias range from 1 to 1500 microns
- Heavy-duty handle for easy installation and removal
- Wide array of media fibers to meet needed temperature and micron specifications
- Bag finish or covers available for strict migration requirements
- OEM replacement ring styles
- Multi-layered filtering capabilities for higher dirt-holding capacities and fewer change-outs
- Dimensions range from 4.12-inch diameter × 8-inch length thru 9-inch diameter × 32-inch length

BAG SPECIFICATIONS

Model No.	Bag Size	Length (inches)	Diameter (inches)	Surface Area (sq. ft.)
44-6	#3	8	4.12	.5
44-12	#4	14	4.12	1.0
66-12	#7	15	5.62	1.3
66-18	#8	21	5.62	2.0
66-30	#9	32	5.62	3.4
88-15	#1	16.5	7.06	2.0
88-15	#1 inner	14.5	5.75	1.6
88-30	#2	32	7.06	4.4
88-30	#2 inner	30	5.75	3.6
M88-30-OEM	#12	30	8.00	5.5
Multi-Rounds	#2	32	7.06	4.4

MICRON RATINGS PERFORMANCE

Fiber	Micron Rating																Temp
	1	5	10	15	25	50	75	100	150	200	250	300	400	600	800	1500	
Felt, Nomex (HT)		•	•	•	•	•		•									450˚F (232.2˚C)
Felt, Polyester (KE)	•	•	•	•	•	•	•	•		•							250˚F (121.1˚C)
Felt, Polypropylene (KO)	•	•	•		•	•		•									200˚F (93.3˚C)
Monofilament Mesh, Nylon (NMO)		•	•		•	•	•	•	•	•	•	•	•	•	•		250˚F (121.1˚C)
Monofilament, Polyester (KEMO)		•	•		•	•	•	•	•	•	•	•	•	•	•		250˚F (121.1˚C)
Monofilament Mesh, Polypropylene (KOMO)											•	•	•	•	•		200˚F (93.3˚C)
Multifilament Mesh, Nylon (NM)									•								250˚F (121.1˚C)
Multifilament Mesh, Polyester (KEM)*								•	•	•	•		•	•	•	•	250˚F (121.1˚C)
Oil Removal (OR)					•												200˚F (93.3˚C)

** Multifilament Polyester also available in 125, 1000 and 1500 microns.*

Pentair Industrial

Liquid Filter Bags

ORDERING INFORMATION

Custom configurations available; please contact Customer Service.

KE	10	K	2	S
SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5

SECTION 1	SECTION 2	SECTION 3
Fibers	**Micron Ratings Available for the Designated Fibers**	**Bag Finish or Cover** (Over Felt Only)
KE = Felt, Polyester	KE = 1, 5, 10, 15, 25, 50, 75, 100, 200	K = None
KO = Felt, Polypropylene	KO = 1, 5, 10, 25, 50, 100	FF = Fiber-Free (Polyester Micron Fiber or Felt Only)
NMO = Monofilament Mesh, Nylon	NMO = 5, 10, 25, 50, 75, 100, 125, 150, 175, 200, 250, 300, 400, 600, 800	G = Glazed Finish
KEM = Multifilament Mesh, Polyester	KEM = 75, 100, 125, 150, 200, 250, 300, 400, 800, 1500	KEM = Polyester Multifilament Mesh Cover
OR = Oil Removal Material	OR = 25	C = Spun-Bonded Nylon (Cerex®)
HT = Felt, Nomex (nylon)	HT = 5, 10, 25, 50, 100	R = Spun-Bonded Polyester (Reemay®)
KOMO = Monofilament Mesh, Polypropylene	KOMO = 75, 100, 125, 150, 175, 200, 250, 300, 400	NM = Nylon Multifilament Mesh Cover
NM = Multifilament Mesh, Nylon	NM = 150	NMO = Nylon Monofilament Mesh Cover
		A = Automotive
		KOMO = Polypropylene Monofilament Mesh Cover

** Multifilament Polyester also available in 125, 1000 and 1500 microns.*

SECTION 4		SECTION 5
Size & Symbol with Useage and Bag Dimensions		**Ring Styles**
1 = Standard #1 Size Housings - Model 88-15 - 7.0625" dia. x 16.5" long	8 = Standard #8 Size Housings - Model 66-18 - 5.625" dia. x 21" long	S = Carbon steel Ring
1K = FSI #1 Size Housings - 7" dia. x 16.5" long	9 = Standard #9 Size Housings - Model 66-30 - 5.625" dia. x 32" long	SS = Stainless Steel Ring
2 = Standard #2 Size Housings - Model 88-30 - 7.0625" dia. x 32" long	12 = Standard #12 Size Housings - Model M88-30-0EM - 8" dia. x 32" long	KO = Polypropylene Ring
2K = FSI #2 Size Housings - 7" dia. x 32" long	CU1 = Cuno #1 Size Housings - Model PC1 - 9" dia. x 20" long	B = Stainless Steel Band on Commercial Bags
3 = Standard #3 Size Housing - Model 44-6 - 4.125" dia. x 8" long	CU2 = Cuno #2 Size Housings - Model PC2 - 9" dia. x 30" long	K = FSI Style Flanged Plastic Top
3K = FSI #3 Size Housings - 4.125" dia. x 8" long	RK1 = Ronningen Petter Fabric Basket Housings #1 Size - 8" dia. x 30" long	
4 = Standard #4 Size Housing - Model 44-12 - 4.125" dia. x 14" long	RK2 = Ronningen Petter Fabric Basket Housings #2 Size - 8" dia. x 40" long	
4K = FSI #4 Size Housings - 4.0625" dia. x 14" long	C01 = Commercial Filters #1 Size Housings - 7.3125" x 17" long	
7 = Standard #7 Size Housing - Model 66-12 - 5.625" dia. x 15" long	C02 = Commercial Filters #2 Size Housings - 7.3125" dia. x 33" long	

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Appendix F

Automation System Design and Components

PROCESS AND INSTRUMENTATION DIAGRAMS

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

P&ID DRAWINGS

PARSONS
8000 Centre Park, Suite 200
Austin, Texas 78754

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO: 748350-01000

DATE : 09.05.2012

DRAWN : RMF

REVISIONS:

P&ID

SHEET NO.

TITLE

GENERAL INSTRUMENT OR CONTROL SYMBOLS

	PRIMARY LOCATION NORMALLY ACCESSABLE TO OPERATOR	FIELD MOUNTED	AUXILIARY NORMALLY ACCESSABLE TO OPERATOR
DISCRETE INSTRUMENTS	FI 001	LT 001	TT 001
SHARED DISPLAY SHARED CONTROL	FI 001	LT 001	TT 001
COMPUTER FUNCTION	FI 001	LT 001	TT 001
PROGRAMMABLE LOGIC CONTROLLER	FI 001	LT 001	TT 001

HAND SWITCH ABBREVIATIONS

HOA	HAND/ OFF/ AUTO
LOC	LOCAL/ OFF/ COMPUTER
LOR	LOCAL/ OFF/ REMOTE
LOS	LOCKOUT STOP
OSC	OPEN/ STOP/ CLOSE
RSL	RAISE/ STOP/ LOWER
L/C	LOCAL/ COMPUTER
L/R	LOCAL/ REMOTE
O/C	OPEN/ CLOSE
S/S	START/ STOP
A/M	AUTO/ MANUAL
H/C	HAND/ COMPUTER

GENERAL ABBREVIATIONS

AI	ANALOG INPUT
AO	ANALOG OUTPUT
AS	AIR SUPPLY
BGS	BELOW GROUND SURFACE
COND	CONDUCTIVITY
COMP	COMPUTER
CP	CONTROL PANEL
CRC	CONTROL ROOM CONSOLE
CR	CHLORINE RESIDUAL
CTU	CENTRAL TELEMETRY UNIT
DCU	DISTRIBUTED CONTROL UNIT
DI	DIGITAL OR DISCRETE INPUT
DO	DISSOLVED OXYGEN OR DIGITAL OUTPUT
DPU	DISTRIBUTIVE PROCESSING UNIT
EBWL	EMERGENCY BOTTOM WATER LEVEL
ES	ELECTRIC SUPPLY
ETWL	EMERGENCY TOP WATER LEVEL
FC	FAILED CLOSE
FLP	FAIL LAST POSITION
FO	FAIL OPEN
HMI	HUMAN MACHINE INTERFACE
IO	INPUT OUTPUT
ISS	INSTRUMENT SYSTEM SUPPLIER
LPU	LOCAL PROCESSING UNIT
MC	MOTOR CONTROLLER
MS	MAGINETIC STARTER
NC	NORMALLY CLOSED
NIM	NETWORK INTERFACE MODULE
NO	NORMALLY OPEN
MMI	MAN MACHINE INTERFACE
pH	HYDROGEN ION CONCENTRATION
OL	OVERLOAD
OWS	OPERATOR WORKSTATION
PLC	PROGRAMMABLE LOGIC CONTROLLER
POLM	POLYMER
RBC	REMOTE BASE CONTROLLER
RIO	REMOTE INPUT OUTPUT
RTU	REMOTE TERMINAL UNIT
TOL	THERMAL OVERLOAD TRIPPED
TURB	TURBIDITY
VIB	VIBRATION
VSD	VARIABLE SPEED DRIVE
WCU	WIRELESS COMMUNICATIONS UNIT

INDENTIFICATION LETTERS FOR PROCESS INSTRUMENTATION

THIS TABLE APPLIES ONLY TO THE FUNCTIONAL IDENTIFICATION OF INSTRUMENTS.

	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INTIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	CONDUCTIVITY			CONTROL	
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER's CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH OR OPEN
I	CURRENT (ELECTRICAL)		INDICATION		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW OR CLOSED
M	MOTION	MOMENTARY			MIDDLE OR INTERMEDIATE
N	TORQUE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	REL HUMIDITY		ORIFICE (RESTRICTION)		
P	PRESSURE, VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE, TOTALIZER			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, OR LOUVER	
W	WEIGHT, FORCE		WELL		
X	DIRECTION	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE, OR PRESSENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVE, ACTUATE OR UNCLASSIFIED CONTROL ELEMENT	

ISA CODES BASED ON ANSI/ISA S5.1-1984 (R 1992)

P&ID CODE EXAMPLES

FLOWMETER INDICATING
FI 001

TEMPERATURE TRANSMITTER
TT 001

POSITION SWITCH - HIGH LEVEL
ZSH 001

LINE SYMBOLS

	MAJOR PROCESS PIPING, FLOW CHANNEL, WITH FLOW DIRECTION AS SHOWN
	MINOR PROCESS PIPING WITH FLOW DIRECTION AS SHOWN
	MISCELLANEOUS PIPING WITH FLOW DIRECTION AS SHOWN
	FUTURE PIPING
	EXISTING PIPING
	ELECTRIC OR ELECTRONIC SIGNAL WITH SIGNAL DIRECTION AS SHOWN
	ELECTROMAGNETIC OR SONIC SIGNAL (GUIDED)
	ELECTROMAGNETIC OR SONIC SIGNAL (UNGUIDED)
	SOFTWARE

PROCESS DEVICE SYMBOLS

	BALL VALVE
	CIRCULATING PUMP
M	MAGNETIC FLOWMETER
	MECHANICAL FLOAT
	LEVEL SENSOR
	PRESSURE SENSOR
	REDUCER CONCENTRIC
	ULTRASONIC SENSOR
M	SUBMERSIBLE WELL PUMP
	VENTURI FLOWMETER
	VORTEX FLOWMETER
	Y-STRAINER

GENERAL NOTES

1	THIS IS A GENERAL LEGEND SHEET WITH SOME SYMBOLS AND ABBREVIATIONS THAT MAY NOT APPLY TO THIS SPECIFIC PROJECT.
2	THIS LEGEND SHEET ONLY APPLIES TO THE INSTRUMENTATION DIAGRAMS WITHIN THIS PROJECT.
3	SOME PROCESS ITEMS MAY NOT BE SHOWN FOR CLARITY SUCH AS SHUT-OFF VALVES, ETC., WHICH ARE NOT CRITICAL TO THE UNDERSTANDING OF THE INSTRUMENTATION FUNCTIONALITY.

PARSONS
8000 CENTRE PARK, SUITE 200
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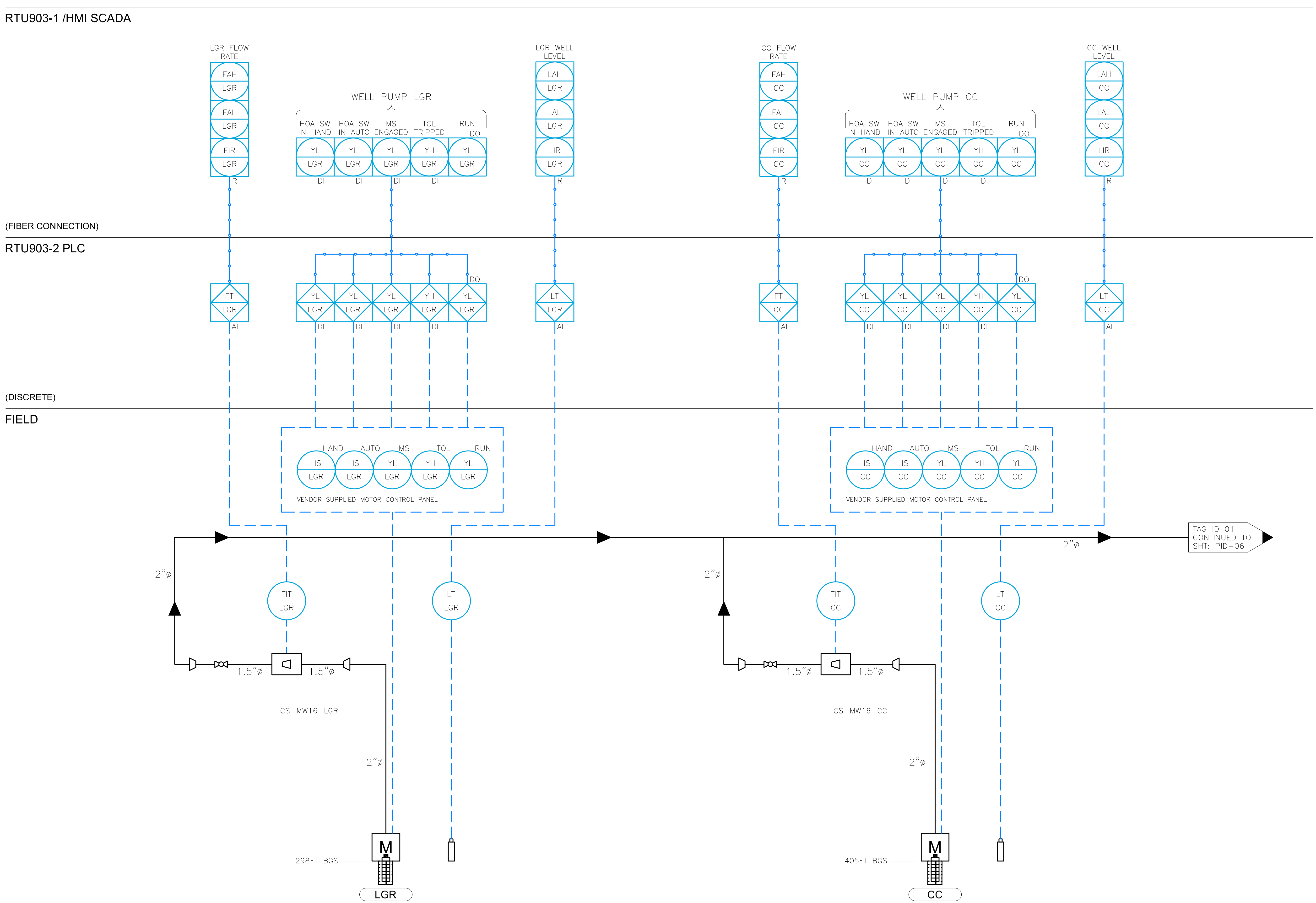
CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO: 748350-01000
DATE : 09.05.2012
DRAWN : RMF
REVISIONS:

P&ID

SHEET NO.
LEGEND



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PROJECT NO: 748350-01000

DATE : 09.05.2012

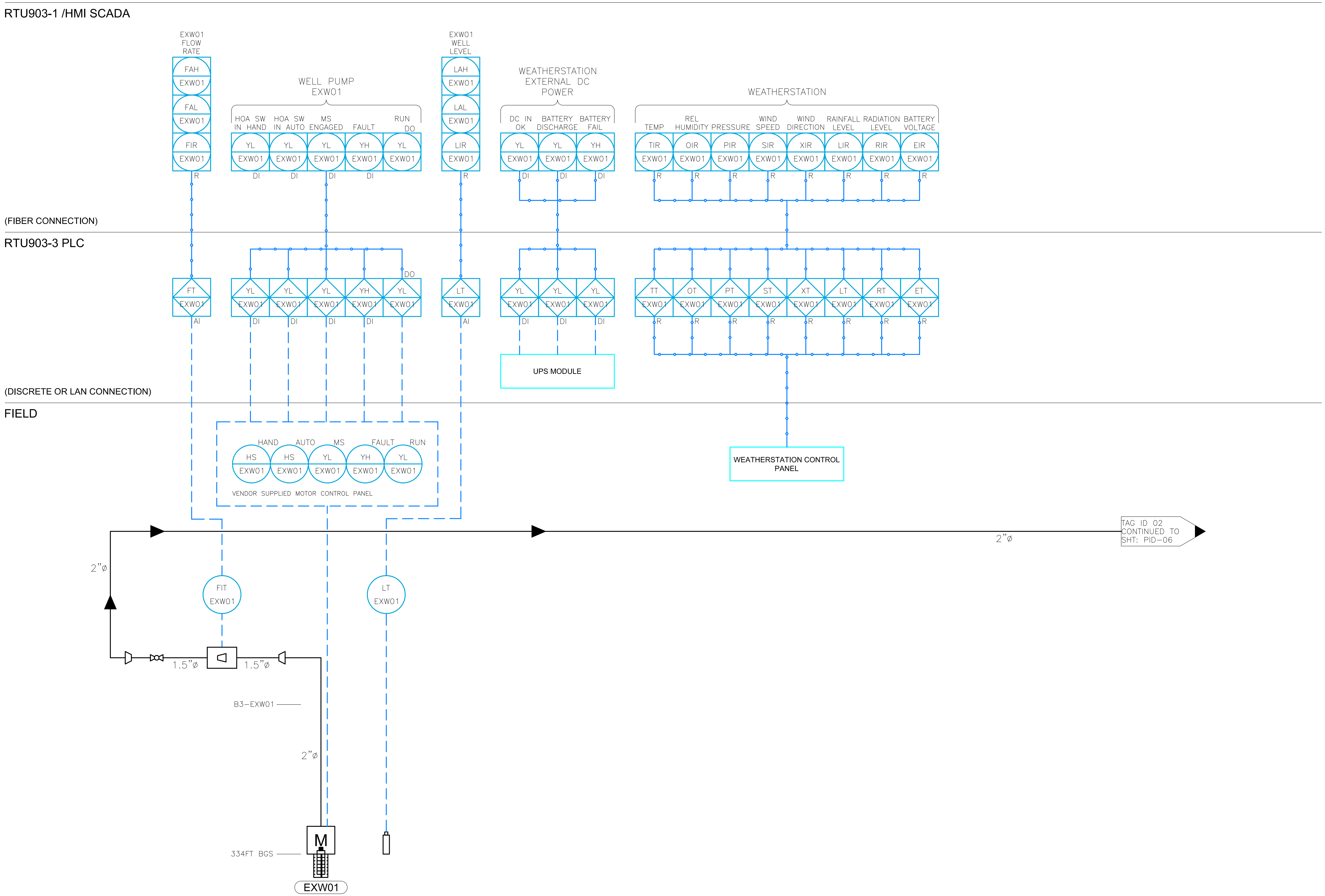
DRAWN : RMF

REVISIONS:

P&ID

SHEET NO.

PID-01



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CAMP STANLEY
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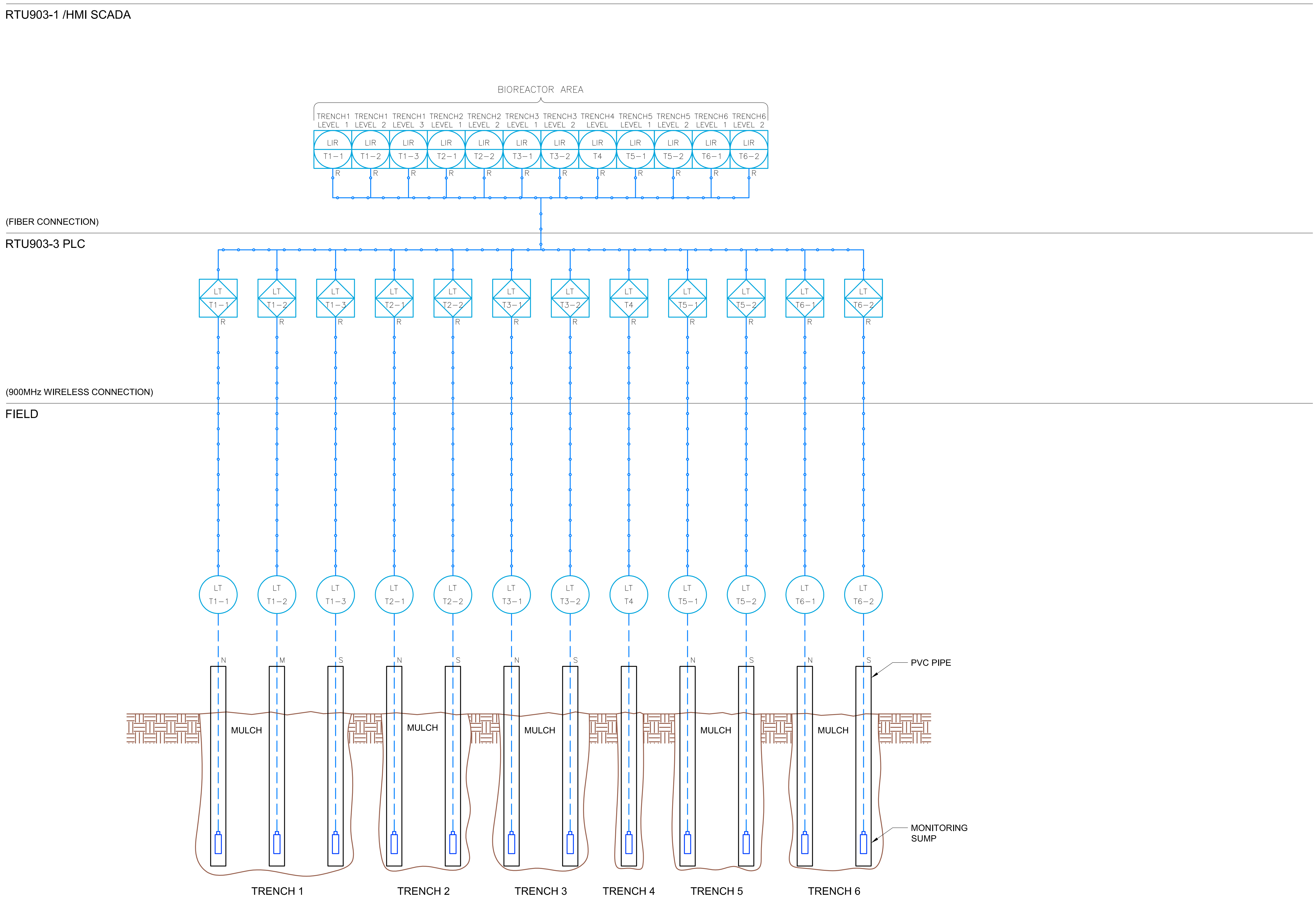
SHEET NO.
PID-02



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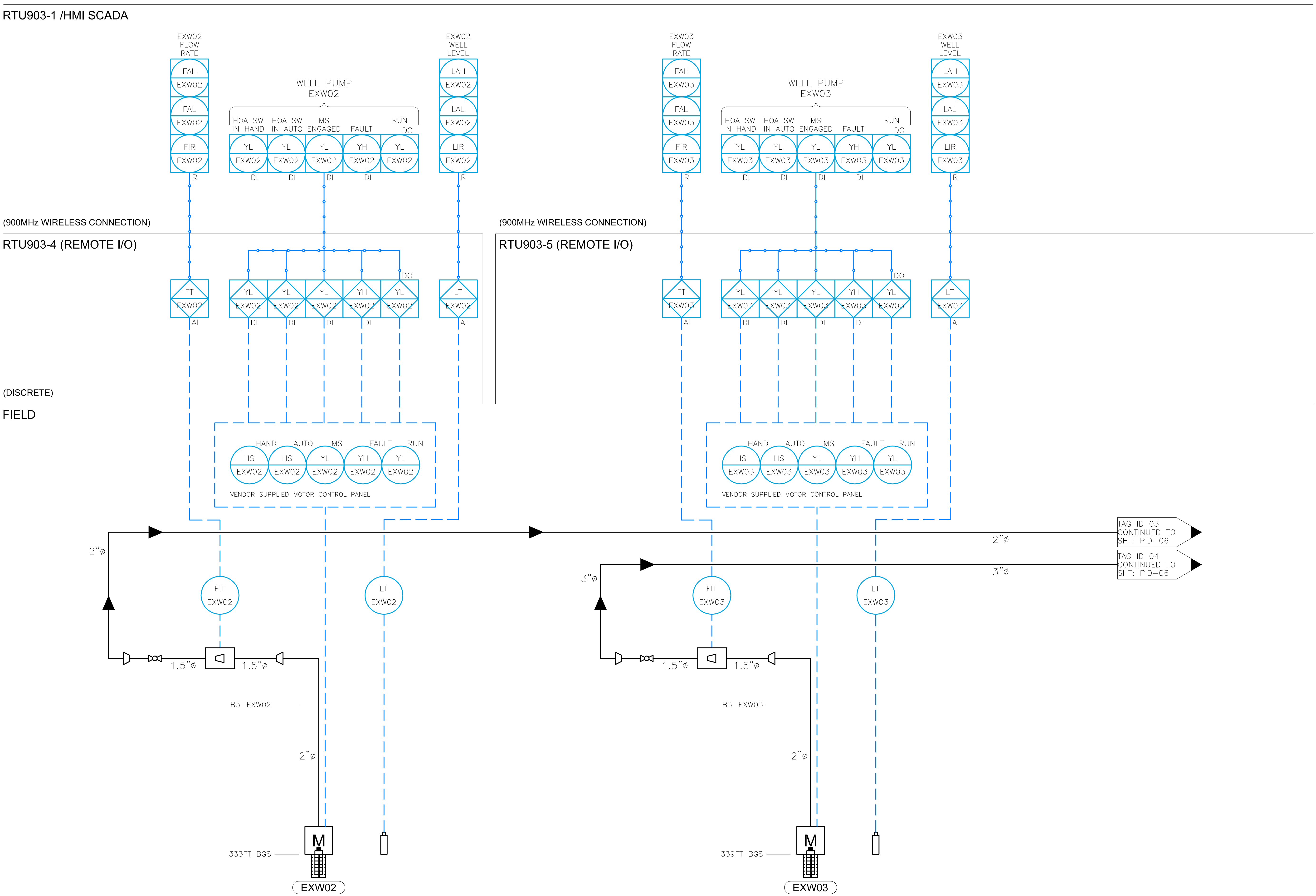
CAMP STANLEY
BIOREACTOR UPGRADE PROJECT
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO: 748350-01000
DATE: 09.05.2012
DRAWN: RMF
REVISIONS:

P&ID

SHEET NO.
PID-03



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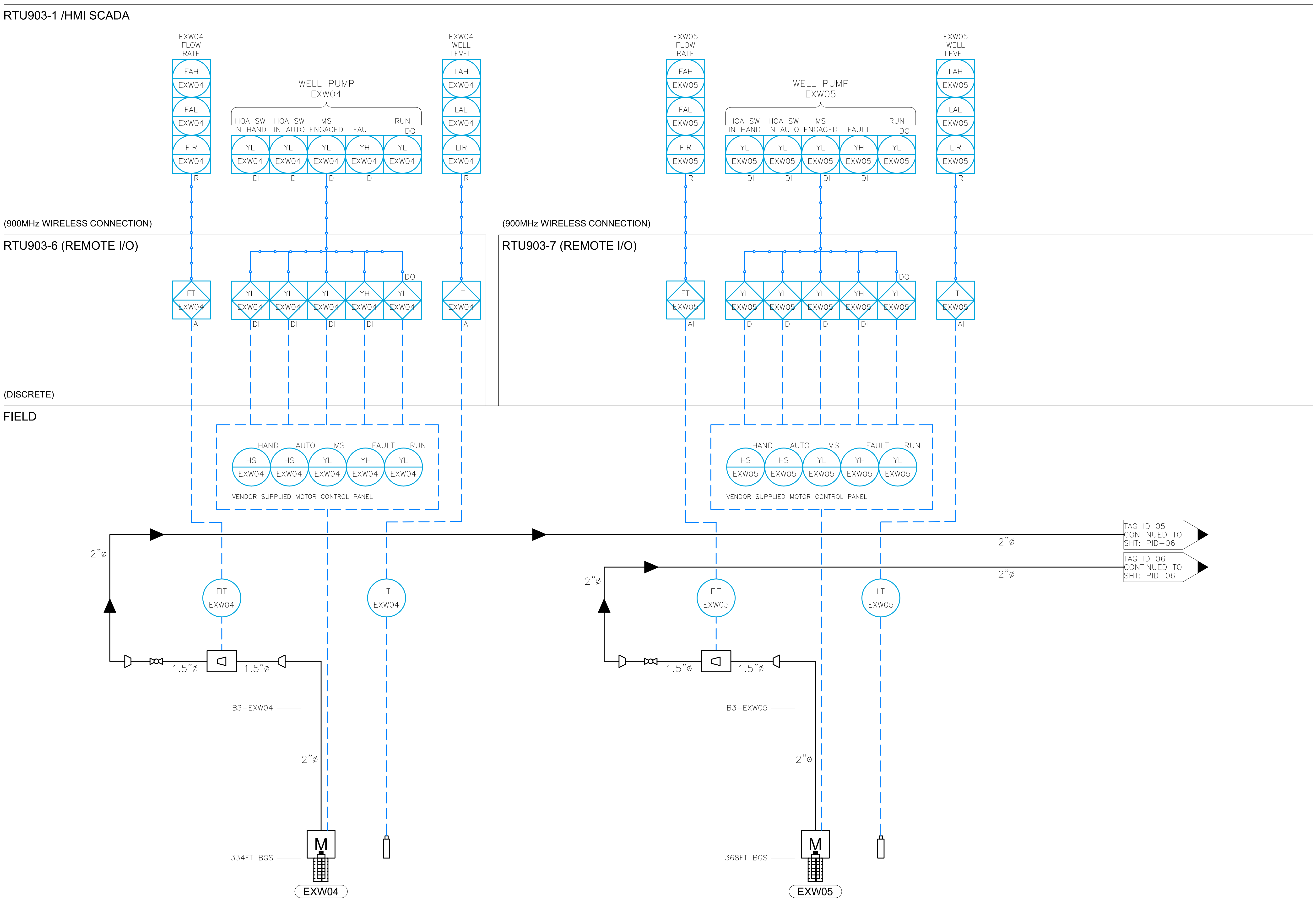
DRAWN : RMF

REVISIONS:

P&ID

SHEET NO.

PID-04



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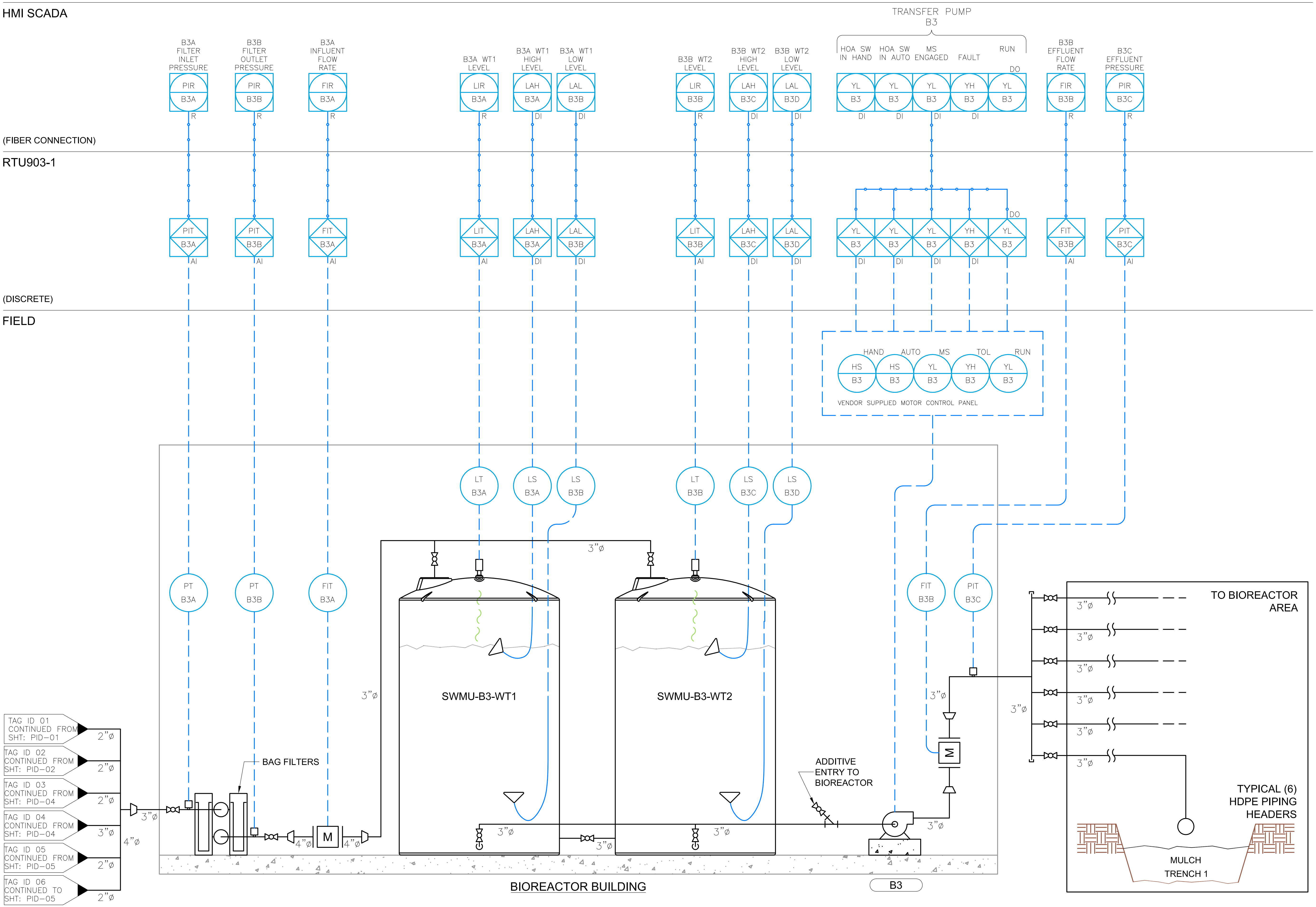
P&ID

SHEET NO.
PID-05



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DATE : 09.05.2012

DRAWN : RMF

REVISIONS:

P&ID

SHEET NO.

PID-06

RTU 903-1
BIOREACTOR BUILDING MAIN CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

MAIN CONTROL PANEL

RTU903-1 SCADA CONTROL PANEL

TRANSFER PUMP MOTOR CONTROL PANEL

PRELIMINARY - NOT FOR CONSTRUCTION

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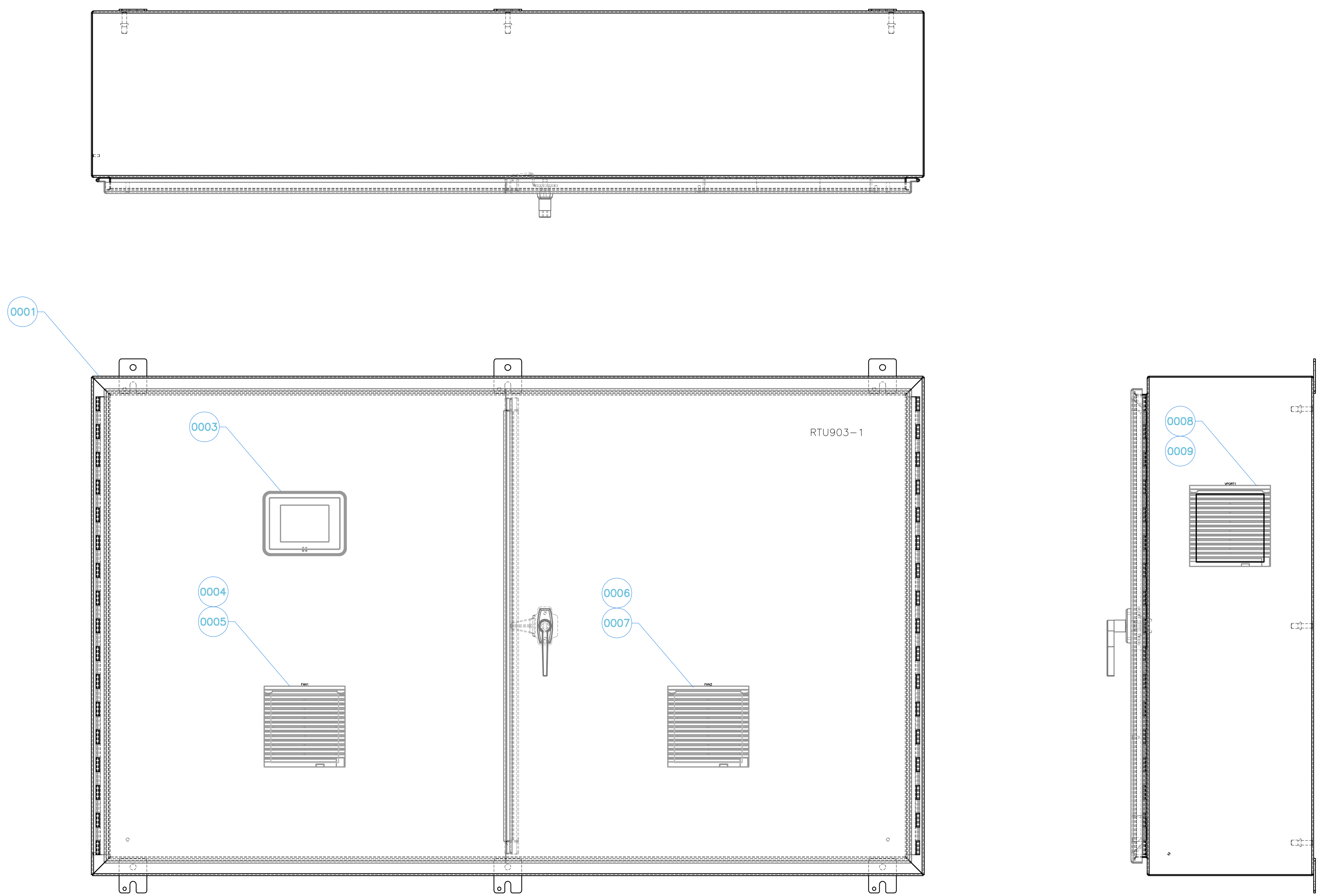
BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
DRAWN : RMF
REVISIONS:

RTU903-1

SHEET NO.
TITLE



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

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PROJECT NO. 2012.01

DATE : 04.25.2012

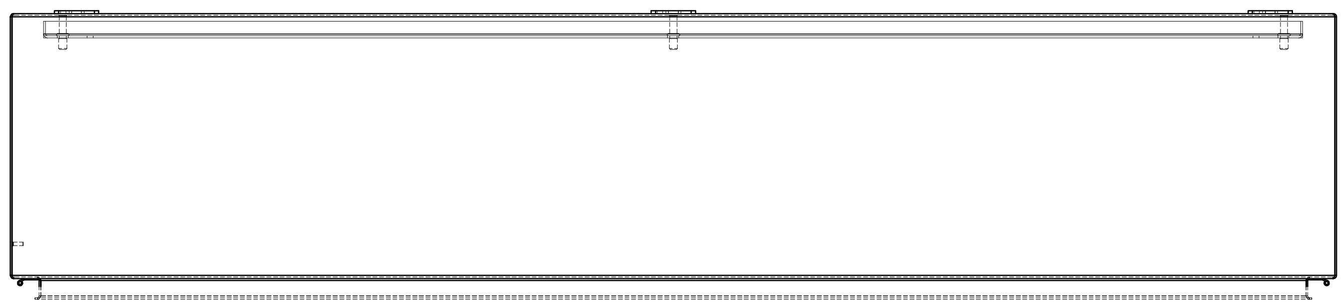
DRAWN : RMF

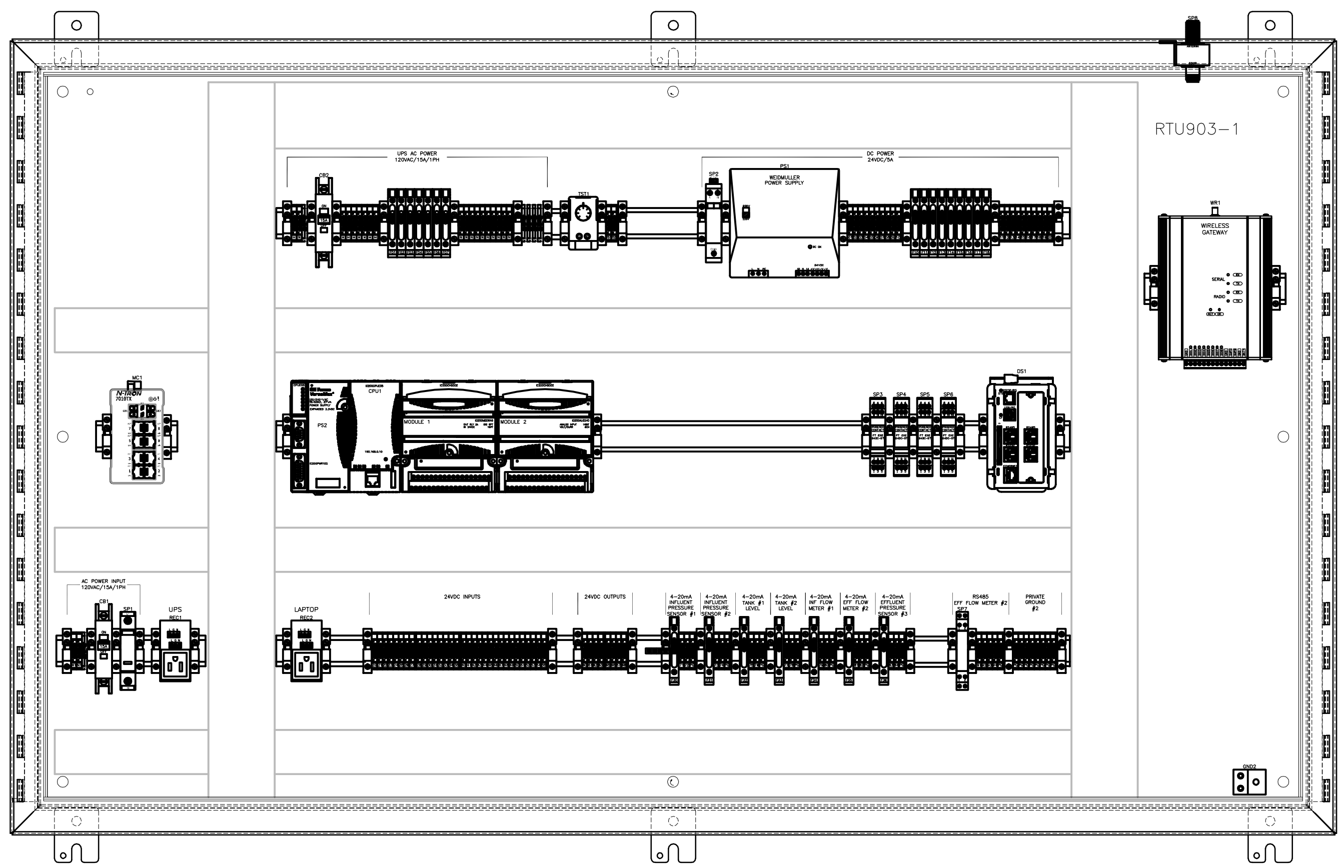
REVISIONS:

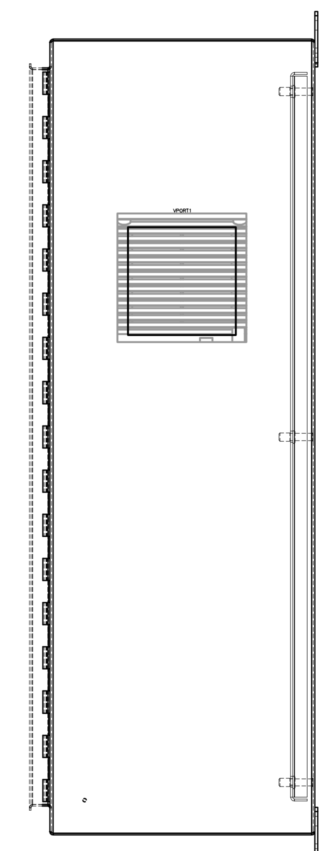
RTU903-1

SHEET NO.

SC-001







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WIRE MARKER LEGEND	
COLOR	SIZE
GR-16	

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
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OR	Orange
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BL	Blue
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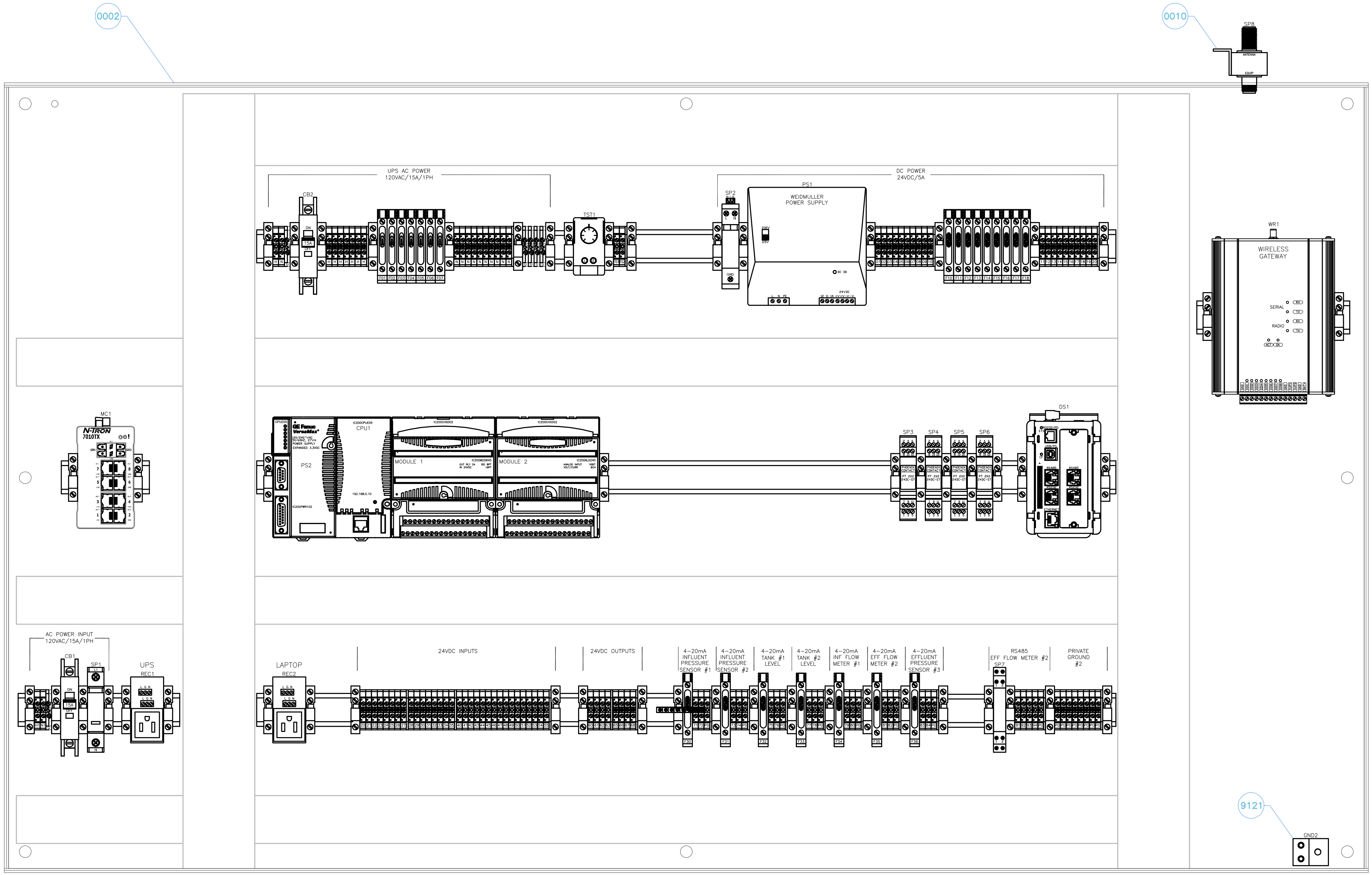
REVISIONS:

RTU903-1

SHEET NO.
SC-002



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND
COLOR SIZE
GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

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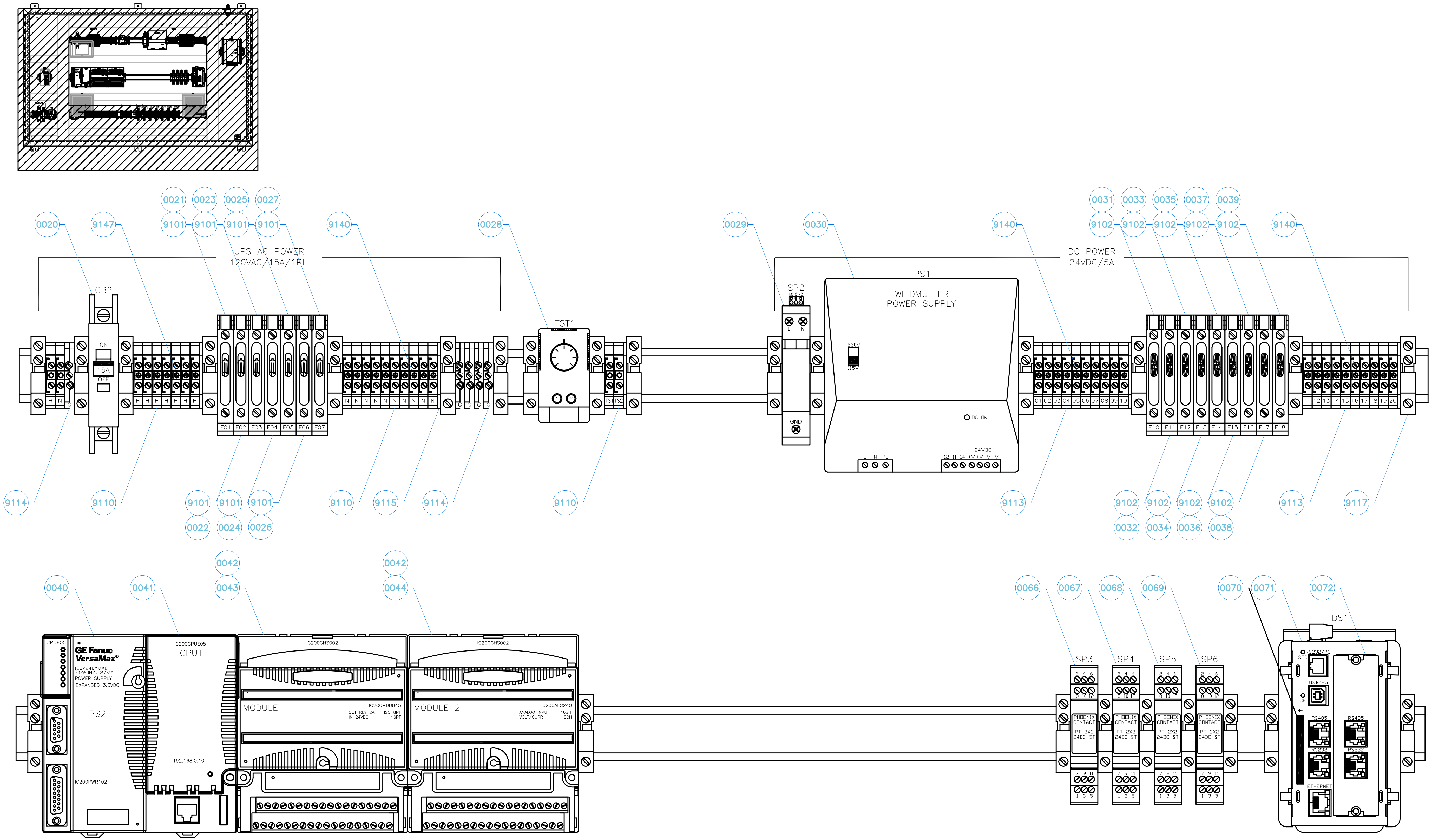
SHEET NO.
SC-003



COLOR CODE	
ID	COLOR
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

GR-16

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

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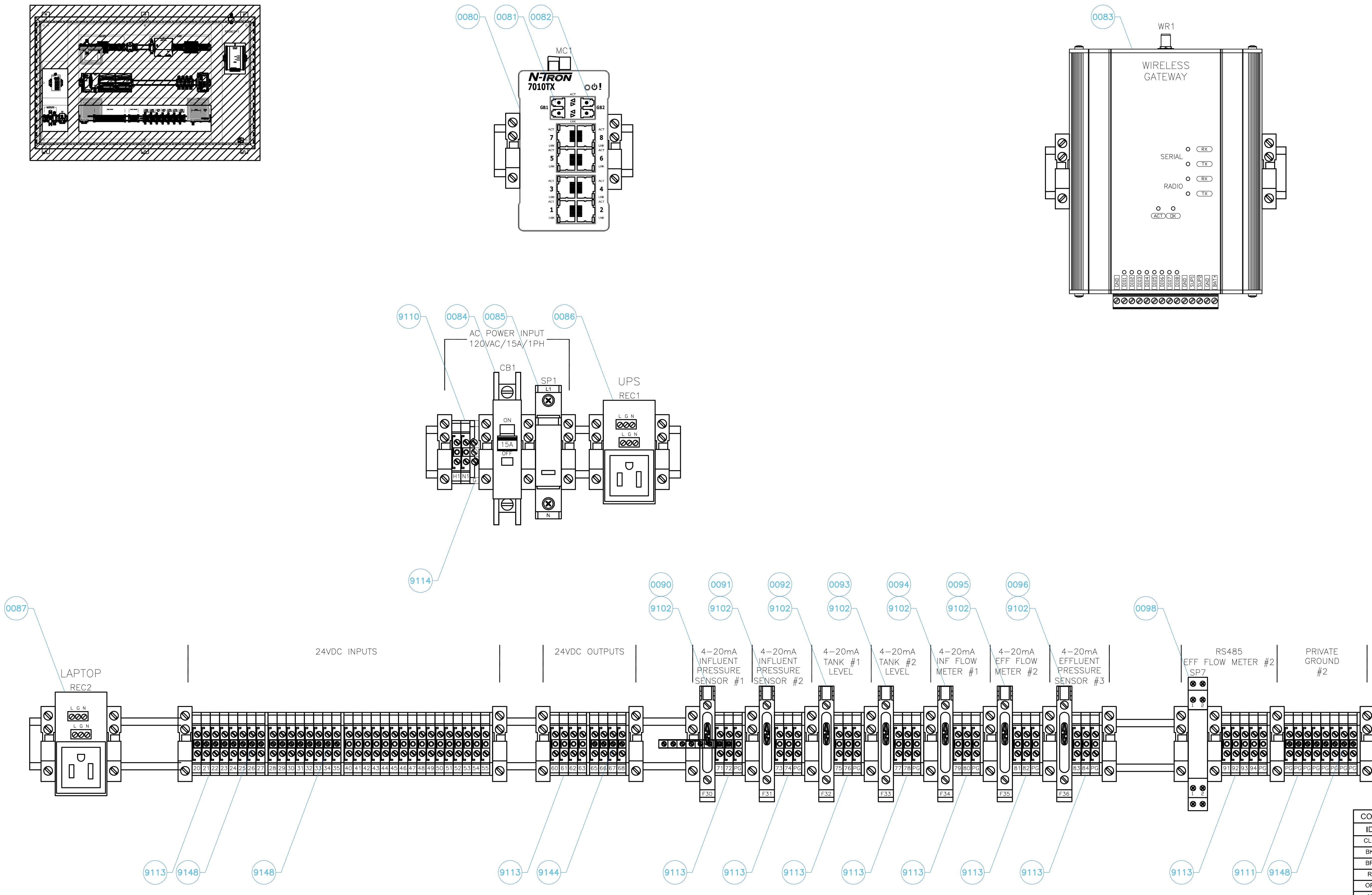
SHEET NO.

SC-004



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
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REVISIONS:

RTU903-1

SHEET NO.

SC-005

BILL OF MATERIAL

ITEM_ID	DEVICE_ID	Count	DESCRIPTION	MFG_NAME	MFG_PN
0001	RTU903-1	1	ENCLOSURE, 36"Hx60"Wx12"D, Nema12	HOFFMANN	A366012WFLP
0002		1	Back Panel, 36"Hx60"W, White Steel	HOFFMANN	A60P36
0003	HMI1	1	HMI Color Touch Screen, 6", 24VDC, LAN PORT	GE FANUC	IC754VSI06STD
0004	FAN1	1	Fan, Filter Unit, 39CFM, 115VAC, 0.24A, 50/60Hz, 19W, Nema 12, Light Grey, 49db(A)	RITTAL	3322.117
0005		1	Replacement Filter Pads, for 5.8"SQ Fans	RITTAL	3322.700
0006	FAN2	1	Fan, Filter Unit, 39CFM, 115VAC, 0.24A, 50/60Hz, 19W, Nema 12, Light Grey, 49db(A)	RITTAL	3322.117
0007		1	Replacement Filter Pads, for 5.8"SQ Fans	RITTAL	3322.700
0008	VPORT1	1	Filter Unit, Holder Only, 124mm	RITTAL	SK3322-207
0009	VPORT2	1	Filter Unit, Holder Only, 124mm	RITTAL	SK3322-207
0010	SP8	1	Broadband DC Blocked Protector, 125-1000MHz, 50 ohm, 50-375W, VSWR: 1.1:1, Surge 50kA, N-Female x N-Female	POLYPHASER	IS-B50LN-C2
0020	CB2	1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0021		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0022		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0023		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0023		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0024		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0025		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0026		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0027		1	Fuse, 5x20mm, 3A, Slow Acting	BUSSMANN	MDL-3
0028	TST1	1	Thermostat, DIN-Rail Mount, 30-140F, Hysteresis +/-4F, 15A, 120VAC	HAMMOND	SKT011419NO
0029		1	Holder, Surge Protection	CITEL	DS220-24DC
0029	SP2	1	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0030	PS1	1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3.6A@115VAC, 24VDC@10A	WEIDMULLER	CP SNT 250W 24V 10A
0031		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0032		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0033		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0034		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0035		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0036		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0037		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0038		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0039		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0040	PS2	1	PLC Power Supply, 120/240VAC, 27VA, 50/60Hz, Expanded 3.3VDC	GE FANUC	IC200PWR102E
0041	CPU1	1	PLC CPU MODULE	GE FANUC	IC200CPUE05
0042		2	Box I/O Style Carrier, AWG 22-14, 2A/ Point, 8A/ Power or GND, 264VAC M	GE FANUC	IC200CHS002
0043	MODULE 1	1	Mixed Module, 16-Input, 8-Output, 24VDC Input, Relay Output	GE FANUC	IC200MDD845
0044	MODULE 2	1	Analog Input Module, 8CH, 16Bit, Voltage/ Current	GE FANUC	IC200ALG240
0066		1	Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0066	SP3	1	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0067		1	Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0067	SP4	1	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0068		1	Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0068	SP5	1	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0069		1	Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0069	SP6	1	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0070		1	Compact Flash Card, 2Gig	SANDISK	G3CFxxxx
0071	DS1	1	Protocol Converter, 200mA min @ 24VDC, 1A Max w/Expansion Card, optional Compactflash Card	Red Lion	DSPSX000
0072		1	Coms Card, RS232/RS485	Red Lion	XCRS0000
0080	MC1	1	Managed Media Converter, 10-49VDC, 410mA @ 24VDC, (8) 10/100BaseTX, Optional Fiber Ports (SM or MM)	N-TRON	7010TX
0081		1	Transceiver, 10km, 1000BaseLX SingeMode Fiber SFP Pluggable Mini-GBIC (LC Style Connector)	N-TRON	NTSFP-LX-10
0082		1	Transceiver, 10km, 1000BaseLX SingeMode Fiber SFP Pluggable Mini-GBIC (LC Style Connector)	N-TRON	NTSFP-LX-10
0083	WR1	1	Wireless Gateway Radio, DIN-RAIL Mount, 15-30VDC, 4 inputs/outputs, Ethernet, RS485	WEIDMULLER	WI-GTWY-9-ET1
0084	CB1	1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0085		1	Holder, Surge Protection	WEIDMULLER	PU II 1S
0085	SP1	1	Surge Protection Module, 130VAC, In:20kA, Imax:40kA, L-N	WEIDMULLER	SH2B-05
0086	REC1	1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0087	REC2	1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0090		7	Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
0098	SP7	1	Surge Protection Module, RS232/RS485, Imax:20kA, Vmax: 8VDC, 1Pair Shield	CITEL	DLA-06D3
9101		7	Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILA 250
9102		16	Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILED 24
9110		23	Terminal Block, Gray, 600V/30A, 30-10AWG	PHOENIX	UK 5 N
9111		16	Terminal Block, Green, 600V/30A, 30-10AWG	PHOENIX	UK 5 N GN
9113		78	Terminal Block, Orange, 600V/30A, 30-10AWG	PHOENIX	UK 5 N OG
9114		6	Ground Terminal, 26-10AWG	PHOENIX	UKLKG 5
9115		19	End Cover Plate, Gray	PHOENIX	D-UK 4/10
9117		53	End Clamp, Gray	PHOENIX	E/UK
9121	GND2	1	Grounding Lug, 2 Conductor, 1/0-14AWG	BURNDY	K2A25U
9140		3	Cross Connector/ Jumper, 10 Position, Al	PHOENIX	FBI 10-6
9144		1	Cross Connector/ Jumper, 10 Position cut to 4, Al	PHOENIX	FBI 10-6
9147		1	Cross Connector/ Jumper, 10 Position cut to 7, Al	PHOENIX	FBI 10-6
9148		4	Cross Connector/ Jumper, 10 Position cut to 8, Al	PHOENIX	FBI 10-6

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

PARSONS

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CAMP STANLEY
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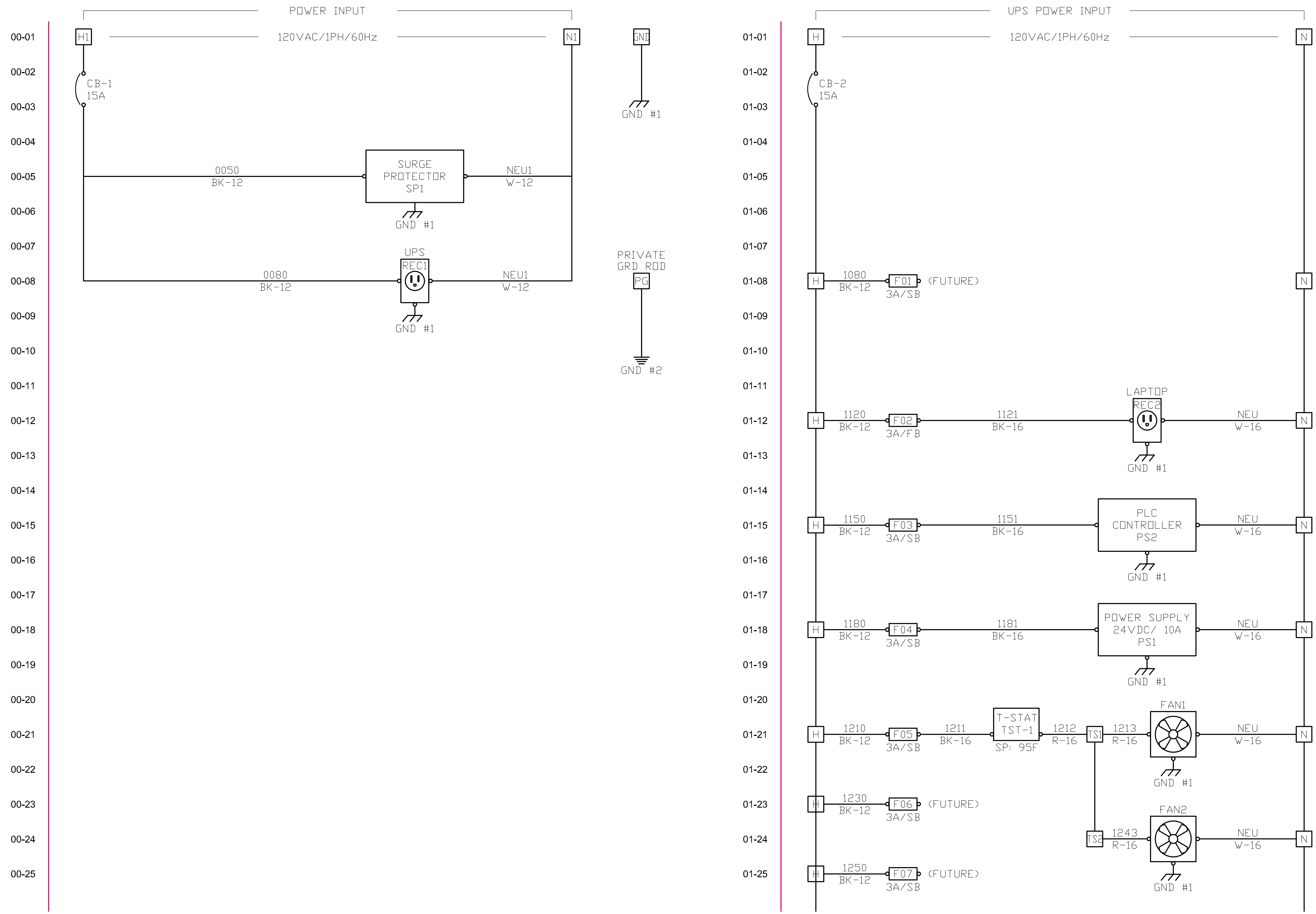
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
DRAWN : RMF
REVISIONS:

RTU903-1

SHEET NO.

SC-006



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COLOR SIZE

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Austin, Texas 78754

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01

DATE : 04.25.2012

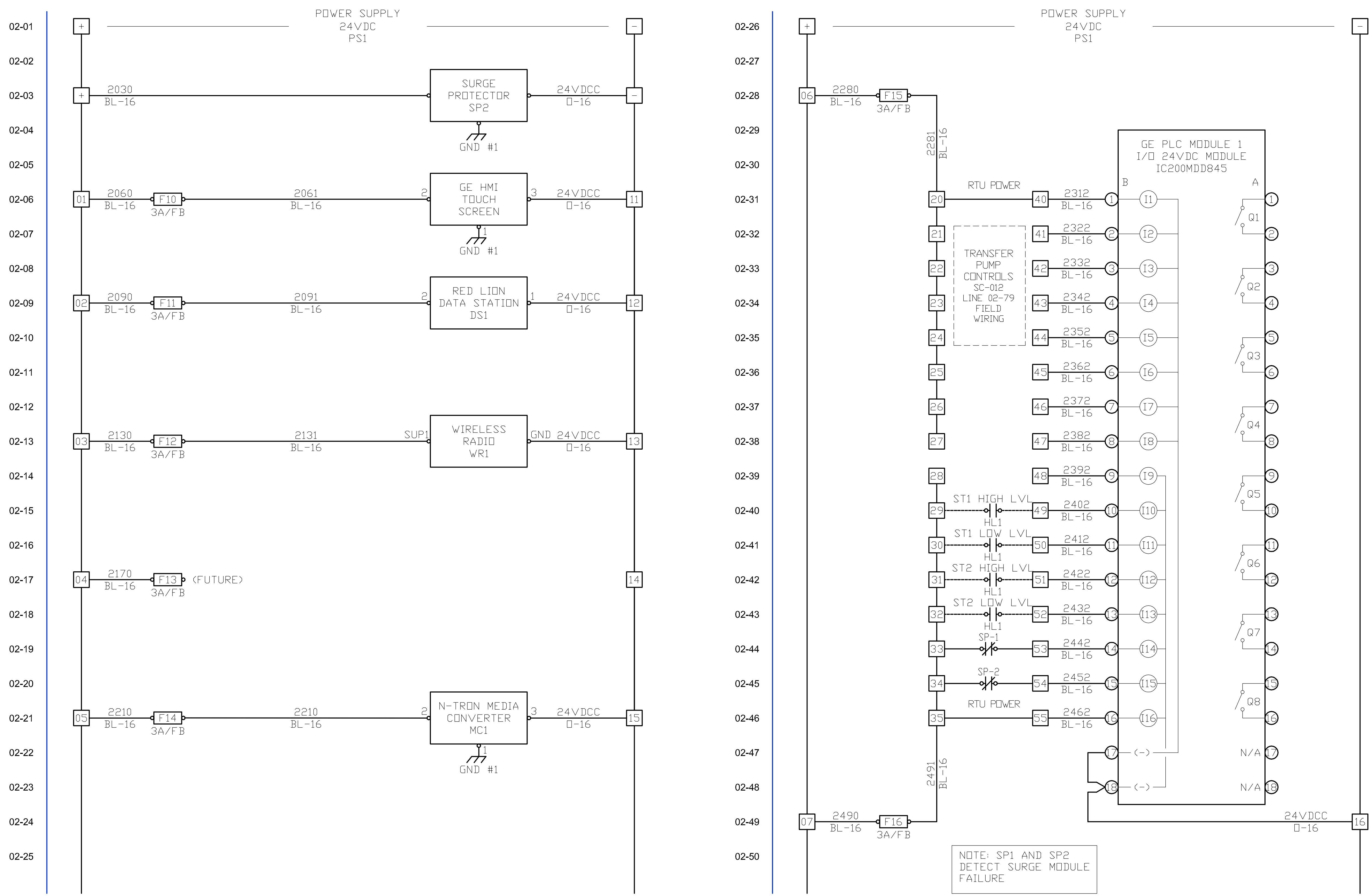
DRAWN : RMF

REVISIONS:

RTU903-1

SHEET NO.

SC-010



NOTE: SP1 AND SP2 DETECT SURGE MODULE FAILURE

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
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PARSONS

8000 CENTRE PARK, SUITE 200
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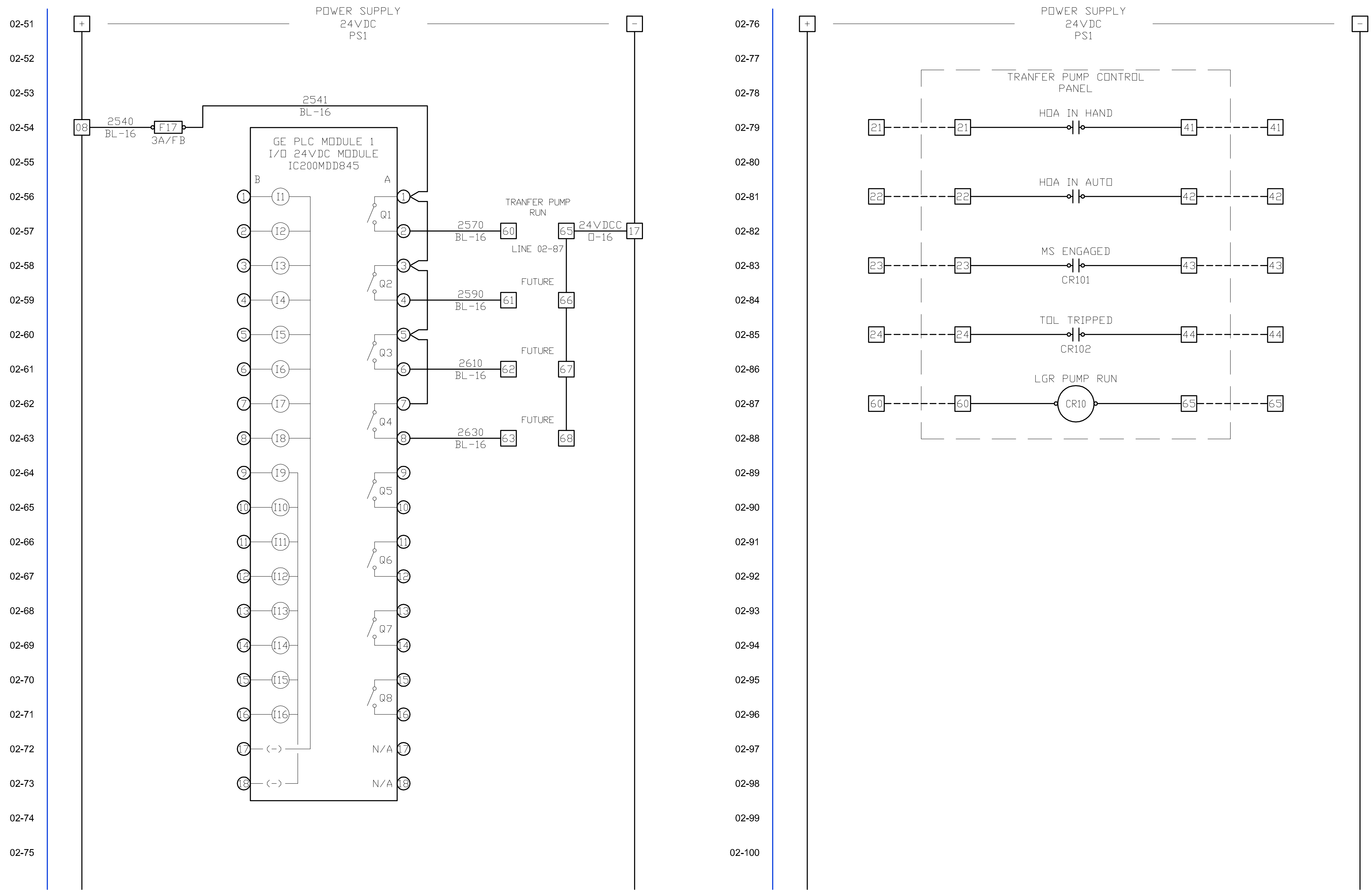

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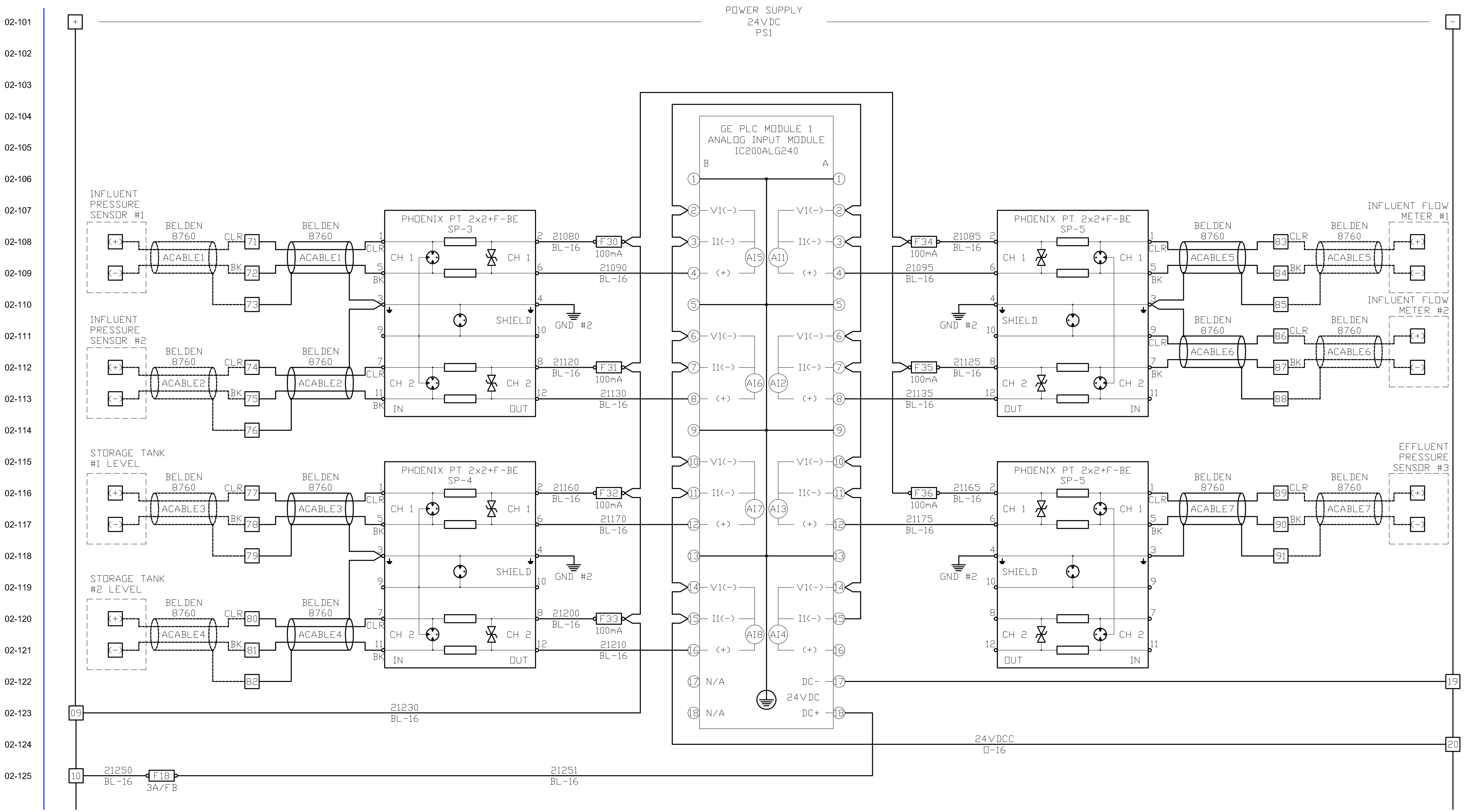

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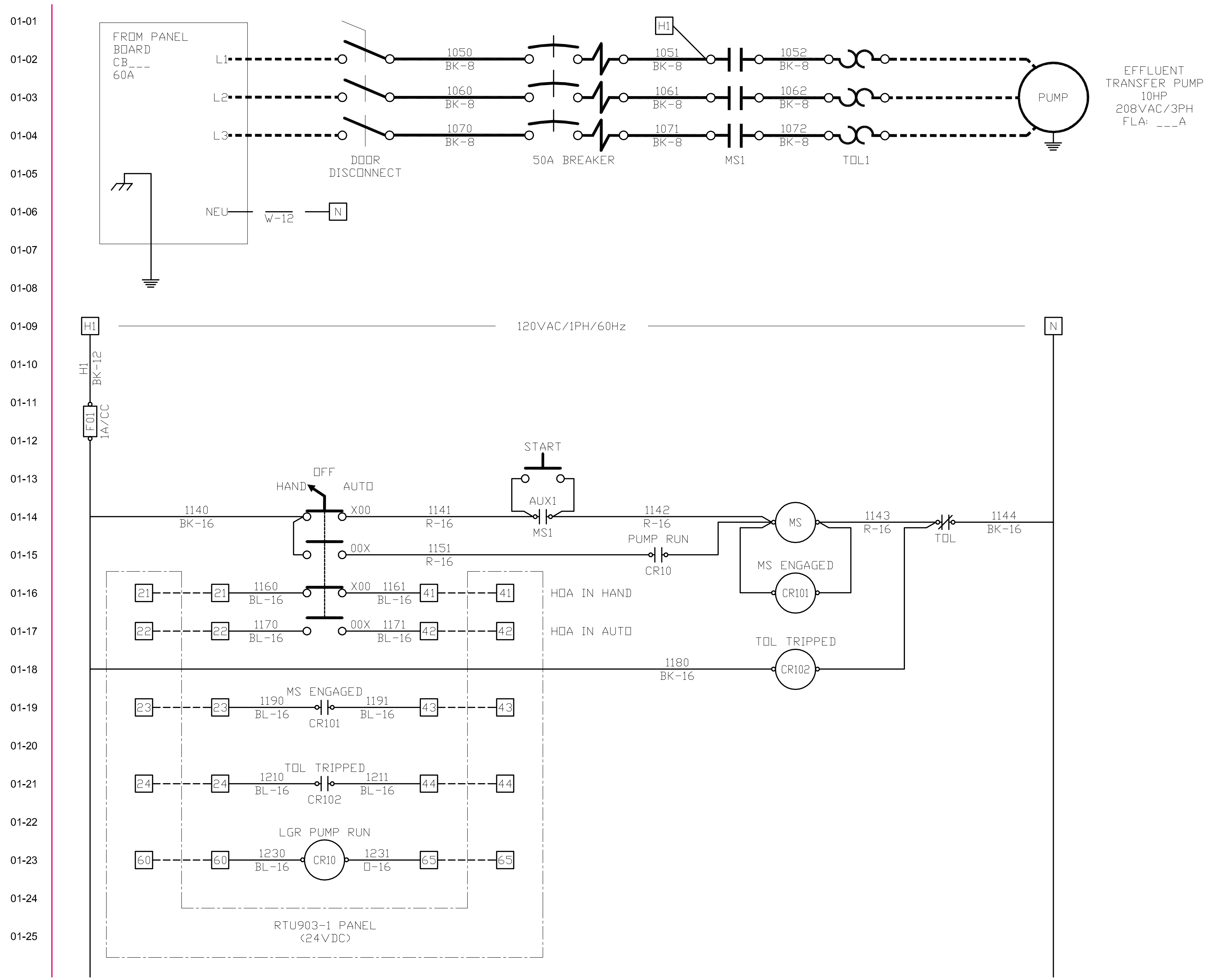
SHEET NO.
SC-013



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SHEET NO.
SC-020

RTU 903-2
CS-MW16-LGR/CS-MW16-CC CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

MW16 (LGR / CC) WELLS

RTU903-2 SCADA CONTROL PANEL

SC-001	EXTERIOR CONTROL PANEL VIEWS
SC-002	INTERIOR CONTROL PANEL VIEWS
SC-003	INTERIOR DETAIL OF CONTROL PANEL
SC-004	INTERIOR PANEL DETAIL "A"
SC-005	INTERIOR PANEL DETAIL "B"
SC-006	CONTROL PANEL BILL-OF-MATERIAL
SC-010	LINE-TO-LINE WIRING DIAGRAM SHT 1 OF 5
SC-011	LINE-TO-LINE WIRING DIAGRAM SHT 2 OF 5
SC-012	LINE-TO-LINE WIRING DIAGRAM SHT 3 OF 5
SC-013	LINE-TO-LINE WIRING DIAGRAM SHT 4 OF 5
SC-014	LGR WELL - RS485 WIRING DETAIL
SC-015	CC WELL - RS485 WIRING DETAIL

WELL PUMPS MOTOR CONTROL PANEL

SC-020	LINE-TO-LINE WIRING DIAGRAM SHT 1 OF 2
SC-021	LINE-TO-LINE WIRING DIAGRAM SHT 2 OF 2

PRELIMINARY - NOT FOR CONSTRUCTION

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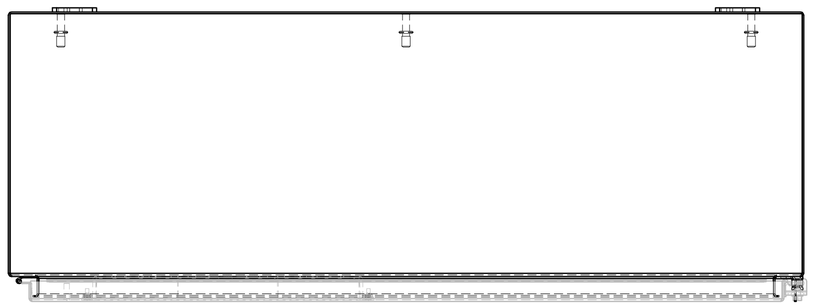
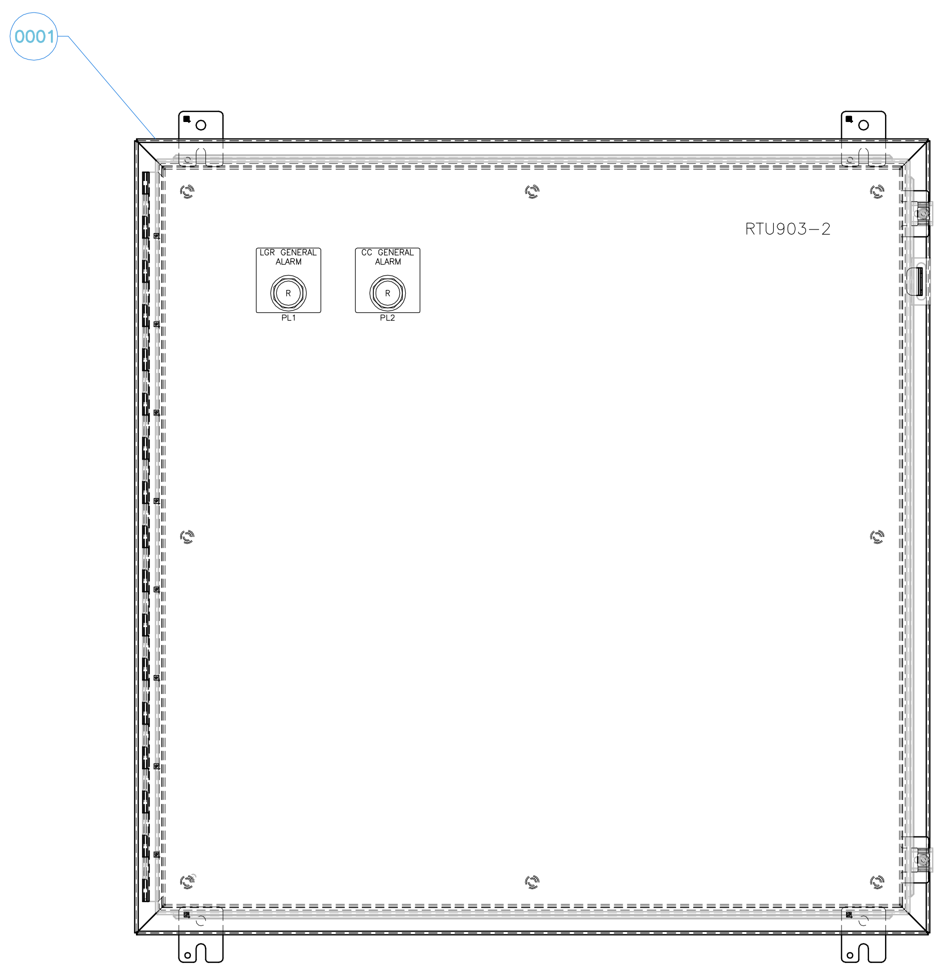
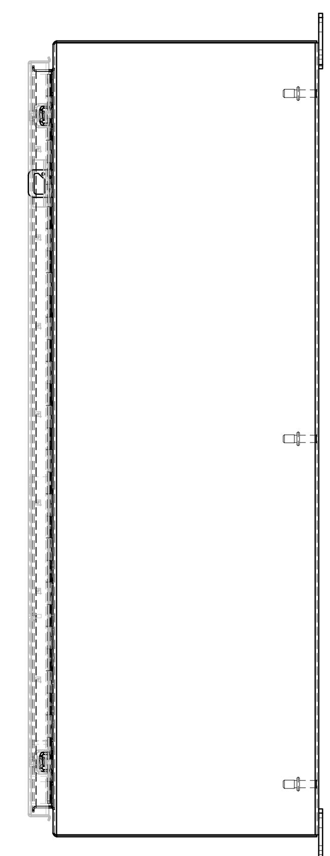
SHEET NO.
TITLE







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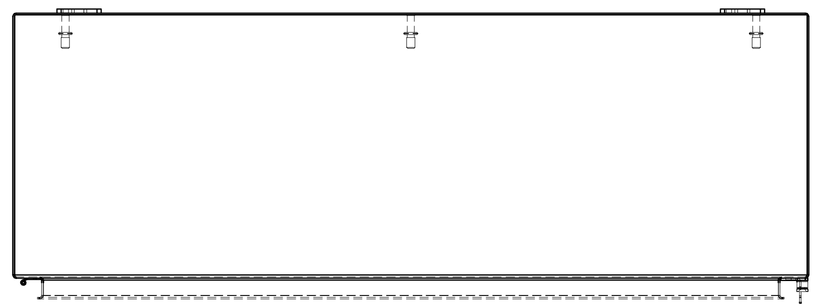
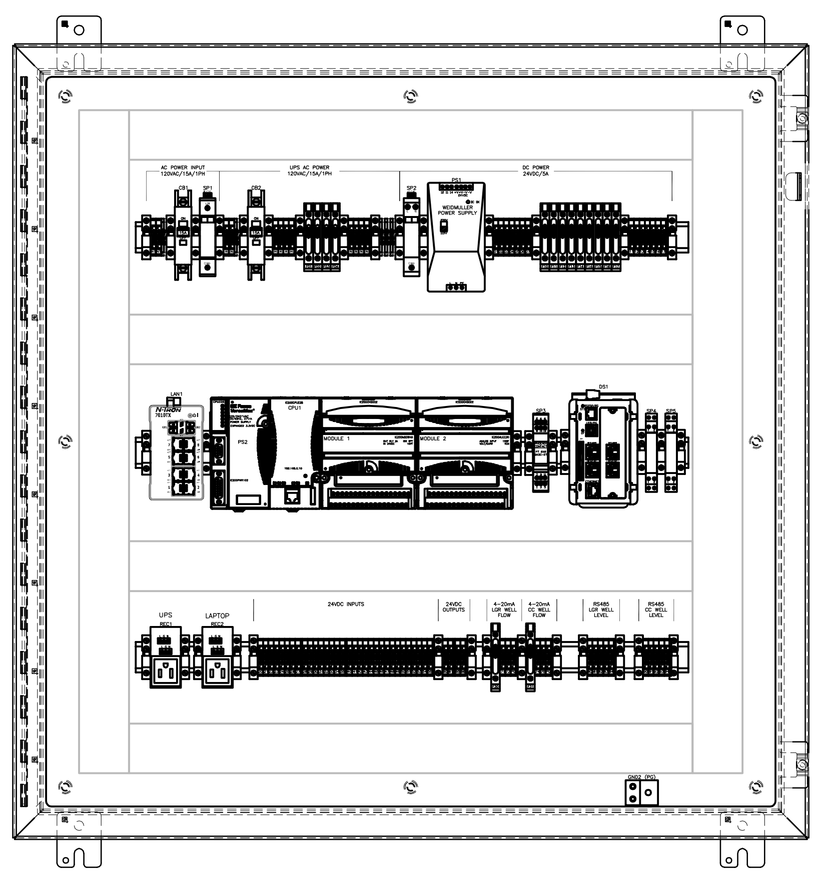
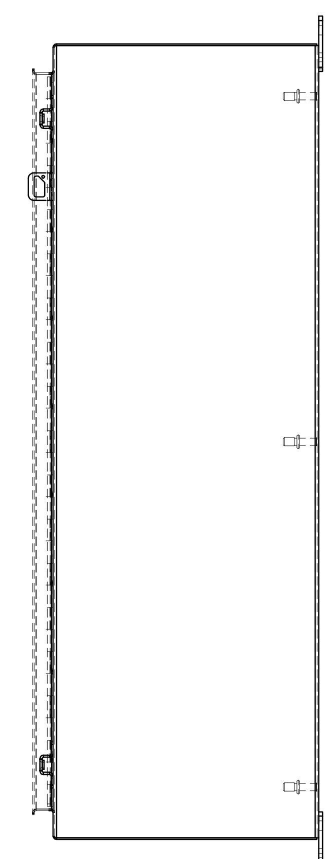
SHEET NO.

SC-001







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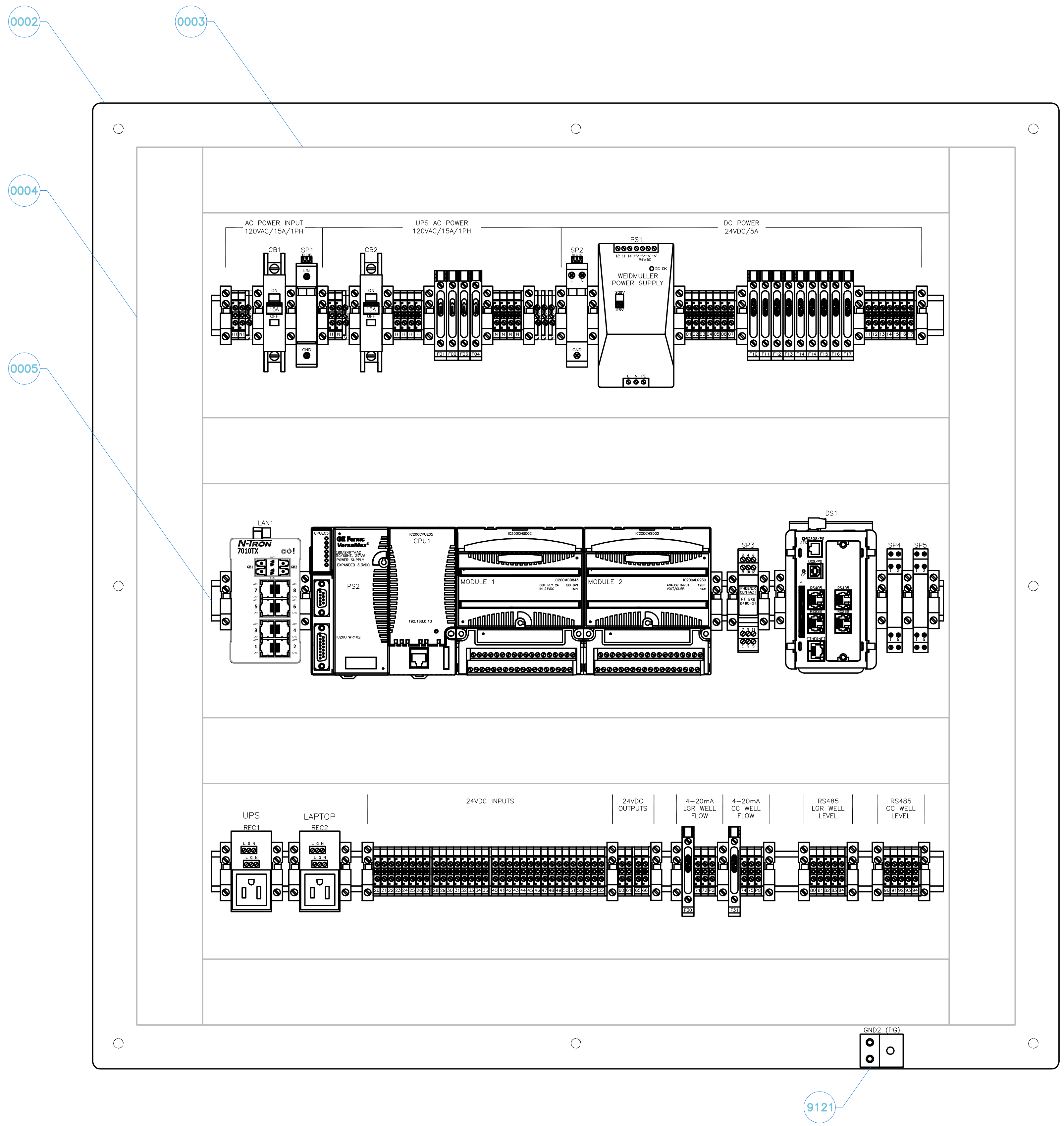
SHEET NO.

SC-002



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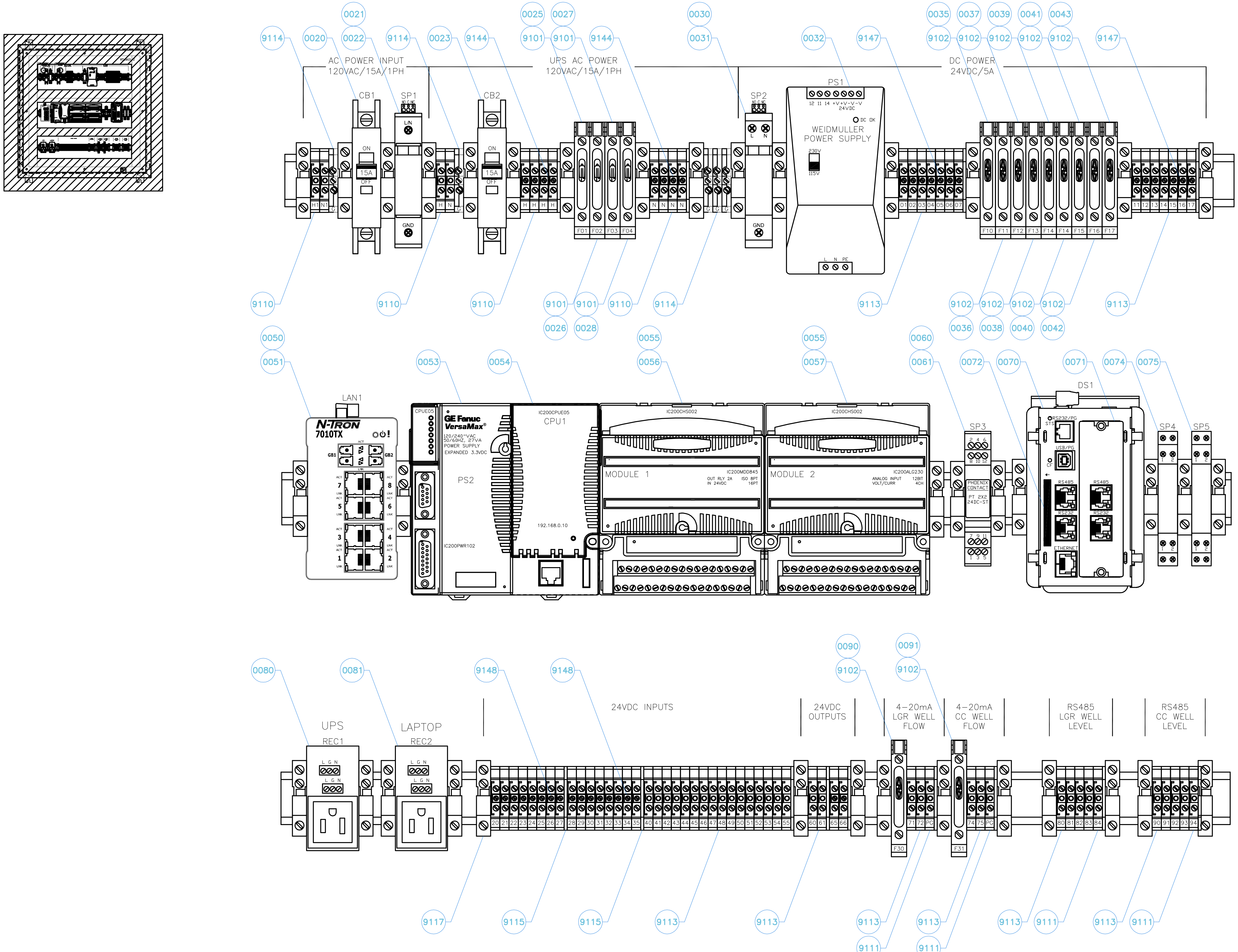
SHEET NO.

SC-003



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RTU903-2

SHEET NO.

SC-004

BILL-OF-MATERIAL

ITEM_ID	Count	DEVICE_ID	DESCRIPTION	MFG_MODEL_NO	MFG_NAME	MFG_PN
0001	1	RTU903-2	ENCLOSURE, 36"Hx36"Wx12"D, Nema12		HOFFMAN	A363612LP
0002	1		Back Panel, 36"Hx36"W, White Steel		HOFFMAN	A36P36
0003	4		Wiring Duct, Narrow Slot Type F, White, PVC, UL, Length 25.5"		PANDUIT	F2X3LG6
0004	2		Wiring Duct, Narrow Slot Type F, White, PVC, UL, Length 30"		PANDUIT	F2X3LG6
0005	3		DIN Rail, Steel, Perforated, 35mm x 2M cut to length of 25"		IBOCO	Omega 3F
0010	1		Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC		AB	800T-QBH24R
0011	1	PL1	Standard Legend Plate, Al, 30.5mm Pilot Lamp, Red, (Custom Text "GENERAL ALARM")		AB	800T-X621E
0012	1		Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC		AB	800T-QBH24R
0013	1	PL2	Standard Legend Plate, Al, 30.5mm Pilot Lamp, Red, (Custom Text "GENERAL ALARM")		AB	800T-X621E
0020	1	CB1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR		SQD	QOU115VH
0021	1	SP1	Surge Protection Module, 120VAC, Imax:40kA, Vmax: 150V		CITEL	DS41-120
0022	1		Holder, Surge Protection		CITEL	DS41-120
0023	1	CB2	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR		SQD	QOU115VH
0025	1		Fuse, 5x20mm, 3A, Slow Acting		BUSSMANN	MDL-3
0026	1		Fuse, 5x20mm, 3A, Slow Acting		BUSSMANN	MDL-3
0027	1		Fuse, 5x20mm, 3A, Slow Acting		BUSSMANN	MDL-3
0028	1		Fuse, 5x20mm, 3A, Slow Acting		BUSSMANN	MDL-3
0030	1	SP2	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC		CITEL	DS220-24DC
0031	1		Holder, Surge Protection		CITEL	DS220-24DC
0032	1	PS1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A		WEIDMULLER	CP SNT 120W 24V 5A
0035	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0036	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0037	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0038	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0039	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0040	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0041	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0042	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0043	1		Fuse, 5x20mm, 3A, Fast Acting		BUSSMANN	AGC-3
0050	1	LAN1	Managed Media Converter, 10-49VDC, 410mA @ 24VDC, (8) 10/100BaseTX, Optional Fiber Ports (SM or MM)	7010TX	N-TRON	7010TX
0051	2		Transceiver, 10km, 1000BaseLX SingeMode Fiber SFP Pluggable Mini-GBIC (LC Style Connector)		N-TRON	NTSFP-LX-10
0053	1	PS2	PLC Power Supply, 120/240VAC, 27VA, 50/60Hz, Expanded 3.3VDC		GE FANUC	IC200PWR102E
0054	1	CPU1	PLC CPU MODULE		GE FANUC	IC200CPUE05
0055	2		Box I/O Style Carrier, AWG 22-14, 2A/ Point, 8A/ Power or GND, 264VAC M		GE FANUC	IC200CHS002
0056	1	MODULE 1	Mixed Module, 16-Input, 8-Output, 24VDC Input, Relay Output		GE FANUC	IC200MDD845
0057	1	MODULE 2	Analog Input Module, 4CH, 12Bit, Voltage/ Current		GE FANUC	IC200ALG230
0060	1	SP3	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)		PHOENIX	PT 2X2-24DC-ST
0061	1		Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail		PHOENIX	PT 2X2+F-BE
0070	1	DS1	Protocol Converter, 200mA min @ 24VDC, 1A Max w/Expansion Card, optional Compactflash Card	DSP	Red Lion	DSPSX000
0071	1		Coms Card, RS232/RS485	XCRS	Red Lion	XCRS0000
0072	1		Compact Flash Card, 2Gig	G3CF	SANDISK	G3CFxxxx
0074	1	SP4	Surge Protection Module, RS232/RS485, Imax:20kA, Vmax: 8VDC, 1Pair Shield		CITEL	DLA-06D3
0075	1	SP5	Surge Protection Module, RS232/RS485, Imax:20kA, Vmax: 8VDC, 1Pair Shield		CITEL	DLA-06D3
0080	1	REC1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount		WEIDMULLER	991548
0081	1	REC2	Receptacle, Simplex 15A, 120vac, DIN Rail Mount		WEIDMULLER	991548
0090	1		Fuse, 5x20mm, 100mA, Fast Acting		BUSSMANN	AGC-100mA
0091	1		Fuse, 5x20mm, 100mA, Fast Acting		BUSSMANN	AGC-100mA
9101	4		Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG		PHOENIX	UK 6,3-HESILA 250
9102	11		Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG		PHOENIX	UK 6,3-HESILED 24
9110	12		Terminal Block, Gray, 600V/30A, 30-10AWG		PHOENIX	UK 5 N
9111	4		Terminal Block, Green, 600V/30A, 30-10AWG		PHOENIX	UK 5 N GN
9113	62		Terminal Block, Orange, 600V/30A, 30-10AWG		PHOENIX	UK 5 N OG
9114	5		Ground Terminal, 26-10AWG		PHOENIX	UKLKG 5
9115	13		End Cover Plate, Gray		PHOENIX	D-UK 4/10
9117	38		End Clamp, Gray		PHOENIX	E/UK
9121	1	GND2 (PG)	Grounding Lug, 2 Conductor, 1/0-14AWG		BURNDY	K2A25U
9132	1		Cross Connector/ Jumper, 2 Position, Al		PHOENIX	FBI 2-6
9144	2		Cross Connector/ Jumper, 10 Position cut to 4, Al		PHOENIX	FBI 10-6
9147	2		Cross Connector/ Jumper, 10 Position cut to 7, Al		PHOENIX	FBI 10-6
9148	2		Cross Connector/ Jumper, 10 Position cut to 8, Al		PHOENIX	FBI 10-6

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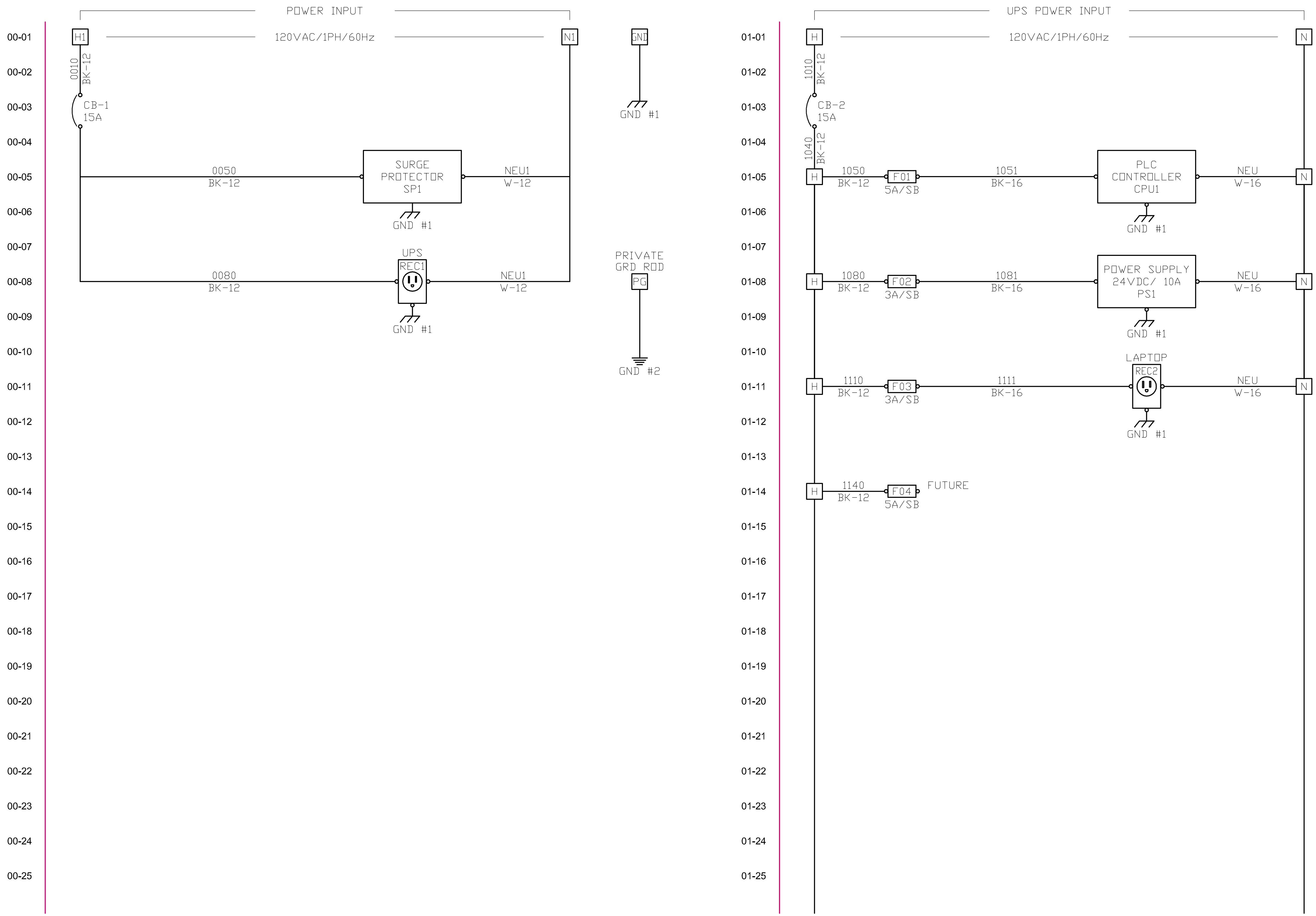
SC-005



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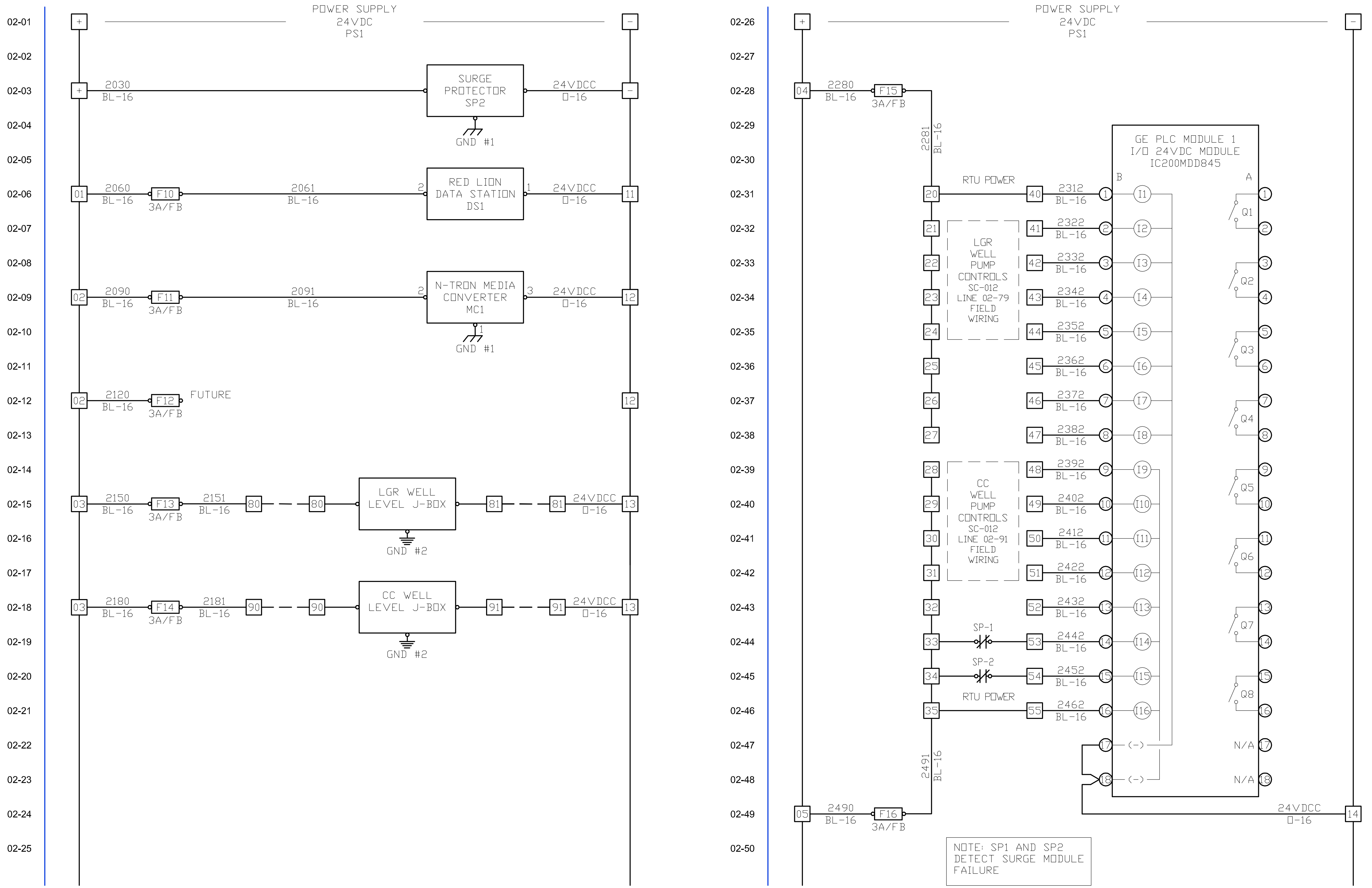

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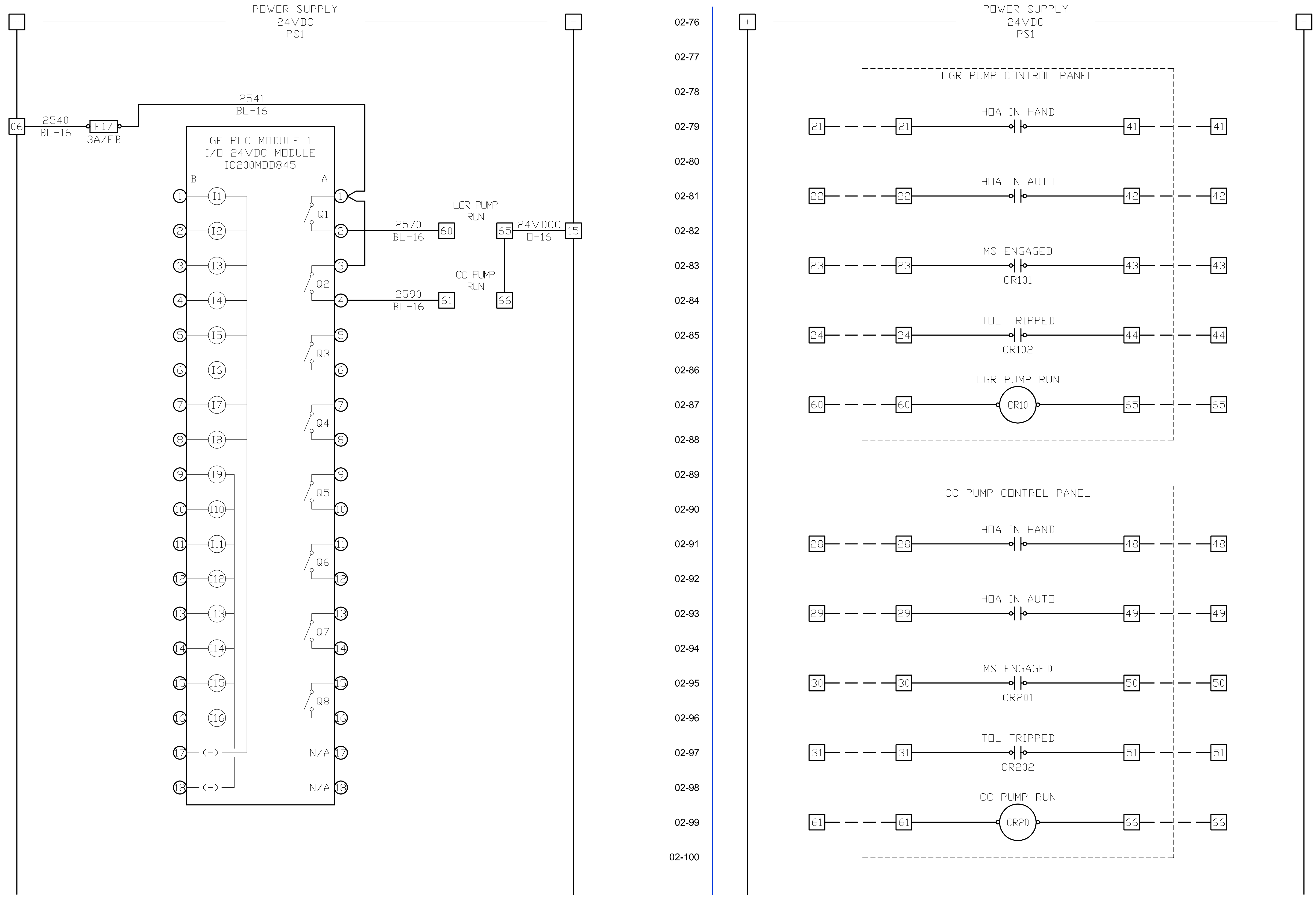

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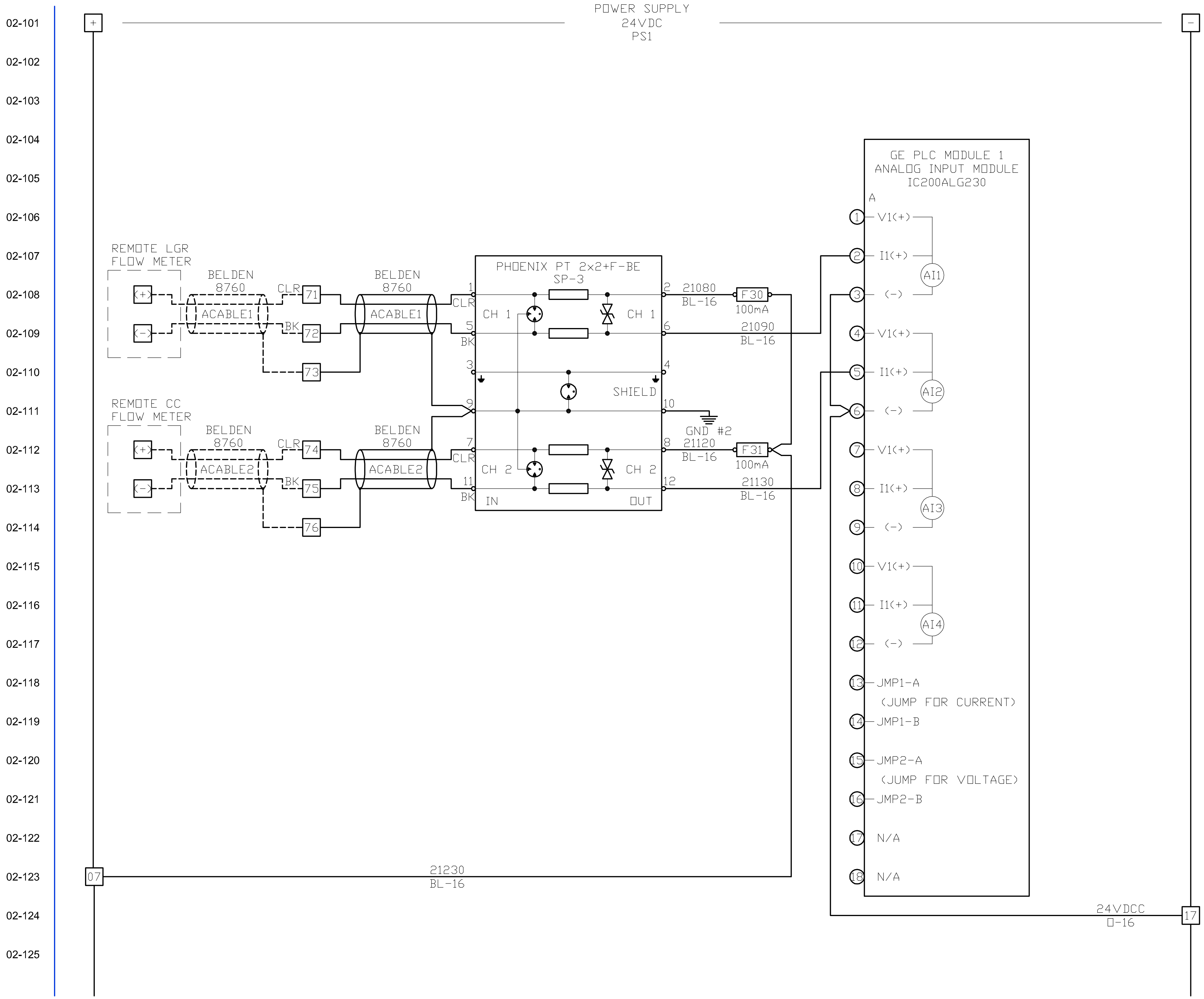

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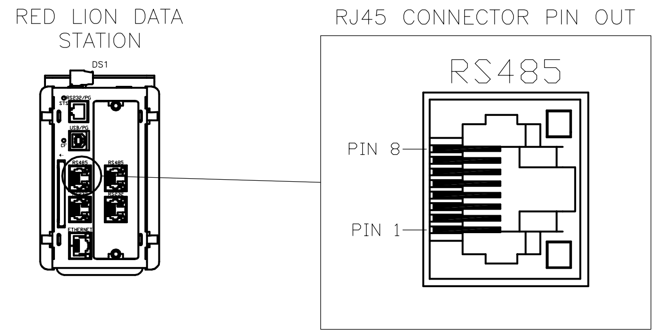
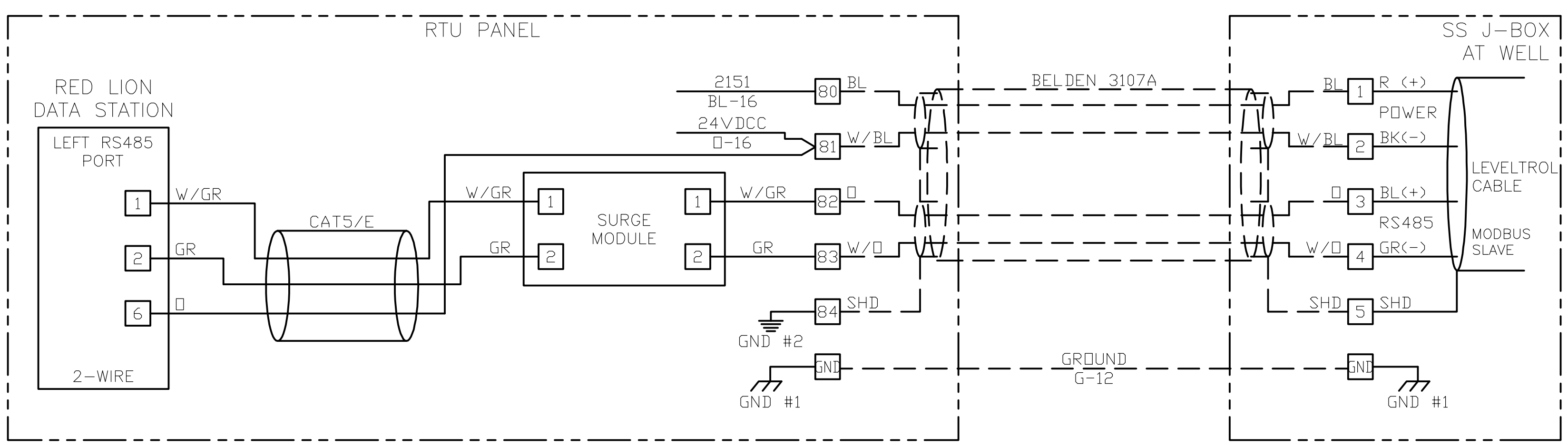
SC-013

LGR WELL



STANDARD ETHERNET WIRE COLOR CABLE USING RJ-45 PIN OUT DETIAL				
RJ-45 PIN	WIRE COLOR	RED LION SIGNAL PIN OUT	RED LION RS485 2-WIRE	RJ45 PIN
1	WHITE-GREEN STRIPE	TxB	YES	1
2	GREEN	TxA	YES	2
3	WHITE-ORANG E STIPE	RxA		3
4	BLUE	RxB		4
5	WHITE-BLUE STRIPE	TxEN		5
6	ORANGE	COM	YES	6
7	WHITE-BROWN STRIPE	TxB		7
8	BROWN	TxA		8



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CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

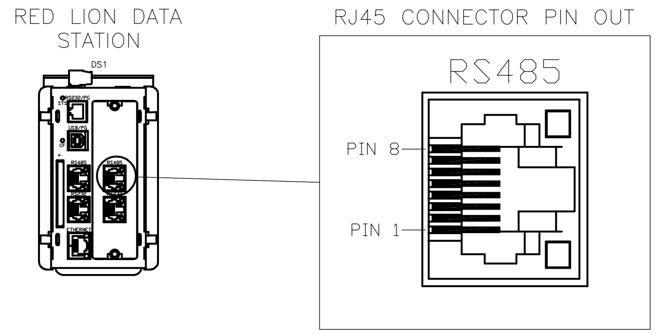
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
DRAWN : RMF
REVISIONS:

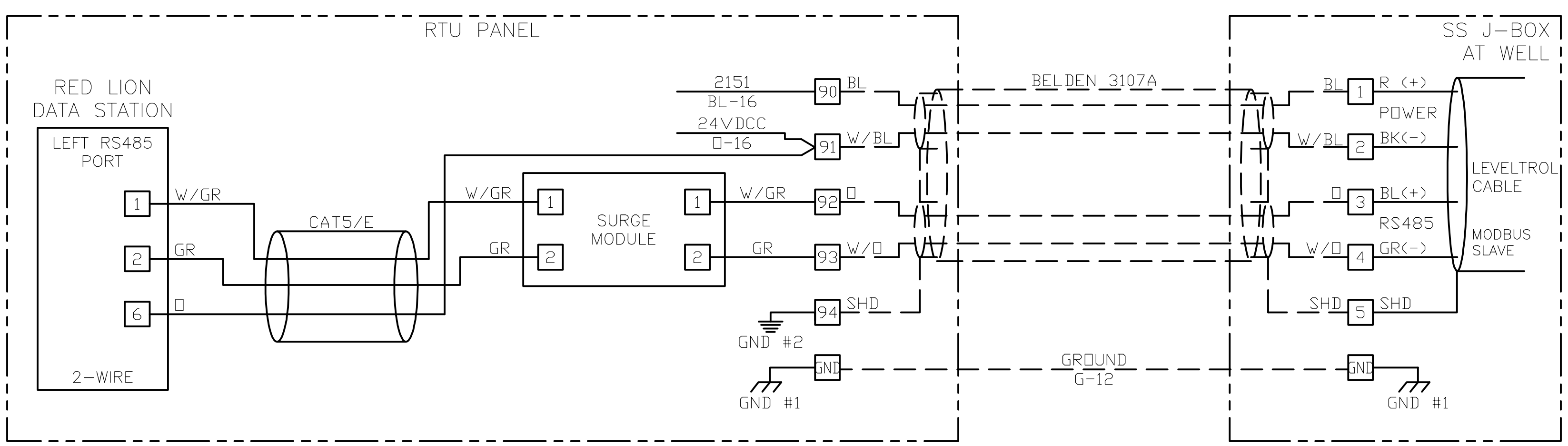
RTU903-2

SHEET NO.
SC-014

CC WELL



STANDARD ETHERNET WIRE COLOR CABLE USING RJ-45 PIN OUT DETIAL				
RJ-45 PIN	WIRE COLOR	RED LION SIGNAL PIN OUT	RED LION RS485 2-WIRE	RJ45 PIN
1	WHITE-GREEN STRIPE	TxB	YES	1
2	GREEN	TxA	YES	2
3	WHITE-ORANG E STIPE	RxA		3
4	BLUE	RxB		4
5	WHITE-BLUE STRIPE	TxEN		5
6	ORANGE	COM	YES	6
7	WHITE-BROWN STRIPE	TxB		7
8	BROWN	TxA		8



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND	
COLOR	SIZE
GR-16	

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
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PARSONS
8000 CENTRE PARK, SUITE 200
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PROJECT NO. 2012.01
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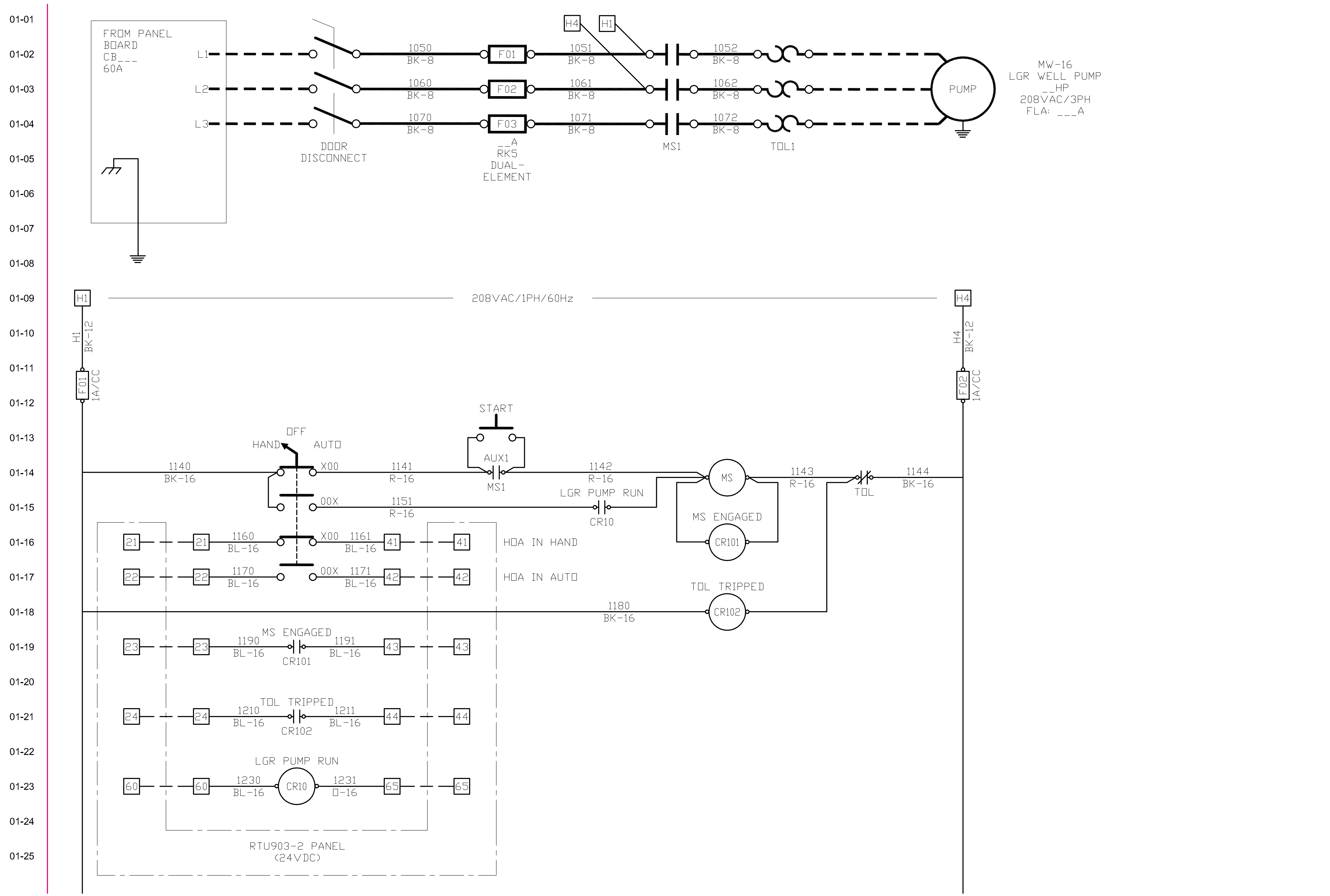
RTU903-2

SHEET NO.
SC-015



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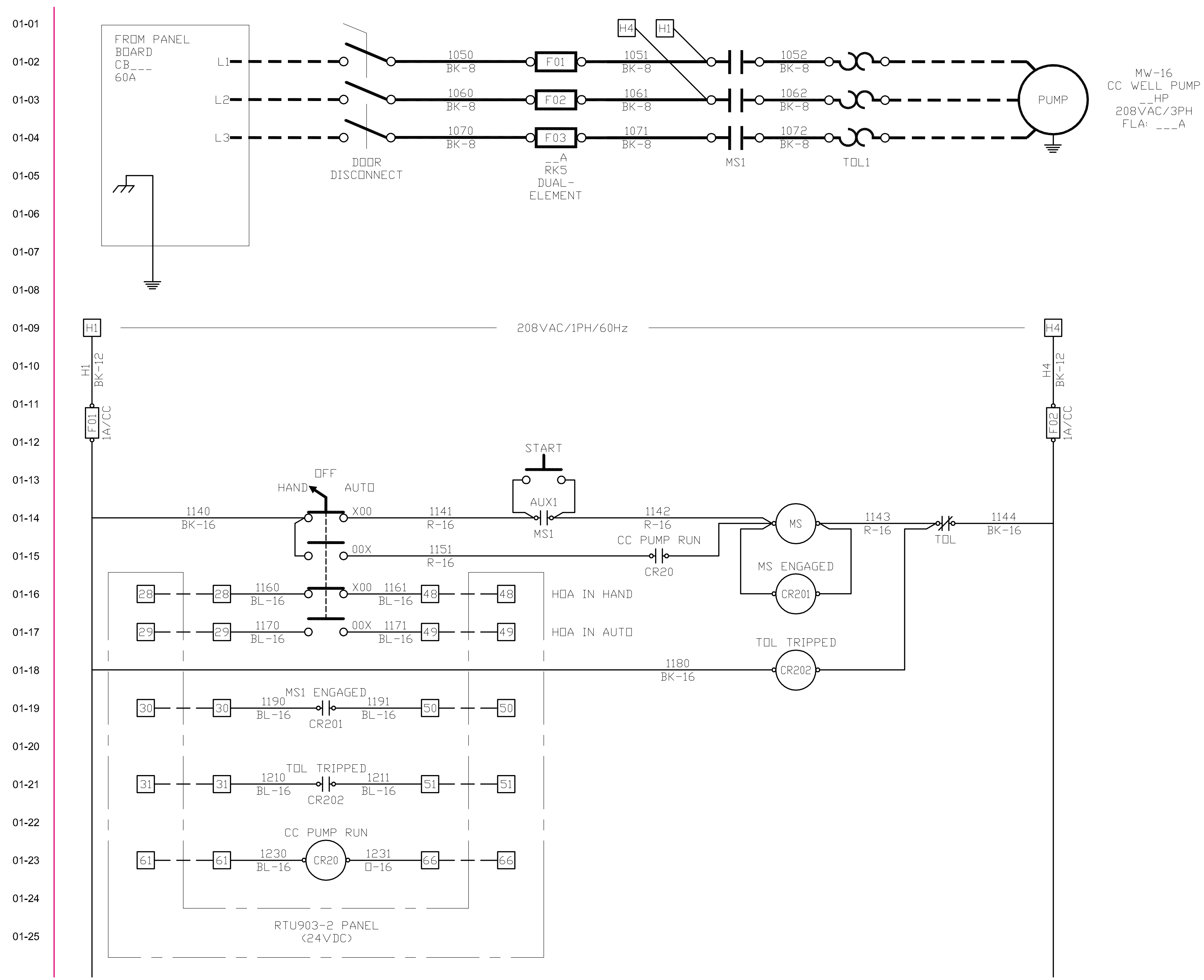
SHEET NO.

SC-020



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RTU903-2

SHEET NO.

SC-021

RTU 903-3
B3-EXW01 CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

EXTRACTION WELL 1

RTU903-3 SCADA CONTROL PANEL

WELL PUMP MOTOR CONTROL PANEL

PRELIMINARY - NOT FOR CONSTRUCTION

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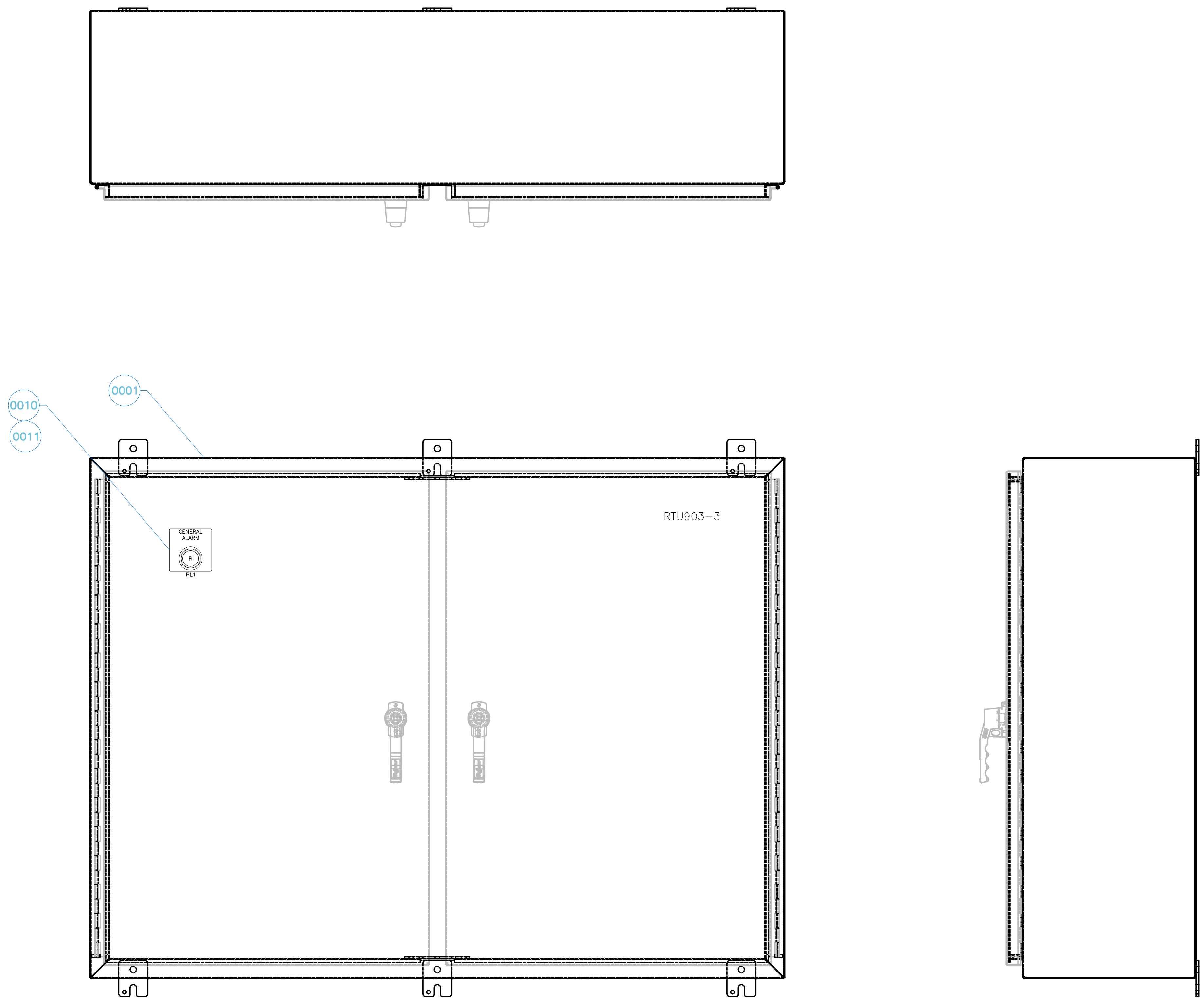
REVISIONS:

RTU903-3

SHEET NO.
TITLE



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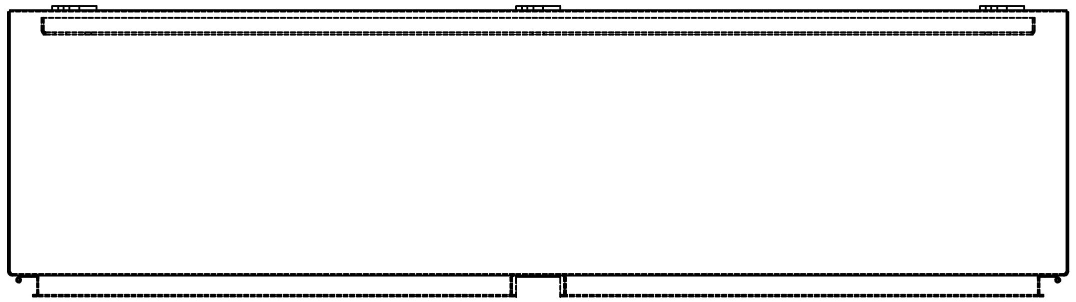
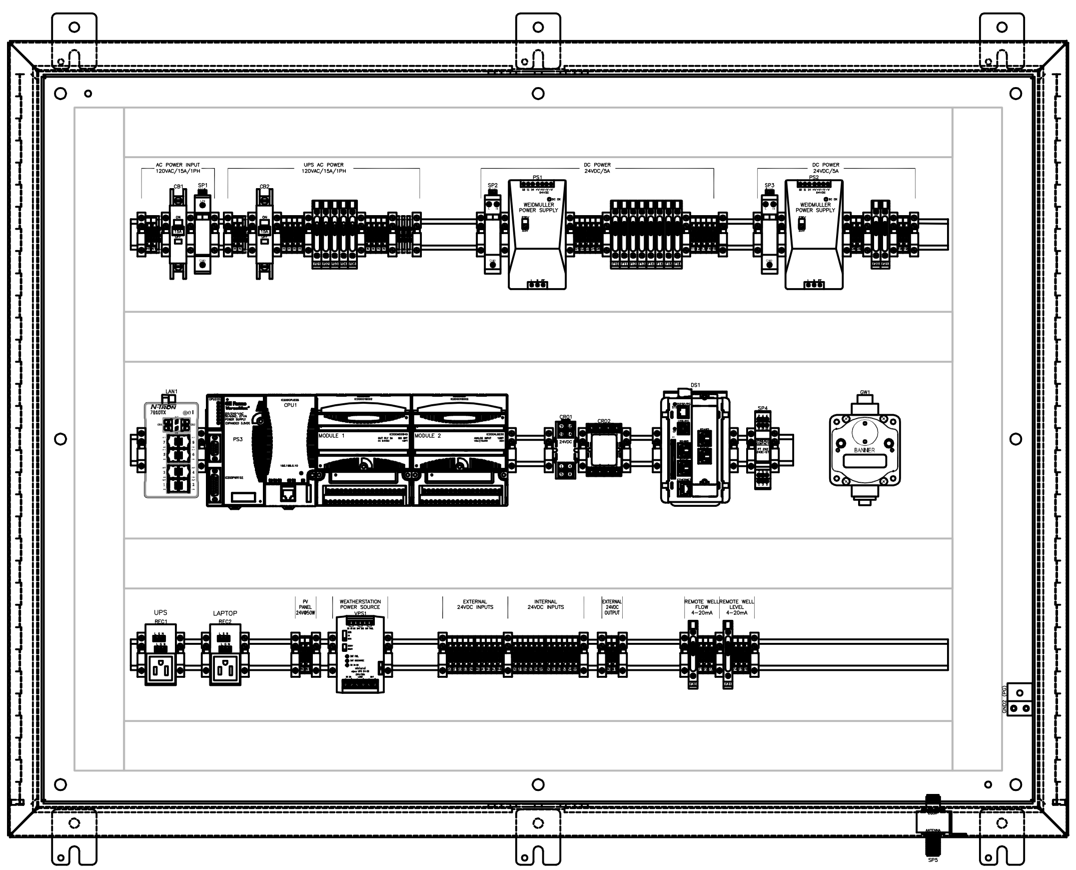
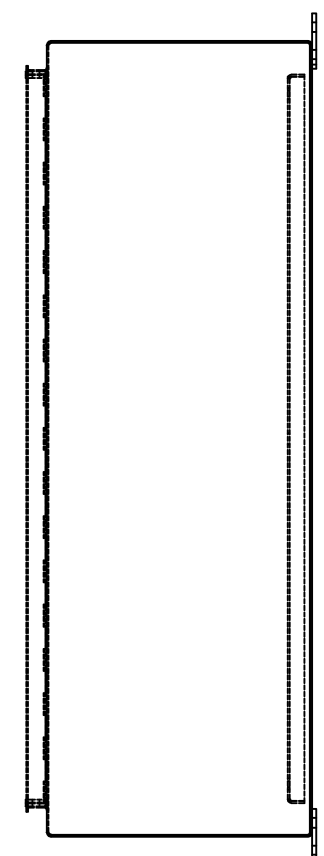
SHEET NO.

SC-001







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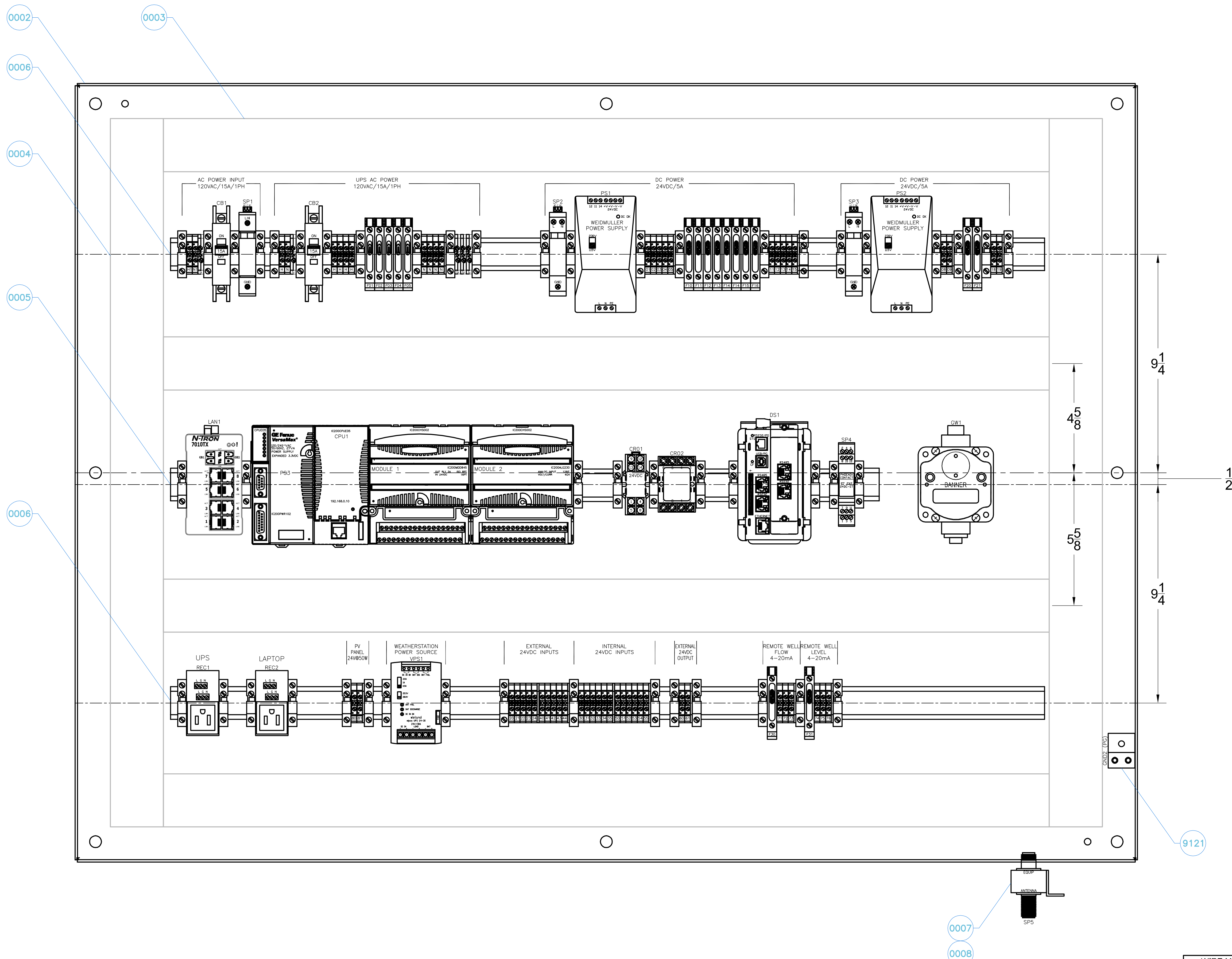
SHEET NO.

SC-002



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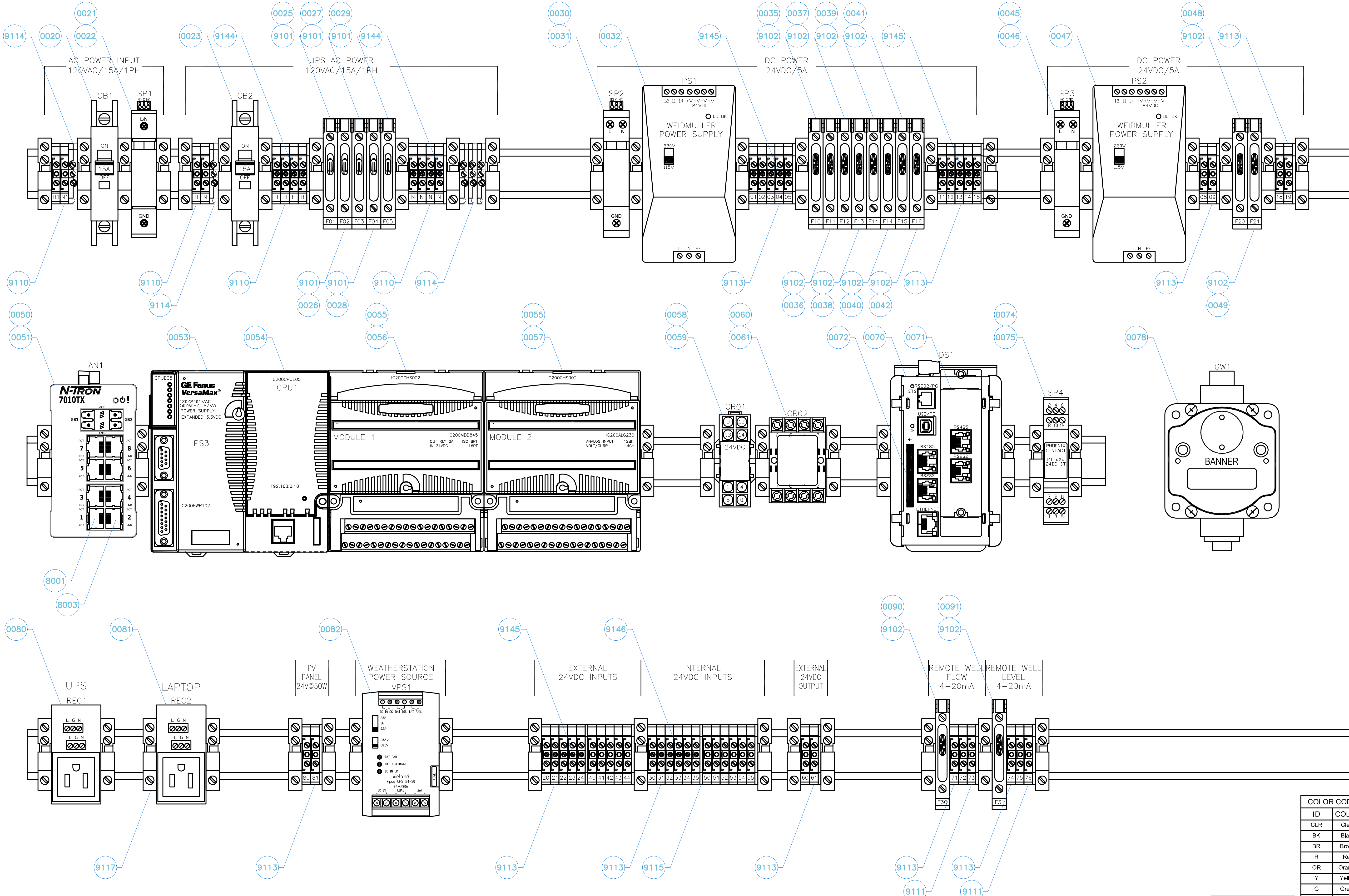
REVISIONS:

RTU903-3

SHEET NO.

SC-003



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REVISIONS:

RTU903-3

SHEET NO.

SC-004

BILL-OF-MATERIAL

ITEM_ID	Count	DEVICE_ID	DESCRIPTION	MFG_NAME	MFG_PN
0001	1	RTU903-3	ENCLOSURE, 48" Wide x 36" High x 12" Deep, Nema 4X Stainless Steel, w/ Handles	HOFFMAN	A36H4812WFSSLP3PT
0002	1		Back Panel, White, 45" Wide x 33" High	HOFFMAN	A48P36
0003	4		Wiring Duct, Narrow Slot Type F, White, PVC, UL, Length 37.5"	PANDUIT	F2X3LG6
0004	2		Wiring Duct, Narrow Slot Type F, White, PVC, UL, Length 30"	PANDUIT	F2X3LG6
0005	1		DIN Rail, Steel, Perforated, 35mm x 2M cut to length of 30"	IBOCO	Omega 3F
0006	2		DIN Rail, Steel, Perforated, 35mm x 2M cut to length of 37"	IBOCO	Omega 3F
0007	1	SP5	Broadband DC Blocked Protector, 125-1000MHz, 50 ohm, 50-375W, VSWR: 1.1:1, Surge 50kA, N-Female x N-Female	POLYPHASER	IS-B50LN-C2
0008	1		Cable, 900MHz Coax, N-male to N-male, 24" Long	TESSCO	100-07-07-P24"
0010	1		Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC	AB	800T-QBH24R
0011	1	PL1	Standard Legend Plate, Al, 30.5mm Pilot Lamp, Red, (Custom Text "GENERAL ALARM")	AB	800T-X621E
0020	1	CB1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0021	1	SP1	Surge Protection Module, 120VAC, Imax:40kA, Vmax: 150V	CITEL	DS41-120
0022	1		Holder, Surge Protection	CITEL	DS41-120
0023	1	CB2	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0025	1		Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0026	1		Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0027	1		Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0028	1		Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0029	1		Fuse, 5x20mm, 2A, Slow Acting	BUSSMANN	MDL-2
0030	1	SP2	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0031	1		Holder, Surge Protection	CITEL	DS220-24DC
0032	1	PS1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A	WEIDMULLER	CP SNT 120W 24V 5A
0035	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0036	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0037	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0038	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0039	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0040	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0041	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0042	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0045	1	SP3	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0046	1		Holder, Surge Protection	CITEL	DS220-24DC
0047	1	PS2	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A	WEIDMULLER	CP SNT 120W 24V 5A
0048	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0049	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0050	1	LAN1	Managed Media Converter, 10-49VDC, 410mA @ 24VDC, (8) 10/100BaseTX, Optional Fiber Ports (SM or MM)	N-TRON	7010TX
0051	2		Transceiver, 10km, 1000BaseLX SingeMode Fiber SFP Pluggable Mini-GBIC (LC Style Connector)	N-TRON	NTSFP-LX-10
0053	1	PS3	PLC Power Supply, 120/240VAC, 27VA, 50/60Hz, Expanded 3.3VDC	GE FANUC	IC200PWR102E
0054	1	CPU1	PLC CPU MODULE	GE FANUC	IC200CPUE05
0055	2		Box I/O Style Carrier, AWG 22-14, 2A/ Point, 8A/ Power or GND, 264VAC M	GE FANUC	IC200CHS002
0056	1	MODULE 1	Mixed Module, 16-Input, 8-Output, 24VDC Input, Relay Output	GE FANUC	IC200MDD845
0057	1	MODULE 2	Analog Input Module, 4CH, 12Bit, Voltage/ Current	GE FANUC	IC200ALG230
0058	1		Relay, 2PDT, Coil: 24VDC/ 36.9mA, 1/6HP, w/Indicator & Check Button	IDEC	RH2B-ULC-DC24V
0059	1	CR01	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0060	1	CR02	RELAY, 2PDT, 120VAC@2.5VA, 50/60Hz, 7.5A Inductive, 1100VA AC	IDEC	RR2P-UL-AC120V
0061	1		RELAY SOCKET, 2PDT, PIN TYPE	IDEC	SR2P-06
0070	1	DS1	Protocol Converter, 200mA min @ 24VDC, 1A Max w/Expansion Card, optional Compactflash Card	Red Lion	DSPSX000
0071	1		Coms Card, RS232/RS485	Red Lion	XCRS0000
0072	1		Compact Flash Card, 2Gig	SANDISK	G3CFxxxx
0074	1	SP4	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0075	1		Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0078	1	GW1	WIRELESS GATEWAY, 900MHz, Frequency Hopping, 24VDC	BANNER	DX80
0080	1	REC1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0081	1	REC2	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0082	1	VPS1	UPS Module, Input 22.5-28VDC, Output Voltage 24VDC, Max Ouput Current 30A, UL508 Listed	WIELAND	81.000.6220.0
0090	1		Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	AGC-100mA
0091	1		Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	AGC-100mA
8001	1		CAT5E Network Cable, Orange, 12" Long	ALTEX	73-6680-1
8003	1		CAT5E Network Cable, Orange, 36" Long	ALTEX	73-6680-3
9101	5		Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILA 250
9102	12		Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILED 24
9110	12		Terminal Block, Gray, 600V/30A, 30-10AWG	PHOENIX	UK 5 N
9111	2		Terminal Block, Green, 600V/30A, 30-10AWG	PHOENIX	UK 5 N GN
9113	44		Terminal Block, Orange, 600V/30A, 30-10AWG	PHOENIX	UK 5 N OG
9114	5		Ground Terminal, 26-10AWG	PHOENIX	UKLKG 5
9115	14		End Cover Plate, Gray	PHOENIX	D-UK 4/10
9117	49		End Clamp, Gray	PHOENIX	E/UK
9121	1	GND2 (PG)	Grounding Lug, 2 Conductor, 1/0-14AWG	BURNDY	K2A25U
9144	2		Cross Connector/ Jumper, 10 Position cut to 4, Al	PHOENIX	FBI 10-6
9145	3		Cross Connector/ Jumper, 10 Position cut to 5, Al	PHOENIX	FBI 10-6
9146	1		Cross Connector/ Jumper, 10 Position cut to 6, Al	PHOENIX	FBI 10-6

SHEET NO.
SC-005
RTU903-3

REVISIONS:
DRAWN : RMF
DATE : 04.25.2012
PROJECT NO. 2012.01

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PARSONS
8000 Centre Park, Suite 200
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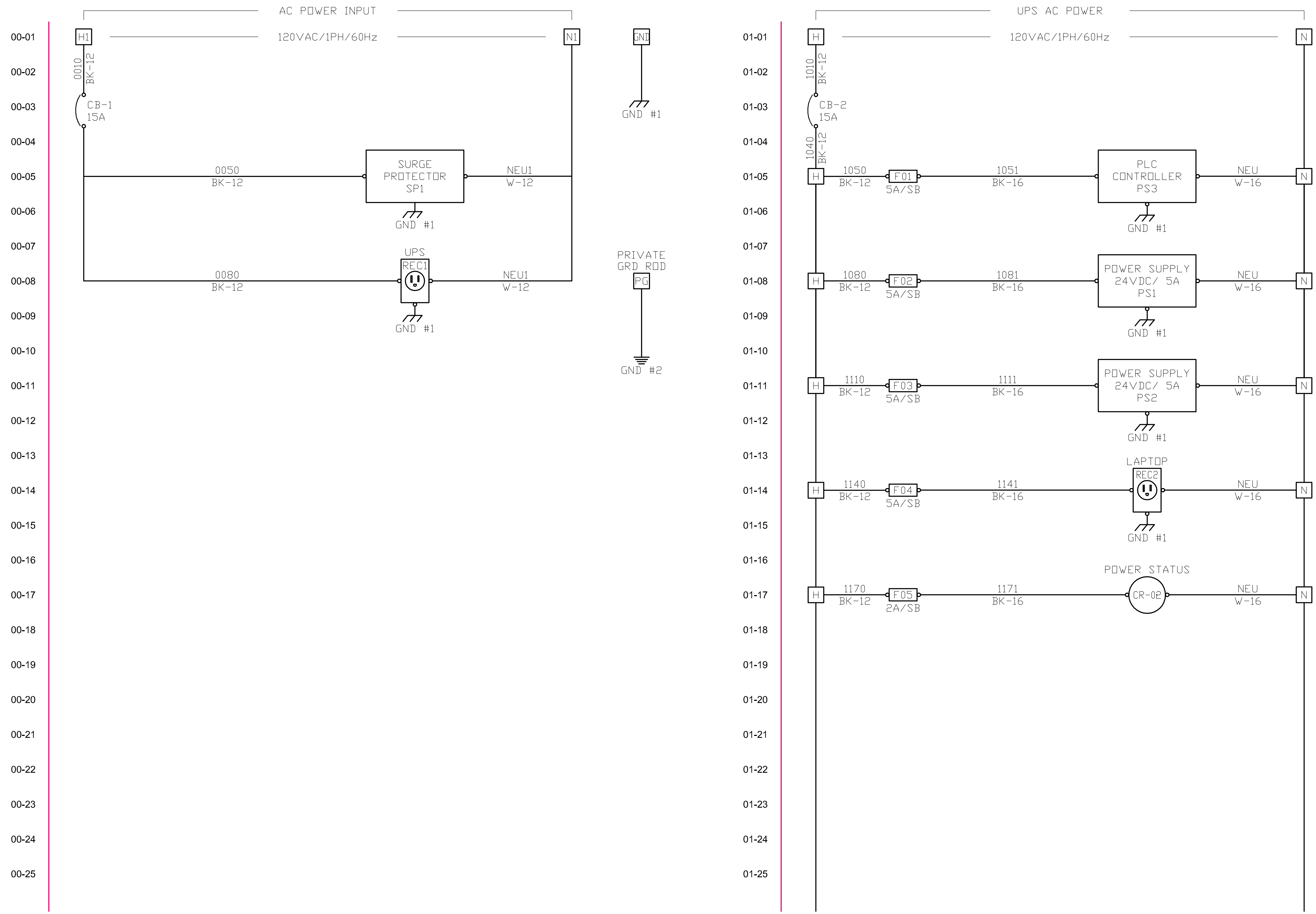

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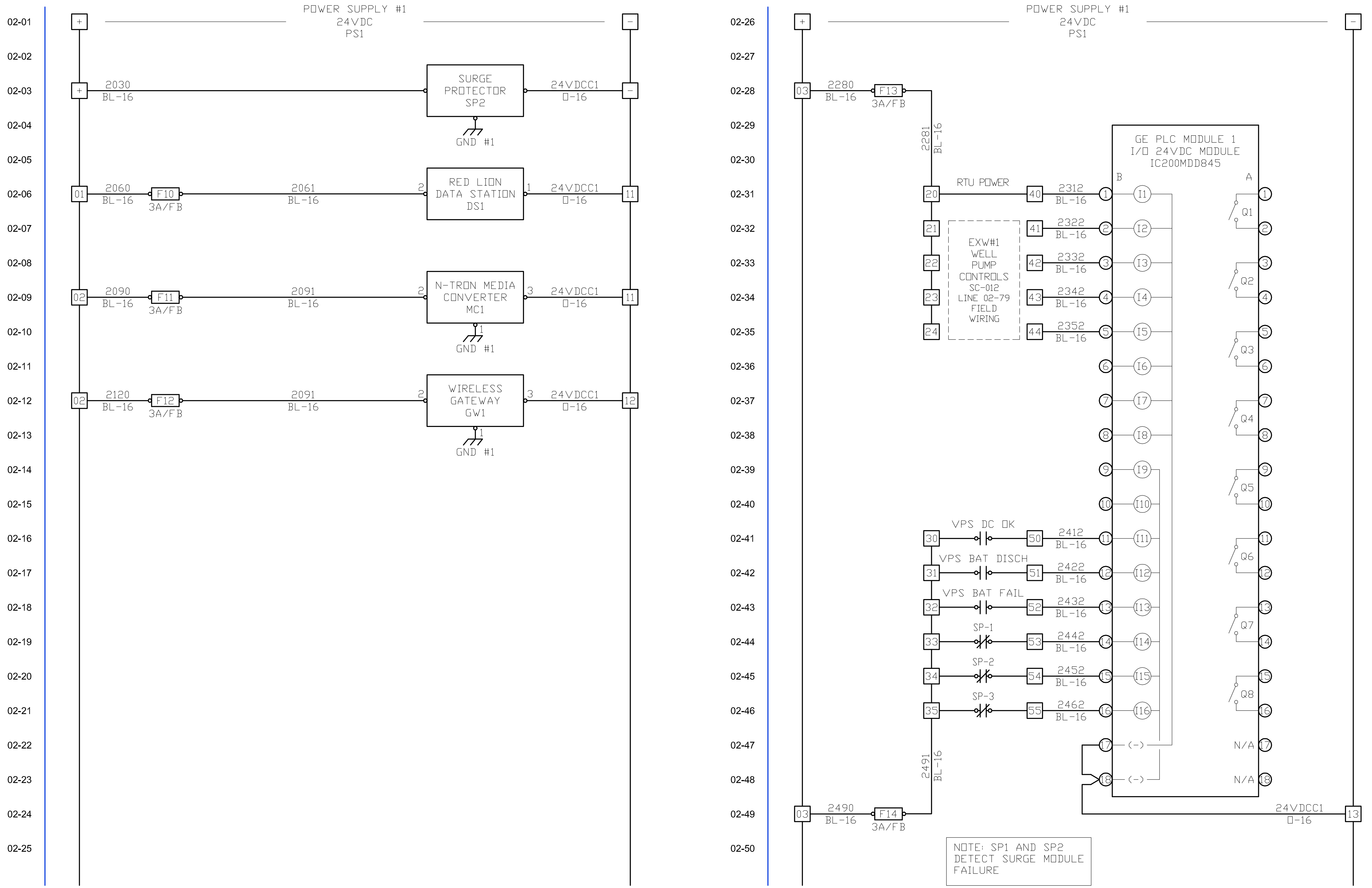
SHEET NO.

SC-010



NOTE: SP1 AND SP2 DETECT SURGE MODULE FAILURE

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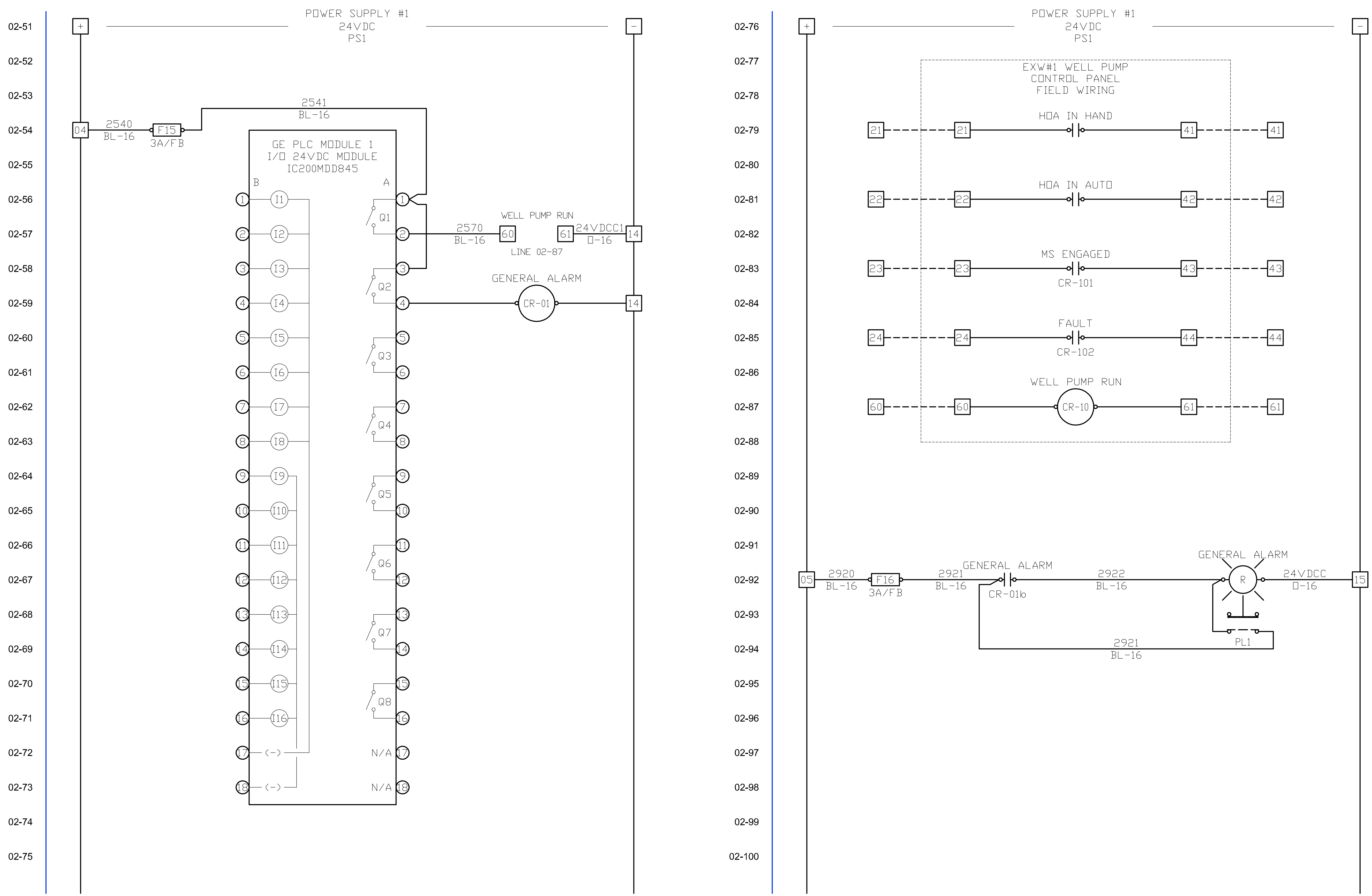
SC-011



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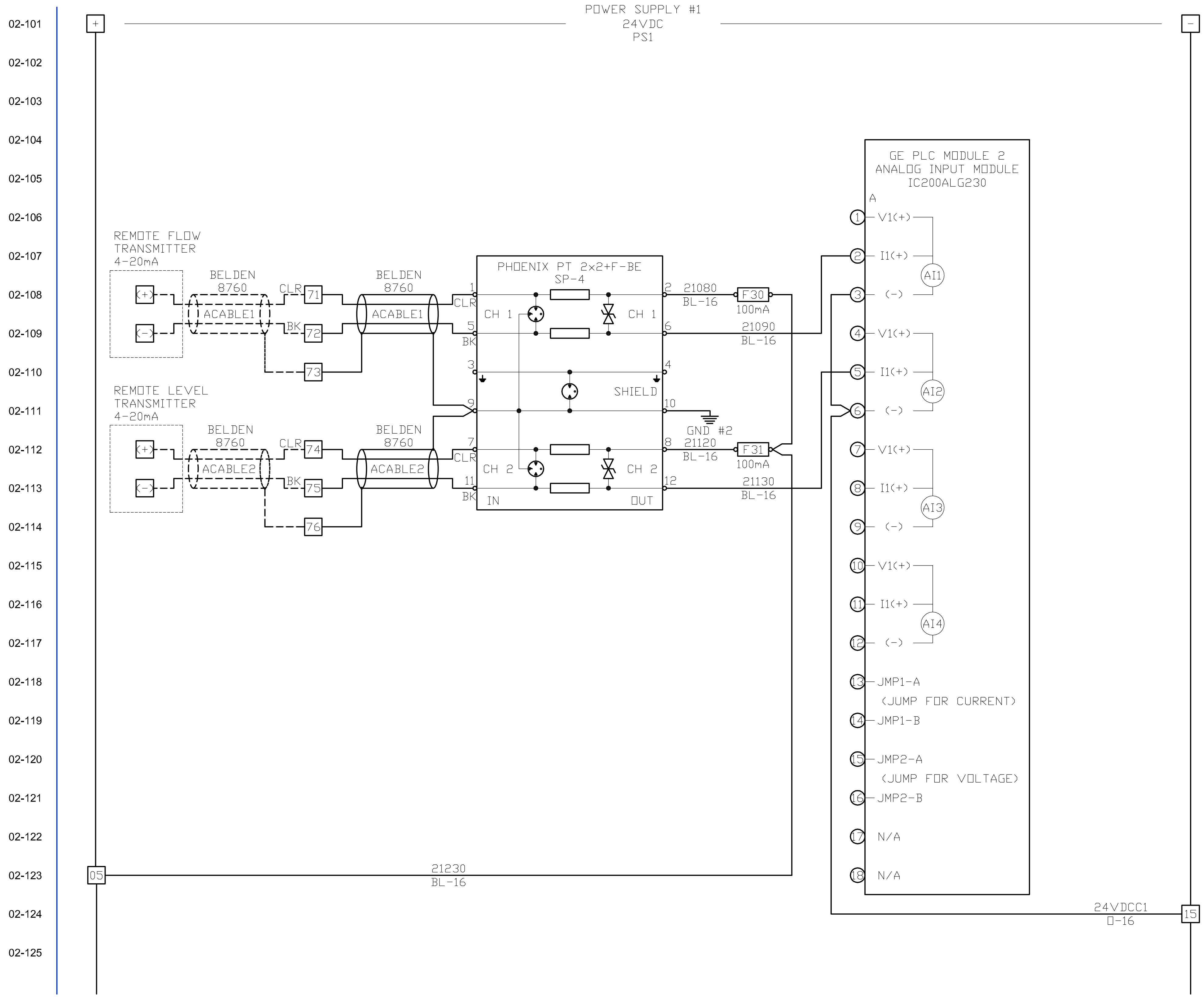

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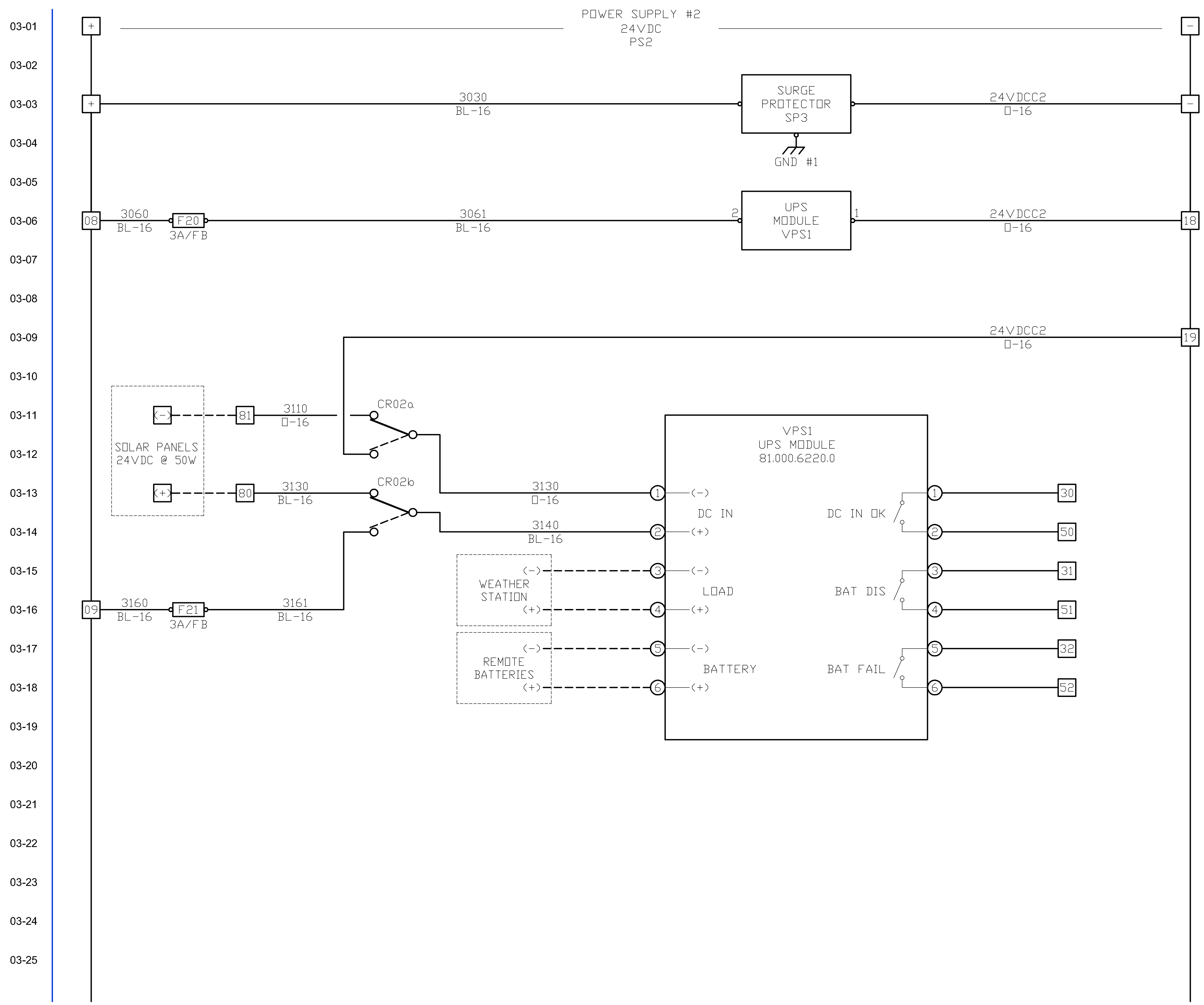
SC-013



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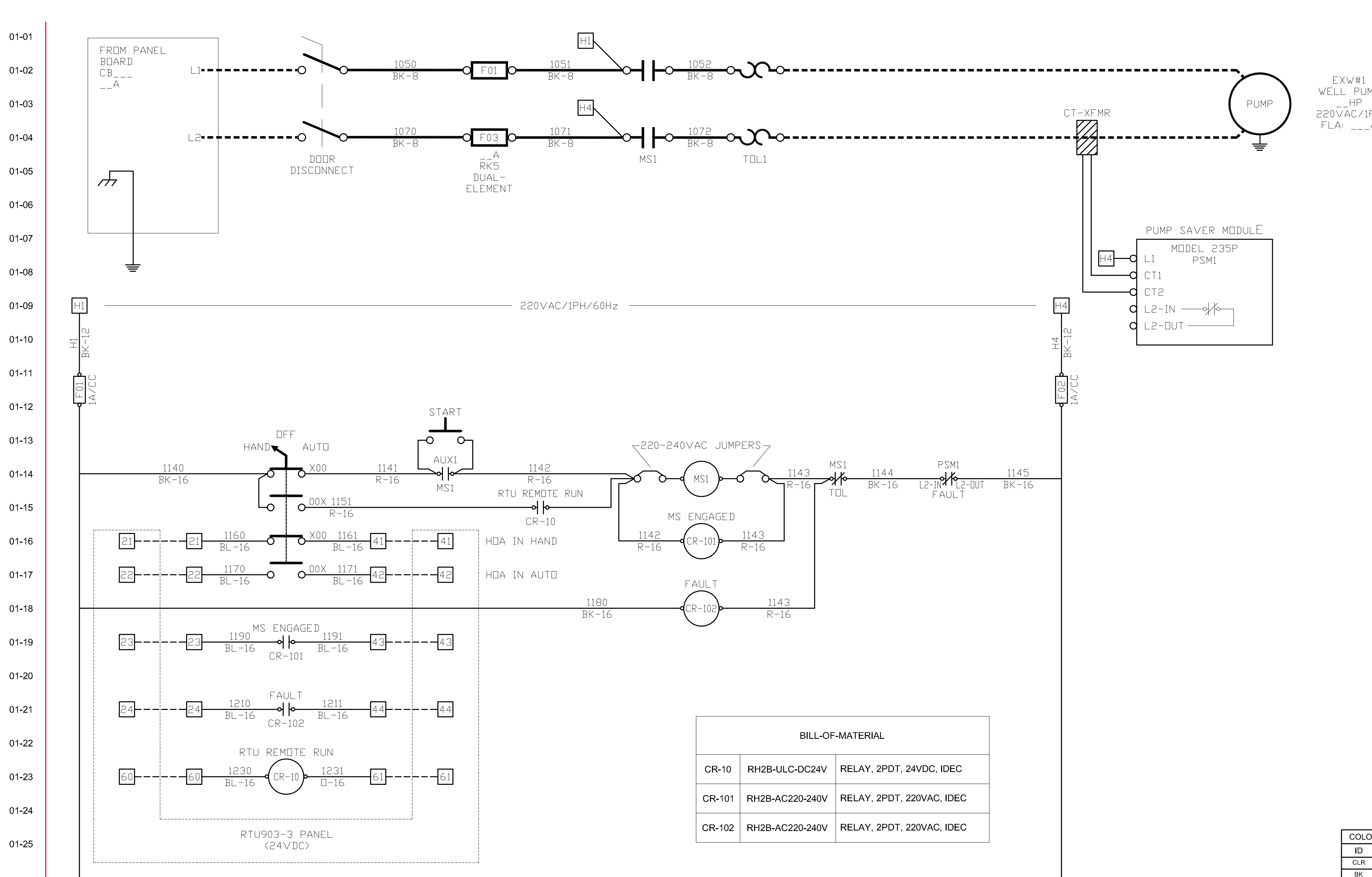

BILL-OF-MATERIAL		
CR-10	RH2B-ULC-DC24V	RELAY, 2PDT, 24VDC, IDEC
CR-101	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC
CR-102	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC

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SHEET NO.
SC-020

RTU 903-4
B3-EXW02 CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

EXTRACTION WELL 2

RTU903-4 SCADA CONTROL PANEL

WELL PUMP MOTOR CONTROL PANEL

PRELIMINARY - NOT FOR CONSTRUCTION

PARSONS
8000 Centre Park, Suite 200
Austin, Texas 78754

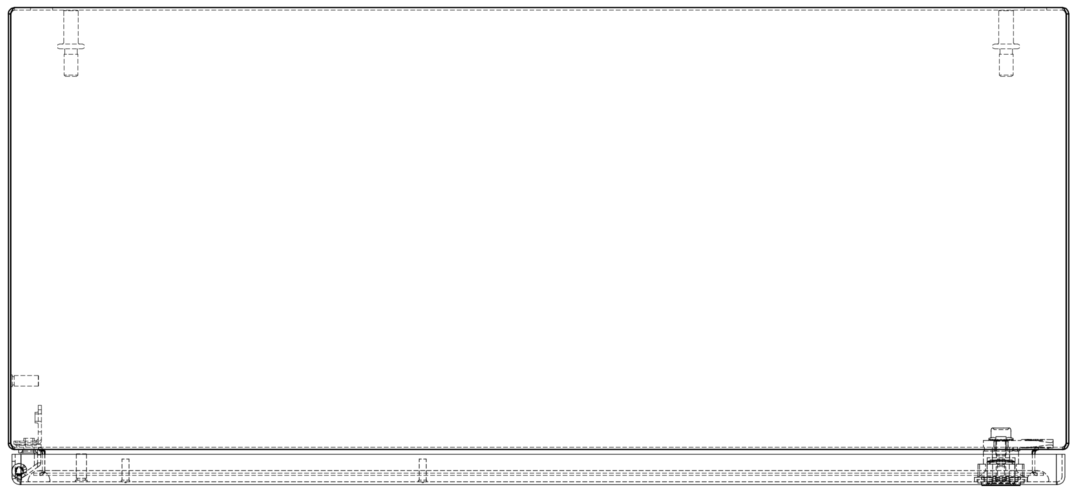
CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

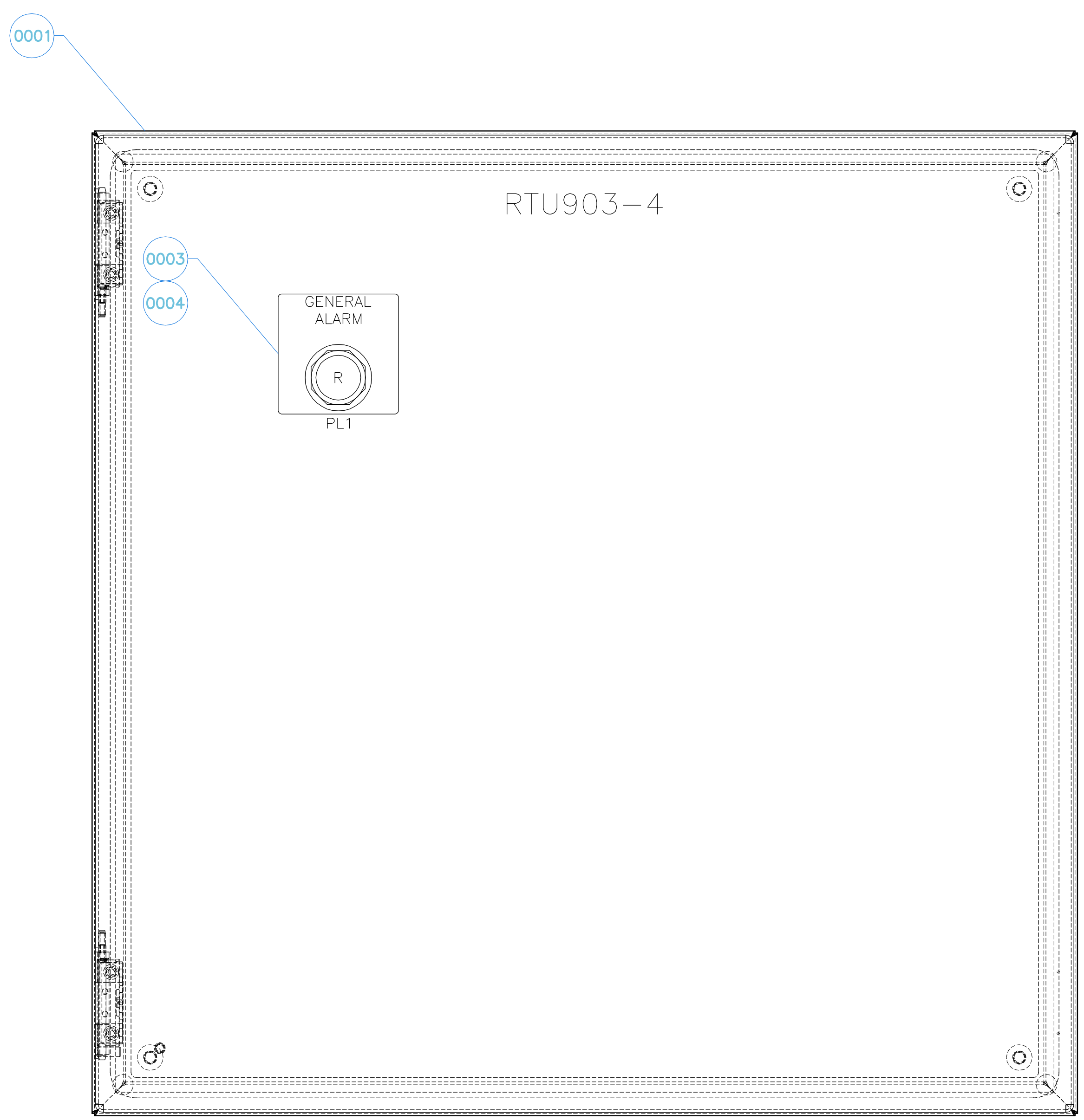
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

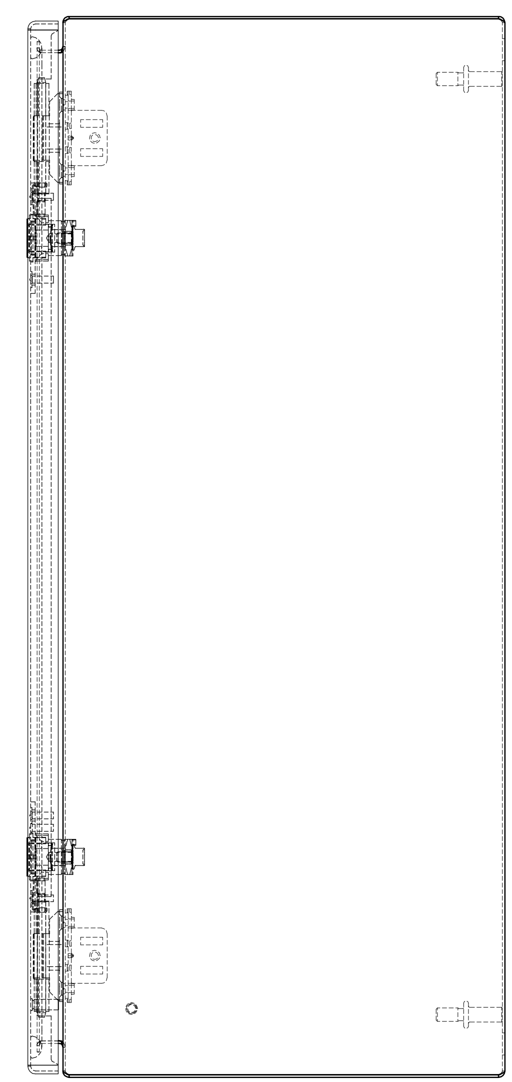
PROJECT NO. 2012.01
DATE : 04.25.2012
DRAWN : RMF
REVISIONS:

RTU903-4

SHEET NO.
TITLE







NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND
COLOR SIZE
GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
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PROJECT NO. 2012.01

DATE : 04.25.2012

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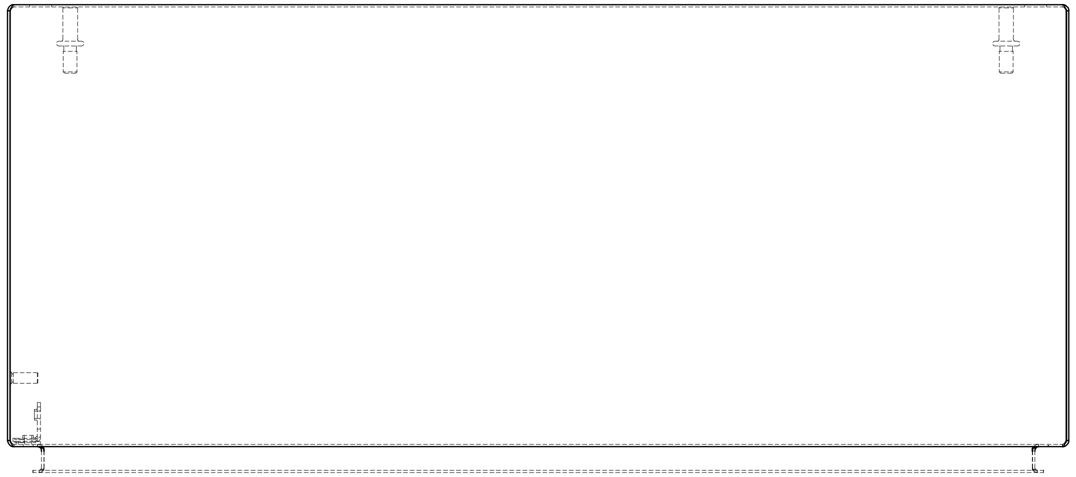
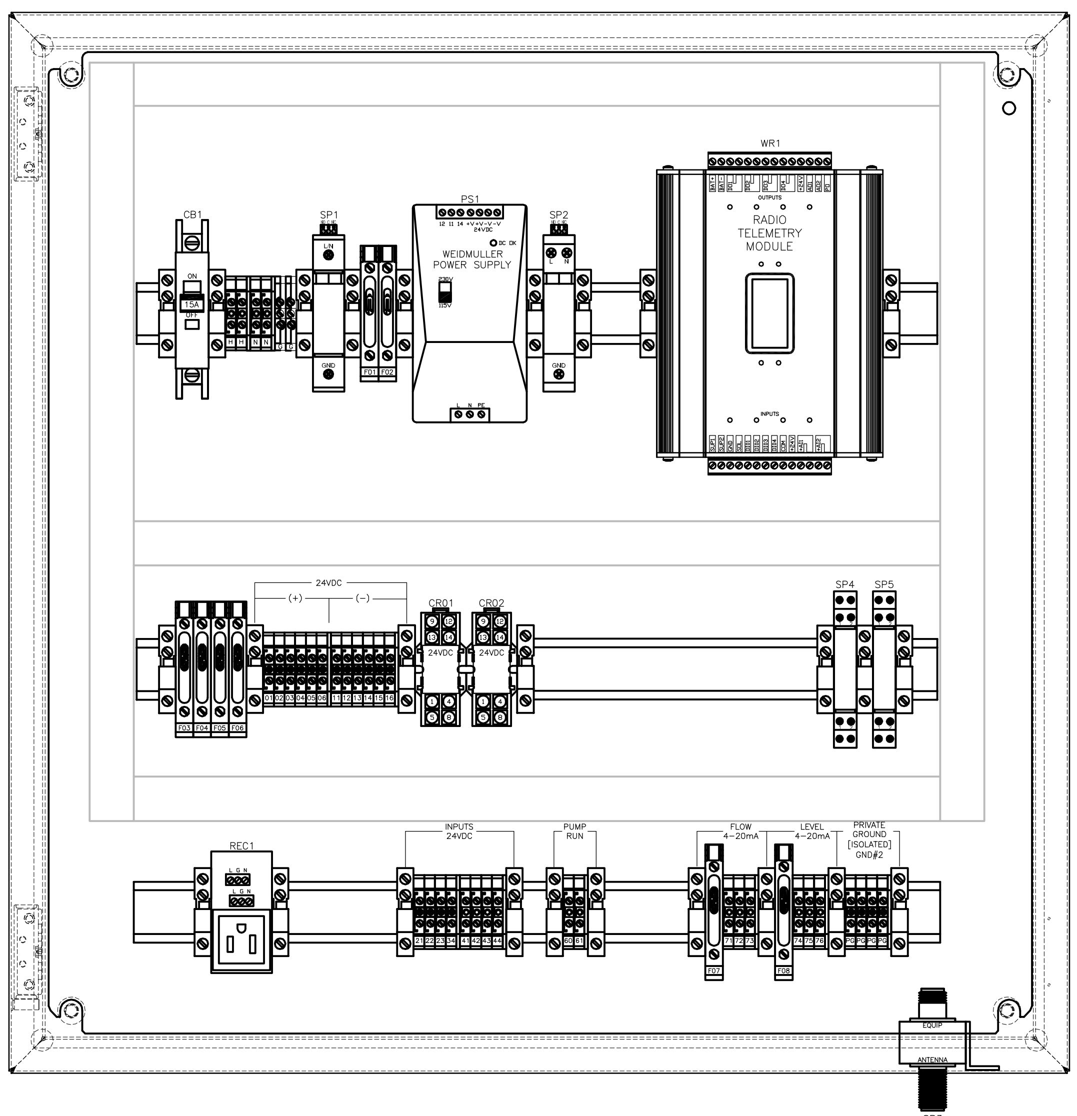
REVISIONS:

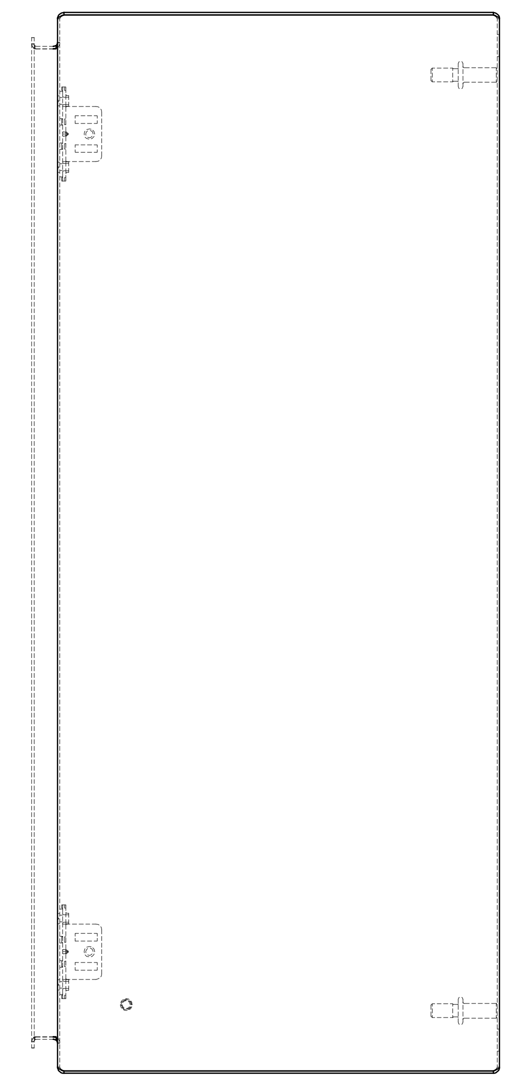
RTU903-4

SHEET NO.

SC-001







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WIRE MARKER LEGEND

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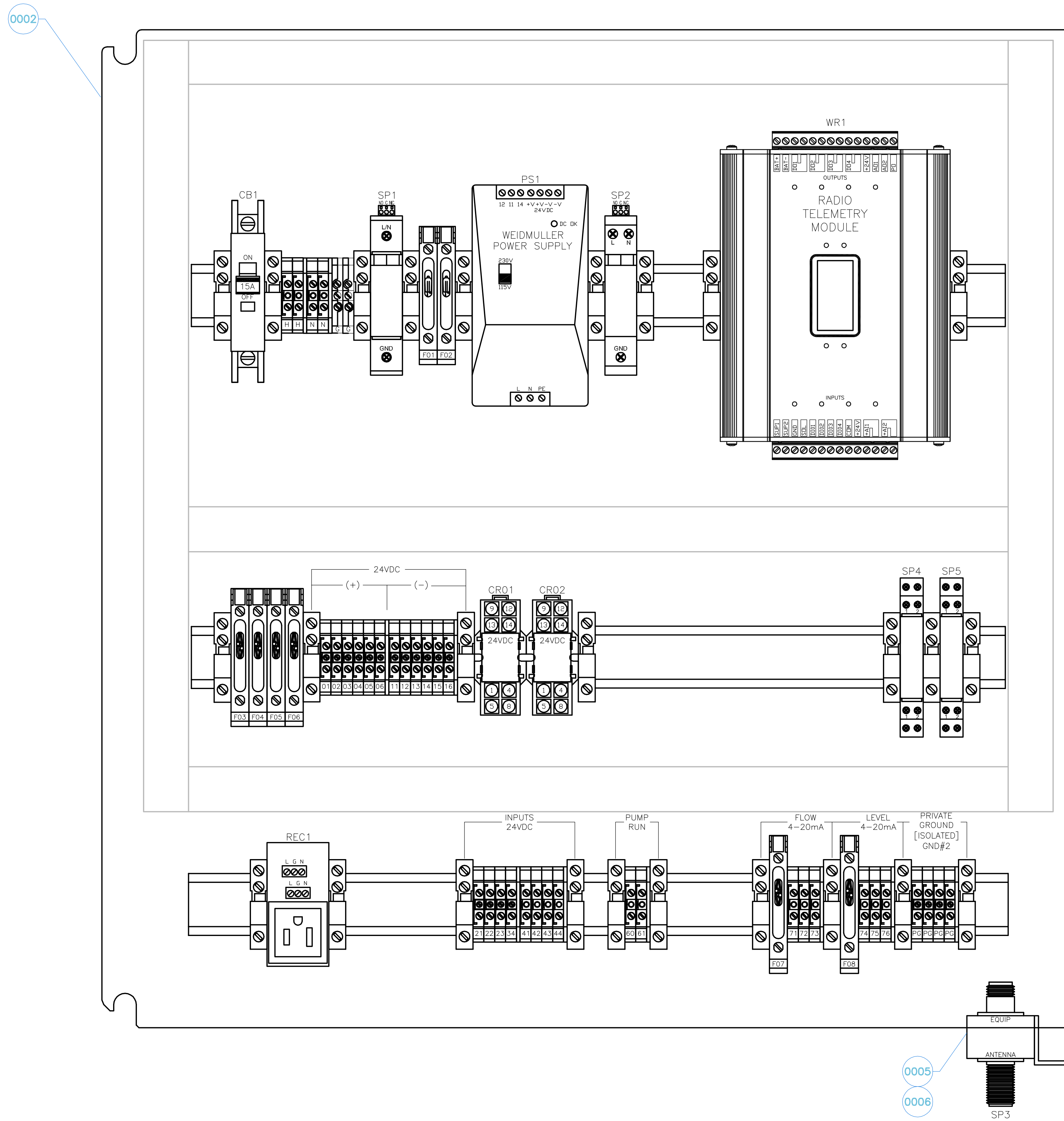
SHEET NO.

SC-002



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COLOR SIZE

GR-16

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REVISIONS:

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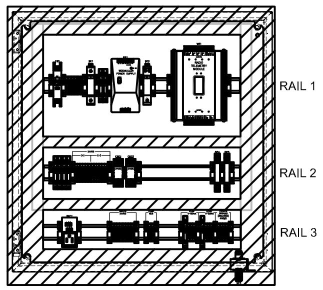
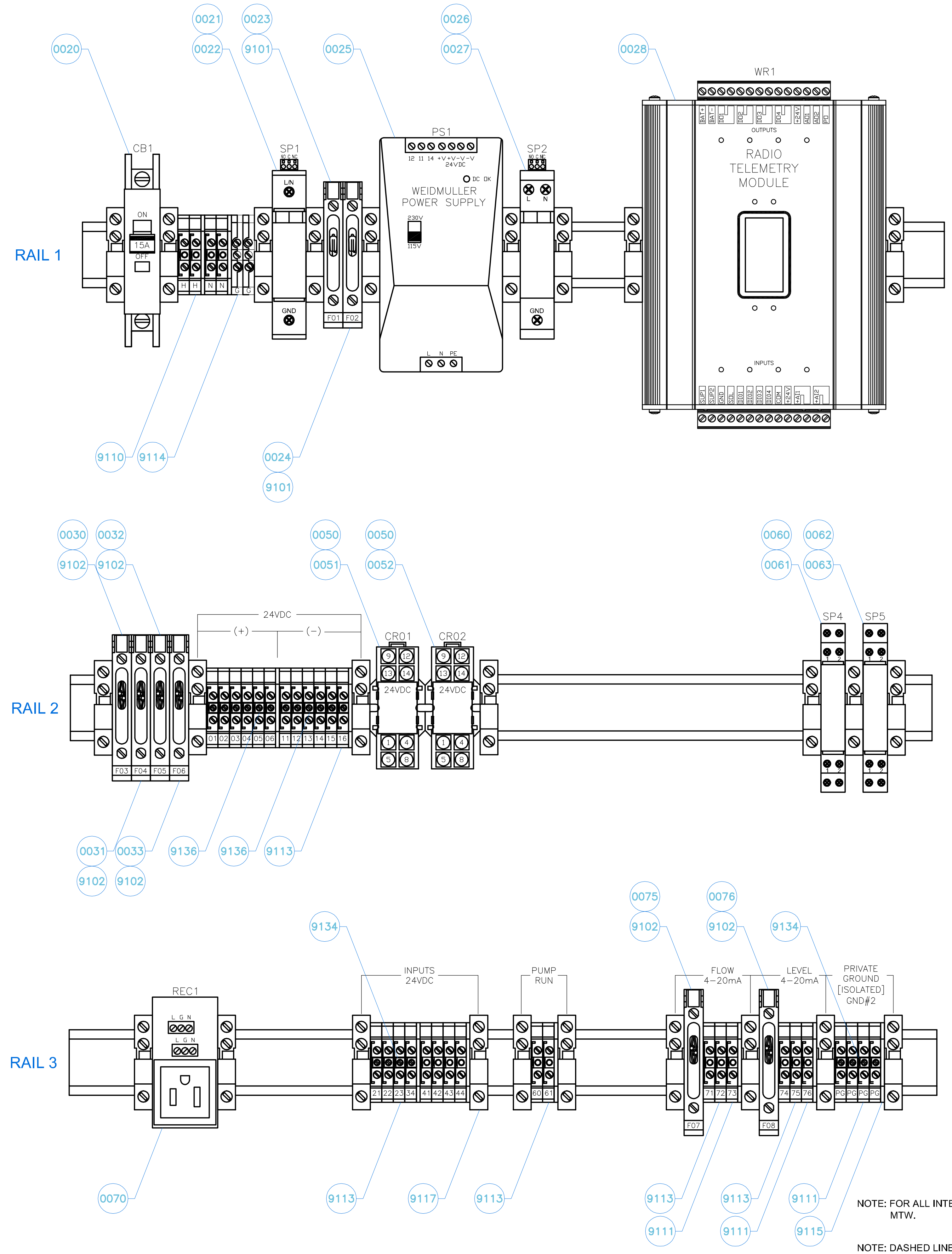
SHEET NO.

SC-003





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COLOR — SIZE

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REVISIONS:

RTU903-4

SHEET NO.

SC-004

BILL-OF-MATERIAL

ITEM_ID	DEVICE_ID	Count	DESCRIPTION	MFG_NAME	MFG_PN
0001	RTU903-4	1	ENCLOSURE, 24"Hx24"Wx10"D, Nema4X SS	HOFFMAN	CSD242410SS
0002		1	Back Panel, 22.2"x22.2", White Steel	HOFFMAN	CP2424
0003	PL1	1	Plastic Label, 30.5mm Pilot Lamp, Red w/White Lettering, 2.4"Wx2.4"H	CUSTOM	99999
0004		1	Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC	AB	800T-QBH24R
0005	SP3	1	Broadband DC Blocked Protector, 125-1000MHz, 50 ohm, 50-375W, VSWR: 1.1:1, Surge 50kA, N-Female x N-Female	POLYPHASER	IS-B50LN-C2
0006		1	Custom Coax Cable, 18", w/ SMA x N Type Male	CUSTOM	9999
0020	CB1	1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0021	SP1	1	Surge Protection Module, 120VAC, Imax:40kA, Vmax: 150V	CITEL	DS41-120
0022		1	Holder, Surge Protection	CITEL	DS41-120
0023		1	Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0024		1	Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0025	PS1	1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A	WEIDMULLER	CP SNT 120W 24V 5A
0026	SP2	1	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0027		1	Holder, Surge Protection	CITEL	DS220-24DC
0028	WR1	1	Wireless Radio, DIN-RAIL Mount, 15-30VDC, 4 inputs, 2- 4-20mA inputs, 4 outputs, 2- 4-20mA outputs, RS232/RS485	WEIDMULLER	WI-I/O 9-1
0030		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0031		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0032		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0033		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0050		2	Relay, 2PDT, Coil: 24VDC/ 36.9mA, 1/6HP, w/Indicator & Check Button	IDEC	RH2B-ULC-DC24V
0051	CR01	1	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0052	CR02	1	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0060	SP4	1	Surge Protection Module, 4-20mA, Imax:20kA, Vmax: 28VDC	CITEL	DLA-24D3
0061		1	Holder, Surge Protection, DLA Series	CITEL	DLA-24D3
0062	SP5	1	Surge Protection Module, 4-20mA, Imax:20kA, Vmax: 28VDC	CITEL	DLA-24D3
0063		1	Holder, Surge Protection, DLA Series	CITEL	DLA-24D3
0070	REC1	1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0075		1	Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
0076		1	Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
9101		2	Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILA 250
9102		6	Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILED 24
9110		4	Terminal Block, Gray, 600V/30A, 30-10AWG	PHOENIX	UK 5 N
9111		6	Terminal Block, Green, 600V/30A, 30-10AWG	PHOENIX	UK 5 N GN
9113		26	Terminal Block, Orange, 600V/30A, 30-10AWG	PHOENIX	UK 5 N OG
9114		2	Ground Terminal, 26-10AWG	PHOENIX	UKLKG 5
9115		10	End Cover Plate, Gray	PHOENIX	D-UK 4/10
9117		26	End Clamp, Gray	PHOENIX	E/UK
9134		2	Cross Connector/ Jumper, Cut to 4 Position, Al	PHOENIX	FBI 10-6
9136		2	Cross Connector/ Jumper, Cut to 6 Position, Al	PHOENIX	FBI 10-6

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
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OR	Orange
Y	Yellow
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PROJECT NO. 2012.01
DATE : 04.25.2012
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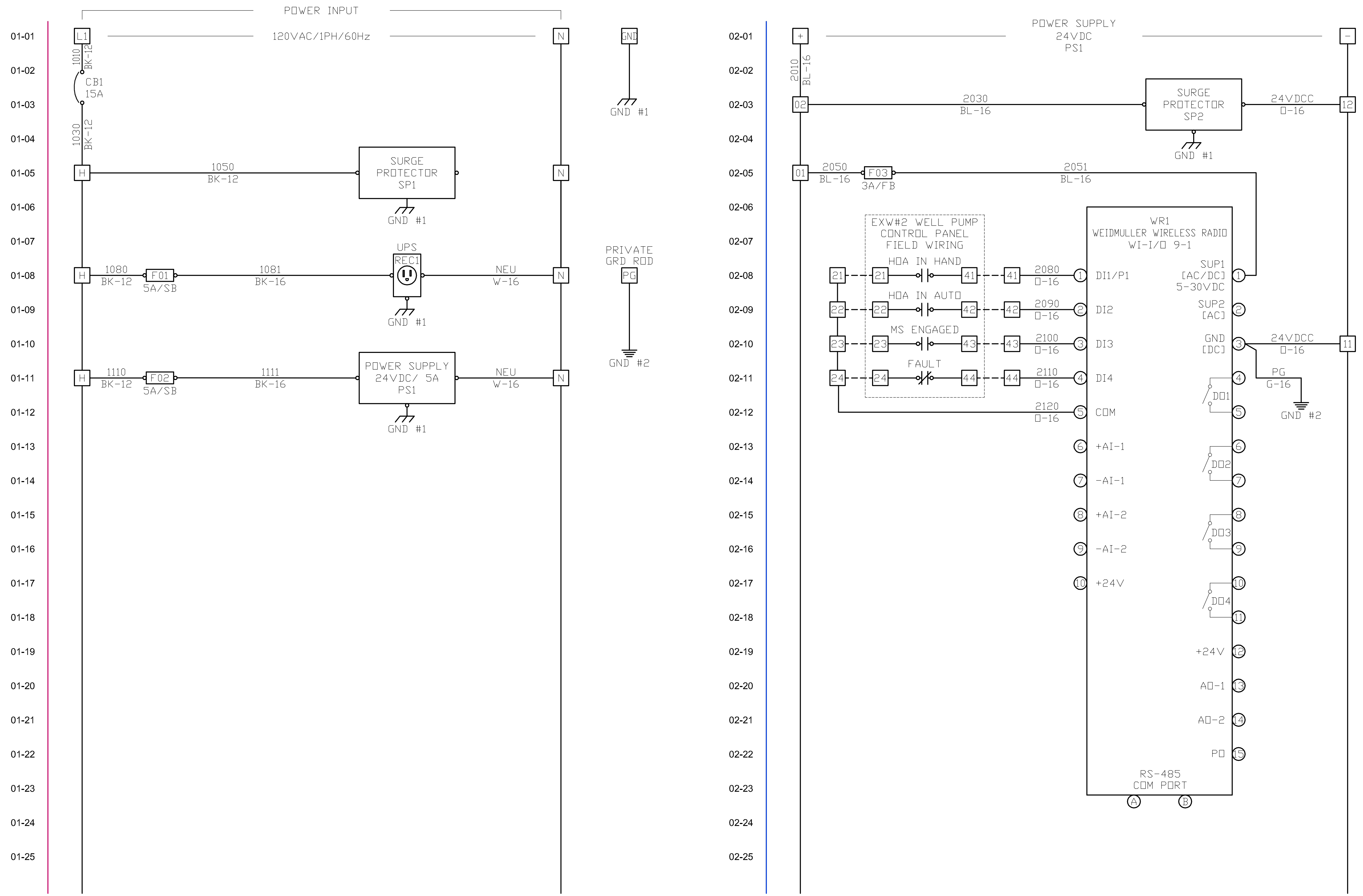
REVISIONS:

RTU903-4

SHEET NO.
SC-005



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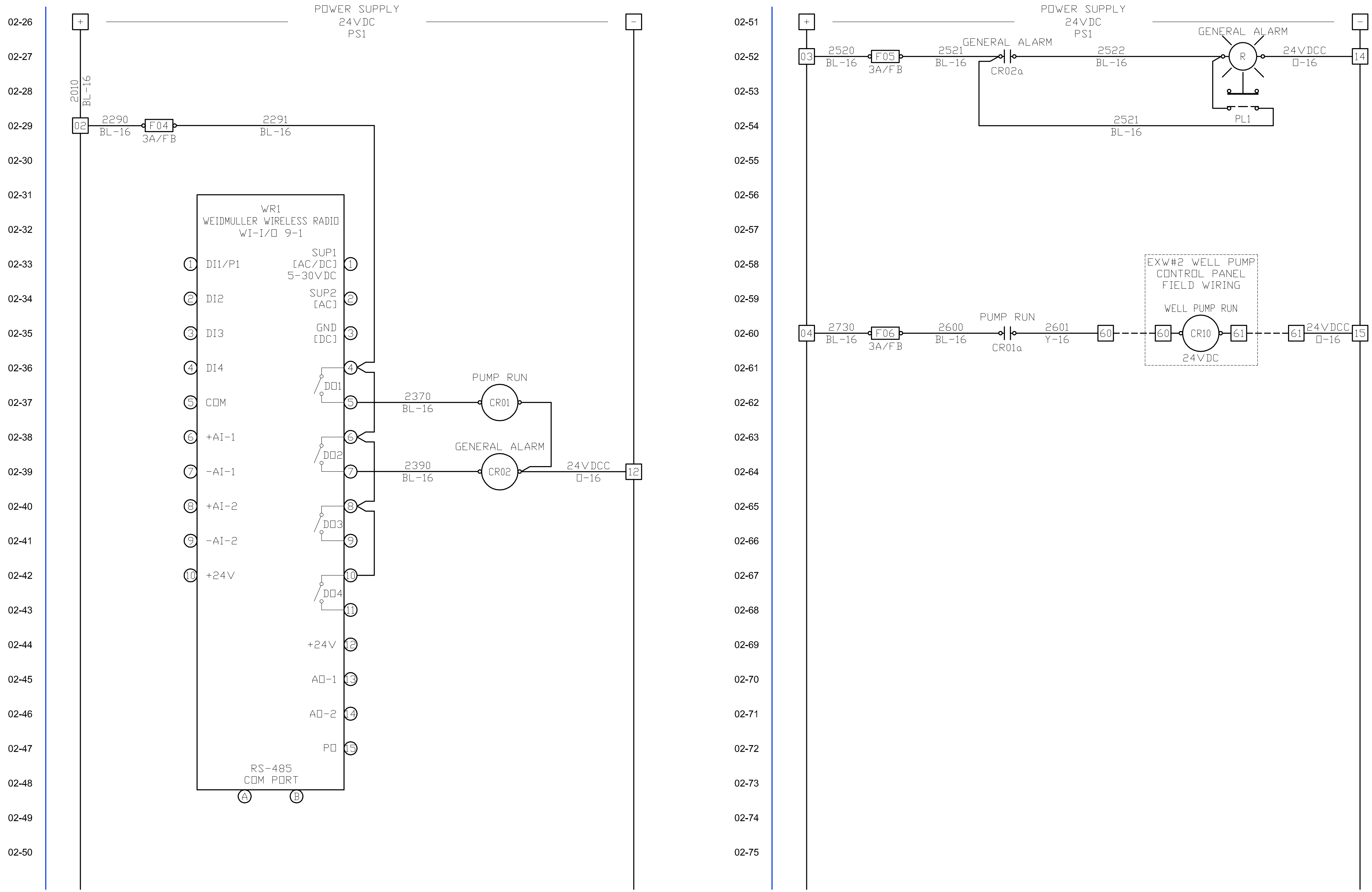
SHEET NO.

SC-010



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SHEET NO.
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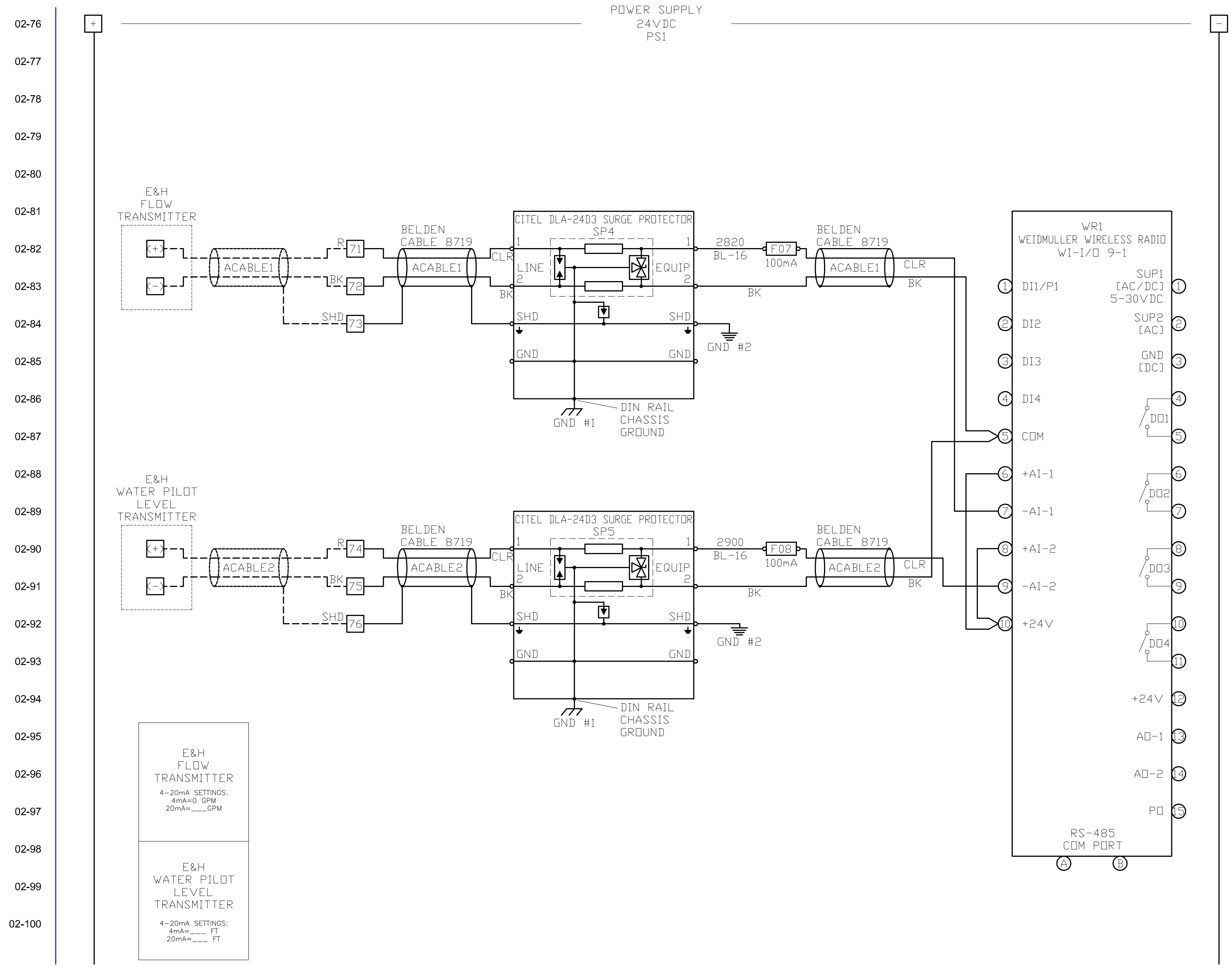

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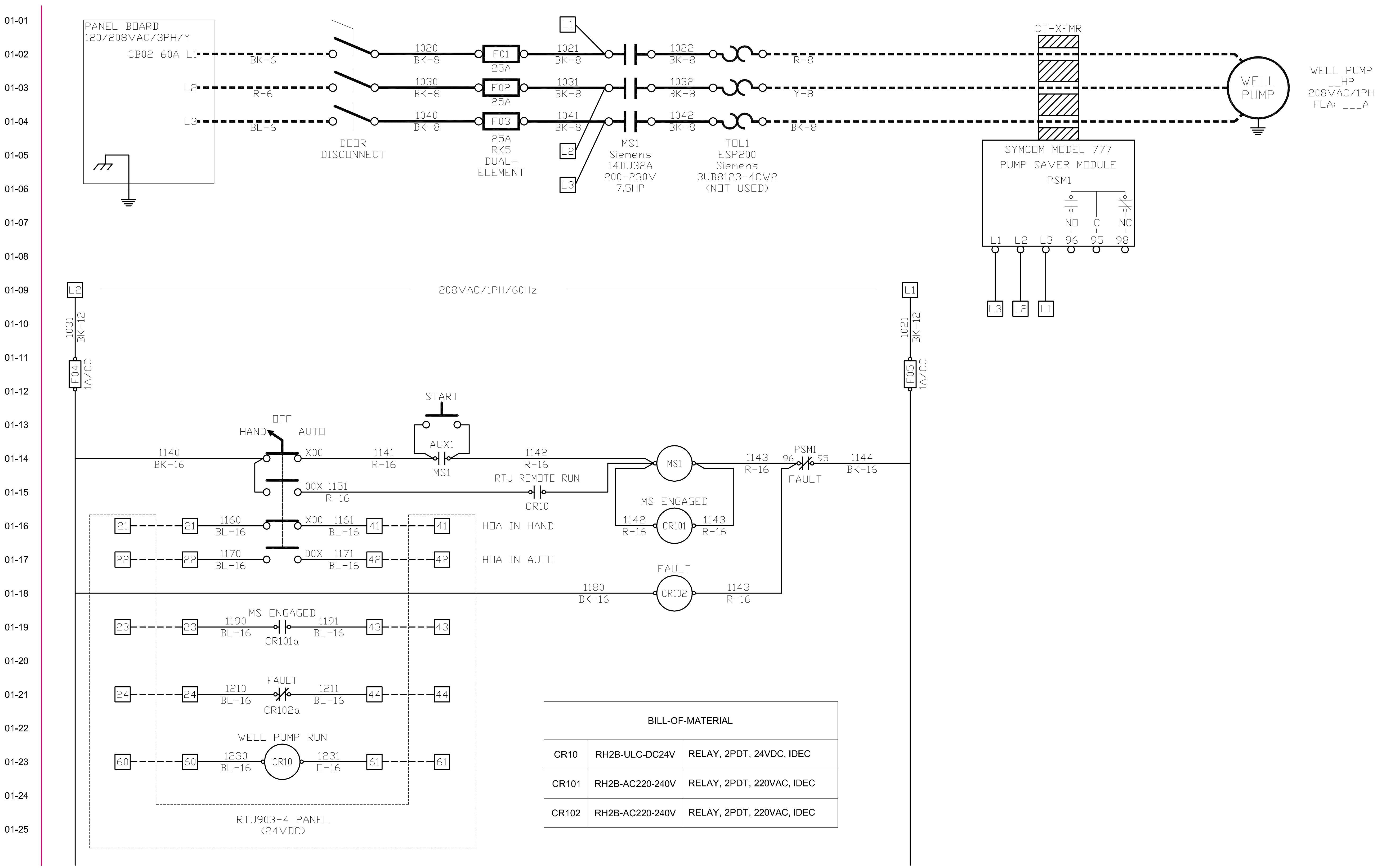
SHEET NO.

SC-012



BILL-OF-MATERIAL		
CR10	RH2B-ULC-DC24V	RELAY, 2PDT, 24VDC, IDEC
CR101	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC
CR102	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC

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GR-16	

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SHEET NO.
SC-020

RTU 903-5
B3-EXW03 CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

EXTRACTION WELL 3

RTU903-5 SCADA CONTROL PANEL

WELL PUMP MOTOR CONTROL PANEL

PRELIMINARY - NOT FOR CONSTRUCTION

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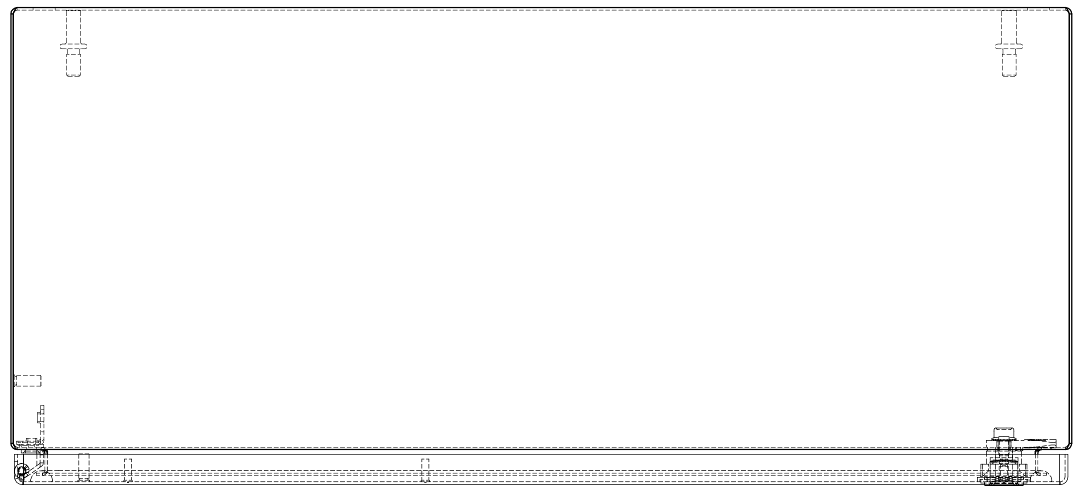

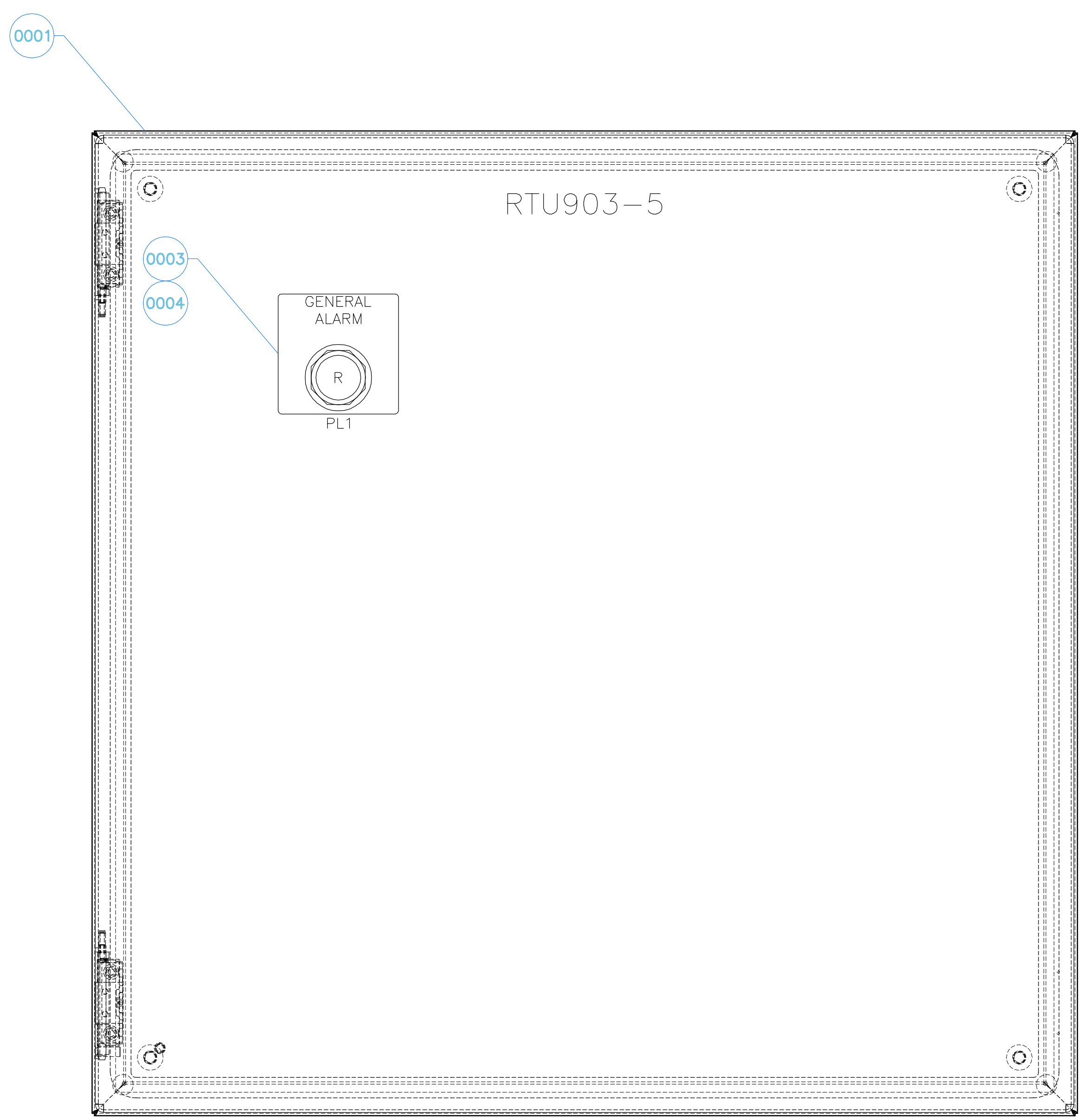

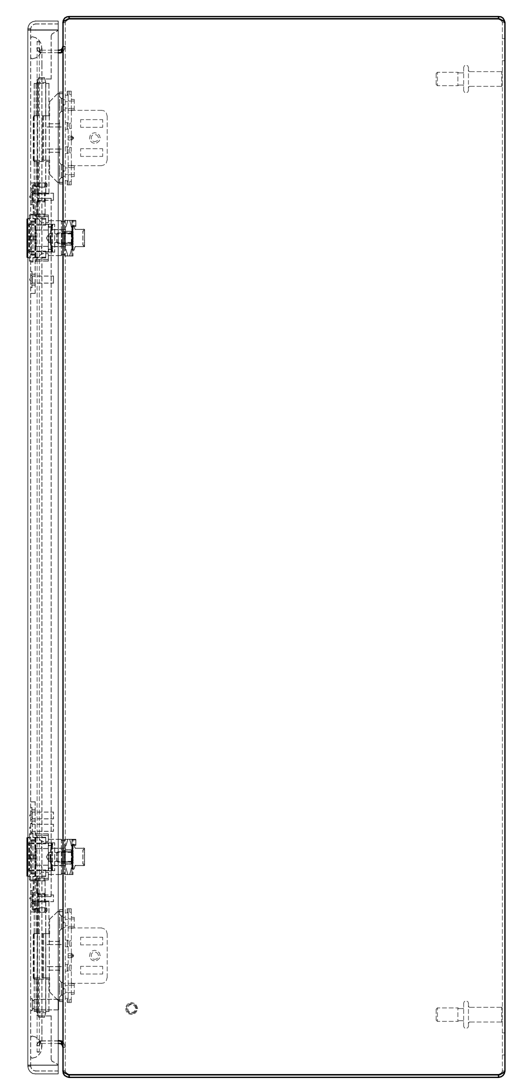

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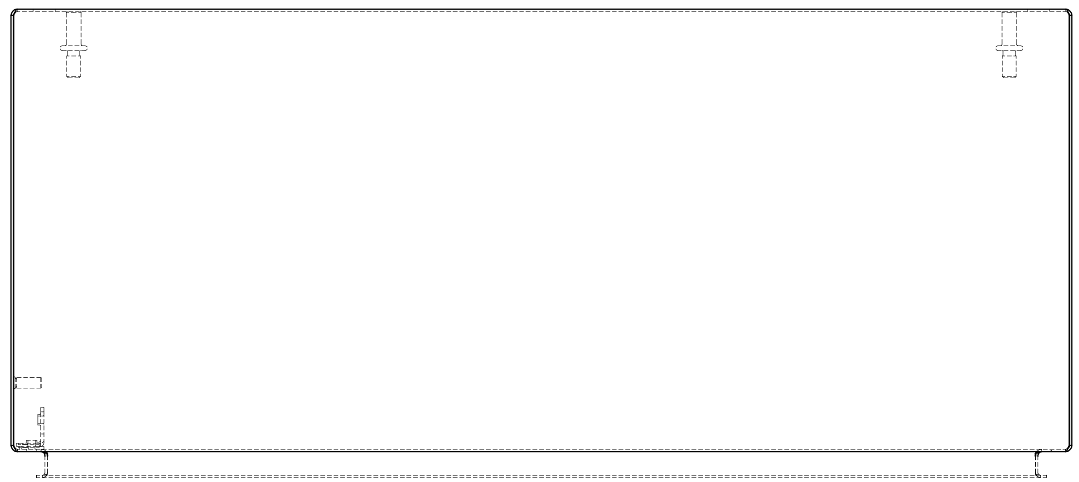
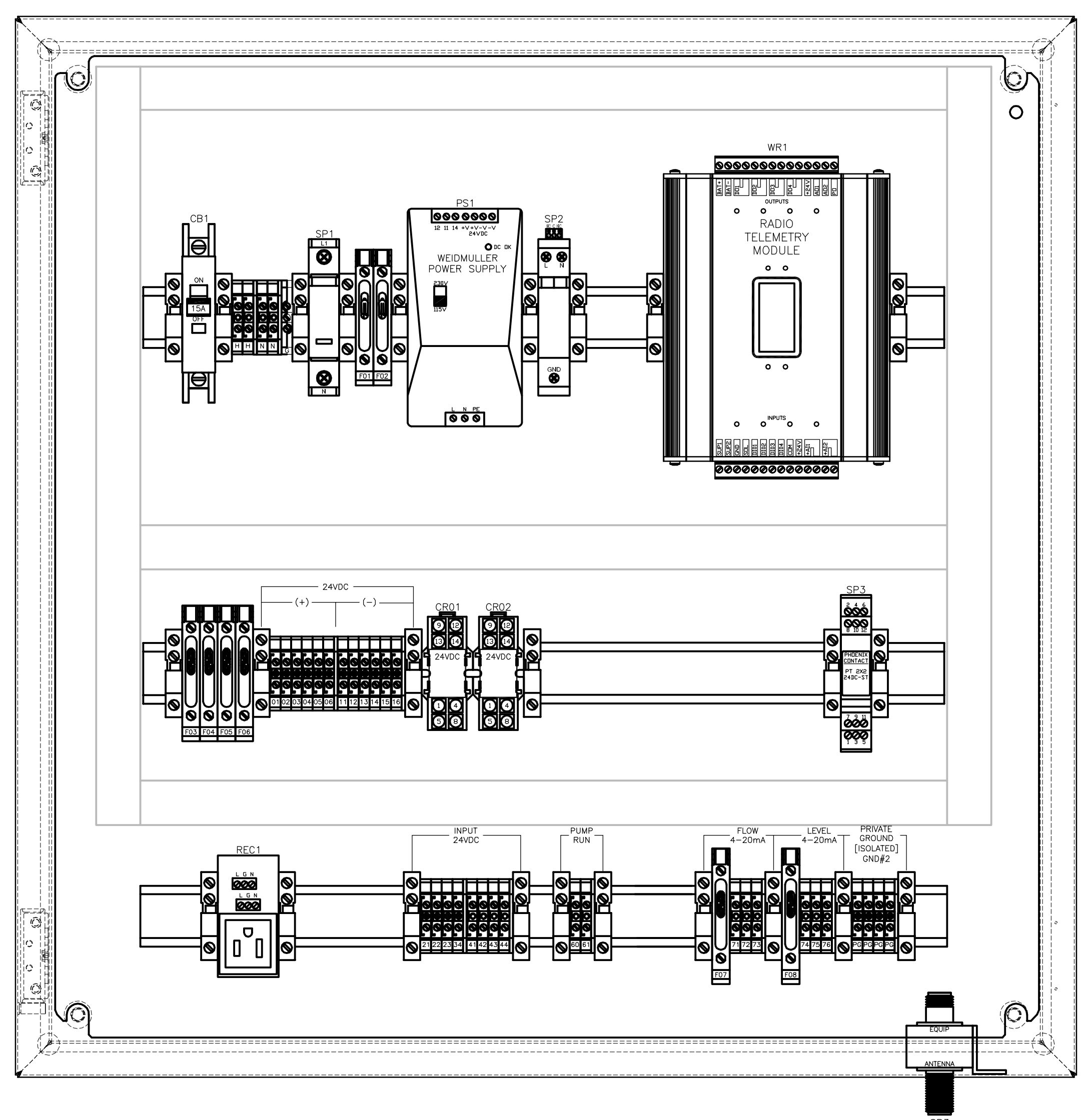
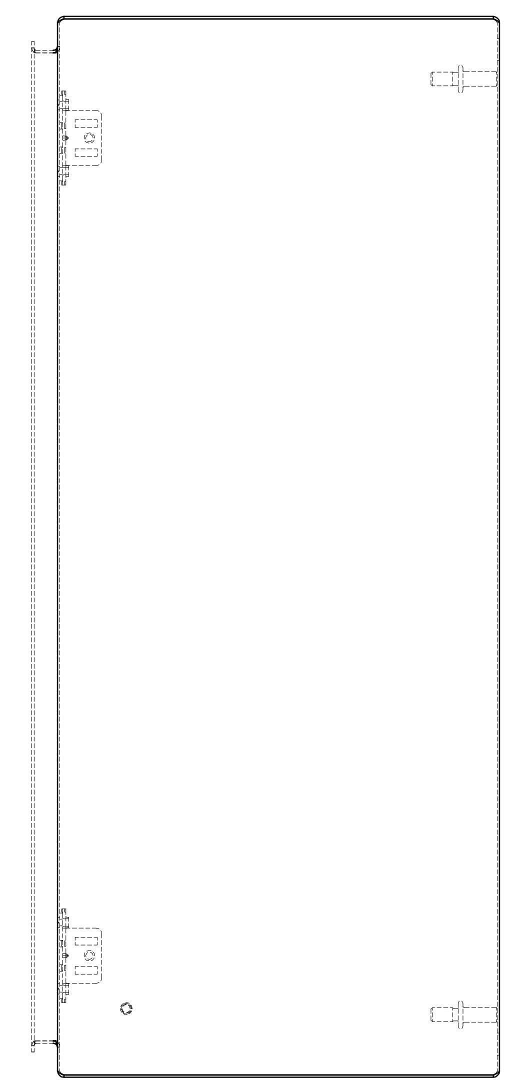
SC-001







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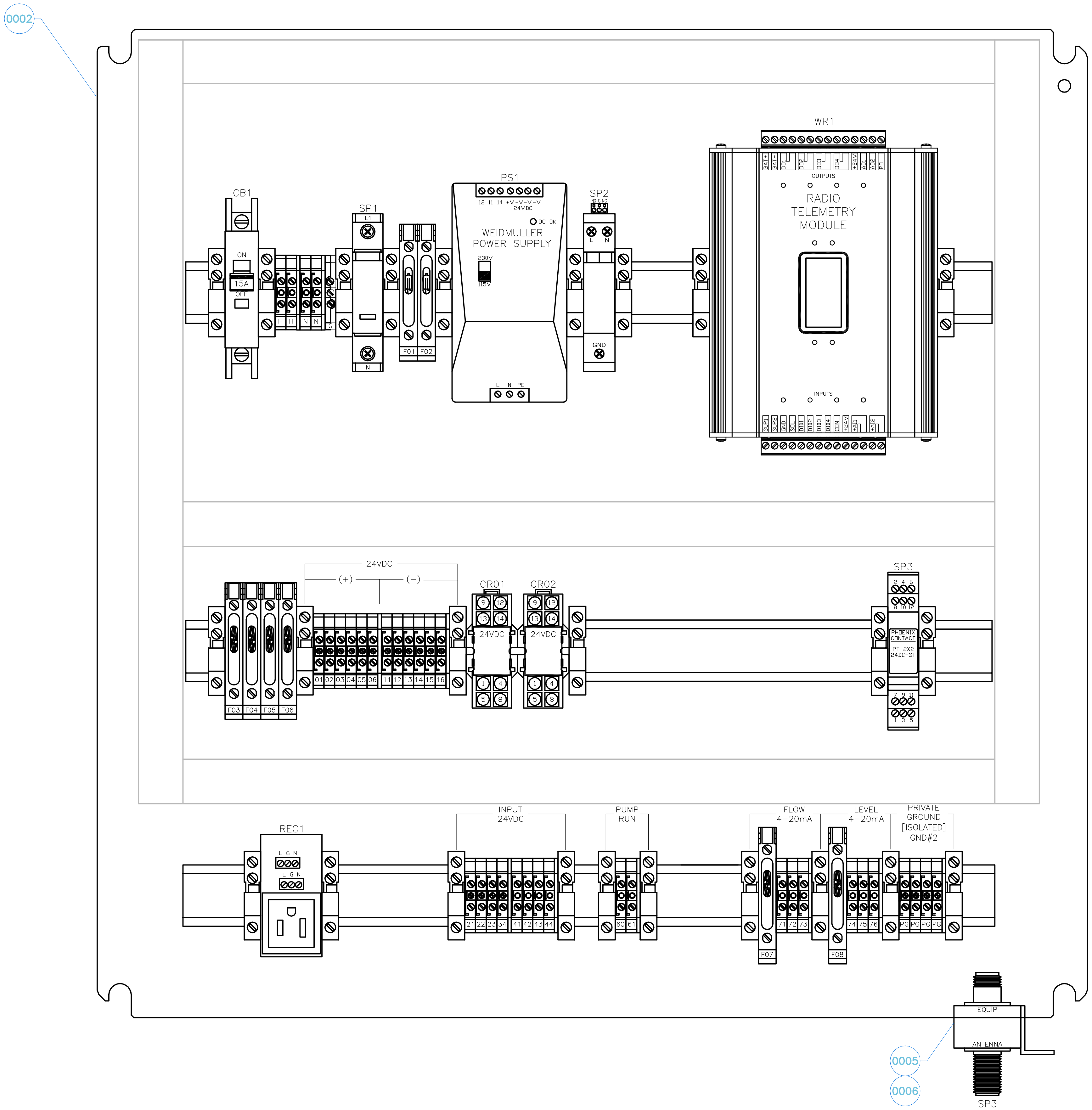
SHEET NO.

SC-002



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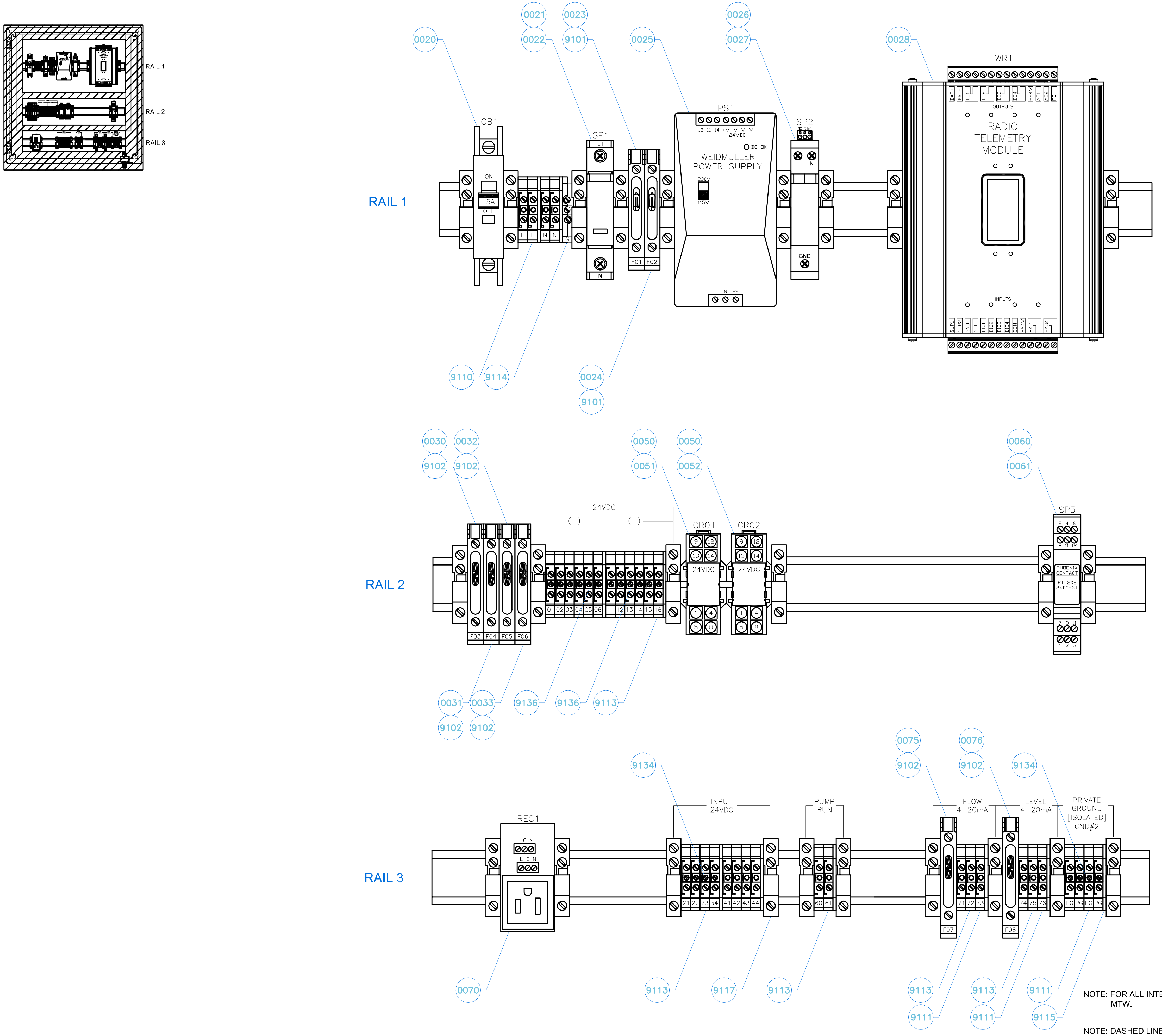
SHEET NO.

SC-003



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SHEET NO.
SC-004

BILL-OF-MATERIAL

ITEM_ID	DEVICE_ID	Count	DESCRIPTION	MFG_NAME	MFG_PN
0001	RTU903-5	1	ENCLOSURE, 24"Hx24"Wx10"D, Nema4X SS	HOFFMAN	CSD242410SS
0002		1	Back Panel, 22.2"x22.2", White Steel	HOFFMAN	CP2424
0003	PL1	1	Plastic Label, 30.5mm Pilot Lamp, Red w/White Lettering, 2.4"Wx2.4"H	CUSTOM	99999
0004		1	Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC	AB	800T-QBH24R
0005	SP3	1	Broadband DC Blocked Protector, 125-1000MHz, 50 ohm, 50-375W, VSWR: 1.1:1, Surge 50kA, N-Female x N-Female	POLYPHASER	IS-B50LN-C2
0006		1	Custom Coax Cable, 18", w/ SMA x N Type Male	CUSTOM	9999
0020	CB1	1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0021		1	Holder, Surge Protection	WEIDMULLER	PU II 1S
0022	SP1	1	Surge Protection Module, 130VAC, In:20kA, Imax:40kA, L-N	WEIDMULLER	SH2B-05
0023		1	Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0024		1	Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0025	PS1	1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A	WEIDMULLER	CP SNT 120W 24V 5A
0026	SP2	1	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0027		1	Holder, Surge Protection	CITEL	DS220-24DC
0028	WR1	1	Wireless Radio, DIN-RAIL Mount, 15-30VDC, 4 inputs, 2- 4-20mA inputs, 4 outputs, 2- 4-20mA outputs, RS232/RS485	WEIDMULLER	WI-I/O 9-1
0030		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0031		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0032		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0033		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0050		2	Relay, 2PDT, Coil: 24VDC/ 36.9mA, 1/6HP, w/Indicator & Check Button	IDEC	RH2B-ULC-DC24V
0051	CR01	1	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0052	CR02	1	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0060		1	Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0061	SP3	1	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0070	REC1	1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0075		1	Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
0076		1	Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
9101		2	Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILA 250
9102		6	Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILED 24
9110		4	Terminal Block, Gray, 600V/30A, 30-10AWG	PHOENIX	UK 5 N
9111		6	Terminal Block, Green, 600V/30A, 30-10AWG	PHOENIX	UK 5 N GN
9113		26	Terminal Block, Orange, 600V/30A, 30-10AWG	PHOENIX	UK 5 N OG
9114		1	Ground Terminal, 26-10AWG	PHOENIX	UKLKG 5
9115		10	End Cover Plate, Gray	PHOENIX	D-UK 4/10
9117		25	End Clamp, Gray	PHOENIX	E/UK
9134		2	Cross Connector/ Jumper, Cut to 4 Position, Al	PHOENIX	FBI 10-6
9136		2	Cross Connector/ Jumper, Cut to 6 Position, Al	PHOENIX	FBI 10-6

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

PROJECT NO. 2012.01

DATE : 04.25.2012

DRAWN : RMF

REVISIONS:

RTU903-5

SHEET NO.

SC-005

CAMP STANLEY

BIOREACTOR UPGRADE PROJECT

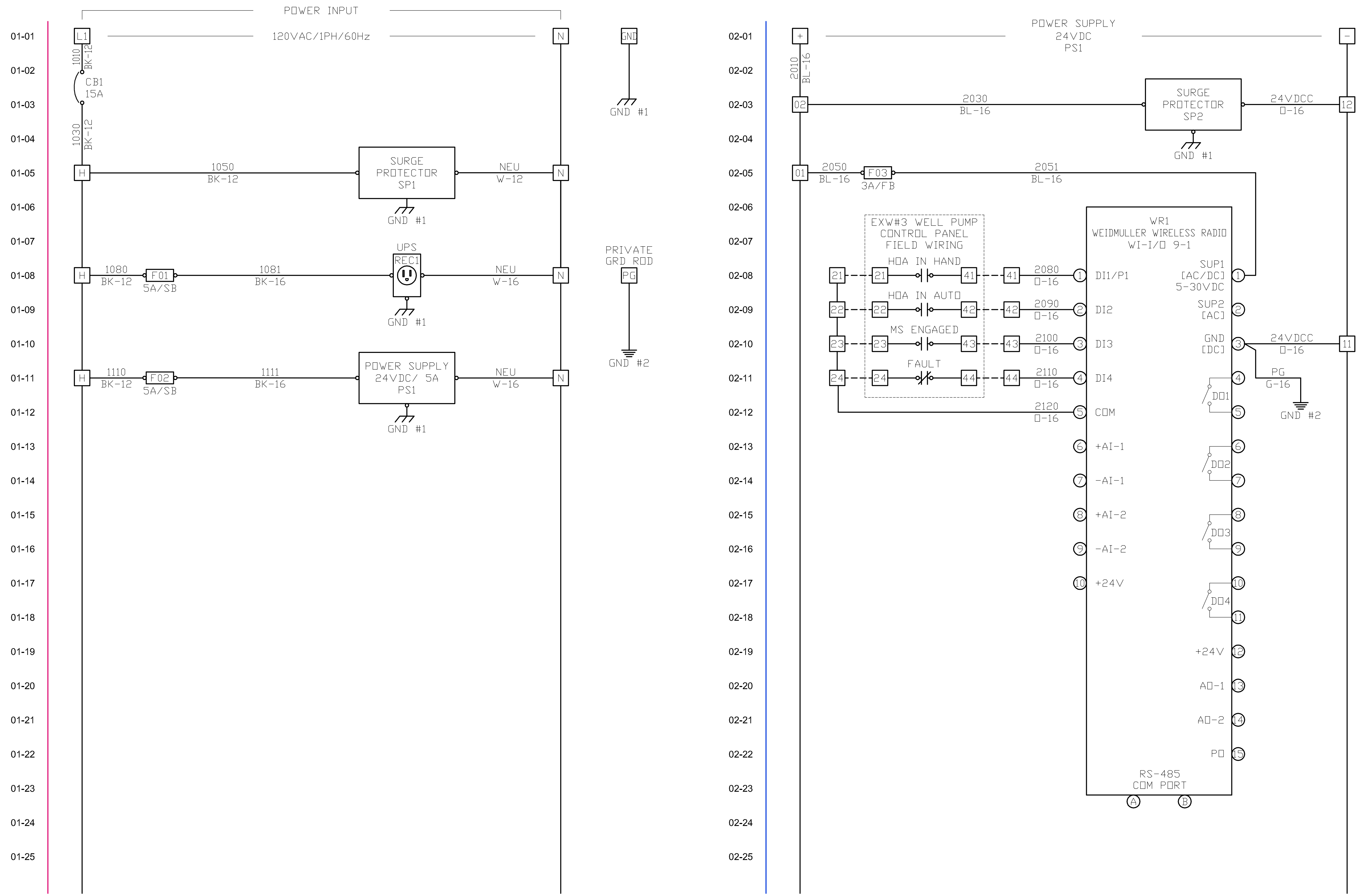
CAMP STANLEY STORAGE ACTIVITY

BOERNE, TEXAS

PARSONS

8000 CENTRE PARK, SUITE 200

AUSTIN, TEXAS 78754



COLOR CODE	
ID	COLOR
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WIRE MARKER LEGEND	
COLOR	SIZE
GR-16	

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PARSONS

8000 CENTRE PARK, SUITE 200
AUSTIN, TEXAS 78754

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

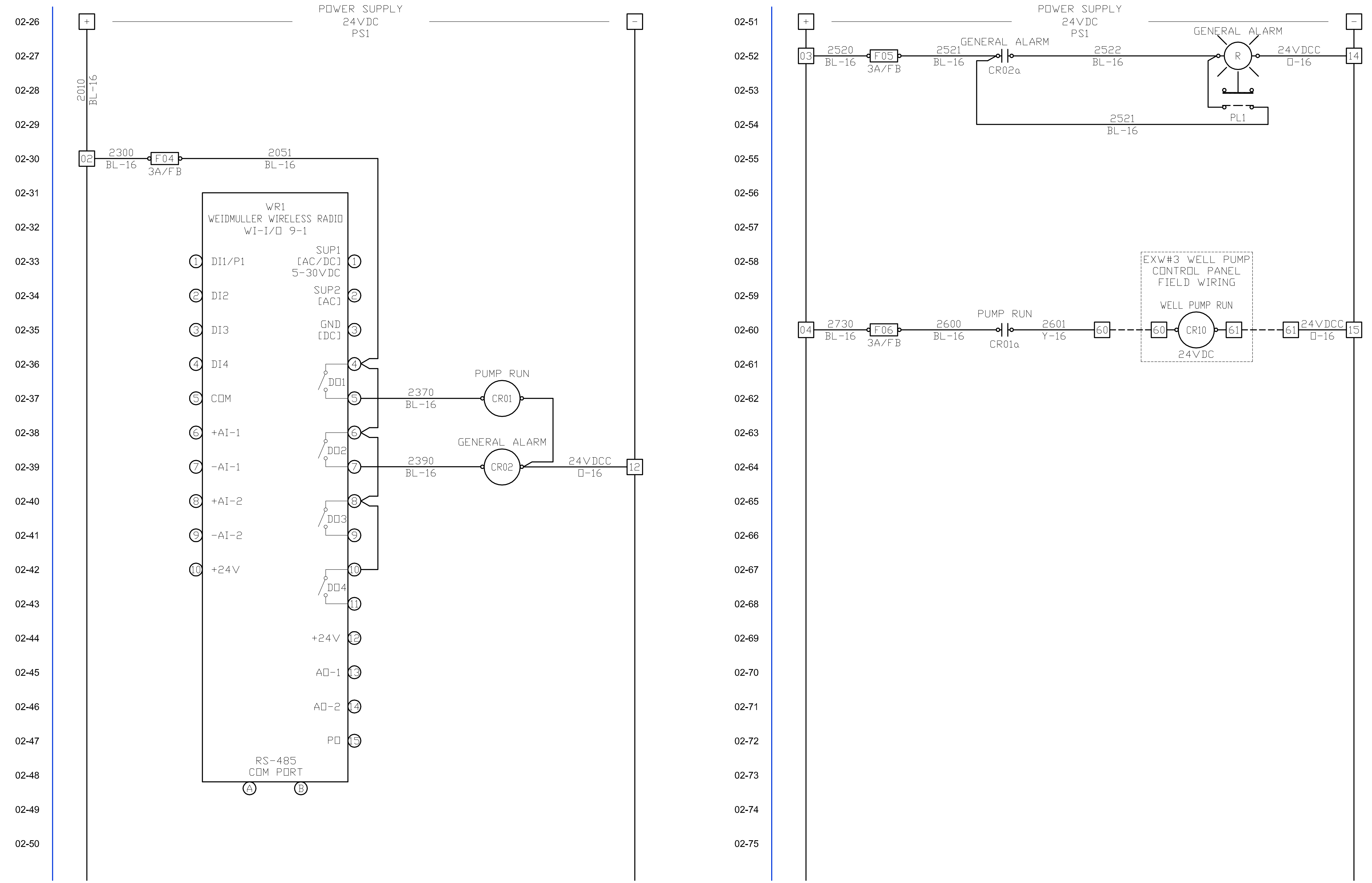
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
DRAWN : RMF
REVISIONS:

RTU903-5

SHEET NO.

SC-010



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COLOR	SIZE
GR-16	

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PARSONS
8000 Centre Park, Suite 200
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CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
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REVISIONS:

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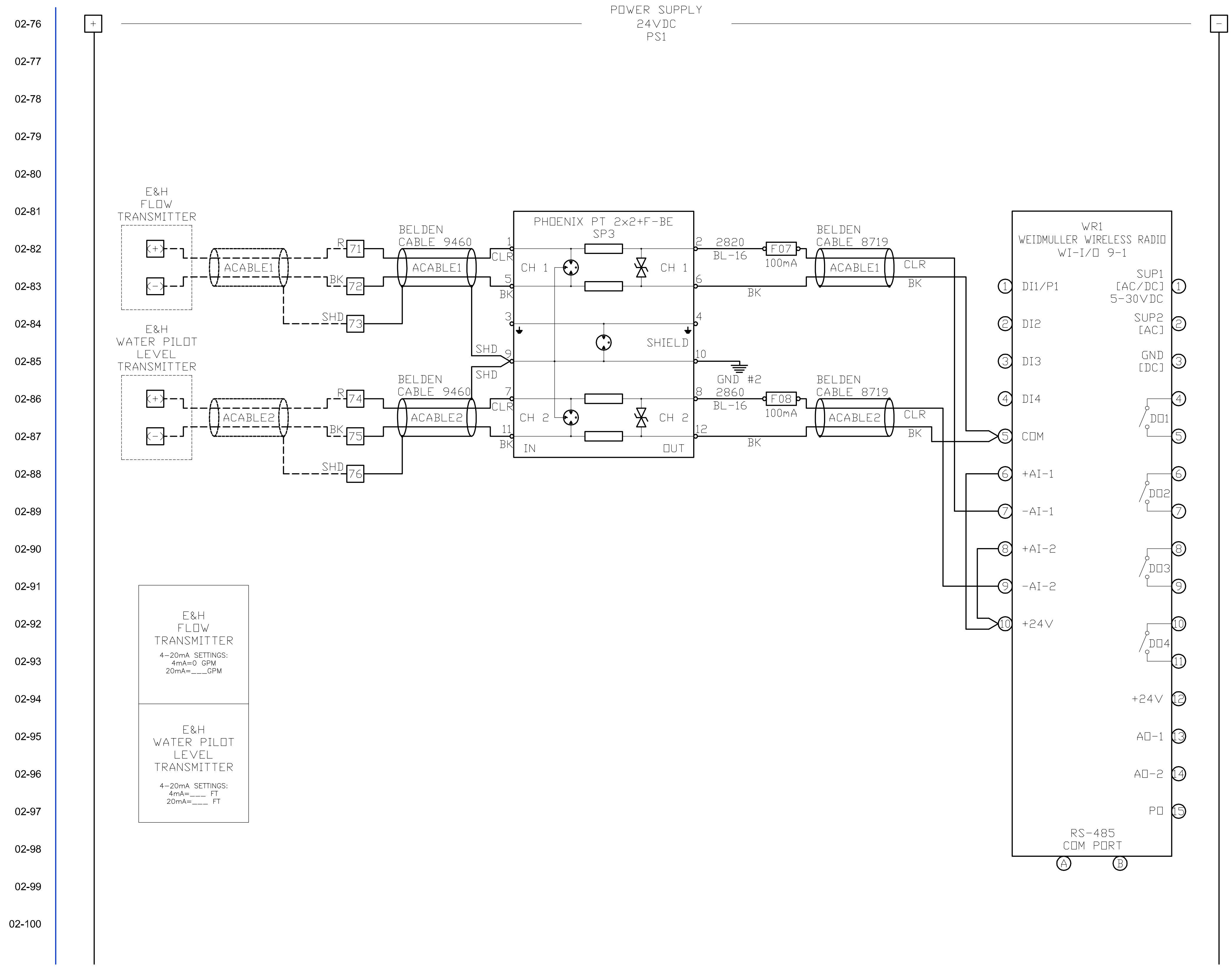
SHEET NO.
SC-011



E&H
FLOW
TRANSMITTER
4-20mA SETTINGS:
4mA=0 GPM
20mA=___GPM

E&H
WATER PILOT
LEVEL
TRANSMITTER
4-20mA SETTINGS:
4mA=___ FT
20mA=___ FT

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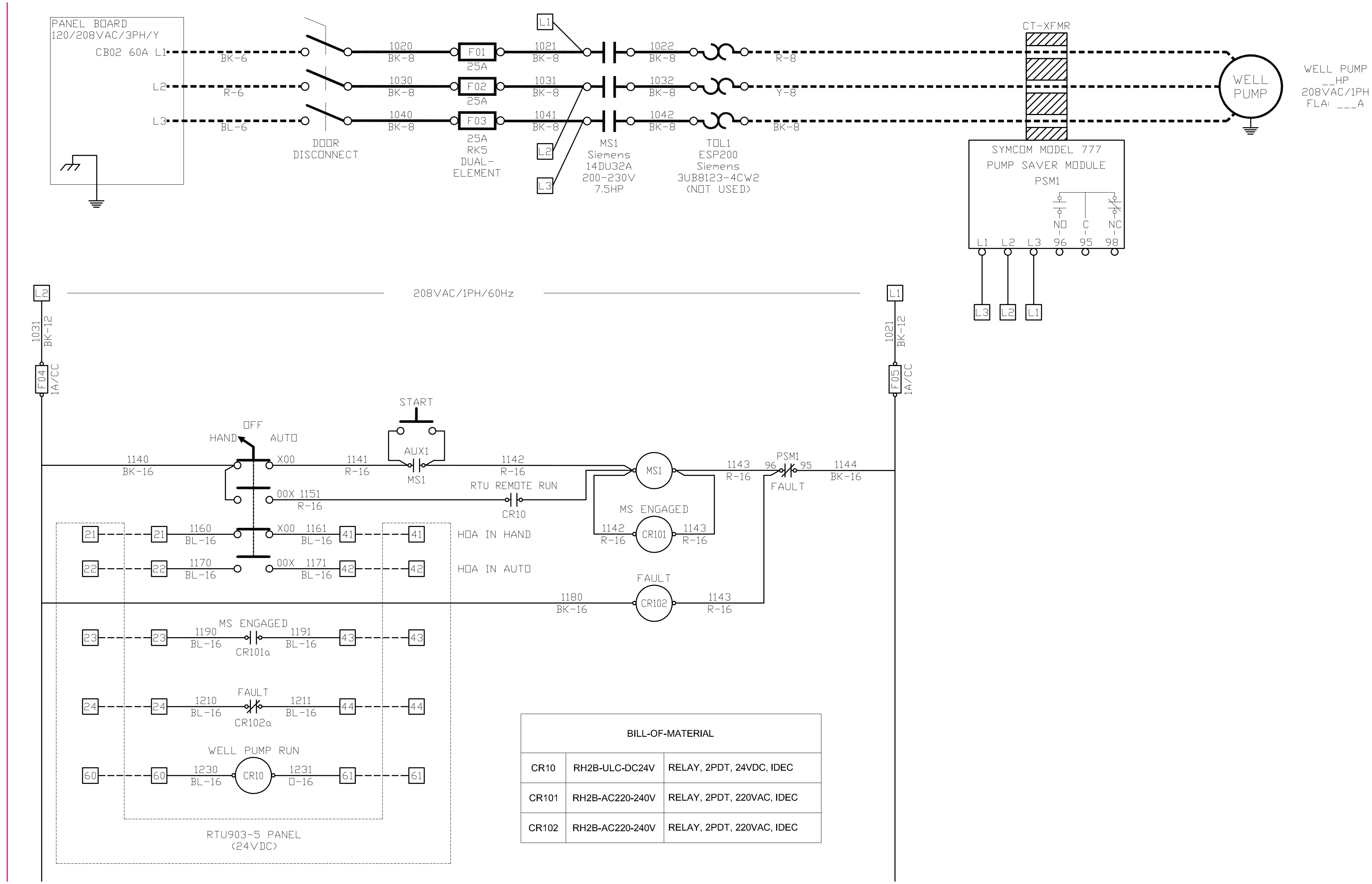

BILL-OF-MATERIAL		
CR10	RH2B-ULC-DC24V	RELAY, 2PDT, 24VDC, IDEC
CR101	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC
CR102	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC

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RTU903-5

SHEET NO.

SC-020

RTU 903-6
B3-EXW04 CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

EXTRACTION WELL 4

RTU903-6 SCADA CONTROL PANEL

WELL PUMP MOTOR CONTROL PANEL

PRELIMINARY - NOT FOR CONSTRUCTION

PARSONS
8000 Centre Park, Suite 200
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CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01
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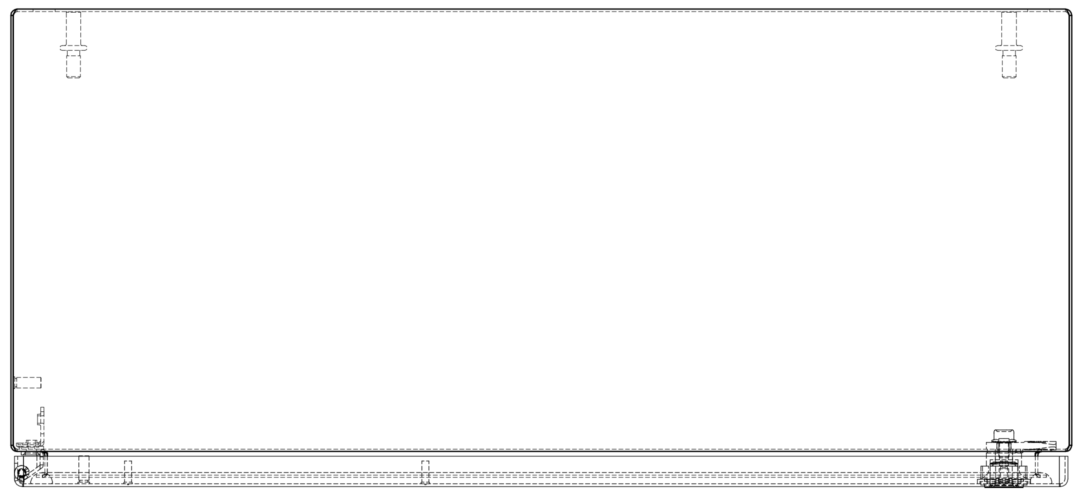
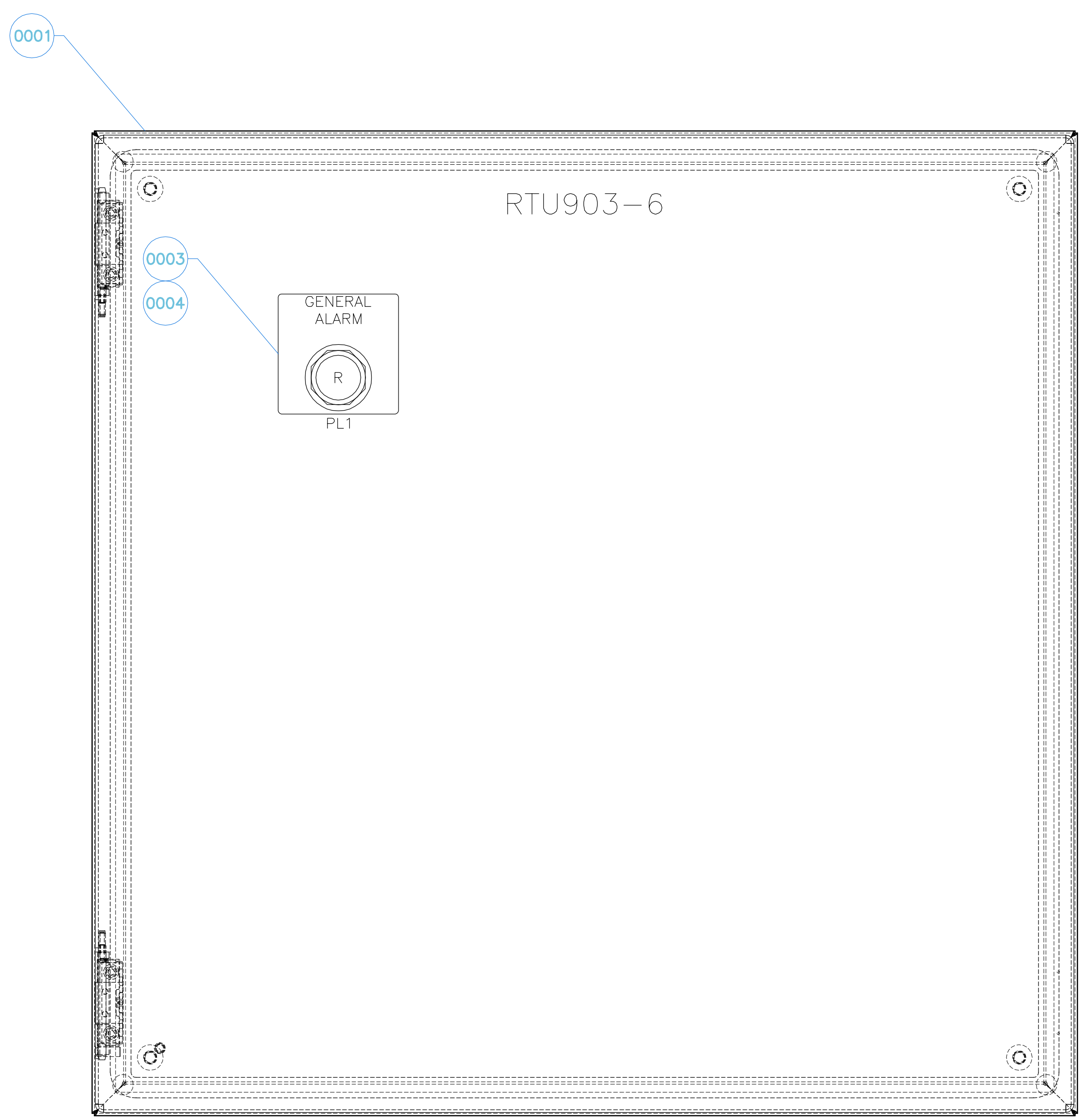
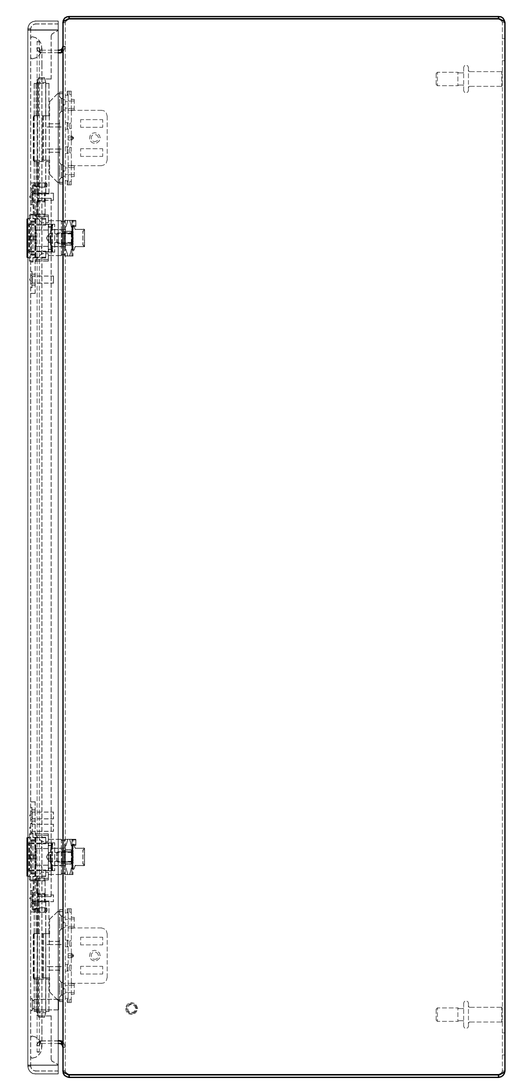
RTU903-6

SHEET NO.
TITLE







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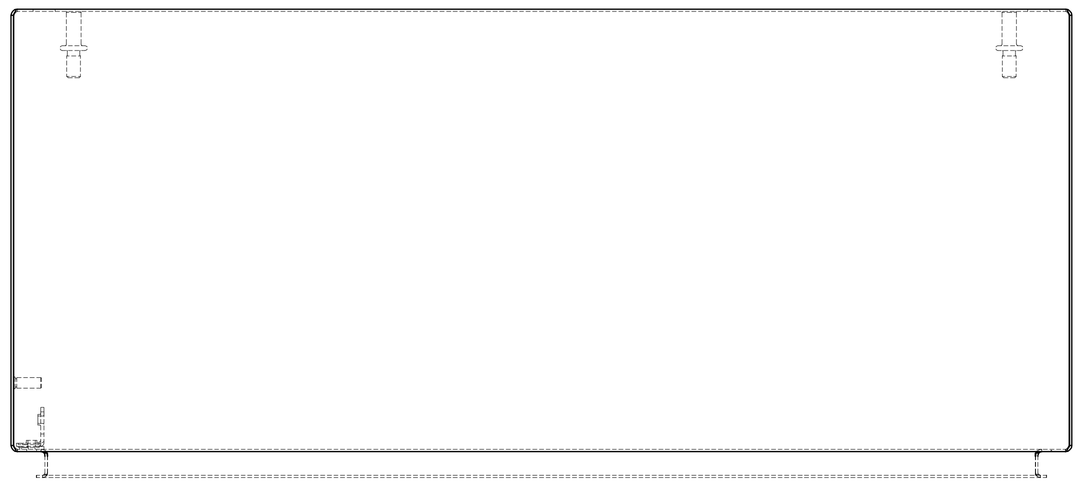
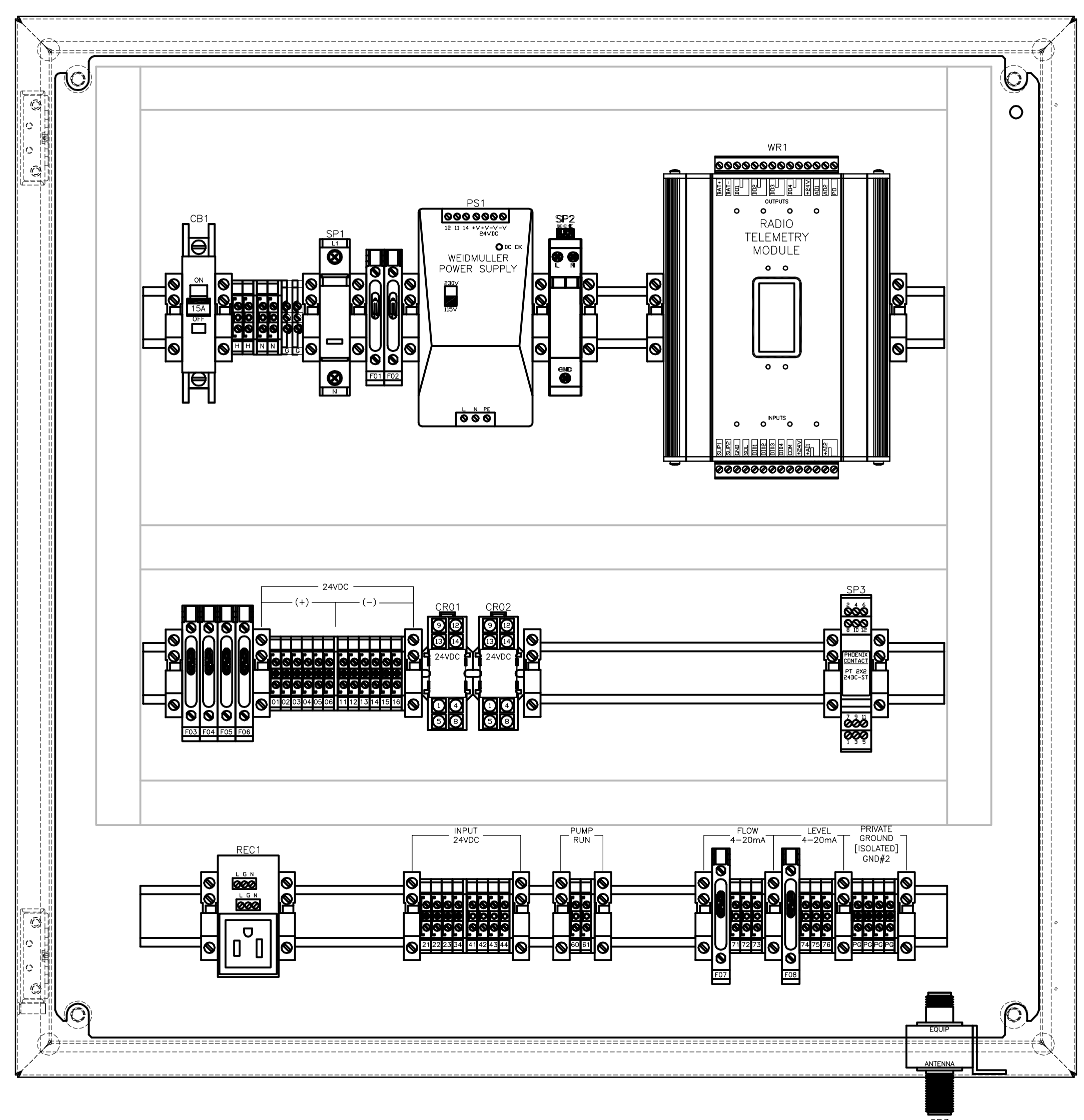
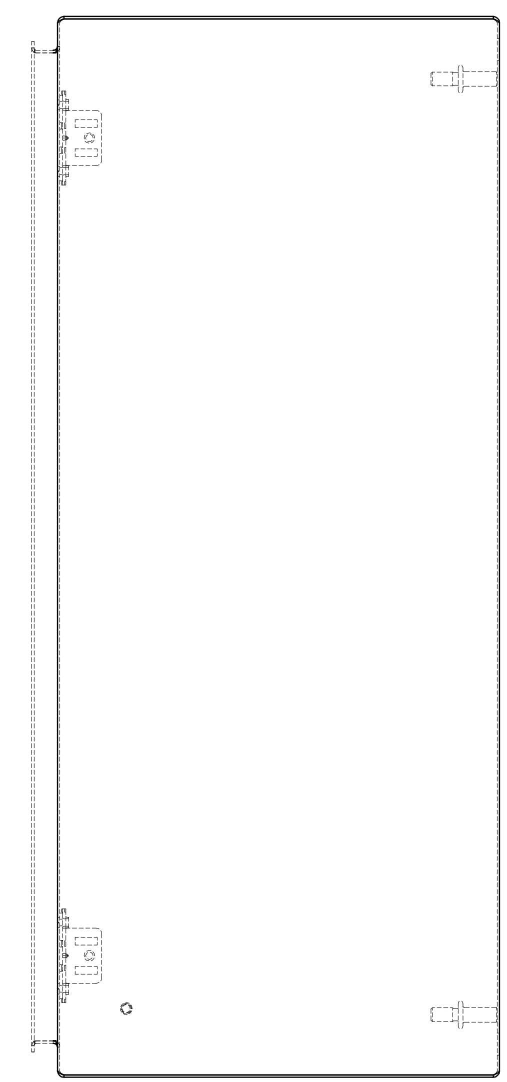
SHEET NO.

SC-001







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WIRE MARKER LEGEND	
COLOR	SIZE
GR-16	

COLOR CODE	
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CAMP STANLEY
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BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
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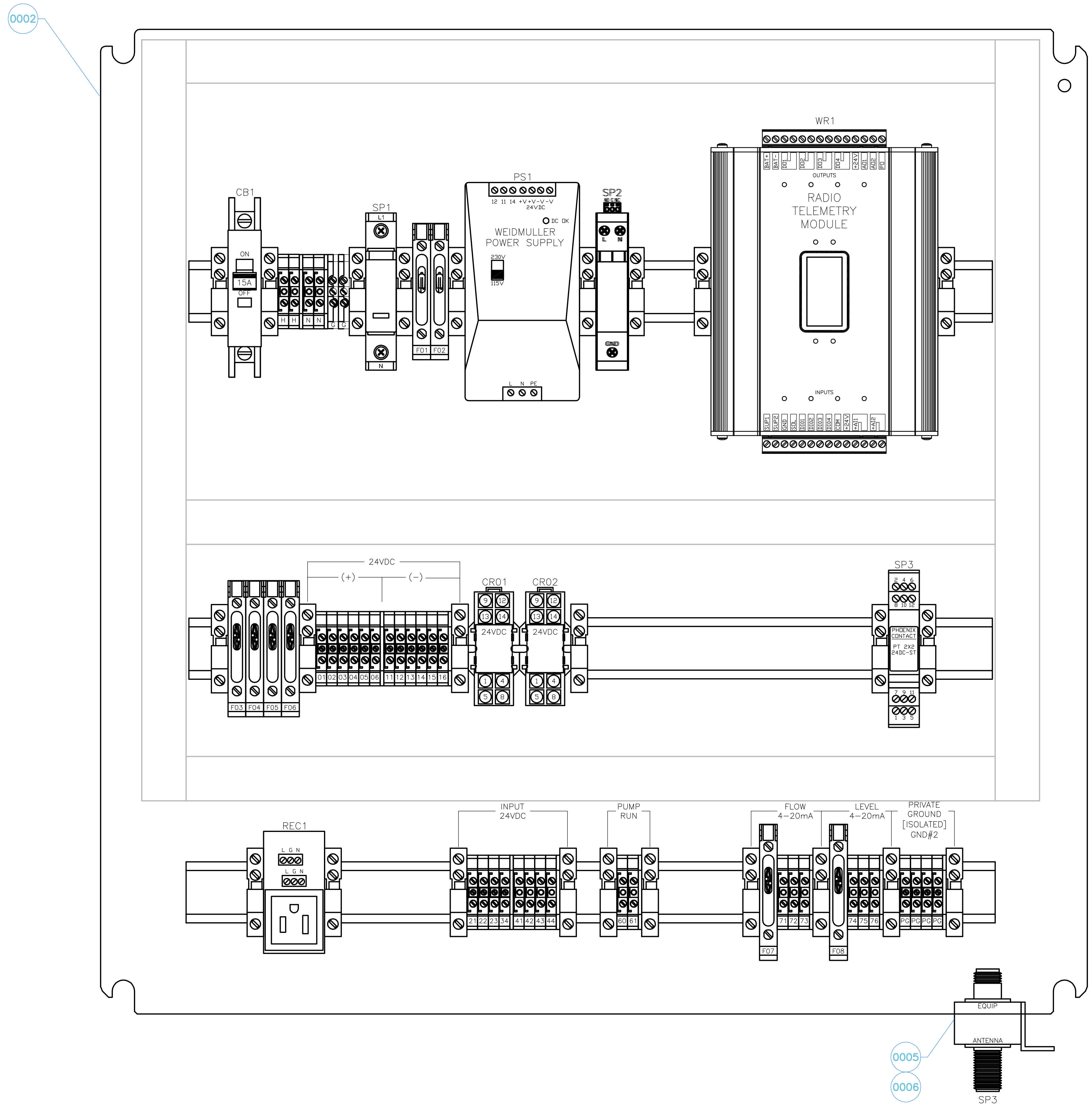
REVISIONS:

RTU903-6

SHEET NO.
SC-002



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE

ID	COLOR
CLR	Clear
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CAMP STANLEY
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PROJECT NO. 2012.01

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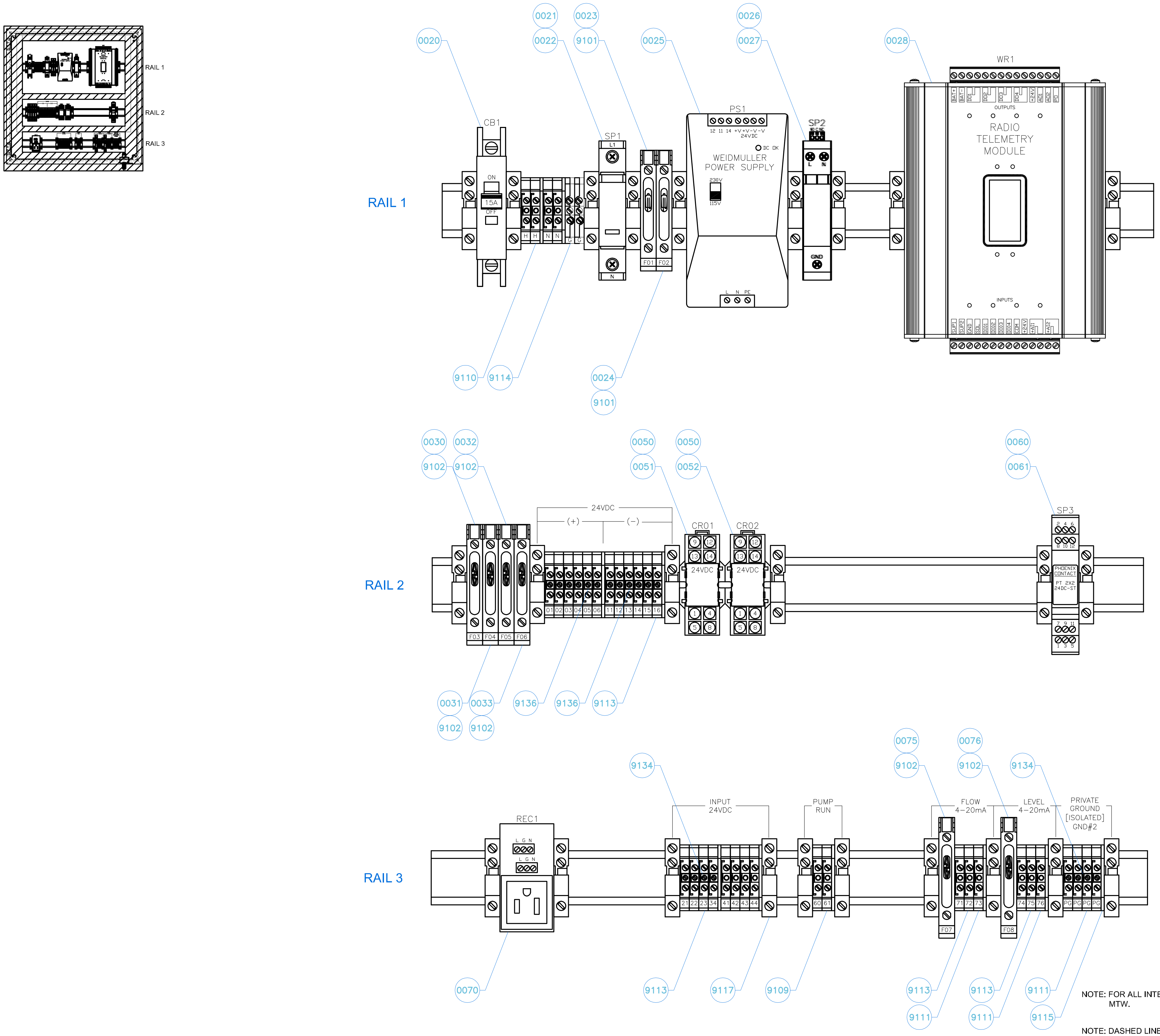
REVISIONS:

RTU903-6

SHEET NO.

SC-003



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WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE

ID	COLOR
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CAMP STANLEY
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CAMP STANLEY STORAGE ACTIVITY
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PROJECT NO. 2012.01

DATE : 04.25.2012

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REVISIONS:

RTU903-6

SHEET NO.

SC-004

BILL-OF-MATERIAL

ITEM_ID	DEVICE_ID	Count	DESCRIPTION	MFG_NAME	MFG_PN
0001	RTU903-6	1	ENCLOSURE, 24"Hx24"Wx10"D, Nema4X SS	HOFFMAN	CSD242410SS
0002		1	Back Panel, 22.2"x22.2", White Steel	HOFFMAN	CP2424
0003	PL1	1	Plastic Label, 30.5mm Pilot Lamp, Red w/White Lettering, 2.4"Wx2.4"H	CUSTOM	99999
0004		1	Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC	AB	800T-QBH24R
0005	SP3	1	Broadband DC Blocked Protector, 125-1000MHz, 50 ohm, 50-375W, VSWR: 1.1:1, Surge 50kA, N-Female x N-Female	POLYPHASER	IS-B50LN-C2
0006		1	Custom Coax Cable, 18", w/ SMA x N Type Male	CUSTOM	9999
0020	CB1	1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0021		1	Holder, Surge Protection	WEIDMULLER	PU II 1S
0022	SP1	1	Surge Protection Module, 130VAC, In:20kA, Imax:40kA, L-N	WEIDMULLER	SH2B-05
0023		1	Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0024		1	Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0025	PS1	1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A	WEIDMULLER	CP SNT 120W 24V 5A
0026	SP2	2	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0027		2	Holder, Surge Protection	CITEL	DS220-24DC
0028	WR1	1	Wireless Radio, DIN-RAIL Mount, 15-30VDC, 4 inputs, 2- 4-20mA inputs, 4 outputs, 2- 4-20mA outputs, RS232/RS485	WEIDMULLER	WI-I/O 9-1
0030		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0031		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0032		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0033		1	Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0050		2	Relay, 2PDT, Coil: 24VDC/ 36.9mA, 1/6HP, w/Indicator & Check Button	IDEC	RH2B-ULC-DC24V
0051	CR01	1	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0052	CR02	1	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0060		1	Base, Gas-filled Surge Arrestor, 2 2-wire floating signals, 600V/ 450mA, DIN Rail	PHOENIX	PT 2X2+F-BE
0061	SP3	1	Protective Plug, 2 2-core floating signals, 24VDC, Max Core Surge 10kA @ (8-20uS)	PHOENIX	PT 2X2-24DC-ST
0070	REC1	1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0075		1	Fuse, 5x20mm, 250mA, Fast Acting	BUSSMANN	GMA-250-R
0076		1	Fuse, 5x20mm, 250mA, Fast Acting	BUSSMANN	GMA-250-R
9101		2	Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILA 250
9102		6	Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILED 24
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9111		6	Terminal Block, Green, 600V/30A, 30-10AWG	PHOENIX	UK 5 N GN
9113		26	Terminal Block, Orange, 600V/30A, 30-10AWG	PHOENIX	UK 5 N OG
9114		2	Ground Terminal, 26-10AWG	PHOENIX	UKLKG 5
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9117		25	End Clamp, Gray	PHOENIX	E/UK
9134		2	Cross Connector/ Jumper, Cut to 4 Position, Al	PHOENIX	FBI 10-6
9136		2	Cross Connector/ Jumper, Cut to 6 Position, Al	PHOENIX	FBI 10-6

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

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WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
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PARSONS

8000 CENTRE PARK, SUITE 200
AUSTIN, TEXAS 78754

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

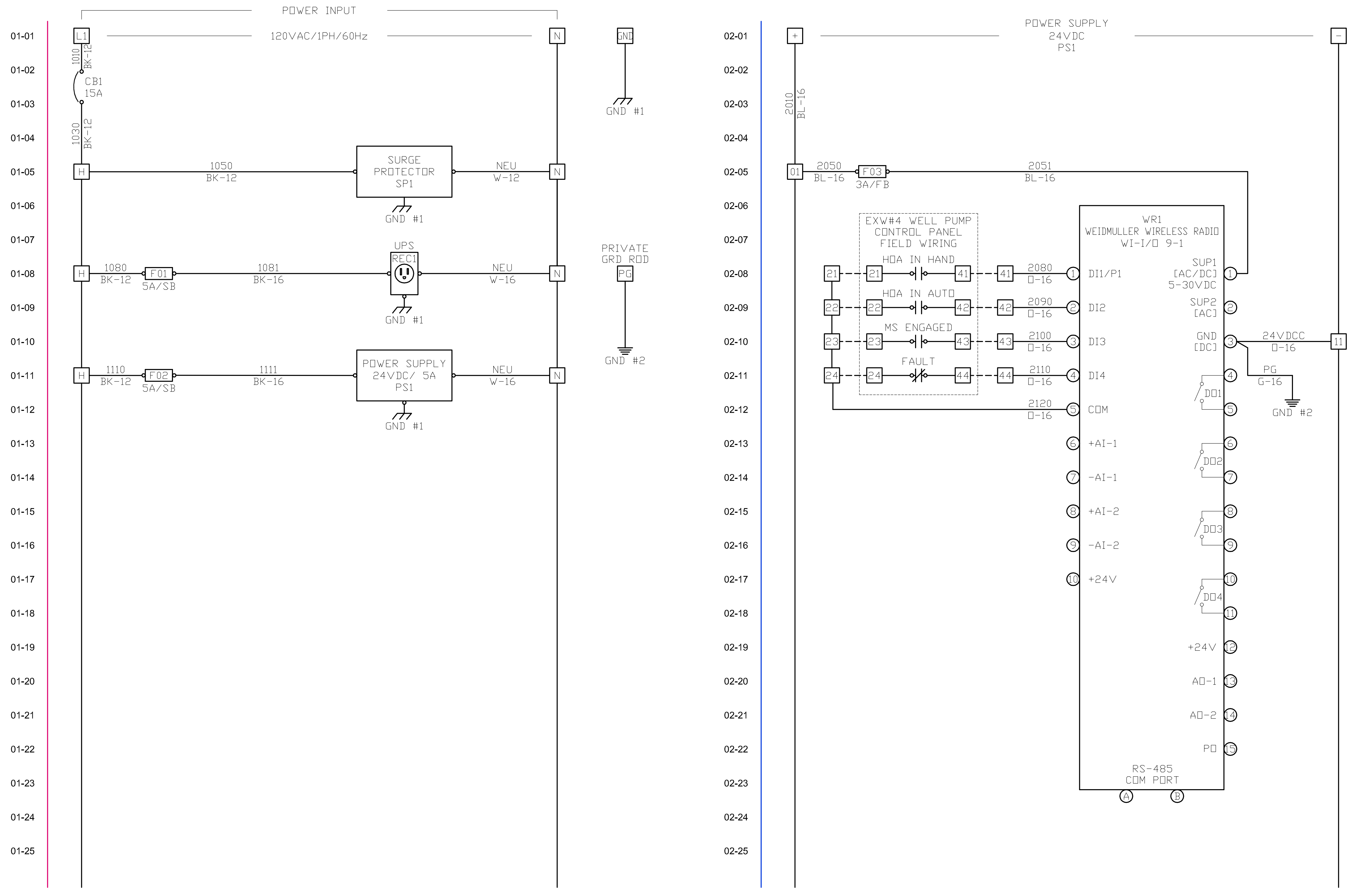
CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01
DATE : 04.25.2012
DRAWN : RMF
REVISIONS:

RTU903-6

SHEET NO.

SC-005



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WIRE MARKER LEGEND
COLOR SIZE
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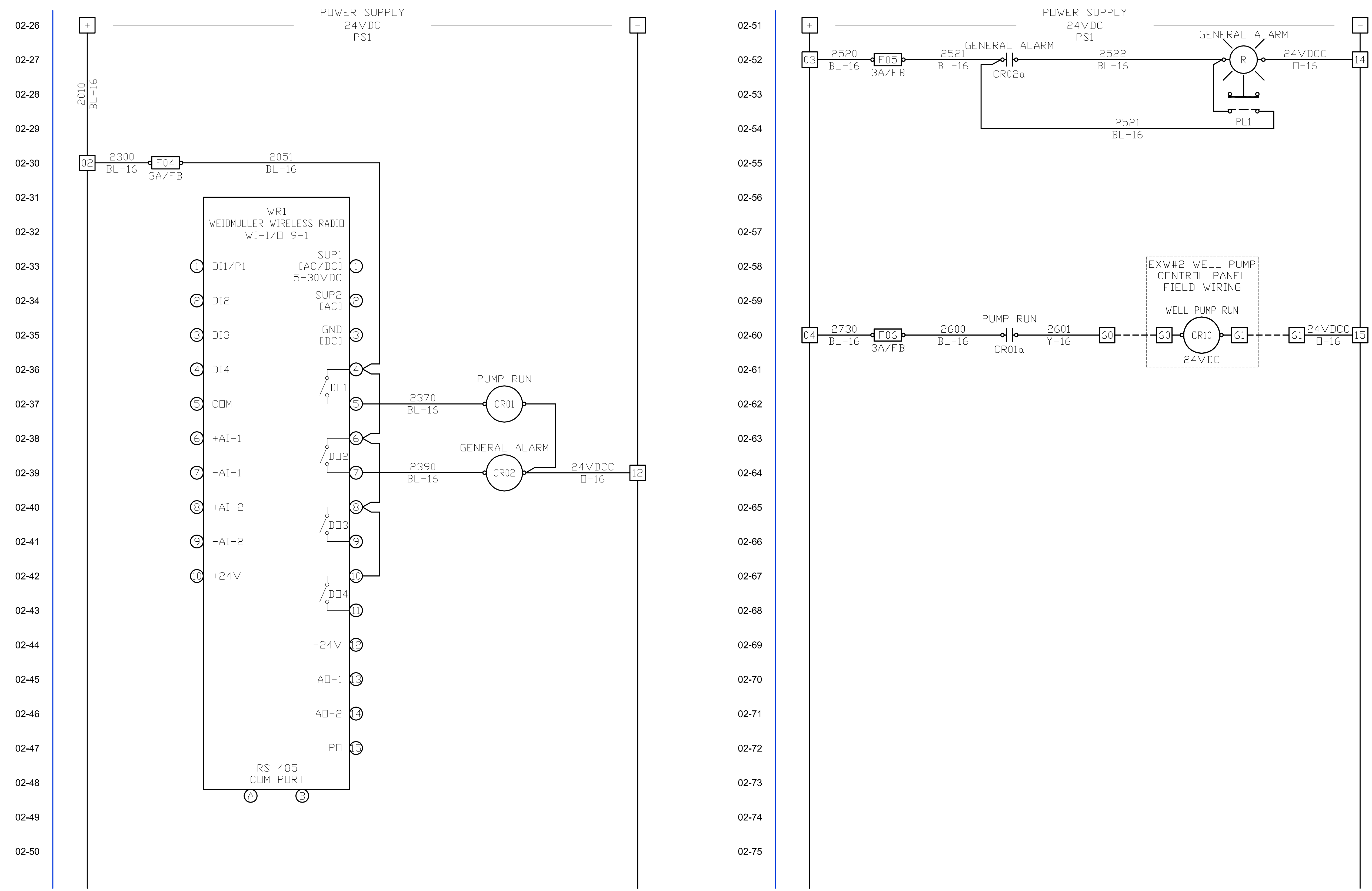

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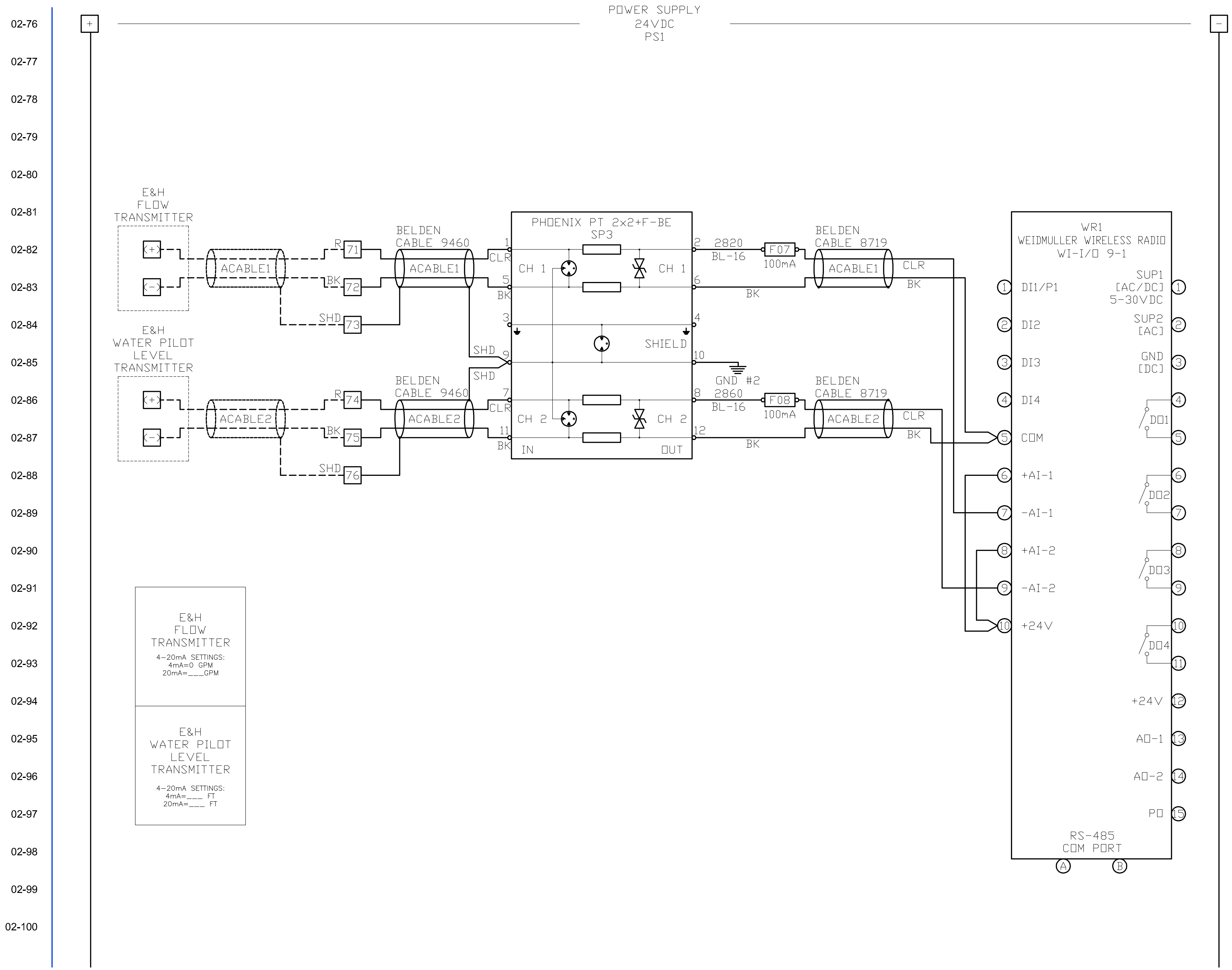

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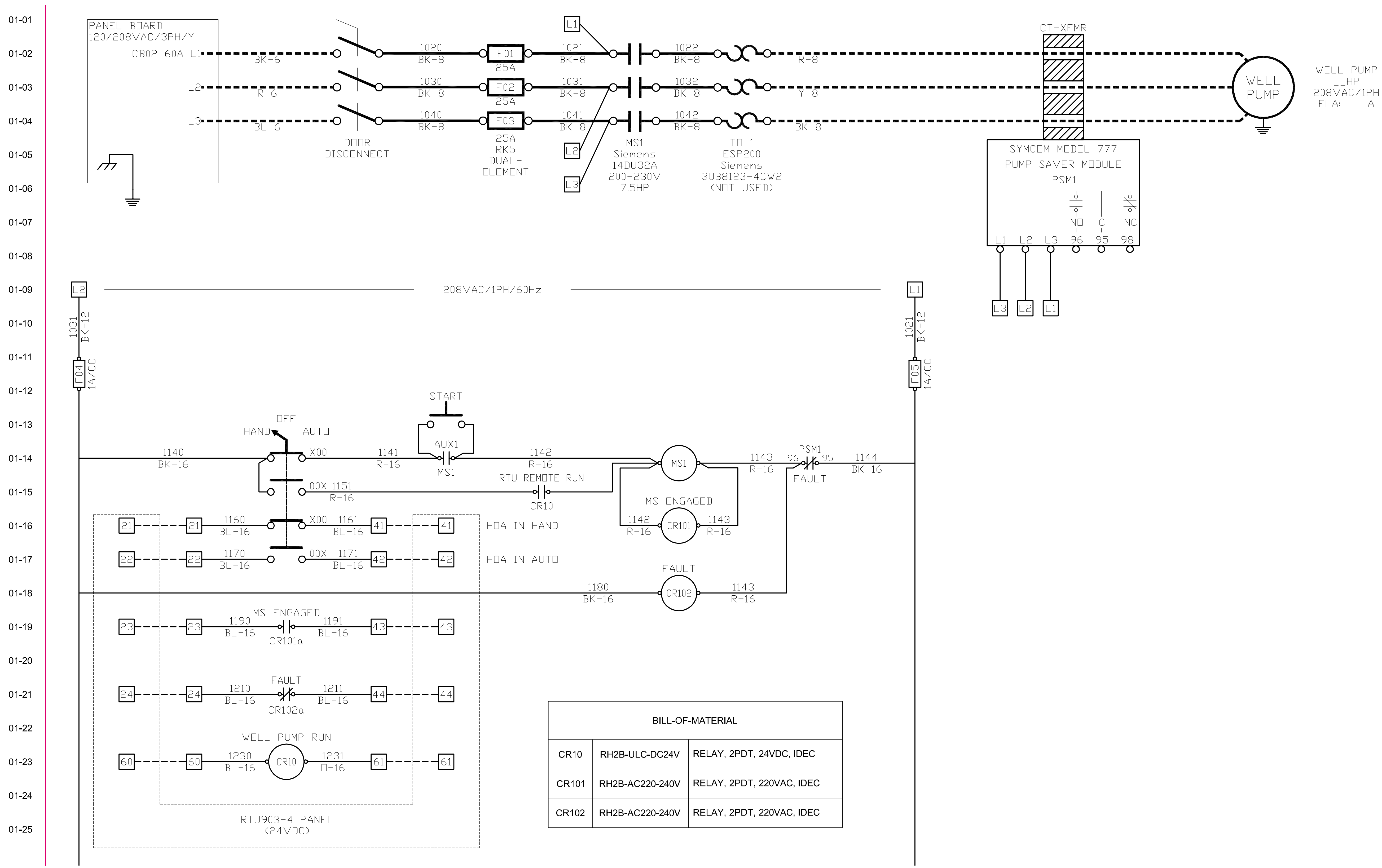

BILL-OF-MATERIAL		
CR10	RH2B-ULC-DC24V	RELAY, 2PDT, 24VDC, IDEC
CR101	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC
CR102	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC

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RTU903-6

SHEET NO.

SC-020

RTU 903-7
B3-EXW05 CONTROL PANEL

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

EXTRACTION WELL 5

RTU903-7 SCADA CONTROL PANEL

WELL PUMP MOTOR CONTROL PANEL

PRELIMINARY - NOT FOR CONSTRUCTION

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CAMP STANLEY
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CAMP STANLEY STORAGE ACTIVITY
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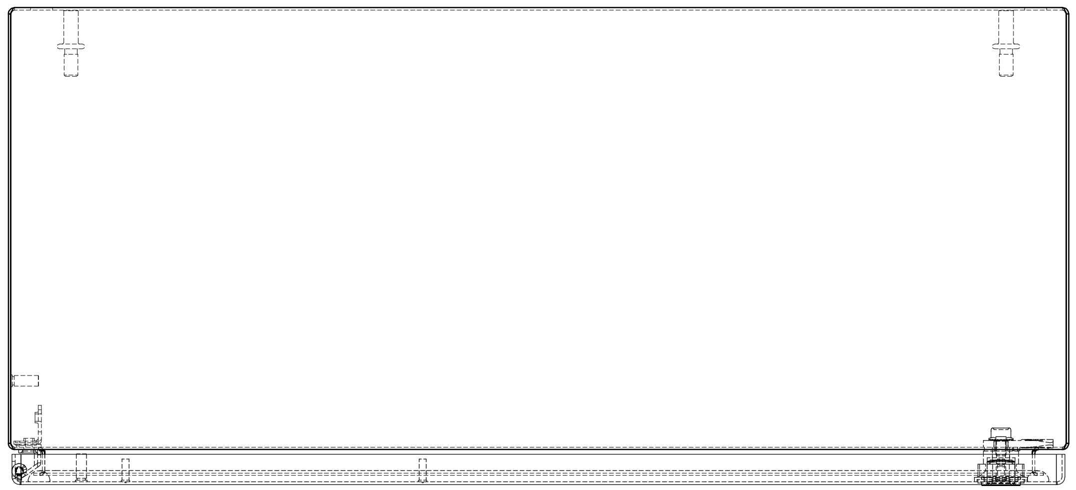

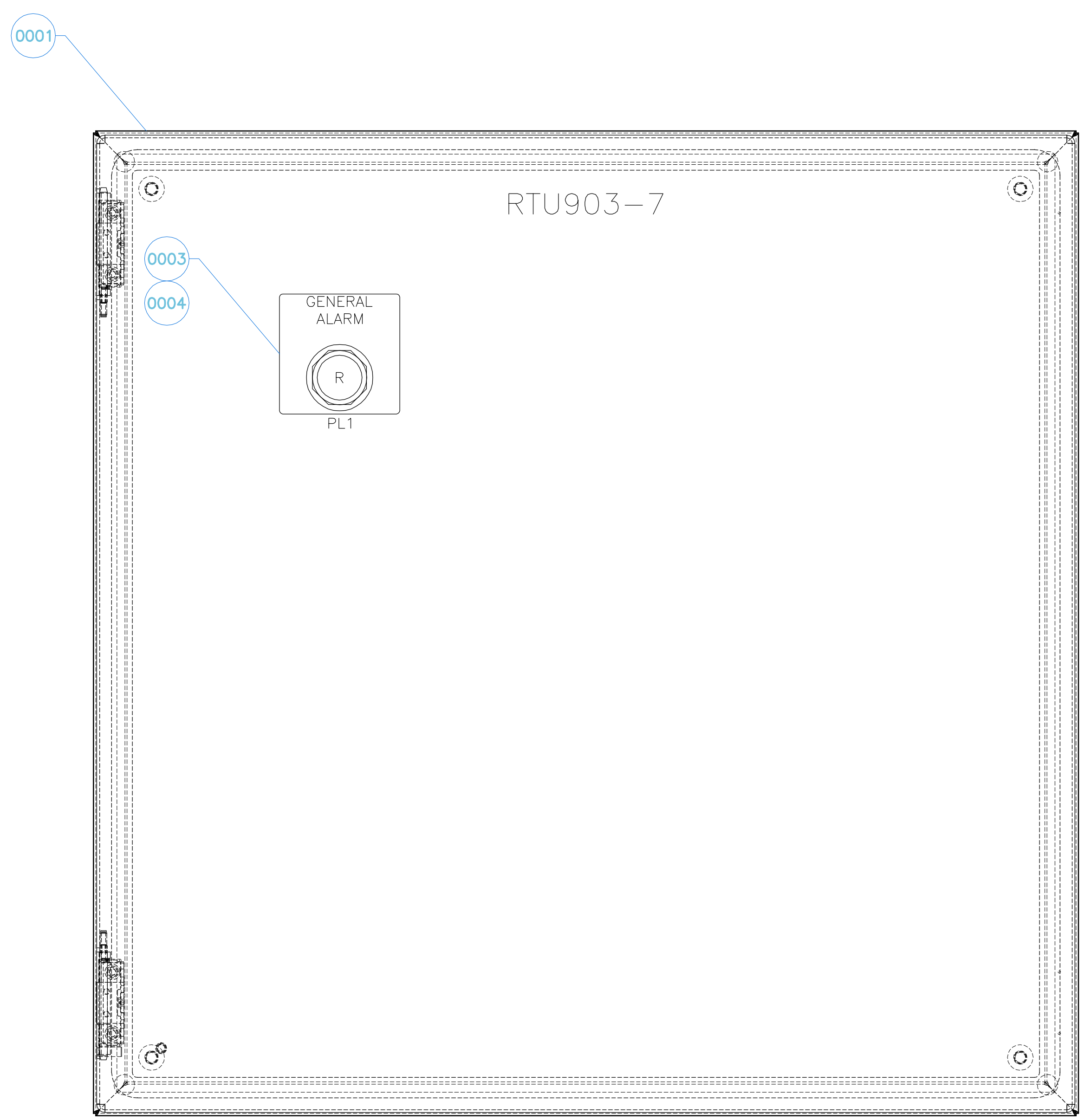

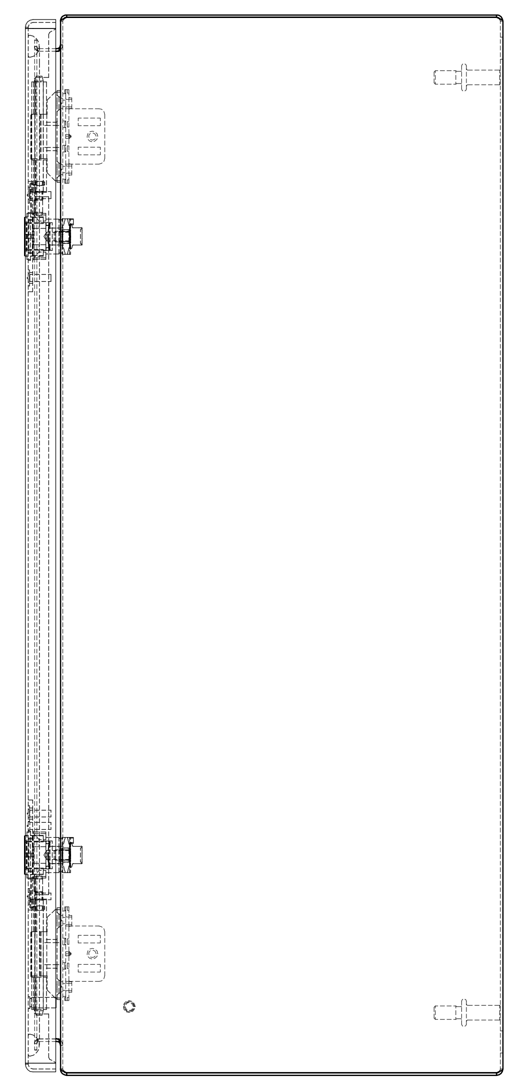

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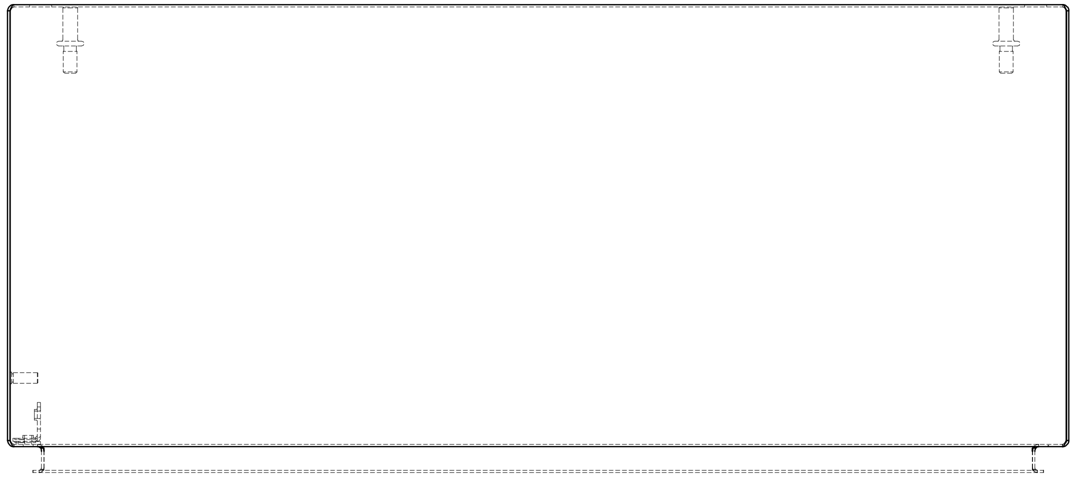
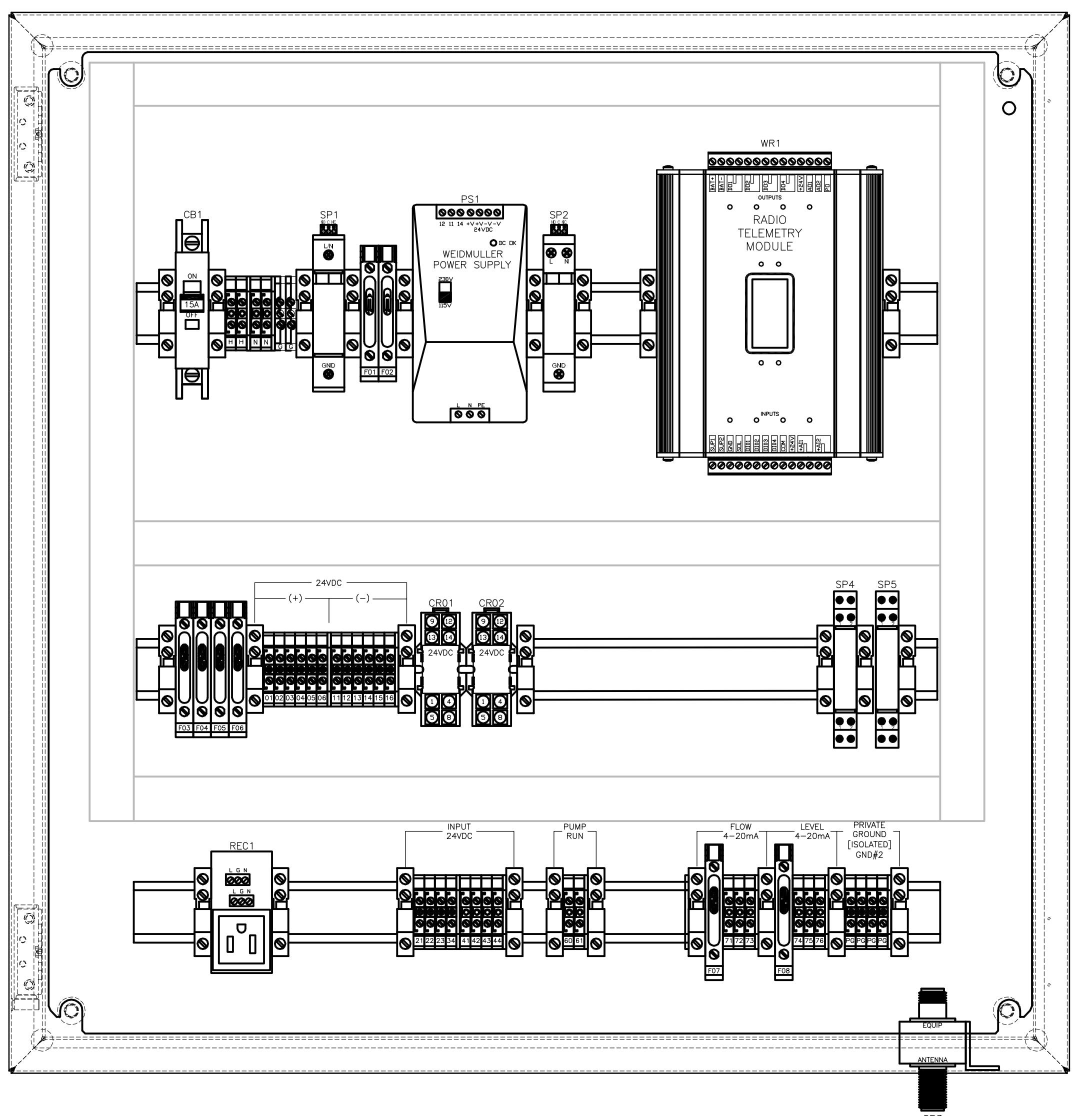
REVISIONS:

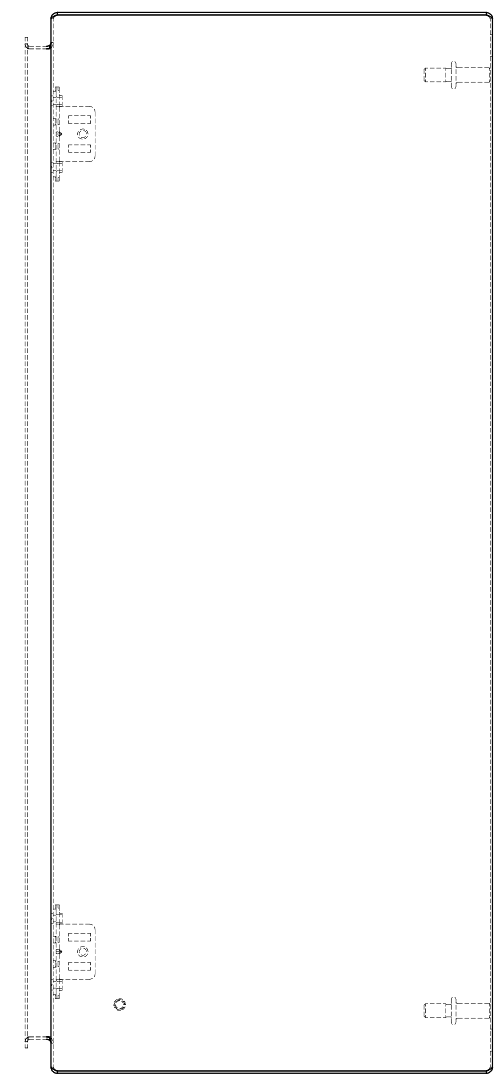
RTU903-7

SHEET NO.

SC-001







NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR	SIZE
GR-16	

COLOR CODE

ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

PARSONS
8000 Centre Park, Suite 200
Austin, Texas 78754

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PROJECT NO. 2012.01

DATE : 04.25.2012

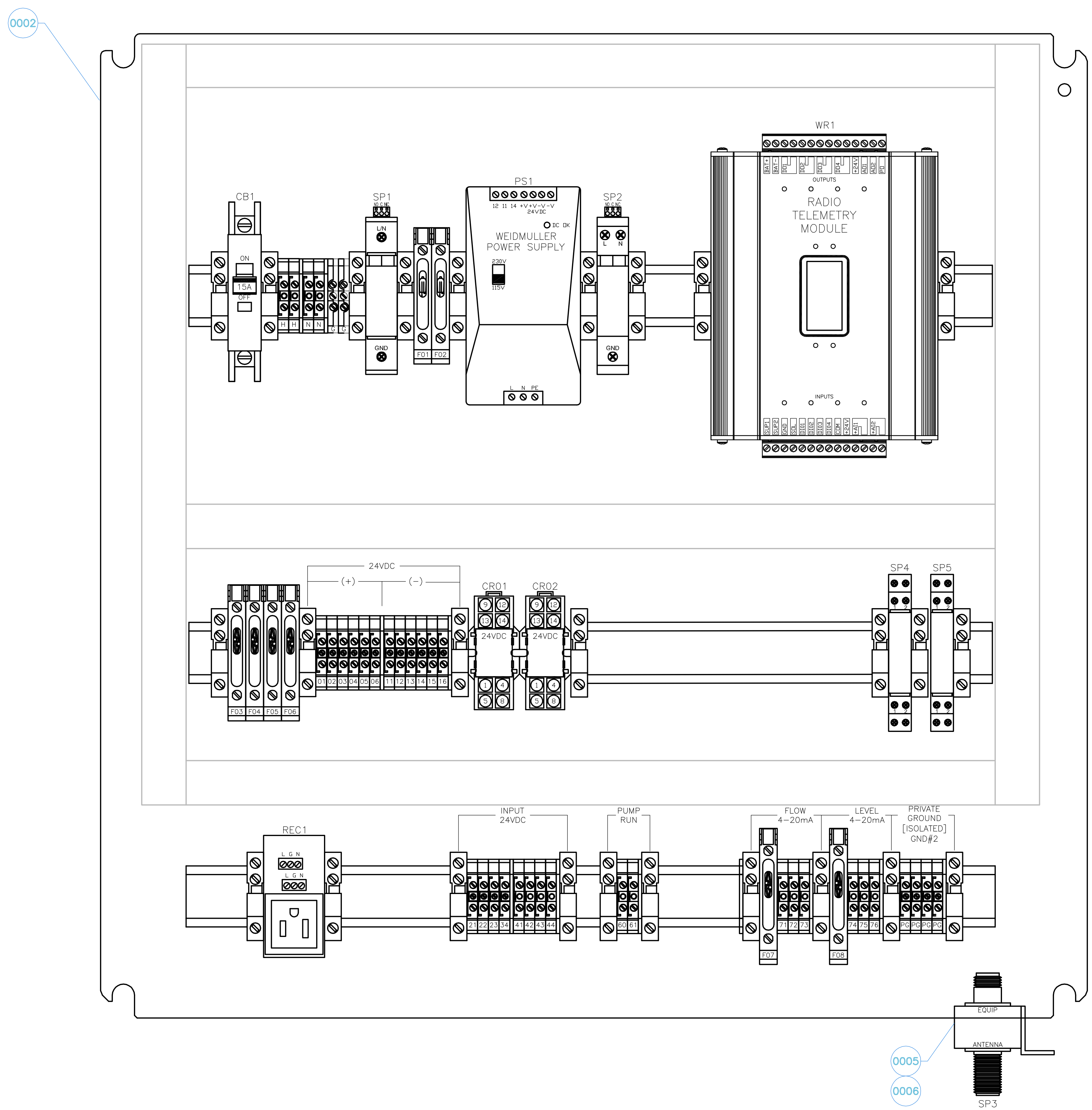
DRAWN : RMF

REVISIONS:

RTU903-7

SHEET NO.

SC-002



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

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DATE : 04.25.2012

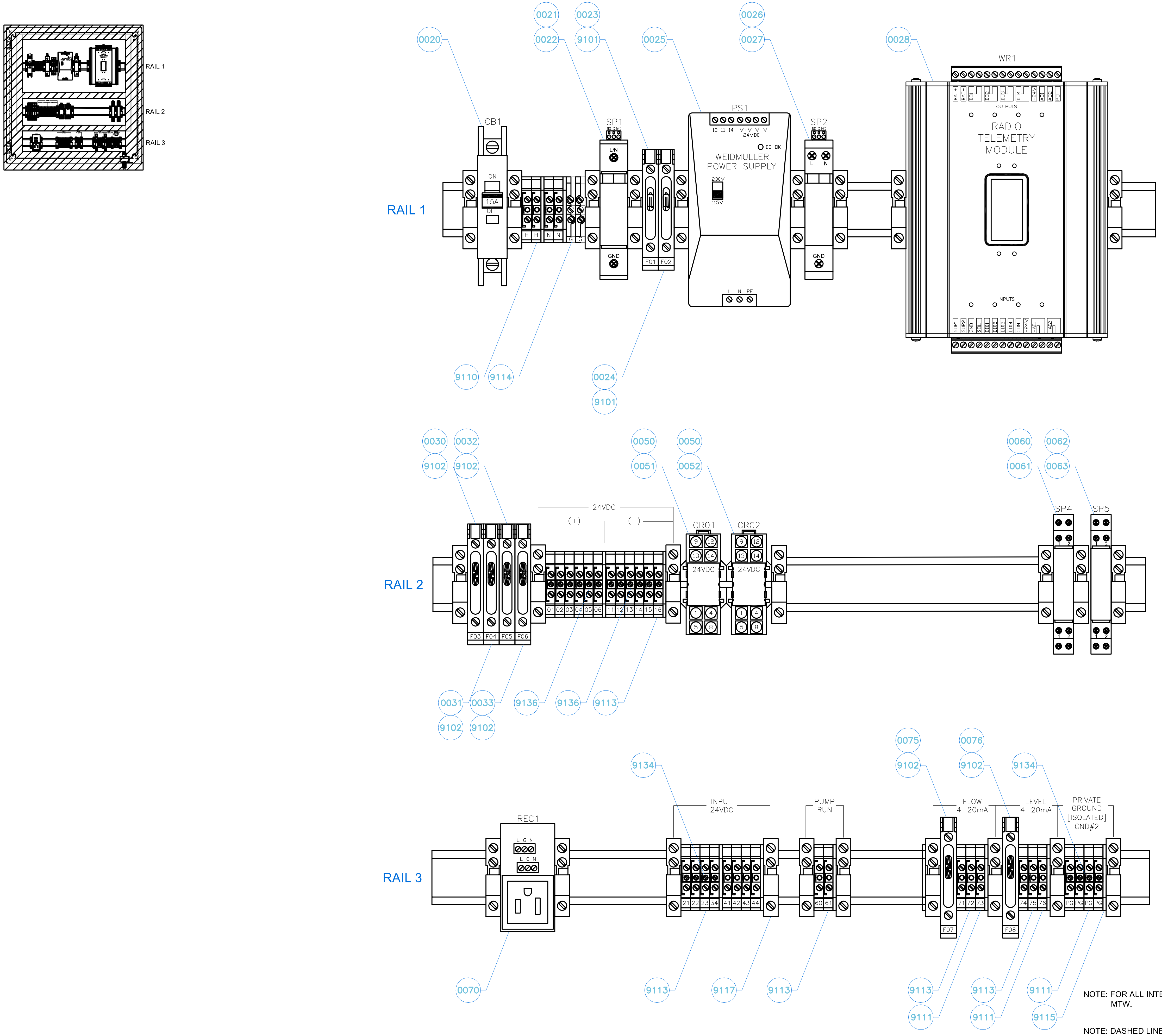
DRAWN : RMF

REVISIONS:

RTU903-7

SHEET NO.

SC-003



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

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CAMP STANLEY
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DATE: 04.25.2012

DRAWN: RMF

REVISIONS:

RTU903-7

SHEET NO.

SC-004

BILL-OF-MATERIAL

ITEM_ID	Count	DEVICE_ID	DESCRIPTION	MFG_NAME	MFG_PN
0001	1	RTU903-7	ENCLOSURE, 24"Hx24"Wx10"D, Nema4X SS	HOFFMAN	CSD242410SS
0002	1		Back Panel, 22.2"x22.2", White Steel	HOFFMAN	CP2424
0003	1	PL1	Plastic Label, 30.5mm Pilot Lamp, Red w/White Lettering, 2.4"Wx2.4"H	CUSTOM	99999
0004	1		Push Button Pilot LED, 30.5mm, 24VDC, Red Lens, 1NO / 1NC	AB	800T-QBH24R
0005	1	SP3	Broadband DC Blocked Protector, 125-1000MHz, 50 ohm, 50-375W, VSWR: 1.1:1, Surge 50kA, N-Female x N-Female	POLYPHASER	IS-B50LN-C2
0006	1		Custom Coax Cable, 18", w/ SMA x N Type Male	CUSTOM	9999
0020	1	CB1	Circuit Breaker, DIN Rail, Class 720, 15A, 120/240VAC, 22K AIR	SQD	QOU115VH
0021	1	SP1	Surge Protection Module, 120VAC, Imax:40kA, Vmax: 150V	CITEL	DS41-120
0022	1		Holder, Surge Protection	CITEL	DS41-120
0023	1		Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0024	1		Fuse, 5x20mm, 5A, Slow Acting	BUSSMANN	MDL-5
0025	1	PS1	Power Supply, DIN-RAIL Mount, 88-132VAC, 176-264VAC, 3A@115VAC, 24VDC@5A	WEIDMULLER	CP SNT 120W 24V 5A
0026	1	SP2	Surge Protection Module, 24VDC, Imax:20kA, Vmax: 56VDC	CITEL	DS220-24DC
0027	1		Holder, Surge Protection	CITEL	DS220-24DC
0028	1	WR1	Wireless Radio, DIN-RAIL Mount, 15-30VDC, 4 inputs, 2- 4-20mA inputs, 4 outputs, 2- 4-20mA outputs, RS232/RS485	WEIDMULLER	WI-I/O 9-1
0030	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0031	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0032	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0033	1		Fuse, 5x20mm, 3A, Fast Acting	BUSSMANN	AGC-3
0050	2		Relay, 2PDT, Coil: 24VDC/ 36.9mA, 1/6HP, w/Indicator & Check Button	IDEC	RH2B-ULC-DC24V
0051	1	CR01	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0052	1	CR02	Relay Mounting Socket, DIN Rail, 2PDT, 300V/10A, 2-#12	IDEC	SH2B-05
0060	1	SP4	Surge Protection Module, 4-20mA, Imax:20kA, Vmax: 28VDC	CITEL	DLA-24D3
0061	1		Holder, Surge Protection, DLA Series	CITEL	DLA-24D3
0062	1	SP5	Surge Protection Module, 4-20mA, Imax:20kA, Vmax: 28VDC	CITEL	DLA-24D3
0063	1		Holder, Surge Protection, DLA Series	CITEL	DLA-24D3
0070	1	REC1	Receptacle, Simplex 15A, 120vac, DIN Rail Mount	WEIDMULLER	991548
0075	1		Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
0076	1		Fuse, 5x20mm, 100mA, Fast Acting	BUSSMANN	GMA-100-R
9101	2		Fuse Block, ILL 110-250V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILA 250
9102	6		Fuse Block, ILL 15-30V, 600V/10A, 26-8AWG	PHOENIX	UK 6,3-HESILED 24
9110	4		Terminal Block, Gray, 600V/30A, 30-10AWG	PHOENIX	UK 5 N
9111	6		Terminal Block, Green, 600V/30A, 30-10AWG	PHOENIX	UK 5 N GN
9113	26		Terminal Block, Orange, 600V/30A, 30-10AWG	PHOENIX	UK 5 N OG
9114	2		Ground Terminal, 26-10AWG	PHOENIX	UKLKG 5
9115	11		End Cover Plate, Gray	PHOENIX	D-UK 4/10
9117	26		End Clamp, Gray	PHOENIX	E/UK
9134	2		Cross Connector/ Jumper, Cut to 4 Position, Al	PHOENIX	FBI 10-6
9136	2		Cross Connector/ Jumper, Cut to 6 Position, Al	PHOENIX	FBI 10-6

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE	
ID	COLOR
CLR	Clear
BK	Black
BR	Brown
R	Red
OR	Orange
Y	Yellow
G	Green
BL	Blue
PU	Purple
GY	Grey
W	White

CAMP STANLEY
BIOREACTOR UPGRADE PROJECT

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

PARSONS
8000 CENTRE PARK, SUITE 200
AUSTIN, TEXAS 78754

PROJECT NO. 2012.01
DATE : 04.25.2012
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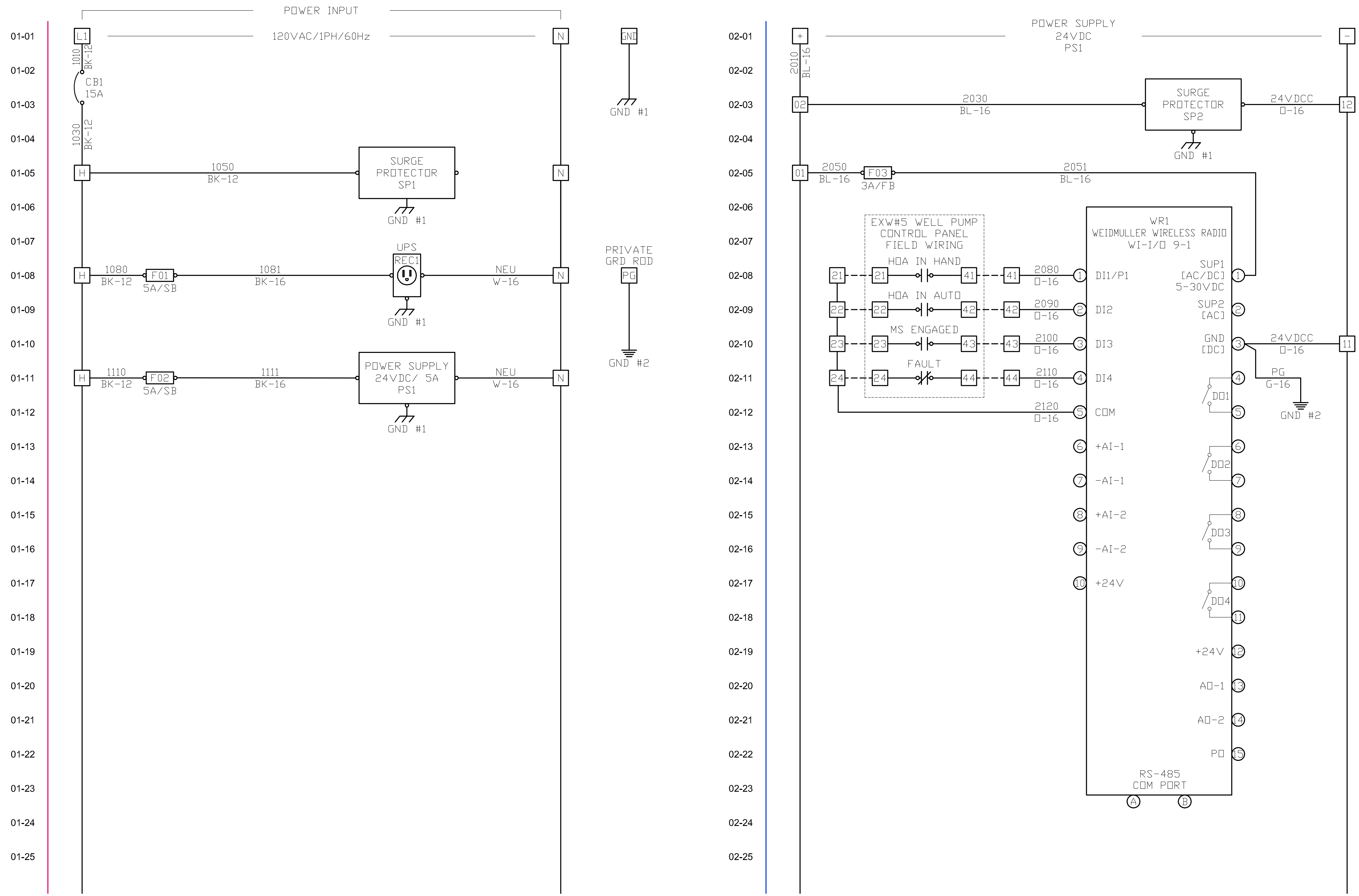
REVISIONS:

RTU903-7

SHEET NO.
SC-005



NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE

ID	COLOR
CLR	Clear
BK	Black
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CAMP STANLEY
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BOERNE, TEXAS

PROJECT NO. 2012.01

DATE : 04.25.2012

DRAWN : RMF

REVISIONS:

RTU903-7

SHEET NO.

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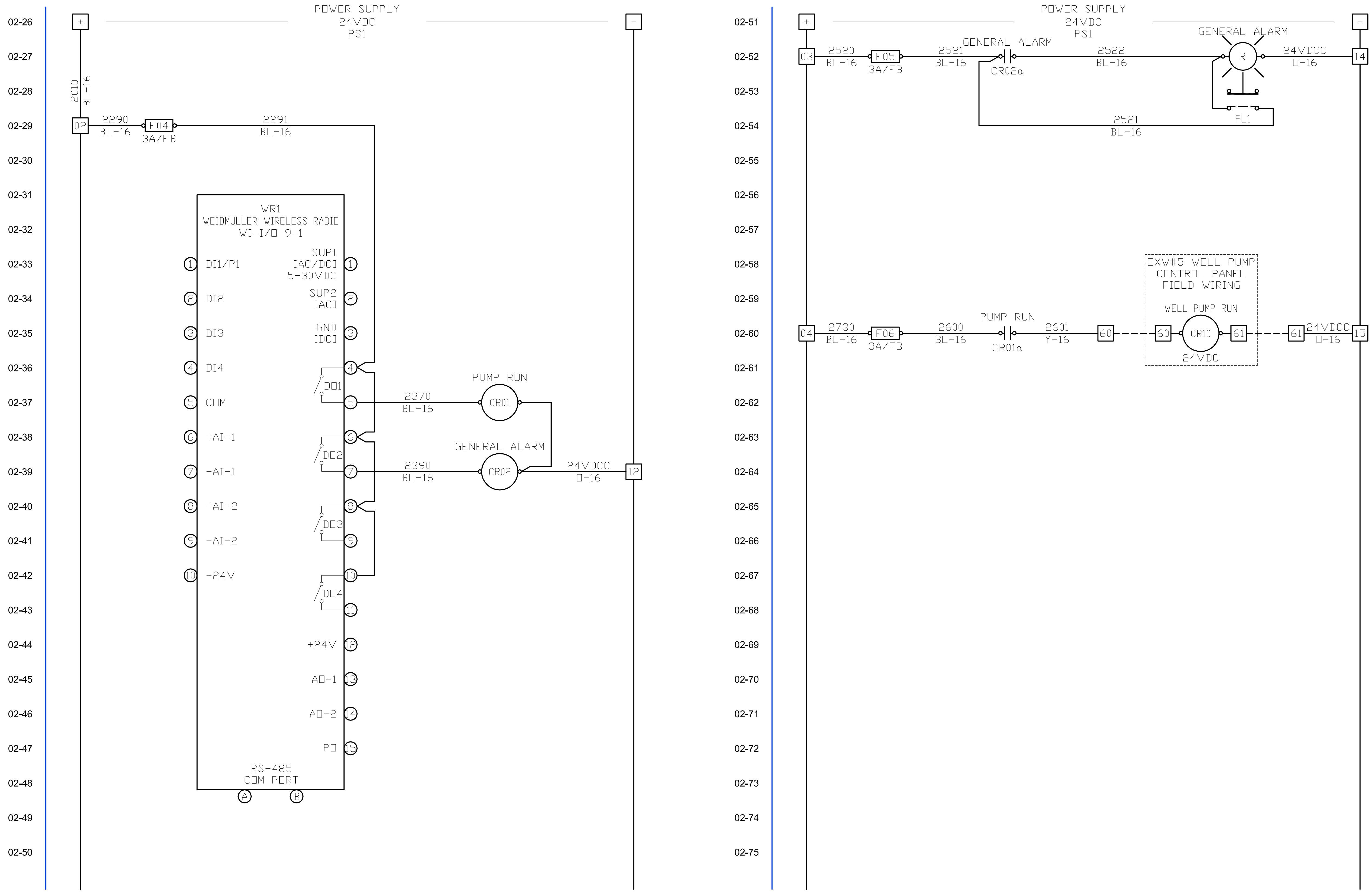

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

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WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE

ID	COLOR
CLR	Clear
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GY	Grey
W	White

PARSONS

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PROJECT NO. 2012.01

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REVISIONS:

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SHEET NO.

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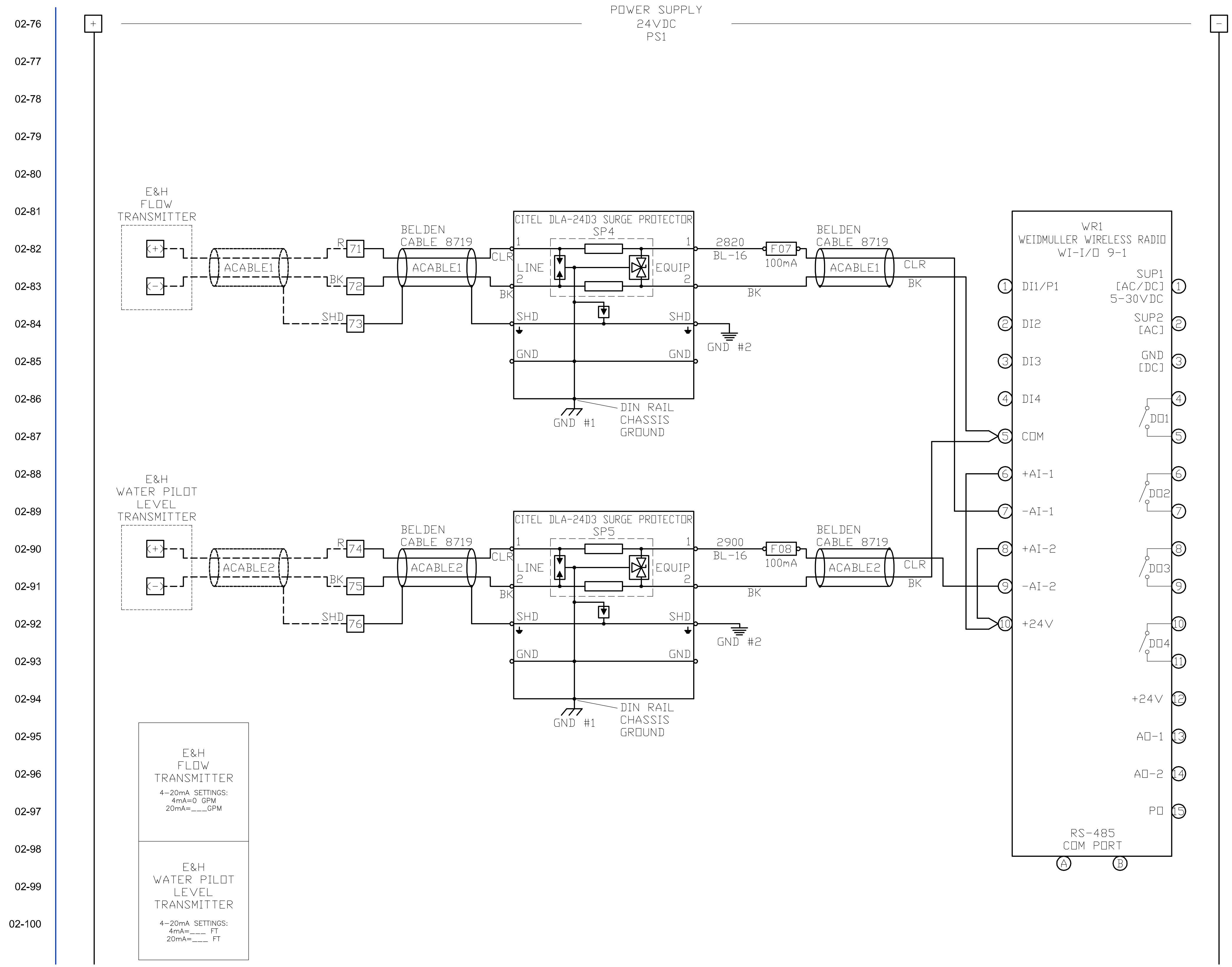

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

NOTE: DASHED LINES INDICATE FIELD WIRING.

WIRE MARKER LEGEND

COLOR SIZE

GR-16

COLOR CODE

ID	COLOR
CLR	Clear
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CAMP STANLEY
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REVISIONS:

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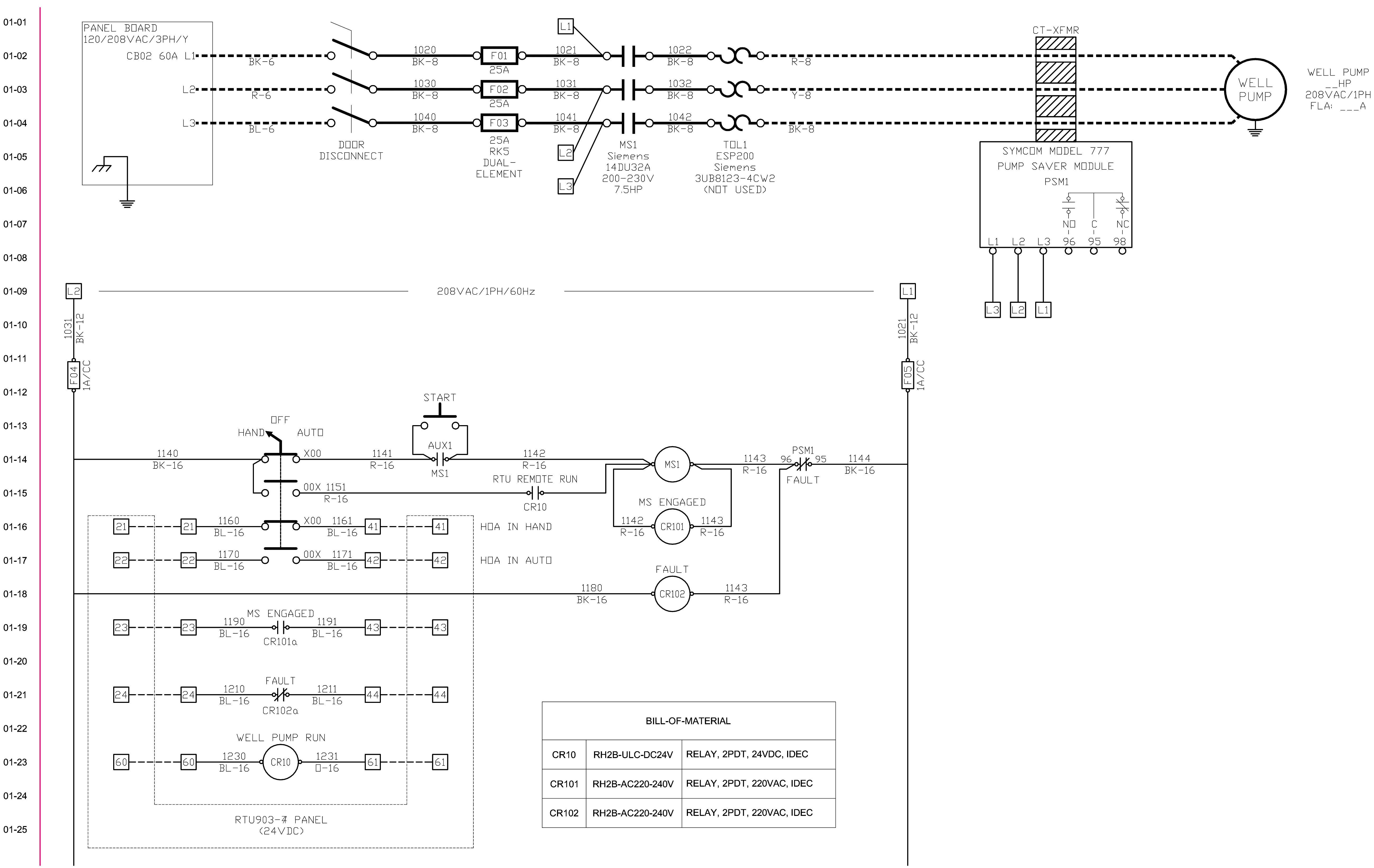
SHEET NO.

SC-012



BILL-OF-MATERIAL

CR10	RH2B-ULC-DC24V	RELAY, 2PDT, 24VDC, IDEC
CR101	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC
CR102	RH2B-AC220-240V	RELAY, 2PDT, 220VAC, IDEC

NOTE: FOR ALL INTERNAL WIRING, USE TYPE MTW.

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WIRE MARKER LEGEND

COLOR	SIZE
GR-16	

COLOR CODE

ID	COLOR
CLR	Clear
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DATE: 04.25.2012
DRAWN: RMF
REVISIONS:

RTU903-7

SHEET NO.
SC-020

Appendix G
Product Information
SCADA Control Components

RTU 903-1
BIOREACTOR BUILDING MAIN CONTROL PANEL EQUIPMENT

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.

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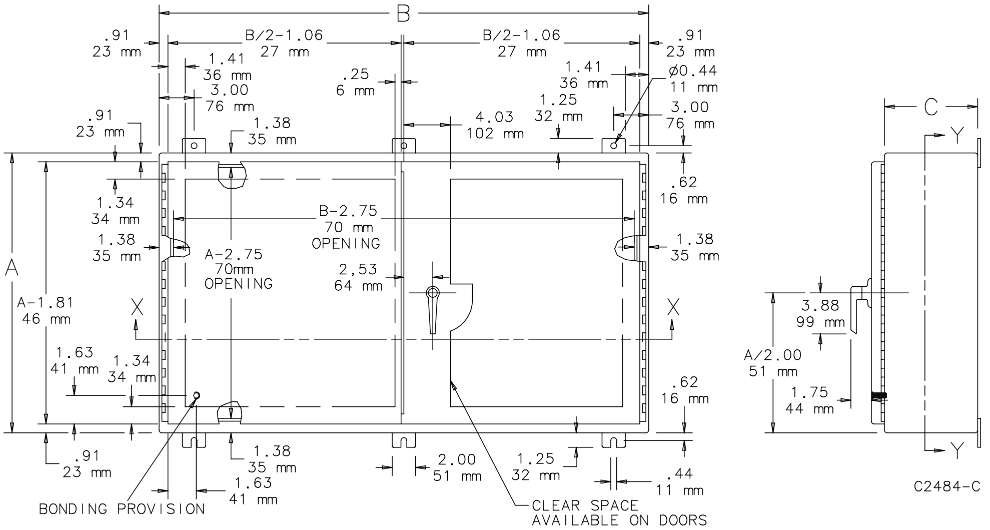
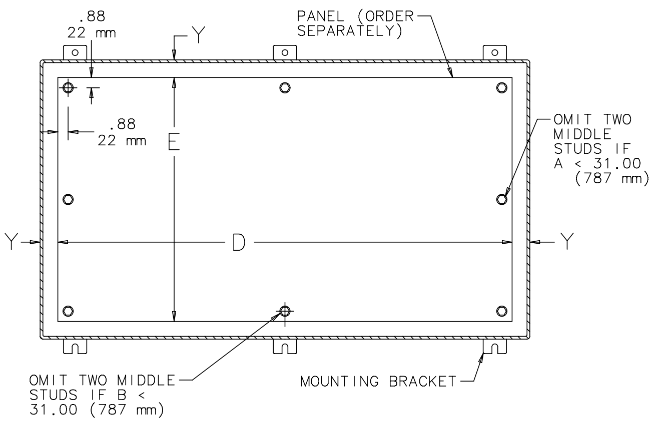
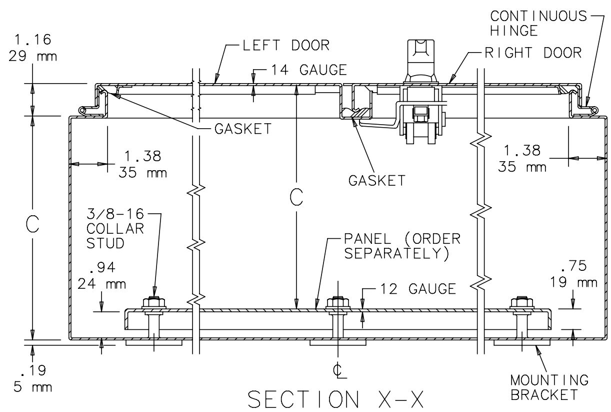
Type 12 Wall-Mount Enclosures





SECTION Y-Y



SECTION X-X

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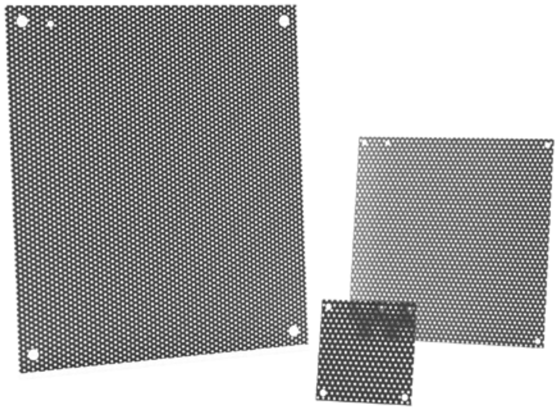
Panels for Enclosures

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.

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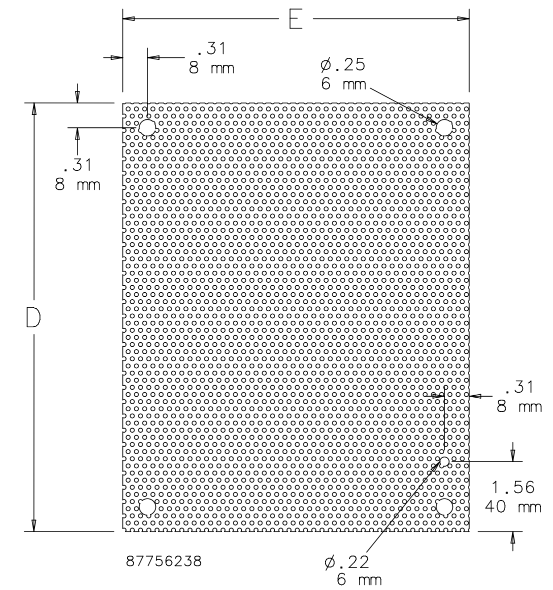
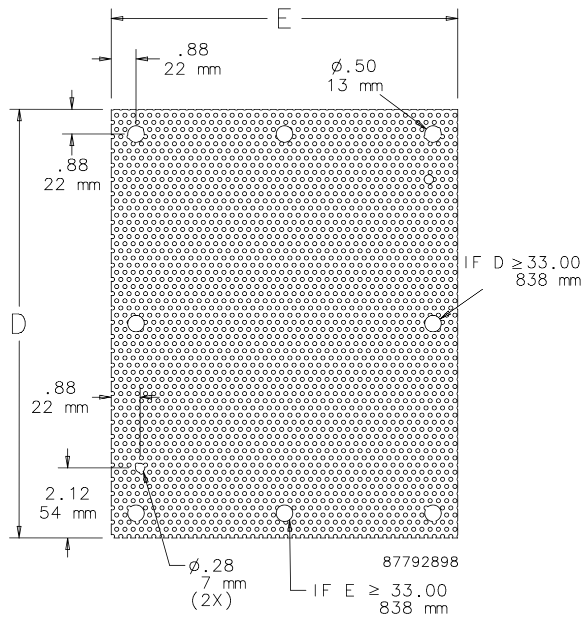
Panels for Enclosures

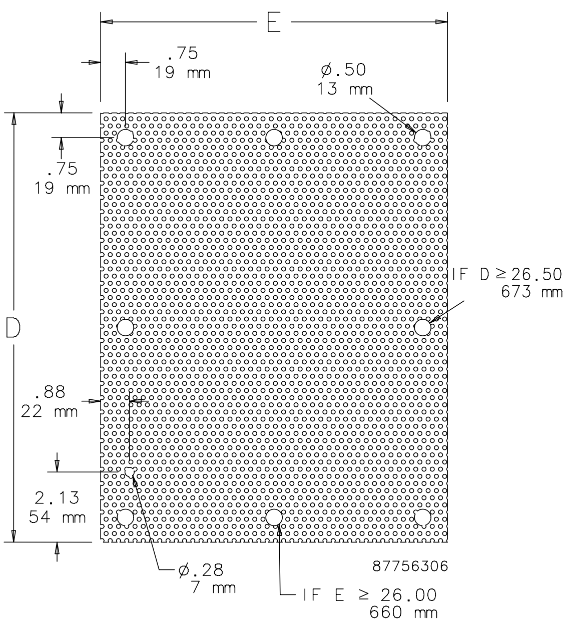
Small Perforated Panels



Medium Type 3R Hinged Cover Perforated Panels



Medium Type 1 Perforated Panels



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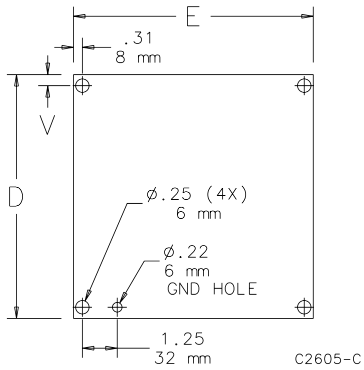
Panels for Junction Boxes



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

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Panels for Enclosures

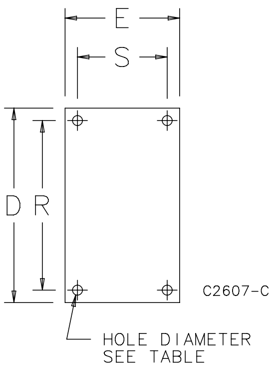
Composite Panels for Junction Boxes and UL/NEMA Wall-Mount Enclosures

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	4.25	2.25	0.25	0.12
	124 x 73	108	57	6	3
A6P6C	4.88 x 4.88	4.25	4.25	0.25	0.12
	124 x 124	108	108	6	3
A8P6C	6.75 x 4.88	6.25	4.25	0.25	0.12
	171 x 124	159	108	6	3
A10P8C	8.75 x 6.88	8.25	6.25	0.25	0.12
	222 x 175	210	159	6	3
A12P10C	10.75 x 8.88	10.25	8.25	0.25	0.19
	273 x 226	260	210	6	5
A14P12C	12.75 x 10.88	12.25	10.25	0.25	0.19
	324 x 276	311	260	6	5
A16P14C	14.75 x 12.88	14.25	12.25	0.25	0.19
	375 x 327	362	311	6	5
A18P16C	16.75 x 14.88	16.25	14.25	0.25	0.19
	425 x 379	413	362	6	5
A20P16C	17.00 x 13.00	15.25	11.25	0.50	0.19
	432 x 330	387	286	13	5
A20P20C	17.00 x 17.00	15.25	15.25	0.50	0.19
	432 x 432	387	387	13	5
A24P20C	21.00 x 17.00	19.25	15.25	0.50	0.19
	533 x 432	489	387	13	5
A24P24C	21.00 x 21.00	19.25	19.25	0.50	0.19
	533 x 533	489	489	13	5
A30P24C	27.00 x 21.00	25.25	19.25	0.50	0.19
	686 x 533	641	489	13	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

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Panels for Enclosures

Junction Box and Wall-Mount Enclosure Swing-Out Panel Kit

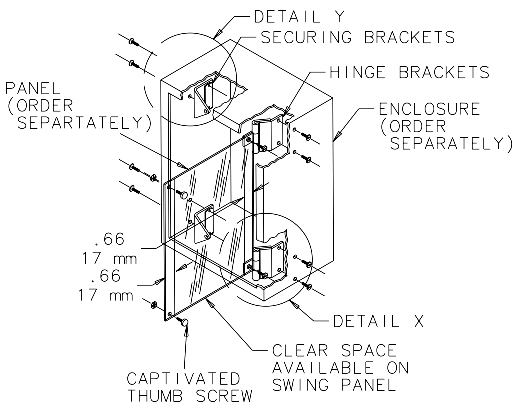

Kits allow mounting standard Hoffman junction box and NEMA style panels (purchase separately) near the front of the enclosure for easy access to or reading of gauges, switches, pilot lights and other components. Kits consist of heavy-gauge brackets and hinges which are easily installed by drilling small 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.

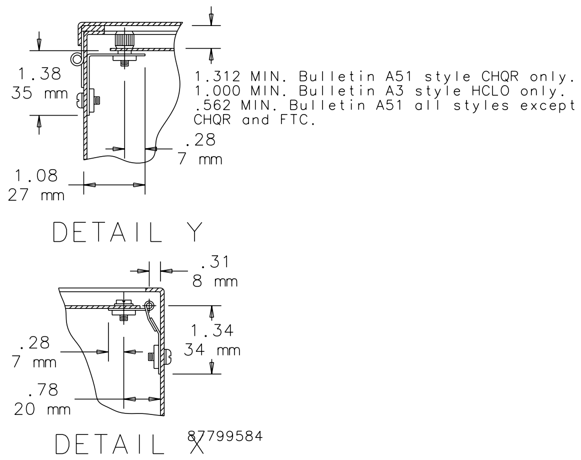
Bulletin: A80

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

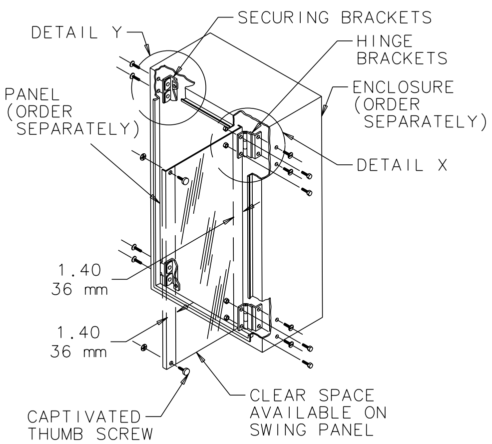
Both kits maintain UL Type 4 rating when properly installed in a Hoffman enclosure.
Maximum load includes the weight of the panel plus the weight of the components, with the weight of the components spread evenly over the panel.

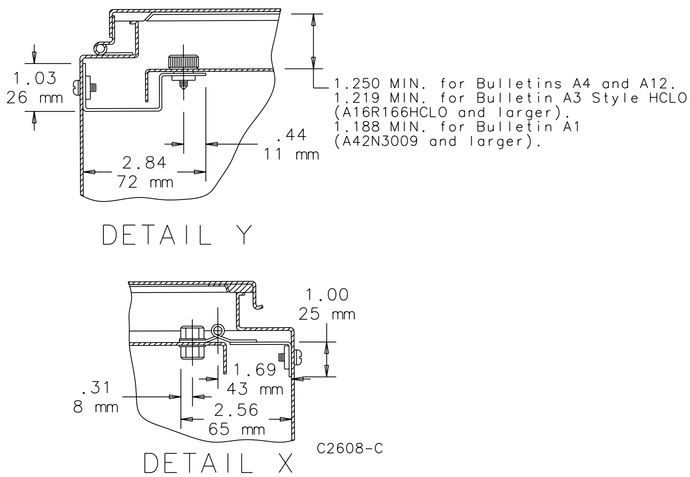
Junction Box Swing-Out Panel Kit





Wall-Mount Enclosure Swing-Out Panel Kit





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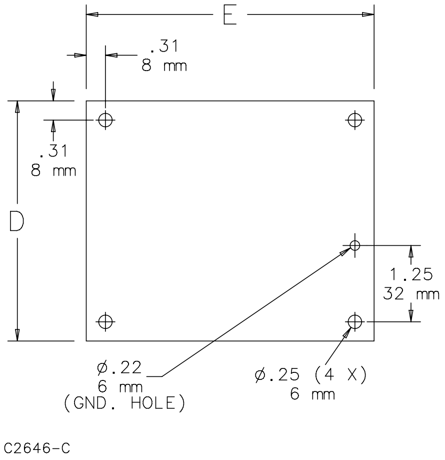
Panels for Enclosures

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



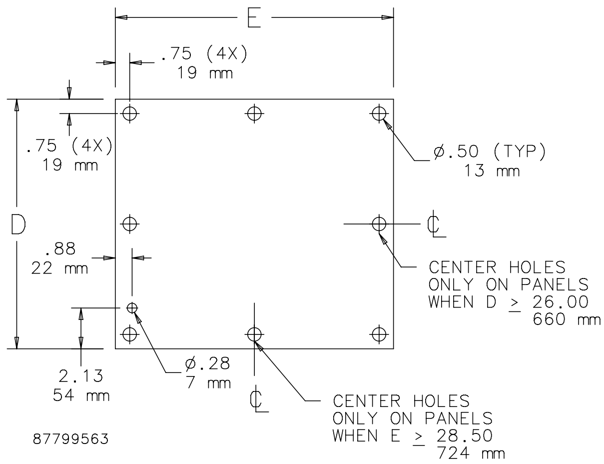
Catalog Number	Panel Size D x E (in.)	Panel Size D x E (mm)
A6N4P	4.25 x 2.25	108 x 57
A6N6P	4.25 x 4.25	108 x 108
A8N6P	6.25 x 4.25	159 x 108
A8N8P	6.25 x 6.25	159 x 159
A10N8P	8.25 x 6.25	210 x 159
A10N10P	8.25 x 8.25	210 x 210
A12N10P	10.25 x 8.25	260 x 210
A12N12P	10.25 x 10.25	260 x 260
A14N12P	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



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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

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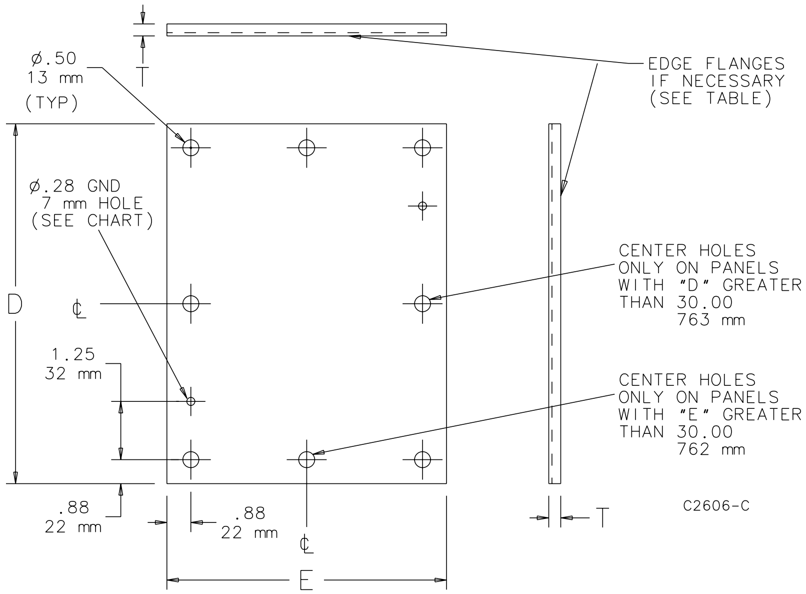
Panels for Enclosures

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



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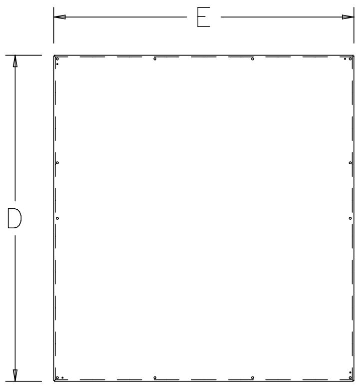
Panels for Large Bulletin A27, A28, A28S4 and A34 Multi-Door Enclosures

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.



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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

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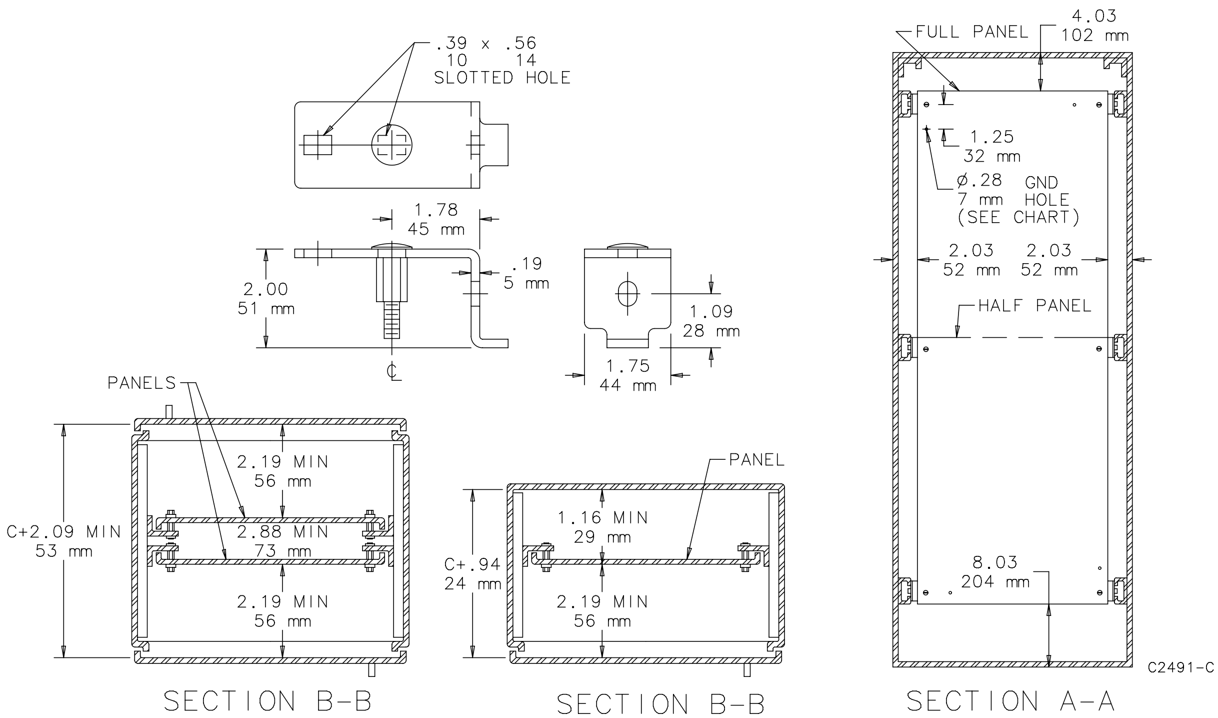
Panels for Free-Stand Type 4, 4X and 12 Single- and Dual-Access One-Door Enclosures with Mounting Channel

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.



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Panels for Enclosures

Panels for Free-Standing Type 4, 4X and 12 Single- and Dual-Access Two-Door Enclosures with Mounting Channel

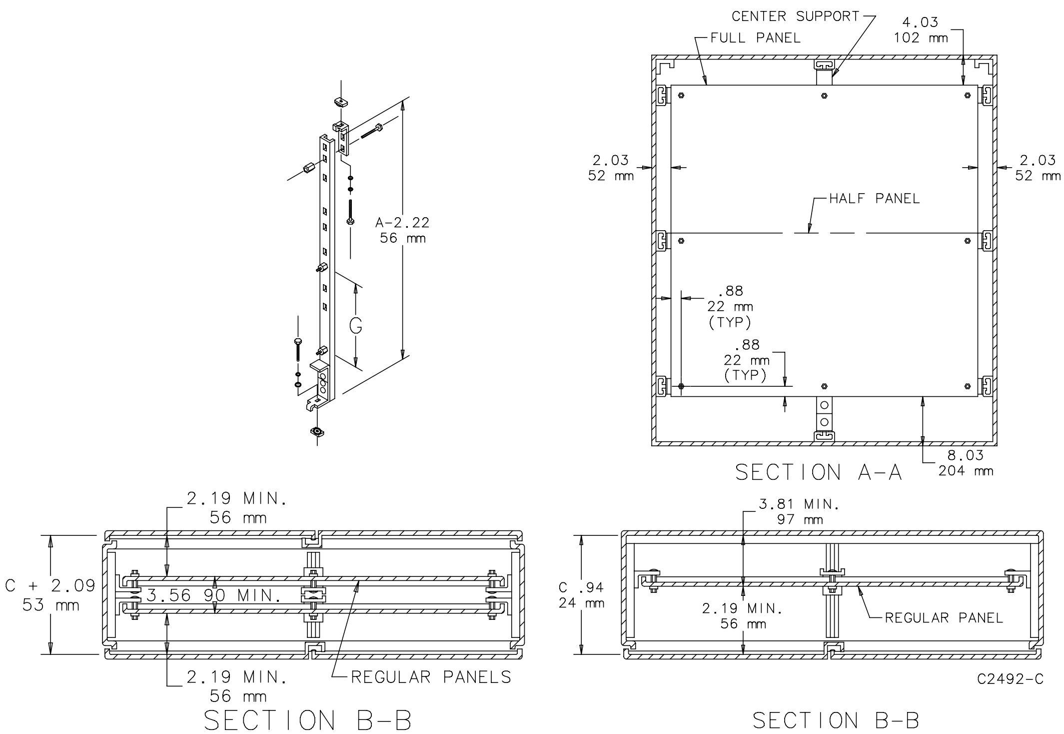
Panels for two-door single access and two-door dual access Free-Stand Type 4, 4X and 12 Enclosures with mounting channel are 10 gauge steel and can be positioned anywhere along horizontal mounting channels (see Sections B-B for limitations). Half-length panels can be located in the upper or lower portion 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



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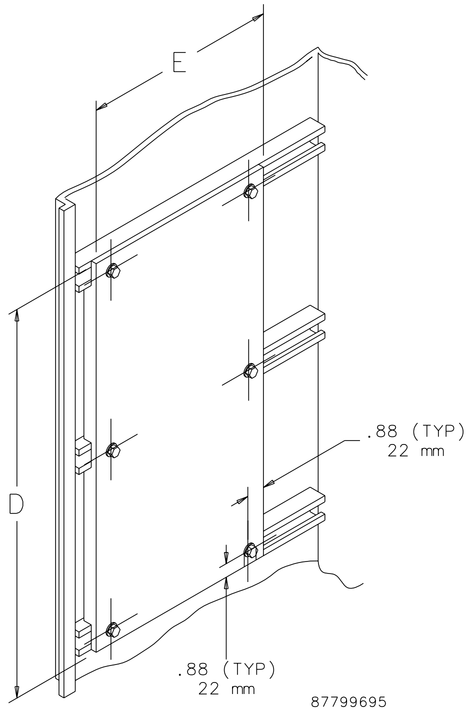
Panels for Enclosures

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



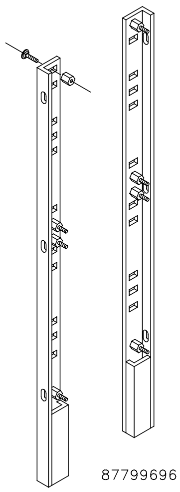
Catalog Number	Description	Panel Size D x E in./mm	Fits Enclosure A in./mm
A60SMP14	Painted steel	48.00 x 14.00 1219 x 356	60.00 1524
A60SMP14G	Conductive	48.00 x 14.00 1219 x 356	60.00 1524
A72SMP14	Painted steel	60.00 x 14.00 1524 x 356	72.00 1829
A72SMP14G	Conductive	60.00 x 14.00 1524 x 356	72.00 1829
A72SMP20	Painted steel	60.00 x 20.00 1524 x 508	72.00 1829
A72SMP20G	Conductive	60.00 x 20.00 1524 x 508	72.00 1829
A90SMP14	Painted steel	78.00 x 14.00 1981 x 356	90.00 2286
A90SMP14G	Conductive	78.00 x 14.00 1981 x 356	90.00 2286
A90SMP20	Painted steel	78.00 x 20.00 1981 x 508	90.00 2286
A90SMP20G	Conductive	78.00 x 20.00 1981 x 508	90.00 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 1524	57.25 1454
A72FSHDPS	72.00 1829	69.25 1759
A90FSHDPS	90.00 2286	87.25 2216

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Panels for Enclosures

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.

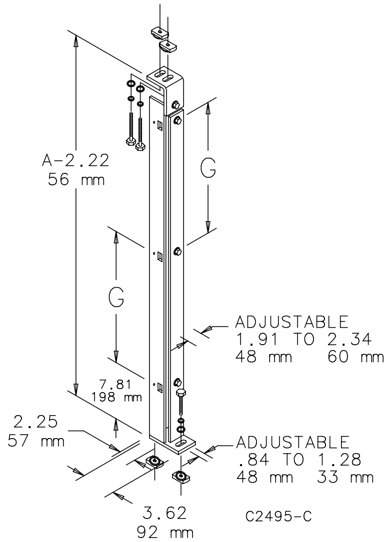
Bulletin: A80

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



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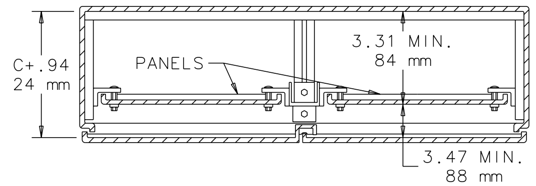
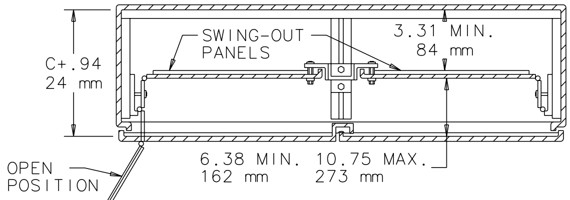
Panels for Enclosures

Center Panel Supports Enclosure Section Views



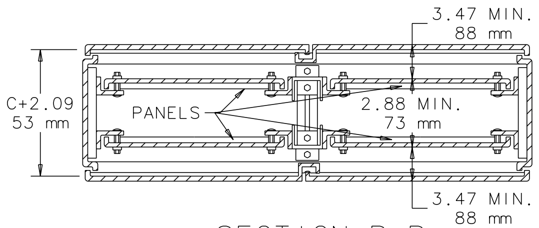
SECTION B-B

Showing two panels (for one-door enclosures)and center panel support mounted in two-door enclosure.



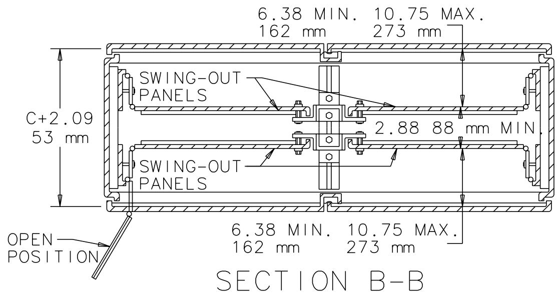
SECTION B-B

Showing four swing-out panels and center panel support mounted in two-door enclosure.



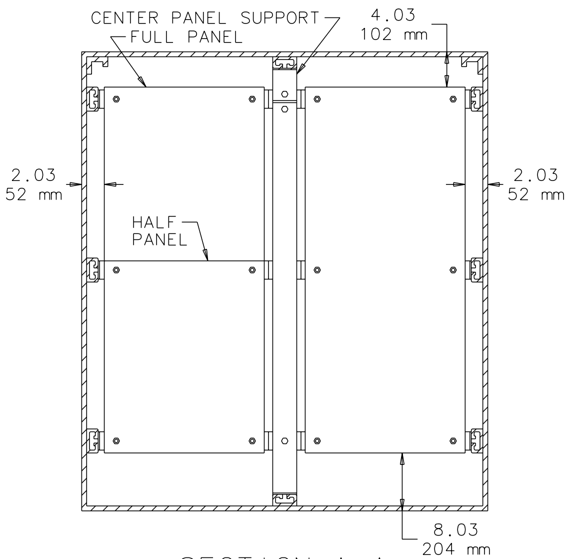
SECTION B-B

Showing four panels (for one-door enclosures) and two center panel supports mounted in two-door access enclosure.



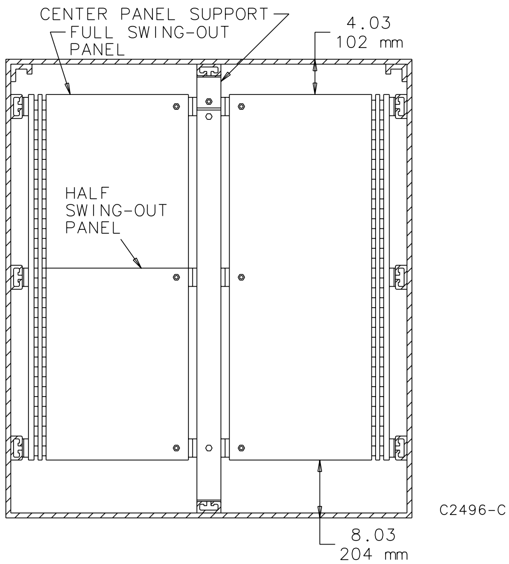
SECTION B-B

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.

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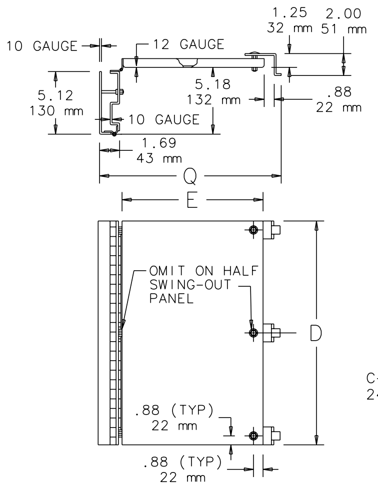
Panels for Enclosures

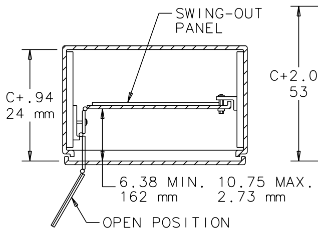
Swing-Out Panels for Free-Stand Type 4, 4X and 12 Enclosures with Mounting Channel

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

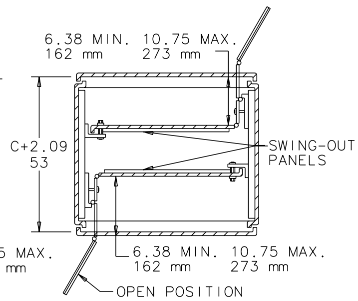
Catalog Number	Description	Panel Size D x E (in.)	Panel Size D x E (mm)	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)	Q (in.)	Q (mm)
A72SP24F3	Full Panel	60.00 x 18.81	1524 x 478	72.00 x 24.00	1829 x 610	21.84	555
A72SP24F4	Half Panel	30.88 x 18.81	784 x 478	72.00 x 24.00	1829 x 610	21.84	555
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





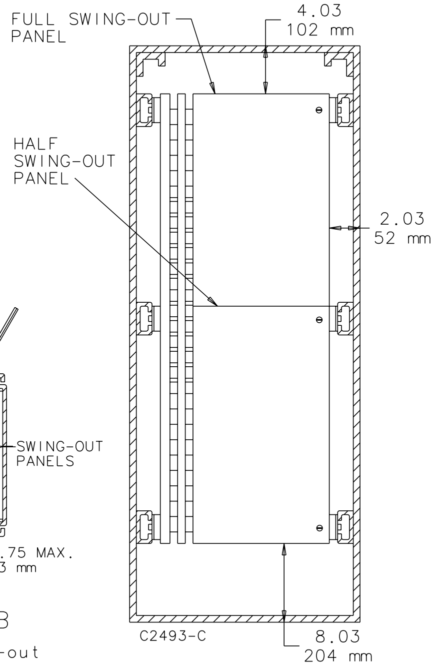
SECTION B-B

Showing swing-out panel mounted in one-door enclosure



SECTION B-B

Showing two swing-out panels mounted in one-door dual access enclosure



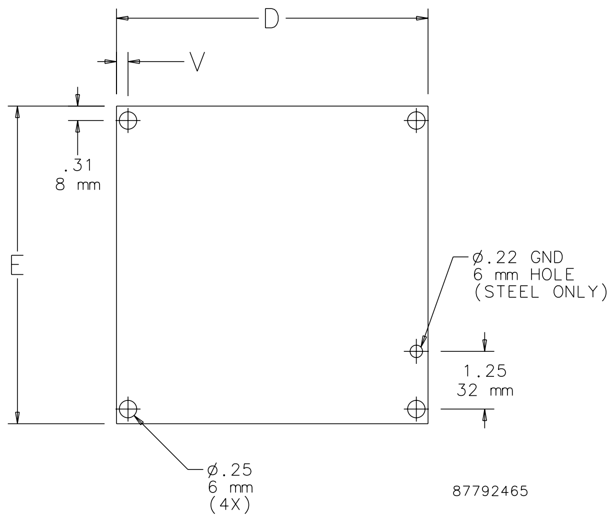
SECTION A-A

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



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Hardware User's Guide

6" QuickPanel View

Intermediate, color STN & monochrome, round bezel

IC754VSI06STD

IC754VBI06STD

IC754VSI06MTD

IC754VBI06MTD

January 2007

GFK-2325A

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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.

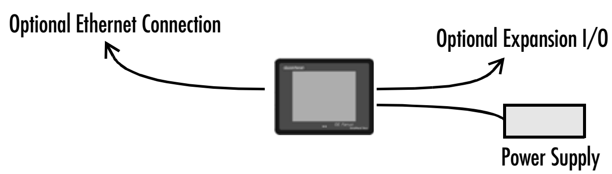
The QuickPanel View is equipped with several memory types to satisfy even the most demanding applications. A 32 MB section of DRAM is split between the operating system, an object store, and application memory. A 32 MB section of non-volatile FLASH memory, functioning as a virtual hard drive, is divided 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

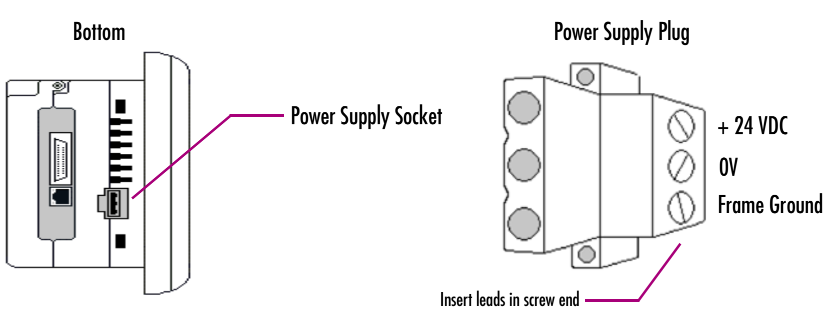
Your 6" QuickPanel View is shipped ready for use after a few configuration steps. To power up all you need to do is connect a DC power supply via the supplied quick-connect plug. Depending on your application, you may also want to connect and configure optional input devices (see page 31), communications 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.

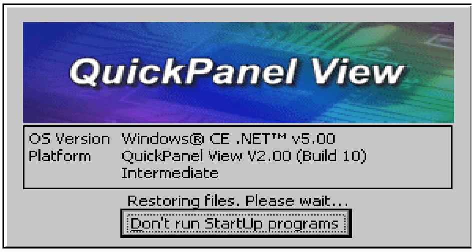
Startup

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.



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

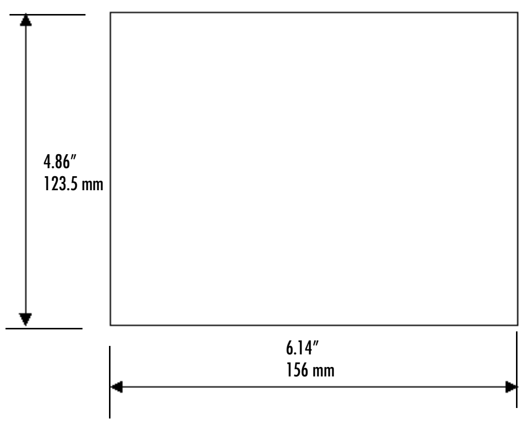
There are no specific dangers associated with a power failure or other unplanned shutdown of the QuickPanel View. In general, programs are retained in FLASH memory and user data can be retained in battery-backed SRAM. However, some operating system settings are retained only with user intervention (noted 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)

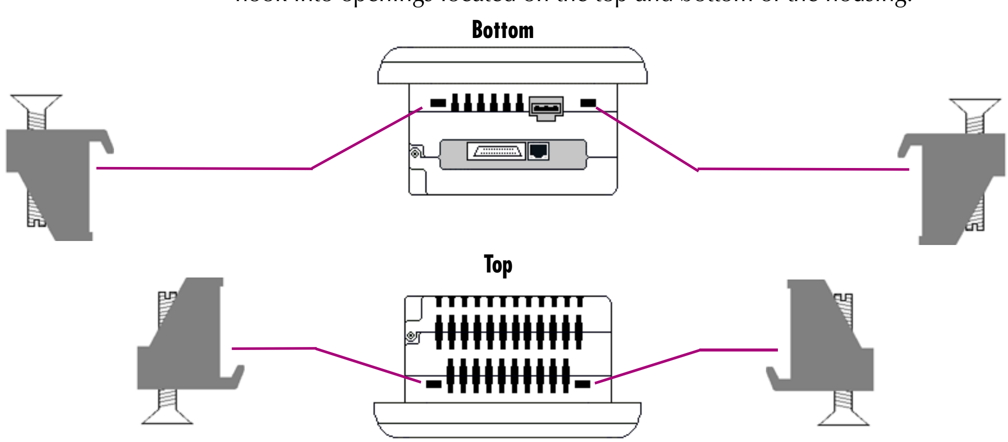
Panel thickness range:.063″ to.196″ (1.6mm to 5mm)

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.

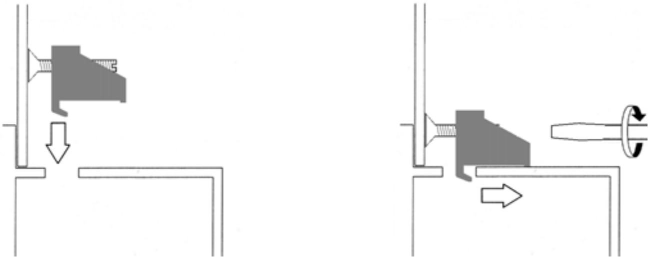


To mount the QuickPanel View in a panel

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

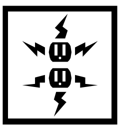
This chapter provides introductory information on the 6" QuickPanel View hardware and software with descriptive procedures for completing some of the most common tasks you will encounter.

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.

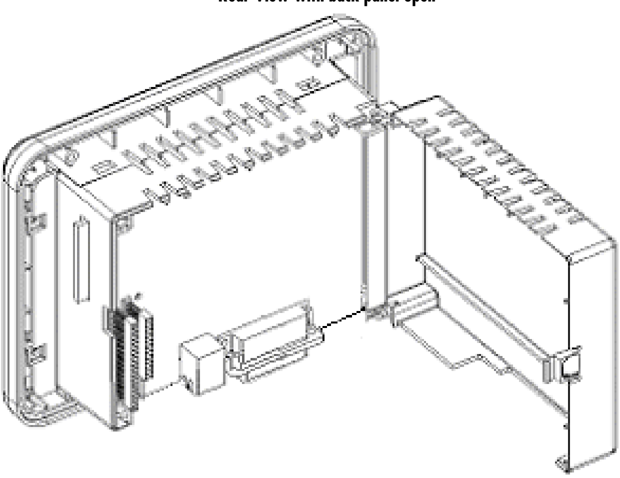


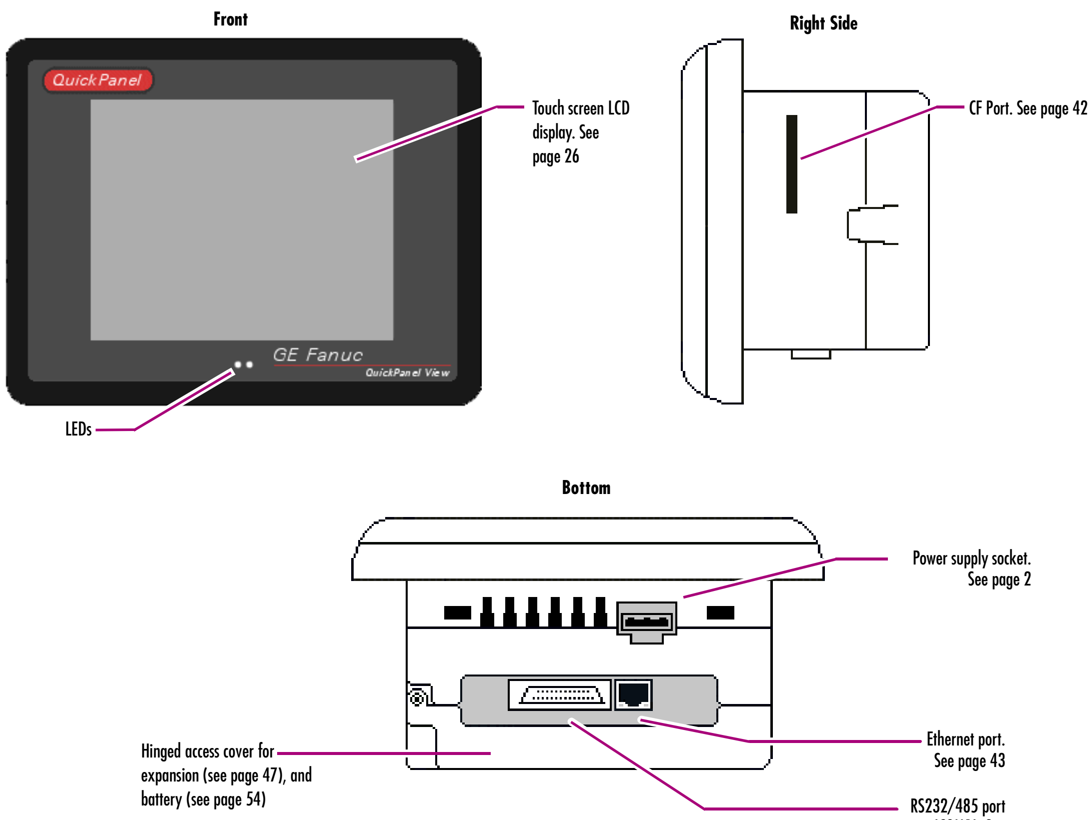
Caution: Remove power from the QuickPanel View before opening the back. Working on a "live" unit may result in damage to equipment and injury to personnel. Always use anti-static precautions (i.e. grounded wrist strap) when accessing the interior of the unit. Do not allow conductive material, liquid 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

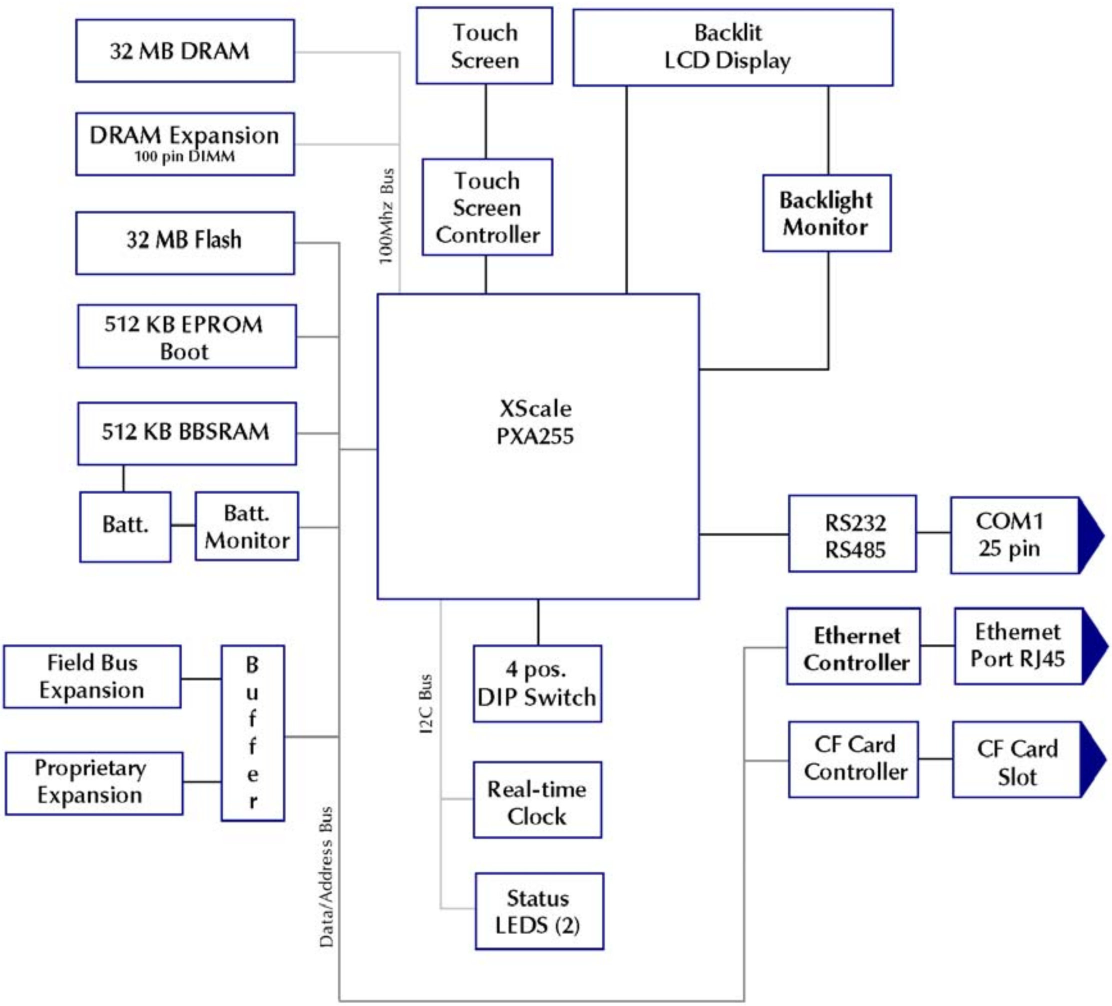



Front
QuickPanel
GE Fanuc
QuickPanel View
Touch screen LCD display. See page 26
LEDs
Right Side
CF Port. See page 42
Bottom
Power supply socket. See page 2
Hinged access cover for expansion (see page 47), and battery (see page 54)
Ethernet port. See page 43
RS232/485 port (COM1). See page 36

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.

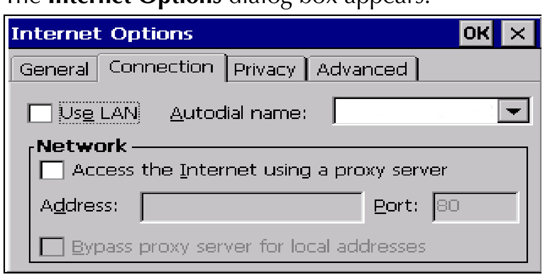
Pocket Internet Explorer supports JScript. Java support can be added from third-party sources. Pocket Internet Explorer does not support VBScript; however, VBScript components are included in the operating system and may be used by third-party applications such as Proficy Machine Edition.

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.



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.

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.

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.

2. Tap **OK**.

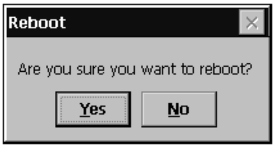
Reboot

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.



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:

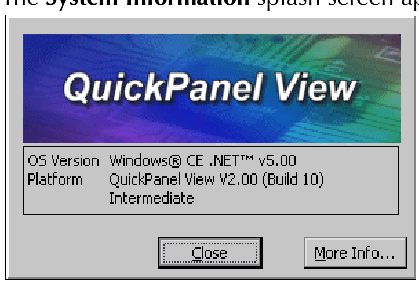
- **Operating System version.** For example, 'Windows CE 5.00'.
- **Platform.** Identifies the host hardware, its version and build number.

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.



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.

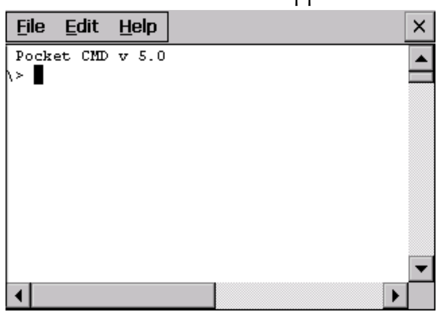
The HTTP utility currently supports two file transfer commands: COPY and DELETE.

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.



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

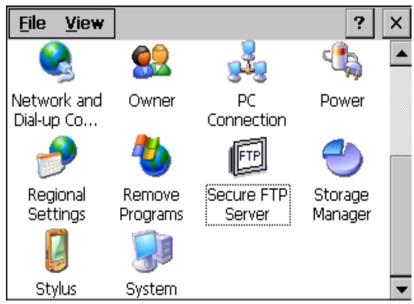
   Where “url” is the remote URL of the file you want to delete. This URL must use the “//” or ”HTTP://” syntax. For example:

```
HTTPUTIL DELETE http://MyServer/webfiles/MyFileBACKUP.txt
```

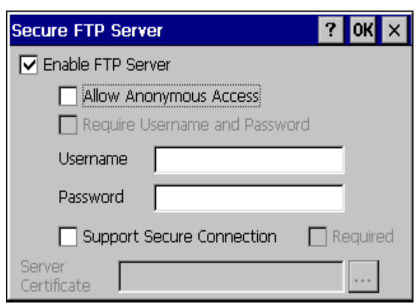
   Deletes a file called MyFileBACKUP.txt from the webfiles directory under the web server at HTTP://MyServer.

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.



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:

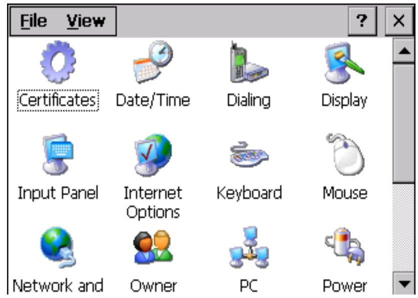
- No support for anonymous login. This is the default.
- Anonymous with no password. This is enabled when 'Allow Anonymous Access' is checked, but 'Require Username and Password' is not checked.
- Anonymous with password requested (but not validated). This is enabled when 'Allow Anonymous Access' and '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

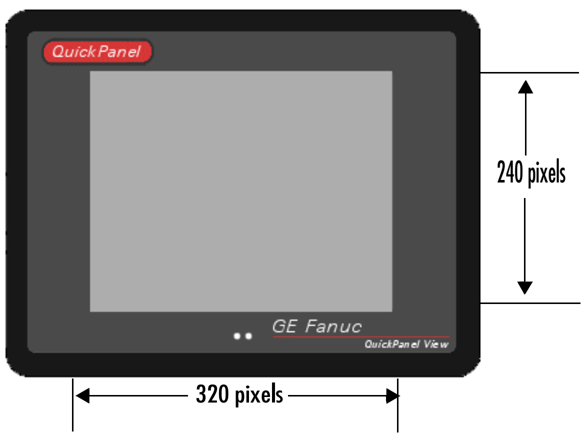
Detailed Operation

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.

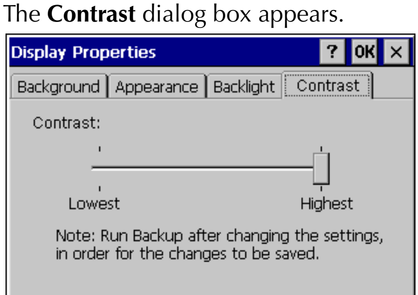
A backlight timer is featured on all models. You can extend backlight life by turning the backlight off automatically.



To adjust the display contrast

1. In the Control Panel, double-tap Display and choose the Contrast tab.

   The **Contrast** dialog box appears.



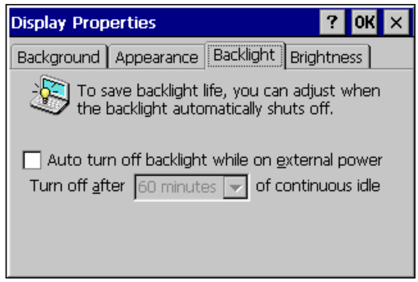
2. Drag the **Contrast** slider between Lowest and Highest.

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.

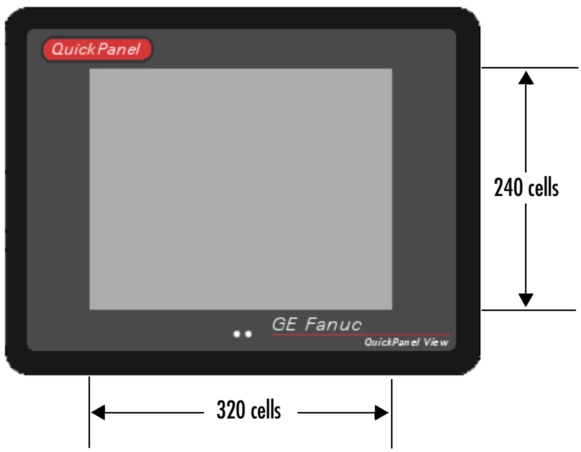


2. Select Auto turn off backlight while on external power.
3. Tap **OK** to exit the control panel.

   To save the settings, run **Backup** (see page 16).

TOUCH SCREEN

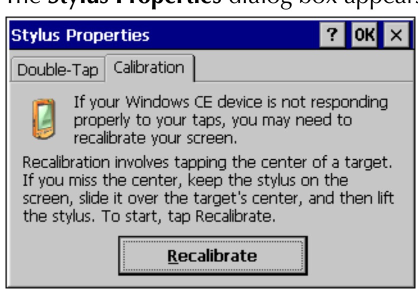
The QuickPanel View display is coupled to a resistive touch panel with 12-bit resolution. When the QuickPanel View is properly calibrated, this translates into a grid of touch cells on the face of the display. Although you can use your finger to activate the touch screen, use of a blunt stylus is recommended.



To calibrate the touch screen

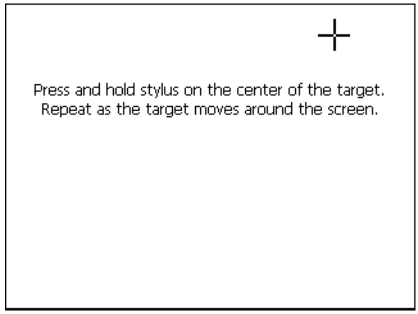
1. In the Control Panel, double-tap **Stylus**.

   The **Stylus Properties** dialog box appears.

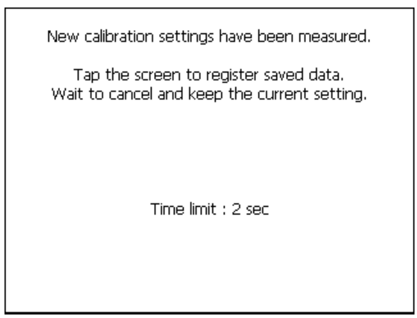


2. Choose the **Calibration** tab.
3. Tap the **Recalibrate** button.

   A cross hair target is displayed.



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.

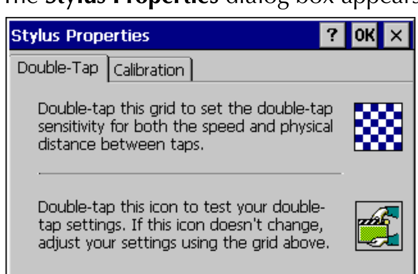


6. To save the settings, run  **Backup** (see page 16).

To set the double-tap sensitivity

1. In the Control Panel, double-tap  **Stylus**.

   The **Stylus Properties** dialog box appears.



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.

To show/hide the Soft Input Panel

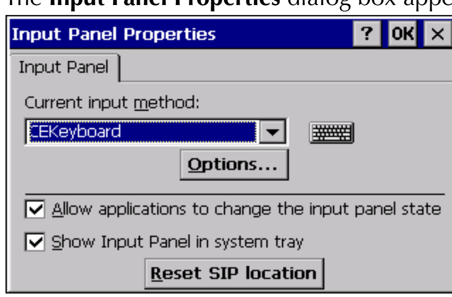
- On the system tray of the task bar, double-tap the icon. The Soft Input Panel appears/disappears.

  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**.

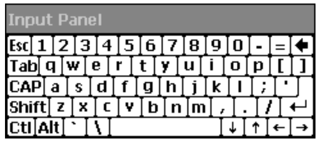
   The **Input Panel Properties** dialog box appears.



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).

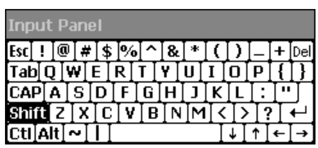
The Soft Input Panel has two basic configurations: **Small key** and **Large key**.

Small Key configuration: Provides a standard QWERTY key layout with numeric keys at the top row as illustrated in the following picture.



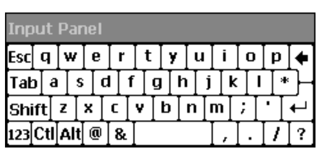
Small key: lower case

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.



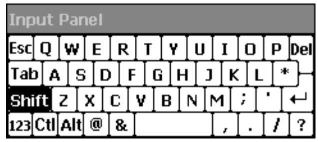
Small key: upper case

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.



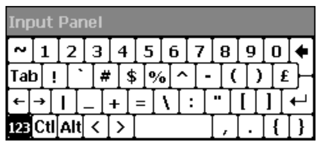
Large key: lower case

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.

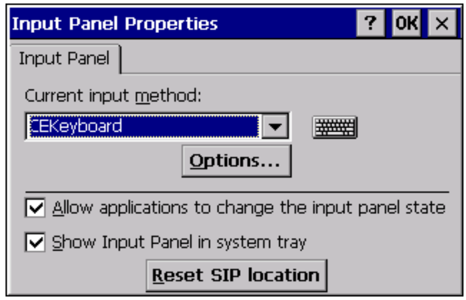


Large key: numeric

To change key configurations

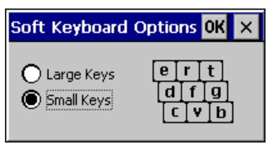
1. In the Control Panel, double-tap  **Input Panel**.

   The **Input Panel Properties** dialog box appears.



2. From the **Current input method** list, choose **CE Keyboard**.
3. Tap **Options**.

   The **Soft Keyboard Options** dialog box appears.



4. Select **Large Buttons** or **Small Keys**.

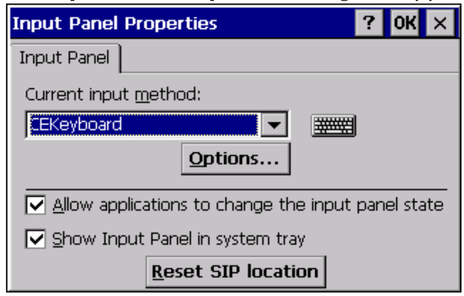
   A preview of the key size is displayed on the dialog box.
5. Tap **OK** twice to finish.
6. To save the settings, run  **Backup** (see page 16).

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.



2. Select **Reset SIP location**.

COMMUNICATION PORT

The QuickPanel View has one serial data communication port (COM1).

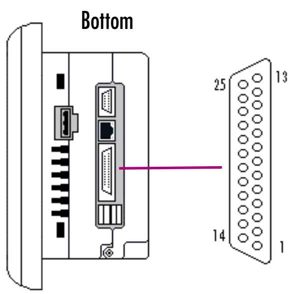
COM1- Serial

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

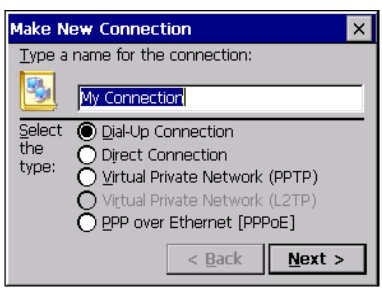
To add a new remote networking serial connection

1. From the **Start** menu, tap **Settings**, then **Network and Dial-up Connections**.

   The **Connection** window appears.

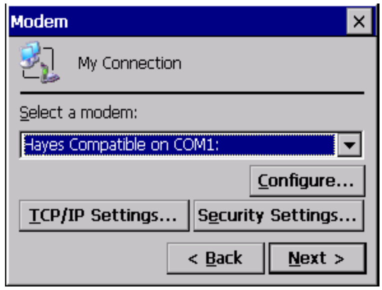
2. Double-tap **Make New Connection**.

   The **Make New Connection** wizard appears.

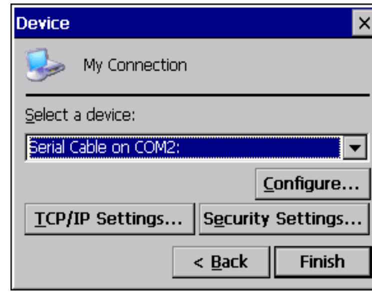


3. Type a name for the new connection.
4. Choose a connection type. If you are configuring a Modem, choose **Dial-Up Connection**. If you have a Device, select **Direct Connection**.
5. Tap **Next**.

The **Modem** or **Device** Connection window appears, depending on the connection type.



or

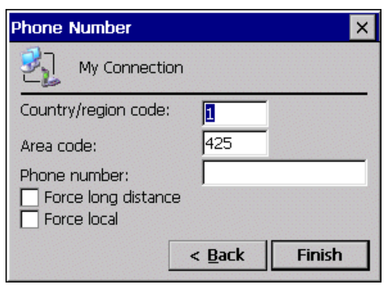


6. From the list, choose the modem or device you want to use. (If a serialCF card is inserted, it is available in the device list).

   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.



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**.

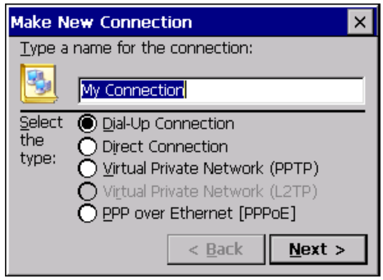
To add a virtual private network or PPP over Ethernet

1. From the **Start** menu, tap **Settings**, then **Network and Dial-up Connections**.

   The **Connection** window appears.

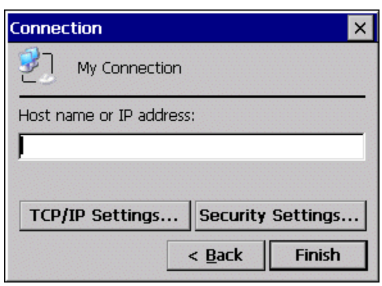
2. Double-tap **Make New Connection**.

The **Make New Connection** wizard appears.

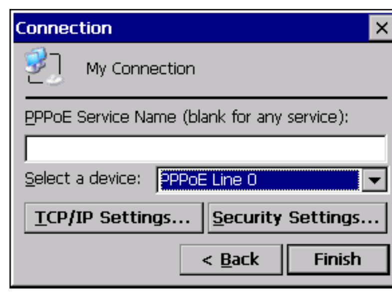


3. Type a name for the new connection.
4. Choose a connection type. Select **Virtual Private Network** to configure a VPN connection. Select **PPP over Ethernet** for a PPPoE connection.
5. Tap **Next**.

   The **VPN** or **PPPoE** Connection window appears, depending on the connection type.



or



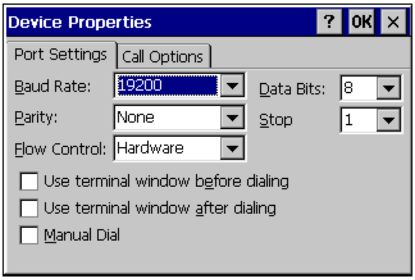
6. Enter the Host Name or IP address for a VPN connection, or a PPPoE Service Name for a PPPoE connection.

   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.



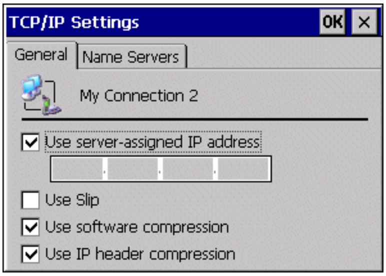
2. In the **Port Settings** tab, choose settings for all connection preferences.
3. If the connection is for terminal emulation, select or clear the terminal-related check boxes.

   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**.

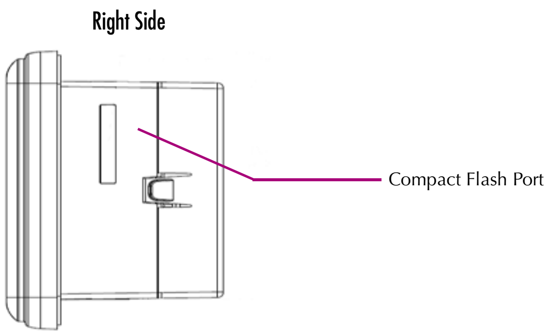
   The **TCP/IP Settings** dialog box appears.



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.

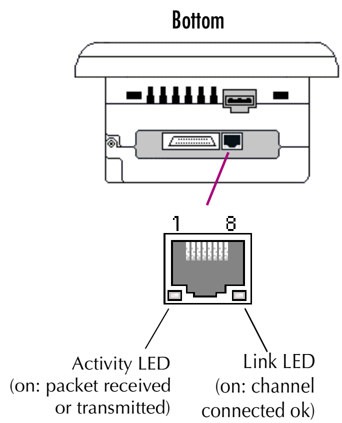
No Compact Flash cards are supplied with the QuickPanel View. A list of cards (and other devices) that have been tested and are compatible can be found by visiting http://globalcare.gefanuc.com, then select the Operator Interface category, then select the QuickPanel View product name.

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.

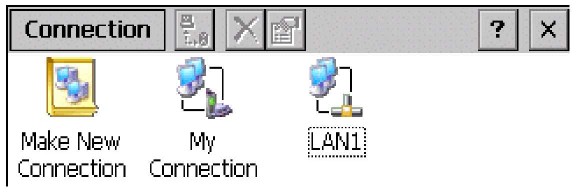
- **Manual method.** The user uniquely specifies the numeric addresses for the QuickPanel View, the Subnet Mask (if applicable), and the Default Gateway.

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

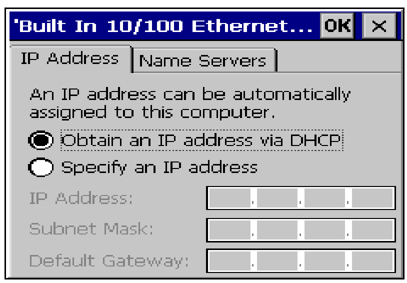
1. From the Control Panel, tap  **Network and Dial-up Connections.**

   The **Connection** window appears.



2. Select a  connection and choose  Properties.

   The **Built-in Ethernet Port Settings** dialog box appears.



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).

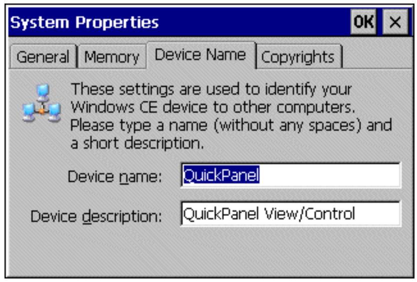
   If the DHCP method was selected, the network server will assign an IP address while the QuickPanel View is initializing. (You must be connected to the network).

   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

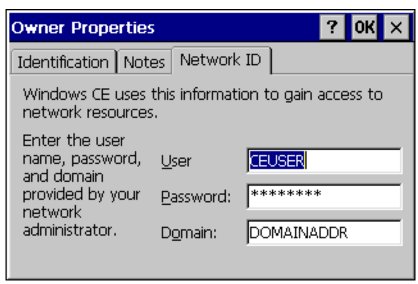
1. In the Control Panel, double-tap **System**.

   The **System Properties** dialog box appears.



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.



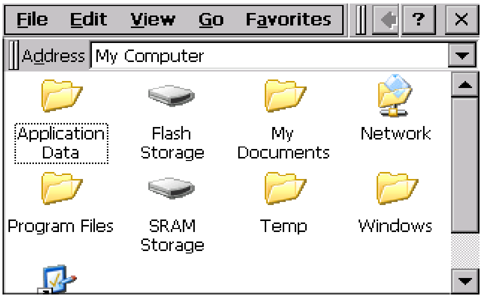
5. On the **Network ID** tab, type your assigned **User name, Password** and **Domain**.
6. Tap **OK**.
7. To save the settings, run **Backup** (see page 16).

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.



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.

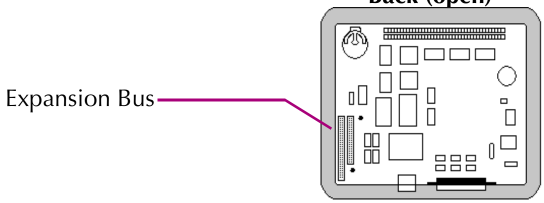
   Note: You can use the NET command from the shell to map a network resource to the QuickPanel View for frequent access. The resource then appears in the **Network** folder.

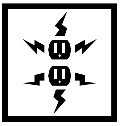
EXPANSION BUS

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.

Back (open)





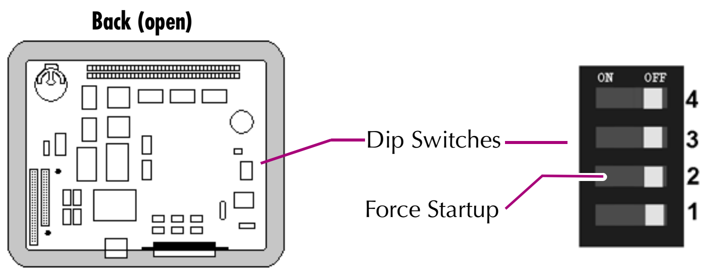
Caution: Remove power from the QuickPanel View before opening the back. Working on a “live” unit may result in damage to equipment and injury to personnel. Always use anti-static precautions (i.e. grounded wrist strap) when accessing the interior of the unit. Do not allow conductive material, liquid 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.

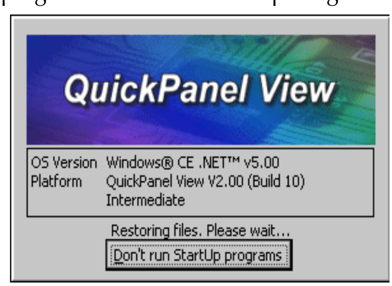
DIP SWITCHES

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.



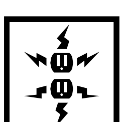
When the switch is set to “OFF”, the QuickPanel View operates normally, displaying the startup splash screen. You can skip running the startup applications by tapping the “Don’t run StartUp Programs” button on the startup splash screen.



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.

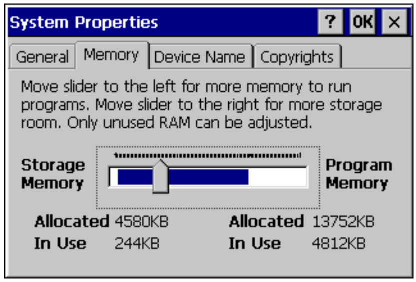
The split between program memory and storage memory may be adjusted as necessary to make more room for one or the other, depending on your specific application needs. For example, if you find that an application is short of memory, use the System Properties dialog box to alter DRAM memory allocation.

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.



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).

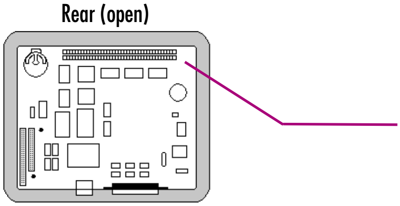
Boot Loader ROM

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.

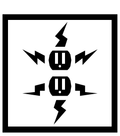
Memory Expansion Slot

The QuickPanel View is equipped with a 100-pin DIMM memory expansion slot which lets you increase DRAM to a total of 96 MB.

Rear (open)



Memory Expansion Slot



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.

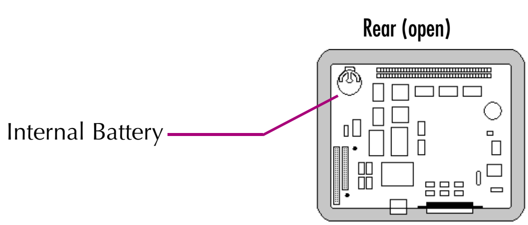
To access the Power Properties control panel

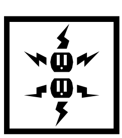
1. In the Control Panel, double-tap Power.

   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.

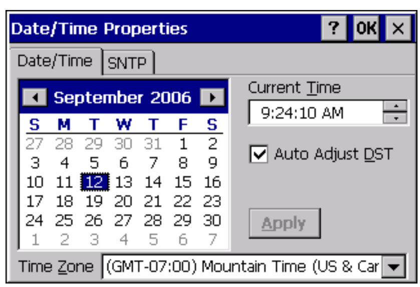
Real-time Clock

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.



   Note: Tap Apply after making changes in any box.

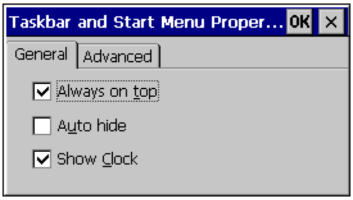
2. To modify the date, select the Date/Time tab.
3. Tap the year to choose a new year; tap the month to choose a new month.
4. Tap a date to specify the day of month.
5. From the **Time Zone** box, choose your zone.
6. Select **Auto Adjust DST** to have the clock automatically compensate for daylight 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.



2. On the **Taskbar Options** tab, select **Show Clock**.
3. Tap **OK**.

   An hours and minutes display now appears in the taskbar.

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.

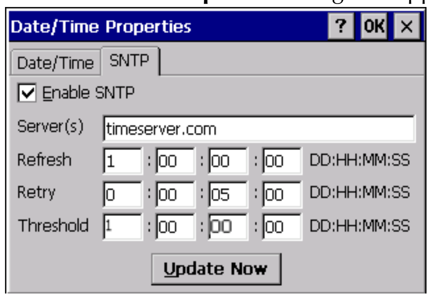
It is recommended that you research any time server selection to ensure that it can meet your specific time server requirements. More information and a list of SNTP time servers can be found at http://support.microsoft.com/kb/262680/.

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.

   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.

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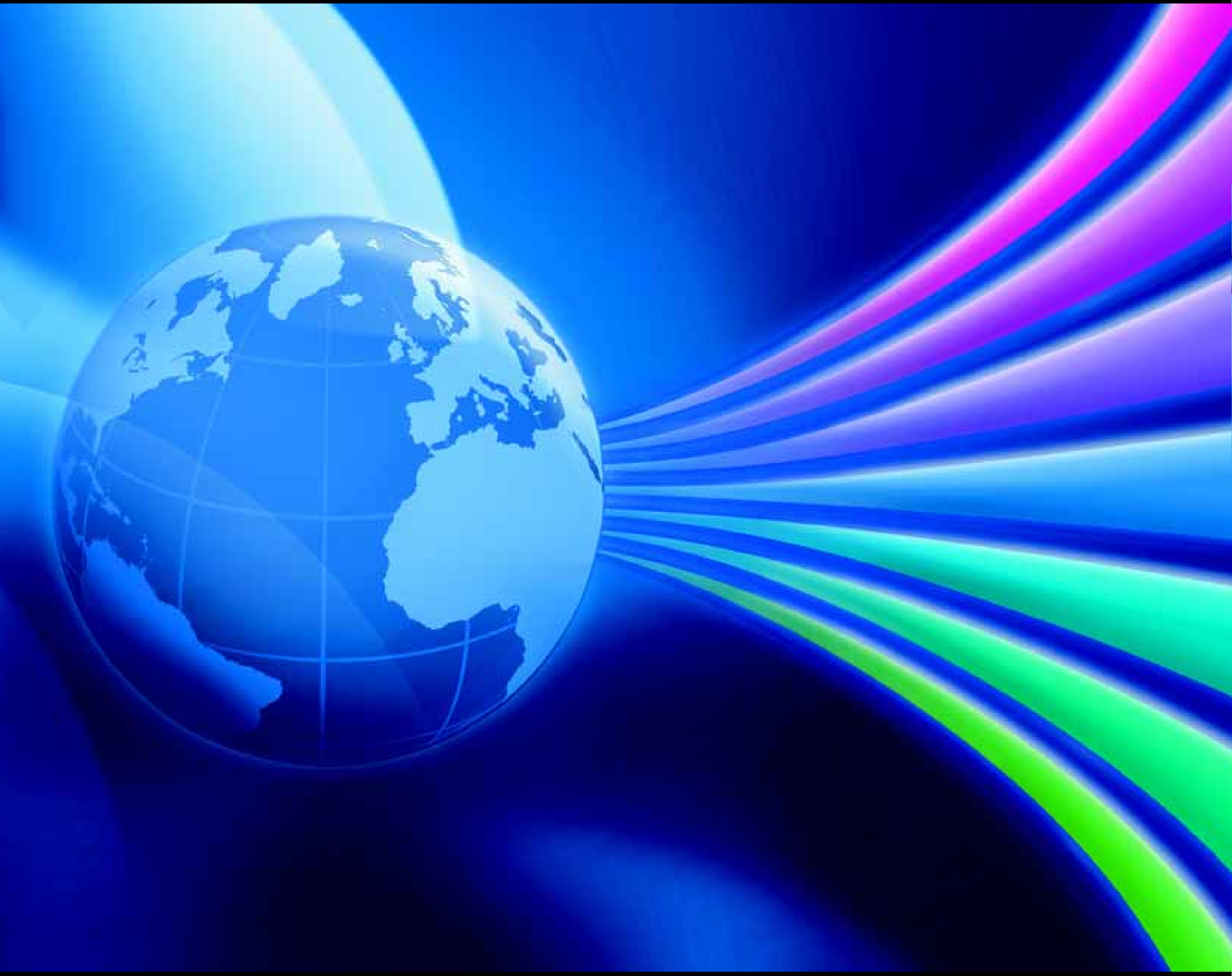

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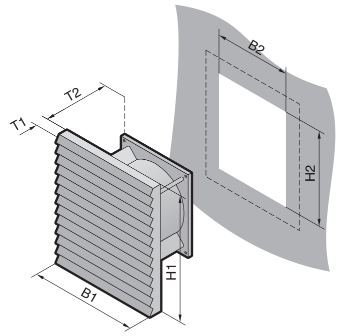
RITTAL®

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			
Dimensions in mm B2/H2	92 + 0.8[2]				124[2]			
Dimensions in mm 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

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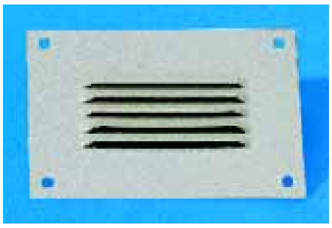
General



Integrated louvers

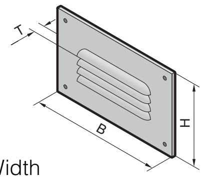
For ventilation by convection; easily retrofitted using 4 screws.

Material:
Sheet steel

Color:
RAL 7035 (light gray)

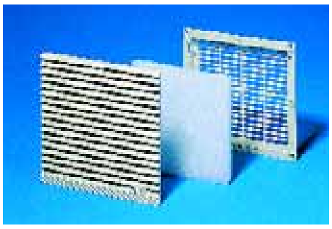
H mm (inches)	W mm (inches)	D mm (inches)	PU	**Part No. SK**
110 (4.3)	160 (6.3)	8 (0.3)	4	**2541.235**
100 (3.9)	210 (8.3)	8 (0.3)	4	**2542.235**
110 (4.3)	330 (13.0)	8 (0.3)	4	**2543.235**

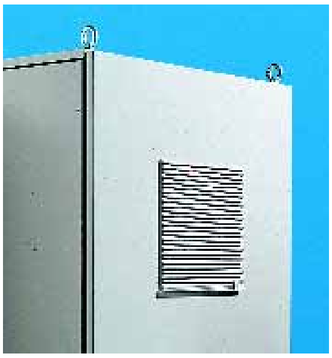
For RAL 7032 (pepple gray), use order extension .200;
to order primed version, use extension .300.
Delivery times available on request.



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.

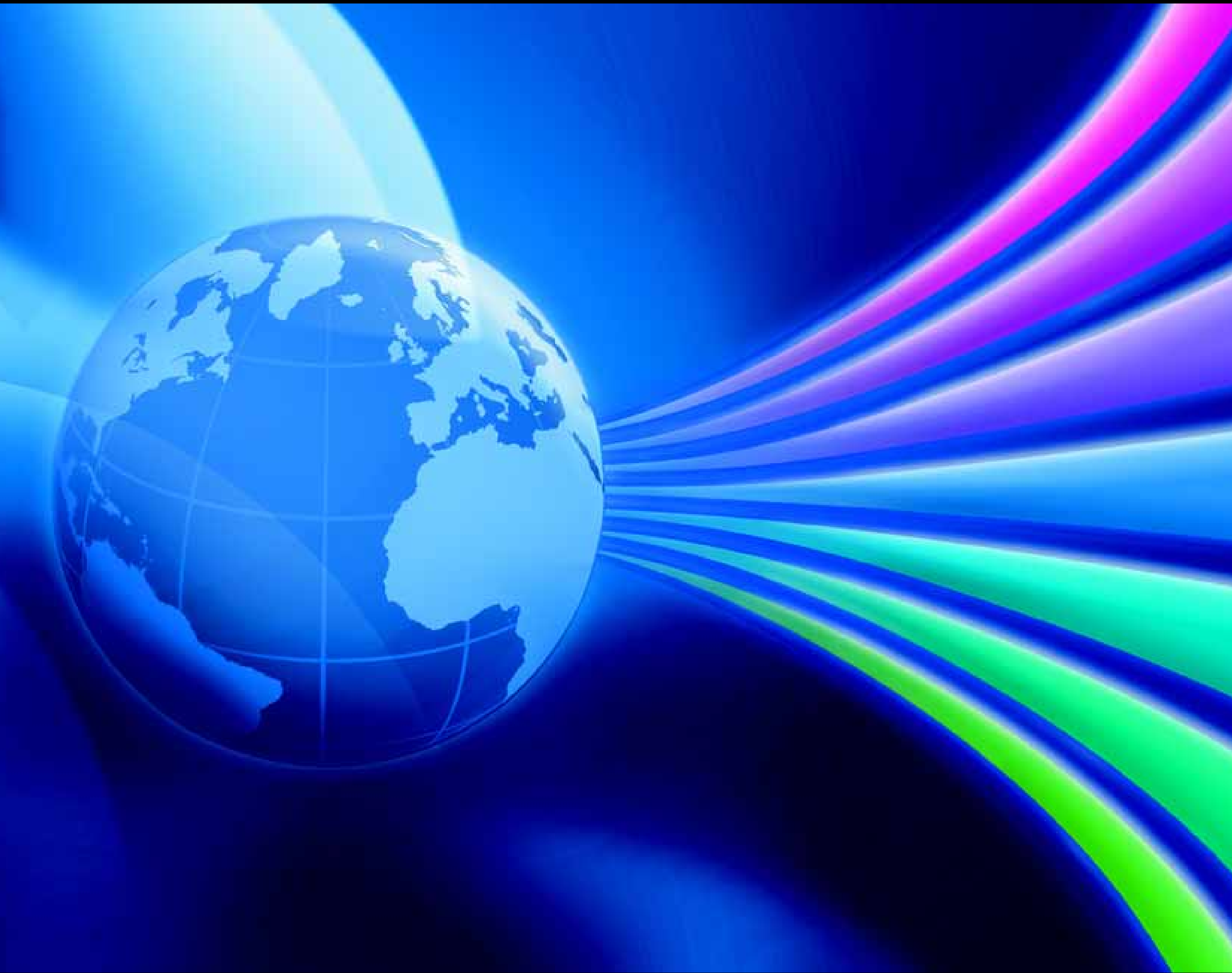
Material:
Stainless steel

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



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FRIEDHELM LOH GROUP

RITTAL

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**

C US **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

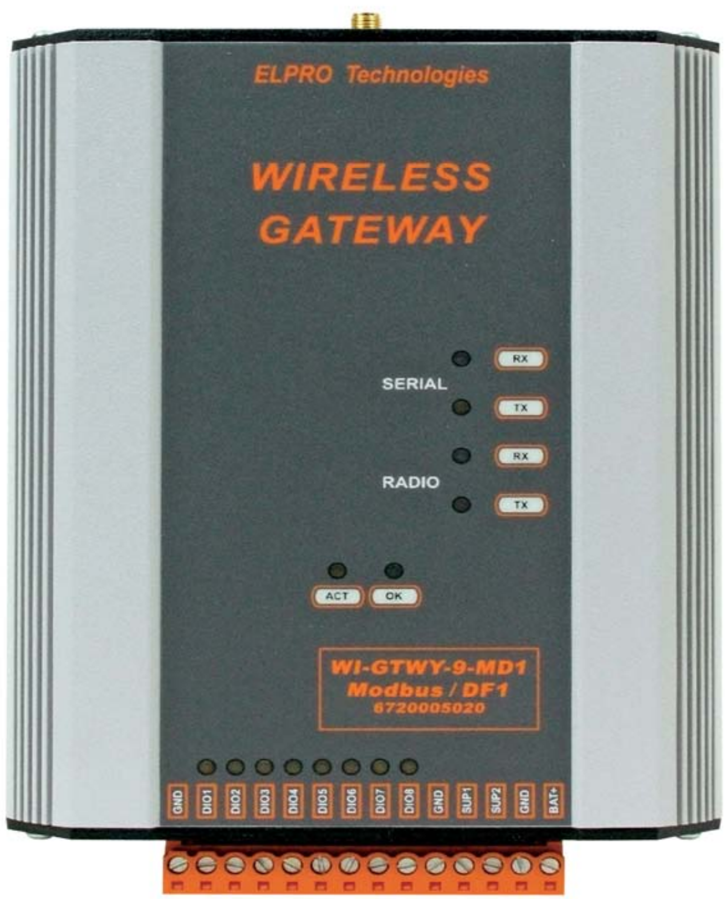
WI-GTWY-9-ET1
Ethernet IP, Modbus TCP, TCP/IP functions

	WI-GTWY-9-PR2	WI-GTWY-9-ET1
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.

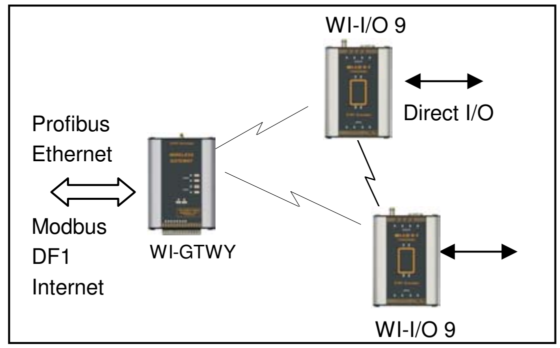
The foldout sheet *WI-GTWY-9-xxx Installation Guide* is an installation drawing appropriate for most applications.

CONTENTS

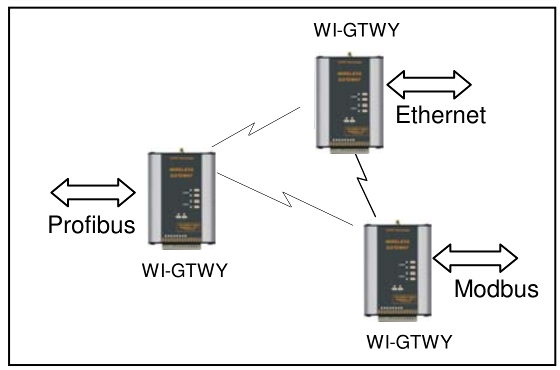
Chapter 1 INTRODUCTION

1.1 Overview

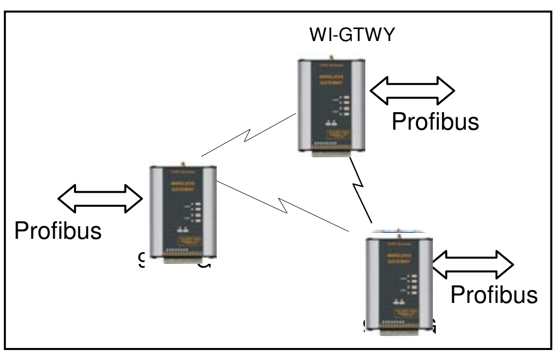
The Wireless Gateway products provide a wireless interface between various fieldbus protocols used in process and automation applications. The WI-GTWY-9-xxx includes an integral 900MHz license-free radio transceiver, and transfers transducer and control signals (I/O) using a highly secure and highly 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.

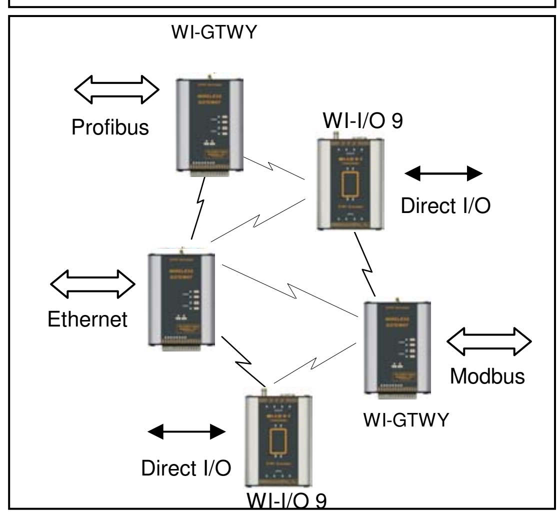


Functionality discussed in this manual for the WI-GTWY-9-xxx range also applies to the 105U-G range.



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.

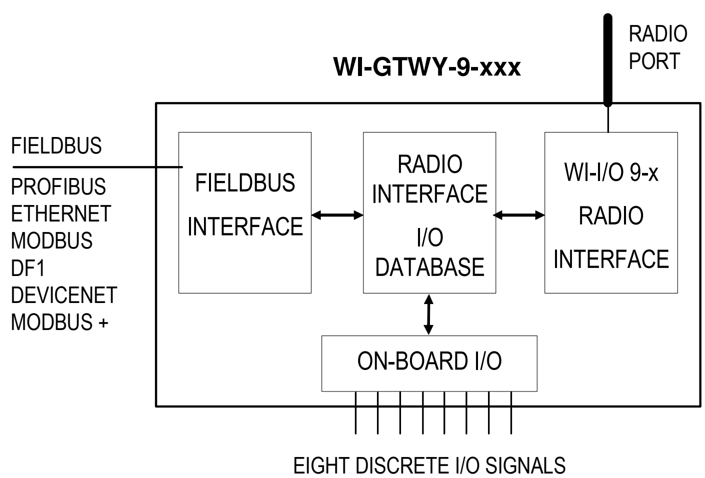
So an Modbus Plus WI-GTWY-9-M+1 can handle up to 4300 I/O total, but analog or pulse inputs are limited to 1024 x 16-bit values. The same limit applies to outputs.

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:

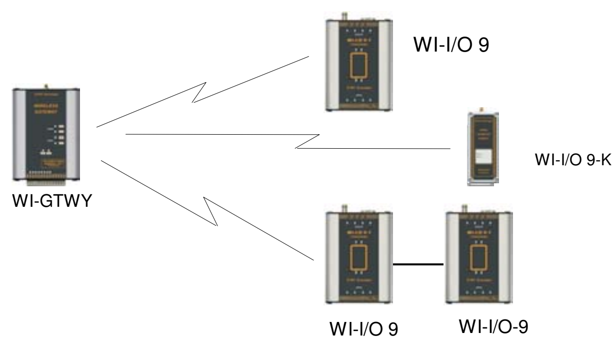
- ♦ Supply voltage status - if the normal supply fails, this status is set on.
- ♦ Low battery voltage. The WI-GTWY-9-xxx has an internal battery charger to trickle charge a back-up battery. If the battery voltage is low, this status is set.
- ♦ Battery voltage - the actual value of the connected battery 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.

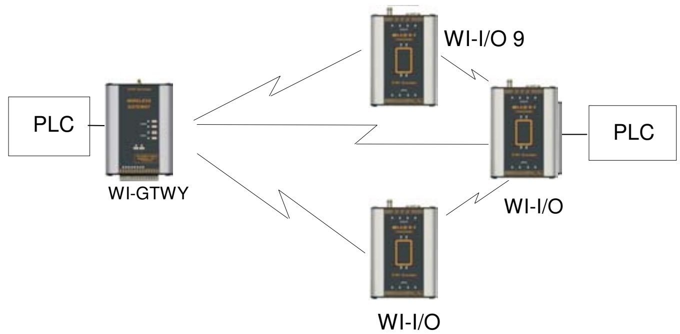
Remote WI-I/O 9-x modules can connect to WI-I/O-EX-1-S-1x modules in the normal way. The WI-GTWY-9-xxx host can access I/O on WI-I/O-EX-1-S-1x modules by using the intermediate WI-I/O 9-x as a repeater.

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:

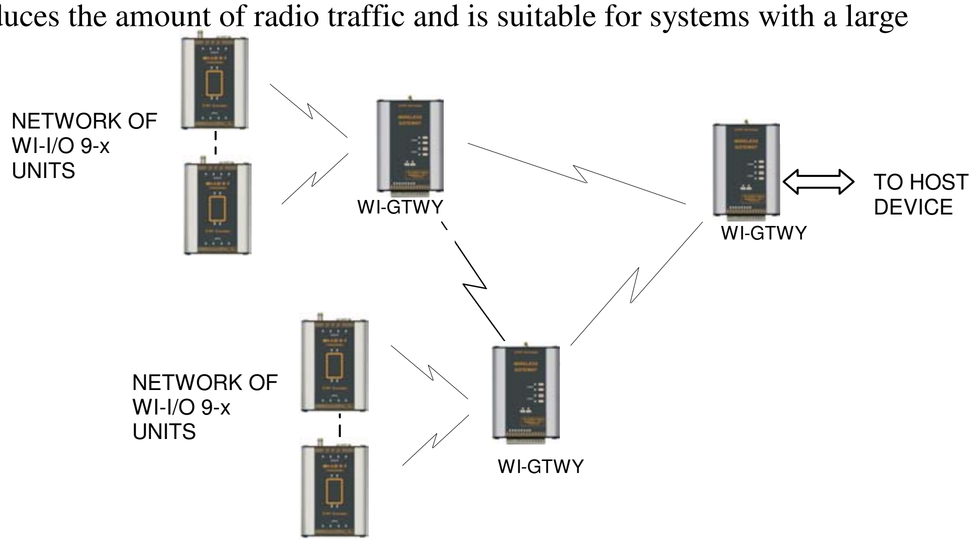
- ♦ time period, configurable 1 – 4096 sec (1.1 hour), or
- ♦ real time clock, or
- ♦ on demand by the host device, by writing to a "trigger register" in the WI-GTWY-9-xxx, or
- ♦ a change-of-state event occurring within the block of I/O registers.

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.

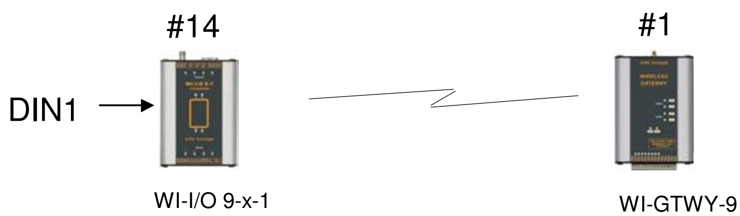
2.2 Operation

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.

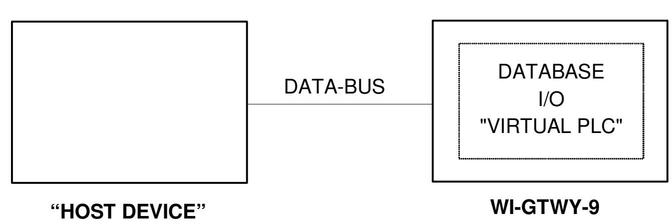
The WI-GTWY-9-xxx also monitors its battery voltage and supply voltage. These are stored in registers 4310 and 4311 respectively, as 16 bit values, scaled so that a value of 16384 decimal (hex 4000) corresponds to 8 V, and a value of 49152 (hex C000) corresponds to 40V.

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)

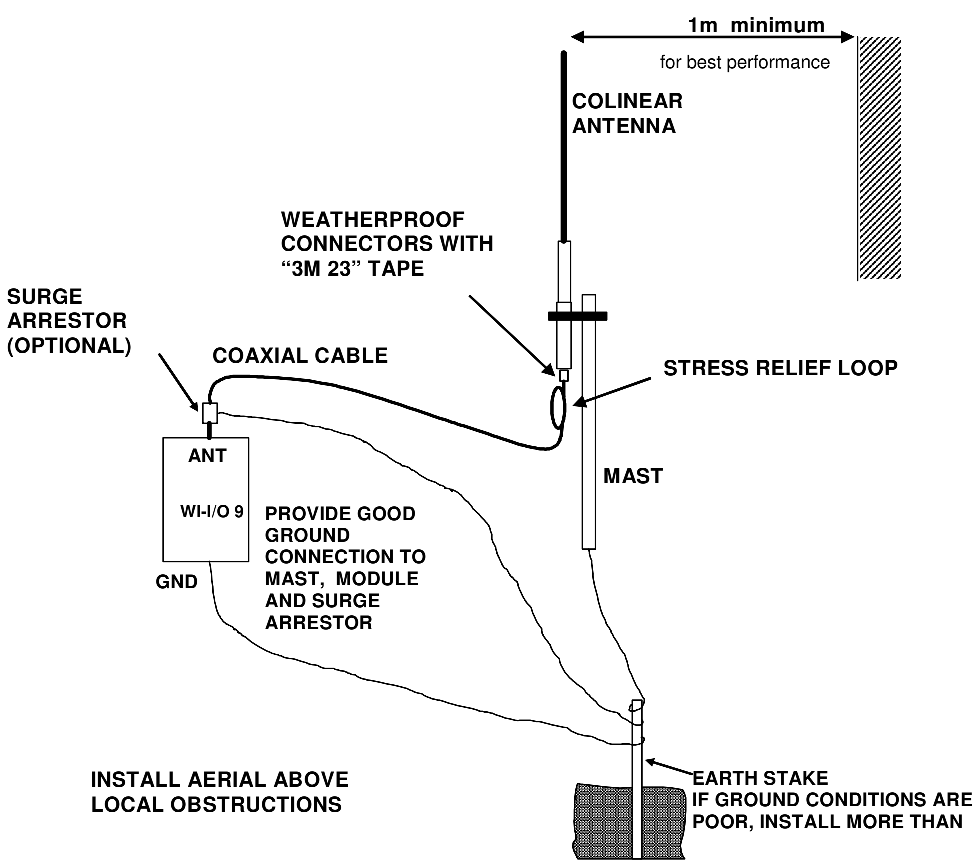
The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6 element Yagi with 66 feet (20 meters) of Cellfoil has a net gain of 4dB (10dB – 6dB).

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..

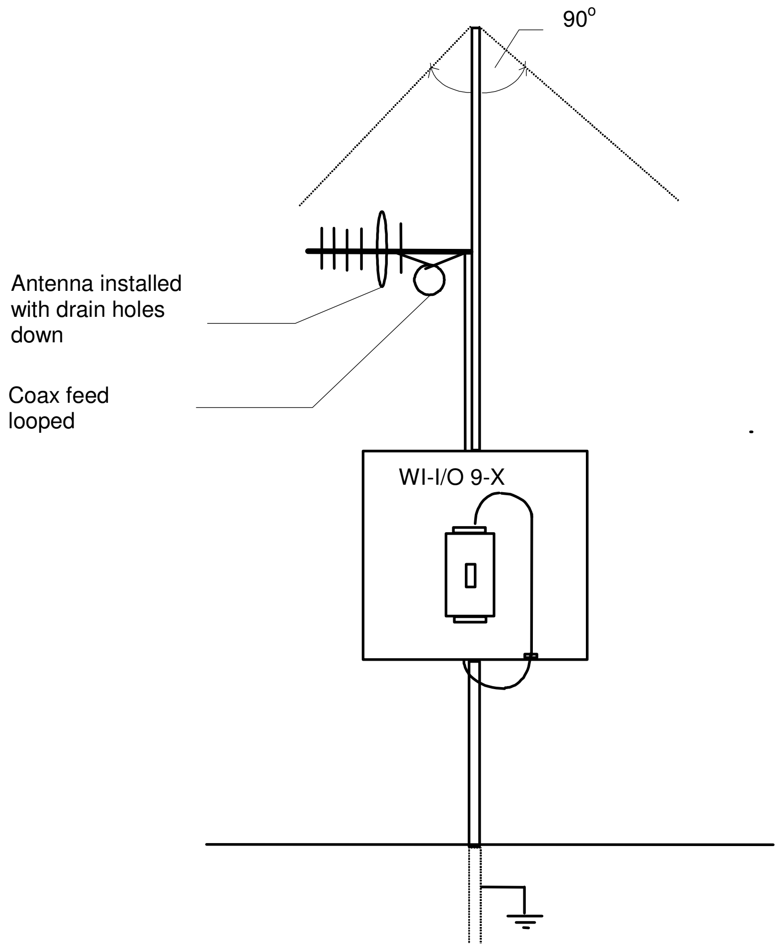
Collinear and dipole antennas should be mounted vertically, preferably no less than 2 ft (0.6 metre) away from a wall or mast to obtain maximum range. The WI-ANT-DPL-0-16 dipole antenna is the preferred antenna for use in industrial plants and factories.

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.

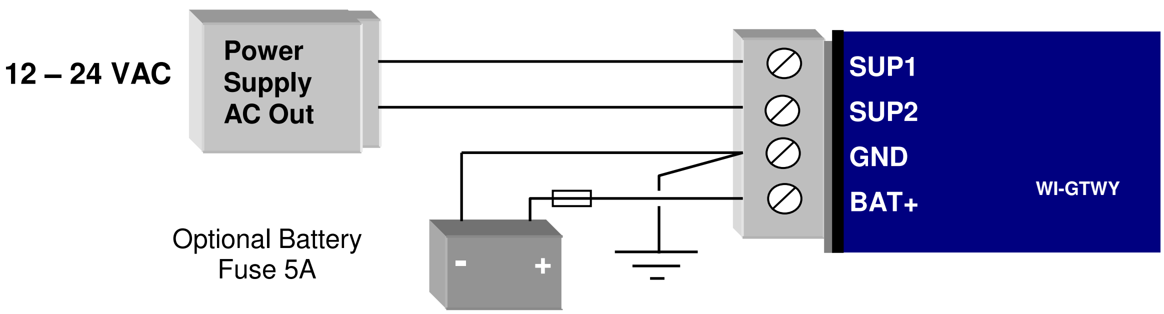
The power supply should be rated at 1.5 Amps and be CSA Certified Class 2. For use in Class 1 Div 2 explosive areas (USA/Canada), the power supply must be approved for Class 1 Div 2 use.

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

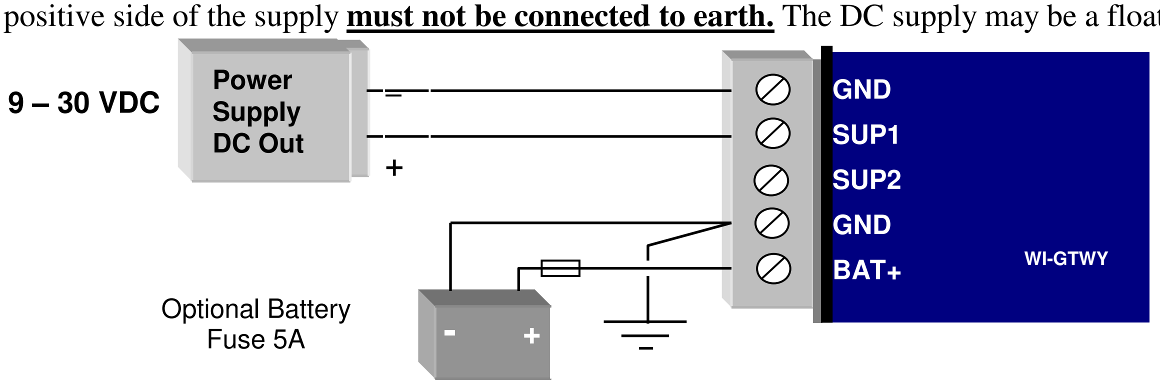
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below. The AC



supply should be "floating" relative to earth.

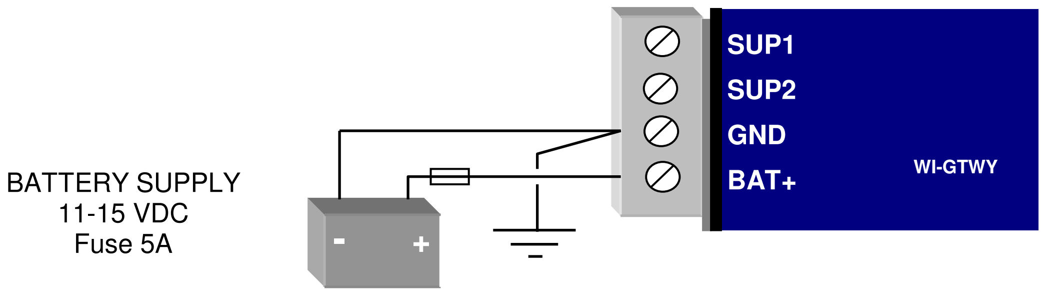
3.3.2 DC Supply

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

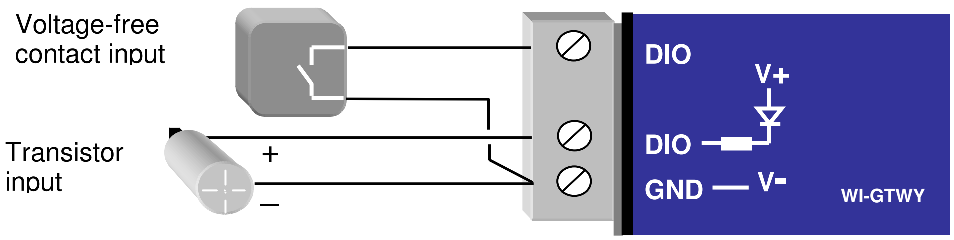
A WI-GTWY-9-xxx can be powered from a solar supply using an external regulator. If a 12V solar supply is used, the 12V battery can be connected to the battery supply connections of the WI-GTWY-9-xxx and the WI-GTWY-9-xxx will monitor for low battery status and also battery voltage. If a 24V solar supply 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

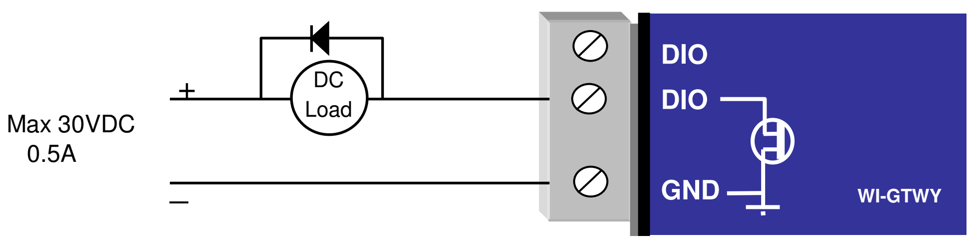
The WI-GTWY-9-xxx has eight on-board discrete/digital I/O. These act as both discrete inputs and discrete outputs.

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

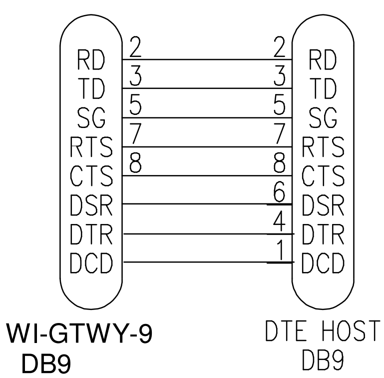
The serial port is a 9 pin DB9 female and provides for connection to a terminal or to a PC for configuration, field testing and for factory testing. It is also used by the Modbus/DF1 version for fieldbus connection.

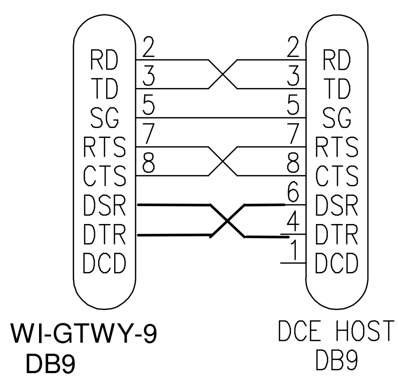
This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS232 signals. The WI-GTWY-9-xxx is configured as DCE equipment with the pinout detailed below.

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

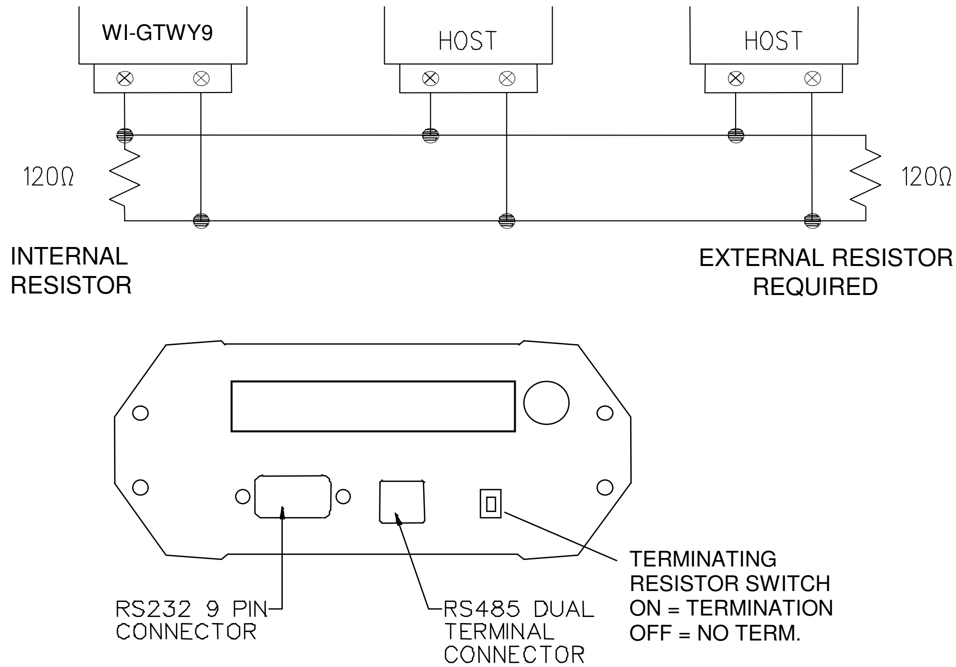
Hardware handshaking using the CTS/RTS lines is provided, and are under the control of the Host Comms Driver. Example cable drawings for connection to a DTE host (a PC) or another DCE host are detailed below:





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.



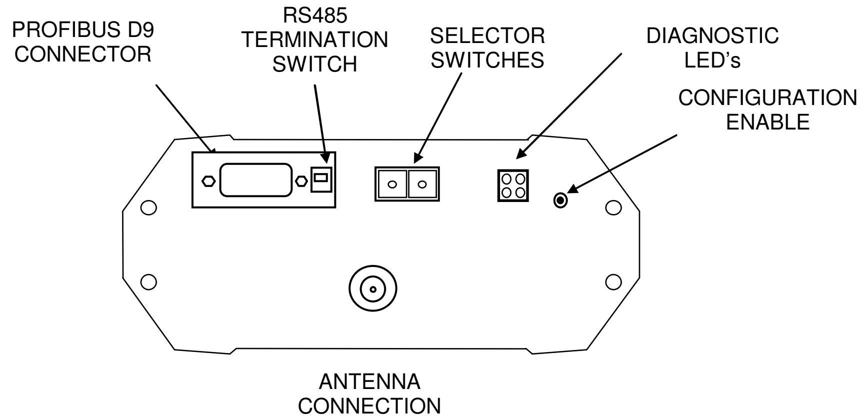
RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential RFI. An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120-ohm resistor. On-board 120 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).

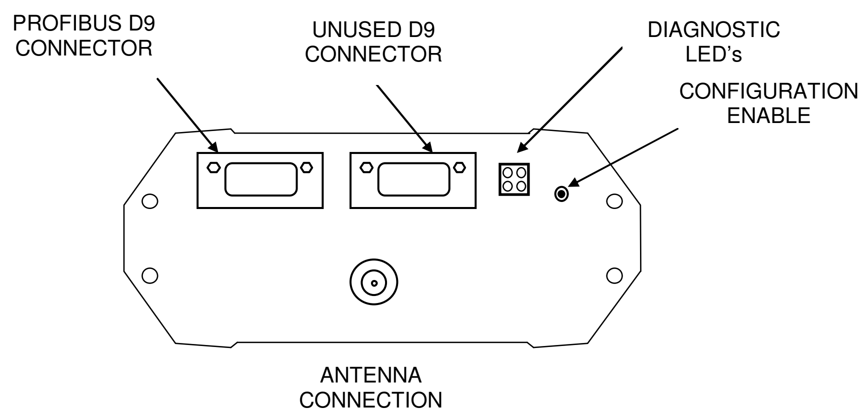
WI-GTWY-9-PR1 (Profibus Slave) End Plate:



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.

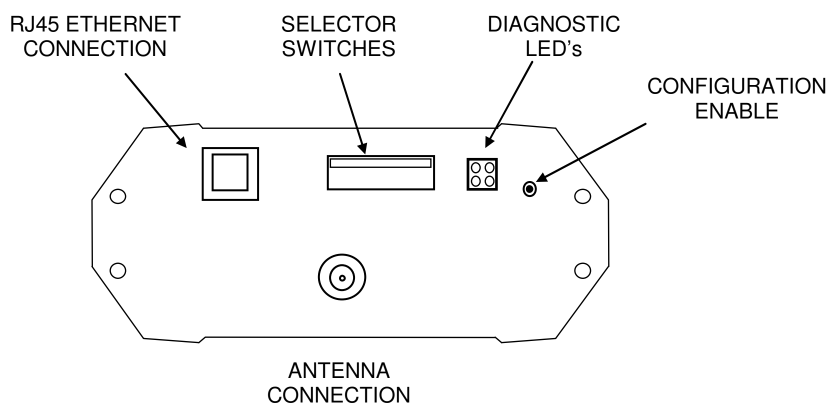
The Profibus RS485 connection should be made to pins 3 and 8 of the Profibus D9 connector. The pinouts for this connector are:

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.

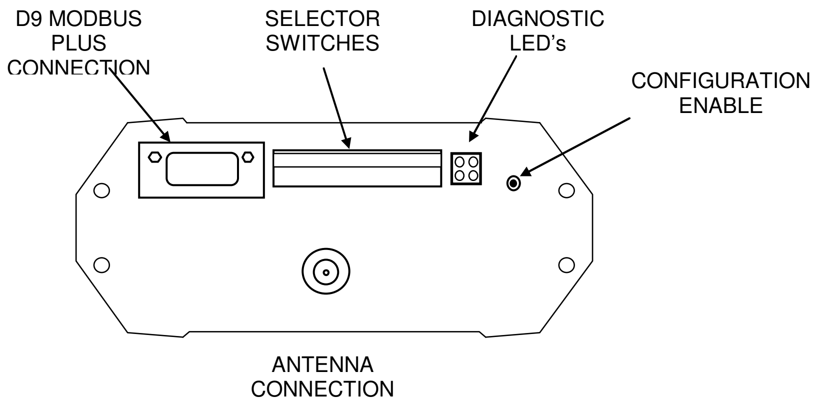
The Ethernet connection uses a standard RJ45 connector on the top end-plate of the module. The selector switches should all be "off" (in the diagram below, "off" is up).



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:

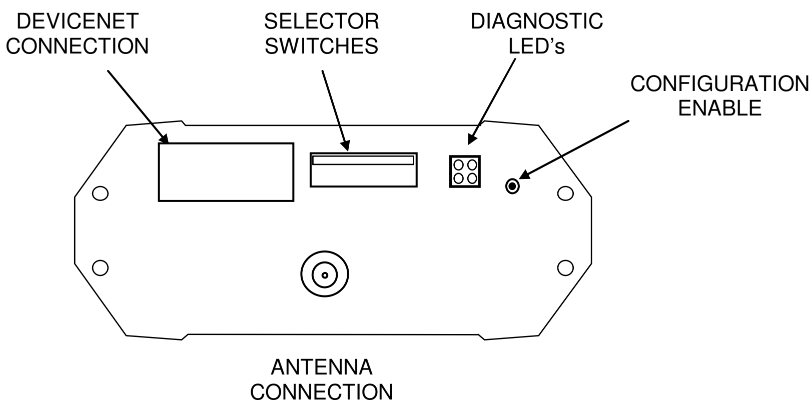
Pin	Name
1	Cable Shielding
2	MBP Line B
3	MBP Line A
Housing	PE

40

3.9 DeviceNet Port

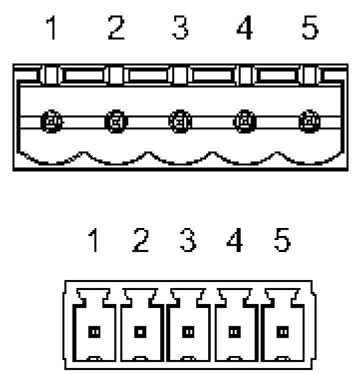
For WI-GTWY-9-DE1 modules only.

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.

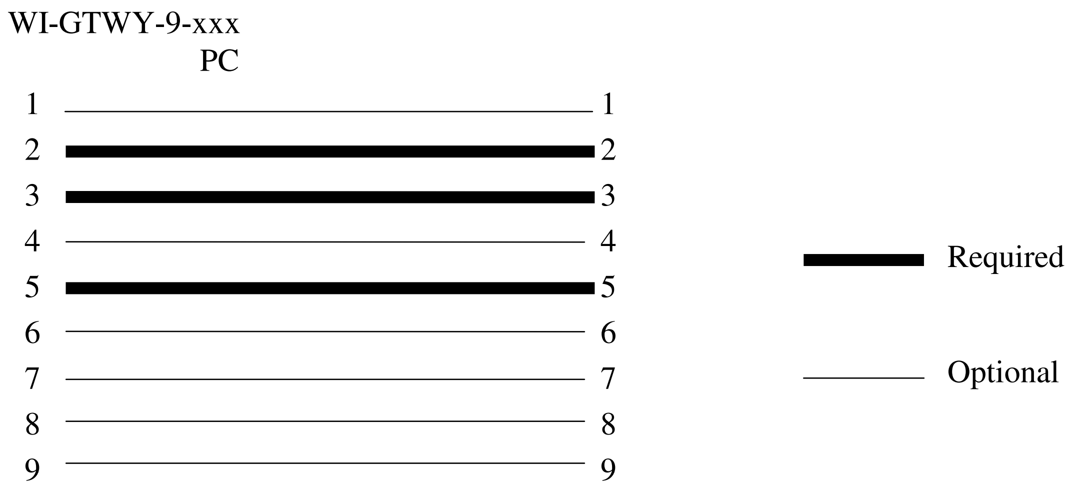
Configuration consists of:

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

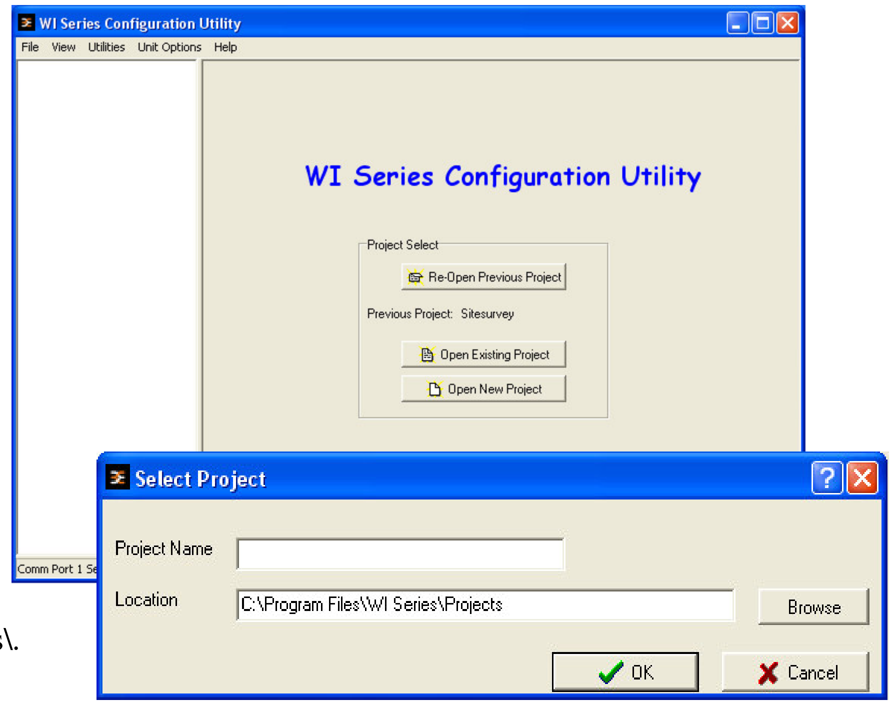
The configuration software is available on a CD, and needs to be installed on your PC before you can use it. The CD contains a setup file called *setup.exe*. Select the configuration software window on the Product CD and an installation Wizard will guide you through the installation procedure. To upload and download configuration files to a module, you will need a RS-232 serial cable as shown below.



4.2.1 Program Operation

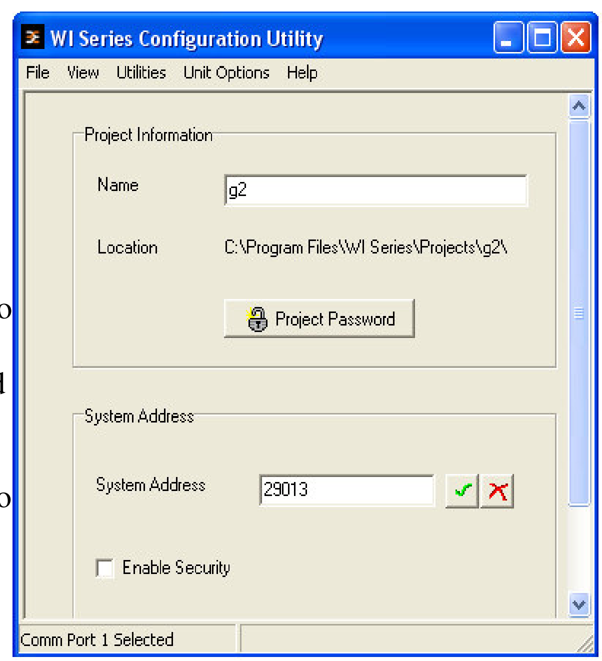
Start the software by either clicking on the start bar and navigating to the Configuration menu or by running WI SERIES.EXE in the directory selected in the setup stage.

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\.

When you have selected the project, a screen will appear where you may enter the system address.

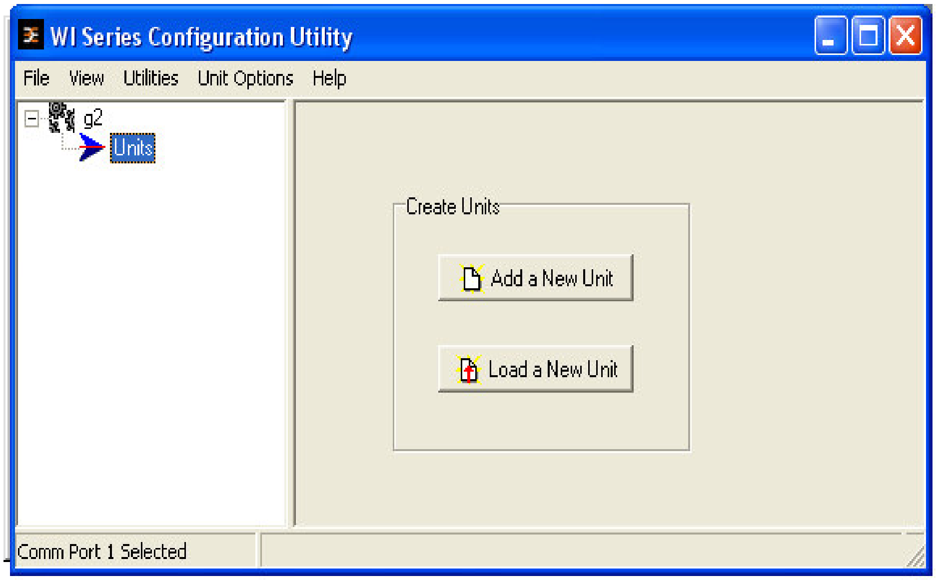


If you are editing an existing project, the system address will already have been entered. Do not change the system address unless you are going to re-program all of the modules in the system.

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

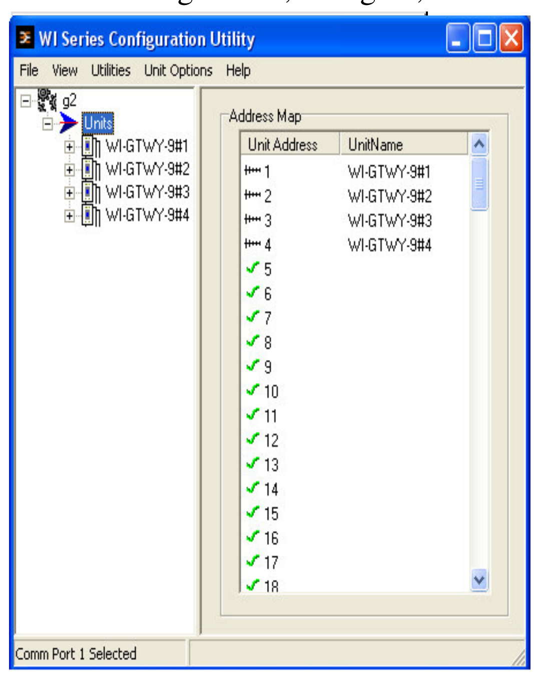
The password can be between 6 and 256 characters. You can also change password at any time by over-typing the passowrd.

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.

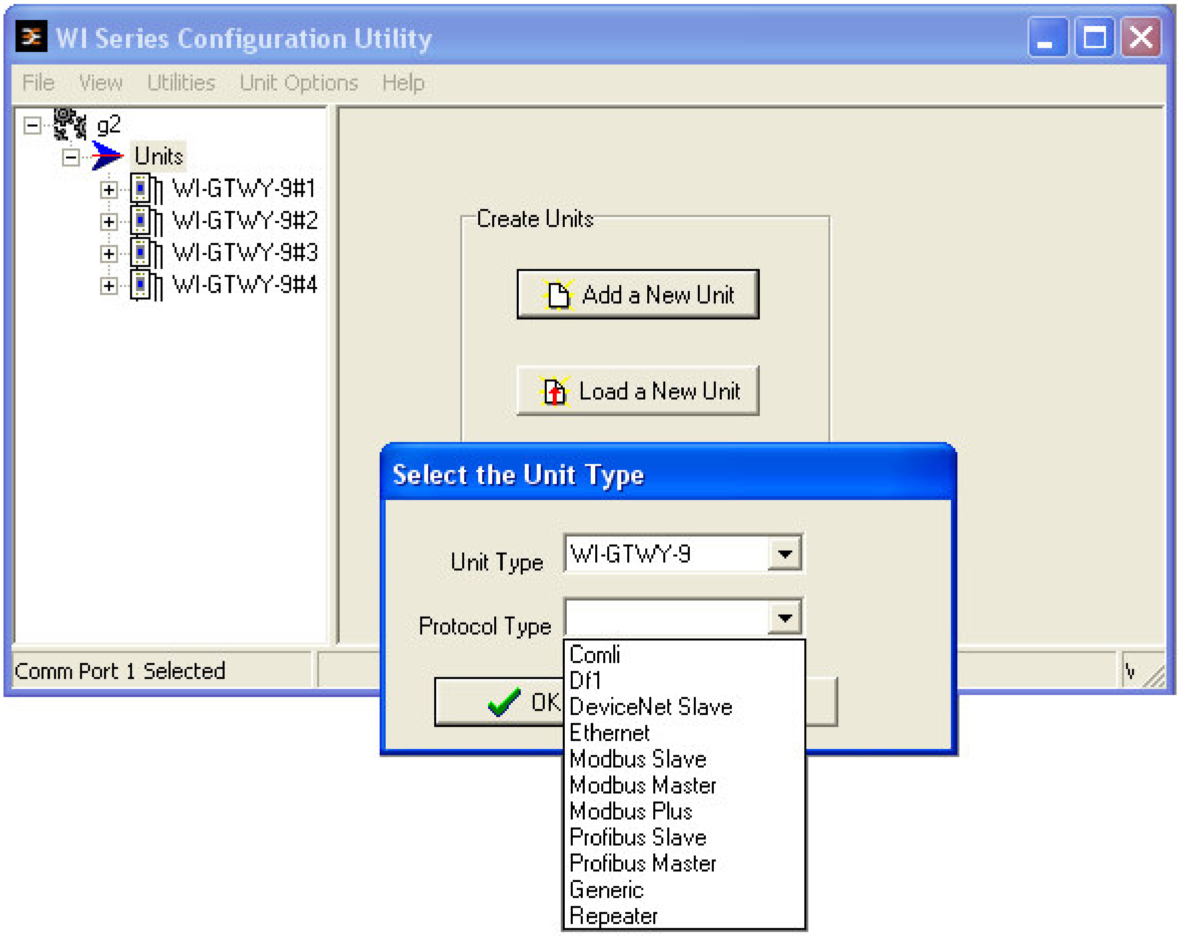
Loading configuration from an existing module
To load the configuration from a module, connect the module to the PC via the RS232 cable, put the module into "Configuration Mode" by pressing the configuration button on the top end-plate, and click on "Load Unit". This will allow you to view the module 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.

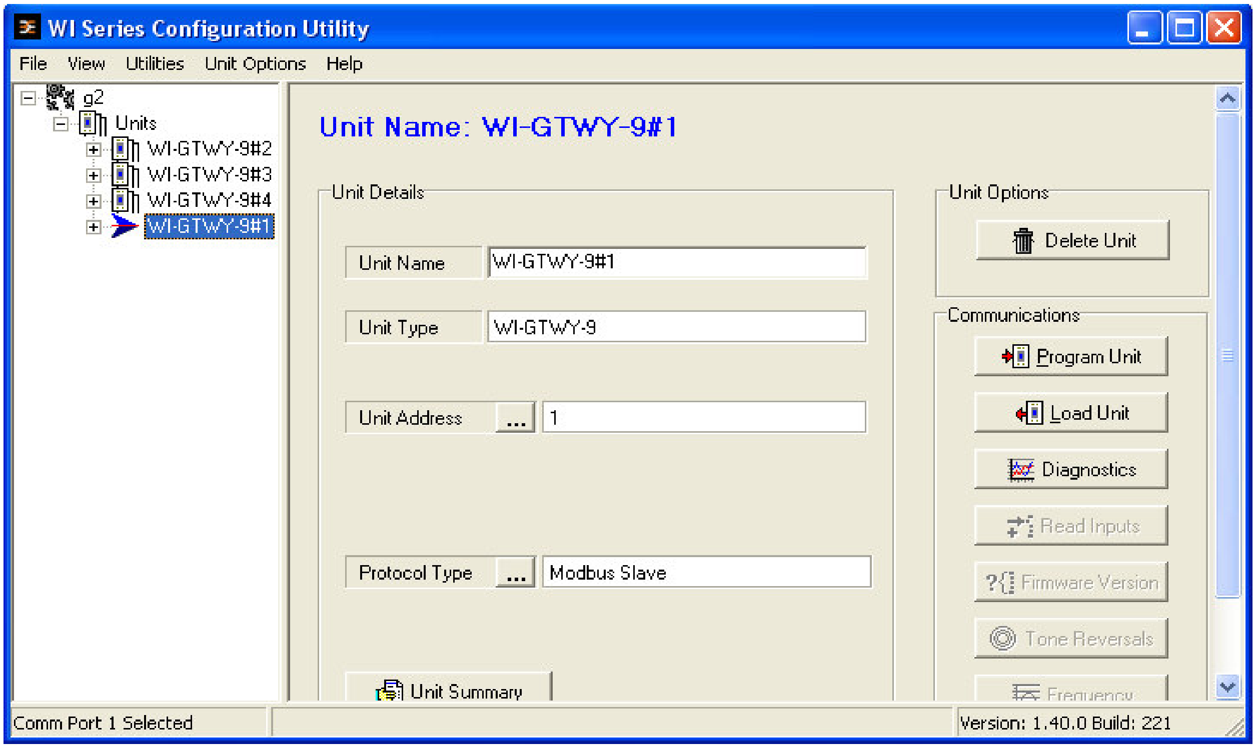
You have the option of selecting a unit address for the module, or allowing the program to select one automatically. If you choose to select the unit address the program will display the list of available addresses for to select - valid addresses are 1 – 95.

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".



Deleting a Unit

A module can be deleted from the configuration by highlighting the unit and selecting "Delete Unit".



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.

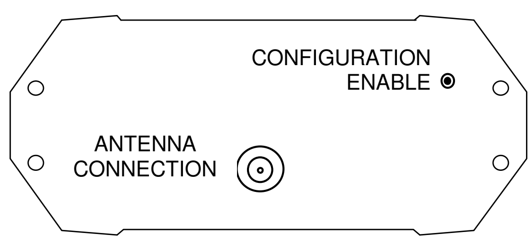
If you wish to change the security key, simply enter a new key in the configuration program, and download the new configuration to all modules in the system.

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.

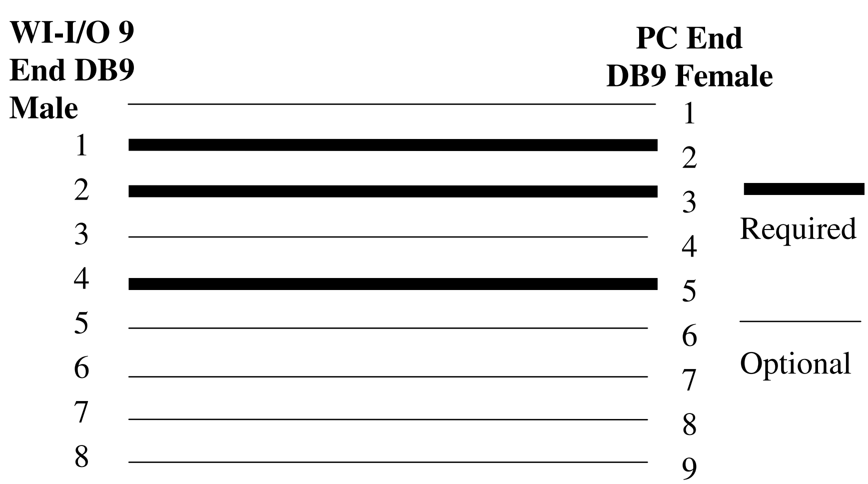
4.3 Uploading and Downloading

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-



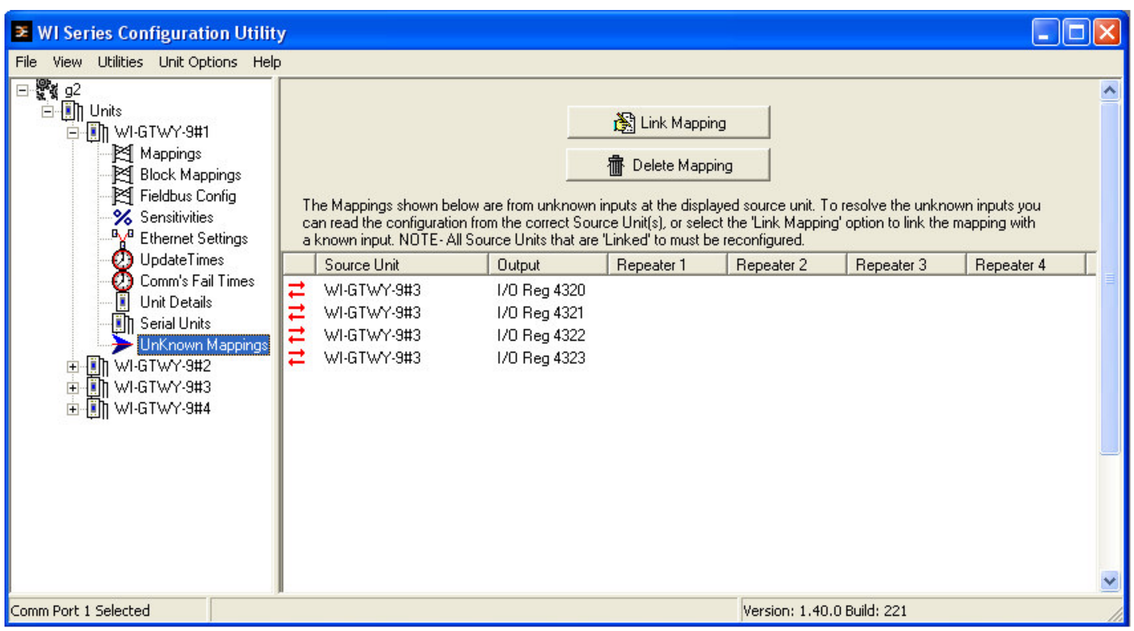
9-xxx by removing power and re-connecting power. The WI-GTWY-9-xxx will start up normally and the OK LED will be on. The serial port will have its original set-up.

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:

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.

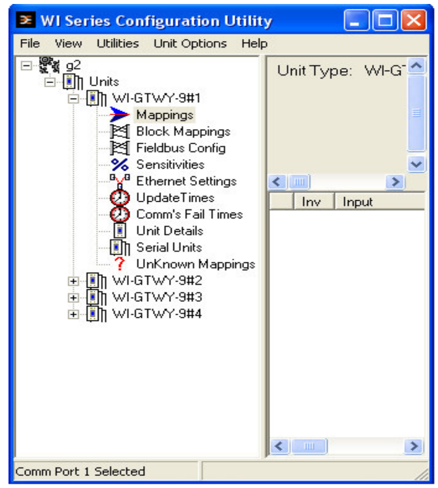
If you are unable to load into the archived project, then mappings to remote modules will be displayed, but mappings from remote inputs will be shown as "Unknown Mappings".



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.

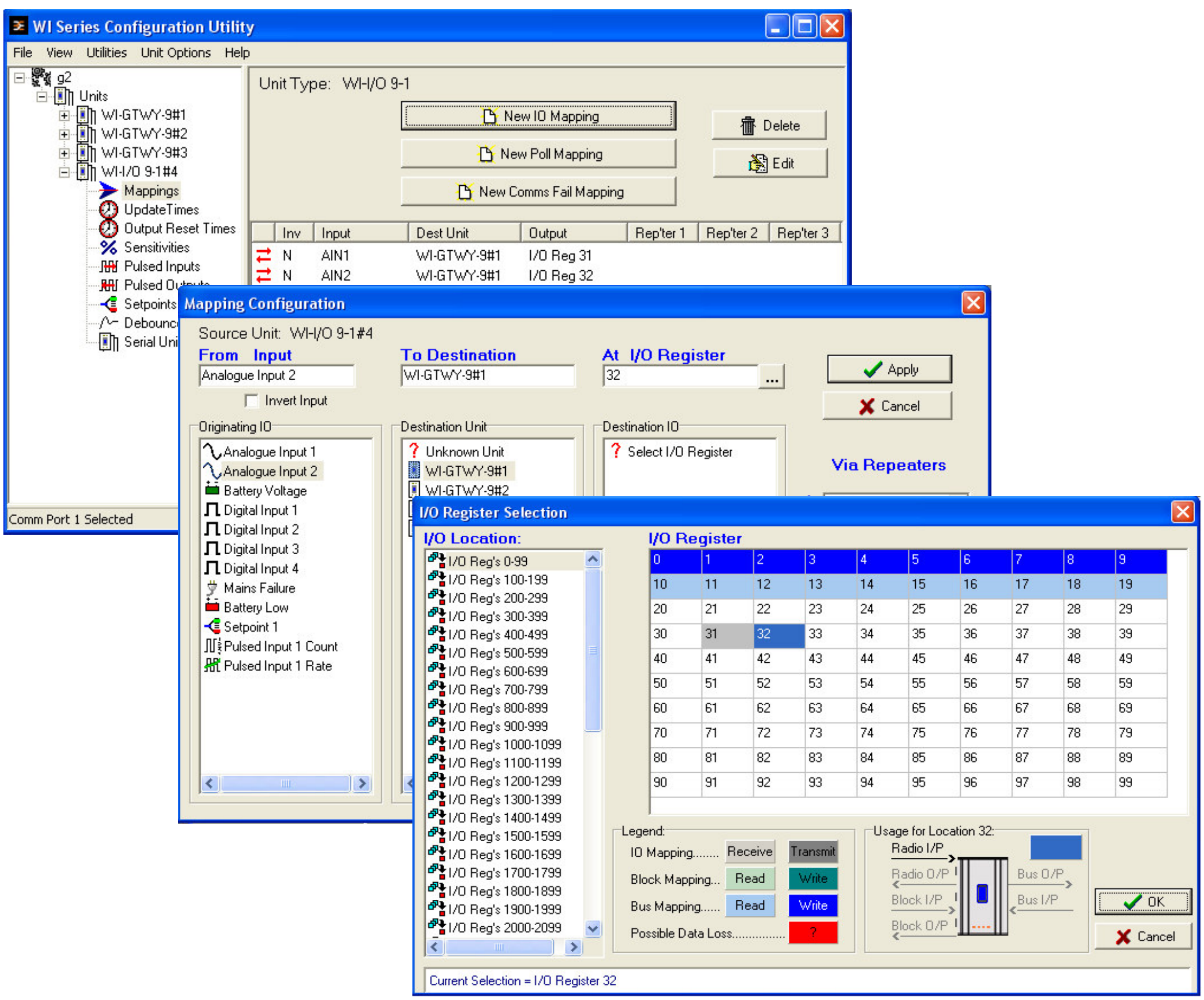
To configure mappings, double-click on the module in the left-hand menu - the menu will expand with selections for that module. Select "Mappings".

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.

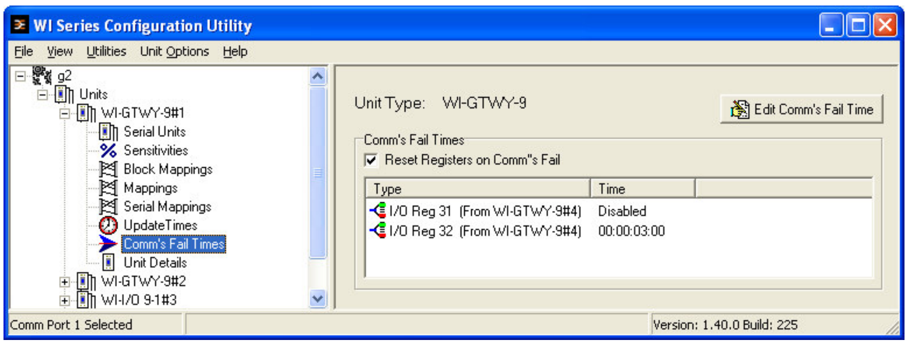


Any I/O registers that have already been selected will have a color shading.

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.

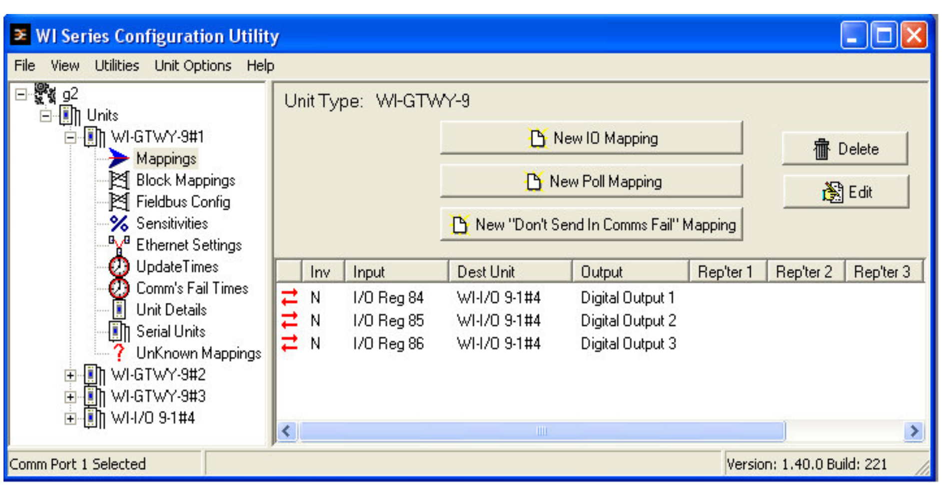
The default value for the comms-fail time is "disabled" or zero. To enter a time, select the I/O register from the list. The comms-fail time should be greater than the update time of the remote input.

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

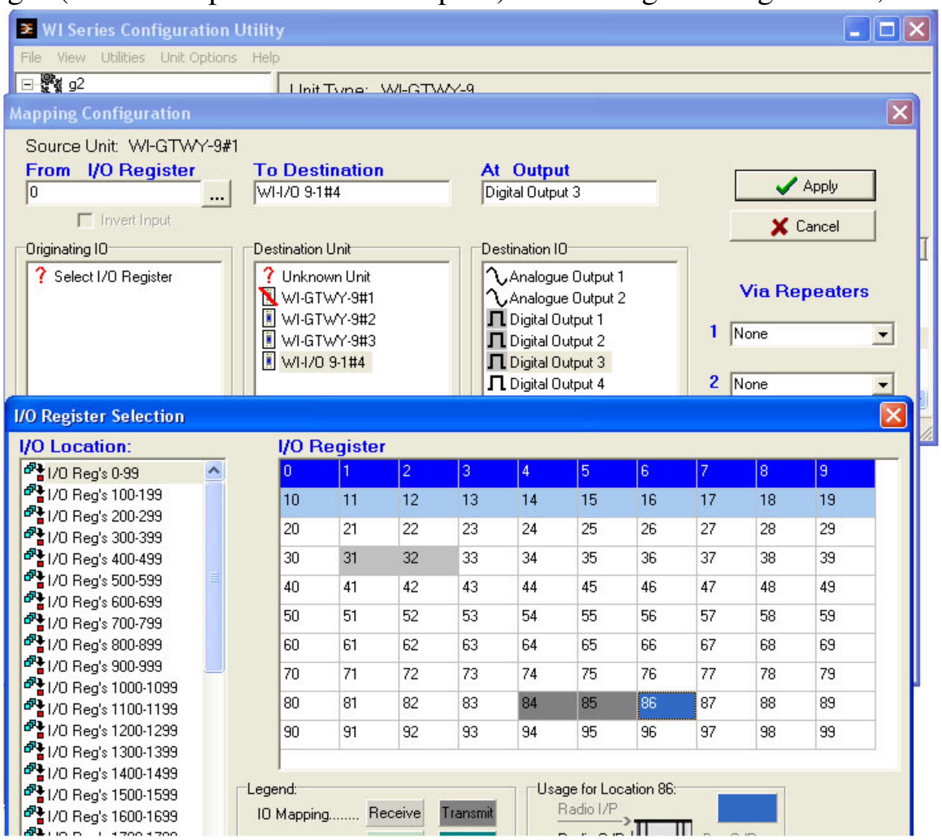
Mappings can be entered in the WI-GTWY-9-xxx to remote outputs. Select the "Mappings" option under the WI-GTWY-9-xxx. Select an I/O register and select the remote module and the output channel.



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.

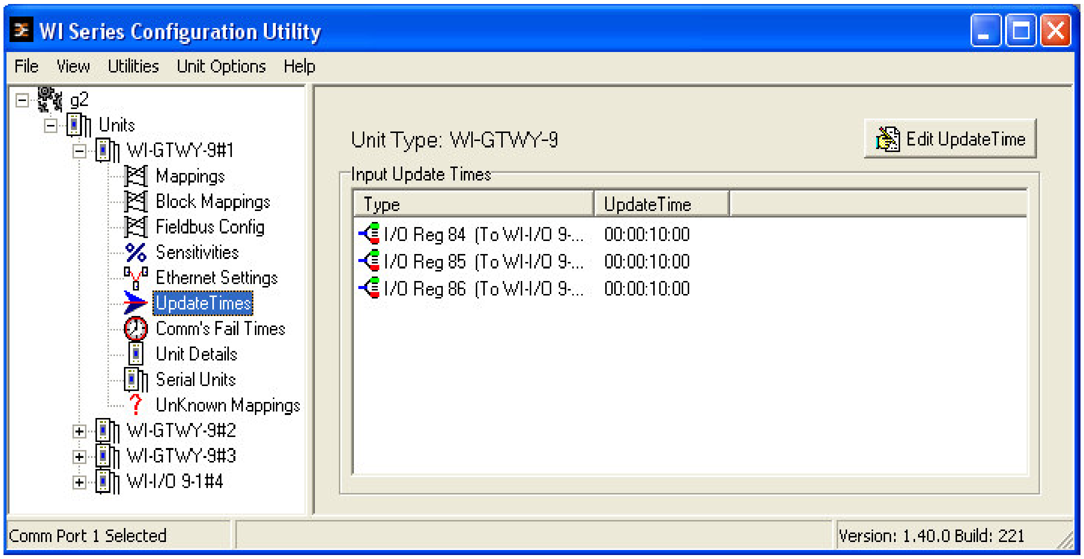


You can configure the amount of change required to trigger a change message - this is called the change sensitivity. Sensitivities are configured for blocks of I/O registers - that is, each I/O register does not have a unique sensitivity. You can configure up to 50 sensitivity values - that is, there can be 50 blocks of registers with different sensitivities.

For more information on this, refer to section 4.6.

Update Times

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.

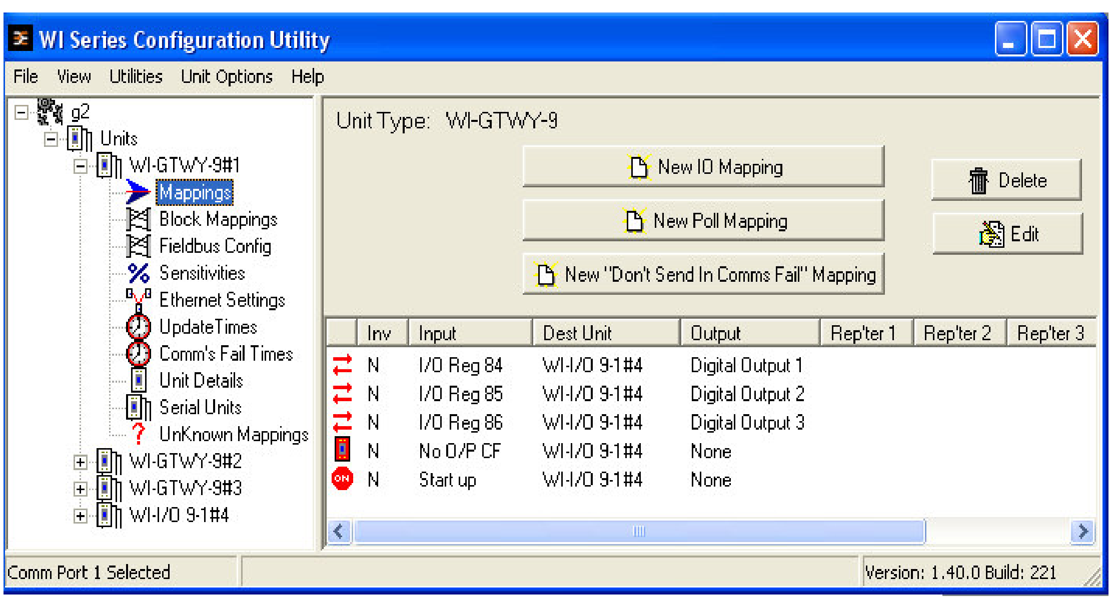


Changing Multiple Settings

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.



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

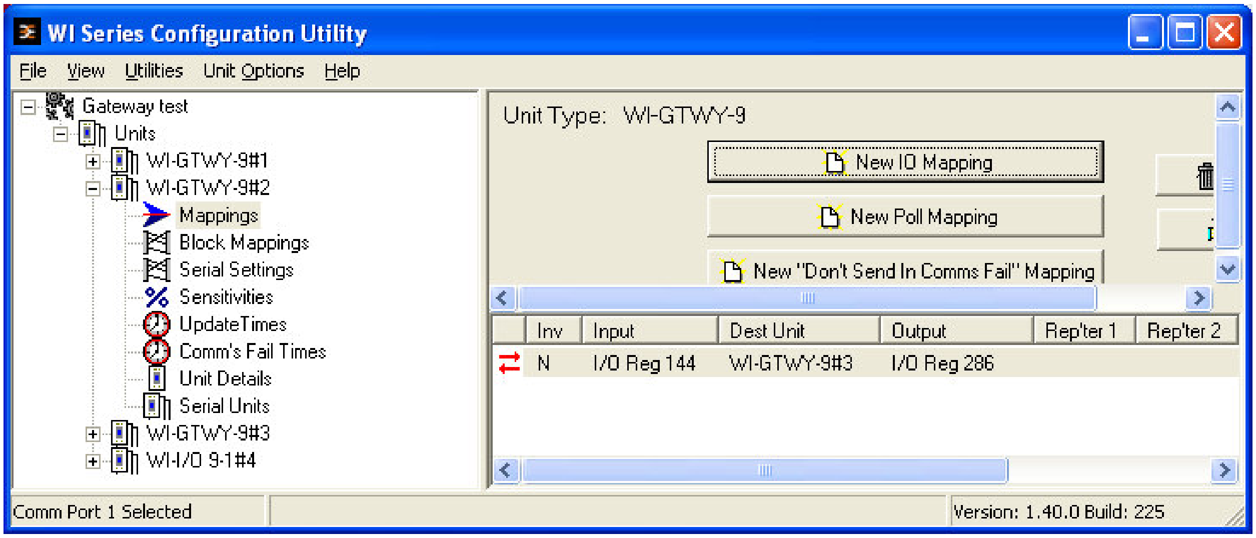
It is possible for a WI-GTWY-9-xxx to send a poll to a remote module at other times apart from start-up. A poll can be sent under the following events:

- 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:

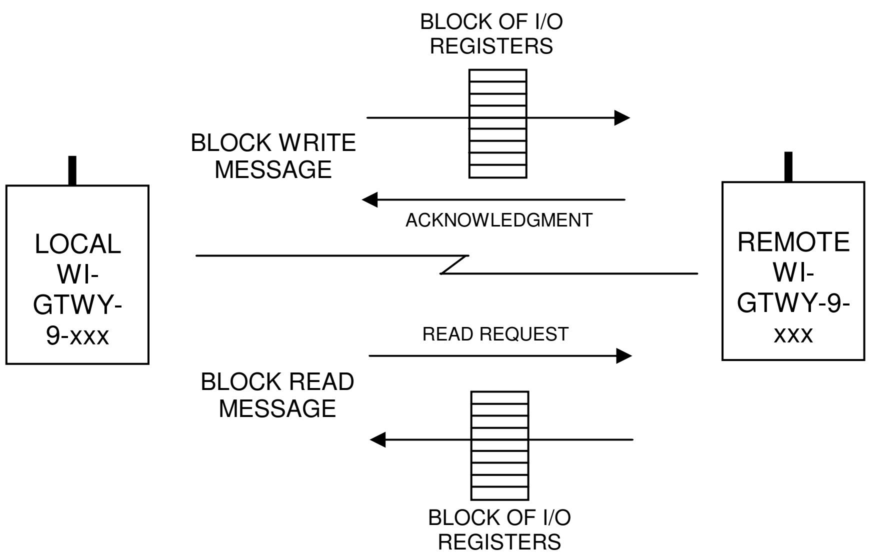


Whenever I/O Reg 144 changed by the sensitivity amount, WI-GTWY-9-xxx#2 would send a message to WI-GTWY-9-xxx#3 to write the value in I/O Reg 286. The problem arises if there are a lot of these mappings. Each radio message only relates to one register-register link. If you want to map 1000 registers 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

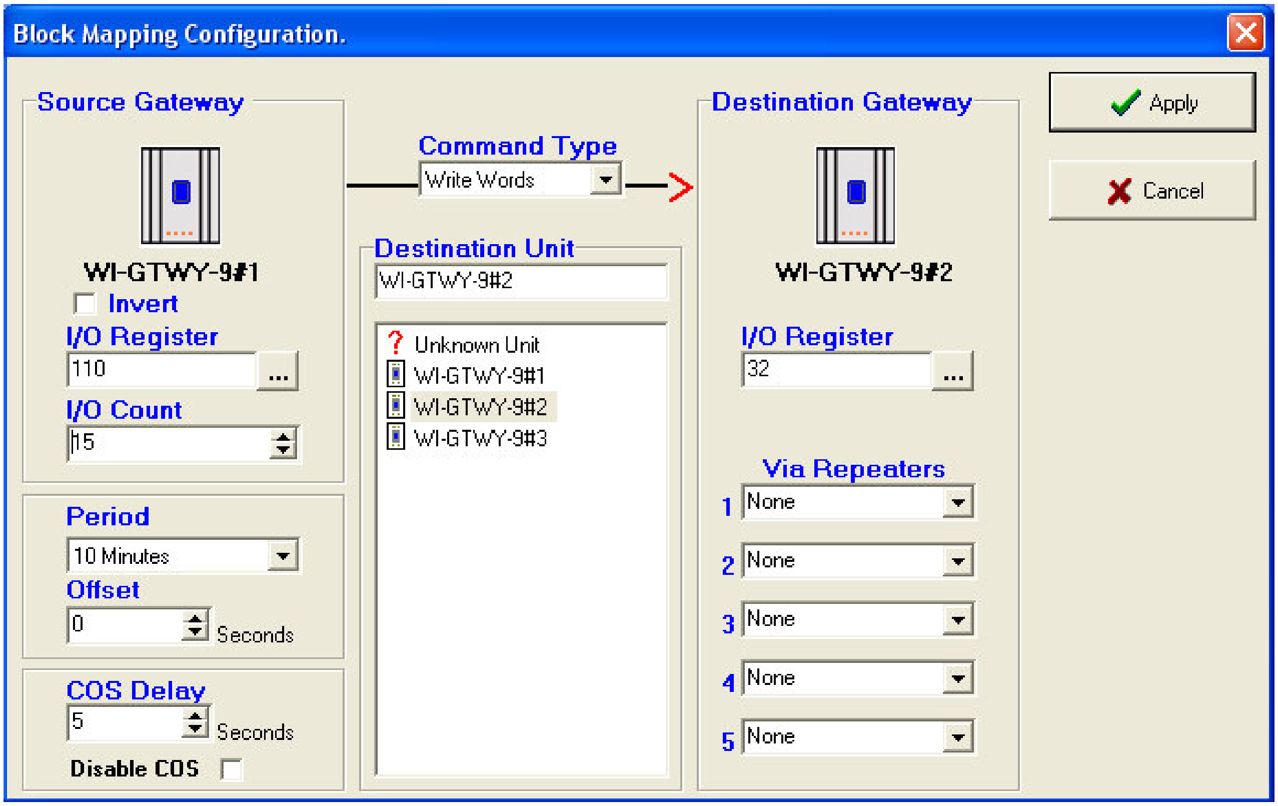
Read and Write mappings are also selected as Word or Bit mappings - that is, you can select a Read Word mapping or a Read Bit mapping and you can select a Write Word mapping or a Write Bit mapping. "Word" refers to a complete 16-bit register value; "Bit" refers to the value of the most significant bit 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.



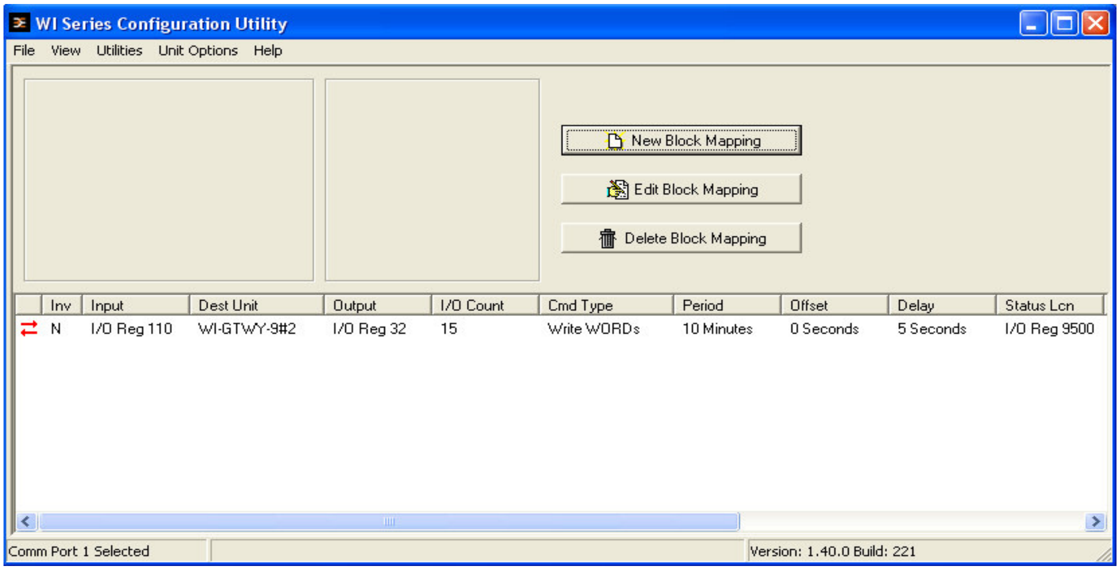
Select the "Command Type" from the pop-down window in the centre of the display. The red arrow will confirm the direction of the block transfer. Now select the destination module - only the WI-GTWY-9-xxx modules already configured will be shown. If you need to use repeaters in the radio link, enter the 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.



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"

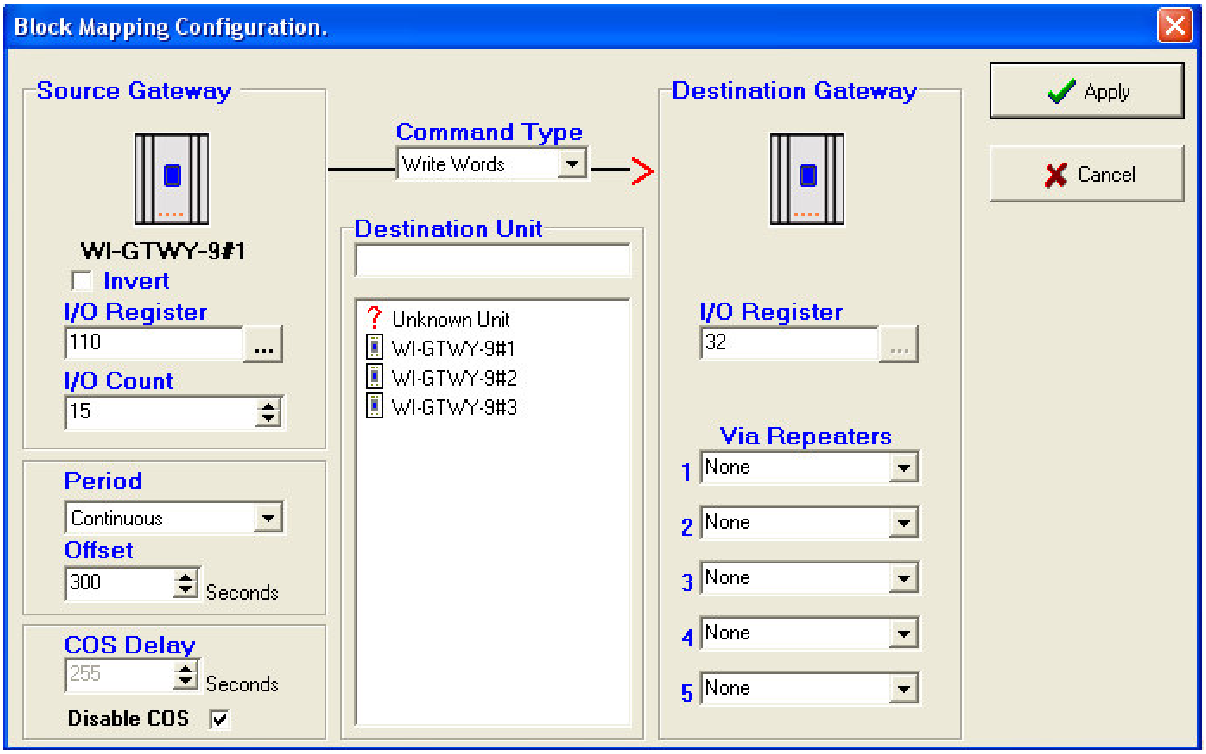
A block mapping can be "triggered" or initiated by several different methods.

- 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.



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.

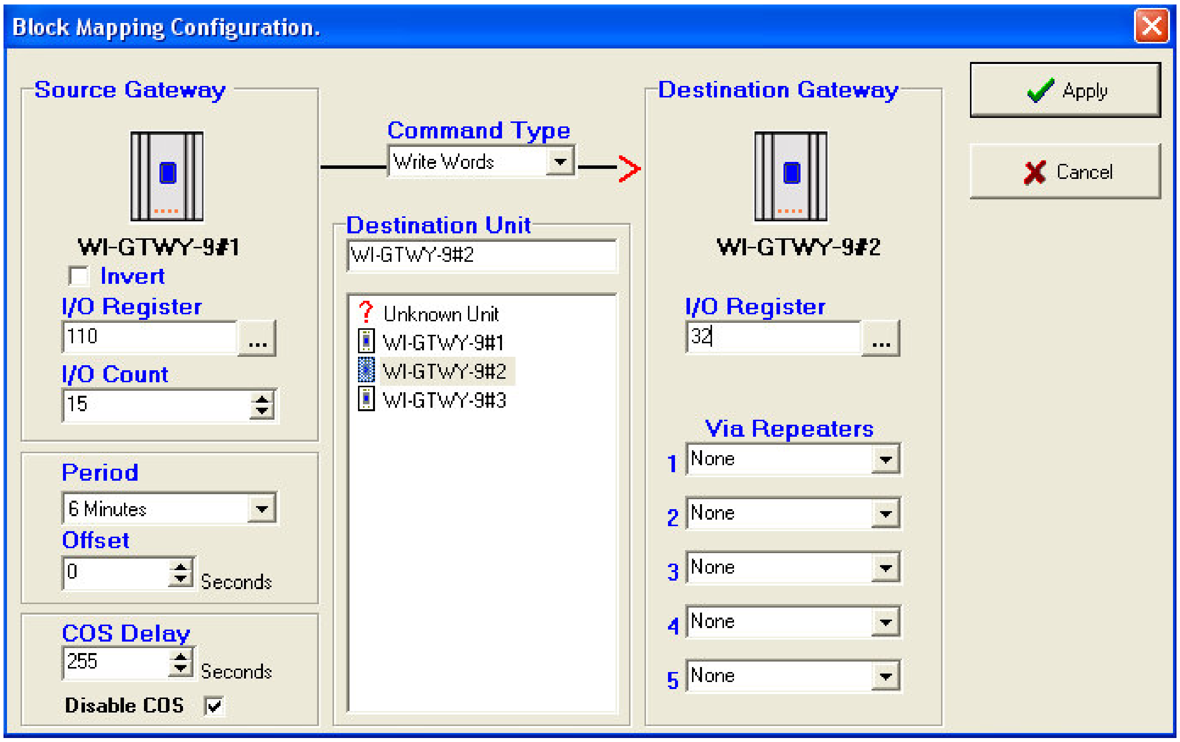
The "Offset" value can be set from 0 – 4095 seconds (68 minutes). If you do not want the message to be sent on a time period, set the "Offset" value to zero.

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.



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

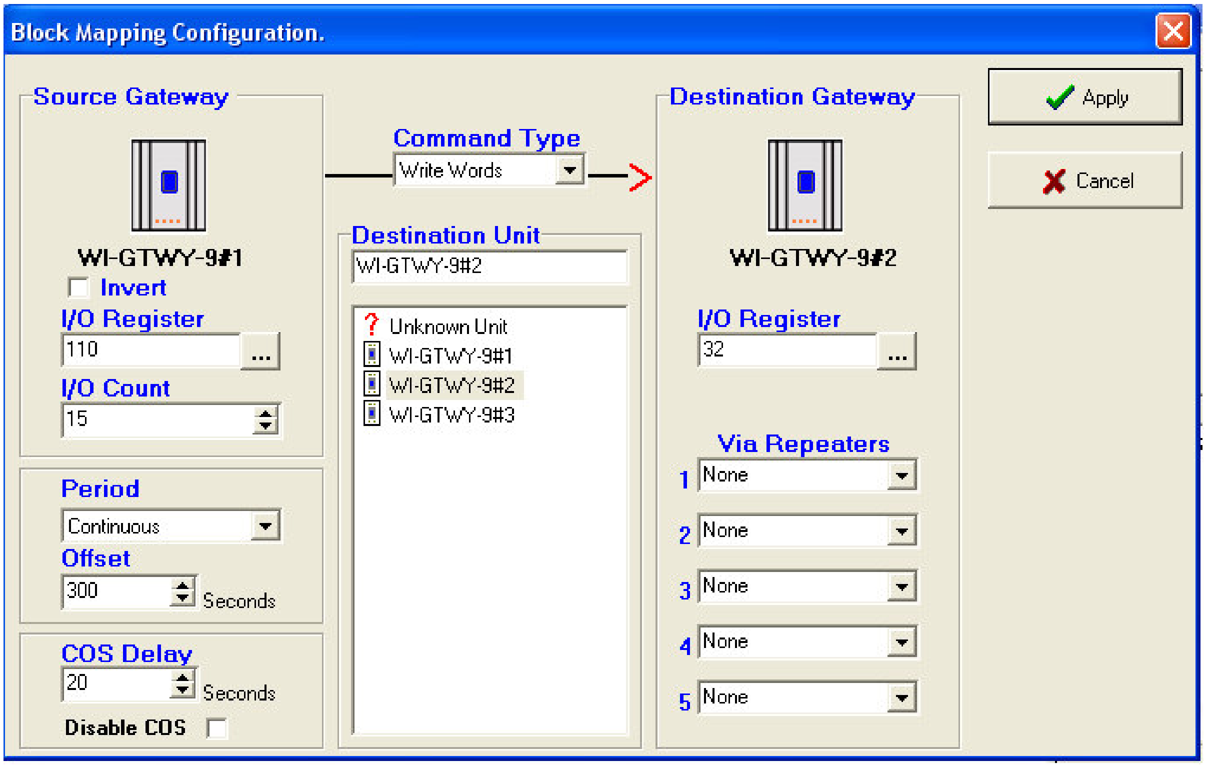
Firmware versions up to 1.50:

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



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.

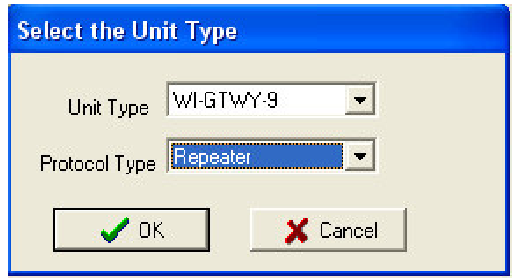
4.5.7 Comms Fail for Block Mappings

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.



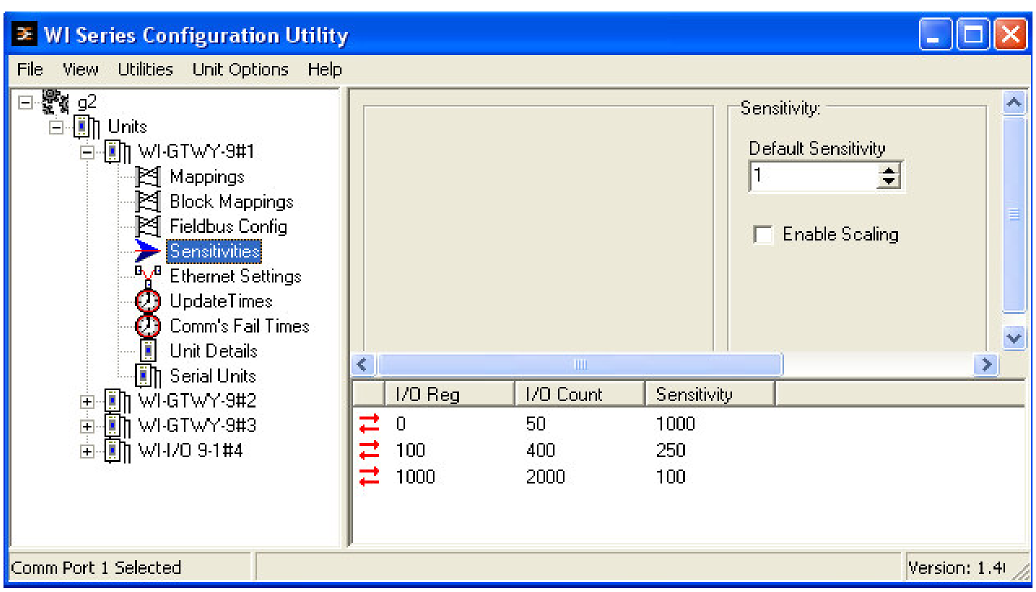
A repeater can be configured as a "Repeater-only" unit. The advantages are:

- 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.



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:

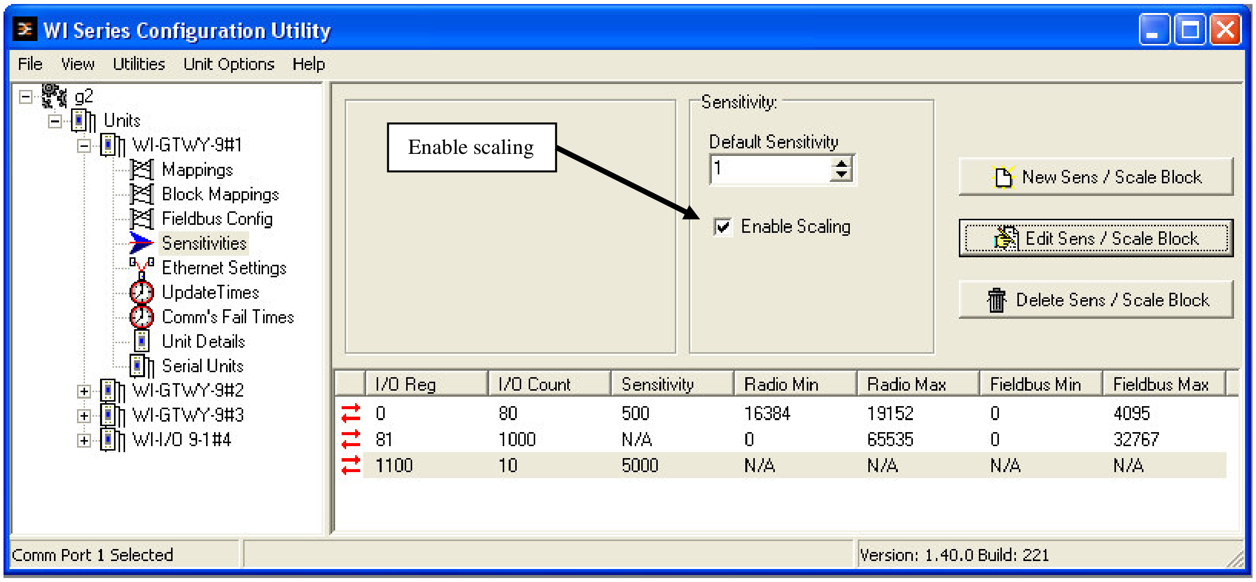
The values in I/O registers can be scaled as the values are transferred to the data bus, or from the data bus.

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:

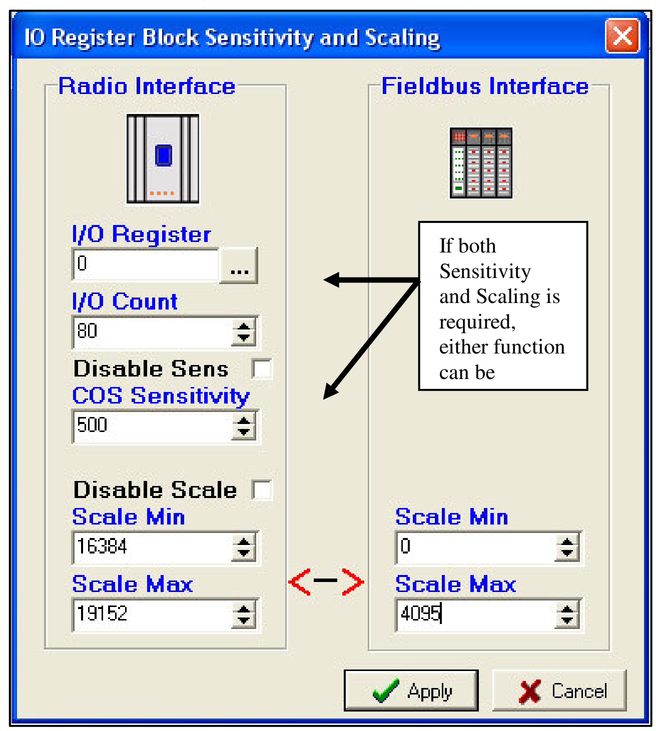
- Honeywell Modbus gateways which only handle 12-bits values (0-4,095 decimal), and
- Sensor / analyzer devices with "signed 16-bit" values. A signed 16-bit value is a 15-bit value with an additional bit to signify plus (0) or minus (1).

Scaling of I/O registers can be configured in blocks. Different blocks can have different scaling.



Note that scaling only affects values transferred in or out of the data bus port. It has no affect on the radio side.

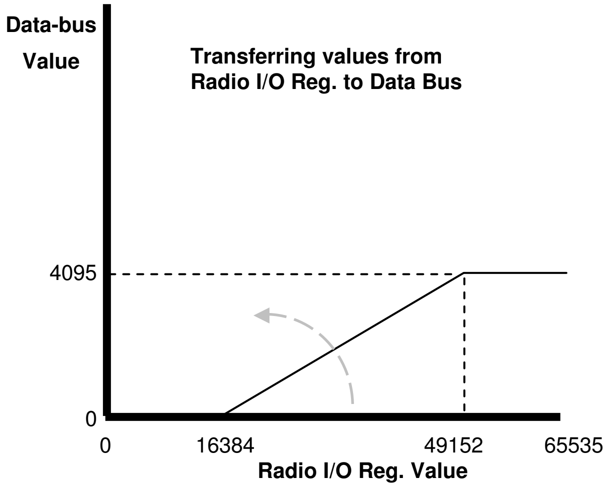
Scaling is configured in the "Sensitivities" section of the configuration software. If you select a new sensitivity/scaling block, you can select/deselect sensitivity or scaling or both. There is no relationship between sensitivity and scaling - we use the same configuration area as it is convenient because both features use blocks of I/O registers.



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.

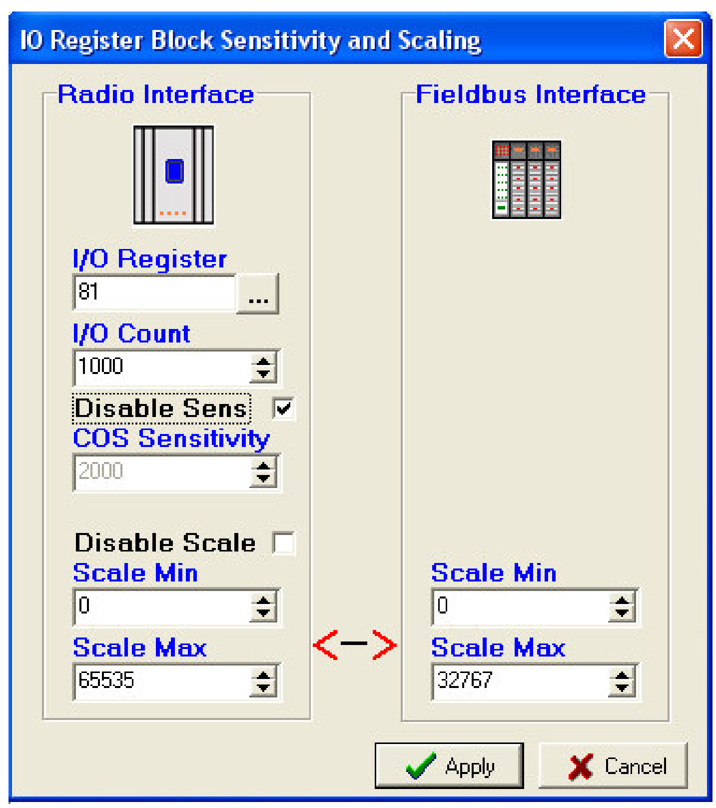
This is an example of converting a 4-20mA value to a "Honeywell 12-bit value". Note that the scaling works in both directions - for values being read from the I/O registers to the data bus, and values written from the data bus to the I/O registers.

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.



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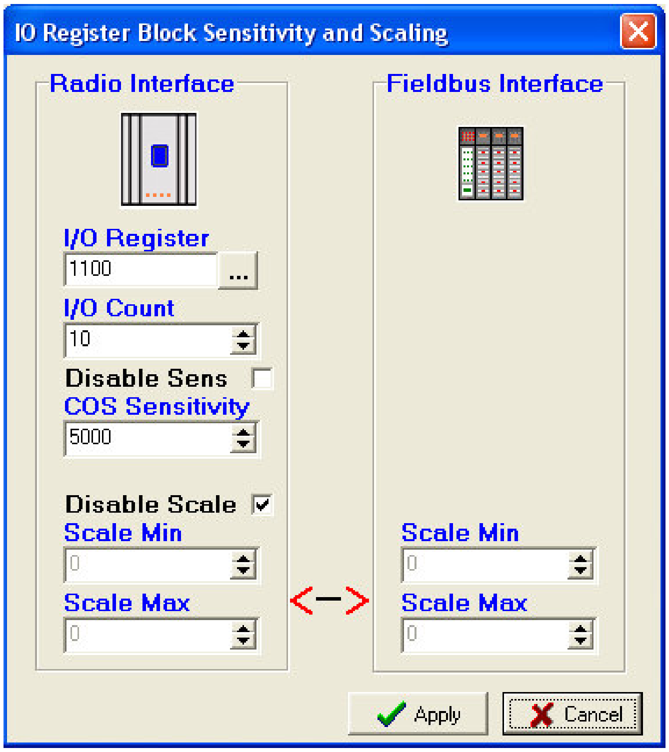
In the last example, Scaling has been disabled for register block 1100 – 1109. Only sensitivity functionality is being used.

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.



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

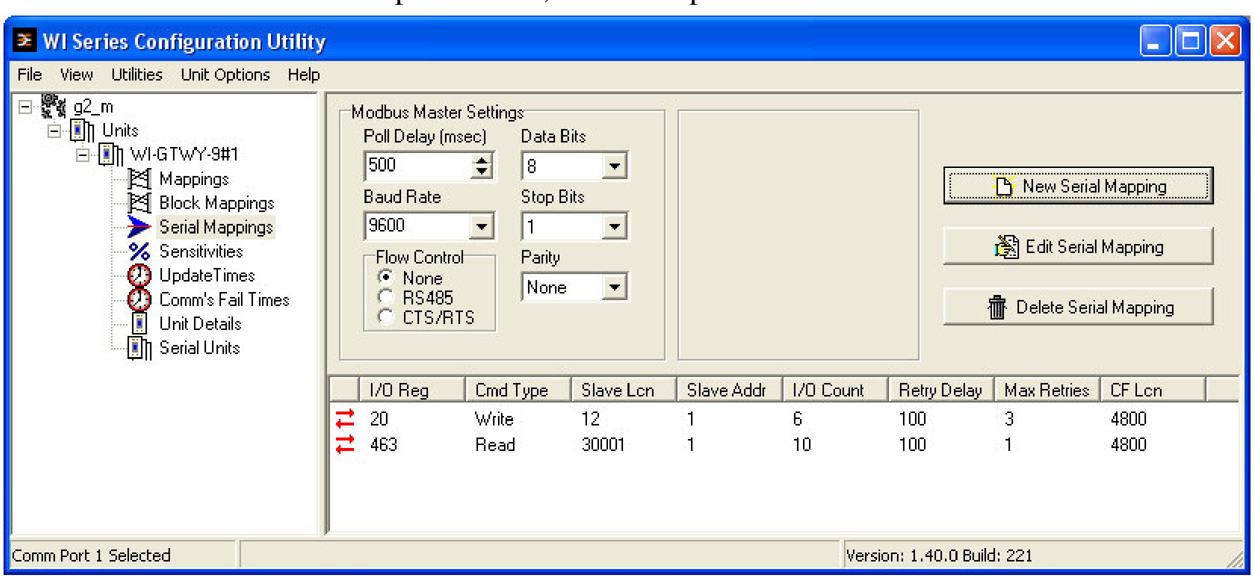
Four Modbus error messages are reported to the Modbus Master. An error response is indicated by the address of the return message being 128 plus the original slave address.

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



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.

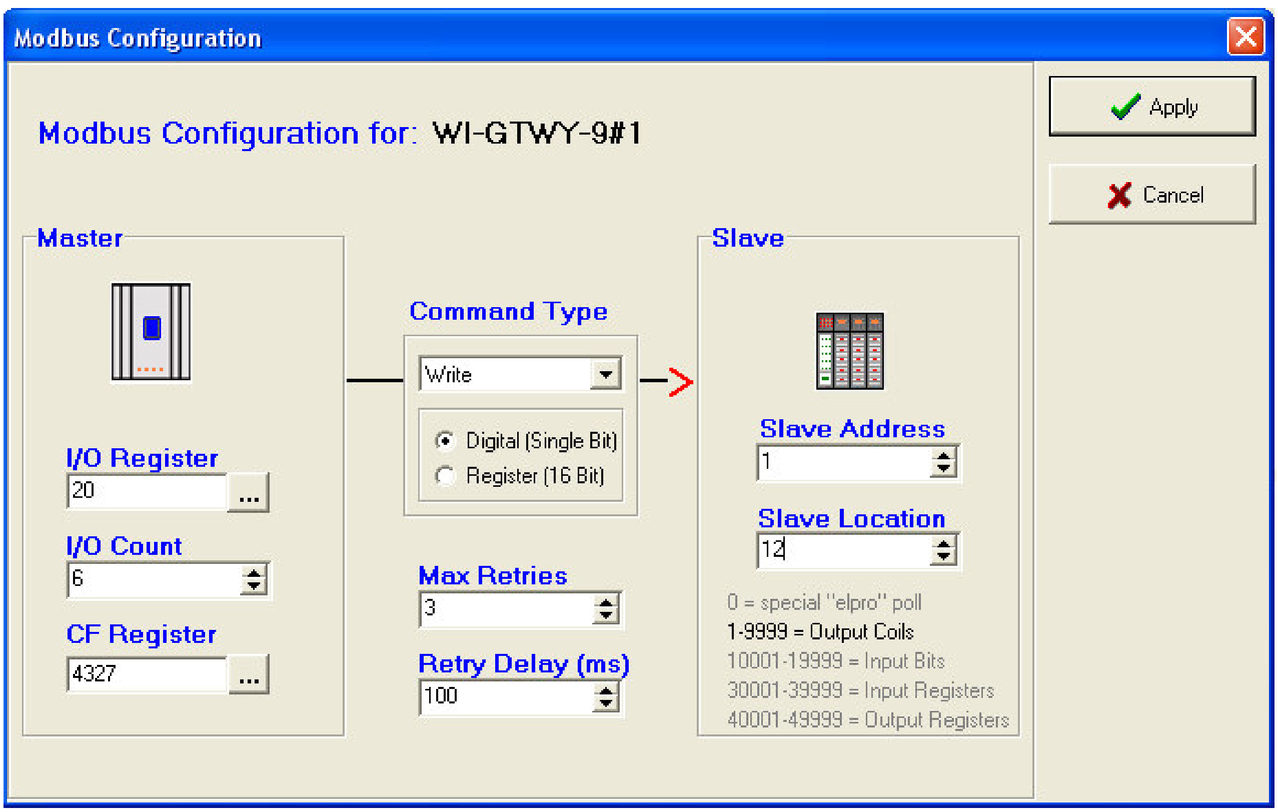
First read the above section on Modbus Slave operation, for an understanding of how the WI-GTWY-9-xxx handles Modbus registers, and the types of Modbus commands the WI-GTWY-9-xxx Master can generate.

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.

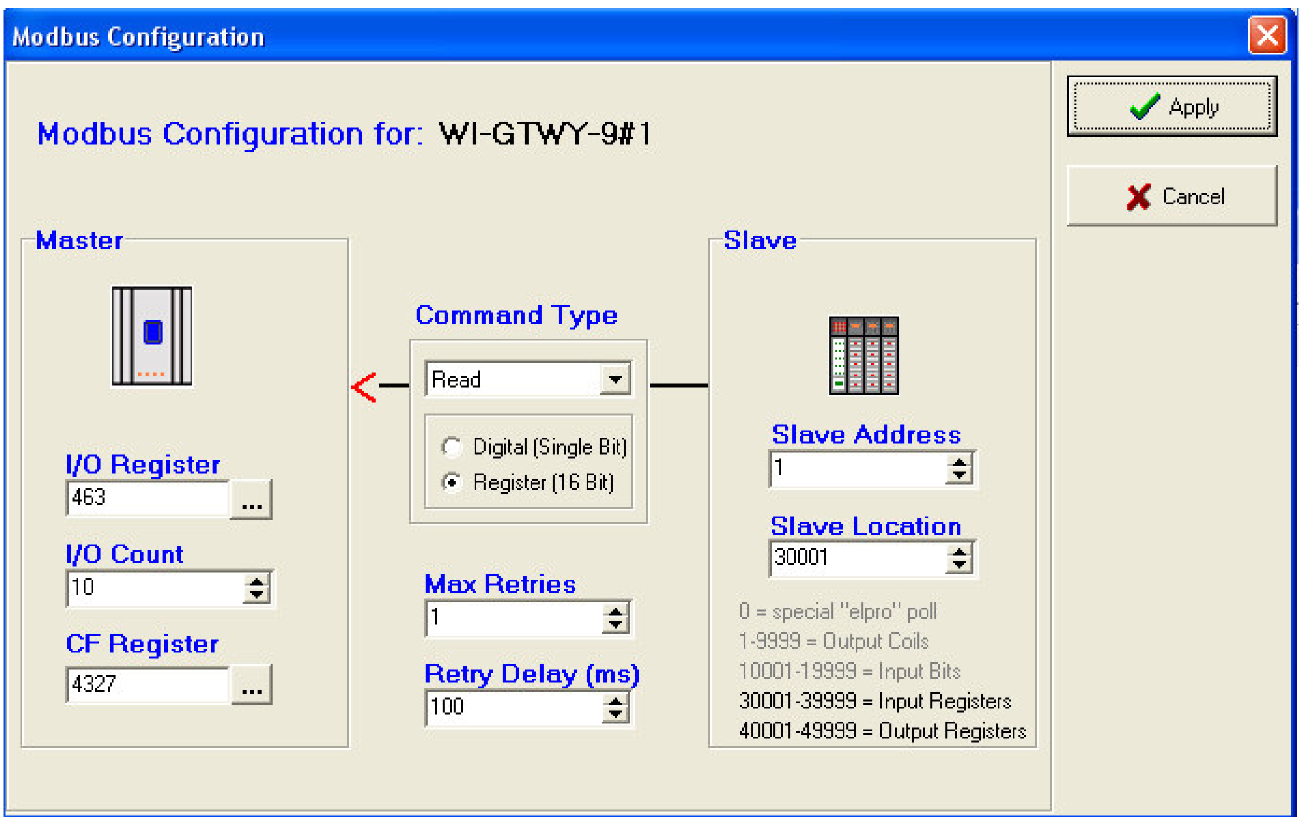
The "Command Type" selected is a write command (you can select read or write) - which means that the values are sent from the WI-GTWY-9-xxx to the Modbus Slave. The type of write command is a "Digital" write, meaning that the register values will be written as digital/binary values".



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.



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.

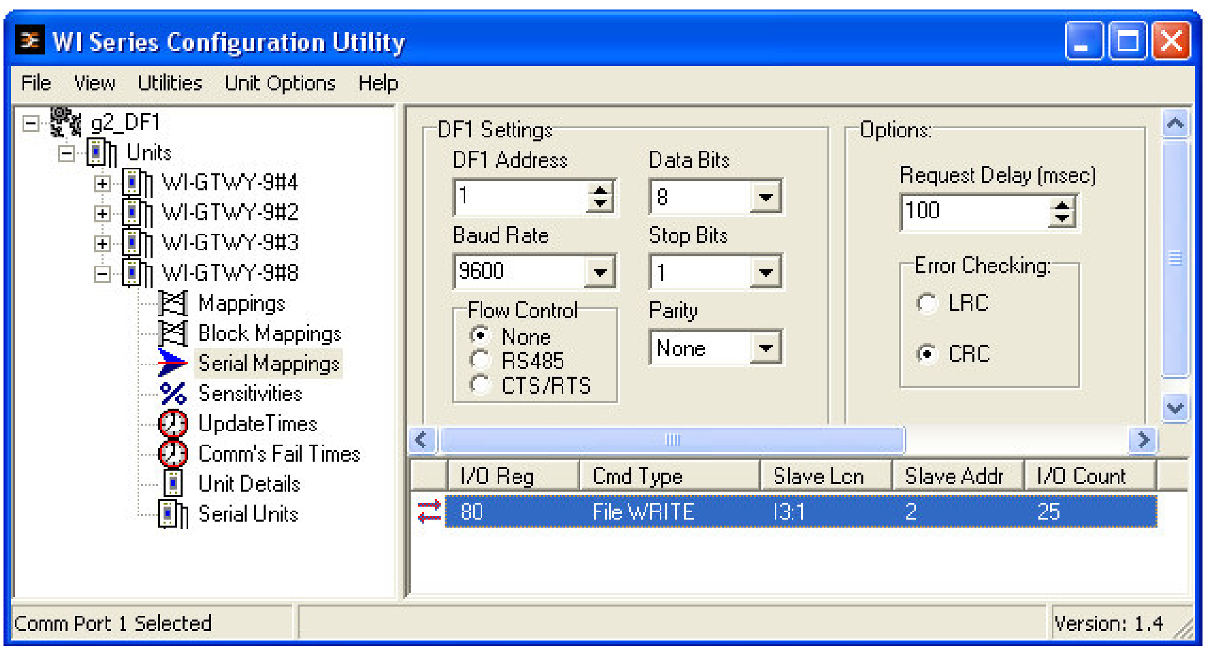
Command Description		Code	Function Code	Comment	
Protected Write		0x00	NONE	PLC2 series and SLC / Micrologix	
Unprotected Read		0x01	NONE	PLC2 series and SLC / Micrologix	
Diagnostic Status		0x06	0x00	Diagnostic Commands	
	Echo message	0x06	0x00		
Unprotected Write		0x08	NONE	PLC2 series and SLC500 / 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

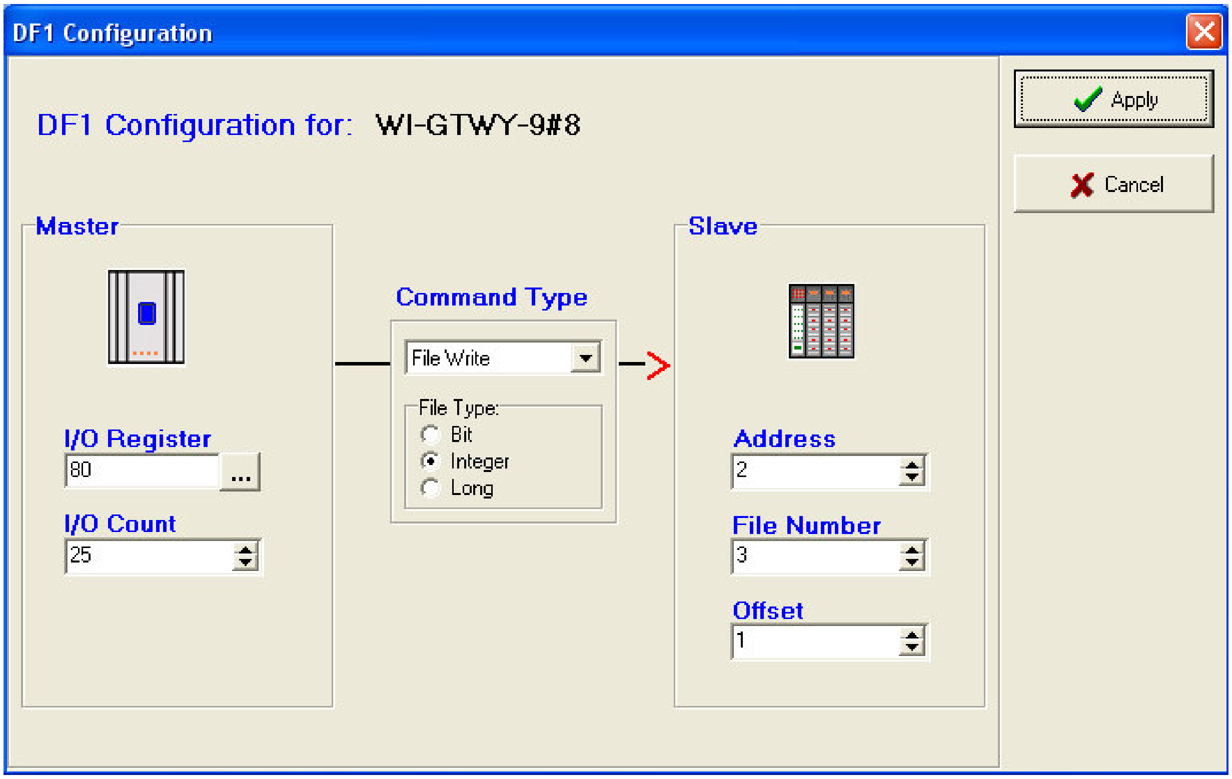


following example is a file write command which writes WI-GTWY-9-xxx I/O registers 80 – 104 (25 registers) to DF1 files I3.1 to I27.1 at DF1 address 2.

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.



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

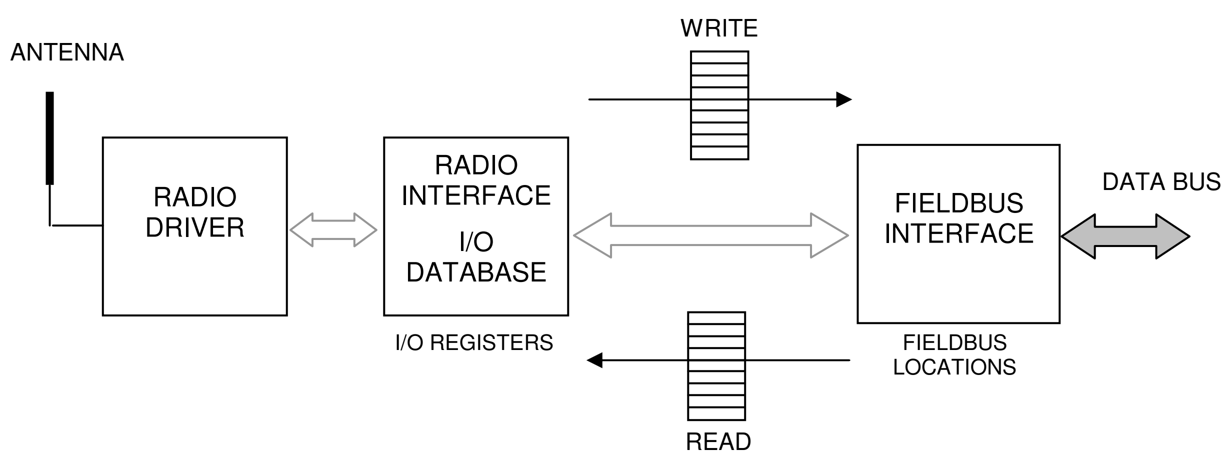
The WI-GTWY-9-xxx provides a linear address space of 10,000 data words. This is compatible with PLC2 addresses, but does not match the addressing used by the 500CPU modules (SLC and Micrologic). These address data by file number and file offset. To address an I/O register, *L,* in the WI-GTWY-9-xxx, 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

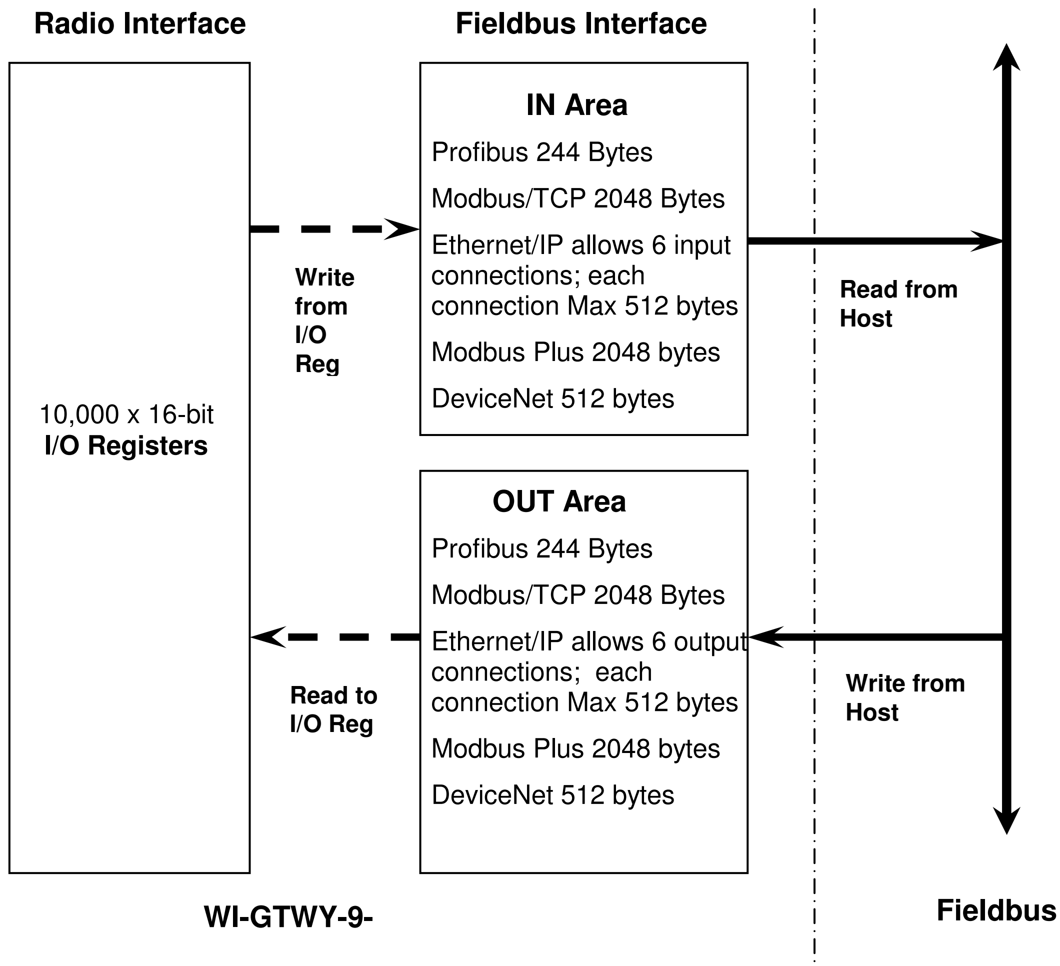
All WI-GTWY-9-xxx modules (*except MD1*) have separate internal hardware comprising the Fieldbus Interface, consisting of a separate microprocessor and appropriate hardware for the network connection. This Fieldbus Interface handles all fieldbus communications, and transfers I/O in the Fieldbus Interface 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.

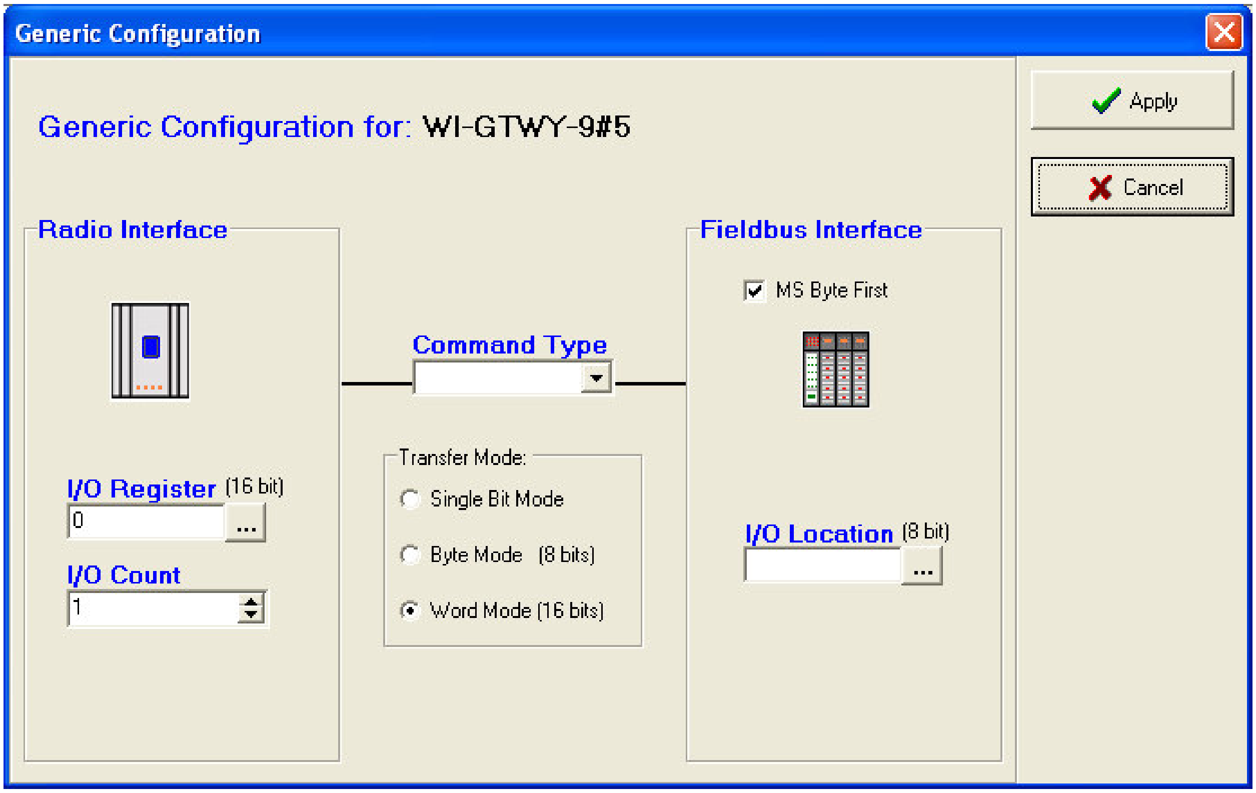
The Fieldbus Interface IN and OUT areas are simply a block of I/O memory, exchanged according to the configured protocol. For example, with a Profibus slave that supports 244 bytes of inputs, the fieldbus interface IN area could be addressed either as byte locations 1 to 244 or as word locations 1 to 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.

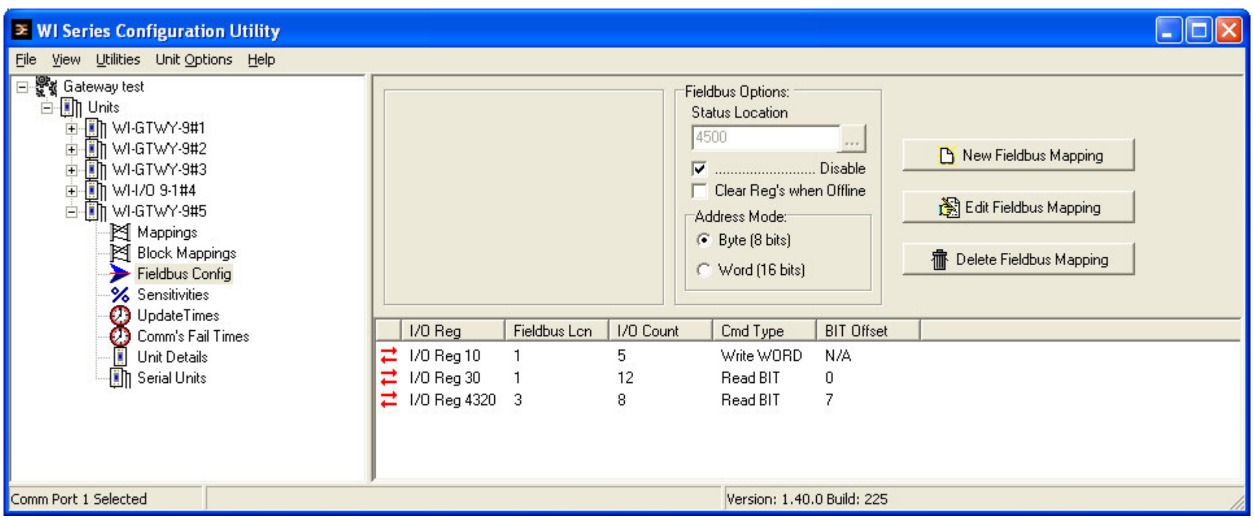
Certain protocols have an inherent or preferred byte or word structure – for example, Modbus is a protocol that usually operates on 16-bit (word) registers. Consequently, configuration software will default to the most common address mode for that protocol. Configuration software may also apply an offset 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).



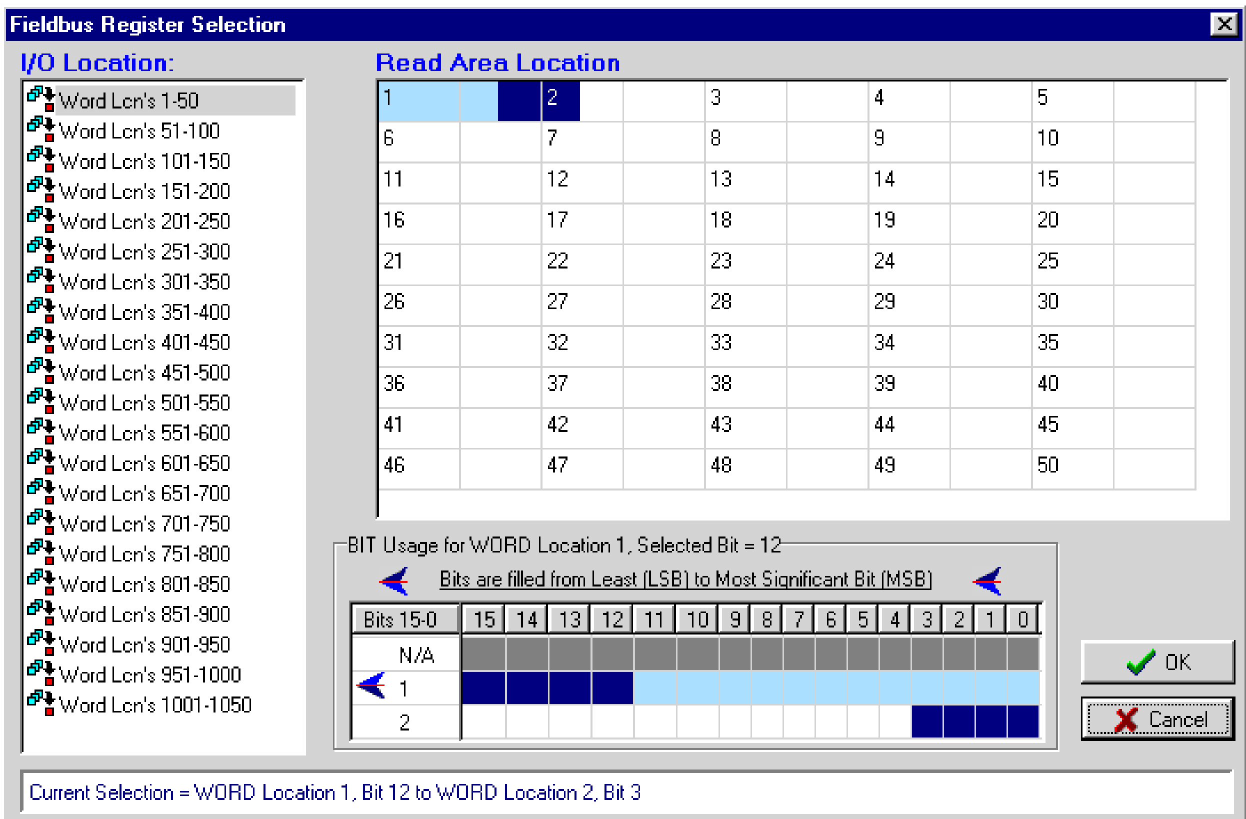


Three Fieldbus Mappings are illustrated in the example above. Note that "Word Address Mode" is selected, meaning that the Fieldbus Interface IN and OUT Areas will be treated as word-addressed arrays by configuration software. The parameters for each fieldbus mapping were setup using the mapping configuration 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).



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.

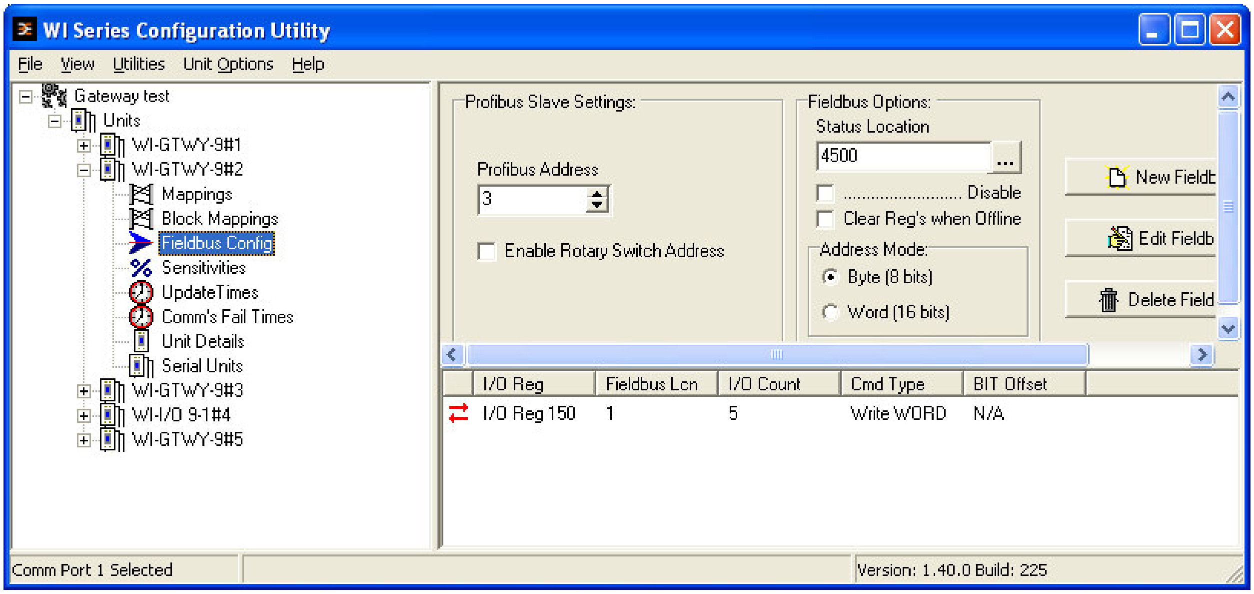
Configuration of the Profibus Fieldbus Interface comprises allocating a Profibus Slave address to the WI-GTWY-9-xxx, and configuring links between the Radio Interface and the Fieldbus Interface (i.e. Fieldbus Mappings).

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.



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)

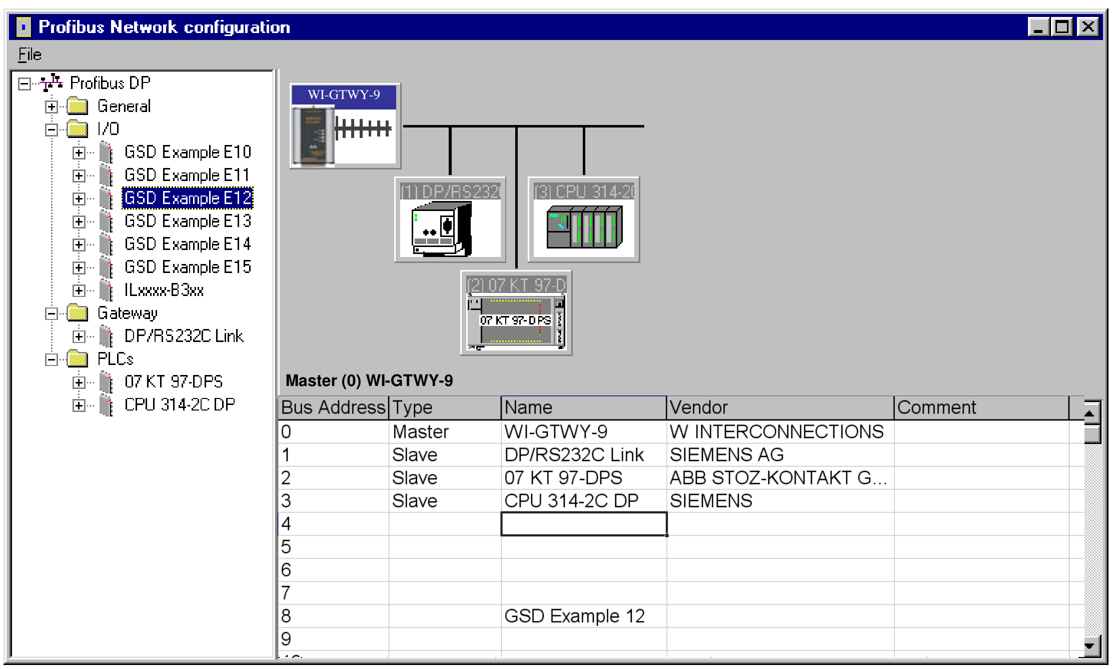
4.11.3 Configuration

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



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

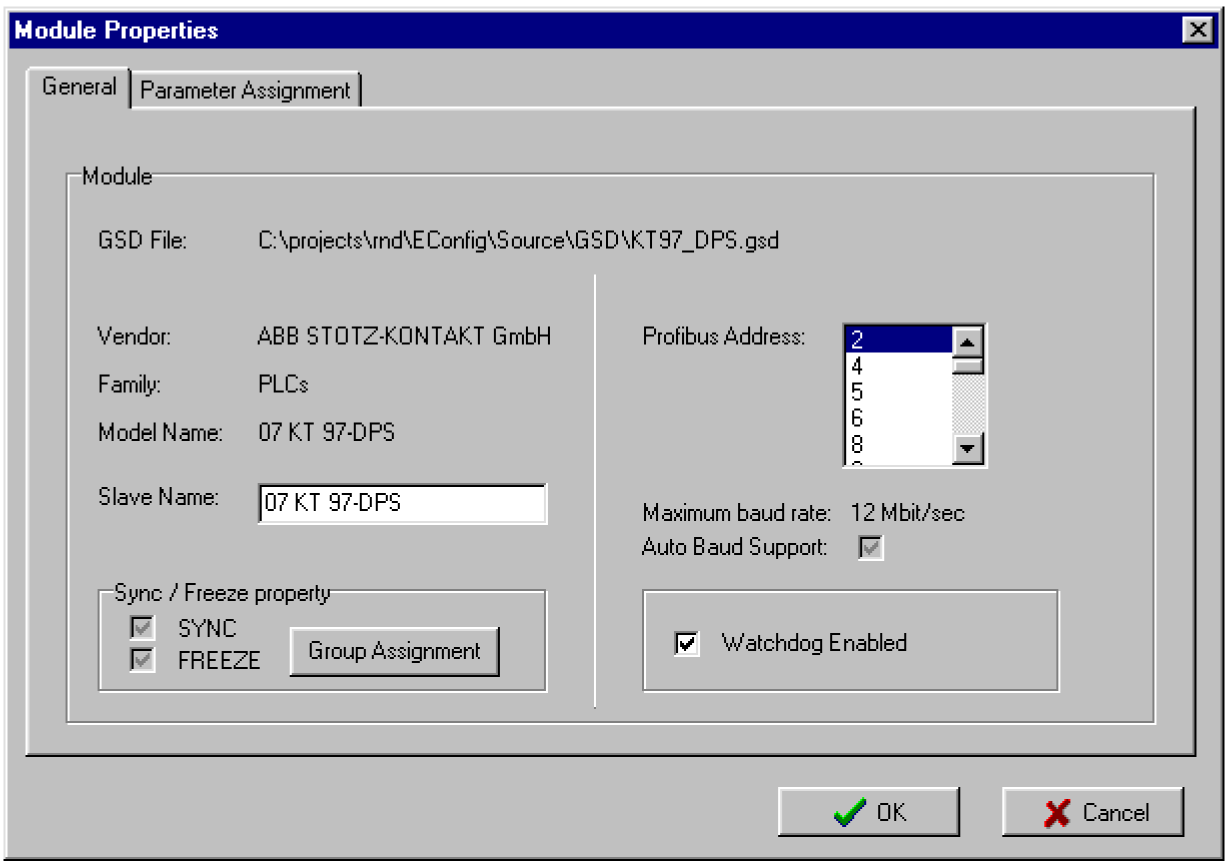
To change the node address of a slave already configured on the network, locate the slave in the network listview and drag it to the position in the list corresponding to the desired address. Alternately, the slave address can be modified from the *module properties* page (see below).

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



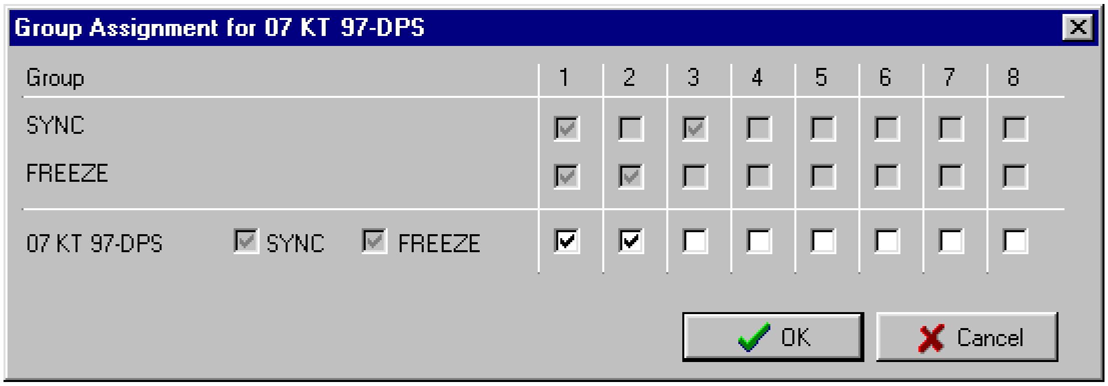
available addresses are listed and can be selected as new address.

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

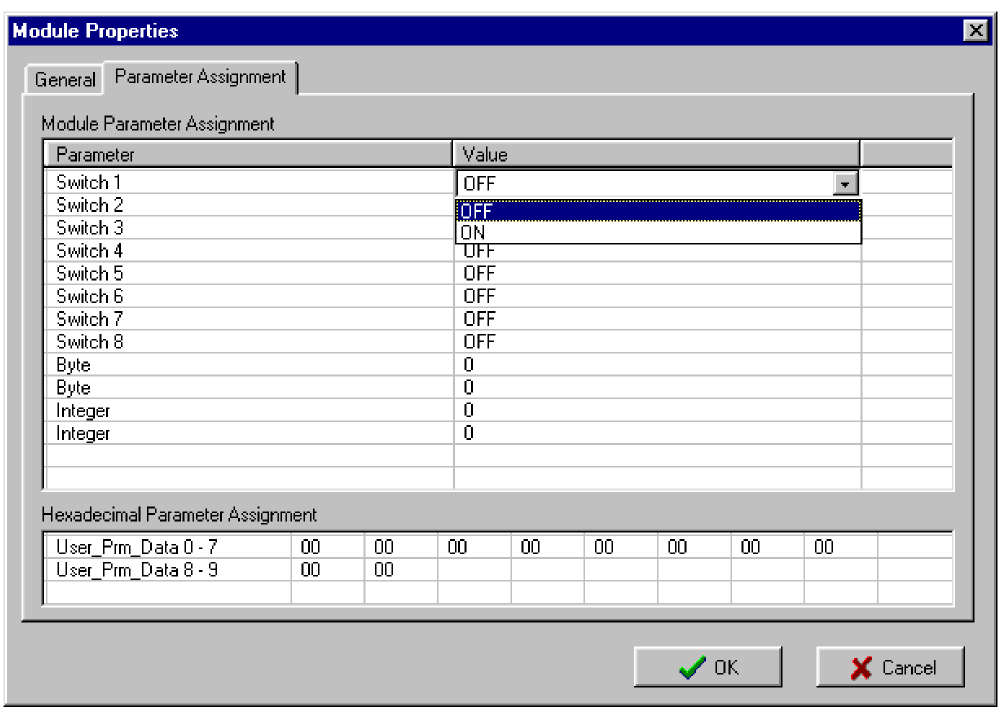
If the slave supports sync/freeze functionality, it can be assigned to the masters sync/freeze groups by clicking on the checkboxes. The sync/freeze assignment of the groups is also displayed (these can be changed via the master properties dialog).



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

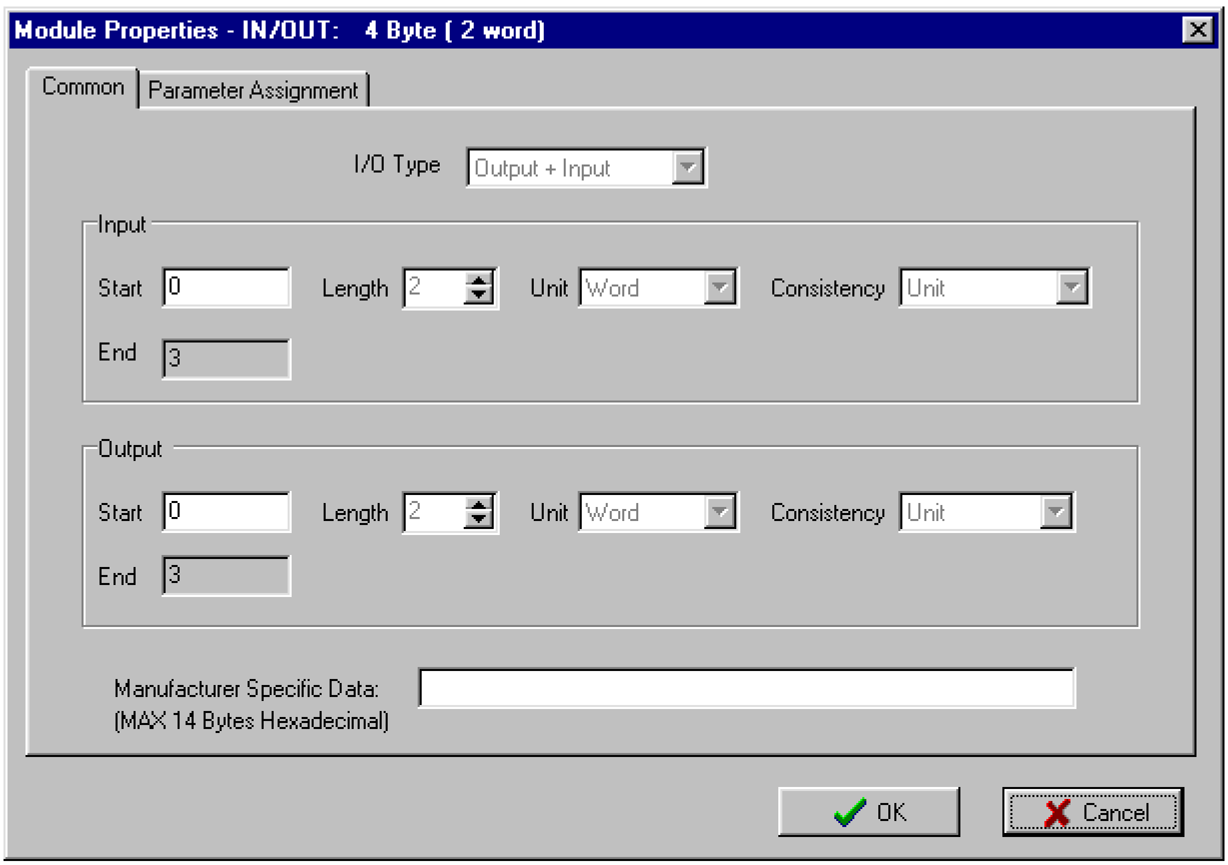


edited directly (consult the device specific documentation for the meaning of these values).

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.



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.

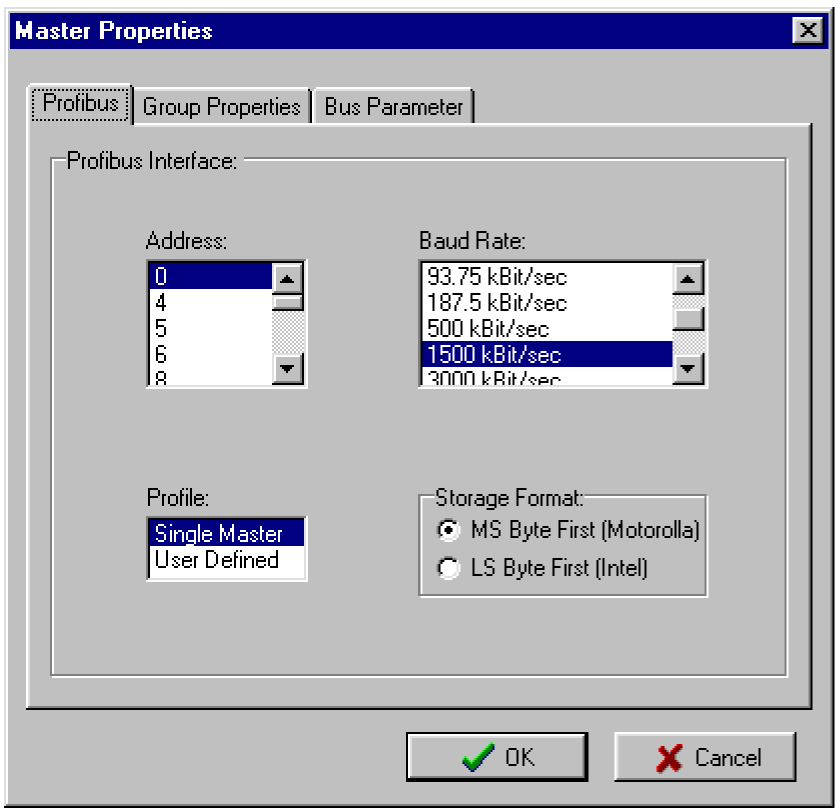
Configuration software also provides an additional I/O module to all slaves that is *not* defined in the GSD files, which is the *Universal Module*. The universal module allows the input/output length, unit, and consistency to be assigned custom values as required – however not all slave implementations 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

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

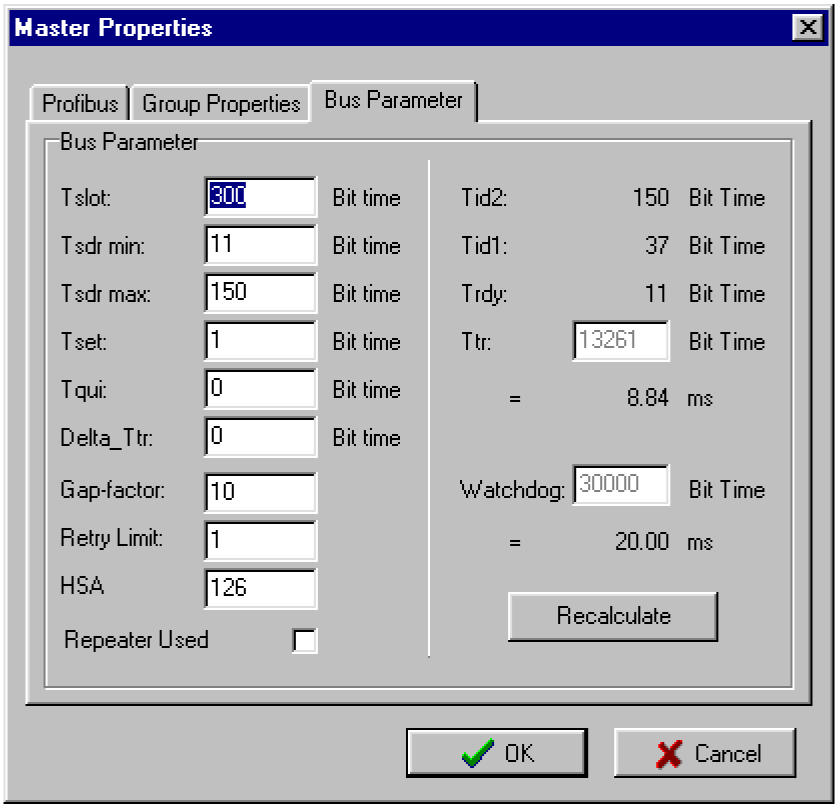
The minimum station delay responder determines the minimum length of time permitted for the responding node to respond.

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



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.

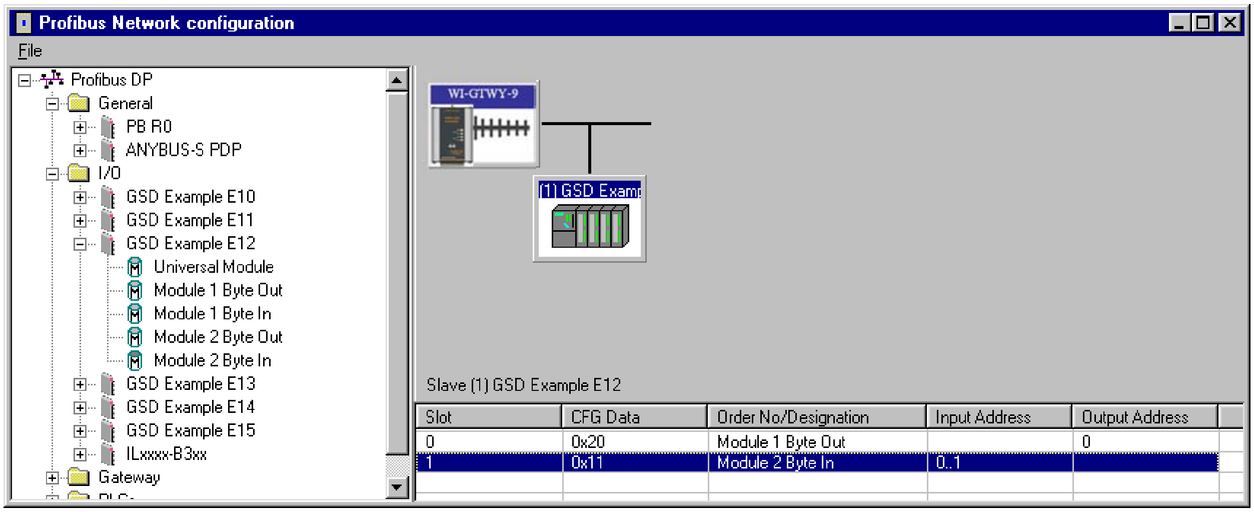
The example will transfer 8 x digital points from the radio network *to* the slave device. A single 16-bit analog value will be transferred from the Profibus slave to the radio network. Several configuration steps via WISeries Configuration Software are required:

- 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).

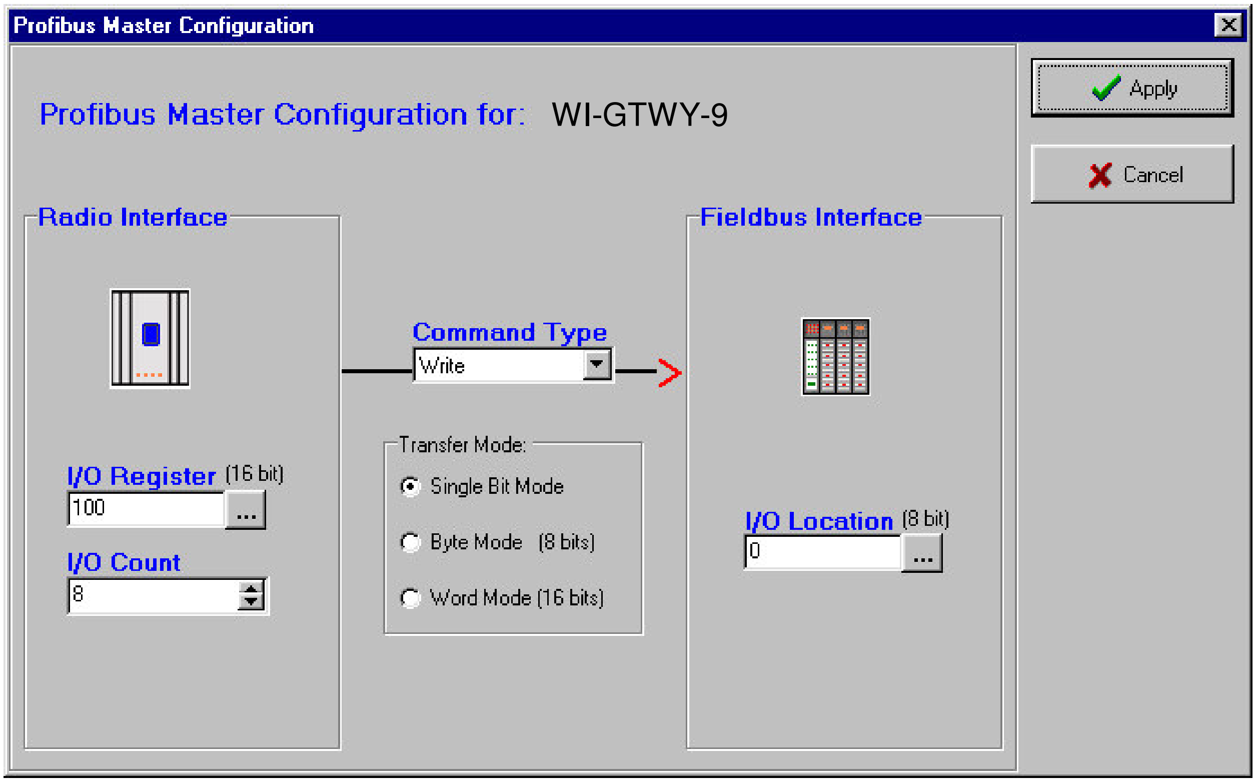


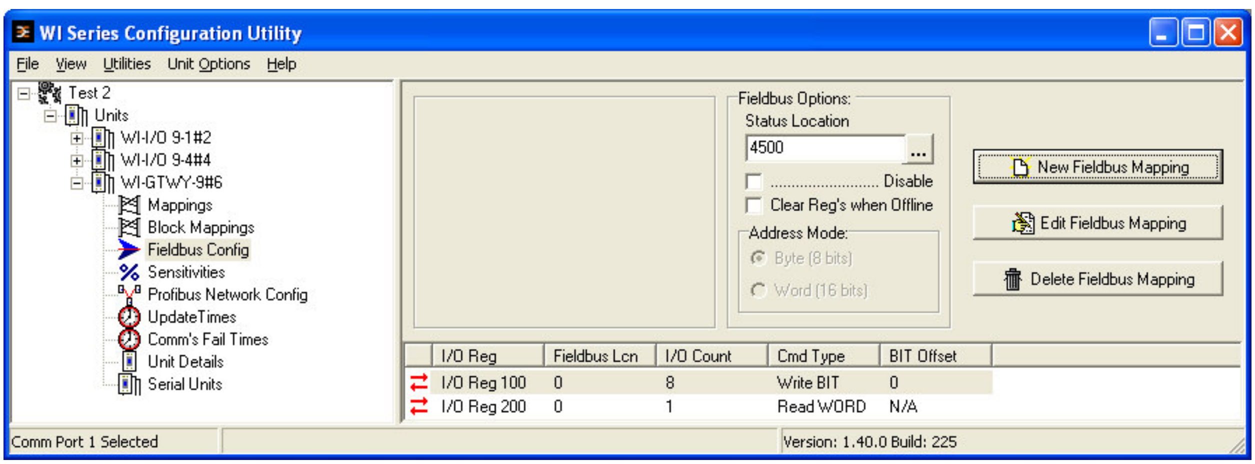
When these modules are added, configuration software automatically picks the next free *fieldbus interface* registers (shown in the *Input Address* and *Output Address* columns), which may later be altered by double-clicking on the relevant I/O module. In this example, the automatically chosen locations 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).

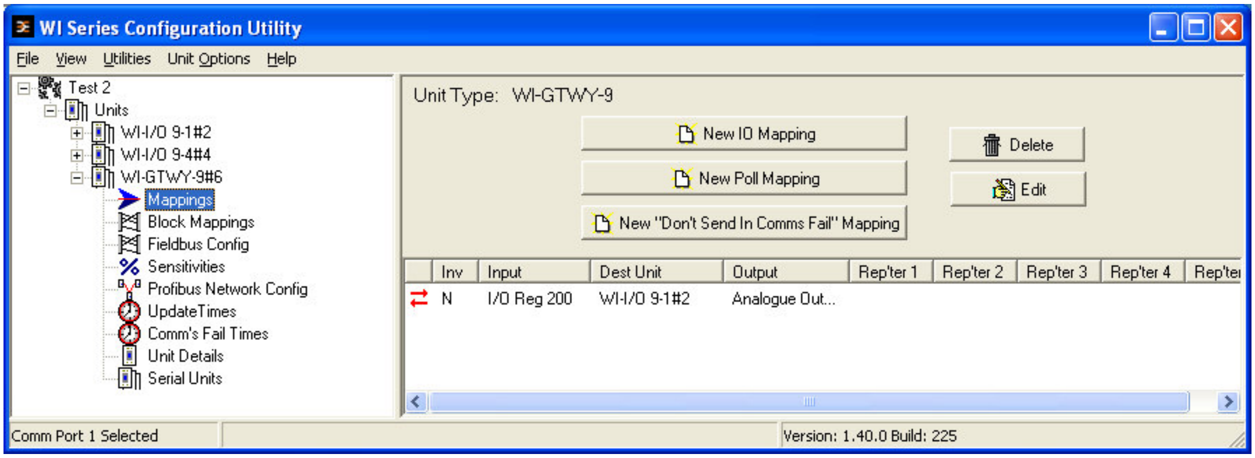
The 1 x analog input to be read from the slave must now be transferred to the radio interface. Here we use a fieldbus read mapping using a 'Word Mode' (16-bit) transfer from Fieldbus Locations 0..1 to I/O Register 200.

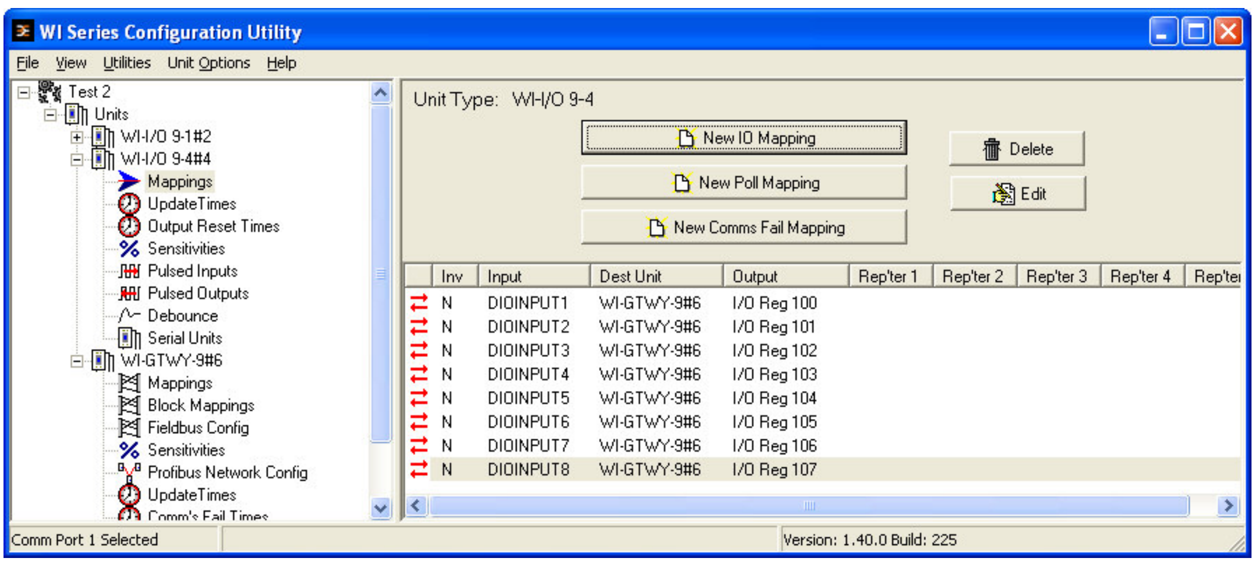

Profibus Master Configuration
Apply
Cancel
Profibus Master Configuration for: WI-GTWY-9
Radio Interface
Fieldbus Interface
Command Type
Write
Transfer Mode:
Single Bit Mode
Byte Mode (8 bits)
Word Mode (16 bits)
I/O Register (16 bit)
100
I/O Count
8
I/O Location (8 bit)
0


WI Series Configuration Utility
File View Utilities Unit Options Help
Test 2
Units
WI-I/O 9-1#2
WI-I/O 9-4#4
WI-GTWY-9#6
Mappings
Block Mappings
Fieldbus Config
Sensitivities
Profibus Network Config
UpdateTimes
Comm's Fail Times
Unit Details
Serial Units
Fieldbus Options:
Status Location
4500
Disable
Clear Reg's when Offline
Address Mode:
Byte (8 bits)
Word (16 bits)
New Fieldbus Mapping
Edit Fieldbus Mapping
Delete Fieldbus Mapping
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

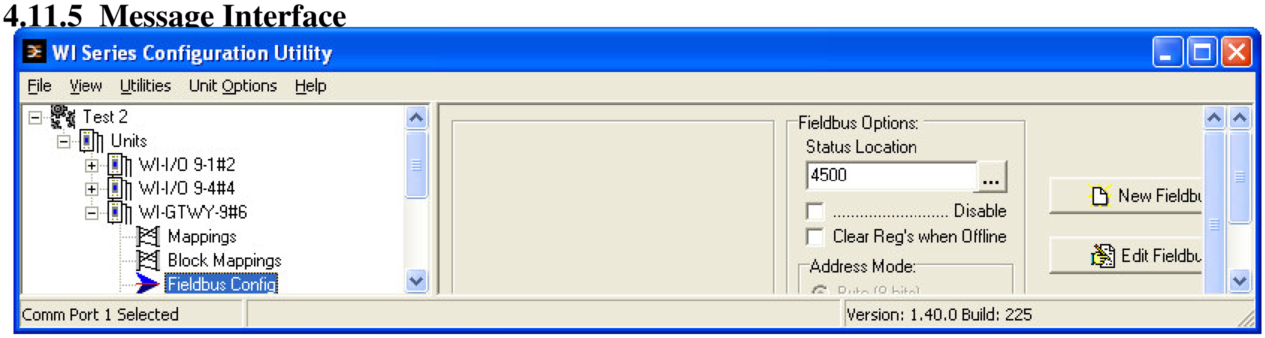
1) Radio Configuration

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).





4.11.5 Message Interface



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	Message Data
:::	(up to
139	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).

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Err	C/R	(reserved)		Error Code				Message Type							

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 **:::** **Response data word n**			Extended Diagnostic Data	

- **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.

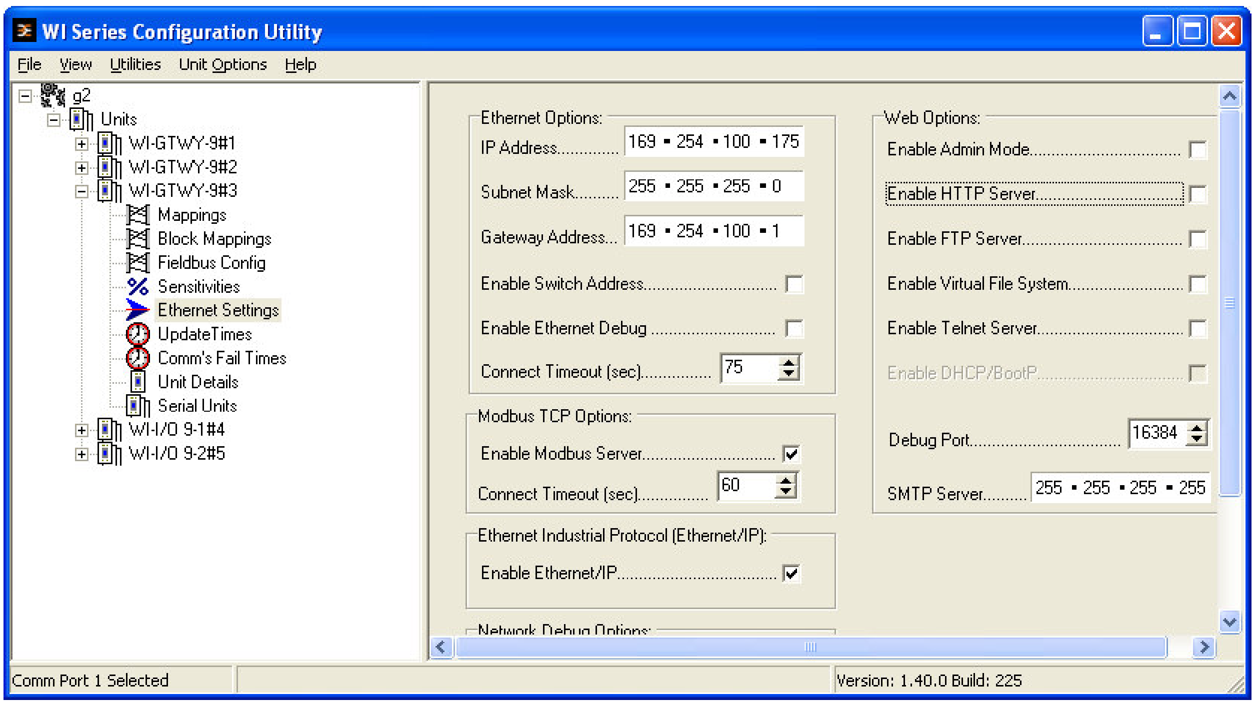
4.12.1 Setting IP Address

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.



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

x.x.x.0 - IP address where the last byte is zero

127.x.x.x - IP address where the first byte is 127

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*)

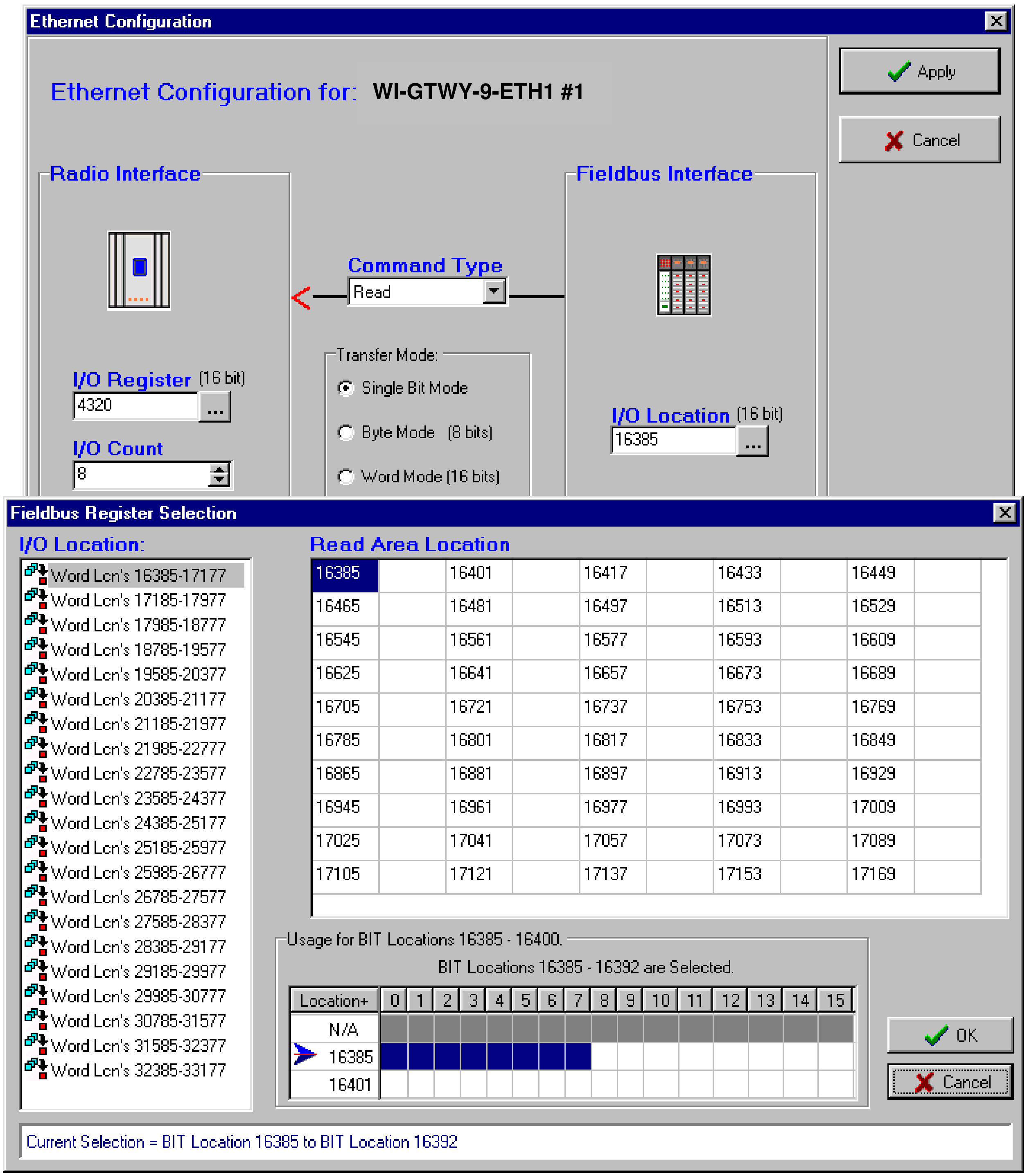
IN Area Location	Modbus Word Address	Modbus Bit Address						
		Bit 15	Bit 14	Bit 13	---	Bit 2	Bit 1	Bit 0
0	1	1	2	3	---	14	15	16
1	2	17	18	19	---	30	31	32
---	---	---	---	---	---	---	---	---
1022	1023	16353	16354	16355	---	16382	16383	16384
1023	1024	16369	16370	16371	---	16382	16383	16384

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).



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:

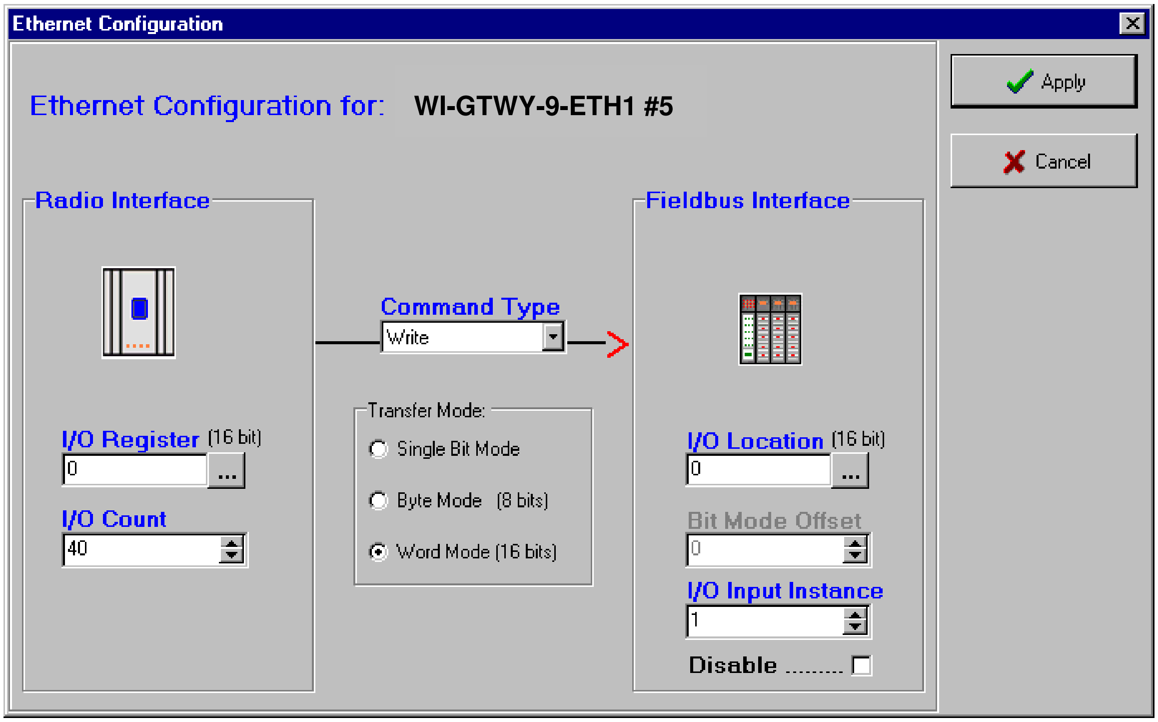
EtherNet/IP requires some mandatory objects; these are implemented, as well as some vendor specific objects. The mandatory objects are the ones in the specification from ODVA.

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”.



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".

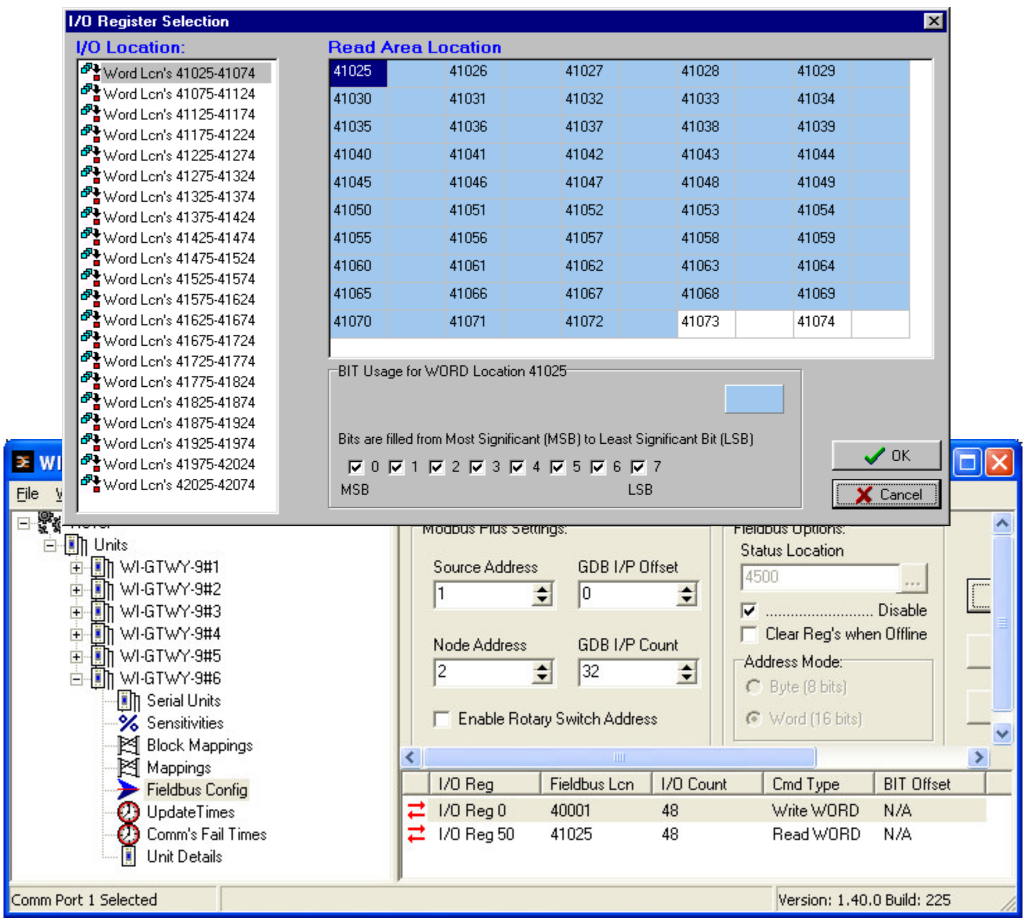
In the below example there is one "Fieldbus Write Mapping" (this will make available Data To Network) and one "Fieldbus Read Mapping" (this will make available Data From Network). When adding mappings, software will automatically adjust the available 40000 register address range depending on the command 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.



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.

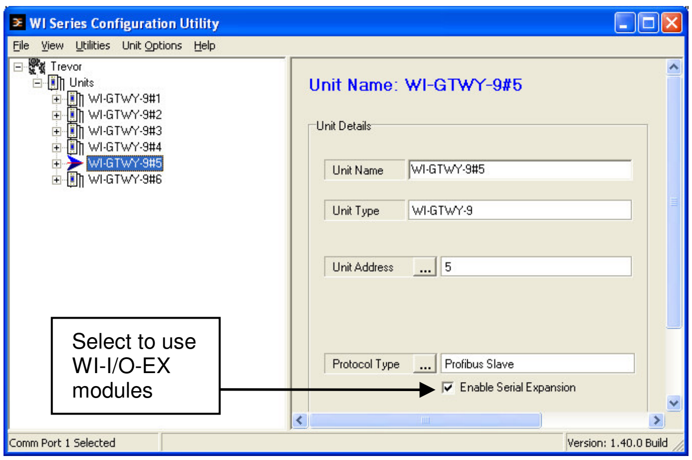
4.15 Connecting WI-I/O-EX-1-S-1x Serial I/O

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.

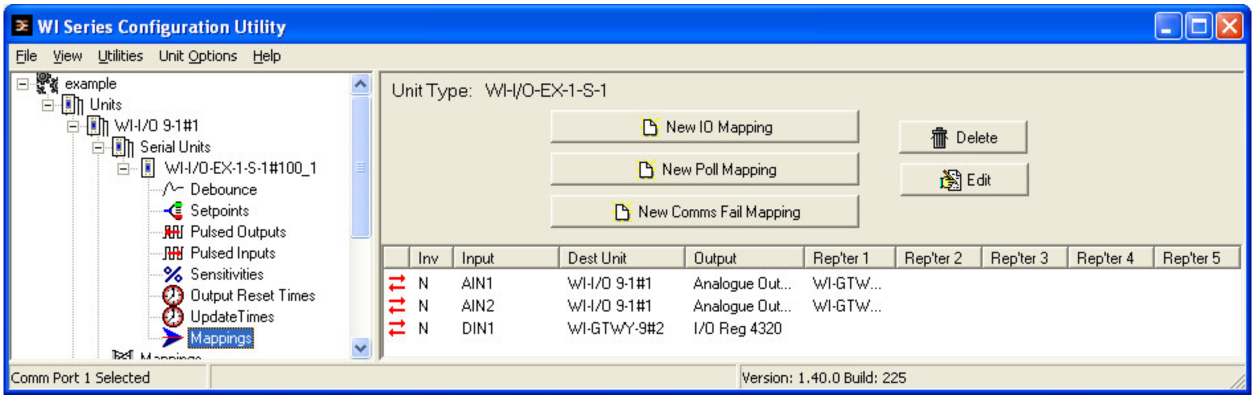
.Up to 31 x WI-I/O-EX-1-S-1x addresses can be connected to each WI-GTWY-9-xxx. The WI-I/O-EX-1-S-1x-1 and WI-I/O-EX-1-S-1x-2 modules use one address per module, and the WI-I/O-EX-1-S-1x-3 and WI-I/O-EX-1-S-1x-4 modules take up two addresses.

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.



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.



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

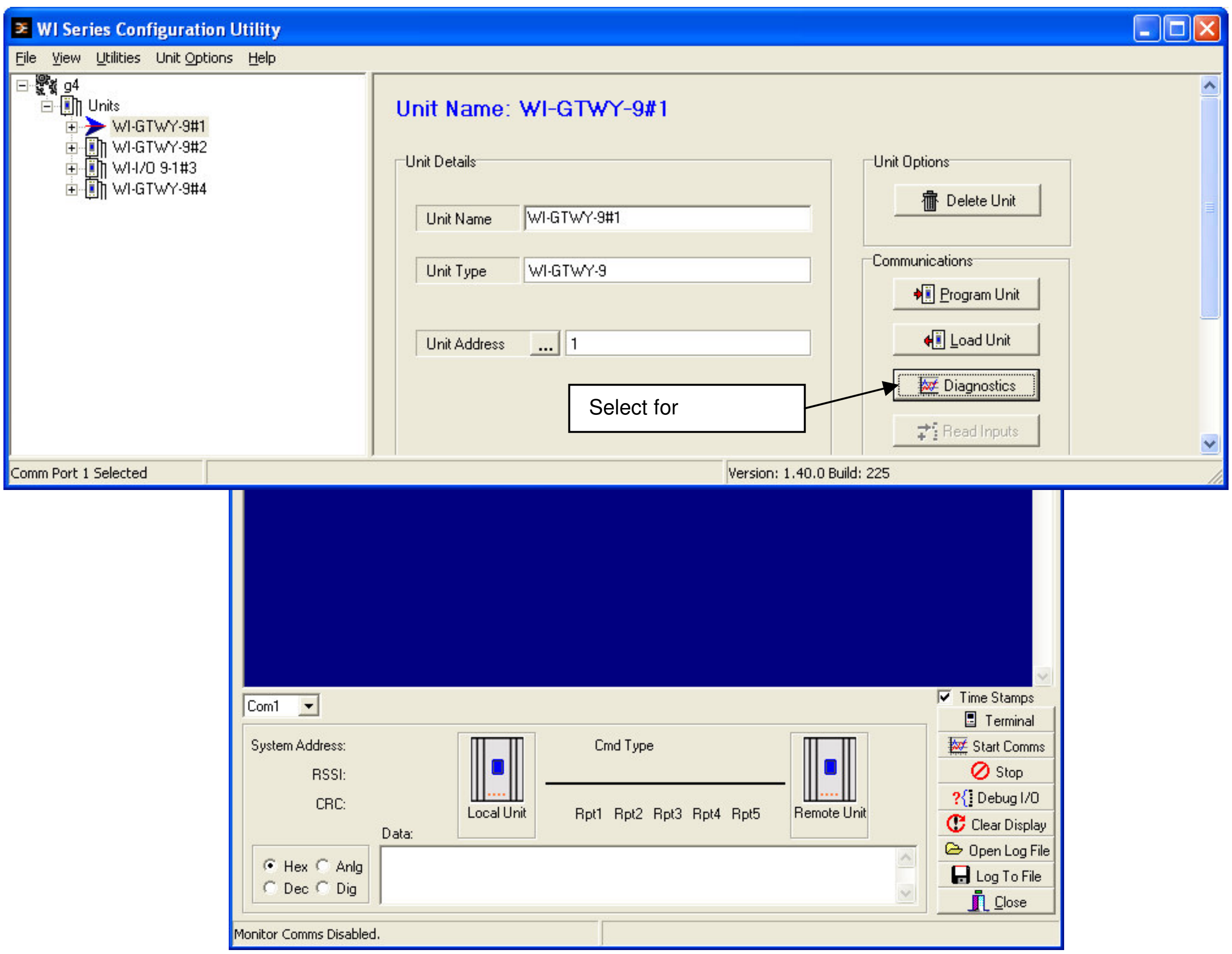
The Ethernet and Profibus modules also have four diagnostic LED's on the end-plate - refer section 6.4.

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.



6.2.1 Offline Diagnostics:

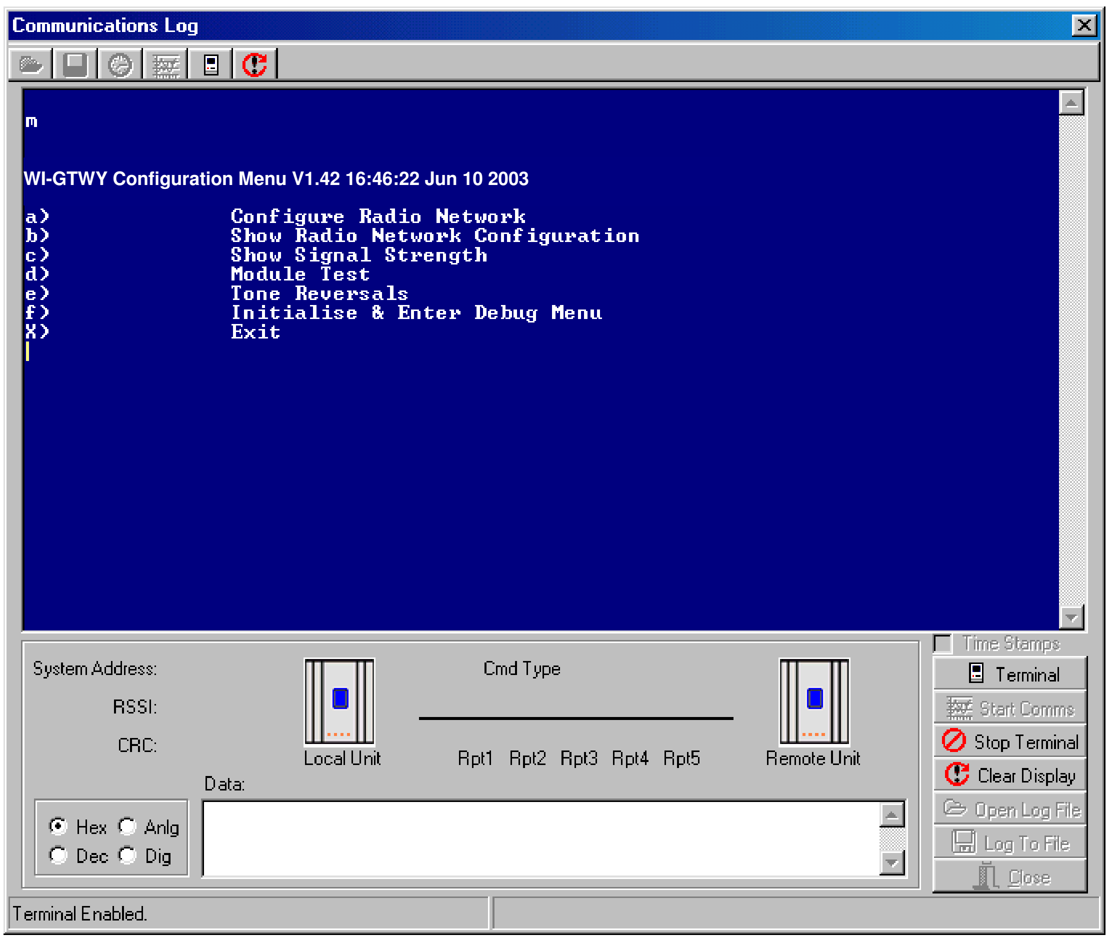
The offline diagnostics menu disables the radio protocol driver *and* the fieldbus protocol driver. Before displaying the offline debug menu open and start the "terminal" window in configuration software (see above), or use any third party terminal package.

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.



(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.

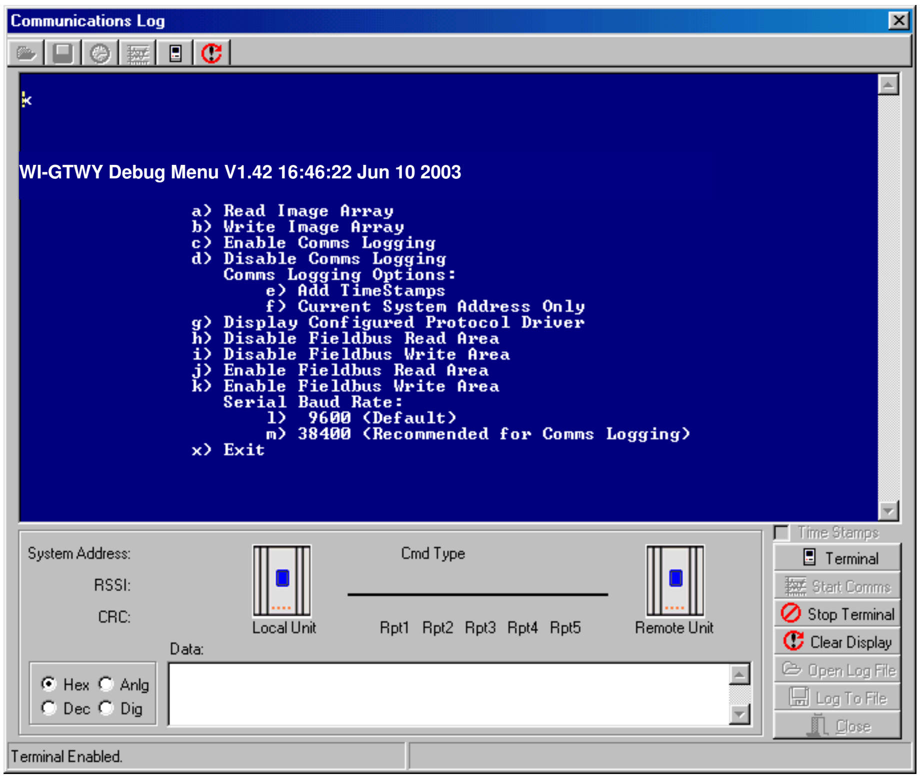
6.2.2 Online Diagnostics

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



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.

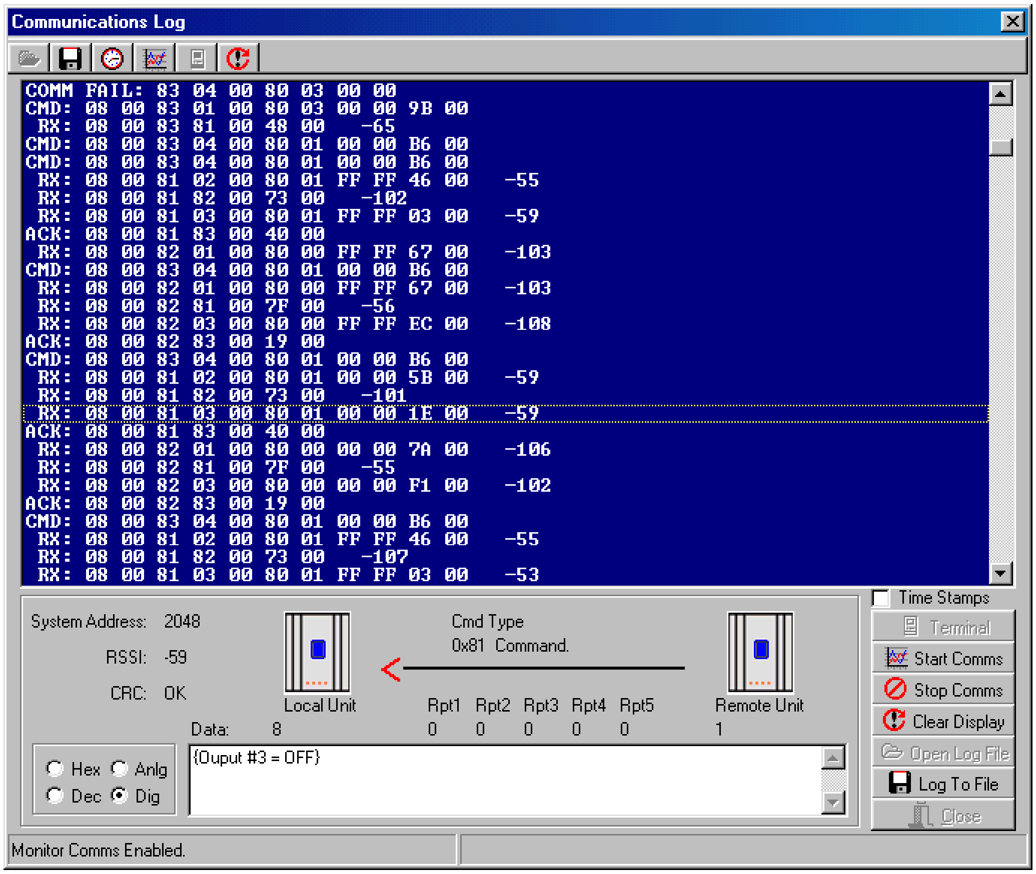
- To decode the radio traffic using configuration software, first start communications logging by selecting option "c) Enable Comms Logging" from the debug menu. Next, in the diagnostics screen select 'Stop Terminal' and then 'Start Comms'. Configuration software now expects the WI-GTWY-9-xxx to be in 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”.

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

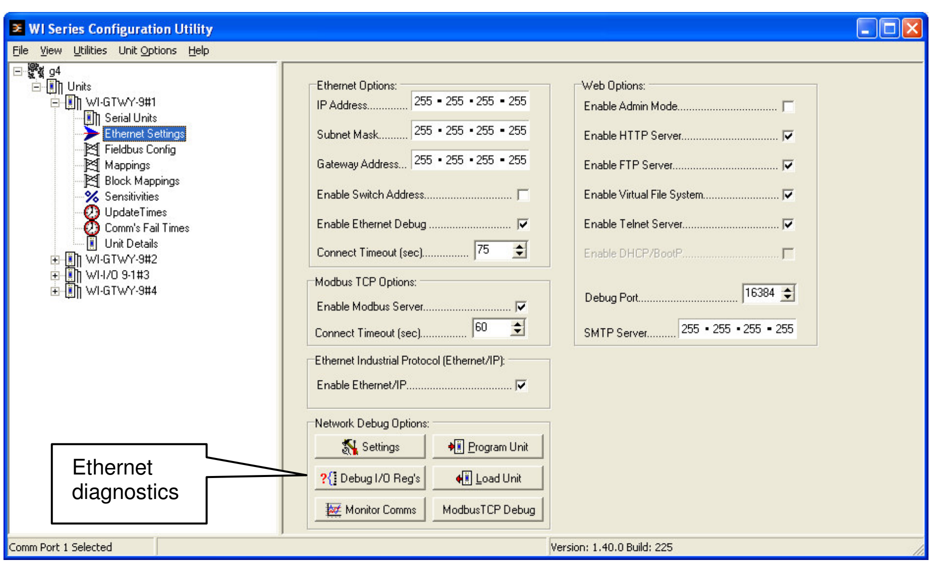
(These options not available on the Modbus/DF1 version)

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.

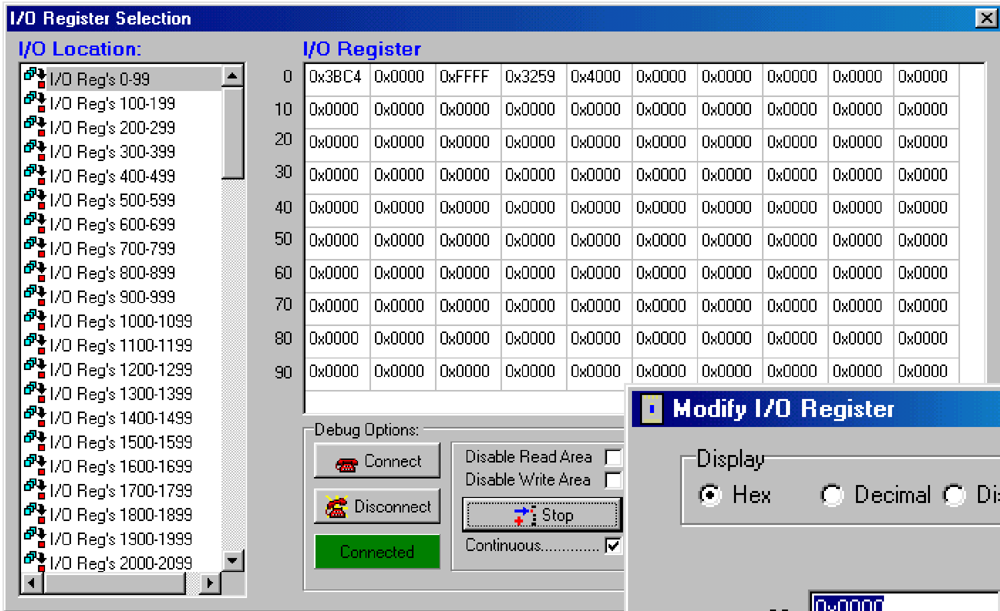
When doing read/write image array and the module has been configured with Fieldbus mappings, you may need to disable the Fieldbus read area option h. This stops the Fieldbus database overwriting the radio database.

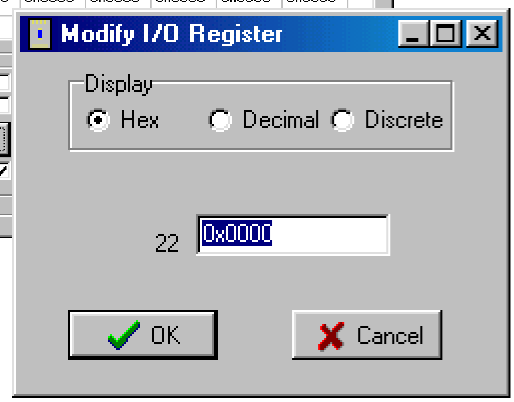
6.3 Ethernet Diagnostics

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.



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.



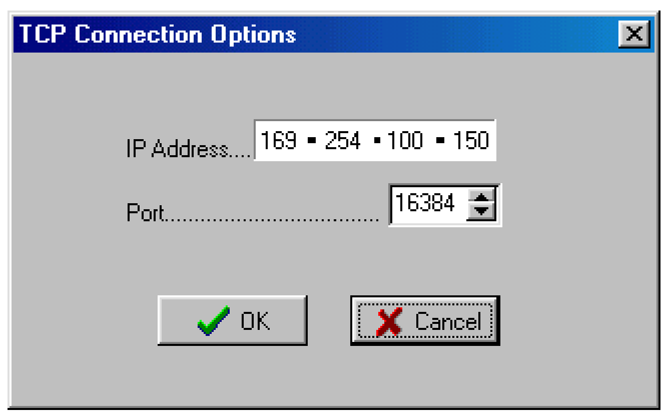


To write to a register double click with mouse on the register and a pop up box will appear as shown below. Enter value and press 'OK'.

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.



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

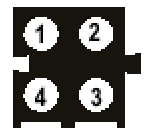
Monitor Comms

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

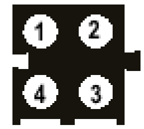
All WI-GTWY-9-xxx modules (*except* MD1) are equipped with four fieldbus indication LED's located in the module end plate, used for diagnostics purposes. The meaning of the LED's for each fieldbus is described below.

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

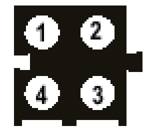


LED No	Indication	Description
1	-	Not Used
2	Green	Module is On-Line and data exchange is possible.
2	Off	Module is not On-Line
3	Red	Module is Off-Line and no data exchange is possible.
3	Off	Module is not Off-Line
4	Flashing Red 1 Hz	Error in configuration: IN and/or OUT length set during initialization 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:

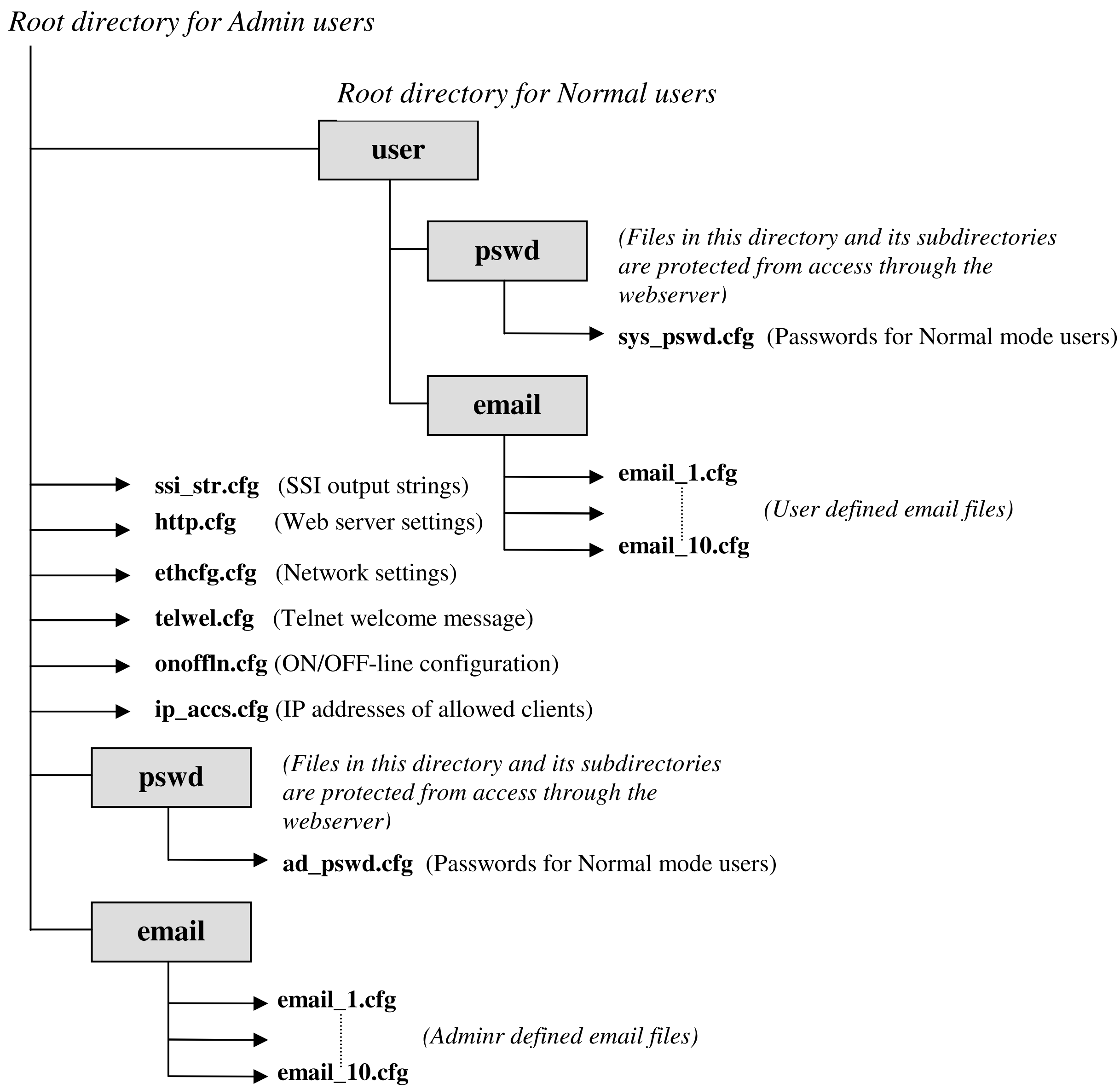
```
[IP address]
192.168.0.150
[Subnet mask]
255.255.255.0
[Gateway address]
192.168.0.1
[DHCP/BOOTP]
OFF                 (allowable values are "ON" and "OFF")
[Speed]
Auto                (allowable values are "Auto", "100", or "10")
[Duplex]
Auto                (allowable values are "Auto", "Full", 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.

Char-acter	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

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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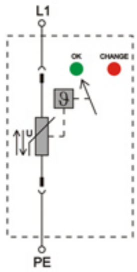


General ordering data	
Order No.	8859950000
Part designation	PU II 1 130V/40kA
Version	Surge protection for low-voltage supply, 120 V, without telecomm. contact
EAN	4032248583843
Qty.	1 pc(s).

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

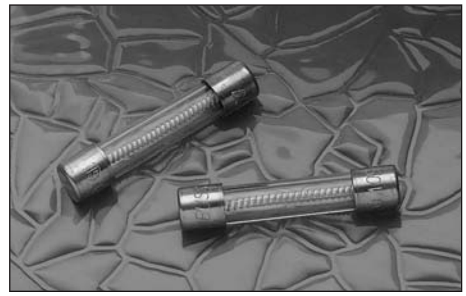
1/4″ x 1 1/4″ Time-Delay, Glass Tube Fuses

MDL Series

RoHS 2002/95/EC

Description
- Time-delay
- Optional axial leads available
- 1/4 x 1 1/4 (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



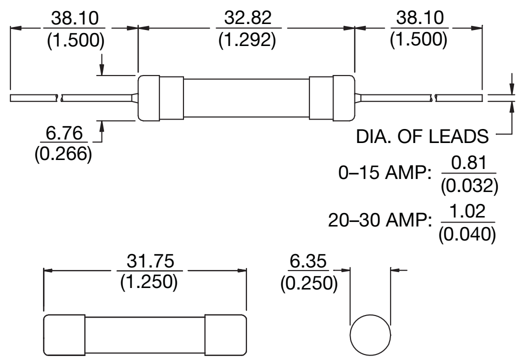
Agency Information
- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDL 1/16 - 8A (Class No. 1422-01)
- CSA Component Acceptance: MDL 9-30A (Class No. 1422-30)
- CE

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

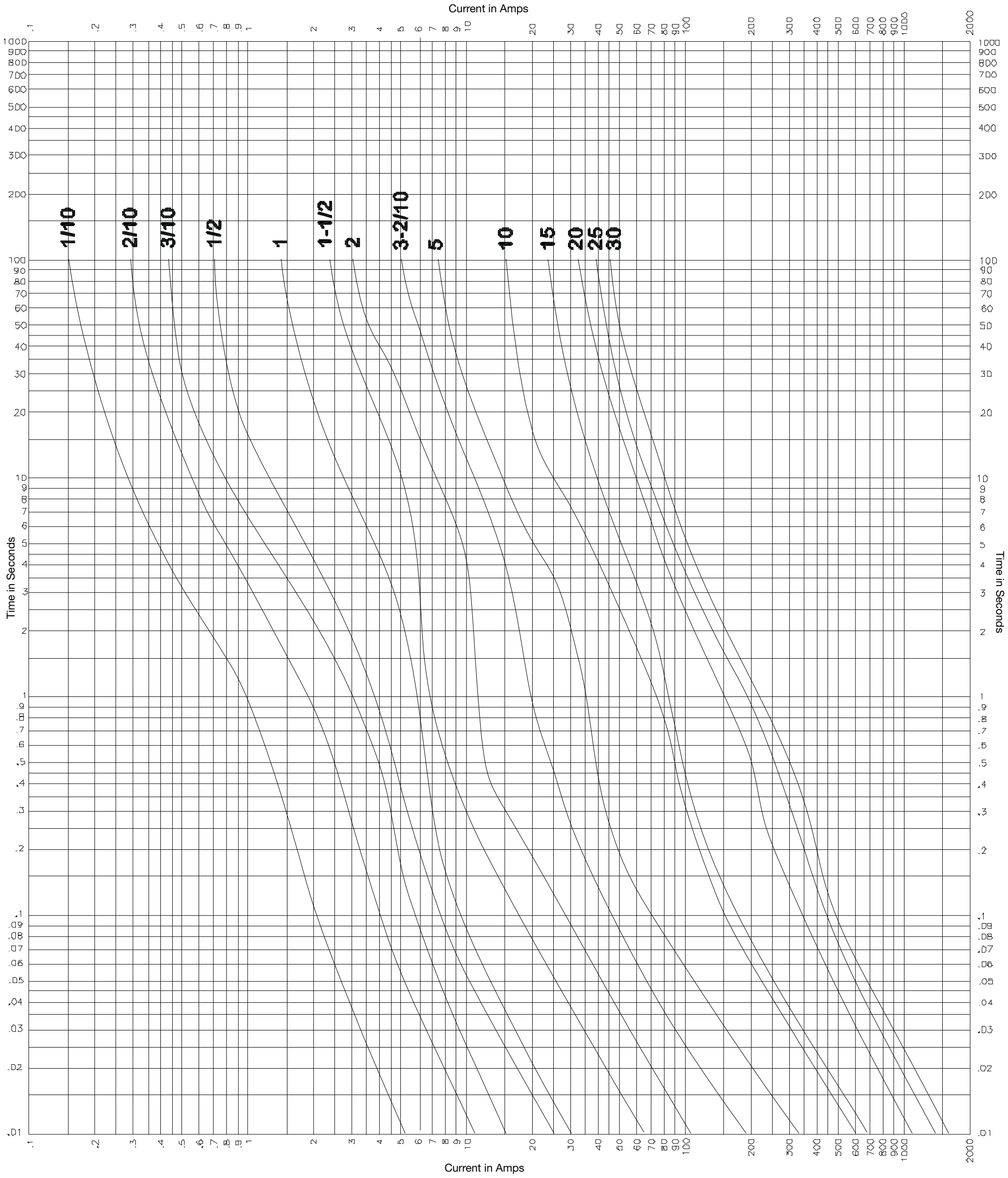


Specifications

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

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St. Louis, MO 63178
www.cooperbussmann.com

COOPER Bussmann

COOPER Bussmann

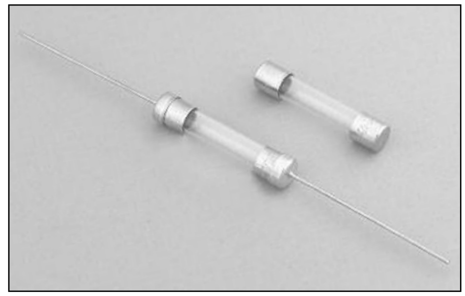
1/4" x 1-1/4" Fuses

AC 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

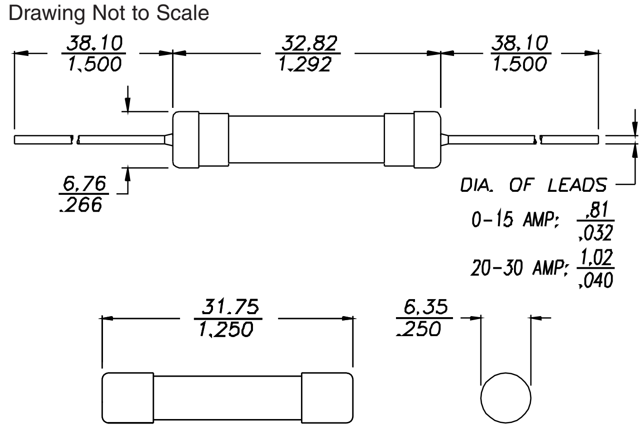
RoHS 2002/95/EC



ELECTRICAL CHARACTERISTICS	
% of Amp Rating	**Opening Time**
100%	None
135%	60 Minutes Maximum
200%	120 Seconds Maximum

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	AC Interrupting Rating 125V	AC Interrupting Rating 32V	Typical DC Cold Resistance** (ohms)	Typical Melting I^2t† 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)

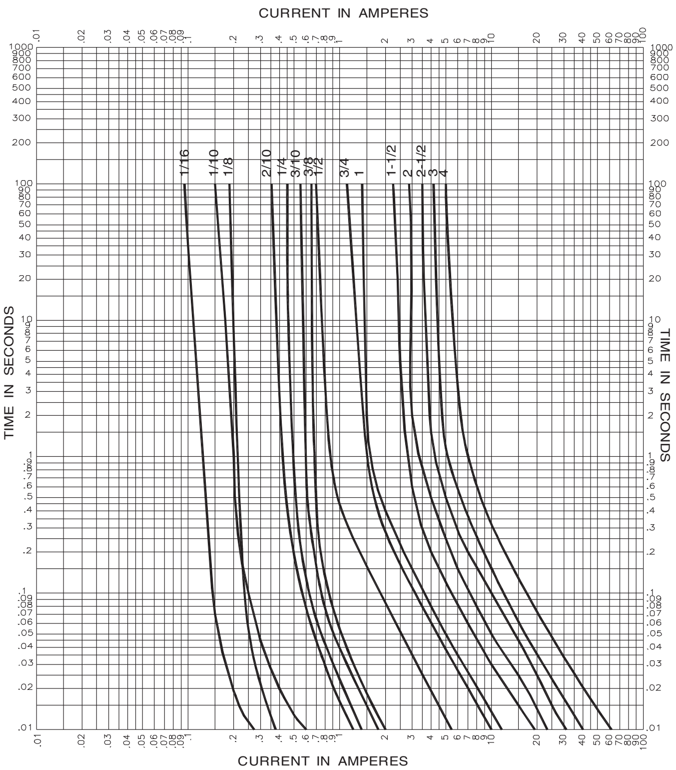
† Typical Melting I^2t (A^2Sec) (I^2t was measured at listed interrupting rating and rated voltage.)

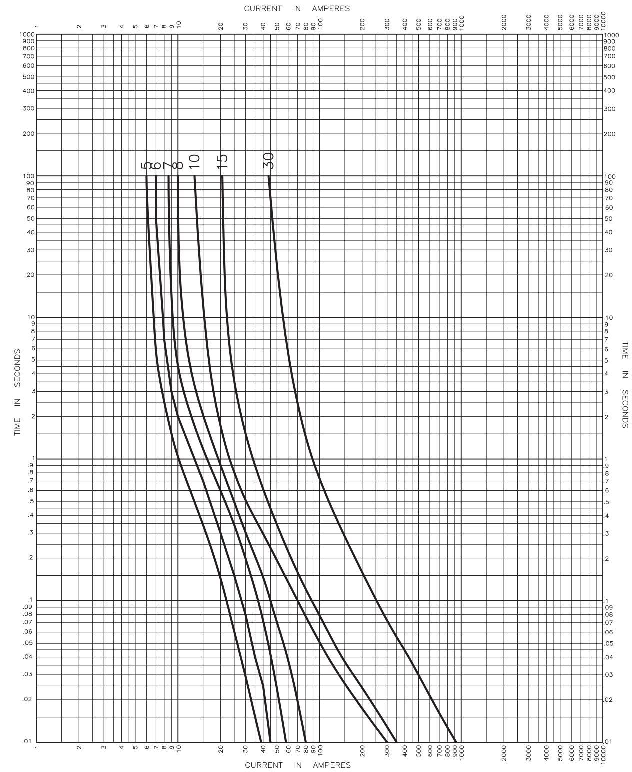
‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

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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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**

Hammond Manufacturing Co. Ltd.
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Guelph, Ontario N1H 1E5 CANADA
Phone: 519-822-2960 Fax: 519-822-0715

www.hammondmfg.com

Hammond Manufacturing Co. Inc.
256 Sonwil Dr.
Cheektowaga, NY 14225 USA
Phone: 716-651-0086 Fax: 716-651-0726

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Model: 485LDRC9

Industrial DIN Rail Mounted Optically Isolated RS-232 to RS-422/485 Converter with Surge Suppression

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.

B&B electronics MANUFACTURING COMPANY
International Headquarters: 707 Dayton Road PO Box 1040 Ottawa, IL 61350 USA
815-433-5100 Fax 433-5104 *www.bb-elec.com orders@bb-elec.com support@bb-elec.com*
European Headquarters: Westlink Commercial Park Oranmore Co. Galway Ireland
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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

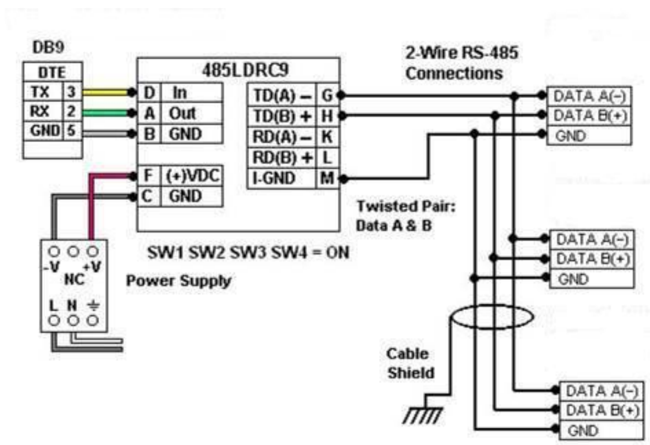

Figure 2 – 4-Wire RS-485

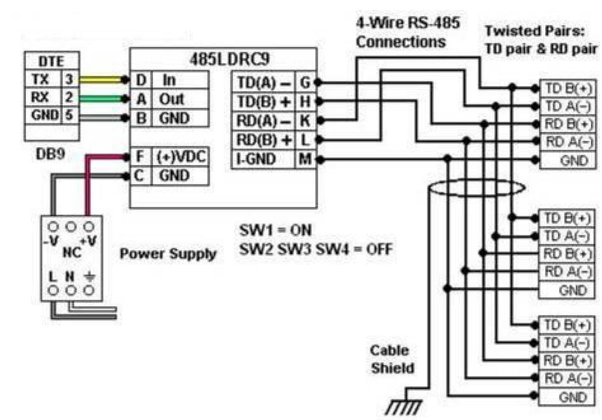

Figure 3 – RS-422

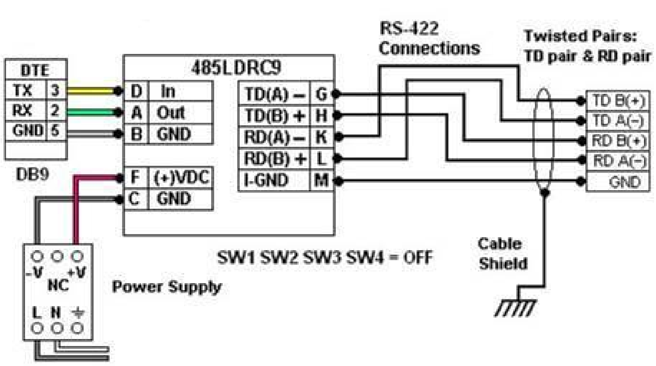

Figure 4 – 2-Wire RS-422 (No RCV)

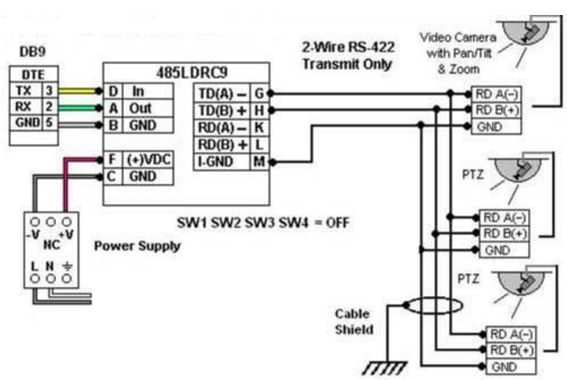

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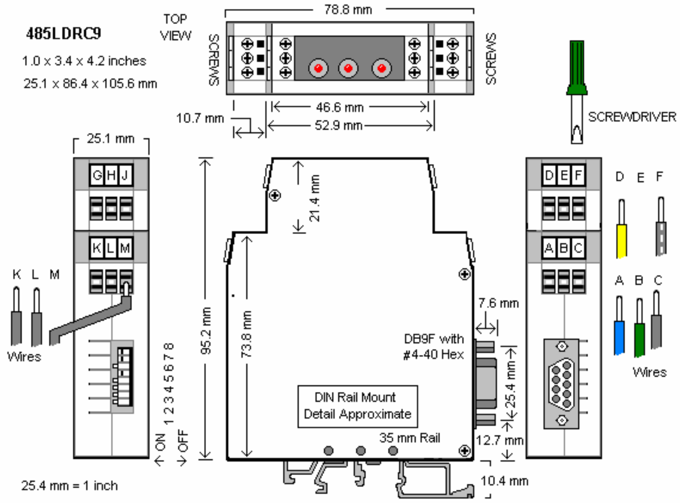
Figure 5 – Mechanical Drawing



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

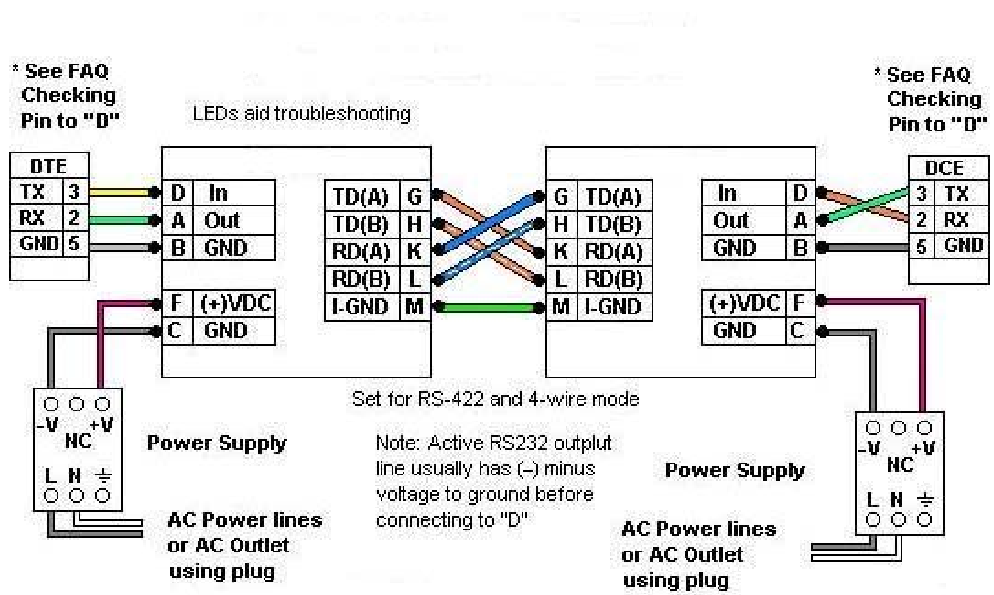


Table 1 – Communications Mode Selection

	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

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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

B&B electronics
MANUFACTURING COMPANY

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DC Power Surge Protector

DS220..DC

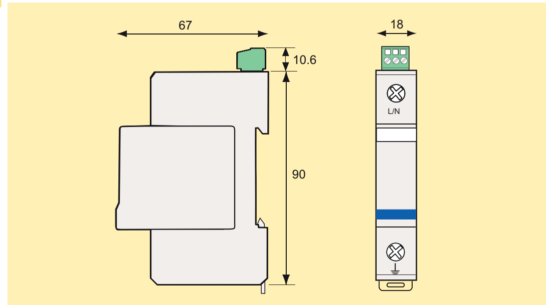
The DS220-24DC surge protector is designed to protect equiptment connected to DC (and AC) power supplies from lightning surges.

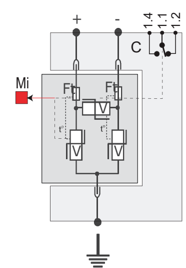
It is based on varistors matched to the network voltage. This SPD is based on varistors equipped with thermal disconnector and failure indicators. Version with remote signaling for disconnection indication is also available. (DS220S-24DC).

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



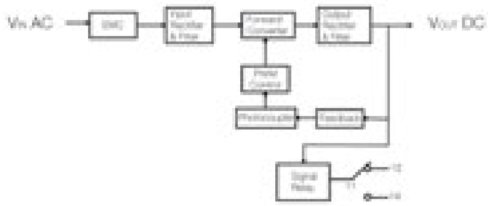


DS220..DC

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.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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CIMSTAR	Modelmaster	Series Five	VersaPro
Field Control	Motion Mate	Series 90	VuMaster
GEnet	PowerMotion	Series One	Workmaster

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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.

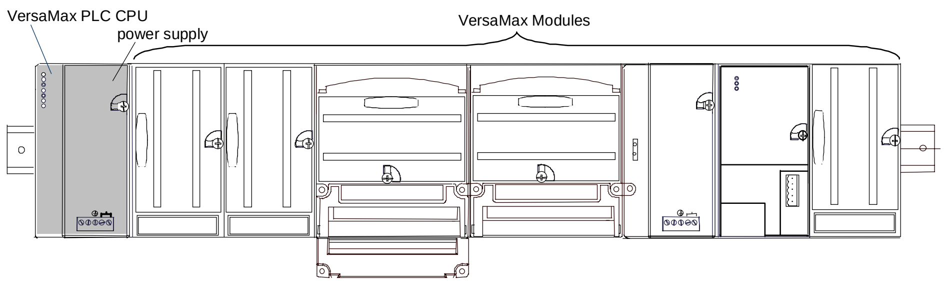
VersaMax provides automatic addressing that can eliminate traditional configuration and the need for hand-held devices. Multiple field wiring termination options provide support for two, three, and four-wire devices.

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.



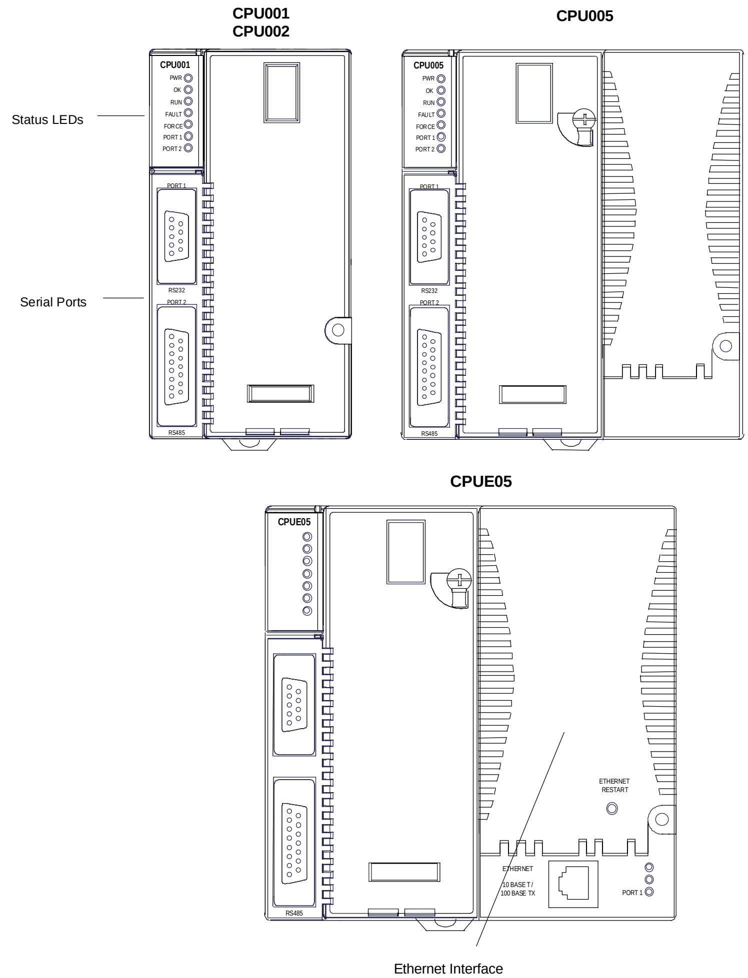
All VersaMax CPUs provide powerful PLC functionality. They are designed to serve as the system controller for up to 64 modules with up to 2048 I/O points. Two serial ports provide RS-232 and RS-485 interfaces for SNP slave and RTU slave communications. CPU model IC200CPUE05 provides a built-in Ethernet 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

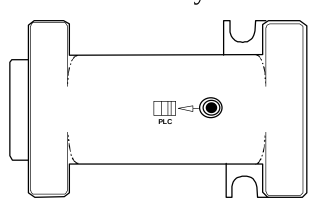
Available VersaMax CPUs

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

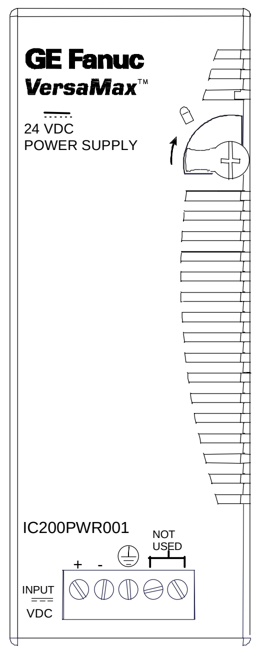
The EZ Program Store device (IC200ACC003) can be used to store and update the configuration, application program, and reference table data of a VersaMax PLC. A programmer and PLC CPU are used to initially write data to the device.



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

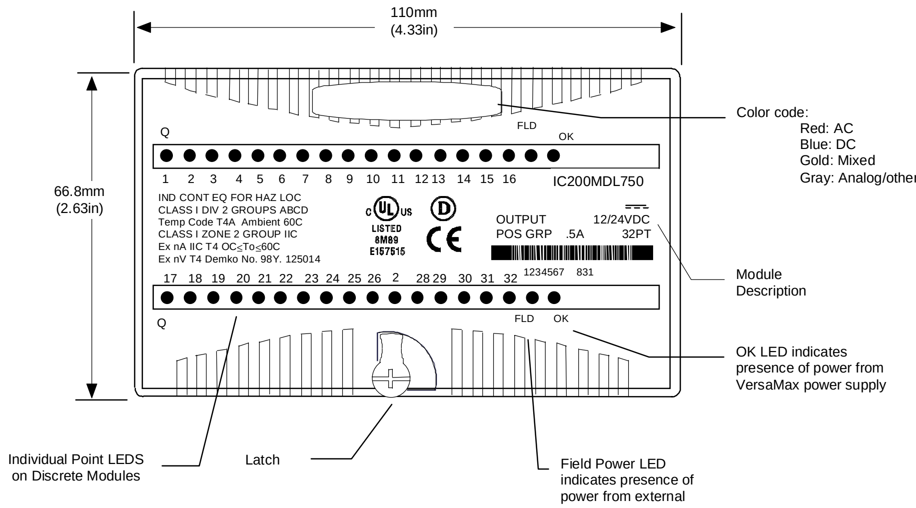
The following VersaMax power supplies and carrier are available:

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

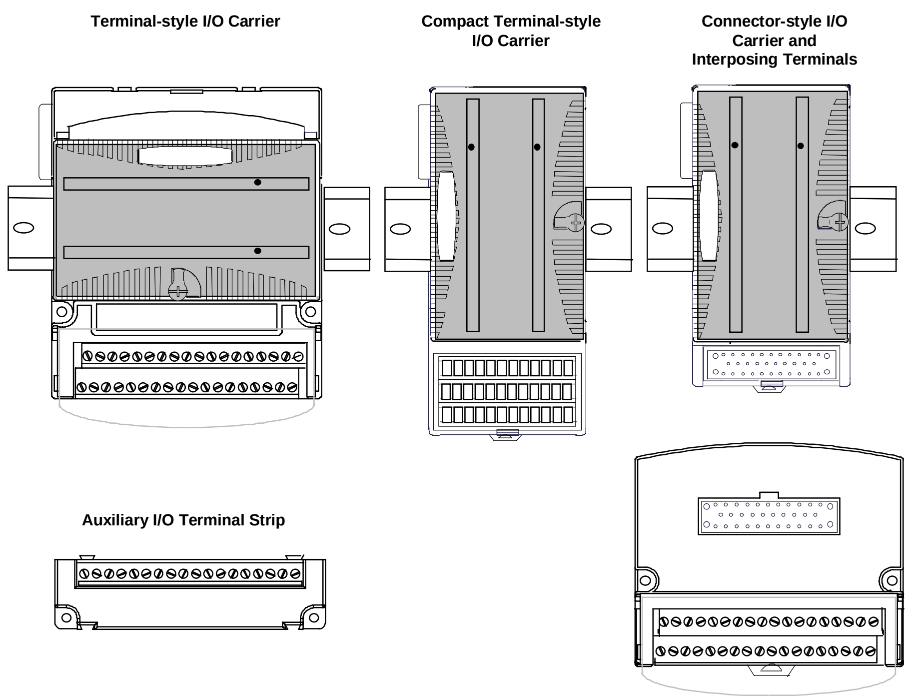
Carriers provide mounting, backplane communications, and field wiring connections for all types of VersaMax modules. I/O modules can be installed on carriers or removed without disturbing field wiring.

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.



Available Carriers and Terminal Strips

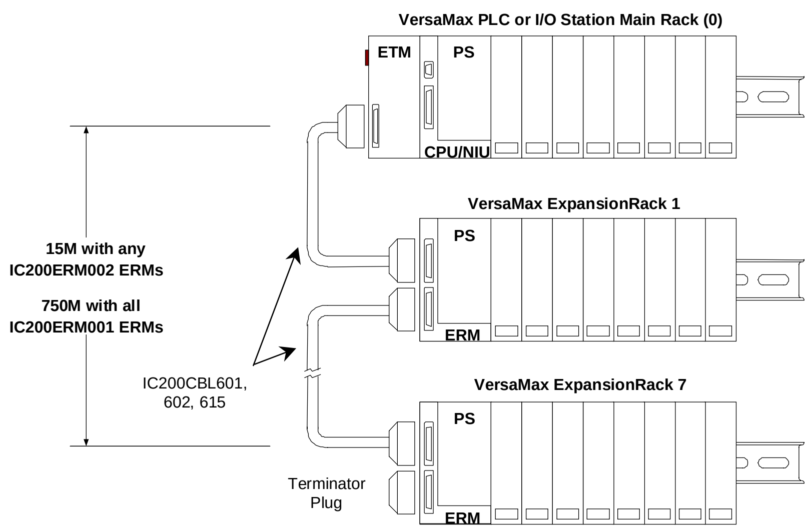
The following types of Carriers, terminals, and cables are available:

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

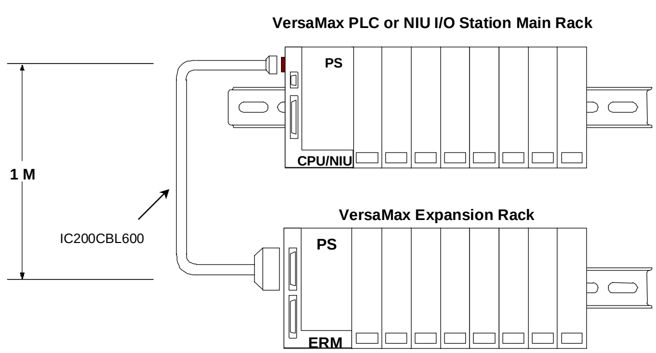
Expansion Modules

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:

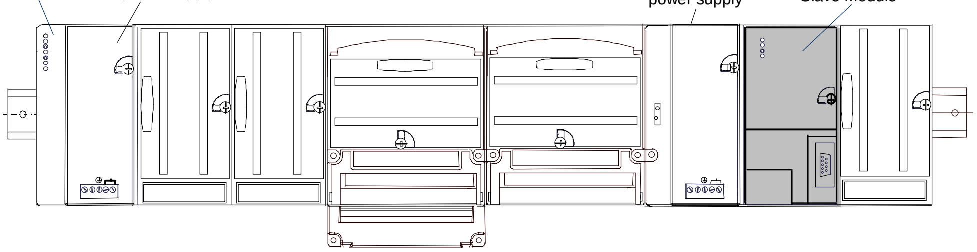
Expansion Modules	
Expansion Transmitter Module	IC200ETM001
Expansion Receiver Module, Isolated	IC200ERM001
Expansion Receiver Module, Non-isolated	IC200ERM002
Cables	
Expansion Cable, 1 meter	IC200CBL601
Expansion Cable, 2 meters	IC200CBL602
Expansion Cable, 15 meters	IC200CBL615
Firmware Update Cable	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

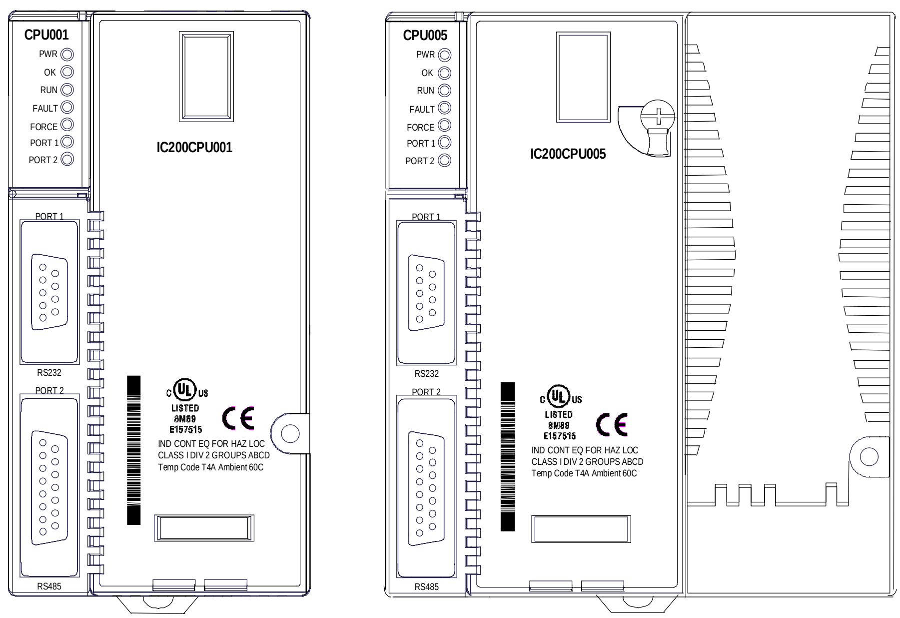
This chapter describes the appearance, features, and functionality of the following VersaMax PLC CPU modules:

- 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

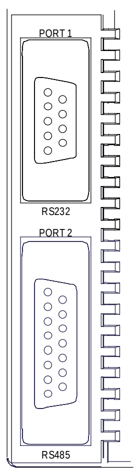
VersaMax products should be installed and used in conformance with product-specific guidelines as well as the following specifications:

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

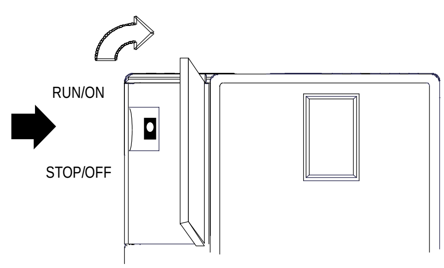
* Only available on one port at a time.

** 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

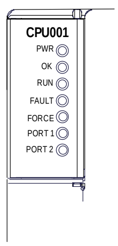
The CPU module has a convenient switch that can be used to place the PLC in Stop or Run mode. The same switch can also be used to block accidental writing to CPU memory and forcing or overriding discrete data. Use of this feature is configurable. The default configuration enables Run/Stop mode selection 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) CPU001, for rel. 1.50 compatibility CPU002, for rel. 1.50 compatibility	128 bytes minimum 12K bytes 20K bytes
Hardware configuration size (not configurable)	400 bytes minimum
Registers (%R) CPU001/002, for rel. 1.50 compatibility	256 bytes minimum 4,096 bytes
Analog Inputs (%AI)	256 bytes minimum
Analog Outputs (%AQ)	256 bytes minimum

Chapter 3 CPU Module Datasheet: CPUE05

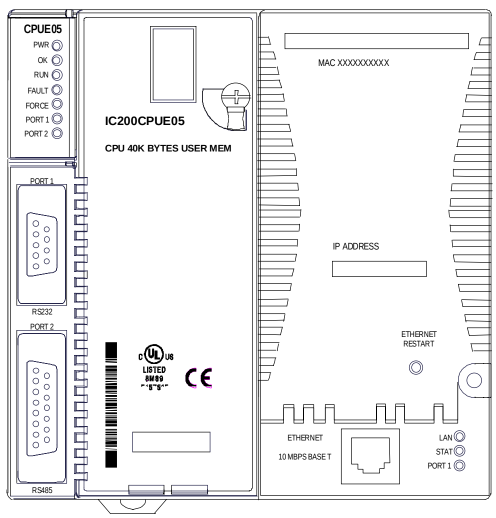
This chapter describes the appearance, features, and functionality of the following VersaMax PLC CPU module:

- 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

<table>
<tr><td>Size</td><td colspan="3">4.95” (126mm) x 5.04” (128mm)</td></tr>
<tr><td>Program storage</td><td colspan="3">System flash, battery-backed RAM</td></tr>
<tr><td rowspan="2">Backplane current consumption:
IC200CPUE05</td><td>no serial port converter or EZ Program Store device</td><td>5V output: 160mA</td><td rowspan="2">3.3V output: 650mA*</td></tr>
<tr><td>with serial port converter or EZ Program Store device</td><td>5V output: 260mA</td></tr>
<tr><td>Floating point</td><td colspan="3">yes</td></tr>
<tr><td>Boolean execution speed</td><td colspan="3">0.5ms/K (typical)</td></tr>
<tr><td>Realtime clock accuracy (for timer functions)</td><td colspan="3">100ppm (0.01%) or +/- 9sec/day</td></tr>
<tr><td>Time of day clock accuracy</td><td colspan="3">23ppm (0.0023%) or +/- 2sec/day @ 30C.
100 ppm (0.01%) or +/- 9sec/day @ full temperature range</td></tr>
<tr><td>Embedded communications</td><td colspan="3">RS-232, RS-485, Ethernet interface</td></tr>
<tr><td>Configurable memory</td><td colspan="3">64K bytes maximum</td></tr>
<tr><td colspan="4">Ethernet Interface Specifications</td></tr>
<tr><td>Number of SRTP server connections</td><td colspan="3">8</td></tr>
<tr><td>Ethernet data rate</td><td colspan="3">10Mbps</td></tr>
<tr><td>Physical interface</td><td colspan="3">10BaseT RJ45</td></tr>
<tr><td>WinLoader support</td><td colspan="3">via CPU port</td></tr>
<tr><td>Number of Ethernet Global Data configuration-based exchanges</td><td colspan="3">32</td></tr>
<tr><td>EGD Exchange limits</td><td colspan="3">100 data ranges and 1400 bytes of data per exchange; 1200 total data ranges across all exchanges.</td></tr>
<tr><td>Time Synchronization</td><td colspan="3">NTP - client only</td></tr>
<tr><td>Selective Consumption of EGD</td><td colspan="3">yes</td></tr>
<tr><td>Load EGD configuration from PLC to programmer</td><td colspan="3">yes</td></tr>
<tr><td>Remote Station Manager over UDP</td><td colspan="3">yes</td></tr>
<tr><td>Local Station Manager (RS-232)</td><td colspan="3">via CPU port</td></tr>
<tr><td>Configurable Advanced User Parameters</td><td colspan="3">yes</td></tr>
</table>

* 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

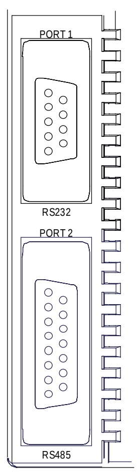
VersaMax products should be installed and used in conformance with product-specific guidelines as well as the following specifications:

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:

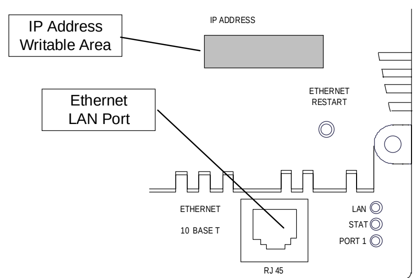
1. For RTU, an “Unsupported Feature in Configuration” fault is logged and the PLC transitions to Stop Faulted mode.
2. For Serial I/O, the same fault is logged when the transition to Run mode occurs. The PLC will immediately transition to Stop Faulted mode.

CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory: IC200CPUE05

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.

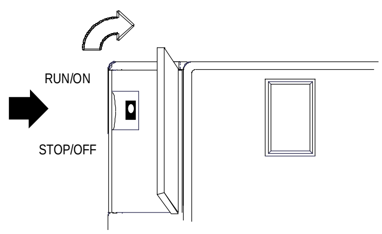
A space is provided on the front of the CPUE05 module where the configured IP Address can be written.



IC200CPUE05: CPU with Two Serial Ports, Embedded Ethernet Interface, and 64K Configurable Memory

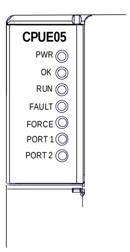
Mode Switch

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.

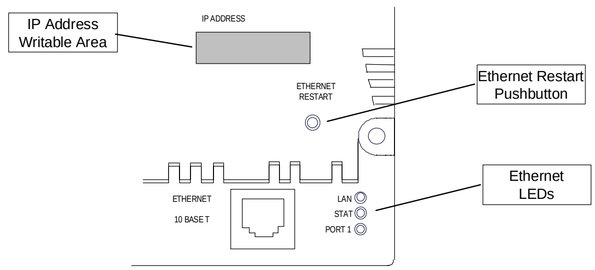
FORCE ON if an override is active on a bit reference.

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:

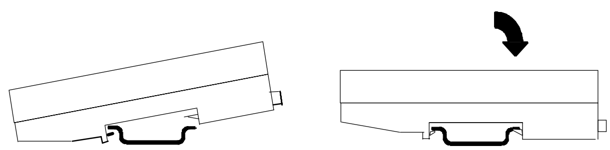
- Installing the CPU
- Installing the power supply
- Installing additional modules
- Activating or replacing the backup battery
- Serial port connections
- Installing expansion modules
- Ethernet connection for CPUE05
- CE Mark installation requirements

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.

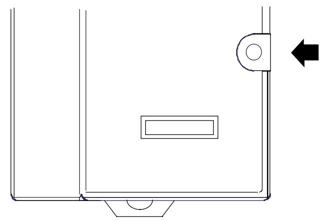


Removing the CPU from the DIN Rail

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.

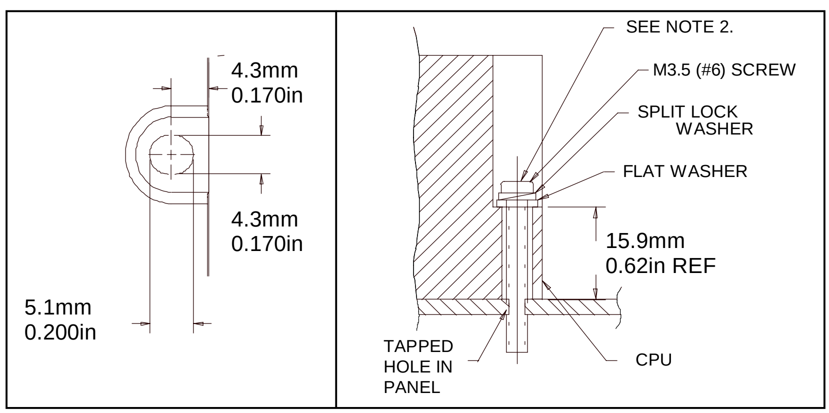
Panel-Mounting

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.



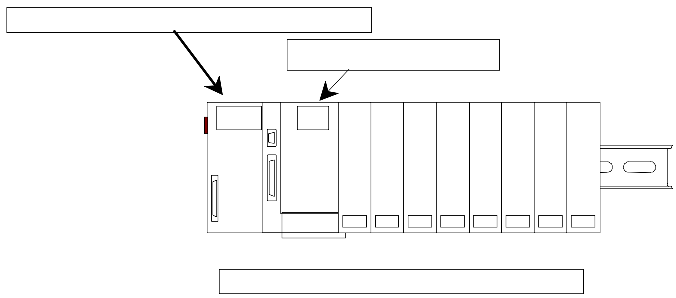
Note 1. Tolerances on all dimensions are +/- 0.13mm +/-0.005in) non-cumulative.

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).

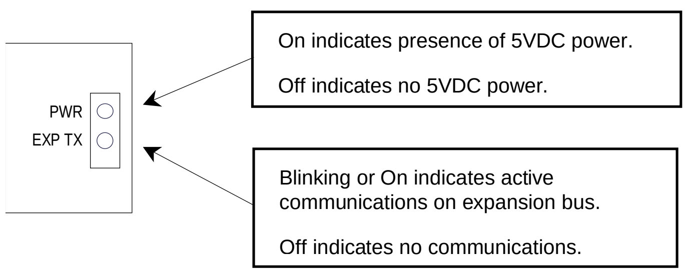


Installing an Expansion Transmitter Module

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.



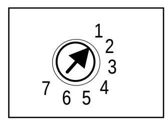
Removing an Expansion Transmitter Module

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.

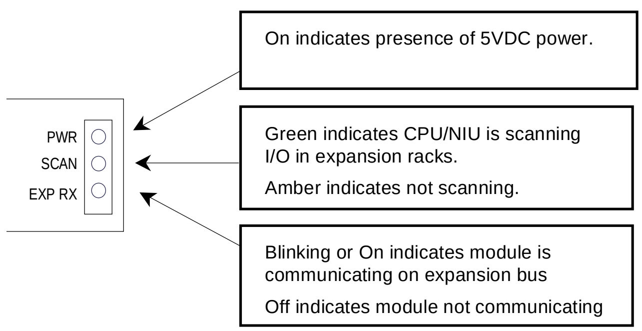
Installing an Expansion Receiver Module

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.



Removing an Expansion Receiver Module

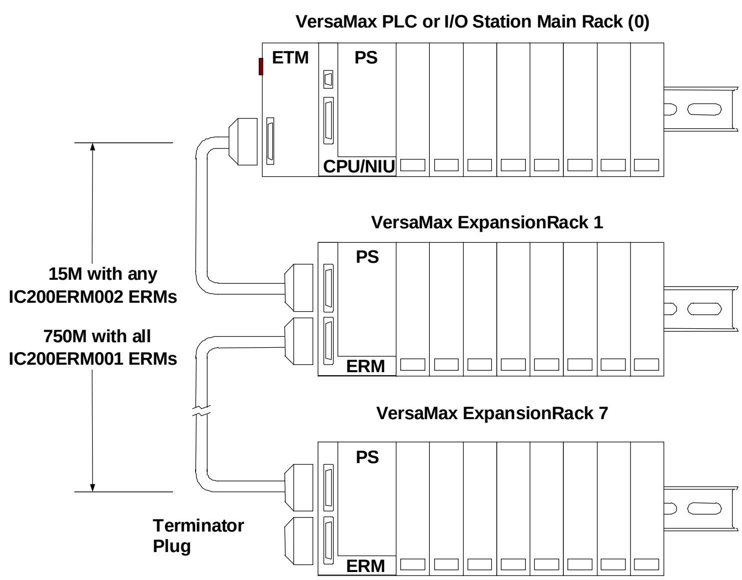
1. Make sure rack power is off.
2. Uninstall the Power Supply module from the Expansion Receiver Module.
3. Slide the Expansion Receiver Module on DIN rail away from the other modules.
4. Using a small screwdriver, pull down on the tab on the bottom of the module and lift the module off the DIN rail.

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.

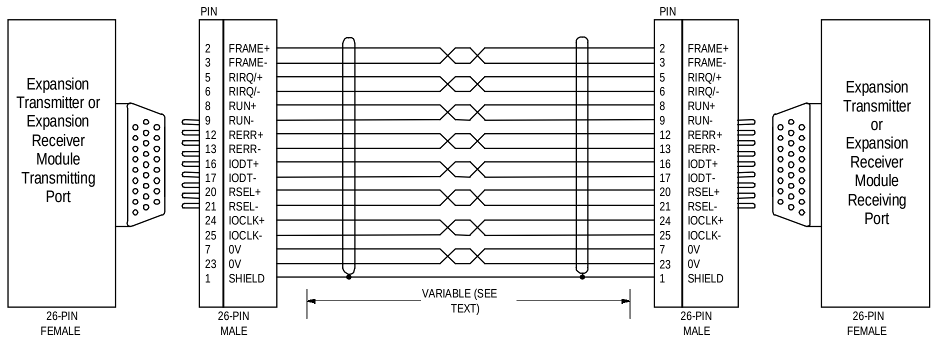
Connecting the Expansion Cable: RS-485 Differential

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)

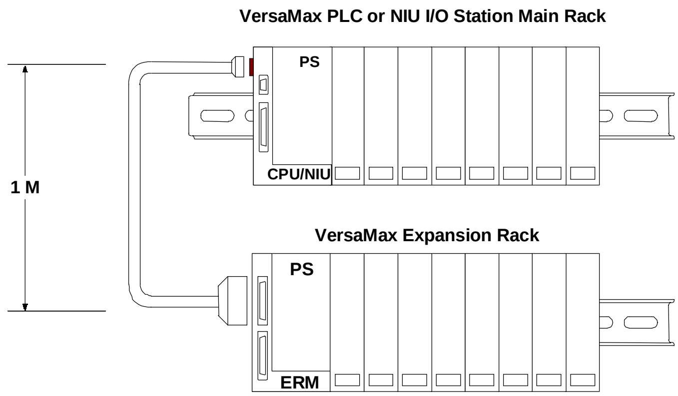


Building a Custom Expansion Cable

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.

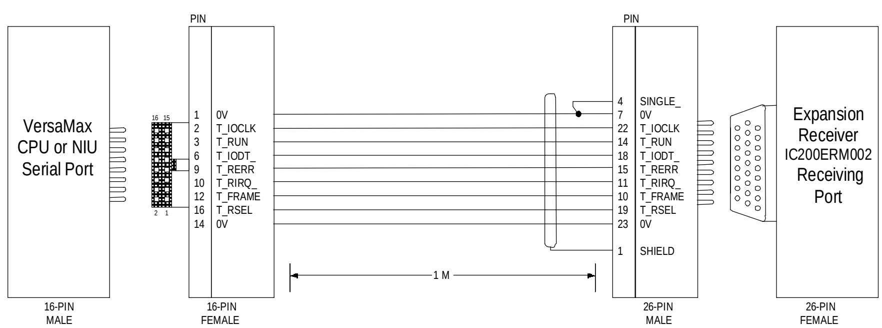
Connecting the Expansion Cable: Single-ended

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

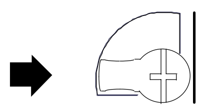
When operating the system in single-ended mode, the power supplies for the main rack and expansion rack must be fed from the same main power source. The main rack and expansion racks cannot be switched ON and OFF separately; either both must be ON or both must be OFF for proper operation.

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.

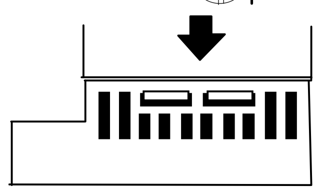
Installing Power Supply Modules

Power supply modules install directly onto the CPU module, Expansion Receiver Modules, and supplementary power supply carriers.

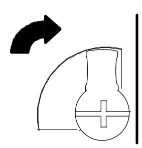
The power supply on the CPU or Expansion Receiver Module supplies +5V and +3.3V to downstream modules through the mating connector. The number of modules that can be supported depends on the power requirements of the modules. Additional booster power supplies can be used as needed to meet the power needs 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.



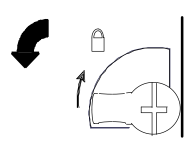
2. Align the connectors and the latch post and press the power supply module down firmly, until the two tabs on the bottom of the power supply click into place. Be sure the tabs are fully inserted in the holes in bottom edge of the CPU, ERM, or carrier.



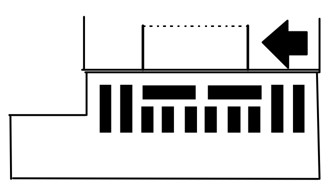
3. Turn the latch to the locked position to secure the power supply.

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.



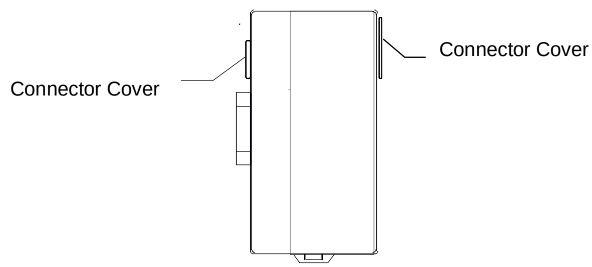
3. Press the flexible panel on the lower edge of the power supply to disengage the tabs on the power supply from the holes in the carrier.
4. Pull the power supply straight off.

Installing Additional Modules

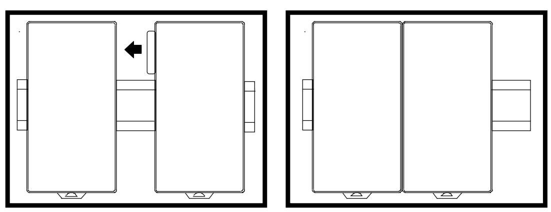
A CPU or Expansion Receiver Module can serve up to 8 additional I/O and option modules on the same section of DIN rail. Power must be off before adding a carrier to the “rack”.

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.



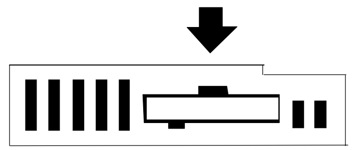
Install each carrier close to the previously-installed carrier, then slide the properly-aligned carriers together to join the mating connectors. To avoid damaging the connector pins, do not force or slam carriers together.



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

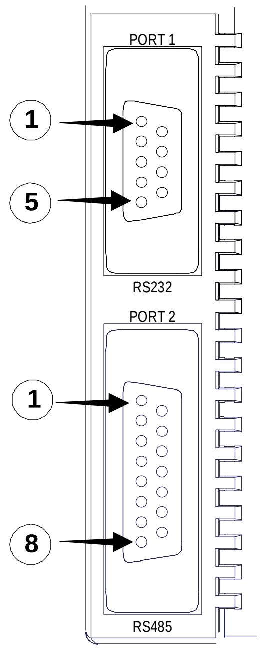
Use of another battery may present a risk of fire or explosion.

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

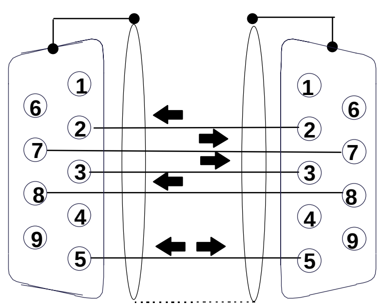
Pin Assignments for Port 1

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

RS232 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.

<table>
<tr><td>Cable:
Belden 9610</td><td colspan="4">Computer cable, overall braid over foil shield
5 conductor †
30 Volt / 80°C (176°F)
24 AWG tinned copper, 7x32 stranding</td></tr>
<tr><td rowspan="2">9 Pin Male
Connector:</td><td><u>Type:</u>
Crimp</td><td><u>Vendor:</u>
ITT/Cannon
AMP</td><td><u>Plug:</u>
DEA9PK87F0
205204-1</td><td><u>Pin:</u>
030-2487-017
66506-9</td></tr>
<tr><td>Solder</td><td>ITT/Cannon
AMP</td><td>ZDE9P
747904-2</td><td>--
--</td></tr>
<tr><td>Connector
Shell:</td><td colspan="4">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</td></tr>
</table>

†   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

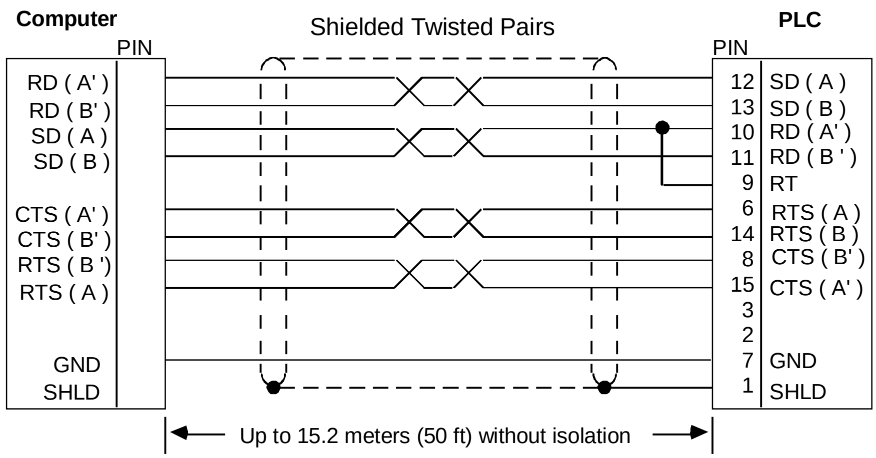
Vendor Part numbers below are provided for reference only. Any part that meets the same specification can be used.

<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>Type:
Crimp</td><td>Vendor:
ITT/Cannon
AMP</td><td>Plug:
DAA15PK87F0
205206-1</td><td>Pin:
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.

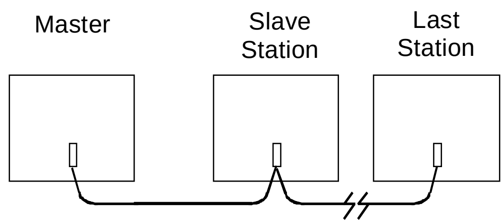
RS485 Point to Point Connection with Handshaking

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.

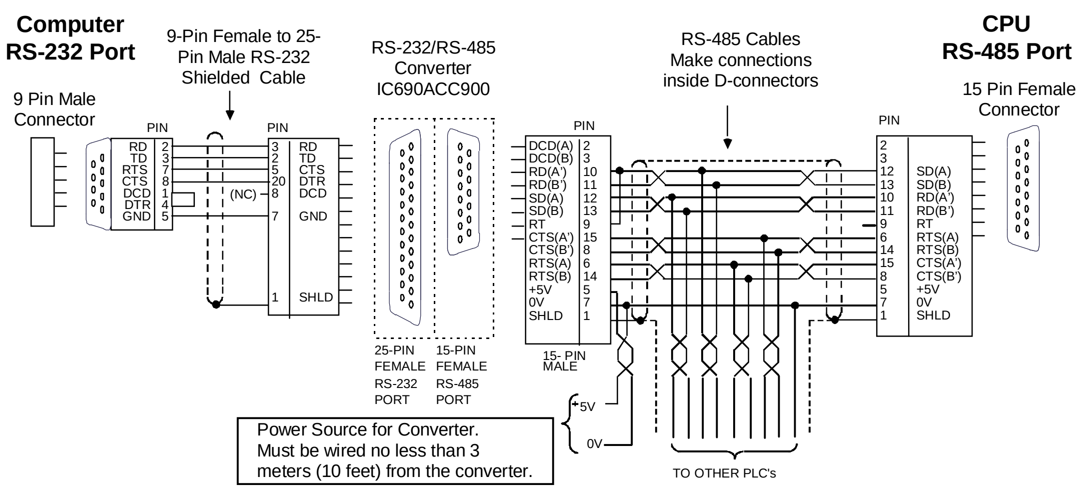


RS-485 Multidrop Serial Connections

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.



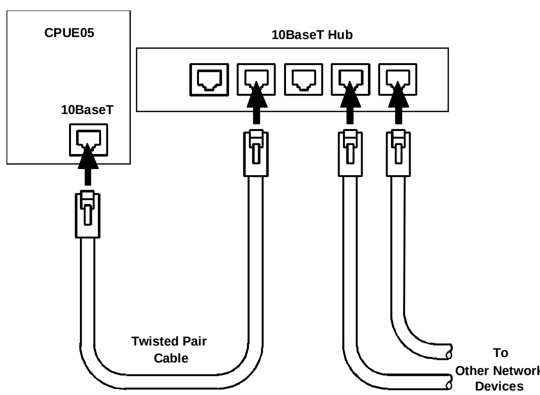
Termination resistance for the Receive Data (RD) signal must be connected only on units at the ends of lines. This termination is made at the CPU by connecting a jumper between pin 9 and pin 10 inside the D-shell connector.
Ground Potential: Multiple units not connected to the same power source must have common ground potential or ground isolation for proper operation of the system.

Ethernet Connection for CPUE05

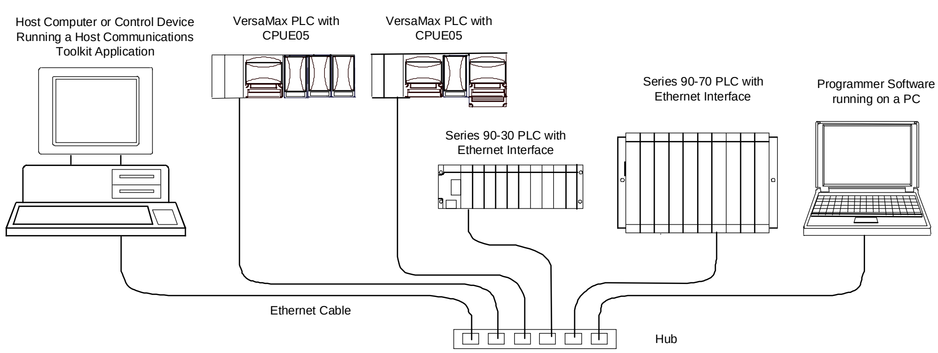
The Ethernet port on PLC module IC200CPUE05 connects directly to a 10BaseT (twisted pair) network without an external transceiver. Connect the port to an external 10BaseT hub or switch or a hub or repeater with auto-sense of 10/100 using a twisted pair cable. Cables are readily available from commercial 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

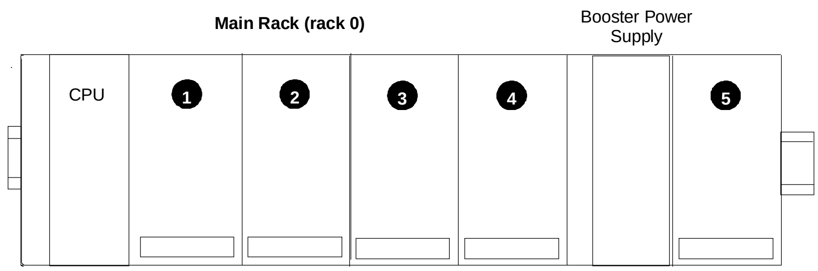
The CPU stores a software configuration in its non-volatile RAM. Storing a configuration disables autoconfiguration, so the PLC will not overwrite the configuration during subsequent startups.

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.

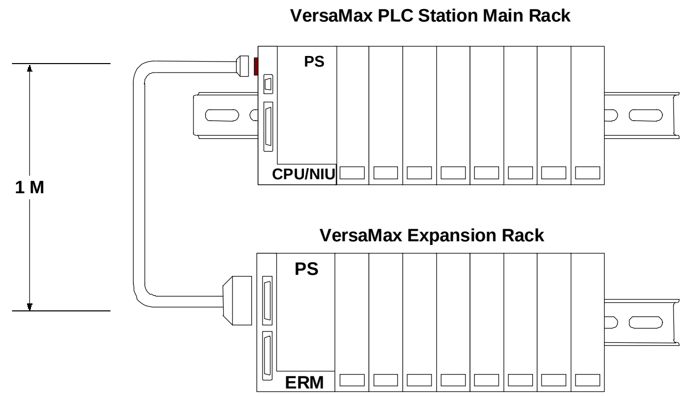
Configuring "Racks" and "Slots"

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.

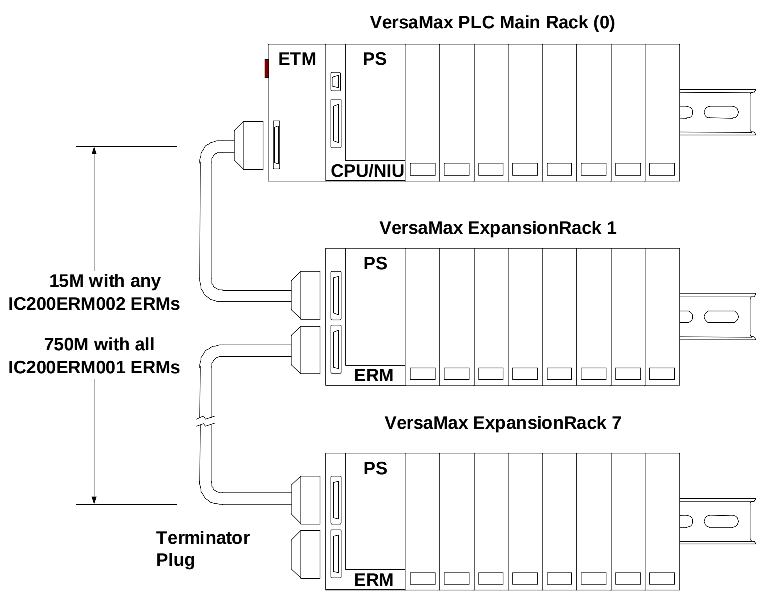


The main rack is rack 0. Additional racks are numbered 1 to 7.

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) CPU001, for rel. 1.50 compatibility CPU002, for rel. 1.50 compatibility	128 bytes minimum 12K bytes 20K bytes
Hardware configuration size (not configurable)	400 bytes minimum
Registers (%R) CPU001/002, for rel. 1.50 compatibility	256 bytes (128 words) minimum 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)

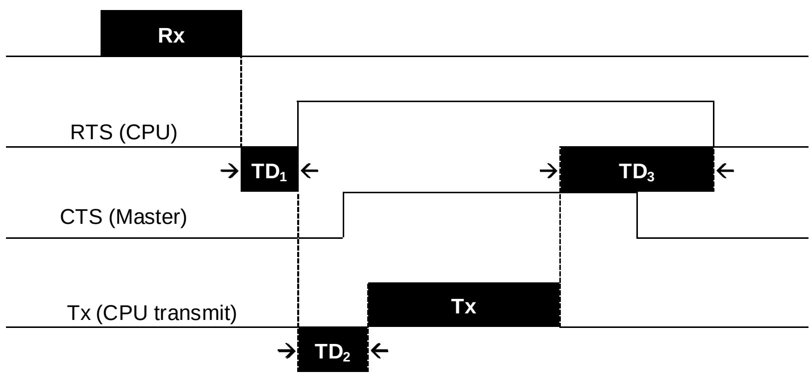
The VersaPro software allows configuration of RTU and Serial I/O at 115.2K baud. However, these baud rates are not supported by the CPU. If a configuration using these baud rates is stored to the PLC:

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 rowspan="3">Status Word

example:</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>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><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 rowspan="4">Exchange Data Ranges

example:</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>Offset</td><td>Reference</td><td>Low Point</td><td>High Point</td><td>Description</td></tr>
<tr><td>0.0</td><td>%R</td><td>100</td><td>105</td><td>Conveyor1 in PLC1</td></tr>
<tr><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:

Parameters	Description
Local Producer ID	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.
Exchange ID	A number that identifies that specific data exchange. It must match the Exchange ID specified in the produced exchange (in the sending device).
Adapter Name	Always 0.0 for CPUE05
Producer ID	The Local Producer ID of the device sending the exchange.
Group ID	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.
Consumer Period	Not used. Default is 200mS.
Update Timeout	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.
Status Word	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.

example:

Offset	Reference	Low Point	High Point	Description
Status	%R	99	99	Status: Where the PLC will place the status data.

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

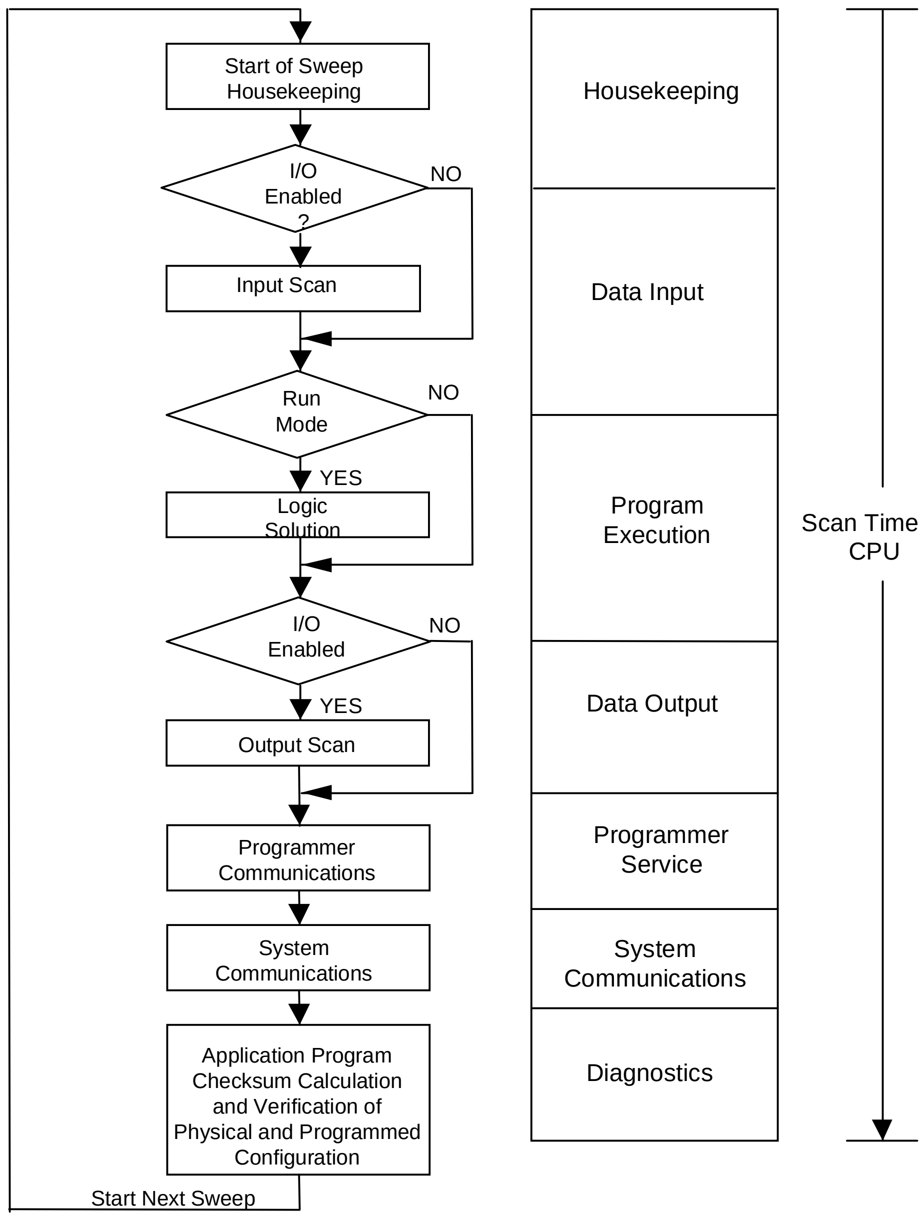
This chapter describes the operating modes of the VersaMax® PLC CPUs, and shows the relationship between the application program execution and other tasks performed by the CPU.

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

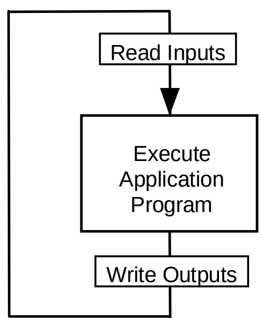
Structure of an Application Program

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.

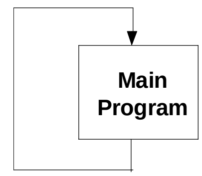
During the CPU Sweep (described in the previous chapter), the CPU reads input data from the modules in the system and stores the data in its configured input memory locations. The CPU then executes the entire application program once, utilizing this fresh input data. Executing the application program 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.



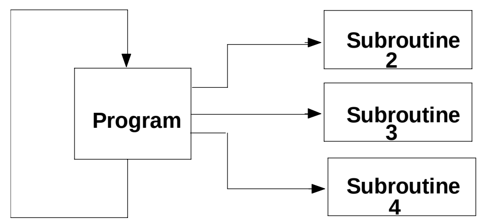
Subroutines

The program can consist of one Main program that executes completely during each CPU sweep.

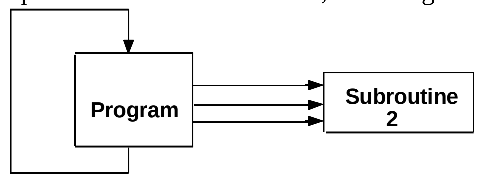


Or a program can be divided into subroutines. The maximum size of a main program or subroutine block is 64kB. The program can contain up to 255 subroutines.

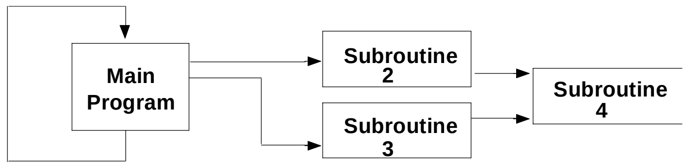
Subroutines can simplify programming and reduce the overall amount of logic. Each subroutine can be called as needed. The main program might serve primarily to sequence the subroutine blocks.



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.



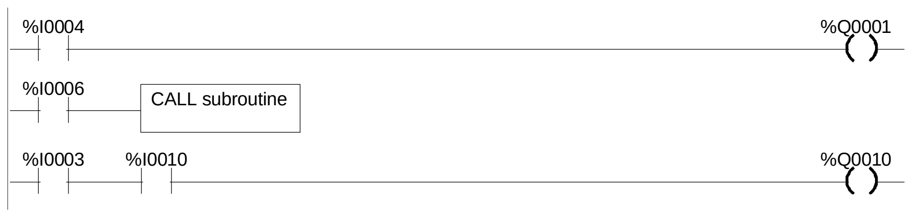
The main program is level 1. The program can include up to eight additional nested call levels.

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

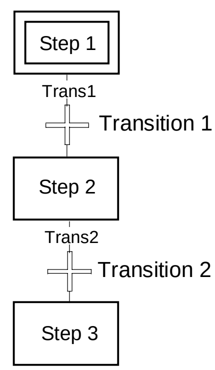
Programs can be created in Ladder Diagram or Instruction List format. The main program or subroutines within the program can also be created in Sequential Function Chart format. The PLC programming software can be used to create both types of logic.

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.

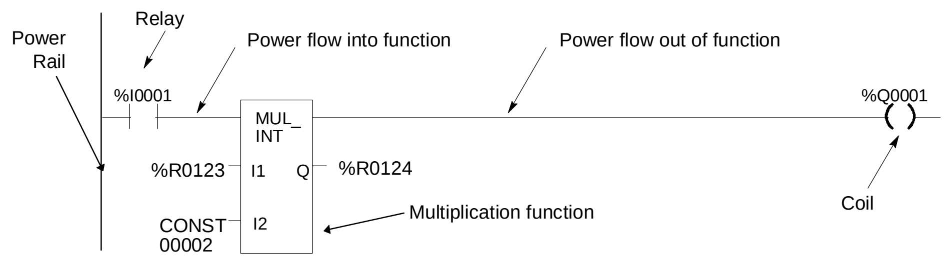
The flow of control passes from one step to the next through a conditional transition that is either true (1) or false (0). If the transition condition is true (1), control passes from the current step (which becomes inactive) to the next step, which then becomes active.

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.
–([illegible])–	**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.
–([illegible])–	**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:

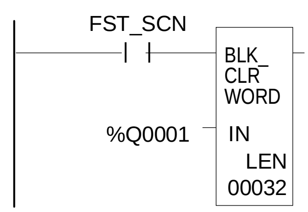
  -( )- coils
  -(/)- negated coils
  -(S)- SET coils
  -(R)- RESET coils

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.

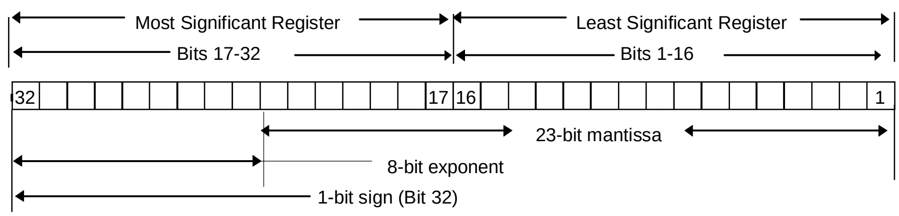
How Program Functions Handle Numerical Data

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).	Word 1 16 bit positions 16 1
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.	Word 1 4 3 2 1 4 BCD Digits 16 13 9 5 1 Bit Positions
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.	Word 2 Word 1 +/- 32 17 16 1 8 bit exponent 23 bit mantissa Two's Complement Values
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.	Word 1 +/- 16 bit positions 16 1 Two's Complement Values
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.	Word 2 Word 1 +/- 32 17 16 1

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.

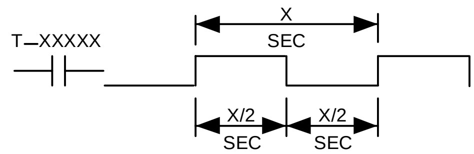
Time-Tick Contacts

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

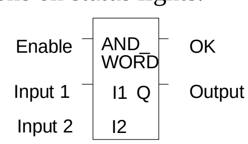
Each scan that power is received, a Logical AND or Logical OR function examines each bit in bit string I1 and the corresponding bit in bit string I2, beginning at the least significant bit in each. A string length of 256 words can be selected.

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.



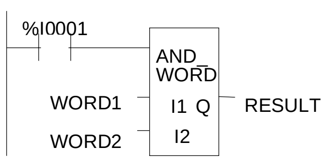
Bit Operation Functions
Logical AND, Logical OR

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

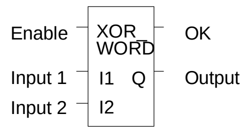
In the example, when input %I0001 is set, the 16-bit strings represented by nicknames WORD1 and WORD2 are examined. The results of the Logical AND are placed in output string RESULT.



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.

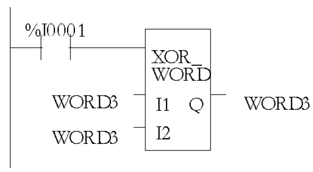
Parameters of the Exclusive OR Function

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.

Bit Operation Functions
Exclusive OR

Example

In the example, whenever %I0001 is set, the bit string represented by the nickname WORD3 is cleared (set to all zeros).

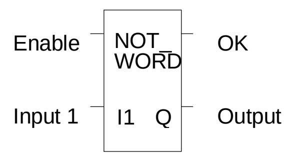


I1 (WORD3)	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0
I2 (WORD3)	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0
Q (WORD3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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.

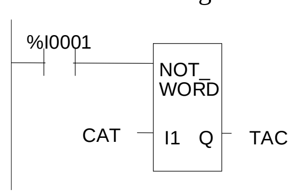


Parameters of the Logical Invert Function

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

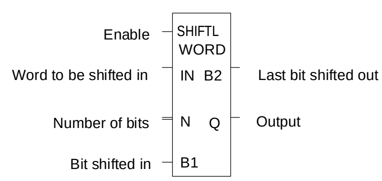
The Shift Left function shifts all the bits in a word or group of words to the left by a specified number of places. When the shift occurs, the specified number of bits is shifted out of the output string to the left. As bits are shifted out of the high end of the string, the same number of bits is shifted 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.

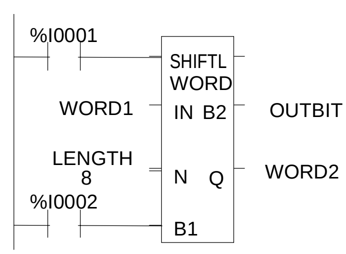
Bit Operation Functions
Shift Bits Right, Shift Bits Left

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.



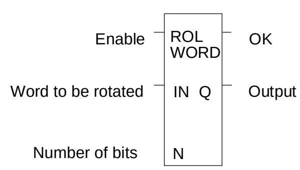
Bit Operation Functions
Rotate Bits Right, Rotate Bits Left

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.

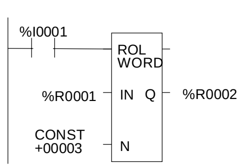


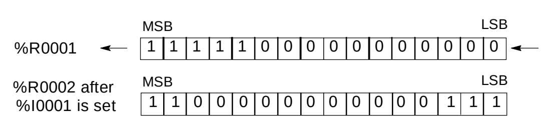
Parameters of the Rotate Bits Right / Left Functions

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.



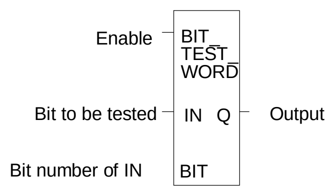


Bit Operation Functions
Bit Test

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

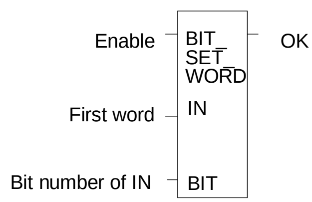
In the example, whenever input %I0001 is set, the bit at the location contained in reference PICKBIT is tested. The bit is part of string PRD_CDE. If it is 1, output Q passes power flow and the coil %Q0001 is turned on.

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.

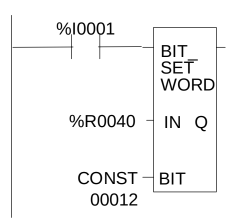


Parameters of the Bit Set and Bit Clear Functions

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.

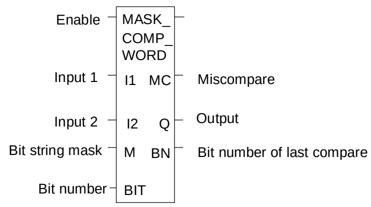
Example

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

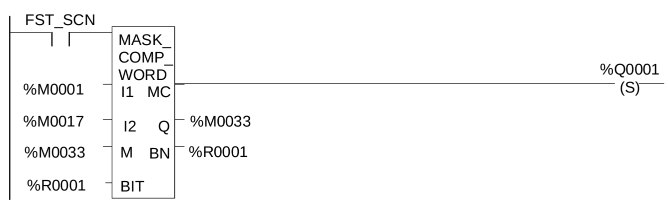
Operation of the Masked Compare

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.

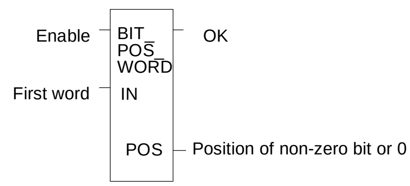
Bit Operation Functions
Bit Position

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.

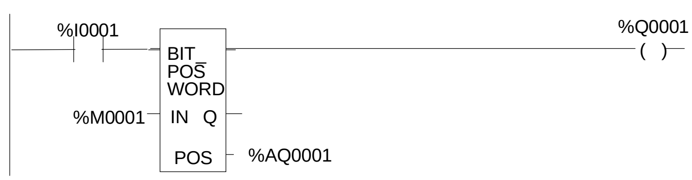


Parameters for the Bit Position Function

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.

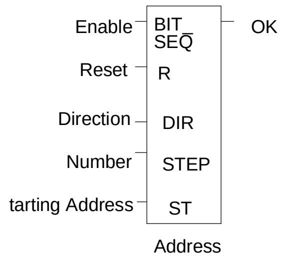
Example

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.

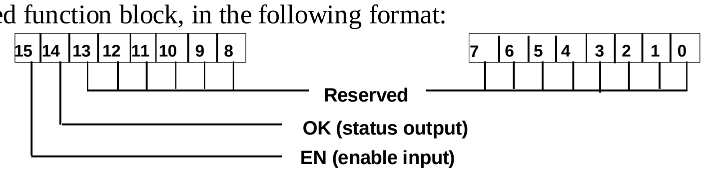
Memory Required for a Bit Sequencer

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

Bit Operation Functions
Bit Sequencer

Word 3 (the control word) stores the state of the boolean inputs and outputs of its associated function block, in the following format:



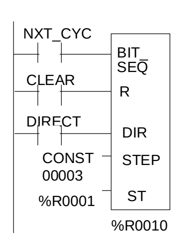
Parameters for the Bit Sequencer Function

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

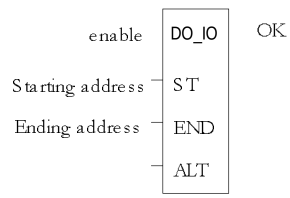
This section describes the control functions, which may be used to limit program execution and to change the way the CPU executes the application program.

- 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:

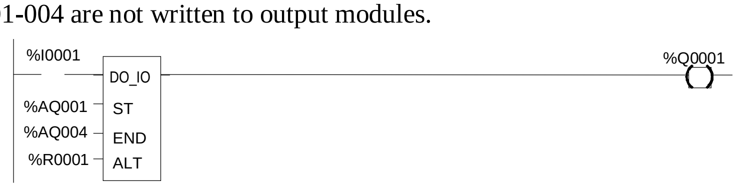
In this example, when the function receives power flow, the PLC scans references %I0001-64 and %Q0001 is turned on. Copies of the scanned inputs are placed in internal memory from %M0001-64. Because a reference is specified for ALT, the real inputs are not updated. This allows the current values of inputs 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.

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.

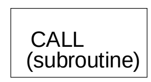
The module to be read/written is specified in the ALT parameter. For example, a constant value of 2 in this parameter indicates to the CPU that it is to execute the Do I/O function block for the module in location 2. The start and end references must be either %I or %Q. These references specify the first 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.

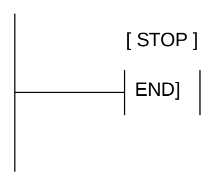
The End of Logic function is useful for debugging purposes because it prevents any logic which follows from being executed.

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

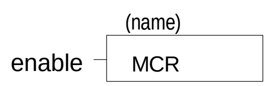
All rungs between an active Master Control Relay (MCRN) and its corresponding End Master Control Relay (ENDMCRN) function are executed without power flow to coils. The ENDMCRN associated with the Master Control Relay is used to resume normal program execution. Unlike Jump functions, Master Control Relays 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.

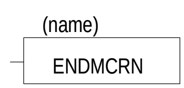
There can be multiple Master Control Relay functions with a single ENDMCRN.

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.

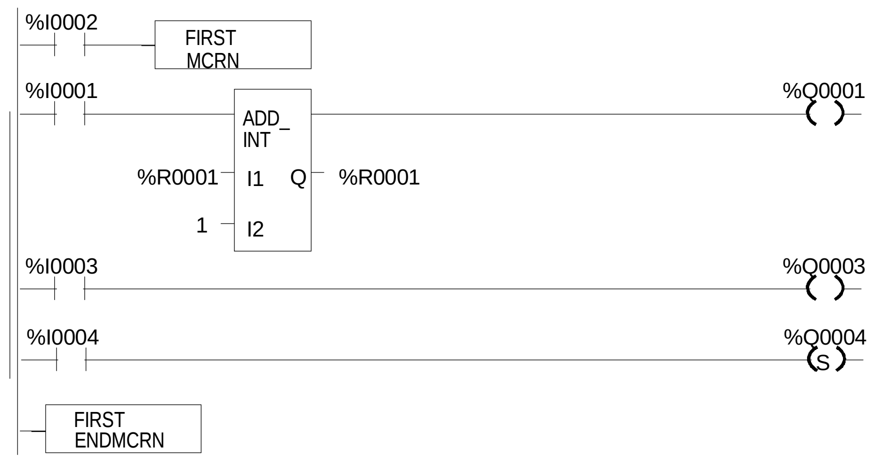


Control Functions
Master Control Relay (MCR) / End MCR

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.

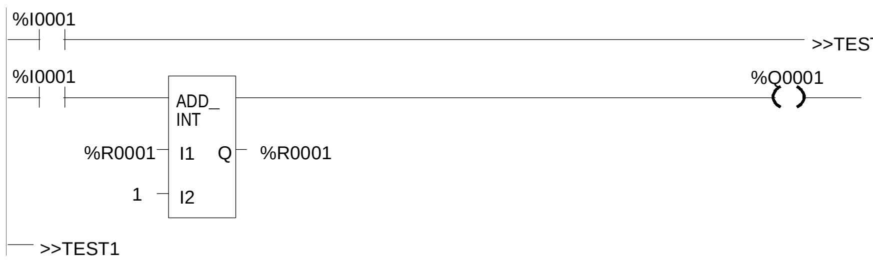
The Label instruction has no inputs and no outputs; there can be nothing either before or after a Label in a rung.

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

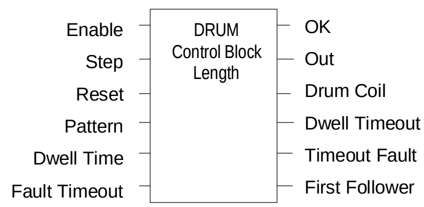
The Comment function is used to enter a comment (rung explanation) in the program. A comment can have up to 2048 characters of text. Longer text can be included in printouts using an annotation text file.

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.

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

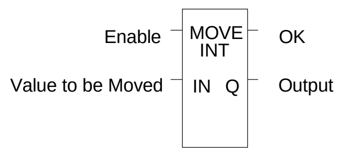
The Data Move functions of the Instruction Set provide basic data move capabilities.

- 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.

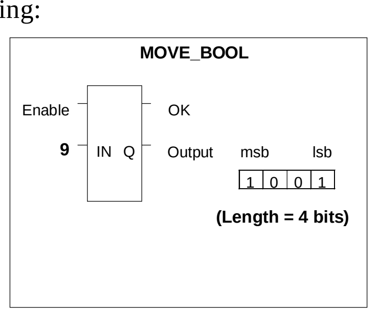
When the Move function receives power flow, it copies data from input parameter IN to output parameter Q as bits. If data is moved from one location in discrete memory to another, (for example, from %I memory to %T memory), the transition information associated with the discrete memory elements is updated 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.

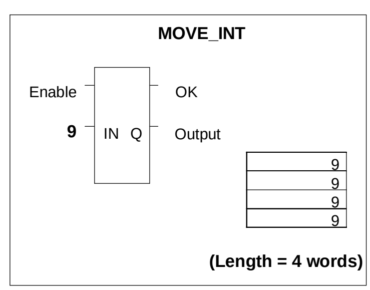


Note that if an array of Bit-type data specified in the Q parameter does not include all the bits in a byte, the transition bits associated with that byte (which are not in the array) are cleared when the Move function receives power flow.

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.

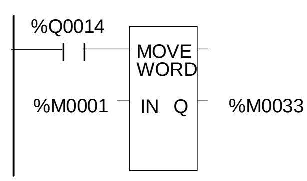
Data Move Functions
Move Data

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

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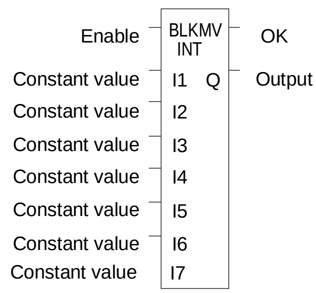
Data Move Functions
Block Move

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.

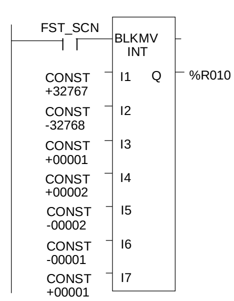


Parameters of the Block Move Function

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

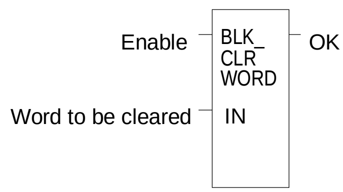
In the example, when the enabling input represented by the nickname FST_SCN is ON, the Block Move function copies the input constants into memory locations %R0010–16.



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.

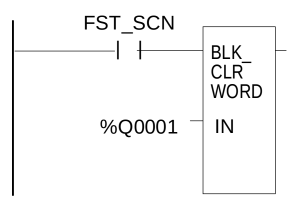


Parameters of the Block Clear Function

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.

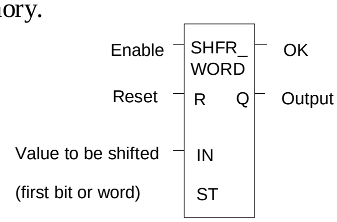


Data Move Functions
Shift Register

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.

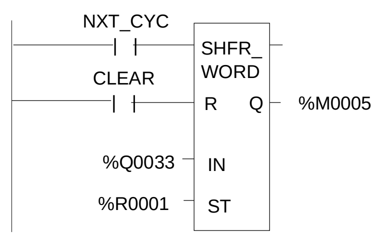
CAUTION: the use of overlapping input and output reference address ranges in multi-word functions is not recommended; it may produce unexpected results.

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.

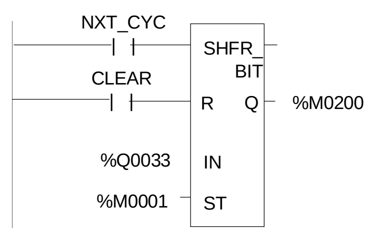
When the NXT_CYC reference is active and CLEAR is not active, the word from output status table location %Q0033 is shifted into the Shift Register at %R0001. The word shifted out of the Shift Register from %R0100 is stored in output %M0005.



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.

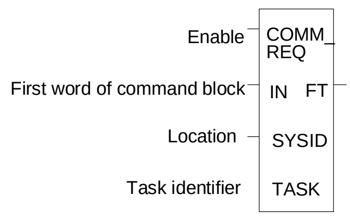
When NXT_CYC is active and CLEAR is not, the Shift Register function shifts the data in %M0001 to %M0100 down by one bit. The bit in %Q0033 is shifted into %M0001 while the bit shifted out of %M0100 is written to %M0200.



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.

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.

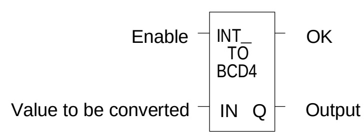
- Convert data to BDC-4
- Convert data to signed integer
- Convert data to double-precision integer
- Convert data to Real
- Convert data to Word
- Round a Real number toward zero (TRUN)

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.

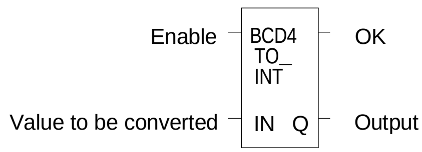
Example

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.

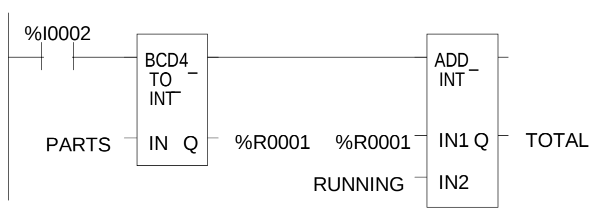


Parameters of the Convert to Signed Integer Function

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

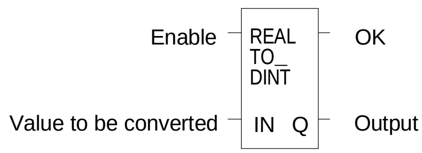
In the example, whenever input %I0002 is set, the BCD-4 value in PARTS is converted to a signed integer and passed to the Addition function, where it is added to the signed integer value represented by the reference RUNNING. The sum is output by the Addition function to the reference TOTAL.



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

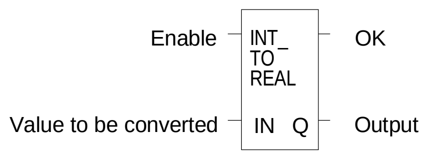
In the example, whenever input %I0002 is set, the integer value at input location %I0017 is converted to a double precision signed integer and the result is placed in location %R0001. The output %Q1001 is set whenever the function executes successfully.

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.

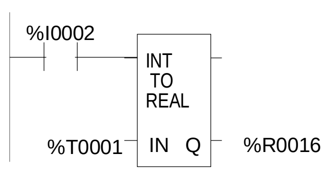


Parameters of the Convert to Real Function

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

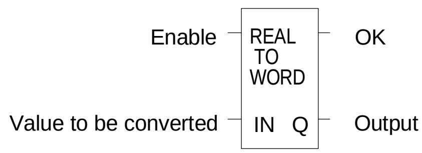
In the example, the integer value of input IN is 678. The result value placed in %T0016 is 678.000.



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.

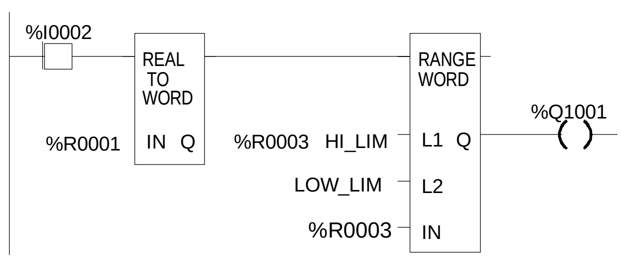
When the function receives power flow, it performs the conversion, making the result available via output Q. The function passes power flow when power is received, unless the specified conversion would result in a value that is outside the range 0 to FFFFh.



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.

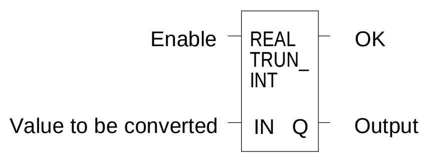
Example



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.

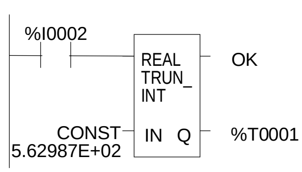


Parameters of the Truncate Function

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

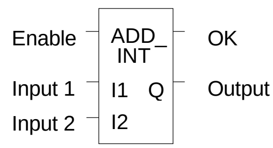
Converting Data for the Math and Numerical Functions

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:

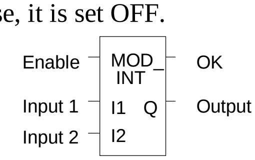
INT	Signed integer
DINT	Double precision signed integer

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.

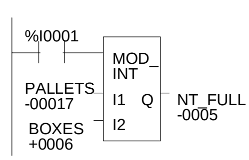


Parameters of the Modulo Division Function

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.

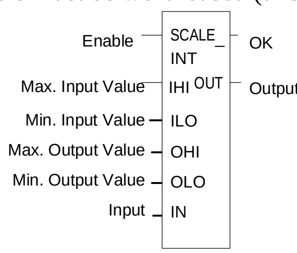
Example

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).

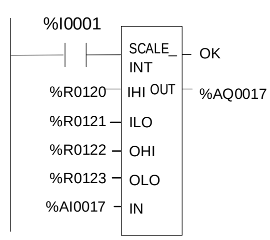


Parameters of the Scaling Function

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.

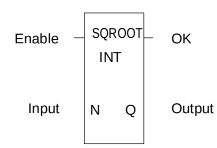
The Square Root function operates on these types of data:

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.

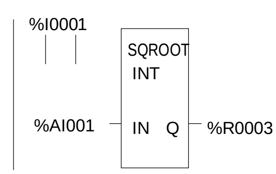


Parameters of the Square Root Function

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.

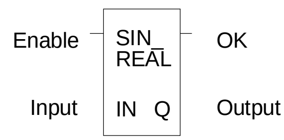


Math and Numerical Functions
Trigonometric Functions

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

$$-2^{63} < IN < +2^{63}, \ (2^{63} = 9.22 \text{x} 10^{18})$$

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:

$$\text{ASIN (IN)} \quad = \quad \frac{\pi}{2} \le Q \le \frac{\pi}{2}$$

The Inverse Cosine Real function produces a result Q such that:

$$\text{ACOS (IN)} \quad = \quad 0 \le Q \le \pi$$

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:

$$\text{ATAN (IN)} \quad = \quad \frac{\pi}{2} \le Q \le \frac{\pi}{2}$$

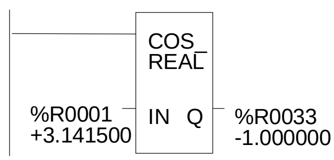
Math and Numerical Functions
Trigonometric Functions

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.

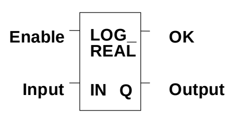


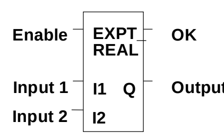
Math and Numerical Functions
Logarithmic / Exponential Functions

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.



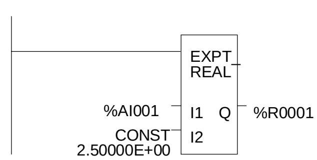


Parameters of the Logarithmic/Exponential Functions

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

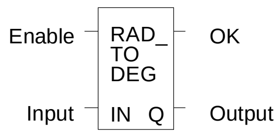
In the example, the value of %AI001 is raised to the power of 2.5 and the result is placed in %R0001.



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).

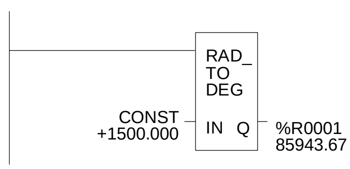


Parameters of the Radian Conversion Function

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.

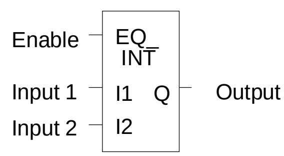


Relational Functions

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

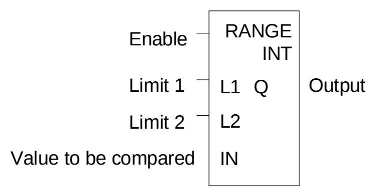
The Range function determines if a value is within the range of two numbers.

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.

<table>
<tr><th>Type of Contact</th><th>Display</th><th>Contact Passes Power to Right:</th></tr>
<tr><td>Normally Open</td><td>-| |-</td><td>When reference is ON.</td></tr>
<tr><td>Normally Closed</td><td>-|/|-</td><td>When reference is OFF.</td></tr>
<tr><td>Continuation Contact</td><td><+>---</td><td>If the preceding continuation coil is set ON.</td></tr>
</table>

Normally Open Contact -| |-

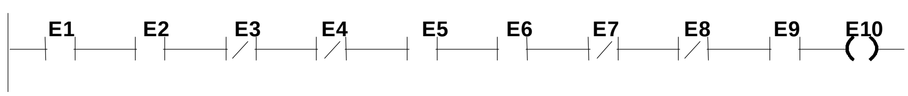
A normally open contact acts as a switch that passes power flow if the associated reference is ON (1).

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.

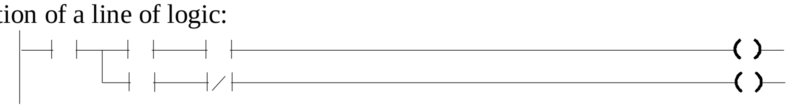


Continuation Coils and Contacts

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

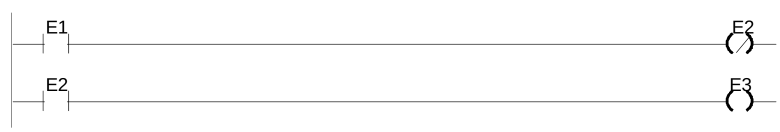
In the example, coil E3 is ON when reference E1 is ON and reference E2 is OFF.

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

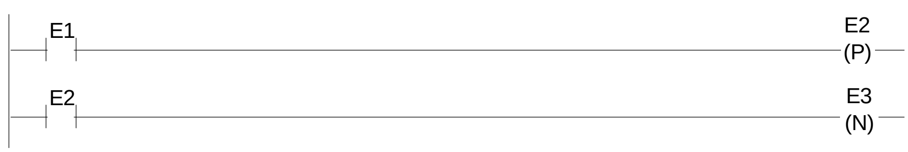
If the reference associated with this coil is OFF, when the coil stops receiving power flow the reference is set to ON until the next time the coil is executed.

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

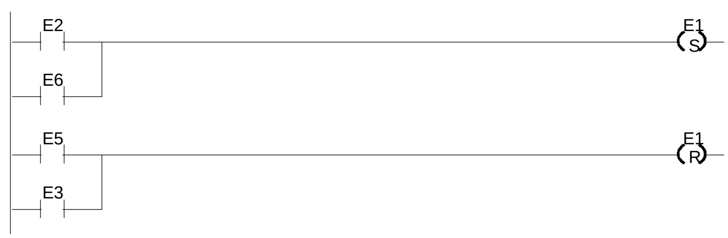
SET and RESET are non-retentive coils that can be used to keep ("latch") the state of a reference either ON or OFF. When a SET coil receives power flow, its reference stays ON (whether or not the coil itself receives power flow) until the reference is reset by another coil.

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

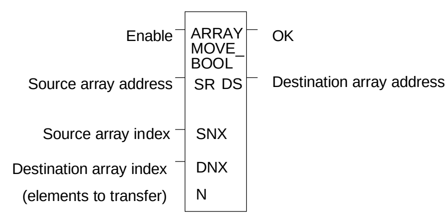
The Array Move function copies a specified number of elements from a source array to a destination array. When the function receives power flow, it copies the number of elements specified from the input array, starting at the indexed location. The function then writes the copied elements to the output 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).



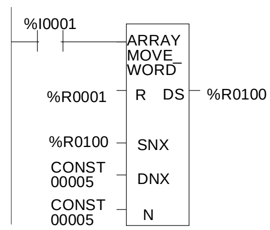
Parameters for the Array Move Function

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

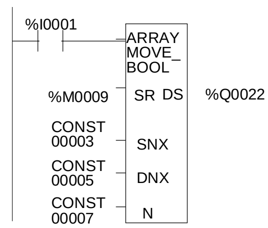
Example 1:

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).

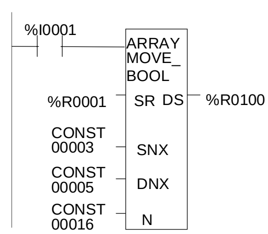
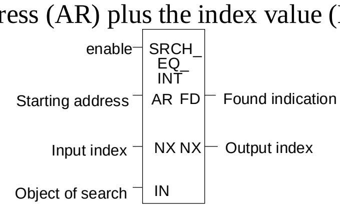


Table Functions
Search for Array Values

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.

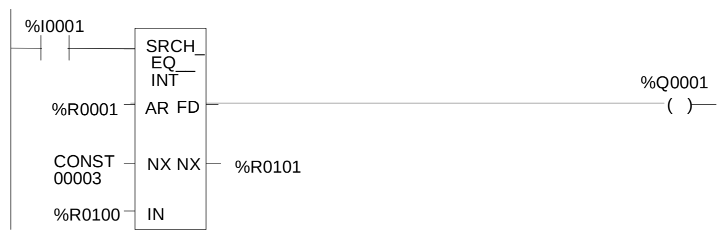
Parameters of the Search Functions

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.

Table Functions
Search for Array Values

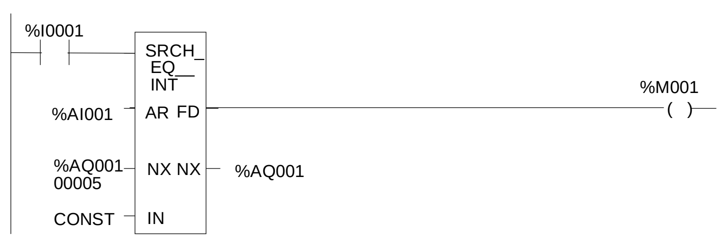
Example 1:

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.

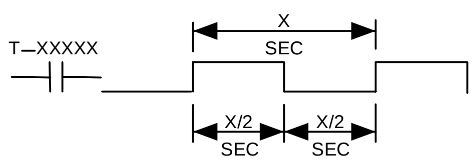
- On-Delay Stopwatch Timer
- Off-Delay Timer
- On-Delay Timer
- Up Counter
- Down Counter

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.



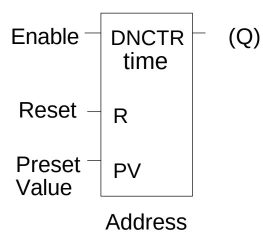
These time-tick contacts represent specific locations in %S memory.

Function Block Data Required for Timers and Counters

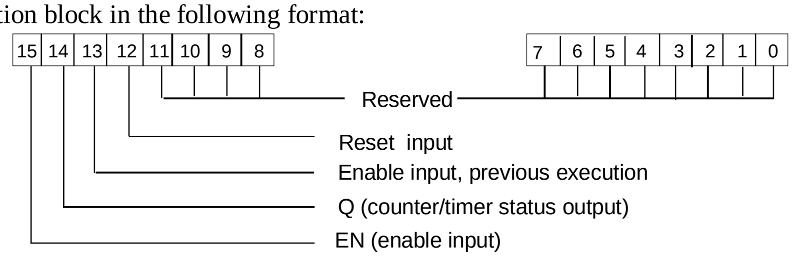
Each timer or counter uses three words (registers) of %R memory to store the following information:

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:



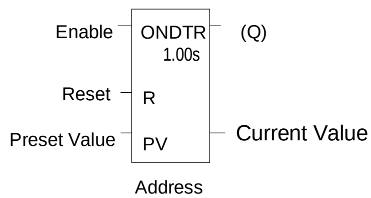
Bits 0 through 11 are used for timer accuracy; not for counters.

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.



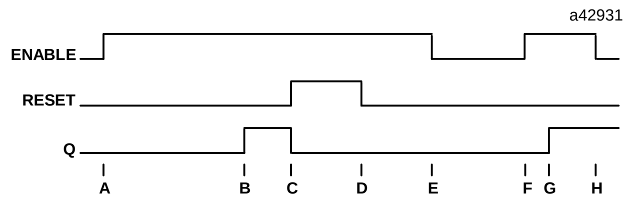
When the Current Value equals or exceeds the Preset Value PV, output Q is energized. As long as the timer continues to receive power flow, it continues accumulating until the maximum value is reached. Once the maximum value is reached, it is retained and output Q remains energized regardless of the state 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.

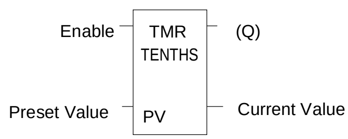
When power flow to the timer stops, the current value stops incrementing and is retained. Output Q, if energized, will remain energized. When the function receives power flow again, the current value again increments, beginning at the retained value. When reset R receives power flow, the current value 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.



Address-3 words

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.

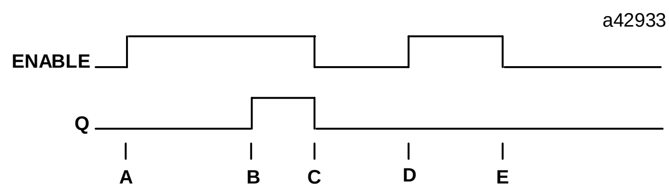
This update occurs as long as the enabling logic remains ON. When the current value equals or exceeds the Preset Value PV, the function begins passing power flow to the right. The timer continues accumulating time until the maximum value is reached. When the enabling parameter transitions from ON to 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.

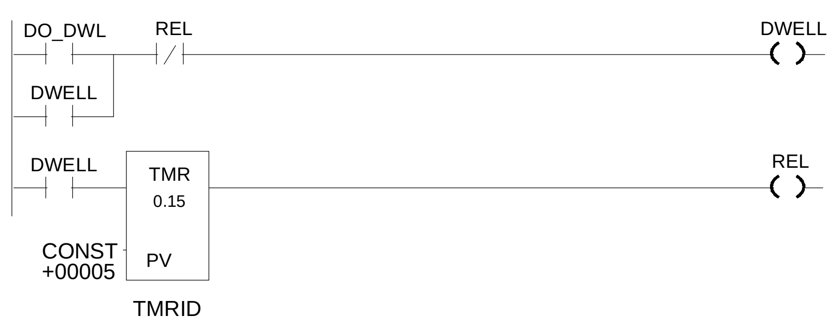
D. ENABLE goes high; timer starts accumulating time.

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

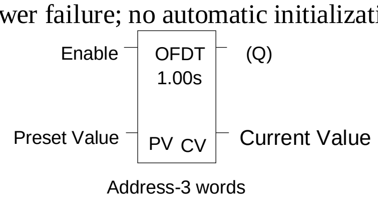
In the example, a delay timer (with address) TMRID is used to control the length of time that coil is on. This coil has been assigned the Nickname DWELL . When the normally open (momentary) contact with the Nickname DO_DWL is on, coil DWELL is energized.

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.

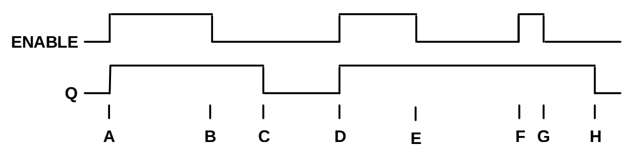
Each time the function is invoked with the enabling logic set to OFF, the Current Value is updated to reflect the elapsed time since the timer was turned off. When the Current Value (CV) is equal to the Preset Value (PV), the function stops passing power flow to the right and the timer stops accumulating. 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



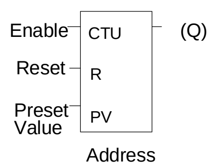
A. ENABLE and Q both go high; timer is reset (CV = 0).
B. ENABLE goes low; timer starts accumulating time.
C. CV reaches PV; Q goes low, and timer stops accumulating time.
D. ENABLE goes high; timer is reset (CV = 0).
E. ENABLE goes low; timer starts accumulating time.
F. ENABLE goes high; timer is reset (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.

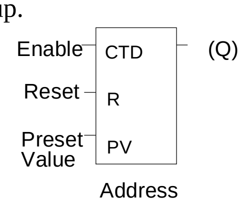
Example of the Up Counter Function

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.

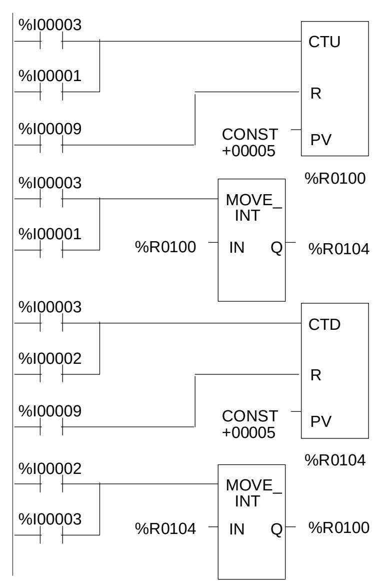
Timer and Counter Functions
Down Counter

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.

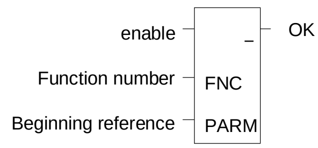
SVCREQ Function Numbers

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:

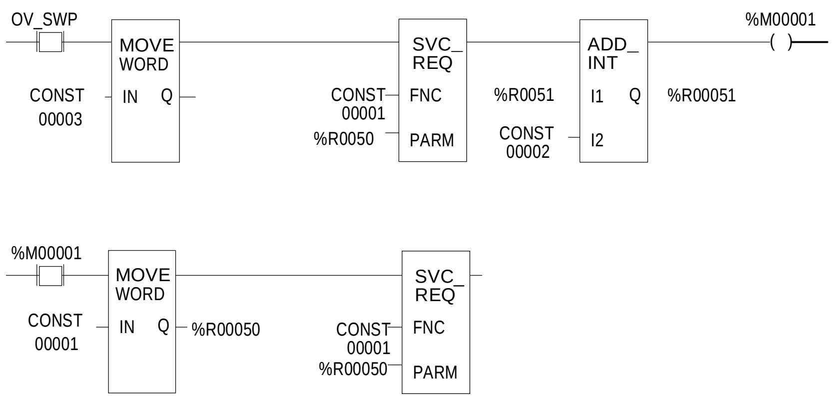
1. A number other than 0, 1, 2, or 3 is entered as the requested operation:
2. The sweep time value is greater than 500ms (0.5 seconds).
3. Constant sweep time is enabled with no timer value programmed or with an old value of 0 for the timer.

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

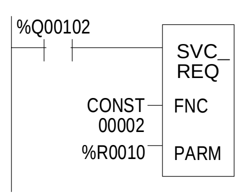
The parameter block has a length of three words:

	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.

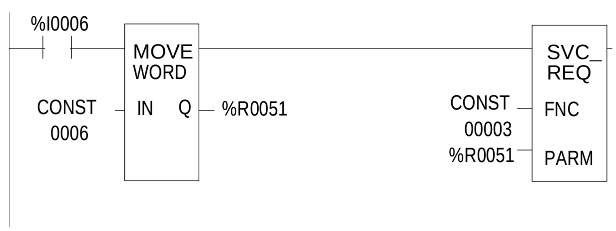
Changing the Programmer Communications Window Mode

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.

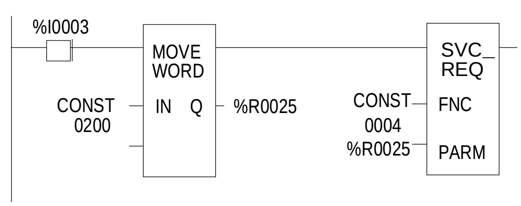
Changing the System Communications Window Mode

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

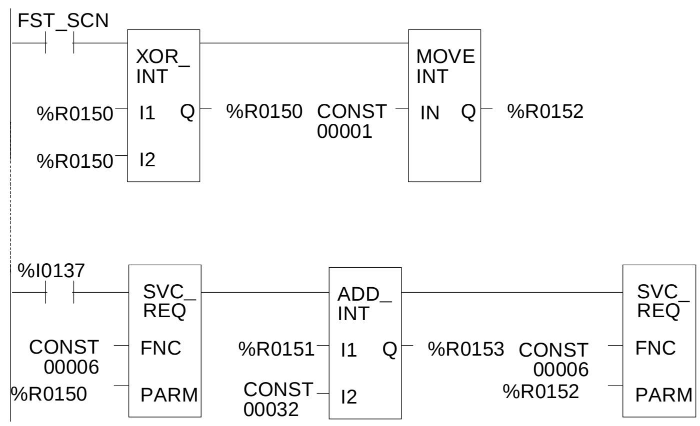
To change the word count, the first word of the parameter block must contain a one:

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: High Byte:	Low Byte		Example: Read Date and Time in BCD format (Sun., July 3, 1998, at 2:45:30 p.m.)	
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: High Byte:	Low Byte		Example: Read Date and Time in BCD format (Sun., July 3, 1998, at 2:45:30 p.m.)	
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

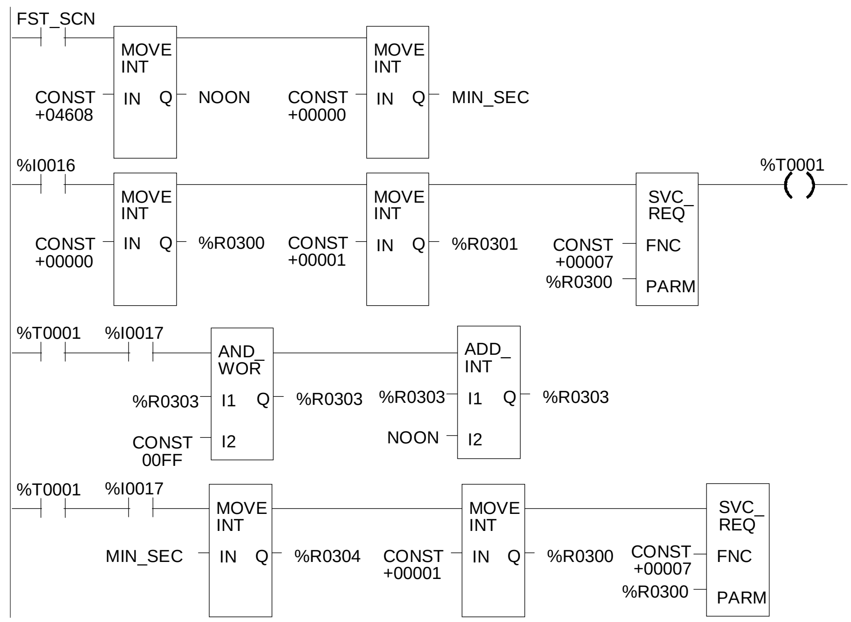
Parameter Block Format: High Byte	Parameter Block Format: Low Byte		Example: Read Date and Time in Packed ASCII Format (Mon, Oct. 5, 1998 at 11:13:00pm)	
1 = change or 0 = read		address	0 (read)	
3 (ASCII format)		address + 1	3 (ASCII format)	
year	year	address + 2	38 (8)	39 (9)
month	(space)	address + 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: High Byte	Parameter Block Format: Low Byte		Example: Read Date and Time in Packed ASCII Format (Mon, Oct. 5, 1998 at 11:13:00pm)	
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

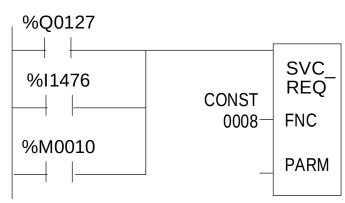
Be sure that resetting the watchdog timer does not adversely affect the controlled process.

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.

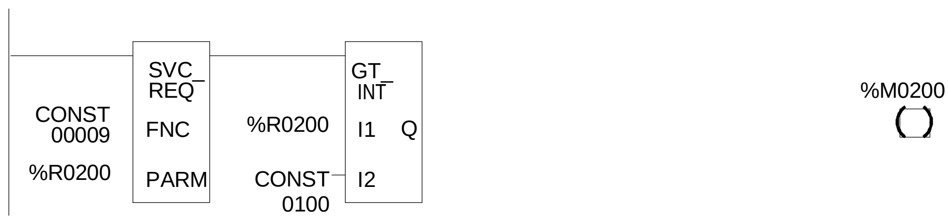
Output Parameter Block Format for SVCREQ 9

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.

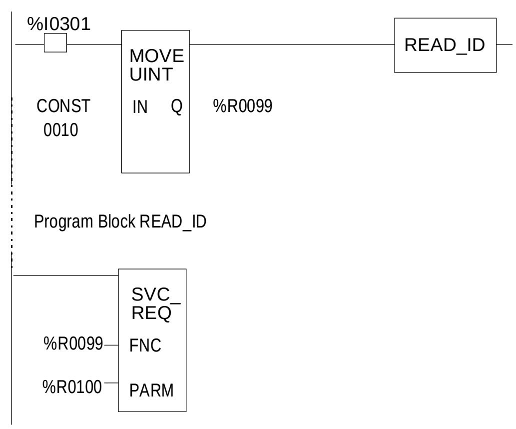
Output Parameter Block Format for SVCREQ 10

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.

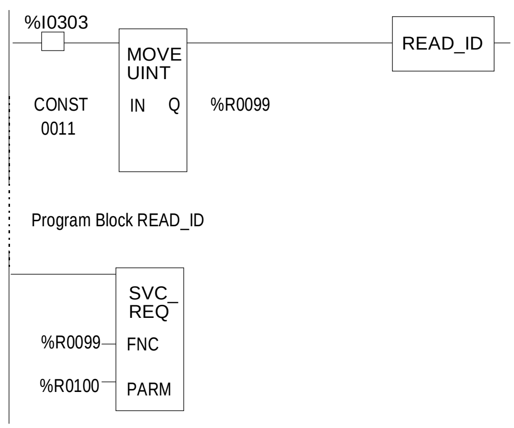
Output Parameter Block Format for SVCREQ 11

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

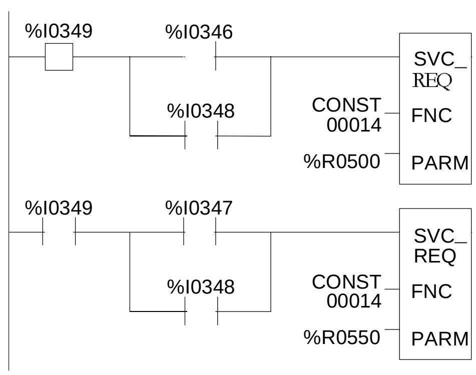
For this function, the parameter block has a length of 1 word. It is an input parameter block only. There is no output parameter block.

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 to address + 18	fault specific data	fault description
	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	

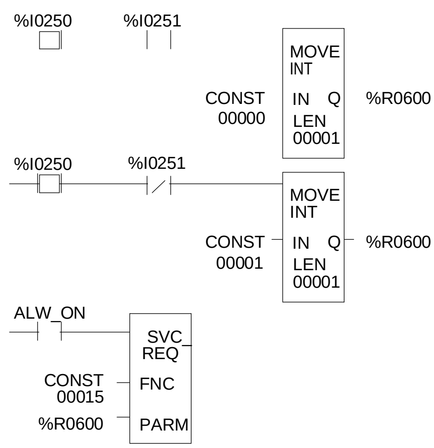
Long/Short Value

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

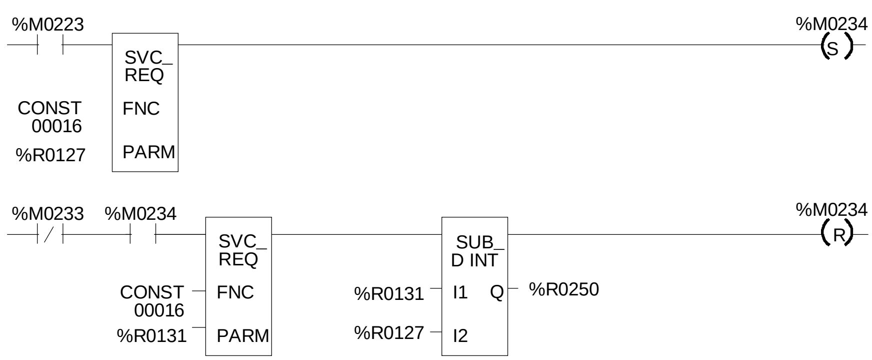
The first two words are the elapsed time in seconds. The last word is the number of 100 microsecond ticks in the current second.

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.

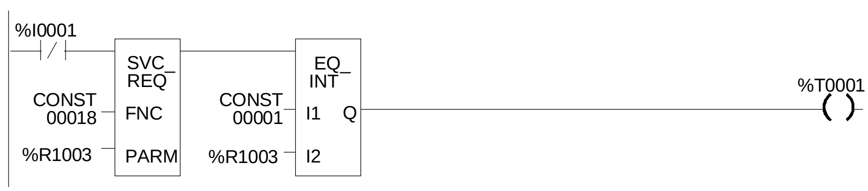
Output Parameter Block for SVCREQ 18

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

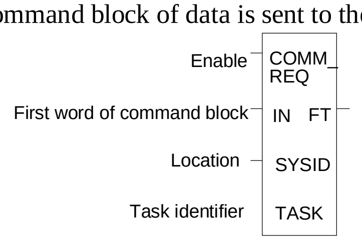
Details of RTU and SNP protocol are described in the *Serial Communications User's Manual* (GFK-0582).

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 Operatio n (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

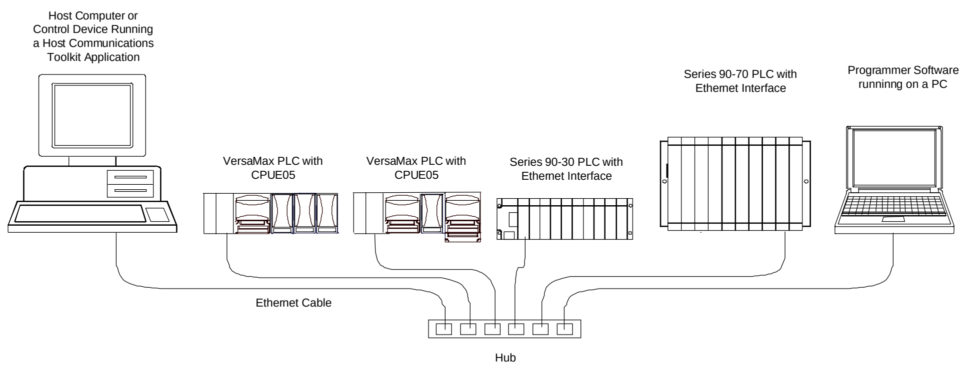
Ethernet Communications

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.

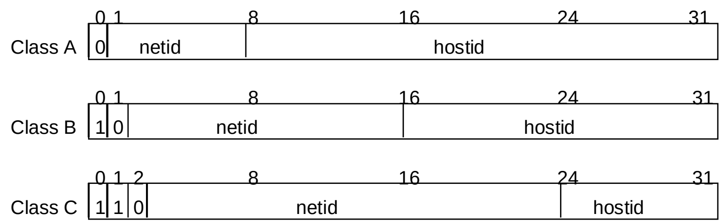
The Station Manager Software

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.

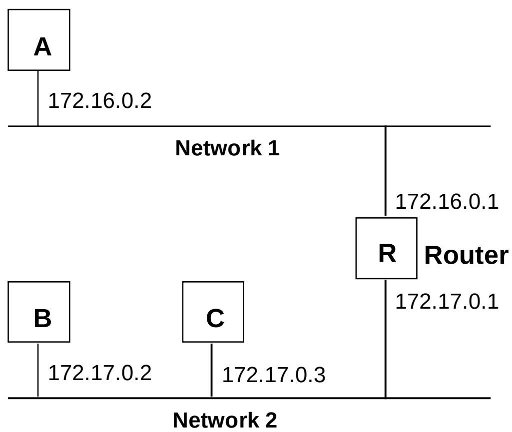
10.0.0.0 – 10.255.255.255 (Class A)
172.16.0.0 – 172.31.255.255 (Class B)
192.168.0.0 – 192.168.255.255 (Class C)
x.y.z.1 is reserved for gateways.
x.y.z.255 is reserved for subnet broadcast

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.



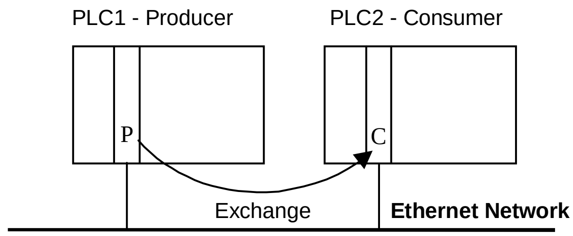
Host B can communicate with host C directly because they are on the same network. Their IP addresses have the same *netid*.

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.

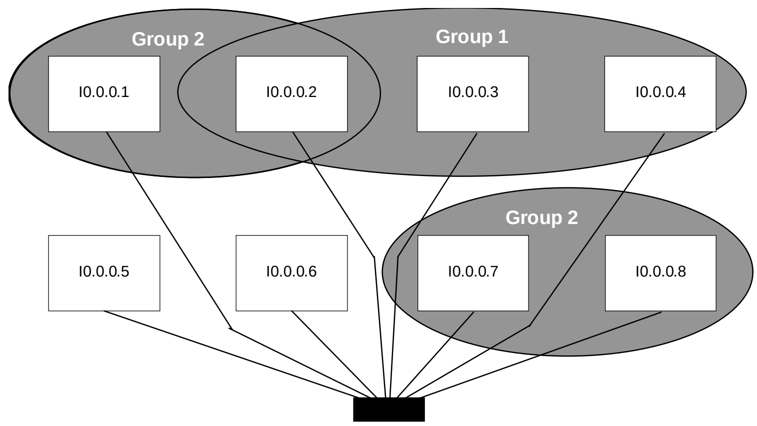
The Consumer Update Timeout Period

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:

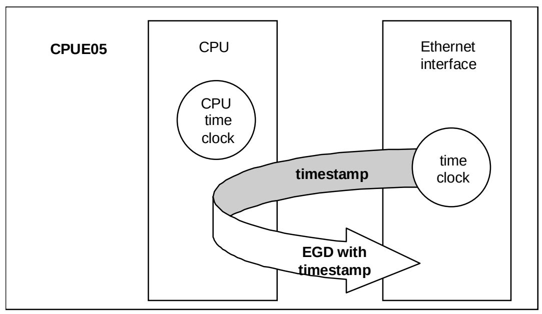
Group ID	IP Address
1	224.0.7.1
2	224.0.7.2
.	.
.	.
.	.
32	224.0.7.32

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.

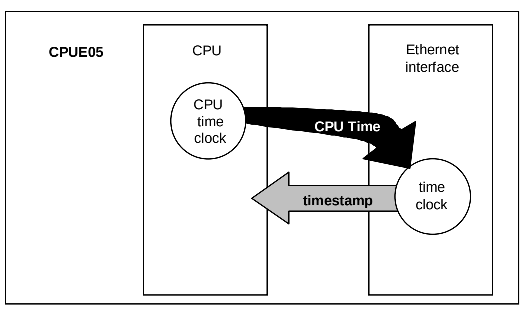
The PLC CPU obtains the timestamp data from the time clock in the Ethernet interface. The CPU only uses this timestamp for Ethernet Global Data exchanges. The timestamp from the Ethernet interface does not affect the time of the CPU's internal time clock.



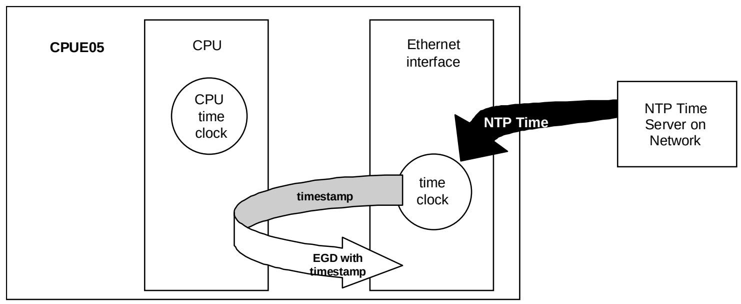
Synchronizing the Timestamp

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.

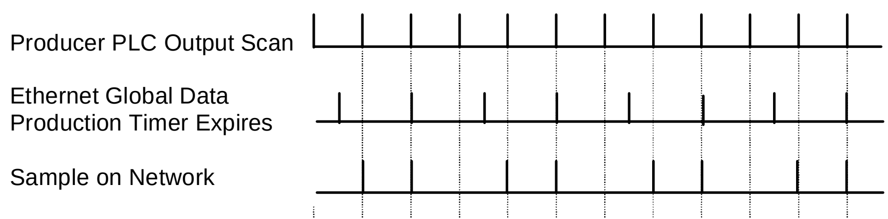
Timing Examples

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.

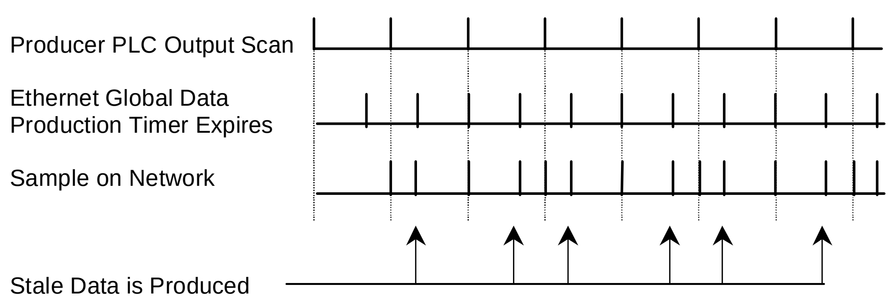
Producer Period = 1.5 Times CPU Sweep



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.

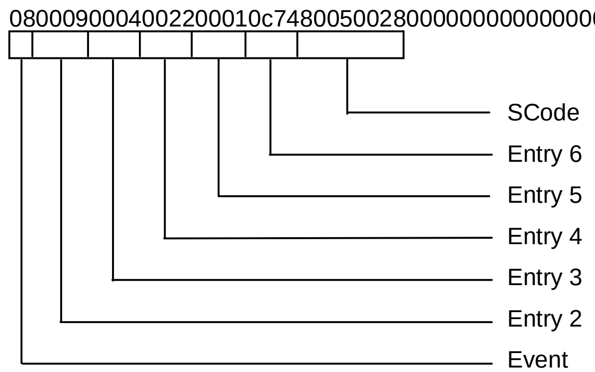
Ethernet LEDs	Indications	Actions
LAN: Off STAT: Slow blink green PORT 1: Off	Waiting for Ethernet configuration data from CPU. PORT 1: PLC CPU is controlling Port 1.	▪ Use the PLC programmer to update the configuration, then store the configuration to the PLC. ▪ Power cycle the PLC. ▪ Clear faults and 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.

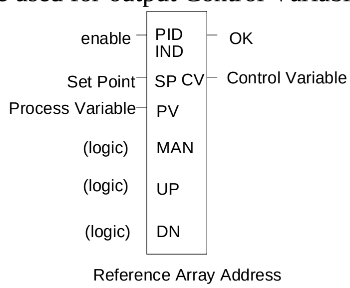
Chapter 14 The PID Function

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.

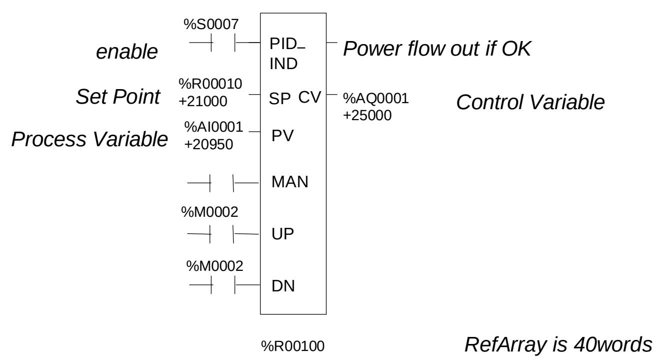
Scaling Input and Outputs

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

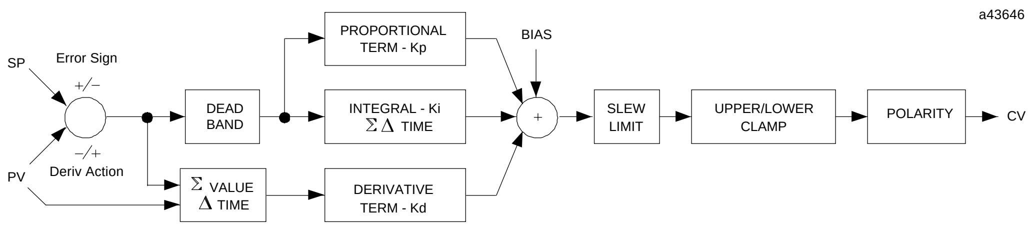
to convert them to use as PID User Parameter inputs.

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

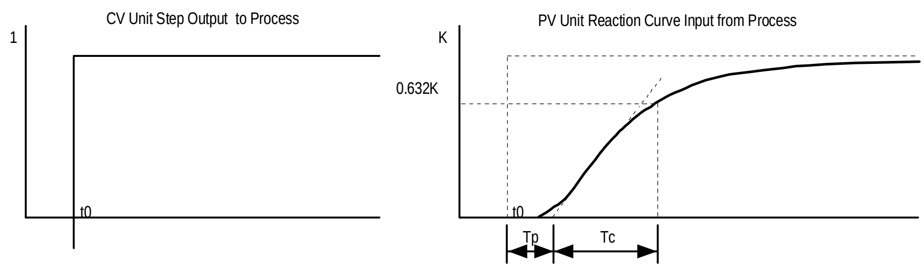
The PID loop gains, Kp, Ki and Kd, are determined by the characteristics of the process being controlled. Two key questions when setting up a PID loop are:

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

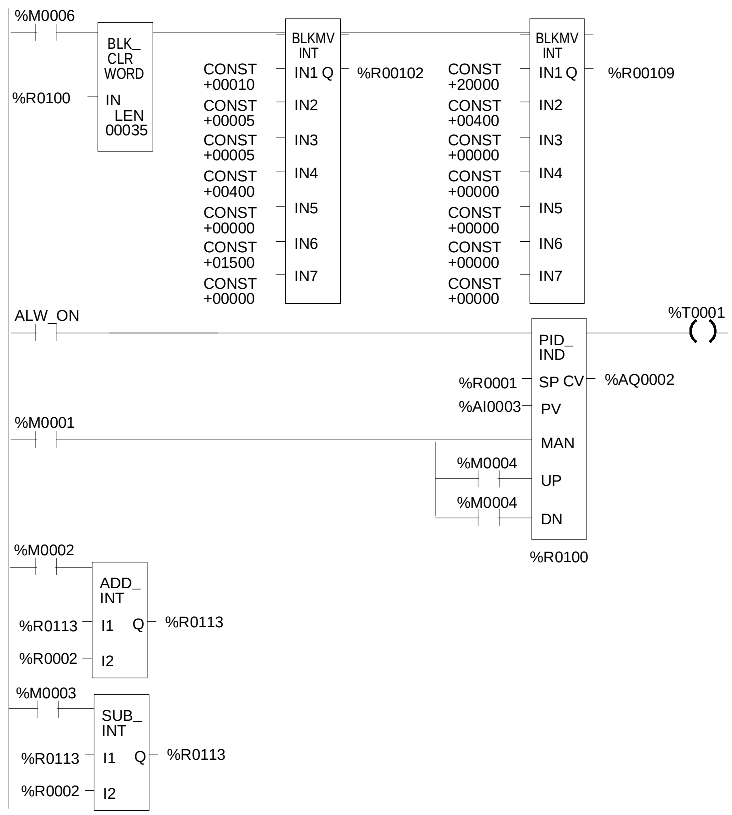
The "Ideal Tuning" procedure provides the best response to SP changes, delayed only by the Tp process delay or dead time.

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

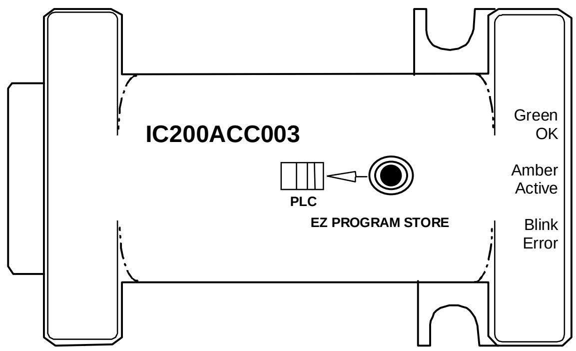
The following PID example has a sample period of 100Ms, a Kp gain of .4.00 and a Ki gain of 1.500. The set point is stored in %R0001, the control variable output in %AQ0002, and the process variable is returned in %AI0003. CV Upper and CV Lower Clamps must be set, in this case to 20000 and 4000, and 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.



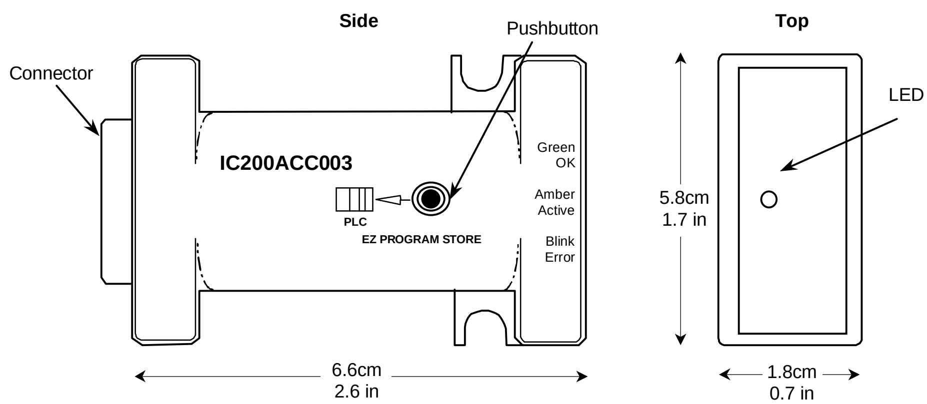
Contents of this chapter:

- 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).

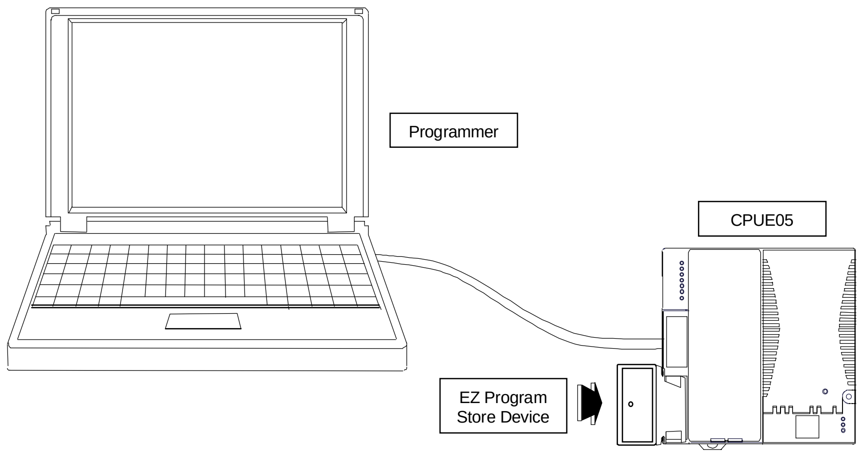
Writing Data to RAM or Flash

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

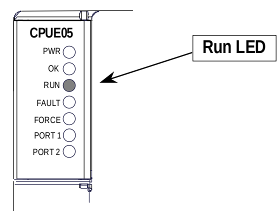


To read/write or verify some or all of the data, follow these steps:

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.

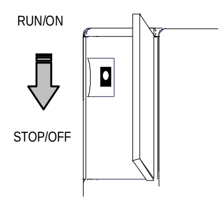
EZ Program Store Device: IC200ACC003

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.

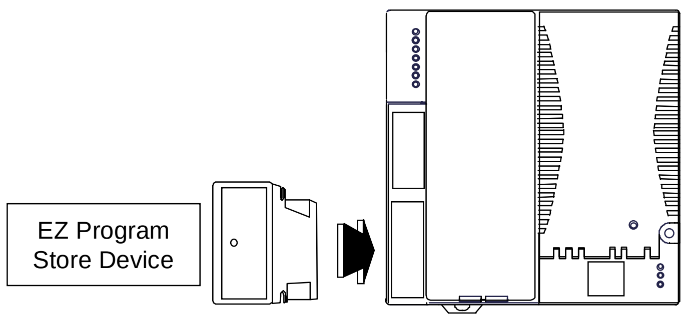
When performing an update with the programmer present, the pushbutton on the EZ Program Store device is not used.

Update a PLC CPU without a Programmer Present

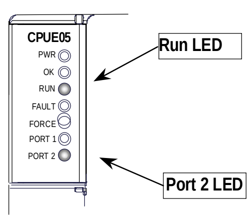
With a program, configuration, tables, Ethernet Global Data, and Advanced User Parameters (if any) already stored in an EZ Program Store device, it can be used to update one or more other PLC CPUs of the same type. All the data stored in the EZ Program Store device will be updated in the PLC CPU.

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.



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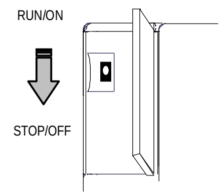
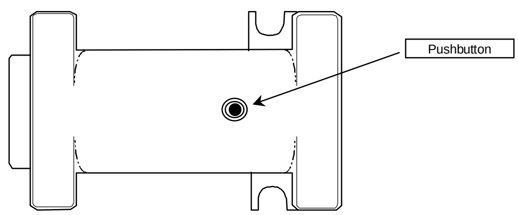
2. If the PLC's Run LED is blinking and the LED on the device is green, stop the PLC by moving the Run/Stop switch from Run/On to Stop/Off position.



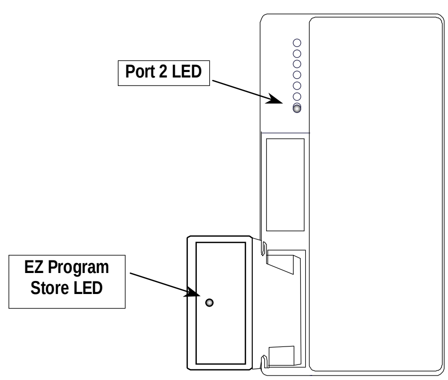
If the switch is already on the Stop/Off position, move it from Run then back to Stop to affirm the change.

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.

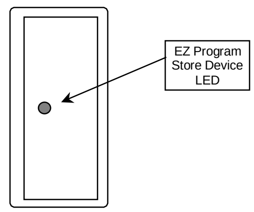


The LED on the EZ Program Store device turns amber and the Port 2 LED on the PLC blinks.



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	OnĐelay Timer	119	90	90	69	–	15
	Timer	110	80	81	60	–	15
	OffĐelay 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.

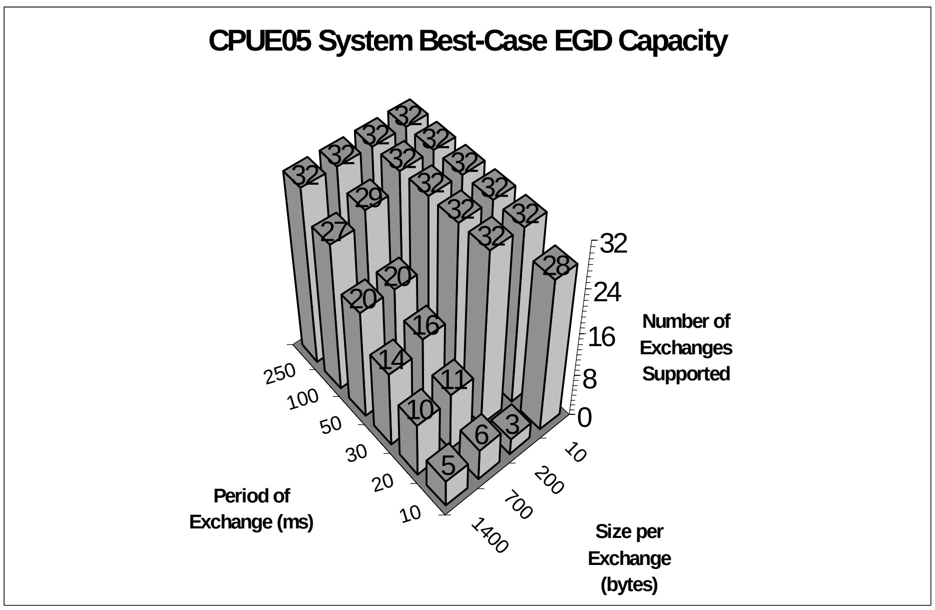
** Represents transfer time if memory type supports overrides.

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 $2 \times \mathit{refresh\ period} + 10ms$



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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

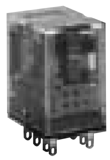
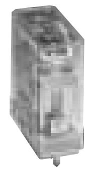
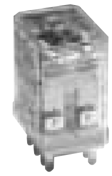
Selection Guides

General Purpose Relays

- $\boxed{\text{RH Series}}$
- ~~RM Series~~
- ~~RY Series~~

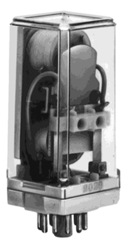
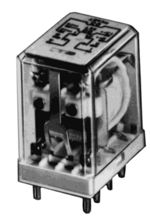
Selection Guides

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)

E

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

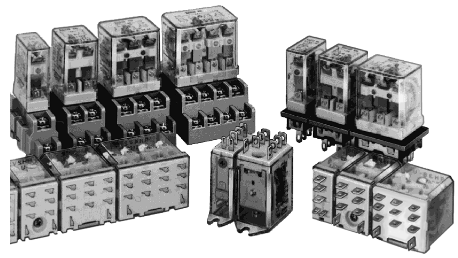
Solid State Relays

	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

<table>
<tr><th rowspan="2">Voltage</th><th rowspan="2">Rating</th><th colspan="4">Resistive</th><th colspan="4">Inductive</th><th colspan="3">Motor Load</th></tr>
<tr><th>SPDT</th><th>DPDT</th><th>3PDT</th><th>4PDT</th><th>SPDT</th><th>DPDT</th><th>3PDT</th><th>4PDT</th><th>SPDT</th><th>DPDT</th><th>3PDT</th></tr>
<tr><td>28V DC</td><td>UL</td><td>10A</td><td>10A</td><td>10A</td><td>10A</td><td>7.5A</td><td>—</td><td>—</td><td>7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="3">30V DC</td><td>UL</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td>—</td><td rowspan="3">7A</td><td>7A</td><td rowspan="2">—</td><td rowspan="2">—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>CSA</td><td rowspan="2">10A</td><td rowspan="2">7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Nominal</td><td>7.5A</td><td>7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>110V DC</td><td>Nominal</td><td>0.5A</td><td>0.5A</td><td>0.5A</td><td>0.5A</td><td>0.3A</td><td>0.3A</td><td>0.3A</td><td>0.3A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="3">120V AC</td><td>UL</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="2">7.5A</td><td>—</td><td rowspan="2">—</td><td rowspan="3">7.5A</td><td>1/6</td><td>1/6</td><td>1/6</td></tr>
<tr><td>CSA</td><td rowspan="2">7.5A</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Nominal</td><td>7A</td><td>7.5A</td></tr>
<tr><td rowspan="3">240V AC</td><td>UL</td><td rowspan="2">10A</td><td rowspan="2">10A</td><td rowspan="2">—</td><td rowspan="2">7.5A</td><td rowspan="2">7A</td><td rowspan="2">7A</td><td>*</td><td rowspan="3">5A</td><td>1/3</td><td>1/3</td><td>1/3</td></tr>
<tr><td>CSA</td><td>7A</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Nominal</td><td>7A</td><td>7.5A</td><td>7.5A</td><td>4.5A</td><td>5A</td><td>5A</td><td>5A</td></tr>
</table>

1. * 6.5A/pole, 20A total.
2. Inductive load cos ø = 0.3, L/R = 7ms.

E

Applicable Sockets

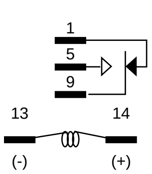
Part Numbers: Sockets

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

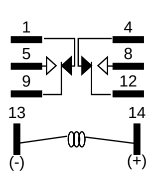
Spring & Clips (optional)	
Part Number	**Use With**
SY2S-02F1 SFA-101 SFA-202	SH1B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH1B-51, 62
SY4S-02F1 SFA-101 SFA-202	SH2B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH2B-51, 62
SH3B-05F1 SFA-101, -202	SH3B-05, 05C
SY4S-51F1 SFA-301 SFA-302	SH3B-51, 62
SH4B-02F1 SFA-101, -202	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.

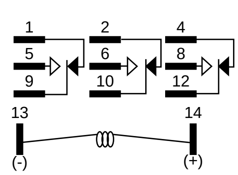
Internal Circuits



RH1



RH2



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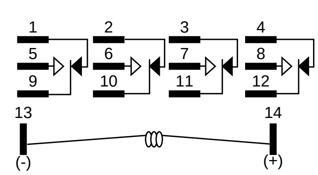
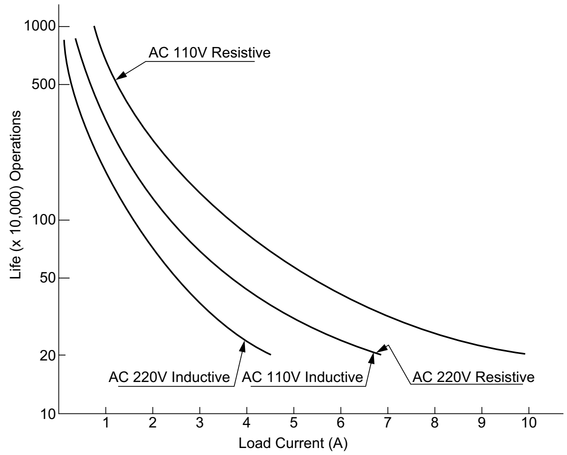


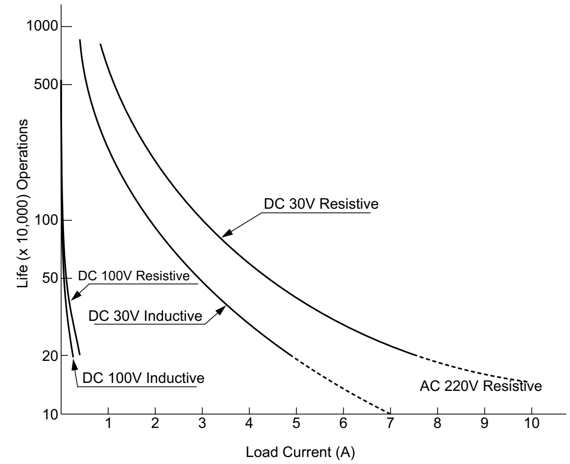
RH4

Electrical Life Curves

E

RH1





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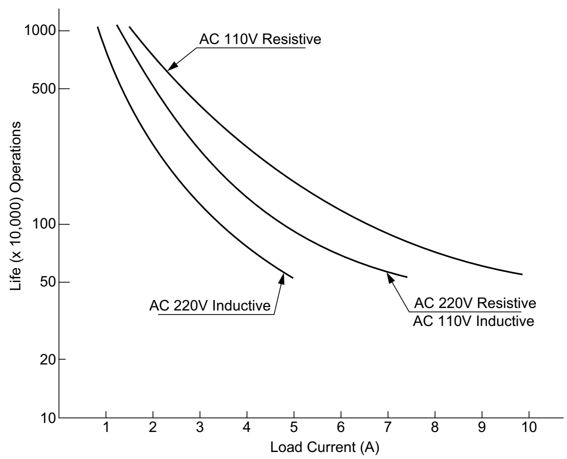
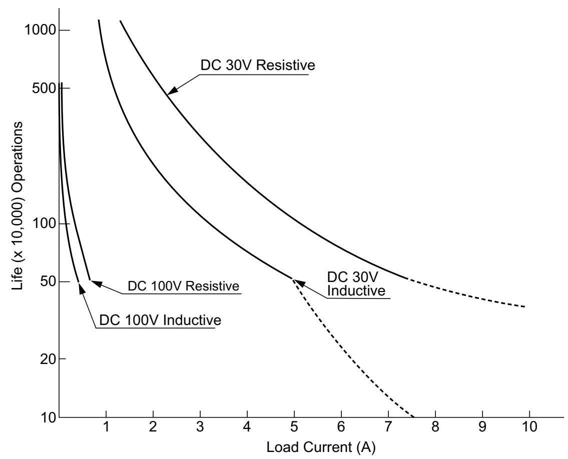
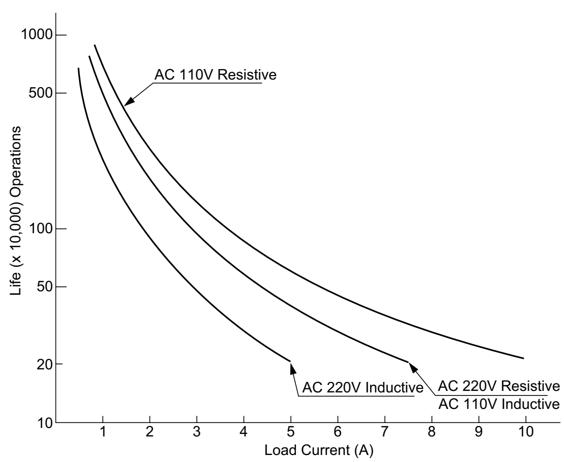
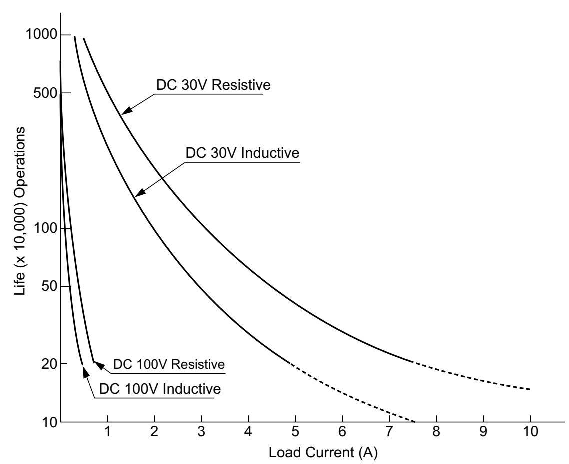




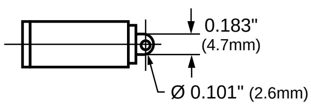
RH3 and 4

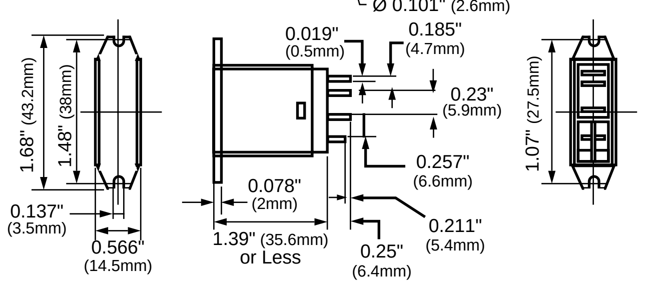




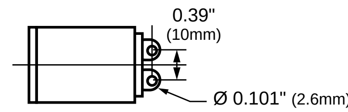
Dimensions

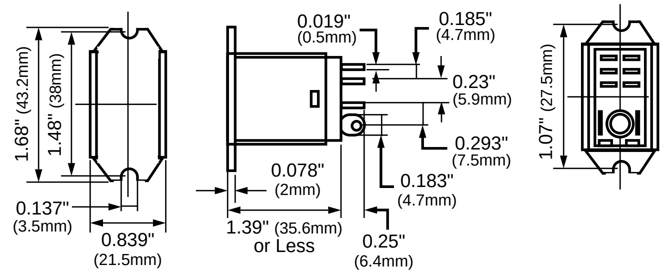
Top Bracket Mounting
Blade Terminal
RH1B-UT





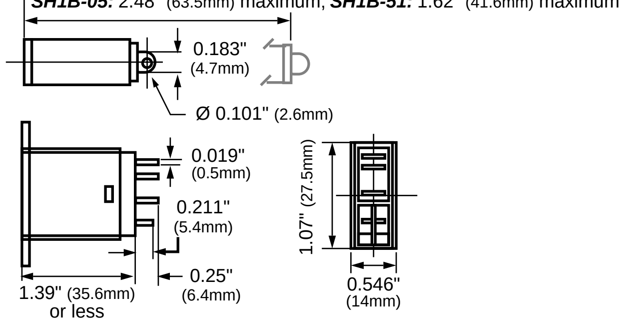
RH2B-UT





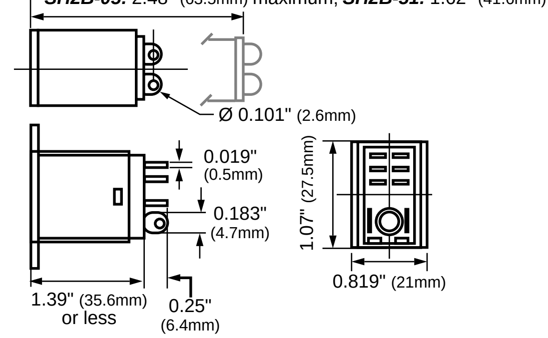
Plug-in
Blade Terminal
RH1B

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



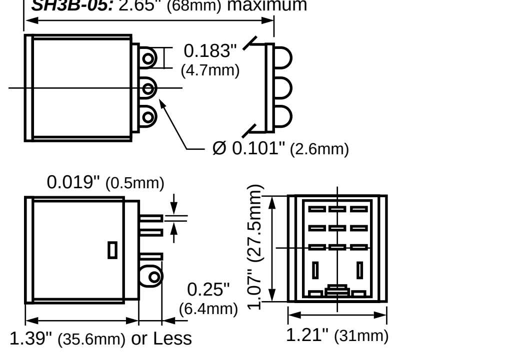
RH2B

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)



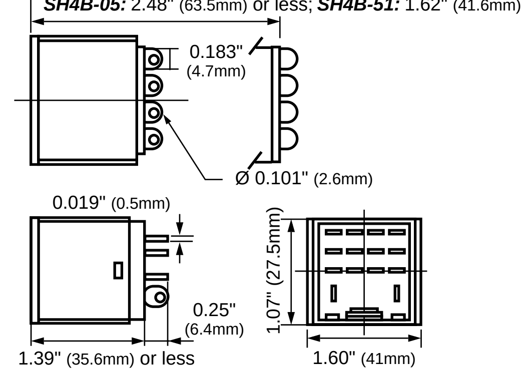
Plug-in
Blade Terminal
RH3B

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

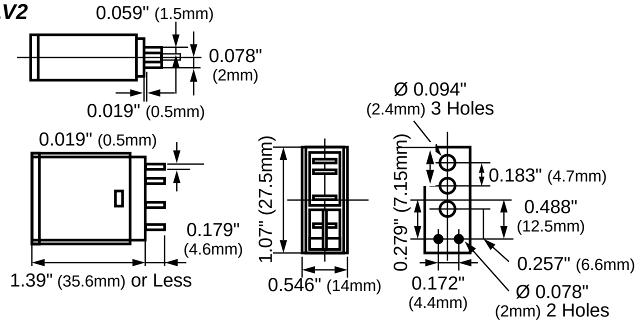
Total length from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41.6mm)



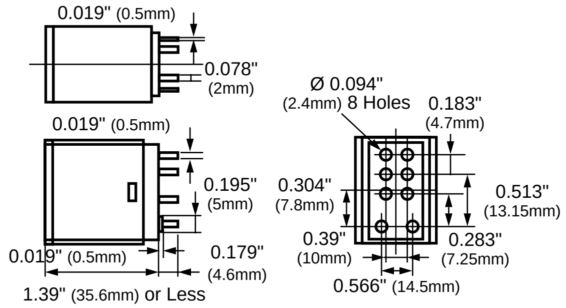
E

Dimensions

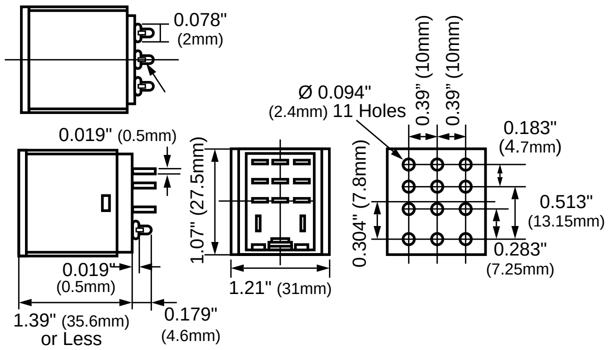
PCB Terminal
RH1V2



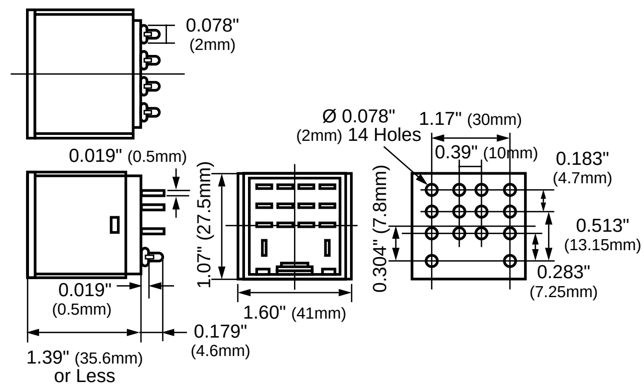
RH2V2



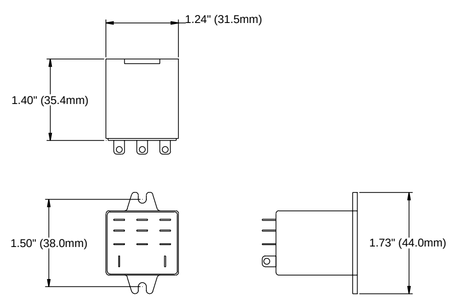
RH3V2



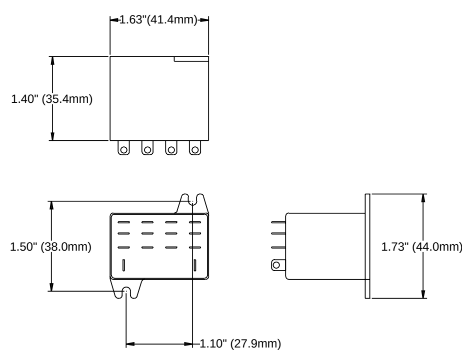
RH4V2



RH3B-UT



RH4B-UT



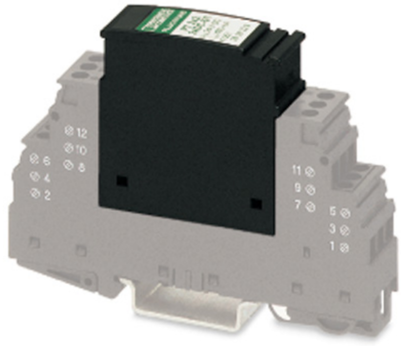
E

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

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.

Commercial data

EAN	4017918182649
Pack	10 pcs.
Customs tariff	85363010
Weight/Piece	0.02511 KG
Catalog page information	Page 86 (TT-2009)

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

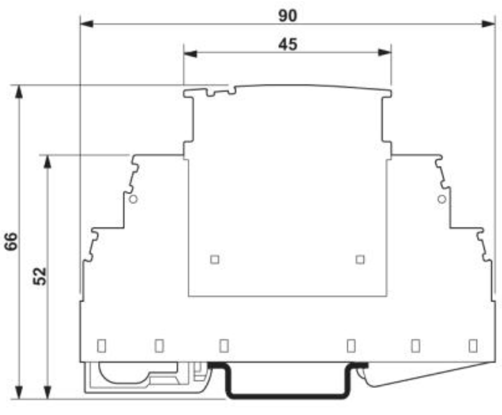
0808668	ZBF 5/WH-100:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, large batch, sufficient for labeling 1000 terminal blocks, color: white
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, 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

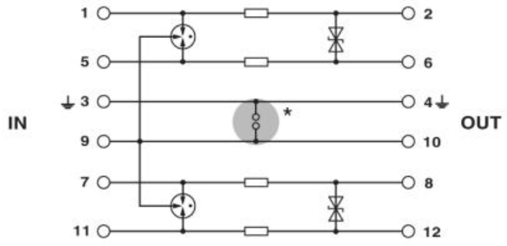
Drawings

Dimensioned drawing



The figure shows the complete module consisting of a base element and connector

Circuit diagram



Approbationslogos (EX-Bereich)

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

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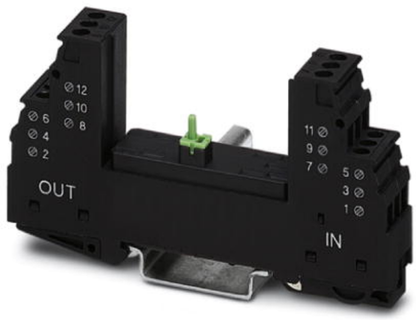
Extract from the online catalog

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

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

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 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

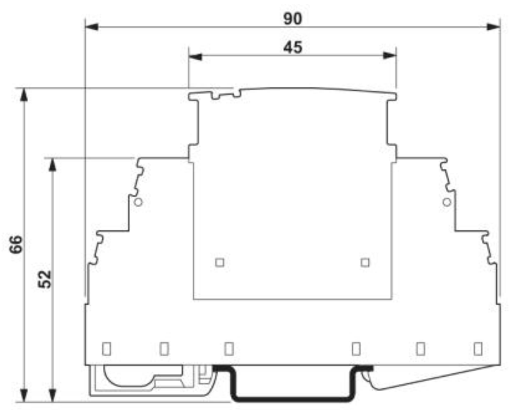
Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

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

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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.

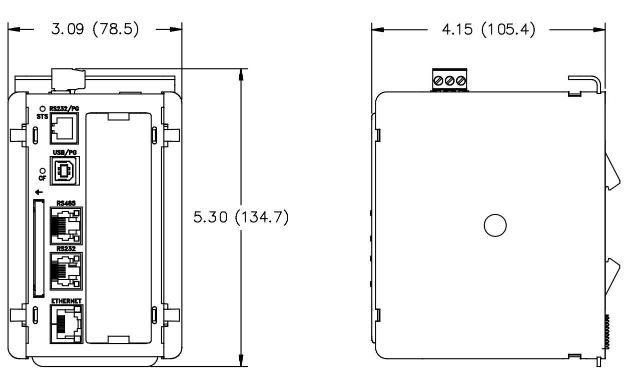
The CompactFlash card allows data to be collected and stored for later review. The files are stored in simple CSV file format allowing common applications, such as Microsoft Excel and Access, to view and manage the data. The free Websync utility provides a means to synchronize the files with a PC's hard 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.

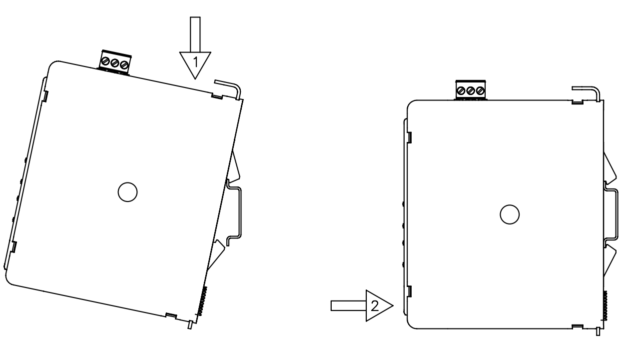
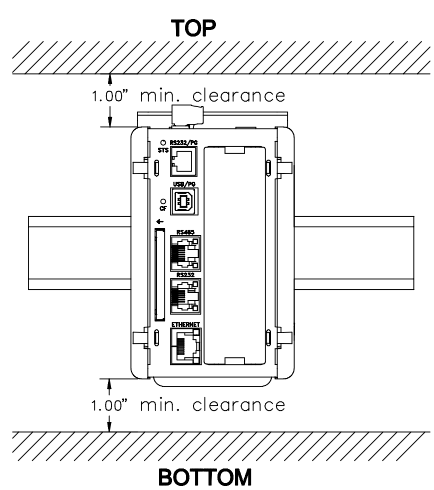


Figure 1 - Attach Data Station To DIN Rail



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.

Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
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

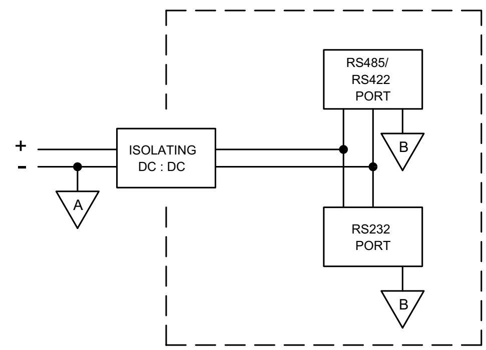
[1] Contact your Red Lion distributor or visit www.redlion.net for complete selection.
[2] Red Lion offers RJ modular jack adapters. Refer to DR literature for complete details.
[3] Use these part numbers to purchase Crimson 2.0 on CD with a printed manual, USB cable and RS-232 cable. Otherwise, download 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.

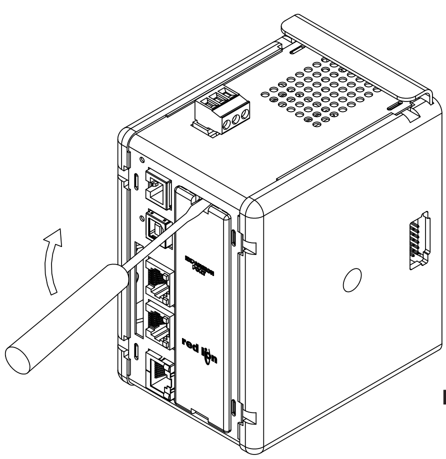


Figure 1

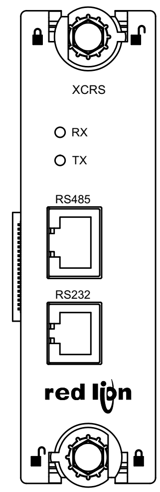


Figure 2

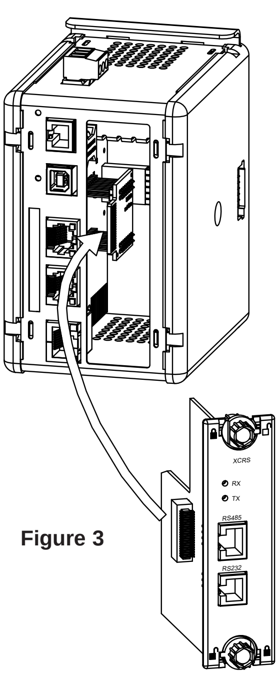


Figure 3

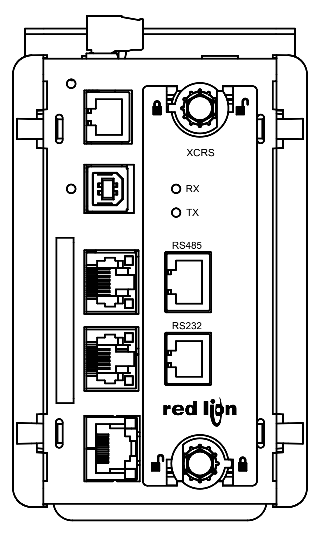


Figure 4

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.

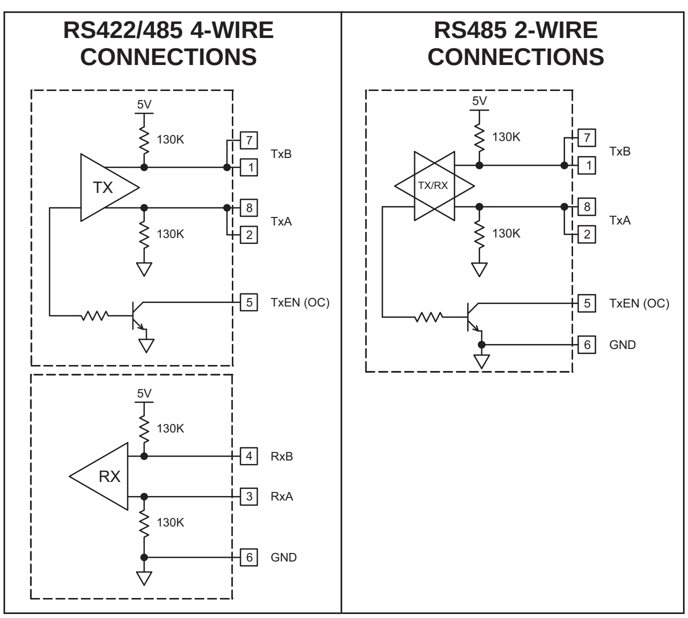
RS232 PORTS

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.



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

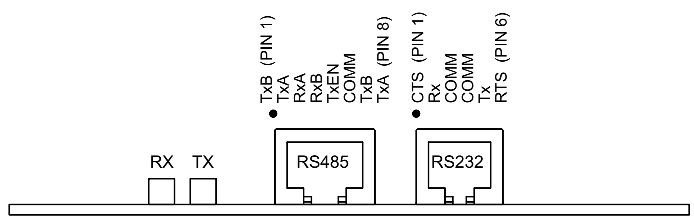
The XCRS option card’s RS422/485 port can also be used for Allen Bradley DH485 communications. When this port is configured to communicate DH485, the RS232 port can not be used because the ports share the same hardware and the XCRS option card multiplexes the ports to communicate via two protocols.

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

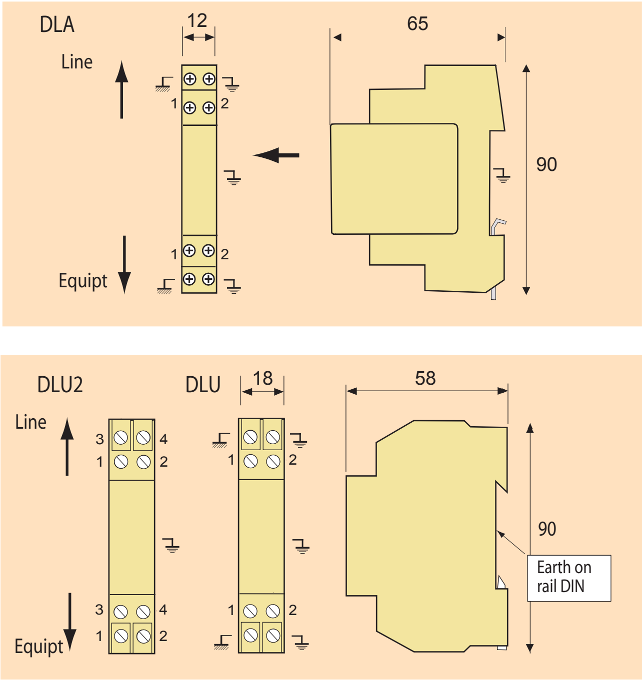
DLA and DLU surge protectors are designed to protect, against surge voltages due to lightning, terminals equipment connected to industrial buses, telecom lines or datalines.
These surge protectors must be installed on symmetrical DIN rail and are available for most of the transmission lines : line voltage 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.

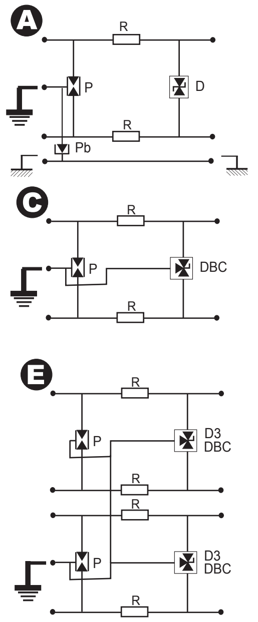
DLU
1-pair (DLU) or 2-pair (DLU2) DIN rail surge protector. Monobloc enclosure. Transmission and protection of the shield wire (DLU). Earth through DIN rail.

- 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

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CITEL Inc., 1515 NW 167th St., Suite 6-303 Miami, FL 33169
Tel. 305-621-0022- Fax 305-621-0766 - Email : citel@citelprotection.com

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).								

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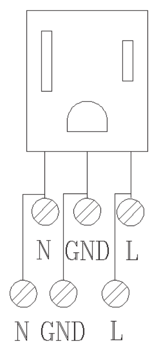
CITEL Inc., 1515 NW 167th Street, Suite 6-303 Miami, FL 33169
Tel. 305-621-0022 - Fax 305-621-0766 - Email : citel@citeprotection.com

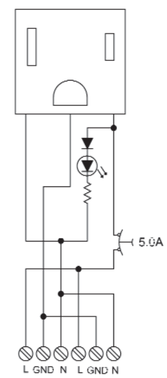
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- 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

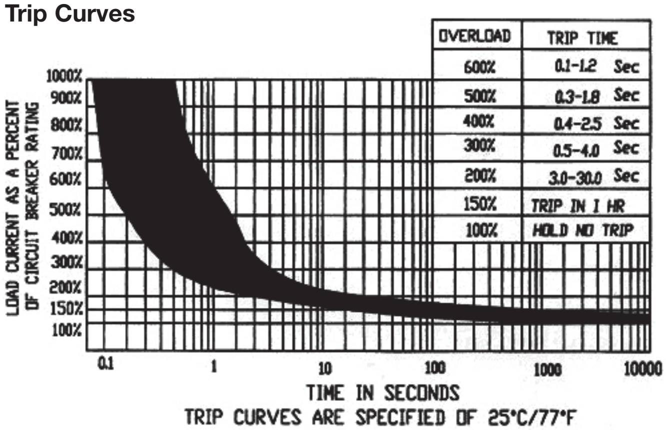
Input voltage		
Rated current	120Vac	120Vac
	5A max via outlet	5A max via outlet
	10A via redundant terminals	10A via redundant terminals
Wire range	26 - 12 AWG (0.14 0 4.0mm²)	26 - 12 AWG (0.14 0 4.0mm²)

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



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

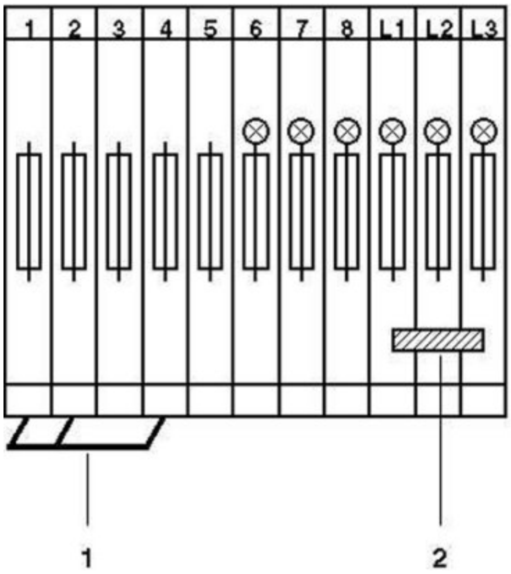
1050525	ZB10:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

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
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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
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

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

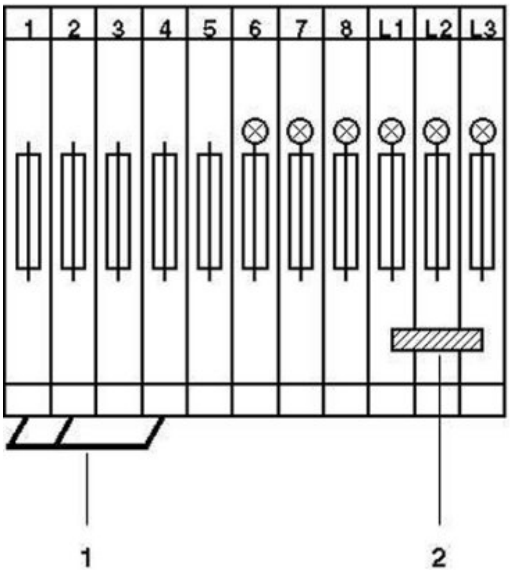
1050525	ZB10:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

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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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

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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

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 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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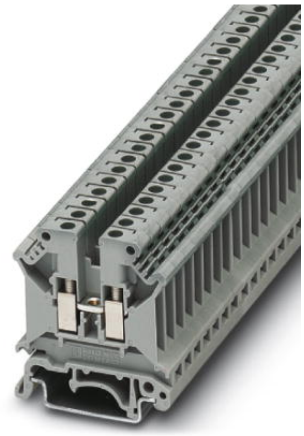
UK 5 N

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)

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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

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

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 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

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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
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.009305 KG

http://www.download.phoenixcontact.com
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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

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 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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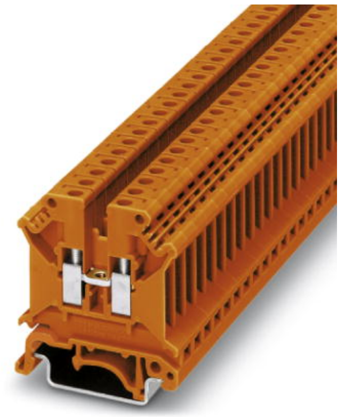
UK 5 N OG

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

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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

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 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)

Address

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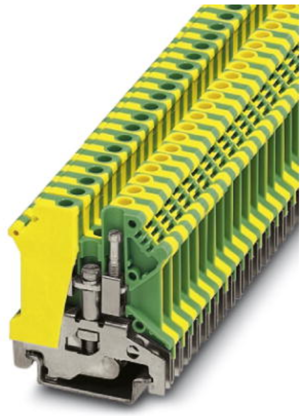
USLKG 5

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

Commercial data	
EAN	4017918002190
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.02081 KG
Catalog page information	Page 347 (CL-2009)

Product notes

WEEE/RoHS-compliant since: 01/15/2005

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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

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
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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

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Phone (800) 888-7388
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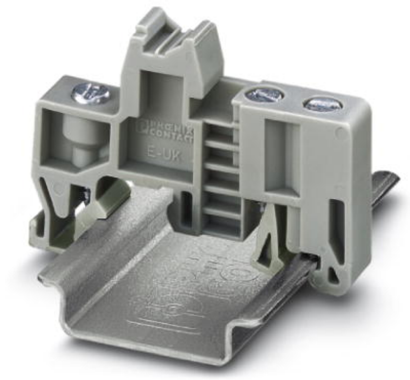
E/UK

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
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

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Technical data

General

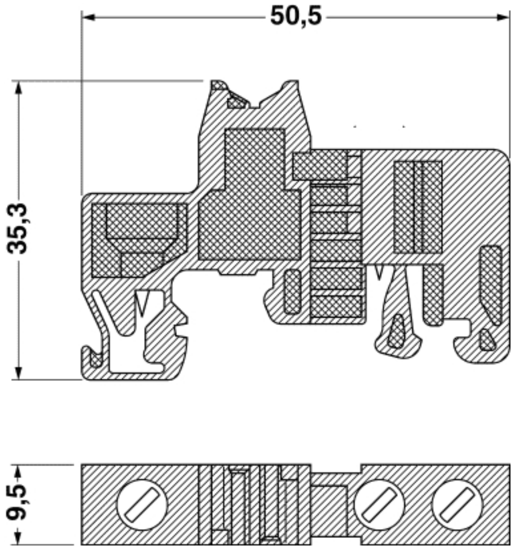
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

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

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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
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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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.

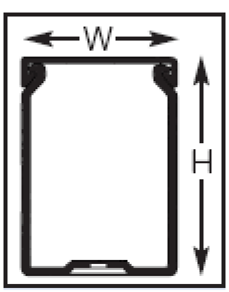
MATERIAL:
Rigid PVC,
self-extinguishing

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

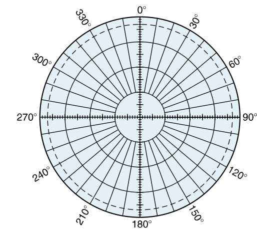
K7515641

Omnidirectional Antenna

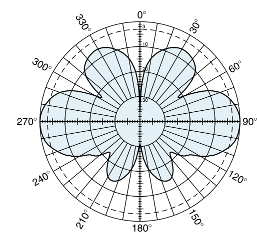
KATHREIN SCALA DIVISION

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.

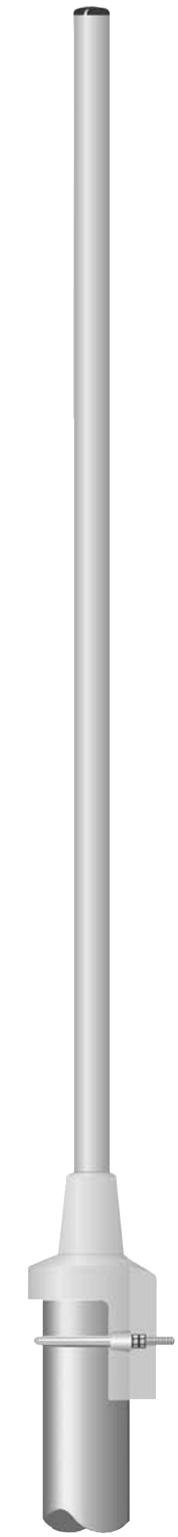
- Wireless
- Paging
- SMR
- Land Mobile
- ISM



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.

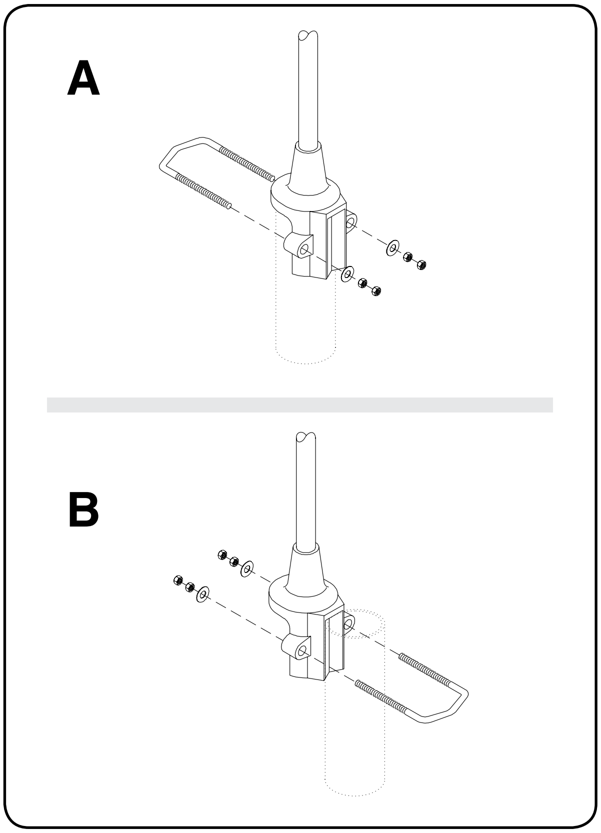
RoHS Lead-Free

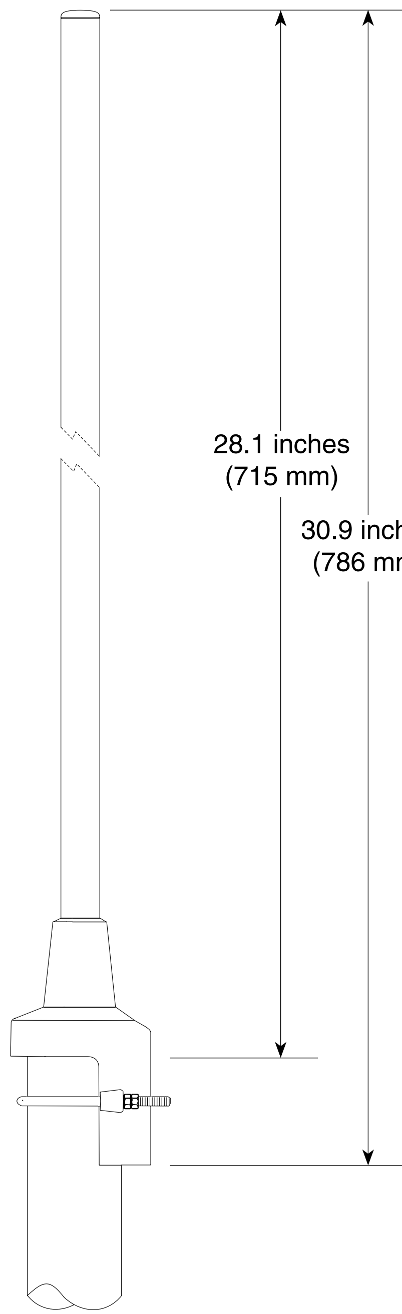
10046-J
936.376/i

Kathrein Inc., Scala Division Post Office Box 4580 Medford, OR 97501 (USA) Phone: (541) 779-6500 Fax: (541) 779-3991
Email: communications@kathrein.com Internet: www.kathrein-scala.com

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.

Kathrein Inc., Scala Division Post Office Box 4580 Medford, OR 97501 (USA) Phone: (541) 779-6500 Fax: (541) 779-3991
Email: communications@kathrein.com Internet: www.kathrein-scala.com

RTU 903-2
CS-MW16-LGR/CS-MW16-CC CONTROL PANEL EQUIPMENT

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$_2$OMIT™ Vent Drains, Type 4X
H$_2$OMIT™ 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

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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.

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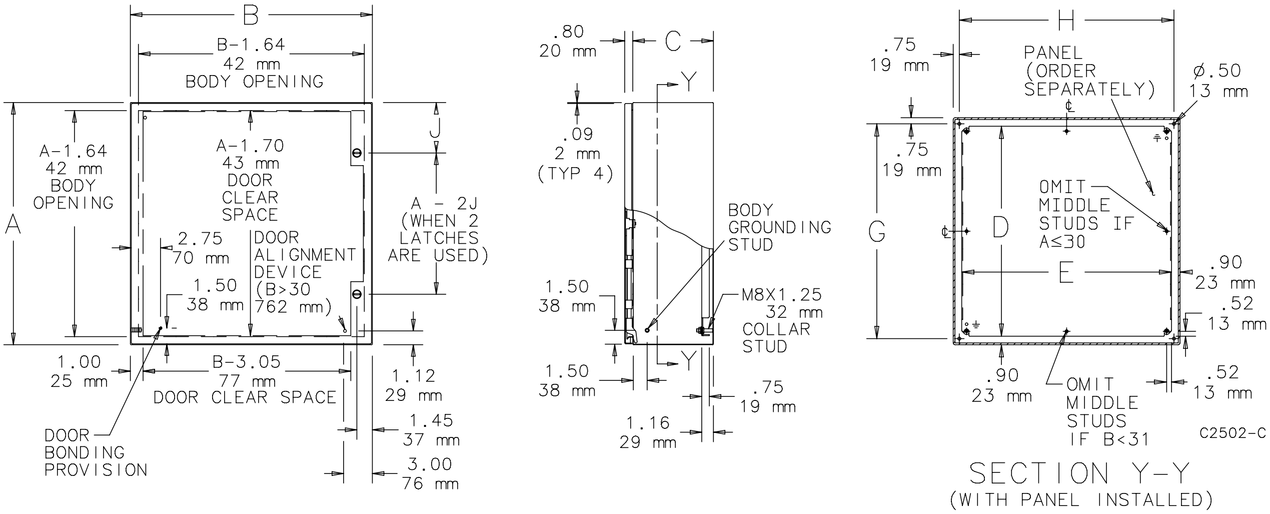
CONCEPT® Wall-Mount Enclosures



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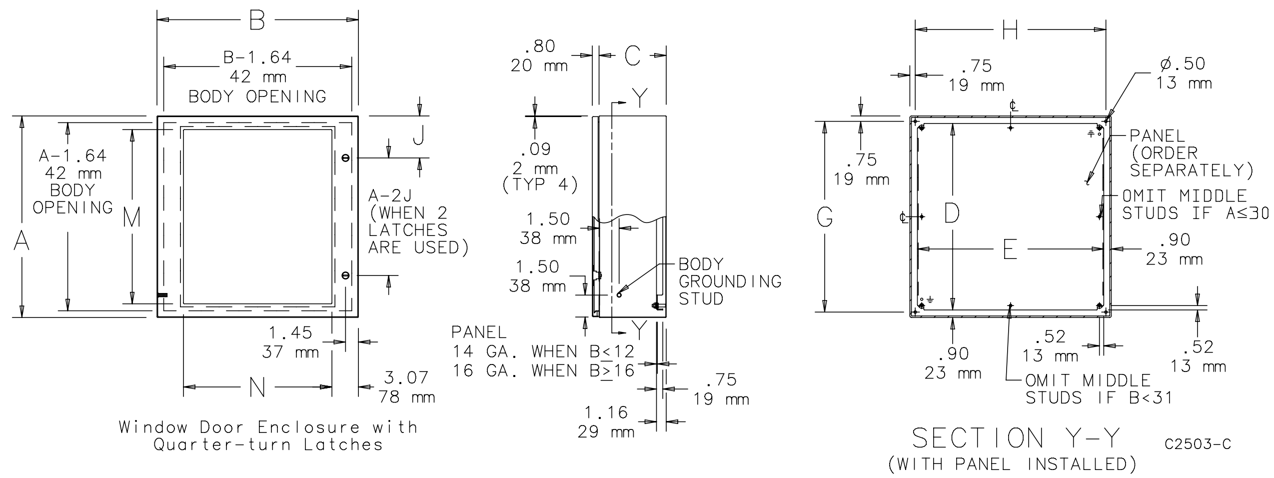
CONCEPT® Wall-Mount Enclosures

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



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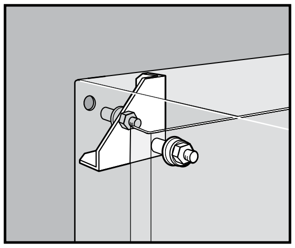
CONCEPT® Accessories

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)

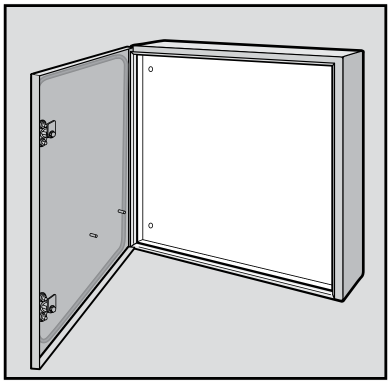
Swing-Out Rack Frame

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

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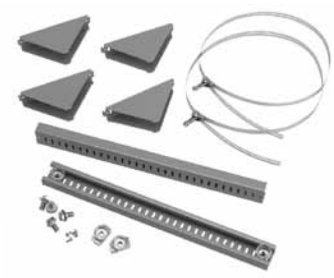
CONCEPT® Accessories

Pole-Mount Kit

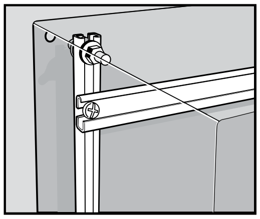


Use to mount CONCEPT®, Networking and wall-mount enclosures to poles of various sizes and shapes. Simply attach the plated steel channel bar to the mounting holes at the back of the enclosure and wrap the stainless steel strap around the pole and through the bar. Kit includes two mounting channels, two 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

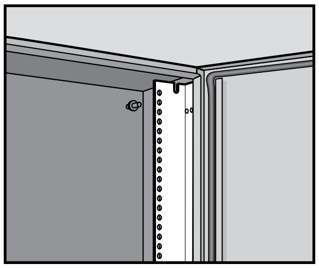


Mounting Channels provide mounting framework for installing DIN rails and grid straps at various positions within the enclosure. Channels can be mounted vertically or horizontally to collar studs or to the slide mechanisms of the adjustable-depth mounting kit. Kit includes two channels.

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)

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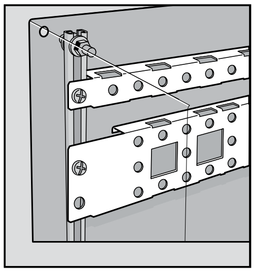
CONCEPT® Accessories

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.)

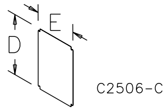
Bulletin: CWY

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.

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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.

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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	when A is less than or equal to 24
	152 x 152	and B is less than or equal to 24
ADP2	12.00 x 12.00	when A is greater than or equal to 30
	305 x 305	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

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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

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30.5 mm Push Buttons

Push Button Operators, Continued

Momentary Contact Push Button Units, Illuminated

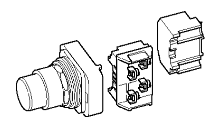
Extended Head Without Guard
Cat. No. 800T-PB16R

Extended Head without Guard
Cat. No. 800H-PRB16R

Type	Lamp Type	Volts	Color	Type 4/13: Extended Head Without Guard✶ Cat. No.	Type 4/13: Extended Head With Guard✶ Cat. No.	Type 4/4X/13: Extended Head without Guard✶ Cat. No.	Type 4/4X/13: Extended Head with Guard✶ 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.

Allen-Bradley

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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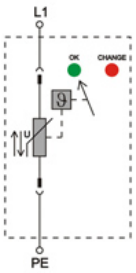


General ordering data	
Order No.	8859950000
Part designation	PU II 1 130V/40kA
Version	Surge protection for low-voltage supply, 120 V, without telecomm. contact
EAN	4032248583843
Qty.	1 pc(s).

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

1/4″ x 1 1/4″ Time-Delay, Glass Tube Fuses

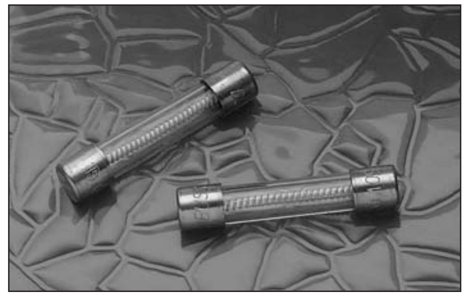
MDL Series

Description

RoHS 2002/95/EC

- Time-delay
- Optional axial leads available
- 1/4 x 1 1/4 (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

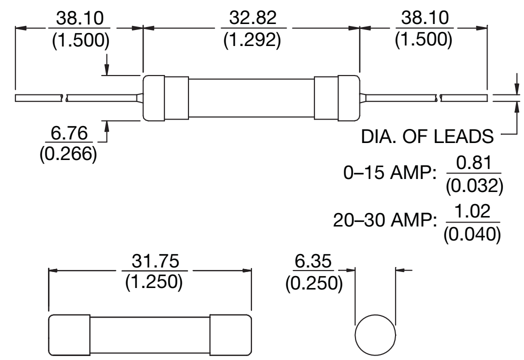
- Insert packaging code prefix before part number. E.g., BK (or BK1)-MDL-5-R

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)

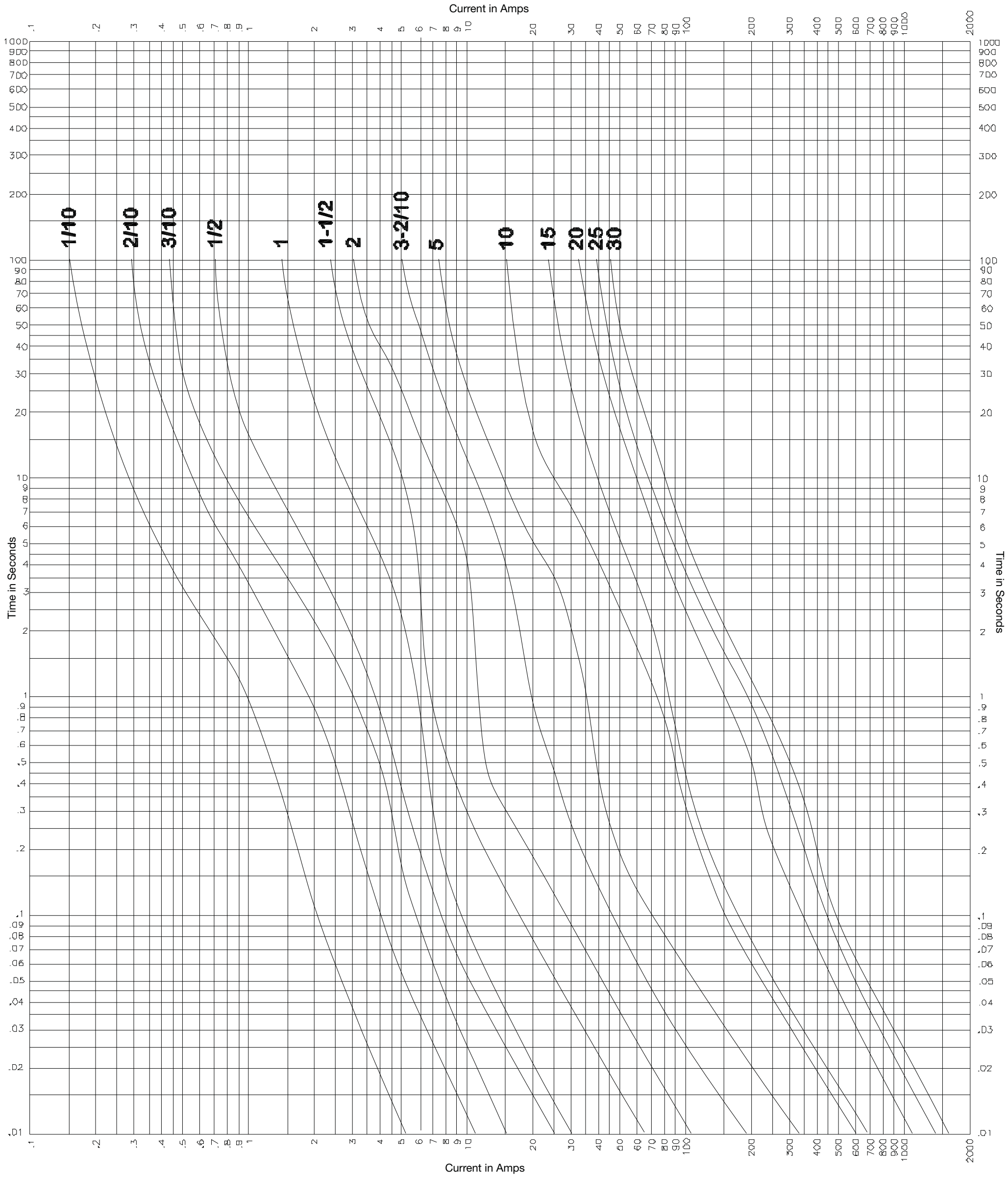
Drawing Not to Scale



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

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.

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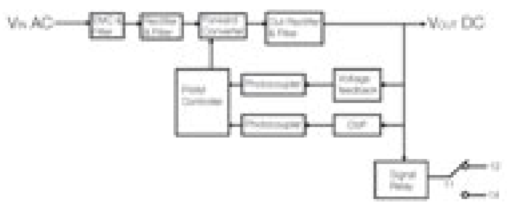

General ordering data	
Order No.	8708670000
Part designation	CP SNT 120W 24V 5A
Version	Switched-mode power supplies
EAN	4032248380831
Qty.	1 pc(s).
Dimensions	
Clamping range, nom.	2.5 mm²
Clamping range, min.	0.13 mm²
Clamping range, max.	4 mm²
temperature	
Ambient temperature (operational)	
Storage 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

Weidmüller

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

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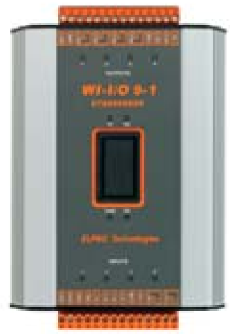
	WI-I/O 9-1	WI-I/O 9-2
		
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA	four inputs	four inputs
Analog: “floating” differential inputs, common mode voltage 27V, 24VDC for powering external loops provided, 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**

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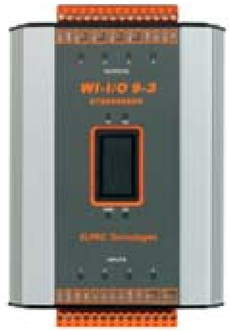
	WI-I/O 9-3	WI-I/O 9-4
		

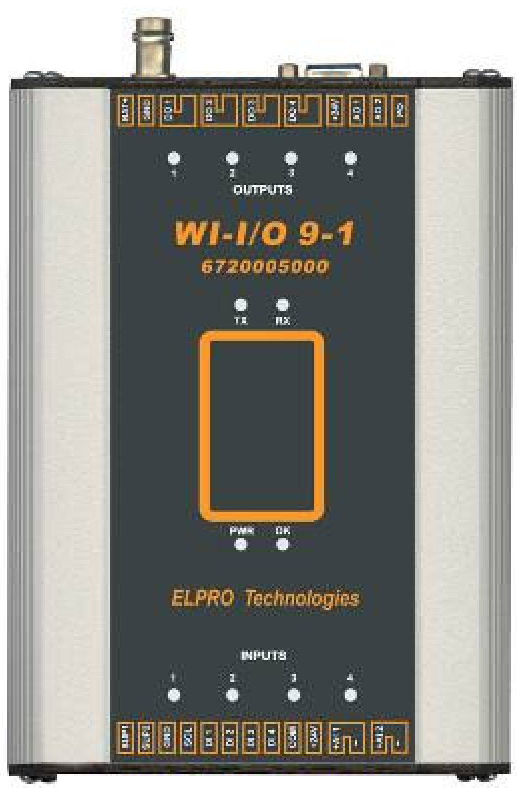
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA		up to 16 inputs (4 inputs + 12 selectable I/O) the 12 selectable inputs are surge protected but not isolated
Analog: "floating" differential inputs, common 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

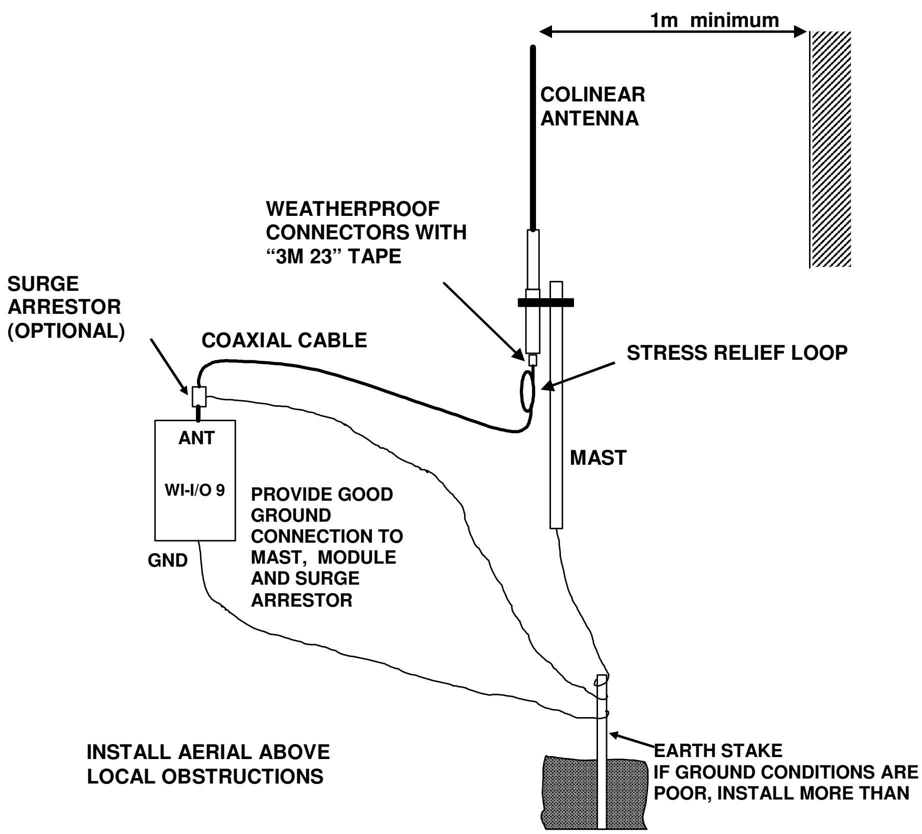
Standard Antennas	**Gain (dB)**	**Part Numbers**
Dipole with integral 15’ cable	0	6720005080
5dBi Collinear (3dBd)	5	6720005081
8dBi Collinear (6dBd)	8	6720005082
6 element Yagi	10	6720005084
16 element Yagi	15	6720005085

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.

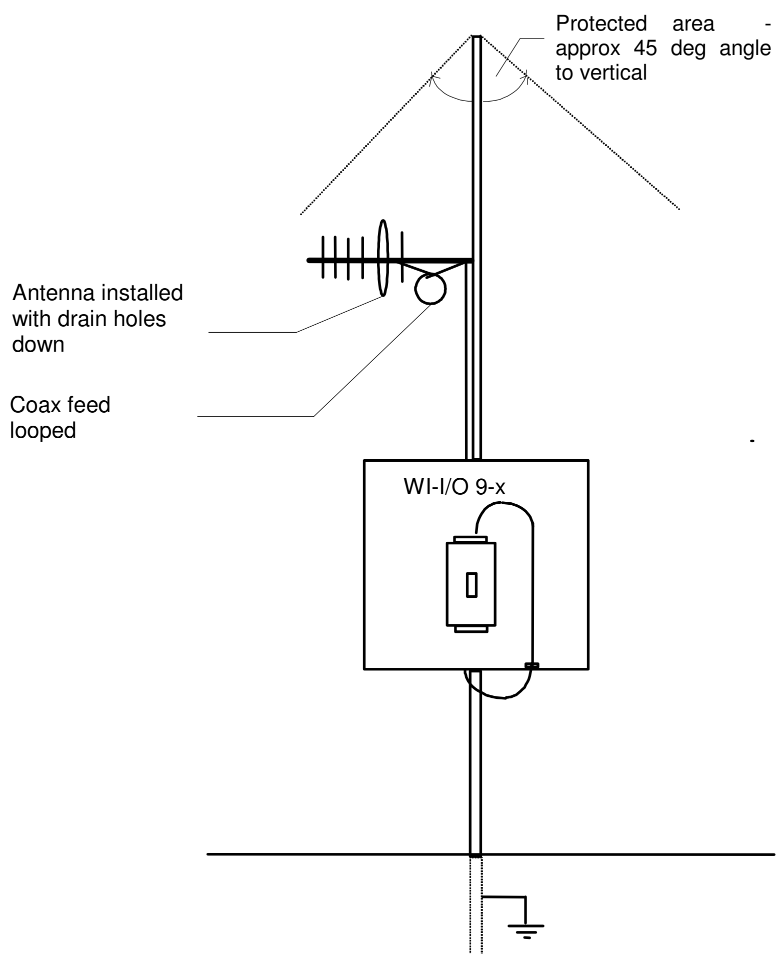
2.2.2 Yagi antennas.

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.



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

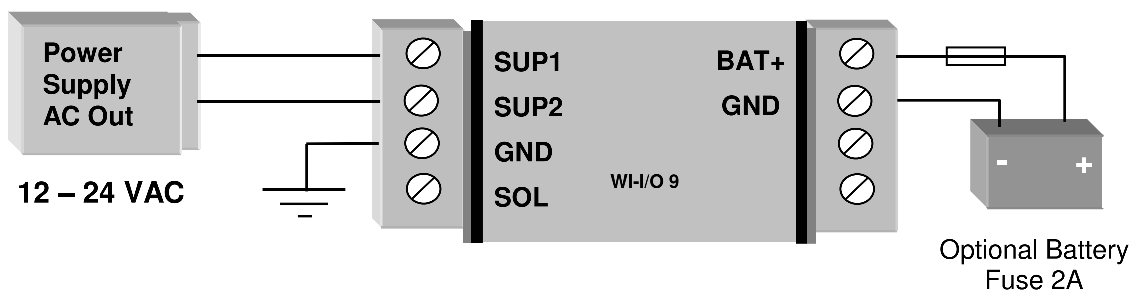
11.5 -15 volts DC at the “battery” terminals.

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

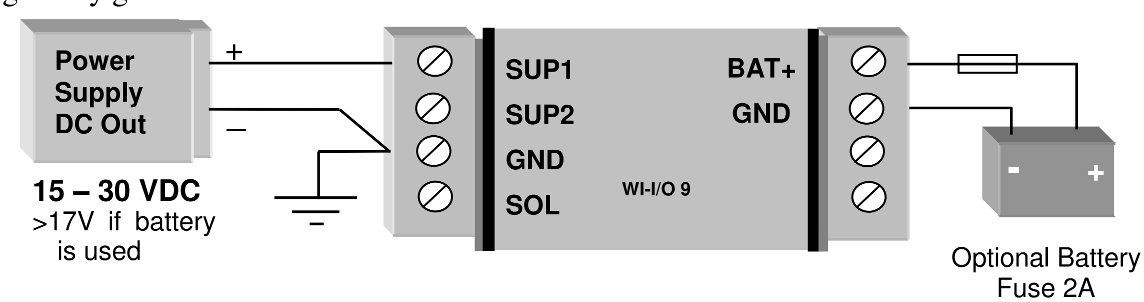
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below.



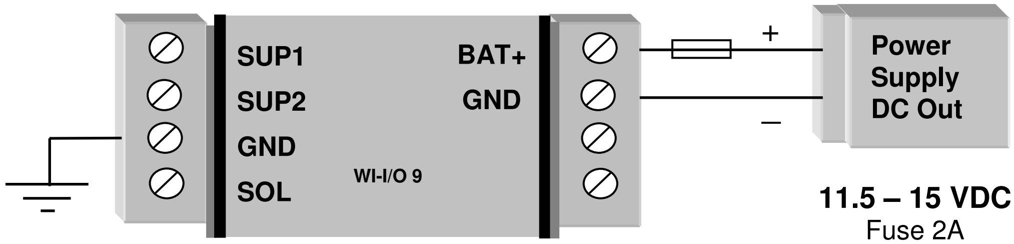
The AC supply should be "floating" relative to earth. AC transformers with grounded/earthed secondary windings should **not** be used.

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

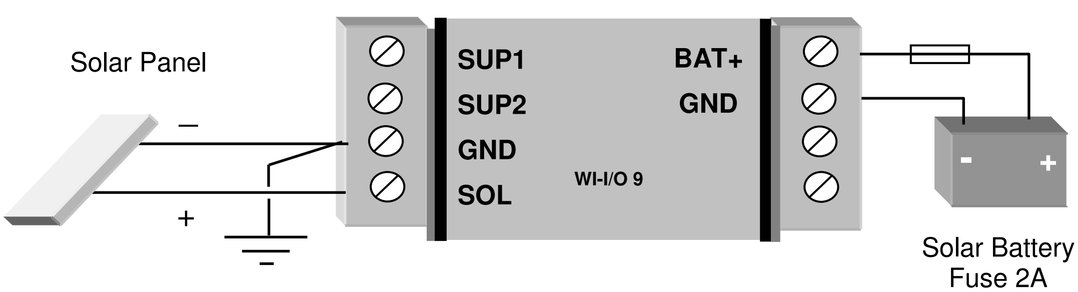
The power supply also includes a 12 V solar regulator for connecting 12V solar panels of up to 30W, and solar batteries of up to 100AHr. **The unit must not be powered from a solar panel without a battery.** A 20W solar panel is sufficient for most solar applications. The size of the solar battery required 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.

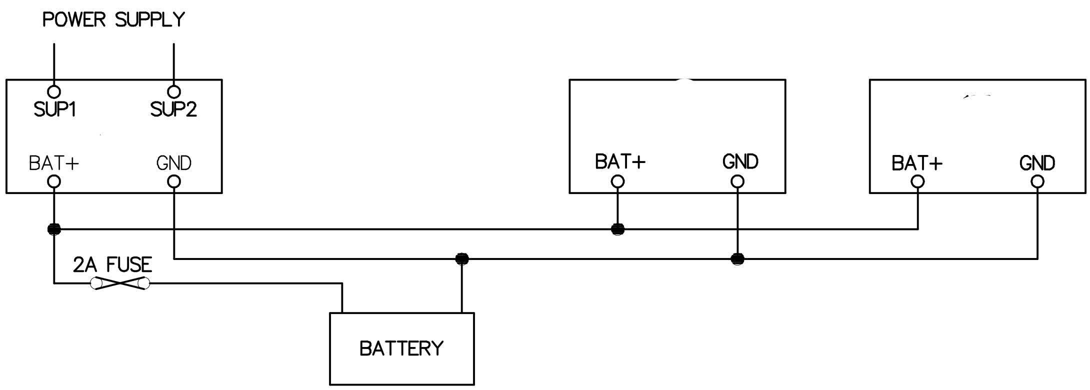
Where a panel larger than 30W is required, an external solar regulator should be used.

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

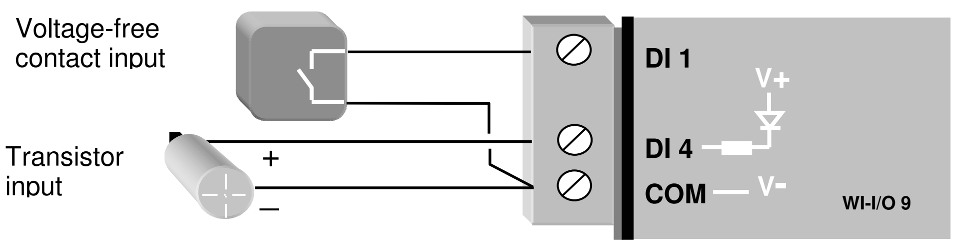
Each module provides a 24V DC regulated supply for analog loop power, except for WI-I/O 9-4_WI-I/O-EX-1-S-4. The supply is rated at 150mA, and should **only** be used for powering analog loops.

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.

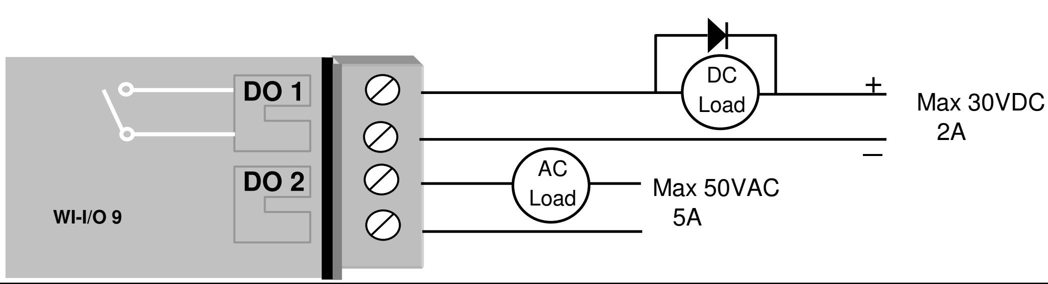
Each digital input is connected between the appropriate "DI" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200 ohms, 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.

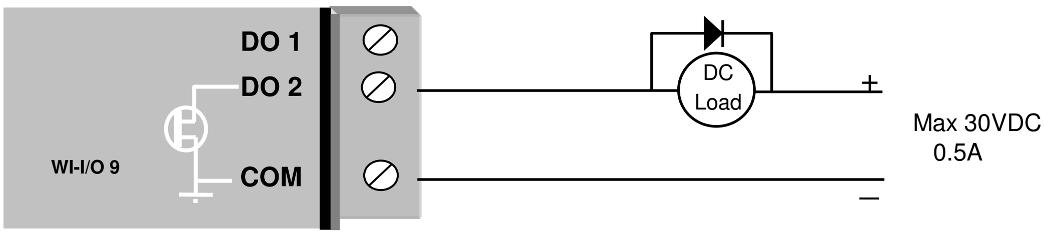


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See section 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.



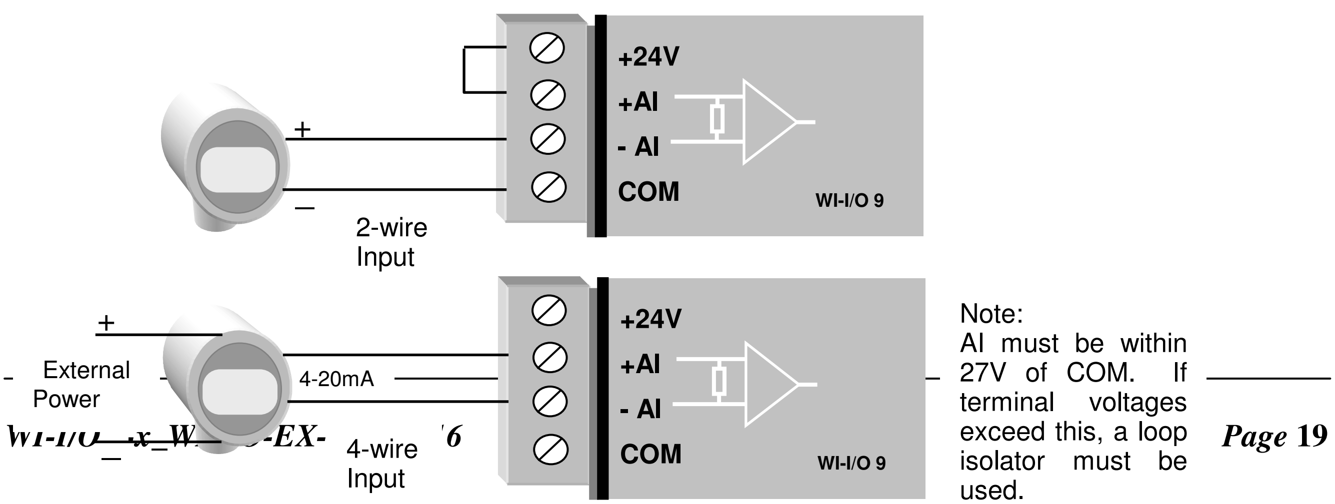
Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 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



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.

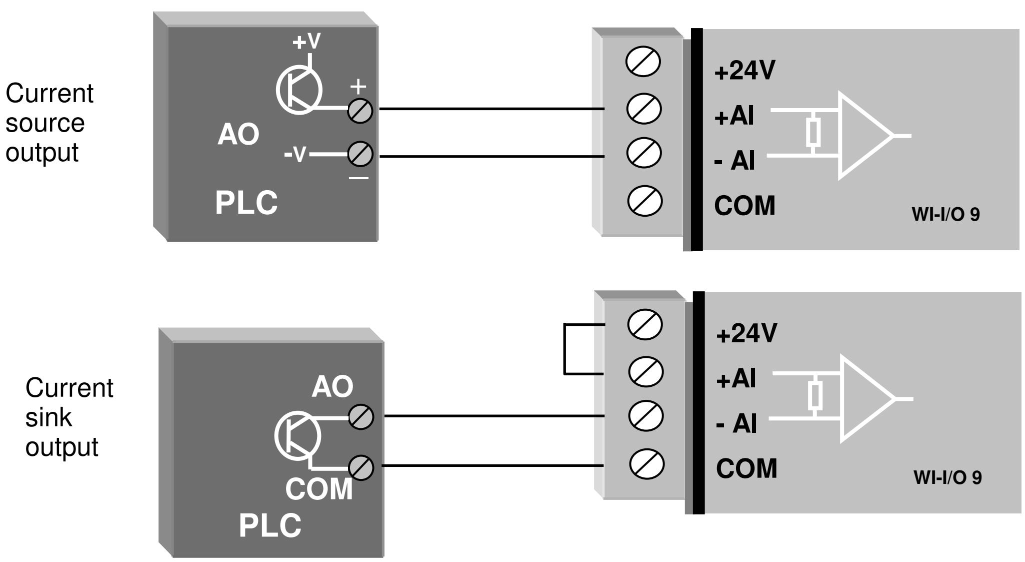
A 24VDC loop supply is available on the module for powering the analog transducer loops. In this case, the analog loop should be connected between a "AI 1-" terminal and "COM" (for the first analog input) or "AI 2-" (for the second analog input), and so on for other inputs.

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.

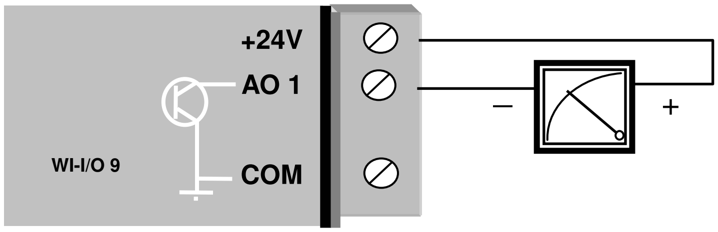
To connect an AI on the WI-I/O 9-x to an analog signal from a PLC or DCS output, check the internal circuit of the output carefully as different devices use different ways to create an analog signal. The following diagram shows two ways of connecting.



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.

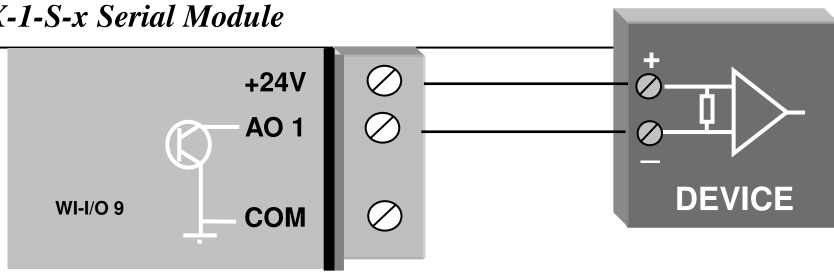


A 24VDC supply is available on the module for powering the analog output loop (max external loop resistance 1000 ohms). In this case, the analog loop is connected between a "+24V" terminal and "AO 1" (for the first analog output) or "AO 2" (for the second analog output), and so on for the other output signals.

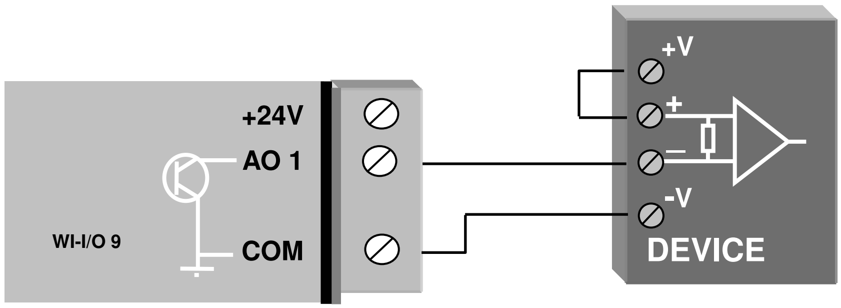
If connecting to an external device such as an electronic indicator, recorder or PLC / DCS input, the loop can be powered by either the WI-I/O 9-x or the device. Externally powered loops to 27 VDC may be connected by connecting the output between the "AO" terminal (positive) and the "COM" terminal (negative). 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.

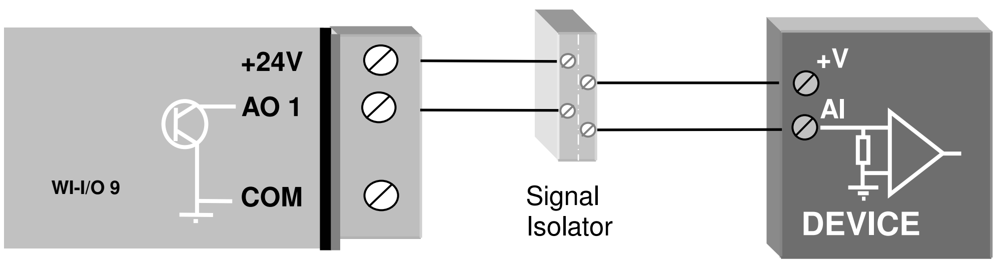


Connecting to a floating input device, powered from the WI-I/O 9-x



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.

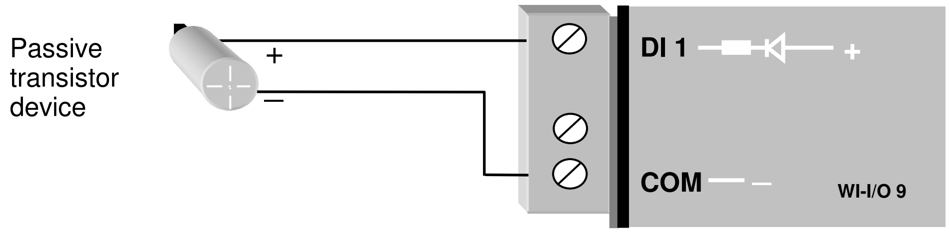
Connecting to an externally powered floating-input device

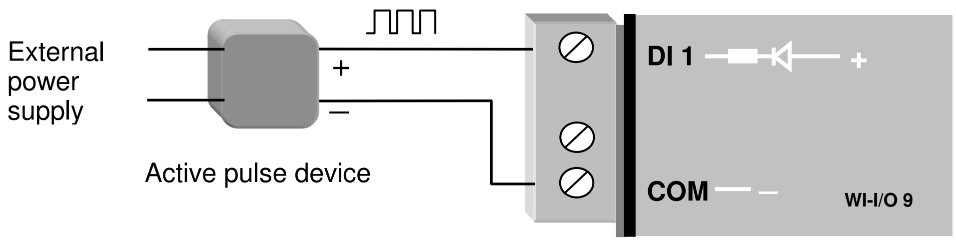


Connecting to a grounded input device via a signal isolator

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.

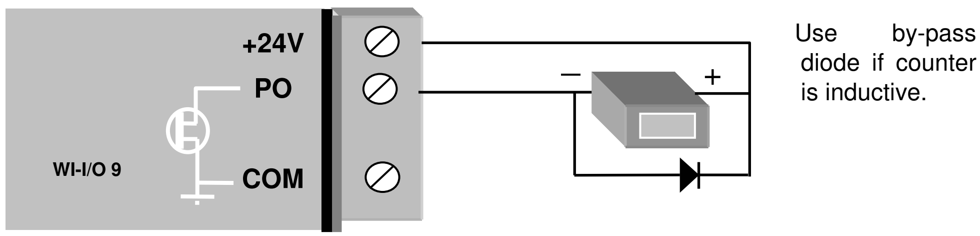
2.4.7 Pulse Inputs (WI-I/O 9-2 and WI-I/O 9-4)

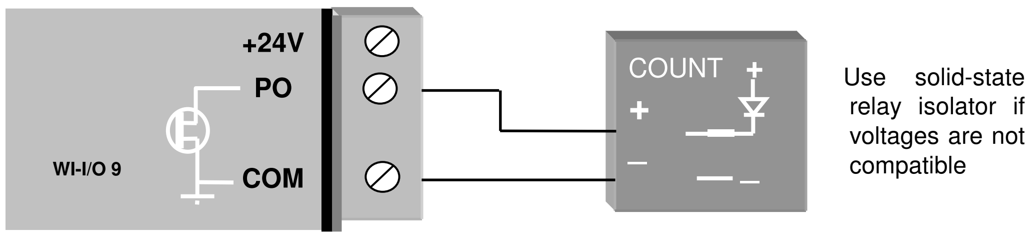
For the "-2" and "-4" modules, the four digital inputs (DI 1-4) may be configured as pulse inputs. The first digital/pulse input DI 1 has a maximum rate of 1000 Hz (min. off time 0.5 ms), while DI 2-4 have a maximum rate of 100 Hz (min. off time 5 ms). When using DI 1 at high pulse rates (more than 100 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.





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.

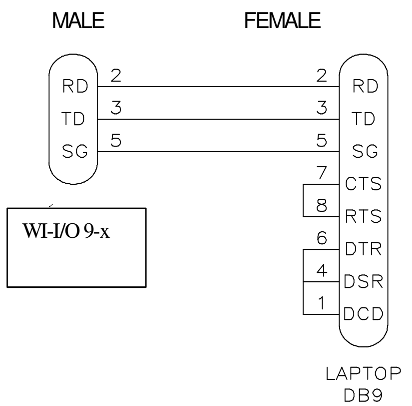
2.4.9 Pulse Output (WI-I/O 9-3 and WI-I/O 9-4)

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.

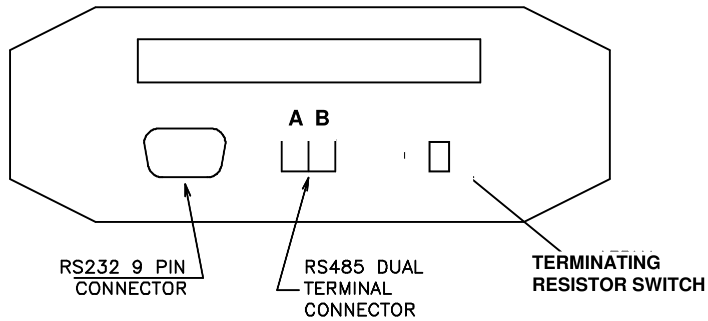
2.4.11 RS485 Serial Port

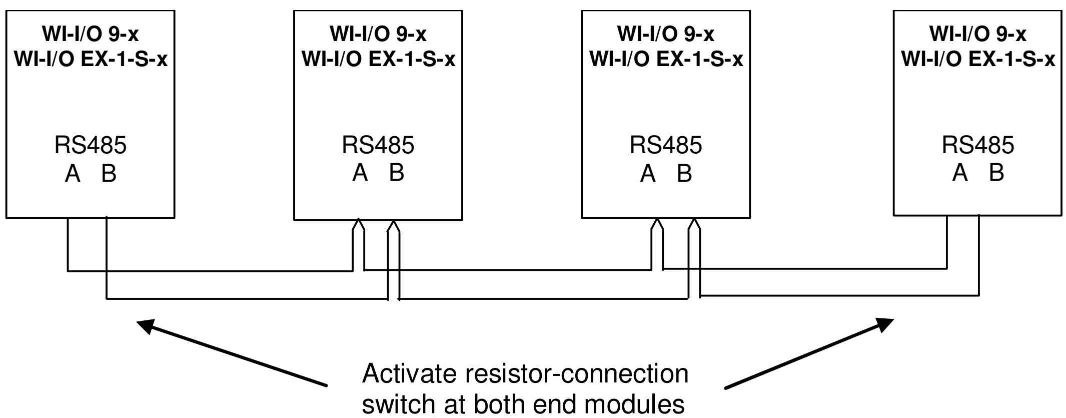
The RS485 port provides for communication between multiple units using a multi-drop cable. Up to 32 units may be connected in each multi-drop network. Each multi-drop network may have one unit providing radio communications with other units in the system. The RS485 feature allows local hubs of control 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.

Chapter Three OPERATION

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	→	• 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.

<u>Example of unsuccessful communications</u>

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".

<u>Example Repeater Communications</u>

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

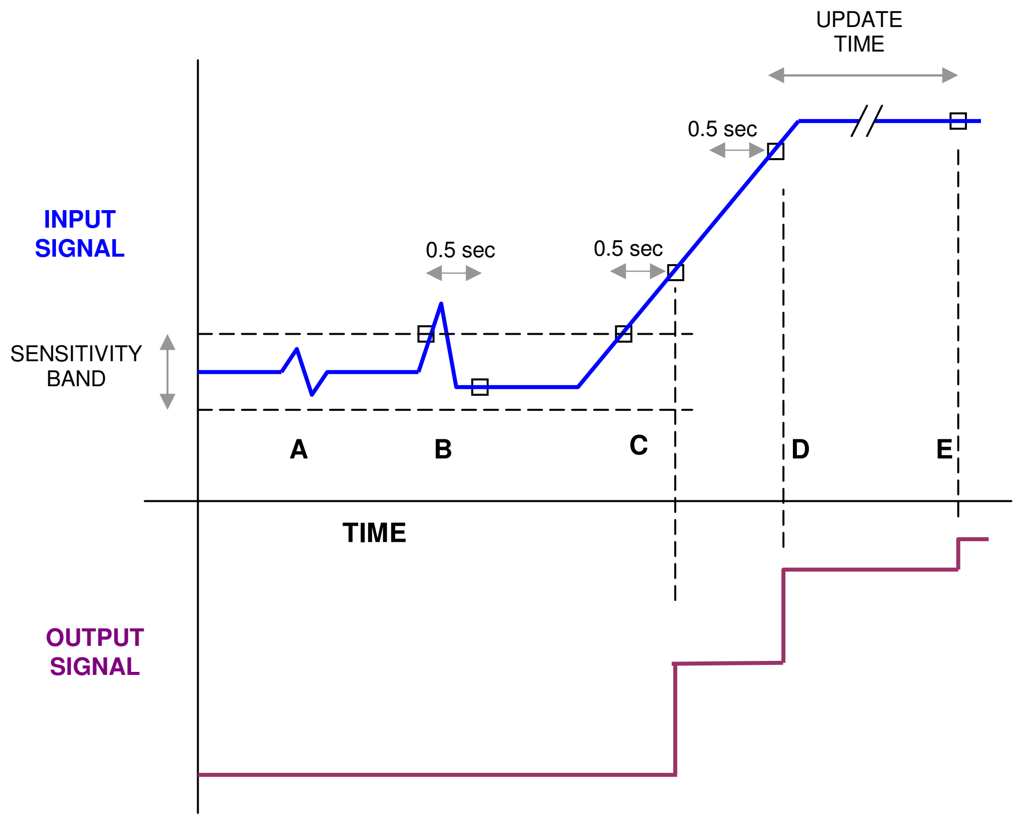
The module transmits a data message whenever it detects a "change-of-state" on one of its input signals. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa provided the change is sustained for 0.5 second (i.e. 0.5 second debounce). The debounce delay 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.

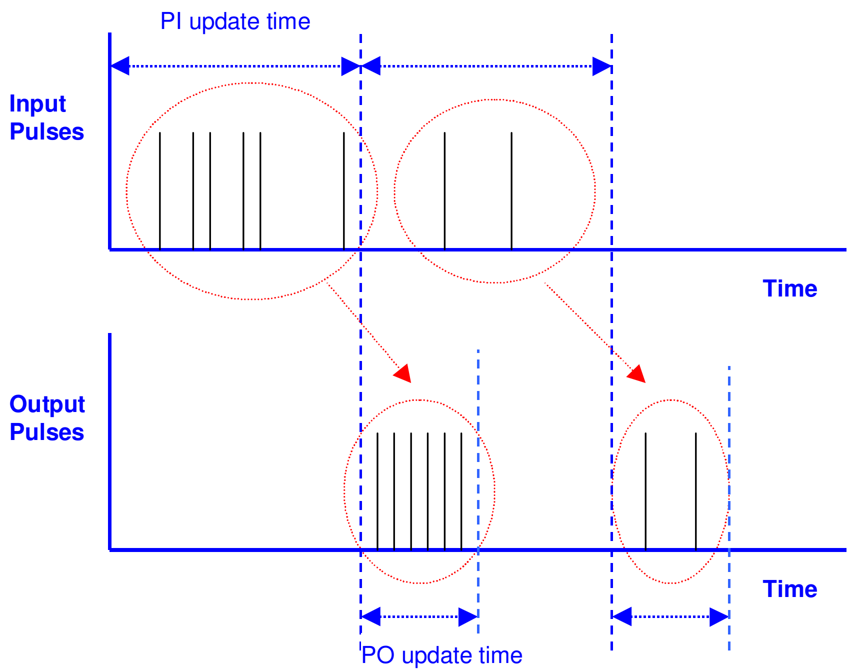
In general, the following may be used as a rule of thumb for calculating the appropriate sensitivity required for a given application:
Instantaneous change of 2 x sensitivity on input → 3 second output response
Instantaneous change of 10 x sensitivity on input → 5 second output response

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.

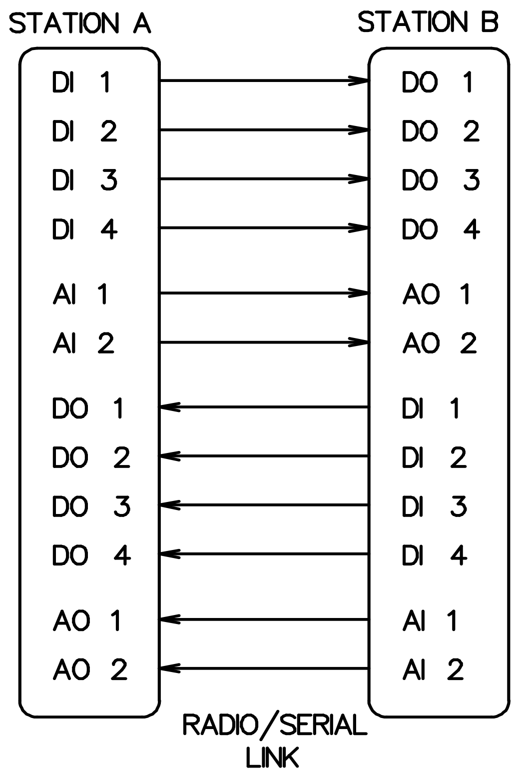
Warning - do not allocate the address number 1 to a “-3” or “-4” module.

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

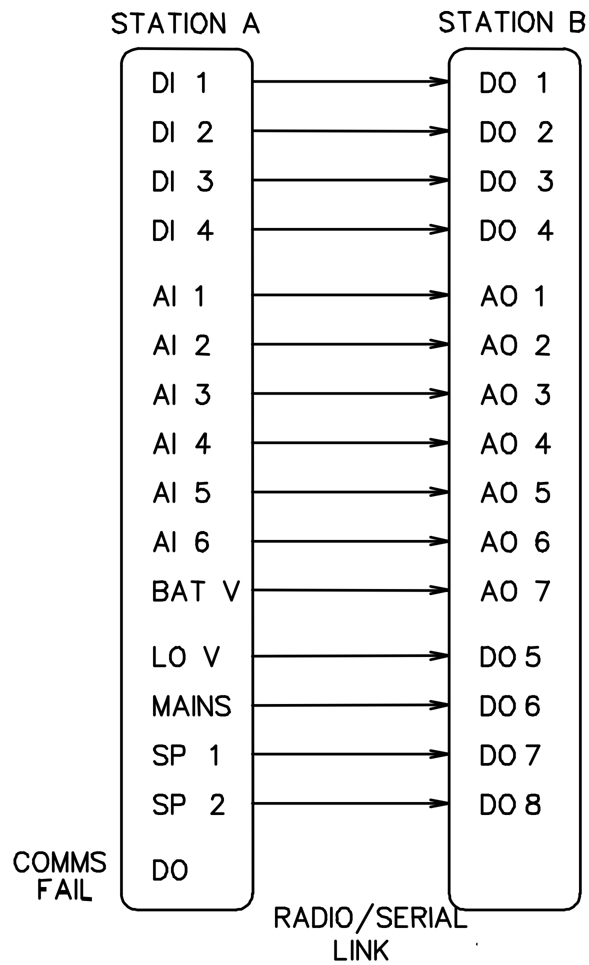
If your application requires only a single pair of modules, communicating via radio or serial link, default settings may satisfy your needs. If so, no configuration is required. Essentially, all inputs at Module A are reflected at the corresponding outputs at Module B. All inputs at Module B are reflected 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

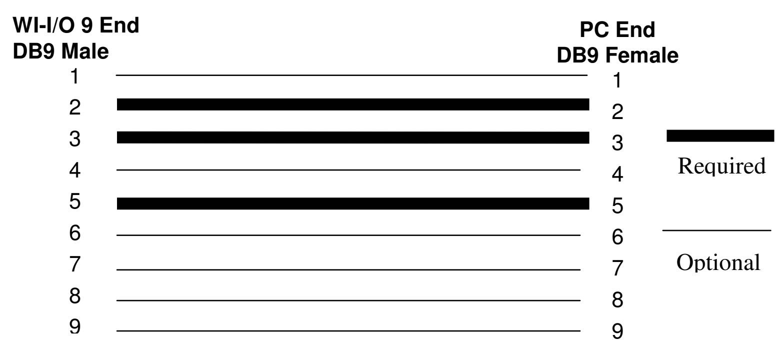
This mapping links DI3 on this module to output channel 2 on the module with address 4, and modules 3 and 11 are repeaters.

User Options may be selected to change the configuration of specific features.

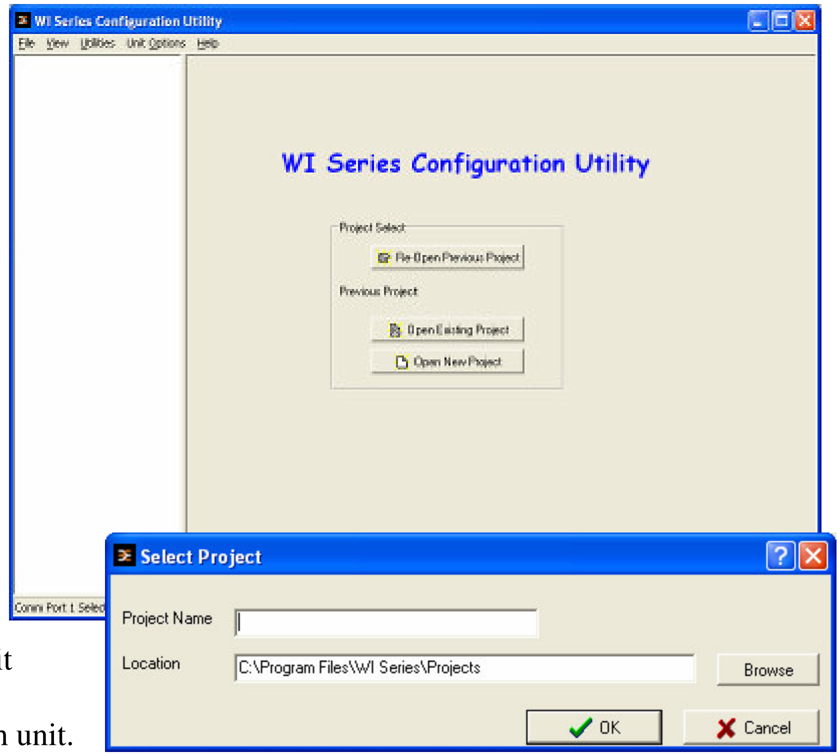
Note: Every module must have at least one mapping configured to another module. If no mappings are required (for example, you are only using outputs at a module), then you need to configure a mapping for a spare input to an unused output on another module.

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.

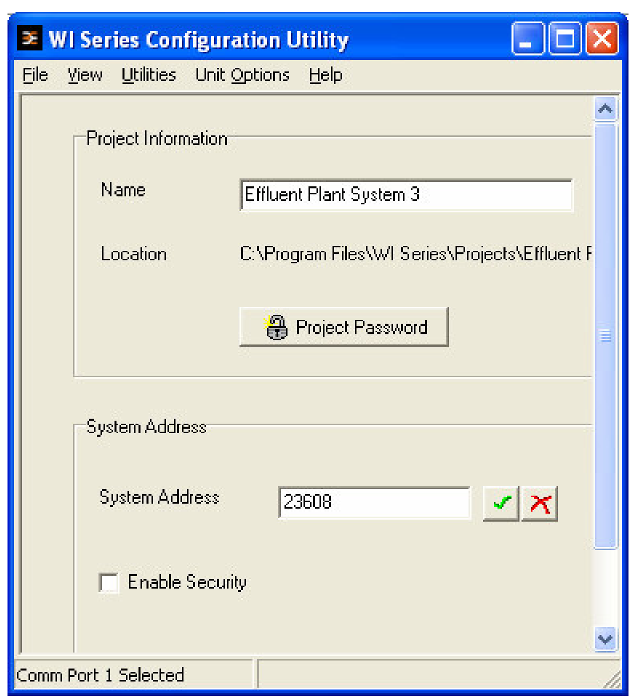
The Initial screen will appear. The configuration is performed for a complete system. The necessary configuration stages are:

- 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.

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 th e 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 as ked 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.

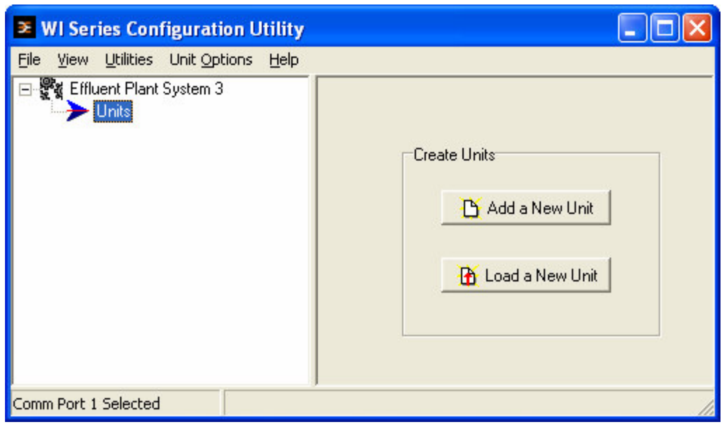
The password can be between 6 and 256 characters. You can also change password by selecting this option from the "Utilities" menu.

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.

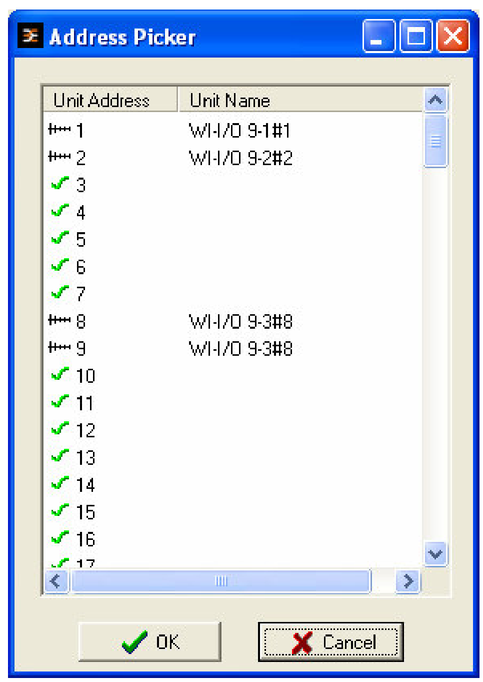
Loading configuration from an existing module
To load the configuration from a module, connect the module to the PC via the RS232 cable and click on "Load Unit". This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3.3 for more information.

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.



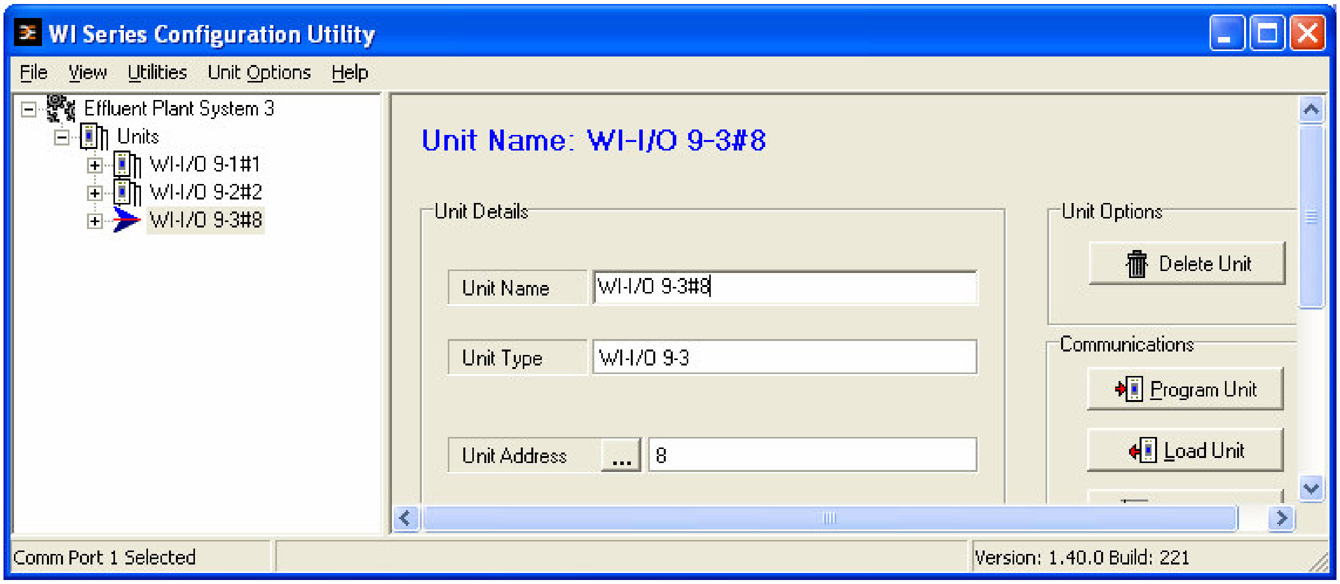
Note that this program covers WI-I/O-EX-1-S-x and WI-I/O 9-x modules. These modules are essentially the same as far as configuration is concerned. That is, a WI-I/O 9-1 selection will configure a WI-I/O-EX-1-S-1 or a WI-I/O 9-1.

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".



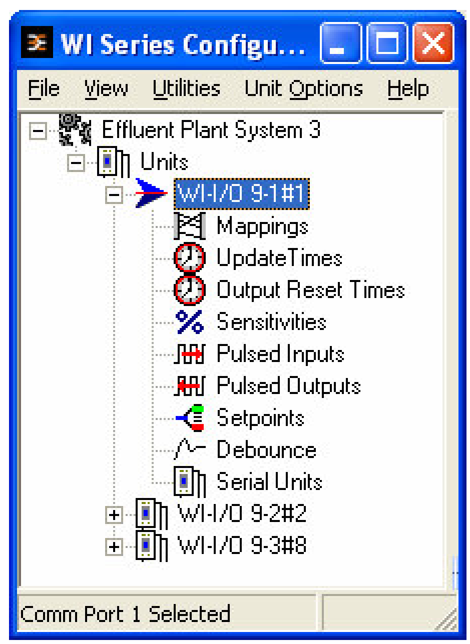
Configuring an individual module

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:

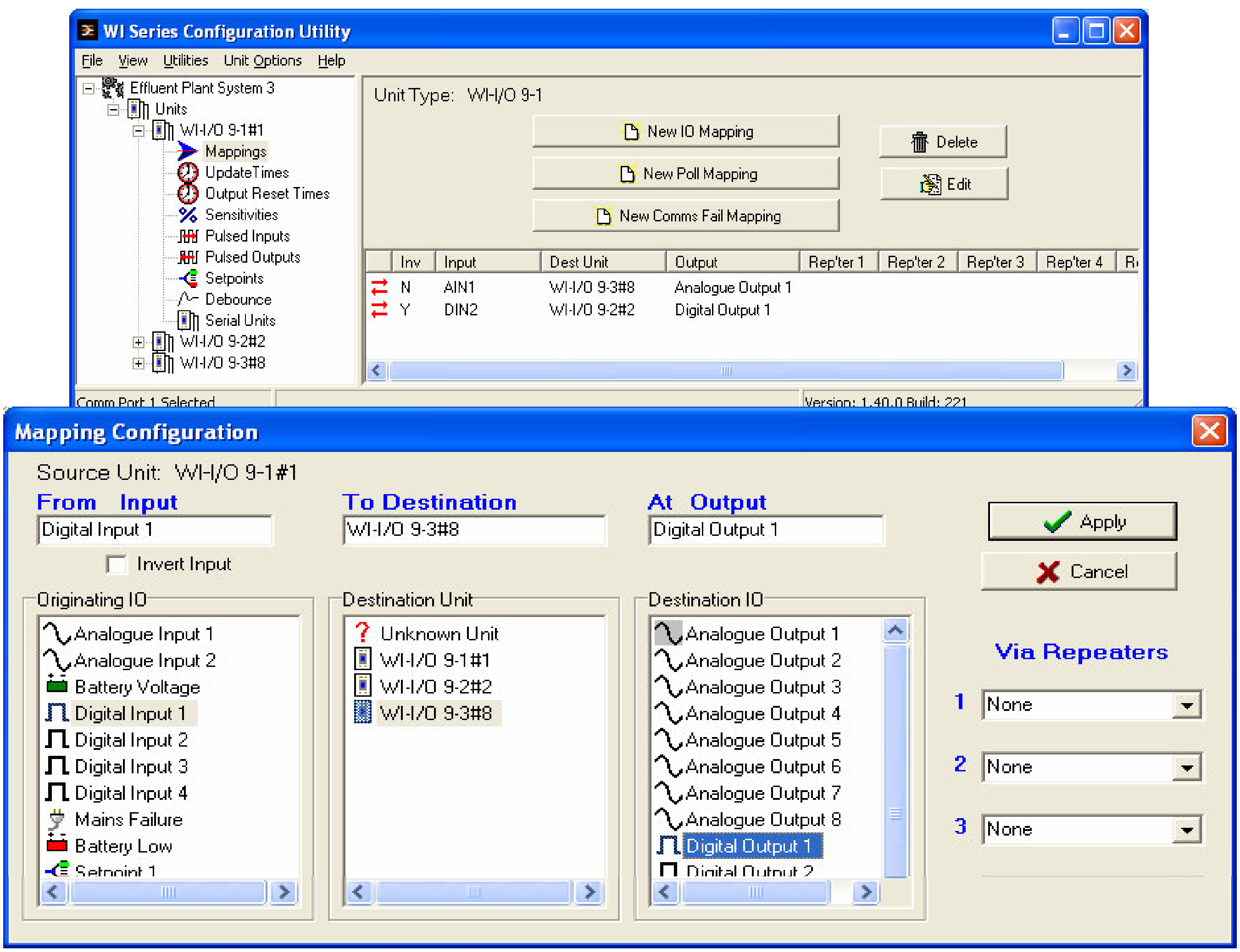
- I/O mappings which link inputs to outputs
- Poll mappings, which enables a module on start-up to request set its outputs quickly

Comms Fail mappings, which maps communication failure status to an output on the local module.



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



	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".

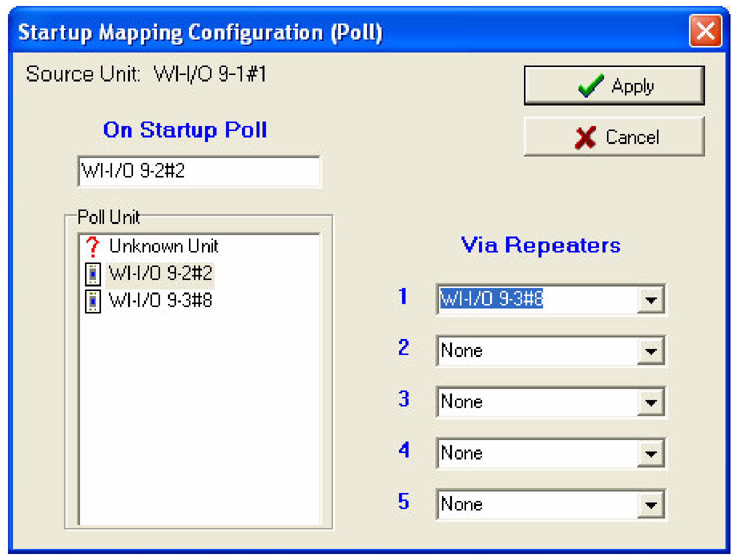
To delete an existing mapping

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.



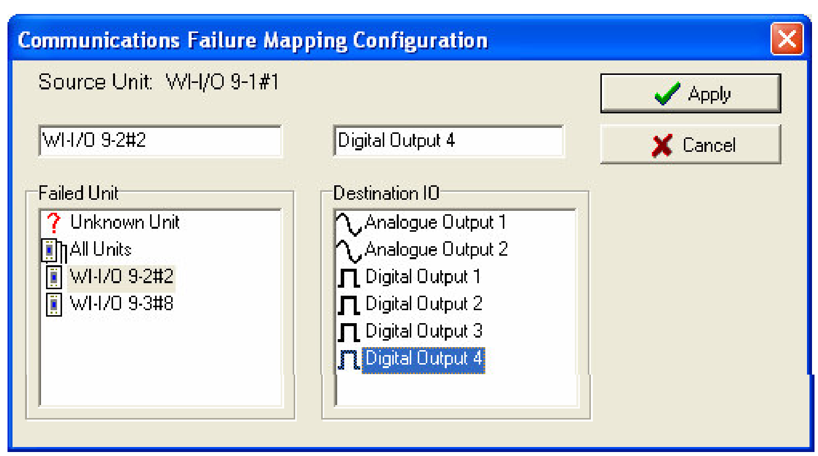
Remember that if more than one remote unit is controlling the local outputs, then more than one start-up poll should be configured.

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).

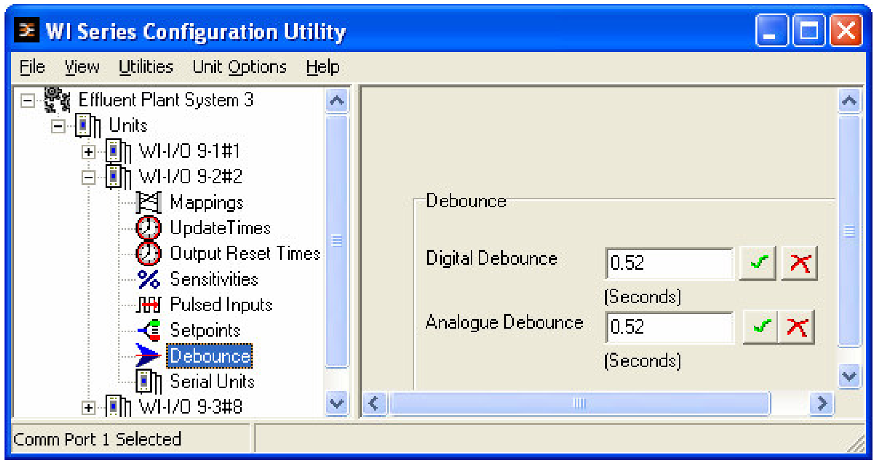
different remote addresses. You can configure several comms fail mappings to the same output - the output will be active if there is comms fail to any of the remote addresses. Configuring a "Comms Fail Address" of zero causes communication failure to any destination module to be indicated on the selected 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.

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.*

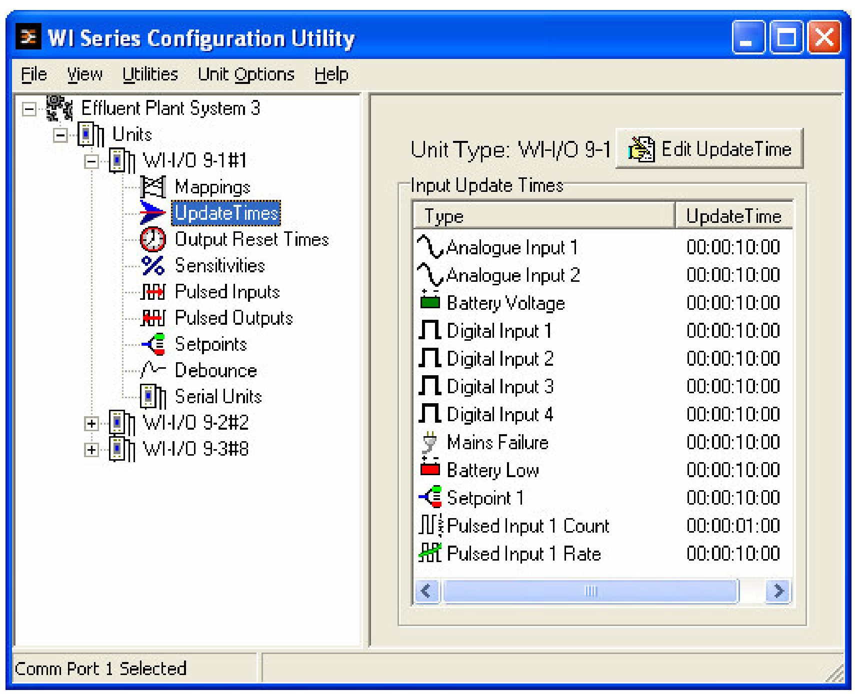


Note that the analog debounce is not configurable for the -1 , but is configurable in the -2.

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



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.

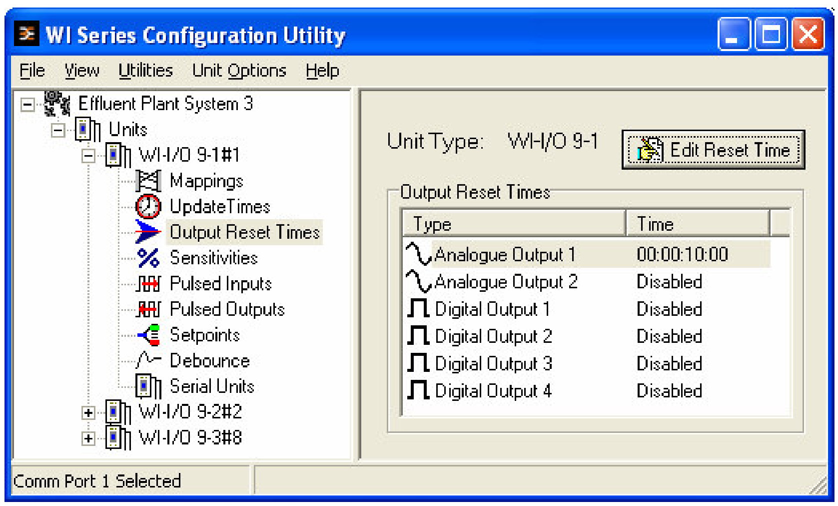
Changing Multiple Settings

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).

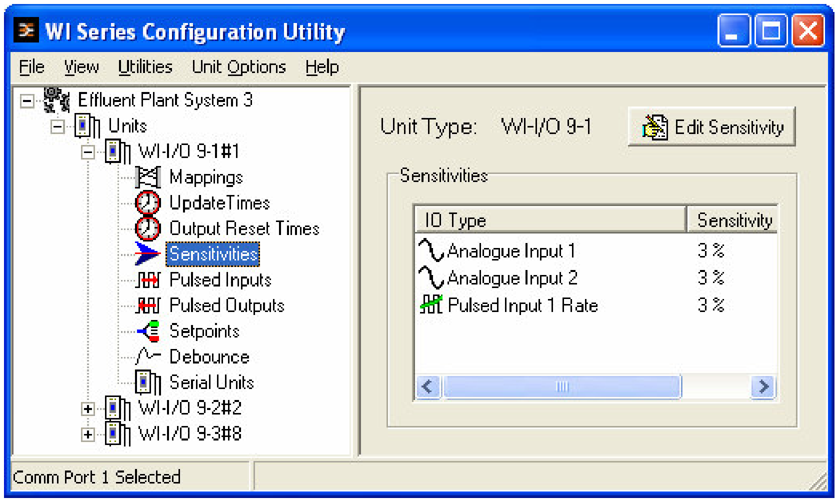


If the reset time is less than the update time, then the output will reset when the reset time expires, and then set again when the update message is received. We recommend that the reset time be a little more than twice the update time.

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

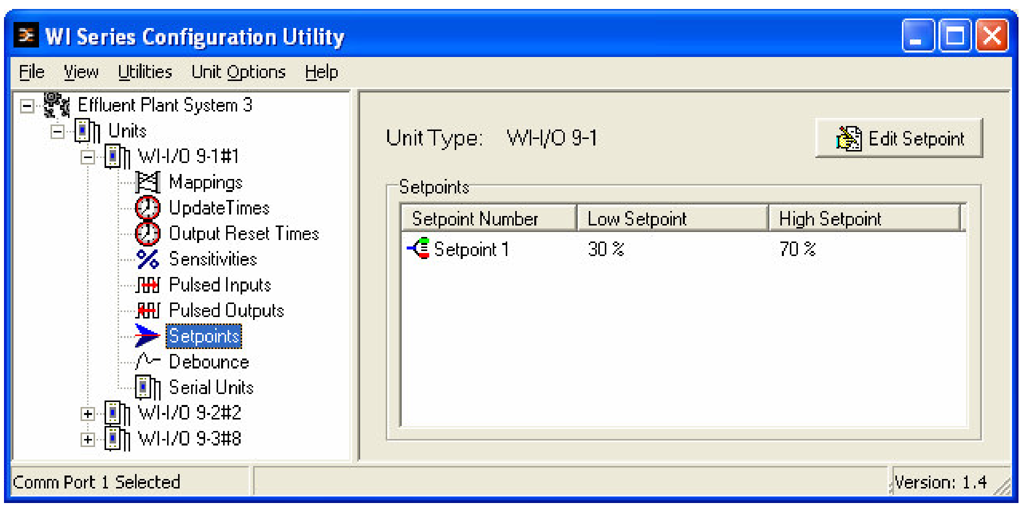
The analog sensitivity is the change required in an analog input before a "Change Of State" is detected, and the new analog value is transmitted. For input signals which vary widely over a short period of time or have a normal oscillation, the analog sensitivity should be set to an appropriately large 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.



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.



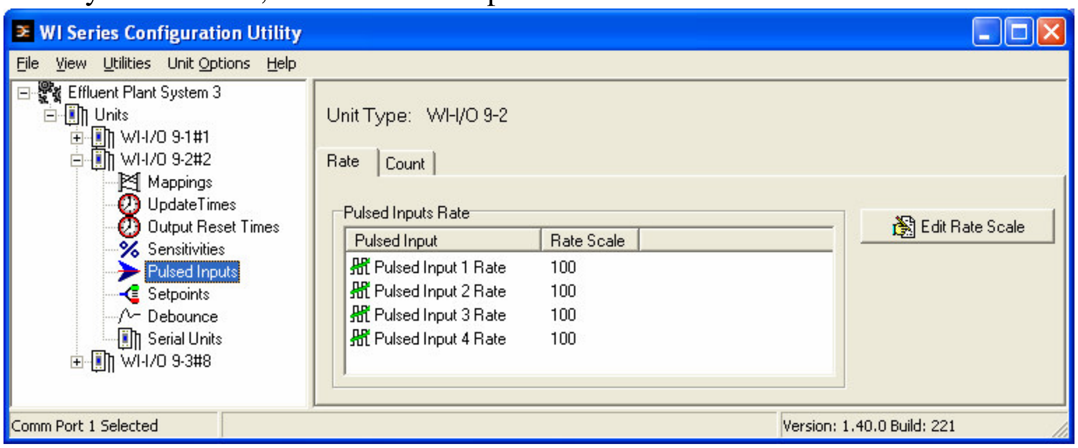
Debounce time operates on the set-point status in the same way as digital inputs.

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.

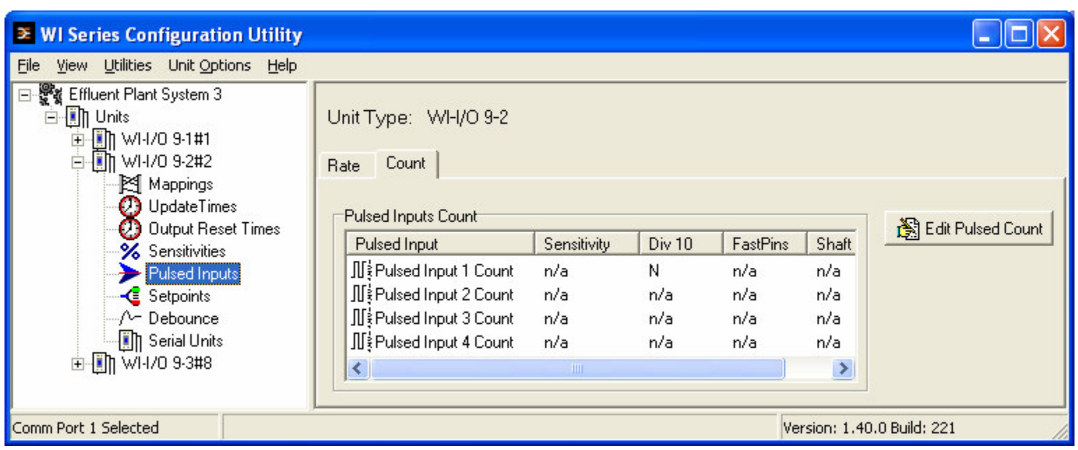
To configure the "divide by 10" feature, select "Pulse Inputs" on the left-hand menu and select the "Count" page - double-click "Pulse Input 1 Count" and enable "divide by 10" counting.



Pulse Input Rate Scale Configuration

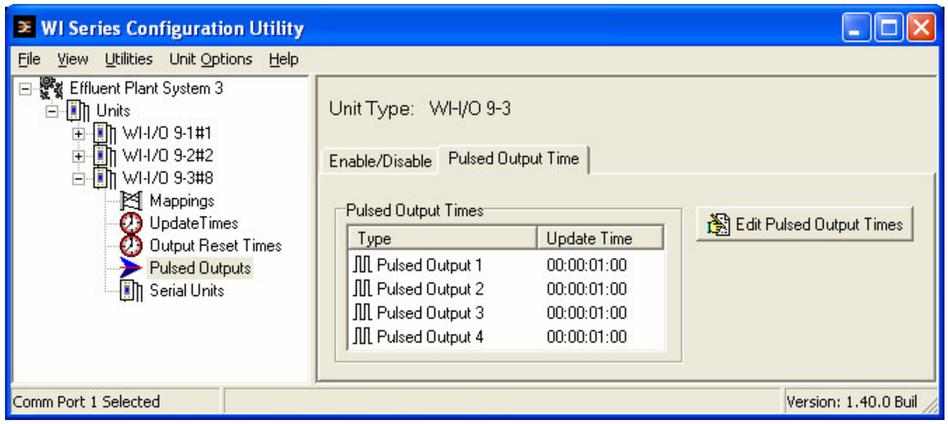
When a pulse rate is mapped to an analog output, the rate must be scaled to the 4-20mA output. The pulse rate scale is the rate (in Hz) corresponding 20 mA.

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.



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.



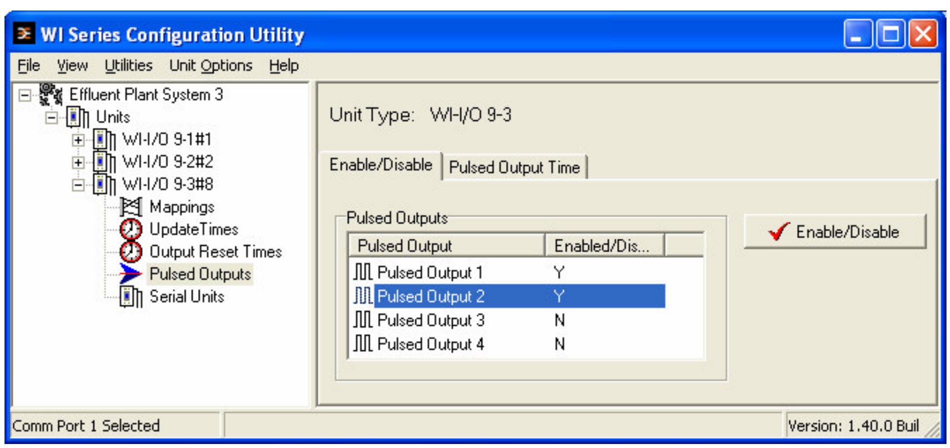
For example, if the PI update time is 1 minute, then the PO update time should also be 1 minute. If the PI update time is changed, then the PO update time at the remote module should be also changed. The PO will still operate if the time is not changed, however pulses may be output faster or slower than 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.



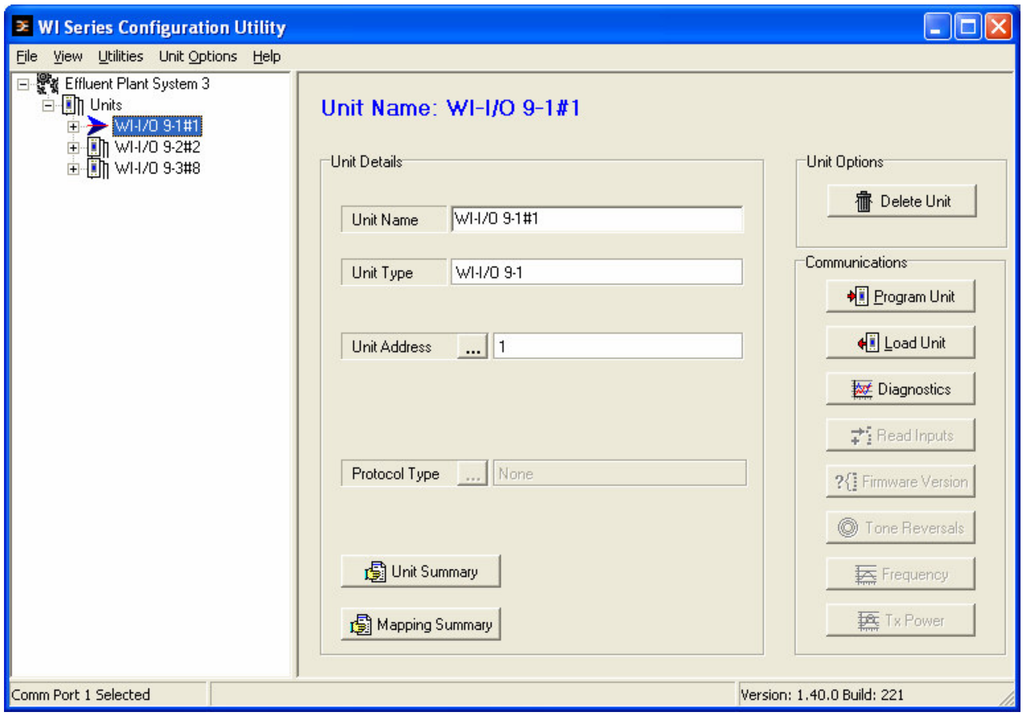
Compiling a System

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.

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.

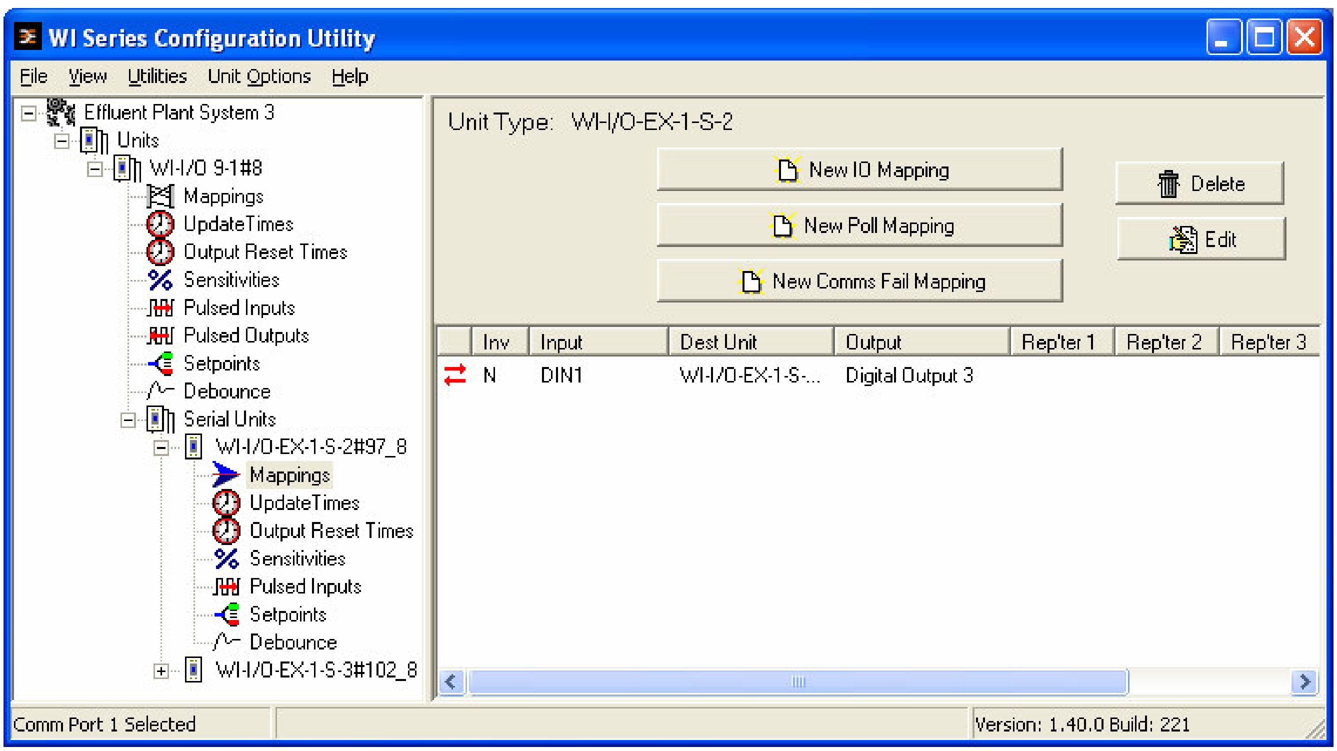
4.3.8 Using WI-I/O-EX-1-S-x Modules

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.

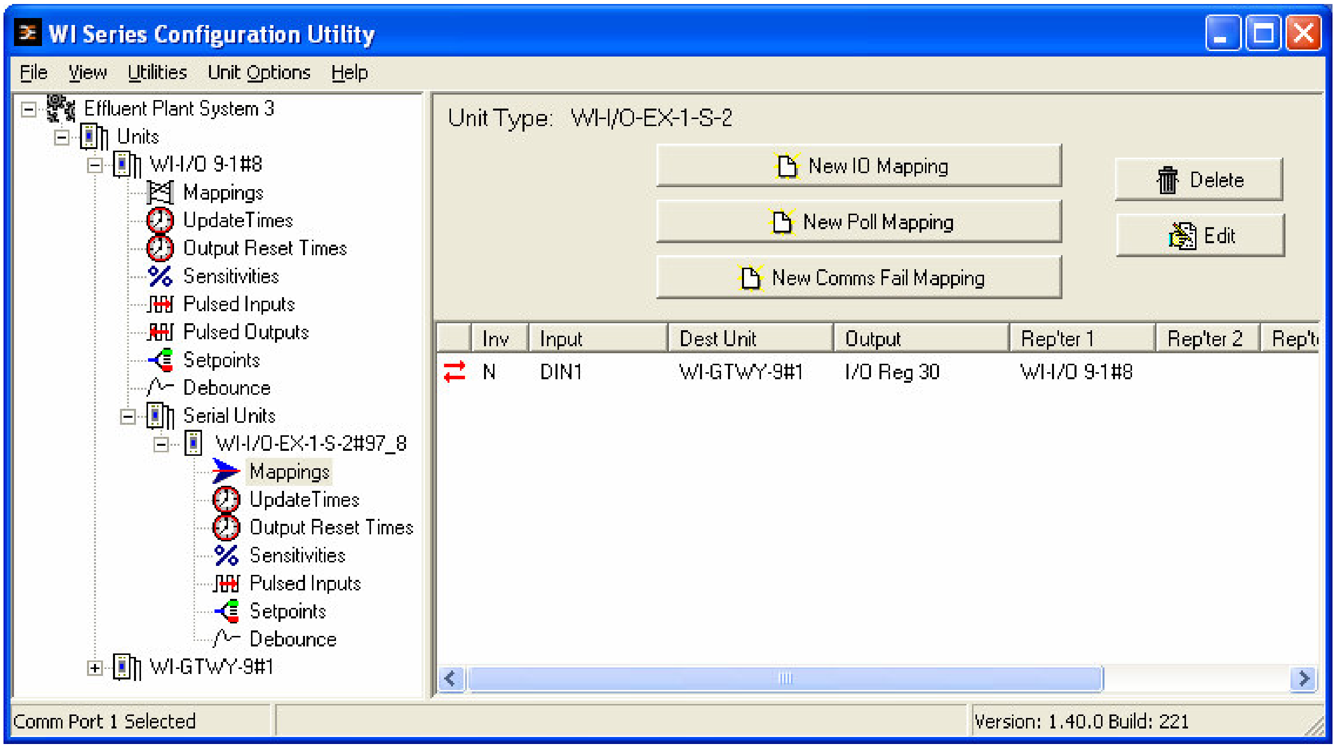
WI-I/O-EX-1-S-x modules are configured with unit addresses in the range 96 – 127.

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.



Example 2 - Mapping to a remote WI-I/O 9-x.

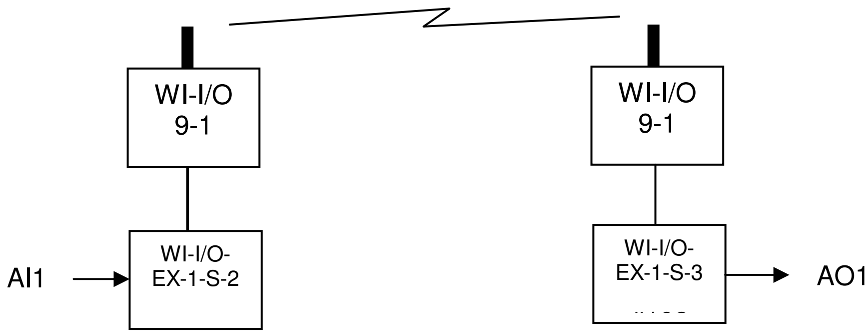


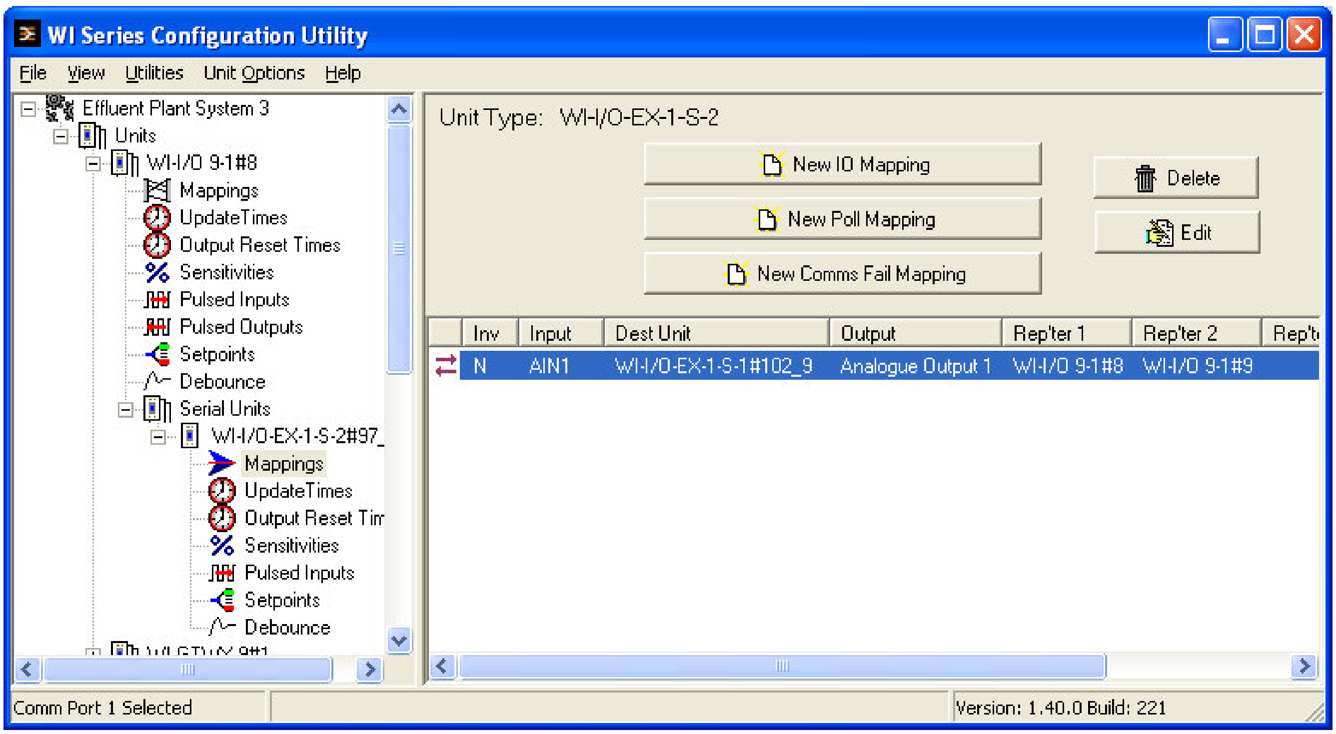
In this example, a WI-I/O-EX-1-S-x-2 is connected to WI-I/O 9-1#8. DI1 is mapped to a remote WI-GTWY-9-MD1 module. The WI-I/O 9-x that is connected to the WI-I/O-EX-1-S-x module acts as a repeater - a serial-to-radio repeater.

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.





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.

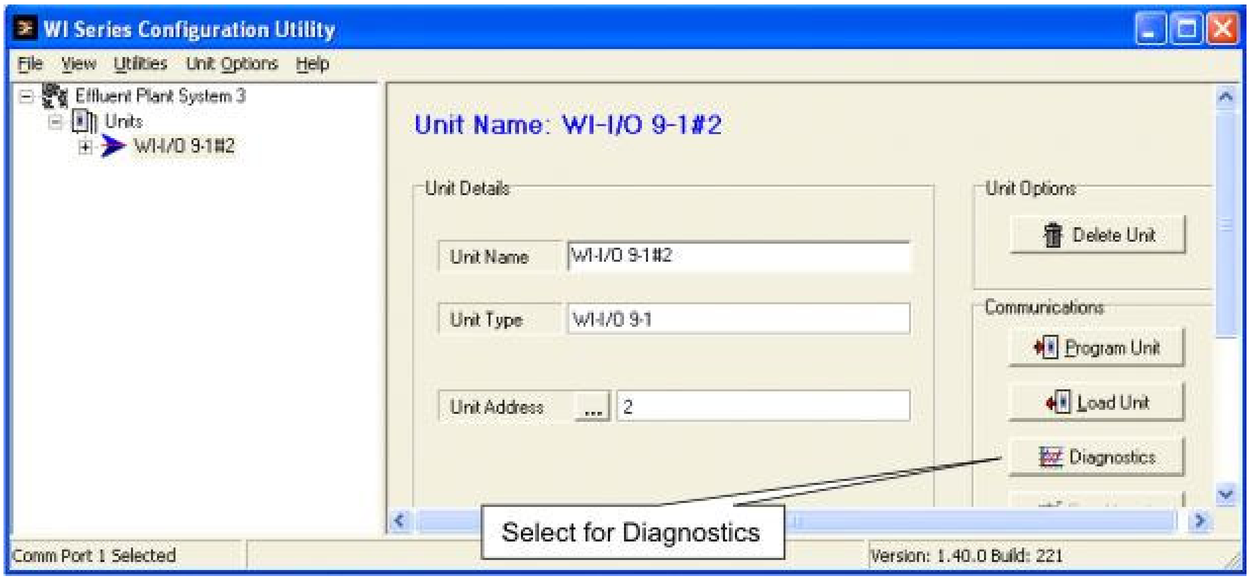
6.2.3 Diagnostics menu

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.

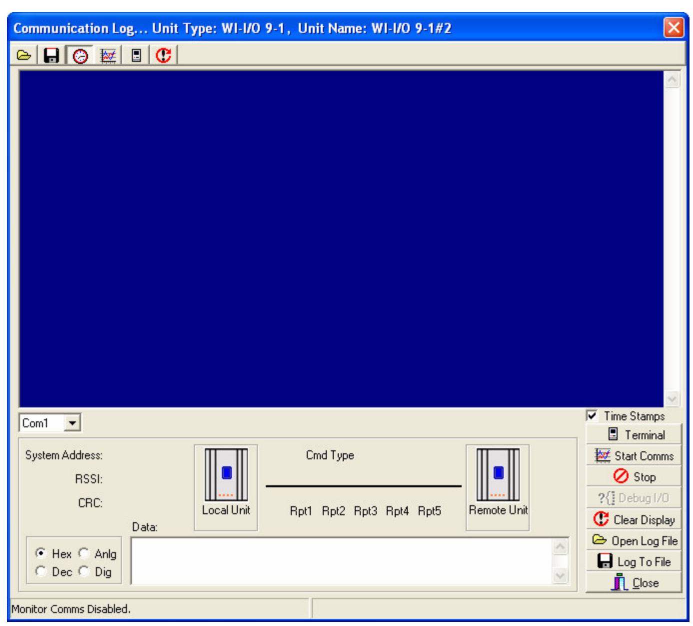
Either open the archived project containing the module, or start a New Project and select "Load a New Unit" - select the correct type of module. After the unit has loaded, select the Diagnostics box.

A "Terminal" screen will appear. Select the "Terminal" box.



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 :



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.

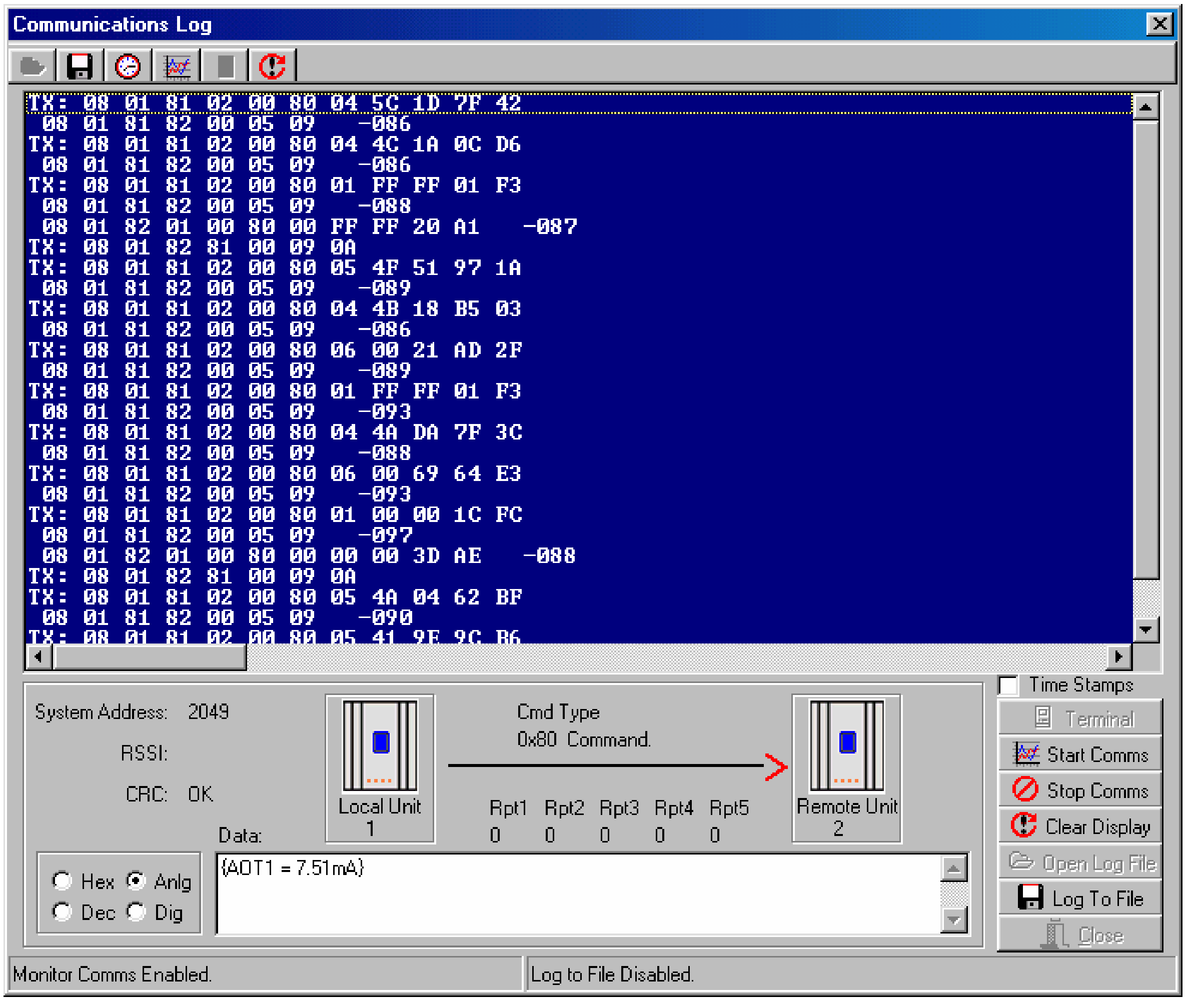
For example, if the noise level is 120, then the radio signal must be 98 or lower for a reliable path. If the noise level is 100, then the radio signal must be 90 or lower.

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



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.

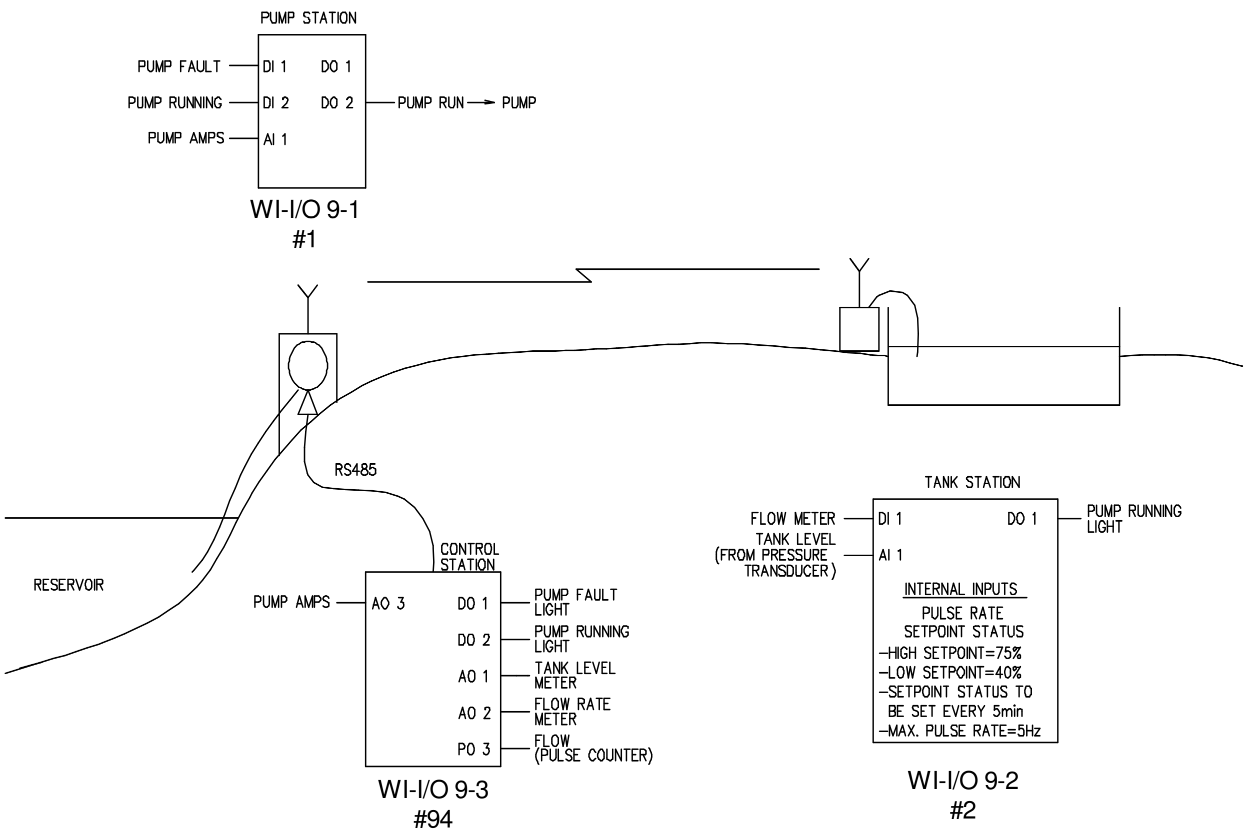
Appendix A SYSTEM EXAMPLE

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.

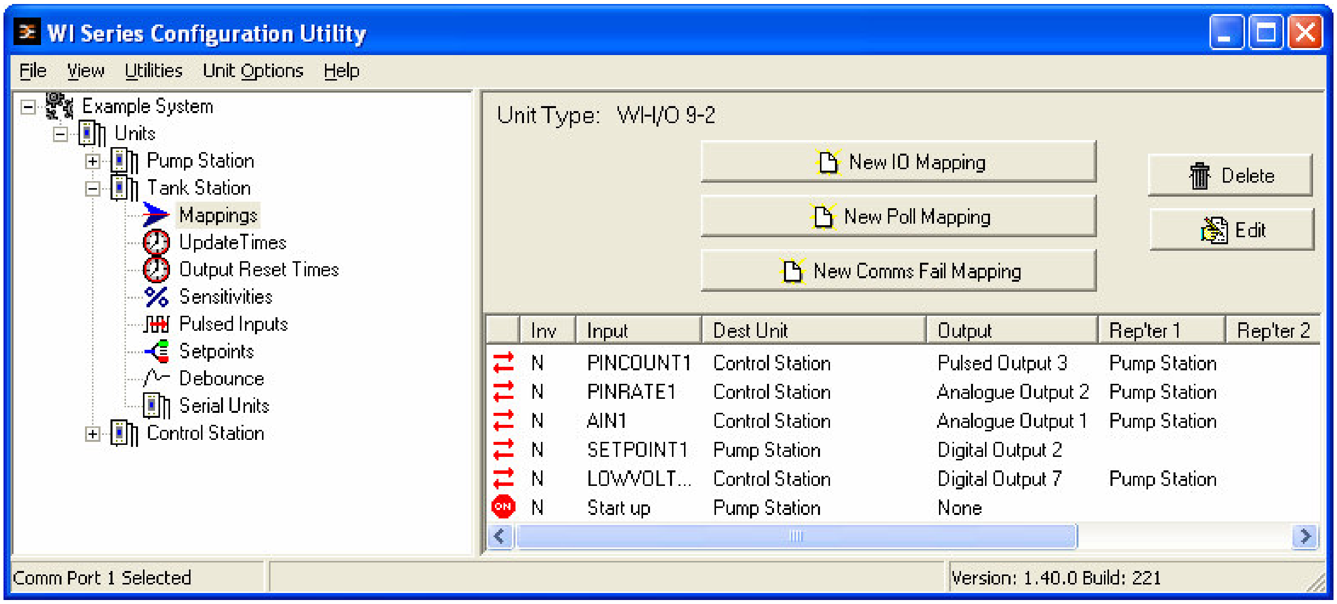
- At the pump station, the antenna was mounted on a 10' J-bracket installed on the roof of the pump station building. The final height of the antenna was approx 20 feet. Care was taken to align the Yagi antennas so they pointed at each other. The Yagi antennas were installed with horizontal polarity - 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.

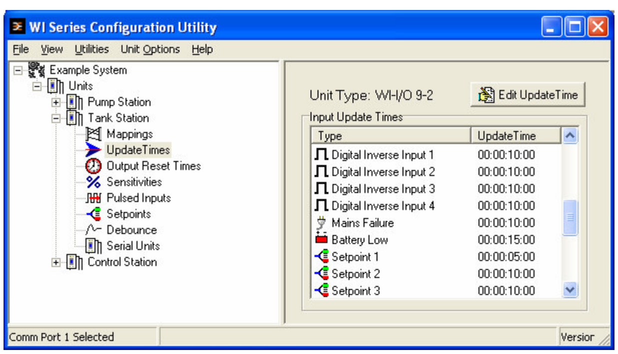
- At the control station, the WI-I/O-EX-1-S-x module was installed inside the existing control panel enclosure. The module was powered from an existing 24VDC power supply.

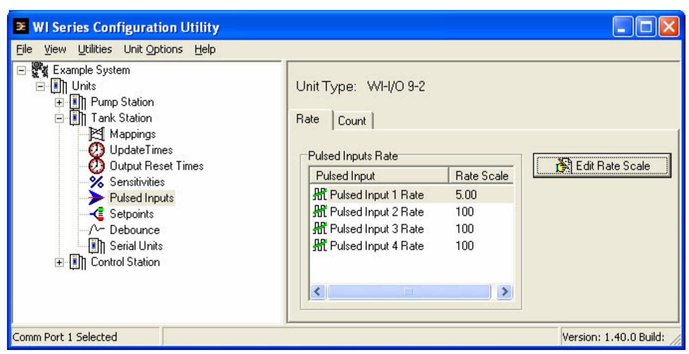
Tank Station Configuration

The WI-I/O 9-2 module has the following configuration :-

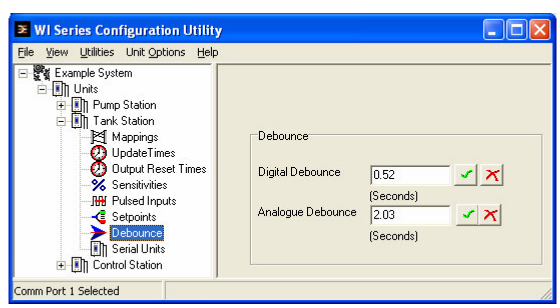


Note the following points in the configuration:





- #1 is a repeater for communications between #2 and #94



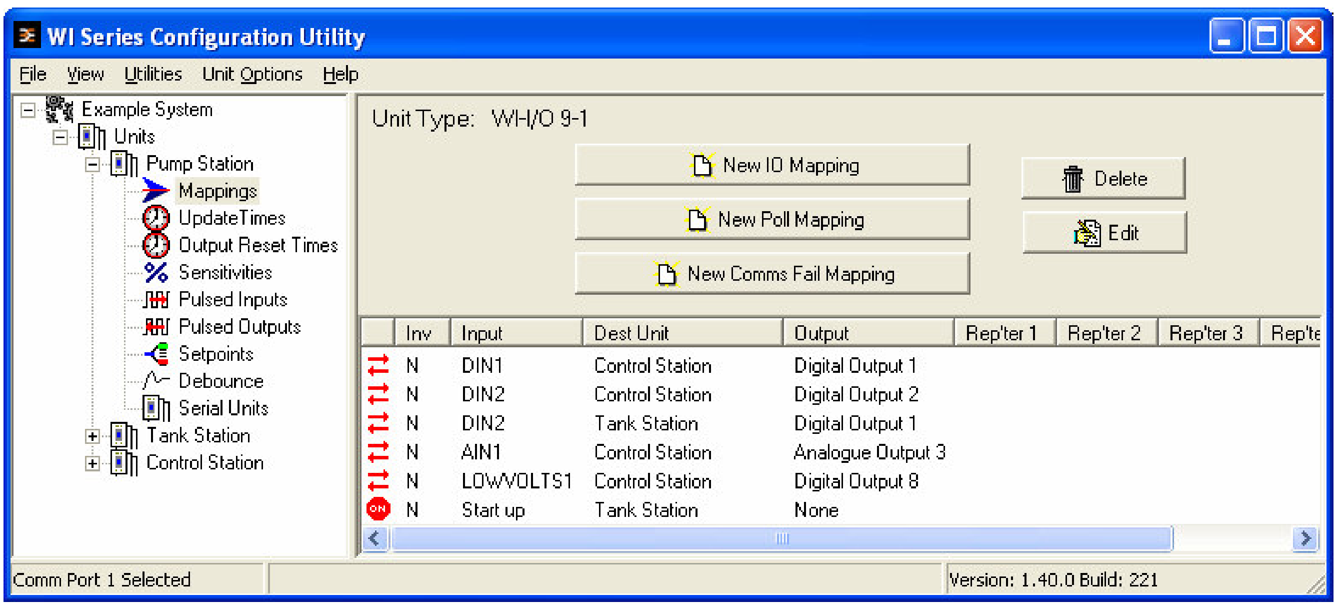
- The pulse rate scaling for PIN1 has been set to 5 Hz to match the maximum flow rate of the flow meter. Note that PIN1 has not been configured for "divide by 10" (for 1000 Hz pulse signals).

- 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.

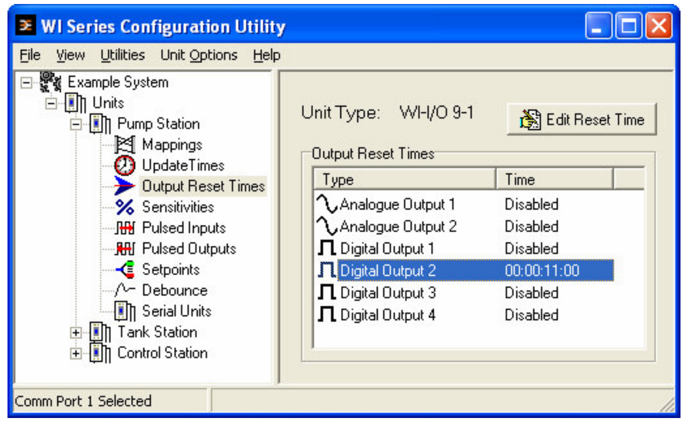
- SETPOINT1 (the set-point status for AI1) is mapped to DO2 of #1 (pump station). The set-point values for this setpoint have been set to 40% and 75%. When the tank level drops to 40%, DO2 at the pump station will activate to start the pump. When the level rises above 75%, DO2 will reset to stop the 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 :-



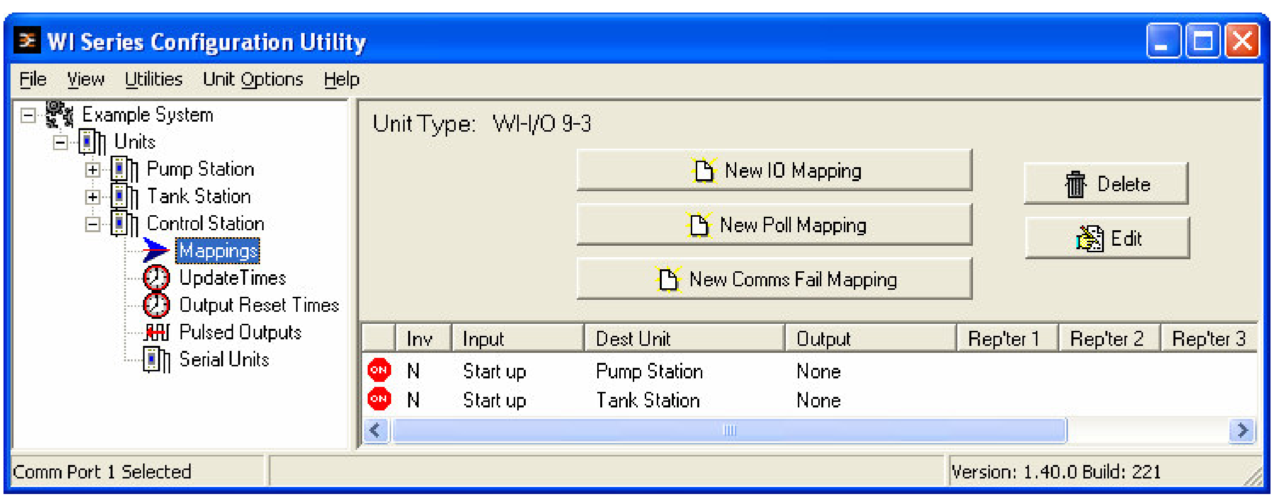
Note the following points in the configuration:



- 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).
- 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).

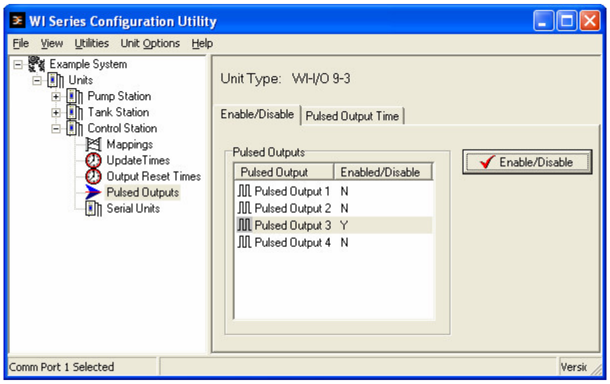
Control Station Configuration

The WI-I/O-EX-1-S-3 module has the following configuration :-



Note the following points in the configuration:

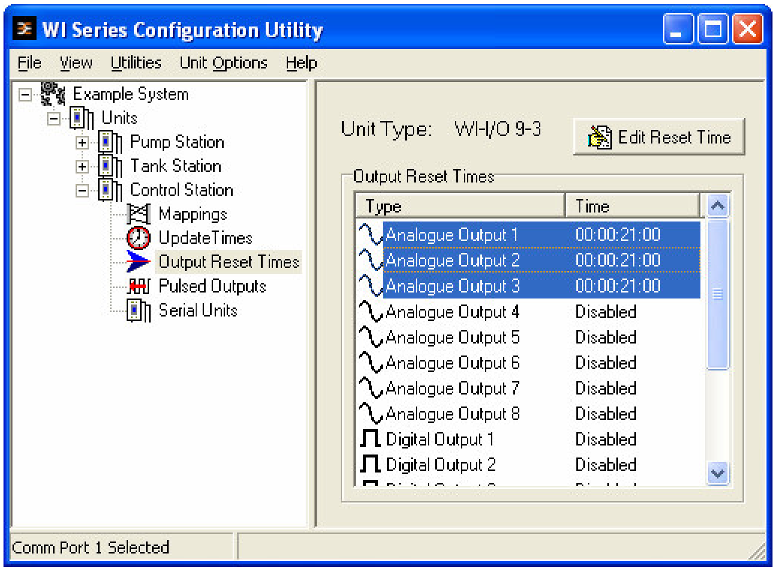
- The only mappings are Start-up polls. Note that there are two separate polls, one for each remote module.
- PO 3 has been configured as a PO. Its pulse output update time is the same as the PI update time at the remote module (both have been left at their default value of 1 minute).



- 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.

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.



The following configuration was added :

At #2 (tank station), Inverse DI4 → DO4 at #94 via 1 ; DI4 Update time = 1 minute

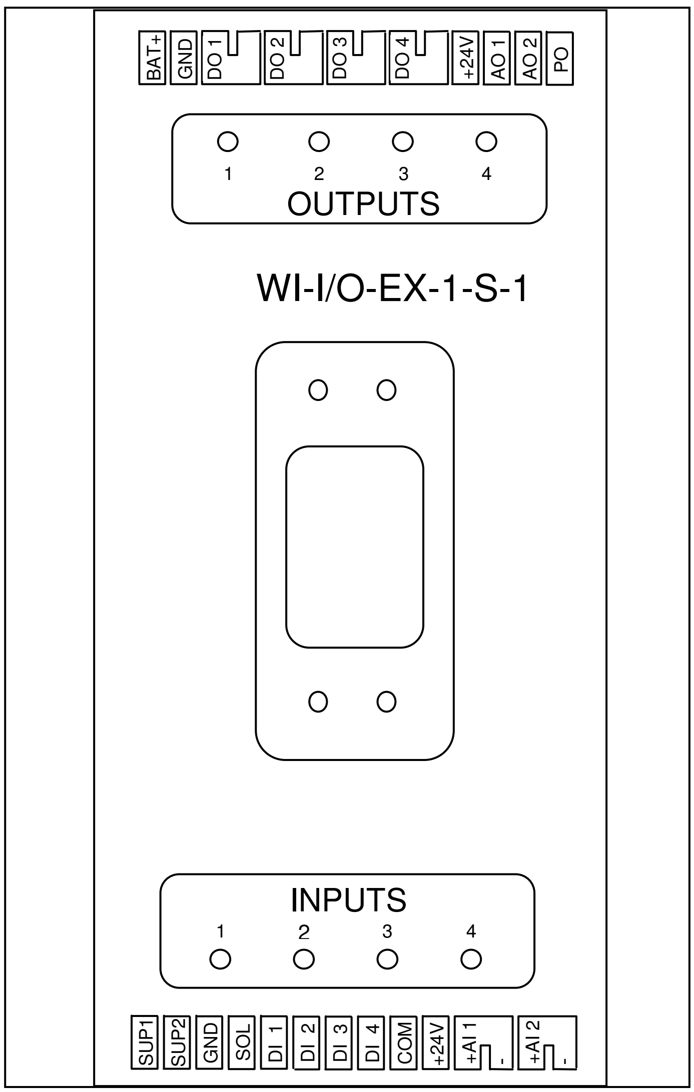
At #94 (control station), DO4 Comms fail reset time = 3.5 min

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.

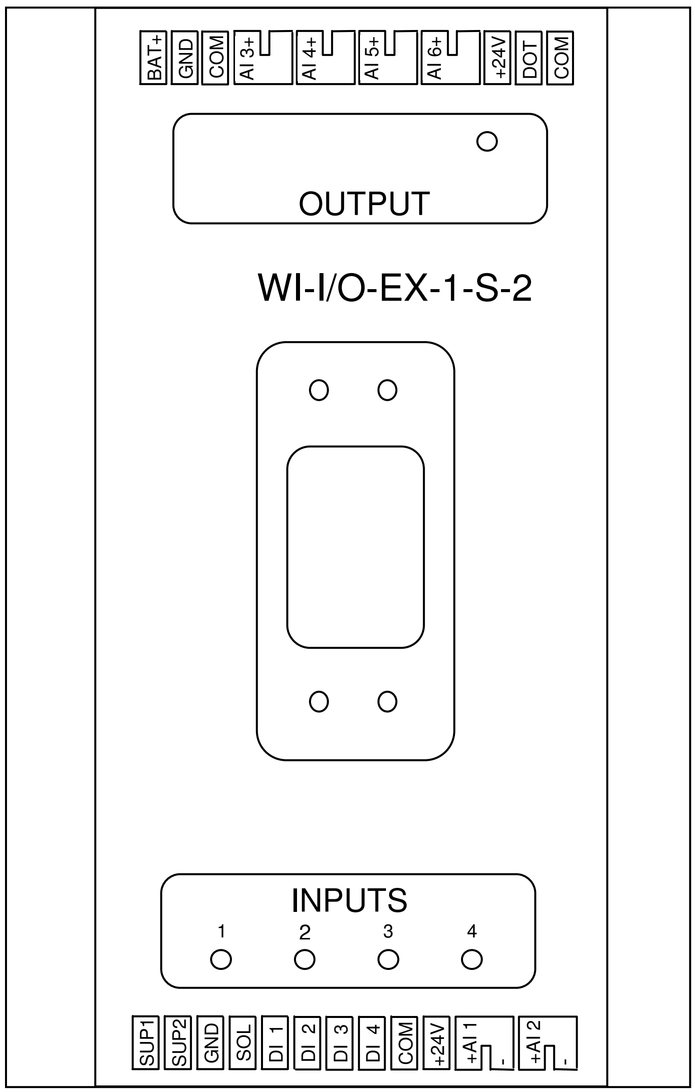
The time of 3.5 minutes was selected as this means that 3 successive update messages have to be missed before a system alarm occurs. Also note, that if module #94 fails, DO4 will reset and give an alarm signal.

Appendix B TERMINAL LAYOUTS

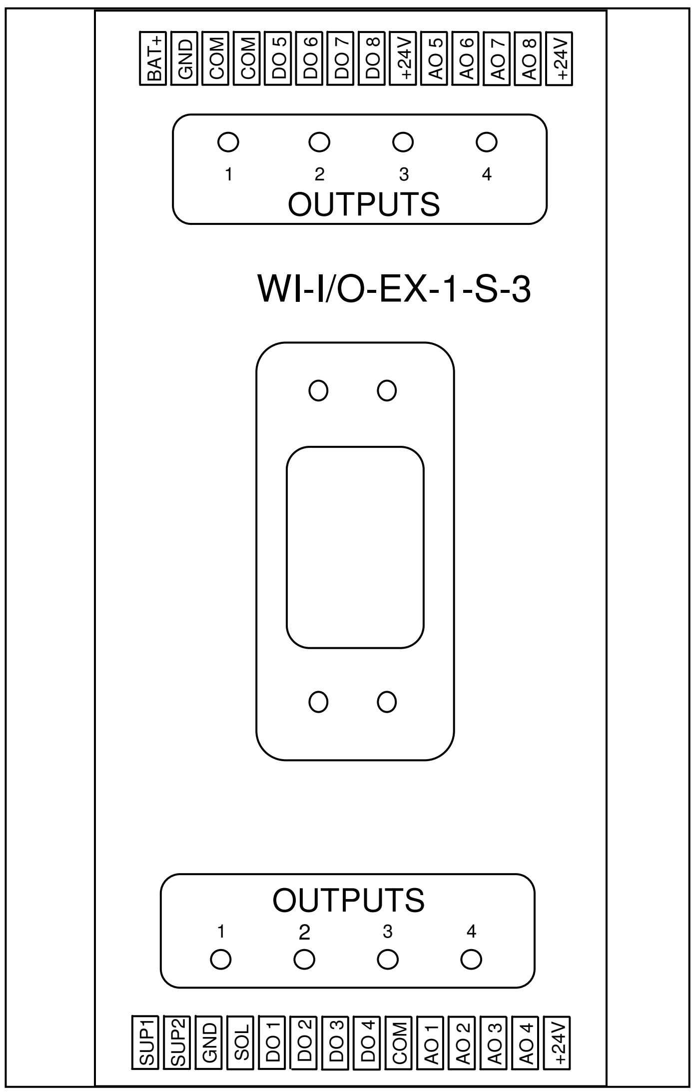
WIRING DRAWING -WI-I/O 9-1 WI-I/O-EX-1-S-1



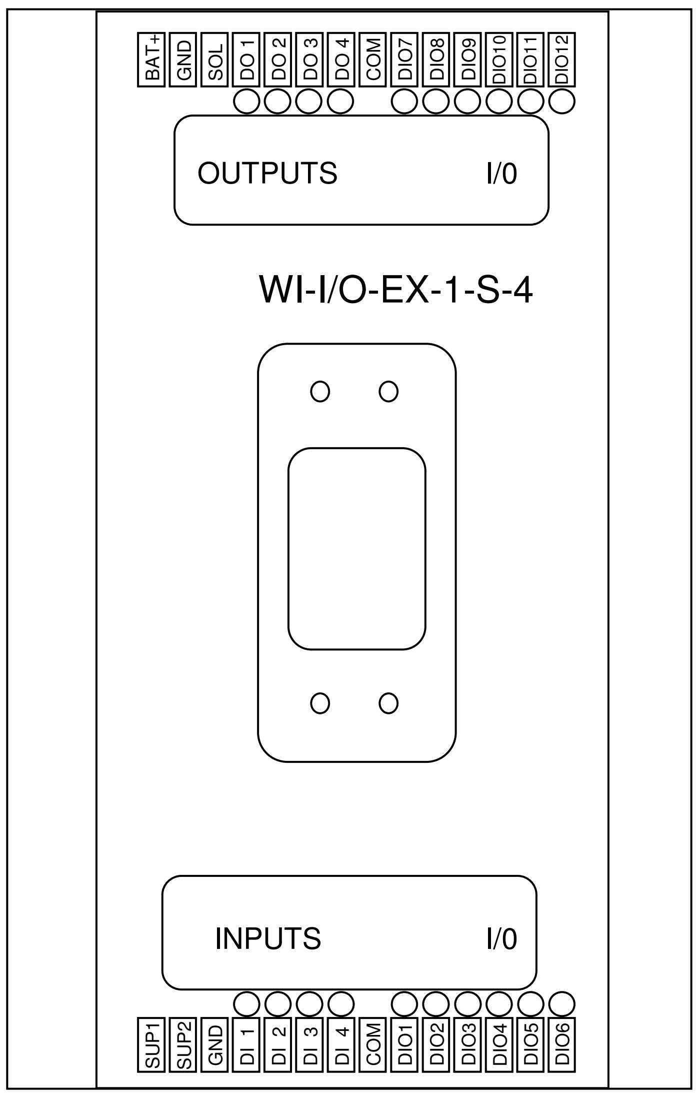
WIRING DRAWING - WI-I/O 9-2 WI-I/O-EX-1-S-2



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

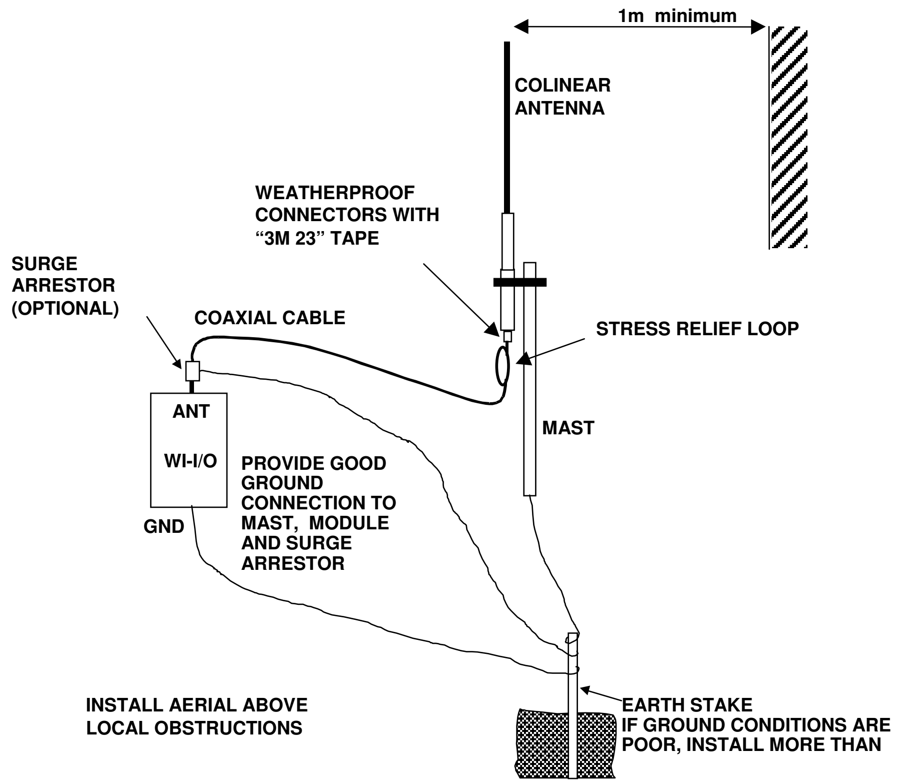
FCC Notice

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!

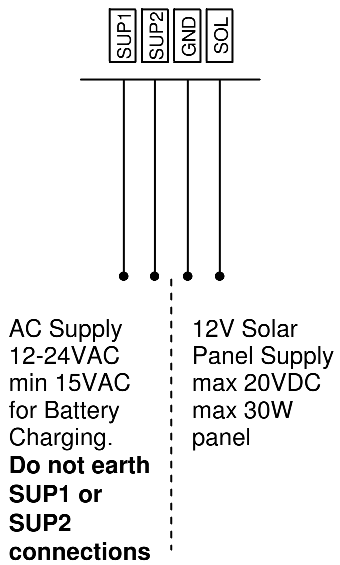
EXPLOSION HAZARD

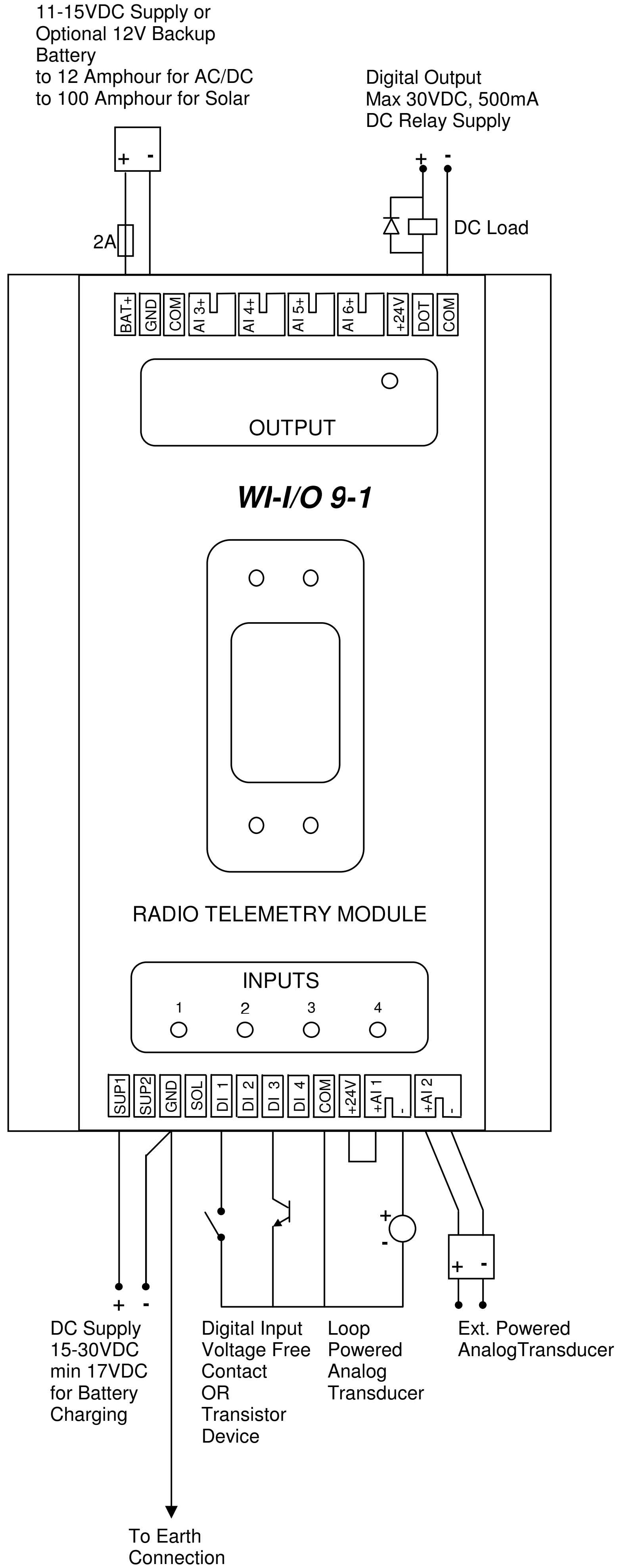
DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON – HAZARDOUS

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.

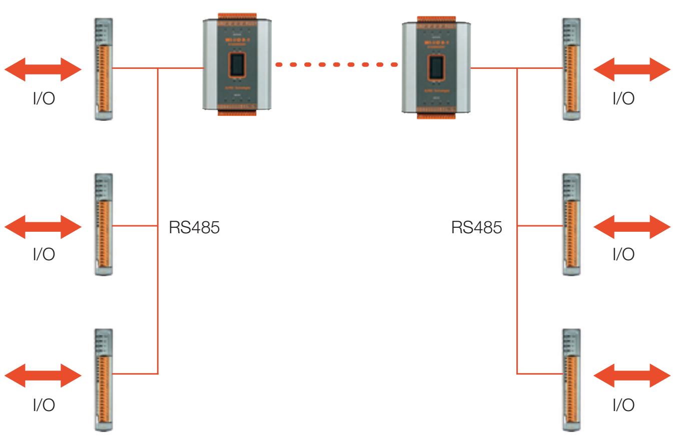
Typical Applications

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.

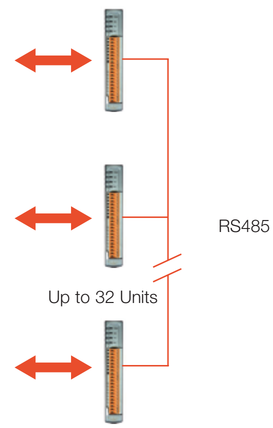
Expansion I/O for Modbus devices

- up to 31 x WI-I/O-EX units can be connected to each Modbus master via RS485 (up to 2 km long).

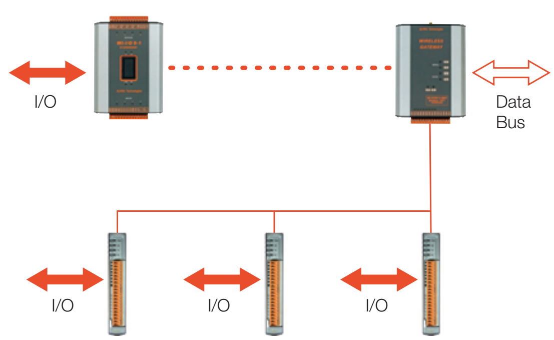


Features

- 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.

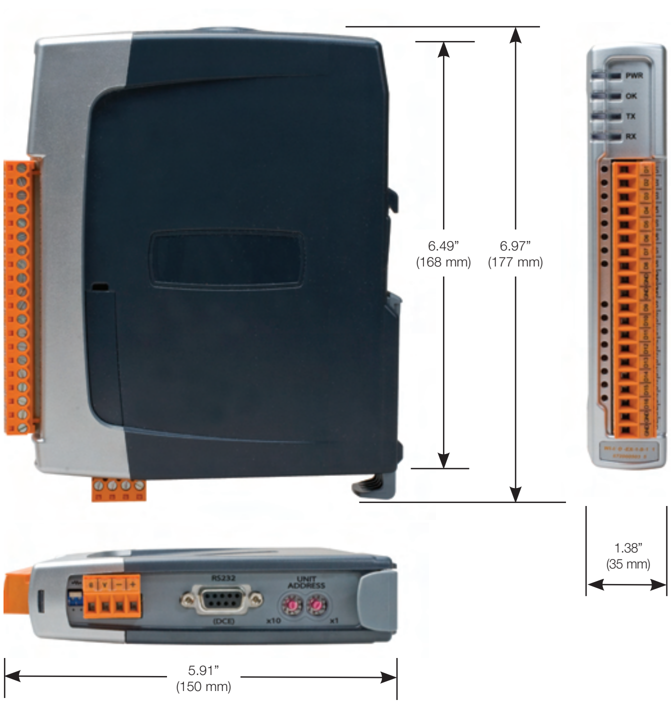
- Multiple communication-failure diagnostics with output status. Fail-to-transmit alarm and fail-to-receive alarm status.
- Class 1 Div 2 hazardous areas approval
- Input measurement display and output "forcing" diagnostics.
- Communication logging diagnostics.
- Easy-to-use E-Series Windows configuration 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

	WI-I/O-EX-1-S-11	WI-I/O-EX-1-S-12
		
Technical Data		
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**

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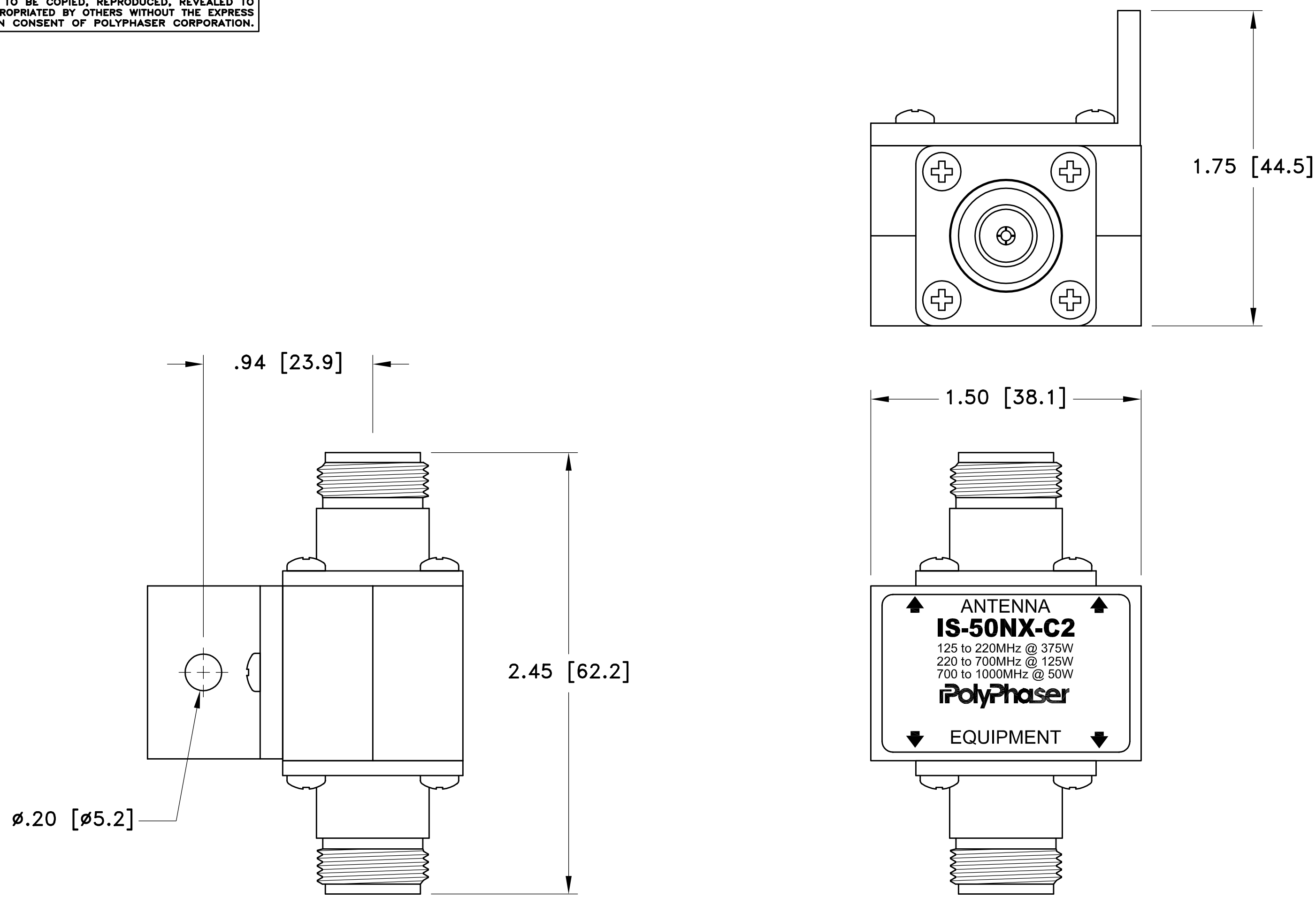
REVISIONS				
REV LTR	DATE	ENG	MKTG	Q.A.
A	01/30/96 PJP	T. K.	– –	R. M.
B	06/30/99 JCG	K.C.B.	T.G.F.	R. M.
C	01/16/01 SH	KCB	PH	RM
D	11/18/02 SH	LC	SD	LJ



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
MECH ENGINEER: – – – –	DATE: – – –	P.O. BOX 9000, MINDEN, NV 89423-9000 (775) 782-2511 FAX (775) 782-4476
ELEC ENGINEER: J. JONES	DATE: 04/12/95	DWG NO/PART NO/DESCRIPTION: 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

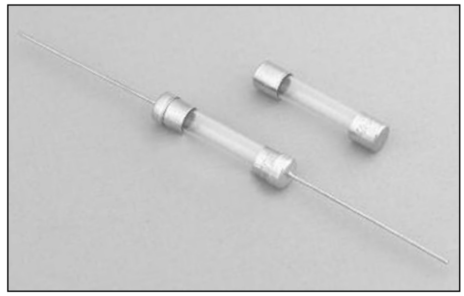
1/4" x 1-1/4" Fuses

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

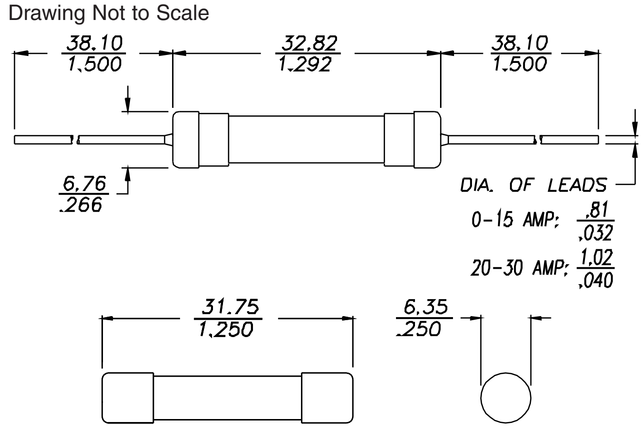
- Shock: 1/100A thru 3/4A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A thru 30A – MIL-STD-202, Method 204, Test Condition A (Except 5g, 500HZ)

Ordering

- Specify packaging, product, and option code

Dimensions (mm/in)

Drawing Not to Scale



SPECIFICATIONS							
Product Code	**Voltage Rating AC**	**AC Interrupting Rating 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 I^2t (A^2Sec) (I^2t was measured at listed interrupting rating and rated voltage.)

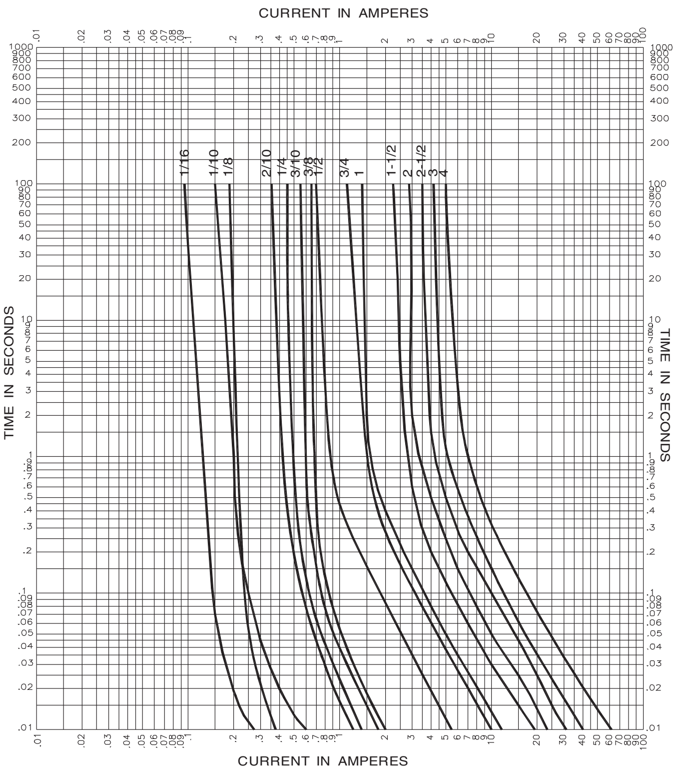
‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

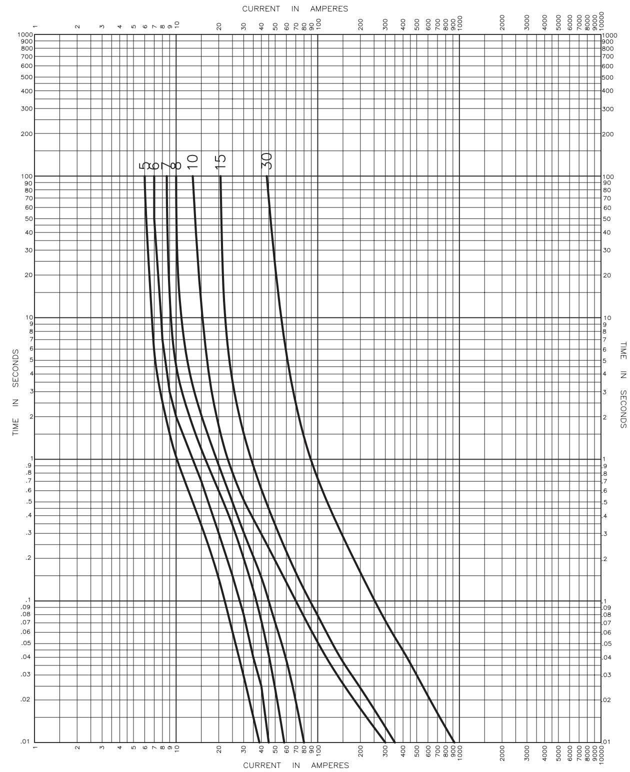
COOPER Bussmann

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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Fax: +65 270 4160

Industrial Automation Catalog Section - U906

Selection Guides

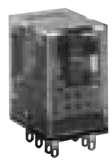
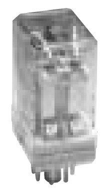
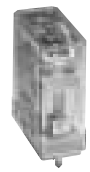
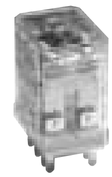
General Purpose Relays

- $\boxed{\text{RH Series}}$
- ~~RM Series~~
- ~~RY Series~~

idec

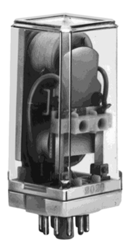
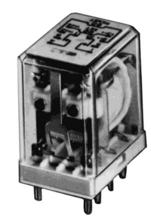
Selection Guides

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)

E

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

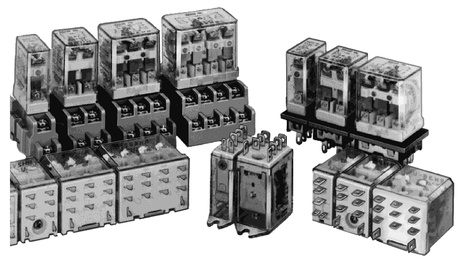
Solid State Relays

	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

	Rated Voltage	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

	Rated Voltage	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

<table>
<tr><th rowspan="2">Voltage</th><th rowspan="2">Rating</th><th colspan="4">Resistive</th><th colspan="4">Inductive</th><th colspan="3">Motor Load</th></tr>
<tr><th>SPDT</th><th>DPDT</th><th>3PDT</th><th>4PDT</th><th>SPDT</th><th>DPDT</th><th>3PDT</th><th>4PDT</th><th>SPDT</th><th>DPDT</th><th>3PDT</th></tr>
<tr><td>28V DC</td><td>UL</td><td>10A</td><td>10A</td><td>10A</td><td>10A</td><td>7.5A</td><td>—</td><td>—</td><td>7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="3">30V DC</td><td>UL</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td>—</td><td rowspan="3">7A</td><td>7A</td><td rowspan="2">—</td><td rowspan="2">—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>CSA</td><td rowspan="2">10A</td><td rowspan="2">7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Nominal</td><td>7.5A</td><td>7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>110V DC</td><td>Nominal</td><td>0.5A</td><td>0.5A</td><td>0.5A</td><td>0.5A</td><td>0.3A</td><td>0.3A</td><td>0.3A</td><td>0.3A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="3">120V AC</td><td>UL</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="2">7.5A</td><td>—</td><td rowspan="2">—</td><td rowspan="3">7.5A</td><td>1/6</td><td>1/6</td><td>1/6</td></tr>
<tr><td>CSA</td><td rowspan="2">7.5A</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Nominal</td><td>7A</td><td>7.5A</td></tr>
<tr><td rowspan="3">240V AC</td><td>UL</td><td rowspan="2">10A</td><td rowspan="2">10A</td><td rowspan="2">—</td><td rowspan="2">7.5A</td><td rowspan="2">7A</td><td rowspan="2">7A</td><td>*</td><td rowspan="3">5A</td><td>1/3</td><td>1/3</td><td>1/3</td></tr>
<tr><td>CSA</td><td>7A</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Nominal</td><td>7A</td><td>7.5A</td><td>7.5A</td><td>4.5A</td><td>5A</td><td>5A</td><td>5A</td></tr>
</table>

1. ** 6.5A/pole, 20A total.*
2. *Inductive load cos ø = 0.3, L/R = 7ms.*

E

Applicable Sockets

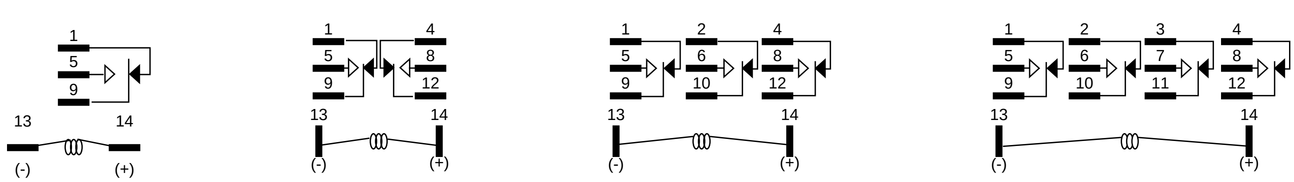
Part Numbers: Sockets

<table>
<tr><th>Relay</th><th>Standard DIN Rail Mount</th><th>Finger-Safe DIN Rail Mount</th><th>Surface Mount</th><th>Panel Mount</th><th>PCB Mount</th></tr>
<tr><td>RH1B</td><td>SH1B-05</td><td>SH1B-05C</td><td>—</td><td>SH1B-51</td><td>SH1B-62</td></tr>
<tr><td>RH2B</td><td>SH2B-05</td><td>SH2B-05C</td><td>SH2B-02</td><td>SH2B-51</td><td>SH2B-62</td></tr>
<tr><td>RH3B</td><td>SH3B-05</td><td>SH3B-05C</td><td rowspan="2">—</td><td>SH3B-51</td><td>SH3B-62</td></tr>
<tr><td>RH4B</td><td>SH4B-05</td><td>SH4B-05C</td><td>SH4B-51</td><td>SH4B-62</td></tr>
</table>

<table>
<tr><th colspan="2">Spring & Clips (optional)</th></tr>
<tr><th>Part Number</th><th>Use With</th></tr>
<tr><td>SY2S-02F1
SFA-101
SFA-202</td><td>SH1B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH1B-51, 62</td></tr>
<tr><td>SY4S-02F1
SFA-101
SFA-202</td><td>SH2B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH2B-51, 62</td></tr>
<tr><td>SH3B-05F1
SFA-101, -202</td><td>SH3B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH3B-51, 62</td></tr>
<tr><td>SH4B-02F1
SFA-101, -202</td><td>SH4B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH4B-51, 62</td></tr>
</table>

See Section F for details on sockets. All DIN rail mount sockets shown above can be mounted using DIN rail BNDN1000.

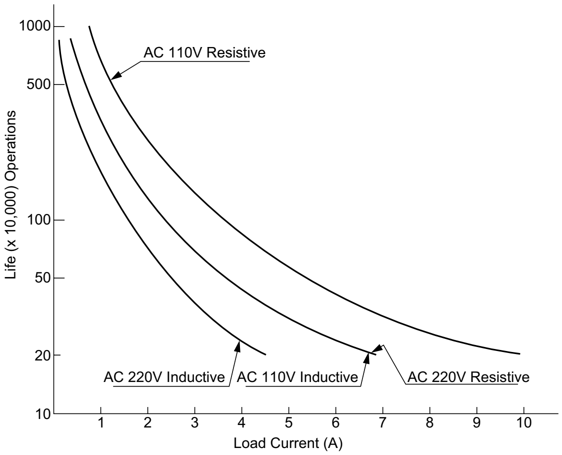
Internal Circuits

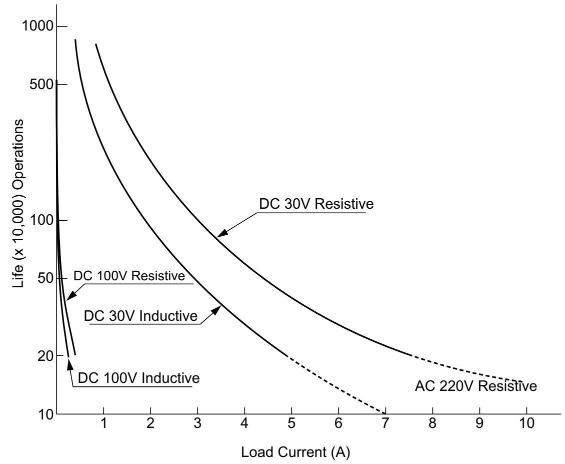


RH1 RH2 RH3 RH4

Electrical Life Curves

RH1





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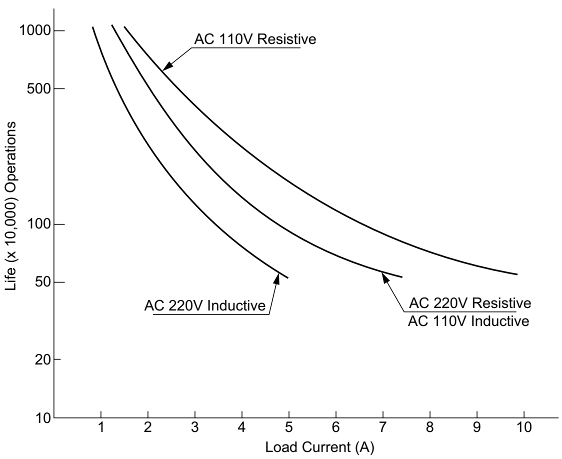
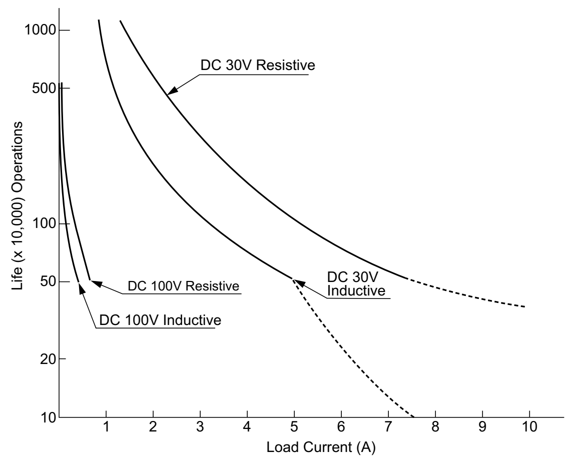
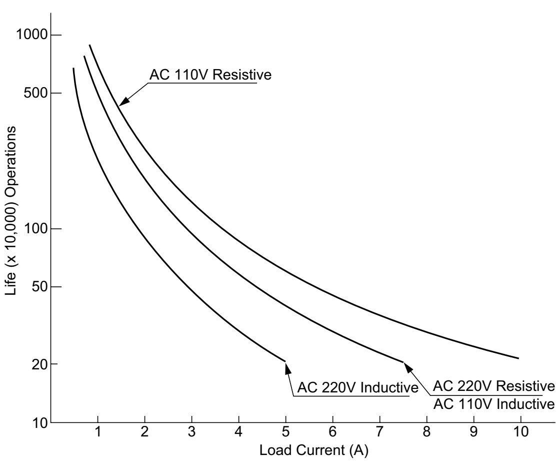
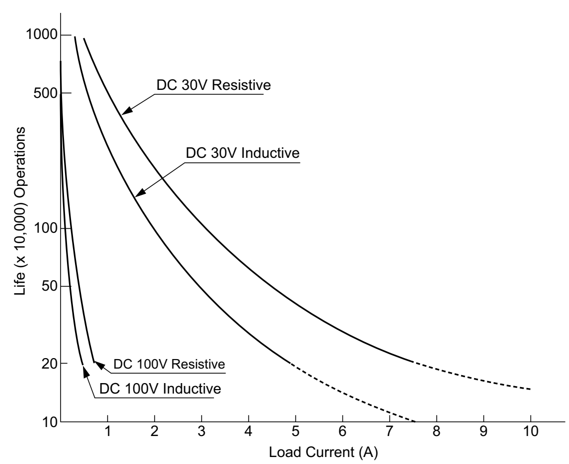
RH2





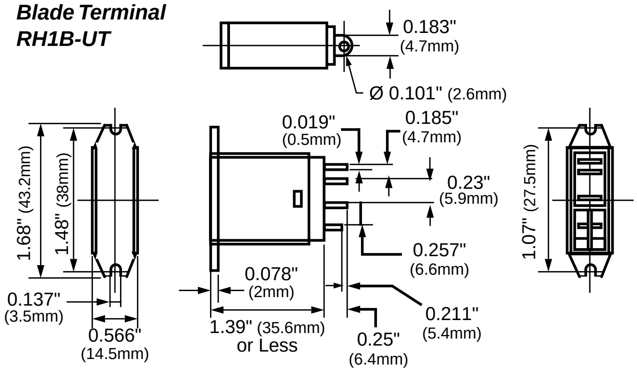
RH3 and 4



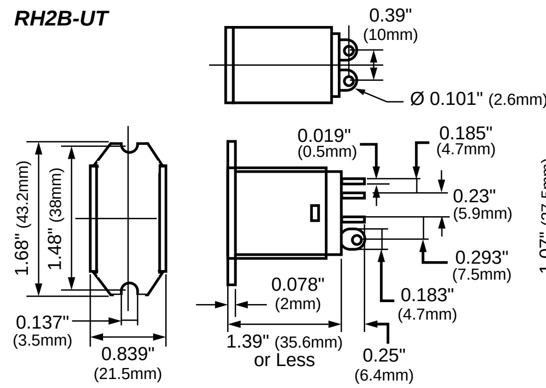


Dimensions

Top Bracket Mounting
Blade Terminal
RH1B-UT

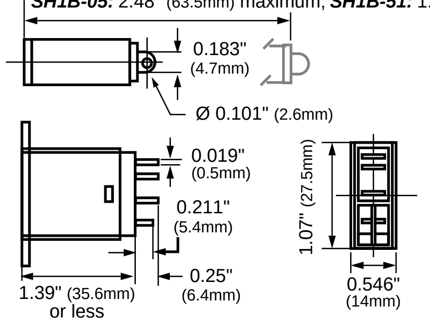


RH2B-UT



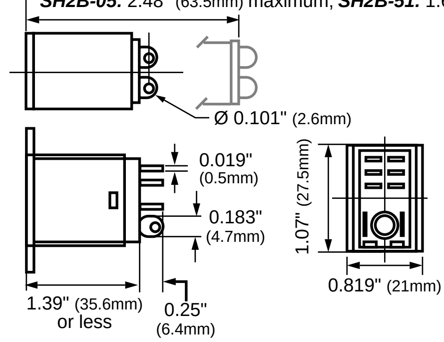
Plug-in
Blade Terminal
RH1B

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



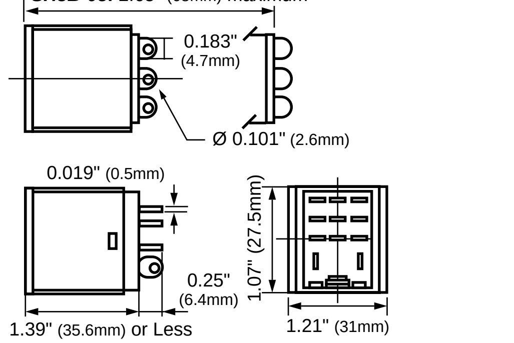
RH2B

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)



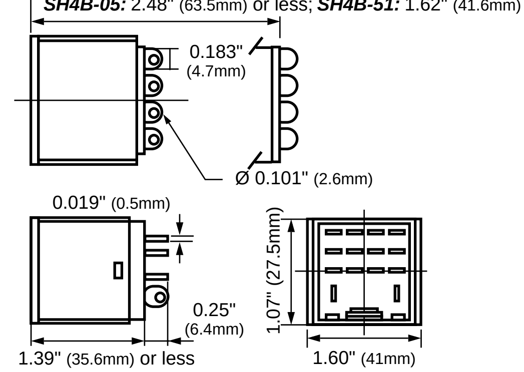
Plug-in
Blade Terminal
RH3B

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

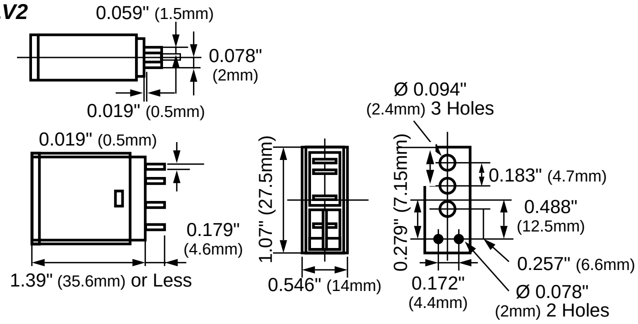
Total length from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39.6mm)
Total length from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41.6mm)



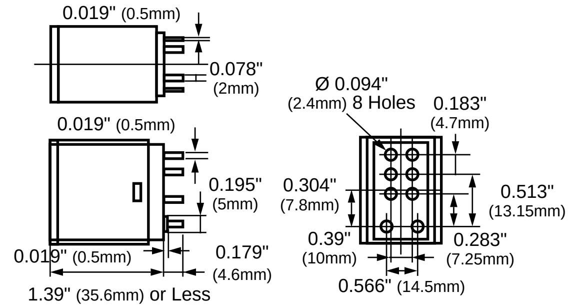
Dimensions

PCB Terminal

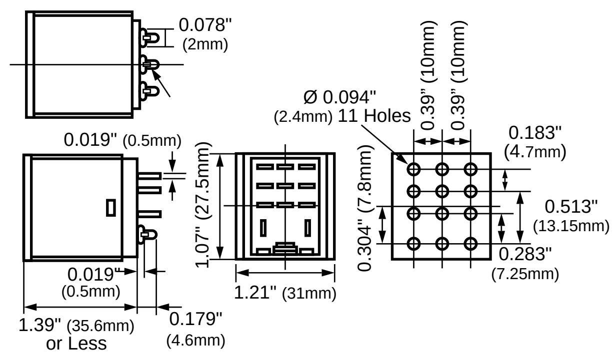
RH1V2



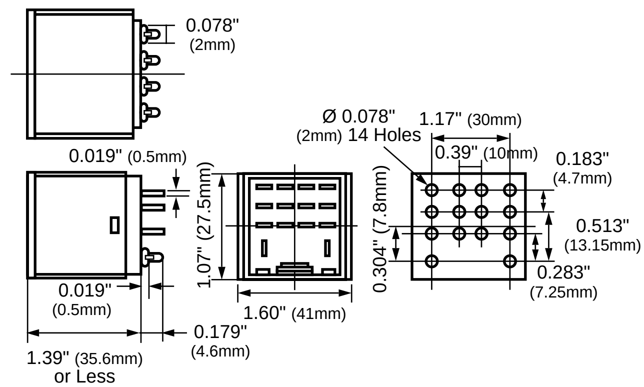
RH2V2



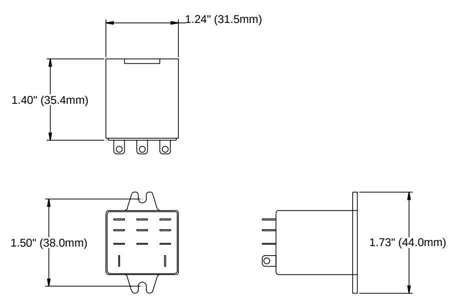
RH3V2



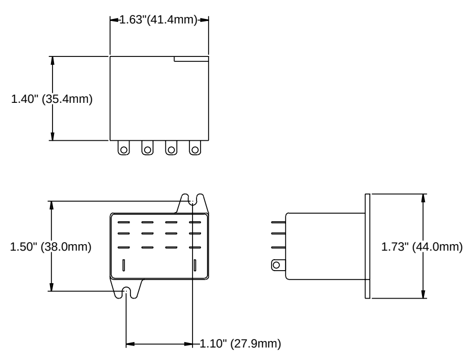
RH4V2



RH3B-UT



RH4B-UT



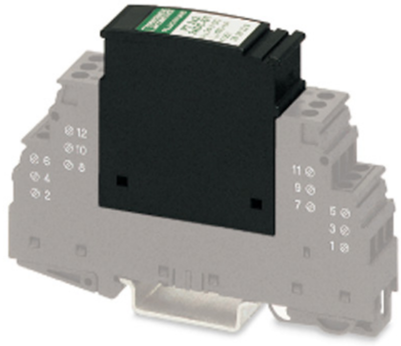
E

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

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

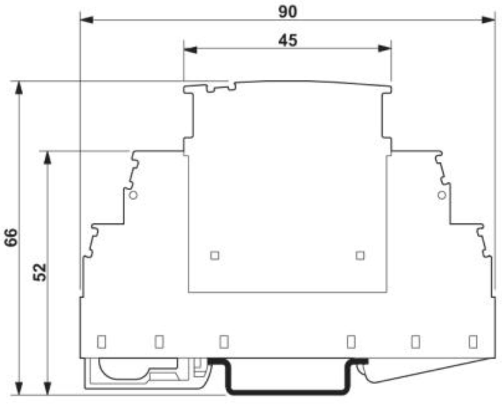
0808668	ZBF 5/WH-100:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, large batch, sufficient for labeling 1000 terminal blocks, color: white
0808642	ZBF 5:UNBEDRUCKT	Zack strip, flat, unprinted: 10-section, for individual labeling with M-PEN or ZBF-T, 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

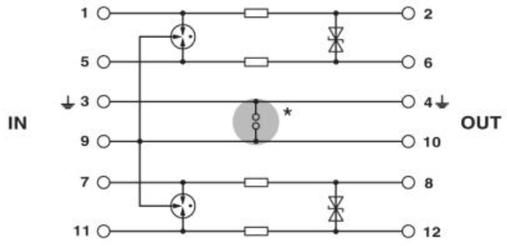
Drawings

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

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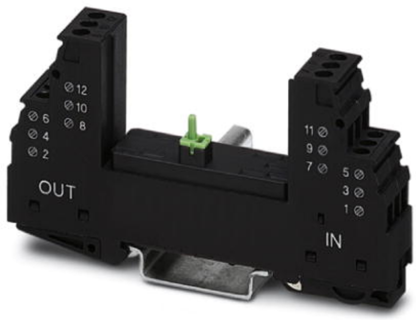
Extract from the online catalog

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

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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

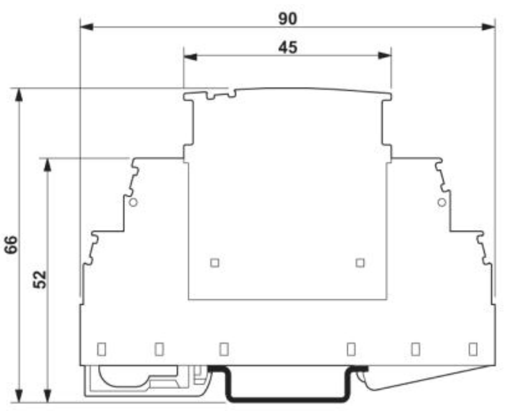
Certification	GOST, UL Listed
Certification Ex:	CUL-EX LIS, UL-EX LIS

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

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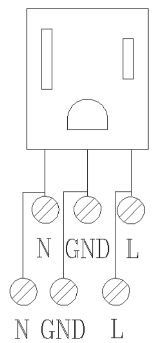
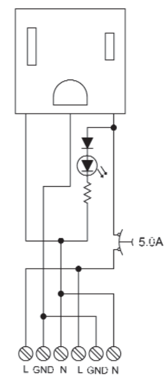
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- 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



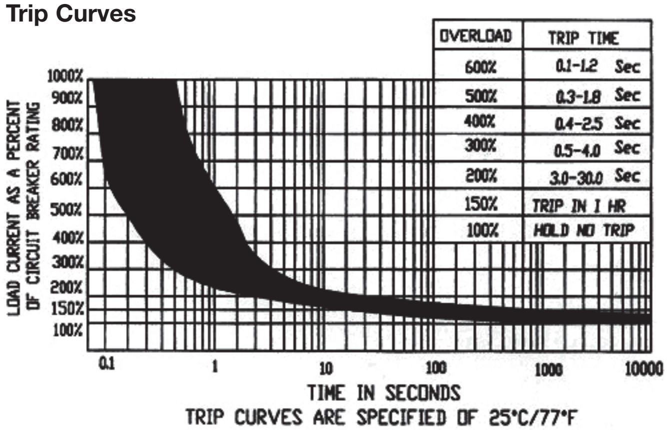
Schematic diagram



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



PHOENIX CONTACT

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

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)

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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)

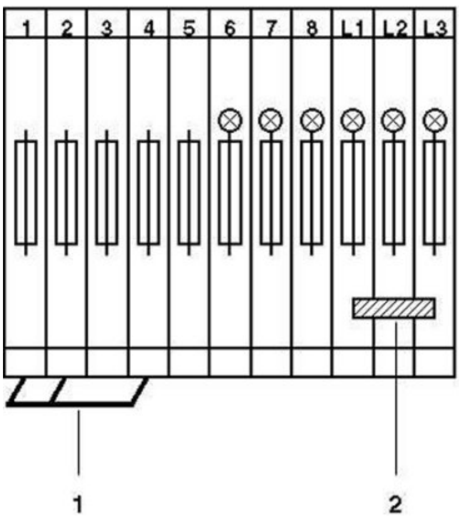
Connection data

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

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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

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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

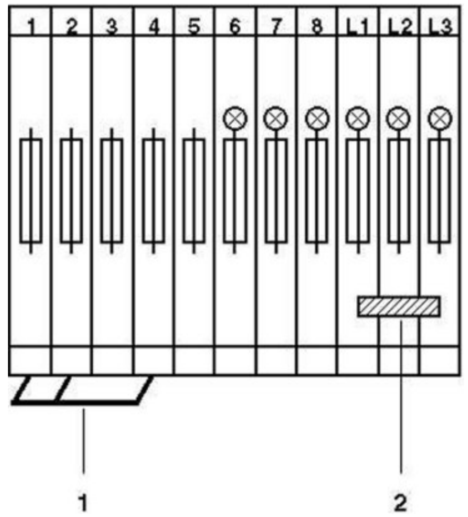
Technical data	
Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Pollution degree	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current I_N	10 A
Nominal voltage U_N	500 V (As a fuse terminal block)

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

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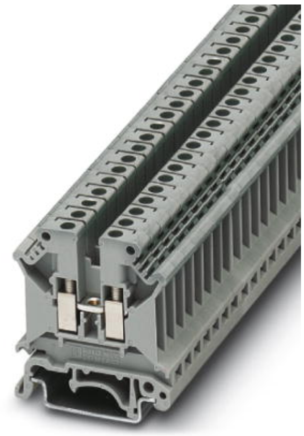
Extract from the online catalog

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

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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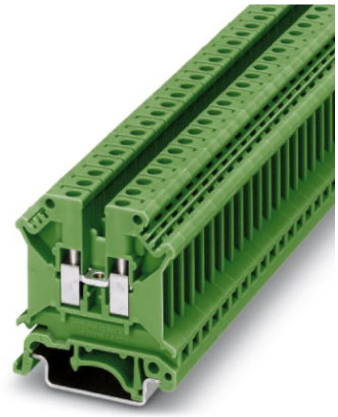
UK 5 N GN

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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GL

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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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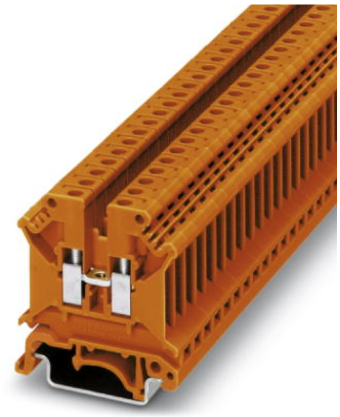
UK 5 N OG

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

Commercial data	
EAN	4017918117498
sales group	A000
Pack	50 pcs.
Customs tariff	85369010
Weight/Piece	0.00922 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)

FM
APPROVED

GL

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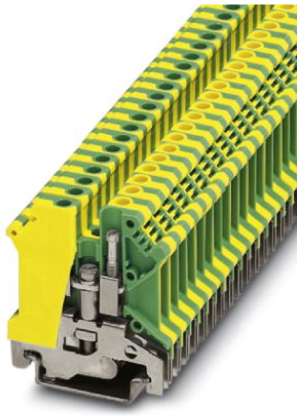
USLKG 5

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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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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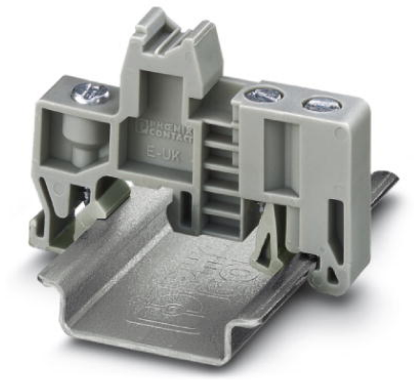
E/UK

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

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Technical data

General

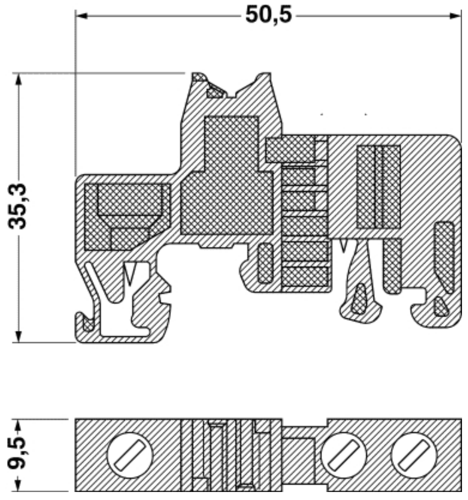
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

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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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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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.

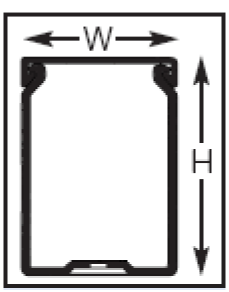
MATERIAL:
Rigid PVC,
self-extinguishing

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) 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.

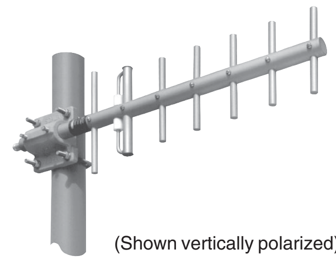
Materials Technical Characteristics	Unit of Measure	Standard	PVC Duct Value	PVC Moulded Components Value	Polyamide 6 Value	Polyethylene Value	Flame Retardant Polyethylene Value
CHEMICAL-PHYSICAL PROPERTIES							
Specific gravity	g/cm^3	ASTM D792	1.55	1.32	1.14	0.92	0.97
H2O 73,4° F absorbtion	%	ISO 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

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.



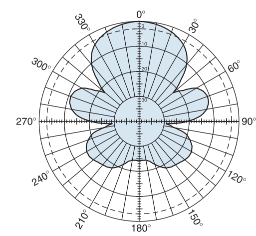
(Shown vertically polarized)

Specifications:

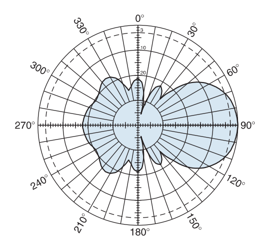
Frequency range	890–960 MHz (broadband)
Gain	10 dBd
Impedance	50 ohms
VSWR	< 1.5:1 maximum (1.35:1 typical)
Polarization	Horizontal or vertical
Front-to-back ratio	>20 dB
Maximum input power	100 watts (at 50°C)
H-plane beamwidth	48 degrees (half-power)
E-plane beamwidth	40 degrees (half-power)
Connector	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



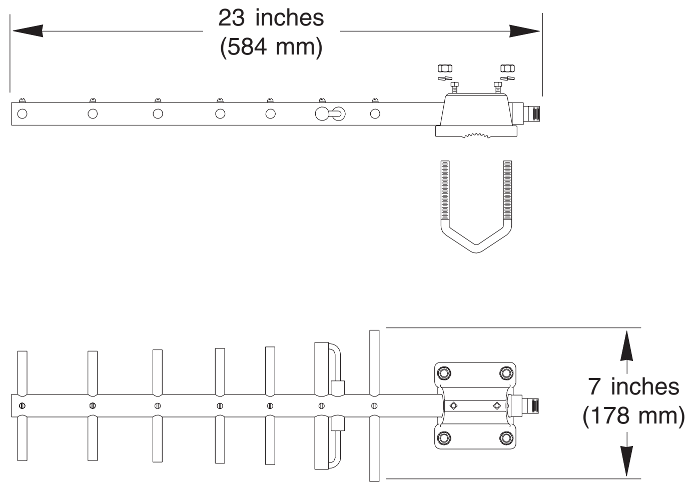
E-plane
Horizontal pattern – H-polarization
Vertical pattern – V-polarization

TÜV MANAGEMENT SERVICE ISO 9001

10065-D

Kathrein Inc., Scala Division Post Office Box 4580 Medford, OR 97501 (USA) Phone: (541) 779-6500 Fax: (541) 779-3991
Email: communications@kathrein.com Internet: www.kathrein-scala.com

TY-900
Yagi Antenna



Order Information:

Model	Description
TY-900	Yagi antenna with N connector

All specifications are subject to change without notice

Kathrein Inc., Scala Division Post Office Box 4580 Medford, OR 97501 (USA) Phone: (541) 779-6500 Fax: (541) 779-3991
Email: communications@kathrein.com Internet: www.kathrein-scala.com

RTUS 903-3 THROUGH 903-7
EXTRACTION WELLS CONTROL PANEL EQUIPMENT

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

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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.

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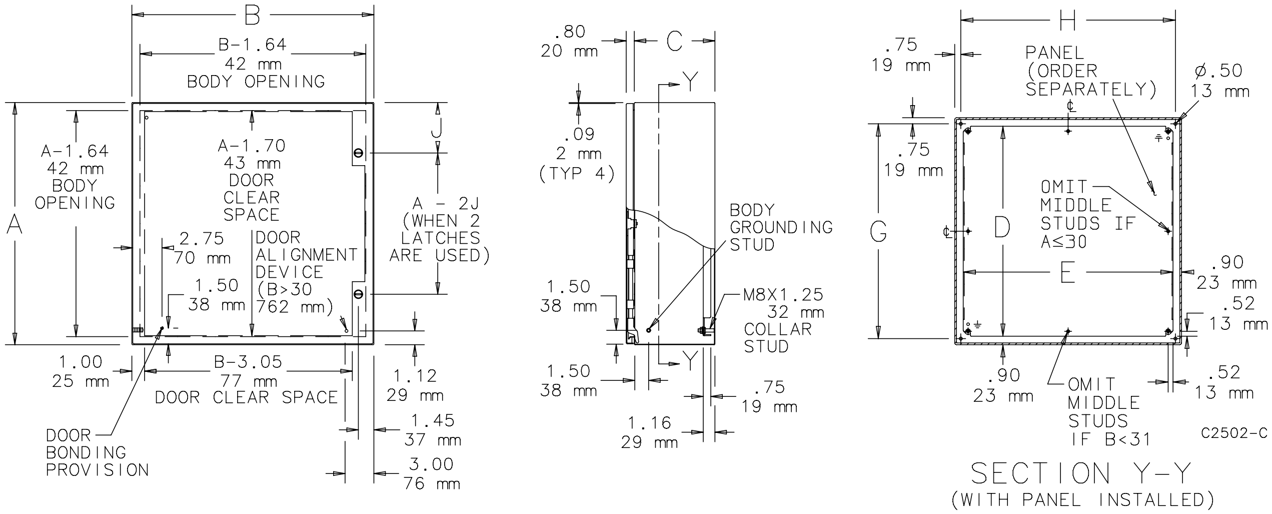
CONCEPT® Wall-Mount Enclosures



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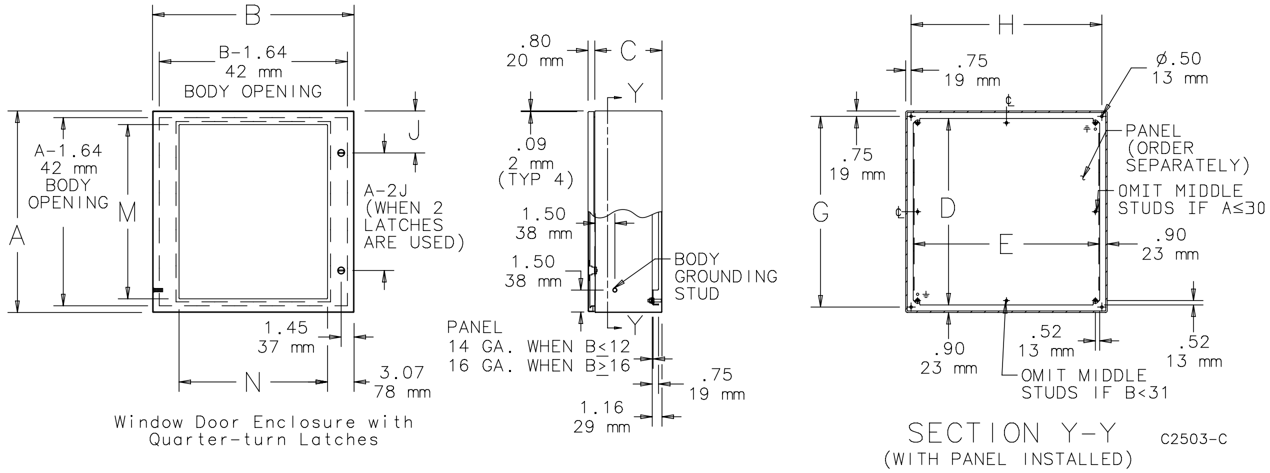
CONCEPT® Wall-Mount Enclosures

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



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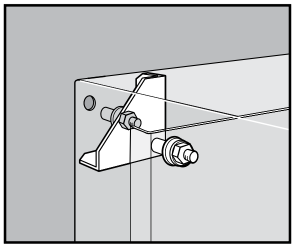
CONCEPT® Accessories

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)

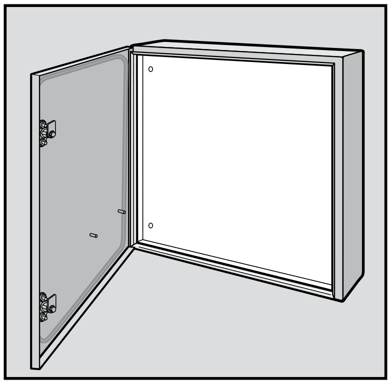
Swing-Out Rack Frame

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

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CONCEPT® Accessories

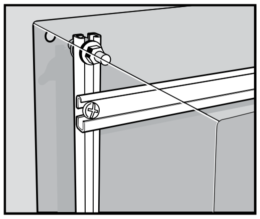
Pole-Mount Kit

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

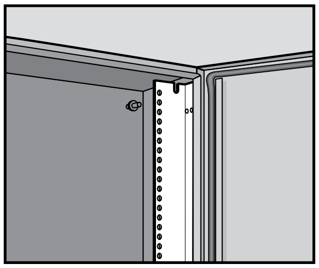


Mounting Channels provide mounting framework for installing DIN rails and grid straps at various positions within the enclosure. Channels can be mounted vertically or horizontally to collar studs or to the slide mechanisms of the adjustable-depth mounting kit. Kit includes two channels.

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)

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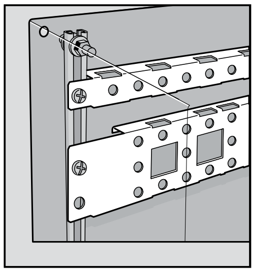
CONCEPT® Accessories

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

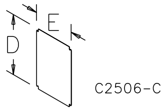
Catalog Number	Fits CONCEPT Enclosure
CGS112	when A or B = 12.00 in. (305 mm)
CGS116	when A or B = 16.00 in. (406 mm)
CGS120	when A or B = 20.00 in. (508 mm)
CGS124	when A or B = 24.00 in. (610 mm)
CGS130	when A or B = 30.00 in. (762 mm)
CGS336	when A or B = 36.00 in. (914 mm)
CGS348	when A or B = 48.00 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.

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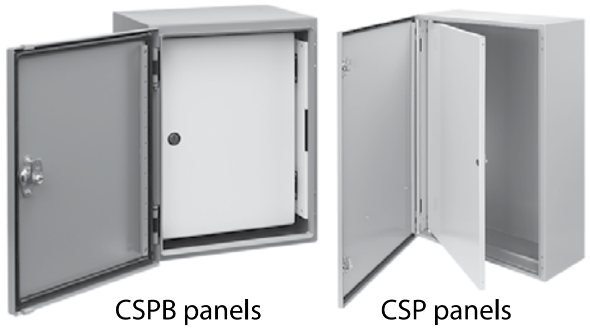
CONCEPT® Accessories

CONCEPT® Swing-Out 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.

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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	when A is less than or equal to 24
	152 x 152	and B is less than or equal to 24
ADP2	12.00 x 12.00	when A is greater than or equal to 30
	305 x 305	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

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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

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30.5 mm Push Buttons

Push Button Operators, Continued

Momentary Contact Push Button Units, Illuminated

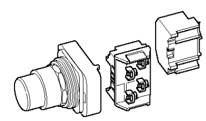
Extended Head Without Guard
Cat. No. 800T-PB16R

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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Type 2 AC power Surge Protector

DS40

Imax 40 kA

A30

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.

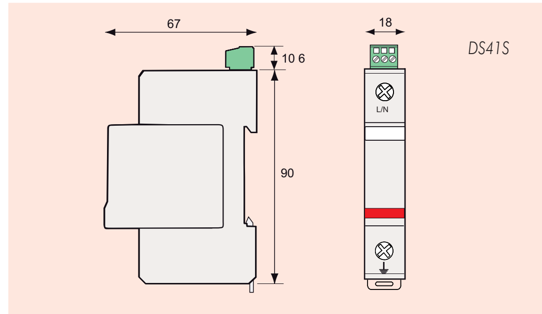
The DS40 impulse discharge capability classifies this SPD as regular Type 2, useful in case of medium lightning density areas. IEC60364 standard requests Type 2 SPD at the entrance of installation if the keraunic level Nk > 25.

*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).*

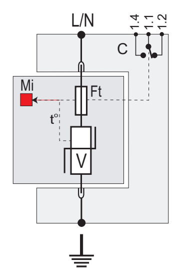
The DS40 is available for a large range of AC voltages.
The DS40 is DIN rail compatible and is built with a plug in module (DSM40 xxx) and a fixed base, which allows an easy and fast maintenance.

- **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

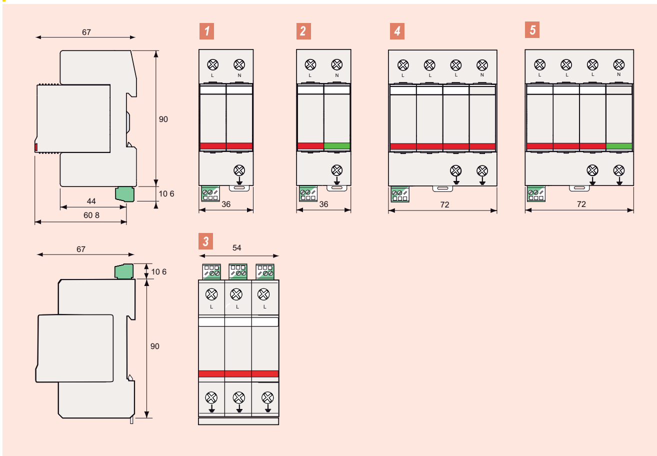
CITEL part number		**DS41-400**	**DS41-230**	**DS41-120**
Network		230/400V	230/400V	120/208V
Max. operating voltage	Uc	400 Vac	255 Vac	150 Vac
Temporary overvoltage withstand	U_T	400 Vac	255 Vac	150 Vac
Operating current *Leakage current at Uc*	Ic	< 1 mA	< 1 mA	< 1 mA
Follow current	If	none	none	none
Nominal discharge current *15 x 8/20 µs impulse*	In	20 kA	20 kA	20 kA
Maximum discharge current *max. withstand 8/20 µs*	Imax	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		

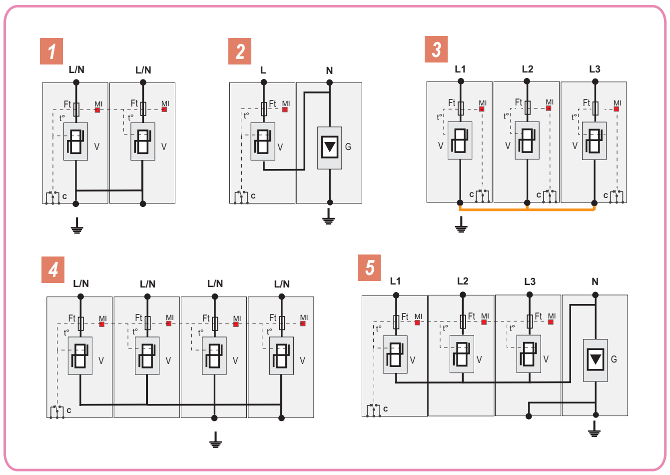
Note 1: Rating in compliance with nominal discharge current. In order to increase service continuity, higher rating can be used (up to 125 A). For further information, please consult product instructions..

Type 2 AC power Multipolar Surge Protector

DS42
DS43
DS44

Dimensions and Diagram





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)

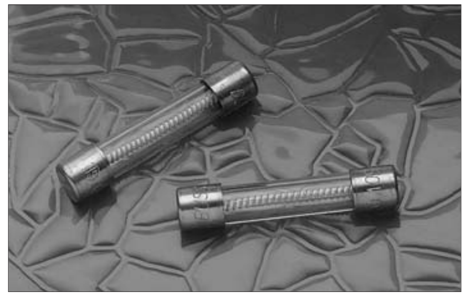
Ordering

Specify packaging code

- Insert packaging code prefix before part number. E.g., BK (or BK1)-MDL-5-R

Specify option codes if desired

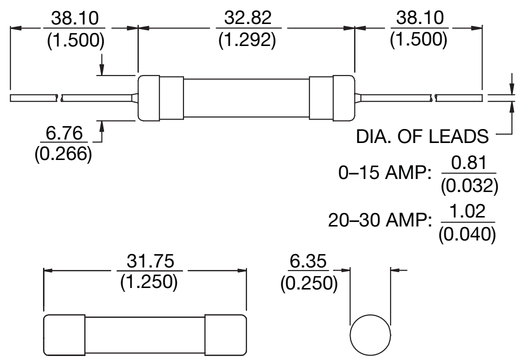
- For axial leads, insert “V” between catalog series and amp rating. E.g., BK-MDL-V-5-R



- 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

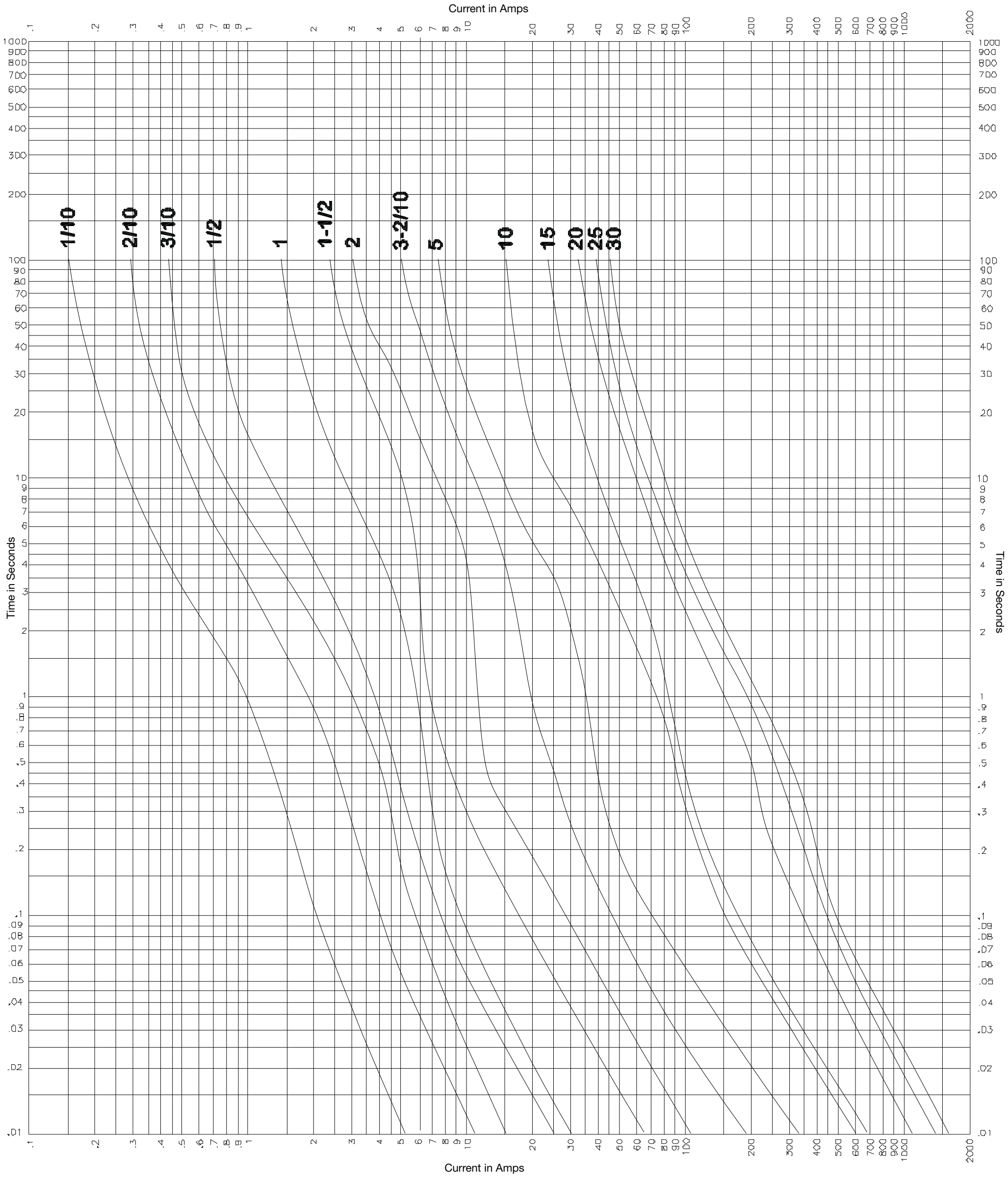


Specifications

Part Number	Voltage Rating Vac	AC Interrupting Rating* (amps)@ 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

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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.

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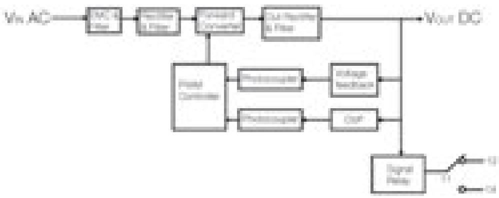


General ordering data	
Order No.	8708670000
Part designation	CP SNT 120W 24V 5A
Version	Switched-mode power supplies
EAN	4032248380831
Qty.	1 pc(s).

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

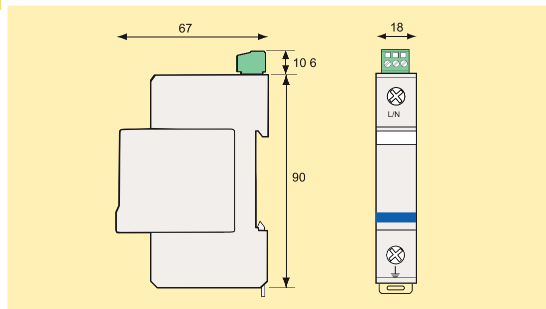
The DS220 24DC surge protector is designed to protect equiptment connected to DC (and AC) power supplies from lightning surges.

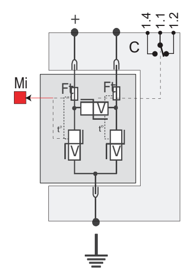
It is based on varistors matched to the network voltage. This SPD is based on varistors equipped with thermal disconnector and failure indicators. Version with remote signaling for disconnection indication is also available. (DS220S 24DC).

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

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

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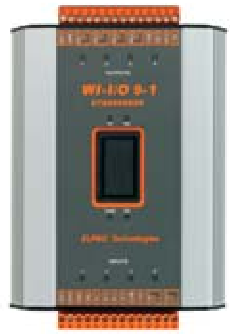
	WI-I/O 9-1	WI-I/O 9-2
		

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**

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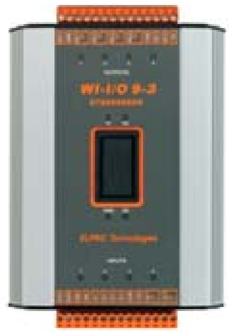
	WI-I/O 9-3	WI-I/O 9-4
		

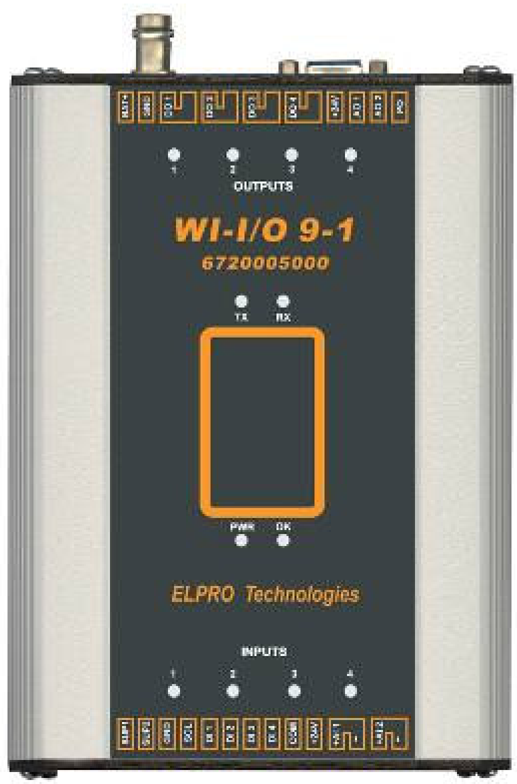
Technical Data		
Inputs		
Digital: opto-isolated (5000V) inputs suitable for voltage free contacts or NPN transistor, contact wetting current 5 mA		up to 16 inputs (4 inputs + 12 selectable I/O) the 12 selectable inputs are surge protected but not isolated
Analog: “floating” differential inputs, common 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**.

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

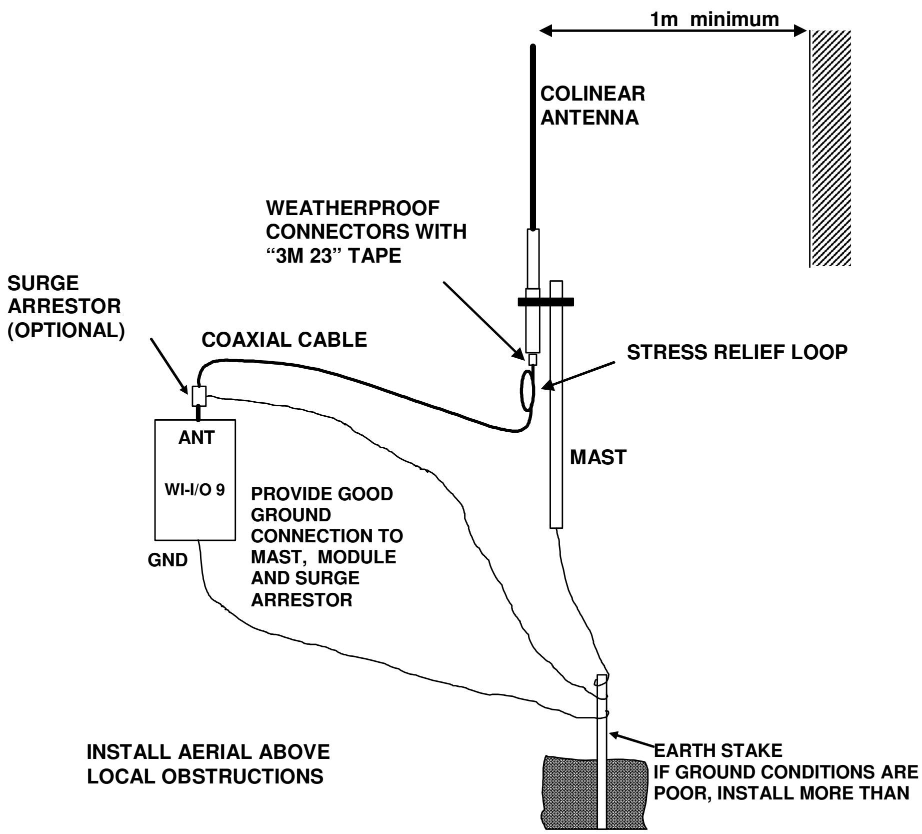
The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6 element Yagi with 70 feet (20 metres) of Cellfoil has a net gain of 4dB (10dB – 6dB).

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.

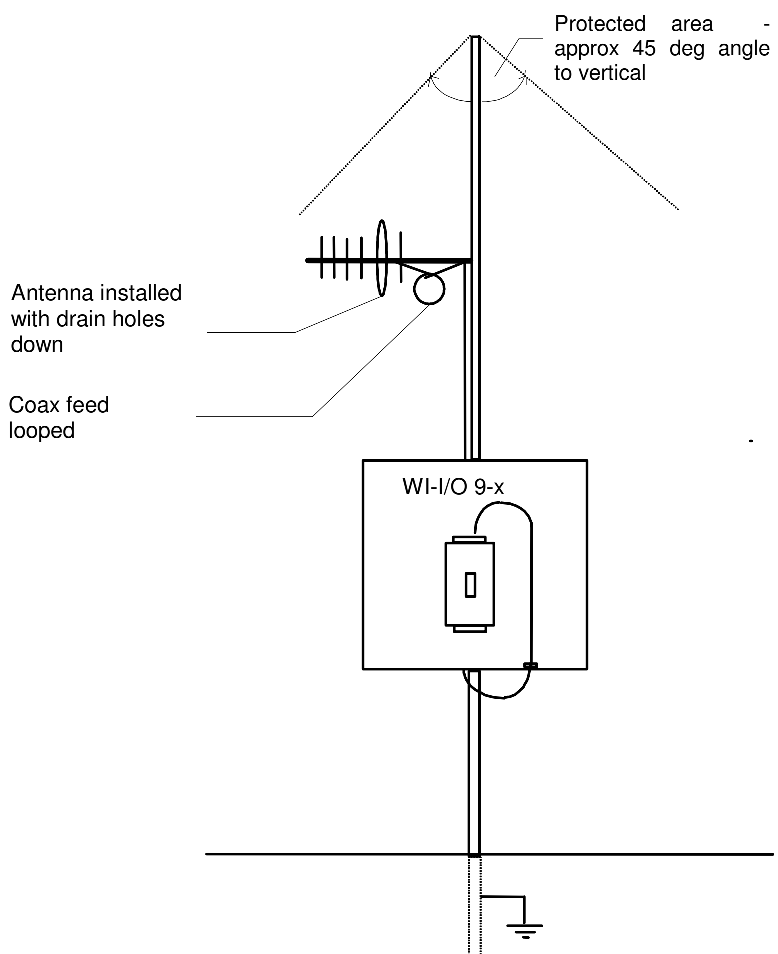
2.2.2 Yagi antennas.

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

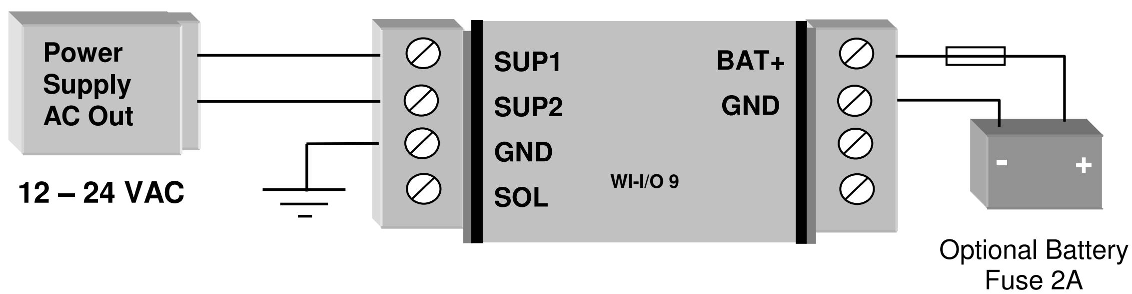
11.5 -15 volts DC at the “battery” terminals.

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

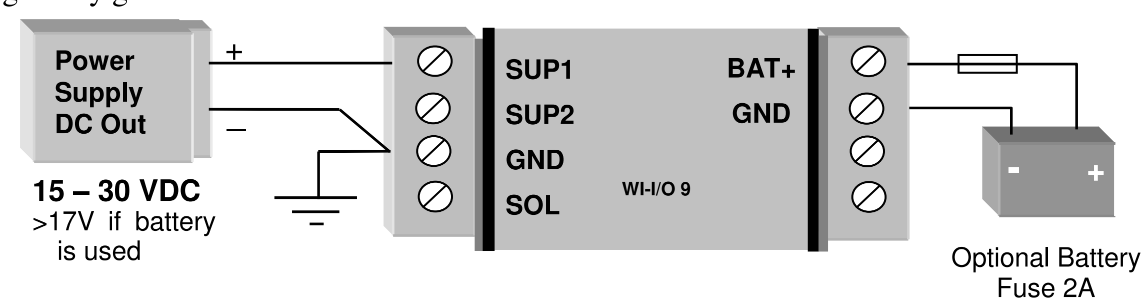
The AC supply is connected to the "SUP1" and "SUP2" terminals as shown below.



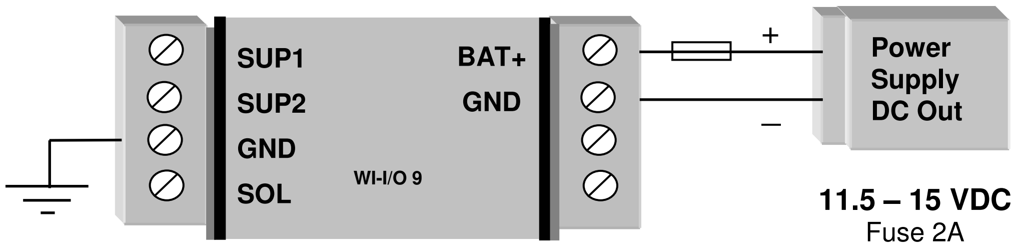
The AC supply should be "floating" relative to earth. AC transformers with grounded/earthed secondary windings should **not** be used.

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

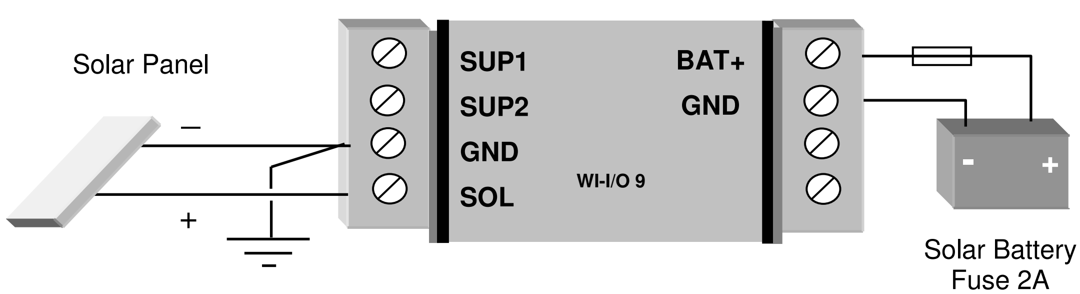
The power supply also includes a 12 V solar regulator for connecting 12V solar panels of up to 30W, and solar batteries of up to 100AHr. **The unit must not be powered from a solar panel without a battery.** A 20W solar panel is sufficient for most solar applications. The size of the solar battery required 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.

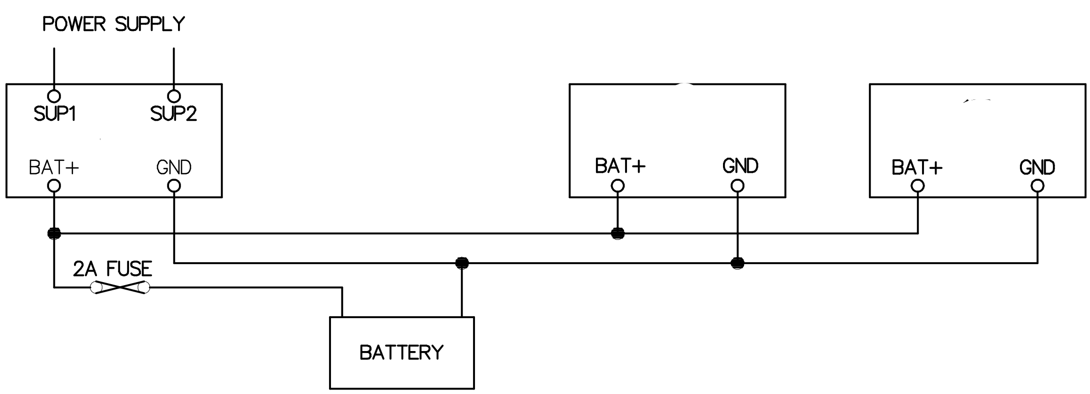
Where a panel larger than 30W is required, an external solar regulator should be used.

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

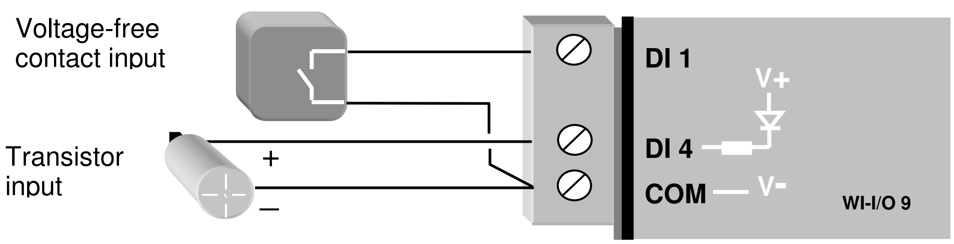
Each module provides a 24V DC regulated supply for analog loop power, except for WI-I/O 9-4_WI-I/O-EX-1-S-4. The supply is rated at 150mA, and should **only** be used for powering analog loops.

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.

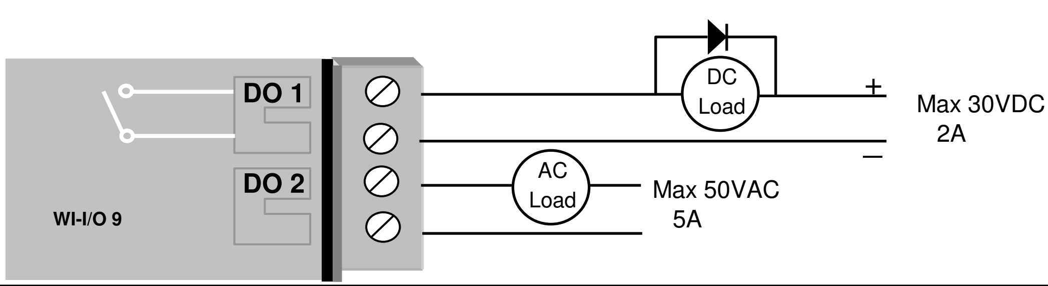
Each digital input is connected between the appropriate "DI" terminal and common "COM". Each digital input circuit includes a LED indicator which is lit when the digital input is active, that is, when the input circuit is closed. Provided the resistance of the switching device is less than 200 ohms, 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.

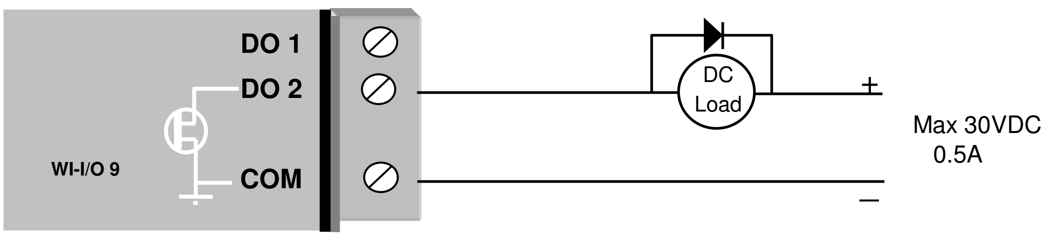


Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See section 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.



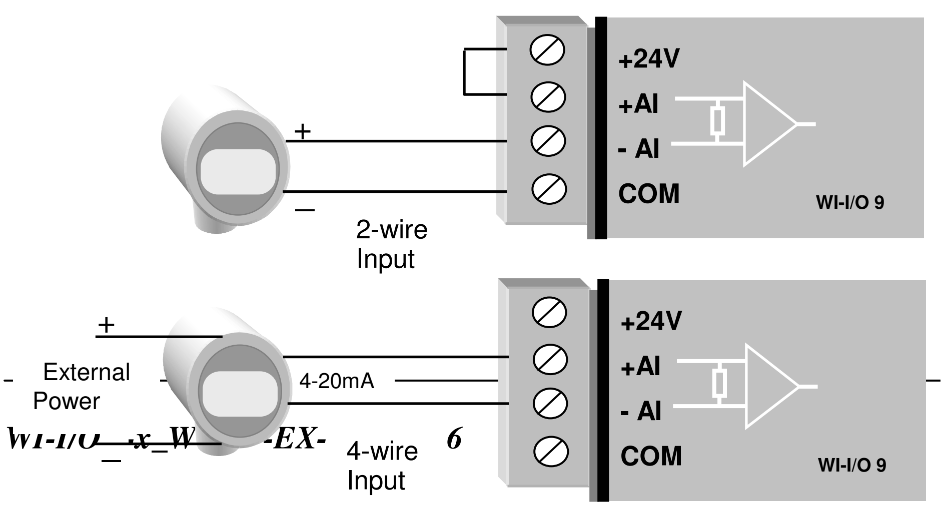
Digital outputs may be configured to individually turn off if no command message is received to that output for a certain period. This feature provides an intelligent watch dog for each output, so that a communications failure at a transmitting site causes the output to revert to a known state. See Chapter 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.

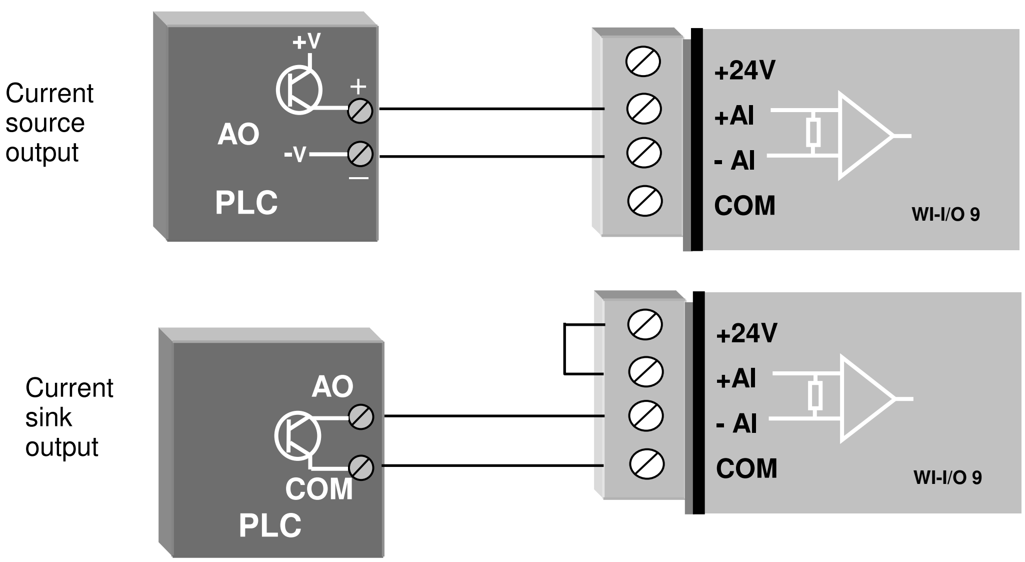
A 24VDC loop supply is available on the module for powering the analog transducer loops. In this case, the analog loop should be connected between a "AI 1-" terminal and "COM" (for the first analog input) or "AI 2-" (for the second analog input), and so on for other inputs.

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.

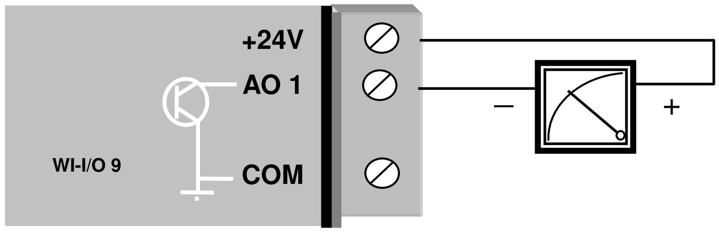
To connect an AI on the WI-I/O 9-x to an analog signal from a PLC or DCS output, check the internal circuit of the output carefully as different devices use different ways to create an analog signal. The following diagram shows two ways of connecting.



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.

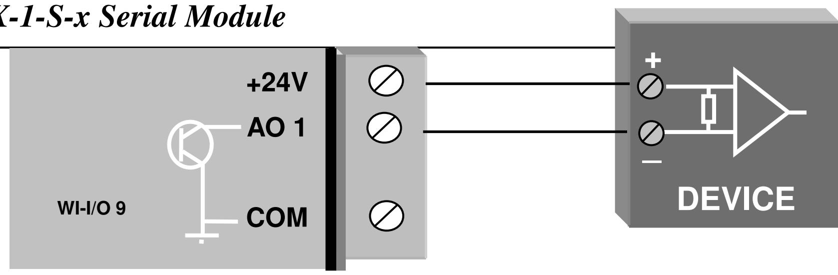


A 24VDC supply is available on the module for powering the analog output loop (max external loop resistance 1000 ohms). In this case, the analog loop is connected between a "+24V" terminal and "AO 1" (for the first analog output) or "AO 2" (for the second analog output), and so on for the other output signals.

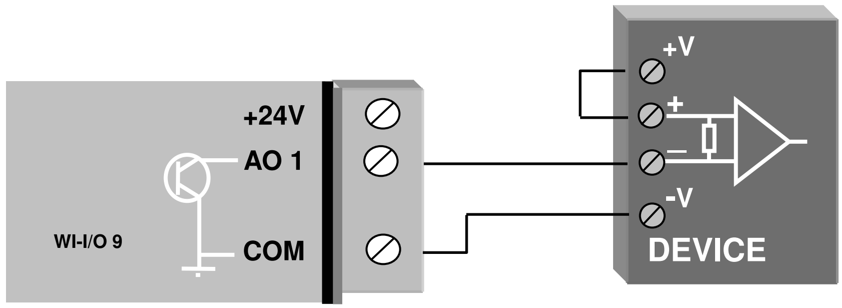
If connecting to an external device such as an electronic indicator, recorder or PLC / DCS input, the loop can be powered by either the WI-I/O 9-x or the device. Externally powered loops to 27 VDC may be connected by connecting the output between the "AO" terminal (positive) and the "COM" terminal (negative). 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.

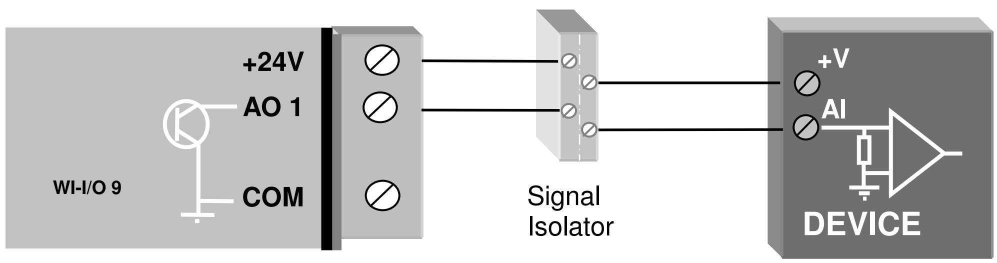


Connecting to a floating input device, powered from the WI-I/O 9-x



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.

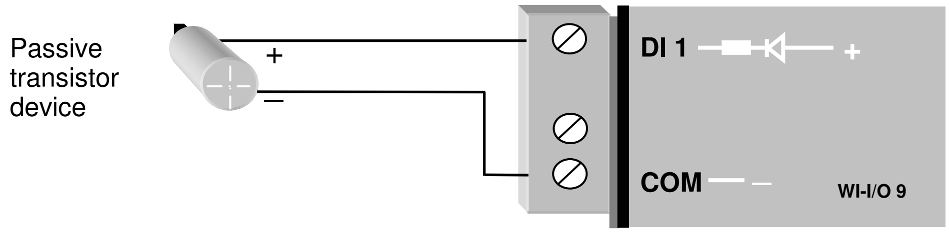
Connecting to an externally powered floating-input device

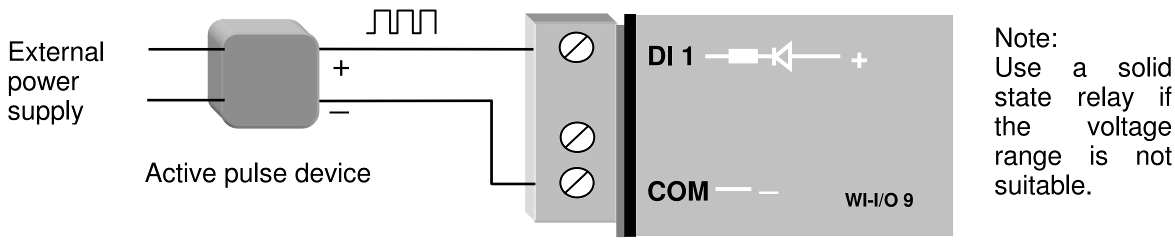


Connecting to a grounded input device via a signal isolator

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.





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.

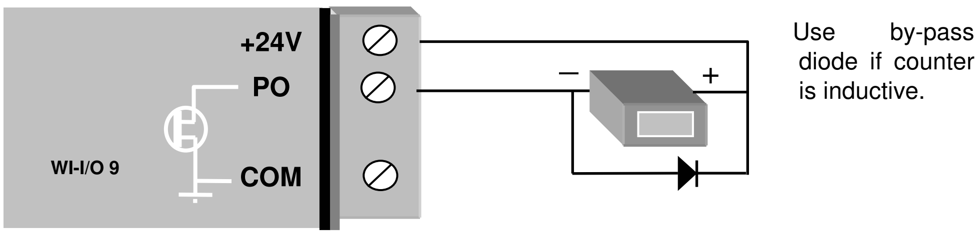
2.4.7 Pulse Inputs (WI-I/O 9-2 and WI-I/O 9-4)

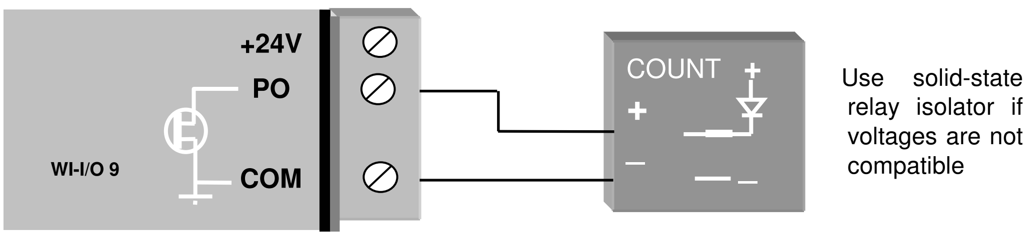
For the ”-2” and ”-4” modules, the four digital inputs (DI 1-4) may be configured as pulse inputs. The first digital/pulse input DI 1 has a maximum rate of 1000 Hz (min. off time 0.5 ms), while DI 2-4 have a maximum rate of 100 Hz (min. off time 5 ms). When using DI 1 at high pulse rates (more than 100 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.





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.

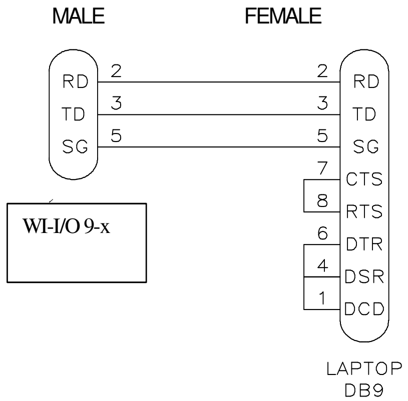
2.4.9 Pulse Output (WI-I/O 9-3 and WI-I/O 9-4)

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.

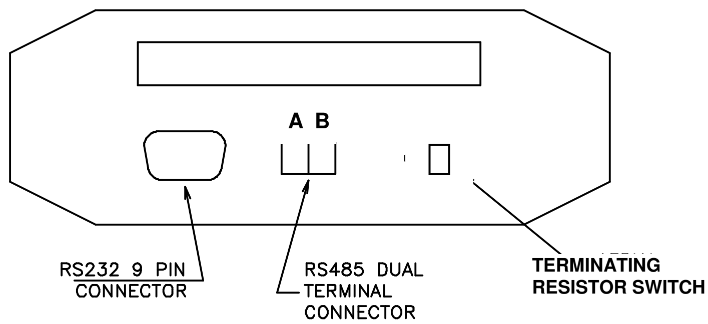
2.4.11 RS485 Serial Port

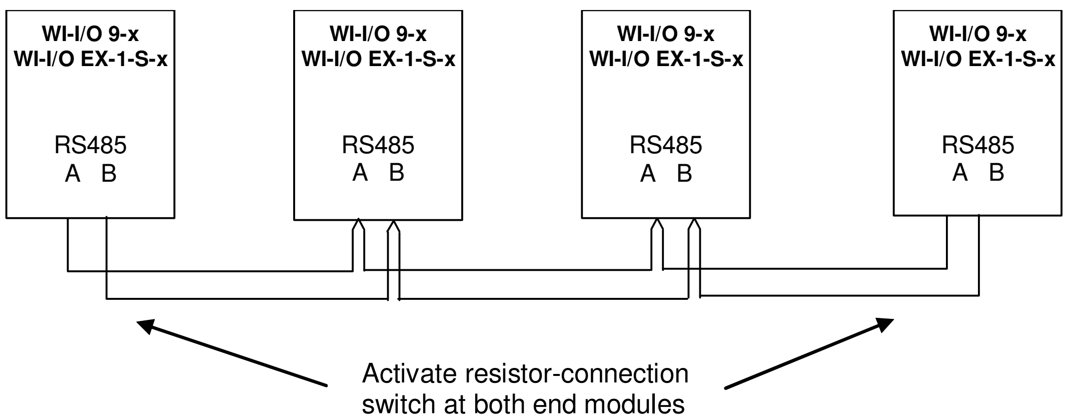
The RS485 port provides for communication between multiple units using a multi-drop cable. Up to 32 units may be connected in each multi-drop network. Each multi-drop network may have one unit providing radio communications with other units in the system. The RS485 feature allows local hubs of control 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 (4) "Comms fail" status to remote unit set If status is mapped to an output, set output	• 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

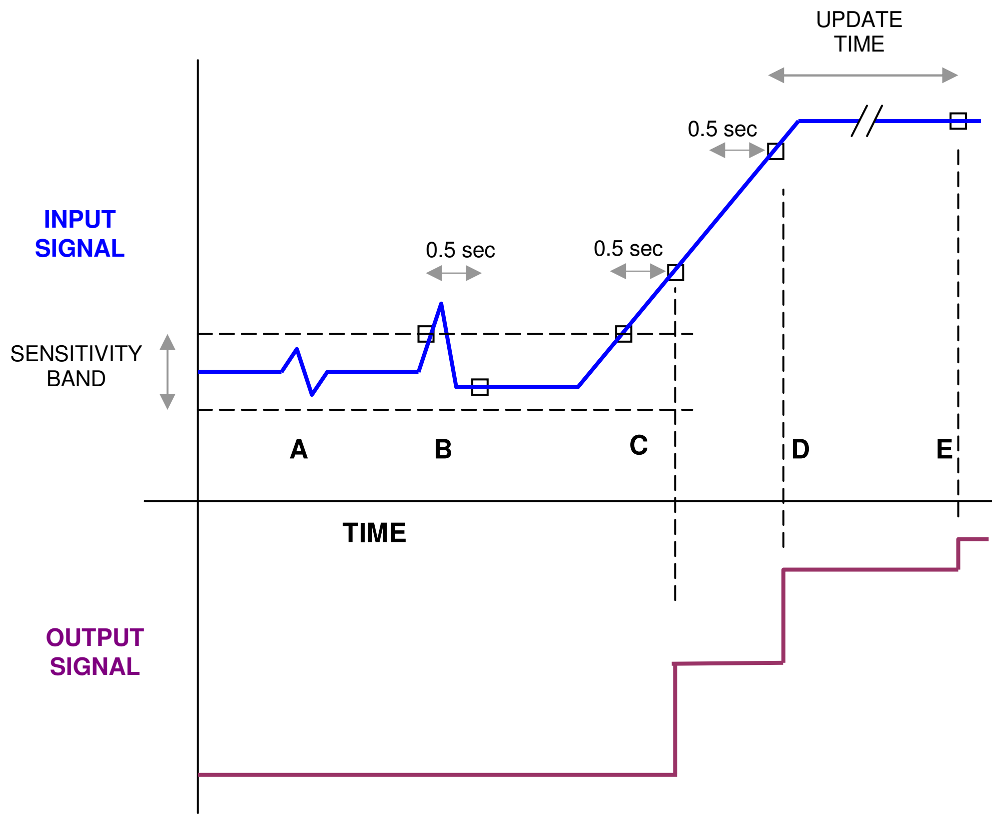
The module transmits a data message whenever it detects a "change-of-state" on one of its input signals. A "change-of-state" of a digital or digital internal input is a change from "off" to "on" or vice-versa provided the change is sustained for 0.5 second (i.e. 0.5 second debounce). The debounce delay 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.

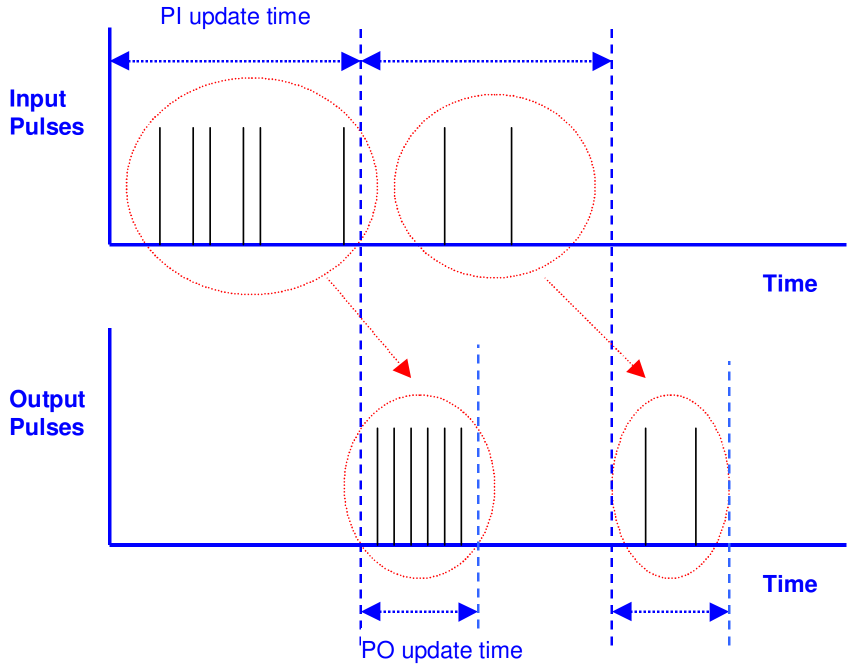
In general, the following may be used as a rule of thumb for calculating the appropriate sensitivity required for a given application:
Instantaneous change of 2 x sensitivity on input → 3 second output response
Instantaneous change of 10 x sensitivity on input → 5 second output response

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.

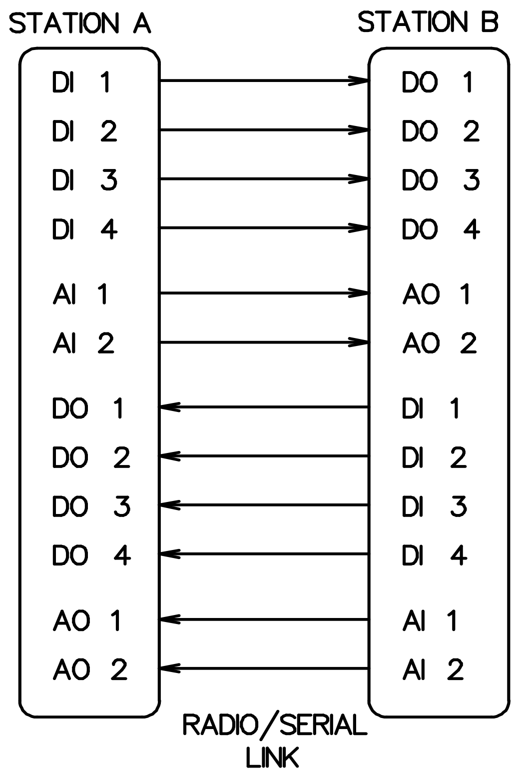
Warning - do not allocate the address number 1 to a “-3” or “-4” module.

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

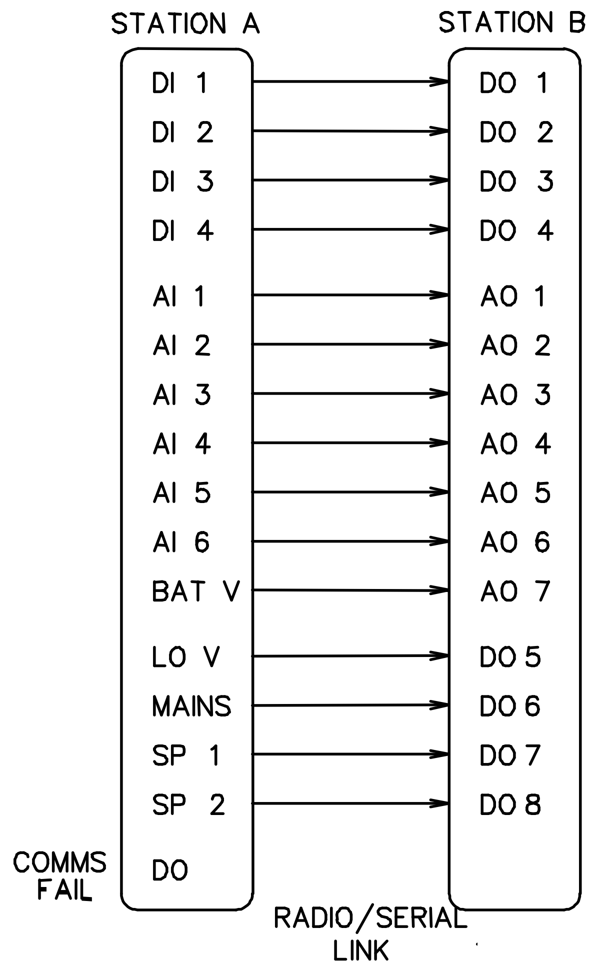
If your application requires only a single pair of modules, communicating via radio or serial link, default settings may satisfy your needs. If so, no configuration is required. Essentially, all inputs at Module A are reflected at the corresponding outputs at Module B. All inputs at Module B are reflected 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 :-

$$\text{DI3} \rightarrow \text{Out2 at 4 via 3, 11}$$

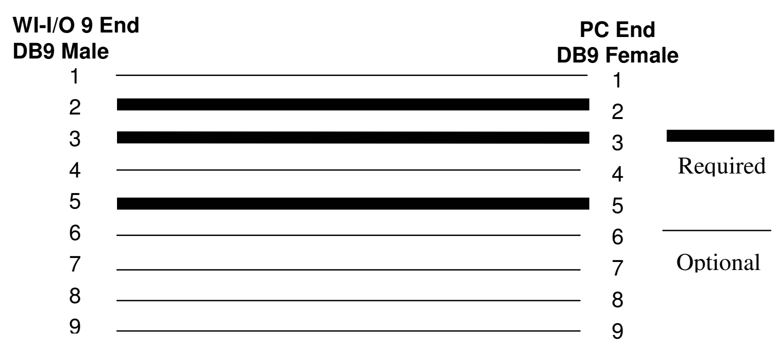
This mapping links DI3 on this module to output channel 2 on the module with address 4, and modules 3 and 11 are repeaters.

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.

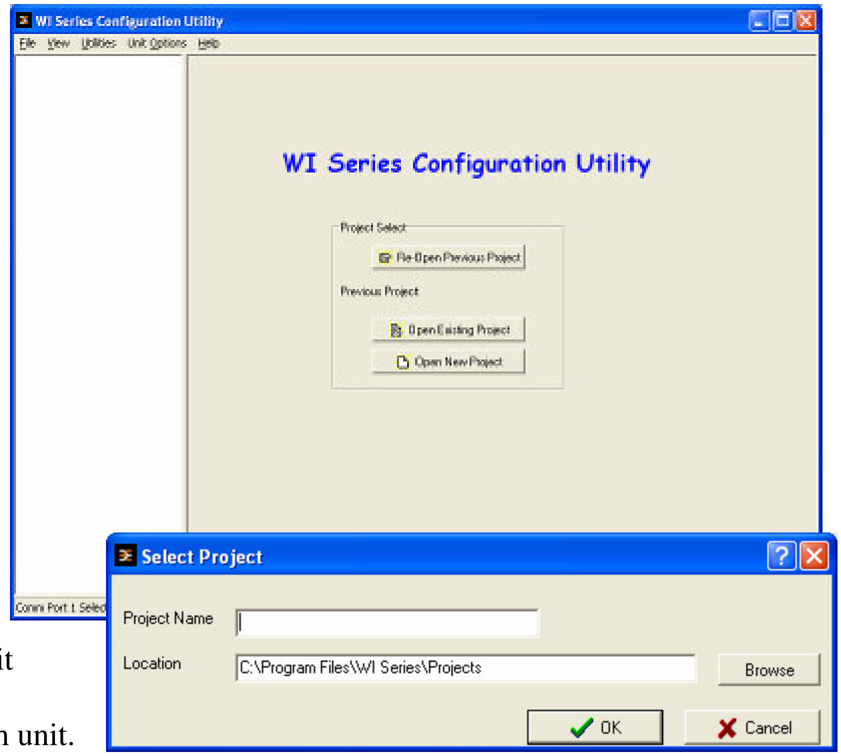


4.3.2 Program Operation

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.



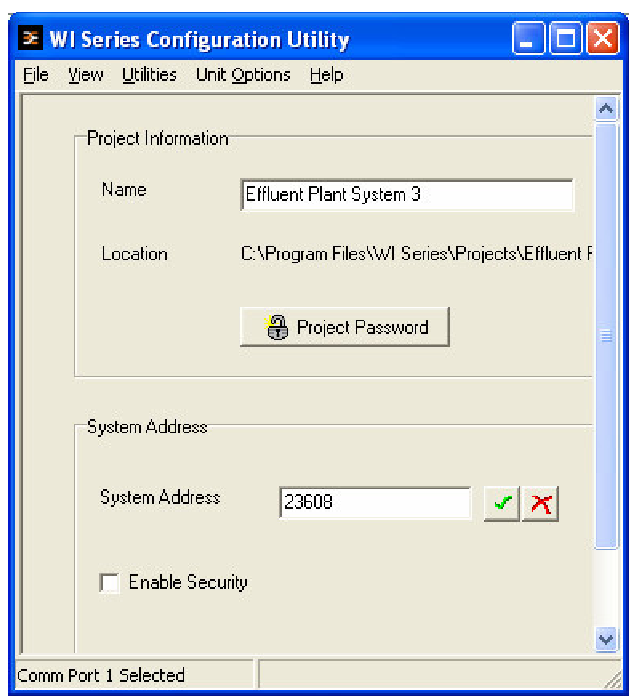
From the initial screen, you can select an existing project, or start a new project. The name of the project will create a new directory which will eventually contain th e configuration files for the modules in this system.

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 as ked 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.

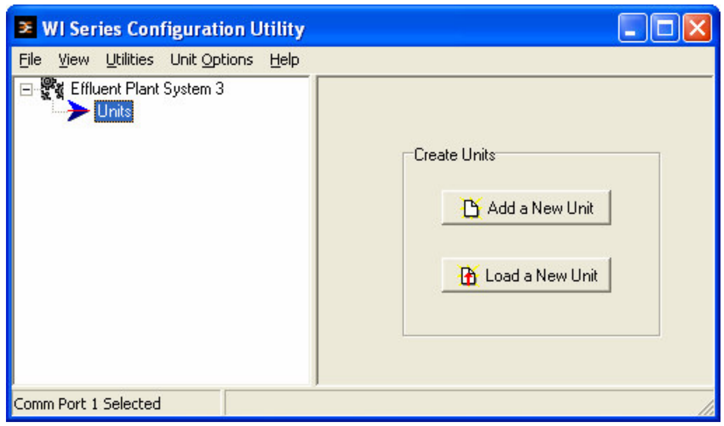


If you are starting a new project, you have the option of "Enabling Security" - please read Section 4.3.7 and the associated warnings before using this option.

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.

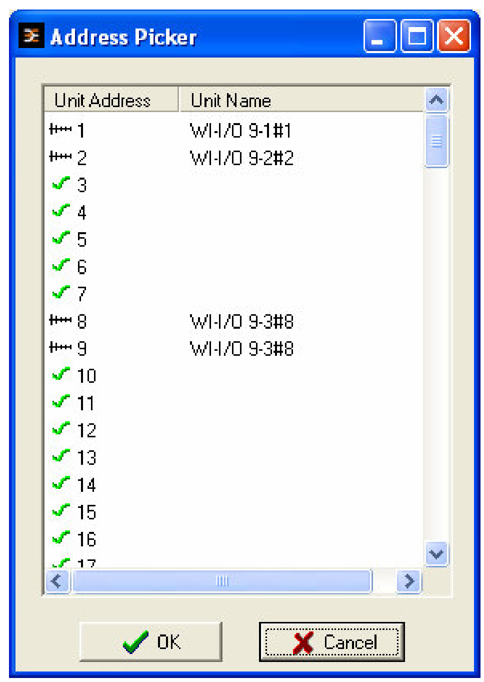
Loading configuration from an existing module
To load the configuration from a module, connect the module to the PC via the RS232 cable and click on "Load Unit". This will allow you to view the module configuration, change it, or copy it for another module - refer to section 4.3.3 for more information.

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.



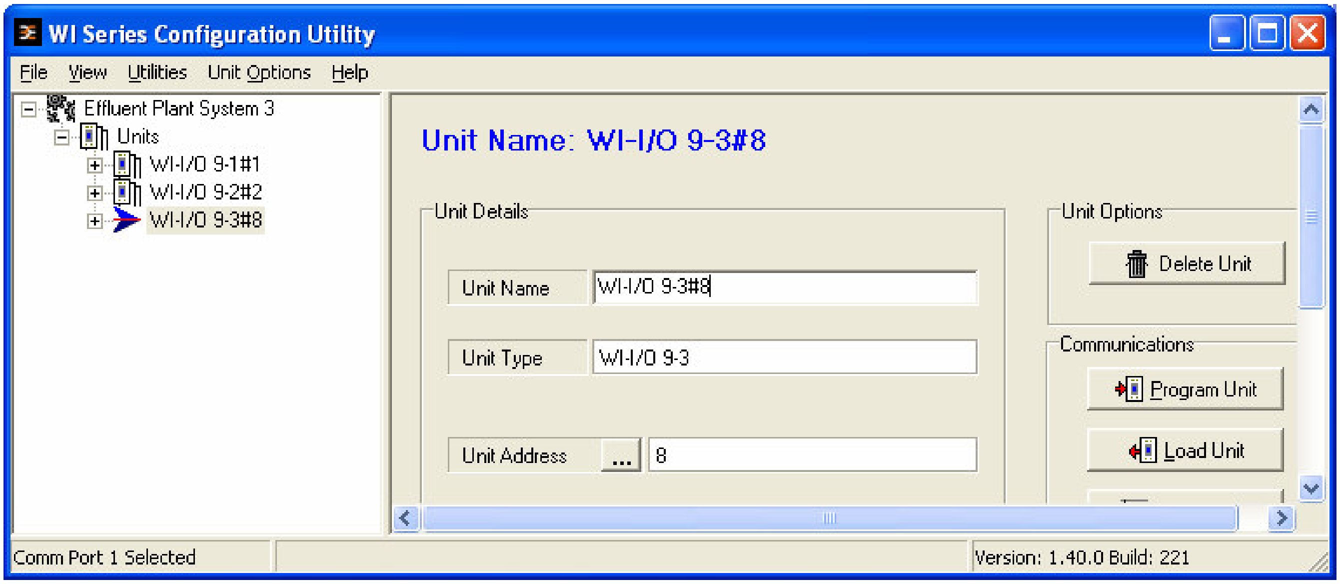
Note that this program covers WI-I/O-EX-1-S-x and WI-I/O 9-x modules. These modules are essentially the same as far as configuration is concerned. That is, a WI-I/O 9-1 selection will configure a WI-I/O-EX-1-S-1 or a WI-I/O 9-1.

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".



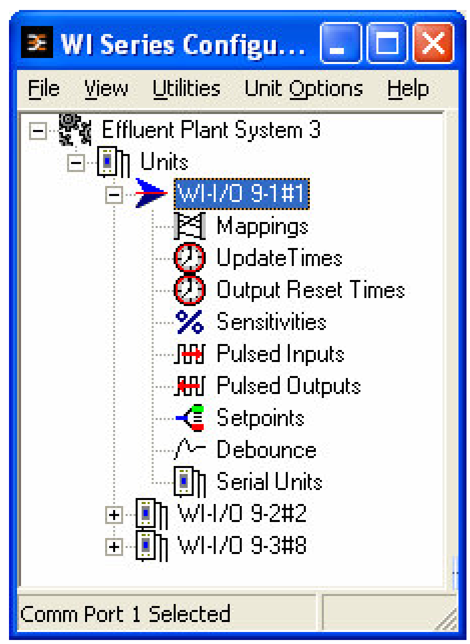
Configuring an individual module

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:

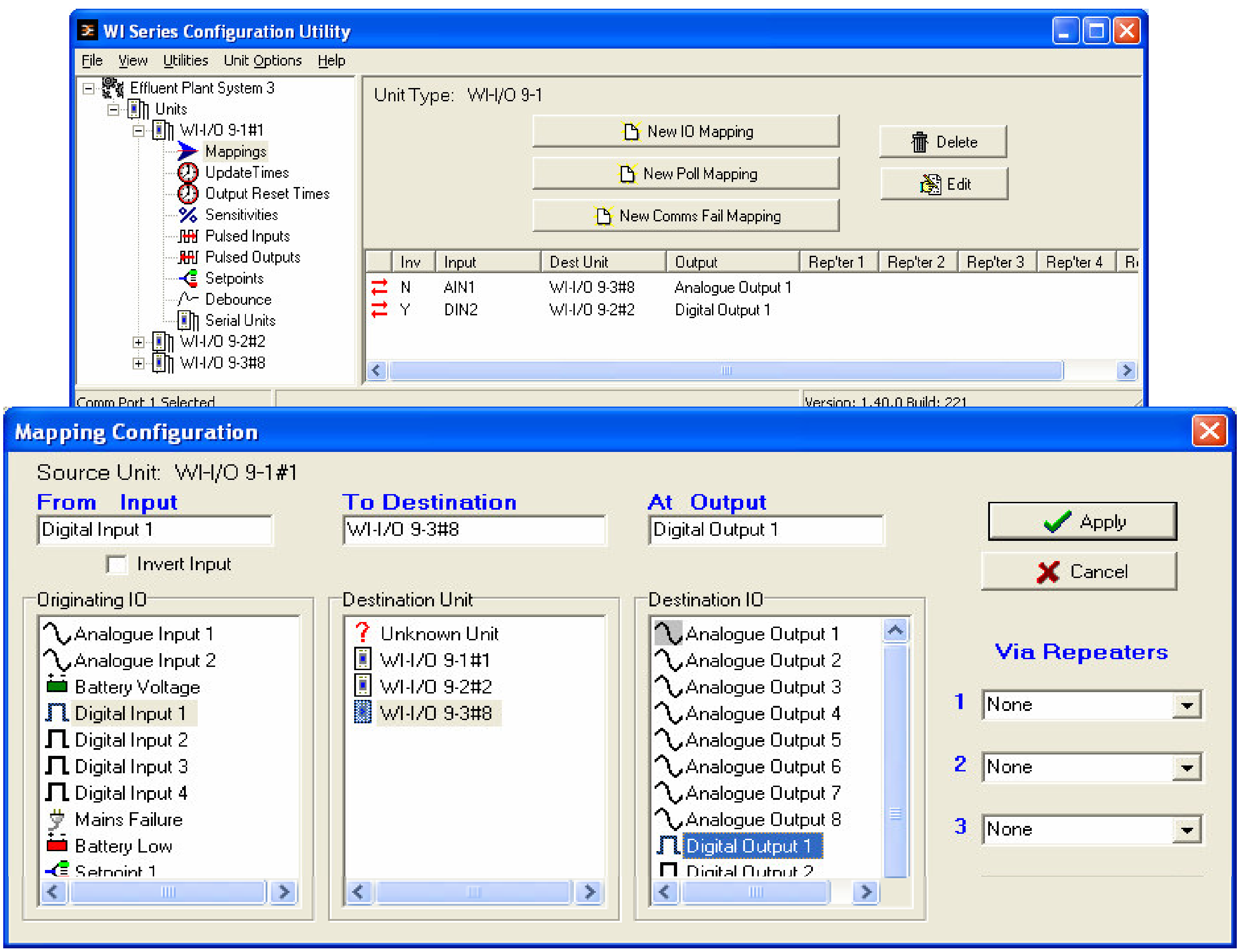
- I/O mappings which link inputs to outputs
- Poll mappings, which enables a module on start-up to request set its outputs quickly

Comms Fail mappings, which maps communication failure status to an output on the local module.



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



	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".

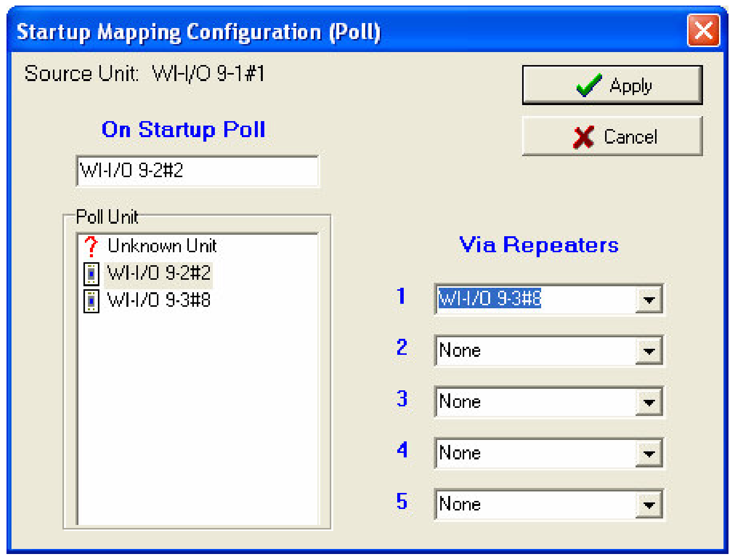
To delete an existing mapping

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.



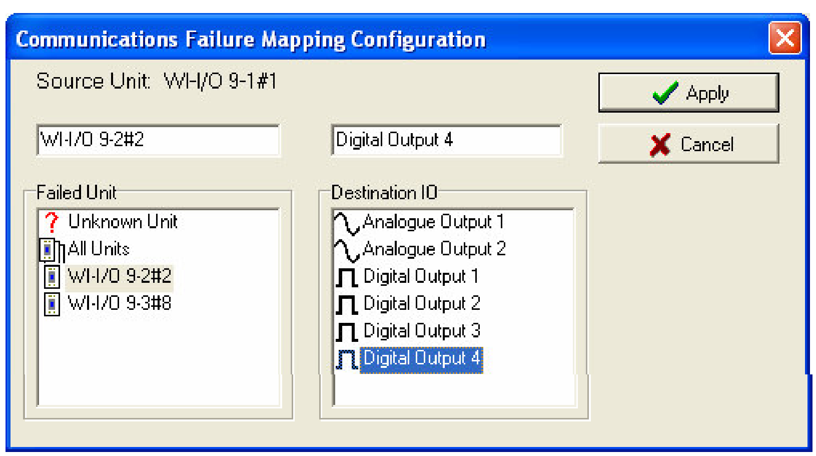
Remember that if more than one remote unit is controlling the local outputs, then more than one start-up poll should be configured.

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).

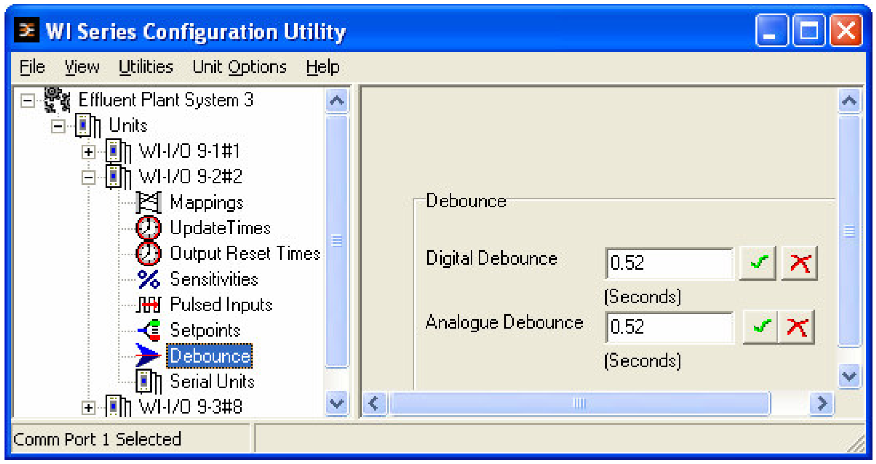
different remote addresses. You can configure several comms fail mappings to the same output - the output will be active if there is comms fail to any of the remote addresses. Configuring a “Comms Fail Address” of zero causes communication failure to any destination module to be indicated on the selected 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.

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.*

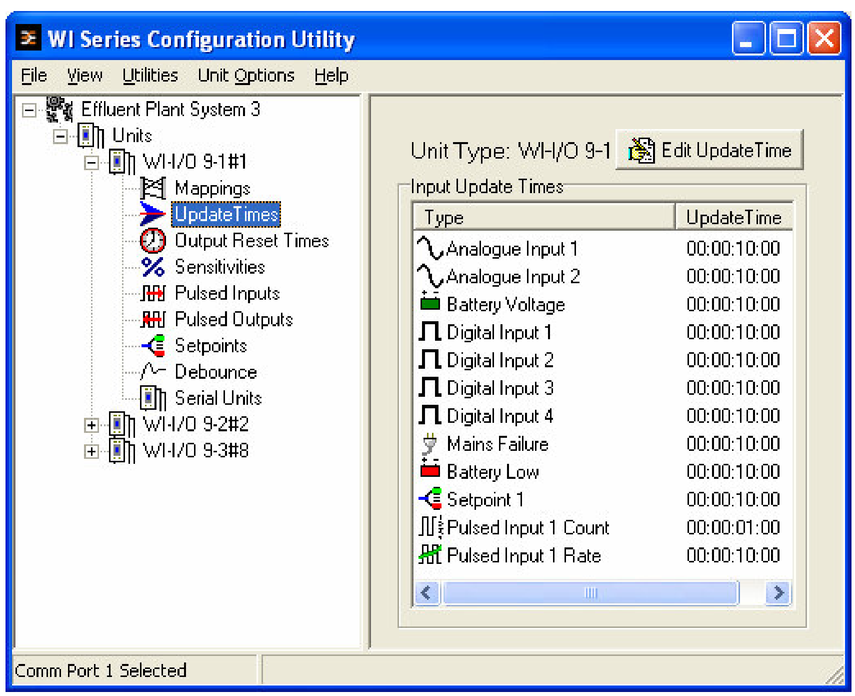


Note that the analog debounce is not configurable for the -1 , but is configurable in the -2.

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



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.

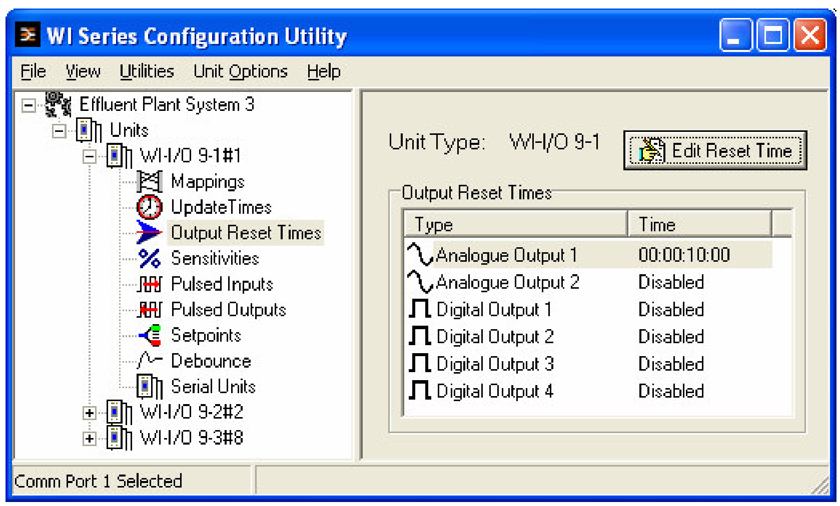
Changing Multiple Settings

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.

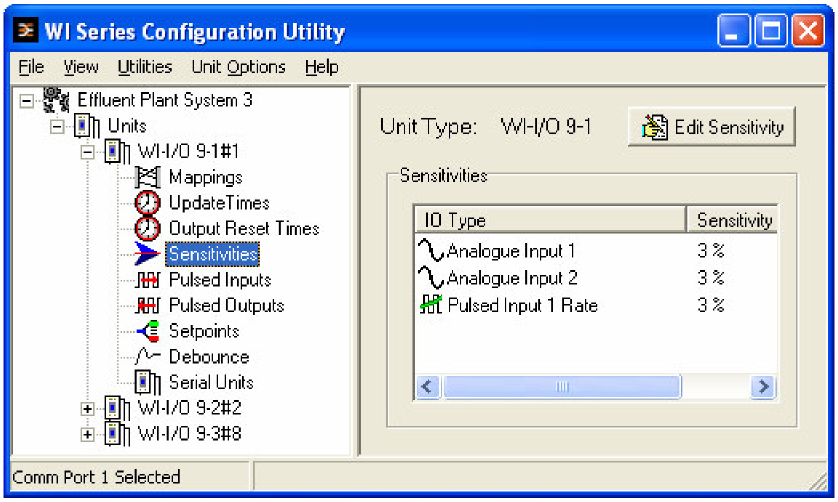
Each output on the unit, either analog or digital, may be configured to reset (off or 0mA) when no update transmission has been received for a certain time. This option can be used to ensure that communications failure will not result in loss of control. For example, outputs connected to pumps should be configured to reset on communications failure so that the pump will turn off. The default condition is zero (no reset).



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.

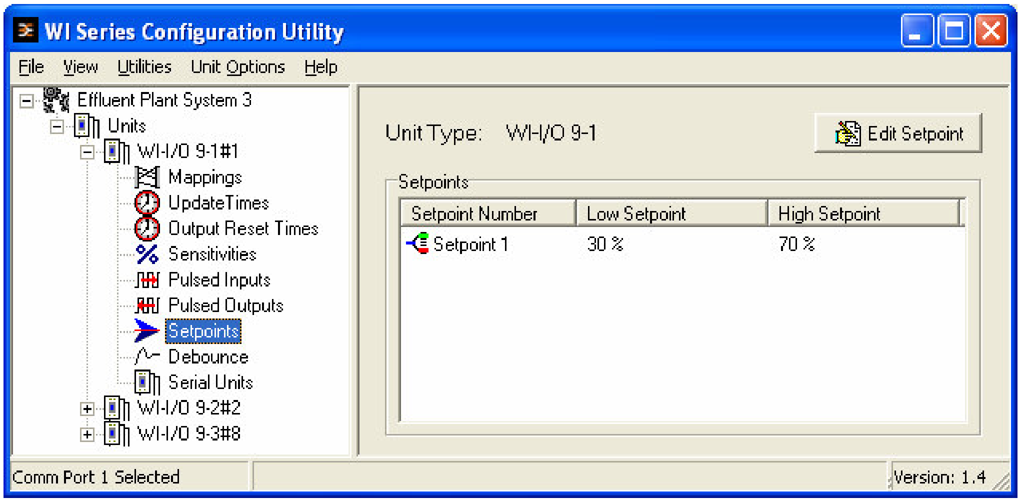
Analog Sensitivity Configuration



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.

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.

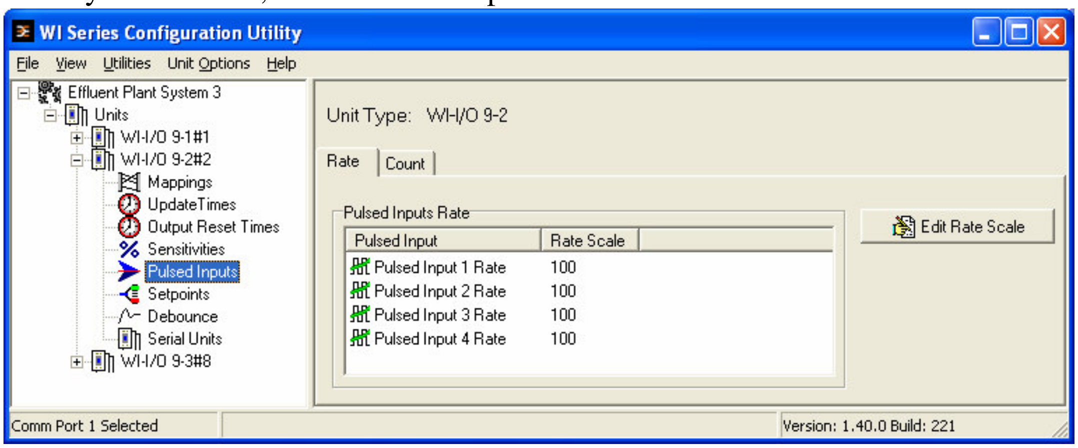
Debounce time operates on the set-point status in the same way as digital inputs.

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.

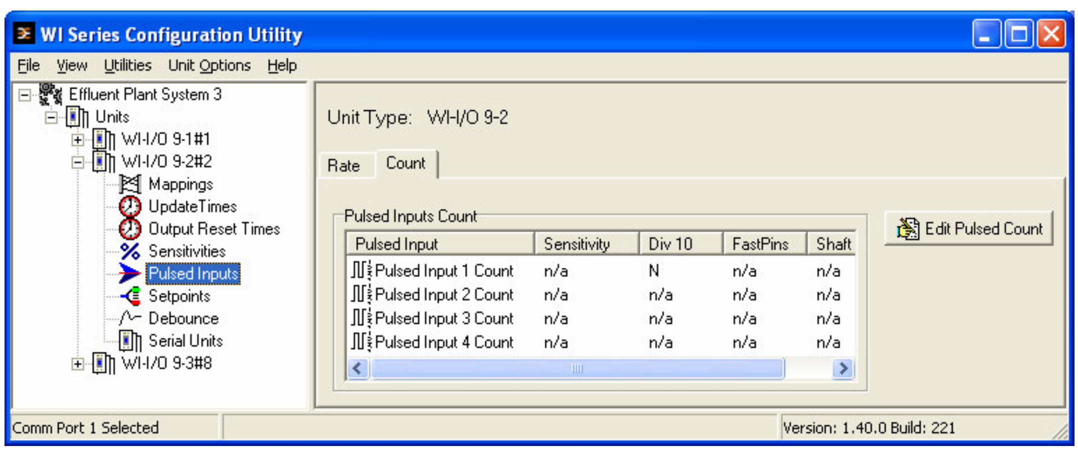
To configure the "divide by 10" feature, select "Pulse Inputs" on the left-hand menu and select the "Count" page - double-click "Pulse Input 1 Count" and enable "divide by 10" counting.



Pulse Input Rate Scale Configuration

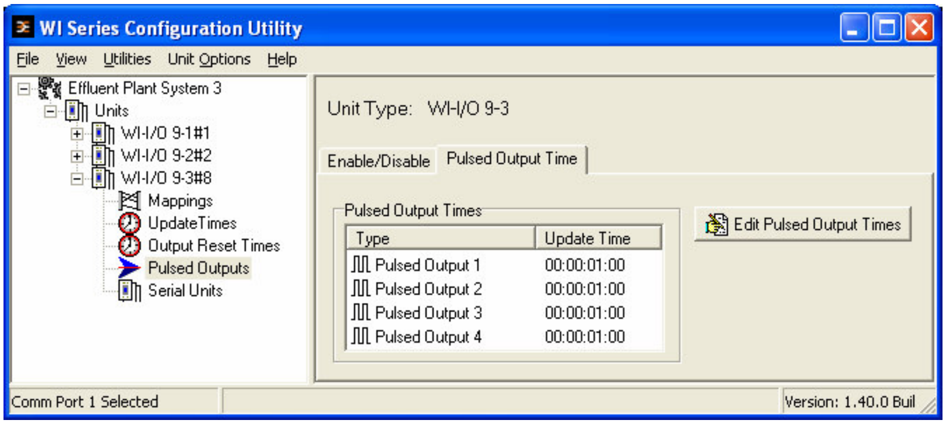
When a pulse rate is mapped to an analog output, the rate must be scaled to the 4-20mA output. The pulse rate scale is the rate (in Hz) corresponding 20 mA.

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.



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.



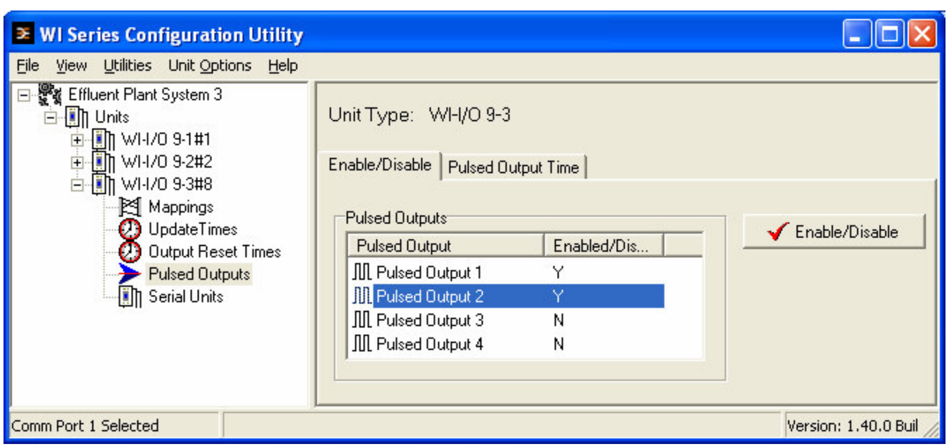
For example, if the PI update time is 1 minute, then the PO update time should also be 1 minute. If the PI update time is changed, then the PO update time at the remote module should be also changed. The PO will still operate if the time is not changed, however pulses may be output faster or slower than 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.



Compiling a System

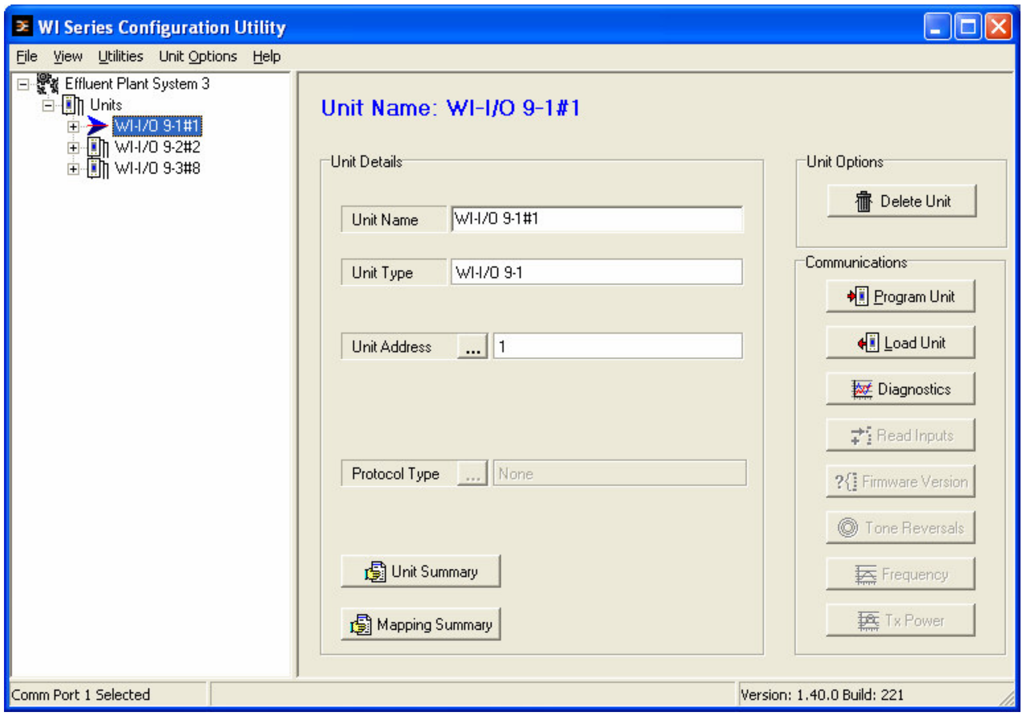
When you have finished configuring the modules, you should compile the system. The compile function scans the configuration and reports any detected errors. To compile the system, select "Compile System" from the "Utilities" menu. Select the "Compile" button. The system will compile - the display will 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.



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.

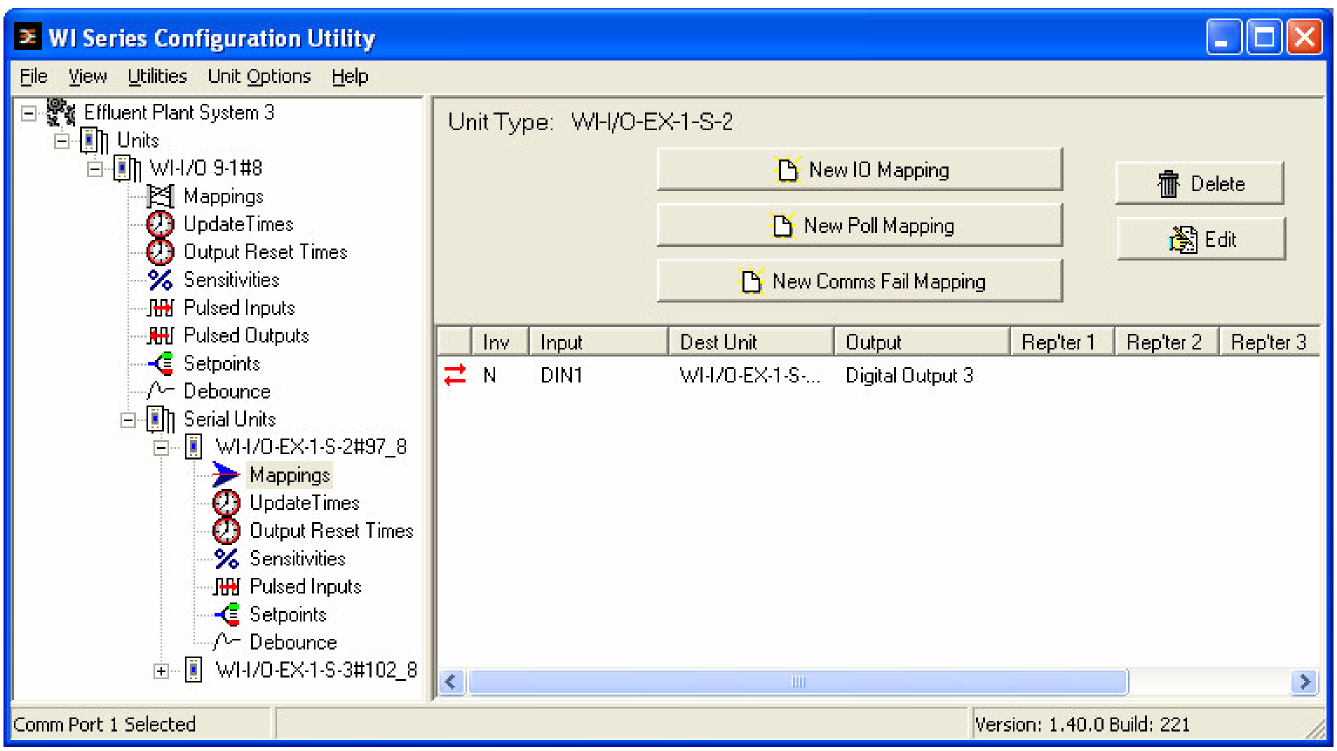
4.3.8 Using WI-I/O-EX-1-S-x Modules

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.

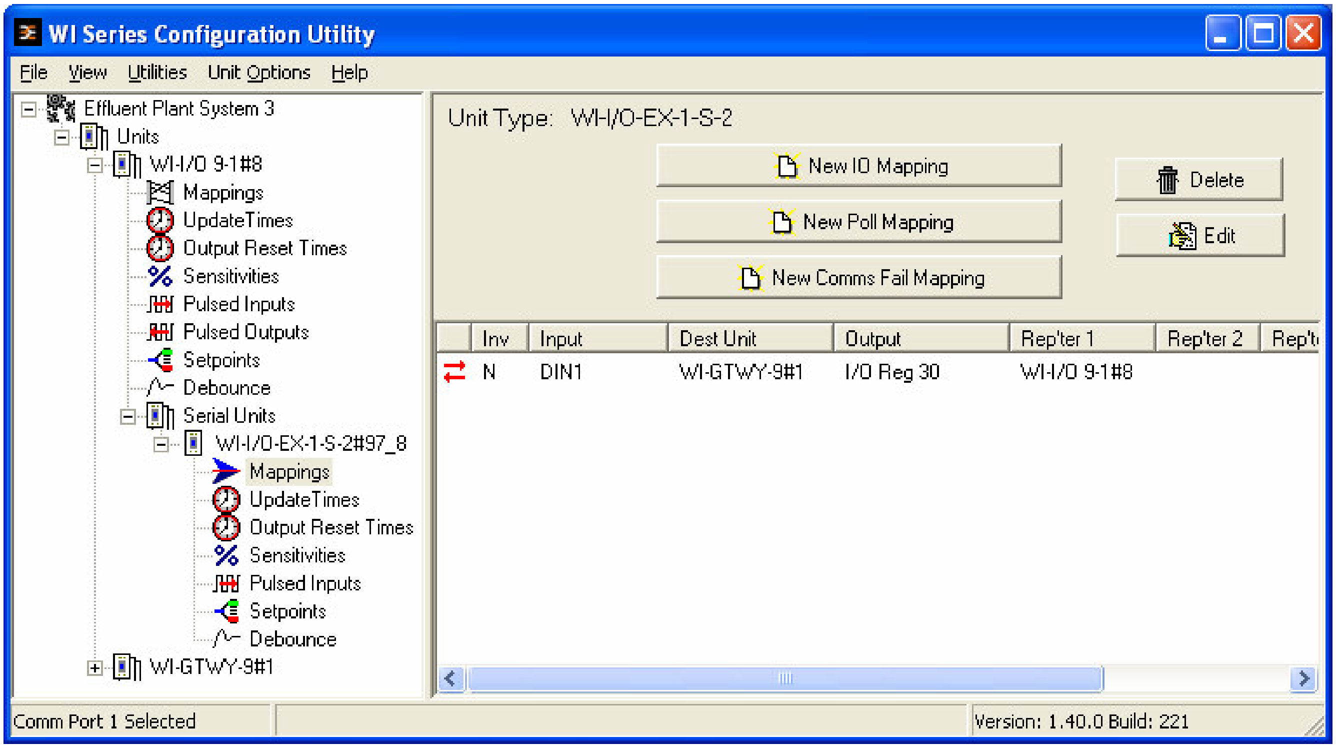
WI-I/O-EX-1-S-x modules are configured with unit addresses in the range 96 – 127.

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.



Example 2 - Mapping to a remote WI-I/O 9-x.

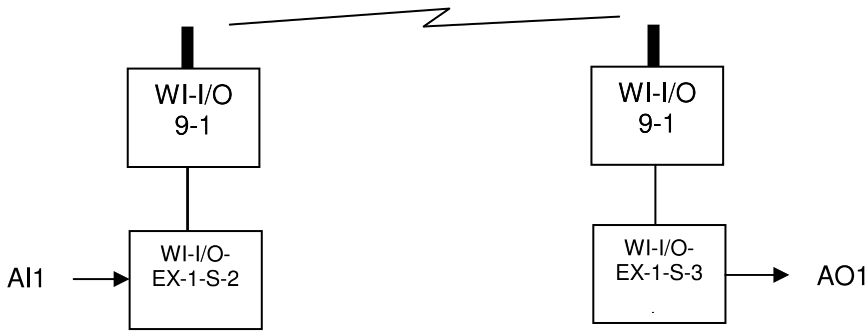


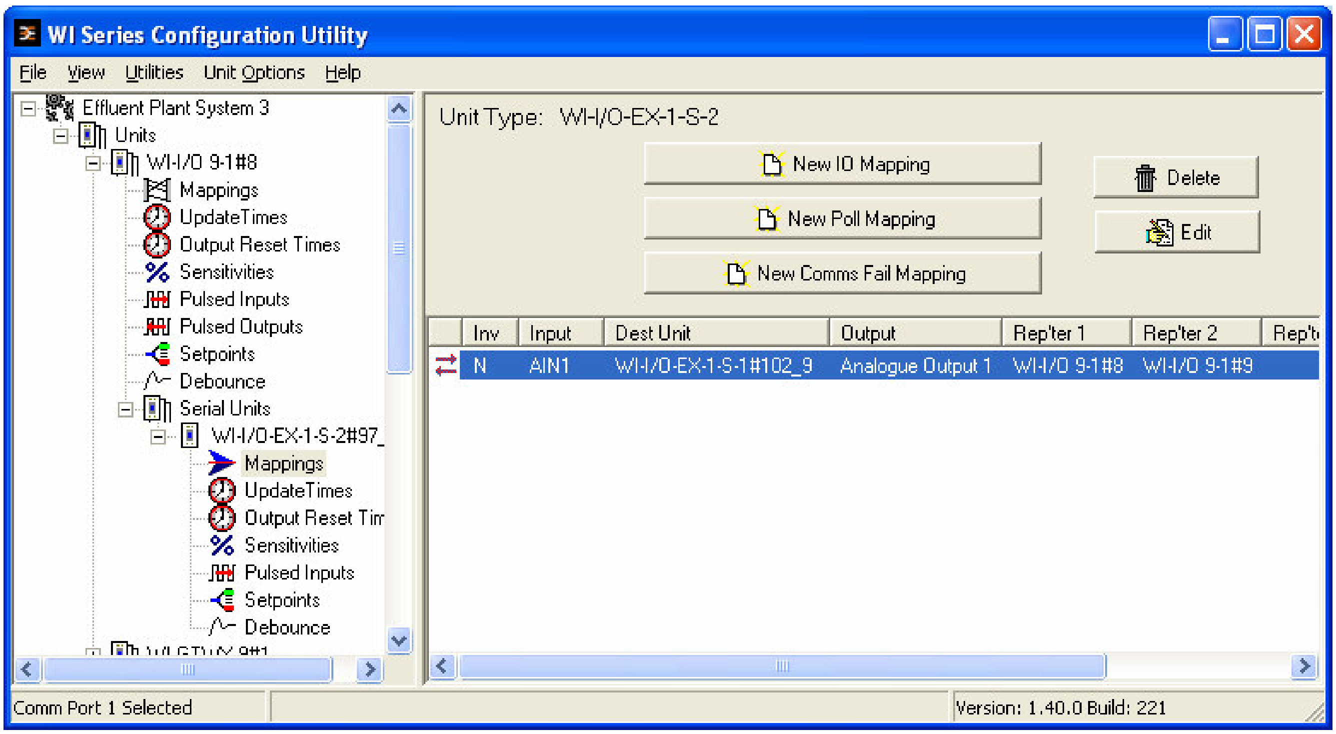
In this example, a WI-I/O-EX-1-S-x-2 is connected to WI-I/O 9-1#8. DI1 is mapped to a remote WI-GTWY-9-MD1 module. The WI-I/O 9-x that is connected to the WI-I/O-EX-1-S-x module acts as a repeater - a serial-to-radio repeater.

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.





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.

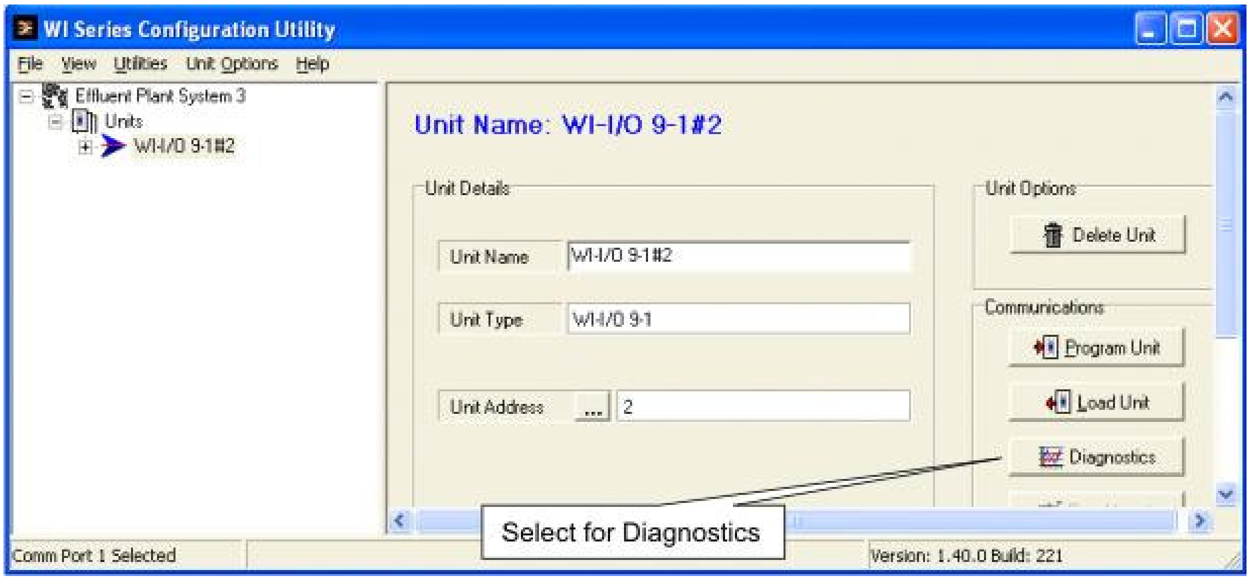
6.2.3 Diagnostics menu

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.

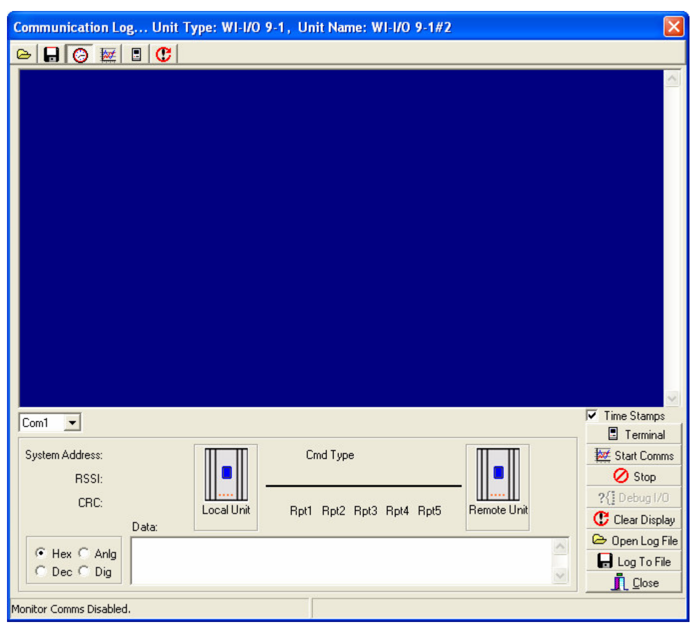
Either open the archived project containing the module, or start a New Project and select "Load a New Unit" - select the correct type of module. After the unit has loaded, select the Diagnostics box.

A "Terminal" screen will appear. Select the "Terminal" box.



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 :



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.

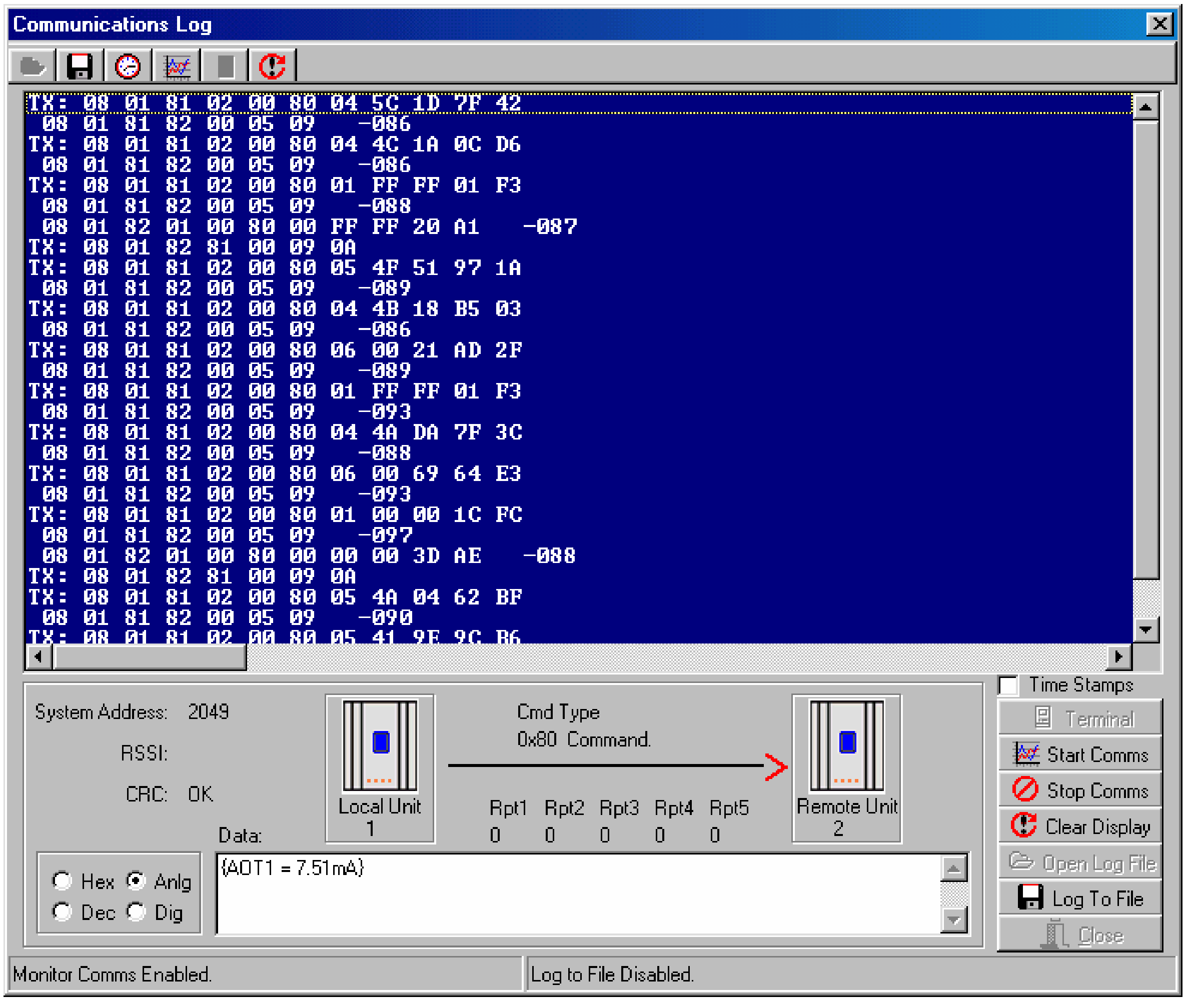
For example, if the noise level is 120, then the radio signal must be 98 or lower for a reliable path. If the noise level is 100, then the radio signal must be 90 or lower.

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



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.

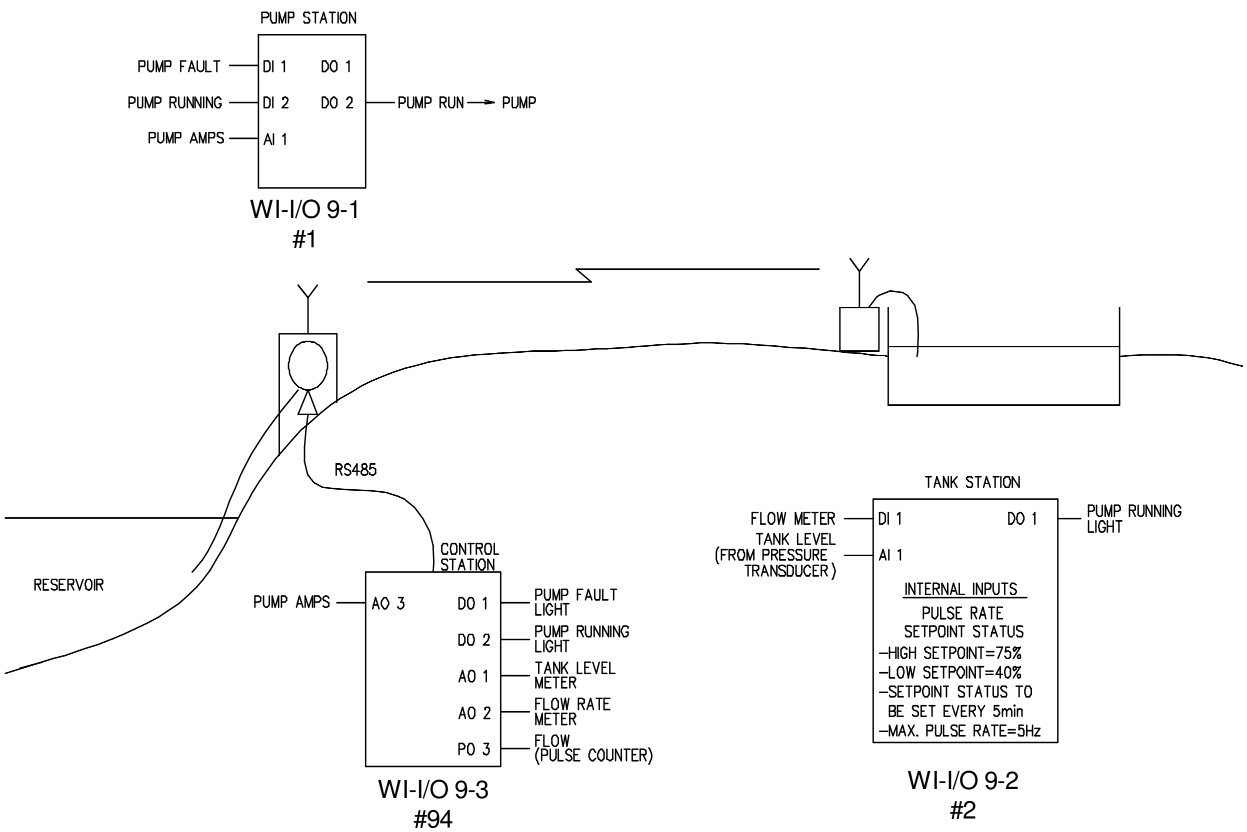
Appendix A SYSTEM EXAMPLE

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.

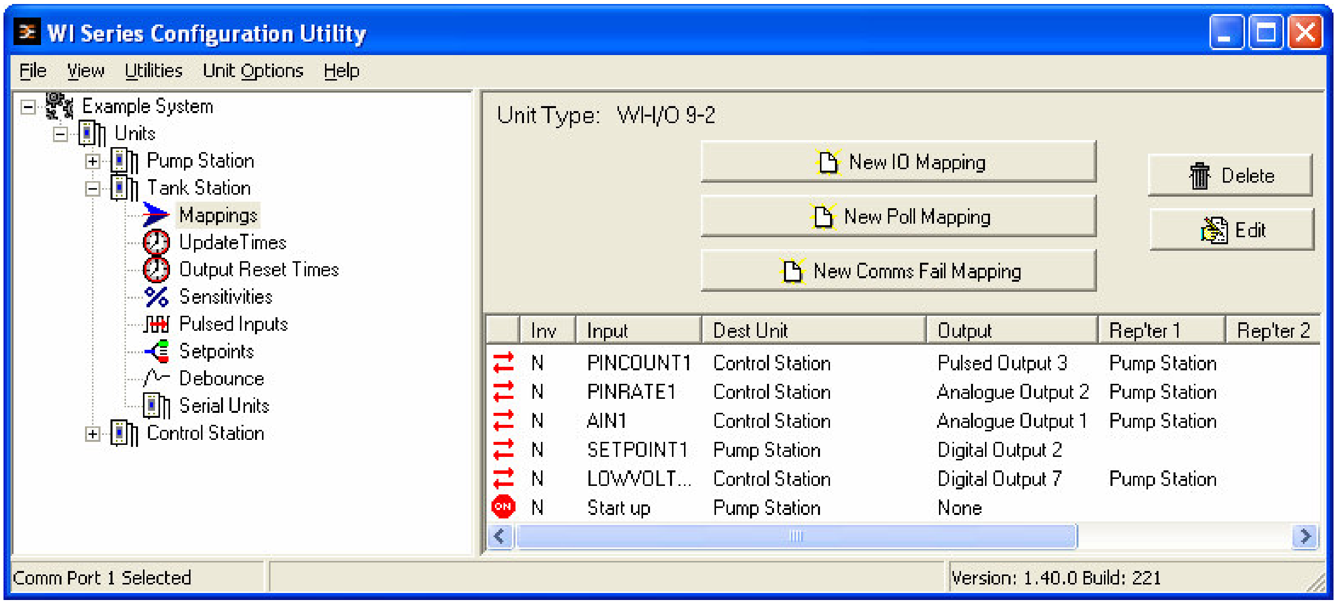
- At the pump station, the antenna was mounted on a 10' J-bracket installed on the roof of the pump station building. The final height of the antenna was approx 20 feet. Care was taken to align the Yagi antennas so they pointed at each other. The Yagi antennas were installed with horizontal polarity - 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.

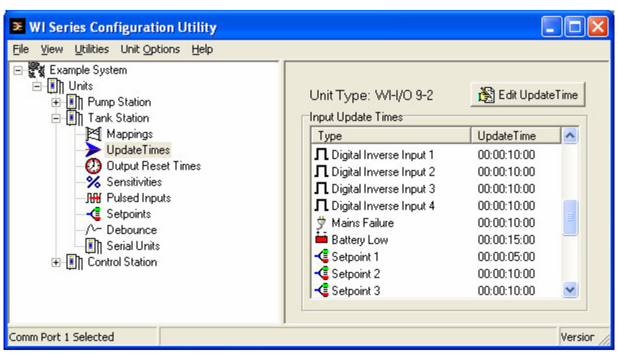
- At the control station, the WI-I/O-EX-1-S-x module was installed inside the existing control panel enclosure. The module was powered from an existing 24VDC power supply.

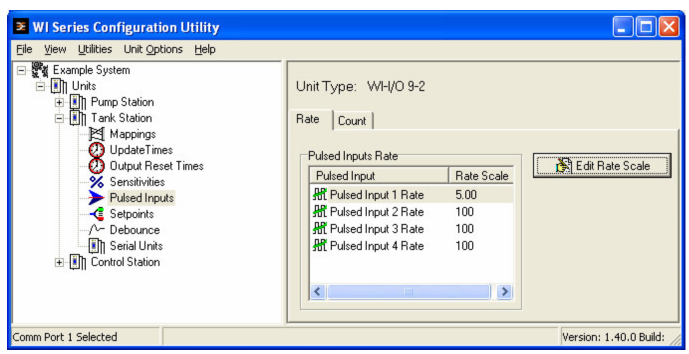
Tank Station Configuration

The WI-I/O 9-2 module has the following configuration :-

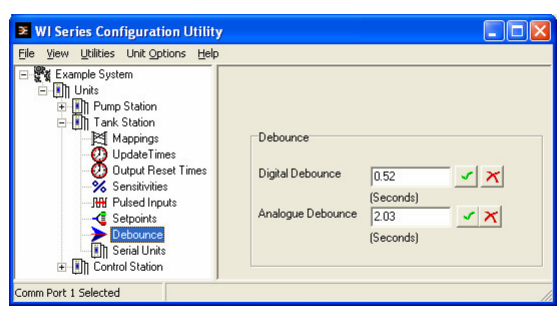


Note the following points in the configuration:





- #1 is a repeater for communications between #2 and #94

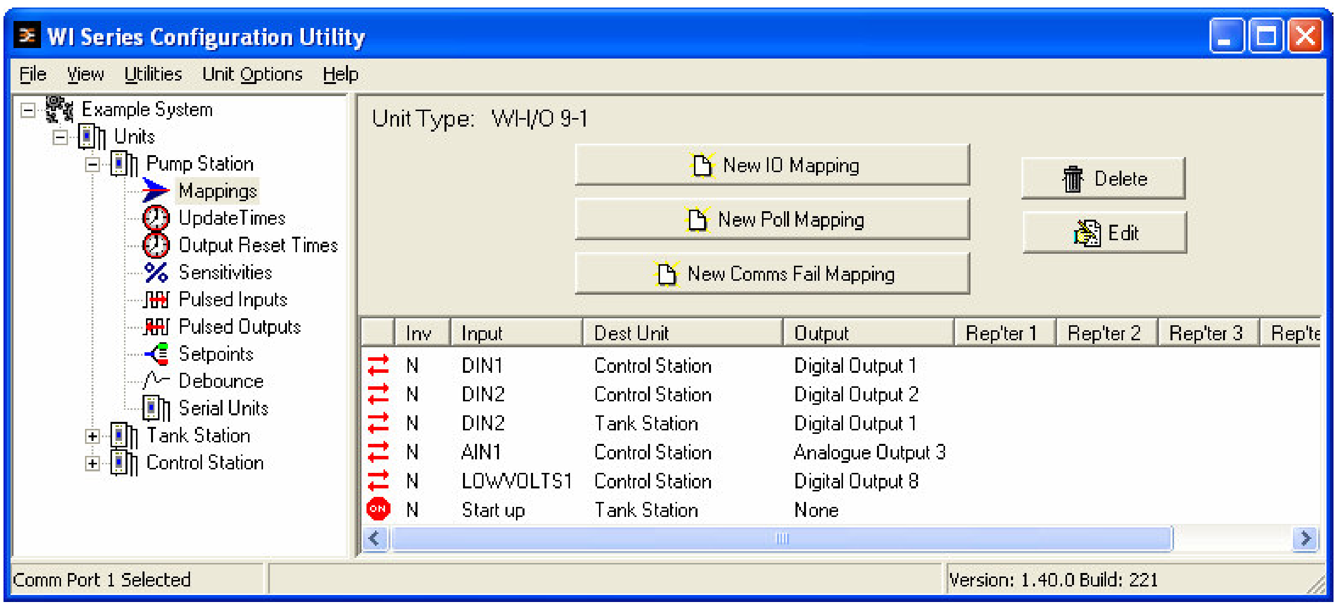


- The pulse rate scaling for PIN1 has been set to 5 Hz to match the maximum flow rate of the flow meter. Note that PIN1 has not been configured for "divide by 10" (for 1000 Hz pulse signals).
- AIN1 (the level transducer) is mapped to AO1 at the WI-I/O 9-3. The analog debounce has been set to 2 sec. 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.

- 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.

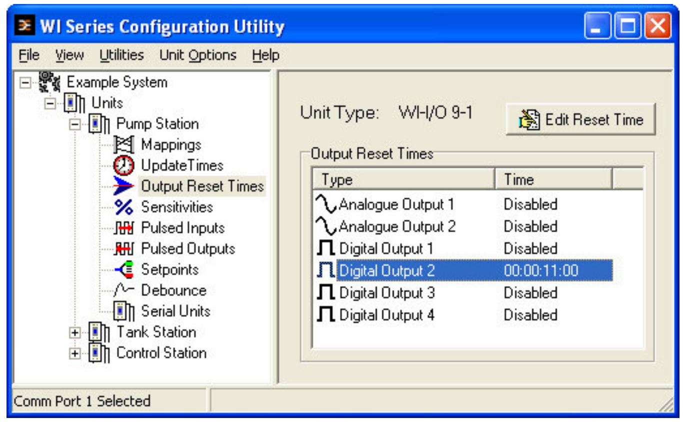
Pump Station Configuration

The WI-I/O 9-1 module has the following configuration :-



Note the following points in the configuration:

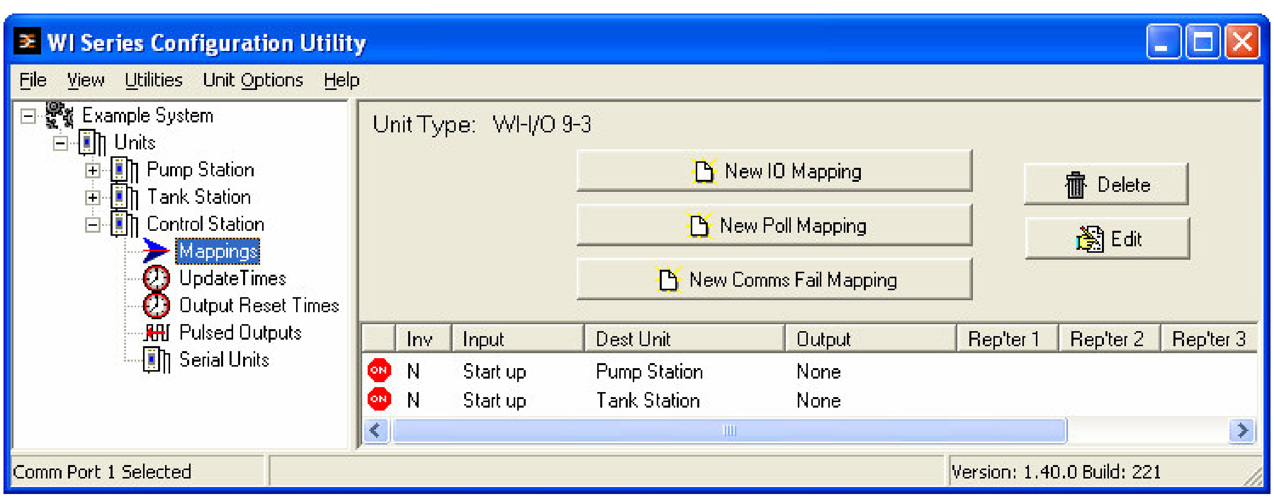
- Note that no repeater address is necessary between #1 and #94.
- DIN2 (pump running signal) has two mappings - a mapping to DO1 at #2 (tank station) and DO2 at #94 (control station). When DIN2 changes, there will be two separate change messages transmitted - one by radio to #2 and one by serial link to #96.
- AIN1 (pump amps) is mapped to AO3 at #94 (control station).



- 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).

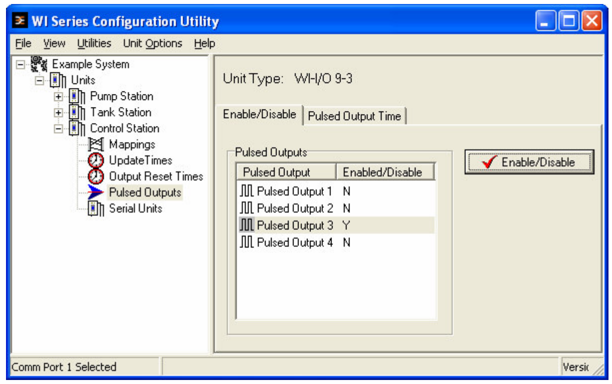
Control Station Configuration

The WI-I/O-EX-1-S-3 module has the following configuration :-



Note the following points in the configuration:

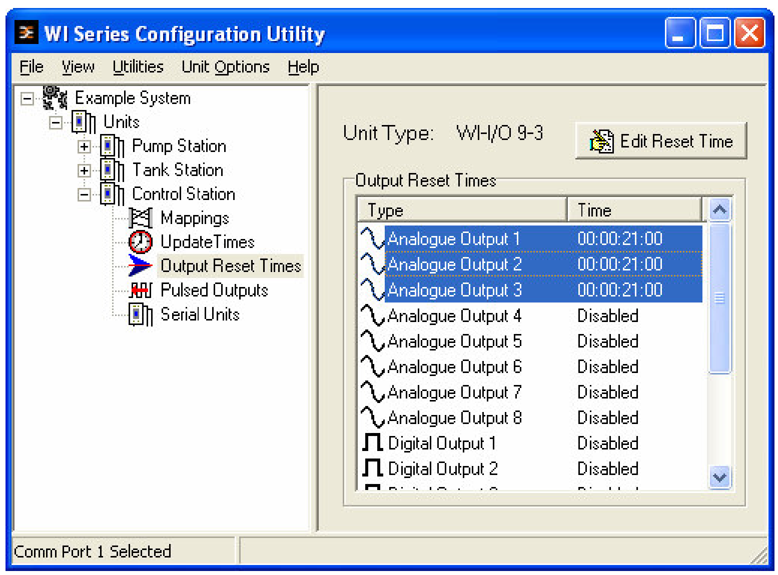
- The only mappings are Start-up polls. Note that there are two separate polls, one for each remote module.
- PO 3 has been configured as a PO. Its pulse output update time is the same as the PI update time at the remote module (both have been left at their default value of 1 minute).



- 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.

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.



The following configuration was added :

At #2 (tank station), Inverse DI4 → DO4 at #94 via 1 ; DI4 Update time = 1 minute

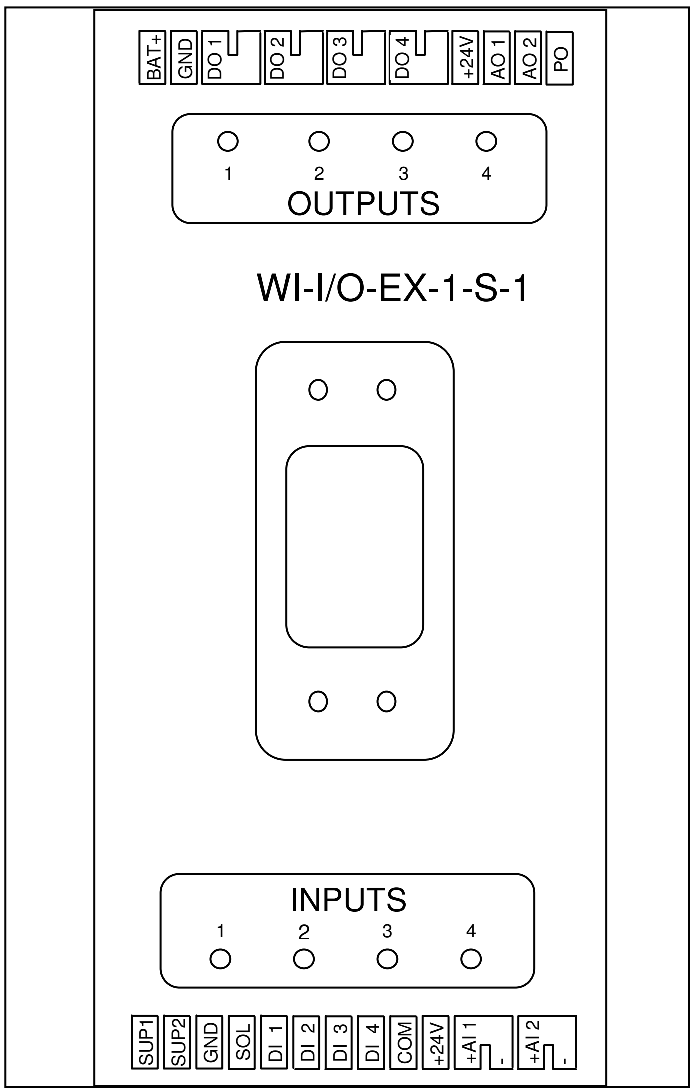
At #94 (control station), DO4 Comms fail reset time = 3.5 min

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.

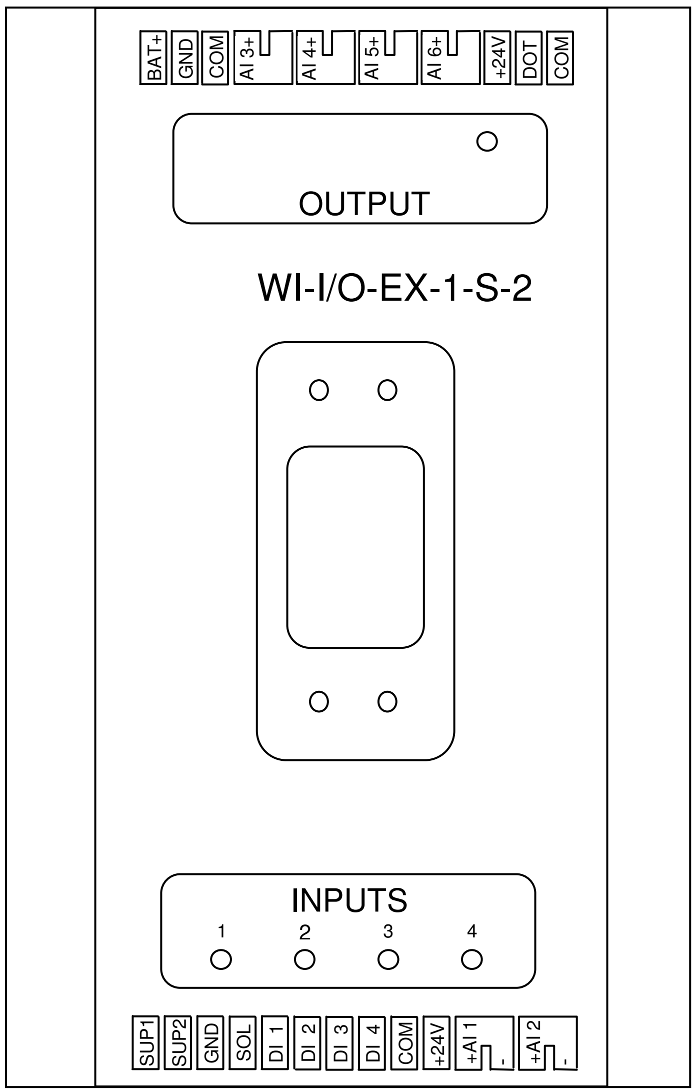
The time of 3.5 minutes was selected as this means that 3 successive update messages have to be missed before a system alarm occurs. Also note, that if module #94 fails, DO4 will reset and give an alarm signal.

Appendix B TERMINAL LAYOUTS

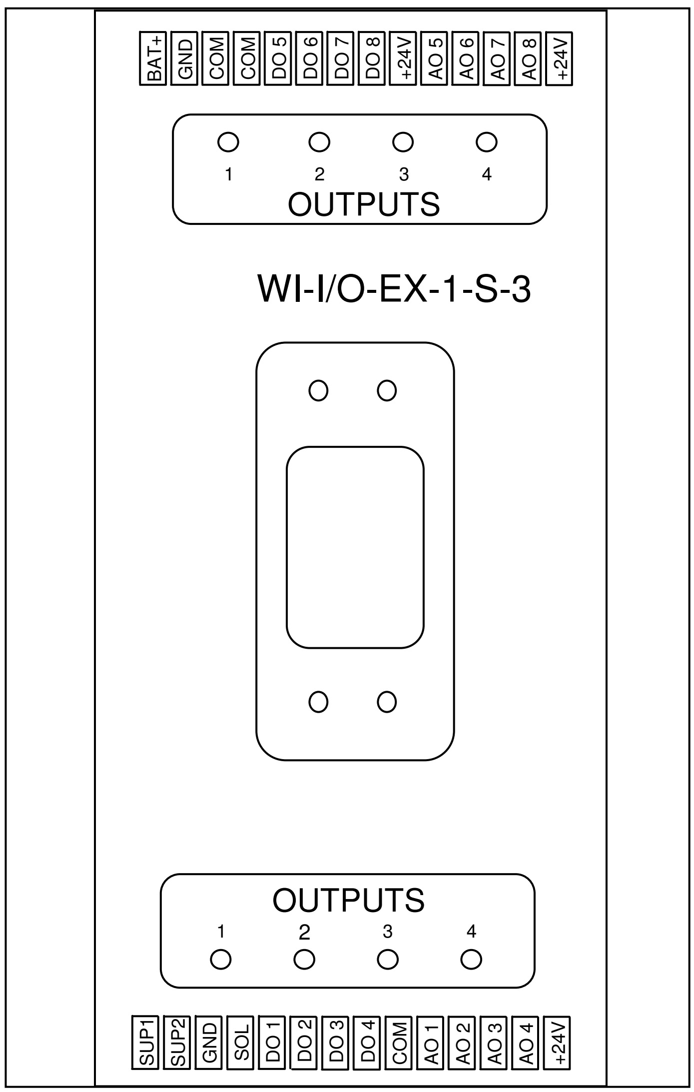
WIRING DRAWING -WI-I/O 9-1 WI-I/O-EX-1-S-1



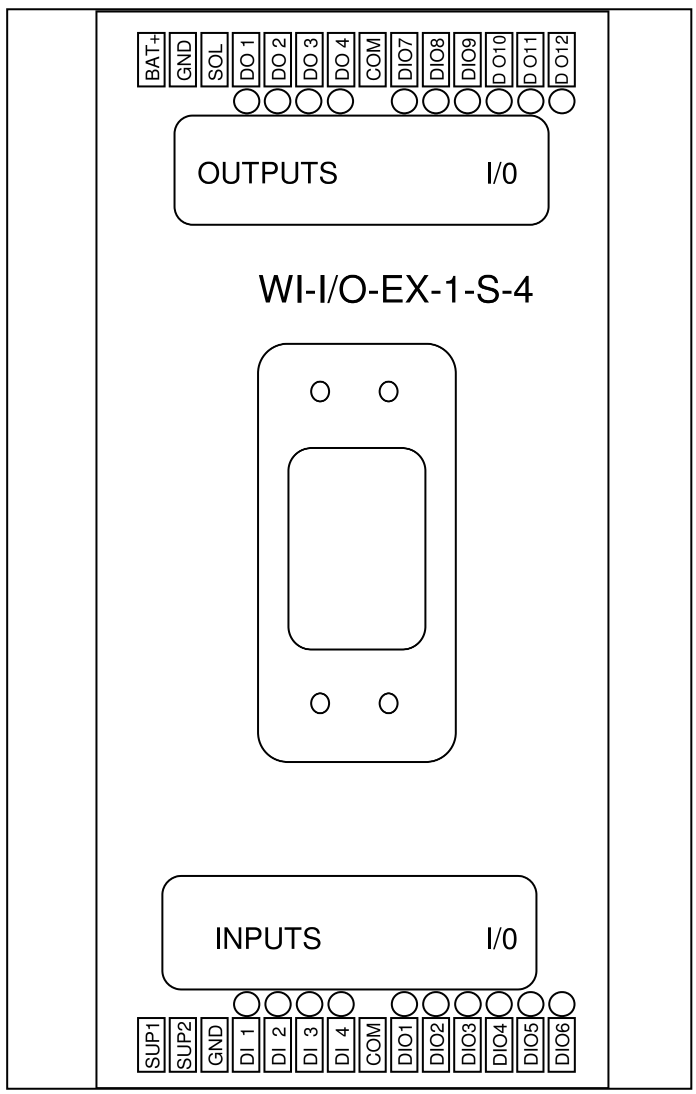
WIRING DRAWING - WI-I/O 9-2 WI-I/O-EX-1-S-2



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

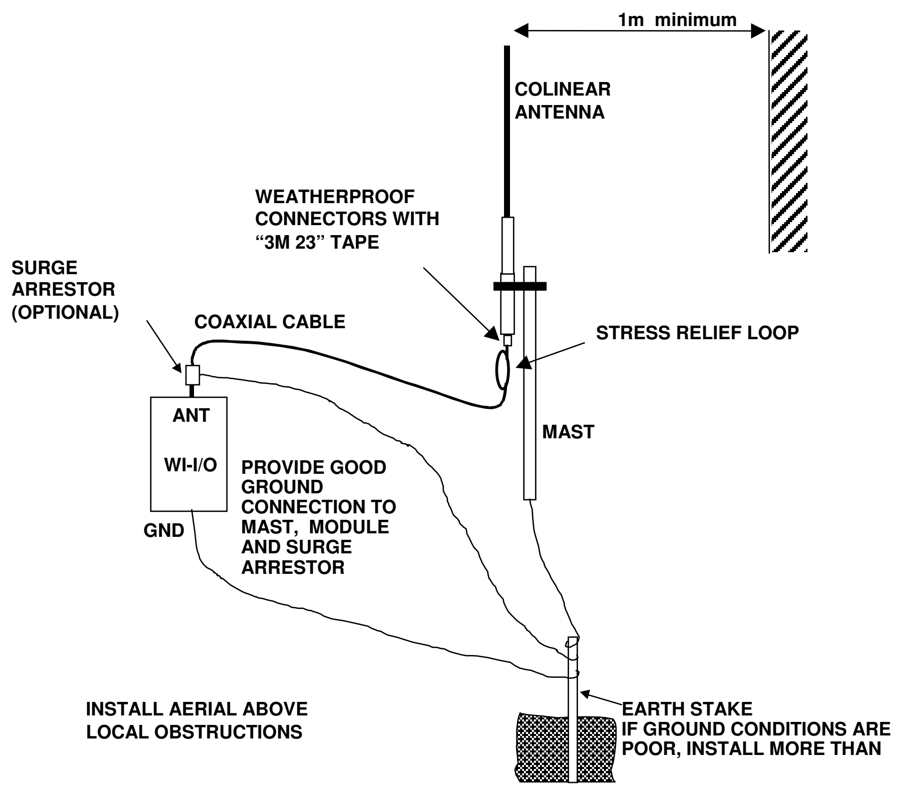
FCC Notice

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!

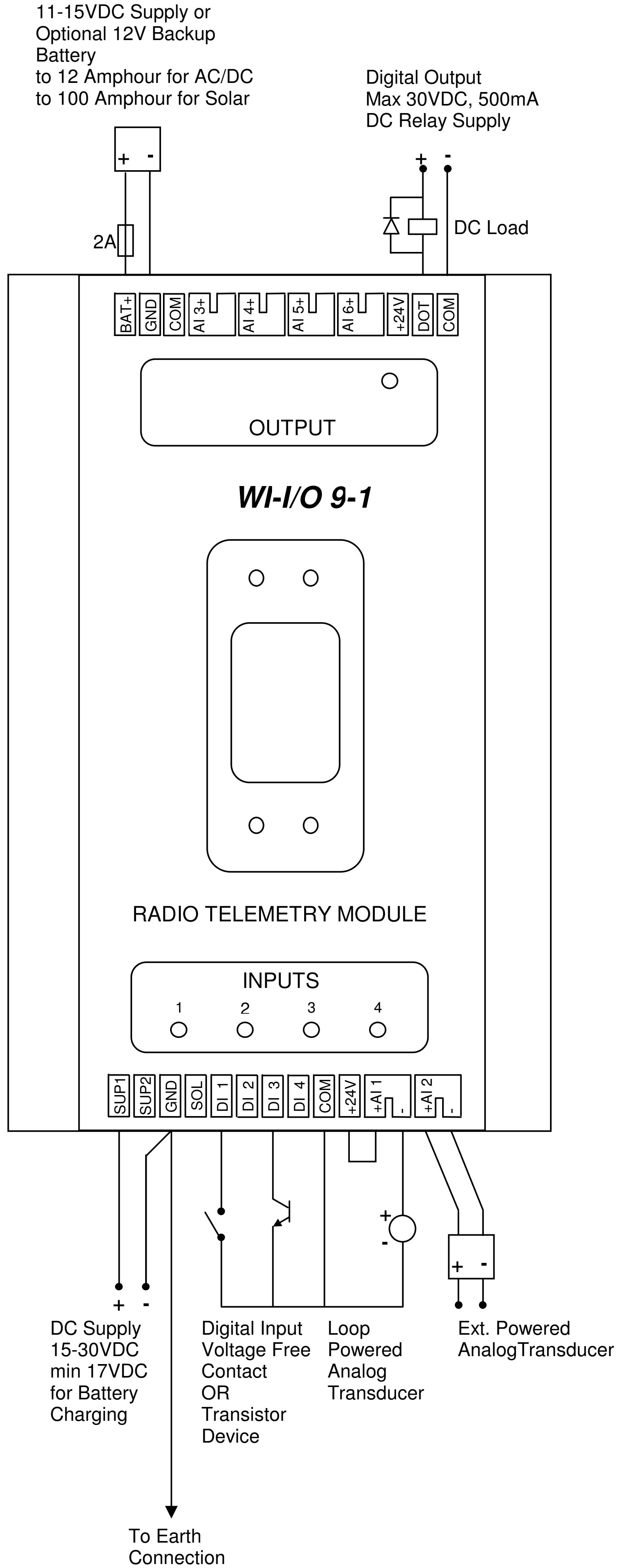
EXPLOSION HAZARD

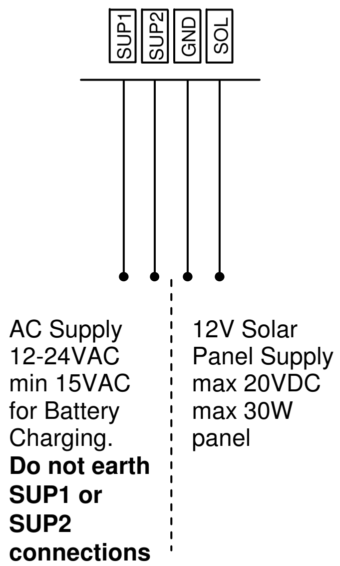
DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON – HAZARDOUS

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





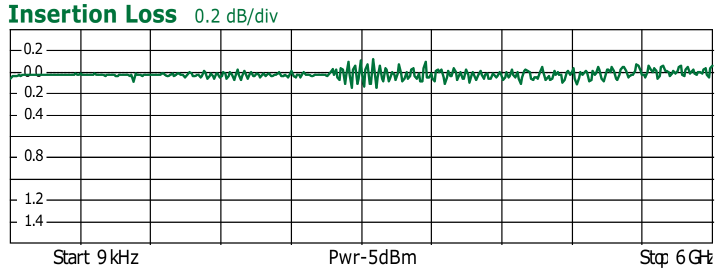
P8AX-6G Series

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.

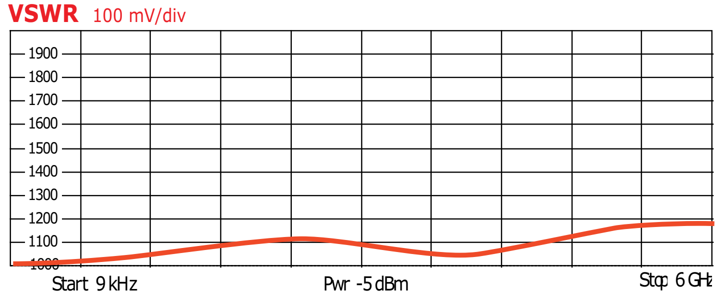
The P8AX 6G series employs replacable gas tubes, are waterproof (IP65) and available with three grounding methods:
M6 ground screw, bulkhead or optional mounting bracket.

- Multi Point Radio & Backhaul Bridges
- Tower Mounted Amplifiers (TMA)
- Antenna Systems
- Tower Top Electronics (TTE)
- Transmitters and Recievers
- WiFi
- Wimax Broadband Wireless

Insertion Loss 0.2 dB/div



VSWR 100 mV/div



Ordering information

P8AX -6G-N-

Max RF Power
09 = 25W
25 = 190W
50 = 780W

Gender Type
MF = Male/Bulkhead Female
FF = Female/Bulkhead Female

Characteristics

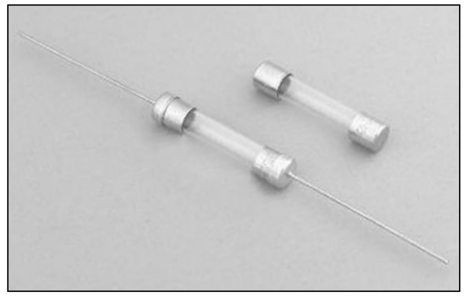
CITEL Part Number	P8AX09 6G	P8AX25 6G	P8AX50 6G
Frequency Range	DC 6.9GHz	DC 6.9GHz	DC 6.9GHz
DC Turn On (Breakdown)	90 130V	200 300V	400 600V
Technology	Gas Discharge Tube	Gas Discharge Tube	Gas Discharge Tube
Insertion Loss	≤0.2db	≤0.2db	≤0.2db
Return Loss	≥19db	≥19db	≥19db
VSWR	<1.25:1	<1.25:1	<1.25:1
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

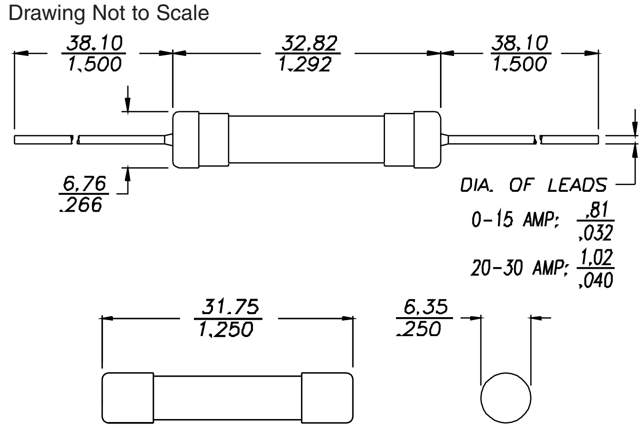
Description
- Fast-acting, glass tube
- Optional axial leads available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

RoHS 2002/95/EC



ELECTRICAL CHARACTERISTICS	
% of Amp Rating	**Opening Time**
100%	None
135%	60 Minutes Maximum
200%	120 Seconds Maximum

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

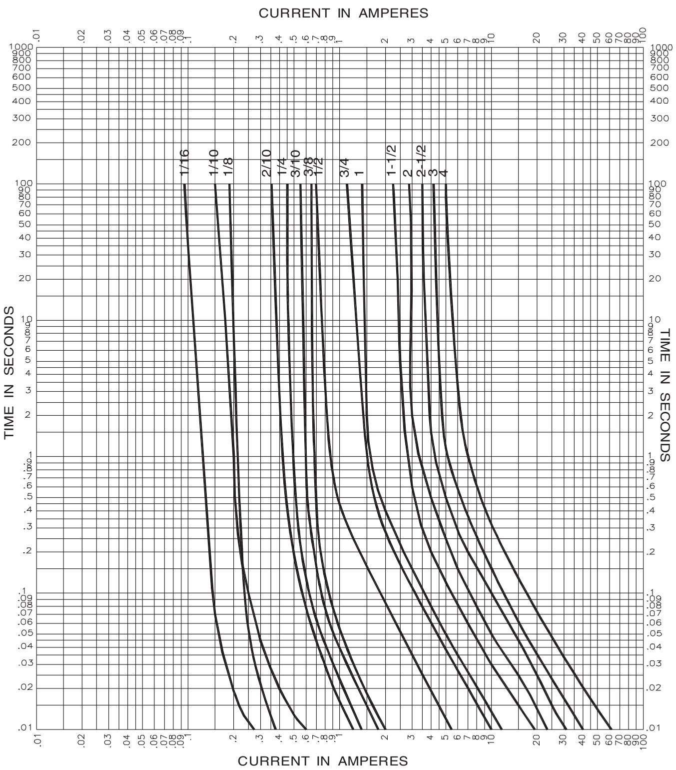
Product Code	Voltage Rating AC	AC Interrupting Rating 250V	125V	32V	Typical DC Cold Resistance** (ohms)	Typical Melting I²t† AC	Typical Voltage Drop‡
AGC-1/20	250V	35A	10000A	-	4.500	0.00773	0.67
AGC-1/16	250V	35A	10000A	-	29.000	0.000181	10.41
AGC-1/10	250V	35A	10000A	-	12.565	0.000787	6.00
AGC-1/8	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	-	-

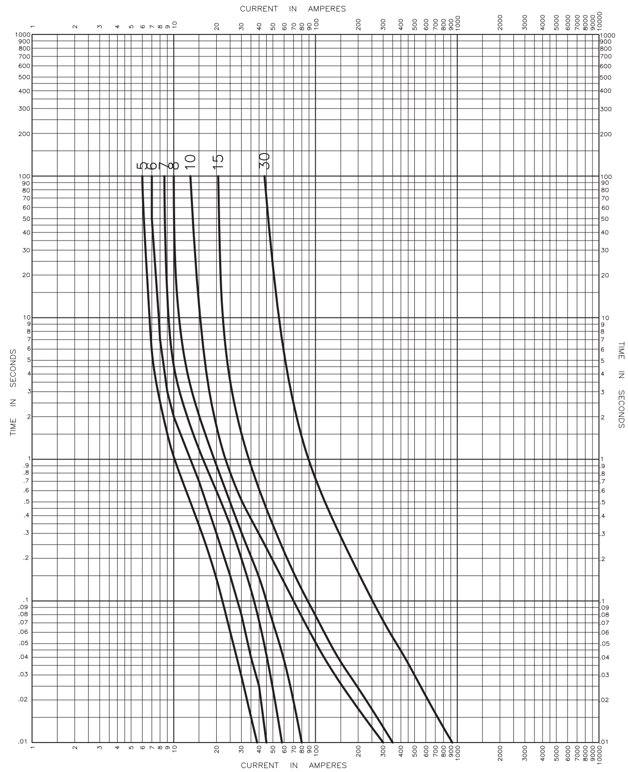
** DC Cold Resistance (Measured at ≤10% of rated current)
† Typical Melting I²t (A²Sec) (I²t was measured at listed interrupting rating and rated voltage.)
‡ Typical Voltage Drop (Voltage drop was measured at 25°C ambient temperature at rated current)

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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Industrial Automation Catalog Section - U906

Selection Guides

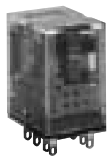
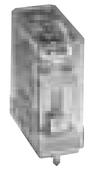
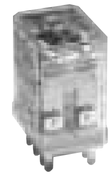
General Purpose Relays

- RH Series
- RM Series
- RY Series

idec

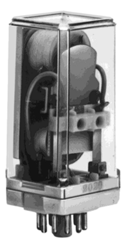
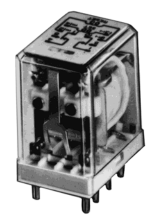
Selection Guides

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)

E

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

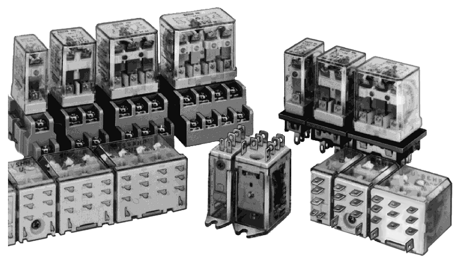
Solid State Relays

	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

E

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

<table>
<tr><th rowspan="2">Voltage</th><th rowspan="2">Rating</th><th colspan="4">Resistive</th><th colspan="4">Inductive</th><th colspan="3">Motor Load</th></tr>
<tr><th>SPDT</th><th>DPDT</th><th>3PDT</th><th>4PDT</th><th>SPDT</th><th>DPDT</th><th>3PDT</th><th>4PDT</th><th>SPDT</th><th>DPDT</th><th>3PDT</th></tr>
<tr><td>28V DC</td><td>UL</td><td>10A</td><td>10A</td><td>10A</td><td>10A</td><td>7.5A</td><td>—</td><td>—</td><td>7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="3">30V DC</td><td>UL</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td>—</td><td rowspan="3">7A</td><td>7A</td><td rowspan="2">—</td><td rowspan="2">—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>CSA</td><td rowspan="2">10A</td><td rowspan="2">7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Nominal</td><td>7.5A</td><td>7.5A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>110V DC</td><td>Nominal</td><td>0.5A</td><td>0.5A</td><td>0.5A</td><td>0.5A</td><td>0.3A</td><td>0.3A</td><td>0.3A</td><td>0.3A</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="3">120V AC</td><td>UL</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="3">10A</td><td rowspan="2">7.5A</td><td>—</td><td rowspan="2">—</td><td rowspan="3">7.5A</td><td>1/6</td><td>1/6</td><td>1/6</td></tr>
<tr><td>CSA</td><td rowspan="2">7.5A</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Nominal</td><td>7A</td><td>7.5A</td></tr>
<tr><td rowspan="3">240V AC</td><td>UL</td><td rowspan="2">10A</td><td rowspan="2">10A</td><td rowspan="2">—</td><td rowspan="2">7.5A</td><td rowspan="2">7A</td><td rowspan="2">7A</td><td>*</td><td rowspan="3">5A</td><td>1/3</td><td>1/3</td><td>1/3</td></tr>
<tr><td>CSA</td><td>7A</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Nominal</td><td>7A</td><td>7.5A</td><td>7.5A</td><td>4.5A</td><td>5A</td><td>5A</td><td>5A</td></tr>
</table>

*1. * 6.5A/pole, 20A total.*
2. Inductive load cos ø = 0.3, L/R = 7ms.

E

Applicable Sockets

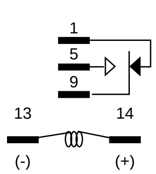
Part Numbers: Sockets

<table>
<tr><th>Relay</th><th>Standard DIN Rail Mount</th><th>Finger-Safe DIN Rail Mount</th><th>Surface Mount</th><th>Panel Mount</th><th>PCB Mount</th></tr>
<tr><td>RH1B</td><td>SH1B-05</td><td>SH1B-05C</td><td>—</td><td>SH1B-51</td><td>SH1B-62</td></tr>
<tr><td>RH2B</td><td>SH2B-05</td><td>SH2B-05C</td><td>SH2B-02</td><td>SH2B-51</td><td>SH2B-62</td></tr>
<tr><td>RH3B</td><td>SH3B-05</td><td>SH3B-05C</td><td rowspan="2">—</td><td>SH3B-51</td><td>SH3B-62</td></tr>
<tr><td>RH4B</td><td>SH4B-05</td><td>SH4B-05C</td><td>SH4B-51</td><td>SH4B-62</td></tr>
</table>

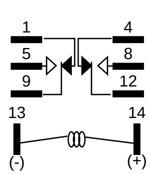
<table>
<tr><th colspan="2">Spring & Clips (optional)</th></tr>
<tr><th>Part Number</th><th>Use With</th></tr>
<tr><td>SY2S-02F1
SFA-101
SFA-202</td><td>SH1B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH1B-51, 62</td></tr>
<tr><td>SY4S-02F1
SFA-101
SFA-202</td><td>SH2B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH2B-51, 62</td></tr>
<tr><td>SH3B-05F1
SFA-101, -202</td><td>SH3B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH3B-51, 62</td></tr>
<tr><td>SH4B-02F1
SFA-101, -202</td><td>SH4B-05, 05C</td></tr>
<tr><td>SY4S-51F1
SFA-301
SFA-302</td><td>SH4B-51, 62</td></tr>
</table>

See Section F for details on sockets. All DIN rail mount sockets shown above can be mounted using DIN rail BNDN1000.

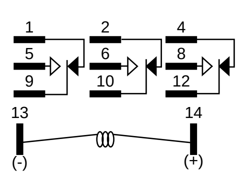
Internal Circuits



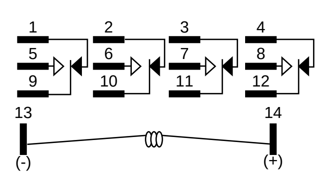
RH1



RH2



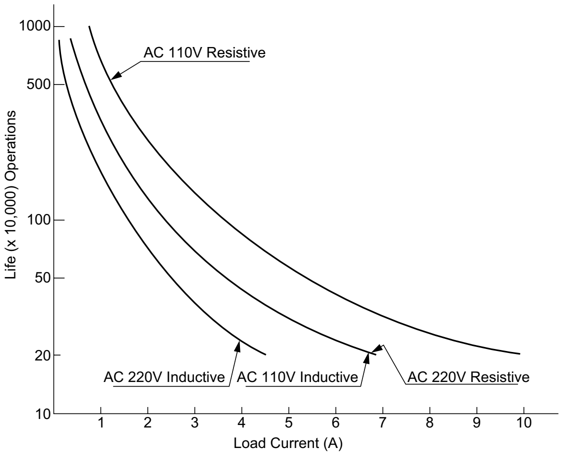
RH3

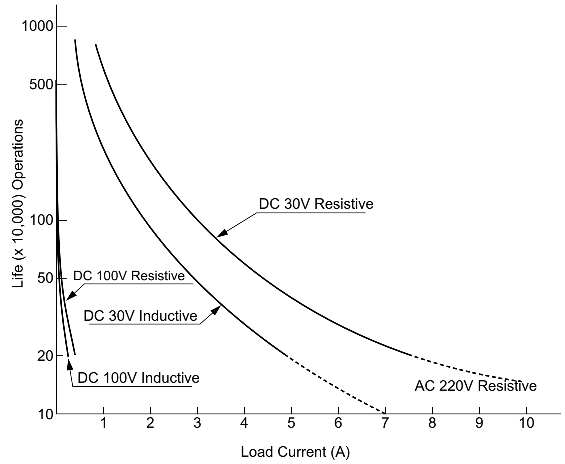


RH4

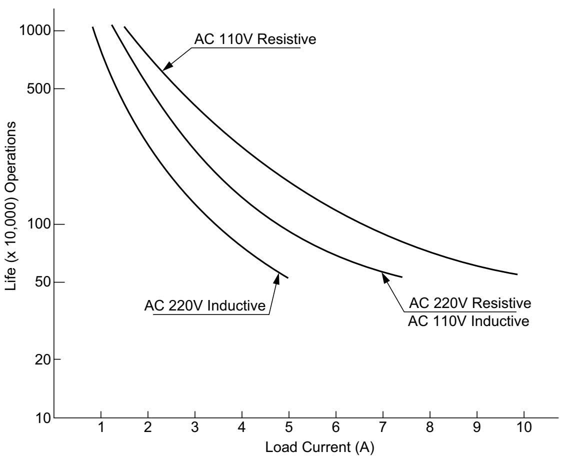
Electrical Life Curves

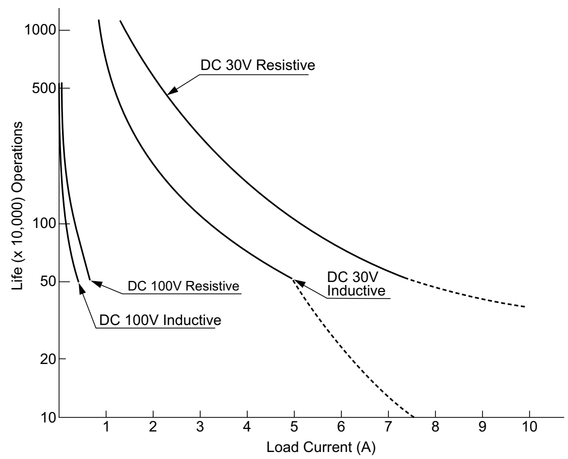
RH1



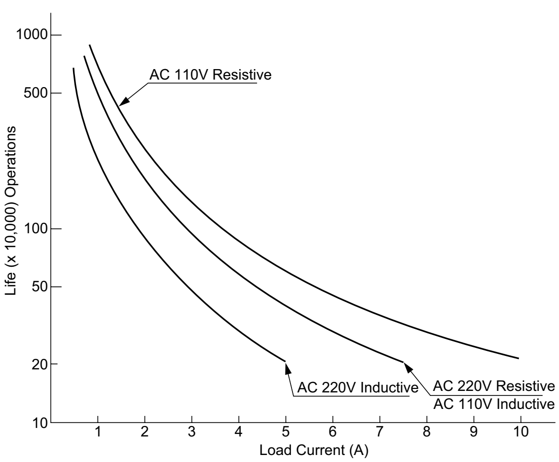


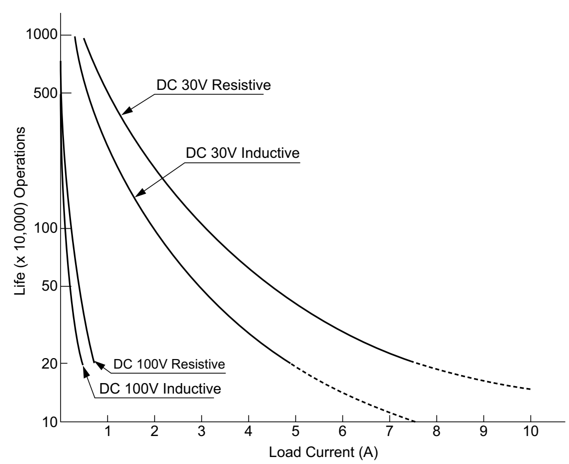
RH2





RH3 and 4

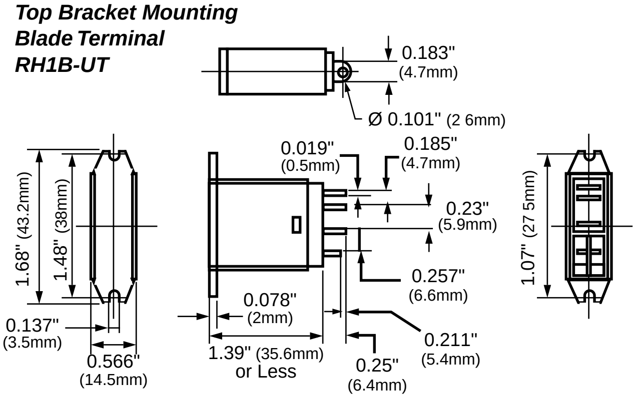




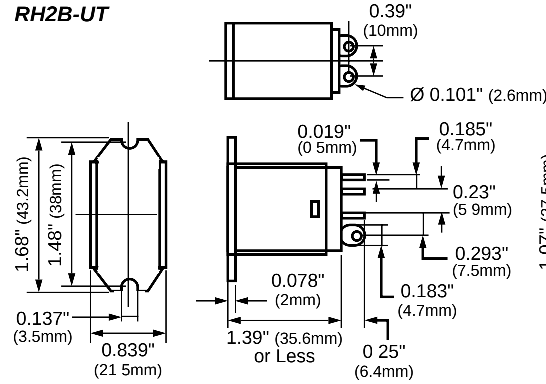
Dimensions

E

Top Bracket Mounting Blade Terminal RH1B-UT

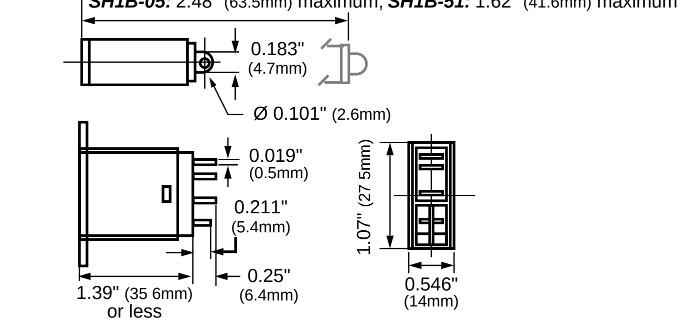


RH2B-UT



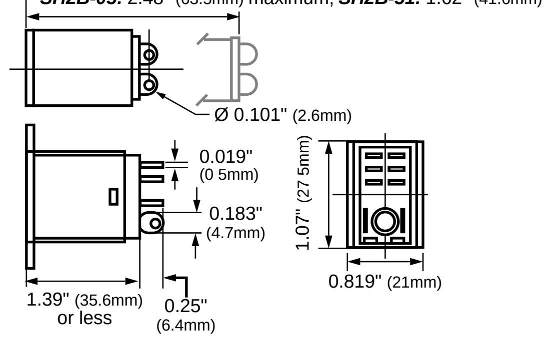
Plug-in Blade Terminal RH1B

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



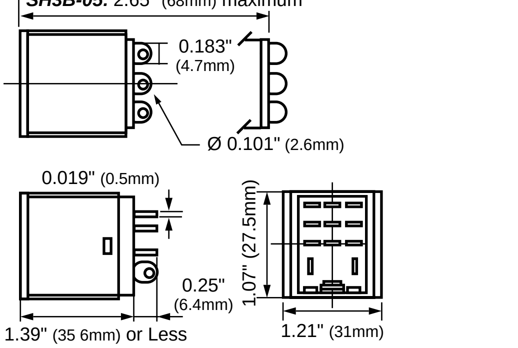
RH2B

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)



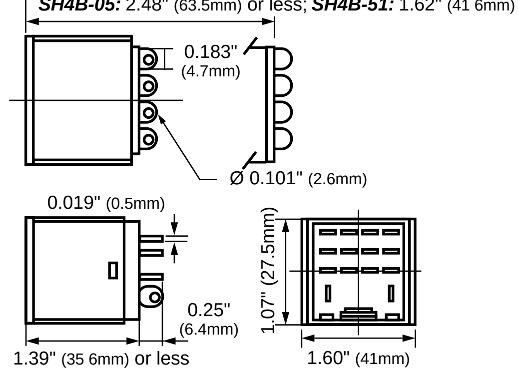
Plug-in Blade Terminal RH3B

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

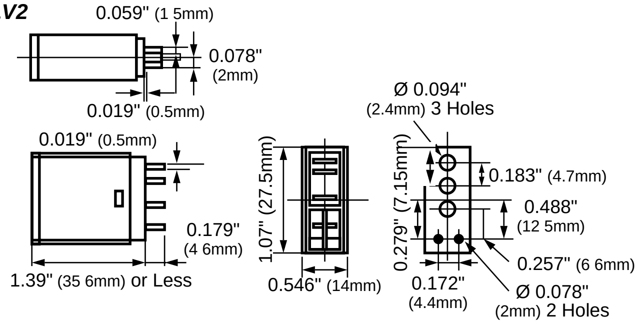
Total leng h from panel surface including socket:
SH4B-05: 2.40" (61.5mm) or less; ***SH4B-51:*** 1.54" (39 6mm)
Total leng h from panel surface including hold-down spring:
SH4B-05: 2.48" (63.5mm) or less; ***SH4B-51:*** 1.62" (41 6mm)



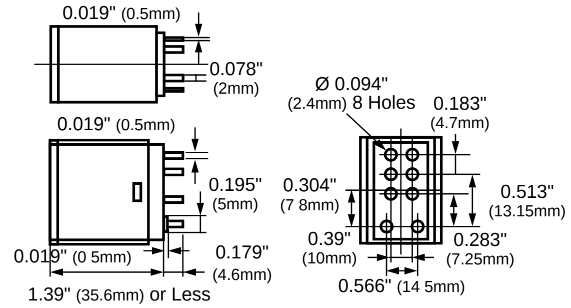
Dimensions

PCB Terminal

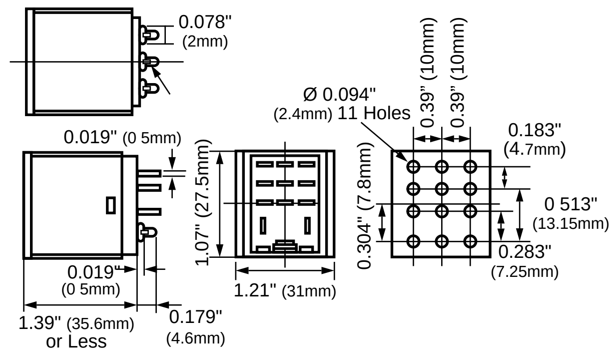
RH1V2



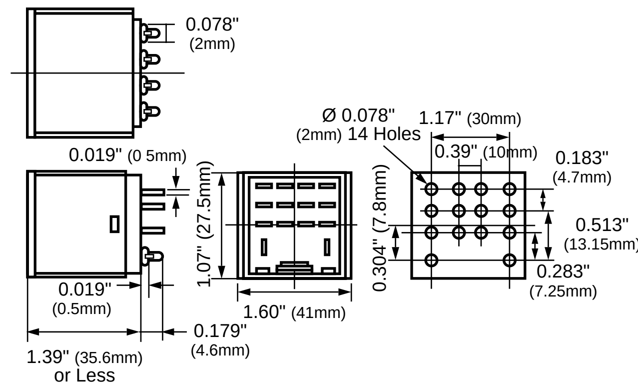
RH2V2



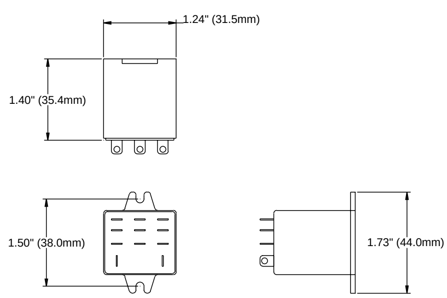
RH3V2



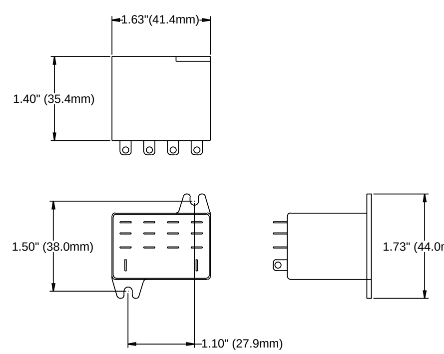
RH4V2



RH3B-UT



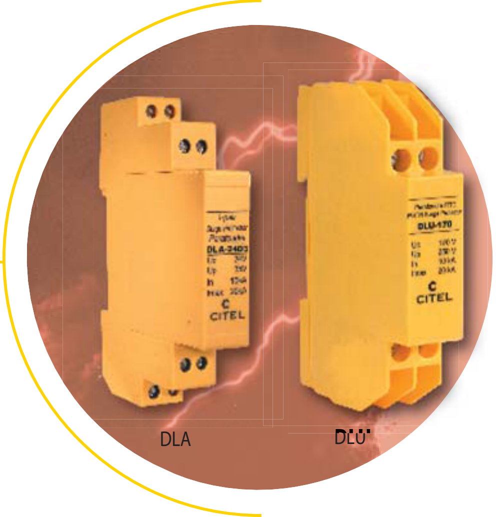
RH4B-UT



E

DIN Rail Surge Protector for Dataline/Telecom

DLA & DLU

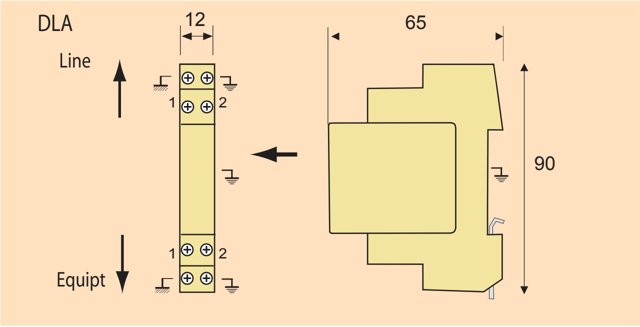


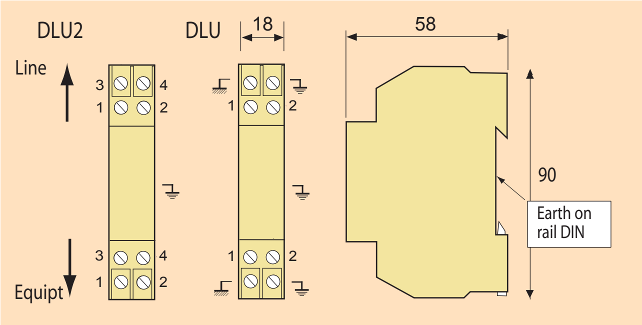
DLA and DLU surge protectors are designed to protect, against surge voltages due to lightning, terminals equipment connected to industrial buses, telecom lines or datalines.
These surge protectors must be installed on symmetrical DIN rail and are available for most of the transmission lines : line voltage 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.

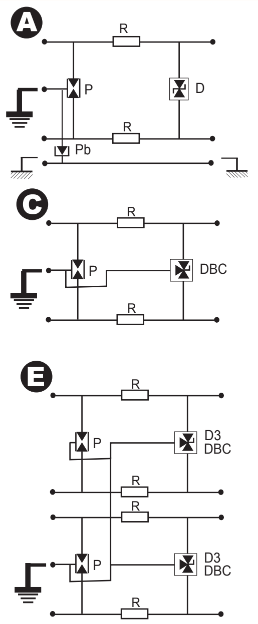
DLU
1-pair (DLU) or 2-pair (DLU2) DIN rail surge protector. Monobloc enclosure. Transmission and protection of the shield wire (DLU). Earth through DIN rail.

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

- For «DIN» rail mounting
- All types of Telephone and Data lines
- Pluggable version (DLA)
- 2-pair version (DLU2)

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					

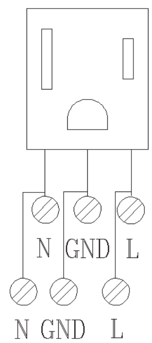
CITEL part number	DLU-170	DLU2-48D3	DLU-48DBC	DLU-24D3	DLU2-12D3	DLU-12D3	DLU-12DBC	DLU2-06D3	DLU2-06DBC
Application	Telephone line ADSL	ISDN-T0 Profibus-PA Liaison 48 V	Fipway WorldFIP Fieldbus-H2	4-20 mA 24 V line	RS232	Profibus-FMS Interbus Fieldbus-H1 Batibus	Profibus-DP LONwork	RS422	T2 - T1 10BaseT
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).								

F050414B - Document could be modified without notice

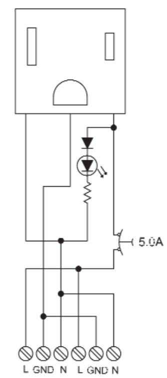
These modules are intended for use within cabinets and enclosures as 120 VAC outlets for power tools, lights, computers or test equipment for troubleshooting.

- 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



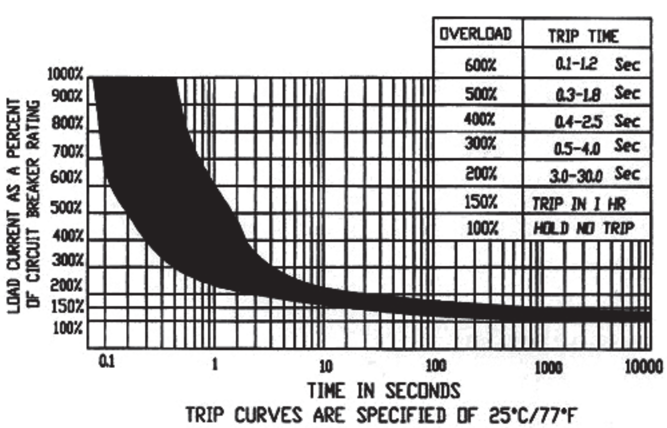
Rated data

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



PHOENIX CONTACT

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

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)

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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)

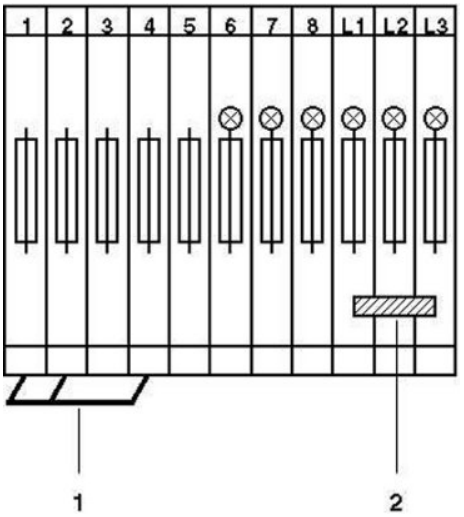
Connection data

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

PHOENIX CONTACT Inc., USA
586 Fulling Mill Road
Middletown, PA 17057,USA
Phone (800) 888-7388
Fax (717) 944-1625
http://www.phoenixcon.com

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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

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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)

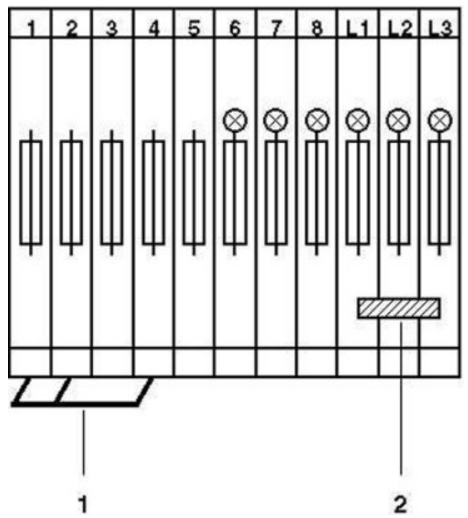
Connection data

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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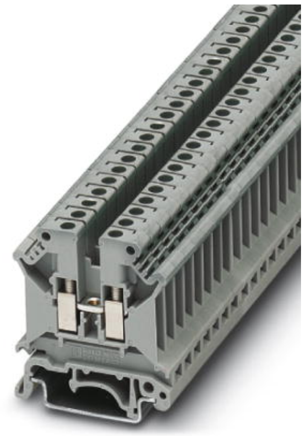
Extract from the online catalog

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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Order No.: 3003965

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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)

Address

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Middletown, PA 17057,USA
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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

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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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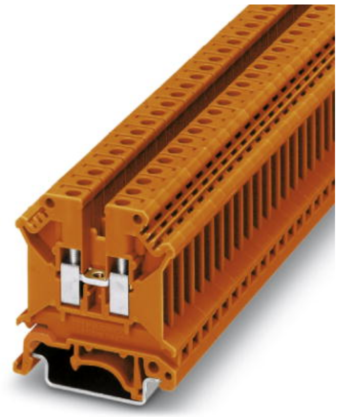
UK 5 N OG

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

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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

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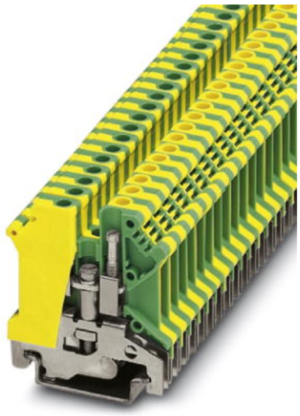
USLKG 5

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

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)

Product notes

WEEE/RoHS-compliant since: 01/15/2005

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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 mm^2
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm^2
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm^2
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm^2
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm^2
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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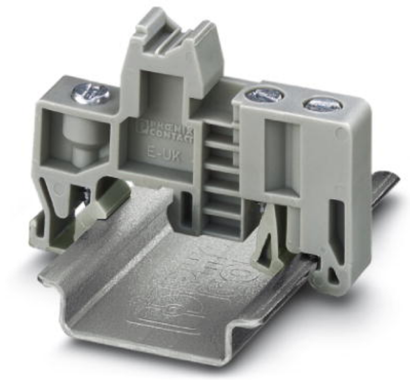
Extract from the online catalog

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

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Technical data

General

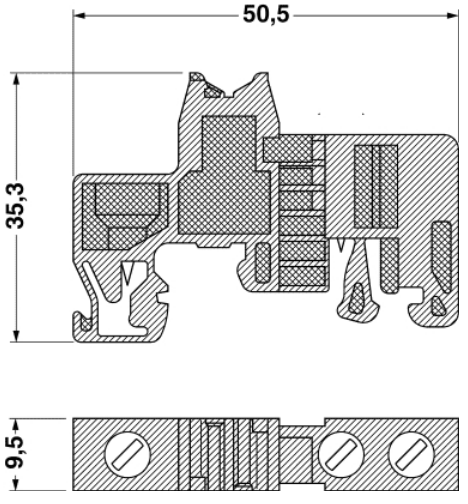
Length (b)	50.5 mm
Height	35.3 mm
Width (a)	9.5 mm
Color	gray
Inflammability class acc. to UL 94	V2
Material	PA

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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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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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.

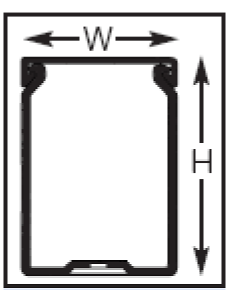
MATERIAL:
Rigid PVC,
self-extinguishing

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) 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.

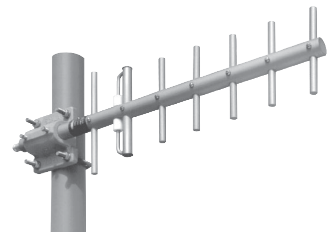
Spiralite is manufactured in natural polyethylene and self-extinguishing polyethylene.

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.



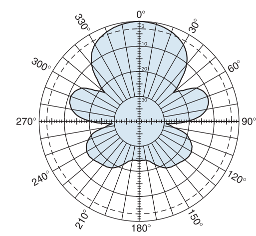
(Shown vertically polarized)

Specifications:

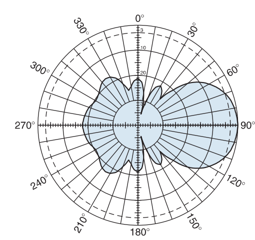
Frequency range	890–960 MHz (broadband)
Gain	10 dBd
Impedance	50 ohms
VSWR	< 1.5:1 maximum (1.35:1 typical)
Polarization	Horizontal or vertical
Front-to-back ratio	>20 dB
Maximum input power	100 watts (at 50°C)
H-plane beamwidth	48 degrees (half-power)
E-plane beamwidth	40 degrees (half-power)
Connector	N female
Weight	3 lb (1.4 kg)
Dimensions	23 x 7 inches (584 x 178 mm)
Equivalent flat plate area	0.24 ft² (0.022 m²)
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



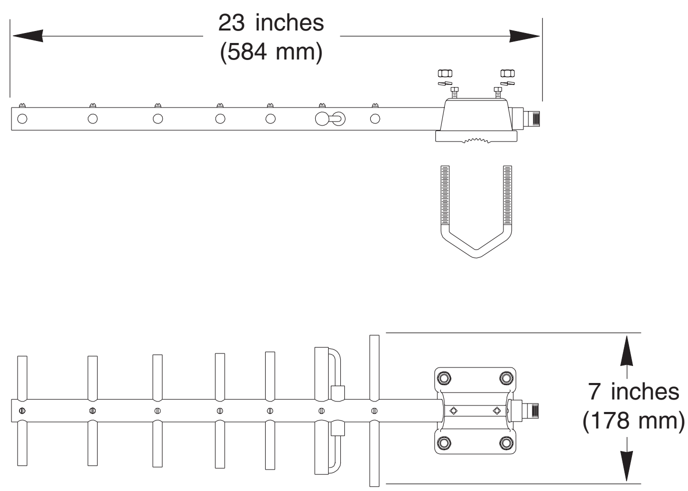
E-plane
Horizontal pattern – H-polarization
Vertical pattern – V-polarization

10065-D

Kathrein Inc., Scala Division Post Office Box 4580 Medford, OR 97501 (USA) Phone: (541) 779-6500 Fax: (541) 779-3991
Email: communications@kathrein.com Internet: www.kathrein-scala.com

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

Kathrein Inc., Scala Division Post Office Box 4580 Medford, OR 97501 (USA) Phone: (541) 779-6500 Fax: (541) 779-3991
Email: communications@kathrein.com Internet: www.kathrein-scala.com

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BANNER WIRELESS SYSTEMS
SUMP MONITORING RADIO EQIUPMENT

SureCross DX80 Node with Analog I/O

Configurable Node with four 0–20mA analog inputs and four 0–20mA analog outputs

Features

IP67 Base
2.4 GHz

IP20 Base
900 MHz

The SureCross™ wireless system is a radio frequency network with integrated I/O that can operate in most environments while eliminating the need for wiring runs. Systems are built around a Gateway, which acts as the wireless network master device, and one or more Nodes.

- Wireless industrial I/O device with four 0 to 20 mA analog inputs and four 0 to 20 mA analog outputs
- 10 to 30V dc power input
- DIP switches for user configuration
- Frequency Hopping Spread Spectrum (FHSS) technology and Time Division Multiple Access (TDMA) control architecture combine to ensure reliable data delivery within the unlicensed Industrial, Scientific, and Medical (ISM) band
- Transceivers provide bidirectional communication between the Gateway and Node, including fully acknowledged data transmission
- Lost RF links are detected and relevant outputs set to user-defined conditions
- The DX80...C models are certified for use in Class I, Division 2, Group A, B, C, D; Zone 2 (Group IIC) Hazardous Locations when properly installed in accordance with the National Electrical Code, the Canadian Electrical Code, LCIE/ATEX, or applicable local codes/regulations (see Specifications)

For additional information, the most recent version of all documentation, and a complete list of accessories, refer to Banner Engineering's website, *www.bannerengineering.com/surecross*.

Models

Model	Frequency	Environmental Rating	I/O
DX80N9X6S0P0M4M4	900 MHz ISM Band	IP67, NEMA 6	**Inputs**: Four 0 to 20 mA analog **Outputs**: Four 0 to 20 mA analog
DX80N2X6S0P0M4M4	2.4 GHz ISM Band		
DX80N9X6S0P0M4M4C	900 MHz ISM Band	IP20, NEMA 1 Class I, Division 2, Group A, B, C, D Hazardous Locations (see *Specifications*)	
DX80N2X6S0P0M4M4C	2.4 GHz ISM Band		

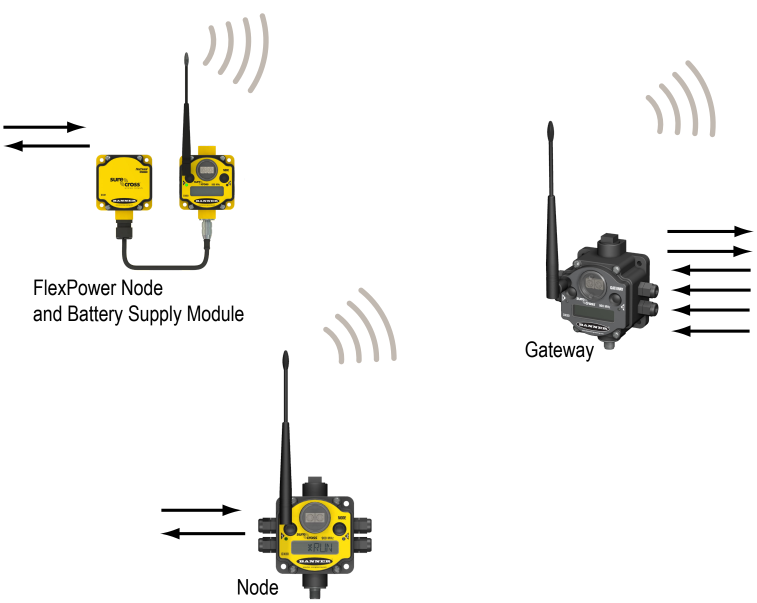
Internal antenna models are also available, but are not UL Listed. For more information, contact your local Banner Engineering Corp. representative.

WARNING: Not To Be Used for Personnel Protection
Never use this product as a sensing device for personnel protection. Doing so could lead to serious injury or death. This product does NOT include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

The SureCross DX80 Wireless Network

The SureCross DX80 wireless I/O network provides reliable monitoring without the burden of wiring or conduit installation. The SureCross wireless network can operate independently or in conjunction with a host system, PLC, and/or PC software.

Each wireless network system consists of one Gateway and one or more Nodes. Devices ship with factory defined inputs and outputs that may be all discrete, all analog, or a mix of discrete and analog I/O.



The SureCross DX80 network is a deterministic system—the network identifies when the radio signal is lost and drives relevant outputs to user-defined conditions. Once the radio signal is reacquired, the network returns to normal operation.

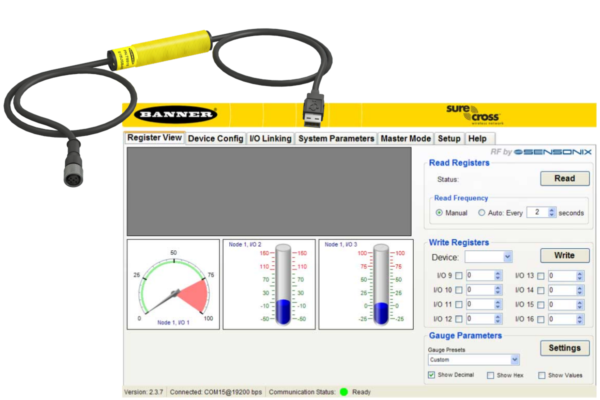
SureCross DX80 Gateways and Nodes

A **Gateway** acts as the master device within each radio network, initiates communication and reporting with the Nodes, and controls the timing for the entire network.

The Gateway also holds the configuration for the network. Every wireless network must have one Gateway that schedules communication traffic and controls the I/O configuration for the network. A radio network contains only one Gateway, but can contain many Nodes. Similar to how a gateway device on a wired network acts as a “portal” between networks, the SureCross Gateway acts as the portal between the wireless network and the central control process.

A **Node** is a wireless network end-point device used to provide sensing capability in a remote area or factory. The Node collects data from sensors and communicates the data back to the Gateway. Nodes are available in a wide variety of power or input/output options. Each Node device can be connected to sensors or output devices and reports I/O status to the Gateway.

SureCross User Configuration Tool



The User Configuration Tool (UCT) offers an easy way to link I/O points in your wireless network, view I/O register values graphically, and set system communication parameters when a host system is not part of the wireless network.

The UCT requires a special USB to RS-485 (model number BWA-HW-006) converter cable to pass information between your computer and the Gateway. Download the most recent revisions of the UCT software from Banner Engineering's website: *http://www.bannerengineering.com/wireless*.

Wiring Diagrams

5-pin Euro-Style Hookup (Nodes)

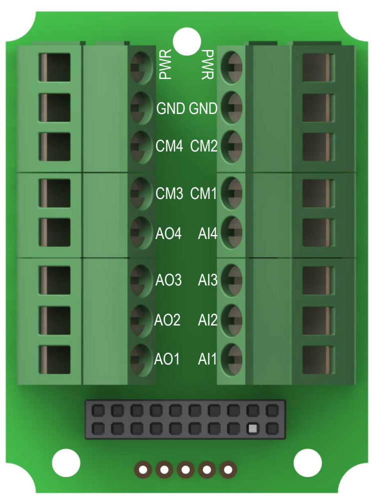
Wiring the 5-pin Euro-style connector depends on the model and power requirements of the device.

	Wire No.	Wire Color	10 to 30V dc Powered Nodes	Battery Powered Nodes
	1	Brown	10 to 30V dc	
	2	White		
	3	Blue	dc common (GND)	dc common (GND)
	4	Black		
	5	Gray		3.6 to 5.5V dc

Connecting dc power to the communication pins will cause permanent damage. For FlexPower devices, do not apply more than 5.5V to the gray wire.

Terminal Block (IP67 Housing)

Connecting dc power to the communication pins will cause permanent damage. Do not exceed analog input ratings for analog inputs. Only connect sensor outputs to analog inputs.



AI*x* or A*x*. Analog IN *x*.

AO*x*. Analog OUT *x*.

CM*x*. Not used. Do not make any wiring connections to these terminals.

GND. Ground/dc common connection.

PWR. Power, 10 to 30V dc power connection.

DX80...C Wiring

Wiring power to the DX80...C models varies depending the power requirements of the model.

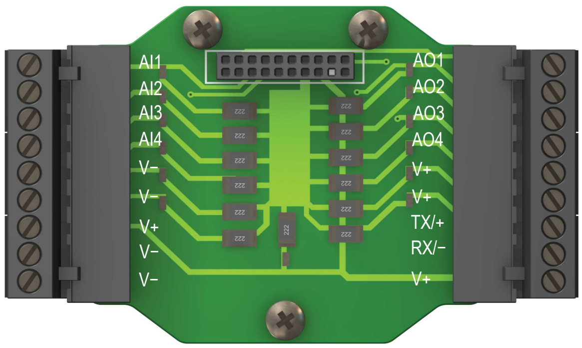
Terminal Label	Gateway, DX85 *	10 to 30V dc Powered Nodes	Battery Powered Nodes **
V+	10 to 30V dc	10 to 30V dc	
Tx/+	RS485 / D1 / B / +		
V-	dc common (GND)	dc common (GND)	dc common (GND)
Rx/-	RS485 / D0 / A / -		
B+			3.6 to 5.5V dc

* Connecting dc power to the communication pins will cause permanent damage.

** For FlexPower devices, do not apply more than 5.5V to the gray wire.

Terminal Block (IP20 Housing)

Connecting dc power to the communication pins will cause permanent damage. Do not exceed analog input ratings for analog inputs. Only connect sensor outputs to analog inputs.



AI*x* or A*x*. Analog IN *x*.

AO*x*. Analog OUT *x*.

CM*x*. Not used. Do not make any wiring connections to these terminals.

RX/-. Serial comms line

TX/+. Serial comms line

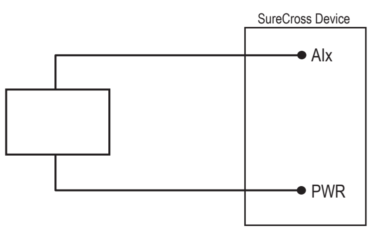
V+. Power, 10 to 30V dc power connection.

V-. Ground/dc common connection.

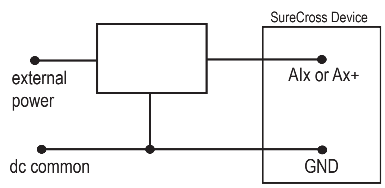
Wiring Diagrams for Analog Inputs

Connecting dc power to the communication pins will cause permanent damage. Do not exceed analog input ratings for analog inputs. Only connect sensor outputs to analog inputs.

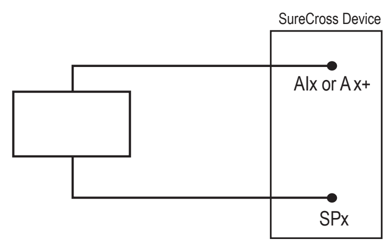
Analog Input Wiring (10 to 30V dc Power)



Analog Input Wiring (Externally Powered Sensors)



Analog Input Wiring (Switch Powered Sensors)

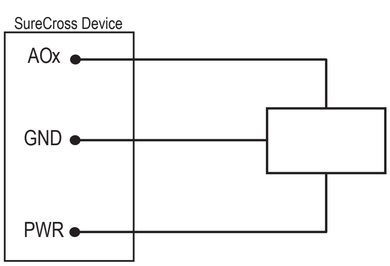


(Only possible in models with switch power (SPx) outputs)

Wiring Diagrams for Analog Outputs

Connecting dc power to the communication pins will cause permanent damage. Do not exceed analog input ratings for analog inputs. Only connect sensor outputs to analog inputs.

Analog Output Wiring



Additional Information

For additional information, including installation and setup, weatherproofing, device menu maps, troubleshooting, and a list of accessories, refer to one of the following product manuals

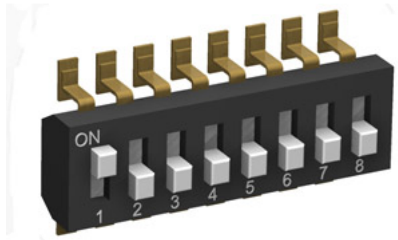
- SureCross Quick Start Guide: Banner part number 128185
- SureCross Wireless I/O Network Manual: 132607
- Web Configurator Manual (used with "Pro" and DX83 models): 134421

Modbus Register Table

I/O	Modbus Holding Register		I/O Type	Units	I/O Range		Holding Register Representation		Terminal Block Labels
	Gateway or DX85	Any Node			Min. Value	Max. Value	Min. (Dec.)	Max. (Dec.)	
1	1	1 + (Node# × 16)	Analog IN 1	mA / V	0.0	20.0 / 10.0	0	65535	AI1
2	2	2 + (Node# × 16)	Analog IN 2	mA / V	0.0	20.0 / 10.0	0	65535	AI2
3	3	3 + (Node# × 16)	Analog IN 3	mA / V	0.0	20.0 / 10.0	0	65535	AI3
4	4	4 + (Node# × 16)	Analog IN 4	mA / V	0.0	20.0 / 10.0	0	65535	AI4
5	5	5 + (Node# × 16)							
6	6	6 + (Node# × 16)							
7	7	7 + (Node# × 16)	Reserved						
8	8	8 + (Node# × 16)	Device Message						
9	9	9 + (Node# × 16)	Analog OUT 1	mA / V	0.0	20.0 / 10.0	0	65535	AO1
10	10	10 + (Node# × 16)	Analog OUT 2	mA / V	0.0	20.0 / 10.0	0	65535	AO2
11	11	11 + (Node# × 16)	Analog OUT 3	mA / V	0.0	20.0 / 10.0	0	65535	AO3
12	12	12 + (Node# × 16)	Analog OUT 4	mA / V	0.0	20.0 / 10.0	0	65535	AO4
13	13	13 + (Node# × 16)							
14	14	14 + (Node# × 16)							
15	15	15 + (Node# × 16)	Control Message						
16	16	16 + (Node# × 16)	Reserved						

Device Configuration

DIP Switch Changes



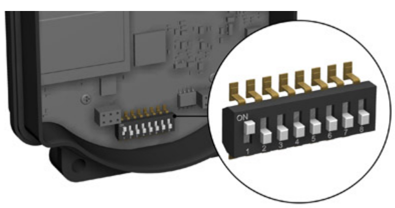
Before making any changes to the DIP switch positions, disconnect the power. For devices with batteries integrated into the housing, remove the battery for at least one minute.

DIP switch changes will not be recognized if power isn't cycled to the device.

Accessing the Internal DIP Switches

To access the internal DIP switches, follow these steps:

1. Unscrew the four screws that mount the cover to the bottom housing.
2. Remove the cover from the housing without damaging the ribbon cable or the pins the cable plugs into.
3. Gently unplug the ribbon cable from the board mounted into the bottom housing. For integrated battery models (no ribbon cable) and Class I, Division 2 certified devices (ribbon cable is glued down), skip this step.
4. Remove the black cover plate from the bottom of the device's cover.



The DIP switches are located behind the rotary dials. After making the necessary changes to the DIP switches, place the black cover plate back into position and gently push into place. Plug the ribbon cable in after verifying that the blocked hole lines up with the missing pin. Mount the cover back onto the housing.

DIP Switch Settings

	Switches							
Device Settings	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Rotary switch address mode	OFF*							
Extended address mode	ON							
Host configured (overrides switches 3-8)		OFF*						
Use switch settings		ON						
Link loss output: zero				OFF*	OFF*			
Link loss output: one				OFF	ON			
Link loss output: hold last state				ON	OFF			
Link loss output: user configuration				ON	ON			
0–20 mA scale **						OFF*		
4–20 mA scale **						ON		

* Default configuration

** Not used on 0–10V I/O models.

Address Mode

The SureCross wireless devices may use one of two types of addressing modes: rotary dial addressing or extended addressing. In **rotary dial** address mode, the left rotary dial establishes the network ID and the right rotary dial sets the device ID. The wireless network is restricted to a maximum of 16 devices.

Extended address mode uses a security code to "bind" Nodes to a specific Gateway. Bound Nodes can only send and receive information from the Gateway to which they are bound. In extended address mode, wireless networks may contain up to 48 radio devices. For more information on extended address mode, refer to the SureCross™ Wireless I/O Network product manual.

The device ships in rotary dial address mode by default, with the DIP switch in the OFF position. To use extended address mode, change the DIP switch to the ON position.

Analog Input and Output Scale

Use the DIP switch to select which current scale to use for all the device's analog inputs and outputs: 0 to 20 mA or 4 to 20 mA.

When using a 4-20 mA sensor with a 0-20 mA input, the sensor uses the 4-20 mA section of the total range. Using a 4-20 mA with a 0-20 mA input allows you to determine when you have an error condition with the sensor. A normal input reading between 4 and 20 mA indicates a functioning sensor whereas a value below 4 mA indicates an error condition, such as a broken wire or loose connection.

This DIP switch is used only on the 0 to 20 mA models, not the 0 to 10V models.

Host Configured

Selecting “Host Configured (override switches)” uses the factory’s default configuration for this device or allows a host system to set parameters. If the host configured option is not selected, use the DIP switches to configure the device parameters.

Link Loss Outputs

The SureCross™ DX80 wireless devices use a deterministic link time-out method to address RF link interruption or failure. When a radio link fails, all pertinent wired outputs are sent to defined states until the link is recovered, ensuring that disruptions in the communications link result in predictable system behavior.

Following a time-out, all outputs linked to the Node in question are set to de-energize (discrete outputs to zero, analog outputs to 0 mA or 4 mA), energize (discrete outputs to one, analog outputs to 20 mA), or to hold the last stable state/value. Use the DIP switches to select the link loss output state.

Verify Communications

After powering up and binding the Gateway and its Nodes, verify all devices are communicating properly. Verify LED 1 is green. Until communication is established with the Gateway, the Node’s LED 2 flashes red. When communication is established, the Node’s LED 1 flashes green.

A Node will not sample its inputs until it is communicating with the Gateway to which it is bound.

LED 1	LED 2	Gateway Status	Node Status
(green on)		Power ON	
(green flashing)			RF Link OK
(red flashing)	(red flashing)	Device Error	Device Error
	(yellow flashing)	Modbus Communication Active	
	(red flashing)	Modbus Communication Error	No radio link (when flashing once every three seconds)

For Gateway and Ethernet Bridge systems, active Modbus communication refers to the communication between the Gateway and the Ethernet Bridge. For GatewayPro systems, the Modbus communication LEDs refer to the communication internal to the Gateway Pro. For Gateway only systems, the Modbus communication LEDs refer to the communication between the Gateway and its host system (if applicable).

When testing the Gateway and Node, verify all radios and antennas are at least two meters apart or the communications may fail.

Specifications

Radio

Range
900 MHz: Up to 4.8 kilometers (3 miles) *
2.4 GHz: Up to 3.2 kilometers (2 miles) *

Transmit Power
900 MHz: 21 dBm conducted
2.4 GHz: 18 dBm conducted, less than or equal to 20 dBm EIRP

900 MHz Compliance (150 mW Radios)
FCC ID TGUDX80 - This device complies with FCC Part 15, Subpart C, 15.247
IC: 7044A-DX8009

2.4 GHz Compliance
FCC ID UE300DX80-2400 - This device complies with FCC Part 15, Subpart C, 15.247
ETSI/EN: In accordance with EN 300 328: V1.7.1 (2006-05)
IC: 7044A-DX8024

Spread Spectrum Technology
FHSS (Frequency Hopping Spread Spectrum)

Antenna Connection
Ext. Reverse Polarity SMA, 50 Ohms
Max Tightening Torque: 0.45 N·m (4 in·lbf)

Link Timeout
Gateway: Configurable
Node: Defined by Gateway

* With the 2 dB antenna that ships with the product. High-gain antennas are available, but the range depends on the environment and line of sight. To determine the range of your wireless network, perform a Site Survey.

General

Power*
Requirements: +10 to 30V dc (For European applications: +10 to 24V dc, ± 10%). (See UL section below for any applicable UL specifications)
Consumption: Less than 1.4 W (60 mA) at 24V dc

Housing
Polycarbonate
Weight: 0.26 kg (0.57 lbs)
Mounting: #10 or M5 (M5 hardware included)
Max. Tightening Torque: 0.56 N·m (5 in·lbf)

Interface
Indicators: Two bi-color LEDs
Buttons: Two
Display: Six character LCD

Wiring Access
Four PG-7, One 1/2-inch NPT, One 5-pin Euro-style male connector

* For European applications, power the DX80 from a Limited Power Source as defined in EN 60950-1.

Inputs and Outputs

Analog Inputs
Rating: 24 mA
Impedance: 100 Ohms
Sample Rate: 62.5 milliseconds
Report Rate: 1 second or On Change of State (1% change in value)
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

To verify the analog input's impedance, use an Ohm meter to measure the resistance between the analog input terminal (AI*x*) and the ground (GND) terminal.

Analog Outputs
Update Rate: 125 milliseconds
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

Environmental

Environmental

Shock and Vibration
IEC 68-2-6 and IEC 68-2-7

Rating for DX80 models:IEC IP67; NEMA 6; (See UL section below for any applicable UL specifications)
Rating for DX80...C models: IEC IP20; NEMA 1 (In a suitable enclosure: Class I, Division 2, Group A, B, C, D; T4 −40 to 80° C)
Operating Temperature: −40 to +85° C (Electronics); −20 to +80° C (LCD)
Operating Humidity: 95% max. relative (non-condensing)
Radiated Immunity: 10 V/m, 80-2700 MHz (EN61000-6-2)
Shock: 30g, 11 millisecond half sine wave, 18 shocks
Vibration: 0.5 mm p-p, 10 to 60 Hz

Refer to the SureCross™ DX80 Wireless I/O Network product manual, Banner p/n 132607, for installation and waterproofing instructions. Operating the devices at the maximum operating conditions for extended periods can shorten the life of the device.

Certifications

DX8x...C (External Wiring Terminal Models)

CSA: Class I, Division 2, Groups A, B, C, D (Ex/A Ex nA II T4); Certificate: 1921239

LCIE/ATEX: Zone 2 (II 3G / Ex nA IIC); Certificate: LCIE 10 ATEX 1012 X

UL Listing

Maximum ambient temperature: 70°C
Mounting instructions: See document 132607
Power rating: 10 to 30V dc, UL Class 2
Enclosure environmental rating: UL Type 1

Included with Device

The following items ship with the DX80 radios.

Included with Device	Model	Qty	Item
DX80 Access Hardware Kit *	BWA-HW-002	4	Plastic threaded plugs, PG-7
		4	Nylon gland fittings, PG-7
		4	Hex nuts, PG-7
		1	Plug, 1/2" NPT
		1	Nylon gland fitting, 1/2" NPT
Mounting Hardware Kit	BWA-HW-001	4	Screw, M5-0.8 x 25mm, SS
		4	Screw, M5-0.8 x 16mm, SS
		4	Hex nut, M5-0.8mm, SS
		4	Bolt, #8-32 x 3/4", SS
PTFE Tape	BWA-HW-003	1	
Antenna **	BWA-9O2-C, or BWA-2O2-C	1	Antenna, 902-928 MHz, 2 dBd Omni, Rubber Swivel RP-SMA Male, or Antenna, 2.4 GHz, 2 dBd Omni, Rubber Swivel RP-SMA Male

SureCross Literature CD	79685	1	
SureCross Quick Start Guide	128185	1	(Ships with Gateways)
Cable *	MQDC1-506	1	Cable, 5-Euro (single ended), Straight, 2m
IP20 Screw Terminal Headers (2 pack) ***	BWA-HW-011	1	

* Not included with IP20 DX80...C models.

** Internal antenna devices do not ship with this antenna.

*** Not included with IP67 DX80 models.

Warnings

The manufacturer does not take responsibility for the violation of any warning listed in this document.

Make no modifications to this product. Any modifications to this product not expressly approved by Banner Engineering could void the user's authority to operate the product. Contact the Factory for more information.

All specifications published in this document are subject to change. Banner reserves the right to modify the specifications of products without notice. Banner Engineering reserves the right to update or change documentation at any time. For the most recent version of any documentation, refer to our website: *www.bannerengineering.com*. © 2006-2010 Banner Engineering Corp. All rights reserved.

Antenna Installation

Always install and properly ground a qualified surge suppressor when installing a remote antenna system. Remote antenna configurations installed without surge suppressors invalidate the manufacturer's warranty.

Always keep the ground wire as short as possible and make all ground connections to a single-point ground system to ensure no ground loops are created. No surge suppressor can absorb all lightning strikes. Do not touch the SureCross™ device or any equipment connected to the SureCross device during a thunderstorm.

Exporting SureCross Radios

It is our intent to fully comply with all national and regional regulations regarding radio frequency emissions. **Customers who want to re-export this product to a country other than that to which it was sold must ensure the device is approved in the destination country.** A list of approved countries appears in the *Agency Certifications* section of the product manual. The SureCross wireless products were certified for use in these countries using the antenna that ships with the product. When using other antennas, verify you are not exceeding the transmit power levels allowed by local governing agencies. Consult with Banner Engineering if the destination country is not on this list.

Limited Warranty

Banner Limited Warranty
Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application of the Banner product. **THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.** This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. **IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.** Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp.

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SureCross Power Solutions and Battery Life Calculations

6/8/2012

Contents

SureCross Power Solutions

The SureCross Power Solutions guide lists the various power options for SureCross devices. Also included in this guide is a battery life calculation for some discrete and analog sensors, examples of solar power installations, and brief instructions explaining how to measure your sensor's current draw and calculate the estimated battery life for your installation.

10 to 30V dc Power

For locations with power, the 10–30V dc devices offer an easy-to-install solution for sensing devices.

- 10–30V dc can power more sensors and more types of sensors to obtain the necessary data.
- The number of sensors powered by the SureCross device is only limited by the number of I/O points available.
- The Node may be set to high-speed I/O sample and reporting rates for quicker data collection.

What is FlexPower®?

Banner’s FlexPower® technology supplies a true wireless solution by allowing the device to operate using either 10 to 30V dc, 3.6V lithium D cell batteries, or solar power. This unique power management system can operate a FlexPower Node and an optimized sensing device for up to five years on a single lithium D cell.

- The FlexPower Node may be powered from 10 to 30V dc and use an external battery supply module to provide a battery back-up solution.
- When a FlexPower Node receives 10 to 30V dc, it operates like a standard 10 to 30V dc Node.
- Good applications for FlexPower devices operating from batteries include sensors that require no or very little power, including dry contacts, RTDs, and thermocouples.

The following FlexPower options are available:

- DX81, a single battery supply module;
- DX81P6, a 6-pack of lithium batteries;
- DX81H, a single battery supply module designed specifically to power the DX99 Intrinsically Safe devices with polycarbonate housings; and
- BWA-SOLAR-001, a solar power assembly that includes the solar panel, rechargeable batteries, and solar power controller.

DX81: Single battery supply module

DX81P6: Six-pack battery supply module

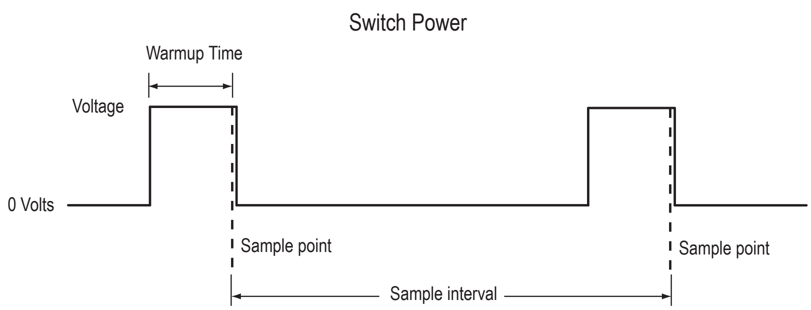
BWA-SOLAR-001: Solar supply; includes solar panel, rechargeable batteries, and controller.

DX81H: Single battery supply module designed specifically to power the DX99 Intrinsically Safe devices with polycarbonate housings

Switch Power (with FlexPower)

Efficient power management technology enables some FlexPower devices to include an internal power supply, called switch power (SP), that briefly steps up to power sensors requiring 5, 10, or 15V power (ideally, 4–20 mA loop-powered sensors). When the switch power output cycles on, the voltage is boosted to the voltage needed to power the sensor for a specific warmup time. This warmup time denotes how long the sensor must be powered before a reliable reading can be taken. After the warmup time has passed, the input reads the sensor, then the switch power shuts off to prolong battery life. The switch power voltage, warm-up time, and sample interval are configurable parameters.

- To reduce power consumption and extend battery life, slower sample and reporting rates are used. Faster sample and report rates can be configured, but this will decrease the battery's life. For details, refer to the included table of DIP switch configurable parameters.
- The FlexPower switched power management system can operate a FlexPower Node and a sensing device for up to five years on a single lithium D cell.



FlexPower with Integrated Battery

A few FlexPower devices operate using a 3.6V lithium D cell battery integrated into the housing.

These integrated battery devices:

- Operate only from the battery and cannot use an external power supply,
- Are limited in the available I/O because of the limited connectivity, and
- Can only be powered from the integrated battery.

FlexPower® Solar Supply

Banner's FlexPower® Solar Supply Assembly can be used to power up to two radio devices, including a FlexPower Node, a FlexPower Gateway, or a data radio.

When used with a FlexPower Node and sensors, the Solar Assembly supplies enough power to run most sensors at higher sample and report rates than a single battery can reasonably support. Rechargeable batteries power the devices while the solar panel recharges the batteries.

Battery Life Calculations

Analog Configuration

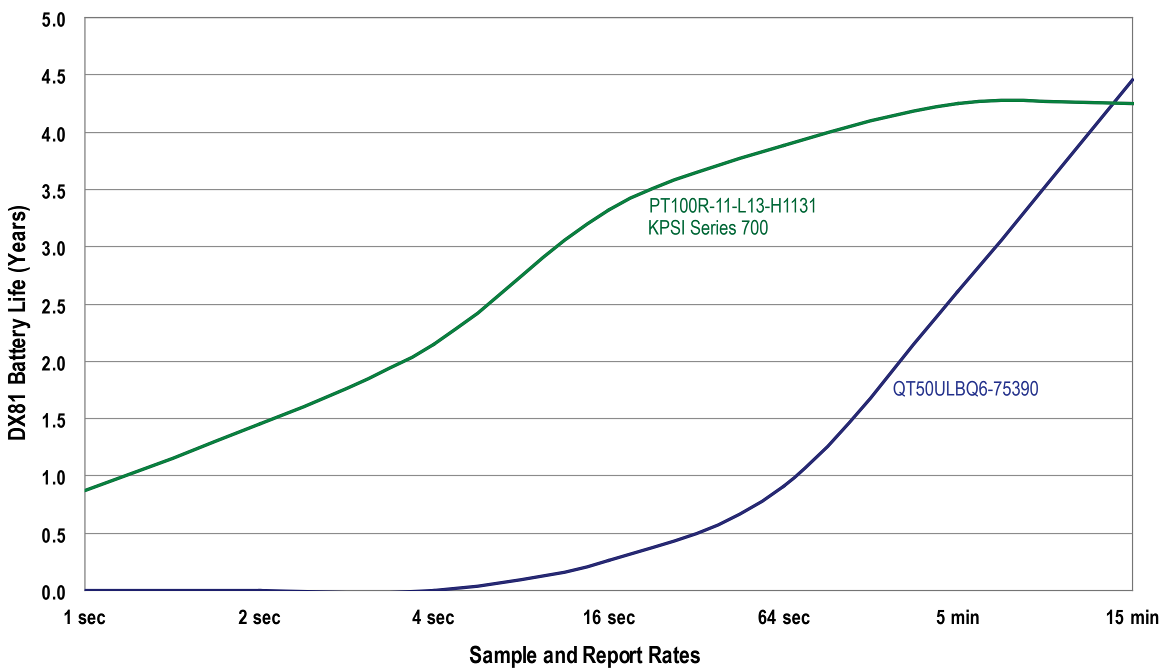
The battery life calculations, in years, for some analog sensors are shown in the table below.

Table 1: Battery Life in Years

	Manufacturer	Device	Model	Boost Voltage	Warmup Time
1	Banner	U-Sonic/Distance	QT50ULBQ6-75390	15V	500 ms
2	Esterlink/KPSI	Submersible Level	KPSI Series 700	10V	10 ms
3	Turck	Pressure	PT100R-11-L13-H1131	10V	10 ms

	Sample and Report Rates						
	1 second	2 seconds	4 seconds	16 seconds	64 seconds	5 minutes	15 minutes
1	0.00	0.00	0.00	0.26	0.91	2.61	4.45
2	0.87	1.45	2.15	3.32	3.89	4.25	4.25
3	0.87	1.45	2.15	3.32	3.89	4.25	4.25

Note, battery life calculations are based on the sensor operating 24 hours a day, 365 days a year.



For each sensor characterized, a boost voltage and warmup time was specified. The sample and reports rates were varied to calculate the estimated battery life. For example, a Banner QT50ULBQ6-75390 sensor set to a boost voltage of 15 volts, a warm-up time of 500 milliseconds, and a sample and report rate of 15 minutes, should have a battery life of 4.45 years.

All battery life calculations are approximations based on a strong radio signal. Weaker radio connections and missed packets will decrease the battery life.

Discrete Configuration

The battery life calculations, in years, for some discrete sensors are shown in the table below.

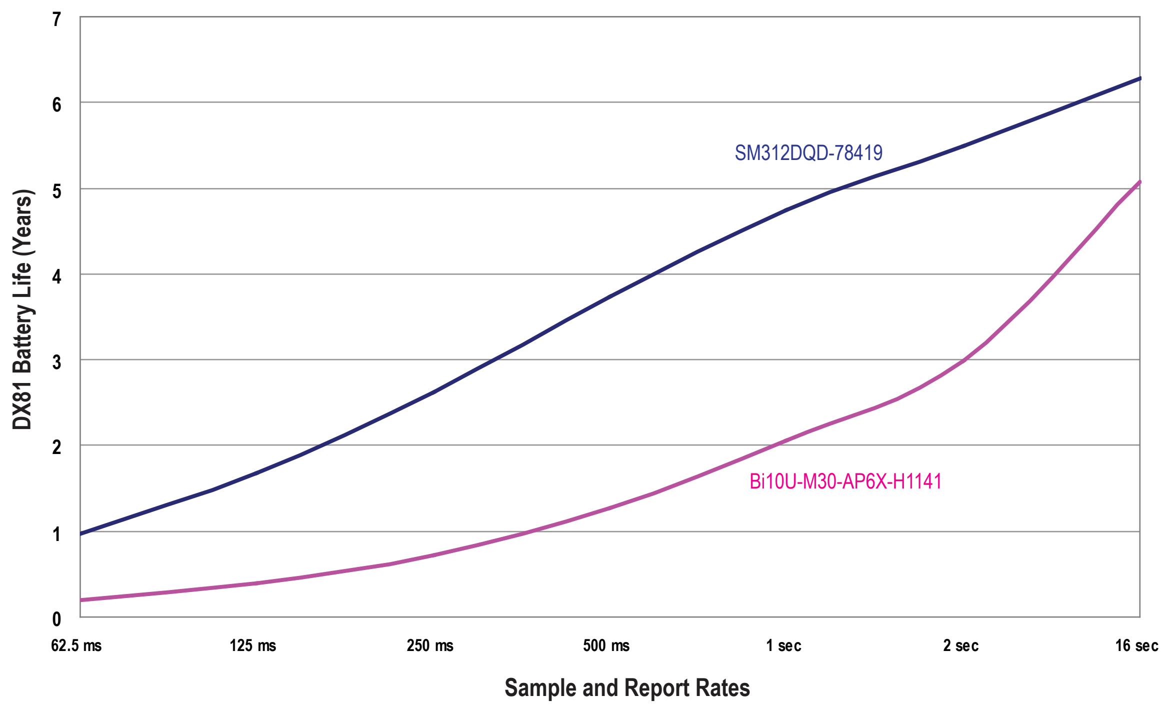
Table 2: Battery Life in Years

	Manufacturer	Device	Model	Boost Voltage	Warmup Time
1	Banner	Optical	SM312DQD-78419	5V	4 ms
2	Turck	Inductive Proximity	Bi10U-M30-AP6X-H1141	10V	10 ms

Battery Life in Years

	Sample and Report Rates						
	62.5 ms	125 ms	250 ms	500 ms	1 second	2 seconds	16 seconds
1	0.97	1.67	2.62	3.74	4.75	5.49	6.28
2	0.20	0.40	0.72	1.27	2.05	2.99	5.07

Note, battery life calculations are based on the sensor operating 24 hours a day, 365 days a year.



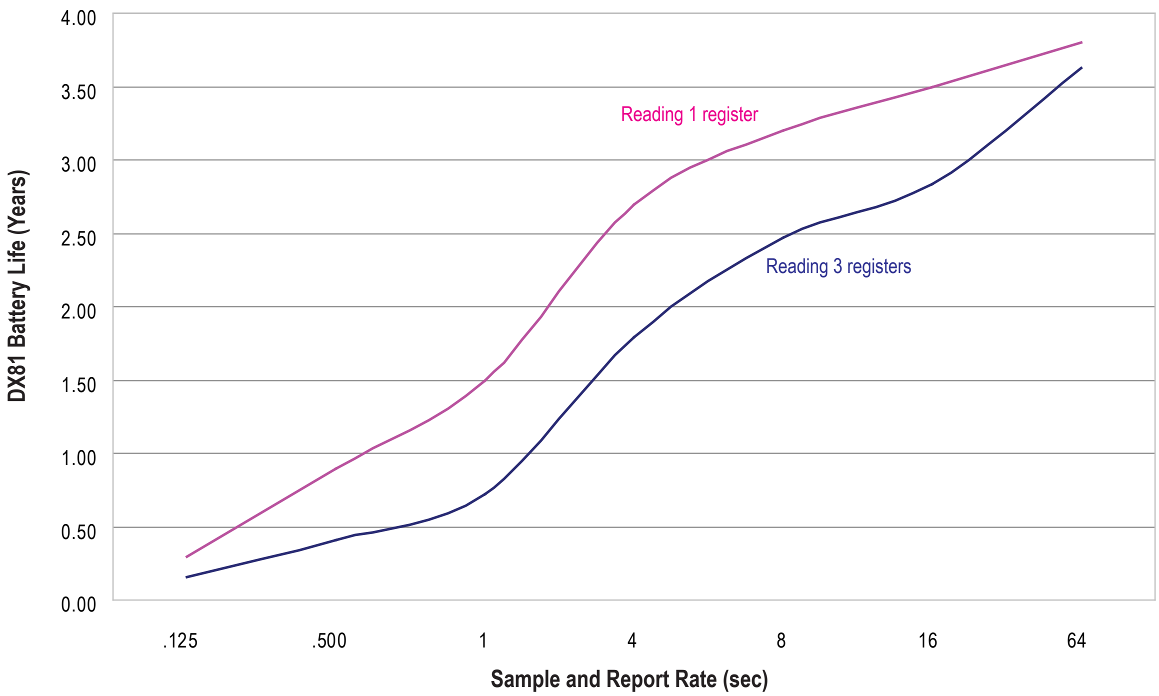
For each sensor characterized, a boost voltage and warmup time was specified. The sample and reports rates were varied to calculate the estimated battery life. For example, a Banner Optical sensor, model SM312DQD-78419, set to a boost voltage of 5 volts, a warm-up time of 4 milliseconds, and a sample and report rate of 16 seconds, should have a battery life of just over 6 years.

The curves for discrete devices represent a "worst case" as far as battery use because we are assuming for each sample of the sensor's output a change in state has occurred (e.g., target present to target absent or vice versa), sending a radio message from Node to Gateway. No messaging occurs unless there is a change to report. Actual battery life depends on how many state changes actually occur.

All battery life calculations are approximations based on a strong radio signal. Weaker radio connections and missed packets will decrease the battery life.

Temperature and Humidity Sensor

The following battery life calculations are based on reading/reporting one register or reading/reporting the contents of all three registers.



These values are estimated based on the current hardware and software configuration and are subject to change without notice. Environmental conditions will also contribute to the battery's lifespan. Current estimates are based on a battery operating at room temperature.

All battery life calculations are approximations based on a strong radio signal. Weaker radio connections and missed packets will decrease the battery life.

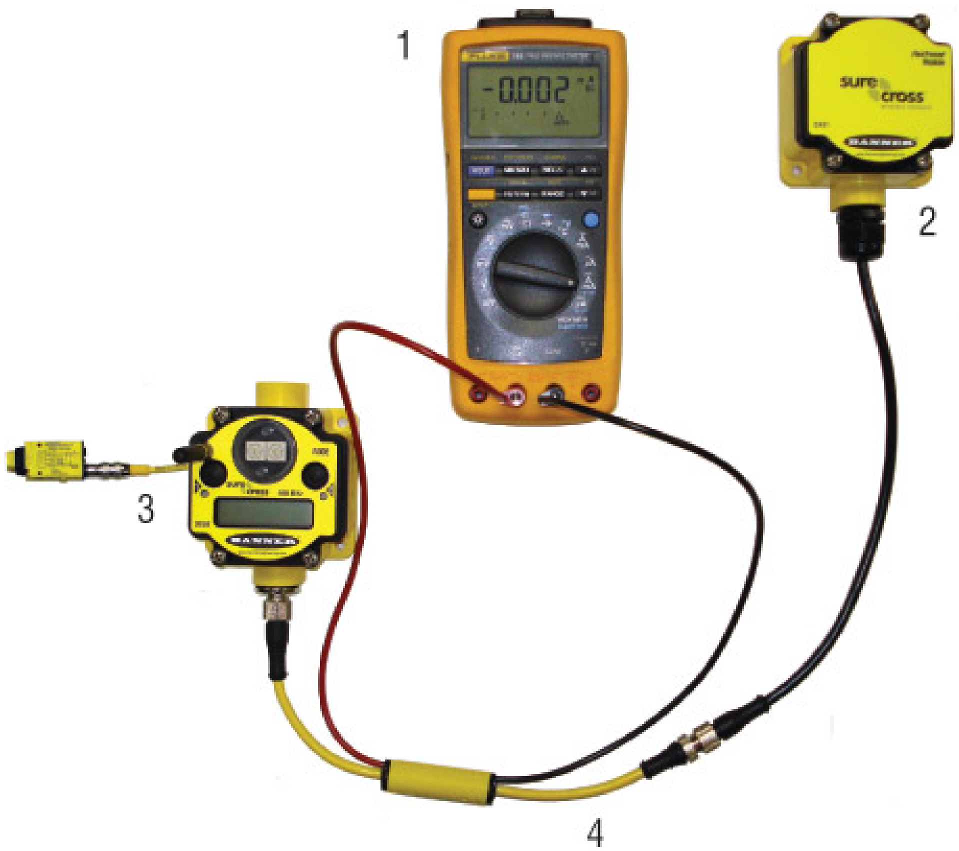
Calculating Battery Life

To estimate the battery life for a sensor not included in our list, use the configuration and cable shown (Banner cable BWA-HW-010) to measure the current draw of your system.

1. Connect the cable to the FlexPower Node and the battery supply module as shown below. The cable's male end plugs into the FlexPower Node and the female end plugs into the battery module.
2. Connect an averaging Fluke meter to the leads. Set the meter to read in amps, not milliamps.
3. Turn off the Node's LCD panel by clicking button 2 five times.
4. Allow the meter to measure the operation for at least 10 times the length of the sample rate.

To estimate the battery life in hours, use the following equation: Battery Life (in hours) = (16,000 mA Hr) ÷ (average current in mA)

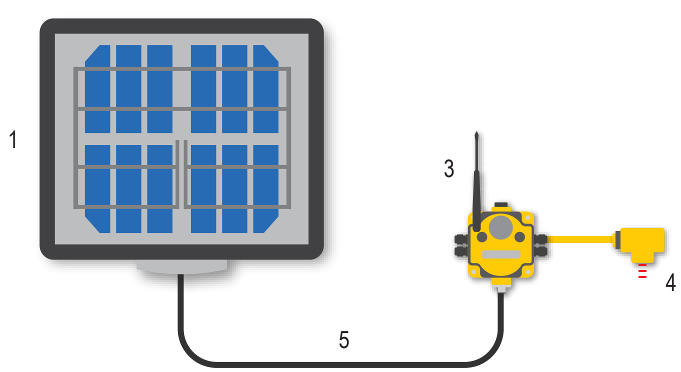
To estimate the battery life in years, use the following equation: Battery Life (in years) = (16,000 mA Hr) ÷ [(average current in mA)(8736 Hr per year)]



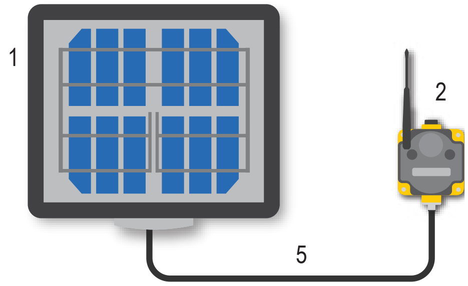
Item	Model No.	Description
1		Averaging Fluke Meter
2	DX81	DX81 Battery Supply Module
3		DX80 FlexPower Node with MINI-BEAM
4	BWA-HW-010	Cable, FlexPower Current Monitoring

Example Solar Powered Systems

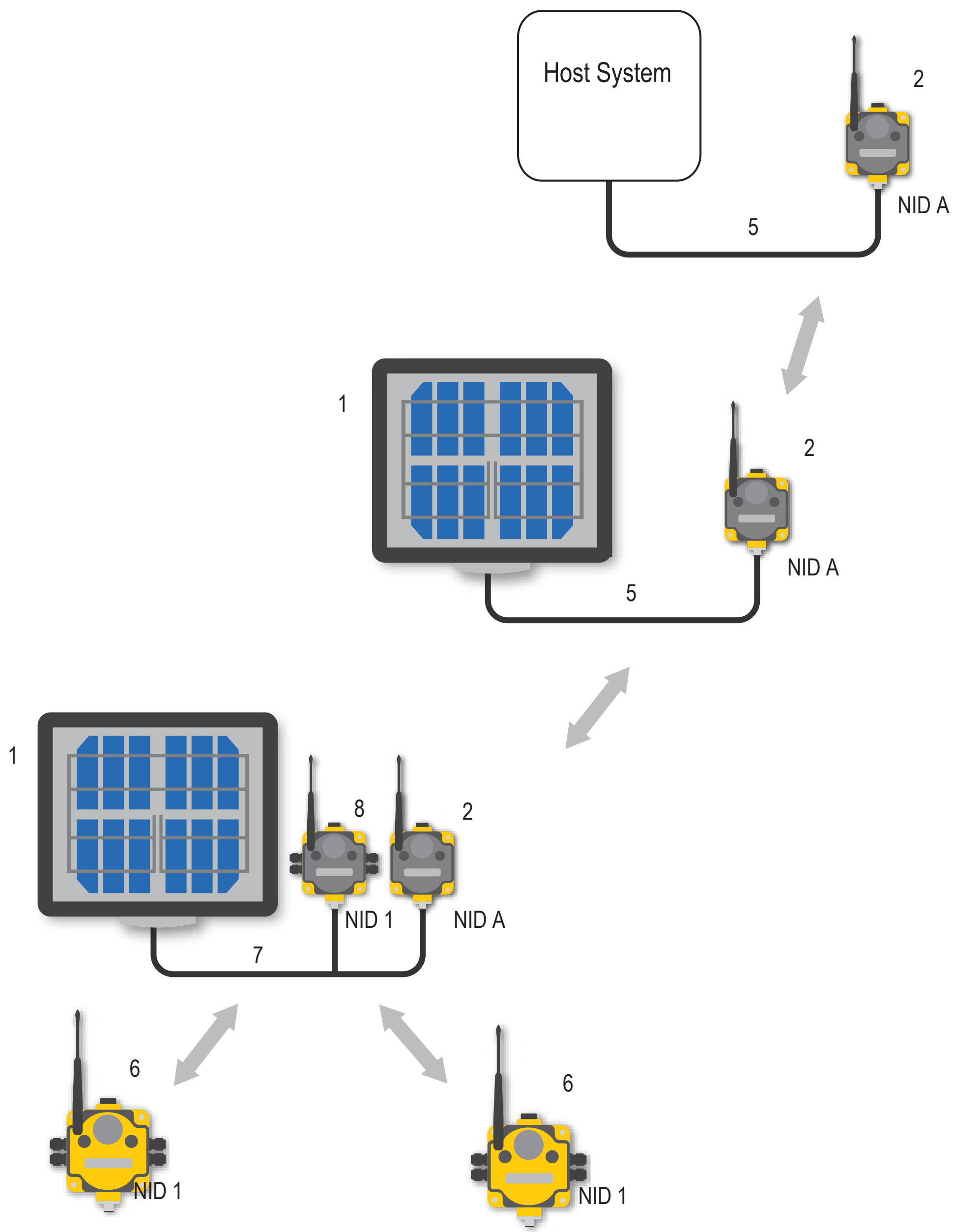
For installations without wired power, a solar powered system with an integrated solar controller and rechargeable batteries may be used to power data radios, FlexPower Gateways, or FlexPower Nodes connected to sensors that require more power than a single battery unit can supply.



Powering a data radio or data radio repeater with a solar panel allows for the expansion of the wireless network to installations with no reliable power source.



The example system shows a solar power system powering data radios and Gateways, expanding the wireless network far beyond the limits of wired power sources.



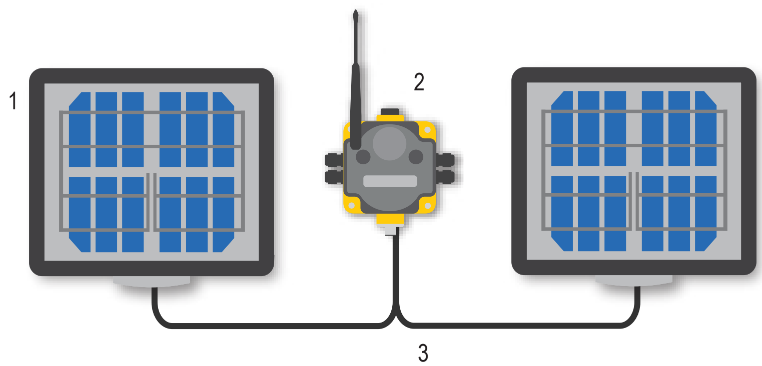
Item	Model No.	Description
1	BWA-SOLAR-001	FlexPower Solar Supply, includes panel, solar controller, rechargeable batteries, and mounting materials
2	DX80DR*M	Data radio, 900MHz or 2.4GHz
3	DX80N9X2S2N2M2	FlexPower Node, 900MHz, Boost Power, 2 discrete IN, 2 NMOS discrete OUT, 2 analog IN (2.4GHz also available)
4	QT50U-75390	U-GAGE Long range ultra-sonic sensor, low power consumption
5	MQDC1-501.5	Cable, RS-485 quick disconnect, 5-pin Euro, straight, 0.5 m*
6	DX80N...	FlexPower Node or 10 to 30V dc Node
7	CSRB-M1250M125.47M125.73	Cable, RS-485, quick disconnect, 5-pin Euro, male trunk, female branches, black*
8	DX80G*M2S	FlexPower Gateway, Serial RS485 Interface, No I/O

* For RS-232 communications, an RS-232 crossover cable must be used between the RS-485 and the data radio or Gateway.

Cables may be either yellow or black. Black is shown here for clarity.

Parallel Solar Systems

Two or more solar systems can be directly ORed together using a splitter cable. Using the Solar Supply in parallel provides a modular approach to incrementally increase the capacity in some challenging applications or locations.



Item	Model No.	Description
1	BWA-SOLAR-001	FlexPower Solar Supply, includes panel, solar controller, rechargeable batteries, and mounting materials
2	DX80N...	FlexPower Node or 10 to 30V dc Node
3		Power Splitter Cable, quick disconnect, 5-pin Euro, female trunk, male branches

Battery Backup Feature

The DX81P6 6-Pack Battery Supply Module can operate as a power backup for the FlexPower Solar Supply when the units are connected using the splitter cable..

The FlexPower Solar Supply can be ORed with the DX81P6 Battery Supply Module using the CSRB-M1253.28M1253.28M1253.28 splitter cable. When the solar panel temporarily disconnects the load because of a lack of sunlight, the DX81P6 Battery Supply Module supports the system and powers the load. This battery backup can support a sensor system consisting of a 2-wire transmitter powered continuously with 15V at 20 mA and a DX80 Node transmitting once per second for up to 30 days.

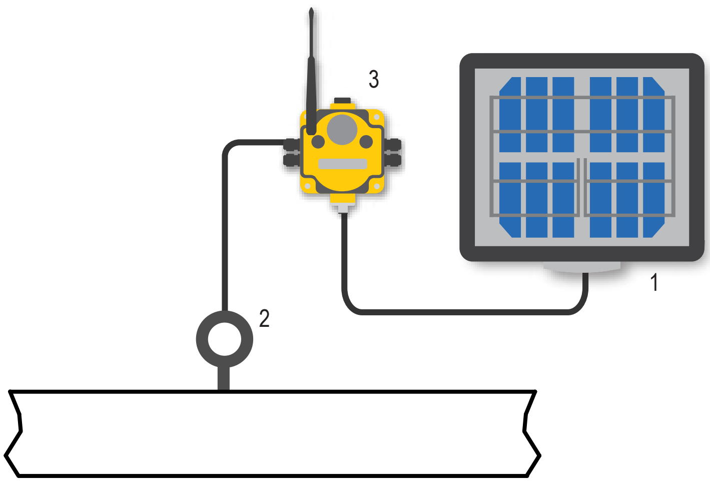
Optional mapping allows a battery backup function to be mapped to a wireless error output to determine if the devices are powered by the solar panel assembly or the battery supply module.

Autonomous Process Monitoring with Continuous Sensor Operation

A single FlexPower Solar Supply can supply any continuously powered 4–20 mA, two-wire transmitter at 13V and power the DX80 FlexPower Node for continuous sensor operation.

This application requires at least 1.7 hours of sun per day and the battery provides about 10 days of autonomy with a full transmitter signal of 20 mA. Marginal solar situations can be supplemented with a DX81P6 Battery Supply Module acting as a battery backup unit to add an additional month of autonomous operation.

The FlexPower Node's boost converter provides an adjustable continuous 21V courtesy power output.

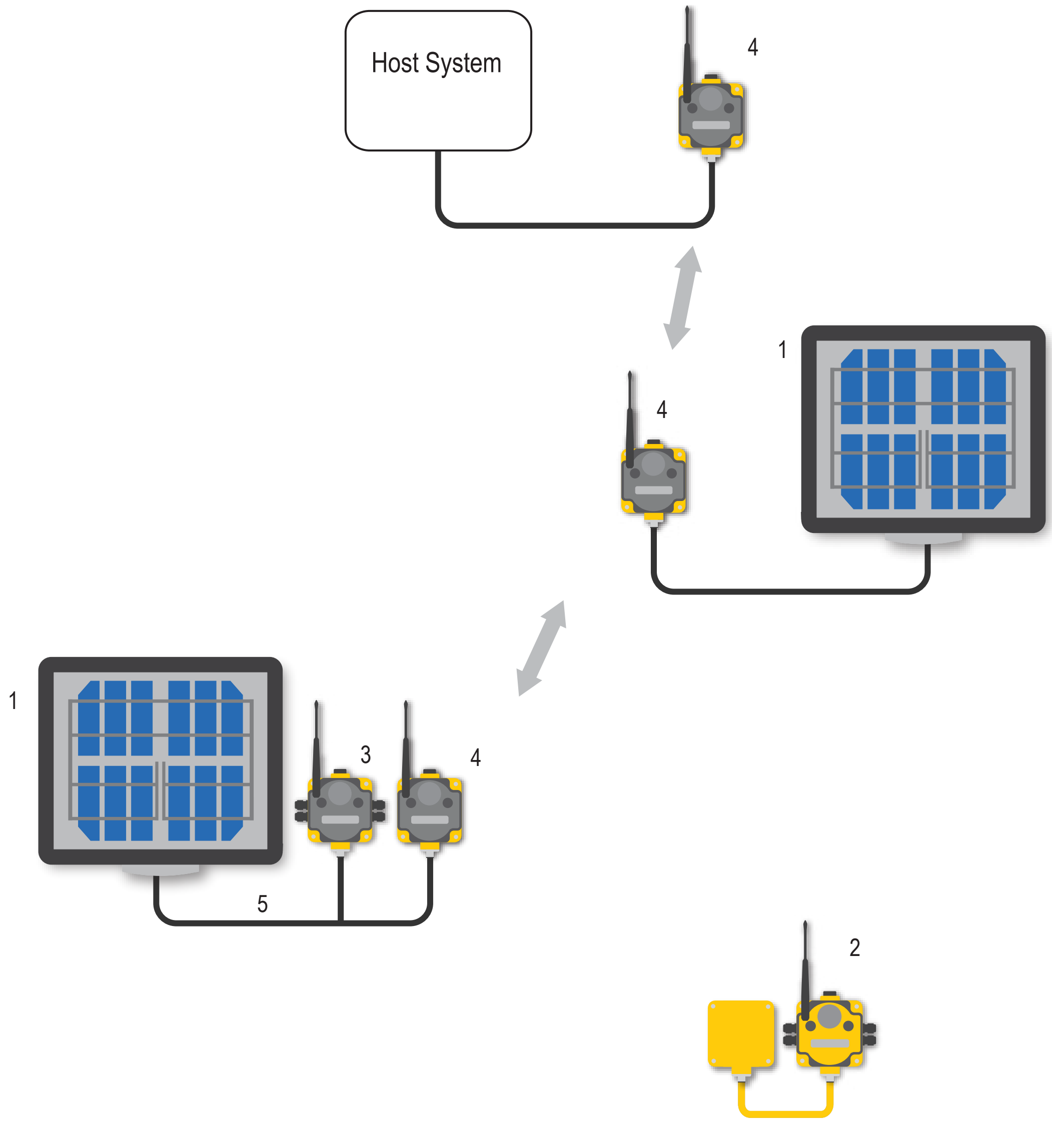


Item	Model No.	Description
1	BWA-SOLAR-001	FlexPower Solar Supply, includes panel, solar controller, rechargeable batteries, and mounting materials
2		Pressure Transmitter, 4-20 mA, two-wire
3	DX80N9X2S-CS1	FlexPower Node for continuous sensor operation

Wireless Network Range Extension

For extending the range of the wireless network, the solar panel and rechargeable battery pack powers data radios and special FlexPower Gateways.

In the system shown, the solar panel system powers a remotely located data radio and Gateway. FlexPower Nodes make up the remainder of the wireless network. To extend this wireless network even farther from the host system, a solar panel powered data radio repeater can be used.



Item	Model No.	Description
1	BWA-SOLAR-001	FlexPower Solar Supply, includes panel, solar controller, rechargeable batteries, and mounting materials
2	DX80N...	FlexPower Node or 10 to 30V dc Node
3	DX80G*M2S	FlexPower Gateway, No I/O
4	DX80DR*M	Data radio, 900MHz or 2.4GHz
5	CSRB-M1250M125.47M125.73	Cable, RS-485, quick disconnect, 5-pin Euro, male trunk, female branches, black*

Index

SureCross™ *Flex*Power™ Solar Supply

Includes the solar panel, mounting kit, and rechargeable battery pack

Figure 1 - The assembled FlexPower Solar Supply.

Features

The *Flex*Power Solar Supply provides autonomous power for continuous wireless sensing and monitoring applications in a compact, plug-and-play power solution.

- *Flex*Power Solar Supply with rechargeable battery pack provides reliable power (nominal 5.0V dc) for applications with higher power demands than a standard DX81 or DX81P6 can supply
- Solar Supply includes the panel, charge controller, rechargeable battery pack, and mounting hardware
- Weather resistant environmental enclosure

For additional information and a complete list of SureCross accessories, refer to Banner Engineering's website, www.bannerengineering.com/surecross.

Models

Model	Nominal Output Voltage	Replacement Battery Pack
BWA-SOLAR-001	5.0V dc	BWA-BATT-003 Replacement battery and controller pack

⚠ WARNING . . . Not To Be Used for Personnel Protection

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.

These devices do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A device failure or malfunction can cause either an energized or de-energized output condition. Consult your current Banner Safety Products catalog for safety products that meet OSHA, ANSI, and IEC standards for personnel protection.

Overview

The *Flex*Power Solar Supply provides autonomous power for continuous wireless sensing and monitoring applications in a compact, plug-and-play power solution. The *Flex*Power Solar Supply includes the panel, charge controller, rechargeable battery pack, and mounting hardware. The ac wall charger is sold separately.

With a rechargeable battery pack, this assembly provides reliable power (nominal 5.0V dc) for applications with higher power demands than a standard DX81 (single battery) or DX81P6 (6-pack battery) can supply. The battery pack recharges in direct sunlight and supplies power to the SureCross devices autonomously without sunlight.

Battery Replacement

Solar Core (Battery) Replacement

When the rechargeable batteries need to be replaced, order model number BWA-BATT-003. This replacement part includes the batteries, controller, and wiring.

To replace the battery pack:

1. Remove the sign-post top cap.
2. Gently remove the battery and controller assembly by pulling the strap.
3. Unplug the core pack from the sign post top cap.
4. Plug the new core pack in and insert the core pack into the tube.
5. Mount the cap securely and tighten.
6. Charge the replacement solar core pack for 8 to 16 hours using the ac wall charger (sold separately as an accessory). Though this solar core pack ships from the factory with a partial charge, this recharge will ensure your battery pack has enough power to operate efficiently regardless of weather conditions and sun availability.

Properly dispose of your used battery according to local regulations by taking it to a hazardous waste collection site, an e-waste disposal center, or any other facility qualified to accept NiMH batteries.

As with all batteries, these are a fire, explosion, and severe burn hazard. Do not burn or expose them to high temperatures. Do not crush, disassemble, or expose the contents to water.

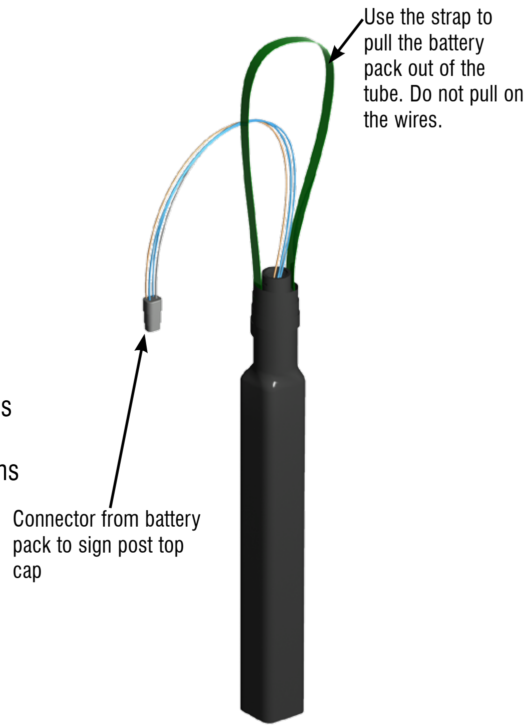


Figure 2

Installation

5-pin M12 Euro Hookup

1	Brown	Not connected
2	White	Not connected
3	Blue	dc common (GND)
4	Black	Not connected
5	Gray	5V dc nominal

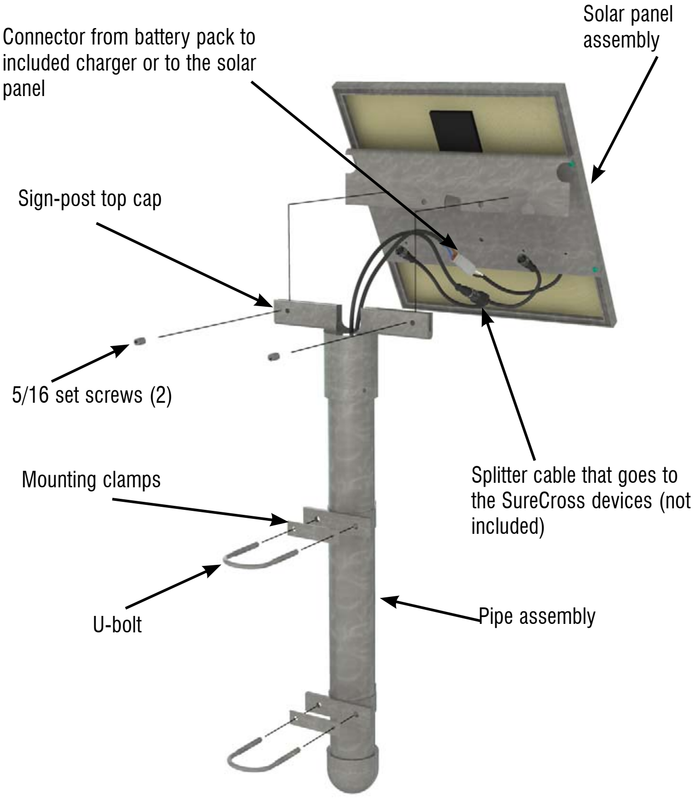


Figure 3 - Exploded view of the Solar Supply.

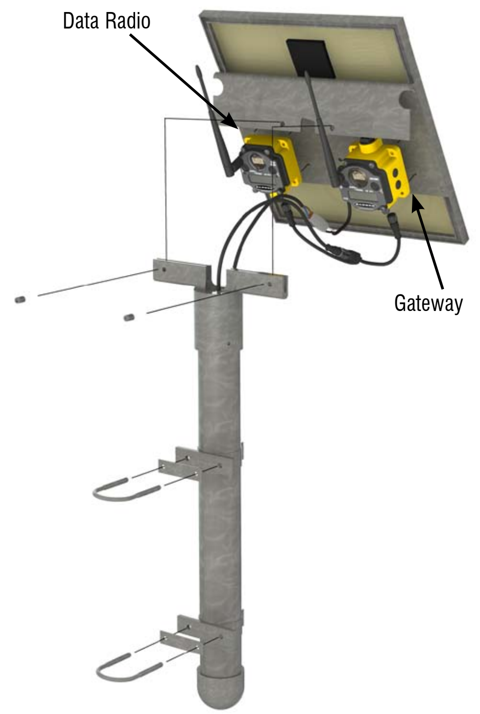


Figure 3b - Exploded view of the Solar Supply showing a Gateway and Data Radio connected to the splitter cable. (Gateway and Data Radio sold separately.)

Installation

The Solar Supply ships with an accessories pack, the pipe assembly, and the solar panel assembly.

Before installing the Solar Supply, the user should charge the solar core pack for 8 to 16 hours using the optional ac wall charger. Though this solar core pack ships from the factory with a partial charge, this recharge will ensure your battery pack has enough power to operate effectively after installation regardless of initial weather conditions and sun availability.

To assemble your solar power device, follow these installation instructions:

1. Connect the two-piece mounting clamps together around the pipe as shown in figure 3. Use the supplied u-bolts to lock the clamps to the pipe, positioning the clamps about 10 inches apart.
2. Insert the solar panel assembly into the sign-post top cap and align the mounting holes.
3. Insert the supplied 5/16 set screws into the sign-post top cap and through the solar panel mounting plate. Tighten.
4. Connect the two cables protruding from the pipe assembly. One cable ends in a gray connector; connect this to the cable coming from the solar panel. The second cable is black with a Euro-style connector; this plugs into the SureCross device or devices that the solar assembly is powering.
5. To mount the assembly to another pipe, use the supplied u-bolts, otherwise mount to a flat surface as necessary.

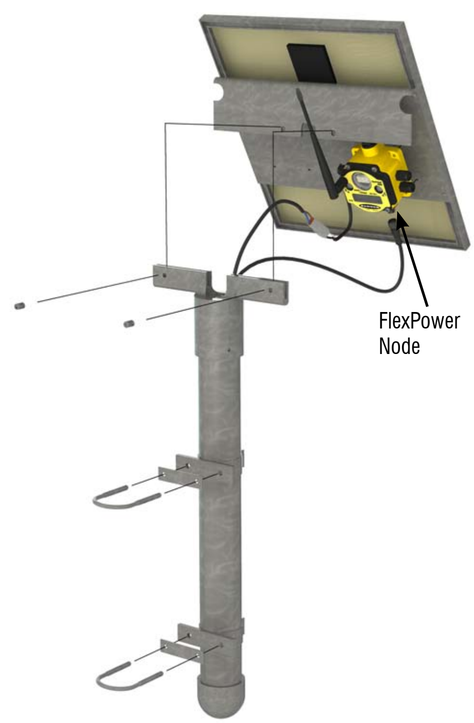


Figure 3c - Exploded view of the Solar Supply showing a FlexPower Node connected to the splitter cable. (FlexPower Node sold separately.)

Application Information

Insolation and Autonomy

In every solar/battery powered application there are two important parameters that help determine how much usable energy can be harnessed from the available sunlight:

- Insolation is the amount of solar radiation falling on an area per unit time. Insolation can be characterized as an equivalent number of hours of direct sunlight per day required to maintain a desired load.
- Autonomy is a measure of how long the assembly will supply power without sunlight. Autonomy depends on the load and battery capacity, but it is also affected by battery temperature. A fully charged battery in our assembly will supply 350 mW with 10 days of autonomy. Ten days of 100% autonomy means that the battery is able to carry the load through 10 days of darkness or 20 days with half the required sunlight.

The SureCross *Flex*Power Solar Supply supports many applications including wireless network range extension, remote sensing, and wireless 4–20 mA transmitter operation and monitoring. These typical 350 mW applications require an average winter insolation of 1 kW·hr/m^2 per day. This is equivalent to an average of 80 minutes of sunlight shining directly on the solar panel per day during the least sunny time of the year. Locations that will provide this amount of sunlight include most locations between the Arctic Circle and Antarctic Circle. For average daily sunlight estimates please refer to an insolation map of your installation location or consult with a Banner Sales Application Engineer.

Load Shedding

Without sunlight, the supply is powered exclusively from the battery. When the battery is mostly depleted, the controller disconnects the load, or sheds the load. This load shedding lasts until the solar panel recharges the battery to a sufficient operating level, which can require up to five minutes of full sunlight.

Solutions for Additional Power

Some applications require more power than one SureCross *Flex*Power Solar Supply can deliver. If load shedding is unacceptable and a standalone solar assembly does not meet your power requirements, consider adding a DX81P6 Battery Supply Module battery backup or consider using more than one solar assembly connected in parallel. See page six for example configurations.

- Battery Backup. The DX81P6 can supply backup power to a 350 mW load for up to 30 days of autonomy after solar autonomy is exhausted.
- Parallel Assemblies. SureCross *Flex*Power Solar Supplies are modular and can be connected in parallel.

Along with the benefit of additional power, parallel assemblies also offer redundancy and flexibility.

When used in parallel, multiple SureCross *Flex*Power Solar Supplies recharge independently for added system flexibility when direct sunlight is unavailable. Multiple panels can be positioned in different directions to maximize recharging at different times of available sunlight. Partial shade from trees or buildings is a common problem in solar applications because partial shade prevents individual solar panels from generating power to recharge the battery. When multiple assemblies are used, partial shade results in a partial system recharge instead of a zero system recharge.

Temperature and Location Considerations

The SureCross *Flex*Power Solar Supply can be expected to drive a 350 mW load with 10 days of autonomy at battery temperatures between -10C to +45C (14F to +113F). Because lower temperatures decrease battery capacity, applications in very cold climates require extra consideration. The SureCross *Flex*Power Solar Supply will stop recharging the battery at temperatures greater than +45C because of battery limitations. All these factors contribute to decreasing system autonomy and may require additional power regardless of insolation.

Be aware that because much of the earth has typical insolation values that are 2 to 6 times higher than 1kW·hr/m^2 per day, it may be possible to get more power from your SureCross *Flex*Power Solar Supply. In some high insolation locations, it is possible for two SureCross *Flex*Power Solar Supply Assemblies to supply up to 2 W continuously with four days of autonomy.

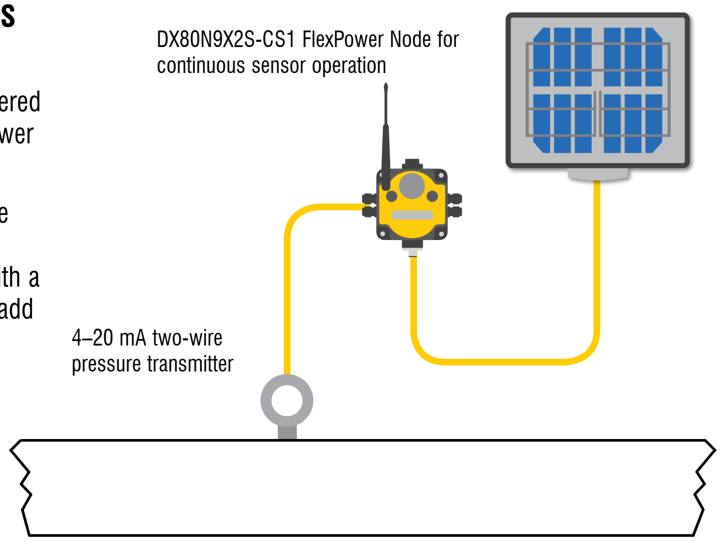
If you have any questions or need help determining the best solution for your solar application, please contact a Banner Applications Engineer to help you find the right solution.

Sample System Configurations

Autonomous Process Monitoring with Continuous Sensor Operation

A single *Flex*Power Solar Supply can supply any continuously powered 4–20 mA, two-wire transmitter at 13V and power the DX80 *Flex*Power Node for continuous sensor operation.

This application requires at least 80 minutes of sun per day and the battery provides about 10 days of autonomy with a full transmitter signal of 20 mA. Marginal solar situations can be supplemented with a DX81P6 Battery Supply Module acting as a battery backup unit to add an additional month of autonomous operation.



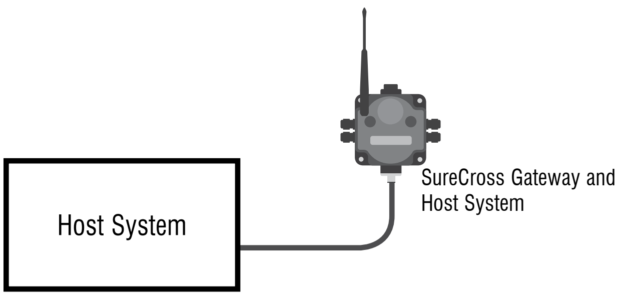
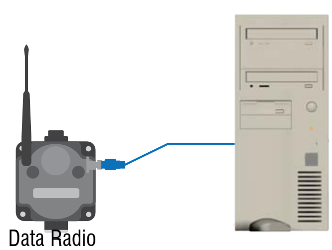


Figure 4

Wireless Network Range Extension

For extending the range of the wireless network, the solar panel and rechargeable battery pack powers data radios and special *Flex*Power Gateways.

In the system shown, the solar panel system powers a remotely located data radio and Gateway. *Flex*Power Nodes make up the remainder of the wireless network. To extend this wireless network even farther from the host system, a solar panel powered data radio repeater can be used.



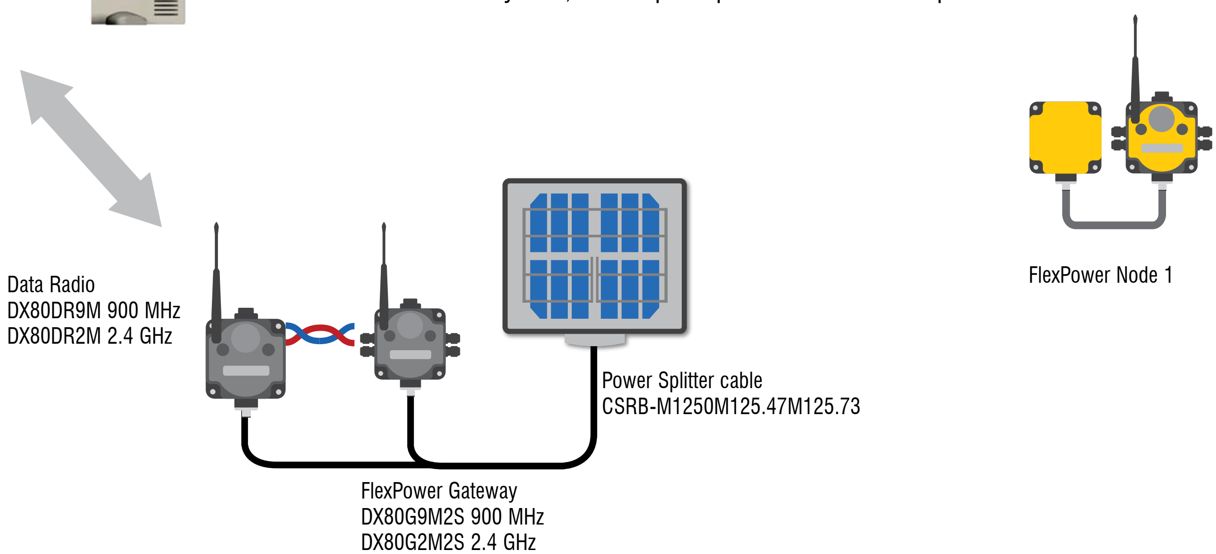


Figure 5

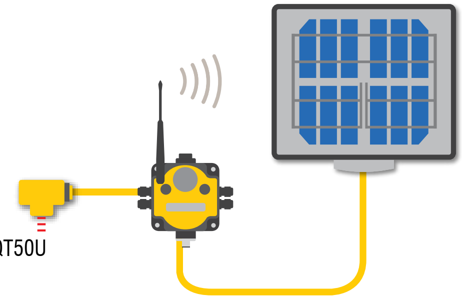


Figure 6

Remote Sensing Applications

For remote sensing applications, the solar panel recharges a rechargeable battery pack, which in turn powers a Node and sensor. Solar panels are recommended for sensors that require power but do not have access to another power source.

In the configuration shown, the sensor is a QT50U with a ten second sample and report rate. The *Flex*Power Node's voltage boost supplies 12V to the sensor.

Parallel Solar Systems

Two or more solar systems can be directly ORed together using a splitter cable. Using the Solar Supply in parallel provides a modular approach to incrementally increase the capacity in some challenging applications or locations.

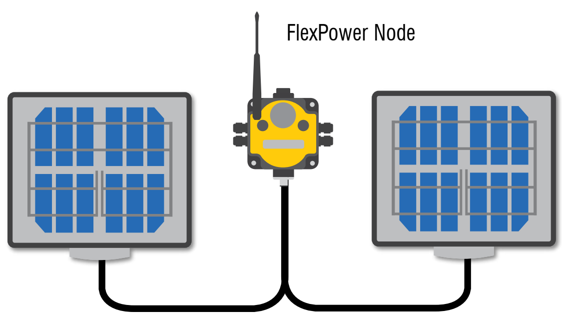


Figure 7

Battery Backup Feature

The *Flex*Power Solar Supply can be ORed with the DX81P6 Battery Supply Module using the CSRB-M1253.28M1253.28M1253.28 splitter cable. When the solar panel temporarily disconnects the load because of a lack of sunlight, the DX81P6 Battery Supply Module supports the system and powers the load. This battery backup can support a sensor system consisting of a 2-wire transmitter powered continuously with 15V at 20 mA and a DX80 Node transmitting once per second for up to 30 days.

For the DX80N*X2*-CS1 models, optional mapping allows a battery backup function to be mapped to a wireless error output to determine if the devices are powered by the solar panel assembly or the battery supply module.

Specifications

Solar Supply

Nominal output voltage. 5.0V dc

Maximum output current. 1000 mA

Continuous output current. 70 mA per hour of sunlight/day

Total weight. 4.70 kg (10.35 lbs)

Solar Panel

Power Rating. 13.5 W at 9V

Non-load voltage. 9V

Short-circuit current. 1.5 A

Solar cells. Polycrystalline

Dimensions. 348mm x 386mm x 19mm (13 11/16” x 15 3/16” x 3/4”)

Battery System

Type. NiMH

Nominal voltage. 6V dc

Capacity. 17.5 amp hours

Mechanical

Housing. Aluminum

Support bracket. Aluminum

Hardware. Zinc plated steel

Mounting angle. 60°

Effective projected area. 117 in^2

Environmental

Recommended operating temperature. −10 to +45° C (14 to 113° F)

Max Operating Temperature Range. −30 to +50° C (−22 to 122° F)

Operating humidity. 95% max. relative (non-condensing)

Outdoor rated. Direct sunlight required

*Battery capacity is reduced and recharging is less efficient outside this temperature range. The controller inhibits charging when the temperature is greater than 45° C (113° F). Protecting the battery from temperature extremes prolongs battery life.

Accessories

BWA-BATT-003	Replacement battery core pack, including the rechargeable batteries and controller (included with kit)
BWA-HW-009	Replacement accessories pack (bolts, set screws, pipe clamps, u-bolts) (included with kit)
BWA-SPANEL-001	Replacement solar panel (included with kit)
CSRB-M1250M125.47M125.73	Splitter cable, 5-pin, Euro-style male trunk to 2 female branches, black
CSRB-M1253.28M1253.28M1253.28	Splitter cable for dual power sources, 5-pin Euro-style female truck to two 5-pin Euro-style male branches. The truck and each branch are 1 meter long.
BWA-SOLAR-CHARGER	Battery pack recharger, ac wall plug

Dimensions

As assembled at the factory, the top of the solar panel is flush with the pipe for mounting against a wall. The panel mounting screws can be loosened and the panel slipped higher or lower as needed.

The mounting brackets are shown here positioned 10" apart, but can be adjusted as needed.

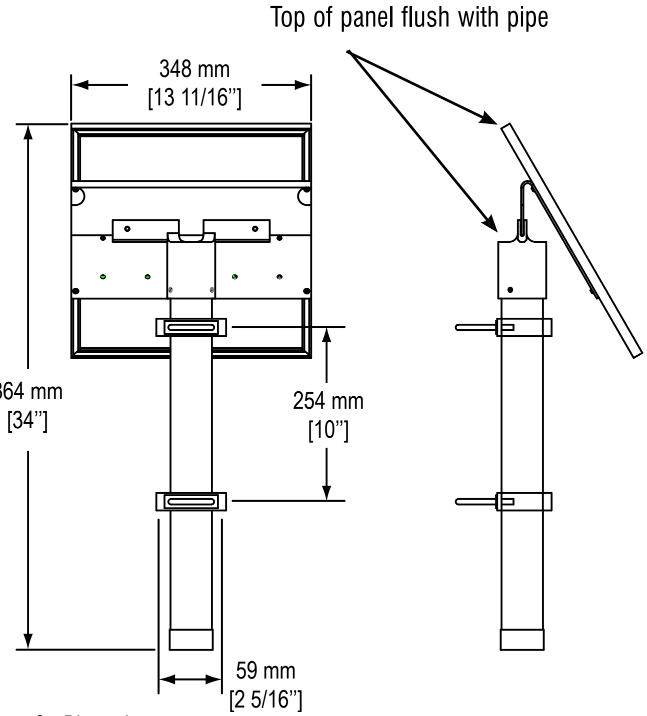


Figure 8 - Dimensions

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

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Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp.

The manufacturer does not take responsibility for the violation of any warning listed in this document.

CAUTION. Make no modifications to this product. Any modifications to this product not expressly approved by Banner Engineering could void the user's authority to operate the product. Contact the Factory for more information.

Lightning Arrestors/Surge Protection. Always use lightning arrestors/surge protection with all remote antenna systems to avoid invalidating the Banner Engineering Corp. warranty. No surge protector can absorb all lightning strikes. Do not touch the SureCross device or any equipment connected to the SureCross device during a thunderstorm.

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P/N 137304 rev. G

Appendix H

Product Information

Endress+Hauser ProMag 50 Flowmeter

Endress+Hauser ProMag 53 Flowmeter

Endress+Hauser Prowirl 72F Flowmeter

Appendix H

Product Information

Endress+Hauser ProMag 50 Flowmeter

Endress+Hauser ProMag 53 Flowmeter

Endress+Hauser Prowirl 72F Flowmeter

ENDRESS+HAUSER PROMAG 50W

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Proline Promag 50W, 53W

Electromagnetic Flow Measuring System
Flow measurement of liquids in water or wastewater applications

Application

Electromagnetic flowmeter for bidirectional measurement of liquids with a minimum conductivity of ≥ 5 µS/cm:
- Drinking water
- Wastewater
- Sewage sludge

- Flow measurement up to 110000 m³/h (484315 gal/min)
- Fluid temperature up to +80 °C (+176 °F)
- Process pressures up to 40 bar (580 psi)
- Lengths in accordance with DVGW/ISO

Application-specific lining of the measuring pipe from polyurethane or hard rubber with the following drinking water permissions:
- KTW
- WRAS
- NSF
- ACS

Approvals for hazardous area:
- ATEX
- IECEx
- FM
- CSA
- NEPSI

Connection to process control system:
- HART
- PROFIBUS DP/PA
- FOUNDATION Fieldbus
- MODBUS RS485

Your benefits

Promag measuring devices offer you cost-effective flow measurement with a high degree of accuracy for a wide range of process conditions.

The uniform Proline transmitter concept comprises:
- Modular device and operating concept resulting in a higher degree of efficiency
- Software options for batching, electrode cleaning and for measuring pulsating flow
- High degree of reliability and measuring stability
- Uniform operating concept

The tried-and-tested Promag sensors offer:
- No pressure loss
- Not sensitive to vibrations
- Simple installation and commissioning

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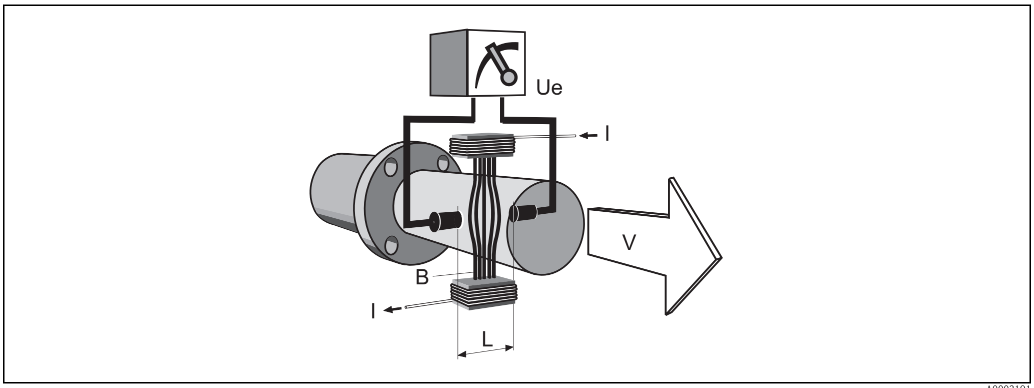
Endress+Hauser
People for Process Automation

Table of contents

Function and system design

Measuring principle

Following *Faraday's law of magnetic induction*, a voltage is induced in a conductor moving through a magnetic field.
In the electromagnetic measuring principle, the flowing medium is the moving conductor.
The voltage induced is proportional to the flow velocity and is supplied to the amplifier by means of two measuring electrodes. The flow volume is calculated by means of the pipe cross-sectional area.
The DC magnetic field is created through a switched direct current of alternating polarity.



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$Ue = B \cdot L \cdot v$
$Q = A \cdot v$

Ue *Induced voltage*
B *Magnetic induction (magnetic field)*
L *Electrode spacing*
v *Flow velocity*
Q *Volume flow*
A *Pipe cross-section*
I *Current strength*

Measuring system

The measuring system consists of a transmitter and a sensor.
Two versions are available:
- Compact version: Transmitter and sensor form a mechanical unit.
- Remote version: Sensor is mounted separate from the transmitter.

Transmitter:
- Promag 50 (user interface with push buttons for operation, two-line display, illuminated)
- Promag 53 ("Touch Control" without opening the housing, four-line display, unilluminated)

Sensor:
- Promag W (DN 25 to 2000 / 1 to 78")

Input

Measured variable	Flow velocity (proportional to induced voltage)
Measuring ranges	Measuring ranges for liquids Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy
Operable flow range	Over 1000 : 1

Input signal

Status input (auxiliary input)
- U = 3 to 30 V DC, R_i = 5 kΩ, galvanically isolated
- Configurable for: totalizer(s) reset, measured value suppression, error-message reset

Status input (auxiliary input) with PROFIBUS DP and MODBUS RS485
- U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated
- Switching level: 3 to 30 V DC, independent of polarity
- Configurable for: totalizer(s) reset, measured value suppression, error-message reset, batching start/stop (optional), batch totalizer reset (optional)

Current input (only Promag 53)
- active/passive selectable, galvanically isolated, full scale value selectable, resolution: 3 µA, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading)
- active: 4 to 20 mA, $R_i \leq 150$ Ω, max. 24 V DC, short-circuit-proof
- passive: 0/4 to 20 mA, $R_i < 150$ Ω, max. 30 V DC

Output

Output signal

Promag 50

Current output
active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s), full scale value selectable, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading), resolution: 0.5 µA
- active: 0/4 to 20 mA, $R_L < 700$ Ω (HART: $R_L \geq 250$ Ω)
- passive: 4 to 20 mA, operating voltage V_S: 18 to 30 V DC, $R_i \geq 150$ Ω

Pulse/frequency output
passive, open collector, 30 V DC, 250 mA, galvanically isolated
- Frequency output: full scale frequency 2 to 1000 Hz (f_{max} = 1250 Hz), on/off ratio 1:1, pulse width max. 10s
- Pulse output: pulse value and pulse polarity selectable, max. pulse width configurable (0.5 to 2000 ms)

PROFIBUS DP interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- Profil version 3.0
- Data transmission rate: 9,6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Function blocks: 1 × analog Input, 1 × totalizer
- Output data: volume flow, totalizer
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

PROFIBUS PA interface
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- Profil version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Function blocks: 1 × analog input, 2 × totalizer
- Output data: volume flow, totalizer
- Input data: positive zero return (ON/OFF), control totalizer, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

Promag 53

Current output
active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s),
full scale value selectable, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading), resolution: 0.5 μA

- active: 0/4 to 20 mA, R_L < 700 Ω (HART: R_L ≥ 250 Ω)
- passive: 4 to 20 mA, operating voltage V_S: 18 to 30 V DC, R_i ≥ 150 Ω

Pulse/frequency output
active/passive selectable, galvanically isolated (Ex i version: only passive)

- active: 24 V DC, 25 mA (max. 250 mA during 20 ms), R_L > 100 Ω
- passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2 to 10000 Hz (f_{max} = 12500 Hz), EEx-ia: 2 to 5000 Hz; on/off ratio 1:1, pulse width max. 10 s
- Pulse output: pulse value and pulse polarity selectable, max. pulse width configurable (0.05 to 2000 ms)

PROFIBUS DP interface

- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- Profil version 3.0
- Data transmission rate: 9,6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Function blocks: 2 × analog Input, 3 × totalizer
- Output data: volume flow, calculated mass flow, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device
- Available output combination → 🗎 8

PROFIBUS PA interface

- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- Profil version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Function blocks: 2 × analog input, 3 × totalizer
- Output data: volume flow, calculated mass flow, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

MODBUS RS485 interface

- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- MODBUS device type: Slave
- Adress range: 1 to 247
- Bus address adjustable via miniature switches or local display (optional) at the measuring device
- Supported MODBUS function codes: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Übertragungsmodus: RTU oder ASCII
- Supported baudrate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Response time:
  – Direct data access = typically 25 to 50 ms
  – Auto-scan buffer (data range) = typically 3 to 5 ms
- Available output combination → 🗎 8

FOUNDATION Fieldbus interface
- FOUNDATION Fieldbus H1
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- ITK version 5.01
- Current consumption: 12 mA
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Bus connection with integrated reverse polarity protection
- Function blocks:
  - 5 × Analog Input (execution time: 18 ms each)
  - 1 × PID (25 ms)
  - 1 × Digital Output (18 ms)
  - 1 × Signal Characterizer (20 ms)
  - 1 × Input Selector (20 ms)
  - 1 × Arithmetic (20 ms)
  - 1 × Integrator (18 ms)
- Output data: volume flow, calculated mass flow, temperature, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), reset totalizer
- Link Master (LM) functionality is supported

Signal on alarm

- Current output → failure response selectable (e.g. in accordance with NAMUR recommendation NE 43)
- Pulse/frequency output → failure response selectable
- Status output (Promag 50) → non-conductive by fault or power supply failure
- Relay output (Promag 53) → de-energized by fault or power supply failure

Load

see "Output signal"

Low flow cutoff

Switch points for low flow cutoff are selectable.

Galvanic isolation

All circuits for inputs, outputs and power supply are galvanically isolated from each other.

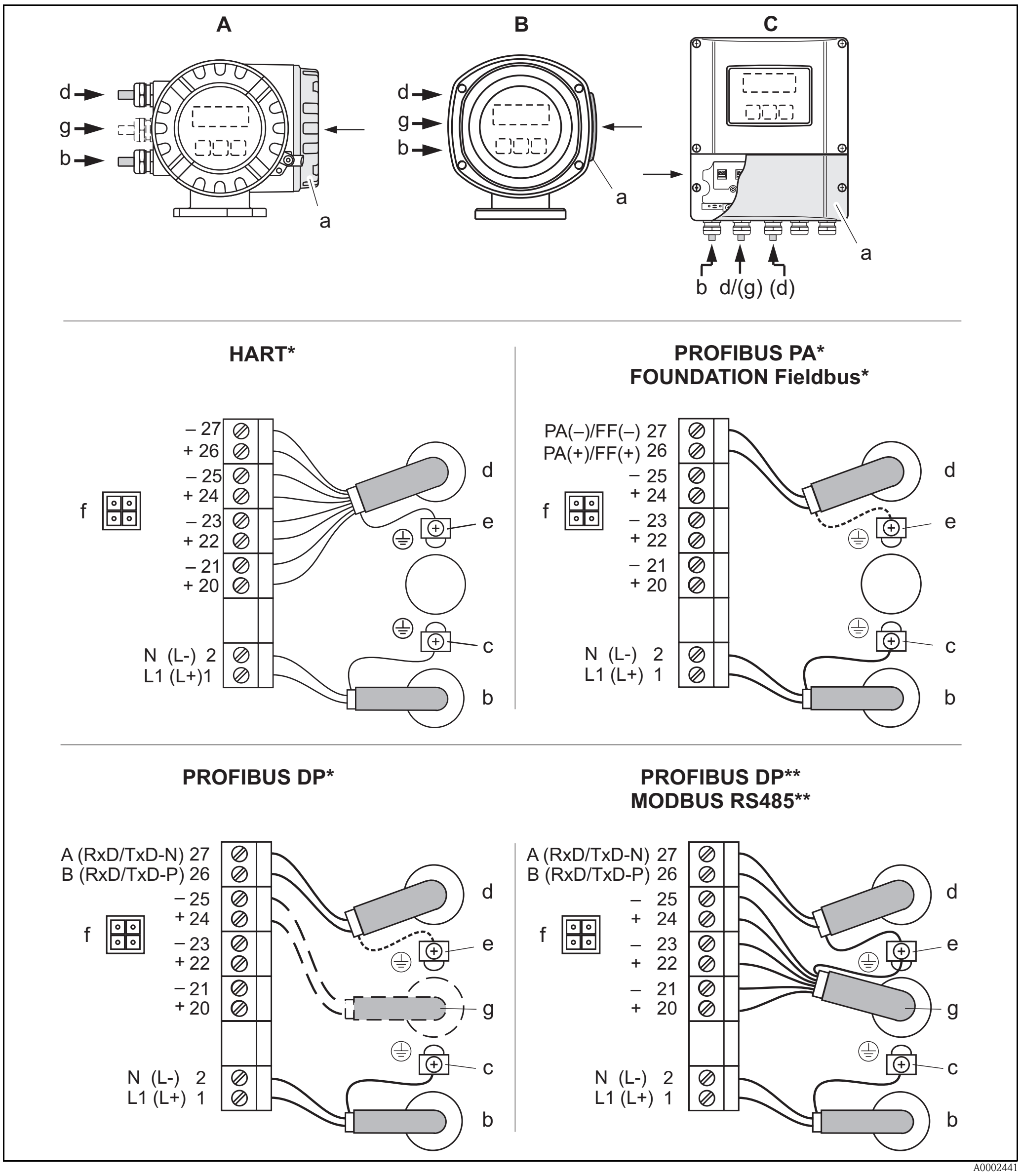
Switching output

Status output (Promag 50, Promag 53)
Open collector, max. 30 V DC / 250 mA, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values.

Relay outputs (Promag 53)
Normally closed (NC or break) or normally open (NO or make) contacts available
(default: relay 1 = NO, relay 2 = NC), max. 30 V / 0,5 A AC ; 60 V / 0,1 A DC, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values, batching contacts.

Power supply

Electrical connection, measuring unit



Connecting the transmitter, cable cross-section max. 2.5 mm² (14 AWG)

A View A (field housing)
B View B (stainless steel field housing)
C View C (wall-mount housing)

**) fixed communication boards*
***) flexible communication boards*
a Connection compartment cover
b Cable for power supply: 85 to 260 V AC / 20 to 55 V AC / 16 to 62 V DC
- Terminal No. 1: L1 for AC, L+ for DC
- Terminal No. 2: N for AC, L– for DC
c Ground terminal for protective conductor
d Signal cable: see "Electrical connection, terminal assignment" → 8
Fieldbus cable:
- Terminal No. 26: DP (B) / PA + / FF + / MODBUS RS485 (B) / (PA, FF: with polarity protection)
- Terminal No. 27: DP (A) / PA – / FF – / MODBUS RS485 (A) / (PA, FF: with polarity protection)
e Ground terminal for signal cable shield / Fieldbus cable / RS485 line
f Service adapter for connecting service interface FXA193 (Fieldcheck, FieldCare)
g Signal cable: see "Electrical connection, terminal assignment" → 8
Cable for external termination (only for PROFIBUS DP with fixed assignment communication board):
- Terminal No. 24: +5 V
- Terminal No. 25: DGND

Electrical connection, terminal assignment

Terminal assignment, Promag 50

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
50***-***********W	–	–	–	Current output HART
50***-***********A	–	–	Frequency output	Current output HART
50***-***********D	Status input	Status output	Frequency output	Current output HART
50***-***********H	–	–	–	PROFIBUS PA
50***-***********J	–	–	+5 V (external termination)	PROFIBUS DP
50***-***********S	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART
50***-***********T	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART

Ground terminal → 🗎 7

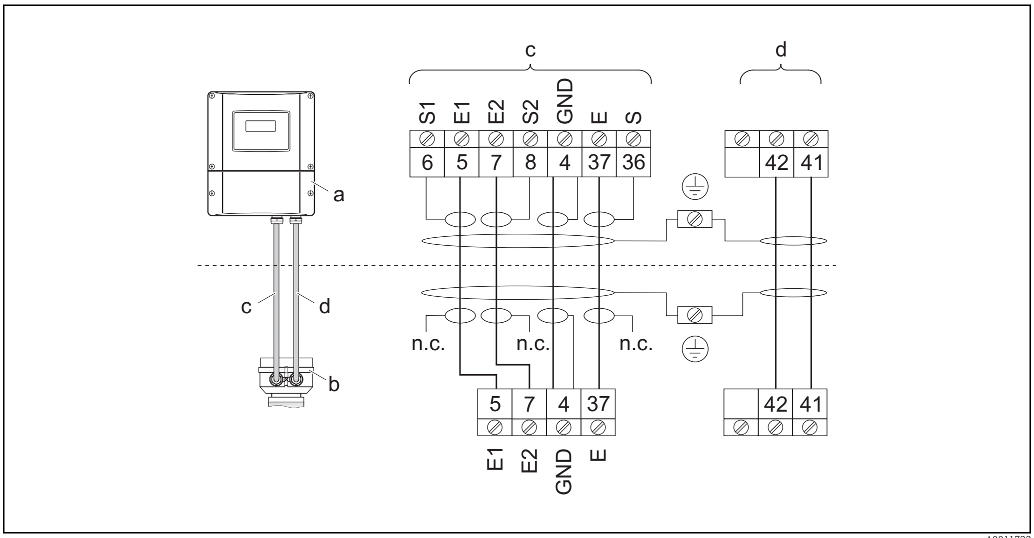
Terminal assignment, Promag 53

The inputs and outputs on the communication board can be either permanently assigned or variable, depending on the version ordered (see table). Replacements for modules which are defective or which have to be replaced can be ordered as accessories.

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
Fixed communication boards (fixed assignment)				
53***-***********A	–	–	Frequency output	Current output HART
53***-***********B	Relay output 2	Relay output 1	Frequency output	Current output HART
53***-***********F	–	–	–	PROFIBUS PA, Ex i
53***-***********G	–	–	–	FOUNDATION Fieldbus, Ex i
53***-***********H	–	–	–	PROFIBUS PA
53***-***********J	–	–	–	PROFIBUS DP
53***-***********K	–	–	–	FOUNDATION Fieldbus
53***-***********Q	–	–	Status input	MODBUS RS485
53***-***********S	–	–	Frequency output, Ex i	Current output, Ex i, passive, HART
53***-***********T	–	–	Frequency output, Ex i	Current output, Ex i, passive, HART
Flexible communication boards				
53***-***********C	Relay output 2	Relay output 1	Frequency output	Current output HART
53***-***********D	Status input	Relay output	Frequency output	Current output HART
53***-***********L	Status input	Relay output 2	Relay output 1	Current output HART
53***-***********M	Status input	Frequency output	Frequency output	Current output HART
53***-***********N	Current output	Frequency output	Status input	MODBUS RS485
53***-***********P	Current output	Frequency output	Status input	PROFIBUS DP
53***-***********V	Relay output 2	Relay output 1	Status input	PROFIBUS DP
53***-***********2	Relay output	Current output	Frequency output	Current output HART
53***-***********4	Current input	Relay output	Frequency output	Current output HART
53***-***********7	Relay output 2	Relay output 1	Status input	MODBUS RS485

Ground terminal → 🗎 7

Electrical connection, remote version



A0011722

Connecting the remote version

a Wall-mount housing connection compartment
b Sensor connection housing cover
c Signal cable
d Coil current cable
n.c. Not connected, insulated cable shields
Terminal no. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

Supply voltage (power supply)

- 85 to 260 V AC, 45 to 65 Hz
- 20 to 55 V AC, 45 to 65 Hz
- 16 to 62 V DC

PROFIBUS PA and FOUNDATION Fieldbus
- Non-Ex: 9 to 32 V DC
- Ex i: 9 to 24 V DC
- Ex d: 9 to 32 V DC

Cable entry

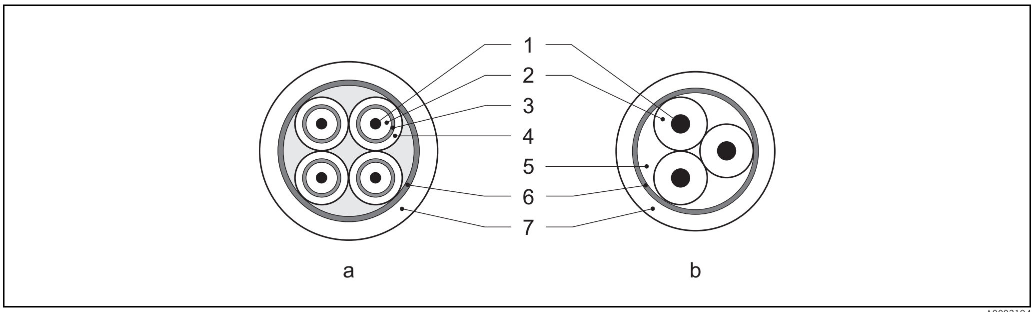
Power supply and signal cables (inputs/ outputs):
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Sensor cable entry for armoured cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entries, ½" NPT, G ½"

Connecting cable for remote version:
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Sensor cable entry for armoured cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entries, ½" NPT, G ½"

Remote version cable specifications

Coil cable
- 2 × 0.75 mm² (18 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28")
- Conductor resistance: ≤ 37 Ω/km (≤ 0.011 Ω/ft)
- Capacitance core/core, shield grounded: ≤ 120 pF/m (≤ 37 pF/ft)
- Operating temperature: –20 to +80 °C (–68 to +176 °F)
- Cable cross-section: max. 2.5 mm² (14 AWG)
- Test voltage for cable insulation: ≤ 1433 AC r.m.s. 50/60 Hz or ≥ 2026 V DC

Signal cable
- 3 × 0.38 mm² (20 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28") and individual shielded cores
- With empty pipe detection (EPD): 4 × 0.38 mm² (20 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28") and individual shielded cores
- Conductor resistance: ≤ 50 Ω/km (≤ 0.015 Ω/ft)
- Capacitance core/shield: ≤ 420 pF/m (≤ 128 pF/ft)
- Operating temperature: –20 to +80 °C (–68 to +176 °F)
- Cable cross-section: max. 2.5 mm² (14 AWG)



A0003194

a Signal cable
b Coil current cable

1 Core
2 Core insulation
3 Core shield
4 Core jacket
5 Core reinforcement
6 Cable shield
7 Outer jacket

Operation in zones of severe electrical interference
The measuring device complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of IEC/EN 61326 and NAMUR recommendation NE 21.

Caution!
Grounding is by means of the ground terminals provided for the purpose inside the connection housing. Ensure that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible.

Power consumption

- AC: < 15 VA (incl. sensor)
- DC: < 15 W (incl. sensor)

Switch-on current:
- Max. 3 A (< 5 ms) for 260 V AC
- Max. 13.5 A (< 50 ms) for 24 V DC

Power supply failure

Lasting min. ½ cycle frequency: EEPROM saves measuring system data
- EEPROM or T-DAT (Promag 53 only) retain the measuring system data in the event of a power supply failure
- S-DAT: exchangeable data storage chip which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point etc.)

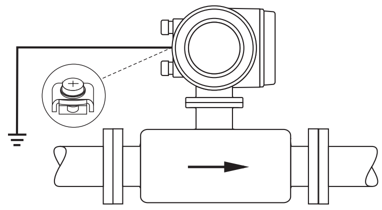
Potential equalization

Warning!
The measuring system must be included in the potential equalization.

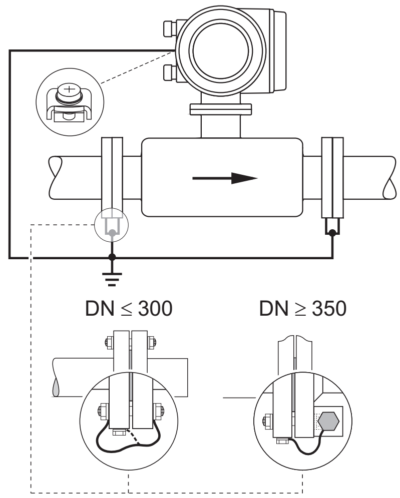
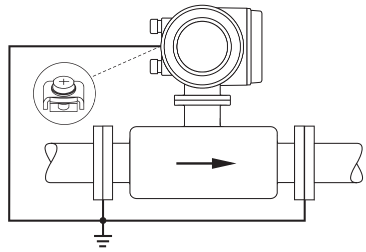
Perfect measurement is only ensured when the fluid and the sensor have the same electrical potential. This is ensured by the reference electrode integrated in the sensor as standard.

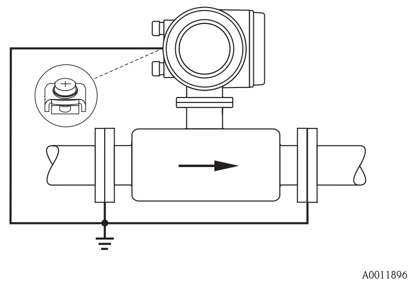
The following should also be taken into consideration for potential equalization:
- Internal grounding concepts in the company
- Operating conditions, such as the material/ grounding of the pipes (see table)

Standard situation

Operating conditions	Potential equalization
When using the measuring device in a: ■ Metal, grounded pipe Potential equalization takes place via the ground terminal of the transmitter. Note! When installing in metal pipes, we recommend you connect the ground terminal of the transmitter housing with the piping.	 A0011892 *Via the ground terminal of the transmitter*

Special situations

Operating conditions	Potential equalization
When using the measuring device in a: ■ Metal pipe that is not grounded This connection method also applies in situations where: ■ Customary potential equalization cannot be ensured. ■ Excessively high equalizing currents can be expected. Both sensor flanges are connected to the pipe flange by means of a ground cable (copper wire, at least 6 mm² / 0.0093 in²) and grounded. Connect the transmitter or sensor connection housing, as applicable, to ground potential by means of the ground terminal provided for the purpose. ■ DN ≤ 300 (12"): the ground cable is mounted directly on the conductive flange coating with the flange screws. ■ DN ≥ 350 (14"): the ground cable is mounted directly on the transportation metal support. Note! The ground cable for flange-to-flange connections can be ordered separately as an accessory from Endress+Hauser.	 A0011893 *Via the ground terminal of the transmitter and the flanges of the pipe*
When using the measuring device in a: ■ Plastic pipe ■ Pipe with insulating lining This connection method also applies in situations where: ■ Customary potential equalization cannot be ensured. ■ Excessively high equalizing currents can be expected. Potential equalization takes place using additional ground disks, which are connected to the ground terminal via a ground cable (copper wire, at least 6 mm² / 0.0093 in²). When installing the ground disks, please comply with the enclosed Installation Instructions.	 A0011895 *Via the ground terminal of the transmitter and the optionally available ground disks*

Operating conditions	Potential equalization
When using the measuring device in a: ■ Pipe with a cathodic protection unit The device is installed potential-free in the pipe. Only the two flanges of the pipe are connected with a ground cable (copper wire, at least 6 mm² / 0.0093 in²). Here, the ground cable is mounted directly on the conductive flange coating with flange screws. Note the following when installing: ■ The applicable regulations regarding potential-free installation must be observed. ■ There should be **no** electrically conductive connection between the pipe and the device. ■ The mounting material must withstand the applicable torques.	 *Potential equalization and cathodic protection* *1 Power supply isolation transformer* *2 Electrically isolated*

Performance characteristics

Reference operating conditions

As per DIN EN 29104 and VDI/VDE 2641:
- Fluid temperature: +28 °C ± 2 K (+82 °F ± 2 K)
- Ambient temperature: +22 °C ±2 K (+72 °F ± 2 K)
- Warm-up period: 30 minutes

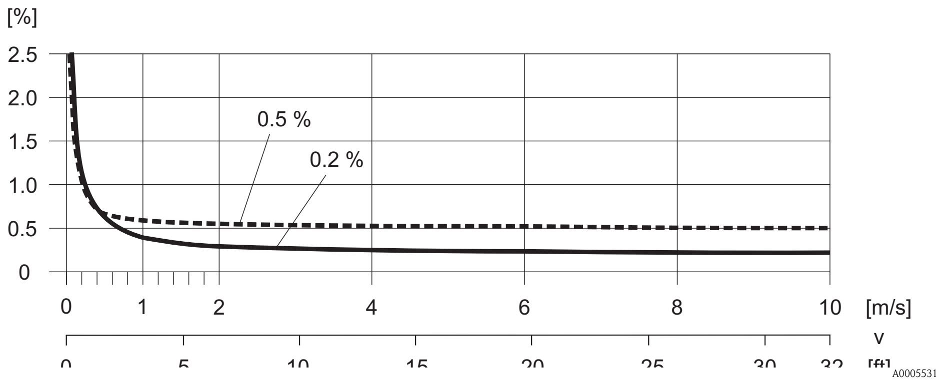
Installation conditions:
- Inlet run > 10 × DN
- Outlet run > 5 × DN
- Sensor and transmitter grounded.
- The sensor is centered in the pipe.

Maximum measured error

Promag 50:
- Current output: also typically ± 5 µA
- Pulse output: ±0.5% o.r. ± 1 mm/s (±0.5% o.r. ± 0.04 in/s)
  optional: ±0.2% o.r. ± 2 mm/s (±0.2% o.r. ± 0.08 in/s) (o.r. = of reading)

Promag 53:
- Current output: also typically ± 5 µA
- Pulse output: ±0.2% o.r. ± 2 mm/s (±0.2% o.r. ± 0.08 in/s) (o.r. = of reading)

Fluctuations in the supply voltage do not have any effect within the specified range.



Max. measured error in % of reading

Repeatability

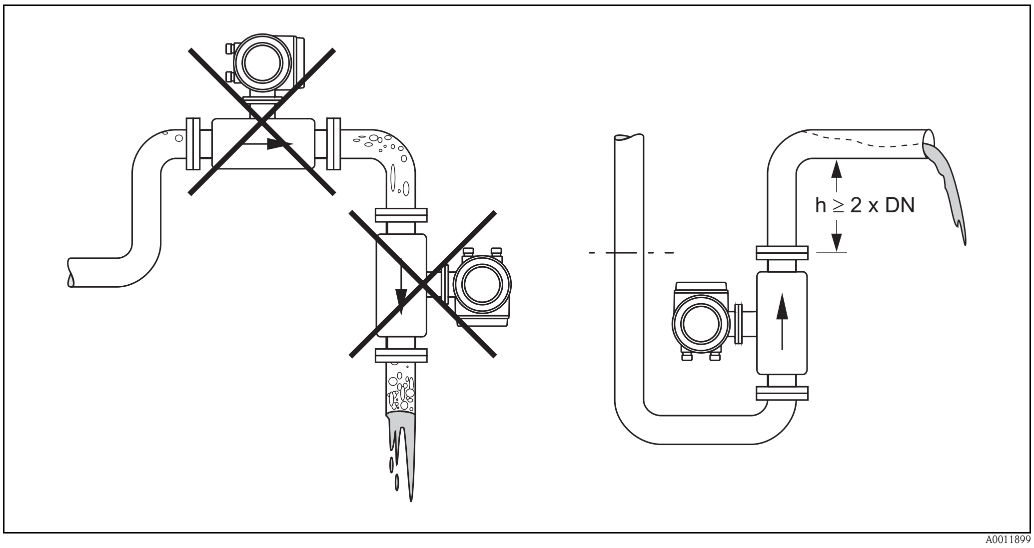
Max. ±0.1% o.r. ± 0.5 mm/s (±0.1% o.r. ± 0.02 in/s) (o.r. = of reading)

Operating conditions: Installations

Installation instructions

Mounting location

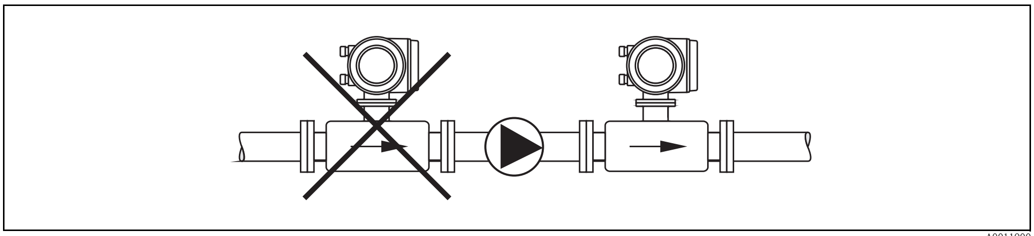
Entrained air or gas bubble formation in the measuring tube can result in an increase in measuring errors.
Avoid the following installation locations in the pipe:
- Highest point of a pipeline. Risk of air accumulating!
- Directly upstream from a free pipe outlet in a vertical pipeline.



Mounting location

Installation of pumps

Sensors may not be installed on the pump suction side. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. Information on the pressure tightness of the measuring tube lining → 🗎 21, Section "Pressure tightness".
Pulsation dampers may be needed when using piston pumps, piston diaphragm pumps or hose pumps. Information on the shock and vibration resistance of the measuring system → 🗎 20, Section "Shock and vibration resistance".

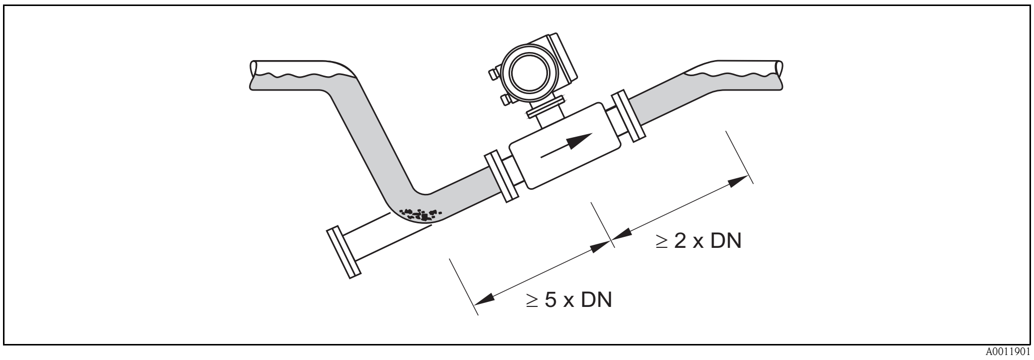


Installation of pumps

Partially filled pipes

Partially filled pipes with gradients necessitate a drain-type configuration.
The empty pipe detection function (EPD) provides additional security in detecting empty or partially filled pipes.

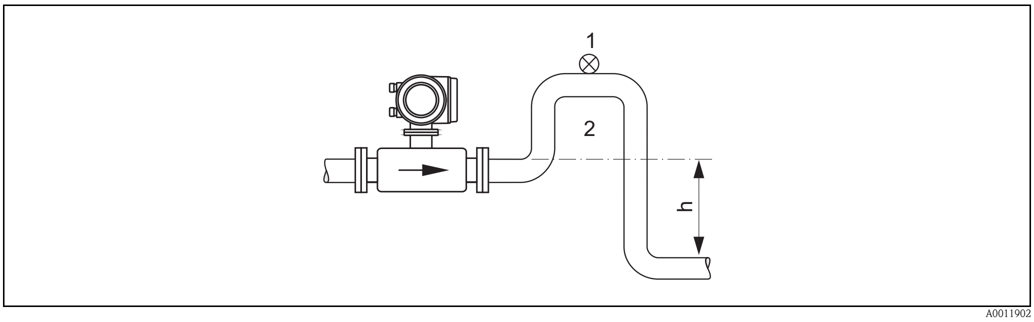
Caution!
Risk of solids accumulating. Do not install the sensor at the lowest point in the drain. It is advisable to install a cleaning valve.



Installation with partially filled pipes

Down pipes

Install a siphon or a vent valve downstream of the sensor in down pipes h ≥ 5 m (16.4 ft). This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. This measure also prevents the liquid current stopping in the pipe which could cause air locks. Information on the pressure tightness of the measuring tube lining → 21, Section "Pressure tightness".

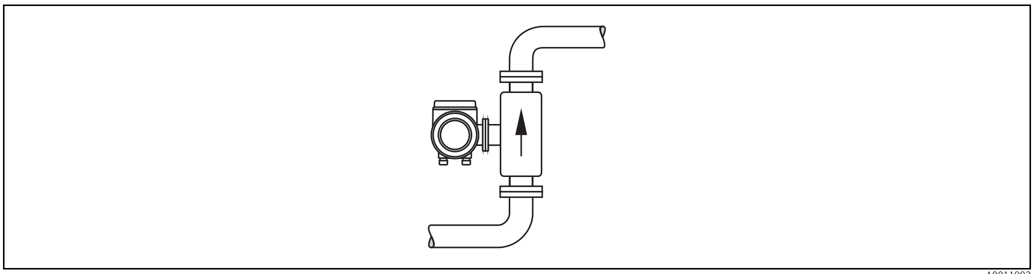


Installation measures for vertical pipes

1 Vent valve
2 Pipe siphon
h Length of the down pipe

Orientation
An optimum orientation helps avoid gas and air accumulations and deposits in the measuring tube. However, the measuring device also offers the additional function of empty pipe detection (EPD) for detecting partially filled measuring tubes or if outgassing fluids or fluctuating operating pressures are present.

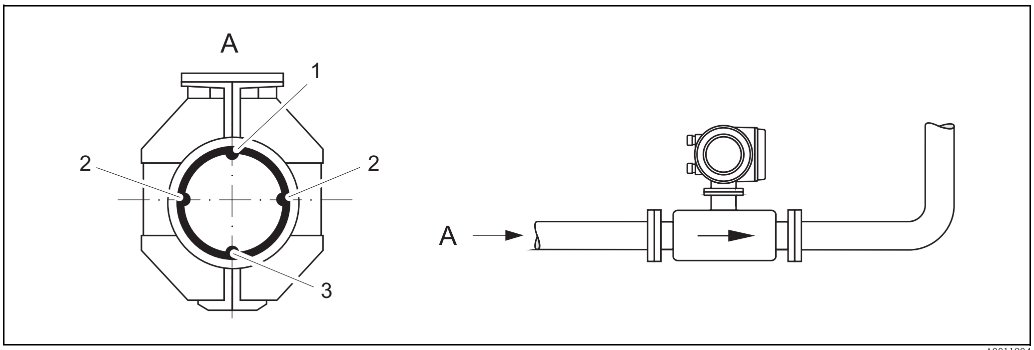
Vertical orientation
This is the ideal orientation for self-emptying piping systems and for use in conjunction with empty pipe detection.


A0011903

Vertical orientation

Horizontal orientation
The measuring electrode axis should be horizontal. This prevents brief insulation of the two measuring electrodes by entrained air bubbles.

Caution!
Empty pipe detection only works correctly with horizontal orientation if the transmitter housing is facing upwards. Otherwise there is no guarantee that empty pipe detection will respond if the measuring tube is only partially filled or empty.



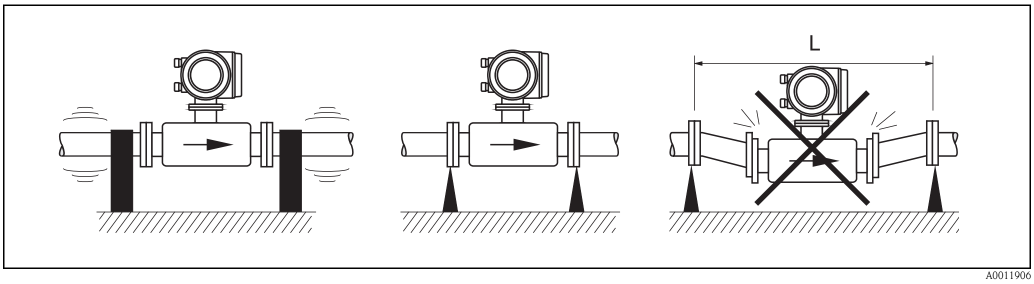
A0011904

Horizontal orientation

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Vibrations
Secure the piping and the sensor if vibration is severe.

Caution!
If vibrations are too severe, we recommend the sensor and transmitter be mounted separately. Information on the permitted shock and vibration resistance → 🗎 20, Section "Shock and vibration resistance".

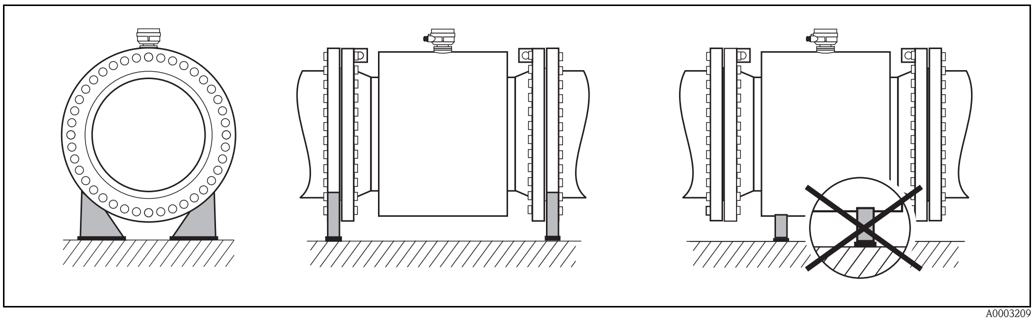


Measures to prevent vibration of the measuring device

L > 10 m (33 ft)

Foundations, supports
If the nominal diameter is DN ≥ 350, mount the transmitter on a foundation of adequate load-bearing strength.

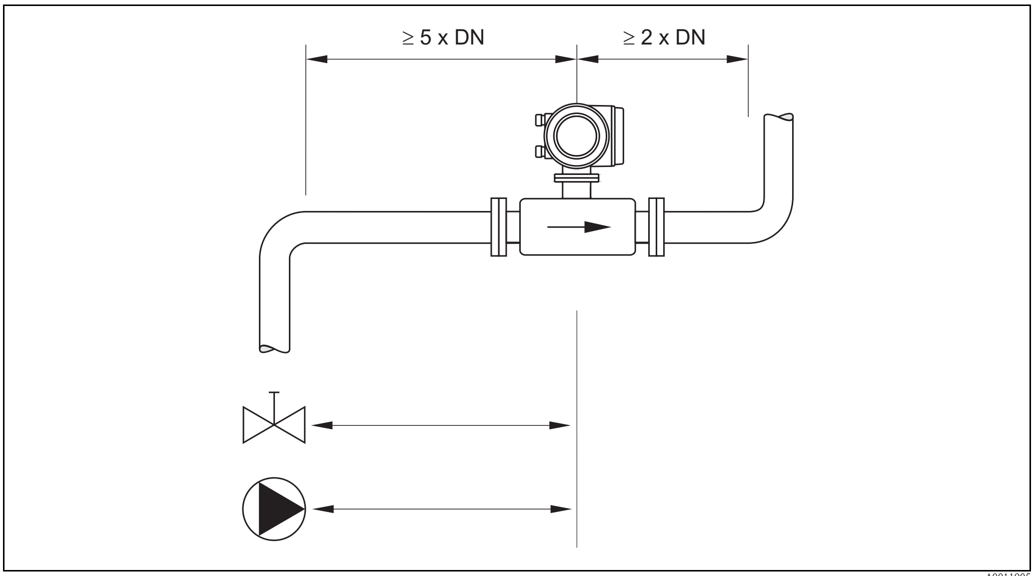
Caution!
Do not allow the casing to take the weight of the sensor. This would buckle the casing and damage the internal magnetic coils.



Inlet and outlet run

If possible, install the sensor well clear of assemblies such as valves, T-pieces, elbows etc.

Note the following inlet and outlet runs to comply with measuring accuracy specifications:
- Inlet run: ≥ 5 × DN
- Outlet run: ≥ 2 × DN



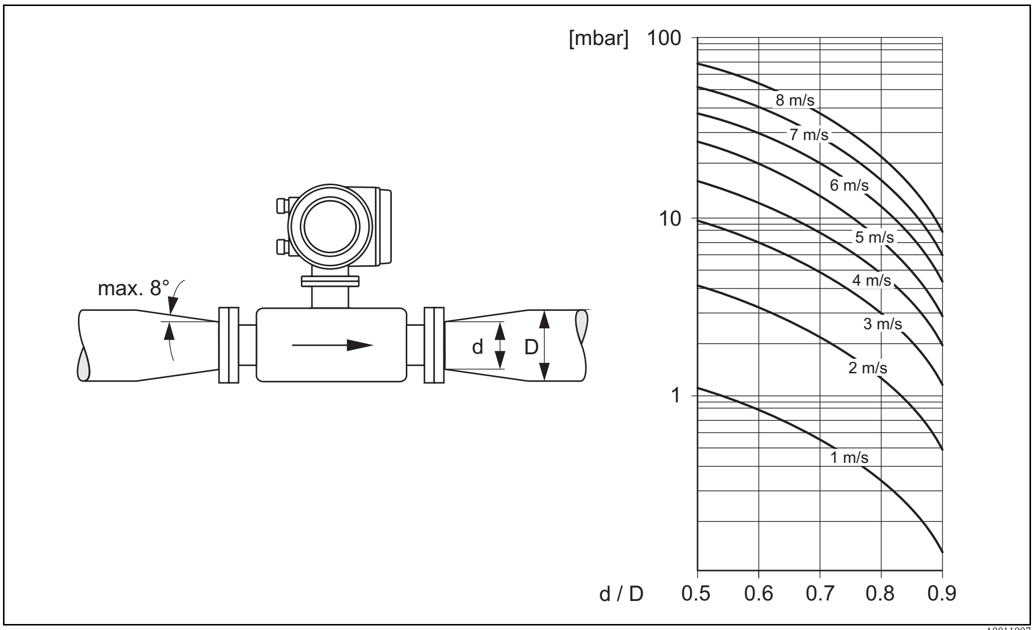
Inlet and outlet run

Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids. The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders.

Note!
The nomogram only applies to liquids of viscosity similar to water.

1. Calculate the ratio of the diameters d/D.
2. From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

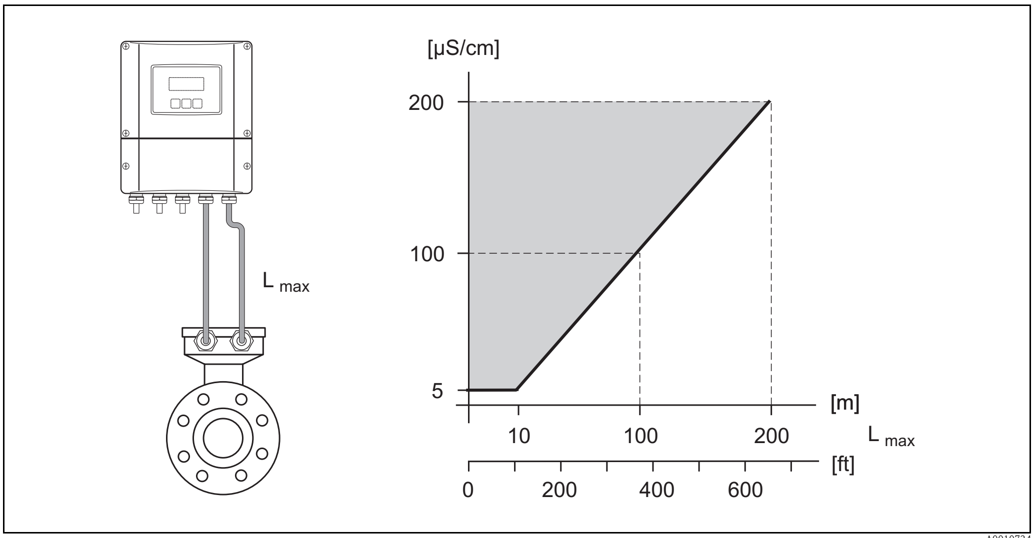


Pressure loss due to adapters

Length of connecting cable

When mounting the remote version, please note the following to achieve correct measuring results:

- Fix cable run or lay in armored conduit. Cable movements can falsify the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- If necessary, ensure potential equalization between sensor and transmitter.
- The permitted cable length L_{max} is determined by the fluid conductivity. A minimum conductivity of 20 µS/cm is required for measuring demineralized water.
- When the empty pipe detection function is switched on (EPD), the maximum connecting cable length is 10 m (33 ft).



A0010734

Permitted length of connecting cable for remote version
Area marked in gray = permitted range; L_{max} = length of connecting cable in [m] ([ft]); fluid conductivity in [µS/cm]

Operating conditions: Environment

Ambient temperature range

Transmitter
- Standard: –20 to +60 °C (–4 to +140 °F)
- Optional: –40 to +60 °C (–40 to +140 °F)

Note!
At ambient temperatures below –20 °C (–4 °F)the readability of the display may be impaired.

Sensor
- Flange material carbon steel: –10 to +60 °C (14 to +140 °F)
- Flange material stainless steel: –40 to +60 °C (–40 to +140 °F)

Caution!
The permitted temperature range of the measuring tube lining may not be undershot or overshot → 21, Section "Medium temperature range".

Please note the following points:
- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions.
- The transmitter must be mounted separate from the sensor if both the ambient and fluid temperatures are high.

Storage temperature

The storage temperature corresponds to the operating temperature range of the measuring transmitter and the appropriate measuring sensors.

Caution!
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- A storage location must be selected where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the liner.
- Do not remove the protective plates or caps on the process connections until the device is ready to install.

Degree of protection

- Standard: IP 67 (NEMA 4X) for transmitter and sensor.
- Optional: IP 68 (NEMA 6P) for sensor for remote version.
- For information regarding applications where the device is buried directly in the soil or is installed in a flooded wastewater basin please contact your local Endress+Hauser Sales Center.

Shock and vibration resistance

Acceleration up to 2 g following IEC 600 68-2-6

Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR recommendation NE 21.

Operating conditions: Process

Medium temperature range

The permitted temperature depends on the lining of the measuring tube:
- Polyurethane: –20 to +50 °C (–4 to +122 °F) (DN 25 to 1200 / 1 to 48")
- Hard rubber: ±0 to +80 °C (+32 to +176 °F) (DN 50 to 2000 / 2 to 78")

Conductivity

The minimum conductivity is:
- ≥ 5 μS/cm for fluids generally
- ≥ 20 μS/cm for demineralized water

Note!
In the remote version, the necessary minimum conductivity also depends on the cable length (→ 19, Section "Length of connecting cable").

Medium pressure range (nominal pressure)

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 2000 / 14 to 78")
  - PN 10 (DN 200 to 2000 / 8 to 78")
  - PN 16 (DN 65 to 2000 / 3 to 78")
  - PN 25 (DN 200 to 1000 / 8 to 40")
  - PN 40 (DN 25 to 150 / 1 to 6")
- ANSI B 16.5
  - Class 150 (DN 1 to 24")
  - Class 300 (DN 1 to 6")
- AWWA
  - Class D (DN 28 to 78")
- JIS B2220
  - 10 K (DN 50 to 300 / 2 to 12")
  - 20 K (DN 25 to 300 / 1 to 12")
- AS 2129
  - Table E (DN 80, 100, 150 to 400, 500, 600 / 3", 4", 6 to 16", 20", 24")
- AS 4087
  - PN 16 (DN 80, 100, 150 to 400, 500, 600 / 3", 4", 6 to 16", 20", 24")

Pressure tightness

Measuring tube lining: Polyurethane

Nominal diameter		Limit values for abs. pressure [mbar] ([psi]) at fluid temperatures:			
		25 °C (77 °F)		50 °C (122 °F)	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]
25 to 1200	1 to 48"	0	0	0	0

Measuring tube lining: Hard rubber

Nominal diameter		Limit values for abs. pressure [mbar] ([psi]) at fluid temperatures:					
		25 °C (77 °F)		50 °C (122 °F)		80 °C (176 °F)	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]	[mbar]	[psi]
50 to 2000	2 to 78"	0	0	0	0	0	0

Limiting flow

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor.
The optimum flow velocity is between 2 to 3 m/s (6.5 to 9.8 ft/s). The velocity of flow (v), moreover, has to be matched to the physical properties of the fluid:

- v < 2 m/s (6.5 ft/s): for abrasive fluids such as potter's clay, lime milk, ore slurry etc.
- v > 2 m/s (6.5 ft/s): for fluids causing build-up such as wastewater sludges etc.

Flow characteristic values (SI units)					
Diameter		Recommended flow	Factory settings		
[mm]	[inch]	Min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value Current output (v ~ 2.5 m/s)	Pulse value (~ 2 pulses/s)	Low flow (v ~ 0.04 m/s)
25	1"	9 to 300 dm^3/min	75 dm^3/min	0.50 dm^3	1 dm^3/min
32	–	15 to 500 dm^3/min	125 dm^3/min	1.00 dm^3	2 dm^3/min
40	1½"	25 to 700 dm^3/min	200 dm^3/min	1.50 dm^3	3 dm^3/min
50	2"	35 to 1100 dm^3/min	300 dm^3/min	2.50 dm^3	5 dm^3/min
65	–	60 to 2000 dm^3/min	500 dm^3/min	5.00 dm^3	8 dm^3/min
80	3"	90 to 3000 dm^3/min	750 dm^3/min	5.00 dm^3	12 dm^3/min
100	4"	145 to 4700 dm^3/min	1200 dm^3/min	10.00 dm^3	20 dm^3/min
125	–	220 to 7500 dm^3/min	1850 dm^3/min	15.00 dm^3	30 dm^3/min
150	6"	20 to 600 m^3/h	150 m^3/h	0.025 m^3	2.5 m^3/h
200	8"	35 to 1100 m^3/h	300 m^3/h	0.05 m^3	5.0 m^3/h
250	10"	55 to 1700 m^3/h	500 m^3/h	0.05 m^3	7.5 m^3/h
300	12"	80 to 2400 m^3/h	750 m^3/h	0.10 m^3	10 m^3/h
350	14"	110 to 3300 m^3/h	1000 m^3/h	0.10 m^3	15 m^3/h
375	15"	140 to 4200 m^3/h	1200 m^3/h	0.15 m^3	20 m^3/h
400	16"	140 to 4200 m^3/h	1200 m^3/h	0.15 m^3	20 m^3/h
450	18"	180 to 5400 m^3/h	1500 m^3/h	0.25 m^3	25 m^3/h
500	20"	220 to 6600 m^3/h	2000 m^3/h	0.25 m^3	30 m^3/h
600	24"	310 to 9600 m^3/h	2500 m^3/h	0.30 m^3	40 m^3/h
700	28"	420 to 13500 m^3/h	3500 m^3/h	0.50 m^3	50 m^3/h
–	30"	480 to 15000 m^3/h	4000 m^3/h	0.50 m^3	60 m^3/h
800	32"	550 to 18000 m^3/h	4500 m^3/h	0.75 m^3	75 m^3/h
900	36"	690 to 22500 m^3/h	6000 m^3/h	0.75 m^3	100 m^3/h
1000	40"	850 to 28000 m^3/h	7000 m^3/h	1.00 m^3	125 m^3/h
–	42"	950 to 30000 m^3/h	8000 m^3/h	1.00 m^3	125 m^3/h
1200	48"	1250 to 40000 m^3/h	10000 m^3/h	1.50 m^3	150 m^3/h
–	54"	1550 to 50000 m^3/h	13000 m^3/h	1.50 m^3	200 m^3/h
1400	–	1700 to 55000 m^3/h	14000 m^3/h	2.00 m^3	225 m^3/h
–	60"	1950 to 60000 m^3/h	16000 m^3/h	2.00 m^3	250 m^3/h
1600	–	2200 to 70000 m^3/h	18000 m^3/h	2.50 m^3	300 m^3/h
–	66"	2500 to 80000 m^3/h	20500 m^3/h	2.50 m^3	325 m^3/h
1800	72"	2800 to 90000 m^3/h	23000 m^3/h	3.00 m^3	350 m^3/h
–	78"	3300 to 100000 m^3/h	28500 m^3/h	3.50 m^3	450 m^3/h
2000	–	3400 to 110000 m^3/h	28500 m^3/h	3.50 m^3	450 m^3/h

Flow characteristic values (US units)					
Diameter		Recommended flow rate	Factory settings		
[inch]	[mm]	Min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value Current output (v ~ 2.5 m/s)	Pulse value (~ 2 pulses/s)	Low flow (v ~ 0.04 m/s)
1"	25	2.5 to 80 gal/min	18 gal/min	0.20 gal	0.25 gal/min
–	32	4 to 130 gal/min	30 gal/min	0.20 gal	0.50 gal/min
1½"	40	7 to 190 gal/min	50 gal/min	0.50 gal	0.75 gal/min
2"	50	10 to 300 gal/min	75 gal/min	0.50 gal	1.25 gal/min
–	65	16 to 500 gal/min	130 gal/min	1 gal	2.0 gal/min
3"	80	24 to 800 gal/min	200 gal/min	2 gal	2.5 gal/min
4"	100	40 to 1250 gal/min	300 gal/min	2 gal	4.0 gal/min
–	125	60 to 1950 gal/min	450 gal/min	5 gal	7.0 gal/min
6"	150	90 to 2650 gal/min	600 gal/min	5 gal	12 gal/min
8"	200	155 to 4850 gal/min	1200 gal/min	10 gal	15 gal/min
10"	250	250 to 7500 gal/min	1500 gal/min	15 gal	30 gal/min
12"	300	350 to 10600 gal/min	2400 gal/min	25 gal	45 gal/min
14"	350	500 to 15000 gal/min	3600 gal/min	30 gal	60 gal/min
15"	375	600 to 19000 gal/min	4800 gal/min	50 gal	60 gal/min
16"	400	600 to 19000 gal/min	4800 gal/min	50 gal	60 gal/min
18"	450	800 to 24000 gal/min	6000 gal/min	50 gal	90 gal/min
20"	500	1000 to 30000 gal/min	7500 gal/min	75 gal	120 gal/min
24"	600	1400 to 44000 gal/min	10500 gal/min	100 gal	180 gal/min
28"	700	1900 to 60000 gal/min	13500 gal/min	125 gal	210 gal/min
30"	–	2150 to 67000 gal/min	16500 gal/min	150 gal	270 gal/min
32"	800	2450 to 80000 gal/min	19500 gal/min	200 gal	300 gal/min
36"	900	3100 to 100000 gal/min	24000 gal/min	225 gal	360 gal/min
40"	1000	3800 to 125000 gal/min	30000 gal/min	250 gal	480 gal/min
42"	–	4200 to 135000 gal/min	33000 gal/min	250 gal	600 gal/min
48"	1200	5500 to 175000 gal/min	42000 gal/min	400 gal	600 gal/min
54"	–	9 to 300 Mgal/min	75 Mgal/min	0.0005 Mgal	1.3 Mgal/min
–	1400	10 to 340 Mgal/min	85 Mgal/min	0.0005 Mgal	1.3 Mgal/min
60"	–	12 to 380 Mgal/min	95 Mgal/min	0.0005 Mgal	1.3 Mgal/min
–	1600	13 to 450 Mgal/min	110 Mgal/min	0.0008 Mgal	1.7 Mgal/min
66"	–	14 to 500 Mgal/min	120 Mgal/min	0.0008 Mgal	2.2 Mgal/min
72"	1800	16 to 570 Mgal/min	140 Mgal/min	0.0008 Mgal	2.6 Mgal/min
78"	–	18 to 650 Mgal/min	175 Mgal/min	0.001 Mgal	3.0 Mgal/min
–	2000	20 to 700 Mgal/min	175 Mgal/min	0.001 Mgal	3.0 Mgal/min

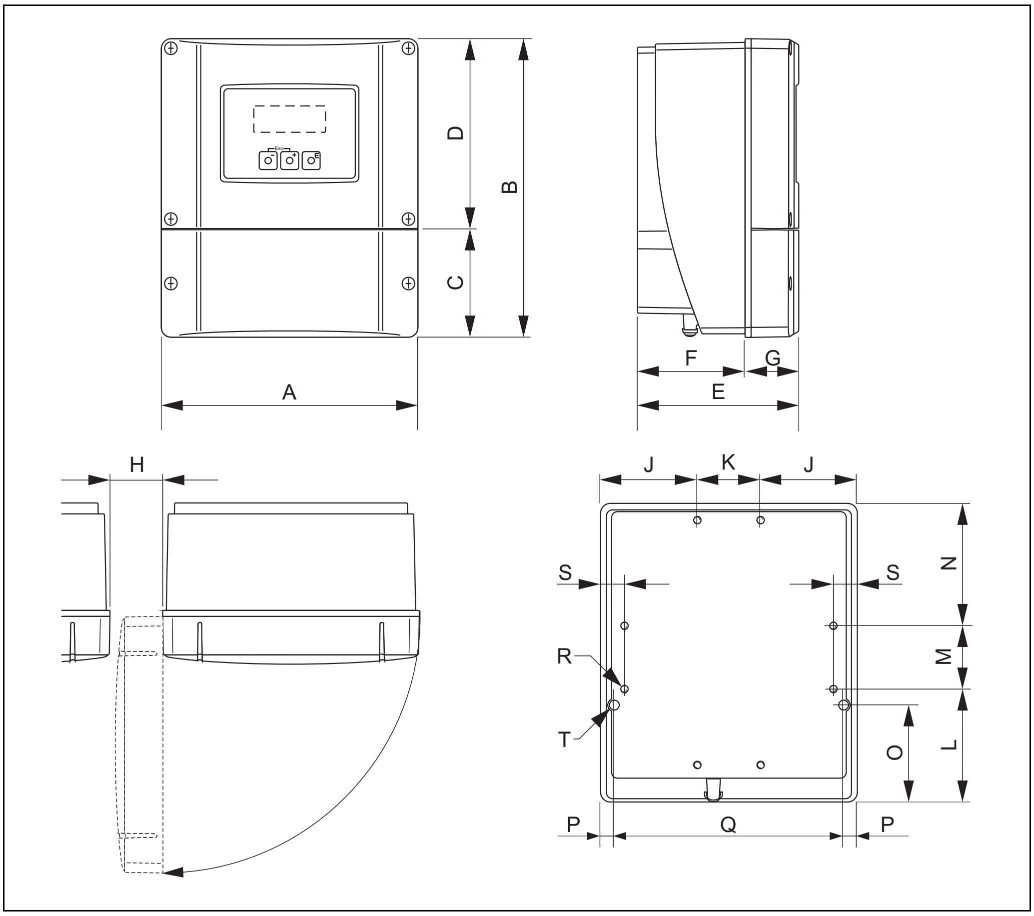
Pressure loss

- No pressure loss if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 (→ 🗎 18, Section "Adapters").

Mechanical construction

Design, dimensions

Transmitter remote version, wall-mount housing (non Ex-zone and II3G/Zone 2)



A0001150

Dimensions (SI units)

A	B	C	D	E	F	G	H	J
215	250	90.5	159.5	135	90	45	> 50	81
K	L	M	N	O	P	Q	R	S
53	95	53	102	81.5	11.5	192	8 × M5	20

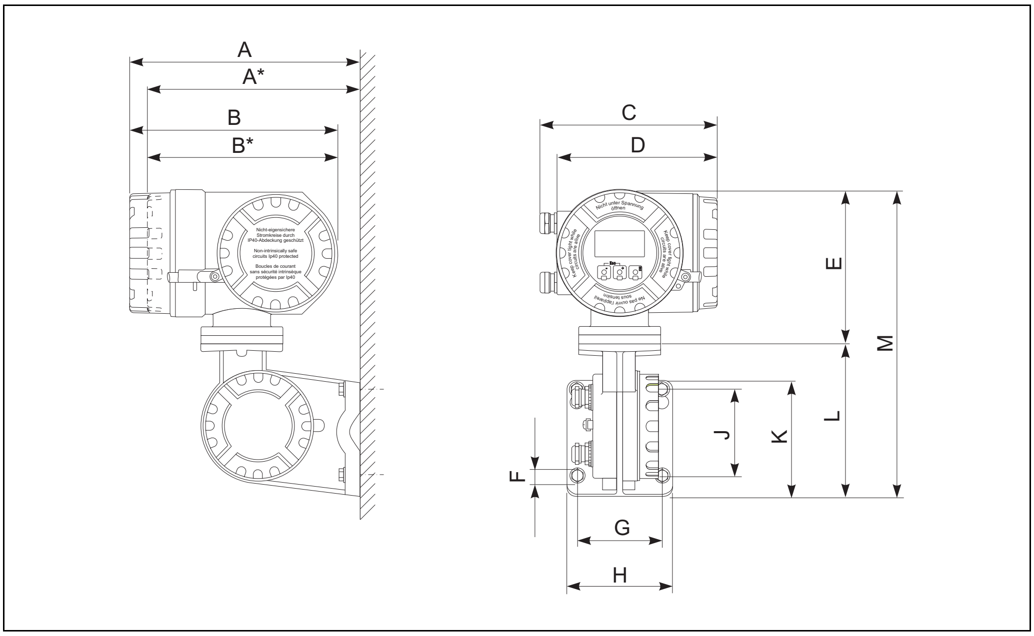
All dimensions in [mm]

Dimensions (US units)

A	B	C	D	E	F	G	H	J
8.46	9.84	3.56	6.27	5.31	3.54	1.77	> 1.97	3.18
K	L	M	N	O	P	Q	R	S
2.08	3.74	2.08	4.01	3.20	0.45	7.55	8 × M5	0.79

All dimensions in [inch]

Transmitter remote version, connection housing (II2GD/Zone 1)



A0002128

Dimensions (SI units)

A	A*	B	B*	C	D	E	Ø F	G	H	J	K	L	M
265	242	240	217	206	186	178	8.6 (M8)	100	130	100	144	170	355

All dimensions in [mm]

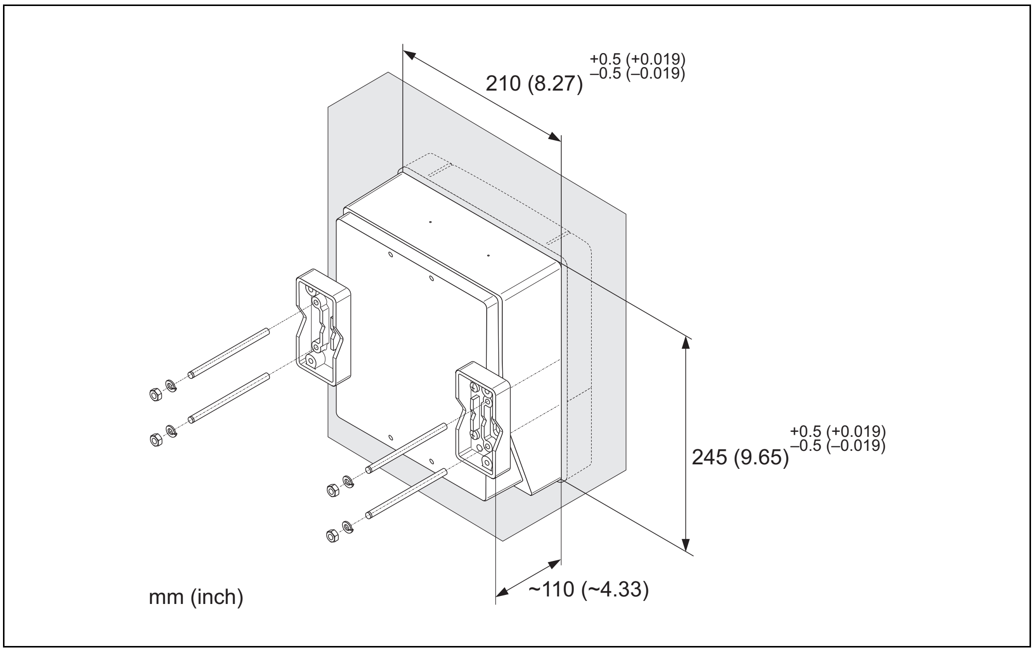
Dimensions (US units)

A	A*	B	B*	C	D	E	Ø F	G	H	J	K	L	M
10.4	9.53	9.45	8.54	8.11	7.32	7.01	0.34 (M8)	3.94	5.12	3.94	5.67	6.69	14.0

All dimensions in [inch]

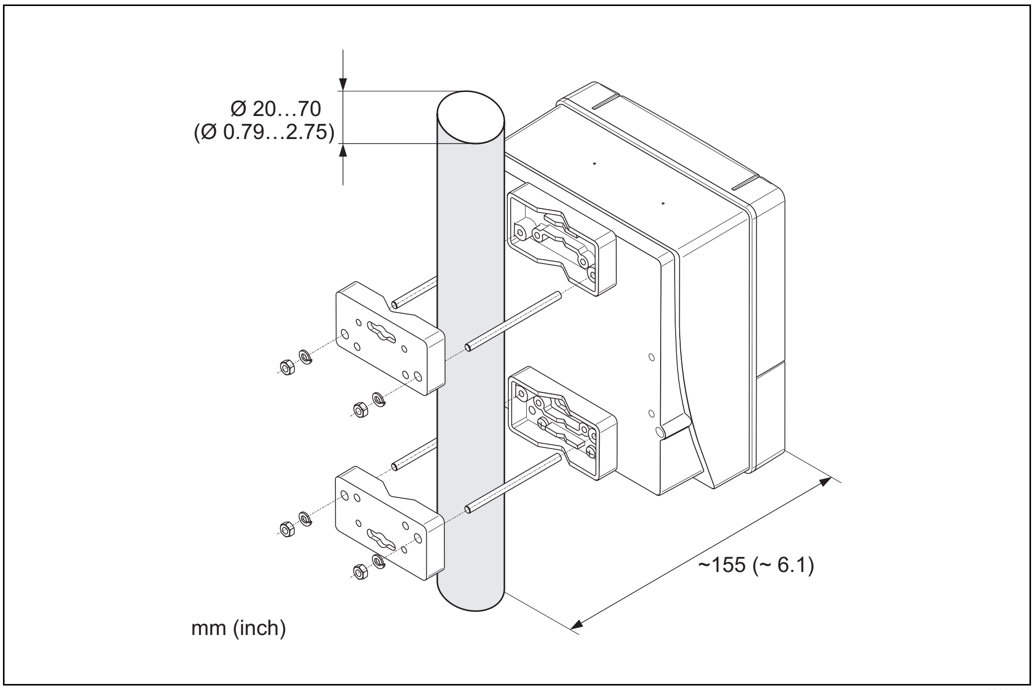
There is a separate mounting kit for the wall-mounted housing. It can be ordered from Endress+Hauser as an accessory. The following installation variants are possible:
- Panel-mounted installation
- Pipe mounting

Installation in control panel



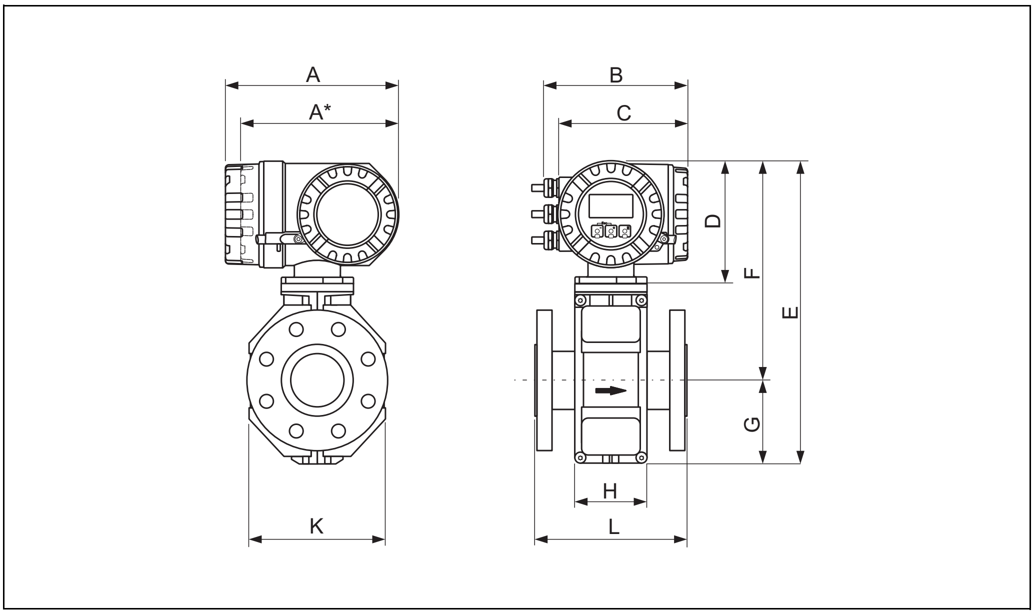
A0001131

Pipe mounting



A0001132

Compact version DN ≤ 300 (12")



A0005423

Dimensions (SI units)

DN EN (DIN) / JIS / AS [2)]	L [1)]	A	A*	B	C	D	E	F	G	H	K
25	200	227	207	187	168	160	341	257	84	94	120
32	200						341	257	84	94	120
40	200						341	257	84	94	120
50	200						341	257	84	94	120
65	200						391	282	109	94	180
80	200						391	282	109	94	180
100	250						391	282	109	94	180
125	250						472	322	150	140	260
150	300						472	322	150	140	260
200	350						527	347	180	156	324
250	450						577	372	205	166	400
300	500						627	397	230	166	460

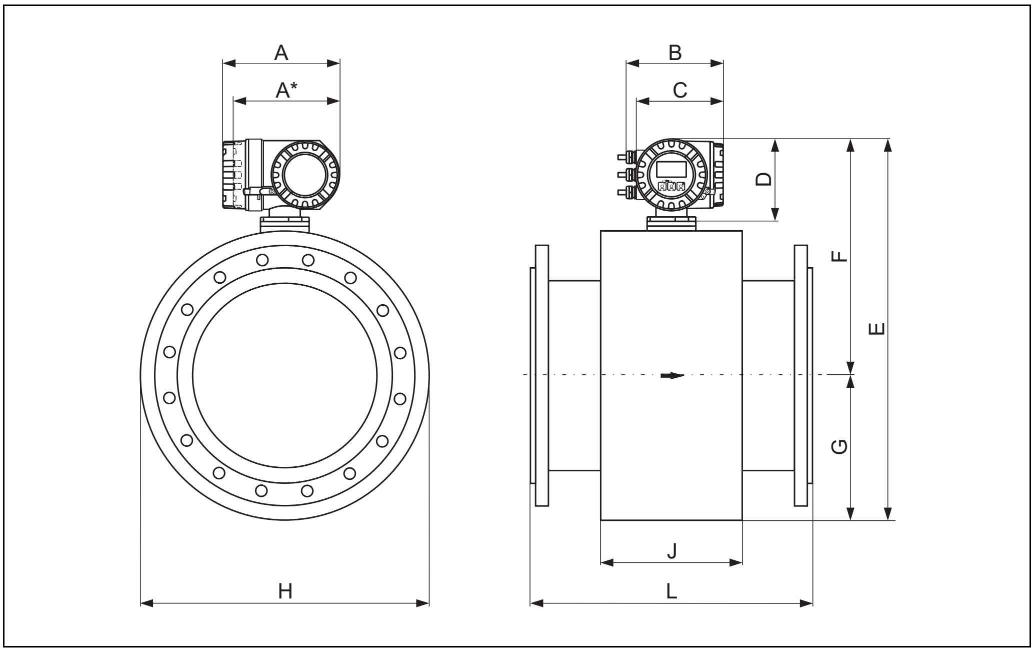
[1)] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2)] For flanges to AS, only the nominal diameters DN 80, 100 and 150 to 300 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	A*	B	C	D	E	F	G	H	K
1"	7.87						13.4	10.1	3.31	3.70	4.72
1½"	7.87						13.4	10.1	3.31	3.70	4.72
2"	7.87						13.4	10.1	3.31	3.70	4.72
3"	7.87						15.4	11.1	4.29	3.70	7.09
4"	9.84	8.94	8.15	7.36	6.61	6.30	15.4	11.1	4.29	3.70	7.09
6"	11.8						18.6	12.7	5.91	5.51	10.2
8"	13.8						20.8	13.7	7.09	6.14	12.8
10"	17.7						22.7	14.7	8.07	6.14	15.8
12"	19.7						24.7	15.6	9.06	6.54	18.1

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Compact version DN ≥ 350 (14")



A0005424

Dimensions (SI units)

DN EN (DIN) / AS 2)	L 1)	A	A*	B	C	D	E	F	G	H	J
350	550	227	207	187	168	160	738.5	456.5	282.0	276	564
375	600						790.5	482.5	308.0	276	616
400	600						790.5	482.5	308.0	276	616
450	650						840.5	507.5	333.0	292	666
500	650						891.5	533.0	358.5	292	717
600	780						995.5	585.0	410.5	402	821
700	910						1198.5	686.5	512.0	589	1024
750	975						1198.5	686.5	512.0	626	1024
800	1040						1241.5	708.5	533.5	647	1067
900	1170						1394.5	784.5	610.0	785	1220
1000	1300						1546.5	860.5	686.0	862	1372
1050	1365						1598.5	886.5	712.0	912	1424
1200	1560						1796.5	985.5	811.0	992	1622
1350	1755						1998.5	1086.5	912.0	1252	1824
1400	1820						2148.5	1161.5	987.0	1252	1974
1500	1950						2196.5	1185.5	1011.0	1392	2022
1600	2080						2286.5	1230.5	1056.0	1482	2112
1650	2145						2360.5	1267.5	1093.0	1482	2186
1800	2340						2550.5	1362.5	1188.0	1632	2376
2000	2600						2650.5	1412.5	1238.0	1732	2476

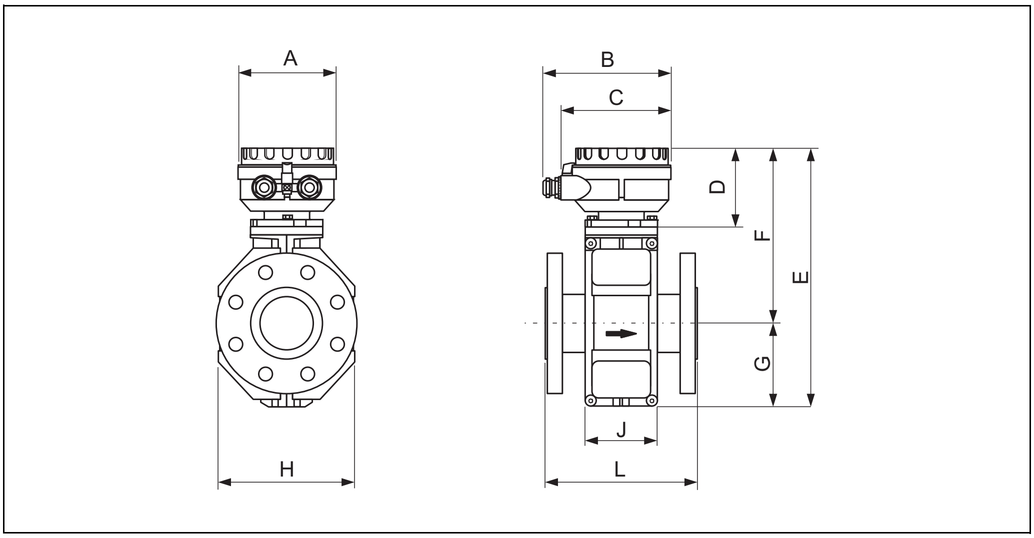
1) The length is regardless of the pressure rating selected. Fitting length to DVGW.
2) For flanges to AS, only DN 350, 400, 500 and 600 are available.
All dimensions in [mm]

Dimensions (US units)

<table>
<tr><th>DN
ANSI / AWWA 2)</th><th>L 1)</th><th>A</th><th>A*</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>J</th></tr>
<tr><td>14"</td><td>21.6</td><td rowspan="20">8.94</td><td rowspan="20">8.15</td><td rowspan="20">7.36</td><td rowspan="20">6.61</td><td rowspan="20">6.30</td><td>29.1</td><td>17.9</td><td>11.1</td><td>10.9</td><td>22.2</td></tr>
<tr><td>15"</td><td>23.6</td><td>31.1</td><td>18.9</td><td>12.1</td><td>10.9</td><td>24.2</td></tr>
<tr><td>16"</td><td>23.6</td><td>31.1</td><td>18.9</td><td>12.1</td><td>10.9</td><td>24.2</td></tr>
<tr><td>18"</td><td>25.6</td><td>33.1</td><td>19.9</td><td>13.1</td><td>11.5</td><td>26.2</td></tr>
<tr><td>20"</td><td>25.6</td><td>35.1</td><td>20.9</td><td>14.1</td><td>11.5</td><td>28.2</td></tr>
<tr><td>24"</td><td>30.7</td><td>39.2</td><td>23.0</td><td>16.2</td><td>15.8</td><td>32.3</td></tr>
<tr><td>28"</td><td>35.8</td><td>47.2</td><td>27.0</td><td>20.1</td><td>23.2</td><td>40.3</td></tr>
<tr><td>30"</td><td>38.4</td><td>47.2</td><td>27.0</td><td>20.1</td><td>24.6</td><td>40.3</td></tr>
<tr><td>32"</td><td>40.9</td><td>48.9</td><td>27.9</td><td>21.0</td><td>25.5</td><td>42.0</td></tr>
<tr><td>36"</td><td>46.0</td><td>54.9</td><td>30.9</td><td>24.0</td><td>30.9</td><td>48.0</td></tr>
<tr><td>40"</td><td>51.2</td><td>60.9</td><td>33.9</td><td>27.0</td><td>33.9</td><td>54.0</td></tr>
<tr><td>42"</td><td>53.7</td><td>62.9</td><td>34.9</td><td>28.0</td><td>35.9</td><td>56.0</td></tr>
<tr><td>48"</td><td>61.4</td><td>71.7</td><td>38.8</td><td>31.9</td><td>39.0</td><td>63.8</td></tr>
<tr><td>54"</td><td>69.1</td><td>78.7</td><td>42.8</td><td>35.9</td><td>42.3</td><td>71.8</td></tr>
<tr><td>56"</td><td>71.7</td><td>84.6</td><td>45.7</td><td>38.9</td><td>49.3</td><td>77.7</td></tr>
<tr><td>60"</td><td>76.8</td><td>86.5</td><td>46.7</td><td>39.8</td><td>54.8</td><td>79.6</td></tr>
<tr><td>64"</td><td>81.9</td><td>90.0</td><td>48.4</td><td>41.6</td><td>58.4</td><td>83.2</td></tr>
<tr><td>66"</td><td>84.4</td><td>92.9</td><td>49.9</td><td>43.0</td><td>58.4</td><td>86.0</td></tr>
<tr><td>72"</td><td>92.1</td><td>100.4</td><td>53.6</td><td>46.8</td><td>64.2</td><td>93.5</td></tr>
<tr><td>78"</td><td>102.3</td><td>104.3</td><td>55.6</td><td>48.7</td><td>68.2</td><td>97.5</td></tr>
</table>

1) The length is regardless of the pressure rating selected. Fitting length to DVGW.
2) Flanges ≤ 24" only to ANSI available, ≥ 28" only to AWWA available.
All dimensions in [inch]

Sensor, remote version DN ≤ 300 (12")



A0012462

Dimensions (SI units)

DN EN (DIN) / JIS / AS [2]	L [1]	A	B	C	D	E	F	G	H	J
25	200	129	163	143	102	286	202	84	120	94
32	200	129	163	143	102	286	202	84	120	94
40	200	129	163	143	102	286	202	84	120	94
50	200	129	163	143	102	286	202	84	120	94
65	200	129	163	143	102	336	227	109	180	94
80	200	129	163	143	102	336	227	109	180	94
100	250	129	163	143	102	336	227	109	180	94
125	250	129	163	143	102	417	267	150	260	140
150	300	129	163	143	102	417	267	150	260	140
200	350	129	163	143	102	472	292	180	324	156
250	450	129	163	143	102	522	317	205	400	166
300	500	129	163	143	102	572	342	230	460	166

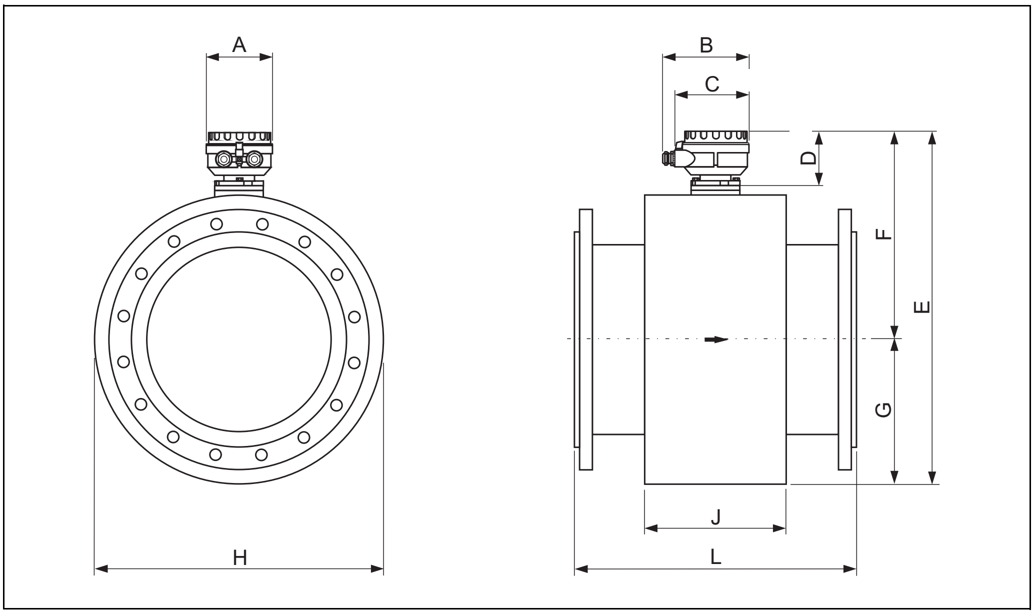
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] For flanges to AS, only the nominal diameters DN 80, 100 and 150 to 300 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	B	C	D	E	F	G	H	J
1"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.32	4.72	3.70
1½"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.32	4.72	3.70
2"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.32	4.72	3.70
3"	7.87	5.08	6.42	5.63	4.02	13.2	8.94	4.30	7.10	3.70
4"	9.84	5.08	6.42	5.63	4.02	13.2	8.94	4.30	7.10	3.70
6"	11.8	5.08	6.42	5.63	4.02	16.4	10.5	5.91	10.2	5.51
8"	13.8	5.08	6.42	5.63	4.02	18.6	11.5	7.10	12.8	6.14
10"	17.7	5.08	6.42	5.63	4.02	20.6	12.5	8.08	15.8	6.14
12"	19.7	5.08	6.42	5.63	4.02	22.5	13.5	9.06	18.1	6.54

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Sensor, remote version DN ≥ 350 (14")



A0003220

Dimensions (SI units)

DN EN (DIN) / AS 2)	L 1)	A	B	C	D	E	F	G	H	J
350	550	129	163	143	102	683.5	401.5	282.0	564	276
375	600					735.5	427.5	308.0	616	276
400	600					735.5	427.5	308.0	616	276
450	650					785.5	452.5	333.0	666	292
500	650					836.5	478.0	358.5	717	292
600	780					940.5	530.0	410.5	821	402
700	910					1143.5	631.5	512.0	1024	589
750	975					1143.5	631.5	512.0	1024	626
800	1040					1186.5	653.0	533.5	1067	647
900	1170					1339.5	729.5	610.0	1220	785
1000	1300					1491.5	805.5	686.0	1372	862
1050	1365					1543.5	831.5	712.0	1424	912
1200	1560					1741.5	930.5	811.0	1622	992
1350	1755					1943.5	1031.5	912.0	1824	1252
1400	1820					2093.5	1106.5	987.0	1974	1252
1500	1950					2141.5	1130.5	1011.0	2022	1392
1600	2080					2231.5	1175.5	1056.0	2112	1482
1650	2145					2305.5	1212.5	1093.0	2186	1482
1800	2340					2495.5	1307.5	1188.0	2376	1632
2000	2600					2595.5	1357.5	1238.0	2476	1732

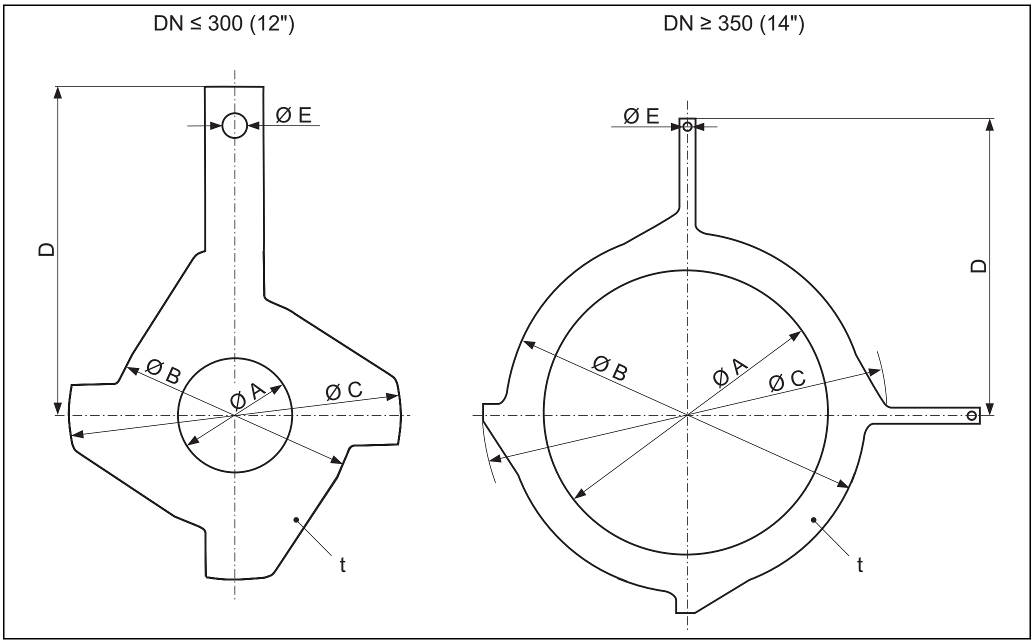
1) The length is regardless of the pressure rating selected. Fitting length to DVGW.
2) For flanges to AS, only DN 350, 400, 500 and 600 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI / AWWA [2]	L [1]	A	B	C	D	E	F	G	H	J
14"	21.6	5.08	6.42	5.63	4.02	29.1	15.8	11.1	22.2	10.9
15"	23.6					31.1	16.8	12.1	24.2	10.9
16"	23.6					31.1	16.8	12.1	24.2	10.9
18"	25.6					33.1	17.8	13.1	26.2	11.5
20"	25.6					35.1	18.8	14.1	28.2	11.5
24"	30.7					39.2	20.9	16.2	32.3	15.8
28"	35.8					45.0	24.9	20.1	40.3	23.2
30"	38.4					45.0	24.9	20.1	40.3	24.6
32"	40.9					46.7	25.7	21.0	42.0	25.5
36"	46.0					52.7	28.7	24.0	48.0	30.9
40"	51.2					58.7	31.7	27.0	54.0	33.9
42"	53.7					60.7	32.7	28.0	56.0	35.9
48"	61.4					68.5	36.6	31.9	63.8	39.0
54"	69.1					76.5	40.6	35.9	71.8	42.3
56"	71.7					82.4	43.6	38.9	77.7	49.3
60"	76.8					84.3	44.5	39.8	79.6	54.8
64"	81.9					87.9	46.3	41.6	83.2	58.4
66"	84.4					90.8	47.7	43.0	86.0	58.4
72"	92.1					98.2	51.5	46.8	93.5	64.2
78"	102.3					102.2	53.4	48.7	97.5	68.2

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] Flanges ≤ 24" only to ANSI available, ≥ 28" only to AWWA available.
All dimensions in [inch]

Ground disk for flange connections



A0003221

Dimensions (SI units)

DN [1] EN (DIN) / JIS / AS [2]	A	B	C	D	E	t
25	26	62	77.5	87.5		
32	35	80	87.5	94.5		
40	41	82	101	103		
50	52	101	115.5	108		
65	68	121	131.5	118		
80	80	131	154.5	135		
100	104	156	186.5	153	6.5	
125	130	187	206.5	160		
150	158	217	256	184		
200	206	267	288	205		2
250	260	328	359	240		
300 [3]	312	375	413	273		
300 [4]	310	375	404	268		
350 [3]	343	433	479	365		
375 [3]	393	480	542	395		
400 [3]	393	480	542	395		
450 [3]	439	538	583	417	9.0	
500 [3]	493	592	650	460		
600 [3]	593	693	766	522		

1) Ground disks can be used for all flange standards/pressure ratings that can be delivered, except for DN ≥ 300.
2) Only DN 32, 40, 65 and 125 are available for flanges according to AS.
3) PN 10/16
4) PN 25, JIS 10K/20K
All dimensions in [mm]

Dimensions (US units)

DN [1] ANSI	A	B	C	D	E	t
1"	1.02	2.44	3.05	3.44	0.26	0.08
1½"	1.61	3.23	3.98	4.06		
2"	2.05	3.98	4.55	4.25		
3"	3.15	5.16	6.08	5.31		
4"	4.09	6.14	7.34	6.02		
6"	6.22	8.54	10.08	7.24		
8"	8.11	10.5	11.3	8.07		
10"	10.2	12.9	14.1	9.45		
12"	12.3	14.8	16.3	10.8		
14"	13.5	17.1	18.9	14.4	0.35	
15"	15.45	18.9	21.3	15.6		
16"	15.45	18.9	21.3	15.6		
18"	17.3	21.2	23.0	16.4		
20"	19.4	23.3	25.6	18.1		
24"	23.4	27.3	30.1	20.6		

[1] Ground disks can be used for all flange standards/pressure ratings.
All dimensions in [inch]

Weight

Weight in SI units

Weight data in kg														
Nominal diameter		Compact version						Remote version (without cable)						
								Sensor						Transmitter
[mm]	[inch]	EN (DIN) / AS [1)]		JIS		ANSI / AWWA		EN (DIN) / AS [1)]		JIS		ANSI / AWWA		Wall-mount housing
25	1"	PN 40	7.3	10K	7.3	Class 150	7.3	PN 40	5.3	10K	5.3	Class 150	5.3	
32	–		8.0		7.3		–		6.0		5.3		–	
40	1½"		9.4		8.3		9.4		7.4		6.3		7.4	
50	2"		10.6		9.3		10.6		8.6		7.3		8.6	
65	–	PN 16	12		11.1		–	PN 16	10.0		9.1		–	
80	3"		14		112.5		14.0		12.0		10.5		12.0	
100	4"		16		14.7		16.0		14.0		12.7		14.0	
125	–		21.5		21.0		–		19.5		19.0		–	
150	6"		25.5		24.5		25.5		23.5		22.5		23.5	
200	8"	PN 10	45		41.9		45	PN 10	43		39.9		43	
250	10"		65		69.4		75		63		67.4		73	
300	12"		70		72.3		110		68		70.3		108	
350	14"	PN 6	105				175	PN 6	103				173	
375	15"		120				–		118				–	
400	16"		120				205		118				203	
450	18"		161				255		159				253	
500	20"		156				285		154				283	6.0
600	24"		208				405		206				403	
700	28"		304			Class D	400		302			Class D	398	
–	30"		–				460		–				458	
800	32"		357				550		355				548	
900	36"		485				800		483				798	
1000	40"		589				900		587				898	
–	42"		–				1100		–				1098	
1200	48"		850				1400		848				1398	
–	54"		–				2200		–				2198	
1400	–		1300				–		1298				–	
–	60"		–				2700		–				2698	
1600	–		1700				–		1698				–	
–	66"		–				3700		–				3698	
1800	72"		2200				4100		2198				4098	
–	78"		–				4600		–				4598	
2000	–		2800				–		2798				–	

[1)] For flanges to AS, only DN 80, 100, 150 to 400, 500 and 600 are available.

- Transmitter (compact version): 3.4 kg
- Weight data valid for standard pressure ratings and without packaging material.

Weight in US units (only ANSI / AWWA)

Weight data in lbs						
Nominal diameter		Compact version		Remote version (without cable)		
				Sensor		Transmitter
[mm]	[inch]	ANSI /AWWA		ANSI / AWWA		Wall-mount housing
25	1"	Class 150	16.1	Class 150	11.7	13.2
40	1½"		20.7		16.3	
50	2"		23.4		19.0	
80	3"		30.9		26.5	
100	4"		35.3		30.9	
150	6"		56.2		51.8	
200	8"		99.2		94.8	
250	10"		165.4		161.0	
300	12"		242.6		238.1	
350	14"		385.9		381.5	
400	16"		452.0		447.6	
450	18"		562.3		557.9	
500	20"		628.4		624.0	
600	24"		893.0		888.6	
700	28"	Class D	882.0	Class D	877.6	
–	30"		1014.3		1009.9	
800	32"		1212.8		1208.3	
900	36"		1764.0		1759.6	
1000	40"		1984.5		1980.1	
–	42"		2425.5		2421.1	
1200	48"		3087.0		3082.6	
–	54"		4851.0		4846.6	
–	60"		5953.5		5949.1	
–	66"		8158.5		8154.1	
1800	72"		9040.5		9036.1	
–	78"		10143.0		10138.6	

- Transmitter (compact version): 7,5 lbs
- Weight data valid for standard pressure ratings and without packaging material.

Measuring tube specifications

Diameter		Pressure rating						Internal diameter			
		EN (DIN)	AS 2129	AS 4087	ANSI	AWWA	JIS	Hard rubber		Polyurethane	
[mm]	[inch]	[bar]			[lbs]			[mm]	[inch]	[mm]	[inch]
25	1"	PN 40	–	–	Cl. 150	–	20 K	–	–	24	0.94
32	–	PN 40	–	–	–	–	20 K	–	–	32	1.26
40	1½"	PN 40	–	–	Cl. 150	–	20 K	–	–	38	1.50
50	2"	PN 40	Table E	PN 16	Cl. 150	–	10 K	50	1.97	50	1.97
65	–	PN 16	–	–	–	–	10 K	66	2.60	66	2.60
80	3"	PN 16	Table E	PN 16	Cl. 150	–	10 K	79	3.11	79	3.11
100	4"	PN 16	Table E	PN 16	Cl. 150	–	10 K	102	4.02	102	4.02
125	–	PN 16	–	–	–	–	10 K	127	5.00	127	5.00
150	6"	PN 16	Table E	PN 16	Cl. 150	–	10 K	156	6.14	156	6.14
200	8"	PN 10	Table E	PN 16	Cl. 150	–	10 K	204	8.03	204	8.03
250	10"	PN 10	Table E	PN 16	Cl. 150	–	10 K	258	10.2	258	10.2
300	12"	PN 10	Table E	PN 16	Cl. 150	–	10 K	309	12.2	309	12.2
350	14"	PN 6	Table E	PN 16	Cl. 150	–	–	342	13.5	342	13.5
375	15"	–	–	PN 16	–	–	–	392	15.4	–	–
400	16"	PN 6	Table E	PN 16	Cl. 150	–	–	392	15.4	392	15.4
450	18"	PN 6	–	–	Cl. 150	–	–	437	17.2	437	17.2
500	20"	PN 6	Table E	PN 16	Cl. 150	–	–	492	19.4	492	19.4
600	24"	PN 6	Table E	PN 16	Cl. 150	–	–	594	23.4	594	23.4
700	28"	PN 6	–	–	–	Class D	–	692	27.2	692	27.2
–	30"	–	–	–	–	Class D	–	742	29.2	742	29.2
800	32"	PN 6	–	–	–	Class D	–	794	31.3	794	31.3
900	36"	PN 6	–	–	–	Class D	–	891	35.1	891	35.1
1000	40"	PN 6	–	–	–	Class D	–	994	39.1	994	39.1
–	42"	–	–	–	–	Class D	–	1043	41.1	1043	41.1
1200	48"	PN 6	–	–	–	Class D	–	1197	47.1	1197	47.1
–	54"		–	–	–	Class D	–	1339	52.7	–	–
1400	–	PN 6	–	–	–	–	–	1402	55.2	–	–
–	60"	–	–	–	–	Class D	–	1492	58.7	–	–
1600	–	PN 6	–	–	–	–	–	1600	63.0	–	–
–	66"	–	–	–	–	Class D	–	1638	64.5	–	–
1800	72"	PN 6	–	–	–	Class D	–	1786	70.3	–	–
2000	78"	PN 6	–	–	–	Class D	–	1989	78.3	–	–

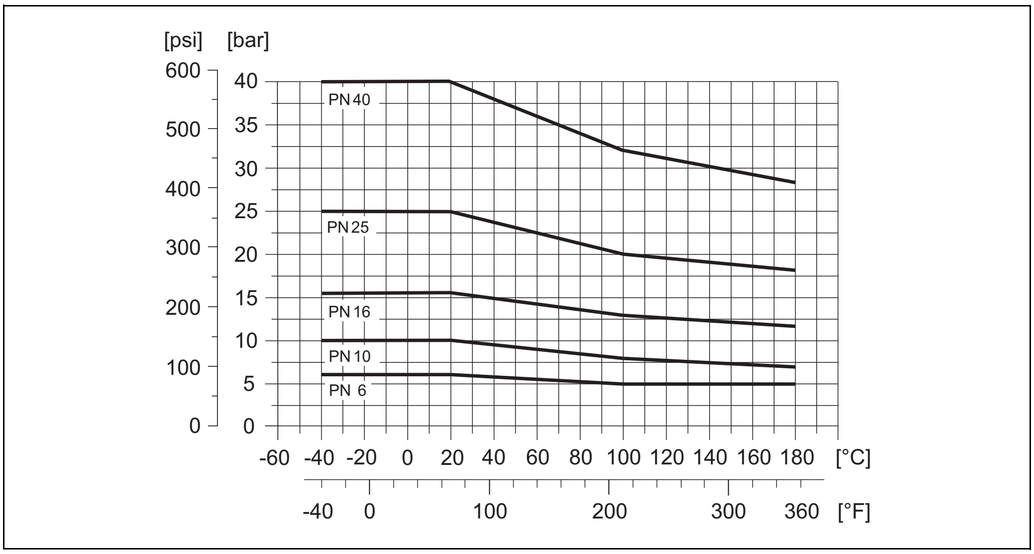
Material

- Transmitter housing
  - Compact housing: powder-coated die-cast aluminum
  - Wall-mount housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  - DN 350 to 2000 (14 to 78"): with protective lacquering
- Measuring tube
  - DN ≤ 300 (12"): stainless steel 1.4301 or 1.4306/304L;
    (for flanges made of carbon steel with Al/Zn protective coating)
  - DN ≥ 350 (14"): stainless steel 1.4301 or 1.4306/304L;
    (for flanges made of carbon steel with Al/Zn protective coating)
- Electrodes: 1.4435, Alloy C-22, Tantalum
- Flanges
  - EN 1092-1 (DIN 2501): 1.4571/316L; RSt37-2 (S235JRG2); C22; FE 410W B
    (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - ANSI: A105; F316L
    (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - AWWA: 1.0425
  - JIS: RSt37-2 (S235JRG2); HII; 1.0425/316L
    (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - AS 2129
    - DN 150 to 300, 600 (6 to 12", 24"): A105 or RSt37-2 (S235JRG2)
    - DN 50, 80, 100, 350, 400, 500 (2", 3", 4", 14", 16", 20"): A105 or St44-2 (S275JR)
  - AS 4087: A105 or St44-2 (S275JR)
- Seals: to DIN EN 1514-1
- Ground disks: 1.4435/316L, Alloy C-22, Tantalum

Material load diagram

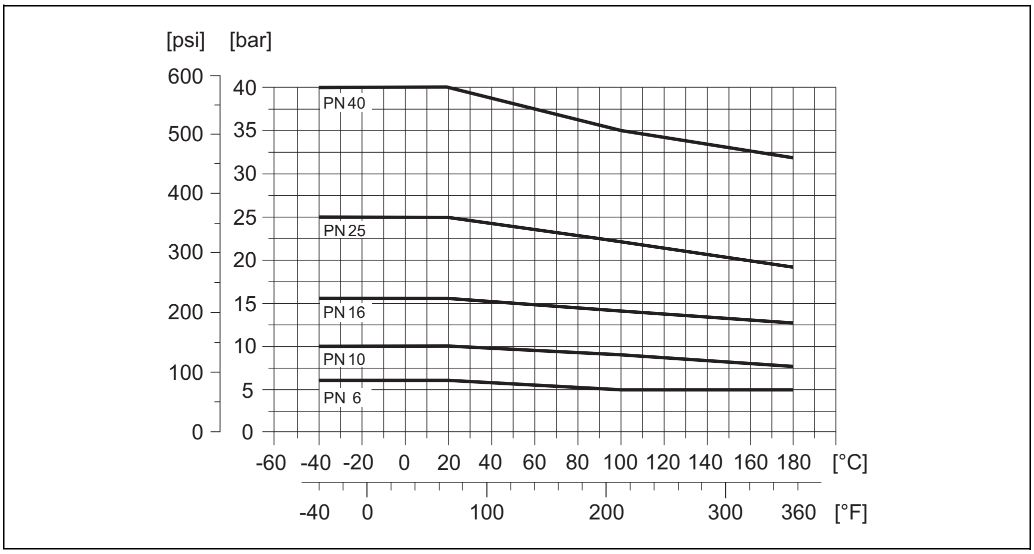
Caution!
The following diagrams contain material load diagrams (reference curves) for flange materials with regard to the medium temperature. However, the maximum medium temperatures permitted always depend on the lining material of the sensor and/or the sealing material (→ 21).

Flange connection to EN 1092-1 (DIN 2501)
Material: RSt37-2 (S235JRG2) / C22 / Fe 410W B



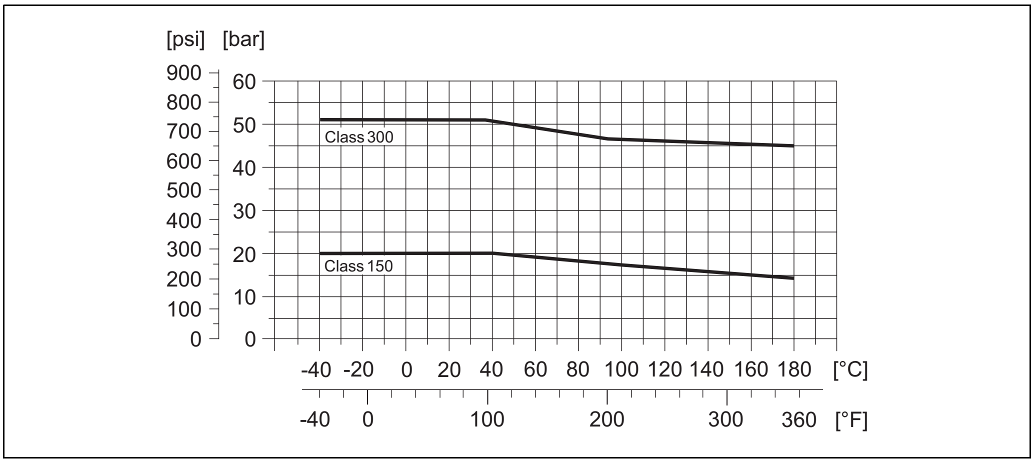
A0005594

Flange connection to EN 1092-1 (DIN 2501)
Material: 316L / 1.4571



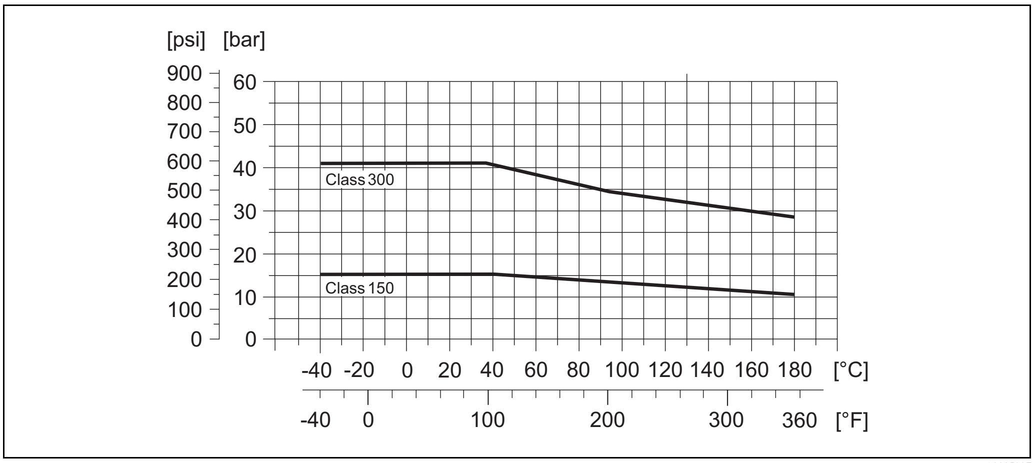
A0005304

Flange connection to ANSI B16.5
Material: A 105



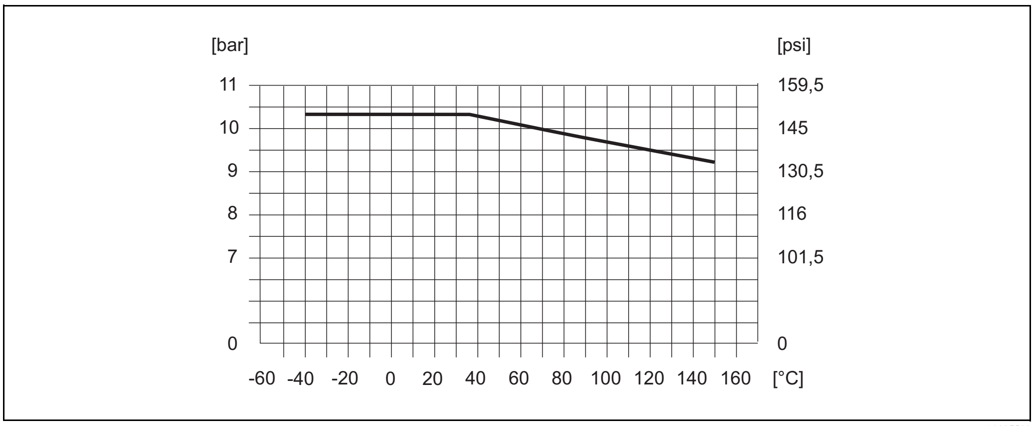
A0003226

Flange connection to ANSI B16.5
Material: F316L



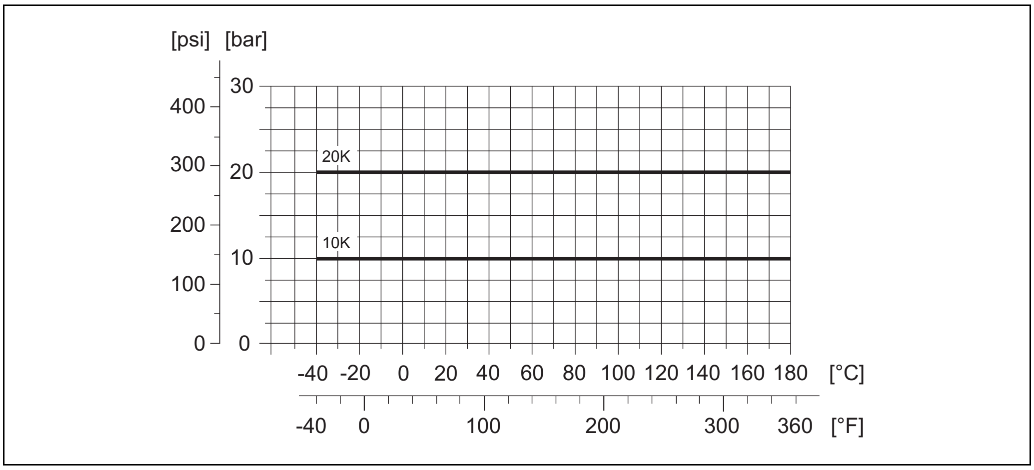
A0005307

Flange connection to AWWA C 207, Class D
Material: 1.0425



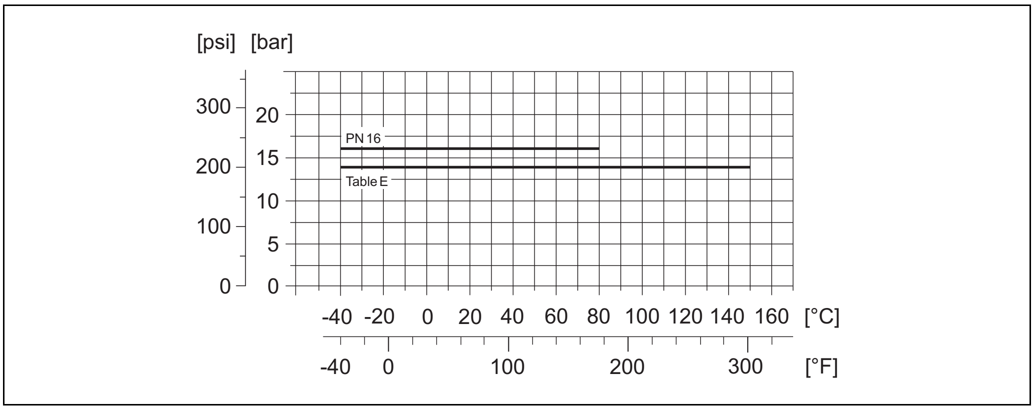
A0005592

Flange connection to JIS B2220
Material: RSt37-2 (S235JRG2) / HII / 1.0425 / 316L



A0003228

Flange connection to AS 2129 Table E or AS 4087 PN 16
Material: A105 / RSt37-2 (S235JRG2) / St44-2 (S275JR)



A0005595

Fitted electrodes	Measuring electrodes, reference electrodes and empty pipe detection electrodes: ▪ Standard available with 1.4435, Alloy C-22, tantalum ▪ Optional: exchangeable measuring electrodes made of 1.4435 (DN 350 to 2000 / 14 to 78")
Process connections	Flange connection: ▪ EN 1092-1 (DIN 2501), DN ≤ 300 (12") form A, DN ≥ 350 (14") form B (Dimensions to DIN 2501, DN 65 PN 16 and DN 600 (24") PN 16 exclusively to EN 1092-1) ▪ ANSI B16.5 ▪ AWWA C 207, Class D ▪ JIS B2220 ▪ AS 2129 Table E ▪ AS 4087 PN 16
Surface roughness	▪ Elektroden – 1.4435, Alloy C-22, tantal: ≤ 0.3 to 0.5 µm (≤ 11.8 to 19.7 µin) (all data refer to parts in contact with medium)

Human interface

Display elements	▪ Liquid crystal display: backlit, two lines (Promag 50) or four lines (Promag 53) with 16 characters per line ▪ Custom configurations for presenting different measured-value and status variables ▪ Totalizer – Promag 50: 2 totalizers – Promag 53: 3 totalizers
Operating elements	Unified operation concept for both types of transmitter: Promag 50: ▪ Local operation via three keys (−, +, E) ▪ Quick Setup menus for straightforward commissioning Promag 53: ▪ Local operation via three keys (−, +, E) ▪ Application-specific Quick Setup menus for straightforward commissioning
Language groups	Language groups available for operation in different countries: Promag 50, Promag 53: ▪ Western Europe and America (WEA): English, German, Spanish, Italian, French, Dutch, Portuguese ▪ Eastern Europe and Scandinavia (EES): English, Russian, Polish, Norwegian, Finnish, Swedish, Czech ▪ South and east Asia (SEA): English, Japanese, Indonesian Promag 53: ▪ China (CN): English, Chinese You can change the language group via the operating program "FieldCare".
Remote operation	▪ Promag 50: Remote control via HART, PROFIBUS DP/PA ▪ Promag 53: Remote control via HART, PROFIBUS DP/PA, MODBUS RS485, FOUNDATION Fieldbus

Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives.
Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-tick mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Pressure measuring device approval

Measuring devices 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. Where necessary (depending on the medium and process pressure), there are additional optional approvals to Category II/III for larger nominal diameters.

Ex approval

Information about currently available Ex versions (ATEX, IECEx, FM, CSA, NEPSI) can be supplied by your Endress+Hauser Sales Center on request. All explosion protection data are given in a separate documentation which is available upon request.

Other standards and guidelines

- EN 60529
  Degrees of protection by housing (IP code)
- EN 61010
  Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.
- IEC/EN 61326
  "Emission in accordance with requirements for Class A".
  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.
- 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 requirements for Electrical Equipment for Measurement and Control and Laboratory Use.
  Pollution degree 2, Installation Category II

FOUNDATION Fieldbus certification

The flow device has successfully passed all the test procedures carried out 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 5.01 (device certification number: on request)
- The device can also be operated with certified devices of other manufacturers
- Physical Layer Conformance Test of the Fieldbus Foundation

MODBUS RS485 certification

The measuring device meets all the requirements of the MODBUS/TCP conformity test and has the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "MODBUS/TCP Conformance Test Laboratory" of the University of Michigan.

PROFIBUS DP/PA certification

The flow device has successfully passed all the test procedures carried out and is certified and registered by the PNO (PROFIBUS User Organisation). 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)

Ordering information

Your Endress+Hauser service organization can provide detailed ordering information and information on the order codes on request.

Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Your Endress+Hauser service organization can provide detailed information on the order codes in question.

Documentation

- Flow Measurement (FA005D/06)
- Operating Instructions Promag Promag 50 (BA046D/06 and BA049D/06)
- Operating Instructions Promag Promag 50 PROFIBUS PA (BA055D/06 and BA056D/06)
- Operating Instructions Promag Promag 53 (BA047D/06 and BA048D/06)
- Operating Instructions Promag Promag 53 FOUNDATION Fieldbus (BA051D/06 and BA052D/06)
- Operating Instructions Promag Promag 53 MODBUS RS485 (BA117D/06 and BA118D/06)
- Operating Instructions Promag Promag 53 PROFIBUS DP/PA (BA053D/06 and BA054D/06)
- Supplementary documentation on Ex-ratings: ATEX, IECEx, FM, CSA, NEPSI

Registered trademarks

HART®
Registered trademark of the HART Communication Foundation, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS Nutzerorganisation e.V., Karlsruhe, D

FOUNDATION™ Fieldbus
Registered trademark of the Fieldbus Foundation, Austin, USA

MODBUS®
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HistoROM™, S-DAT®, T-DAT™, F-CHIP®, FieldCare®, Fieldcheck®, FieldXpert™, Applicator®
Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

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Endress+Hauser
People for Process Automation

TI046D/06/en/11.09
71106269
FM+SGML6.0 ProMoDo

ENDRESS+HAUSER PROMAG 53P

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Proline Promag 50P, 53P

Electromagnetic Flow Measuring System
Flow measurement of liquids in chemical or process applications

Application
Electromagnetic flowmeter for bidirectional measurement of liquids with a minimum conductivity of ≥ 5 µS/cm:

- Acid, alkalis
- Paints
- Pastes
- Water, wastewater etc.

- Flow measurement up to 9600 m^3/h (42268 gal/min)
- Fluid temperature up to +180 °C (356 °F)
- Process pressures up to 40 bar (580 psi)
- Lengths in accordance with DVGW/ISO

Application-specific lining materials:
- PTFE
- PFA

Approvals for hazardous area:
- ATEX
- IECEx
- FM
- CSA
- NEPSI
- TIIS

Connection to process control system:
- HART
- PROFIBUS DP/PA
- FOUNDATION Fieldbus
- MODBUS RS485

Your benefits
Promag measuring devices offer you cost-effective flow measurement with a high degree of accuracy for a wide range of process conditions.

The uniform Proline transmitter concept comprises:
- Modular device and operating concept resulting in a higher degree of efficiency
- Software options for batching, electrode cleaning and for measuring pulsating flow
- High degree of reliability and measuring stability
- Uniform operating concept

The tried-and-tested Promag sensors offer:
- No pressure loss
- Not sensitive to vibrations
- Simple installation and commissioning

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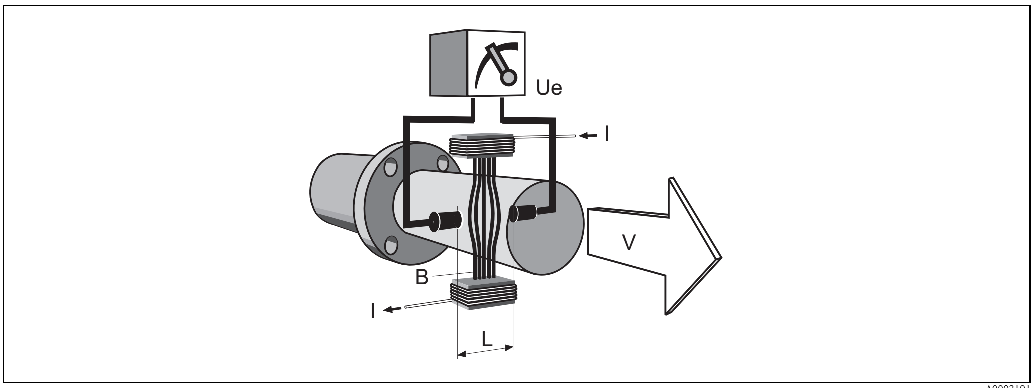
Endress+Hauser
People for Process Automation

Table of contents

Function and system design

Measuring principle

Following *Faraday's law of magnetic induction*, a voltage is induced in a conductor moving through a magnetic field.
In the electromagnetic measuring principle, the flowing medium is the moving conductor.
The voltage induced is proportional to the flow velocity and is supplied to the amplifier by means of two measuring electrodes. The flow volume is calculated by means of the pipe cross-sectional area.
The DC magnetic field is created through a switched direct current of alternating polarity.



A0003191

$Ue = B \cdot L \cdot v$
$Q = A \cdot v$

Ue *Induced voltage*
B *Magnetic induction (magnetic field)*
L *Electrode spacing*
v *Flow velocity*
Q *Volume flow*
A *Pipe cross-section*
I *Current strength*

Measuring system

The measuring system consists of a transmitter and a sensor.
Two versions are available:
- Compact version: Transmitter and sensor form a mechanical unit.
- Remote version: Sensor is mounted separate from the transmitter.

Transmitter:
- Promag 50 (user interface with push buttons for operation, two-line display, illuminated)
- Promag 53 ("Touch Control" without opening the housing, four-line display, unilluminated)

Sensor:
- Promag P (DN 15 to 600 / ½ to 24")

Input

Measured variable

Flow velocity (proportional to induced voltage)

Measuring ranges

Measuring ranges for liquids
Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy

Operable flow range

Over 1000 : 1

Input signal

Status input (auxiliary input)
- U = 3 to 30 V DC, R_i = 5 kΩ, galvanically isolated
- Configurable for: totalizer(s) reset, measured value suppression, error-message reset

Status input (auxiliary input) with PROFIBUS DP and MODBUS RS485
- U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated
- Switching level: 3 to 30 V DC, independent of polarity
- Configurable for: totalizer(s) reset, measured value suppression, error-message reset, batching start/stop (optional), batch totalizer reset (optional)

Current input (only Promag 53)
- active/passive selectable, galvanically isolated, full scale value selectable, resolution: 3 µA, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading)
- active: 4 to 20 mA, $R_i \leq 150$ Ω, max. 24 V DC, short-circuit-proof
- passive: 0/4 to 20 mA, $R_i < 150$ Ω, max. 30 V DC

Output

Output signal

Promag 50

Current output
active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s),
full scale value selectable, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading), resolution: 0.5 µA
- active: 0/4 to 20 mA, $R_L < 700$ Ω (HART: $R_L \geq 250$ Ω)
- passive: 4 to 20 mA, operating voltage V_S: 18 to 30 V DC, $R_i \geq 150$ Ω

Pulse/frequency output
passive, open collector, 30 V DC, 250 mA, galvanically isolated
- Frequency output: full scale frequency 2 to 1000 Hz (f_{max} = 1250 Hz), on/off ratio 1:1, pulse width max. 10s
- Pulse output: pulse value and pulse polarity selectable, max. pulse width configurable (0.5 to 2000 ms)

PROFIBUS DP interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- Profil version 3.0
- Data transmission rate: 9,6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Function blocks: 1 × analog Input, 1 × totalizer
- Output data: volume flow, totalizer
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

PROFIBUS PA interface
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- Profil version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Function blocks: 1 × analog input, 2 × totalizer
- Output data: volume flow, totalizer
- Input data: positive zero return (ON/OFF), control totalizer, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

Promag 53

Current output
active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s),
full scale value selectable, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading), resolution: 0.5 µA
- active: 0/4 to 20 mA, R_L < 700 Ω (HART: R_L ≥ 250 Ω)
- passive: 4 to 20 mA, operating voltage V_S: 18 to 30 V DC, R_i ≥ 150 Ω

Pulse/frequency output
active/passive selectable, galvanically isolated (Ex i version: only passive)
- active: 24 V DC, 25 mA (max. 250 mA during 20 ms), R_L > 100 Ω
- passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2 to 10000 Hz (f_{max} = 12500 Hz), EEx-ia: 2 to 5000 Hz; on/off ratio 1:1, pulse width max. 10 s
- Pulse output: pulse value and pulse polarity selectable, max. pulse width configurable (0.05 to 2000 ms)

PROFIBUS DP interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- Profil version 3.0
- Data transmission rate: 9,6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Function blocks: 2 × analog Input, 3 × totalizer
- Output data: volume flow, calculated mass flow, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device
- Available output combination → 🗎 8

PROFIBUS PA interface
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- Profil version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Function blocks: 2 × analog input, 3 × totalizer
- Output data: volume flow, calculated mass flow, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

MODBUS RS485 interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- MODBUS device type: Slave
- Adress range: 1 to 247
- Bus address adjustable via miniature switches or local display (optional) at the measuring device
- Supported MODBUS function codes: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Übertragungsmodus: RTU oder ASCII
- Supported baudrate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Response time:
  – Direct data access = typically 25 to 50 ms
  – Auto-scan buffer (data range) = typically 3 to 5 ms
- Available output combination → 🗎 8

FOUNDATION Fieldbus interface
- FOUNDATION Fieldbus H1
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- ITK version 5.01
- Current consumption: 12 mA
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Bus connection with integrated reverse polarity protection
- Function blocks:
  - 5 × Analog Input (execution time: 18 ms each)
  - 1 × PID (25 ms)
  - 1 × Digital Output (18 ms)
  - 1 × Signal Characterizer (20 ms)
  - 1 × Input Selector (20 ms)
  - 1 × Arithmetic (20 ms)
  - 1 × Integrator (18 ms)
- Output data: volume flow, calculated mass flow, temperature, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), reset totalizer
- Link Master (LM) functionality is supported

Signal on alarm

- Current output → failure response selectable (e.g. in accordance with NAMUR recommendation NE 43)
- Pulse/frequency output → failure response selectable
- Status output (Promag 50) → non-conductive by fault or power supply failure
- Relay output (Promag 53) → de-energized by fault or power supply failure

Load

see "Output signal"

Low flow cutoff

Switch points for low flow cutoff are selectable.

Galvanic isolation

All circuits for inputs, outputs and power supply are galvanically isolated from each other.

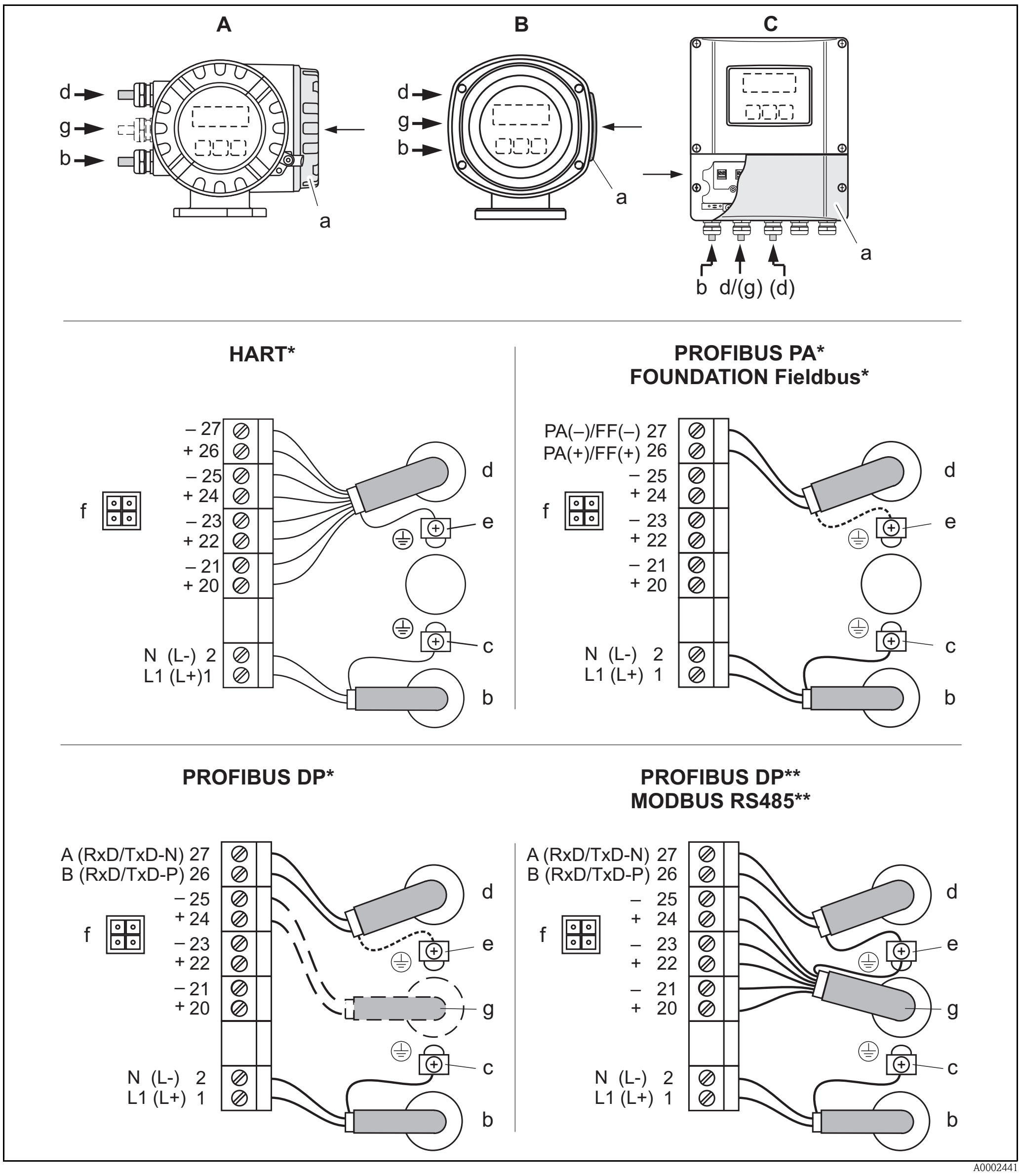
Switching output

Status output (Promag 50, Promag 53)
Open collector, max. 30 V DC / 250 mA, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values.

Relay outputs (Promag 53)
Normally closed (NC or break) or normally open (NO or make) contacts available
(default: relay 1 = NO, relay 2 = NC), max. 30 V / 0,5 A AC ; 60 V / 0,1 A DC, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values, batching contacts.

Power supply

Electrical connection, measuring unit



Connecting the transmitter, cable cross-section max. 2.5 mm² (14 AWG)

A	*View A (field housing)*
B	*View B (stainless steel field housing)*
C	*View C (wall-mount housing)*

**)*	*fixed communication boards*
***)*	*flexible communication boards*
a	*Connection compartment cover*
b	*Cable for power supply: 85 to 260 V AC / 20 to 55 V AC / 16 to 62 V DC* *- Terminal No. 1: L1 for AC, L+ for DC* *- Terminal No. 2: N for AC, L– for DC*
c	*Ground terminal for protective conductor*
d	*Signal cable: see "Electrical connection, terminal assignment" → 📄 8* *Fieldbus cable:* *- Terminal No. 26: DP (B) / PA + / FF + / MODBUS RS485 (B) / (PA, FF: with polarity protection)* *- Terminal No. 27: DP (A) / PA – / FF – / MODBUS RS485 (A) / (PA, FF: with polarity protection)*
e	*Ground terminal for signal cable shield / Fieldbus cable / RS485 line*
f	*Service adapter for connecting service interface FXA193 (Fieldcheck, FieldCare)*
g	*Signal cable: see "Electrical connection, terminal assignment" → 📄 8* *Cable for external termination (only for PROFIBUS DP with fixed assignment communication board):* *- Terminal No. 24: +5 V* *- Terminal No. 25: DGND*

Electrical connection, terminal assignment

Terminal assignment, Promag 50

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
50***-***********W	–	–	–	Current output HART
50***-***********A	–	–	Frequency output	Current output HART
50***-***********D	Status input	Status output	Frequency output	Current output HART
50***-***********H	–	–	–	PROFIBUS PA
50***-***********J	–	–	+5 V (external termination)	PROFIBUS DP
50***-***********S	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART
50***-***********T	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART

Ground terminal → 🗎 7

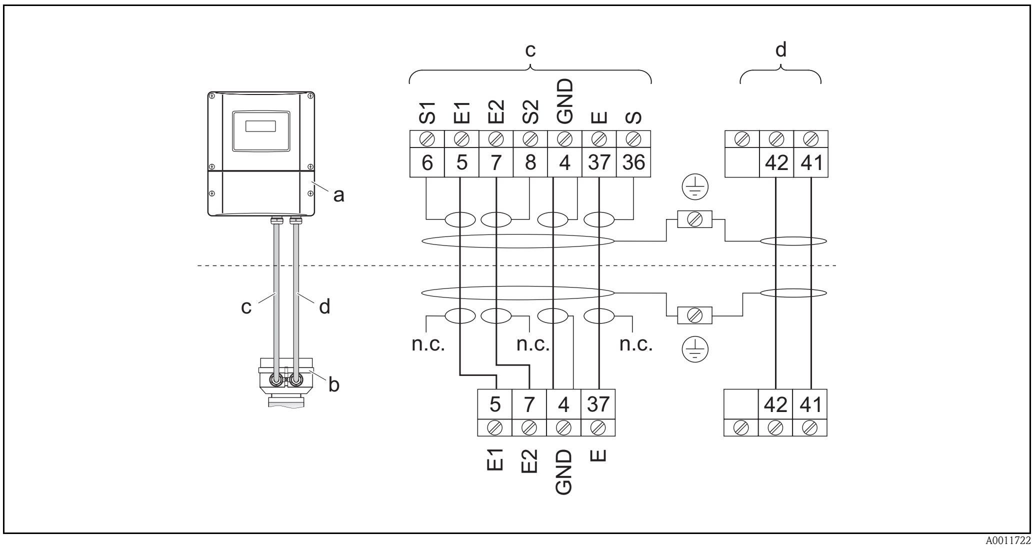
Terminal assignment, Promag 53

The inputs and outputs on the communication board can be either permanently assigned or variable, depending on the version ordered (see table). Replacements for modules which are defective or which have to be replaced can be ordered as accessories.

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
Fixed communication boards (fixed assignment)				
53***-***********A	–	–	Frequency output	Current output HART
53***-***********B	Relay output 2	Relay output 1	Frequency output	Current output HART
53***-***********F	–	–	–	PROFIBUS PA, Ex i
53***-***********G	–	–	–	FOUNDATION Fieldbus, Ex i
53***-***********H	–	–	–	PROFIBUS PA
53***-***********J	–	–	–	PROFIBUS DP
53***-***********K	–	–	–	FOUNDATION Fieldbus
53***-***********Q	–	–	Status input	MODBUS RS485
53***-***********S	–	–	Frequency output, Ex i	Current output, Ex i, passive, HART
53***-***********T	–	–	Frequency output, Ex i	Current output, Ex i, passive, HART
Flexible communication boards				
53***-***********C	Relay output 2	Relay output 1	Frequency output	Current output HART
53***-***********D	Status input	Relay output	Frequency output	Current output HART
53***-***********L	Status input	Relay output 2	Relay output 1	Current output HART
53***-***********M	Status input	Frequency output	Frequency output	Current output HART
53***-***********N	Current output	Frequency output	Status input	MODBUS RS485
53***-***********P	Current output	Frequency output	Status input	PROFIBUS DP
53***-***********V	Relay output 2	Relay output 1	Status input	PROFIBUS DP
53***-***********2	Relay output	Current output	Frequency output	Current output HART
53***-***********4	Current input	Relay output	Frequency output	Current output HART
53***-***********5	Status input	Current input	Frequency output	Current output HART
53***-***********7	Relay output 2	Relay output 1	Status input	MODBUS RS485

Ground terminal → 🗎 7

Electrical connection, remote version



Connecting the remote version

a *Wall-mount housing connection compartment*
b *Sensor connection housing cover*
c *Signal cable*
d *Coil current cable*
n.c. *Not connected, insulated cable shields*
Terminal no. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

Supply voltage (power supply)

- 85 to 260 V AC, 45 to 65 Hz
- 20 to 55 V AC, 45 to 65 Hz
- 16 to 62 V DC

PROFIBUS PA and FOUNDATION Fieldbus
- Non-Ex: 9 to 32 V DC
- Ex i: 9 to 24 V DC
- Ex d: 9 to 32 V DC

Cable entry

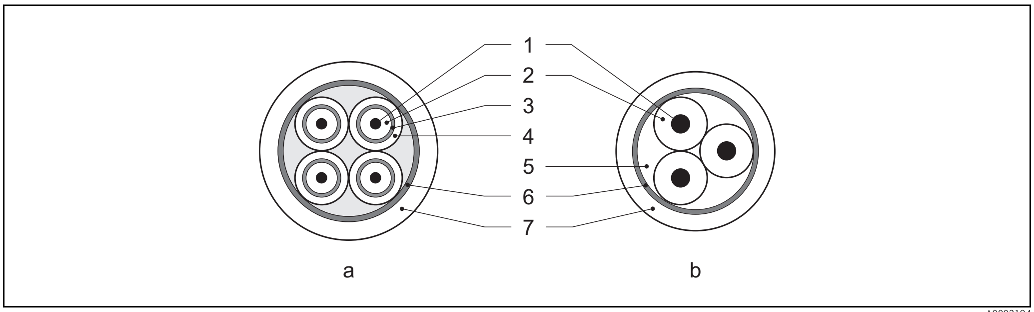
Power supply and signal cables (inputs/ outputs):
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Sensor cable entry for armoured cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entries, ½" NPT, G ½"

Connecting cable for remote version:
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Sensor cable entry for armoured cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entries, ½" NPT, G ½"

Remote version cable specifications

Coil cable
- 2 × 0.75 mm^2 (18 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28")
- Conductor resistance: ≤ 37 Ω/km (≤ 0.011 Ω/ft)
- Capacitance core/core, shield grounded: ≤ 120 pF/m (≤ 37 pF/ft)
- Operating temperature: –20 to +80 °C (–68 to +176 °F)
- Cable cross-section: max. 2.5 mm^2 (14 AWG)
- Test voltage for cable insulation: ≤ 1433 AC r.m.s. 50/60 Hz or ≥ 2026 V DC

Signal cable
- 3 × 0.38 mm^2 (20 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28") and individual shielded cores
- With empty pipe detection (EPD): 4 × 0.38 mm^2 (20 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28") and individual shielded cores
- Conductor resistance: ≤ 50 Ω/km (≤ 0.015 Ω/ft)
- Capacitance core/shield: ≤ 420 pF/m (≤ 128 pF/ft)
- Operating temperature: –20 to +80 °C (–68 to +176 °F)
- Cable cross-section: max. 2.5 mm^2 (14 AWG)



a *Signal cable*
b *Coil current cable*

1 *Core*
2 *Core insulation*
3 *Core shield*
4 *Core jacket*
5 *Core reinforcement*
6 *Cable shield*
7 *Outer jacket*

Operation in zones of severe electrical interference
The measuring device complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of IEC/EN 61326 and NAMUR recommendation NE 21.

Caution!
Grounding is by means of the ground terminals provided for the purpose inside the connection housing. Ensure that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible.

Power consumption

- AC: < 15 VA (incl. sensor)
- DC: < 15 W (incl. sensor)

Switch-on current:
- Max. 3 A (< 5 ms) for 260 V AC
- Max. 13.5 A (< 50 ms) for 24 V DC

Power supply failure

Lasting min. ½ cycle frequency: EEPROM saves measuring system data
- EEPROM or T-DAT (Promag 53 only) retain the measuring system data in the event of a power supply failure
- S-DAT: exchangeable data storage chip which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point etc.)

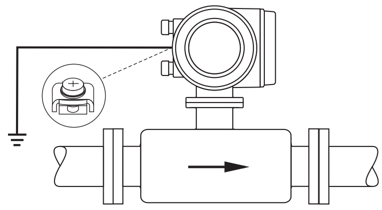
Potential equalization

⚠ Warning!
The measuring system must be included in the potential equalization.

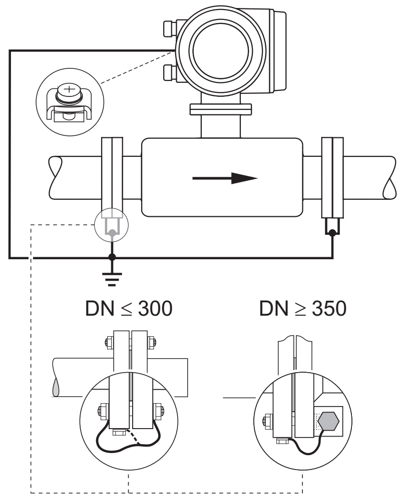
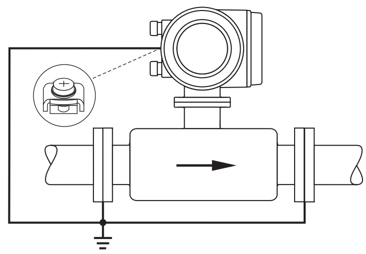
Perfect measurement is only ensured when the fluid and the sensor have the same electrical potential. This is ensured by the reference electrode integrated in the sensor as standard.

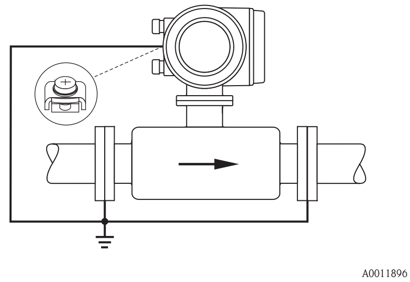
The following should also be taken into consideration for potential equalization:
- Internal grounding concepts in the company
- Operating conditions, such as the material/ grounding of the pipes (see table)

Standard situation

Operating conditions	Potential equalization
When using the measuring device in a: ▪ Metal, grounded pipe Potential equalization takes place via the ground terminal of the transmitter. ✎ Note! When installing in metal pipes, we recommend you connect the ground terminal of the transmitter housing with the piping.	 A0011892 *Via the ground terminal of the transmitter*

Special situations

Operating conditions	Potential equalization
When using the measuring device in a: ▪ Metal pipe that is not grounded This connection method also applies in situations where: ▪ Customary potential equalization cannot be ensured. ▪ Excessively high equalizing currents can be expected. Both sensor flanges are connected to the pipe flange by means of a ground cable (copper wire, at least 6 mm² / 0.0093 in²) and grounded. Connect the transmitter or sensor connection housing, as applicable, to ground potential by means of the ground terminal provided for the purpose. ▪ DN ≤ 300 (12"): the ground cable is mounted directly on the conductive flange coating with the flange screws. ▪ DN ≥ 350 (14"): the ground cable is mounted directly on the transportation metal support. ✎ Note! The ground cable for flange-to-flange connections can be ordered separately as an accessory from Endress+Hauser.	 A0011893 *Via the ground terminal of the transmitter and the flanges of the pipe*
When using the measuring device in a: ▪ Plastic pipe ▪ Pipe with insulating lining This connection method also applies in situations where: ▪ Customary potential equalization cannot be ensured. ▪ Excessively high equalizing currents can be expected. Potential equalization takes place using additional ground disks, which are connected to the ground terminal via a ground cable (copper wire, at least 6 mm² / 0.0093 in²). When installing the ground disks, please comply with the enclosed Installation Instructions.	 A0011895 *Via the ground terminal of the transmitter and the optionally available ground disks*

Operating conditions	**Potential equalization**
When using the measuring device in a: ■ Pipe with a cathodic protection unit The device is installed potential-free in the pipe. Only the two flanges of the pipe are connected with a ground cable (copper wire, at least 6 mm² / 0.0093 in²). Here, the ground cable is mounted directly on the conductive flange coating with flange screws. Note the following when installing: ■ The applicable regulations regarding potential-free installation must be observed. ■ There should be **no** electrically conductive connection between the pipe and the device. ■ The mounting material must withstand the applicable torques.	 *Potential equalization and cathodic protection* *1 Power supply isolation transformer* *2 Electrically isolated*

Performance characteristics

Reference operating conditions

As per DIN EN 29104 and VDI/VDE 2641:
- Fluid temperature: +28 °C ± 2 K (+82 °F ± 2 K)
- Ambient temperature: +22 °C ±2 K (+72 °F ± 2 K)
- Warm-up period: 30 minutes

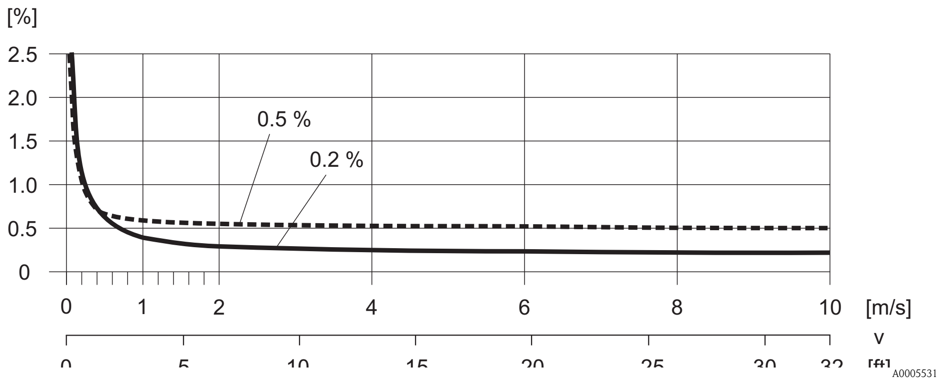
Installation conditions:
- Inlet run > 10 × DN
- Outlet run > 5 × DN
- Sensor and transmitter grounded.
- The sensor is centered in the pipe.

Maximum measured error

Promag 50:
- Current output: also typically ± 5 µA
- Pulse output: ±0.5% o.r. ± 1 mm/s (±0.5% o.r. ± 0.04 in/s)
  optional: ±0.2% o.r. ± 2 mm/s (±0.2% o.r. ± 0.08 in/s) (o.r. = of reading)

Promag 53:
- Current output: also typically ± 5 µA
- Pulse output: ±0.2% o.r. ± 2 mm/s (±0.2% o.r. ± 0.08 in/s) (o.r. = of reading)

Fluctuations in the supply voltage do not have any effect within the specified range.



Max. measured error in % of reading

Repeatability

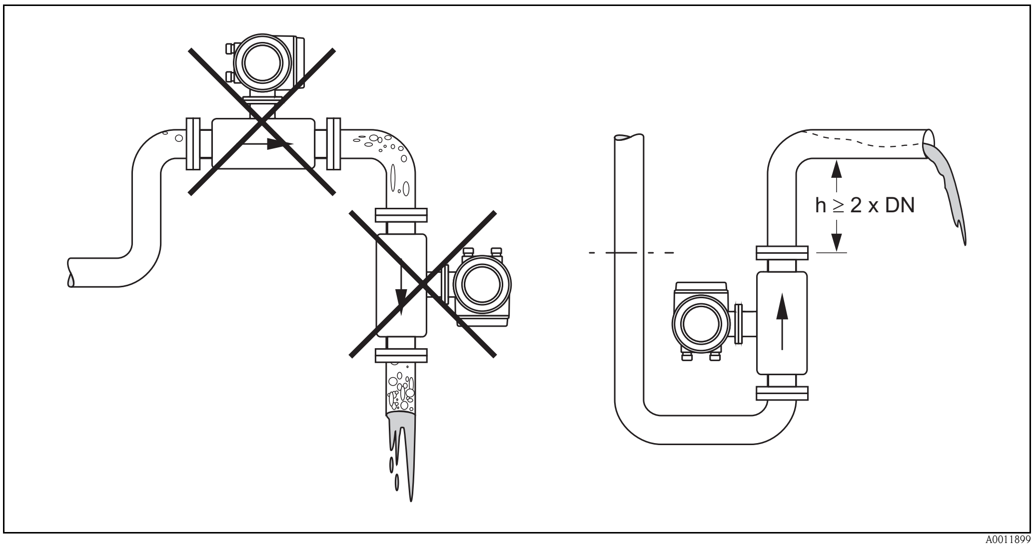
Max. ±0.1% o.r. ± 0.5 mm/s (±0.1% o.r. ± 0.02 in/s) (o.r. = of reading)

Operating conditions: Installations

Installation instructions

Mounting location

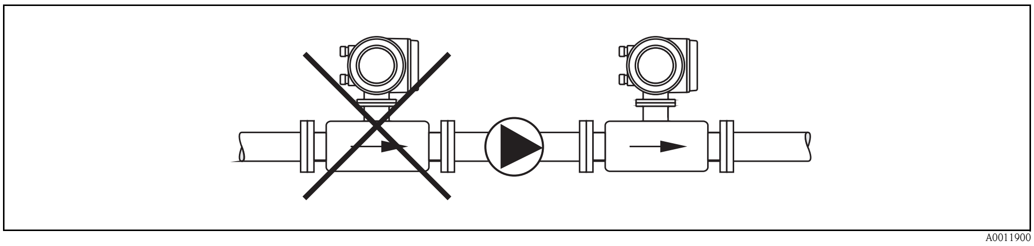
Entrained air or gas bubble formation in the measuring tube can result in an increase in measuring errors.
Avoid the following installation locations in the pipe:
- Highest point of a pipeline. Risk of air accumulating!
- Directly upstream from a free pipe outlet in a vertical pipeline.



Mounting location

Installation of pumps

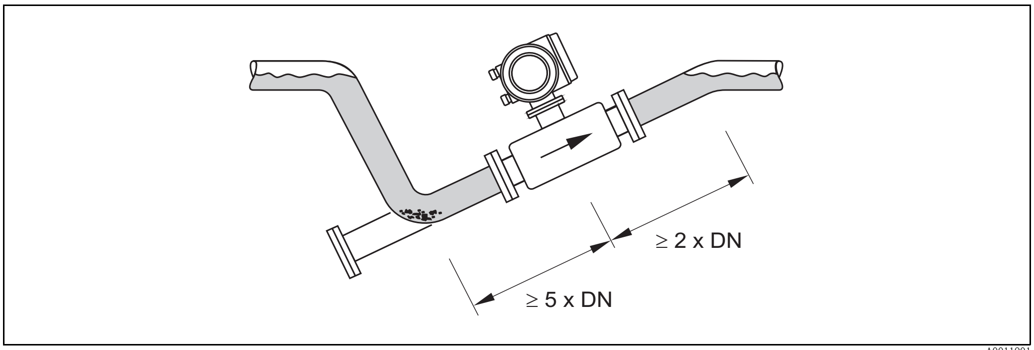
Sensors may not be installed on the pump suction side. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. Information on the pressure tightness of the measuring tube lining → 🗎 22, Section "Pressure tightness".
Pulsation dampers may be needed when using piston pumps, piston diaphragm pumps or hose pumps. Information on the shock and vibration resistance of the measuring system → 🗎 20, Section "Shock and vibration resistance".



Installation of pumps

Partially filled pipes
Partially filled pipes with gradients necessitate a drain-type configuration.
The empty pipe detection function (EPD) provides additional security in detecting empty or partially filled pipes.

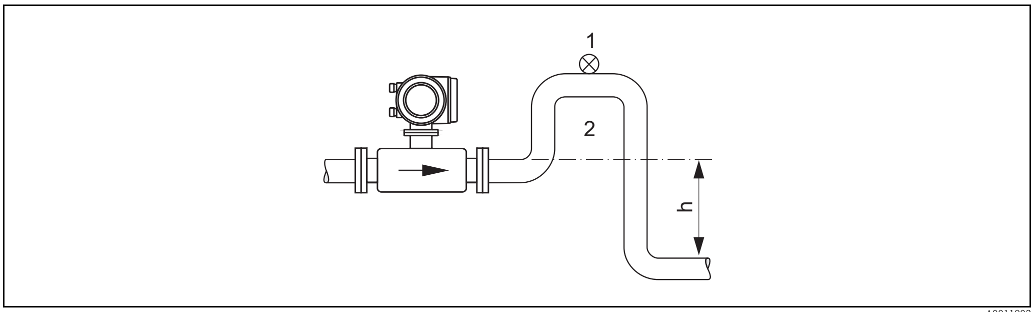
Caution!
Risk of solids accumulating. Do not install the sensor at the lowest point in the drain. It is advisable to install a cleaning valve.



A0011901

Installation with partially filled pipes

Down pipes
Install a siphon or a vent valve downstream of the sensor in down pipes h ≥ 5 m (16.4 ft). This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. This measure also prevents the liquid current stopping in the pipe which could cause air locks. Information on the pressure tightness of the measuring tube lining → 22, Section "Pressure tightness".



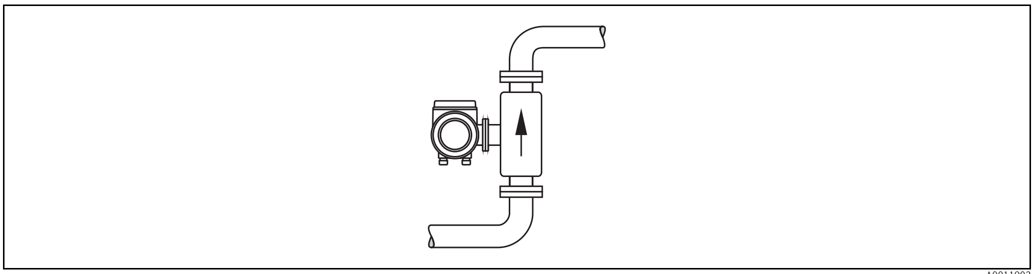
A0011902

Installation measures for vertical pipes

1 Vent valve
2 Pipe siphon
h Length of the down pipe

Orientation
An optimum orientation helps avoid gas and air accumulations and deposits in the measuring tube. However, the measuring device also offers the additional function of empty pipe detection (EPD) for detecting partially filled measuring tubes or if outgassing fluids or fluctuating operating pressures are present.

Vertical orientation
This is the ideal orientation for self-emptying piping systems and for use in conjunction with empty pipe detection.

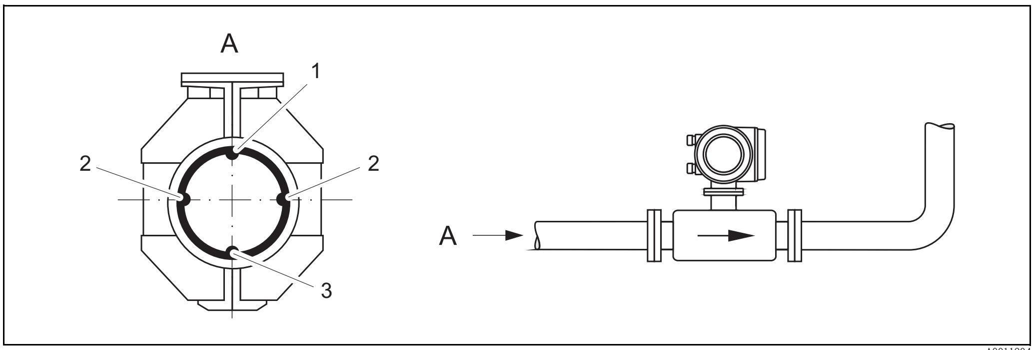


A0011903

Vertical orientation

Horizontal orientation
The measuring electrode axis should be horizontal. This prevents brief insulation of the two measuring electrodes by entrained air bubbles.

Caution!
Empty pipe detection only works correctly with horizontal orientation if the transmitter housing is facing upwards. Otherwise there is no guarantee that empty pipe detection will respond if the measuring tube is only partially filled or empty.



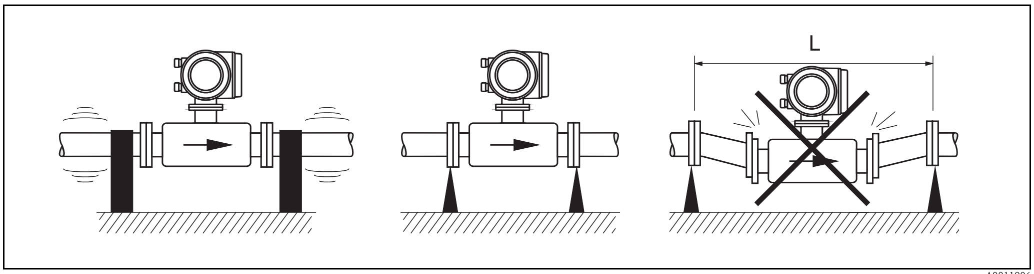
A0011904

Horizontal orientation

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Vibrations
Secure the piping and the sensor if vibration is severe.

Caution!
If vibrations are too severe, we recommend the sensor and transmitter be mounted separately. Information on the permitted shock and vibration resistance → 🗎 20, Section "Shock and vibration resistance".



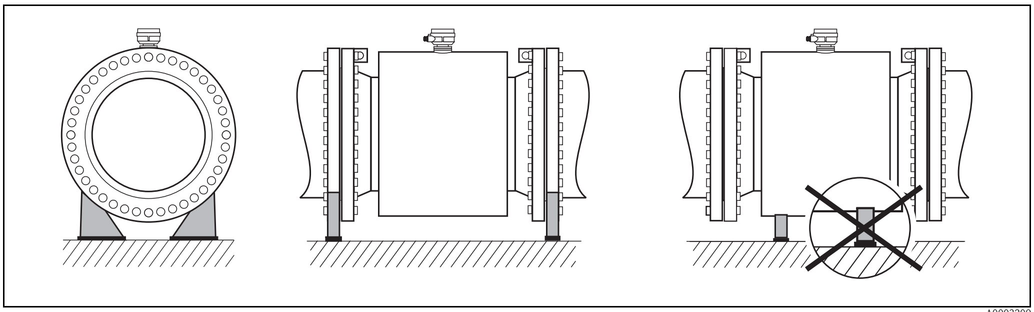
A0011906

Measures to prevent vibration of the measuring device

L > 10 m (33 ft)

Foundations, supports
If the nominal diameter is DN ≥ 350, mount the transmitter on a foundation of adequate load-bearing strength.

Caution!
Do not allow the casing to take the weight of the sensor. This would buckle the casing and damage the internal magnetic coils.

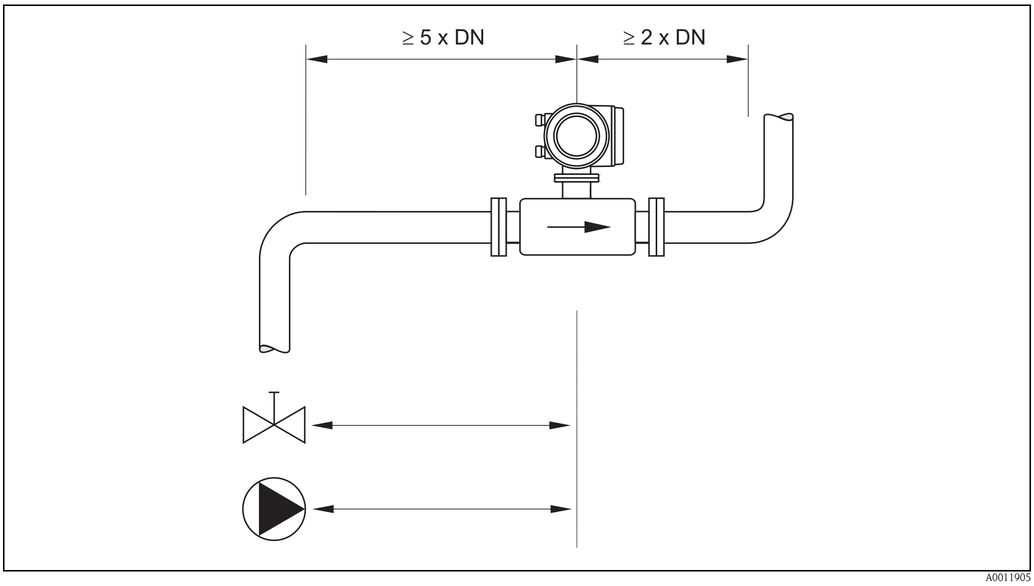


A0003209

Inlet and outlet run

If possible, install the sensor well clear of assemblies such as valves, T-pieces, elbows etc.

Note the following inlet and outlet runs to comply with measuring accuracy specifications:
- Inlet run: ≥ 5 × DN
- Outlet run: ≥ 2 × DN



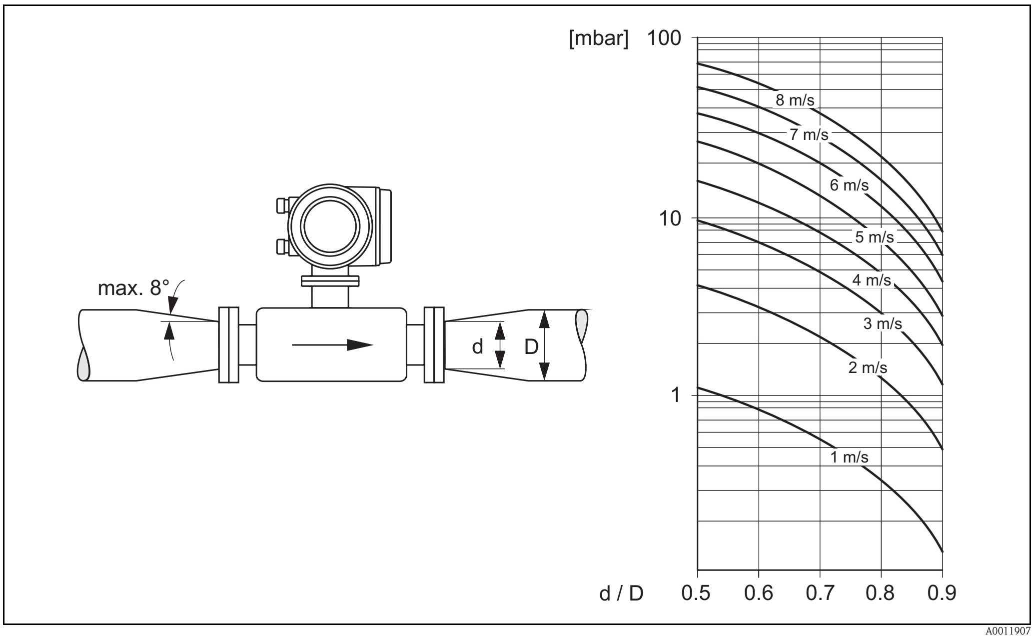
Inlet and outlet run

Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids. The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders.

Note!
The nomogram only applies to liquids of viscosity similar to water.

1. Calculate the ratio of the diameters d/D.
2. From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

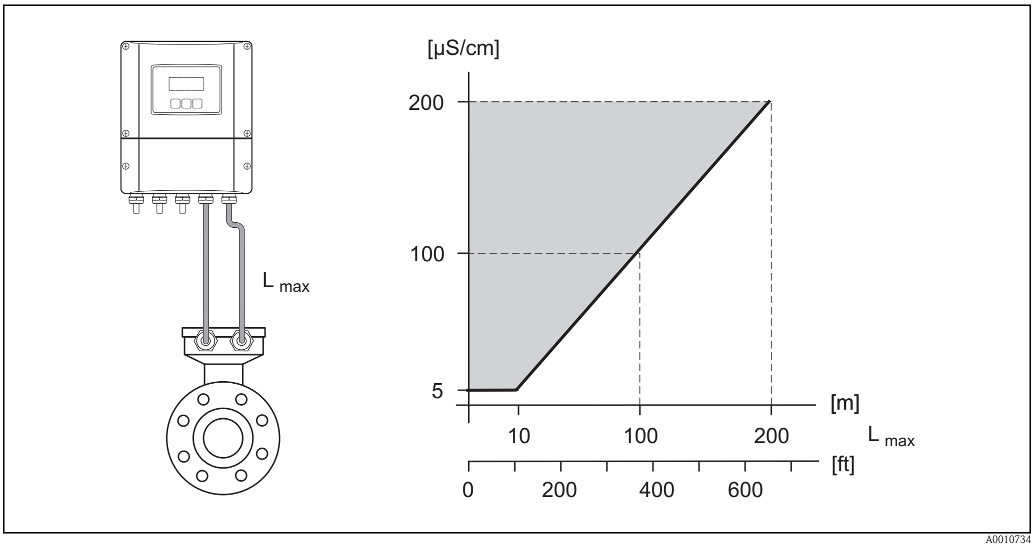


Pressure loss due to adapters

Length of connecting cable

When mounting the remote version, please note the following to achieve correct measuring results:

- Fix cable run or lay in armored conduit. Cable movements can falsify the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- If necessary, ensure potential equalization between sensor and transmitter.
- The permitted cable length L_{max} is determined by the fluid conductivity. A minimum conductivity of 20 µS/cm is required for measuring demineralized water.
- When the empty pipe detection function is switched on (EPD), the maximum connecting cable length is 10 m (33 ft).



Permitted length of connecting cable for remote version
Area marked in gray = permitted range; L_{max} = length of connecting cable in [m] ([ft]); fluid conductivity in [µS/cm]

Operating conditions: Environment

Ambient temperature range

Transmitter
- Standard: –20 to +60 °C (–4 to +140 °F)
- Optional: –40 to +60 °C (–40 to +140 °F)

Note!
At ambient temperatures below –20 °C (–4 °F)the readability of the display may be impaired.

Sensor
- Flange material carbon steel: –10 to +60 °C (+14 to +140 °F)
- Flange material stainless steel: –40 to +60 °C (–40 to +140 °F)

Caution!
The permitted temperature range of the measuring tube lining may not be undershot or overshot → 21, Section "Medium temperature range".

Please note the following points:
- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions.
- The transmitter must be mounted separate from the sensor if both the ambient and fluid temperatures are high.

Storage temperature

The storage temperature corresponds to the operating temperature range of the measuring transmitter and the appropriate measuring sensors.

Caution!
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- A storage location must be selected where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the liner.
- Do not remove the protective plates or caps on the process connections until the device is ready to install.

Degree of protection

- Standard: IP 67 (NEMA 4X) for transmitter and sensor.
- Optional: IP 68 (NEMA 6P) for sensor for remote version.
- For information regarding applications where the device is buried directly in the soil or is installed in a flooded wastewater basin please contact your local Endress+Hauser Sales Center.

Shock and vibration resistance

Acceleration up to 2 g following IEC 600 68-2-6

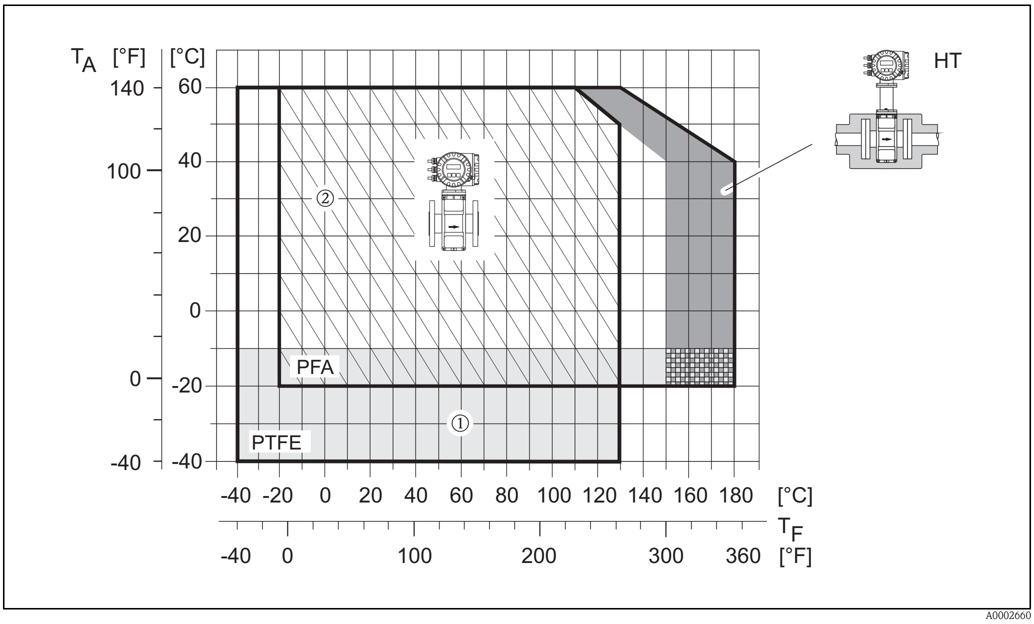
Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR recommendation NE 21.

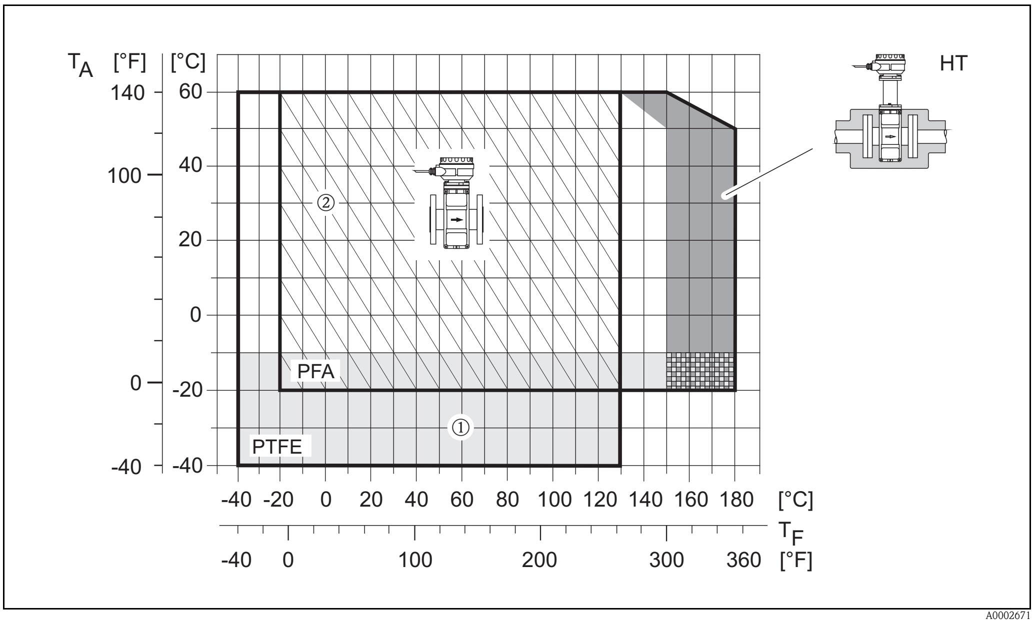
Operating conditions: Process

Medium temperature range

The permitted temperature depends on the lining of the measuring tube:
- PTFE: –40 to +130 °C (–40 to +266 °F) (DN 15 to 600 / ½ to 24"), restrictions → see diagrams
- PFA: –20 to +180 °C (–4 to +356 °F) (DN 25 to 200 / 1 to 8"), restrictions → see diagrams



Compact version (with PFA or PTFE lining)
T_A = Ambient temperature, T_F = Fluid temperature, HT = High temperature version with insulatio
① Gray shaded area → temperature range from –10 to –40 °C (–14 to –40 °F) applies only to stainless steel flanges
② HE + IP 68 to 130 °C (266 °F) only



Remote version (with PFA or PTFE lining)
T_A = Ambient temperature, T_F = Fluid temperature, HT = High temperature version with insulatio
① Gray shaded area → temperature range from –10 to –40 °C (–14 to –40 °F) applies only to stainless steel flanges
② HE + IP 68 to 130 °C (266 °F) only

Conductivity

The minimum conductivity is:
- ≥ 5 µS/cm for fluids generally
- ≥ 20 µS/cm for demineralized water

Note!
In the remote version, the necessary minimum conductivity also depends on the cable length (→ 🗎 19, Section "Length of connecting cable").

Medium pressure range (nominal pressure)

- EN 1092-1 (DIN 2501)
  - PN 10 (DN 200 to 600 / 8 to 24")
  - PN 16 (DN 65 to 600 / 3 to 24")
  - PN 25 (DN 200 to 600 / 8 to 24")
  - PN 40 (DN 15 to 150 / ½ to 6")
- ANSI B 16.5
  - Class 150 (DN ½ to 24")
  - Class 300 (DN ½ to 6")
- JIS B2220
  - 10 K (DN 50 to 300 / 2 to 12")
  - 20 K (DN 15 to 300 / ½ to 12")
- AS 2129
  - Table E (DN 25, 50 / 1", 2")
- AS 4087
  - PN 16 (DN 50 / 2")

Pressure tightness

Measuring tube lining: PTFE

Nominal diameter		Limit values for abs. pressure [mbar] ([psi]) at fluid temperatures:							
		25 °C (77 °F)		80 °C (176 °F)		100 °C (212 °F)		130 °C (266 °F)	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]	[mbar]	[psi]	[mbar]	[psi]
15	½"	0	0	0	0	0	0	100	1.45
25	1"	0	0	0	0	0	0	100	1.45
32	–	0	0	0	0	0	0	100	1.45
40	1½"	0	0	0	0	0	0	100	1.45
50	2"	0	0	0	0	0	0	100	1.45
65	–	0	0	*	*	40	0.58	130	1.89
80	3"	0	0	*	*	40	0.58	130	1.89
100	4"	0	0	*	*	135	1.96	170	2.47
125	–	135	1.96	*	*	240	3.48	385	5.58
150	6"	135	1.96	*	*	240	3.48	385	5.58
200	8"	200	2.90	*	*	290	4.21	410	5.95
250	10"	330	4.79	*	*	400	5.80	530	7.69
300	12"	400	5.80	*	*	500	7.25	630	9.14
350	14"	470	6.82	*	*	600	8.70	730	10.6
400	16"	540	7.83	*	*	670	9.72	800	11.6
450	18"	Partial vacuum is impermissible!							
500	20"								
600	24"								

* No value can be specified.

Measuring tube lining: PFA

Nominal diameter		Limit values for abs. pressure [mbar] ([psi]) at fluid temperatures:					
		25 °C (77 °F)		80 °C (176 °F)		100 to 180 °C (212 to 356 °F)	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]	[mbar]	[psi]
25	1"	0	0	0	0	0	0
32	–	0	0	0	0	0	0
40	1½"	0	0	0	0	0	0
50	2"	0	0	0	0	0	0
65	–	0	0	*	*	0	0
80	3"	0	0	*	*	0	0
100	4"	0	0	*	*	0	0
125	–	0	0	*	*	0	0
150	6"	0	0	*	*	0	0
200	8"	0	0	*	*	0	0

* No value can be specified.

Limiting flow

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor.
The optimum flow velocity is between 2 to 3 m/s (6.5 to 9.8 ft/s). The velocity of flow (v), moreover, has to be matched to the physical properties of the fluid:

- v < 2 m/s (6.5 ft/s): for abrasive fluids such as potter's clay, lime milk, ore slurry etc.
- v > 2 m/s (6.5 ft/s): for fluids causing build-up such as wastewater sludges etc.

Flow characteristic values (SI units)					
Diameter		Recommended flow rate	Factory settings		
[mm]	[inch]	Min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value, current output (v ~ 2.5 m/s)	Pulse value (~ 2 pulses/s)	Low flow cut off (v ~ 0.04 m/s)
15	½"	4 to 100 dm^3/min	25 dm^3/min	0.20 dm^3	0.50 dm^3/min
25	1"	9 to 300 dm^3/min	75 dm^3/min	0.50 dm^3	1.00 dm^3/min
32	–	15 to 500 dm^3/min	125 dm^3/min	1.00 dm^3	2.00 dm^3/min
40	1½"	25 to 700 dm^3/min	200 dm^3/min	1.50 dm^3	3.00 dm^3/min
50	2"	35 to 1100 dm^3/min	300 dm^3/min	2.50 dm^3	5.00 dm^3/min
65	–	60 to 2000 dm^3/min	500 dm^3/min	5.00 dm^3	8.00 dm^3/min
80	3"	90 to 3000 dm^3/min	750 dm^3/min	5.00 dm^3	12.0 dm^3/min
100	4"	145 to 4700 dm^3/min	1200 dm^3/min	10.0 dm^3	20.0 dm^3/min
125	–	220 to 7500 dm^3/min	1850 dm^3/min	15.0 dm^3	30.0 dm^3/min
150	6"	20 to 600 m^3/h	150 m^3/h	0.03 m^3	2.50 m^3/h
200	8"	35 to 1100 m^3/h	300 m^3/h	0.05 m^3	5.00 m^3/h
250	10"	55 to 1700 m^3/h	500 m^3/h	0.05 m^3	7.50 m^3/h
300	12"	80 to 2400 m^3/h	750 m^3/h	0.10 m^3	10.0 m^3/h
350	14"	110 to 3300 m^3/h	1000 m^3/h	0.10 m^3	15.0 m^3/h
400	16"	140 to 4200 m^3/h	1200 m^3/h	0.15 m^3	20.0 m^3/h
450	18"	180 to 5400 m^3/h	1500 m^3/h	0.25 m^3	25.0 m^3/h
500	20"	220 to 6600 m^3/h	2000 m^3/h	0.25 m^3	30.0 m^3/h
600	24"	310 to 9600 m^3/h	2500 m^3/h	0.30 m^3	40.0 m^3/h

Flow characteristic values (US units)					
Diameter		Recommended flow rate	Factory settings		
[inch]	[mm]	Min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value, current output (v ~ 2.5 m/s)	Pulse value (~ 2 pulses/s)	Low flow cut off (v ~ 0.04 m/s)
½"	25	1.0 to 26 gal/min	6 gal/min	0.10 gal	0.15 gal/min
1"	25	2.5 to 80 gal/min	18 gal/min	0.20 gal	0.25 gal/min
1½"	40	7 to 190 gal/min	50 gal/min	0.50 gal	0.75 gal/min
2"	50	10 to 300 gal/min	75 gal/min	0.50 gal	1.25 gal/min
3"	80	24 to 800 gal/min	200 gal/min	2.00 gal	2.50 gal/min
4"	100	40 to 1250 gal/min	300 gal/min	2.00 gal	4.00 gal/min
6"	150	90 to 2650 gal/min	600 gal/min	5.00 gal	12.0 gal/min
8"	200	155 to 4850 gal/min	1200 gal/min	10.0 gal	15.0 gal/min
10"	250	250 to 7500 gal/min	1500 gal/min	15.0 gal	30.0 gal/min
12"	300	350 to 10600 gal/min	2400 gal/min	25.0 gal	45.0 gal/min
14"	350	500 to 15000 gal/min	3600 gal/min	30.0 gal	60.0 gal/min
16"	400	600 to 19000 gal/min	4800 gal/min	50.0 gal	60.0 gal/min
18"	450	800 to 24000 gal/min	6000 gal/min	50.0 gal	90.0 gal/min
20"	500	1000 to 30000 gal/min	7500 gal/min	75.0 gal	120.0 gal/min
24"	600	1400 to 44000 gal/min	10500 gal/min	100.0 gal	180.0 gal/min

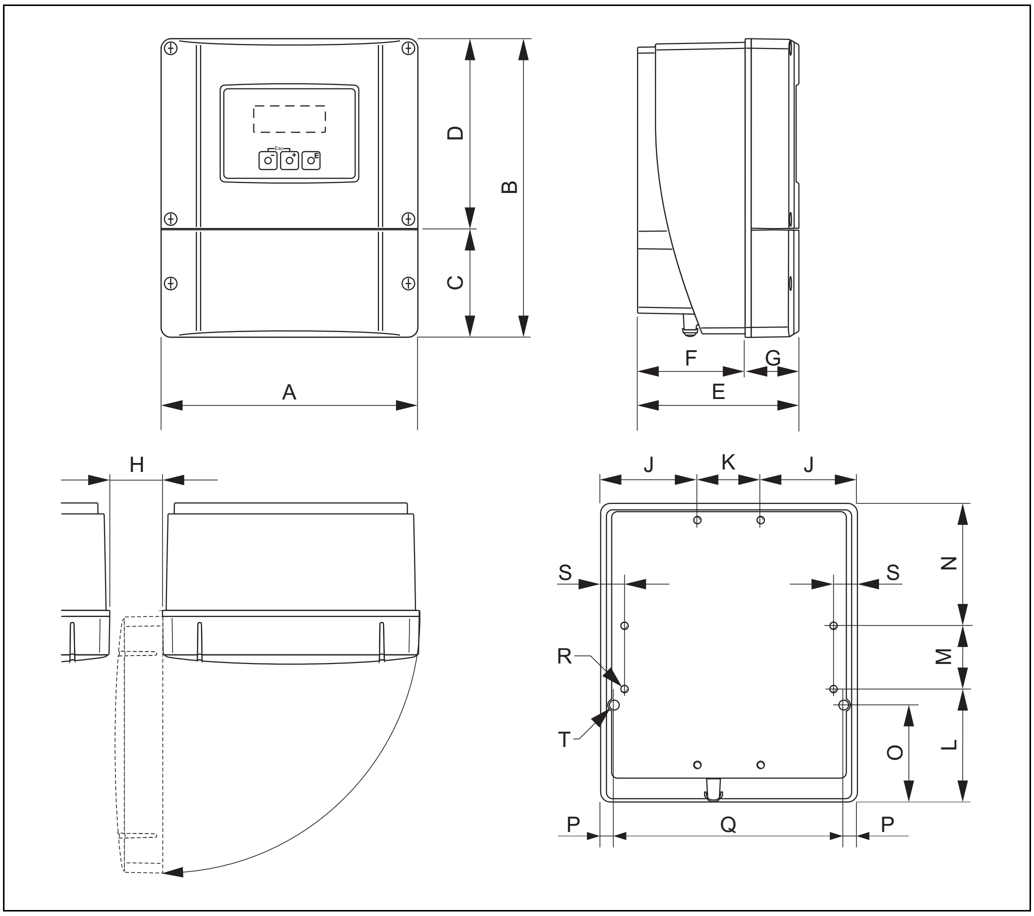
Pressure loss

- No pressure loss if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 (→ 🗎 18, Section "Adapters").

Mechanical construction

Design, dimensions

Transmitter remote version, wall-mount housing (non Ex-zone and II3G/Zone 2)



A0001150

Dimensions (SI units)

A	B	C	D	E	F	G	H	J
215	250	90.5	159.5	135	90	45	> 50	81
K	L	M	N	O	P	Q	R	S
53	95	53	102	81.5	11.5	192	8 × M5	20

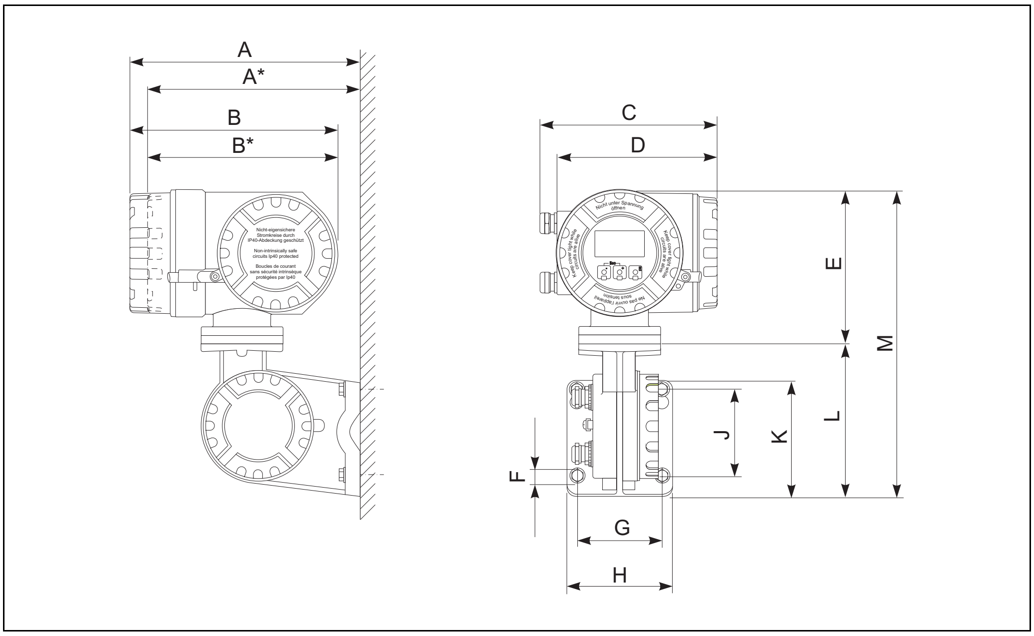
All dimensions in [mm]

Dimensions (US units)

A	B	C	D	E	F	G	H	J
8.46	9.84	3.56	6.27	5.31	3.54	1.77	> 1.97	3.18
K	L	M	N	O	P	Q	R	S
2.08	3.74	2.08	4.01	3.20	0.45	7.55	8 × M5	0.79

All dimensions in [inch]

Transmitter remote version, connection housing (II2GD/Zone 1)



A0002128

Dimensions (SI units)

A	A*	B	B*	C	D	E	Ø F	G	H	J	K	L	M
265	242	240	217	206	186	178	8.6 (M8)	100	130	100	144	170	355

All dimensions in [mm]

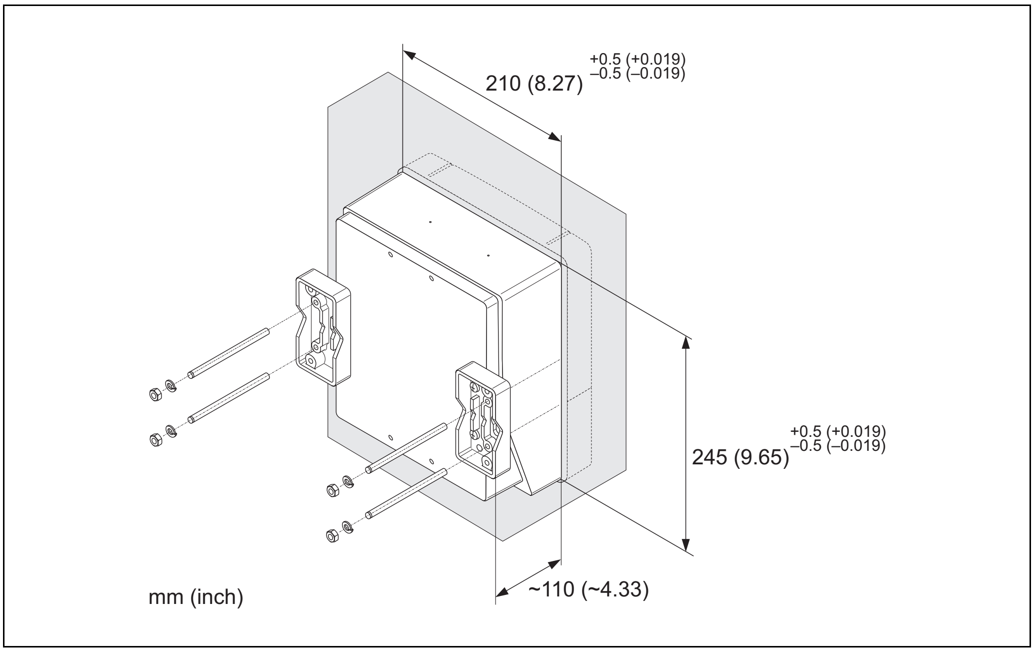
Dimensions (US units)

A	A*	B	B*	C	D	E	Ø F	G	H	J	K	L	M
10.4	9.53	9.45	8.54	8.11	7.32	7.01	0.34 (M8)	3.94	5.12	3.94	5.67	6.69	14.0

All dimensions in [inch]

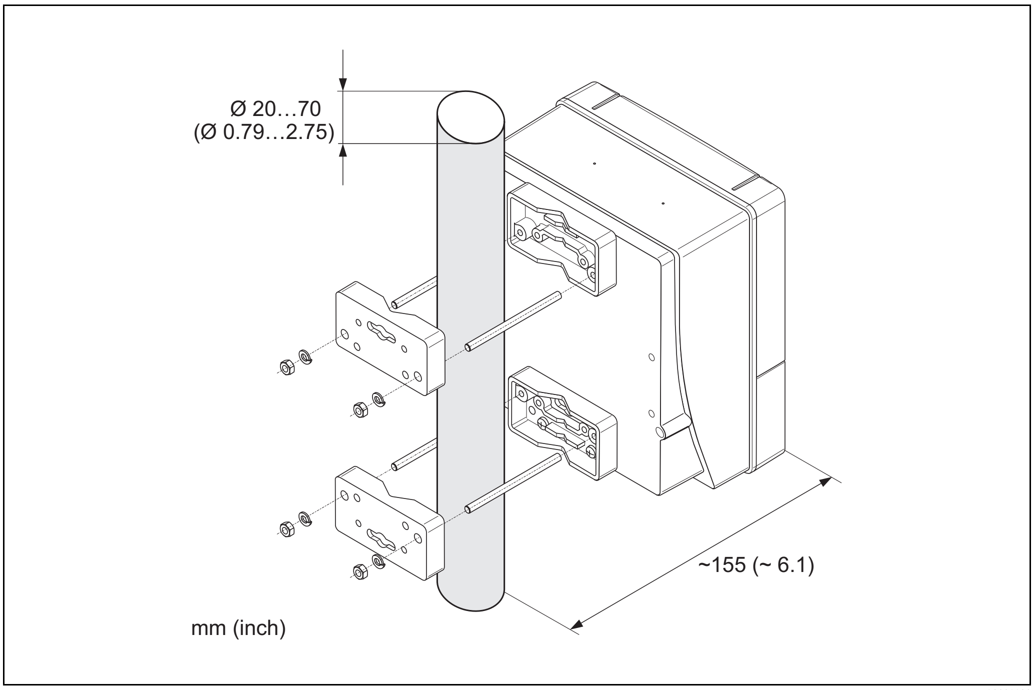
There is a separate mounting kit for the wall-mounted housing. It can be ordered from Endress+Hauser as an accessory. The following installation variants are possible:
- Panel-mounted installation
- Pipe mounting

Installation in control panel



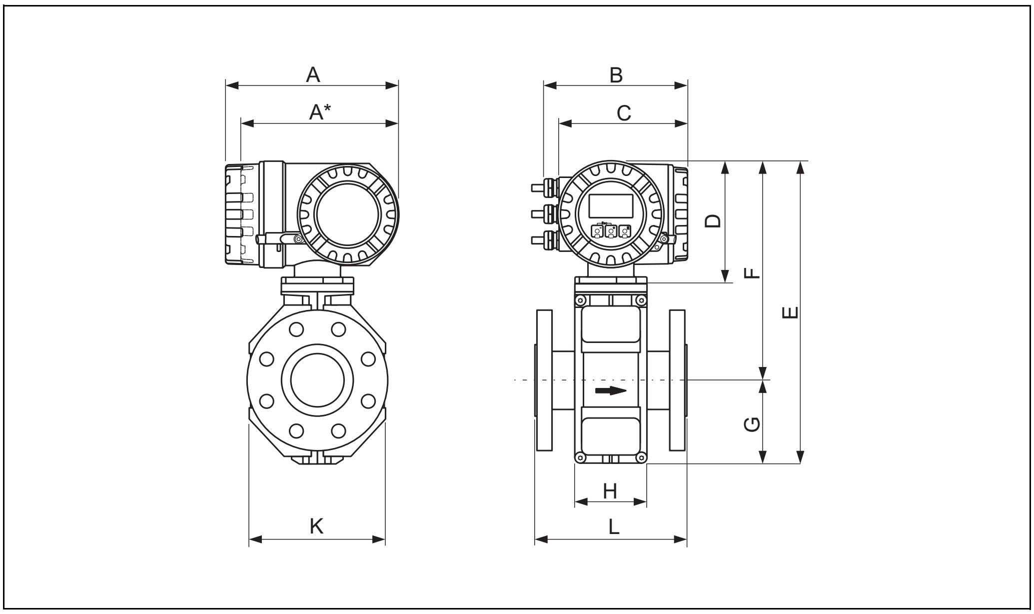
A0001131

Pipe mounting



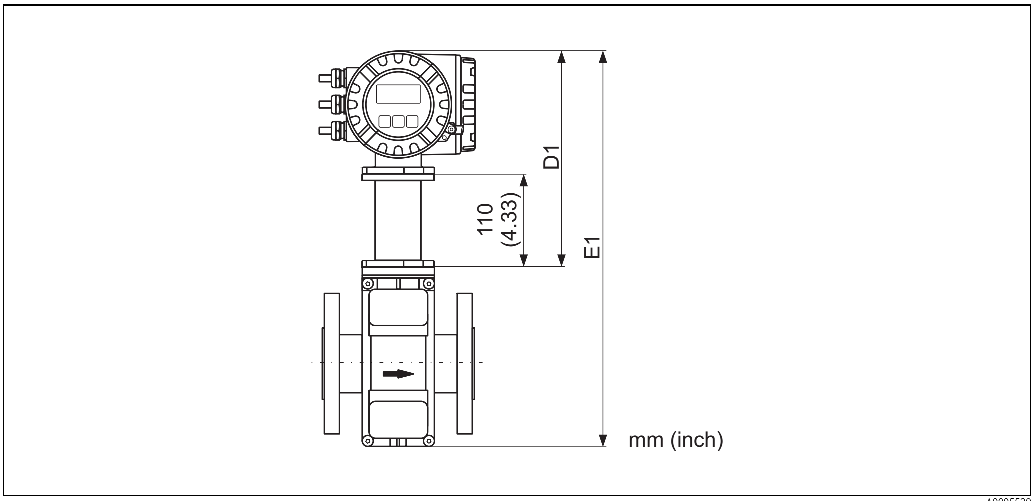
A0001132

Compact version DN ≤ 300 (12")



A0005423

High temperature version DN ≤ 300 (12")



A0005529

Measurement D1, E1 = Measurement D, E of the standard compact version plus 110 mm (4.33")

Dimensions (SI units)

DN EN (DIN) / JIS / AS [2]	L [1]	A	A*	B	C	D	E	F	G	H	K
15	200						341	257	84	94	120
25	200						341	257	84	94	120
32	200						341	257	84	94	120
40	200						341	257	84	94	120
50	200						341	257	84	94	120
65	200						391	282	109	94	180
80	200	227	207	187	168	160	391	282	109	94	180
100	250						391	282	109	94	180
125	250						472	322	150	140	260
150	300						472	322	150	140	260
200	350						527	347	180	156	324
250	450						577	372	205	166	400
300	500						627	397	230	166	460

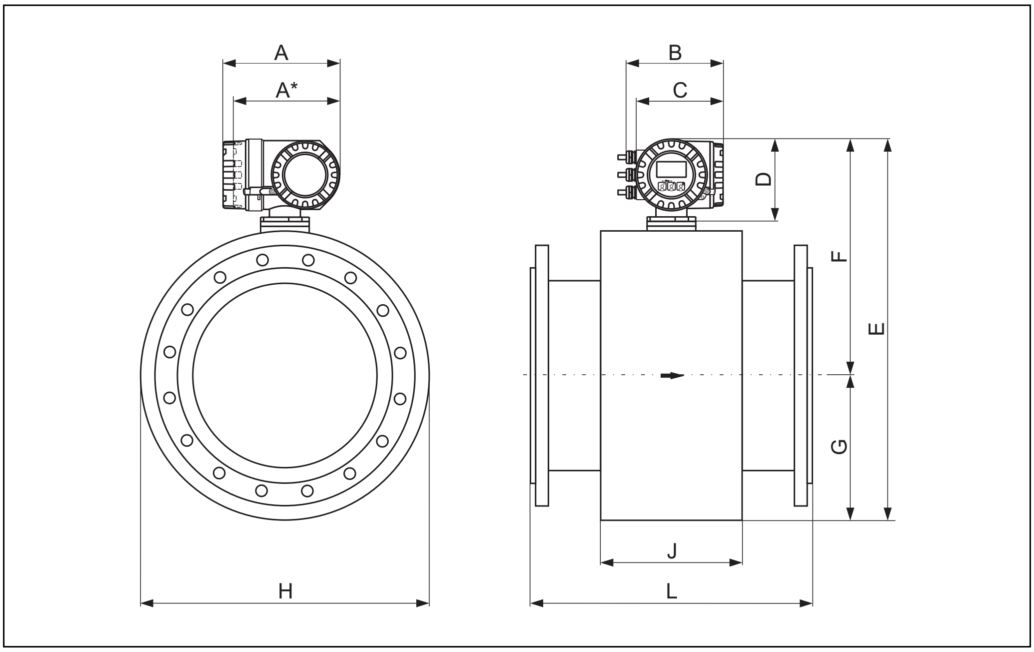
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] Only DN 25 and DN 50 are available for flanges according to AS.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	A*	B	C	D	E	F	G	H	K
½"	7.87						13.4	10.1	3.31	3.70	4.72
1"	7.87						13.4	10.1	3.31	3.70	4.72
1½"	7.87						13.4	10.1	3.31	3.70	4.72
2"	7.87						13.4	10.1	3.31	3.70	4.72
3"	7.87	8.94	8.15	7.36	6.61	6.30	15.4	11.1	4.29	3.70	7.09
4"	9.84						15.4	11.1	4.29	3.70	7.09
6"	11.8						18.6	12.7	5.91	5.51	10.2
8"	13.8						20.8	13.7	7.09	6.14	12.8
10"	17.7						22.7	14.7	8.07	6.54	15.8
12"	19.7						24.7	15.6	9.06	6.54	18.1

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Compact version DN ≥ 350 (14")



A0005424

Dimensions (SI units)

DN EN (DIN)	L 1)	A	A*	B	C	D	E	F	G	H	J
350	550						738.5	456.5	282.0	564	276
400	600						790.5	482.5	308.0	616	276
450	650	227	207	187	168	160	840.5	507.5	333.0	666	292
500	650						891.5	533.0	358.5	717	292
600	780						995.5	585.0	410.5	821	402

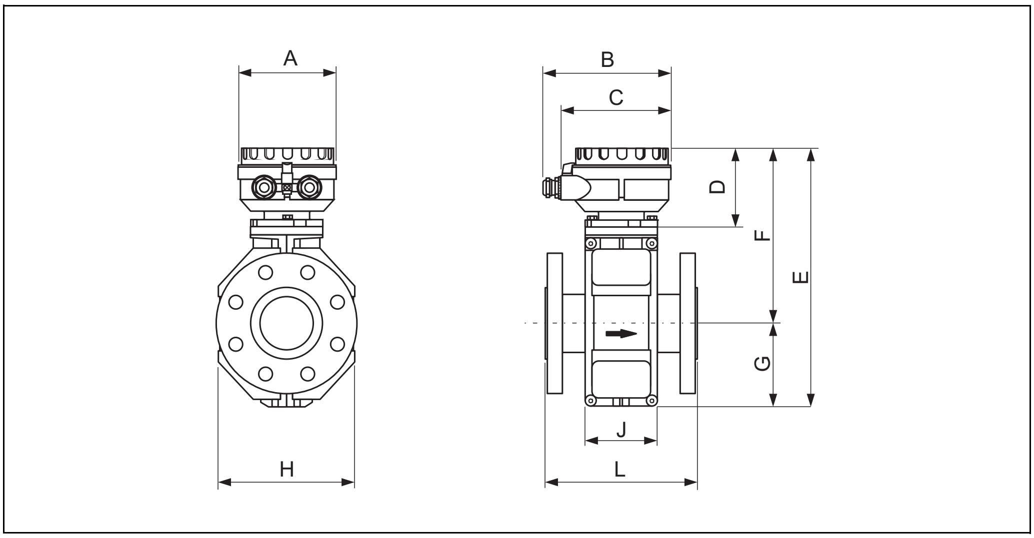
1) The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L 1)	A	A*	B	C	D	E	F	G	H	J
14"	21.7						29.1	18.0	11.1	22.2	10.9
16"	23.6						31.1	19.0	12.1	24.3	10.9
18"	25.6	8.94	8.15	7.36	6.61	6.30	33.1	20.0	13.1	26.2	11.5
20"	25.6						35.1	21.0	14.1	28.2	11.5
24"	30.7						39.2	23.0	16.2	32.3	15.8

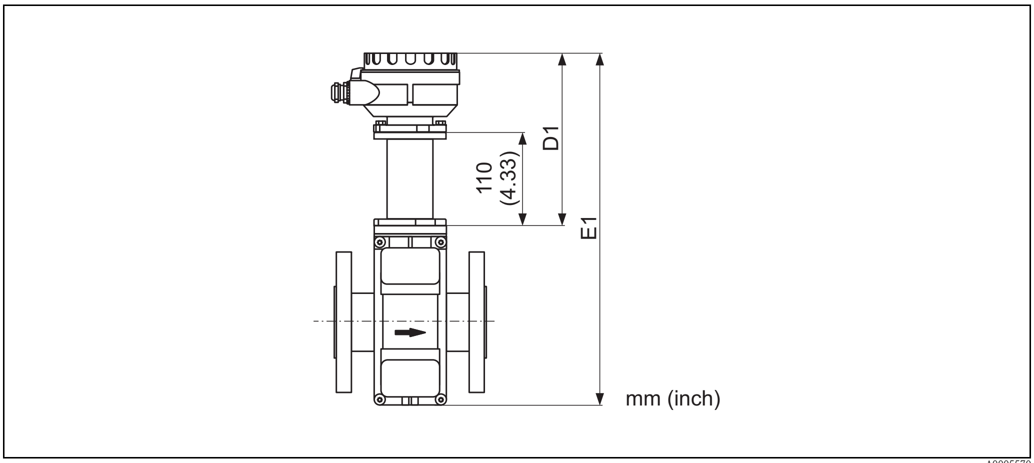
1) The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Sensor, remote version DN ≤ 300 (12")



A0012462

High temperature version DN ≤ 300 (12")



A0005570

Measurement D1, E1 = Measurement D, E of the standard remote version plus 110 mm (4.33")

Dimensions (SI units)

DN EN (DIN) / JIS / AS [2]	L [1]	A	B	C	D	E	F	G	H	J
15	200	129	163	143	102	286	202	84	120	94
25	200					286	202	84	120	94
32	200					286	202	84	120	94
40	200					286	202	84	120	94
50	200					286	202	84	120	94
65	200					336	227	109	180	94
80	200					336	227	109	180	94
100	250					336	227	109	180	94
125	250					417	267	150	260	140
150	300					417	267	150	260	140
200	350					472	292	180	324	156
250	450					522	317	205	400	166
300	500					572	342	230	460	166

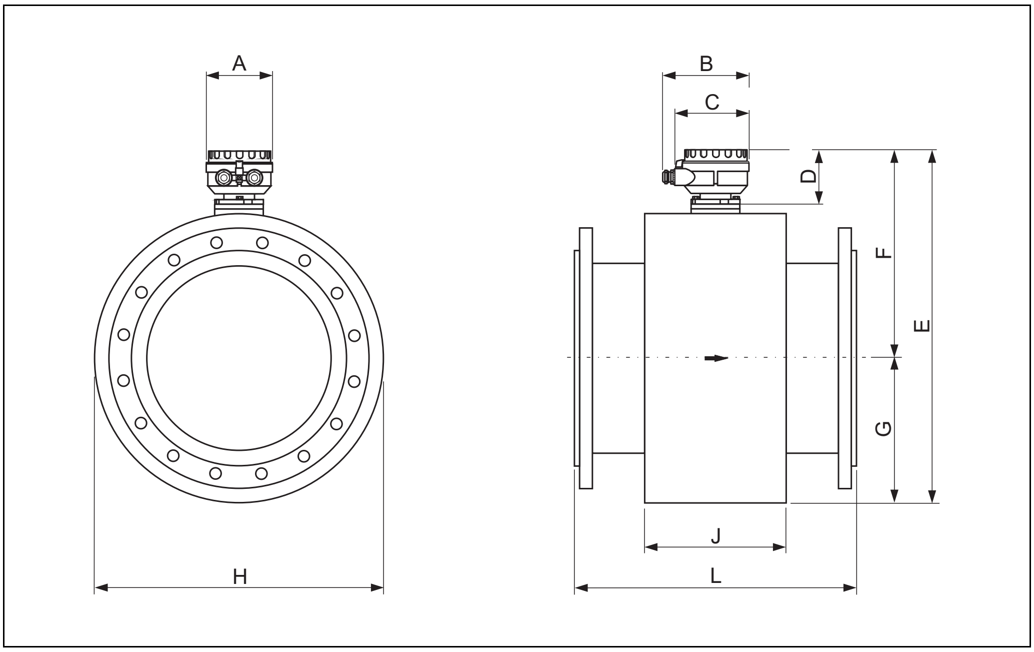
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] Only DN 25 and DN 50 are available for flanges according to AS.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	B	C	D	E	F	G	H	J
½"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.31	4.72	3.70
1"	7.87					11.3	7.95	3.31	4.72	3.70
1½"	7.87					11.3	7.95	3.31	4.72	3.70
2"	7.87					11.3	7.95	3.31	4.72	3.70
3"	7.87					13.2	8.94	4.29	7.09	3.70
4"	9.84					13.2	8.94	4.29	7.09	3.70
6"	11.8					16.4	10.5	5.91	10.2	5.51
8"	13.8					18.6	11.5	7.08	12.8	6.14
10"	17.7					20.6	12.5	8.07	15.8	6.54
12"	19.7					22.5	13.5	9.06	18.1	6.54

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Sensor, remote version DN ≥ 350 (14")



A0003220

Dimensions (SI units)

DN EN (DIN)	L [1]	A	B	C	D	E	F	G	H	J
350	550	129	163	143	102	683.5	401.5	282.0	564	276
400	600					735.5	427.5	308.0	616	276
450	650					785.5	452.5	333.0	666	292
500	650					836.5	478.0	358.5	717	292
600	780					940.5	530.0	410.5	821	402

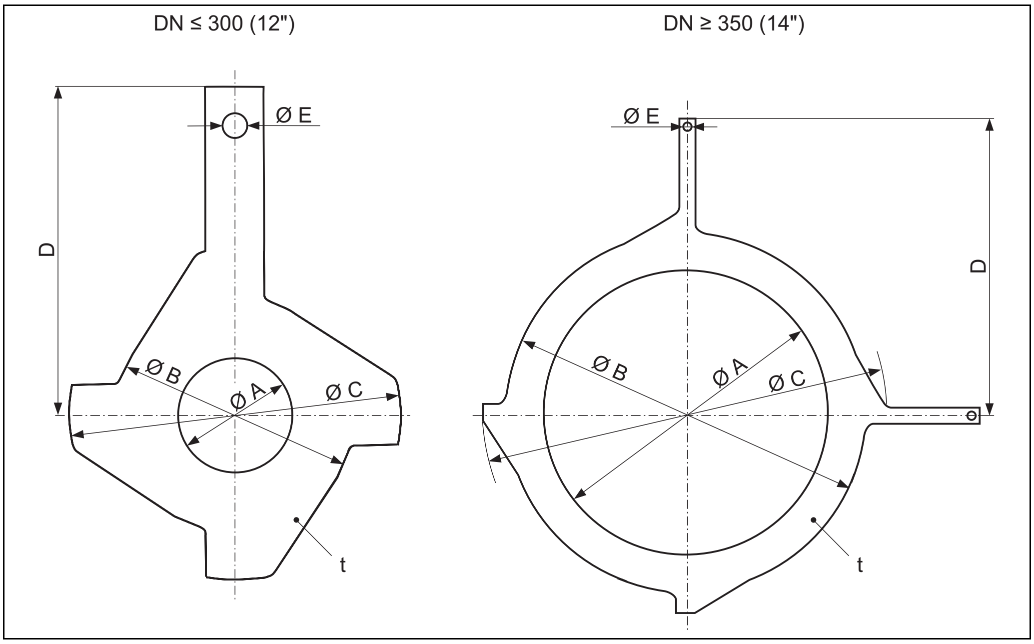
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	B	C	D	E	F	G	H	J
14"	21.7	5.08	6.42	5.63	4.02	26.9	15.8	11.1	22.2	10.9
16"	23.6					29.0	16.8	12.1	24.3	10.9
18"	25.6					30.9	17.8	13.1	26.2	11.5
20"	25.6					32.9	18.8	14.1	28.2	11.5
24"	30.7					37.0	20.9	16.2	32.3	15.8

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Ground disk for flange connections



A0003221

Dimensions (SI units)

DN 1) EN (DIN) / JIS / AS 2)	A PTFE, PFA	B	C	D	E	t
15	16	43	61.5	73		
25	26	62	77.5	87.5		
32	35	80	87.5	94.5		
40	41	82	101	103		
50	52	101	115.5	108		
65	68	121	131.5	118		
80	80	131	154.5	135		
100	104	156	186.5	153	6.5	
125	130	187	206.5	160		
150	158	217	256	184		2
200	206	267	288	205		
250	260	328	359	240		
300 3)	312	375	413	273		
300 4)	310	375	404	268		
350 3)	343	433	479	365		
400 3)	393	480	542	395		
450 3)	439	538	583	417	9.0	
500 3)	493	592	650	460		
600 3)	593	693	766	522		

1) Ground disks at DN 15 to 250 (½ to 10") can be used for all flange standards/pressure ratings.
2) Only DN 25 and DN 50 are available for flanges according to AS.
3) PN 10/16
4) PN 25, JIS 10K/20K
All dimensions in [mm]

Dimensions (US units)

DN [1] ANSI	A PTFE, PFA	B	C	D	E	t
½"	0.63	1.69	2.42	2.87	0.26	0.08
1"	1.02	2.44	3.05	3.44		
1½"	1.61	3.23	3.98	4.06		
2"	2.05	3.98	4.55	4.25		
3"	3.15	5.16	6.08	5.31		
4"	4.09	6.14	7.34	6.02		
6"	6.22	8.54	10.08	7.24		
8"	8.11	10.5	11.3	8.07		
10"	10.2	12.9	14.1	9.45		
12"	12.3	14.8	16.3	10.8		
14"	13.5	17.1	18.9	14.4	0.35	
16"	15.45	18.9	21.3	15.6		
18"	17.3	21.2	23.0	16.4		
20"	19.4	23.3	25.6	18.1		
24"	23.4	27.3	30.1	20.6		

[1] Ground disks can be used for all flange standards/pressure ratings.
All dimensions in [inch]

Weight

Weight in SI units

Weight data in kg														
Nominal diameter		Compact version						Remote version (without cable)						
								Sensor						Transmitter
[mm]	[inch]	EN (DIN) / AS [1)]		JIS		ANSI		EN (DIN) / AS [1)]		JIS		ANSI		Wall-mount housing
15	½"	PN 40	6.5	10K	6.5	Class 150	6.5	PN 40	4.5	10K	4.5	Class 150	4.5	6.0
25	1"		7.3		7.3		7.3		5.3		5.3		5.3	
32	–		8.0		7.3		–		6.0		5.3		–	
40	1½"		9.4		8.3		9.4		7.4		6.3		7.4	
50	2"		10.6		9.3		10.6		8.6		7.3		8.6	
65	–	PN 16	12.0		11.1		–	PN 16	10.0		9.1		–	
80	3"		14.0		12.5		14.0		12.0		10.5		12.0	
100	4"		16.0		14.7		16.0		14.0		12.7		14.0	
125	–		21.5		21.0		–		19.5		19.0		–	
150	6"		25.5		24.5		25.5		23.5		22.5		23.5	
200	8"	PN 10	45		41.9		45	PN 10	43		39.9		43	
250	10"		65		69.4		75		63		67.4		73	
300	12"		70		72.3		110		68		70.3		108	
350	14"		115				175		113				173	
400	16"		135				205		133				203	
450	18"		175				255		173				253	
500	20"		175				285		173				283	
600	24"		235				405		233				403	

1) For flanges to AS, only DN 25 and 50 are available.

- Transmitter (compact version): 3.4 kg, high temperature version: +1.5 kg
- Weight data valid for standard pressure ratings and without packaging material.

Weight in US units (only ANSI)

Weight data in lbs						
Nominal diameter		Compact version		Remote version (without cable)		
				Sensor		Transmitter
[mm]	[inch]	ANSI		ANSI		Wall-mount housing
15	½"		14.3		9.92	
25	1"		16.1		11.7	
40	1½"		20.7		16.3	
50	2"		23.4		19.0	
80	3"		30.9		26.5	
100	4"		35.3		30.9	
150	6"		56.2		51.8	
200	8"	Class 150	99.2	Class 150	94.8	13.2
250	10"		165.4		161.0	
300	12"		242.6		238.1	
350	14"		385.9		381.5	
400	16"		452.0		447.6	
450	18"		562.3		557.9	
500	20"		628.4		624.0	
600	24"		893.0		888.6	

- Transmitter (compact version): 7.50 lbs, high temperature version: +3.31 lbs
- Weight data valid for standard pressure ratings and without packaging material.

Measuring tube specifications

Diameter		Pressure rating					Internal diameter			
		EN (DIN)	AS 2129	AS 4087	ANSI	JIS	PFA		PTFE	
[mm]	[inch]	[bar]			[lbs]		[mm]	[inch]	[mm]	[inch]
15	½"	PN 40	–	–	Cl.150	20K	–	–	15	0.59
25	1"	PN 40	Table E	–	Cl.150	20K	23	0.91	26	1.02
32	–	PN 40	–	–	–	20K	32	1.26	35	1.38
40	1½"	PN 40	–	–	Cl.150	20K	36	1.42	41	1.61
50	2"	PN 40	Table E	PN 16	Cl.150	10K	48	1.89	52	2.05
65	–	PN 16	–	–	–	10K	63	2.48	67	2.64
80	3"	PN 16	–	–	Cl.150	10K	75	2.95	80	3.15
100	4"	PN 16	–	–	Cl.150	10K	101	3.98	104	4.09
125	–	PN 16	–	–	–	10K	126	4.96	129	5.08
150	6"	PN 16	–	–	Cl.150	10K	154	6.06	156	6.14
200	8"	PN 10	–	–	Cl.150	10K	201	7.91	202	7.95
250	10"	PN 10	–	–	Cl.150	10K	–	–	256	10.1
300	12"	PN 10	–	–	Cl.150	10K	–	–	306	12.0
350	14"	PN 10	–	–	Cl.150	–	–	–	337	13.3
400	16"	PN 10	–	–	Cl.150	–	–	–	387	15.2
450	18"	PN 10	–	–	Cl.150	–	–	–	432	17.0
500	20"	PN 10	–	–	Cl.150	–	–	–	487	19.2
600	24"	PN 10	–	–	Cl.150	–	–	23	593	23.3

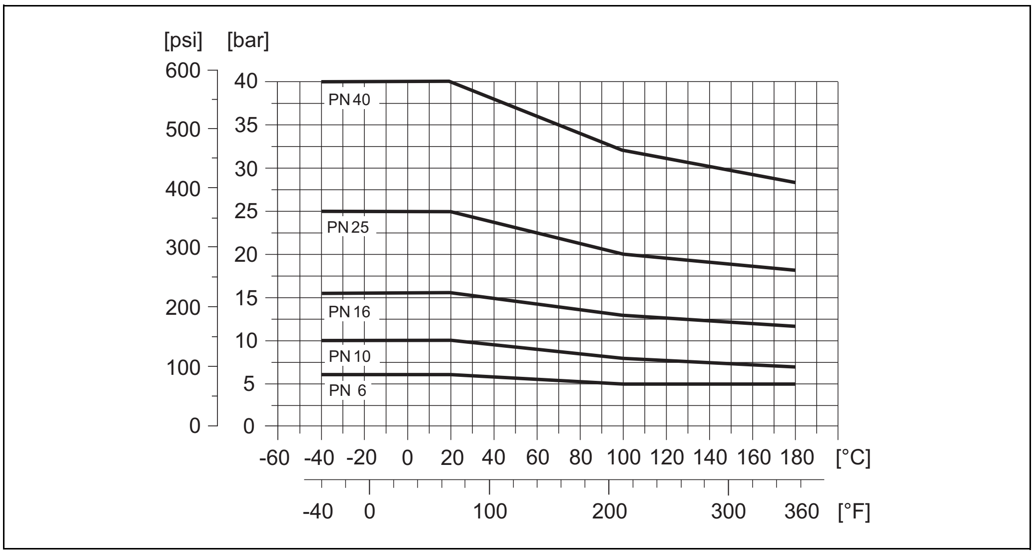
Material

- Transmitter housing
  – Compact housing: powder-coated die-cast aluminum
  – Wall-mount housing: powder-coated die-cast aluminum
- Sensor housing
  – DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  – DN 350 to 600 (14 to 24"): with protective lacquering
- Measuring tube
  – DN ≤ 300 (12"): stainless steel 1.4301 or 1.4306/304L;
  (for flanges made of carbon steel with Al/Zn protective coating)
  – DN ≥ 350 (14"): stainless steel 1.4301 or 1.4306/304L;
  (for flanges made of carbon steel with protective lacquering)
- Electrodes: 1.4435, Platinum, Alloy C-22, Tantalum, Titanium
- Flanges
  – EN 1092-1 (DIN 2501): 1.4571/316L; RSt37-2 (S235JRG2); C22; FE 410W B
  (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  – ANSI: A105; F316L
  (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  – AWWA: 1.0425
  – JIS: RSt37-2 (S235JRG2); HII; 1.0425/316L
  (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  – AS 2129
    – DN 25 (1"): A105 or RSt37-2 (S235JRG2)
    – DN 40 (1 ½"): A105 or St44-2 (S275JR)
  – AS 4087: A105 or St44-2 (S275JR)
- Seals: to DIN EN 1514-1
- Ground disks: 1.4435/316L or Alloy C-22

Material load diagram

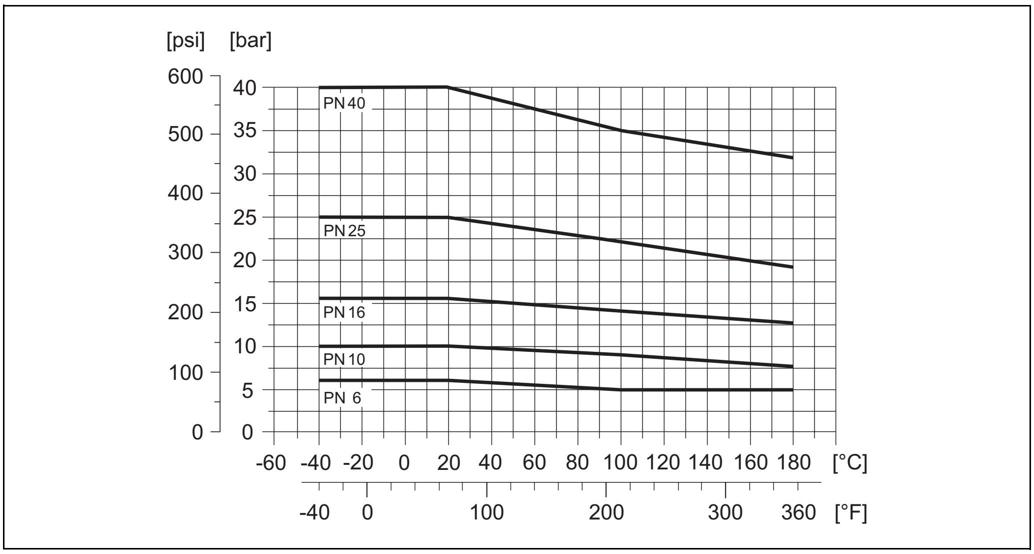
Caution!
The following diagrams contain material load diagrams (reference curves) for flange materials with regard to the medium temperature. However, the maximum medium temperatures permitted always depend on the lining material of the sensor and/or the sealing material (→ 21).

Flange connection to EN 1092-1 (DIN 2501)
Material: RSt37-2 (S235JRG2) / C22 / Fe 410W B



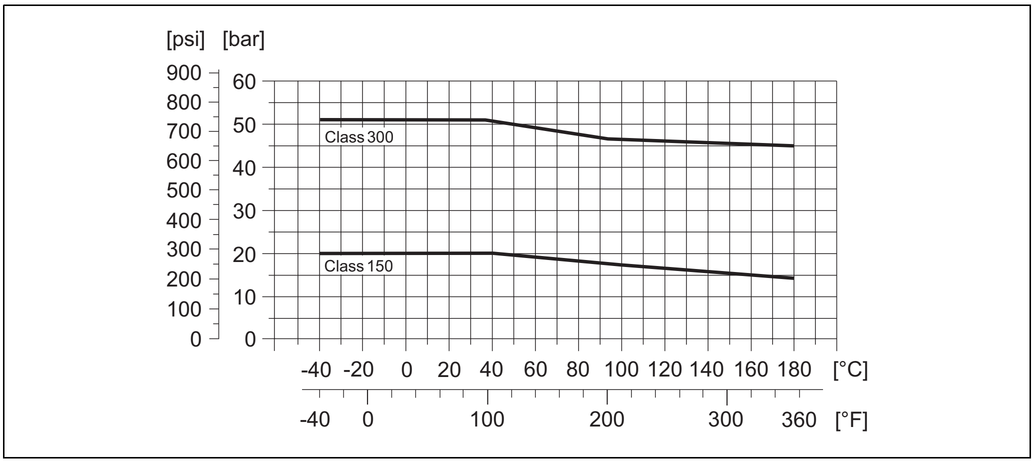
A0005594

Flange connection to EN 1092-1 (DIN 2501)
Material: 316L / 1.4571



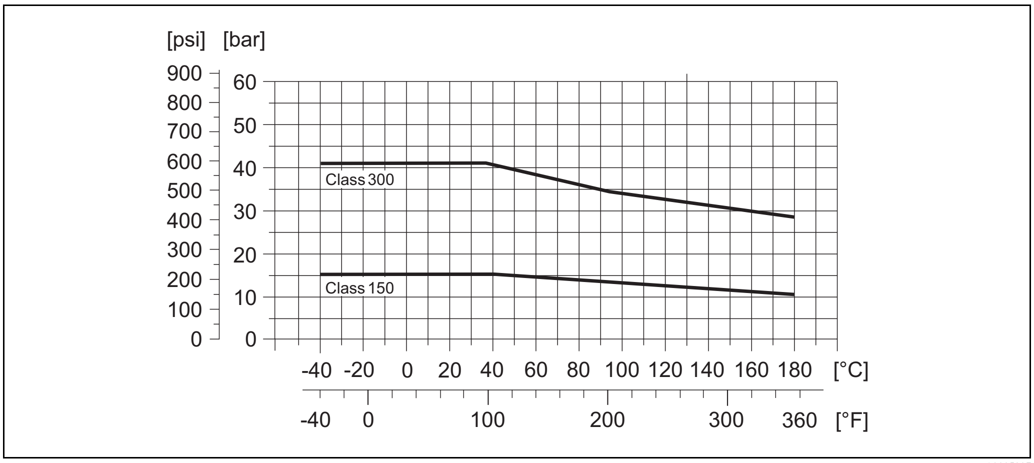
A0005304

Flange connection to ANSI B16.5
Material: A 105



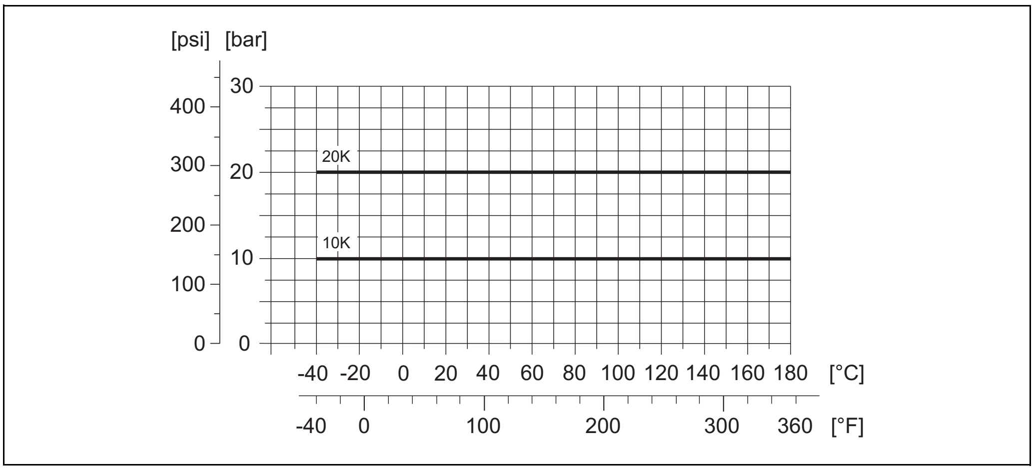
A0003226

Flange connection to ANSI B16.5
Material: F316L



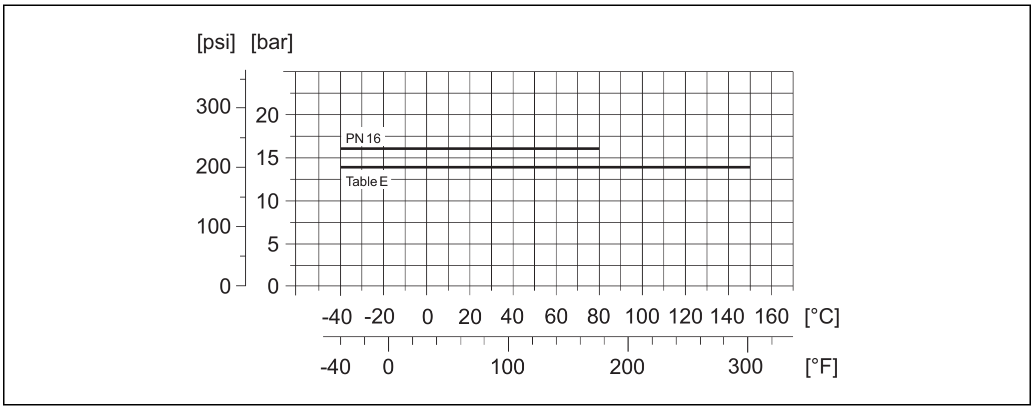
A0005307

Flange connection to JIS B2220
Material: RSt37-2 (S235JRG2) / HII / 1.0425 / 316L



A0003228

Flange connection to AS 2129 Table E or AS 4087 PN 16
Material: A105 / RSt37-2 (S235JRG2) / St44-2 (S275JR)



A0005595

Fitted electrodes

Measuring electrodes, reference electrodes and empty pipe detection electrodes:
- Standard available with 1.4435, Alloy C-22, tantalum, platinum/rhodium 80/20, titanium
- Optional: measuring electrodes made of platinum/rhodium 80/20

Process connections

Flange connection:
- EN 1092-1 (DIN 2501), DN ≤ 300 (12") form A, DN ≥ 350 (14") form B
  (Dimensions to DIN 2501, DN 65 PN 16 and DN 600 (24") PN 16 exclusively to EN 1092-1)
- ANSI B16.5
- JIS B2220
- AS 2129 Table E
- AS 4087 PN 16

Surface roughness

- PFA liner: ≤ 0.4 µm (15.7 µin)
- Elektroden
  - 1.4435, Alloy C-22, titanium: ≤ 0.3 to 0.5 µm (≤ 11.8 to 19.7 µin)
  - Tantal, Platin/Rhodium: ≤ 0.3 to 0.5 µm (≤ 11.8 to 19.7 µin)

(All data refer to parts in contact with medium)

Human interface

Display elements	▪ Liquid crystal display: backlit, two lines (Promag 50) or four lines (Promag 53) with 16 characters per line ▪ Custom configurations for presenting different measured-value and status variables ▪ Totalizer – Promag 50: 2 totalizers – Promag 53: 3 totalizers
Operating elements	Unified operation concept for both types of transmitter: Promag 50: ▪ Local operation via three keys (−, +, E) ▪ Quick Setup menus for straightforward commissioning Promag 53: ▪ Local operation via three keys (−, +, E) ▪ Application-specific Quick Setup menus for straightforward commissioning
Language groups	Language groups available for operation in different countries: Promag 50, Promag 53: ▪ Western Europe and America (WEA): English, German, Spanish, Italian, French, Dutch, Portuguese ▪ Eastern Europe and Scandinavia (EES): English, Russian, Polish, Norwegian, Finnish, Swedish, Czech ▪ South and east Asia (SEA): English, Japanese, Indonesian Promag 53: ▪ China (CN): English, Chinese You can change the language group via the operating program "FieldCare".
Remote operation	▪ Promag 50: Remote control via HART, PROFIBUS DP/PA ▪ Promag 53: Remote control via HART, PROFIBUS DP/PA, MODBUS RS485, FOUNDATION Fieldbus

Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives.
Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-tick mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Pressure measuring device approval

Measuring devices 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. Where necessary (depending on the medium and process pressure), there are additional optional approvals to Category II/III for larger nominal diameters.

Ex approval

Information about currently available Ex versions (ATEX, IECEx, FM, CSA, NEPSI) can be supplied by your Endress+Hauser Sales Center on request. All explosion protection data are given in a separate documentation which is available upon request.

Other standards and guidelines

- EN 60529
  Degrees of protection by housing (IP code)
- EN 61010
  Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.
- IEC/EN 61326
  "Emission in accordance with requirements for Class A".
  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.
- 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 requirements for Electrical Equipment for Measurement and Control and Laboratory Use.
  Pollution degree 2, Installation Category II

FOUNDATION Fieldbus certification

The flow device has successfully passed all the test procedures carried out 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 5.01 (device certification number: on request)
- The device can also be operated with certified devices of other manufacturers
- Physical Layer Conformance Test of the Fieldbus Foundation

MODBUS RS485 certification

The measuring device meets all the requirements of the MODBUS/TCP conformity test and has the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "MODBUS/TCP Conformance Test Laboratory" of the University of Michigan.

PROFIBUS DP/PA certification

The flow device has successfully passed all the test procedures carried out and is certified and registered by the PNO (PROFIBUS User Organisation). 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)

Ordering information

Your Endress+Hauser service organization can provide detailed ordering information and information on the order codes on request.

Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Your Endress+Hauser service organization can provide detailed information on the order codes in question.

Documentation

- Flow Measurement (FA005D/06)
- Operating Instructions Promag Promag 50 (BA046D/06 and BA049D/06)
- Operating Instructions Promag Promag 50 PROFIBUS PA (BA055D/06 and BA056D/06)
- Operating Instructions Promag Promag 53 (BA047D/06 and BA048D/06)
- Operating Instructions Promag Promag 53 FOUNDATION Fieldbus (BA051D/06 and BA052D/06)
- Operating Instructions Promag Promag 53 MODBUS RS485 (BA117D/06 and BA118D/06)
- Operating Instructions Promag Promag 53 PROFIBUS DP/PA (BA053D/06 and BA054D/06)
- Supplementary documentation on Ex-ratings: ATEX, IECEx, FM, CSA, NEPSI

Registered trademarks

HART®
Registered trademark of the HART Communication Foundation, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS Nutzerorganisation e.V., Karlsruhe, D

FOUNDATION™ Fieldbus
Registered trademark of the Fieldbus Foundation, Austin, USA

MODBUS®
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Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

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People for Process Automation

TI047D/06/en/11.09
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FM+SGML6.0 ProMoDo

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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Endress+Hauser
People for Process Automation

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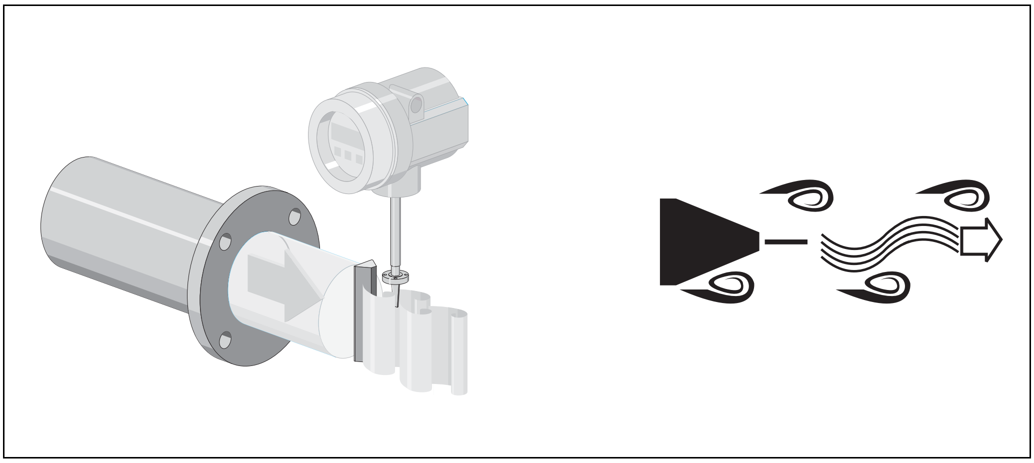
Function and system design

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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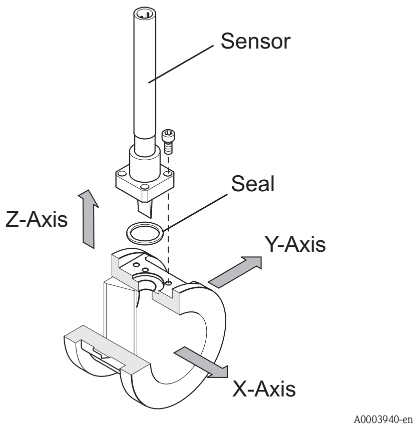
- Within the application limits of the device, the K-factor only depends on the geometry of the device. It is independent of the fluid velocity and the fluid properties viscosity and density. In this way, the K-factor is also independent of the type of matter that is to be measured, regardless of whether 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

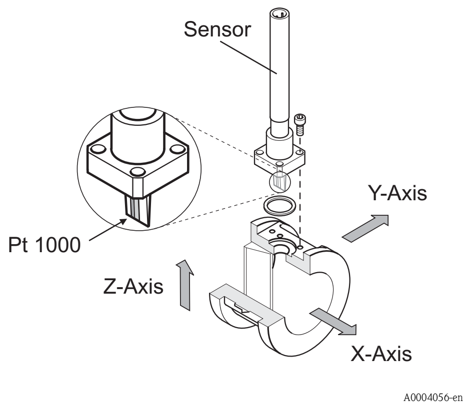
The sensor of a vortex flowmeter has a major influence on the performance, robustness and reliability of the whole measuring system.

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.

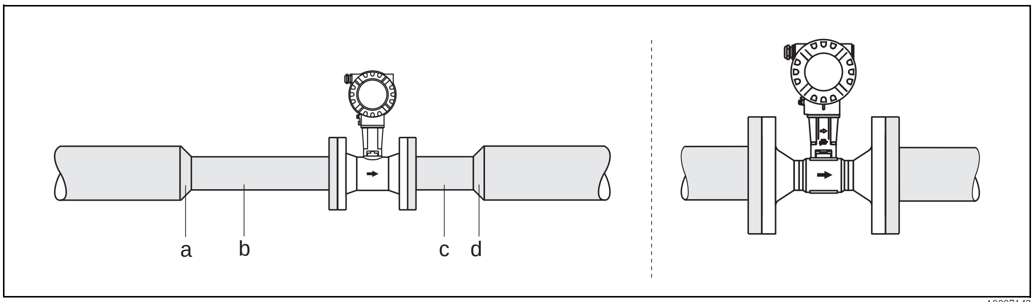
Thus, the Prowirl product line offers calibration for life if the measuring device is used in non-abrasive and non-corrosive fluids.

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	Helium 4	Nitrogen
Argon	Hydrogen (normal)	Oxygen
Butane	Hydrogen chloride	Propane
Carbon dioxide	Hydrogen sulfide	Xenon
Chlorine	Krypton	Mixtures of up to 8 components of these gases
Ethane	Methane	
Ethylene (ethene)	Neon	

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.

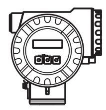
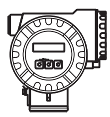
Diagnostic functions (Prowirl 73)

Extensive diagnostic options, such as retracing fluid and ambient temperatures, extreme flows etc., are also optionally available for the measuring device.

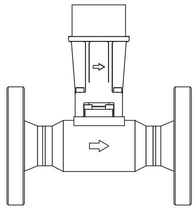
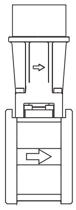
Measuring system

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

$$\text{DN 15...25} \rightarrow v_{min.}{}^{*} = \frac{6}{\sqrt{\rho\,[kg/m^3]}}\,[m/s] \qquad \text{DN 40...300} \rightarrow v_{min.}{}^{*} = \frac{7}{\sqrt{\rho\,[kg/m^3]}}\,[m/s]$$

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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/dm³)	
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:

$$\rho\ [\mathrm{kg/m^3}] = \frac{\rho_N\ [\mathrm{kg/Nm^3}] \cdot P\ [\mathrm{bar\ abs}] \cdot 273.15\ [\mathrm{K}]}{T\ [\mathrm{K}] \cdot 1.013\ [\mathrm{bar\ abs}]} \qquad \rho_N\ [\mathrm{kg/Nm^3}] = \frac{\rho\ [\mathrm{kg/m^3}] \cdot T\ [\mathrm{K}] \cdot 1.013\ [\mathrm{bar\ abs}]}{P\ [\mathrm{bar\ abs}] \cdot 273.15\ [\mathrm{K}]}$$

A0003946-en

The following formulae can be used to calculate the volume [Q] or corrected volume [Q_N] in the case of ideal gases:

$$Q\ [\mathrm{m^3/h}] = \frac{Q_N\ [\mathrm{Nm^3/h}] \cdot T\ [\mathrm{K}] \cdot 1.013\ [\mathrm{bar\ abs}]}{P\ [\mathrm{bar\ abs}] \cdot 273.15\ [\mathrm{K}]} \qquad Q_N\ [\mathrm{Nm^3/h}] = \frac{Q\ [\mathrm{m^3/h}] \cdot P\ [\mathrm{bar\ abs}] \cdot 273.15\ [\mathrm{K}]}{T\ [\mathrm{K}] \cdot 1.013\ [\mathrm{bar\ abs}]}$$

A0003941-en

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

<table>
<tr><th rowspan="2"></th><th colspan="4">4 to 20 mA HART measuring devices</th><th rowspan="2">Profibus - PA (4 AI Blocks)</th><th rowspan="2">Foundation Fieldbus FF (7 AI Blocks)</th></tr>
<tr><th>Current output</th><th>Frequency output (only for output option A)</th><th>Pulse output (only for output option A)</th><th>Status output (only for output option A)</th></tr>
<tr><td>Compressed air</td><td>▪ Volume flow/ mass flow/heat flow/corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume flow/ mass flow/heat flow/corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume
▪ Mass
▪ Corrected volume</td><td>▪ 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)</td><td>▪ Volume flow/ mass flow/ corrected volume flow
▪ Temperature
▪ Compressibility
▪ Frequency
▪ Flow velocity
▪ Totalizer
▪ Optional:
– Reynolds number
– Electronics temperature</td><td>▪ Volume flow/ mass flow/ corrected volume flow
▪ Temperature
▪ Compressibility
▪ Frequency
▪ Flow velocity
▪ Totalizer
▪ Optional:
– Reynolds number
– Electronics temperature</td></tr>
<tr><td>Ar, NH3, C4H10, CO2, CO, Cl2, C2H6, C2H4, He 4, H2 (normal), HCl, H2S, Kr, CH4, Ne, N2, O2, C3H8, Xe*</td><td>▪ Volume flow/ mass flow/heat flow/corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume flow/ mass flow/heat flow/corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume
▪ Mass
▪ Heat
▪ Corrected volume</td><td>▪ 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)</td><td>No data
→ Use real gas equation</td><td>No data
→ Use real gas equation</td></tr>
<tr><td>Mixtures of up to 8 of the components above</td><td>▪ Volume flow/ mass flow/heat flow/corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume flow/ mass flow/heat flow/corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume
▪ Mass
▪ Heat
▪ Corrected volume</td><td>▪ 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)</td><td>No data
→ Use real gas equation</td><td>No data
→ Use real gas equation</td></tr>
<tr><td>Real gas equation</td><td>▪ Volume flow/ mass flow/ corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume flow/ mass flow/ corrected volume flow
▪ Temperature
▪ External pressure (if it can be read in)</td><td>▪ Volume
▪ Mass
▪ Corrected volume</td><td>▪ 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)</td><td>▪ Volume flow/ mass flow/ corrected volume flow
▪ Temperature
▪ Frequency
▪ Flow velocity
▪ Totalizer
▪ Optional: electronics temperature</td><td>▪ Volume flow/ mass flow/ corrected volume flow
▪ Temperature
▪ Frequency
▪ Flow velocity
▪ Totalizer
▪ Optional: electronics temperature</td></tr>
<tr><td colspan="7">* 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</td></tr>
</table>

	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 ▪ Supercompressibi-lity ▪ Frequency ▪ Flow velocity ▪ Totalizer ▪ Optional: – Reynolds number – Electronics temperature	▪ Volume flow/ mass flow/ corrected volume flow ▪ Temperature ▪ Supercompressibi-lity ▪ 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

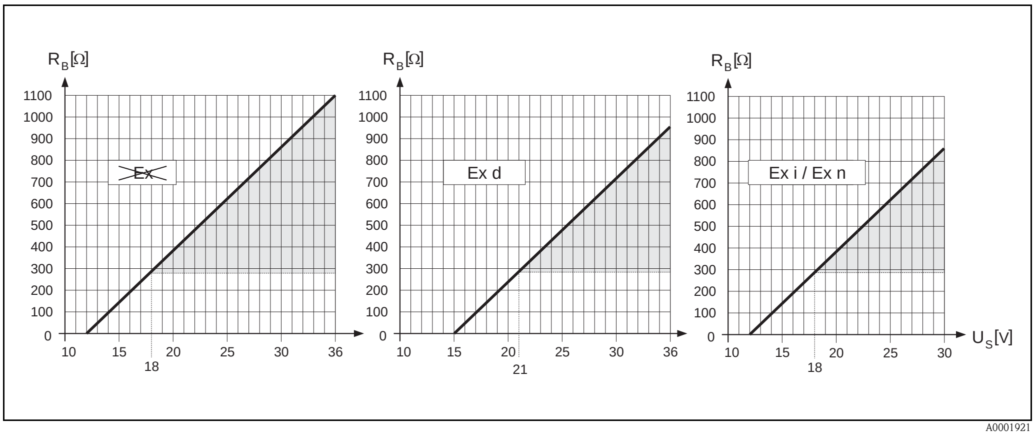
FOUNDATION Fieldbus interface:

- 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

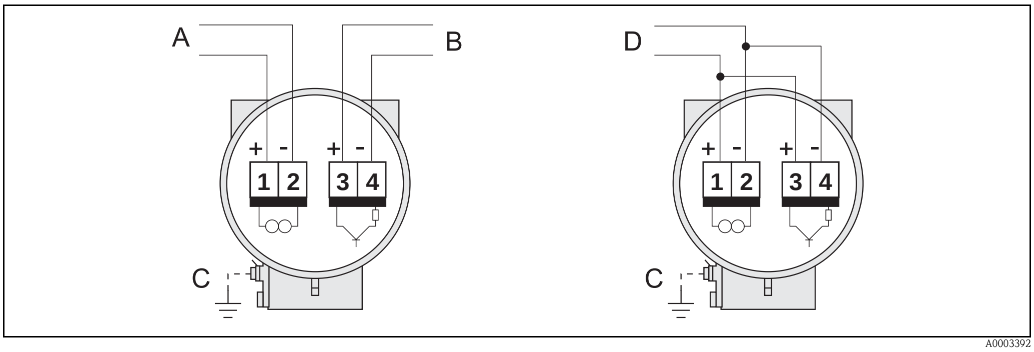
Switch points for low flow cut off can be selected as required.

Galvanic isolation

All electrical connections are galvanically isolated from one another.

Power supply

Electrical connection



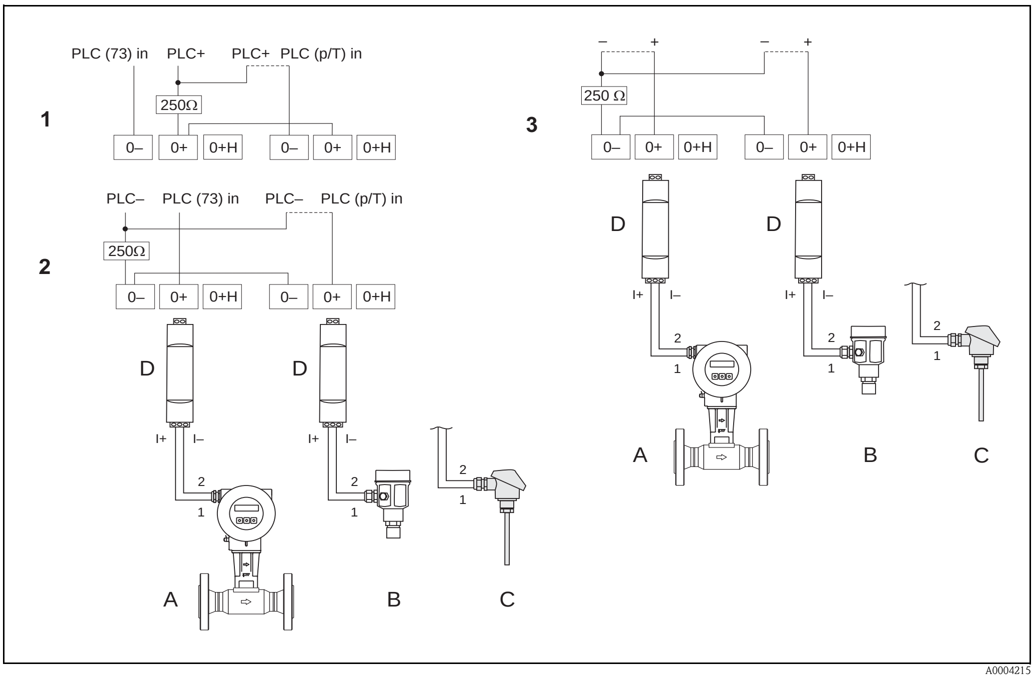
A – *HART: power supply, current output*
– *PROFIBUS PA: 1 = PA+, 2 = PA–*
– *FOUNDATION Fieldbus: 1 = FF+, 2 = FF–*

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



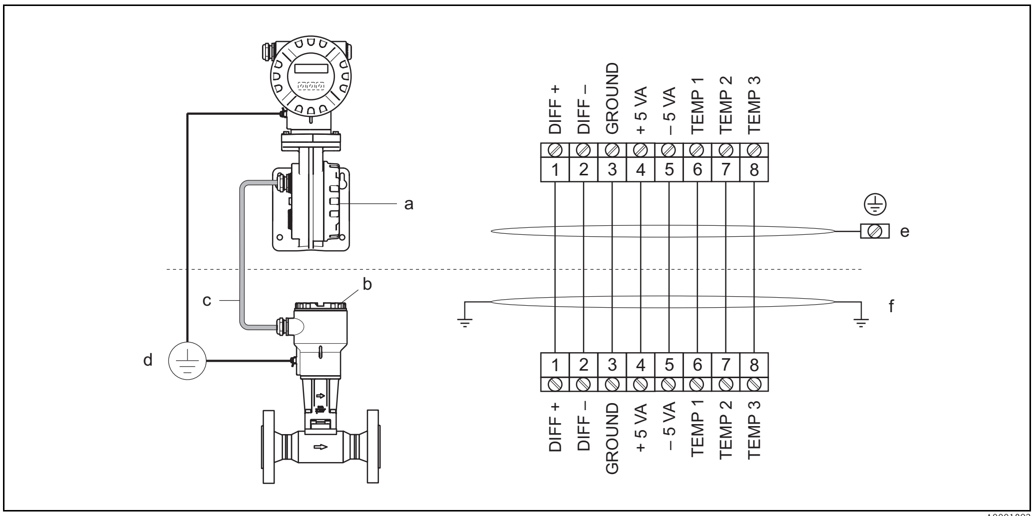
1 *Connection diagram for PLC with common "plus"*
Dotted line = alternative wiring when only the signal of the Prowirl 73 is fed to the PLC.

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

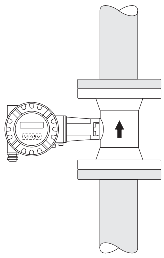
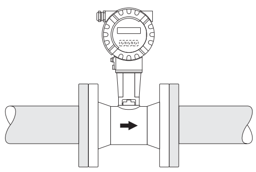
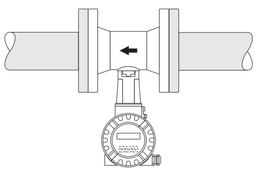
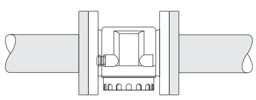
Current output (additional error, in reference to the span of 16 mA):
- Zero point (4 mA):
  Average Tk: 0.05%/10K, max. 0.6% over the entire temperature range –40 to +80 °C
- Span (20 mA):
  Average Tk: 0.05%/10K, max. 0.6% over the entire temperature range –40 to +80 °C

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:

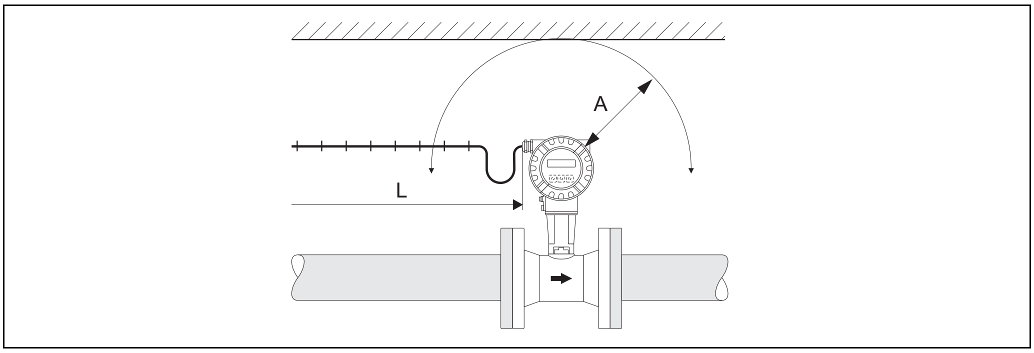
③ Select orientation C or D for hot fluids (e.g. steam or fluid temperature (TM) ≥200 °C

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



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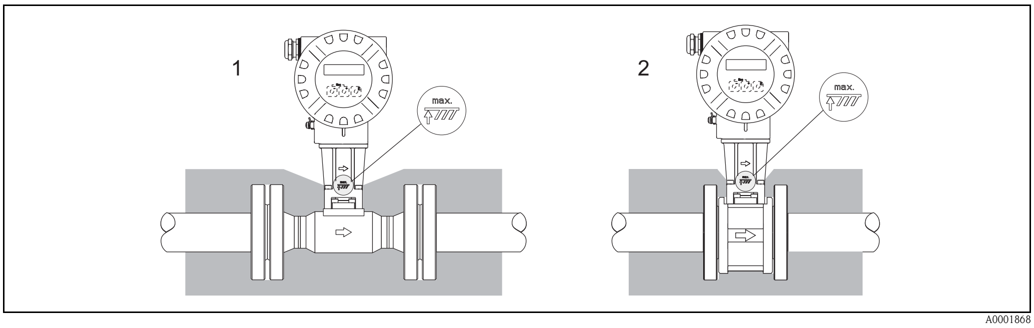
Rotating the electronics housing and the display

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

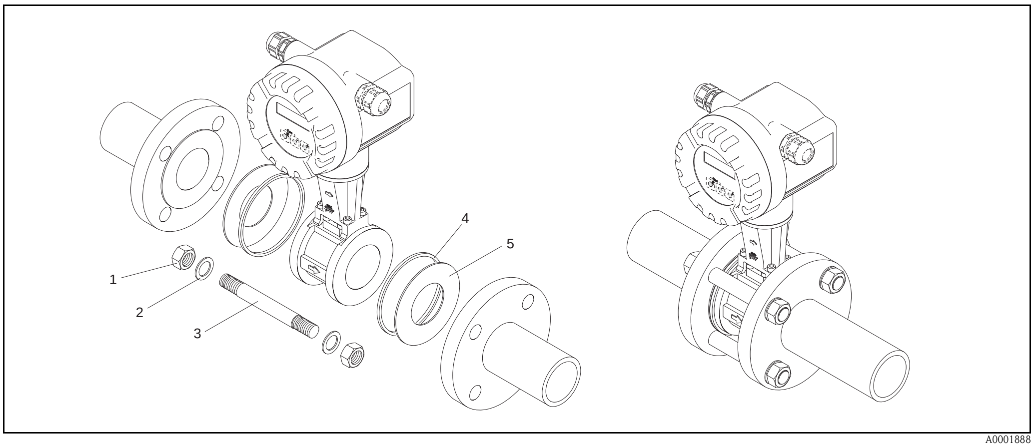
When insulating, please ensure that a sufficiently large area of the housing support is exposed.
The uncovered part serves as a radiator and protects the electronics from overheating (or undercooling).
The maximum insulation height permitted is illustrated in the diagrams. These apply equally to both the compact version and the sensor in the remote version.



1 = Flanged version
2 = Wafer version

Wafer version mounting set

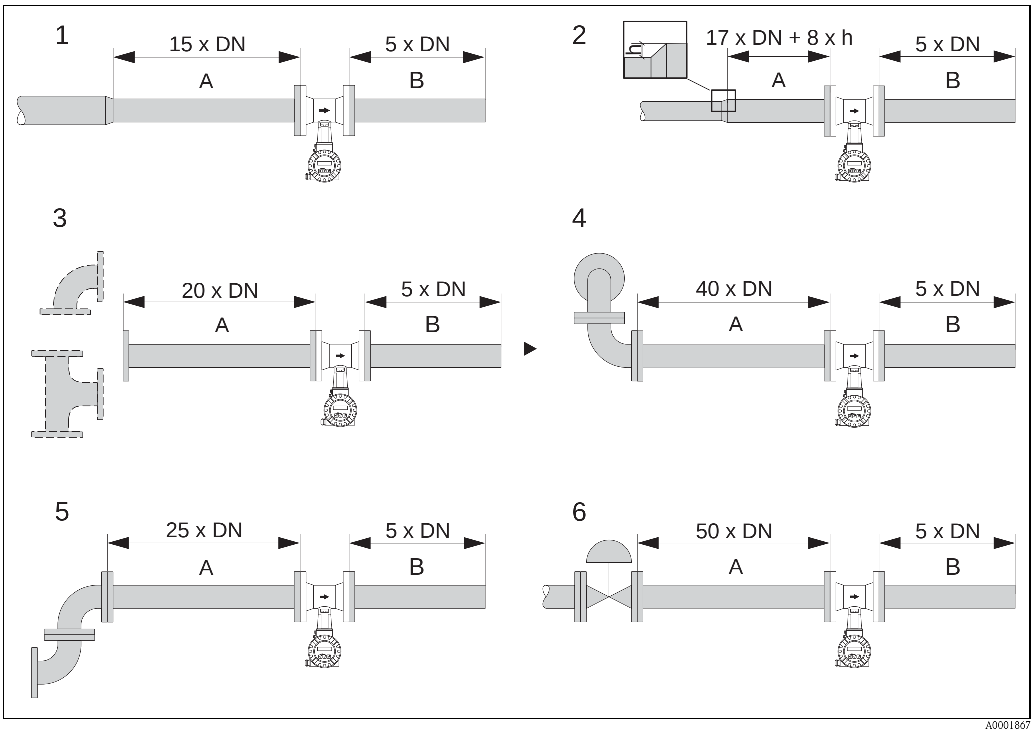
The centering rings supplied are used to mount and center the wafer-style devices. A mounting set consisting of tie rods, seals, nuts and washers can be ordered separately.



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.



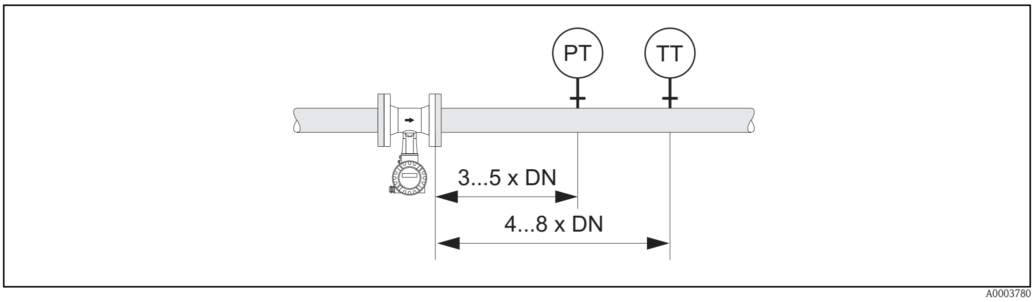
Minimum inlet and outlet runs with various flow obstructions

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

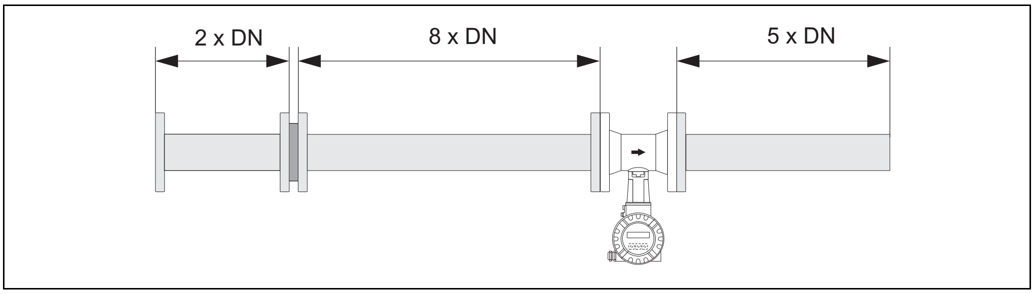
If pressure and temperature measuring points are installed after the device, please ensure there is a large enough distance between the device and the measuring point so there are no negative effects on vortex formation in the sensor.



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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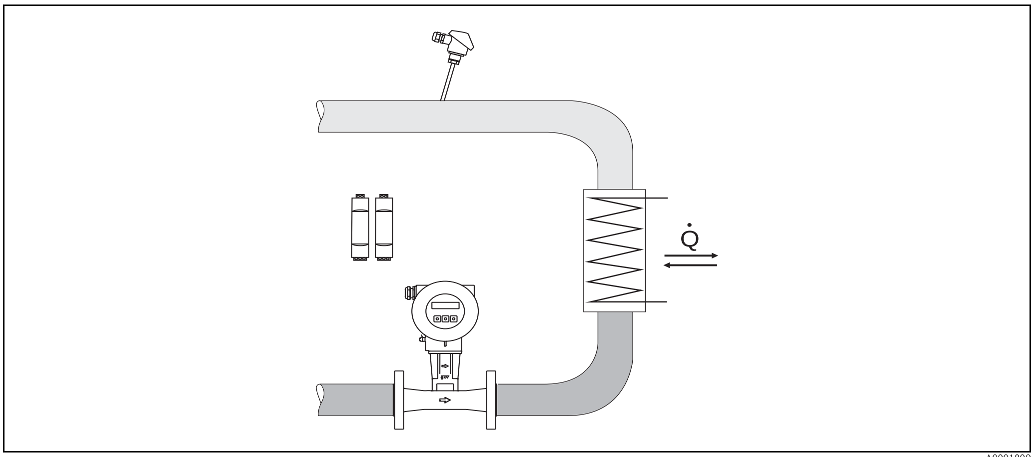
The pressure loss for flow conditioners is calculated as follows:
Δp [mbar] = 0.0085 · ρ [kg/m³] · v² [m/s]

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

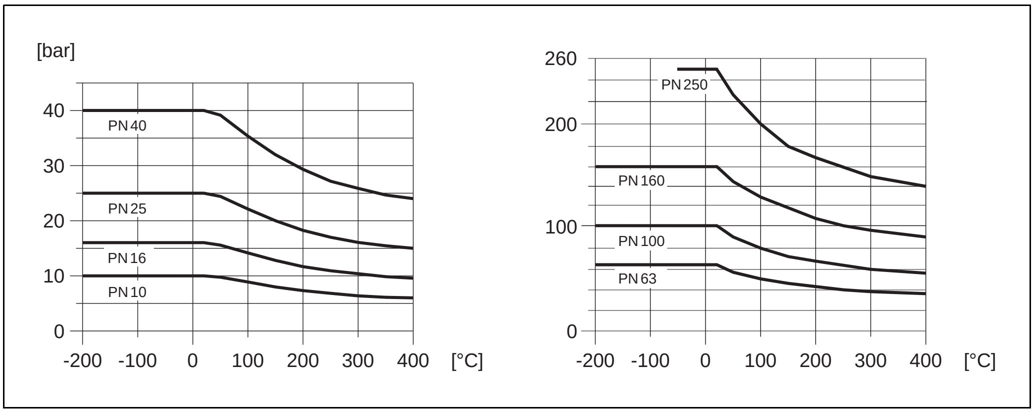
Stainless steel	–200 to +400 °C
Special version for high fluid temperatures (on request)	–200 to +450 °C –200 to +440 °C, Ex version

Medium pressure

Prowirl 72

Pressure-temperature curve to EN (DIN), stainless steel

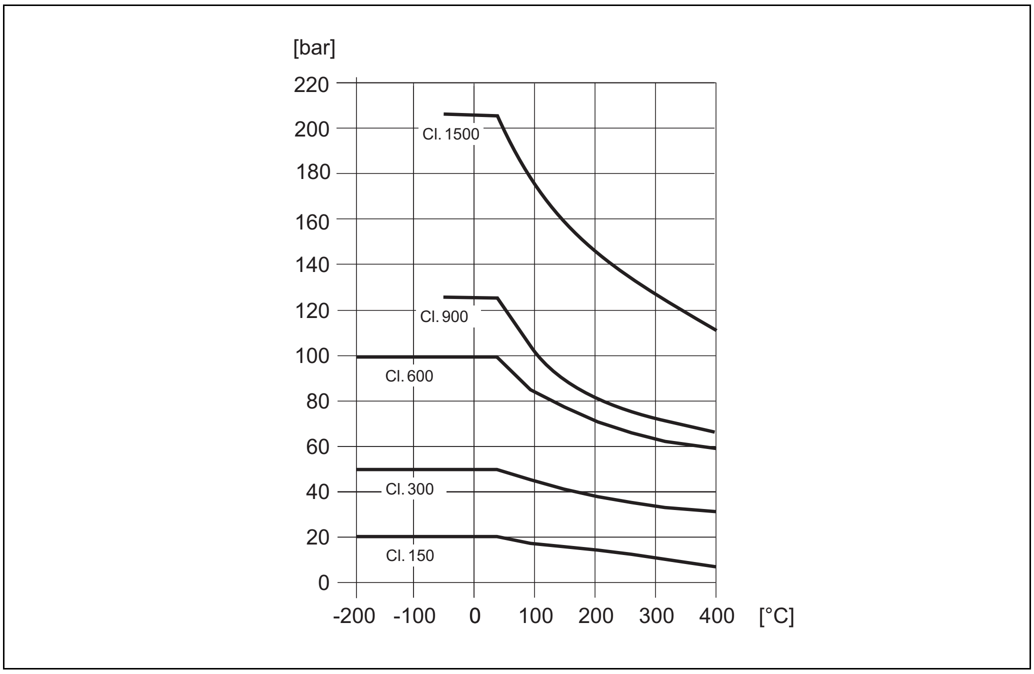
PN 10 to 40 → Prowirl 72W and 72F
PN 63 to 250 → Prowirl 72F



A0003238-en

Pressure-temperature curve to ANSI B16.5, stainless steel

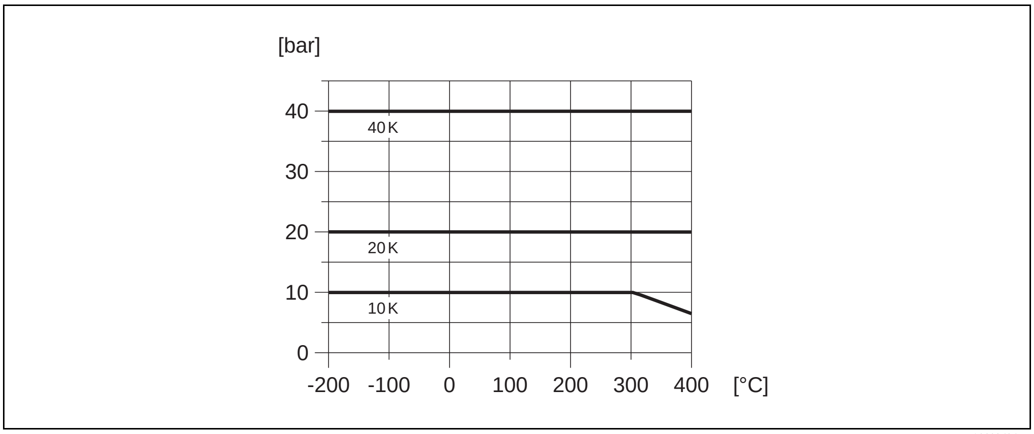
Class 150 to 300 → Prowirl 72W and 72F
Class 600 to 1500 → Prowirl 72F



A0003402-en

Pressure-temperature curve to JIS B2220, stainless steel:

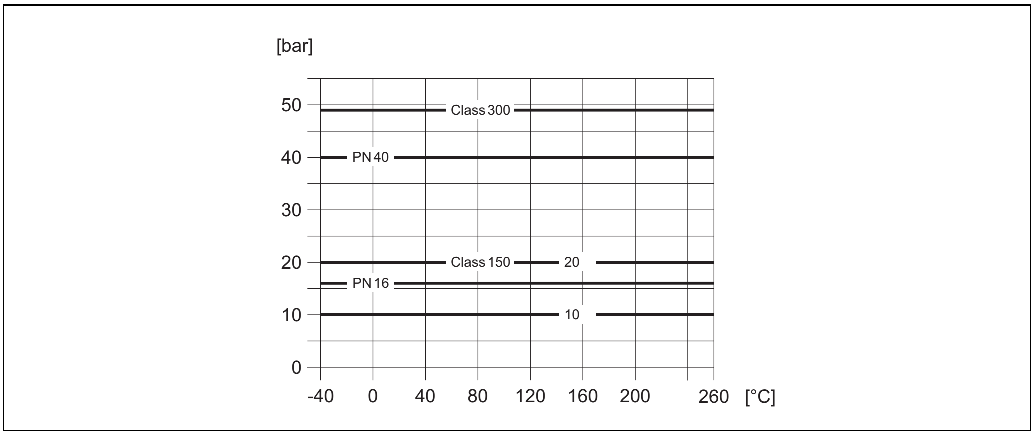
10 to 20K → Prowirl 72W and 72F
40K → Prowirl 72F



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

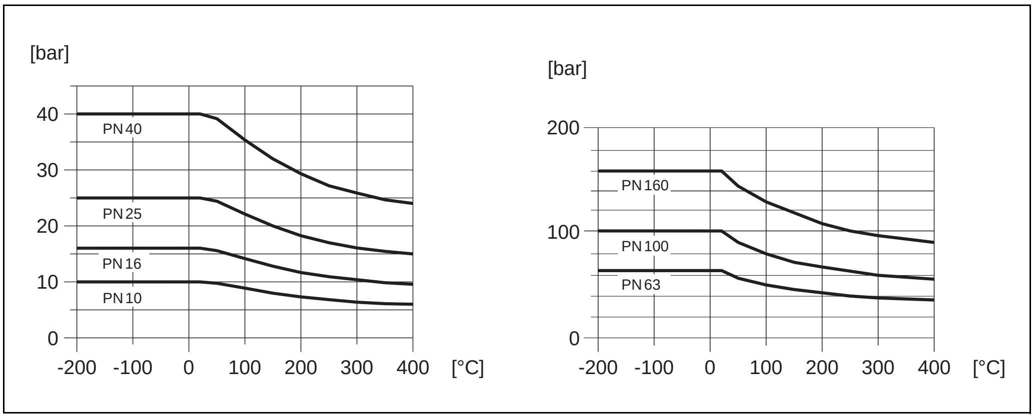


A0003395-en

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)

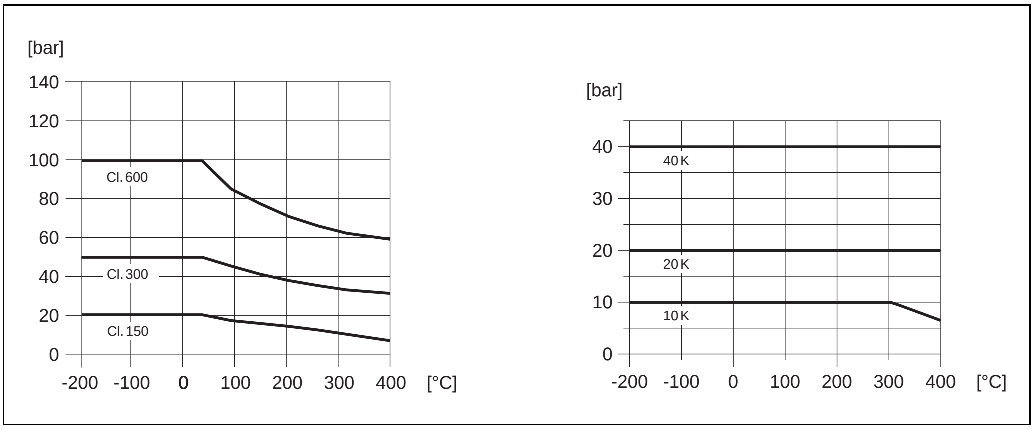


A0007085-en

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

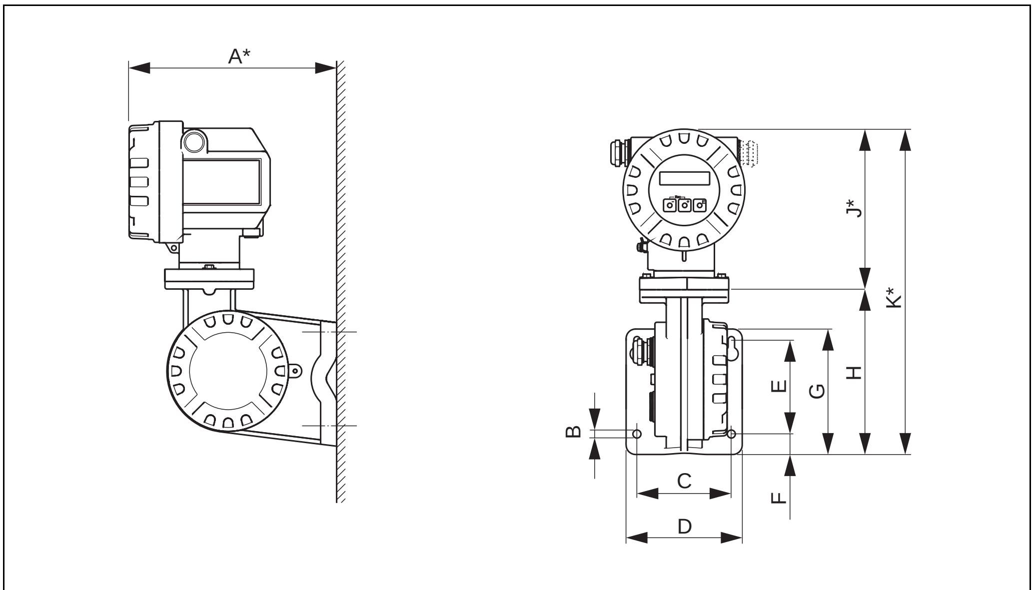
Pressure loss

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

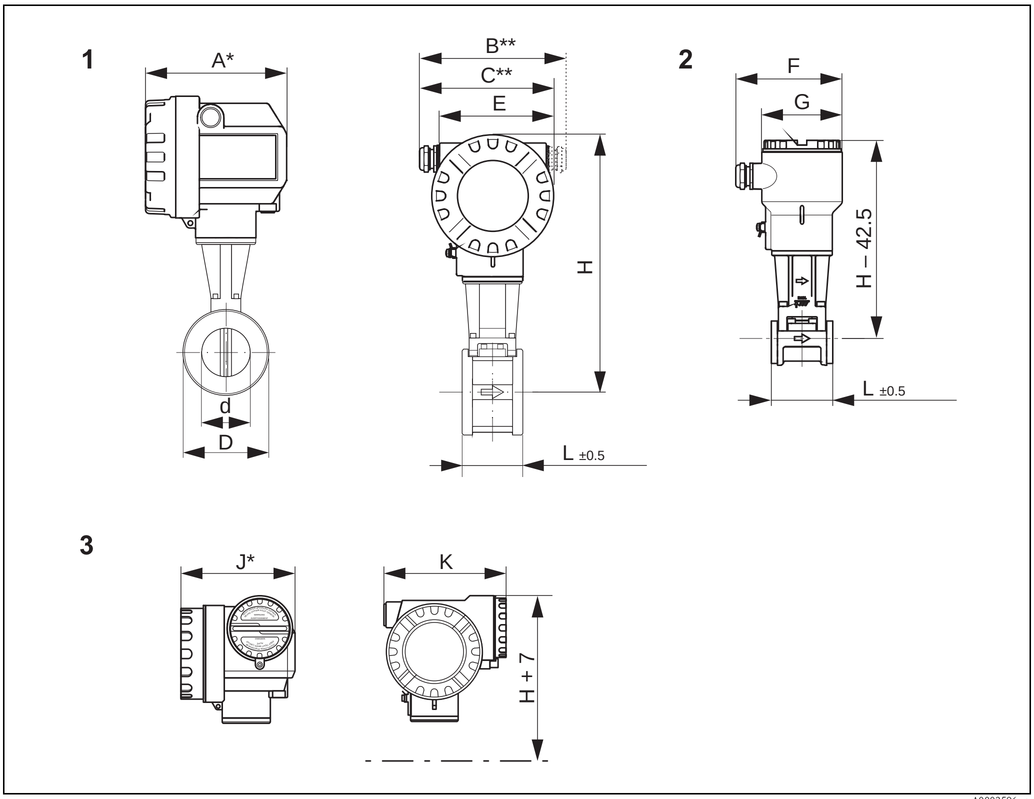
A	B	C	D	E	F	G	H	J	K
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
232	∅ 8.6 (M8)	100	123	100	23	144	170	170	340

* 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

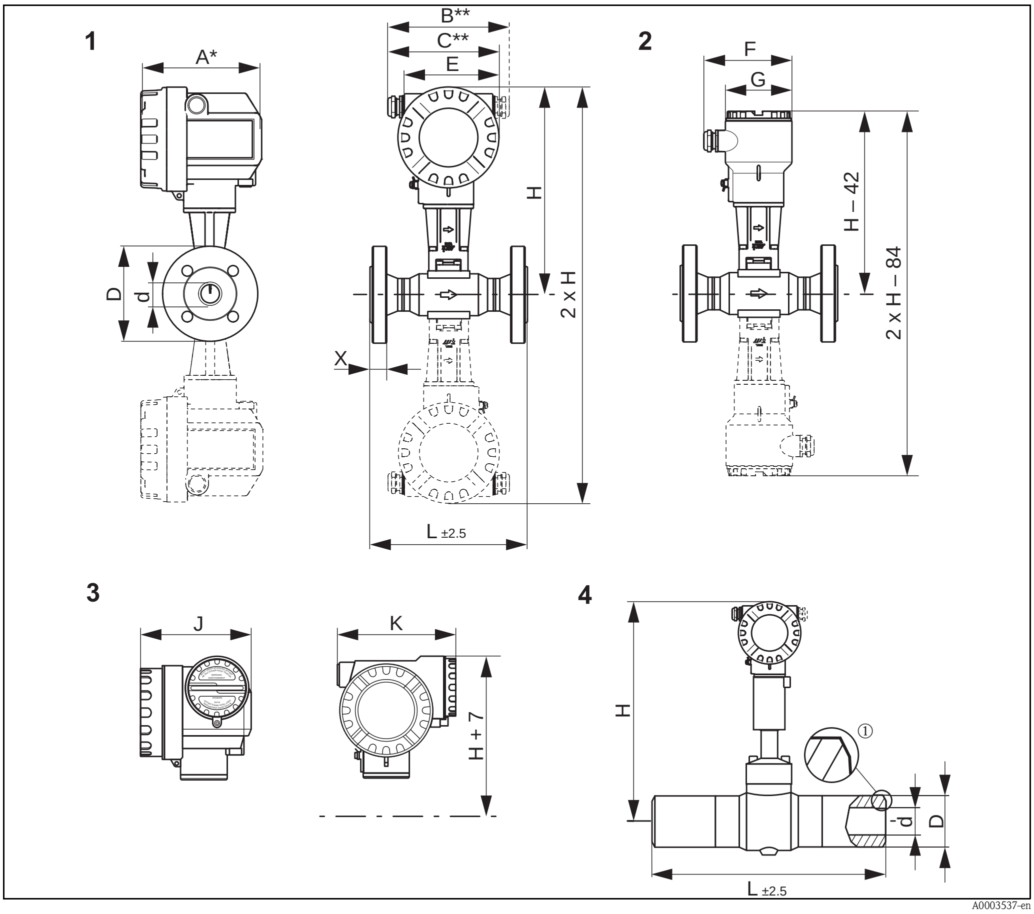
[1] The dimension H increases by 29 mm for Prowirl 72 (high-temperature version and for the version with a DSC sensor made of Alloy C-22) and for Prowirl 73 (version with extended temperature range).

[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 mm	D mm	H[3)] mm	L mm	X mm	Weight[4)] 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 mm	D mm	H[3] mm	L mm	X mm	Weight[4] 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

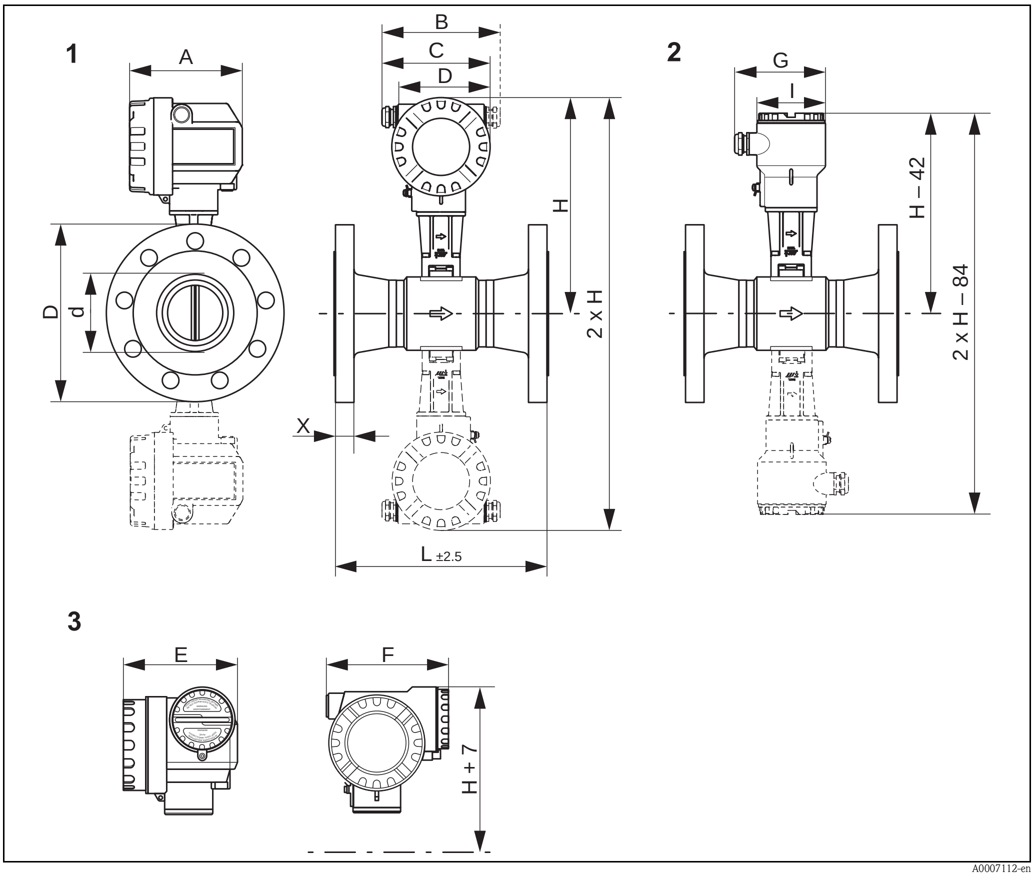
Flanged versions (standard devices) to JIS B2220 Prowirl 72F, 73F									
DN	Pressure rating		d [mm]	D [mm]	H[2)] [mm]	L [mm]	X [mm]	Weight[3)] [kg]
300[4)]	Schedule 40	10K	304.8	445	398	450	51	119
	Schedule 40	20K	304.8	480	398	450	51	134

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.

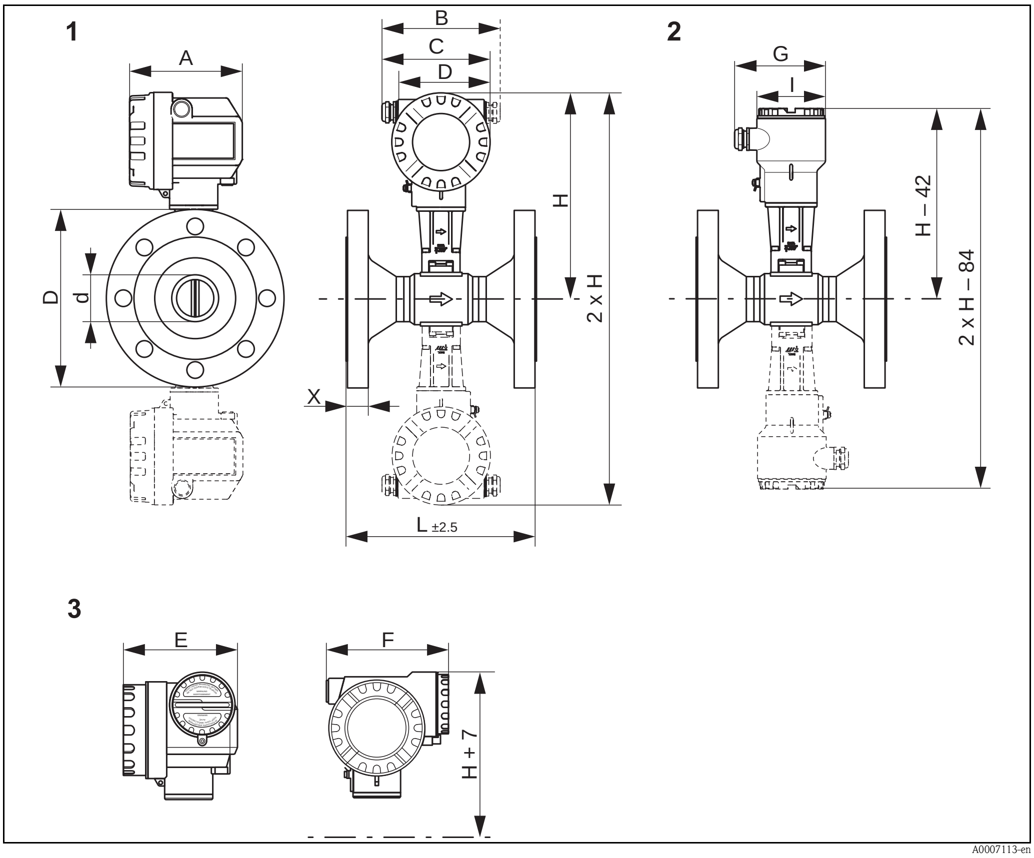
Flanged versions (R Style) to JIS B2220 Prowirl 72F, 73F										
DN	Inner diameter	Pressure rating		d [mm]	D [mm]	H[1] [mm]	L [mm]	X [mm]	Weight[2] [kg]
25[3]	15	Sched. 40	20K	22.0	125	248	200	18.5	7
		Sched. 80	20K	22.0	125	248	200	18.5	7
40[3]	25	Sched. 40	20K	30.0	140	255	200	18.5	8
		Sched. 80	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



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 dia-meter	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

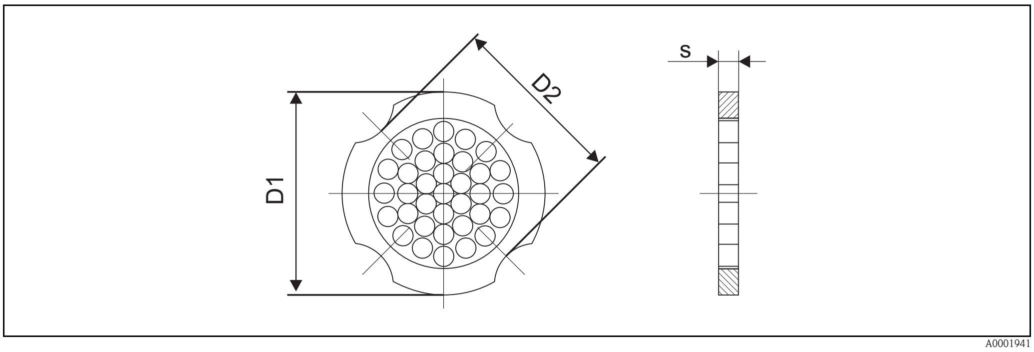
DN	Inner diameter	Pressure rating		d [mm]	D [mm]	H[1] [mm]	L [mm]	X [mm]	Weight[2] [kg]
40[3]	15	Sched. 40	20K	22	140	248	200	20.5	8
		Sched. 80	20K	22	140	248	200	20.5	8
50[3]	25	Sched. 40	10K	30	155	255	200	20.5	9
		Sched. 40	20K	30	155	255	200	21.0	11
		Sched. 80	10K	30	155	255	200	20.5	9
		Sched. 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.



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™ 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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Endress+Hauser
People for Process Automation

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71081835
FM+SGML 6.0 ProMoDo

Appendix I

Product Information

Endress+Hauser FMU40 Ultrasonic Meter

Endress+Hauser WaterPilot FMX167 Level Meter

Endress+Hauser PMC71 Pressure Transmitter

Appendix I
Product Information
Endress+Hauser FMU40 Ultrasonic Meter
Endress+Hauser WaterPilot FMX167 Level Meter
Endress+Hauser PMC71 Pressure Transmitter

ENDRESS+HAUSER PROSONIC FMU40 LEVEL METER

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Prosonic M FMU40/41/42/43/44

Ultrasonic Level Measurement
Compact transmitters for non-contact level measurement of fluids, pastes and coarse bulk materials

Application

- Continuous, non-contact level measurement in fluids, pastes, sullages and coarse bulk materials
- Flow measurement in open channels and measuring weirs
- System integration via:
  - HART (standard), 4...20mA
  - PROFIBUS PA
  - Foundation Fieldbus
- Maximum measuring range:
  - FMU 40:
    5 m in fluids / 2 m in bulk materials
  - FMU 41:
    8 m in fluids / 3,5 m in bulk materials
  - FMU 42:
    10 m in fluids / 5 m in bulk materials
  - FMU 43:
    15 m in fluids / 7 m in bulk materials
  - FMU44:
    20 m in fluids / 10 m in bulk materials

Features and benefits

- Quick and simple commissioning via menu-guided on-site operation with four-line plain text display
- Envelope curves on the on-site display for simple diagnosis
- Easy remote operation, diagnosis and measuring point documentation with the supplied ToF Tool operating program.
- Suitable for explosion hazardous areas (Gas-Ex, Dust-Ex)
- Linearisation function (up to 32 points) for conversion of the measured value into any unit of length, volume or flow rate
- Non-contact measurement method minimizes service requirements
- optional remote display and operation (up to 20 m from transmitter)
- Installation possible from thread G 1½“ or 1½ NPT upwards
- Integrated temperature sensor for automatic correction of the temperature dependent sound velocity

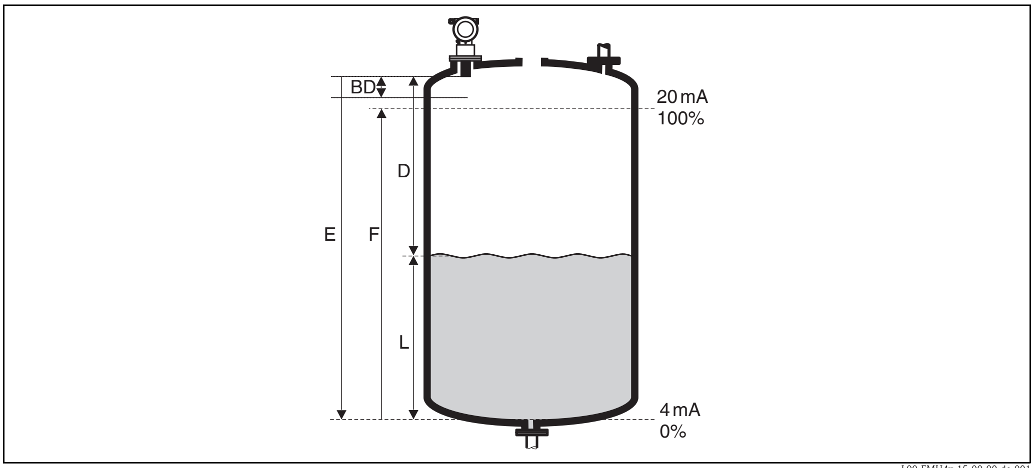
TI365F/00/en/01.09
71089083

Endress+Hauser
People for Process Automation

Inhaltsverzeichnis

Function and system design

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
FMU40	0.25 m	5 m	2 m
FMU41	0.35 m	8 m	3.5 m
FMU42	0.4 m	10 m	5 m
FMU43	0.6 m	15 m	7 m
FMU44	0.5 m	20 m	10 m

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.

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.

Calibration

Enter the empty distance E and the span F to calibrate the device.

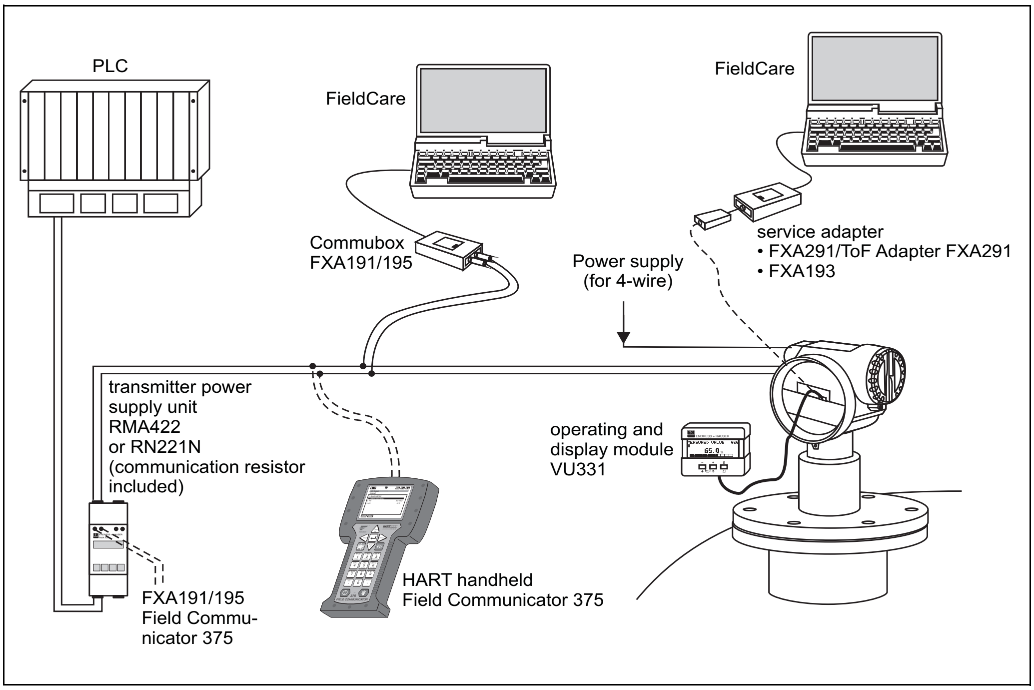
Blocking distance

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.

Equipment architecture

4…20 mA output with HART protocol

The complete measuring system consists of:



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If the HART communication resistor is not built into the supply unit, it is necessary to insert a communication resistor of 250 Ω into the 2-wire line.

On-site operation

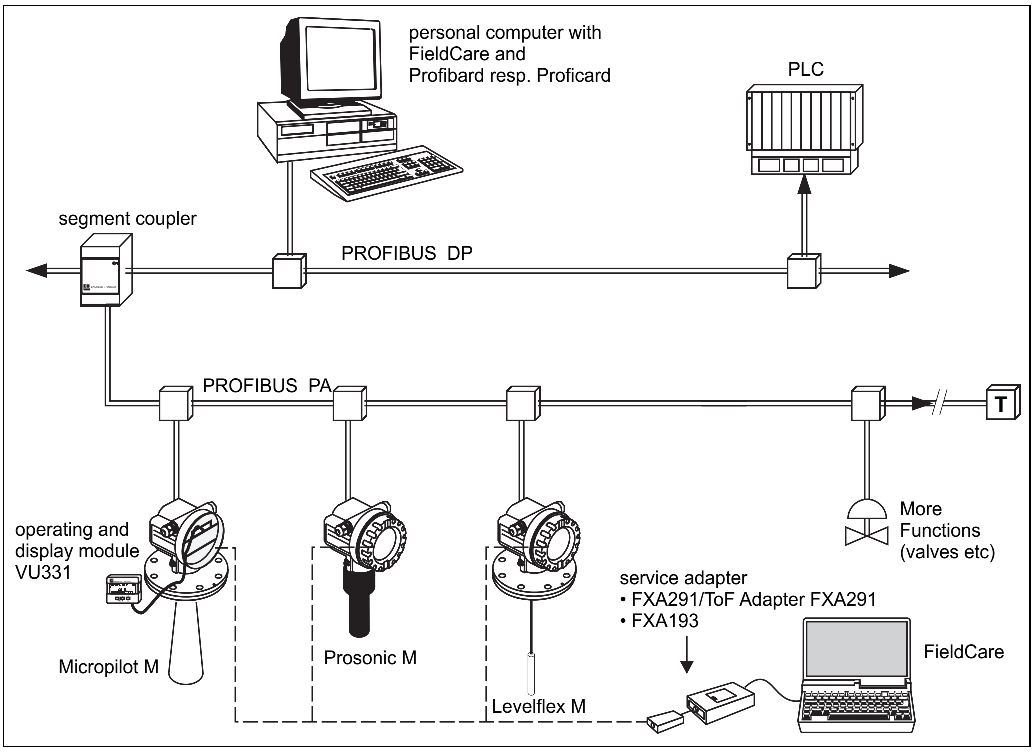
- with display and operating module VU 331
- with a Personal Computer, FXA 193 and the operating software ToF Tool

Remote operation

- with HART handheld terminal DXR 375
- with a Personal Computer, Commubox FXA 191 and the operating software COMMUWIN II respectively ToF Tool.

System integration using PROFIBUS PA

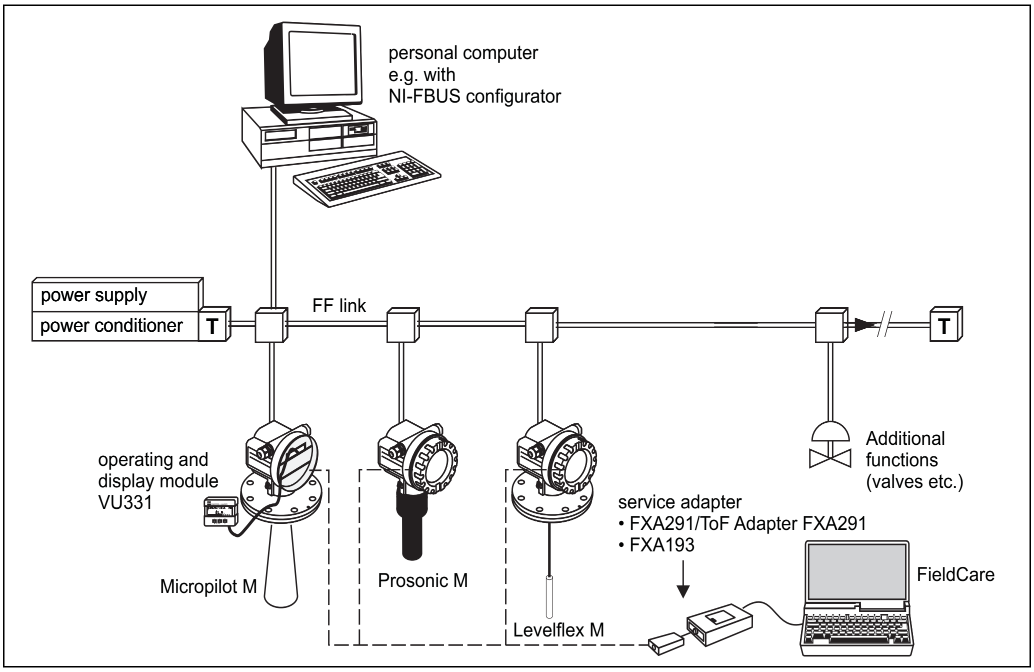
A maximum of 32 transmitters (8 if mounted in an explosion hazardous location EEx ia IIC according to FISCO-model) can be connected to the bus.The segment coupler provides the operating voltage to the bus. Both on-site as well as remote operation are possible.



L00-FMxxXXXX-14-00-06-en-001

System integration using Foundation Fieldbus (FF)

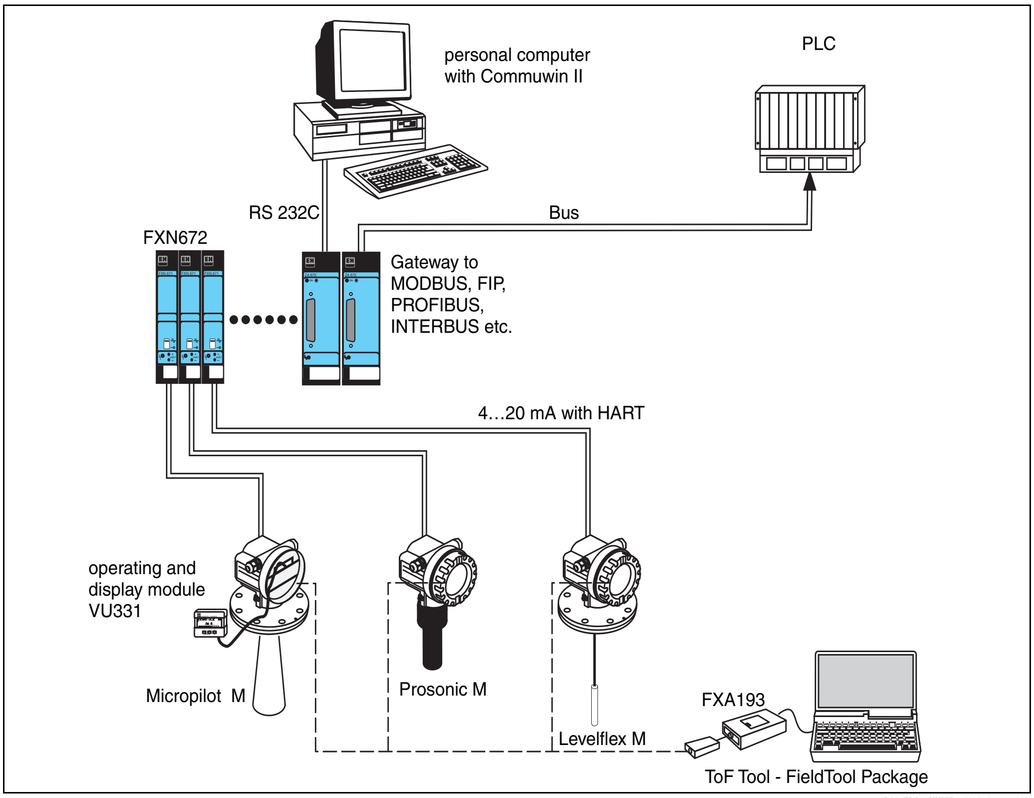
A maximum of 32 transmitters (standard or EEx d) can be connected to the bus. For protection class EEx ia: the maximum number of transmitters depends on the established rules and standards for intrinsically safe circuits (EN 60070-14) and proof of instrinsic safety. Both on-site and remote operation are possible.



L00-FMxxXXXX-14-00-06-en-003

System integration using Endress+Hauser Rackbus

You can interconnect a maximum of 64 2-wire devices with HART protocol to a Rackbus. Use an FXN 672 interface module for each device. You can integrate this bus into a higher-level bus by using a ZA gateway. Gateways are available for MODBUS, FIP, PROFIBUS, INTERBUS etc. Both on-site and remote operation are possible.



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Hinweis!
The FXN672 can be used with all 2-wire devices of the Prosonic M family.

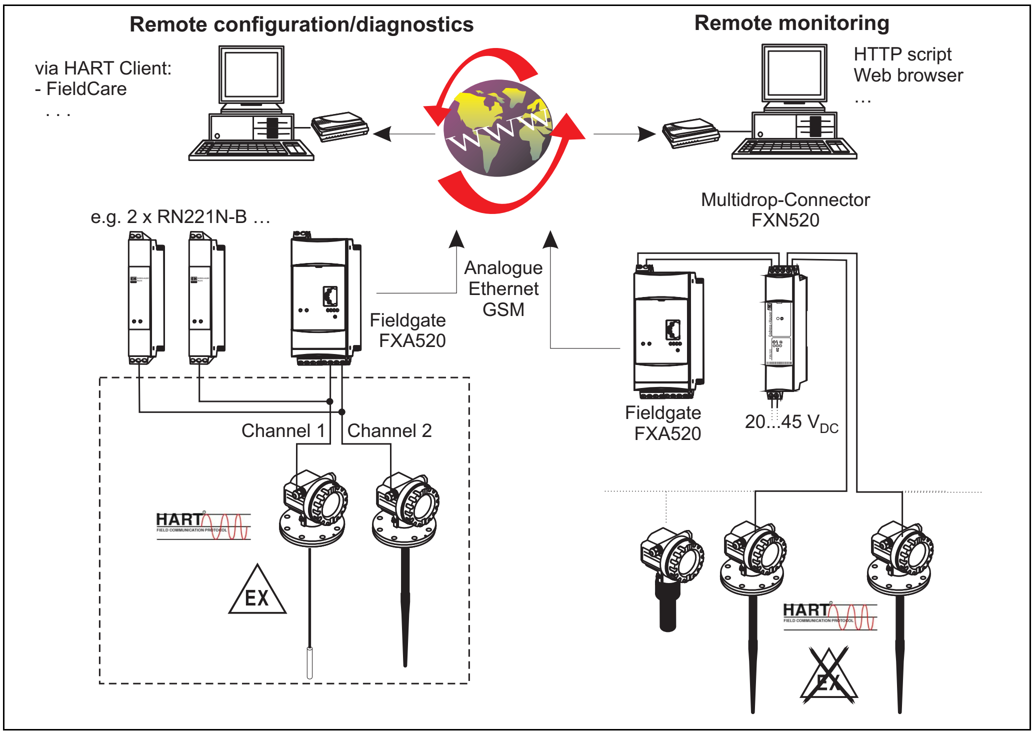
System integration via Fieldgate

Vendor Managed Inventory

By using Fieldgates to interrogate tank or silo levels remotely, suppliers of raw materials can provide their regular customers with information about the current supplies at any time and, for example, account for them in their own production planning. For their part, the Fieldgates monitor the configured level limits and, if required, automatically activate the next supply. The spectrum of options here ranges from a simple purchasing requisition via e-mail through to fully automatic order administration by coupling XML data into the planning systems on both sides.

Remote maintenance of measuring equipment

Fieldgates not only transfer the current measured values, they also alert the responsible standby personnel, if required, via e-mail or SMS. In the event of an alarm or also when performing routine checks, service technicians can diagnose and configure connected HART devices remotely. All that is required for this is the corresponding HART operating software (e.g. ToF Tool - FieldTool Package, FieldCare, ...) for the connected device. Fieldgate passes on the information transparently, so that all options for the respective operating software are available remotely. Some on-site service operations can be avoided by using remote diagnosis and remote configuration and all others can at least be better planned and prepared.



L00-FXA520xx-14-00-06-en-009

Note!
The number of instruments which can be connected in mutidrop mode can be calculated by the "FieldNetCalc" program. A description of this program can be found in Technical Information TI 400F (Multidrop Conncector FXN520). The program is available form your Endress+Hauser sales organisation or in the internet at: "**www.endress.com ➔ Download**" (Text Search = "Fieldnetcalc").

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

Measuring range

The measuring range is limited by the range of a sensor. The sensor range is, in turn, dependent on the operating conditions. To estimate the actual range, proceed as follows (see also the calculation example in the diagram):

1. Determine which of the influences shown in the following table are appropriate for your process.
2. Add the corresponding attenuation values.
3. From the total attenuation, use the diagram to calculate the range.

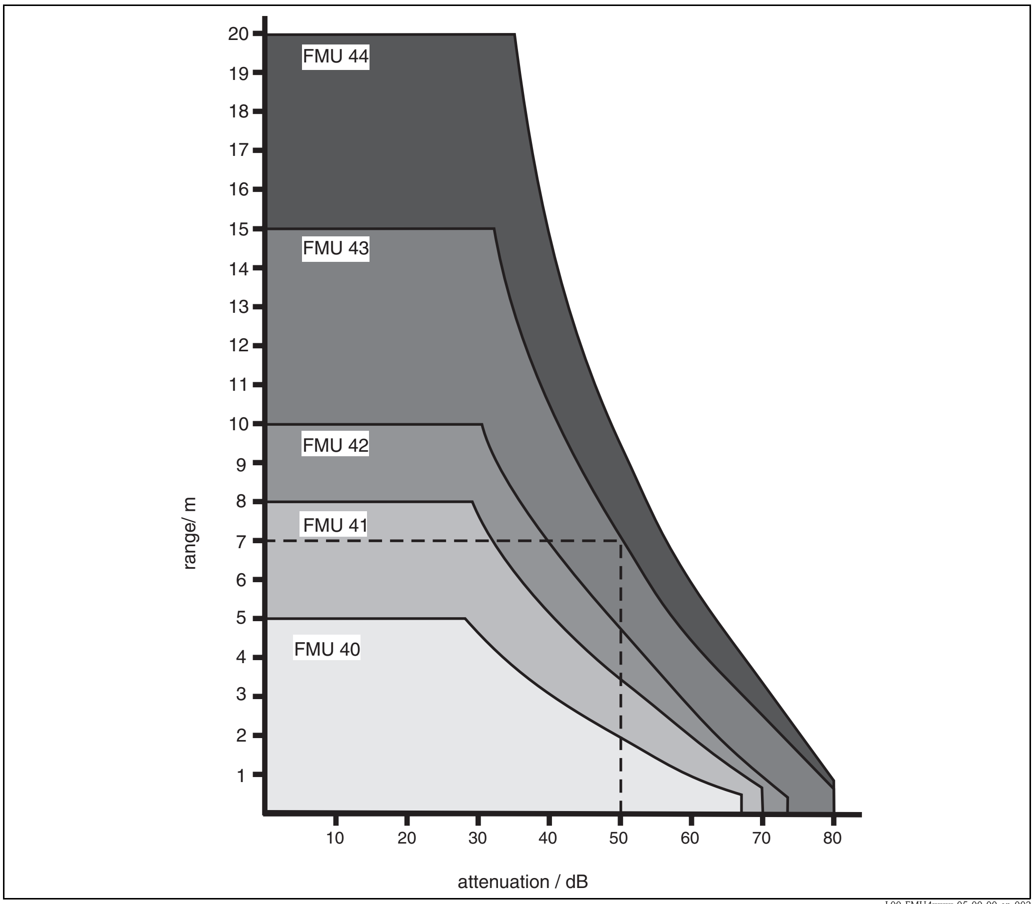
Fluid surface	Attenuation
Calm	0 dB
Waves	5 ... 10 dB
Strong turbulence (e.g. stirrers)	10 ... 20 dB
Foaming	Ask Endress+Hauser

Bulk material surface	Attenuation
Hard, rough (e.g. rubble)	40 dB
Soft (e.g. peat, dust-covered clinker)	40 ... 60 dB

Dust	Attenuation
No dust formation	0 dB
Little dust formation	5 dB
Heavy dust formation	5 ... 20 dB

Filling curtain in detection range	Attenuation
None	0 dB
Small quantities	5 ... 10 dB
Large quantities	10 ... 40 dB

Temperature difference between sensor and product surface	Attenuation
to 20 °C	0 dB
to 40 °C	5 ... 10 dB
to 80 °C	10 ... 20 dB



L00-FMU4xxxx-05-00-00-en-002

Example (for FMU 43)

For typical solid applications, a certain amount of dust coverage is normally present. Therefore, the following range results from the table and the diagram

▪ Dust-covered rubble	approx. 50 dB	
▪ no dust formation	0 dB	
▪ No filling curtain in detection range	0 dB	
▪ Temperature diff. < 20°C	0 dB	
	approx. 50 dB	=> range approx. 7 m

These measuring conditions have been taken into account during the calculation of the maximum measuring range in solid applications.

Operating frequency

Sensor	Operating frequency
FMU40	approx. 70 kHz
FMU41	approx. 50 kHz
FMU42	approx. 42 kHz
FMU43	approx. 35 kHz
FMU44	approx. 30 kHz

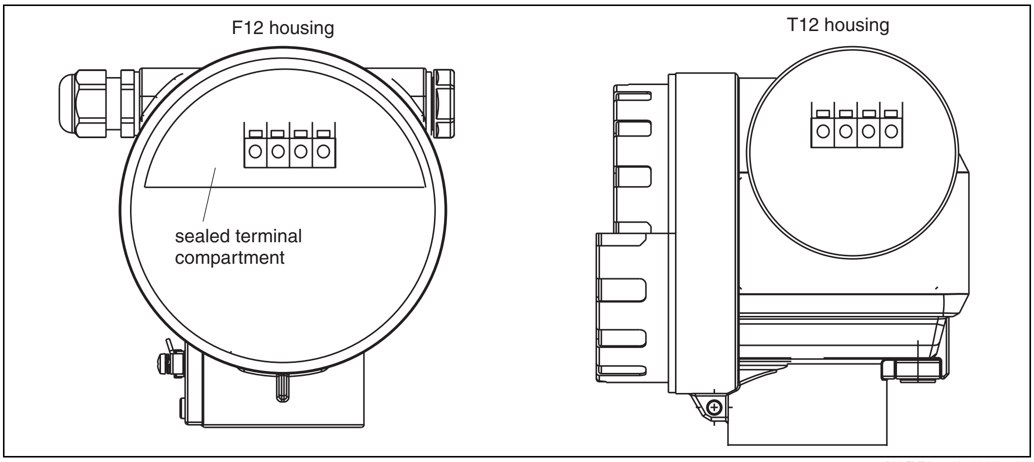
Output

Output signal	according to the instrument version ordered: ▪ 4…20 mA with HART protocol ▪ PROFIBUS PA ▪ Foundation Fieldbus (FF)
Signal on alarm	Error information can be accessed via the following interfaces: ▪ On-site display (error symbol, error code and plain text description) ▪ Current output (error current configurable) ▪ Digital interface
Load HART	Minimum load for HART communication: 250 Ω
Output damping	Freely selectable, 0 ... 255 s
Linearisation	The linearisation function of the Prosonic M allows conversion of the measured value into any unit of length or volume. In open channels or measuring weirs, also a flow linearistion is possible (calculation of the flow from the measured level). The linearisation table for calculating the volume in an horizontal cylindrical tank is preprogrammed. You can also enter any number of other tables containing up to 32 value pairs either manually or semi-automatically (by filling the vessel under controlled conditions). The supplied ToF Tool operating program can automatically calculate the table for any tank, weir or flume and upload it into the device. Flow curves for open channels can be calculated and entered into the instrument by the ToT Tool as well.

Auxiliary energy

Terminal compartment

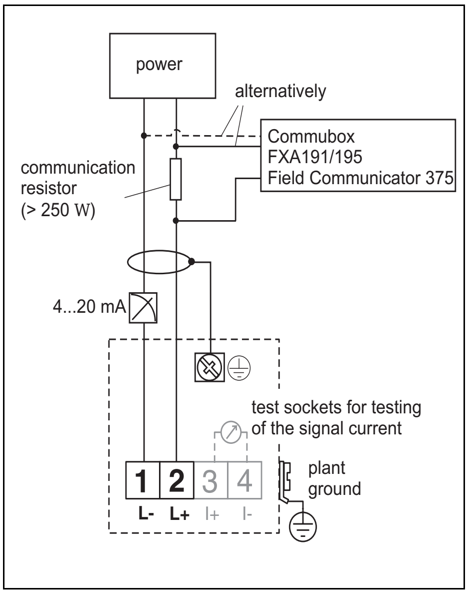
In the F12 housing, the terminals are located underneath the housing cover. In the T12 housing, they are under the cover of the separate terminal compartment.



L00-FMR2xxxx-04-00-00-en-001

Terminal assignment

4 ... 20 mA with HART, 2-wire



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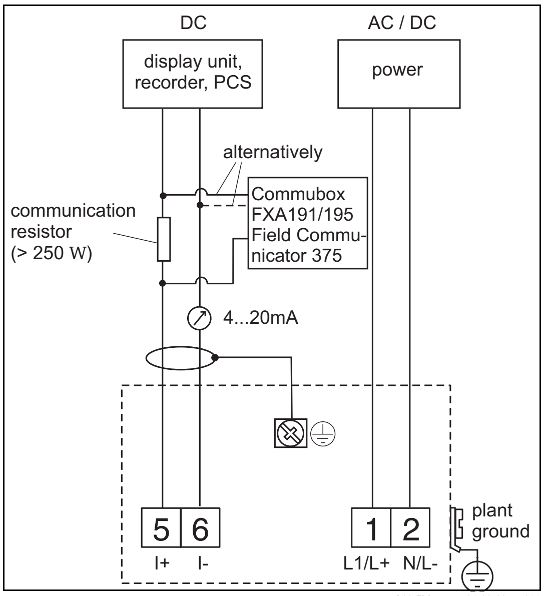
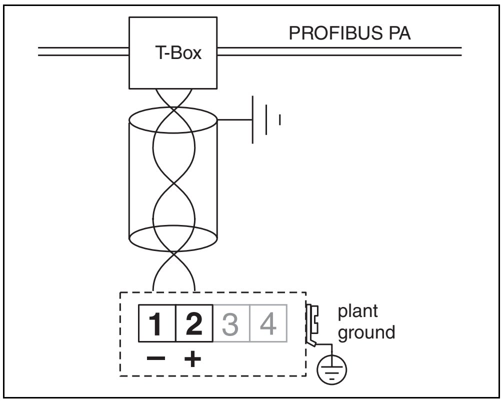
4 ... 20 mA active with HART, 4-wire



L00-FMxxxxxx-04-00-00-en-011

- Connect the connecting line to the screw terminals (line cross-sections of 0.5 ... 2.5 mm) in the terminal compartment.
- Use 2-wire twisted pair cable with screen for the connection.
- Protective circuitry against reverse polarity, RFI and over-voltage peaks is built into the device (see also Technical Information TI 241F/00/en "EMC Test Procedures")

PROFIBUS PA



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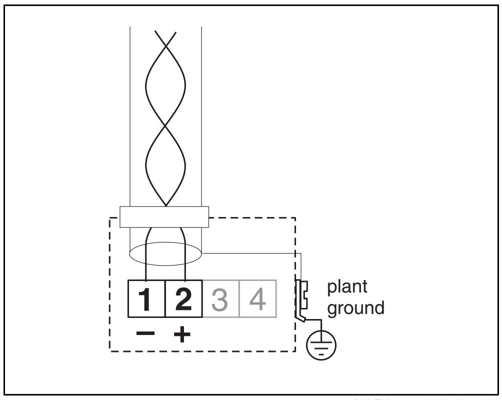
Foundation Fieldbus



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The digital communication signal is transmitted to the bus via a 2-wire connection. The bus also provides the auxiliary energy. Use 2-wire twisted pair cable with screen.

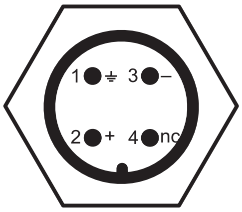
Refer to the following operating manuals for information on cable types, and how to set up and ground the network:

- BA 198F/00/de „PROFIBIS -DP/-PA, Guidelines for planning and commissioning“
- BA 013S/04/en „Foundation Fieldbus, Installation and Commissioning Guidelines“

Fieldbus plug connectors

For the versions with fieldbus plug connector (M12 or 7/8"), the signal line can be connected without opening the housing.

Pin assignment of the M12 plug connector (PROFIBUS PA plug)



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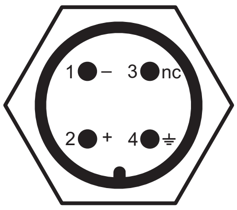
Pin	Meaning
1	Ground
2	Signal +
3	Signal -
4	not connected

Pin assignment of the 7/8" plug connector (FOUNDATION Fieldbus plug)



L00-FMxxxxxx-04-00-00-yy-017

Pin	Meaning
1	Signal -
2	Signal +
3	not connected
4	ground

Supply voltage

HART, 2-wire

The following values are the voltages across the terminals directly at the instrument:

Version		Current consumption	Terminal voltage minimum	Terminal voltage maximum
2-wire HART	Standard	4 mA	14 V	36 V
		20 mA	8 V	36 V
	EEx ia	4 mA	14 V	30 V
		20 mA	8 V	30 V
	EEx d	4 mA	14 V	30 V
		20 mA	11 V	30 V
Fixed current, adjustable, e.g. for solar power operation (measured value via HART)	Standard	11 mA	10 V	36 V
	EEx ia	11 mA	10 V	30 V
Fixed current for HART multidrop mode	Standard	4 mA[1)]	14 V	36 V
	EEx ia	4 mA[1]	14 V	30 V

1) Start-up current 11 mA

HART, 4-wire, active

Version	Voltage	max. load
DC	10,5 ... 32 V	600 Ω
AC 50/60 Hz	90 ... 253 V	600 Ω

Terminals

Cable cross-section: 0.5 to 2.5 mm (20 to 14 AWG)

Cable entry

- Cable gland: M20x1.5 (recommended cable diameter 6 ... 10 mm)
- Cable entry G ½ or ½ NPT
- PROFIBUS-PA M12 plug
- Fieldbus Foundation 7/8" plug

Power consumption

Version	Power consumption
2-wire	51 mW ... 800 mW
4-wire AC	max. 4VA
4-wire DC; FMU 40/41	330 mW ... 830 mW
4-wire DC; FMU 42/43	600 mW ... 1 W

Current consumption (2-wire-instruments)

Communication	Current consumption
HART	3,6 ... 22 mA
PROFIBUS PA	max. 13 mA
Foundation Fieldbus	max. 15 mA

HART ripple	47...125 Hz: Vpp = 200 mV (measured at 500 Ω)
Max. noise HART	500 Hz...10 kHz: Vrms = 2.2 mV (measured at 500 Ω)
Galvanic isolation	With 4-wire devices, the evaluation electronics and mains voltage are galvanically isolated from each other.

Performance characteristics

Reaction time

The reaction time depends on the parameter settings. The minimum values are:

- 2-wire devices (FMU40/41/42): min. 2 s
- 2-wire diveces (FMU43 - PROFIBUS PA or FOUNDATION Fieldbus): min. 2 s
- 2-wire devices (FMU44): min. 3 s
- 4-wire devices (FMU40/41/42/43/44): 0.5 s

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
FMU40	1 mm
FMU41	1 mm
FMU42	2 mm
FMU43	2 mm
FMU44	2 mm

Pulse frequency

- 2-wire devices (FMU40/41/42): max. 0.5 Hz
- 2-wire devices (FMU43 - PROFIBUS PA or FOUNDATION Fieldbus): max. 0.5 Hz
- 2-wire devices (FMU44): max. 0.3 Hz
- 4-wire devices (FMU40/41/42/43/44): max. 2 Hz

The exact values are dependent on the type of device and the parameter settings.

Measuring error

Typical specifications for reference operating conditions (include linearity, repeatability, and hysteresis):

Sensor	Measuring error
FMU40	±2mm or 0.2% of set measuring distance (empty calibration)[1]
FMU41	± 2 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU42	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU43	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU44	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]

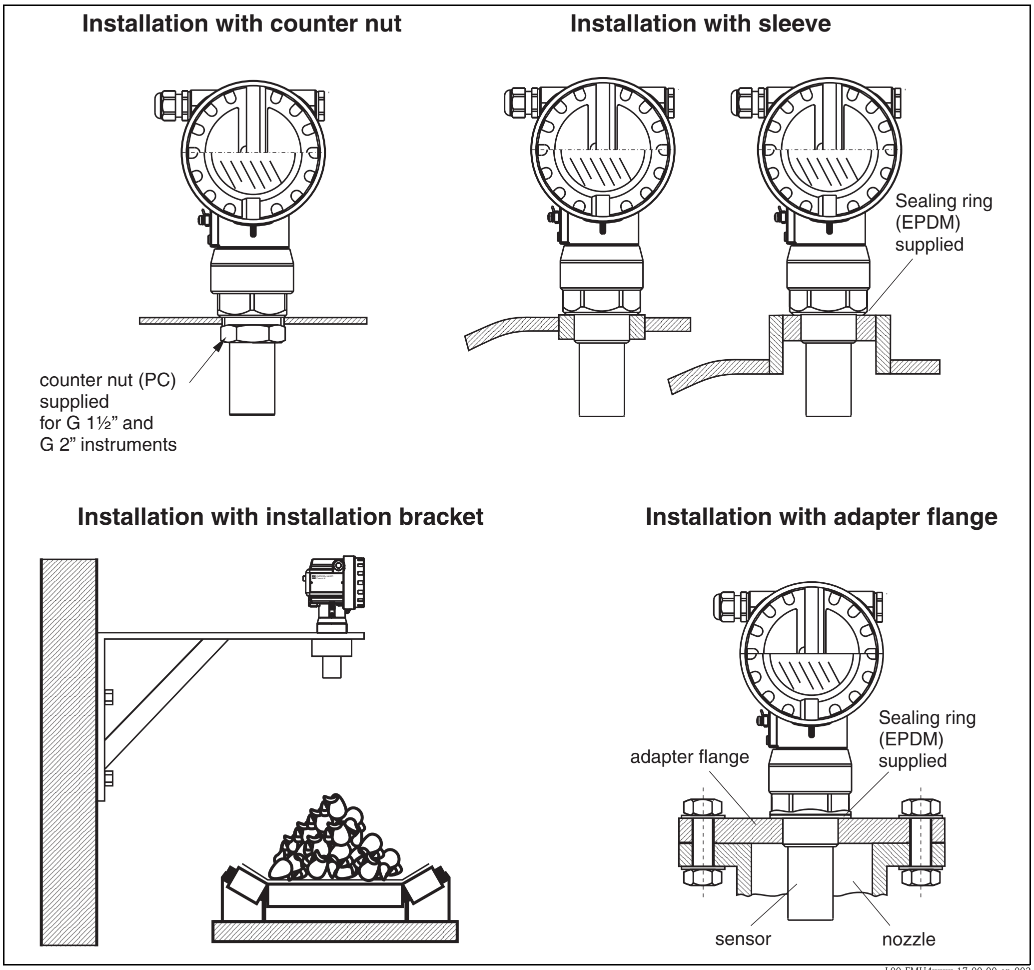
[1]whichever is greater

Influence of the vapor pressure

The vapor pressure at 20 °C (68 °F) gives a hint on the accuracy of the ultrasonic level measurement. If the vapor pressure at 20 °C (68 °F) is below 50 mbar, ultrasonic level measurement is possible with a very high accuracy. This is valid for water, aqueous solutions, water-solid-solutions, dilute acids (hydrochloric acid, sulfuric acid, ...), dilute bases (caustic soda, ...), oils, greases, slurries, pastes, ...
High vapor pressures or outgassing media (ethanol, acetone, ammonia, ...) can influence the accuracy. If conditions like these are present, please contact the Endress+Hauser support.

Installation conditions

Installation variants FMU 40, FMU 41



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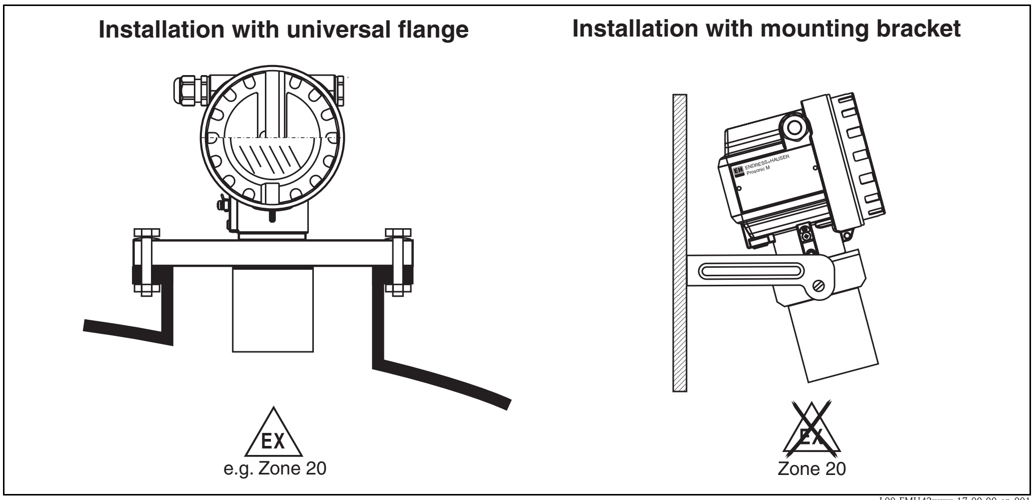
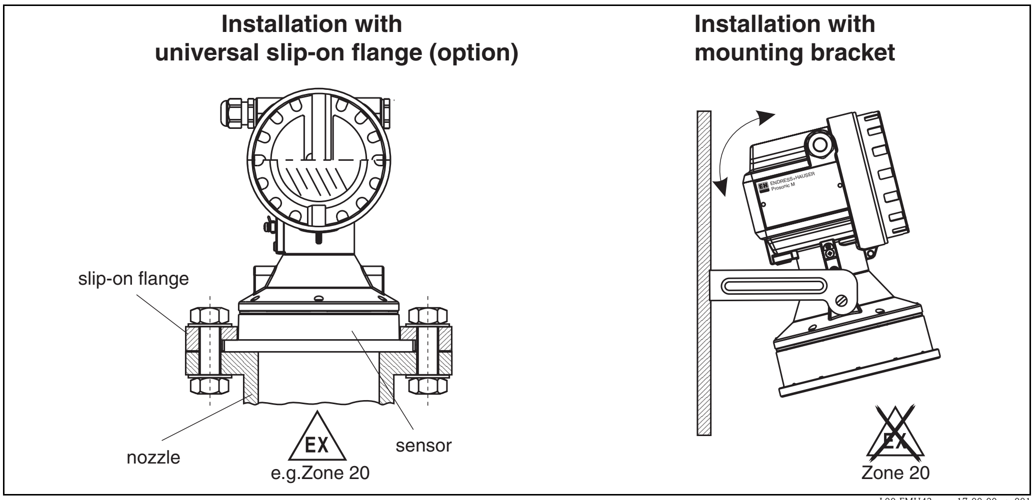
For installation bracket or adapter flange s. chapter "Accessories".

Installation variants FMU42, FMU44



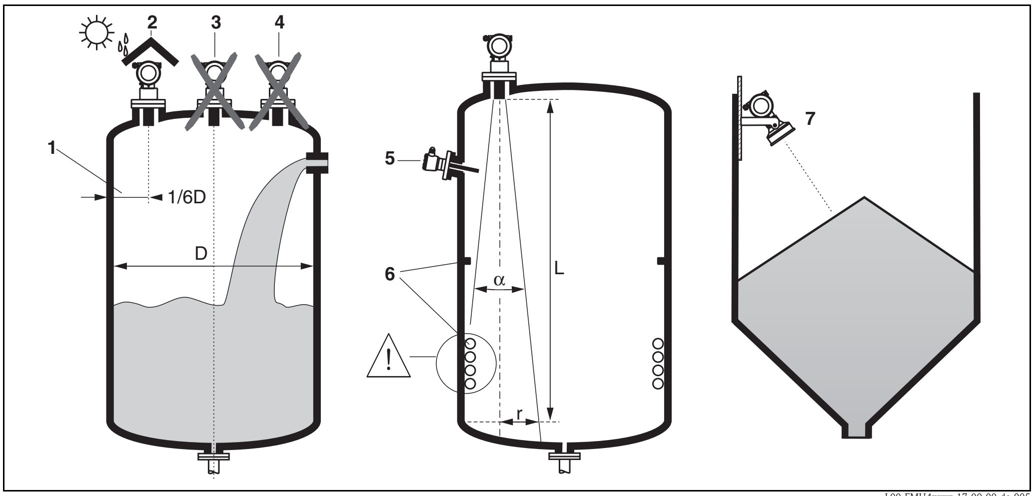
L00-FMU42xxxx-17-00-00-en-001

Installation variants FMU 43



L00-FMU43xxxx-17-00-00-en-001

Installation conditions for level measurements



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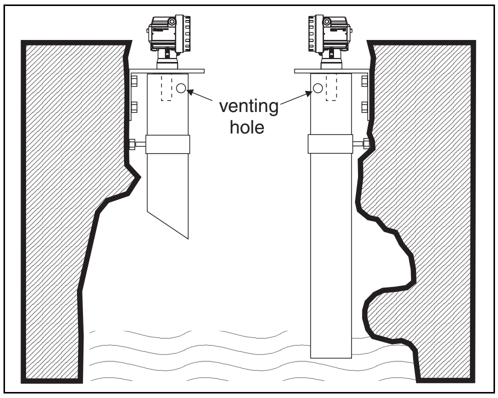
- Do not install the sensor in the middle of the tank (3). We recommend leaving a distance between the sensor and the tank wall (1) measuring 1/6 of the tank diameter.
- Use a protective cover, in order to protect the device from direct sun or rain (2).
- Avoid measurements through the filling curtain (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}
FMU40	11°	5 m	0.48 m
FMU41	11°	8 m	0.77 m
FMU42	9°	10 m	0.79 m
FMU43	6°	15 m	0.79 m
FMU44	11 °	20 m	1.93 m

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.



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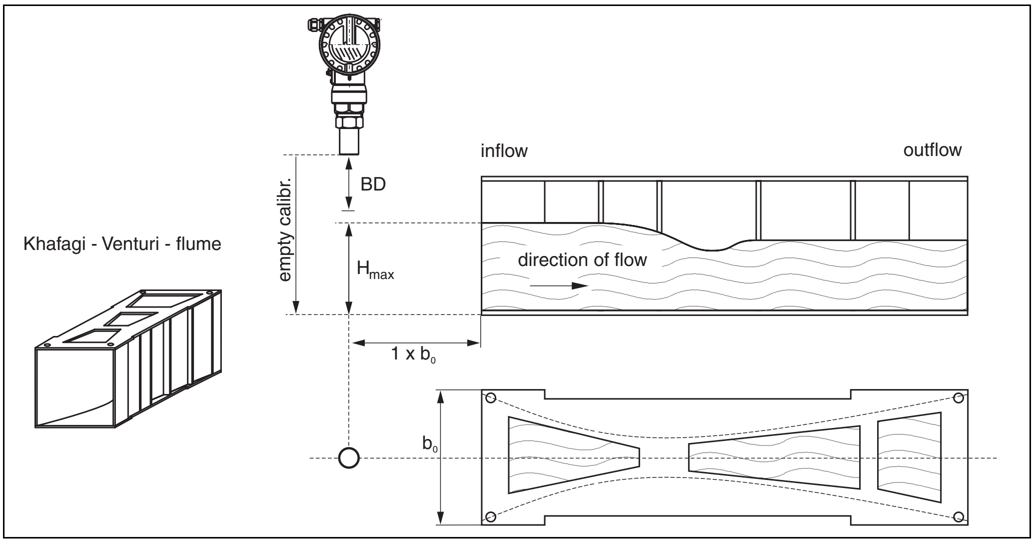
Installation conditions for flow measurements

- 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



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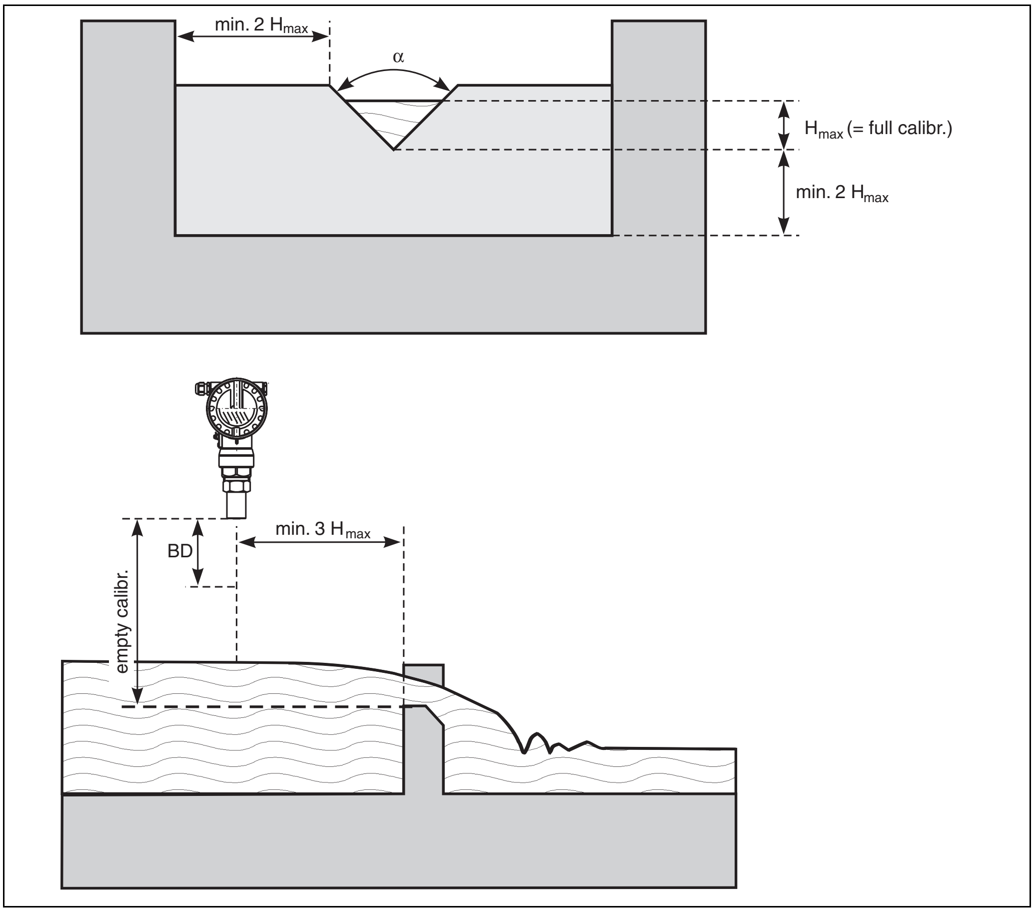
Example: Triangular weir



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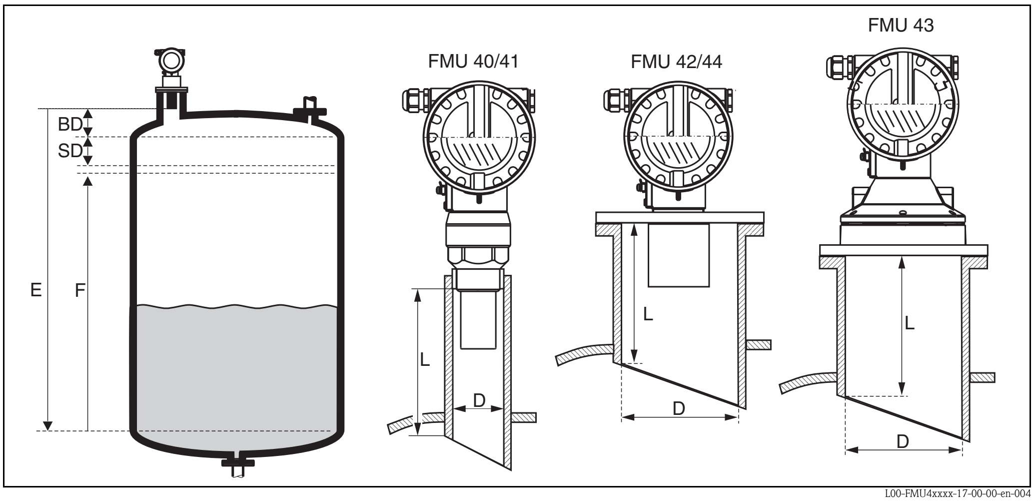
Blocking distance, nozzle installation

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°).



BD: *blocking distance;* **SD:** *safety distance;* **E:** *empty calibration;* **F:** *full calibration (span);* **D:** *nozzle diameter;* **L:** *nozzle length*

	Maximum nozzle length[mm]				
Nozzle diameter	**FMU40**	**FMU41**	**FMU42**	**FMU43**	**FMU44**
DN50/2"	80				
DN80/3"	240	240	250		
DN100/4"	300	300	300	300	
DN150/6"	400	400	400	300	400
DN200/8"	400	400	400	300	400
DN250/10"	400	400	400	300	400
DN300/12"	400	400	400	300	400
Emitting angle α	11°	11°	9°	6°	11°
Blocking distance [m]	0,25	0,35	0,4	0,6	0,5
Max. range [m] in liquids	5	8	10	15	20
Max. range [m] in solids	2	3,5	5	7	10

Caution!
If the blocking distance is undershot, it may cause device malfunction.

Note!
In order to notice if the level approaches the blocking distance, you can specify a safety distance (SD). If the level is within this safety distance, the Prosonic M outputs a warning or alarm message.

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

Resistance to alternating temperature cycles

to DIN EN 60068-2-14; Nb test : +80°C/-40°C, 1K/min, 100cycles

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)

Caution!
Degree of protection IP 68 NEMA 6P applies for M12 PROFIBUS-PA plugs only when the PROFIBUS cable is plugged in.

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).

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.

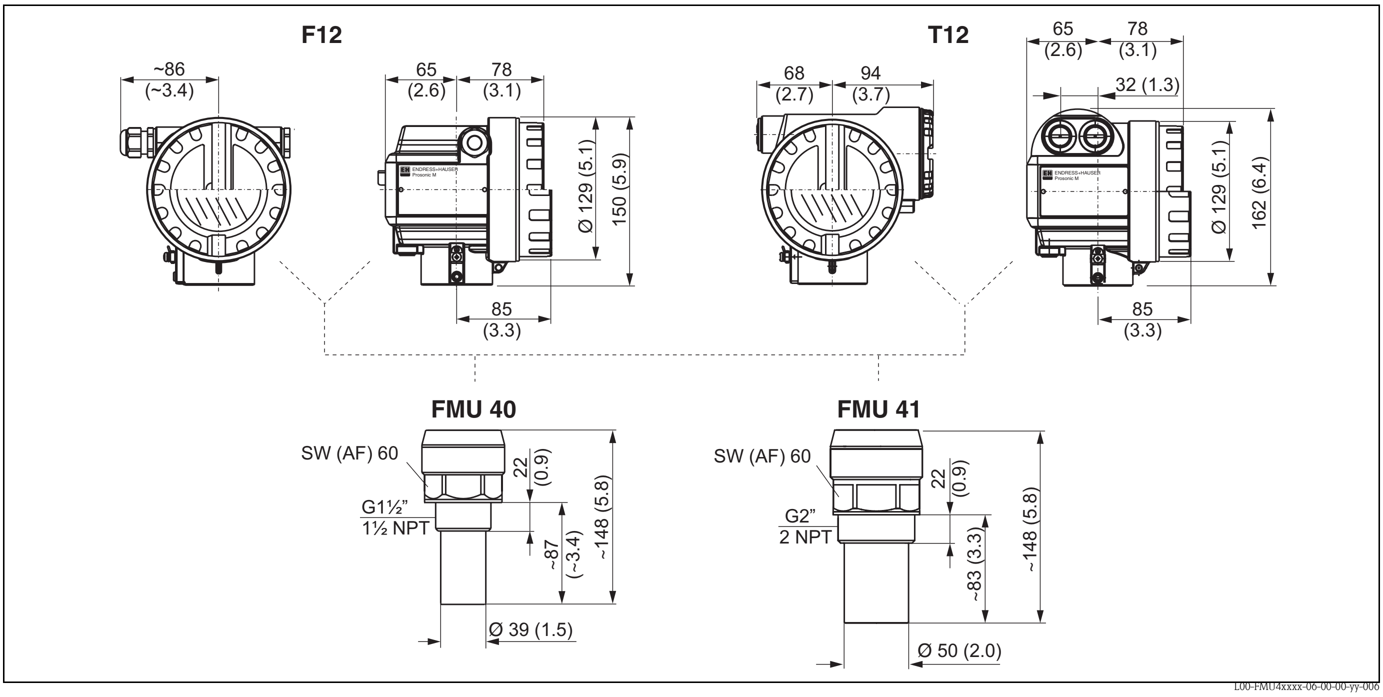
Process pressure

- FMU 40/41: 0.7 bar ... 3bar abs.
- FMU 42/43/44: 0.7 bar ... 2.5bar abs.

Mechanical construction

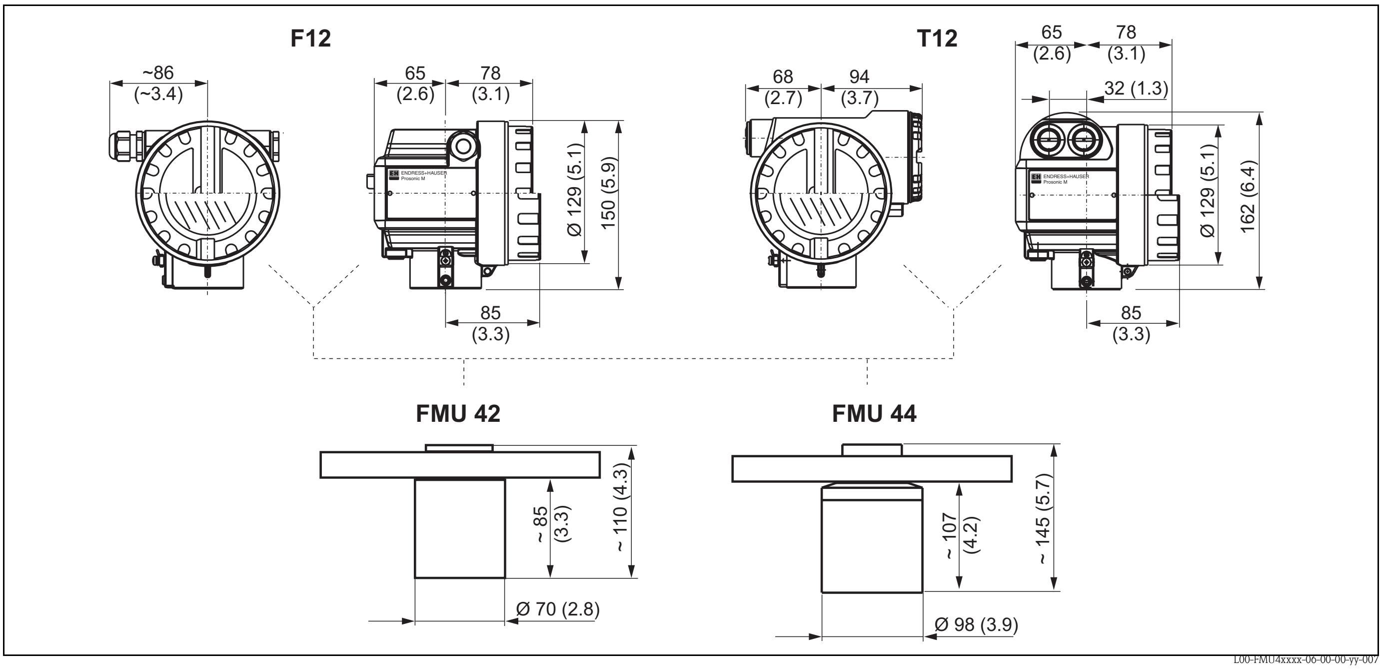
Design; dimensions

FMU40, FMU41



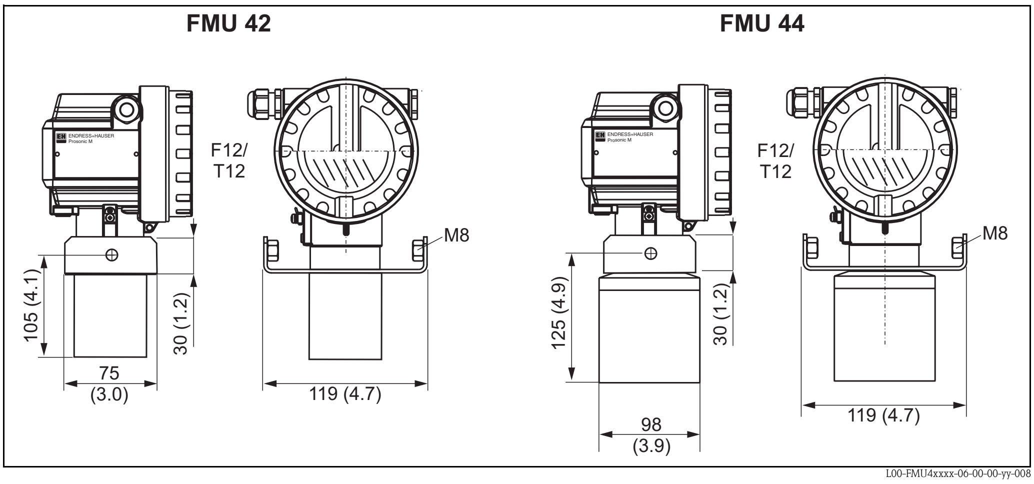
Dimensions in mm (inch)

FMU42, FMU44 with slip-on flange



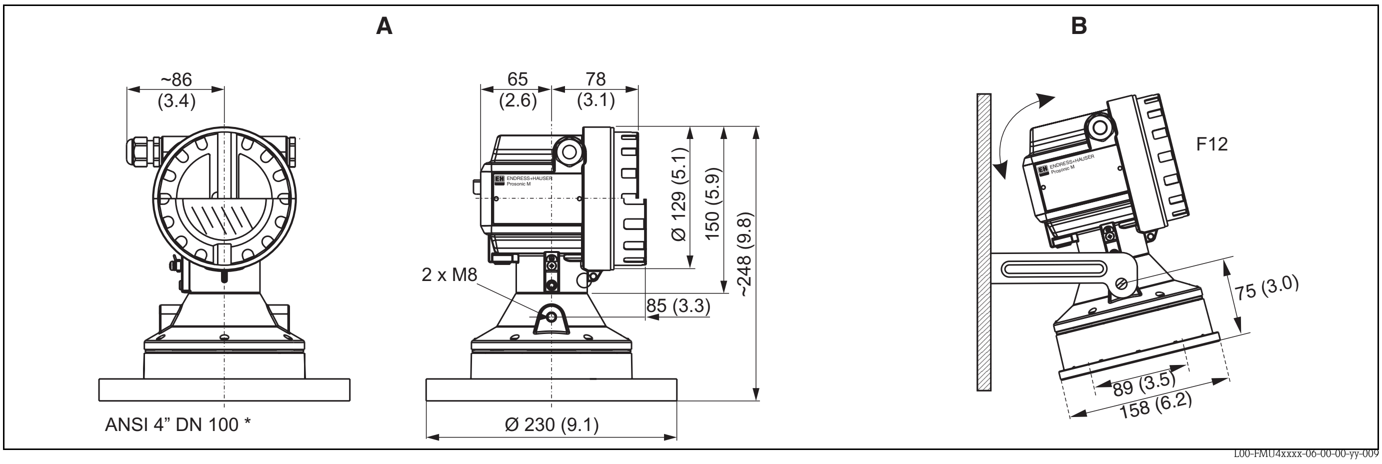
Dimensions in mm (inch)

FMU42, FMU44 with mounting bracket



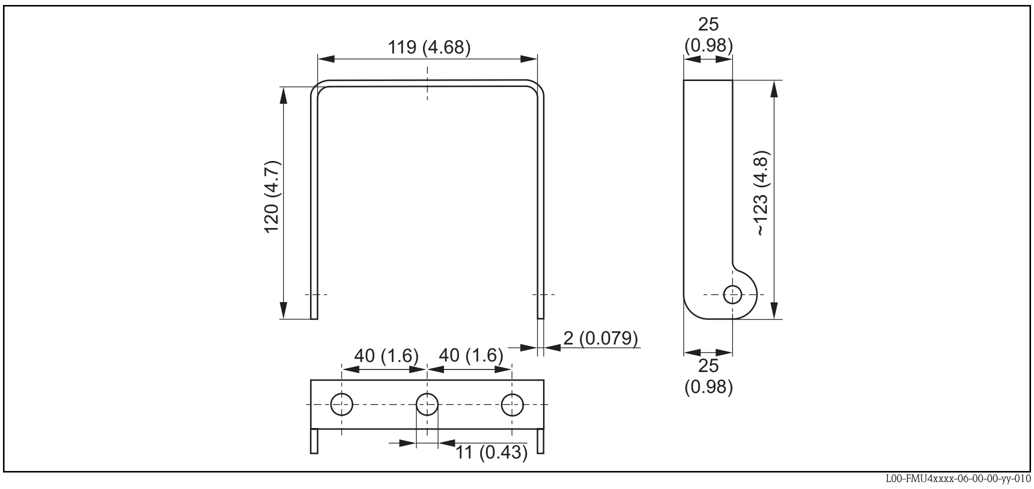
Dimensions in mm (inch)

FMU43



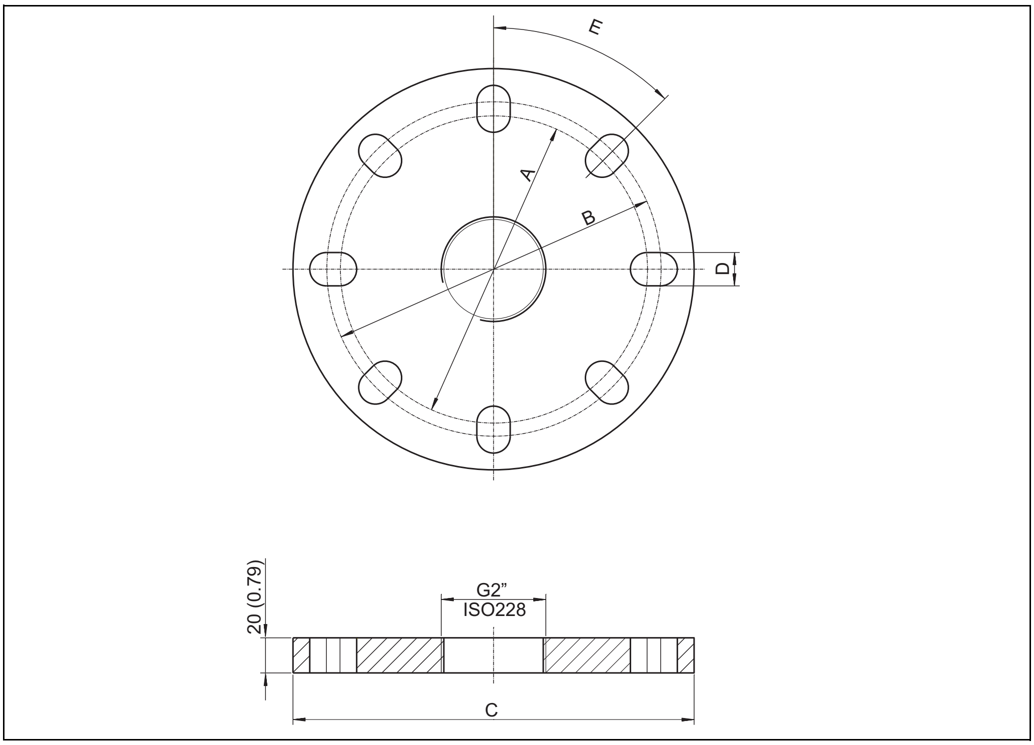
Dimensions in mm (inch);
A: *with slip-on flange;* **B:** *with mounting bracket*

Mounting bracket for FMU42, FMU43 and FMU44



Dimensions in mm (inch)

Flanges for FMU42 and FMU44



L00-FMU4xxxx-06-00-00-yy-011

suitable for	A	B	C	D	E	number of boreholes
3" 150lbs / DN80 PN16 / 10K 80	150 mm (5,91")	160 mm (6,30")	200 mm (7,87")	19 mm (0,75")	45°	8
4" 150 lbs / DN100 PN16 / 10K 100	175 mm (6,90")	190,5 mm (7,50")	228,6 mm (9,00")	19 mm (0,75")	45°	8
6" 150 lbs / DN150 PN16 / 10 K 150	240 mm (9,45")	241,3 mm (9,50")	285 mm (11,22")	23 mm (0,91")	45°	8
8" 150 lbs	298,5 mm (11,75")	298,5 mm (11,75")	342,9 mm (13,50")	22, 5 mm (0,89")	45°	8
DN200 PN16 / 10 K 200	290 mm (11,42")	295 mm (11,61")	340 mm (13,39")	23 mm (0,91")	30°	12

Weight

Sensor	Weight
FMU40	approx. 2,5 kg
FMU41	approx. 2,6 kg
FMU42	approx. 3 kg
FMU43	approx. 3,5 kg
FMU44	approx. 4 kg

Housing design

Types of housings

- F12 housing with sealed terminal compartment for standard or EEx ia applications
- T12 housing with separate terminal compartment and explosionproof encapsulation

Material

Aluminium, seawater resistant, powder-coated

Cover

- Aluminium, for version without on-site display
- Inspection glass for version with on-site display. This version cannot be supplied together with the ATEX II 1/2 D certificate.

Process connection, sealing material, sensor material

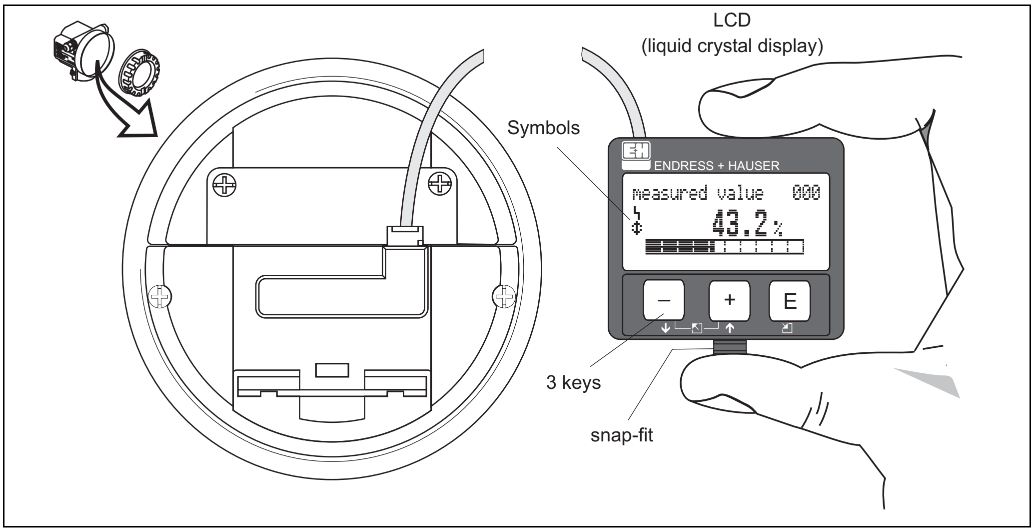
Sensor	Process connection	Material in contact with process
FMU40	▪ Thread G 1½" ▪ Thread NPT 1½" - 11.5	Sensor: PVDF Seal: EPDM
FMU41	▪ Thread 2" ▪ Thread NPT 2" - 11,5	Sensor: PVDF Seal: EPDM
FMU42	▪ Universal flange DN 80 PN16 / ANSI 3" 150 lbs / JIS 10K 80 ▪ Universal flange DN 100 PN16 / ANSI 4" 150 lbs / JIS 10K 100 ▪ Mounting bracket	Sensor: PVDF Seal: VITON or EPDM Flange: PP, PVDF or SS 316L (1.4435 or 1.4404)[1)]
FMU43	▪ Universal flange DN 100 / ANSI 4" / JIS16K100 ▪ Mounting bracket	Sensor: UP and SS 316Ti Seal: EPDM Flange: PP or SS 316Ti
FMU44	▪ Universal flange DN 100 PN16 / ANSI 4" 150 lbs / JIS 10K 100 ▪ Universal flange DN 150 PN16 / ANSI 6" 150 lbs / JIS 10K 150 ▪ Universal flange DN200 PN16 / JIS 10K 200 ▪ Flange ANSI 8" 150 lbs ▪ Mounting bracket	Sensor PVDF Seal: VITON or EPDM Flange: PP, PVDF or SS 316L (1.4435 or 1.4404)[1]

1) Endress+Hauser supplies DIN/EN flanges made of stainless steel AISI 316L with the material number 1.4435 or 1.4404. With regard to their temperature stability properties, the materials 1.4435 and 1.4404 are grouped under 13E0 in EN 1092-1 Tab. 18. The chemical composition of the two materials can be identical.

Human interface

Display and operating elements

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

Symbol in display	continuous	flashing		
Meaning	Alarm	Warning	Communication	Security Locking

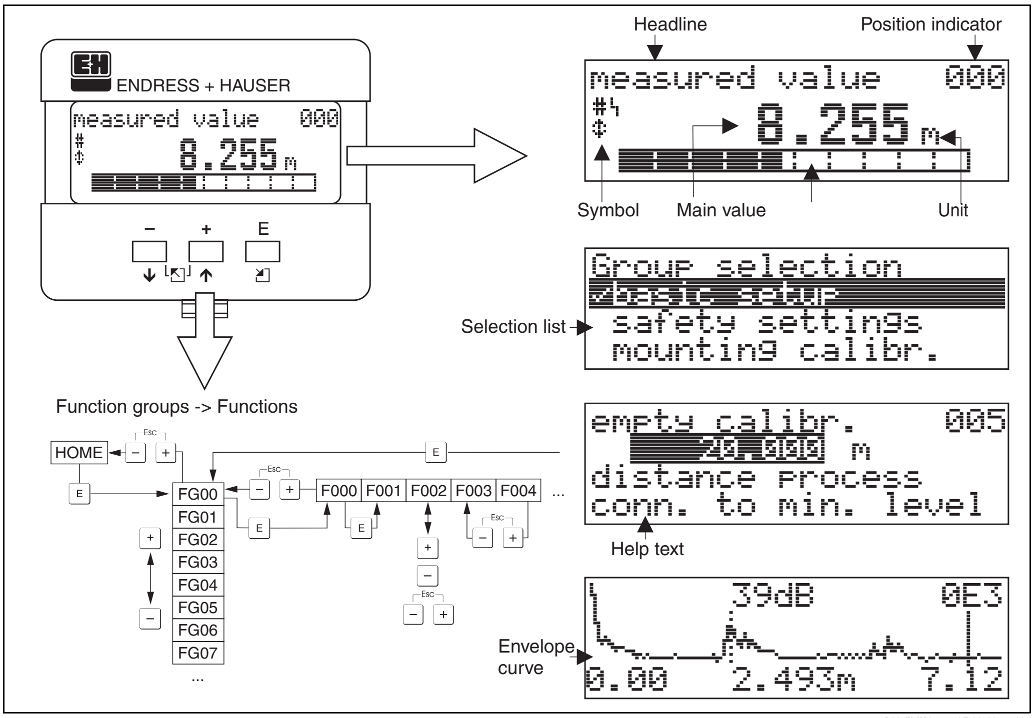
Function of the keys

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.

On-site operation

Operation with VU 331

The LC-Display VU 331 allows configuration via 3 keys directly at the instrument. All device functions can be set through a menu system. The menu consists of function groups and functions. Within a function, application parameters can be read or adjusted. The user is guided through a complete configuration procedure.



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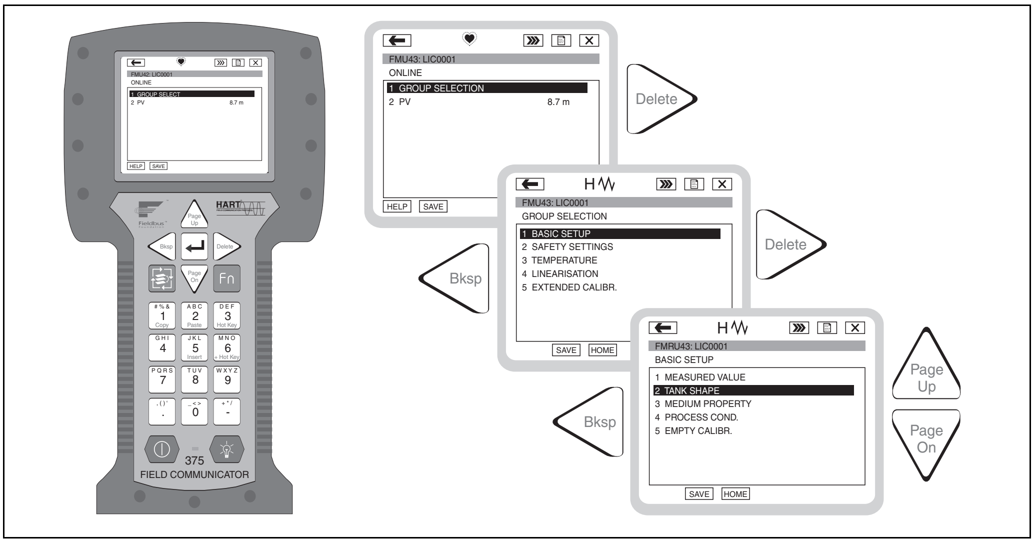
Operation with the handheld terminal DXR 375

On devices with HART communication, you can also access the menu using the handheld terminal DXR 375.



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Remote operation

Operation with ToF Tool

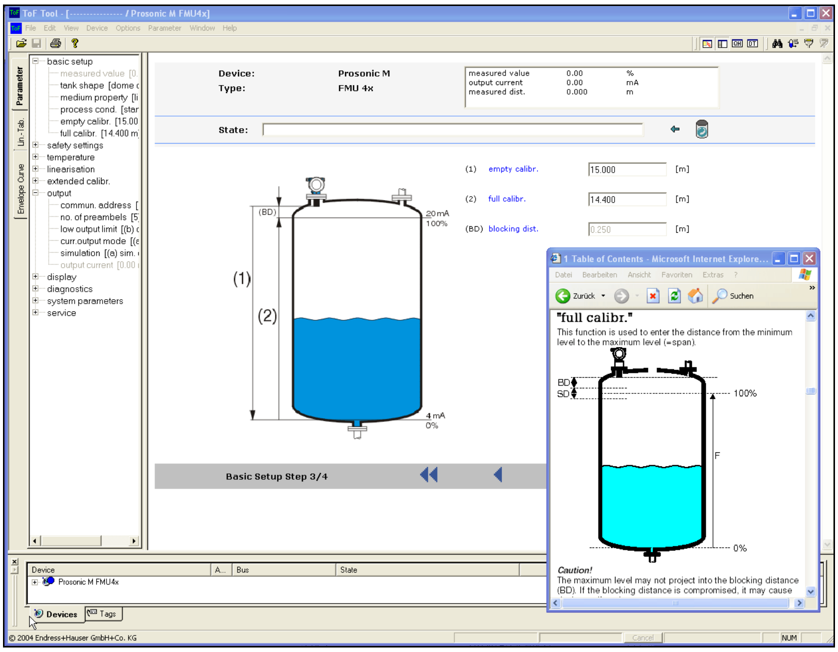
The ToF Tool is a graphical operation software for instruments from Endress+Hauser. It is used to support commissioning, securing of data, signal analysis and documentation of the instruments. It is compatible with the following operating systems: WinNT4.0, Win2000 and WinXP.

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.

Connection options
- HART with Commubox FXA 191 (available as accessory)
- PROFIBUS PA
- Service-interface with adapter FXA 193 (available as accessory)

Menu-guided commissioning:



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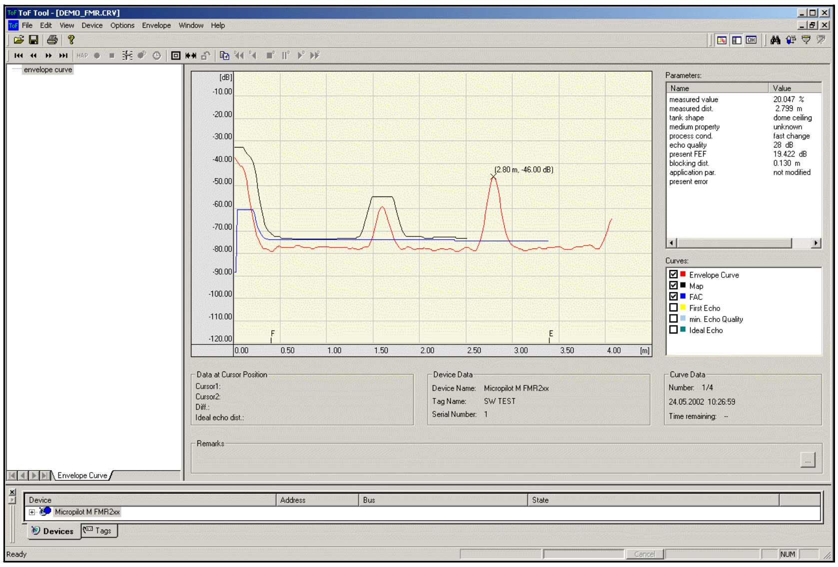
Signal analysis via envelope curve:



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Operation with FieldCare

FieldCare is Endress+Hauser's FDT based Plant Asset Management Tool. It can configure all intelligent field devices in your plant and supports you in managing them. By using status information, it also provides a simple but effective means of checking their health.

- Supports Ethernet, HART, PROFIBUS, FOUNDATION Fieldbus etc.
- Operates all Endress+Hauser devices
- Operates all third-party actuators, I/O systems and sensors supporting the FDT standard
- Ensures full functionality for all devices with DTMs
- Offers generic profile operation for any third-party fieldbus device that does not have a vendor DTM

Operation with Commuwin II (for communication variants HART or PROFIBUS-PA)

Commuwin II is an operating software with graphical support (MS Windows) for intelligent transmitters with the communication protocols Rackbus, Rackbus RS-485, HART and PROFIBUS-PA.

Commuwin II supports the following functions:
- Online configuration of transmitters
- Loading and saving of instrument data (Upload/Download)
- Orderly visualisation of measured values and limit values
- Display and recording of measured values with a line recorder

It is not possible to display envelope curves with Commuwin II. To display them, please use the ToF Tool program supplied.

Connections:
- HART with Commubox FXA 191 (available as accessory)
- PROFIBUS PA

Operation with NI-FBUS Configurator (only Foundation Fieldbus)

The NI-FBUS Configurator is an easy-to-use graphical environment for creating linkages, loops, and a schedule based on the fieldbus concepts.

You can use the NI-FBUS Configurator to configure a fieldbus network as follows:
- Set block and device tags
- Set device addresses
- Create and edit function block control strategies (function block applications)
- Configure vendor-defined function and transducer blocks
- Create and edit schedules
- Read and write to function block control strategies (function block applications)
- Invoke Device Description (DD) methods
- Display DD menus
- Download a configuration
- Verify a configuration and compare it to a saved configuration
- Monitor a downloaded configuration
- Replace devices
- Save and print a configuration

Certificates and Approvals

CE mark

The measuring system meets the legal requirements of the EC-guidelines. Endress+Hauser confirms the instrument passing the required tests by attaching the CE-mark.

Ex approval

The available certificates are listed in the ordering information. Note the associated safety instructions (XA) and control or installation drawings (ZD).

External standards and guidelines

EN 60529

Protection class of housing (IP-code)

EN 61326

Electromagnetic compatibility (EMC requirements)

NAMUR

Standards committee for measurement and control in the chemical industry

Ordering information

Product structure FMU 40

	Certificates	
	A	Variant for non-hazardous area
	E	NEPSI Ex nA II T6
	G	ATEX II 3G EEx nA II T6
	I	NEPSI Ex ia IIC T6
	J	NEPSI Ex d(ia) IIC T6
	K	TIIS Ex ia II C T6
	N	CSA General Purpose
	Q	NEPSI DIP
	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
	1	ATEX II 1/2 G or II 2 G; EEX ia IIC T6
	2	ATEX II 1/2D, Alu blind cover
	4	ATEX II 1/2 G or II 2 G; EEX d [ia] IIC T6
	5	ATEX II 1/3D
	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

Product structure FMU 41

	Certificates	
	A	Variant for non-hazardous area
	E	NEPSI Ex nA II T6
	G	ATEX II 3G EEx nA II T6
	I	NEPSI Ex ia IIC T6
	J	NEPSI Ex d(Ia) IIC T6
	K	TIIS Ex ia II C T6
	N	CSA General Purpose
	Q	NEPSI DIP
	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
	1	ATEX II 1/2 G or II 2 G; EEX ia IIC T6
	2	ATEX II 1/2D, Alu blind cover
	4	ATEX II 1/2 G or II 2 G; EEX d [ia] IIC T6
	5	ATEX II 1/3D
	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

Product structure FMU 42

	Certificates
A	Variant for non-hazardous area
E	NEPSI Ex nA II T6
G	ATEX II 3G EEx nA II T6
I	NEPSI Ex ia IIC T6
J	NEPSI Ex d (Ia) IIC T6
K	TIIS Ex ia II C T6 (in preparation)
N	CSA General Purpose
Q	NEPSI DIP
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
1	ATEX II 1/2 G EEX ia IIC T6
2	ATEX II 1/2 D, Alu bond cover
4	ATEX II 1/2 G EEX d [ia] IIC T6
5	ATEX II 1/3D
Y	Special certificate

	Process connection
M	Mounting bracket FAU20
P	UNI flange 3"/DN80/80, PP, max. 2.5bar abs./ 36psia suitable for 3" 150lbs / DN80 PN16 / 10K 80
Q	UNI flange 3"/DN80/80, PVDF, max. 2.5bar abs./ 36psia suitable for 3" 150lbs / DN80 PN16 / 10K 80
S	UNI flange 3"/DN80/80, 316L, max. 2.5bar abs./ 36psia suitable for 3" 150lbs / DN80 PN16 / 10K 80
T	UNI flange 4"/DN100/100, PP, max. 2.5bar abs./ 36psia suitable for 4" 150lbs / DN100 PN16 / 10K100
U	UNI flange 4"/DN100/100, PVDF, max. 2.5bar abs./ 36psia suitable for 4" 150lbs / DN100 PN16 / 10K100
V	UNI flange 4"/DN100/100, 316L, max. 2.5bar abs./ 36psia suitable for 4" 150lbs / DN100 PN16 / 10K100
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

							Sealing Sensor/Flange		
							3	EPDM flat sealing	
							9	special version	
								Additional options	
								A	Additional options not selected
FMU 42 -									Product designation

Product structure FMU 43

	Certificates						
	A	Variant for non-hazardous area					
	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					
	Q	NEPSI DIP					
	2	ATEX II 1/2 D or II 2 D, Aluminium Deckel					
	5	ATEX II 1/3 D or II 3 D, Sichtdeckel					
	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

Product structure FMU 44

	Approval				
	A	Non-hazardous area			
	1	ATEX II 1/2G EEx ia IIC T6 (in preparation)			
	4	ATEX II 1/2G EEx d (ia) IIC T6 (in preparation)			
	G	ATEX II 3 G EEx nA II T6 (in preparation)			
	2	ATEX II 1/2 D, Alu blind cover (in preparation)			
	5	ATEX II 1/3 D			
	S	FM IS Cl.I,II,III Div.1 Gr.A-G, NI Cl.I Div.2 (in preparation)			
	T	FM XP Cl.I,II,III Div.1 Gr.A-G (in preparation)			
	N	CSA General Purpose			
	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			
	K	TIIS EEx ia IIC T6 (in preparation)			
	I	NEPSI Ex ia IIC T6 (in preparation)			
	J	NEPSI Ex d(ia) IIC T6 (in preparation)			
	E	NEPSI Ex nA II T6 (in preparation)			
	Q	NEPSI DIP (in preparation)			
	Y	Special version, to be specified			
		Process connection			
		A	8" 150lbs FF, 316L, max 2.5bar abs./36psia		
		E	UNI flange 6"/DN150/150, PP, max 2.5bar abs./ 36psia, suitable for 6" 150lbs / DN150 PN16 / 10K 150		
		F	UNI flange 6"/DN150/150, PVDF, max 2.5bar abs./36psia, suitable for 6" 150lbs /DN150 PN16 / 10K 150		
		G	UNI flange 6"/DN150/150, 316L, max 2.5bar abs. 36psia, suitable for 6" 150lbs / DN150 PN16 / 10K 150		
		H	UNI flange DN200/200, PP, max 2.5bar abs./ 36 psia, suitable for DN200 PN16 / 10K 200		
		J	UNI flange DN200/200, PVDF, max 2.5bar abs./ 36psia, suitable for DN200 PN16 / 10K 200		
		K	UNI flange DN200/200, 316L, max 2.5bar abs./ 36psia, suitable for DN200 PN16 / 10K 200		
		L	8" 150lbs FF, PP, max 2.5bar abs./ 36psia		
		M	Mounting bracket FAU20		
		N	8" 150lbs FF, PVDF, max 2.5bar abs./ 36psia		
		T	UNI flange 4"/DN100/100, PP, max 2.5bar abs./ 36psia, suitable for 4" 150lbs / DN100 PN16 / 10K 100		
		U	UNI flange 4"/DN100/100, PVDF, max. 2.5bar abs./ 36 psia, suitable for 4" 150lbs / DN100 PN16 / 10K 100		
		V	UNI flange 4"/DN100/100, 316L, max 2.5bar abs./ 36psia, suitable for 4" 150lbs / DN100 PN16 / 10K 100		
		Y	Special version, to be specified		
			Power supply; Output		
			B	2-wire; 4-20mA HART	
			D	2-wire; PROFIBUS PA	
			F	2-wire; FOUNDATION Fieldbus	
			G	4-wire 90-250VAC; 4-20mA HART	
			H	4-wire 10.5-32VDC; 4-20mA HART	
			Y	Special version, to be specified	
				Operation	
				1	w/o display, via communication
				2	4-line display VU331, Envelope curve display on site
				3	Prepared for FHX40, Remote display (accessory)
				9	Special version, to be specified
FMU 44 -					product designation, part 1

							Housing
						A	F12 Alu, coated IP68 NEMA6P
						C	T12 Alu, coated IP68 NEMA6P, Separate conn. compartment
						D	T12 Alu, coated IP68 NEMA6P + OVP, Sep. conn. compartment, OVP = overvoltage protection
						9	Special version, to be specified

								CAble entry
							2	Gland M20 (EEx d > thread M20)
							3	Thread G1/2
							4	Thread NPT 1/2
							5	Plug M12
							6	Plug 7/8“
							9	Special version, to be specified

									Process Sealing Sensor/ Flange
								2	Viton
								3	EPDM
								9	Special version, to be specified

										Additional option
									A	Basic version
									Y	Special version, to be specified
FMU 44 -										complete product designation

Scope of delivery

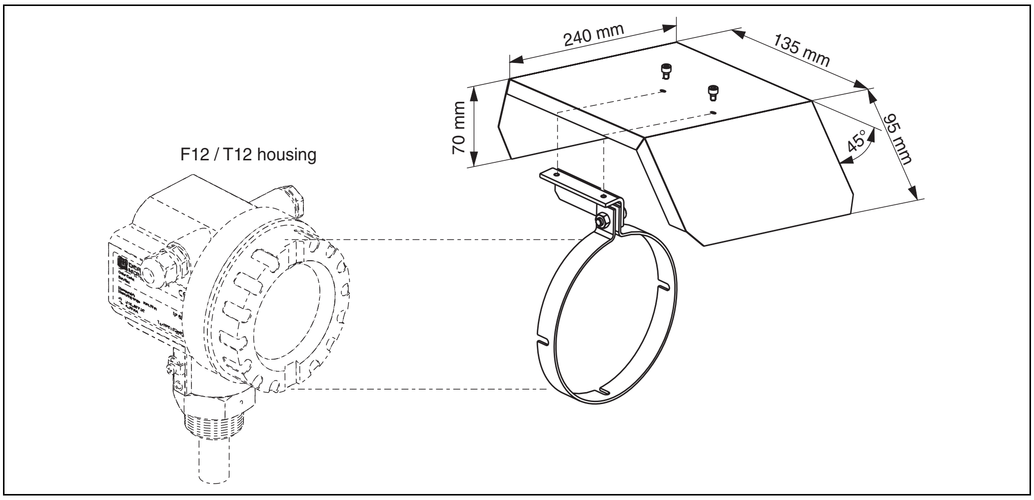
- Instrument according to the version ordered
- "ToF Tool FieldTool Package (2 CD-ROMs: Program CD-ROM, Utility CD-ROM)
- Operating manual according to the communication version
- for certified instrument versions: Safety Instructions, Control- or Installation drawings
- for FMU 40 *R**** and FMU 41 *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.

Accessories

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.



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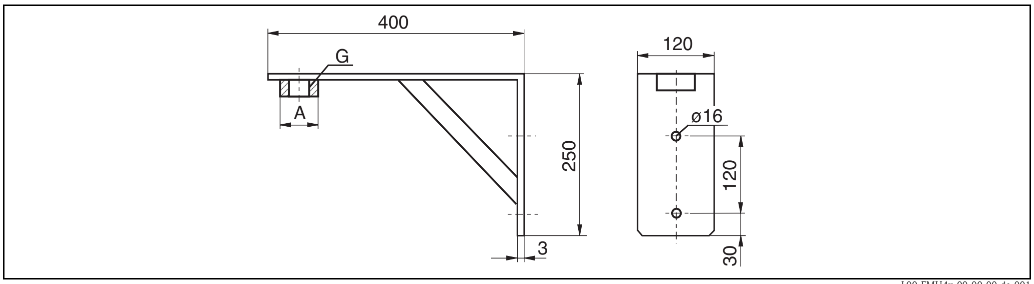
Installation bracket for FMU 40/41

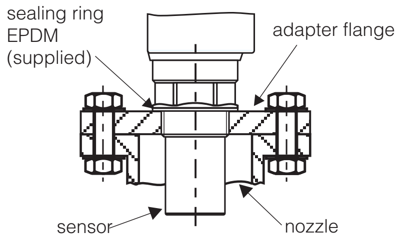


L00-FMU4x-00-00-00-de-001

- for FMU 40, G1½: Order No. 942669-0000
- for FMU 41, G2: Order No. 942669-0001

suited for NPT 1½" and 2" as well

Adapter flange



L00-FMUX3XXX-00-00-00-en-001

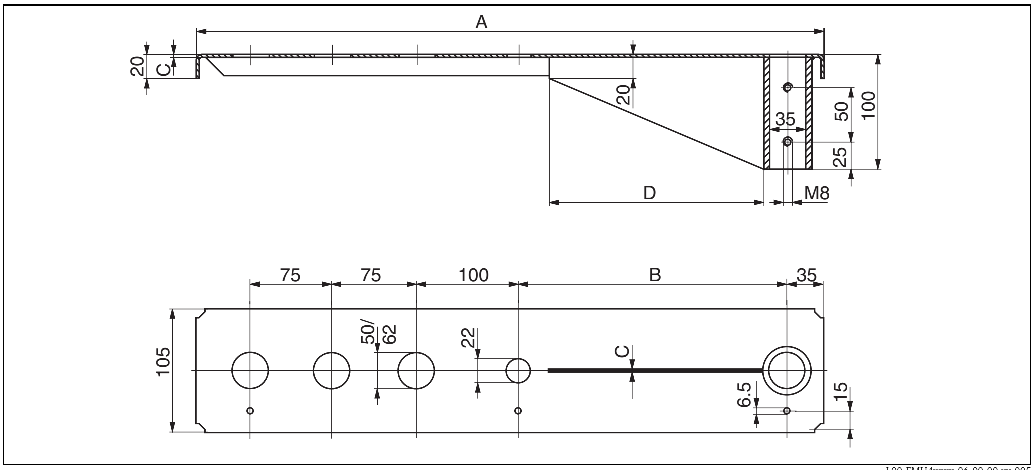
Version with metrical thread (FAU 70 E)

	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

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

Cantilever

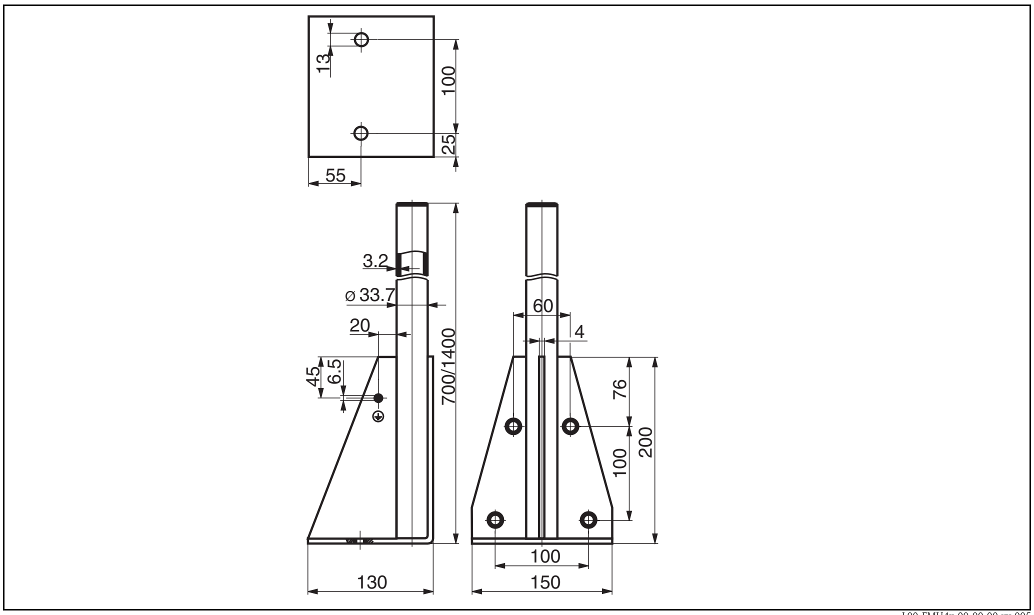


L00-FMU4xxxx-06-00-00-yy-005

A	B	C	D	for Sensor	Material	Order Code
585 mm	250 mm	2 mm	200 mm	FMU 40	316Ti/1.4571	52014132
					galv. steel	52014131
				FMU 41	316Ti/1.4571	52014136
					galv. steel	52014135
1085 mm	750 mm	3 mm	300 mm	FMU 40	316Ti/1.4571	52014134
					galv. steel	52014133
				FMU 41	316Ti/1.4571	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.

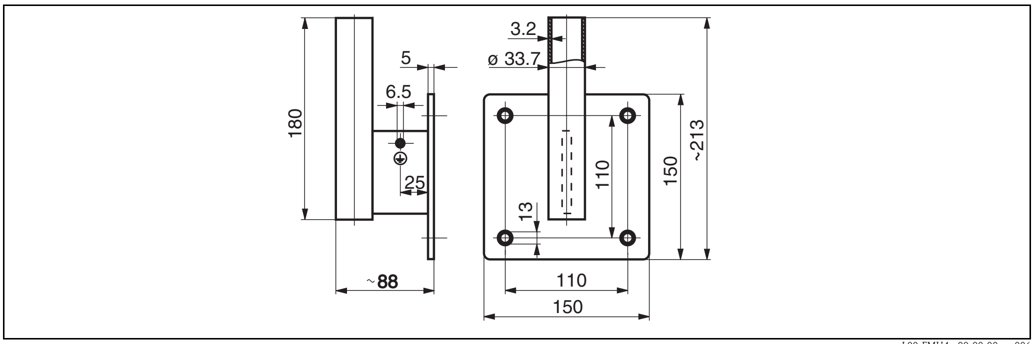
Mounting Frame



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

Wall Bracket



L00-FMU4x-00-00-00-yy-006

Material	Order Code
galv. steel	919792-0000
316Ti/1.4571	919792-0001

Commubox FXA191 HART For intrinsically safe communication with ToF Tool/FieldCare via the RS232C interface. For details refer to TI237F/00/en.

Commubox FXA195 HART For intrinsically safe communication with ToF Tool/FieldCare via the USB interface. For details refer to TI404F/00/en.

Service Interface FXA193

The Service-Interface connects the Service plug of Proline and ToF instruments with the 9 pin RS 232C interface of a PC. (USB connectors must be equipped with a usual commercial USB/Serial adapter.)

Product structure

	Approvals	
	A	For use in non-hazardous areas
	B	ATEX II (1) GD
	C	CSA/FM Class I Div. 1
	D	ATEX, CSA, FM
	9	other

		Connection cable	
		B	Connection cable for ToF devices
		E	Connection cable for Proline and ToF devices
		H	Connection cable for Proline and ToF devices and Connection cable for Ex two-wire devices
		X	without connection cable
		9	others
FXA193-			Complete product designation

Associated documentation

- Technical Information: TI063D
- Safety Instructions for ATEX II (1) GD: XA077D
- Supplementary information for the cable adapters: SD092D

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)
- Prosonic S FMU9x

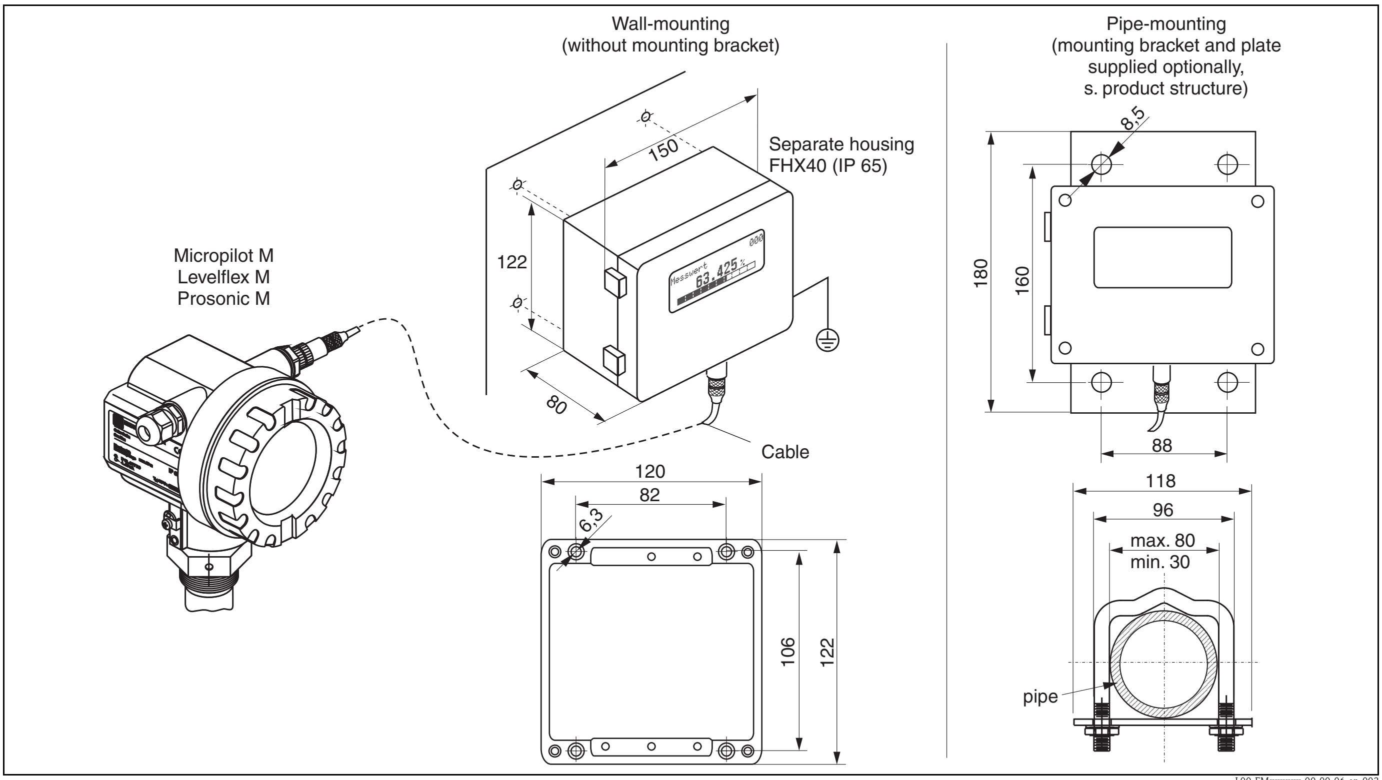
ToF Adapter FXA291

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)
- Prosonic S FMU9x

For details refer to KA271F/00/a2.

Remote display FHX40



L00-FMxxxxxx-00-00-06-en-003

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	IP65/67 (housing); IP68 (cable) acc. to IEC 60529
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.

Supplementary documentation

System Information

SI 005F

Ultrasonic level measurement

Operating manual

Depending on the communication variant ordered, the following operating manuals are supplied with the device:

Communication	Operating manual
4 ... 20mA, HART	BA 237F
Profibus PA	BA 238F
Foundation Fieldbus	BA 239F

These instructions describe the installation and first commissioning of the Prosonic M. From the operating menu, all functions are included, which are required for standard measurement tasks. Additional functions are **not** contained in the manual.

Description of device functions

BA 240F

This contains a detailed description of **all** the functions of the Prosonic M and is valid for all communication variants.
A pdf file of this document can be found
- in the supplied "ToF Tool - FieldTool Package" at "Help/ToF Tool Help/ Online Manual/ Operating Manual/Ultrasonic/Prosonic M FMU4x Functions"[1].
- in the internet at "www.endress.com". Klick "Download" and enter the product code "FMU4*" into the search form.

Short instructions

KA 183F

can be found under the device housing cover.
The most important menu functions are summarised on this sheet. It is intended primarily as a memory jogger for users who are familiar with the operating concept of Endress+Hauser time-of-flight instruments.

Safety Instructions ATEX

The following safety instructions are supplied with ATEX-certified device versions. If the devices are used in explosive areas, comply with all the specifications in these safety instructions.

Instrument version	Certificate	Communication	Housing	Safety Instructions
▪ FMU40 - 1*B*A* ▪ FMU41 - 1*B*A* ▪ FMU42 - 1*B*A***	ATEX II 1/2 G or II 2 G EEx ia II C T6	HART (2-wire)	F12	XA 174F
▪ FMU40 - 1*B*D* ▪ FMU41 - 1*B*D* ▪ FMU42 - 1*B*D***	ATEX II 1/2 G or II 2 G EEx ia II C T6	HART (2-wire)	T12 with overvoltage protection	XA 224F
▪ FMU40 - 1*D*A* - 1*F*A* ▪ FMU41 - 1*D*A* - 1*F*A* ▪ FMU42 - 1*D*A*** - 1*F*A***	ATEX II 1/2 G or II 2 G EEx ia II C T6	▪ Profibus-PA ▪ Foundation Fieldbus	F12	XA 175F
▪ FMU40 - 1*D*D* - 1*F*D* ▪ FMU41 - 1*D*D* - 1*F*D* ▪ FMU42 - 1*D*D*** - 1*F*D***	ATEX II 1/2 G or II 2 G EEx ia II C T6	▪ Profibus-PA ▪ Foundation Fieldbus	T12 with overvoltage protection	XA 225F

1) If the Operating Instructions have not been installed together with the "ToF Tool - FieldTool Package", they can be added to the installation subsequently.

Instrument version	Certificate	Communication	Housing	Safety Instructions
▪ FMU40 - 4*B*C* - 4*D*C* - 4*F*C* ▪ FMU41 - 4*B*C* - 4*D*C* - 4*F*C* ▪ FMU42 - 4*B*C*** - 4*D*C*** - 4*F*C***	ATEX II 1/2 G or II 2 G EEx d [ia] II C T6	▪ HART (2-wire) ▪ Profibus-PA ▪ Foundation Fieldbus	T12	XA 176F
▪ FMU40 - G***** ▪ FMU41 - G***** ▪ FMU42 - G*******	ATEX II 3G EEx nA II T6	▪ HART (2-wire) ▪ HART (4-wire, DC) ▪ HART (4-wire, AC) ▪ Profibus-PA ▪ Foundation Fieldbus	▪ F12 ▪ T12 ▪ T12 with overvoltage protection	XA 179F
▪ FMU40 - 2*B*A* - 2*D*A* - 2*F*A* - 5*B*A* - 5*D*A* - 5*F*A* ▪ FMU41 - 2*B*A* - 2*D*A* - 2*F*A* - 5*B*A* - 5*D*A* - 5*F*A* ▪ FMU42 - 2*B*A*** - 2*D*A*** - 2*F*A*** - 5*B*A*** - 5*D*A*** - 5*F*A***	▪ ATEX II 1/2D ▪ ATEX II 1/3D	▪ HART (2-wire) ▪ Profibus-PA ▪ Foundation Fieldbus	F12	XA 180F
▪ FMU40 - 2*G*A* - 2*H*A* - 5*G*A* - 5*H*A* ▪ FMU41 - 2*G*A* - 2*H*A* - 5*G*A* - 5*H*A* ▪ FMU42 - 2*G*A*** - 2*H*A*** - 5*G*A*** - 5*H*A***	▪ ATEX II 1/2D ▪ ATEX II 1/3 D	▪ HART (4-wire, DC) ▪ HART (4-wire, AC)	F12	XA 259
▪ FMU43 - 2*G*A* - 2*H*A* - 5*G*A* - 5*H*A*	▪ ATEX II 1/2 D or II 2 D ▪ ATEX II 1/3 D or II 3 D	▪ HART (4-wire, DC) ▪ HART (4-wire, AC)	F12	XA 177F
▪ FMU43 - 2*D*A* - 2*F*A* - 5*D*A* - 5*F*A*	▪ ATEX II 1/2 D or II 2 D ▪ ATEX II 1/3 D or II 3 D	▪ Profibus-PA ▪ Foundation Fieldbus	F12	XA 178F

Safety Instructions NEPSI

The following safety instructions are supplied with NEPSI-certified device versions. If the devices are used in explosive areas, comply with all the specifications in these safety instructions.

Instrument version	Certificate	Communication	Housing	Safety Instructions
▪ FMU40 - I*B*A* ▪ FMU41 - I*B*A* ▪ FMU42 - I*B*A***	Ex ia II C T1 ... T6 NEPSI GYJ071468	HART (2-wire)	F12	XA 436F
▪ FMU40 - I*B*D* ▪ FMU41 - I*B*D* ▪ FMU42 - I*B*D***	Ex ia II C T1 ... T6 NEPSI GYJ071468	HART (2-wire)	T12 with overvoltage protection	XA 442F
▪ FMU40 - I*D*A* - I*F*A* ▪ FMU41 - I*D*A* - I*F*A* ▪ FMU42 - I*D*A*** - I*F*A***	Ex ia II C T1 ... T6 NEPSI GYK071468	▪ Profibus-PA ▪ Foundation Fieldbus	F12	XA 437F
▪ FMU40 - I*D*D* - I*F*D* ▪ FMU41 - I*D*D* - I*F*D* ▪ FMU42 - I*D*D*** - I*F*D***	Ex ia II C T1 ... T6 NEPSI GYJ071468	▪ Profibus-PA ▪ Foundation Fieldbus	T12 with overvoltage protection	XA 443F
▪ FMU40 - J*B*C* - J*D*C* - J*F*C* ▪ FMU41 - J*B*C* - J*D*C* - J*F*C* ▪ FMU42 - J*B*C*** - J*D*C*** - J*F*C***	Ex d [ia] II C T1 ... T6 NEPSI GYJ071468	▪ HART (2-wire) ▪ Profibus-PA ▪ Foundation Fieldbus	T12	XA 438F
▪ FMU40 - Q*B*A* - Q*D*A* - Q*F*A* ▪ FMU41 - Q*B*A* - Q*D*A* - Q*F*A* ▪ FMU42 - Q*B*A*** - Q*D*A*** - Q*F*A***	DIP A21/A22 T_A, T* NEPSI GYJ071468	▪ HART (2-wire) ▪ Profibus-PA ▪ Foundation Fieldbus	F12	XA 441F
▪ FMU40 - Q*G*A* - Q*H*A* ▪ FMU41 - Q*G*A* - Q*H*A* ▪ FMU42 - Q*G*A*** - Q*H*A***	DIP A21/A22 T_A, T* NEPSI GYJ071468	▪ HART (4-wire, DC) ▪ HART (4-wire, AC)	F12	XA 444F
▪ FMU43 - Q*G*A* - Q*H*A*	DIP A21/A22 T_A, T*	▪ HART (4-wire, DC) ▪ HART (4-wire, AC)	F12	XA 439F
▪ FMU43 - Q*D*A* - Q*F*A*	DIP A21/A22 T_A, T*	▪ Profibus-PA ▪ Foundation Fieldbus	F12	XA 440F
▪ FMU40 - E***** ▪ FMU41 - E***** ▪ FMU42 - E*******	NEPSI Ex nA IIC T6	▪ HART ▪ Profibus PA ▪ Foundation Fieldbus	▪ F12 ▪ T12	XA 403F

Control drawings Installation drawings

The following control or installation drawings are supplied with the FM, CSA and TIIS-certified device versions:

Instrument version	Certificate	Communication	Housing	Control or Installation Drawing
▪ FMU40 - S*B*A* ▪ FMU41 - S*B*A* ▪ FMU42 - S*B*A***	FM IS	HART (2-wire)	F12	ZD 096F
▪ FMU40 - S*D*A* - S*F*A* ▪ FMU41 - S*D*A* - S*F*A* ▪ FMU42 - S*D*A*** - S*F*A***	FM IS	▪ Profibus-PA ▪ Foundation Fieldbus	F12	ZD 097F
▪ FMU40 - S*B*D* ▪ FMU41 - S*B*D* ▪ FMU42 - S*B*D***	FM IS	HART (2-wire)	T12 with overvoltage protection	ZD 139F
▪ FMU40 - S*D* D* - S*F*D* ▪ FMU41 - S*D* D* - S*F*D* ▪ FMU42 - S*D* D*** - S*F*D***	FM IS	▪ Profibus-PA ▪ Foundation Fieldbus	T12 with overvoltage protection	ZD 140F
▪ FMU40 - T*B*C* - T*D*C* - T*F*C* ▪ FMU41 - T*B*C* - T*D*C* - T*F*C* ▪ FMU42 - T*B*C*** - T*D*C*** - T*F*C***	FM XP	▪ HART (2-wire) ▪ Profibus PA ▪ Foundation Fieldbus	T12	ZD 098F
▪ FMU40 - U*B*A* ▪ FMU41 - U*B*A* ▪ FMU42 - U*B*A*** ▪ FMU44 - U*B*A***	CSA IS	HART (2-wire)	F12	ZD 088F
▪ FMU40 - U*D*A* - U*F*A* ▪ FMU41 - U*D*A* - U*F*A* ▪ FMU42 - U*D*A*** - U*F*A*** ▪ FMU44 - U*D*A*** - U*F*A***	CSA IS	▪ Profibus-PA ▪ Foundation Fieldbus	F12	ZD 099F
▪ FMU40 - U*B* D* ▪ FMU41 - U*B* D* ▪ FMU42 - U*B* D*** ▪ FMU44 - U*B* D***	CSA IS	HART (2-wire)	T12 with overvoltage protection	ZD 101F
▪ FMU40 - U*D*D* - U*F*D* ▪ FMU41 - U*D*D* - U*F*D* ▪ FMU42 - U*D*D*** - U*F*D*** ▪ FMU44 - U*D*D*** - U*F*D***	CSA IS	▪ Profibus-PA ▪ Foundation Fieldbus	T12 with overvoltage protection	ZD 102F

Instrument version	Certificate	Communication	Housing	Control or Installation Drawing
▪ FMU40 - V*B*C* - V*D*C* - V*F*C* ▪ FMU41 - V*B*C* - V*D*C* - V*F*C* ▪ FMU42 - V*B*C*** - V*D*C*** - V*F*C*** ▪ FMU44 - V*B*C*** - V*D*C*** - V*F*C***	CSA XP	▪ HART (2-wire) ▪ Profibus PA ▪ Foundation Fieldbus	T12	ZD 100F
▪ FMU 40 - K***** ▪ FMU 41 - K*****	TIIS Ex ia IIC T6	HART	F12	ZD 138F

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Endress+Hauser
People for Process Automation

TI365F/00/en/01.09
71089083
FM+SGML 6.0 ProMoDo

71089083

ENDRESS+HAUSER WATERPILOT FMX167 LEVEL TRANSDUCER

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Waterpilot FMX167

Hydrostatic level measurement
Reliable and robust level probe with ceramic measuring cell
Compact device for level measurement in fresh water, wastewater and saltwater

Application

The Waterpilot FMX167 is a pressure sensor for hydrostatic level measurement.
Three versions of FMX167 are available at Endress+Hauser:

- FMX167 with a stainless steel housing, outer diameter of 22 mm (0.87 in): Standard version suitable for drinking water applications and for use in bore holes and wells with small diameters
- FMX167 with a stainless steel housing, outer diameter of 42 mm (1.66 in): Heavy duty version, easy clean flush-mounted process diaphragm. Ideally suited to wastewater and sewage treatment plants
- FMX167 with a coated housing, outer diameter of 29 mm (1.15 in): Corrosion resistant version generally for use in saltwater, particularly for ship ballast water tanks.

Your benefits

- High mechanical resistance to overload and aggressive media
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2-filter pressure compensation system
- 4 to 20 mA output signal with integrated overvoltage protection
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Usage in drinking water: KTW, NSF, ACS
- Approvals: ATEX, FM and CSA
- Marine certificate: GL, ABS
- Extensive range of accessories provides complete measuring point solutions

TI00351P/00/EN/13.11
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Endress+Hauser
People for Process Automation

Table of contents

Function and system design

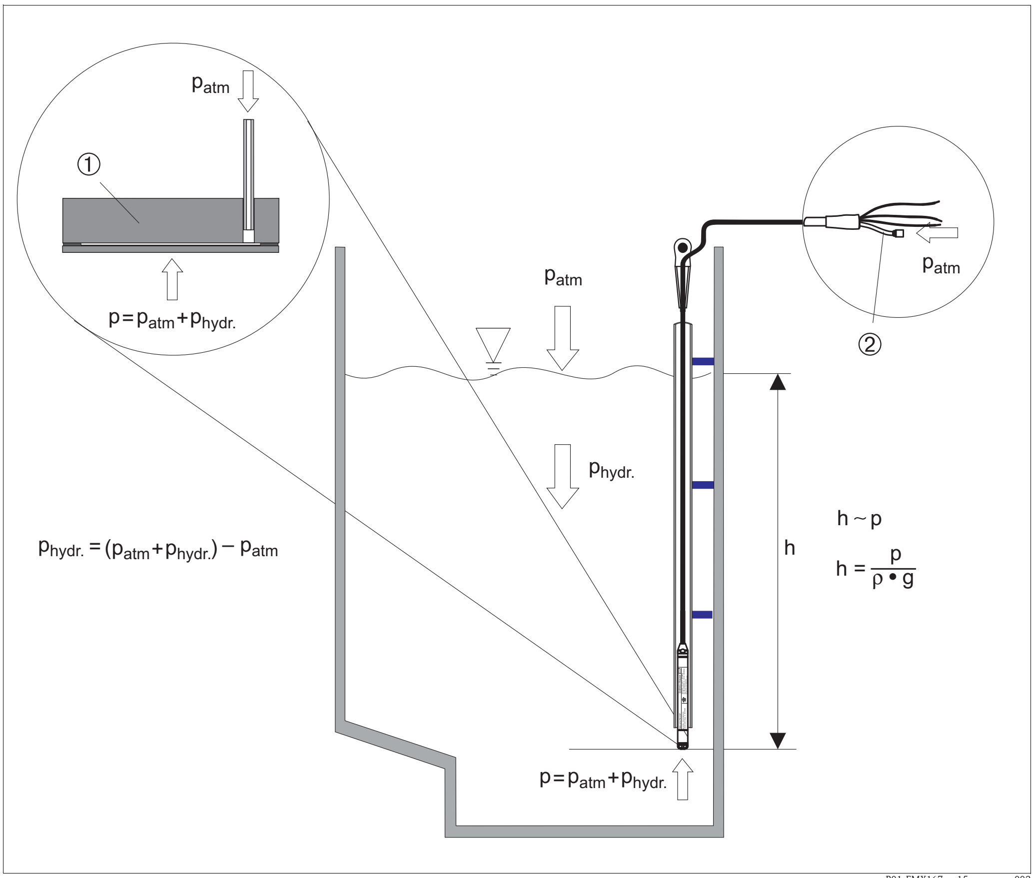
Device selection

Waterpilot FMX167	 P01-FMX167xx-16-xx-xx-xx-002	 P01-FMX167xx-16-xx-xx-xx-003	 P01-FMX167xx-16-xx-xx-xx-004
Field of application	Hydrostatic level measurement in deep wells e.g. drinking water	Hydrostatic level measurement in wastewater	Hydrostatic level measurement in saltwater
	Caution! The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, extension cable). Endress+Hauser offers the Deltapilot level transmitter for biogas applications.		
Process connection	– Mounting clamp – Extension cable mounting screw with G1 ½ A or 1 ½ NPT thread		
Outer diameter	22 mm (0.87 in)	42 mm (1.65 in)	max. 29 mm (max. 1.14 in)
Extension cable	– PE extension cable – PUR extension cable – FEP extension cable		
Seals	– FKM Viton – EPDM [1]	– FKM Viton	– FKM Viton – EPDM [1]
Measuring ranges	– Nine fixed pressure measuring ranges in bar, mH_2O, psi and ftH_2O, from 0 to 0.1 bar to 0 to 20 bar (0 to 1 mH_2O to 0 to 200 mH_2O/ 0 to 1.5 psi to 0 to 300 psi/0 to 3 ftH_2O to 0 to 600 ftH_2O) – Customer-specific measuring ranges; factory-calibrated		– Seven fixed pressure measuring ranges in bar, mH_2O, psi and ftH_2O, from 0 to 0.1 bar to 0 to 4 bar (0 to 1 mH_2O to 0 to 40 mH_2O/ 0 to 1.5 psi to 0 to 60 psi/ 0 to 3 ftH_2O to 0 to 150 ftH_2O) – Customer-specific measuring ranges; factory-calibrated
Overload	Up to 40 bar (580 psi)		Up to 25 bar (362 psi)
Process temperature	–10 to +70 °C (+14 to +158 °F)		0 to +50 °C (+32 to +122 °F)
Ambient temperature range	–10 to +70 °C (+14 to +158 °F)		0 to +50 °C (+32 to +122 °F)
Maximum measured error	±0.2 % of upper range value (URV)		
Supply voltage	10 to 30 V DC		
Output	4 to 20 mA (invertible)		
Options	– Drinking water approval		
	– Integrated Pt100 temperature sensor – Integrated Pt100 temperature sensor and TMT181 temperature head transmitter (4 to 20 mA HART) – Marine certificate		
Specialties	– Large selection of approvals, including ATEX II 2 G, FM and CSA – High-precision, robust ceramic measuring cell with long-term stability – Customer-specific cable marking		

1) Recommended for drinking water applications, not suitable for use in hazardous areas.

Measuring principle

The ceramic measuring cell is a dry measuring cell, i.e. pressure acts directly on the robust ceramic process isolating diaphragm of the Waterpilot.
Any changes in the air pressure are routed through the extension cable, via a pressure compensation tube, to the rear of the ceramic process isolating diaphragm and compensated for. A pressure-dependent change in capacitance caused by the movement of the process isolating diaphragm is measured at the electrodes of the ceramic carrier. The electronics convert the movement into a pressure-proportional signal which is linear to the medium level.



P01-FMX167xx-15-xx-xx-xx-002

Measuring principle

1	*Ceramic measuring cell*
2	*Pressure compensation tube*
h	*Level height*
p	*Total pressure = hydrostatic pressure + atmospheric pressure*
ρ	*Density of the medium*
g	*Gravitational acceleration*
$p_{hydr.}$	*Hydrostatic pressure*
p_{atm}	*Atmospheric pressure*

Temperature measurement with optional Pt100[1)]

Endress+Hauser also offers the Waterpilot FMX167 with an optional 4-wire Pt100 resistance thermometer to measure level and temperature simultaneously. The Pt100 belongs to Accuracy Class B in accordance with DIN EN 60751, see also → 🗎 22, Sect. "Accessories.

Temperature measurement with optional Pt100 and TMT181 temperature head transmitter [1)]

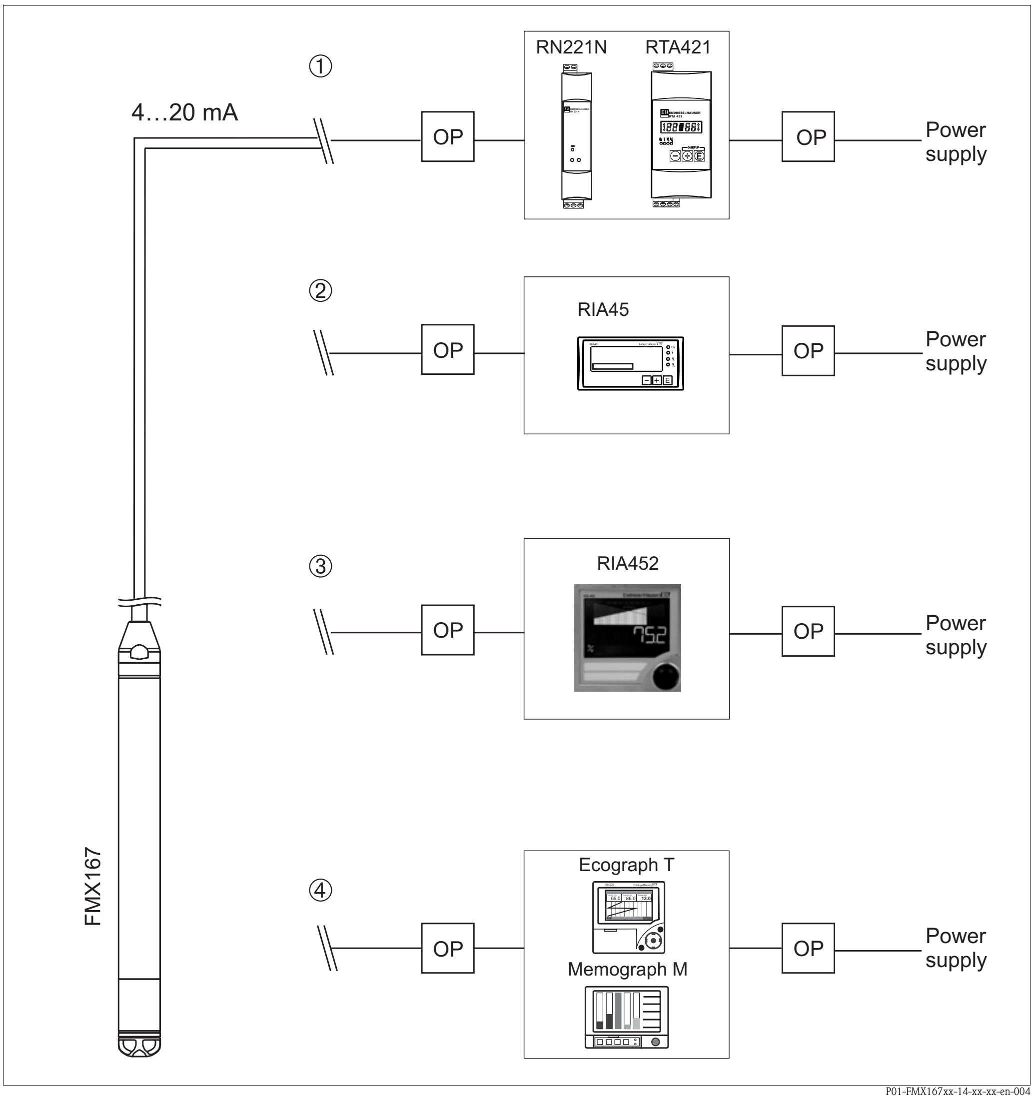
To convert the Pt100 signal to a 4 to 20 mA signal, Endress+Hauser also offers the TMT181 temperature transmitter.

1) Not for use in hazardous areas.

Measuring system

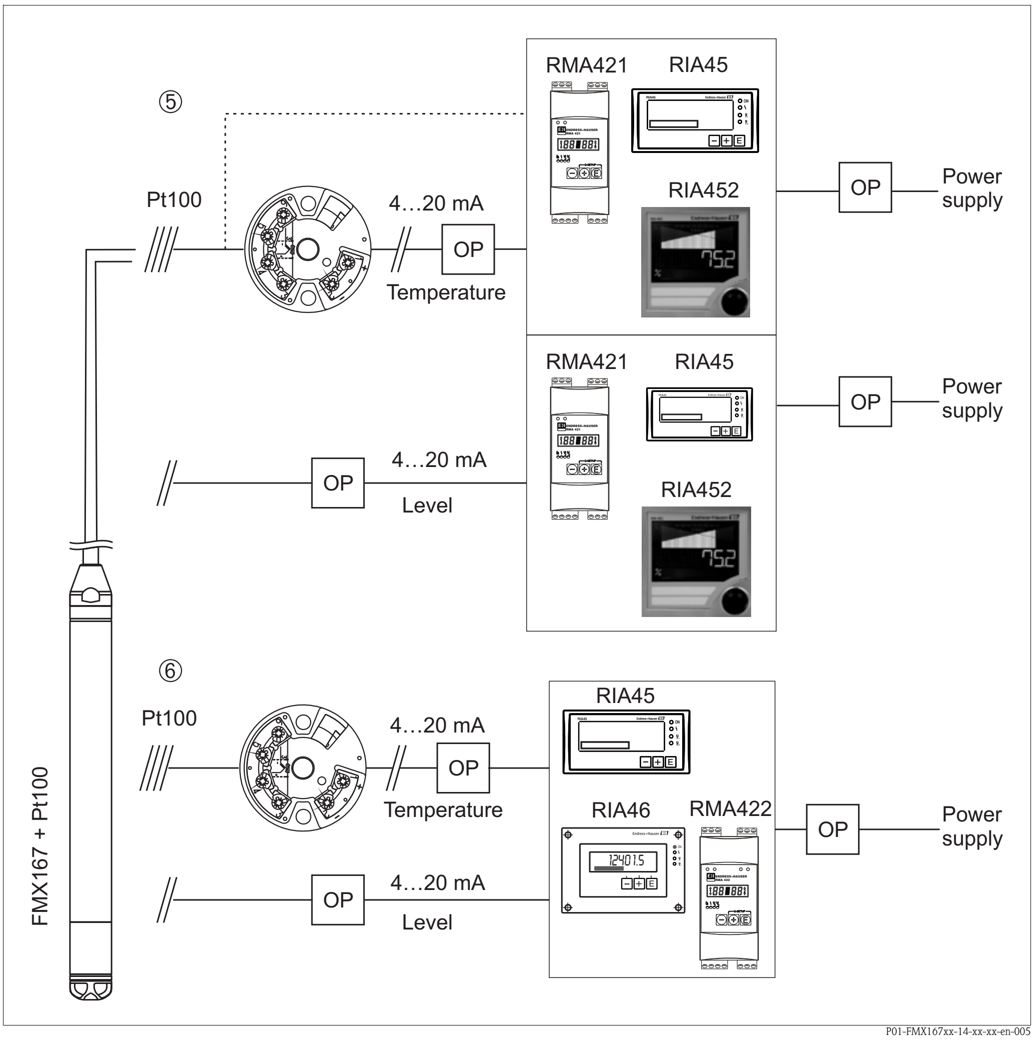
The complete standard measuring system consists of Waterpilot and a transmitter power supply unit with supply voltage of 10 to 30 V DC.

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:



Application examples with FMX167
OVP = Overvoltage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)
- OVP on the sensor side for field installation: HAW569/for top-hat rail/DINrail: HAW562
- OVP on the supply side for top-hat rail/DINrail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)
Option dependent on supply voltage.

1. Simple cost-effective measuring point solution: Power supply of Waterpilot in hazardous and non-hazardous areas using RN221N active barrier.
   Power supply and additional control of two consumers, e.g. pumps, via limit switch RTA421 with onsite display.
2. Evaluation unit RIA45 (for panel mounting) provides a power supply system, an onsite display and two switch outputs.
3. If several pumps are used, the pump service life can be prolonged by alternate switching. With alternating pump control, the pump which was out of service for the longest period of time is switched on. The evaluation unit RIA452 (for panel mounting) provides this option in additional to several other functions.
4. State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph T, Memograph M, or paper recorders such as Alphalog for documenting, monitoring, visualizing and archiving purposes.



Application examples with FMX167
OVP = Overvoltage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)
- OVP on the sensor side for field installation: HAW569/for top-hat rail/DINrail: HAW562
- OVP on the supply side for top-hat rail/DINrail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)
Option dependent on supply voltage.

5. If you want to measure, display and evaluate the temperature as well as the level, e.g. to monitor temperature in fresh water to detect temperature limits for germ formation, you have the following options:
   The optional TMT181 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA HART signal and transfer it to any common evaluation unit. The RMA421, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.
6. If you want to record and evaluate the level and temperature measured value with one device, use the RMA422, RIA45 and RIA46 evaluation units with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation units are not HART-compatible.

System integration

The device can be fitted with a tag name, see → 🗎 21 ff, "Ordering information", feature 995 "Marking" version "1".

Input

Measured variable

FMX167 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: Temperature of a liquid

TMT181 temperature head transmitter (optional)

Temperature

Measuring range

- Nine fixed pressure measuring ranges in bar, mH_2O, psi and ftH_2O; → 21, "Ordering information"
- Customer-specific measuring ranges; factory-calibrated
- Temperature measurement from –10 to +70 °C (+14 to +158 °F) optional with Pt100

Sensor measuring range [bar (psi)]	Lowest span that can be calibrated [bar (psi)]	Maximum overload/OPL [1)] [bar (psi)]	Vacuum resistance [bar_{abs}(psi_{abs})]
0.1 (1.5)	0,01 (0.15)	5.0 (75.0)	0.3 (4.5)
0.2 (3.0)	0.02 (0.3)	5.0 (75.0)	0.3 (4.5)
0.4 (6.0)	0.04 (1.0)	7.0 (105)	0
0.6 (9.0)	0.06 (1.0)	10.0 (150)	0
1.0 (15.0)	0.1 (1.5)	10.0 (150)	0
2.0 (30.0)	0.2 (3.0)	18.0 (270)	0
4.0 (60.0)	0.4 (6.0)	25.0 (375)	0
10.0 (150) [2)]	1.0 (15)	40.0 (600)	0
20.0 (300) [2)]	2.0 (30)	40.0 (600)	0

1) OPL: overpressure limit, depending on the weakest element, in terms of pressure, of the selected components

2) These measuring ranges are not offered for the probe version with a coated housing, outer diameter 29 mm (1.14 in).

Input signal

FMX167 + Pt100 (optional)

- Change in capacitance
- Pt100: change in resistance

TMT181 temperature head transmitter (optional)

Pt100 resistance signal, 4-wire

Output

Output signal

FMX167 + Pt100 (optional)

- FMX167: 4 to 20 mA for hydrostatic pressure measured value, two-wire
- Pt100: Temperature-dependent resistance value of the Pt100

TMT181 temperature head transmitter (optional)

4 to 20 mA for temperature measured value, two-wire

Load

FMX167 + Pt100 (optional)

$$R_{tot} \leq \frac{U_b - 10\ V}{0.0225\ A} - 2 \cdot 0.09 \frac{\Omega}{m} \cdot l - R_{add}$$

P01-FMX167xx-16-xx-xx-xx-000

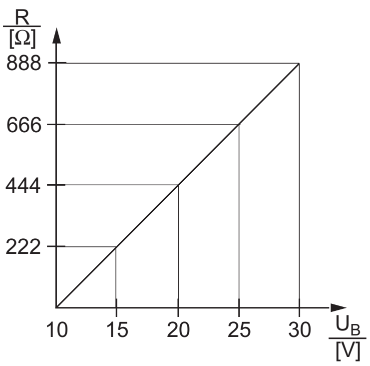
TMT181 temperature head transmitter (optional)

$$R_{tot} \leq \frac{U_b - 8\ V}{0.025\ A} - R_{add}$$

P01-FMX167xx-16-xx-xx-xx-001

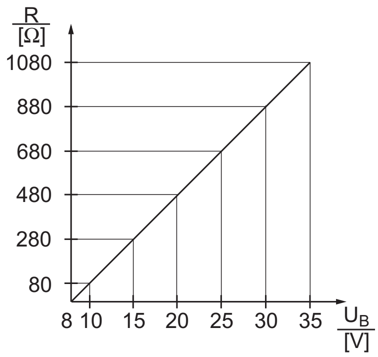
R_{ges} = Max. load resistance [Ω]
R_{add} = additional resistances such as resistance of evaluation unit and/or display unit, cable resistance [Ω]
U_b = Supply voltage [V]
l = Simple length of extension cable [m] (cable resistance per wire ≤ 0.09 /Ωm)

Note!
When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions or Installation or Control Drawings.



P01-FMX167xx-05-xx-xx-xx-001

FMX167 load chart for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.



P01-FMX167xx-05-xx-xx-xx-003

Temperature head transmitter load chart for estimating the load resistance. Additional resistances have to be subtracted from the value calculated as shown in the equation.

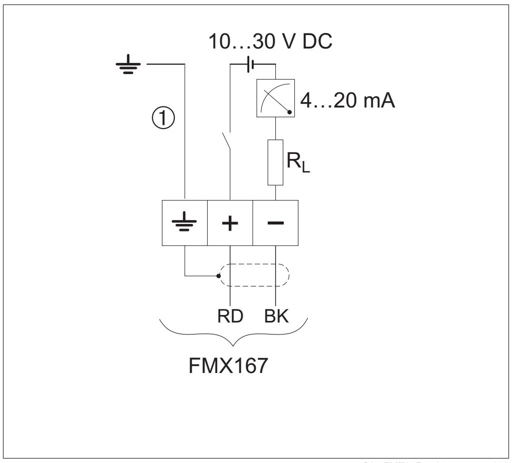
Power supply

Measuring unit electrical connection

Note!

- When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs), see also → 24, "Safety instructions", "Installation/Control Drawings".
- Reverse polarity protection is integrated in the Waterpilot FMX167 and in the temperature head transmitter TMT181. Changing the polarities will not result in the destruction of the devices.
- The cable must end in a dry room or a suitable terminal box. For installation outside, use the terminal box (IP 66/IP 67) with a GORE-TEX® filter from Endress+Hauser. The terminal box can be ordered using the order code of the FMX167 (→ 21, "Ordering information") or as an accessory (order number: 52006252).

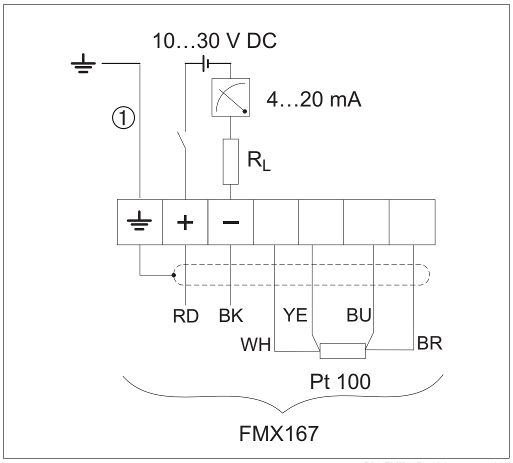
Waterpilot FMX167, standard



P01-FMX167xx-04-xx-xx-xx-008

Electrical connection, versions "7" or "3" for Feature 70 "Additional options" in the order code (→ 21).

Waterpilot FMX167 with Pt100 [1)]

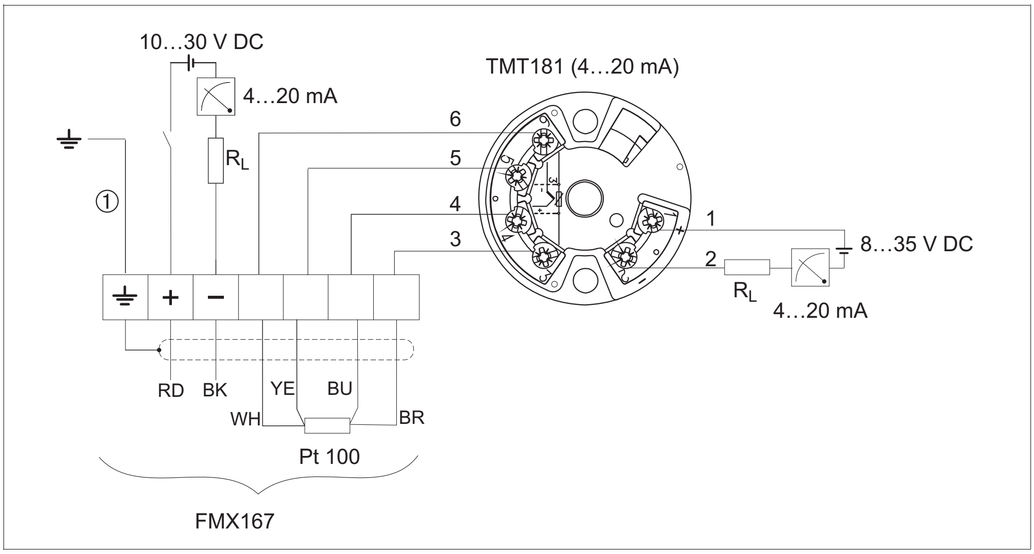


P01-FMX167xx-04-xx-xx-xx-006

Electrical connection with Pt100, versions "1" or "4" for Feature 70 "Additional options" in the order code (→ 21).

① Not for FMX167 with outer diameter 29 mm (1.14 in).
1) Not for use in hazardous areas.

Waterpilot FMX167 with Pt100 and TMT181 temperature head transmitter TMT181 (4 to 20 mA) [1)]



P01-FMX167xxx-04-xx-xx-xx-007

FMX167 with Pt100 and TMT181 temperature head transmitter (4 to 20 mA), version "5" for Feature 70 in the order code (→ 21).

① Not for FMX167 with outer diameter 29 mm (1.14 in)
Wire colors: RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

1) Not for use in hazardous areas.

Supply voltage	Note! When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). → 24, Sect. "Safety instructions", "Installation/Control Drawings".	
	FMX167 + Pt100 (optional)	**TMT181 temperature head transmitter (optional)**
	▪ FMX167: 10 to 30 V DC ▪ Pt100: 10 to 30 V DC	8 to 35 V DC
Cable specification	**FMX167 + Pt100 (optional)**	**TMT181 temperature head transmitter (optional)**
	▪ Commercially available instrument cable ▪ Terminals in terminal housing FMX167: 0.08 to 2.5 mm^2 (28 to 14 AWG) ▪ If the Pt100 signal is directly connected to a display and/or evaluation unit, Endress+Hauser recommends using a shielded cable.	▪ Commercially available instrument cable ▪ Terminals in terminal housing FMX167: 0.08 to 2.5 mm^2 (28 to 14 AWG) ▪ Transmitter connection: max. 1.75 mm^2 (15 AWG)
Power consumption	**FMX167 + Pt100 (optional)**	**TMT181 temperature head transmitter (optional)**
	≤ 0.675 W at 30 V DC	≤ 0.875 W at 35 V DC
Current consumption	**FMX167 + Pt100 (optional)**	**TMT181 temperature head transmitter (optional)**
	▪ Max. current consumption: ≤ 22.5 mA Min. current consumption: ≥ 3.5 mA ▪ Pt100: ≤ 0.6 mA	▪ Max. current consumption: ≤ 25 mA Min. current consumption: ≥ 3.5 mA ▪ Pt100 via temperature head transmitter: ≤ 0.6 mA
Residual ripple	**FMX167 + Pt100 (optional)**	**TMT181 temperature head transmitter (optional)**
	No effect for 4 to 20 mA signal up to ±5 % residual ripple within permissible range	$U_{ss} \geq 5$ V at $U_B \geq 13$ V, $f_{max.} = 1$ kHz

Performance characteristics

	FMX167 + Pt100 (optional)	TMT181 temperature head transmitter (optional)
Reference operating conditions	DIN EN 60770 T_U = 25 °C (77 °F)	Calibration temperature 23 °C (73 °F) ±5 K
Maximum measured error	■ Non-linearity including hysteresis and non-repeatability as per DIN EN 60770: ±0.2 % of upper range value (URV) ■ Pt100: max. ±0.7 K (Class B to DIN EN 60751)	■ ±0.2 K ■ With Pt100: max. ±0.9 K
Long-term stability	±0.1 % of the upper range limit (URL) per year	≤ 0.1 K per year

Influence of medium temperature

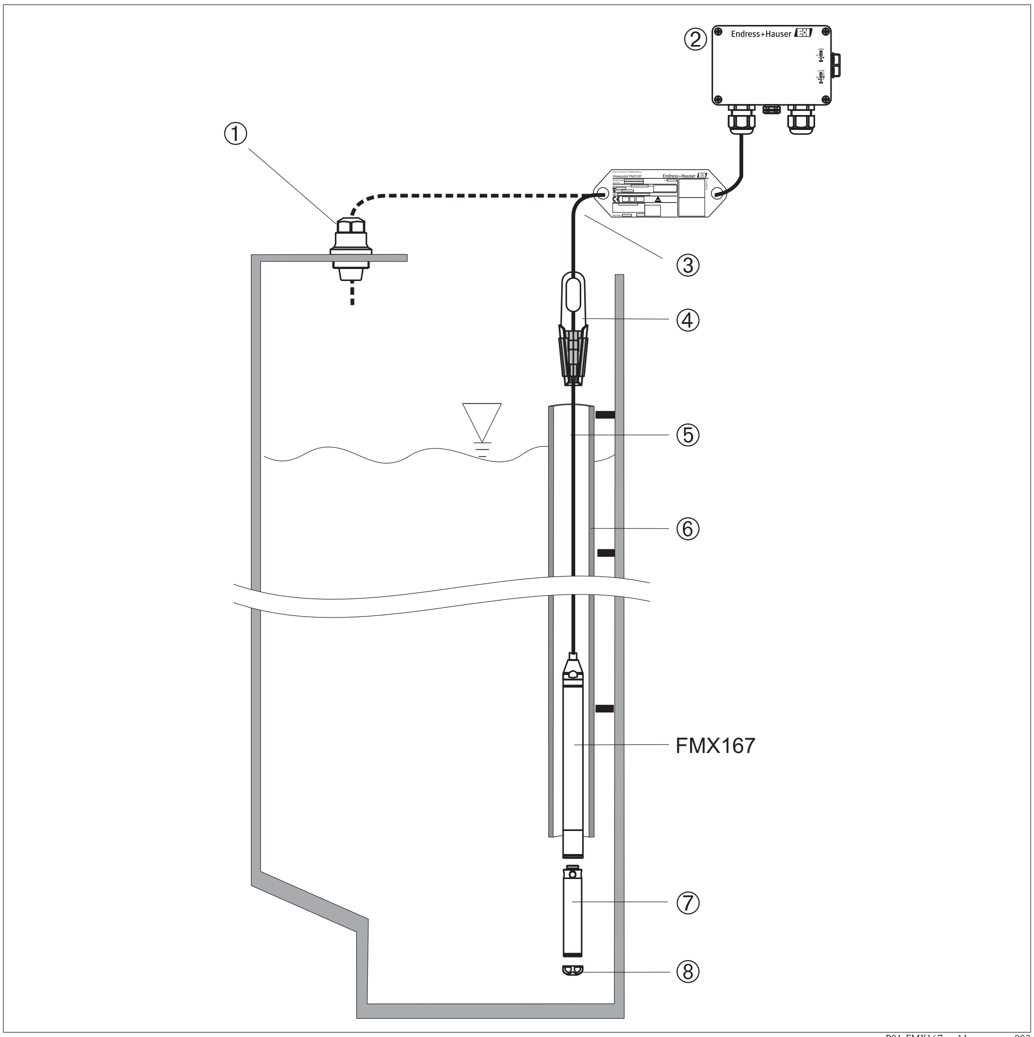
- Thermal change in zero signal and output span for typical application temperature range 0 to +30 °C (+32 to +86°F): ±0.4 % (±0.5 %)* of the upper range limit (URL)
- Thermal change in zero signal and output span for the entire medium temperature range –10 to +70 °C (+14 to +158°F): ±1.0 % (±1.5 %)* of the upper range limit (URL)
- Temperature coefficient $_K$) of zero signal and output span: 0.15 %/10 K (0.3 %/10 K)* of the upper range limit (URL)

* Specifications for sensors 0.1 bar (1 mH_2O, 1.5 psi, 3 ftH_2O) and 0.6 bar (6 mH_2O, 10 psi, 20 ftH_2O)

	FMX167 + Pt100 (optional)	TMT181 temperature head transmitter (optional)
Warm-up period	20 ms	4 s
Rise time	■ FMX167: 80 ms ■ Pt100: 160 s	–
Settling time	■ FMX167: 150 ms ■ Pt100: 300 s	–

Installation conditions

Installation instructions



P01-FMX167xx-11-xx-xx-xx-003

Installation examples, here shown the FMX167 with an outer diameter 22 mm (0.87 in)

1 *Extension cable mounting screw can be ordered via order code or as an accessory → 21 ff*
2 *Terminal housing can be ordered using the order code or as an accessory → 21*
3 *Extension cable bending radius >120 mm (4.72 in)*
4 *Mounting clamp can be ordered via order code or as an accessory → 21 ff*
5 *Extension cable, cable length → 18*
6 *Guide pipe*
7 *Additional weight can be ordered as an accessory with an outer diameter of 22 mm (0.87 in) and 29 mm (1.14 in) → 22*
8 *Protection cap*

Note!

- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) larger than the outer diameter of the selected FMX167.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation.
- Protection cap: The device is provided with a protection cap to prevent mechanical damage to the measuring cell. This cap should not be removed during the transportation and installation process.
- If the cable is shortened, the filter at the pressure compensation tube has to be reattached. Endress+Hauser offers a cable shortening kit for this purpose, see the documentation SD00552P/00/A6.
- Endress+Hauser recommends using twisted, shielded cables for any further wiring.
- Note for ship building applications: Measures for limitation of the propagation of fire along cable bundles are required (fire stops).

Ambient conditions

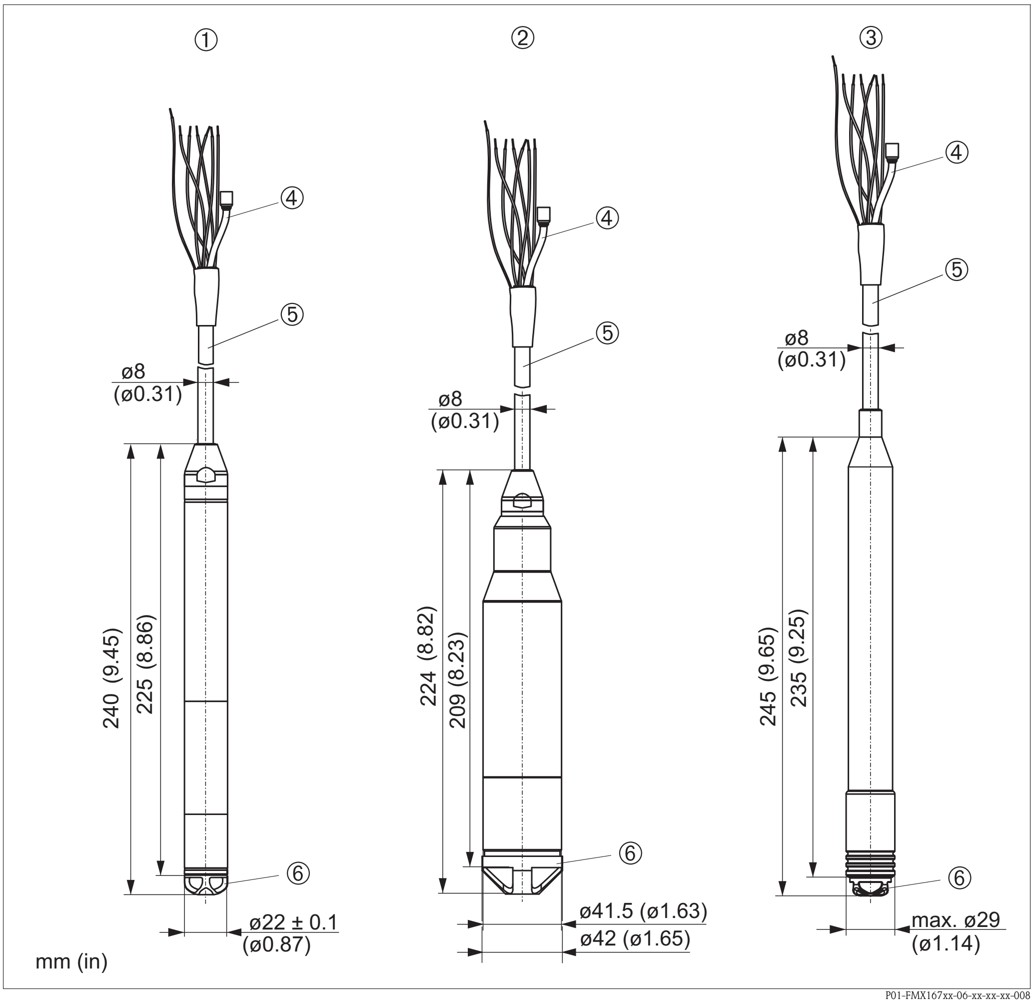
Ambient temperature range	**FMX167 + Pt100 (optional)** ▪ with outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): –10 to +70 °C (14 to +158 °F) (= medium temperature) ▪ with outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F) (= medium temperature) **Terminal box** –40 to +80 °C (–40 to +176 °F)	**TMT181 temperature head transmitter (optional)** –40 to +85 °C (–40 to +185 °F)
Storage temperature range	**FMX167 + Pt100 (optional)** –40 to +80 °C (–40 to +176 °F) **Terminal box** –40 to +80 °C (–40 to +176 °F)	**TMT181 temperature head transmitter (optional)** –40 to +100 °C (–40 to +212 °F)
Degree of protection	**FMX167 + Pt100 (optional)** ▪ IP 68, permanently hermetically sealed ▪ Optional terminal box: IP 66/IP 67	**TMT181 temperature head transmitter (optional)** ▪ IP 00, moisture condensation permissible ▪ When mounted in the optional terminal boxes: IP 66/IP67
Electromagnetic compatibility (EMC)	**FMX167 + Pt100 (optional)** ▪ Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial) ▪ Maximum deviation <0.5 % of the span.	**TMT181 temperature head transmitter (optional)** Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial)
Overvoltage protection	**FMX167 + Pt100 (optional)** Integrated overvoltage protection to EN 61000-4-5 (500 V symmetrical/1000 asymmetrical) Install overvoltage protection ≥1.0 kV, external if necessary	**TMT181 temperature head transmitter (optional)** Install overvoltage protection, external if necessary.

Process conditions

Medium temperature range	**FMX167 + Pt100 (optional)** ▪ with outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): –10 to +70 °C (–14 to +158 °F) ▪ FMX167 with outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to 122 °F)	**TMT181 temperature head transmitter (optional)** –40 to +85 °C (-40 to +185°F) (= ambient temperature), install temperature head transmitter outside medium.
Medium temperature limits	**FMX167 + Pt100 (optional)** ▪ with outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): –20 to +70 °C (–4 to +158 °F) Note! In hazardous areas incl. CSA GP, the medium temperature limit is at –10 to +70 °C (+14 to +158 °F). ▪ with outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F) (You may operate the FMX167 in this temperature range. The specification can then be exceeded, e.g. measuring accuracy).	

Mechanical construction

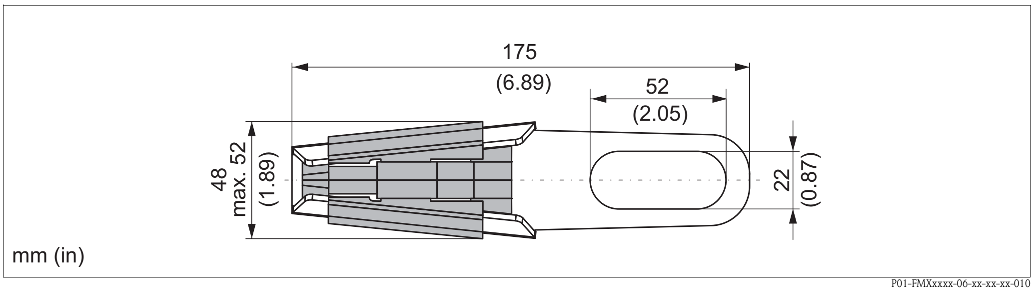
Dimensions of the level probe



Versions of FMX167

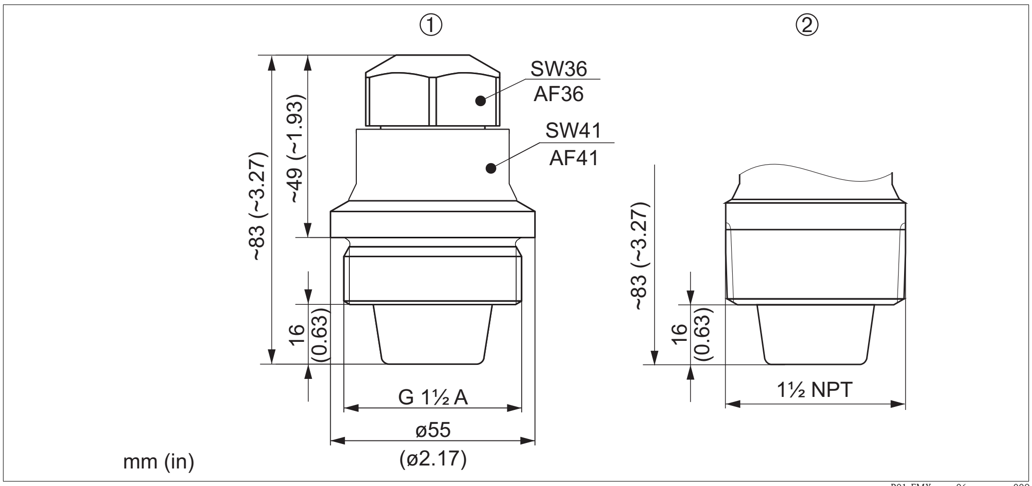
1 Version "A" or "D" for Feature 30 "Probe tube" in the order code (→ 🗎 21)
2 Version "B" for Feature 30 "Probe tube" in the order code (→ 🗎 21)
3 Version "C" for Feature 30 "Probe tube" in the order code (→ 🗎 21)
4 Pressure compensation tube
5 Extension cable
6 Protection cap

Dimensions of the mounting clamp



Mounting clamp, version "2" for Feature 20 "Connection" in the order code (→ 🗎 21)

Dimensions of the extension cable mounting screws



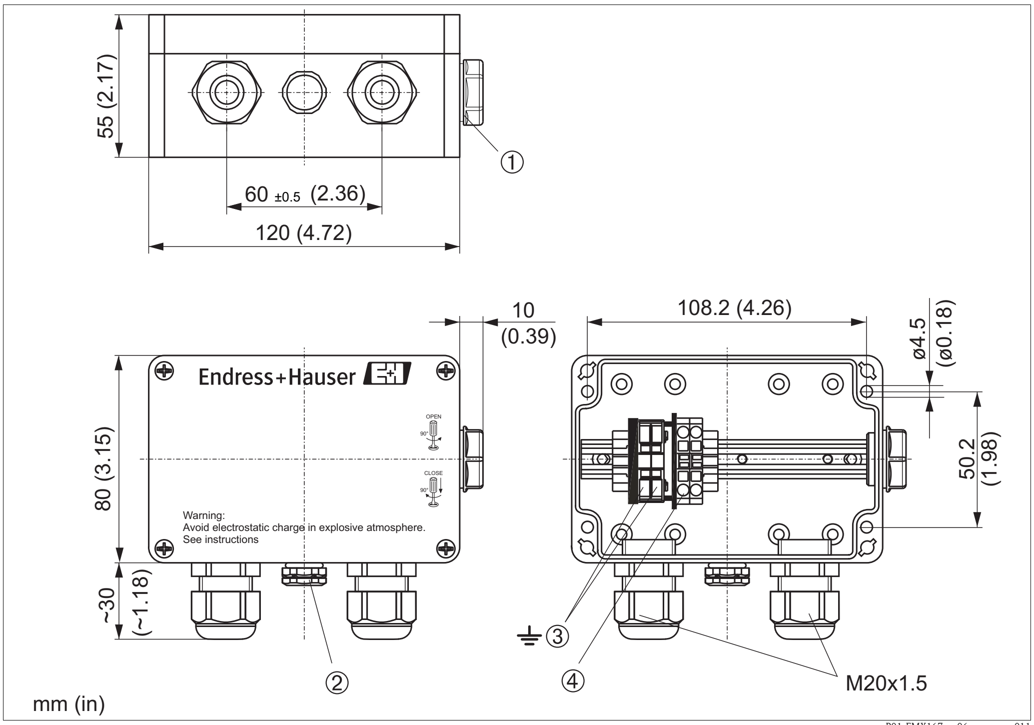
P01-FMXxxxx-06-xx-xx-xx-009

Extension cable mounting screws

1 *Extension cable mounting screw G1 ½ A, version "3" for Feature 20 "Connection" in the order code (→ 21)*
2 *Extension cable mounting screw 1 ½ NPT, version "4" for Feature 20 "Connection" in the order code (→ 21)*

Note!
Application in unpressurized containers only.

Dimensions of the terminal box IP 66/IP 67 with filter



P01-FMX167xx-06-xx-xx-xx-011

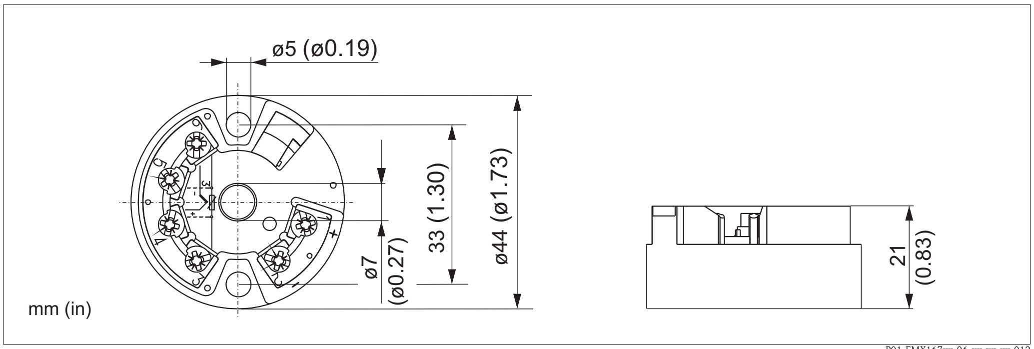
Version "3", "4" or "5" for Feature 70 "Additional options" in the order code (→ 21)

1 *Dummy plug M20x1.5*
2 *GORE-TEX® filter*
3 *Ground connection / terminals for 0.08 to 2.5 mm² (28 to 14 AWG)*
4 *4 to 20 mA / terminals for 0.08 to 2.5 mm² (28 to 14 AWG)*

If ordered together with FMX167 but without the optional TMT181 temperatur transmitter, the terminal box is incl. a 4-terminal strip.

Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Dimensions of the TMT181 temperature head transmitter

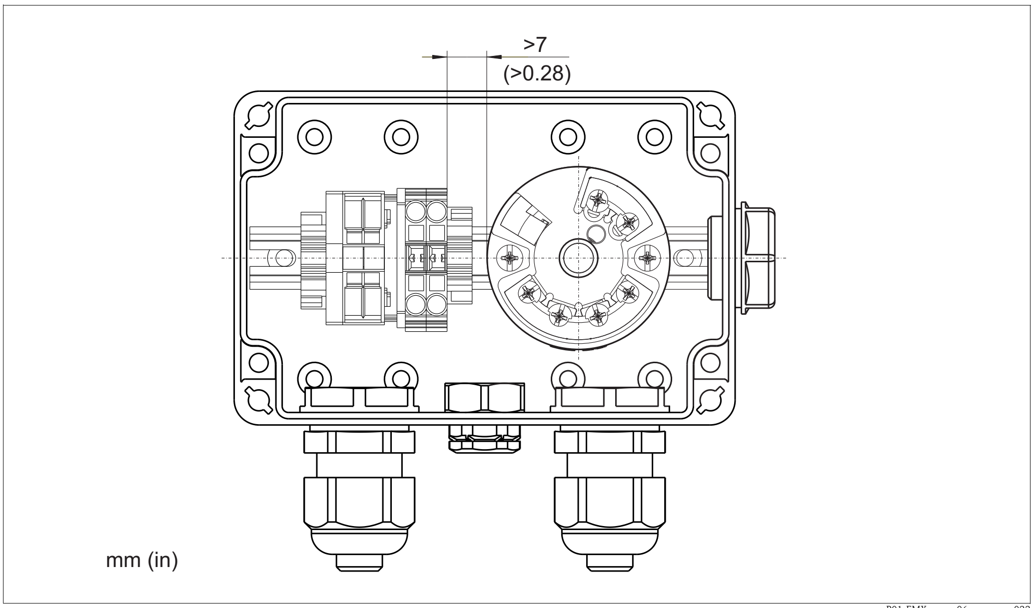


P01-FMX167xx-06-xx-xx-xx-012

TMT181 temperature head transmitter (4 to 20 mA)

Version "5" for Feature 70 "Additional options" in the order code (→ 🗎 21). The temperature head transmitter can be used in non-hazardous areas.

Terminal box with integrated TMT181 temperature head transmitter



P01-FMXxxxxx-06-xx-xx-xx-022

Note!
A distance of >7 mm (>0.28 in) must be maintained between the terminal strip and the TMT181 temperature head transmitter.

Weight

- Level probe, outer diameter 22 mm (0.87 in): 290 g (10.228 oz)
- Level probe, outer diameter 42 mm(1.65 in): 1150 g (40.561 oz)
- Level probe, outer diameter 29 mm(1.14 in): 340 g (11.992 oz)
- PE extension cable: 52 g/m (0.33 lbs/1 ft)
- PUR extension cable: 60 g/m (0.039 lbs/1 ft)
- FEP extension cable: 108 g/m (0.072 lbs/1 ft)
- Mounting clamp: 170 g (5.996 oz)
- Extension cable mounting screw G 1 ½ A: 770 g (27.158 oz)
- Extension cable mounting screw 1 ½ NPT: 724 g (25.535 oz)
- Terminal box: 235 g (8.288 oz)
- Temperature head transmitter TMT181: 40 g (1.411 oz)
- Additional weight: 300 g (10.581 oz)
- Testing adapter: 39 g (1.376 oz)

Material

- Level probe, outer diameter 22 mm (0.87 in): 1.4435 (AISI 316L)
- Level probe, outer diameter 42 mm (1.65 in): 1.4435 (AISI 316L)
- Level probe, outer diameter 29 mm (1.14 in): 1.4435 (AISI 316L)
  - Sensor sleeve: PPS (polyphenylene sulfide), Heat-shrink sleeve/cover: Polyolefin

  Metal does not come into contact with the medium.
- Process ceramic: Al_2O_3 aluminum oxide ceramic
- Seal (internal): EPDM or Viton
- Protection cap: – PPO (polyphenylene oxide) for FMX167 with outer diameter 22 mm (0.87 in) and 29 mm (1.14 in).
  - PFA (perfluoroalkoxy) for FMX167 with outer diameter 42 mm (1.65 in).
- Extension cable insulation: Either PE-LD (low-density polyethylene), FEP (fluorinated ethylene propylene) or PUR (polyurethane). For more information, see → 🗎 18, "Extension cable"
- Mounting clamp: 1.4404 (AISI 316L) and fiberglass reinforced PA (polyamide)
- Extension cable mounting screw G 1 ½A: 1.4301 (AISI 304)
- Extension cable mounting screw 1 ½NPT: 1.4301 (AISI 304)
- Terminal box: PC (polycarbonate)
- Temperature head transmitter TMT181: PC housing (polycarbonate)

Extension cable

PE extension cable
- Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyethylene (PE), black; copper wires, twisted
- Pressure compensation tube with Teflon filter

PUR extension cable
- Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyurethane (PUR), black; copper wires, twisted
- Pressure compensation tube with Teflon filter

FEP extension cable
- Abrasion-resistant extension cable; shielded with galvanized steel wire netting; insulated with fluorinated ethylene propylene (FEP), black; copper wires, twisted
- Pressure compensation tube with Teflon filter

Cross-section of PE/PUR/FEP extension cable
- Total outer diameter: 8.0 mm (0.31 in) ±0.25 mm (±0.01 in)
- FMX167: 3 x 0.227 mm^2 (3 x 26 AWG) + pressure compensation tube with Teflon filter
- FMX167 with Pt100 (optional): 7x0.227 mm^2 (7x26 AWG) + pressure compensation tube with Teflon filter
- Pressure compensation tube with Teflon filter:
  Outer diameter 2.5 mm (0.1 in), internal diameter 1.5 mm (0.06 in)

Cable resistance of PE/PUR/FEP extension cable
Cable resistance per wire: ≤ 0.09 Ω/m

Cable length of PE/PUR/FEP extension cable
- Please refer also to → 🗎 8, Sect. "Load".
- Cable length that can be ordered
  - Customer-specific length in meters or feet (→ 🗎 21, "Ordering information")
  - Limited cable length when performing installation with freely suspended device with extension cable mounting screw or mounting clamp, as well as for Ex approval: max. 300 m (984 ft).
- When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs). See also → 🗎 24, "Safety instructions" and "Installation/Control Drawings" Sections.

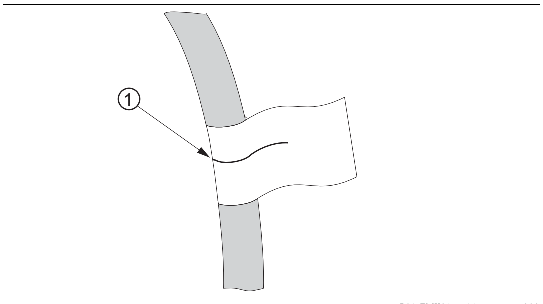
Further technical data of PE /PUR/FEP extension cable
- Minimum bending radius: 120 mm (4.72 in)
- Tensile strength: max. 950 N (213.56 lbf)
- Cable extraction force: typical ≥ 400 N (89.92 lbf) PE, FEP / typical ≥ 150 N (33.72 lbf) PUR
  (The extension cable could be extracted from the level probe with a appropriate tensile force.)
- Resistance to UV light
- PE: Approved for use with drinking water

Terminals

- Three terminals as standard in the terminal box
- 4-terminal strip can be ordered as an accessory, Order No: 52008938
  Conductor cross-section 0.08 to 2.5 mm^2 (28 to 14 AWG)

Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Installation tool – indicating the customer-specific length on the cable



1 cable marking, distance to the lower end of the cable probe

- To make installation easier, Endress+Hauser offers a mark on the extension cable for a customer-specific length, see also → 21, "Ordering information".
- Mark tolerance: up to ±50 mm (1.97 in) (the mark tolerance corresponds to a measured error from up to ±50 mm (1.97 in))
- Material: PET
- Adhesive: acrylic
- Immunity to temperature change: –30 to +100 °C (–22 to 212 °F)

Note!

- The mark is for installation purposes only.
  It must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.
- Not for use in hazardous areas.

Certificates and approvals

CE mark	The device meets the legal requirements of the applicable EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
Approvals, types of protection	▪ ATEX II 2 G Ex ia IIC T6 Gb [1)] ▪ ATEX II 3 G Ex nA II T6[1)] ▪ FM: IS, Class I, Division 1, Groups A–D[1)] ▪ CSA: IS, Class I, Division 1, Groups A–D[1)] ▪ CSA: General Purpose 1) Only for Waterpilot FMX167 without Pt100 and TMT181 Note! ▪ Waterpilot FMX167 is only available for use in hazardous areas with the FKM Viton seal. ▪ The cable marking cannot be ordered with the Ex approvals listed due to a potential electrostatic charge (see → 🗎 21, "Ordering information"). ▪ All explosion-protection data are given in a separate documentation which is available upon request. The Ex documentation is provided with all Ex-systems as standards, see also → 🗎 24, Sect. "Additional documentation", "Safety instructions" and "Installation/Control Drawings".
Drinking water approval (for FMX167 with Outer diameter 22 mm (0.87 in))	▪ KTW certificate ▪ NSF 61 approval ▪ ACS approval
Marine certificate	▪ GL (Germanischer Lloyd) ▪ ABS (American Bureau of Shipping)
Standards and guidelines applied	The European standards and guidelines that have been applied are listed in the associated EC Declarations of Conformity. In addition, the following standards were also applied for the Waterpilot FMX167: ▪ DIN EN 60770 (IEC 60770): Transmitters for use in industrial process control systems Part 1: Methods for performance evaluation ▪ DIN 16086: Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets ▪ EN 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements ▪ EN 61010-1 (IEC 61010-1): Safety requirements for electrical equipment for measurement, control and laboratory use ▪ EN 60529: Degrees of protection provided by enclosures

Ordering information

FMX167

You can enter the versions for the specific feature in the following table. The versions entered make up the complete order code. Options which are mutually exclusive are not marked.

10	**Approval**
A	Non-hazardous area
B	ATEX II 2 G EEx ia IIC T6
C	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
F	CSA General Purpose

20	**Connection**
1	Probe cable
2	Mounting clamp, AISI 316L
3	Cable mounting screw G1-½, AISI 304
4	Cable mounting screw NPT 1-½, AISI 304

30	**Probe tube:**
A	Outer diameter d = 22 mm, AISI 316L
B	Outer diameter d = 42 mm, flush-mounted, AISI 316L
C	Outer diameter d = 29 mm, AISI 316L with heat-shrink sleeve PPS/polyolefin for saltwater applications
D	Outer diameter d = 22 mm, AISI 316L + potable water approval KTW/NSF/ACS (can only be selected in conjunction with EPDM seal and PE probe cable)

40	**Measuring range:**		
Measuring range		**Measuring range**	
BA	0 to 0.1 bar	MA	0 to 1 mH_2O
BB	0 to 0.2 bar	MB	0 to 2 mH_2O
BC	0 to 0.4 bar	MC	0 to 4 mH_2O
BD	0 to 0.6 bar	MD	0 to 6 mH_2O
BE	0 to 1.0 bar	ME	0 to 10 mH_2O
BF	0 to 2.0 bar	MF	0 to 20 mH_2O
BG	0 to 4.0 bar	MG	0 to 40 mH_2O
BH	0 to 10.0 bar	MH	0 to 100 mH_2O
BK	0 to 20.0 bar	MK	0 to 200 mH_2O
PA	0 to 1.5 psi	FA	0 to 3 ftH_2O
PB	0 to 3 psi	FB	0 to 6 ftH_2O
PC	0 to 6 psi	FC	0 to 15 ftH_2O
PD	0 to 10 psi	FD	0 to 20 ftH_2O
PE	0 to 15 psi	FE	0 to 30 ftH_2O
PF	0 to 30 psi	FF	0 to 60 ftH_2O
PG	0 to 60 psi	FG	0 to 150 ftH_2O
PH	0 to 150 psi	FH	0 to 300 ftH_2O
PK	0 to 300 psi	FK	0 to 600 ftH_2O
VV	Adjusted to customer specifications from 0 to ___ (upper range value) in ___ (unit),upper range value: 0.1 bar (1 mH_2O, 1.5 psi, 3 ftH_2O) to 20 bar (200 m$_2$HO, 300 psi, 600 ft$_2$HO)		

50	**Sensor seal:**
1	FKM Viton
2	EPDM

60	**Probe cable:**
A	... m, shortable, PE
B	10 m, shortable, PE
C	20 m, shortable, PE
E	30 ft, shortable, PE
F	60 ft, shortable, PE
G	... ft, shortable, PE
I	... m, shortable, FEP
K	10 m, shortable, FEP
L	20 m, shortable, FEP
M	30 ft, shortable, FEP
N	60 ft, shortable, FEP
P	... ft, shortable, FEP

FMX167							Order code

→ Ordering information for FMX167 continued on next page.

FMX167 (continued)

60	Probe cable:
R	... m cable, shortable, PUR
S	10 m cable, shortable, PUR
T	20 m cable, shortable, PUR
U	... m cable, shortable, PUR
V	30 ft cable, shortable, PUR
W	60 ft cable, shortable, PUR

70	Additional option:
7	Basic version
1	Pt100, 4-wire
5	Pt100 + temperature head transmitter TMT181, 2-wire, 4 to 20 mA = –20 to +80 °C (-4 to +176°F)[1)]
3	Terminal box IP66/67
4	Terminal box IP66/67 + Pt, 4-wire
A	m cable marking>installation
B	ft cable marking>installation
C	m cable marking, terminal box, cable marking>installation, terminal box IP66/67
D	ft cable marking, terminal box, cable marking>installation, terminal box IP66/67
S	GL/ABS marine certificate

995	Marking
1	Measuring point (TAG)

FMX167									Complete order code

1) incl. terminal box, see feature "3" or "4"

Accessories

Mounting clamp

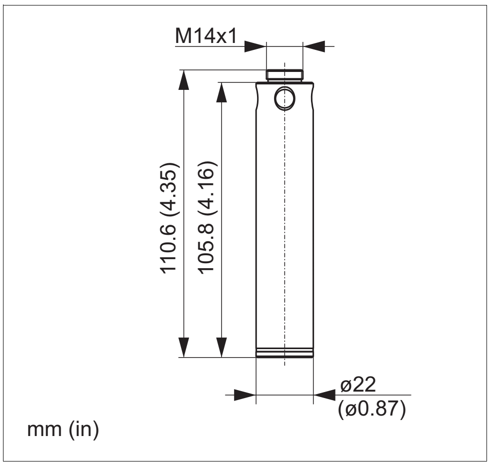
- Endress+Hauser offers a mounting clamp for simple FMX167 mounting → 15
- Material: 1.4404 (AISI 316L) and fiberglass reinforced PA (polyamide)
- Order number: 52006151
  See also → 21, "Ordering information"

Terminal box

- Terminal box IP 66/IP 67 with GORE-TEX®-filter incl. 3 installed terminals.
  The terminal box is also suitable for installing a temperature head transmitter (Order No. 52008794) or for four additional terminals (Order No. 52008938) → 23.
- Order number: 52006152

Note!
The terminal box is not intended for the FMX167 with Ex nA explosion protection in the hazardous area.

Additional weight (for FMX167 with an ou inter diameter of 22 mm (0.87) and 29 mm 1.14 in))



P01-FMXxxxxx-06-xx-xx-xx-014

- Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.
  You can screw several weights together. The weights are then attached directly to the FMX167. For FMX167 with outer diameter 29 mm (1.14 in), a maximum of 5 weights may be screwed on to FMX167.
- Material: 1.4435 (AISI 316L)
- Weight: 300 g (10.581 oz)
- Order number: 52006153

TMT181 temperature head transmitter

- 2-wire temperature head transmitter, configured for a measuring range from –20 to +80 °C (–4 to 176 °F). This setting offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance thermometer is designed for a temperature range from –10 to +70 °C (–14 to 158 °F) → 23.
- Order number: 52008794

Note!
The TM181 temperature head transmitter is not intended for use in hazardous areas incl. CSA GP.

Extension cable mounting screw

- Endress+Hauser offers extension cable mounting screws to simplify the installation of the FMX167 and to close the measuring open → 16.
- Material: 1.4301 (AISI 304)
- Order number for extension cable mounting screw with G 1 ½ A thread: 52008264
- Order number for extension cable mounting screw with 1 ½ NPT thread: 52009311

Terminals

- Four terminals in strip for FMX167 terminal box, suitable for wire cross-section of 0.08 to 2.5 mm^2 (28...14 AWG)
- Order number: 52008938

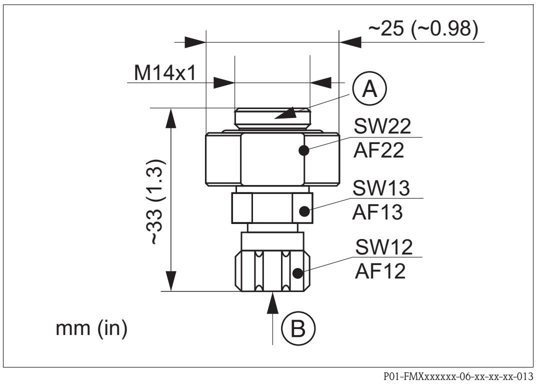
Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Cable shortening kit

The cable shortening kit is used to easily and professionally shorten a cable, see SD00552P/00/A6.

Note!
The cable shortening kit is not intended for the FMX167 with FM/CSA approval.

Test adapter
(for FMX167 with an outer diameter of 22 mm (0.87) and 29 mm 1.14 in))



Testing adapter

A FMX167 level probe connection
B Compressed air hose connection, internal diameter of quick coupling piece 4 mm (0.16 in)

- Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for the compressed air hose and the maximum overload for the level probe → 7.
- Maximum pressure of the quick coupling piece supplied: 10 bar (145 psi)
- Adapter material: 1.4301 (AISI 304)
- Quick coupling piece material: anodized aluminum
- Adapter weight: 39 g (1.376 oz)
- Order number: 52011868

Additional documentation

Field of activities	■ Pressure measurement: FA00004P/00/EN ■ Recording technology: FA00014R/09/EN ■ System components: FA00016K/09/EN
Technical Information	■ Technical Information Waterpilot FMX21 with 4 to 20 mA with HART output signal: TI00431P/00/EN ■ Technical Information Deltapilot M: TI00437P/00/EN ■ Temperature Head Transmitter iTEMP PCP TMT181: TI00070R/09/EN
Operating Instructions	■ Waterpilot FMX167: BA00231P/00/EN ■ Cable shortening kit: SD00552P/00/A6
Safety instructions	■ ATEX II 2 G: XA00131P/00/A3 ■ ATEX II 3 G: XA00132P/00/A3
Installation/Control Drawings	■ FM IS Class I, Div. 1, Groups A – D: ZD00063P/00/EN ■ CSA IS Class I, Div. 1, Groups A – D: ZD00064P/00/EN
Drinking water approval	■ SD00289P/00/A3 (NSF) ■ SD00126P/00/A3 (KTW/ACS)

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Endress+Hauser
People for Process Automation

TI00351P/00/EN/13.11
71129101
CCS/FM+SGML 6.0

71129101

ENDRESS+HAUSER CERABAR PMC71 PRESSURE TRANSMITTER

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Cerabar S PMC71, PMP71, PMP75

Process pressure measurement
Pressure transmitter with ceramic and metal sensors
Overload-resistant and function-monitored; Communication via HART, PROFIBUS PA or FOUNDATION Fieldbus

Application

The Cerabar S pressure transmitter is used for the following measuring tasks:

- Absolute pressure and gauge pressure in gases, steams or liquids in all areas of process engineering and process measurement technology
- Level, volume or mass measurements in liquids
- High process temperature
  - without diaphragm seals up to 150 °C (302 °F)
  - with typical diaphragm seals up to 400 °C (752 °F)
- High pressure up to 700 bar (10500 psi)
- MID part certificate as per OIML R117-1 Edition 2007 (E) and EN 12405-1/A1 Edition 2006
- International usage thanks to a wide range of approvals

Your benefits

- Very good reproducibility and long-term stability
- High reference accuracy: up to ±0.075 %, as PLATINUM version: ±0.05 %
- Turn down up to 100:1, higher on request
- Used for process pressure monitoring up to SIL3, certified to IEC 61508 by TÜV SÜD
- HistoROM®/M-DAT memory module
- Function-monitored from the measuring cell to the electronics
- Continuous modularity for differential pressure, hydrostatics and pressure (Deltabar S – Deltapilot S – Cerabar S), e.g.
  - replaceable display
  - universal electronics
- Quick commissioning with Quick Setup menu
- Menu-guided operation
- Extensive diagnostic functions
- Device versions compliant with ASME-BPE
- Usage in drinking water: NSF

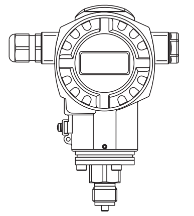
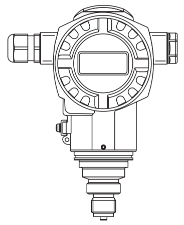
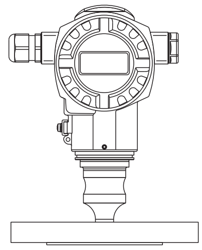
TI00383P/00/EN/15.12
No 71185798

Endress+Hauser
People for Process Automation

Table of contents

Function and system design

Device selection

Cerabar S – Product family	PMC71  P01-PMC71xxx-16-xx-xx-xx-000 **With capacitance measuring cell and ceramic process isolating diaphragm (Ceraphire®)**	PMP71  P01-PMP71xxx-16-xx-xx-xx-000 **With piezoresistive measuring cell and metallic welded process isolating diaphragm**	PMP75  P01-PMP75xxx-16-xx-xx-xx-000 **With diaphragm seal**
Field of application	– Gauge pressure and absolute pressure – Level		
Process connections	– Diverse thread – DN 25 – DN 80 – ANSI 1 1/2" – 4" – JIS 50 A – 100 A	– Diverse thread – DN 25 – DN 80 – ANSI 1 1/2" – 4" – JIS 25 A – 100 A – Oval flange adapter – Prepared for diaphragm seal mount	– Wide range of diaphragm seals
Measuring ranges	From –100/0 to 100 mbar (–1.5/0 to 1.5 psi) to –1/0 to 40 bar (–15/0 to 600 psi)	From –100/0 to 100 mbar (–1.5/0 to 1.5 psi) to –1/0 to 700 bar (–15/0 to 10500 psi)	From –400/0 to 400 mbar (–6/0 to 6 psi) to –1/0 to 400 bar (–15/0 to 6000 psi)
OPL [1]	Max. 60 bar (900 psi)	Max. 1050 bar (15750 psi)	Max. 600 bar (9000 psi)
Process temperature range	–25 to +125°C (-13 to +257 °F)/ –20 to +150 °C (-4 to 302 °F)[2]	–40 to +125 °C (-40 to +257 °F)	-70 to 400 °C (-94 to 752 °F) Dependent on the filling oil
Ambient temperature range	▪ Without LCD display: –40 to +85 °C (–40 to +185 °F)[3] ▪ With LCD display: –20 to +70 °C (–4 to +158 °F) ▪ Separate housing: -20 to +50 °C (-4 to +122 °F) ▪ Diaphragm seal systems depending on the version		
Reference accuracy	– Up to ±0.075 % of the set span – PLATINUM version: up to ±0.05 % of the set span		Up to ±0.075 % of the set span
Supply voltage	– Version for non-hazardous areas: 10.5 to 45 V DC – Ex ia: 10.5 to 30 V DC		
Output	4 to 20 mA with superimposed HART protocol, PROFIBUS PA or FOUNDATION Fieldbus		
Options	– PMP71, PMP75: gold-rhodium coated process isolating diaphragm – PMP71, PMP75: NACE-compliant materials – PMC71, PMP71, PMP75: inspection certificate 3.1 – HistoROM®/M-DAT memory module – Separate housing		
Specialties	– Metal-free measurement with PVDF connection – Special cleaning of the transmitter to remove paint-wetting substances, for use in paint shops	– Process connections with minimum oil volume – Gas-tight, elastomer-free	– Wide range of diaphragm seals – For high media temperatures – Process connections with minimum oil volume – Completely welded versions

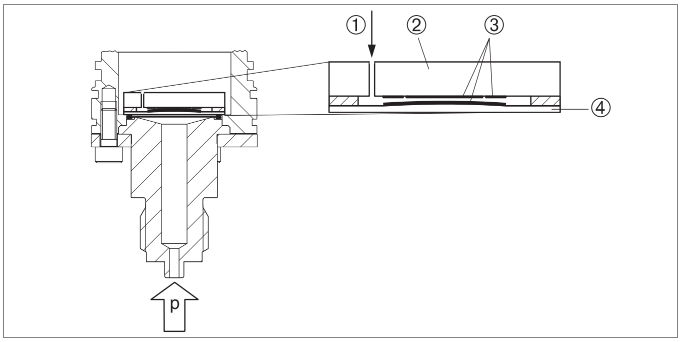
1) OPL: over pressure limit; dependent on the lowest-rated element, with regard to pressure, of the selected components

2) High-temperature version "T" for feature 100 "Additional option 1" or for feature 110 "Additional option 2"

3) PMP71 and PMP75: lower temperatures on request

Measuring principle

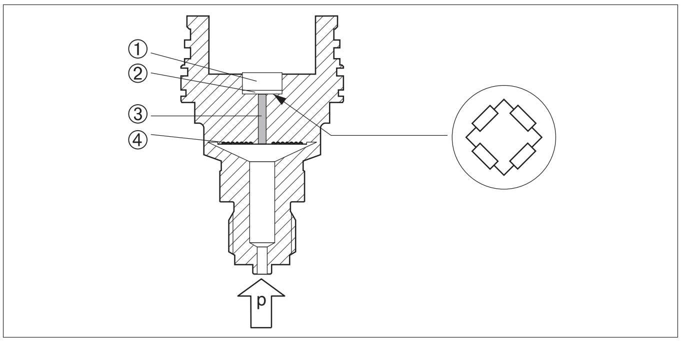
Ceramic process isolating diaphragm used for PMC71 (Ceraphire®)



Ceramic sensor

1 Air pressure (gauge pressure sensors)
2 Ceramic substrate
3 Electrodes
4 Ceramic process isolating diaphragm

Metallic process isolating diaphragm used for PMP71 and PMP75



Metal sensor

1 Silicon measuring element, substrate
2 Wheatstone bridge
3 Channel with fill fluid
4 Metallic process isolating diaphragm

Ceramic process isolating diaphragm used for PMC71 (Ceraphire®)

The ceramic sensor is a dry sensor, i.e. the process pressure acts directly on the robust ceramic process isolating diaphragm and deflects it. A pressure-dependent change in capacitance is measured at the electrodes of the ceramic substrate and the process isolating diaphragm. The measuring range is determined by the thickness of the ceramic process isolating diaphragm.

Advantages:
- Guaranteed overload resistance up to 40 times the nominal pressure (see column "OPL" in table on Page 7)
- Thanks to ultrapure 99.9% ceramic (Ceraphire®, see also "www.endress.com/ceraphire")
  - extremely high chemical stability, comparable with Alloy
  - less relaxation
  - high mechanical stability
- Suitable for vacuums
- Secondary containment for enhanced integrity
- Process temperatures up to 150 °C (302 °F)

Metallic process isolating diaphragm used for PMP71 and PMP75

PMP71

The operating pressure deflects the process isolating diaphragm and a fill fluid transfers the pressure to a resistance bridge (semiconductor technology). The pressure-dependent change in the bridge output voltage is measured and evaluated.

Advantages:
- Can be used for process pressures up to 700 bar (10500 psi) absolute pressure
- High long-term stability
- Guaranteed overload resistance up to 4 times the nominal pressure
- Secondary containment for enhanced integrity
- Significantly less thermal effect compared to diaphragm seal systems

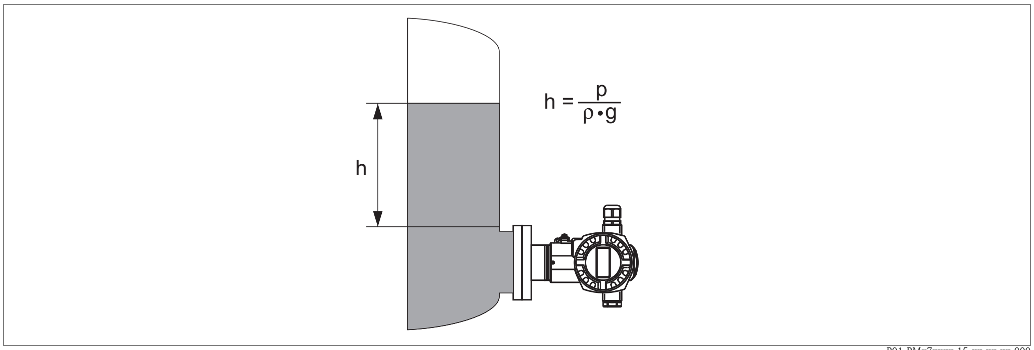
PMP75

The operating pressure acts on the process isolating diaphragm of the diaphragm seal and is transferred to the process isolating diaphragm of the sensor by a diaphragm seal fill fluid. The process isolating diaphragm is deflected and a fill fluid transfers the pressure to a resistance measuring bridge. The pressure-dependent change in the bridge output voltage is measured and evaluated.

Advantages:
- Depending on the version, can be used for process pressures up to 400 bar (6000 psi) and extreme process temperatures
- High long-term stability
- Guaranteed overload resistance up to 4 times the nominal pressure
- Secondary containment for enhanced integrity

Level measurement (level, volume and mass)

Design and operation mode



P01-PMx7xxxx-15-xx-xx-xx-000

Level measurement

h *Height (level)*
p *Pressure*
ρ *Density of the media*
g *Gravitation constant*

Your benefits

- Selection of the level operating mode which is optimum for your application in the device software.
- Volume and mass measurements in any tank shapes by means of a freely programmable characteristic curve.
- Choice of diverse level units with automatic unit conversion.
- A specific unit can be defined.
- Has a wide range of uses, even in the following cases:
  - in the event of foam formation
  - in tanks with agitators of screen fittings
  - in the event of liquid gases

Applications suitable for custody transfer measurement

The Parts Certificate is issued on the basis of the following standards:
- WELMEC guide 8.8 "General and Administrative Aspects of the Voluntary System of Modular Evaluation of Measuring instruments under the MID".
- OIML R117-1 Edition 2007 (E) "Dynamic measuring systems for liquids other than water".
- EN 12405-1/A1 Edition 2006 "Gas meters – Conversion devices – Part 1: Volume conversion".

Communication protocol

- 4 to 20 mA with HART communication protocol
- PROFIBUS PA
  - The Endress+Hauser devices meet the requirements of the FISCO model.
  - Due to the low current consumption of 13 mA ± 1 mA, the following number of devices can be operated on one bus segment if installing as per FISCO:
    - up to 7 Cerabar S for Ex ia, CSA IS and FM IS applications
    - up to 27 Cerabar S for all other applications, e.g. in non-hazardous areas, Ex nA etc.

  Further information on PROFIBUS PA can be found in Operating Instructions BA00034S "PROFIBUS DP/ PA: Guidelines for planning and commissioning" and in the PNO Guideline.
- FOUNDATION Fieldbus
  - The Endress+Hauser devices meet the requirements of the FISCO model.
  - Due to the low current consumption of 15 mA ± 1 mA, the following number of devices can be operated on one bus segment if installing as per FISCO:
    - up to 6 Cerabar S for Ex ia, CSA IS and FM IS applications
    - up to 24 Cerabar S for all other applications, e.g. in non-hazardous areas, Ex nA etc.

  Further information on FOUNDATION Fieldbus, such as requirements for bus system components can be found in Operating Instructions BA00013S "FOUNDATION Fieldbus Overview".

Input

Measured variable

Absolute pressure and gauge pressure, from which level (level, volume or mass) is derived

Measuring range

PMC71 – with ceramic process isolating diaphragm (Ceraphire®) for gauge pressure

Nominal value	Range limit		Smallest calibratable span 4	MWP 1	OPL 2	Vacuum resistance	Versions in the order code 3
	lower (LRL)	upper (URL)					
	[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar_{abs} (psi_{abs})]	
100 mbar (1.5 psi)	–0.1 (–1.5)	+0.1 (+1.5)	0.005 (0.075)	2.7 (40.5)	4 (60)	0.7 (10.5)	1C
250 mbar (3,75 psi)	–0.25 (–4)	+0.25 (+4)	0.005 (0.075)	3.3 (49.5)	5 (75)	0.5 (7.5)	1E
400 mbar (6 psi)	–0.4 (–6)	+0.4 (+6)	0.005 (0.075)	5.3 (79.5)	8 (120)	0	1F
1 bar (15 psi)	–1 (–15)	+1 (+15)	0.01 (0.15)	6.7 (100.5)	10 (150)	0	1H
2 bar (30 psi)	–1 (–15)	+2 (+30)	0.02 (0.3)	12 (180)	18 (270)	0	1K
4 bar (60 psi)	–1 (–15)	+4 (+60)	0.04 (0.6)	16.7 (250.5)	25 (375)	0	1M
10 bar (150 psi)	–1 (–15)	+10 (+150)	0.1 (1.5)	26.7 (400.5)	40 (600)	0	1P
40 bar (600 psi)	–1 (–15)	+40 (+600)	0.4 (6)	40 (600)	60 (900)	0	1S

PMC71 – with ceramic process isolating diaphragm (Ceraphire®) for absolute pressure

Nominal value	Range limit		Smallest calibratable span 4	MWP 1	OPL 2	Versions in the order code 3
	lower (LRL)	upper (URL)				
	[bar_{abs} (psi_{abs})]	[bar_{abs} (psi_{abs})]	[bar (psi)]	[bar_{abs} (psi_{abs})]	[bar_{abs} (psi_{abs})]	
100 mbar (15 psi)	0	+0.1 (+1.5)	0.005 (0.075)	2.7 (40.5)	4 (60)	2C
250 mbar (3,75 psi)	0	+0.25 (+4)	0.005 (0.075)	3.3 (49.5)	5 (75)	2E
400 mbar (6 psi)	0	+0.4 (+6)	0.005 (0.075)	5.3 (79.5)	8 (120)	2F
1 bar (15 psi)	0	+1 (+15)	0.01 (0.15)	6.7 (100.5)	10 (150)	2H
2 bar (30 psi)	0	+2 (+30)	0.02 (0.3)	12 (180)	18 (270)	2K
4 bar (60 psi)	0	+4 (+60)	0.04 (0.6)	16.7 (250.5)	25 (375)	2M
10 bar (150 psi)	0	+10 (+150)	0.1 (1.5)	26.7 (400.5)	40 (600)	2P
40 bar (600 psi)	0	+40 (+600)	0.4 (6)	40 (600)	60 (900)	2S

1) The MWP (maximum working pressure) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection (→ 🗎 33 ff) has to taken into consideration in addition to the measuring cell (→ see Table above). Also observe pressure-temperature dependency. For the appropriate standards and further information, see → 🗎 32, "Pressure specifications" section.
2) OPL: over pressure limit depends on the lowest-rated element, with regard to pressure, of the selected components.
3) Version in the order code → see also → 🗎 79 ff, feature 40 "Sensor range; Sensor over pressure limit (= OPL)"
4) Turn down > 100:1 on request or can be set at the device

PMP71 and PMP75 – metallic process isolating diaphragm for gauge pressure

Nominal value	Range limit lower (LRL) [bar (psi)]	Range limit upper (URL) [bar (psi)]	Smallest calibratable span 5 [bar (psi)]	MWP 1 [bar (psi)]	OPL 2 [bar (psi)]	Vacuum resistance 3 Silicone oil/ Inert oil [bar_{abs} (psi_{abs})]	Versions in the order code 4
400 mbar (6 psi)	–0.4 (–6)	+0.4 (+6)	0.005 (0.075)	4 (60)	6 (90)	0.01/0.04 (0.15/0.6)	1F
1 bar (15 psi)	–1 (–15)	+1 (+15)	0.01 (0.15)	6.7 (100)	10 (150)		1H
2 bar (30 psi)	–1 (–15)	+2 (+30)	0.02 (0.3)	13.3 (200)	20 (300)		1K
4 bar (60 psi)	–1 (–15)	+4 (+60)	0.04 (0.6)	18.7 (280.5)	28 (420)		1M
10 bar (150 psi)	–1 (–15)	+10 (+150)	0.1 (1.5)	26.7 (400.5)	40 (600)		1P
40 bar (600 psi)	–1 (–15)	+40 (+600)	0.4 (6)	100 (1500)	160 (2400)		1S
100 bar (1500 psi)	–1 (–15)	+100 (+1500)	1.0 (15)	100 (1500)	400 (6000)		1U
400 bar (6000 psi)	–1 (–15)	+400 (+6000)	4.0 (60)	400 (6000)	600 (9000)		1W
700 bar (10500) 6	–1 (–15)	+700 (+10500)	7.0 (105)	700 (10500)	1050 (15750)		1X

PMP71 and PMP75 – metallic process isolating diaphragm for absolute pressure

Nominal value	Range limit lower (LRL) [bar_{abs}]	Range limit upper (URL) [bar_{abs}]	Smallest calibratable span 5 [bar]	MWP 1 [bar_{abs}]	OPL 2 [bar_{abs}]	Vacuum resistance 3 Silicone oil/ Inert oil [bar_{abs}]	Versions in the order code 4
400 mbar (6 psi)	0	+0.4 (+6)	0.005 (0.075)	4 (60)	6 (90)	0.01/0.04 (0.15/0.6)	2F
1 bar (15 psi)	0	+1 (+15)	0.01 (0.15)	6.7 (100)	10 (150)		2H
2 bar (30 psi)	0	+2 (+30)	0.04 (0.6)	13.3 (200)	20 (300)		2K
4 bar (60 psi)	0	+4 (+60)	0.04 (0.6)	18.7 (280.5)	28 (420)		2M
10 bar (150 psi)	0	+10 (+150)	0.1 (1.5)	26.7 (400.5)	40 (600)		2P
40 bar (600 psi)	0	+40 (+600)	0.4 (6)	100 (1500)	160 (2400)		2S
100 bar (1500 psi)	0	+100 (+1500)	1.0 (15)	100 (1500)	400 (6000)		2U
400 bar (6000 psi)	0	+400 (+6000)	4.0 (60)	400 (6000)	600 (9000)		2W
700 bar (10500) 6	0	+700 (+10500)	7.0 (105)	700 (10500)	1050 (15750)		2X

1) The MWP (maximum working pressure) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection (→ 33 ff) has to taken into consideration in addition to the measuring cell (→ see Table above). Also observe pressure-temperature dependency. For the appropriate standards and further information, see → 32, "Pressure specifications" section.
2) OPL: over pressure limit depends on the lowest-rated element, with regard to pressure, of the selected components.
3) The vacuum resistance applies for the measuring cell under reference operating conditions. The pressure and temperature application limits of the selected filling oil must also be observed for the PMP75. → 75, "Filling oil" section.
4) Version in the order code → 79 ff, feature 40 "Sensor range; Sensor over pressure limit (= OPL)"
5) Turn down > 100:1 on request or can be set at the device
6) PMP71 only, PMP75 on request

PMP71 - metallic process diaphragms for absolute pressure with MID parts certificate

Nominal value [bar (psi)]	Range limit lower (LRL) [bar (psi)]	Range limit upper (URL) 5) [bar (psi)]	Min. WP for gas applications suitable for custody transfer measurement [bar (psi)]	Min. WP for liquid applications suitable for custody transfer measurement [bar (psi)]	MWP 1) [bar (psi)]	OPL 2) [bar (psi)]	Vacuum resistance 3) Silicone oil / inert oil [bar (psi)]	Versions in the order code 4)
10 (150)	0	+10 (150)	0.5 (7.5)	0.5 (7.5)	26.7 (400.5)	40 (600)	0.01/0.04 (0.15/1)	MP
50 (750)	0	+50 (750)	10 (150)	2.5 (37.5)	100 (1500)	400 (6000)	0.01/0.04 (0.15/1)	MT
100 (1500)	0	+100 (1500)	5 (75)	5 (75)	100 (1500)	400 (6000)	0.01/0.04 (0.15/1)	MU

1) The MWP (maximum working pressure) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection (→ 🗎 33 ff) has to be taken into consideration in addition to the measuring cell (→ see Table above). Also observe pressure-temperature dependency. For the appropriate standards and further information, see → 🗎 32, "Pressure specifications" section.
2) OPL: over pressure limit depends on the lowest-rated element, with regard to pressure, of the selected components
3) The vacuum resistance applies for the measuring cell under reference operating conditions.
4) Version in the order code → 🗎 79 ff, feature 40 "Sensor range; sensor over pressure limit (= OPL)"
5) Max. WP for gas and liquid applications suitable for custody transfer measurement

Explanation of terms

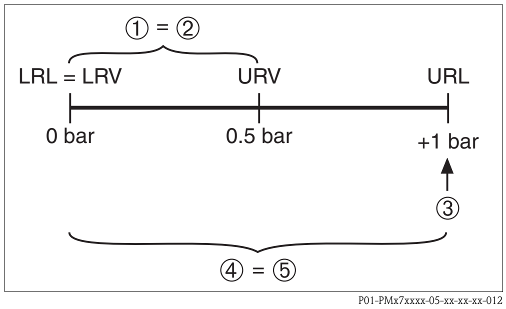
Explanation of the terms "turn down (TD)", "set span" and "zero-based span"

Case 1:
- |Lower range value (LRV)| ≤ |Upper range value (URV)|

Example:
- Lower range value (LRV) = 0 bar
- Upper range value (URV) = 0.5 bar (7.5 psi)
- Nominal value (URL) = 1 bar (15 psi)

Turn down:
- TD = URL / |URV| = 2:1

Set span:
- URV – LRV = 0.5 bar (7.5 psi)
  This span is based on the zero point.



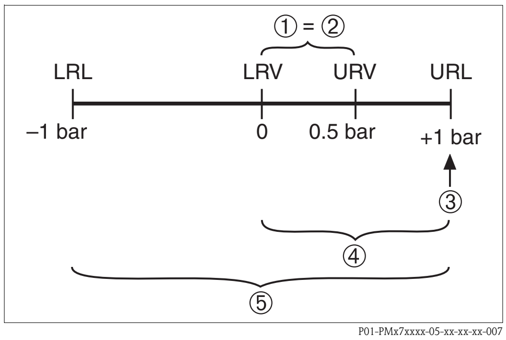
Example: 1 bar (15 psi) measuring cell

Case 2:
- |Lower range value (LRV)| ≤ |Upper range value (URV)|

Example:
- Lower range value (LRV) = 0 bar
- Upper range value (URV) = 0.5 bar (7.5 psi)
- Nominal value (URL) = 1 bar (15 psi)

Turn down:
- TD = URL / |URV| = 2:1

Set span:
- URV – LRV = 0.5 bar (7.5 psi)
  This span is based on the zero point.



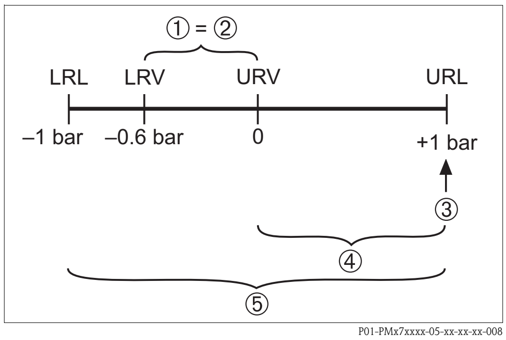
Example: 1 bar (15 psi) measuring cell

Case 3:
- |Lower range value (LRV)| ≥ |Upper range value (URV)|

Example:
- Lower range value (LRV) = –0.6 bar (–9 psi)
- Upper range value (URV) = 0 bar
- Nominal value (URL) = 1 bar (15 psi)

Turn down:
- TD = URL / |LRV| = 1.67:1

Set span:
- URV – LRV = 0.6 bar (9 psi)
  This span is based on the zero point.



Example: 1 bar (15 psi) measuring cell

1 Set span
2 Zero-based span
3 Nominal value ≙ upper range limit (URL)
4 Nominal measuring range
5 Sensor measuring range
LRL Lower range limit
URL Upper range limit
LRV Lower range value
URV Upper range value

Output

Output signal

- 4 to 20 mA with superimposed digital communication protocol HART 5.0, 2-wire
- Digital communication signal PROFIBUS PA (Profile 3.0), 2-wire
  – signal coding: Manchester Bus Powered (MBP): Manchester II
  – data transmission rate: 31.25 KBit/s voltage mode
- Digital communication signal FOUNDATION Fieldbus, 2-wire
  – signal coding: Manchester Bus Powered (MBP): Manchester II
  – data transmission rate: 31.25 KBit/s voltage mode

Signal range – 4 to 20 mA HART

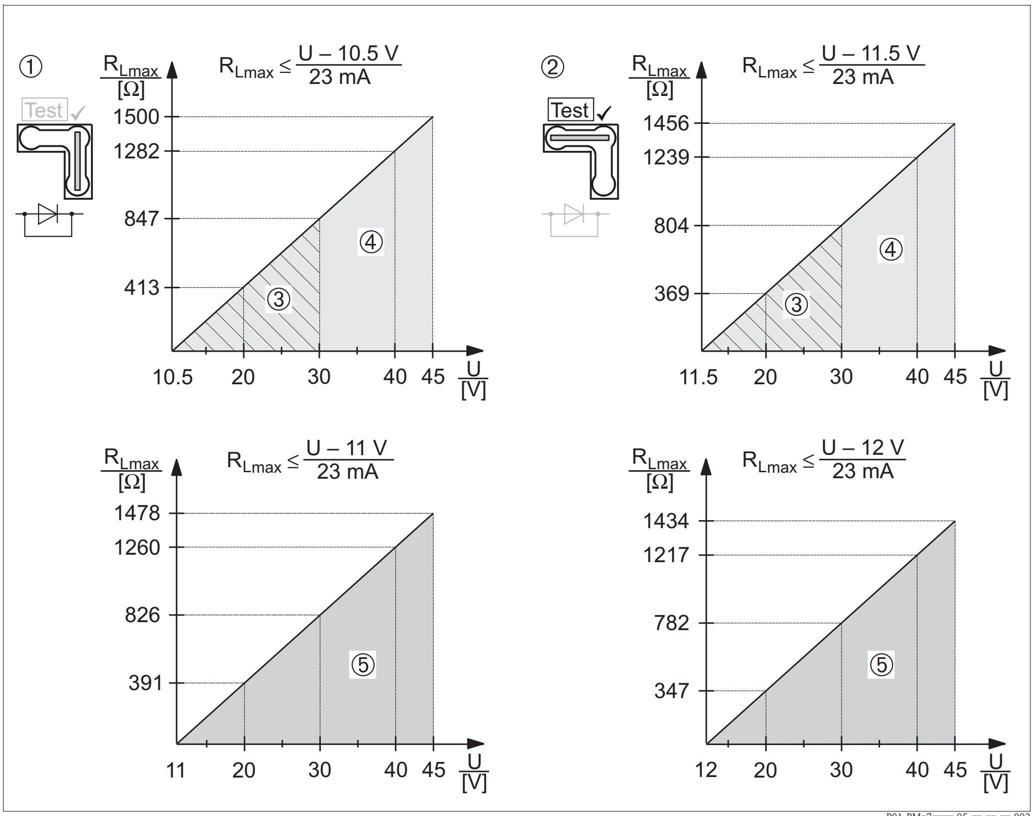
3.8 mA to 20.5 mA

Signal on alarm

As per NAMUR NE43

- 4 to 20 mA HART
  Options:
  – Max. alarm*: can be set from 21 to 23 mA
  – Hold measured value: last measured value is held
  – Min. alarm: 3.6 mA
  * Factory setting: 22 mA
- PROFIBUS PA: can be set in the Analog Input block,
  Options: Last Valid Out Value, Fsafe Value (factory setting), Status Bad
- FOUNDATION Fieldbus: can be set in the Analog Input block,
  Options: Last Good Value, Fail Safe Value (factory setting), Wrong Value

Load – 4 to 20 mA HART



P01-PMx7xxxx-05-xx-xx-xx-003

Load diagram, observe the position of the jumper and the explosion protection (→ See also Page 18, "Measuring a 4 to 20 mA test signal" section.)

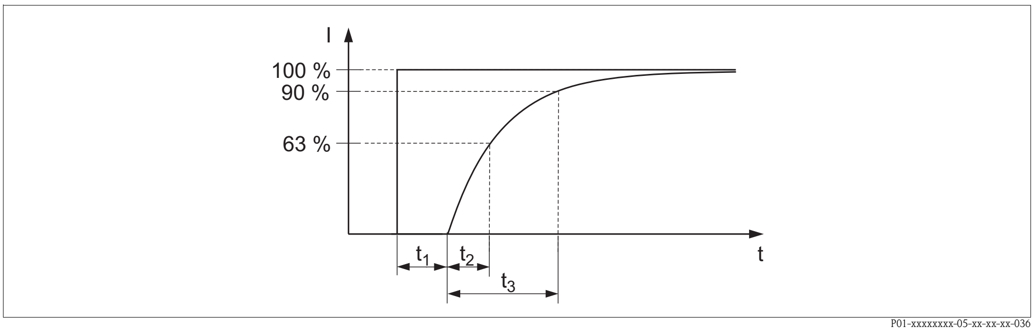
1 Jumper for 4 to 20 mA test signal set to "Non-test" position
2 Jumper for 4 to 20 mA test signal set to "Test" position
3 Power supply 10.5 (11.5) to 30 V DC for 1/2 G, 1 GD, 1/2 GD, FM IS, CSA IS, IECEx ia, NEPSI Ex ia
4 Power supply 10.5 (11.5) to 45 V DC for devices for non-hazardous areas, 1/2 D, 1/3 D, 2 G Ex d, 3 G Ex nA, FM XP, FM DIP, FM NI, CSA XP, CSA dust ignition proof, NEPSI Ex d
5 Power supply 11 (12) to 45 V DC for PMC71, Ex d[ia], NEPSI Ex d[ia]
R_{Lmax} Maximum load resistance
U Supply voltage

Note!
When operating via a handheld terminal or via a PC with an operating program, a minimum communication resistance of 250 Ω must exist within the loop.

Resolution

- Current output: 1 µA
- Display: can be set (factory setting: presentation of the maximum accuracy of the transmitter)

Dead time, time constant



Presentation of the dead time and the time constant

Dynamic behavior, current output

Type	Dead time t_1	Time constant (T63), t_2	Time constant (T90), t_3
PMC71	90 ms	120 ms	276 ms
PMP71	45 ms	▪ 400 mbar (6 psi) measuring cell: 70 ms ▪ Measuring cells ≥ 1 bar (15 psi): 35 ms	▪ 400 mbar (6 psi) measuring cell: 161 ms ▪ Measuring cells ≥ 1 bar (15 psi): 81 ms
PMP75	PMP71 + influence of the diaphragm seal		

Dynamic behavior, HART

Type	Dead time t_1	Time constant (T63), t_2	Time constant (T90), t_3
PMC71	340 ms	120 ms	276 ms
PMP71	295 ms	▪ 400 mbar (6 psi) measuring cell: 70 ms ▪ Measuring cells ≥ 1 bar (15 psi): 35 ms	▪ 400 mbar (6 psi) measuring cell: 161 ms ▪ Measuring cells ≥ 1 bar (15 psi): 81 ms
PMP75	PMP71 + influence of the diaphragm seal		

Reading cycle

- HART commands: 3 to 4 per second on average.
  The Cerabar S commands the BURST MODE function for cyclic value transmission via the HART communication protocol.

Response time

≤ 250 ms

Cycle time (update time)

On average 250 to 330 ms.

Dynamic behavior, PROFIBUS PA

A typical cyclic parametrization for the PLC of 20 values per second results in the following behavior:

Type	Dead time t_1	Time constant (T63), t_2	Time constant (T90), t_3
PMC71	340 ms	120 ms	620 ms
PMP71	295 ms	▪ 400 mbar (6 psi) measuring cell: 70 ms ▪ Measuring cells ≥ 1 bar (15 psi): 35 ms	▪ 400 mbar (6 psi) measuring cell: 161 ms ▪ Measuring cells ≥ 1 bar (15 psi): 81 ms
PMP75	PMP71 + influence of the diaphragm seal		

Response time

- Cyclic: approx. 10 ms per request
- Acyclic: < 50 ms

All values are typical values.

Cycle time (update time)

The cycle time in a bus segment in cyclic data communication depends on the number of devices, on the segment coupler used and on the internal PLC cycle time.

Dynamic behavior, FOUNDATION Fieldbus

A typical configuration for the macro cycle time (host system) of 250 ms results in the following behavior:

Type	Dead time t_1	Time constant (T63), t_2	Time constant (T90), t_3
PMC71	340 ms	120 ms	620 ms
PMP71	295 ms	▪ 400 mbar (6 psi) measuring cell: 70 ms ▪ Measuring cells ≥ 1 bar (15 psi): 35 ms	▪ 400 mbar (6 psi) measuring cell: 161 ms ▪ Measuring cells ≥ 1 bar (15 psi): 81 ms
PMP75	PMP71 + influence of the diaphragm seal		

Reading cycle

- Cyclic: up to 5/s, dependent on the number and type of function blocks used in a closed-control loop
- Acyclic: 10/s

Response time

- Cyclic: < 80 ms
- Acyclic: < 40 ms

All values are typical values.

Cycle time (update time)

250 ms

Damping

A damping affects all outputs (output signal, display).

- Via onsite display, handheld terminal or PC with operating program, continuous from 0 to 999 s
- Additionally for HART and PROFIBUS PA: via DIP switch on the electronic insert, switch position "on" = set value and "off"
- Factory setting: 2 s

Data of the FOUNDATION Fieldbus interface

Basic data

Device Type	1007F (hex)
Device Revision	06 (hex)
DD Revision	01 (hex)
CFF Revision	01 (hex)
ITK Version	5.0
ITK Certification Driver No.	IT054600
Link-Master (LAS) capable	Yes
Link Master / Basic Device selectable	Yes; Factory setting: Basic Device
Number of VCRs	44
Number of Link Objects in VFD	50

Virtual communication references (VCRs)

Permanent Entries	44
Client VCRs	0
Server VCRs	5
Source VCRs	8
Sink VCRs	0
Subscriber VCRs	12
Publisher VCRs	19

Link settings

Slot time	4
Min. inter PDU delay	12
Max. response delay	10

Transducer Blocks

Block	Content	Output values
TRD1 Block	Contains all parameters related to the measurement	▪ Pressure or level (channel 1) ▪ Process temperature (channel 2)
Service Block	Contains service information	▪ Pressure after damping (channel 3) ▪ Pressure peakhold indicator (channel 4) ▪ Counter for max. pressure transgressions (channel 5)
Diagnostic Block	Contains diagnostic information	Error code via DI channels (channel 0 to 16)
Display Block	Contains parameters to configure the onsite display	No output values

Function blocks

Block	Content	Number of blocks	Execution time	Functionality
Resource Block	The Resource Block contains all the data that uniquely identify the device. It is an electronic version of a nameplate of the device.	1		enhanced
Analog Input Block 1 Analog Input Block 2	The AI Block receives the measuring data from the Sensor Block, (selectable via a channel number) and makes the data available to other function blocks at its output. Enhancement: digital outputs for process alarms, fail safe mode.	2	45 ms	enhanced
Digital Input Block	This block contains the discrete data of the Diagnose Block (selectable via a channel number 0 to 16) and provides them for other blocks at the output.	1	40 ms	standard
Digital Output Block	This block converts the discrete input and thus initiates an action (selectable via a channel number) in the DP Flow Block or in the Service Block. Channel 1 resets the counter for max. pressure transgressions.	1	60 ms	standard
PID Block	The PID Block serves as a proportional-integral-derivative controller and is used almost universally for closed-loop-control in the field including cascade and feedforward. Input IN can be indicated on the display. The selection is performed in the Display Block (DISPLAY_MAIN_LINE_CONTENT).	1	120 ms	standard
Arithmetic Block	This block is designed to permit simple use of popular measurement math functions. The user does not have to know how to write equations. The math algorithm is selected by name, chosen by the user for the function to be performed.	1	50 ms	standard
Input Selector Block	The Input Selector Block facilitates the selection of up to four inputs and generates an output based on the configured action. This block normally receives its inputs from AI Blocks. The block performs maximum, minimum, average and 'first good' signal selection. Inputs IN1 to IN4 can be indicated on the display. The selection is performed in the Display Block (DISPLAY_MAIN_LINE_CONTENT).	1	35 ms	standard
Signal Characterizer Block	The Signal Characterizer Block has two sections, each with an output that is a non-linear function of the respective input. The non-linear function is generated by a single look-up table with 21 arbitrary x-y pairs.	1	30 ms	standard
Integrator Block	The Integrator Block integrates a variable as a function of the time or accumulates the counts from a Pulse Input Block. The block may be used as a totalizer that counts up until reset or as a batch totalizer that has a setpoint, where the integrated or accumulated value is compared to pre-trip and trip settings, generating a binary signal when the setpoint is reached.	1	35 ms	standard
Analog Alarm Block	This block contains all process alarm conditions (working like a comparator) and represents them at the output.	1	35 ms	standard

Additional function block information:

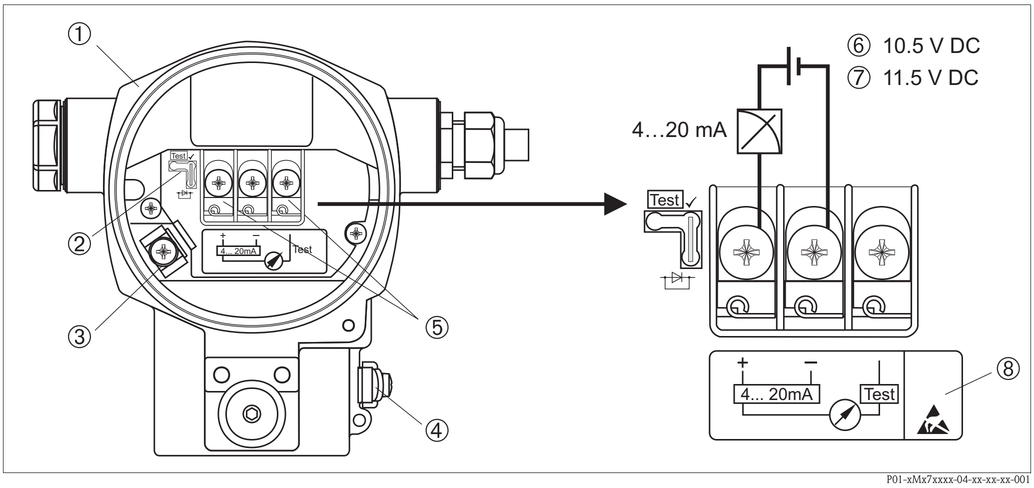
Instantiate Function Block	YES
Number of instantiate blocks	15

Power supply

Electrical connection

Note!
- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings. → 🗎 91 ff, "Safety Instructions" and "Installation/Control Drawings" sections.
- Devices with integrated overvoltage protection must be grounded. → 🗎 30.
- Protective circuits against reverse polarity, HF influences and overvoltage peaks are installed.

4 to 20 mA HART



Electrical connection 4 to 20 mA HART

1 Housing
2 Jumper for 4 to 20 mA test signal
→ 🗎 18, "Measuring a 4 to 20 mA test signal" section.
3 Internal ground terminal
4 External ground terminal
5 4 to 20 mA test signal between positive and test terminal
6 Minimum supply voltage = 10.5 V DC, jumper is set as illustrated in the diagram.
7 Minimum supply voltage = 11.5 V DC, jumper is set to "Test" position.
8 Devices with integrated overvoltage protection are labeled OVP (overvoltage protection) here (→ 🗎 30).

PROFIBUS PA

The digital communication signal is transmitted to the bus via a 2-wire connection. The bus also provides the power supply. For further information on the network structure and grounding, and for further bus system components such as bus cables, see the relevant documentation, e.g. Operating Instructions BA00034S "PROFIBUS DP/PA: Guidelines for planning and commissioning" and the PNO Guideline.

Cable specifications:
- Use a twisted, shielded two-wire cable, preferably cable type A

Note!
For further information on the cable specifications, see Operating Instructions BA00034S "PROFIBUS DP/PA: Guidelines for planning and commissioning", the PNO Guideline 2.092 PROFIBUS PA User and Installation Guideline" and IEC 61158-2 (MBP).

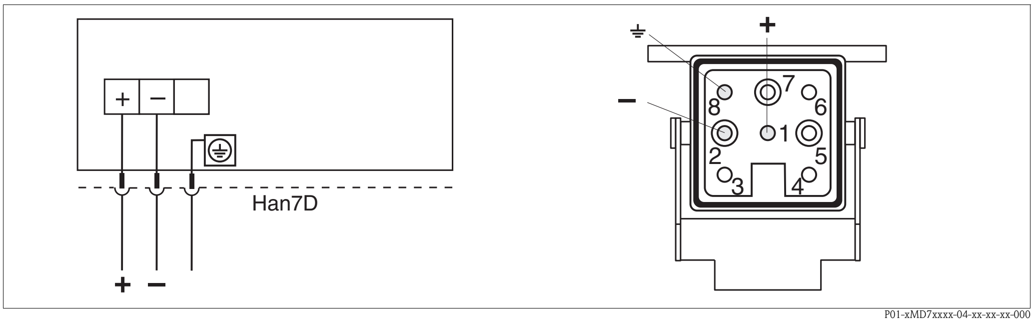
FOUNDATION Fieldbus

The digital communication signal is transmitted to the bus via a 2-wire connection. The bus also provides the power supply. For further information on the network structure and grounding and for further bus system components such as bus cables, see the relevant documentation, e.g. Operating Instructions BA00013S "FOUNDATION Fieldbus Overview" and the FOUNDATION Fieldbus Guideline.

Cable specifications:
- Use a twisted, shielded two-wire cable, preferably cable type A

Note!
For further information on the cable specifications, see Operating Instructions BA00013S "FOUNDATION Fieldbus Overview", FOUNDATION Fieldbus Guideline and IEC 61158-2 (MBP).

Devices with Harting plug Han7D

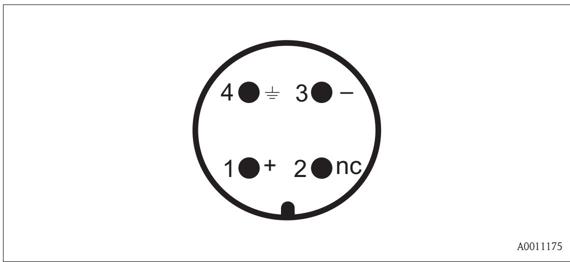


Left: electrical connection for devices with Harting plug Han7D
Right: view of the plug connector at the device

Material: CuZn

Devices with M12 plug

PIN assignment for M12 connector



PIN	Meaning
1	Signal +
2	Not assigned
3	Signal –
4	Earth

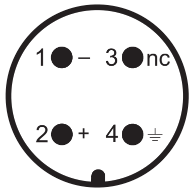
Endress+Hauser offers the following accessories for devices with an M12 plug:
Plug-in jack M 12x1, straight
- Material: body PA; slotted nut CuZn, nickel-plated
- Degree of protection (fully locked): IP67
- Order number: 52006263

Plug-in jack M 12x1, elbowed
- Material: body PBT/PA; slotted nut GD-Zn, nickel-plated
- Degree of protection (fully locked): IP67
- Order number: 71114212

Cable 4x0.34 mm² (20 AWG) with M12 socket, elbowed, screw plug, length 5 m (16 ft)
- Material: body PUR; slotted nut CuSn/Ni; cable PVC
- Degree of protection (fully locked): IP67
- Order number: 52010285

Devices with 7/8" plug

PIN assignment for 7/8" connector



A0011176

PIN	Meaning
1	Signal –
2	Signal +
3	Not assigned
4	Earth

External thread: 7/8 - 16 UNC
- Material: housing / body CuZn, nickel-plated
- Protection: IP68

Cable gland

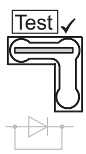
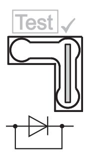
Approval	Type	Clamping area
Standard, II1/2G Exia, IS	Plastic M20x1.5	5 to 10 mm (0.2 to 0.39 in)
ATEX II1/2D, II1/3D, II1/2GD Exia, II1GD Exia, II3G Ex nA	Metal M20x1.5 (Ex e)	7 to 10.5 mm (0.28 to 0.41 in)

Terminals

For wire cross-sections of 0.5 to 2.5 mm² (20 to 14 AWG)

Measuring a 4 to 20 mA test signal

A 4 to 20 mA test signal may be measured via the positive and test terminal without interrupting the measurement. The minimum supply voltage of the device can be reduced by simply changing the position of the jumper. As a result, operation is also possible with lower voltage sources. Observe the position of the jumper in accordance with the following table.

Jumper position for test signal	Description
	– Measuring 4 to 20 mA test signal via the plus and test terminal: possible. (Thus, the output current can be measured without interruption via the diode.) – Delivery status – Minimum supply voltage: 11.5 V DC
	– Measuring 4 to 20 mA test signal via the plus and test terminal: not possible. – Minimum supply voltage: 10.5 V DC

Supply voltage

Note!

- When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings.
- All explosion protection data are given in separate documentation which is available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas. → 🗎 91 ff, "Safety Instructions" and "Installation/Control Drawings" sections.

4 to 20 mA HART

Version	Jumper for 4 to 20 mA test signal	Supply voltage
non-hazardous areas	in "Test" position	11.5...45 V DC
	in "Non-test" position	10.5...45 V DC
Intrinsically safe	in "Test" position	11.5 ... 30 V DC
	in "Non-test" position	10.5 ... 30 V DC
▪ Other types of protection ▪ Devices without certificate	in "Test" position	11.5 ... 45 V DC (Versions with plug-in connection 35 V DC)
	in "Non-test" position	10.5 ... 45 V DC (Versions with plug-in connection 35 V DC)

PROFIBUS PA

- Version for non-hazardous areas: 9 to 32 V DC

FOUNDATION Fieldbus

- Version for non-hazardous areas: 9 to 32 V DC

Current consumption

- PROFIBUS PA: 13 mA ± 1 mA, switch-on current corresponds to IEC 61158-2, Clause 21
- FOUNDATION Fieldbus: 15 mA ± 1 mA, switch-on current corresponds to IEC 61158-2, Clause 21

Cable entry

→ 🗎 79 ff, feature 30 "Housing; Cable entry; Protection".

Cable specification

- Endress+Hauser recommends using shielded, twisted-pair two-wire cables.
- Terminals for core cross-sections 0.5 to 2.5 mm^2 (20 to 14 AWG)
- Cable outer diameter: 5 to 9 mm (0.2 to 0.35 in) depends on the used cable gland (→ 🗎 18)

Residual ripple

Without influence on 4 to 20 mA signal up to ± 5 % residual ripple within the permitted voltage range [according to HART hardware specification HCF_SPEC-54 (DIN IEC 60381-1)]

Influence of power supply

≤ 0.0006% of URL/1 V

Performance characteristics – general

Reference operating conditions

- As per IEC 60770
- Ambient temperature T_U = constant, in the range of: +21 to +33 °C (+70 to 91 °F)
- Humidity φ = constant, in the range of: 5 to 80 % rH
- Ambient pressure p_A = constant, in the range of: 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of the measuring cell = constant, in range: horizontally ±1°
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value
- Zero based span
- Material of process isolating diaphragm PMC71: Al_2O_3 (aluminum oxide ceramic)
- Material of process isolating diaphragm PMP71 and PMP75: AISI 316L/1.4435
- Filling oil PMP71 and PMP75: silicone oil
- Supply voltage: 24 V DC ± 3 V DC
- Load with HART: 250 Ω

Uncertainty of measurement for small absolute pressure ranges

The smallest extended uncertainty of measurement that can be returned by our standards is:
- 0.4% of the measured value in the range 1 to 30 mbar (0.0145 to 0.435 psi)
- 1% of the measured value in the range < 1 mbar (0.0145 psi)

Long-term stability

PMC71/PMP75:
- For measuring ranges ≥ 1 bar (15 psi): ± 0.05 % of URL/year

PMC71:
- 100 mbar to 40 bar (1.5 psi to 600 psi): ±0.2 % of URL/10 years
- 100 mbar to 40 bar (1.5 psi to 600 psi) (absolute pressure sensor): ±0.3 % of URL/10 years

PMP71 gauge pressure sensors:

	1 year	**5 years**	**10 year**
Measuring ranges [bar (psi)]	**% of URL**		
1 (15)	±0.020	±0.080	±0.180
10 (150)	±0.025	±0.050	±0.075
40 (600)	±0.025	±0.075	±0.100
100 (1500)	±0.050	±0.150	±0.200
400 (6000)	±0.050	–	±1

Influence of the installation position

- PMC71 [1]: ≤ 0.18 mbar (3 psi)
- PMP71 [1, 2]
  - Process connections thread G 1 A, G 1 1/2, G 2, 1 1/2 MNPT, 2 MNPT, M 44x1,25, EN/DIN, ANSI and JIS flanges: ≤ 10 mbar (0.15 psi)
  - Process connections thread: G 1/2, 1/2 MNPT, JIS G 1/2, JIS R 1/2, M20x1.5: ≤ 4 mbar (0.06 psi)

1) Device rotated 180°, process connection pointing upwards.
2) The value is doubled for devices with inert oil.

Note!
Position-dependent zero shift can be corrected. → 25, "General installation instructions" section and → 75 ff, "Installation instructions, diaphragm seal systems" section

Performance characteristics – ceramic process isolating diaphragm

Reference accuracy – PMC71

The reference accuracy comprises the non-linearity (terminal based), hysteresis and non-reproducibility as per IEC 60770. The data refer to the calibrated span.

Measuring cell	Gauge pressure sensor	Absolute pressure sensor
100 mbar (1.5 psi)	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD	▪ TD 1:1 to TD 5:1 = ±0.075 ▪ TD > 5:1 = ±0.015 x TD
250 mbar (3,75 psi)	▪ TD 1:1 to TD 15:1 = ±0.075 ▪ TD > 15:1 = ±0.005 x TD	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD
400 mbar (6 psi), 1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi)	▪ TD 1:1 to TD 15:1 = ±0.075 ▪ TD > 15:1 = ±0.005 x TD	▪ TD 1:1 to TD 15:1 = ±0.075 ▪ TD > 15:1 = ±0.005 x TD
40 bar (600 psi)	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD
Platinum version: 1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	▪ TD 1:1 = ±0.05	▪ TD 1:1 = ±0.05

Total performance – PMC71

The "Total performance" specification comprises the non-linearity including hysteresis, non-reproducibility as well as the thermal change in the zero point.
For devices with NBR or HNBR seals, the values must be multiplied by a factor of 3.
All specifications apply to the temperature range –10 to +60 °C (+14 to +140 °F) and a turn down of 1:1.

Measuring cell	PMC71	PMC71 high-temperature version
	% of URL	
100 mbar (1.5 psi), 250 mbar (3,75 psi), 400 mbar (6 psi)	±0.2	±0.46
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	±0.15	±0.46

Total error - PMC71

The total error comprises the long-term stability and the total performance.
For devices with NBR or HNBR seals, the values must be multiplied by a factor of 3.
All specifications apply to the temperature range –10 to +60 °C (+14 to +140 °F) and a turn down of 1:1.

Measuring cell	PMC71	PMC71 high-temperature version
	% of URL/year	
100 mbar (1.5 psi), 250 mbar (3,75 psi), 400 mbar (6 psi)	±0.25	±0.51
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	±0.2	±0.51

Warm-up period – PMC71

- 4 to 20 mA HART: < 10 s
- PROFIBUS PA: 6 s
- FOUNDATION Fieldbus: 50 s

Thermal change of the zero output and the output span – PMC71

PMC71

Measuring cell	–10 to +60°C (+14 to +140 °F)	–20 to –10 °C, +60 to +125 °C (–4 to +14°F, +140 to +257°F)
	% of the set span	
100 mbar (1.5 psi), 250 mbar (3,75 psi), 400 mbar (6 psi)	±(0.088 x TD + 0.088)	±(0.138 x TD + 0.138)
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	±(0.088 x TD + 0.04)	±(0.175 x TD + 0.075)

PMC71 high-temperature version

Gauge pressure measuring cell	–10 to +60°C (+14 to +140°F)	to +150°C (to +302°F)
	% of the set span	
100 mbar (1.5 psi), 250 mbar (3,75 psi), 400 mbar (6 psi)	±(0.088 x TD + 0.088)	±(0.75 x TD)
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	±(0.088 x TD + 0.040)	±(0.50 x TD)
Absolut pressure measuring cell		
100 mbar (1.5 psi)	±(0.088 x TD + 0.088)	±(1.25 x TD)
250 mbar (3,75 psi), 400 mbar (6 psi)	±(0.088 x TD + 0.088)	±(0.75 x TD)
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi)	±(0.088 x TD + 0.040)	±(0.75 x TD)
40 bar (600 psi)	±(0.088 x TD + 0.040)	±(0.50 x TD)

Performance characteristics – metallic process isolating diaphragm

Reference accuracy – PMP71, PMP75

The reference accuracy comprises the non-linearity (terminal based), hysteresis and non-reproducibility as per IEC 60770. The data refer to the calibrated span.

Measuring cell	Sensor	PMP71 and PMP75 without capillary	PMP75 with capillary
400 mbar (6 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 = ±0.15 ▪ TD > 1:1 = ±0.15 x TD	▪ TD 1:1 = ±0.15 ▪ TD > 1:1 = ±0.15 x TD
1 bar (15 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 to TD 2.5:1 = ±0.075 ▪ TD > 2.5:1 = ±0.03 x TD	▪ TD 1:1 to TD 2.5:1 = ±0.1 ▪ TD > 2.5:1 = ±0.04 x TD
2 bar (30 psi)	Gauge pressure	▪ TD 1:1 to TD 5:1 = ±0.075 ▪ TD > 5:1 = ±0.015 x TD	▪ TD 1:1 to TD 2.5:1 = ±0.1 ▪ TD > 2.5:1 = ±0.04 x TD
2 bar (30 psi)	Absolute pressure	▪ TD 1:1 to TD 5:1 = ±0.075 ▪ TD > 5:1 = ±0.015 x TD	▪ TD 1:1 to TD 5:1 = ±0.075 ▪ TD > 5:1 = ±0.015 x TD
4 bar (60 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD
10 bar (150 psi), 40 bar (600 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 to TD 15:1 = ±0.075 ▪ TD > 15:1 = ±0.005 x TD	▪ TD 1:1 to TD 15:1 = ±0.075 ▪ TD > 15:1 = ±0.005 x TD
100 bar (1500 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD	▪ TD 1:1 to TD 10:1 = ±0.075 ▪ TD > 10:1 = ±0.0075 x TD
400 bar (6000 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 to TD 5:1 = ±0.15 ▪ TD > 5:1 = ±0.03 x TD	▪ TD 1:1 to TD 5:1 = ±0.15 ▪ TD > 5:1 = ±0.03 x TD
700 bar (10500 psi)	Absolute pressure	▪ TD 1:1 to TD 5:1 = ±0.15 ▪ TD > 5:1 = ±0.03 x TD	—
Platinum version [1)] 1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi), 400 bar (6000 psi), 700 bar (10500 psi)	Gauge pressure/ absolute pressure	▪ TD 1:1 = ±0.05	—

1) Platinum version not for flush-mounted process connections G 1/2 and M20.

Total performance – PMP71

The "Total performance" specification comprises the non-linearity including hysteresis, non-reproducibility as well as the thermal change of the zero point.
All specifications apply to the temperature range –10 to +60 °C (+14 to +140 °F) and a turn down of 1:1.

Measuring cell	PMP71	PMP71 with gold-rhodium-coated process isolating diaphragm
	% of URL	
400 mbar (6 psi)	±0.25	±1.25
1 bar (15 psi)	±0.15	±0.75
2 bar (30 psi)	±0.15	±0.45
4 bar (60 psi)	±0.15	±0.3
10 bar (150 psi), 40 bar (600 psi)	±0.15	±0.15
100 bar (1500 psi)	±0.25	±0.25
400 bar (6000 psi)	±0.3	±0.3
700 bar (10500 psi)	±0.3	±0.3

Total error - PMP71

The total error comprises the total performance and long-term stability.
All specifications apply to the temperature range –10 to +60 °C (+14 to +140 °F) and a turn down of 1:1.

Measuring cell	% of URL/year
400 mbar (6 psi)	▪ ±0,3
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	▪ ±0.2
100 bar (1500 psi)	▪ ±0.3
400 bar (6000 psi)	▪ ±0.35
700 bar (10500 psi)	▪ ±0.35

Warm-up period – PMP71, PMP75

- 4 to 20 mA HART: < 10 s
- PROFIBUS PA: 6 s
- FOUNDATION Fieldbus: 50 s

Thermal change of the zero output and the output span – PMP71 and PMP75

Note!
When using a PMP75, the influence from the respective diaphragm seal must be taken into account.
(→ 📄 73 ff "Planning instructions, diaphragm seal systems".

PMP71 and PMP75 (basic device), internal process isolating diaphragm

Measuring cell	Material of the process isolating diaphragm		–10 to +60°C (+14 to +140 °F)	–40 to –10 °C, +60 to +85 °C (–40 to +14 °F, +140 to +185 °F)
	316 L	Gold-rhodium	% of the set span	
400 mbar (6 psi)	x	x	±(0.2 x TD + 0.015)	±(0.4 x TD + 0.03)
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi)	x	x	±(0.1 x TD + 0.01)	±(0.4 x TD + 0.02)
40 bar (600 psi)	x	-	±(0.1 x TD + 0.01)	±(0.4 x TD + 0.02)
100 bar (1500 psi)	x	-	±(0.2 x TD + 0.015)	±(0.4 x TD + 0.03)
400 bar (6000 psi)	x	-	±(0.35 x TD + 0.02)	±(0.7 x TD + 0.04)
700 bar (10500 psi)	x	-	±(0.4 x TD + 0.03)	±(0.7 x TD + 0.04)

PMP71, flush-mounted process isolating diaphragm made of 316L with gold-rhodium coating

Measuring cell	–10 to +60°C (+14 to +140 °F)	–40 to –10 °C, +60 to +85 °C (–40 to +14 °F, +140 to +185 °F)
	% of the set span	
400 mbar (6 psi)	±(0.2 x TD + 0.015) x 5	±(0.4 x TD + 0.03) x 5
1 bar (15 psi), 2 bar (30 psi), 4 bar (60 psi), 10 bar (150 psi), 40 bar (600 psi)	±(0.1 x TD + 0.01) x 5	±(0.4 x TD + 0.02) x 5
100 bar (1500 psi)	±(0.2 x TD + 0.015) x 5	±(0.4 x TD + 0.03) x 5
400 bar (6000 psi)	±(0.35 x TD + 0.02) x 5	±(0.7 x TD + 0.04) x 5
700 bar (10500 psi)	±(0.4 x TD + 0.03) x 5	±(0.7 x TD + 0.04) x 5

Operating conditions (Installation)

General installation instructions

- For PMP75: See → 75, "Installation instructions" section.
- The position-dependent zero point shift can be corrected directly at the device via operating keys, and also in hazardous areas in the case of devices with external operation. Diaphragm seals also shift the zero point, depending on the installation position
(→ See also → 75, "Installation instructions" section).
- The housing of the Cerabar S can be rotated 380°. See → 27, "Turning the housing" section.
- Endress+Hauser offers a mounting bracket for installing the device on pipes or walls.
→ See also → 26, "Wall and pipe-mounting" section.
- Use flushing rings for flange and cell diaphragm seals if buildup or clogging can be expected at the diaphragm seal connection. The flushing ring can be fitted between the process connection and diaphragm seal. Material buildup in front of the process isolating diaphragm can be flushed away, and the pressure chamber vented, via the two lateral flushing holes.

Measuring arrangement for devices without diaphragm seals – PMC71, PMP71

Cerabar S transmitters without diaphragm seals are mounted as per the norms for a manometer (DIN EN 837-2). We recommend the use of shutoff devices and siphons. The orientation depends on the measuring application.

Pressure measurement in gases

- Mount Cerabar S with shutoff device above the tapping point so that any condensate can flow into the process.

Pressure measurement in steams

- Mount Cerabar S with siphon above the tapping point.
The siphon reduces the temperature to almost the ambient temperature.
- Fill the siphon with liquid before commissioning.

Pressure measurement in liquids

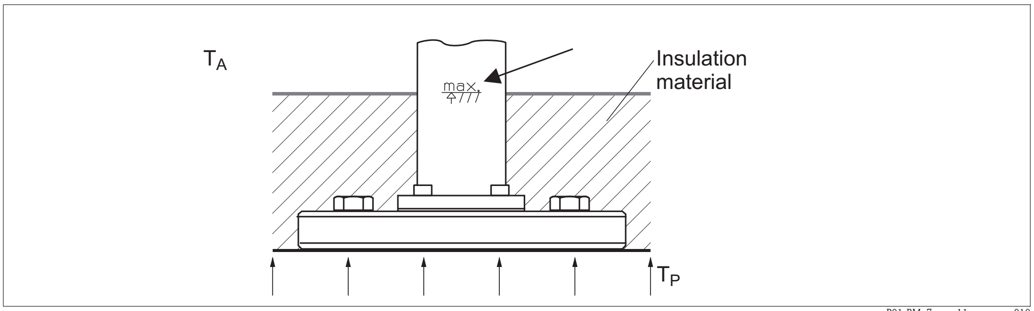
- Mount Cerabar S with shutoff device below or at the same level as the tapping point.

Level measurement

- Mount Cerabar S below the lowest measuring point.
- Do not mount the device at the following positions:
In the filling curtain, in the tank outlet or at a point in the container which could be affected by pressure pulses from an agitator or a pump.
- The adjustment and functional test can be carried out more easily if you mount the device downstream of a shutoff device.

Heat insulation – PMC71 high-temperature version

The PMC71 high-temperature version must only be insulated up to a certain height. The maximum permitted insulation height is indicated on the devices and applies to an insulation material with a heat conductivity ≤ 0.04 W/(m x K) and to the maximum permitted ambient and process temperature (→ see table below). The data were determined under the most critical application "quiescent air".



Maximum insulation height, here indicated on a PMC71 with a flange

	PMC71 high-temperature version
Ambient temperature (T_A)	≤ 70 °C (158 °F)
Process temperature (T_P)	≤ 150 °C (302 °F)

Measuring arrangement for devices with diaphragm seals – PMP75	▪ See → 🗎 73, "Planning instructions, diaphragm seal systems" section.
Wall and pipe-mounting	Endress+Hauser offers a mounting bracket for installing the device on pipes or walls. See also → 🗎 79 ff, feature 110, "Additional option 2" or separate accessory (part number: 71102216). For the dimensions, see → 🗎 63.

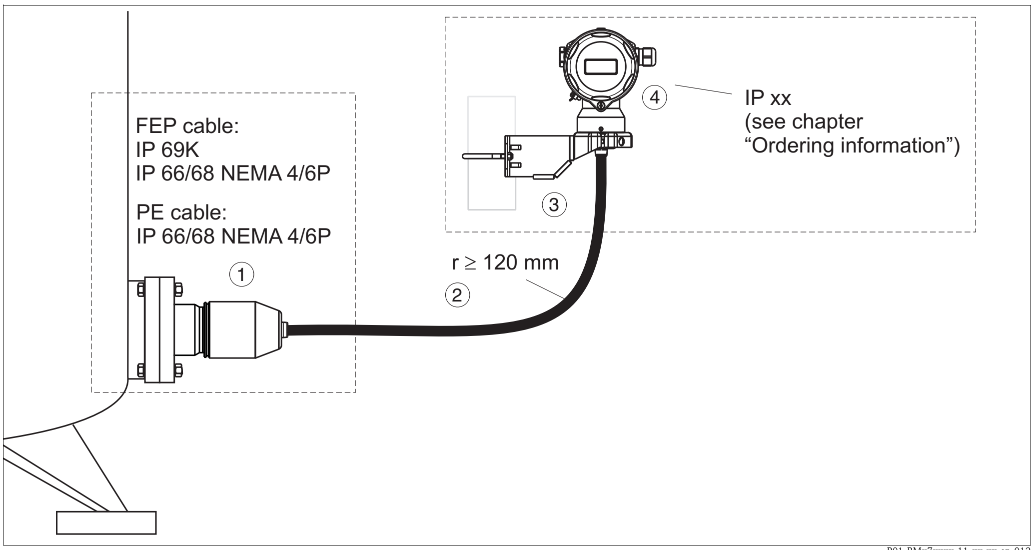
"Separate housing" version

With the "separate housing" version, you are able to mount the housing with the electronics insert at a distance from the measuring point. This version facilitates trouble-free measurement:
- Under particularly difficult measuring conditions (at installation locations that are cramped or difficult to access)
- If rapid cleaning of the measuring point is required
- If the measuring point is exposed to vibrations
- For compact installations

You can choose between different cable versions:
- PE (2 m (6.6 ft), 5 m (16 ft) and 10 m (33 ft))
- FEP (5 m (16 ft)).

→ 🗎 82 ff, feature 110, "Additional option 2", version "G".

For the dimensions, → 🗎 63.



In the case of the "separate housing" version, the sensor is delivered with the process connection and cable ready mounted. The housing and a mounting bracket are enclosed as separate units. The cable is provided with a socket at both ends. These sockets are simply connected to the housing and the sensor.

1 Process connection with sensor
2 Cable, both ends are fitted with a socket
3 Mounting bracket provided, suitable for pipe and wall mounting
4 Housing with electronic insert

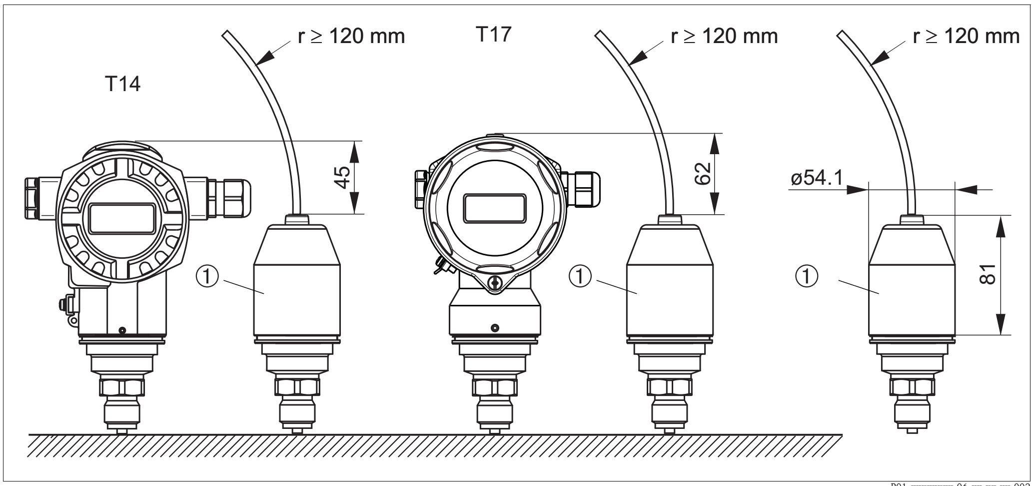
Degree of protection for the process connection and sensor with the use of
- FEP cable:
  - IP 69K
  - IP 66 NEMA 4/6P
  - IP 68 (1.83 mH_2O for 24 h) NEMA 4/6P
- PE cable:
  - IP 66 NEMA 4/6P
  - IP 68 (1.83 mH_2O for 24 h) NEMA 4/6P

Technical data of the PE and FEP cable:
- Minimum bending radius: 120 mm (4.72 in)
- Cable extraction force: max. 450 N (101 lbf)
- Resistance to UV light

Use in hazardous area:
- Intrinsically safe installations (Ex ia/IS)
- FM/CSA IS: for Div. 1 installation only

Reduction of the installation height

If the separate housing is used, the installation height of the process connection is reduced compared to the dimensions of the standard version.



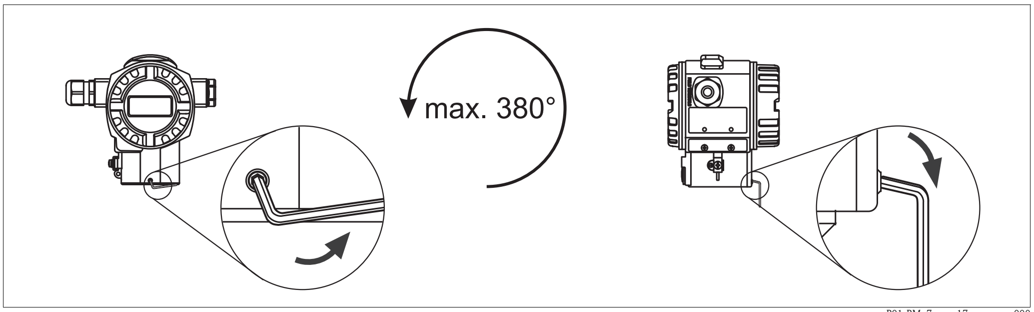
P01-xxxxxxxx-06-xx-xx-xx-002

Reduction of the installation height of the process connection when using the separate housing.
1 Process connection adapter.

Turning the housing

The housing can be rotated 380° by loosening the Allen screw.

Your benefits
- Simple mounting by optimally aligning the housing
- Good, accessible device operation
- Optimum readability of the onsite display (optional).



P01-PMx7xxxx-17-xx-xx-xx-000

Aligning the housing by releasing the setscrew
T14 housing: 2 mm (0.08 in) Allen screw; T17 housing: 3 mm (0.12 in) Allen screw

Oxygen applications

Oxygen and other gases can react explosively to oils, grease and plastics, such that, among other things, the following precautions must be taken:
– All components of the system, such as measuring devices, must be cleaned in accordance with the BAM (DIN 19247) requirements.
– Dependent on the materials used, a certain maximum temperature and a maximum pressure for oxygen applications must not be exceeded.

The devices suitable for gaseous oxygen applications are listed in the following table with the specification p_{max}.

Order code for devices [1] cleaned for oxygen applications	p_{max} for oxygen applications	T_{max} for oxygen applications
PMC71 – * * * ** * ** 2 * *, Devices with sensors, nominal value < 10 bar (150 psi)	Over pressure limit (OPL) of sensor[2), 3)]	60 °C (140 °F)
PMC71 – * * * ** * ** 2 * *, Devices with sensors, nominal value ≥ 10 bar (150 psi)	30 bar (450 psi)	60 °C (140 °F)
PMP71 – * * * ** * * ** N * *	Dependent on the lowest-rated element, with regard to pressure, of the selected components: over pressure limit (OPL) of the sensor[1)], process connection (1.5 x PN) or fill fluid (160 bar (2400 psi))	85 °C (185 °F)
PMP75 – * * * ** * * * ** N * *	Dependent on the lowest-rated element, with regard to pressure, of the selected components: over pressure limit (OPL) of the sensor[1)], process connection (1.5 x PN) or fill fluid (160 bar (2400 psi))	85 °C (185 °F)

1) Only devices, not accessories or enclosed accessories.

2) → 🗎 79 ff "Ordering information", feature 40 "Sensor range; Sensor over pressure limit (= OPL)

3) PMC71 with PVDF thread or flange p_{max} = 15 bar (225 psi)

Silicone-free applications

Special cleaning of the transmitter to remove paint-wetting substances, for use in paint shops → 🗎 81 "Ordering information PMC71", feature 80 "Seal", version "L" and "M".

Ultrapure gas applications

Endress+Hauser also offers devices for special applications, such as ultrapure gas, cleaned from oil and grease. No special restrictions regarding the process conditions apply to these devices.

→ 🗎 79, "Ordering information PMC71", feature 80 "Seal" or → 🗎 85, "Ordering information PMP71", feature 90 "Fill fluid".

Applications with hydrogen

With regard to materials in which hydrogen formation takes place, hydrogen atoms can diffuse through the metallic process isolating diaphragm. This can result in incorrect measurement results.
Endress+Hauser offers process isolating diaphragms with gold-rhodium coating for this application.

→ 🗎 83 "Ordering information PMP71" and → 🗎 87 "Ordering information PMP75", feature 60 "Membrane material" version "6".

Operating conditions (Environment)

Ambient temperature range

Version	PMC71 high-temperature version	PMC71	PMP71 [1]	PMP75 [1]
Without LCD display	–20 to +70 °C (-4 to +158 °F)	–40 to +85 °C (-40 to +185 °F)		
With LCD display [2]		–20 to +70 °C (-4 to +158 °F)		
With M12 connector, elbowed		-25 to +85 °C (-13 to +185 °F)		
With separate housing	–20 to +50 °C (-4 to +122 °F) (installation without insulation)			—
Diaphragm seal systems	—	—	—	→ 🗎 73
MID parts certificate	—	—	–25 to +55 °C (-13 to +131 °F)	—

1) Lower temperatures on request

2) Extended temperature application range (-40 °C to +85 °C (-40 °F to +185 °F)) with restrictions in optical properties such as display speed and contrast

Note!
For high-temperature applications, either a PMP75 with a temperature isolator or with a capillary can be used. If vibrations also occur in the application, Endress+Hauser recommends using a PMP75 with a capillary. If a PMP75 with a temperature isolator or capillary is used, we recommend a suitable retaining unit for mounting (see "Wall and pipe-mounting" section on → 🗎 26).

For devices for use in hazardous areas, see Safety Instructions, Installation or Control Drawing. (→ 🗎 91 ff, "Safety Instructions" and "Installation/Control Drawings" sections)

Storage temperature range

- –40 to +90 °C (-40 to +194 °F)
- Onsite display: –40 to +85 °C (-40 to +185 °F)
- Separate housing: -40 to +60 °C (-40 to +140 °F)

Degree of protection

- → See Page 79 ff, feature 30 "Housing; Cable entry; Protection".
- Degree of protection IP 68 for T17 housing: 1.83 mH_2O for 24 h
- Separate housing → 🗎 26

Climate class

Class 4K4H (air temperature: –20 to +55 °C (-4 to +131 °F), relative humidity: 4 to 100 %)
fulfilled as per DIN EN 60721-3-4 (condensation possible. With PMC71, avoid condensate in the device).

Vibration resistance

Device/accessory	Test standard	Vibration resistance
PMC71 [1]	GL	Guaranteed for 3 to 25 Hz: ±1.6 mm (0.063 in); 25 to 100 Hz: 4 g in all 3 planes
PMP71		
PMP75 [2], [3]		
With mounting bracket	IEC 61298-3	Guaranteed for 10 to 60 Hz: ±0.15 mm (0.0059 in); 60 to 500 Hz: 2 g in all 3 planes
PMP71 with MID parts certificate	OIML R117-1	Class M3

1) Not for high-temperature version with Ex d[ia], CSA XP or FM XP

2) With aluminum T14 housing only

3) For high-temperature applications, either a PMP75 with a temperature isolator or with a capillary can be used. If vibrations also occur in the application, Endress+Hauser recommends using a PMP75 with a capillary. If a PMP75 with a temperature isolator or capillary is used, it must be mounted with a mounting bracket (→ 🗎 26).

Electromagnetic compatibility

- Electromagnetic compatibility to EN 61326 and NAMUR recommendation EMC (NE21). For details refer to the Declaration of Conformity.
- With enhanced immunity against electromagnetic fields as per EN 61000-4-3:
  30 V/m with closed cover [1]
- Maximum deviation: < 0.5 % of span
- All EMC measurements were performed with a turn down (TD) = 2:1.
- Class E3 as per OIML R75-2

1) For devices with T14 housing

Overvoltage protection (optional)

- Overvoltage protection:
  - Nominal functioning DC voltage: 600 V
  - Nominal discharge current: 10 kA
- Surge current check î = 20 kA as per DIN EN 60079-14: 8/20 μs satisfied
- Arrester AC current check I = 10 A satisfied

→ 🗎 79 ff, feature 100 "Additional option 1" and feature 110 "Additional option 2", version "M Overvoltage protection".

Note!
Devices with integrated overvoltage protection must be grounded.

Operating conditions (Process)

Process temperature limits

PMC71 (with ceramic process isolating diaphragm)

- –25 to +125 °C (–13 to +257 °F)
- High-temperature version: –20 to +150 °C (–4 to +302 °F); → 79, feature 100 "Additional option 1", version "T".
- With applications involving saturated steam, a Cerabar S with a metallic process isolating diaphragm must be used, or a siphon for temperature isolation should be provided during installation.
- Observe the process temperature range of the seal in the following table.

Versions for feature 80 in the order code	Seal	Process temperature range
A, L	FKM Viton	–25 to +125 °C/150 °C (-13 to +257 °F/302 °F) [1]
B[2]	EPDM (FDA 21CFR177.2600; 3A Class II; USP Class VI) DVGW (KTW, W270, W534), WRAS, ACS, NSF61	–20 to +125 °C/150 °C (-4 to +257 °F/302 °F) [1]
B	EPDM	–20 to +150 °C (-4 to +302 °F)
D, M	Kalrez, Compound 4079	+5 to +125 °C/150 °C (+41 to +257 °F/302 °F) [1]
E	Chemraz, Compound 505	–10 to +125 °C/150 °C (+14 to +257 °F/302 °F) [1]
F[2]	HNBR (FDA 21CFR177.2600; 3A Class II; KTW; AFNOR; BAM)	–25 to +125 °C (-13 to +257 °F
F	NBR	–10 to +100 °C (+14 to +212 °F)
G	FKM Viton, FDA 21CFR177.2600	–5 to +125 °C (+23 to +257 °F)
1	FKM Viton, cleaned from oil and grease	–10 to +125 °C/150 °C (14 to +257 °F/302 °F) [1]
2	FKM Viton, cleaned for oxygen service	–10 to +60 °C (+14 to +140 °F)
The process temperature ranges specified here refer to permanent application of the PMC71. They may be exceeded for a short time (e.g. for cleaning).		

1) 150 °C (302 °F): for high-temperature version

2) These seals are used for devices with 3A-approved process connections.

Applications with jumps in temperature

Extreme jumps in temperature can result in temporary measuring errors. Temperature compensation takes effect after several minutes. Internal temperature compensation is faster the smaller the jump in temperature and the longer the time interval involved.
For further information please contact your local Endress+Hauser Sales Center.

PMP71 (with metallic process isolating diaphragm)

Description	Temperature operating range
Process connections with internal process isolating diaphragm	–40 to +125 °C (-40 to +257 °F) (+150 °C (302 °F) for max. one hour)
Process connections with flush-mounted process isolating diaphragm, G 1 A, G 1 1/2 A, G 2 A, 1 NPT, 1 1/2 NPT, 2 NPT, M 44 x 1.25, EN/DIN, ANSI and JIS flanges	–40 to +100 °C (-40 to +212 °F)
Process connections with flush-mounted process isolating diaphragm, G 1/2 A, M20x1.5	–20 to +85 °C (-4 to 185 °F)

PMP71 (with metallic process isolating diaphragm) with MID parts certificate

–25 to +55 °C (–13 to +131 °F)

PMP75 (with diaphragm seal)

- Depending on the diaphragm seal and filling oil from -70 °C (-94 °F) to +400 °C (+752 °F). Observe the temperature application limits → 🗎 73.

Note!
- The PTFE foil used is designed to protect the unit against abrasion. It does not provide protection against corrosive media.
- Do not use diaphragm seals with 0.09 mm (0.0035 in)/0.25 mm (0.01 in) PTFE foil on AISI 316L (1.4435/ 1.4404) for vacuum applications, upper temperature limit +204 °C (+399 °F).
- For oxygen applications, observe → 🗎 28, "Oxygen applications" section.

Pressure specifications

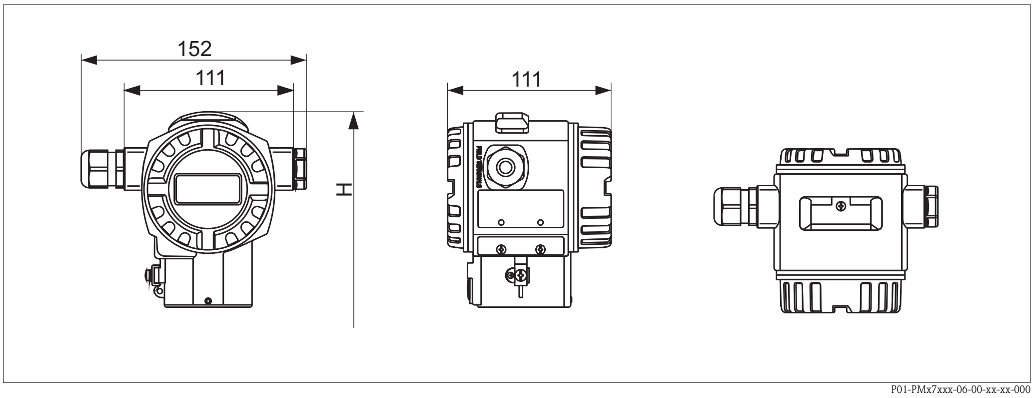
- The maximum pressure for the measuring device depends on the lowest-rated element with regard to pressure.
  See the following sections:
  - → 🗎 7 ff, "Measuring range" section
  - "Mechanical construction" section.

  The MWP (maximum working pressure) is specified on the nameplate. This value refers to a reference temperature of 20°C (68°F), or 100°F (38 °C) for ANSI flanges, and may be applied to the device for an unlimited time. Observe the temperature dependency of the MWP.
- The pressure values permitted at higher temperatures can be found in the following standards:
  - EN 1092-1: 2001 Tab. 18 [1]
  - ASME B 16.5a – 1998 Tab. 2-2.2 F316
  - ASME B 16.5a – 1998 Tab. 2.3.8 N10276
  - JIS B 2220
- The test pressure corresponds to the over pressure limit of the device (OPL = 1.5 x MWP [2]) and may be applied for only a limited time period in order to avoid permanent damage.
- The Pressure Equipment Directive (EC Directive 97/23/EC) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the measuring device.
- In the case of sensor range and process connections where the over pressure limit (OPL) of the process connection is smaller than the nominal value of the sensor, the device is set at the factory, at the very maximum, to the OPL value of the process connection. If you want to use the entire sensor range, select a process connection with a higher OPL value (1.5 x PN; MWP = PN).
- In oxygen applications, the values for "p_{max} and T_{max} for oxygen applications" as per → 🗎 28, "Oxygen applications" may not be exceeded.

1) With regard to their stability-temperature property, the materials 1.4435 and 1.4404 are grouped together under 13EO in EN 1092-1: 2001 Tab. 18. The chemical composition of the two materials can be identical.
2) The equation does not apply for PMP71 and PMP75 with a 40 bar (600 psi) or 100 bar (1500 psi) measuring cell.

Mechanical construction

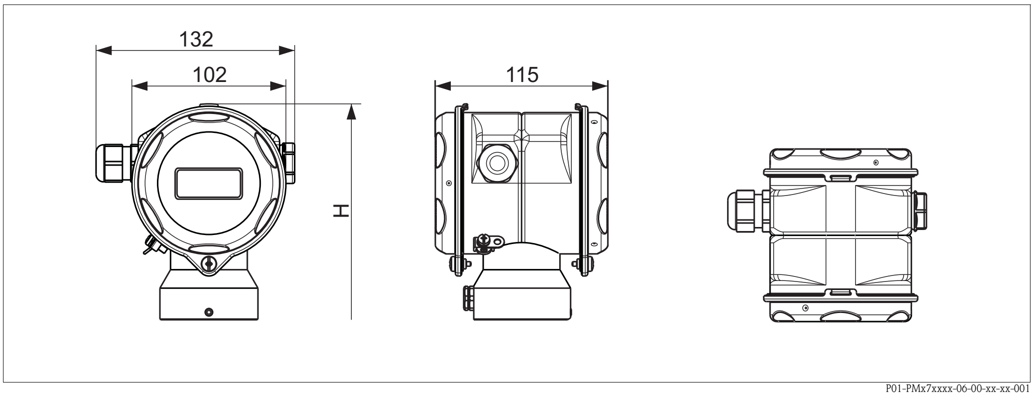
Dimensions of T14 housing, optional display on the side



Front view, left-hand side view, top view
→ Installation height H, see process connection in question. Housing weight → *🗎 63.*

Note!
For custody transfer applications, the cover clamp screws have to be locked with seal wire.

Dimensions of T17 housing (hygienic), optional display on the side

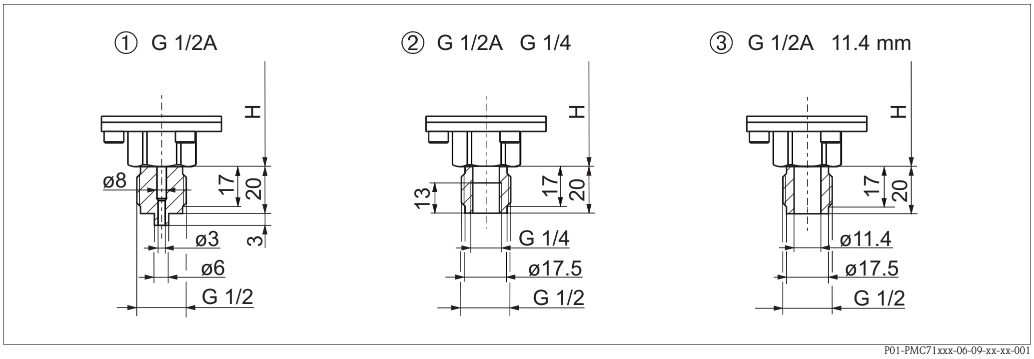


Front view, left-hand side view, top view
→ Installation height H, see process connection in question. Housing weight → *🗎 63.*

Note!
For custody transfer applications, the cover clamp screws have to be locked with seal wire.

Process connections PMC71 (with ceramic process isolating diaphragm)

Thread, internal process isolating diaphragm

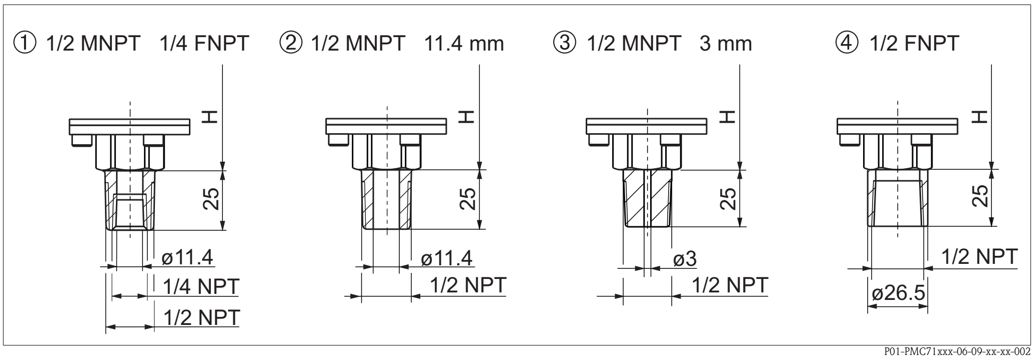


Process connections PMC71, thread ISO 228
Installation height → 🗎 35.

1 *Thread ISO 228 G 1/2 A EN 837;*
Material version GA: AISI 316L, version GB: Alloy C276, version GC: Monel,
version GD: PVDF (max.: 15 bar (225 psi), –10 to +60 °C/+14 to +140 °F), only mount version "GD" with a mounting bracket (→ see also Page 26); weight: 0.63 kg (1.39 lbs)

2 *Thread ISO 228 G 1/2 A G 1/4 (female);*
Material version GE: AISI 316L, version GF: Alloy C276, version GG: Monel;
Weight: 0.63 kg (1.39 lbs)

3 *Thread ISO 228 G 1/2 A hole 11.4 mm;*
Material version GH: AISI 316L, version GJ: Alloy C276, version GK: Monel;
Weight: 0.63 kg (1.39 lbs)



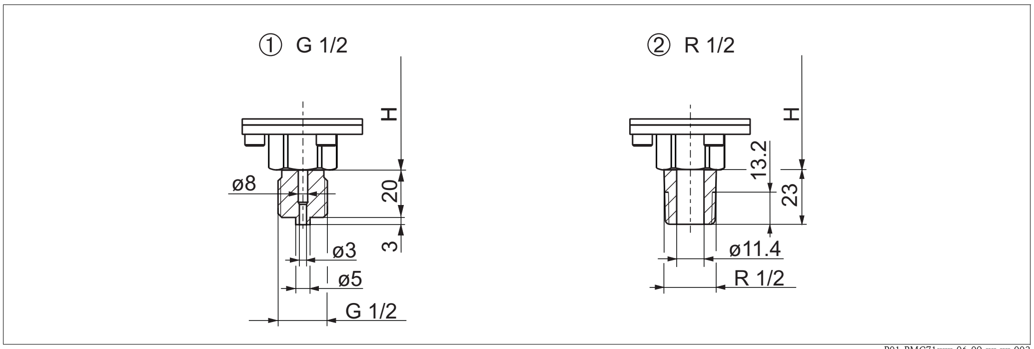
Process connections PMC71, thread ANSI
Installation height → 🗎 35.

1 *Thread ANSI 1/2 MNPT 1/4 FNPT;*
Material version RA: AISI 316L, version RB: Alloy C276, version RC: Monel;
Weight: 0.63 kg (1.39 lbs)

2 *Thread ANSI 1/2 MNPT hole 11.4 (0.45 in);*
Material version RD: AISI 316L, version RE: Alloy C276, version RF: Monel;
Weight: 0.63 kg (1.39 lbs)

3 *Thread ANSI 1/2 MNPT hole 3 mm (0.12 in);*
Material version RG: PVDF (max.: 15 bar (225 psi), –10 to +60 °C/+14 to +140 °F) - only mount with a mounting bracket
(→ 🗎 26); Weight: 0.63 kg (1.39 lbs)

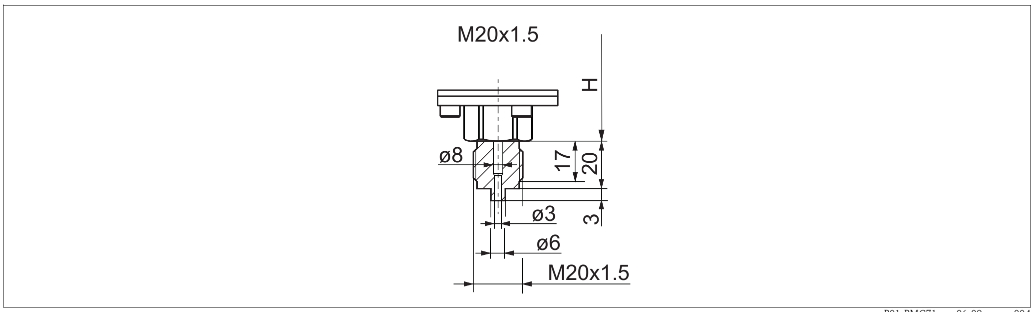
4 *Thread ANSI 1/2 FNPT;*
Material version RH: AISI 316L, version RJ: Alloy C276, version RK: Monel;
Weight: 0.63 kg (1.39 lbs)



P01-PMC71xxx-06-09-xx-xx-003

Process connections PMC71, thread JIS
Installation height H → 🗎 35.

1 Version GL: thread JIS B0202 G 1/2 (male), material: AISI 316L; weight: 0.63 kg (1.39 lbs)
2 Version RL: thread JIS B0203 R 1/2 (male), material: AISI 316L; weight: 0.63 kg (1.39 lbs)



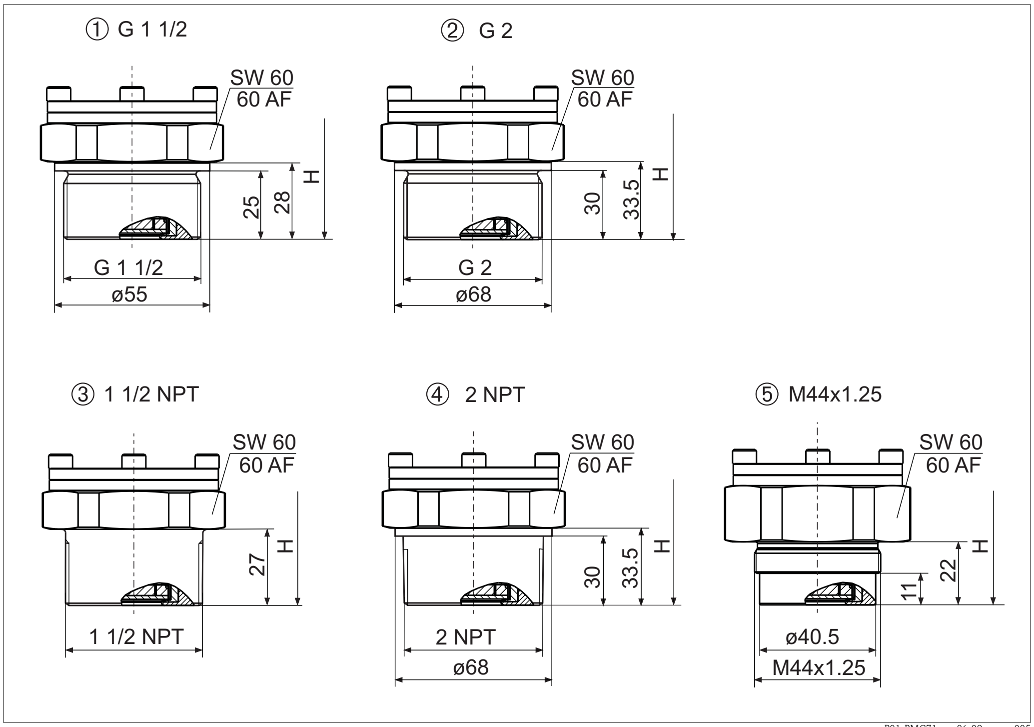
P01-PMC71xxx-06-09-xx-xx-004

Process connections PMC71 thread DIN 13 M 20x1.5 hole 3 mm (0.12 in)
Material version GP: AISI 316L, version GQ: Alloy C276; weight: 0.63 kg (1.39 lbs)
Installation height H → 🗎 35.

Installation height H for devices with threaded connection and internal process isolating diaphragm

Description	T14 housing	T17 housing
PMC71	155 mm (6.1 in)	171 mm (6.73 in)
PMC71 with Ex d[ia], CSA XP or FM XP	225 mm (8.86 ft)	241 mm (9.94 in) (Ex d = 311 mm (12.2 in))
PMC71 high-temperature version	235 mm (9.25 in)	251 mm (9.88 in)
PMC 71 high-temperature version with Ex d[ia], CSA XP or FM XP	305 mm (12 in)	321 mm (12.6 in) (Ex d = 391 mm (15.4 in))

Thread, flush-mounted process isolating diaphragm



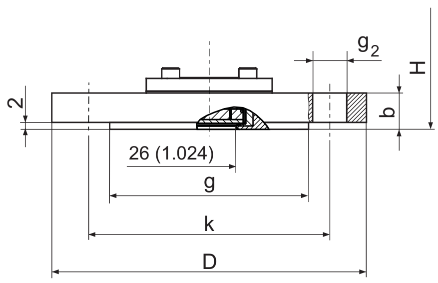
Process connections PMC71,
→ Installation height see table below.

1 *Thread ISO 228 G 1 1/2 A;*
Material version 1G: AISI 316L, version 1H: Alloy C276, version 1J: Monel;
Weight: 0.63 kg (1.39 lbs)
2 *Thread ISO 228 G 2 A;*
Material version 1K: AISI 316L, version 1L: Alloy C276, version 1M: Monel;
Weight: 0.63 kg (1.39 lbs)
3 *Thread ANSI 1 1/2 MNPT;*
Material version 2D: AISI 316L, version 2E: Alloy C276, version 2F: Monel;
Weight: 0.63 kg (1.39 lbs)
4 *Thread ANSI 2 MNPT;*
Material version 2G: AISI 316L, version 2H: Alloy C276, version 2J: Monel;
Weight: 0.63 kg (1.39 lbs)
5 *Thread DIN 13 M 44x1.25;*
Material version 1R: AISI 316L, version 1S: Alloy C276; weight: 0.63 kg (1.39 lbs)

Installation height H for devices with threaded connection and flush-mounted process isolating diaphragm

Description	T14 housing	T17 housing
PMC71/PMC71 high-temperature version	215 mm (8.46 in)	231 mm (9.09 in)
PMC71/PMC71 high-temperature version: with Ex d[ia], CSA XP or FM XP	280 mm (11 in)	296 mm (11.7 in)

EN/DIN flanges, connection dimensions as per EN 1092-1/DIN 2527



P01-PMC71xxx-06-09-xx-xx-006

Process connection PMC71, EN/DIN flange with raised face (flush-mounted process isolating diaphragm)
Installation height H → *39.*

	Flange [1]							Boltholes			
Version	Material	Nominal diameter	Nominal pressure	Shape[2]	Diameter D [mm]	Thickness b [mm]	Raised face g [mm]	Quantity	Diameter g_2 [mm]	Hole circle k [mm]	Flange weight [3] [kg]
BA	AISI 316L	DN 25	PN 10-40	B1 (D)	115	18	68	4	14	85	1.4
CP	AISI 316L	DN 32	PN 10-40	B1 (D)	140	18	78	4	18	100	2.0
CQ	AISI 316L	DN 40	PN 10-40	B1 (D)	150	18	88	4	18	110	2.4
B3	AISI 316L	DN 50	PN 10-40	B1 (D)	165	20	102	4	18	125	3.2
BR	PVDF [4]	DN 50	PN 10-16	B1 (D)	165	21.4	102	4	18	125	0.6
C3	AISI 316L	DN 50	PN 63 (64)	B2 (D)	180	26	102	4	22	135	4.6
BS	PVDF [4]	DN 80	PN 10-16	B1 (D)	200	21.4	138	8	18	160	1.0
B4	AISI 316L	DN 80	PN 10-40	B1 (D)	200	24	138	8	18	160	5.4

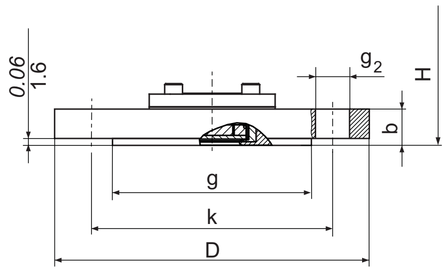
1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Hastelloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Designation as per DIN 2527 in brackets

3) Housing weight → 63

4) Max.: 15 bar (225 psi), –10 to +60 °C (+14 to +140 °F)

ANSI flanges, connection dimensions as per ANSI B 16.5, raised face RF



P01-PMC71xxx-06-09-xx-xx-007

Process connection PMC71, ANSI flange with raised face RF (flush-mounted process isolating diaphragm)
Installation height H → *39.*

	Flange [1]						Boltholes			
Version	Material	Nominal diameter	Class	Diameter	Thickness	Raised face	Quantity	Diameter	Hole circle	Flange weight [2]
				D	b	g		g_2	k	
		[in]	[lb./sq.in]	[in (mm)]	[in (mm)]	[in (mm)]		[in (mm)]	[in (mm)]	[kg]
AA [3]	AISI 316/316L [4]	1	150	4.25 / 108	0.56 / 14.2	2 / 50.8	4	0.62 / 15.7	3.12 / 79.2	0.9
AB	AISI 316/316L [4]	1	300	4.88 / 123.9	0.69 / 17.2	2 / 50.8	4	0.75 / 19	3.5 / 88.9	1.4
AE	AISI 316/316L [4]	1 1/2	150	5 (127)	0.69 (17.5)	2.88 (73.2)	4	0.62 (15.7)	3.88 (98.6)	1.0
AQ	AISI 316/316L [4]	1 1/2	300	6.12 (155.4)	0.81 (20.6)	2.88 (73.2)	4	0.88 (22.4)	4.5 (114.3)	2.6
AF	AISI 316/316L [4]	2	150	6 (152.4)	0.75 (19.1)	3.62 (91.9)	4	0.75 (19.1)	4.75 (120.7)	2.4
JR	ECTFE [5]	2	150	6 (152.4)	0.75 (19.1)	3.62 (91.9)	4	0.75 (19.1)	4.75 (120.7)	2.4
A3	PVDF [6]	2	150	6 (152.4)	0.75 (19.1)	3.62 (91.9)	4	0.75 (19.1)	4.75 (120.7)	0.5
AR	AISI 316/316L [4]	2	300	6.5 (165.1)	0.88 (22.4)	3.62 (91.9)	8	0.75 (19.1)	5 (127)	3.2
AG	AISI 316/316L [4]	3	150	7.5 (190.5)	0.94 (23.9)	5 (127)	4	0.75 (19.1)	6 (152.4)	4.9
JS	ECTFE [5]	3	150	7.5 (190.5)	0.94 (23.9)	5 (127)	4	0.75 (19.1)	6 (152.4)	4.9
A4	PVDF [6]	3	150	7.5 (190.5)	0.94 (23.9)	5 (127)	4	0.75 (19.1)	6 (152.4)	0.9
AS	AISI 316/316L [4]	3	300	8.25 (209.5)	1.12 (28.6)	5 (127)	8	0.88 (22.4)	6.62 (168.1)	6.8
AH	AISI 316/316L [4]	4	150	9 (228.6)	0.94 (23.9)	6.19 (157.2)	8	0.75 (19.1)	7.5 (190.5)	7.1
JT	ECTFE [5]	4	150	9 (228.6)	0.94 (23.9)	6.19 (157.2)	8	0.75 (19.1)	7.5 (190.5)	7.1
AT	AISI 316/316L [4]	4	300	10 (254)	1.25 (31.8)	6.19 (157.2)	8	0.88 (22.4)	7.88 (200.2)	11.6

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Hastelloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Housing weight → 63

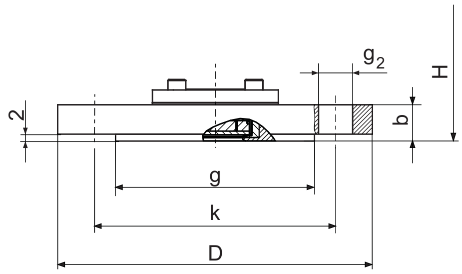
3) Screws must be 15 mm (0.59 in) longer than the standard flange screws.

4) Combination of AISI 316 for required pressure resistance and AISI 316L for required chemical resistance (dual rated)

5) ECTFE coating on AISI 316/316L. When operating in hazardous areas, avoid electrostatic charge of the plastic surfaces.

6) Max.: 15 bar (225 psi), –10 to +60 °C (+14 to +140 °F)

JIS flanges, connection dimensions as per JIS B 2220 BL, raised face RF



P01-PMC71xxx-06-09-xx-xx-008

Process connection PMC71, JIS flange with raised face RF (flush-mounted process isolating diaphragm), material: AISI 316L (1.4435)
→ Installation height H, see table below.

	Flange 1)					Boltholes			
Version	**Nominal diameter**	**Nominal pressure**	**Diameter** **D** [mm]	**Thickness** **b** [mm]	**Raised face** **g** [mm]	**Quantity**	**Diameter** **g_2** [mm]	**Hole circle** **k** [mm]	**Flange weight 2)** [kg]
KF	50 A	10 K	155	16	96	4	19	120	2.0
KL	80 A	10 K	185	18	127	8	19	150	3.3
KH	100 A	10 K	210	18	151	8	19	175	4.4

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Alloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

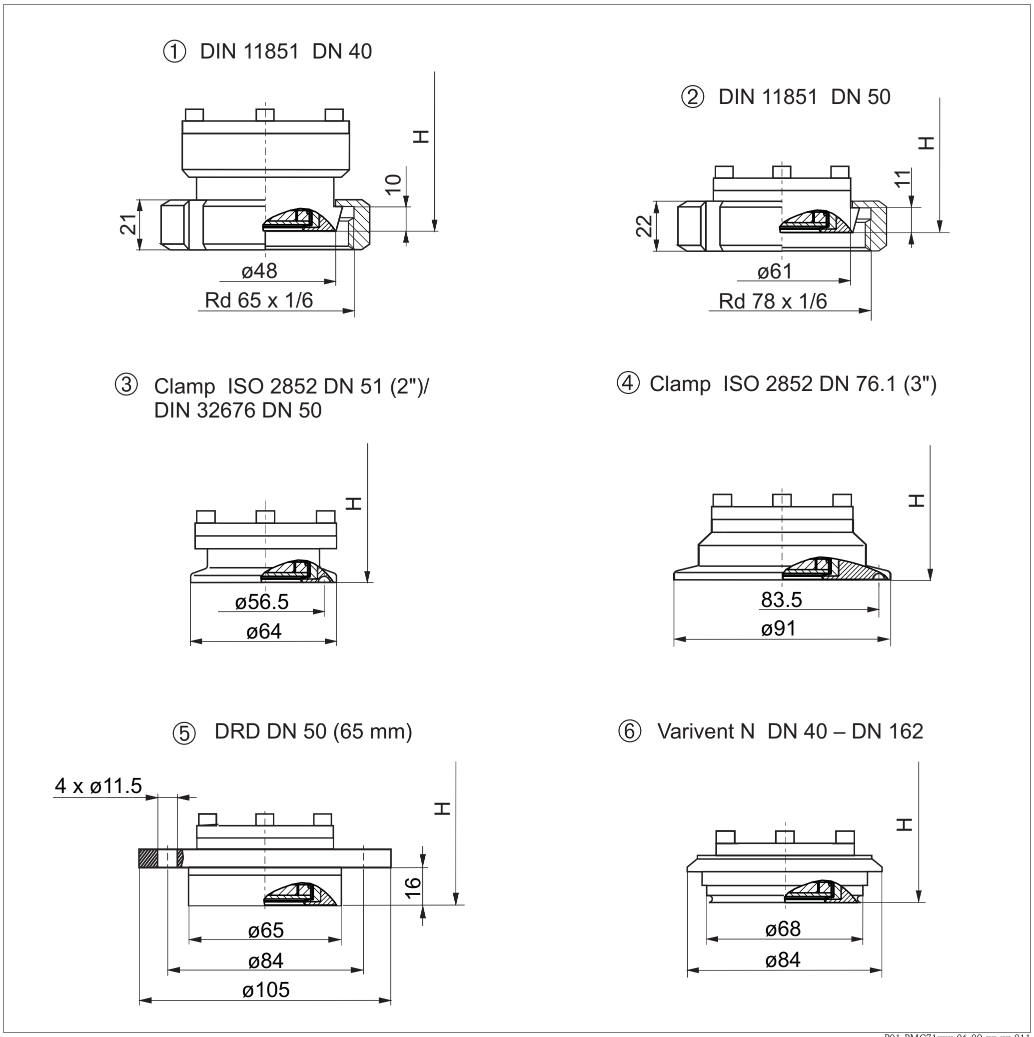
2) Housing weight see → 🗎 63

Installation height H for devices with flange

Description	T14 housing	T17 housing
PMC71	215 mm (8.46 in)	231 mm (9.09 in)
PMC71 with Ex d[ia], CSA XP or FM XP	280 mm (11 in)	296 mm (11.7 in)

Hygienic connections, flush-mounted process isolating diaphragm

Note!
Many process connections with an EPDM or HNBR seal are approved for the PMC71 in accordance with the guidelines of the 3A Sanitary Standard. To ensure that the 3A approval is valid for the PMC71 version, a 3A-approved process connection together with an EPDM or HNBR seal must be selected when ordering → 81 "Ordering information PMC71", feature 80 "Seal", version B or F.



P01-PMC71xxx-06-09-xx-xx-011

Process connections PMC71, hygienic connections, material AISI 316L
Surface roughness of the surfaces in contact with the media $R_a \leq 0.8\,\mu m$ (31.5 µin) as standard. Lower surface roughness on request.

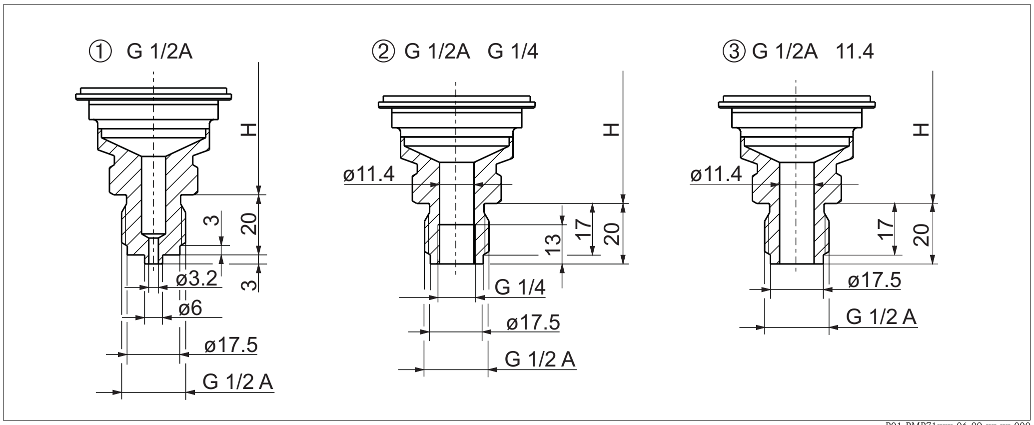
1 *Version MP: DIN 11851 DN 40 PN 25, 3A with HNBR or EPDM seal*
2 *Version MR: DIN 11851 DN 50 PN 25, 3A with HNBR or EPDM seal*
3 *Version TD: Tri-Clamp ISO 2852 (2"), DIN 32675 DN 50, 3A with HNBR or EPDM seal*
4 *Version TF: Tri-Clamp ISO 2852 (3"), 3A with HNBR or EPDM seal*
5 *Version TK: DRD DN 50 (65 mm) PN 25, 3A with HNBR or EPDM seal*
6 *Version TR: Varivent type N for pipes 40 – 162, PN 40, 3A with HNBR or EPDM seal*

Installation height H for devices with hygienic connection and flush-mounted process isolating diaphragm

Description	T14 housing	T17 housing
PMC71/PMC71 high-temperature version	215 mm (8.46 in)	231 mm (9.09 in)
PMC71/PMC71 high-temperature version: with Ex d[ia], CSA XP or FM XP	280 mm (11 in)	296 mm (11.7 in)

Process connections PMP71 (with metallic process isolating diaphragm)

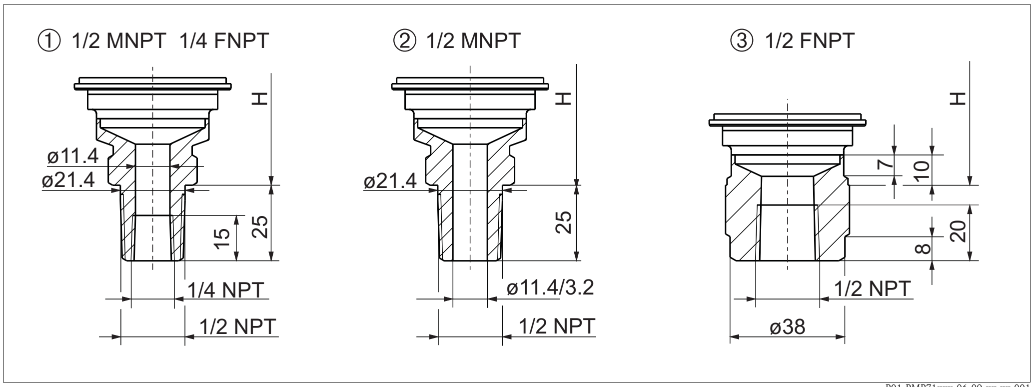
Thread, internal process isolating diaphragm



P01-PMP71xxx-06-09-xx-xx-000

Process connections PMP71, thread ISO 228
Installation height H → *42.*

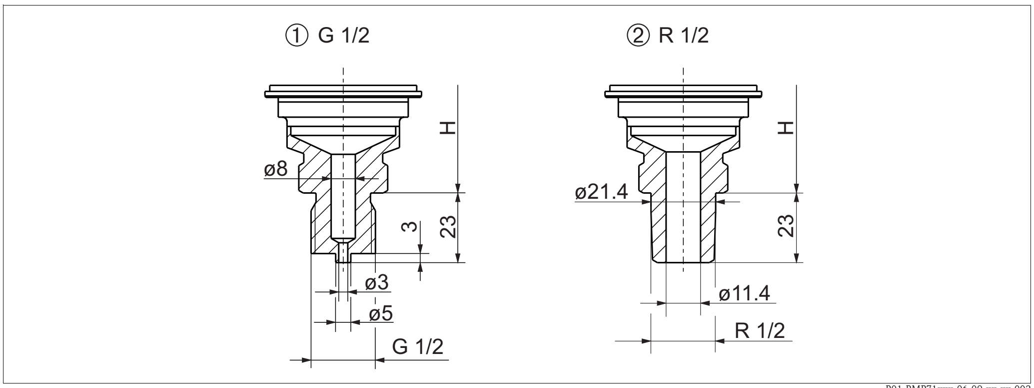
1 *Thread ISO 228 G 1/2 A EN 837;*
Material version GA: AISI 316L, version GB: Alloy C276; weight: 0.6 kg (1.32 lbs)
2 *Thread ISO 228 G 1/2 A G 1/4 (female);*
Material version GE: AISI 316L, version GF: Alloy C276; weight: 0.6 kg (1.32 lbs)
3 *Thread ISO 228 G 1/2 A hole 11.4 mm (0.45 in);*
Material version GH: AISI 316L, version GJ: Alloy C276; weight: 0.6 kg (1.32 lbs)



P01-PMP71xxx-06-09-xx-xx-001

Process connections PMP71, thread ANSI
Installation height H → *42.*

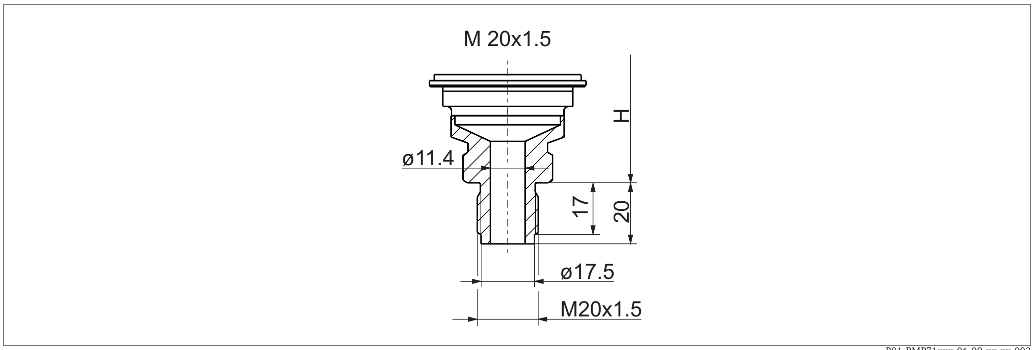
1 *Thread ANSI 1/2 MNPT 1/4 FNPT;*
Material version RA: AISI 316L, version RB: Alloy C276; weight: 0.6 kg (1.32 lbs)
2 *Thread ANSI 1/2 MNPT hole: 400 bar (6000 psi) = 11.4 mm (0.45 in);*
700 bar (10500 pis) = 3.2 mm (0.13 in)
Material version RD: AISI 316L, version RE: Alloy C276; weight: 0.6 kg (1.32 lbs)
3 *Thread ANSI 1/2 FNPT;*
Material version RH: AISI 316L, version RJ: Alloy C276; weight: 0.7 kg (1.54 lbs)



P01-PMP71xxx-06-09-xx-xx-002

Process connections PMP71, thread JIS
→ Installation height H see table below.

1 *Version GL: thread JIS B0202 G 1/2 (male), material: AISI 316L; weight: 0.6 kg (1.32 lbs)*
2 *Version RL: thread JIS B0203 R 1/2 (male), material: AISI 316L; weight: 0.6 kg (1.32 lbs)*



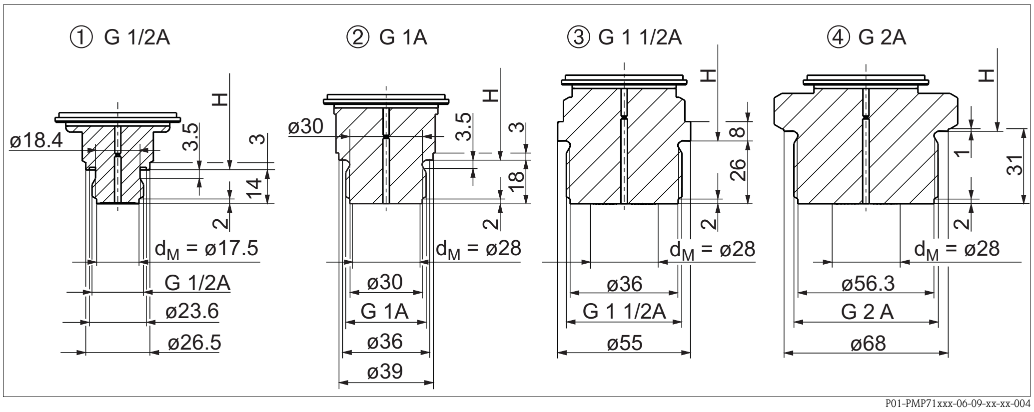
P01-PMP71xxx-06-09-xx-xx-003

Process connections PMP71 thread DIN 13 M 20x1.5 hole 11.4 mm (0.45 in)
Material version GP: AISI 316L, version GQ: Alloy C276; weight: 0.6 kg (1.32 lbs)
→ Installation height H, see table below.

Installation height H for devices with threaded connection and internal process isolating diaphragm

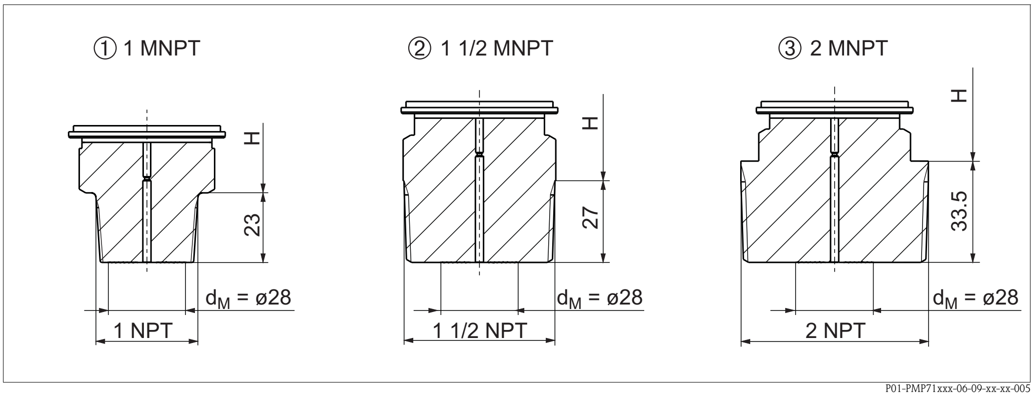
	T14 housing	**T17 housing**
Height H	165 mm (6.5 in)	181 mm (7.13 in)
	Note! The versions with a 700 bar (10500 psi) sensor are approx. 20 mm (0.79 in) higher.	

Thread, flush-mounted process isolating diaphragm



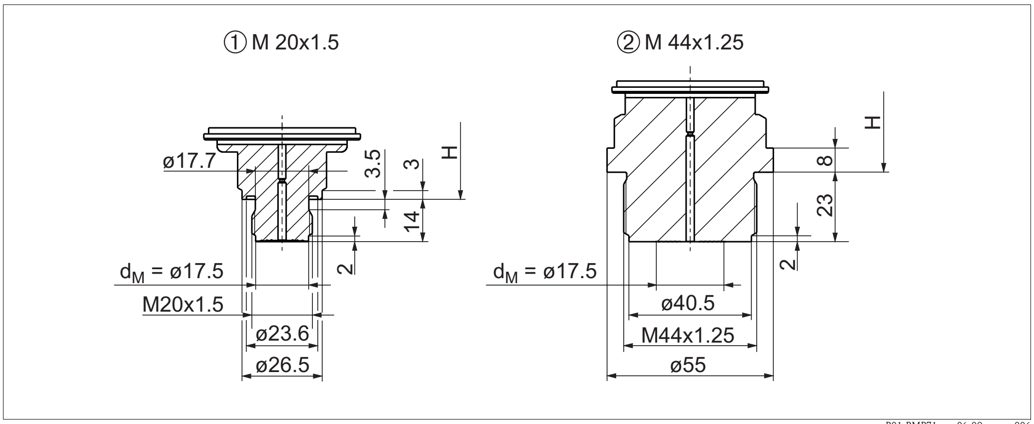
Process connections PMP71, thread ISO 228
Installation height H → 🗎 44.

1 *Thread ISO 228 G 1/2 A DIN 3852 (Viton seal included);*
Material version 1A: AISI 316L, version 1B: Alloy C276; weight: 0.4 kg (0.88 lbs)
2 *Thread ISO 228 G 1 A;*
Material version 1D: AISI 316L, version 1E: Alloy C276; weight: 0.7 kg (1.54 lbs)
3 *Thread ISO 228 G 1 1/2 A*
Material version 1G: AISI 316L, version 1H: Alloy C276; weight: 1.1 kg (2.43 lbs)
4 *Thread ISO 228 G 2 A*
Material version 1K: AISI 316L, version 1L: Alloy C276; weight: 1.5 kg (3.31 lbs)



Process connections PMP71, thread ANSI
Installation height H → 🗎 44.

1 *Thread ANSI 1 MNPT;*
Material version 2A: AISI 316L, version 2B: Alloy C276; weight: 0.7 kg (1.54 lbs)
2 *Thread ANSI 1 1/2 MNPT;*
Material version 2D: AISI 316L, version 2E: Alloy C276; weight: 1.0 kg (2.21 lbs)
3 *Thread ANSI 2 MNPT*
Material version 2G: AISI 316L, version 2H: Alloy C276; weight: 1.3 kg (2.87 lbs)



P01-PMP71xxx-06-09-xx-xx-006

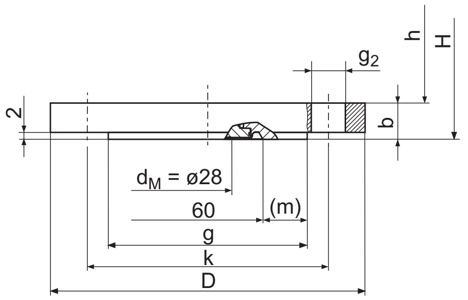
Process connections PMP71, thread DIN
→ Installation height H see table, below.

1 *Thread DIN 16288 M20;*
Material version 1N: AISI 316L, version 1P: Alloy C276; weight: 0.4 kg (0.88 lbs)
2 *Thread DIN 13 M 44 x 1.25;*
Material version 1R: AISI 316L, version 1S: Alloy C276; weight: 1.1 kg (2.43 lbs)

Installation height H for devices with threaded connection and flush-mounted process isolating diaphragm

Description	T14 housing	T17 housing
G 1/2	163 mm (6.42 in)	179 mm (7.05 in)
G 1	167 mm (6.57 in)	183 mm (7.2 in)
G 1 1/2 A	163 mm (6.42 in)	179 mm (7.05 in)
G 2 A	162 mm (6.38 in)	178 mm (7.01 in)
1 MNPT	162 mm (6.38 in)	178 mm (7.01 in)
1 1/2 MNPT	165 mm (6.5 in)	181 mm (7.13 in)
2 MNPT	159 mm (6.26 in)	175 mm (6.89 in)
M 20x1.5	163 mm (6.42 in)	179 mm (7.05 in)
M 44x1.25	170 mm (6.69 in)	186 mm (7.32 in)

EN/DIN flanges, connection dimensions as per EN 1092-1/DIN 2527



P01-PMP71xxx-06-09-xx-xx-008

Process connection PMP71, EN/DIN flange with raised face, material AISI 316L

H: device height = height of the device without flange h + flange thickness b
Height h → *46.*

	Flange [1]							Boltholes			
Version	**Nominal diameter**	**Nominal pressure**	**Shape [2]**	**Diameter** **D** [mm]	**Thickness** **b** [mm]	**Raised face** **g** [mm]	**Width of raised face** **(m)** [mm]	**Quantity**	**Diameter** g_2 [mm]	**Hole circle** **k** [mm]	**Flange weight [3]** [kg]
CN	DN 25	PN 10-40	B1 (D)	115	18	68 [4]	4	4	14	85	1.2
CP	DN 32	PN 10-40	B1 (D)	140	18	78 [4]	9	4	18	100	1.9
CQ	DN 40	PN 10-40	B1 (D)	150	18	88 [4]	14	4	18	110	2.2
B3	DN 50	PN 10-40	B1 (D)	165	20	102	-	4	18	125	3.0
B4	DN 80	PN 10-40	B1 (D)	200	24	138	-	8	18	160	5.3

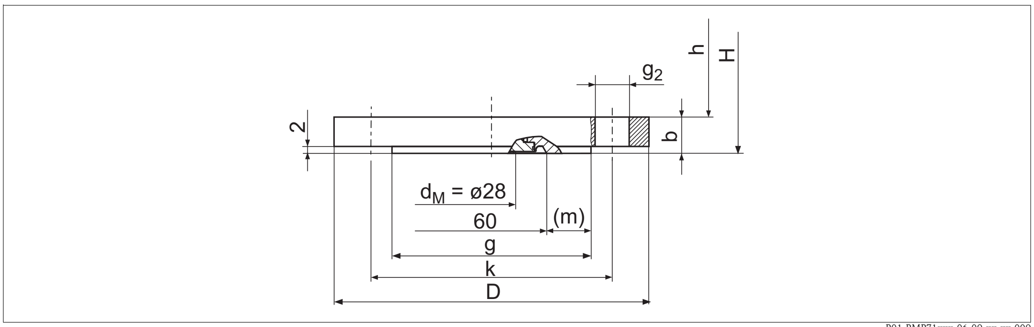
1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Alloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Designation as per DIN 2527 in brackets

3) Housing weight → 63

4) With these process connections the raised face is smaller than described in the standard. Due to a smaller raised face a special seal must be used. Refer to a manufacturer of seals or your local Endress+Hauser Sales Center.

ANSI flanges, connection dimensions as per ANSI B 16.5, raised face RF
JIS flanges, connection dimensions as per B 2220 BL, raised face RF



P01-PMP71xxx-06-09-xx-xx-009

Process connection PMP71, ANSI flange or JIS flange with raised face RF (see table below)

H: device height = height of device without flange h + flange thickness b. For the height h → 46.

	Flange 1)							Boltholes			
Version	Material	Nominal diameter	Class/ nominal pressure	Diameter D [in (mm)]	Thickness b [in (mm)]	Diameter of raised face g [in (mm)]	Width of raised face (m) [in (mm)]	Quantity	Diameter g_2 [in (mm)]	Hole circle k [in (mm)]	Flange weight 2) [kg]
ANSI flanges											
AN	AISI 316/316L 3)	1 in	300 lb./sq.in	4.88 (124)	0.69 (17.5)	2.76 4) (70)	0.2 (5)	4	0.75 (19.1)	3.5 (88.9)	1.3
AE	AISI 316/316L 3)	1 1/2 in	150 lb./sq.in	5 (127)	0.69 (17.5)	2.88 4) (73.2)	0.52 (6.6)	4	0.62 (15.7)	3.88 (98.6)	1.5
AQ	AISI 316/316L 3)	1 1/2 in	300 lb./sq.in	6.12 (155.4)	0.81 (20.6)	2.88 4) (73.2)	0.52 (6.6)	4	0.88 (22.4)	4.5 (114.3)	2.6
AF	AISI 316/316L 3)	2 in	150 lb./sq.in	6 (152.4)	0.75 (19.1)	3.62 (91.9)	-	4	0.75 (19.1)	4.75 (120.7)	2.4
AR	AISI 316/316L 3)	2 in	300 lb./sq.in	7.5 (190.5)	0.88 (22.3)	3.62 (91.9)	-	8	0.75 (19.1)	5 (127)	3.2
AG	AISI 316/316L 3)	3 in	150 lb./sq.in	7.5 (190.5)	0.94 (23.9)	5 (127)	-	4	0.75 (19.1)	6 (152.4)	4.9
AS	AISI 316/316L 3)	3 in	300 lb./sq.in	8.25 (209.5)	1.12 (28.6)	5 (127)	-	8	0.88 (22.4)	6.62 (168.1)	6.7
AH	AISI 316/316L 3)	4 in	150 lb./sq.in	9 (228.6)	0.94 (23.9)	6.19 (157.2)	-	8	0.75 (19.1)	7.5 (190.5)	7.1
AT	AISI 316/316L 3)	4 in	300 lb./sq.in	10 (254)	1.25 (31.8)	6.19 (157.2)	-	8	0.88 (22.4)	7.88 (200.2)	11.6
JIS flanges											
KA	AISI 316L	25 A	20 K	*125*	*16*	67 4)	0.14 (3.5)	4	*19*	*90*	1.5
KF	AISI 316L	50 A	10 K	*155*	*16*	*96*	-	4	*19*	*120*	2.0
KL	AISI 316L	80 A	10 K	*185*	*18*	*127*	-	8	*19*	*150*	3.3
KH	AISI 316L	100 A	10 K	*210*	*18*	*151*	-	8	*19*	*175*	4.4

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Alloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Housing weight → 63

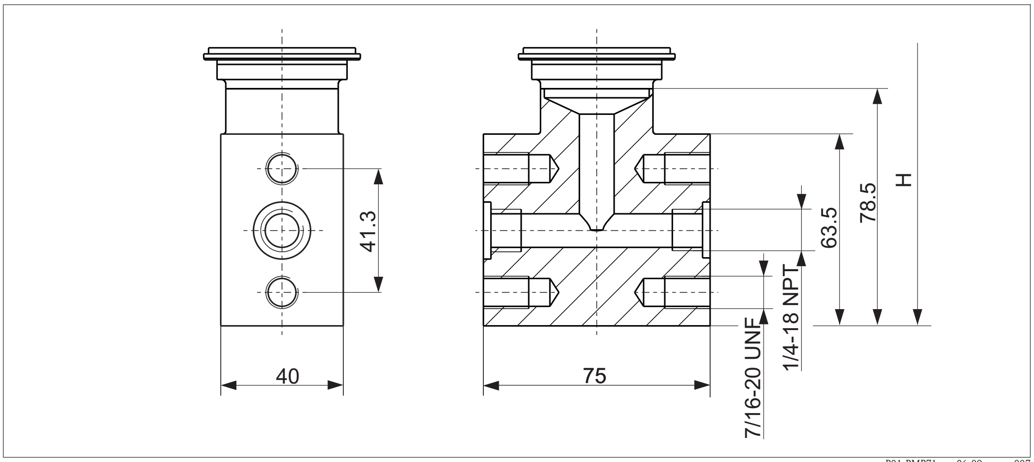
3) Combination of AISI 316 for required pressure resistance and AISI 316L for required chemical resistance (dual rated)

4) With these process connections the raised face is smaller than described in the standard. Due to a smaller raised face a special seal must be used. Refer to a manufacturer of seals or your local Endress+Hauser Sales Center.

Height h for devices with flange

	T14 housing	T17 housing
Height h	165 mm (6.5 in)	181 mm (7.13 in)

Oval flange

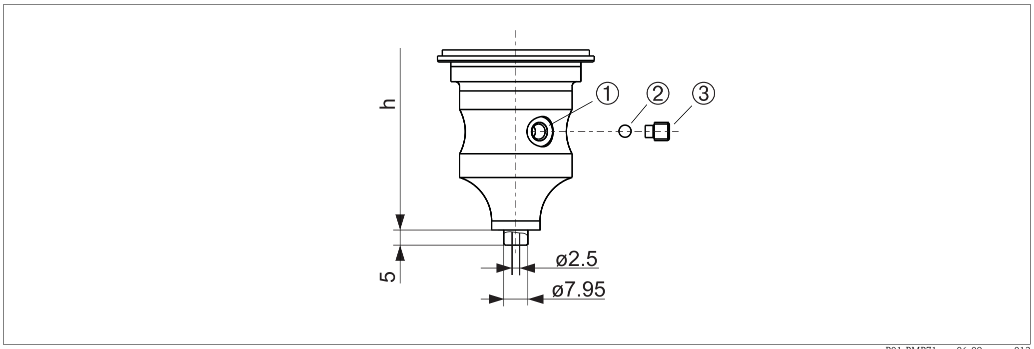


P01-PMP71xxx-06-09-xx-xx-007

Version UR: oval flange adapter 1/4-18 NPT as per IEC 61518, material 316L (1.4404), mounting: 7/16-20 UNF; Weight: 1.9 kg (4.19 lbs)

	T14 housing	T17 housing
Height H	199 mm (7.83 in)	215 mm (8.46 in)

Prepared for diaphragm seal mount



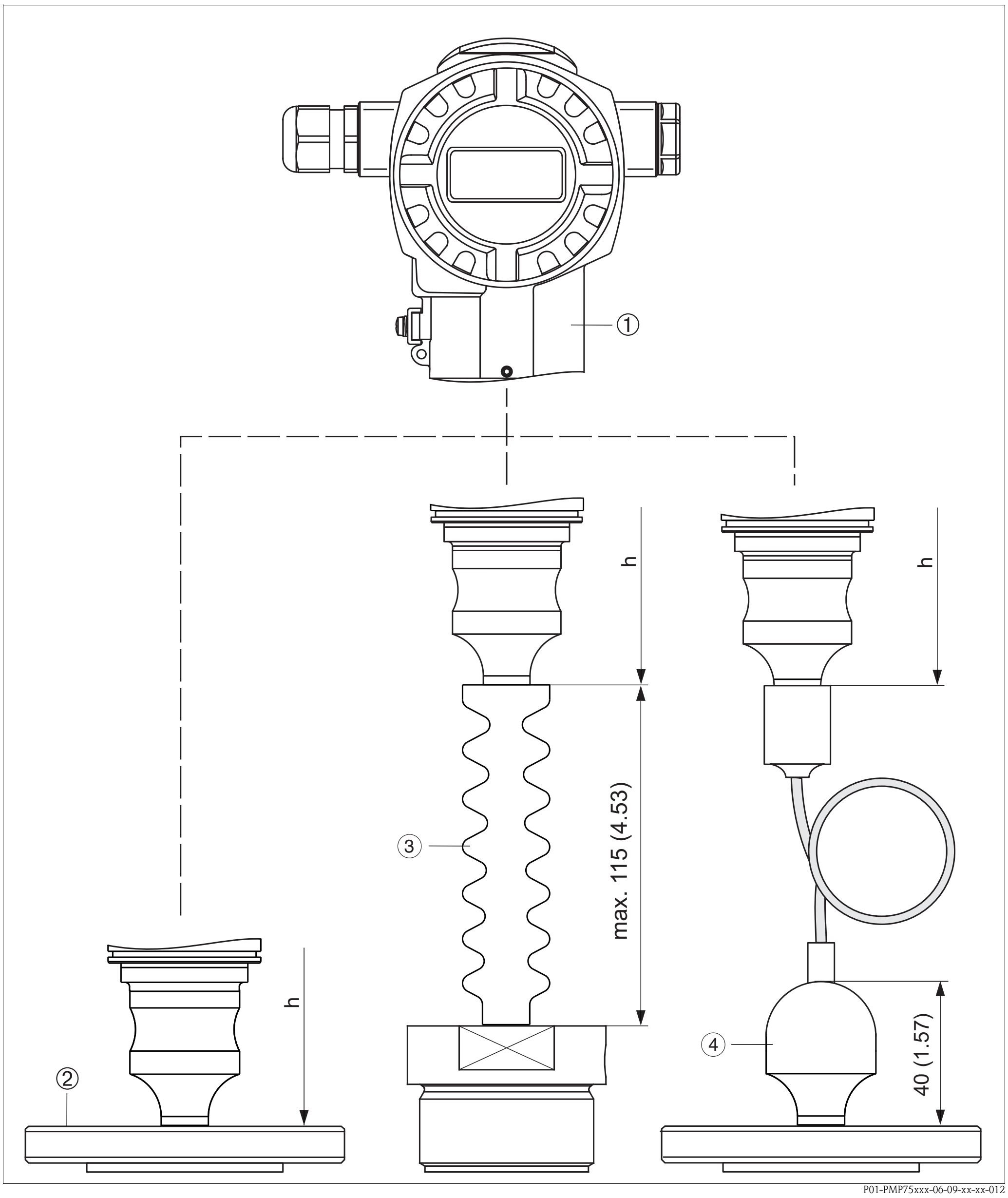
P01-PMP71xxx-06-09-xx-xx-013

Version U1: material AISI 316L (1.4404), prepared for diaphragm seal mount

1 *Hole for filling fluid*
2 *Bearing DIN 5401 (1.3505)*
3 *Setscrew with hexagonal recess 4 mm (0.16 in), material A2-70*

	T14 housing	T17 housing
Height h	190 mm (7.48 in)	204 mm (8.03 in)

PMP75 basic device



PMP75 basic device with diaphragm seal

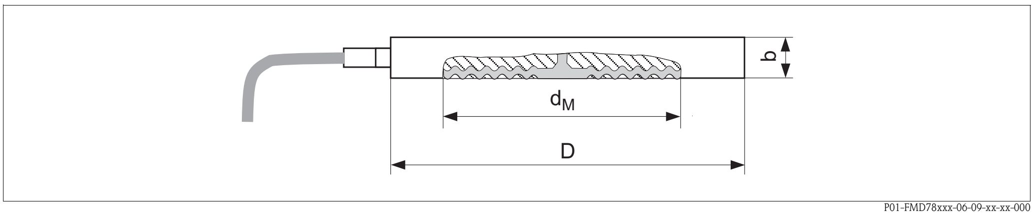
1 PMP75 basic device
2 Diaphragm seal, here e.g. flange diaphragm seal
3 Diaphragm seal with temperature isolator
4 Process connections with capillary tubes are 40 mm (1,57 in) higher than process connections without capillary tubes

	T14 housing	**T17 housing**
Height h	190 mm (7.48 in)	204 mm (8.03 in)

Process connections PMP75 (with diaphragm seal)

Note!
- The weights of the diaphragm seals are given in the tables. See → 🗎 63 for the weight of the housing.
- The following drawings are drawings that illustrate how the system works in principle. In other words, the dimensions of a diaphragm seal supplied can deviate from the dimensions given in this document.
- With the use of high-temperature oils the design can deviate strongly.
- Observe the information in the "Planning instructions, diaphragm seal systems" section → 🗎 73 ff.
- For further information please contact your local Endress+Hauser Sales Center.

Diaphragm seal cell structure

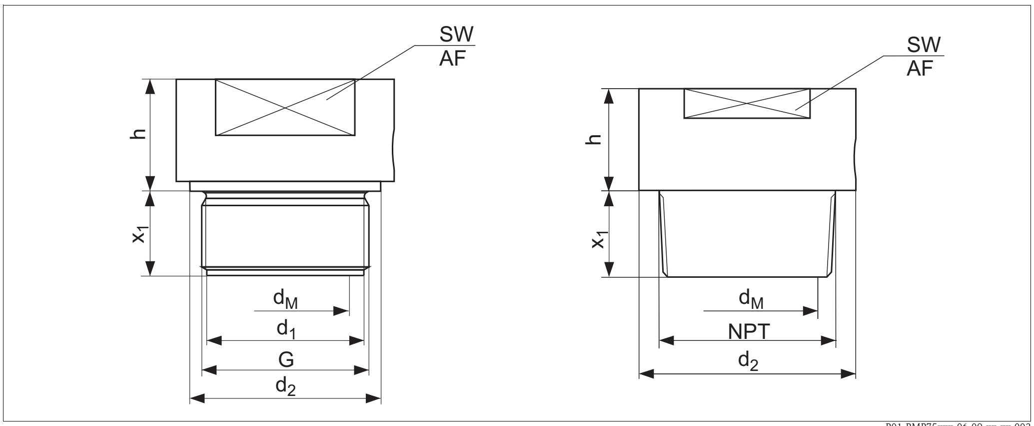


Process connection PMP75, material AISI 316L

	Flange				**Diaphragm seal**	
Version	**Nominal diameter**	**Nominal pressure** [1]	**Max. diameter** **D** [mm]	**Thickness** **b** [mm]	**Max. diameter of the process isolating diaphragm** d_M [mm]	**Weight of two diaphragm seals** [kg]
UI	DN 50	PN 16-400	102	20	59	2.6
UJ	DN 80	PN 16-400	138	20	89	4.6
UK	DN 100	PN 16-400	162	20	89	6.2
	[in]	[lb/sq.in]	[in (mm)]	[in (mm)]	[in (mm)]	[kg]
UL	2	150-2500	4.01 (102)	0.79 (20)	2.32 (59)	2.6
UM	3	150-2500	5.35 (136)	0.79 (20)	3.50 (89)	4.6
UR	4	150-2500	6.22 (158)	0.79 (20)	3.50 (89)	6.2

1) The specified nominal pressure applies to the diaphragm seal. The maximum pressure for the measuring device is dependent on the lowest-rated element, with regard to pressure, of the selected components. See also → 32, "Pressure specifications" section.

Thread, flush-mounted process isolating diaphragm



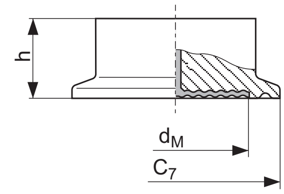
P01-PMP75xxx-06-09-xx-xx-003

Process connections PMP75, left: thread ISO 228, right: thread ANSI

Threaded connections								Diaphragm seal		
Version	Material	Thread	Nominal pressure PN	Diameter d_1 [mm]	Diameter d_2 [mm]	Screw-in length x_1 [mm]	Across flats SW/AF	Max. diameter of the process isolating diaphragm d_M [mm]	Height h [mm]	Diaphragm seal weight [kg]
1D	AISI 316L	G 1 A	400	30	39	21 [1)]	41	30	19	0.4
1E	Alloy C276									0.5
1G	AISI 316L	G 1 1/2 A	400	44	55	30	50	42	20	0.9
1H	Alloy C276									1.0
1K	AISI 316L	G 2	400	56	68	30	65	50	20	1.9
1L	Alloy C276									2.1
2A	AISI 316L	1 MNPT	400	–	48	28	41	24	37	0.6
2B	Alloy C276									0.7
2D	AISI 316L	1 1/2 MNPT	400	–	60	30	41	36	20	0.9
2E	Alloy C276									1.0
2G	AISI 316L	2 MNPT	400	–	78	30	65	38	35	1.8
2H	Alloy C276									2.0

1) 28 mm (1.1 in) in conjunction with high-temperature oil

Tri-Clamp ISO 2852



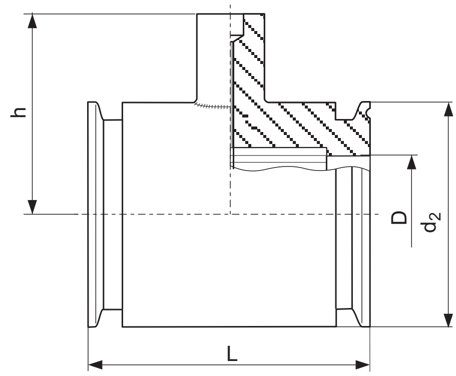
P01-FMD78xxx-06-09-xx-xx-005

Process connection PMP75, material: AISI 316L, surface roughness of the surfaces in contact with the media $R_a \leq 0.8\,\mu m$ (31.5 µin) as standard.

Version	Nominal diameter ISO 2852	Nominal diameter DIN 32676	Nominal diameter [in]	Diameter C_7 [mm]	Max. diameter of the process isolating diaphragm d_M [mm]	Height h [mm]	Diaphragm seal weight [kg]
TB	DN 25	DN 25	1	50.5	24	37	0.32
TC [1)]	DN 38	DN 40	1 1/2	50.5	34	30	1.0
TD [1)]	DN 51	DN 50	2	64	48	30	1.1
TF	DN 76.1	–	3	91	73	30	1.2

1) Diaphragm seal versions optionally in conformity with ASME-BPE for use in biochemical processes, wetted surfaces $R_a \leq 0.38\,\mu m$, electropolished; to be ordered using feature 110 "Additional option", version "P" in the order code.

Tri-Clamp pipe diaphragm seal ISO 2852



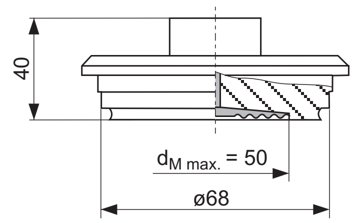
P01-FMD78xxx-06-09-xx-xx-001

Process connection PMP75, material AISI 316L, surface roughness of the surfaces in contact with the media $R_a \leq 0.8\,\mu m$ (31.5 µin) as standard. Lower surface roughness on request.

Version	Nominal diameter ISO 2852	Nominal diameter	Nominal pressure	Diameter D [in]	Diameter d_2 [mm]	Height h [mm]	Face-to-face length L [mm]	Diaphragm seal weight [kg]
SB	DN 25	1	PN 40	22.5	50.5	67	126	1.7
SC [1)]	DN 38	1 1/2	PN 40	35.5	50.5	67	126	1.0
SD [1)]	DN 51	2	PN 40	48.6	64	79	100	1.7

1) Including 3.1 and pressure test as per Pressure Equipment Directive, category II

Varivent N for pipes DN 40 – DN 162



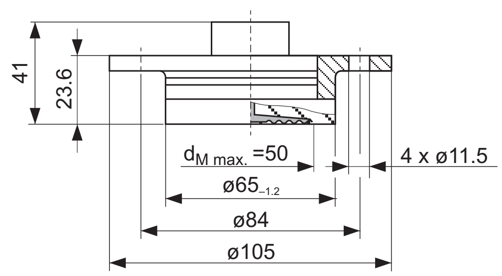
P01-FMD78xxx-06-09-xx-xx-006

Process connection PMP75, surface roughness of the surfaces in contact with the media $R_a \leq 0.8\ \mu m$ (31.5 µin) as standard.

Version	Material	Nominal pressure	Diaphragm seal weight [kg]
TR [1)]	AISI 316L	PN 40	1.3

1) Diaphragm seal versions optionally in conformity with ASME-BPE for use in biochemical processes, wetted surfaces $R_a \leq 0.38\ \mu m$ (15 µin), electropolished; to be ordered using feature 110 "Additional option", version "P" in the order code.

DRD DN50 (65 mm)

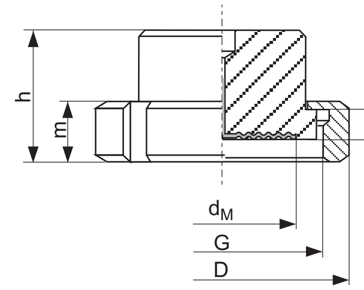


P01-FM78xxx-06-09-xx-xx-002

Process connection PMP75, surface roughness of the surfaces in contact with the media $R_a \leq 0.8\ \mu m$ (31.5 µin) as standard. Lower surface roughness on request.

Version	Material	Nominal pressure	Diaphragm seal weight [kg]
TK	AISI 316L	PN 25	0.75

SMS nozzles with slotted nut

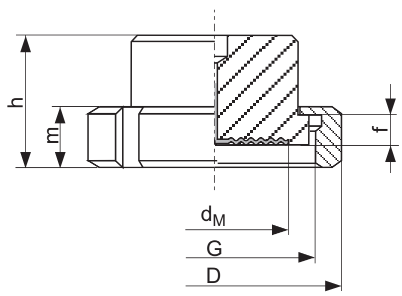


P01-PMP75xxx-06-09-xx-xx-009

Process connection PMP75, material AISI 316L, surface roughness of the surfaces in contact with the media $R_a \leq 0.8$ µm (31.5 µin) as standard. Lower surface roughness on request.

Version	Nominal diameter [inch]	Nominal pressure [bar]	Diameter D [mm]	Adapter height f [mm]	Thread G	Height m [mm]	Height h [mm]	Max. diameter of the process isolating diaphragm d_M [mm]	Diaphragm seal weight [kg]
TG	1	PN 25	54	3.5	Rd 40 – 1/6	20	42.5	24	0.25
TH	1 1/2	PN 25	74	4	Rd 60 – 1/6	25	57	36	0.65
TI	2	PN 25	84	4	Rd 70 – 1/6	26	62	48	1.05

APV-RJT nozzles with slotted nut

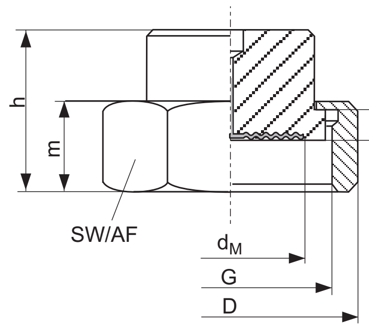


P01-PMP75xxx-06-09-xx-xx-010

Process connection PMP75, material AISI 316L, surface roughness of the surfaces in contact with the media $R_a \leq 0.8$ µm (31.5 µin) as standard. Lower surface roughness on request.

Version	Nominal diameter [inch]	Nominal pressure PN [bar]	Diameter D [mm]	Adapter height f [mm]	Thread G	Height m [mm]	Height h [mm]	Max. diameter of the process isolating diaphragm d_M [mm]	Diaphragm seal weight [kg]
TL	1	PN 40	77	6.5	1 13/16 – 1/8"	22	42.6	21	0.45
TM	1 1/2	PN 40	72	6.4	2 5/16 – 1/8"	22	42.6	28	0.75
TN	2	PN 40	86	6.4	2 7/8 – 1/8"	22	42.6	38	1.2

APV-ISS nozzles with slotted nut

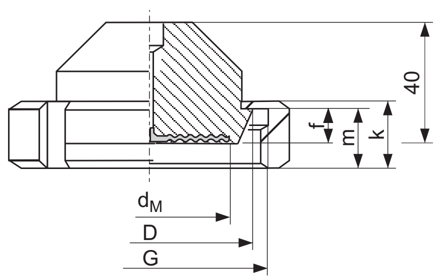


P01-PMP75xxx-06-09-xx-xx-011

Process connection PMP75, material AISI 316L, surface roughness of the surfaces in contact with the media $R_a \leq 0.8$ µm (31.5 µin) as standard. Lower surface roughness on request.

Version	Nominal diameter	Nominal pressure	Diameter	Adapter height	Thread	Height	Across flats	Height	Max. diaameter of the process isolating diaphragm	Diaphragm seal weight
			D	f	G	m	AF	h	d_M	
	[inch]	[bar]	[mm]	[mm]		[mm]		[mm]	[mm]	[kg]
TP	1	PN 40	54.1	4	1 1/2" – 1/8"	30	46.8	50	24	0.4
TQ	1 1/2	PN 40	72	4	2" – 1/8"	30	62	50	34	0.6
TS	2	PN 40	89	4	2 1/2" – 1/8"	30	77	50	45	1.1

Taper adapter with slotted nut, DIN 11851

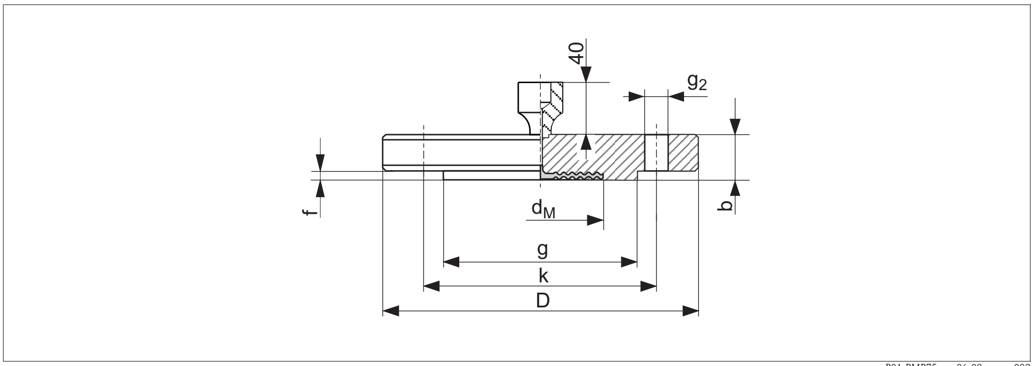


P01-FMD78xxx-06-09-xx-xx-007

Process connection PMP75, material AISI 316L, surface roughness of the surfaces in contact with the media $R_a \leq 0.8$ µm (31.5 µin) as standard. Lower surface roughness on request.

	Taper adapter				Slotted nut			Diaphragm seal	
Version	Nominal diameter	Nominal pressure	Diameter	Adapter height	Thread	Height	Height	Max. diameter of the process isolating diaphragm	Diaphragm seal weight
			D	f	G	k	m	d_M	
			[mm]	[mm]		[mm]	[mm]	[mm]	[kg]
MR	DN 50	PN 25	68.5	11	Rd 78 x 1/6"	22	19	52	1.1
MS	DN 65	PN 25	86	12	Rd 95 x 1/6"	35	21	66	2.0
MT	DN 80	PN 25	100	12	Rd 110 x 1/4"	30	26	81	2.55

EN/DIN flanges, connection dimensions as per EN 1092-1/DIN 2527 and DIN 2501-1



P01-PMP75xxx-06-09-xx-xx-002

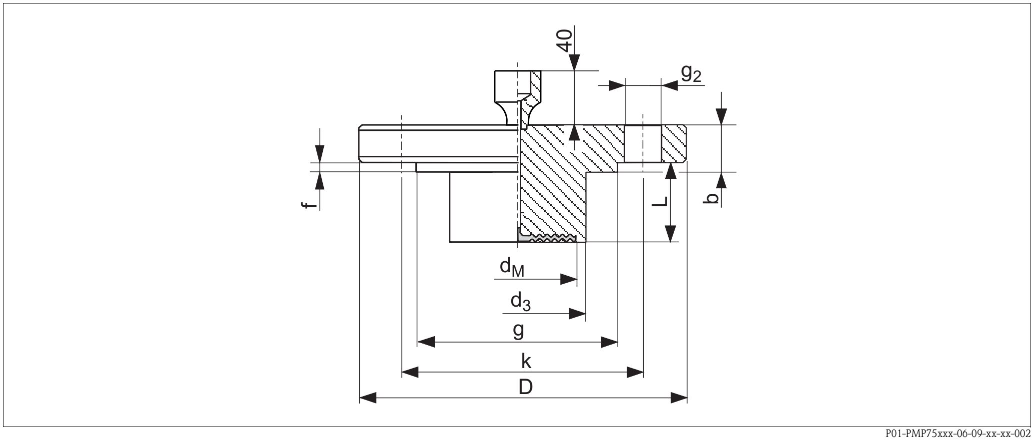
Process connection PMP75, EN/DIN flange with flush-mounted process isolating diaphragm, material AISI 316L

	Flange [1]							Boltholes			Diaphragm seal	
Version	Nominal diameter	Nominal pressure	Shape[2]	Diameter	Thick-ness	Raised face		Quantity	Diameter	Hole circle	Max. diameter of the process isolating diaphragm	Diaphragm seal weight
				D	b	g	f		g_2	k	d_M	
				[mm]	[mm]	[mm]	[mm]		[mm]	[mm]	[mm]	[kg]
CN	DN 25	PN 10-40	B1 (D)	115	18	68	3	4	14	85	32	2.1
DN	DN 25	PN 63-160	B2 (E)	140	24	68	2	4	18	100	28	2.5
EN	DN 25	PN 250	B2 (E)	150	28	68	2	4	22	105	28	3.7
E1	DN 25	PN 400	B2 (E)	180	38	68	2	4	26	130	28	7.0
CP	DN 32	PN 10-40	B1 (D)	140	18	77	2.6	4	18	100	34	1.9
CQ	DN 40	PN 10-40	B1 (D)	150	18	87	2.6	4	18	110	48	2.2
B3	DN 50	PN 10-40	B1 (D)	165	20	102	3	4	18	125	59	3.0
C3	DN 50	PN 63	B2 (E)	180	26	102	3	4	22	135	59	4.6
EF	DN 50	PN 100-160	B2 (E)	195	30	102	3	4	26	145	59	6.2
ER	DN 50	PN 250	B2 (E)	200	38	102	3	8	26	150	59	7.7
E3	DN 50	PN 400	B2 (E)	235	52	102	3	8	30	180	59	14.7
B4	DN 80	PN 10-40	B1 (D)	200	24	138	3.5	8	18	160	89	5.3
C4	DN 80	PN 100	B2 (E)	230	32	138	4	8	24	180	89	8.9
C5	DN 100	PN 100	B2 (E)	265	36	175	5	8	30	210	89	13.7

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Hastelloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Designation as per DIN 2527 in brackets

EN/DIN flanges with extended diaphragm seal, connection dimensions as per EN 1092-1/DIN 2527 and DIN 2501-1



Process connection PMP75, EN/DIN flange with flush-mounted process isolating diaphragm, material AISI 316L

	Flange 1)							Boltholes			Diaphragm seal	
Version	**Nominal diameter**	**Nominal pressure**	**Shape 2)**	**Diameter**	**Thick-ness**	**Raised face**		**Quantity**	**Diameter**	**Hole circle**	**Max. diameter of the process isolating diaphragm**	**Diaphragm seal weight**
				D	**b**	**g**	**f**		**g_2**	**k**	**d_M**	
				[mm]	[mm]	[mm]	[mm]		[mm]	[mm]	[mm]	[kg]
D3 3)	DN 50	PN 10-40	B1 (D)	165	20	102	3	4	18	125	47	3)
D4 3)	DN 80	PN 10-40	B1 (D)	200	24	138	3.5	8	18	160	72	3)

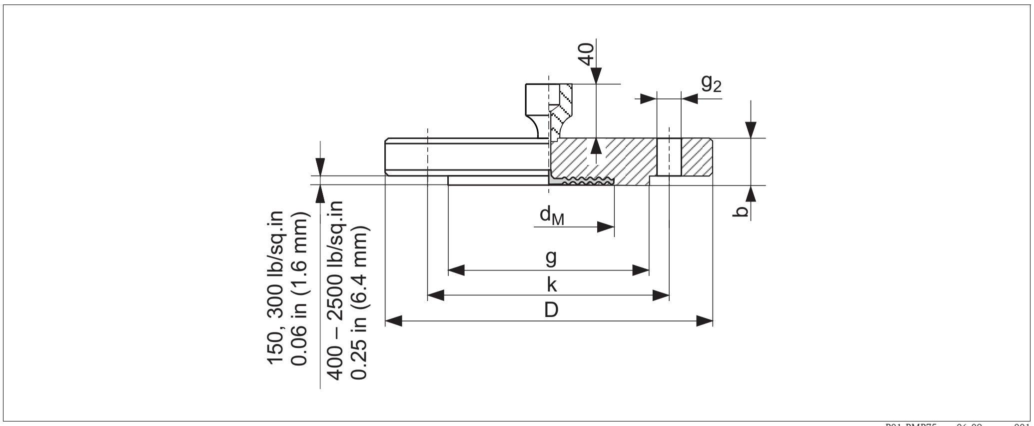
1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Hastelloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Designation as per DIN 2527 in brackets

3) Available with 50 mm (1.97 in), 100 mm (3.94 in) and 200 mm (7.87 in) extended diaphragm seal, for extended diaphragm seal diameter and weight see the following table

Version	Nominal diameter	Nominal pressure	Extended diaphragm seal length (L)	Extended diaphragm seal diameter d_3	Diaphragm seal weight
			[mm]	[mm]	[kg]
D3	DN 50	PN 10-40	50 / 100 / 200	48.3	3.2 / 3.8 / 4.4
D4	DN 80	PN 10-40	50 /100 / 200	76	6.2 / 6.7 / 7.8

ANSI flanges, connection dimensions as per ANSI B 16.5, raised face RF



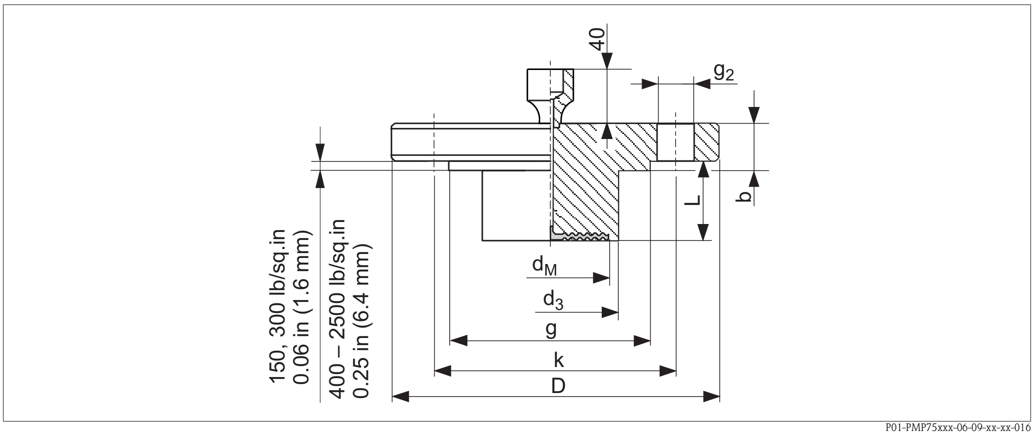
P01-PMP75xxx-06-09-xx-xx-001

Process connection PMP75, ANSI flange, material AISI 316/316L (Combination of AISI 316 for required pressure resistance and AISI 316L for required chemical resistance (dual rated))

	Flange 1)					**Boltholes**			**Diaphragm seal**	
Version	**Nominal diameter**	**Class**	**Diameter**	**Thickness**	**Raised face**	**Quantity**	**Diameter**	**Hole circle**	**Max. diameter of the process isolating diaphragm**	**Diaphragm seal weight**
			D	**b**	**g**		**g_2**	**k**	**d_M**	
	[in]	[lb./sq.in]	[in (mm)]	[in (mm)]	[in (mm)]		[in (mm)]	[in (mm)]	[in (mm)]	[kg]
AC	1	150	4.25 (108)	0.56 (14.2)	2 (50.8)	4	0.62 (15.7)	3.12 (79.2)	1.26 (32)	1.2
AN	1	300	4.88 (124)	0.69 (17.5)	2 (50.8)	4	0.75 (19.1)	3.5 (88.9)	1.26 (32)	1.3
HC	1	400/600	4.88 (124)	0.69 (17.5)	2 (50.8)	4	0.75 (19.1)	3.5 (88.9)	1.26 (32)	1.4
HN	1	900/1500	5.88 (149.4)	1.12 (28.6)	2 (50.8)	4	1 (25.4)	4 (101.6)	1.26 (32)	3.2
HO	1	2500	6.25 (158.8)	1.38 (35.1)	2 (50.8)	4	1 (25.4)	4.25 (108)	1.26 (32)	4.6
AE	1 1/2	150	5 (127)	0.69 (17.5)	2.88 (73.2)	4	0.62 (15.7)	3.88 (96.6)	1.89 (48)	1.5
AQ	1 1/2	300	6.12 (155.4)	0.81 (20.6)	2.88 (73.2)	4	0.88 (22.4)	4.5 (114.3)	1.89 (48)	2.6
AF	2	150	6 (152.4)	0.75 (19.1)	3.62 (91.9)	4	0.75 (19.1)	4.75 (120.7)	2.32 (59)	2.2
AR	2	300	6.5 (165.1)	0.88 (22.4)	3.62 (91.9)	8	0.75 (19.1)	5 (127)	2.32 (59)	3.4
HF	2	400/600	6.5 (165.1)	1 (25.4)	3.62 (91.9)	8	0.75 (19.1)	5 (127)	2.32 (59)	4.3
HR	2	900/1500	8.5 (215.9)	1.5 (38.1)	3.62 (91.9)	8	1 (25.4)	6.5 (165.1)	2.32 (59)	10.3
H3	2	2500	9.25 (235)	2 (50.8)	3.62 (91.9)	8	1.12 (28.4)	6.75 (171.5)	2.32 (59)	15.8
AG	3	150	7.5 (190.5)	0.94 (23.9)	5 (127)	4	0.75 (19.1)	6 (152.4)	3.50 (89)	5.1
AS	3	300	8.25 (209.5)	1.12 (28.6)	5 (127)	8	0.75 (19.1)	6 (152.4)	3.50 (89)	7.0
AH	4	150	9 (228.6)	0.94 (23.9)	6.19 (157.2)	8	0.75 (19.1)	7.5 (190.5)	3.50 (89)	7.2
AT	4	300	10 (254)	1.25 (31.8)	6.19 (157.2)	8	0.88 (22.4)	7.88 (200.2)	3.50 (89)	11.7

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Alloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

ANSI flanges with extended diaphragm seal, connection dimensions as per ANSI B 16.5, raised face RF



Process connection PMP75, ANSI flange, material AISI 316/316L (Combination of AISI 316 for required pressure resistance and AISI 316L for required chemical resistance (dual rated))

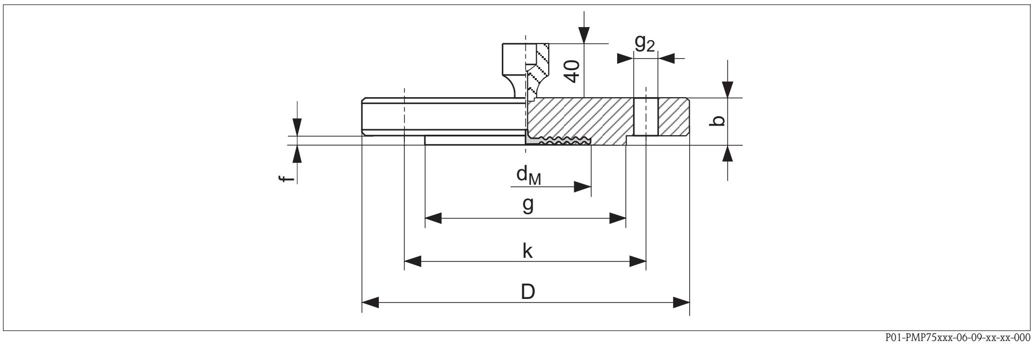
	Flange [1]					Boltholes			Diaphragm seal	
Version	Nominal diameter	Class	Diameter	Thickness	Raised face	Quantity	Diameter	Hole circle	Max. diameter of the process isolating diaphragm	Diaphragm seal weight
			D	b	g		g_2	k	d_M	
	[in]	[lb./sq.in]	[in (mm)]	[in (mm)]	[in (mm)]		[in (mm)]	[in (mm)]	[in (mm)]	[kg]
J3 [2]	2	150	6 (152.4)	0.75 (19.1)	3.62 (91.9)	4	0.75 (19.1)	4.75 (120.7)	1.85 (47)	[2]
J4 [2]	3	150	7.5 (190.5)	0.94 (23.9)	5 (127)	4	0.75 (19.1)	6 (152.4)	2.83 (72)	[2]
J7 [2]	3	300	8.25 (209.5)	1.12 (28.6)	5 (127)	8	0.88 (22.4)	6.62 (168.1)	2.83 (72)	[2]
J5 [2]	4	150	9 (228.6)	0.94 (23.9)	6.19 (157.2)	8	0.75 (19.1)	7.5 (190.5)	3.50 (89)	[2]
J8 [2]	4	300	10 (254)	1.25 (31.8)	6.19 (157.2)	8	0.88 (22.4)	7.88 (200.2)	3.50 (89)	[2]

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Alloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Available with 2", 4", 6" or 8" extended diaphragm seal, for extended diaphragm seal diameter and weight see the following table

Version	Nominal diameter	Class	Extended diaphragm seal length (L)	Extended diaphragm seal diameter d_3	Diaphragm seal weight
	[in]	[lb./sq.in]	in (mm)	in (mm)	[kg]
J3	2	150	2 (50.8) / 4 (101.6) / 6 (152.4) / 8 (203.2)	1.9 (48.3)	3.0 / 3.4 / 3.9 / 4.4
J4	3	150	2 (50.8) / 4 (101.6) / 6 (152.4) / 8 (203.2)	2.99 (75.9)	6.0 / 6.6 / 7.1 / 7.8
J7	3	300	2 (50.8) / 4 (101.6) / 6 (152.4) / 8 (203.2)	2.99 (75.9)	7.9 / 8.5 / 9.0 / 9.6
J5	4	150	2 (50.8) / 4 (101.6) / 6 (152.4) / 8 (203.2)	3.7 (94)	8.6 / 9.9 / 11.2 / 12.4
J8	4	300	2 (50.8) / 4 (101.6) / 6 (152.4) / 8 (203.2)	3.7 (94)	13.1 / 14.4 / 15.7 / 16.9

JIS flanges, connection dimensions as per JIS B 2220 BL, raised face RF



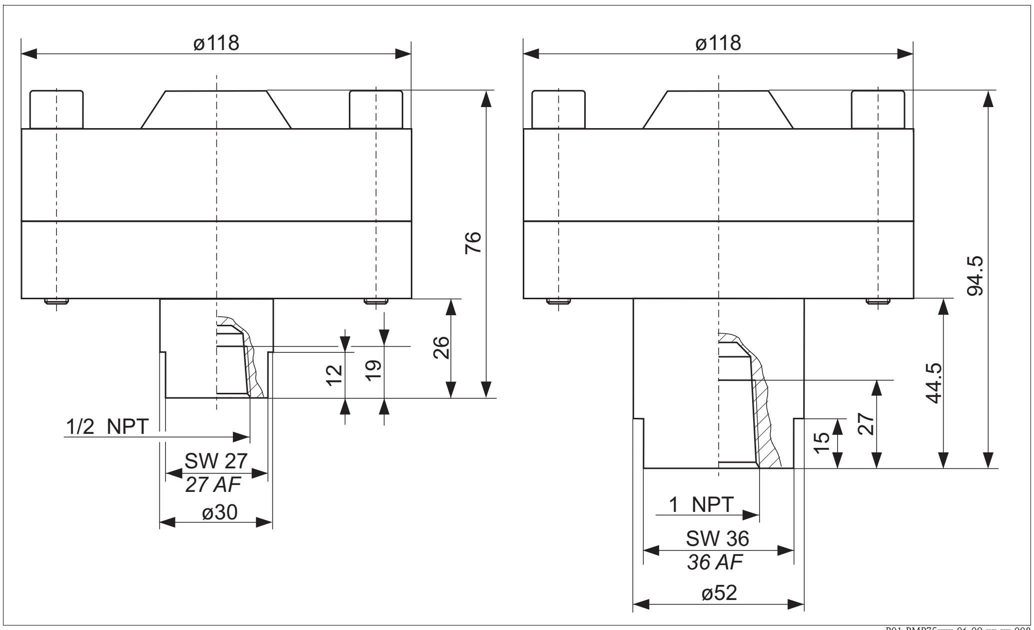
Process connection PMP75, JIS flange with raised face RF, material AISI 316L

	Flange 1)						Boltholes			Diaphragm seal	
Version	**Nominal diameter**	**Nominal pressure**	**Diameter** D [mm]	**Thickness** b [mm]	**Diameter raised face** g [mm]	**Raised face height** f [mm]	**Quantity**	**Diameter** g_2 [mm]	**Hole circle** k [mm]	**Max. diameter of the process isolating diaphragm** d_M [mm]	**Diaphragm seal weight 2)** [kg]
KC	25 A	10 K	125	14	67	1	4	19	90	32	1.5
KF	50 A	10 K	155	16	96	2	4	19	120	59	2.3
KL	80 A	10 K	185	18	127	2	8	19	150	89	3.3
KH	100 A	10 K	210	18	151	2	8	19	175	89	4.4

1) The roughness of the surface in contact with the media, including the raised face of the flanges (all standards) made of Alloy C, Monel or tantalum, is Ra 0.8 µm (31.5 µin). Lower surface roughness on request.

2) Housing weight → 🗎 63

Thread 1/2 NPT and 1 NPT, separator

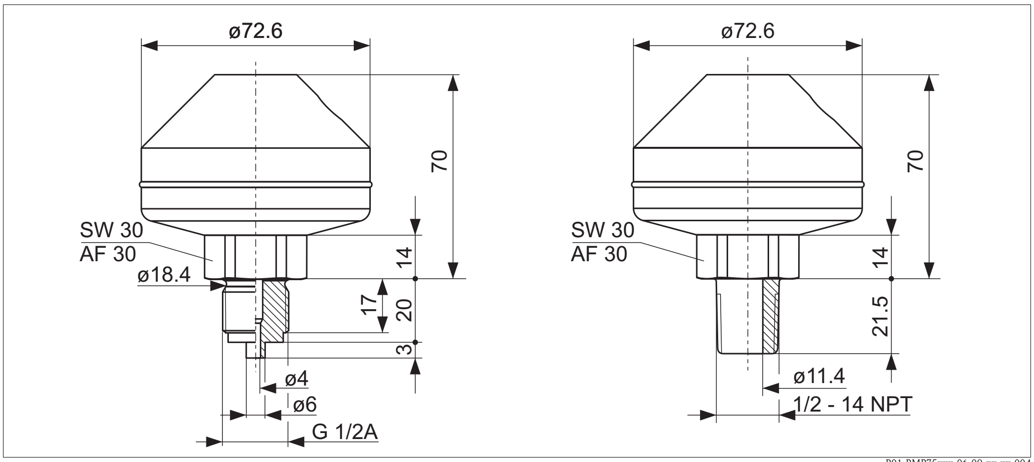


P01-PMP75xxx-06-09-xx-xx-008

Process connection PMP75, versions "UG" and "UH", threaded, material AISI 316L, seal Viton

Version	Description	Nominal pressure	Diaphragm seal weight [kg]
UG	1/2 NPT	PN 250	4.75
UH	1 NPT	PN 250	5.0

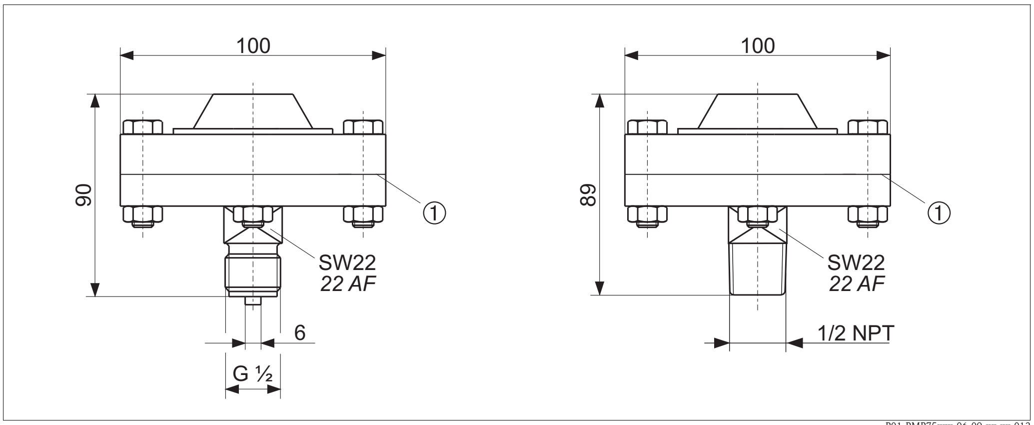
Thread ISO 228 G 1/2 A and ANSI 1/2 MNPT, separator



P01-PMP75xxx-06-09-xx-xx-004

Process connection PMP75, versions "UA" and "UB", welded, material AISI 316L

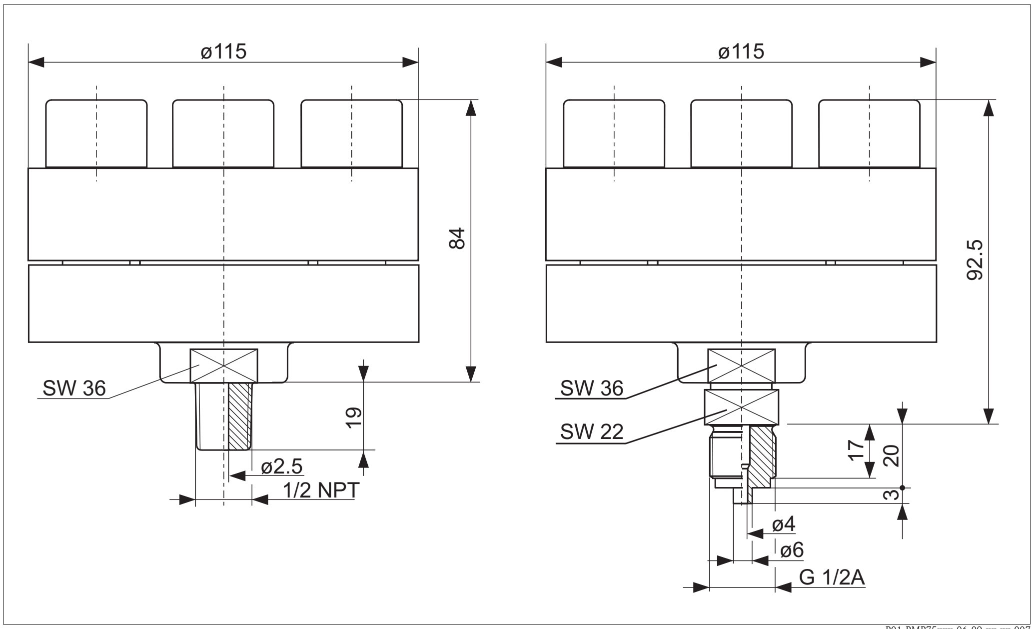
Version	Description	Nominal pressure	Diaphragm seal weight [kg]
UA	ISO 228 G 1/2 A	PN 160	1.43
UB	ANSI 1/2 MNPT	PN 160	1.43



Process connection PMP75, left: version "UC" with threaded connection ISO 228 G 1/2 B, right: version "UD" with threaded connection ANSI 1/2 MNPT
Materials: AISI 316L (1.44.04), screws made of 1.4571

1 PTFE seal as standard max. 260 °C (500 °F) (higher temperatures on request)

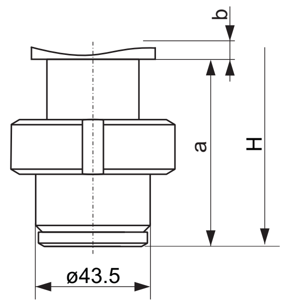
Version	**Measuring range**	**Description**	**Nominal pressure**	**Diaphragm seal weight** [kg]
UC	≤ 40 bar	ISO 228 G 1/2 B	PN 40	1.43
UD	≤ 40 bar	ANSI 1/2 MNPT	PN 40	1.43



Process connection PMP75, versions "UC" and "UD", threaded, with integrated sealing lip
Materials: AISI 316L (1.44.04), screws made of 1.4571

Version	**Measuring range**	**Description**	**Nominal pressure**	**Diaphragm seal weight** [kg]
UC	> 40 bar	ISO 228 G 1/2 A	PN 400	4.75
UD	> 40 bar	ANSI 1/2 MNPT	PN 400	4.75

Universal adapter



P01-PMP75xxx-06-09-xx-xx-014

Process connection PMP75, material: b = top section AISI 316L (1.4404), a = bottom section AISI 316L (1.4435); Surface roughness of the surfaces in contact with the media R_a ≤0.8 µm (31.5 µin) as standard. Lower surface roughness on request.

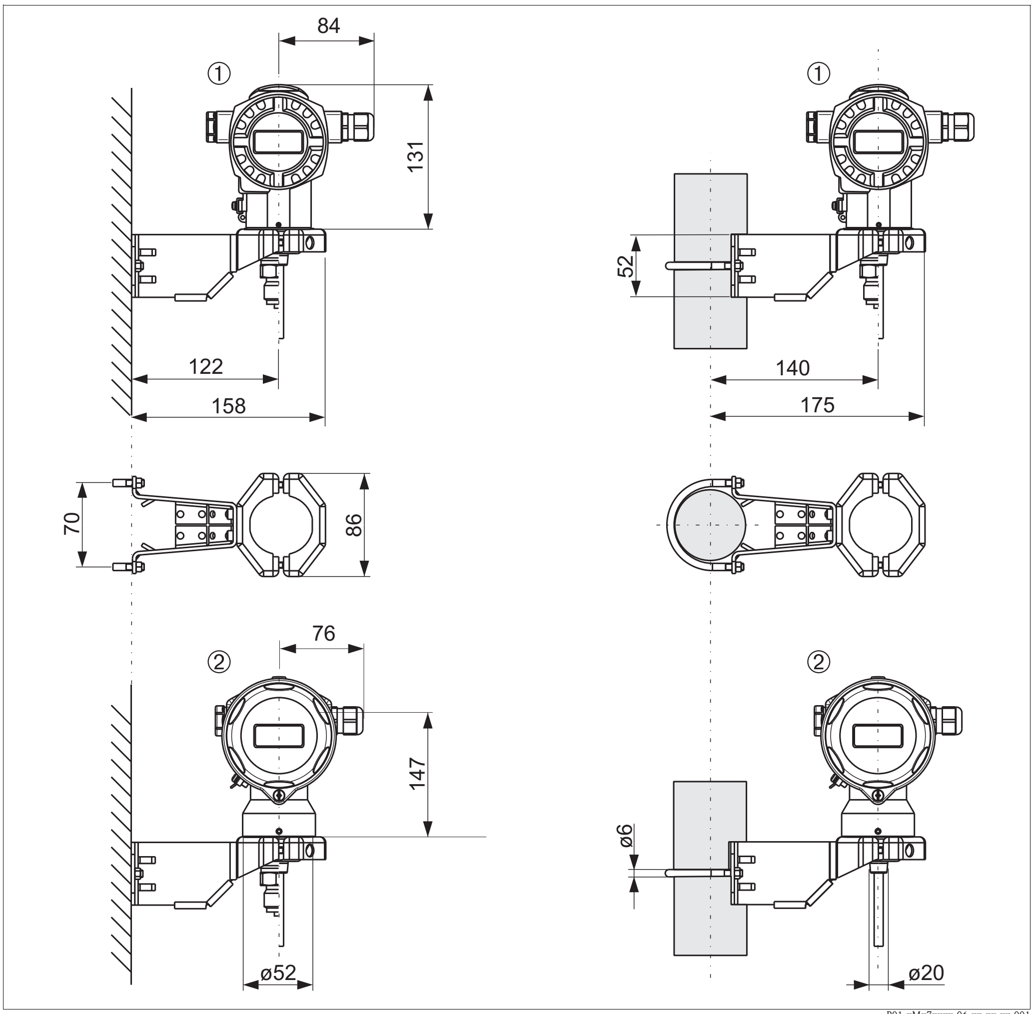
Version 00 [1)]: universal adapter incl. silicone molded seal FDA 21CFR177.2600/USP Class VI-70C, EHEDG, 3A

Installation height H for devices with universal adapter

Description	Device height H, universal adapter
T14 housing, optional display on the side	197 mm (7.76 in)
T15 housing without display, flat cover	203 mm (7.99 in)
T15 housing with display, high cover	215.5 mm (8.48 in)
T17 housing, optional display on the side	213 mm (8.39 in)

1) Endress+Hauser supplies these slotted nuts in stainless steel AISI 304 (DIN/EN material number 1.4301) or in AISI 304L (DIN/EN material number 1.4307).

Wall and pipe mounting with mounting bracket



① *Dimensions of T14 housing, optional display on the side. For the weight, see the following section.*

② *Dimensions of T17 housing, optional display on the side. For the weight, see the following section.*

Weight

Housing

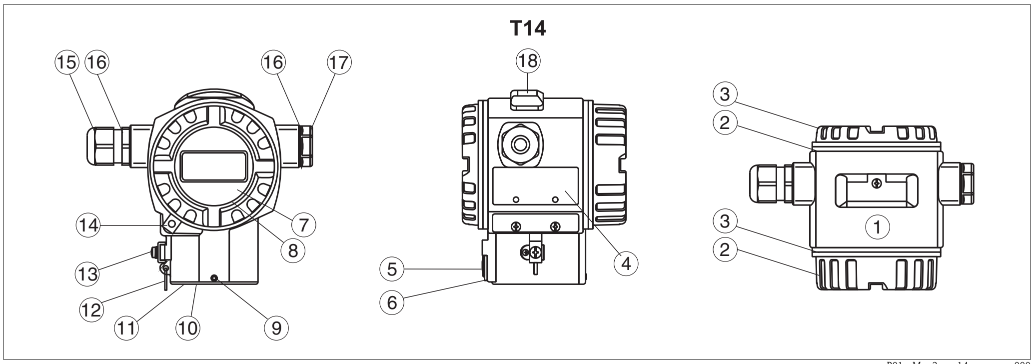
	T14		T17	Separate housing
	Aluminum	**AISI 316L**	**AISI 316L**	
With electronic insert and display	1.2 kg (2.65 lbs)	2.1 kg (4.63 lbs)	1.2 kg (2.65 lbs)	Weight of housing + 0.5 kg (1.10 lbs). Weight of sensor + 0.5 kg (1.10 lbs).
With electronic insert without display	1.1 kg (2.43 lbs)	2.0 kg (4.41 lbs)	1.1 kg (2.43 lbs)	

Process connections

- Process connections PMC71 (with ceramic process isolating diaphragm): → 34 ff
- Process connections PMP71 (with metallic process isolating diaphragm): → 41 ff
- Process connections PMP75 (with diaphragm seal): → 48 ff

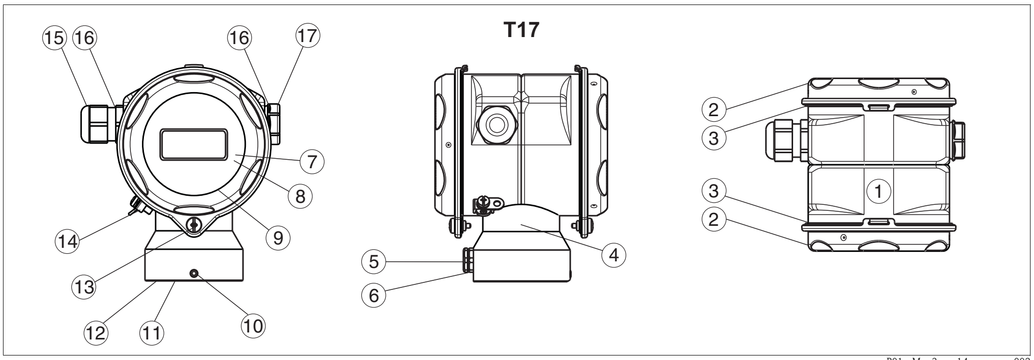
Material (not wetted)

Housing



Front view, left-hand side view, top view

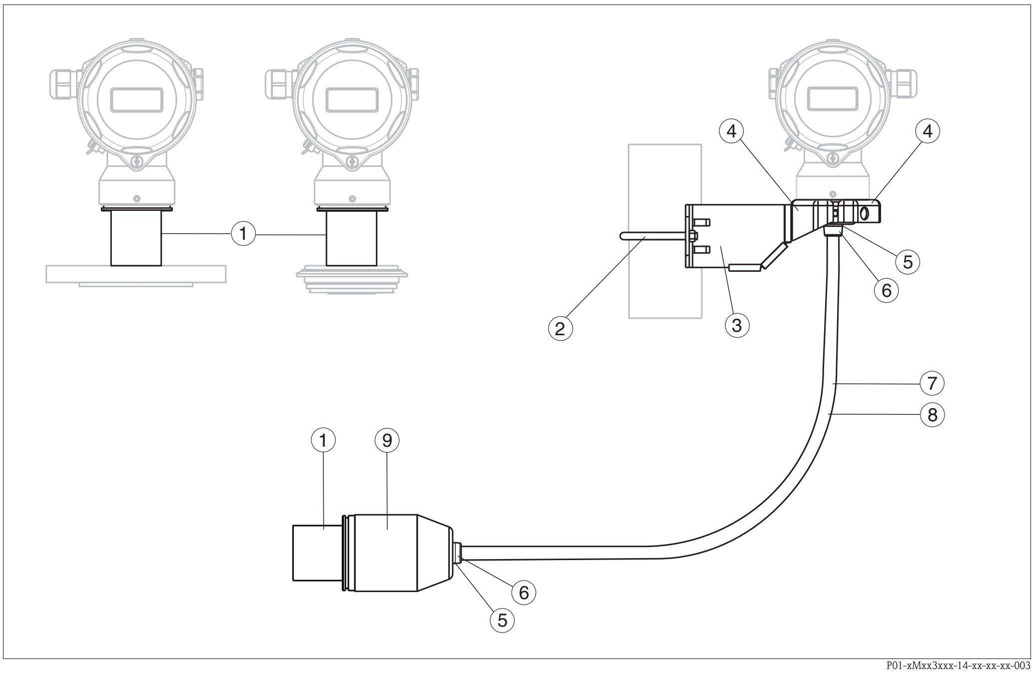
Item number	Component part	Material
1	T14 and T15 housing, RAL 5012 (blue)	Die-cast aluminum with protective powder-coating on polyester base
	T14 housing	Precision casting AISI 316L (1.4435)
2	Cover, RAL 7035 (gray)	Die-cast aluminum with protective powder-coating on polyester base
	Cover	Precision casting AISI 316L (1.4435)
3	Cover seal	EPDM
4	Nameplates	AISI 304 (1.4301)
5	Pressure compensation filter	PA6 GF10
6	Pressure compensation filter, O-ring	Silicone (VMQ)
7	Sight glass	Mineral glass
8	Sight glass seal	Silicone (VMQ)
9	Screw	A4
10	Sealing ring	EPDM
11	Snap ring	PA66-GF25
12	Snap ring for nameplates	AISI 304 (1.4301)/ AISI 316 (1.4401
13	External ground terminal	AISI 304 (1.4301)
14	Cover clamp	Clamp AISI 316L (1.4435, screw A4
15	Cable gland	Polyamide (PA) or CuZn nickel-plated
16	Seal of cable gland and blind plug	Silicone (VMQ)
17	Blind plug	PBT-GF30 FR, for dust ignition-proof: AISI 316L (1.4435)
18	External operation (keys and key cover), RAL 7035 (gray)	Polycarbonate PC-FR, screw A4
	Devices with MID parts certificate	
	Seal wire	DIN 1367-0 St/Zn (soft galvanized steel)
	Seals	Pb (lead)



Front view, left-hand side view, top view

Item number	Component part	Material
1	T17 housing	AISI 316L (1.4404)
2	Cover	
3	Cover seal	EPDM
4	Nameplates	Lasered
5	Pressure compensation filter	PA6 GF10
6	Pressure compensation filter, O-ring	Silicone (VMQ)
7	Sight glass for non-hazardous area, ATEX Ex ia, NEPSI Zone 0/1 Ex ia, IECEx Zone 0/1 Ex ia, FM NI, FM IS, CSA IS	Polycarbonate (PC)
8	Sight glass for ATEX 1/2 D, ATEX 1/3 D, ATEX 1 GD, ATEX 1/2 GD, ATEX 3 G, FM DIP, CSA dust ignition-proof	Mineral glass
9	Sight glass seal	EPDM
10	Screw	A2-70
11	Sealing ring	EPDM
12	Snap ring	PA6
13	Screw	A4-50
14	External ground terminal	AISI 304 (1.4301)
15	Cable gland	Polyamide PA, for dust ignition-proof: CuZn nickel-plated
16	Seal of cable gland and blind plug	Silicone (VMQ)
17	Blind plug	PBT-GF30 FR, for dust ignition-proof: AISI 316L (1.4435)
	Devices with MID parts certificate	
	Seal wire	DIN 1367-0 St/Zn (soft galvanized steel)
	Seals	Pb (lead)

Connecting parts



Front view, left-hand side view, top view

Item number	Component part	Material
1	Connection between the housing and process connection	AISI 316L (1.4404)
2	Mounting bracket	Bracket AISI 304 (1.4301), AISI 304L (1.4306
3		Screw and nuts A2-70
4		Half-shells: AISI 304L (1.4306)
5	Seal for cable from separate housing	EPDM
6	Gland for cable from separate housing	AISI 316L (1.4404)
7	PE cable for separate housing	Abrasion-proof cable with strain-relief Dynema members; shielded using aluminum-coated film; insulated with polyethylene (PE-LD), black; copper wires, twisted, UV-resistant
8	FEP cable for separate housing	Abrasion-proof cable; shielded using galvanized steel wire netting; insulated with fluorinated ethylene propylene (FEP), black; copper wires, twisted, UV-resistant
9	Process connection adapter for separate housing	AISI 316L (1.4404)

Filling oil

See "Ordering information" (→ 🗎 79)

Miscellaneous:

- Diaphragm seal capillary: AISI 316 Ti (1.4571)
- Protective hose for diaphragm seal capillary: AISI 304 (1.4301)

Material (wetted)

Note!
Process-wetted device components are listed in the "Mechanical construction" (→ 🗎 33) and "Ordering information" (→ 🗎 79) sections.

TSE Certificate of Suitability (Transmissible Spongiform Encephalopathy)

The following applies to all process wetted device components:
- They do not contain any materials derived from animals.
- No additives or operating materials derived from animals are used in production or processing.

Process connections

- "Clamp connections" and "Hygienic connections" (see also "Ordering information" section): AISI 316L (DIN/EN material number 1.4435)
- Endress+Hauser supplies process connections with threaded connections and DIN/ EN flanges made of stainless steel as per AISI 316L (DIN/EN material number 1.4404 (AISI 316) or 14435). With regard to their stability-temperature property, the materials 1.4404 and 1.4435 are grouped together under 13E0 in EN 1092-1 Tab.18. The chemical composition of the two materials can be identical.
- Some process connections are also available in the material Alloy C276 (DIN/EN material number 2.4819). See the information in the "Mechanical construction" section.

Process isolating diaphragm

- PMC71: Al_2O_3 aluminum oxide ceramic (FDA 21CFR186.1256, USP Class VI), ultrapure 99.9 % (→ see also www.endress.com/ceraphire)
- PMP71:
  - AISI 316L (DIN/EN material number 1.4435)
  - AISI 316L with gold-rhodium coating
  - Alloy C276 (DIN/EN material number 2.4819)
- PMP75:
  - AISI 316L (DIN/EN material number 1.4435)
  - AISI 316L with gold-rhodium coating
  - AISI 316L with 0.09 mm PTFE foil (not for vacuum applications)
  - AISI 316L with 0.25 mm PTFE foil (not for vacuum applications)
  - Alloy C276 (DIN/EN material number 2.4819)
  - Monel
  - Tantalum

Seals

See ordering information, → 🗎 79 ff

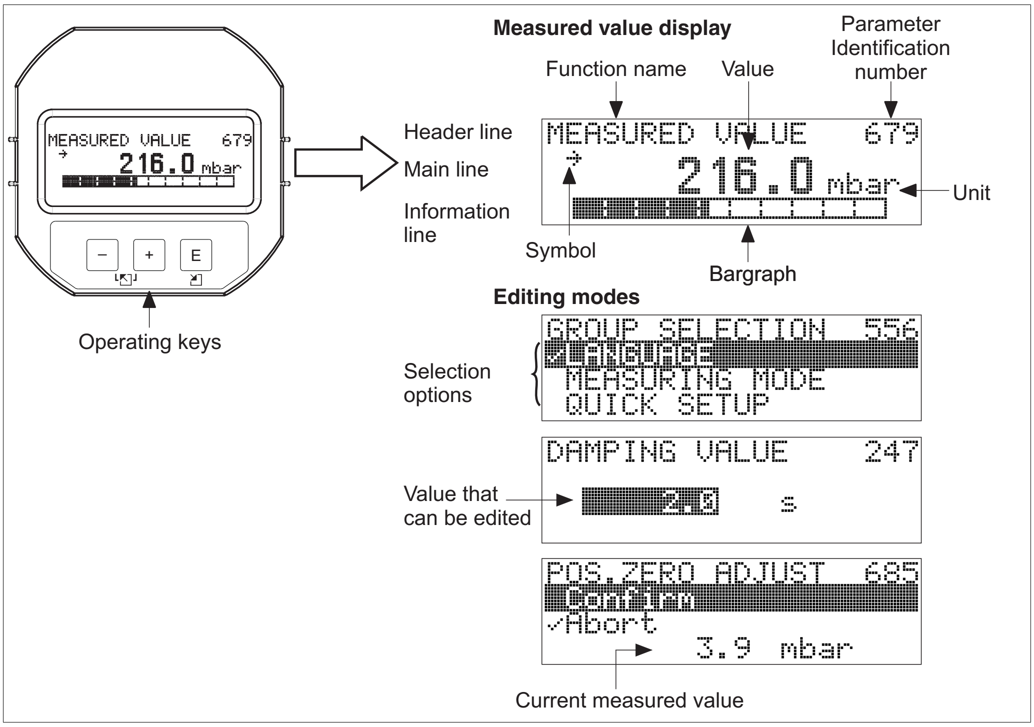
Human interface

Operating elements

Onsite display (optional)

A 4-line liquid crystal display (LCD) is used for display and operation. The onsite display shows measured values, dialog text as well as fault and notice messages in plain text, thereby supporting the user in every stage of operation. The display of the device can be turned in 90° steps.
Depending on the installation position of the device, this makes it easy to operate the device and read the measured value.

Functions:
- 8-digit measured value display including sign and decimal point, bar graph for 4 to 20 mA HART as current display; or for PROFIBUS PA as graphic display of the standardized value of the AI Block; for FOUNDATION Fieldbus as graphic display of the transducer output.
- Simple and complete menu guidance thanks to separation of the parameters into several levels and groups.
- Menu guidance in 8 languages (de, en, fr, es it, nl, jp, ch) for HART and PROFIBUS PA, for FOUNDATION Fieldbus in 6 languages (de, en, fr, es, jp, ch)
- Each parameter is given a 3-digit ID number for easy navigation.
- Option for configuring the display according to individual requirements and preferences, such as language, alternating display, display of other measured values such as sensor temperature, contrast setting.
- Comprehensive diagnostic functions (fault and warning message, peak-hold indicators, etc.).
- Rapid and safe commissioning with the Quick Setup menus.



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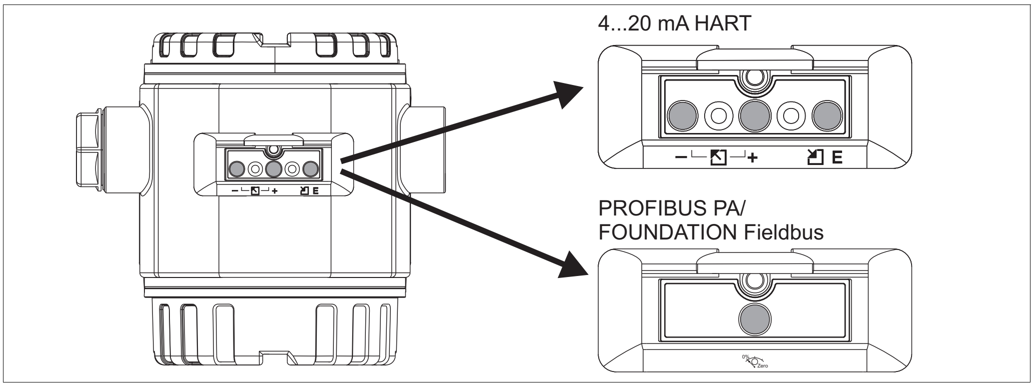
Operating elements

Operating keys on the exterior of the device

With the T14 housing (aluminum or stainless steel), the operating keys are located either outside of the housing, under the protection cap or inside on the electronic insert. With the T17 housing (stainless steel), the operating keys are located inside the housing on the electronic insert.



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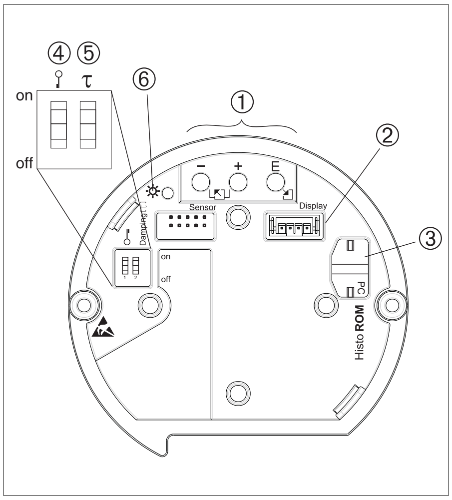
The operating keys located externally on the device work on the Hall sensor principle. As a result, no additional openings are required in the device. This guarantees:

- Complete protection against environmental influences such as moisture and contamination.
- Simple operation without any tools.
- No wear.

Operating keys and elements located internally on the electronic insert



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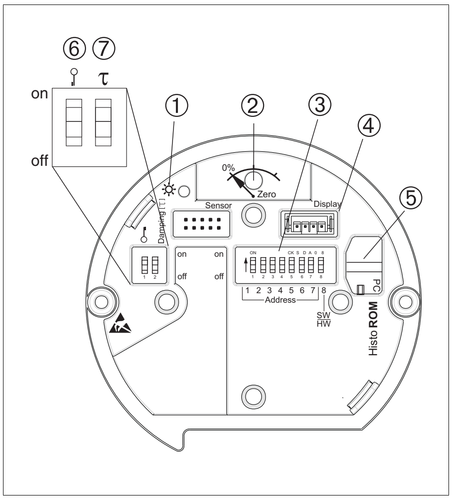
Electronic insert HART

1 *Operating keys*
2 *Slot for optional display*
3 *Slot for optional HistoROM®/M-DAT*
4 *DIP-switch for locking/unlocking parameters relevant to the measured values*
5 *DIP-switch for damping on/off*
6 *Green LED to indicate value being accepted*



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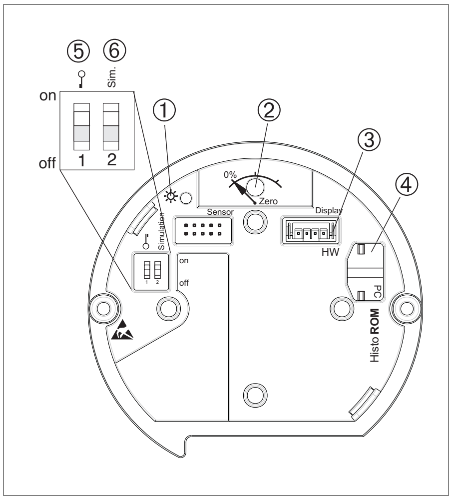
Electronic insert PROFIBUS PA

1 *Green LED to indicate value being accepted*
2 *Key for position adjustment and device reset*
3 *DIP-switch for bus address*
4 *Slot for optional display*
5 *Slot for optional HistoROM®/M-DAT*
6 *DIP-switch for locking/unlocking parameters relevant to the measured values*
7 *DIP-switch for damping on/off*



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Electronic insert FOUNDATION Fieldbus

1 *Green LED to indicate value being accepted*
2 *Key for position adjustment and device reset*
3 *Slot for optional display*
4 *Slot for optional HistoROM®/M-DAT*
5 *DIP-switch for locking/unlocking parameters relevant to the measured values*
6 *DIP-switch for simulation mode on/off*

Local operation

Function	External operation (operating keys, optional, not T17 housing)	Internal operation (electronic insert)	Display (optional)
Position adjustment (zero point correction)	X	X	X
Setting lower-range value and upper-range value - reference pressure present at the device	X (HART only)	X (HART only)	X
Device reset	X	X	X
Locking and unlocking parameters relevant to the measured value	– – –	X	X
Value acceptance indicated by green LED	X	X	X
Switching damping on and off	– – –	X (HART and PA only)	X
Setting bus address (PA)	– – –	X	X
Switching simulation mode on and off (FOUNDATION Fieldbus)	– – –	X	X

Remote operation

Depending on the position of the write protection switch on the device, all software parameters are accessible.

HART

Remote operation via:
- FieldCare (see "Hardware and software for onsite and remote operation" section → 71 ff) with Commubox FXA195 (see "Hardware and software for onsite and remote operation" section → 71 ff)
- Field Xpert SFX100:
  Field Xpert is an industrial PDA with integrated 3.5" touchscreen from Endress+Hauser based on Windows Mobile. It communicates via wireless with the optional VIATOR Bluetooth modem connected to a HART device point-to-point or wireless via WiFi and Endress+Hauser's Fieldgate FXA520. Field Xpert also works as a stand-alone device for asset management applications. For details, refer to BA00060S/04/EN.

PROFIBUS PA

Remote operation via:
- FieldCare (see "Hardware and software for onsite and remote operation" section → 71 ff)
  – Profiboard: For connecting a PC to PROFIBUS
  – Proficard: For connecting a laptop to PROFIBUS

FOUNDATION Fieldbus

Remote operation via:
- Use an FF-configuration program for example NI-FBUS Configurator, to
  – connect devices with "FOUNDATION Fieldbus signal" into an FF-network
  – set FF-specific parameters
  Operation with NI-FBUS Configurator:
  The NI-FBUS Configurator is an easy-to-use graphical environment for creating linkages, loops, and a schedule based on the fieldbus concepts.
  You can use the NI-FBUS Configurator to configure a fieldbus network as follows:
  – Set block and device tags
  – Set device addresses
  – Create and edit function block control strategies (function block applications)
  – Configure vendor-defined function and transducer blocks
  – Create and edit schedules
  – Read and write to function block control strategies (function block applications)
  – Invoke Device Description (DD) methods
  – Display DD menus
  – Download a configuration
  – Verify a configuration and compare it to a saved configuration
  – Monitor a downloaded configuration

- Replace a virtual device by a real device
- Save and print a configuration

Note!
For further information please contact your local Endress+Hauser Sales Center.

Hardware and software for onsite and remote operation

Commubox FXA195

For intrinsically safe HART communication with FieldCare via the USB interface. For details refer to TI404F/00/EN.

Commubox FXA291

The Commubox FXA291 connects Endress+Hauser field devices with a 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 devices you need the "ToF adapter FXA291" as an additional accessory:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70

ToF adapter FXA291

The ToF adapter FXA291 connects the Commubox FXA291 with devices of the ToF platform, pressure equipment and the Gammapilot via the USB port of a computer or laptop. For details refer to KA271F.

Field Xpert SFX100

Compact, flexible and robust industry handheld terminal for remote parametrization and measured value inspection via the HART current output (4-20mA).
For details refer to Operating Instructions BA00060S/04/EN.

HistoROM®/M-DAT (optional)

HistoROM®/M-DAT is a memory module which can be attached to every electronic insert. The HistoROM®/M-DAT can be retrofitted at any stage (order number: 52027785).

Your benefits

- Quick and safe commissioning of the same measuring points by copying the configuration data of one transmitter to another transmitter.
- Reliable process monitoring thanks to cyclical recording of pressure and sensor temperature measured values.
- Simple diagnosis by recording diverse events such as alarms, configuration changes, counters for measuring range undershoot and overshoot for pressure and temperature as well as user limit overshoot and undershoot for pressure and temperature etc.
- Analysis and graphic evaluation of the events and process parameters via software (contained in scope of supply).

HistoROM®/M-DAT can be ordered via feature 100 "Additional option 1" or feature 110 "Additional option 2" or as a spare part. → 🗎 79 ff. A CD with an Endress+Hauser operating program is also included in the scope of delivery.
You can copy data from one transmitter to another transmitter when operating a FOUNDATION Fieldbus device via an FF configuration program. You need the Endress+Hauser FieldCare operating program and the Commubox FXA291 service interface and the ToF adapter FXA291 to be able to access the data and events saved in the HistoROM®/M-DAT.
FieldCare and the service interface Commubox FXA291 and the ToF adapter FXA291.

FieldCare

FieldCare is an Endress+Hauser asset management tool based on FDT technology. With FieldCare, you can configure all Endress+Hauser devices as well as devices from other manufacturers that support the FDT standard.

FieldCare supports the following functions:
- Configuration of transmitters in offline and online mode

- Loading and saving device data (upload/download)
- HistoROM®/M-DAT analysis
- Documentation of the measuring point

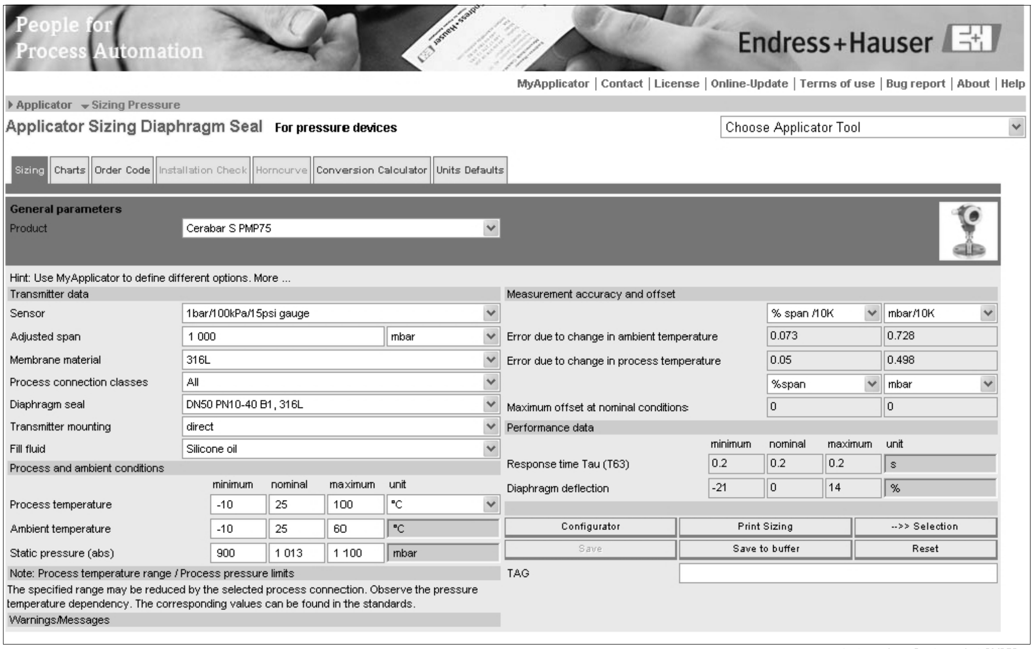
Connection options:
- HART via Commubox FXA195 and the USB port on a computer
- PROFIBUS PA via segment coupler and PROFIBUS interface card

- Service interface with Commubox FXA291 and ToF adapter FXA291 (USB).

For further information → www.endress.com

Planning instructions, diaphragm seal systems

Note!
The performance and the permitted range of application of a diaphragm seal system depend on the process isolating diaphragm used, the filling oil, the coupling, the unit design and on the process and ambient conditions present in the individual application.
To help you select the right diaphragm seal system for your applications, Endress+Hauser provides its customers with the free "Applicator Sizing Diaphragm Seal" tool, which is available on CD or online at "www.endress.com/applicator".



Applicator Sizing Diaphragm Seal PMP75-en

For more detailed information or the layout of the optimum diaphragm seal solution for your application, please contact your local Endress+Hauser Sales Center.

Applications

Diaphragm seal systems should be used if the process and the device should be separated. Diaphragm seal systems offer clear advantages in the following instances:

- In the case of extreme process temperatures
- For aggressive media
- In the case of process media that crystallize
- In the case of corrosive or highly various process media or process media with solids content
- In the case of heterogeneous and fibrous process media
- If extreme measuring point cleaning is necessary, or for very humid mounting locations
- If the measuring point is exposed to severe vibrations
- For mounting locations that are difficult to access

Design and operation mode

Diaphragm seals are separating equipment between the measuring system and the process.

A diaphragm seal system consists of:

- A diaphragm seal
- A capillary tube or temperature isolator if necessary
- Fill fluid
- A pressure transmitter

The process pressure acts via the process isolating diaphragm of a diaphragm seal on the liquid-filled system, which transfers the process pressure onto the sensor of the pressure transmitter.
Endress+Hauser delivers all diaphragm seal systems as welded versions. The system is hermetically sealed, which ensures the highest reliability.

The diaphragm seal determines the application range of the system by:

- The process isolating diaphragm diameter
- The process isolating diaphragm stiffness and material
- The design (oil volume)

Diameter of the process isolating diaphragm

The greater the diameter of the process isolating diaphragm (less stiff), the smaller the temperature effect on the measurement result.

Process isolating diaphragm stiffness

The stiffness depends on the diameter of the process isolating diaphragm, the material, any existing coating and the thickness and shape of the process isolating diaphragm. The process isolating diaphragm thickness and the shape are determined by the design. The stiffness of a process isolating diaphragm of a diaphragm seal influences the temperature operating range and the measuring error caused by temperature effects.

Capillary

Capillaries with an internal diameter of 1 mm (0.04 in) are used as standard.
The capillary tube influences the thermal change, the ambient temperature operating range and the response time of a diaphragm seal system as a result of its length and internal diameter.

Filling oil

When selecting the filling oil, the media and ambient temperature as well as the operating pressure are of crucial importance. Observe the temperatures and pressures during commissioning and cleaning. A further selection criterion is the compatibility of the filling oil with the requirements of the process media. For this reason, only filling oils that are harmless to health are used in the food industry, such as vegetable oil or silicone oil.
→ See also the following section "Diaphragm seal filling oils".
The filling oil used influences the thermal change, the temperature operating range of a diaphragm seal system and the response time. A temperature change results in a volume change of the filling oil. The volume change is dependent on the expansion coefficient and the volume of the filling oil at calibration temperature (constant in the range: +21 to +33 °C (+70 to 91 °F)).
For example, the filling oil expands in the event of a temperature increase. The additional volume presses against the process isolating diaphragm of a diaphragm seal. The stiffer a diaphragm is, the greater its return force, which counteracts a volume change and acts on the measuring cell together with the operating pressure, thus shifting the zero point.

Pressure transmitter

The pressure transmitter influences the temperature operating range, the T_K zero point and the response time as a result of its volume change. The volume change is the volume that has to be shifted to pass through the complete measuring range.
Pressure transmitters from Endress+Hauser are optimized with regard to minimum volume change.

Diaphragm seal filling oils

Version [1]	Filling oil	Permissible temperature range [2] at 0.05 bar (0.725 psi) ≤ p_{abs} ≤ 1 bar (14.5 psi)	Permissible temperature range [2] at p_{abs} ≥ 1 bar (14.5 psi)	Density [g/cm³] / [SGU]	Viscosity [mm²/s] / [cSt] at 25 °C (77 °F)]	Coefficient of thermal expansion [1/K]	Notes
A, H, 1 or 2	Silicone oil	–40 to +180°C (–40 to +356°F)	–40 to +250°C (–40 to +482 °F)	0.96	100	0.00096	Suitable for foods FDA 21 CFR 175.105
G, 3 or 4	High-temperature oil	–10 to +200°C (+14 to +392 °F)	–10 to +400°C (+14 to +752 °F)	1.07	37	0.0007	High temperatures
F or N	Inert oil	–40 to +80°C (–40 to +176 °F)	–40 to +175°C (–40 to +347 °F)	1.87	27	0.000876	For ultrapure gas and oxygen applications
D, 5 or 6	Vegetable oil	–10 to +120°C (+14 to +248 °F)	–10 to +200°C (+14 to +392 °F)	0.94	9.5	0.00101	Suitable for foods FDA 21 CFR 172.856
7 or 8	Low-temperature oil	–70 to +80°C (–94 to +176 °F)	–70 to +180°C (–94 to +356 °F)	0.92	4.4	0.00108	Low temperatures

1) Version for feature 90 in the order code (→ 🗎 87 ff)

2) Observe temperature limits of the device (→ 🗎 31) and the system (→ 🗎 73).

Installation instructions

Diaphragm seal systems

- Endress+Hauser offer flushing rings as accessories to clean process isolating diaphragms without taking the transmitters out of the process.
  For further information please contact your local Endress+Hauser Sales Center.
- The diaphragm seal together with the transmitter form a closed, calibrated system, which is filled through ports in the diaphragm seal and in the measuring system of the transmitter. These ports are sealed and must not be opened.
- For devices with a temperature isolator or capillary, a suitable fastening device (mounting bracket) is recommended.
- For more detailed installation instructions, Endress+Hauser provides its customers with the free "Applicator Sizing Diaphragm Seal" tool, which is available on CD or can be downloaded online at "www.endress.com/applicator".

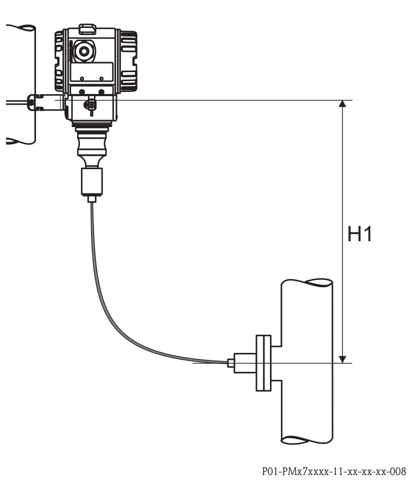
Capillary

In order to obtain more precise measurement results and to avoid a defect in the device, mount the capillaries as follows:
- vibration-free (in order to avoid additional pressure fluctuations)
- not in the vicinity of heating or cooling lines
- insulate if the ambient temperature is below or above the reference temperature
- with a bending radius of ≥ 100 mm (3.94 in).
- When using diaphragm seal systems with capillaries, sufficient strain relief must be allowed for in order to prevent the capillary bending down (capillary bending radius ≥ 100 mm (3.94 in)).
- In the case of devices with diaphragm seals and capillaries, the zero point shift caused by the hydrostatic pressure of the filling liquid column in the capillaries must be taken into account when selecting the measuring cell. If a measuring cell with a small measuring range is selected, a position adjustment can cause range violation.

Vacuum applications

For applications under vacuum, Endress+Hauser recommends mounting the pressure transmitter below the diaphragm seal. This prevents vacuum load of the diaphragm seal caused by the presence of fill fluid in the capillary.

When the pressure transmitter is mounted above the diaphragm seal, the maximum height difference H1 in accordance with the illustration below must not be exceeded. The maximum height difference is dependent on the density of the filling oil and the smallest ever pressure that is permitted to occur at the diaphragm seal (empty tank), see the following illustration, on the right.



Installation above the diaphragm seal

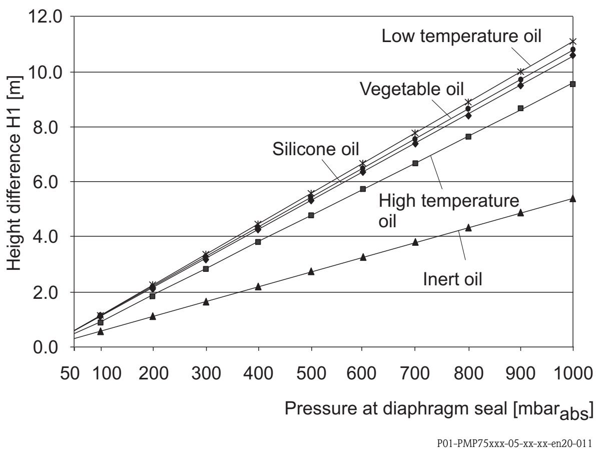
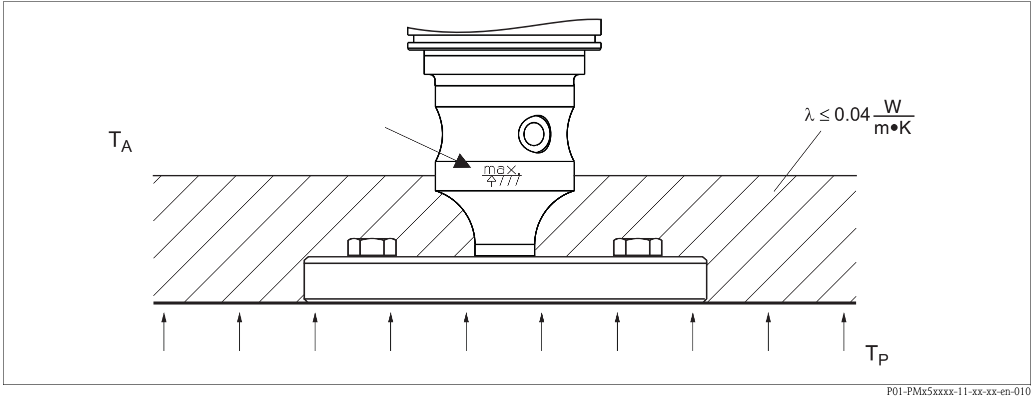


Diagram of maximum installation height above the diaphragm seal for vacuum applications

Heat insulation

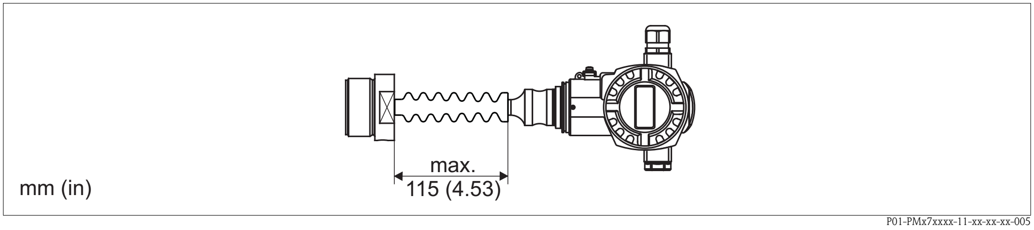
The PMP75 must only be insulated up to a certain height. The maximum permitted insulation height is indicated on the devices and applies to an insulation material with a heat conductivity ≤ 0.04 W/(m x K) and to the maximum permitted ambient and process temperature. The data were determined under the most critical application "quiescent air".



Maximum insulation height, here indicated on a PMP75 with a flange

Mounting with temperature isolator

Endress+Hauser recommends the use of temperature isolators in the event of constant extreme media temperatures which cause the maximum permissible electronics temperature of +85 °C (185 °F) to be exceeded. Depending on the filling oil used, diaphragm seal systems with temperature isolators can be used for maximum temperatures of up to 260 °C (500 °F). → Temperature application limits, see → 🗎 75, "Diaphragm seal filling oils" section.
To minimize the influence of rising heat, Endress+Hauser recommends the device be mounted horizontally or with the housing pointing downwards.
The additional installation height also brings about a zero point shift of maximum 21 mbar (0.315 psi) due to the hydrostatic column in the temperature isolator. You can correct this zero point shift at the device.



PMP75 with temperature isolator, material 316L (1.4404)

Certificates and approvals

CE mark

The device meets the legal requirements of the relevant EC directives.
Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

Ex approvals

- ATEX
- FM
- CSA
- NEPSI
- IECEx
- TIIS
- GOST
- Also combinations of different approvals

All explosion protection data are given in separate documentation which is available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.
→ 91 ff, "Safety Instructions" and "Installation/Control Drawings" sections.

Suitability for hygienic processes

The Cerabar S is suitable for use in hygienic processes.
Overview of suitable process connections from Page 34.
Many versions meet the requirements of 3A-Sanitary Standard No. 74 and are certified by the EHEDG.
Suitable fittings and seals must be used to ensure hygiene-compliant design according to the specifications of 3A and EHEDG.

Note!
The gap-free connections can be cleaned without residue using the usual cleaning methods.

CERTIFIED HYGIENIC ENGINEERING & DESIGN GROUP EHEDG EUROPEAN
TYPE EL
October 2007

3A ®
74 -

Marine certificate

- GL
- ABS

Functional safety SIL/ IEC 61508 Declaration of Conformity (optional)

The Cerabar S devices with a 4 to 20 mA output signal have been developed in accordance with the IEC 61508 standard. These devices can be used to monitor the process level and pressure up to SIL 3.
For a detailed description of the safety functions with Cerabar S, settings and functional safety data, see the "Functional safety manual - Cerabar S" SD00190P.
For devices up to SIL 3 / IEC 61508 Declaration of Conformity, see → 79 ff, feature 100 "Additional option 1" and feature 110 "Additional option 2" version E "SIL / IEC 61508 Declaration of Conformity".

Overfill prevention

WHG: ZE00260P/00/DE

CRN approvals

Some device versions have CRN approval. For a CRN-approved device, a CRN-approved process connection (→ 33 ff, "Process connection") has to be ordered with a CSA approval (→ 79 ff, feature 10 "Approval"). PMP75 devices with a capillary are not CRN-approved. These devices are fitted with a separate plate bearing the registration number 0F10525.5C.

Pressure Equipment Directive (PED)

The devices PMC71, PMP71 and PMP75 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.

The following also applies:
- PMP71 with threaded connection and internal process isolating diaphragm PN > 200 as well as oval flange adapter PN > 200:
  Suitable for stable gases in group 1, category I
- PMP75 with pipe diaphragm seal ≥ 1.5"/PN 40:
  Suitable for stable gases in group 1, category II
- PMP75 with separators PN > 200 ≥ 1.5"/PN40:
  Suitable for stable gases in group 1, category I
- PMP75 with threaded connection PN > 200

Drinking water approval

PMC71/PMP71: NSF 61 approval

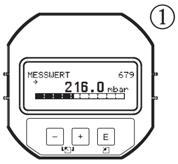
Standards and guidelines	DIN EN 60770 (IEC 60770): Transmitters for use in industrial-process control systems Part 1: Methods for performance evaluation DIN 16086: Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets EN 61326-X: EMC product family standard for electrical equipment for measurement, control and laboratory use. WELMEC guide 8.8 “General and Administrative Aspects of the Voluntary System of Modular Evaluation of Measuring instruments under the MID”. OIML R117-1 Edition 2007 (E) “Dynamic measuring systems for liquids other than water”. EN 12405-1/A1 Edition 2006 “Gas meters – Conversion devices – Part 1: Volume conversion”.
Approvals for custody transfer	All aspects of OIML R117-1 Edition 2007 (E) and EN 12405-1/A1 Edition 2006 are fulfilled.
MID Parts Certificate	TC7975
North-American practice for installation of process seals	Endress+Hauser instruments are designed according to ANSI/ISA 12.27.01 either as single seal or dual seal devices with annunciation, allowing the user to waive the use and save the cost of installing external secondary process seals in the conduit as required by the process sealing sections of ANSI/NFPA 70 (NEC) and CSA 22.1 (CEC). These instruments comply with the North-American installation practice and provide a very safe and cost-saving installation for pressurized applications with hazardous fluids. Further information can be found in the control drawings of the relevant devices.

Ordering information

PMC71

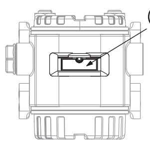
This overview does not mark options which are mutually exclusive.

①

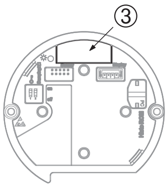


10	Approval:
A	For non-hazardous areas
E	Combined certificates ATEX II Ex ia + FM IS + CSA IS ATEX II 1/2G Ex ia IIC T6 + FM/CSA IS Class I, II, III Division 1 Group A - G
1	ATEX II 1/2 G Ex ia IIC T6
6	ATEX II 1/2 G Ex ia IIC T6, Overfill prevention WHG
2	ATEX II 1/2 D Ex ia IIC T6
8	ATEX II 1 GD Ex ia IIC T6
3	ATEX II 1/2 GD Ex ia IIC T6
5	ATEX II 2 G Ex d ia IIC T6 Gb
7	ATEX II 3 G Ex nA II T6
S	FM IS, Class I, II, III Division 1, Groups A – G; NI Class I Division 2, Groups A – D; AEx ia
T	FM XP, Class I Division 1, Groups A – D; AEx d
R	FM NI, Class I, Division 2, Groups A – D
U	CSA IS, Class I, II, III Division 1, Groups A – G; Class I Division 2, Groups A – D, Ex ia
V	CSA XP, Class I Division 1, Groups B – D; Ex d
G	NEPSI Ex d[ia] IIC T4/T6
H	NEPSI Ex ia IIC T6
L	TIIS Ex d (ia) IIC T6
M	TIIS Ex d (ia) IIC T4
I	IECEx Zone 0/1 Ex ia IIC T6
B	IEC Ex d (ia) IIC T6 Gb

②

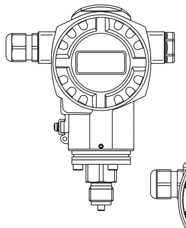


③

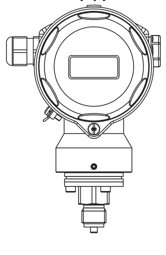


20	Output; Operation:
A	4 to 20 mA HART, operation outside, LCD (→ see Fig. ①, ②)
B	4 to 20 mA HART, operation inside, LCD (→ see Fig. ①, ③)
C	4 to 20 mA HART, operation inside (→ see Fig. ③)
M	PROFIBUS PA, operation outside, LCD (→ see Fig. ①, ②)
N	PROFIBUS PA, operation inside, LCD (→ see Fig. ①, ③)
O	PROFIBUS PA, operation inside (→ see Fig. ③)
P	FOUNDATION Fieldbus, operation outside, LCD (→ see Fig. ①, ③)
Q	FOUNDATION Fieldbus, operation inside, LCD (→ see Fig. ①, ③)
R	FOUNDATION Fieldbus, operation inside (→ see Fig. ③)

T14



T17



30	Housing; Cable entry; Protection:
A	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Gland M 20x1.5
B	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread G 1/2
C	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread 1/2 NPT
D	Aluminum T14 housing, optional display on the side, IP66/67/NEMA 4X/ 6P, M 12x1 PA plug,
E	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, 7/8" FF plug
F	Aluminum T14 housing, optional display on the side, IP 65/NEMA 4X, Han7D plug, 90°
1	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Gland M 20x1.5
2	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread G 1/2
3	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread 1/2 NPT
4	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, M 12x1 PA plug
5	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, 7/8" FF plug
6	AISI 316L T14 housing, optional display on the side, IP 65/NEMA 4X, Han7D plug, 90°
R	T17 316L Hygiene IP66/68 NEMA6P; M20 gland, T17 = side cover
S	T17 316L Hygiene IP66/68 NEMA6P; G1/2 thread, T17 = side cover
T	T17 316L Hygiene IP66/68 NEMA6P; NPT1/2 thread, T17 = side cover
U	T17 316L Hygiene IP66/67 NEMA6P; M12 plug, T17 = side cover
V	T17 316L Hygiene IP66/68 NEMA6P; 7/8" plug, T17 = side cover

40 Sensor range; Sensor over pressure limit (= OPL):

Sensors for gauge pressure

Measurement limits: –100 % (–1 bar) to +100 % of sensor nominal value

	Sensor rated value (URL)	OPL (over pressure limit)
1C	100 mbar/10 kPa/1.5 psi g	4 bar/400 kPa/60 psi g
1E	250 mbar/25 kPa/3.75 psi g	5 bar/500 kPa/75 psi g
1F	400 mbar/40 kPa/6 psi g	8 bar/800 kPa/120 psi g
1H	1 bar/100 kPa/15 psi g	10 bar/1 MPa/150 psi g
1K	2 bar/200 kPa/30 psi g	18 bar/1.8 MPa/270 psi g
1M	4 bar/400 kPa/60 psi g	25 bar/2.5 MPa/375 psi g

40				Sensor range; Sensor over pressure limit (= OPL):		
				1P	10 bar/1 MPa/150 psi g	40 bar/4 MPa/600 psi g
				1S	40 bar/4 MPa/600 psi g	60 bar/6 MPa/900 psi g
				Sensors for absolute pressure		
					Sensor rated value (URL)	**OPL (over pressure limit)**
				2C	100 mbar/10 kPa/1.5 psi abs	4 bar/400 kPa/60 psi abs
				2E	250 mbar/25 kPa/3.75 psi abs	5 bar/500 kPa/75 psi abs
				2F	400 mbar/40 kPa/6 psi abs	8 bar/800 kPa/120 psi abs
				2H	1 bar/100 kPa/15 psi abs	10 bar/1 MPa/150 psi abs
				2K	2 bar/200 kPa/30 psi abs	18 bar/1.8 MPa/270 psi abs
				2M	4 bar/400 kPa/60 psi abs	25 bar/2.5 MPa/375 psi abs
				2P	10 bar/1 MPa/150 psi abs	40 bar/4 MPa/600 psi abs
				2S	40 bar/4 MPa/600 psi abs	60 bar/6 MPa/900 psi abs

50					Calibration; Unit:	
					1	Sensor range; mbar/bar
					2	Sensor range; kPa/MPa
					3	Sensor range; mmH_2O/mH_2O
					4	Sensor range; inH_2O/ftH_2O
					6	Sensor range; psi
					B	Customer-specific; see additional specification
					C	Factory calibration certificate, 5-point; see additional specification
					D	DKD/DAkkS certificate; see additional specification
					E	Customised pressure; see additional specification
					F	Customised level; see additional specification
					H	Customised pressure + 5-point works calibration certificate; see additional specification
					I	Customised level + 5-point works calibration certificate; see additional specification
					K	Platinum; see additional specification
					L	Platinum and factory calibration certificate, 5-point; see additional specification
					M	Platinum and DKD/DAkkS certificate; see additional specification

70						Process connection; Material:	
							Thread, internal process isolating diaphragm
						GA	Thread ISO 228 G 1/2 A EN 837, AISI 316L (CRN)
						GB	Thread ISO 228 G 1/2 A EN 837, Alloy C (CRN)
						GC	Thread ISO 228 G 1/2 A EN 837, Monel
						GD	Thread ISO 228 G 1/2 A EN 837, PVDF (max. 15 bar/225 psi, –10 to +60°C/+14 to +140°F)
						GE	Thread ISO 228 G 1/2 A G 1/4 (female), AISI 316L (CRN)
						GF	Thread ISO 228 G 1/2 A G 1/4 (female), Alloy C (CRN)
						GG	Thread ISO 228 G 1/2 A G 1/4 (female), Monel
						GH	Thread ISO 228 G 1/2 A hole 11.4 mm, AISI 316L (CRN)
						GJ	Thread ISO 228 G 1/2 A hole 11.4 mm, Alloy C (CRN)
						GK	Thread ISO 228 G 1/2 A hole 11.4 mm, Monel
						RA	Thread ANSI 1/2 MNPT 1/4 FNPT, AISI 316L (CRN)
						RB	Thread ANSI 1/2 MNPT 1/4 FNPT, Alloy C (CRN)
						RC	Thread ANSI 1/2 MNPT 1/4 FNPT, Monel
						RD	Thread ANSI 1/2 MNPT, hole 11.4 mm, AISI 316L (CRN)
						RE	Thread ANSI 1/2 MNPT, hole 11.4 mm, Alloy C (CRN)
						RF	Thread ANSI 1/2 MNPT, hole 11.4 mm, Monel
						RG	Thread ANSI 1/2 MNPT hole 3 mm, PVDF (max. 15 bar/225 psi, –10 to +60°C/+14 to +140°F)
						RH	Thread ANSI 1/2 FNPT, AISI 316L (CRN)
						RJ	Thread ANSI 1/2 FNPT, Alloy C
						RK	Thread ANSI 1/2 FNPT, Monel
						GL	Thread JIS B0202 G 1/2 (male), AISI 316L
						RL	Thread JIS B0203 R 1/2 (male), AISI 316L
						GP	Thread DIN 13 M 20x1.5 EN 837 hole 3 mm, AISI 316L
						GQ	Thread DIN 13 M 20x1.5 EN 837 hole 3 mm, Alloy C
							Thread, flush-mounted process isolating diaphragm
						1G	Thread ISO 228 G 1 1/2 A, AISI 316L
						1H	Thread ISO 228 G 1 1/2 A, Alloy C
						1J	Thread ISO 228 G 1 1/2 A, Monel
						1K	Thread ISO 228 G 2 A, AISI 316L
						1L	Thread ISO 228 G 2 A, Alloy C
						1M	Thread ISO 228 G 2 A, Monel
						2D	Thread ANSI 1 1/2 MNPT, AISI 316L (CRN)
						2E	Thread ANSI 1 1/2 MNPT, Alloy C (CRN)
						2F	Thread ANSI 1 1/2 MNPT, Monel (CRN)
						2G	Thread ANSI 2 MNPT, AISI 316L (CRN)

70						Process connection; Material:	
						2H	Thread ANSI 2 MNPT, Alloy C
						2J	Thread ANSI 2 MNPT, Monel
						1R	Thread DIN 13 M 44x1.25, AISI 316L
						1S	Thread DIN 13 M 44x1.25, Alloy C
							EN/DIN flanges, flush-mounted process isolating diaphragm
						BA	DN 25 PN10-40 B1, AISI 316L
						CP	DN 32 PN 10-40 B1, AISI 316L
						CQ	DN 40 PN 10-40 B1, AISI 316L
						BR	DN 50 PN 10-16 A, PVDF (max. 15 bar/225 psi, –10 to +60°C/+14 to +140°F)
						B3	DN 50 PN 10-40 B1, AISI 316L
						C3	DN 50 PN 63 B2, AISI 316L
						BS	DN 80 PN 10-16 A, PVDF (max. 15 bar/225 psi, –10 to +60°C/+14 to +140°F)
						B4	DN 80 PN 10-40 B1, AISI 316L
							ANSI flanges, flush-mounted process diaphragms
						AA	1" 150 lbs RF, AISI 316/316L
						AB	1" 300 lbs RF, AISI 316/316L
						AE	1 1/2" 150 lbs RF, AISI 316/316L (CRN)
						AQ	1 1/2" 300 lbs RF, AISI 316/316L (CRN)
						AF	2" 150 lbs RF, AISI 316/316L (CRN)
						JR	2" 150 lbs RF, AISI 316/316L with ECTFE-coating
						A3	2" 150 lbs RF, PVDF (max. 15 bar/225 psi, –10 to +60°C/+14 to +140°F)
						AR	2" 300 lbs RF, AISI 316/316L (CRN)
						AG	3" 150 lbs RF, AISI 316/316L (CRN)
						JS	3" 150 lbs RF, AISI 316/316L with ECTFE-coating
						A4	3" 150 lbs RF, PVDF (max. 15 bar/225 psi, –10 to +60°C/+14 to +140°F)
						AS	3" 300 lbs RF, AISI 316/316L (CRN)
						AH	4" 150 lbs RF, AISI 316/316L (CRN)
						JT	4" 150 lbs RF, AISI 316/316L with ECTFE-coating
						AT	4" 300 lbs RF, AISI 316/316L (CRN)
							JIS flanges, flush-mounted process isolating diaphragm
						KF	10K 50A RF, AISI 316L
						KL	10K 80A RF, AISI 316L
						KH	10K 100A RF, AISI 316L
							Hygienic connections, flush-mounted process isolating diaphragm
						MP	DIN 11851 DN 40 PN 25, AISI 316L, slotted nut, EHEDG, 3A with HNBR/EPDM seal (CRN)
						MR	DIN 11851 DN 50 PN 25, AISI 316L, slotted nut, EHEDG, 3A with HNBR/EPDM seal (CRN)
						TD	Tri-Clamp ISO 2852 DN 51 (2"), AISI 316L, EHEDG, 3A with HNBR/EPDM seal (CRN)
						TF	Tri-Clamp ISO 2852 DN 76.1 (3"), AISI 316L, EHEDG, 3A with HNBR/EPDM seal (CRN)
						TK	DRD DN50 (65 mm), PN 25, AISI 316L, with HNBR/EPDM seal
						TR	Varivent type N for tubes DN 40 – DN 162, PN 40, AISI 316L, EHEDG, 3A with HNBR/EPDM seal (CRN)

80							Seal:	
							A	FKM Viton
							B	EPDM
							D	Kalrez
							E	Chemraz
							F	NBR (FDA)/3A: HNBR (FDA)
							L	FKM Viton, cleaned for silicone-free applications
							M	Kalrez, cleaned for silicone-free applications
							1	FKM Viton, cleaned from oil and grease
							2	FKM Viton, cleaned for oxygen service Note application limits pressure/temp.

100								Additional option 1:	
								A	Not selected
								E	SIL/IEC 61508 Declaration of Conformity
								T	High-temperature version
								B	Material test certificate for wetted components, inspection certificate as per EN 10204 3.1 acc. to specification 52005759
								M	Overvoltage protection
								J	Software setting, see additional spec. Min alarm current HART burst mode PV Min alarm current + HART burst mode PV
								N	HistoROM/M-DAT
								S	GL/ABS marine certificate
								F	NSF potable water approval

100								Additional option 1:
								V Mounting on shut-off valve from above
								2 Test report acc. to EN 10204 2.2
								3 Routine test with certificate, inspection certificate as per EN 10204 3.1
								4 Overpressure test with certificate, inspection certificate as per EN 10204 3.1

110									Additional option 2:
									A Not selected
									E SIL2/IEC61508 Declaration of Conformity
									G Separate housing, cable length see additional spec. + mounting bracket, wall/pipe, 316L
									T High-temperature version
									M Overvoltage protection
									J Software setting, see additional spec.
									Min alarm current
									HART burst mode PV
									Min alarm current + HART burst mode PV
									N HistoROM/M-DAT
									S GL/ABS marine certificate
									F NSF potable water approval
									U Mounting bracket for wall/pipe, AISI 304
									2 Test report acc. to EN10204 2.2
									3 Routine test with certificate, inspection certificate as per EN 10204 3.1
									4 Overpressure test with certificate, inspection certificate as per EN 10204 3.1
									5 Helium leak test EN 1518 with test certificate, inspection certificate as per EN 10204 3.1

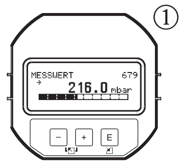
995										Identification:
										1 Measuring point TAG, see additional specification
										2 Bus address, see additional specification

PMC71										Order code

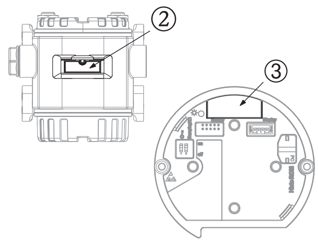
PMP71

This overview does not mark options which are mutually exclusive.

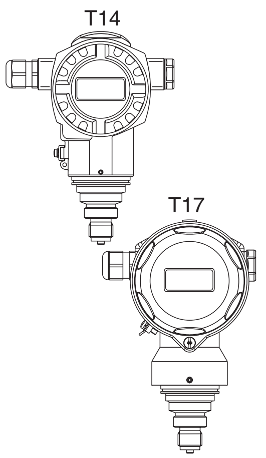
10	Approval:	
	A	For non-hazardous areas
	1	ATEX II 1/2 G Ex ia IIC T6
	6	ATEX II 1/2 G Ex ia IIC T6, Overfill prevention WHG
	2	ATEX II 1/2 D
	4	ATEX II 1/3 D
	8	ATEX II 1 GD Ex ia IIC T6
	3	ATEX II 1/2 GD Ex ia IIC T6
	5	ATEX II 2 G Ex d IIC T6 Gb
	7	ATEX II 3 G Ex nA II T6
	S	FM IS, Class I, II, III Division 1, Groups A – G; NI Class I Division 2, Groups A – D; AEx ia
	T	FM XP, Class I Division 1, Groups A – D; AEx d
	Q	FM DIP, Class II, III Division 1, Groups E – G
	R	FM NI, Class I, Division 2, Groups A – D
	U	CSA IS, Class I, II, III Division 1, Groups A – G; Class I Division 2, Groups A – D, Ex ia
	V	CSA XP, Class I Division 1, Groups B – D; Ex d
	W	CSA Class II, III Division 1, Groups E – G (Dust-Ex)
	G	NEPSI Ex d IIC T6
	H	NEPSI Ex ia IIC T6
	L	TIIS Ex d IIC T6
	I	IECEx Zone 0/1 Ex ia IIC T6
	M	IEC Ex d IIC T6 Gb
	B	Combined certificates: ATEX II 1/2 G Ex ia IIC T6 + II 2 G Ex d IIC T6
	C	Combined certificates: FM IS and XP Class I Division 1, Groups A – D
	D	Combined certificates: CSA IS and XP Class I Division 1, Groups A – D
	E	Combined certificates: FM/CSA IS and XP Class I Division 1, Groups A – D
	F	Combined certificates: ATEX II Ex ia / Ex d + FM/CSA IS + XP ATEX II 1/2G Ex ia IIC T6+ ATEX II 2G Ex d IIC T6+ FM/CSA IS + XP Cl.I Div.1 Gr.A-D



20		Output; Operation:	
		A	4 to 20 mA HART, operation outside, LCD (→ see Fig. ①, ②)
		B	4 to 20 mA HART, operation inside, LCD (→ see Fig. ①, ③)
		C	4 to 20 mA HART, operation inside (→ see Fig. ③)
		M	PROFIBUS PA, operation outside, LCD (→ see Fig. ①, ②)
		N	PROFIBUS PA, operation inside, LCD (→ see Fig. ①, ③)
		O	PROFIBUS PA, operation inside (→ see Fig. ③)
		P	FOUNDATION Fieldbus, operation outside, LCD (→ see Fig. ①, ③)
		Q	FOUNDATION Fieldbus, operation inside, LCD (→ see Fig. ①, ③)
		R	FOUNDATION Fieldbus, operation inside (→ see Fig. ③)



30			Housing; Cable entry; Protection:	
			A	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Gland M 20x1.5
			B	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread G 1/2
			C	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread 1/2 NPT
			D	Aluminum T14 housing, optional display on the side, IP66/67/NEMA 4X/ 6P, M 12x1 PA plug,
			E	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, 7/8" FF plug
			F	Aluminum T14 housing, optional display on the side, IP 65/NEMA 4X, Han7D plug, 90°
			1	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Gland M 20x1.5
			2	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread G 1/2
			3	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread 1/2 NPT
			4	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, M 12x1 PA plug
			5	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, 7/8" FF plug
			6	AISI 316L T14 housing, optional display on the side, IP 65/NEMA 4X, Han7D plug, 90°
			R	T17 316L Hygiene IP66/68 NEMA6P; M20 gland, T17 = side cover
			S	T17 316L Hygiene IP66/68 NEMA6P; G1/2 thread, T17 = side cover
			T	T17 316L Hygiene IP66/68 NEMA6P; NPT1/2 thread, T17 = side cover
			U	T17 316L Hygiene IP66/67 NEMA6P; M12 plug, T17 = side cover
			V	T17 316L Hygiene IP66/68 NEMA6P; 7/8" plug, T17 = side cover



40				Sensor range; Sensor over pressure limit (= OPL):		
				Sensors for gauge pressure		
				Measurement limits: –100 % (–1 bar) to +100 % of sensor nominal value		
					Sensor rated value (URL)	**OPL (over pressure limit)**

40	Sensor range; Sensor over pressure limit (= OPL):	
1F	400 mbar/40 kPa/6 psi g	6 bar/600 kPa/90 psi g
1H	1 bar/100 kPa/15 psi g	10 bar/1 MPa/150 psi g
1K	2 bar/200 kPa/30 psi g	20 bar/2 MPa/300 psi g
1M	4 bar/400 kPa/60 psi g	28 bar/2.8 MPa/420 psi g
1P	10 bar/1 MPa/150 psi g	40 bar/4 MPa/600 psi g
1S	40 bar/4 MPa/600 psi g	160 bar/16 MPa/2400 psi g
1U	100 bar/10 MPa/1500 psi g	400 bar/40 MPa/6000 psi g
1W	400 bar/40 MPa/6000 psi g	600 bar/60 MPa/9000 psi g
1X	700 bar/70 MPa/10500 psi g	1050 bar/105 MPa/15700 psi g
Sensors for absolute pressure		
	Sensor rated value (URL)	**OPL (over pressure limit)**
2F	400 mbar/40 kPa/6 psi abs	6 bar/600 kPa/90 psi abs
2H	1 bar/100 kPa/15 psi abs	10 bar/1 MPa/150 psi abs
2K	2 bar/200 kPa/30 psi abs	20 bar/2 MPa/300 psi abs
2M	4 bar/400 kPa/60 psi abs	28 bar/2.8 MPa/420 psi abs
2P	10 bar/1 MPa/150 psi abs	40 bar/4 MPa/600 psi abs
2S	40 bar/4 MPa/600 psi abs	160 bar/16 MPa/2400 psi abs
2U	100 bar/10 MPa/1500 psi abs	400 bar/40 MPa/6000 psi abs
2W	400 bar/40 MPa/6000 psi abs	600 bar/60 MPa/9000 psi abs
2X	700 bar/70 MPa/10500 psi abs	1050 bar/105 MPa/15700 psi abs
MP	10 bar	40 bar
MT	50 bar	400 bar
MU	100 bar	400 bar

50	Calibration; Unit:
1	Sensor range; mbar/bar
2	Sensor range; kPa/MPa
3	Sensor range; mmH_2O/mH_2O
4	Sensor range; inH_2O/ftH_2O
6	Sensor range; psi
B	Customer-specific; see additional specification
C	Factory calibration certificate, 5-point; see additional specification
D	DKD/DAkkS certificate; see additional specification
E	Customised pressure; see additional specification
F	Customised level; see additional specification
H	Customised pressure + 5-point works calibration certificate; see additional specification
I	Customised level + 5-point works calibration certificate; see additional specification
K	Platinum; see additional specification
L	Platinum and factory calibration certificate, 5-point; see additional specification
M	Platinum and DKD/DAkkS certificate; see additional specification

60	Material of the process isolating diaphragm:
1	AISI 316L
2	Alloy C276
6	AISI 316L with gold-rhodium coating

70	Process connection; Material:
	Thread, internal process isolating diaphragm:
GA	Thread ISO 228 G 1/2 A EN 837, AISI 316L
GB	Thread ISO 228 G 1/2 A EN 837, Alloy C
GE	Thread ISO 228 G 1/2 A G 1/4 (female), AISI 316L
GF	Thread ISO 228 G 1/2 A G 1/4 (female), Alloy C
GH	Thread ISO 228 G 1/2 A hole 11.4 mm, AISI 316L
GJ	Thread ISO 228 G 1/2 A hole 11.4 mm, Alloy C
RA	Thread ANSI 1/2 MNPT 1/4 FNPT, AISI 316L (CRN)
RB	Thread ANSI 1/2 MNPT 1/4 FNPT, Alloy C (CRN)
RD	Thread ANSI 1/2 MNPT hole, AISI 316L (CRN)
RE	Thread ANSI 1/2 MNPT hole, Alloy C (CRN)
RH	Thread ANSI 1/2 FNPT, AISI 316L (CRN)
RJ	Thread ANSI 1/2 FNPT, Alloy C
GL	Thread JIS B0202 G 1/2 (male), AISI 316L
RL	Thread JIS B0203 R 1/2 (male), AISI 316L
	Thread, internal process isolating diaphragm
GP	Thread DIN 13 M 20x1.5 EN 837 hole 11.4 mm, AISI 316L
GQ	Thread DIN 13 M 20x1.5 EN 837 hole 11.4 mm, Alloy C
	Thread, flush-mounted process isolating diaphragm
1A	Thread ISO 228 G 1/2 A, DIN 3852, AISI 316L
1B	Thread ISO 228 G 1/2 A, DIN 3852, Alloy C
1D	Thread ISO 228 G 1 A, AISI 316L

70	Process connection; Material:
1E	Thread ISO 228 G 1 A, Alloy C
1G	Thread ISO 228 G 1 1/2 A, AISI 316L
1H	Thread ISO 228 G 1 1/2 A, Alloy C
1K	Thread ISO 228 G 2 A, AISI 316L
1L	Thread ISO 228 G 2 A, Alloy C
2A	Thread ANSI 1 MNPT, AISI 316L
2B	Thread ANSI 1 MNPT, Alloy C (CRN)
2D	Thread ANSI 1 1/2 MNPT, AISI 316L (CRN)
2E	Thread ANSI 1 1/2 MNPT, Alloy C (CRN)
2G	Thread ANSI 2 MNPT, AISI 316L (CRN)
2H	Thread ANSI 2 MNPT, Alloy C
1N	Thread DIN 16288 M 20x1.5, AISI 316L
1P	Thread DIN 16288 M 20x1.5, Alloy C
1R	Thread DIN 13 M 44x1.25, AISI 316L
1S	Thread DIN 13 M 44x1.25, Alloy C
	EN/DIN flanges, flush-mounted process isolating diaphragm
CN	DN 25 PN 10-40 B1, AISI 316L
CP	DN 32 PN 10-40 B1, AISI 316L
CQ	DN 40 PN 10-40 B1, AISI 316L
B3	DN 50 PN 10-40 B1, AISI 316L
B4	DN 80 PN 10-40 B1, AISI 316L
	ANSI flanges, flush-mounted process isolating diaphragm
AN	1" 300 lbs RF, AISI 316/316L (CRN)
AE	1 1/2" 150 lbs RF, AISI 316/316L (CRN)
AQ	1 1/2" 300 lbs RF, AISI 316/316L (CRN)
AF	2" 150 lbs RF, AISI 316/316L (CRN)
AR	2" 300 lbs RF, AISI 316/316L (CRN)
AG	3" 150 lbs RF, AISI 316/316L (CRN)
AS	3" 300 lbs RF, AISI 316/316L (CRN)
AH	4" 150 lbs RF, AISI 316/316L (CRN)
AT	4" 300 lbs RF, AISI 316/316L (CRN)
	JIS flanges, flush-mounted process isolating diaphragm
KA	20K 25A RF, AISI 316L
KF	10K 50A RF, AISI 316L
KL	10K 80A RF, AISI 316L
KH	10K 100A RF, AISI 316L
	Other
UR	Oval flange adapter 1/4-18 NPT, mounting: 7/16-20 UNF, AISI 316L (CRN)
U1	Prepared for diaphragm seal mount, AISI 316L (CRN)

90	Fill fluid:
A	Silicone oil
F	Inert oil
K	Inert oil, cleaned from oil and grease
N	Inert oil, cleaned for oxygen service (observe application limits pressure/temperature)

100	Additional option 1:
A	Not selected
E	SIL/IEC 61508 Declaration of Conformity
B	Material test certificate for wetted components, inspection certificate as per EN 10204 3.1 acc. to specification 52005759
C	NACE MR0175 (wetted parts)
D	Material test certificate for wetted components as per EN 10204 3.1 and NACE MR0175 material, inspection certificate as per EN 10204 acc. to specification 52010806
M	Overvoltage protection
V	Mounting on shut-off valve from above
J	Software setting, see additional spec. Min alarm current HART burst mode PV Min alarm current + HART burst mode PV
N	HistoROM/M-DAT
S	GL/ABS marine certificate
F	NSF potable water approval
2	Test report acc. to EN10204 2.2
3	Routine test with certificate, inspection certificate as per EN 10204 3.1
4	Overpressure test with certificate, inspection certificate as per EN 10204 3.1

110										Additional option 2:	
										A	Not selected
										E	SIL/IEC 61508 Declaration of Conformity
										G	Separate housing, cable length see additional spec. + mounting bracket, wall/pipe, 316L
										M	Overvoltage protection
										J	Software setting, see additional spec.
											Min alarm current
											HART burst mode PV
											Min alarm current + HART burst mode PV
										N	HistoROM/M-DAT
										S	GL/ABS marine certificate
										F	NSF potable water approval
										U	Mounting bracket for wall/pipe, AISI 304
										2	Test report acc. to EN 10204 2.2
										3	Individual testing with test certificate, inspection certificate as per EN10204 3.1
										4	Overpressure test with certificate, inspection certificate as per EN 10204 3.1
										5	Helium leak test EN 1528 with test certificate, inspection certificate as per EN 10204 3.1

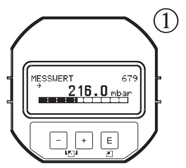
995											Identification:	
											1	Measuring point TAG, see additional specification
											2	Bus address, see additional specification

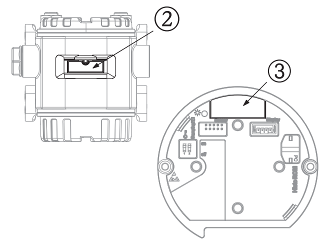
PMP71											Order code

PMP75

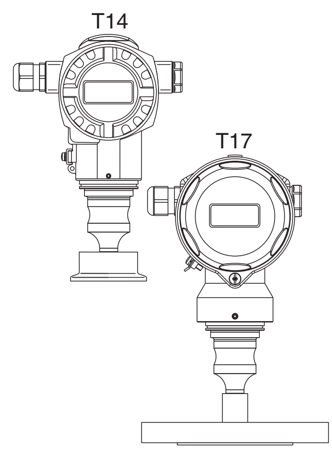
This overview does not mark options which are mutually exclusive.

10		Approval:
	A	For non-hazardous areas
	1	ATEX II 1/2 G Ex ia IIC T6
	6	ATEX II 1/2 G Ex ia IIC T6, Overfill prevention WHG
	2	ATEX II 1/2 D
	4	ATEX II 1/3 D
	8	ATEX II 1 GD Ex ia IIC T6
	3	ATEX II 1/2 GD Ex ia IIC T6
	5	ATEX II 2 G Ex d IIC T6 Gb
	7	ATEX II 3 G Ex nA II T6
	S	FM IS, Class I, II, III Division 1, Groups A – G; NI Class I Division 2, Groups A – D; AEx ia
	T	FM XP, Class I Division 1, Groups A – D; AEx d
	Q	FM DIP, Class II, III Division 1, Groups E – G
	R	FM NI, Class I, Division 2, Groups A – D
	U	CSA IS, Class I, II, III Division 1, Groups A – G; Class I Division 2, Groups A – D, Ex ia
	V	CSA XP, Class I Division 1, Groups B – D; Ex d
	W	CSA Class II, III Division 1, Groups E – G (Dust-Ex)
	G	NEPSI Ex d IIC T6
	H	NEPSI Ex ia IIC T6
	L	TIIS Ex d IIC T6
	I	IECEx Zone 0/1 Ex ia IIC T6
	M	IEC Ex d IIC T6 Gb
	B	Combined certificates: ATEX II 1/2 G Ex ia IIC T6 + II 2 G Ex d IIC T6
	C	Combined certificates: FM IS and XP Class I Division 1, Groups A – D
	D	Combined certificates: CSA IS and XP Class I Division 1, Groups A – D
	E	Combined certificates: FM/CSA IS and XP Class I Division 1, Groups A – D
	F	Combined certificates: ATEX II Ex ia / Ex d + FM/CSA IS + XP ATEX II 1/2G Ex ia IIC T6+ ATEX II 2G Ex d IIC T6+ FM/CSA IS + XP Cl.I Div.1 Gr.A-D





20		Output; Operation:
	A	4 to 20 mA HART, operation outside, LCD (→ see Fig. ①, ②)
	B	4 to 20 mA HART, operation inside, LCD (→ see Fig. ①, ③)
	C	4 to 20 mA HART, operation inside (→ see Fig. ③)
	M	PROFIBUS PA, operation outside, LCD (→ see Fig. ①, ②)
	N	PROFIBUS PA, operation inside, LCD (→ see Fig. ①, ③)
	O	PROFIBUS PA, operation inside (→ see Fig. ③)
	P	FOUNDATION Fieldbus, operation outside, LCD (→ see Fig. ①, ③)
	Q	FOUNDATION Fieldbus, operation inside, LCD (→ see Fig. ①, ③)
	R	FOUNDATION Fieldbus, operation inside (→ see Fig. ③)



30		Housing; Cable entry; Protection:
	A	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Gland M 20x1.5
	B	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread G 1/2
	C	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread 1/2 NPT
	D	Aluminum T14 housing, optional display on the side, IP66/67/NEMA 4X/ 6P, M 12x1 PA plug,
	E	Aluminum T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, 7/8" FF plug
	F	Aluminum T14 housing, optional display on the side, IP 65/NEMA 4X, Han7D plug, 90°
	1	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Gland M 20x1.5
	2	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread G 1/2
	3	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, Thread 1/2 NPT
	4	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, M 12x1 PA plug
	5	AISI 316L T14 housing, optional display on the side, IP 66/67/NEMA 4X/ 6P, 7/8" FF plug
	6	AISI 316L T14 housing, optional display on the side, IP 65/NEMA 4X, Han7D plug, 90°
	R	T17 316L Hygiene IP66/68 NEMA6P; M20 gland, T17 = side cover
	S	T17 316L Hygiene IP66/68 NEMA6P; G1/2 thread, T17 = side cover
	T	T17 316L Hygiene IP66/68 NEMA6P; NPT1/2 thread, T17 = side cover
	U	T17 316L Hygiene IP66/67 NEMA6P; M12 plug, T17 = side cover
	V	T17 316L Hygiene IP66/68 NEMA6P; 7/8" plug, T17 = side cover

40		Sensor range; Sensor over pressure limit (= OPL):	
		Sensors for gauge pressure	
		Measurement limits: –100 % (–1 bar) to +100 % of sensor nominal value	
		Sensor rated value (URL)	**OPL (over pressure limit)**
	1F	400 mbar/40 kPa/6 psi	6 bar/600 kPa/90 psi

40	Sensor range; Sensor over pressure limit (= OPL):	
1H	1 bar/100 kPa/15 psi	10 bar/1 MPa/150 psi
1K	2 bar/200 kPa/30 psi	20 bar/2 MPa/300 psi
1M	4 bar/400 kPa/60 psi	28 bar/2.8 MPa/420 psi
1P	10 bar/1 MPa/150 psi	40 bar/4 MPa/600 psi
1S	40 bar/4 MPa/600 psi	160 bar/16 MPa/2400 psi
1U	100 bar/10 MPa/1500 psi	400 bar/40 MPa/6000 psi
1W	400 bar/40 MPa/6000 psi	600 bar/60 MPa/9000 psi
Sensors for absolute pressure		
	Sensor rated value (URL)	**OPL (over pressure limit)**
2F	400 mbar/40 kPa/6 psi abs	6 bar/600 kPa/90 psi abs
2H	1 bar/100 kPa/15 psi abs	10 bar/1 MPa/150 psi abs
2K	2 bar/200 kPa/30 psi abs	20 bar/2 MPa/300 psi abs
2M	4 bar/400 kPa/60 psi abs	28 bar/2.8 MPa/420 psi abs
2P	10 bar/1 MPa/150 psi abs	40 bar/4 MPa/600 psi abs
2S	40 bar/4 MPa/600 psi abs	160 bar/16 MPa/2400 psi abs
2U	100 bar/10 MPa/1500 psi abs	400 bar/40 MPa/6000 psi abs
2W	400 bar/40 MPa/6000 psi abs	600 bar/60 MPa/9000 psi abs

50	Calibration; Unit:
1	Sensor range; mbar/bar
2	Sensor range; kPa/MPa
3	Sensor range; mmH_2O/mH_2O
4	Sensor range; inH_2O/ftH_2O
6	Sensor range; psi
B	Customer-specific; see additional specification
C	Factory calibration certificate, 5-point; see additional specification
D	DKD/DAkkS calibration: see additional specification
E	Customised pressure; see additional specification
F	Customised level; see additional specification
H	Customised pressure + 5-point works calibration certificate; see additional specification
I	Customised level + 5-point works calibration certificate; see additional specification

60	Material of the process isolating diaphragm:
1	AISI 316L
2	Alloy C276
3	Monel
5	Tantalum
6	AISI 316L with gold-rhodium coating
7	AISI 316L with 0.09 mm PTFE foil (not for vacuum applications)
8	AISI 316L with 0.25 mm PTFE foil (not for vacuum applications)

70	Process connection, material:
	Diaphragm seal cell structure
UI	Pancake DN 50 PN 16-400, AISI 316L
UJ	Pancake DN 80 PN 16-400, AISI 316L
UK	Pancake DN 100 PN 16-400, AISI 316L
UL	Pancake 2" 150-2500 lbs, AISI 316L (CRN)
UM	Pancake 3" 150-2500 lbs, AISI 316L (CRN)
UR	Pancake 4" 150-2500 lbs, AISI 316L (CRN)
	Thread, flush-mounted process isolating diaphragm
1D	Thread ISO 228 G 1 A, AISI 316L
1E	Thread ISO 228 G 1 A, Alloy C
1G	Thread ISO 228 G 1 1/2 A, AISI 316L
1H	Thread ISO 228 G 1 1/2 A, Alloy C
1K	Thread ISO 228 G 2 A, AISI 316L
1L	Thread ISO 228 G 2 A, Alloy C
2A	Thread ANSI 1 MNPT, AISI 316L
2B	Thread ANSI 1 MNPT, Alloy C (CRN)
2D	Thread ANSI 1 1/2 MNPT, AISI 316L (CRN)
2E	Thread ANSI 1 1/2 MNPT, Alloy C (CRN)
2G	Thread ANSI 2 MNPT, AISI 316L (CRN)
2H	Thread ANSI 2 MNPT, Alloy C (CRN)
	Clamp connections
TB	Tri-Clamp, ISO 2852 DN 25 (1"), DIN 32676 DN 25, AISI 316L (CRN), EHEDG
TC	Tri-Clamp, ISO 2852 DN 38 (1 1/2"), DIN 32676 DN 40, AISI 316L (CRN), EHEDG
TD	Tri-Clamp, ISO 2852 DN 51 (2")/DN 50, AISI 316L (CRN), EHEDG
TF	Tri-Clamp, ISO 2852 DN 76.1 (3"), AISI 316L (CRN), EHEDG
	Pipe diaphragm seal Clamp connections
SB	Tri-Clamp, ISO 2852 DN 25 (1"), AISI 316L (CRN)

70							Process connection, material:	
							SC	Tri-Clamp, ISO 2852 DN 38 (1 1/2"), AISI 316L, 3.1 + Pressure test acc. to PED Cat.II (CRN)
							SD	Tri-Clamp, ISO 2852 DN 51 (2"), AISI 316L, 3.1 + Pressure test acc. to PED Cat.II (CRN)
							Hygienic connections	
							MR	DIN 11851 DN 50 PN 25, slotted nut, AISI 316L, EHEDG, 3A
							MS	DIN 11851 DN 65 PN 25, slotted nut, AISI 316L, EHEDG, 3A
							MT	DIN 11851 DN 80 PN 25, slotted nut, AISI 316L, EHEDG, 3A
							TG	SMS 1" PN 25, AISI 316L, EHEDG
							TH	SMS 1 1/2" PN 25, AISI 316L, EHEDG
							TI	SMS 2" PN 25, AISI 316L, EHEDG
							TL	APV-RJT 1" PN 40, AISI 316L
							TM	APV-RJT 1 1/2" PN 40, AISI 316L
							TN	APV-RJT 2" PN 40, AISI 316L
							TP	APV-ISS 1" PN 40, AISI 316L
							TQ	APV-ISS 1 1/2" PN 40, AISI 316L
							TS	APV-ISS 2" PN 40, AISI 316L
							TK	DRD DN50 (65 mm) PN 25, AISI 316L
							TR	Varivent Type N for pipes DN 40 – DN 162 PN 40, AISI 316L, EHEDG
							00	Universal adapter 44 mm including silicon molded seal, EHEDG, 3A (CRN)
							EN/DIN flanges, flush-mounted process isolating diaphragm	
							CN	DN 25 PN 10-40 B1, AISI 316L
							DN	DN 25 PN 63-160 E, AISI 316L
							EN	DN 25 PN 250 E, AISI 316L
							E1	DN 25 PN 400 E, AISI 316L
							CP	DN 32 PN 10-40 B1, AISI 316L
							CQ	DN 40 PN 10-40 B1, AISI 316L
							B3	DN 50 PN 10-40 B1, AISI 316L
							C3	DN 50 PN 63 B2, AISI 316L
							EF	DN 50 PN 100-160 E, AISI 316L
							ER	DN 50 PN 250 E, AISI 316L
							E3	DN 50 PN 400 E, AISI 316L
							B4	DN 80 PN 10-40 B1, AISI 316L
							C4	DN 80 PN 100 B2, AISI 316L
							C5	DN 100 PN 100 B2, AISI 316L
							EN/DIN flanges with ext. diaph. seal, flush-mounted process isolating diaphragm	
							D3	DN 50 PN 10-40 B1, extended diaphragm seal 50 mm/100 mm/200 mm, AISI 316L
							D4	DN 80 PN 10-40 B1, extended diaphragm seal 50 mm/100 mm/200 mm, AISI 316L
							ANSI flanges, flush-mounted process isolating diaphragm	
							AC	1" 150 lbs RF, AISI 316/316L (CRN)
							AN	1" 300 lbs RF, AISI 316/316L (CRN)
							HC	1" 400/600 lbs RF, AISI 316/316L (CRN)
							HN	1" 900/1500 lbs RF, AISI 316/316L (CRN)
							H0	1" 2500 lbs RF, AISI 316/316L (CRN)
							AE	1 1/2" 150 lbs RF, AISI 316/316L (CRN)
							AQ	1 1/2" 300 lbs RF, AISI 316/316L (CRN)
							AF	2" 150 lbs RF, AISI 316/316L (CRN)
							AR	2" 300 lbs RF, AISI 316/316L (CRN)
							HF	2" 400/600 lbs RF, AISI 316/316L (CRN)
							HR	2" 900/1500 lbs RF, AISI 316/316L (CRN)
							H3	2" 2500 lbs RF, AISI 316/316L
							AG	3" 150 lbs RF, AISI 316/316L (CRN)
							AS	3" 300 lbs RF, AISI 316/316L (CRN)
							AH	4" 150 lbs RF, AISI 316/316L (CRN)
							AT	4" 300 lbs RF, AISI 316/316L (CRN)
							ANSI flanges with ext. diaph. seal, flush-mounted process isolating diaphragm	
							J3	2" 150 lbs RF, extended diaphragm seal 2"/4"/6"/8", AISI 316/316L (CRN)
							J4	3" 150 lbs RF, extended diaphragm seal 2"/4"/6"/8", AISI 316/316L (CRN)
							J7	3" 300 lbs RF, extended diaphragm seal 2"/4"/6"/8", AISI 316/316L (CRN)
							J5	4" 150 lbs RF, extended diaphragm seal 2"/4"/6"/8", AISI 316/316L (CRN)
							J8	4" 300 lbs RF, extended diaphragm seal 2"/4"/6"/8", AISI 316/316L (CRN)
							JIS flanges, flush-mounted process isolating diaphragm	
							KC	10K 25A RF, AISI 316L
							KF	10K 50A RF, AISI 316L
							KL	10K 80A RF, AISI 316L
							KH	10K 100A RF, AISI 316L
							Other	
							UA	Thread ISO 228 G 1/2 A PN 160, separator, EN 837, welded, AISI 316L
							UB	Thread ANSI 1/2 MNPT PN 160, separator, welded, AISI 316L (CRN)

70	Process connection, material:
UC	Thread ISO 228 G 1/2 B, separator, EN 837, threaded, AISI 316L
UD	Thread ANSI 1/2 MNPT, separator, threaded, AISI 316L
UG	Thread 1/2 NPT PN 250, separator, threaded, AISI 316L
UH	Thread 1 NPT PN 250, separator, threaded, AISI 316L

90	Fill fluid, temperature isolation:
A	Silicone oil
B	...m capillary, inert oil
C	...ft capillary, inert oil
D	Vegetable oil
F	Inert oil
G	High-temperature oil, temp. isolator 100 mm
H	Silicone oil, temp. isolator 100 mm
K	Inert oil, cleaned from oil and grease
N	Inert oil, cleaned for oxygen services
1	... m capillary, silicone oil
2	... ft capillary, silicone oil
3	... m capillary, high-temperature oil
4	... ft capillary, high-temperature oil
5	... m capillary, vegetable oil
6	... ft capillary, vegetable oil
7	... m capillary, low-temperature oil
8	... ft capillary, low-temperature oil

100	Additional option 1:
A	Not selected
E	SIL2/IEC61508 Declaration of Conformity
B	Material test certificate for wetted components, inspection certificate as per EN 10204 3.1 acc. to specification 52005759
C	NACE MR0175 (wetted parts)
D	Material test certificate for wetted parts, inspection certificate as per EN 10204 3.1 and NACE MR0175 material, inspection certificate as per EN 10204 acc. to specification 52010806
M	Overvoltage protection
J	Software setting, see additional spec.
	Min alarm current
	HART burst mode PV
	Min alarm current + HART burst mode PV
N	HistoROM/M-DAT
S	GL/ABS marine certificate
2	Test report acc. to EN10204 2.2
3	Routine test with certificate, inspection certificate as per EN 10204 3.1
4	Overpressure test with certificate, inspection certificate as per EN 10204 3.1

110	Additional option 2:
A	Not selected
E	SIL2/IEC61508 Declaration of Conformity
G	Separate housing, cable length see additional spec. + mounting bracket, wall/pipe, 316L
M	Overvoltage protection
J	Software setting, see additional spec.
	Min alarm current
	HART burst mode PV
	Min alarm current + HART burst mode PV
N	HistoROM/M-DAT
P	Ra < 0.38 µm/15.75 µin, electropolished + EN10204-3.1 material (wetted) inspection certificate; in conjunction with process connection versions "TC", "TD" and "TR" please order roughness test separately
S	GL/ABS marine certificate
U	Mounting bracket for wall/pipe, AISI 304
2	Test report acc. to EN 10204 2.2
3	Routine test with certificate, inspection certificate as per EN 10204 3.1
4	Overpressure test with certificate, inspection certificate as per EN 10204 3.1

995	Identification:
1	Measuring point TAG, see additional specification
2	Bus address, see additional specification

PMP75											Order code

Additional documentation

Field of Activities

- Pressure measurement, powerful instruments for process pressure, differential pressure, level and flow: FA00004P/00/EN

Technical Information

- Deltabar S: TI00382P/00/EN
- Deltapilot S: TI00416P/00/EN
- EMC test procedures TI00241F/00/EN

Operating Instructions

4 to 20 mA HART:
- Cerabar S: BA00271P/00/EN
- Description of device functions Cerabar S/Deltabar S/Deltapilot S: BA00274P/00/EN

4 to 20 mA HART with MID parts certificate:
- BA00412P/00/EN
- Description of Device Functions: BA00413P/00/EN

PROFIBUS PA:
- Cerabar S: BA00295P/00/EN
- Description of device functions Cerabar S/Deltabar S/Deltapilot S: BA00296P/00/EN

FOUNDATION Fieldbus:
- Cerabar S: BA00302P/00/EN
- Description of device functions Cerabar S/Deltabar S/Deltapilot S: BA00303P/00/EN

Brief Operating Instructions

- 4 to 20 mA HART, Cerabar S: KA01019P/00/EN
- PROFIBUS PA, Cerabar S: KA01022P/00/EN
- FOUNDATION Fieldbus, Cerabar S: KA01025P/00/EN

Functional safety manual (SIL)

- Cerabar S (4 to 20 mA): SD00190P/00/EN

Safety Instructions

Certificate/type of protection	Device	Electronics	Documentation	Version in the order code
ATEX II 1/2 G Ex ia IIC T6	PMC71, PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00244P	1
ATEX II 1/2 D	PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00246P – XA00289P	2
ATEX II 1/2 D Ex ia IIC	PMC71	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00247P – XA00290P	2
ATEX II 1/3 D	PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00248P – XA00291P	4
ATEX II 2 G Ex d IIC T6 Gb	PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00249P	5
ATEX II 2 G Ex d ia IIC T6 Gb	PMC71	– 4 to 20 mA HART, PROFIBUS PA., FOUNDATION Fieldbus	– XA00250P	5
ATEX II 3 G Ex nA II T6	PMC71, PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00251P	7
ATEX II 1/2 GD Ex ia IIC T6	PMC71, PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00253P	3
ATEX II 1 GD Ex ia IIC T6	PMC71, PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00276P	8

Certificate/type of protection	Device	Electronics	Documentation	Version in the order code
ATEX II 1/2 G Ex ia IIC T6 + ATEX II 2 G Ex d IIC T6	PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00252P	B

Certificate/type of protection	Device	Electronic insert	Documentation	Version in the order code
IECEx Zone 0/1 Ex ia IIC T6	PMC71, PMP71, PMP75	– 4 to 20 mA HART	– XB00005P	I
IEC Ex d ia IIC T6 Gb	PMC71	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00511P	B
IEC Ex d IIC T6 Gb	PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XA00510P	M

Certificate/type of protection	Device	Electronic insert	Documentation	Version in the order code
NEPSI Ex ia IIC T6	PMC71, PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XC00003P	H
NEPSI Ex d IIC T6	PMP71, PMP75	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XC00005P	G
NEPSI Ex d[ia] IIC T6	PMC71	– 4 to 20 mA HART, PROFIBUS PA, FOUNDATION Fieldbus	– XC00005P	G

Certificate/type of protection	Device	Electronics	Documentation	Version in the order code
TIIS Ex d [ia] IIC T6	PMC71	– 4 to 20 mA HART	– TC17436	L
TIIS Ex d [ia] IIC T4	PMC71	– 4 to 20 mA HART	– TC17398, TC17399	M
TIIS Ex d IIC T6	PMP71 (700 bar version)	– 4 to 20 mA HART	– TC17445	L
TIIS Ex d IIC T6	PMP71, PMP75	– 4 to 20 mA HART	– TC17446	L

Installation/Control Drawings

Certificate/type of protection	Device	Electronics	Documentation	Version in the order code
FM IS Class I, II, III, Division 1, Groups A – G; NI, Class I Division 2, Groups A – D; AEx ia	PMC71, PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– ZD00147P – ZD00188P	S
CSA IS Class I, II, III, Division 1, Groups A – G; Class I Division 2, Groups A – G	PMC71, PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00593P – XA00596P	U
FM IS + XP Class I, Division 1, Groups A – D	PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– ZD00187P – ZD00190P	C
CSA IS + XP Class I Division 1, Groups A – D	PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00592P – XA00590P	D
FM/CSA IS + XP Class I Division 1, Groups A – D	PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00592P + ZD00187P – ZD00190P + XA00590P	E

Certificate/type of protection	Device	Electronics	Documentation	Version in the order code
CSA +XP Class I Division 1, Groups B - D, Class II Division 1, Groups E - G, Class III	PMP71, PMP75	– 4 to 20 mA HART – PROFIBUS PA, FOUNDATION Fieldbus	– XA00599P	-

Overfill prevention

- WHG: ZE00260P/00/DE

Configuration data sheet

Level

The following configuration data sheet has to be filled in and to be included in the order when the option "F – Customised level" or the option "I – Customised level + 5-point works calibration certificate" has been selected in feature 50 "Calibration; Unit" of the product structure.

Pressure Engineering Unit

❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pascal	❑ torr
❑ bar	❑ mH_2O	❑ inHg	❑ hPa	
	❑ ftH_2O		❑ kPa	❑ g/cm^2
❑ psi	❑ inH_2O	❑ gf/cm^2	❑ MPa	❑ kg/cm^2
		❑ kgf/cm^2		
				❑ lb/ft^2
				❑ atm

Output Unit (Scaled unit)

Mass	Length	Volume	Volume	Percent
❑ kg	❑ m	❑ l	❑ USgal	❑ %
❑ t	❑ dm	❑ hl	❑ impgal	
❑ lb	❑ cm		❑ USbblPETR	
	❑ mm	❑ m^3		
		❑ ft^3		
	❑ ft			
	❑ inch			

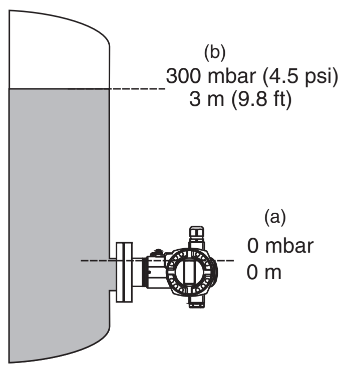
Empty pressure [a]:
Low pressure value (empty) ______________
[pres. eng. unit]

Full pressure [b]:
High pressure value (full) ______________
[pres. eng. unit]

Empty calibration [a]:
Low level value (empty) ______________
[Scaled Unit]

Full calibration [b]:
High level value (full) ______________
[Scaled Unit]

Example



Display Information

Display the contents of the main line [1)]

❑ Main Value [PV] (Default)
❑ Main Value [%]
❑ Pressure
❑ Current [mA] (HART only)
❑ Temperature
❑ Level before lin.
❑ Tank content
❑ Error number
❑ Alternating display

1) Depending on sensor and comunication variant

Damping

Damping: ___________ sec (Default 2 sec)

Pressure

The following configuration data sheet has to be filled in and to be included in the order when the option "E – Customised pressure" or the option "H – Customised pressure + 5-point works calibration certificate" has been selected in feature 50 "Calibration; Unit" of the product structure.

Pressure Engineerung Unit

❑ mbar	❑ mmH_2O	❑ mmHg	❑ Pascal	❑ torr
❑ bar	❑ mH_2O	❑ inHg	❑ hPa	
	❑ ftH_2O		❑ kPa	❑ g/cm^2
❑ psi	❑ inH_2O	❑ gf/cm^2	❑ MPa	❑ kg/cm^2
		❑ kgf/cm^2		
				❑ lb/ft^2
				❑ atm

Calibration Range / Output

Low range value (LRV): ____________________ [pressure engineering unit)]
Upper range value (URV): ____________________ [pressure engineering unit)]

Display Information

Display the contents of the main line [1)]
❑ Main Value [PV] (Default)
❑ Main Value [%]
❑ Pressure
❑ Current [mA] (HART only)
❑ Temperature
❑ Error number
❑ Alternating display

[1)] Depending on sensor and comunication variant

Damping

Damping: _____________ sec (Default 2 sec)

Note!
Smallest span (factory calibration) → 🗎 7.

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People for Process Automation

TI00383P/00/EN/15.12
No 71185798
CSS/FM+SGML 9.0

71185798

Appendix J

Lock-out/Tag-out Form

Lockout/Tagout Log

Name	Activity Requiring Lockout/Tagout	Date	Time	
			Start	Finish

Appendix K

Product Information

Westbay® Monitoring Well Operations and Repair Manual

Appendix K

Product Information

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.

This document contains proprietary information. No part of this document may be photocopied, reproduced or translated to another language without the prior written consent of Westbay Instruments Inc. The information contained in this document is subject to change without notice.

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.

Schlumberger Private

Manual Revision: 1.13 20 October 2006

Issued for Serial No.: __________

Date: __________

Signature: __________

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2531V1_13.doc

Contents

Schlumberger Private

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.

Schlumberger Private

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.

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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.

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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

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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.

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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.

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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). <u>The arm assembly has to be held in place while replacing the face seal</u> 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.

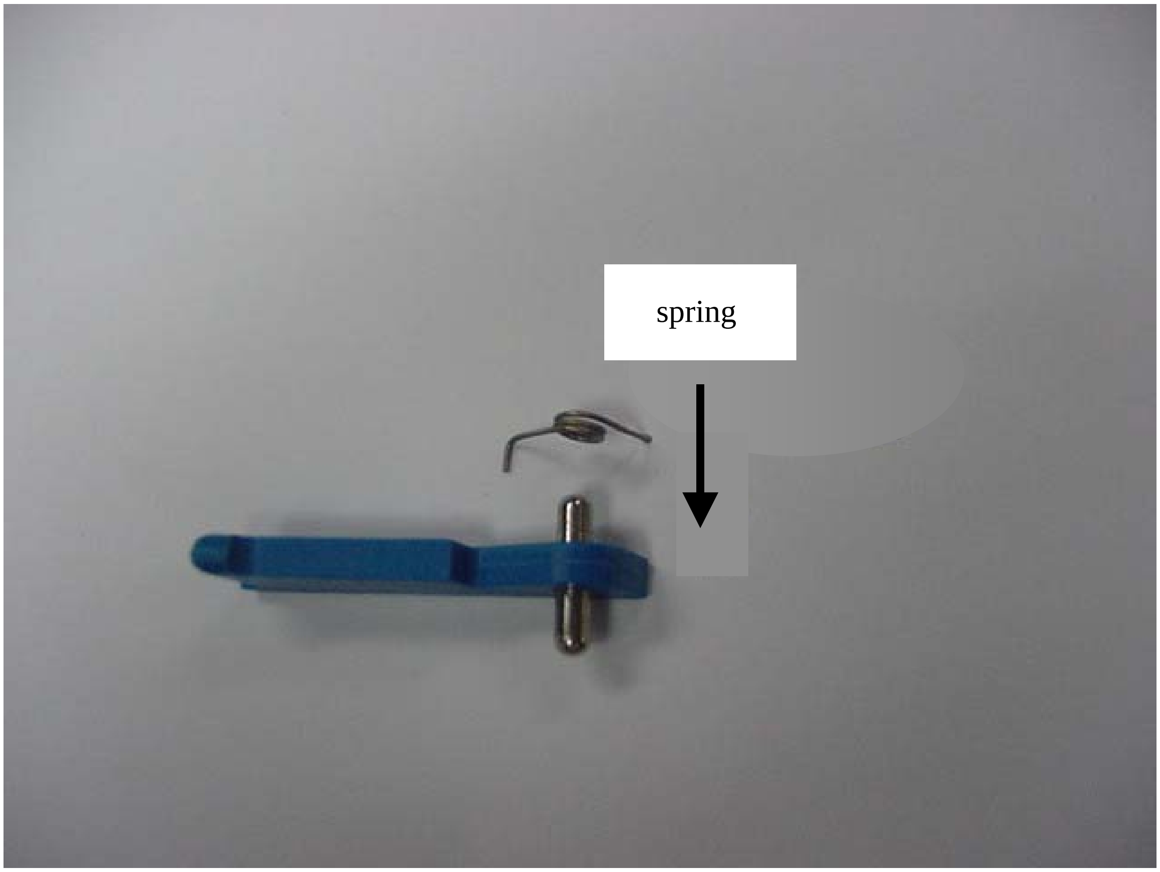


Figure **C-2** - Position of spring and pivot in the arm.

Figure **C-3** - Placement of arm assembly.

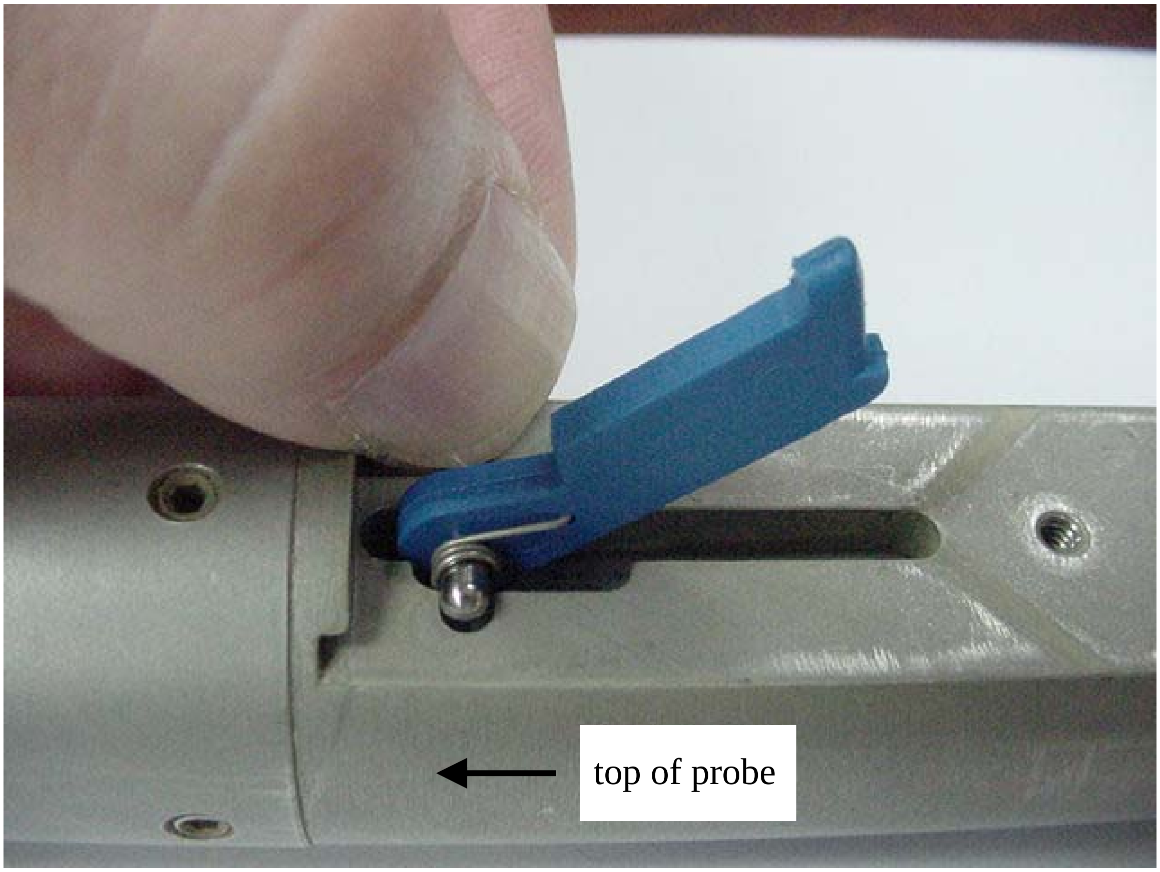
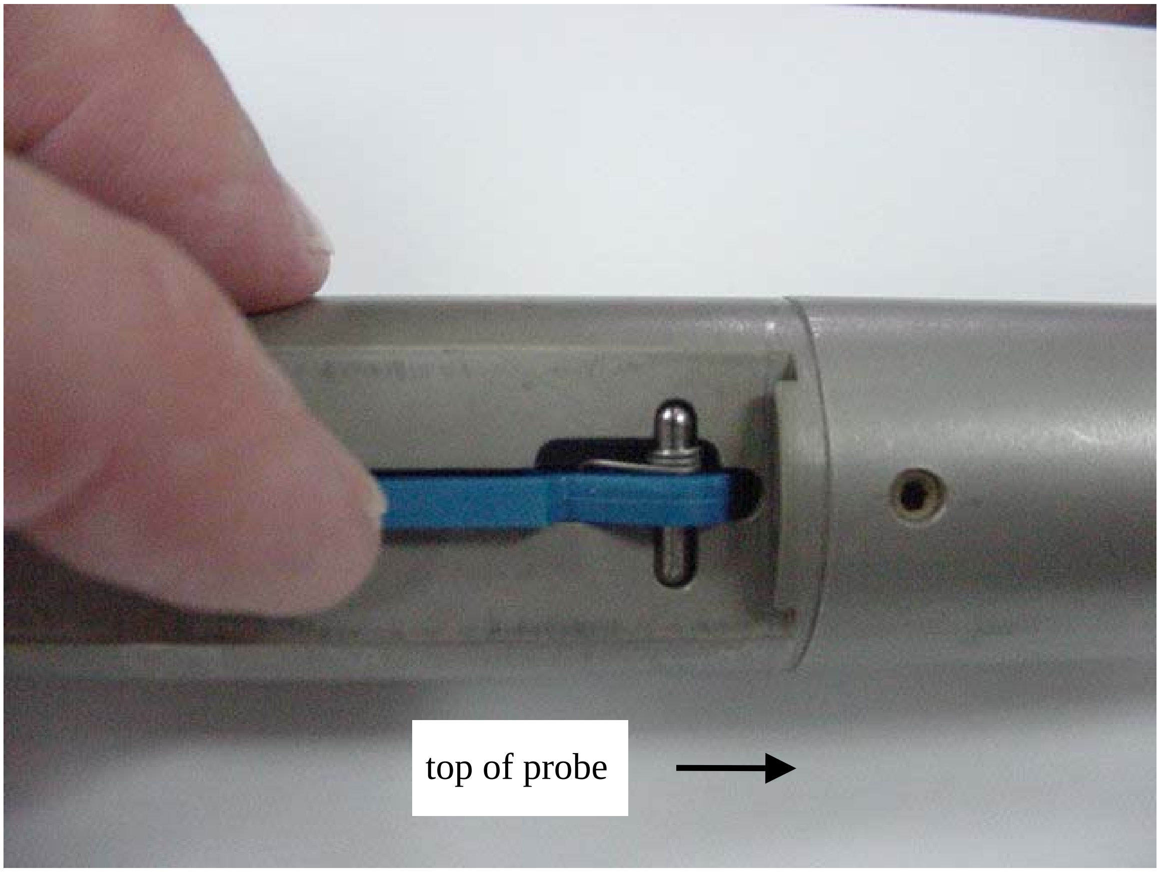


Figure **C-4** - Top view of arm and spring placement.



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.

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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.

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Groundwater Sampling
Field Data Sheet

Schlumberger WATER SERVICES

Project: ______________________

Monitoring Well No.: ______________________

Sampling Zone No(s).: ______________________

Date: ______________________

Start Time: ____________ Atm. Rdg: ____________

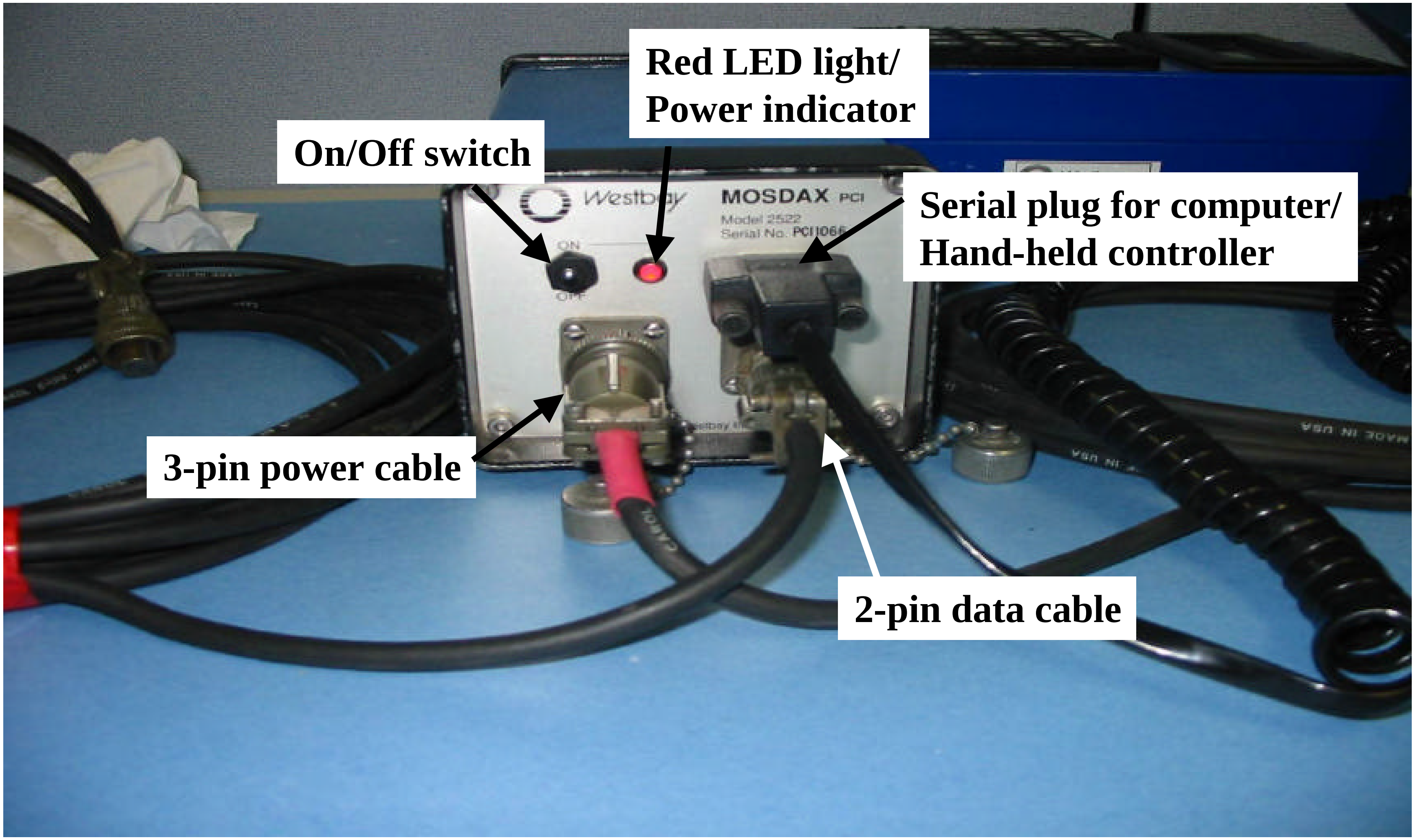
End Time: ____________ Atm. Rdg: ____________

Operators: ______________________

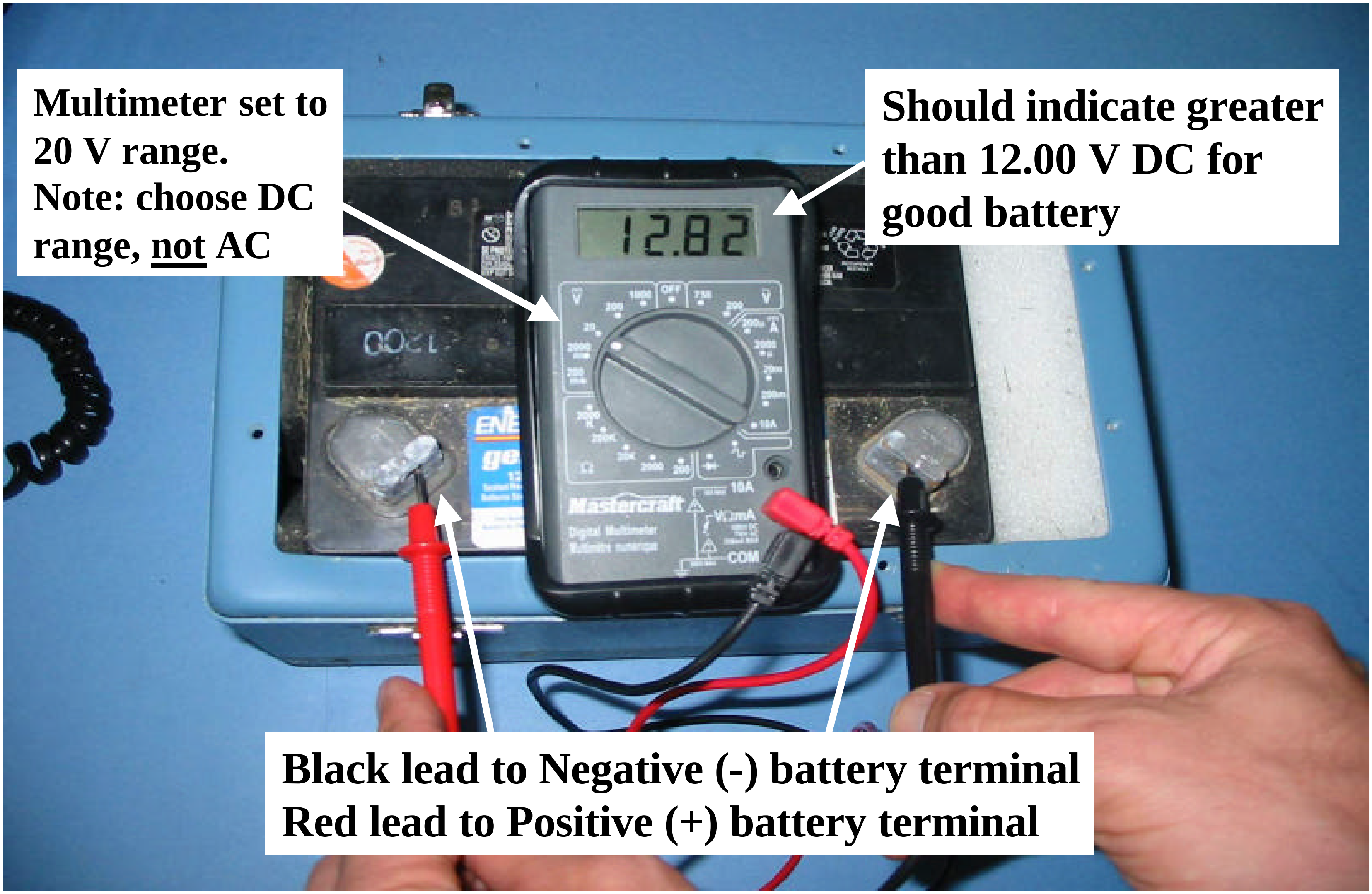
Port No.	Run No.	Surface Function Tests (probe in flushing collar)						Position Sampler			Sample Collection Checks (probe located at sampling zone in Westbay casing)								Comments (volume recovered)
		Shoe Out	Close Valve	Check Vacuum	Open Valve	Apply Vacuum	Close Valve	Locate Port	Arm Out	Land Probe	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.)

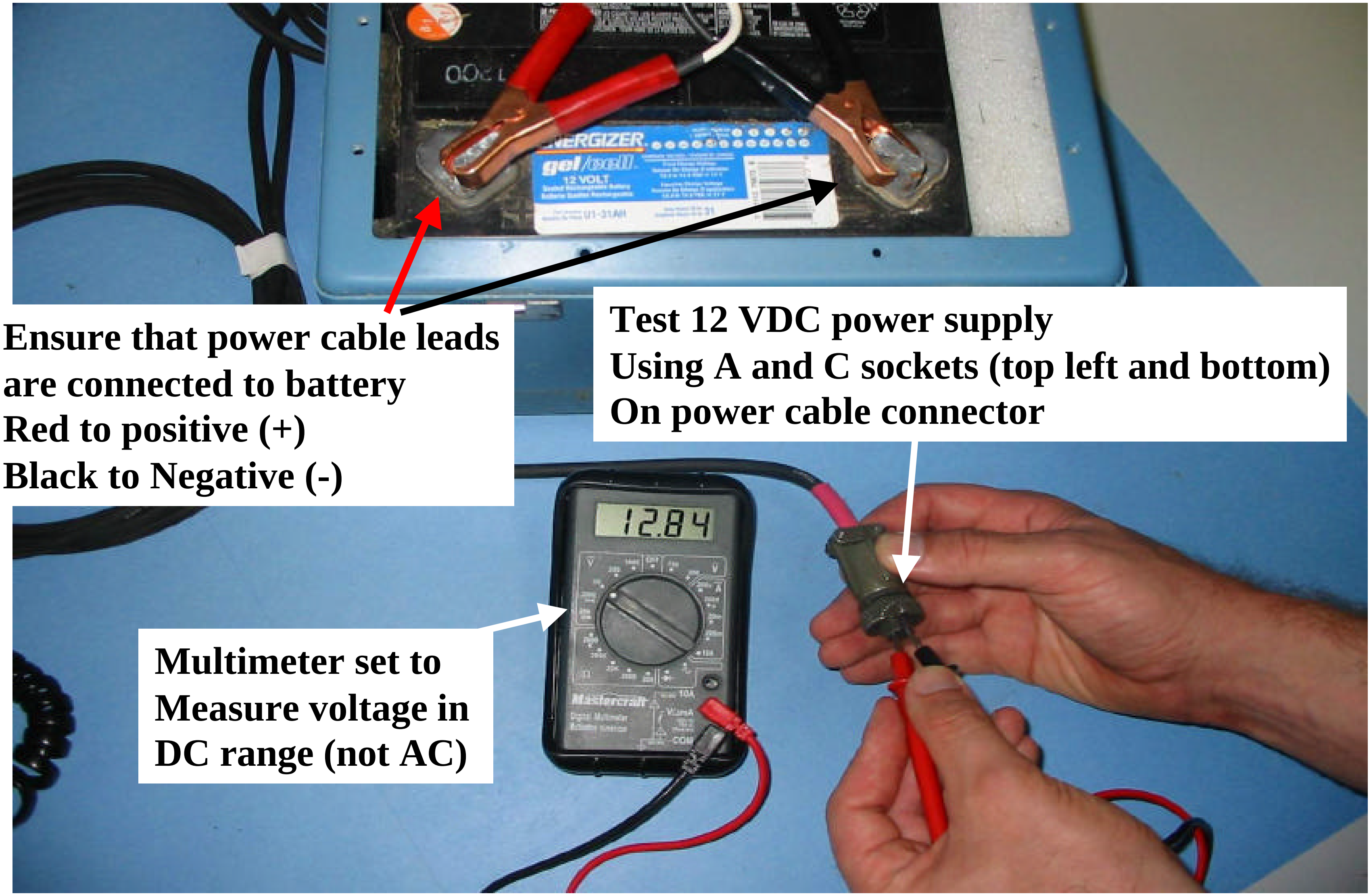
Pic.1 Computer Interface Units, old and new:
MPCI model 2522 (left) and MAGI model 2536 (right)



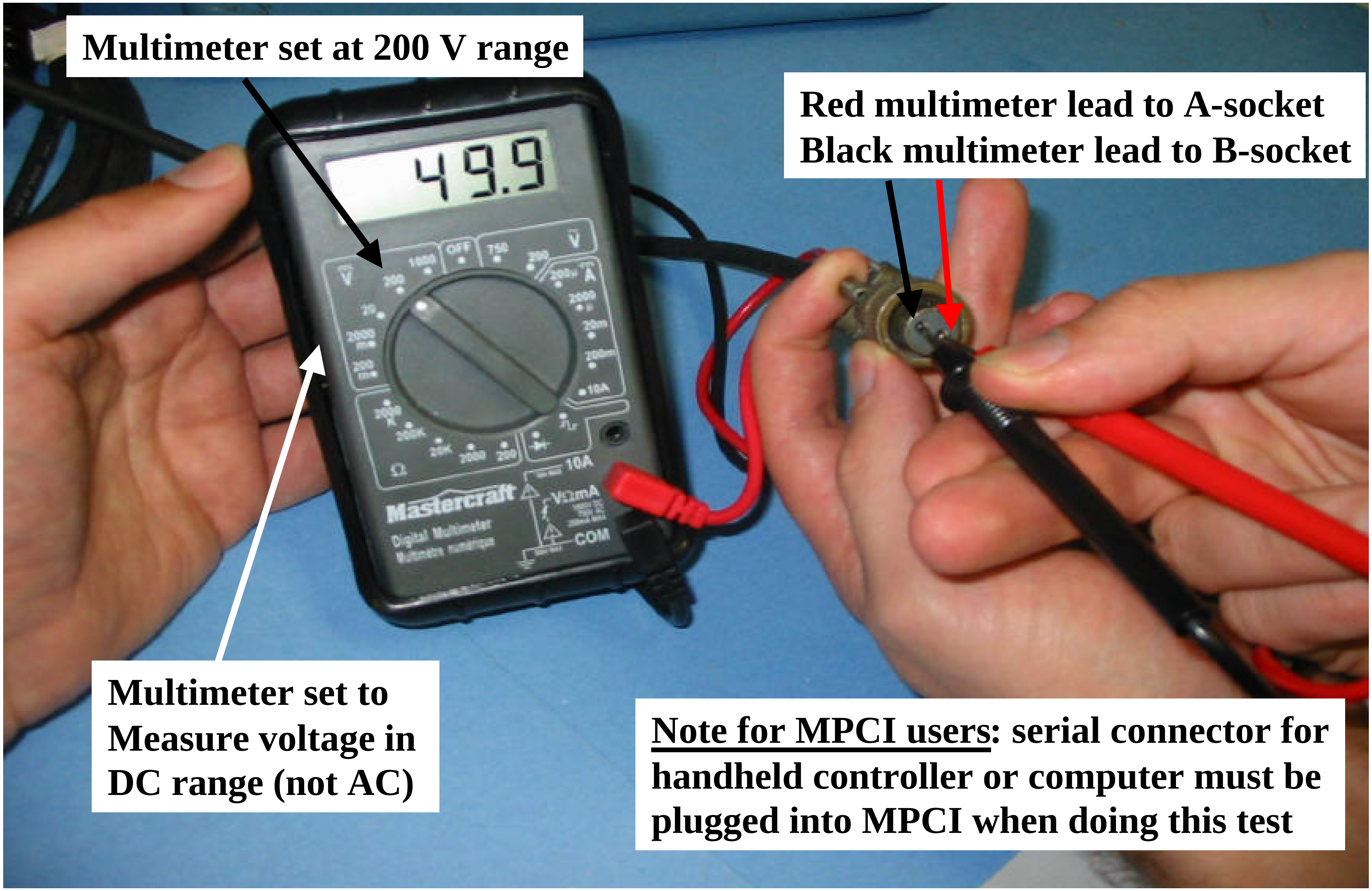
Pic.2 MPCI unit showing typical set-up configuration



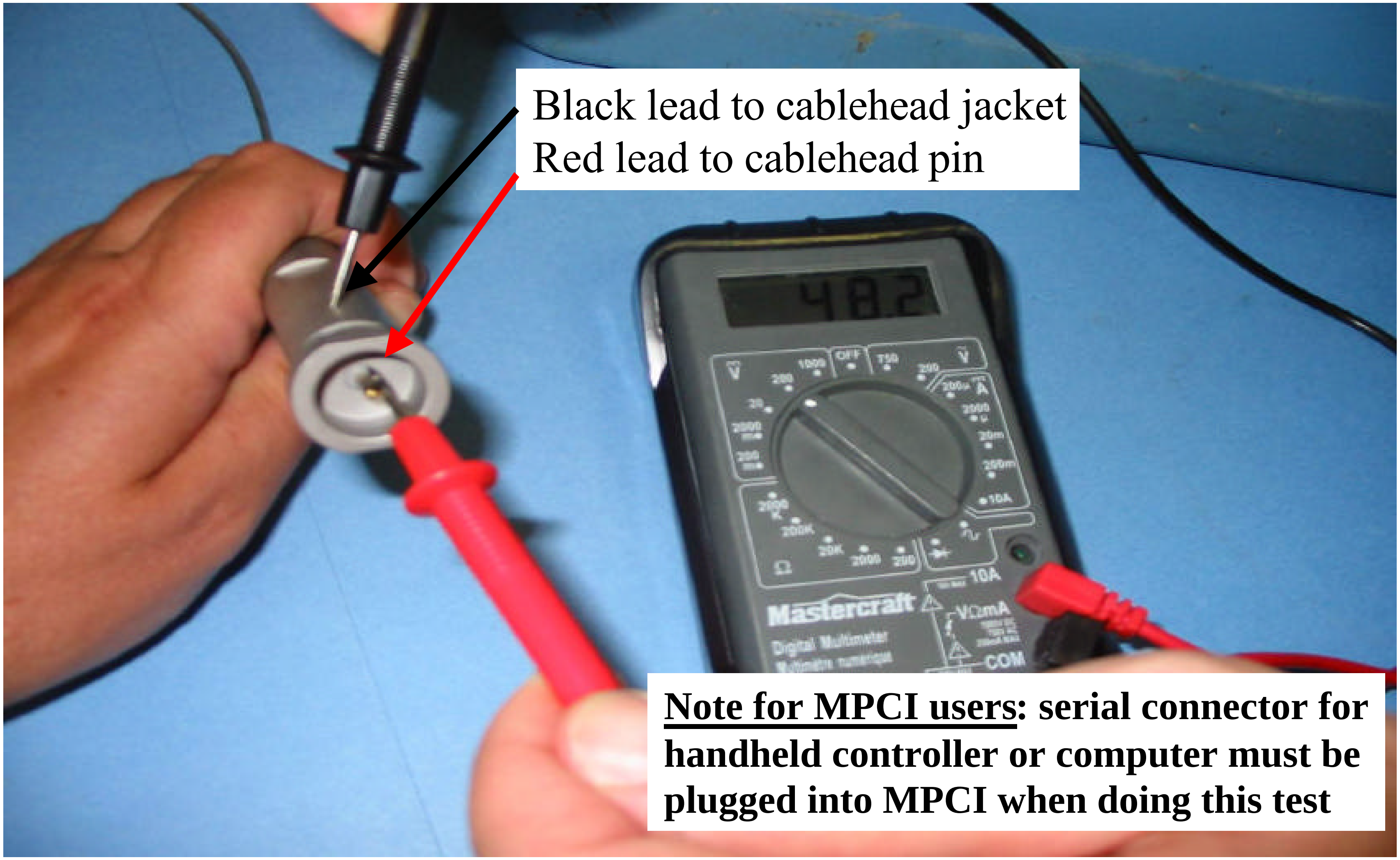
Pic.3 Testing 12 VDC Power Supply using Multimeter



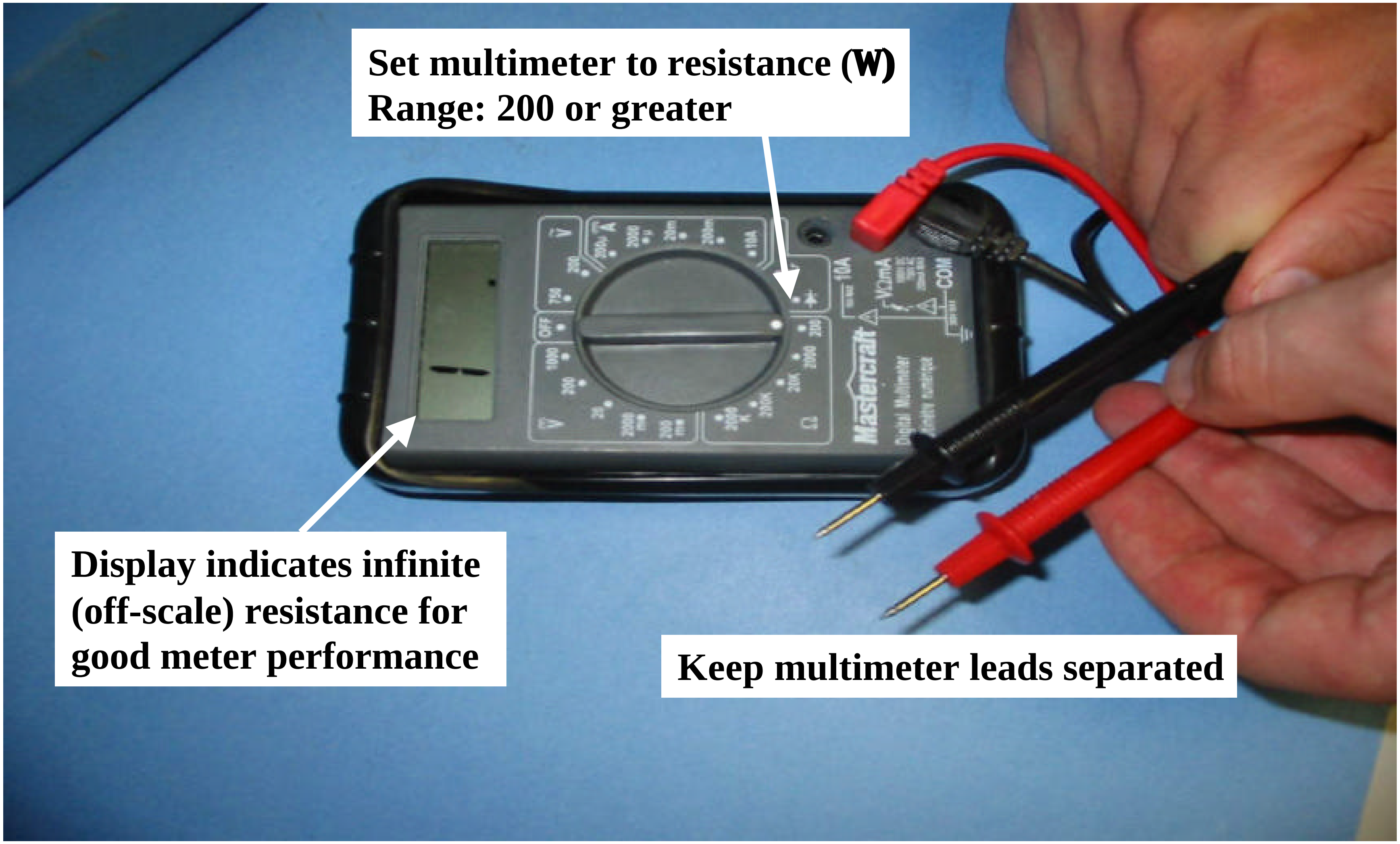
Pic.4 Testing Power Cable Voltage
(should indicate greater than 12.00 V DC for good battery and cable)



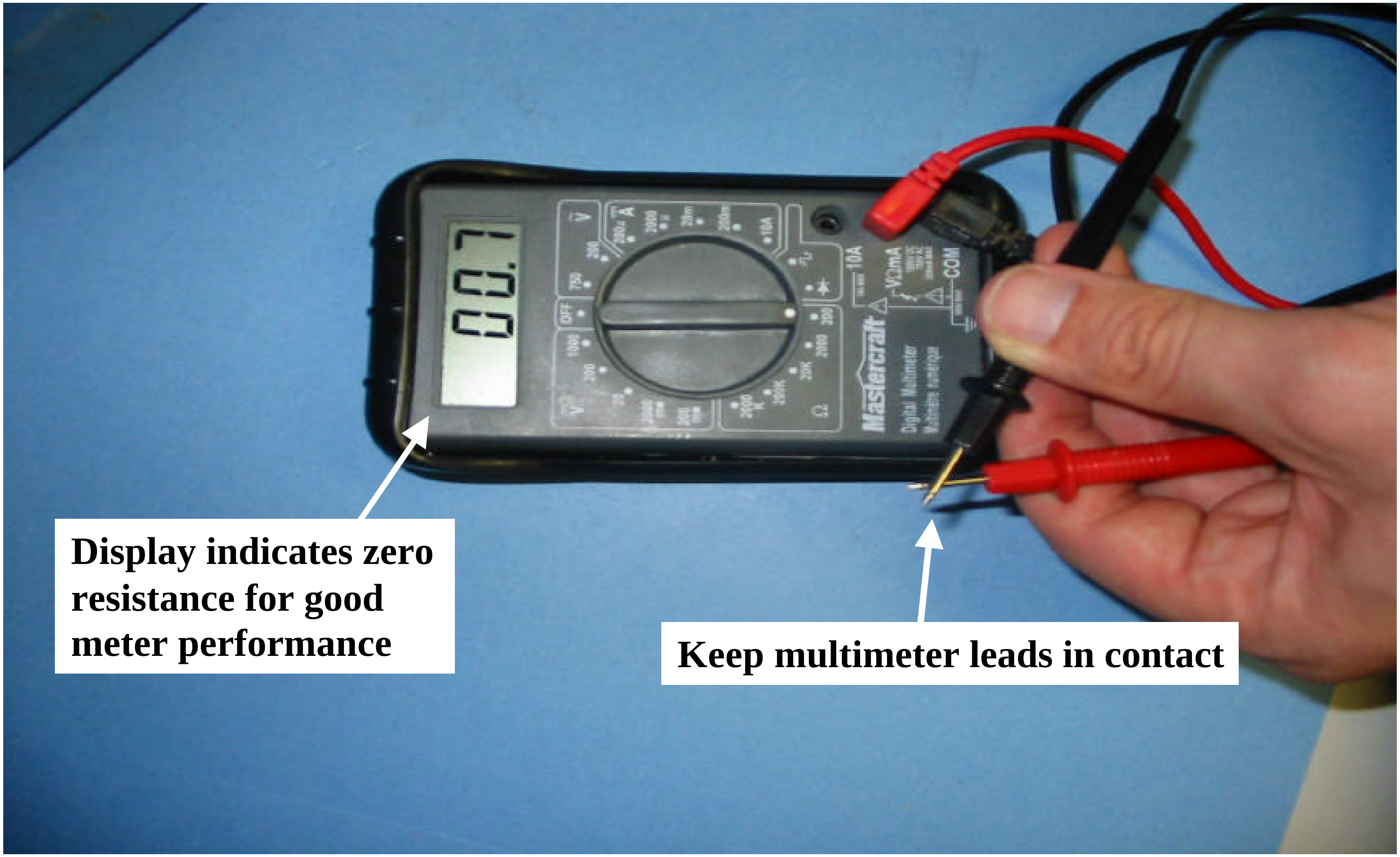
Pic.5 Testing Power output from MPCI or MAGI using data cable (should be greater than 48 V) ***Note: MPCI/MAGI must have power 'on' and be connected to power supply.***



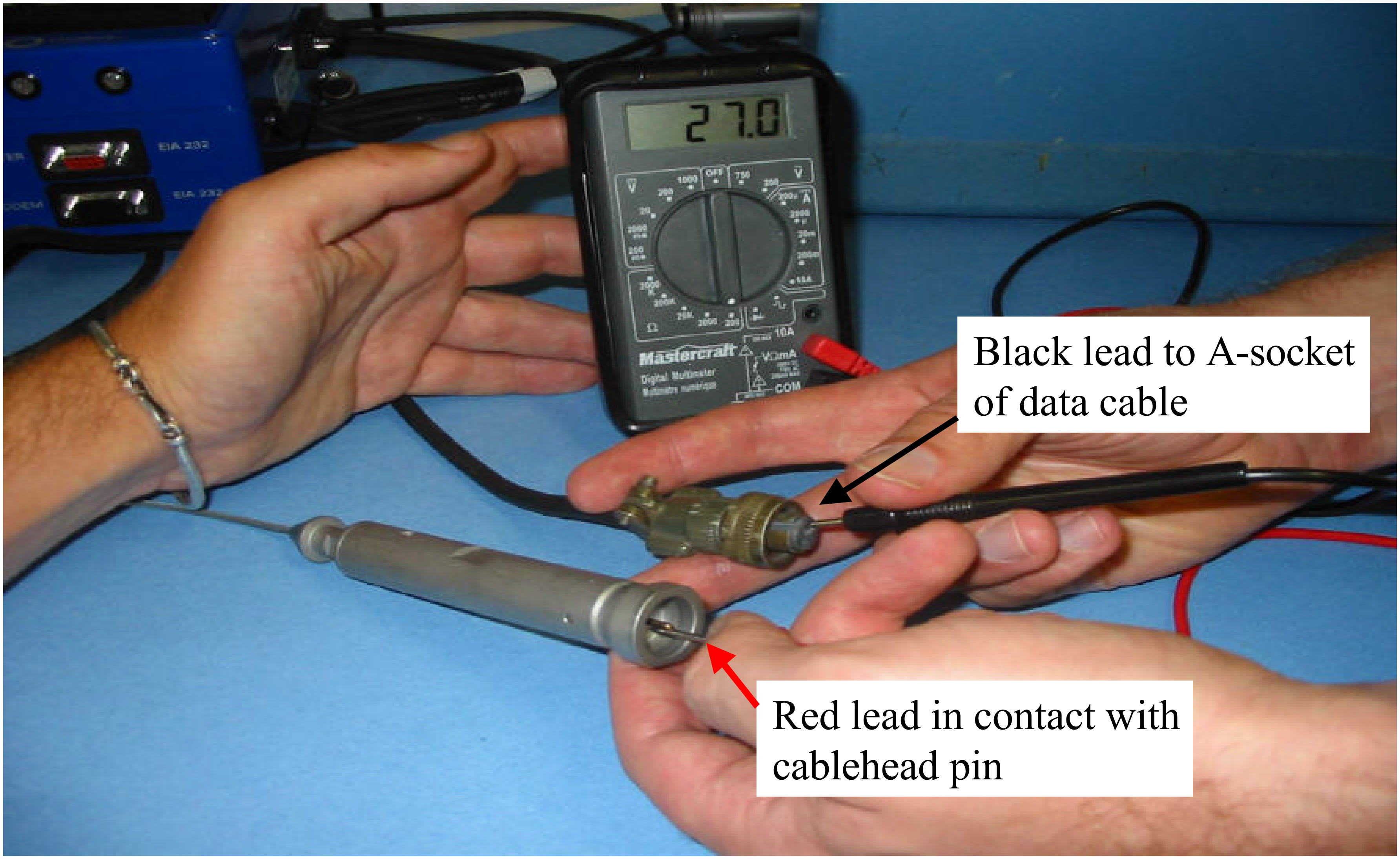
Pic.6 Checking power output at cablehead (should be greater than 48 V)
Note: MPCI/MAGI must have power 'on' and be connected to power supply.



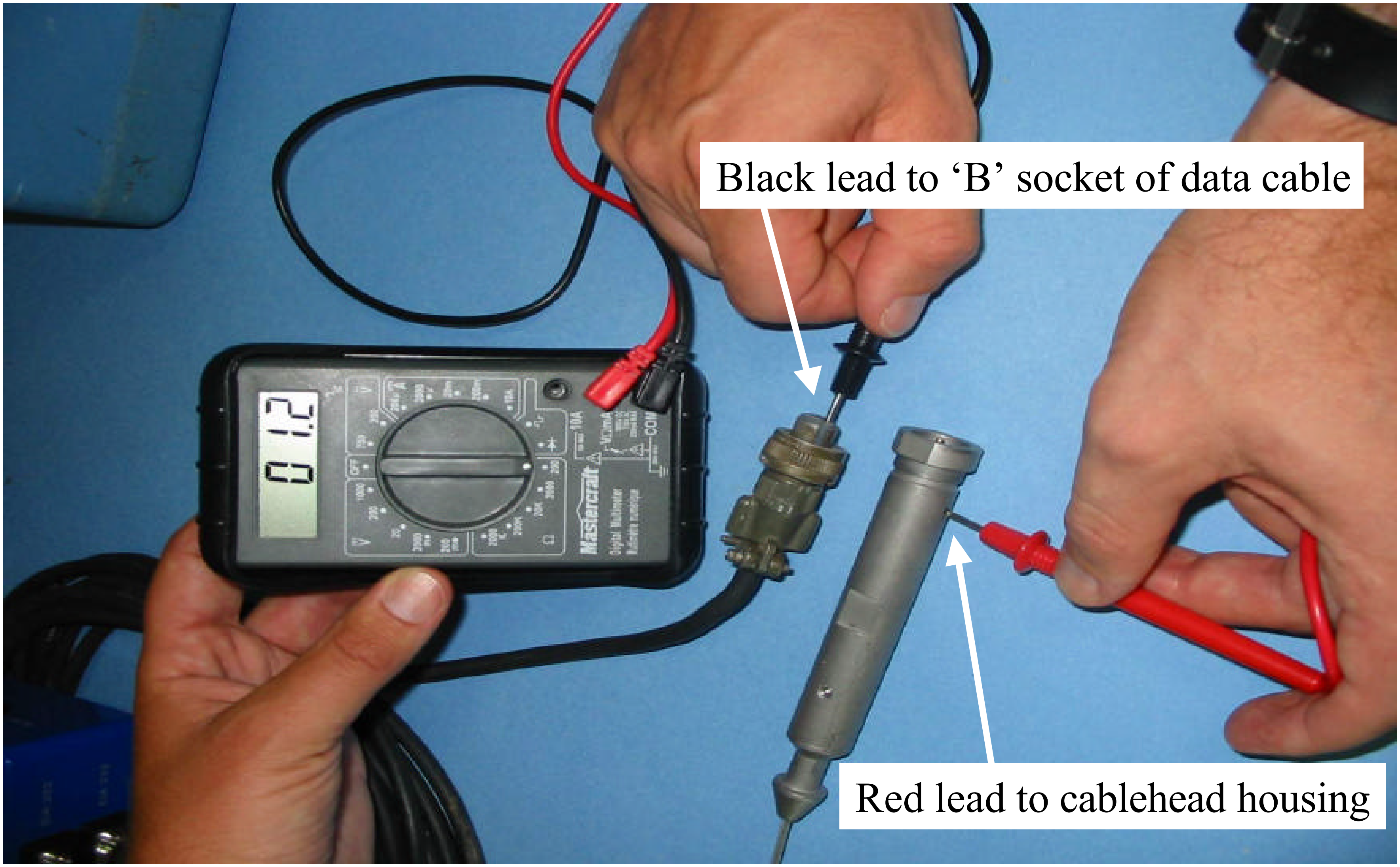
Pic.7 Test multimeter “open” resistence



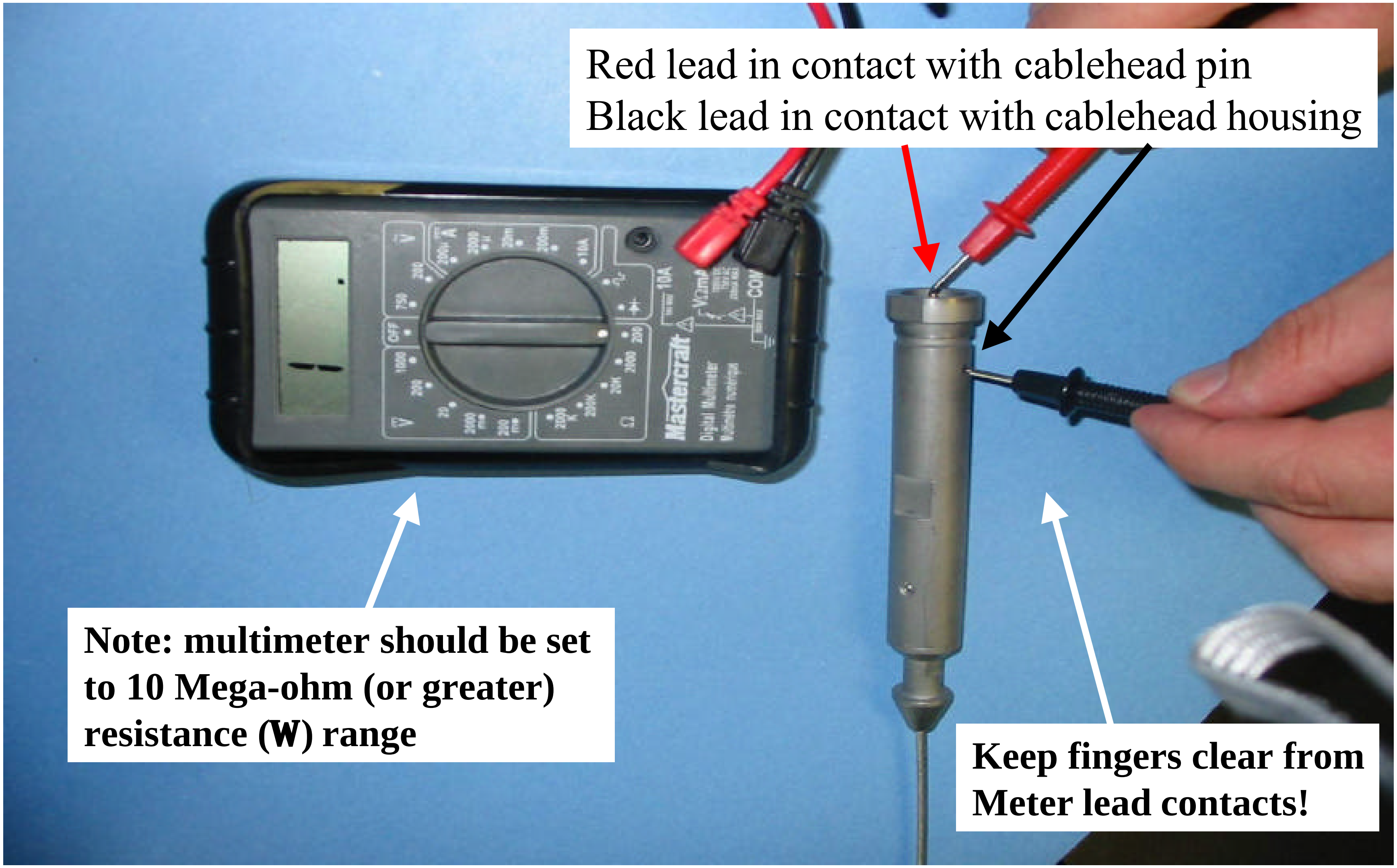
Pic.8 Test multimeter "closed" resistence



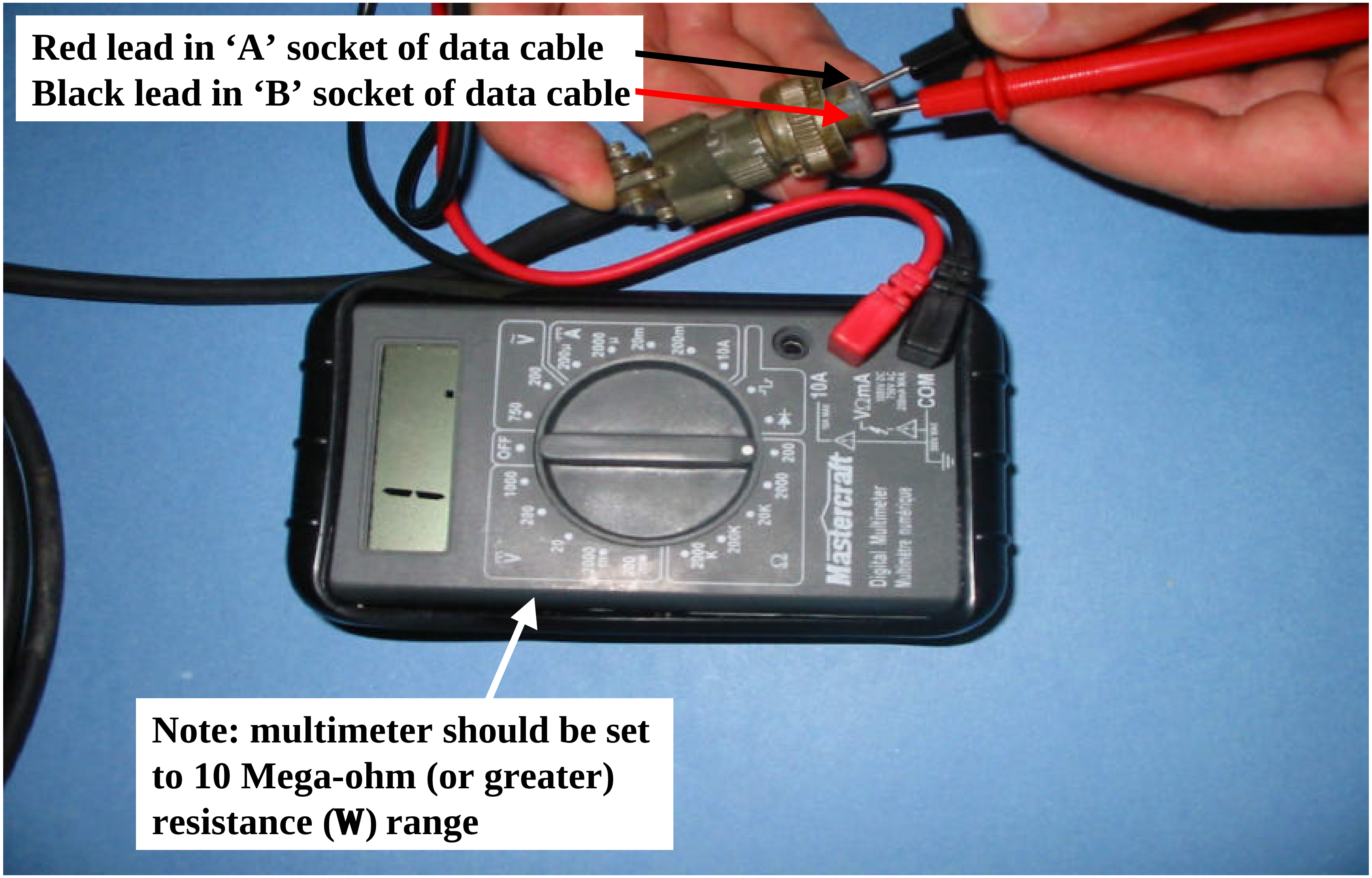
Pic.9 Test wireline 'A-A' resistance (approx. 27 W/1000 ft)



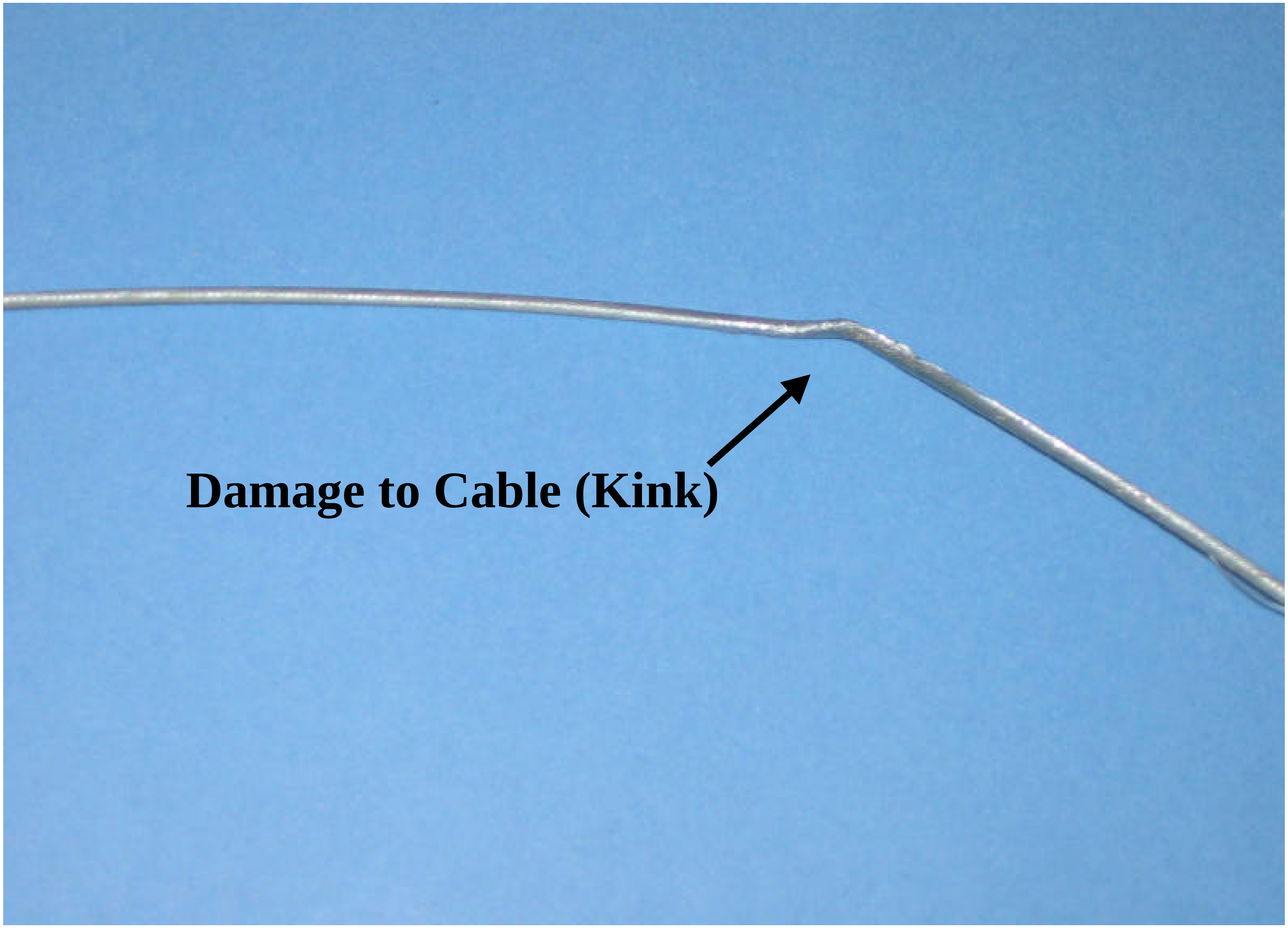
Pic.10 Test wireline ‘B-B’ resistance (should be less than ‘A-A’)



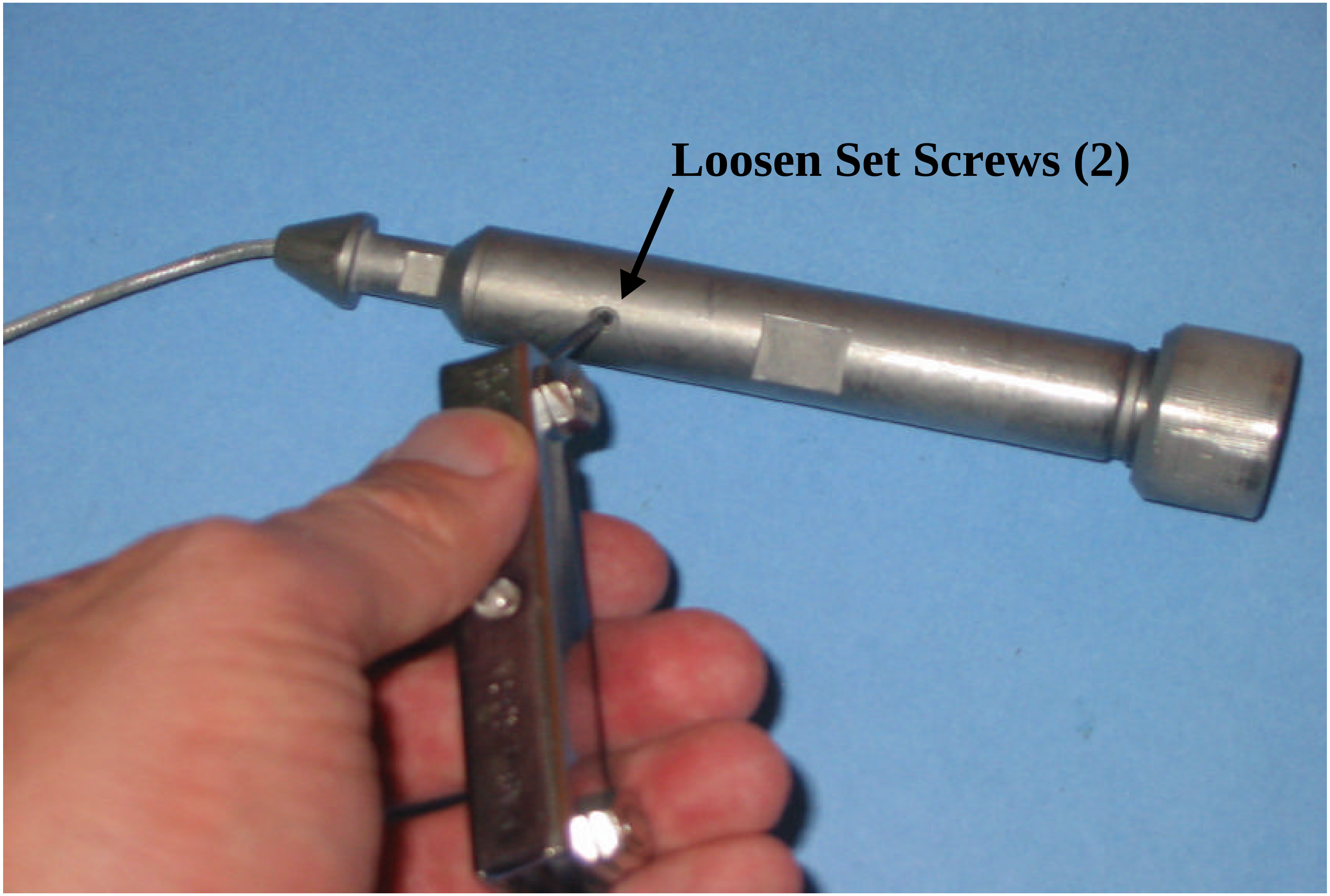
Pic.11 Test wireline 'A-B' resistance at cablehead (should be off-scale)



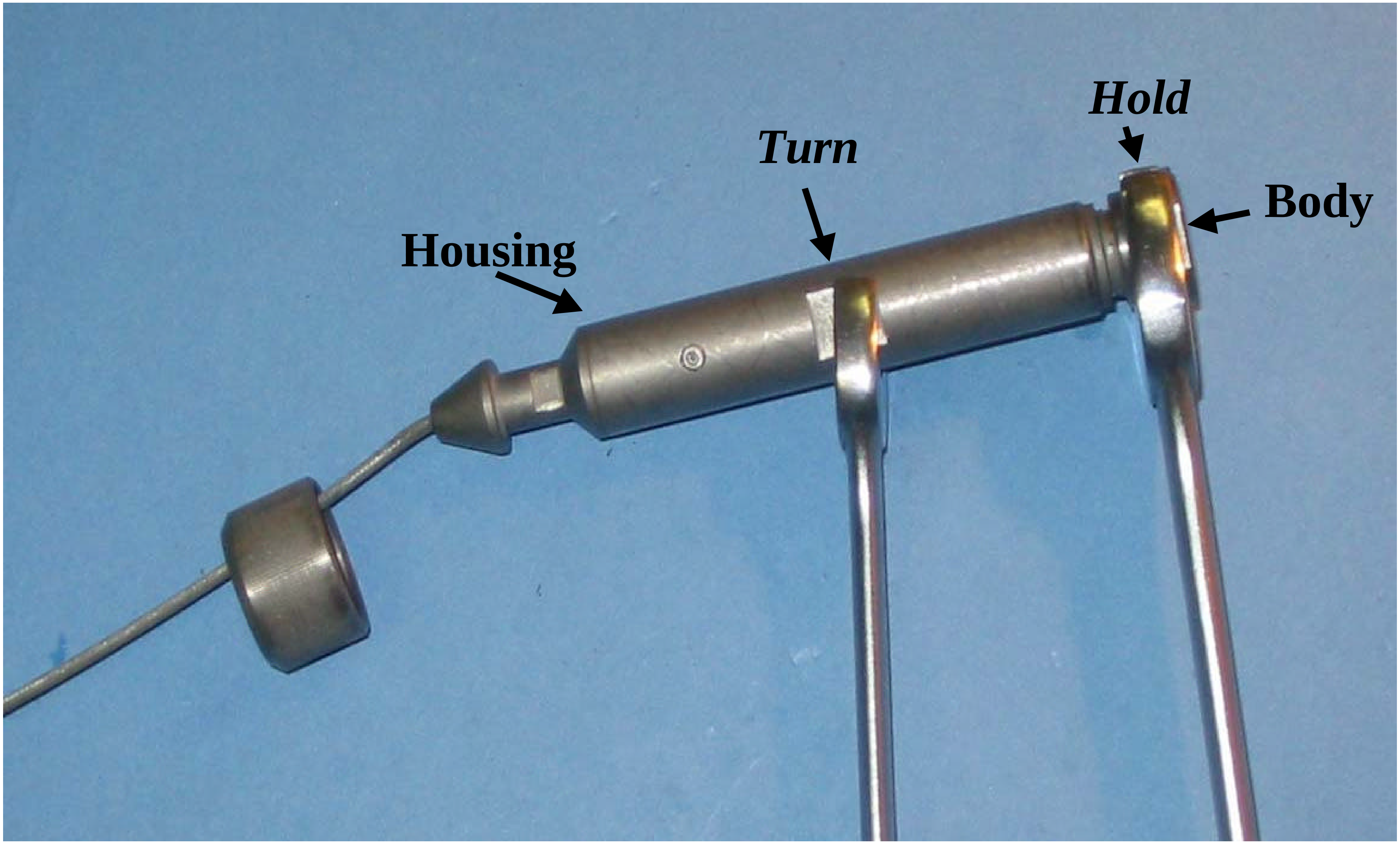
Pic.11 Test wireline ‘A-B’ resistance at data cable (should be off-scale)



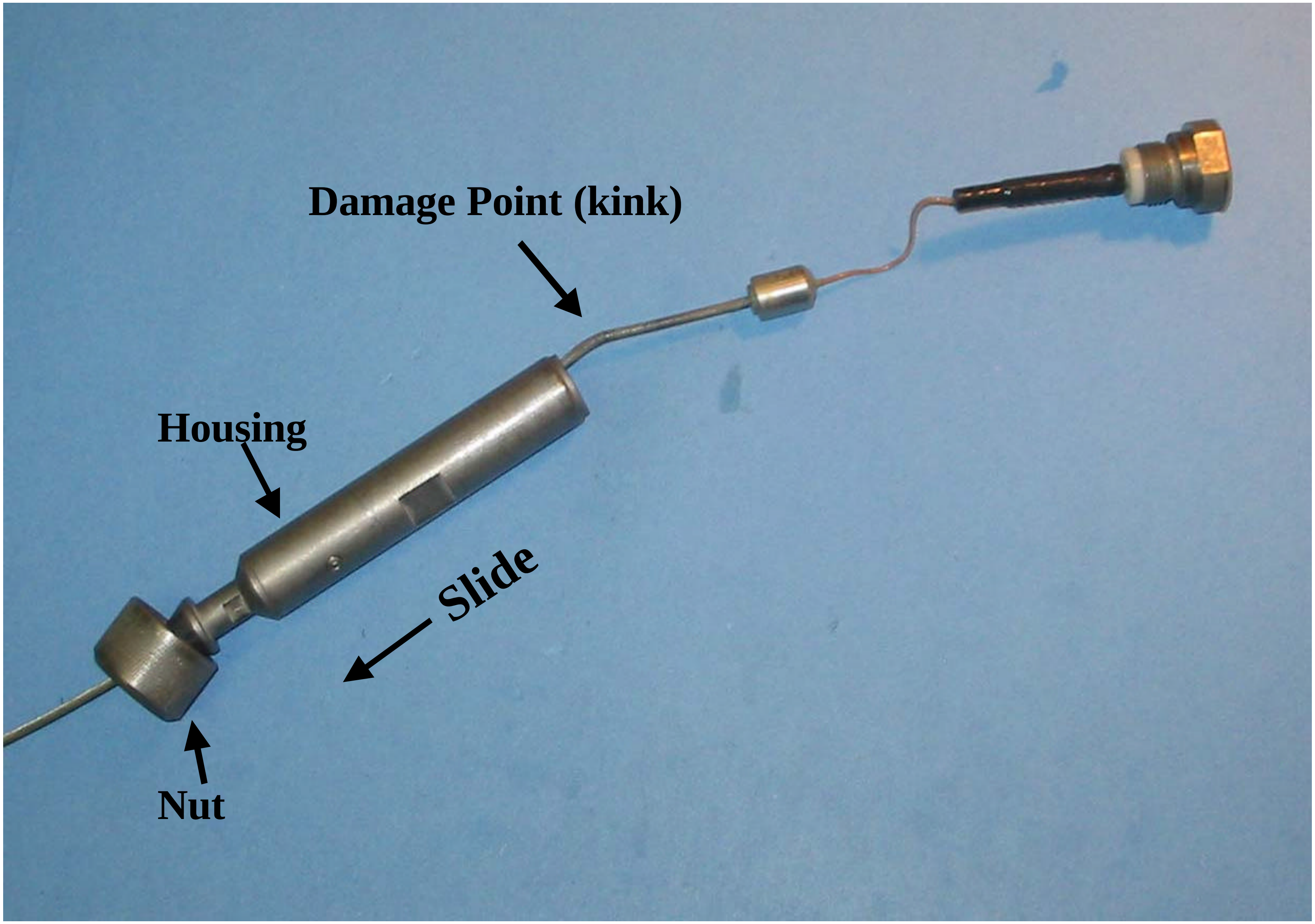
Pic.1 Identification of Cable Damage



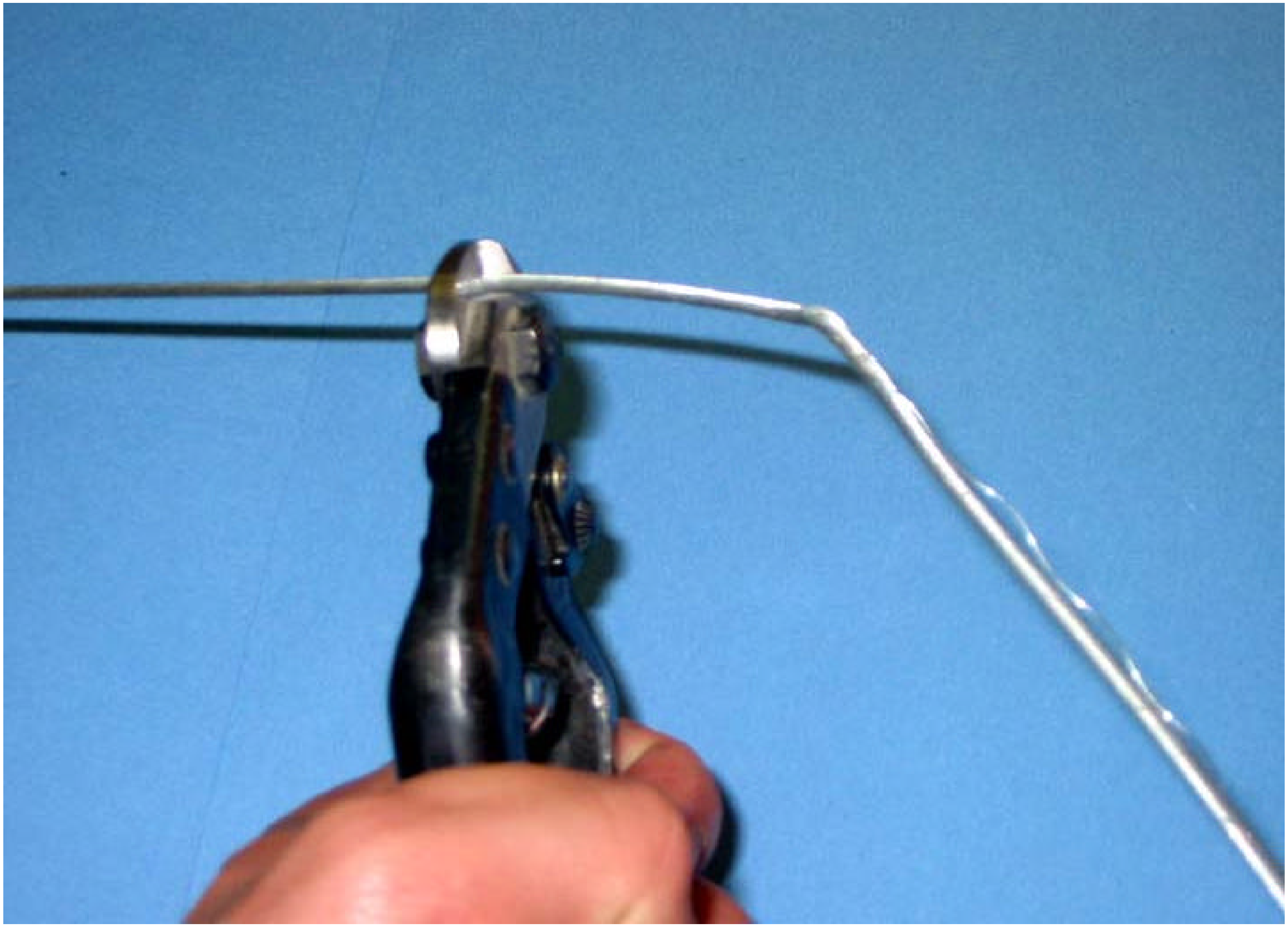
Pic.2 Cablehead Disassembly (1): Loosen set Screws



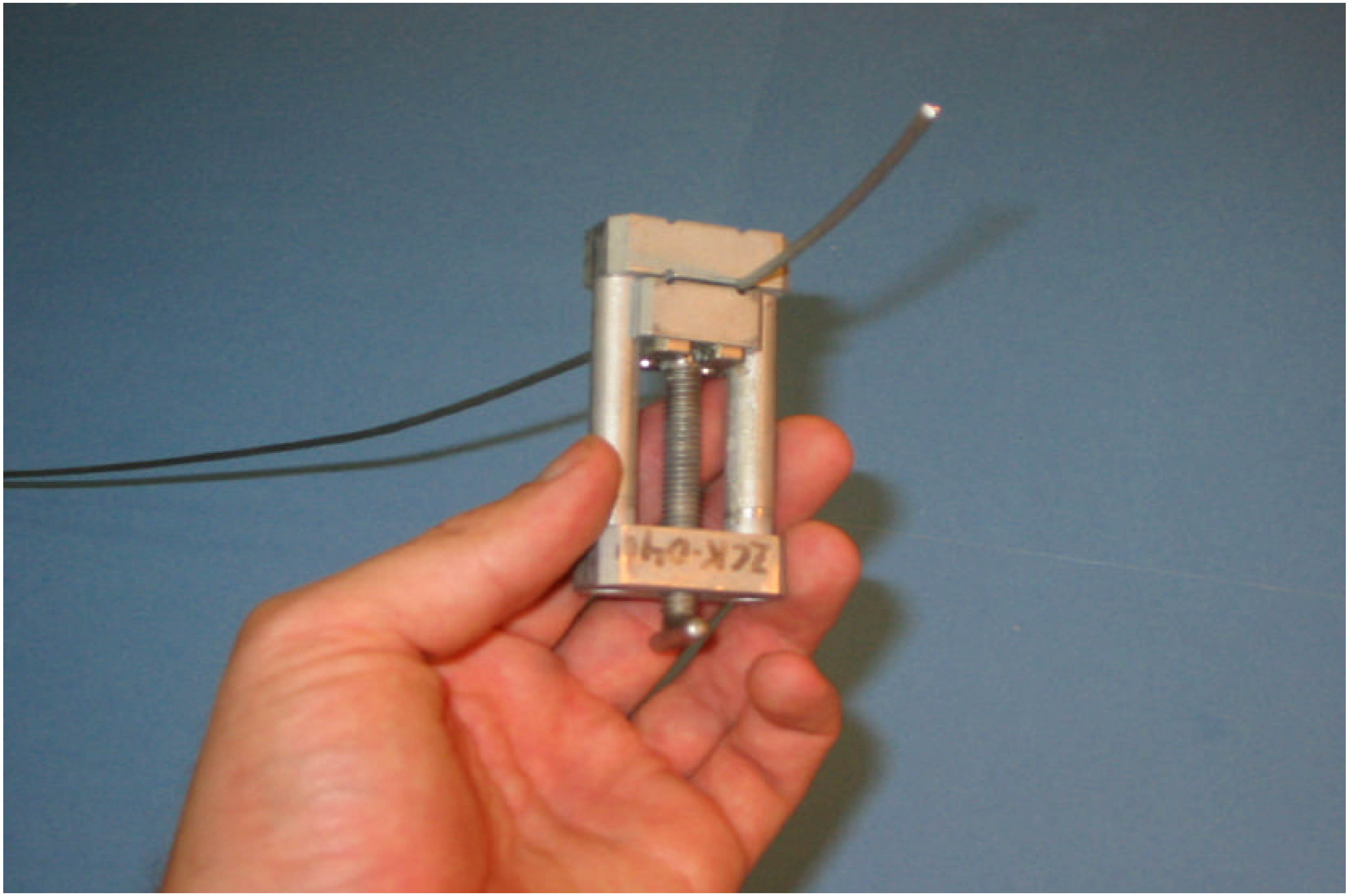
Pic.3 Cablehead Disassembly(2): Unscrew Housing From Body



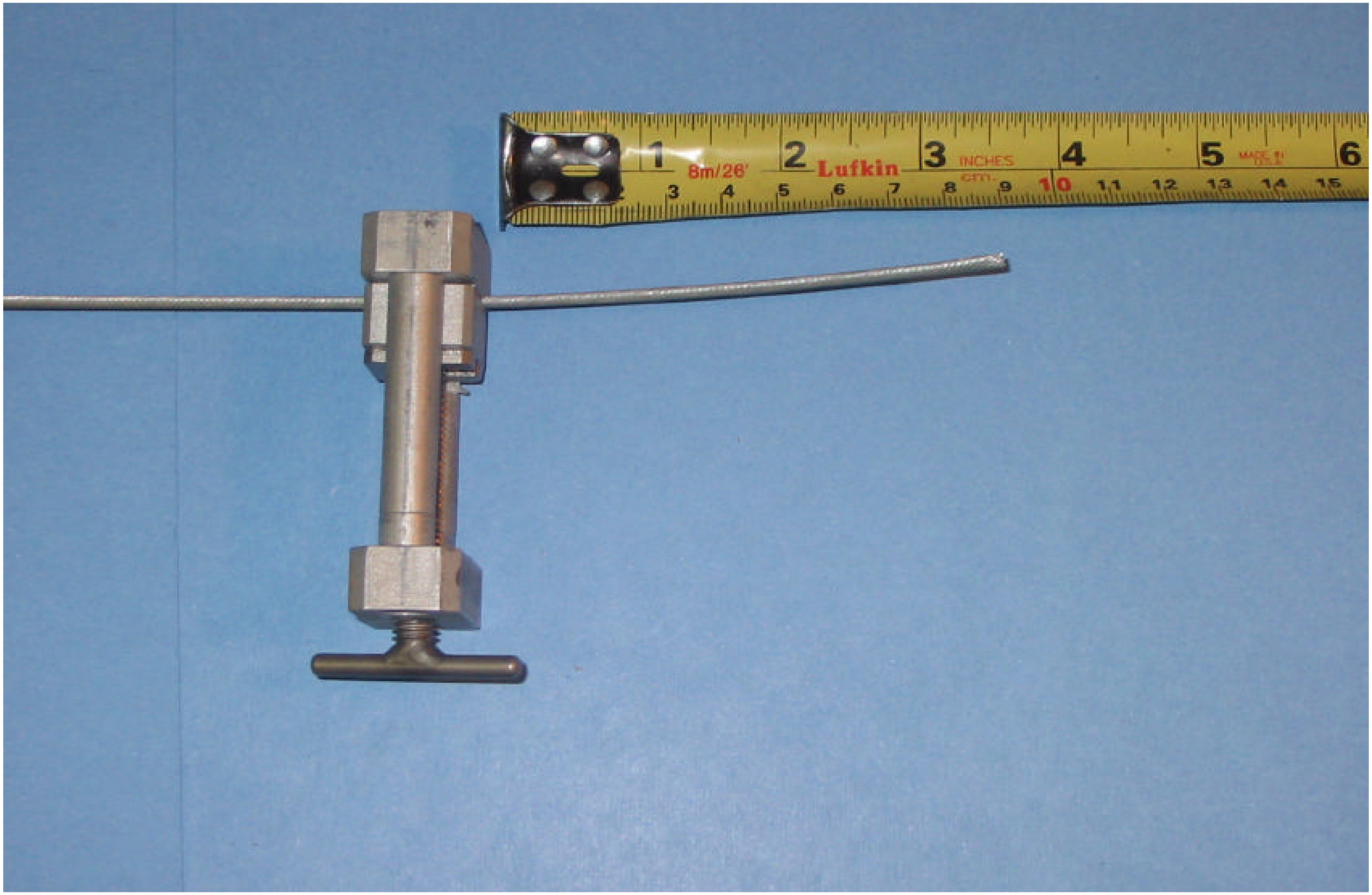
Pic.4 Cablehead Disassembly(3):
Slide Housing and Cablehead Nut Past Damage Point



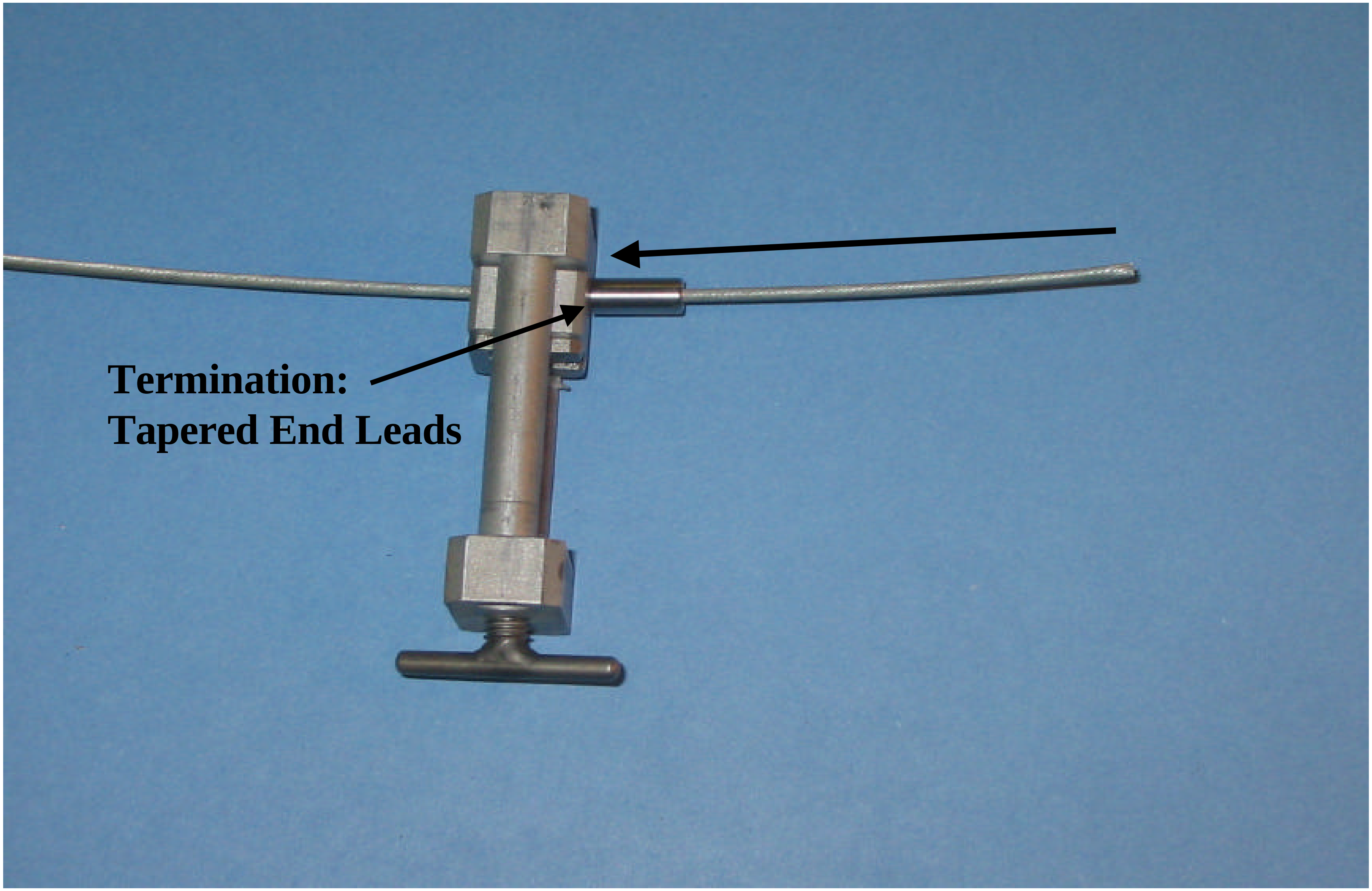
Pic.5 Cut Cable above Damage Point



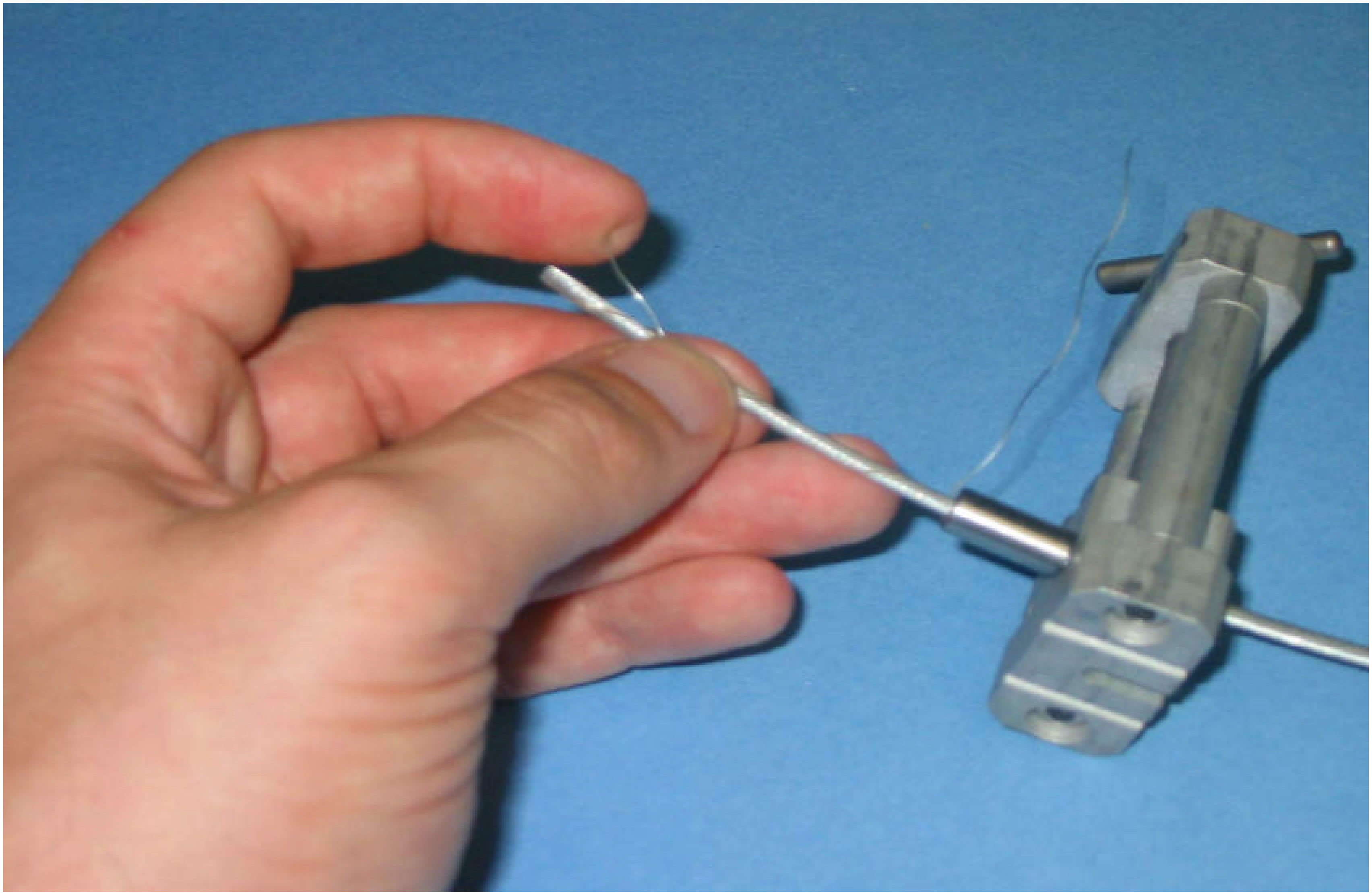
Pic.6a Clamp Cable in Termination Jig



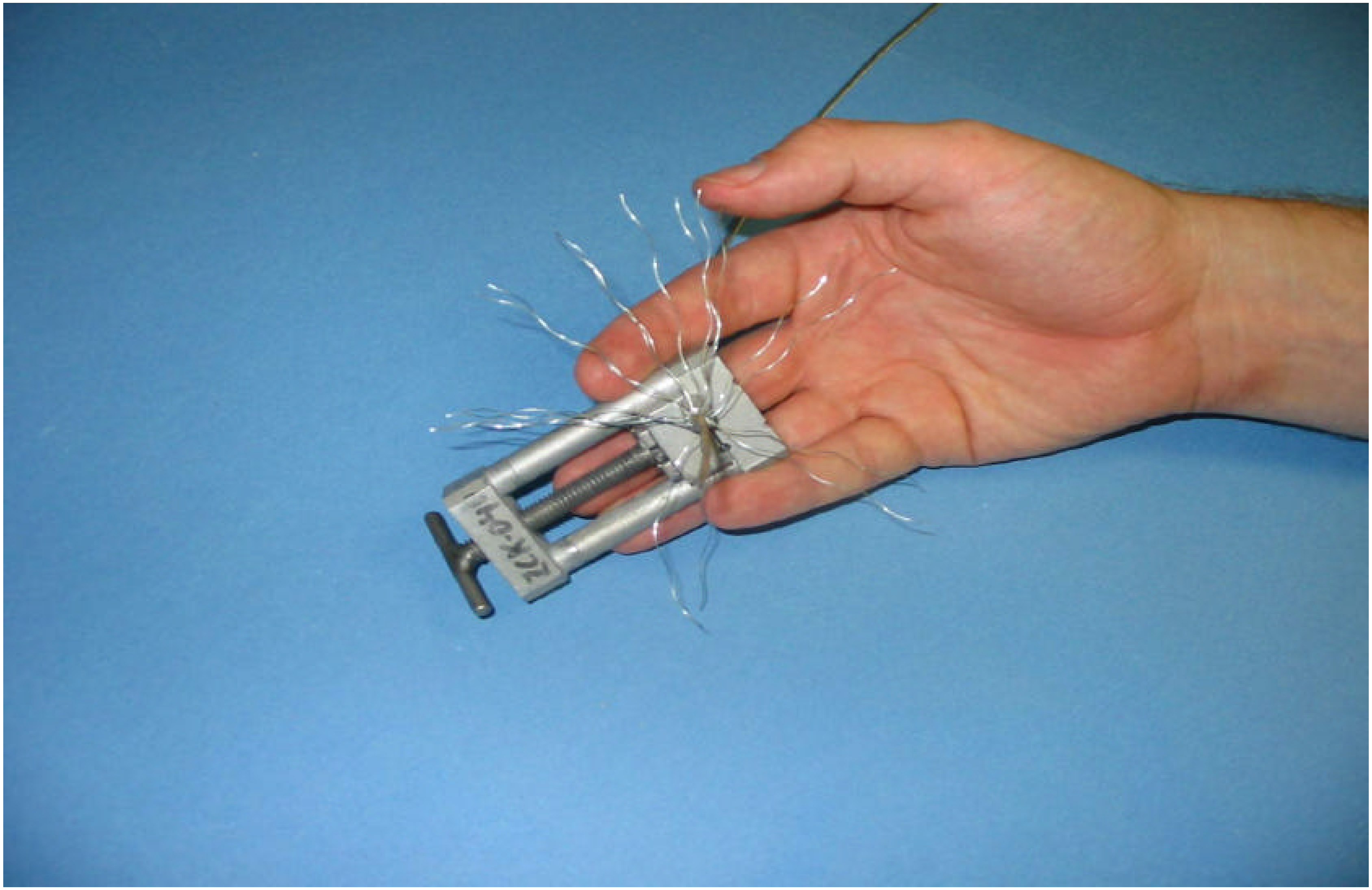
Pic.6b Leave 3.5 inches Cable Exposed



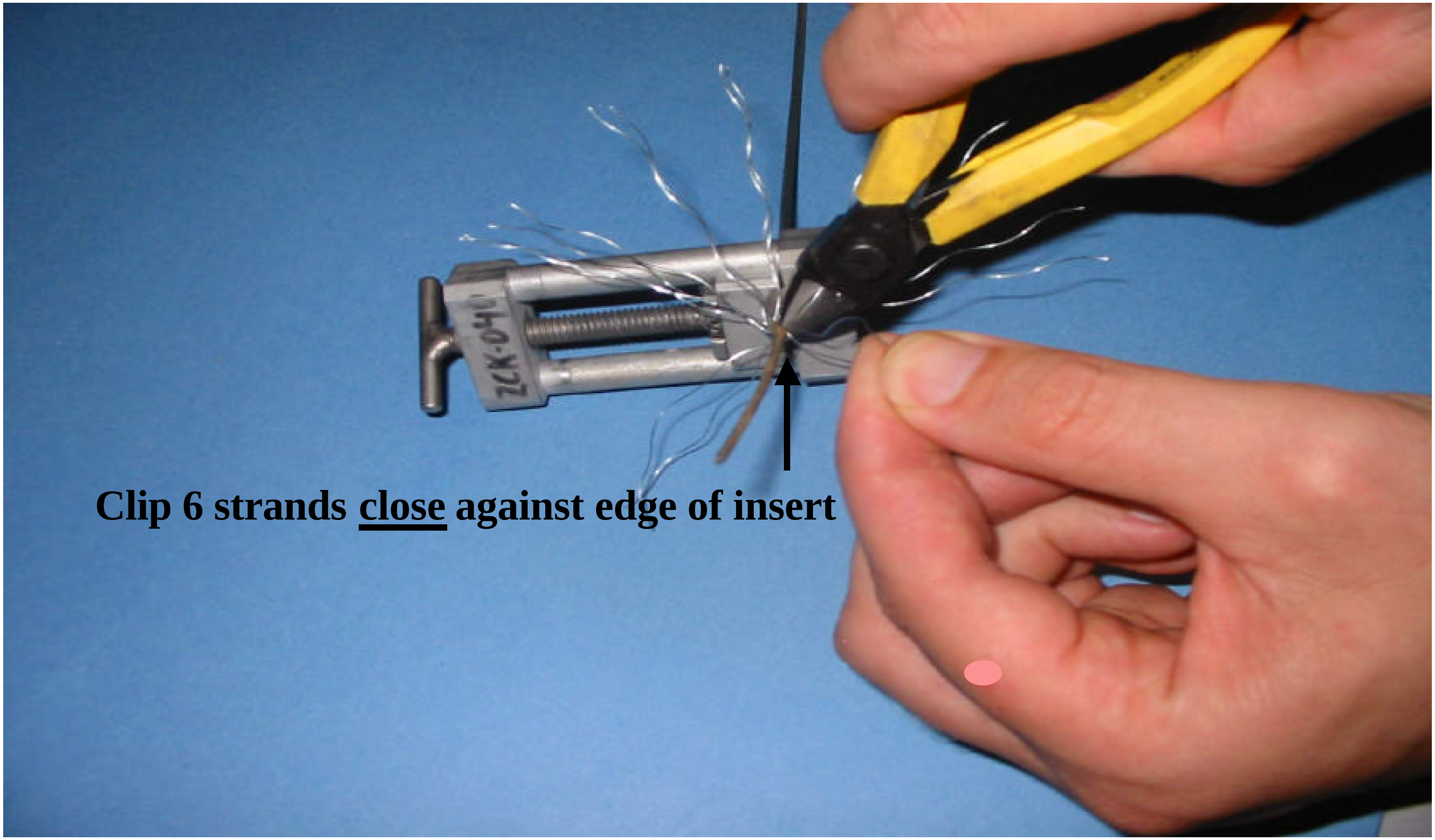
Pic.6c Slide Termination Insert Over Cable



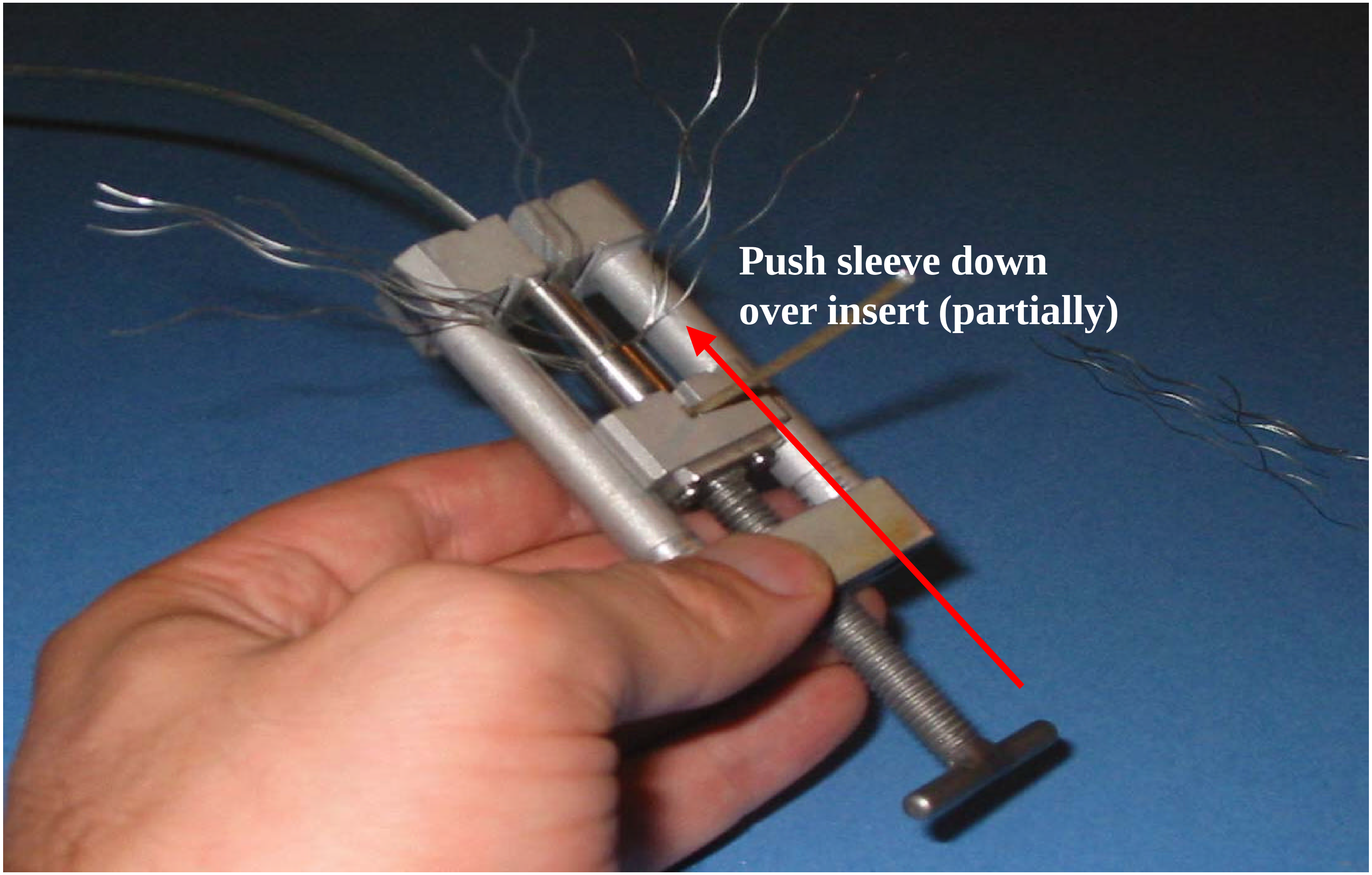
Pic.7a Unwind Outer-layer Strands (start)



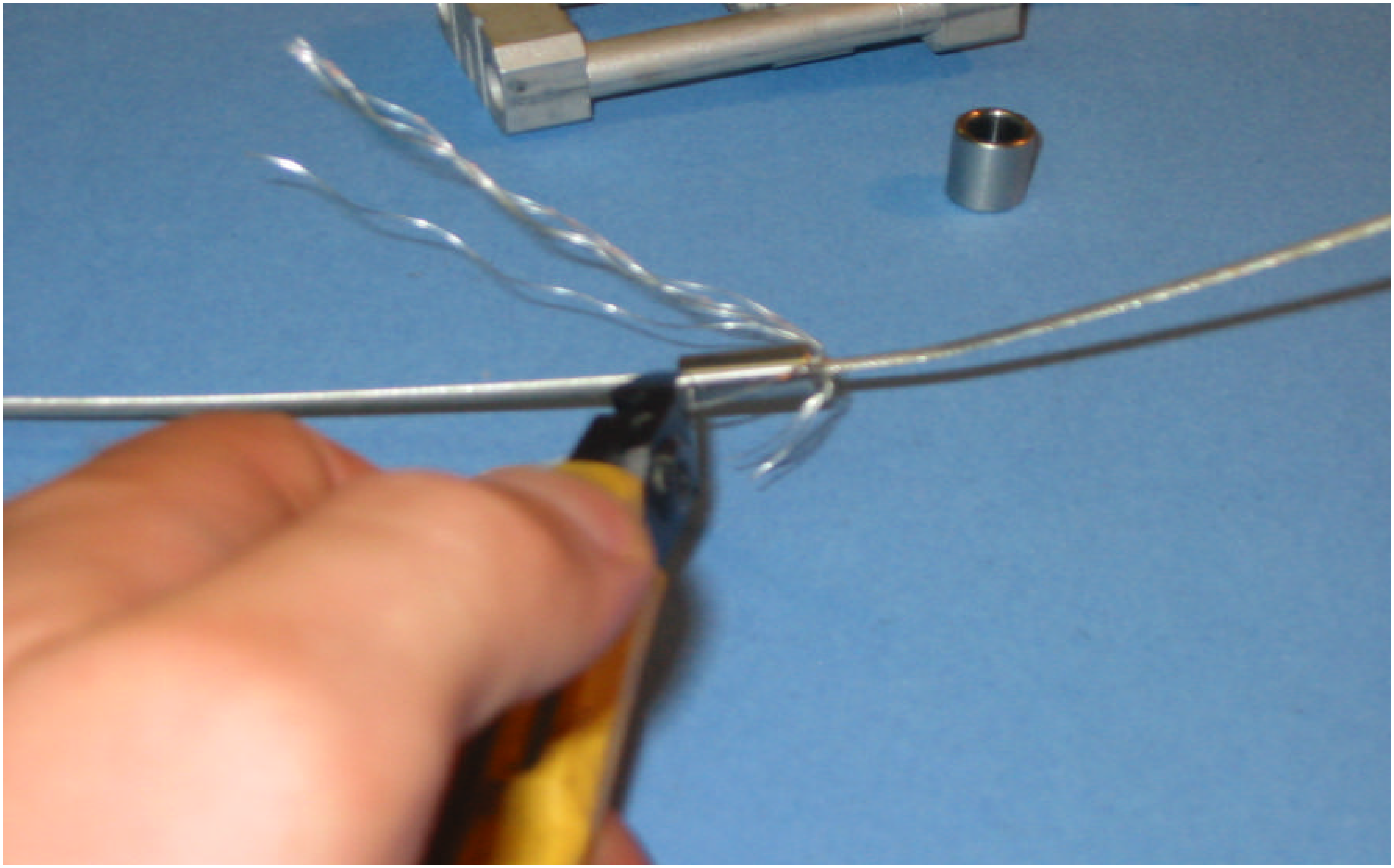
Pic.7b Unwind Outer Layer Strands (finish)



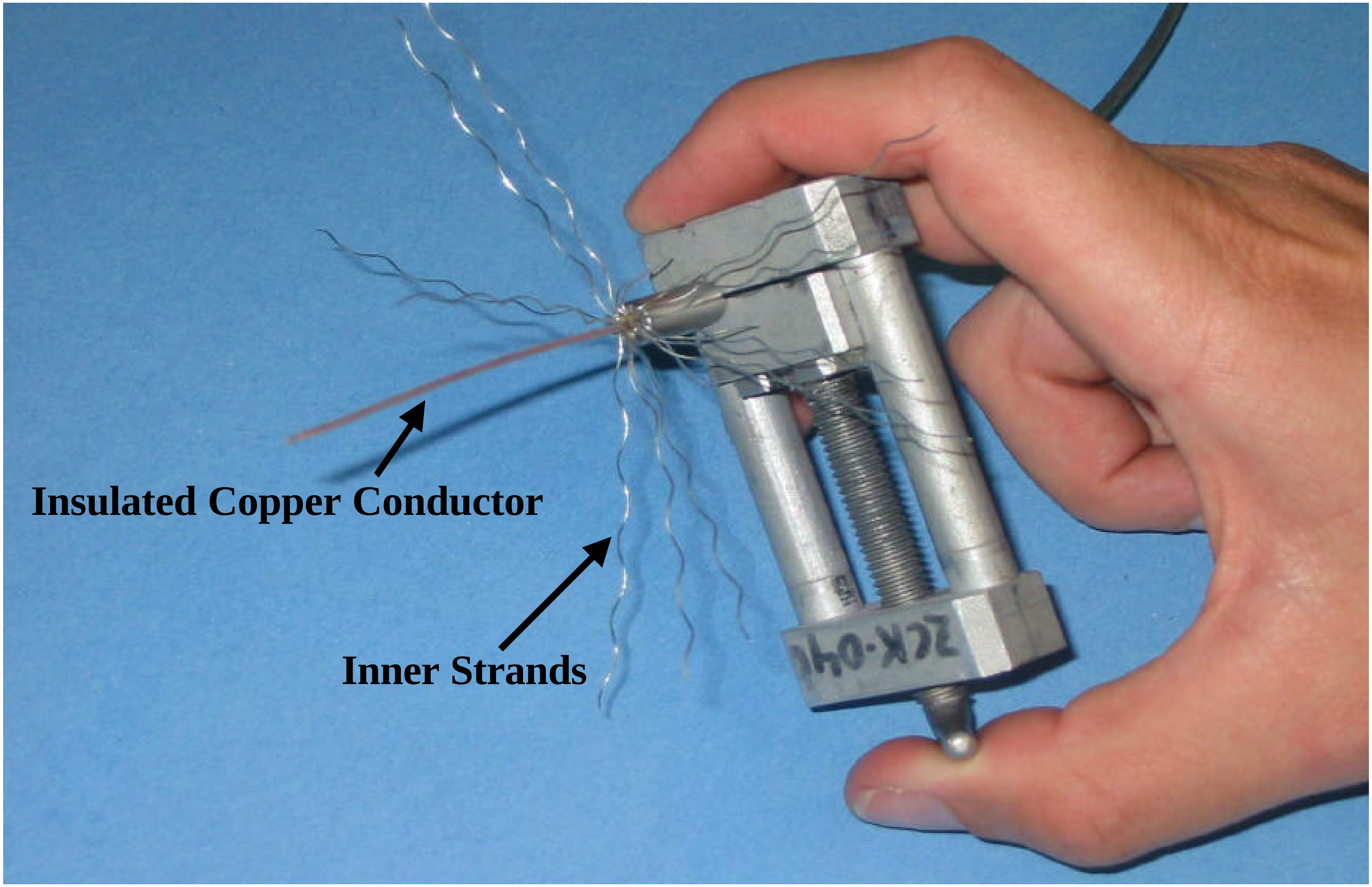
Pic.8 Clipping Outer Wire Strands (6 strands out of 18)



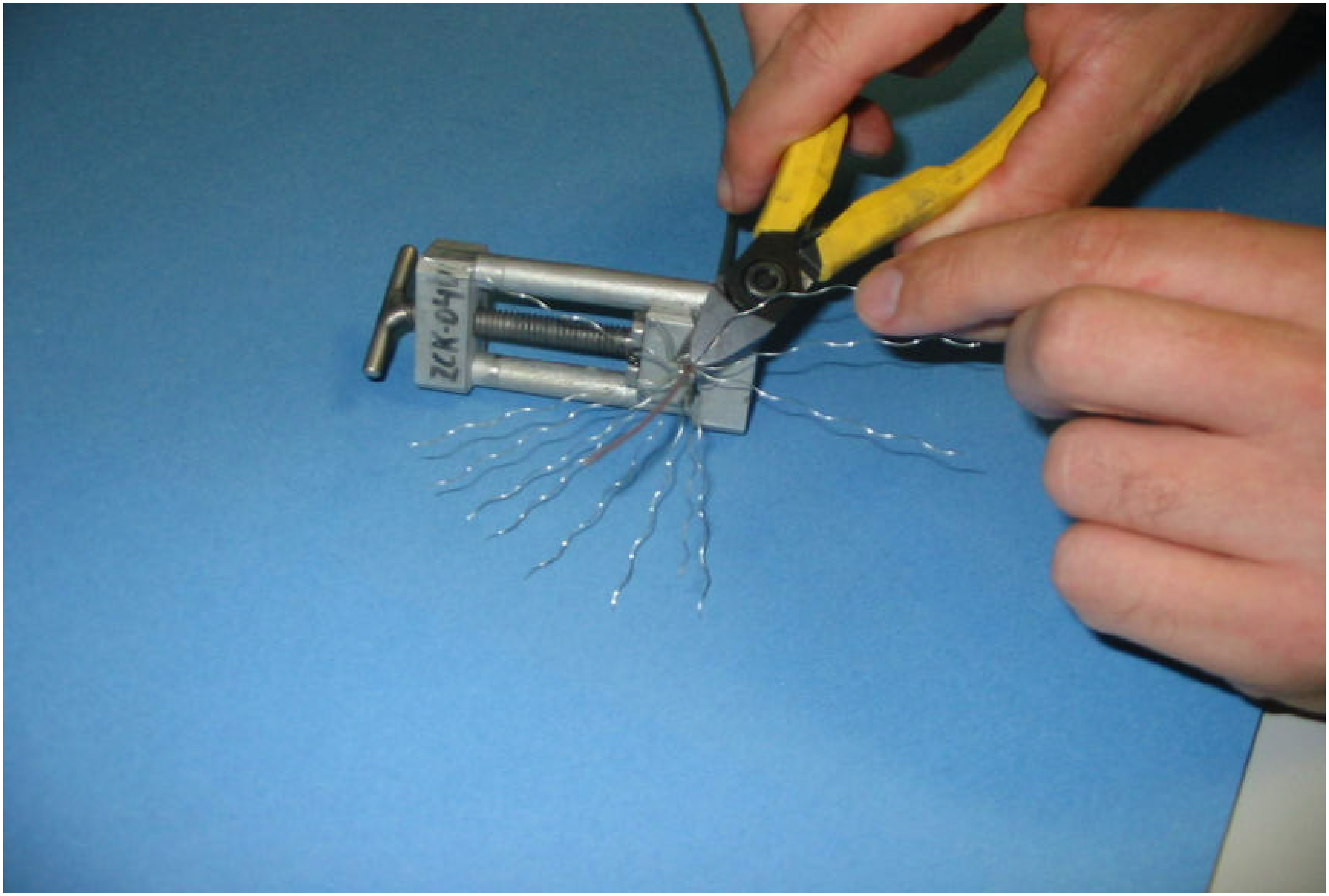
Pic.9 Partially Push Sleeve Down on Insert Using Jig
(enough to bend strands down along insert)



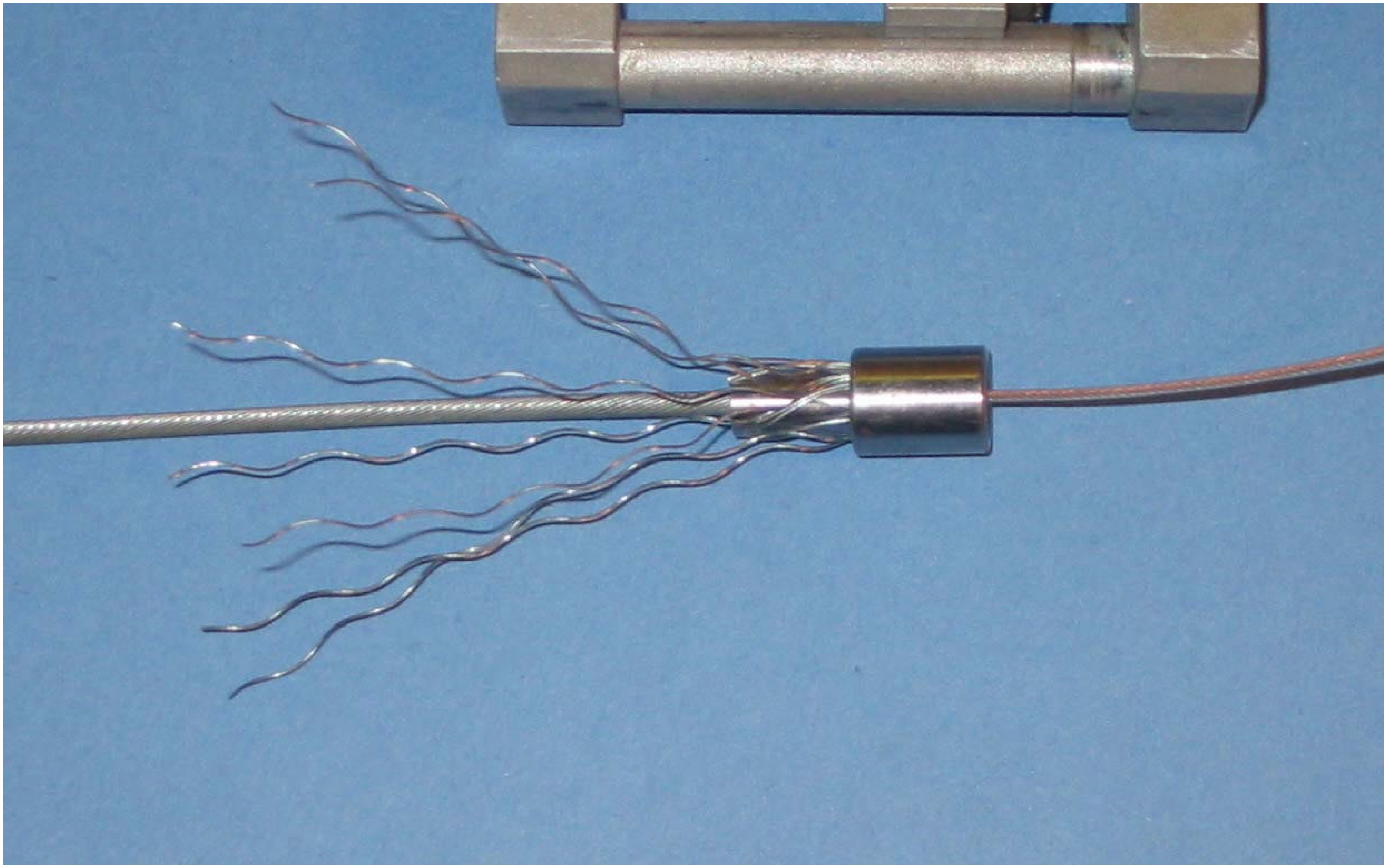
Pic.10 Trim Outer Wire Strands to Base of Insert.



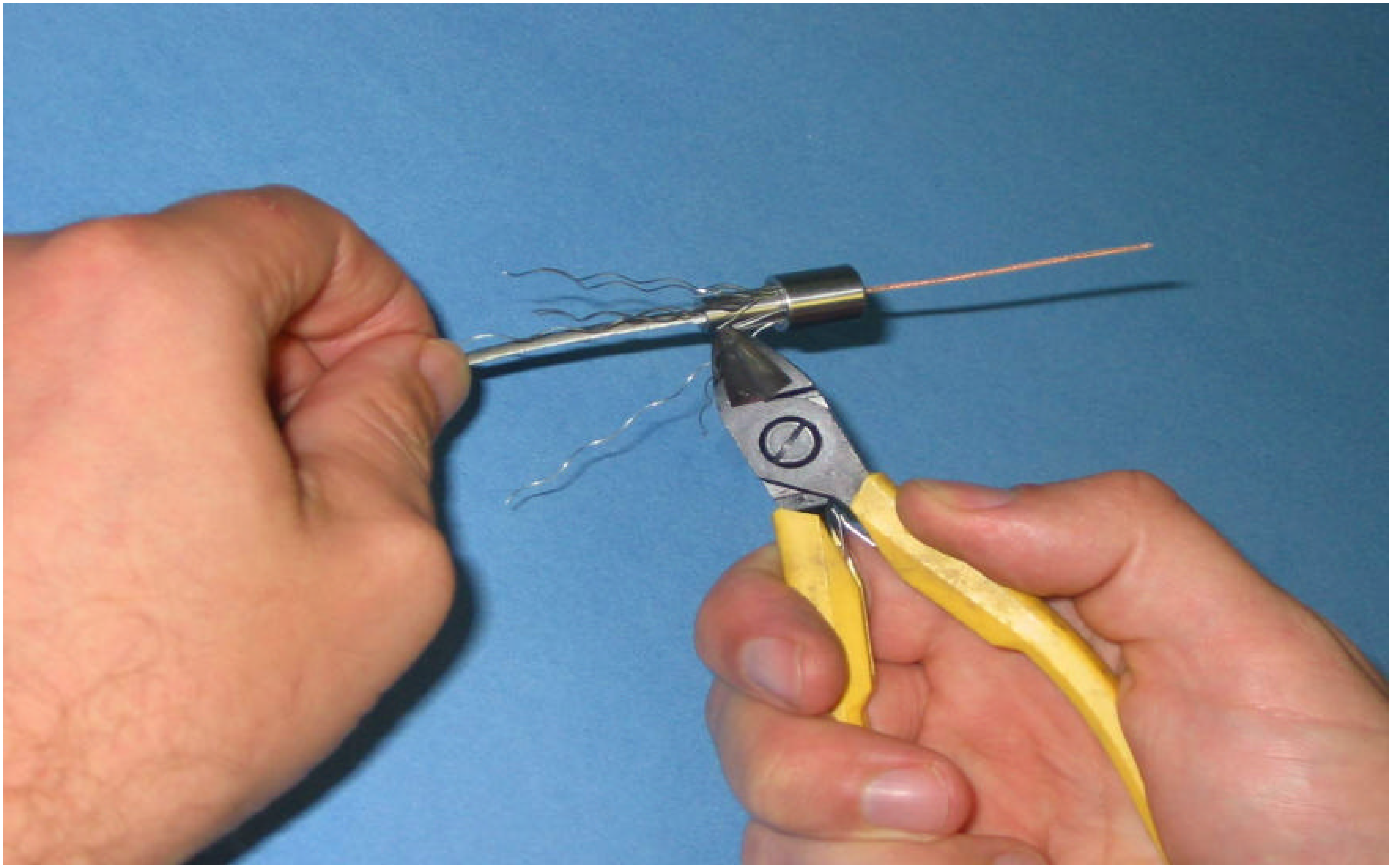
Pic.11 Unwind inner-layer strands of armor (exposing the insulated conductor wire)



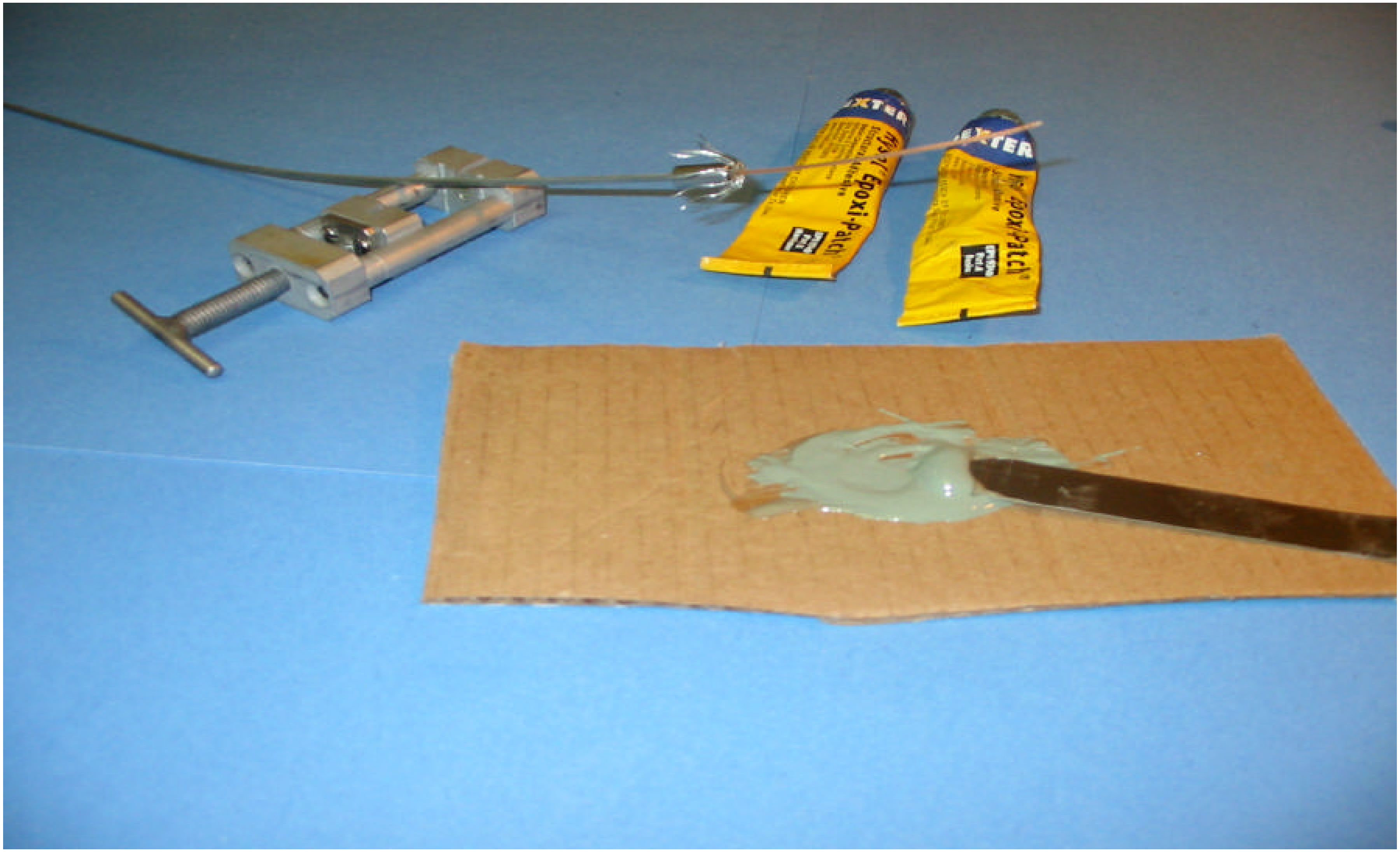
Pic.12 Clip 5 of the 12 inner armor strands close to the top of the insert



Pic.13 Bend down Remaining Inner Wire Strands
(Use jig and termination sleeve)

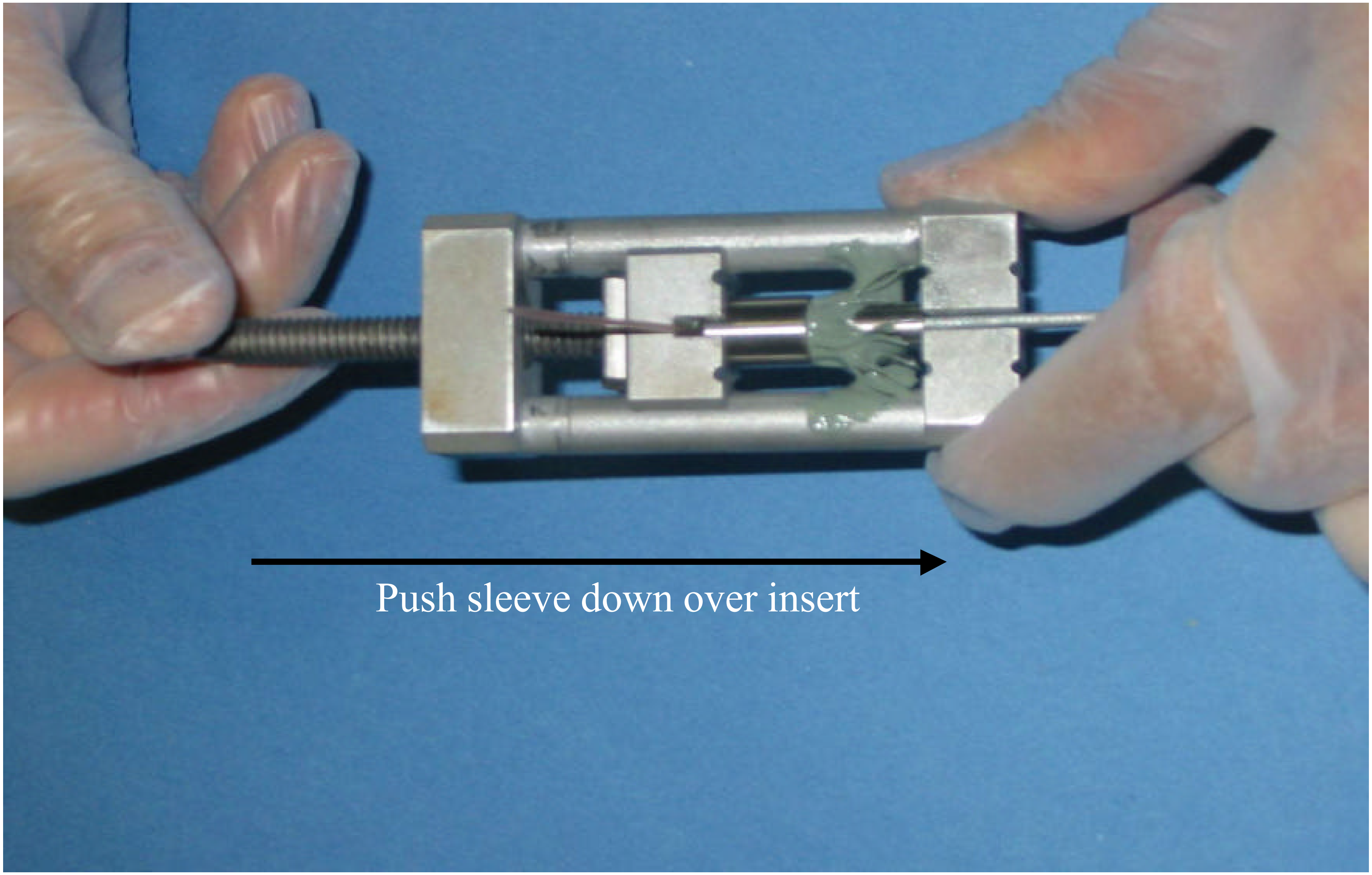


Pic.13 Trim Inner Wire Strands to Base of Insert

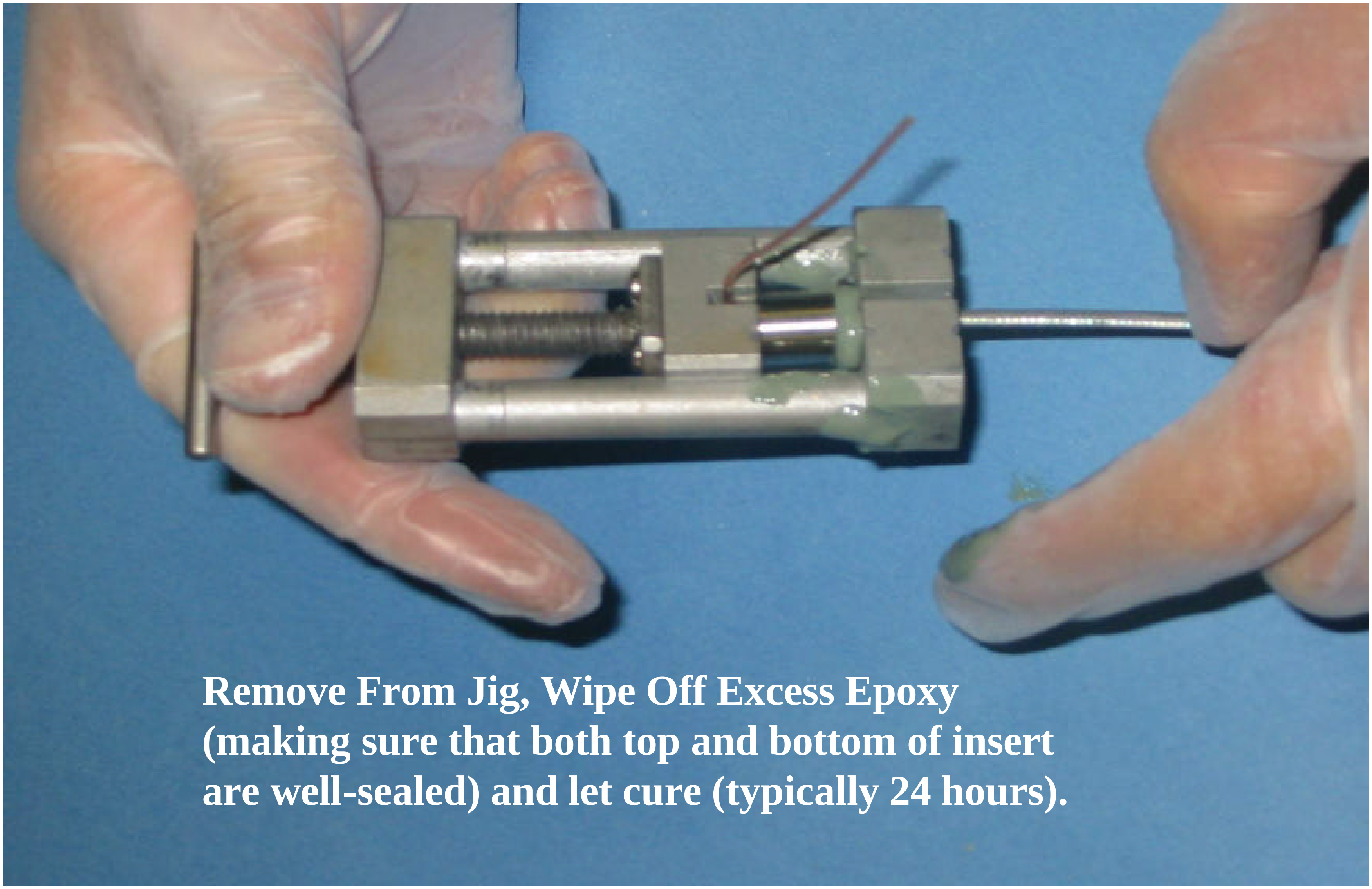


Pic.14 Mix epoxy

Pic.15 Apply epoxy. Cover the trimmed armor strands with epoxy

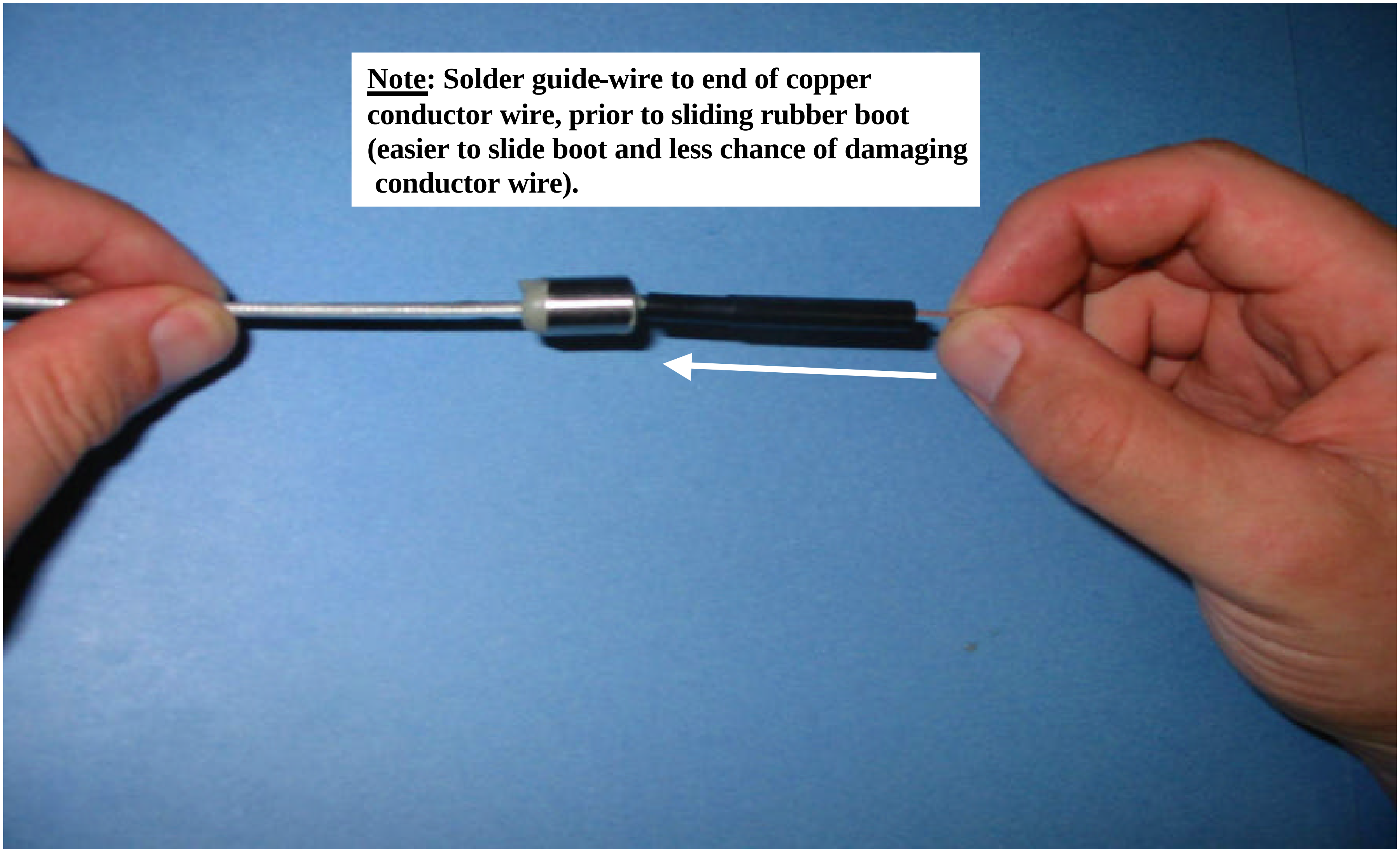


Pic.16 Using the termination jig, push the termination sleeve completely down over the insert

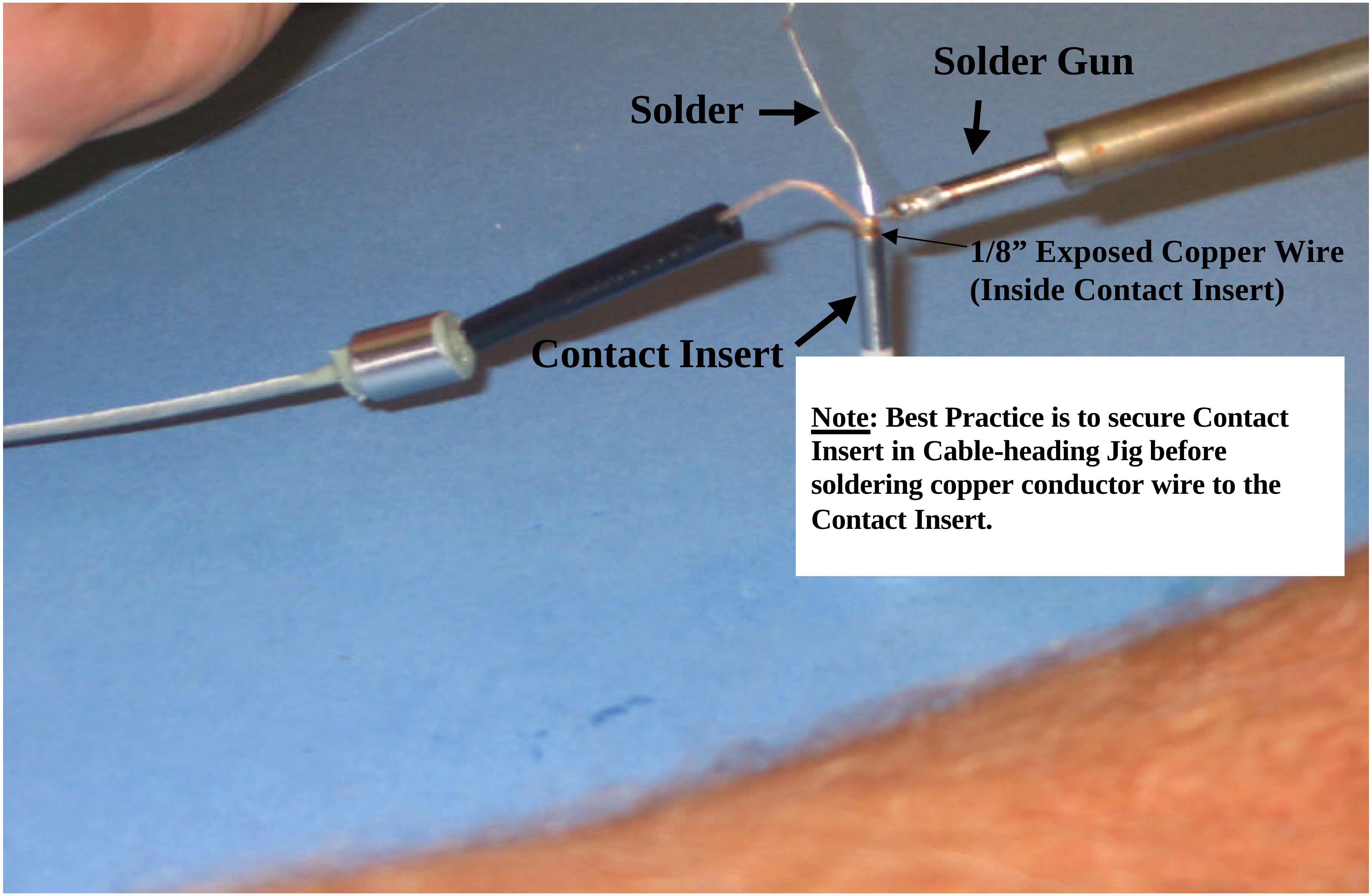


Pic.17 Termination Sleeve completely pushed down over insert

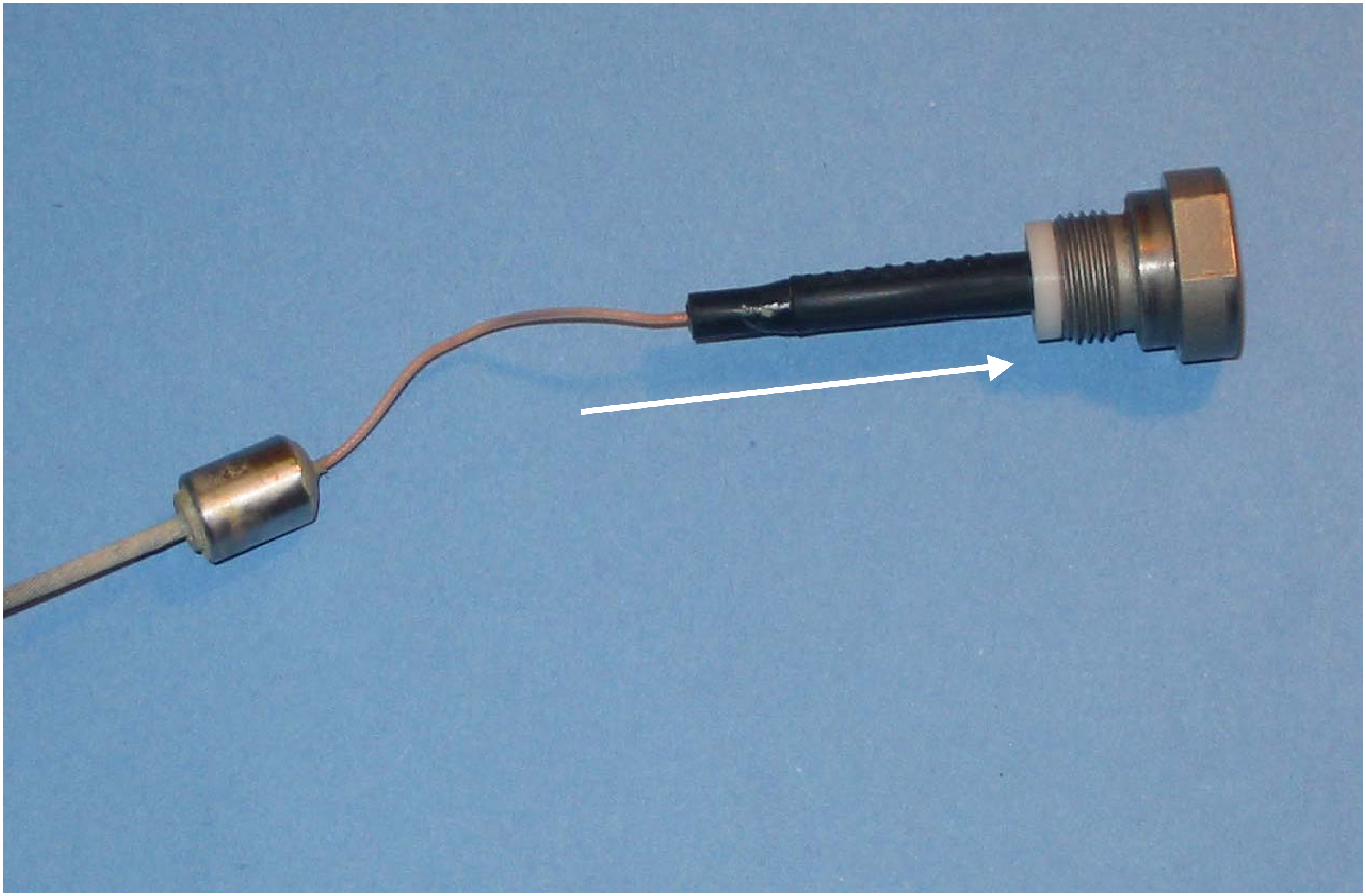
Pic.18 Apply silicon lubricant to the insulated conductor wire



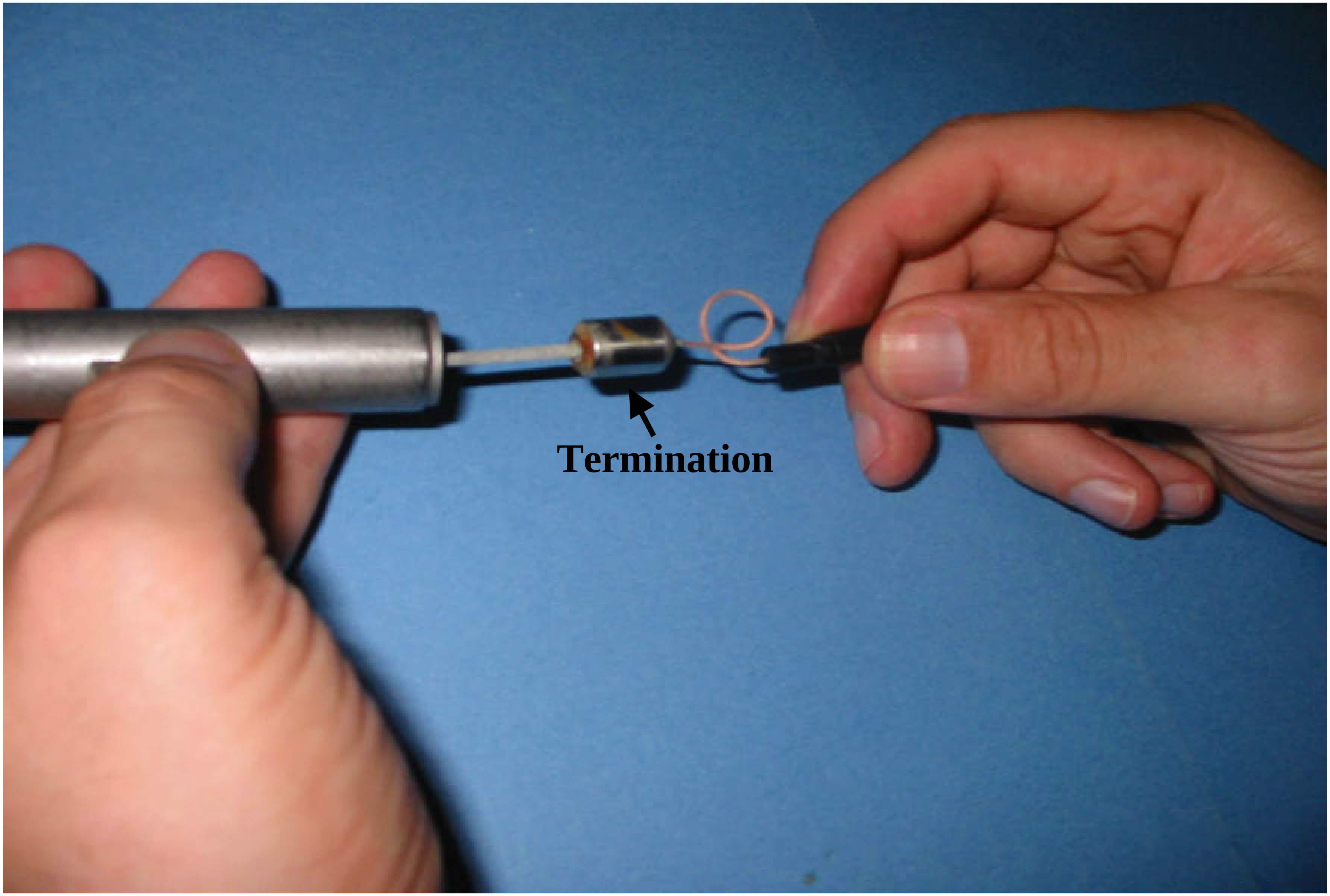
Pic.20 Slide the rubber boot towards the cablehead termination (final position)



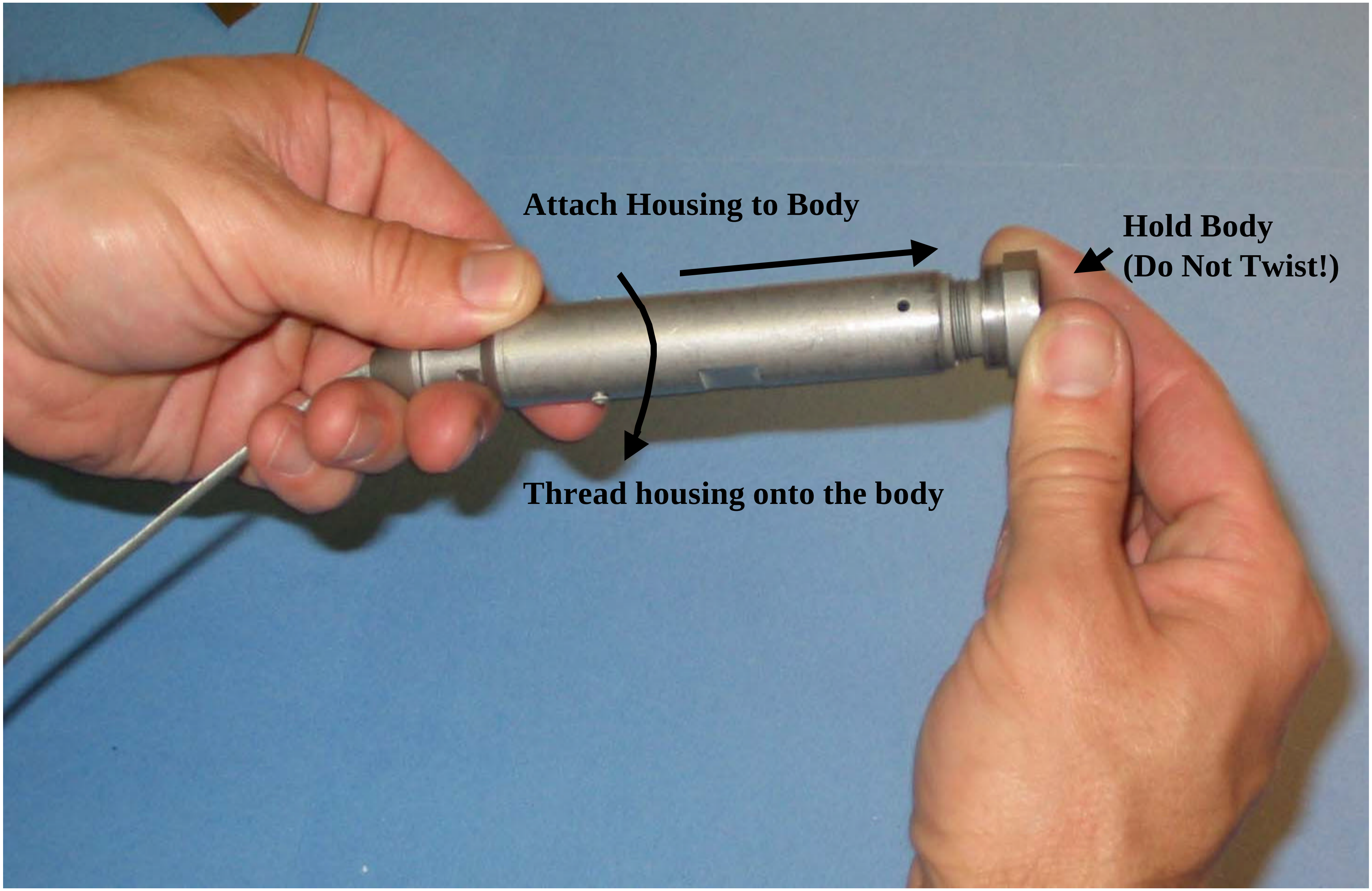
Pic.21 Solder 1/8 inch exposed copper wire (use wire strippers) into contact insert



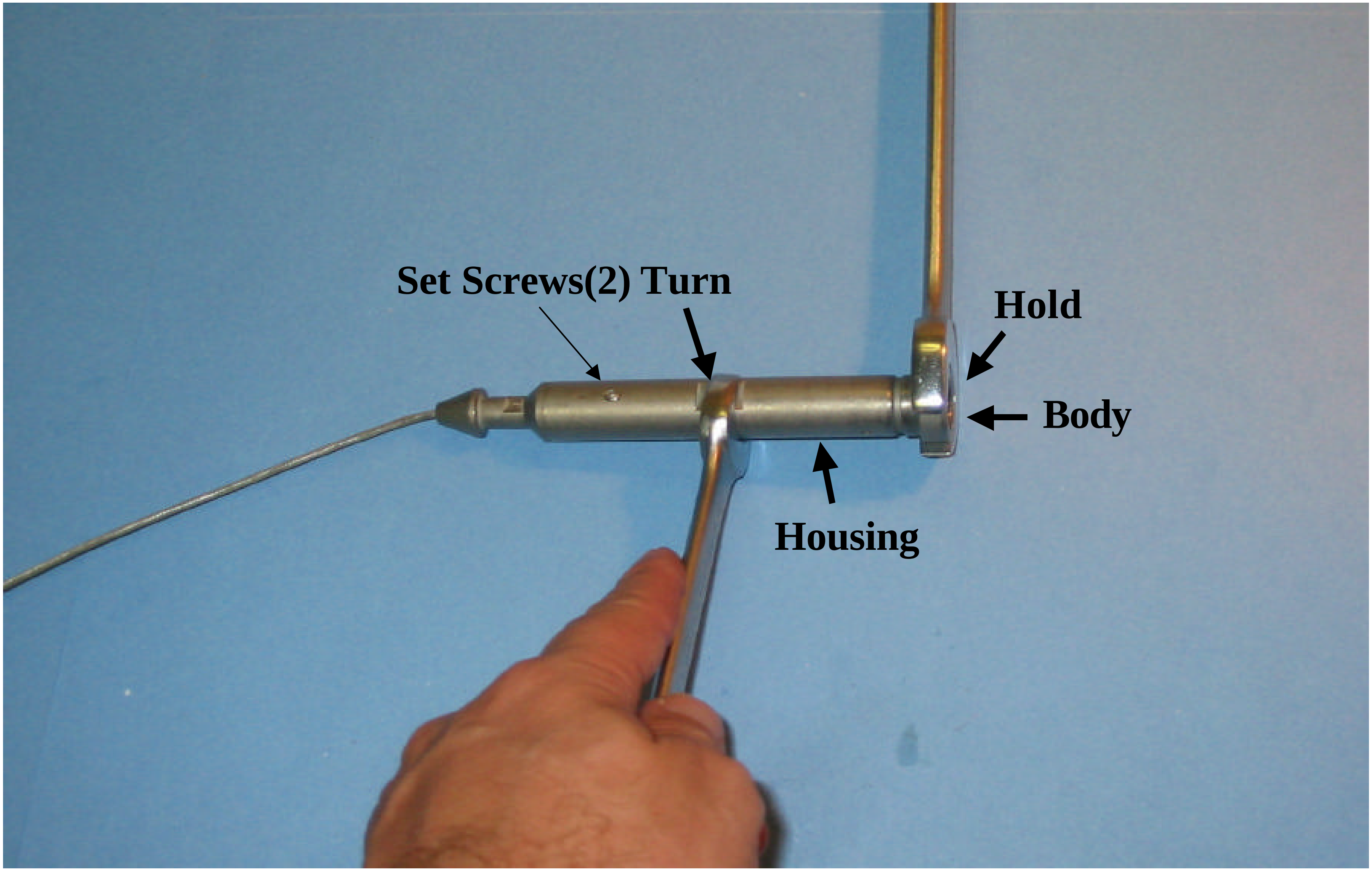
Pic.22 Slide the rubber boot down over the contact insert (when the solder has cooled)



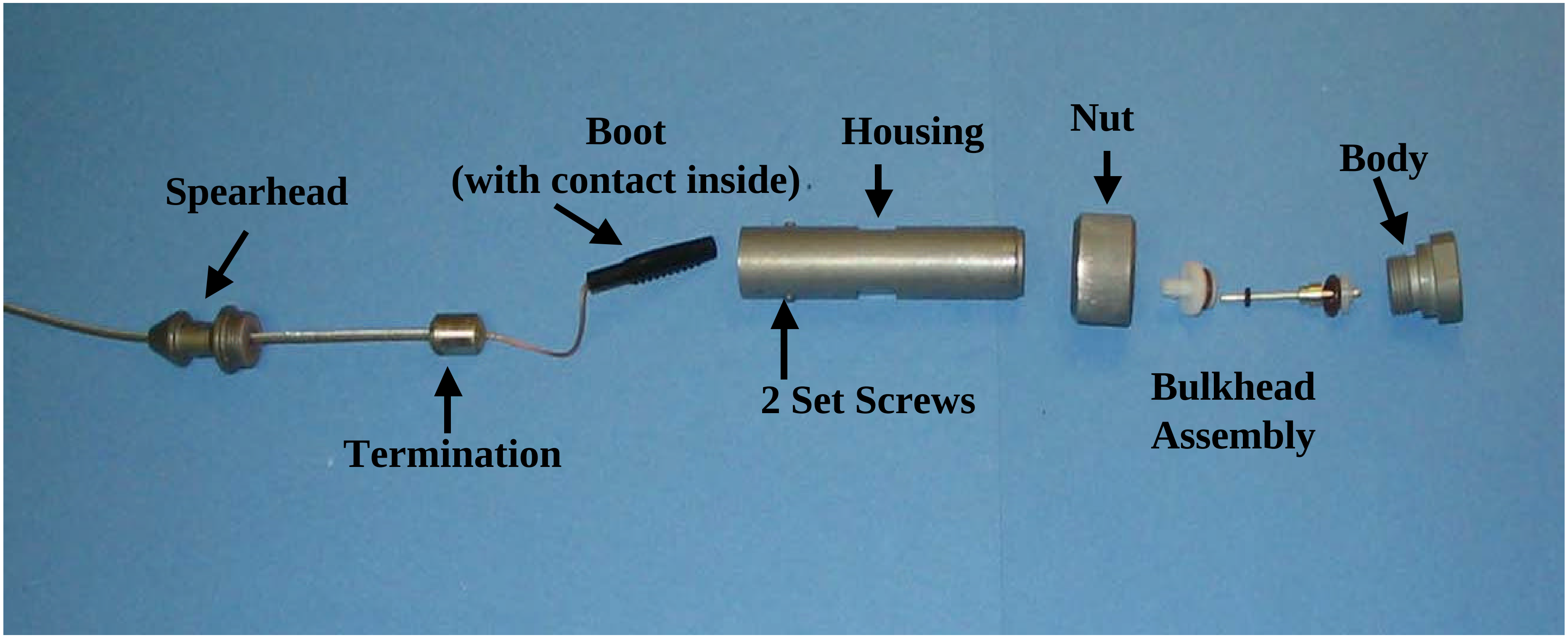
Pic.23 Create a loop in the conductor wire before sliding the cablehead housing down over the termination



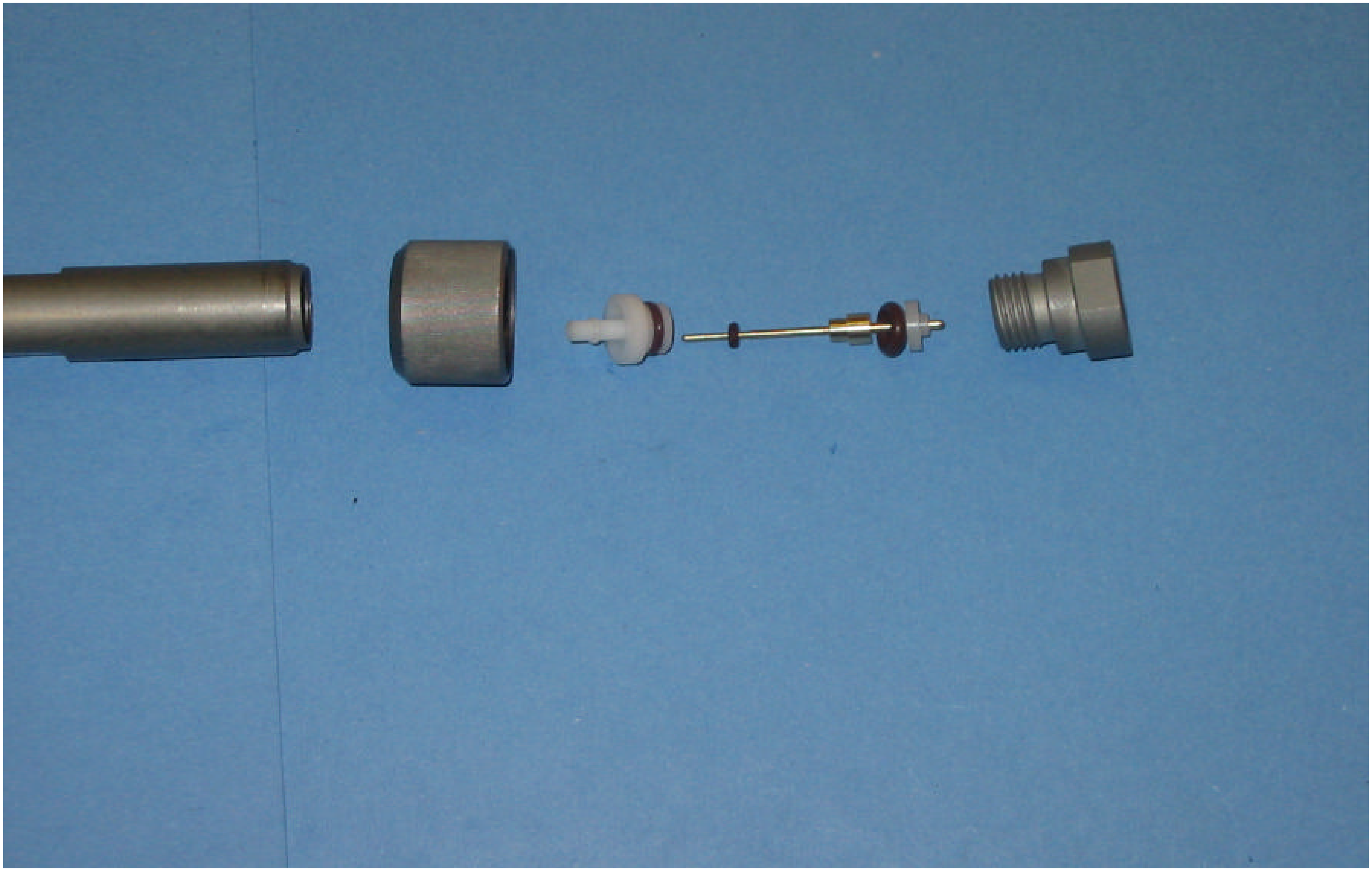
Pic.24 Thread the cablehead housing onto the body
(Do not twist the body! –this can damage the conductor wire)



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 L

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:

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*	

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							