Appendix H

Product Information

Magnetrol Liquid Level Switch model C10 and T20

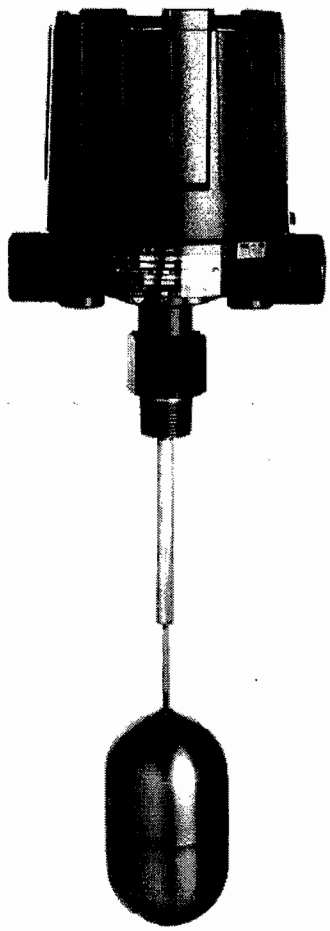
In-Situ LevelTroll 500

Endress+Hauser WaterPilot FMX 167

Magnetrol Liquid Level Switch T21

Top Mounting

Installation and Operating Manual



Liquid

Level

Switches

Models [redacted] & T21

Magnetrol®

STI

Read this Manual Before Installing

This manual provides information on the Top Mounting Liquid Level Switch. It is important that all instructions are read carefully and followed in sequence. Detailed instructions are included in the Installation section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

NOTES

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

WARNINGS

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

Follow all standard industry procedures for servicing electrical equipment when working with or around high voltage. Always shut off the power supply before touching any components.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Low Voltage Directive

For use in Category II installations. If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

Notice of Trademark, Copyright, and Limitations

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Performance specifications are effective with date of issue and are subject to change without notice. Magnetrol reserves the right to make changes to the product described in this manual at any time without notice. Magnetrol makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All Magnetrol/STI mechanical level and flow controls are warranted free of defects in materials or workmanship for five full years from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, Magnetrol/STI will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

Magnetrol/STI shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some Magnetrol/STI products.

Quality Assurance

The quality assurance system in place at Magnetrol/STI guarantees the highest level of quality throughout the company. Magnetrol/STI is committed to providing full customer satisfaction both in quality products and quality service.

Magnetrol's quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.

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Top Mounting
Liquid Level Switches

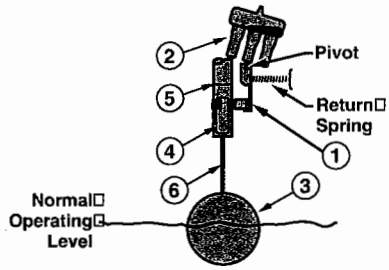
[redacted]

[redacted] and T21 level switches are float operated units designed for top mounting to a tank or vessel by means of threaded or flanged pipe connections. T20 standard units are equipped with a single switch mechanism for high or low level alarm or control applications. T21 tandem units are equipped with two switch mechanisms, each operated by a separate float, for applications requiring widely spaced separate high and low level switch actuation.

[redacted]

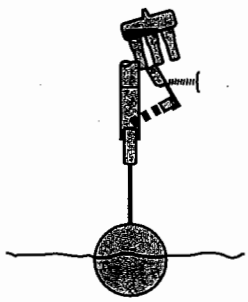
The simple and foolproof operation of the top mounted float switches is illustrated in figures 1 and 2.

A magnetic attraction sleeve ④ is fixed at the top of a rigid float stem ⑥. As the float and stem assembly ③ ⑥ move s with the level of the liquid, the attraction sleeve is moved into or out of the field of the switch magnet ①. The presence or the absence of the attraction sleeve causes the switch magnet and attached switch ② to move and change state. A non-magnetic barrier tube ⑤ isolates the process media from the switch without interfering with the field of the switch magnet and provides a static pressure boundary to the process.



Rising Level

Figure 1



Falling Level

Figure 2

[redacted]

This section provides detailed procedures for properly installing top mounted level switches.

Caution: If equipment is used in a manner not specified by the manufacturer, protection provided by the equipment may be impaired.

[redacted]

Unpack the instrument carefully. Inspect all units for damage. Report any concealed damage to carrier within 24 hours. Check the contents of the packing slip against purchase order. Check and record the model number against serial number for future reference when ordering parts.

Model Number: _____

Serial Number: _____

It is recommended that for critical alarm functions, an additional level switch be installed as a high–high or low–low level alarm for maximum protection.

Caution: Operation of all buoyancy type level devices should be done in such a way as to minimize the action of dynamic forces on the float or displacer sensing element. Good practice for reducing the likelihood of damage to the control is to equalize pressure across the device very slowly.

Ensure that no tubes, rods, or other obstacles in the tank or vessel which could interfere with the operation of float(s).

Caution: This instrument is intended for use in Installation Category II, Pollution Degree 2.

Adjust the process connection as required to bring control to a vertical position. Magnetrol controls must be mounted within three degrees (3°) of vertical in all directions. A three degree slant is noticeable by eye, but installation should be checked with a spirit level on top and/or sides of float stem or enclosing tube.

NOTE: Do not insulate switch mechanism housing.

On controls equipped with pneumatic switch assemblies, consult bulletin on mechanism furnished for air (or gas) piping instructions.

Switch Series Letter	Description	Bulletin No.
A	Standard Mercury Switch	42-683
B, C, D	Dry Contact Switch	
E	Vibration Resistant Mercury Switch	
F	Hermetically Sealed Snap Switch	
HS	Hermetically Sealed Snap Switch	42-694
J	Bleed Type Pneumatic Switch	42-685
K	Non-Bleed Type Pneumatic Switch	42-686

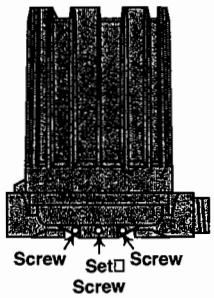


Figure 3
Housing Set Screws

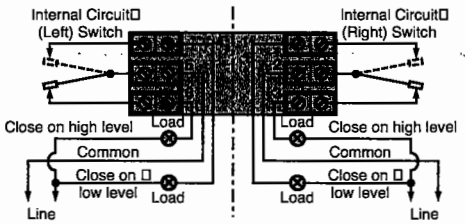


Figure 4
Terminal Connections
DPDT Switch Mechanism
Series A, B, C, D, and E

Caution: All Top Mounting units are shipped from the factory with the enclosing tube tightened and the switch housing set screw locked to the enclosing tube. Failure to loosen the set screw prior to repositioning the supply and output connections may cause the enclosing tube to loosen, resulting in possible leakage of the process liquid or vapor.

Top mounting controls are shipped with the conduit entry of the switch housing placed 180° opposite the tank connections to simplify installation in most cases. If the location of the conduit entry on the level switch is appropriate to the installation, proceed to Step 4 to begin wiring the unit. If another configuration is desired, the switch housing can be easily rotated by first following Steps 1, 2, and 3.

NOTE: A switch or circuit breaker shall be installed in close proximity to equipment and within easy reach of operator. It shall be marked as the disconnecting device for the equipment.

1. Loosen set screw(s) at base of switch housing. Refer to Figure 3.
2. Switch housing may be rotated 360° to allow correct positioning of conduit outlet.
3. Tighten set screw(s) at base of switch housing.
4. Unscrew and remove switch housing cover. The threads have been lubricated to facilitate removal.

NOTE: For supply connections use wire with a minimum rating of 75° C, as required by process conditions. Use a minimum of 14 AWG wire for power and ground field wires. On high temperature applications (above 250° F [121° C] at mounting flange or bushing), high temperature wire should be used between control and first junction box located in a cooler area. On non-hazardous applications, flexible conduit may be used between the control and the first junction box.

5. The switch terminals are located next to the conduit outlet to facilitate wiring. Bring supply wires through conduit outlet. Route extra wire around enclosing tube under the baffle plate, and connect them to the proper terminals. Refer to the wiring diagram, Figure 4, or your switch bulletin for this information.

6. Dress wiring to ensure no interference or contact with tilt of switch, or replacement of switch housing cover.

NOTE: Observe all applicable electrical codes and proper wiring procedures.

Prevent moisture seepage into the enclosure by installing approved seal-drain fittings in the conduit run leading into the unit.

Caution: In hazardous areas, do not power the unit until the conduit is sealed and the enclosure cover is screwed down securely.

7. Replace housing cover.
8. If control has been furnished with an explosion proof or moisture proof switch housing, it must be sealed at the conduit outlet with a suitable compound or non-hardening sealant to prevent entrance of air.
9. Test switch action by varying liquid level in the tank or vessel. The upper switch on Model T21 units is actuated by movement of the lower float, while the lower switch is actuated by the upper float.

NOTE: If switch mechanism fails to function properly, check vertical alignment of control housing and consult installation bulletin on switch mechanism furnished.

10. Check cover to base fit to be certain gasketed joint is tight. A positive seal is necessary to prevent infiltration of moisture laden air or corrosive gasses into switch housing.

Field Adjustment of Differential

The standard differential of the single float Model T20 may be field adjusted. Adjustment may be necessary if a wider differential needs to be set to overcome switch chatter caused by the process.

The differential, or the amount of level travel between switch-on and switch-off, may be adjusted by repositioning the lower jam nuts on the float stem. The standard factory setting is for a minimum amount of play (gap) between the top jam nuts and the attraction sleeve as shown in Figure 6.

NOTE: For assistance in computing level differential change for a specific control, consult the factory giving the model and serial numbers of the control.

Caution: Maximum differential adjustment is 0.50 inch.

NOTE: To widen the differential 0.50 inch, the lower jam nuts must be set proportionately lower on the stem (i.e. in this example 0.50 inch).

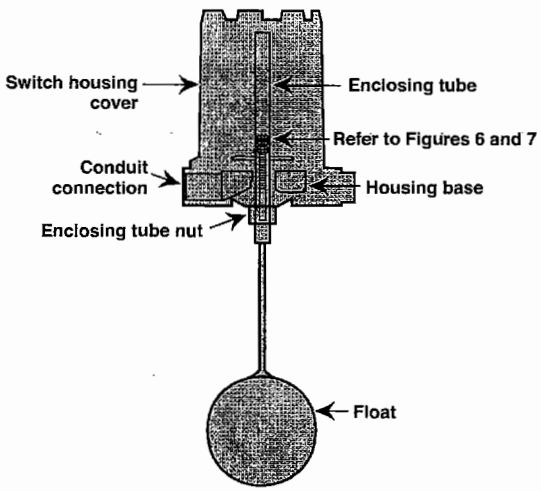


Figure 5

Caution: Before attempting any work on the control, pull disconnect switch, or otherwise assure that electrical circuit(s) through the control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms.

1. Determine what change in differential is necessary.
2. Make sure power source is turned off.
3. Unscrew and remove switch housing cover.
4. Disconnect power supply wires from switch mechanism. Pull wires out of conduit connection opening in housing base. Refer to Figure 5.
5. Perform system shut-down procedures as required to relieve pressure from tank or vessel and drain off liquid head, if required. Allow unit to cool.

NOTE: The amount of level travel between switch-on and switch-off actuation (differential) may be field adjusted by repositioning the lower jam nuts on the float stem. The standard factory setting is for a minimum amount of play (gap) between the top jam nuts and the attraction sleeve, as shown in Figure 6. This setting may be increased to a maximum of 0.50" (13 mm), as shown in Figure 7.

6. Remove switch housing assembly by loosening the enclosing tube nut, which is located immediately below housing base. Refer to Figure 5.

7. With switch housing and enclosing tube removed, jam nuts and attraction sleeve are accessible. Measure position of upper jam nuts from stem end; then loosen and remove upper jam nuts, guide washer, and attraction sleeve.
8. Loosen and adjust lower jam nuts to desired position. Make certain jam nuts are retightened securely.

NOTE: Use new enclosing tube gasket in assembly of switch housing to the mounting bushing or flange. Refer to **Sections 5.4.1.1** and **5.4.2.1** for enclosing tube gasket part numbers.

9. Test switch actuation by varying liquid level in tank or vessel.

Caution: Instructions given are for standard base model units which use a single magnet switch mechanism only. No differential adjustment should be attempted on tandem float models in the field. Switch actuation levels have been set at the factory to meet specific customer specifications. Variations in actual conditions from design conditions usually requires special control modifications. Consult with the factory or local representative for assistance.

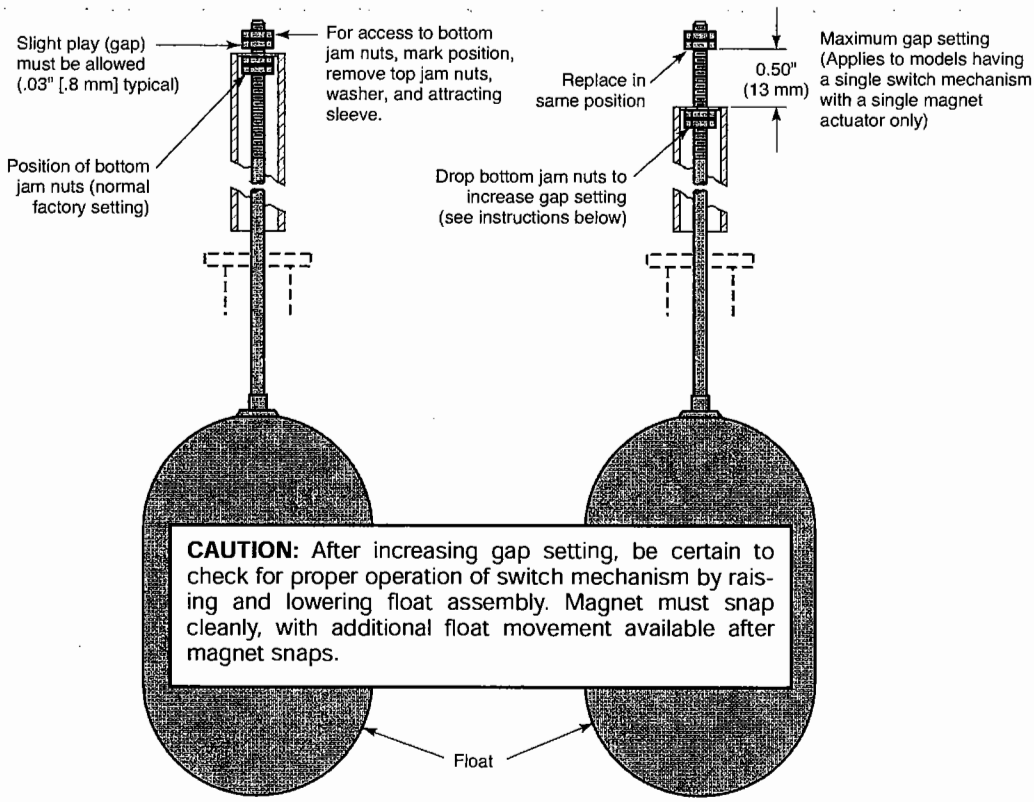


Figure 6
Normal Factory Setting (minimum differential)

Figure 7
Differential adjustment

Periodic inspections are a necessary means to keep your level control in good working order. This control is a safety device to protect the valuable equipment it serves. Therefore, a systematic program of "preventive maintenance" must be implemented when the control is placed into service. If the following sections on "what to do" and "what to avoid" are observed, your control will provide reliable protection of your equipment for many years.

4.1.1 Keep control clean

Be sure the switch housing cover is always in place on the control. This cover is designed to keep dust and dirt from interfering with switch mechanism operation. In addition, it protects against damaging moisture and acts as a safety feature by keeping bare wires and terminals from being exposed. Should the housing cover or any seals become damaged or misplaced, obtain a replacement immediately.

4.1.2 Inspect switch mechanisms, terminals, and connections monthly

1. Mercury switches may be visually inspected for short circuit damage. Check for small cracks in the glass tube containing the mercury. Such cracks can allow entrance of air into the tube causing the mercury to "oxidize". This is noticeable as the mercury will appear dirty or dull, and will not break into clean, round pools. If these conditions exist, replace the mercury switch immediately.
2. Dry contact switches should be inspected for excessive wear on actuating lever or misalignment of adjustment screw at point of contact between screw and lever. Such wear can cause false switch actuating levels. See switch mechanism bulletin supplied with control should switch adjustment or replacement be necessary.
3. DO NOT operate your control with defective or maladjusted switch mechanisms (refer to bulletin on switch mechanisms furnished for service instructions.)

4. Level controls may sometimes be exposed to excessive heat or moisture. Under such conditions, insulation on electrical wiring may become brittle, eventually breaking or pealing away. The resulting "bare" wires can cause short circuits.

NOTE: Check wiring carefully and replace at the first sign of brittle insulation.

5. Vibration may sometimes cause terminal screws to work loose. Check all terminal connections to be certain that screws are tight.
6. On units with pneumatic switches, air (or gas) lines subjected to vibration, may eventually crack or become loose at connections causing leakage. Check lines and connections carefully and repair or replace, if necessary.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

4.1.3 Inspect entire unit periodically

Isolate control from vessel. Raise and lower liquid level to check for switch contact and reset.

1. Never leave switch housing cover off the control longer than necessary to make routine inspections.
2. Never place a jumper wire across terminals to "cut-out" the control. If a "jumper" is necessary for test purposes, be certain it is removed before placing control into service.
3. Never attempt to make adjustments or replace switches without reading instructions carefully. Certain adjustments provided for in level controls should not be attempted in the field. When in doubt, consult the factory or your local representative.
4. Never use lubricants on pivots of switch mechanisms. A sufficient amount of lubricant has been applied at the factory to ensure a lifetime of service. Further oiling is unnecessary and will only tend to attract dust and dirt which can interfere with mechanism operation.

Usually the first indication of improper operation is failure of the controlled equipment to function, i.e.: pump will not start (or stop), signal lamps fail to light, etc. When these symptoms occur, whether at time of installation or during routine service thereafter, check the following potential external causes first.

a. Fuses may be blown.

b. Reset button(s) may need resetting.

c. Power switch may be open.

d. Controlled equipment may be faulty.

e. Wiring leading to control may be defective.

If a thorough inspection of these possible conditions fails to locate the trouble, proceed next to a check of the control's switch mechanism.

5.1.1 Check switch mechanism

1. Pull disconnect switch or otherwise disconnect power to the control.
2. Remove switch housing cover.
3. Disconnect power wiring from switch assembly.
4. Swing magnet assembly in and out by hand to check carefully for any sign of binding. Assembly should require minimal force to move it through its full swing.
5. If binding exists, magnet may be rubbing enclosing tube. If magnet is rubbing, loosen magnet clamp screw and shift magnet position. Retighten magnet clamp screw.
6. If switch magnet assembly swings freely and mechanism still fails to actuate, check installation of control to be certain it is within the specified three (3°) degrees of vertical. (Use spirit level on side of enclosing tube in two places, 90° apart.

7. If mechanism is equipped with a mercury switch, examine glass mercury tube closely as previously described in **Section 4.0 Preventive Maintenance**. If switch is damaged, replace it immediately. If microswitch, check continuity with ohmmeter.
8. If switch mechanism is operating satisfactorily, proceed to check sensing unit.

5.1.2 Check complete unit

1. Reconnect power supply and carefully actuate switch mechanism manually (using a non-conductive tool) to determine whether controlled equipment will operate.

Caution: With electrical power on, care should be taken to avoid contact with switch leads and connections at terminal block.

2. If controlled equipment responds to manual actuation test, trouble may be located in the level sensing portion of the control–float(s), stem(s), and magnetic attraction sleeve(s).

NOTE: Ensure that liquid is entering the storage tank or vessel. A valve may be closed or a pipe line plugged.

Caution: Be certain to pull disconnect switch or otherwise ensure that electrical circuit(s) through control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms.

3. With liquid in tank or vessel, raise the liquid level above the set points. Magnets should "pull-in" on rising level. On Model T21 the lower float actuates the upper switch, and the upper float actuates the lower switch. If magnets fail to "pull-in", lower the level and purge pressure.
   a. Disconnect wiring from supply side of switch mechanism(s) and remove electrical conduit or operating medium line connections to switch housing.
   b. Remove switch housing assembly by loosening hex nut, which is located immediately below housing base.
4. With switch housing assembly removed, inspect attraction sleeve(s) and inside of enclosing tube for excessive corrosion or solids buildup, which could restrict movement, preventing sleeve(s) from reaching field of switch magnet(s).
5. If differential has been changed in the field by repositioning the lower jam nuts on the float stem, check tightness and position of the jam nuts. Refer to Figure 6.

NOTE: Differential adjustment affects a change in the amount of level travel between switch-on and switch-off actuation. Do not attempt adjustment without first consulting factory for assistance in computing level differential change for your control.

6. Check float to be certain it is buoyant in the liquid (tank or vessel must have adequate liquid level). If float is determined to be filled with liquid, or it is collapsed, it must be replaced immediately. Do not attempt to repair a float.

If all components in the control are in operating condition, the trouble must be (and should be) located external to the control. Repeat inspection of external conditions previously described.

When communicating about your control, be certain to always specify the complete Model and Serial numbers.

Specifications

AGENCY	MODEL APPROVED	APPROVAL CLASSES
FM  APPROVED	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
CSA 	All with a Series A, E, F, HS or H1 electric switch mechanism and a housing listed as CSA TYPE 4X	Class I, Div 2, Groups B, C & D
	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as NEMA 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
ATEX / IEC Ex ② 	All with an electric switch mechanism and an ATEX housing①	ATEX II 2 G EEx d IIC T6 IEC Ex Ex d IIC T6
CE 	Low Voltage Directives 73/23/EEC & 93/68/EEC Per Harmonized Standard: EN 61010-1/1993 & Amendment No. 1	Installation Category II Pollution Degree 2

① Dual stage units with 'HS' switches are not ATEX approved.

② IEC Installation Instructions:

The cable entry and closing devices shall be Ex d certified suitable for the conditions of use and correctly installed.

For ambient temperatures above +55° C or for process temperatures above +150° C, suitable heat resistant cables shall be used.

Heat extensions (between process connection and housing) shall never be insulated.

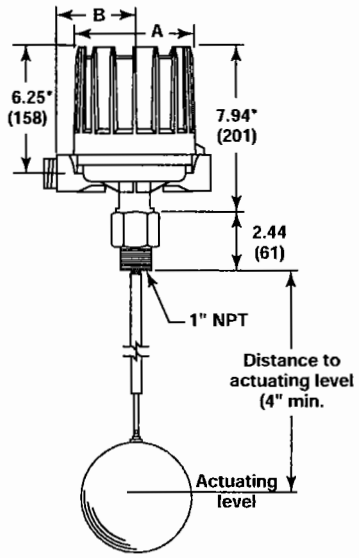
Special conditions for safe use:

When the equipment is installed in process temperatures higher than +85° C the temperature classification must be reduced according to the following table as per IEC60079-0.

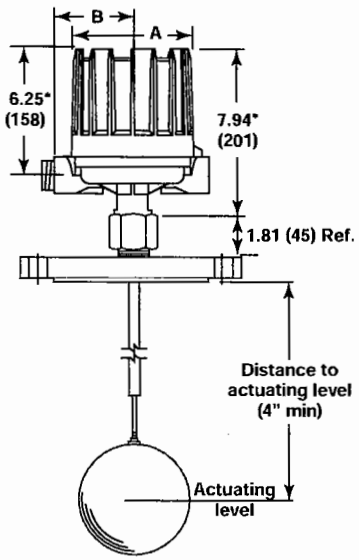
Maximum Process Temperature	Temperature Classification
< 85° C	T6
< 100° C	T5
< 135° C	T4
< 200° C	T3
< 300° C	T2
< 450° C	T1

These units are in comformity with IECEx KEM 05.0020X
Classification Ex d IIC T6
$T_{ambient}$ -40° C to +70° C

5.3.1 Physical inches (mm)

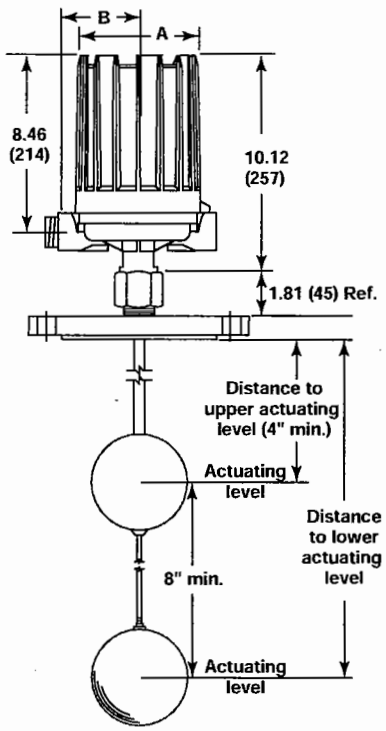


Model T20 with 1" NPT



Model T20 with flange

* These dimensions increase by 2.19 (55) when unit is supplied with an HS switch with terminal block.



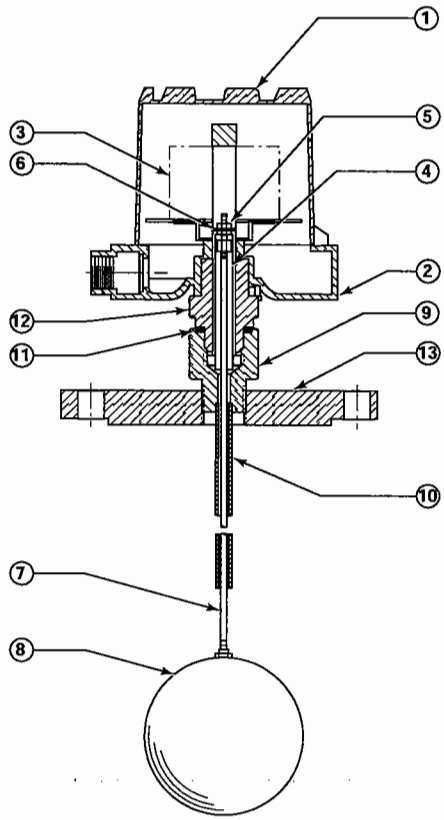
Model T21 with flange

Housing ①	A	B	Conduit Connections
NEMA 4X/7/9, Group B	5.93 (151)	3.87 (98)	1" NPT dual entry
NEMA 1 ② Pneumatics	4.70 (119)	5.00 (127)	¼" NPT single entry

① All housings rotatable 360°.
② Pneumatic switches available with Series T20 units only.

Distance To	Maximum	Minimum
Upper level	40" (1016)	4" (102)
Lower level	48" (1219)	12" (305)

NOTE: On Model T21 the lower float actuates upper switch mechanism. The upper float actuates the lower switch mechanism.



5.4.1 Model T20 Parts Identification

Item	Description
1	Housing cover
2	Housing base
3	Switch mechanism
4	Attraction sleeve
5	Jam nuts
6	Guide washer(s)
7	Float stem
8	Float
9	Adaptor bushing
10	Stem guide tube
11	Enclosing tube gasket
12	Enclosing tube
13	Mounting flange

5.4.1.1 Model T20

	T20-1	T20-4
Housing cover	See below	
Housing base	See below	
Switch mechanism	See below	
Stem kit, includes items 2, 3, 6, & 7	Consult factory	
Float: 3" x 5"	Z07-1202-003	
2.00"	Z07-1102-008	
4.50"	Z07-1102-009	
Adapter bushing	004-5734-120	004-5734-125
Float stem	Consult factory	
Stem guide tube	Consult factory	
Enclosing tube gasket	012-1301-002	
Enclosing tube	Z32-6625-001	Z32-6625-002
Mounting flange	See below	

5.4.1.2 Mounting flanges

	125 lb cast iron	150 lb forged steel	300 lb forged steel	150 lb forged 304	150 lb forged 316
4" flange	Z04-5840-001	Z04-5840-011	Z04-5840-016	004-5840-021	004-5840-026
5" flange	Z04-5840-002	Z04-5840-012	Z04-5840-017	004-5840-022	004-5840-027
6" flange	Z04-5840-003	Z04-5840-013	Z04-5840-018	004-5840-023	004-5840-028
8" flange	Z04-5840-004	Z04-5840-014	Z04-5840-019	004-5840-024	004-5840-029

5.4.1.3 Switch and housing reference

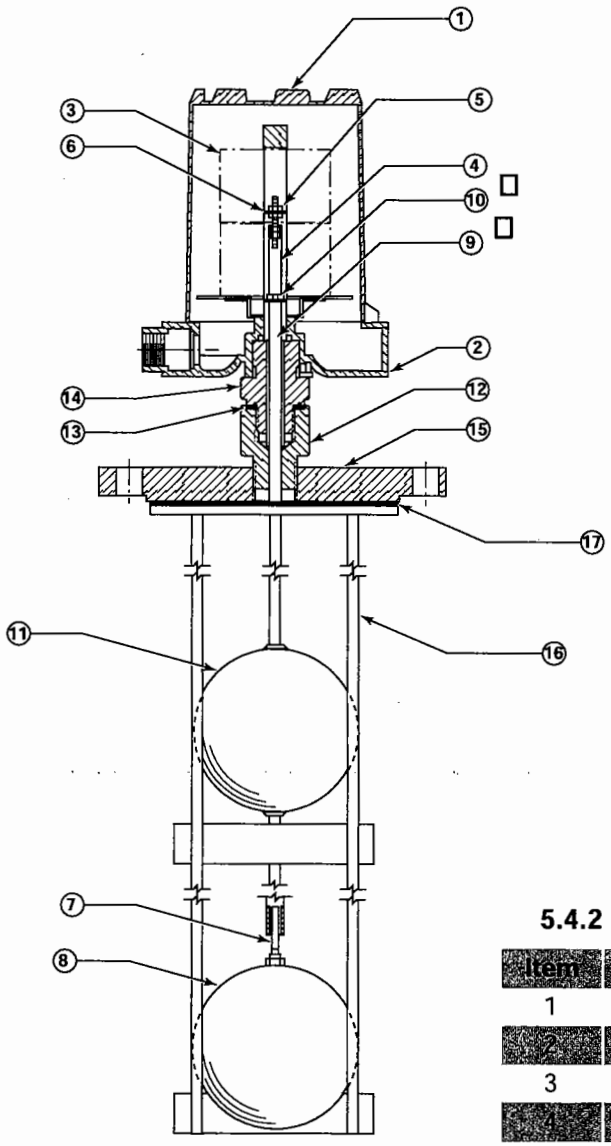
	Series type	Bulletin
Mercury	A, 3	42-683
Anti-tubulation mercury	E2	42-683
Dry contact	B, C, D	42-683
Hermetically sealed		42-694
Hermetically sealed	HS	42-694
Bleed type pneumatic		42-486
Non-bleed type pneumatic	K	42-486

Important: When ordering spare parts, please specify:

A. Model and serial numbers.

B. Name and part number of replacement part or assembly.

All replacement parts are for standard models only. Consult your local representative for ordering assistance on all specially modified models (model numbers preceded by an X).



5.4.2 Model T21 Parts Identification

Item	Description
1	Housing cover
2	Housing base
3	Switch mechanism
4	Upper attraction sleeve
5	Jam nuts
6	Guide washer(s)
7	Upper stem assembly
8	Lower float
9	Lower attraction sleeve, stop tube, and washers
10	Retaining nuts
11	Upper float and tube assembly
12	Adapter bushings
13	Enclosing tube gasket
14	Enclosing tube
15	Mounting flange
16	Float guide cage (optional)
17	Float guide cage gasket (optional)

5.4.2.1 Model T21

	T21-1	T21-2
Housing cover	See below	
Housing gasket	See below	
Switch mechanism	See below	
Float stem kit (includes items 4, 5, 6, & 7)	Consult factory	
Lower float: 3" x 5"	Z07-1201-003	Z07-1202-003
4.00"	Z07-1101-015	Z07-1102-008
4.50"	Z07-1102-009	
Upper float and tube assembly kit (includes items 9, 10, & 11)	Consult factory	
Adaptor bushing	Z04-5734-110	004-5734-123
Enclosing tube gasket	012-1301-002	
Enclosing tube	Z32-6325-004	Z32-6325-005
Guide cage kit (includes items 17 & 18)	Consult factory	
Mounting flange	See below	

5.4.2.2 Mounting flanges

	125 lb cast iron	150 lb forged steel	300 lb forged steel	150 lb forged 304	150 lb forged 316
4" flange	Z04-5840-001	Z04-5840-011	Z04-5840-016	004-5840-021	004-5840-026
5" flange	Z04-5840-002	Z04-5840-012	Z04-5840-017	004-5840-022	004-5840-027
6" flange	Z04-5840-003	Z04-5840-013	Z04-5840-018	004-5840-023	004-5840-028
8" flange	Z04-5840-004	Z04-5840-014	Z04-5840-019	004-5840-024	004-5840-029

5.4.2.3 Switch and housing reference

	Series/type	Bulletin
Mercury	A, 3	42-683
Anti-vibration mercury	E	42-683
Dry contact	B, C, D	42-683
Hermetically sealed	H	42-683
Hermetically sealed	HS	42-694
Bleed type pneumatic	J	42-695
Non-bleed type pneumatic	K	42-486

Important: When ordering spare parts, please specify:

A. Model and serial numbers.

B. Name and part number of replacement part or assembly.

All replacement parts are for standard models only. Consult your local representative for ordering assistance on all specially modified models (model numbers preceded by an X).

5.5.1 Model T20

IMPORTANT: Actuating level(s), in either the rising or falling state, and specific gravity must be provided upon placement of order.

MODEL NUMBER CODE AND MATERIALS OF CONSTRUCTION

Model No.	Set Points	Tank Connection	Float and Trim	Sleeve
T20-1	1—Single float	Carbon steel	300 Series SS	400 Series SS
T20-4		316 SS	316 SS	316 SS

IMPORTANT: The maximum available insertion depth is governed by the liquid specific gravity and selected float size as given in the table below. The minimum insertion depth is four inches.

MAXIMUM INSERTION LENGTH inches (mm)

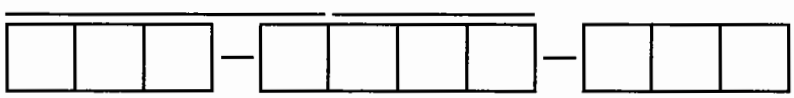
Liquid Specific Gravity	Float Size		
	3.00 x 5.00 (76 x 127)	4.00 (102)	4.50 (114)
1.00	39 (991)	48 (1219)	48 (1219)
0.90	20 (508)	33 (838)	48 (1219)
0.80	—	11 (279)	48 (1219)
0.70	—	—	38 (965)
0.60	—	—	6 (152)

FLOAT PRESSURE RATINGS

Float Size	Pressure Rating psig (bar)	
	@ 100° F (38° C)	@ Maximum Temperature
3.00 x 5.00 (76 x 127)	500 psig (34 bar)	300 psig @ +750° F (21 bar @ +399° C)
4.00 (102) Diameter	600 psig (41 bar)	400 psig @ +750° F (28 bar @ +399° C)
4.50 (114) Diameter	500 psig (34 bar)	340 psig @ +750° F (23 bar @ +399° C)

TANK CONNECTION AND FLOAT SIZE

Tank Connection ①	Float Diameter		
	3.00 x 5.00 (76 x 127)	4.00 (102)	4.50 (114)
1" NPT	B2A	B2B	B2C
4" 125 lb. C.I. flange ② ③	H2A	—	—
4" 150 lb. F.S. flange	H3A	—	—
5" 125 lb. C.I. flange ② ③	J2A	J2B	J2C
5" 150 lb. F.S. flange	J3A	J3B	J3C
6" 125 lb. C.I. flange ② ③	K2A	K2B	K2C
6" 150 lb. F.S. flange	K3A	K3B	K3C
6" 300 lb. F.S. flange	—	—	K4C
8" 125 lb. C.I. flange ② ③	L2A	L2B	L2C
8" 150 lb. F.S. flange	L3A	L3B	L3C



5.5.1 Model T20 (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE

Switch Description	Maximum Process ④ Temperature ° F (° C)	One Set Point	T20-1 Models NEMA 4X/7/9 Aluminum Enclosure ⑤⑥ Class I, Div. 1, Groups C & D	T20-1 Models NEMA 4X/7/9 Aluminum Enclosure ⑤⑥ Class I, Div. 1, Group B	T20-4 Models NEMA 4X/7/9 Aluminum Enclosure ⑤⑥ Class I, Div. 1, Groups C & D	T20-4 Models NEMA 4X/7/9 Aluminum Enclosure ⑤⑥ Class I, Div. 1, Group B
Series A Mercury	550 (288)	SPDT DPDT	AKP ANP	AKT ANT	AKQ ANQ	AKS ANS
Series 3 Mercury with Beaded Leads	750 (399)	SPDT DPDT	3KP 3NP	3KT 3NT	3KQ 3NQ	3KS 3NS
Series B Snap	250 (121)	SPDT DPDT	BKP BNP	BKT BNT	BKQ BNQ	BKS BNS
Series C Snap	450 (232)	SPDT DPDT	CKP CNP	CKT CNT	CKQ CNQ	CKS CNS
Series D Snap for DC Current	250 (121)	SPDT DPDT	DKQ DNQ	DKS DNS	DKQ DNQ	DKS DNS
Series E Mercury Vibration Resistant	550 (288)	SPDT DPDT	EKP ENP	EKT ENT	EKQ ENQ	EKS ENS
Series 2 Mercury Vibration Resistant	750 (399)	SPDT DPDT	2KP 2NP	2KT 2NT	2KQ 2NQ	2KS 2NS
Series HS Snap Hermetically Sealed w/Wiring Leads	550 ⑦ (288)	SPDT DPDT	HMC HMF	HEK ⑧ HET ⑧	HMC HMF	HEK ⑧ HET ⑧
Series HS Snap Hermetically Sealed w/Term. Block	550 ⑦ (288)	SPDT DPDT	HM3 HM7	HM4 HM8	HM3 HM7	HM4 HM8

PNEUMATIC SWITCH MECHANISM AND ENCLOSURE

Switch Description	Maximum Supply Pressure	Maximum Process Temperature	Bleed Orifice Diameter	NEMA 1
Series J Bleed Type	100 psig (7 bar)	400° F (204° C)	.063 (1.6 mm)	JDE
	60 psig (4 bar)		.094 (2.4 mm)	JEE
	100 psig (7 bar)	700° F (371° C)	.055 (1.4 mm)	JFE
Series K Non-Bleed	100 psig (4 bar)	400° F (204° C)	—	KOE
	40 psig (3 bar)		—	KOG

① Flanges are ANSI standard. Forged steel flanges have standard raised face.

② Not available with Model T20-4.

③ Available only in cast iron.

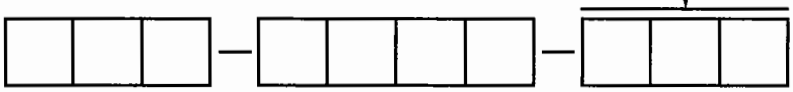
④ Process temperature based on +100° F (+38° C) ambient.

⑤ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosure.

⑥ Consult factory for NEMA 4X/7/9 cast iron housings.

⑦ On steam applications, temperature down-rated to +400° F (+204° C) process at +100° F (+38° C) ambient.

⑧ CSA approval does not apply to Series HE switches.



5.5.2 Model T21

IMPORTANT: Actuating level(s), in either the rising or falling state, and specific gravity must be provided upon placement of order.

MODEL NUMBER CODE AND MATERIALS OF CONSTRUCTION

Model No.	Set Points	Tank Connection	Float and Trim	Sleeve
T21-1	2—Tandem float	Carbon steel	300 Series SS	400 Series SS
T21-4		316 SS	316 SS	316 SS

IMPORTANT: The maximum available insertion depth is governed by the liquid specific gravity and selected float size as given in the table below. The minimum insertion depth is four inches. The minimum distance between the top and bottom insertion depths is eight inches.

MAXIMUM INSERTION LENGTH inches (mm)

Liquid Specific Gravity	Float Size					
	3.00 x 5.00 (76 x 127)		4.00 (102)		4.50 (114)	
	Upper	Lower	Upper	Lower	Upper	Lower
1.00	21 (533)	48 (1219)	32 (813)	48 (1219)	40 (1016)	48 (1219)
0.90	9 (229)	30 (762)	18 (457)	44 (1118)	40 (1016)	48 (1219)
0.80	—	—	4 (102)	21 (533)	40 (1016)	48 (1219)
0.70	—	—	—	—	21 (533)	48 (1219)

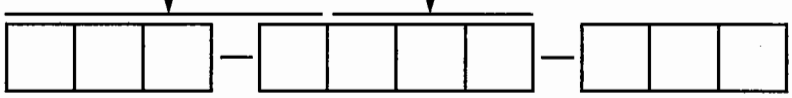
FLOAT PRESSURE RATINGS

Float Size	Pressure Rating psig (bar)	
	@ 100° F (38° C)	@ Maximum Temperature
3.00 x 5.00 (76 x 127)	500 psig (34 bar)	300 psig @ +750° F (21 bar @ +399° C)
4.00 (102) Diameter	600 psig (41 bar)	400 psig @ +750° F (28 bar @ +399° C)
4.50 (114) Diameter	500 psig (34 bar)	340 psig @ +750° F (23 bbar @ +399° C)

TANK CONNECTION AND FLOAT SIZE

Tank Connection ①	Float Diameter		
	3.00 x 5.00 (76 x 127)	4.00 (102)	4.50 (114)
4" 125 lb. C.I. flange ② ③	H2A	—	—
4" 150 lb. F.S. flange	H3A	—	—
5" 125 lb. C.I. flange ② ③	J2A	J2B	J2C
5" 150 lb. F.S. flange	J3A	J3B	J3C
6" 125 lb. C.I. flange ② ③	K2A	K2B	K2C
6" 150 lb. F.S. flange	K3A	K3B	K3C
6" 300 lb. F.S. flange	—	—	K4C
8" 125 lb. C.I. flange ② ③	L2A	L2B	L2C
8" 150 lb. F.S. flange	L3A	L3B	L3C

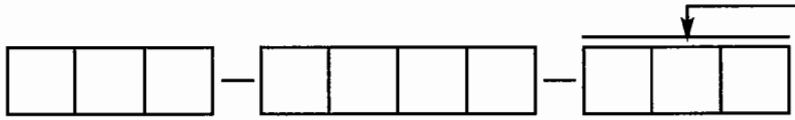
① Flanges are ANSI standard. Forged steel flanges have standard raised face.
② Not available with -4 Materials of Construction.
③ Available only in cast iron.
④ Process temperature based on +100° F (+38° C) ambient.
⑤ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosure.
⑥ Consult factory for NEMA 4X/7/9 cast iron housings.
⑦ On steam applications, temperature down-rated to +400° F (+204° C) process at +100° F (+38° C) ambient.



5.5.2 Model T21 (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE

Switch Description	Maximum Process ④ Temperature ° F (° C)	One Set Point	T21-1 Models		T21-4 Models	
			NEMA 4X/7/9 Aluminum Enclosure ⑤⑥			
			Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B
Series A Mercury	550 (288)	SPDT DPDT	ALA AOA	ALJ AOJ	ALB AOB	ALK AOK
Series 3 Mercury with Beaded Leads	750 (399)	SPDT DPDT	3LA 3OA	3LJ 3OJ	3LB 3OB	3LK 3OK
Series B Snap	250 (121)	SPDT DPDT	BLA BOA	BLJ BOJ	BLB BOB	BLK BOK
Series C Snap	450 (232)	SPDT DPDT	CLA COA	CLJ COJ	CLB COB	CLK COK
Series D Snap for DC Current	250 (121)	SPDT DPDT	DLB DOB	DLK DOK	DLB DOB	DLK DOK
Series E Mercury Vibration Resistant	550 (288)	SPDT DPDT	ELA EOA	ELJ EOJ	ELB EOB	ELK EOK
Series 2 Mercury Vibration Resistant	750 (399)	SPDT DPDT	2LA 2OA	2LJ 2OJ	2LB 2OB	2LK 2OK
Series HS Snap Hermetically Sealed w/Wiring Leads	550 ⑦ (288)	SPDT DPDT	HMN HMY	HMP HMZ	HMN HMY	HMP HMZ



Service Policy

Owners of Magnetrol controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. Magnetrol will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory, prior to the material's return. This is available through Magnetrol's local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

Magnetrol®

5300 Belmont Road • Downers Grove, Illinois 60515-4499 • 630-969-4000 • Fax 630-969-9489 • www.magnetrol.com
145 Jardin Drive, Units 1 & 2 • Concord, Ontario Canada L4K 1X7 • 905-738-9600 • Fax 905-738-1306
Heikensstraat 6 • B 9240 Zele, Belgium • 052 45.11.11 • Fax 052 45.09.93
Regent Business Ctr., Jubilee Rd. • Burgess Hill, Sussex RH15 9TL U.K. • 01444-871313 • Fax 01444-871317

STI®

5300 Belmont Road • Downers Grove, Illinois 60515-4499 • 630-969-4028 • Fax 630-969-9489 • www.sticontrols.com

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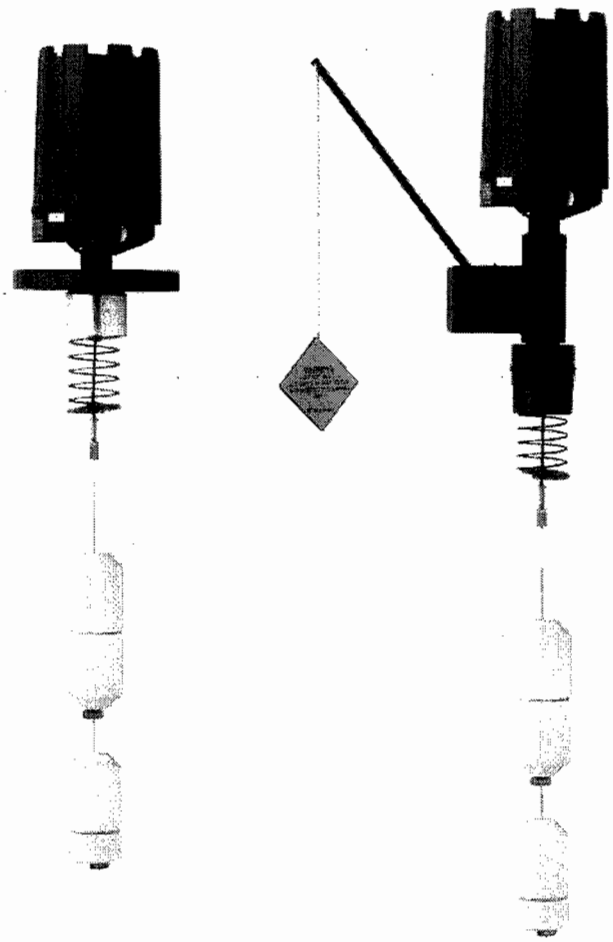
SUPERSEDES: January 2005

Magnetrol Liquid Level Switch – Displacer Type

Displacer Type

Installation and Operating Manual



Liquid

Level

and

Proof-er®

Switches

Magnetrol®

STI®

Read this Manual Before Installing

This manual provides information on the External Cage Displacer Liquid Level Switch. It is important that all instructions are read carefully and followed in sequence. Detailed instructions are included in the Installation section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

Notes

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Warnings

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

Follow all standard industry procedures for servicing electrical equipment when working with or around high voltage. Always shut off the power supply before touching any components.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Low Voltage Directive

For use in Installation Category II, Pollution Degree 2. If equipment is used in a manner not specified by the manufacturer, protection provided by the equipment may be impaired.

Notice of Trademark, Copyright, and Limitations

Magnetrol reserves the right to make changes to the product described in this manual at any time without notice. Magnetrol makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All Magnetrol/STI mechanical level and flow controls are warranted free of defects in materials or workmanship for five full years from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, Magnetrol/STI will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

Magnetrol/STI shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some Magnetrol/STI products.

Quality Assurance

The quality assurance system in place at Magnetrol/STI guarantees the highest level of quality throughout the company. Magnetrol/STI is committed to providing full customer satisfaction both in quality products and quality service.

Magnetrol's quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.

Magnetrol®

STI®

Displacer Type Liquid Level and Proof-er® Switches

Displacement type level switches offer the industrial user a wide choice of alarm and control configurations. These units utilize simple buoyancy principle and are well suited for simple or complex applications.

1.1.1 Displacer Controls

The design of displacer operated level switches is based upon the principle that a magnetic field will not be affected by non-magnetic materials such as 316 stainless steel. In this case, the displacer moves a magnetic attraction sleeve within a non-magnetic enclosing tube and actuates a magnetic switch mechanism. The enclosing tube provides a pressure seal to the chamber and, therefore, to the process.

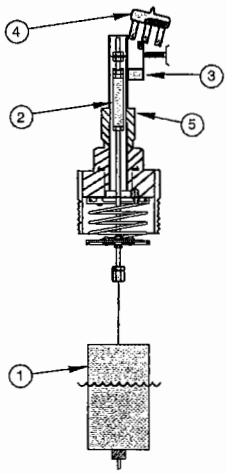


Figure 1
Switch position on rising level

A spring is loaded with a weighted displacer ① which is heavier than the liquid. Immersion of the displacers caused by rising liquid level imparts buoyancy forces on the displacer allowing the spring to compress. The attraction sleeve ② attached to the spring, moves upward into the field of a permanent magnet ③. The movement of the magnet toward the sleeve causes the switch ④ to actuate. A non-magnetic barrier tube ⑤ provides a static pressure boundary between the switch mechanism and the displacer assembly. As the liquid level falls, the displacer lowers, causing the spring to extend, and moving the attraction sleeve out of the magnetic field of the switch mechanism. This allows the switch to again change position and to break or make. See Figures 1 and 2.

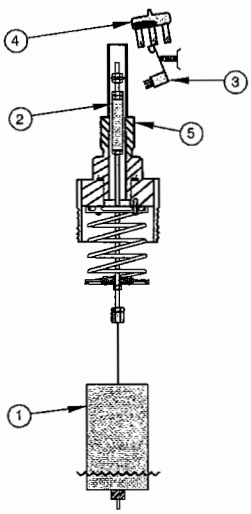


Figure 2
Switch position on falling level

The purpose of the Proof-er is to check the operation of a displacer control without having to raise the level in the tank. This is accomplished by pulling downward on the Proof-er cable. This causes the spring loaded lever arm to lift the switch actuator, simulating a high or high–high level condition. When the cable is released, the Proof-er returns the actuator to its original position resuming normal operation.

Caution: If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

Top mounting displacer units are shipped from the factory with the displacer and cable assembly removed from the head assembly and packed separately in the same container.

Caution: If reshipping to another location, displacer assembly must again be removed from the control to prevent damage.

Unpack the instrument carefully. Inspect all units for damage. Report any concealed damage to carrier within 24 hours. Check the contents of the packing slip and purchase order. Check and record the serial number for future reference when ordering parts.

Caution: The threaded connection link and stem protruding from the head assembly are extremely fragile. DO NOT handle or place control in a position so that any amount of force is placed on the stem. Proper operation of the control requires that the stem is not damaged or bent.

Caution: Displacer spring and stem are fragile. DO NOT drop displacers into tank. Hand feed cable into position to avoid bending stem.

Caution: This instrument is intended for use in Installation Category II, Pollution Degree 2.

Adjust the displacers on the displacer cable for the desired switch actuating levels (instruction tag is attached to cable). Screw displacer cable fitting to threaded connection link protruding from the underside of control.

Be sure there are no tubes, rods, or other obstacles in the tank or vessel to interfere with the operation of the displacers. No guides into the tank are necessary unless liquid turbulence is excessive, in which case a guide pipe or tube should be at least 1 inch larger than the displacer diameter, open at the bottom end, and with several vent holes located above the maximum high level of the liquid.

Check the installation of pipe or tube to be certain it is plumb.

Caution: Before attaching Magnetrol control to tank or vessel, using a level, check to see that tank mounting flange is within 3° of horizontal in all directions. Proper operation of the control depends on the switch housing being plumb.

Caution: Level controls are shipped from the factory with the enclosing tube tightened and the middle set screw, on the housing base, locked to the enclosing tube. Failure to loosen the set screw prior to repositioning the conduit connection may cause the enclosing tube to loosen, resulting in the possible leakage of the process liquid or vapor.

NOTE: If control is equipped with pneumatic switch mechanism, disregard these instructions and refer to instruction bulletin on mechanism furnished for air (or gas) connections.

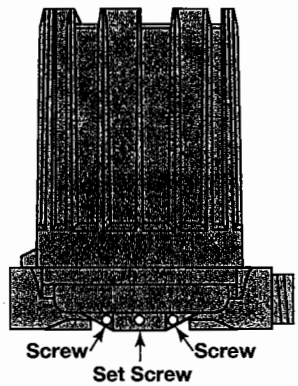


Figure 2
NEMA 4X, NEMA 4X/7/9, NEMA 4X/7/9 Group B

Most switch enclosures are designed to provide 360° positioning of the conduit outlet by loosening the set screw(s) located at the bottom of the switch housing base. To rotate conduit entry:

1. Loosen set screw(s) at base of switch housing. Refer to Figure 2.
2. Rotate switch housing so that conduit entry is positioned as desired.
3. Tighten set screws at base of housing.

At the factory, terminal blocks are positioned next to the conduit entry to facilitate wiring. If repositioning of the switch mechanisms is desired:

1. Unscrew and remove switch housing cover. The threads have been lubricated to facilitate removal.
2. Loosen the frame mounting screw on each switch mechanism. Refer to Figure 3.
3. Carefully rotate the baffle plate and all switch mechanisms together until the terminal blocks are in the desired position.

NOTE: On dual and triple stage controls the correct spacing of the mechanisms is maintained using brackets that connect the mechanisms. Take care when rotating the baffle plate and mechanisms to rotate them as a unit and not one at a time. This will ensure that the brackets and mechanisms will not be damaged during repositioning.

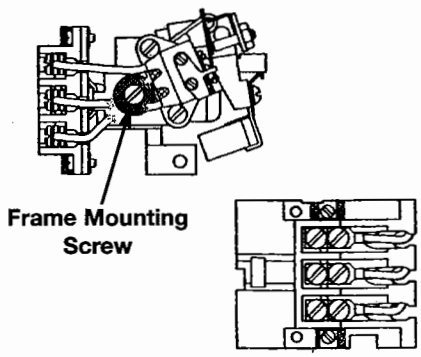
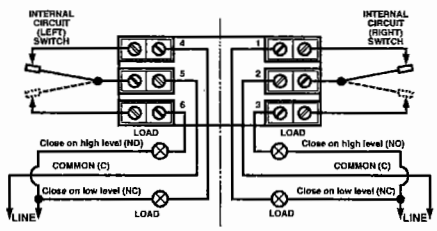


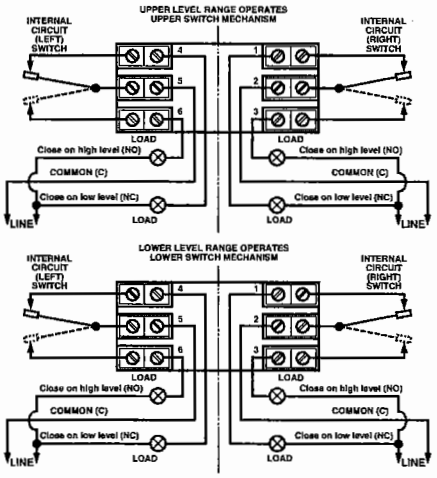
Figure 3
Switch Mechanism

4. Ensure that the terminal blocks are aligned vertically to prevent stress on the brackets and mechanisms.
5. Tighten the frame mounting screw on each switch mechanism.



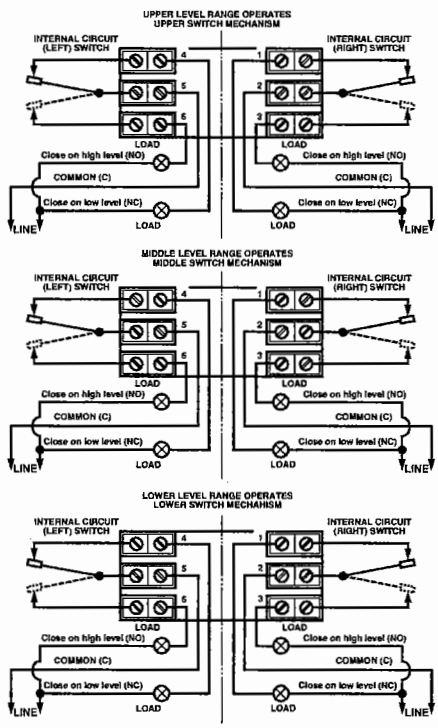
NOTES: 1. Double pole action is obtained by simultaneous operation of the right and left side single pole switches.
2. Rising Level Closes Contacts 5 & 6 and 2 & 3.
3. Falling Level Closes Contacts 4 & 5 and 1 & 2.

Figure 4 – Single Stage with DPDT contacts



NOTES: 1. Double pole action is obtained by simultaneous operation of the right and left side single pole switches.
2. Rising Level Closes Contacts 5 & 6 and 2 & 3.
3. Falling Level Closes Contacts 4 & 5 and 1 & 2.

Figure 5 – Dual Stage with DPDT contacts



NOTES: 1. Double pole action is obtained by simultaneous operation of the right and left side single pole switches.
2. Rising Level Closes Contacts 5 & 6 and 2 & 3.
3. Falling Level Closes Contacts 4 & 5 and 1 & 2.

Figure 6 – Triple Stage with DPDT contacts

NOTE: On high temperature applications above +250° F (+121° C), high temperature wire should be used between control and first junction box located in a cooler area. On non-hazardous applications, flexible conduit may be used between the control and the first junction box.

6. Bring supply wires through conduit entry. Route extra wire around enclosing tube under baffle plate, and connect then to the appropriate terminals. Refer to Figures 4–9 for wiring diagrams, or refer to wiring information in specific switch manuals. Switch instruction manual numbers are as follows:

Switch Series Letter	Description	Bulletin No.
A, T	Standard Mercury Switch	42-683
B, C, D, O, Q	Dry Contact Switch	
E, N	Vibration Resistant Mercury Switch	
HS	Hermetically Sealed Snap Switch	42-694
J	Bleed Type Pneumatic Switch	42-685
K	Non-Bleed Type Pneumatic Switch	42-686

NOTE: For models with a Series HS switch with high temperature lead wire, the leads are routed out through the conduit opening by the factory. A suitable conduit box should be provided for the connection of the leads to the control wiring.

7. Dress wiring to ensure no interference or contact with tilt of switch, or replacement of switch housing cover.

NOTE: Observe all applicable electrical codes and proper wiring procedures.

Prevent moisture seepage into the enclosure by installing approved seal-drain fittings in the conduit run leading into the unit.

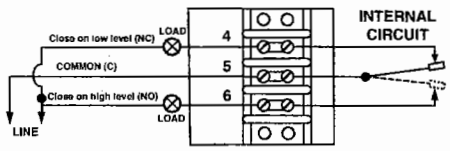
Caution: In hazardous areas, do not power the unit until the conduit is sealed and the enclosure cover is screwed down securely.

8. Test switch action by varying liquid level or manually moving displacers.

9. Replace housing cover.

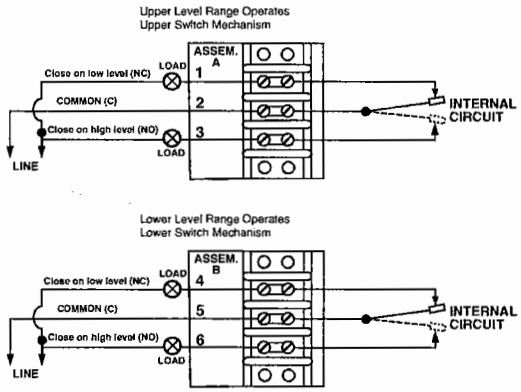
10. If control has been furnished with an explosion proof or moisture proof (gasketed) switch housing, it must be sealed at the conduit outlet with a suitable compound or non-hardening sealant to prevent entrance of air.

NOTE: If switch mechanism fails to function properly, check vertical alignment of control housing and consult installation bulletin on switch mechanism furnished.



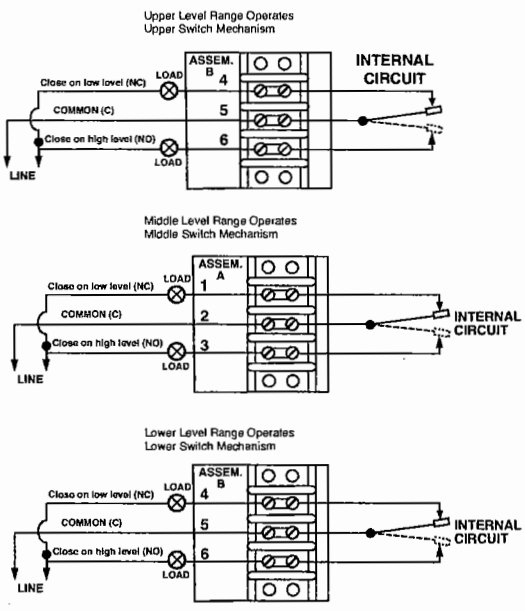
NOTES: 1. Rising level closes contacts 5 & 6.
2. Falling level closes contacts 4 & 5.

Figure 7 – Single Stage with SPDT contacts



NOTES: 1. Rising level closes contacts 5 & 6 and 2 & 3.
2. Falling level closes contacts 4 & 5 and 1 & 2.

Figure 8 – Dual Stage with SPDT contacts



NOTES: 1. Rising level closes contacts 5 & 6 and 2 & 3.
2. Falling level closes contacts 4 & 5 and 1 & 2.

Figure 9 – Triple Stage with SPDT contacts

11. Check cover to base fit to be certain gasketed joint is tight. A positive seal is necessary to prevent infiltration of moisture laden air or corrosive gasses into switch housings.

Periodic inspections are a necessary means to keep your level control in good working order. This control is a safety device to protect the valuable equipment it serves. A systematic program of "preventive maintenance" must be implemented when the control is placed into service. If the following sections on "What to do" and "What to avoid" are observed, your control will provide reliable protection of your equipment for many years.

3.1.1 Keep control clean

Be sure the switch housing cover is always in place on the control. This cover is designed to keep dust and dirt from interfering with switch mechanism operation. It protects against damaging moisture and acts as a safety feature by keeping bare wires and terminals from being exposed. Should the housing cover or any seal become damaged or misplaced, obtain a replacement immediately.

3.1.2 Inspect switch mechanisms, terminals, and connections monthly

1. Mercury switches may be visually inspected for short circuit damage. Check for small cracks in the glass tube containing the mercury. Such cracks can allow entrance of air into the tube causing the mercury to "oxidize". This is noticeable as the mercury will appear dirty or dull, and will not break into clean, round pools. If these conditions exist, replace the mercury switch immediately.

2. Dry contact switches should be inspected for excessive wear on actuating lever or misalignment of adjustment screw at point of contact between screw and lever. Such wear can cause false switch actuating levels. See switch mechanism bulletin supplied with control should switch adjustment or replacement be necessary.

3. DO NOT operate your control with defective or maladjusted switch mechanisms (refer to bulletin on switch mechanisms furnished for service instructions.)

4. Level controls may sometimes be exposed to excessive heat or moisture. Under such conditions, insulation on electrical wiring may become brittle, eventually breaking or pealing away. The resulting "bare" wires can cause short circuits.

NOTE: Check wiring carefully and replace at the first sign of brittle insulation.

5. Vibration may sometimes cause terminal screws to work loose. Check all terminal connections to be certain that screws are tight.

6. On units with pneumatic switches, air (or gas) lines subjected to vibration, may eventually crack or become loose at connections causing leakage. Check lines and connections carefully and repair or replace, if necessary.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

1. Never leave switch housing cover off the control longer than necessary to make routine inspections.

2. Never place a jumper wire across terminals to "cut-out" the control. If a "jumper" is necessary for test purposes, be certain it is removed before placing control into service.

3. Never attempt to make adjustments or replace switches without reading instructions carefully. Certain adjustments provided for in level controls should not be attempted in the field. When in doubt, consult the factory or your local representative.

4. Never use lubricants on pivots of switch mechanisms. A sufficient amount of lubricant has been applied at the factory to ensure a lifetime of service. Further oiling is unnecessary and will only tend to attract dust and dirt which can interfere with mechanism operation.

5. Never attempt to readjust magnetic attraction sleeve. It is factory set, and tampering may cause failure of control while in service, even if manual operation activates switch.

Usually the first indication of improper operation is failure of the controlled equipment to function, i.e., pump will not start (or stop), signal lamps fail to light, etc. When these symptoms occur, whether at time of installation or during routine service thereafter, check the following potential external causes first.

a. Fuses may be blown.

b. Reset button(s) may need resetting.

c. Power switch may be open.

d. Controlled equipment may be faulty.

e. Wiring leading to control may be defective.

If a thorough inspection of these possible conditions fails to locate the trouble, proceed next to a check of the control's switch mechanism.

4.1.1 Check switch mechanism

1. Pull disconnect switch or otherwise disconnect power to the control.
2. Remove switch housing cover.
3. Disconnect power wiring from switch assembly.
4. Swing magnet assembly in and out by hand to check carefully for any sign of binding. Assembly should require minimal force to move it through its full swing.
5. If binding exists, magnet may be rubbing enclosing tube. If magnet is rubbing, loosen magnet clamp screw and shift magnet position. Retighten magnet clamp screw.
6. If switch magnet assembly swings freely and mechanism still fails to actuate, check installation of control to be certain it is within the specified three degrees of vertical. (Use spirit level on side of enclosing tube in two places, 90° apart.)

7a. If mechanism is equipped with a mercury switch, examine glass mercury tube closely as previously described in Section 3.0 Preventive Maintenance. If switch is damaged, replace it immediately.

7b. If mechanism is equipped with a microswitch, check continuity with ohmmeter.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

8. If switch mechanism is operating satisfactorily, proceed to check sensing unit.

4.1.2 Test control's performance

1. Reconnect power supply and carefully actuate switch mechanism manually, using a non-conductive tool on electrical switch mechanism, to determine whether controlled equipment will operate.

Caution: With electrical power on, care should be taken to avoid contact with switch leads and connections at terminal block.

2. If controlled equipment responds to manual actuation test, trouble may be located in level sensing portion of the control (displacers, spring, stem, and magnetic attracting sleeve).

NOTE: Check first to be certain liquid is entering tank or vessel. A valve may be closed or pipe line plugged.

3. With liquid in tank or vessel, proceed to check level sensing action by removing switch housing assembly.

Caution: Be certain to pull disconnect switch or otherwise assure that electrical circuit(s) through control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms

a. Disconnect wiring from supply side of switch mechanism(s) and remove electrical conduit or operating medium line connections to switch housing.

b. Relieve pressure from vessel and allow unit to cool.

c. Remove switch housing assembly by loosening set screws located at the bottom of the housing base.

4. With switch housing assembly removed, inspect attraction sleeve and inside of enclosing tube for excessive corrosion or solids buildup which could restrict movement, preventing sleeve from reaching field of switch magnet.

5. Inspect displacer stem and spring assembly to assure it is not damaged. If stem or spring is bent or otherwise damaged, movement of the attraction sleeve inside the e-tube will be restricted, preventing proper function of the control.

6. If trouble is still not located, proceed to remove the entire sensing unit from the tank or vessel by unbolting head flange or unscrewing mounting bushing. Inspect displacer assembly and all internal parts for any signs of damage. Check assembly for binding by supporting head flange or mounting bushing over the edge of a bench and move displacer assembly by hand.

NOTE: When in doubt about the condition or performance of a control, contact the factory or consult your local representative.

4.1.3 Proof-er

If the Proof-er is not functioning properly, listed below are potential problems and corrective action.

1. Proof-er does not return to the down position after it is activated.

CAUSE	REMEDY
Defective return spring.	Replace Spring.
Buildup between the shaft and housing restricting movement.	Clean Proof-er to remove buildup.
Handle stops are not adjusted properly.	Adjust handle stop screws in or out to allow the handle to move to the proper position.

2. Switch will not trip when Proof-er is activated.

CAUSE	REMEDY
The switch mechanism is defective and not the Proof-er.	Check switch mechanism.
Handle stops are not adjusted properly.	Adjust handle stop screws in or out to allow the handle to move to the proper position.

AGENCY	APPROVED MODEL	APPROVAL CLASSES
FM FM APPROVED	All with an electric switch mechanism and a housing listed as Type 4X/7/9	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as Type 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
CSA	All with a Series A, E, 2, 3 or HS electric switch mechanism and a housing listed as CSA Type 4X	Class I, Div 2, Groups B, C & D
	All with an electric switch mechanism and a housing listed as Type 4X/7/9 ①	Class I, Div 1, Groups C & D Class II, Div 1, Groups E, F & G
	All with an electric switch mechanism and a housing listed as Type 4X/7/9 Class I, Div 1, Group B	Class I, Div 1, Groups B, C & D Class II, Div 1, Groups E, F & G
ATEX / IEC Ex ③	All with an electric switch mechanism and an ATEX housing ②	ATEX II 2 G EEx d IIC T6 IEC Ex Ex d IIC T6
CE	Low Voltage Directives 73/23/EEC & 93/68/EEC Per Harmonized Standard: EN 61010-1/1993 & Amendment No. 1	Installation Category II Pollution Degree 2

① With housing drain, CSA drops Group E and FM drops Group C.

② Models B10 and B15 with 'HS' switches and all Model C10 and C15 are not ATEX approved.

③ IEC Installation Instructions:

The cable entry and closing devices shall be Ex d certified suitable for the conditions of use and correctly installed.

For ambient temperatures above +55° C or for process temperatures above +150° C, suitable heat resistant cables shall be used.

Heat extensions (between process connection and housing) shall never be insulated.

Special conditions for safe use:

When the equipment is installed in process temperatures higher than +85° C the temperature classification must be reduced according to the following table as per IEC60079-0.

Maximum Process Temperature	Temperature Classification
< 85° C	T6
< 100° C	T5
< 135° C	T4
< 200° C	T3
< 300° C	T2
< 450° C	T1

These units are in comformity with IECEx KEM 05.0020X
Classification Ex d IIC T6
$T_{ambient}$ -40° C to +70° C

4.3.1 Basic Electrical Ratings

Displacer	Switch Series and Non-Inductive Ampere Rating									
	A	B	C	D	E	HS	N	O	Q	T
120 VAC	13.00	15.00	15.00	10.00	4.00	5.00	13.00	15.00	15.00	4.00
240 VAC	6.50	15.00	15.00	—	2.00	5.00	6.50	15.00	15.00	2.00
24 VDC	10.00	6.00	10.00	10.00	—	5.00	—	—	6.00	—
120 VDC	10.00	0.50	1.00	10.00	4.00	0.50	10.00	1.00	0.50	4.00
240 VDC	5.00	0.25	0.50	3.00	2.00	0.25	5.00	0.50	0.25	2.00

4.3.2 Pressure/Temperature Ratings

Threaded Models*	800 psig @ +100° F (55 bar @ +38° C) 250 psig @ +400° F (17 bar @ +204° C)
Flanged Models	Limited to the pressure rating of the selected flange or displacer. Cast iron flanges are flat face type conformi ng to ANSI dimensional specifications
Low Pressure Proof-er Models	25 psig @ +200° F (1.7 bar @ +93° C)
Medium Pressure Proof-er Models	125 psig @ +300° F (8.6 bar @ +149° C)

*Models with stainless steel displacers are rated 720 psig @ +100° F (50 bar @ +38° C)

4.3.3 Model A10 Dimensional Data and Actuating Levels

Inches (mm)

Model A10

Outline Dimensions				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	5.00 (127)	122.00 (3098)	7.00 (177)	124.00 (3149)
Stainless Steel or Karbate	4.75 (120)	122.00 (3098)	6.75 (171)	124.00 (3149)

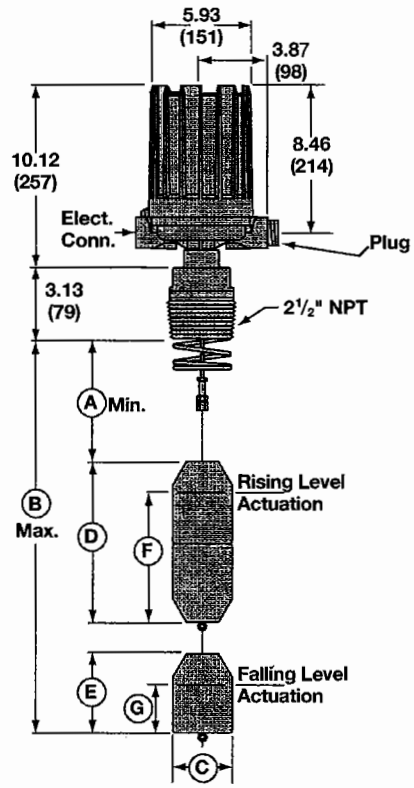
Displacer Type	C	D	E
Porcelain	2.56 (65)	7.25 (184)	3.62 (91)
Stainless Steel or Karbate	2.50 (63)	9.00 (228)	4.50 (114)

Electrical Connections
NEMA 4X/7/9, Group B: 1" NPT NEMA 1 Pneumatic: ¼" NPT

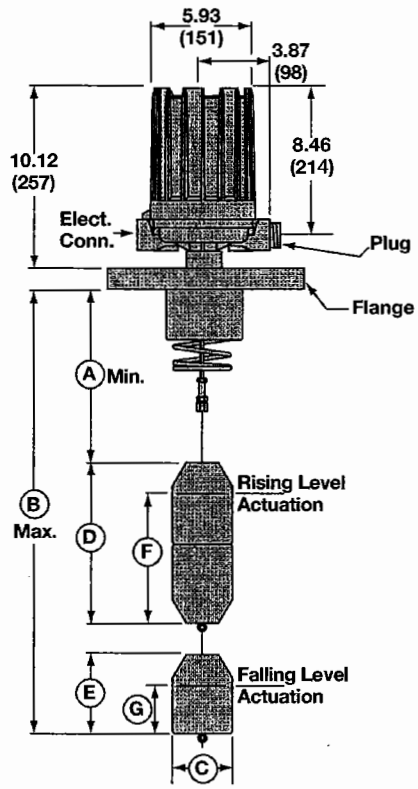
A10 Standard actuating levels and liquid specific gravity

Displacer Type	Liquid Temp. °F	0.60		0.70		0.80		0.90		1.00	
		F	G	F	G	F	G	F	G	F	G
Porcelain	100	5.30 (134)	1.50 (38)	4.10 (104)	1.20 (30)	3.20 (81)	1.10 (27)	2.50 (63)	1.00 (25)	2.00 (50)	0.90 (22)
	200	—	—	4.80 (121)	2.00 (50)	3.80 (96)	1.80 (45)	3.00 (76)	1.60 (40)	2.50 (63)	1.50 (38)
	300	—	—	—	—	4.30 (109)	2.40 (60)	3.40 (86)	2.10 (53)	2.90 (73)	1.90 (48)
	400	—	—	—	—	—	—	3.40 (86)	2.60 (66)	2.90 (73)	2.40 (60)
Stainless Steel or Karbate	100	7.00 (177)	2.40 (60)	5.30 (134)	2.00 (50)	4.10 (104)	1.80 (45)	3.10 (78)	1.60 (40)	2.40 (60)	1.40 (35)
	200	—	—	5.90 (149)	2.80 (71)	4.70 (119)	2.50 (63)	3.60 (91)	2.20 (55)	2.80 (71)	2.00 (50)
	300	—	—	—	—	5.10 (129)	3.10 (78)	4.00 (101)	2.70 (68)	3.20 (81)	2.40 (60)
Stainless Steel	400	—	—	—	—	—	—	4.40 (111)	3.20 (81)	3.60 (91)	2.90 (73)
	500	—	—	—	—	—	—	—	—	3.90 (99)	3.30 (83)

Note: All levels ±0.25" (6).



Model A10 with Threaded Mounting



Model A10 with Flanged Mounting

4.3.4 Model A15 Dimensional Data and Actuating Levels

Inches (mm)

Model A15

Outline Dimensions				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	5.62 (142)	122.00 (3098)	7.62 (193)	124.00 (3149)
Stainless Steel or Karbate	5.62 (142)	122.00 (3098)	7.62 (193)	124.00 (3149)

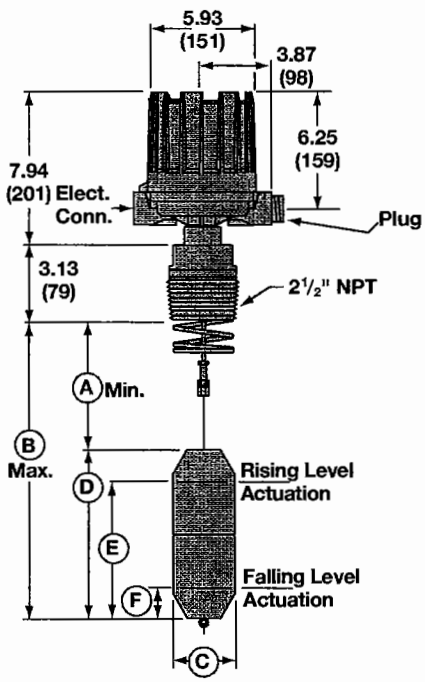
Displacer Type	C	D
Porcelain	2.56 (65)	7.25 (184)
Stainless Steel or Karbate	2.50 (63)	9.00 (228)

Electrical Connections
NEMA 4X/7/9, Group B: 1" NPT NEMA 1 Pneumatic: ¼" NPT

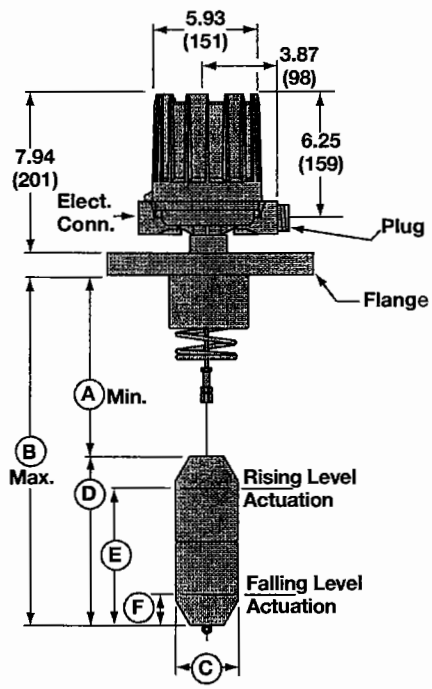
A15 Standard actuating levels and liquid specific gravity

Displacer Type	Liquid Temp. °F	0.50		0.60		0.70		0.80		0.90		1.00	
		E	F	E	F	E	F	E	F	E	F	E	F
Porcelain	100	—	—	5.10 (129)	2.10 (53)	4.50 (114)	1.70 (43)	3.90 (99)	1.70 (43)	3.50 (88)	1.50 (38)	3.20 (81)	1.40 (35)
	200	—	—	5.60 (142)	2.60 (66)	4.90 (124)	2.10 (53)	4.30 (109)	2.10 (53)	3.80 (96)	1.80 (45)	3.50 (88)	1.70 (43)
	300	—	—	—	—	5.20 (132)	2.40 (60)	4.50 (114)	2.30 (58)	4.10 (104)	2.10 (53)	3.70 (93)	1.90 (48)
	400	—	—	—	—	5.60 (142)	2.80 (71)	4.80 (121)	2.60 (66)	4.30 (109)	2.30 (58)	3.90 (99)	2.10 (53)
	500	—	—	—	—	—	—	5.10 (129)	2.90 (73)	4.60 (116)	2.60 (66)	4.20 (106)	2.40 (60)
Stainless Steel or Karbate	100	5.40 (137)	2.00 (50)	4.50 (114)	1.60 (40)	3.90 (99)	1.40 (35)	3.40 (86)	1.20 (30)	3.00 (76)	1.10 (27)	2.70 (68)	1.00 (25)
	200	6.00 (152)	2.60 (66)	5.00 (127)	2.10 (53)	4.30 (109)	1.80 (45)	3.70 (93)	1.60 (40)	3.30 (83)	1.40 (35)	3.00 (76)	1.30 (33)
	300	6.40 (162)	3.00 (76)	5.30 (134)	2.40 (60)	4.60 (116)	2.10 (53)	4.00 (101)	1.80 (45)	3.60 (91)	1.70 (43)	3.20 (81)	1.50 (38)
Stainless Steel	400	6.90 (175)	3.50 (88)	5.70 (144)	2.80 (71)	4.90 (124)	2.40 (60)	4.30 (109)	2.10 (53)	3.80 (96)	1.90 (48)	3.40 (86)	1.70 (43)
	500	—	—	6.10 (154)	3.20 (81)	5.20 (132)	2.80 (71)	4.60 (116)	2.40 (60)	4.10 (104)	2.20 (55)	3.70 (93)	2.00 (50)

Note: All levels ±0.25" (6).



Model A15 with Threaded Mounting



Model A15 with Flanged Mounting

4.3.5 Model B10 Dimensional Data

Inches (mm)

Model B10

Outline Dimensions				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	4.88 (123)	122.00 (3098)	6.88 (174)	124.00 (3149)
Stainless Steel or Karbate	4.75 (120)	122.00 (3098)	6.75 (171)	124.00 (3149)

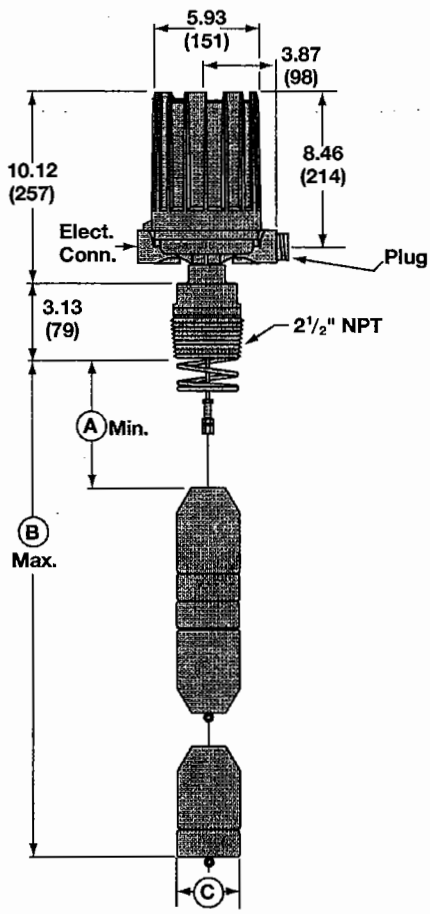
Model B10 with displacer arrangements 1 and 2

Displacer Type	C	D	E
Porcelain	2.56 (65)	10.04 (255)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	12.00 (304)	6.00 (152)

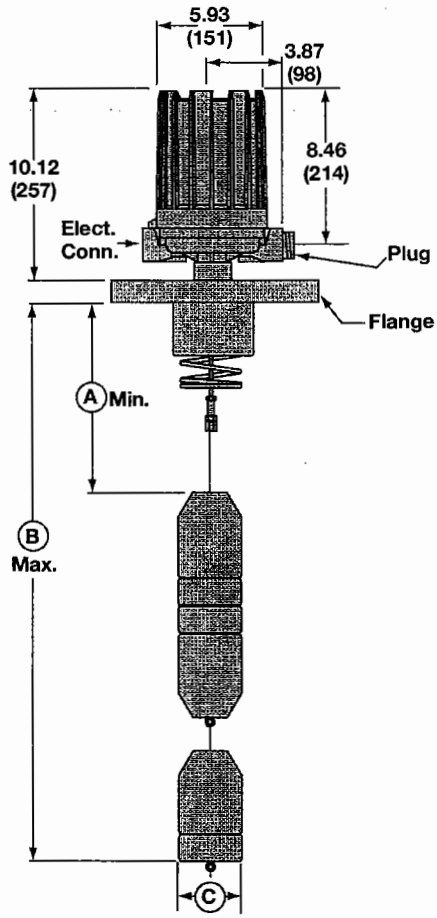
Model B10 with displacer arrangements 3, 4, and 5

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	5.02 (127)	5.02 (127)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	6.00 (152)	6.00 (152)	6.00 (152)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



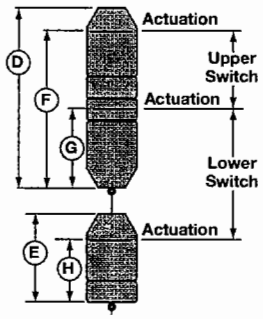
Model B10
with Threaded Mounting



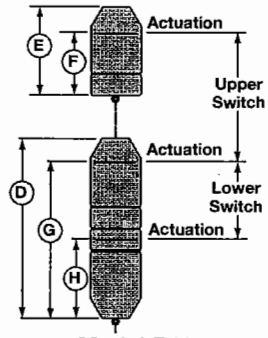
Model B10
with Flanged Mounting

4.3.6 Model B10 Actuating Levels

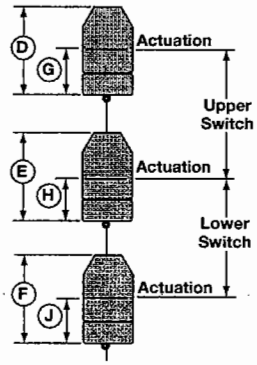
Inches (mm)



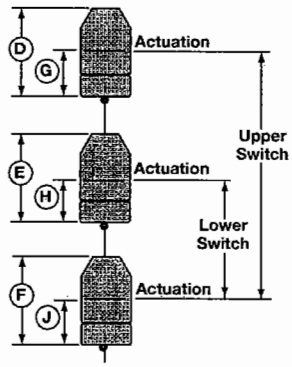
Model B10
Displacer Arrangement 1



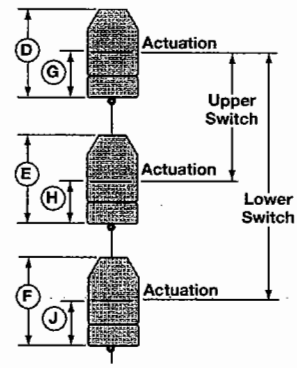
Model B10
Displacer Arrangement 2



Model B10
Displacer Arrangement 3



Model B10
Displacer Arrangement 4



Model B10
Displacer Arrangement 5

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 1

Displacer Type	Liquid Temp. ° F	Level	0.60 – 0.64	0.65 – 0.71	0.72 – 0.73	0.74 – 0.82	0.83 – 0.92	0.93 – 1.00	1.01 – 1.07
Porcelain	100	F	7.79 – 7.04 (197 – 178)	7.66 – 6.65 (194 – 168)	7.22 – 7.06 (133 – 179)	6.91 – 5.81 (175 – 147)	6.73 – 5.65 (180 – 143)	5.55 – 4.86 (140 – 123)	4.97 – 4.53 (126 – 115)
		G	2.62 – 2.19 (56 – 55)	2.88 – 2.28 (73 – 57)	2.91 – 2.81 (73 – 71)	2.71 – 2.03 (68 – 51)	2.99 – 2.28 (75 – 57)	2.21 – 1.76 (56 – 44)	1.90 – 1.63 (48 – 41)
		H	2.01 – 1.89 (51 – 48)	1.86 – 1.70 (47 – 43)	1.68 – 1.65 (42 – 41)	1.63 – 1.47 (41 – 37)	1.45 – 1.31 (36 – 33)	1.30 – 1.21 (33 – 30)	1.02 – 0.97 (25 – 24)
	200	F	7.91 (200)	7.72 – 6.71 (196 – 170)	6.56 – 6.41 (166 – 162)	6.73 – 5.66 (170 – 143)	6.37 – 5.33 (161 – 135)	6.15 – 5.42 (156 – 137)	5.02 – 4.57 (127 – 116)
		G	3.06 (77)	2.95 – 2.34 (74 – 59)	2.25 – 2.16 (57 – 54)	2.54 – 1.87 (64 – 47)	2.63 – 1.95 (66 – 49)	2.81 – 2.32 (71 – 58)	1.94 – 1.67 (49 – 42)
		H	2.76 (70)	2.72 – 2.49 (69 – 63)	2.45 – 2.42 (62 – 61)	2.39 – 2.15 (60 – 54)	2.13 – 1.92 (54 – 48)	1.90 – 1.77 (48 – 44)	1.58 – 1.49 (40 – 37)
	300	F	—	—	—	7.48 – 6.34 (189 – 161)	7.04 – 5.93 (178 – 150)	6.75 – 5.98 (171 – 151)	5.57 – 5.10 (141 – 129)
		G	—	—	—	3.29 – 2.55 (83 – 64)	3.30 – 2.56 (83 – 65)	3.41 – 2.87 (86 – 72)	2.50 – 2.19 (63 – 55)
		H	—	—	—	3.14 – 2.83 (79 – 71)	2.80 – 2.53 (71 – 64)	2.50 – 2.32 (63 – 58)	2.13 – 2.01 (54 – 51)
	400	F	—	—	—	—	—	—	6.12 – 5.62 (155 – 142)
		G	—	—	—	—	—	—	3.05 – 2.72 (77 – 69)
		H	—	—	—	—	—	—	2.68 – 2.53 (68 – 64)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 1

Displacer Type	Liquid Temp. ° F	Level	1.08 – 1.12	1.13 – 1.17	1.18 – 1.27	1.28 – 1.30	1.31 – 1.39	1.40 – 1.50
Porcelain	100	F	4.47 – 4.20 (113 – 106)	4.90 – 4.64 (124 – 117)	4.57 – 4.05 (116 – 102)	3.99 – 3.89 (101 – 98)	4.23 – 3.82 (107 – 97)	3.77 – 3.33 (95 – 84)
		G	1.59 – 1.43 (40 – 36)	2.16 – 1.99 (54 – 50)	1.94 – 1.60 (49 – 40)	1.57 – 1.50 (39 – 38)	1.86 – 1.59 (47 – 40)	1.56 – 1.26 (39 – 32)
		H	0.96 – 0.92 (24 – 23)	0.92 – 0.88 (23 – 22)	0.88 – 0.81 (22 – 20)	0.81 – 0.80 (20 – 20)	0.79 – 0.74 (20 – 18)	0.74 – 0.69 (18 – 17)
	200	F	4.66 – 4.39 (118 – 111)	4.33 – 4.08 (109 – 103)	4.32 – 3.81 (109 – 96)	4.29 – 4.18 (108 – 106)	4.13 – 3.73 (104 – 94)	3.93 – 3.47 (99 – 88)
		G	1.79 – 1.62 (45 – 41)	1.58 – 1.43 (40 – 36)	1.69 – 1.36 (42 – 34)	1.87 – 1.80 (47 – 45)	1.76 – 1.49 (44 – 37)	1.71 – 1.40 (43 – 35)
		H	1.48 – 1.42 (37 – 36)	1.41 – 1.36 (35 – 34)	1.35 – 1.25 (34 – 31)	1.24 – 1.23 (31 – 31)	1.22 – 1.15 (30 – 29)	1.14 – 1.06 (28 – 26)
	300	F	5.18 – 4.89 (131 – 124)	4.82 – 4.56 (122 – 115)	4.79 – 4.25 (121 – 107)	4.73 – 4.61 (120 – 117)	4.56 – 4.13 (115 – 104)	4.32 – 3.84 (109 – 97)
		G	2.31 – 2.12 (58 – 53)	2.08 – 1.91 (52 – 48)	2.16 – 1.80 (54 – 45)	2.31 – 2.23 (58 – 56)	2.19 – 1.90 (55 – 48)	2.11 – 1.78 (53 – 45)
		H	1.99 – 1.92 (50 – 48)	1.90 – 1.84 (48 – 46)	1.82 – 1.69 (45 – 42)	1.68 – 1.66 (42 – 42)	1.64 – 1.55 (41 – 39)	1.54 – 1.43 (39 – 36)
	400	F	5.70 – 5.39 (144 – 136)	5.32 – 5.04 (135 – 128)	5.26 – 4.69 (133 – 119)	5.17 – 5.04 (131 – 128)	4.98 – 4.53 (126 – 115)	4.72 – 4.22 (119 – 107)
		G	2.82 – 2.62 (71 – 66)	2.57 – 2.39 (65 – 60)	2.63 – 2.24 (66 – 56)	2.74 – 2.66 (69 – 67)	2.61 – 2.30 (66 – 58)	2.51 – 2.15 (63 – 54)
		H	2.51 – 2.42 (63 – 61)	2.40 – 2.32 (60 – 58)	2.30 – 2.13 (58 – 54)	2.12 – 2.08 (53 – 52)	2.07 – 1.95 (52 – 49)	1.94 – 1.81 (49 – 45)
	500	F	6.22 – 5.89 (157 – 149)	5.81 – 5.52 (147 – 140)	5.74 – 5.13 (145 – 130)	5.60 – 5.47 (142 – 138)	5.41 – 4.93 (137 – 125)	5.12 – 4.59 (130 – 116)
		G	3.34 – 3.12 (84 – 79)	3.07 – 2.86 (77 – 72)	3.11 – 2.68 (78 – 68)	3.18 – 3.09 (80 – 78)	3.04 – 2.70 (77 – 68)	2.91 – 2.52 (73 – 64)
		H	3.03 – 2.92 (76 – 74)	2.89 – 2.79 (73 – 70)	2.77 – 2.57 (70 – 65)	2.55 – 2.51 (64 – 63)	2.50 – 2.35 (63 – 59)	2.33 – 2.18 (59 – 55)

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel and Karbate	100	F	9.91 – 7.72 (251 – 196)	9.19 – 6.62 (233 – 168)	8.44 – 7.16 (214 – 181)	7.66 – 6.86 (194 – 174)	6.71 – 4.93 (170 – 125)	4.82 – 4.61 (122 – 117)
		G	3.46 – 2.16 (86 – 54)	3.72 – 2.08 (94 – 52)	3.96 – 3.07 (100 – 77)	3.63 – 3.07 ((92 – 77)	2.96 – 1.71 (75 – 43)	1.63 – 1.48 (41 – 37)
		H	2.51 – 2.16 (63 – 54)	2.13 – 1.77 (54 – 44)	1.74 – 1.59 (44 – 40)	1.57 – 1.48 (39 – 37)	1.46 – 1.25 (37 – 31)	1.24 – 1.22 (31 – 30)
	200	F	10.22 – 7.98 (259 – 202)	7.74 – 7.44 (196 – 188)	7.50 – 6.30 (190 – 160)	6.15 – 5.44 (156 – 138)	6.97 – 5.15 (177 – 130)	—
		G	3.76 – 2.42 (95 – 61)	2.27 – 1.89 (57 – 48)	3.02 – 2.22 (76 – 56)	2.12 – 1.64 (53 – 41)	3.22 – 1.93 (81 – 49)	—
		H	3.67 – 3.16 (93 – 80)	3.11 – 2.58 (78 – 65)	2.55 – 2.32 (64 – 58)	2.29 – 2.16 (58 – 54)	2.13 – 1.84 (54 – 46)	—
	300	F	—	9.68 – 7.25 (245 – 184)	8.31 – 7.04 (211 – 178)	6.88 – 6.12 (174 – 155)	7.65 – 5.73 (194 – 145)	—
		G	—	4.30 – 2.70 (109 – 68)	3.83 – 2.96 (97 – 75)	2.84 – 2.32 (72 – 58)	3.89 – 2.51 (98 – 63)	—
		H	—	4.03 – 3.40 (102 – 86)	3.36 – 3.06 (85 – 77)	3.02 – 2.84 (76 – 72)	2.81 – 2.42 (71 – 61)	—

continued on page 16

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 1 (cont.)

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel	400	F	—	—	9.11 – 7.77 (231 – 197)	7.60 – 6.80 (193 – 172)	8.32 – 6.32 (211 – 160)	—
		G	—	—	4.63 – 3.69 (117 – 93)	3.57 – 3.01 (90 – 76)	4.57 – 3.09 (116 – 78)	—
		H	—	—	4.16 – 3.79 (105 – 96)	3.75 – 3.53 (95 – 89)	3.48 – 3.00 (88 – 76)	—
	500	F	—	—	—	—	9.00 – 6.90 (228 – 175)	—
		G	—	—	—	—	5.24 – 3.67 (133 – 93)	—
		H	—	—	—	—	4.16 – 3.58 (105 – 90)	—

Note: All levels ±0.25" (6).

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 2

Displacer Type	Liquid Temp. ° F	Level	0.60 – 0.64	0.65 – 0.71	0.72 – 0.73	0.74 – 0.82	0.83 – 0.92	0.93 – 1.00	1.01 – 1.07
Porcelain	100	F	2.77 – 2.01 (70 – 51)	2.63 – 1.62 (66 – 41)	2.67 – 2.51 (67 – 63)	2.58 – 1.42 (65 – 36)	3.16 – 1.94 (80 – 49)	1.82 – 1.04 (45 – 26)	1.69 – 1.23 (42 – 31)
		G	7.27 – 6.84 (184 – 173)	7.54 – 6.93 (191 – 176)	7.56 – 7.46 (192 – 189)	7.36 – 6.68 (186 – 169)	7.64 – 6.93 (194 – 176)	6.86 – 6.41 (174 – 162)	5.15 – 4.89 (130 – 124)
		H	2.67 – 2.53 (67 – 64)	3.29 – 3.05 (83 – 77)	3.73 – 3.68 (94 – 93)	3.64 – 3.32 (92 – 84)	4.32 – 3.93 (109 – 99)	3.90 – 3.65 (99 – 92)	2.42 – 2.31 (61 – 58)
	200	F	3.15 (80)	2.96 – 1.93 (75 – 49)	1.77 – 1.62 (44 – 41)	2.64 – 1.47 (67 – 37)	2.79 – 1.61 (70 – 40)	2.79 – 1.94 (70 – 49)	1.56 – 1.11 (39 – 28)
		G	7.71 (195)	7.60 – 6.99 (193 – 177)	6.90 – 6.81 (175 – 172)	7.19 – 6.52 (182 – 165)	7.28 – 6.60 (184 – 167)	7.46 – 6.97 (189 – 177)	5.19 – 4.92 (131 – 124)
		H	3.40 (86)	3.36 – 3.10 (85 – 78)	3.07 – 3.03 (77 – 76)	3.46 – 3.16 (87 – 80)	3.96 – 3.61 (100 – 91)	4.50 – 4.21 (114 – 106)	2.46 – 2.35 (62 – 59)
	300	F	—	—	—	3.39 – 2.15 (86 – 54)	3.47 – 2.22 (88 – 56)	3.39 – 2.50 (86 – 63)	2.11 – 1.63 (53 – 41)
		G	—	—	—	7.94 – 7.20 (201 – 182)	7.95 – 7.21 (201 – 183)	8.06 – 7.53 (204 – 191)	5.75 – 5.45 (146 – 138)
		H	—	—	—	4.21 – 3.84 (106 – 97)	4.63 – 4.21 (117 – 106)	5.10 – 4.77 (129 – 121)	3.02 – 2.87 (76 – 72)
	400	F	—	—	—	—	—	—	2.67 – 2.15 (67 – 54)
		G	—	—	—	—	—	—	6.30 – 5.97 (160 – 151)
		H	—	—	—	—	—	—	3.57 – 3.39 (90 – 86)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 2 (cont.)

Displacer Type	Liquid Temp. ° F	Level	1.08 – 1.12	1.13 – 1.17	1.18 – 1.27	1.28 – 1.30	1.31 – 1.39	1.40 – 1.50
Porcelain	100	F	1.16 – 0.89 (29 – 22)	2.04 – 1.75 (51 – 44)	1.68 – 1.10 (42 – 27)	1.04 – 0.92 (26 – 23)	2.05 – 1.56 (52 – 39)	1.50 – 0.97 (38 – 24)
		G	4.84 – 4.68 (122 – 118)	5.41 – 5.24 (137 – 133)	5.20 – 4.85 (132 – 123)	4.82 – 4.75 (122 – 120)	5.11 – 4.84 (129 – 122)	4.81 – 4.51 (122 – 114)
		H	2.29 – 2.22 (58 – 56)	2.97 – 2.88 (75 – 73)	2.86 – 2.68 (72 – 68)	2.66 – 2.63 (67 – 66)	3.01 – 2.85 (76 – 72)	2.84 – 2.67 (72 – 67)
	200	F	1.68 – 1.38 (42 – 35)	1.31 – 1.05 (33 – 26)	1.71 – 1.13 (43 – 28)	1.75 – 1.62 (44 – 41)	1.56 – 1.09 (39 – 27)	1.53 – 1.00 (38 – 25)
		G	5.04 – 4.88 (128 – 123)	4.84 – 4.68 (122 – 118)	4.94 – 4.62 (125 – 117)	5.12 – 5.05 (130 – 128)	5.01 – 4.75 (127 – 120)	4.96 – 4.65 (125 – 118)
		H	2.49 – 2.41 (63 – 61)	2.39 – 2.33 (60 – 59)	2.60 – 2.44 (66 – 61)	2.97 – 2.93 (73 – 70)	2.91 – 2.76 (73 – 70)	2.99 – 2.82 (75 – 77)
	300	F	2.19 – 1.88 (55 – 47)	1.81 – 1.52 (45 – 38)	2.19 – 1.57 (55 – 39)	2.18 – 2.05 (50 – 37)	1.98 – 1.49 (50 – 37)	1.93 – 1.37 (49 – 34)
		G	5.56 – 5.37 (141 – 136)	5.33 – 5.16 (135 – 131)	5.41 – 5.06 (137 – 128)	5.56 – 5.48 (138 – 130)	5.44 – 5.15 (138 – 130)	5.36 – 5.03 (136 – 127)
		H	3.01 – 2.91 (76 – 73)	2.89 – 2.80 (73 – 71)	3.07 – 2.88 (77 – 73)	3.40 – 3.36 (84 – 80)	3.33 – 3.16 (84 – 80)	3.39 – 3.19 (86 – 81)
	400	F	2.71 – 2.38 (68 – 60)	2.30 – 2.00 (58 – 50)	2.66 – 2.01 (67 – 51)	2.62 – 2.48 (61 – 48)	2.41 – 1.90 (61 – 48)	2.33 – 1.74 (59 – 44)
		G	6.08 – 5.87 (154 – 149)	5.82 – 5.64 (147 – 143)	5.89 – 5.49 (149 – 139)	5.99 – 5.91 (152 – 150)	5.87 – 5.55 (149 – 140)	5.76 – 5.40 (146 – 137)
		H	3.52 – 3.41 (89 – 86)	3.38 – 3.28 (85 – 83)	3.55 – 3.32 (90 – 84)	3.84 – 3.79 (97 – 96)	3.76 – 3.56 (95 – 90)	3.79 – 3.56 (96 – 90)
	500	F	3.23 – 2.88 (82 – 73)	2.80 – 2.48 (71 – 62)	3.13 – 2.45 (79 – 62)	3.05 – 2.91 (77 – 73)	2.84 – 2.30 (72 – 58)	2.73 – 2.11 (69 – 53)
		G	6.59 – 6.37 (167 – 161)	6.32 – 6.12 (160 – 155)	6.36 – 5.93 (161 – 150)	6.43 – 6.34 (163 – 161)	6.29 – 5.95 (159 – 151)	6.16 – 5.77 (156 – 146)
		H	4.04 – 3.91 (102 – 99)	3.88 – 3.76 (98 – 95)	4.02 – 3.76 (102 – 95)	4.28 – 4.21 (108 – 106)	4.19 – 3.97 (106 – 100)	4.19 – 3.93 (106 – 99)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangement 2

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel and Karbate	100	F	3.77 – 1.60 (95 – 40)	4.10 – 1.38 (104 – 35)	4.43 – 2.97 (112 – 75)	4.58 – 3.60 (24 – 91)	3.42 – 1.26 (86 – 31)	1.13 – 0.88 (28 – 22)
		G	9.46 – 8.16 (240 – 207)	9.72 – 8.08 (246 – 205)	9.96 – 9.07 (252 – 230)	9.63 – 9.07 (244 – 230)	8.96 – 7.71 (227 – 195)	7.63 – 7.48 (193 – 189)
		H	3.73 – 3.21 (94 – 81)	4.86 – 4.04 (123 – 102)	5.97 – 5.44 (151 – 138)	6.05 – 5.69 (153 – 144)	5.63 – 4.84 (143 – 122)	4.79 – 4.70 (121 – 119)
	200	F	4.22 – 1.98 (107 – 50)	1.74 – 1.44 (44 – 36)	3.74 – 2.35 (94 – 59)	2.17 – 1.33 (55 – 33)	3.89 – 1.66 (98 – 42)	—
		G	9.76 – 8.42 (247 – 213)	8.27 – 6.88 (210 – 174)	9.02 – 8.22 (229 – 208)	8.12 – 7.64 (206 – 194)	9.22 – 7.93 (234 – 201)	—
		H	4.03 – 3.47 (102 – 88)	3.41 – 2.84 (86 – 62)	5.04 – 4.59 (128 – 116)	4.53 – 4.27 (115 – 108)	5.88 – 5.06 (149 – 128)	—
	300	F	—	4.87 – 2.26 (123 – 57)	4.55 – 3.08 (115 – 78)	2.89 – 2.02 (73 – 51)	4.56 – 2.24 (115 – 56)	—
		G	—	10.30 – 8.70 (261 – 220)	9.83 – 8.96 (249 – 227)	8.84 – 8.32 (224 – 211)	9.89 – 8.51 (251 – 216)	—
		H	—	5.52 – 4.66 (140 – 118)	5.84 – 5.33 (148 – 135)	5.26 – 4.95 (133 – 125)	6.56 – 5.64 (166 – 131)	—
Stainless Steel	400	F	—	—	5.35 – 3.82 (135 – 97)	3.62 – 2.70 (91 – 68)	5.24 – 2.82 (133 – 71)	—
		G	—	—	10.63 – 9.69 (270 – 246)	9.57 – 9.01 (243 – 228)	10.57 – 9.09 (183 – 157)	—
		H	—	—	6.65 – 6.06 (168 – 153)	5.99 – 5.63 (152 – 143)	7.24 – 6.22 (183 – 157)	—
	500	F	—	—	—	—	5.91 – 3.41 (150 – 86)	—
		G	—	—	—	—	11.24 – 9.67 (285 – 245)	—
		H	—	—	—	—	7.91 – 6.80 (200 – 172)	—

Note: All levels ±0.25" (6).

B10 Standard actuating levels and liquid specific gravity with displacer arrangements 3, 4, and 5

Displacer Type	Liquid Temp. ° F	Level	0.60 – 0.64	0.65 – 0.71	0.72 – 0.73	0.74 – 0.82	0.83 – 0.92	0.93 – 1.00	1.01 – 1.07
Porcelain	100	G	2.77 – 2.01 (70 – 51)	2.63 – 1.62 (66 – 41)	2.67 – 2.51 (67 – 63)	2.58 – 1.42 (65 – 36)	3.16 – 1.94 (80 – 49)	1.82 – 1.04 (45 – 26)	1.69 – 1.23 (42 – 31)
		H	2.24 – 1.81 (56 – 45)	2.51 – 1.90 (63 – 48)	2.53 – 2.43 (64 – 61)	2.34 – 1.66 (59 – 42)	2.62 – 1.91 (66 – 48)	1.84 – 1.38 (46 – 35)	1.53 – 1.26 (38 – 32)
		J	2.01 – 1.89 (51 – 48)	1.86 – 1.70 (47 – 43)	1.68 – 1.65 (42 – 41)	1.63 – 1.47 (41 – 37)	1.45 – 1.31 (36 – 33)	1.30 – 1.21 (33 – 30)	1.02 – .097 (25 – 24)
	200	G	3.15 (80)	2.96 – 1.93 (75 – 49)	1.77 – 1.62 (44 – 41)	2.64 – 1.47 (67 – 37)	2.79 – 1.61 (70 – 40)	2.79 – 1.94 (70 – 49)	1.56 – 1.11 (39 – 28)
		H	2.69 (68)	2.57 – 1.96 965 – 49)	1.87 – 1.78 (47 – 45)	2.16 – 1.50 (54 – 38)	2.25 – 1.58 (57 – 40)	2.44 – 1.94 (61 – 49)	1.40 – 1.14 (35 – 28)
		J	2.76 (70)	2.72 – 2.49 (69 – 63)	2.45 – 2.42 (62 – 61)	2.39 – 2.15 (60 – 54)	2.13 – 1.92 (54 – 48)	1.90 – 1.77 (48 – 44)	1.58 – 1.49 (40 – 37)
	300	G	—	—	—	3.39 – 2.15 (86 – 54)	3.47 – 2.22 (88 – 56)	3.39 – 2.50 (86 – 63)	2.11 – 1.63 (53 – 41)
		H	—	—	—	2.92 – 2.18 (74 – 55)	2.93 – 2.18 (74 – 55)	3.04 – 2.50 (77 – 63)	1.95 – 1.66 (49 – 42)
		J	—	—	—	3.14 – 2.83 (79 – 71)	2.80 – 2.53 (71 – 64)	2.50 – 2.32 (63 – 58)	2.13 – 2.01 (54 – 51)
	400	G	—	—	—	—	—	—	2.67 – 2.15 (67 – 54)
		H	—	—	—	—	—	—	2.68 – 2.34 (68 – 59)
		J	—	—	—	—	—	—	2.68 – 2.53 (68 – 64)

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangements 3, 4, and 5 (cont.)

Displacer Type	Liquid Temp. ° F	Level	1.08 – 1.12	1.13 – 1.17	1.18 – 1.27	1.28 – 1.30	1.31 – 1.39	1.40 – 1.50
Porcelain	100	G	1.16 – 0.89 (29 – 22)	2.04 – 1.75 (51 – 44)	1.68 – 1.10 (42 – 27)	1.04 – 0.92 (26 – 23)	2.05 – 1.56 (52 – 39)	1.50 – 0.97 (38 – 24)
		H	1.22 – 1.06 (30 – 26)	1.78 – 1.61 (45 – 40)	1.57 – 1.23 (39 – 31)	1.19 – 1.12 (30 – 28)	1.49 – 1.21 (37 – 30)	1.18 – 0.89 (29 – 22)
		J	0.96 – 0.92 (24 – 23)	0.92 – 0.88 (23 – 22)	0.88 – 0.81 (22 – 20)	0.81 – 0.80 (20 – 20)	0.79 – 0.74 (20 – 18)	0.74 – 0.69 (18 – 17)
	200	G	1.68 – 1.38 (42 – 35)	1.31 – 1.05 (33 – 26)	1.71 – 1.13 (43 – 28)	1.75 – 1.62 (44 – 41)	1.56 – 1.09 (39 – 27)	1.53 – 1.00 (38 – 25)
		H	1.42 – 1.25 (36 – 31)	1.21 – 1.06 (30 – 26)	1.31 – 0.99 (33 – 25)	1.50 – 1.42 (38 – 36)	1.39 – 1.12 (35 – 28)	1.33 – 1.03 (33 – 26)
		J	1.48 – 1.42 (37 – 36)	1.41 – 1.36 (35 – 34)	1.35 – 1.25 (34 – 31)	1.24 – 1.23 (31 – 31)	1.22 – 1.15 (30 – 29)	1.14 – 1.06 (28 – 26)
	300	G	2.19 – 1.88 (55 – 47)	1.81 – 1.52 (45 – 38)	2.19 – 1.57 (55 – 39)	2.18 – 2.05 (50 – 37)	1.98 – 1.49 (50 – 37)	1.93 – 1.37 (49 – 34)
		H	1.93 – 1.75 (49 – 44)	1.70 – 1.53 (43 – 38)	1.79 – 1.43 (45 – 36)	1.93 – 1.85 (49 – 46)	1.81 – 1.52 (45 – 38)	1.73 – 1.40 (43 – 35)
		J	1.99 – 1.92 (50 – 48)	1.90 – 1.84 (48 – 46)	1.82 – 1.69 (45 – 42)	1.68 – 1.66 (42 – 42)	1.64 – 1.55 (41 – 39)	1.54 – 1.43 (39 – 36)
	400	G	2.71 – 2.38 (68 – 60)	2.30 – 2.00 (58 – 50)	2.66 – 2.01 (67 – 51)	2.62 – 2.48 (61 – 48)	2.41 – 1.90 (61 – 48)	2.33 – 1.74 (59 – 44)
		H	2.45 – 2.25 (62 – 57)	2.20 – 2.01 (55 – 51)	2.26 – 1.87 (57 – 47)	2.37 – 2.28 (60 – 57)	2.24 – 1.92 (56 – 23)	2.13 – 1.77 (54 – 44)
		J	2.51 – 2.42 (63 – 61)	2.40 – 2.32 (60 – 58)	2.30 – 2.13 (58 – 54)	2.12 – 2.08 (53 – 52)	2.07 – 1.95 (52 – 49)	1.94 – 1.81 (49 – 45)
	500	G	3.23 – 2.88 (82 – 73)	2.80 – 2.48 (71 – 62)	3.13 – 2.45 (79 – 62)	3.05 – 2.91 (77 – 73)	2.84 – 2.30 (72 – 58)	2.73 – 2.11 (69 – 53)
		H	2.97 – 2.75 (75 – 69)	2.69 – 2.49 (68 – 63)	2.73 – 2.31 (69 – 58)	2.80 – 2.71 (71 – 68)	2.67 – 2.33 (67 – 59)	2.53 – 2.15 (64 – 54)
		J	3.03 – 2.92 (76 – 74)	2.89 – 2.79 (73 – 70)	2.77 – 2.57 (70 – 65)	2.55 – 2.51 (64 – 63)	2.50 – 2.35 (63 – 59)	2.33 – 2.18 (59 – 55)

Note: All levels ±0.25" (6).

4.3.6 Model B10 Actuating Levels (cont.)

Inches (mm)

B10 Standard actuating levels and liquid specific gravity with displacer arrangements 3, 4, and 5

Displacer Type	Liquid Temp. ° F	Level	0.50 – 0.58	0.59 – 0.71	0.72 – 0.79	0.80 – 0.85	0.86 – 1.00	1.01 – 1.03
Stainless Steel and Karbate	100	G	3.77 – 1.60 (95 – 40)	4.10 – 1.38 (104 – 35)	4.43 – 2.97 (112 – 75)	4.58 – 3.60 (24 – 91)	3.42 – 1.26 (86 – 31)	1.13 – 0.88 (28 – 22)
		H	3.46 – 2.16 (87 – 54)	3.72 – 2.08 (94 – 52)	3.96 – 3.07 (100 – 77)	3.63 – 3.07 (92 – 77)	2.96 – 1.71 ((75 – 43)	1.45 – 1.31 (36 – 33)
		J	2.51 – 2.16 (63 – 54)	2.13 – 1.77 (54 – 44)	1.74 – 1.59 (44 – 40)	1.57 – 1.48 (39 – 37)	1.46 – 1.25 (37 – 31)	1.24 – 1.22 (31 – 30)
	200	G	4.22 – 1.98 (107 – 50)	1.74 – 1.44 (44 – 36)	3.74 – 2.35 (94 – 59)	2.17 – 1.33 (55 – 33)	3.89 – 1.66 (98 – 42)	—
		H	3.76 – 2.42 (95 – 61)	2.27 – 1.89 (57 – 48)	3.02 – 2.22 (76 – 56)	2.12 – 1.64 (53 – 41)	3.22 – 1.93 (81 – 49)	—
		J	3.67 – 3.16 (93 – 80)	3.11 – 2.58 (78 – 65)	2.55 – 2.32 (64 – 58)	2.29 – 2.16 (58 – 54)	2.13 – 1.84 (54 – 46)	—
	300	G	—	4.87 – 2.26 (123 – 57)	4.55 – 3.08 (115 – 78)	2.89 – 2.02 (73 – 51)	4.56 – 2.24 (115 – 56)	—
		H	—	4.30 – 2.70 (109 – 68)	3.83 – 2.96 (97 – 75)	2.84 – 2.32 (72 – 58)	3.89 – 2.51 (98 – 63)	—
		J	—	4.03 – 3.40 (102 – 86)	3.36 – 3.06 (85 – 77)	3.02 – 2.84 (76 – 72)	2.81 – 2.42 (71 – 61)	—
Stainless Steel	400	G	—	—	5.35 – 3.82 (135 – 97)	3.62 – 2.70 (91 – 68)	5.24 – 2.82 (133 – 71)	—
		H	—	—	4.63 – 3.69 (117 – 93)	3.57 – 3.01 (90 – 76)	4.57 – 3.09 (116 – 78)	—
		J	—	—	4.16 – 3.79 (105 – 96)	3.75 – 3.53 (95 – 89)	3.48 – 3.00 (88 – 76)	—
	500	G	—	—	—	—	5.91 – 3.41 (150 – 86)	—
		H	—	—	—	—	5.24 – 3.67 (133 – 93)	—
		J	—	—	—	—	4.16 – 3.58 (105 – 90)	—

Note: All levels ±0.25" (6).

4.3.7 Model B15 Dimensional Data

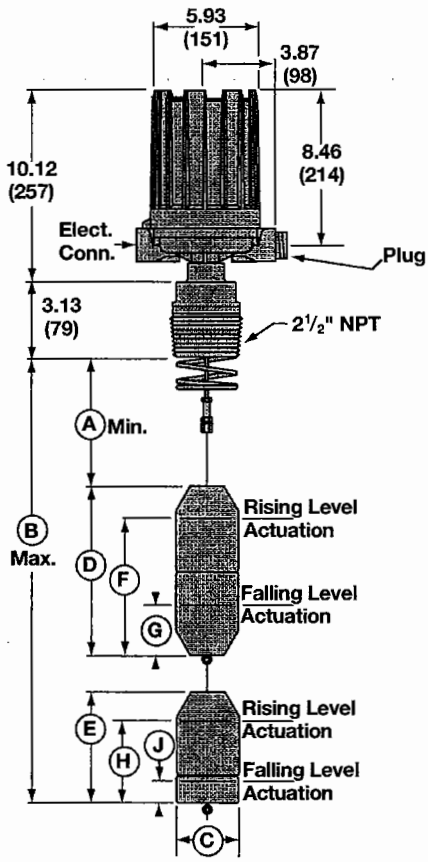
Inches (mm)

Model B15

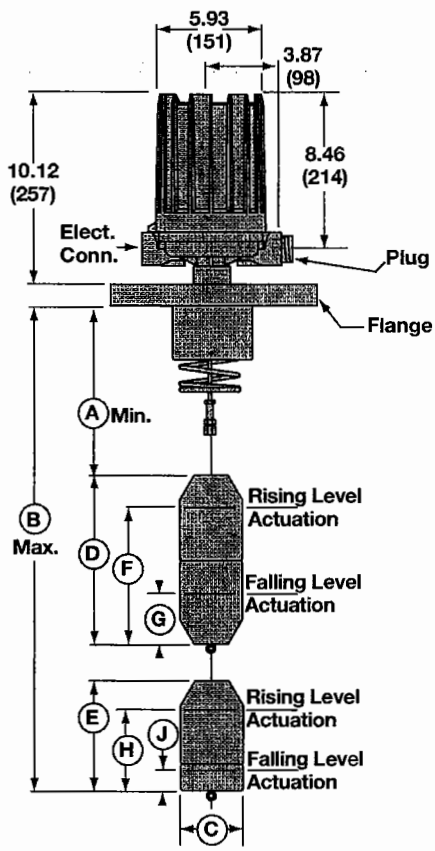
Outline Dimensions				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	5.50 (139)	123.00 (3124)	7.50 (190)	125.00 (3175)
Stainless Steel or Karbate	5.88 (149)	123.00 (3124)	7.88 (200)	125.00 (3175)

Displacer Type	C	D	E
Porcelain	2.56 (65)	7.25 (184)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	10.50 (266)	6.00 (152)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



Model B15
with Threaded Mounting



Model B15
with Flanged Mounting

4.3.8 Model B15 Actuating Levels

Inches (mm)

B15 Standard actuating levels and liquid specific gravity

Displacer Type	Liquid Temp. ° F	0.70				0.80			
		F	G	H	J	F	G	H	J
Stainless Steel or Karbate	100	9.50 (241)	5.00 (127)	4.90 (124)	1.30 (33)	7.60 (193)	3.70 (93)	4.30 (109)	1.10 (27)
	200	—	—	—	—	8.20 (208)	4.30 (109)	5.00 (127)	1.80 (45)

Displacer Type	Liquid Temp. ° F	0.95				1.00			
		F	G	H	J	F	G	H	J
Porcelain	100	5.50 (139)	2.00 (50)	3.70 (93)	1.00 (25)	5.00 (127)	1.70 (43)	3.50 (88)	0.80 (20)
Stainless Steel	100	5.50 (139)	2.00 (50)	3.70 (93)	1.00 (25)	4.90 (124)	1.70 (43)	3.40 (86)	0.90 (22)
	200	6.00 (152)	2.70 (68)	4.20 (106)	1.50 (38)	5.40 (137)	2.20 (55)	4.00 (101)	1.50 (38)
	300	6.40 (162)	3.10 (78)	4.70 (119)	2.00 (50)	5.70 (144)	2.50 (63)	4.40 (111)	1.90 (48)
	400	—	—	—	—	6.10 (154)	2.90 (73)	4.90 (124)	2.40 (60)
Karbate	100	5.50 (139)	2.00 (50)	3.70 (93)	1.00 (25)	4.90 (124)	1.70 (43)	3.40 (86)	0.90 (22)
	200	6.00 (152)	2.70 (68)	4.20 (106)	1.50 (38)	5.40 (137)	2.20 (55)	4.00 (101)	1.50 (38)
	300	6.40 (162)	3.10 (78)	4.70 (119)	2.00 (50)	5.70 (144)	2.50 (63)	4.40 (111)	1.90 (48)

Note: All levels ±0.25" (6).

4.3.9 Model C10 Dimensional Data

Inches (mm)

Model C10 with all displacer arrangements

Outline Dimensions				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	6.38 (965)	123.00 (3124)	8.38 (212)	125.00 (3175)
Stainless Steel or Karbate	5.75 (146)	123.00 (3124)	7.75 (196)	125.00 (3175)

Model C10 with displacer arrangements A, B, and C

Displacer Type	C	D	E	F	G
Porcelain	2.56 (65)	6.42 (163)	5.02 (127)	5.02 (127)	3.62 (91)
Stainless Steel or Karbate	2.50 (63)	6.00 (152)	6.00 (152)	4.50 (114)	4.50 (114)

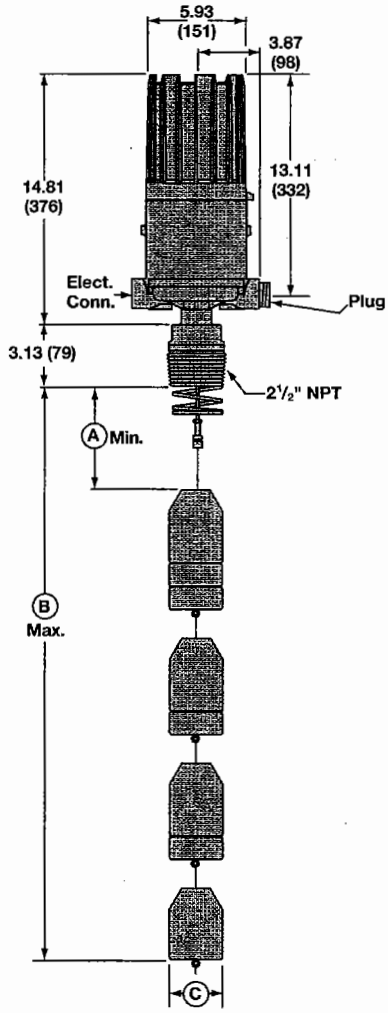
Model C10 with displacer arrangements D and F

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	14.44 (367)	5.02 (127)	3.62 (91)
Stainless Steel or Karbate	2.50 (63)	12.00 (304)	4.50 (114)	4.50 (114)

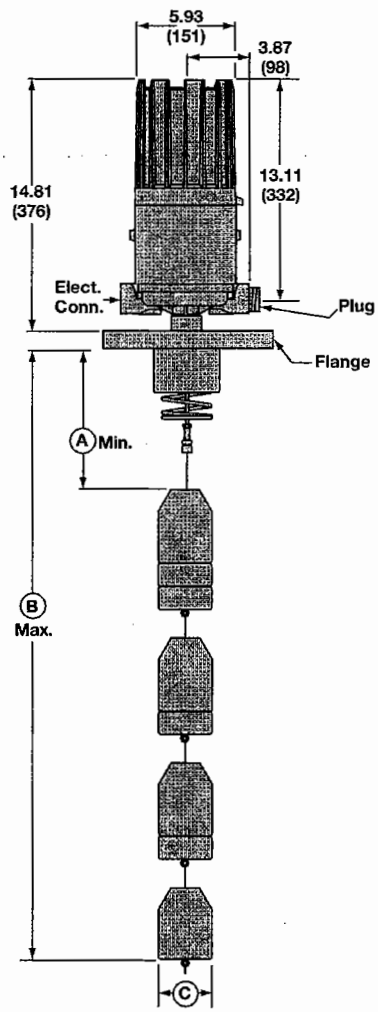
Model C10 with displacer arrangements E and G

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	6.42 (153)	5.02 (127)	8.65 (219)
Stainless Steel or Karbate	2.50 (63)	6.00 (152)	6.00 (152)	9.00 (228)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



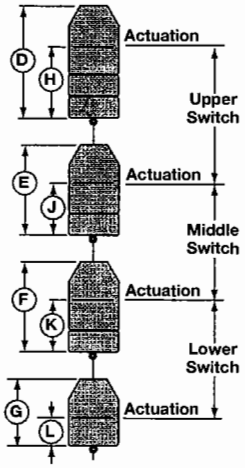
Model C10
with Threaded Mounting



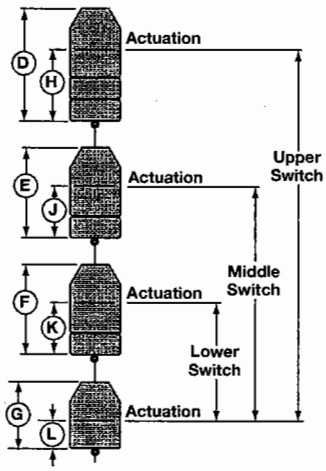
Model C10
with Flanged Mounting

4.3.10 Model C10 Actuating Levels

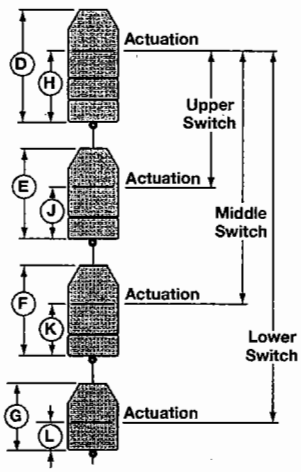
Inches (mm)



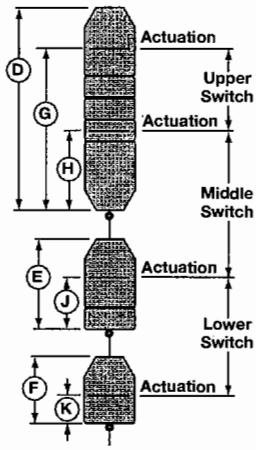
Model C10
Displacer Arrangement A



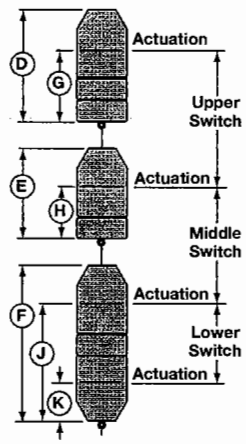
Model C10
Displacer Arrangement B



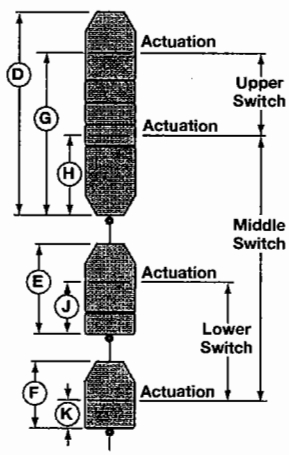
Model C10
Displacer Arrangement C



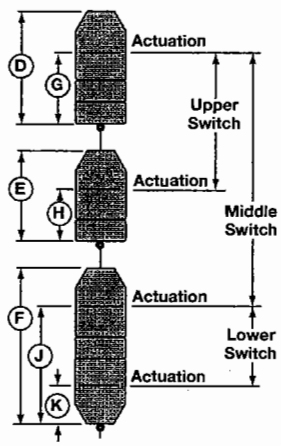
Model C10
Displacer Arrangement D



Model C10
Displacer Arrangement E



Model C10
Displacer Arrangement F



Model C10
Displacer Arrangement G

4.3.10 Model C10 Actuating Levels (cont.)

Inches (mm)

C10 Standard actuating levels and liquid specific gravity with displacer arrangements A, B, and C

Displacer Type	Liquid Temp. °F	0.58				0.60				0.70				0.80			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	—	—	—	—	—	—	—	—	2.50 (63)	2.20 (55)	2.20 (55)	2.00 (50)	2.30 (58)	2.00 (50)	1.90 (48)	1.70 (43)
Stainless Steel or Karbate	100	4.50 (114)	3.70 (93)	3.20 (81)	2.30 (58)	3.80 (96)	3.20 (81)	3.00 (76)	2.20 (55)	4.20 (106)	3.80 (96)	2.10 (53)	1.90 (48)	1.80 (45)	2.20 (55)	1.30 (33)	1.70 (43)
	200	—	—	—	—	—	—	—	—	—	—	—	—	3.20 (81)	2.90 (73)	2.50 (63)	2.30 (58)

Displacer Type	Liquid Temp. °F	0.90				1.00				1.10				1.20			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	3.0 (76)	2.4 (61)	2.7 (69)	1.5 (38)	1.4 (36)	1.4 (36)	2.1 (53)	1.4 (36)	3.0 (76)	2.6 (66)	2.5 (64)	1.2 (30)	1.7 (43)	1.7 (43)	2.1 (53)	1.1 (28)
	200	—	—	—	—	3.2 (81)	2.7 (69)	2.8 (71)	1.7 (43)	1.7 (43)	1.7 (43)	2.3 (58)	1.6 (41)	—	—	—	—
Stainless Steel or Karbate	100	3.1 (79)	3.2 (81)	2.5 (64)	1.5 (38)	1.3 (33)	1.9 (48)	1.8 (46)	1.3 (33)	3.1 (79)	3.2 (81)	2.5 (64)	1.3 (33)	1.6 (41)	2.2 (56)	1.9 (48)	1.2 (30)
	200	3.6 (91)	3.6 (91)	1.7 (43)	2.0 (51)	1.7 (43)	2.3 (58)	1.1 (28)	1.8 (46)	—	—	—	—	—	—	—	—
	300	3.4 (86)	3.0 (76)	2.4 (61)	2.7 (69)	1.6 (41)	1.8 (46)	1.7 (43)	2.4 (61)	—	—	—	—	—	—	—	—

C10 Standard actuating levels and liquid specific gravity with displacer arrangements D and F

Displacer Type	Liquid Temp. °F	0.58				0.60				0.70				0.80			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	—	—	—	—	—	—	—	—	7.50 (190)	2.60 (66)	2.20 (55)	2.00 (50)	6.90 (175)	2.40 (60)	1.90 (48)	1.70 (43)
Stainless Steel or Karbate	100	9.90 (251)	3.70 (93)	3.20 (81)	2.30 (58)	9.20 (233)	3.20 (81)	3.00 (76)	2.20 (55)	8.90 (226)	3.80 (96)	2.10 (53)	1.90 (48)	6.70 (170)	2.20 (55)	1.30 (33)	1.70 (43)
	200	—	—	—	—	—	—	—	—	—	—	—	—	7.40 (187)	2.90 (73)	2.50 (63)	2.30 (58)

Displacer Type	Liquid Temp. °F	0.90				1.00				1.10				1.20			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	6.60 (167)	2.80 (71)	2.70 (68)	1.50 (38)	5.20 (132)	1.80 (45)	2.10 (53)	1.40 (35)	6.10 (154)	3.00 (76)	2.50 (63)	1.20 (30)	5.00 (127)	2.10 (53)	2.10 (53)	1.10 (27)
	200	—	—	—	—	6.20 (157)	3.10 (78)	2.80 (71)	1.70 (43)	5.20 (132)	2.10 (53)	2.30 (58)	1.60 (40)	—	—	—	—
Stainless Steel or Karbate	100	7.20 (182)	3.20 (81)	2.50 (63)	1.50 (38)	5.50 (139)	1.90 (48)	1.80 (45)	1.30 (33)	6.40 (162)	3.20 (81)	2.50 (63)	1.30 (33)	5.20 (132)	2.20 (55)	1.90 (48)	1.20 (30)
	200	7.60 (193)	3.60 (91)	1.70 (43)	2.00 (50)	5.90 (149)	2.30 (58)	1.10 (27)	1.80 (45)	—	—	—	—	—	—	—	—
	300	7.00 (177)	3.00 (76)	2.40 (60)	2.70 (68)	5.40 (137)	1.80 (45)	1.70 (43)	2.40 (60)	—	—	—	—	—	—	—	—

Note: All levels ±0.25" (6).

4.3.10 Model C10 Actuating Levels (cont.)

Inches (mm)

C10 Standard actuating levels and liquid specific gravity with displacer arrangements E and G

Displacer Type	Liquid Temp. °F	0.58				0.60				0.70				0.80			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	—	—	—	—	—	—	—	—	2.50 (63)	2.20 (55)	5.80 (147)	1.90 (48)	2.30 (58)	2.00 (50)	5.50 (139)	2.10 (53)
Stainless Steel or Karbate	100	4.50 (114)	3.70 (93)	7.70 (195)	2.80 (71)	3.80 (96)	3.20 (81)	7.50 (190)	2.70 (68)	4.20 (106)	3.80 (96)	6.60 (167)	2.50 (63)	1.80 (45)	2.20 (55)	5.80 (147)	2.20 (55)
	200	—	—	—	—	—	—	—	—	—	—	—	—	3.20 (81)	2.90 (73)	7.00 (177)	3.40 (86)

Displacer Type	Liquid Temp. °F	0.90				1.00				1.10				1.20			
		H	J	K	L	H	J	K	L	H	J	K	L	H	J	K	L
Porcelain	100	3.00 (76)	2.40 (60)	6.30 (160)	3.20 (81)	1.40 (35)	1.40 (35)	5.70 (144)	1.90 (48)	3.00 (76)	2.60 (66)	6.10 (154)	3.60 (91)	1.70 (43)	1.70 (43)	5.70 (144)	3.40 (86)
	200	—	—	—	—	3.20 (81)	2.70 (68)	6.40 (162)	3.60 (91)	1.70 (43)	1.70 (43)	5.90 (149)	3.40 (86)	—	—	—	—
Stainless Steel or Karbate	100	3.10 (78)	3.20 (81)	7.00 (177)	3.80 (96)	1.30 (33)	1.90 (48)	6.30 (160)	3.40 (86)	3.10 (78)	3.20 (81)	7.00 (177)	4.40 (111)	1.60 (40)	2.20 (55)	6.40 (162)	4.00 (101)
	200	3.60 (91)	3.60 (91)	6.20 (157)	3.00 (76)	1.70 (43)	2.30 (58)	5.60 (142)	2.70 (68)	—	—	—	—	—	—	—	—
	300	3.40 (86)	3.00 (76)	6.90 (175)	3.70 (93)	1.60 (40)	1.80 (45)	6.20 (157)	3.30 (83)	—	—	—	—	—	—	—	—

Note: All levels ±0.25" (6).

4.3.11 Model C15 Dimensional Data

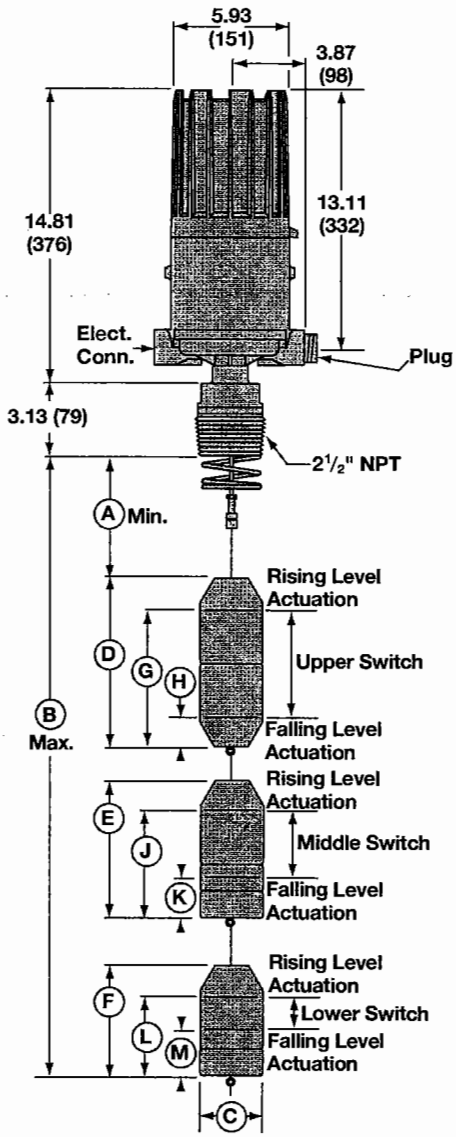
Inches (mm)

Model C15

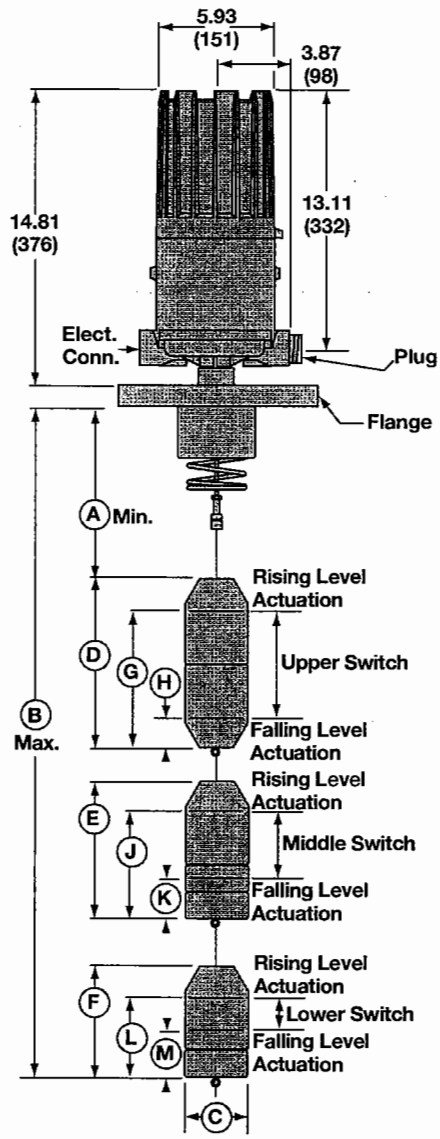
OUTLINE DIMENSIONS				
Displacer Type	Threaded Mounting		Flanged Mounting	
	A	B	A	B
Porcelain	7.75 (196)	125.00 (3175)	9.75 (247)	127.00 (3225)
Stainless Steel or Karbate	7.25 (184)	124.00 (3149)	9.25 (234)	126.00 (3200)

Displacer Type	C	D	E	F
Porcelain	2.56 (65)	7.25 (184)	6.42 (163)	5.02 (127)
Stainless Steel or Karbate	2.50 (63)	9.00 (228)	7.50 (190)	6.00 (152)

Electrical Connections
NEMA 4X/7/9 Group B: 1" NPT



Model C15
with Threaded Mounting



Model C15
with Flanged Mounting

4.3.12 Model C15 Actuating Levels

Inches (mm)

C15 Standard actuating levels and liquid specific gravity

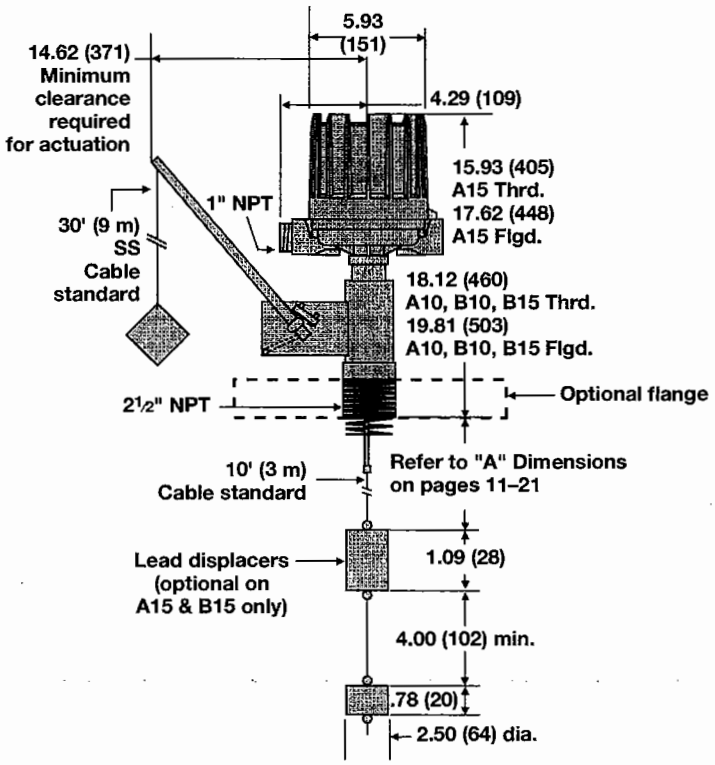
Displacer Type	Liquid Temp. ° F	0.65						0.70						0.80					
		G	H	J	K	L	M	G	H	J	K	L	M	G	H	J	K	L	M
Porcelain	0 to +130	—	—	—	—	—	—	—	—	—	—	—	—	6.20 (157)	1.40 (35)	5.30 (134)	1.00 (25)	3.80 (96)	0.90 (22)
Stainless Steel or Karbate	0 to +130	7.70 (195)	2.20 (55)	6.10 (154)	2.00 (50)	4.90 (124)	1.40 (35)	6.70 (170)	1.60 (40)	5.50 (139)	1.60 (40)	4.60 (116)	1.30 (33)	6.50 (165)	2.00 (50)	5.20 (132)	1.60 (40)	4.30 (109)	1.10 (27)

Displacer Type	Liquid Temp. ° F	0.90						1.00						1.10					
		G	H	J	K	L	M	G	H	J	K	L	M	G	H	J	K	L	M
Porcelain	0 to +130	6.20 (157)	1.90 (48)	5.00 (127)	1.40 (35)	3.60 (91)	1.00 (25)	4.60 (116)	0.70 (17)	4.00 (101)	0.80 (20)	3.30 (83)	0.90 (22)	4.20 (106)	1.10 (27)	3.80 (96)	1.00 (25)	3.10 (78)	0.90 (22)
Stainless Steel or Karbate	0 to +130	6.60 (167)	2.60 (66)	5.20 (132)	1.80 (45)	4.00 (101)	1.20 (30)	4.60 (116)	1.00 (25)	4.00 (101)	1.00 (25)	3.60 (91)	1.10 (27)	—	—	—	—	—	—

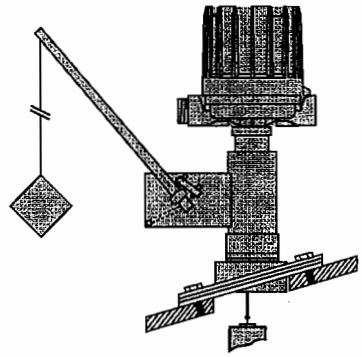
Displacer Type	Liquid Temp. ° F	1.20						1.25					
		G	H	J	K	L	M	G	H	J	K	L	M
Porcelain	0 to +130	4.50 (114)	1.60 (40)	3.70 (93)	1.10 (27)	2.90 (73)	0.90 (22)	3.90 (99)	1.10 (27)	3.30 (83)	0.90 (22)	2.80 (71)	0.80 (20)

4.3.13 Proof-er Dimensional Data

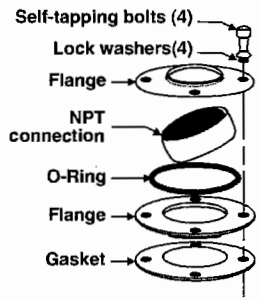
Inches (mm)



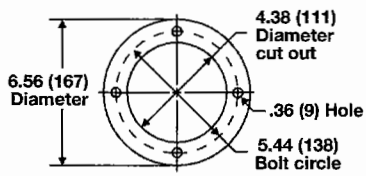
TYPICAL PROOF-ER INSTALLATION WITH VERSA FLANGE



VERSA FLANGE ASSEMBLY
PART NUMBER 089-5207-001

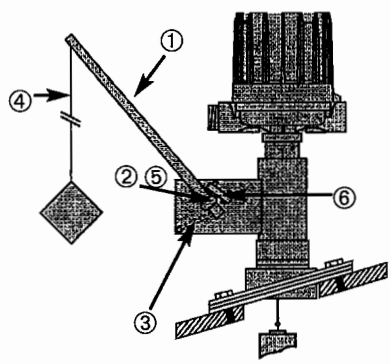


VERSA FLANGE BOLT CIRCLE



4.3.14 Proof-er Replacement Parts

Item	Description	Proof-er Replacement Part Number	
		Low Pressure	Medium Pressure
1	Handle	002-4011-001	002-0496-001
2	O-Ring	Not Required	012-2205-001
3	Spring	002-2502-001	
4	Cable Assembly	089-5807-001	
5	O-Ring Cover	Not Required	002-0489-001
6	Nut	010-2107-004	Not Required



Item No.	Description		A10	A15	B10/B15	C10/C15
1	Enclosing Tube	Standard	Z32-6325-007	Z32-6325-001	Z32-6325-007	Z32-6301-029
		316 SS	Z32-6325-008	Z32-6325-002	Z32-6325-008	Z32-6301-029
2	E-Tube Gasket		012-1301-002			
3	Spring and Stem Kit①	Standard	089-5327-001	089-5325-001	Consult Factory	
		316 SS	089-5328-001	089-5326-001	Consult Factory	
4	Body Bushing		089-5707-001			
5	Flange and Spring Protector		Specify size and rating. Furnish serial number of control.			

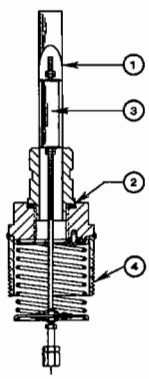
① 316 SS Spring and Stem Kit includes 316 SS sheathed magnetic sleeve.

4.4.1 Displacer Replacement Parts

Displacer Material		A10	A15	B10	B15	C10	C15
Porcelain②		089-6141-001	089-6142-001	089-6143-001	089-6144-001	089-6153-001	089-6156-001
Kynar®		089-6145-001	089-6146-001	089-6147-001	089-6148-001	089-6154-001	089-6157-001
Stainless Steel②		089-6149-001	089-6150-001	089-6151-001	089-6152-001	089-6155-001	089-6158-001
Direct (3m) Cable	316 SS	089-5802-003③					
with Displacer	Hastelloy	089-5803-003③					
Clamps only	Monel	089-5804-003③					

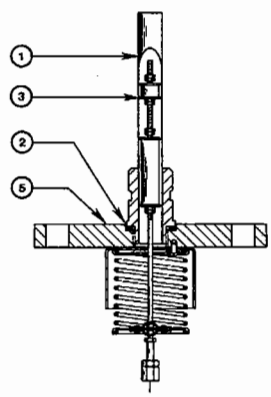
② Kits contain 10 feet (3m) 316 SS cable.
③ For Model C10 with operating sequences A, B, or C order kits:
89-5802-004 (316 SS), 89-5803-004 (Hastelloy), or 89-5804-004 (Monel).

NOTE: Refer to pages 11, 12, 13, 21, 23 & 27 for dimensional specifications of displacers.



Threaded Connection Model
(Typical Single Switch Model)

Flanged Connection Model
(Typical Dual Switch Model)



4.5.1 A10 & A15 Single Switch Models

PART NUMBER CODE AND SPECIFIC GRAVITY LIMITS*

Part Number Code	Description	Liquid Temp.		Series A thru E, J and K Switches		
		° F	° C	Porcelain	Stainless Steel	Karbate
A10①	Wide Differential, 1 switch	100	38	0.60 to 1.20	0.60 to 1.20	0.60 to 1.20
		200	93	0.70 to 1.20	0.70 to 1.20	0.70 to 1.20
		300	149	0.80 to 1.20	0.80 to 1.20	0.80 to 1.20
		400	204	1.00 to 1.20	0.90 to 1.20	—
		500	260	1.10 to 1.20	1.00 to 1.20	—
A15	Narrow Differential, 1 switch	100	38	0.60 to 2.40	0.40 to 1.65	0.40 to 1.65
		200	93	0.62 to 2.40	0.40 to 1.65	0.45 to 1.65
		300	149	0.65 to 2.40	0.50 to 1.65	0.50 to 1.65
		400	204	0.70 to 2.40	0.55 to 1.65	—
		500	260	0.75 to 2.40	0.60 to 1.65	—

MATERIALS OF CONSTRUCTION

Code	Support Spring	Trim	E-Tube Mtg. Nut	Displacer Clamps/ Susp. Cable	Magnetic Sleeve	Process Connection
1	Inconel 600	300 Series SS	Carbon Steel	316 SS	400 Series SS	Carbon Steel⑭
2①	Inconel 600	316 SS	316 SS	316 SS	316 SS	Carbon Steel⑭
4①						316 SS
5①	Inconel 600	300 Series SS	Carbon Steel	Monel	400 Series SS	Carbon Steel⑭
6①				Hastelloy		
M①② NACE Const.	Inconel X750	316 SS	316 SS	316 SS	316 SS	316 SS
N①② NACE Const.	Inconel X750	300 Series SS	316 SS	316 SS	316 SS	Carbon Steel

TANK CONNECTION

Tank Connection	Code
2½" NPT Threaded ③	E2
3" 125 lb. Cast Iron Flange ④⑤⑥	G2
3" 150 lb. Steel Flange ⑤⑦	G3
4" 125 lb. Cast Iron Flange ④⑥	H2
4" 150 lb. Steel Flange ⑦	H3
4" 300 lb. Steel Flange ⑦	H4
6" 125 lb. Cast Iron Flange ④⑥	K2
6" 150 lb. Steel Flange ⑦	K3
6" 300 lb. Steel Flange ⑦	K4

DISPLACER MATERIAL AND PROOF-ER OPTION

Proof-er** Type	Displacer Material			Floating Roof Weight Mat'l
	Porcelain	316 SS	Karbate	Lead
Without Proof-er	A	B	C	K④
Low Pressure③	D④	E④	F④	L④
Medium Pressure③	G④	H④	J④	—

A	1		—					—			

* Specific gravity limits do not apply to floating roof top units not to be used in liquid.
**Proof-er option constructed of carbon steel material.

4.5.1 A10 & A15 Single Switch Models (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE® FOR MODELS A10 AND A15

Switch Description	Max.⑨ Process Temp. ° F (°C)	One Set Point	A10 Codes			A15 Codes		
			Aluminum Polymer Coated NEMA 4X/7/9 ⑩					
			Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	ATEX	Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	ATEX
Series A Mercury Switch	500 (260)	SPDT	AKB	AKK	AC9	AKQ	AKS	AA9
		DPDT	ANB	ANK	AF9	ANQ	ANS	AB9
Series B Snap Switch	250 (121)	SPDT	BKB	BKK	BC9	BKQ	BKS	BA9
		DPDT	BNB	BNK	BF9	BNQ	BNS	BB9
Series C Snap Switch	450 (232)	SPDT	CKB	CKK	CC9	CKQ	CKS	CA9
		DPDT	CNB	CNK	CF9	CNQ	CNS	CB9
Series D Snap Switch For DC Current Applications	250 (121)	SPDT	DKB	DKK	DC9	DKQ	DKS	DA9
		DPDT	DNB	DNK	DF9	DNQ	DNS	DB9
Series E Vibration Resistant Mercury Switch	500 (260)	SPDT	EKB	EKK	EC9	EKQ	EKS	EA9
		DPDT	ENB	ENK	EF9	ENQ	ENS	EB9
Series HS Hermetically Sealed Snap Switch w/Wiring Leads	500 ⑪ (260)	SPDT	HMJ	HMK	—	HMC	HEK ⑫	—
		DPDT	HMS	HMT	—	HMF	HET ⑫	—
Series HS Hermetically Sealed Snap Switch w/Terminal Block	500 ⑪ (260)	SPDT	HM3	HM4	HA9	HM3 ⑬	HM4 ⑬	HA9
		DPDT	HM7	HM8	HB9	HM7 ⑬	HM8 ⑬	HB9

PNEUMATIC SWITCH MECHANISM AND ENCLOSURE FOR MODELS A10 AND A15

Switch Description	Maximum Supply Pressure		Maximum⑨ Process Temperature		Bleed Orifice Diameter		A10 Codes	A15 Codes
	psig	bar	° F	° C	Inches	mm	NEMA 1	NEMA 1
Series J Bleed Type Pneumatic Switch	100	7	400	204	.063	1.6	JGF	JDE
	60	4	400	204	.094	2.3	JHF	JEE
Series K Non-Bleed Pneumatic Switch	100	7	400	204	—	—	KOF	KOE

① Not available with displacer material and proof-er option codes K, L.

② Not available with displacer material and proof-er option codes D, E, F, G, H, J, K and L.

③ Pressure/temperature ratings on page 10. Flanges are ANSI type.

④ Not available with material of construction codes M and N.

⑤ Not available with displacer material and Proof-er option codes K, L.

⑥ Not available with material of construction code 4.

⑦ 316 SS flange is provided with material of construction code 4 and M.

⑧ Consult factory for NEMA 4X/7/9 cast iron housings.

⑨ Process temperature based on +100° F (+38° C) ambient.

⑩ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosures. Consult factory for standard part numbers.

⑪ On steam applications, temperature down rated to +400° F (+204° C) process at +100° F (+38° C) ambient. Available with a 6" tall cover only.

⑫ CSA approval does not apply to these switch designations.

⑬ Available with a 6" tall cover only.

⑭ 125# flanges will be cast iron.

A	1		—					—			

4.5.2 B10 & B15 Dual Switch Models

PART NUMBER CODE AND SPECIFIC GRAVITY LIMITS*

Part Number Code	Description	Liquid Temp.		Series A thru E, J and K Switches		
		° F	° C	Porcelain	Stainless Steel	Karbate
B10	Wide Differential, 2 switches	100	38	0.60 to 1.50	0.50 to 1.00	0.50 to 1.00
		200	93	0.64 to 1.50	0.50 to 1.00	0.50 to 1.00
		300	149	0.80 to 1.50	0.60 to 1.00	0.60 to 1.00
		400	204	1.00 to 1.50	0.72 to 1.00	—
		500	260	1.10 to 1.50	0.84 to 1.00	—
B15	Narrow Differential, 2 switches	100	38	0.95 to 1.20	0.70 to 1.20	0.70 to 1.20
		200	93	1.10 to 1.20	0.80 to 1.20	0.80 to 1.20
		300	149	—	0.90 to 1.20	0.90 to 1.20
		400	204	—	1.00 to 1.20	—
		500	260	—	1.04 to 1.20	—

MATERIALS OF CONSTRUCTION

Code	Support Spring	Trim	E-Tube Mtg. Nut	Displacer Clamps/ Susp. Cable	Magnetic Sleeve	Process Connection
1	Inconel 600	300 Series SS	Carbon Steel	316 SS	400 Series SS	Carbon Steel ⑬
2 ①	Inconel 600	316 SS	316 SS	316 SS	316 SS	Carbon Steel ⑬
4 ①						316 SS
5 ①	Inconel 600	300 Series SS	Carbon Steel	Monel	400 Series SS	Carbon Steel ⑬
6 ①				Hastelloy		
M ①② NACE Const.	Inconel X750	316 SS	316 SS	316 SS	316 SS	316 SS
N ①② NACE Const.	Inconel X750	300 Series SS	316 SS	316 SS	316 SS	Carbon Steel

TANK CONNECTION

Tank Connection	Code
2½" NPT Threaded ③	E2
3" 125 lb. Cast Iron Flange ④⑤⑥	G2
3" 150 lb. Steel Flange ⑤⑦	G3
4" 125 lb. Cast Iron Flange ④⑥	H2
4" 150 lb. Steel Flange ⑦	H3
4" 300 lb. Steel Flange ⑦	H4
6" 125 lb. Cast Iron Flange ④⑥	K2
6" 150 lb. Steel Flange ⑦	K3
6" 300 lb. Steel Flange ⑦	K4

DISPLACER MATERIAL AND PROOF-ER OPTION

Proof-er** Type	Displacer Material			Floating Roof Weight Mat'l Model B15 Only
	Porcelain	316 SS	Karbate	Lead
Without Proof-er	A	B	C	K ④
Low Pressure ③	D ④	E ④	F ④	L ④

B	1		—					—			

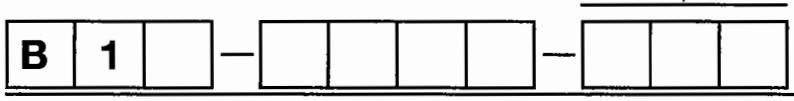
* Specific gravity limits do not apply to floating roof top units not to be used in liquid.
**Proof-er option constructed of carbon steel material.

4.5.2 B10 & B15 Dual Switch Models (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE ⑧ FOR MODELS B10 AND B15

Switch Description ⑨	Max. ⑩ Process Temp. ° F (°C)	Two Set Points	Switch Enclosure		
			NEMA 4X/7/9 ⑪		
			Class I, Div. 1, Groups C & D	Class I, Div. 1, Group B	ATEX
Series A Mercury Switch	500 (260)	SPDT	ALB	ALK	AD9
		DPDT	AOB	AOK	AG9
Series B Snap Switch	250 (121)	SPDT	BLB	BLK	BD9
		DPDT	BOB	BOK	BG9
Series C Snap Switch	450 (232)	SPDT	CLB	CLK	CD9
		DPDT	COB	COK	CG9
Series D Snap Switch For DC Current Applications	250 (121)	SPDT	DLB	DLK	DD9
		DPDT	DOB	DOK	DG9
Series E Vibration Resistant Mercury Switch	500 (260)	SPDT	ELB	ELK	ED9
		DPDT	EOB	EOK	EG9
Series HS Hermetically Sealed Snap Switch w/Wiring Leads	500 ⑫ (260)	SPDT	HMN	HMP	—
		DPDT	HMY	HMZ	—

① Not available with displacer material and proof-er option codes K, L.
② Not available with displacer material and proof-er option codes D, E, F, K and L.
③ Pressure/temperature ratings on page 10. Flanges are ANSI type.
④ Not available with material of construction codes M and N.
⑤ Not available with displacer material and Proof-er option codes K, L.
⑥ Not available with material of construction code 4.
⑦ 316 SS flange is provided with material of construction code 4 and M.
⑥ Not available with displacer material and Proof-er option codes K, L.
⑧ Consult factory for NEMA 4X/7/9 cast iron housings.
⑨ Pneumatic switch mechanisms and enclosures are unavailable for Models B10 and B15 switches.
⑩ Process temperature based on +100° F (+38° C) ambient.
⑪ Uncontrolled housing heater or drain available in NEMA 4X/7/9 enclosures. Consult factory for standard part numbers.
⑫ On steam applications, temperature down rated to +400° F (+204° C) process at +100° F (+38° C) ambient.
⑬ 125# flanges will be cast iron.



4.5.3 C10 & C15 Triple Switch Models

PART NUMBER CODE AND SPECIFIC GRAVITY LIMITS**

Part Number Code	Description	Liquid Temp.		Series A thru E, J and K Switches		
		° F	° C	Porcelain	Stainless Steel	Karbate
C10	Wide Differential, 3 switches	100	38	0.65 to 1.20	0.58 to 1.20	0.58 to 1.20
		200	93	0.95 to 1.10	0.76 to 1.00	0.76 to 1.00
		300	149	—	0.82 to 1.00	0.82 to 1.00
C15*	Narrow Differential, 3 switches	130	54	0.80 to 1.25	0.65 to 1.00	0.65 to 1.00

* Consult factory for high temperatures

** Each C10/C15 instrument is factory calibrated to operate for a given specific gravity within the minimum and maximum values listed

MATERIALS OF CONSTRUCTION

Code	Support Spring	Trim	E-Tube Mtg. Nut	Displacer Clamps/ Susp. Cable	Magnetic Sleeve	Process Connection
1	Inconel 600	300 Series SS	Carbon Steel	316 SS	400 Series SS	Carbon Steel ⑦
2 ①	Inconel 600	316 SS	316 SS	316 SS	316 SS	Carbon Steel ⑦
4 ①						316 SS
5 ①	Inconel 600	300 Series SS	Carbon Steel	Monel	400 Series SS	Carbon Steel ⑦
6 ①				Hastelloy		
M ①② NACE Const.	Inconel X750	316 SS	316 SS	316 SS	316 SS	316 SS
N ①② NACE Const.	Inconel X750	300 Series SS	316 SS	316 SS	316 SS	Carbon Steel

TANK CONNECTION

Tank Connection	Code
2½" NPT Threaded ①	E2
3" 125 lb. Cast Iron Flange ②	G2
3" 150 lb. Steel Flange ③	G3
4" 125 lb. Cast Iron Flange ②	H2
4" 150 lb. Steel Flange ③	H3
4" 300 lb. Steel Flange ③	H4
6" 125 lb. Cast Iron Flange ②	K2
6" 150 lb. Steel Flange ③	K3
6" 300 lb. Steel Flange ③	K4

DISPLACER MATERIAL

Displacer Material		
Porcelain	316 SS	Karbate
A	B	C

C	1		—					—			

4.5.3 C10 & C15 Triple Switch Models (continued)

ELECTRIC SWITCH MECHANISM AND ENCLOSURE ⑥ FOR MODELS C10 AND C15

Switch Description ④	Maximum ⑤ Process Temp. ° F (° C)	Three Set Points	Aluminum Polymer Coated Switch Enclosure NEMA 4X/7/9			
			Class I, Div. 1, Groups C & D	Aluminum With Heater	Aluminum With Drain	Aluminum Class I, Div. 1, Group B
Series N Mercury Switch	300 (149)	SPDT	NMB	NRB	NWB	NMN
		DPDT	NKB	NLB	NNB	NKN
Series O Snap Switch	300 (149)	SPDT	OMB	Not Available	OWB	OMN
		DPDT	OKB		ONB	OKN
Series Q Snap Switch	250 (121)	SPDT	QMB	QRB	QWB	QMN
		DPDT	QKB	QLB	QNB	QKN
Series T Vibration Resistant Mercury Switch	300 (149)	SPDT	TMB	TRB	TWB	TMN
		DPDT	TKB	TLB	TNB	TKN

① Pressure/temperature ratings on page 10. Flanges are ANSI type.
② Not available with material of construction codes 4, M and N.
③ 316 SS flange is provided with material of construction code 4 and M.
④ Pneumatic switch mechanisms and enclosures are unavailable for Models C10 and C15 switches.
⑤ Process temperature based on +100° F (+38° C) ambient.
⑥ Consult factory for NEMA 4X/7/9 cast iron housings.
⑦ 125# flanges will be cast iron.

C	1		—					—			

Service Policy

Owners of Magnetrol controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. Magnetrol will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory, prior to the material's return. This is available through Magnetrol's local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

Magnetrol

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145 Jardin Drive, Units 1 & 2 • Concord, Ontario Canada L4K 1X7 • 905-738-9600 • Fax 905-738-1306
Heikensstraat 6 • B 9240 Zele, Belgium • 052 45.11.11 • Fax 052 45.09.93
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BULLETIN: 45-610.19
EFFECTIVE: May 2006
SUPERSEDES: December 2005

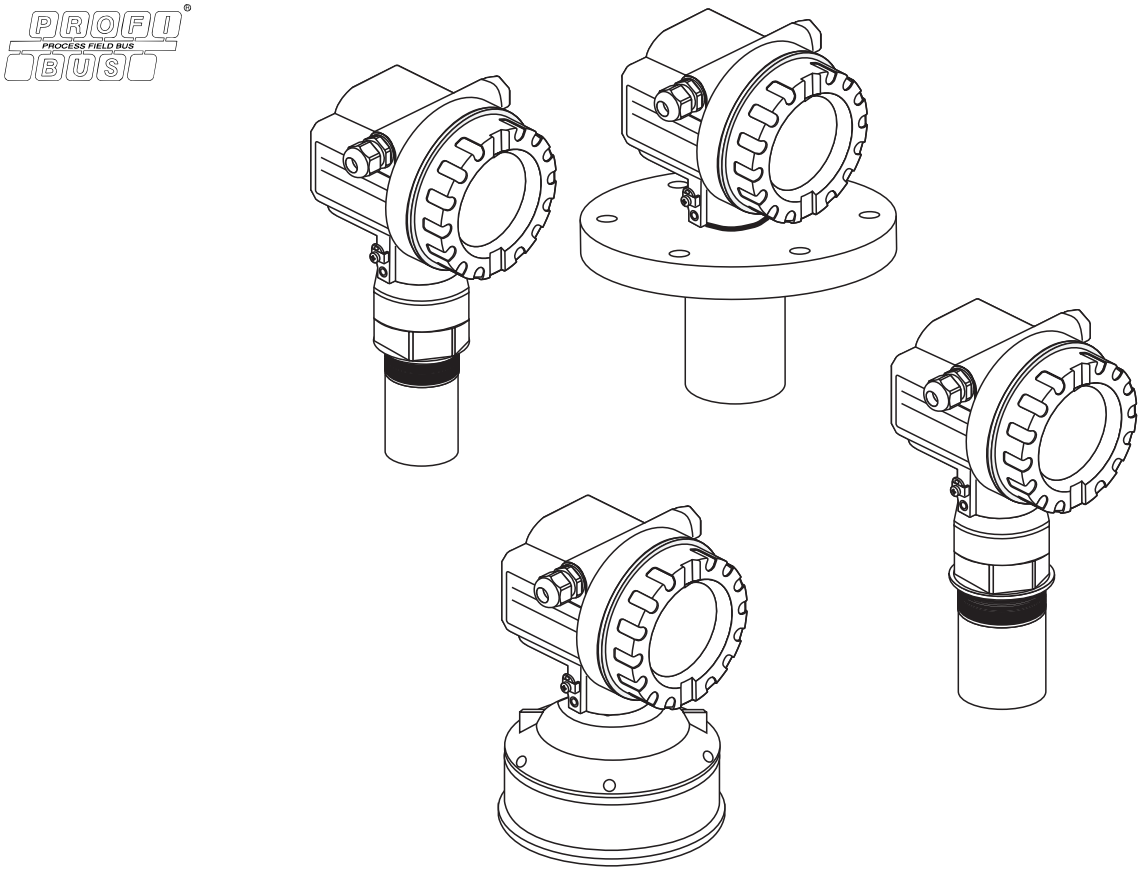
Endress+Hauser FMU40 Ultrasonic Meter

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Operating Instructions

Prosonic M FMU40/~~41/42/43~~

Ultrasonic Level Measurement



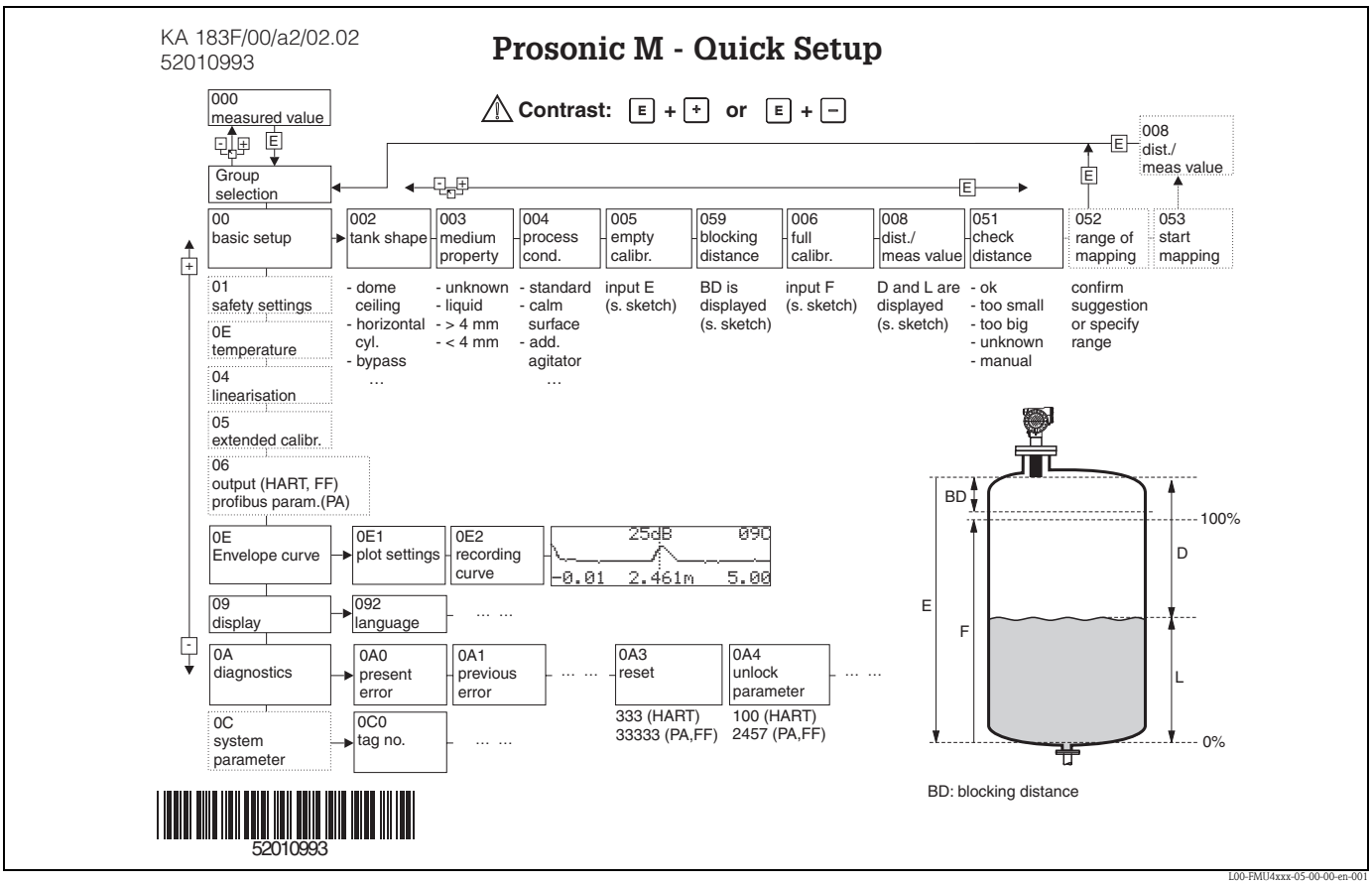
BA238F/00/en/08.06
52010986

Valid as of software version:
V 01.02.00 (amplifier)
V 01.02.00 (communication)

Endress+Hauser

People for Process Automation

Short instructions



Contents of the operating instructions

This operating instructions describes the installation and commissioning of the Prosonic M ultrasonic level transmitter. It contains all the functions required for a normal measuring operation. Also, the Prosonic M provides additional functions for optimising the measuring point and for converting the measured value. These functions are not included in this operating instructions.

You can find an **overview of all the device functions** in the Appendix.

You can find a **detailed description of all the device functions** in the operating instructions BA 240F/00/en "Prosonic M – Description of Instrument Functions". This is located on the supplied documentation CD-ROM.

Table of contents

1 Safety instructions

1.1 Designated use

The Prosonic M is a compact measuring device for continuous, non-contact level measurement. Depending on the sensor, the measuring range is up to 15m in fluids and up to 7m in bulk solids. By using the linearisation function, the Prosonic M can also be used for flow measurements in open channels and measuring weirs.

1.2 Installation, commissioning, operation

The Prosonic M is fail-safe and is constructed to the state-of-the-art. It meets the appropriate standards and EC directives. However, if you use it improperly or other than for its designated use, it may pose application-specific hazards, e.g. product overflow due to incorrect installation or configuration. Installation, electrical connection, start-up, operation and maintenance of the measuring device must therefore be carried out exclusively by trained specialists authorised by the system operator. Technical personnel must have read and understood these operating instructions and must adhere to them. You may only undertake modifications or repair work to the device when it is expressly permitted by the operating instructions.

1.3 Hazardous area

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local standards and regulations.

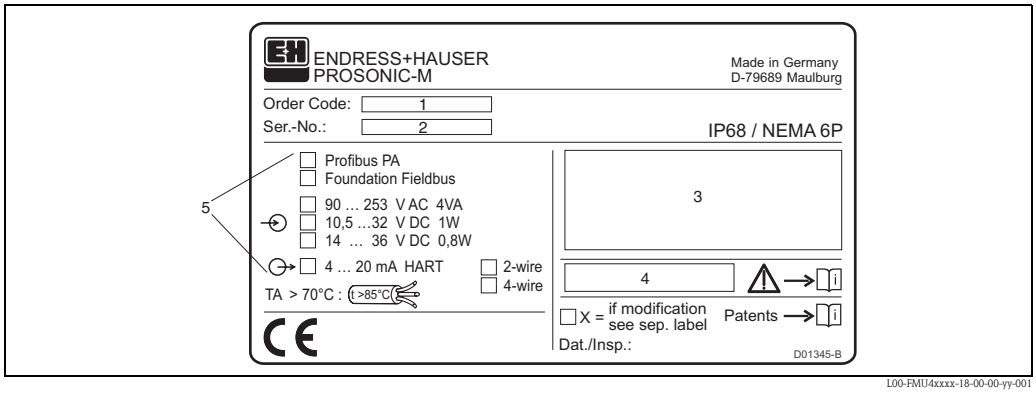
1.4 Notes on safety conventions and symbols

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.

Safety conventions	
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned
Explosion protection	
	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its name plate it can be installed in an explosion hazardous area
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. Devices located in and wiring entering areas with the designation “explosion hazardous areas” must conform with the stated type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas
Electrical symbols	
	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied
	Alternating voltage A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice
	**Temperature resistance of the connection cables** States, that the connection cables must be resistant to a temperature of at least 85 °C.

2 Identification

2.1 Nameplate



L00-FMU4xxxx-18-00-00-yy-001

1: Order Code; 2: Serial number; 3: Designation according to Directive 94/9/EC and designation of the type of protection (only for certified device variants); 4: Reference to additional safety-relevant documentation (only for certified device variants); 5: Communication variant and supply voltage (the appropriate option is highlighted)

2.2 Product structure FMU 40

	Certificates							
	A	Variant for non-hazardous area						
	1	ATEX II 1/2 G or II 2 G; EEX ia IIC T6						
	4	ATEX II 1/2 G or II 2 G; EEX d [ia] IIC T6						
	G	ATEX II 3G EEx nA II T6						
	2	ATEX II 1/2D, Alu blind cover						
	5	ATEX II 1/3D						
	S	FM IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2						
	T	FM XP Cl. I,II,III Div. 1 Gr. A-G						
	U	CSA IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2						
	V	CSA XP Cl. I,II,III Div. 1 Gr. A-G						
	N	CSA General Purpose						
	K	TIIS Ex ia II C T6						
	Y	Special certificate						
		Process connection						
		R	G 1½“ threadISO 228					
		N	NPT 1½“ - 11,5 thread					
		Y	Special version					
			Power supply/communication					
			B	2 wire, 4...20mA-loop/HART				
			H	4 wire, 10,5...32VDC / 4-20mA HART				
			G	4 wire, 90...253VAC / 4-20mA HART				
			D	2 wire, PROFIBUS PA				
			F	2 wire, Foundation Fieldbus				
			Y	Special version				
				Display / on-site operation				
				1	Without LC display			
				2	With LC display VU 331 incl. on-site operation			
				3	Prepared for remote display FHX 40			
				9	Special version			
					Housing			
					A	Aluminium F12 housing coated to IP 68		
					C	Aluminium T12 housing coated to IP 68; with separate terminal compartment		
					D	Aluminium T12 housing coated to IP 68; with separate terminal compartment; with overvoltage protection		
					9	Special version		
						Screw union/entry		
						2	M20x1.5 screw union	
						3	G 1/2“ entry	
						4	NPT 1/2“ entry	
						5	M12 PROFIBUS-PA plug-in connector	
						6	7/8" FF plug	
						9	Special version	
FMU 40 -								Product designation

2.3 Product structure FMU 41

	Certificates							
	A	Variant for non-hazardous area						
	1	ATEX II 1/2 G or II 2 G; EEX ia IIC T6						
	4	ATEX II 1/2 G or II 2 G; EEX d [ia] IIC T6						
	G	ATEX II 3G EEx nA II T6						
	2	ATEX II 1/2D, Alu blind cover						
	5	ATEX II 1/3D						
	S	FM IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2						
	T	FM XP Cl. I,II,III Div. 1 Gr. A-G						
	U	CSA IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2						
	V	CSA XP Cl. I,II,III Div. 1 Gr. A-G						
	N	CSA General Purpose						
	K	TIIS Ex ia II C T6						
	Y	Special certificate						
		Process connection						
		R	G 2“ threadISO 228					
		N	NPT 2“ - 11,5 thread					
		Y	Special version					
			Power supply/communication					
			B	2 wire, 4...20mA-loop/HART				
			H	4 wire, 10,5...32VDC / 4-20mA HART				
			G	4 wire, 90...253VAC / 4-20mA HART				
			D	2 wire, PROFIBUS PA				
			F	2 wire, Foundation Fieldbus				
			Y	Special version				
				Display / on-site operation				
				1	Without LC display			
				2	With LC display VU 331 incl. on-site operation			
				3	Prepared for remote display FHX 40			
				9	Special version			
					Housing			
					A	Aluminium F12 housing coated to IP 68		
					C	Aluminium T12 housing coated to IP 68 with separate terminal compartment		
					D	Aluminium T12 housing coated to IP 68; with separate terminal compartment; with overvoltage protection		
					9	Special version		
						Screw union/entry		
						2	M20x1.5 screw union	
						3	G 1/2“ entry	
						4	NPT 1/2“ entry	
						5	M12 PROFIBUS-PA plug-in connector	
						6	7/8" FF plug	
						9	Special version	
FMU 41 -								Product designation

2.4 Product structure FMU 42

	Certificates									
	A	Variant for non-hazardous area								
	1	ATEX II 1/2 G EEX ia IIC T6								
	4	ATEX II 1/2 G EEX d [ia] IIC T6								
	G	ATEX II 3G EEx nA II T6 (in preparation)								
	S	FM IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2								
	T	FM XP Cl. I,II,III Div. 1 Gr. A-G								
	U	CSA IS Cl. I,II,III Div. 1 Gr. A-G / NI Cl. I Div. 2								
	V	CSA XP Cl. I,II,III Div. 1 Gr. A-G								
	N	CSA General Purpose								
	K	TIIS Ex ia II C T6 (in preparation)								
	Y	Special certificate								
		Process connection								
		M	mounting bracket FAU20							
		P	DN80/ANSI 3"/JIS10K80, PP, Universal flange							
		Q	DN80/ANSI 3"/JIS10K80, PVDF, Universal flange							
		S	DN80/ANSI 3"/JIS10K80, 316L, Universal flange							
		T	DN100/ANSI 4"/JIS16K100, PP, Universal flange							
		U	DN100/ANSI 4"/JIS16K100, PVDF, Universal flange							
		V	DN100/ANSI 4"/JIS16K100, 316L, Universal flange							
		Y	Special version							
			Power supply/communication							
			B	2 wire, 4...20mA-loop/HART						
			H	4 wire, 10,5...32VDC / 4-20mA HART						
			G	4 wire, 90...253VAC / 4-20mA HART						
			D	2 wire, PROFIBUS PA						
			F	2 wire, Foundation Fieldbus						
			Y	Special version						
				Display / on-site operation						
				1	Without LC display					
				2	With LC display VU 331 incl. on-site operation					
				3	Prepared for remote display FHX 40					
				9	Special version					
					Housing					
					A	Aluminium F12 housing coated to IP 68				
					C	Aluminium T12 housing coated to IP 68, with separate terminal compartment				
					D	Aluminium T 12 housing coated to IP 68, with separate terminal compartment; with overvoltage protection				
					Y	Special version				
						Gland/Entry				
						2	M20x1.5 gland			
						3	G 1/2“ entry			
						4	NPT 1/2“ entry			
						5	M12 PROFIBUS-PA plug			
						6	7/8" FF plug			
						9	Special version			
							Sealing Sensor/Flange			
							2	VITON flat sealing		
							3	EPDM flat sealing		
							9	special version		
								Additional options		
								A	Additional options not selected	
FMU 42 -										Product designation

2.5 Product structure FMU 43

	Certificates							
	A	Variant for non-hazardous area						
	2	ATEX II 1/2 D or II 2 D, Aluminium Deckel						
	5	ATEX II 1/3 D or II 3 D, Sichtdeckel						
	M	FM DIP Class II, III, Div. 1, Gr. E,F,G NI						
	N	CSA General Purpose						
	P	CSA DIP, Class II, III, Div. 1, Gr. E,F,G NI						
	Y	Special version						
		Process connection/material						
		P	Flange DN 100/ANSI 4"/JIS 16K100, PP (universal slip-on flange included)					
		S	Flange DN 100/ANSI 4"/JIS 16K100, SS 316TI (universal slip-on flange included)					
		K	Without slip-on flange/without mounting bracket (customer mounting equipment)					
		M	With mounting bracket					
		Y	Special version					
			Power supply/communication					
			H	4 wire, 10,5...32VDC / 4-20mA HART				
			G	4 wire, 90...253VAC / 4-20mA HART				
			D	2 wire, PROFIBUS PA				
			F	2 wire, Foundation Fieldbus				
			Y	Special version				
				Display / on-site operation				
				1	Without LC display			
				2	With LC display VU 331 incl. on-site operation			
				3	Prepared for remote display FHX 40			
				9	Special version			
					Housing			
					A	Aluminium F12 housing coated to IP 68		
					9	Special version		
						Screw union/entry		
						2	M20x1.5 screw union	
						3	G 1/2“ entry	
						4	NPT 1/2“ entry	
						5	M12 PROFIBUS-PA plug-in connector	
						6	7/8" FF plug	
						9	Special version	
FMU 43 -								Product designation

2.6 Scope of delivery

2.6.1 Instrument and accessories

- Instrument according to the version ordered
- "ToF Tool – FieldTool Package" (2 CD-ROMs)
- for FMU 40/41 in the versions FMU 40 *R**** and FMU 41 *R****: counter nut (PC)
- for FMU 40/41: sealing ring (EPDM)
- for gland M20x1.5:
  – 1 cable gland for 2-wire instruments
  – 2 cable glands for 4-wire instruments
  The cable glands are mounted on delivery.

2.6.2 Supplied documentation

Short instructions (KA 183F, in the instrument)

intended as a memory jogger for users who are familiar with the operating concept of Endress+Hauser Time-of-Flight instruments.

Operating instructions (BA 238F, this booklet)

This describes the installation and commissioning of the Prosonic M. The operating menu includes all the functions which are required for standard measurement tasks. Any additional functions are **not** included.

Description of Instrument Functions (BA 240F)

contains a detailed description of all the functions of the Prosonic M. You can find this document as a pdf file on the supplied ToF Tool – FieldTool CD-ROM 1.

Safety instructions

Additional safety instructions (XA, ZE, ZD) are supplied with certified device versions. Refer to the nameplate for the names of the safety instructions that apply to your device version.

2.7 Certificates and approvals

CE mark, declaration of conformity
The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

2.8 Registered trademarks

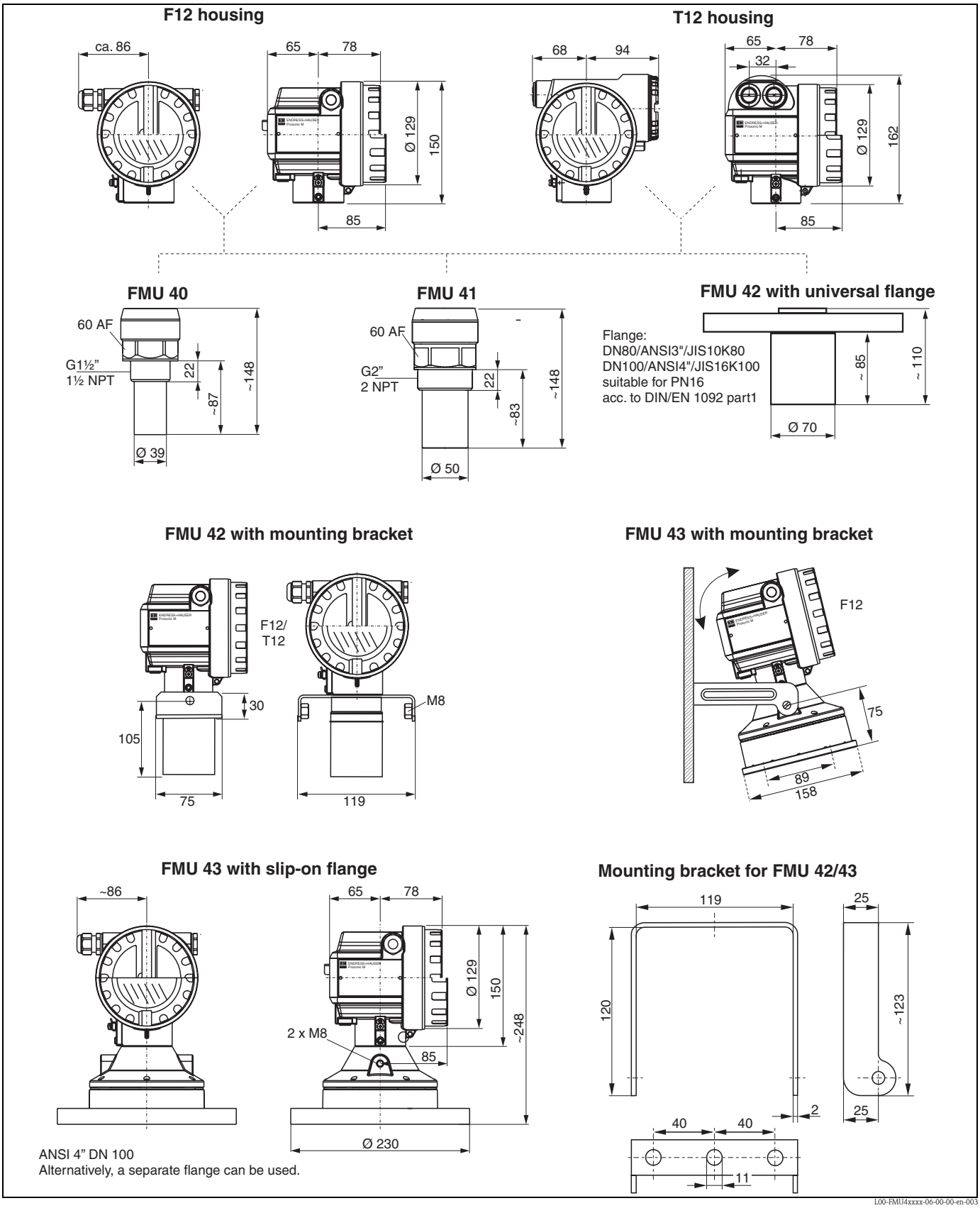
ToF®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

PulseMaster®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

PROFIBUS®
Registered trademark of the PROFIBUS Trade Organisation, Karlsruhe, Germany

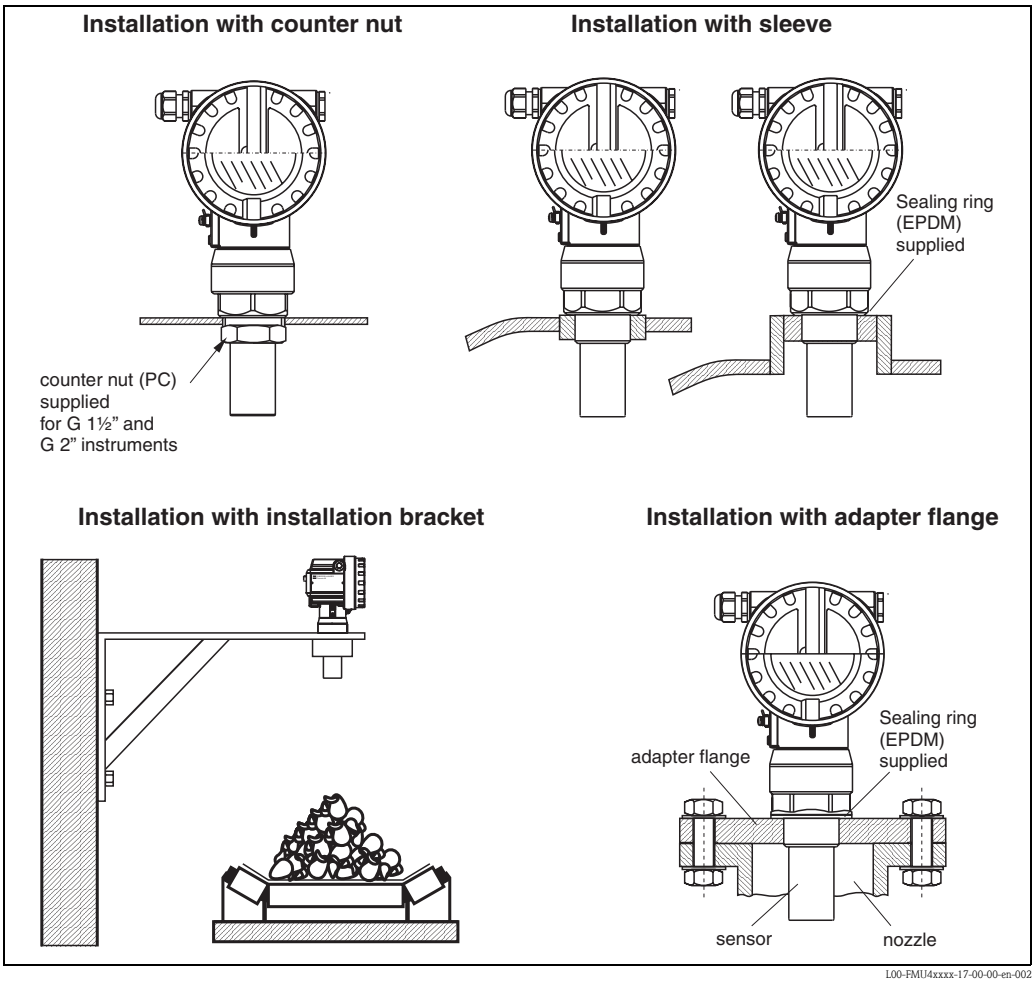
3 Installation

3.1 Dimensions



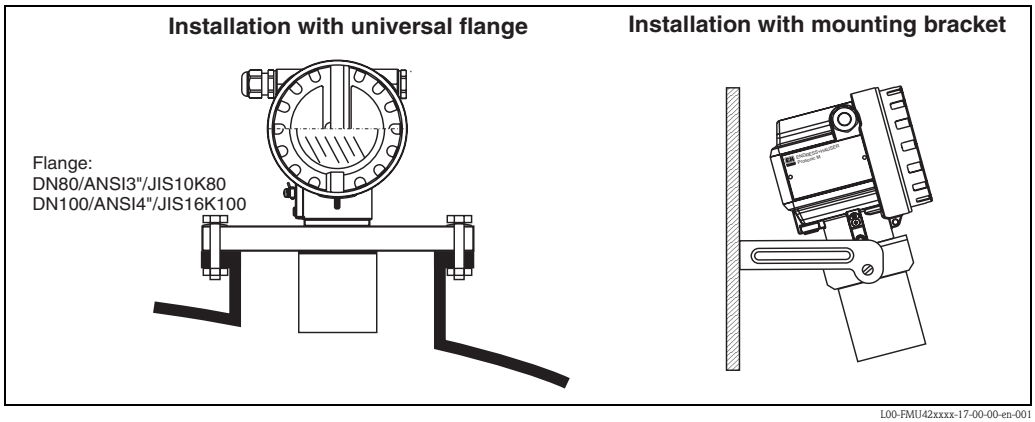
3.2 Installation variants

3.2.1 Installation variants FMU 40, FMU 41



For installation bracket or adapter flange s. chapter "Accessories".

3.2.2 Installation variants FMU 42



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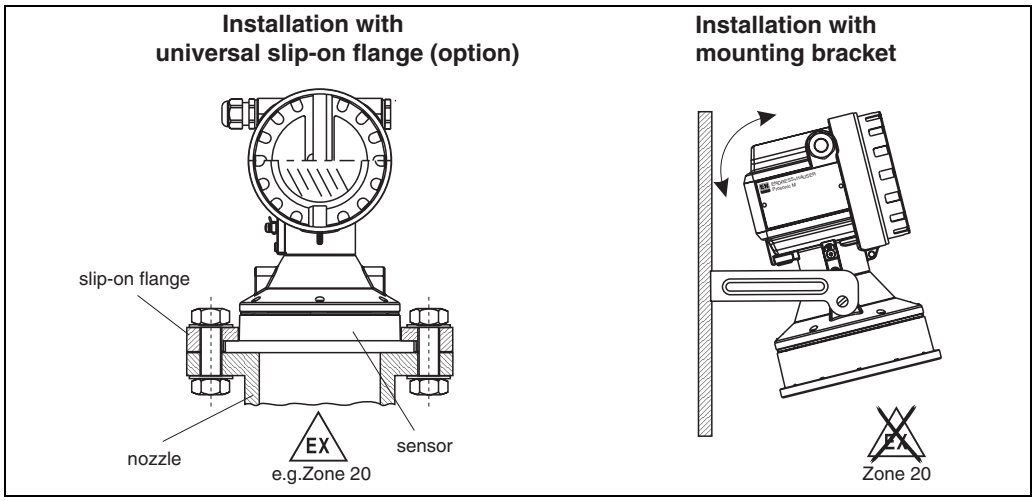
3.2.3 Installation variants FMU 43



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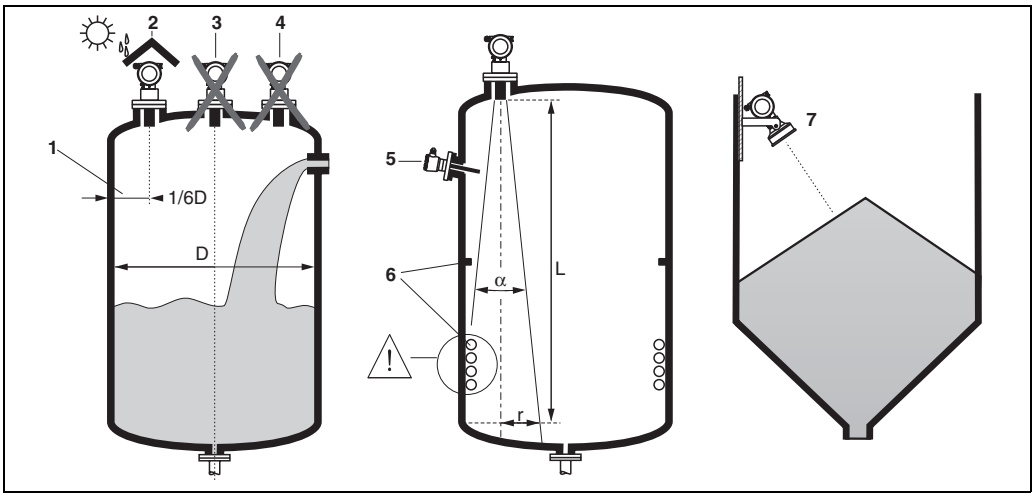
3.3 Installation conditions

3.3.1 Installation conditions for level measurements



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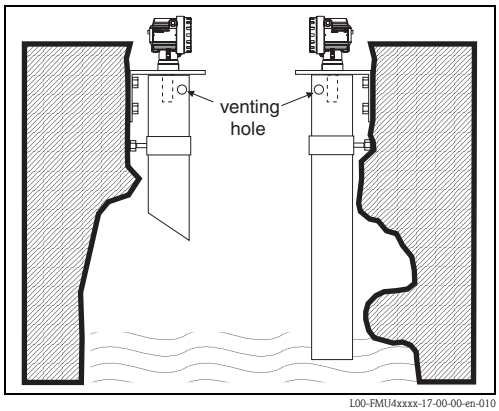
- Do not install the sensor in the middle of the tank (3). We recommend leaving a distance between the sensor and the tank wall (1) measuring 1/6 of the tank diameter.
- Use a protective cover, in order to protect the device from direct sun or rain (2).
- Avoid measurements through the filling curtain (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}
FMU 40	11°	5 m	0,48 m
FMU 41	11°	8 m	0,77 m
FMU 42	9°	10 m	0,96 m
FMU 43	6°	15 m	0,79 m

3.3.2 Installation in narrow shafts

In narrow shafts with strong interference echoes, we recommend using an ultrasound guide pipe (e.g. PE or PVC wastewater pipe) with a minimum diameter of 100 mm.
Make sure that the pipe is not soiled by accumulated dirt. If necessary, clean the pipe at regular intervals.



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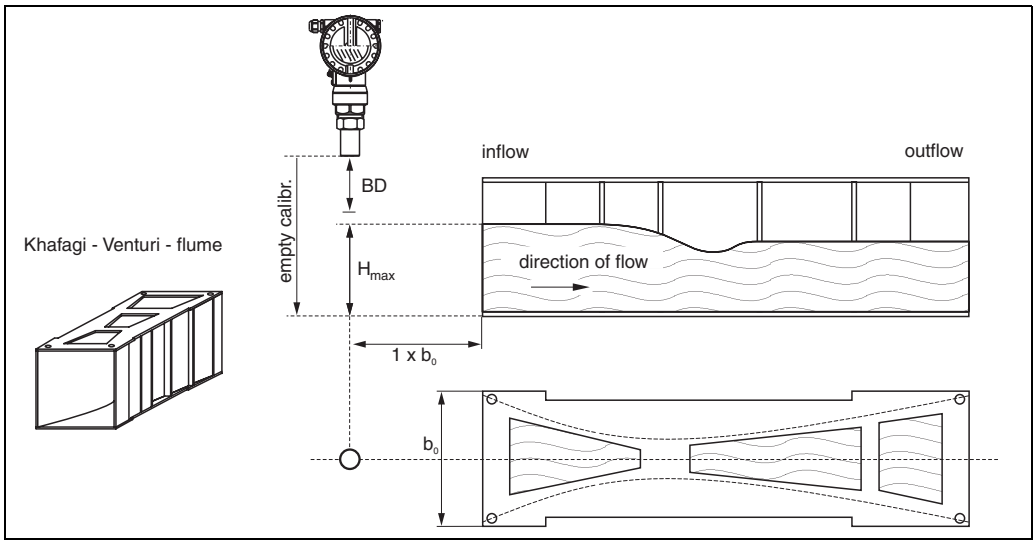
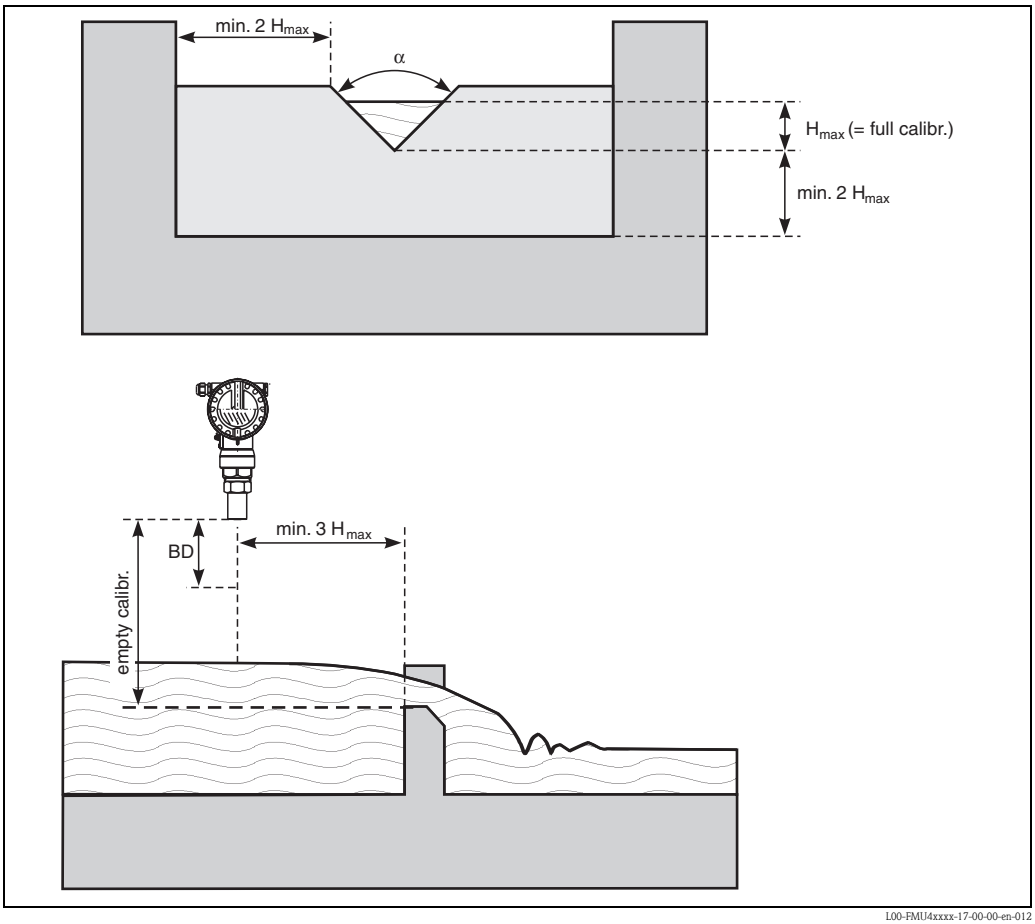
3.3.3 Installation conditions for flow measurements

- Install the Prosonic M at the inflow side, as close above the maximum water level H_{max} as possible (take into account the blocking distance BD).
- Position the Prosonic M in the middle of the channel or weir.
- Align the sensor membrane parallel to the water surface.
- Keep to the installation distance of the channel or weir.
- You can enter the "Flow to Level" linearisation curve ("Q/h curve") using ToF Tool or manually via the on-site display.

Example: Khafagi-Venturi flume



Example: Triangular weir



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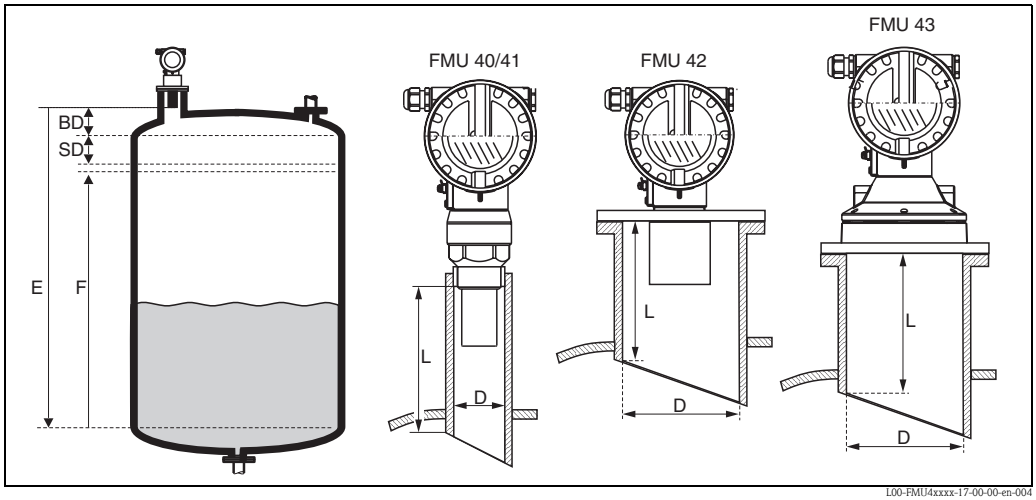
3.4 Measuring range

3.4.1 Blocking distance, Nozzle mounting

Install the Prosonic M at a height so that the blocking distance BD is not undershot, even at maximum fill level. Use a pipe nozzle if you cannot maintain the blocking distance in any other way. The interior of the nozzle must be smooth and may not contain any edges or welded joints. In particular, there should be no burr on the inside of the tank side nozzle end. Note the specified limits for nozzle diameter and length. To minimise disturbing factors, we recommend an angled socket edge (ideally 45°).



BD: *blocking distance;* ***SD:*** *safety distance;* ***E:*** *empty calibration;* ***F:*** *full calibration (span);* ***D:*** *nozzle diameter;* ***L:*** *nozzle length*

Sensor	BD	Max. range liquids	Max. range bulk materials	nozzle diameter	max. nozzle length
FMU 40	0.25 m	5 m	2 m	50 mm	approx. 80 mm
				80 mm	approx. 240 mm
				100 mm	approx. 300 mm
FMU 41	0.35 m	8 m	3.5 m	80 mm	approx. 240 mm
				100 mm	approx. 300 mm
FMU 42	0.4 m	10 m	5 m	80 mm	approx. 250 mm
				100 mm	approx. 300 mm
FMU 43	0.6 m	15 m	7 m	min. 100 mm	approx. 300 mm

Caution!
If the blocking distance is undershot, it may cause device malfunction.

3.4.2 Safety distance

If the level rises to the safety distance SD, the device switches to warning or alarm status.
The size of SD can be set freely in the **"Safety distance" (015)** function.The **"in safety distance" (016)** function defines how the device reacts if the level enters the safety distance.

There are three options:
- **Warning**: The device outputs an error message but continues measurement.
- **Alarm**: The device outputs an error message. The output signal assumes the value defined in the **"Output on alarm" (011)** function (MAX, MIN, user-specific value or holds the last value). As soon as the level drops below the safety distance, the device recommences measurement.
- **Self holding**: The device reacts in the same way as for an alarm. However, the alarm condition continues after the level drops below the safety distance. The device only recommences measurement when you cancel the alarm using the **"Ackn. alarm" (017)** function.

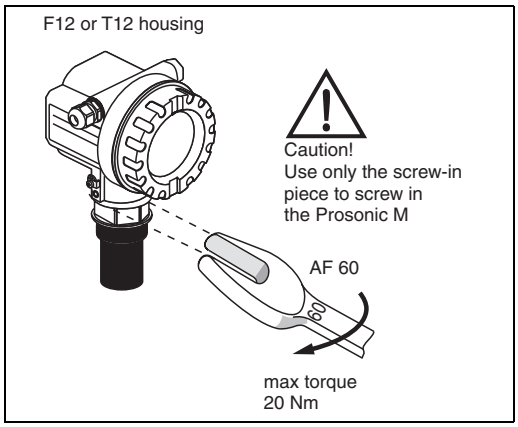
3.4.3 Range

The sensor range is dependent on the measuring conditions. Refer to Technical Information TI 365F/00/en for an estimation. The maximum range is shown in the above diagram (valid for good conditions).

Sensor	maximum range
FMU 40	5 m
FMU 41	8 m
FMU 42	10 m
FMU 43	15 m

3.5 Installation hint for FMU 40/41

Screw the Prosonic M at the screw-in piece using an 60 AF spanner.
Maximum torque: 20 Nm.



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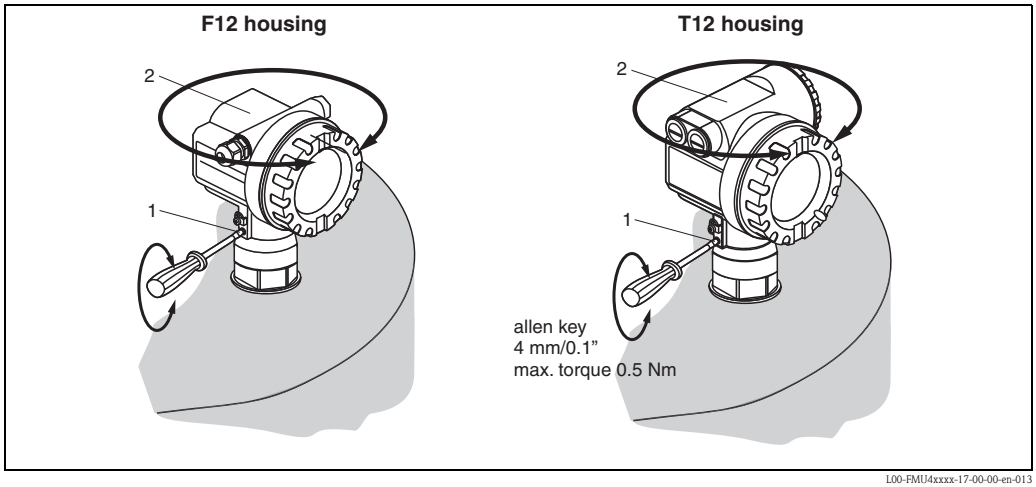
3.6 Turn housing

After mounting, the housing can be turned 350° in order to simplify access to the display and the terminal compartment. Proceed as follows to turn the housing to the required position:
- Undo the fixing screws (1)
- Turn the housing (2) in the required direction
- Tighten up the fixing screws (1). Maximum torque 0.5 Nm.
- Loctite can be used for securing the screw.



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3.7 Installation check

After installing the device, carry out the following checks:
- Is the device damaged (visual inspection)?
- Does the device correspond to the measuring point specifications for process temperature, process pressure, ambient temperature, measuring range etc.
- If available: Are the measuring point number and labelling correct (visual inspection)?
- Is the measuring device sufficiently protected against precipitation and direct sunlight?
- Are the cable glands tightened correctly?
- After aligning the housing, check the process seal at the nozzle or flange.

4 Wiring

4.1 Electrical connection

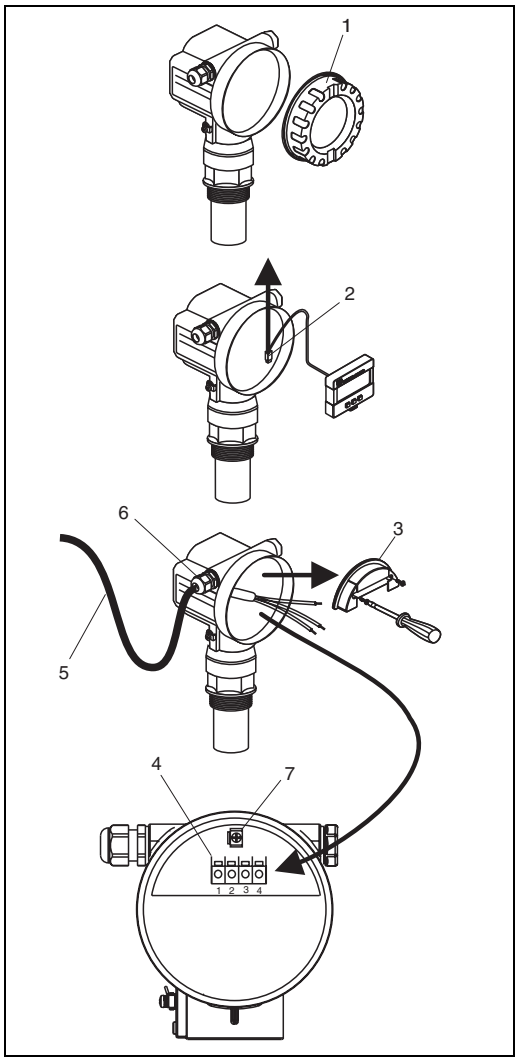
Caution!
Before connection please note the following:
- The power supply must be identical to the data on the nameplate.
- Switch off power supply before connecting up the instrument.
- Connect equipotential bonding to transmitter ground terminal before connecting up the instrument (s. section "Potential matching")

Warning!
When you use the measuring system in hazardous areas, make sure to comply with national standards and the specifications in the safety instructions (XA's). Make sure you use the specified cable gland.

4.1.1 Wiring in the housing F12

1. Unscrew housing cover (1).
2. Remove display (2) if fitted.
3. Remove cover plate (3) from terminal compartment.
4. Pull out terminal module (4) slightly using pulling loop.
5. Insert cable (5) through gland (6).

   Caution!
   If possible, insert the cable from above and let a draining loop in order to avoid intrusion of humidity.
6. Connect cable screen to the grounding terminal (7) within the terminal compartment.
7. Make connection according to terminal assignment (see below).
8. Re-insert terminal module (4).
9. Tighten cable gland (6).
10. Tighten screws on cover plate (3).
11. Insert display (2) if fitted.
12. Screw on housing cover (1).
13. Switch on power supply.

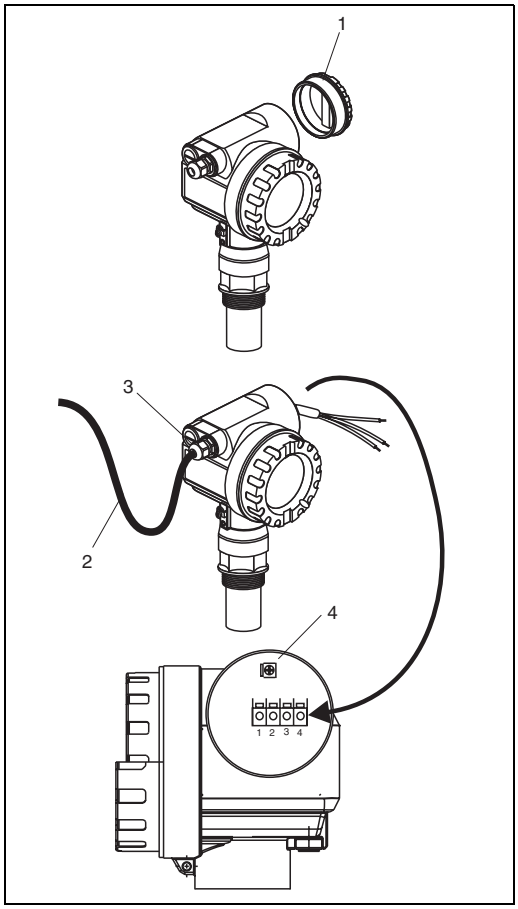


L00-FMU4xxxx-04-00-00-yy-008

4.1.2 Wiring in the housing T12

1. Unscrew the cover (1) of the separate connection room.
2. Insert cable (2) through gland (3).

   ☝ Caution!
   If possible, insert the cable from above and let a draining loop in order to avoid intrusion of humidity.
3. Connect cable screen to the grounding terminal (4) within the connection room.
4. Make connection according to the terminal assignment (see below).
5. Tighten cable gland (3).
6. Screw on housing cover (1).
7. Switch on power supply.



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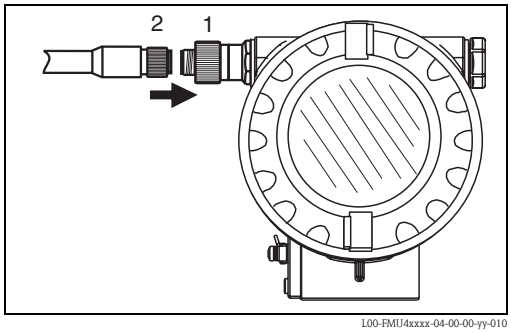
4.1.3 Wiring with M12 plug

1. Insert plug (1) into bushing (2).
2. Screw firmly.
3. Ground instrument according to the desired safety concept.



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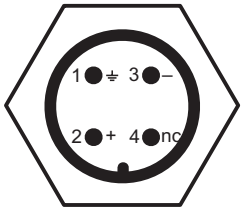
Pin assignment of the M12 plug connector (PROFIBUS PA plug)



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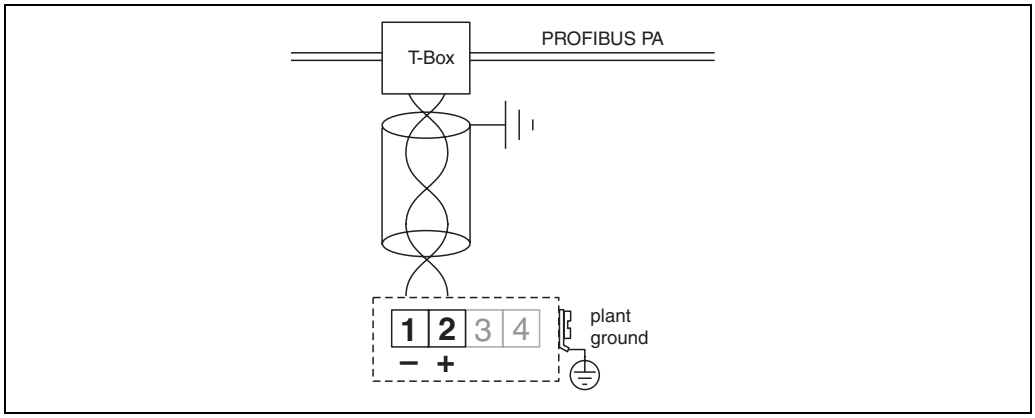
Pin	Meaning
1	Ground
2	PA +
3	PA -
4	not connected

4.2 Terminal assignment



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4.3 Cable specifications PROFIBUS

Twisted, screened pairs must be used. The following specification must be met for explosion hazardous application (EN 50 020, FISCO model):

- Loop-resistance (DC): 15…150 Ω/km,
- Specific inductance: 0.4…1 mH/km,
- Specific capacitance: 80…200 nF/km

The following cable types can be used, for example

Non-Ex-area:
- Siemens 6XV1 830-5BH10 (black),
- Kerpen CEL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL (grey)
- Belden 3076F (orange)

Ex-area:
- Siemens 6XV1 830-5AH10 (blue),
- Belden 3076F, Kerpen CEL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL (blue)

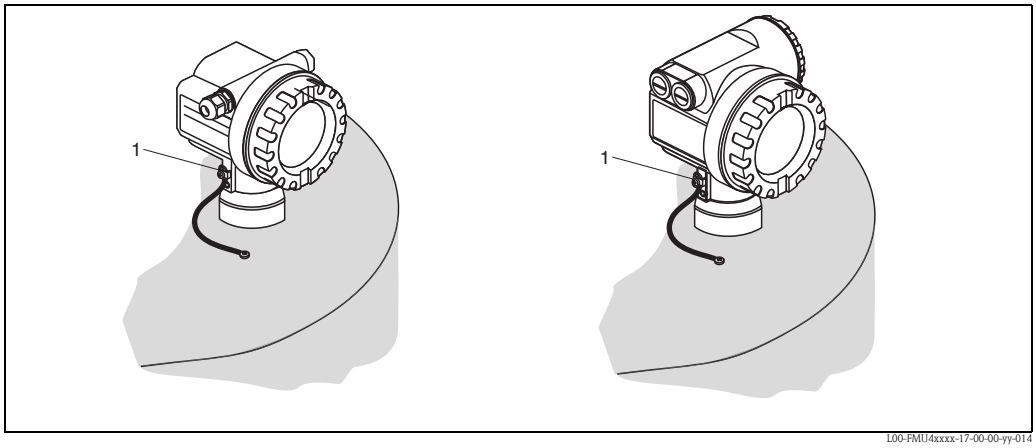
4.4 Supply voltage

The following values are the voltages across the terminals directly at the instrument:

Type	minimum terminal voltage	maximum terminal voltage
standard	9 V	32 V
EEx ia (FISCO model	9 V	17,5 V
EEx ia (Entity concept)	9 V	24 V

The current consumption is approx. 13 mA for the range of voltages given above.

4.5 Recommended connection



1: external ground terminal of the transmitter

For maximum EMC protection please observe the following points:
- As the metal housing of the Prosonic M is isolated from the tank by the plastic sensor, a low-impedance connection between the housing and tank/bracket/flange should be installed in order to ensure electromagnetic compatibility (EMC).
  For optimum EMC the connection should be as short as possible. Ideally, a ground strap should be used.
- The external ground terminal on the transmitter must be connected to ground.
- The continuity of the cable screening between tapping points must be ensured.
- If potential equalisation is present between the individual grounding points, ground the screening at each cable end or connect it to the device housing (as short as possible).
- If there are large differences in potential between grounding points, the grounding should run via a capacitor that is suitable for high frequency use (e.g. ceramic 10 nF/250 V~).

Caution!
Applications, which are subject to the explosion prevention, permit only under special conditions the repeated grounding of the protective screen , see to EN 60 079-14..

Note!
Further recommendations concerning the structure and equipotential bonding of the network can be found in Operating Instructions BA 198F "PROFIBUS-DP/-PA: Guidlines for planning and commissioning" and in the PROFIBUS-PA sapecifications EN 50170 (DIN 19245).

4.6 Checking the connection

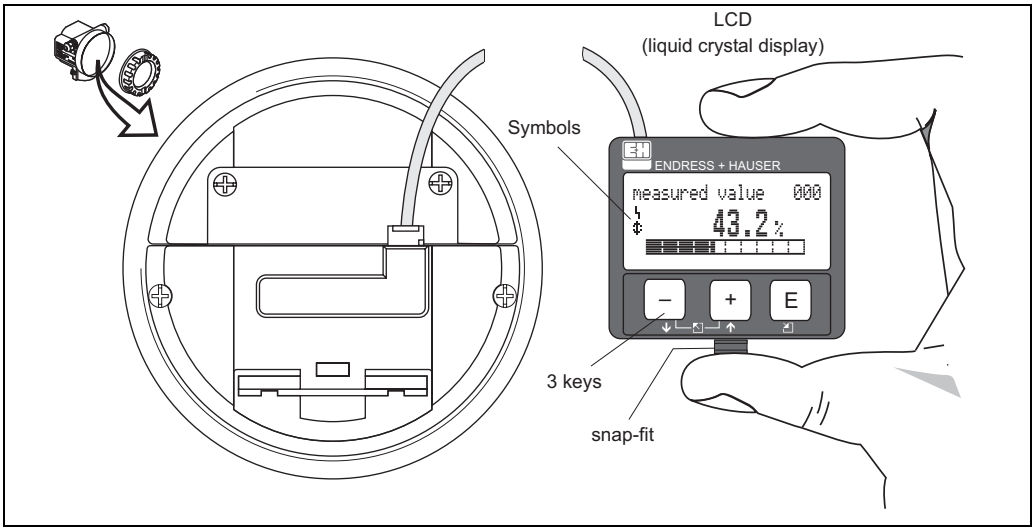
After wiring the device, carry out the following checks:
- Are the terminals correctly assigned?
- Is the cable gland tight?
- Is the M12 connector screwed tight?
- Is the housing cover fully screwed on?
- If power supply available: Does a display appear on the display module?

5 Operation

5.1 Display and operating elements

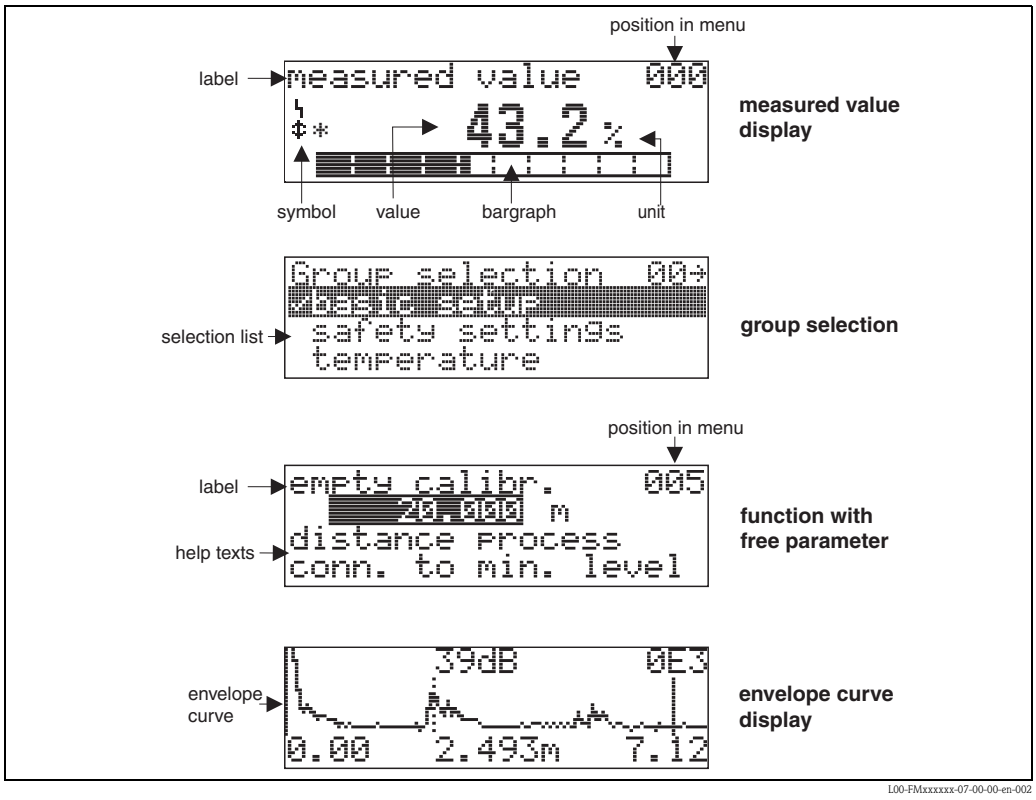
5.1.1 On-site display VU 331

The LCD module VU 331 for display and operation is located beneath the housing cover. The measured value is legible through the glass in the cover. Open the cover to operate the device.



L00-FMxxxxxx-07-00-00-en-001

5.1.2 Display appearance



In the measured value display, the bargraph corresponds to the output.
The bargraph is segmented in 10 bars. Each completely filled bar represents a change of 10% of the adjusted span.

5.1.3 Display symbols

The following table describes the symbols that appear on the liquid crystal display:

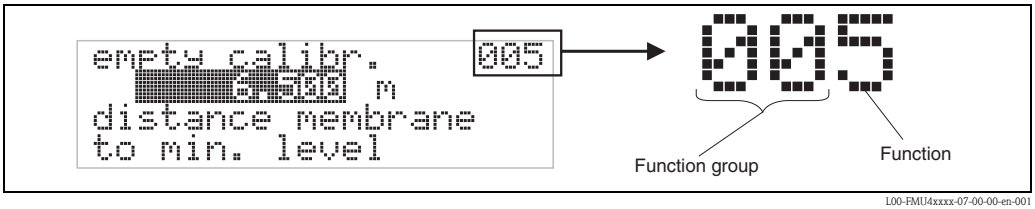
Sybmol	Meaning
	ALARM_SYMBOL This alarm symbol appears when the instrument is in an alarm state. If the symbol flashes, this indicates a warning.
	LOCK_SYMBOL This lock symbol appears when the instrument is locked,i.e. if no input is possible.
	COM_SYMBOL This communication symbol appears when a data transmission via e.g. HART, PROFIBUS PA or FOUNDATION Fieldbus is in progress.

5.1.4 Function of the keys

Key(s)	Meaning
[+] or [↑]	Navigate upwards in the selection list Edit numeric value within a function
[−] or [↓]	Navigate downwards in the selection list Edit numeric value within a function
[Esc] [−] [+] or [←]	Navigate to the left within a function group
[E]	Navigate to the right within a function group, confirmation.
[+] and [E] or [−] and [E]	Contrast settings of the LCD
[+] and [−] and [E]	Hardware lock / unlock After a hardware lock, an operation of the instrument via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

5.2 Function codes

For easy orientation within the function menus, for each function a position is shown on the display.



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The first two digits identify the function group:

- **basic setup** **00**
- **safety settings** **01**
- **linearisation** **04**

. . .

The third digit numbers the individual functions within the function group:

- **basic setup** **00** →
  - **tank shape** **002**
  - **medium property** **003**
  - **process cond.** **004**

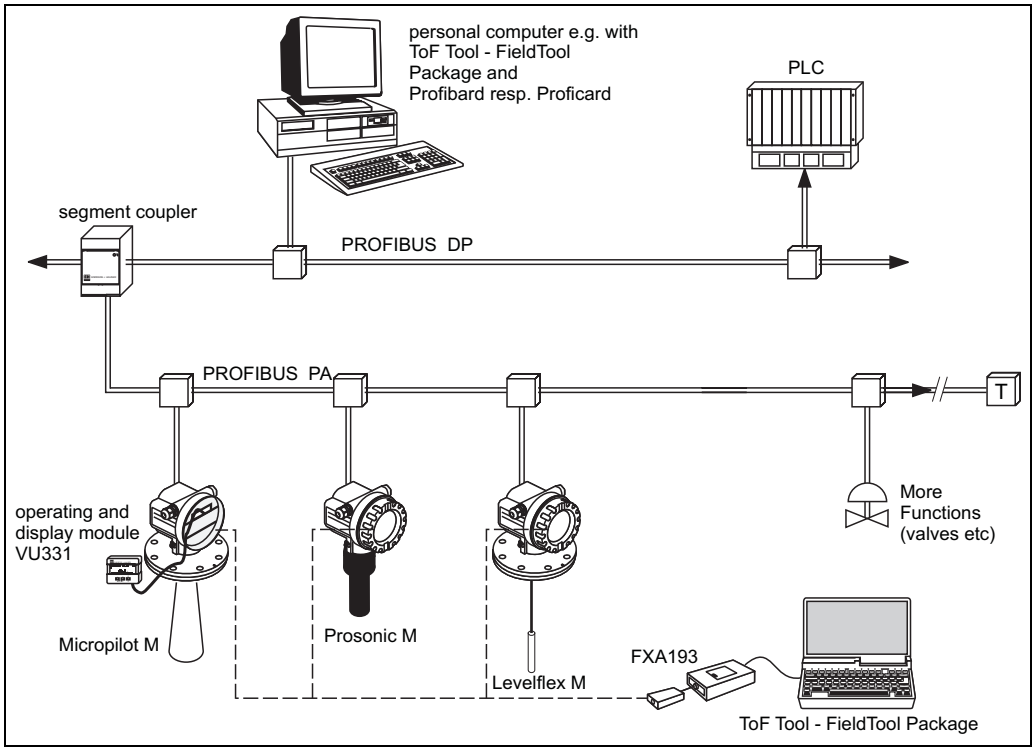
  . . .

Hereafter the position is always given in brackets (e.g. "**tank shape**" **(002)**) after the described function.

5.3 PROFIBUS PA interface

5.3.1 System integration using PROFIBUS PA

A maximum of 32 transmitters (8 if mounted in an explosion hazardous location EEx ia IIC according to FISCO-model) can be connected to the bus.The segment coupler provides the operating voltage to the bus. Both on-site as well as remote operation are possible.



5.3.2 Device address

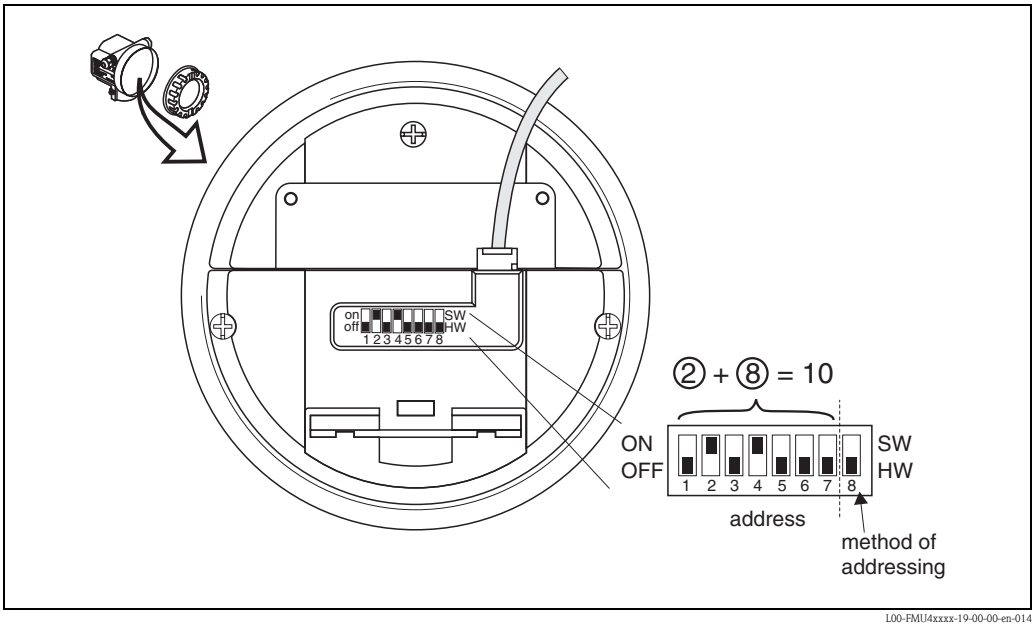
Selecting the device address

- Every PROFIBUS-PA device must be given an address. If the address is not set correctly, the device will not be recognised by the process control system.
- A device address may appear only once within a particular PROFIBUS-PA network, see BA 198F.
- Valid device addresses are in the range 1 and 126. All devices are delivered from the factory with the software address 126.
- The default address can be used to check the function of the device and connect it to an operating PROFIBUS-PA system. Afterwards the address must be changed to allow other devices to be connected to the network.

Software addressing

Software addressing comes into operation, when DIP-switch 8 is in the position "ON". BA 198F/00/en, chap. 5.7 describes, how to set the address in this case.
In ToF Tool, the address can be set via the "**Set address**" function in the "**Device**" menu.

Hardware addressing



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Hardware addressing comes into operation, when DIP switch 8 is in the position "HW (OFF)". In this case the address is determinded by the position of DIP-switches 1 to 7 according to the following table:

Switch No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Value in position "OFF"	0	0	0	0	0	0	0
Value in Position "ON"	1	2	4	8	16	32	64

The new address becomes valid 10 seconds after switching.
It results a new device restart.

5.3.3 Device database and type files

A device database file (GSD) contains a description of the properties of the PROFIBUS-PA device, e.g. the supported transmission rates and the type and format of the digital information output to the PLC.
Additional bitmap files are required in order to represent the device by an icon in the network design software.
Every device is allocated an identity code by the PROFIBUS User Organisation (PNO). This appears in the device data base file name (.gsd).

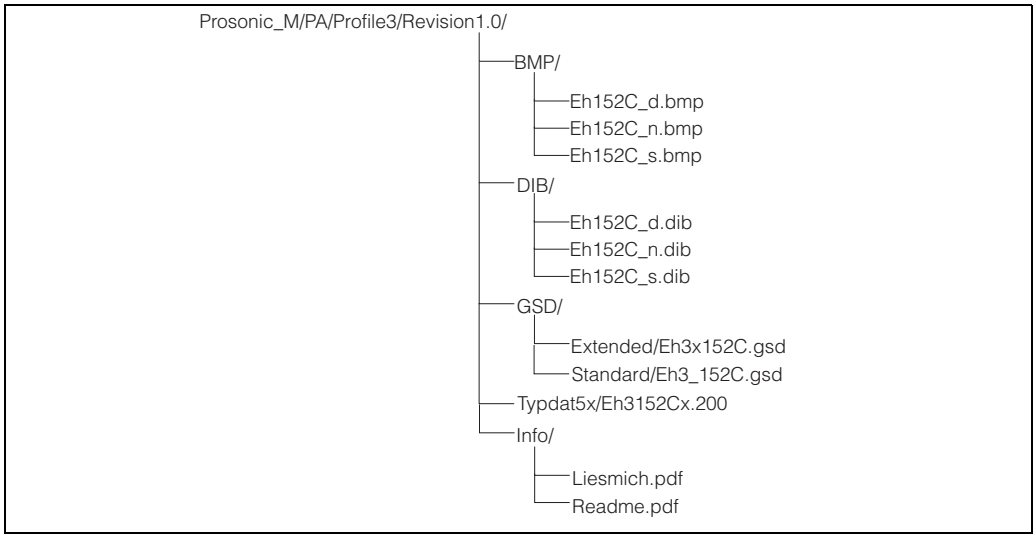
The Prosonic M has the ID number 0x152C(hex) = 5420 (dec).

Sources of supply

- Internet (ftp-Server): ftp://194.196.152.203/pub/communic/gsd
- www.endress.de
  click on "Download" and enter "GSD" into the "Search for" field. A list appears containing the links to all available GSD files.
- CD-ROM with GSD files for all E+H devices. Order-Code: 50097200
- GSD library of the PROFIBUS User Organisation (PNO):http: //www.PROFIBUS.com

Directory structure

The files are organized in the following structure:



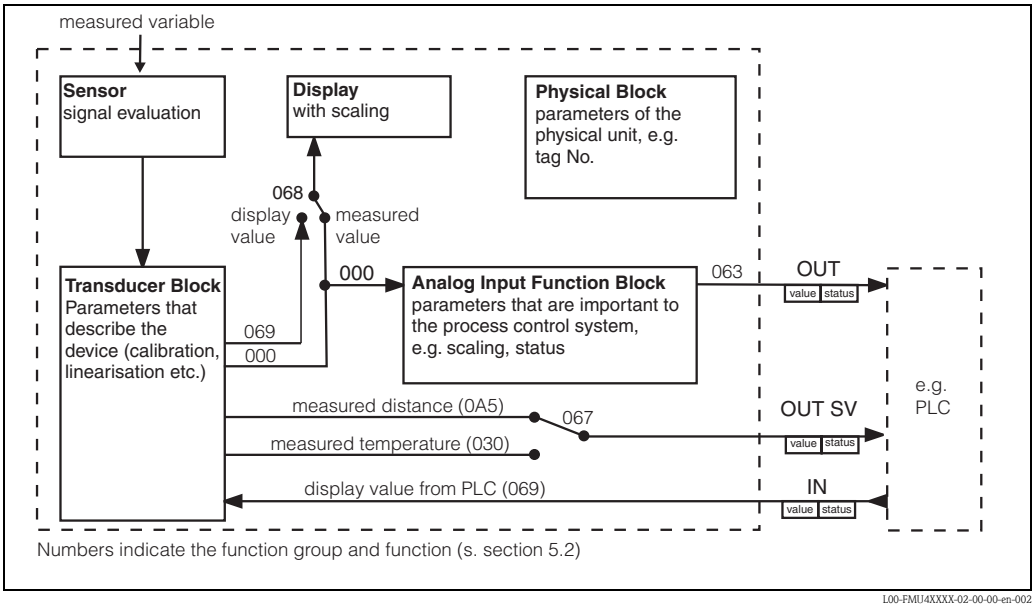
- The GSD files in the directory "Extended" are needed for the network design software STEP 7 of the S7-300/400 PLC family.
- The GSD files in the directory "Standard" are used for PLCs, which do not support an identifier format but only an identifier byte (e.g. PLC5 of Allen-Bradley)
- For the network design tool COM ET200 with Siemens S5 instead of an GSD file the Type file "EH_152Cx.200" and instead of the BMP files the DIB files have to be used.

Universal Database File

As an alternative to the device specific GSD file, the PNO provides an universal database file with the designation PA139700.gsd for devices with one analogue input block. This file supports the transmission of the main value. Transmission of a second cyclic value or a display value is not supported.
When the universal database is used, the option **"profile"** must be selected in the function **"Ident number" (061)**.

5.3.4 Cyclic data exchange

Block model of the Prosonic M



The block model shows, which data are exchanged continously (i.e. by cyclic data transfer) between the Prosonic M and the PLC. The numbers refer to the function groups and functions.

- After linearization and integration in the transducer block the **"measured value"(000)** is transmitted to the Analog-Input Block. There, it may be scaled and checked for limit transgression, and is written out to the PLC. The parameters of the Analog-Input Block are not available when operating via ToF Tool.
- The function **"select V0H0" (068)** determines, if the main value, or a read in value from the PLC is shown on the display in the field for the main value.
- The function **"second cyclic value" (067)** determines, if the **"measured distance" (0A5)** or the **"measured temperature" (030)** is transmitted as the second cyclic value.

Modules for the cyclic data telegram

For the cyclic data telegram the Prosonic provides the following modules:

1. **Main Process Value**
   This is the main measured value scaled by the Analog Input Block (063).
2. **2nd Cyclic Value**
   This is the measured distance between the sensor mebrane and the product surface (0A5) or the measured temperature (030).
3. **Display Value**
   This is a value which can be transferred from the PLC to the Prosonic M in order to be shown on the display.
4. **FREE PLACE**
   This module must be applied during configuration (see below), if the 2nd cyclic value or the display value are not to appear in the data telegram.

Configuration of the cyclic data telegram

Use the configuration software of your PLC in order to compose the data telegram from these modules in one of the following ways:

1. **Main value**
   In order to transmit the main measured value, selct the module **Main Process Value**.
2. **Main value and second cyclic value**
   In order to transmit the main value and the second cyclic value (temperature or measured distance), select the modules in the following order: **"Main Process Value"**, **"2nd Cyclic Value"**, **"FREE PLACE"**.
3. **Main value and display value**
   In order to transmitt the main value and to receive a display value select the modules in the following order: **"Main Process Value"**, **"FREE PLACE"**, **"Display Value"**.
4. **Main value, second cyclic value and display value**
   In order to transmit the main value and the second cyclic value and to receive a display value, select the modules in the following order: **"Main Process Value"**, **"2nd Cyclic Value"**, **"Display Value"**.

The exact way of performing the configuration depends on the configuration software of the PLC.

Structure of the input data (instrument -> SPS)

The input data are transmitted according to the following structure:

Index Input data	**Data**	**Access**	**Format/Remarks**
0, 1, 2, 3	Main value (level)	read	32 bit floating point number (IEEE-754)
4	Status code for main value	read	see. "Status codes"
5, 6, 7, 8 (optional)	Secondary value (measured distance)	read	32 bit floating point number (IEEE-754)
9 (optional)	Status code for secondary value	read	s. "Status codes"

Structure of the output data (SPS Æ Prosonic M)

The output data are transmitted according to the following structure:

Index Output data	**Data**	**Access**	**Format/Remarks**
0, 1, 2, 3	Display value	write	32 bit floating point number (IEEE-754)
4	Status code for Display value	write	s. "Status codes"

IEEE-754 Floating Point Number

The measured value is transmitted as a IEEE 754 floating point number, whereby:
Measured value = $(-1)^{VZ}$ x $2^{(E-127)}$ x (1+F)

Byte 1								Byte 2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sign	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
	Exponent (E)							Mantissa (F)							

Byte 3								Byte 4							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}
Mantissa (F)															

Example:

40 F0 00 00 (hex) = 0**100 0000 1**111 0000 0000 0000 0000 0000 (bin)
$= (-1)^0 \times 2^{(129-127)} \times (1 + 2^{-1} + 2^{-2} + 2^{-3})$
$= 1 \times 2^2 \times (1 + 0.5 + 0.25 + 0.125)$
$= 1 \times 4 \times 1.875$
$= 7.5$

Stauts codes

The status codes comprise one byte and have got the following meaning:

Status-Code	**Device status**	**Significance**	**Primary value**	**Secondary value**
0C Hex	BAD	device error		X
0F Hex	BAD	device error	X	
1F Hex	BAD	out-of-service (target mode)	X	
40 Hex	UNCERTAIN	non-specific		X
47 Hex	UNCERTAIN	last usable value (Fail-safe-Mode aktiv)	X	
4B Hex	UNCERTAIN	Substitute set (fail-Safe mode active)	X	
4F Hex	UNCERTAIN	initial value (fail-Safe mode active)	X	
5C Hex	UNCERTAIN	Configuration error (limits not set correctly)	X	
80 Hex	GOOD	OK	X	X
84 Hex	GOOD	Active block alarm (static revision counter incremented)	X	
89 Hex	GOOD	LOW_LIM (alarm active)	X	
8A Hex	GOOD	HI_LIM (alarm active)	X	
8D Hex	GOOD	LOW_LOW_LIM (alarm active)	X	
8E Hex	GOOD	HI_HI_LIM (alarm active)	X	

If a stauts other than "GOOD" is sent to the device, the display indicates an error.

5.3.5 Acyclic data exchange

Acyclic data exchange allows device parameters to be changed independently of the communication between the device and a PLC.
Acyclic data exchange is used
- to transmit device parameters during commissioning and maintenance;
- to display measured values that are not acquired in cyclic traffic.

There are two types of acyclic data exchange:

Acyclic communication with a Class 2 master (MS2AC)

In the case of MS2AC, a Class 2 master opens a communication channel via a so-called service access point (SAP) in order to access the device. Class 2 masters are for example:
- ToF Tool
- FieldCare
- PDM

Before data can be exchanged via PROFIBUS, however, the Class 2 master must be made aware of the parameters contained within the field device. This can be done by:
- a device description (DD)
- a device type manager (DTM)
- a software component within the master, which accesses the parameters via slot and index addresses.

Note!
- The DD or DTM is supplied by the device manufacturer.
- The number of Class 2 masters that can simultaneously access a device, is determined by the number of SAPs that the device can provide.
- The use of a Class 2 master increases the cycle time of the bus system. This must be taken into consideration when the control system or PLC is programmed.

Acyclic communication with a Class 1 master (MS1AC)

In the case of MS1AC, a Class 1 master that is already communicating cyclically with a device opens a communication channel via SAP 0x33, a special access point for MS1AC. As is the case for a Class 2 master, the parameter is read or written via the slot and index.

Note!
- At the time of writing, there are only a few PROFIBUS masters that support this type of communication.
- Not all PROFIBUS field devices support MS1AC.

Caution!
Permanent writing of parameters, e.g. with every cycle of the application program, must be avoided, since this can drastically reduce the life of the device.
Acyclic write parameters are stored electrically in the RAM (EEPROM, Flash...). The RAM modules are design for a limited number of write operations only. In standard operation without MS1AC, i.e. during parametrisation of the device, the number of write operations is negligible when compared to the limit. If the application program is badly designed, however, this limit can be reached quickly, and the RAM will fail

5.3.6 Slot/index tables

Device management

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Directory object header		1	0	12	Array of UNSIGNED16	X		constant
Composite list directory entries		1	1	24	Array of UNSIGNED16	X		constant
GAP Directory continuous		1	2-8					
GAP reserved		1	9-15					

Analog Input Block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block Data		1	16	20	DS-32*	X		constant
Static revision		1	17	2	UNSIGNED16	X		non-vol.
Device tag		1	18	32	OSTRING	X	X	static
Strategy		1	19	2	UNSIGNED16	X	X	static
Alert key		1	20	1	UNSIGNED8	X	X	static
Target Mode		1	21	1	UNSIGNED8	X	X	static
Mode		1	22	3		X		dynamic non-vol. constant
Alarm summary		1	23	8		X		dynamic
Batch		1	24	10		X	X	static
Gap		1	25					
Block parameters								
Out		1	26	5	DS-33*	X		dynamic
PV Scale		1	27	8	Array of FLOAT	X	X	static
Out Scale		1	28	11	DS-36*	X	X	static
Linearisation type		1	29	1	UNSIGNED8	X	X	static
Channel		1	30	2	UNSIGNED16	X	X	static
Gap		1	31					
PV fail safe time		1	32	4	FLOAT	X		non-vol.
Fail safe type		1	33	1	UNSIGNED8	X	X	static
Fail safe value		1	34	4	FLOAT	X	X	static
Alarm Hysteresis		1	35	4	FLOAT	X	X	static
Gap		1	36					
HI HI Limit		1	37	4	FLOAT	X	X	static
Gap		1	38					
HI Limit		1	39	4	FLOAT	X	X	static
Gap		1	40					
LO Limit		1	41	4	FLOAT	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Gap		1	42					
LO LO Limit		1	43	4	FLOAT	X	X	static
Gap		1	44-45					
HI HI Alarm		1	46	16	DS-39*	X		dynamic
HI Alarm		1	47	16	DS-39*	X		dynamic
LO Alarm		1	48	16	DS-39*	X		dynamic
LO LO Alarm		1	49	16	DS-39*	X		dynamic
Simulate		1	50	6	DS-51*	X	X	non-vol.
Out unit text		1	51	16	OSTRING	X	X	static
Gap reserved		1	52-60					

Physical Block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block Data		0	16	20	DS-32*	X		constant
Static revision		0	17	2	UNSIGNED16	X		non-vol.
Device tag		0	18	32	OSTRING	X	X	static
Strategy		0	19	2	UNSIGNED16	X	X	static
Alert key		0	20	1	UNSIGNED8	X	X	static
Target mode		0	21	1	UNSIGNED8	X	X	static
Mode		0	22	3	DS-37*	X		dynamic non-vol. constant
Alarm summary		0	23	8	DS-42*	X		dynamic
Block parameters								
Software revision		0	24	16	OSTRING	X		constant
Hardware revision		0	25	16	OSTRING	X		constant
Device manufacturer ID		0	26	2	UNSIGNED16	X		constant
Device ID		0	27	16	OSTRING	X		constant
Device serial number		0	28	16	OSTRING	X		constant
Diagnosis		0	29	4	OSTRING	X		dynamic
Diagnosis extension		0	30	6	OSTRING	X		dynamic
Diagnosis mask		0	31	4	OSTRING	X		constant
Diagnosis mask ext.		0	32	6	OSTRING	X		constant
Device certification		0	33	32	OSTRING	X	X	non-vol.
Security locking		0	34	2	UNSIGNED16	X	X	non-vol.
Factory reset		0	35	2	UNSIGNED16		X	non-vol.
Descriptor		0	36	32	OSTRING	X	X	static
Device message		0	37	32	OSTRING	X	X	static
Device instal. date		0	38	8	OSTRING	X	X	static
Gap reserved		0	39					
Ident number select		0	40	1	UNSIGNED8	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
HW write protection		0	41	1	UNSIGNED8	X	X	static
Gap reserved		0	42-48					
Gap		0	49-53					
E+H parameters								
error code		0	54	2	UNSIGNED16	X		dynamic
last error code		0	55	2	UNSIGNED16	X	X	dynamic
Up Down features		0	56	1	OSTRING	X		constant
Up Down control		0	57	1	UNSIGNED8		X	dynamic
Up Down param		0	58	20	OSTRING	X	X	dynamic
Bus address		0	59	1	UNSIGNED8	X		dynamic
Device SW No.		0	60	2	UNSIGNED16	X		dynamic
set unit to bus		0	61	1	UNSIGNED8	X	X	static
input value		0	62	6	FLOAT+U8+U 8	X		dynamic
Select Main value		0	63	1	UNSIGNED8	X	X	dynamic
PA profile revision		0	64	16	OSTRING	X		constant
Gap		0	65-69					
Gap reserved		0	119-125					

E+H specific level transducer block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standard parameters								
Block data		1	130	20	DS-32*	X		constant
Static revision		1	131	2	UNSIGNED16	X		non-vol.
Device tag		1	132	32	OSTRING	X	X	static
Strategy		1	133	2	UNSIGNED16	X	X	static
Alert key		1	134	1	UNSIGNED8	X	X	static
Target mode		1	135	1	UNSIGNED8	X	X	static
Mode		1	136	3	DS-37*	X		dynamic non-vol. static
Alarm summary		1	137	8	DS-42*	X		dynamic
E+H parameters								
Measured value	V0H0	1	138	4	FLOAT	X		dynamic
tank shape	V0H2	1	140	1	UNSIGNED8	X	X	static
medium cond.	V0H3	1	141	1	UNSIGNED8	X	X	static
process cond.	V0H4	1	142	1	UNSIGNED8	X	X	static
empty calibration	V0H5	1	143	4	FLOAT	X	X	static
full calibration	V0H6	1	144	4	FLOAT	X	X	static
output on alarm	V1H0	1	148	1	UNSIGNED8	X	X	static
outp. echo loss	V1H2	1	150	1	UNSIGNED8	X	X	static
ramp %span/min	V1H3	1	151	4	FLOAT	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
delay time	V1H4	1	152	2	UNSIGNED16	X	X	static
safety distance	V1H5	1	153	4	FLOAT	X	X	static
in safety dist.	V1H6	1	154	1	UNSIGNED8	X	X	static
ackn. alarm	V1H7	1	155	1	UNSIGNED8	X	X	static
measured temp.	V2H0	1	158	1	UNSIGNED8	X	X	static
max. temp. limit	V2H1	1	159	1	UNSIGNED8	X	X	static
max. meas. temp.	V2H2	1	160	1	UNSIGNED8	X	X	static
on high temp.	V2H3	1	161	1	UNSIGNED8	X	X	static
def. temp. sens.	V2H4	1	162	2	ENUM	X	X	static
level/ullage	V3H0	1	168	1	UNSIGNED8	X	X	static
linearisation	V3H1	1	169	1	UNSIGNED8	X	X	static
customer unit	V3H2	1	170	2	UNSIGNED16	X	X	static
table no.	V3H3	1	171	1	UNSIGNED8	X	X	static
input level	V3H4	1	172	4	FLOAT	X	X	static
input volume	V3H5	1	173	4	FLOAT	X	X	static
max. scale	V3H6	1	174	4	FLOAT	X	X	static
diameter vessel	V3H7	1	175	4	FLOAT	X	X	static
check distance	V4H1	1	179	1	UNSIGNED8	X	X	static
range of mapping	V4H2	1	180	4	FLOAT	X	X	static
start mapping	V4H3	1	181	1	UNSIGNED8	X	X	static
pres. map. dist.	V4H4	1	182	4	FLOAT	X		dynamic
cust. Tank map	V4H5	1	183	1	UNSIGNED8	X	X	static
echo quality	V4H6	1	184	1	UNSIGNED8	X		dynamic
offset	V4H7	1	185	4	FLOAT	X	X	static
output damping	V4H8	1	186	4	FLOAT	X	X	static
blocking dist.	V4H9	1	187	4	FLOAT	X	X	static
instrument_addr.	V5H0	1	188	1	UNSIGNED8	X		dynamic
ident number	V5H1	1	189	1	UNSIGNED8	X	X	static
set unit to bus	V5H2	1	190	1	UNSIGNED8	X	X	static
out value	V5H3	1	191	4	FLOAT	X		dynamic
out status	V5H4	1	192	1	UNSIGNED8	X		dynamic
simulation	V5H5	1	193	1	UNSIGNED8	X	X	static
simulation value	V5H6	1	194	4	FLOAT	X	X	static
2nd cyclic value	V5H7	1	195	1	UNSIGNED8	X	X	static
select V0H0	V5H8	1	196	1	UNSIGNED8	X	X	static
display value	V5H9	1	197	4	FLOAT	X		dynamic
display contrast	V6H1	1	199	1	UNSIGNED8	X	X	static
language	V6H2	1	200	1	UNSIGNED8	X	X	static
back to home	V6H3	1	201	2	INT16	X	X	static
format display	V6H4	1	202	1	UNSIGNED8	X	X	static
no. decimals	V6H5	1	203	1	UNSIGNED8	X	X	static
sep. character	V6H6	1	204	1	UNSIGNED8	X	X	static
display test	V6H7	1	205	1	UNSIGNED8	X	X	static

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
present error	V9H0	1	228	2	U16	X		dynamic
previous error	V9H1	1	229	2	U16	X		dynamic
clear last error	V9H2	1	230	1	UNSIGNED8	X	X	static
reset	V9H3	1	231	2	UNSIGNED16	X	X	static
unlock parameter	V9H4	1	232	2	UNSIGNED16	X	X	static
measured dist.	V9H5	1	233	4	FLOAT	X		dynamic
measured level	V9H6	1	234	4	FLOAT	X		dynamic
application par.	V9H8	1	236	1	UNSIGNED8	X		dynamic
tag no.	VAH0	1	238	32	STRING	X		const.
profile version	VAH1	1	239	32	STRING	X	X	static
protocol+sw-no.	VAH2	1	240	32	STRING	X		const
serial no.	VAH4	1	242	32	STRING	X	X	static
distance unit	VAH5	1	243	2	UNSIGNED16	X	X	static
temperature unit	VAH6	1	244	2	ENUM	X	X	static
download mode	VAH8	1	246	1	UNSIGNED8	X	X	static

Data strings

In der Slot/Index table some data types, e.g. DS-33 are marked by an asterisk. These are data strings according to the PROFIBUS-PA specifications part 1, Version 3.0. They contain several elements, which are addressed by an additional subindex. The following table gives an example.

Data type	Subindex	Type	Size [bytes]
DS-33	1	FLOAT	4
	5	UNSIGNED8	1

5.3.7 Parameter access via Commuwin II

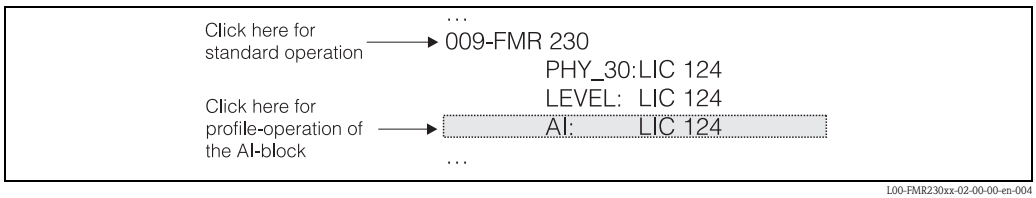
The block parameters can be accessed by a PROFIBUS-DP Class 2 master, for example, Commuwin II. Commuwin II runs on an IBM-compatible computer or laptop. The computer must be equipped with a PROFIBUS interface, i.e. PROFIBOARD for PCs and PROFICARD for laptops. During the system integration, the computer is registered as a Class 2 master.

Connection

- Profiboard for connection to a PC
- Proficard for connection to a Laptop

Generating the device list

- The PA-DPV1 server must be installed. The connection to Commuwin II is opened selecting the PA-DPV1 server in the "Open connection" function in the "Connect" menu. The empty device list appears.
- The function "Display with tags" in the "Connect" menu generates the live list with measuring point tags.
- Two operation modes are possible:
  – The **E+H standard operation** is selected by clicking on the device name
  – The **profile operation** is selected by clicking on the tag for the appropriate block
- The settings are entered in the device menu.



L00-FMR230xx-02-00-00-en-004

Device menu

The device menu allows matrix or graphical operation to be selected.

- In the case of **matrix operation**, the device or profile parameters are displayed in a matrix. For the standard operation this is the E+H standard matrix. For the profile operation this is the matrix of the selected blockA parameter can be changed when the corresponding matrix field is selected.
- In the case of **graphical operation**, the operating sequence is shown in a series of templates with parameters. For profile operation, the pictures Diagnosis, Scaling, Simulation and Block are of interest.

The meaning and the parametrization of the parameters is described in Chapter 6.

Note!
The instrument can also be operated locally using the keys. If operation is prevented by the keys being locked locally, parameter entry via communication is not possible either.

Note!
Further information on Commuwin II is given in the Operating Manual BA 124F/00/en

5.3.8 Parameter access via ToF Tool

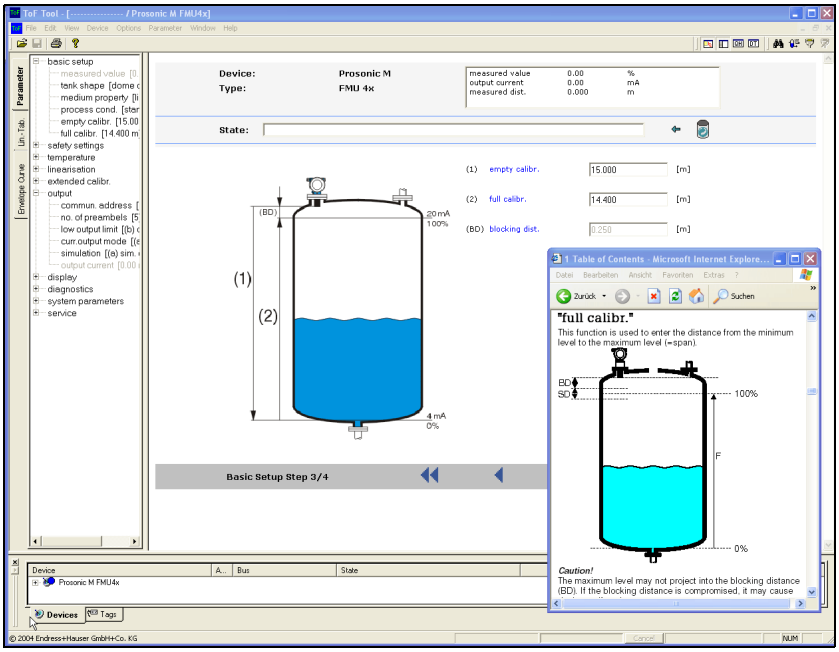
The ToF Tool is a graphical operation software for instruments from Endress+Hauser. It is used to support commissioning, securing of data, signal analysis and documentation of the instruments. It is compatible with the following operating systems: WinNT4.0, Win2000 and WinXP.

The ToF Tool supports the following functions:
- Online configuration of transmitters
- Signal analysis via envelope curve
- Linearisation table (graphically supported creation, editing, importing and exporting)
- Loading and saving of instrument data (Upload/Download)
- Documentation of measuring point

Note!
Further information you may find on the CD-ROM, which is enclosed to the instrument.

Note!
The parameters of the Analog-Input block are presently not accessible via ToF Tool.

Menu-guided commissioning

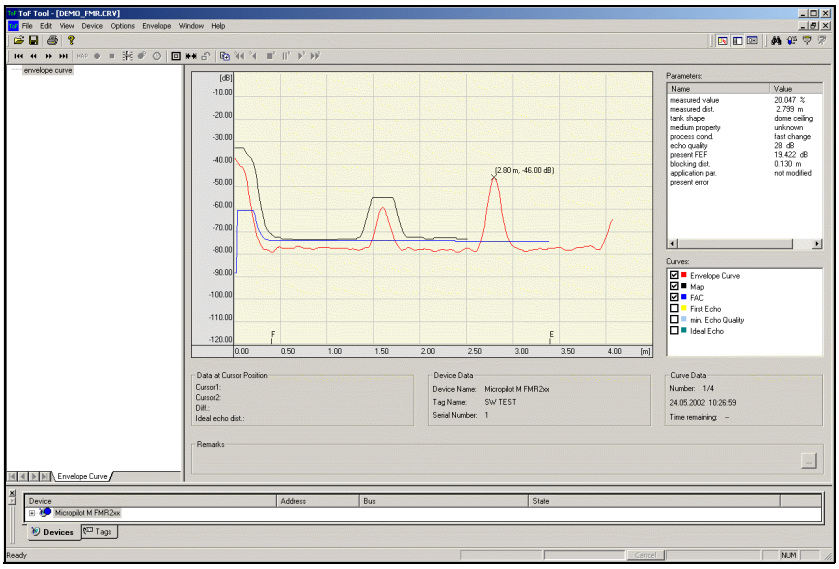


L00-FMU4xxxx-19-00-00-en-003

- You can find the function groups and functions of the device in the **navigation bar**.
- You can find the input fields for the parameters in the **main window**.
- If you click on a parameter name, the **Help pages** open with precise explanations of the required input.

Signal analysis via envelope curve

The ToF Tool offers easy analysis of the envelope curve via the "Envelope" menu:



L00-FMU4xxxx-19-00-00-en-004

Connection options:

- Service-interface with adapter FXA 193
- Profiboard for connection to a Laptop
- Proficard for connection to a PC

5.3.9 Scaling of the output data

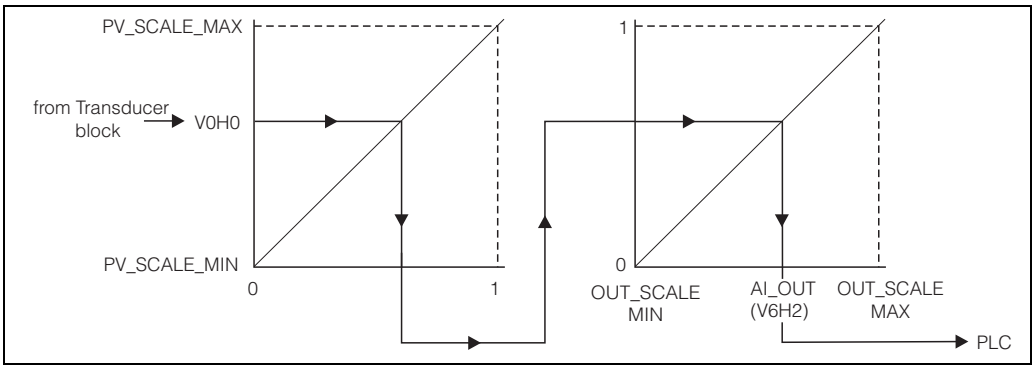
The on-site display and the digital output are working independently of each other.

On-site display

The on-site display always displayes the main value V0H0 directly from the Transducer Block.

Digital output

For the digital output this value is rescaled in two steps:

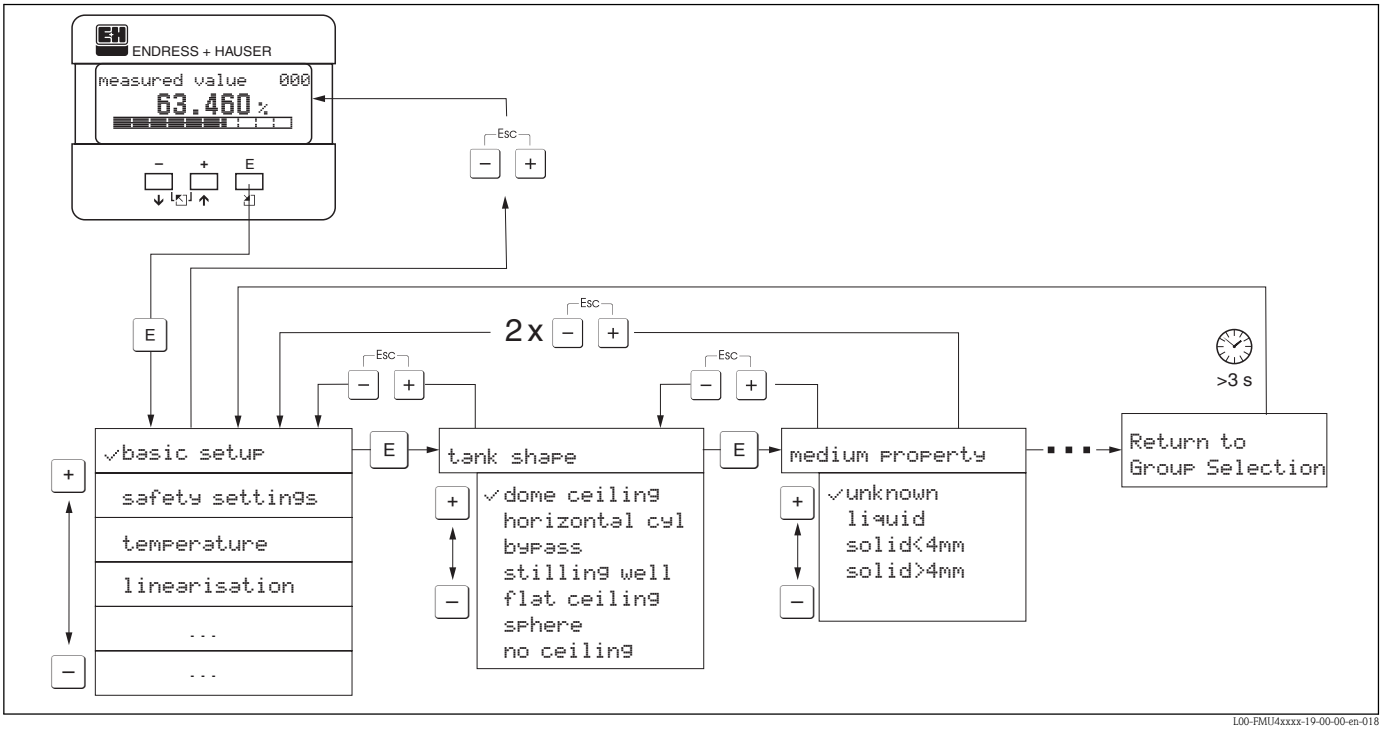


1. In a first step, the main value is mapped to the interval [0;1]. PV_SCALE_MIN and PV_SCALE_MAX determine the limits of this mapping.
2. In a second step, the interval [0,1] is mapped to the interval [OUT_SCALE_MIN, OUT_SCALE_MAX]. The value resulting from this mapping is transfered via V6H2 to the PLC.

Note!
The scaling of the ouptut value is required by the Profibus profiles. It prevents uncontrolled jumps of the output value when one changes the unit of the measuring value in the Transducer Block. If units are changed, PV_SCALE_MIN and PV_SCALE_MAX automatically adapt themselves in such a way that the output value remains unchanged. Only after confirming the change by the "**Set unit to bus**" **(062)** function,
OUT_SCALE_MIN is set equal to PV_SCALE_MIN and
OUT_SCALE_MAX equal to PV_SCALE_MAX.
Thereby the new unit also becomes effective at the output.

Caution!
If a linearisation has been carried out, it must be confirmed by the "**Set unit to bus**" **(062)** function in order to become effective at the digital output.

5.4 Operation using the on-site display VU 331



1. Change from Measured Value Display to **Group Selection** by pressing E.
2. Press − or + to select the required **Function Group** and confirm by pressing E.
   The active selection is marked by a 3 in front of the menu text.
3. Activate Edit mode with + or − .

   Selection menus

   a. Select the required **Parameter** in selected **function** with − oder + .

   b. E confirms selection; 3appears in front of the selected parameter.

   c. E confirms the edited value; system quits edit mode.

   d. + and − (= ±) interrupts selection; system quits edit mode.

   Typing in numerals and text

   a. Press + or − to edit the first character of the **numeral / text**.

   b. E positions the cursor at the next character; continue with a. until you have completed your input.

   c. If a ↵ symbol appears at the cursor, press E to accept the value entered; system quits edit mode.

   d. If a ← symbol appears at the cursor, press E to return to the previous character (e.g. for correction of entries).

   e. + and − (= ±) interrupts selection; system quits edit mode.
4. Press E to select the next **function**.
5. Press + and − (= ±) once; return to previous **function**.
   Press + and − (= ±) twice; return to **Group Selection**.
6. Press + and − (= ±) to return to **Measured value display**.

5.5 Lock/unlock configuration

5.5.1 Software security locking

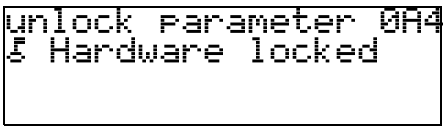
Enter a number ≠ 2457 in the **"unlock parameter" (0A4)** function in the **"diagnostics" (0A)** function group.
The symbol appears on the display. Inputs are no longer possible.

If you try to change a parameter, the device jumps to the **"unlock parameter" (0A4)** function.
Enter "2457"
Now change the parameters.

5.5.2 Hardware security locking

Press −, + and E simultaneously.
Inputs are no longer possible.

If you try to change a parameter, the following appears:



L00-fmrxf0a4-20-00-00-de-001

Press −, + and E simultaneously. The **"unlock parameter" (0A4)** function appears.
Enter "2457"
Now change the parameters.

Note!
A hardware locking can **only** be unlocked again via the display by pressing the +, − and E keys at the same time again. It is **not** possible to unlock the hardware by communication.

5.6 Resetting the customer parameters

It is advisable to reset the customer parameters if you want to use a device with an unknown history.

Effects of resetting:
- All customer parameters are reset to their default values.
- Customer interference echo suppression is **not** deleted.
- Linearisation is switched to **"linear"**, but the table values are kept. The table can be switched back on in the **"linearisation" (04)** function group in the **"linearisation" (041)** function.

In order to carry out the reset, enter the number "33333" in the **"reset" (0A3)** function in the **"diagnostics" (0A)** function group.

Caution!
A reset may lead to impairment of the measurement. As a rule, a basic calibration is required after a reset.

Note!
The default values of each parameter are shown in bold in the menu overview in the appendix.

5.7 Resetting an interference echo suppression (tank map)

It is always advisable to reset the interference echo suppression (tank mapping) when:
- a device with an unknown history is used
- an incorrect suppression was input.

Proceed as follows:

1. Switch to the **"extended calibr." (05)** function group and to the **"selection" (050)** function.
2. Select **"extended map."**
3. Then proceed to the **"cust. tank map" (055)** function.
4. Select
   – **"reset"**, to delete (reset) the existing interference echo suppression.
   – **"inactive"** to deactivate an existing interference echo suppression. The suppression remains saved.
   – **"active"** to reactivate an existing interference echo suppression.

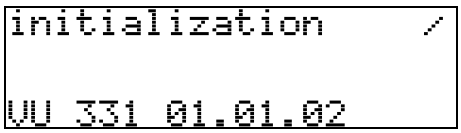
6 Commissioning

Commission the Prosonic M in the following stages:
- Installation check
- Power-up device
- Basic calibration
- Measuring signal check using the envelope curve

The chapter describes the commissioning process using the on-site display. Commissioning using ToF Tool is identical. Access to the device functions using ToF Tool is described on Page 21. You can find detailed information in the Tof Tool operating instructions (BA 224F/00/en) on the supplied CD-ROM.

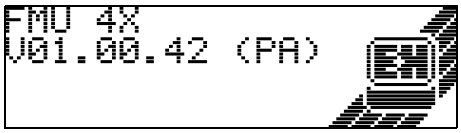
6.1 Power up instrument

After switching on the supply voltage, the instrument is first initialised.



L00-fmp-fxxx-20-00-00-en-003

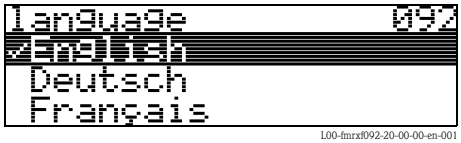
Then the following appear for approximately five seconds:
- Device type
- Software version
- Type of digital communication signal



L00-fmuxfxxx-20-00-00-de-002

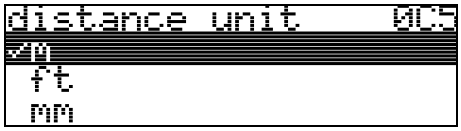
Press E to exit this display.

On first power-up, you are requested to select the language for the display texts.



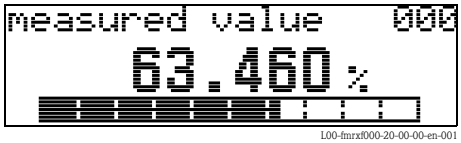
L00-fmrxf092-20-00-00-en-001

Then you are requested to select the unit of length for your measurements.



L00-fmrxf0c5-20-00-00-en-001

A measured value is displayed. This is NOT equivalent to the level in your tank. Firstly carry out a basic calibration.



L00-fmrxf000-20-00-00-en-001

Press E to switch to the group selection.
Press E again to start the basic calibration.

L00-fmrxfg00-20-00-00-en-001

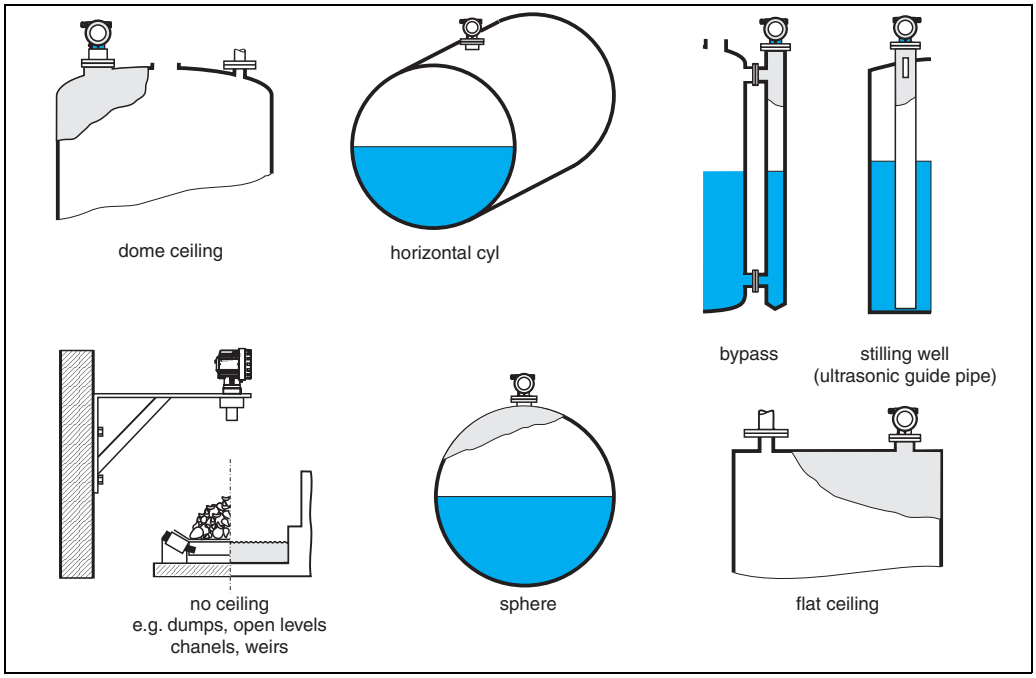
6.2 Basic calibration

The **"Basic setup" (00)** function group lists all the functions which are required for a standard measurement task to commission the Prosonic M. When you have completed your input for a function, the next function appears automatically. In this way, you are guided through the complete calibration.

6.2.1 Measuring point settings

Function "tank shape" (002)

In this function, select one of the following options:



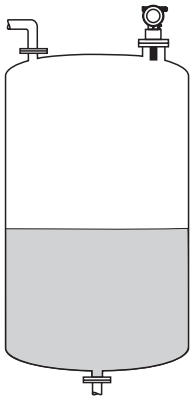
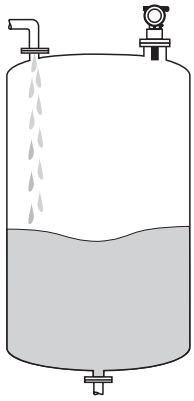
Function "medium property" (003)

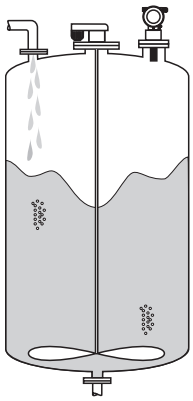
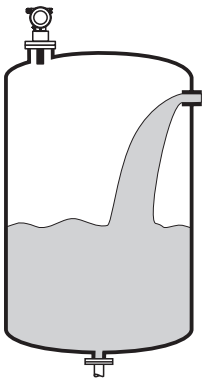
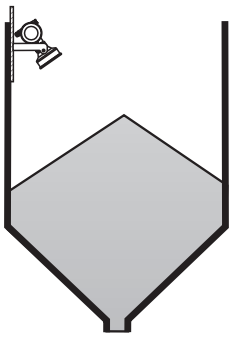
Set the medium type in this function.

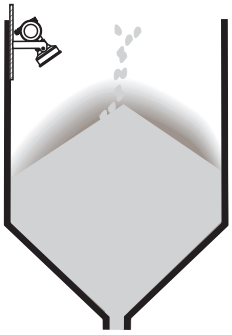
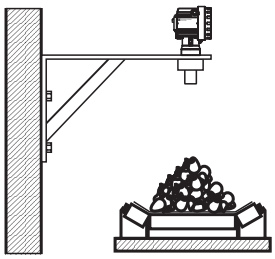
You have the following options:
- unknown (e.g. pasty media such as greases, creams, gels etc.)
- liquid
- solid, grain size < 4mm (fine)
- solid, grain size > 4mm (coarse)

Function "process conditions" (004)

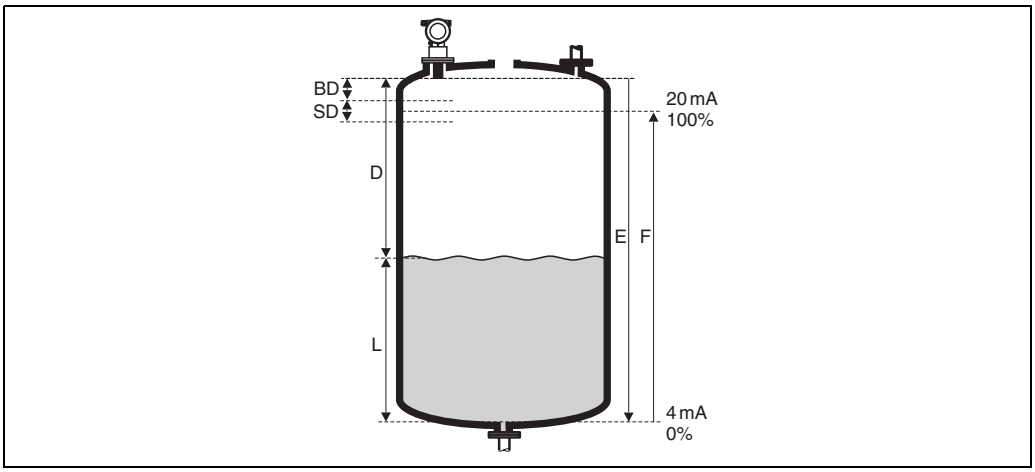
For this function, you have the following options:

standard liquids	calm surface	turb. surface
For all fluid applications which do not fit in any of the following groups.	Storage tanks with immersion tube or bottom filling	Storage / accumulation tanks with uneven surface due to free filling, mixing nozzles or small bottom stirrers
	 L00-FMU4xxxx-14-00-00-xx-001	 L00-FMU4xxxx-14-00-00-xx-002
The filters and output damping are set to average values.	The averaging filters and output damping are set to large values. -> Stable measured value -> Accurate measurement -> Slow reaction time	Special filters for stabilising the input signal are activated. -> Stable measured value -> Medium reaction time

add. agitator	fast change	standard solid
Moving surfaces (poss. with vortex formation) due to agitators	Rapid level change, particularly in small tanks	For all bulk solids applications which do not fit in any of the following groups.
 L00-FMU4xxxx-14-00-00-xx-003	 L00-FMU4xxxx-14-00-00-xx-004	 L00-FMU4xxxx-14-00-00-xx-006
Special filters for stabilising the input signal are set to large values. -> Stable measured value -> Medium reaction time	The averaging filters are set to small values. -> Rapid reaction time -> Possibly unstable measured value	The filter and output damping are set to average values.

solid dusty	conveyor belt	Test: no filter
Dusty bulk solids	Bulk solids with rapid level change	All the filters can be switched off for purposes of service and diagnosis.
 L00-FMU4xxxx-14-00-00-xx-007	 L00-FMU4xxxx-14-00-00-xx-005	
The filters are set to detect even relatively weak signals.	The averaging filters are set to small values. -> Rapid reaction time Possibly unstable measured value	All filters off

6.2.2 Empty and full calibration



L00-FMU4xxxx-19-00-00-yy-019

Function "empty calibration" (005)

In this function, enter the distance E from the sensor membrane to the minimum level (zero point).

Caution!
With dished boiler heads or conical outflows, the zero point should not be deeper than the point at which the ultrasonic wave impinges on the tank bottom.

Function "blocking distance" (059)

In this function the blocking distance (BD) of the sensor is displayed.

Caution!
When entering the full calibration (span), please take into account, that the maximum level may not project into the blocking distance (BD)

Note!
After basic calibration, enter a safety distance (SD) in the **"safety distance" (015)** function. If the level is within this safety distance, the Prosonic M signals a warning or an alarm, depending on your selection in the **"in safety distance" (016)** function.

Function "full calibration" (006)

In this function, enter the span F, i.e. the distance from the minimum level to the maximum level.

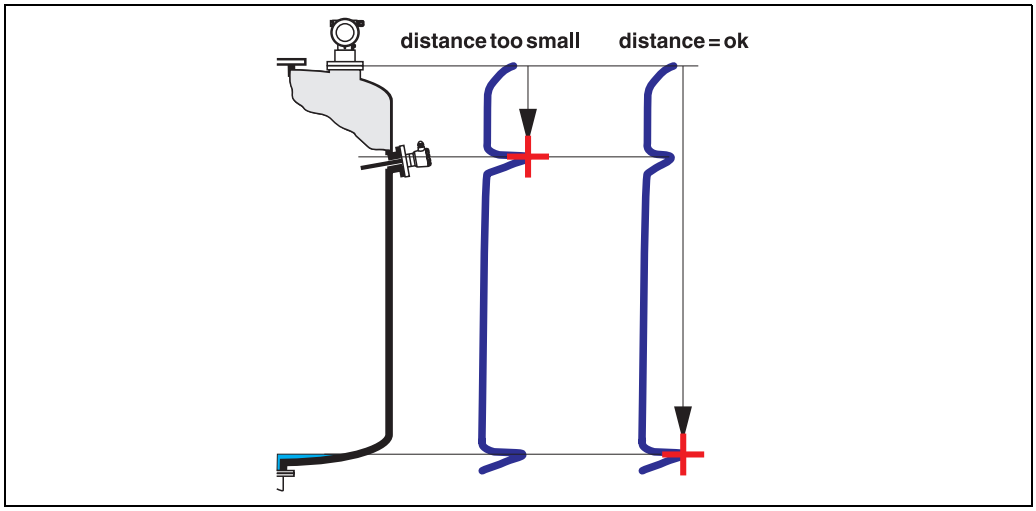
6.2.3 Interference echo suppression (tank mapping)

Function "dist./measured value" (008)

In the **"dist./meas.value" (008)** function, the measured distance D from the sensor membrane to the product surface is displayed together with level L. Check these values.

Function "check distance" (051)

The mapping is initialized by this function.



Select
- **"distance=ok"** if the correct distance is displayed. Any echoes closer to the sensor will be suppressed by the following interference echo suppression.
- **"dist. too small"** if the displayed distance is too small. In this case, the signal comes from an interference echo which will be suppressed.
- **"dist. too big"** if the displayed distance is too large. This error cannot be cancelled by suppressing the interference echo. This means that the following two functions are skipped. Check the application parameters **"tank shape" (002)**, **"medium proerty" (003)** and **"process cond." (004)** and the **"empty calibr."(005)** in the **"basic setup" (00)** function group.
- **"dist. unknown"** if you do not know the actual distance. This means that the following two functions are skipped.
- **"manual"** if you want to specify the suppression area yourself in the following function.

Function "range of mapping" (052)

The suggested suppression area is displayed in this function. The reference point is always the sensor membrane. You can still edit the value. With manual suppression, the default value is 0 m.

Caution!
The suppression range must end 0.5 m in front of the echo of the actual level. With an empty tank, do not enter E but E – 0.5 m.

Function "start mapping" (053)

You have the following options for this function:
- **off**: Nothing is suppressed.
- **on**: Starts suppression.

Note!
If a mapping already exists, it will be overwritten up to the distance specified in the **"range of mapping" (052)** function. Beyond this distance the existing mapping remains unchanged.

Function dist./measured value (008)

After suppression, the measured distance D from the sensor membrane to the product surface is displayed together with the level. Check that the values correspond to the actual level and/or the actual distance.

The following cases may occur:
- Distance correct – Level correct -> End of basic calibration
- Distance incorrect – Level incorrect -> An additional interference echo suppression must be carried out. Go back to the **"check distance" (051)** function.
- Distance correct – Level incorrect -> Check the value of the **"empty calibr." (005)** function.

Rücksprung zur Gruppenauswahl

Nach der Störechoausblendung ist der Grundabgleich beendet und das Gerät springt automatisch in die Gruppenauswahl zurück.

6.3 Envelope curve

After the basic setup, an evaluation of the measurement with the aid of the envelope curve ("**envelope curve**" **(0E)** function group) is recommended.

6.3.1 Funxtion "plot settings" (0E1)

In this function, select whether you want to display
- just the envelope curve
- The envelope curve and the echo evaluation line FAC
- The envelope curve and interference echo suppression (map)

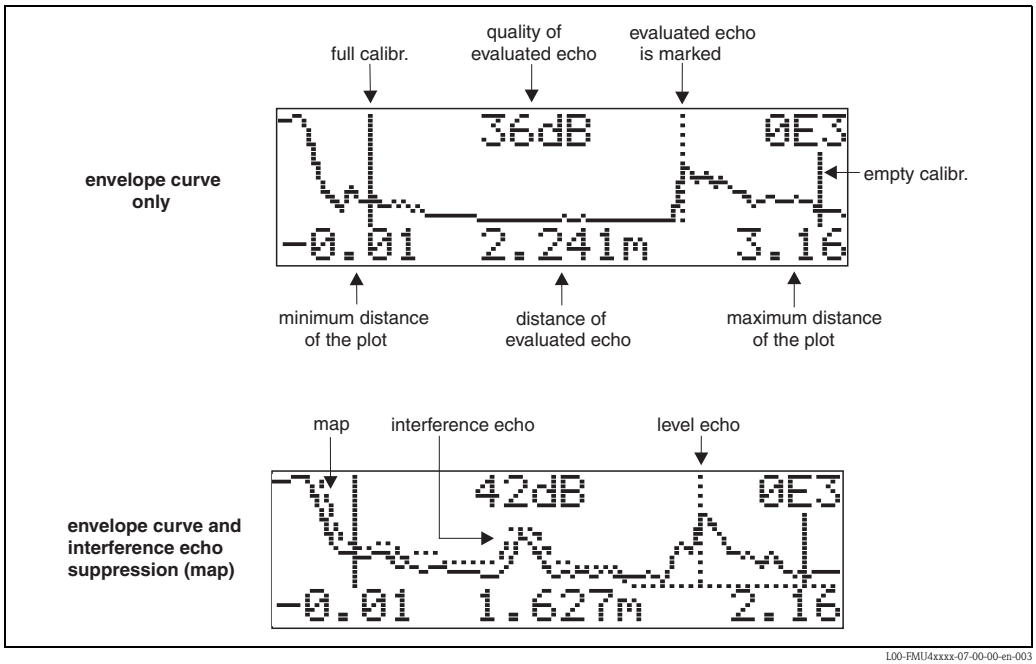
Note!
The FAC and the interference echo suppression (map) are explained in BA 240F "Prosonic M – Description of Instrument Functions"

6.3.2 Function "recording curve" (0E2)

In this function, specify whether you want to display
- an individual envelope curve
- The current envelope curve, with cyclical refreshment.

6.3.3 Function "envelope curve display" (0E3)

The envelope curve is displayed in this function. You can use it to obtain the following information:

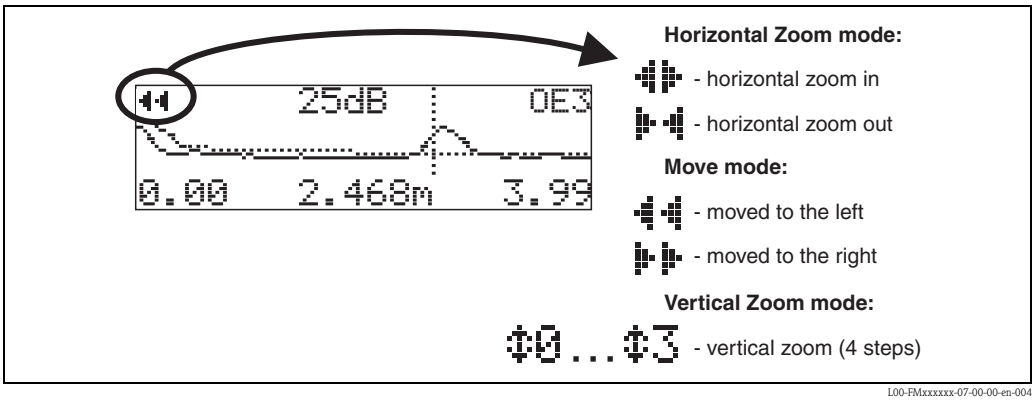


Check that the following conditions are fulfilled:
- The echo quality at the end of measuring range should be at least 10dB.
- There should be practically no interference echoes in front of the level signal.
- If interference echoes cannot be avoided, they must be below the suppression curve.

Note!
If the cyclical envelope curve display is still active on the display, the measured value is updated at a slower cycle time. We therefore advise you to exit the envelope curve display after optimising the measuring point. To do this, press E. (The instrument does not leave the envelope curve display automatically.)

6.3.4 Navigation in the envelope curve display

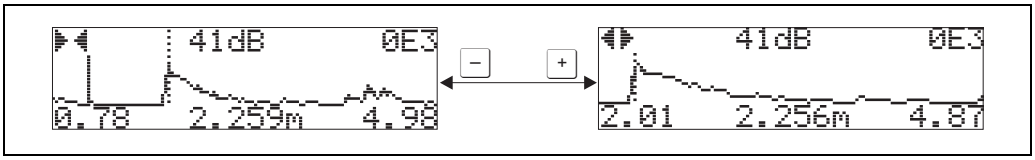
Using navigation, the envelope curve can be scaled horizontally and vertically and shifted to the left or the right. The active navigation mode is indicated by a symbol in the top left hand corner of the display.



L00-FMxxxxxx-07-00-00-en-004

Horizontal Zoom mode

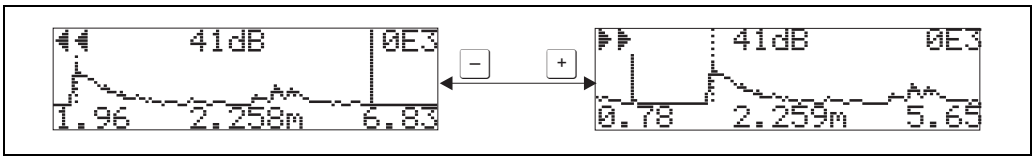
Firstly, go into the envelope curve display. Then press + or − to switch to the envelope curve navigation. You are then in Horizontal Zoom mode. Either ◂▸ or ▸◂ is displayed.
- + increases the horizontal scale.
- − reduces the horizontal scale.



L00-FMxxxxxx-07-00-00-yy-007

Move mode

Then press E to switch to Move mode. Either ▸▸ or ◂◂ is displayed.
- + shifts the curve to the right.
- − shifts the curve to the left.

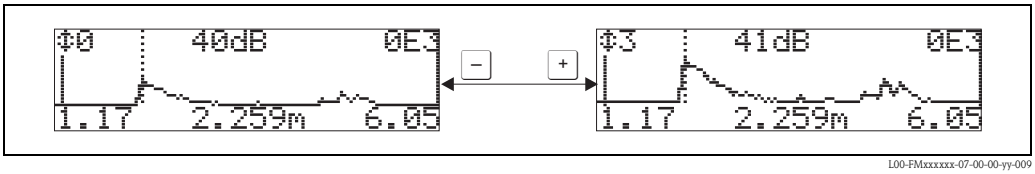


L00-FMxxxxxx-07-00-00-yy-008

Vertical Zoom mode

Press E once more to switch to Vertical Zoom mode. ⇕1 is displayed. You now have the following options.
- + increases the vertical scale.
- − reduces the vertical scale.

The display icon shows the current zoom factor (⇕0 to ⇕3).



L00-FMxxxxxx-07-00-00-yy-009

Exiting the navigation

- Press [E] again to run through the different modes of the envelope curve navigation.
- Press [+] and [–] to exit the navigation. The set increases and shifts are retained. Only when you reactivate the "**recording curve**" **(0E2)** function the display settings return to their standard values.

7 Troubleshooting

7.1 System error messages

7.1.1 Current error

Errors which the Prosonic M detects during commissioning or operation are displayed:

- In the **"measured value" (000)** function
- In the **"diagnostics" (0A)** function group in the **"present error" (0A0)** function
  Only the highest priority error is displayed; in the case of multiple errors, you can scroll between the different error messages by pressing ⊞ or ⊟.
- by the status of the main value

7.1.2 Last error

The last error is displayed in the **"diagnostics" (0A)** function group in the **"previous error" (0A1)** function. This display can be deleted in the **"clear last error" (0A2)** function.

7.1.3 Types of error

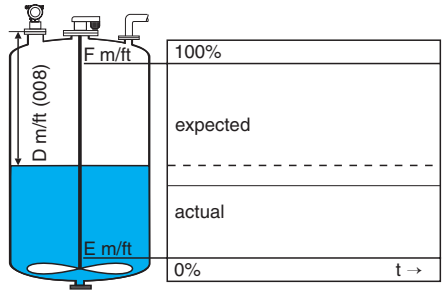
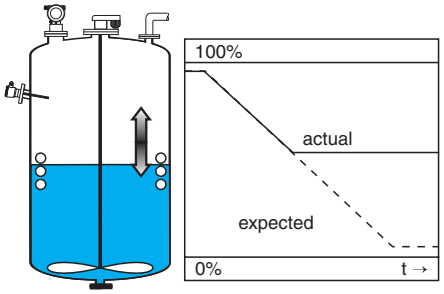
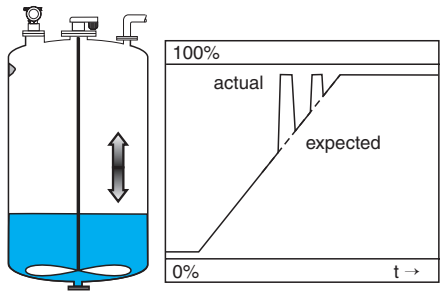
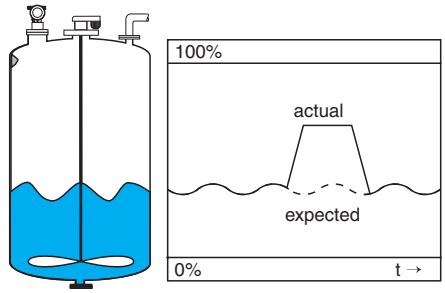
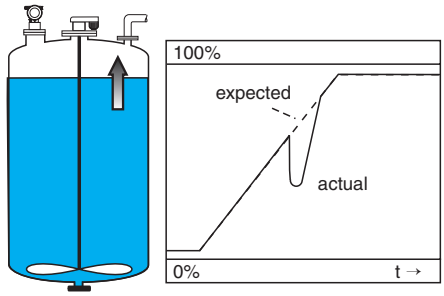
Type of error	Symbol	Meaning
Alarm (A)	 continuous	The output signal assumes a value which can be set using the **"output on alarm" (010)** function: ■ MAX: 110% ■ MIN: -10% ■ Hold: last value is on hold ■ User-specific value
Warning (W)	 flashing	The device continues measurement. An error message is displayed.
Alarm/Warning (E)	You can define whether the error should behave as an alarm or as a warning.	

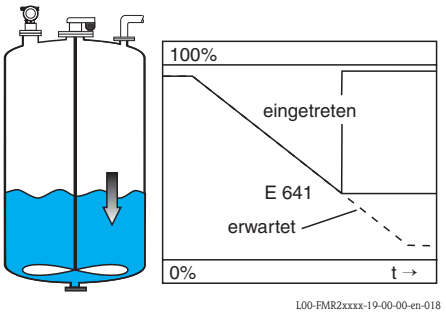
7.1.4 Error codes

Code	Error description	Action
A102 A110 A152 A160	checksum error	Reset; If alarm still present after reset, replace electronics
W103	initialising	If the message does not disappear after several seconds, replace the electronics
A106	downloading	Wait; Message disappears after load sequence
A111 A113 A114 A115 A121 A125 A155 A164 A171	electronics defect	Reset; Check system for EMC, improve as necessary If alarm still present after reset, replace electronics
A116	download error	Check connection; Restart download
W153	initialising	Wait a few seconds; if error is still displayed, switch the power off and on again
A231	sensor defect	Check connection, if necessary replace HF module or electronics

Code	Error description	Action
A281	interruption temperature sensor	Exchange sensor
A502	Sensor type not detected	Exchange sensor and/or electronics
A512	recording of mapping	Alarm disappears after a few seconds
A521	new sensor type detected	Reset
W601	linearisation curve not monotone	Correct table (enter monotonously increasing table)
W611	less than 2 linea-risation points	Enter additional value pairs
W621	simulation on	Switch simulation mode off [**"output" (06)** function group, **"simulation" (065)** function]]
E641	no usable echo	Check basic calibration
E651	level in safety distance - risk of overspill	Error disappears when the level leaves the safety distance. Possibly reset the lock. [**"safety settings" (01)** function group, **"ackn. alarm" (017)** function]]
A661	Sensor overtemperature	
A671	Linearisation incomplete	Activate linearisation table
W681	current out of range	Carry out basic calibration; check linearisation
W691	Filling noise detected, level ramp is active	

7.2 Application errors

Error	Example	Elimination
Measured value (00) is incorrect but measured distance (008) is correct	 L00-FMR2xxxx-19-00-00-en-019	1. Check empty calibration (005) and full calibration (006). 2. Check linearisation – level/ullage (040) – max. scale(046) – diameter vessel(047) – linearisation table
Measured value (000) and measured distance (008) are incorrect		1. For measurements in bypass or stilling well: Select the according option in the **"tank shape" (002)** function. 2. Carry out interference echo suppression.
No change in measured value on filling/ emptying	 L00-FMR2xxxx-19-00-00-en-014	1. Carry out interference echo suppression. 2. Clean sensor if necessary 3. If necessary, select better installation position 4. If necessary due to wide interference echoes, set function "detection window" (0A7) to "off".
With an uneven surface (e.g. filling, emptying, running agitator) the measured value may jump sporadically to higher levels	 L00-FMR2xxxx-19-00-00-en-015  L00-FMR2xxxx-19-00-00-en-016	1. Carry out interference echo suppression 2. Set the process cond. (004) to "calm surface" or "add. agitator" 3. Increase output damping (058). 4. If necessary, select a different installation position and/or a larger sensor
On filling/emptying the measured value drops	 L00-FMR2xxxx-19-00-00-en-017	1. Check tank shape (002), e.g. "dome ceiling" or "horizontal cyl." 2. If possible, do not select a central installation position 3. Possible user stilling well/echo guide pipe

Error	Example	Elimination
E 641 (echo loss)		1. Check application parameters (002), (003) and (004) 2. If necessary, select a different installation position and/or a larger sensor 3. Align the sensor parallel to the product surface (particularly for bulk solids applications)

8 Maintenance and repairs

8.1 Exterior cleaning

When cleaning the exterior, always use cleaning agents that do not attack the surface of the housing and the seals.

8.2 Repairs

The Endress+Hauser repair concept assumes that the measuring devices have a modular design and that customers are able to undertake repairs themselves.
Spare parts are contained in suitable kits. They contain the related replacement instructions.
All the spare parts kits which you can order from Endress+Hauser for repairs are listed with their order numbers in the section "Spare parts".
For more information on service and spare parts, contact the Service Department at Endress+Hauser.

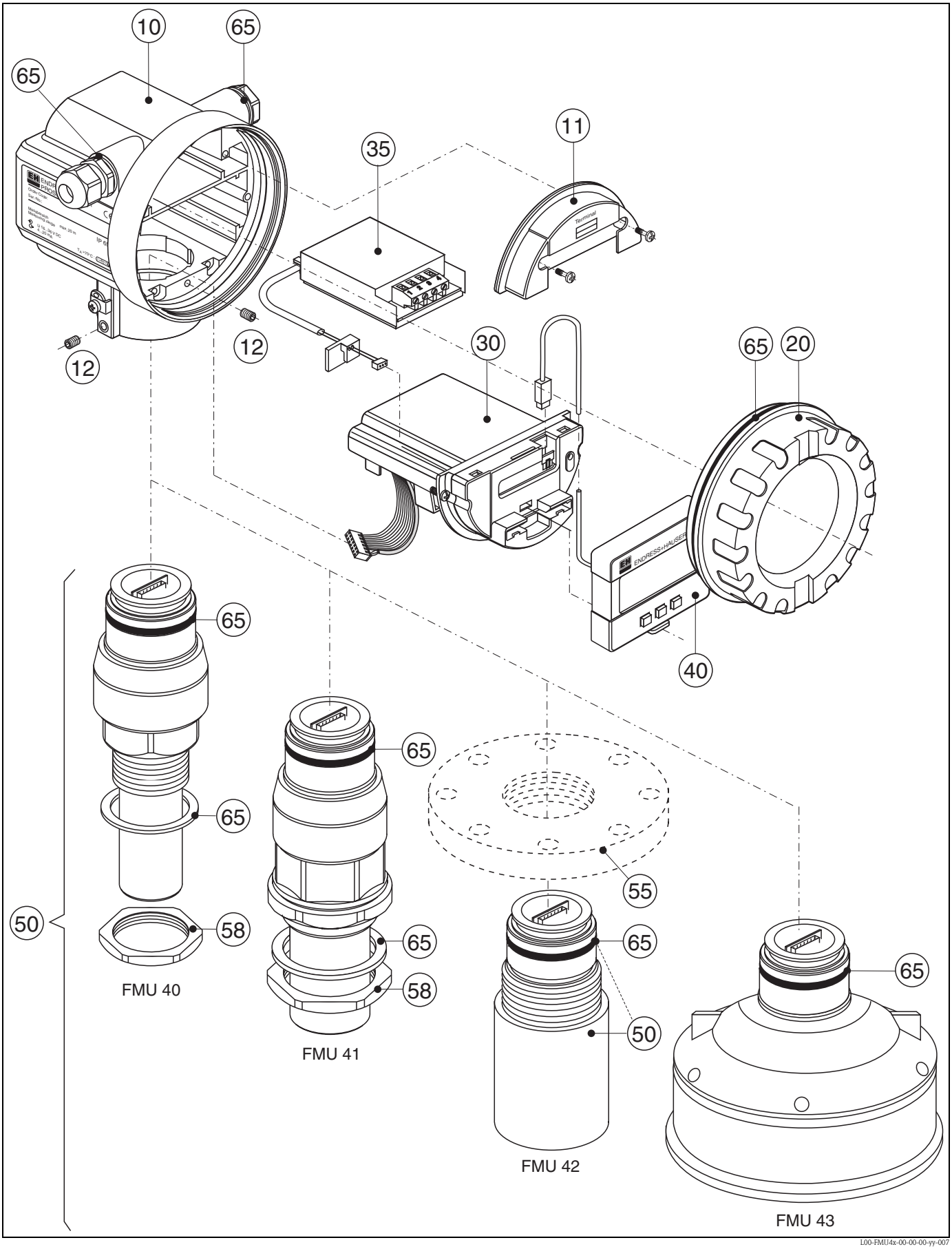
8.3 Repairs to Ex-approved devices

When carrying out repairs to Ex-approved devices, please note the following:
- Repairs to Ex-approved devices may only be carried out by trained personnel or by the Endress+Hauser Service.
- Comply with the prevailing standards, national Ex-area regulations, safety instructions (XA) and certificates.
- Only use original spare parts from Endress+Hauser.
- When ordering a spare part, please note the device designation on the nameplate. Only replace parts with identical parts.
- Carry out repairs according to the instructions. On completion of repairs, carry our the specified routine test on the device.
- Only Endress+Hauser Service may convert a certified device into a different certified variant.
- Document all repair work and conversions.

8.4 Replacement

After a complete instrument or electronic module has been replaced, the parameters can be downloaded into the instrument again via the communication interface. Prerequisite to this is that the data were uploaded to the PC beforehand using the ToF Tool / Commuwin II. Measurement can continue without having to carry out a new setup. Only a linearisation and a tank map (interference echo suppression) have to be recorded again.

8.5 Spare parts (housing type F12)



10 Housing

543120-0022 Housing F12, aluminium, G1/2

543120-0023 Housing F12, aluminium, NPT1/2

543120-0024 Housing F12, aluminium, M20

52001992 Housing F12, aluminium, M20, PA connector

52008556 Housing F12, aluminium, M20, FF connector

52013350 Housing F12, aluminium, coated, M20, 4-wire

52013351 Housing F12, aluminium, coated, M20, metal

52013348 Housing F12, aluminium, coated, G1/2, 4-wire

52013349 Housing F12, aluminium, coated, NPT1/2, 4-wire

11 Hood for terminal compartment

52006026 Cover for the connection compartment F12

52019062 Cover for the connection compartment F12, FHX40

12 Set of screws

535720-9020 Set of screws for housing F12/T12

20 Cover

52005936 Cover F12/T12 aluminium, inspection glass, seal

517391-0011 Cover F12/T12 aluminium, coated, seal

30 Electronics

71025600 electronics FMU4x, Ex, 2-wire HART, V4.0

71025602 electronics FMU4x, Ex, 4-wire HART, V4.0

71025603 electronics FMU4x, Ex, PROFIBUS PA, V4.0

52023759 Electronics Prosonic M, Ex, FF, V2.04

35 Terminal module / power unit

52006197 Terminal module 4-pin, HART, 2-wire with connecting cable

52012156 Terminal module 4-pin, PROFIBUS PA, Foundation Fieldbus

52013304 Power unit, 10.5...32V DC (housing F12) for electronics, 4-wire

52013305 Power unit, 90 ...250V AC (housing F12) for electronics, 4-wire

52015585 Power unit, CSA, 10.5...32V DC (housing F12) for electronics, 4-wire

52015586 Power unit, CSA, 90...250V AC (housing F12) for electronics, 4-wire

40 Display

52005585 Display/operating module VU331

50 Probe with process connection

52010509 Sensor FMU40 G1-1/2

52010507 Sensor FMU40 NPT1-1/2

52010510 Sensor FMU41 G2

52010508 Sensor FMU41 NPT2

52023965 Sensor FMU42

52013543 Sensor FMU43 4", gasket

55 Flanges

52023919 Flange, Uni-DN80/ANSI 3"/JIS 80A, PP

52023920 Flange, Uni-DN80/ANSI 3"/JIS 80A, PVDF

52023921 Flange, Uni-DN80/ANSI 3"/JIS 80A, 316L

52023922 Flange, Uni-DN100/ANSI 4"/JIS 100A, PP

52023923 Flange, Uni-DN100/ANSI 4"/JIS 100A, PVDF

58 Hexagon nut

52000599 Hexagon nut (SW60) G1-1/2, bk, PC

52000598 Hexagon nut (SW70) G2, bk, PC

65 Sealing kit

52010526 Sealing kit FMU4x

Miscellaneous

52010545 Nameplate Prosonic M, modification

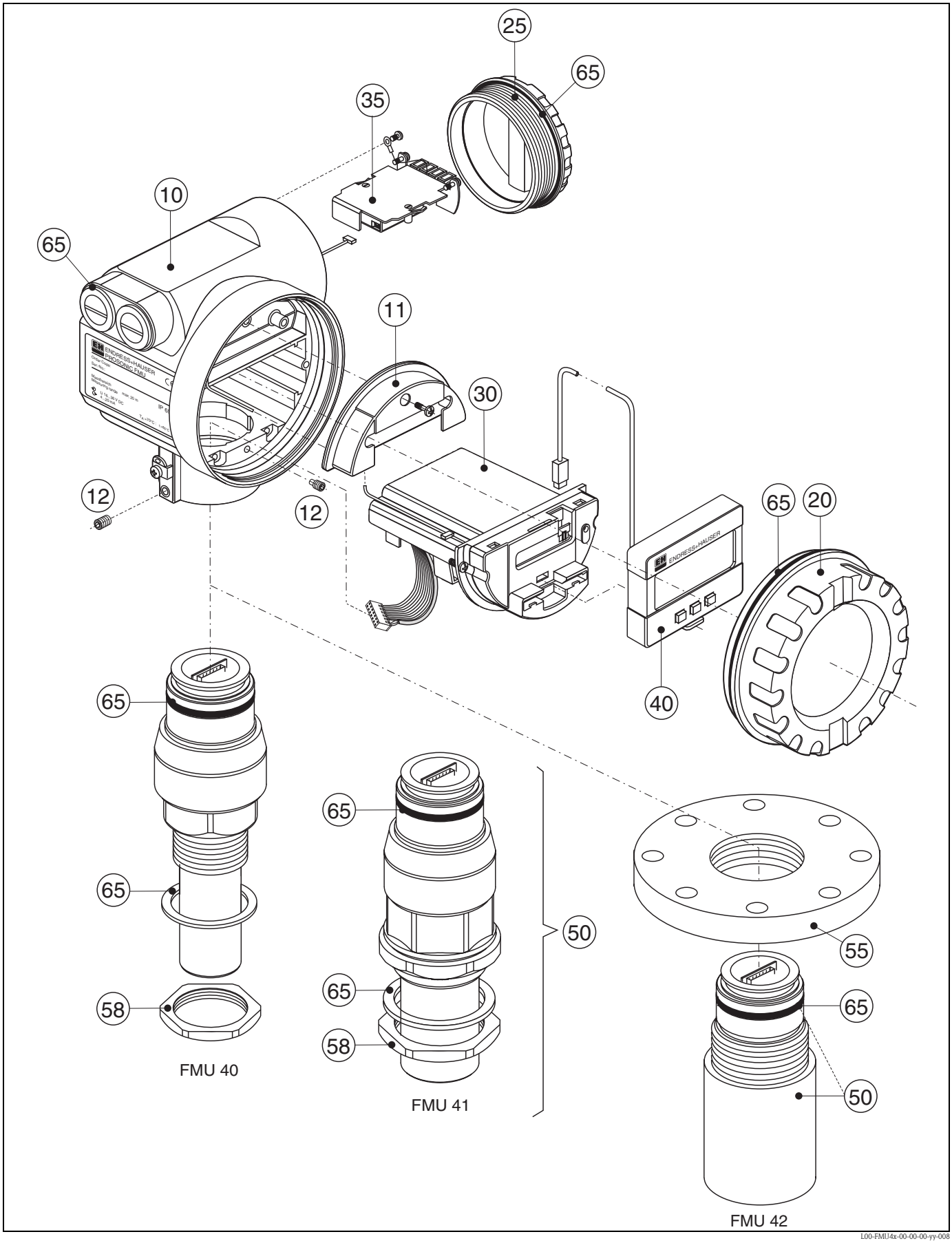
Spare parts for FHX40

52018204 Adaption kit housing F12, 2-wire, FHX40

52018205 Adaption kit housing F12, 4-wire, FHX40

52016334 Cable FHX40, 20m

8.6 Spare parts (housing type T12)



10 Housing

543180-1023 Housing T12, aluminium, NPT1/2, PEL

52006204 Housing T12, aluminium, G1/2, PEL, cover

52006205 Housing T12, aluminium, M20, PEL, cover

11 Hood for terminal compartment

52005643 Hood T12

12 Set of screws

535720-9020 Set of screws for housing F12/T12

20 Cover

517391-0011 Cover F12/T12 aluminium, coated, seal

52005936 Cover F12/T12 aluminium, inspection glass, seal

25 Cover for the connection compartment

518710-0020 Cover T3/T12, aluminium, coated, seal

30 Electronics

71025600 electronics FMU4x, Ex, 2-wire HART, V4.0

71025603 electronics FMU4x, Ex, PROFIBUS PA, V4.0

52023759 Electronics Prosonic M, Ex, FF, V2.04

35 Terminal module / power unit

52013302 Terminal module Ex d, 4-pin, 2-wire, HART, T12

52013303 Terminal module Ex d, 2-pin, 2-wire, PROFIBUS PA, Foundation Fieldbus, T12

52018949 Terminal module EEx ia, 4-pin, HART, T12, OVP

52018950 Terminal module EEx ia, 4-pin, PROFIBUS PA, Foundation Fieldbus, T12, OVP

40 Display

52005585 Display/operating module VU331

50 Probe with process connection

52010509 Sensor FMU40 G1-1/2

52010507 Sensor FMU40 NPT1-1/2

52010510 Sensor FMU41 G2

52010508 Sensor FMU41 NPT2

52023965 Sensor FMU42

55 Flanges

52023919 Flange, Uni-DN80/ANSI 3"/JIS 80A, PP

52023920 Flange, Uni-DN80/ANSI 3"/JIS 80A, PVDF

52023921 Flange, Uni-DN80/ANSI 3"/JIS 80A, 316L

52023922 Flange, Uni-DN100/ANSI 4"/JIS 100A, PP

52023923 Flange, Uni-DN100/ANSI 4"/JIS 100A, PVDF

52023924 Flange, Uni-DN100/ANSI 4"/JIS 100A, 316L

58 Hexagon nut

52000598 Hexagon nut (SW70) G2, bk, PC

52000599 Hexagon nut (SW60) G1-1/2, bk, PC

65 Sealing kit

52010526 Sealing kit FMU4x

Miscellaneous

52010545 Nameplate Prosonic M, modification

8.7 Return

The following procedures must be carried out before a transmitter is sent to Endress+Hauser e.g. for repair or calibration:
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- Always enclose a duly completed "Declaration of contamination" form (a copy of the “Declaration of contamination” is included at the end of this operating manual). Only then can Endress +Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/ 155/EEC.

Additionally specify:
- An exact description of the application.
- The chemical and physical characteristics of the product.
- A short description of the error that occurred (specify error code if possible)
- Operating time of the device.

8.8 Disposal

In case of disposal please seperate the different components according to their material consistence.

8.9 Software history

Software version / date	Changes to software	Changes to documentation
V 01.02.00 / 01.2002 V 01.02.02 / 03.2003	Original software Compatible with: ■ ToF Tool ■ Commuwin II (version 2.05.03 and higher ■ HART Communicator DXR 275 (from OS 4.6) with Rev. 1, DD 1	
V 01.02.04/02.2004	■ FMU 42 added ■ compatible with HART Communicator DXR 375	FMU 42 added
V 01.04.00/07.2006	■ "detection window" function added can be operated via: ■ ToF Tool from version 4.50 ■ HART Communicator DXR375 with Rev. 1, DD1	"detection window" added Version: 07.06

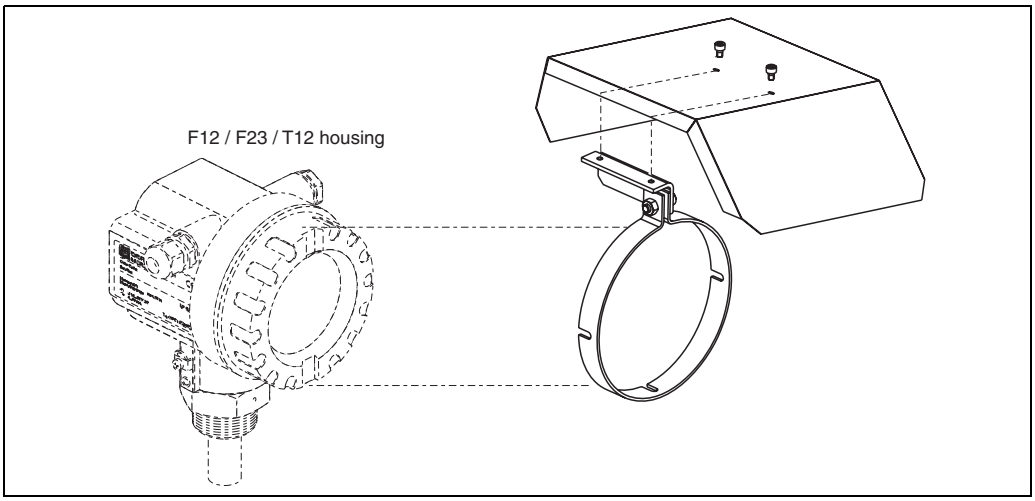
8.10 Contact addresses of Endress+Hauser

Contact addresses can be found on our homepage: www.endress.com/worldwide. If you have any questions, please do not hesitate to contact your Endress+Hauser representative.

9 Accessories

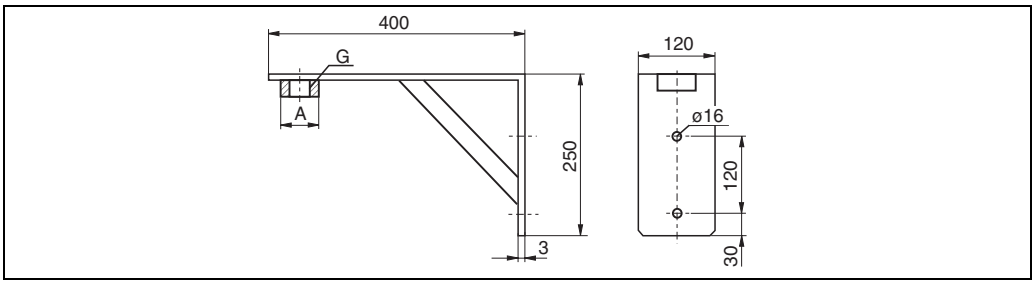
9.1 Weather protection cover

A Weather protection cover made of stainless steel is recommended for outdoor mounting (order code: 543199-0001). The shipment includes the protective cover and tension clamp.



L00-FMR2xxxx-00-00-06-en-001

9.2 Installation bracket for FMU 40/41

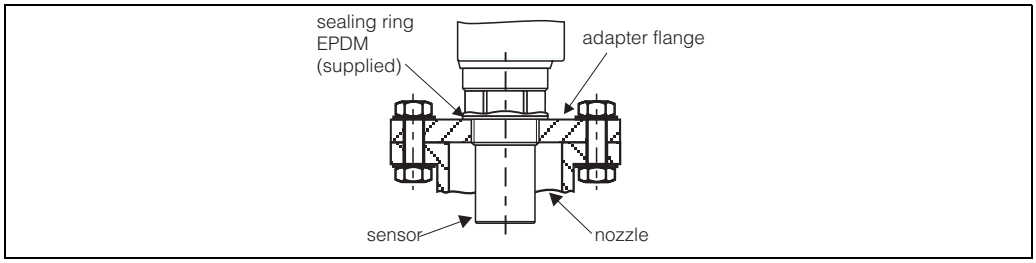


L00-FMU4x-00-00-00-de-001

- for FMU 40, G1½: Order No. 942669-0000
- for FMU 41, G2: Order No. 942669-0001

suited for NPT 1½" and 2" as well

9.3 Adapter flange



L00-FMUX3XXX-00-00-00-en-001

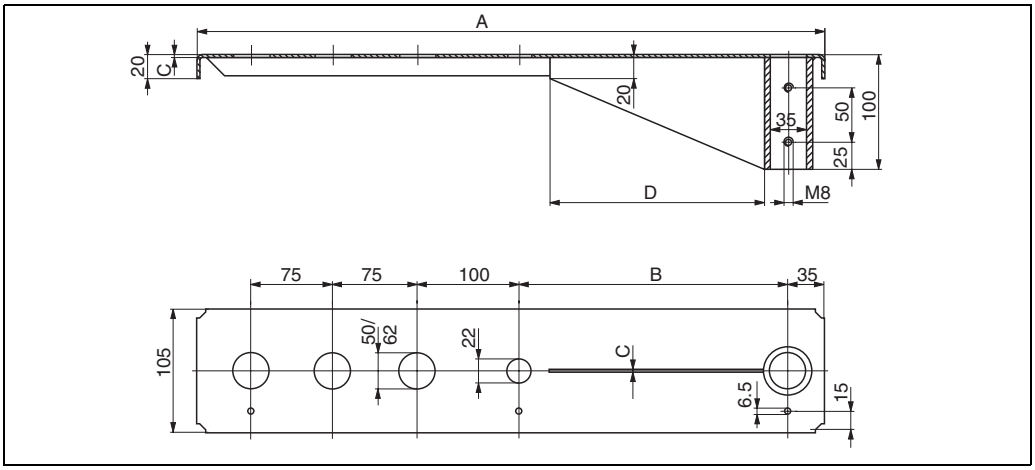
9.3.1 Version with metrical thread (FAU 70 E)

	Process Connection				
	12	DN 50 PN 16 A, flange EN1092-1 (DIN2527 B)			
	14	DN 80 PN 16 A, flange EN1092-1 (DIN2527 B)			
	15	DN 100 PN 16, A, flange EN1092-1 (DIN2527 B)			
		Sensor Connection			
		3	Thread ISO228 G1-1/2		
		4	Thread ISO228 G2		
			Flange Material		
			2	316L	
			7	Polypropylene	
FAU 70 E					Product designation

9.3.2 Version with conical thread(FAU 70 A)

	Process Connection				
	22	2" 150lbs FF, flange ANSI B16.5			
	24	3" 150lbs FF, flange ANSI B16.5			
	25	4" 150lbs FF, flange ANSI B16.5			
		Sensor Connection			
		5	Thread NPT1-1/2		
		6	Thread NPT2		
			Flange Material		
			2	316L	
			7	Polypropylene	
FAU 70 A					Product designation

9.4 Cantilever

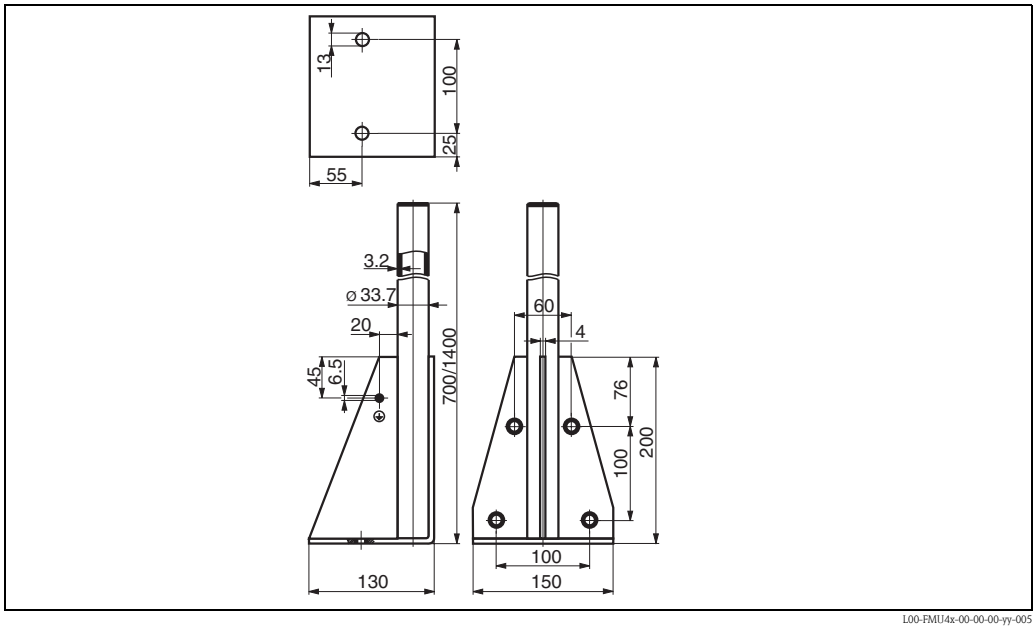


L00-FMU4xxxx-06-00-00-yy-005

A	B	C	D	for Sensor	Material	Order Code
585 mm	250 mm	2 mm	200 mm	FMU 40	1.4301 (AISI 304)	52014132
					galv. steel	52014131
				FMU 41	1.4301 (AISI 304)	52014136
					galv. steel	52014135
1085 mm	750 mm	3 mm	300 mm	FMU 40	1.4301 (AISI 304)	52014134
					galv. steel	52014133
				FMU 41	1.4301 (AISI 304)	52014138
					galv. steel	52014137

- The 50 mm or 62 mm orifices serve for the mounting of the FMU 40 or FMU 41 sensor, respecitvely.
- The 22 mm orifice may be used for an additional sensor.

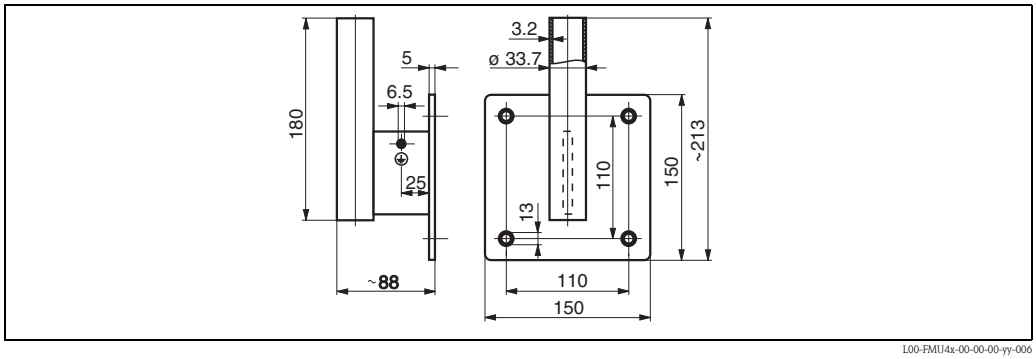
9.5 Mounting Frame



L00-FMU4x-00-00-00-yy-005

Height	Material	Order Code
700 mm	galv. steel	919791-0000
700 mm	1.4301 (AISI 304)	919791-0001
1400 mm	galv. steel	919791-0002
1400 mm	1.4301 (AISI 304)	919791-0003

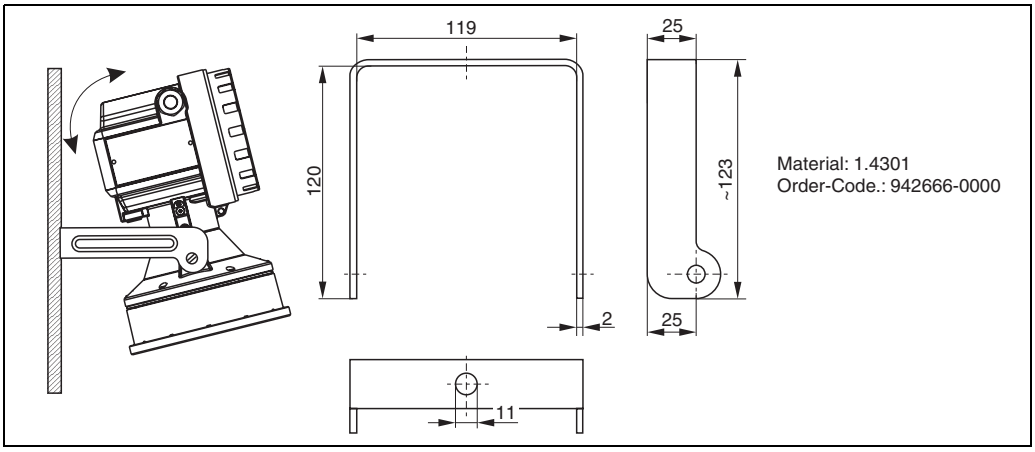
9.6 Wall Bracket



L00-FMU4x-00-00-00-yy-006

Material	Order Code
galv. steel	919792-0000
316Ti/1.4571	919792-0001

9.7 Mounting bracket for FMU 43



9.8 Commubox FXA291

The Commubox FXA291 connects Endress+Hauser field instruments with CDI interface (= Endress+Hauser Common Data Interface) to the USB interface of a personal computer or a notebook. For details refer to TI405C/07/en.

Note!
For the following Endress+Hauser instruments you need the "ToF Adapter FXA291" as an additional accessory:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70
- Gammapilot M FMG60
- Levelflex M FMP4x
- Micropilot FMR130/FMR131
- Micropilot M FMR2xx
- Micropilot S FMR53x, FMR540
- Prosonic FMU860/861/862
- Prosonic M FMU4x
- Tank Side Monitor NRF590 (with additional adapter cable)

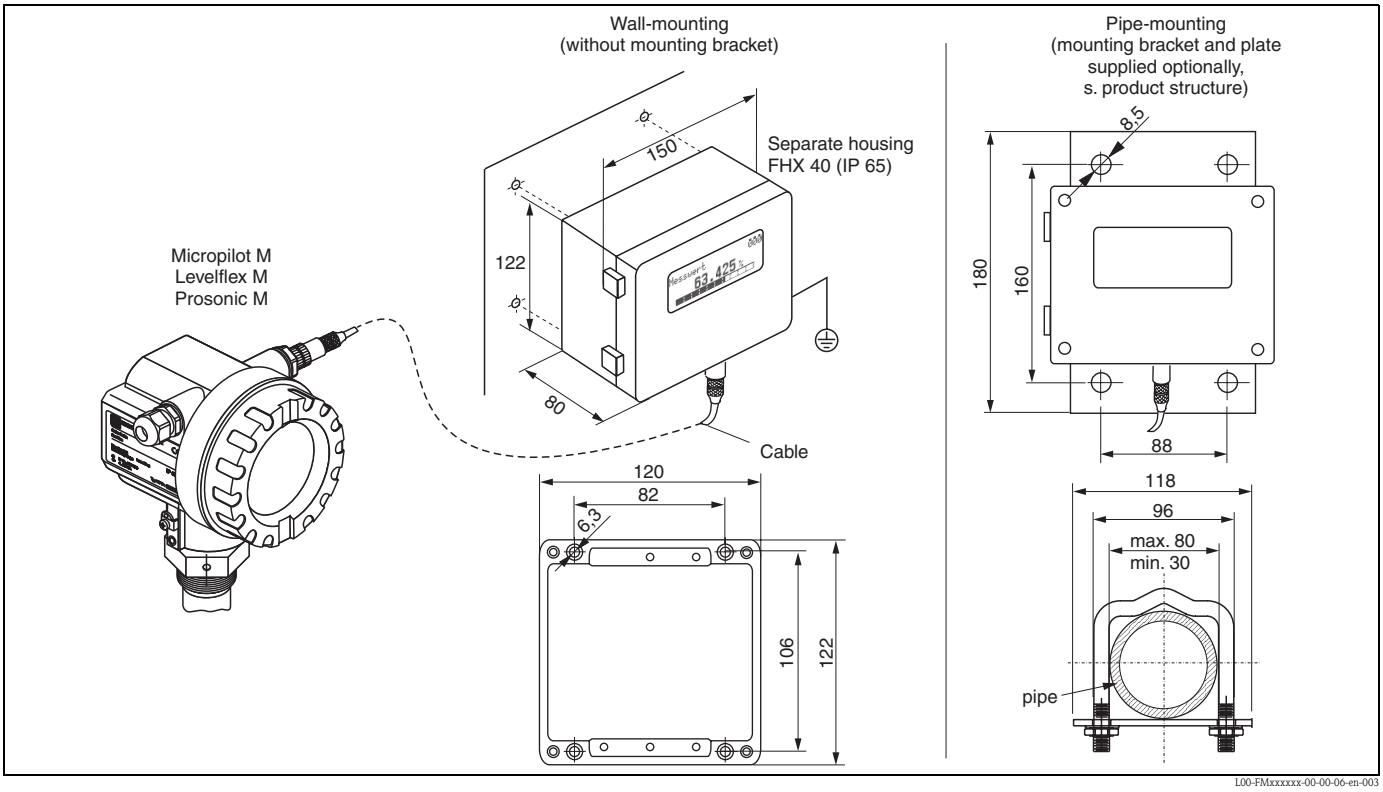
9.9 ToF Adapter FXA291

The ToF Adapter FXA291 connects the Commubox FXA291 via the USB interface of a personal computer or a notebook to the following Endress+Hauser instruments:

- Cerabar S PMC71, PMP7x
- Deltabar S PMD7x, FMD7x
- Deltapilot S FMB70
- Gammapilot M FMG60
- Levelflex M FMP4x
- Micropilot FMR130/FMR131
- Micropilot M FMR2xx
- Micropilot S FMR53x, FMR540
- Prosonic FMU860/861/862
- Prosonic M FMU4x
- Tank Side Monitor NRF590 (with additional adapter cable)

For details refer to KA271F/00/a2.

9.10 Remote display FHX40



9.10.1 Technical data (cable and housing) and product structure:

Max. cable length	20 m (65 ft)
Temperature range	-30 °C...+70 °C (-22 °F...158 °F)
Degree of protection	IP65 acc. to EN 60529 (NEMA 4)
Materials	Housing: AlSi12; cable glands: nickle plated brass
Dimensions [mm] / [inch]	122x150x80 (HxWxD) / 4.8x5.9x3.2

	Approval:			
	A			Nn-hazardous area
	1			ATEX II 2 G EEx ia IIC T6, ATEX II 3D
	S			FM IS Cl.I Div.1 Gr.A-D
	U			CSA IS Cl.I Div.1 Gr.A-D
	N			CSA General Purpose
	K			TIIS ia IIC T6 (in preparation)
		Cable:		
		1		20m/65ft; for HART
		5		20m/65ft; for PROFIBUS PA/FOUNDATION Fieldbus
			Additional option:	
			A	Basic version
			B	Mounting bracket, pipe 1"/ 2"
FHX40 -				Complete product designation

For connection of the remote display FHX40 use the cable which fits the communication version of the respective instrument.

10 Technical Data

10.1 Technical data at a glance

10.1.1 Input

Measured variable

The distance D between the sensor membrane and the product surface is measured.

Using the linearisation function, the device uses D to calculate:
- level L in any units
- volume V in any units
- flow Q across measuring weirs or open channels in any units

Maximum range/blocking distance

Sensor	Maximum range in liquids[1]	Maximum range in solids[1]	blocking distance
FMU 40	5 m	2 m	0,25 m
FMU 41	8 m	3,5 m	0,35 m
FMU 42	10 m	5 m	0,4 m
FMU 43	15 m	7 m	0,6 m

[1]The actual range is dependent on the measuring conditions. Refer to Technical Information TI 365F/00/en for an estimation.

10.1.2 Output

Output signal

PROFIBUS PA

Signal on alarm

- Error symbol, error code and plain text description on the on-site display
- Status byte of the digital signal input

10.1.3 Auxiliary energy

Cable entry

- Cable gland M20x1.5 (recommended cable diameter 6 ... 10 mm)
- Cable entry G½ or ½ NPT
- PROFIBUS M12 plug

Supply voltage

9 V ... 32 V
There may be additional restrictions for devices with an explosion protection certificate. Refer to the notes in the appropriate safety instructions (XA).

Current consumption

approx. 12 mA for the range of voltages given above

10.1.4 Performance characteristics

Reaction time

The reaction time depends on the parameter settings (min. 2s).

Reference operating conditions

- Temperature = +20 °C
- Pressure = 1013 mbar abs.
- Humidity = 50 %
- Ideal reflective surface (e.g. calm, smooth fluid surface)
- No interference reflections within signal beam
- Set application parameters:
  - Tank shape = flat ceiling
  - Medium property = liquid
  - process conditions = calm surface

Measured value resolution

Sensor	Measured value resolution
FMU 40	1 mm
FMU 41	1 mm
FMU 42	2 mm
FMU 43	2 mm

Measuring error

Typical specifications for reference operating conditions (include linearity, repeatability, and hysteresis):

Sensor	Measuring error
FMU 40	±2mm or 0.2% of set measuring distance (empty calibration)[1]
FMU 41	± 2 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU 42	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]
FMU 43	± 4 mm or 0,2% of set measuring distance (empty calibration)[1]

[1] whichever is greater

10.1.5 Ambient conditions

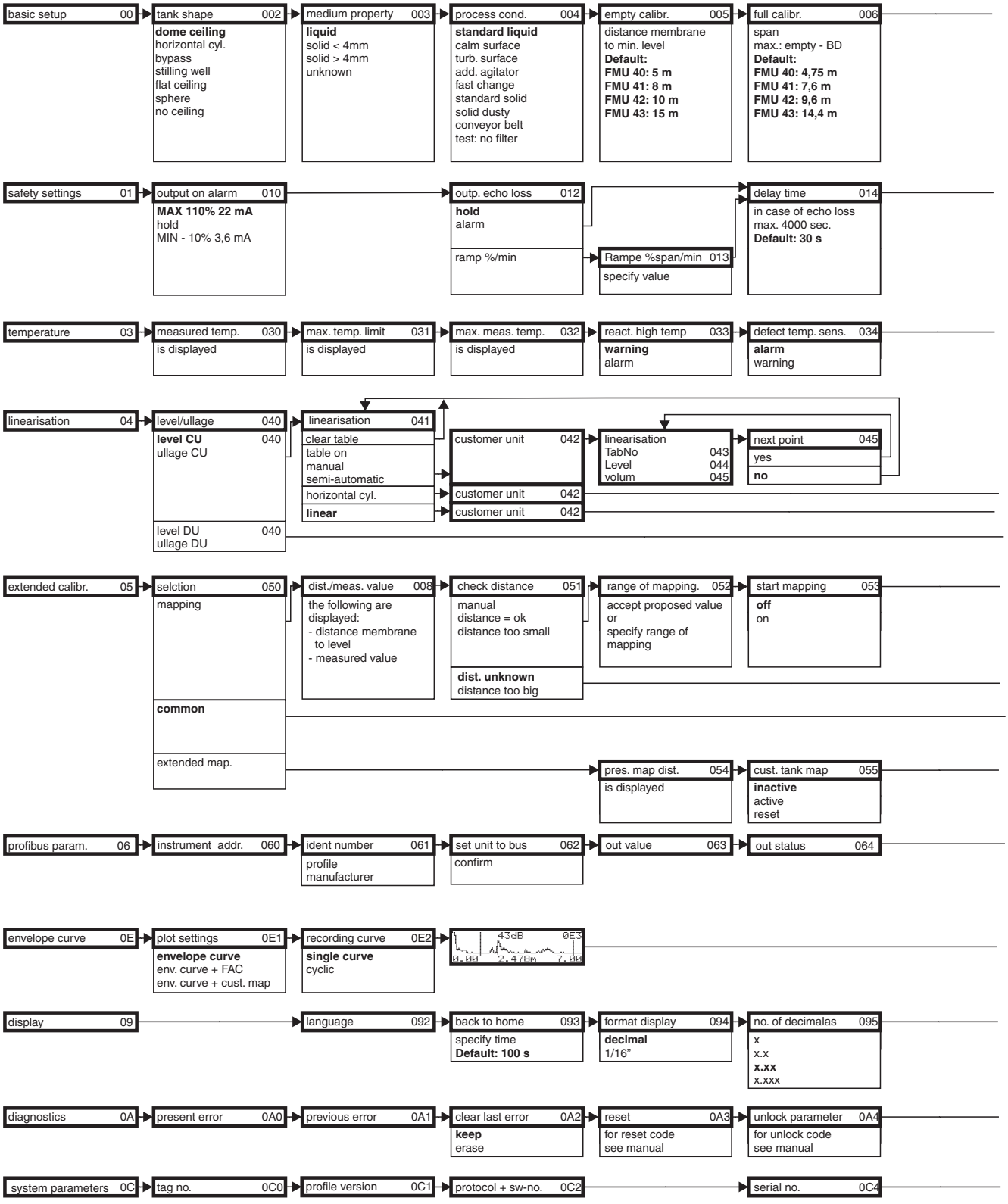
Ambient temperature	-40 °C ... +80 °C The functionality of the LC display becomes restricted at Tu<-20 °C and Tu>+60 °C. If the device is operated outdoors in strong sunlight, you should use a protective cover.
Storage temperature	-40 °C ... +80 °C
Climate class	DIN EN 60068-2-38 (Test Z/AD) DIN/IEC 68 T2-30Db
Ingress protection	■ With closed housing, tested according to – IP 68, NEMA 6P (24h at 1.83m under water surface) – IP 66, NEMA 4x ■ With open housing: IP 20, NEMA 1 (also ingress protection of the display)
Vibration resistance	DIN EN 60068-2-64 / IEC 68-2-64: 20…2000 Hz, 1 $(m/s^2)^2/Hz$; 3 x 100 min
Electromagnetic compatibility (EMC)	■ Interference emission to EN 61326, Equipment Class B ■ Interference immunity to EN 61326, Appendix A (Industrial) and NAMUR Recommendation NE 21 (EMC). ■ A standard installation cable is sufficient if only the analogue signal is used. Use a screened cable when working with a superimposed communication signal (HART).

10.1.6 Process conditions

Process temperature	-40°C ... +80°C A temperature sensor is integrated in the sensor for correction of the temperature-dependent time-of-flight.
Process pressure	■ FMU 40/41: 0.7 bar ... 3bar abs. ■ FMU 42/43: 0.7 bar ... 2.5bar abs. Note! For pressures less than 0.7 bar please contact Endress+Hauser

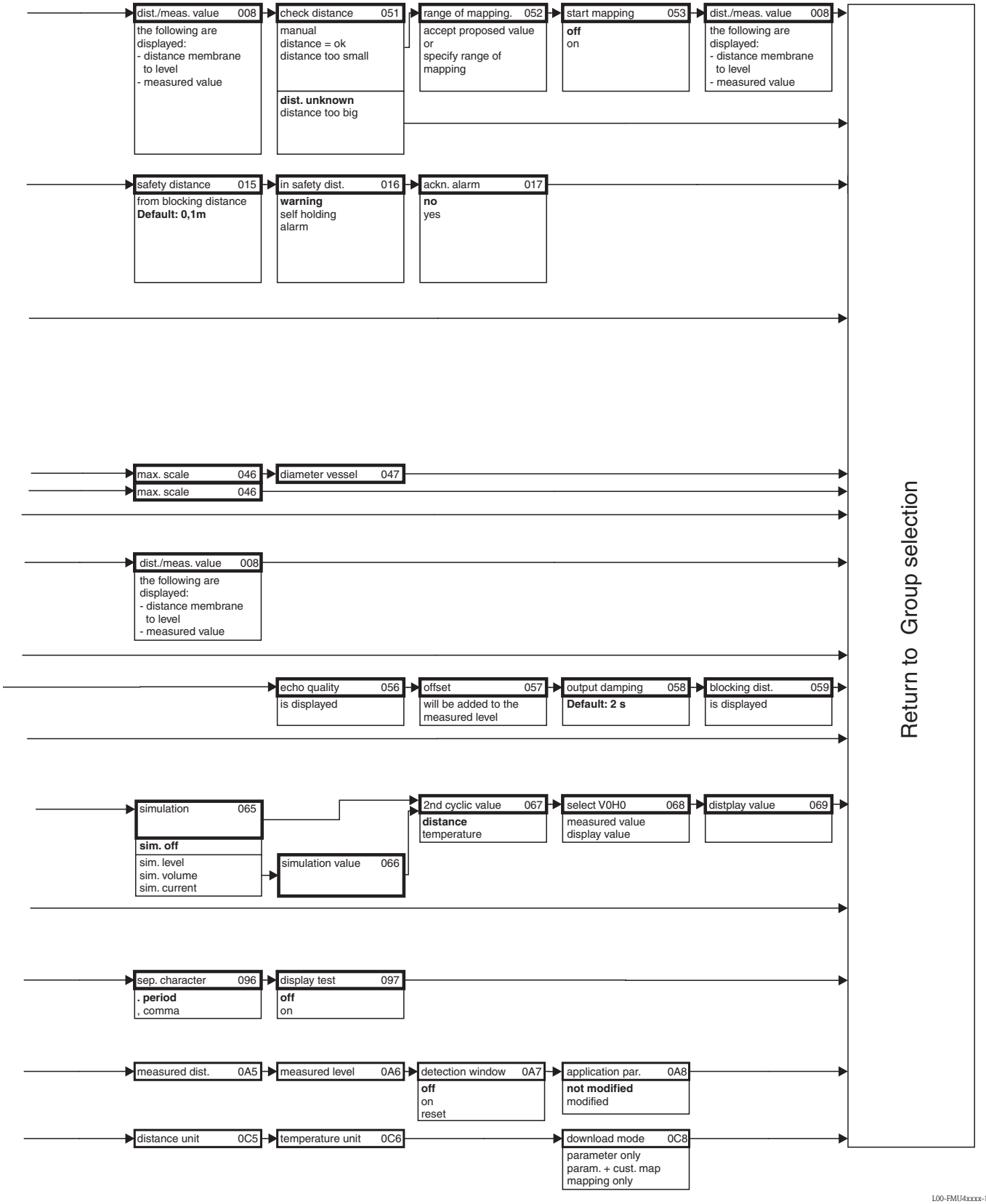
11 Appendix

11.1 Operating menu



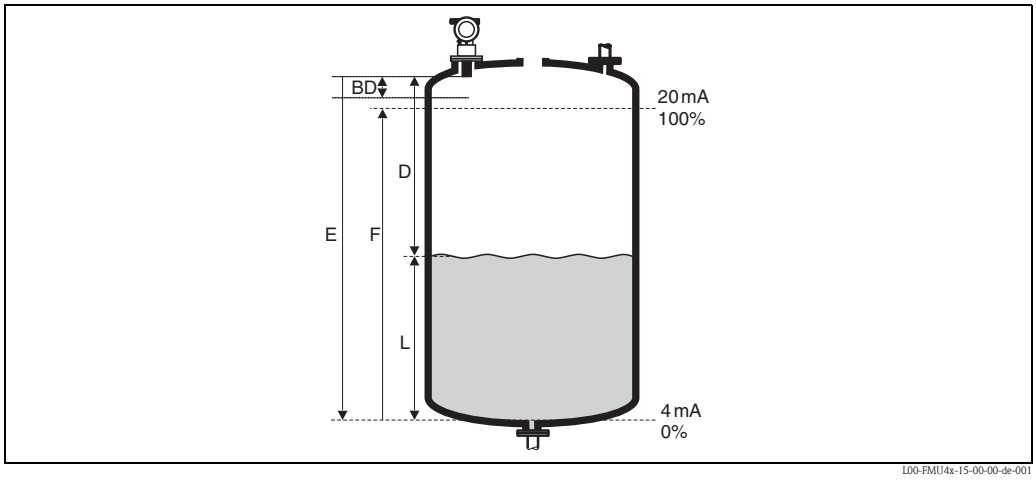
Note! The Default values of the parameters are typed in bold face.

L00-FMU4xxxx-19-00-01-en-016



L00-FMU4xxxx-19-00-02-en-016

11.2 Measuring principle



E: *Empty distance;* ***F:*** *Span (full distance);* ***D:*** *Distance from sensor membrane – product surface;* ***L:*** *Level;* ***BD:*** *Blocking distance*

Sensor	BD	Max. range fluids	Max. range bulk materials
FMU 40	0.25 m	5 m	2 m
FMU 41	0.35 m	8 m	3.5 m
FMU 42	0.4 m	10 m	5 m
FMU 43	0.6 m	15 m	7 m

11.2.1 Time-of-flight method

The sensor of the Prosonic M transmits ultrasonic pulses in the direction of the product surface. There, they are reflected back and received by the sensor. The Prosonic M measures the time t between pulse transmission and reception. The instrument uses the time t (and the velocity of sound c) to calculate the distance D between the sensor membrane and the product surface:

$D = c \cdot t/2$

As the device knows the empty distance E from a user entry, it can calculate the level as follows:

$L = E - D$

An integrated temperature sensor compensates for changes in the velocity of sound caused by temperature changes.

11.2.2 Interference echo suppression

The interference echo suppression feature on the Prosonic M ensures that interference echos (e.g. from edges, welded joints and installations) are not interpreted as a level echo.

11.2.3 Calibration

Enter the empty distance E and the span F to calibrate the device.

11.2.4 Blocking distance

Span F may not extend into the blocking distance BD. Level echos from the blocking distance cannot be evaluated due to the transient characteristics of the sensor.

Index

Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination

Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.

Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.

Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

☐ **Used as SIL device in a Safety Instrumented System /** *Einsatz als SIL Gerät in Schutzeinrichtungen*

Process data/ *Prozessdaten*

Temperature / *Temperatur* _____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

	Medium /concentration *Medium /Konzentration*	Identification CAS No.	 flammable *entzündlich*	 toxic *giftig*	 corrosive *ätzend*	 harmful/ irritant *gesundheits-schädlich/ reizend*	 other * *sonstiges**	 harmless *unbedenklich*
Process medium / *Medium im Prozess*								
Medium for process cleaning / *Medium zur Prozessreinigung*								
Returned part cleaned with / *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

Phone number of contact person / *Telefon-Nr. Ansprechpartner:*

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."

"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

_____ (place, date / *Ort, Datum*)

_____ Name, dept./ *Abt.* (please print / *bitte Druckschrift*)

_____ Signature / *Unterschrift*

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA238F/00/en/08.06
CCS/FM+SGML 6.0/ProMoDo

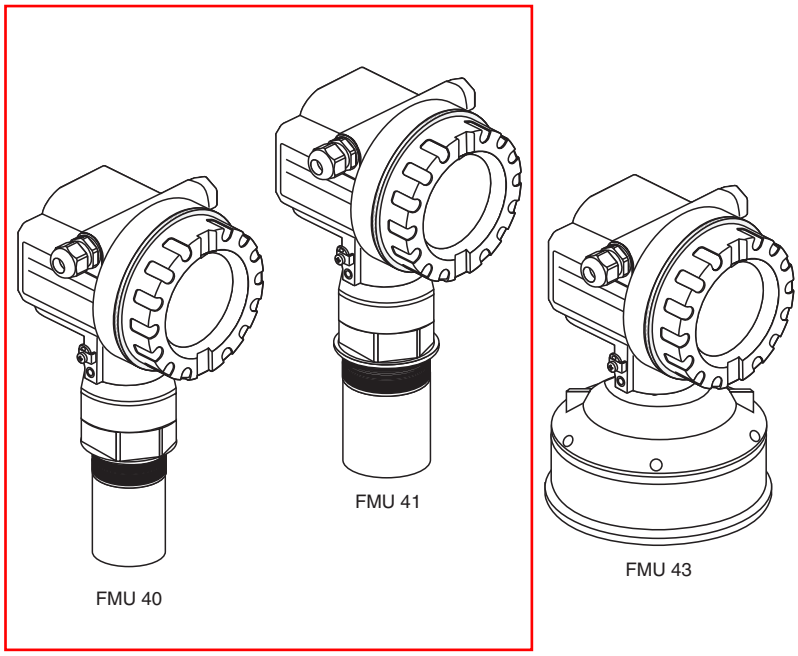
52010986

BA 240F/00/en/01.02
Nr. 52011048

Valid as of software version:
V 01.02.00 (amplifier)
V 01.02.00 (communication)

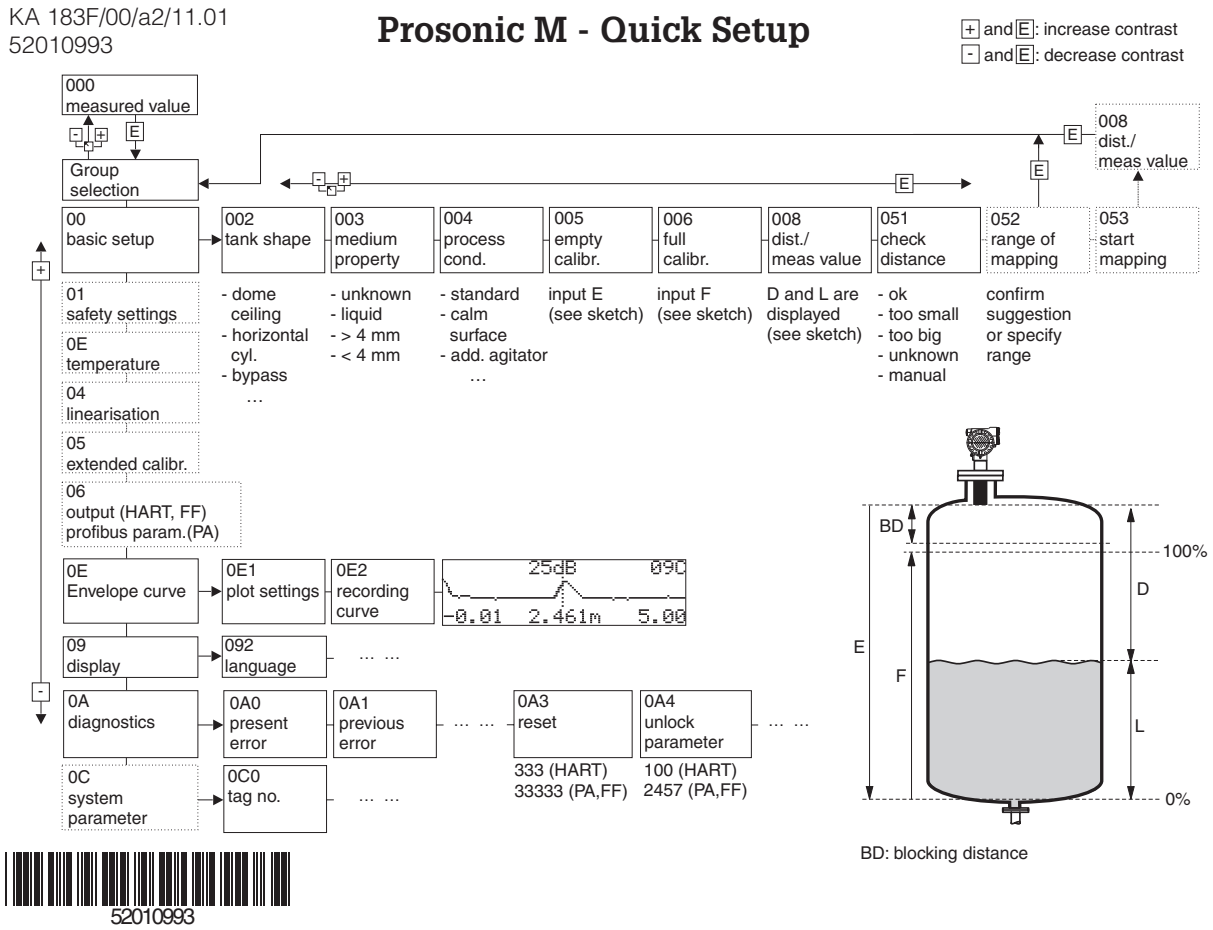
prosonic M
FMU 40/41/43
with HART, PROFIBUS-PA and Foundation Fieldbus
Ultrasonic Level Measurement

Description of Instrument Functions



Endress + Hauser
The Power of Know How

Short instructions



Contents of the operating instructions

This operating instrucitons contain all functions off the Prosonic M operating menu. All types of devices (FMU 40/41/43) and all communication variants are considered.

Information on mounting, wiring, trouble shooting and maintenance can be found in the following documents which are supplied together with the instrument:

- BA 237F/00/en (HART)
- BA 238F/00/en (PROFIBUS-PA)
- BA 239F/00/en (Foundation Fieldbus)

These documents can also be found on the second ToF Tool CD-ROM "Device Desriptions + Documentation"

Table of contents

1 Notes on use

You have various options for accessing the descriptions of instrument functions or how to enter parameters.

1.1 Using the table of contents to locate a function description

All the functions are listed in the table of contents sorted by function group (e.g. basic setup, safety settings, etc.). You can access a more detailed description of a function by using a page reference / link.
The table of contents is on Page 3.

1.2 Using the graphic of the function menu to locate a function description

This guides you step by step from the highest level, the function groups, to the exact function description you require.

All the available function groups and instrument functions are listed in the table (see Page 11). Select your required function group or function. You can access an exact description of the function group or function by using a page reference.

1.3 Using the index of the function menu to locate a function description

To simplify navigation within the function menu, each function has a position which is shown in the display. You can access each function via a page reference in the function menu index (see page 79) which lists all the function names alphabetically and numerically.

1.4 General structure of the operating menu

The operating menu is made up of two levels:

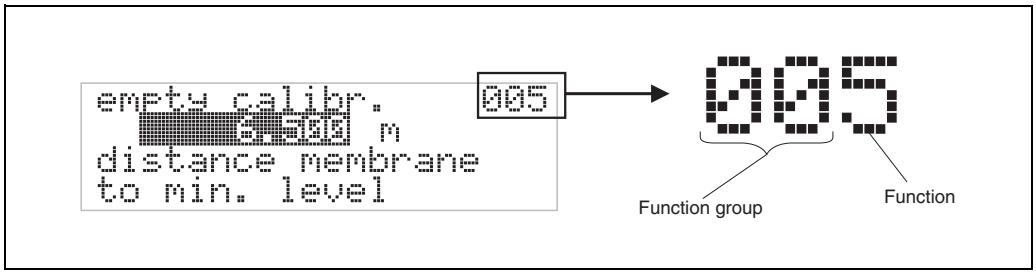
- **Function groups (00, 01, 03, …, 0C, 0D):**
  The individual operating Selection of the instrument are split up roughly into different function groups. The function groups that are available include, e.g.: "**basic setup**", "**safety settings**", "**output**", "**display**", etc.
- **Functions (001, 002, 003, …, 0D8, 0D9):**
  Each function group consists of one or more functions. The functions perform the actual operation or parameterisation of the instrument. Numerical values can be entered here and parameters can be selected and saved. The available functions of the "**basic setup (00)**" function group include, e.g.: "**tank shape (002)**", "**medium property (003)**", "**process cond. (004)**", "**empty calibr. (005)**", etc.

If, for example, the application of the instrument is to be changed, carry out the following procedure:

1. Select the "**basic setup (00)**" function group.
2. Select the "**tank shape (002)**" function (where the existing tank shape is selected).

1.4.1 Identifying the functions

For simple orientation within the function menus (see Page 11 ff.), for each function a position is shown on the display.



The first two digits identify the function group:

- **basic setup** **00**
- **safety settings** **01**
- **temperature** **03**

…

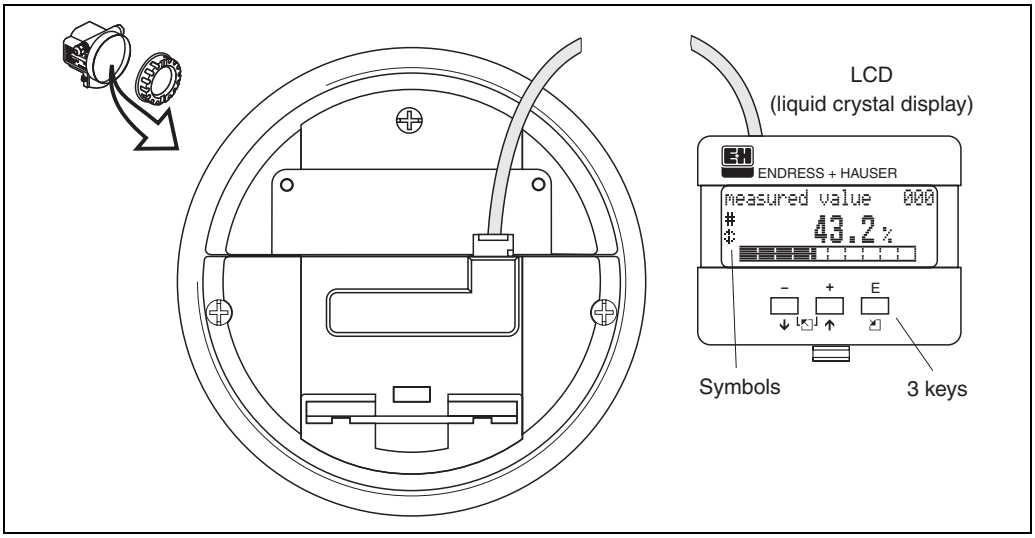
The third digit numbers the individual functions within the function group:

- **basic setup** **00** →
  - **tank shape** **002**
  - **medium property** **003**
  - **process cond.** **004**

  …

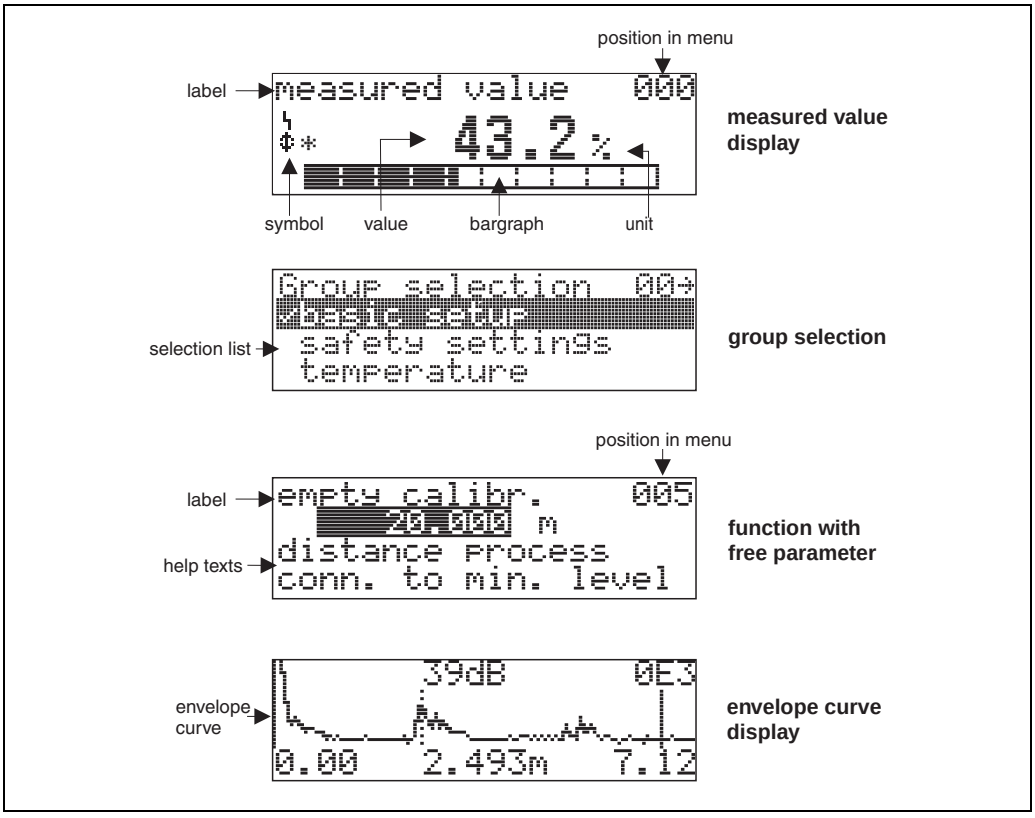
Hereafter the position is always given in brackets (e.g. "**tank shape**" **(002)**) after the described function.

1.5 Display and operating elements



1.5.1 Display

Liquid crystal display (LCD):
Four lines with 20 characters each. Display contrast adjustable through key combination.



1.5.2 Display symbols

The following table describes the symbols that appear on the liquid crystal display:

Symbols	Meaning
	**ALARM_SYMBOL** This alarm symbol appears when the instrument is in an alarm state. If the symbol flashes, this indicates a warning.
	**LOCK_SYMBOL** This lock symbol appears when the instrument is locked,i.e. if no input is possible.
	**COM_SYMBOL** This communication symbol appears when a data transmission via e.g. HART, PFOFIBUS-PA or Foundation Fieldbus is in progress.
	**SIMULATION_SWITCH_ENABLE** This communication symbol appears when simulation in FF is enabled via the DIP switch.

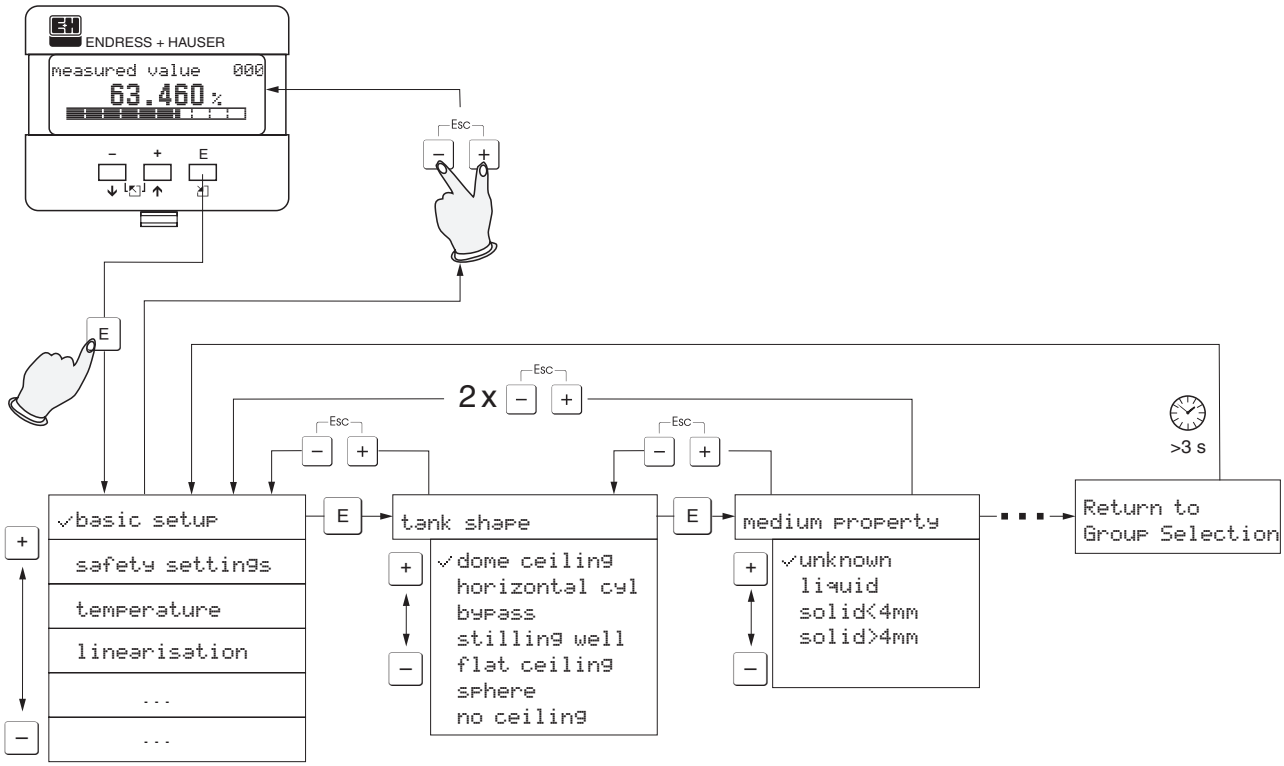
1.5.3 Key assignment

The operating elements are located inside the housing and are accessible for operation by opening the lid of the housing.

Function of the keys

Key(s)	Meaning
+ or ↑	Navigate upwards in the selection list Edit numeric value within a function
− or ↓	Navigate downwards in the selection list Edit numeric value within a function
Esc − + or ←	Navigate to the left within a function group
E or E	Navigate to the right within a function group, confirmation.
+ and E or − and E	Contrast settings of the LCD
+ and − and E	Hardware lock / unlock After a hardware lock, an operation of the instrument via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

1.5.4 Operation with the VU 331



Selection and configuration in Operation menu:

1.) Change from Measured Value Display to **Group Selection** by pressing E

2.) Press − or + to select the required **Function Group** (e.g.. "basic setup (00)") and confirm by pressing E

➜ First f**unction** (e.g. "tank shape (002)") is selected.

Note!
The active selection is marked by a ✔ in front of the menu text.

3.) Activate Edit mode with + or −.

Selection menus:

a) Select the required **Parameter** in selected **function** (e.g. "tank shape (002)") with − or +.

b) E confirms selection ➜ ✔ appears in front of the selected parameter

c) E confirms the edited value ➜ system quits Edit mode

d) + / − (= Esc) interrupts selection ➜ system quits Edit mode

Typing in numerals and text:

a) Press + or − to edit the first character of the **numeral / text** (e.g. "empty calibr. (005)")

b) E positions the cursor at the next character ➜ continue with (a) until you have completed your input

c) if a ↵ symbol appears at the cursor, press E to accept the value entered
➜ system quits Edit mode

d) if a ← symbol appears at the cursor, press E to return to the previous character
(e.g. for correction of entries)

e) + / − (= Esc) interrupts the input, system quits Edit mode

4) Press E to select the next **function** (e.g. "medium property (003)")

5) Press + / − (= Esc) once ➜ return to previous **function** (e.g. "tank shape (002)")

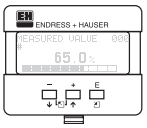
Press + / − (= Esc) twice ➜ return to **Group selection**

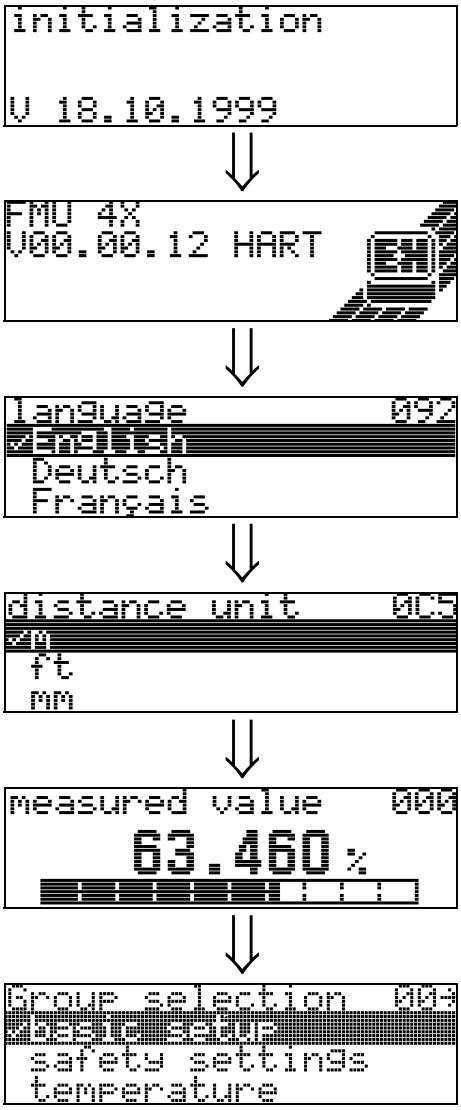
6) Press + / − (= Esc) to return to **Measured value display**

1.6 Commissioning

1.6.1 Switching on the measuring device

When the instrument is switched on for the first time, the following messages appear on the display:





After 5 s, the following message appears

After 5 s or after you have pressed [E] the following message appears

Select the language
(this message appears the first time the instrument is switched on)

Select the basic unit
(this message appears the first time the instrument is switched on)

The current measured value is displayed

After [E] is pressed, you reach the group selection.

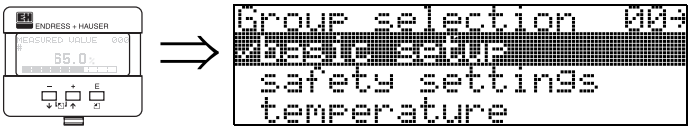
This selection enables you to perform the basic setup

2 Function menu Prosonic M

Function group		Function			Description
basic setup	**00**	measured value	000	→	Page 13
(see Page 13)		tank shape	002	→	Page 13
⇓		medium property	003	→	Page 14
		process cond.	004	→	Page 14
		empty calibr.	005	→	Page 16
		blocking dist.	059	→	Page 16
		full calibr.	006	→	Page 17
		display	008		Page 17
		check distance	051	→	Page 18
		range of mapping	052	→	Page 19
		start mapping	053	→	Page 19
		display	008		Page 20
safety settings	**01**	output on alarm	010	→	Page 21
(see Page 21)		output on alarm (HART only)	011	→	Page 23
⇓		outp. echo loss	012	→	Page 23
		ramp %span/min	013	→	Page 24
		delay time	014	→	Page 25
		safety distance	015	→	Page 25
		in safety dist.	016	→	Page 26
		ackn. alarm	017	→	Page 28
temperature	**03**	measured temp.	030	→	Page 29
(see Page 29)		max. temp. limit	031	→	Page 29
⇓		max. meas. temp.	032	→	Page 29
		react high temp.	033	→	Page 30
		defect temp. sens.	034	→	Page 30
linearisation	**04**	level/ullage	040	→	Page 31
(see Page 31)		linearisation	041	→	Page 32
⇓		customer unit	042	→	Page 36
		table no.	043	→	Page 37
		input level	044	→	Page 37
		input volume	045	→	Page 38
		max. scale	046	→	Page 38
		diameter vessel	047	→	Page 38
extended calibr.	**05**	selection	050	→	Page 39
(see Page 39)		check distance	051	→	Page 39
⇓		range of mapping	052	→	Page 40
		start mapping	053	→	Page 41
		pres. map dist.	054	→	Page 41
		cust. tank map	055	→	Page 42
		echo quality	056	→	Page 42
		offset	057	→	Page 43
		output damping	058	→	Page 43
		blocking dist.	059	→	Page 43

Function group			Function			Description
output	**06**	⇒	commun. address (HART only)	060	→	Page 44
profibus param.	**06**		instrument addr. (PROFIBUS-PA only)	060	→	Page 44
PROFIBUS-PA only			no. of preambels (HART only)	061	→	Page 45
(see Page 44)			ident number (PROFIBUS-PA only)	061	→	Page 45
⇓			thres. main val. (HART only)	062	→	Page 46
			set unit to bus (PROFIBUS-PA only)	062	→	Page 46
			current output mode (HART only)	063	→	Page 47
			out value (PROFIBUS-PA only)	063	→	Page 47
			fixed cur. value (HART only)	064	→	Page 48
			out status (PROFIBUS-PA only)	064	→	Page 48
			simulation	065	→	Page 49
			simulation value	066	→	Page 50
			output current (HART only)	067	→	Page 51
			2nd cyclic value (PROFIBUS-PA only)	067	→	Page 51
			4 mA value	068	→	Page 51
			select v0h0 (PROFIBUS-PA only)	068	→	Page 52
			20 mA value		→	Page 52
			display value (PROFIBUS-PA only)	069	→	Page 52
envelope	**0E**	⇒	plot settings	0E1	→	Page 53
(see Page 53)			recording curve	0E2	→	Page 53
⇓			envelope curve display	0E3	→	Page 54
display	**09**	⇒	language	092	→	Page 56
(see Page 56)			back to home	093	→	Page 56
⇓			format display	094	→	Page 57
			no.of decimals	095	→	Page 57
			sep. character	096	→	Page 57
			display test	097	→	Page 58
diagnostics	**0A**	⇒	present error	0A0	→	Page 60
(see Page 59)			previous error	0A1	→	Page 60
⇓			clear last error	0A2	→	Page 60
			reset	0A3	→	Page 61
			unlock parameter	0A4	→	Page 62
			measured dist.	0A5	→	Page 63
			measured level	0A6	→	Page 64
			application par.	0A8	→	Page 64
system parameter	**0C**	⇒	tag no.	0C0	→	Page 65
(see Page 65)			device tag (Foundation Fieldbus only)	0C0	→	Page 65
⇓			Profile Version (PROFIBUS-PA only)	0C1	→	Page 65
			protocol+sw-no.	0C2	→	Page 65
			serial no.	0C4	→	Page 66
			device id (Foundation Fieldbus only)	0C4	→	Page 66
			distance unit	0C5	→	Page 66
			temperature unit	0C6	→	Page 67
			download mode	0C8	→	Page 67
service	**D00**	⇒	service level	D00		Page 68

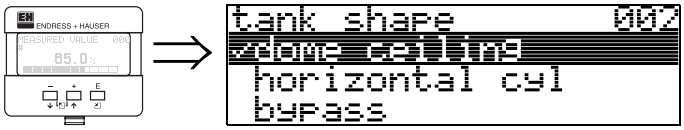
3 Function group "basic setup" (00)



3.1 Function "measured value" (000)

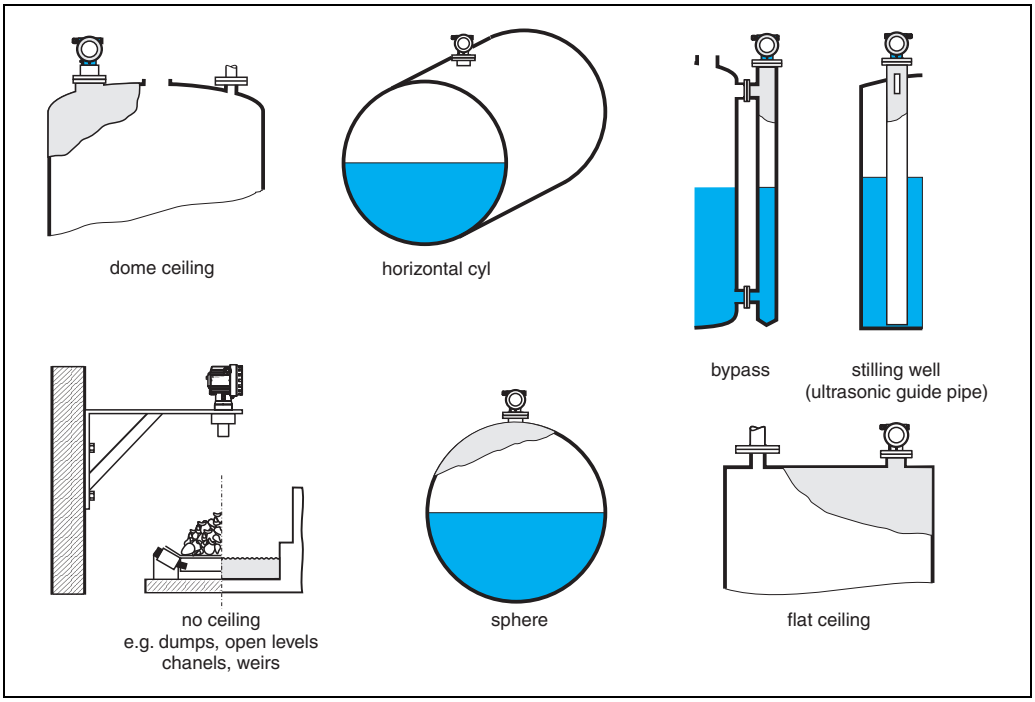
This function displays the current measured value in the selected unit (see "**customer unit**" **(042)** function). The number of places after decimal point can be selected in the "**no.of decimals**" **(095)** function.

3.2 Function "tank shape" (002)

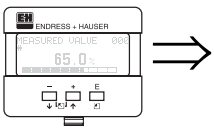


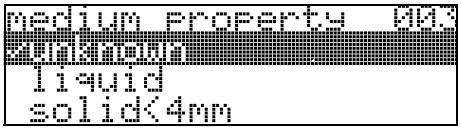
This function is used to select the tank shape.

Selection



3.3 Function "medium property" (003)

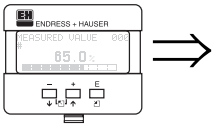




This function is used to set the medium properties:

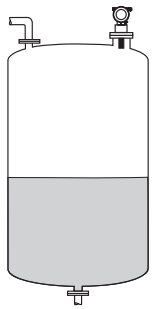
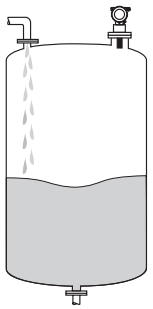
- **unknown** (e.g. pasty media such as greases, creams, gels etc.)
- liquid
- solid, grain size < 4mm (fine)
- solid, grain size > 4mm (coarse)

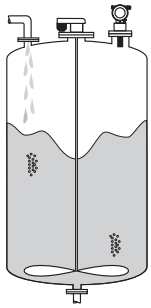
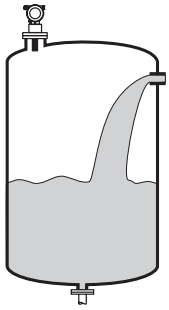
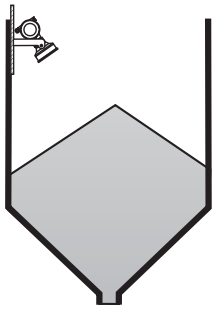
3.4 Function "process cond." (004)

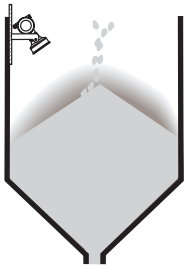
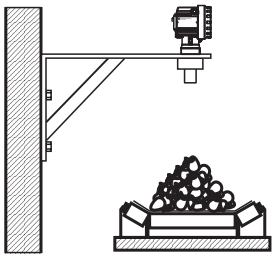


This function is used to select the process conditions.

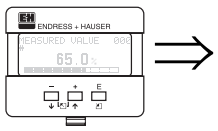
Selection:

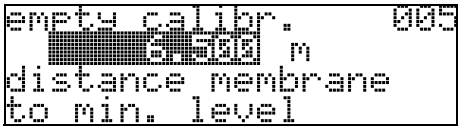
standard liquids	calm surface	turb. surface
For all fluid applications which do not fit in any of the following groups.	Storage tanks with immersion tube or bottom filling	Storage / accumulation tanks with uneven surface due to free filling, mixing nozzles or small bottom stirrers
		
The filters and output damping are set to average values.	The averaging filters and output damping are set to large values. -> Stable measured value -> Accurate measurement -> Slow reaction time	Special filters for stabilising the input signal are activated. -> Stable measured value -> Medium reaction time

add. agitator	fast change	standard solid
Moving surfaces (poss. with vortex formation) due to agitators	Rapid level change, particularly in small tanks	For all bulk solids applications which do not fit in any of the following groups.
		
Special filters for stabilising the input signal are set to large values. -> Stable measured value -> Medium reaction time	The averaging filters are set to small values. -> Rapid reaction time -> Possibly unstable measured value	The filter and output damping are set to average values.

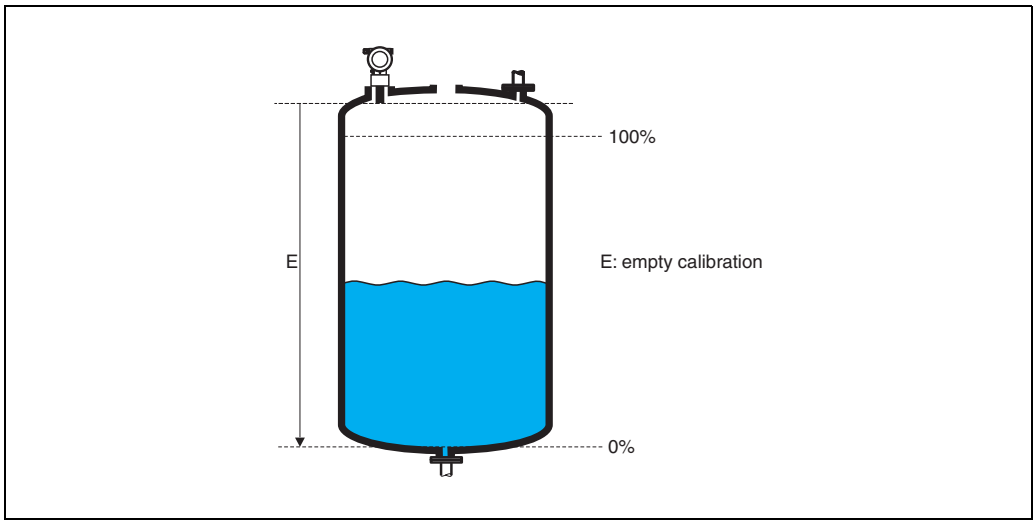
solid dusty	conveyor belt	Test: no filter
Dusty bulk solids	Bulk solids with rapid level change	All the filters can be switched off for purposes of service and diagnosis.
		
The filters are set to detect even relatively weak signals.	The averaging filters are set to small values. -> Rapid reaction time -> Possibly unstable measured value	All filters off

3.5 Function "empty calibr." (005)



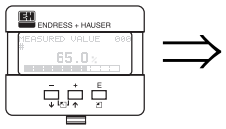


This function is used to enter the distance from the sensor membrane (reference point of the measurement) to the minimum level (=zero).



Caution!
For dish bottoms or conical outlets, the zero point should be no lower than the point at which the radar beam hits the bottom of the tank.

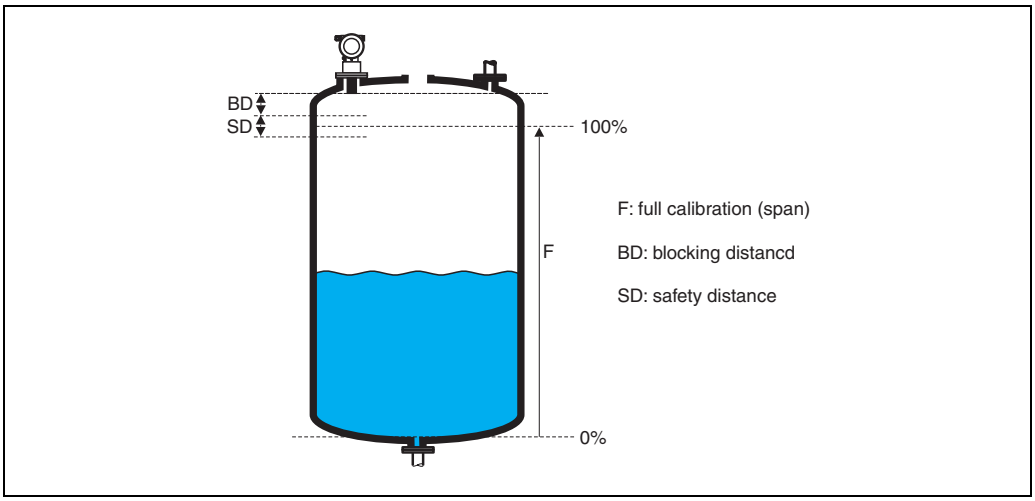
3.6 Function "blocking dist." (059)



In this function the blocking distance is displayed. Level echoes within the blocking distance can not be detected by the Prosonic M. Make sure that the maximum level will never run into the blocking distance.

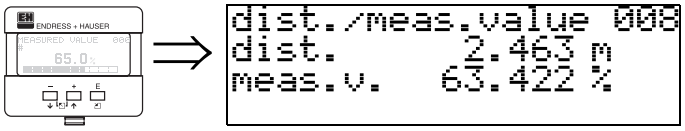
3.7 Function "full calibr." (006)

This function is used to enter the distance from the minimum level to the maximum level (=span).



Caution!
The maximum level may not project into the blocking distance (BD). If the blocking distance is compromised, it may cause device malfunction.
After basic calibration, enter a safety distance (SD) in the **"safety distance" (015)** function. If the level is within this safety distance, the Prosonic M signals a warning or an alarm, depending on your selection in the **"in safety distance" (016)** function.

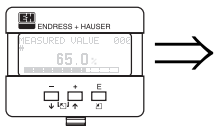
3.8 Display (008)

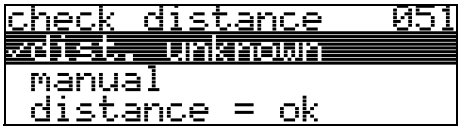


The **distance** measured from the sensor membrane to the product surface and the **level** calculated with the aid of the empty calibration are displayed. Check whether the values correspond to the actual level or the actual distance. The following cases can occur:

- Distance correct – level correct -> continue with the next function, "**check distance**" **(051)**
- Distance correct – level incorrect -> Check "**empty calibr.**" **(005)**
- Distance incorrect – level incorrect -> continue with the next function, "**check distance**" **(051)**

3.9 Function "check distance" (051)

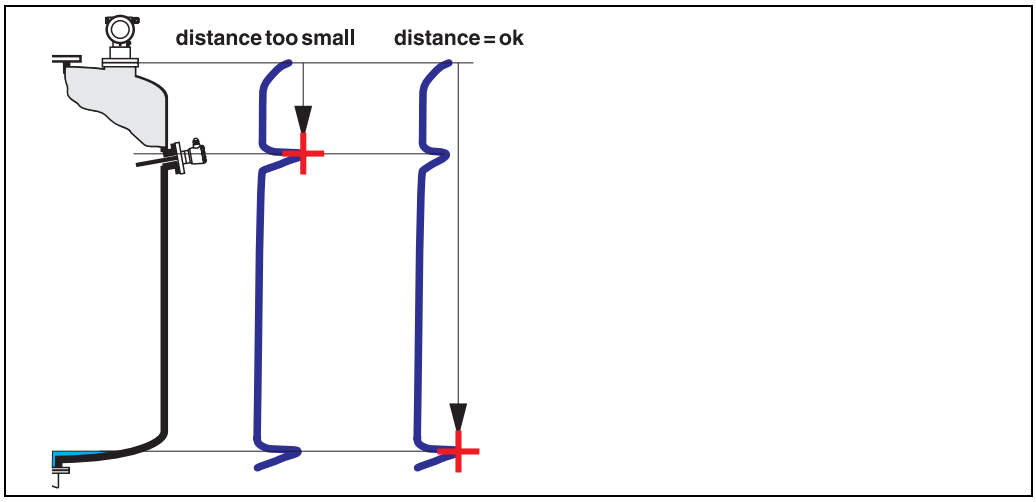




This function triggers the mapping of interference echoes. To do so, the measured distance must be compared with the actual distance to the product surface. The following options are available for selection:

Selection:

- distance = ok
- dist. too small
- dist. too big
- **dist. unknown**
- manual



distance = ok

- mapping is carried out up to the currently measured echo
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

Anyway, it is wise to carry out a mapping even in this case.

dist. too small

- At the moment, an interference is being evaluated
- Therefore, a mapping is carried out including the presently measured echoes
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

dist. too big

- This error cannot be remedied by interference echo mapping
- Check the application parameters **(002), (003), (004)** and "**empty calibr.**" **(005)**

dist. unknown

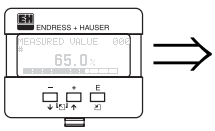
If the actual distance is not known, no mapping can be carried out.

manual

A mapping is also possible by manual entry of the range to be suppressed. This entry is made in the "**range of mapping (052)**" function.

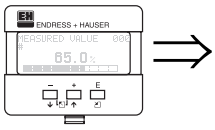
Caution!
The range of mapping must end 0.5 m (20") before the echo of the actual level. For an empty tank, do not enter E, but E – 0.5 m (20").

3.10 Function "range of mapping" (052)



This function displays the suggested range of mapping. The reference point is always the sensor membrane. This value can be edited by the operator.
For manual mapping, the default value is: 0 m.

3.11 Funktion "start mapping" (053)

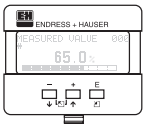


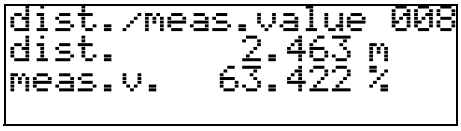
This function is used to start the interference echo mapping up to the distance given in "**range of mapping**" **(052)**.

Selection:
- **off**: no mapping is carried out
- on: mapping is started

Note!
If a mapping already exists, it is overwriten up to the distance specified in "**range of mapping**" **(052)**. Beyond this value the existing mapping remains unchanged.

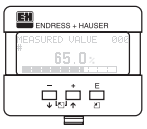
3.12 Display (008)

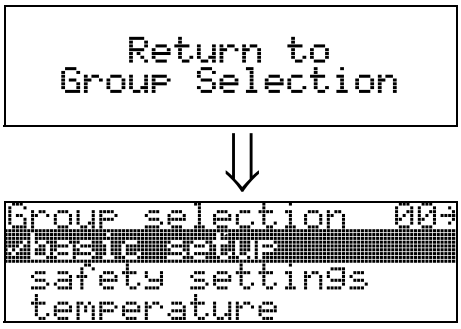




The distance measured from the reference point to the product surface and the level calculated with the aid of the empty alignment are displayed again. Check whether the values correspond to the actual level or the actual distance. The following cases can occur:

- Distance correct – level correct -> basic setup completed
- Distance incorrect – level incorrect -> a further interference echo mapping must be carried out "**check distance**" (**051)**.
- Distance correct – level incorrect -> check "**empty calibr.**" **(005)**

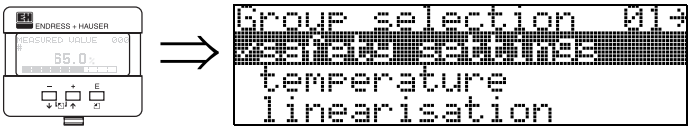




After 3 s, the following message appears

Note!
After the basic setup, an evaluation of the measurement with the aid of the envelope curve ("**display**" **(09)** function group) is recommended.

4 Function group "safety settings" (01)

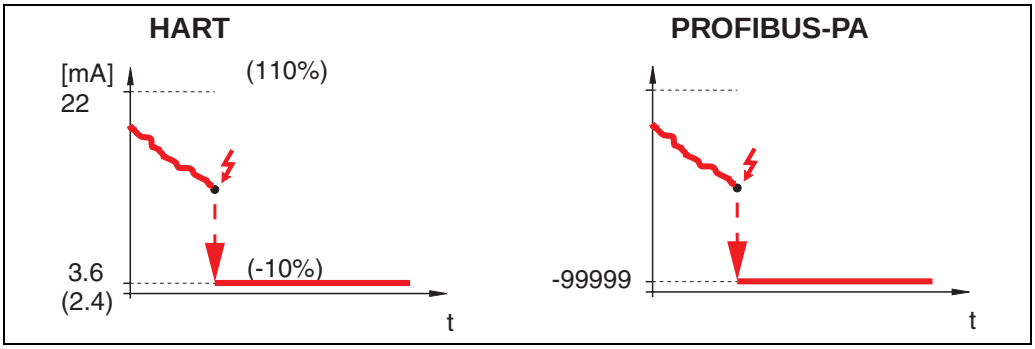


4.1 Function "output on alarm" (010)

This function is used to select the reaction of the device on an alarm.

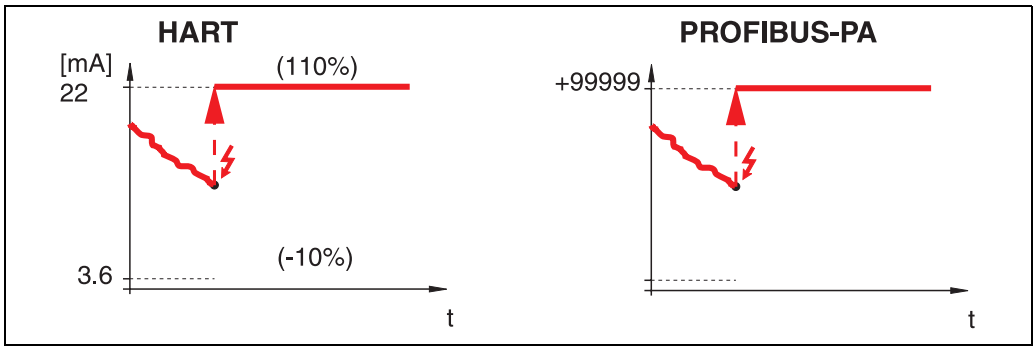
Selection:
- MIN (<= 3.6mA)
- **MAX (22mA)**
- hold
- user specific

MIN (<= 3.6 mA)



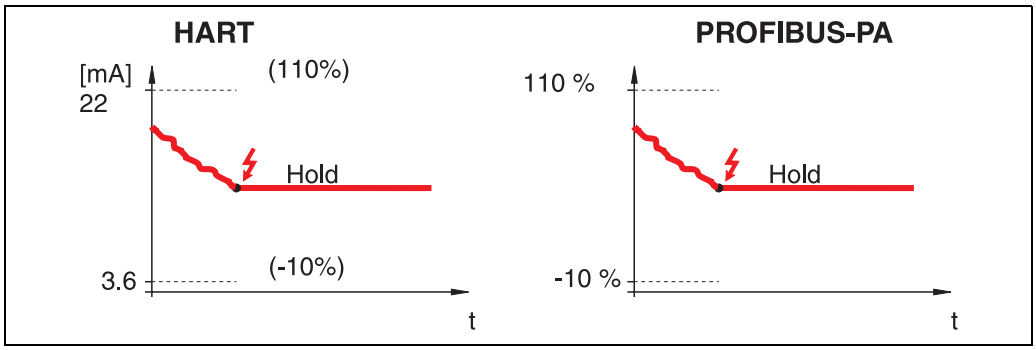
If the instrument is in alarm state, the output changes as follows:
- HART: MIN-Alarm 3.6 mA (2.4 mA for four-wire instruments)
- PROFIBUS-PA: MIN-Alarm -99999

MAX (22mA)



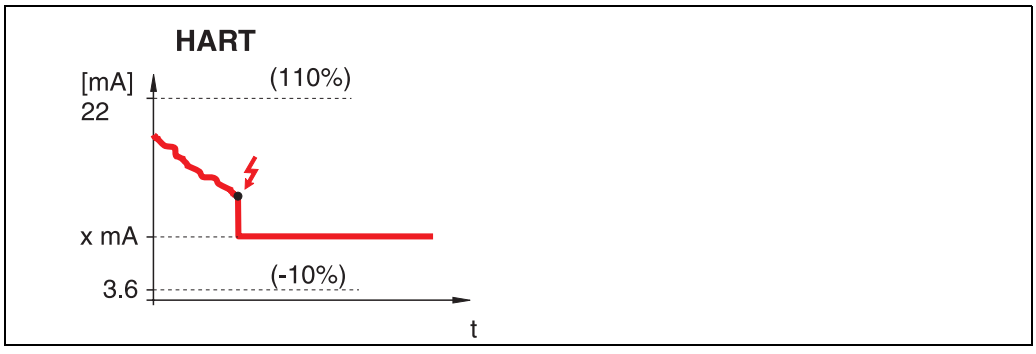
If the instrument is in alarm state, the output changes as follows:
- HART: MAX-Alarm 22 mA
- PROFIBUS-PA: MAX-Alarm +99999

hold



If the instrument is in alarm state, the last measured value is held.

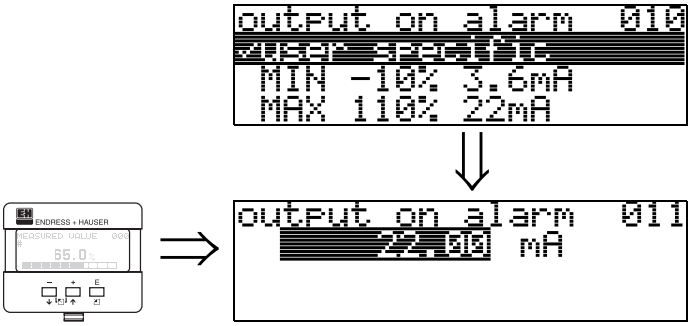
user specific



If the instrument is in an alarm state, the output is set to the value configured in "**output on alarm**" **(011)** (x mA).

Caution!
This selection is available for HART devices only!

4.2 Function "output on alarm" (011), HART only



The current (in mA) which will be output in case of an alarm. This function is active when you selected "**user specific**" in the "**output on alarm**" **(010)** function.

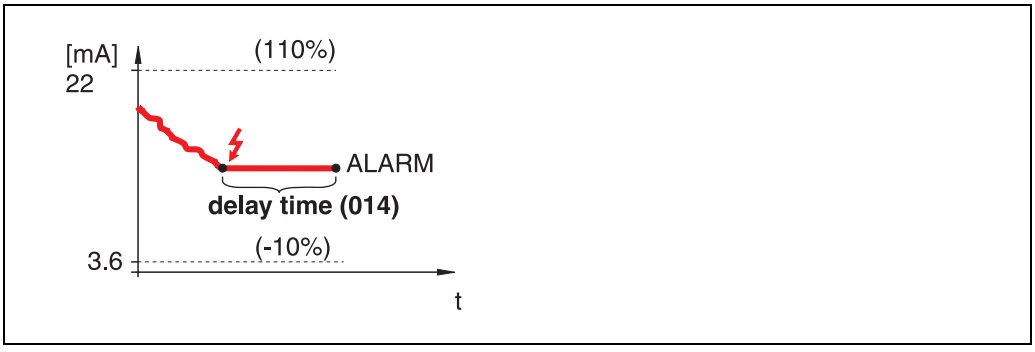
Caution!
This function is available for HART devices only!

4.3 Function "outp. echo loss" (012)

Use this function to set the output response on echo loss.

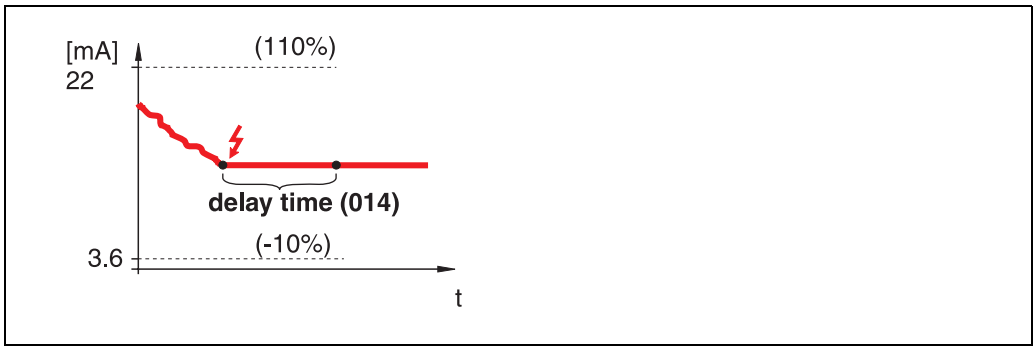
Selection:
- alarm
- **hold**
- ramp %/min

alarm



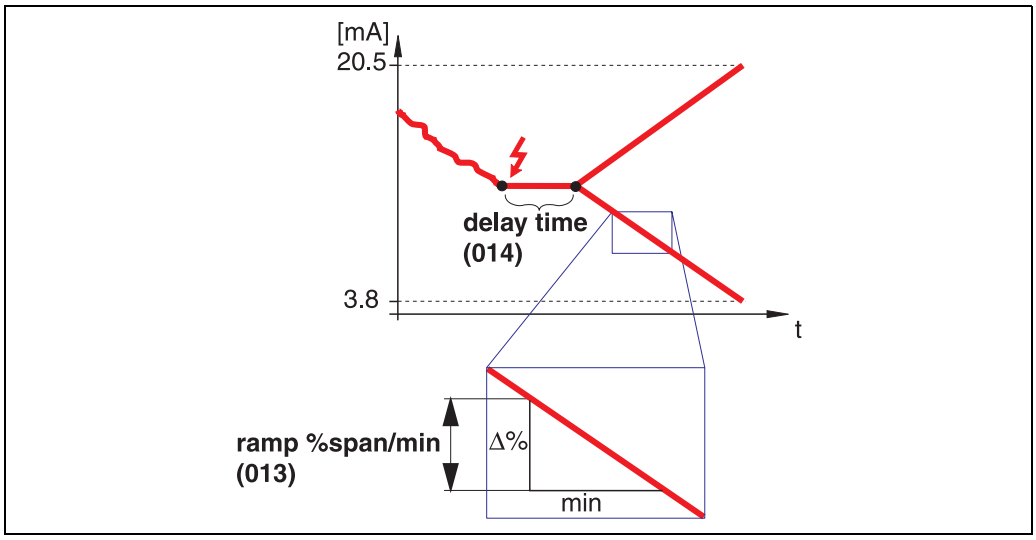
On echo loss, the instrument switches to alarm state after an adjustable "**delay time**" **(014)**. The output response depends on the configuration set in "**output on alarm**" **(010)**.

hold



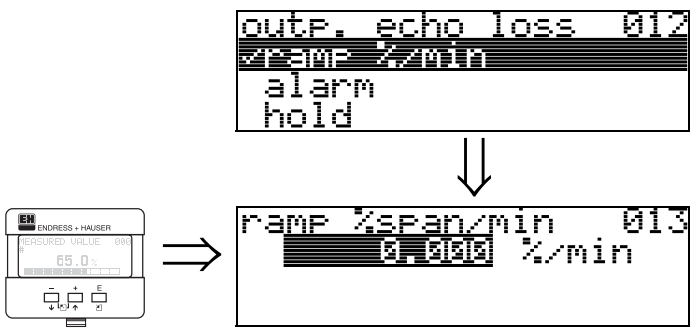
On echo loss, a warning is generated after a definable "**delay time**" **(014)**. Output is held.

ramp %/min



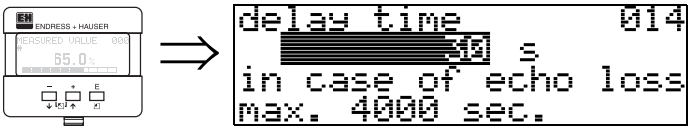
On echo loss, a warning is generated after a definable "**delay time**" **(014)**. The output is changed towards 0% or 100% depending on the slope defined in "**ramp %span/min**" **(013)**.

4.4 Function "ramp %span/min" (013)



Ramp slope which defines the output value on echo loss. This value is used if "**ramp %span/min**" is selected in "**outp. echo loss**" **(012)**. The slope is given in % of the measuring range per minute.

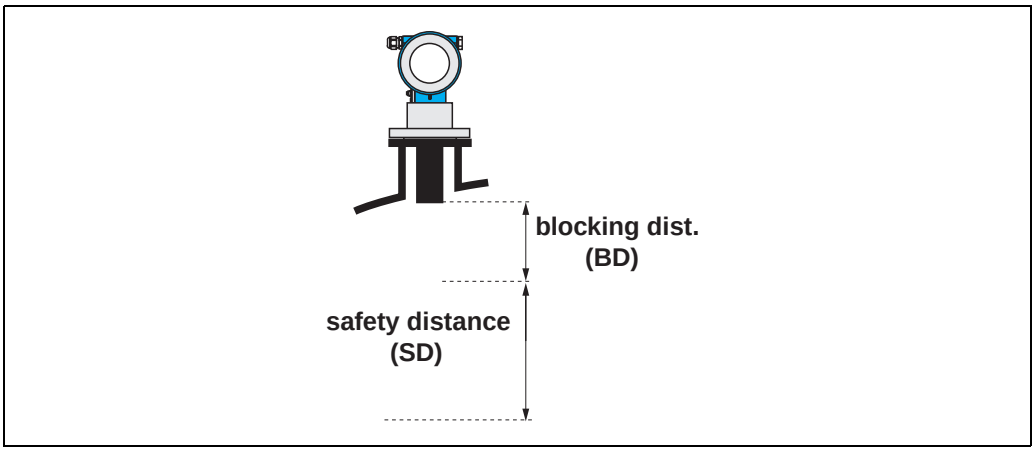
4.5 Function "delay time" (014)

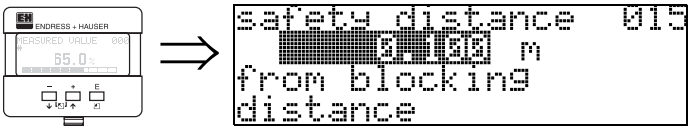


Use this function to enter the delay time (Default = 30 s) after which a warning is generated on echo loss, or after which the instrument switches to alarm state.

4.6 Function "safety distance" (015)

A configurable safety distance is placed before the "**blocking dist.**" **(059)** (Page 43). This distance warns you that any further level increase would make the measurement invalid, because the blocking distance would be compromised.





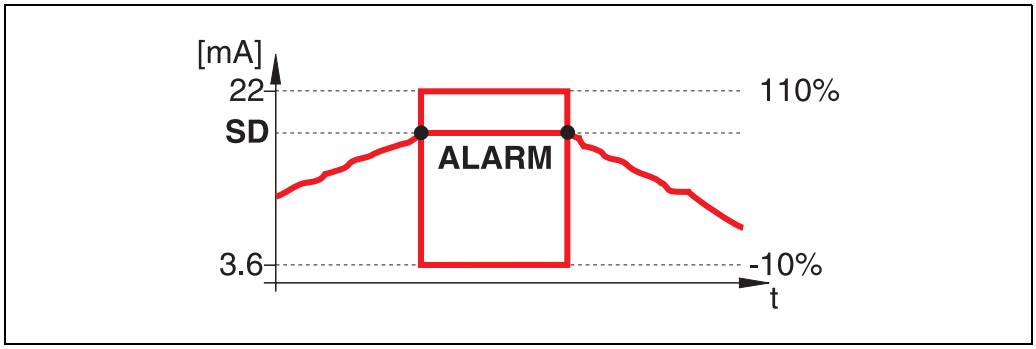
Enter the size of the safety distance here. The default value is: 0.1 m.

4.7 Function "in safety dist." (016)

This function defines the response when the level enters the safety distance .

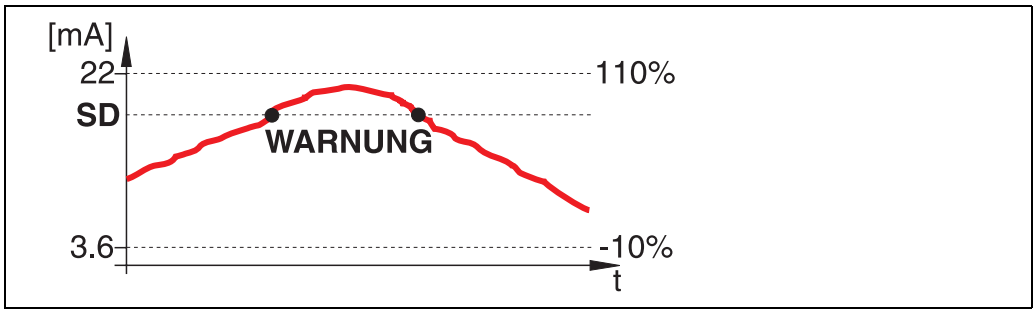
Selection:
- alarm
- **warning**
- self holding

alarm



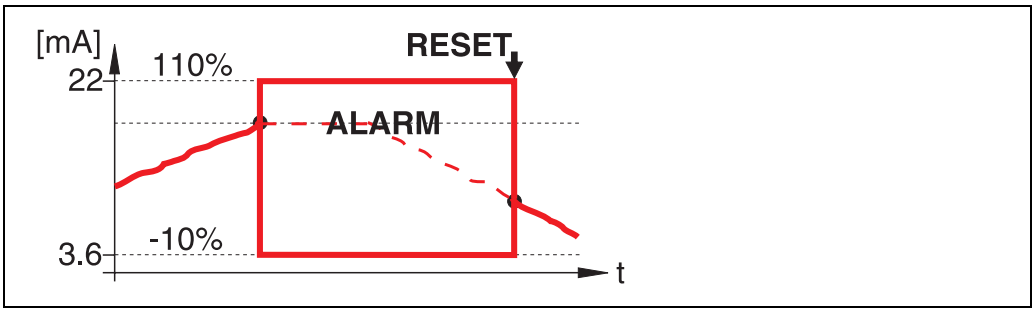
Instrument enters the defined alarm state ("**output on alarm**" **(011)**). The alarm message **E651** - "**level in safety distance** - **risk of overspill**" is displayed.
If the level drops out of the safety distance, the alarm warning disappears and the instrument starts to measure again.

warning



Instrument displays a warning **E651** - "**level in safety distance** - **risk of overspill**", but continues to measure. If the level leaves the safety distance, the warning disappears.

self holding



Instrument switches to defined alarm state ("**output on alarm**" **(011)**). The alarm message **E651** - "**level in safety distance** - **risk of overspill**" is displayed.
If the level leaves the safety distance, the measurement continues only after a reset of the self holding (function: "**ackn. alarm**" **(017)**).

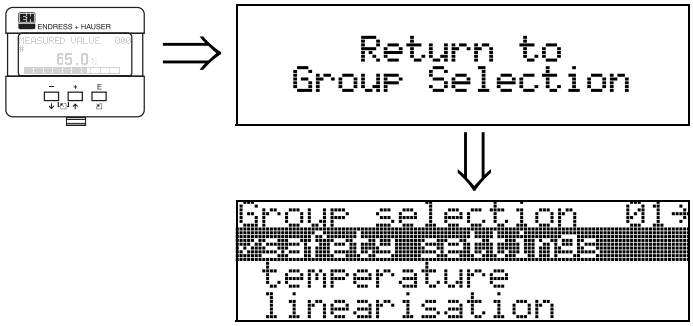
4.8 Function "ackn. alarm" (017)

This function acknowledges an alarm in case of "**self holding**".

Selection:
- **no**
- yes

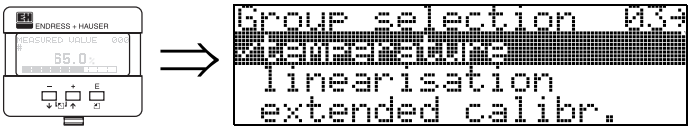
no
The alarm is not acknowledged.

yes
Acknowledgement takes place.



After 3 s, the following message appears

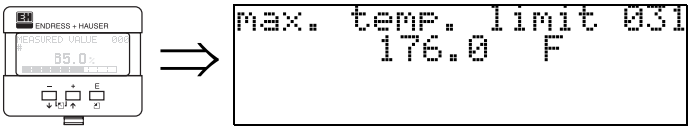
5 Function group "temperature" (03)



5.1 Function "measured temp." (030)

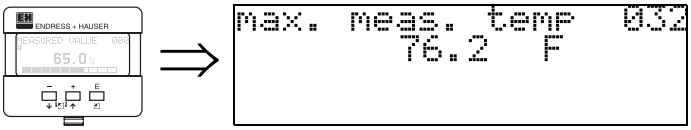
In this function the temperature at the sensor is displayed. The temperature unit is determined by the function **"temperature unit" (0C6)**.

5.2 Function "max. temp. limit" (031)



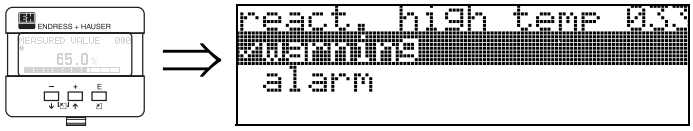
In this function the maximum permitted temperature of the sensor is displayed. The temperature unit is determined by the function **"temperature unit" (0C6)**. If this temperature is exceeded, the sensor may become damaged.

5.3 Function "max. meas. temp." (032)



In this function the maximum temperature, which has ever been measured at the senosr, is displayed. The temperature unit is determined by the function **"temperature unit" (0C6)**. This function is not influenced by a reset of the parameters.

5.4 Function "react high temp." (033)

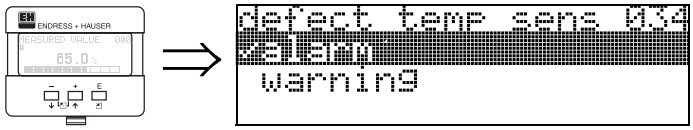


In this function you determine, how the Prosonic M will react if the maximum permitted temperature of the sensor is exceeded.
You may choose one of the following options:

Warning
The instrument continues measuring. An error message is displayed.

Alarm
The current output adopts the value defined in the funcion **"output on alarm" (010)**.
Additionally an error message is displayed.

5.5 Function "defect temp. sens." (034)

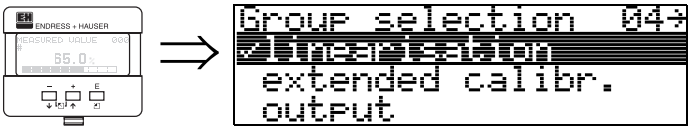


In this function you determine, how the Prosonic M will react, if the maximum permitted temperature of the sensor is exceeded.
You may choose one of the following options:

Alarm
The current output adopts the value defined in the funcion **"output on alarm" (010)**.
Additionally an error message is displayed.

Warning
The instrument continues measuring. An error message is displayed.

6 Function group "linearisation" (04)



6.1 Function "level/ullage" (040)

Selection:
- **level CU**
- level DU
- ullage CU
- ullage DU

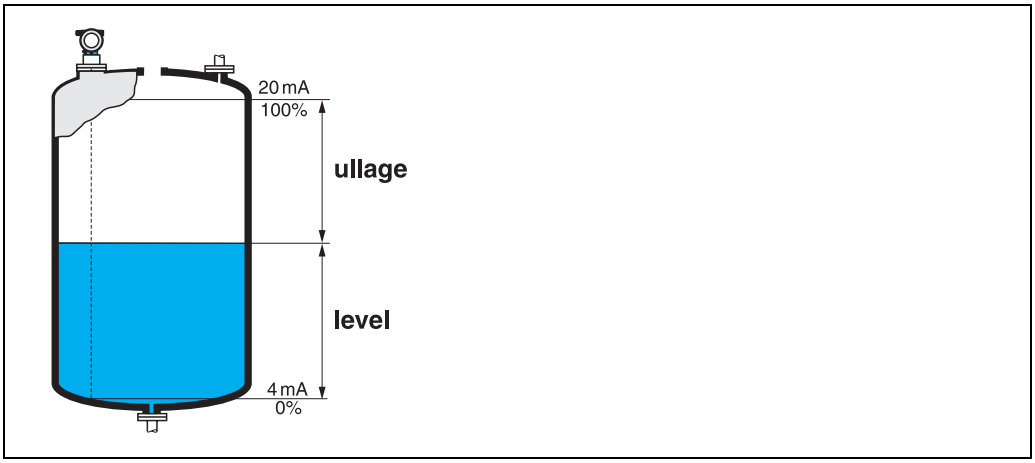
level CU
Level in customer units. The measured value can be linearised.
The "**linearisation**" **(041)** default value is set to a linear 0...100%.

level DU
Level in the selected "**distance unit**" **(0C5)**.

ullage CU
Ullage in customer units. The value can be linearised.
The "**linearisation**" **(041)** default value is set to a linear 0...100%.

ullage DU
Ullage in the selected "**distance unit**" **(0C5)**.

Note!
Reference point for the ullage is "full calibr." (=span).



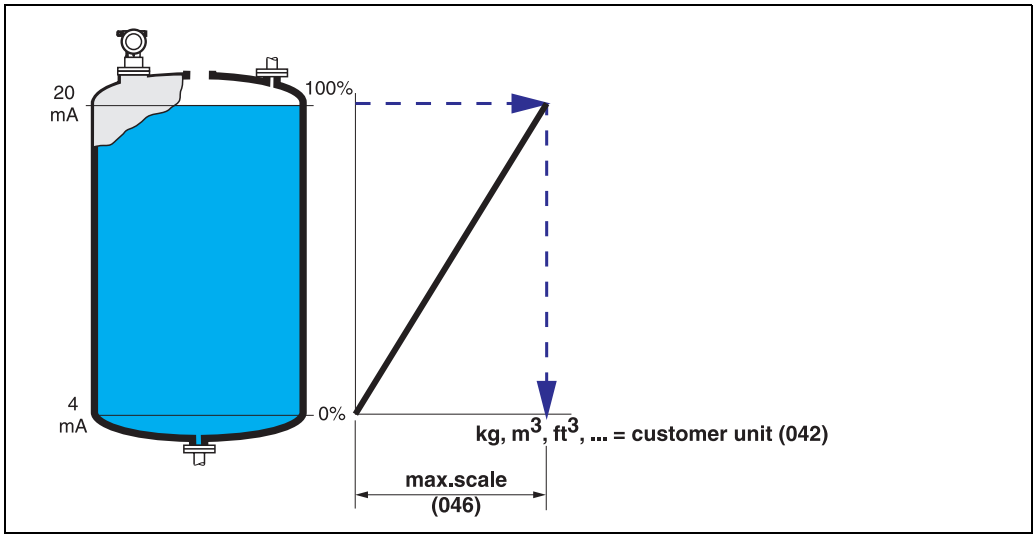
6.2 Function "linearisation" (041)

Linearisation defines the ratio of level to container volume or product weight and allows a measurement in customer units, e.g. metres, hectolitres etc. The measured value in (000) is then displayed in the selected unit.

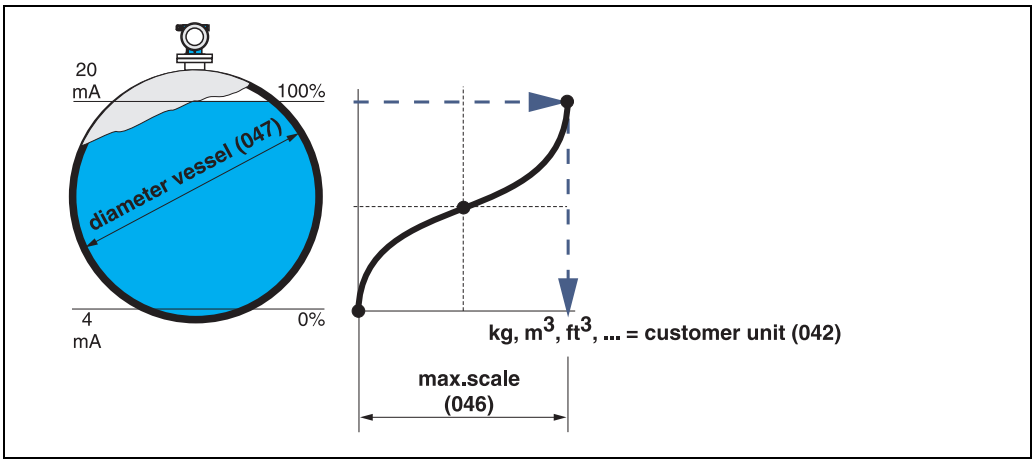
This function is used to select the linearisation modes.

Selection:
- **linear**
- horizontal cyl
- manual
- semi-automatic
- table on
- clear table

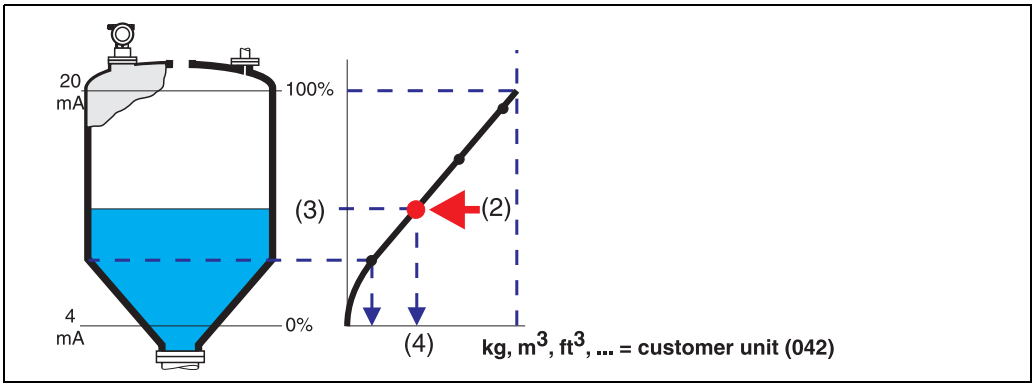
linear
The tank is linear e.g. a cylindrical vertical tank. You can measure in customer units by entering a maximum volume/weight.
You can select the "**customer unit**" **(042)**. Define the volume value corresponding to the calibration in "**max. scale**" **(046)**. This value corresponds to an output of 100% (= 20 mA for HART).



horizontal cyl
The volume, mass etc. are calculated automatically in cylindrical horizontal tanks by entering the "**diameter vessel**" **(047)**, the "**customer unit**" **(042)** and the "**max. scale**" **(046)**. The "**max. scale**" **(046)** corresponds to an output of 100% (= 20 mA for HART).

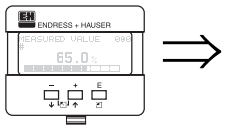


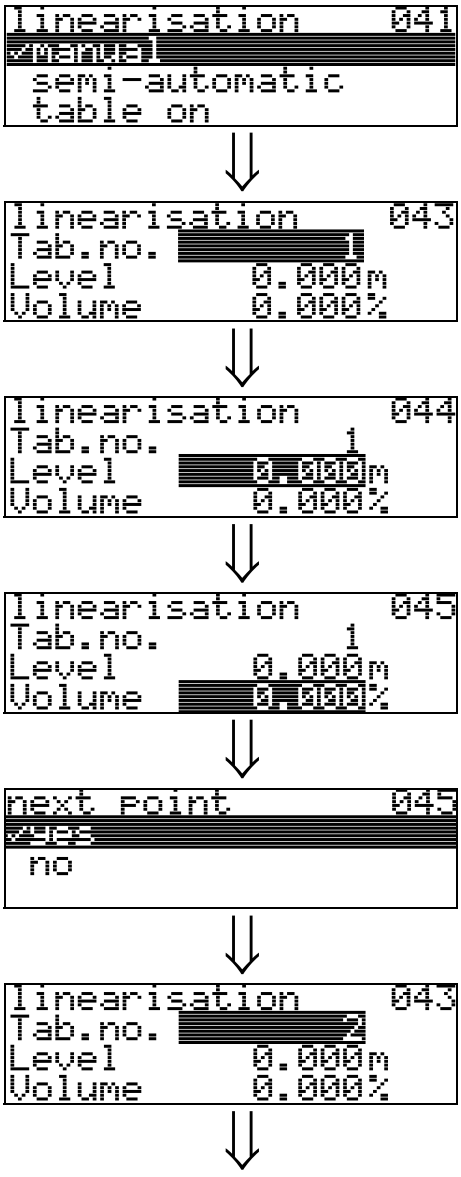
manual
If the level is not proportional to the volume or weight within the set measuring range, you can enter a linearisation table in order to measure in customer units. The requirements are as follows:
- The 32 (max.) value pairs for the linearisation curve points are known.
- The level values must be given in ascending order. The curve is monotonously increasing.
- The level heights for the first and last points on the linearisation curve correspond to empty and full calibration respectively.
- The linearisation takes place in the basic setup unit ("**distance unit**" **(0C5)**).



Each point (2) in the table is described by a value pair: level (3) and, for example, volume (4). The last value pair defines the 100% output (= 20 mA for HART).

Note!
The manual linearisation mode can also be used for flow measurements. To do this, simply enter the respective flow level (instead of the volume) into the table. You can find the appropriate flow values in the Q/h table of your channel or weir.





Select the table point (Point 1).

Enter the level belonging to Point 1.

Enter the corresponding volume.

Enter a further table point?

Next table point.

...

Continue until "**next point" (045)** is answered with no.

Note!
After making entries into the table, activate it with "**table on**".
The 100% value (=20 mA for HART) is defined by the last point in the table.

Note!
Before confirming 0.00 m as the level or 0.00% as the volume, activate the Edit mode with + or −.

Entries can be made into the linearisation table in ToF Tool using the table editor.
You can also display the contents graphically.

semi-automatic
The tank is filled in stages when the linearisation curve is entered semi-automatically. The Prosonic M automatically detects the level and the corresponding volume/weight has to be entered.
The procedure is similar to manual table entry, where the level value for each table point is given automatically by the instrument.

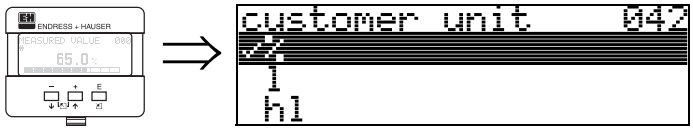
Note!
If the tank is emptied (out litres), pay attention to the following points:
- The number of points must be known in advance.
- The first table number = (32 - number of points).
- Entries in "**Tab. no.**" **(043)** are made in reverse order (last entry = 1).

table on
An entered linearisation table only becomes effective when activated.

clear table
Before making entries into the linearisation table, any existing tables must be deleted. The linearisation mode automatically switches to linear.

Note!
A linearisation table can be deactivated by selecting "**linear**" or "**horizontal cyl**" (or the "**level/ullage**" **(040)** function = "**level DU**", "**ullage DU**"). It is not deleted and can be reactivated at any time by selecting "**table on**".

6.3 Function "customer unit" (042)

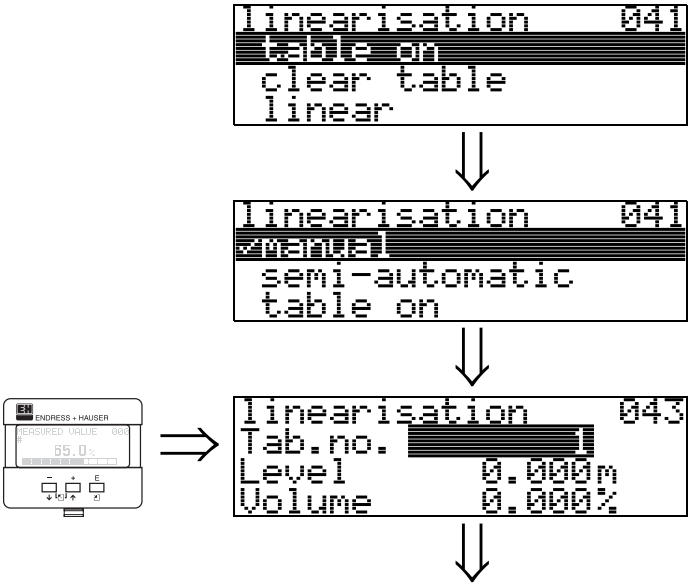


You can select the customer unit with this function.

Selection:
- **%**
- Volume: l, hl, m3, dm3, cm3, ft3, usgal, i gal
- Weight: kg, t, lb, ton
- Length: m, ft, mm, inch
- Flow: l/s, l/min, l/h, m3/s, m3/min, m3/h, ft3/s, gal/s, gal/m, gal/hr, mgal/d, igal/s, igal/min, igal/h

Dependence
The units of the following parameters are changed:
- measured value (000)
- input volume (045)
- max. scale (046)
- simulation value (066)

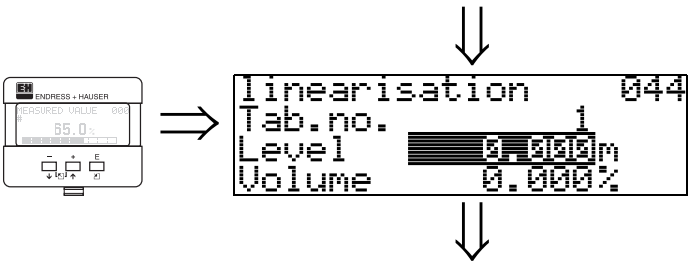
6.4 Function "table no." (043)



Position of the value pair in the linearisation table.

Dependence
Updates "**input level**" **(044)** , "**input volume**" **(045)**.

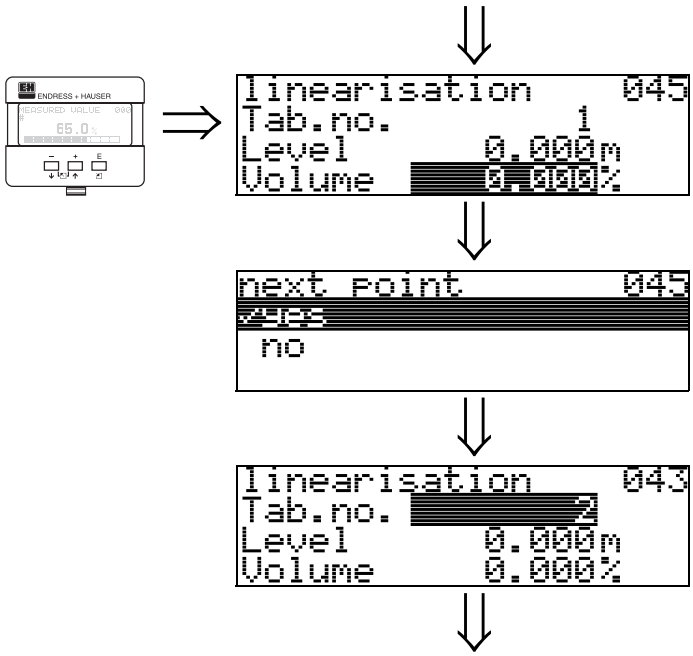
6.5 Function "input level" (044)



You can enter the level for each point of the linearisation curve with this function. When the linearisation curve is entered semi-automatically, Micropilot detects the level automatically.

User input:
Level in "**distance unit**" **(0C5)**.

6.6 Function "input volume" (045)



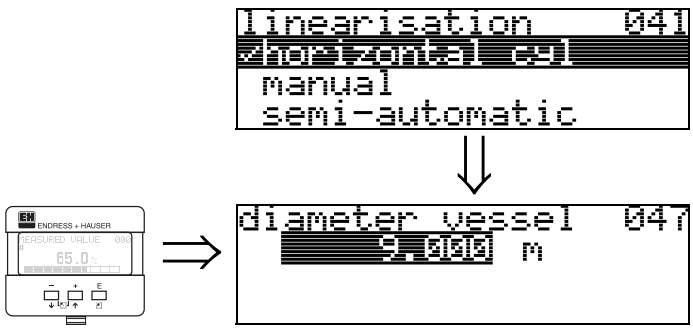
Specify the volume for each point of the linearisation curve with this function.

User input:
Volume in "**customer unit**" **(042)**.

6.7 Function "max. scale" (046)

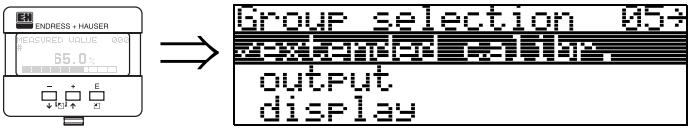
You can enter the end value of the measuring range with this function. This input is necessary if you selected "**linear**" or "**horizontal cyl**" in the "**linearisation**" **(041)** function.

6.8 Function "diameter vessel" (047)



Enter the tank diameter with this function. This entry is necessary if you selected "**horizontal cyl**" in the "**linearisation**" **(041)** function.

7 Function group "extended calibr." (05)



7.1 Function "selection" (050)

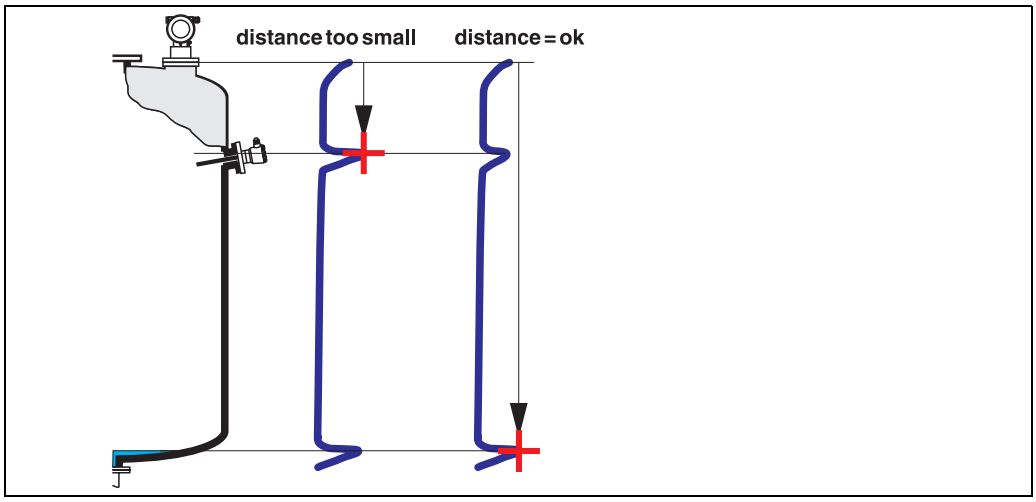
Select the function of the extended calibration.

Selection:
- **common**
  leads to the functions **"echo quality" (056)**, **"offset" (057)**, **"output damping" (058)** and **"blocking distance" (059)**
- mapping
  leads to the functions for an interference echo suppression (tank map): **(051) ... (053)**
- extended map
  leads to the functions **" pres. map. dist." (054)** and **"cust. tank map" (055)**

7.2 Function "check distance" (051)

This function triggers the mapping of interference echoes. To do so, the measured distance must be compared with the actual distance to the product surface. The following options are available for selection:

Selection:
- distance = ok
- dist. too small
- dist. too big
- **dist. unknown**
- manual



distance = ok
- mapping is carried out up to the currently measured echo
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

Anyway, it is wise to carry out a mapping even in this case.

dist. too small
- At the moment, an interference is being evaluated
- Therefore, a mapping is carried out including the presently measured echoes
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

dist. too big
- This error cannot be remedied by interference echo mapping
- Check the application parameters **(002), (003), (004)** and "**empty calibr.**" **(005)**

dist. unknown
If the actual distance is not known, no mapping can be carried out.

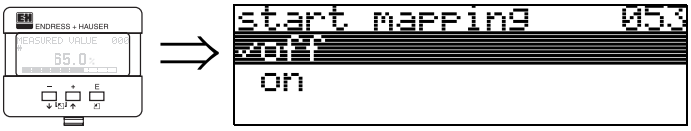
manual
A mapping is also possible by manual entry of the range to be suppressed. This entry is made in the "**range of mapping (052)**" function.

Caution!
The range of mapping must end 0.5 m (20") before the echo of the actual level. For an empty tank, do not enter E, but E – 0.5 m (20").

7.3 Function "range of mapping" (052)

This function displays the suggested range of mapping. The reference point is always the sensor membrane. This value can be edited by the operator.
For manual mapping, the default value is: 0 m.

7.4 Function "start mapping" (053)

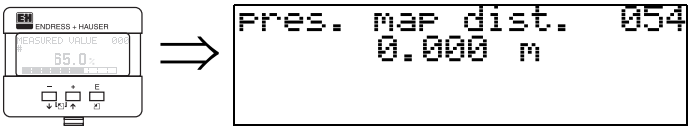


This function is used to start the interference echo mapping up to the distance given in "**range of mapping**" **(052)**.

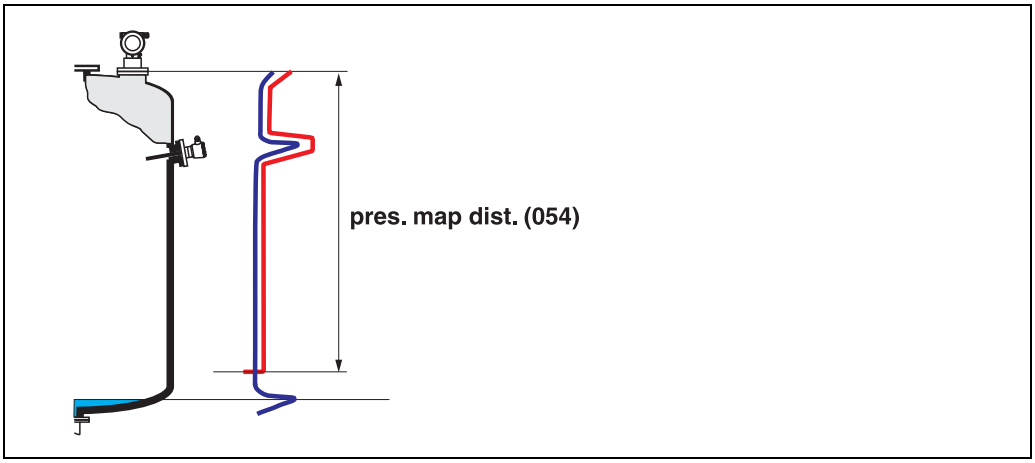
Selection:
- **off**: no mapping is carried out
- on: mapping is started

Caution!
If a mapping already exists, it is overwriten up to the distance specified in "**range of mapping**" **(052)**. Beyond this value the existing mapping remains unchanged.

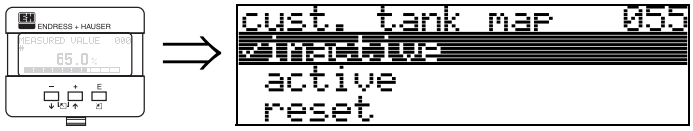
7.5 Function "pres. map dist." (054)



Displays the distance up to which a mapping has been recorded.
A value of 0 indicates that no mapping was recorded so far.



7.6 Function "cust. tank map" (055)



This function displays the evaluation mode using the customer tank map.

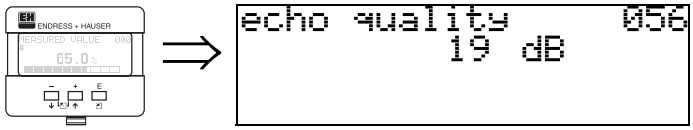
Selection:
- **inactive**
- active
- reset

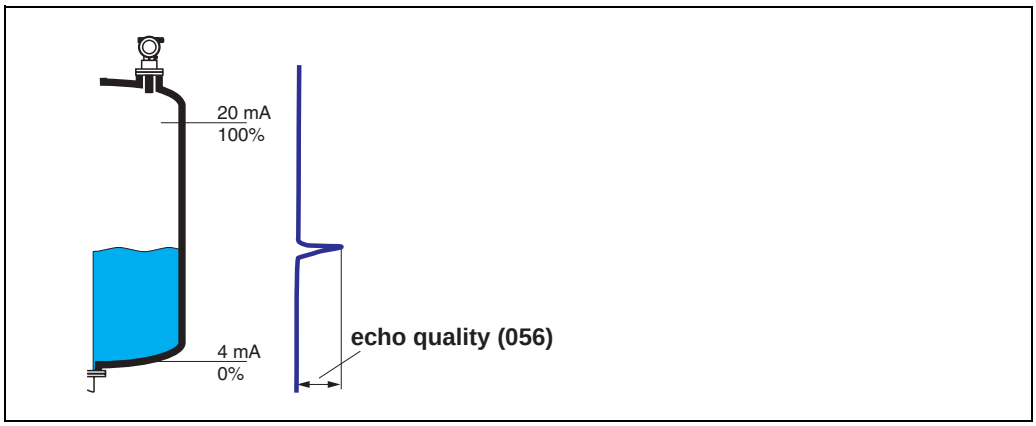
inactive
No tank mapping has been recorded, or map is switched off. Evaluation is only using FAC (Page 71).

active
Evaluation is using the customer tank map (Page 70).

reset
Deletes the complete tank map.

7.7 Function "echo quality" (056)





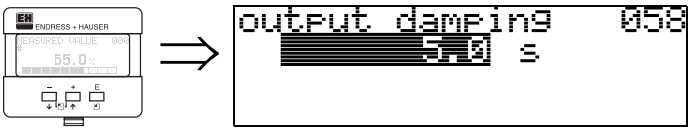
The echo quality is the benchmark for measurement reliability. It describes the amount of reflected energy and depends primarily on the following conditions:
- Surface characteristics (waves, foam etc.)
- Distance between sensor and product

Low values increase the probability that the echo is lost through a change in measurement conditions, e.g. turbulent surface, foam, large measuring distance.

7.8 Function "offset" (057)

This function corrects the measured level by a constant value. The entered value is added to the measured level.

7.9 Function "output damping" (058)

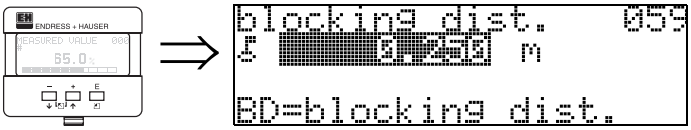


Influences the time an output requires to react to a sudden level jump (63% of steady state). A high value attenuates, for example, the influences of rapid changes on the measured variable.

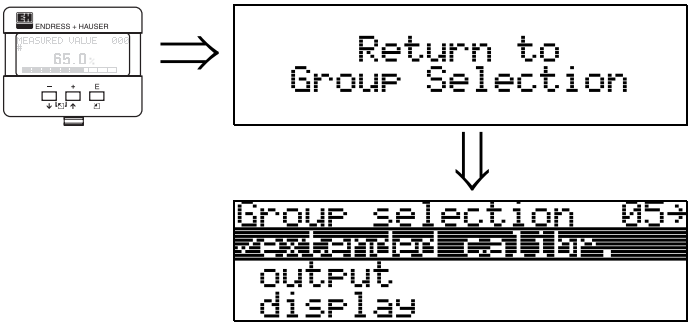
User input:
0...255 s

The default value depends on the selected application parameters "**tank shape**" **(002)**, "**medium property**" **(003)** and "**process cond.**" **(004)**.

7.10 Function "blocking dist." (059)



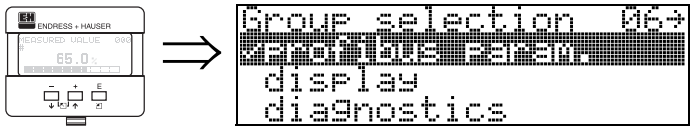
In this function the blocking distance is displayed. Level echoes within the blocking distance can not be detected by the Prosonic M. Make sure that the maximum level will never run into the blocking distance.



After 3 s, the following message appears

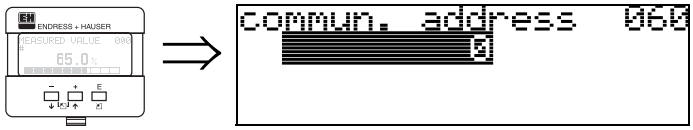
8 Function group "output" (06), - "profibus param." (06), PROFIBUS-PA only

Display at HART and Foundation Fieldbus instrument



Display at PROFIBUS-PA instrument

8.1 Function "commun. address" (060), HART only

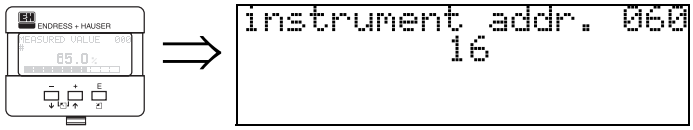


Enter the communication address for the instrument with this function.
- Standard: 0
- Multidrop: 1-15

The output current is constant at 4mA in multidrop mode.

Caution!
This function is available for HART devices only!

8.2 Function "instrument addr." (060), PROFIBUS-PA only



The PA bus address is displayed in this field. The address is set either directly on the instrument using DIP switches (see instrument operating instructions) or using a special SetSlaveAddress command via the bus, e.g. by the ToF Tool.

Caution!
This function is available for PROFIBUS-PA devices only!

8.3 Function "no. of preambels" (061), HART only

Enter the number of preambles for the HART protocol with this function.
An increase in the value is advisable for "bad" lines with communications problems.

Caution!
This user input is available for HART devices only!

8.4 Function "ident number" (061), PROFIBUS-PA only

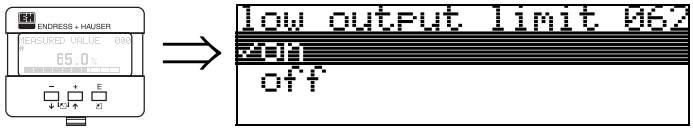
- **manufacturer**
- profile

manufacturer
Set to152C hex according to manufacturer (PNO registered).

profile
Setting defined as in PA Profile 3.0: 9700 hex - instrument with one AI block.

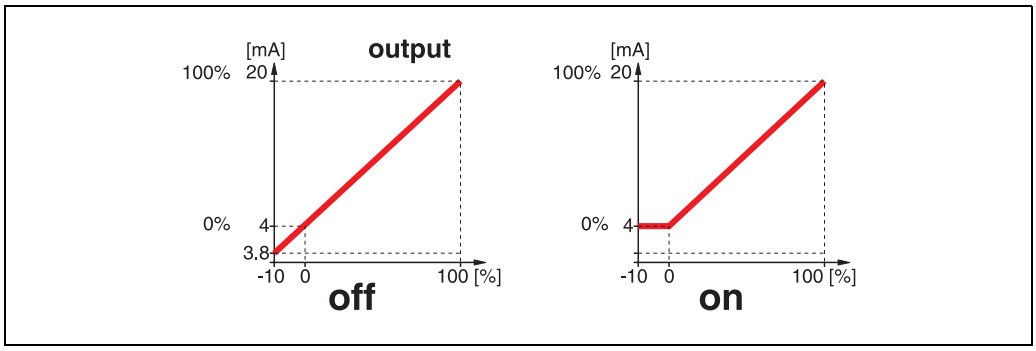
Caution!
This function is available for PROFIBUS-PA devices only!

8.5 Function "thres. main val." (062), HART only



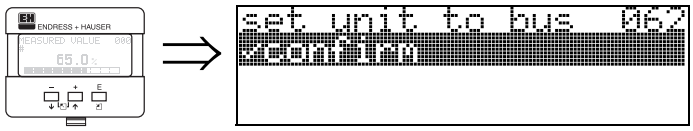
The output of negative level values can be suppressed with this function.

Selection:
- **off**: minimum output -10% (3.8 mA for HART)
- on**:** minimum output 0% (4 mA for HART)



Caution!
This user input is available for HART devices only!

8.6 Function "set unit to bus" (062), PROFIBUS-PA only

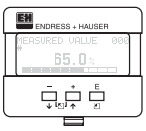


- confirm

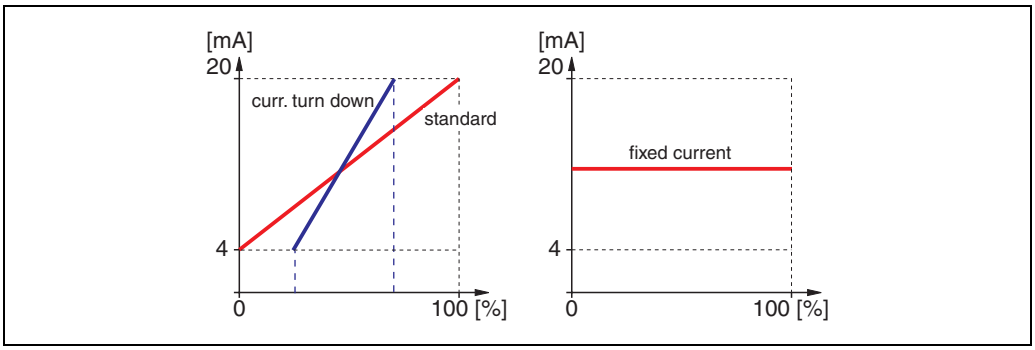
After confirming this function, the unit of the measured variable is taken over in the AI block (PV scale -> Out scale).
This function must always be executed after changing the unit.

Caution!
This function is available for PROFIBUS-PA devices only!

8.7 Function "curr. output mode" (063), HART only



In this function you specify the mode of the current output.
You may choose one of the following options:



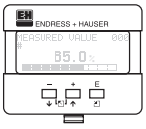
standard
The total measuring range (0 ... 100%) will be mapped to the current intervall (4 ... 20 mA).

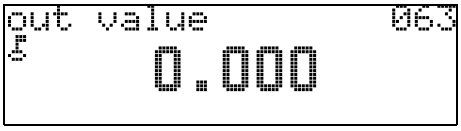
curr. turn down
Only a part of the measuring range will be mapped to the current intervall (4 ... 20 mA).
Use the functions **"4-mA-value" (068)** and **"20-mA-value" (069)** to define the concerning range.

fixed current
The current is fixed. The measured value is transmitted by the HART signal only. The value of the current is defined in the **"fixed current" (064)** function.

Caution!
This function is active for HART devices only.

8.8 Function "out value" (063), PROFIBUS-PA only





This displays the AI block output.

Caution!
This function is available for PROFIBUS-PA devices only!

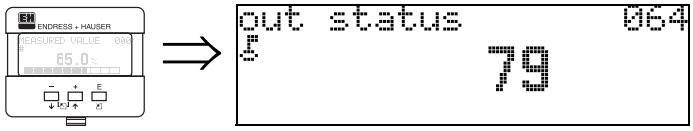
8.9 Function "fixed cur. value" (064), HART only

Set the fixed current value with this function. This entry is necessary when you have switched on the "**fixed current**" **(063)** function.

User input:
3,8...20,5 mA

Caution!
This user input is available for HART devices only!

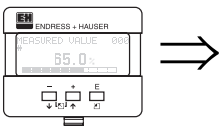
8.10 Function "out status" (064), PROFIBUS-PA only



Displays the current output status (for value, see operating instructions of relevant instrument).

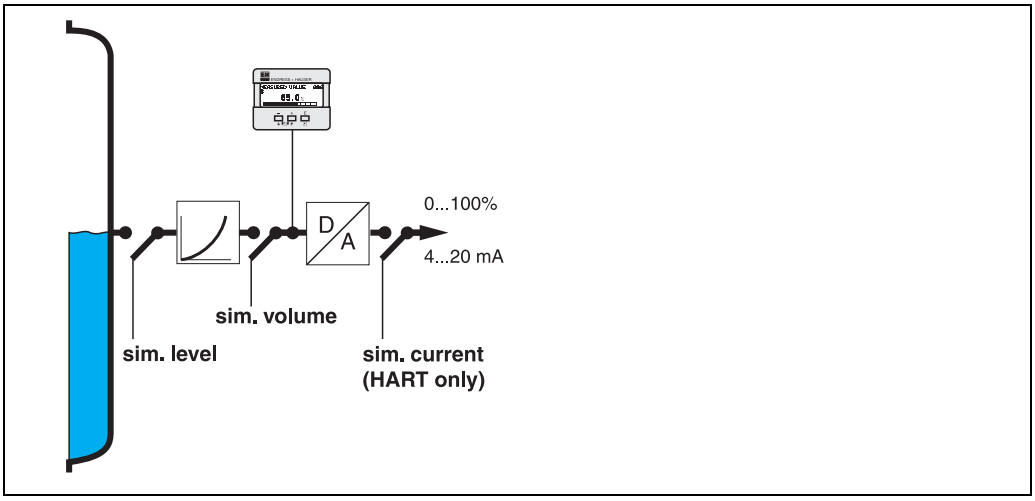
Caution!
This function is available for PROFIBUS-PA devices only!

8.11 Function "simulation" (065)



If necessary, linearisation, the output signal and the current output can be tested with the simulation function. You have the following simulation options:

Selection:
- **sim. off**
- sim. level
- sim. volume
- sim. current (HART only)



sim. off
Simulation is switched off.

sim. level
Enter the level value in "**simulation value**" **(066)**.
The functions
- measured value (000)
- measured level (0A6)
- output current" (067) - only with HART instruments!

follow the entered values.

sim. volume
Enter the volume value in "**simulation value**" **(066)**.
The functions
- measured value (000)
- output current" (067) - only with HART instruments!

follow the entered values.

sim. current (HART only)
Enter the current value in "**simulation value**" **(066)**.
The function
- output current" (067) - only with HART instruments!

follows the entered values.

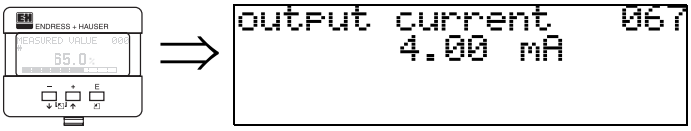
8.12 Function "simulation value" (066)

After selecting the "**sim. level**" option in the "**simulation**" **(065)** function, the following message appears in the display: you can enter the level.

After selecting the "**sim. volume**" option in the "**simulation**" **(065)** function, the following message appears in the display: you can enter the volume.

After selecting the "**sim. current**" option in the "**simulation**" **(065)** function, the following message appears in the display: Enter the output current (only for HART instruments).

8.13 Function "output current" (067), HARD only



Displays the output current in mA.

Caution!
This function is available for HART devices only!

8.14 Function "2nd cyclic value" (067), PROFIBUS-PA only

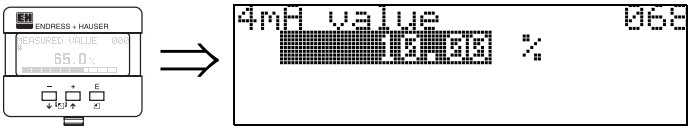
Selects the second cyclical value.

- height/dist.

The Prosonic M always transmits the distance as the second cyclical value.

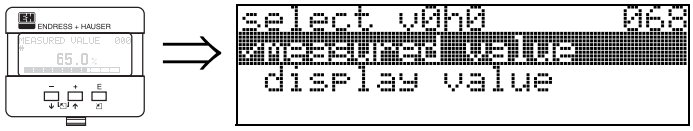
Caution!
This function is available for PROFIBUS-PA devices only!

8.15 Function "4mA-value" (068), HARD only



In this function specify the level (or volume, weight, flow resp.), at which the output current should be 4 mA. This value will be used if you choose the option "curr. turn down" in the **"current output mode" (063)** function.

8.16 Function "select v0h0" (068), PROFIBUS-PA only



Selects the value displayed in "**measured value**" **(000)**.

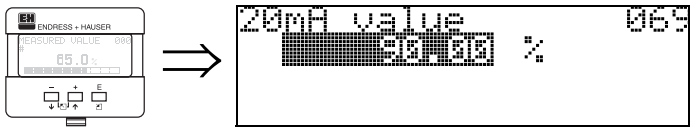
Selection:
- **measured value**
- display value

measured value
The configured measured value is displayed in the "**measured value**" **(000)** function.

display value
The value in "**display value**" **(069)** is displayed in the "**measured value**" **(000)** function.

Caution!
This function is available for PROFIBUS-PA devices only!

8.17 Function "20mA-value" (069), HART only



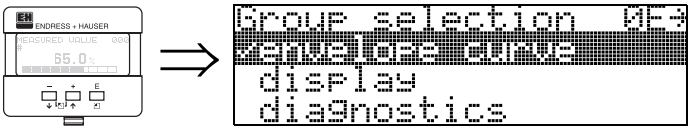
In this function specify the level (or volume, weight, flow resp.), at which the output current should be 20 mA. This value will be used if you choose the option "curr. turn down" in the **"current output mode" (063)** function.

8.18 Function "display value" (069), PROFIBUS-PA only

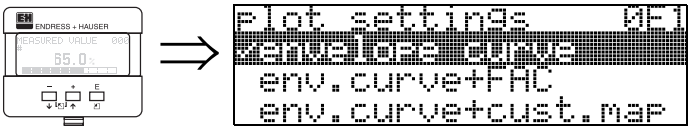
This field can be set externally, e.g. from a PLC. The value is then displayed as the main measured variable in the display by selecting the "**select v0h0**" **(068)** = "**display value**" function.

Caution!
This function is available for PROFIBUS-PA devices only!

9 Function group "Enelope curve" (0E)



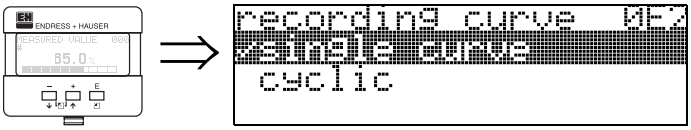
9.1 Function "plot settings" (0E1)



Here select which information is displayed in the LCD:
- **envelope curve**
- env.curve+FAC (on FAC see Page 71)
- env.curve+cust.map (i.e. customer tank map is also displayed, see Page 70)

9.2 Function "recording curve" (0E2)

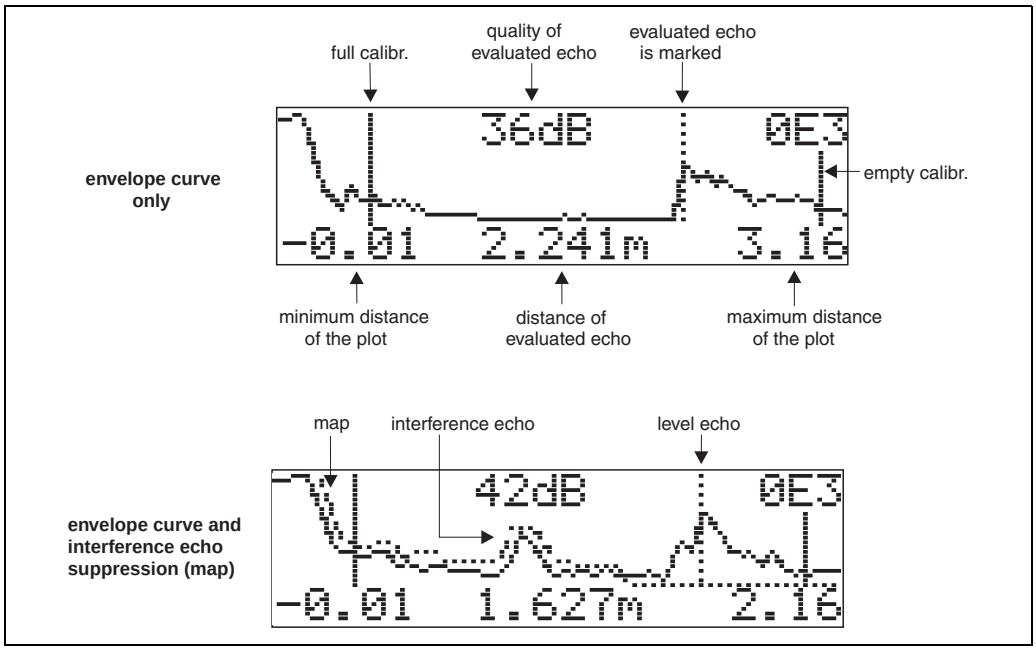
This function defines whether the envelope curve is read as a
- **single curve**
  or
- cyclic.



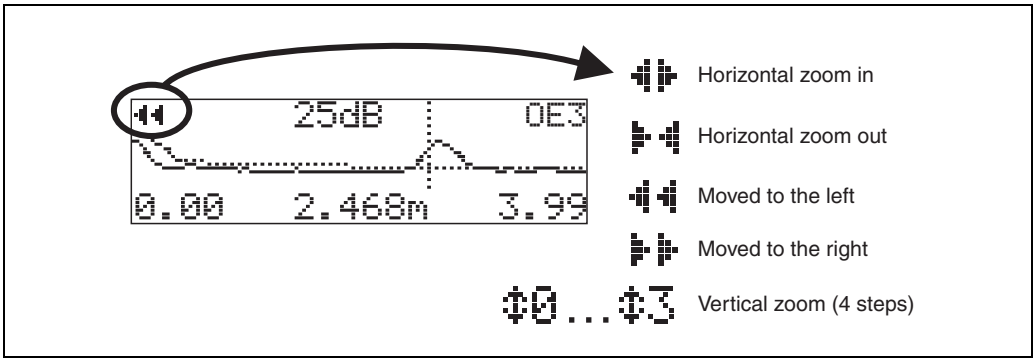
Note!
If the cyclical envelope curve is active in the display, the measured variable is refreshed in a slower cycle time. It is therefore recommended to exit the envelope curve display after optimising the measuring point.

9.3 Function "envelope curve display" (0E3)

The envelope curve is displayed in this function. You can use it to obtain the following information:

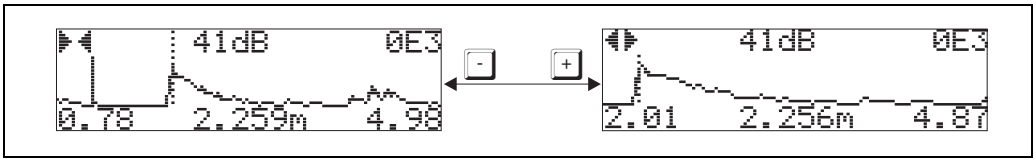


Navigating in the envelope curve display
Using navigation, the envelope curve can be scaled horizontally and vertically and shifted to the left or the right. The active navigation mode is indicated by a symbol in the top left hand corner of the display.



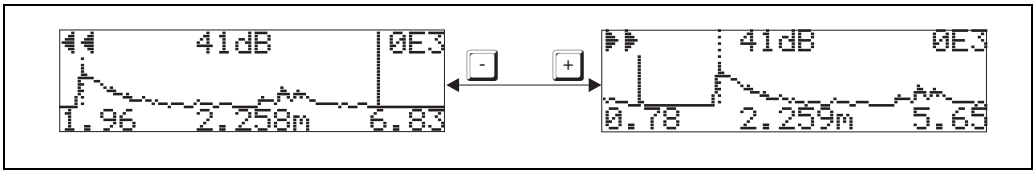
Horizontal Zoom mode

Firstly, go into the envelope curve display (see Page 31). Then press ⊞ or ⊟ to switch to the envelope curve navigation. You are then in Horizontal Zoom mode. Either ⇹ or ⇸⇷ is displayed.
You now have the following options:
- ⊞ increases the horizontal scale.
- ⊟ reduces the horizontal scale.



Move mode

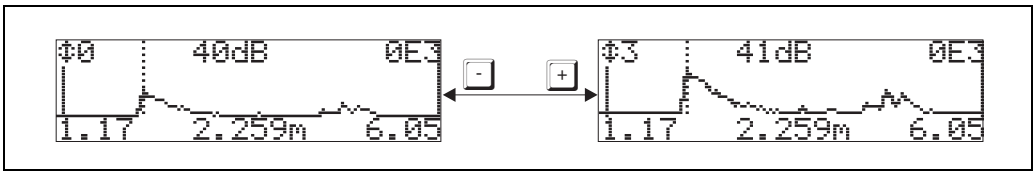
Then press E to switch to Move mode. Either ⊫ or ⊩ is displayed.
You now have the following options:
- + shifts the curve to the right.
- - shifts the curve to the left.



Vertical Zoom mode

Press E once more to switch to Vertical Zoom mode. ⇳1 is displayed.
You now have the following options:
- + increases the vertical scale.
- - reduces the vertical scale.

The display icon shows the current zoom factor (⇳0 to ⇳3).

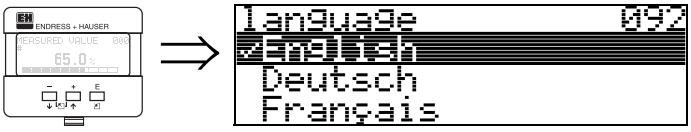


Exiting the navigation

- Press E again to run through the different modes of the envelope curve navigation.
- Press + and - to exit the navigation. The set increases and shifts are retained. Only when you reactivate the **"recording curve" (0E2)** function does the Prosonic use the standard display again.

10 Function group "display" (09)

10.1 Function "language" (092)



Selects the display language.

Selection:
- **English**
- Deutsch
- Français
- Español
- Italiano
- Nederlands

Dependence
All texts are changed.

Caution!
This function is not visualised in Commuwin II!

10.2 Function "back to home" (093)

If no entry is made using the display during the specified time period, the display returns to the measured value display.
9999 s means that there is no return.

User input:
3...9999 s

Caution!
This function is not visualised in Commuwin II!

10.3 Function "format display" (094)

Selects the display format.

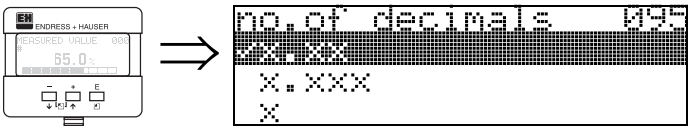
Selection:
- **decimal**
- 1/16''

decimal
The measured value is given in decimal form in the display (e.g. 10.70%).

1/16"
The measured value is given in the display in this format (e.g 5'05-14/16").
This option is only possible for "**distance unit**" **(0C5)** - "**ft**" and "**in**"!

Caution!
This function is not visualised in Commuwin II!

10.4 Function "no.of decimals" (095)



Selection:
- x
- x.x
- **x.xx**
- x.xxx

10.5 Function "sep. character" (096)

Selection:
- **.**
- ,

.
The decimal place is separated by a point.

,
The decimal place is separated by a comma.

10.6 Function "display test" (097)

All display pixels are switched on. If the whole LCD is dark, it is working correctly.

11 Function group "diagnostics" (0A)

In the "**diagnostics**" function group, you can display and confirm error messages.

Type of error
Errors that occur during commissioning or measuring are displayed immediately on the local display. If two or more system or process errors occur, the error with the highest priority is the one shown on the display.
The measuring system distinguishes between two types of error:

- **A (Alarm):**
  Instrument goes into a defined state (e.g. MAX)
  Indicated by a constant ϟ symbol.
  (For a description of the codes, see Page 73)
- **W (Warning):**
  Instrument continue measuring, error message is displayed.
  Indicated by a flashing ϟ symbol.
  (For a description of the codes, see Page 73)
- **E (Alarm / Warning):**
  Configurable (e.g. loss of echo, level within the safety distance)
  Indicated by a constant/flashing ϟ symbol.
  (For a description of the codes, see Page 73)

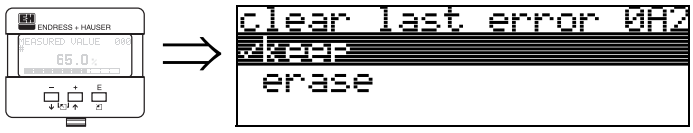
11.1 Function "present error" (0A0)

The present error is shown using this function.

11.2 Function "previous error" (0A1)

The last error presented is shown with this function.

11.3 Function "clear last error" (0A2)



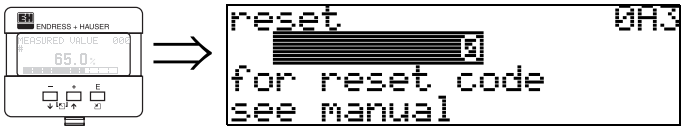
Selection:
- **keep**
- erase

Caution!
This function can be performed on the display only!

11.4 Function "reset" (0A3)

Caution!
A reset sets the instrument back to the factory settings. This can lead to an impairment of the measurement. Generally, you should perform a basic setup again following a reset.

A reset is only necessary:
- if the instrument no longer functions
- if the instrument must be moved from one measuring point to another
- if the instrument is being de-installed /put into storage/installed



Entry ("reset" (0A3)):
- 333 = customer parameters (HART)
- 33333 = customer parameters (PROFIBUS-PA and Foundation Fieldbus)

333 = reset customer parameters for HART
33333 = reset customer parameters for PROFIBUS-PA and Foundation Fieldbus
This reset is recommended whenever an instrument with an unknown 'history' is to be used in an application:
- The Micropilot is reset to the default values.
- The customer specific tank map is not deleted.
- A linearisation is switched to "**linear**" although the table values are retained. The table can be reactivated in the "**linearisation**" **(04)** function group.

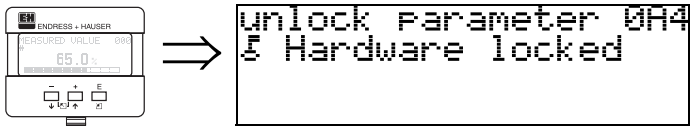
List of functions that are affected by a reset:

- tank shape (002)
- empty calibr. (005)
- full calibr. (006)
- output on alarm (010)
- output on alarm (011)
- outp. echo loss (012)
- ramp %span/min (013)
- delay time (014)
- safety distance (015)
- in safety dist. (016)
- level/ullage (040)
- linearisation (041)
- customer unit (042)
- diameter vessel (047)
- range of mapping (052)
- pres. Map dist (054)
- offset (057)
- low output limit (062)
- fixed current (063)
- fixed cur. value (064)
- simulation (065)
- simulation value (066)
- format display (094)
- distance unit (0C5)
- download mode (0C8)

The tank map can also be reset in the "**cust. tank map**" **(055)** function of the "**extended calibr.**" **(05)** function group.

This reset is recommended whenever an instrument with an unknown 'history' is to be used in an application or if a faulty mapping was started:
- The tank map is deleted. The mapping must be recommenced.

11.5 Function "unlock parameter" (0A4)



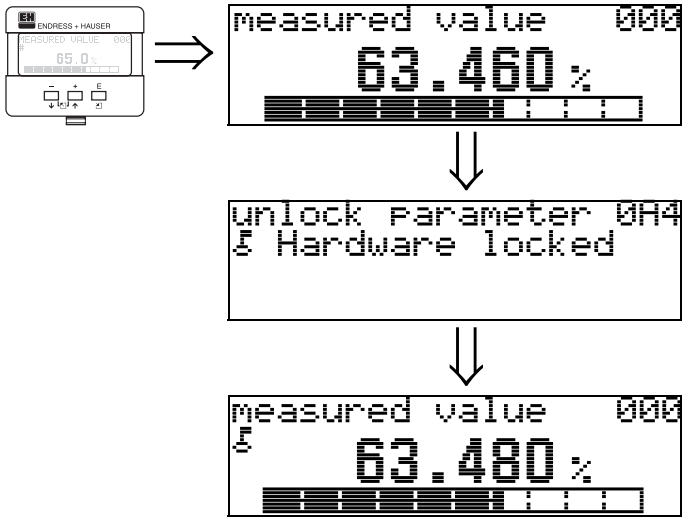
Set-up can be locked and unlocked with this function.

11.5.1 Locking of the configuration mode

The Micropilot can be protected in two ways against unauthorised changing of instrument data, numerical values or factory settings:

"**unlock parameter**" **(0A4):**
A value **<> 100 for HART** (e.g. 99) or **<> 2457 for PROFIBUS-PA and Foundation Fieldbus** (e.g. 2456) must be entered in "**unlock parameter**" **(0A4)** in the "**diagnostics**" **(0A)** function group. The lock is shown on the display by the symbol and can be released again either via the display or by communication.

Hardware lock:
The instrument is locked by pressing the + and − and E keys at the same time.
The lock is shown on the display by the symbol and can **only** be unlocked again via the display by pressing the + and − and E keys at the same time again. It is **not** possible to unlock the hardware by communication.
All parameters can de displayed even if the instrument is locked.



+ and − and E press simultaneous

The LOCK_SYMBOL appears on the LCD.

11.5.2 Unlocking of configuration mode

If an attempt is made to change parameters when the instrument is locked, the user is automatically requested to unlock the instrument:

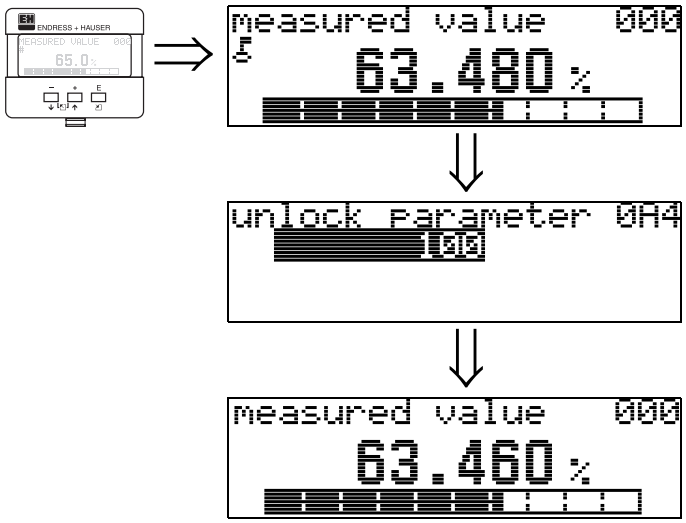
"**unlock parameter**" **(0A4):**
By entering the unlock parameter (on the display or via communication)

100 = for HART devices
2457 = for PROFIBUS-PA and Foundation Fieldbus devices

the Micropilot is released for operation.

Hardware-Verriegelung:
After pressing the [+] and [−] and [E] keys at the same time, the user is asked to enter the unlock parameter

100 = for HART devices
2457 = for PROFIBUS-PA and Foundation Fieldbus devices.

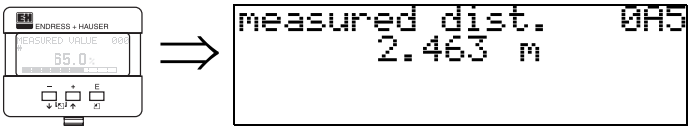


[+] and [−] and [E] press simultaneous

Please enter unlock code and confirm with [E].

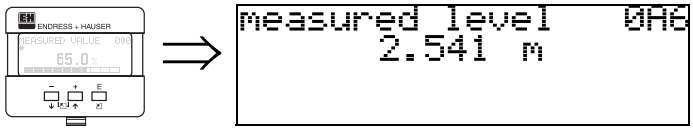
Caution!
Changing certain parameters such as all sensor characteristics, for example, influences numerous functions of the entire measuring system, particularly measuring accuracy. There is no need to change these parameters under normal circumstances and consequently, they are protected by a special code known only to the E+H service organization. Please contact Endress+Hauser if you have any questions.

11.6 Function "measured dist." (0A5)

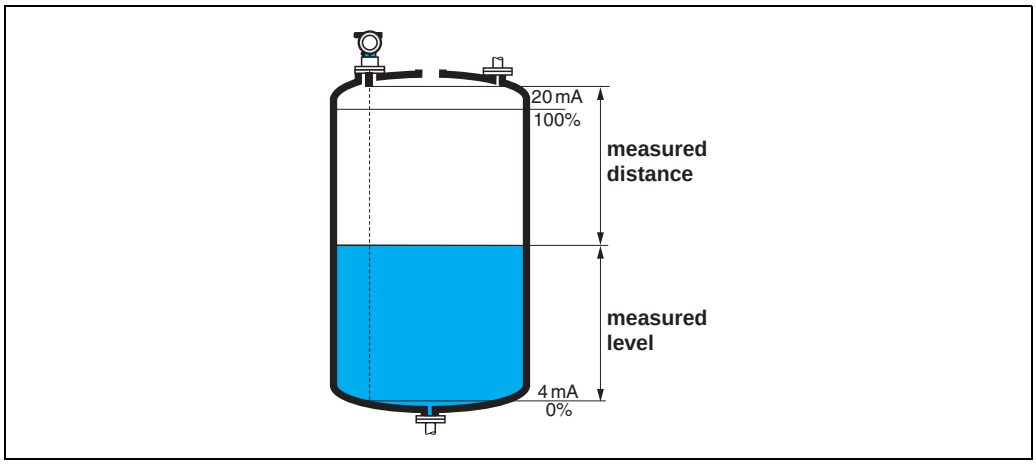


Display of measured distance in the selected "**distance unit**" **(0C5)**.

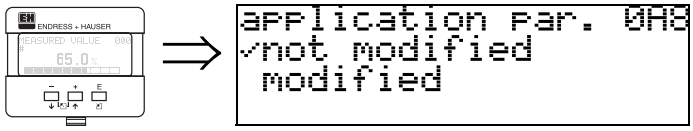
11.7 Function "measured level" (0A6)



Display of measured level in the selected "**distance unit**" **(0C5)**.

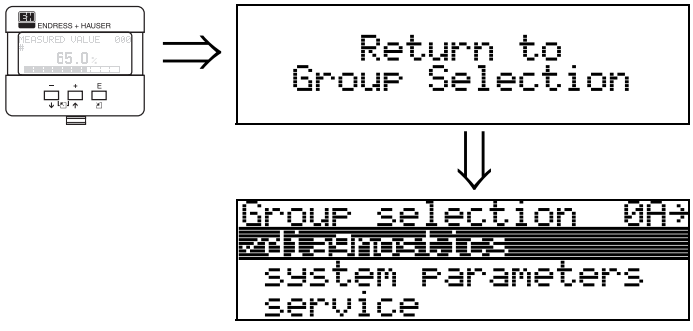


11.8 Function "application par." (0A8)



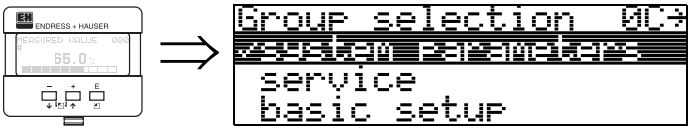
Displays whether or not one of the settings dependent on the "**tank shape**" **(002)**, "**medium property**" **(003)** and "**process cond.**" **(004)** application parameters has been changed or not.
If, for example, the "**output damping**" **(058)** is changed, the "**application par.**" shows "**modified**".

Display:
- **not modified**
- modified



After 3 s, the following message appears

12 Function group "system parameters" (0C)



12.1 Function "tag no." (0C0)

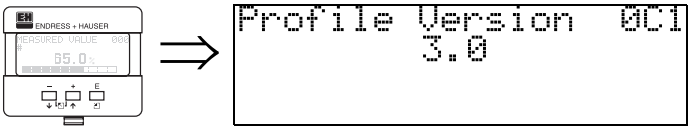
You can define the tag number with this function.

User input:
- 16 alphanumeric characters for HART instruments (8 using the HART universal command)
- 32 alphanumeric characteristics for PROFIBUS-PA instruments

12.2 Function "device tag" (0C0), Foundation Fieldbus only

This function displays the tag number.

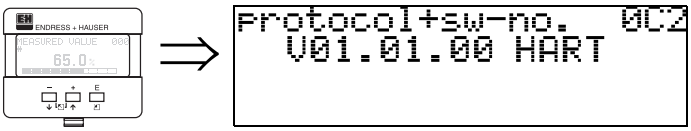
12.3 Function "Profile Version" (0C1), PROFIBUS-PA only



The PA Profile version is shown using this function (Profile 3.0).

Caution!
This function is available for PROFIBUS-PA devices only!

12.4 Function "protocol+sw-no." (0C2)



This function shows the protocol and the hardware and software version: Vxx.yy.zz.prot.

Display:
xx: hw-version
yy: sw-version
zz: sw-revision
prot: protocoll type (e.g. HART)

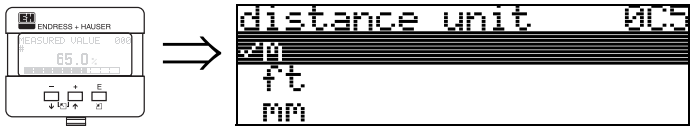
12.5 Function "serial no." (0C4)

This function displays the instrument serial number.

12.6 Function "device id" (0C4), Foundation Fieldbus only

This function displays the instrument serial number.

12.7 Function "distance unit" (0C5)



You can select the basic distance unit with this function.

Selection:
- **m**
- ft
- mm
- inch

Dependence
m, mm: "**format display**" **(094)** can only be "**decimal**".

The units are changed for the following parameters:
- empty calibr. (005)
- full calibr. (006)
- safety distance (015)
- input level (044)
- diameter vessel (047)
- range of mapping (052)
- cust. tank map (055)
- offset (057)
- simulation value (066)
- measured dist. (0A5)
- measured level(0A6)

12.8 Function "temperature unit" (0C6)

In this function you select the temperature unit.

Selection:
- °C
- **°F**

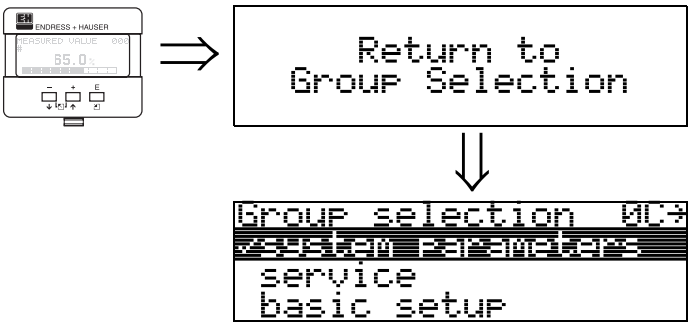
The unit is changed for the following functions
- Function **"measured temp." (030)**
- Function **"max. temp. limit" (031)**
- Function **"max. meas. temp" (032)**

12.9 Function "download mode" (0C8)

This parameter defines which values are written to the instrument during a ToF Tool or Commuwinn II configuration download.

Selection:
- **parameter only**
- param+cust.map
- mapping only

Note!
This parameter must not be described explicitly in ToF Tool. The various possibilities can be selected from the download dialog.



After 3 s, the following message appears

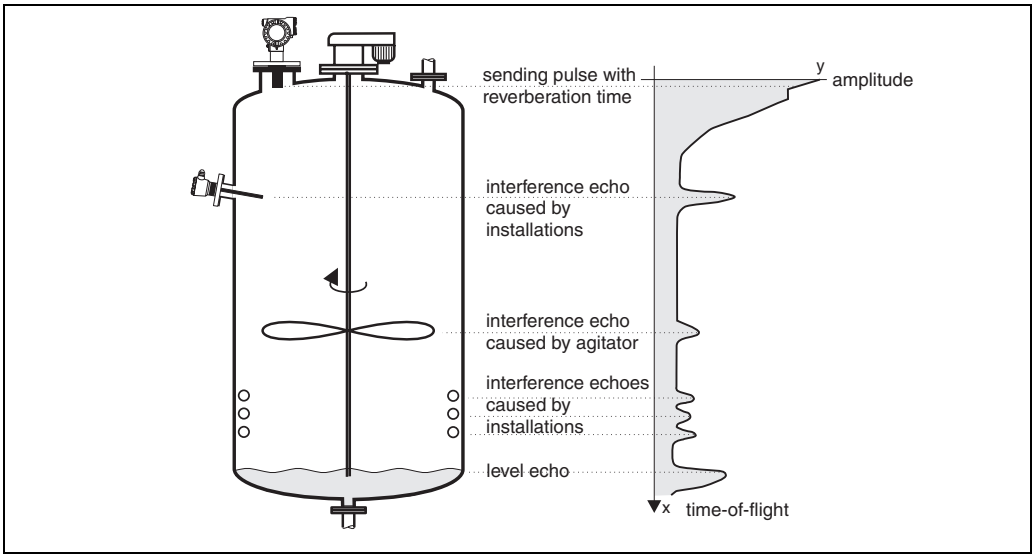
13 Function group "service" (0D)

You can find a detailed description of the "Service" function group as well as a detailed overview of the function menu in the Service Manual: SM 10F for Prosonic M.

14 Signal evaluation

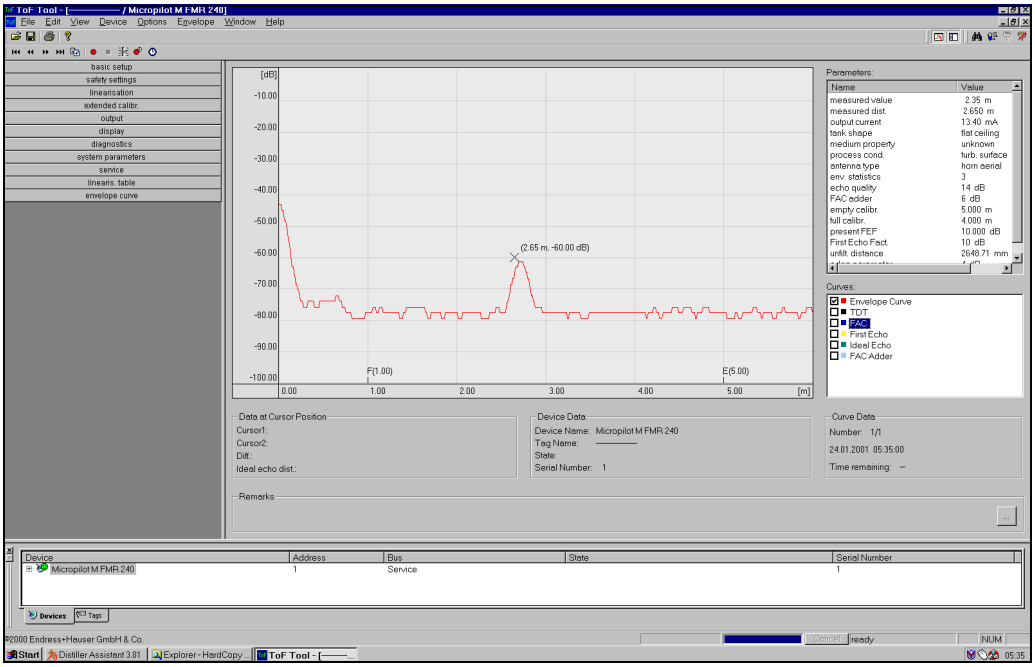
14.1 Envelope curve

The echo of an ultrasonic impulse does not only contain the desired echo from the product surface, but also interference echoes (e.g. from tank fittings or multiple reflections). In order to identify these echoes one plots the logarithmic amplitude of the echo versus the time-of-flight of the ultrasonic impulse. This plot is called **envelope curve**.



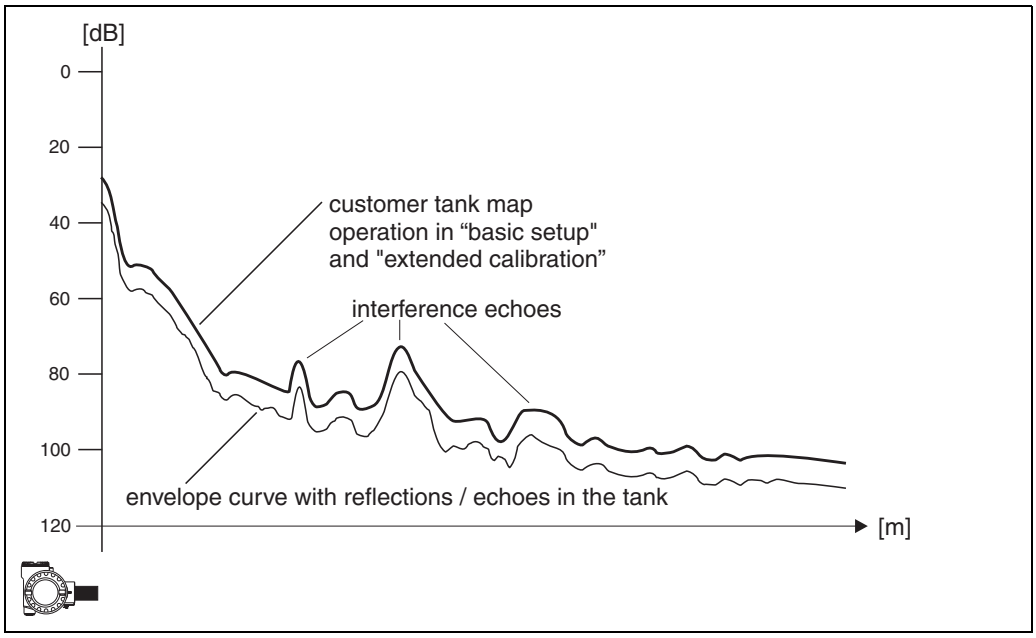
The envelope curve can be displayed in the **"envelope curve" (0E)** function group (see Page 52).

In the ToF Tool the envelope curve may also be displayed in the "envelope" menu:



14.2 Interference echo suppression (tank mapping)

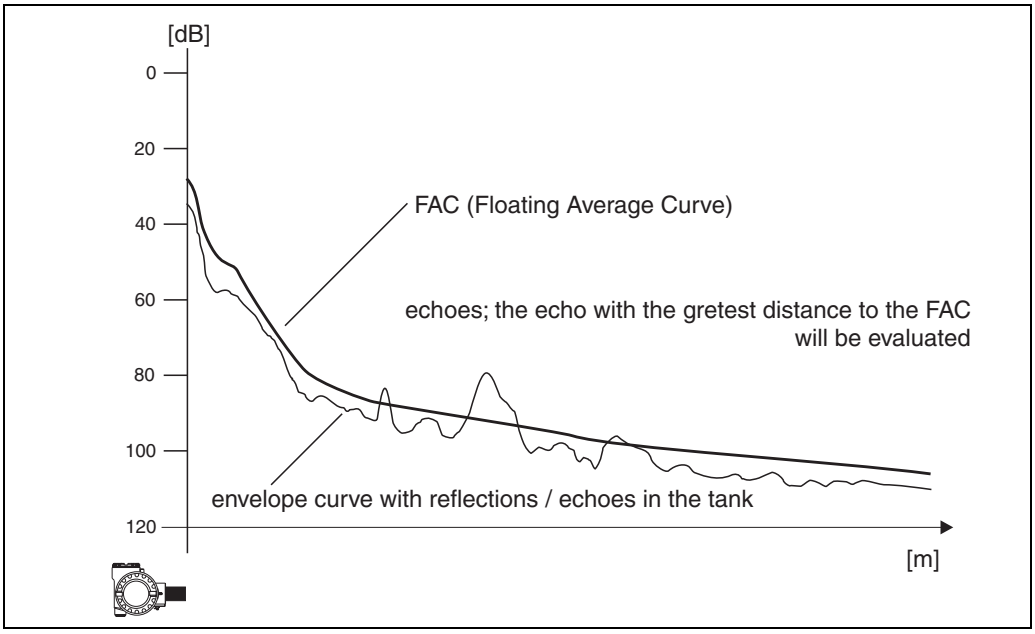
The interference echo suppression of the Prosonic M makes sure that interference echoes are not interpreted as the level echo by fault.
In order to carry out the interference echo suppression one must record a time-of-flight dependent threshold (**TDT**), which is also called the **tank map**.
All maxima of the envelope curve which are situated below the TDT are discarded by the signal evaluation procedures.



It is recommended to record the tank map when the vessel is as possible empty. Then, the map will inclue all echoes except the level echo.
But even, if it is not possible to empty the vessel during the commissioning of the Prosonic M, you should perform the map. In this case it is recommended to repeat the record of the mapping at a later time - when the vessel is as possible empty.

The tank map is recorded in the function group **"extended calibration" (05)**. Select the option "mapping" in the **"selection" (050)** function.

14.3 Floating Average Curve (FAC)



The function of the Floating Average Curve (FAC) is similar to the interference echo suppression.
The main difference is, that the tank map is recorded only once whilst the FAC adjusts itself continuously to the changing measuring conditions.
By this procedure changes of the interference echoes (e.g. by build-up) can be compensated for.
In contrast to the tank map, the FAC can only register small interference echoes.
The FAC is always used in the signal evaluation, even if the tank map has been deactivated.
In the envelope curve, the maximum with the largest distance to the FAC is interpreted as the level echo.

15 Trouble shooting

15.1 System error messages

Current error
Errors which the Prosonic M detects during commissioning or operation are displayed:
- In the **"measured value" (000)** function
- In the **"diagnostics" (0A)** function group in the **"present error" (0A0)** function (only the highest priority error is displayed; in the case of multiple errors, you can scroll between the different error messages by pressing □ or □.)

Last error
The last error is displayed in the **"diagnostics" (0A)** function group in the **"previous error" (0A1)** function. This display can be deleted in the **"clear last error" (0A2)** function.

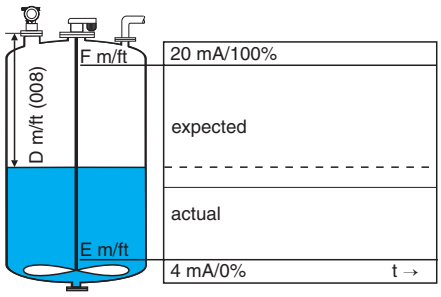
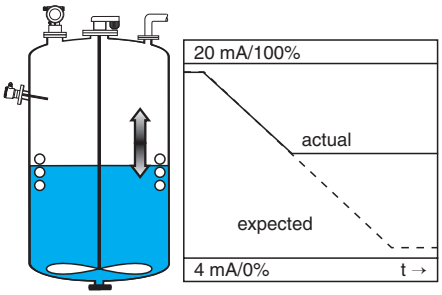
Types of errors

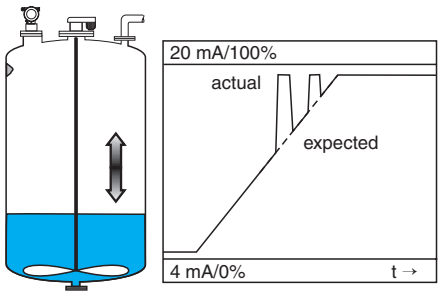
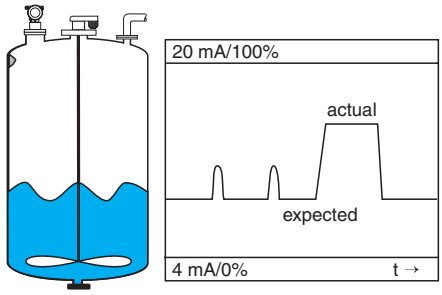
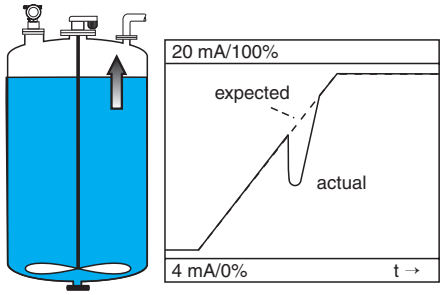
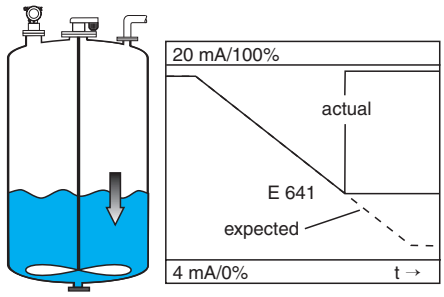
Type of error	Symbol	Meaning
Alarm (A)	Continuous	The output signal assumes a value which can be set using the **"**output on alarm**" (010)** function: • MAX: 110%, 22mA • MIN: -10%, 3.8mA • Hold: last value is on hold • User-specific value
Warning (W)	Flashing	The device continues measurement. An error message is displayed.
Alarm/Warning (E)	You can define whether the error should behave as an alarm or as a warning.	

Error codes

Code	Error description (on the display)	Action
A101 A102 A110 A152 A160	checksum error	Reset; If alarm still present after reset, replace electronics
W103	initialising	If the message does not disappear after several seconds, replace the electronics
A106	downloading	Wait Message disappears after load sequence
A111 A113 A114 A115 A121 A125 A155 A164 A171	electronics defect	Reset; Check system for EMC, improve as necessary If alarm still present after reset, replace electronics
A116	download error	Check connection Restart download
W153	initialising	Wait a few seconds; if error is still displayed, switch the power off and on again
A231	sensor defect	Check connection, if necessary replace HF module or electronics
A281	interruption temperature sensor	Exchange sensor
A502	Sensor type not detected	Exchange sensor and/or electronics
W511	no factory calibration	Carry out factory calibration
A512	recording of mapping	Alarm disappears after a few seconds
A521	new sensor type detected	Reset
W601	linearisation curve not monotone	Correct table (enter monotonously increasing table)
W611	less than 2 linea-risation points	Enter additional value pairs
W621	simulation on	Switch simulation mode off [**"output" (06)** function group, **"simulation" (065)** function]
E641	no usable echo	Check basic calibration (see Page 26)
E651	level in safety distance - risk of overspill	Error disappears when the level leaves the safety distance. Possibly reset the lock. [**"safety settings" (01)** function group, **"ackn. alarm" (017)** function]
A661	Sensor overtemperature	
A671	Linearisation incomplete	Activate linearisation table
W681	current out of range	Carry out basic calibration; check linearisation
W691	Filling noise detected, level ramp is active	

15.2 Application errors

Error	Output	Possible cause		Elimination
A warning or alarm is present.	Depending on the configuration	See Error Codes table (Page 73)		1. See Error Codes table (Page 73)
Measured value (00) is incorrect		Measured distance (008) OK?	yes →	1. Check empty calibration (005) and full calibration (006). 2. Check linearisation: → level/ullage (040) → max. scale(046) → diameter vessel(047) → Check table
		no ↓		
		Measurement in bypass or stilling well?	yes →	1. In tank shape(002) is bypass or stiliing well selected?
		no ↓		
		An interference echo might be under evaluation.	yes →	1. Carry out interference echo suppression → basic setup
No change in measured value on filling/ emptying		Interference echoes from fixings, nozzles or build-up on sensor membrane		1. Carry out interference echo suppression → basic setup 2. Clean sensor if necessary 3. If necessary, select better installation position

Error	Output	Possible cause		Elimination
With an uneven surface (e.g. filling, emptying, running agitator) the measured value may jump sporadically to higher levels	 	Signal is weakened by uneven surface — periodically interference echos, e.g. from internals, are stronger		1. Carry out interference echo suppression → basic setup 2. Set the process cond. (004) to "calm surface" or "add. agitator" 3. Increase output damping (058) 4. If necessary, select a different installation position and/or a larger sensor
On filling/ emptying the measured value drops		Multiple echoes	yes →	1. Check tank shape (002), e.g. "dome ceiling" or "horizontal cyl." 2. In the blocking distance range (059) there is no echo evaluation 3. If possible, do not select a central installation position 4. Possible user stilling well/echo guide pipe
E 641 (echo loss)		Level echo is too weak. Possible causes: • Uneven surface through filling/ emptying • Active agitator • Foam • Sensor not aligned parallel to product surface	yes →	1. Check application parameters (002), (003) and (004) 2. If necessary, select a different installation position and/or a larger sensor 3. Align the sensor parallel to the product surface (particularly for bulk solids applications)

Index function menu

Function group

Function

Europe

Austria
❑ Endress+Hauser Ges.m.b.H.
Wien
Tel. (01) 88056-0, Fax (01) 88056-35

Belarus
❑ Belorgsintez
Minsk
Tel. (0172) 508473, Fax (0172) 508583

Belgium / Luxembourg
❑ Endress+Hauser N.V.
Brussels
Tel. (02) 2480600, Fax (02) 2480553

Bulgaria
INTERTECH-AUTOMATION
Sofia
Tel. (02) 664869, Fax (02) 9631389

Croatia
❑ Endress+Hauser GmbH+Co.
Zagreb
Tel. (01) 6637785, Fax (01) 6637823

Cyprus
I+G Electrical Services Co. Ltd.
Nicosia
Tel. (02) 484788, Fax (02) 484690

Czech Republic
❑ Endress+Hauser GmbH+Co.
Praha
Tel. (026) 6784200, Fax (026) 6784179

Denmark
❑ Endress+Hauser A/S
Søborg
Tel. (70) 131132, Fax (70) 132133

Estonia
ELVI-Aqua
Tartu
Tel. (7) 441638, Fax (7) 441582

Finland
❑ Endress+Hauser Oy
Helsinki
Tel. (0204) 83160, Fax (0204) 83161

France
❑ Endress+Hauser S.A.
Huningue
Tel. (389) 696768, Fax (389) 694802

Germany
❑ Endress+HauserMesstechnik GmbH+Co.
Weil am Rhein
Tel. (07621) 975-01, Fax (07621) 975-555

Great Britain
❑ Endress+Hauser Ltd.
Manchester
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I & G Building Services Automation S.A.
Athens
Tel. (01) 9241500, Fax (01) 9221714

Hungary
Mile Ipari-Elektro
Budapest
Tel. (01) 4319800, Fax (01) 4319817

Iceland
BIL ehf
Reykjavik
Tel. (05) 619616, Fax (05) 619617

Ireland
Flomeaco Company Ltd.
Kildare
Tel. (045) 868615, Fax (045) 868182

Italy
❑ Endress+Hauser S.p.A.
Cernusco s/N Milano
Tel. (02) 92192-1, Fax (02) 92192-362

Latvia
Rino TK
Riga
Tel. (07) 315087, Fax (07) 315084

Lithuania
UAB "Agava"
Kaunas
Tel. (07) 202410, Fax (07) 207414

Netherlands
❑ Endress+Hauser B.V.
Naarden
Tel. (035) 6958611, Fax (035) 6958825

Norway
❑ Endress+Hauser A/S
Tranby
Tel. (032) 859850, Fax (032) 859851

Poland
❑ Endress+Hauser Polska Sp. z o.o.
Warszawy
Tel. (022) 7201090, Fax (022) 7201085

Portugal
Tecnisis - Tecnica de Sistemas Industriais
Linda-a-Velha
Tel. (21) 4267290, Fax (21) 4267299

Romania
Romconseng S.R.L.
Bucharest
Tel. (01) 4101634, Fax (01) 4112501

Russia
❑ Endress+Hauser Moscow Office
Moscow
Tel. (095) 1587564, Fax (095) 1589871

Slovakia
Transcom Technik s.r.o.
Bratislava
Tel. (7) 44888684, Fax (7) 44887112

Slovenia
❑ Endress+Hauser D.O.O.
Ljubljana
Tel. (01) 5192217, Fax (01) 5192298

Spain
❑ Endress+Hauser S.A.
Sant Just Desvern
Tel. (93) 4803366, Fax (93) 4733839

Sweden
❑ Endress+Hauser AB
Sollentuna
Tel. (08) 55511600, Fax (08) 55511655

Switzerland
❑ Endress+Hauser Metso AG
Reinach/BL 1
Tel. (061) 7157575, Fax (061) 7111650

Turkey
Intek Endüstriyel Ölcü ve Kontrol Sistemleriltanbul
Tel. (0212) 2751355, Fax (0212) 2662775

Ukraine
Photonika GmbH
Kiev
Tel. (44) 26881, Fax (44) 26908

Yugoslavia Rep.
Meris d.o.o.
Beograd
Tel.(11) 4441966, Fax (11) 4441966

Africa

Egypt
Anasia
Heliopolis/Cairo
Tel. (02) 4179007, Fax (02) 4179008

Morocco
Oussama S.A.
Casablanca
Tel. (02) 241338, Fax (02) 402657

South Africa
❑ Endress+Hauser Pty. Ltd.
Sandton
Tel. (011) 26280000, Fax (011) 2628062

Tunisia
Controle, Maintenance et Regulation
Tunis
Tel. (01) 793077, Fax (01) 788595

America

Argentina
❑ Endress+Hauser Argentina S.A.
Buenos Aires
Tel. (01) 145227970, Fax (01) 145227909

Bolivia
Tritec S.R.L.
Cochabamba
Tel. (042) 56993, Fax (042) 50981

Brazil
❑ Samson Endress+Hauser Ltda.
Sao Paulo
Tel. (011) 50313455, Fax (011) 50313067

Canada
❑ Endress+Hauser Ltd.
Burlington, Ontario
Tel. (905) 6819292, Fax (905) 6819444

Chile
❑ Endress+Hauser Chile Ltd.
Santiago
Tel. (02) 321-3009, Fax (02) 321-3025

Colombia
Colsein Ltda.
Bogota D.C.
Tel. (01) 2367659, Fax (01) 6104186

Costa Rica
EURO-TEC S.A.
San Jose
Tel. (02) 961542, Fax (02) 961542

Ecuador
Insetec Cia. Ltda.
Quito
Tel. (02) 269148, Fax (02) 461833

Guatemala
ACISAAutomatizacionYControlIndustrial S.A.
Ciudad de Guatemala, C.A.
Tel. (03) 345985, Fax (03) 327431

Mexico
❑ Endress+Hauser S.A. de C.V.
Mexico City
Tel. (5) 5682405, Fax (5) 5687459

Paraguay
Incoel S.R.L
.Asuncion
Tel. (021) 213989, Fax (021) 226583

Uruguay
Circular S.A.
Montevideo
Tel. (02) 925785, Fax (02) 929151

USA
❑ Endress+Hauser Inc.
Greenwood, Indiana
Tel. (317) 535-7138, Fax (317) 535-8498

Venezuela
Controval C.A.
Caracas
Tel. (02) 9440966, Fax (02) 9444554

Asia

China
❑ Endress+Hauser Shanghai Instrumentation Co. Ltd.
Shanghai
Tel. (021) 54902300, Fax (021) 54902303

❑ Endress+Hauser Beijing Office
Beijing
Tel. (010) 68344058, Fax: (010) 68344068

Hong Kong
❑ Endress+Hauser HK Ltd.
Hong Kong
Tel. 25283120, Fax 28654171

India
❑ Endress+Hauser (India) Pvt. Ltd.
Mumbai
Tel. (022) 8521458, Fax (022) 8521927

Indonesia
PT Grama Bazita
Jakarta
Tel. (21) 7975083, Fax (21) 7975089

Japan
❑ Sakura Endress Co. Ltd.
Tokyo
Tel. (0422) 540613, Fax (0422) 550275

Malaysia
❑ Endress+Hauser (M) Sdn. Bhd.
Petaling Jaya, Selangor Darul Ehsan
Tel. (03) 7334848, Fax (03) 7338800

Pakistan
Speedy Automation
Karachi
Tel. (021) 7722953, Fax (021) 7736884

Philippines
❑ Endress+Hauser Philippines Inc.
Metro Manila
Tel. (2) 3723601-05, Fax (2) 4121944

Singapore
❑ Endress+Hauser (S.E.A.) Pte., Ltd.
Singapore
Tel. 5668222, Fax 5666848

South Korea
❑ Endress+Hauser (Korea) Co., Ltd.
Seoul
Tel. (02) 6587200, Fax (02) 6592838

Taiwan
Kingjarl Corporation
Taipei R.O.C.
Tel. (02) 27183938, Fax (02) 27134190

Thailand
❑ Endress+Hauser Ltd.
Bangkok
Tel. (2) 9967811-20, Fax (2) 9967810

Vietnam
Tan Viet Bao Co. Ltd.
Ho Chi Minh City
Tel. (08) 8335225, Fax (08) 8335227

Iran
PATSA Co.
Tehran
Tel. (021) 8754748, Fax(021) 8747761

Israel
Instrumetrics Industrial Control Ltd.
Tel-Aviv
Tel. (09) 8357090, Fax (09) 8350619

Jordan
A.P. Parpas Engineering S.A.
Amman
Tel. (06) 4643246, Fax (06) 4645707

Kingdom of Saudi Arabia
Anasia Ind. Agencies
Jeddah
Tel. (02) 6710014, Fax (02) 6725929

Lebanon
Network Engineering
Jbeil
Tel. (3) 944080, Fax (9) 548038

Sultanate of Oman
Mustafa & Sultan Sience & Industry Co. L.L.C.
Ruwi
Tel. 602009, Fax 607066

United Arab Emirates
Descon Trading EST.
Dubai
Tel. (04) 2653651, Fax (04) 2653264

Yemen
YemenCompany for Ghee and Soap Industry
Taiz
Tel. (04) 230664, Fax (04) 212338

Australia + New Zealand

Australia
ALSTOM Australia Limited
Milperra
Tel. (02) 97747444, Fax (02) 97744667

New Zealand
EMC Industrial Group Limited
Auckland
Tel. (09) 4155110, Fax (09) 4155115

All other countries

❑ Endress+Hauser GmbH+Co. KG
Instruments International
Weil am Rhein
Germany
Tel. (07621) 975-02, Fax (07621) 975-345

http://www.endress.com

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In-Situ LevelTroll 500

In-Situ Inc.

Level **TROLL**®

OPERATOR'S MANUAL

Level ***TROLL*** *300*

Level ***TROLL*** *500*

Level ***TROLL*** *700*

Baro ***TROLL***

September 2006

Revision history

Beta draft June 10, 2005 (Level TROLL 500)
Initial release, June 27, 2005
Rev. 001, August 17, 2005
Rev. 002, April 2006 (Level TROLL 300, 500, 700, BaroTROLL)
Rev. 003, September 2006

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Support Line: 800 446 7488
(US & Canada)

In-Situ Inc.

Contents

1 INTRODUCTION

SYSTEM DESCRIPTION

Your new Level TROLL is a compact, modular system for measuring level and temperature in natural groundwater and surface water, as well as industrial, waste, and other installations. Components include the instrument body, vented and non-vented cables, communication cables, external power accessories, desiccants and other installation accessories, and software.

HOW TO USE THIS MANUAL

This operator's manual is designed as both a start-up guide and a permanent reference for the Level TROLL's features and applications.

Section 1: Introduction to the Level TROLL Operator's Manual and to In-Situ Inc. — Warranty Provisions — Instrument Repair & Return Recommendations

Section 2: Components and features of the Level TROLL system — Accessories — Product Specifications

Section 3: Getting Started — Attaching Cable — Installing & Launching the Software

Section 4: Using Win-Situ — Connecting for the First Time — Setting the Clock — Setting a Device Site — Preparing to Log Data —Disconnecting

Section 5: About the Pressure (Level) Sensor: The two basic types of pressure sensors — Factory and field calibration

Section 6: Field Installation — Guidelines and Precautions for Long-Term Deployment of the Level TROLL

Section 7: The BaroTROLL

Section 8: Connecting for use with SDI-12, Analog (4-20 mA), and Modbus loggers and controllers

Section 9: Care & Maintenance

Section 10: Troubleshooting

CONVENTIONS

Throughout this operator's manual you will see the following symbols.

The check mark highlights a tip about a convenient feature of the Level TROLL

The exclamation point calls your attention to a requirement or important action that should not be overlooked

CERTIFICATION

The Level TROLL complies with all applicable directives required by CE and the FCC and found to comply with EN 61326, ICES-003, and FCC Part 15 specifications. Declarations of conformity may be found at end of this manual.

UNPACKING AND INSPECTION

Your Level TROLL was carefully inspected before shipping. Check for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carriers involved if there is any such damage; do not attempt to operate the instrument. Accessories may be shipped separately and should also be inspected for physical damage and the fulfillment of your order.

TIP: *Please save packing materials for future storage and shipping of your Level TROLL. The shipping boxes have been performance-tested and provide protection for the instrument and its accessories.*

SERIAL NUMBER

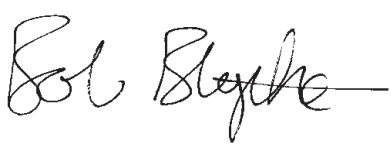
The serial number is engraved on the body of the Level TROLL. It is also programmed into the instrument and displayed when the instrument is connected to a computer running Win-Situ 5 or Win-Situ Mobile. We recommend that owners keep a separate record of this number. Should your Level TROLL be lost or stolen, the serial number is often necessary for tracing and recovery, as well as any insurance claims. If necessary, In-Situ maintains complete records of original owner's names and serial numbers.

TO OUR CUSTOMERS . . .

Thank you for your purchase of an In-Situ product. We are glad you chose us and our products to help you with your environmental monitoring needs. In-Situ Inc. has been designing and manufacturing world-class environmental monitoring instrumentation for over 25 years in the Rocky Mountains of the United States. As it was in the beginning, our expectation is that this product will provide you with many trouble-free years of use. To that end, we pride ourselves on delivering the best customer service and support possible—24 hours a day, 7 days a week. We believe that this level of commitment to you, our customer, is imperative in helping you ensure clean, safe groundwater and surface water resources across the globe. We also understand the need for accurate, reliable assessments and we continue to make significant investments in Research and Development to ensure that we deliver the latest product and technological innovations to support your needs.

Whether you are gathering information about your body of water for a few moments, or over a period of years, you can rely upon us to provide you with a quality product and outstanding customer support at a fair price and have that product delivered to you when and where you need it.

We want your experience with In-Situ Inc. to be pleasant and professional, whether you are renting from us, or purchasing from us. We would be pleased to hear from you and learn more about your needs, and your experiences with our products. Again, we thank you for choosing In-Situ Inc. and we look forward to serving your needs now, and in the future.



Bob Blythe, President and CEO
In-Situ Inc.
bblythe@in-situ.com

WHAT WE PROVIDE

WARRANTY PROVISIONS

In-Situ Inc. warrants all products sold against defects in materials and workmanship under normal operating conditions. Consult the separate warranty for specific warranties that may apply.

Maintenance & calibration plans as well as extended warranties are available for U.S. customers. Contact your In-Situ representative for complete information.

FIRMWARE & SOFTWARE UPGRADES

The Level TROLL is upgradeable. Contact In-Situ Inc. for details.

HOW TO CONTACT US

Technical Support:	800 446 7488
	Toll-free 24 hours a day in the U.S. and Canada
Address:	In-Situ Inc. 221 E. Lincoln Ave. Fort Collins, CO 80524 USA
Phone:	970 498 1500
Fax:	970 498 1598
Internet:	www.in-situ.com
e-mail:	support@in-situ.com

TO OBTAIN REPAIR SERVICE (U.S.)

If you suspect that your Level TROLL is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call or e-mail In-Situ Technical Support (support@in-situ.com). Have the product model and serial number handy.

2. Be prepared to describe the problem, including how the instrument was being used and the conditions noted at the time of the malfunction.

3. If Tech Support determines that service is needed, they will ask that your company pre-approve a specified dollar amount for repair charges. When the pre-approval is received, Tech Support will assign an RMA (Return Material Authorization) number.

TIP: *Please keep your RMA number for future reference.*

4. Clean the Level TROLL and cable. Decontaminate thoroughly if it has been used in a toxic or hazardous environment. See the Cleaning Guidelines and form on page 13.

5. Carefully pack your Level TROLL in its original shipping box, if possible. Include a statement certifying that the instrument and cable have been decontaminated, and any supporting information.

6. Mark the RMA number clearly on the outside of the box with a marker or label.

7. Send the package, shipping prepaid, to

   In-Situ Inc.
   ATTN: Repairs
   221 E. Lincoln Ave.
   Fort Collins, CO 80524

The warranty does not cover damage during transit. We recommend the customer insure all shipments. Warranty repairs will be shipped back prepaid.

Outside the U.S.

Contact your international In-Situ distributor for repair and service information.

GUIDELINES FOR CLEANING RETURNED EQUIPMENT

If an instrument returned for servicing shows evidence of having been deployed in a toxic or hazardous environment, Customer Service personnel will require written proof of decontamination before they can service the unit.

Please help us protect the health and safety of our employees by cleaning and decontaminating equipment that has been subjected to any potential biological or health hazards, and labeling such equipment. Unfortunately, *we cannot service your equipment without such notification*. Please complete and sign the form on page 13 (or a similar statement certifying that the equipment has been cleaned and decontaminated) and send it along to us with each downhole instrument.

- We recommend a good cleaning solution, such as Alconox®, a glassware cleaning product available from In-Situ (Catalog No. 0029810) and laboratory supply houses.

TIP: *Alconox® is available from In-Situ Inc. (Catalog No. 29810).*

- Clean all cabling. Remove all foreign matter.
- Clean cable connector(s) with a clean, dry cloth. Do not submerge.
- Clean the probe body—including the nose cone, cable head, and protective caps. Remove all foreign matter.

If an instrument is returned to our Service Center for repair or recalibration without a statement that it has been cleaned and decontaminated, or in the opinion of our Service Representatives presents a potential health or biological hazard, we reserve the right to withhold service until proper certification has been obtained.

Decontamination & Cleaning Statement

Company Name _____ Phone _____

Address _____

City _____ State _____ Zip _____

Instrument Type _____ Serial Number _____

Contaminant(s) (if known) _____

_____

Decontamination procedure(s) used _____

_____

Cleaning verified by _____ Title _____

Date _____

In-Situ Inc.

2 SYSTEM COMPONENTS

BODY

There are no user-serviceable parts in the Level TROLL body.

The completely sealed Level TROLL contains pressure and temperature sensors, real-time clock, microprocessor, sealed lithium battery, data logger, and memory. Options include a vented or non-vented pressure sensor in a variety of ranges.

CABLE

Several basic cable types are used in the Level TROLL system.

***TIP:** Cable markings include VF = vent-free, HF = halogen-free*

- RuggedCable™, TPU-jacketed (Thermoplastic PolyUrethane)
  - vented or non-vented
  - Halogen-Free vented or non-vented (LSZH-rated, low smoke zero halide)
- Vented FEP* cable
- Stainless steel suspension wire for deployment of a non-vented instrument
- Communication cables for programming the device/downloading the logged data

** FEP (fluorinated ethylene propylene) is the generic equivalent of DuPont Teflon®*

RuggedCable™

Cable includes conductors for power and communication signals, a strength member, and a Kellems® grip to anchor the Level TROLL securely. Available in standard and custom lengths.

Uphole and downhole ends are identical “female” bayonet-type Twist-Lock connectors that mate with the Level TROLL body, TROLL Com communication cable, desiccants, and other accessories. Available in rugged all-titanium or standard carbon-filled ABS plastic.

Vented cable is designed for use with vented pressure/level sensors (gauged measurements). The cable vent tube insures that atmospheric pressure is the reference pressure applied to the sensor diaphragm. Vented cable includes a small desiccant cap.

Non-vented cable may be used with non-vented pressure/level sensors (absolute measurements).

RuggedCable "Stripped & Tinned"

In place of the "uphole" Twist-Lock connector, this cable ends in bare conductors for wiring to a logger or controller using SDI-12, analog (4-20 mA), or Modbus communication protocols. Vented cable includes an outboard desiccant to protect against condensation.

Also available in a shorter length ending in a "male" Twist-Lock connector to mate with RuggedCable.

For connections, refer to wiring diagrams in Section 7.

Suspension Wire

FEP-coated stainless steel suspension cable is ideal for deployment of instruments with non-vented pressure sensors: Level TROLL 300, non-vented Level TROLL 500 or 700, and BaroTROLL.

Small Desiccant

Vented cable includes a clear cap of indicating silica gel desiccant to protect the cable and electronics from condensation. The desiccant is blue when active. It will absorb moisture from the top down and for best results should be replaced before the entire volume has lost its color. Replacements are available from In-Situ Inc. or your distributor.

Large Desiccant

The optional high-volume desiccant pack may last up to 20 times longer than the small desiccant in humid environments. It attaches to vented Level TROLL cable in the same way. Refill kits are also available from In-Situ Inc. or your distributor.

TIP: Protect new desiccant from moisture until ready to use.

Outboard Desiccant

Vented "stripped & tinned" cable includes an outboard desiccant pack attached to the cable vent tube. Same size as large desiccant. Replacements and refills are available.

Accessory	Catalog No.
Small desiccant (3)	52230
Large desiccant	51810
Outboard desiccant (replacement)	51380
Refill kit for large & outboard desiccant	29140

COMMUNICATION CABLES

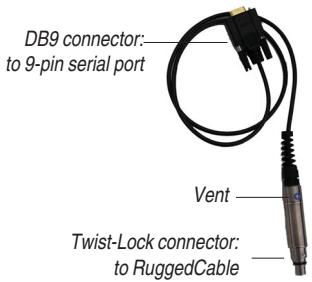
Comm cables provide an interface between the Level TROLL and a desktop/laptop PC or handheld PDA for profiling, programming, and downloading.

The computer connectors are not submersible.

For Connection to Cable

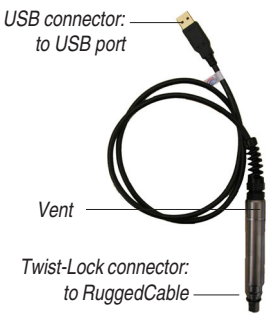
TROLL Com, RS232

Vented polyurethane cable (0.9 m, 3 ft), connects the Level TROLL's RuggedCable to a PC's serial port. Converts the Level TROLL's RS485 signal to a standard RS232 signal for communication via the serial port on a host computer. Weatherproof, withstands a temporary immersion. Cable vents into unit, protected by a hydrophobic membrane.



USB TROLL Com

Same as the RS232 TROLL Com but connects the Level TROLL's RuggedCable to a USB port.



Accessory	Catalog No.
TROLL Com, RS232	51460
USB to serial adapter	31090
USB TROLL Com	52500

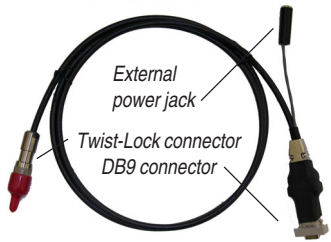
For Direct Connection to Level TROLL

These connect a Level TROLL directly to a serial or USB port for programming and downloading. A good choice for permanent connection to a PC, or for programming a non-vented Level TROLL that will be deployed without RuggedCable.

Programming Cable (RS232)

The computer connectors are not submersible.

Vented polyurethane or halogen-free polyurethane cable (1.8 m, 6 ft) combines the functions of the RuggedCable and TROLL Com; connects the Level TROLL directly to a serial port; includes RS485/RS232 converter and external power input jack; ideal for profiling.



Direct USB TROLL Com

"Female" connector attaches directly to the Level TROLL. No external power input. The non-locking connector is not designed for submersion, but may be used for brief dips into shallow water--hold on to the Level TROLL, not the cable.

Accessory	Catalog No.
USB TROLL Com, direct to Level TROLL	52510
Programming cable	51840
Programming cable, halogen-free	51850

POWER COMPONENTS

INTERNAL POWER

TIP: Win-Situ 5 can display the approximate percentage of internal battery life remaining when the Level TROLL is connected to a computer.

The Level TROLL operates on 3.6 VDC, supplied by a completely sealed, non-replaceable AA lithium battery. Battery life depends on sampling speed. Typical battery life is 5 years or 2,000,000 data records, whichever occurs first.

EXTERNAL POWER

External Battery Pack

TIP: When a Level TROLL is used as an Analog (4-20 mA), SDI-12, or Modbus device, power is supplied by the data logger or controller to which the Level TROLL is wired.

The sealed, submersible TROLL Battery Pack (lithium) supplies 14.4 V. When this power source is connected, the Level TROLL will use the external battery source first and switch to the internal batteries when external battery power is depleted. Battery life depends on sampling speed.

0.5 sec sampling interval	1.2 months
1 sec sampling interval	2.3 months
1 min sampling interval or longer	1 year

AC Adapter

Use only In-Situ's AC adapter. Damage to the Level TROLL caused by the use of third-party converters is not covered by the warranty.

In-Situ's AC adapter provides 24 VDC, 0.75 A, AC input 100-250 V, includes North American power cord. The Programming Cable includes an external power input for connection to this adapter.

Accessory	Catalog No.
External Battery Pack	51450
AC Adapter	52440

INSTALLATION ACCESSORIES

NPT Adapter

Twist-Lock Hanger

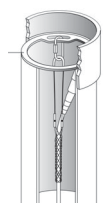
Cable Extender

Weighted nose cone

- 1/4" NPT Adapter: allows Level TROLL installation in piping
- Twist-Lock Hanger: titanium or stainless steel hanger to suspend a non-vented Level TROLL or BaroTROLL while taking data; no venting, no communication capabilities
- Cable Extender: connects two lengths of RuggedCable
- Wellcaps, locking and vented
- Well Docks: top-of-well support for 2", 4", or 6" well
- Panel-mounted bulkhead for connection to RuggedCable

Accessory	Catalog No.
NPT Adapter	51470
Twist-Lock Hanger, titanium for Level TROLL 500, 700, Baro	51480
Twist-Lock Hanger, stainless steel for Level TROLL 300	55050
Cable Extender	51490
Locking Wellcap, 2"	20360
Locking Wellcap, 2" vented	20370
Locking Wellcap, 4"	20380
Locking Wellcap, 4" vented	20390
Top-of-well installation ring	WELLDOCK2", 4", 6"
Bulkhead connector	53240
Weighted nose cone	57570

Locking Wellcap



Well Dock

CONTROL SOFTWARE

Win-Situ® 5 is easy-to-use software for programming the Level TROLL.

Win-Situ provides instrument control for direct reads and profiling, long-term data logging, data downloads, data viewing, data export to popular spreadsheet programs, choice of units and other display options, battery/memory usage tracking, interface to networks and telemetry.

TIP: Win-Situ connects through a serial COM port. If your computer does not have one, a USB-to-serial adapter is available from In-Situ Inc. (Catalog No. 31090).

Minimum system requirements: 400 MHz Pentium® II processor, 128 Mb RAM, 100 Mb free disk space, Internet Explorer® 6.01 or higher, Windows® 2000 Professional SP4 or higher, or Windows XP Professional SP1 or higher, CD-ROM drive, and a serial communications port.

Complete information on using the software is available from Win-Situ's Help menu.

Win-Situ® Mobile (formerly Pocket-Situ 5) provides Win-Situ's features and functions on a field-portable platform. Requirements: supported PDA with Microsoft Pocket PC 2003 (Windows Mobile) or later operating system, serial communications port, and at least 16 Mb for data storage (SD card, CF card, or the device's built-in non-volatile memory). For installation and file exchange, Microsoft® ActiveSync® must be installed on an office desktop or laptop computer.

Accessory	Catalog No.
Win-Situ 5 (no license required)	51980
Win-Situ Mobile license for RuggedReader	47520
Win-Situ Mobile license (upgrade from Pocket-Situ 4)	47550

PRODUCT SPECIFICATIONS

	Level TROLL 300	Level TROLL 500	Level TROLL 700
Operating Temperature	-5 to 50°C (23 to 122°F)	-20 to 80°C (-4 to 176°F)	-20 to 80°C (-4 to 176°F)
Storage Temperature	-40 to 80°C (-40 to 176°F)	-40 to 80°C (-40 to 176°F)	-40 to 80°C (-40 to 176°F)
Dimensions			
O.D.	0.82" (20.82 mm)	0.72" (18.3 mm)	0.72" (18.3 mm)
Length	9.0" (22.9 cm)	8.5" (21.6 cm)	8.5" (21.6 cm)
Weight	0.54 lb (0.24 kg)	0.43 lb (0.197 kg)	0.43 lb (0.197 kg)
Material			
Housing	316L Stainless steel	Titanium	Titanium
Nose Cone	Black Delrin®	Black Delrin®	Black Delrin®
Output Options	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA
Power			
Internal Battery	3.6V lithium	3.6V lithium	3.6V lithium
Battery Life	5 yrs or 1M data records	5 yrs or 2M data records	5 yrs or 2M data records
External Power	8-36 VDC	8-36 VDC	8-36 VDC
Memory	1 MB	2 MB	4 MB
Data Records	50,000	100,000	350,000
Fastest Logging Rate	1 per sec	2 per sec	4 per sec
Real-Time Sampling Rate			
Modbus	2 per sec	2 per sec	2 per sec
SDI-12	2 per sec	2 per sec	2 per sec
4-20 mA update rate	2 per sec	2 per sec	2 per sec
Max. no. of logs	2	2	50
Log Types	Linear, Fast Linear	Linear, Fast Linear	Linear, Fast Linear, Linear Average, Step Linear, Event, True Logarithmic

	Level TROLL 300	Level TROLL 500	Level TROLL 700
Pressure/Level Sensor			
Type	Silicon strain gauge	Silicon strain gauge	Silicon strain gauge
Material	Stainless steel	Titanium	Titanium
Accuracy*			
@ 15°	± 0.2% FS	± 0.05% FS	± 0.05% FS
-5 to +50°C	± 0.2% FS	± 0.1% FS	± 0.1% FS
-20 to -5 & +50 to +80°C	NA	± 0.25% FS typical	± 0.25% FS typical
Resolution	± 0.01% FS or better	± 0.005% FS or better	± 0.005% FS or better
Range			
Non-Vented (PSIA)	30, 100, 300	30, 100, 300, 500	30, 100, 300, 500
Vented (PSIG)	––	5, 15, 30, 100, 300, 500	5, 15, 30, 100, 300, 500
Max. pressure	2X range	2X range	2X range
Burst pressure	3X range	3X range	3X range
Temperature Sensor			
Material	Silicon	Silicon	Silicon
Accuracy	± 0.25°C	± 0.1°C	± 0.1°C
Resolution	0.1°C	0.01°C	0.01°C

** FS = full scale. Accuracy with 4-20 mA output option: ± 0.25% FS typical*

Range and Usable Depth

Non-Vented Level TROLL

Range	Effective Range**		Usable Depth	
PSIA	PSIA	kPa	Meters	Feet
30	15.5	106.9	0-10.9	0-35.8
100	85.5	589.5	0-60.1	0-197.3
300	285.5	1968	0-200.7	0-658.7
500	485.5	3347	0-341.3	0-1120

*** At sea level (14.5 PSI atmospheric pressure).*

Vented Level TROLL

Range		Usable Depth	
PSIG	kPa	Meters	Feet
5	34.5	0-3.5	0-11.5
15	103.4	0-11	0-35
30	206.8	0-21	0-69
100	689.5	0-70	0-231
300	2068	0-210	0-692
500	3447	0-351	0-1153

BaroTROLL

Same as Level TROLL 500 specs, **except** Pressure Range: 0 to 16.5 PSIA (1.14 bar, 33.59 in Hg), Log Types: Linear, Fastest Logging Rate: 1 per minute

Cable

Jacket options	Polyurethane, halogen-free (HF) polyurethane, FEP*
Connector	Titanium or carbon-filled ABS plastic, 18.5 mm (0.73 in) O.D.
Conductors	6 conductors, 24 AWG, polypropylene insulation
Diameter	6.7 mm (0.265 in)
Break strength	127 kg (280 lb)
Minimum bend radius (vented cable)	2X cable diameter (13.5 mm, 0.54 in)
Weight	Vented, regular & HF: 14 kg/300 m (32.3 lb/1000 ft) Non-vented, regular & HF: 16 kg/300 m (35.6 lb/1000 ft) Vented FEP: 23 kg/300 m (52 lb/1000 ft)

Suspension Wire

Material	304 stainless steel, 7 x 7 strand
Coating	Recycled FEP*, 0.5 mm (0.020 in) thick
Weight	4.3 kg /300 m (9.75 lb/1000 ft)
Overall O.D.	2.2 mm (approx. 1/16 in)
Break strength	122 kg (270 lb)

** FEP = fluorinated ethylene propylene, the generic equivalent of DuPont Teflon®*

3 GETTING STARTED

This section provides a quick overview of the initial steps necessary to get the instrument ready to log data.

You will need—

- Level TROLL or BaroTROLL
- Cable
  - RuggedCable and TROLL Com communication cable (for devices that will be deployed on RuggedCable), or
  - Programming Cable (for devices that will be deployed on suspension wire)
- In-Situ Software/Resource CD
- Desktop / laptop PC
- Optional: RuggedReader® handheld PDA
- Software License Certificate for licensed software (Win-Situ Mobile)

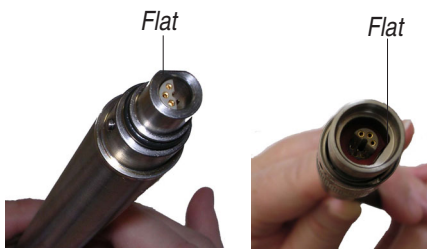
A. CONNECT THE RUGGEDCABLE OR PROGRAMMING CABLE TO THE LEVEL TROLL

1. Remove the protective caps from the Level TROLL and cable.

TIP: *Retain the dust caps to protect the pins and o-ring from damage when cable is not attached.*

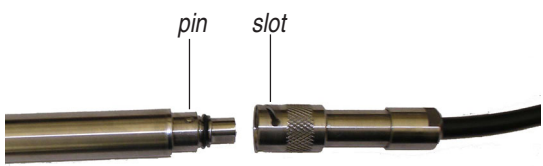
Level TROLL (or TROLL Com) *Cable*

2. Take a moment to look at the connectors. Each has a flat side.



Level TROLL (or TROLL Com) *Cable*

Note the pins on the body connector (one on each side) and the slots on the cable connector (one on each side).

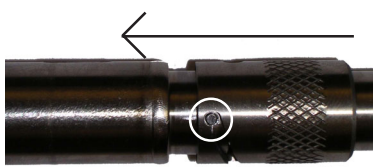


3. Slide back the sleeve on the cable connector.

4. Orient the “flats” so they will mate up, and insert the Level TROLL connector firmly into the cable connector.

Level TROLL *Cable*

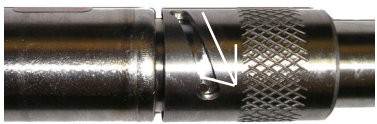
5. Slide the sleeve on the cable toward the Level TROLL body until the pin on the body pops into the round hole in the slot on the cable connector.



Level TROLL *Cable*

6. Grasp the knurled (textured) section of the cable connector in one hand and the Level TROLL body in the other. Push and twist firmly so that the pin on the body connector slides along the slot on the cable connector and locks securely into the other hole.

Be sure you hear the "click." The "click" ensures the cable is securely attached.



Level TROLL *Cable*

If you connected RuggedCable, continue to step B. If you connected a Programming Cable, skip to step C.

B. CONNECT THE TROLL COM TO THE RUGGEDCABLE

1. Remove the desiccant from the free end of the RuggedCable (if present) by grasping the knurled (textured) section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.

2. Slide back the sleeve on the cable connector. Locate the “flats” on the cable connector and the TROLL Com connector as before.

3. Orient the “flats” so they will mate up, and insert the TROLL Com connector firmly into the cable connector.

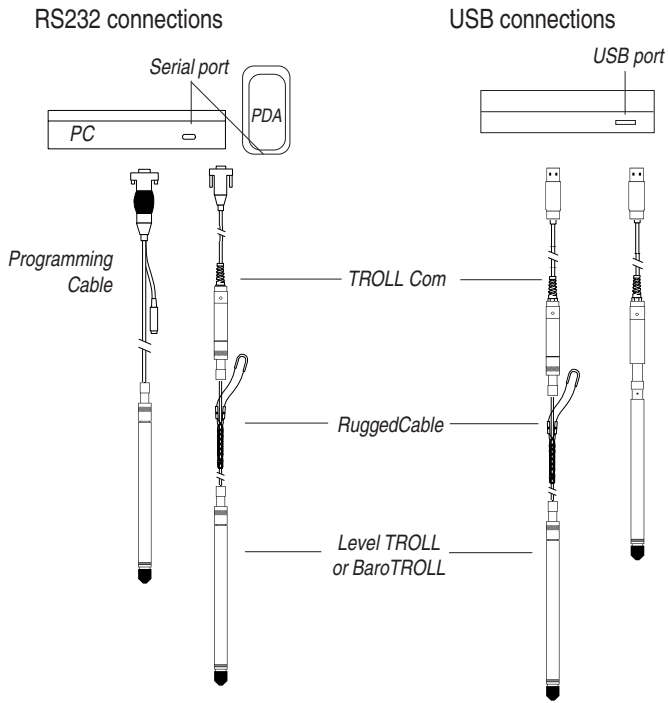
4. Slide the metal sleeve on the cable toward the TROLL Com body until the pin on the body pops into the hole in the slot on the cable connector.

Be sure you hear the “click.” The “click” ensures the cable is securely attached.

5. Grasp the knurled (textured) section of the cable connector in one hand and the TROLL Com body in the other. Push and twist firmly so that the pin on the body slides along the slot on the cable connector and snaps securely into the other hole.

C. CONNECT TO THE HOST PC

Attach the TROLL Com or Programming Cable to a PC's RS232 serial port or USB port.



D. INSTALL THE SOFTWARE

Install Win-Situ 5 from the In-Situ software/resource CD or from the In-Situ website:

1. Insert the In-Situ software/resource CD in your computer's CD drive.
2. Select Win-Situ 5, then click on Setup. Follow the instructions to install Win-Situ 5 to your local hard drive.

TIP: If the CD menu does not display auto–matically, choose Run from the Windows Start Menu and type D:\ISISoftwareCD.html, where D is your CD-ROM drive letter.

For communication using a RuggedReader handheld in the field, install the desktop component of Win-Situ Mobile (formerly called Pocket-Situ 5) on the same desktop/laptop computer:

1. Return to the website or the CD main menu and select Win-Situ Mobile. Click on Setup and follow the instructions to install the Win-Situ Software Manager to your local hard drive.
2. Connect the RuggedReader to the desktop computer, establish a connection in Microsoft ActiveSync®, launch the Win-Situ Software Manager, and follow the instructions to install Win-Situ Mobile on the RuggedReader.

TIP: Insure Microsoft ActiveSync is installed on the desktop or laptop PC and a Guest connection or partnership has been established between the computers.

E. LAUNCH THE SOFTWARE

Start Win-Situ by double-clicking the shortcut  created on the desktop during installation.

The next section of this manual provides a brief overview of Win-Situ. For more detailed information, see Win-Situ's Help menu.

4 USING WIN-SITU

Win-Situ® 5 is In-Situ's instrument control software for Level TROLLs. Use Win-Situ to

- display real-time readings from the connected Level TROLL, in meter, tabular, or graphic format
- program the device to log data; download the logged data
- customize the output of a pressure/level sensor to record draw-down, surface water elevation, gauge height, stage height, etc.
- set communication options in the device—Modbus, SDI-12, analog, IP, telemetry, etc.

TIP: *Win-Situ® Mobile provides Win-Situ's features and functionality in a convenient field-worthy platform.*

CONNECT TO THE LEVEL TROLL

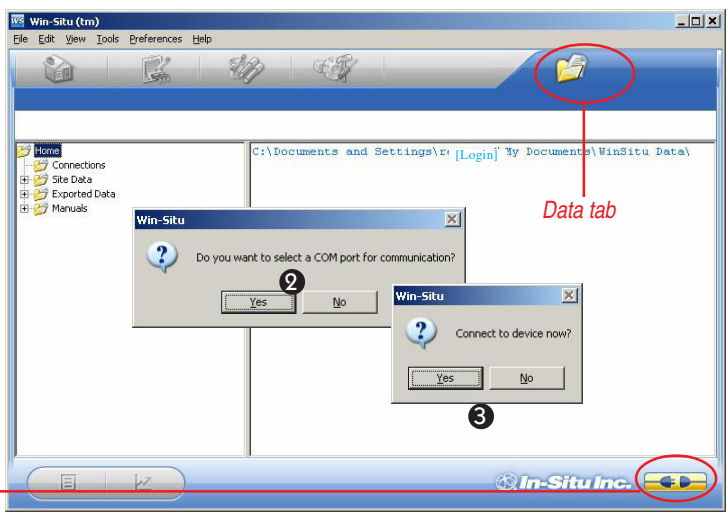
1. Start Win-Situ by double-clicking the shortcut  created on the desktop during installation.

Win-Situ launches and displays the Data area ("tab").

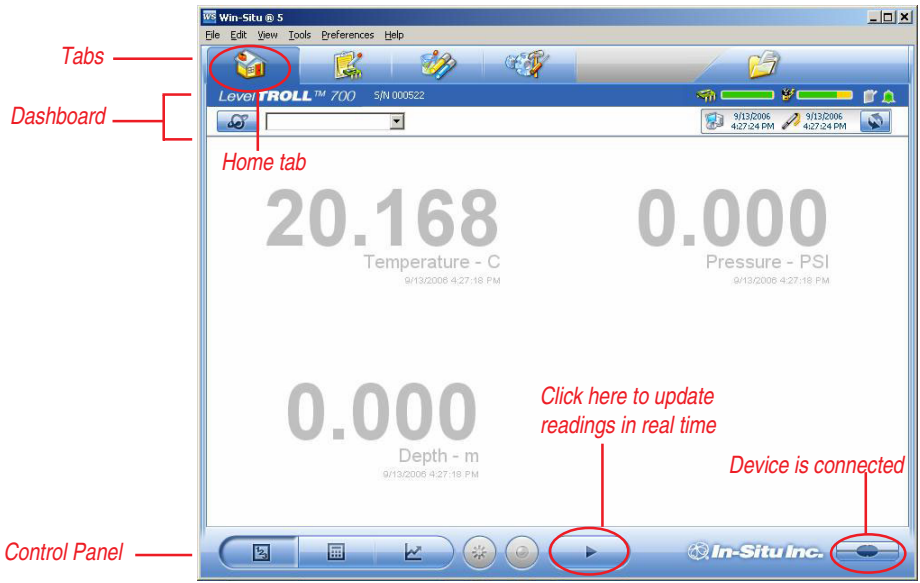
2. Check the COM port (optional). When you launch for the first time, the software may ask if you want to select a COM port. Do one of the following:
   - Answer Yes to the prompt, then check or change the port in the Comm Settings dialog, and click OK to close it, or
   - Answer No to bypass this step.
3. Win-Situ asks if you want to connect to the Level TROLL (the "device"). If the Level TROLL is connected to your computer as described in the previous section, answer Yes.

TIP: *The port is usually COM 1 for direct serial connection. This is Win-Situ's default.*

TIP: *You can turn off the "Connect now?" prompt: Select Preferences menu > General Settings, deselect "Prompt for connect at startup," click OK. In this case, connect to the device by clicking the Connect button*



4. The software connects and displays current temperature, pressure, and level/depth readings (temperature and pressure for a BaroTROLL).



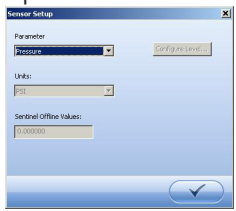
THE HOME SCREEN

- Note the **Tabs** at the top of the screen— this is the Home tab, which displays current readings from the connected device.
- The **Dashboard** (status area) below the tabs displays the device model and serial number, battery and memory capacity, the device clock and the computer clock, and other device information.
- The **Control Panel** at the bottom contains action buttons. You can start updating the readings in real time by pressing  .

CUSTOMIZING THE HOME SCREEN DISPLAY

Changing Units

1. Click the Sensors tab  , select the level/pressure sensor.
2. Click the Configure button  in the control panel.
3. In the Sensor Setup screen, select a parameter, then select a unit. Repeat for each parameter as necessary.



4. Click OK  to change the units and return to the Sensors tab.

Changing the Rate at Which the Readings Update

Also called the "poll rate," this can range from 1 to 30 seconds.

1. Select Preferences menu > Home View Settings.
2. Adjust the Poll Rate. Default: 5 seconds.

Changing the Significant Digits

To change the number of significant digits displayed for each reading:

1. Select Preferences menu > General Settings.
2. Under Parameter Defaults, select the significant digits for each parameter.

Real-Time Graphing

To view a real-time trend graph: click the graph button 

To view a graph with a data table below it, select Preferences menu > Graph Settings. Check ☑ the Data Panel option. Click OK.

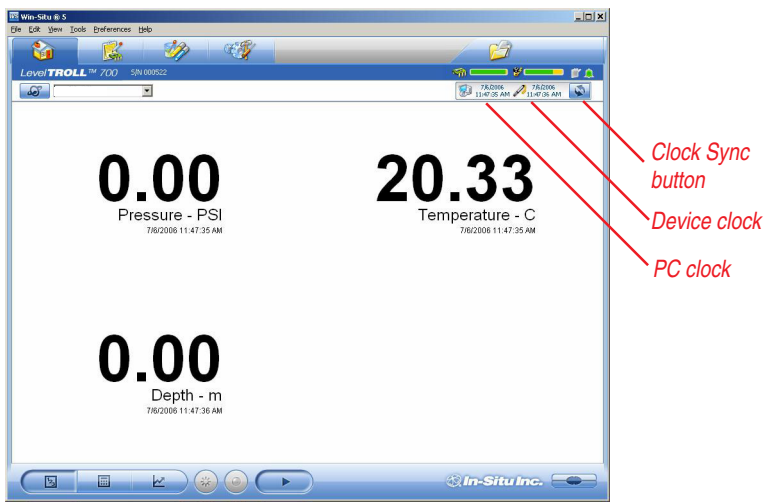
Now you're ready to give the Level TROLL some specific information through the software. Win-Situ provides many options. At a minimum:

- set the Level TROLL clock
- enter a name for the site where the Level TROLL will collect data
- enter data logging instructions

A brief overview is provided here. For more detailed information, see Win-Situ's Help menu.

SETTING THE CLOCK

Data collection schedules depend on the device's real-time clock. Both the device clock and the system (PC) clock are shown on the dashboard. The clocks update every 2 seconds. If the device clock differs by more than 2 seconds from the system clock, the device clock is displayed in red. To synchronize the clocks, click the Sync button.



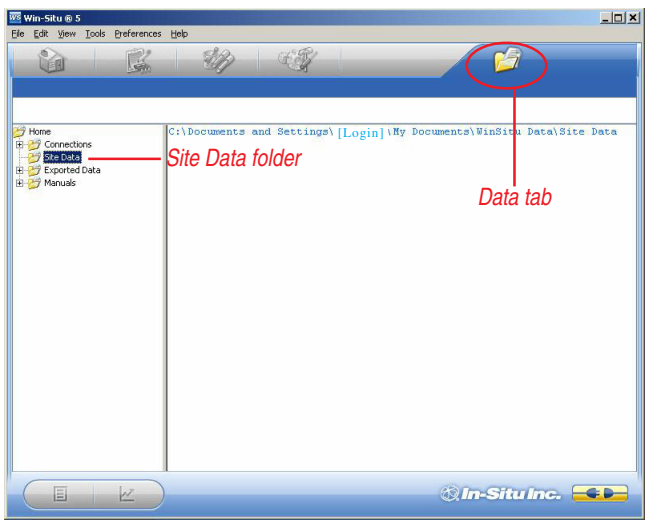
ADDING A NEW SITE

TIP: For complete information on Sites, see Win-Situ's On-Line Help.

Logged data are organized and filed by the **site** where the data were logged. This feature can help you manage data from multiple sites. You can create as many sites as you like, with or without a Level TROLL connected. Sites are stored in the site database in your Win-Situ working directory and are available to select for any Level TROLL, any log.

You will need a site when setting up a data log. Here are the steps to set up a new site:

1. On the Data tab, click the Site Data folder.
2. Select File menu > New > Site.

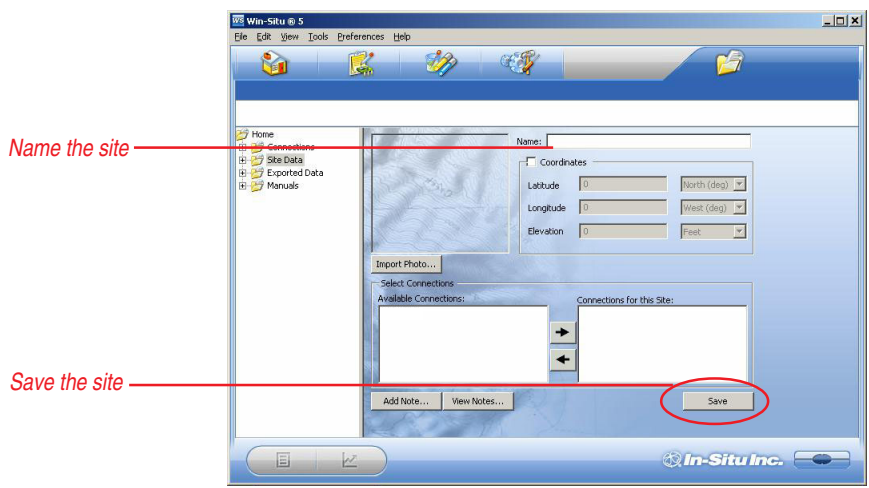


3. In the Site Information screen, enter a name for the site. A short, descriptive name is best—for example, a project, well, water body, gauging station, town, nearby landmark, etc. Length is limited to 32 characters.

TIP: The site coordinates are optional. They are used to uniquely identify a data site. They are not used elsewhere by the software.

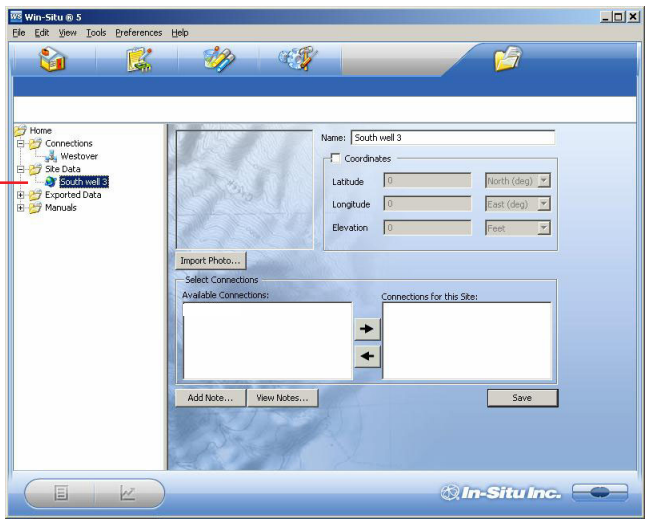
A site name the only required field, but there are many additional options for identifying a site. To include site Coordinates, check ☑ Coordinates, then enter Latitude (0.00 to 90.00, select North or South from listbox), Longitude (0.00 to 180.00, select East or West) and Elevation (select Feet or Meters). You can add a short descriptive Note, import a site Photo (bitmap), and/or specify a custom Connection. (If any connections have been defined, they will be displayed.)

4. When finished, click **Save** to save the site.



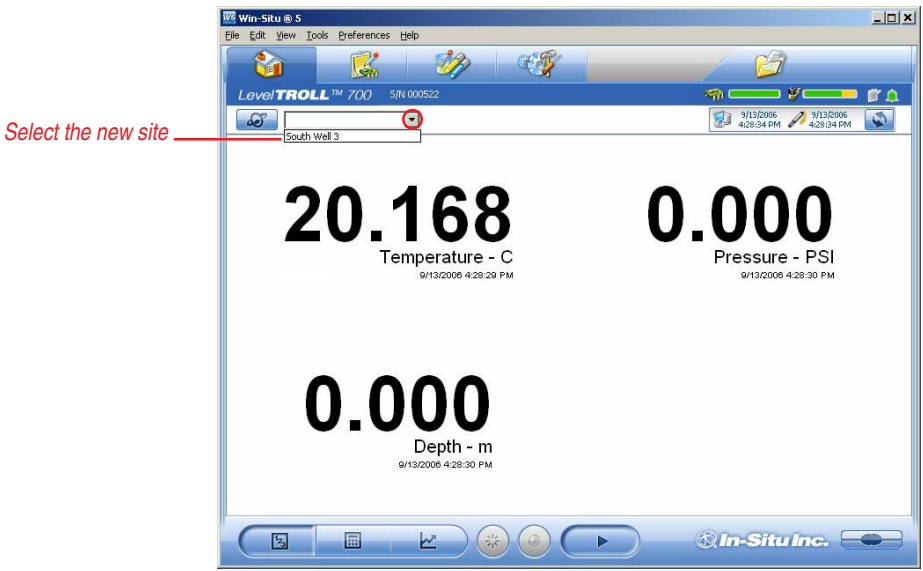
The new site will appear in the Site Data folder, and Win-Situ will add it to the site database in the working directory on your computer. It is now available to select for any device, any log.

New site appears in Site Data folder



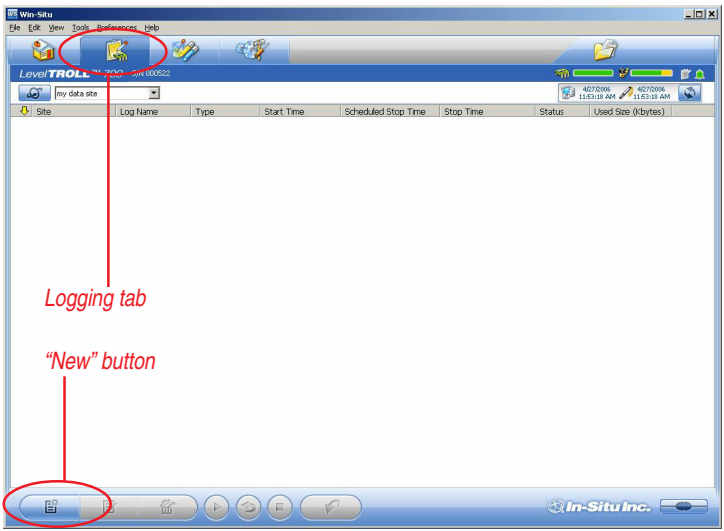
5. To set this new site in the connected Level TROLL: Return to the Home tab, click the down arrow beside the site box, and select your new site.

   This site now becomes the “current” site for the connected Level TROLL, and is available to use in data logs.



PREPARING TO LOG DATA

1. To program the device to log data, first select the Logging tab.
2. Click the "New" button.



TIP: *For more complete information on setting up data logs, see Win-Situ's Help menu.*

TIP: *For a Level TROLL 300 or other non-vented Level TROLL that will be deployed on wire, be sure to select a Scheduled Start so the log will start by itself, without a communication connection.*

The Logging Setup Wizard will prompt you through the configuration of a data log—including the site, log name, parameters to measure, sample schedule, start time, stop time, output (depth or level), and other options. For details on setting the pressure sensor output, refer to Win-SItu's Help menu, or Section 5 in this manual.

To Start logging:

- A “Pending” (scheduled) log will start at its programmed time
- You can start a “Ready” (manual) log at any time while connected by selecting the log and pressing “Start”

TIP: As an alternative to the log control buttons, right-click a log to display a short context menu of available actions.

To Stop logging:

- Select the log and press the “Stop” button
- Or suspend (temporarily stop) it with the “Pause” button

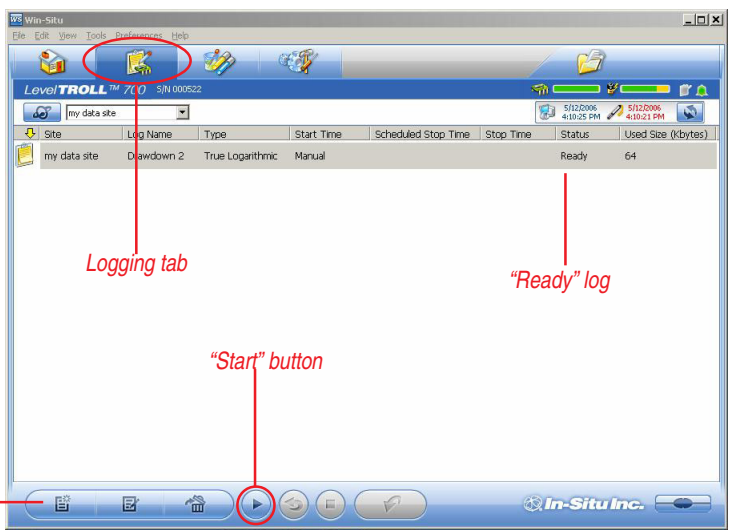
To Download the log to the connected PC:

- Select the log and press the “Download” button

To View the log after downloading:

- Go to the Data tab and select the log; for a graph press

TIP: The available log control buttons will vary depending on the status of the log selected.



DISCONNECTING

After the Level TROLL is programmed to log data, you're ready to

- Exit the software (File menu > Exit).
- Disconnect the TROLL Com from the cable connector, by grasping the knurled (textured) section of the cable connector in one hand and the TROLL Com in the other. Twist in opposite directions to unlock the TROLL Com from the cable.
- Vented cable: Attach desiccant to the cable connector—line up the flat sides of the connectors, push, twist, and click to lock the desiccant to the cable. Remove red dust cap (if present) from the desiccant's vent.
- Non-vented Level TROLL or BaroTROLL: Attach a Twist-Lock hanger to prevent flooding, and suspension wire (if using).
- Install the instrument in its field location. See Section 6 for guidelines.

Be sure to remove the desiccant dust cap (if present) before deployment to allow air to reach the cable's vent tube.

5 ABOUT THE PRESSURE/ LEVEL SENSOR

A pressure transducer senses changes in pressure, measured in force per square unit of surface area, exerted by water or other fluid on an internal media-isolated strain gauge. Common measurement units are pounds per square inch (PSI) or newtons per square meter (pascals).

NON-VENTED (ABSOLUTE) VS. VENTED (GAUGED) SENSORS

A non-vented or “absolute” pressure sensor measures all pressure forces exerted on the strain gauge, including atmospheric pressure. Its units are **PSIA** (pounds per square inch “absolute”), measured with respect to zero pressure.

Non-vented pressure measurements are useful in vacuum testing, in short-term testing when atmospheric pressure would not be expected to change, in very deep aquifers where the effects of atmospheric pressure are negligible, and in unconfined aquifers that are open to the atmosphere.

With vented or “gauged” pressure sensors, a vent tube in the cable applies atmospheric pressure to the back of the strain gauge. The basic unit for vented measurements is **PSIG** (pounds per square inch “gauge”), measured with respect to atmospheric pressure. Vented sensors thus exclude the atmospheric or barometric pressure component.

This difference between absolute and gauged measurements may be represented by a simple equation:

$$P_{gauge} = P_{absolute} - P_{atmosphere}$$

PRESSURE, DEPTH, AND LEVEL

Output options for pressure measurement are completely software-selectable. Each log configuration presents the following choices:

- Pressure in PSI or kPa
- Depth in feet or meters
- Water Level with a reference (an “offset”)
  - Surface Elevation reference
  - Depth to Water (drawdown) reference

Pressure is a simple check box. For depth or level, the software presents additional options:

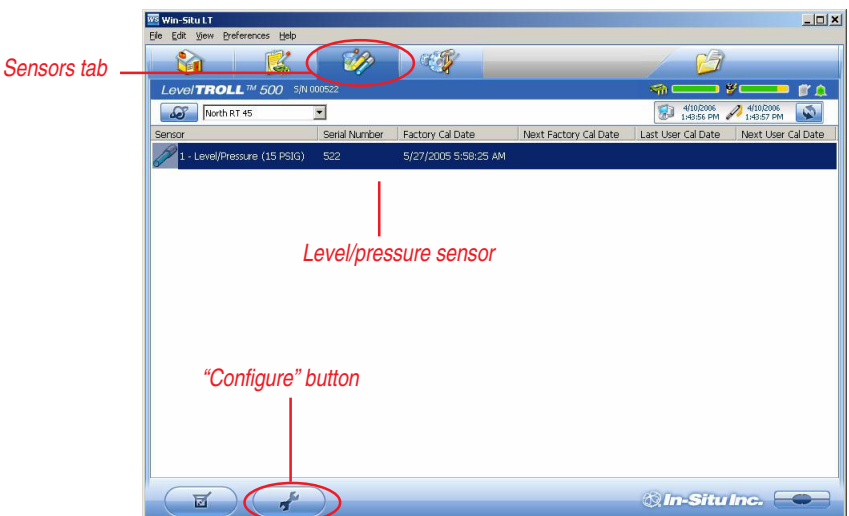
- The type of Level measurement you wish to log
- The Level Reference you wish to use
- The type of water you will be monitoring in (fresh, brackish, or saline). Or choose the **Advanced** button for a pressure-to-level conversion that compensates pressure readings for fluid density, latitude, and elevation

CONFIGURING DEPTH AND LEVEL

TIP: When you configure level using the Sensors tab, the settings are stored in the Level TROLL and are available for use in Modbus, SDI-12, and analog communications, as well as in Win-Situ. Different configuration may be selected when setting up a log.

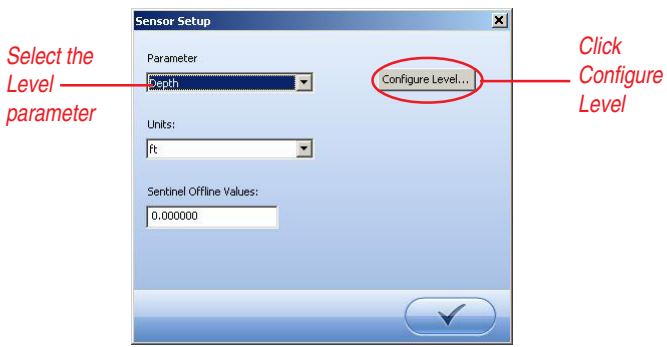
This procedure stores the configuration settings in the Level TROLL. When setting up a log, the same options are presented.

1. While connected to the Level TROLL in software, click the Sensors tab.
2. Select the level/pressure sensor and click the "Configure" button  . (Not available for a BaroTROLL.)

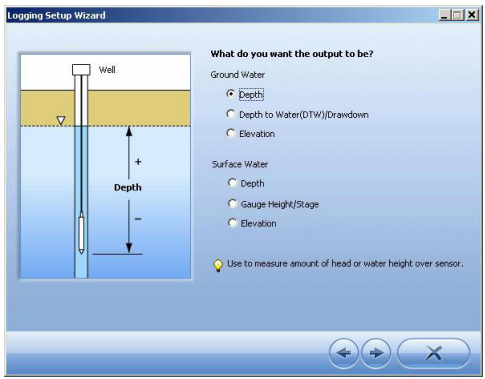


TIP: *The Level TROLL measures three parameters—Pressure, Temperature, and Level—on one sensor. A BaroTROLL does not measure Level, so the Configure Level option is not available.*

3. In the Sensor Setup window, select the Level parameter, then click Configure Level. The Level parameter shown is the one currently stored in the device (device's default or the most recent choice). You will have a chance to change this in a moment.



4. In the Level Configuration Wizard, select the options you want. Each choice includes an illustration. For more information, see Win-Situ's On-Line Help.



PRESSURE SENSOR CALIBRATION

FACTORY RECALIBRATION

Pressure sensor accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse, as well as normal drift in the device's electronic components. Aside from damage to the sensor, the need for factory recalibration is dependent upon the amount of drift a customer is willing to tolerate. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan.

FIELD RECALIBRATION

The following procedure may be used, **with caution,** to "zero" the offset of a vented pressure sensor to correct for electronic drift. The drifted offset is visible when the sensor is in air and reading other than zero.

TIP: *Field recalibration is not available for a BaroTROLL.*

It is recommended you **do not** zero the offset if it is outside the specified accuracy of your pressure sensor, as shown in the table below. If the reading in air deviates from zero by more than the amounts shown, you may want to consider a factory recalibration.

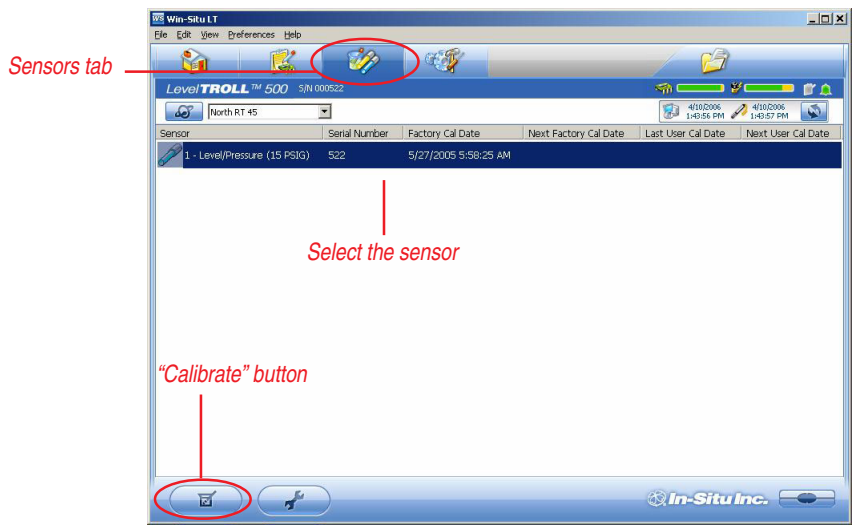
Sensor range	Accuracy (-5°C to +50°C)	Acceptable Offset from zero
5 PSI	± 0.1% FS	± 0.005 PSI
15 PSI	± 0.1% FS	± 0.015 PSI
30 PSI	± 0.1% FS	± 0.03 PSI
100 PSI	± 0.1% FS	± 0.10 PSI
300 PSI	± 0.1% FS	± 0.30 PSI
500 PSI	± 0.1% FS	± 0.50 PSI

Field Recalibration Procedure

1. With the Level TROLL connected in software, select the **Sensors** tab.
2. Select the pressure sensor and click the **Calibrate** button.

   You will be prompted to ensure the device is in air.
3. With the device in air, click **Calibrate**.

The current pressure reading will be set to zero.



BAROMETRIC COMPENSATION OF NON-VENTED PRESSURE/LEVEL DATA USING BAROMERGE™

Win-Situ BaroMerge can post-correct absolute (non-vented) level sensor data to eliminate barometric pressure from the measurements. BaroMerge provides 3 options:

- Fixed Correction – A single offset value is applied to all selected log data. Use this option if you know what the barometric pressure was during the log, and it did not change
- Manual Entry – Specify 2 or more correction values to apply to the log data. Use this option if you know that barometric pressure changed during the log
- BaroTROLL log file – Absolute level sensor data are corrected by barometric pressure values logged by an In-Situ BaroTROLL during the same general time period

Launching BaroMerge

BaroMerge may be launched as a stand-alone application from the program group In-Situ Inc., or accessed from Win-Situ's Tools menu when both are installed on the same system.

Input

In the Fixed Correction and Manual Entry options, it is important to know the barometric pressure for the general time period covered by the log or logs you want to correct.

BaroMerge uses a Wizard-like interface consisting of three main steps:

1. First, choose the type of compensation/correction you wish to use

2. Then, choose the absolute (non-vented) log file or files you wish to correct. BaroMerge displays these automatically
3. Click OK and the barometric compensation is applied

Output

Your original log file is not changed. A new, corrected log file with the same name and path is created. The original ".wsl" extension is replaced by "-BaroMerge.wsl".

For help on using Win-Situ BaroMerge, press F1 at any BaroMerge screen.

For more detailed information on barometric compensation see the tech notes installed with Win-Situ. They are accessible in Win-Situ from the Data tab. They are also on the In-Situ software/resource CD, and available in the Downloads section of the In-Situ website at *www.In-Situ.com/downloads.*

In-Situ Inc.

6 FIELD INSTALLATION

POSITION THE LEVEL TROLL

Lower the Level TROLL gently to approximately the desired depth. Position the instrument below the lowest anticipated water level, but not so low that its range might be exceeded at the highest anticipated level. Refer to the tables below for usable depth.

Note that a Baro TROLL is not designed for submersion. Position it above water level near a submerged Level TROLL.

Vented Level TROLL

Range		Usable Depth	
PSIG	kPa	Meters	Feet
5	34.5	0-3.5	0-11.5
15	103.4	0-11	0-35
30	206.8	0-21	0-69
100	689.5	0-70	0-231
300	2068	0-210	0-692
500	3447	0-351	0-1153

Non-Vented Level TROLL

Range	Effective Range*		Usable Depth	
PSIA	PSIA	kPa	Meters	Feet
30	15.5	106.9	0-10.9	0-35.8
100	85.5	589.5	0-60.1	0-197.3
300	285.5	1968	0-200.7	0-658.7
500	485.5	3347	0-341.3	0-1120

** At sea level (14.5 PSI atmospheric pressure).*

CHECK THE INSTRUMENT'S DEPTH

At this point, if convenient, you can connect the Level TROLL to a PC, launch the software, and take a reading. If the instrument is at the desired depth, secure it in position as suggested below. If not, reposition the Level TROLL as necessary.

If you requested the software to "Remind me later" to set a Level Reference, enter the level reference after installation when prompted.

Kellems grip

SECURE THE CABLE

The RuggedCable has a handy device called a Kellems® grip near the surface end. You can slide it along the cable to the desired position by compressing it. When you pull on it, it tightens and stops sliding. You may need to pull on both ends of the Kellems grip to properly tighten it and keep it from slipping.

Use the loop of the Kellems grip to anchor the cable to a convenient stationary object. It works well with In-Situ's "well dock" installation ring. Simply insert the loop into the locking clip on the well dock, and position the assembly on the top of a well.

INSTALLATION TIPS

- Never let a probe "free fall" down a well. The resulting shock wave when it hits the water surface can damage the strain gauge (the "waterhammer" effect).
- It is always wise to check the level of water above the probe, then move it and read again to be sure that the probe is giving a reasonable reading and showing change. It might not be

located where you think it is — for example, it could be wedged against the casing with a loop of cable hanging below it. A probe in such a position might become dislodged and move while logging, giving a false change in level. *A secure placement is critical to accurate measurements.*

- Do not allow the vented cable to kink or bend. If the internal vent tube is obstructed, water level measurements can be adversely affected. The recommended minimum bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.

The minimum bend radius for vented cable is 13.5 mm (0.54 in).

- For accurate measurements, the instrument should remain immobile while logging data.

Do not submerge the connector at the uphole end of the cable.

- Be sure the "uphole" cable end is capped—desiccant cap on the vented cable connector, soft dust cap on non-vented cable—and positioned above the highest anticipated water level. Avoid areas that may flood.

STABILIZATION TIME

Allow the Level TROLL to stabilize to the water conditions for *about an hour* before logging data. A generous stabilization time is always desirable, especially in long-term deployments. Even though the cable is shielded, temperature stabilization, stretching, and unkinking can cause apparent changes in the probe reading. If you expect to monitor water levels to the accuracy of the probe, it's worth allowing the extra time for the probe to stabilize to its environment.

INSTALLATION OF A LEVEL TROLL 300 OR OTHER NON-VENTED LEVEL TROLL

All Level TROLL 300s and non-vented Level TROLL 500s and 700s include non-vented (absolute, PSIA) pressure sensors and do not require vented cable for proper operation. They may be deployed on non-vented RuggedCable or with a Twist-Lock Hanger and economical stainless steel suspension wire while logging data.

- Because the Twist-Lock Hanger has no communication capabilities, program the Level TROLL in advance, and download the data the same way
- Logged pressure data will show the effects of changes in barometric pressure (unlike vented Level TROLLs). However, post-processing tools such as Win-Situ BaroMerge may be used to eliminate the effects of barometric pressure changes from the data, if required.

TIP: *Be sure to program a non-vented Level TROLL or BaroTROLL before attaching the Twist-Lock Hanger, as this accessory has no communication capability.*

DO NOT submerge a non-vented Level TROLL 500 or 700 without first attaching a Twist-Lock Hanger, or a cable, as the unit could be damaged by flooding.

Although the Level TROLL 300 is completely sealed from flooding, a Hanger is recommended.

7 BAROTROLL

TIP: For more detailed information on barometric compensation see the tech notes installed with this manual and accessible in Win-Situ from the My Data tab. They are also on the In-Situ software/ resource CD, and available in the Downloads section of the In-Situ website at www.In-Situ.com

In-Situ's BaroTROLL® is a special model of non-vented Level TROLL designed to log barometric pressure from 0 to 16.5 PSIA (1.14 bar, 33.59 in Hg) at the surface near a submerged non-vented Level TROLL. BaroTROLL data may then be used to correct the Level TROLL data for barometric pressure fluctuations.

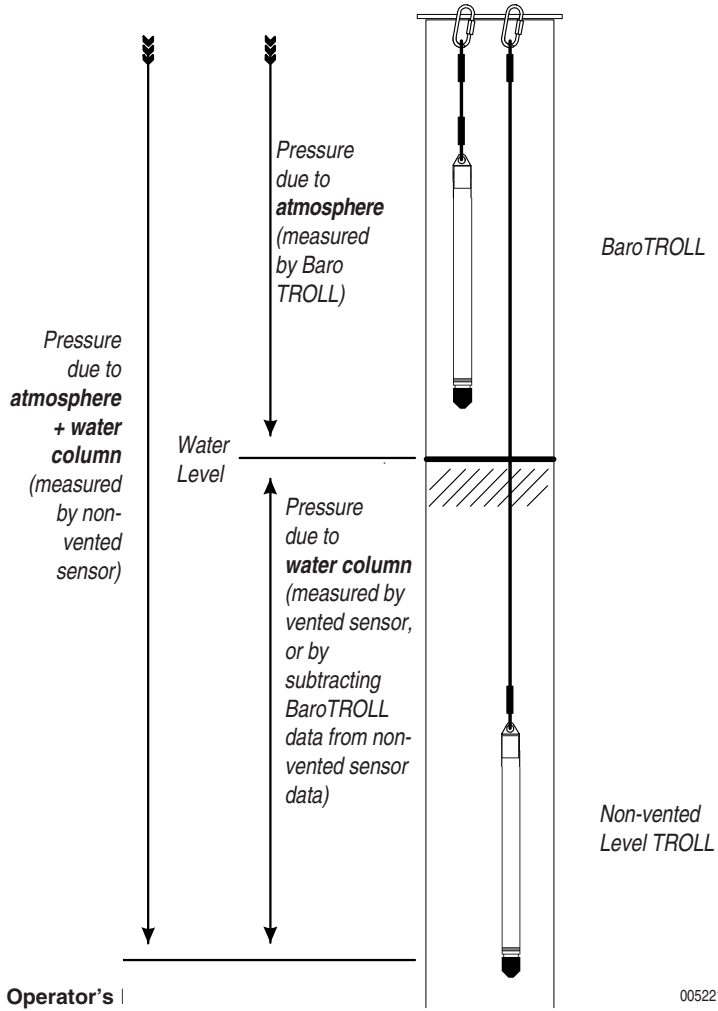
PROGRAMMING

- Program before installation. Be sure to sync the clock.
- Schedule a log with the same start time as that in the paired non-vented Level TROLL. Select the same sample interval.

INSTALLATION

After programming, install the BaroTROLL in a protected location above water level. Install the BaroTROLL near the submerged non-vented unit. One possibility is shown below, using a Twist-Lock Hanger and suspension wire.

- Be sure to attach the Twist-Lock Hanger before installation to prevent flooding.


Pressure due to atmosphere (measured by Baro TROLL)
BaroTROLL
Pressure due to atmosphere + water column (measured by non-vented sensor)
Water Level
Pressure due to water column (measured by vented sensor, or by subtracting BaroTROLL data from non-vented sensor data)
Non-vented Level TROLL

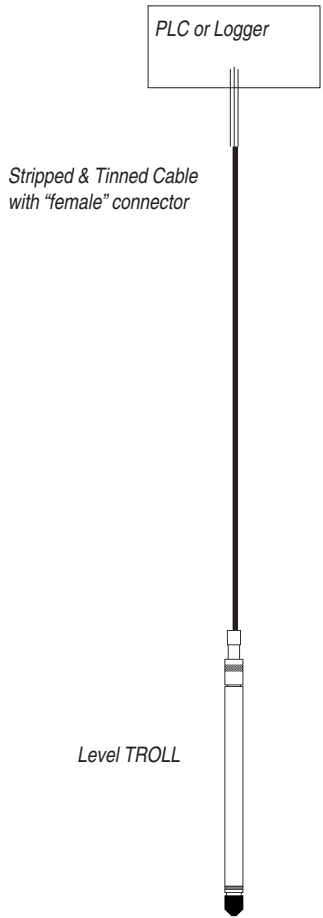
8 ANALOG, SDI-12 & MODBUS CONNECTIONS

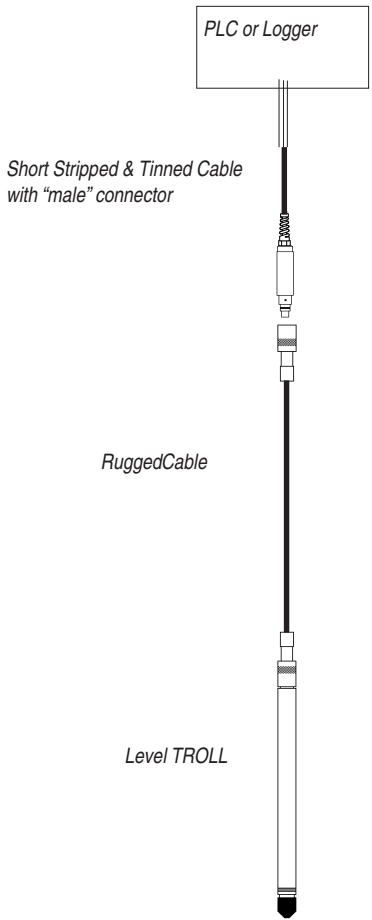
The Level TROLL may be connected to a controller or logger for communication via:

- Analog (4-20 mA)
- SDI-12
- RS485 Modbus
- RS232 Modbus (with a customer-supplied converter)

RuggedCable™ Stripped & Tinned has a “female” Twist-Lock connector on one end to mate with the Level TROLL body. The uphole end terminates in bare wires for connection to a PLC or data logger.

Also available in a shorter length ending in a “male” Twist-Lock connector to mate with RuggedCable.

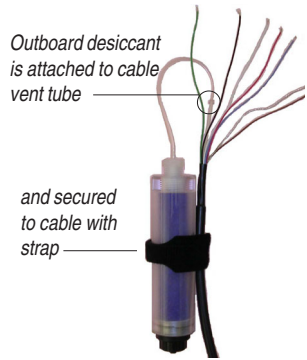

PLC or Logger
Stripped & Tinned Cable
with “female” connector
Level TROLL


PLC or Logger
Short Stripped & Tinned Cable
with “male” connector
RuggedCable
Level TROLL

DESICCANT

Vented cable includes removable outboard desiccant to protect the cable vent tube and Level TROLL electronics from condensation in high-humidity environments.

The desiccant may be removed from the vent tube, if needed, to trim the conductor wires. Pull the vent tube extender off the cable vent tube to remove, replace desiccant after trimming and connecting wires.

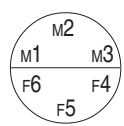


WIRING

Refer to diagrams on the following pages. Trim back and insulate unused wires. The shield should be wired to a chassis ground or earth ground.

RuggedCable (TPU)

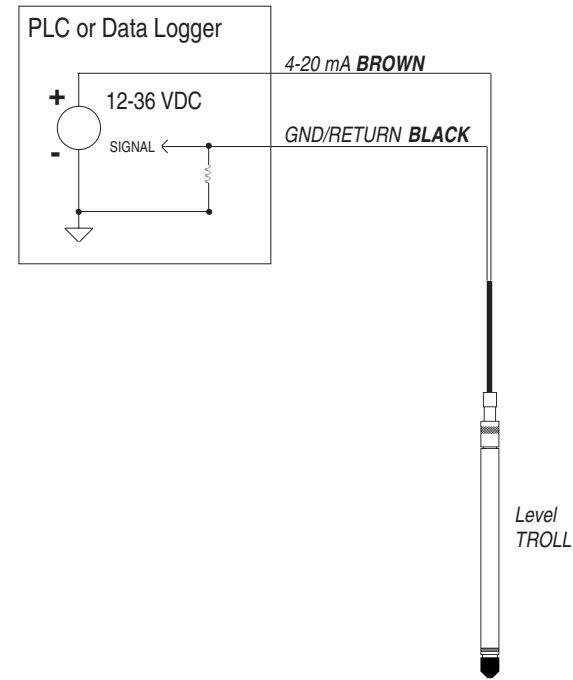
Signal	Color	Pin
Gnd/Return	BLACK	6
Ext Power	RED	5
4-20 mA	BROWN	4
RS485(–)	GREEN	3
RS485(+)	BLUE	2
SDI-12	WHITE	1



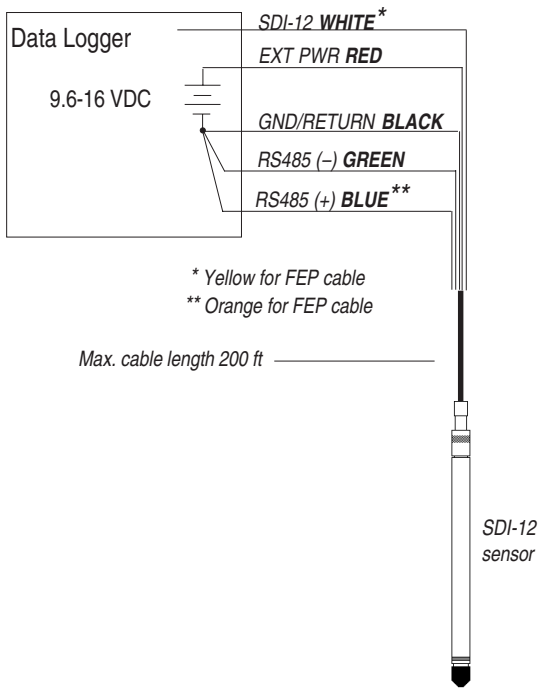
FEP Cable

Signal	Color
Gnd/Return	BLACK
Ext Power	RED
4-20 mA	BROWN
RS485(–)	GREEN
RS485(+)	ORANGE
SDI-12	YELLOW

ANALOG (4-20 mA) 2 WIRE

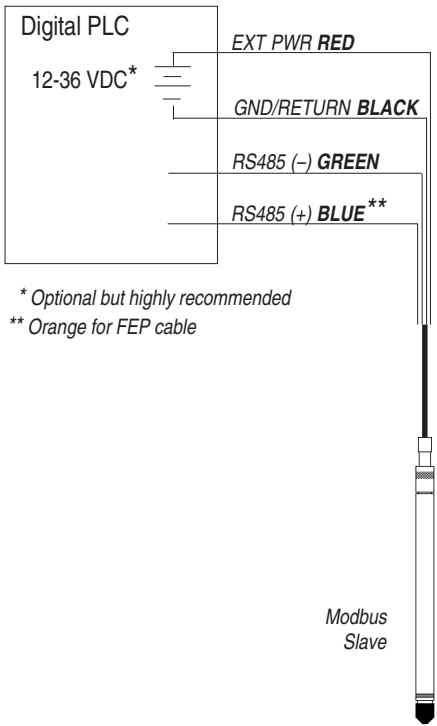


SDI-12 3 WIRE


Data Logger
9.6-16 VDC
SDI-12 WHITE*
EXT PWR RED
GND/RETURN BLACK
RS485 (–) GREEN
RS485 (+) BLUE**
* Yellow for FEP cable
** Orange for FEP cable
Max. cable length 200 ft
SDI-12
sensor

MODBUS MASTER

with RS485 built in

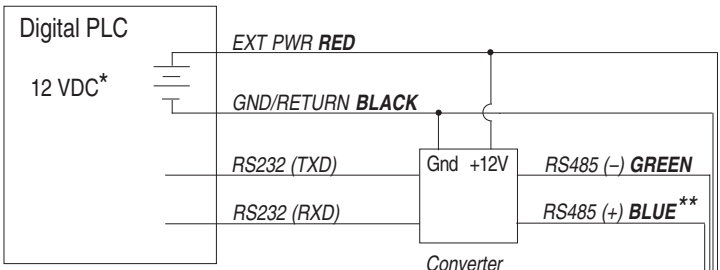


** Optional but highly recommended*

*** Orange for FEP cable*

MODBUS MASTER

with RS232 built in (converter required)

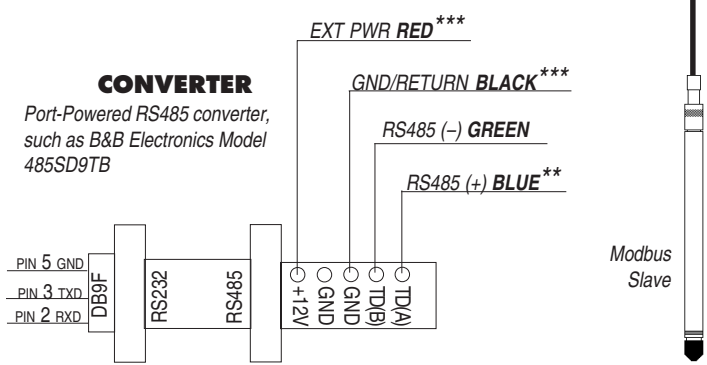


* Voltage limited by converter

** Orange for FEP cable

CONVERTER

Port-Powered RS485 converter, such as B&B Electronics Model 485SD9TB



***Required if port power is not available

POWER CONNECTIONS

The Red wire provides power for Modbus and SDI-12 modes. The Brown wire provides power for the 4-20 mA mode. If power is present on the Brown wire and not on the Red wire, the device enters the 4-20 mA mode automatically and stays in the 4-20 mode until power is removed from the Brown wire or is applied to the Red wire. The Red wire has priority — if power is applied to both wires at the same time, the device will operate in Modbus or SDI-12 modes but not in 4-20.

COMMUNICATIONS

The device automatically switches between Modbus and SDI-12 modes depending on which of the two interfaces has activity. Modbus and SDI-12 cannot be used at the same time — whichever one is currently in use will block communication on the other.

USING WIN-SITU

Win-Situ provides options for configuring analog/SDI-12 communications (Setup tab) and Modbus communications (File menu > Settings). In addition, the Level TROLL is capable of internal logging (programmed in Win-Situ) while participating in a Modbus, SDI-12 or analog network. However, Win-Situ cannot communicate with the Level TROLL while it is transmitting Modbus, SDI-12 or analog data, and conversely, the instrument cannot receive or respond to Modbus, SDI-12 or analog commands while connected to a PC serial port.

This “redundant logging” feature means

- if the PLC or recorder somehow “loses” data, the Level TROLL data can be retrieved using Win-Situ.

- if the PLC or recorder ceases to function due to power loss, the Level TROLL will continue to collect data using its own internal batteries and clock.

A port-powered RS485 converter like that shown for Modbus connections may be used for temporary connection of the Level TROLL to a serial port on a PC.

FOR MORE INFORMATION

For additional information on Modbus and SDI-12 communications, including the SDI-12 commands, see the tech notes and application notes installed with this manual and accessible in Win-Situ from the My Data tab. They are also on the In-Situ software/resource CD, and available in the Downloads section of the In-Situ website at www.In-Situ.com.

9 CARE & MAINTENANCE

OPERATING CONSIDERATIONS

The Level TROLL has been designed to withstand harsh field conditions. However, as with any electronic instrument, it can be permanently damaged if used outside its operating specifications.

TEMPERATURE

The Level TROLL 500 and Level TROLL 700 operate within a temperature range of -20°C to +80°C (-4°F to 176°F). The Level TROLL 300's temperature range is -5°C to 50°C (23°F to 122°F)

PRESSURE RANGE

The Level TROLL can withstand pressures of up to two times (2X) the rated range of the pressure sensor without damage, although it may not read correctly at such pressure. If the pressure range is exceeded by 3X, the sensor will be destroyed.

CALIBRATION

Accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan.

STORAGE

Store the Level TROLL clean and dry. Place the protective red dustcap on the cable end, or store with cable attached to protect the connector pins and o-ring.

Store the instrument where it will be safe from mechanical shocks that may occur, such as rolling off a bench onto a hard surface.

Protect the instrument from temperature extremes. Store within a temperature range of -40°C to +80°C (-40°F to +176°F).

GENERAL MAINTENANCE

CLEANING—BODY AND FRONT END

When the nose cone is removed, the sensitive pressure sensor diaphragm is completely exposed. Do not touch this area with any object! Replace the nose cone as soon as possible.

Clean the Level TROLL body with water and a soft brush, or soak overnight in a mild acidic solution, such as household vinegar, or clean in an ultrasonic bath with a good concentrated detergent solution.

If the ports in the front end are clogged with silt or mud, try the following:

- Swish the instrument vigorously in a bucket of clean water
- Apply a gentle squeeze of water from a wash bottle
- In severe cases, remove the nose cone and clean out the holes with a soft brush or pipe cleaner

To avoid damage to the pressure sensor diaphragm, *do not insert any object into the sensor opening or attempt to dig out dirt or other materials.*

Nose cone in place

Nose cone removed

Damage caused by digging or scraping in the pressure sensor opening to remove silt, mud, etc. is not covered by the warranty.

If contamination cannot be removed using the recommendations above, please contact In-Situ Inc. for cleaning.

Do not submerge the cable connector; do not immerse in any fluid.

TWIST-LOCK CONNECTORS

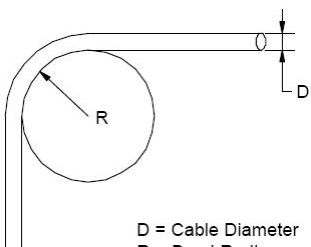
Keep the pins on all connectors free of dirt and moisture by using the soft protective dustcap when cable is not attached.

CABLE VENT TUBE (VENTED CABLE)

Vented cable assures that atmospheric pressure is the reference pressure to the vented pressure sensor diaphragm. *The vent tube should not be blocked, kinked, or otherwise obstructed.* Such obstructions will cause barometric pressure to appear in measurements, and errors will be introduced due to thermal expansion and contraction of air within the vent tube and probe body.

The minimum bend radius for vented cable is 13.5 mm (0.54 in).

The recommended minimum bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.



***TIP:** If batteries are completely exhausted, remember that external power and battery pack options are available.*

BATTERIES

Internal batteries in the Level TROLL are not user-replaceable. The approximate percentage remaining is displayed on the Dashboard when the Level TROLL is connected in software.

10 TROUBLESHOOTING

TROUBLESHOOTING CONNECTIONS

Problem: Win-Situ cannot connect to the Level TROLL

Probable Cause: Wrong COM port selected, incompatible Communication settings, loose or dirty cable connections, low batteries

Suggested Remedy: Check the following:

- all cable connections are tight, connectors are clean and dry
- the cable is securely attached to the instrument
- the correct COM port is selected (select Comm Settings from Win-Situ's Preferences menu to check this)
- the software settings are correct for the device (check Win-Situ's on-line Help for "Communication Settings")
- the internal battery has voltage remaining

Problem: Real-time readings are in the wrong units

Probable Cause: Default units are being used

Suggested Remedy: Click the Sensors tab, select the sensor, click the configure button  and select the desired units for each parameter in the Sensor Setup window. Click OK  .

Problem: I cannot add a new log

Probable Cause 1: Only one "active" log can reside in the device at a time—an "active" log is a log that is Ready, Pending, Running, or Suspended as shown in the Status column of the Logging Tab

Probable Cause 2: The device has its maximum number of logs already stored—the Level TROLL 300, 500, and Baro TROLL have a capacity of 2 logs

Suggested Remedy: Download, and then delete a log you are through with. This will make room for an additional log on the device

Problem: I just defined a new log, but the software is telling me it exceeds the available memory

Probable Cause: The log as configured would exceed the device memory

Suggested Remedy: Edit the log and try these:

Select a longer sampling interval

If available, select the "Wrap data" option (later data will overwrite earlier data when the memory is full)

For a log with a scheduled start, select "None" as the stop condition, or select a stop time that is closer to the start time

Index

M

N

P

R

S

T

U

V

W

In-Situ Inc.

221 East Lincoln Avenue • Fort Collins, CO 80524 USA
1 800 446 7488 • 1 970 498 1500 (Tel)
1 970 498 1598 (Fax)

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 300
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

In-Situ Inc.

221 East Lincoln Avenue • Fort Collins, CO 80524 USA
1 800 446 7488 • 1 970 498 1500 (Tel)
1 970 498 1598 (Fax)

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 500
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

In-Situ Inc.

221 East Lincoln Avenue • Fort Collins, CO 80524 USA
1 800 446 7488 • 1 970 498 1500 (Tel)
1 970 498 1598 (Fax)

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 700
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

In-Situ Inc.

221 East Lincoln Avenue • Fort Collins, CO 80524 USA
1 800 446 7488 • 1 970 498 1500 (Tel)
1 970 498 1598 (Fax)

WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Product name: Baro TROLL
Product Description: The Baro TROLL measures and logs barometric pressure and temperature.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1998, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

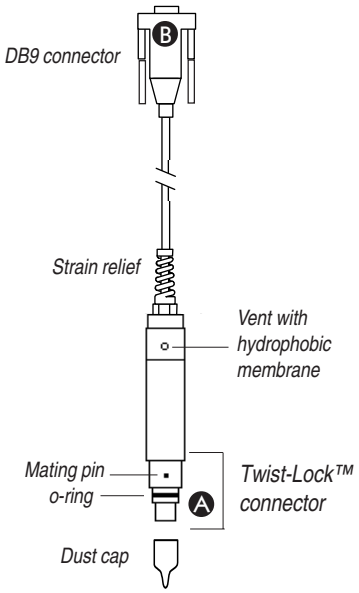
Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

CE FC

Information Sheet

Catalog No. 51460

TROLL COM™ COMMUNICATION INTERFACE



Tip: The desiccant protects the Level TROLL's vented cable from condensation during deployment. The TROLL Com enables connection to a PC for programming the Level TROLL. Be sure to re-attach the desiccant after programming, before deployment.

APPLICATION

Communication interface between a Level TROLL or MP TROLL 9500 and a desktop/laptop PC or handheld PDA. Contains a port-powered RS485 – RS232 converter. Vented deployment cable vents through the unit, protected by a hydrophobic membrane.

PHYSICAL DESCRIPTION

Wetted materials	Titanium, nylon, Viton®, polyurethane
Environmental rating	IP67 when connected (3 meters for 30 minutes), up to the DB9 connector
Dimensions	8.9 cm (3.5 in) long, 18.3 mm (0.72 in) O.D.
Input	MP TROLL 9500 RS485 Level TROLL RS485 Modbus
Output	RS232
Cable	Black polyurethane, 91 cm (3 ft) long
Temperature range	-5°C to 60°C (23°F to 140°F)
PC Interface	DB 9 pin, null modem (crossover), DTE to DTE

CONNECTIONS

Ⓐ Mates with the Twist-Lock Connector on the instrument's RuggedCable™

Ⓑ Connects to the 9-pin serial port on a PC or PDA

INSTALLATION

1. Remove the desiccant (if present) from the free end of the RuggedCable by grasping the knurled (textured) section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.

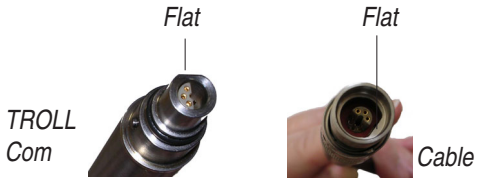
2. Follow these steps to attach the TROLL Com to the cable:

   2a. Remove the protective caps from the TROLL Com and cable (if present).

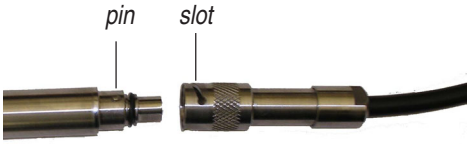
(over)

TROLL COM
Catalog No. 51460

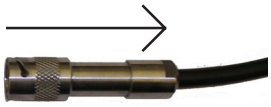
2b. Note that each connector has a flat side.



Note the pins on the TROLL Com connector and the slots on the cable connector.

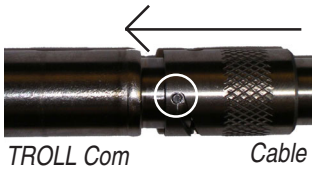


2c. Slide back the sleeve on the cable connector.

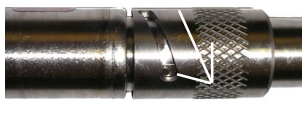


2d. Orient the "flats" so they will mate up, and insert the TROLL Com connector firmly into the cable connector.

2e. Slide the sleeve toward the TROLL Com until the pin on the TROLL Com pops into the round hole in the slot on the cable connector.



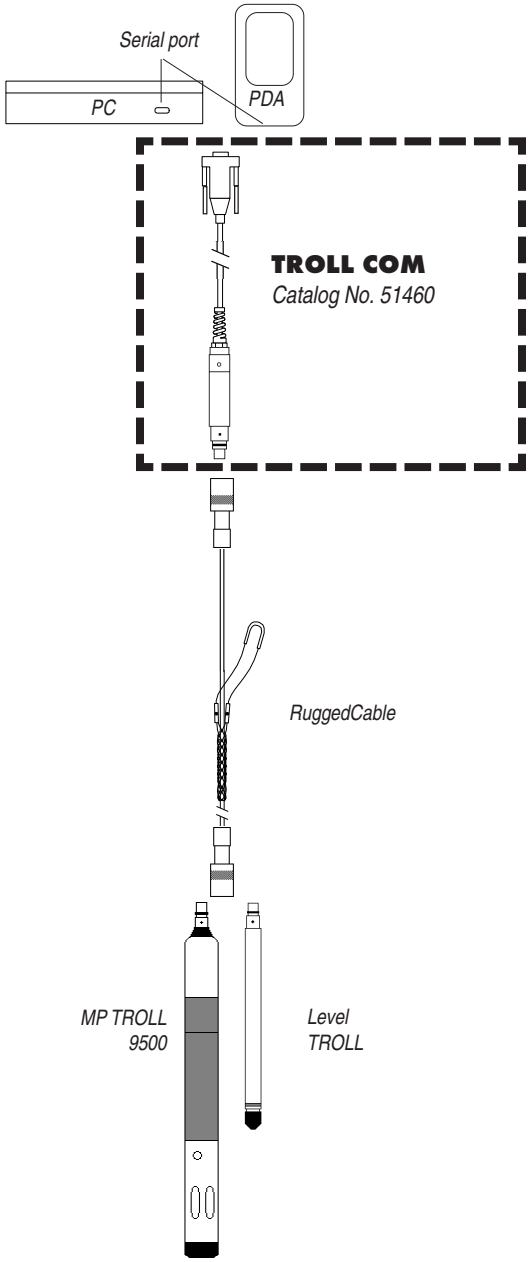
2f. Grasp the knurled (textured) section of the cable connector in one hand and the TROLL Com in the other, push and twist firmly so that the pin on the TROLL Com slides along the slot on the cable connector and locks securely into the other hole. The "click" ensures the connectors are securely mated.



3. Attach the DB9 connector on the TROLL Com to a PC's standard 9-pin RS232 serial port.

GUIDELINES AND PRECAUTIONS

- A serial cable, serial card, and/or a null-modem adapter may be needed with some PDAs
- The DB9 connector is not waterproof
- Soft dust caps protect the connectors during shipping. Keep the dust caps to protect the connector pins and o-ring when the connectors are not mated.



1 800 4INSITU
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In-Situ Inc.

0051462 rev. 002 02/06

Endress+Hauser WaterPilot FMX167

BA 231P/24/ae/07.01
52010550

Waterpilot FMX 167
Hydrostatic Level Measurement









Operating Instructions

Endress+Hauser
The Power of Know How

Table of contents

1 Safety instructions

1.1 Intended application

The Waterpilot FMX 167 is a hydrostatic pressure sensor for measuring the level of fresh water, drinking water and wastewater. Versions with a Pt 100 resistance thermometer can also measure temperature. The optional temperature transmitter converts the Pt 100 signal into a 4-20 mA signal.

The manufacturer shall not accept any liability for damage arising from improper use or if the device is used for purposes for which it was not intended.

1.2 Installation, setup, operation

The Waterpilot FMX 167 and the temperature transmitter (optional) are designed as fail-safe to the state of the art and comply with prevailing regulations and EC directives. If the devices are not used properly or for purposes for which they were not intended, they may become hazards arising from the particular application, e.g. product overflow through incorrect installation or adjustment. For these reasons, only trained personnel authorized by the plant operator may install, connect electrically, set up, operate and maintain the measuring system. Trained personnel must have read and understood these Operating Instructions and follow the instructions. Any changes and repairs to the devices may only be performed if the Operating Instructions expressly permit this.

1.3 Operational safety

Explosion hazardous area:
If the measuring system is used in explosion hazardous areas, you must comply with the prevailing national standards. The device is supplied with a separate document on explosion hazards which is a component part of this documentation. Please comply with the installation instructions, connecting values and safety instructions contained therein.

- Make sure that personnel have received sufficient training.
- Please comply with the technical measuring and safety conditions at the measuring points.

Order Code (refer to Chapter 2 "Identification")
FMX 167 - ❑ ❑ ❑ ❑❑ ❑ ❑ ❑

Code	Certificate	Protection
B	ATEX	ATEX II 2 G EEx ia IIC T6
C	ATEX	ATEX II 3 G EEx nA II T6
D	FM	IS, Class I, Division 1, Groups A-D
E	CSA	IS, Class I, Division 1, Groups A-D

1.4 Safety warnings and symbols

In order to emphasize safety or alternative processes, we have defined the following safety warnings and appended a pictogram to each one.

Safety warnings

Symbol	Meaning
	**Warning!** Warning indicates activities or processes which – if they are not performed properly – will lead to serious personal injury, a safety hazard or destruction of the device.
	**Caution!** Caution indicates activities or processes which – if they are not performed properly – will lead to personal injury or malfunctioning of the device.
	**Note!** Note indicates activities or processes which – if they are not performed properly – may have an indirect impact on functioning or an unforeseen response from the device.

Type of protection

	**Explosion-protected, type tested apparatus** If this symbol is on the device nameplate, the device may be used in explosion hazardous areas or in non explosion hazardous areas, depending on the approval.
	**Explosion hazardous area** This symbol in drawings in these Operating Instructions identifies an explosion hazardous area. – Devices which are located in a hazardous area or cables for such devices must be suitably protected.
	**Safe area (non explosion hazardous area)** This symbol in drawings in these Operating Instructions identifies a non explosion hazardous area. – Devices in a non explosion hazardous area must also be certified if connecting cables are routed in the explosion hazardous area.

Electrical symbols

	DC voltage A terminal to which a DC voltage is applied or through which a DC voltage flows.
	**AC voltage** A terminal to which a (sinusoidal) AC voltage is applied or through which an AC voltage flows.
	**Ground connection** A grounded terminal which is already grounded by a grounding system from the user's viewpoint.
	**Protective earth terminal** A terminal which must be grounded before any other connections are made.
	**Potential Equalization terminal** A terminal which must be connected with the equipment grounding system: this may be a potential matching line or a star-shaped grounding system, depending on national or corporate practice.

2 Identification

2.1 Device designation

- Waterpilot FMX 167 for hydrostatic level measurement, refer to Chapter 2.1.1.
- Waterpilot FMX 167 with optional Pt 100 resistance thermometer for simultaneous level and temperature measurement, refer to Chapter 2.1.1.
- Waterpilot FMX 167 with optional Pt 100 resistance thermometer and optional temperature transmitter TMT 181, refer to Chapters 2.1.1 and 2.1.2.

2.1.1 Nameplate of Waterpilot FMX 167

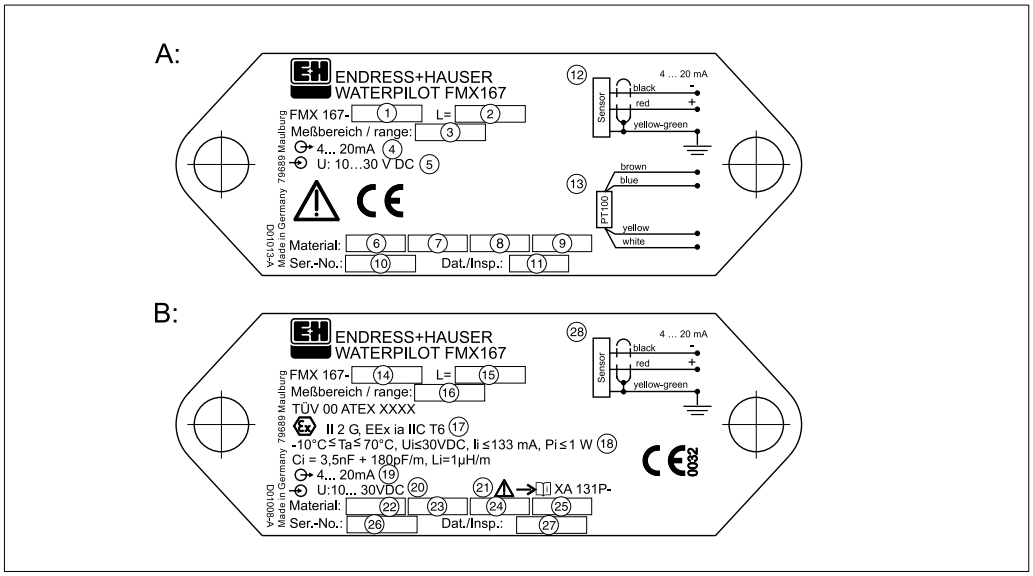


Fig. 1: Nameplates for Waterpilot FMX 167

Nameplate A: Example for non hazardous area

1 *Order Code*
The meaning of the individual letters and numbers is specified in the order confirmation. See page 31.
2 *Length of support cable*
3 *Measuring range*
4 *Current output: 4-20 mA*
5 *Auxiliary energy/Supply voltage: 10 - 30 V DC*
6 *Housing material: 1.4435 (AISI 316L)*
7 *Measuring cell material: aluminum oxide Al_2O_3*
8 *Support cable material: (PE) polyethylene*
9 *Seal material: 1: Viton, 2: EPDM*
10 *Serial No.*
11 *Test date/Tester*
12 *Wiring diagram of FMX 167*
13 *Wiring diagram of FMX 167 with Pt 100 if Waterpilot FMX 167 was ordered with Pt 100.*

Nameplate B: Example for hazardous area

14 *Order Code*
The meaning of the individual letters and numbers is specified in the order confirmation. See page 31.
15 *Length of support cable*
16 *Measuring range*
17 *Type of protection*
18 *Permissible ambient temperature range and other electrical data*
19 *Current output: 4-20 mA*
20 *Auxiliary energy/Supply voltage: 10 - 30 V DC*
21 *Reference to related Safety Instructions (e.g. XA 131P)*
22 *Housing material: 1.4435 (AISI 316L)*
23 *Measuring cell material: aluminum oxide Al_2O_3*
24 *Support cable material: (PE) polyethylene*
25 *Seal material: 1: Viton, 2: EPDM*
26 *Serial No.*
27 *Test date/Tester*

Note!
A sensor number and the measuring range are specified on each probe; in addition a certificate and the type of protection are specified on probes designed for explosion hazardous areas.
The nameplate does not specify the sensor number. If you need to assign a nameplate to a probe at a later date, please refer to the supplied calibration report. This is where the sensor and the serial number are specified.

2.1.2 Nameplate of Temperature Transmitter TMT 181

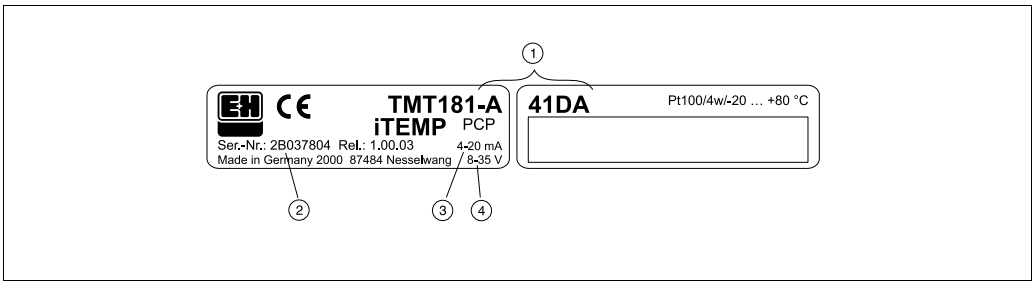


Fig. 2: Nameplate of Temperature Transmitter iTEMP® PCP TMT181

1 Order Code of Temperature Transmitter TMT 181-A41DA
A: Variant for non-hazardous area
4: 4-wire
1: Sensor Pt 100
D: Temperature transmitter with settings for –4 to +176°F (–20 to +80°C) range
A: Label: standard version
2 Serial No.
3 Current output: 4 to 20 mA
4 Supply voltage: 8 to 35 V DC

2.2 Scope of supply

The scope of supply is comprised of:
- Waterpilot FMX 167, optionally with integrated Pt 100 temperature sensor
- Optional accessories, refer to Chapter 7

Supplied documentation:
- Operating Instructions (this manual)
- Calibration report
- For hazardous areas: additional "Safety Instructions" (XA…)
- For FM, CSA: Control Drawing or Installation Drawing
- Drinking water approval (optional)

2.2.1 CE symbol, Declaration of Conformity

The devices are designed fail-safe to the state of the art and left the factory in perfect condition with regard to safety. The devices comply with the prevailing standards and regulations contained in DIN EN 61010 “Safety requirements for electrical equipment for measurement, control and laboratory use”.
The measuring system described in these Operating Instructions therefore meet the statutory requirements of EC directives. Endress+Hauser confirms the successful testing of the device by affixing the CE symbol.

3 Installation

3.1 Incoming acceptance

Check the following items upon receipt of the product:
- Check whether the packaging or its contents are damaged.
- Check the delivered products for completeness and compare the contents with your order data.

3.2 Installation guidelines

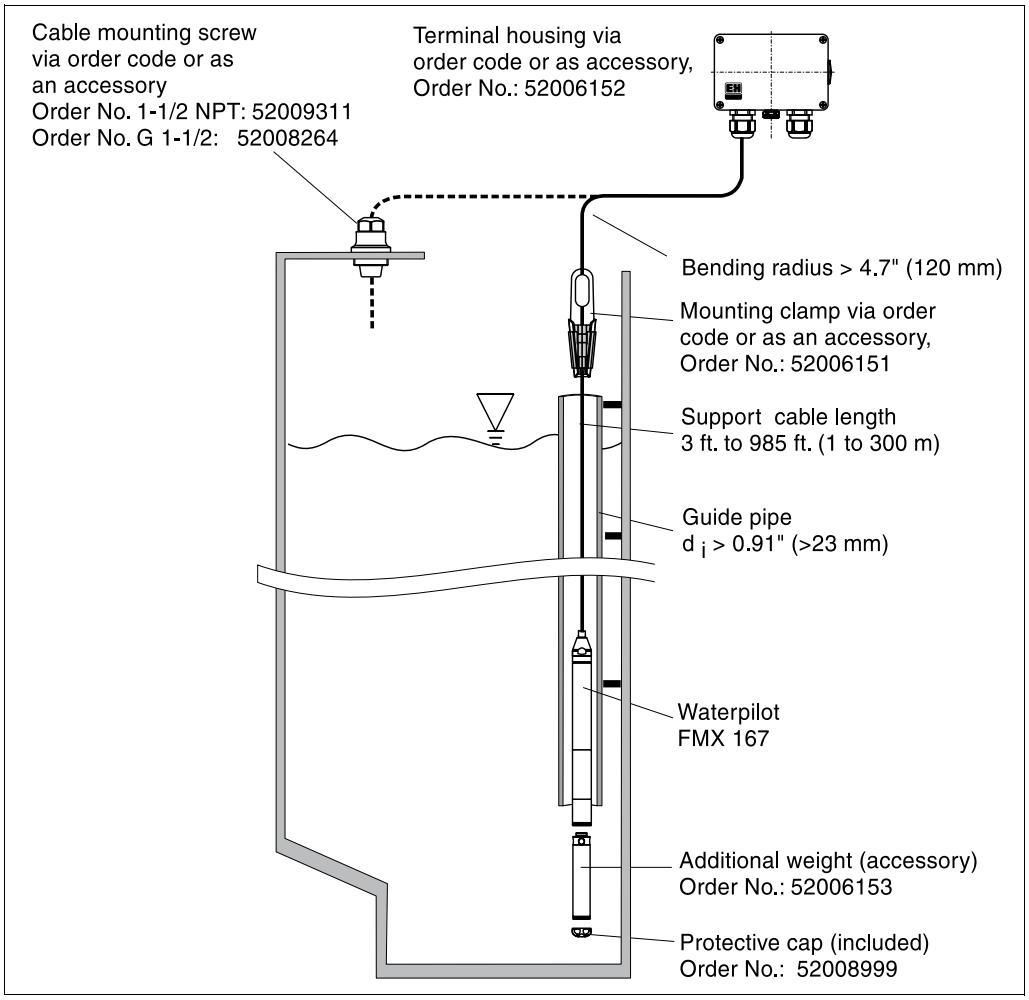


Fig. 3: Installation examples

The FMX 167 should be installed at a point that is free from flow or turbulence, or mounted in a guide tube with an inner diameter greater than 0.90" (23 mm). If the cable is terminated outdoors, a junction box from E+H is recommended (Part No. 52006152). The atmospheric pressure compensation tube (located inside cable) must be kept from blockage or kinking. The atmospheric compensation tube is protected from condensation by a teflon filter and an additional GORE-TEX® filter which is terminated in the junction box.

3.2.1 Installation dimensions

See Chapter 9.3 "Technical data, Dimensions" for the dimensions.

3.3 Installation instructions

3.3.1 Installing Waterpilot with a mounting clamp

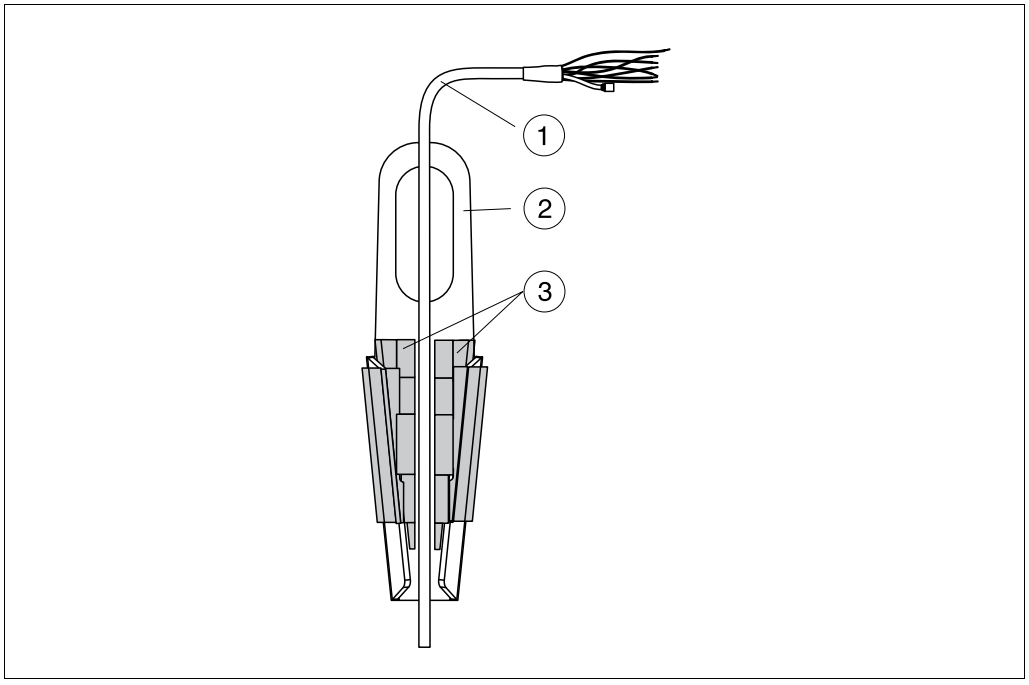


Fig. 4: Installing Waterpilot FMX 167 with a mounting clamp

1 Support cable
2 Mounting clamp
3 Clamping jaws

How to mount the mounting clamp:

1. Mount the mounting clamp (Pos. 2). When selecting the type of mounting, note the weight of the support cable (Pos. 2) and the device (refer to Chapter 9.1.).
2. Raise clamping jaws (Pos. 3). Place support cable (Pos. 1) acc. to Fig. 4 between clamping jaws.
3. Hold support cable (Pos. 1) tight and push clamping jaws (Pos. 3) back down. Set clamping jaws by tapping lightly.

Note!

By attaching a piece of electrical tape or a cable-tie to the cable, re-installation to identical depth is ensured after inspection or temporary removal.

3.3.2 Installing Waterpilot with cable mounting screw

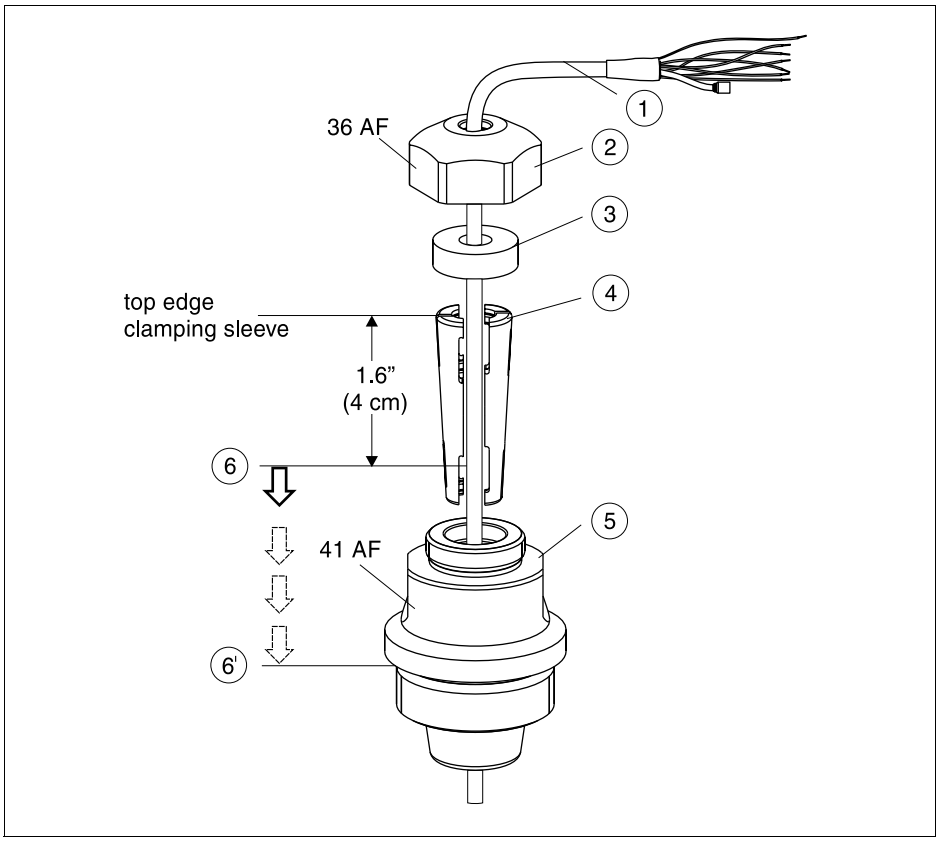


Fig. 5: Installing the Waterpilot FMX 167 with cable mounting screw, depicted here with G 1 1/2 thread

1 Support cable
2 Mounting screw cap nut
3 Sealing ring
4 Clamping sleeve
5 Mounting screw adapter
6 Required length of support cable and FMX 167 probe before assembly
6´ After assembly Pos. 6) is located next to the mounting screw with
G 1 1/2 thread: sealing surface of mounting screw adapter
1 1/2 NPT thread: thread run-out of mounting screw adapter

Note!

Note!
If you want to lower the level probe to a certain depth, place the top edge of the clamping sleeve 1.6" (4 cm) higher than the required depth. Then push the support cable and the clamping sleeve into the adapter as described in the following section, Step 6.

How to mount the cable mounting screw with G 1 1/2 or 1 1/2 NPT thread:
1. Mark required length of support cable, refer to "Note" on this page.
2. Insert probe through measuring opening and carefully lower on support cable. Hold support cable to prevent it from slipping.
3. Push adapter (Pos. 5) over support cable and screw tightly in measuring opening.
4. Push sealing ring (Pos. 3) and cap (Pos. 2) from top onto cable. Press sealing ring into cap.
5. Place clamping sleeve (Pos. 4) around support cable (Pos. 1) acc. to Figure 5.
6. Push support cable and clamping sleeve (Pos. 4) into adapter (Pos. 5).
7. Push cap (Pos. 2) and sealing ring (Pos. 3) onto adapter (Pos. 5) and screw tightly to adapter (Pos. 5).

Note!
Remove the cable mounting screw in the opposite sequence of operation to installation.

Note!

3.3.3 Mounting the terminal housing

Mount the optional terminal housing with four screws (M 4). See Chapter 9.3 "Dimensions" for the dimensions of the terminal housing. The drilling template for the housing is located in Chapter 10.2.

3.3.4 Mounting the Temperature Transmitter TMT 181

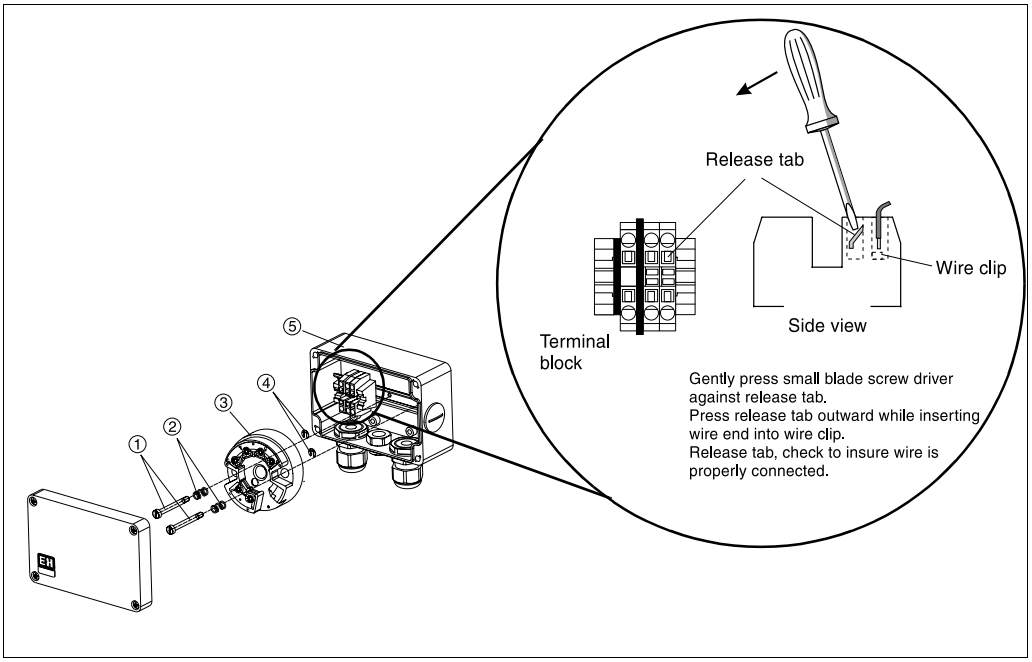


Fig. 6: Mounting the temperature transmitter, depicted here with terminal housing

1 Mounting screws
2 Mounting springs
3 Temperature Transmitter TMT 181
4 Screw retainers
5 Terminal housing

How to mount the temperature transmitter
1. Insert the mounting screws (Pos. 1) with the mounting springs (Pos. 2) through the boring of the temperature transmitter (Pos. 3).
2. Set the mounting screws with the screw retainers (Pos. 4).
   The screw retainers, mounting screws and springs are contained in the contents of the temperature transmitter.
3. Screw the temperature transmitter tightly in the field housing.

Caution!
Do not overtighten the mounting screws to avoid damage to the temperature transmitter.

Caution!

3.4 Checking the installation

Check that all screws are seated firmly.

4 Wiring

Warning!
When connecting devices with explosion protection certificates, please comply with national standards and the warnings and wiring diagrams in the additional explosion protection documentation accompanying these Operating Instructions. Also refer to Chapters 9.1 and 9.2, Section "Supplementary documentation". If you have any questions, please contact your nearest Endress+Hauser Service Organization.

4.1 Electrical connection

How to connect the devices:

- The supply voltage must match the specification on the nameplate, refer to Chapters 2.1.1 and 2.1.2.
- Switch off supply voltage before you connect the device.
- The cable must end in a dry room or in a proper terminal housing. The terminal housing with GORE-TEX® filter, NEMA 4/NEMA 4X (IP 66/IP 67) from Endress+Hauser is suitable for outdoor installation.
- Connect device according. to Figures 7 and 8. A polarity protection is integrated in the Waterpilot FMX 167 and the Temperature Transmitter TMT 181. Changing the polarities will not destroy the devices.

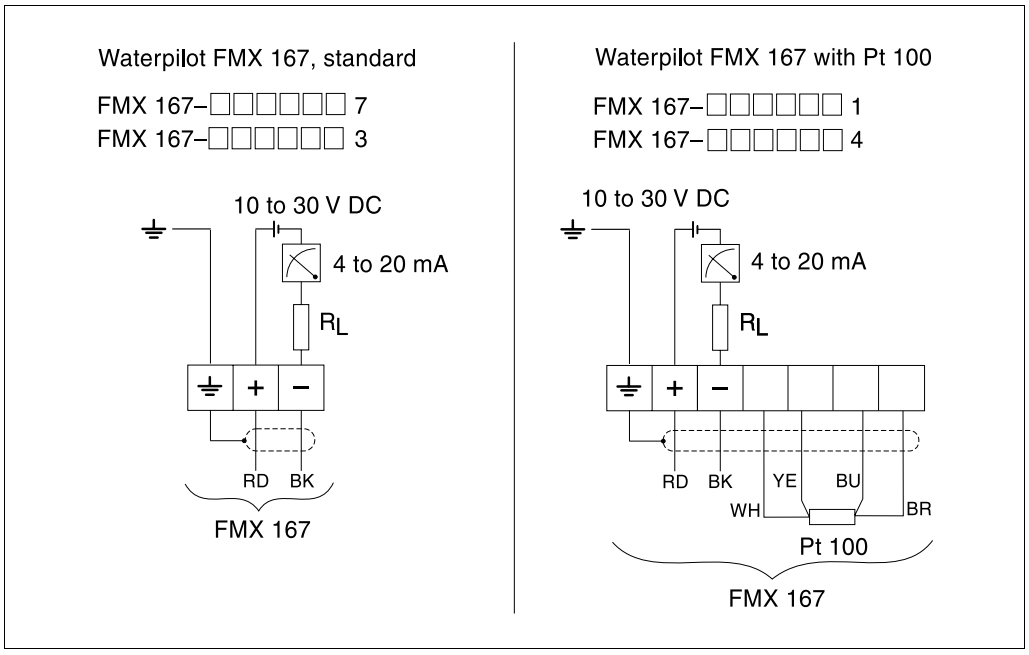


Fig. 7: Electrical connection: left for FMX 167, right for FMX 167 with Pt 100

Wire colors
RD = red
BK = black
WH = white
YE = yellow
BU = blue
BR = brown

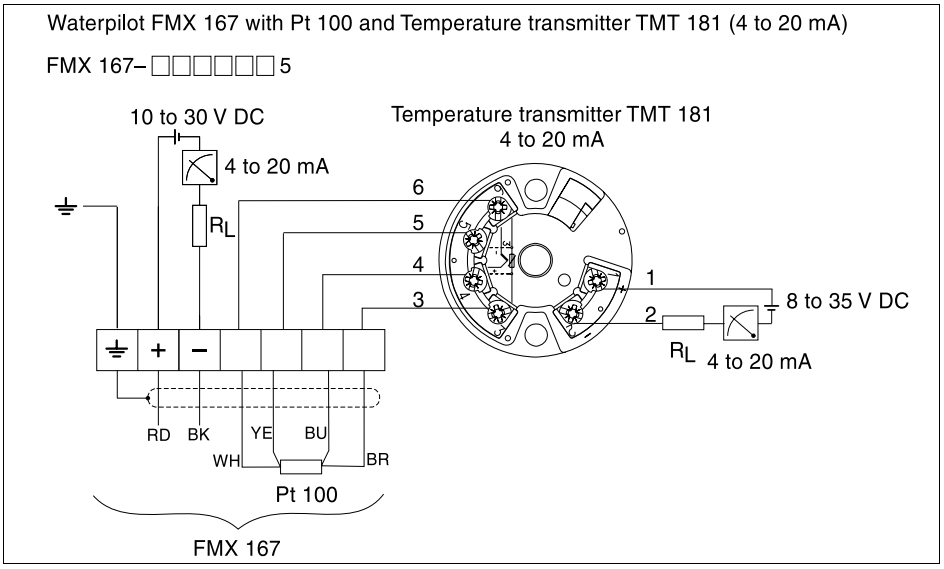


Fig. 8: Electrical connection: FMX 167 with Pt 100 and Temperature Transmitter TMT 181

Wire colors
RD = red
BK = black
WH = white
YE = yellow
BU = blue
BR = brown

Supply voltage

Certificate	Supply voltage		Supply voltage
	FMX 167	FMX 167 + Pt 100	Temperature transmitter
standard	10 to 30 V DC	10 to 30 V DC	8 to 35 V DC
EEx nA IIC T6	10 to 30 V DC	10 to 30 V DC	–
FM IS **CSA IS** **EEx ia IIC T6**	10 to 30 V DC	–	–

Cable specification

FMX 167 with Pt 100 (optional)	Temperature transmitter (optional)
– Commercially available installation cable – Terminals in terminal housing FMX 167: ≤14 AWG (2.5 mm²).	– Commercially available installation cable – Terminals in terminal housing FMX 167: – ≤14 AWG (2.5 mm²) – Transmitter terminals: max. 15 AWG (1.75 mm²)

Note!
The support cable of the Waterpilot FMX 167 is shielded. In the following cases Endress+Hauser recommends use of a shielded cable for the cable extension:
– for large distances between support cable end and display and/or evaluation unit,
– for large distances between support cable end and temperature transmitter
– for directly connecting Pt 100 signals to the display and/or evaluation unit.

Power consumption/current drain

	FMX 167	FMX 167 + Pt 100	Temperature transmitter TMT 181
Power consumption	≤ 0.675 W at 30 V DC	≤ 0.675 W at 30 V DC	≤ 0.77 W at 35 V DC
Current drain	max. ≤ 22.5 mA min. ≥ 3.5 mA	max. ≤ 22.5 mA min. ≥ 3.5 mA Pt 100: ≤ 0.6 mA	max. ≤ 22 mA min. ≥ 3.5 mA

Load

The maximum load resistance is dependent on the supply voltage (U_b) and must be determined for every current loop separately. Refer to equations and diagrams for "FMX 167 with Pt 100 (optional)" and "Temperature transmitter".
The total resistance resulting from the resistances of the connected devices, the connecting cable and if necessary, the resistor of the support cable may not exceed the load resistance.

FMX 167 with Pt 100 (optional)	Temperature transmitter (optional) TMT 181
$R_{tot} \leq \frac{U_b - 10\ V}{0.0225\ A} - 2 \cdot 0.09\ \frac{\Omega}{m} \cdot l - R_{add}$	$R_{tot} \leq \frac{U_b - 8\ V}{0.022\ A} - R_{add}$

R_{tot} = *Max. load resistance [Ω]*
R_{add} = *Additional resistances, e.g. resistance of evaluating device and/or the display instrument, line resistance [Ω]*
U_b = *Supply voltage [V]*
l = *Simple length of support cable [m] (cable resistance per wire ≤ 0.09 Ω/m)*

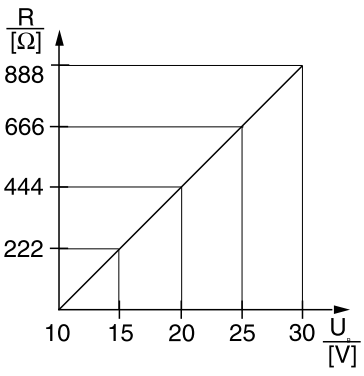


Fig. 9:
Load chart FMX 167 for estimating load resistance

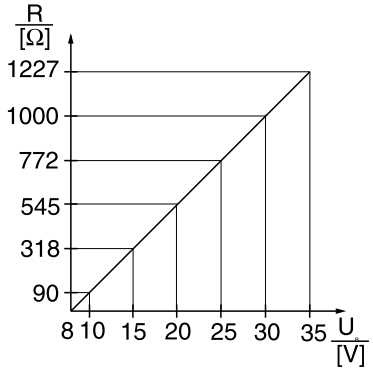


Fig. 10:
Load chart of temperature transmitter TMT 181 for estimating load resistance

Note!

Note!
Additional resistances, e.g. resistance of support cable, must then be subtracted from the value determined from the diagram, as shown in the equation.

4.2 Wiring the measuring unit

Overvoltage protection

Note!
In order to protect the Waterpilot FMX167 and the Temperature Transmitter TMT 181 from large transients, Endress+Hauser recommends the installation of an overvoltage protector upstream and downstream of the display and/or evaluation device as shown in the figure.
The Waterpilot FMX 167 has an integrated overvoltage protection to EN 61000 of ≤ 1.2 kV as standard.

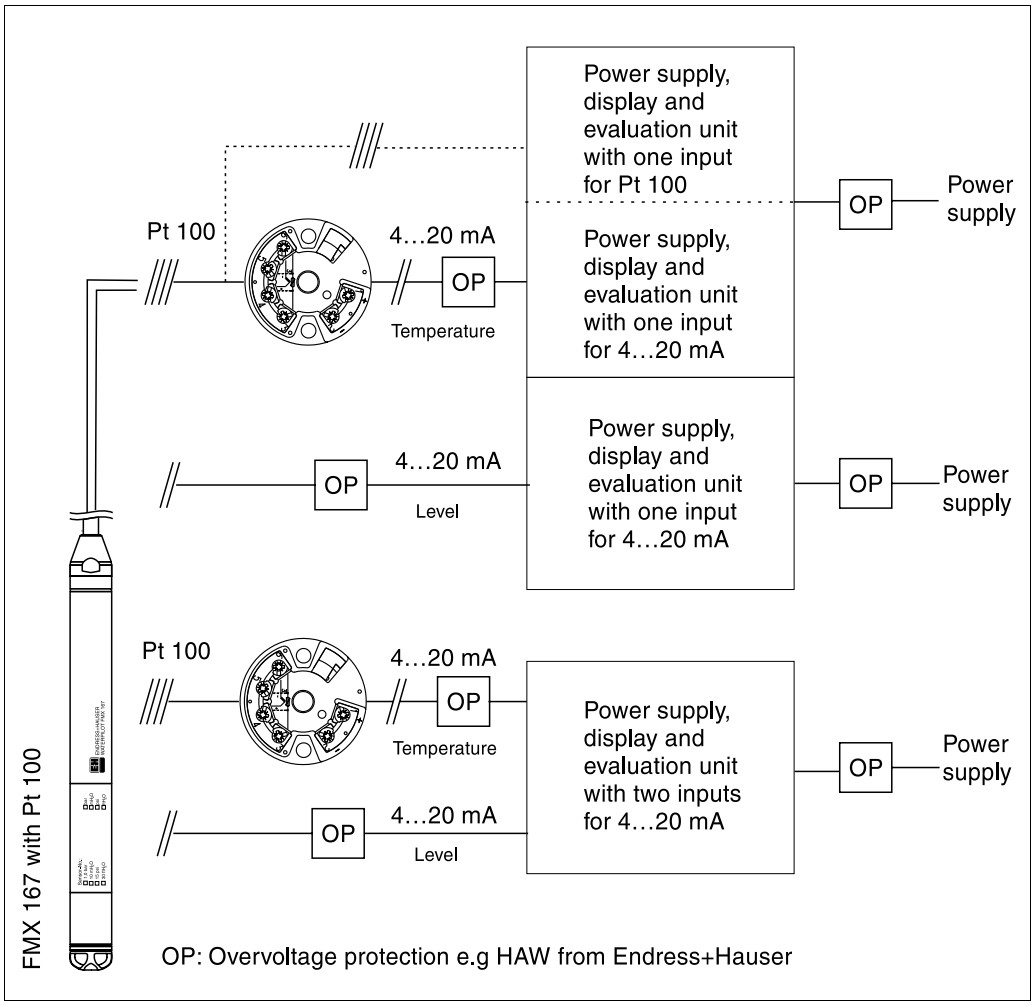


Fig. 11: Wiring the measuring unit

4.3 Checking the wiring

After wiring the measuring instrument, carry out the following inspections:
- Does the supply voltage match the specification on the nameplate?
- Is the device connected as shown in Figures 7 and 8?
- Are all the screws tightened?
- Optional terminal housing: are the conduit entries tight?

5 Operation

Note!
Endress+Hauser offers extensive measuring point solutions with display and/or evaluation units for the Waterpilot FMX 167 and the Temperature Transmitter TMT 181. For more information, please contact your nearest Endress+Hauser Service Organization. Please refer to the back page of this documentation for contact addresses.

6 Maintenance

No special maintenance work is required for the Waterpilot FMX 167 or for the optional Temperature Transmitter TMT 181.

Cleaning the device exterior
When cleaning the exterior of the measuring device, please note the following:
- Do not use a cleaning agent that is aggressive to the housing surface or the seal.
- Waterpilot FMX 167: avoid any mechanical damage to the membrane or the support cable.

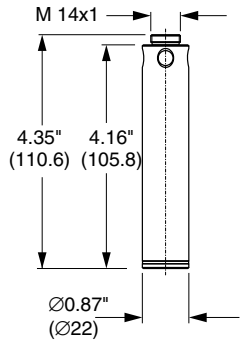
7 Accessories

There are a number of accessories available for the Waterpilot FMX 167. You can order them separately from Endress+Hauser.

Mounting clamp
Endress+Hauser offers a mounting clamp for simple mounting. Refer to page 26.
Material: 1.4435 (AISI 316L), Order No.: 52006151

Terminal housing
Terminal housing NEMA 4/NEMA 4X (IP 66/IP 67) with GORE-TEX® filter including three mounted terminals.
The terminal housing is also suitable for installing a temperature transmitter (Order No. 52008794) or for four additional terminals (Order No. 52008938).
Refer to page 27.
Order No.: 52006152

Additional weight



To prevent sideways movement leading to measuring errors or to ensure that the device lowers into a guide tube, Endress+Hauser provides additional weights. You can attach several weights to the FMX 167.

Material: 1.4435 (AISI 316L)
Weight: 10.6 oz. (300 g)
Order No.: 52006153

Temperature Transmitter TMT 181, 4-20 mA
Temperature transmitter, 2-wire, pre-set for measuring range from –4 to +176°F (–20 to +80°C).
This setting offers an easily displayable temperature range of (212°F) 100°C. Note that the Pt 100 resistance thermometer is designed for a temperature range of +14 to +158°F (–10 to +70°C). Refer to page 27.
Order No.: 52008794

Cable mounting screw
Endress+Hauser offers cable mounting screws to simplify the installation of the FMX 167.
Refer to page 26. Material: 1.4301 (AISI 304)
Order No. for cable mounting screw with G 1 1/2 A thread: 52008264
Order No. for cable mounting screw with 1 1/2 NPT thread: 52009311

Terminals
Four terminals in strip for FMX 167 terminal housing,
suitable for wire cross section of $\leq$14 AWG (0.08 to 2.5 mm^2)
Order No.: 52008938
Protective front cap (set of 5)
Order No.: 52008999

Membrane protective cap
5 pieces in set, refer to Fig. 3, page 8
Order No.: 52008999

Pressure compensation set
10 pieces in set, comprised of Teflon filter and sleeve for support cable, refer to Fig. 3, page 8
Order No.: 52005578

8 Trouble-shooting

8.1 Faults on Waterpilot FMX 167 and Waterpilot FMX 167 with Pt 100 (optional)

Error description	Cause	Action
No measuring signal	Connection of 4-20 mA line incorrect	Connect device according to Chapter 4.1, Figs. 7 or 8
	No supply voltage over 4-20 mA line	Check current loop
	Supply voltage too low (min. 10 V DC)	Check supply voltage Total resistance greater than max. load resistance, refer to Chapter 4.1, page 14
	Waterpilot defective	Replace Waterpilot
Temperature measuring value inaccurate/incorrect (only with Waterpilot FMX 167 with Pt 100)	Pt 100 connected to 2-wire circuit, line resistance not compensated	Compensate line resistance Connect Pt 100 as 3-wire or 4-wire circuit

8.2 Faults of Temperature Transmitter TMT 181 (optional)

Error description	Cause	Action
No measuring signal	Connection of 4-20 mA line incorrect	Connect device according to Chapter 4.1, Fig. 8
	No supply voltage over 4-20 mA line	Check current loop
	Supply voltage too low (min. 8 V DC)	Check supply voltage Total resistance greater than max. load resistance, refer to Chapter 4.1, page 14
Error current ≤ 3.6 mA or ≥ 21 mA	Connection of Pt 100 incorrect	Connect device according to Chapter 4.1, Fig. 8
	Connection of 4-20 mA line incorrect	Connect device according to Chapter 4.1, Fig. 8
	No supply voltage over 4-20 mA line	Check current loop, refer to Chapter 4.1, Fig. 8
	Pt 100 element defective	Replace Waterpilot FMX 167
	Temperature transmitter defective	Replace temperature transmitter
Measuring value inaccurate/ incorrect	Pt 100 connected in 2-wire circuit, line resistance not compensated	Compensate line resistance Connect Pt 100 as 3-wire or 4-wire circuit

8.3 Spare Parts

Note!
You can order spare parts directly from your nearest Endress+Hauser Service Organization.

9 Technical Data

9.1 Technical Data Waterpilot FMX 167 and Waterpilot FMX 167 with Pt 100 (optional)

Applications

Applications	The Waterpilot FMX 167 is a hydrostatic pressure sensor for measuring the level of fresh water, drinking water and wastewater. The version with a Pt 100 resistance sensor measures temperature at the same time.

Input Parameters

Measured variable	• Hydrostatic pressure of a liquid • Pt 100: Temperature of a liquid
Measuring range	• Nine fixed pressure measuring ranges in psi, ftH_2O, bar and mH_2O, • Customer-specific measuring ranges between 1.5 and 300 psi (3 to 600 ftH_2O); factory-calibrated and special measuring ranges on request • Pt 100 (optional): Temperature measurement from –4 to +176°F (–20 to +80°C)

Output Parameters

Output signal	• 4-20 mA for hydrostatic pressure measured value, two-wire loop powered • Pt 100 (optional): temperature-dependent resistance of the Pt 100
Load	see Chapter 4.1, section "Load"

Auxiliary energy

Electrical connection	see Chapter 4.1, integrated polarity protection
Supply voltage	• 10 - 30 V DC, EEx nA and EEx ia: 10 - 30 V DC • Pt 100: 10 - 30 V DC, EEx nA: 10 - 30 V DC
Power consumption	≤ 0.675 W at 30 V DC
Current drain	• Max. current drain: ≤ 22.5 mA; Min. current drain: ≥ 3.5 mA • Pt 100 (optional): ≤ 0.6 mA
Residual ripple	No effect for 4-20 mA signal up to ± 5% residual ripple within permissible range

Performance characteristics

Reference operating conditions	DIN EN 60770 T_U= 77°F (25°C)
Accuracy	• Linearity including hysteresis and repeatability as per DIN EN 60770: ± 0.2% of Full Scale • Pt 100: max.: ±0.7 K (Class B to DIN EN 60751)
Long-term stability	±0.1 % of Full Scale per year
Influence of medium temperature	• Thermal change in zero signal and output span for typical temperature range +32 to +86°F (0 to +30°C): ± 0.4 % (± 0.5 %)* of span • Thermal change in zero signal and output span for the total medium temperature range +14 to +158°F (–10 to +70°C): ± 1.0 % (± 1.5 %)* of span • Maximum temperature coefficient (T_K) in zero signal and output span: 0.15 %/10 K (0.3 %/10 K)* of span * Specifications for sensors 1.5 psi (3 ft H_2O, 0.1 bar, 1 mH_2O), 10 psi (20 ft H_2O, 0.6 bar, 6 mH_2O)

Performance characteristics (continuation)

Warm-up period	20 ms
Rise time (T90-time)	• 80 ms • Pt 100 (optional): 160 s
Setting time	• 150 ms • Pt 100 (optional): 300 s

Ambient Conditions

Ambient temperature range	+14 to +158°F (–10 to +70°C), (= Medium temperature range)
Storage temperature	–40 to +176°F (–40 to +80°C)
Ingress protection	– NEMA 6P (IP 68), permanently submersible to 700 ftH_2O – Optional terminal housing: NEMA 4/NEMA 4X (IP 66/IP 67)
Electromagnetic compatibility	Interference emission to EN 61326; Equipment Class B Interference immunity to EN 61326, Appendix A (industrial usage)
Overvoltage protection	Integrated overvoltage protection to EN 61000-4-5 ≤ 1.2 kV Install overvoltage protection ≥ 1.2 kV, external if necessary.

Process Conditions

Medium temperature range	+14 to +158°F (–10 to +70°C) For devices approved for use in hazardous areas, see Safety Instructions.
Medium temperature limits	–4 to 158°F (–20 to +70°C) (You may operate the FMX 167 in this temperature range. The values quoted in the specifications may then be exceeded, e.g. measuring accuracy. Also refer to DIN 16086.)

Mechanical Construction

Construction, Dimensions	see Chapter 9.3
Weight	– Cable probe: 10 oz. (290 g) – Support cable: Approximately 2 oz/ft (52 g/m) – Mounting clamp: 6 oz. (170 g) – Cable mounting screw G 1 1/2 A: 1.7 lb. (0.77 kg) – Cable mounting screw 1 1/2 NPT: 1.6 lb. (0.72 kg) – Terminal housing: 8.3 oz. (235 g) – Additional weight: 10.6 oz. (300 g)
Materials	Cable probe: – Cable probe 1.4435 (AISI 316L) – Process ceramic: Al_2O_3 aluminum oxide ceramic – Seal (internal): EPDM or Viton – Protective cap: PE-HD (high-density polyethylene) – Support cable insulation: PE (polyethylene), for more details, see section "Support cable" optional: – Mounting clamp 1.4435 (AISI 316L) and glass fiber reinforced PA (polyamide) – Cable mounting screw G 1 1/2 A: 1.4301 (AISI 304) – Cable mounting screw 1 1/2 NPT: 1.4301 (AISI 304) – Additional weight: 1.4435 (AISI 316L) – Temperature transmitter: Housing PC (polycarbonate)

Mechanical Construction (continuation)

Support cable	Construction – Slip-resistant extension cable with strain-relief members made of Kevlar; shielded using aluminum-coated film; insulated with polyethylene (PE), black; copper wires, twisted – Pressure compensation tube with Teflon filter Cross section – FMX 167: 3 x 0.0004 in^2 (0.227 mm^2) + pressure compensation tube with Teflon filter – FMX 167 with Pt 100 (optional): 7 x 0.0004 in^2 (0.227 mm^2) + pressure compensation tube with Teflon filter – Total outer diameter: 0.315 inch ± 0.0098 inch (8.0 mm ± 0.25 mm) – Pressure compensation tube with Teflon filter: Outer diameter OD = 0.098 inch (2.5 mm), Internal diameter ID = 0.059 inch (1.5 mm) Cable resistance – Cable resistance per wire: ≤ 90 Ω/km Cable length – Max. free suspended length (mechanical stability under load): 3280 feet (1000 m) – Max. free length for non-Ex and EEx nA IIC T6: see Section "Load", Chapter 4.1 Max. free length for EEx ia IIC T6: see Safety Instructions (XA...) Further technical data – Minimum bending radius: 4.7 inch (120 mm) – Tensile strength: ≥ 269 lb force (1200 N) – Cable extraction force: ≥ 101 lb force (450 N) (The extension cable could be extracted from the cable probe at a tensile force ≥ 101 lb force (450 N).) – Approved for use with drinking water NSF 61 – Increased resistance to UV light
Terminals	– 3 standard terminals in terminal housing – 4-terminal strip available as accessory , Order No. 52008938 for wire cross section of 0.0001 in^2 to 0.004 in^2 (0.08 to 2.5 mm^2)

Certificates and Approvals

Explosion protection approval, Type of protection	– ATEX II 2G/EEx ia IIC T6 – ATEX II 3 G/EEx nA II T6 – FM: IS, Class I, Division 1, Groups A-D – CSA: IS, Class I, Division 1, Groups A-D Note: Waterpilot FMX 167 with integrated Pt 100 is not available for FM, IS, Class 1, Div. 1, Groups A-D; CSA, IS, Class 1, Div. 1, Groups A-D and ATEX. Waterpilot FMX 167 with integrated Pt 100 is available for CSA, General purpose and for the Standard version. All explosion protection data are contained in separate explosion protection documentation which you can also request. Explosion protection documents are supplied as standard for all devices approved for use in explosion hazadous areas.

Ordering Information

Ordering information	You will receive ordering information and Order Code details from Endress+Hauser Service Organization. Refer also to Technical Information Waterpilot FMX 167 (TI 351P/24/ae)

Supplementary Documentation

Supplementary Documentation	– System Information Waterpilot (SI 028P/00/en) – Technical Information Waterpilot FMX 167 (TI 351P/24/ae) – Safety Instructions, ATEX II 2 G/EEx ia IIC T6 (XA 131P/01/a3) – Safety Instructions, ATEX II 3 G/EEx nA II T6 (XA 132P/01/a3)

9.2 Technical Data Temperature Transmitter TMT 181 (optional)

Applications

Applications	The temperature transmitter TMT 181 converts the Pt 100 signal into a 4-20 mA.

Input Parameters

Measured variable	Temperature
Measuring range	The temperature transmitter is pre-set for a measuring range of –4 to +176°F (–20 to +80°C). This setting offers an easily displayable temperature range of 212°F (100°C). Please note that the Pt 100 resistance thermometer is designed for a temperature range of 14 to 158°F (-10 to +70°C)
Input signal	Pt 100 resistance signal, 4-wire

Output Parameters

Output signal	4 to 20 mA for temperature measured value, two-wire
Load	see Chapter 4.1, section "Load"

Auxiliary energy

Electrical connection	see Chapter 4.1, integrated polarity protection
Supply voltage	8 - 35 V DC, EEx ia: 9.6 - 30 V DC
Cable specifications	see Chapter 4.1, section "Cable specifications"
Power consumptionn	≤ 0.77 W at 35 V DC
Current drain	• Max. current drain: ≤ 22 mA Min. current drain: ≥ 3.5 mA • with optional Pt 100 of the FMX 167: ≤ 0.6 mA
Residual ripple	U_{ss} ≤ 5 V at U_B ≥ 13 V, $f_{max.}$= 1 KHz

Performance characteristics

Reference operating conditions	Calibration temperature: 73°F (23°C) ± 5K
Accuracy	• ±0.2 K • with optional Pt 100 of the FMX 167: max. ±0.9 K
Warm-up period	4 s

Ambient Conditions

Ambient temperature range	–40 to +185°F (–40 to +85°C)
Storage temperature	–40 to +212°F (– 40 to +100°C)
Ingress protection	– IP 00, moisture condensation permissible – When mounted in optional terminal housing: NEMA 4X (IP 66/IP 67)
Electromagnetic compatibility (EMC)	Interference emission to EN 61326; Equipment Class B Interference immunity to EN 61326, Appendix A (industrial usage)
Overvoltage protection	Install overvoltage protection, external if necessary.

Mechanical Construction

Construction, dimensions	see Chapter 9.3
Weight	1.4 oz. (40 g)
Material	Housing PC (polycarbonate)

Terminals	Connection terminals temperature transmitter: 15 AWG (1.75 mm^2)

Certificates and Approvals

Explosion protection approval, Type of protection	FM IS Class 1, Div. 1, Group A-D Non Incendive, Class 1, Div. 2, Group A-D Note: Waterpilot FMX 167 with integrated Pt 100 is not available for FM IS, Class 1, Div. 1, Groups A-D; CSA IS, Class 1, Div. 1, Groups A-D and ATEX. Waterpilot FMX 167 with integrated Pt 100 is available for CSA, General purpose and for the Standard version.

Ordering Information

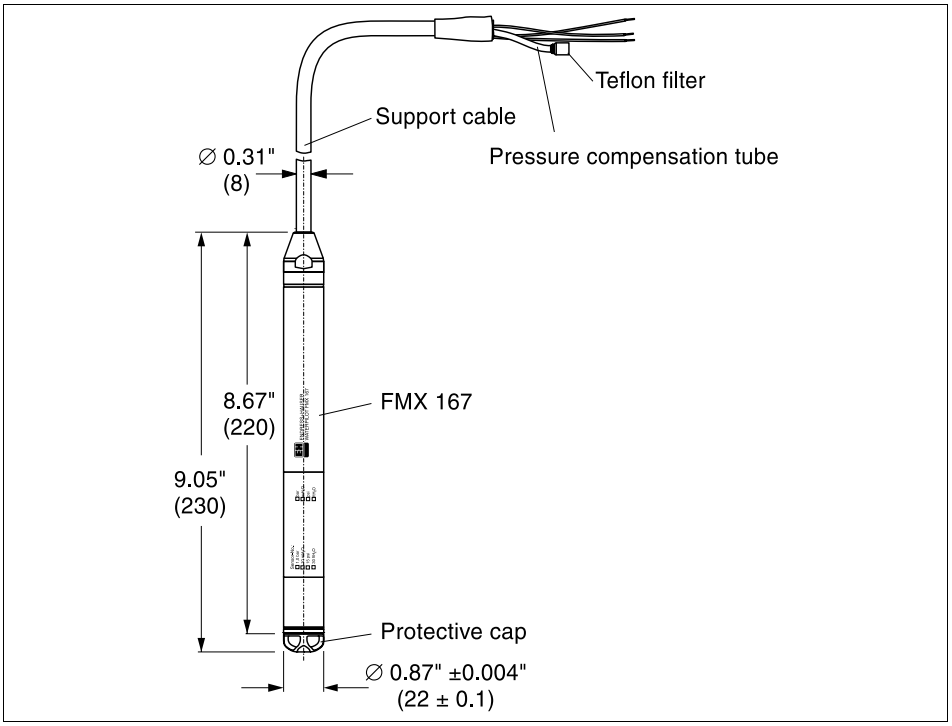
Ordering information	You will receive ordering information and Order Code details from Endress+Hauser Service Organization. See also Technical Information Temperature Head Transmitter iTEMP PCP TMT 181 (TI 070R/09/en).

Supplementary Documentation

Supplementary Documentation	– System Information Waterpilot (SI 028P/00/en) – System Information System Components (SI 006R/09/en) (Display, Power, Convert, Separate and Switch) – System Information Recorders with System Integration (SI 007R/09/en) – Technical Information Temperature Head Transmitter iTEMP PCP TMT 181 (TI 070R/09/en)

9.3 Dimensions

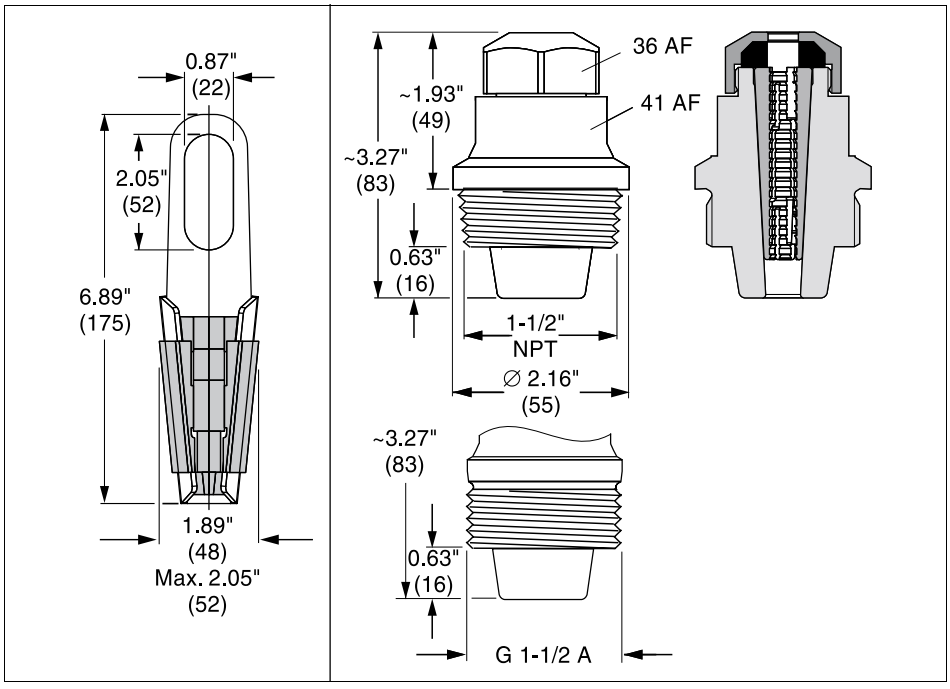
Dimensions of cable probe



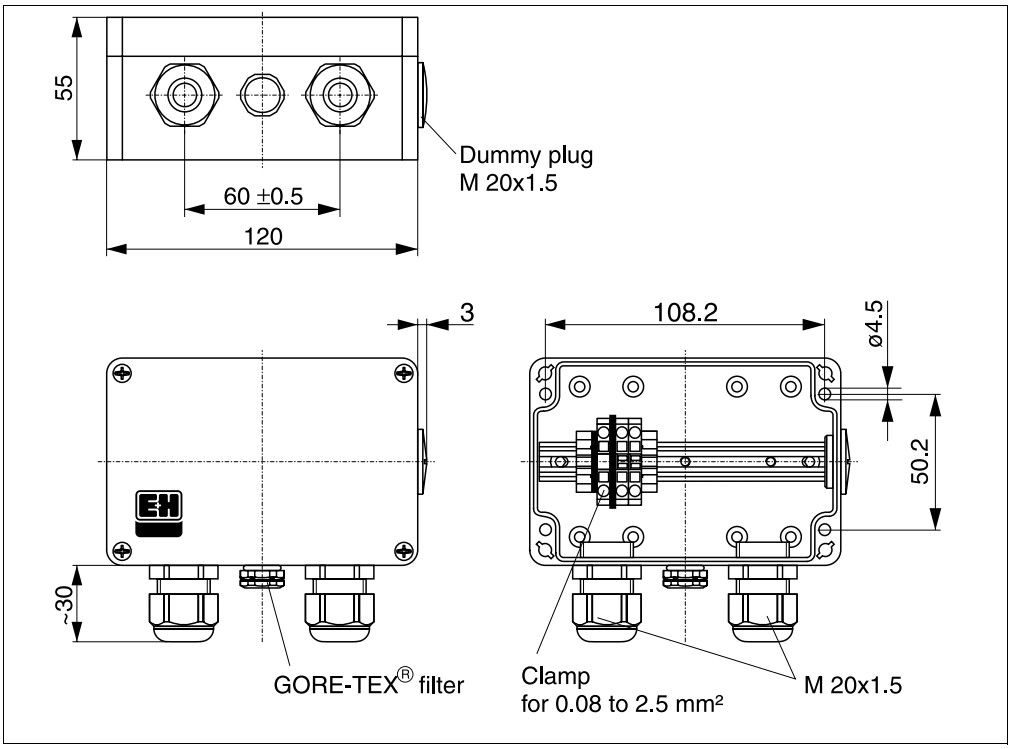
Dimensions of cable mounting screw G 1 1/2 A
FMX 167-❑3❑❑❑❑❑

Dimensions of mounting clamp
FMX 167-❑2❑❑❑❑❑

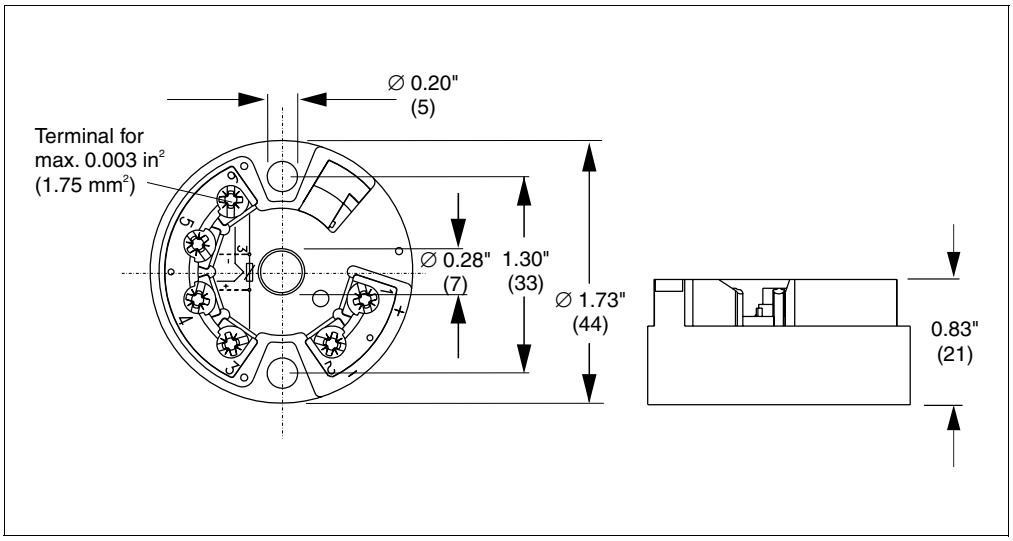
Dimensions of cable mounting screw 1 1/2 NPT
FMX 167-❑4❑❑❑❑❑



Dimensions terminal housing IP 66/IP 67 with filter
FMX 167 - ❑❑❑❑❑❑❑3:Terminal housing incl. 3 terminals,
FMX 167 - ❑❑❑❑❑❑❑4:Terminal housing incl. 7 terminals for FMX 167 with Pt 100,
FMX 167 - ❑❑❑❑❑❑❑5:Terminal housing incl. 3 terminals +
temperature transmitter TMT 181, 4-20 mA for FMX 167 with Pt 100



Dimensions temperature transmitter TMT 181 (4…20 mA)
FMX 167 - ❑❑❑❑❑❑❑5:Terminal housing incl. 3 terminals +
temperature transmitter TMT 181, 4-20 mA for FMX 167 with Pt 100



10 Appendix

10.1 Functions and system design

The FMX 167 is a submersible level transmitter with a ceramic pressure sensor for the level measurement of liquids. The Waterpilot is available with nine permanently calibrated measuring ranges from 3 to 600 ftH2O to ensure use in all standard applications (optional application specific range). Due to its compact outer diameter of only 0.87" (22 mm), it is ideal for use in 1" well casings. Options include output for temperature measurement.

The FMX 167 is a loop-powered self-contained 4-20 mA device. The hydrostatic column acts directly on the ceramic diaphragm. The deflection of the diaphragm generates a change in the capacitance of the sensor. The transmitter electronics, which is located in the 316L SS probe, converts the capacitance change to a repeatable and accurate 4-20 mA output signal.

A complete measuring system consists of the FMX 167 and a transmitter power supply unit (10 to 30 VDC). Endress+Hauser has a complete line of power supplies with displays and/or indicators.

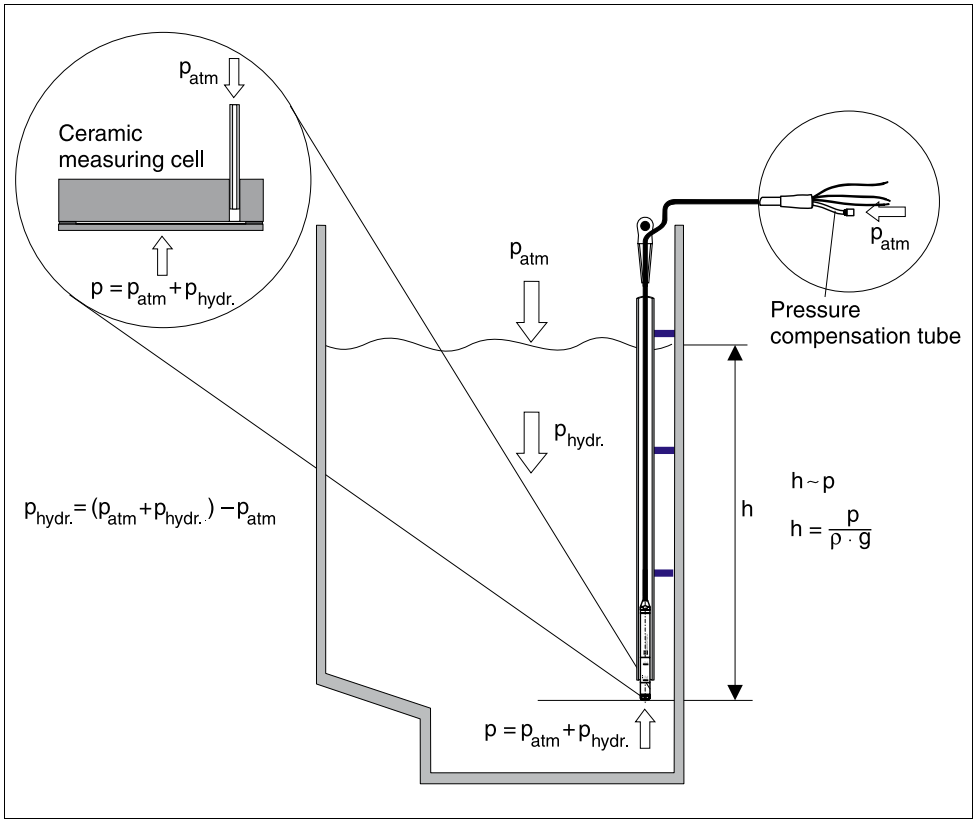


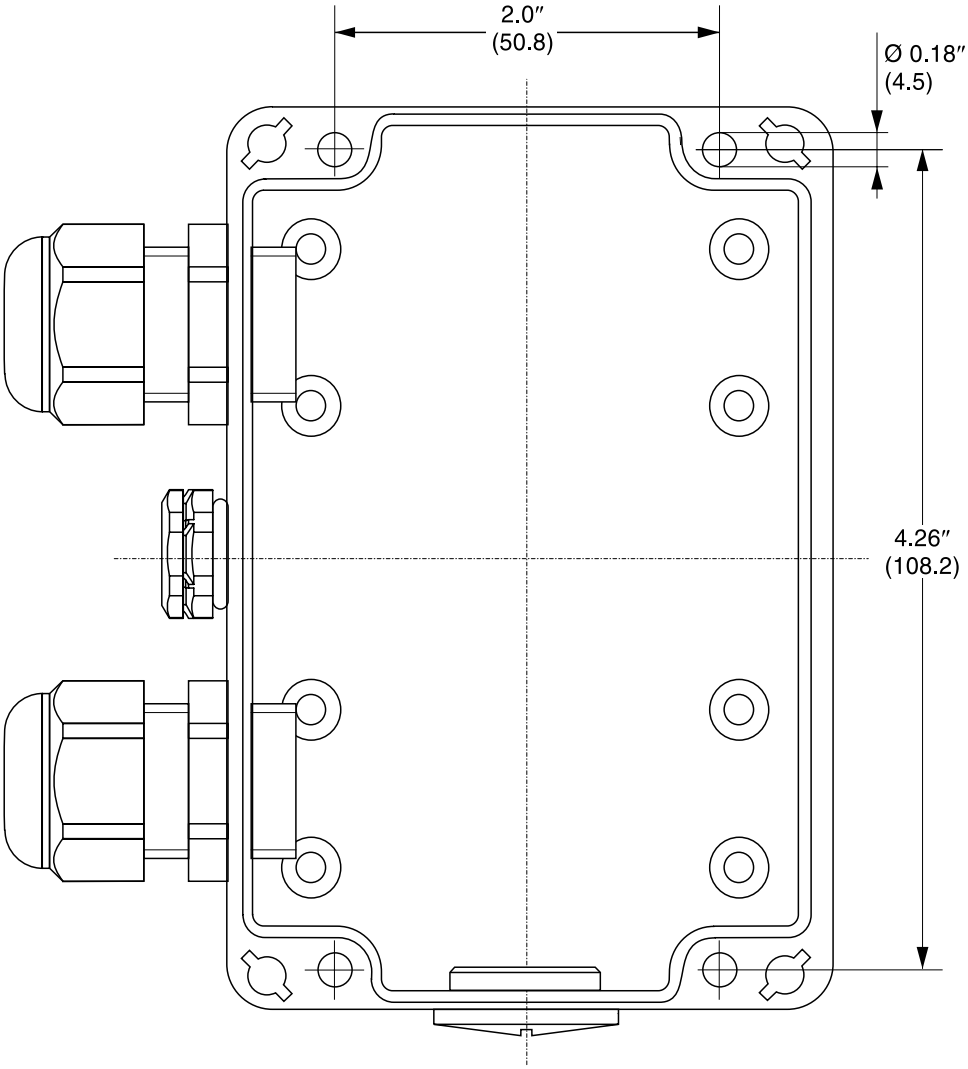
Fig. 12: Functions and system design

h = level height
p = total pressure = hydrostatic pressure + atmospheric pressure
ρ = medium density
g = gravitational acceleration
$p_{hydr.}$ = hydrostatic pressure
p_{atm} = atmospheric pressure

Temperature measurement with Pt 100 (optional)
Endress+Hauser offers an optional 4-wire Pt 100 resistance sensor for Waterpilot FMX 167 to measure level and temperature simultaneously. The Pt 100 belongs to Accuracy Class B to DIN EN 60751.

Temperature measurement with Pt 100 and Temperature Transmitter TMT 181 (optional)
To convert Pt 100 signals into a 4-20 mA signal Endress+Hauser also offers a temperature transmitter for mounting in the FMX 167 terminal housing.

10.2 Drilling template terminal housing



10.3 Control Drawing - Waterpilot FMX 167

Intrinsically safe (entity), Class I, DIV.1, Groups A, B, C, D
Hazardous Location Installations

1. Control room equipment may not use or generate over 250 V
2. Use Factory Mutual Entity-approved intrinsic safety barrier with Voc or Vt ≤ Vmax, Isc or It ≤ Imax, Ca ≥ Ci + C_{cable}, La ≥Li + L_{cable}
   Barrier must be incapable of delivering more than 1 Watt to a matched load.
   Transmitter entity parameters are as follows: Vmax = 30 VDC
   I max = 133 mA
   Pmax = 1 W

   Ci and Li per table:

Length of sensor cable	Ci (5.3 nF + 180pF/m)	Li (1 µH/m)
5 m	6.2 nF	5 µH
10 m	7.1 nF	10 µH
20 m	8.9 nF	20 µH
30 m	10.7 nF	30 µH
50 m	14.3 nF	50 µH
100 m	23.3 nF	100 µH
200 m	41.3 nF	200 µH
300 m	59.3 nF	300 µH

3. Installation should be in accordance with ANSI/ISA RP 12.6 "Installation of intrinsically safe systems for hazardous (classified) locations" and the National Electrical Code (ANSI/NFPA 70).
4. Warning: Substitution of Components may impair intrinsic safety.
5. Intrinsic safety barrier manufacturer's installation drawing must be followed, when installing this equipment: The configuration of the intrinsic safety barrier(s) must be FMRC approved.
6. Use supply wires suitable for 5°C above surrounding ambient.

Non-incendive Class I, DIV.2, Groups A, B, C, D
Hazardous Location Installation

1. Install per National Electrical Code (NEC)
   DIV.2 barrier required
   max. supply voltage 30 VDC
2. Warning: Explosion Hazard – Do not disconnect equipment unless power has been switched off or area is known to be non hazardous.
   Warning: Substitution of Components may impair suitability for Class I, DIV.2

Note: For non-incendive field circuit evaluations, the input current (Imax or Ii) of the receiving device need not match the output current (Isc or Io) of the barrier/associated equipment supplying the energy.

Agency controlled drawing.
No changes without prior agency approval.

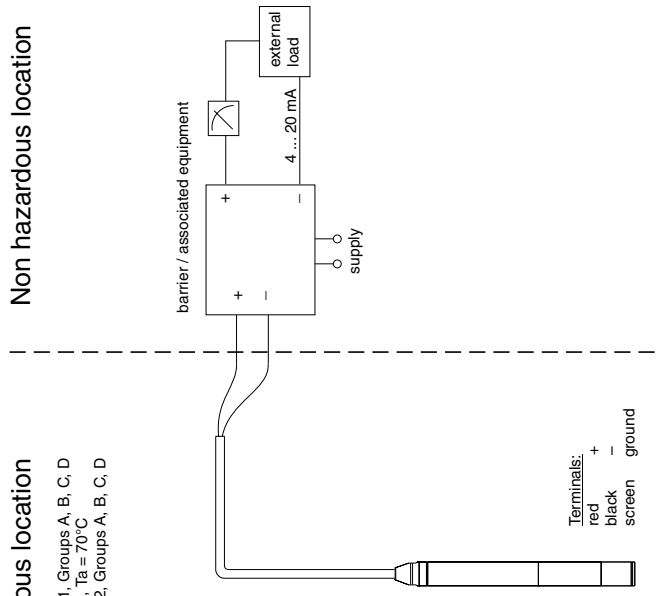


Table: Entity parameters
sensor:

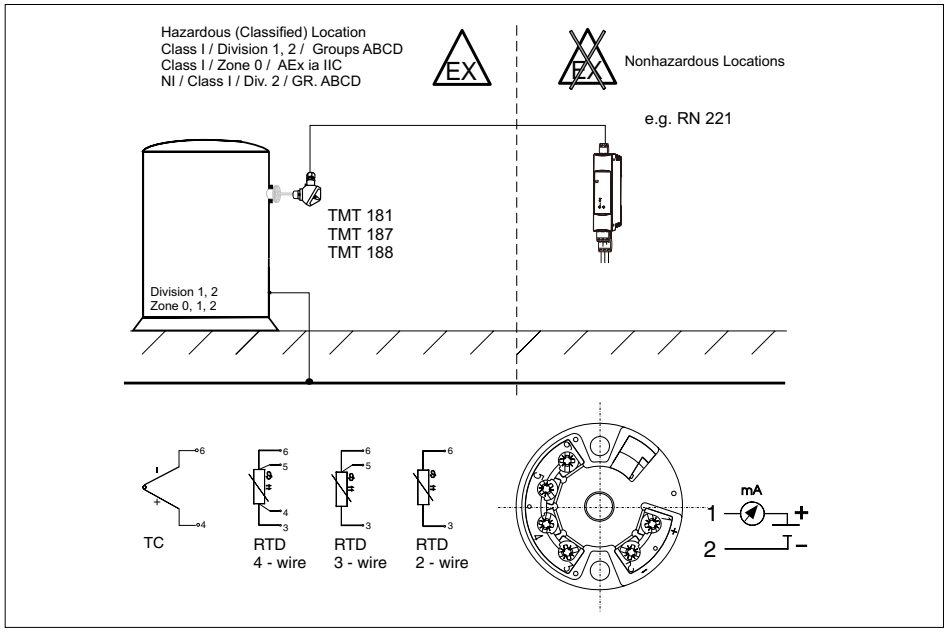
Vmax. = 30 VDC
I max. = 133 mA
Pmax. = 1 W
Ci see table
Li see table

ZD 063P-A/01/en/03.01/CCS
FM / A 30.10.00
52008498

Control drawing (IS)
960503-1009 A
Waterpilot FMX 167

Endress+Hauser

10.4 Control Drawing TMT 181



Installation Notes TMT 181, TMT 187, TMT 188

1) FMRC certified apparatus must be installed in accordance with manufacturer instructions.
2) FMRC certified associated apparatus must meet the following requirements:
   Uo or Voc < Ui or Vmax Io or Isc < Ii or Imax Po or Pmax < Pi or Pmax Ca > Ci + Ccable La > Li + Lcable
3) The installation must be in accordance with the National Electrical Code.
   NEC ANSI / NFPA 70, Article 504 and ANSI / ISA-RP 12.6
4) Use supply wires suitable for 5°C above surrounding.
5) The configuration of the headtransmitter TMT 181 is only pemitted in nonhazardous locations.
6) The voltage of the "tools" used for configuration should not exceed Um = 30 V. This can be achieved e.g. by a batterie powered laptop. An approved adapter with barrier (e.g. TMT181A) has to be used for configuration using a PC with mains connection (Um < 253V).

Warning:
- Substitution of Components may impair intrinsic safety

TMT 181 / TMT 187 / TMT 188			**IS / Class I / Division 1 / Groups ABCD / T4/T5/T6 Class I / Zone 0 / AEx ia IIC / T4/T5/T6 NI / Class I / Division 2 / Groups ABCD / T4/T5/T6**	
Supply circuit (Terminal 1 and 2)			Vmax = Ui < 30 VDC Imax = Ii < 100 mA Pmax = Pi < 750 mW Ci ~ 0 Li ~ 0	
Sensor circuit (Terminal 3 until 6)			Voc = Uo < 8.2 VDC Isc = Io < 4.6 mA P = Po < 9.35 mW	
Max. Connecting Values	Group A, B Group C Group D	Ex ia IIC Ex ia IIB Ex ia IIA	La = Lo = 4.5 mH La = Lo = 8.5 mH La = Lo = 1000 mH	Ca = Co = 974 nF Ca = Co = 1900 nF Ca = Co = 210 µF
Temperature range			T6: Ta = -40°C ... +55°C T5: Ta = -40°C ... +70°C T4: Ta = -40°C ... +85°C	

Nr.: 510 01932

GEOMETRICAL TOLERANCING DIN ISO 1101 DIN ISO 5459	H						DATE	NAME	Endress+Hauser 87484 Nesselwang, Germany
	G						DESIGN		
	F						DRAWN	13.12.99 Kellermann	DOCUMENT PROTECTED BY DIN 34
EDGES OF WORKING PARTS DIN 6784	E						APPROVED	07.12.00 Kellermann	
	D						SCALE	TITLE Control Drawing FM TMT 181(7)(8)	DRAWING NO. 14 05 00 111
	C								
	B								
	A						TOLERANCE	MATERIAL	REPL. FOR
		NO.		Kollor-mann	Kollor-mann	01.09.00 DATE			REPL. BY SHEET SIZE A4

Ordering Information

FMX 167 - 1 2 3 4 5 6 7

1 Certificate
- A Standard
- B ATEX II 2 G EEx ia IIC T6
- C ATEX II 3 G EEx nA IIC T6
- D FM approved IS, Class I, Div. 1, Grps. A-D
- E CSA approved IS, Class I, Div. 1, Grps. A-D
- F CSA General purpose

2 Mechanical connection (cable suspension)
- 1 None
- 2 Mounting clamp, 316L SS
- 3 Cable mounting screw G 1-1/2 A, 304 SS
- 4 Cable mounting screw 1-1/2" NPT, 304 SS
- 9 Special version

3 Measuring cell tube material
- A 316L SS cell enclosure
- D 316L SS cell enclosure, with drinking water approval (NSF std. 61) for all parts in contact with the medium (only for probes with EPDM seals)
- Y Special version

4 Measuring range

				Max. overload
FA	0 to 3 ftH_2O	PA	0 to 1.5 psi	73 psi
FB	0 to 6 ftH_2O	PB	0 to 3 psi	73 psi
FC	0 to 15 ftH_2O	PC	0 to 6 psi	101 psi
FD	0 to 20 ftH_2O	PD	0 to 10 psi	145 psi
FE	0 to 30 ftH_2O	PE	0 to 15 psi	145 psi
FF	0 to 60 ftH_2O	PF	0 to 30 psi	261 psi
FG	0 to 150 ftH_2O	PG	0 to 60 psi	362 psi
FH	0 to 300 ftH_2O	PH	0 to 150 psi	580 psi
FK	0 to 600 ftH_2O	PK	0 to 300 psi	580 psi
BA	0 to 0.1 bar	MA	0 to 1 mH_2O	5 bar
BB	0 to 0.2 bar	MB	0 to 2 mH_2O	5 bar
BC	0 to 0.4 bar	MC	0 to 4 mH_2O	7 bar
BD	0 to 0.6 bar	MD	0 to 6 mH_2O	10 bar
BE	0 to 1.0 bar	ME	0 to 10 mH_2O	10 bar
BF	0 to 2.0 bar	MF	0 to 20 mH_2O	18 bar
BG	0 to 4.0 bar	MG	0 to 40 mH_2O	25 bar
BH	0 to 10.0 bar	MH	0 to 100 mH_2O	40 bar
BK	0 to 20.0 bar	MK	0 to 200 mH_2O	40 bar

- VV Adjusted to customer specifications from 0 _____ (full scale value) to _____ (units)
- YY Special version

5 Measuring cell seal
- 1 Viton
- 2 EPDM
- 9 Special version

6 Extension cable
- A Length in _____ meters, PE cable, can be shortened, from 1 to 300 m
- B 10 m PE cable, can be shortened
- C 20 m PE cable, can be shortened
- E 30 ft cable, PE, can be shortened
- F 60 ft cable, PE, can be shortened
- G Length in _____ feet, PE cable, can be shortened, from 1 to 985 ft
- Y Special version

7 Additional equipment
- 1 Probe with integrated Pt 100, 4-wire
- 3 Terminal housing with GORE-TEX® filter, NEMA 4X
- 4 Probe with integrated Pt 100, 4-wire and terminal housing with GORE-TEX® filter, NEMA 4X
- 5 Probe with integrated Pt 100, -4° to +176°F (-20° to +80°C), TMT 181 temperature transmitter, 4 to 20 mA, 2-wire in terminal housing with GORE-TEX® filter, NEMA 4X
- 7 No additional equipment

Index

IMPORTANT NOTICE
RETURN AUTHORIZATION POLICY

Endress + Hauser must pre-approve and assign a Return Authorization number to any instrument you plan to return. Please identify the Return Authorization number clearly on all shipping cartons and paperwork.

Please note that the issuance of a Return Authorization number does not automatically mean that credit will be issued, or that the return is covered by our warranty. An Endress + Hauser associate will contact you regarding the disposition of your returned equipment.

In order to serve you better, and to protect our employees from any potentially hazardous contaminants, Endress + Hauser must return unopened, at the sender's expense, all items that do not have a Return Authorization number.

To get a Return Authorization number, call

1-800-428-4344

Please be sure to include the following information when requesting a Return Authorization number. This information will help us speed up the repair and return process.

Customer name:
Customer address:
Customer phone number:
Customer contact:
Equipment type:
Original sales order or purchase order number:
Reason for return:
Failure description, if applicable:
Process material(s) to which the equipment has been exposed:

OSHA Hazard Communication Standard 29CFR 1910.1200 mandates that we take specific steps to protect our employees from exposure to potentially hazardous materials. Therefore, all equipment so exposed must be accompanied by a letter certifying that the equipment has been decontaminated prior to its acceptance by Endress + Hauser.

The employees of Endress + Hauser sincerely appreciate your cooperation in following this policy.

Address your equipment to:

Endress + Hauser
2350 Endress Place
Greenwood, IN 46143
Return Authorization number:

Effective November 1987

United States

Endress+Hauser
2350 Endress Place
Greenwood, IN 46143
Phone: (317) 535-7138
1-800-428-4344
FAX: (317) 535-8498

Regional Office
Endress+Hauser
2901 West Sam Houston
Parkway North, Ste. C-250
Houston, TX 77043
Phone: (832) 590-6200
FAX: (832) 590-6202

RPS Industries
Div. of Endress+Hauser
500 W. Central Avenue
Suite A
Brea, CA 92821
Phone: (714) 529-1925
FAX: (714) 529-2966

Regional Office
Endress+Hauser
P.O. Box 901
Harvey, LA 70059
Phone: (504) 366-3264
1-800-288-2364
FAX: (504) 366-3816

Sterling IPC
Div. of Endress+Hauser
68950 Powell Road
Romeo, MI 48065
Phone: (810) 752-0700
FAX: (810) 752-0705

A.D. Instruments
Div. of Endress+Hauser
4711-A Nations Crossing Road
Charlotte, NC 28217
Phone: (704) 522-8415/8536
FAX: (704) 527-5005

Regional Office
Endress+Hauser
942 Town Center
New Britain, PA 18901
Phone: (267) 880-1750
1-877-880-1750
FAX: (267) 880-1759

Canada

Endress+Hauser
Canada Ltd.
1440 Graham's Lane
Unit 1, Burlington
ON, L7S 1W3
Phone: (905) 681-9292
1-800-668-3199
FAX: (905) 681-9444

Endress+Hauser
Canada Ltée
6800 Côte de Liesse, Ste. 100
St. Laurent, Que H4T 2A7
Téléphone: (514) 733-0254
Télécopieur: (514) 733-2924

Endress+Hauser
Canada Ltd.
18103 - 105 Ave. NW #101
Edmonton, AB T5S 2L5
Phone: (780) 846-3222
FAX: (780) 486-3466

Mexico

Paseo del Pedregal No. 610
Col. Jardines del Pedregal
01900, Mexico D.F.
MEXICO
Phone: (525) 568-2405
FAX: (525) 568-7459

Endress+Hauser
The Power of Know How

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