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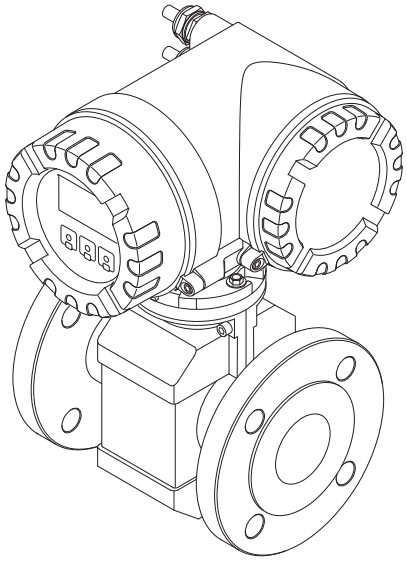
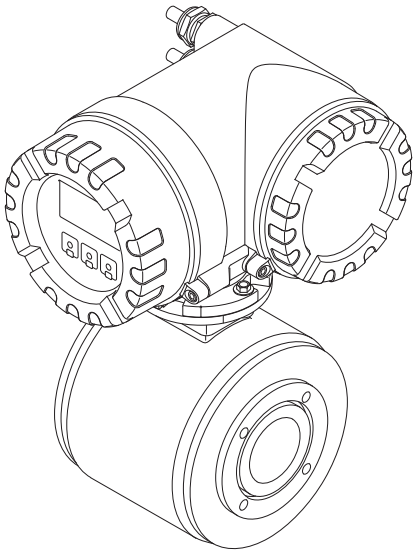
Valid as of software version
V 3.06.XX (Device software)

Operating Instructions
Proline Promag 53
Modbus RS485

Electromagnetic flowmeter





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1 Safety instructions

1.1 Designated use

The measuring device described in this Operating Manual is to be used only for measuring the flow rate of conductive fluids in closed pipes.

A minimum conductivity of 20 µS/cm is required for measuring demineralized water. Most liquids can be measured as of a minimum conductivity of 5 µS/cm.

Examples:
- Acids, alkalis
- Drinking water, wastewater, sewage sludge
- Milk, beer, wine, mineral water, etc.

Resulting from incorrect use or from use other than that designated the operational safety of the measuring devices can be suspended. The manufacturer accepts no liability for damages being produced from this.

1.2 Installation, commissioning and operation

Note the following points:
- Installation, connection to the electricity supply, commissioning and maintenance of the device must be carried out by trained, qualified specialists authorized to perform such work by the facility's owner-operator. The specialist must have read and understood these Operating Instructions and must follow the instructions it contains.
- The device must be operated by persons authorized and trained by the facility's owner-operator. Strict compliance with the instructions in these Operating Instructions is mandatory.
- Endress+Hauser is willing to assist in clarifying the chemical resistance properties of parts wetted by special fluids, including fluids used for cleaning. However, small changes in temperature, concentration or the degree of contamination in the process can result in changes to the chemical resistance properties. Therefore, Endress+Hauser can not guarantee or accept liability for the chemical resistance properties of the fluid wetted materials in a specific application. The user is responsible for the choice of fluid wetted materials in regards to their in-process resistance to corrosion.
- If welding work is performed on the piping system, do not ground the welding appliance through the flowmeter.
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams. The transmitter must be grounded, except in cases where special protective measures have been taken (e.g. galvanically isolated power supply SELV or PELV).
- Always note the regulations applicable in your country to the operation, maintenance and repair of electrical devices. Special instructions relating to the device can be found in the relevant sections of the documentation.

1.3 Operational safety

Note the following points:
- Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory. The symbol on the front of this supplementary Ex documentation indicates the approval and the certification body (e.g. Ⓔx Europe, Ⓕ USA, Ⓒ Canada).
- The measuring device meets the general safety requirements according to EN 61010-1 and the EMC requirements according to IEC/EN 61326 in addition to the NAMUR recommendations NE 21, NE 43 and NE 53.

- Depending on the application, the seals of the process connections of the Promag H sensor require periodic replacement.
- When hot fluid passes through the measuring tube, the surface temperature of the housing increases. In the case of the sensor, in particular, users should expect temperatures that can be close to the fluid temperature. If the temperature of the fluid is high, implement sufficient measures to prevent burning or scalding.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Operating Instructions.

1.4 Return

The measuring device must be returned if repairs or a factory calibration are required, or if the wrong measuring device has been ordered or delivered. According to legal regulations, Endress+Hauser, as an ISO-certified company, is required to follow certain procedures when handling returned products that are in contact with medium.
To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material

1.5 Notes on safety conventions and icons

The devices are designed to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate. The devices comply with the applicable standards and regulations in accordance with EN 61010-1 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures". The devices can, however, be a source of danger if used incorrectly or for other than the designated use.
Consequently, always pay particular attention to the safety instructions indicated in these Operating Instructions by the following icons:

Warning!
"Warning" indicates an action or procedure which, if not performed correctly, can result in injury or a safety hazard. Comply strictly with the instructions and proceed with care.

Caution!
"Caution" indicates an action or procedure which, if not performed correctly, can result in incorrect operation or destruction of the device. Comply strictly with the instructions.

Note!
"Note" indicates an action or procedure which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.

2 Identification

2.1 Device designation

The flow measuring system consists of the following components:
- Promag 53 transmitter
- Promag E/H/L/P/W sensor

Two versions are available:
- Compact version: transmitter and sensor form a single mechanical unit.
- Remote version: transmitter and sensor are installed separately.

2.1.1 Nameplate of the transmitter

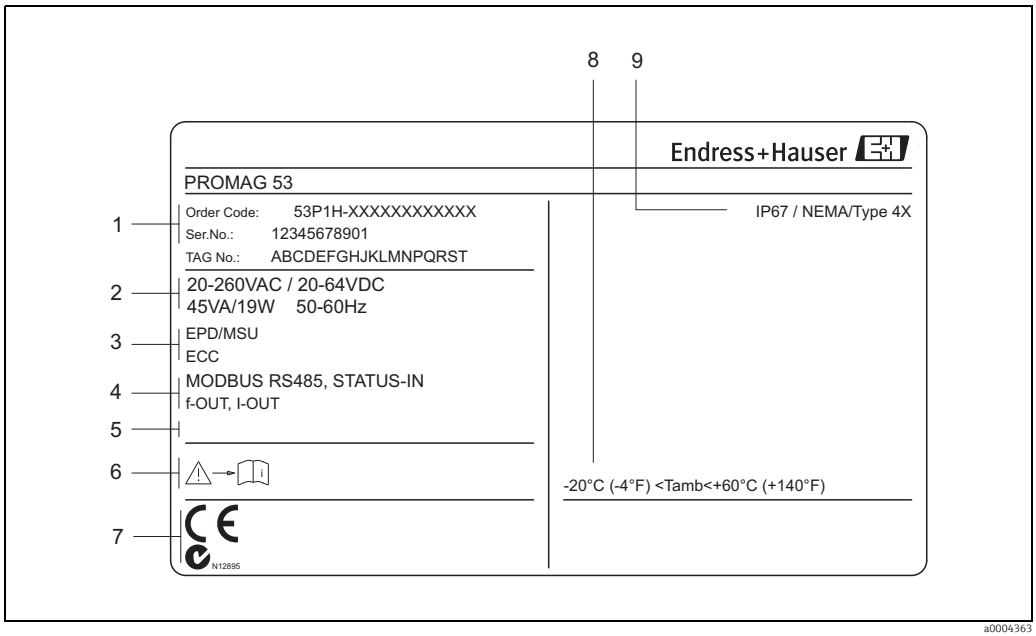

Fig. 1: Nameplate specifications for the "Promag 53" transmitter (example)

1 Order code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
2 Power supply/frequency/power consumption
3 Additional functions and software
– EPD: with empty pipe detection electrode
– ECC: with electrode cleaning
4 Available outputs:
– I-OUT: with current output
– RELAY: with relay output
– STATUS-IN: with status input (auxiliary input)
5 Reserved for additional information on special products
6 Please comply with the Operating Instructions
7 Reserved for additional information on device version (approvals, certificates)
8 Permitted ambient temperature range
9 Degree of protection

2.1.2 Nameplate of the sensor

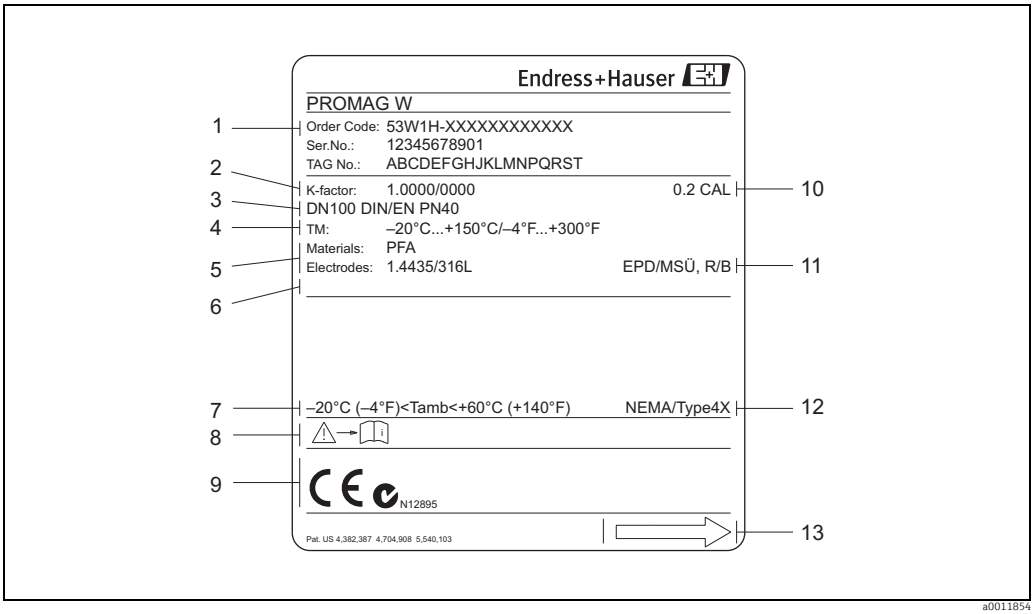

Fig. 2: Nameplate specifications for the "Promag W" sensor (example)

1 Order code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
2 Calibration factor with zero point
3 Nominal diameter/nominal pressure
4 Medium temperature range
5 Materials: lining/measuring electrode
6 Reserved for additional information on special products
7 Permitted ambient temperature range
8 Please comply with the Operating Instructions
9 Reserved for additional information on device version (approvals, certificates)
10 Calibration tolerance
11 Additional information
- *EPD: with empty pipe detection electrode*
- *R/B: with reference electrode*

12 Degree of protection
13 Flow direction

2.1.3 Nameplate for connections

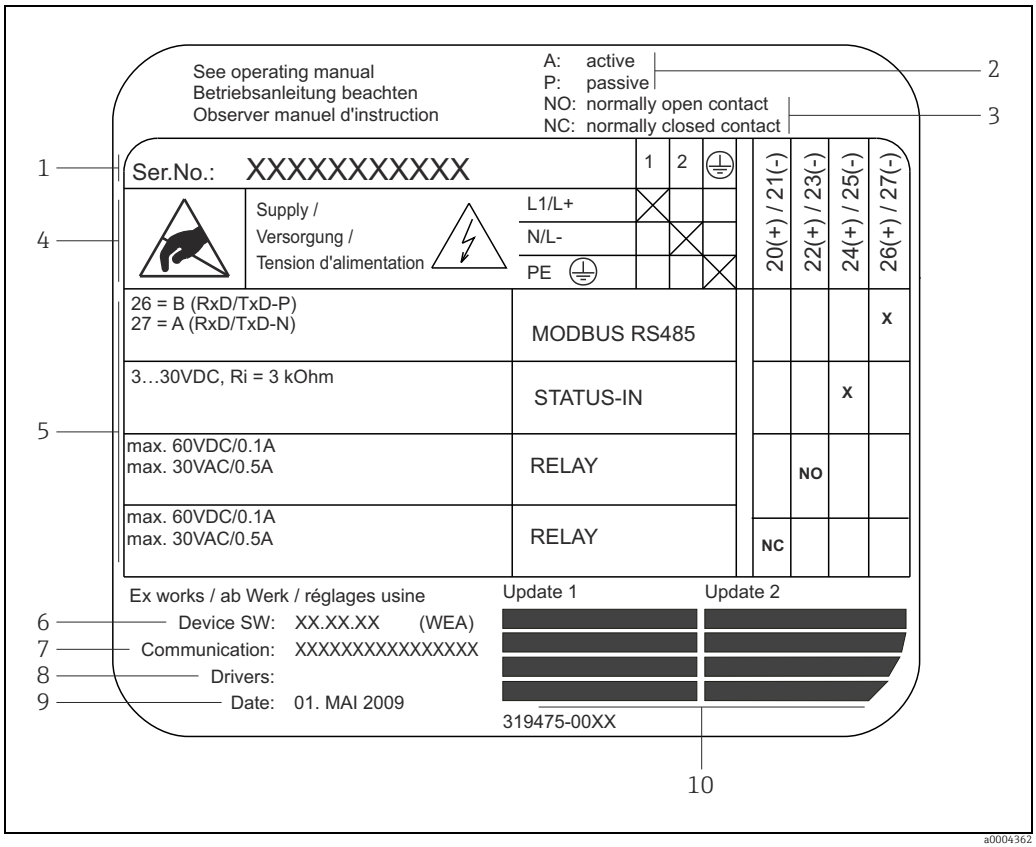

Fig. 3: Nameplate specifications for Proline transmitter connections (example)

1 *Serial number*
2 *Possible configuration of current output*
3 *Possible configuration of relay contacts*
4 *Terminal assignment, cable for power supply:*
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
5 *Pending signals at the inputs and outputs, possible configurations and terminal assignment → 🖹 56*
6 *Version of device software currently installed*
7 *Installed communication type*
8 *Information on communication driver*
9 *Date of installation*
10 *Current updates to data specified in 6 to 9*

2.2 Certificates and approvals

The devices are designed and tested to meet state-of-the-art safety requirements in accordance with sound engineering practice. They have left the factory in a condition in which they are safe to operate. The devices comply with the standards EN 61010 -1 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures" and with the EMC requirements of IEC/EN 61326.
The measuring system described in these Operating Instructions therefore complies with the legal requirements of the EU Directives. Endress+Hauser confirms this by affixing the CE mark to it and by issuing the CE Declaration of Conformity.
The measuring system is in conformity with the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

The measuring device meets all the requirements of the Modbus/TCP conformity test and holds the "Modbus/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "Modbus/TCP Conformance Test Laboratory" of the University of Michigan.

2.3 Registered trademarks

Modbus®
Registered trademark of the Modbus Organization

KALREZ® and VITON®
Registered trademarks of E.I. Du Pont de Nemours & Co., Wilmington, USA

TRI-CLAMP®
Registered trademark of Ladish & Co., Inc., Kenosha, USA

HistoROM™, S-DAT®, T-DAT™, F-CHIP®, FieldCare®, Fieldcheck®, Applicator®
Registered or registration-pending trademarks of the Endress+Hauser Group

3 Installation

3.1 Incoming acceptance, transport and storage

3.1.1 Incoming acceptance

On receipt of the goods, check the following points:
- Check the packaging and the contents for damage.
- Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Transport

The following instructions apply to unpacking and to transporting the device to its final location:
- Transport the devices in the containers in which they are delivered.
- Do not remove the protection plates or caps on the process connections until you are ready to install the device. This is particularly important in the case of sensors with PTFE linings.

Special notes on flanged devices

Caution!
- The wooden covers mounted on the flanges before the device leaves the factory protect the linings on the flanges during storage and transportation. Do not remove these protection plates until *immediately before* the device is installed in the pipe.
- Do not lift flanged devices by the transmitter housing or, in the case of the remote version, by the connection housing.

Transporting flanged devices DN ≤ 300 (12")

Use webbing slings slung round the two process connections. Do not use chains, as they could damage the housing.

Warning!
Risk of injury if the measuring device slips. The center of gravity of the assembled measuring device might be higher than the points around which the slings are slung.
At all times, therefore, make sure that the device does not unexpectedly turn around its axis or slip.

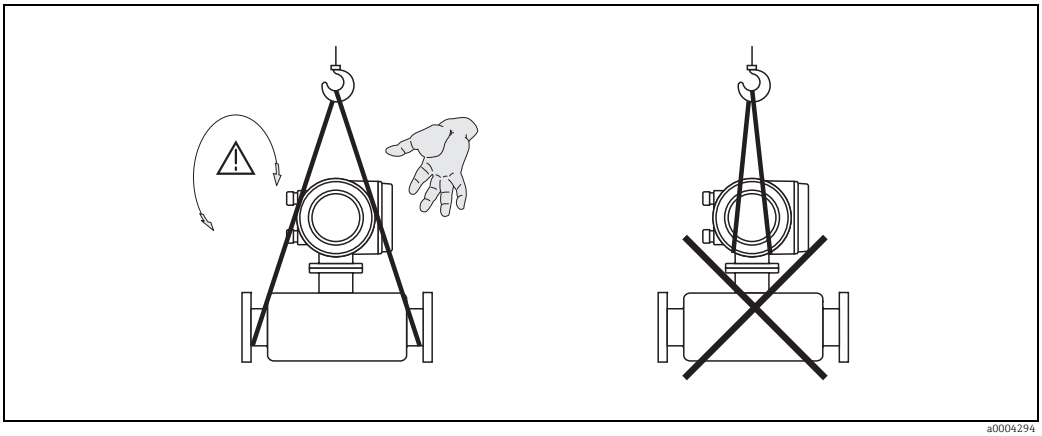

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Fig. 4: Transporting sensors with DN ≤ 300 (12")

Transporting flanged devices DN > 300 (12")

Use only the metal eyes on the flanges for transporting the device, lifting it and positioning the sensor in the piping.

Caution!
Do not attempt to lift the sensor with the tines of a fork-lift truck beneath the metal casing. This would buckle the casing and damage the internal magnetic coils.

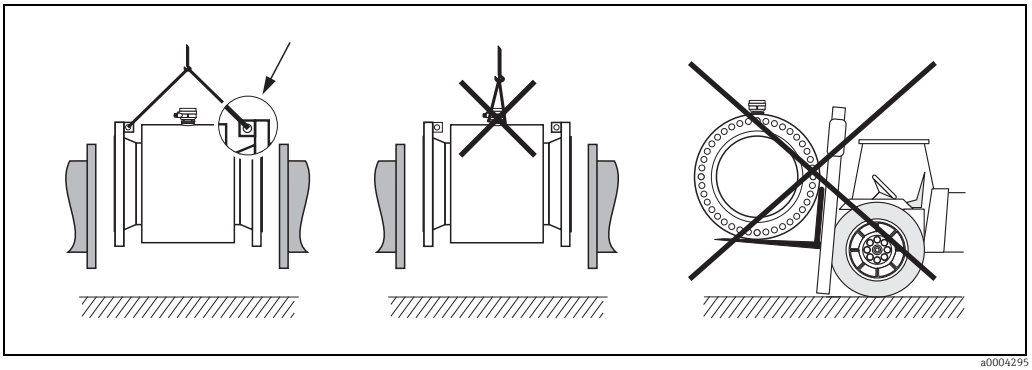

Fig. 5: Transporting sensors with DN > 300 (12")

3.1.3 Storage

Note the following points:
- Pack the measuring device in such a way as to protect it reliably against impact for storage (and transportation). The original packaging provides optimum protection.
- The storage temperature corresponds to the operating temperature range of the measuring transmitter and the appropriate measuring sensors → 127.
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Choose a storage location where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the lining.
- Do not remove the protection plates or caps on the process connections until you are ready to install the device. This is particularly important in the case of sensors with PTFE linings.

3.2 Installation conditions

3.2.1 Dimensions

The dimensions and installation lengths of the sensor and transmitter can be found in the "Technical Information" for the device in question. This document can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents available is provided in the "Documentation" section on → 📄 151.

3.2.2 Mounting location

The accumulation of air or gas bubbles in the measuring tube could result in an increase in measuring errors.
Avoid the following locations:
- At the highest point of a pipeline. Risk of air accumulating.
- Directly upstream from a free pipe outlet in a vertical pipeline.

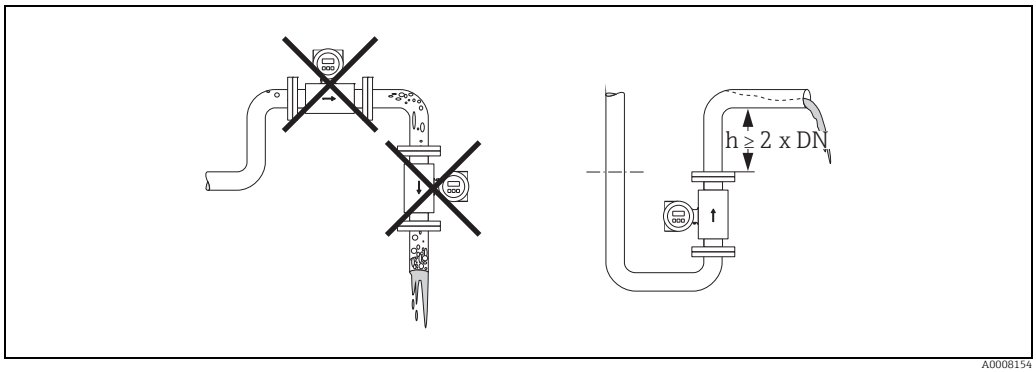

Fig. 6: Mounting location

Installing pumps

Do not install the sensor on the intake side of a pump. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. Information on the lining's resistance to partial vacuum → 📄 132.
It might be necessary to install pulse dampers in systems incorporating reciprocating, diaphragm or peristaltic pumps. Information on the measuring system's resistance to vibration and shock → 📄 127.

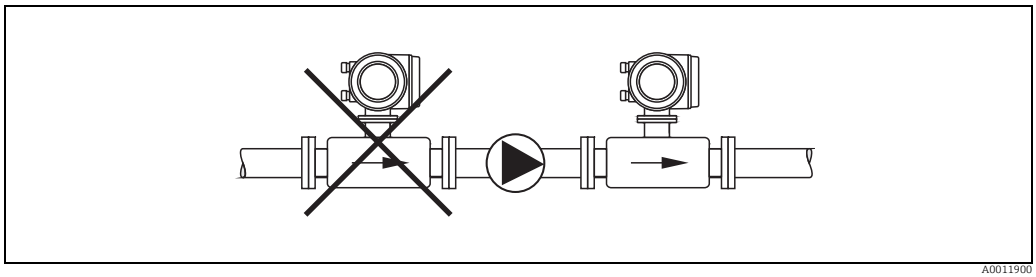

Fig. 7: Installing pumps

Partially filled pipes

Partially filled pipes with gradients necessitate a drain-type configuration. The Empty Pipe Detection function offers additional protection by detecting empty or partially filled pipes → 📄 99.

Caution!
Risk of solids accumulating. Do not install the sensor at the lowest point in the drain. It is advisable to install a cleaning valve.

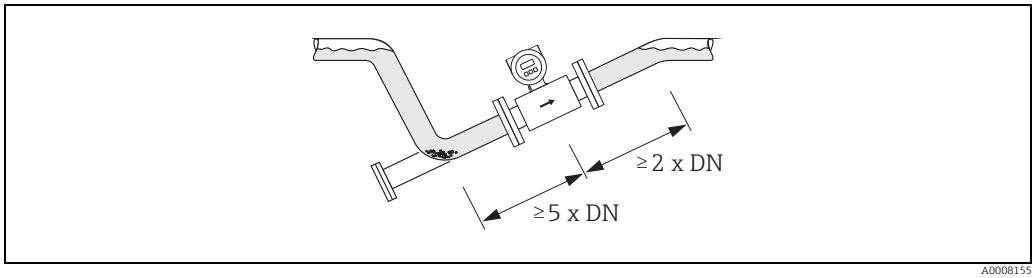

Fig. 8: Installation in partially filled pipe

Down pipes

Install a siphon or a vent valve downstream of the sensor in down pipes longer than 5 m (16.3 ft). This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. This measure also prevents the system losing prime, which could cause air inclusions. Information on the lining's resistance to partial vacuum → 132.

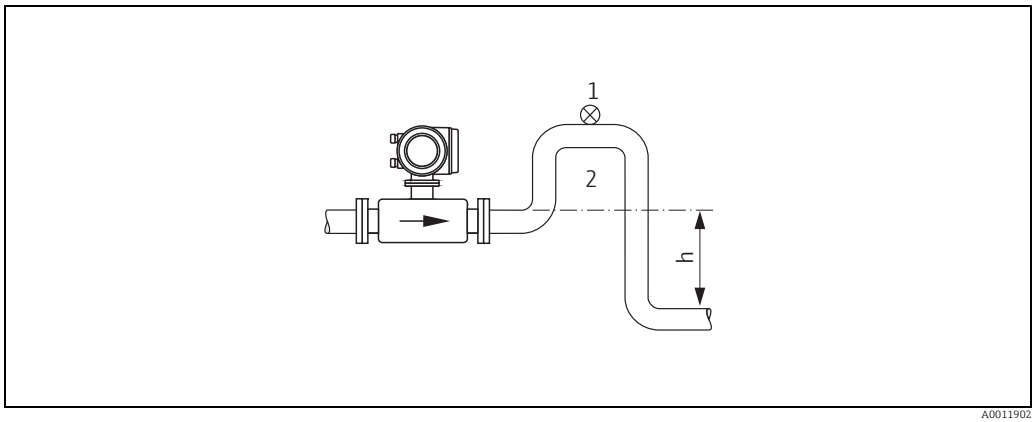

Fig. 9: Measures for installation in a down pipe

1 Vent valve
2 Siphon
h Length of down pipe (h ≥ 5 m (16.3 ft))

3.2.3 Orientation

An optimum orientation position helps avoid gas and air accumulations and deposits in the measuring tube. Promag, nevertheless, supplies a range of functions and accessories for correct measuring of problematic fluids:

- Electrode Cleaning Circuitry (ECC) to prevent electrically conductive deposits in the measuring tube, e.g. for fluids causing buildup (see "Description of Device Functions" manual).
- Empty Pipe Detection (EPD) ensures the detection of partially filled measuring tubes or in the case of degassing fluids → 📄 99.
- Exchangeable Measuring Electrodes for abrasive fluids (→ 📄 121).

Vertical orientation

A vertical orientation is ideal in the following cases:

- For self-emptying piping systems and when using empty pipe detection.
- For sludge containing sand or stones and where the solids cause sedimentation.

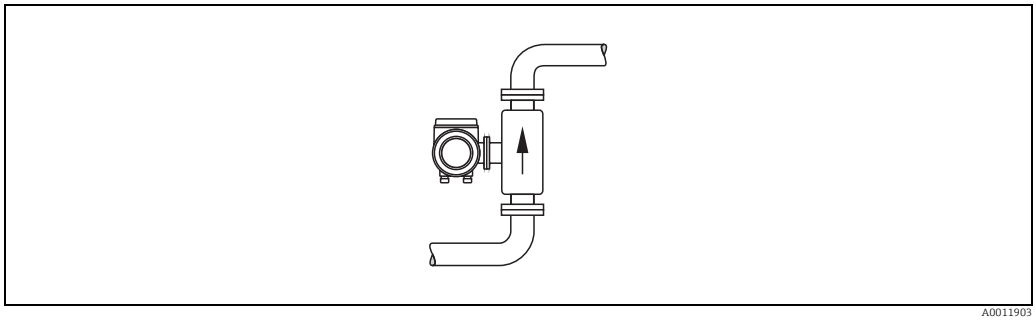

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Fig. 10: Vertical orientation

Horizontal orientation

The measuring electrode plane should be horizontal. This prevents brief insulation of the two electrodes by entrained air bubbles.

Caution!
Empty Pipe Detection functions correctly with the measuring device installed horizontally only when the transmitter housing is facing upward (see diagram). Otherwise there is no guarantee that Empty Pipe Detection will respond if the measuring tube is only partially filled.

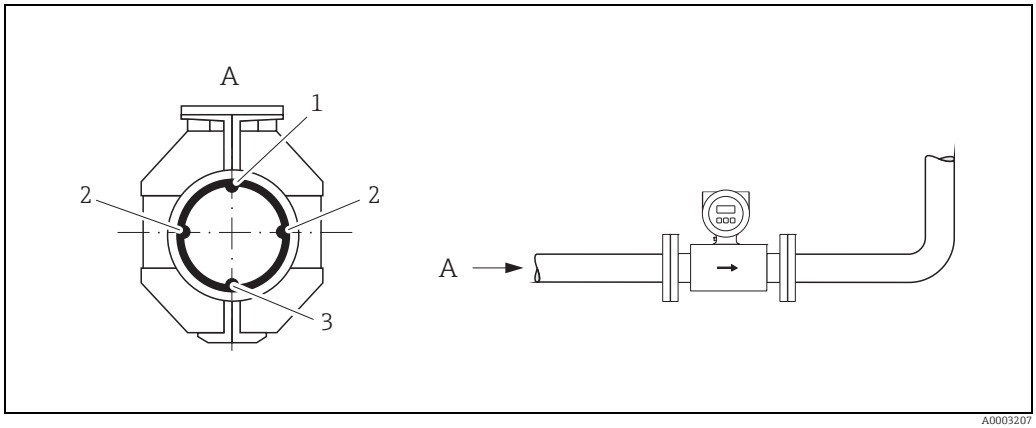

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Fig. 11: Horizontal orientation

1 EPD electrode for empty pipe detection (not available for "measuring electrode only" option, not in Promag H, DN 2 to 8/ 1/12 to 5/16"))
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization (not available for "measuring electrode only" option, not in Promag H)

3.2.4 Inlet and outlet runs

If possible, install the sensor in a location upstream of fittings such as valves, T-pieces, elbows, etc.

Compliance with the following requirements for the inlet and outlet runs is necessary in order to ensure measuring accuracy.
- Inlet run ≥ 5 × DN
- Outlet run ≥ 2 × DN

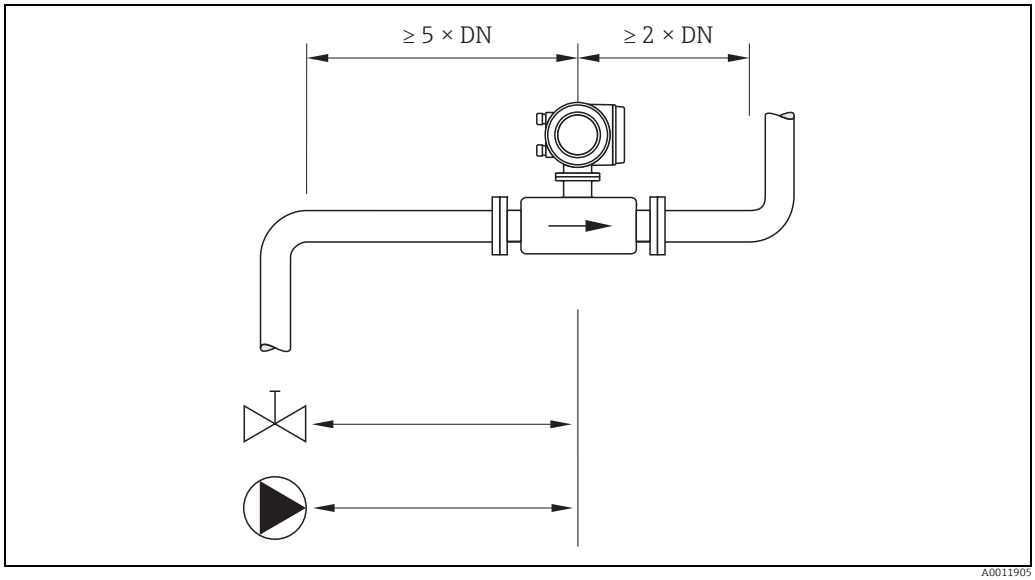


Fig. 12: Inlet and outlet runs

3.2.5 Vibrations

Secure and fix both the piping and the sensor if the vibrations are severe.

Caution!
It is advisable to install sensor and transmitter separately if vibration is excessively severe.
Information on the permitted resistance to vibration and shock → 📄 127.

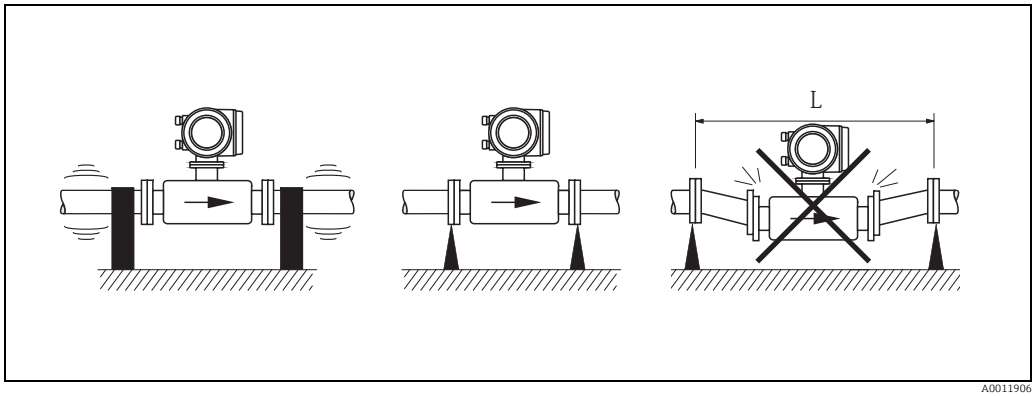


Fig. 13: Measures to prevent vibration of the measuring device (L > 10 m / 33 ft)

3.2.6 Foundations, supports

If the nominal diameter is DN ≥ 350 (14"), mount the sensor on a foundation of adequate load-bearing strength.

Caution!
Risk of damage.
Do not support the weight of the sensor on the metal casing: the casing would buckle and damage the internal magnetic coils.

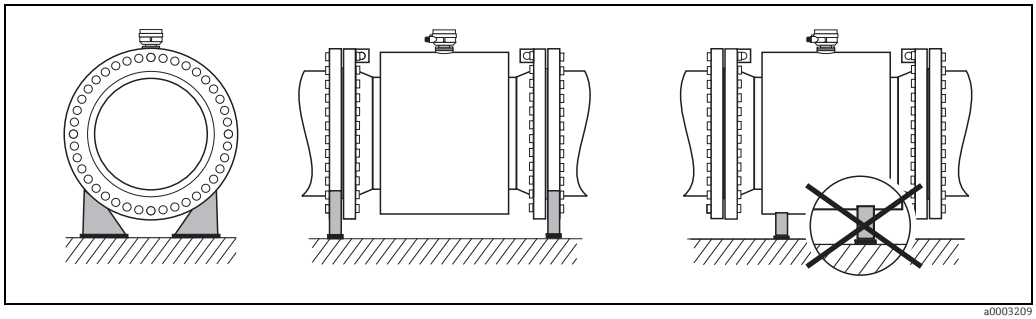


Fig. 14: Correct support for large nominal diameters (DN ≥ 350 / 14")

3.2.7 Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids.
The nomogram shown here can be used to calculate the pressure loss caused by cross-section reduction.

Note!
- The nomogram only applies to liquids of viscosity similar to water.
- For Promag H the selection of a pipe with larger diameter for high viscosities of the fluid may be considered to reduce the pressure loss.

1. Calculate the ratio of the diameters d/D.
2. From the nomogram, read off the pressure loss as a function of fluid velocity (*downstream* from the reduction) and the d/D ratio.

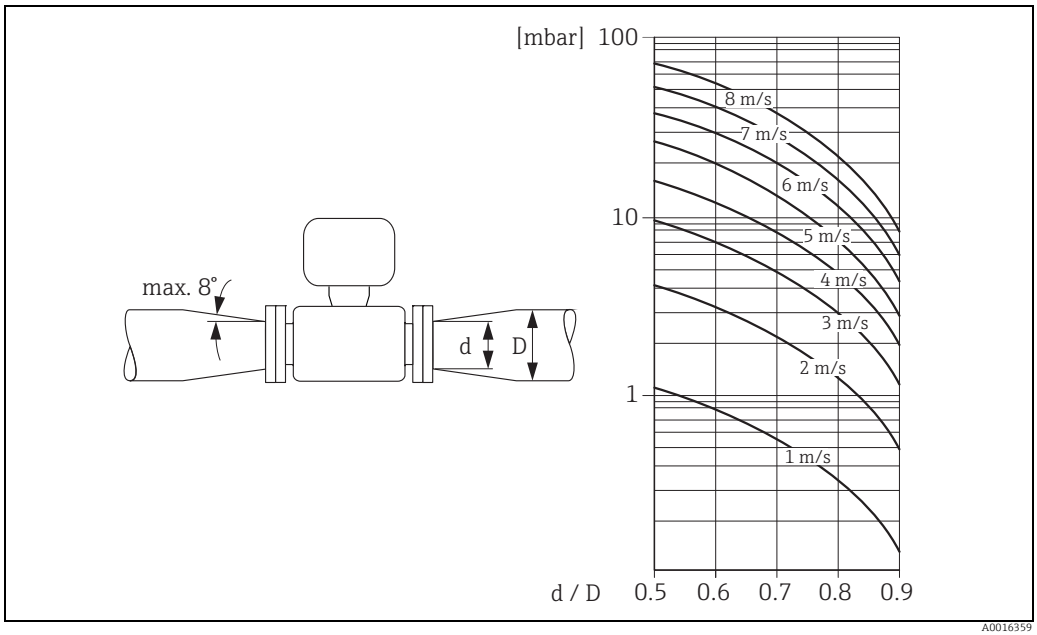


Fig. 15: Pressure loss due to adapters

3.2.8 Nominal diameter and flow rate

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor. The optimum velocity of flow is between 2 and 3 m/s (6.5 to 9.8 ft/s)

The velocity of flow (v), moreover, has to be matched to the physical properties of the fluid:
- v < 2 m/s (v < 6.5 ft/s): for low conductivity values
- v > 2 m/s (v > 6.5 ft/s): for media that produce buildup (e.g. milk with high fat content)

Note!
- A necessary increase in the flow velocity can be achieved by reducing the sensor nominal diameter → 16.
- For Promag H the selection of a pipe with nominal diameter > DN 8 (3/8") for fluids with high levels of solids may be considered, to improve the stability of the signal and cleanability due to larger electrodes.

Recommended flow (SI units)

Nominal diameter [mm]	Promag E/P	Promag H	Promag L	Promag W
	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [dm³/min]			
2	–	0.06 to 1.8	–	–
4	–	0.25 to 7	–	–
8	–	1 to 30	–	–
15	4 to 100	4 to 100	–	–
25	9 to 300	9 to 300	9 to 300	9 to 300
32	15 to 500	–	15 to 500	15 to 500
40	25 to 700	25 to 700	25 to 700	25 to 700
50	35 to 1100	35 to 1100	35 to 1100	35 to 1100
65	60 to 2000	60 to 2000	60 to 2000	60 to 2000
80	90 to 3000	90 to 3000	90 to 3000	90 to 3000
100	145 to 4700	145 to 4700	145 to 4700	145 to 4700
125	220 to 7500	220 to 7500	220 to 7500	220 to 7500
[mm]	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [m³/h]			
150	20 to 600	20 to 600	20 to 600	20 to 600
200	35 to 1100	–	35 to 1100	35 to 1100
250	55 to 1700	–	55 to 1700	55 to 1700
300	80 to 2400	–	80 to 2400	80 to 2400
350	110 to 3300	–	110 to 3300	110 to 3300
375	–	–	140 to 4200	140 to 4200
400	140 to 4200	–	140 to 4200	140 to 4200
450	180 to 5400	–	180 to 5400	180 to 5400
500	220 to 6600	–	220 to 6600	220 to 6600
600	310 to 9600	–	310 to 9600	310 to 9600
700	–	–	420 to 13500	420 to 13500
750	–	–	480 to 15200	480 to 15200
800	–	–	550 to 18000	550 to 18000
900	–	–	690 to 22500	690 to 22500
1000	–	–	850 to 28000	850 to 28000
1200	–	–	1250 to 40000	1250 to 40000
1400	–	–	1700 to 55000	1700 to 55000
1600	–	–	2200 to 70000	2200 to 70000
1800	–	–	2800 to 90000	2800 to 90000
2000	–	–	3400 to 110000	3400 to 110000
2200	–	–	4100 to 136000	–
2400	–	–	4800 to 162000	–

Recommended flow (US units)

Nominal diameter [inch]	Promag E/P	Promag H	Promag L	Promag W
	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [gal/min]			
1/12"	–	0.015 to 0.5	–	–
1/8"	–	0.07 to 2	–	–
3/8"	–	0.25 to 8	–	–
1/2"	1.0 to 27	1.0 to 27	–	–
1"	2.5 to 80	2.5 to 80	2.5 to 80	2.5 to 80
1 1/2"	7 to 190	7 to 190	7 to 190	7 to 190
2"	10 to 300	10 to 300	10 to 300	10 to 300
3"	24 to 800	24 to 800	24 to 800	24 to 800
4"	40 to 1250	40 to 1250	40 to 1250	40 to 1250
6"	90 to 2650	90 to 2650	90 to 2650	90 to 2650
8"	155 to 4850	–	155 to 4850	155 to 4850
10"	250 to 7500	–	250 to 7500	250 to 7500
12"	350 to 10600	–	350 to 10600	350 to 10600
14"	500 to 15000	–	500 to 15000	500 to 15000
15"	–	–	600 to 19000	600 to 19000
16"	600 to 19000	–	600 to 19000	600 to 19000
18"	800 to 24000	–	800 to 24000	800 to 24000
20"	1000 to 30000	–	1000 to 30000	1000 to 30000
24"	1400 to 44000	–	1400 to 44000	1400 to 44000
28"	–	–	1900 to 60000	1900 to 60000
30"	–	–	2150 to 67000	2150 to 67000
32"	–	–	2450 to 80000	2450 to 80000
36"	–	–	3100 to 100000	3100 to 100000
40"	–	–	3800 to 125000	3800 to 125000
42"	–	–	4200 to 135000	4200 to 135000
48"	–	–	5500 to 175000	5500 to 175000
[inch]	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [Mgal/d]			
54"	–	–	9 to 300	9 to 300
60"	–	–	12 to 380	12 to 380
66"	–	–	14 to 500	14 to 500
72"	–	–	16 to 570	16 to 570
78"	–	–	18 to 650	18 to 650
84"	–	–	24 to 800	–
90"	–	–	27 to 910	–

3.2.9 Length of connecting cable

In order to ensure measuring accuracy, please comply with the following instructions when installing the remote version:

- Secure the cable run or route the cable in an armored conduit. Movement of the cable can falsify the measuring signal, particularly if the fluid conductivity is low.
- Route the cable well clear of electrical machines and switching elements.
- Ensure potential equalization between sensor and transmitter, if necessary.
- The permissible cable length L_{max} depends on the fluid conductivity (→ 16).
- The maximum connecting cable length is 10 m (32.8 ft) when empty pipe detection (EPD → 99) is switched on.

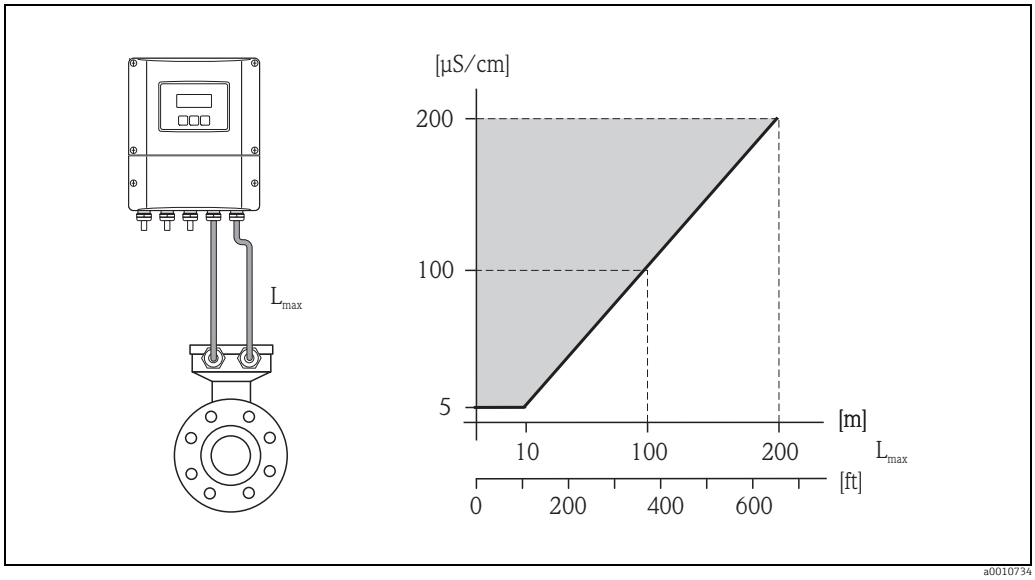


Fig. 16: Permitted lengths for connecting cable in remote version, as a function of the conductivity of the fluid

Gray shaded area = permissible range
L_{max} = length of connecting cable

3.3 Installation

3.3.1 Installing the Promag E sensor

Caution!
- The protective covers mounted on the two sensor flanges guard the PTFE lining, which is turned over the flanges. Consequently, do not remove these protection plates **until immediately before** the sensor is installed in the pipe.
- Protection plates must remain in place while the device is in storage.
- Make sure that the lining is not damaged or removed from the flanges.

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges:
- It is essential that you observe the necessary screw tightening torques on → 📄 21.
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment.

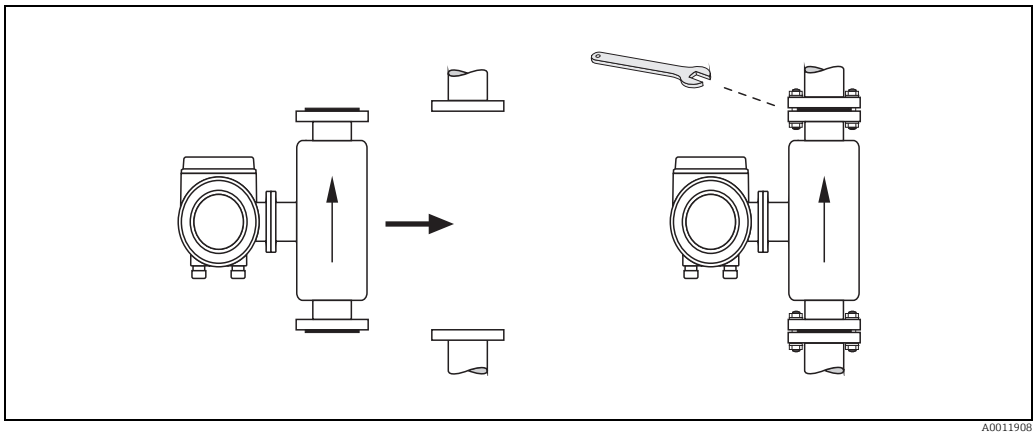


Fig. 17: Installing the Promag P sensor

Seals

Comply with the following instructions when installing seals:
- PFA or PTFE lining → seals are **not** required.
- Only use seals that comply with DIN EN 1514-1 for DIN flanges.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compound such as graphite. An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables can be ordered as accessories for potential equalization, → 📄 102.
- For information on potential equalization and detailed installation instructions for using ground cables, please refer to → 📄 57.

Screw tightening torques (Promag E)

Please note the following:
- The screw tightening torques listed below apply only to lubricated threads and to pipes not subjected to tensile stress.
- Tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.

Tightening torques for:
- EN (DIN) → 🖹 21
- ASME → 🖹 22
- JIS → 🖹 22

Promag E screw tightening torques for EN 1092-1 (DIN 2501), PN 6/10/16/40

Nominal diameter [mm]	EN (DIN) Pressure rating	Threaded fasteners	Flange thickness [mm]	Max. tightening torque PTFE [Nm]
15	PN 40	4 × M 12	16	11
25	PN 40	4 × M 12	18	26
32	PN 40	4 × M 16	18	41
40	PN 40	4 × M 16	18	52
50	PN 40	4 × M 16	20	65
65 *	PN 16	8 × M 16	18	43
80	PN 16	8 × M 16	20	53
100	PN 16	8 × M 16	20	57
125	PN 16	8 × M 16	22	75
150	PN 16	8 × M 20	22	99
200	PN 10	8 × M 20	24	141
200	PN 16	12 × M 20	24	94
250	PN 10	12 × M 20	26	110
250	PN 16	12 × M 24	26	131
300	PN 10	12 × M 20	26	125
300	PN 16	12 × M 24	28	179
350	PN 6	12 × M 20	22	200
350	PN 10	16 × M 20	26	188
350	PN 16	16 × M 24	30	254
400	PN 6	16 × M 20	22	166
400	PN 10	16 × M 24	26	260
400	PN 16	16 × M 27	32	330
450	PN 6	16 × M 20	22	202
450	PN 10	20 × M 24	28	235
450	PN 16	20 × M 27	40	300
500	PN 6	20 × M 20	24	176
500	PN 10	20 × M 24	28	265
500	PN 16	20 × M 30	34	448
600	PN 6	20 × M 24	30	242
600	PN 10	20 × M 27	28	345
600 *	PN 16	20 × M 33	36	658
* Designed acc. to EN 1092-1 (not to DIN 2501)				

Promag E screw tightening torques for EN 1092-1, PN 6/10/16, P245GH/stainless-steel; Calculated according to EN 1591-1:2014 for flanges according to EN 1092-1:2013

Nominal diameter [mm]	EN(DIN) Pressure rating	Threaded fasteners	Flange thickness [mm]	Nom. tightening torque PTFE [Nm]
350	PN 10	16 × M 20	26	60
350	PN 16	16 × M 24	30	115

Nominal diameter [mm]	EN(DIN) Pressure rating	Threaded fasteners	Flange thickness [mm]	Nom. tightening torque PTFE [Nm]
400	PN 10	16 × M 24	26	90
400	PN 16	16 × M 27	32	155
450	PN 10	20 × M 24	28	90
450	PN 16	20 × M 27	34	155
500	PN 10	20 × M 24	28	100
500	PN 16	20 × M 30	36	205
600	PN 10	20 × M 27	30	150
600	PN 16	20 × M 33	40	310

Promag E screw tightening torques for ASME B16.5, Class 150

Nominal diameter		ASME	Threaded fasteners	Max. tightening torque PTFE	
[mm]	[inch]	Pressure rating		[Nm]	[lbf · ft]
15	½"	Class 150	4 × ½"	6	4
25	1"	Class 150	4 × ½"	11	8
40	1 ½"	Class 150	4 × ½"	24	18
50	2"	Class 150	4 × 5/8"	47	35
80	3"	Class 150	4 × 5/8"	79	58
100	4"	Class 150	8 × 5/8"	56	41
150	6"	Class 150	8 × ¾"	106	78
200	8"	Class 150	8 × ¾"	143	105
250	10"	Class 150	12 × 7/8"	135	100
300	12"	Class 150	12 × 7/8"	178	131
350	14"	Class 150	12 × 1"	260	192
400	16"	Class 150	16 × 1"	246	181
450	18"	Class 150	16 × 1 ⅛"	371	274
500	20"	Class 150	20 × 1 ⅛"	341	252
600	24"	Class 150	20 × 1 ¼"	477	352

Promag E screw tightening torques for JIS B2220, 10/20K

Nominal diameter [mm]	JIS Pressure rating	Threaded fasteners	Max. tightening torque PTFE [Nm]
15	20K	4 × M 12	16
25	20K	4 × M 16	32
32	20K	4 × M 16	38
40	20K	4 × M 16	41
50	10K	4 × M 16	54
65	10K	4 × M 16	74
80	10K	8 × M 16	38
100	10K	8 × M 16	47
125	10K	8 × M 20	80
150	10K	8 × M 20	99
200	10K	12 × M 20	82
250	10K	12 × M 22	133
300	10K	16 × M 22	99

3.3.2 Installing the Promag H sensor

The sensor is supplied, as per your order, with or without installed process connections. Installed process connections are screwed onto the sensor using 4 or 6 hexagonal-headed bolts.

Caution!
Depending on the application and the length of the pipe, the sensor must be supported or more securely mounted if necessary. Particularly when using process connections made of plastic, it is essential that the sensor be mounted securely. A wall mounting kit for this purpose can be ordered separately as an accessory from Endress+Hauser (→ 🖹 102).

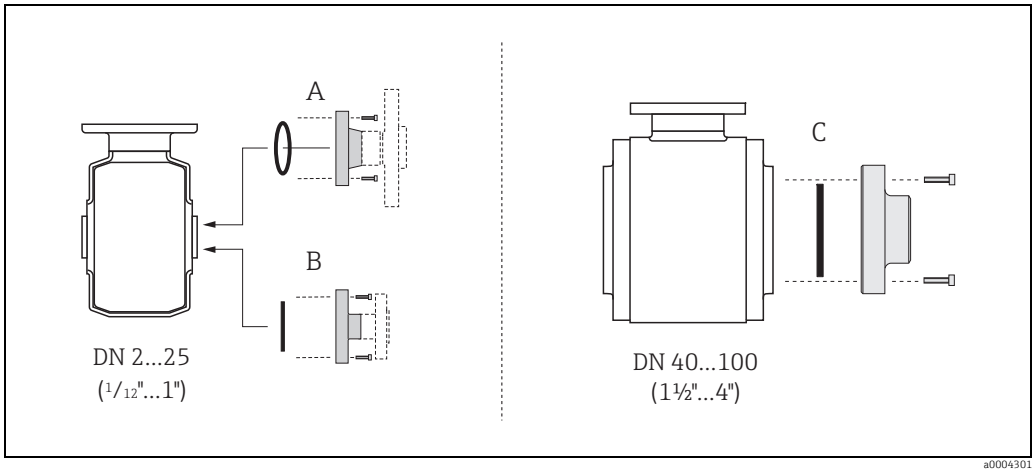


Fig. 18: Promag H process connections

A = DN 2 to 25 (1/12 to 1") / Process connections with O-ring
Weld nipple (DIN EN ISO 1127, ODT / SMS), flange (EN (DIN), ASME, JIS), flange made of PVDF (EN (DIN), ASME, JIS), external thread, internal thread, hose connection, PVC adhesive fitting

B = DN 2 to 25 (1/12 to 1") / Process connections with aseptic molded seal
Weld nipple (EN 10357 (DIN 11850), ODT / SMS), clamp (ISO 2852, DIN 32676, L14 AM7), coupling (DIN 11851, DIN 11864-1, SMS 1145), flange DIN 11864-2

C = DN 40 to 150 / 1½ to 6") / Process connections with aseptic molded seal
Weld nipple (EN 10357 (DIN 11850), ODT / SMS), clamp (ISO 2852, DIN 32676, L14 AM7), coupling (DIN 11851, DIN 11864-1, ISO 2853, SMS 1145), flange DIN 11864-2

Seals

When mounting the process connections, please ensure that the relevant seals are clean and properly centered.

Caution!
- In the case of metallic process connections, the screws must be fully tightened. The process connection forms a metallic connection with the sensor, which ensures a defined compression of the seal.
- In the case of process connections made of plastic, the maximum screw tightening torques for lubricated threads (7 Nm / 5.2 lbf ft) must be adhered to. In the case of plastic flanges, a seal must always be used between the connection and the counterflange.
- Depending on the application, the seals should be replaced periodically, particularly when molded seals (aseptic version) are used!
  The interval between replacements depends on the frequency of the cleaning cycles and on the temperatures of the fluid and the cleaning process. Replacement seals can be ordered as an accessory at a later stage → 🖹 102.

Using and installing grounding rings (DN 2 to 25 / 1/12 to 1")

In case the process connections are made of plastic (e.g. flanges or adhesive fittings), the potential between the sensor and the fluid must be equalized using additional ground rings. If the ground rings are not installed this can affect the accuracy of the measurements or cause the destruction of the sensor through the galvanic corrosion of the electrodes.

Caution!

- Depending on the option ordered, plastic rings may be installed at the process connections instead of ground rings. These plastic rings serve only as spacers and have no potential equalization function. In addition, they provide a sealing function at the interface between the sensor and process connection. For this reason, with process connections without ground rings, these plastic rings/seals must not be removed, or must always be installed.
- Ground rings can be ordered separately from Endress+Hauser as accessories → 102. When placing the order, make certain that the ground ring is compatible with the material used for the electrodes. Otherwise, there is a risk that the electrodes may be destroyed by galvanic corrosion! Information about the materials can be found on → 144.
- Ground rings, including the seals, are mounted within the process connections. Therefore, the fitting length is not affected.

1. Loosen the four or six hexagonal headed bolts (1) and remove the process connection from the sensor (4).
2. Remove the plastic ring (3), including the two O-ring seals (2).
3. Place one seal (2) in the groove of the process connection.
4. Place the metal ground ring (3) on the process connection.
5. Now place the second seal (2) in the groove of the ground ring.
6. Finally, mount the process connection on the sensor again. With plastic process connections, note the max. torques for lubricated threads (7 Nm / 5.2 lbf ft).

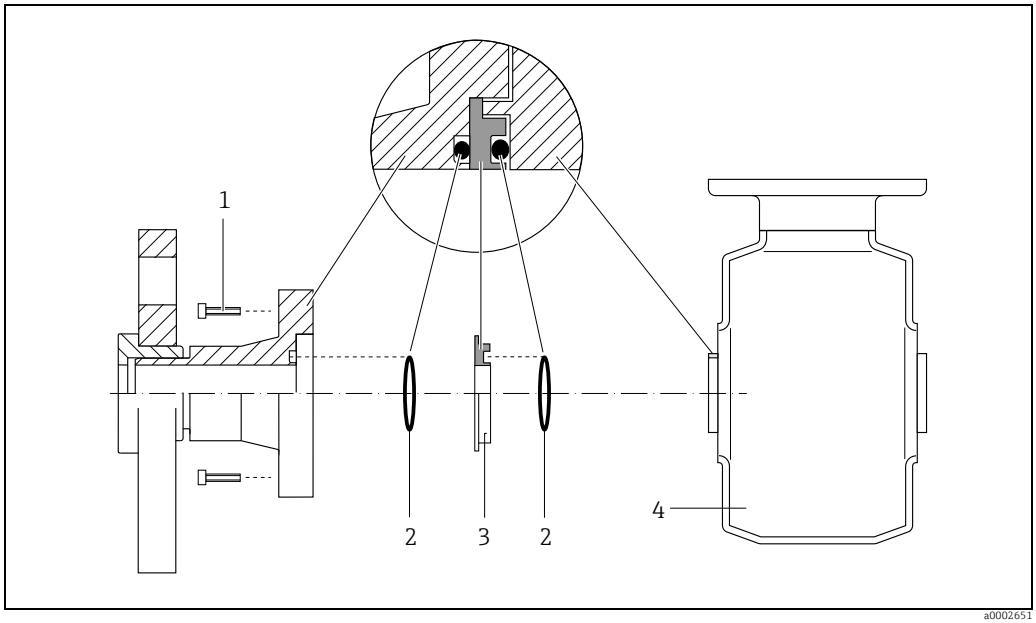


Fig. 19: Installing grounding rings in the Promag H (DN 2 to 25 / 1/12 to 1")

1 = Hexagonal-headed bolts, process connection
2 = O-ring seals
3 = Grounding ring or plastic ring (spacer)
4 = Sensor

Welding the transmitter into the pipe (weld nipple)

Caution!
Risk of electronics being destroyed. Please ensure that the welding system is *not* grounded via the sensor or transmitter.

1. Secure the sensor using several welding points in the piping. A welding jig suitable for this purpose can be ordered separately as an accessory → 102.
2. Loosen the screws at the process connection flange, and remove the sensor incl. seal from the piping.
3. Weld the process connection into the pipe.
4. Mount the sensor back into the pipe. When doing so, make sure that the seal is clean and positioned correctly.

Note!
- If the welding is done properly with thin-walled food pipes, the seal will not be damaged by heat even when mounted. Nonetheless, it is recommended that you dismantle the sensor and seal.
- For dismantling purposes, it must be possible to open the piping a total of approx. 8 mm.

Cleaning using pigs

When cleaning using pigs, please note the internal diameters of the measuring tube and the process connection. All the dimensions and lengths of the sensor and transmitter are provided in the separate documentation "Technical Information" → 151.

3.3.3 Installing the Promag L sensor

Caution!
- The protective covers mounted on the two sensor flanges (DN 25 to 300 / 1 to 12") are used to hold the lap joint flanges in place and to protect the PTFE liner during transportation. Consequently, do not remove these covers until **immediately before** the sensor is installed in the pipe.
- The covers must remain in place while the device is in storage.
- Make sure that the lining is not damaged or removed from the flanges.

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges.
- Observe in any case the necessary screw tightening torques on → 27.
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment.
- To comply with the device specification, a concentrical installation in the measuring section is required.

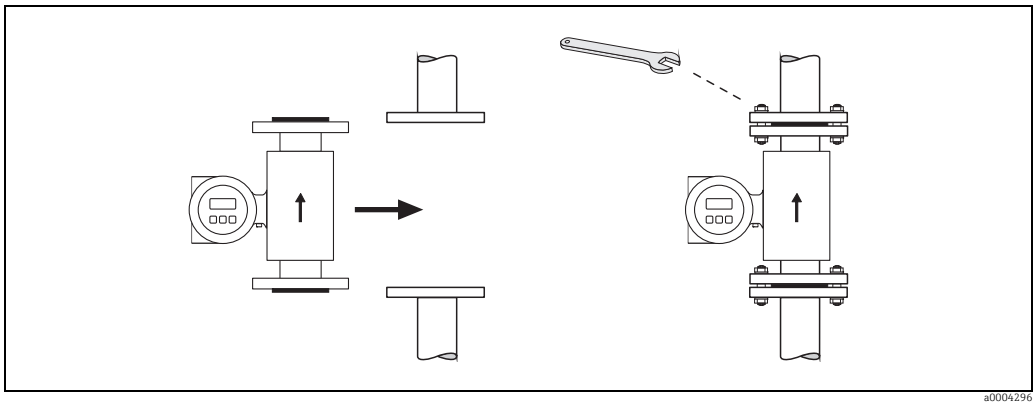


Fig. 20: Installing the Promag L sensor

Seals

Comply with the following instructions when installing seals:
- Hard rubber lining → additional seals are **always** necessary.
- Polyurethane lining → **no** seals are required.
- PTFE lining → **no** seals are required.
- For DIN flanges, use only seals according to EN 1514-1.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit!
Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables for potential equalization can be ordered as an accessory (→ 102).
- Information on potential equalization and detailed mounting instructions for the use of ground cables can be found on → 57.

Screw tightening torques (Promag L)

Please note the following:
- The screw tightening torques listed below apply only to lubricated threads and to pipes not subjected to tensile stress.
- Tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.

Promag L screw tightening torques for EN 1092-1 (DIN 2501), PN 6/10/16

Nominal diameter [mm]	EN (DIN) Pressure rating	Threaded fasteners	Flange thickness [mm]	Max. tightening torque		
				Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
25	PN 10/16	4 × M 12	18	-	6	11
32	PN 10/16	4 × M 16	18	-	16	27
40	PN 10/16	4 × M 16	18	-	16	29
50	PN 10/16	4 × M 16	18	-	15	40
65*	PN 10/16	8 × M 16	18	-	10	22
80	PN 10/16	8 × M 16	20	-	15	30
100	PN 10/16	8 × M 16	20	-	20	42
125	PN 10/16	8 × M 16	22	-	30	55
150	PN 10/16	8 × M 20	22	-	50	90
200	PN 16	12 × M 20	24	-	65	87
250	PN 16	12 × M 24	26	-	126	151
300	PN 16	12 × M 24	28	-	139	177
350	PN 6	12 × M 20	22	111	120	-
350	PN 10	16 × M 20	26	112	118	-
350	PN 16	16 × M 24	30	152	165	-
400	PN 6	16 × M 20	22	90	98	-
400	PN 10	16 × M 24	26	151	167	-
400	PN 16	16 × M 27	32	193	215	-
450	PN 6	16 × M 20	22	112	126	-
450	PN 10	20 × M 24	28	153	133	-
500	PN 6	20 × M 20	24	119	123	-
500	PN 10	20 × M 24	28	155	171	-
500	PN 16	20 × M 30	34	275	300	-
600	PN 6	20 × M 24	30	139	147	-
600	PN 10	20 × M 27	28	206	219	-
600*	PN 16	20 × M 33	36	415	443	-
700	PN 6	24 × M 24	24	148	139	-
700	PN 10	24 × M 27	30	246	246	-
700	PN 16	24 × M 33	36	278	318	-
800	PN 6	24 × M 27	24	206	182	-
800	PN 10	24 × M 30	32	331	316	-
800	PN 16	24 × M 36	38	369	385	-
900	PN 6	24 × M 27	26	230	637	-
900	PN 10	28 × M 30	34	316	307	-
900	PN 16	28 × M 36	40	353	398	-
1000	PN 6	28 × M 27	26	218	208	-
1000	PN 10	28 × M 33	34	402	405	-
1200	PN 6	32 × M 30	28	319	299	-
1200	PN 10	32 × M 36	38	564	568	-
1200	PN 16	32 × M 45	48	701	753	-
1400	PN 6	36 × M 33	32	430	-	-
1400	PN 10	36 × M 39	42	654	-	-
1400	PN 16	36 × M 45	52	729	-	-
1600	PN 6	40 × M 33	34	440	-	-
1600	PN 10	40 × M 45	46	946	-	-
1600	PN 16	40 × M 52	58	1007	-	-
1800	PN 6	44 × M 36	36	547	-	-

Nominal diameter [mm]	EN (DIN) Pressure rating	Threaded fasteners	Flange thickness [mm]	Max. tightening torque		
				Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
1800	PN 10	44 × M 45	50	961	-	-
1800	PN 16	44 × M 52	62	1108	-	-
2000	PN 6	48 × M 39	38	629	-	-
2000	PN 10	48 × M 45	54	1047	-	-
2000	PN 16	48 × M 56	66	1324	-	-
2200	PN 6	52 × M 39	42	698	-	-
2200	PN 10	52 × M 52	58	1217	-	-
2400	PN 6	56 × M 39	44	768	-	-
2400	PN 10	56 × M 52	62	1229	-	-
* Designed acc. to EN 1092-1 (not to DIN 2501)						

Promag L screw tightening torques for EN 1092-1, PN 6/10/16, P245GH/stainless-steel; Calculated according to EN 1591-1:2014 for flange according to EN 1092-1:2013

Nominal diameter [mm]	EN(DIN) pressure rating	Threaded fastener	Flange thickness [mm]	Nom. tightening torques	
				Hard rubber [Nm]	Polyurethane [Nm]
350	PN 6	12 × M 20	22	60	75
350	PN 10	16 × M 20	26	70	80
400	PN 6	16 × M 20	22	65	70
400	PN 10	16 × M 24	26	100	120
400	PN 16	16 × M 27	32	175	190
450	PN 6	16 × M 20	22	70	90
450	PN 10	20 × M 24	28	100	110
500	PN 6	20 × M 20	24	65	70
500	PN 10	20 × M 24	28	110	120
500	PN 16	20 × M 30	36	225	235
600	PN 6	20 × M 24	30	105	105
600	PN 10	20 × M 27	30	165	160
600	PN 16	20 × M 33	40	340	340
700	PN 6	24 × M 24	30	110	110
700	PN 10	24 × M 27	35	190	190
700	PN 16	24 × M 33	40	340	340
800	PN 6	24 × M 27	30	145	145
800	PN 10	24 × M 30	38	260	260
800	PN 16	24 × M 36	41	465	455
900	PN 6	24 × M 27	34	170	180
900	PN 10	28 × M 30	38	265	275
900	PN 16	28 × M 36	48	475	475
1000	PN 6	28 × M 27	38	175	185
1000	PN 10	28 × M 33	44	350	360
1000	PN 16	28 × M 39	59	630	620
1200	PN 6	32 × M 30	42	235	250
1200	PN 10	32 × M 36	55	470	480
1200	PN 16	32 × M 45	78	890	900
1400	PN 6	36 × M 33	56	300	-
1400	PN 10	36 × M 39	65	600	-
1400	PN 16	36 × M 45	84	1050	-
1600	PN 6	40 × M 33	63	340	-
1600	PN 10	40 × M 45	75	810	-
1600	PN 16	40 × M 52	102	1420	-
1800	PN 6	44 × M 36	69	430	-
1800	PN 10	44 × M 45	85	920	-
1800	PN 16	44 × M 52	110	1600	-

Nominal diameter [mm]	EN(DIN) pressure rating	Threaded fastener	Flange thickness [mm]	Nom. tightening torques Hard rubber [Nm]	Polyurethane [Nm]
2000	PN 6	48 × M 39	74	530	-
2000	PN 10	48 × M 45	90	1040	-
2000	PN 16	48 × M 56	124	1900	-
2200	PN 6	52 × M 39	81	580	-
2200	PN 10	52 × M 52	100	1290	-
2400	PN 6	56 × M 39	87	650	-
2400	PN 10	56 × M 52	110	1410	-

Promag L screw tightening torques for ASME B16.5, Class 150

Nominal diameter		ASME Pressure rating	Threaded fasteners	Max. tightening torque					
				Hard rubber		Polyurethane		PTFE	
[mm]	[inch]			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
25	1"	Class 150	4 × 5/8"	-	-	5	4	14	13
40	1 ½"	Class 150	8 × 5/8"	-	-	10	17	21	15
50	2"	Class 150	4 × 5/8"	-	-	15	11	40	29
80	3"	Class 150	4 × 5/8"	-	-	25	18	65	48
100	4"	Class 150	8 × 5/8"	-	-	20	15	44	32
150	6"	Class 150	8 × ¾"	-	-	45	33	90	66
200	8"	Class 150	8 × ¾"	-	-	65	48	87	64
250	10"	Class 150	12 × 7/8"	-	-	126	93	151	112
300	12"	Class 150	12 × 7/8"	-	-	146	108	177	131
350	14"	Class 150	12 × 1"	135	100	158	117	-	-
400	16"	Class 150	16 × 1"	128	94	150	111	-	-
450	18"	Class 150	16 × 1 ⅛"	204	150	234	173	-	-
500	20"	Class 150	20 × 1 ⅛"	183	135	217	160	-	-
600	24"	Class 150	20 × 1 ¼"	268	198	307	226	-	-

Promag L screw tightening torques for AWWA, Class D

Nominal diameter		AWWA Pressure rating	Threaded fasteners	Max. tightening torque					
				Hard rubber		Polyurethane		PTFE	
[mm]	[inch]			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
700	28"	Class D	28 × 1 ¼"	247	182	292	215	-	-
750	30"	Class D	28 × 1 ¼"	287	212	302	223	-	-
800	32"	Class D	28 × 1 ½"	394	291	422	311	-	-
900	36"	Class D	32 × 1 ½"	419	309	430	317	-	-
1000	40"	Class D	36 × 1 ½"	420	310	477	352	-	-
–	42"	Class D	36 × 1 ½"	528	389	518	382	-	-
1200	48"	Class D	44 × 1 ½"	552	407	531	392	-	-

Promag L screw tightening torques for AS 2129, Table E

Nominal diameter [mm]	AS 2129 Pressure rating	Threaded fasteners	Max. tightening torque Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
350	Table E	12 × M 24	203	-	-
400	Table E	12 × M 24	226	-	-
450	Table E	16 × M 24	226	-	-
500	Table E	16 × M 24	271	-	-
600	Table E	16 × M 30	439	-	-
700	Table E	20 × M 30	355	-	-
750	Table E	20 × M 30	559	-	-

Nominal diameter [mm]	AS 2129 Pressure rating	Threaded fasteners	Max. tightening torque		
			Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
800	Table E	20 × M 30	631	-	-
900	Table E	24 × M 30	627	-	-
1000	Table E	24 × M 30	634	-	-
1200	Table E	32 × M 30	727	-	-

Promag L screw tightening torques for AS 4087, PN16

Nominal diameter [mm]	AS 4087 Pressure rating	Threaded fasteners	Max. tightening torque		
			Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
350	PN 16	12 × M 24	203	-	-
375	PN 16	12 × M 24	137	-	-
400	PN 16	12 × M 24	226	-	-
450	PN 16	12 × M 24	301	-	-
500	PN 16	16 × M 24	271	-	-
600	PN 16	16 × M 27	393	-	-
700	PN 16	20 × M 27	330	-	-
750	PN 16	20 × M 30	529	-	-
800	PN 16	20 × M 33	631	-	-
900	PN 16	24 × M 33	627	-	-
1000	PN 16	24 × M 33	595	-	-
1200	PN 16	32 × M 33	703	-	-

3.3.4 Installing the Promag P sensor

Caution!
- The protective covers mounted on the two sensor flanges guard the PTFE lining, which is turned over the flanges. Consequently, do not remove these protection plates **until immediately before** the sensor is installed in the pipe.
- Protection plates must remain in place while the device is in storage.
- Make sure that the lining is not damaged or removed from the flanges.

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges:
- It is essential that you observe the necessary screw tightening torques on → 32.
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment.

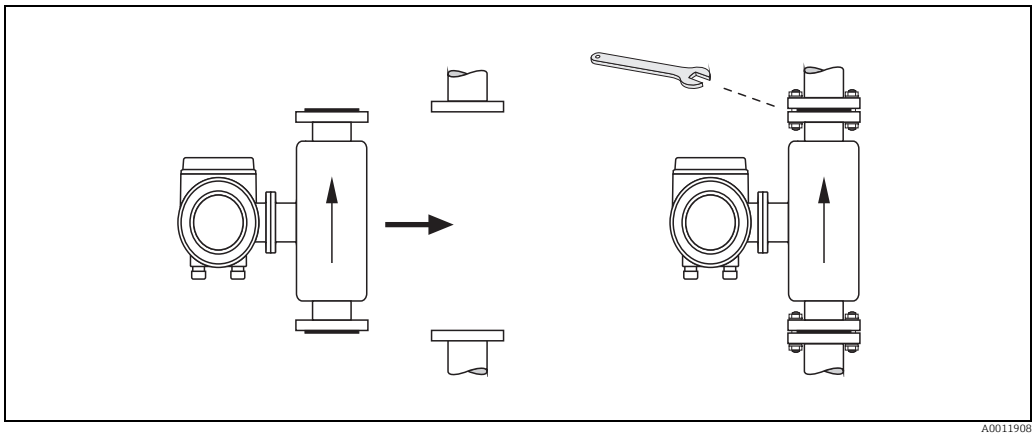


Fig. 21: Installing the Promag P sensor

Seals

Comply with the following instructions when installing seals:
- PFA or PTFE lining → seals are **not** required.
- Only use seals that comply with DIN EN 1514-1 for DIN flanges.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compound such as graphite. An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables can be ordered as accessories for potential equalization, → 102.
- For information on potential equalization and detailed installation instructions for using ground cables, please refer to → 57.

Installing the high-temperature version (with PFA lining)

The high-temperature version has a housing support for the thermal separation of sensor and transmitter. The high-temperature version is always used for applications in which high ambient temperatures are encountered in conjunction with high fluid temperatures. The high-temperature version is obligatory if the fluid temperature exceeds +150 °C (+300 °F).

Note!
You will find information on permissible temperature ranges on → 128.

Insulation
Pipes generally have to be insulated if they carry very hot fluids to avoid energy losses and prevent accidental contact with pipes at temperatures that could cause injury. Guidelines regulating the insulation of pipes have to be taken into account.

Caution!
Risk of electronics overheating. The housing support dissipates heat and its entire surface area must remain uncovered. Make sure that the sensor insulation does not extend past the top of the two sensor half-shells.

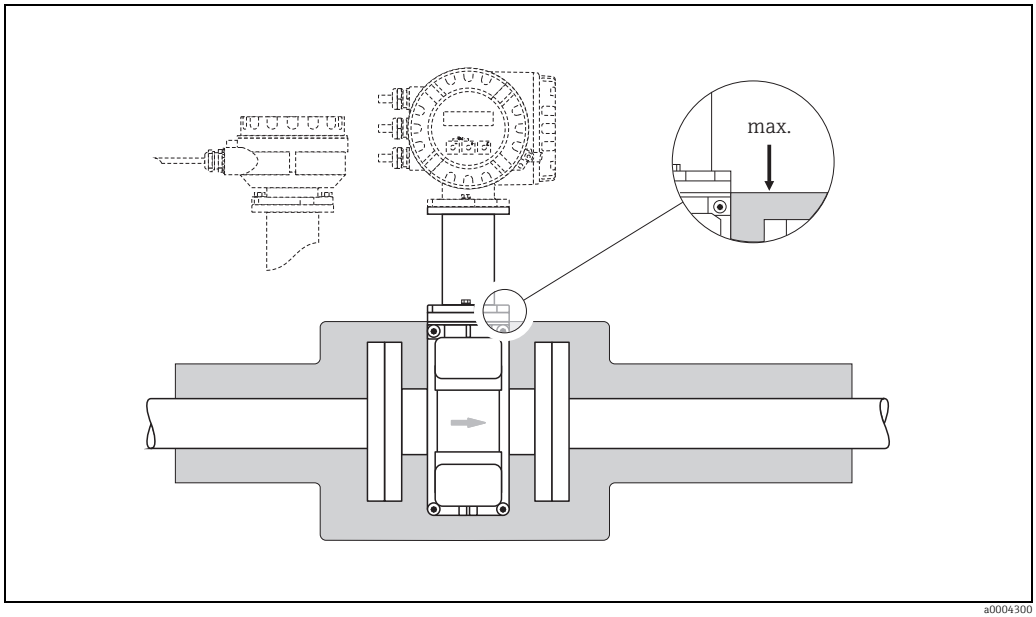


Fig. 22: Promag P sensor (high-temperature version): insulating the pipe

Screw tightening torques (Promag P)

Please note the following:
- The screw tightening torques listed below apply only to lubricated threads and to pipes not subjected to tensile stress.
- Tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.

Tightening torques for:
- EN (DIN) → 33
- ASME → 34
- JIS → 35
- AS 2129 → 35
- AS 4087 → 35

Promag P screw tightening torques for EN 1092-1 (DIN 2501), PN 10/16/25/40

Nominal diameter [mm]	EN (DIN) Pressure rating	Screws	Flange thickness [mm]	Max. tightening torque PTFE [Nm]	Max. tightening torque PFA [Nm]
15	PN 40	4 × M 12	16	11	–
25	PN 40	4 × M 12	18	26	20
32	PN 40	4 × M 16	18	41	35
40	PN 40	4 × M 16	18	52	47
50	PN 40	4 × M 16	20	65	59
65 *	PN 16	8 × M 16	18	43	40
65	PN 40	8 × M 16	22	43	40
80	PN 16	8 × M 16	20	53	48
80	PN 40	8 × M 16	24	53	48
100	PN 16	8 × M 16	20	57	51
100	PN 40	8 × M 20	24	78	70
125	PN 16	8 × M 16	22	75	67
125	PN 40	8 × M 24	26	111	99
150	PN 16	8 × M 20	22	99	85
150	PN 40	8 × M 24	28	136	120
200	PN 10	8 × M 20	24	141	101
200	PN 16	12 × M 20	24	94	67
200	PN 25	12 × M 24	30	138	105
250	PN 10	12 × M 20	26	110	–
250	PN 16	12 × M 24	26	131	–
250	PN 25	12 × M 27	32	200	–
300	PN 10	12 × M 20	26	125	–
300	PN 16	12 × M 24	28	179	–
300	PN 25	16 × M 27	34	204	–
350	PN 10	16 × M 20	26	188	–
350	PN 16	16 × M 24	30	254	–
350	PN 25	16 × M 30	38	380	–
400	PN 10	16 × M 24	26	260	–
400	PN 16	16 × M 27	32	330	–
400	PN 25	16 × M 33	40	488	–
450	PN 10	20 × M 24	28	235	–
450	PN 16	20 × M 27	40	300	–
450	PN 25	20 × M 33	46	385	–
500	PN 10	20 × M 24	28	265	–
500	PN 16	20 × M 30	34	448	–
500	PN 25	20 × M 33	48	533	–
600	PN 10	20 × M 27	28	345	–
600 *	PN 16	20 × M 33	36	658	–
600	PN 25	20 × M 36	58	731	–

* Designed acc. to EN 1092-1 (not to DIN 2501)

Promag P screw tightening torques for EN 1092-1, PN 10/16/25, P245GH/stainless-steel; Calculated according to EN 1591-1:2014 for flange according to EN 1092-1:2013

Nominal diamter [mm]	EN (DIN) pressure rating	Threaded fasteners	Flange thickness [mm]	Nom. tightening torques PTFE [Nm]
350	PN 10	16 × M 20	26	60
350	PN 16	16 × M 24	30	115
350	PN 25	16 × M 30	38	220
400	PN 10	16 × M 24	26	90
400	PN 16	16 × M 27	32	155
400	PN 25	16 × M 33	40	290
450	PN 10	20 × M 24	28	90
450	PN 16	20 × M 27	34	155
450	PN 25	20 × M 33	46	290
500	PN 10	20 × M 24	28	100
500	PN 16	20 × M 30	36	205
500	PN 25	20 × M 33	48	345
600	PN 10	20 × M 27	30	150
600	PN 16	20 × M 33	40	310
600	PN 25	20 × M 36	48	500

Promag P screw tightening torques for ASME B16.5, Class 150/300

Nominal diameter		ASME Pressure rating	Screws	Max. tightening torque			
				PTFE		PFA	
[mm]	[inch]			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
15	½"	Class 150	4 × ½"	6	4	–	–
15	½"	Class 300	4 × ½"	6	4	–	–
25	1"	Class 150	4 × ½"	11	8	10	7
25	1"	Class 300	4 × 5/8"	14	10	12	9
40	1 ½"	Class 150	4 × ½"	24	18	21	15
40	1 ½"	Class 300	4 × ¾"	34	25	31	23
50	2"	Class 150	4 × 5/8"	47	35	44	32
50	2"	Class 300	8 × 5/8"	23	17	22	16
80	3"	Class 150	4 × 5/8"	79	58	67	49
80	3"	Class 300	8 × ¾"	47	35	42	31
100	4"	Class 150	8 × 5/8"	56	41	50	37
100	4"	Class 300	8 × ¾"	67	49	59	44
150	6"	Class 150	8 × ¾"	106	78	86	63
150	6"	Class 300	12 × ¾"	73	54	67	49
200	8"	Class 150	8 × ¾"	143	105	109	80
250	10"	Class 150	12 × 7/8"	135	100	–	–
300	12"	Class 150	12 × 7/8"	178	131	–	–
350	14"	Class 150	12 × 1"	260	192	–	–
400	16"	Class 150	16 × 1"	246	181	–	–
450	18"	Class 150	16 × 1 ⅛"	371	274	–	–
500	20"	Class 150	20 × 1 ⅛"	341	252	–	–
600	24"	Class 150	20 × 1 ¼"	477	352	–	–

Promag P screw tightening torques for JIS B2220, 10/20K

Nominal diameter [mm]	JIS Pressure rating	Screws	Max. tightening torque PTFE [Nm]	Max. tightening torque PFA [Nm]
15	10K	4 × M 12	16	–
15	20K	4 × M 12	16	–
25	10K	4 × M 16	32	27
25	20K	4 × M 16	32	27
32	10K	4 × M 16	38	–
32	20K	4 × M 16	38	–
40	10K	4 × M 16	41	37
40	20K	4 × M 16	41	37
50	10K	4 × M 16	54	46
50	20K	8 × M 16	27	23
65	10K	4 × M 16	74	63
65	20K	8 × M 16	37	31
80	10K	8 × M 16	38	32
80	20K	8 × M 20	57	46
100	10K	8 × M 16	47	38
100	20K	8 × M 20	75	58
125	10K	8 × M 20	80	66
125	20K	8 × M 22	121	103
150	10K	8 × M 20	99	81
150	20K	12 × M 22	108	72
200	10K	12 × M 20	82	54
200	20K	12 × M 22	121	88
250	10K	12 × M 22	133	–
250	20K	12 × M 24	212	–
300	10K	16 × M 22	99	–
300	20K	16 × M 24	183	–

Promag P tightening torques for JIS B2220, 10/20K

Nominal diameter [mm]	JIS Pressure rating	Threaded fasteners	Nom. tightening torques Hard rubber [Nm]	Nom. tightening torques Polyurethane [Nm]
350	10K	16 × M 22	109	109
350	20K	16 × M 30 x3	217	217
400	10K	16 × M 24	163	163
400	20K	16 × M 30x3	258	258
450	10K	16 × M 24	155	155
450	20K	16 × M 30x3	272	272
500	10K	16 × M 24	183	183
500	20K	16 × M 30x3	315	315
600	10K	16 × M 30	235	235
600	20K	16 × M 36x3	381	381

Promag P screw tightening torques for AS 2129, Table E

Nominal diameter [mm]	AS 2129 Pressure rating	Screws	Max. tightening torque PTFE [Nm]
25	Table E	4 × M 12	21
50	Table E	4 × M 16	42

Promag P screw tightening torques for AS 4087, PN16

Nominal diameter [mm]	AS 4087 Pressure rating	Screws	Max. tightening torque PTFE [Nm]
50	PN 16	4 × M 16	42

3.3.5 Installing the Promag W sensor

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges:
- It is essential that you observe the necessary screw tightening torques on → 36.
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment.

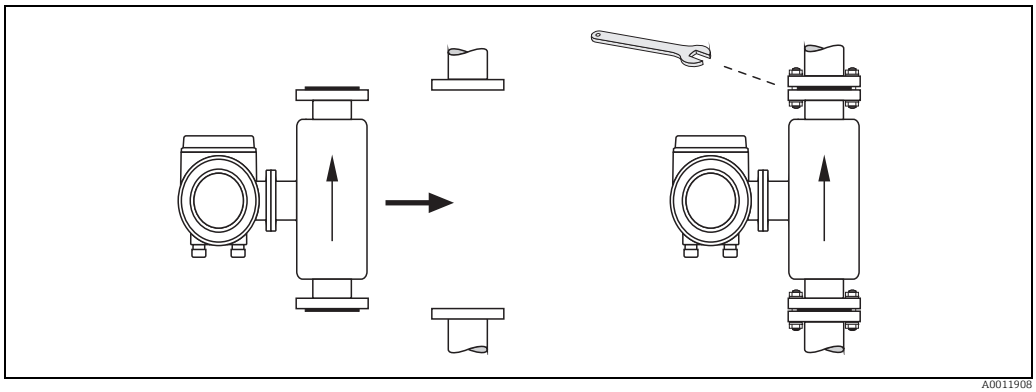


Fig. 23: Installing the Promag W sensor

Seals

Comply with the following instructions when installing seals:
- Hard rubber lining → additional seals are **always** required.
- Polyurethane lining → seals are **not** required.
- Only use seals that comply with DIN EN 1514-1 for DIN flanges.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compound such as graphite. An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables can be ordered as accessories for potential equalization, → 102.
- For information on potential equalization and detailed installation instructions for using ground cables, please refer to → 57.

Screw tightening torques (Promag W)

Please note the following:
- The screw tightening torques listed below apply only to lubricated threads and to pipes not subjected to tensile stress.
- Tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.

Tightening torques for:

- EN (DIN) → 37
- JIS → 39
- ASME → 40
- AWWA → 41
- AS 2129 → 41
- AS 4087 → 42

Promag W screw tightening torques for EN 1092-1 (DIN 2501), PN 6/10/16/25/40

Nominal diameter [mm]	EN (DIN)	Screws	Flange thickness [mm]	Max. tightening torque Hard rubber [Nm]	Max. tightening torque Polyurethane [Nm]
25	PN 40	4 × M 12	18	-	15
32	PN 40	4 × M 16	18	-	24
40	PN 40	4 × M 16	18	-	31
50	PN 40	4 × M 16	20	-	40
65*	PN 16	8 × M 16	18	32	27
65	PN 40	8 × M 16	22	32	27
80	PN 16	8 × M 16	20	40	34
80	PN 40	8 × M 16	24	40	34
100	PN 16	8 × M 16	20	43	36
100	PN 40	8 × M 20	24	59	50
125	PN 16	8 × M 16	22	56	48
125	PN 40	8 × M 24	26	83	71
150	PN 16	8 × M 20	22	74	63
150	PN 40	8 × M 24	28	104	88
200	PN 10	8 × M 20	24	106	91
200	PN 16	12 × M 20	24	70	61
200	PN 25	12 × M 24	30	104	92
250	PN 10	12 × M 20	26	82	71
250	PN 16	12 × M 24	26	98	85
250	PN 25	12 × M 27	32	150	134
300	PN 10	12 × M 20	26	94	81
300	PN 16	12 × M 24	28	134	118
300	PN 25	16 × M 27	34	153	138
350	PN 6	12 × M 20	22	111	120
350	PN 10	16 × M 20	26	112	118
350	PN 16	16 × M 24	30	152	165
350	PN 25	16 × M 30	38	227	252
400	PN 6	16 × M 20	22	90	98
400	PN 10	16 × M 24	26	151	167
400	PN 16	16 × M 27	32	193	215
400	PN 25	16 × M 33	40	289	326
450	PN 6	16 × M 20	22	112	126
450	PN 10	20 × M 24	28	153	133
450	PN 16	20 × M 27	40	198	196
450	PN 25	20 × M 33	46	256	253
500	PN 6	20 × M 20	24	119	123
500	PN 10	20 × M 24	28	155	171
500	PN 16	20 × M 30	34	275	300
500	PN 25	20 × M 33	48	317	360
600	PN 6	20 × M 24	30	139	147
600	PN 10	20 × M 27	28	206	219
600 *	PN 16	20 × M 33	36	415	443
600	PN 25	20 × M 36	58	431	516
700	PN 6	24 × M 24	24	148	139
700	PN 10	24 × M 27	30	246	246
700	PN 16	24 × M 33	36	278	318
700	PN 25	24 × M 39	46	449	507
800	PN 6	24 × M 27	24	206	182
800	PN 10	24 × M 30	32	331	316
800	PN 16	24 × M 36	38	369	385
800	PN 25	24 × M 45	50	664	721
900	PN 6	24 × M 27	26	230	637

Nominal diameter [mm]	EN (DIN)	Screws	Flange thickness [mm]	Max. tightening torque Hard rubber [Nm]	Max. tightening torque Polyurethane [Nm]
900	PN 10	28 × M 30	34	316	307
900	PN 16	28 × M 36	40	353	398
900	PN 25	28 × M 45	54	690	716
1000	PN 6	28 × M 27	26	218	208
1000	PN 10	28 × M 33	34	402	405
1000	PN 16	28 × M 39	42	502	518
1000	PN 25	28 × M 52	58	970	971
1200	PN 6	32 × M 30	28	319	299
1200	PN 10	32 × M 36	38	564	568
1200	PN 16	32 × M 45	48	701	753
1400	PN 6	36 × M 33	32	430	398
1400	PN 10	36 × M 39	42	654	618
1400	PN 16	36 × M 45	52	729	762
1600	PN 6	40 × M 33	34	440	417
1600	PN 10	40 × M 45	46	946	893
1600	PN 16	40 × M 52	58	1007	1100
1800	PN 6	44 × M 36	36	547	521
1800	PN 10	44 × M 45	50	961	895
1800	PN 16	44 × M 52	62	1108	1003
2000	PN 6	48 × M 39	38	629	605
2000	PN 10	48 × M 45	54	1047	1092
2000	PN 16	48 × M 56	66	1324	1261
* Designed acc. to EN 1092-1 (not to DIN 2501)					

Promag W screw tightening torques for EN 1092-1, PN 6/10/16/25, P245GH/stainless-steel; Calculated according to EN 1591-1:2014 for flange according to EN 1092-1:2013

Nominal diameter [mm]	EN (DIN) pressure rating	Threaded fasteners	flange thickness [mm]	Nom. tightening torque Hard rubber [Nm]	Nom. tightening torque Polyurethane [Nm]
350	PN 6	12 × M 20	22	60	75
350	PN 10	16 × M 20	26	70	80
350	PN 16	16 × M 24	30	125	135
350	PN 25	16 × M 30	38	230	235
400	PN 6	16 × M 20	22	65	70
400	PN 10	16 × M 24	26	100	120
400	PN 16	16 × M 27	32	175	190
400	PN 25	16 × M 33	40	315	325
450	PN 6	16 × M 20	22	70	90
450	PN 10	20 × M 24	28	100	110
450	PN 16	20 × M 27	34	175	190
450	PN 25	20 × M 33	46	300	310
500	PN 6	20 × M 20	24	65	70
500	PN 10	20 × M 24	28	110	120
500	PN 16	20 × M 30	36	225	235
500	PN 25	20 × M 33	48	370	370
600	PN 6	20 × M 24	30	105	105
600	PN 10	20 × M 27	30	165	160
600	PN 16	20 × M 33	40	340	340
600	PN 25	20 × M 36	48	540	540
700	PN 6	24 × M 24	30	110	110
700	PN 10	24 × M 27	35	190	190
700	PN 16	24 × M 33	40	340	340

Nominal diameter [mm]	EN (DIN) pressure rating	Threaded fasteners	flange thickness [mm]	Nom. tightening torque	
				Hard rubber [Nm]	Polyurethane [Nm]
700	PN 25	24 × M 39	50	615	595
800	PN 6	24 × M 27	30	145	145
800	PN 10	24 × M 30	38	260	260
800	PN 16	24 × M 36	41	465	455
800	PN 25	24 × M 45	53	885	880
900	PN 6	24 × M 27	34	170	180
900	PN 10	28 × M 30	38	265	275
900	PN 16	28 × M 36	48	475	475
900	PN 25	28 × M 45	57	930	915
1000	PN 6	28 × M 27	38	175	185
1000	PN 10	28 × M 33	44	350	360
1000	PN 16	28 × M 39	59	630	620
1000	PN 25	28 × M 52	63	1300	1290
1200	PN 6	32 × M 30	42	235	250
1200	PN 10	32 × M 36	55	470	480
1200	PN 16	32 × M 45	78	890	900
1400	PN 6	36 × M 33	56	300	-
1400	PN 10	36 × M 39	65	600	-
1400	PN 16	36 × M 45	84	1050	-
1600	PN 6	40 × M 33	63	340	-
1600	PN 10	40 × M 45	75	810	-
1600	PN 16	40 × M 52	102	1420	-
1800	PN 6	44 × M 36	69	430	-
1800	PN 10	44 × M 45	85	920	-
1800	PN 16	44 × M 52	110	1600	-
2000	PN 6	48 × M 39	74	530	-
2000	PN 10	48 × M 45	90	1040	-
2000	PN 16	48 × M 56	124	1900	-

Promag W screw tightening torques for JIS B2220, 10/20K

Sensor Nominal diameter [mm]	JIS Pressure rating	Screws	Max. tightening torque	
			Hard rubber [Nm]	Polyurethane [Nm]
25	10K	4 × M 16	–	19
25	20K	4 × M 16	–	19
32	10K	4 × M 16	–	22
32	20K	4 × M 16	–	22
40	10K	4 × M 16	–	24
40	20K	4 × M 16	–	24
50	10K	4 × M 16	–	33
50	20K	8 × M 16	–	17
65	10K	4 × M 16	55	45
65	20K	8 × M 16	28	23
80	10K	8 × M 16	29	23
80	20K	8 × M 20	42	35
100	10K	8 × M 16	35	29
100	20K	8 × M 20	56	48
125	10K	8 × M 20	60	51
125	20K	8 × M 22	91	79

Sensor Nominal diameter [mm]	JIS Pressure rating	Screws	Max. tightening torque	
			Hard rubber [Nm]	Polyurethane [Nm]
150	10K	8 × M 20	75	63
150	20K	12 × M 22	81	72
200	10K	12 × M 20	61	52
200	20K	12 × M 22	91	80
250	10K	12 × M 22	100	87
250	20K	12 × M 24	159	144
300	10K	16 × M 22	74	63
300	20K	16 × M 24	138	124

Promag W screw tightening torques for JIS B2220, 10/20K

Nominal diameter [mm]	JIS Pressure rating	Threaded fasteners	Nom. tightening torque	
			Hard rubber [Nm]	Polyurethane [Nm]
350	10K	16 × M 22	109	109
350	20K	16 × M 30 x3	217	217
400	10K	16 × M 24	163	163
400	20K	16 × M 30x3	258	258
450	10K	16 × M 24	155	155
450	20K	16 × M 30x3	272	272
500	10K	16 × M 24	183	183
500	20K	16 × M 30x3	315	315
600	10K	16 × M 30	235	235
600	20K	16 × M 36x3	381	381
700	10K	16 × M 30	300	300
750	10K	16 × M 30	339	339

Promag W screw tightening torques for ASME B16.5, Class 150/300

Sensor Nominal diameter [inch]	ASME Pressure rating	Screws	Max. tightening torque	
			Hard rubber [Nm]	Polyurethane [Nm]
1"	Class 150	4 × ½"	–	7
1"	Class 300	4 × 5/8"	–	8
1 ½"	Class 150	4 × ½"	–	10
1 ½"	Class 300	4 × ¾"	–	15
2"	Class 150	4 × 5/8"	–	22
2"	Class 300	8 × 5/8"	–	11
3"	Class 150	4 × 5/8"	60	43
3"	Class 300	8 × ¾"	38	26
4"	Class 150	8 × 5/8"	42	31
4"	Class 300	8 × ¾"	58	40
6"	Class 150	8 × ¾"	79	59
6"	Class 300	12 × ¾"	70	51
8"	Class 150	8 × ¾"	107	80
10"	Class 150	12 × 7/8"	101	75
12"	Class 150	12 × 7/8"	133	103
14"	Class 150	12 × 1"	135	158

Sensor Nominal diameter [inch]	ASME Pressure rating	Screws	Max. tightening torque	
			Hard rubber [Nm]	Polyurethane [Nm]
16"	Class 150	16 × 1"	128	150
18"	Class 150	16 × 1 ⅛"	204	234
20"	Class 150	20 × 1 ⅛"	183	217
24"	Class 150	20 × 1 ¼	268	307

Promag W screw tightening torques for AWWA, Class D

Sensor Nominal diameter [inch]	AWWA Pressure rating	Screws	Max. tightening torque	
			Hard rubber [Nm]	Polyurethane [Nm]
28"	Class D	28 × 1 ¼"	247	292
30"	Class D	28 × 1 ¼"	287	302
32"	Class D	28 × 1 ½"	394	422
36"	Class D	32 × 1 ½"	419	430
40"	Class D	36 × 1 ½"	420	477
42"	Class D	36 × 1 ½"	528	518
48"	Class D	44 × 1 ½"	552	531
54"	Class D	44 × 1 ¾"	730	633
60"	Class D	52 × 1 ¾"	758	832
66"	Class D	52 × 1 ¾"	946	955
72"	Class D	60 × 1 ¾"	975	1087
78"	Class D	64 × 2"	853	786

Promag W screw tightening torques for AS 2129, Table E

Sensor Nominal diameter [mm]	AS 2129 Pressure rating	Screws	Max. tightening torque Hard rubber [Nm]
80	Table E	4 × M 16	49
100	Table E	8 × M 16	38
150	Table E	8 × M 20	64
200	Table E	8 × M 20	96
250	Table E	12 × M 20	98
300	Table E	12 × M 24	123
350	Table E	12 × M 24	203
400	Table E	12 × M 24	226
500	Table E	16 × M 24	271
600	Table E	16 × M 30	439
700	Table E	20 × M 30	355
750	Table E	20 × M 30	559
800	Table E	20 × M 30	631
900	Table E	24 × M 30	627
1000	Table E	24 × M 30	634
1200	Table E	32 × M 30	727

Promag W screw tightening torques for AS 4087, PN16

Sensor Nominal diameter [mm]	AS 4087 Pressure rating	Screws	Max. tightening torque Hard rubber [Nm]
80	PN 16	4 × M 16	49
100 *	PN 16	8 × M 16	38
150	PN 16	8 × M 20	52
200	PN 16	8 × M 20	77
250	PN 16	8 × M 20	147
300	PN 16	12 × M 24	103
350	PN 16	12 × M 24	203
375	PN 16	12 × M 24	137
400	PN 16	12 × M 24	226
500	PN 16	16 × M 24	271
600	PN 16	16 × M 30	393
700	PN 16	20 × M 27	330
750	PN 16	20 × M 30	529
800	PN 16	20 × M 33	631
900	PN 16	24 × M 33	627
1000	PN 16	24 × M 33	595
1200	PN 16	32 × M 33	703
* Designed acc. to AS 2129 (not to AS 4087)			

3.3.6 Turning the transmitter housing

Turning the aluminum field housing

Warning!
The rotating mechanism in devices with Ex d/de or FM/CSA Cl. I Div. 1 approval is different to that described here. The relevant procedure is described in the Ex-specific documentation.

1. Loosen the two securing screws.
2. Turn the bayonet catch as far as it will go.
3. Carefully lift the transmitter housing as far as it will go.
4. Turn the transmitter housing to the desired position (max. 2 × 90° in either direction).
5. Lower the housing into position and reengage the bayonet catch.
6. Retighten the two securing screws.

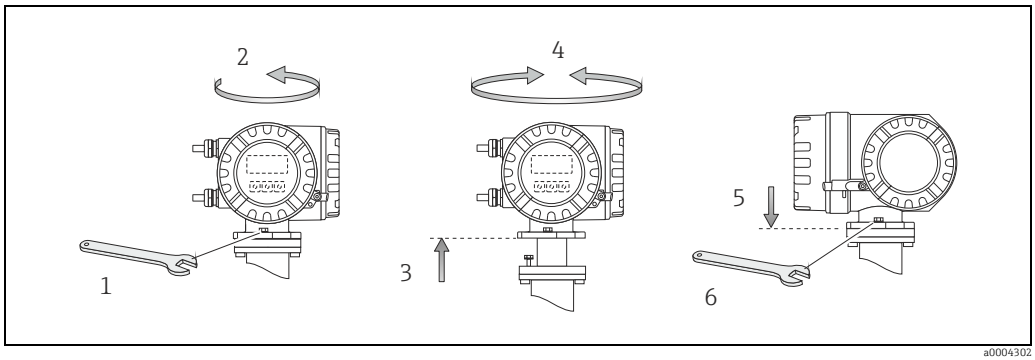


Fig. 24: Turning the transmitter housing (aluminum field housing)

Turning the stainless steel field housing

a. Loosen the two securing screws.
b. Carefully lift the transmitter housing as far as it will go.
c. Turn the transmitter housing to the desired position (max. 2 × 90° in either direction).
d. Lower the housing into position once more.
e. Retighten the two securing screws.

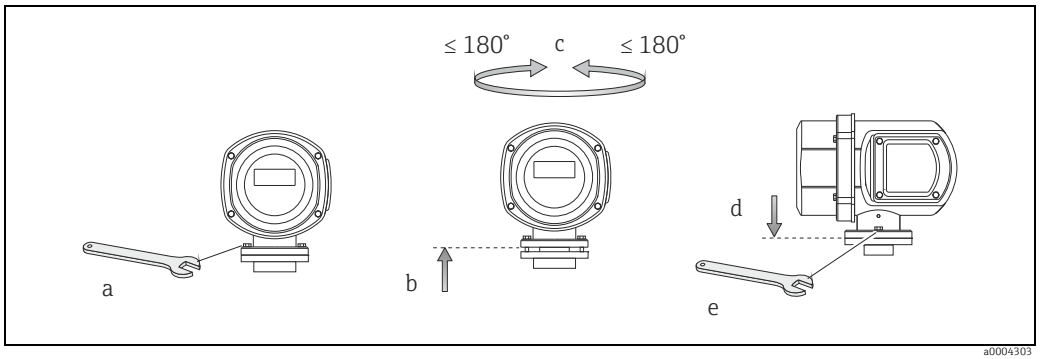


Fig. 25: Turning the transmitter housing (stainless steel field housing)

3.3.7 Turning the local display

1. Unscrew the electronics compartment cover from the transmitter housing.
2. Press the latches on the side of the display module and pull the module out of the electronics compartment cover.
3. Turn the display to the desired position (max. 4 × 45° in both directions) and position it back on the electronics compartment cover.
4. Screw the cover of the electronics compartment firmly onto the transmitter housing.

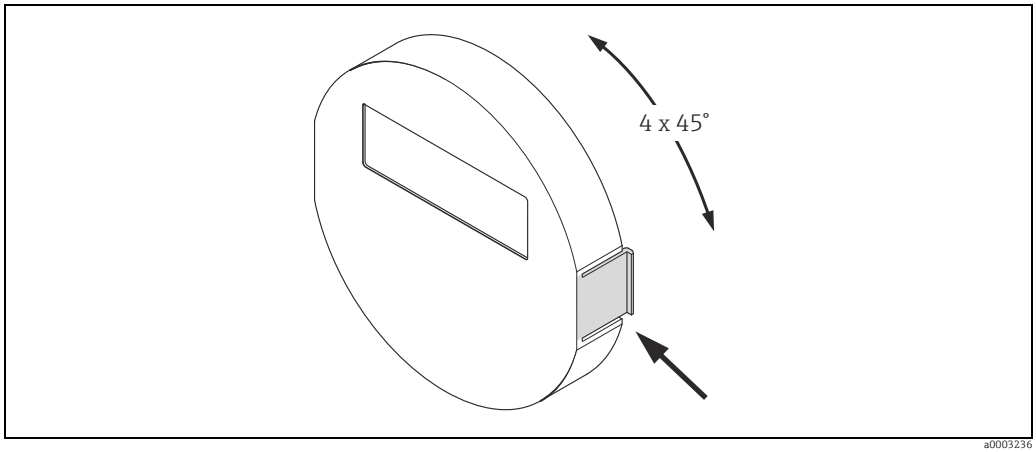


Fig. 26: Turning the local display (field housing)

3.3.8 Installing the wall-mount housing

There are various ways of installing the wall-mount housing:

- Mounted directly on the wall
- Panel mounting (with separate mounting kit, accessories) → 🖹 46
- Pipe mounting (with separate mounting kit, accessories) → 🖹 46

Caution!

- Make sure that the permitted ambient temperature range is observed (see nameplate or → 🖹 127). Install the device in a shady location. Avoid direct sunlight.
- Always install the wall-mount housing in such a way that the cable entries are pointing down.

Mounted directly on the wall

1. Drill the holes as illustrated.
2. Remove the cover of the connection compartment (a).
3. Push the two securing screws (b) through the appropriate bores (c) in the housing.
   – Securing screws (M6): max. Ø 6.5 mm (0.26")
   – Screw head: max. Ø 10.5 mm (0.4")
4. Secure the transmitter housing to the wall as indicated.
5. Screw the cover of the connection compartment (a) firmly onto the housing.

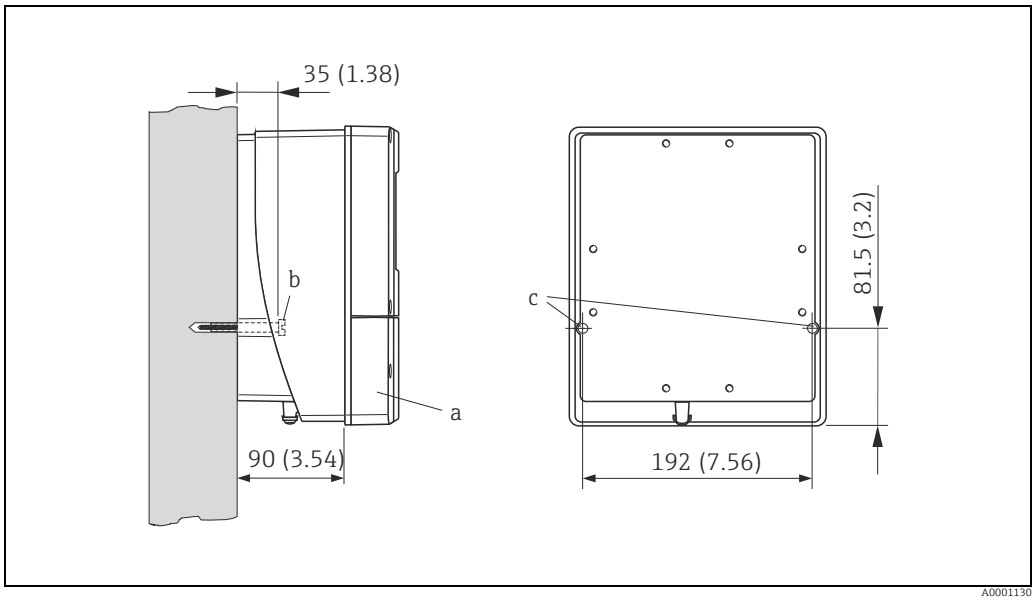


Fig. 27: Mounted directly on the wall. Engineering unit mm (in)

Panel mounting

1. Prepare the opening in the panel as illustrated.
2. Slide the housing into the opening in the panel from the front.
3. Screw the fasteners onto the wall-mount housing.
4. Place the threaded rods in the fasteners and screw them down until the housing is seated tightly against the panel wall. Afterwards, tighten the locking nuts. Additional support is not necessary.

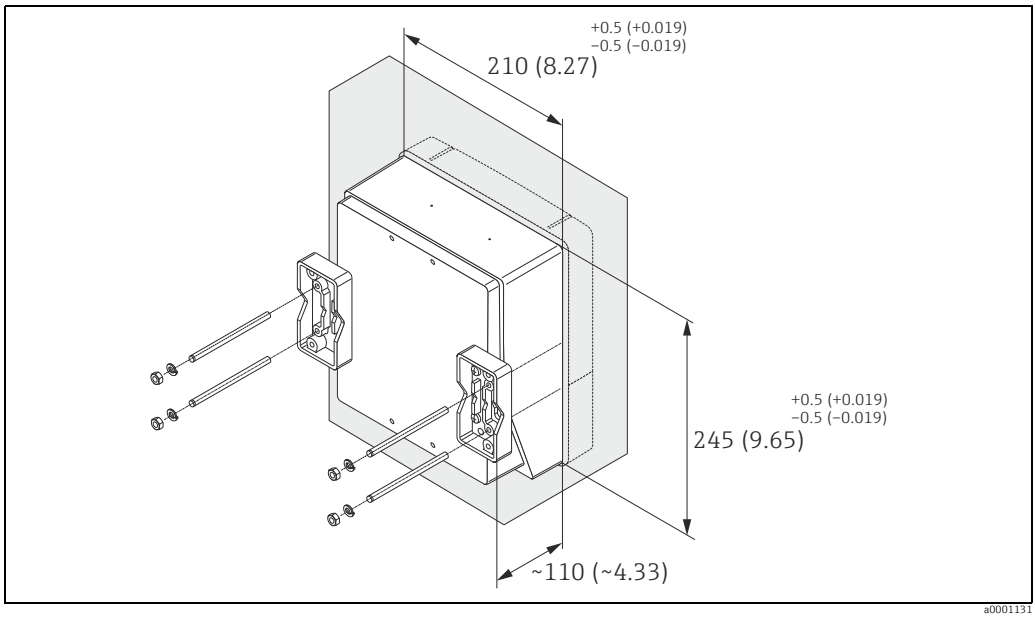


Fig. 28: Panel mounting (wall-mount housing). Engineering unit mm (in)

Pipe mounting

The assembly should be performed by following the instructions in the following diagram.

Caution!
If the device is mounted to a warm pipe, make sure that the housing temperature does not exceed +60 °C (+140 °F), which is the maximum permissible temperature.

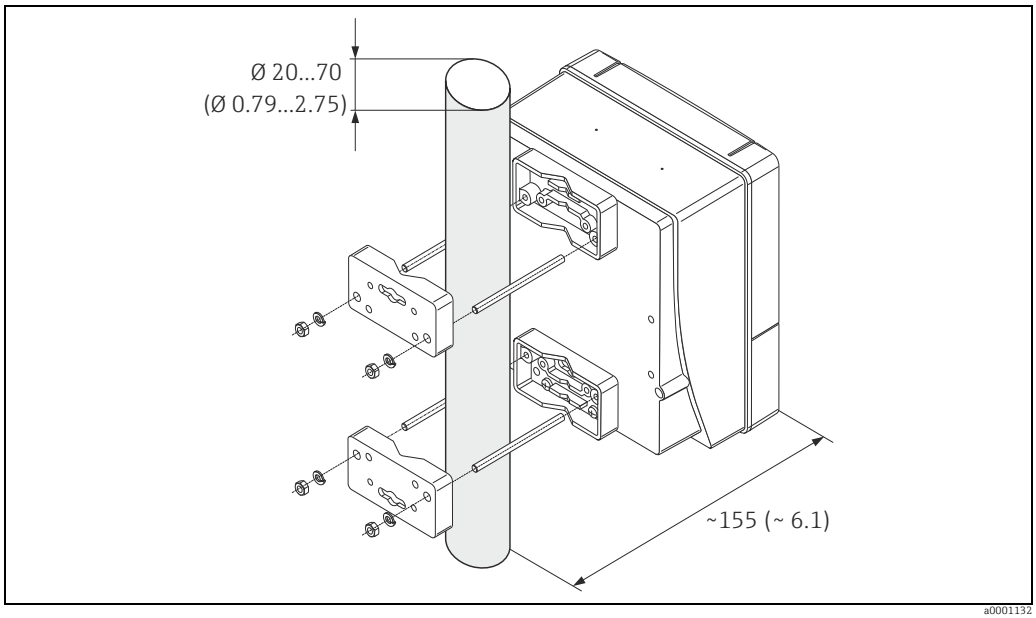


Fig. 29: Pipe mounting (wall-mount housing). Engineering unit mm (in)

3.4 Post-installation check

Perform the following checks after installing the measuring device in the pipe:

Device condition/specifications	Notes
Is the device damaged (visual inspection)?	–
Does the device correspond to specifications at the measuring point, including process temperature and pressure, ambient temperature, minimum fluid conductivity, measuring range, etc.?	→ 🖹 124
Installation	**Notes**
Does the arrow on the sensor nameplate match the direction of flow through the pipe?	–
Is the position of the measuring electrode plane correct?	→ 🖹 14
Is the position of the empty pipe detection electrode correct?	→ 🖹 14
Were all screws tightened to the specified tightening torques when the sensor was installed?	→ 🖹 20
Were the correct seals installed (type, material, installation)?	→ 🖹 36
Are the measuring point number and labeling correct (visual inspection)?	–
Process environment / process conditions	**Notes**
Are the inlet and outlet runs respected?	Inlet run ≥ 5 × DN Outlet run ≥ 2 × DN
Is the measuring device protected against moisture and direct sunlight?	–
Is the sensor adequately protected against vibration (attachment, support)?	Acceleration up to 2 g in accordance with IEC 600 68-2-6 → 🖹 127

4 Wiring

Warning!
When connecting Ex-certified devices, please take note of the instructions and wiring diagrams in the Ex-specific supplement to these Operating Instructions. Should you have any questions, please contact your Endress+Hauser sales office for assistance.

Note!
The device does not have an internal circuit breaker. An external switch or circuit breaker must therefore be installed which can be used to disconnect the device from the main power source.

4.1 Cable specification Modbus RS485

4.1.1 Cable type

In the EIA/TIA-485 standard, two versions (cable type A and B) are specified for the bus line and can be used for all transmission rates. However, we recommend you use cable type A. The cable specification for cable type A are provided in the following table:

Cable type A	
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m
Core cross-section	> 0.34 mm², corresponds to AWG 22
Cable type	Twisted pairs
Loop-resistance	≤ 110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shielding	Copper braided shielding or braided shielding and foil shielding

Note the following points for the bus structure:
- All the measuring devices are connected in a bus structure (line).
- Using cable type A and with a transmission rate of 115200 Baud, the maximum line length (segment length) of the Modbus RS485 system is 1200 m. The total length of the spurs may not exceed a maximum of 6.6 m here.
- A maximum of 32 users are permitted per segment.
- Each segment is terminated at either end with a terminating resistor.
- The bus length or the number of users can be increased by introducing a repeater.

4.1.2 Shielding and grounding

When planning the shielding and grounding for a fieldbus system, there are three important points to consider:

- Electromagnetic compatibility (EMC)
- Explosion protection
- Safety of the personnel

To ensure the optimum electromagnetic compatibility of systems, it is important that the system components and above all the cables, which connect the components, are shielded and that no portion of the system is unshielded. Ideally, the cable shields are connected to the normally metal housings of the connected field devices. Since these are generally connected to the protective earth, the shield of the bus cable is grounded many times. Keep the stripped and twisted lengths of cable shield to the terminals as short as possible.
This approach, which provides the best electromagnetic compatibility and personnel safety, can be used without restriction in systems with good potential matching.
In the case of systems without potential matching, a power supply frequency (50 Hz) equalizing current can flow between two grounding points which, in unfavorable cases, e.g. when it exceeds the permissible shield current, may destroy the cable.
To suppress the low frequency equalizing currents on systems without potential matching, it is therefore recommended to connect the cable shield directly to the building ground (or protective earth) at one end only and to use capacitive coupling to connect all other grounding points.

Caution!
The legal EMC requirements are fulfilled **only** when the cable shield is grounded on both sides!

4.2 Connecting the remote version

4.2.1 Connecting the sensor

Warning!
- Risk of electric shock! Switch off the power supply before opening the device. Do **not** install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock! Connect the protective conductor to the ground terminal on the housing before the power supply is applied.

Caution!
- Only sensors and transmitters with the same serial number can be connected to one another. Communication problems can occur if the devices are not connected in this way.
- Risk of damaging the coil driver. Always switch off the power supply before connecting or disconnecting the coil current cable.

Procedure

1. Transmitter: Remove the cover from the connection compartment (a).
2. Sensor: Remove the cover from the connection housing (b).
3. Feed the electrode cable (c) and the coil current cable (d) through the appropriate cable entries.

   Caution!
   Route the connecting cables securely (see "Connecting cable length" → 19).
4. Terminate the signal and coil current cable as indicated in the table:
   Promag E/L/P/W → Refer to the table → 52
   Promag H → Refer to the "Cable termination" table → 53
5. Establish the wiring between the sensor and the transmitter.
   The electrical wiring diagram that applies to your device can be found:
   – In the corresponding graphic:
     → 30 (Promag E/L/P/W); → 31 (Promag H)
   – In the cover of the sensor and transmitter

   Note!
   The cable shields of the Promag H sensor are grounded by means of the strain relief terminals (see also the "Cable termination" table → 53).

   Caution!
   Insulate the shields of cables that are not connected to eliminate the risk of short-circuits with neighbouring cable shields inside the connection housing.
6. Transmitter: Screw the cover on the connection compartment (a).
7. Sensor: Secure the cover on the connection housing (b).

Promag E/L/P/W

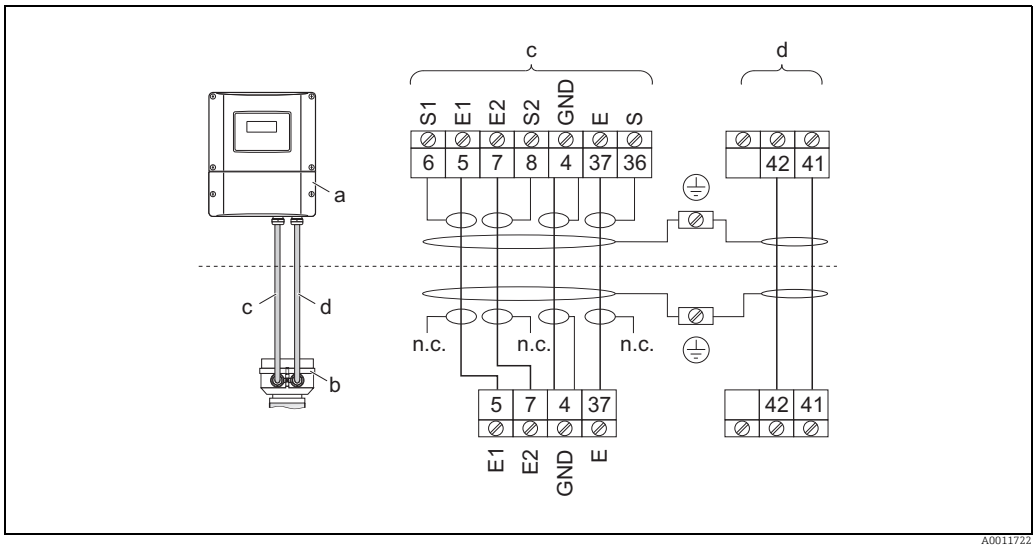


Fig. 30: Connecting the remote version of Promag E/L/P/W

a Wall-mount housing connection compartment
b Cover of the sensor connection housing
c Electrode cable
d Coil current cable
n.c. Not connected, insulated cable shields

Wire colors/Terminal No.:
5/6 = brown, 7/8 = white, 4 = green, 37/36 = yellow

Promag H

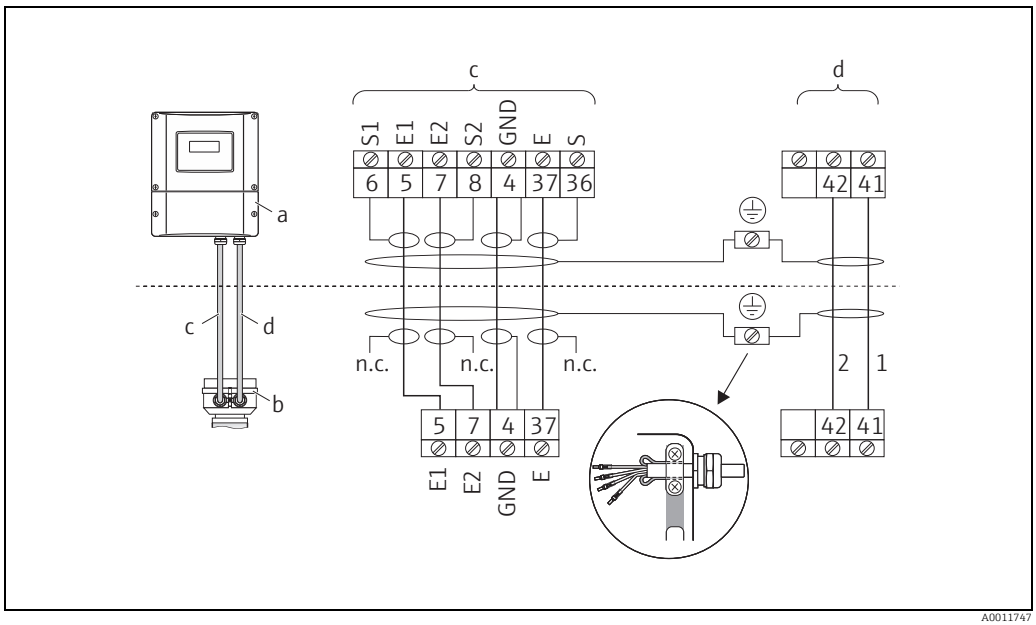


Fig. 31: Connecting the remote version of Promag H

a Wall-mount housing connection compartment
b Cover of the sensor connection housing
c Electrode cable
d Coil current cable
n.c. Not connected, insulated cable shields

Wire colors/Terminal No.:
5/6 = brown, 7/8 = white, 4 = green, 37/36 = yellow

Cable termination in remote version
Promag E/L/P/W

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Fit the fine-wire cores with wire end ferrules (detail B: ① = red ferrules, Ø 1.0 mm; ② = white ferrules, Ø 0.5 mm)
* Stripping for reinforced cables only

Caution!
When fitting the connectors, pay attention to the following points:
- *Electrode cable* → Make sure that the wire end ferrules do not touch the wire shields on the sensor side! Minimum distance = 1 mm (exception "GND" = green cable)
- *Coil current cable* → Insulate one core of the three-core wire at the level of the core reinforcement; you only require two cores for the connection.

TRANSMITTER

Electrode cable

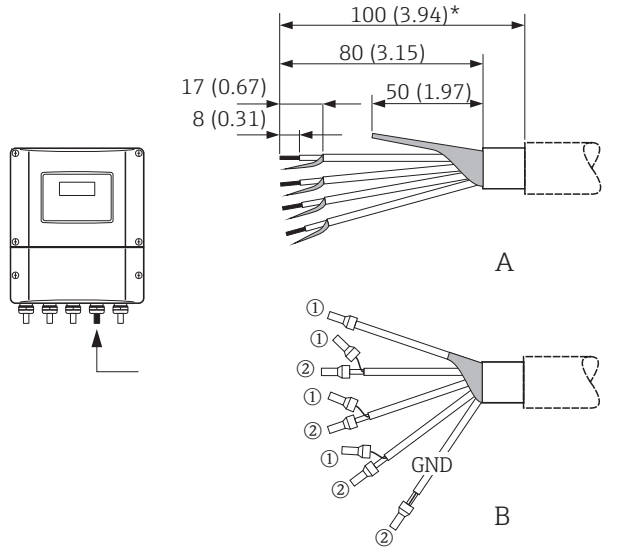


Fig. 32: Engineering unit mm (in)

Coil current cable

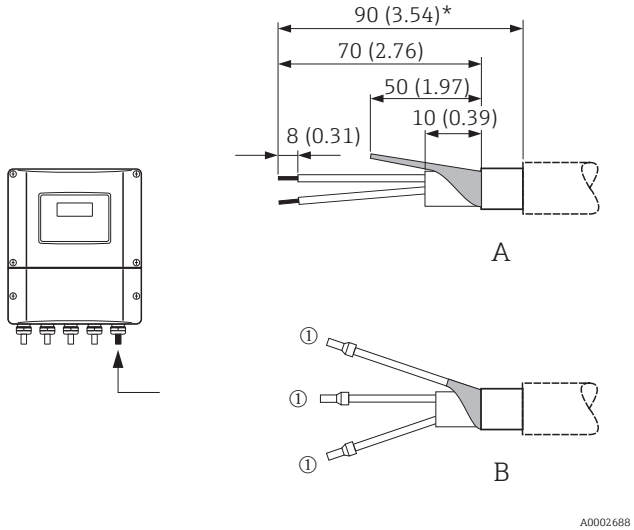


Fig. 33: Engineering unit mm (in)

SENSOR

Electrode cable

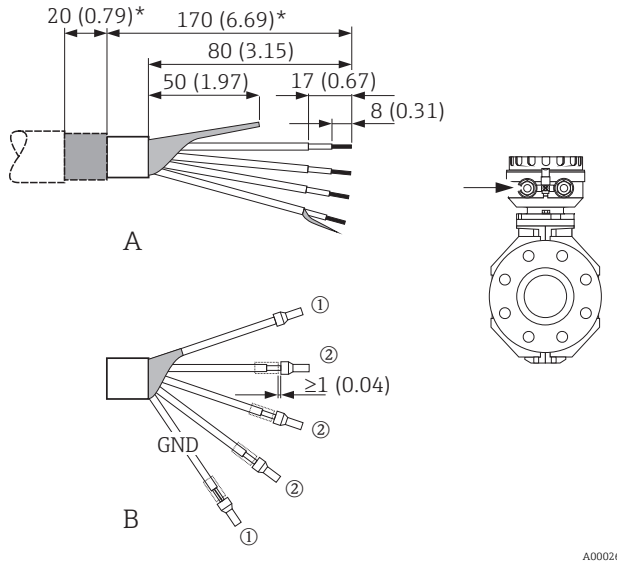


Fig. 34: Engineering unit mm (in)

Coil current cable

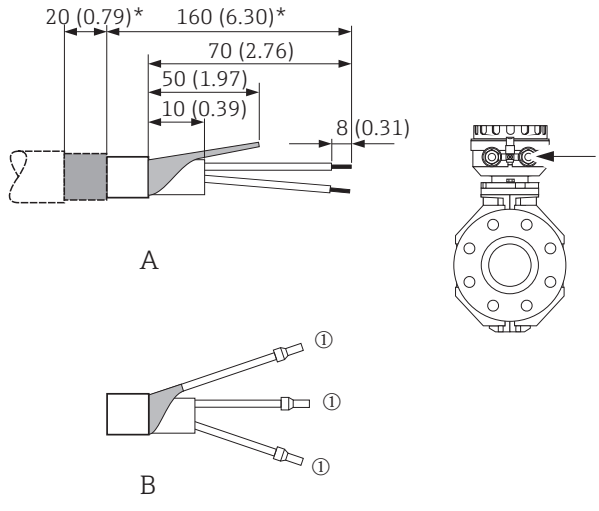


Fig. 35: Engineering unit mm (in)

Cable termination in remote version
Promag H

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Fit the fine-wire cores with wire end ferrules (detail B: ① = ferrules red, Ø 1.0 mm; ② = ferrule white, Ø 0.5 mm)

Caution!
When fitting the connectors, pay attention to the following points:
- *Electrode cable* → Make sure that the wire end ferrules do not touch the wire shields on the sensor side! Minimum distance = 1 mm (exception "GND" = green cable)
- *Coil current cable* → Insulate one core of the three-core wire at the level of the core reinforcement; you only require two cores for the connection.
- On the sensor side, reverse both cable shields approx. 15 mm over the outer jacket. The strain relief ensures an electrical connection with the connection housing.

TRANSMITTER

Electrode cable

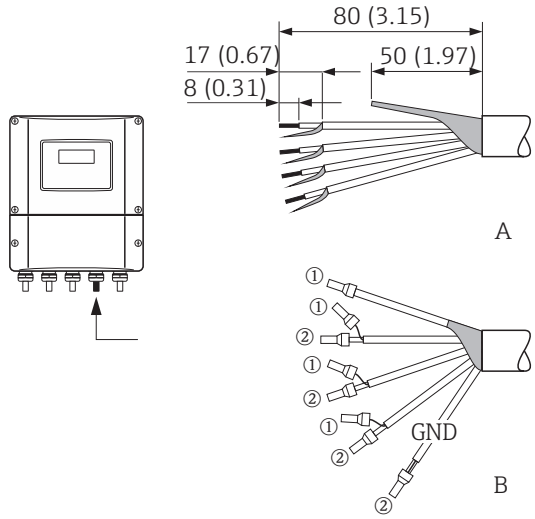


Fig. 36: Engineering unit mm (in)

Coil current cable

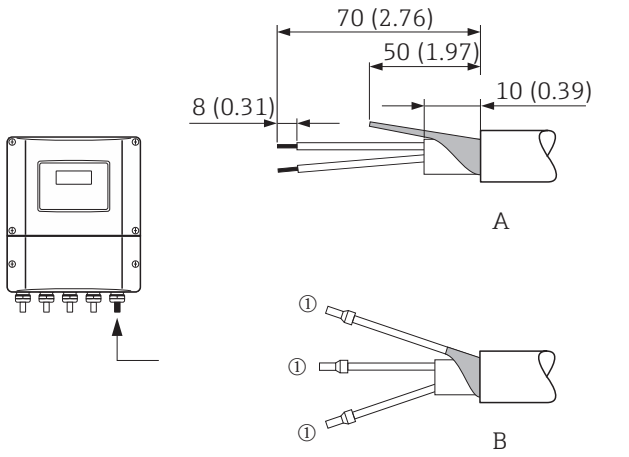


Fig. 37: Engineering unit mm (in)

SENSOR

Electrode cable

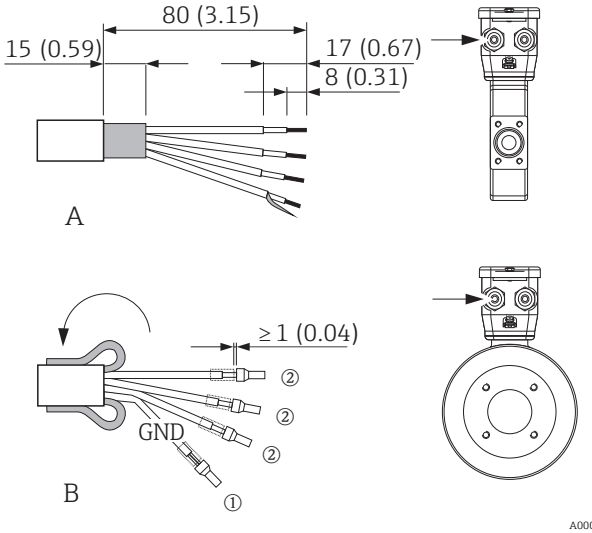


Fig. 38: Engineering unit mm (in)

Coil current cable

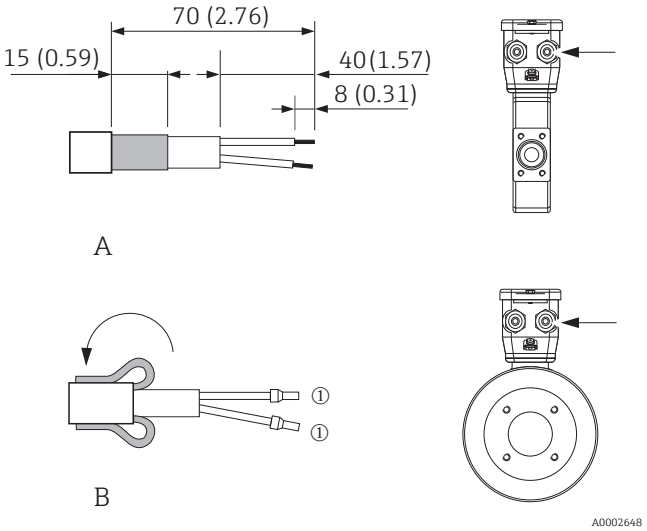


Fig. 39: Engineering unit mm (in)

4.2.2 Cable specifications

Electrode cable

- 3 × 0.38 mm² PVC cable with common, braided copper shield (Ø ~ 9.5 mm/ 0.37")) and individually shielded cores
- With Empty Pipe Detection (EPD): 4 × 0.38 mm² PVC cable with common, braided copper shield (Ø ~ 9.5 mm/ 0.37") and individually shielded cores
- Conductor resistance: ≤ 50 Ω/km
- Capacitance: core/shield: ≤ 420 pF/m
- Operating temperature: –20 to +80 °C
- Conductor cross-section: max. 2.5 mm²

Coil current cable

- 3 × 0.75 mm² PVC cable with common, braided copper shield (Ø ~ 9 mm/ 0.35")
- Conductor resistance: ≤ 37 Ω/km
- Capacitance: core/core, shield grounded: ≤ 120 pF/m
- Operating temperature: –20 to +80 °C
- Conductor cross-section: max. 2.5 mm²
- Test current for cable insulation: ≥ 1433 V AC rms 50/60 Hz or ≥ 2026 V DC

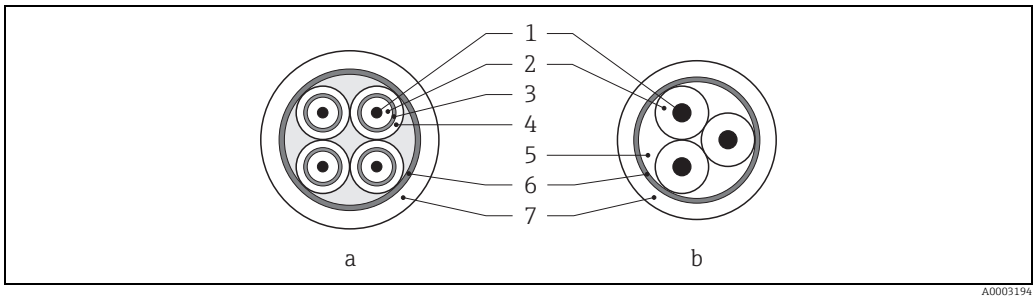


Fig. 40: Cable cross-section

a Electrode cable
b Coil current cable

1 = Core, 2 = Core insulation, 3 = Core shield, 4 = Core jacket, 5 = Core reinforcement, 6 = Cable shield, 7 = Outer jacket

Reinforced connecting cables

As an option, Endress+Hauser can also deliver reinforced connecting cables with an additional, reinforcing metal braid.

We recommend such cables for the following cases:
- Directly buried cable
- Cables endangered by rodents
- Device operation which should comply with the IP 68 (NEMA 6P) standard of protection

Operation in zones of severe electrical interference

The measuring device complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of IEC/EN 61326.

Caution!
Grounding is by means of the ground terminals provided for the purpose inside the connection housing. Keep the stripped and twisted lengths of cable shield to the terminals as short as possible.

4.3 Connecting the measuring unit

4.3.1 Transmitter connection

Warning!
- Risk of electric shock. Switch off the power supply before opening the device. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock. Connect the protective earth to the ground terminal on the housing before the power supply is applied (not required for galvanically isolated power supply).
- Compare the specifications on the nameplate with the local supply voltage and frequency. The national regulations governing the installation of electrical equipment also apply.

1. Unscrew the connection compartment cover (a) from the transmitter housing.
2. Feed the power supply cable (b), the electrode cable (d) and the fieldbus cable (e) through the appropriate cable entries.
3. Perform wiring in accordance with the respective terminal assignment and the associated wiring diagram.

   Caution!
   – Risk of damage to the fieldbus cable!
   Observe the information about shielding and grounding the fieldbus cable → 49.
   – We recommend that the fieldbus cable not be looped using conventional cable glands. If you later replace even just one measuring device, the bus communication will have to be interrupted.
4. Screw the cover of the connection compartment (a) back onto the transmitter housing.

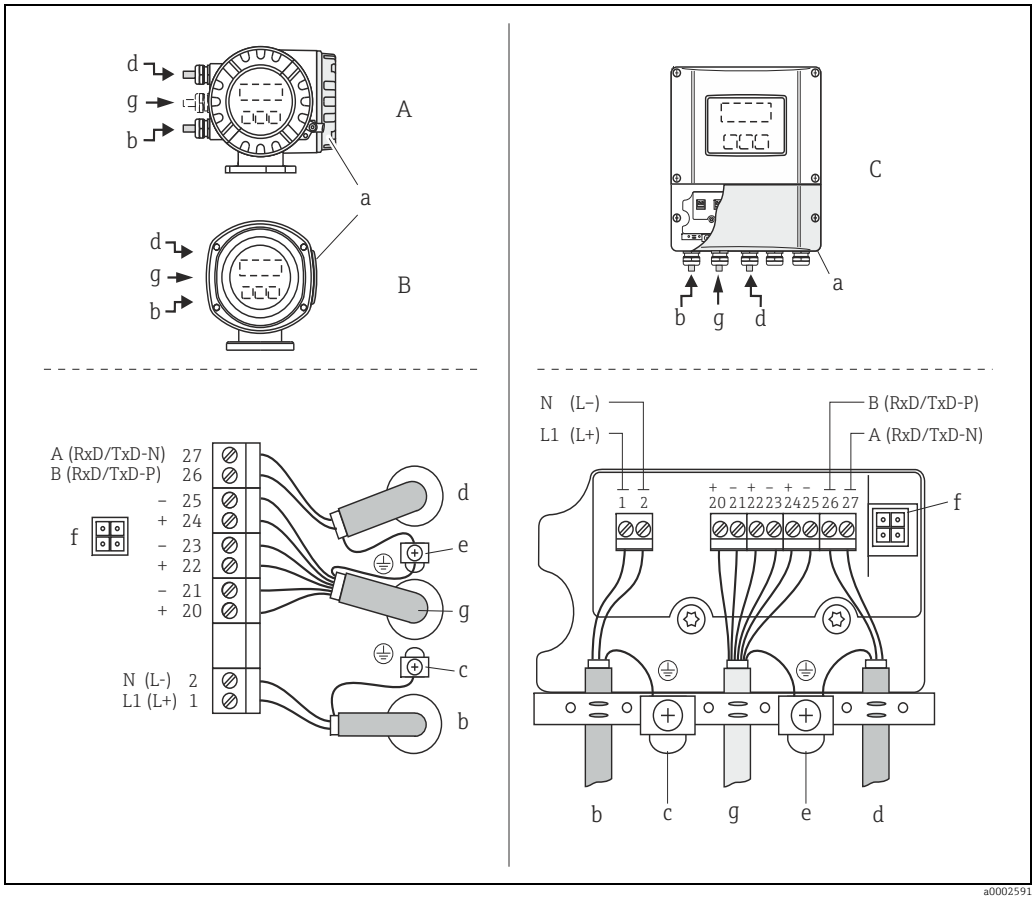


Fig. 41: Connecting the transmitter, Cable cross-section: max. 2.5 mm²

A View A (field housing)
B View B (stainless steel field housing)
C View C (wall-mount housing)

a Cover of the connection compartment
b Cable for power supply: 85 to 260 V AC, 20 to 55 V AC,16 to 62 V DC
Terminal No. 1: L1 for AC, L+ for DC
Terminal No. 2: N for AC, L- for DC
c Ground terminal for protective conductor
d Fieldbus cable
Terminal No. 26: B (RxD/TxD-P)
Terminal No. 27: A (RxD/TxD-N)
e Ground terminal for electrode cable shield/fieldbus cable shield
Observe the following:
– the shielding and grounding of the fieldbus cable → 49
– that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible
f Service adapter for connecting service interface FXA 193 (Fieldcheck, FieldCare)
g Electrode cable: see Terminal assignment → 56

4.3.2 Terminal assignment

Caution!
Only certain combinations of submodules (see Table) on the I/O board are permissible. The individual slots are marked and assigned to the following terminals in the connection compartment of the transmitter:
- "INPUT / OUTPUT 3" slot = terminals 22/23
- "INPUT / OUTPUT 4" slot = terminals 20/21

Order code for "Input / Output"	Terminal No.			
	20 (+) / 21 (-) Submodule on slot No. 4	22 (+) / 23 (-) Submodule on slot No. 3	24 (+) / 25 (-) Fixed on I/O board	26 = B (RxD/TxD-P) 27 = A (RxD/TxD-N) Fixed on I/O board
Q	-	-	Status input	Modbus RS485
7	Relay output 2	Relay output 1	Status input	Modbus RS485
N	Current output	Frequency output	Status input	Modbus RS485

Note!
The electrical values of the inputs and outputs can be found in the "Technical data" section.

4.4 Potential equalization

Warning!
The measuring system must be included in potential equalization.

Perfect measurement is only ensured when the medium and the sensor have the same electrical potential. Most Promag sensors have a reference electrode installed as standard, which guarantees the required potential equalization.

The following must also be taken into account for potential equalization:
- Company-internal grounding guidelines
- Operating conditions such as material/grounding of piping etc. (see table)

4.4.1 Potential equalization, Promag E/L/P/W

Reference electrode available as standard

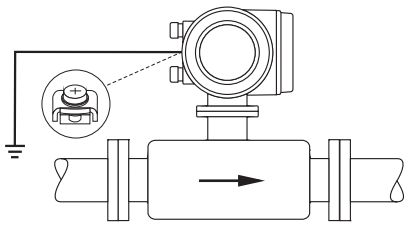
4.4.2 Potential equalization, Promag H

No reference electrode available!
There is always one electrical connection to the fluid via the metallic process connection.

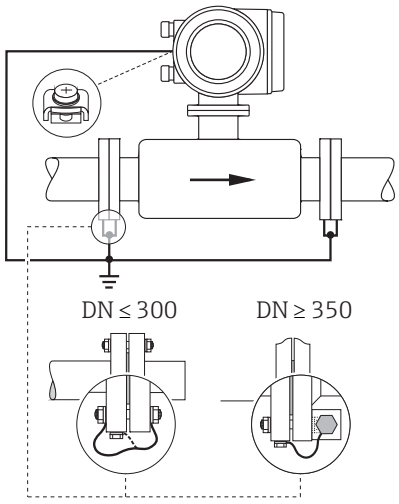
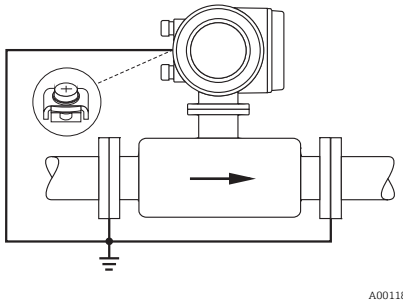
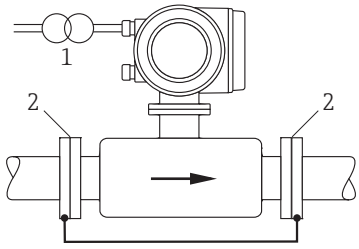
Caution!
When using process connections made of plastic, potential equalization must be guaranteed through the use of grounding rings → 24.
The necessary grounding rings may be ordered separately as an accessory from Endress+Hauser (→ 102).

4.4.3 Connection examples for potential equalization

Standard case

Operating conditions	Potential equalization
When using the measuring device in: ▪ Metallic, grounded piping Potential equalization is carried out via the ground terminal of the transmitter. Note! For installation in metal pipes, it is advisable to connect the ground terminal of the transmitter housing to the piping.	 A0011892 *Fig. 42: Via the transmitter's ground terminal*

Special cases

Operating conditions	Potential equalization
When using the measuring device in: ▪ Metallic, ungrounded piping This type of connection occurs when: ▪ The usual potential equalization cannot be guaranteed ▪ Extremely high equalizing currents are expected A ground cable (copper wire, at least 6 mm² (0.0093 in²)) is used to connect both sensor flanges to the respective pipe flange and ground them. Connect the transmitter or sensor connection housing, as applicable, to ground potential by means of the ground terminal provided for the purpose. The installation of the ground cable depends on the nominal diameter: ▪ DN ≤ 300 (12"): The ground cable is in direct connection with the conductive flange coating and is secured by the flange screws. ▪ DN ≥ 350 (14"): The ground cable connects directly to the metal transport bracket. Note! The ground cable for flange-to-flange connections can be ordered separately as an accessory from Endress+Hauser.	 *Fig. 43: Via the transmitter's ground terminal and the pipe flanges*
When using the measuring device in: ▪ Plastic pipes ▪ Isolating lined pipes This type of connection occurs when: ▪ The usual potential equalization cannot be guaranteed ▪ Extremely high equalizing currents are expected Potential equalization takes place using additional ground disks, which are connected to the ground terminal via a ground cable (copper wire, min. 6 mm² (0.0093 in²)). When installing the ground disks, please comply with the enclosed Installation Instructions.	 *Fig. 44: Via the transmitter's ground terminal and the optionally available ground disks*
When using the measuring device in: ▪ Pipes with cathodic protection The device is installed in the pipeline in such a way that it is potential-free. Using a ground cable (copper wire, min. 6 mm² (0.0093 in²)), only the two pipe flanges are connected. When doing so, the ground cable is mounted directly on the conductive flange coating using flange screws. Please note the following during installation: ▪ The relevant regulations for potential-free installations must be observed. ▪ There must not be an electrically conductive connection between the piping and the device. ▪ The mounting material must be able to withstand the relevant torques.	 *Fig. 45: Potential equalization and cathodic protection* *1 Isolation transformer power supply* *2 Electrically isolated*

4.5 Degree of protection

The devices fulfill all the requirements for IP 67 (NEMA 4X).

Compliance with the following points is mandatory following installation in the field or servicing, in order to ensure that IP 67 protection (NEMA 4X) is maintained:
- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- All housing screws and screw covers must be firmly tightened.
- The cables used for connection must be of the specified external diameter → 126.
- Tighten cable glands to prevent leakages.
- The cables must loop down before they enter the cable entries ("water trap"). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Close off unused cable entries using suitable insert plugs.
- Do not remove the grommet from the cable entry.

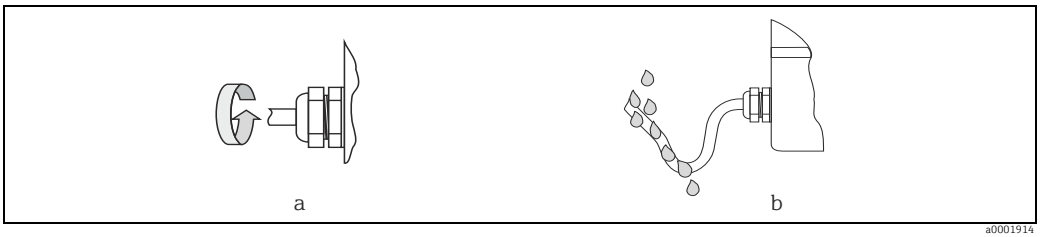


Fig. 46: Installation instructions, cable entries

Caution!
Do not loosen the screws of the sensor housing as otherwise the degree of protection guaranteed by Endress+Hauser no longer applies.

Note!
- The sensor can be supplied with IP 68 rating (permanent immersion in water to a depth of 3 meters (10 ft)). In this case the transmitter must be installed remote from the sensor.

4.6 Post-connection check

Perform the following checks after electrical installation of the measuring device:

Device condition and specifications	Notes
Are cables or the device damaged (visual inspection)?	–
Terminal assignment	**Notes**
Does the supply voltage match the specifications on the nameplate?	85 to 260 V AC (45 to 65 Hz) 20 to 55 V AC (45 to 65 Hz) 16 to 62 V DC
Do the cables comply with the specifications?	→ 🖹 54
Do the cables have adequate strain relief?	–
Cables correctly segregated by type? Without loops and crossovers?	–
Are the power-supply and electrode cables correctly connected?	See the wiring diagram inside the cover of the connection compartment
Are all screw terminals firmly tightened?	–
Have the measures for grounding/potential matching been correctly implemented?	→ 🖹 57
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ 🖹 59
Are all housing covers installed and firmly tightened?	–
Fieldbus terminal assignment	**Notes**
Has each fieldbus segment been terminated at both ends with a bus terminator?	→ 🖹 84
Has the max. length of the fieldbus cable been observed in accordance with the specifications?	→ 🖹 48
Has the max. length of the spurs been observed in accordance with the specifications?	→ 🖹 48
Is the fieldbus cable fully shielded and correctly grounded?	→ 🖹 49

5 Operation

5.1 Quick operation guide

You have a number of options for configuring and commissioning the device:

1. **Local display (option)** → 62
   The local display enables you to read all important variables directly at the measuring point, configure bus-specific and device-specific parameters in the field and perform commissioning.
2. **Configuration programs** → 81
   Operation via FieldCare.
   The Proline flowmeters are accessed via the service interface or via the service interface FXA 193.
3. **Jumpers/miniature switches for hardware settings** → 82
   You can make the following hardware settings using a jumper or miniature switches on the I/O board:
   – Address mode configuration (select software or hardware addressing)
   – Device bus address configuration (for hardware addressing)
   – Hardware write protection enabling/disabling

Note!
A description of the configuration of the current output (active/passive) and the relay output (NC contact/NO contact) can be found in the "Hardware settings" section → 82.

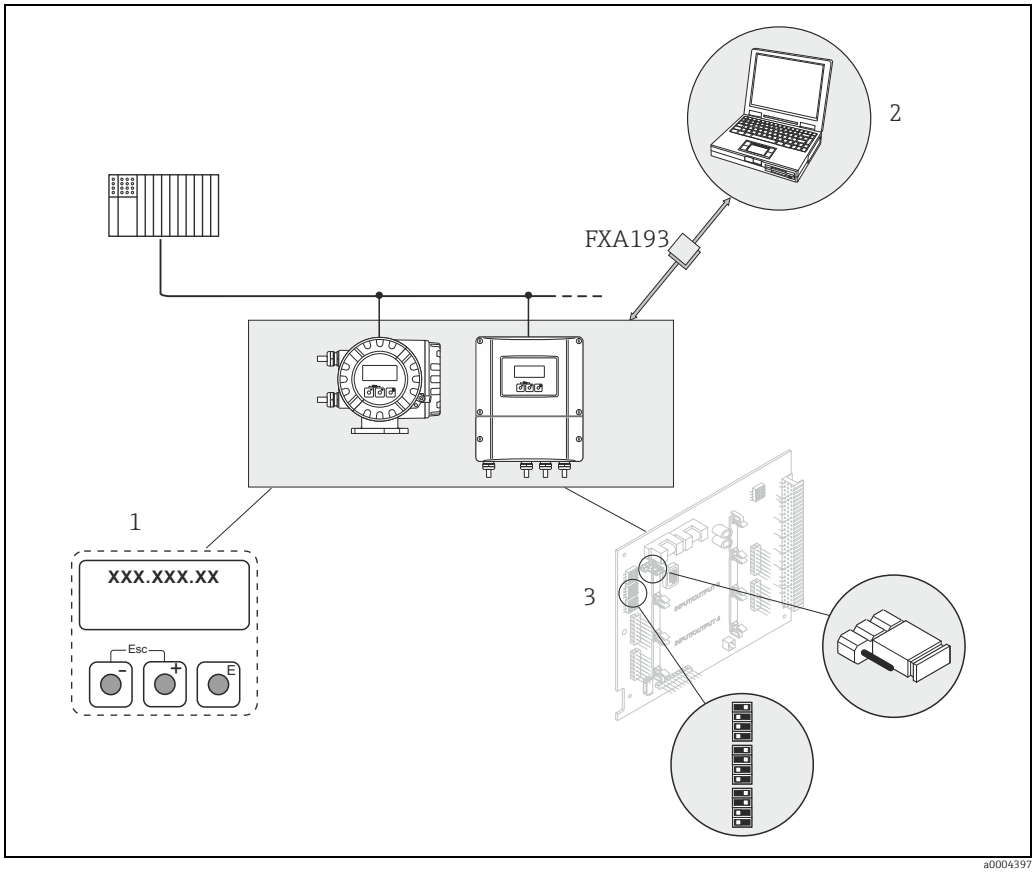


Fig. 47: Methods of operating Modbus RS485 devices

1 Local display for device operation in the field (option)
2 Configuration/operating program for operating via the service interface FXA 193 (e.g. FieldCare)
3 Jumper/miniature switches for hardware settings (write protection, device address, address mode)

5.2 Local display

5.2.1 Display and operating elements

The local display enables you to read important parameters directly at the measuring point or to configure your device using the "Quick Setup" or the function matrix.
The display consists of four lines; this is where measured values and/or status variables (direction of flow, empty pipe, bar graph, etc.) are displayed. You can change the assignment of display lines to variables at will in order to customize the display to suit your needs and preferences (→ see the "Description of Device Functions" manual).

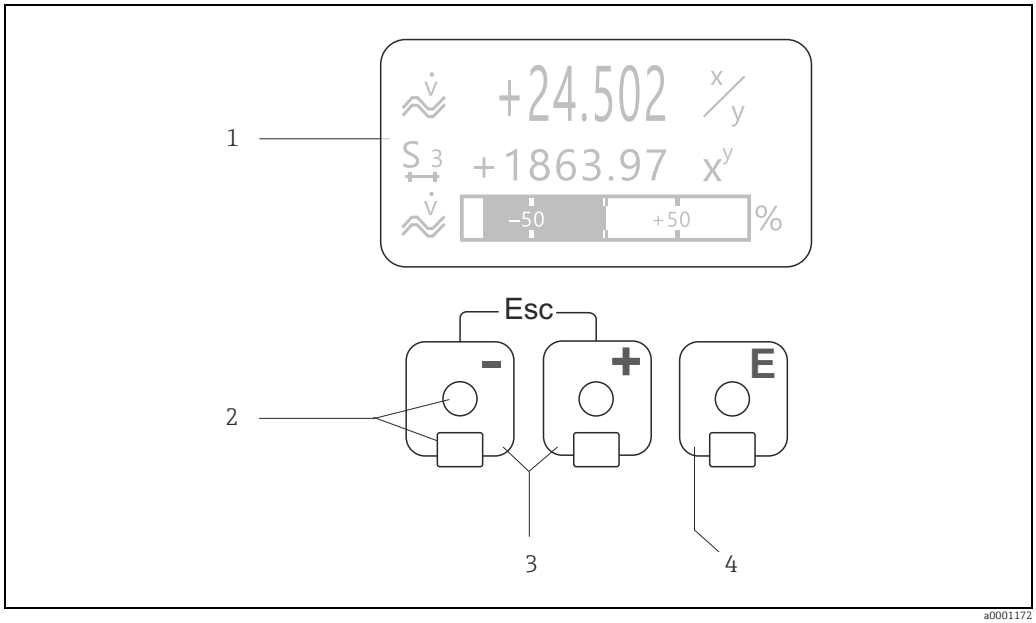


Fig. 48: Display and operating elements

1 Liquid crystal display
The backlit, four-line liquid crystal display shows measured values, dialog texts, fault messages and notice messages. The display as it appears when normal measuring is in progress is known as the HOME position (operating mode display).
2 Optical sensors for Touch Control
3 ⊞/⊟ keys
- *HOME position → Direct access to totalizer values and actual values of inputs/outputs*
- *Enter numerical values, select parameters*
- *Select different blocks, groups and function groups within the function matrix*

Press the ⊟/⊞ keys simultaneously to trigger the following functions:
- *Exit the function matrix step by step → HOME position*
- *Press and hold down the ⊟/⊞ keys for longer than 3 seconds → Return directly to the HOME position*
- *Cancel data entry*

4 Ⓔ key (Enter key)
- *HOME position → Entry into the function matrix*
- *Save the numerical values you input or settings you change*

5.2.2 Display (operating mode)

The display area consists of three lines in all; this is where measured values are displayed, and/or status variables (direction of flow, bar graph, etc.). You can change the assignment of display lines to variables at will in order to customize the display to suit your needs and preferences (→ see the "Description of Device Functions" manual).

Multiplex mode:
A maximum of two different display variables can be assigned to each line. Variables multiplexed in this way alternate every 10 seconds on the display.

Error messages:
Display and presentation of system/process errors → 68.

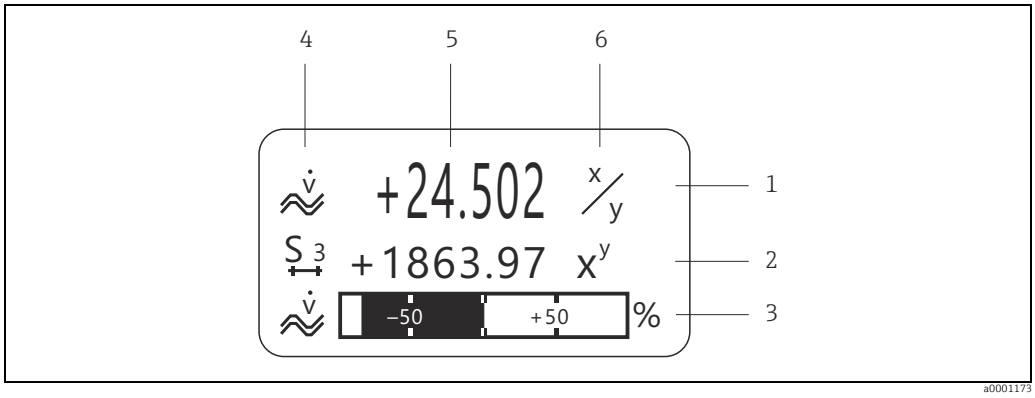


Fig. 49: Typical display for normal operating mode (HOME position)

1 Main line shows main measured values, e.g. flow
2 Supplementary line shows supplementary measured or status variables, e.g. totalizer reading.
3 Information line shows additional information on measured or status variables, e.g. bar graph representation of the full scale value attained by the flow rate
4 "Info icons" field shows additional information in the form of icons on the measured values displayed. A complete overview of all icons and their meaning can be found on → 64
5 "Measured values" field shows the current measured values
6 "Engineering unit" field shows the engineering units and time units defined for the current measured values.

5.2.3 Additional display functions

Depending on the order option (F-CHIP → 100), the local display has different display functions.

Device without batching software

From HOME position, use the ⊞⊟ keys to open an "Info Menu" containing the following information:
- Totalizer (including overflow)
- Actual values or states of the configured inputs/outputs
- Device TAG number (user-definable)

⊞⊟ → Scan of individual values within the Info Menu
(Esc key) → Back to HOME position

Device with batching software

On measuring instruments with installed batching software (F-Chip → 100) and a suitably configured display line, you can carry out filling processes directly using the local display.
You will find a detailed description on → 65.

5.2.4 Icons

The icons which appear in the field on the left make it easier to read and recognize measured variables, device status, and error messages.

Icon	Meaning	Icon	Meaning
S	System error	P	Process error
ϟ	Fault message (with effect on outputs)	!	Notice message (without effect on outputs)
| 1 to n	Current output 1 to n	P 1 to n	Pulse output 1 to n
F 1 to n	Frequency output 1 to n	S 1 to n	Status/relay output 1 to n (or status input)
Σ 1 to n	Totalizer 1 to n		
 a0001181	Measuring mode: PULSATING FLOW	 a0001182	Measuring mode: SYMMETRY (bidirectional)
 a0001183	Measuring mode: STANDARD	 a0001184	Counting mode totalizer: BALANCE (forward and reverse flow)
 a0001185	Counting mode totalizer: forward	 a0001186	Counting mode totalizer: reverse
 a0001187	Status input		
 a0001188	Volume flow	 a0001195	Mass flow
 a0001200	Fluid density		
 a0001201	Batching quantity upwards	 a0001202	Batching quantity downwards
 a0001203	Batching quantity	 a0001204	Batch sum
 a0001205	Batch counter (x times)	 a0001206	Modbus communication active

5.2.5 Controlling the batching processes using the local display

Filling processes can be carried out directly by means of the local display with the aid of the optional "(Batching)" software package (F-CHIP, accessories → 🖹 102). Therefore, the device can be fully deployed in the field as a "batch controller".

Procedure:

1. Configure all the required batching functions and assign the lower display info line (= BATCHING KEYS) using the "Batch" Quick Setup menu (→ 🖹 93) or use the function matrix (→ 🖹 66).
   The following "softkeys" then appear on the bottom line of the local display → 🖹 50:
   – START = left display key (⊟)
   – PRESET = middle display key (⊞)
   – MATRIX = right display key (Ⓔ)
2. Press the "PRESET (⊞)" key. Various batching process functions requiring configuration will now appear on the display:

"PRESET" → Initial settings for the batching process		
No.	**Function**	**Settings**
7200	BATCH SELECTOR	⊞⊟ → Select the batching liquid (BATCH #1 to 6)
7203	BATCHING QUANTITY	If the "ACCESS CUSTOMER" option was selected for the "PRESET batch quantity" prompt in the "Batching" Quick Setup, the batching quantity can be altered via the local display. If the "LOCKED" option was selected, the batching quantity can only be read and cannot be altered until the private code has been entered.
7265	RESET TOTAL QUANTITY/ TOTALIZER	Resets the batching quantity counter or the total batching quantity to "0".

3. After exiting the PRESET menu, you can now start the batching process by pressing "START (⊟)". New softkeys (STOP / HOLD or GO ON) now appear on the display. You can use these to interrupt, continue or stop the batching process at any time → 🖹 50.
   STOP (⊟) → Stops batching process
   HOLD (⊞) → Interrupts batching process (softkey changes to "GO ON")
   GO ON (⊞) → Continues batching process (softkey changes to "HOLD")
   After the batch quantity is reached, the "START" or "PRESET" softkeys reappear on the display.

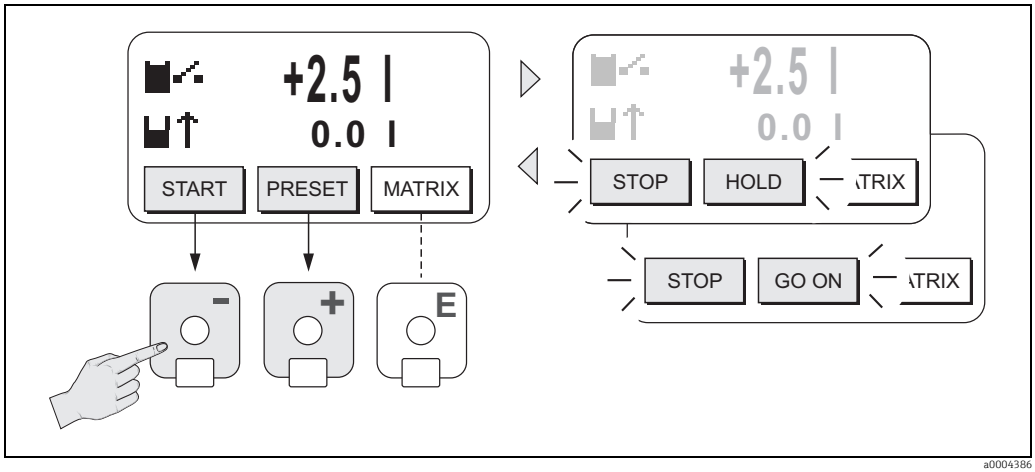


Fig. 50: Controlling batching processes using the local display (softkeys)

5.3 Brief operating instructions to the function matrix

Note!
- See the general notes → 67.
- Function descriptions → see the "Description of Device Functions" manual

1. HOME position → E → Entry into the function matrix.
2. ⊞/⊟ → Select a block (e.g. OUTPUTS).
3. ⊞/⊟ → Select a group (e.g. CURRENT OUTPUT 1).
4. ⊞/⊟ → Select a function group (e.g. CONFIGURATION).
5. Select a function (e.g. UNIT VOLUME FLOW) and change parameters/enter numerical values:
   ⊞⊟ → Select or enter release code, parameters, numerical values
   E → Save entries
6. Exit the function matrix:
   – Press and hold down Esc key (⊟+⊞) for longer than 3 seconds → HOME position
   – Repeatedly press Esc key (⊟+⊞) → Return step by step to HOME position

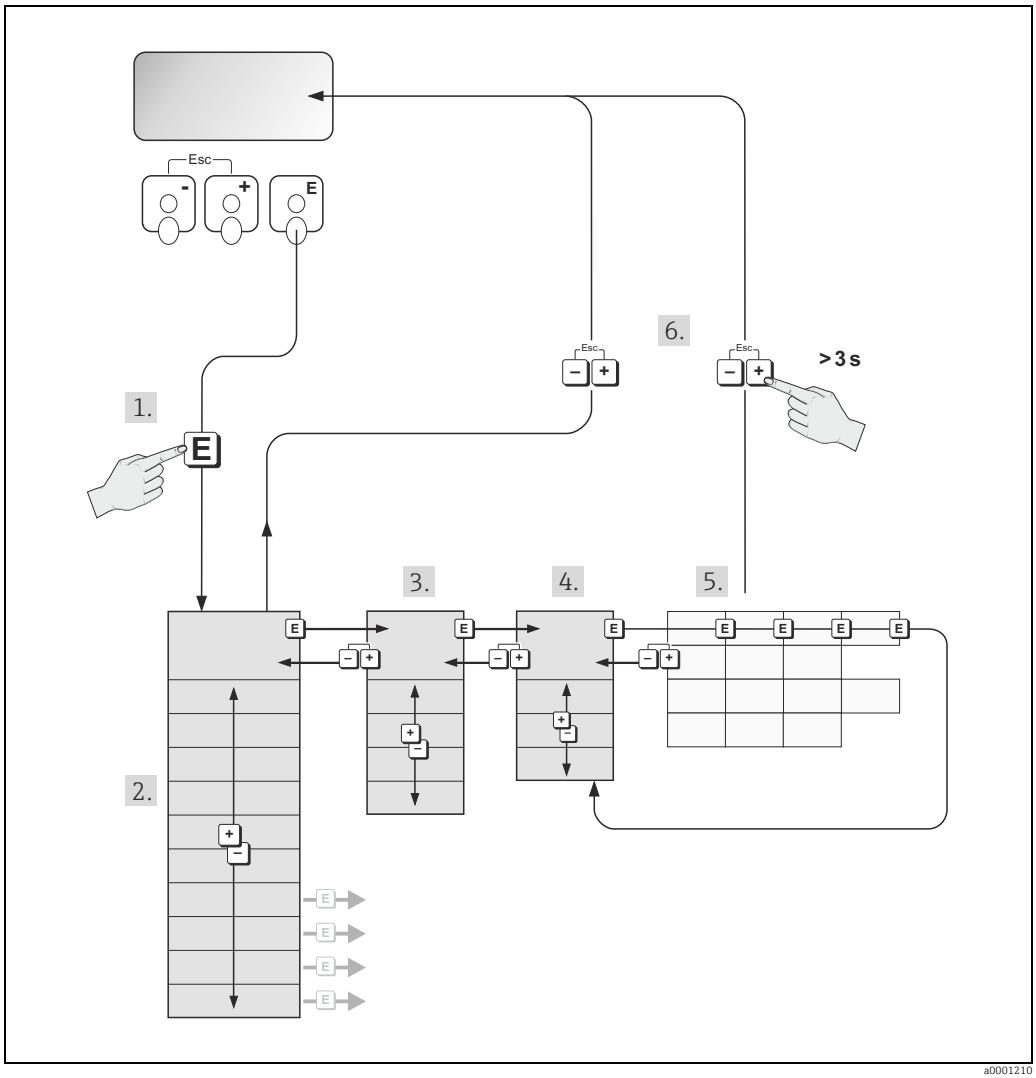


Fig. 51: Selecting functions and configuring parameters (function matrix)

5.3.1 General notes

The Quick Setup menu is adequate for commissioning with the necessary standard settings. Complex measuring operations on the other hand necessitate additional functions that you can configure as necessary and customize to suit your process parameters. The function matrix, therefore, comprises a multiplicity of additional functions which, for the sake of clarity, are arranged on a number of menu levels (blocks, groups, and function groups).

Comply with the following instructions when configuring functions:
- You select functions as described → 66.
  Each cell in the function matrix is identified by a numerical or letter code on the display.
- You can switch off certain functions (OFF). If you do so, related functions in other function groups will no longer be displayed.
- Certain functions prompt you to confirm your data entries. Press ⊕/⊖ to select "SURE [YES]" and press Ⓔ again to confirm. This saves your setting or starts a function, as applicable.
- Return to the HOME position is automatic if no key is pressed for 5 minutes.
- Programming mode is automatically disabled if you do not press a key within 60 seconds following automatic return to the HOME position.

Caution!
All functions are described in detail, including the function matrix itself, in the "Description of Device Functions" manual, which is a separate part of these Operating Instructions.

Note!
- The transmitter continues to measure while data entry is in progress, i.e. the current measured values are output via the signal outputs in the normal way.
- If the power supply fails, all preset and parameterized values remain safely stored in the EEPROM.

5.3.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 53) has to be entered before settings can be changed.
If you use a code number of your choice, you exclude the possibility of unauthorized persons accessing data (→ "Description of Device Functions" manual).

Comply with the following instructions when entering codes:
- If programming is disabled and the ⊕⊖ keys are pressed in any function, a prompt for the code automatically appears on the display.
- If "0" is entered as the customer's code, programming is always enabled.
- The Endress+Hauser service organization can be of assistance if you mislay your personal code.

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 Endress+Hauser service organization. Please contact Endress+Hauser first if you have any questions.

5.3.3 Disabling the programming mode

Programming mode is disabled if you do not press a key within 60 seconds following automatic return to the HOME position.
You can also disable programming in the ACCESS CODE function by entering any number (other than the customer's code).

5.4 Error messages

5.4.1 Type of error

Errors which occur during commissioning or measuring operation are displayed immediately. 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:
- *System errors:* This group comprises all device errors, e.g. communication errors, hardware errors, etc. → 📄 105.
- *Process errors:* This group comprises all application errors, e.g. empty pipe, etc. → 📄 110.

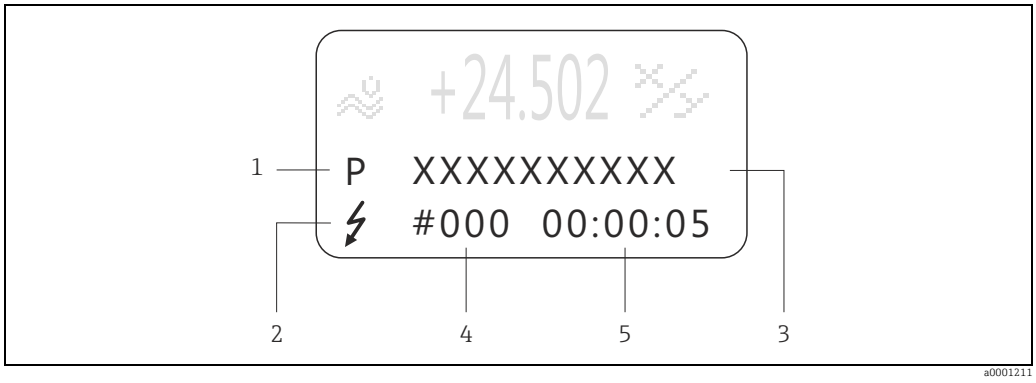


Fig. 52: Error messages on the display (example)

1 Error type: P = process error, S = system error
2 Error message type: ϟ = fault message, ! = notice message
3 Error designation
4 Error number
5 Duration of most recent error occurrence (hours:minutes:seconds)

5.4.2 Error message type

Users have the option of weighting certain errors differently, in other words having them classed as **"Fault messages"** or **"Notice messages".** You can define messages in this way with the aid of the function matrix (see the "Description of Device Functions" manual). Serious system errors, e.g. module defects, are always identified and classed as "fault messages" by the measuring device.

Notice message (!)
- Displayed as → Exclamation mark (!), error type (S: system error, P: process error).
- The error in question has no effect on the outputs of the measuring device.

Fault message (ϟ)
- Displayed as → Lightening flash (ϟ), error type (S: system error, P: process error)
- The error in question has a direct effect on the outputs.
  The response of the outputs (failsafe mode) can be defined by means of functions in the function matrix→ 📄 113.

Note!
- Error conditions can be output via the relay outputs or the fieldbus communication.
- If an error message occurs, an upper or lower signal level for the breakdown information according to NAMUR NE 43 can be output via the current output.

5.5 Modbus RS485 communication

5.5.1 Modbus RS485 technology

The Modbus is an open, standardized fieldbus system which is deployed in the areas of manufacturing automation, process automation and building automation.

System architecture

The Modbus RS485 is used to specify the functional characteristics of a serial fieldbus system with which distributed, digital automation systems are networked together.
The Modbus RS485 distinguishes between master and slave devices.

- **Master devices**
  Master devices determine the data traffic on the fieldbus system. They can send data without an external request.
- **Slave devices**
  Slave devices, like this measuring device, are peripheral devices. They do not have their own access rights to the data traffic of the fieldbus system and only send their data due to an external request from a master.

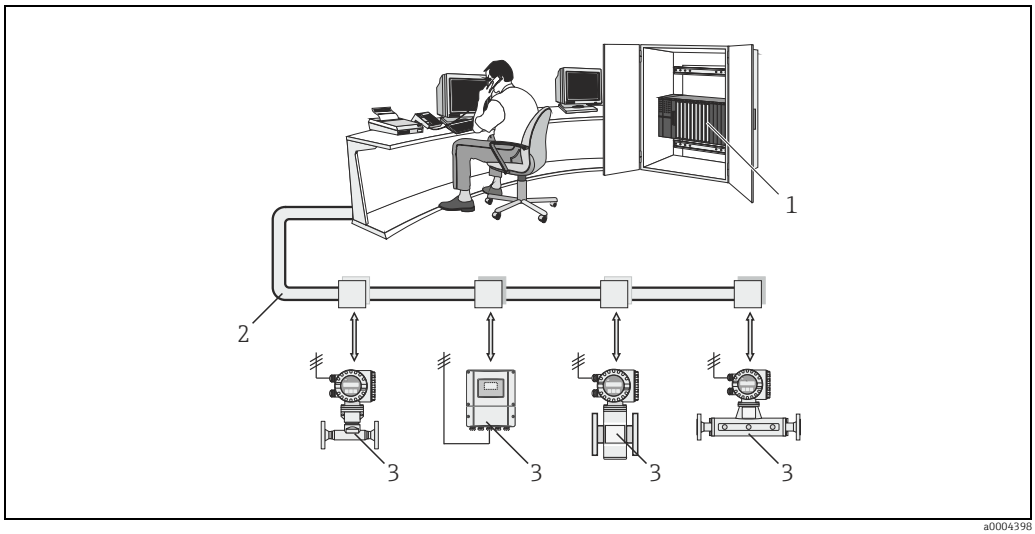


Fig. 53: Modbus RS485 system architecture

1 Modbus master (PLC, etc.)
2 Modbus RS485
3 Modbus slave (measuring devices, etc.)

Master/slave communication

A distinction is made between two methods of communication with regard to master/slave communication via Modbus RS485:

- **Polling (request-response-transaction)**
  The master sends a request telegram to **one** slave and waits for the slave's response telegram. Here, the slave is contacted directly due to its unique bus address (1 to 247).

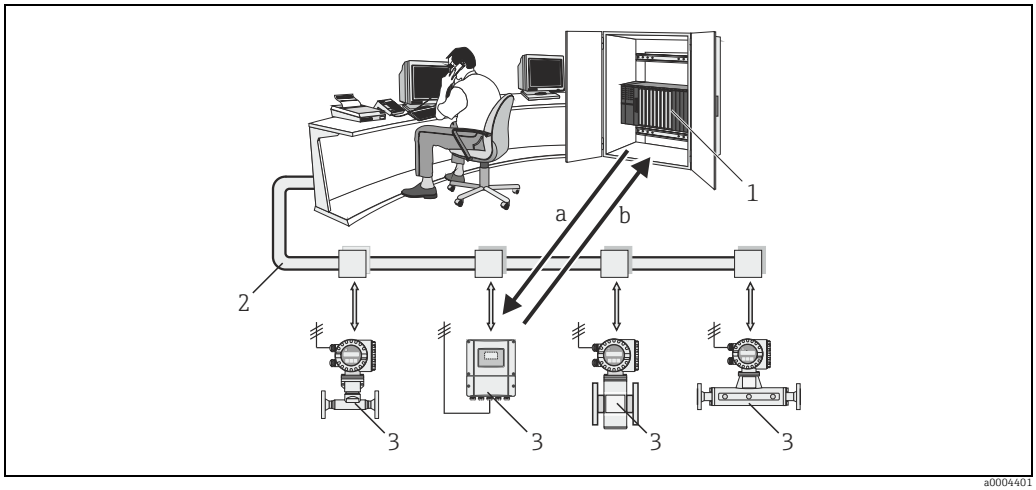


Fig. 54: Modbus RS485 polling data traffic

1 Modbus master (PLC, etc.)
2 Modbus RS485
3 Modbus slave (measuring devices, etc.)
a Request telegram to this one specific Modbus slave
b Response telegram to the Modbus master

- **Broadcast message**
  By means of the global address 0 (broadcast address), the master sends a command to all the slaves in the fieldbus system. The slaves execute the command without reporting back to the master. Broadcast messages are only permitted in conjunction with write function codes.

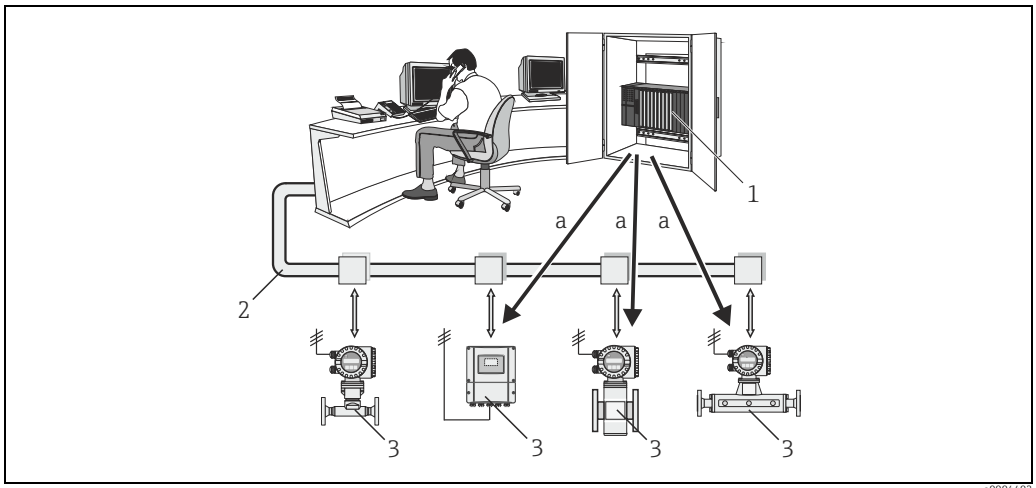


Fig. 55: Modbus RS485 polling data traffic

1 Modbus master (PLC, etc.)
2 Modbus RS485
3 Modbus slave (measuring devices, etc.)
a Broadcast message command to all Modbus slaves (request is executed without a response telegram to the master)

5.5.2 Modbus telegram

General

The master-slave process is used for data exchange. Only the master can initiate data transmission. Following the prompt, the slave sends the master the necessary data as a response telegram or executes the command requested by the master.

Telegram structure

The data is transferred between the master and slave by means of a telegram.
A request telegram from the master contains the following telegram fields:

Telegram structure:

Slave address	Function code	Data	Check sum

- Slave address
  The slave address can be in an address range from 1 to 247.
  The master talks to all the slaves simultaneously by means of the slave address 0 (broadcast message).
- Function code
  The function code determines which read, write and test operations should be executed by means of the Modbus protocol. Function codes supported by the measuring device→ 🖹 72.
- Data
  Depending on the function code, the following values are transmitted in this data field:
  – Register start address (from which the data is transmitted)
  – Number of registers
  – Write/read data
  – Data length
  – etc.
- Check sum (CRC or LRC check)
  The telegram check sum forms the end of the telegram.

The master can send another telegram to the slave as soon as it has received an answer to the previous telegram or once the time-out period set at the master has expired. This time-out period can be specified or modified by the user and depends on the slave response time.

If an error occurs during data transfer or if the slave cannot execute the command from the master, the slave returns an error telegram (exception response) to the master.

The slave response telegram consists of telegram fields which contain the requested data or which confirm that the action requested by the master has been executed. It also contains a check sum.

5.5.3 Modbus function codes

The function code determines which read, write and test operations should be executed by means of the Modbus protocol. The measuring device supports the following function codes:

Function code	Name in accordance with Modbus specification	Description
03	READ HOLDING REGISTER	Reads one or more registers of the Modbus slave. 1 to a maximum of 125 consecutive registers (1 register = 2 byte) can be read with a telegram. **Application:** For reading measuring device parameters with read and write access, such as reading the volume flow.
04	READ INPUT REGISTER	Reads one or more registers of the Modbus slave. 1 to a maximum of 125 consecutive registers (1 register = 2 byte) can be read with a telegram. **Application:** For reading measuring device parameters with read access, such as reading the measured values (volume flow, totalizer value etc.).
06	WRITE SINGLE REGISTERS	Writes **a** slave register with a new value. **Application:** For writing just one measuring device parameter, such as writing the batch quantity or resetting the totalizer. Note! Function code 16 is used for writing several registers by means of just one telegram.
08	DIAGNOSTICS	Checks the communication connection between the master and slave. The following "diagnostics codes" are supported: ▪ Sub-function 00 = Return query data (loopback test) ▪ Sub-function 02 = Return diagnostics register
16	WRITE MULTIPLE REGISTERS	Writes several slave registers with a new value. A maximum of 120 consecutive registers can be written with a telegram. **Application:** For writing several measuring device parameters, such as writing the batch quantity and resetting the totalizer.
23	READ/WRITE MULTIPLE REGISTERS	Simultaneous reading and writing of 1 to max. 118 registers in a telegram. Write access is executed before read access. **Application:** For writing and reading several measuring device parameters, such as writing the batch quantity and the compensation quantity and reading the totalizer value.

Note!
- Broadcast messages are only permitted with function codes 06, 16 and 23.
- The measuring device does not differentiate between function codes 03 and 04. These codes have the same result.

5.5.4 Maximum number of writes

If a nonvolatile device parameter is modified via the Modbus function codes 06, 16 or 23, this change is saved in the EEPROM of the measuring device.
The number of writes to the EEPROM is technically restricted to a maximum of 1 million. Attention must be paid to this limit since, if exceeded, it results in data loss and measuring device failure. For this reason, avoid constantly writing nonvolatile device parameters via the Modbus!

5.5.5 Modbus register addresses

Each device parameter has its own register address. The Modbus master uses this register address to talk to the individual device parameters and access the device data.
The register addresses of the individual device parameters can be found in the "Description of Device Functions" manual under the parameter description in question.

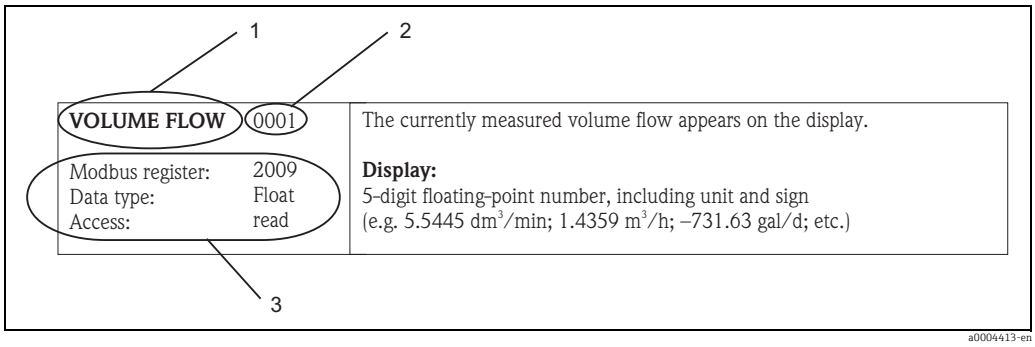


Fig. 56: Example of how a function description is illustrated in the "Description of Device Functions" manual

1 Name of the function
*2 Number of the function (appears on the local display; is **not** identical to the Modbus register address)*
3 Information on communication via Modbus RS485
- Modbus register (information in decimal numerical format)
- Data type: Float, Integer, String
- Possible ways of accessing the function:
read = read access via function codes 03, 04 or 23
write = write access via function codes 06, 16 or 23

Modbus register address model

The Modbus RS485 register addresses of the measuring device are implemented in accordance with "Modbus Applications Protocol Specification V1.1".

Note!
In addition to the specification mentioned above, systems are also deployed which work with a register address model in accordance with the "Modicon Modbus Protocol Reference Guide -(PI-MBUS-300 Rev. J)" specification. With this specification, the register address is extended, depending on the function code used. A "3" is put in front of the register address in the "read" access mode and a "4" in the "write" access mode.

Function code	Access type	Register in accordance with: "Modbus Applications Protocol Specification"		Register in accordance with: "Modicon Modbus Protocol Reference Guide"
03 04 23	Read	XXXX Example: volume flow = 2009	→	3XXXX Example: volume flow = 32009
06 16 23	Write	XXXX Example: reset totalizer 1 = 2608	→	4XXXX Example: reset totalizer 1 = 42608

Response times

The time it takes a measuring device to respond to a request telegram from the Modbus master is typically 25 to 50 ms. If faster response times are needed for time-critical applications (e.g. batching applications), the "auto-scan buffer" is to be used.

Note!
It may take longer for a command to be executed in the device. The data is not updated until the command has been executed. Especially write commands are affected by this!

Data types

The following data types are supported by the measuring device:

- **FLOAT** (floating-point numbers IEEE 754)
  Data length = 4 bytes (2 registers)

Byte 3	Byte 2	Byte 1	Byte 0
SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM

S = sign
E = exponent
M = mantissa

- **INTEGER**
  Data length = 2 bytes (1 register)

Byte 1	Byte 0
Most significant byte (MSB)	Least significant byte (LSB)

- **STRING**
  Data length = depends on device parameter,
  e.g. illustration of a device parameter with a data length = 18 bytes (9 registers):

Byte 17	Byte 16	...	Byte 1	Byte 0
Most significant byte (MSB)		...		Least significant byte (LSB)

Byte transmission sequence

Byte addressing, i.e. the transmission sequence of the bytes, is not specified in the Modbus specification. For this reason, it is important to coordinate the addressing method between the master and slave during commissioning. This can be configured in the measuring device by means of the "BYTE SEQUENCE" parameter (see "Description of Device Functions" manual). Depending on the selection in the "BYTE SEQUENCE" parameter, the bytes are transmitted as follows:

FLOAT

	Sequence			
Selection	**1st**	**2nd**	**3rd**	**4th**
1 - 0 - 3 - 2*	Byte 1 (MMMMMMMM)	Byte 0 (MMMMMMMM)	Byte 3 (SEEEEEEE)	Byte 2 (EMMMMMMM)
0 - 1 - 2 - 3	Byte 0 (MMMMMMMM)	Byte 1 (MMMMMMMM)	Byte 2 (EMMMMMMM)	Byte 3 (SEEEEEEE)
2 - 3 - 0 - 1	Byte 2 (EMMMMMMM)	Byte 3 (SEEEEEEE)	Byte 0 (MMMMMMM)	Byte 1 (MMMMMMM)
3 - 2 - 1 - 0	Byte 3 (SEEEEEEE)	Byte 2 (EMMMMMMM)	Byte 1 (MMMMMMMM)	Byte 0 (MMMMMMMM)

* = Factory setting
S = sign
E = exponent
M = mantissa

INTEGER

	Sequence	
Selection	**1st**	**2nd**
1 - 0 - 3 - 2 * 3 - 2 - **1 - 0**	Byte 1 (MSB)	Byte 0 (LSB)
0 - 1 - 2 - 3 2 - 3 - **0 - 1**	Byte 0 (LSB)	Byte 1 (MSB)

* = Factory setting
MSB = most significant byte
LSB = least significant byte

STRING

Illustration using the example of a device parameter with a data length of 18 bytes.

	Sequence				
Selection	**1st**	**2nd**	**...**	**17th**	**18th**
1 - 0 - 3 - 2 * 3 - 2 - **1 - 0**	Byte 1	Byte 0 (LSB)	...	Byte 17 (MSB)	Byte 16
0 - 1 - 2 - 3 2 - 3 - **0 - 1**	Byte 0 (LSB)	Byte 1	...	Byte 16	Byte 17 (MSB)

* = Factory setting
MSB = most significant byte
LSB = least significant byte

5.5.6 Modbus error messages

If the Modbus slave detects an error in the request telegram from the master, it sends a reply to the master in the form of an error message consisting of the slave address, function code, exception code and check sum. To indicate that this is an error message, the lead bit of the returned function code is used. The reason for the error is transmitted to the master by means of the exception code.

The following exception codes are supported by the measuring device:

Exception codes	Description
01	ILLEGAL_FUNCTION The function code sent by the master is not supported by the measuring device (slave). ✎ Note! Description of the function codes supported by the measuring device → 🖹 72.
02	ILLEGAL_DATA_ADDRESS The register addressed by the master is not assigned (i.e. it does not exist) or the length of the requested data is too big.
03	ILLEGAL_DATA_VALUE ▪ The master is attempting to write to a register which only allows read access. ▪ The value that appears in the data field is not permitted, e.g. range limits exceeded or incorrect data format.
04	SLAVE DEVICE FAILURE The slave did not respond to the request telegram from the master or an error occurred when processing the request telegram.

5.5.7 Modbus auto-scan buffer

Function description

The Modbus master uses the request telegram to access the device parameters (data) of the measuring device. Depending on the function code, the master gains read or write access to a single device parameter or a group of consecutive device parameters. If the desired device parameters (registers) are not available as a group, the master has to send a request telegram to the slave for each parameter.
The measuring device has a special storage area, known as the auto-scan buffer, for grouping nonconsecutive device parameters. This can be used to flexibly group up to 16 device parameters (registers). The master can talk to this complete data block by means of just one request telegram.

Structure of the auto-scan buffer

The auto-scan buffer consists of two data records, the configuration area and the data area. In the configuration area, a list known as the scan list specifies which device parameters should be grouped. For this purpose, the corresponding register address, e.g. the register address 2009 for volume flow, is entered in the scan list. Up to 16 device parameters can be grouped.

The measuring device cyclically reads out the register addresses entered in the scan list and writes the associated device data to the data area (buffer). The request cycle runs automatically. The cycle starts again when the last entry in the scan list has been queried. By means of Modbus, the grouped device parameters in the data area can be read or written by the master with just one request telegram (register address 5051 to 5081).

Configuration of the scan list

During configuration, the Modbus register addresses of the device parameters to be grouped must be entered in the scan list. The scan list can contain up to 16 entries. Float and Integer-type device parameters with read and write access are supported.

The scan list can be configured by means of:

1. The local display or a configuration program (e.g. FieldCare).
   The scan list is configured here by means of the function matrix:
   BASIC FUNCTION → Modbus RS485 → SCAN LIST REG. 1 to SCAN LIST REG. 16
2. The Modbus master.
   Here, the scan list is configured via the register addresses 5001 to 5016.

Scan list		
No.	**Modbus configuration Register address (data type = Integer)**	**Configuration via local operation / configuration program (BASIC FUNCTION → Modbus RS485 →)**
1	5001	SCAN LIST REG. 1
2	5002	SCAN LIST REG. 2
3	5003	SCAN LIST REG. 3
4	5004	SCAN LIST REG. 4
5	5005	SCAN LIST REG. 5
6	5006	SCAN LIST REG. 6
7	5007	SCAN LIST REG. 7
8	5008	SCAN LIST REG. 8
9	5009	SCAN LIST REG. 9
10	5010	SCAN LIST REG. 10
11	5011	SCAN LIST REG. 11
12	5012	SCAN LIST REG. 12
13	5013	SCAN LIST REG. 13
14	5014	SCAN LIST REG. 14
15	5015	SCAN LIST REG. 15
16	5016	SCAN LIST REG. 16

Access to data via Modbus

The Modbus master uses the register addresses 5051 to 5081 to access the data area of the auto-scan buffer. This data area contains the values of the device parameters defined in the scan list. For example, if the register 2009 was entered for volume flow in the scan list by means of the SCAN LIST REG. 1 function, the master can read out the current measured value of the volume flow in register 5051.

Data area				
Parameter value/Measured values		**Access via Modbus register address**	**Data type ***	**Access****
Value of scan list entry No. 1	→	5051	Integer / Float	Read/write
Value of scan list entry No. 2	→	5053	Integer / Float	Read/write
Value of scan list entry No. 3	→	5055	Integer / Float	Read/write
Value of scan list entry No. 4	→	5057	Integer / Float	Read/write
Value of scan list entry No. 5	→	5059	Integer / Float	Read/write
Value of scan list entry No. 6	→	5061	Integer / Float	Read/write
Value of scan list entry No. 7	→	5063	Integer / Float	Read/write
Value of scan list entry No. 8	→	5065	Integer / Float	Read/write
Value of scan list entry No. 9	→	5067	Integer / Float	Read/write
Value of scan list entry No. 10	→	5069	Integer / Float	Read/write
Value of scan list entry No. 11	→	5071	Integer / Float	Read/write
Value of scan list entry No. 12	→	5073	Integer / Float	Read/write
Value of scan list entry No. 13	→	5075	Integer / Float	Read/write
Value of scan list entry No. 14	→	5077	Integer / Float	Read/write
Value of scan list entry No. 15	→	5079	Integer / Float	Read/write
Value of scan list entry No. 16	→	5081	Integer / Float	Read/write

* The data type depends on the device parameter entered in the scan list

** The data access depends on the device parameter entered in the scan list. If the device parameter entered supports read and write access, the parameter can also be accessed by means of the data area.

Response time

The response time when accessing the data area (register addresses 5051 to 5081) is typically between 3 to 5 ms.

Note!
It may take longer for a command to be executed in the device. The data is not updated until the command has been executed. Especially write commands are affected by this!

Example

The following device parameters should be grouped via the auto-scan buffer and read out by the master with just one request telegram:
- Volume flow → Register address 2009
- Totalizer 1 → Register address 2610
- Actual system condition → Register address 6859

1. Configuration of the scan list

- With the local operation or a configuration program (via the function matrix):
  BASIC FUNCTION block → Modbus RS485 function group → SCAN LIST REG. function
  → Entry of the address 2009 under SCAN LIST REG. 1
  → Entry of the address 2610 under SCAN LIST REG. 2
  → Entry of the address 6859 under SCAN LIST REG. 3
- Via the Modbus master (the register addresses of the device parameters are written to the registers 5001 to 5003 via Modbus):
  1. Write address 2009 (volume flow) to register 5001
  2. Write address 2610 (totalizer 1) to register 5002
  3. Write address 6859 (actual system condition) to register 5003

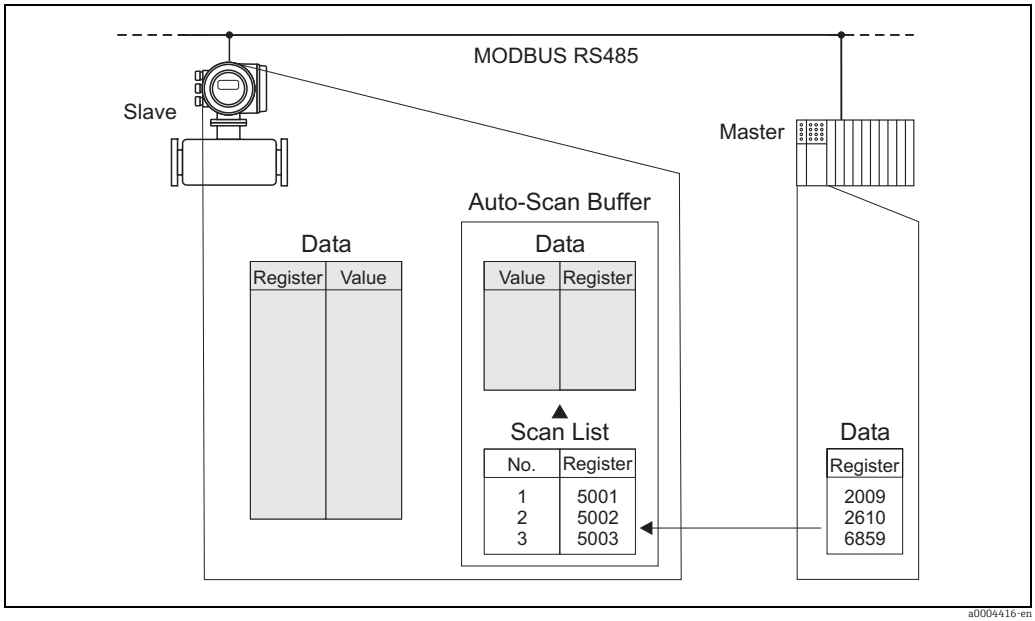


Fig. 57: Configuration of the scan list via the Modbus master

2. Access to data via Modbus

By specifying the register start address 5051 and the number of registers, the Modbus master can read out the measured values with just one request telegram.

Data area			
Access via Modbus register address	**Measured values**	**Data type**	**Access**
5051	Volume flow = 4567.67	Float	Read
5053	Totalizer 1 = 56345.6	Float	Read
5055	Actual system condition = 1 (system ok)	Integer	Read

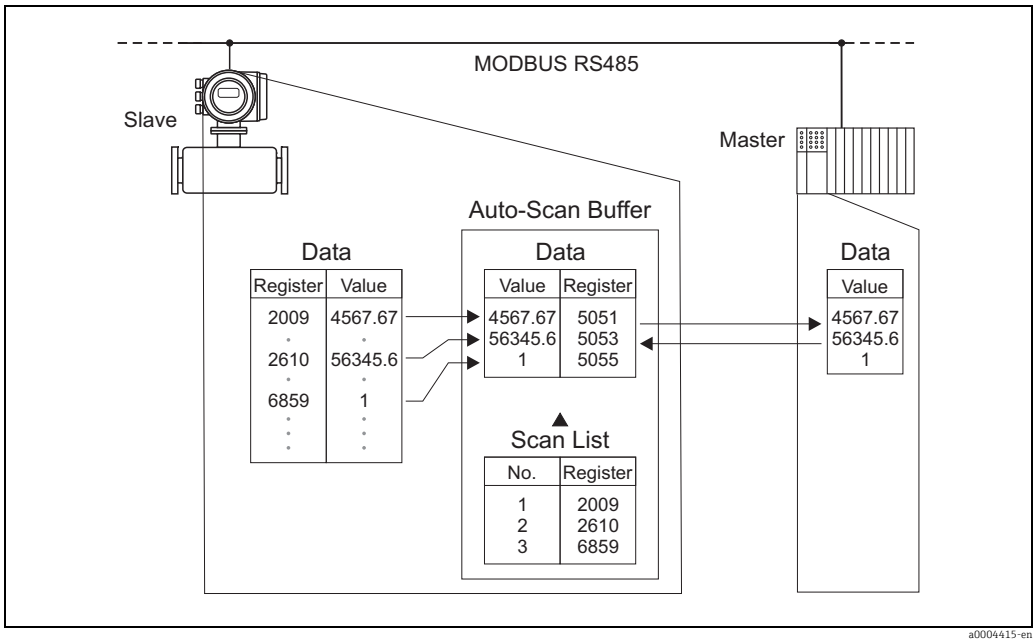


Fig. 58: With just one request telegram, the Modbus master reads out the measured values via the auto-scan buffer of the measuring device.

5.6 Operating options

5.6.1 FieldCare

Fieldcare is Endress+Hauser's FDT-based plant Asset Management Tool and allows the configuration and diagnosis of intelligent field devices. By using status information, you also have a simple but effective tool for monitoring devices. The Proline flow measuring devices are accessed via a service interface or via the service interface FXA193.

5.6.2 Device drivers for operating programs

The following table illustrates the suitable device drivers for the operating tool in question and then indicates where these can be obtained.

Operation via service protocol:

Valid for device software: 3.06.XX **Software release:** 10.2010	→ "DEVICE SOFTWARE" function (8100)
Operating program/Device driver:	**How to acquire:**
FieldCare / DTM	▪ www.endress.com →Download ▪ CD-ROM (Endress+Hauser order number 56004088) ▪ DVD (Endress+Hauser order number 70100690)

Tester/simulator:

Device:	**How to acquire:**
Fieldcheck	Update via FieldCare using the Flow Device FXA193/291 DTM in the Fieldflash module

Note!
The Fieldcheck tester/simulator is used for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.

5.7 Hardware settings

5.7.1 Hardware write protection, switching on and off

A jumper on the I/O board provides the means of switching hardware write protection on or off. When the write protection is switched on, it is **not** possible to write to the device parameters via Modbus RS485.

⚠ Warning!
Risk of electric shock. Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

1. Switch off power supply.
2. Remove the I/O board → 🖹 116.
3. Configure the hardware write protection accordingly with the aid of the jumpers (see Figure).
4. Installation is the reverse of the removal procedure.

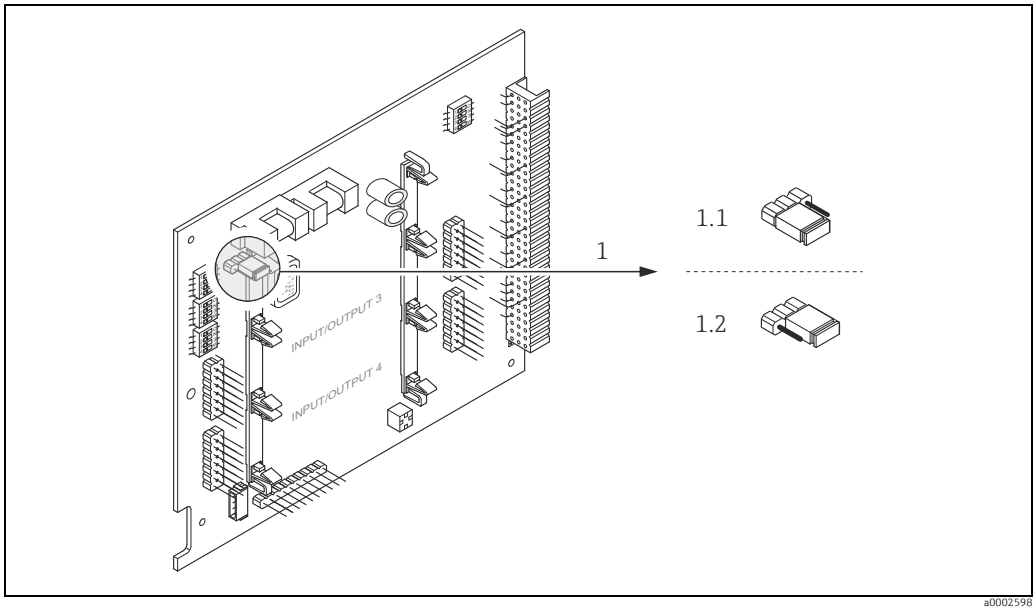


Fig. 59: Switching write protection on and off with the aid of a jumper on the I/O board

1 Jumper for switching write protection on and off
*1.1 Write protection switched on = it is **not** possible to write to the device parameters via Modbus RS485*
1.2 Write protection switched off (factory setting) = it is possible to write to the device parameters via Modbus RS485

5.7.2 Configuring the device address

The device address must always be configured for a Modbus slave. The valid device addresses are in a range from 1 to 247. In a Modbus RS485 network, each address can only be assigned once. If an address is not configured correctly, the device is not recognized by the Modbus master. All measuring devices are delivered from the factory with the device address 247 and with the "software addressing" address mode.

Addressing via local operation

More detailed explanations for addressing the measuring device via the local display→ 🖹 96.

Addressing via miniature switches

⚠ Warning!
Risk of electric shock. Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

1. Loosen the Allen screw (3 mm) of the securing clamp.
2. Unscrew cover of the electronics compartment from the transmitter housing.
3. Remove the local display (if present) by loosening the set screws of the display module.
4. Set the position of the miniature switches on the I/O board using a sharp pointed object.
5. Installation is the reverse of the removal procedure.

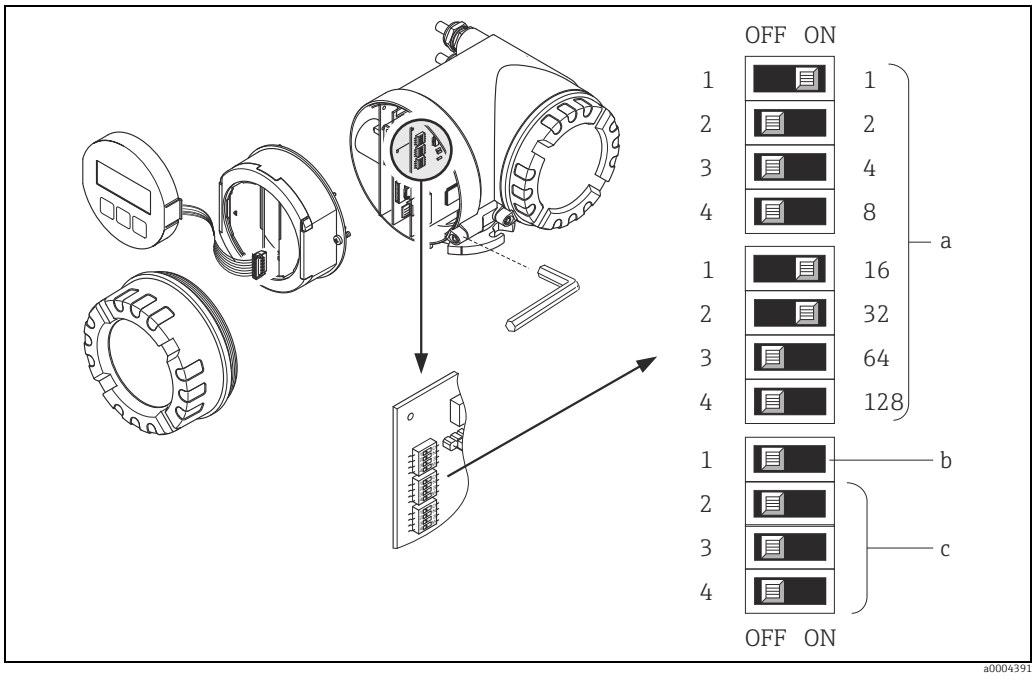


Fig. 60: Addressing with the aid of miniature switches on the I/O board

a Miniature switches for setting the device address (illustrated: 1 + 16 + 32 = device address 49)
b Miniature switches for the address mode (method of addressing)
– OFF = software addressing via local operation (factory setting)
– ON = hardware addressing via miniature switches
c Miniature switches not assigned

5.7.3 Configuring the terminating resistors

It is important to terminate the Modbus RS485 line correctly at the start and end of the bus segment since impedance mismatch results in reflections on the line which can cause faulty communication transmission.

Warning!
Risk of electric shock. Exposed components carry dangerous voltages.
Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

The miniature switch for termination is located on the I/O board (see Figure):

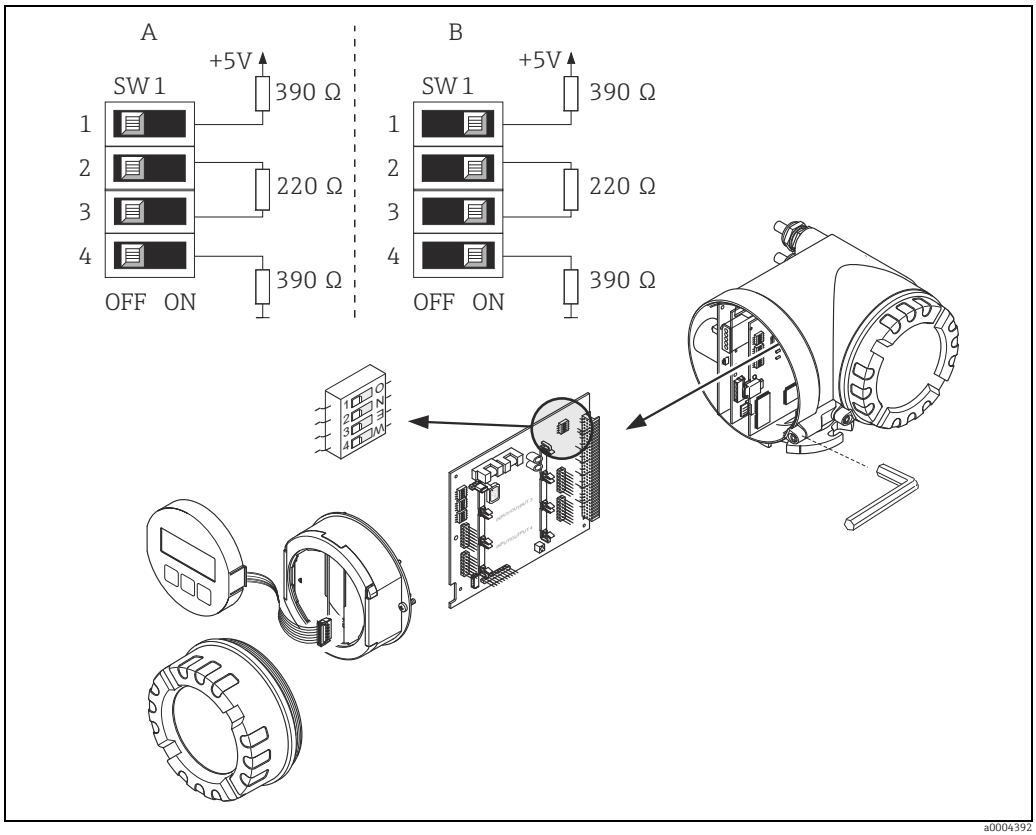


Fig. 61: Configuring the terminating resistors

A = Factory setting
B = Setting at the last transmitter

Note!
It is generally recommended to use external termination since if a device that is terminated internally is defect, this can result in the failure of the entire segment.

5.7.4 Current output configuration

The current output is configured as "active" or "passive" by means of various jumpers on the current submodule.

⚠ Warning!
Risk of electric shock. Exposed components carry dangerous voltages.
Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

1. Switch off power supply.
2. Remove the I/O board → 📄 116.
3. Position the jumpers (see Figure).

   ☝ Caution!
   Risk of destroying the measuring device. Set the jumpers exactly as shown in the diagram. Incorrectly set jumpers can cause overcurrents that would destroy either the measuring device or external devices connected to it.
4. Installation of the I/O board is the reverse of the removal procedure.

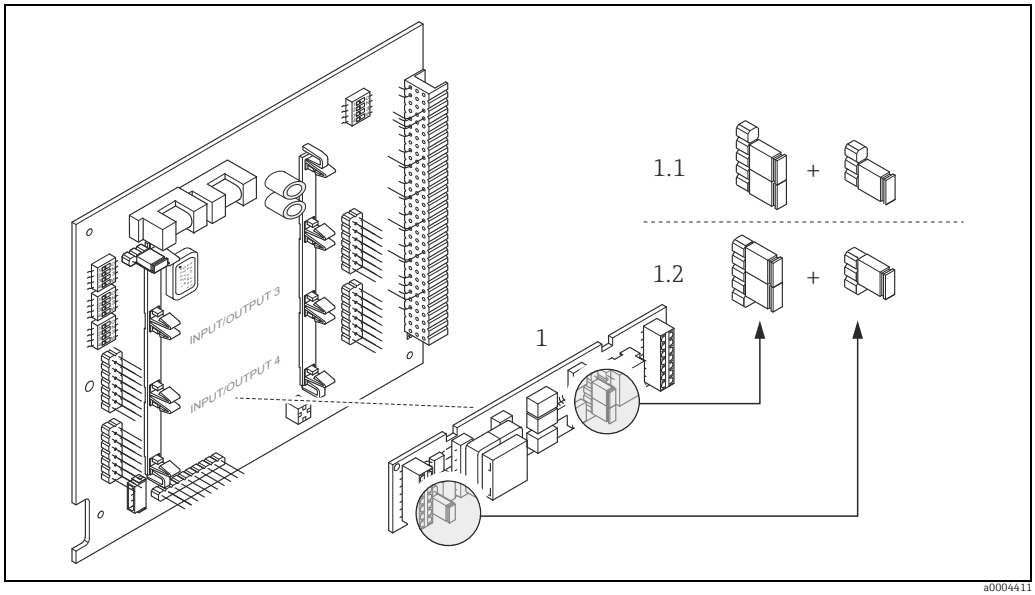


Fig. 62: Configuring the current input with the aid of jumpers (I/O board)

1 Current output
1.1 Active current output (factory setting)
1.2 Passive current output

5.7.5 Relay output configuration

The relay contact can be configured as normally open (NO or make) or normally closed (NC or break) contacts by means of two jumpers on the pluggable submodule. This configuration can be called up at any time with the ACTUAL STATUS RELAY function (No. 4740).

⚠ Warning!
Risk of electric shock. Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

1. Switch off power supply.
2. Remove the I/O board → 📄 116.
3. Position the jumpers (see Figure).

   ☝ Caution!
   If you change the setting you must always change the positions of **both** jumpers. Note precisely the specified positions of the jumpers.
4. Installation of the I/O board is the reverse of the removal procedure.

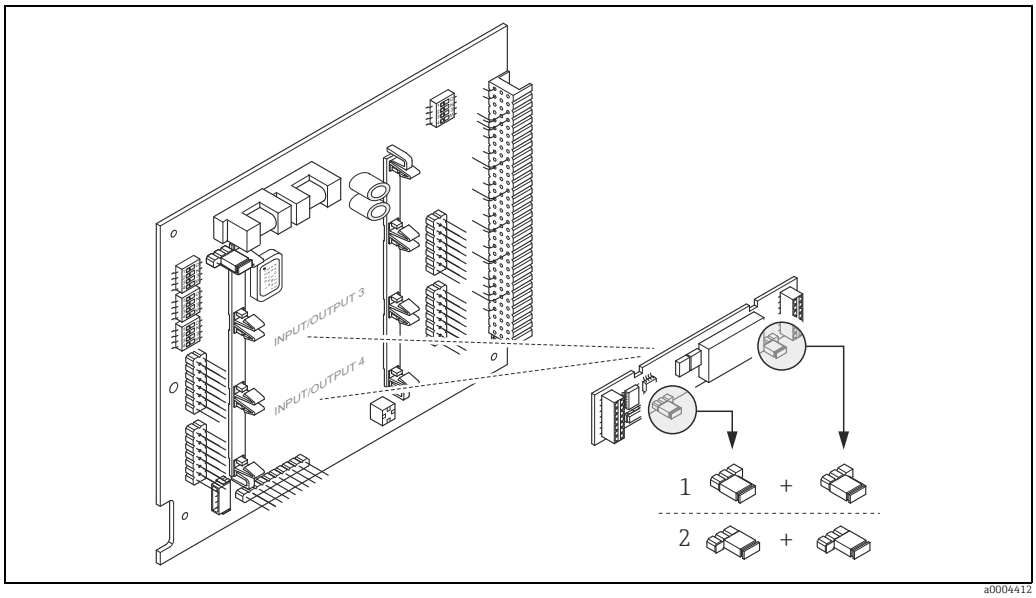


Fig. 63: Configuring relay contacts (NC / NO) on the convertible I/O board (submodule) with the help of jumpers.

1 Configured as NO contact (factory setting, relay 1)
2 Configured as NC contact (factory setting, relay 2)

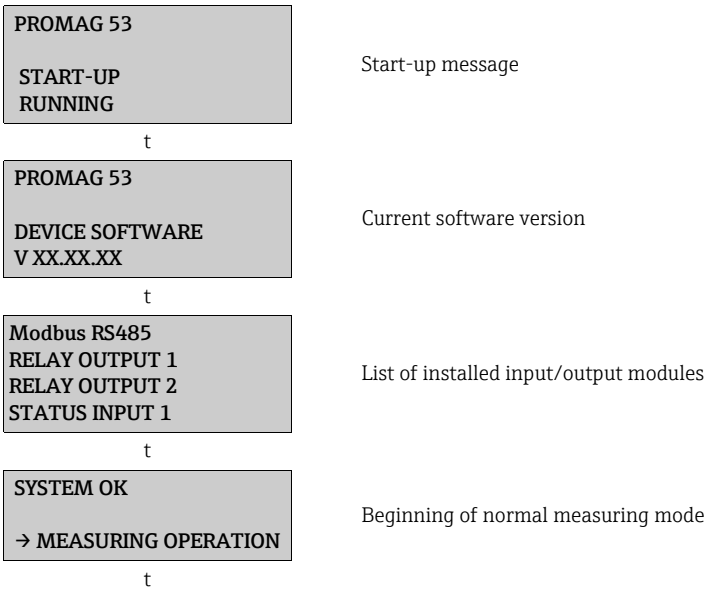
6 Commissioning

6.1 Function check

Make sure that all final checks have been completed before you start up your measuring point:
- Checklist for "Post-installation check" → 47
- Checklist for "Post-connection check" → 60

6.2 Switching on the measuring device

Once the post-connection checks have been successfully completed, it is time to switch on the supply voltage. The device is now operational.
The measuring device performs a number of post switch-on self-tests. As this procedure progresses the following sequence of messages appears on the local display:



Normal measuring mode commences as soon as startup completes.
Various measured-value and/or status variables (HOME position) appear on the display.

Note!
If startup fails, an error message indicating the cause is displayed.

6.3 Quick Setup

In the case of measuring devices without a local display, the individual parameters and functions must be configured via the configuration program, e.g. FieldCare.
If the measuring device is equipped with a local display, all the important device parameters for standard operation, as well as additional functions, can be configured quickly and easily by means of the following Quick Setup menus.

6.3.1 Quick Setup "Commissioning"

✎ Note!

- The display returns to the cell SETUP COMMISSIONING (1002) if you press the ESC key combination during parameter interrogation. The stored parameters remain valid.
- The "Commissioning" Quick Setup must be carried out before one of the other Quick Setups described in these Operating Instructions is run.

① The DELIVERY SETTINGS option sets each selected unit to the factory setting. The ACT.SETTING option accepts the units previously set by you.

② Only units not yet configured in the current Setup are offered for selection in each cycle. The unit for mass and volume is derived from the corresponding flow unit.

③ The "YES" option remains visible until all the units have been configured.
"NO" is the only option displayed when no further units are available.

④ This prompt only appears if a current output and/or pulse/frequency output is available. Only the outputs not yet configured in the current Setup are offered for selection in each cycle.

⑤ The "YES" option remains visible until all the outputs have been parameterized.
"NO" is the only option displayed when no further outputs are available.

⑥ The "automatic parameterization of the display" option contains the following basic settings/factory settings

YES	Main line = volume flow Additional line = totalizer 1 Information line = operating/system condition
NO	The existing (selected) settings remain.

⑦ The BATCHING QUICK SETUP is only available when the optional software package BATCHING is installed.

⑧ The PULSATING FLOW QUICK SETUP is only available if the device has a current output or a pulse/frequency output.

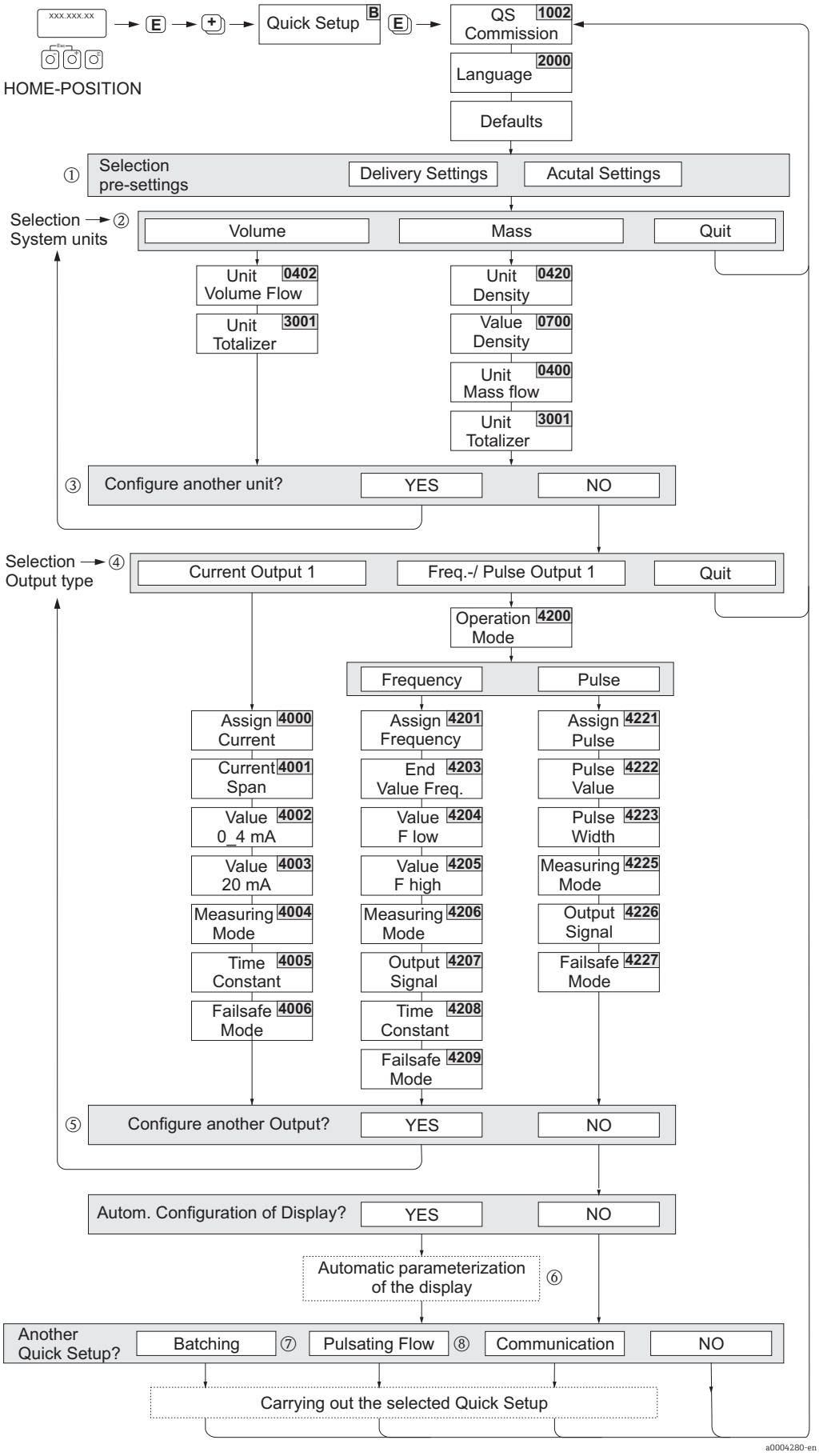


Fig. 64: Quick Setup for fast commissioning

6.3.2 Quick Setup "Pulsating Flow"

Note!
The "Pulsating flow" Quick Setup is only available if the device has a current output or a pulse/frequency output.

Certain types of pump such as reciprocating, peristaltic and cam-type pumps, for example, create a flow characterized by severe periodic fluctuations . Negative flows can occur with pumps of these types on account of the closing volume of the valves or valve leaks.

Note!
Before carrying out the Quick Setup "Pulsating Flow" the Quick Setup "Commissioning" has to be executed → 88.

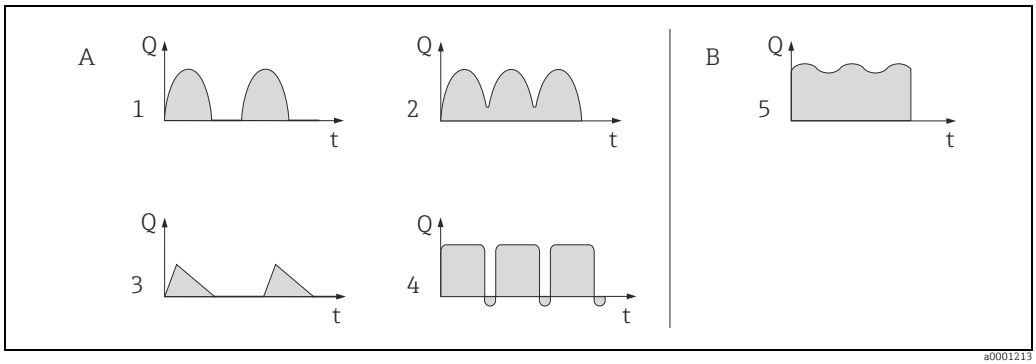


Fig. 65: Flow characteristics of various types of pump

A With severely pulsating flow
B With low pulsating flow

1 1-cylinder cam pump
2 2-cylinder cam pump
3 Magnetic pump
4 Peristaltic pump, flexible connecting hose
5 Multi-cylinder reciprocating pump

Severely pulsating flow

Once several device functions have been configured in the "Pulsating flow" Quick Setup menu, flow fluctuations of this nature can be compensated over the entire flow range and pulsating liquid flows measured correctly. Below you will find detailed instructions on how to use this Quick Setup menu.

Note!
It is always advisable to work through the "Pulsating flow" Quick Setup menu if there is any uncertainty about the exact flow characteristic.

Slightly pulsating flow

If flow fluctuations are no more than minor, as is the case, for example with gear-type, three-cylinder or multi-cylinder pumps, it is **not** absolutely necessary to work through the "Pulsating Flow" menu.
In cases of this nature, however, it is advisable to adapt the functions listed below in the function matrix (see the "Description of Device Functions" manual) to suit local process conditions in order to ensure a stable, unvarying output signal:

- Measuring system damping: FLOW DAMPING function → increase the value
- Current output damping: TIME CONSTANT function → increase the value

Performing the "Pulsating flow" Quick Setup

This Quick Setup menu guides you systematically through the setup procedure for all the device functions that have to be parameterized and configured for measuring pulsating flows. Note that this has no effect on values configured beforehand, such as measuring range, current range or full scale value.

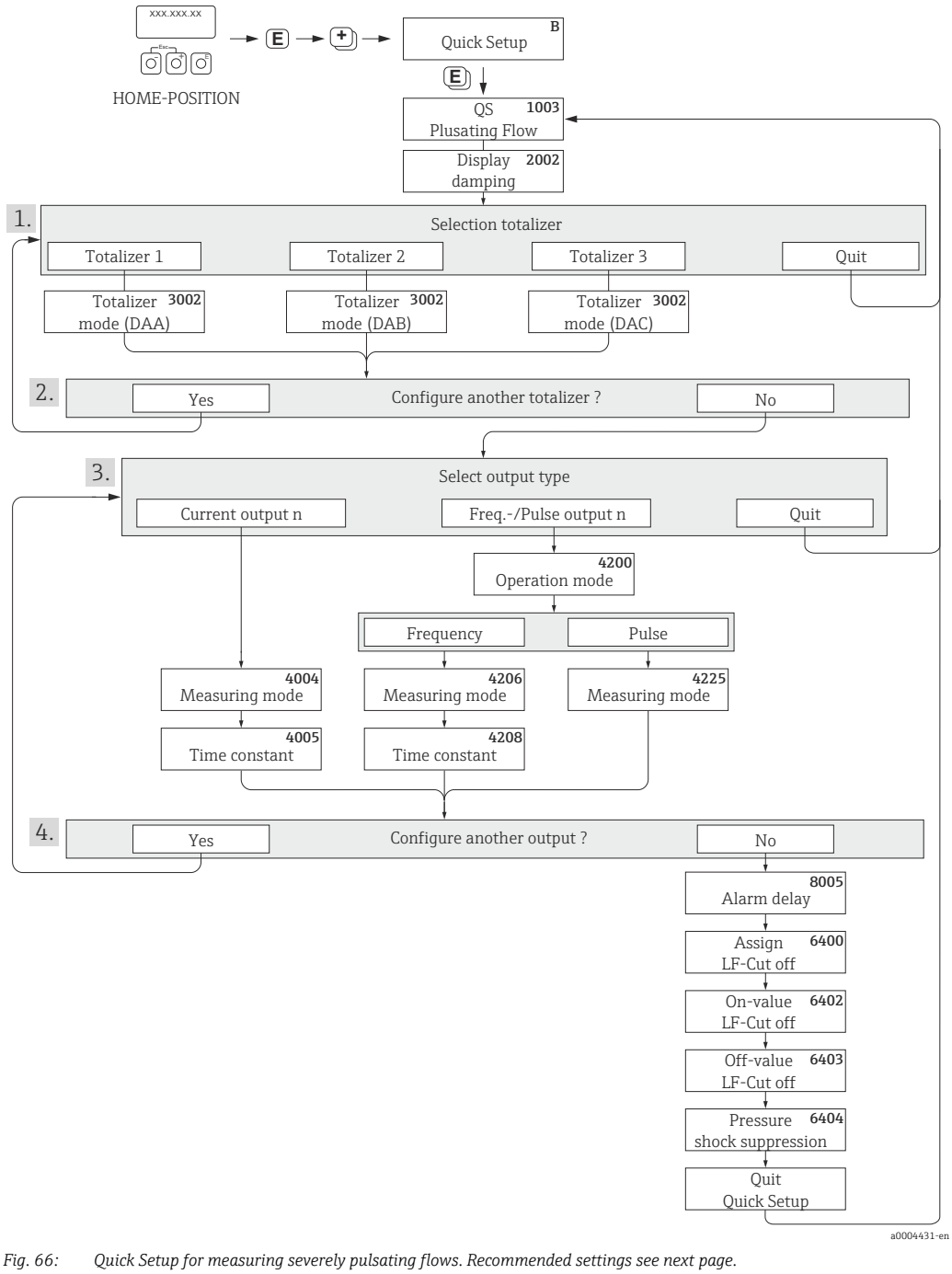


Fig. 66: Quick Setup for measuring severely pulsating flows. Recommended settings see next page.

① Only totalizers not yet configured in the current Setup are offered for selection in each cycle.

② The "YES" option remains visible until all the totalizers have been configured. "NO" is the only option displayed when no further totalizers are available.

③ Only the output not yet configured in the current Setup is offered for selection in the second cycle.

④ The "YES" option remains visible until both outputs have been parameterized. "NO" is the only option displayed when no further outputs are available.

Note!
- The display returns to the cell QUICK SETUP PULSATING FLOW (1003) if you press the ⊞ key combination during parameter interrogation.
- You can call up the Setup menu either directly from the "COMMISSIONING" Quick Setup menu or manually by means of the function QUICK SETUP PULSATING FLOW (1003).

Quick Setup "Pulsating Flow"		
HOME position → Ⓔ → MEASURAND → ⊞ → QUICK SETUP → 📖 → QS PULSATING FLOW (1003)		
Function No.	Function name	Selection with ⊞⊟ To the next function with Ⓔ
1003	QS PULS. FLOW	YES After Ⓔ is pressed by way of confirmation, the Quick Setup menu calls up all the subsequent functions in succession.

t

Basic configuration		
2002	DISPLAY DAMPING	3 s
3002	TOTALIZER MODE (DAA)	BALANCE (Totalizer 1)
3002	TOTALIZER MODE (DAB)	BALANCE (Totalizer 2)
3002	TOTALIZER MODE (DAC)	BALANCE (Totalizer 3)
Signal type for "CURRENT OUTPUT"		
4004	MEASURING MODE	PULS. FLOW
4005	TIME CONSTANT	3 s
Signal type for "FREQ./PULSE OUTPUT" (for FREQUENCY operating mode)		
4206	MEASURING MODE	PULS. FLOW
4208	TIME CONSTANT	0 s
Signal type for "FREQ./PULSE OUTPUT" (for PULSE operating mode)		
4225	MEASURING MODE	PULS. FLOW
Other settings		
8005	ALARM DELAY	0 s
6400	ASSIGN LOW FLOW CUT OFF	VOLUME FLOW
6402	ON-VALUE LOW FLOW CUT OFF	Recommended setting: $\text{On-value} \approx \frac{\text{max. full scale (per DN)*}}{1000}$ a0004432-en **Full scale values → 17*
6403	OFF-VALUE LOW FLOW CUT OFF	50%
6404	PRESSURE SHOCK SUPPRESSION	0 s

t

Back to the HOME position:
→ Press and hold down the ⊟+ key for longer than three seconds or
→ Repeatedly press and release the ⊟+ key → Exit the function matrix step by step

6.3.3 Quick Setup "Batching"

Note!
This function is only available when the additional "batching" software is installed in the measuring device (order option). You can order this software from Endress+Hauser as an accessory at a later date → 102.

This Quick Setup menu guides you systematically through the setup procedure for all the device functions that have to be parameterized and configured for batching operation. These basic settings allow simple (one step) batching processes.
Additional settings, e.g. for multi-stage batching procedures, must be made via the function matrix itself (see the "Description of Device Functions" manual).

Caution!
The "Batching" Quick Setup sets certain device parameters for discontinuous measurement operation.
If the measuring device is used for continuous flow measurement at a later time, we recommend at you rerun the "Commissioning" and/or "Pulsating Flow" Quick Setup.

Note!
- Before carrying out the Quick Setup "Batching" the Quick Setup "Commissioning" has to be executed → 88.
- You can find detailed information on the batching functions in the separate "Description of Device Functions" manual.
- You can also directly control filling process using the local display. During Quick Setup, an appropriate dialog appears concerning the automatic display configuration. Acknowledge this by clicking "YES".
  This assigns special batching functions (START, PRESET, etc.) to the bottom line of the display. These can be directly executed on-site using the three operating keys (⊞/⊟/Ⓔ). Therefore, the measuring device can be fully deployed in the field as a "batch controller" → 65.
- You can also directly control the filling process using the fieldbus.

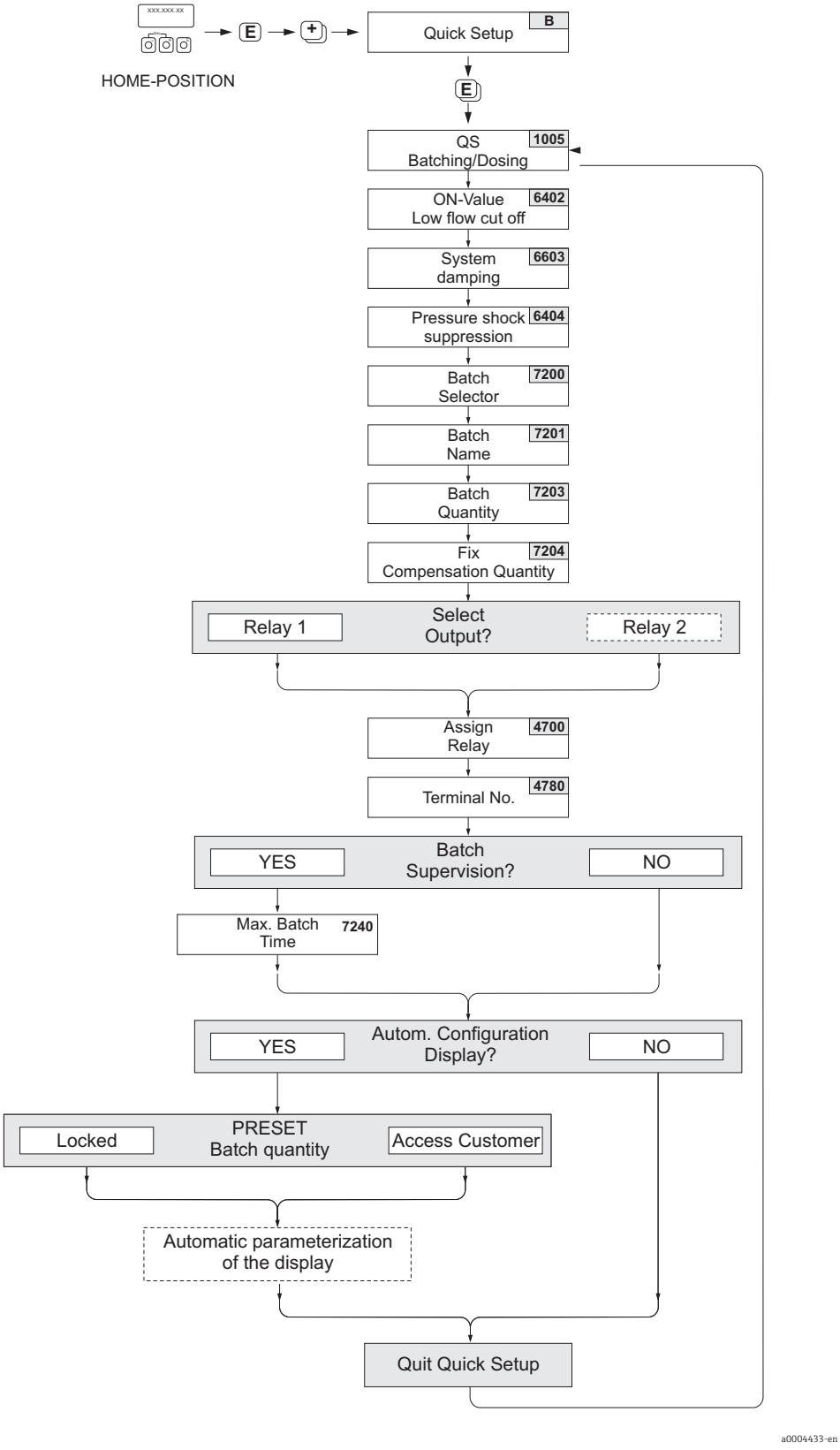


Fig. 67: Quick Setup "Batching". Recommended settings see next page.

Recommended settings

Quick Setup "Batching"		
HOME position → E → MEASURAND → + → QUICK SETUP → E → QUICK SETUP BATCHING (1005)		
Function No.	Function name	Setting to be selected (±) (to the next function with E)
1005	QUICK SETUP BATCHING	YES After E is pressed by way of confirmation, the Quick Setup menu calls up all the subsequent functions in succession.
▼		
Note! Some of the functions listed below (with a gray background) are configured automatically, i.e. by the measuring system.		
6400	ASSIGN LOW FLOW CUT OFF	VOLUME FLOW
6402	ON-VALUE LOW FLOW CUT OFF	The recommended setting can be found on → 92 in Function No. 6402.
6403	OFF-VALUE LOW FLOW CUT OFF	50%
6603	SYSTEM DAMPING	9 Note! The parameter has to be optimized for highly accurate and short filling processes: to do this, put the setting to "0".
6404	PRESSURE SHOCK SUPPRESSION	0 s
7200	BATCH SELECTOR	BATCH #1
7201	BATCH NAME	BATCH #1
7202	ASSIGN BATCH VARIABLE	VOLUME
7203	BATCH QUANTITY	0
7204	FIX COMPENSATION QUANTITY	0
7208	BATCH STAGES	1
7209	INPUT FORMAT	Value input
4700	ASSIGN RELAY	BATCHING VALVE 1
4780	TERMINAL NUMBER	Output (display only)
7220	OPEN VALVE 1	0% or 0 [unit]
7240	MAXIMUM BATCH TIME	0 s (= switched off)
7241	MINIMUM BATCH QUANTITY	0
7242	MAXIMUM BATCH QUANTITY	0
2200	ASSIGN (Main line)	BATCH NAME
2220	ASSIGN (Multiplex main line)	Off
2400	ASSIGN (Additional line)	BATCH DOWNWARDS
2420	ASSIGN (Multiplex additional line)	Off
2600	ASSIGN (Information line)	BATCHING KEYS
2620	ASSIGN (Multiplex information line)	Off
▼		
Back to the HOME position: → Press and hold down the ESC key for longer than three seconds or → Repeatedly press and release the ESC key → Exit the function matrix step by step		

6.3.4 Quick Setup "Communication"

To establish serial data transfer, various arrangements between the Modbus master and Modbus slave are required which have to be taken into consideration when configuring various functions. These functions can be configured quickly and easily by means of the "Communication" Quick Setup. The following table explains the parameter configuration options in more detail.

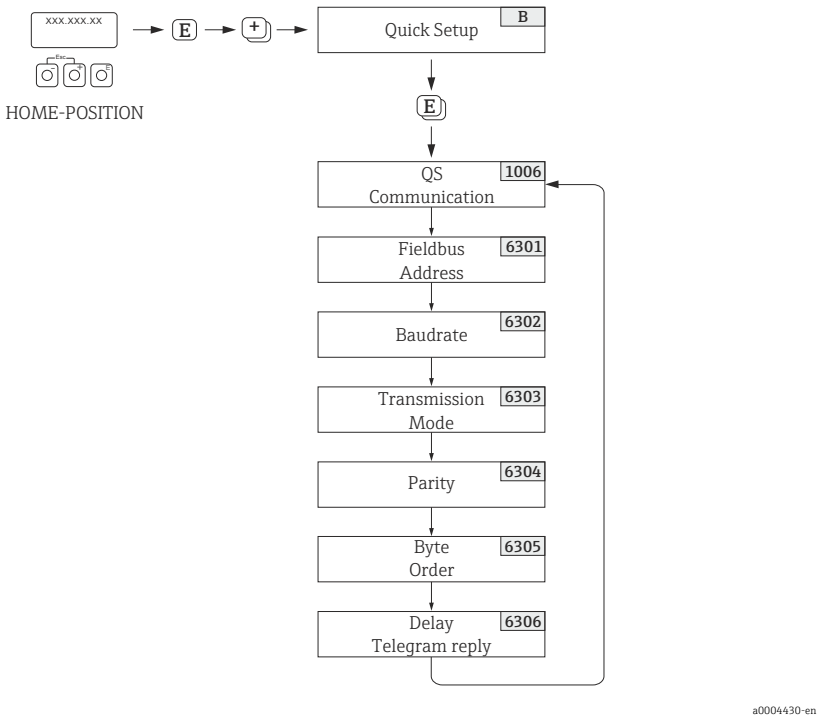


Fig. 68: Quick Setup communication

Quick Setup "Communication"		
HOME position → E → MEASURAND → ⊞ → QUICK SETUP → E → QUICK SETUP COMMUNICATION		
Function No.	Function name	Setting to be selected (⊞⊟) (to the next function with E)
1006	QS-COMMUNICATION	YES → After E is pressed by way of confirmation, the Quick Setup menu calls up all the subsequent functions in succession.
6301	FIELDBUS ADDRESS	Enter the device address (permitted address range: 1 to 247) **Factory setting:** 247
6302	BAUDRATE	Supported baudrates [BAUD]: 1200/2400/4800/9600/19200/38400/57600/115200 **Factory setting:** 19200 BAUD
6303	TRANSMISSION MODE	Select the data transfer mode: ▪ ASCII → Data transmission in the form of readable ASCII characters. Error protection via LRC. ▪ RTU → Data transmission in binary form. Error protection via CRC16. **Factory setting:** RTU
6304	PARITY	Selection depends on the "TRANSMISSION MODE" function: NONE; EVEN; ODD ▪ Available in the ASCII transfer mode → even or uneven parity bit (EVEN, ODD). ▪ Available in the RTU transfer mode → no parity bit (NONE) or even or uneven parity bit (EVEN, ODD). **Factory setting:** EVEN

Quick Setup "Communication"		
6305	BYTE ORDER	For selecting the byte transmission sequence for the Integer, Float and String data types: 0 - 1 - 2 - 3 3 - 2 - 1 - 0 2 - 3 - 0 - 1 1 - 0 - 3 - 2 **Factory setting:** 1 - 0 - 3 - 2 Note! The transmission sequence must suit the Modbus master.
6306	DELAY TELEGRAM REPLY	For entering a delay time after which the measuring device replies to the request telegram of the Modbus master. This allows communication to be adapted to slow Modbus masters: 0 to 100 ms **Factory setting:** 10 ms
Back to the HOME position: → Press and hold down the key for longer than three seconds or → Repeatedly press and release the key = Exit the function matrix step by step		

Note!
The parameters described in the table can be found in the "Modbus RS485" group of the "BASIC FUNCTION" block in the function matrix (see separate "Description of Device Functions" manual).

6.3.5 Data backup/transmission

Using the T-DAT SAVE/LOAD function, you can transfer data (device parameters and settings) between the T-DAT (exchangeable memory) and the EEPROM (device storage unit).

This is required in the following instances:
- Creating a backup: current data are transferred from an EEPROM to the T-DAT.
- Replacing a transmitter: current data are copied from an EEPROM to the T-DAT and then transferred to the EEPROM of the new transmitter.
- Duplicating data: current data are copied from an EEPROM to the T-DAT and then transferred to EEPROMs of identical measuring points.

Note!
For information on installing and removing the T-DAT → 115.

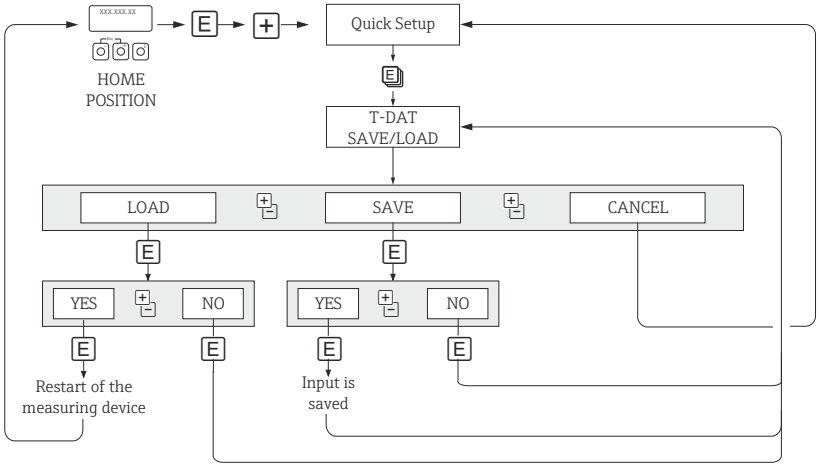


Fig. 69: Data backup/transmission with T-DAT SAVE/LOAD function

Information on the LOAD and SAVE options available:

LOAD: Data are transferred from the T-DAT to the EEPROM.

Note!
- Any settings already saved on the EEPROM are deleted.
- This option is only available, if the T-DAT contains valid data.
- This option can only be executed if the software version of the T-DAT is the same or newer than that of the EEPROM. Otherwise, the error message "TRANSM. SW-DAT" appears after restarting and the LOAD function is then no longer available.

SAVE:
Data are transferred from the EEPROM to the T-DAT.

6.4 Adjustment

6.4.1 Empty-pipe/Full-pipe adjustment

Flow cannot be measured correctly unless the measuring pipe is completely full.
This status can be monitored at all times with the Empty Pipe Detection function:
- EPD = Empty Pipe Detection (with the help of an EPD electrode).
- OED = Open Electrode Detection (Empty Pipe Detection with the help of the measuring electrodes, if the sensor is not equipped with an EPD electrode or the orientation is not suitable for using EPD).

Caution!
A **detailed** description and other helpful hints for the empty-pipe/full-pipe adjustment procedure can be found in the separate "Description of Device Functions" Manual:
- EPD/OED ADJUSTMENT (6481) → Carrying out the adjustment.
- EPD (6420) → Switching on and off EPD/OED.
- EPD RESPONSE TIME (6425) → Input of the response time for EPD/OED.

Note!
- The EPD function is not available unless the sensor is fitted with an EPD electrode.
- The devices are already calibrated at the factory with water (approx. 500 µS/cm). If the liquid conductivity differs from this reference, empty-pipe/full-pipe adjustment has to be performed again on site.
- The default setting for EPD/OED when the devices are delivered is OFF; the function has to be activated if required.
- The EPD/OED process error can be output by means of the configurable relay outputs.

Performing empty-pipe and full-pipe adjustment (EPD/OED)

1. Select the corresponding function in the function matrix:
   HOME → E → + → BASIC FUNCTIONS → E → + → PROCESS PARAMETERS → E → + → ADJUSTMENT → E → EPD/OED ADJUSTMENT
2. Empty the piping. In case of an EPD adjustment, the wall of the measuring tube should be wetted with fluid for the adjustment procedure but this is not the case with an OED adjustment!
3. Start empty-pipe adjustment: Select "EMPTY PIPE ADJUST" or "OED EMPTY ADJUST" and press E to confirm.
4. After empty-pipe adjustment, fill the piping with fluid.
5. Start full-pipe adjustment: Select "FULL PIPE ADJUST" or "OED FULL ADJUST" and press E to confirm.
6. Having completed the adjustment, select the setting "OFF" and exit the function by pressing E.
7. Now select the "EPD" function (6420). Switch on Empty Pipe Detection by selecting the following settings:
   – EPD → Select ON STANDARD or ON SPECIAL and press E to confirm.
   – OED → Select OED and confirm with E.

Caution!
The adjustment coefficients must be valid before you can activate the EPD/OED function. If adjustment is incorrect the following messages might appear on the display:
- ADJUSTMENT FULL = EMPTY
  The adjustment values for empty pipe and full pipe are identical. In such instances, empty-pipe adjustment/full-pipe adjustment **must** be carried out again.
- ADJUSTMENT NOT OK
  Adjustment is not possible because the fluid's conductivity is out of range.

6.5 Data memory

At Endress+Hauser, the term HistoROM refers to various types of data storage modules on which process and measuring device data is stored. By plugging and unplugging such modules, device configurations can be duplicated onto other measuring devices to cite just one example.

6.5.1 HistoROM/S-DAT (sensor-DAT)

The S-DAT is an exchangeable data memory in which all sensor relevant parameters are stored, i.e., diameter, serial number, calibration factor, zero point.

6.5.2 HistoROM/T-DAT (transmitter-DAT)

The T-DAT is an exchangeable data memory in which all transmitter parameters and settings are stored.
Storing of specific parameter settings from the device memory (EEPROM) to the T-DAT module and vice versa has to be carried out by the user (= manual save function). Detailed information about the procedure → 🖹 98.

6.5.3 F-CHIP (Function-Chip)

The F-Chip is a microprocessor chip that contains additional software packages that extend the functionality and application possibilities of the transmitter.
In the case of a later upgrade, the F-CHIP can be ordered as an accessory and can simply be plugged on to the I/O board. After start up, the software is immediately made available to the transmitter.
Accessories → 🖹 102
Plugging on to the I/O board → 🖹 115

Caution!
To ensure an unambiguous assignment, the F-CHIP is coded with the transmitter serial number once it is plugged in. Thus, it can not be reused with other measuring devices.

7 Maintenance

No special maintenance work is required.

7.1 Exterior cleaning

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

7.2 Seals

The seals of the Promag H sensor must be replaced periodically, particularly in the case of molded seals (aseptic version). The period between changes depends on the frequency of cleaning cycles, the cleaning temperature and the fluid temperature.

Replacement seals (accessories) → 102.

8 Accessories

Various accessories, which can be ordered separately or with the device from Endress+Hauser, are available for the device. Detailed information can be provided by the Endress+Hauser service organization or can be found on the product page of the Endress+Hauser website: www.endress.com

8.1 Device-specific accessories

Accessory	Description	Order code
Promag 53 transmitter	Transmitter for replacement or for stock. Use the order code to define the following specifications: ▪ Approvals ▪ Degree of protection / version ▪ Cable type for the remote version ▪ Cable entries ▪ Display / power supply / operation ▪ Software ▪ Outputs / inputs	53XXX – XXXXX * * * * * * * *
Conversion kit for inputs/ outputs	Conversion kit with appropriate plug-in point sub-modules for converting the input/output configuration in place to date to a new version.	DKUI – * *
Software packages for Promag 53	Software add-ons on F-CHIP, can be ordered individually: ▪ Electrode Cleaning Circuitry (ECC) ▪ Batching	DK5SO – *

8.2 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting kit for Promag 53 transmitter	Mounting kit for wall-mounted housing (remote version). Suitable for: ▪ Wall mounting ▪ Pipe mounting ▪ Panel mounting Mounting set for aluminum housings. Suitable for: ▪ Pipe mounting	DK5WM – *
Cable for remote version	Coil and electrode cables, various lengths. Reinforced cable on request.	DK5CA – * *
Ground cable for Promag E/L/P/W	A set consists of two ground cables.	DK5GC – * * *
Ground disk for Promag E/L/P/W	Ground disk for potential matching	DK5GD * * *
Mounting kit for Promag H	Mounting kit for Promag H, comprising: ▪ 2 process connections ▪ Screws ▪ Seals	DKH * * – * * * *
Adapter connection for Promag A, H	Adapter connections for installing Promag 53 H instead of Promag 30/33 A or Promag 30/33 H DN 25.	DK5HA – * * * * * *
Ground rings for Promag H	If the process connections are made of PVC or PVDF, ground rings are necessary to ensure that potential is matched. A set comprises 2 ground rings.	DK5HR – * * * *
Set of seals for Promag H	For regular replacement of the seals of the Promag H sensor.	DK5HS – * * *
Wall-mounting kit for Promag H	Wall-mounting kit for the Promag H sensor.	DK5HM – * *
Welding jig for Promag H	Weld nipples as process connection: Welding jig for installation in pipes.	DK5HW – * * *

8.3 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and configuring flowmeters. Applicator can be downloaded from the Internet or ordered on CD-ROM for installation on a local PC. Contact your Endress+Hauser representative for more information.	DKA80 – *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	FieldCare is Endress+Hauser's FDT-based plant Asset Management Tool. It can configure all the intelligent field units in your system and helps you manage these units. By providing status information, it is also a simple but effective method of controlling the units' status.	See the product page on the Endress+Hauser website: www.endress.com
FXA193	The FXA193 service interface connects the device to the PC for configuration via FieldCare.	FXA193 – *
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific power consumption, boiler efficiency and other parameters which are important for efficient energy management.	RSG40-**********

9 Troubleshooting

9.1 Troubleshooting instructions

Always start troubleshooting with the checklist below, if faults occur after startup or during operation. The routine takes you directly to the cause of the problem and the appropriate remedial measures.

Check the display	
No display visible and no output signals present.	1. Check the supply voltage → Terminals 1, 2 2. Check device fuse → 🖹 120 85 to 260 V AC: 0.8 A slow-blow / 250 V 20 to 55 V AC and 16 to 62 V DC: 2 A slow-blow / 250 V 3. Measuring electronics defective → order spare parts → 🖹 115
No display visible, but output signals are present.	1. Check whether the ribbon-cable connector of the display module is correctly plugged into the amplifier board → 🖹 115 2. Display module defective → order spare parts → 🖹 115 3. Measuring electronics defective → order spare parts → 🖹 115
Display texts are in a foreign language.	Switch off power supply. Press and hold down both the ⊞⊟ keys and switch on the measuring device. The display text will appear in English (default) and is displayed at maximum contrast.
Measured value indicated, but no signal at the current or pulse output	Measuring electronics defective → order spare parts → 🖹 115

▼

Error messages on display	
Errors which occur during commissioning or measuring operation are displayed immediately. Error messages consist of a variety of icons. The meanings of these icons are as follows (example): – Type of error: **S** = system error, **P** = process error – Error message type: ϟ = fault message, **!** = notice message – **EMPTY PIPE** = Type of error, e.g. measuring tube is only partly filled or completely empty – **03:00:05** = Duration of error occurrence (in hours, minutes and seconds) – **#401** = error number ☞ Caution! ▪ See the information on → 🖹 68. ▪ The measuring system interprets simulations and positive zero return as system errors, but displays them as notice messages only.	
Error number: No. 001 - 399 No. 501 - 699	System error (device error) has occurred→ 🖹 105
Error number: No. 401 - 499	Process error (application error) has occurred→ 🖹 110

▼

Other error (without error message)	
Other errors are present	Diagnosis and rectification → 🖹 112

9.2 System error messages

Serious system errors are **always** recognized by the instrument as "Fault message", and are shown as a lightning flash (ϟ) on the display. Fault messages immediately affect the inputs and outputs. Simulations and positive zero return, on the other hand, are classed and displayed as "Notice messages".

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Important procedures must be carried out before you return a flowmeter to Endress+Hauser → 123.
Always enclose a duly completed "Declaration of contamination" form. You will find a preprinted blank of this form at the back of this manual.

Note!
- The error types listed in the following correspond to the factory settings.
- See the information on → 68.

Modbus **Register: 6859 Data type: Integer**	**Register: 6821 Data type: String (18 byte)**	**No.**	**Device status message (local display)**	**Cause**	**Remedy (spare part → 115)**
Response to a fault message: The value "NaN" (not a number) is transmitted to the Modbus master instead of the current measured value.			**Depicted on the local display:** S = System error ϟ = Fault message (with an effect on the inputs and outputs) ! = Notice message (without any effect on the inputs and outputs)		
1	SYSTEM OK	-	*There is no error present in the device*		
No. # 0xx → Hardware error					
2	CRITICAL FAIL.	**001**	S: CRITICAL FAILURE ϟ: # 001	Serious device error.	Replace amplifier board.
3	AMP HW EEPROM	**011**	S: AMP HW EEPROM ϟ: # 011	Amplifier: faulty EEPROM.	Replace amplifier board.
4	AMP SW EEPROM	**012**	S: AMP SW EEPROM ϟ: # 012	Amplifier: Error accessing EEPROM data.	The EEPROM data blocks in which an error has occurred are displayed in the "TROUBLESHOOTING" function (No. 8047). Press Enter to acknowledge the errors in question; default values are automatically inserted instead of the faulty parameter values. Note! The measuring device must be restarted after fault elimination.
11	SENSOR HW DAT	**031**	S: SENSOR HW DAT ϟ: # 031	Sensor DAT: 1. S-DAT is defective. 2. S-DAT is not plugged into the amplifier board or is missing.	1. Check whether the S-DAT is correctly plugged into the amplifier board. 2. Replace the S-DAT if it is defective. Check that the new replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. 4. Plug the S-DAT into the amplifier board.
12	SENSOR SW DAT	**032**	S: SENSOR SW DAT ϟ: # 032	Sensor: Error accessing the adjustment values stored in the S-DAT.	

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy (spare part → 📄 115)
13	TRANSM. HW-DAT	**041**	S: TRANSM. HW-DAT ϟ: # 041	Transmitter DAT: 1. T-DAT is defective. 2. T-DAT is not plugged into the amplifier board or is missing.	1. Check whether the T-DAT is correctly plugged into the amplifier board. 2. Replace the T-DAT if it is defective. Check that the new replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. 4. Plug the T-DAT into the amplifier board.
14	TRANSM. SW-DAT	**042**	S: TRANSM. SW-DAT ϟ: # 042	Transmitter: Error accessing the adjustment values stored in the T-DAT.	
115	HW F-CHIP	**061**	S: HW F-CHIP ϟ: # 061	Transmitter F-Chip: 1. F-Chip is defective. 2. F-CHIP is not plugged into the I/O board or is missing.	1. Replace the F-CHIP. 2. Plug the F-CHIP into the I/O board
No. # 1xx → Software error					
19	GAIN ERROR AMP	**101**	S: GAIN ERROR AMP ϟ: # 101	Gain deviation compared to reference gain is greater than 2%.	Replace amplifier board.
114	A/C SW COMPATIB.	**121**	S: A / C COMPATIB. !: # 121	Due to different software versions, I/O board and amplifier board are only partially compatible (possibly restricted functionality). ✎ Note! ▪ The indication on the display as notice message appears only for 30 seconds (with listing in "Previous system condition" function). ▪ This condition can occur if only one electronics board has been exchanged; the extended software functionality is not available. The previously existing software functionality is still working and the measurement possible.	Module with lower software version has either to be updated by "FieldCare" with the required software version or the module has to be replaced.
No. # 2xx → Error in DAT/no communication					
22	LOAD T-DAT	**205**	S: LOAD T-DAT !: # 205	Transmitter DAT: Data back-up (downloading) to T-DAT failed or Error when accessing (uploading) the values stored in the T-DAT.	1. Check whether the T-DAT is correctly plugged into the amplifier board. 2. Replace the T-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary.
23	SAVE T-DAT	**206**	S: SAVE T-DAT !: # 206		

Modbus Register: 6859 Data type: Integer	Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy (spare part → 🖹 115)
28	COMMUNIC. I/O	**261**	S: COMMUNICATION I/O ϟ: # 261	No data reception between amplifier and I/O board or faulty internal data transfer.	Check the BUS contacts.
No. # 3xx → System limits exceeded					
32	TOL.COIL CURR.	**321**	S: TOL. COIL CURR. ϟ: # 321	Sensor: Coil current is out of tolerance.	⚠ Warning! Switch off power supply before manipulating the coil current cable, coil current cable connector or measuring electronics boards! Remote version: 1. Check wiring of terminals 41/42 → 🖹 50 2. Check coil current cable connector. Compact and remote version: If the error can not be resolved, please contact your local Endress+Hauser service organization.
102 to 105	STACK CUR. OUT n	**339 to 342**	S: STACK CUR OUT n ϟ: # 339 to 342	The temporarily buffered flow portions (measuring mode for pulsating flow) could not be cleared or output within 60 seconds.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable. Recommendation in the event of fault category FAULT MESS. (ϟ): ▪ Configure the fault response of the output to "ACTUAL VALUE", so that the temporary buffer can be cleared. ▪ Clear the temporary buffer by the measures described under Item 1.
106 to 109	STACK FREQ. OUT n	**343 to 346**	S: STACK FREQUENCY OUTPUT n ϟ: # 343 to 346		
110 to 113	STACK PULSE n	**347** to **350**	S: STACK PULSE OUT n ϟ: # 347 to 350	The temporarily buffered flow portions (measuring mode for pulsating flow) could not be cleared or output within 60 seconds.	1. Increase the setting for pulse weighting. 2. Increase the max. pulse frequency, if the totalizer can handle a higher number of pulses. 3. Increase or reduce flow, as applicable. Recommendation in the event of fault category FAULT MESS. (ϟ): – Configure the fault response of the output to "ACTUAL VALUE", so that the temporary buffer can be cleared. – Clear the temporary buffer by the measures described under Item 1.
39 to 42	RANGE CUR. OUT n	**351 to 354**	S: CURRENT RANGE n !: # 351 to 354	Current output: The actual value for the flow lies outside the set limits.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable.
43 to 46	RANGE FREQ. OUT n	**355 to 358**	S: FREQ. RANGE n !: # 355 to 358	Frequency output: The actual value for the flow lies outside the set limits.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable.

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy (spare part → 📄 115)
47 to 50	RANGE PULSE n	**359 to 362**	S: PULSE RANGE !: # 359 to 362	Pulse output: Pulse output frequency is out of range.	1. Increase the setting for pulse weighting. 2. When selecting the pulse width, choose a value that can still be processed by a connected counter (e.g. mechanical counter, PLC, etc.). *Determine the pulse width:* – Version 1: Enter the minimum duration that a pulse must be present at the connected counter to ensure its registration. – Variant 2: Enter the maximum (pulse) frequency as the half "reciprocal value" that a pulse must be present at the connected counter to ensure its registration. *Example:* The maximum input frequency of the connected counter is 10 Hz. The pulse width to be entered is: $\frac{1}{2 \cdot 10\ \text{Hz}} = 50\ \text{ms}$ a0004437 3. Reduce flow
No. # 5xx → Application error					
60	SW. UPDATE ACT	**501**	S: SW.-UPDATE ACT. !: # 501	New software version for the amplifier or communication (I/O module) is loaded. Currently no other functions are possible.	Wait until process is finished. The device will restart automatically.
61	UP/DOWNL. ACT	**502**	S: UP-/DOWNLOAD ACT. !: # 502	Up- or downloading the device data via configuration program. Currently no other functions are possible.	Wait until process is finished.
100	BATCH RUNNING	**571**	S: BATCH RUNNING !: # 571	Batching is started and active (valves are open)	No measures needed (during the batching process some other functions may not be activated).
101	BATCH HOLD	**572**	S: BATCH HOLD !: # 572	Batching has been interrupted (valves are closed)	Remedy optionally via: ▪ Modbus RS485 ▪ Local display – Continue batching with "GO ON". – Interrupt batching with "STOP".
No. # 6xx → Simulation mode active					
64	POS.ZERO -RET.	**601**	S: POS. ZERO-RETURN !: # 601	Positive zero return active. ☝ Caution! This message has the highest display priority!	Switch off positive zero return.
65 to 68	SIM. CURR. OUT n	**611 to 614**	S: SIM. CURR. OUT. n !: # 611 to 614	Simulation current output active.	Switch off simulation.

Modbus Register: 6859 Data type: Integer	 Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy (spare part → 🖹 115)
69 to 72	SIM FREQ.OUT n	**621 to 624**	S: SIM. FREQ. OUT. n !: # 621 to 624	Simulation frequency output active.	Switch off simulation.
73 to 76	SIM. PULSE n	**631 to 634**	S: SIM. PULSE n !: # 631 to 634	Simulation pulse output active.	Switch off simulation.
77 to 80	SIM. STAT. OUT n	**641 to 644**	S: SIM. STAT. OUT n !: # 641 to 644	Simulation status output active.	Switch off simulation.
81 to 84	SIM. REL.OUT n	**651 to 654**	S: SIM. RELAY n !: # 651 to 654	Simulation relay output active.	Switch off simulation.
89 to 92	SIM. STATUS IN n	**671 to 674**	S: SIM. STATUS IN n !: # 671 to 674	Simulation status input active.	Switch off simulation.
93	SIM. FAILSAFE	**691**	S: SIM. FAILSAFE ϟ: # 691	Simulation of response to error (outputs) active.	Switch off simulation.
94	SIM. MEASURAND	**692**	S: SIM. MEASURAND !: # 692	Simulation of a measurand active.	Switch off simulation.
121	DEV. TEST ACT.	**698**	S: DEV. TEST ACT. !: # 698	The measuring device is being checked on-site using the test and simulation device.	–

9.3 Process error messages

Process errors can be defined as either "Fault" or "Notice" messages and can thereby be weighted differently. You can define messages in this way with the aid of the function matrix (→ "Description of Device Functions" manual).

Note!
- The listed error message types below correspond to the factory setting.
- See the information on → 🖹 68.

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
Response to a fault message: The value "NaN" (not a number) is transmitted to the Modbus master instead of the current measured value.			**Depicted on the local display:** S = System error ϟ = Fault message (with an effect on the inputs and outputs) ! = Notice message (without any effect on the inputs and outputs)		
1	SYSTEM OK	-	*There is no error present in the device*		
52	EMPTY PIPE	**401**	P: EMPTY PIPE ϟ: # 401	Measuring tube partially filled or empty.	1. Check the process conditions of the plant 2. Fill the measuring tube
55	EPD ADJ N.OK	**461**	P: ADJ N. OK !: # 461	EPD/OED adjustment not possible because the fluid's conductivity is either too low or too high.	The EPD/OED function cannot be used with fluids of this nature.
57	EPD FULL = EMPTY	**463**	P: FULL = EMPTY ϟ: # 463	The EPD/OED adjustment values for empty pipe and full pipe are identical, therefore incorrect.	Repeat adjustment, making sure procedure is correct → 🖹 99.
97	> BATCH TIME	**471**	P: > BATCH TIME ϟ: # 471	The maximum permitted batching time was exceeded.	1. Increase flow rate. 2. Check valve (opening). 3. Adjust time setting to changed batch quantity. Note! If the errors listed above occur, these are displayed in the Home position flashing continuously. ▪ General: These error messages can be reset by configuring any batching parameter. It is sufficient to confirm with the OS key and then the F key. ▪ Batching via status input: The error message can be reset by means of a pulse. Another pulse then restarts the batching. ▪ Batching via operating keys (soft keys) The error message is reset by pressing the START key. Pressing the START key a second time starts the batching process. ▪ Batching via the BATCHING PROCESS function (7260): The error message can be reset by pressing the STOP, START, HOLD or GO ON keys. Pressing the START key a second time starts the batching process.

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
98	>< BATCH QUANT.	**472**	P: >< BATCH QUANTITY ϟ: # 472	*Underbatching:* The minimum quantity was not reached. *Overbatching:* The maximum permitted batching quantity was exceeded.	Underbatching: 1. Increase fixed correction quantity. 2. Valve closes too quickly with active after run correction. Enter smaller after run as mean value. 3. If the batching quantity changes, the minimum batching quantity must be adjusted. Overbatching: 1. Reduce fixed correction quantity. 2. Valve closes too slowly with active after run correction. Enter larger after run as mean value. 3. If the batching quantity changes, the maximum batching quantity must be adjusted. ✎ Note! Please observe Note in error message No. 471
99	PROGRESS NOTE	**473**	P: PROGRESS NOTE !: # 473	End of filling process approaching. The running filling process has exceeded the predefined batch quantity point for the display warning message.	No measures required (if necessary prepare to replace container).
122	> MAX.FLOW RATE	**474**	P: > MAX. FLOW RATE ϟ: # 474	Maximum flow value entered is exceeded.	Reduce the flow value. ✎ Note! Please observe Note in error message No. 471

9.4 Process errors without messages

Symptoms	Rectification
✎ Note! You may have to change or correct certain settings of the function matrix in order to rectify faults. The functions outlined below, such as DISPLAY DAMPING, for example, are described in detail in the "Description of Device Functions" manual.	
Flow values are negative, even though the fluid is flowing forwards through the pipe.	1. Remote version: – Switch off the power supply and check the wiring → 🖹 50 – If necessary, reverse the connections at terminals 41 and 42 2. Change the setting in the INSTALLATION DIRECTION SENSOR function accordingly
Measured-value reading fluctuates even though flow is steady.	1. Check grounding and potential matching. → 🖹 57 2. The medium is too inhomogeneous. Check the following medium characteristics: – Gas bubble percentage too high? – Solids percentage too high? – Conductivity fluctuations too high? 3. SYSTEM DAMPING function → increase value (→ BASIC FUNCTION/SYSTEMPARAMETER/ CONFIGURATION) 4. TIME CONSTANT function → increase the value (→ OUTPUTS/CURRENT OUTPUT/CONFIGURATION) 5. DISPLAY DAMPING function → increase the value (→ USER INTERFACE/CONTROL/BASIC CONFIGURATION)
Measured-value reading or measured-value output pulsates or fluctuates, e.g. because of reciprocating pump, peristaltic pump, diaphragm pump or pump with similar delivery characteristic.	Perform the "Pulsating flow" Quick Setup (only possible if a pulse/frequency output is available) → 🖹 90. If the problem persists despite these measures, a pulsation damper will have to be installed between pump and measuring device.
There are differences between the flowmeter's internal totalizer and the external metering device.	This symptom is due primarily to backflow in the piping because the pulse output cannot subtract in the STANDARD or SYMMETRY measuring modes. The problem can be solved as follows: Allow for flow in both directions. Set the MEASURING MODE function to PULSATING FLOW for the pulse output in question.
Measured value reading shown on display, even though the fluid is at a standstill and the measuring tube is full.	1. Check grounding and potential matching → 🖹 57. 2. Check the fluid for presence of gas bubbles. 3. Activate the ON-VALUE LOW FLOW CUT OFF function, i.e. enter or increase the value for the low flow cut off (→ BASIC FUNCTIONS / PROCESS PARAMETERS / CONFIGURATION).
Measured-value reading on display, even though measuring tube is empty.	1. Perform empty-pipe/full-pipe adjustment and then switch on Empty Pipe Detection → 🖹 99. 2. Remote version: Check the terminals of the EPD cable → 🖹 50. 3. Fill the measuring tube.
The current output signal is always 4 mA, irrespective of the flow signal at any given time.	Value for creepage too high: Reduce the corresponding value in the ON-VALUE LOW FLOW CUT OFF function.
The fault cannot be rectified or some other fault not described above has arisen. In these instances, please contact your Endress+Hauser service organization.	The following options are available for tackling problems of this nature: ▪ **Request the services of an Endress+Hauser service technician** If you contact our service organization to have a service technician sent out, please be ready to quote the following information: – Brief description of the fault – Nameplate specifications: order code, serial number → 🖹 6 ▪ **Returning devices to Endress+Hauser** The required procedures must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. → 🖹 123 Always enclose a duly completed "Declaration of contamination" form with the flowmeter. You will find a preprinted form at the back of these Operating Instructions. ▪ **Replace transmitter electronics** Components in the measuring electronics defective → order spare parts → 🖹 115.

9.5 Response of outputs to errors

Note!
The failsafe mode of totalizers, current, pulse and frequency outputs can be customized by means of various functions in the function matrix. You will find detailed information on these procedures in the "Description of Device Functions" manual.

You can use positive zero return to reset the signals of the current, pulse and frequency outputs to their fallback value, or reset measured value transmission via fieldbus to "0", for example when measuring has to be interrupted while a pipe is being cleaned. This function takes priority over all other device functions. Simulations, for example, are suppressed.

Failsafe mode of outputs and totalizers		
	System/process error is present	**Positive zero return is activated**
Caution! System or process errors defined as "Notice messages" have no effect whatsoever on the inputs and outputs. See the information on → 68		
Current output	MINIMUM VALUE 0–20 mA → 0 mA 4–20 mA → 2 mA 4–20 mA NAMUR →3.5 mA 4–20 mA US → 3.75 mA 0–20 mA (25 mA) → 0 mA 4–20 mA (25 mA) → 2 mA MAXIMUM VALUE 0–20 mA → 22 mA 4–20 mA → 22 mA 4–20 mA NAMUR →22.6 mA 4–20 mA US → 22.6 mA 0–20 mA (25 mA) → 25 mA 4–20 mA (25 mA) → 25 mA HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured-value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Pulse output	FALLBACK VALUE Signal output → no pulses HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured-value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Frequency output	FALLBACK VALUE Signal output → 0 Hz FAILSAFE VALUE Output of the frequency specified in the FAILSAFE VALUE function. HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured-value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"

Failsafe mode of outputs and totalizers		
	System/process error is present	**Positive zero return is activated**
Totalizer	STOP The totalizers are paused until the error is rectified. ACTUAL VALUE Fault is ignored, i.e. the totalizer continues to count according to the current flow value. HOLD VALUE The totalizers continue to count the flow in accordance with the last valid flow value (before the error occurred).	Totalizer stops
Relay output	In the event of a fault or power supply failure: Relay → deenergized The "Description of Device Functions" manual contains detailed information on relay switching response for various configurations such as error message, flow direction, EPD, limits, etc.	No effect on relay output
Modbus RS485	In the event of faults, the value "NaN" (not a number) is transmitted instead of the current measured value.	-

9.6 Spare parts

The previous sections contain a detailed troubleshooting guide → 📄 104.
The measuring device, moreover, provides additional support in the form of continuous self-diagnosis and error messages.
Fault rectification can entail replacing defective components with tested spare parts. The illustration below shows the available scope of spare parts.

Note!
You can order spare parts directly from your Endress+Hauser service organization by providing the serial number printed on the transmitter's nameplate → 📄 6.

Spare parts are shipped as sets comprising the following parts:
- Spare part
- Additional parts, small items (screws, etc.)
- Mounting instructions
- Packaging

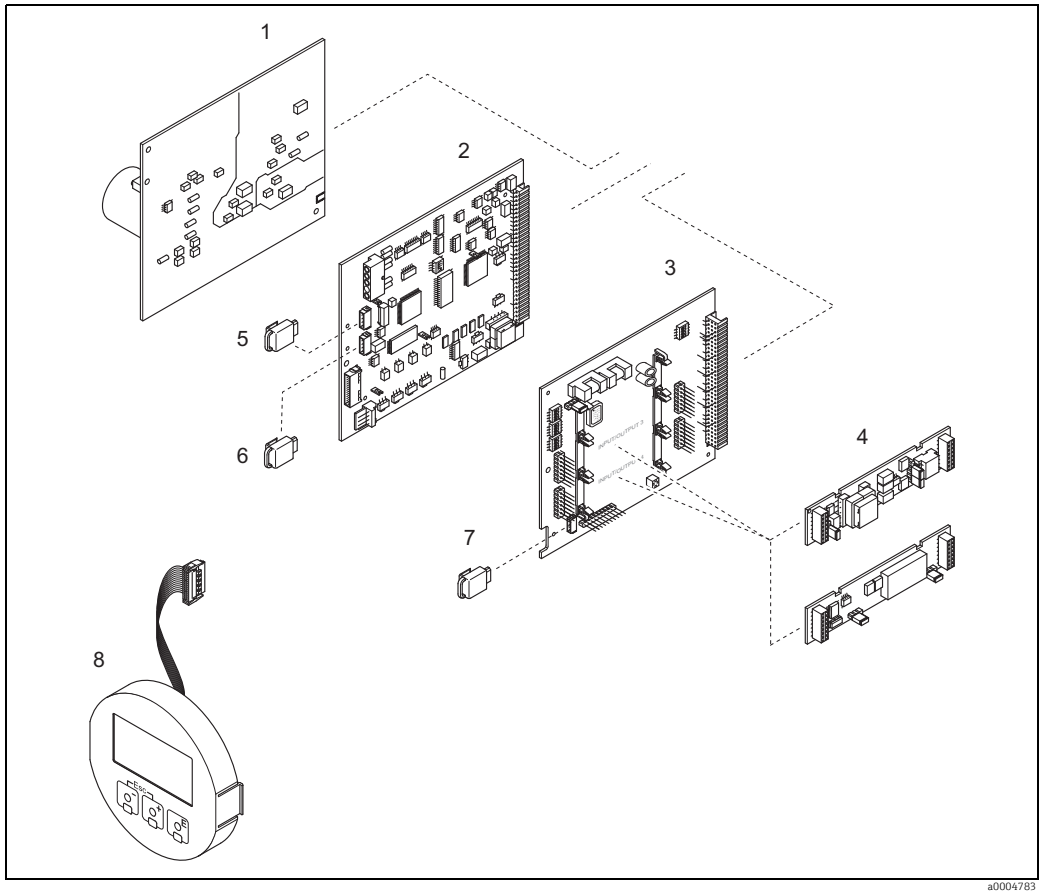


Fig. 70: Spare parts for transmitter (field and wall-mount housings)

1 Power unit board (85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC)
2 Amplifier board
3 I/O board (COM module), flexible assignment
4 Pluggable sub-modules (inputs/outputs); ordering structure → 📄 102
5 S-DAT (sensor data memory)
6 T-DAT (transmitter data memory)
7 F-CHIP (function chip for optional software)
8 Display module

9.6.1 Removing and installing printed circuit boards

Field housing

Warning!
- Risk of electric shock. Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purpose-built for electrostatically sensitive devices!
- If you cannot guarantee that the dielectric strength of the device is maintained in the following steps, then an appropriate inspection must be carried out in accordance with the manufacturer's specifications.
- When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions.

Caution!
Use only original Endress+Hauser parts.

Installing and removing printed circuit boards → 71:

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the local display (1) as follows:
   – Press in the latches (1.1) at the side and remove the display module.
   – Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
3. Remove the screws and remove the cover (2) from the electronics compartment.
4. Remove power unit board (4) and I/O board (6):
   Insert a thin pin into the hole (3) provided for the purpose and pull the board clear of its holder.
5. Removing sub-modules (6.2, only for measuring devices with convertible I/O board):
   No tools are required for removing the submodules (inputs/outputs) from the I/O board. Installation is also a no-tools operation.

   Caution!
   Only certain combinations of submodules on the I/O board are permissible → 56.
   The individual slots are marked and correspond to certain terminals in the connection compartment of the transmitter:
   – "INPUT / OUTPUT 3" slot = terminals 22/23
   – "INPUT / OUTPUT 4" slot = terminals 20/21
6. Remove amplifier board (5):
   – Disconnect the plug of the electrode cable (5.1) including S-DAT (5.3) from the board.
   – Loosen the plug locking of the coil current cable (5.2) and gently disconnect the plug from the board, i.e. without moving it back and forward.
   – Insert a thin pin into the hole (3) provided for the purpose and pull the board clear of its holder.
7. Installation is the reverse of the removal procedure.

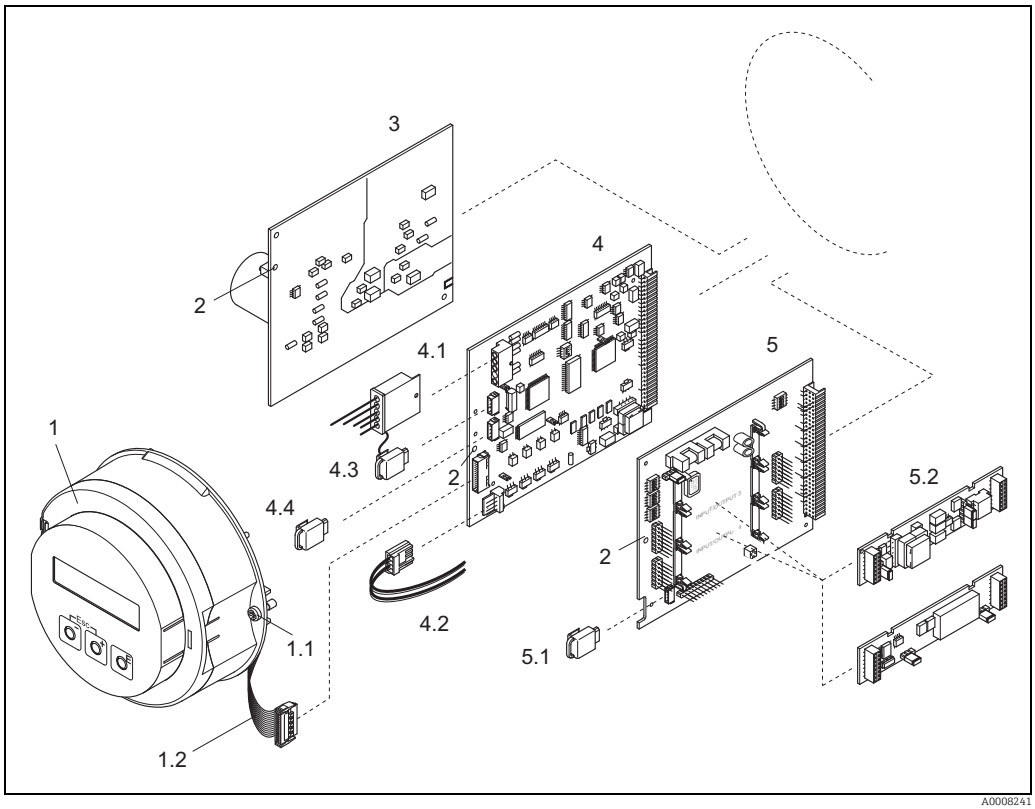


Fig. 71: Field housing: removing and installing printed circuit boards

1 Local display
1.1 Screws of electronics compartment cover
1.2 Ribbon cable (display module)
2 Aperture for installing/removing boards
3 Power unit board
4 Amplifier board
4.1 Electrode cable (sensor)
4.2 Coil current cable (sensor)
4.3 S-DAT (sensor data memory)
4.4 T-DAT (transmitter data memory)
5 I/O board (flexible assignment)
5.1 F-CHIP (function chip for optional software)
5.2 Pluggable sub-modules (current, pulse/frequency and relay output)

Wall-mount housing

Warning!
- Risk of electric shock. Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purpose-built for electrostatically sensitive devices!
- If you cannot guarantee that the dielectric strength of the device is maintained in the following steps, then an appropriate inspection must be carried out in accordance with the manufacturer's specifications.
- When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions.

Caution!
Use only original Endress+Hauser parts.

Installing and removing the circuit boards → 72:

1. Remove the screws and open the hinged cover (1) of the housing.
2. Remove the screws securing the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mount housing.
3. Disconnect the following cable plugs from amplifier board (7):
   – Electrode cable plug (7.1) including S-DAT (7.3)
   – Plug of coil current cable (7.2):
     Loosen the plug locking and gently disconnect the plug from the board, i.e. without moving it back and forward.
   – Ribbon cable plug (3) of the display module.
4. Remove the cover (4) from the electronics compartment by loosening the screws.
5. Remove the boards (6, 7, 8):
   (5) Insert a thin pin into the hole provided for the purpose and pull the board clear of its holder.
6. Removing sub-modules (8.2, only for measuring devices with convertible I/O board):
   No tools are required for removing the submodules (inputs/outputs) from the I/O board. Installation is also a no-tools operation.

   Caution!
   Only certain combinations of submodules on the I/O board are permissible → 56. The individual slots are marked and correspond to certain terminals in the connection compartment of the transmitter:

   "INPUT / OUTPUT 3" slot = terminals 22/23
   "INPUT / OUTPUT 4" slot = terminals 20/21
7. Installation is the reverse of the removal procedure.

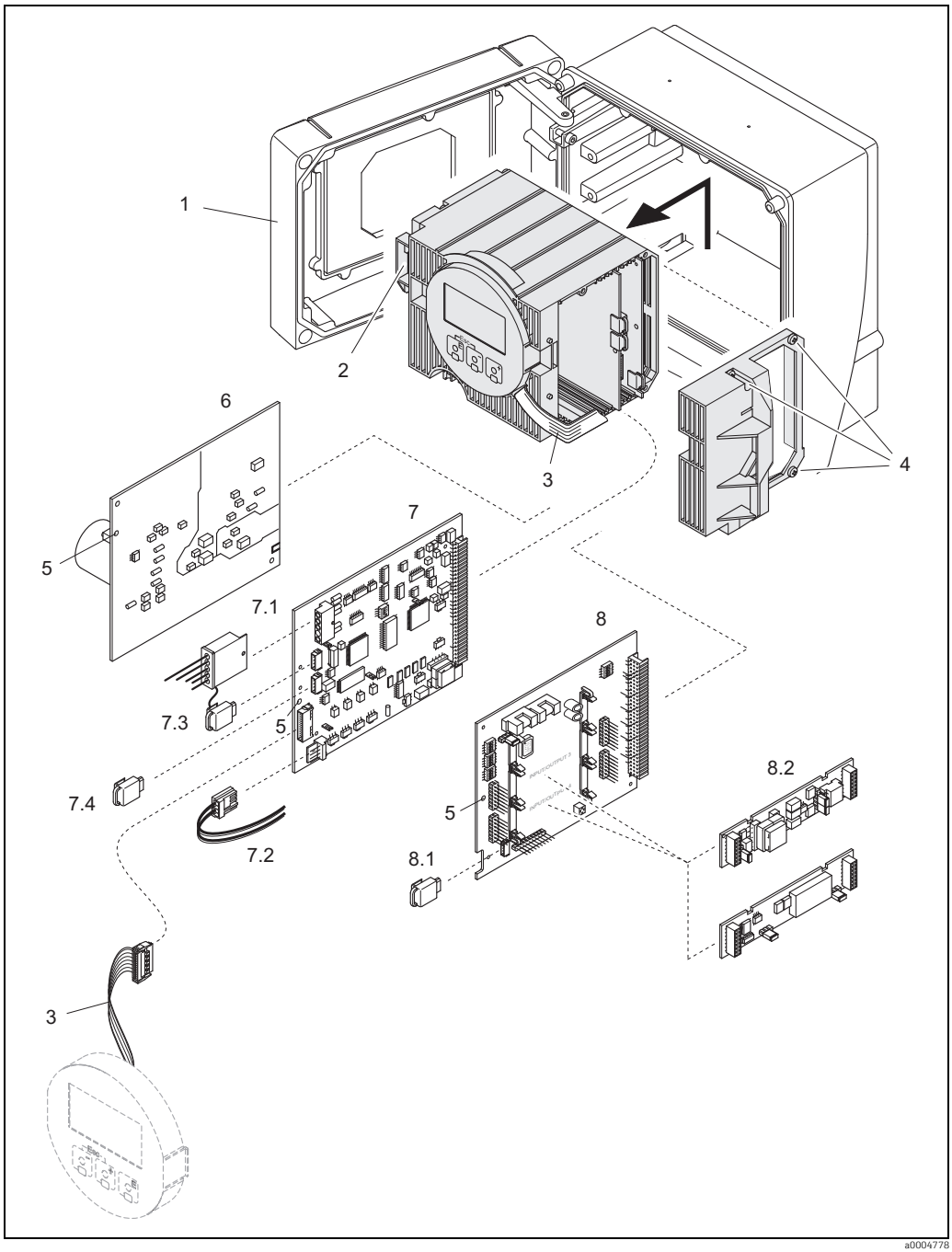


Fig. 72: Wall-mount housing: removing and installing printed circuit boards

1 Housing cover
2 Electronics module
3 Ribbon cable (display module)
4 Screws of electronics compartment cover
5 Aperture for installing/removing boards
6 Power unit board
7 Amplifier board
7.1 Electrode cable (sensor)
7.2 Coil current cable (sensor)
7.3 S-DAT (sensor data memory)
7.4 T-DAT (transmitter data memory)
8 I/O board (flexible assignment)
8.1 F-CHIP (function chip for optional software)
8.2 Pluggable sub-modules (current, pulse/frequency and relay output)

9.6.2 Replacing the device fuse

Warning!
Risk of electric shock. Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

The main fuse is on the power supply board → 73.
The procedure for replacing the fuse is as follows:

1. Switch off power supply.
2. Remove power unit board → 116.
3. Remove cap (1) and replace the device fuse (2).
   Use only the following types of fuses:
   – 85 to 260 V AC: 0.8 A slow-blow / 250 V
     20 to 55 V AC and 16 to 62 V DC: 2 A slow-blow / 250 V
   – Ex-rated devices → See the Ex documentation
4. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

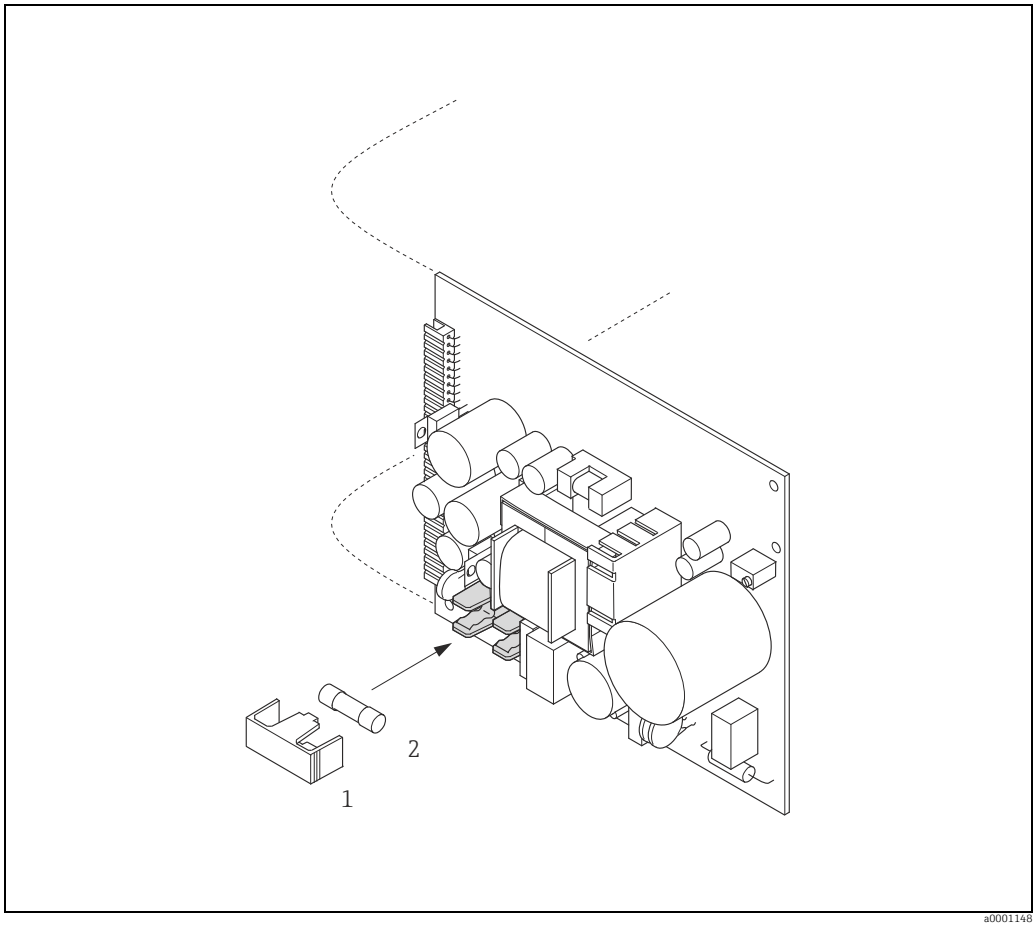


Fig. 73: Replacing the device fuse on the power supply board

1 Protection cap
2 Device fuse

9.6.3 Replacing the exchangeable electrode

The Promag W sensor (DN 350 to 2000 / 14 to 78") can be supplied with optional exchangeable measuring electrodes. This design allows the measuring electrodes to be exchanged or cleaned under process conditions.

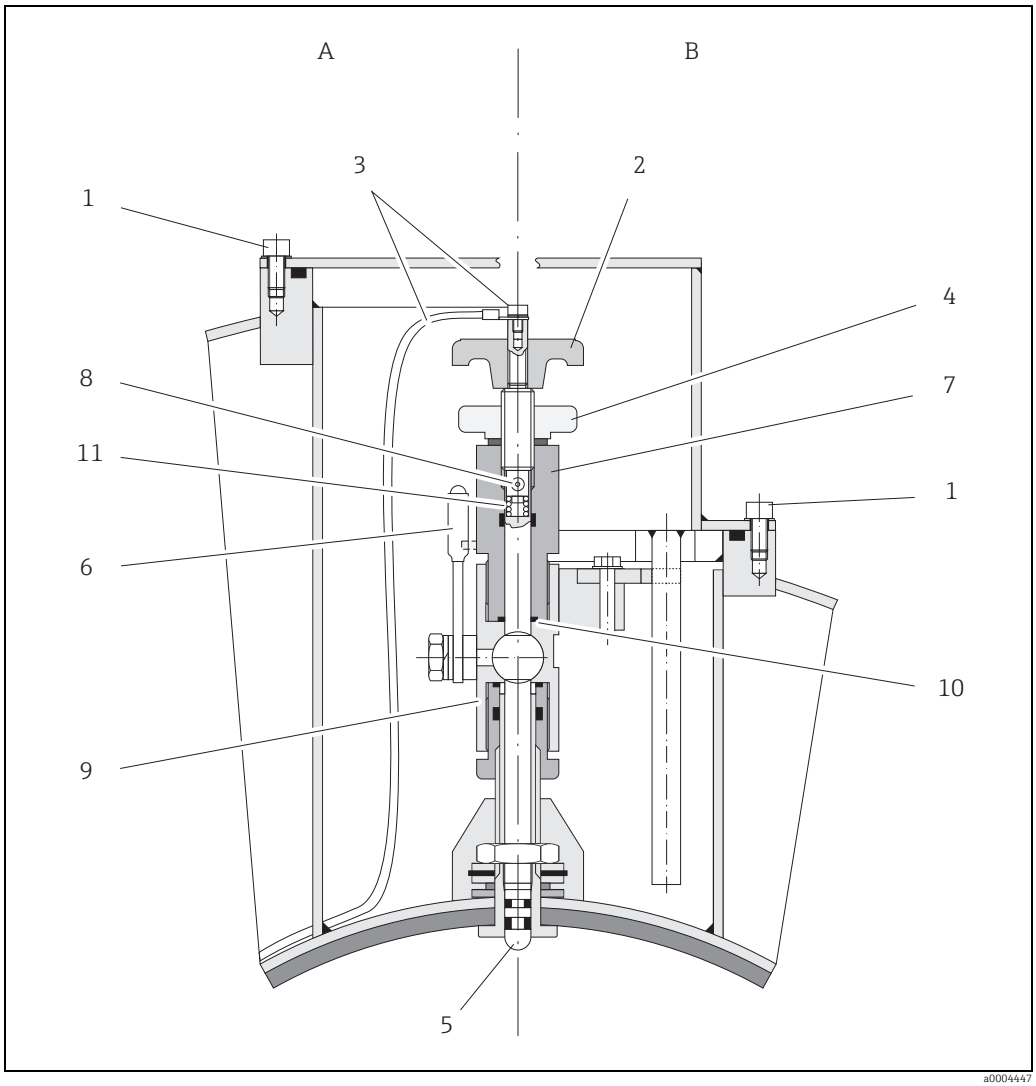


Fig. 74: Device for replacing the exchangeable measuring electrodes

View A = DN 1200 to 2000 (48 to 78")

View B = DN 350 to 1050 (14 to 42")

1 Socket head cap screw
2 Rotary handle
3 Electrode cable
4 Knurled nut (counter nut)
5 Measuring electrode
6 Stop cock (ball valve)
7 Retaining cylinder
8 Locking bolt (rotary handle)
9 Ball valve housing
10 Seal (retaining cylinder)
11 Coil spring

Removing the electrode	Fitting the electrode
1 Release the socket head cap screw (1) and remove the cap.	1 Insert the new electrode (5) from underneath into the retaining cylinder (7). Ensure that the seals at the tip of the electrode are clean.
2 Unscrew the electrode cable (3) secured on the rotary handle (2).	2 Attach the rotary handle (2) to the electrode and secure with the locking bolt (8). Caution! Ensure that the coil spring (11) is inserted to guarantee perfect electrical contact and thus correct measuring signals.
3 Release the knurled nut (4) by hand. This knurled nut serves as a counter nut.	3 Pull the electrode back until the tip is no longer protruding from the retaining cylinder (7).
4 Unscrew the electrode (5) using the rotary handle (2). It can now be pulled out of the retaining cylinder (7) up to a defined point. Warning! Risk of injury! The electrode can bounce back to its stop under process conditions (pressure in the pipe). Exert counter pressure against it when releasing.	4 Screw the retaining cylinder (7) onto the ball valve housing (9) and secure tightly by hand. The seal (10) at the retaining cylinder must be fitted and clean. Note! Ensure that the rubber hoses attached to the retaining cylinder (7) and stop cock (6) are the same color (red or blue).
5 Close the stop cock (6) after you have pulled out the electrode as far as it will go. Warning! Do not open the stop cock after this to ensure that no fluid comes out.	5 Open the stop cock (6) and screw the electrode as far as it will go into the retaining cylinder using the rotary handle (2).
6 You can now unscrew the entire electrode with the retaining cylinder (7).	6 Now, screw the knurled nut (4) on the retaining cylinder. This secures the electrode in position.
7 Remove the rotary handle (2) from the electrode (5) by pushing out the locking bolt (8). Ensure that you do not lose the coil spring (11).	7 Secure the electrode cable (3) on the rotary handle (2) once more using the socket head cap screw. Caution! Ensure that the socket head cap screw of the electrode cable is securely tightened. This guarantees perfect electrical contact and thus correct measuring signals.
8 Now replace the old electrode with the new one. You can order replacement electrodes separately from Endress+Hauser	8 Refit the cover and tighten the socket head cap screw (a).

9.7 Return

The measuring device must be returned if repairs or a factory calibration are required, or if the wrong measuring device has been ordered or delivered. According to legal regulations, Endress+Hauser, as an ISO-certified company, is required to follow certain procedures when handling returned products that are in contact with medium.
To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material

9.8 Disposal

Observe the regulations applicable in your country!

9.9 Software history

Date	Software version	Changes to software	Operating Instructions
10.2010	3.06.XX	–	71249472/13.14
07.2009	3.04.XX	Introduction of Calf history	71108004/12.09
10.2005	3.01.XX	-	71005396/10.05

10 Technical data

10.1 Application

→ 🖹 4

10.2 Function and system design

Measuring principle

Electromagnetic flow measurement on the basis of Faraday's Law.

Measuring system

→ 🖹 6

10.3 Input

Measured variable

Flow rate (proportional to induced voltage)

Measuring range

Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified measuring accuracy

Operable flow range

Over 1000 : 1

Input signal

Status input (auxiliary input):

U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated.
Switch level: ±3 to ±30 VDC, independent of polarity

10.4 Output

Output signal

Current output

Active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s), Full scale value selectable, temperature coefficient: typically 0.005% o.r./°C (0.003 % o.f.s/ °F), resolution: 0.5 µA

- Active: 0/4 to 20 mA, R_L < 700 Ω
- Passive: 4 to 20 mA; supply voltage V_S 18 to 30 V DC; R_i ≥ 150 Ω

Pulse / frequency output:

Active/passive selectable, galvanically isolated
- Active: 24 V DC, 25 mA (max. 250 mA during 20 ms), R_L > 100 Ω
- Passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2 to 10000 Hz (f_{max} = 12500 Hz), on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity selectable, pulse width configurable (0.05 to 2000 ms)

Modbus RS485:

- Modbus device type: slave
- Address range: 1 to 247
- Functions codes supported: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23

- Physical interface: RS485 in accordance with standard EIA/TIA-485
- Baudrate supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU or ASCII
- Parity:
  RTU mode = NONE, EVEN, UNEVEN
  ASCII mode = EVEN, UNEVEN
- Response time:
  Direct data access = typically 25 to 50 ms
  Auto-scan buffer (data area) = typically 3 to 5 ms

Signal on alarm

Current output:
Failsafe mode selectable (e.g. in accordance with NAMUR recommendation NE 43)

Pulse / frequency output:
Failsafe mode selectable

Relay output:
De-energized by fault or power supply failure

Modbus RS485:
If an error occurs, the value NaN (not a number) is output for the measured values.

Load

See "Output signal"

Low flow cut off

Switch points for low flow cut off are selectable.

Galvanic isolation

All circuits for inputs, outputs, and power supply are galvanically isolated from each other.

Switching output

Relay output:

Normally closed (NC or break) or normally open (NO or make) contacts available (default: relay 1 = NO, relay 2 = NC), max. 30 V / 0.5 A AC; 60 V / 0.1 A DC, galvanically isolated.

10.5 Power supply

Terminal assignment

→ 🖹 48

Supply voltage

20 to 55 V AC, 45 to 65 Hz
85 to 260 V AC, 45 to 65 Hz
16 to 62 V DC

Power consumption

AC: <15 VA (including sensor)
DC: <15 W (including sensor)

Switch-on current:
- Max. 13.5 A (< 50 ms) at 24 V DC
- Max. 3 A (< 5 ms) at 260 V AC

Power supply failure

Lasting min. 1 power cycle
- EEPROM or T-DAT saves measuring system data if power supply fails
- S-DAT: exchangeable data memory which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point, etc.)

Potential equalization → 📄 57

Cable entries

Power supply and electrode cable (inputs/outputs):
- Cable gland M20 × 1.5 (8 to 12 mm / 0.31 to 0.47 in)
- Cable gland sensor for armored cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63 in)
- Cable entries for thread ½" NPT, G ½"

Connecting cable for remote version:
- Cable gland M20 × 1.5 (8 to 12 mm / 0.31 to 0.47 in)
- Cable gland sensor for armored cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63 in)
- Cable entries for thread ½" NPT, G ½"

Cable specifications (remote version) → 📄 54

10.6 Performance characteristics

Reference operating conditions
- Error limits following DIN EN 29104, future ISO 20456
- Water, typically +15 to +45°C (+59 to +113 °F); 0,5 to 7 bar (73 to 101 psi)
- Specification as per calibration protocol
- Data on the measured error based on accredited calibration rigs traced back to ISO 17025

Maximum measured error

Standard: ±0.2% o.r. ± 2 mm/s (o.r. = of reading)

Note!
Supply-voltage fluctuations have no effect within the specified range.

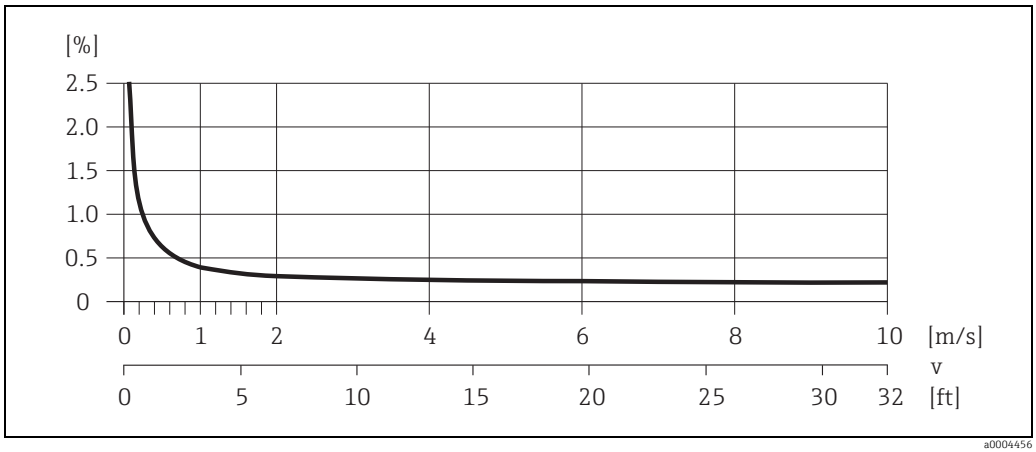


Fig. 75: Max. measured error in % of reading

Repeatability Standard: max. ±0.1% o.r. ± 0.5 mm/s (o.r. = of reading)

10.7 Installation

Installation instructions → 📄 12

Inlet and outlet runs

Inlet run: typically ≥ 5 × DN
Outlet run: typically ≥ 2 × DN

Length of connecting cable

- The permissible cable length L_{max} for the remote version depends on the conductivity of the medium → 19.
- A minimum conductivity of 20 µS/cm is required to measure demineralized water.

10.8 Environment

Ambient temperature range

Transmitter:
- Standard: −20 to +60 °C (−4 to +140 °F)
- Optional: −40 to +60 °C (−40 to +140 °F)

Note!
At ambient temperatures below −20 °C (−4 °F), the readability of the display may be impaired.

Sensor:
- Flange material carbon steel: −10 to +60 °C (+14 to +140 °F)
- Flange material stainless steel: −40 to +60 °C (−40 to +140 °F)

Caution!
Do not exceed the min. and max. temperatures for the lining of the measuring tube (→ "Medium temperature range").

Note the following points:
- Install the device at a shady location. Avoid direct sunlight, particularly in warm climatic regions.
- If both fluid and ambient temperatures are high, install the transmitter at a remote location from the sensor (→ "Medium temperature range").

Storage temperature

The storage temperature corresponds to the operating temperature range of the transmitter and sensor.

Caution!
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Choose a storage location where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the lining.

Degree of protection

Transmitter
- As standard: IP 67, type 4X enclosure
- Promag L when housing is open: IP 20, type 1 enclosure

Sensor
- As standard: IP 67, type 4X enclosure
- Optionally available for remote version for Promag P/W:
  − IP 68, type 6P enclosure

Shock and vibration resistance

Acceleration up to 2 g in accordance with IEC 600 68-2-6
(High-temperature version: no data available)

Interior cleaning

Caution!
The maximum fluid temperature permitted for the measuring device must not be exceeded.

CIP cleaning possible:
Promag E (110 °C / 230 °F), Promag H/P

CIP cleaning not possible:
Promag L/W

SIP cleaning possible:
Promag H, Promag P (with PFA lining)

SIP cleaning not possible:
Promag E/L/W

Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR Recommendation NE 21
- Emission: to limit value for industry EN 55011

10.9 Process

Medium temperature range

The permitted temperature depends on the lining of the measuring tube:

Promag E

PTFE: −10 to +110 °C (+14 to +230 °F)

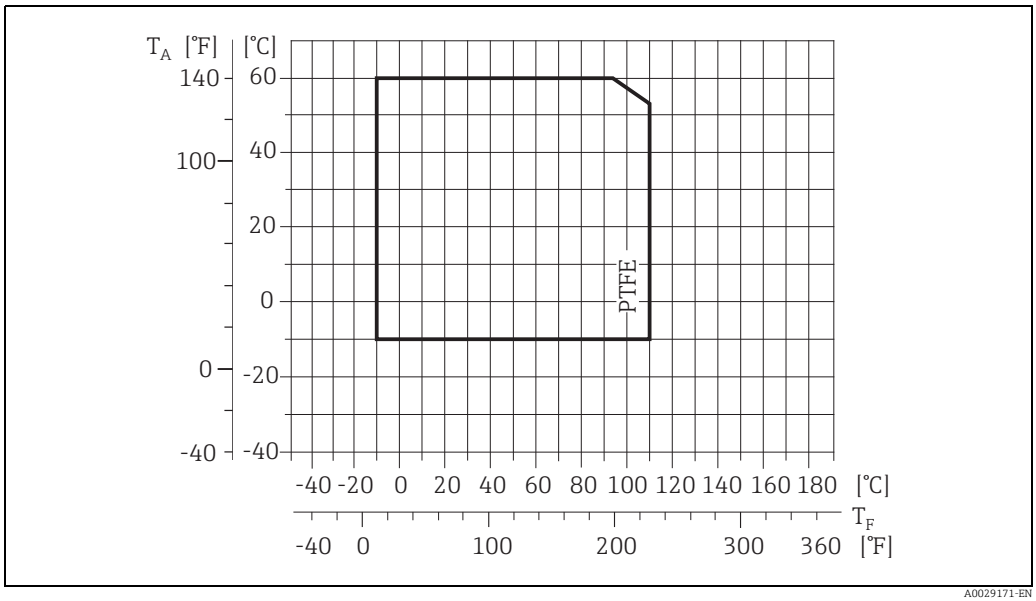


Fig. 76: Compact and remote version (T_A = Ambient temperature, T_F = Fluid temperature)

Promag H

Sensor:
- DN 2 to 25 (1/12 to 1"): −20 to +150 °C (−4 to +302 °F)
- DN 40 to 100 (1 ½ to 4"): −20 to +150 °C (−4 to +302 °F)

Seals:
- EPDM: −20 to +150 °C (−4 to +302 °F)
- Silicone (VMQ): −20 to +150 °C (−4 to +302 °F)
- Viton (FKM): −20 to +150 °C (−4 to +302 °F)
- Kalrez: −20 to +150 °C (−4 to +302 °F)

Promag L

- 0 to +80 °C (+32 to +176 °F) for hard rubber (DN 350 to 2400 / 14 to 90")
- −20 to +50 °C (−4 to +122 °F) for polyurethane (DN 25 to 1200 / 1 to 48")
- −20 to +90 °C (−4 to +194 °F) for PTFE (DN 25 to 300 / 1 to 12")

Promag P

Standard
- −40 to +130 °C (−40 to +266 °F) for PTFE (DN 15 to 600 / ½ to 24"), restrictions → see diagrams below
- −20 to +130 °C (−4 to +266 °F) for PFA/HE (DN 25 to 200 / 1 to 8"), restrictions → see diagrams below
- −20 to +150 °C (−4 to +302 °F) for PFA (DN 25 to 200 / 1 to 8"), restrictions → see diagrams below

Optional
High-temperature version (HT): −20 to +180 °C (−4 to +356 °F) for PFA (DN 25 to 200 / 1 to 8")

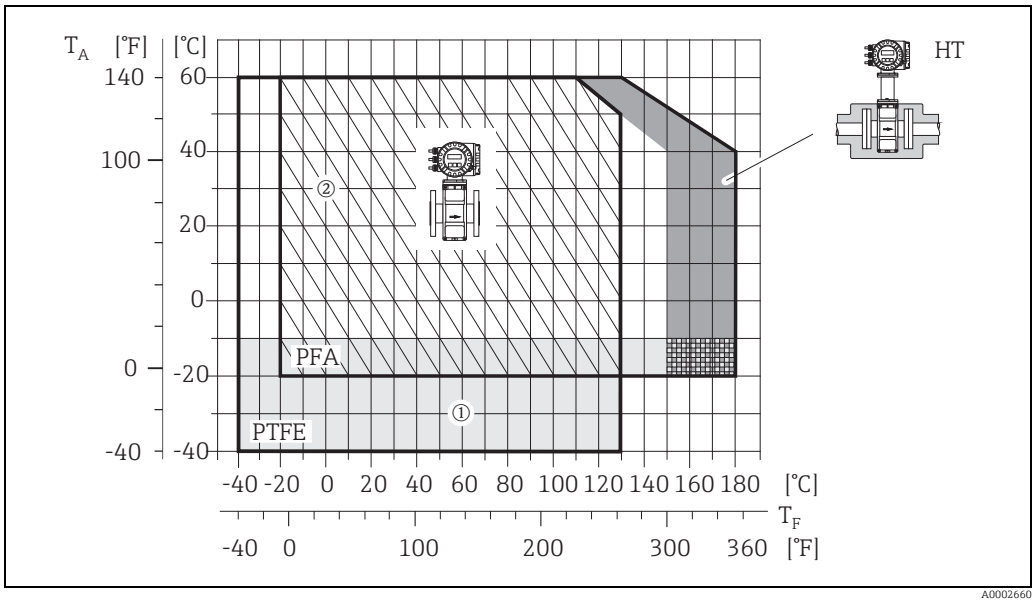


Fig. 77: Promag P compact version (with PFA or PTFE lining)

T_A = ambient temperature; T_F = fluid temperature; HT = high-temperature version with insulation
1 = Light gray area →temperature range from −10 to −40 °C (−14 to −40 °F) applies only to stainless steel flanges
2 = Diagonally hatched area → foam lining (HE) + degree of protection IP68 = fluid temperature max. 130 °C (266 °F)

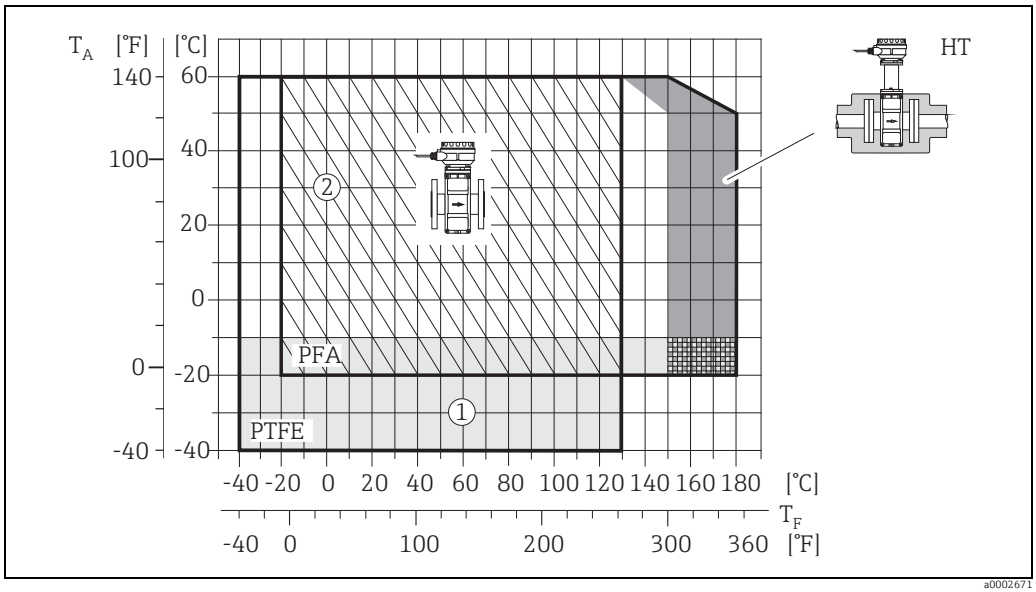


Fig. 78: Remote versions (with PFA or PTFE lining)

T_A = ambient temperature; T_F = fluid temperature; HT = high-temperature version with insulation
1 = Light gray area →temperature range from −10 to −40 °C (−14 to −40 °F) applies only to stainless steel flanges
2 = Diagonally hatched area → foam lining (HE) + degree of protection IP68 = fluid temperature max. 130 °C (266 °F)

Promag W

- 0 to +80 °C (+32 to +176 °F) for hard rubber (DN 65 to 2000 / 2½ to 80")
- −20 to +50 °C (−4 to +122 °F) for polyurethane (DN 25 to 1200 / 1 to 48")

Conductivity

The minimum conductivity is:
- ≥ 5 µS/cm for fluids generally
- ≥ 20 µS/cm for demineralized water

Note!
In the remote version, the required minimum conductivity is also influenced by the length of the connecting cable → 19.

Limiting medium pressure range (nominal pressure)

Promag E

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 600 / 14 to 24")
  - PN 10 (DN 200 to 600 / 8 to 24")
  - PN 16 (DN 65 to 600 / 3 to 24")
  - PN 40 (DN 15 to 150 / ½ to 2")
- ASME B 16.5
  - Class 150 (½ to 24")
- JIS B2220
  - 10K (DN 50 to 300 / 2 to 12")
  - 20K (DN 15 to 40 / ½ to 1½")

Promag H

The permissible nominal pressure depends on the process connection, the seal and the nominal diameter.
Details are provided in the separate documentation "Technical Information" → 151.

Promag L

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 2400 / 14 to 90")
  - PN 10 (DN 200 to 2400 / 8 to 90")
  - PN 16 (DN 25 to 2000 / 1 to 78")
- EN 1092-1, lap joint flange, stample plate
  - PN 10 (DN 25 to 300 / 1 to 12")
- ASME B16.5
  - Class 150 (1 to 24")
- AWWA C207
  - Class D (28 to 90")
- AS2129
  - Table E (350 to 1200 / 14 to 48")
- AS4087
  - PN 16 (350 to 1200 / 14 to 48")

Promag P

- EN 1092-1 (DIN 2501)
  - PN 10 (DN 200 to 600 / 8 to 24")
  - PN 16 (DN 65 to 600 / 3 to 24")
  - PN 25 (DN 200 to 600 / 8 to 24")
  - PN 40 (DN 25 to 150 / 1 to 6")
- ASME B 16.5
  - Class 150 (1 to 24")
  - Class 300 (1 to 6")
- JIS B2220
  - 10K (DN 50 to 600 / 2 to 24")
  - 20K (DN 25 to 600 / 2 to 24")
- AS 2129
  - Table E (DN 25 / 1"), 50 / 2")
- AS 4087
  - PN 16 (DN 50 / 2")

Promag W

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 2000 / 14 to 84")
  - PN 10 (DN 200 to 2000 / 8 to 84")
  - PN 16 (DN 65 to 2000 / 3 to 84")
  - PN 25 (DN 200 to 1000 / 8 to 40")
  - PN 40 (DN 25 to 150 / 1 to 6")
- ASME B 16.5
  - Class 150 (1 to 24")
  - Class 300 (1 to 6")
- AWWA
  - Class D (28 to 78")
- JIS B2220
  - 10K (DN 50 to 750 / 2 to 30")
  - 20K (DN 25 to 600 / 1 to 24")
- AS 2129
  - Table E (DN 80 / 3", 100 / 4", 150 to 1200 / 6 to 48")
- AS 4087
  - PN 16 (DN 80 / 3", 100 / 4", 150 to 1200 / 6 to 48")

Pressure-temperature ratings

An overview of the pressure-temperature ratings for the process connections are to be found in the "Technical Information" documents of the device in question.
List of supplementary documentation → 🖹 151 section.

Pressure tightness (measuring tube lining)

Promag E (Measuring tube lining: PTFE)

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures							
		25 °C		80 °C		100 °C		110 °C	
		77 °F		176 °F		212 °F		230 °F	
[mm]	[inch]	[mbar]	[psi]			[mbar]	[psi]	[mbar]	[psi]
15	½"	0	0	0	0	0	0	100	1.45
25	1"	0	0	0	0	0	0	100	1.45
32	–	0	0	0	0	0	0	100	1.45
40	1 ½"	0	0	0	0	0	0	100	1.45
50	2"	0	0	0	0	0	0	100	1.45
65	–	0	0	*	*	40	0.58	130	1.89
80	3"	0	0	*	*	40	0.58	130	1.89
100	4"	0	0	*	*	135	1.96	170	2.47
125	–	135	1.96	*	*	240	3.48	385	5.58
150	6"	135	1.96	*	*	240	3.48	385	5.58
200	8"	200	2.90	*	*	290	4.21	410	5.95
250	10"	330	4.79	*	*	400	5.80	530	7.69
300	12"	400	5.80	*	*	500	7.25	630	9.14
350	14"	470	6.82	*	*	600	8.70	730	10.59
400	16"	540	7.83	*	*	670	9.72	800	11.60
450	18"	Partial vacuum is impermissible!							
500	20"								
600	24"								
* No value can be quoted.									

Promag H (measuring tube lining: PFA)

Nominal diameter		Pressure tightness, measuring tube lining: limit values for absolute pressure [mbar] ([psi]) at various fluid temperature					
		25 °C	80° C	100 °C	130 °C	150 °C	180 °C
[mm]	[inch]	77 °F	176° F	212 °F	266 °F	302 °F	356 °F
2 to 150	1/12 to 6"	0	0	0	0	0	0

Promag L (Measuring tube lining: Polyurethane, Hard rubber)

Nominal diameter		Measuring tube lining	Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures		
			25 °C	50 °C	80 °C
[mm]	[inch]		77 °F	122 °F	176 °F
25 to 1200	1 to 48"	25 to 1200	1 to 48"	0	–
350 to 2400	14 to 90"	Hard rubber	0	0	0

Promag L (Measuring tube lining: PTFE)

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures			
		25 °C		90 °C	
		77 °F		194 °F	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]
25	1"	0	0	0	0
32	–	0	0	0	0
40	1 ½"	0	0	0	0
50	2"	0	0	0	0
65	–	0	0	40	0.58
80	3"	0	0	40	0.58
100	4"	0	0	135	1.96
125	–	135	1.96	240	3.48
150	6"	135	1.96	240	3.48
200	8"	200	2.90	290	4.21
250	10"	330	4.79	400	5.80
300	12"	400	5.80	500	7.25

Promag P (Measuring tube lining: PFA)

Nominal diameter		Resistance of measuring tube lining to partial vacuum: limit values for absolute pressure [mbar] ([psi]) at various fluid temperatures					
		25 °C	80° C	100 °C	130 °C	150 °C	180 °C
[mm]	[inch]	77 °F	176° F	212 °F	266 °F	302 °F	356 °F
25	1"	0	0	0	0	0	0
32	-	0	0	0	0	0	0
40	1 ½"	0	0	0	0	0	0
50	2"	0	0	0	0	0	0
65	-	0	*	0	0	0	0
80	3"	0	*	0	0	0	0
100	4"	0	*	0	0	0	0
125	-	0	*	0	0	0	0
150	6"	0	*	0	0	0	0
200	8"	0	*	0	0	0	0
* No value can be quoted.							

Promag P (Measuring tube lining: PTFE)

Nominal diameter		Resistance of measuring tube lining to partial vacuum: limit values for absolute pressure [mbar] ([psi]) at various fluid temperatures								
		25 °C		80° C	100 °C		130 °C		150 °C	180 °C
		77 °F		176° F	212 °F		266 °F		302 °F	356 °F
[mm]	[inch]	[mbar]	[psi]		[mbar]	[psi]	[mbar]	[psi]		
15	½"	0	0	0	0	0	100	1.45	–	–
25	1"	0	0	0	0	0	100	1.45	–	–
32	-	0	0	0	0	0	100	1.45	–	–
40	1 ½"	0	0	0	0	0	100	1.45	–	–
50	2"	0	0	0	0	0	100	1.45	–	–
65	-	0	0	*	40	0.58	130	1.89	–	–
80	3"	0	0	*	40	0.58	130	1.89	–	–
100	4"	0	0	*	135	1.96	170	2.47	–	–
125	-	135	1.96	*	240	3.48	385	5.58	–	–
150	6"	135	1.96	*	240	3.48	385	5.58	–	–
200	8"	200	2.90	*	290	4.21	410	5.95	–	–
250	10"	330	4.79	*	400	5.80	530	7.69	–	–
300	12"	400	5.80	*	500	7.25	630	9.14	–	–
350	14"	470	6.82	*	600	8.70	730	10.59	–	–
400	16"	540	7.83	*	670	9.72	800	11.60	–	–
450	18"	Partial vacuum is impermissible								
500	20"									
600	24"									
* No value can be quoted.										

Promag W

Nominal diameter		Measuring tube lining	Resistance of measuring tube lining to partial vacuum: limit values for absolute pressure [mbar] ([psi]) at various fluid temperatures						
			25 °C	50 °C	80° C	100 °C	130 °C	150 °C	180 °C
[mm]	[inch]		77 °F	122 °F	176° F	212 °F	266 °F	302 °F	356 °F
25 to 1200	1 to 48"	Polyurethane	0	0	-	-	-	-	-
65 to 2000	3 to 78"	Hard rubber	0	0	0	-	-	-	-

Limiting flow

Further information can be found in the "Nominal diameter and flow rate" → 🖹 17 section.

Pressure loss

- No pressure loss if the sensor is installed in piping with the same nominal diameter (for Promag H only from DN 8 (5/16")).
- Pressure losses for configurations incorporating adapters according to DIN EN 545 → 🖹 16.

10.10 Mechanical construction

Design, dimensions

The dimensions and face-to-face length of the sensor and transmitter can be found in the separate "Technical Information" documentation for each device which can be downloaded in PDF format from www.endress.com. A list of available "Technical Information" documentation can be found in the "Documentation" → 📄 151 section.

Weight (SI units)

Promag E

Weight data in kg							
Nominal diameter		Compact version					
		EN (DIN)				ASME	JIS
[mm]	[inch]	PN 6	PN 10	PN 16	PN 40	Class 150	10K
15	½"	–	–	–	6.5	6.5	6.5
25	1"	–	–	–	7.3	7.3	7.3
32	–	–	–	–	8.0	–	7.3
40	1½"	–	–	–	9.4	9.4	8.3
50	2"	–	–	–	10.6	10.6	9.3
65	–	–	–	12.0	–	–	11.1
80	3"	–	–	14.0	–	14.0	12.5
100	4"	–	–	16.0	–	16.0	14.7
125	–	–	–	21.5	–	–	21.0
150	6"	–	–	25.5	–	25.5	24.5
200	8"	–	45.0	46.0	–	45.0	41.9
250	10"	–	65.0	70.0	–	75.0	69.4
300	12"	–	70.0	81.0	–	110.0	72.3
350	14"	77.4	88.4	104	–	137.4	–
400	16"	89.4	104.4	125	–	168.4	–
450	18"	103	118	149	–	193	–
500	20"	115	132.4	190	–	228.4	–
600	24"	155.4	181	300	–	329	–

- Transmitter (compact version): 1.8 kg
- Weight data without packaging material

Weight data in kg								
Nominal diameter		Remote version (without cable)						
		Sensor						Transmitter
		EN (DIN)				ASME	JIS	
[mm]	[inch]	PN 6	PN 10	PN 16	PN 40	Class 150	10K	Wall-mount housing
15	½"	–	–	–	4.5	4.5	4.5	6.0
25	1"	–	–	–	5.3	5.3	5.3	
32	–	–	–	–	6.0	–	5.3	
40	1½"	–	–	–	7.4	7.4	6.3	
50	2"	–	–	–	8.6	8.6	7.3	
65	–	–	–	10.0	–	–	9.1	
80	3"	–	–	12.0	–	12.0	10.5	
100	4"	–	–	14.0	–	14.0	12.7	
125	–	–	–	19.5	–	–	19.0	
150	6"	–	–	23.5	–	23.5	22.5	
200	8"	–	43.0	44.0	–	43.0	39.9	
250	10"	–	63.0	68.0	–	73.0	67.4	
300	12"	–	68.0	79.0	–	108.0	70.3	
350	14"	73.1	84.1	100	–	133.1		
400	16"	85.1	100.1	121	–	164.1		
450	18"	99	114	145	–	189		
500	20"	111	128.1	186	–	224.1		
600	24"	158.1	177	296	–	325		

- Transmitter (remote version): 3.1 kg
- Weight data without packaging material

Promag H

Note!
The following weights apply to standard pressure ratings and without packaging material.

Nominal diameter	Compact version (DIN)		Remote version (without cable; DIN)	
DIN	Aluminum field housing	Stainless steel field housing	Sensor	Transmitter (wall-mount housing)
[mm]	[kg]	[kg]	[kg]	[kg]
2	5.2	5.7	2.0	6.0
4	5.2	5.7	2.0	6.0
8	5.3	5.8	2.0	6.0
15	5.4	5.9	1.9	6.0
25	5.5	6.0	2.8	6.0
40	7.1	7.6	4.1	6.0
50	7.6	8.1	4.6	6.0
65	8.4	8.9	5.4	6.0
80	9.0	9.5	6.0	6.0
100	10.3	10.8	7.3	6.0
125	15.7	16.2	12.7	6.0
150	18.1	18.6	15.1	6.0
Transmitter (compact version): 3.4 kg Weight data valid for standard pressure ratings and without packaging material.				

Promag L

Weight data in kg												
Nominal diameter		Compact version (including transmitter)[1]										
[mm]	[inch]	EN (DIN)						ASME/ AWWA		AS		
25	1"	PN 6	–	PN 10	–	PN 16	7.3	ASME / Class 150	7.9	PN 16	–	Table E	–
32	–		–		–		8.0		–		–		–
40	1 ½"		–		–		9.0		7.5		–		–
50	2"		–		–		9.4		7.6		–		–
65	–		–		–		10.4		–		–		–
80	3"		–		–		12.4		12.8		–		–
100	4"		–		–		14.4		16.1		–		–
125	–		–		–		15.9		–		–		–
150	6"		–		–		23.9		24.4		–		–
200	8"		–		43.4		44.9		49.6		–		–
250	10"		–		63.4		70.7		75.1		–		–
300	12"		–		68.4		85.8		100		–		–
350	14"		77.4		88.4		107		137		99.4		99.4
375	15"		–		–		–		–		105		–
400	16"		89.4		104		125		168		124		120
450	18"		104		119		150		191		142		152
500	20"		114		132		191		228		191		182
600	24"		155		182		301		327		283		281
700	28"		215		274		335	AWWA / Class D	278		386		350
750	30"		–		–		–		338		470		458
800	32"		289		374		462		402		569		518
900	36"		384		476		582		498		739		739
1000	40"		493		615		795		666		854		856
–	42"		–		–		–		771		–		–
1200	48"		707		916		1314		1035		1368		1368
–	54"		–		–		–		1438		–		–
1400	–		1126		1482		1906		–		–		–
–	60"		–		–		–		1785		–		–
1600	–		1521		2197		2698		–		–		–
–	66"		–		–		–		2463		–		–
1800	72"		2001		2838		3687		2857		–		–
–	78"		2777		3508		4646		3532		–		–
2000	–		2777		3508		4646		3532		–		–
–	84"		–		–		–		3883		–		–
2200	–		3065		4172		–		–		–		–
–	90"		–		–		–		4847		–		–
2400	–		3940		5035		–		–		–		–
Transmitter Promag (compact version): 3.4 kg (Weight data valid without packaging material)													

1) Lap joint flanges / welded flanges DN > 300 (12")

Weight data in kg

Nominal diameter		Remote version (sensor plus sensor housing without cable)[1]											
[mm]	[inch]	EN (DIN)						ASME/ AWWA		AS			
25	1"	PN 6	–	PN 10	–	PN 16	5.3	ASME / Class 150	5.9	PN 16	–	Table E	–
32	–		–		–		6.0		–		–		–
40	1 ½"		–		–		7.0		5.5		–		–
50	2"		–		–		7.4		5.6		–		–
65	–		–		–		8.4		–		–		–
80	3"		–		–		10.4		10.8		–		–
100	4"		–		–		12.4		14.1		–		–
125	–		–		–		13.9		–		–		–
150	6"		–		–		21.9		22.4		–		–
200	8"		–		41.4		42.9		47.6		–		–
250	10"		–		61.4		68.7		73.1		–		–
300	12"		–		66.4		83.8		98		–		–
350	14"		75.4		86.4		103		139		97.4		97.4
375	15"		–		102		–		–		103		–
400	16"		87.4		102		121		170		123		118
450	18"		103		118		149		193		141		151
500	20"		112		130		190		230		190		180
600	24"		156		181		300		329		282		280
700	28"		214		273		334	AWWA / Class D	278		385		349
750	30"		–		–		–		339		471		457
800	32"		288		373		461		402		568		517
900	36"		383		475		581		498		738		738
1000	40"		492		614		794		666		853		855
–	42"		–		–		–		771		-		–
1200	48"		706		915		1313		1035		1367		1367
–	54"		–		–		–		1438		–		–
1400	–		1125		1381		1905		–		–		–
–	60"		–		–		–		1785		–		–
1600	–		1520		2196		2697		–		–		–
–	66"		–		–		–		2463		–		–
1800	72"		2000		2837		3686		2857		–		–
–	78"		2776		2837		4645		3532		–		–
2000	–		2776		3507		4645		3532		–		–
–	84"		–		–		–		3883		–		–
2200	–		3064		4171		–		–		–		–
–	90"		–		–		–		4847		–		–
2400	–		3939		5034		–		–		–		–

Transmitter Promag (remote version): 3.4 kg
(Weight data valid without packaging material)

1) Lap joint flanges / welded flanges DN > 300 (12")

Weight data in kg						
Nominal diameter		Compact version[1]		Remote version (without cable)1)		
[mm]	[inch]	EN (DIN)		Sensor EN (DIN)		Transmitter
25	1"	PN 10	5.8	PN 10	3.8	4.2
32	–		5.4		3.4	4.2
40	1 ½"		6.3		4.7	4.2
50	2"		5.4		3.4	4.2
65	–		6.2		4.2	4.2
80	3"		7.2		5.2	4.2
100	4"		9.7		7.7	4.2
125	–		13.2		11.2	4.2
150	6"		17.2		15.2	4.2
200	8"		35.7		33.7	4.2
250	10"		54.2		52.2	4.2
300	12"		55.2		53.2	4.2
Transmitter Promag (compact version): 3.4 kg (Weight data valid for standard pressure ratings and without packaging material)						

1) Lap joint flanges, stamped plate

Promag P

Note!
The following weights apply to standard pressure ratings and without packaging material.

Nominal diameter	Weights in [kg]								
	Compact version				Remote version (without cable)				
					Sensor				Transmitter
[mm]	EN (DIN) / AS*		JIS		EN (DIN) / AS*		JIS		
15	PN 40	6.5	10K	6.5	PN 40	4.5	10K	4.5	6.0
25		7.3		7.3		5.3		5.3	6.0
32		8.0		7.3		6.0		5.3	6.0
40		9.4		8.3		7.4		6.3	6.0
50		10.6		9.3		8.6		7.3	6.0
65	PN 16	12.0		11.1	PN 16	10.0		9.1	6.0
80		14.0		12.5		12.0		10.5	6.0
100		14.4		14.7		14.0		12.7	6.0
125		16.0		21.0		19.5		19.0	6.0
150		21.5		24.5		23.5		22.5	6.0
200	PN 10	45		41.9	PN 10	43		39.9	6.0
250		65		69.4		63		67.4	6.0
300		70		72.3		68		70.3	6.0
350		115		81.0		113		79.0	6.0
400		135		102		133		100	6.0
450		175		130		173		128	6.0
500		175		144		173		142	6.0
600		235		190		233		188	6.0
Promag transmitter (compact version): 3.4 kg High-temperature version: +1.5 kg * Only DN 25 and 50 are available for flanges as per AS									

Promag W

Note!
The following weights apply to standard pressure ratings and without packaging material.

Nominal diameter	Weights in [kg]							
	Compact version				Remote version (without cable)			
					Sensor			Transmitter
[mm]	EN (DIN) / AS*		JIS		EN (DIN) / AS*		JIS	
25	PN 40	7.3	10K	7.3	PN 40	5.3	10K	5.3	6.0
32		8.0		7.3		6.0		5.3	6.0
40		9.4		8.3		7.4		6.3	6.0
50		10.6		9.3		8.6		7.3	6.0
65	PN 16	12.0		11.1	PN 16	10.0		9.1	6.0
80		14.0		12.5		12.0		10.5	6.0
100		16.0		14.7		14.0		12.7	6.0
125		21.5		21.0		19.5		19.0	6.0
150		25.5		24.5		23.5		22.5	6.0
200	PN 10	45		41.9	PN 10	43		39.9	6.0
250		65		69.4		63		67.4	6.0
300		70		72.3		68		70.3	6.0
350		115		81.1		113		79.1	6.0
375		134		-		133		-	6.0
400		135		102		133		100	6.0
450		175		130		173		128	6.0
500		175		144		173		142	6.0
600		235		190		233		188	6.0
700		355		282		353		280	6.0
800		435		-		433		-	6.0
900		575		-		573		-	6.0
1000		700		-		698		-	6.0
1200	PN 6	850		-	PN 6	848		-	6.0
1400		1300		-		1298		-	6.0
1600		1700		-		1698		-	6.0
1800		2200		-		2198		-	6.0
2000		2800		-		2798		-	6.0

Promag transmitter (compact version): 3.4 kg
*Only DN 80, 100, 150 to 400, 500 and 600 are available for flanges as per AS

Weight (US units)

Promag E (ASME)

Weight data in lbs				
Nominal diameter		Compact version	Remote version (without cable)	
			Sensor	Transmitter
		ASME	ASME	
[mm]	[inch]	Class 150	Class 150	Wall-mount housing
15	½"	14.3	9.92	13.2
25	1"	16.1	11.7	
40	1½"	20.7	16.3	
50	2"	23.4	19.0	
80	3"	30.9	26.5	
100	4"	35.3	30.9	
150	6"	56.2	51.8	
200	8"	99.2	94.8	
250	10"	165.4	161.0	
300	12"	242.6	238.1	
350	14"	303.0	293.5	
400	16"	371.3	361.8	
450	18"	424	417	
500	20"	503.6	494.1	
600	24"	725	717	

- Transmitter: 4.0 lbs (compact version); 6.8 lbs (remote version)
- Weight data without packaging material

Promag H

Note!
The following weights apply to standard pressure ratings and without packaging material.

Nominal diameter	Compact version (DIN)		Remote version (without cable; DIN)	
DIN	Aluminum field housing	Stainless steel field housing	Sensor	Transmitter (wall-mount housing)
[in]	[lbs]	[lbs]	[lbs]	[lbs]
1/12"	11.5	12.6	4.0	13.0
1/8"	11.5	12.6	4.0	13.0
3/8"	11.7	12.8	4.0	13.0
½"	11.9	13.0	4.0	13.0
1"	12.1	13.2	6.0	13.0
1 ½"	15.7	16.8	4.1	13.0
2"	16.8	17.9	4.6	13.0
3"	19.8	20.9	6.0	13.0
4"	22.7	23.8	7.3	13.0
6"	39.9	41.0	15.1	13.0
Transmitter (compact version): 7.5 lbs (Weight data valid for standard pressure ratings and without packaging material)				

Promag L (ASME/AWWA)

Weight data in lbs					
Nominal diameter		Compact version[1]		Remote version1)	
[mm]	[inch]	ASME/AWWA		ASME/AWWA	
25	1"	ASME / Class 150	17.4	ASME / Class 150	13
32	–		–		–
40	1 ½"		16.5		12.1
50	2"		16.8		12.3
65	–		–		–
80	3"		28.2		23.8
100	4"		35.5		31.1
125	–		–		–
150	6"		53.8		49.4
200	8"		109		105
250	10"		166		161
300	12"		221		216
350	14"		302		306
375	15"		–		–
400	16"		370		274
450	18"		421		425
500	20"		503		507
600	24"		726		725
700	28"	AWWA / Class D	613	AWWA / Class D	612
750	30"		745		746
800	32"		886		885
900	36"		1098		1097
1000	40"		1468		1467
–	42"		1701		1700
1200	48"		2283		2282
–	54"		3171		3170
1400	–		–		–
–	60"		3935		3934
1600	–		–		–
–	66"		5430		5429
1800	72"		6300		6299
–	78"		7787		7786
2000	–		7787		-
–	84"		8561		8560
2200	–		–		–
–	90"		10686		10685
2400	–		–		–
Transmitter Promag (compact version): 7.5 lbs Transmitter Promag (remote version): 13.2 lbs (Weight data valid without packaging material)					

1) Lap joint flanges / welded flanges DN > 300 (12")

Promag P (ASME)

Note!
The following weights apply to standard pressure ratings and without packaging material.

Nominal diameter [inch]	Weights in [lbs]				
	Compact version ASME/AWWA		Remote version (without cable) Sensor ASME/AWWA		Transmitter
½"	Class 150	14	Class 150	10	13
1"		16		12	13
1 ½"		21		16	13
2"		23		19	13
3"		31		26	13
4"		35		31	13
6"		56		52	13
8"		99		95	13
10"		165		161	13
12"		243		238	13
14"		386		381	13
16"		452		448	13
18"		562		558	13
20"		628		624	13
24"		893		889	13
Promag transmitter (compact version): 7.5 lbs High-temperature version: + 3.3 lbs					

Promag W

Note!
The following weights apply to standard pressure ratings and without packaging material.

Nominal diameter [inch]	Weights in [lbs]				
	Compact version ASME/AWWA		Remote version (without cable) Sensor ASME/AWWA		Transmitter
1"	Class 150	16	Class 150	12	13
1 ½"		21		16	13
2"		23		19	13
3"		31		26	13
4"		35		31	13
6"		56		52	13
8"		99		95	13
10"		143		161	13
12"		243		238	13
14"		386		381	13
16"		452		448	13
18"		562		558	13
20"		628		624	13
24"		893		889	13

Nominal diameter [inch]	Weights in [lbs]				
	Compact version		Remote version (without cable)		
			Sensor		Transmitter
	ASME/AWWA		ASME/AWWA		
28"	Class D	882	Class D	878	13
30"		1014		1010	13
32"		1213		1208	13
36"		1764		1760	13
40"		1985		1980	13
42"		2426		2421	13
48"		3087		3083	13
54"		4851		4847	13
60"		5954		5949	13
66"		8159		8154	13
72"		9041		9036	13
78"		10143		10139	13
Promag transmitter (compact version): 7.5 lbs					

Materials

Promag E

- Transmitter housing
  - Compact housing: powder-coated die-cast aluminum
  - Wall-mount housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  - DN 350 to 600 (14 to 24"): with protective lacquering
- Measuring tube
  - DN ≤ 300 (12"): stainless steel 1.4301 (304) or 1.4306 (304L) (with Al/Zn protective coating)
  - DN ≥ 350 (14"): stainless steel 1.4301 (304) or 1.4306 (304L) (with protective lacquering)
- Electrodes: 1.4435 (316, 316L), Alloy C22, Tantalum
- Flanges (with protective lacquering)
  - EN 1092-1 (DIN2501): carbon steel, S235JRG2, S235JR+N, P245GH, E250C1, A105
  - ASME B16.5: carbon steel, A105
  - JIS B2220: carbon steel, A105, A350 LF2

  1 DN DN ≤ 300 (12") with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering
- Seals: to DIN EN 1514-1 IBC form
- Ground disks: 1.4435 (316, 316L) or Alloy C22

Promag H

- Transmitter housing:
  - Compact housing: powder-coated die-cast aluminum or stainless steel field housing (1.4301 (304))
  - Wall-mounted housing: powder-coated die-cast aluminum
  - Window material: glass or polycarbonate
- Sensor housing: stainless steel 1.4301 (304)
- Wall mounting kit: stainless steel 1.4301 (304)
- Measuring tube: stainless steel 1.4301 (304)

- Liner: PFA (USP class VI; FDA 21 CFR 177.1550: 3A)
- Electrodes:
  - Standard: 1.4435 (316, 316L)
  - Option: Alloy C22, Tantalum, Platinum
- Flange:
  - All connections stainless-steel 1.4404 (F316L)
  - EN (DIN), ASME, JIS made of PVDF
  - Adhesive fitting made of PVC
- Seals
  - DN 2 to 25 (1/12 to 1"): O-ring (EPDM, Viton, Kalrez), gasket seal (EPDM*, Viton, Silicone*)
  - DN 40 to 150 (1½ to 6"): gasket seal (EPDM*, Silicone*)
    * = USP class VI; FDA 21 CFR 177.2600: 3A
- Ground rings: 1.4435 (316, 316L) (optional: Tantalum, Alloy C22)

Promag L

- Transmitter housing:
  - Compact housing: powder-coated die-cast aluminum
  - Wall-mounted housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  - DN 350 to 1200 (14 to 48"): with protective lacquering
- Measuring tube:
  - DN 25 to 300 (1 to 12"): Stainless-steel, 1.4301/1.4306 (304L)
  - DN 350 to 1200 (14 to 48"): Stainless-steel, 1.4301/1.4307 (304)
  - DN 1350 to 2400 (54 to 90"): Stainless-steel, 1.4301/1.4307
- Electrodes: 1.4435 (316L), Alloy C22, 2.4602 (UNS N06022)
- Flange
  - EN 1092-1 (DIN 2501)
    - DN 25 to 300
      Lap joint flange:
      - Stainless-steel, 1.4306/1.4307
      - Carbon steel, 235JR
      Lap joint flange, stampel plate:
      - Stainless-steel, 1.4301 (304)
      - Carbon steel, RSt37-2
    - DN 350 to 2400: carbon steel, S235JRG2, S235JR+N, P250GH, P245GH, E250C, A105
    - DN 350 to 600: Stainless-steel, 1.4571
    - DN 700 to 1000: Stainless-steel, 1.4404
  - ASME B16.5
    - DN ≤ 300 (12"), lap joint flange:
      - Stainless-steel, F316L
      - Carbon steel, A105
    - DN ≥ 350 (14"):
      - Carbon steel, A105
      - Stainless-steel, F316L
  - AWWA C207: A105, A181 Cl.70, E250C, S235JRG2, P265GH, S275JR
  - AS 2129: Carbon steel, A105, P235GH, P265GH, S235JRG2, E250C
  - AS 4087: Carbon steel, A105, P265GH, S275JR, E250C
- Seals: to DIN EN 1514-1 IBC form
- Ground disks: 1.4435 (316L) or Alloy C22

Promag P

- Transmitter housing:
  - Compact housing: powder-coated die-cast aluminum
  - Wall-mounted housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 15 to 300 (½ to 12"): powder-coated die-cast aluminum
  - DN 350 to 2000 (14 to 84"): with protective lacquering
- Measuring tube
  - DN ≤ 300 (12"): stainless steel 1.4301 (304) or 1.4306 (304L); for flanges made of carbon steel with Al/Zn protective coating
  - DN ≥ 350 (14"): stainless steel 1.4301 (304) or 1.4306 (304L); for flanges made of carbon steel with Al/Zn protective coating
- Electrodes: 1.4435 (316, 316L), Platinum, Alloy C22, Tantalum, Titanium
- Flange
  - EN 1092-1 (DIN2501):
    - Stainless-steel, 1.4571, F316L
    - Carbon steel, S235JRG2, S235JR+N, P245GH, P250GH, A105, E250C1
    (1 DN ≤ 300 (12") with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - ASME B16.5:
    - Stainless-steel, F316L
    - Carbon steel, A105
    (DN ≤ 300 mit Al/Zn-Schutzbeschichtung; DN ≥ 350 mit Schutzlackierung)
  - AWWA: 1.0425 (316L)
  - JIS B2220:
    - Stainless-steel, 1.0425 F316L1
    - Carbon steel, A105, A350 LF2
    (1 DN ≤ 300 (12") with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - AS 2129: Carbon steel, A105, P235GH, P265GH, S235JRG2, E250C
  - AS 4087: Carbon steel, A105, P265GH, S275JR, E250C
- Seals: to DIN EN 1514-1 IBC form
- Ground disks: 1.4435 (316, 316L) or Alloy C22

Promag W

- Transmitter housing:
  - Compact housing: powder-coated die-cast aluminum
  - Wall-mounted housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  - DN 350 to 2000 (14 to 84"): with protective lacquering
- Measuring tube
  - DN ≤ 300 (12"): stainless steel 1.4301 (304) or 1.4306 (304L)
  (for flanges made of carbon steel with Al/Zn protective coating)
  - DN ≥ 350 (14"): stainless steel 1.4301 (304) or 1.4306 (304L)
  (for flanges made of carbon steel with protective lacquering)
- Electrodes: 1.4435 (316, 316L) or Alloy C22, Tantalum
- Flange
  - EN 1092-1 (DIN2501)
    - DN 25 to 3001:
      - Stainless-steel, 1.4571, F316L
      - Carbon steel, S235JRG2, S235JR+N, P250GH, E250C, A105
    - DN 350 to 6001:
      - Stainless-steel, 1.4571, F316L

  - Carbon steel, P245GH, S235JRG2, S235JR+N, P250GH, E250C
  - DN > 600:
    - Stainless-steel, 1.4404/F316L
    - Carbon steel, P245GH
- ASME B16.5: Carbon steel, A105
- AWWA: Carbon steel, A105, Cl.70 A181, P265GH, S275JR, E250C
- JIS B2220:
  - Carbon steel, A105, A350 LF2
  - Stainless-steel, F316L
  (DN ≤ 300 (12") mit Al/Zn-Schutzbeschichtung; DN ≥ 350 (14") mit Schutzlackierung)
- AS 2129: Carbon steel, A105, P235GH, P265GH, S235JRG2
- AS 4087: Carbon steel, A105, P265GH, S275JR

- Seals: to DIN EN 1514-1 IBC form
- Ground disks: 1.4435 (316, 316L), Alloy C22, Titanium, Tantalum

1 For flange material carbon steel with Al/Zn protective coating (DN 25 to 300 (1 to 12")), protective varnish (IP68) (DN 50 to 300 (2 to 12")) or protective varnish ≥ DN 350 (14")

Fitted electrodes

Promag E/L

- 2 measuring electrodes for signal detection
- 1 EPD electrode for empty pipe detection
- 1 reference electrode for potential equalization

Promag H

- 2 measuring electrodes for signal detection
- 1 EPD electrode for empty pipe detection, not for DN 2 to 8 (1/12 to 5/16")

Promag P

Available as standard:
- 2 measuring electrodes for signal detection
- 1 EPD electrode for empty pipe detection
- 1 Reference electrode for potential equalization

Optionally available:
- Platinum measuring electrodes only

Promag W

Available as standard:
- 2 measuring electrodes for signal detection
- 1 EPD electrode for empty pipe detection
- 1 Reference electrode for potential equalization

Optionally available:
- Exchangeable measuring electrodes for DN 350 to 2000 (14 to 78")

Process connection

Promag E

Flange connections:
- EN 1092-1 (DIN 2501)
  - DN ≤300 (12") = form A
  - DN ≥ 350 (14") = flat face
  - DN 65 PN 16 and DN 600 PN 16 only as per EN 1092-1
- ASME B16.5
- JIS B2220

Promag H

With O-ring:
- Weld nipple DIN (EN), ISO 1127, ODT/SMS
- Flange EN (DIN), ASME, JIS
- Flange made of PVDF EN (DIN), ASME, JIS
- External thread
- Internal thread
- Hose connection
- PVC adhesive fitting

With molded seal:
- Weld nipple EN 10357 (DIN 11850), ODT/SMS
- Clamp ISO 2852, DIN 32676, L14 AM7
- Coupling DIN 11851, DIN 11864-1, ISO 2853, SMS 1145
- Flange DIN 11864-2

Promag L

Flange connection:
- EN 1092-1 (DIN 2501)
  - DN ≤300 (12") = form A
  - DN ≥ 350 (14") = form B
  - 1.0038 (S235JRG2), A105
- ASME B16.5
- AWWA C207
- AS 2129
- AS 4087

Promag P/W

Flange connections:
- EN 1092-1 (DIN 2501)
  - DN ≤300 (12") = form A
  - DN ≥ 350 (14") = flat face
  - DN 65 PN 16 and DN 600 PN 16 exclusively according to EN 1092-1
- ASME B16.5
- AWWA C207 (only Promag W)
- JIS 10K, 20K
- AS 2129
- AS 4087

Surface roughness

All data relate to parts in contact with fluid.
- Liner → PFA: ≤ 0.4 µm (15 µin)
- Electrodes: 0.3 to 0.5 µm (12 to 20 µin)
- Process connection made of stainless-steel (Promag H):
  - with O-ring seal: ≤ 1.6 µm (63 µin)
  - with aseptic gasket seal: ≤ 0.8 µm (31.5 µin)
  - optional: ≤ 0.38 µm (15 µin)

10.11 Operability

Display elements
- Liquid crystal display: illuminated, four lines with 16 characters per line
- Selectable display of different measured values and status variables
- 3 totalizers
- At ambient temperatures below −20 °C the readability of the display may be impaired.

Operating elements
- Local operation with three optical keys (⊟/⊞/Ⓔ)
- Application-specific Quick Setup menus for straightforward commissioning

Language packages

Language groups available for operation in different countries:

- Western Europe and America (WEA):
  English, German, Spanish, Italian, French, Dutch and Portuguese
- Eastern Europe and Scandinavia (EES):
  English, Russian, Polish, Norwegian, Finnish, Swedish, Czech
- South and east Asia (SEA):
  English, Japanese, Indonesian
- China (CN):
  English, Chinese

Note!
You can change the language group via the operating program "FieldCare".

10.12 Certificates and approvals

CE approval

The measuring system complies with the legal requirements of the EU directives. Endress+Hauser confirms that the device has been tested successfully by affixing the CE mark to it.

C-tick symbol

The measuring system is in conformity with the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Ex approval

Information about currently available Ex versions (ATEX, FM, CSA, TIIS, IECEx, NEPSI etc.) can be supplied by your Endress+Hauser Sales Center on request. All explosion protection data are given in a separate documentation which is available upon request.

Sanitary compatibility

Promag H
- 3A-approval and EHEDG-certified
- Seals: FDA-compliant (except for Kalrez seals)

Promag E/L/P/W
No applicable approvals or certification

Drinking water approval

Promag P
- ACS

Promag W
- WRAS BS 6920
- ACS
- NSF 61
- KTW/W270

Certification Modbus RS485

The measuring device meets all the requirements of the Modbus/TCP conformity and integration test and holds the "Modbus/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "Modbus/TCP Conformance Test Laboratory" of the University of Michigan.

Pressure equipment directive

The devices can be ordered with or without a PED approval. If a device with a PED approval is required, this must be explicitly stated in the order. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary.

- With the PED/G1/x (x = category) marking on the sensor nameplate, Endress+Hauser confirms compliance with the "Essential Safety Requirements" specified in Annex I of the Pressure Equipment Directive 2014/68/EU.

- Devices bearing this marking (PED) are suitable for the following types of medium: Media in Group 1 and 2 with a vapor pressure greater than, or smaller and equal to 0.5 bar (7.3 psi)
- Devices not bearing this marking (PED) are designed and manufactured according to good engineering practice. They meet the requirements of Art.4 Section 3 of the Pressure Equipment Directive 2014/68/EU. The range of application is indicated in tables 6 to 9 in Annex II of the Pressure Equipment Directive 2014/68/EU.

Other standards and guidelines

- EN 60529: Degrees of protection by housing (IP code)
- EN 61010-1
  Protection measures for electrical equipment for measurement, control, regulation and laboratory procedures
- IEC/EN 61326
  "Emission in accordance with requirements for class A".
  Electromagnetic compatibility (EMC requirements).
- ANSI/ISA-S82.01
  Safety Standard for Electrical and Electronic Test, Measuring, Controlling and related Equipment - General Requirements. Pollution degree 2, Installation Category II.
- CAN/CSA-C22.2 (No. 1010.1-92)
  Safety requirements for Electrical Equipment for Measurement and Control and Laboratory Use. Pollution degree 2, Installation Category I.
- NAMUR NE 21
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.
- NAMUR NE 43
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR NE 53
  Software of field devices and signal-processing devices with digital electronics.

10.13 Ordering information

Detailed ordering information is available from the following sources:
- In the Product Configurator on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide

Note!
Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

10.14 Accessories

Various accessories are available for the transmitter and the sensor. These can be ordered separately from Endress+Hauser → 🖹 102.

Note!
For detailed information on specific order codes, please contact the Endress+Hauser service organization.

10.15 Documentation

- Flow Measurement (FA00005D/06)
- Promag 53E Technical Information (TI01164D/06)
- Promag 53H Technical Information (TI00048D/06)
- Promag 53P Technical Information (TI00047D/06)
- Promag 53W Technical Information (TI00046D/06)
- Description of Device Functions Promag 53 Modbus RS485 (BA00118D/06)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA

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