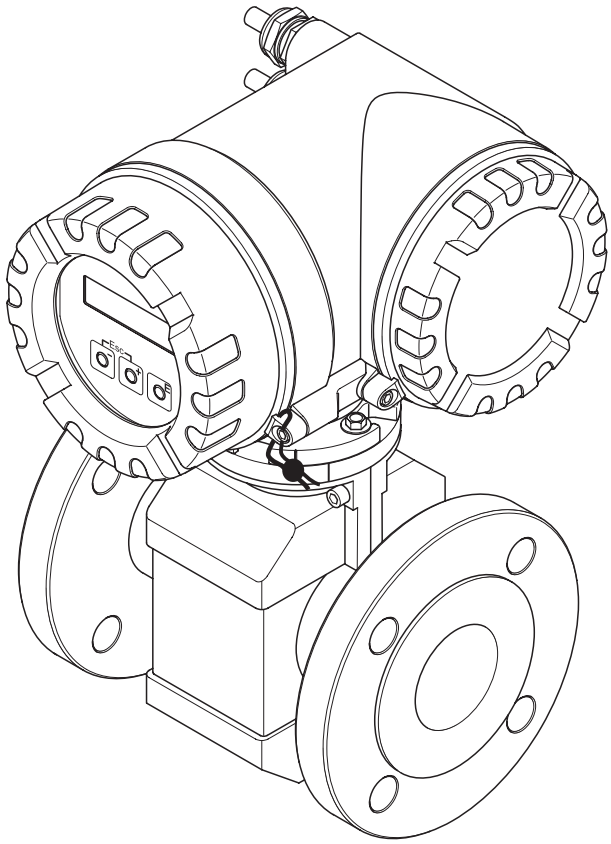
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Proline Promag 51

Electromagnetic Flow Measuring System
For custody transfer with cold water

HART® FIELD COMMUNICATION PROTOCOL



BA080D/06/en/03.05
50101924
Valid as of version:
V 2.00.XX (Device software)

Endress+Hauser
People for Process Automation

Brief operating instructions

These brief operating instructions show you how to configure the measuring device quickly and easily:

Safety instructions	Page 7
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Installation	Page 15
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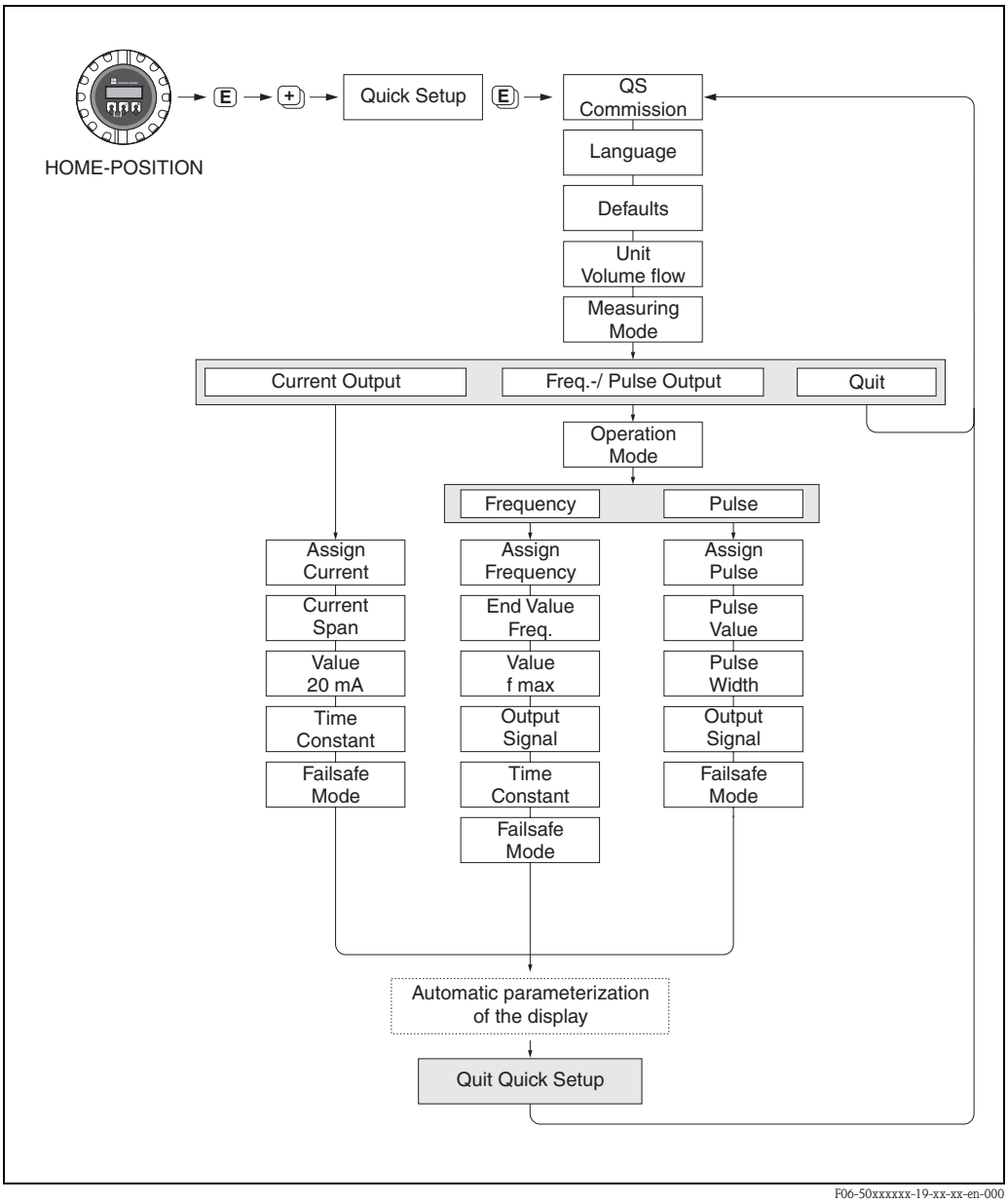
Wiring	Page 39
▼	
Display and operating elements	Page 53
▼	
Commissioning with "QUICK SETUP"	Page 76 ff.
You can commission the measuring device quickly and easily, using the special "Quick Setup" menu. It enables to configure important basic functions using the local display, for example display language, measured variables, units engineering, type of signal, etc. The following adjustments can be made separately as necessary: – Empty-pipe/full-pipe adjustment for empty pipe detection (EPD) – Configuration of current output (active/passive)	
▼	
Customer-specific configuration	Page 54 ff.
Complex measuring operations necessitate additional functions that you can configure as necessary with the aid of the function matrix, and customize to suit the process parameters. All functions are described in detail, as is the function matrix itself, in the **"Description of Device Functions"** manual, which is a separate part of this Operating Instruction.	
▼	
Activating custody transfer mode	Page 72

Note!
Always start trouble-shooting with the checklist on Page 83, if faults occur after commissioning or during operation. The routine takes you directly to the cause of the problem and the appropriate remedial measures.

“QUICK SETUP” commissioning

Caution!
- In custody transfer mode, the Quick Setup menu is not available.
- After official approval or leaded sealing, configuration can no longer be carried out using the local display. In custody transfer mode, device functions can then only be selected or altered via the HART interface or using the FieldTool software.



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Contents

1 Safety instructions

1.1 Designated use

The measuring system Promag 51 is PTB certified for custody transfer with cold water and may be used for measuring the flow of freshwater having a minimum conductivity of 5 µS/cm. A minimum conductivity of 20 µS/cm is required for measuring demineralized water.
The Promag 51 is operated with a totalizer display suitable for custody transfer and, optionally, with a pulse output suitable for custody transfer. The measuring system operates within a temperature range of 0...+30 °C and can be deployed, for example, in the supply of drinking water:
- Internal monitoring of delivery pipe network (local water network)
- Calculation of the bill from the main supply pipe (junctions)
- Monitoring of the water source. For example, the amount of ground water (tank inlet points, incl. pump stations).
- Certification for the amount supplied to the delivery network (tank outlet points).
- Monitoring of the withdrawal and supply of different water works in a supply pipe (overland supply pipe of a water network).

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:
- A calibrated Promag 51 measuring system is protected by seals on the transmitter or the sensor connection housing from manipulation of calibration parameters. As a rule, these seals may only be broken by a representative of the appropriate approval authorities.
- 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 the Operating Manual is mandatory.
- Endress+Hauser will be happy to assist in clarifying the chemical resistance properties of parts wetted by special fluids, including fluids used for cleaning.
- If welding work is performed on the piping system, do not ground the welding appliance through the Promag flowmeter.
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams. The transmitter must be grounded, unless special protective measures have been taken (e.g. galvanically isolated power supply SELV or PELV).
- Invariably, local regulations governing the opening and repair of electrical devices apply.

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 documentation indicates the approval and the certification body (Ⓔx Europe, FM USA, CSA Canada).
- The measuring device complies with the general safety requirements in accordance with EN 61010, the EMC requirements of EN 61326/A1, and NAMUR recommendation NE 21.
- 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 following procedures must be carried out before a flowmeter requiring repair or calibration, for example, is returned to Endress+Hauser:
- Always enclose a duly completed "Declaration of contamination" form. Only then can Endress+Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.
- Remove all residues. Pay special attention to the grooves for seals and crevices which could contain residues. This is particularly important if the substance is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.

Note!
You will find a *preprinted* "Declaration of contamination" form at the back of this manual.

Warning!
- Do not return a measuring device if you are not absolutely certain that all traces of hazardous substances have been removed, e.g. substances which have penetrated crevices or diffused through plastic.
- Costs incurred for waste disposal and injury (burns, etc.) due to inadequate cleaning will be charged to the owner-operator.

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 “Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures”. They 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 “Promag 51” flow measuring system consists of the following components:
- Promag 51 transmitter
- Promag W or Promag P sensor

In the *compact version*, transmitter and sensor form a single mechanical unit; in the *remote version* they are installed separately.

2.1.1 Nameplate of the transmitter

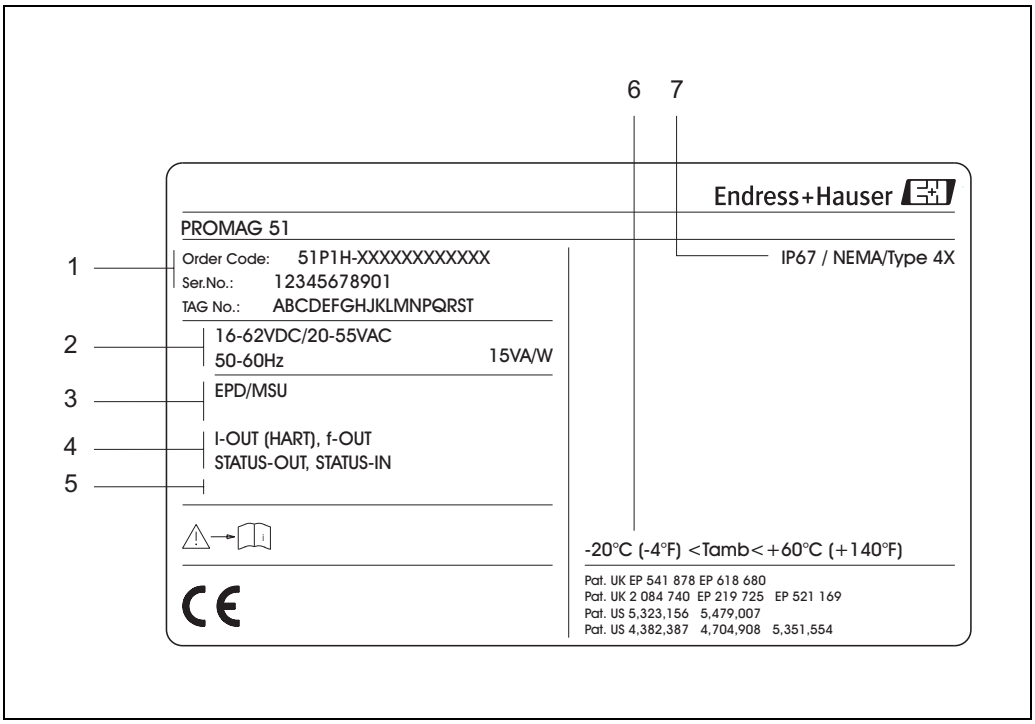

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Fig. 1: Nameplate specifications for the “Promag 51” transmitter (example)

1 Ordering code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits.
2 Power supply / frequency: 16...62 V DC / 20...55 V AC / 50...60 Hz
Power consumption: 15 VA / W
3 Additional functions and software:
– EPD/MSÜ: with Empty Pipe Detection
4 Outputs / inputs:
I-OUT (HART): with current output (HART)
f-OUT: with pulse/frequency output
STATUS-IN: with status input (auxiliary input)
STATUS-OUT: with status output
5 Reserved for information on special products
6 Ambient temperature range
7 Degree of protection

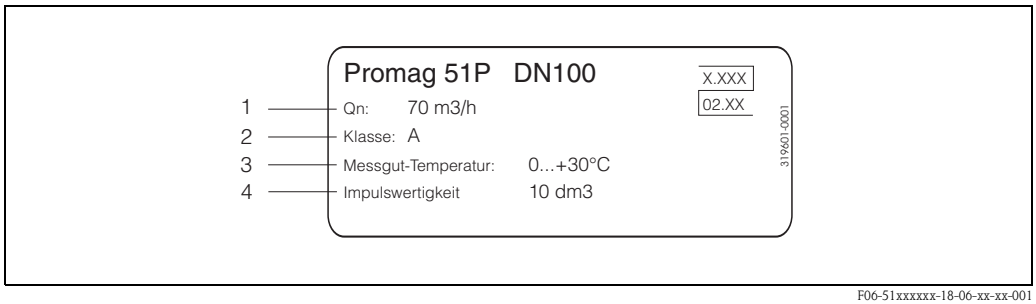

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Fig. 2: Additional nameplate for certified Promag 51 measuring devices (example)

1 Q_n: Nominal flow rate (see Page 23)
2 Metrological Class A (see Page 74)
3 Permissible fluid temperature (cold water) in custody transfer mode
4 Pulse value for the pulse output in custody transfer mode

2.1.2 Nameplate of the sensor

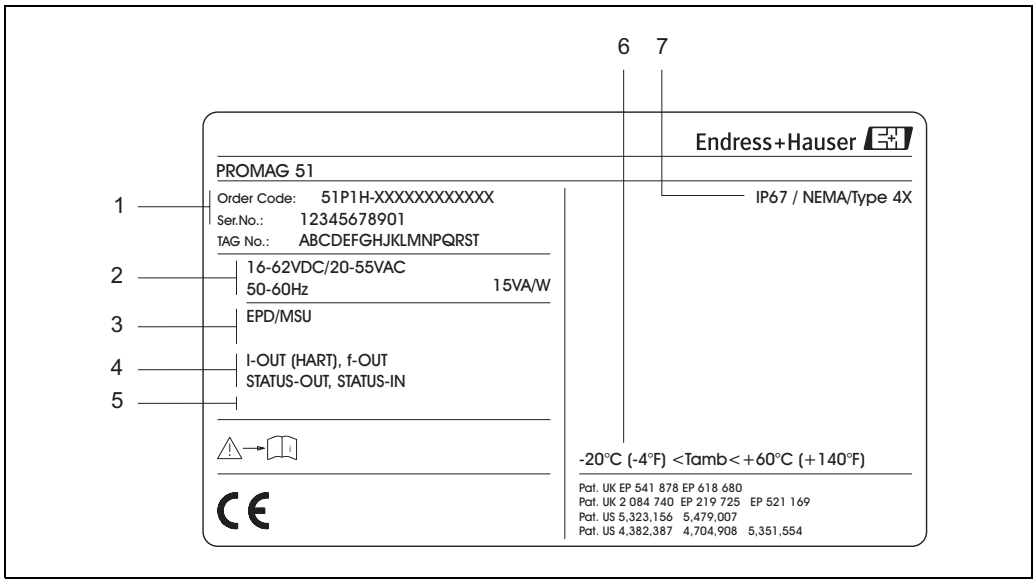

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Fig. 3: Nameplate specifications for the "Promag" sensor (example)

1 Ordering code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits.
2 Calibration factor: 0.5328; zero point: −5
3 Nominal diameter: DN 100
Pressure rating: EN (DIN) PN 16 bar
4 TMmax +80 °C (max. fluid temperature)
5 Materials:
– Lining: PFA
– Measuring electrodes: stainless steel 1.4435
6 Additional information (examples):
– EPD/MSU: with Empty Pipe Detection electrode
– R/B: with reference electrode
– EME/AWE: with exchangeable measuring electrodes
– 0.5% CAL: with 0.5% calibration
7 Reserved for information on special products
8 Ambient temperature range
9 Degree of protection
10 Reserved for additional information on device version (approvals, certificates)
11 Flow direction

2.1.3 Nameplate, connections

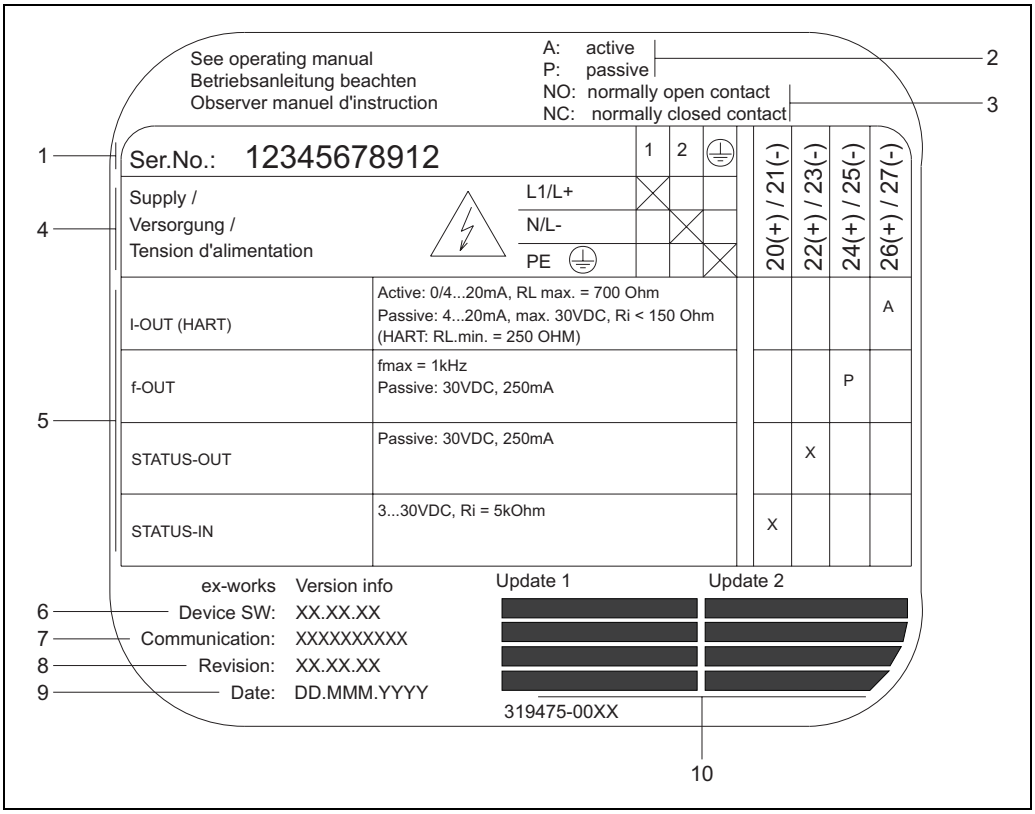

Fig. 4: Nameplate specifications for Proline transmitter (example)

1 Serial number
2 Possible configuration of current output
3 Possible configuration of relay contacts
4 Terminal assignment, cable for power supply: 85...260 V AC, 20...55 V AC, 16...62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L- for DC*
5 Signals present at inputs and outputs, possible configuration and terminal assignment (20...27), see also "Electrical values of inputs/outputs"
6 Version of device software currently installed
7 Installed communication type, e.g.: HART etc.
8 Information on current communication software (Device Revision and Device Description), e.g.: Dev. 01 / DD 01 for HART
9 Date of installation
10 Current updates to data specified in points 6 to 9

2.2 CE mark, declaration of conformity

The devices are designed to meet state-of-the-art safety requirements in accordance with sound engineering practice. They 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 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures" and with the EMC requirements of EN 61326/A1.
The measuring system described in these Operating Instructions is therefore in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

2.3 Registered trademarks

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

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

HART ®
Registered trademark of HART Communication Foundation, Austin, USA

HistoROM™, S-DAT®, ToF Tool - Fieldtool® Package, Fieldcheck®, Applicator®
are registered trademarks of Endress+Hauser Flowtec AG, Reinach, CH

3 Installation

3.1 Incoming acceptance, transport and storage

3.1.1 Incoming acceptance

- 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 protective plates or caps on the process connections until the device is ready to install. 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 covers until *immediately before* the device is installed in the pipe.
- Do not lift flanged devices by the transmitter housing, or the connection housing in the case of the remote version.

Transporting flanged devices (DN ≤ 300):
Use webbing slings slung round the two process connections (Fig. 5). 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.

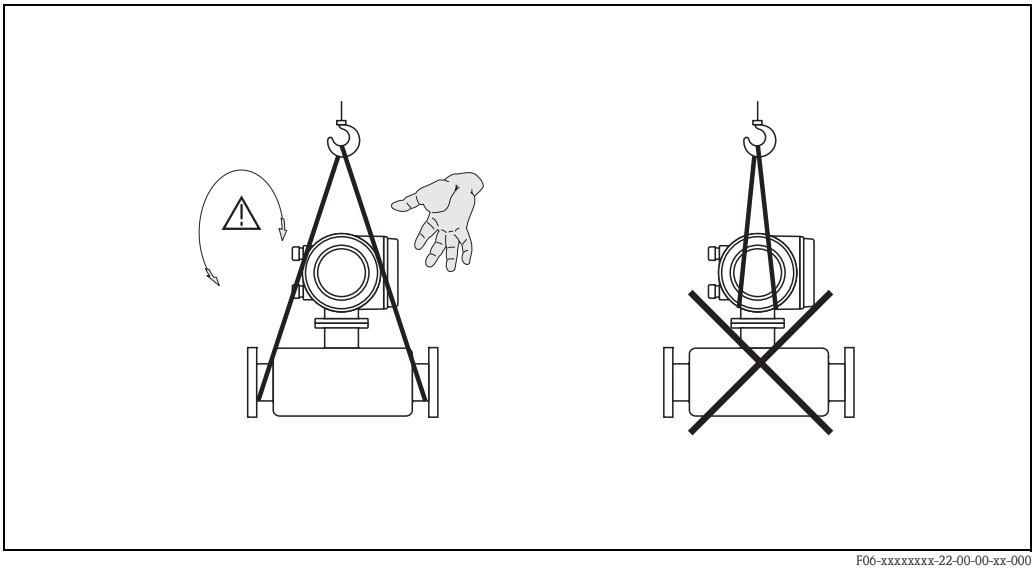

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Fig. 5: Transporting transmitters with DN ≤ 300

Transporting flanged devices (DN ≥ 350):
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.

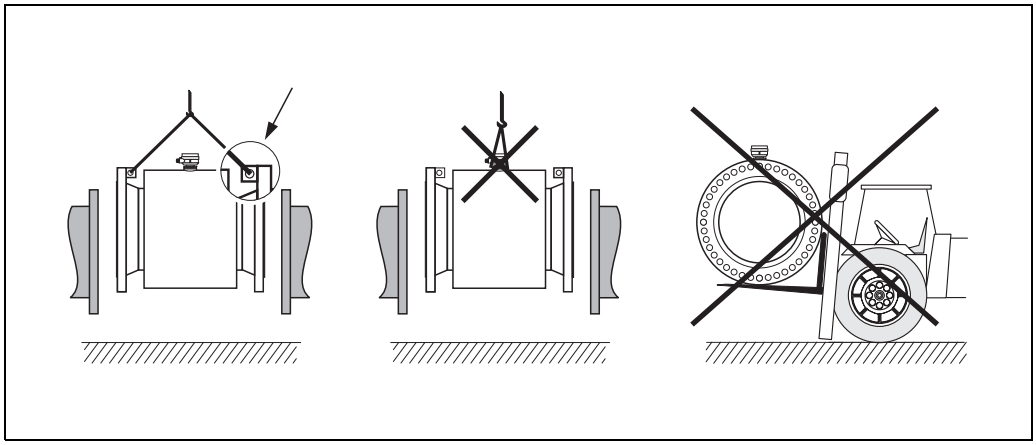

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Fig. 6: Transporting sensors with DN ≥ 350

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.
- 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 liner.
- Do not remove the protective 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

All the dimensions and lengths of the sensor and transmitter are provided in the separate documentation “Technical Information”.

3.2.2 Mounting location

Correct measuring is possible only if the pipe is full. Avoid the following locations:
- Highest point of a pipeline. Risk of air accumulating
- Directly upstream a free pipe outlet in a vertical pipeline.

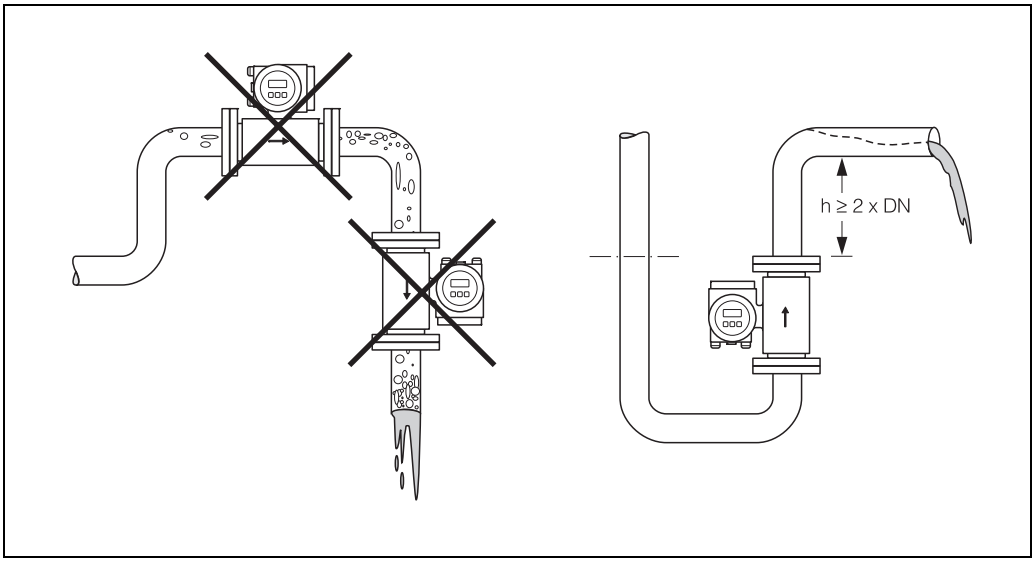

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Fig. 7: Location

Installation of 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 can be found on → Page 111.

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 can be found on → Page 109.

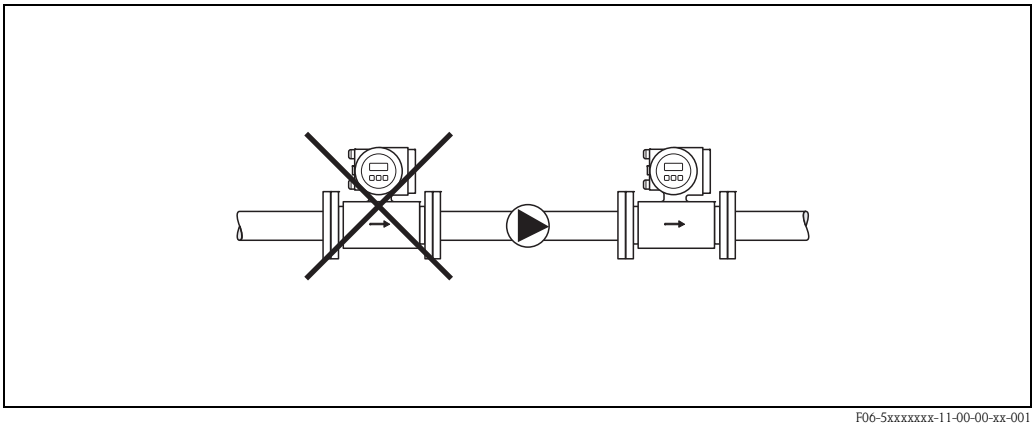

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Fig. 8: Installation of pumps

Partially filled pipes
Partially filled pipes with gradients necessitate a drain-type configuration. The Empty Pipe Detection function (see Page 77) offers additional protection by detecting empty or partially filled pipes.

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

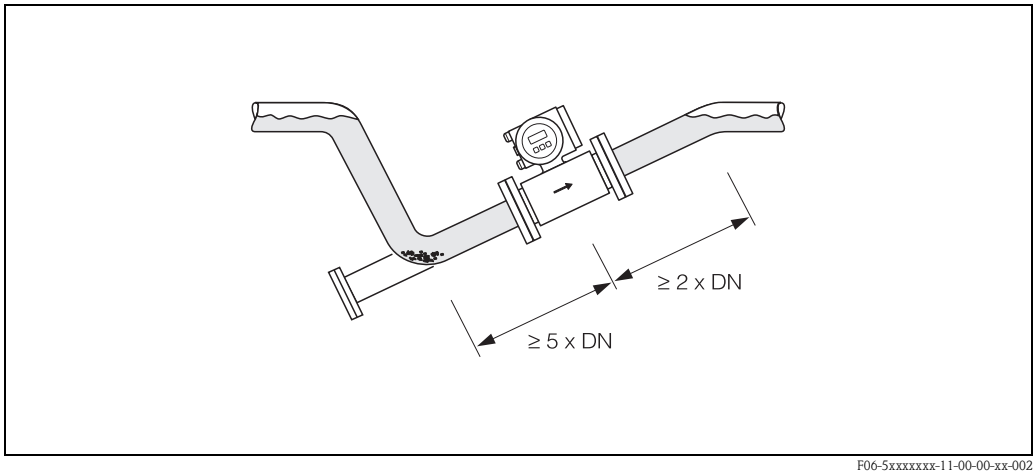

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Fig. 9: Installation in partially filled pipe

Down pipes
Install a siphon or a vent valve downstream of the sensor in down pipes longer than 5 meters. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. These measures also prevent the system losing prime, which could cause air inclusions. Information on the lining's resistance to partial vacuum can be found on Page 111.

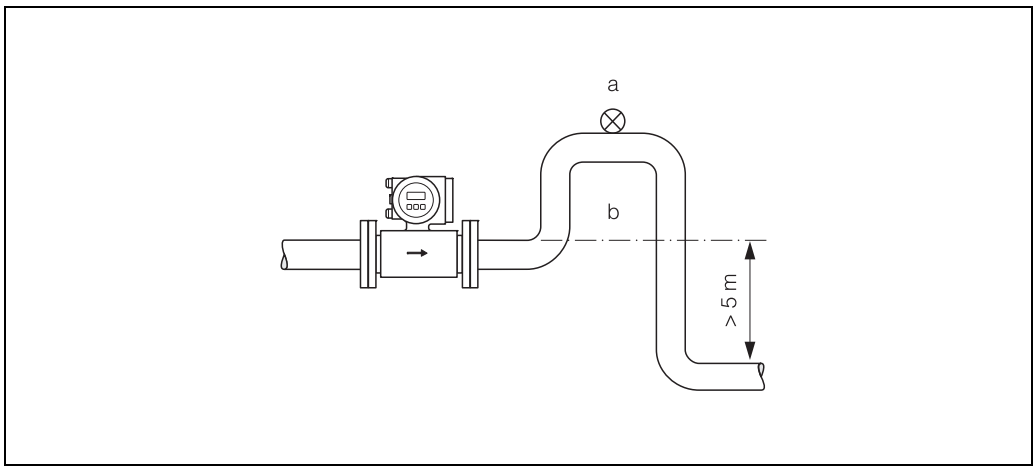

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Fig. 10: Measures for installation in a down pipe (a = vent valve; b = siphon)

3.2.3 Orientation

An optimum orientation 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:

- Empty Pipe Detection (EPD) ensures the detection of partially filled measuring tubes, e.g. in the case of degassing fluids or varying process pressure (see Page 77)
- Exchangeable Measuring Electrodes for abrasive fluids (see Page 100)

Vertical orientation
This is the ideal orientation for self-emptying piping systems and for use in conjunction with Empty Pipe Detection.

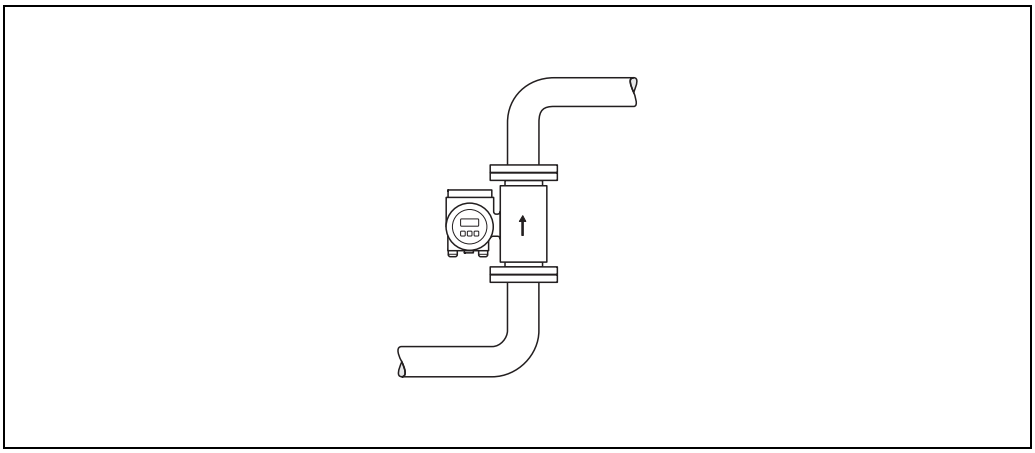

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Fig. 11: Vertical orientation

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 only when the measuring device is installed horizontally and the transmitter housing is facing upward (Fig. 12). Otherwise there is no guarantee that Empty Pipe Detection will respond if the measuring tube is only partially filled or empty.

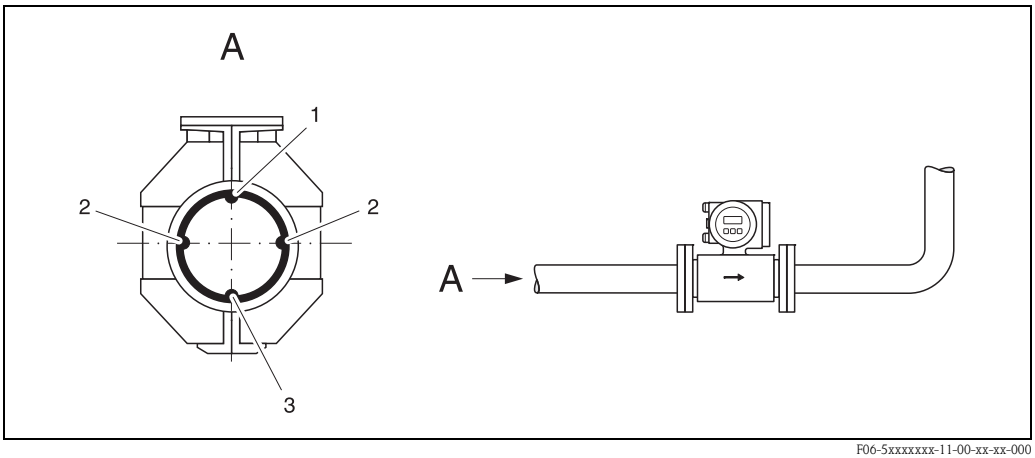

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Fig. 12: Horizontal orientation

1 EPD electrode for the detection of empty pipes
2 Measurement electrodes for the signal acquisition
3 Reference electrode for the potential equalisation

Inlet and outlet runs
If possible, install the sensor well clear 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 x DN
- Outlet run ≥ 2 x DN

Caution!
- The inlet run and the outlet run must have the same nominal width as the flowmeter!
- This data is applicable even with the use of adapters to increase fluid velocity (see Page 22).

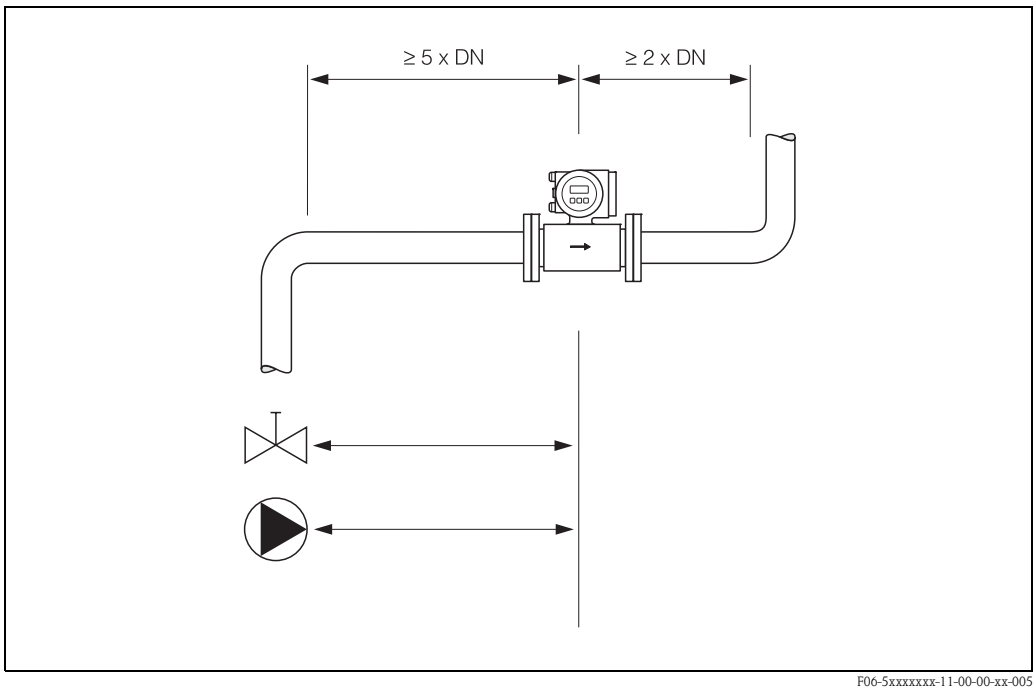

Fig. 13: Inlet and outlet runs

3.2.4 Vibrations

Secure the piping and the sensor if vibration is severe.

Caution!
It is advisable to install sensor and transmitter separately if vibration is excessively severe.
Information on resistance to vibration and shock can be found on → Page 109.

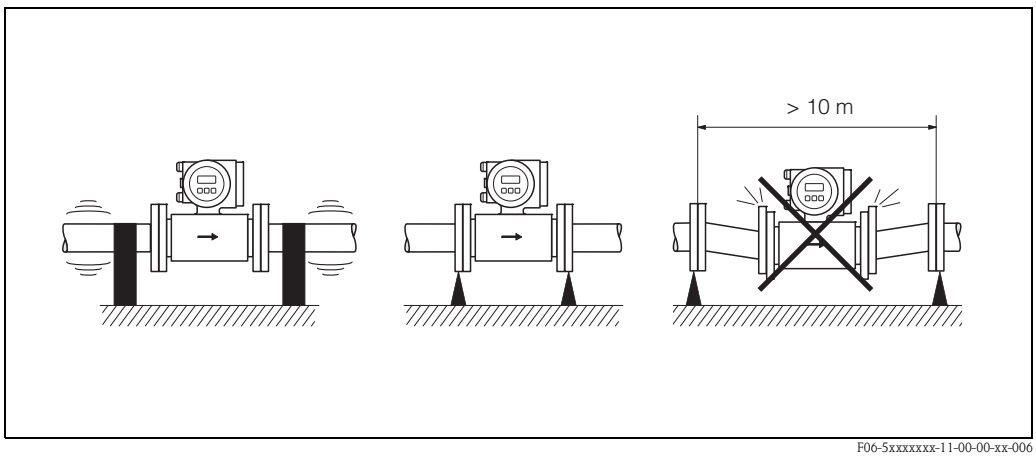

Fig. 14: Measures to prevent vibration of the measuring device

3.2.5 Foundations, supports

If the nominal diameter is DN ≥ 350, mount the transmitter 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.

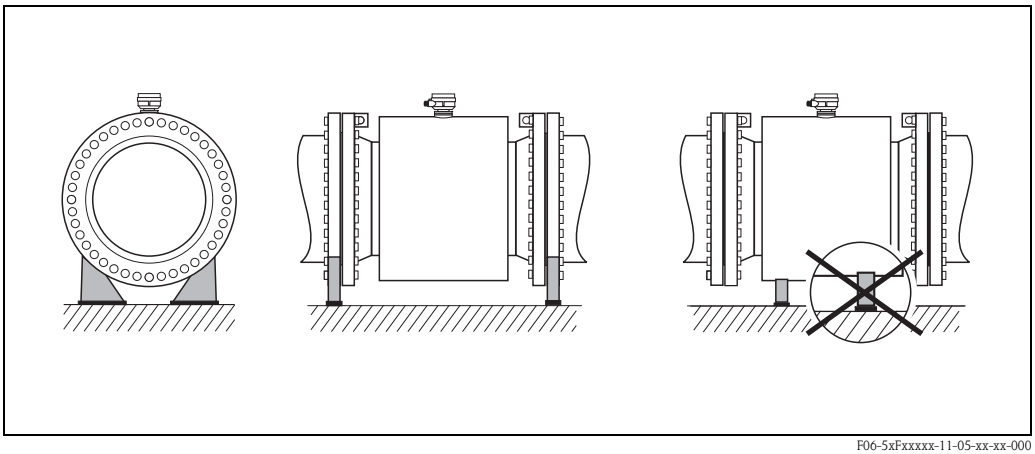

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Fig. 15: Correct support for large nominal diameters (DN ≥ 350)

3.2.6 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. The nomogram applies to fluids of viscosity similar to water:

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

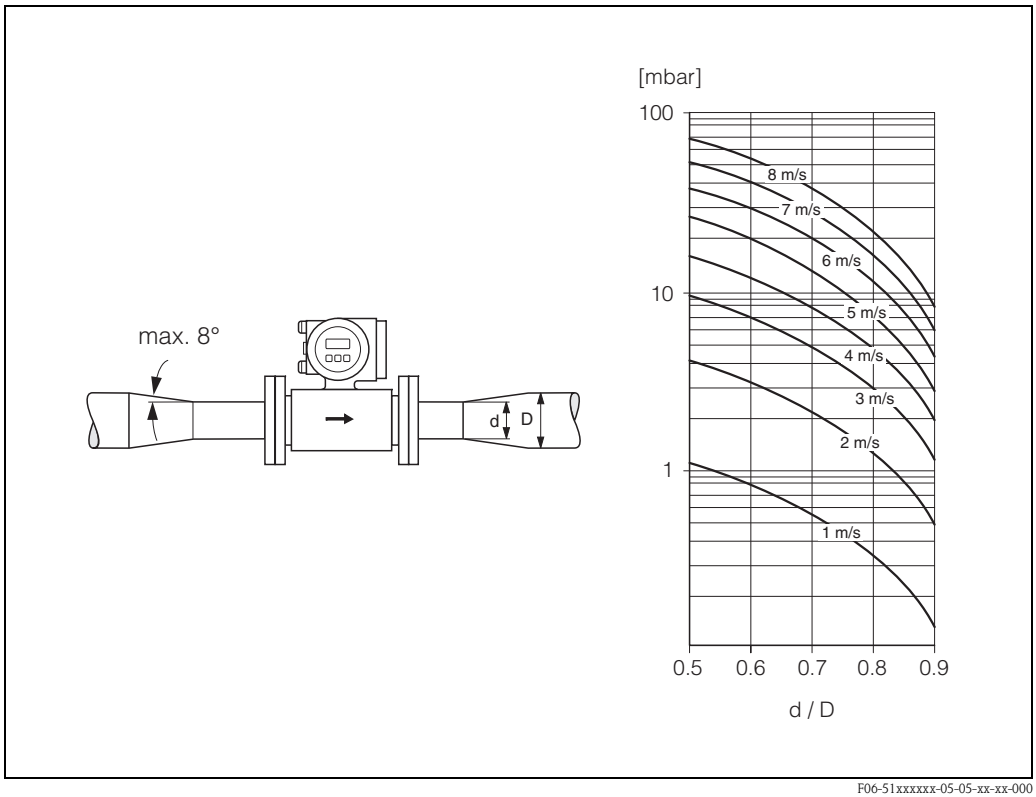

Fig. 16: Pressure loss due to adapters

Caution!
The inlet run (5 x DN) and the outlet run (2 x DN) must have the same nominal width as the flowmeter!

3.2.7 Nominal flow rate (Metrological classes)

The diameter of the pipe usually governs the nominal diameter of the sensor. The plant should be designed so that under "normal" operating conditions, the optimum flow rate lies between 2...3 m/s.
If it is necessary to increase the flow velocity, this can be done by reducing the nominal diameter of the sensor (see Section 3.2.6).

Nominal flow rate Q_n in [m^3/h]						
Nominal Diameter DN	**Metrological class A**			**Metrological class B**		
[mm]	Q_n (min)		Q_n (max)	Q_n (min)		Q_n (max)
15	0.8	$Q_{min} : Q_n = 1 : 25$	3.0	1.6	$Q_{min} : Q_n = 1 : 50$	3.0
25	2.2		8.8	4.4		8.8
32	3.6		14.0	7.2		14.0
40	5.6		22.6	11.3		22.6
50	9.0		35.0	15.0 *	$Q_{min} : Q_n = 1 : 33$	35.0
65	15.0		60.0	20.0		60.0
80	15.0 *	$Q_{min} : Q_n = 1 : 12.5$	90.0	30.0		90.0
100	18.0		140.0	46.0		140.0
125	28.0		220.0	73.0		220.0
150	40.0		320.0	105.0		320.0
200	70.0		550.0	190.0		550.0
250	110.0		880.0	290.0		880.0
300	160.0		1250	420.0		1250
350	215.0		1700	570.0		1700
400	280.0		2200	750.0		2200
500	440.0		3000	1170		3000
600	640.0		3000	1700		3000
700...2000	Diameters DN 700...2000 can also be approved. However, measuring points with these diameters are not normally subject to metrological regulations (Q_{max} = 2 x Q_n > 2000 m^3/h).					

* Limit range $Q \geq 15$ m^3/h (see also Table on Page 74)

Q_n (min) = lowest nominal flow rate with reference to Q (min), v = 0.5 m/s
Q_n (max) = highest nominal flow rate with reference to Q (max), v = 5 m/s

Designations → Page 74

Please indicate the following data in all requests and orders for certified devices:

Nominal flow rate (Qn) for Class A or B
This information is shown on the nameplate and must be given in the order text. Q_n must lie between the corresponding Q_n (min) and Q_n (max) valid for Class A or B.

Current output / pulse output
For scaling the current output, the scale value and if required the pulse output value must be given, and will then set at the factory.
The full scale value and the value Q_n are two different values. For example, the full scale value can be higher than the defined Q_n. In extreme cases, it is double the value of Q_n (max) and lies at 10 m/s.

3.2.8 Flow characteristics and factory settings

In custody transfer mode, certain nominal-diameter-dependent flow ranges or nominal flow rates must be observed (see Page 23). Irrespective of this, the following flow characteristic values and factory settings apply in non-custody transfer mode.

Flow rate characteristic values – Promag W (SI units)

Nominal diameter		Recommended flow rate	Factory setting		
[mm]	[inch]	min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value (v ~ 2.5 m/s)	Pulse value (~ 2 pulse/s)	Low flow cutoff (v ~ 0.04 m/s)
25	1"	9…300 dm^3/min	75 dm^3/min	0.50 dm^3	1 dm^3/min
32	1 1/4"	15…500 dm^3/min	125 dm^3/min	1.00 dm^3	2 dm^3/min
40	1 1/2"	25…700 dm^3/min	200 dm^3/min	1.50 dm^3	3 dm^3/min
50	2"	35…1100 dm^3/min	300 dm^3/min	2.50 dm^3	5 dm^3/min
65	2 1/2"	60…2000 dm^3/min	500 dm^3/min	5.00 dm^3	8 dm^3/min
80	3"	90…3000 dm^3/min	750 dm^3/min	5.00 dm^3	12 dm^3/min
100	4"	145…4700 dm^3/min	1200 dm^3/min	10.00 dm^3	20 dm^3/min
125	5"	220…7500 dm^3/min	1850 dm^3/min	15.00 dm^3	30 dm^3/min
150	6"	20…600 m^3/h	150 m^3/h	0.025 m^3	2.5 m^3/h
200	8"	35…1100 m^3/h	300 m^3/h	0.05 m^3	5.0 m^3/h
250	10"	55…1700 m^3/h	500 m^3/h	0.05 m^3	7.5 m^3/h
300	12"	80…2400 m^3/h	750 m^3/h	0.10 m^3	10 m^3/h
350	14"	110…3300 m^3/h	1000 m^3/h	0.10 m^3	15 m^3/h
400	16"	140…4200 m^3/h	1200 m^3/h	0.15 m^3	20 m^3/h
450	18"	180…5400 m^3/h	1500 m^3/h	0.25 m^3	25 m^3/h
500	20"	220…6600 m^3/h	2000 m^3/h	0.25 m^3	30 m^3/h
600	24"	310…9600 m^3/h	2500 m^3/h	0.30 m^3	40 m^3/h
700	28"	420…13500 m^3/h	3500 m^3/h	0.50 m^3	50 m^3/h
–	30"	480…15000 m^3/h	4000 m^3/h	0.50 m^3	60 m^3/h
800	32"	550…18000 m^3/h	4500 m^3/h	0.75 m^3	75 m^3/h
900	36"	690…22500 m^3/h	6000 m^3/h	0.75 m^3	100 m^3/h
1000	40"	850…28000 m^3/h	7000 m^3/h	1.00 m^3	125 m^3/h
–	42"	950…30000 m^3/h	8000 m^3/h	1.00 m^3	125 m^3/h
1200	48"	1250…40000 m^3/h	10000 m^3/h	1.50 m^3	150 m^3/h
–	54"	1550…50000 m^3/h	13000 m^3/h	1.50 m^3	200 m^3/h
1400	–	1700…55000 m^3/h	14000 m^3/h	2.00 m^3	225 m^3/h
–	60"	1950…60000 m^3/h	16000 m^3/h	2.00 m^3	250 m^3/h
1600	–	2200…70000 m^3/h	18000 m^3/h	2.50 m^3	300 m^3/h
–	66"	2500…80000 m^3/h	20500 m^3/h	2.50 m^3	325 m^3/h
1800	72"	2800…90000 m^3/h	23000 m^3/h	3.00 m^3	350 m^3/h
–	78"	3300…100000 m^3/h	28500 m^3/h	3.50 m^3	450 m^3/h
2000	–	3400…110000 m^3/h	28500 m^3/h	3.50 m^3	450 m^3/h

Flow rate characteristic values – Promag W (US units)

Nominal diameter		Recommended flow rate	Factory setting		
[inch]	[mm]	min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value (v ~ 2.5 m/s)	Pulse value (~ 2 pulse/s)	Low flow cutoff (v ~ 0.04 m/s)
1"	25	2.5…80 gal/min	18 gal/min	0.20 gal	0.25 gal/min
1 1/4"	32	4…130 gal/min	30 gal/min	0.20 gal	0.50 gal/min
1 1/2"	40	7…190 gal/min	50 gal/min	0.50 gal	0.75 gal/min
2"	50	10…300 gal/min	75 gal/min	0.50 gal	1.25 gal/min
2 1/2"	65	16…500 gal/min	130 gal/min	1 gal	2.0 gal/min
3"	80	24…800 gal/min	200 gal/min	2 gal	2.5 gal/min
4"	100	40…1250 gal/min	300 gal/min	2 gal	4.0 gal/min
5"	125	60…1950 gal/min	450 gal/min	5 gal	7.0 gal/min
6"	150	90…2650 gal/min	600 gal/min	5 gal	12 gal/min
8"	200	155…4850 gal/min	1200 gal/min	10 gal	15 gal/min
10"	250	250…7500 gal/min	1500 gal/min	15 gal	30 gal/min
12"	300	350…10600 gal/min	2400 gal/min	25 gal	45 gal/min
14"	350	500…15000 gal/min	3600 gal/min	30 gal	60 gal/min
16"	400	600…19000 gal/min	4800 gal/min	50 gal	60 gal/min
18"	450	800…24000 gal/min	6000 gal/min	50 gal	90 gal/min
20"	500	1000…30000 gal/min	7500 gal/min	75 gal	120 gal/min
24"	600	1400…44000 gal/min	10500 gal/min	100 gal	180 gal/min
28"	700	1900…60000 gal/min	13500 gal/min	125 gal	210 gal/min
30"	–	2150…67000 gal/min	16500 gal/min	150 gal	270 gal/min
32"	800	2450…80000 gal/min	19500 gal/min	200 gal	300 gal/min
36"	900	3100…100000 gal/min	24000 gal/min	225 gal	360 gal/min
40"	1000	3800…125000 gal/min	30000 gal/min	250 gal	480 gal/min
42"	–	4200…135000 gal/min	33000 gal/min	250 gal	600 gal/min
48"	1200	5500…175000 gal/min	42000 gal/min	400 gal	600 gal/min
54"	–	9…300 Mgal/d	75 Mgal/d	0.0005 Mgal	1.3 Mgal/d
–	1400	10…340 Mgal/d	85 Mgal/d	0.0005 Mgal	1.3 Mgal/d
60"	–	12…380 Mgal/d	95 Mgal/d	0.0005 Mgal	1.3 Mgal/d
–	1600	13…450 Mgal/d	110 Mgal/d	0.0008 Mgal	1.7 Mgal/d
66"	–	14…500 Mgal/d	120 Mgal/d	0.0008 Mgal	2.2 Mgal/d
72"	1800	16…570 Mgal/d	140 Mgal/d	0.0008 Mgal	2.6 Mgal/d
78"	–	18…650 Mgal/d	175 Mgal/d	0.001 Mgal	3.0 Mgal/d
–	2000	20…700 Mgal/d	175 Mgal/d	0.001 Mgal	3.0 Mgal/d

Flow rate characteristic values - Promag P (SI units)

Nominal diameter		Recommended flow rate	Factory setting		
[mm]	[inch]	min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value (v ~ 2.5 m/s)	Pulse value (~ 2 pulse/s)	Low flow cutoff (v ~ 0.04 m/s)
15	1/2"	4…100 dm^3/min	25 dm^3/min	0.20 dm^3	0.5 dm^3/min
25	1"	9…300 dm^3/min	75 dm^3/min	0.50 dm^3	1 dm^3/min
32	1 1/4"	15…500 dm^3/min	125 dm^3/min	1.00 dm^3	2 dm^3/min
40	1 1/2"	25…700 dm^3/min	200 dm^3/min	1.50 dm^3	3 dm^3/min
50	2"	35…1100 dm^3/min	300 dm^3/min	2.50 dm^3	5 dm^3/min
65	2 1/2"	60…2000 dm^3/min	500 dm^3/min	5.00 dm^3	8 dm^3/min
80	3"	90…3000 dm^3/min	750 dm^3/min	5.00 dm^3	12 dm^3/min
100	4"	145…4700 dm^3/min	1200 dm^3/min	10.00 dm^3	20 dm^3/min
125	5"	220…7500 dm^3/min	1850 dm^3/min	15.00 dm^3	30 dm^3/min
150	6"	20…600 m^3/h	150 m^3/h	0.025 m^3	2.5 m^3/h
200	8"	35…1100 m^3/h	300 m^3/h	0.05 m^3	5.0 m^3/h
250	10"	55…1700 m^3/h	500 m^3/h	0.05 m^3	7.5 m^3/h
300	12"	80…2400 m^3/h	750 m^3/h	0.10 m^3	10 m^3/h
350	14"	110…3300 m^3/h	1000 m^3/h	0.10 m^3	15 m^3/h
400	16"	140…4200 m^3/h	1200 m^3/h	0.15 m^3	20 m^3/h
450	18"	180…5400 m^3/h	1500 m^3/h	0.25 m^3	25 m^3/h
500	20"	220…6600 m^3/h	2000 m^3/h	0.25 m^3	30 m^3/h
600	24"	310…9600 m^3/h	2500 m^3/h	0.30 m^3	40 m^3/h

Flow rate characteristic values – Promag P (US units)

Nominal diameter		Recommended flow rate	Factory setting		
[inch]	[mm]	min./max. full scale value (v ~ 0.3 or ~ 10 m/s)	Full scale value (v ~ 2.5 m/s)	Pulse value (~ 2 pulse/s)	Low flow cutoff (v ~ 0.04 m/s)
1/2"	15	1.0…27 gal/min	6 gal/min	0.05 gal	0.10 gal/min
1"	25	2.5…80 gal/min	18 gal/min	0.20 gal	0.25 gal/min
1 1/4"	32	4…130 gal/min	30 gal/min	0.20 gal	0.50 gal/min
1 1/2"	40	7…190 gal/min	50 gal/min	0.50 gal	0.75 gal/min
2"	50	10…300 gal/min	75 gal/min	0.50 gal	1.25 gal/min
2 1/2"	65	16…500 gal/min	130 gal/min	1 gal	2.0 gal/min
3"	80	24…800 gal/min	200 gal/min	2 gal	2.5 gal/min
4"	100	40…1250 gal/min	300 gal/min	2 gal	4.0 gal/min
5"	125	60…1950 gal/min	450 gal/min	5 gal	7.0 gal/min
6"	150	90…2650 gal/min	600 gal/min	5 gal	12 gal/min
8"	200	155…4850 gal/min	1200 gal/min	10 gal	15 gal/min
10"	250	250…7500 gal/min	1500 gal/min	15 gal	30 gal/min
12"	300	350…10600 gal/min	2400 gal/min	25 gal	45 gal/min
14"	350	500…15000 gal/min	3600 gal/min	30 gal	60 gal/min
16"	400	600…19000 gal/min	4800 gal/min	50 gal	60 gal/min
18"	450	800…24000 gal/min	6000 gal/min	50 gal	90 gal/min
20"	500	1000…30000 gal/min	7500 gal/min	75 gal	120 gal/min
24"	600	1400…44000 gal/min	10500 gal/min	100 gal	180 gal/min

3.2.9 Length of connecting cable

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

- Secure the cable run or route the cable in a 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 equalisation between sensor and transmitter.
- The permissible cable length Lmax depends on the fluid conductivity (Fig. 17).
  A minimum conductivity of 20 µS/cm is required for measuring demineralized water.

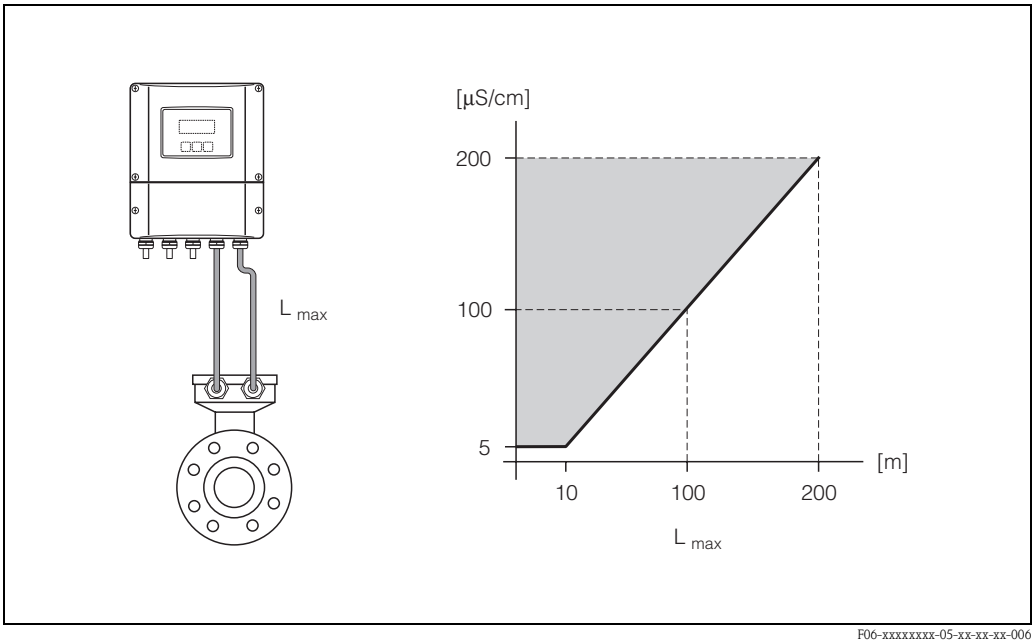

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Fig. 17: Permissible cable length for the remote version

Gray shaded area = permissible range
Lmax = length of connecting cable in [m]
Fluid conductivity in [µS/cm]

3.3 Installation instructions

3.3.1 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:
- Observe in any case the necessary screw tightening torques on Page 30 ff.
- The mounting of additional ground disks is described on Page 29.

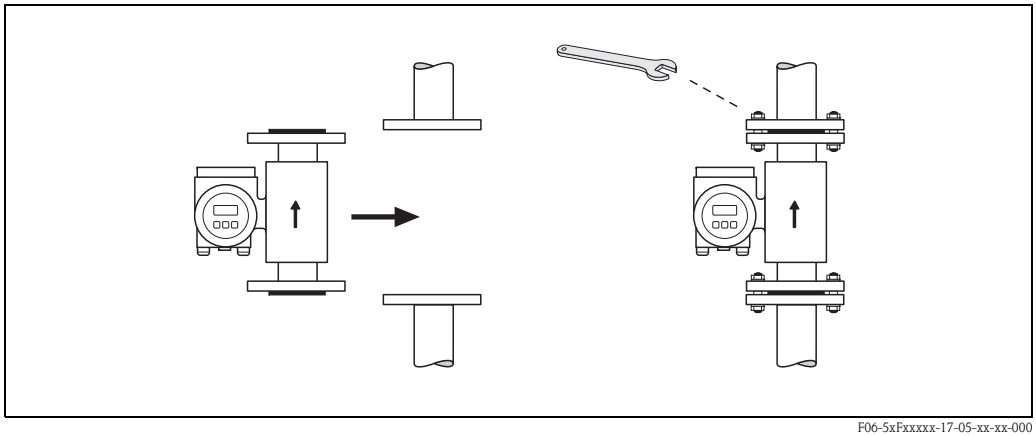

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Fig. 18: Installing the Promag W sensor

Seals
Comply with the following instructions when installing seals:
- Hard rubber lining → additional seals are **always** necessary.
- Polyurethane lining → additional seals are recommended.
- For DIN flanges, use only seals according to DIN 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 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 (DN 25…2000)
If necessary, the special ground cable for potential equalisation can be ordered as an accessory (see Page 81). Detailled assembly instructions → Page 48 ff.

Assembly with ground disks (DN 25…300)
Depending on the application, e.g. with lined or ungrounded pipes (see Page 47 ff.), it may be necessary to mount ground disks between the sensor and the pipe flange for potential equalisation. Ground disks can be ordered separately as an accessory from Endress+Hauser (see Page 81).

Caution!
- In this case, when using ground disks (including seals) the total fitting length increases! All the dimensions are provided in the separate documentation "Technical Information".
- Hard rubber lining → install additional seals between the sensor and ground disk and between the ground disk and pipe flange.
- Polyurethane lining → only install additional seals between the ground disk and pipe flange.

1. Place the ground disk and additional seal(s) between the instrument and the pipe flange (Fig. 19).
2. Insert the bolts through the flange holes. Tighten the nuts so that they are still loose.
3. Now rotate the ground disk as shown in Fig. 19 until the handle strikes the bolts. This will center the ground disk automatically.
4. Now tighten the bolts to the required torque (see Page 30 ff.)
5. Connect the ground disk to ground → Page 49.

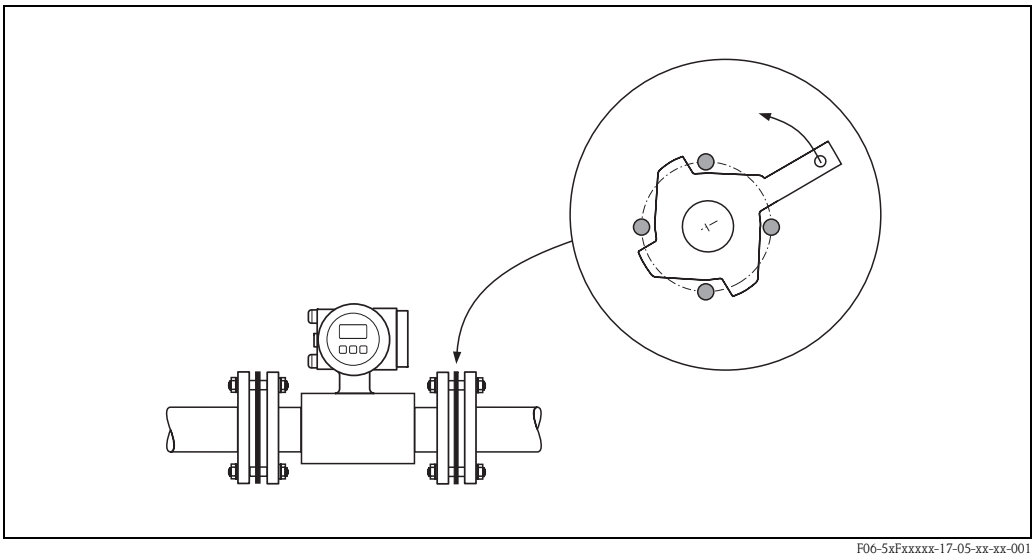

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Fig. 19: Assembly with ground disks (Promag W, DN 25…300)

Screw tightening torques (Promag W)

Note the following points:

- The tightening torques listed below are for lubricated threads only.
- Always tighten threaded fasteners uniformly and in diagonally opposite sequence.
- Overtightening the fasteners will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

Promag W Nominal diameter	EN (DIN) Pressure rating	Threaded fasteners	Max. tightening torque [Nm]	
[mm]	[bar]		Hard rubber	Polyurethane
25	PN 40	4 x M 12	–	15
32	PN 40	4 x M 16	–	24
40	PN 40	4 x M 16	–	31
50	PN 40	4 x M 16	–	40
65 *	PN 16	8 x M 16	32	27
65	PN 40	8 x M 16	32	27
80	PN 16	8 x M 16	40	34
80	PN 40	8 x M 16	40	34
100	PN 16	8 x M 16	43	36
100	PN 40	8 x M 20	59	50
125	PN 16	8 x M 16	56	48
125	PN 40	8 x M 24	83	71
150	PN 16	8 x M 20	74	63
150	PN 40	8 x M 24	104	88
200	PN 10	8 x M 20	106	91
200	PN 16	12 x M 20	70	61
200	PN 25	12 x M 24	104	92
250	PN 10	12 x M 20	82	71
250	PN 16	12 x M 24	98	85
250	PN 25	12 x M 27	150	134
300	PN 10	12 x M 20	94	81
300	PN 16	12 x M 24	134	118
300	PN 25	16 x M 27	153	138
350	PN 10	16 x M 20	112	118
350	PN 16	16 x M 24	152	165
350	PN 25	16 x M 30	227	252
400	PN 10	16 x M 24	151	167
400	PN 16	16 x M 27	193	215
400	PN 25	16 x M 33	289	326
450	PN 10	20 x M 24	153	133
450	PN 16	20 x M 27	198	196
450	PN 25	20 x M 33	256	253
500	PN 10	20 x M 24	155	171
500	PN 16	20 x M 30	275	300
500	PN 25	20 x M 33	317	360
600	PN 10	20 x M 27	206	219
600 *	PN 16	20 x M 33	415	443
600	PN 25	20 x M 36	431	516
700	PN 10	24 x M 27	246	246

Promag W Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Threaded fasteners	Max. tightening torque [Nm]	
			Hard rubber	Polyurethane
700	PN 16	24 x M 33	278	318
700	PN 25	24 x M 39	449	507
800	PN 10	24 x M 30	331	316
800	PN 16	24 x M 36	369	385
800	PN 25	24 x M 45	664	721
900	PN 10	28 x M 30	316	307
900	PN 16	28 x M 36	353	398
900	PN 25	28 x M 45	690	716
1000	PN 10	28 x M 33	402	405
1000	PN 16	28 x M 39	502	518
1000	PN 25	28 x M 52	970	971
1200	PN 6	32 x M 30	319	299
1200	PN 10	32 x M 36	564	568
1200	PN 16	32 x M 45	701	753
1400	PN 6	36 x M 33	430	398
1400	PN 10	36 x M 39	654	618
1400	PN 16	36 x M 45	729	762
1600	PN 6	40 x M 33	440	417
1600	PN 10	40 x M 45	946	893
1600	PN 16	40 x M 52	1007	1100
1800	PN 6	44 x M 36	547	521
1800	PN 10	44 x M 45	961	895
1800	PN 16	44 x M 52	1108	1003
2000	PN 6	48 x M 39	629	605
2000	PN 10	48 x M 45	1047	1092
2000	PN 16	48 x M 56	1324	1261
* Designed acc. to EN 1092-1 (not to DIN 2501)				

3.3.2 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 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 Page 34 ff.
- The mounting of additional ground disks is described on Page 33.

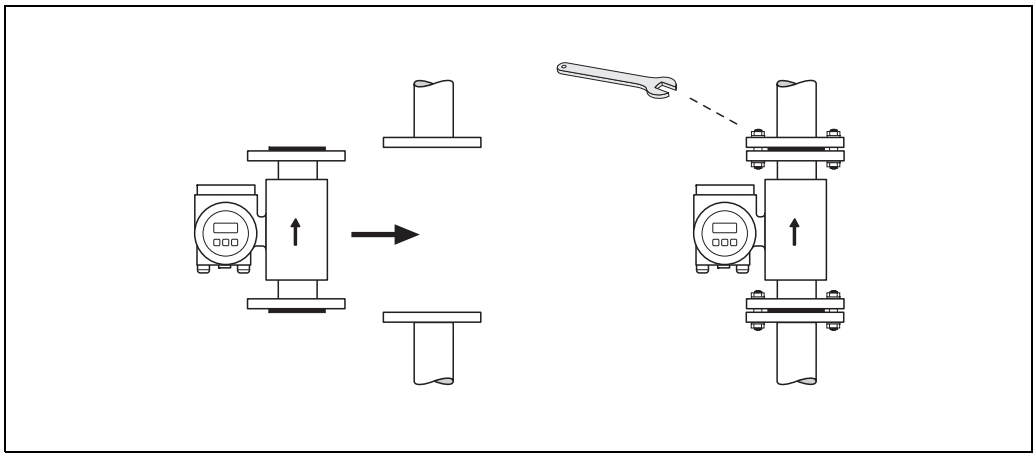

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Fig. 20: Installing the Promag P sensor

Seals
Comply with the following instructions when installing seals:
- Measuring tube linings with PFA or PTFE → **No** seals are required.
- In case you use seals with DIN flanges, use only seals according to DIN 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 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 (DN 15…600)
If necessary, a special ground cable for potential equalisation can be ordered as an accessory (see Page 81). Detailled assembly instructions → Page 48 ff.

Assembly with ground disks (DN 15…300)
Depending on the application, e.g. with lined or ungrounded pipes (see Page 47 ff.), it may be necessary to mount ground disks between the sensor and the pipe flange for the potential equalisation. Ground disks can be ordered separately as an accessory from Endress+Hauser (see Page 81).

Caution!
- In this case, when using ground disks (including seals) the total fitting length increases! All the dimensions are provided in the separate documentation "Technical Information".
- PTFE and PFA lining → only install additional seals between the ground disk and pipe flange.

1. Place the ground disk and the additional seal between the instrument and the pipe flange (Fig. 21).
2. Insert the bolts through the flange holes. Tighten the nuts so that they are still loose.
3. Now rotate the ground disk as shown in Fig. 21 until the handle strikes the bolts. This will center the ground disk automatically.
4. Now tighten the bolts to the required torque (see Page 34 ff.)
5. Connect the ground disk to ground → Page 49.

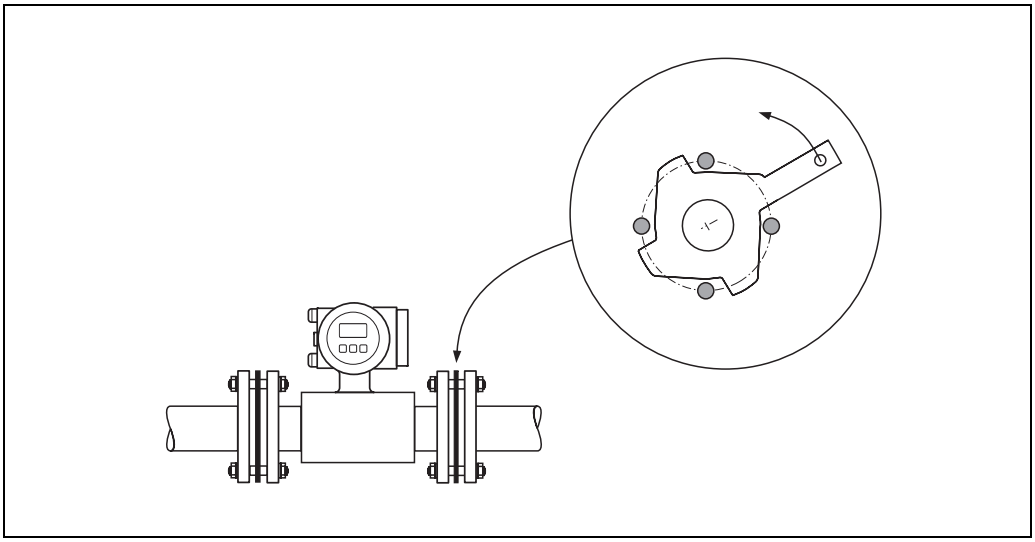

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Fig. 21: Assembly with ground disks (Promag P, DN 15…300)

Tightening torques for threaded fasteners (Promag P)

Note the following points:

- The tightening torques listed below are for lubricated threads only.
- Always tighten threaded fasteners uniformly and in diagonally opposite sequence.
- Overtightening the fasteners will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

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

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

3.3.3 Turning the transmitter housing

Warning!
The turning mechanism in devices with EEx d/de or FM/CSA Cl. I Div. 1 classification is not the same as that described here. The procedure for turning these housings 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 x 90° in either direction).
5. Lower the housing into position and re-engage the bayonet catch.
6. Retighten the two securing screws.

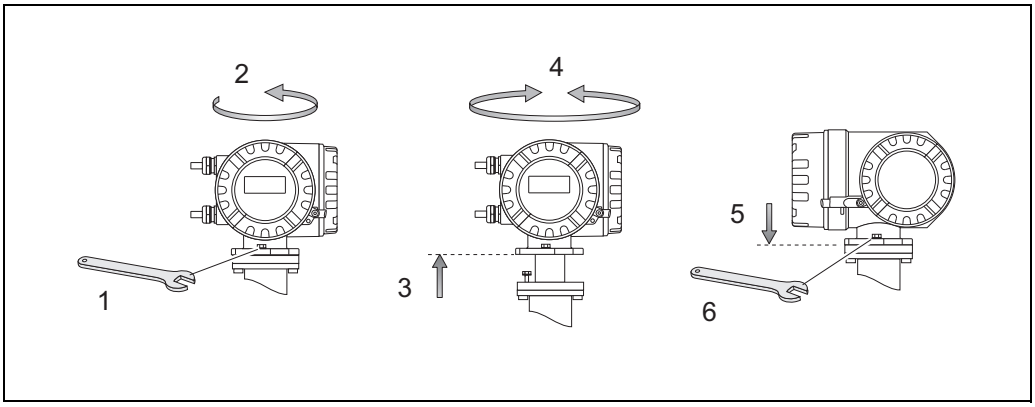

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Fig. 22: Turning the transmitter housing (aluminum field housing)

3.3.4 Turning the local display

1. Remove the cover of the electronics compartment.
2. Press the side latches on the display module and remove it from the electronics compartment cover plate.
3. Rotate the display to the desired position (max. 4 x 45° in each direction), and place it back into the electronics compartment cover plate.
4. Screw the cover of the electronics compartment firmly onto the transmitter housing.

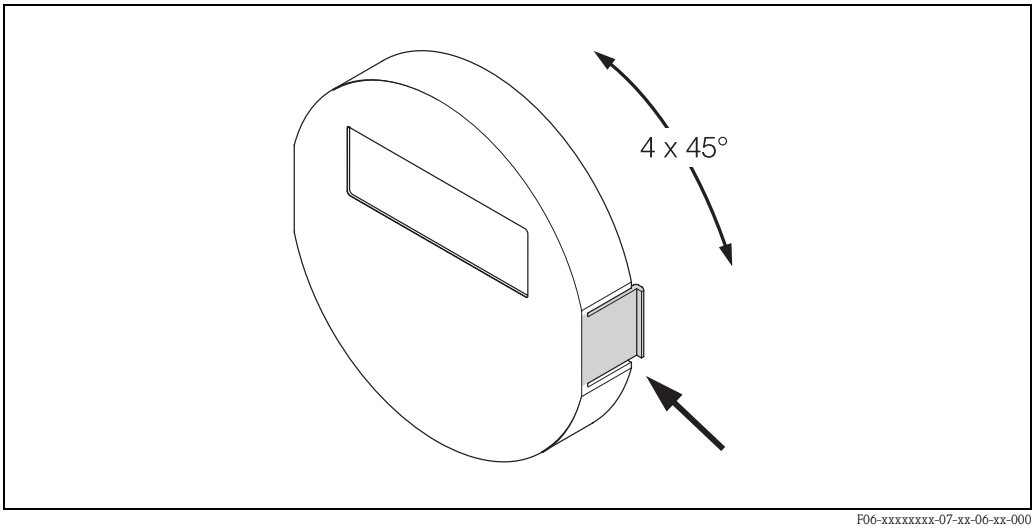

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Fig. 23: Turning the local display (field housing)

3.3.5 Installing the wall-mount transmitter housing

There are various ways of installing the wall-mount transmitter housing:
- Mounted directly on the wall
- Installation in control panel (with separate mounting kit, accessories → Page 81)
- Pipe mounting (with separate mounting kit, accessories → Page 81)

Caution!
- Make sure that ambient temperature does not exceed the permissible range (–20…+60 °C), (optional –40...+60 °C (not in custody transfer mode)). Install the device at a shady location.
  Avoid direct sunlight.
- Always install the wall-mount housing in such a way that the cable entries are pointing down.

Direct wall mounting

1. Drill the holes as illustrated in Fig. 24.
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
   – Screw head: max. Ø 10.5 mm
4. Secure the transmitter housing to the wall as indicated.
5. Screw the cover of the connection compartment (a) firmly onto the housing.

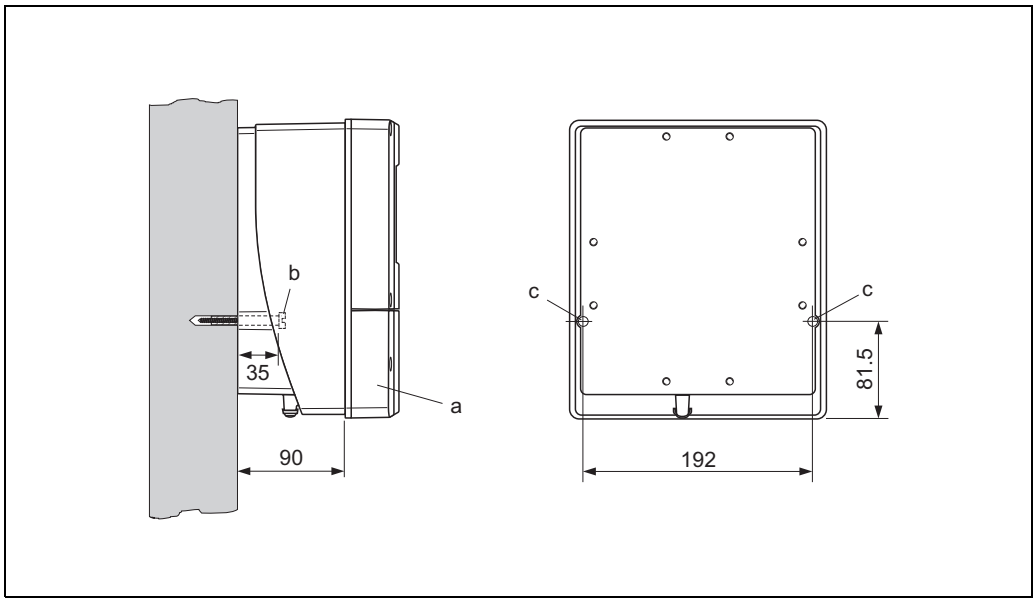

Fig. 24: Mounted directly on the wall

Panel installation

1. Prepare the opening in the panel (Fig. 25).
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. Afterwards, tighten the locking nuts. Additional support is not necessary.

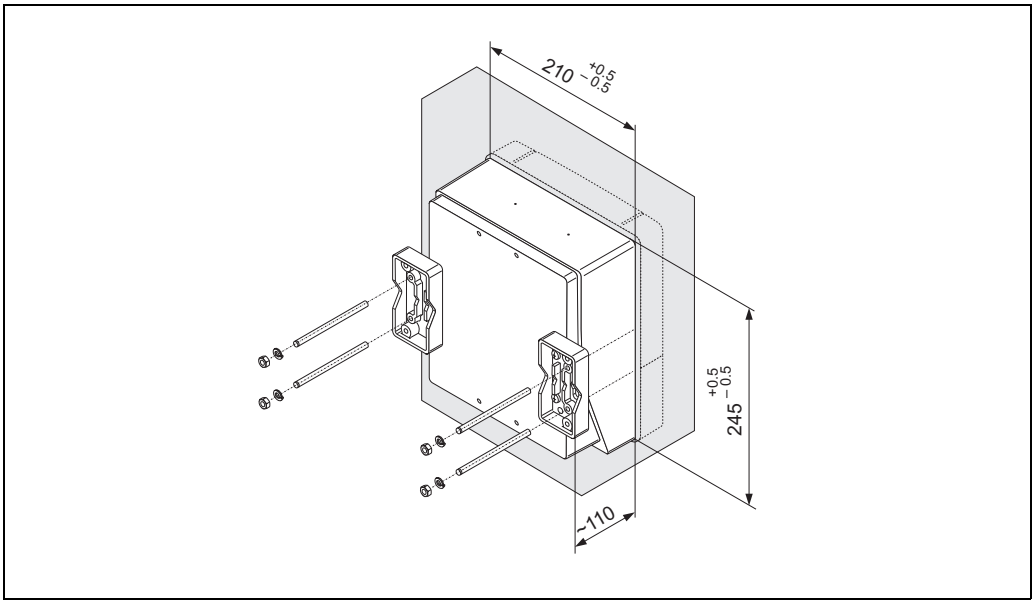

Fig. 25: Panel Installation (wall-mount housing)

Pipe mounting

The assembly should be performed by following the instructions in Fig. 26.

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

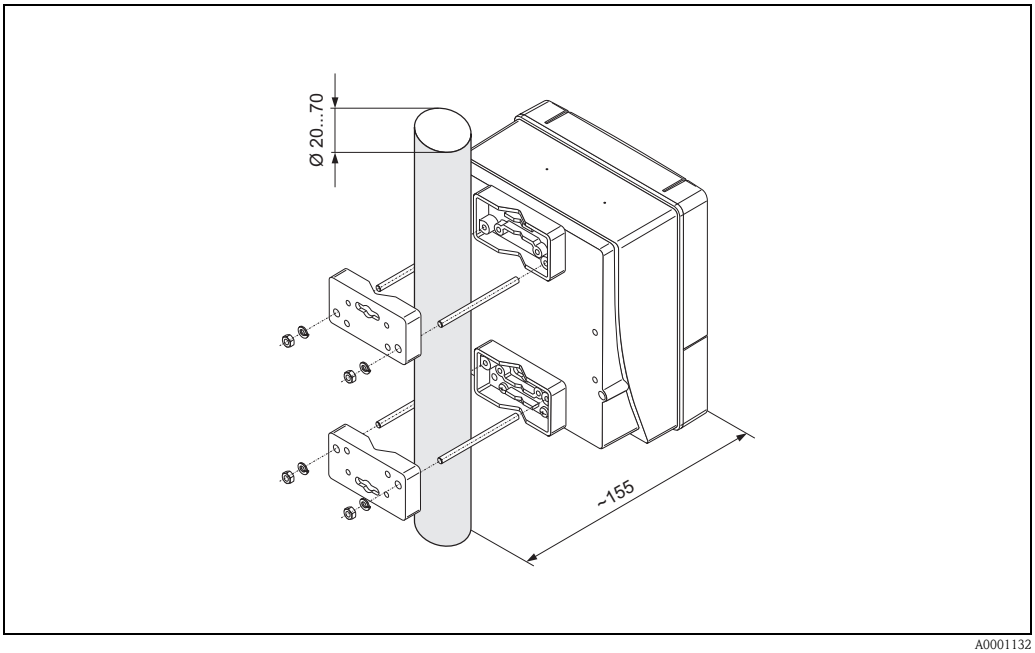

Fig. 26: Pipe mounting (wall-mount housing)

3.4 Post-installation check

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

Device condition and 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.?	see Page 105 ff.
Installation	Notes
Does the arrow on the sensor nameplate match the direction of flow through the pipe?	–
Is the plane of the measuring electrode axis correct?	Horizontal?
Is the position of the Empty Pipe Detection (EPD) electrode correct?	see Page 19
Were all threaded fasteners tightened to the specified torques when the sensor was installed?	see Section 3.3
Were the correct seals installed (type, material, installation)?	Promag W → Page 28 Promag P → Page 32
Are the measuring point number and labeling correct (visual inspection)?	–
Process environment / process conditions	Notes
Are the inlet and outlet runs to respected?	Inlet run ≥ 5 x DN Outlet run ≥ 2 x 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 by analogy with IEC 600 68-2-6 (see Page 109)

4 Wiring

Warning!
- When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to this Operating Manual. Please do not hesitate to contact your Endress+Hauser representative if you have any questions.
- If you use remote versions, connect each sensor *only* to the transmitter having the same serial number. Measuring errors can occur if the devices are not connected in this way.

4.1 Connecting the remote version

4.1.1 Connecting Promag W/P

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.

Procedure (Fig. 27):

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

   Caution!
   – Make sure the connecting cables are secured (see Page 27).
   – Risk of damaging the coil driver. Always switch off the power supply before connecting or disconnecting the coil cable.
4. Preterminate signal cable and coil current cable → Page 41
5. Establish the connections between sensor and transmitter in accordance with the wiring diagram:
   → Fig. 27
   → wiring diagram inside the cover

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

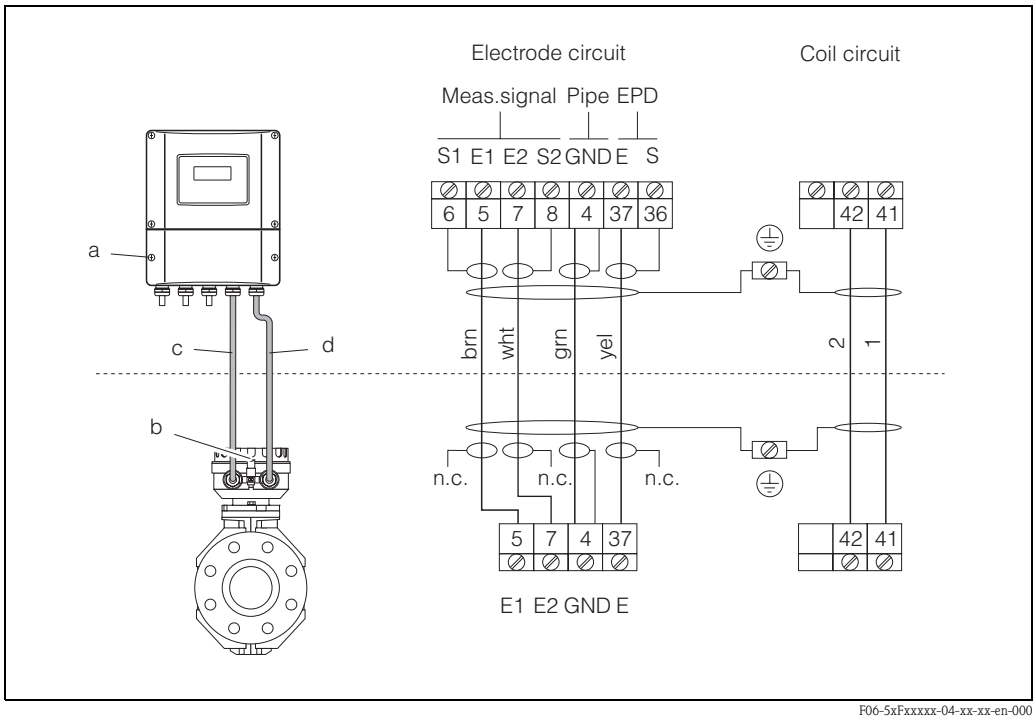

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Fig. 27: Connecting the remote version of Promag W/P

a = cover of the connection compartment, b = cover of the sensor connection housing, c = signal cable, d = coil current cable, n.c. = not connected, insulated cable shields

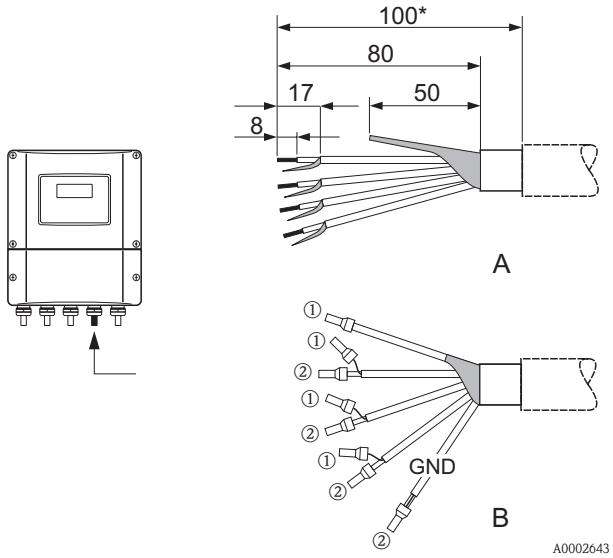
Cable termination for the remote version
Promag W / Promag P

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Fit the fine-wire cores with cable end sleeves (Detail B).

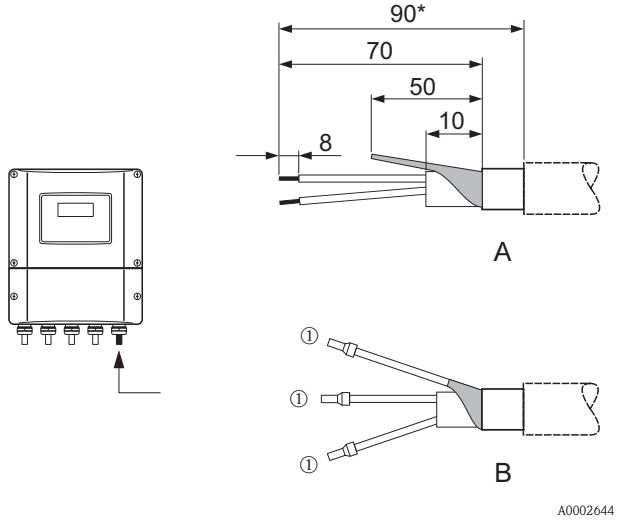
Caution!!
When fitting the connectors, pay attention to the following points:
- *Signal cable* → Make sure that the cable end sleeves do not touch the wire shield on the sensor side. Minimum distance = 1 mm (exception "GND" = green cable).
- *Coil current cable* → Insulate one core of the three-core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

TRANSMITTER

Signal cable

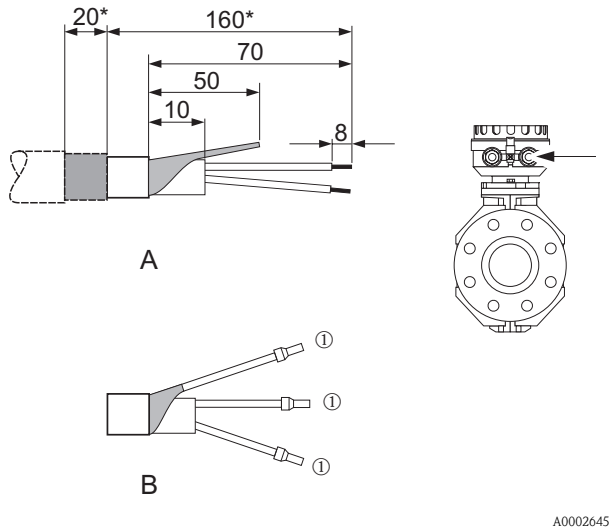


Coil current cable

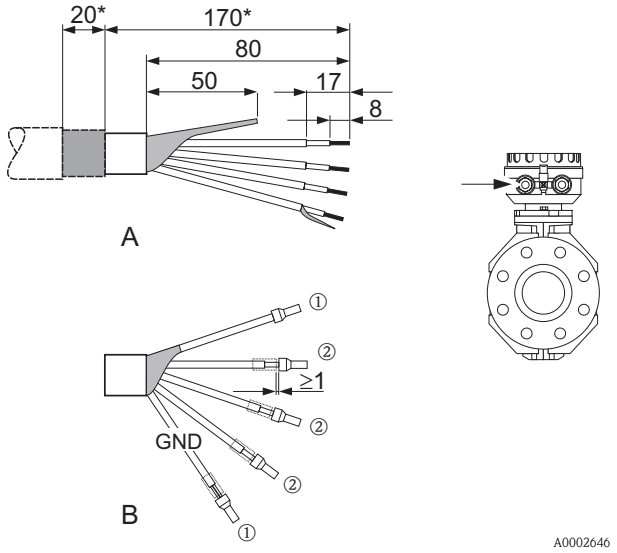


SENSOR

Signal cable



Coil current cable



① = Red cable sleeves ∅ 1,0 mm
② = White cable sleeves ∅ 0,5 mm
* = Stripping for amoured cables only

4.1.2 Cable specifications

Coil cable:
- 2 x 0.75 mm^2 PVC cable with common, braided copper shield (Ø approx. 7 mm)
- Conductor resistance: ≤ 37 Ω/km
- Capacitance: core/core, shield grounded: ≤ 120 pF/m
- Permanent operating temperature: –20...+80 °C
- Cable cross-section: max. 2.5 mm^2

Signal cable:
- 3 x 0.38 mm^2 PVC cable with common, braided copper shield (Ø approx. 7 mm) and individually shielded cores
- With Empty Pipe Detection (EPD): 4 x 0.38 mm^2 PVC cable with common, braided copper shield (Ø approx. 7 mm) and individually shielded cores
- Conductor resistance: ≤ 50 Ω/km
- Capacitance: core/shield: ≤ 420 pF/m
- Permanent operating temperature: –20...+80 °C
- Cable cross-section: max. 2.5 mm^2

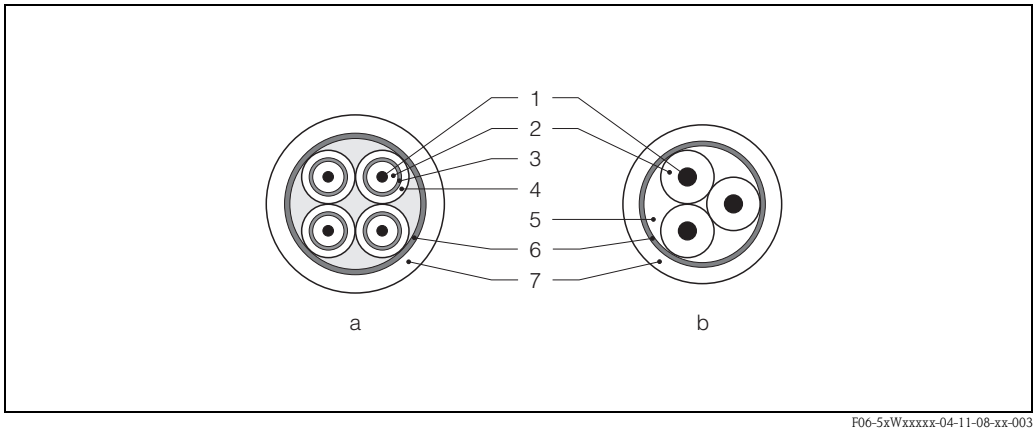


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Fig. 28: Cable cross-section (a = Signal cable, b = Coil current cable)
1 = Core, 2 = Core insulation, 3 = Core shield, 4 = Core jacket, 5 = Core reinforcement, 6 = Cable shield, 7 = Outer jacket

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 standard of protection

Operation in zones of severe electrical interference:
The measuring device complies with the general safety requirements in accordance with EN 61010, the EMC requirements of EN 61326/A1, and NAMUR recommendation NE 21.

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.

4.2 Connecting the measuring unit

4.2.1 Transmitter

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 (not necessary if the power supply is galvanically isolated).
- Compare the specifications on the nameplate with the local voltage supply and frequency. The national regulations governing the installation of electrical equipment also apply.

1. Remove the cover of the connection compartment (f) from the transmitter housing.
2. Feed the power supply cable (a) and signal cables (b) through the appropriate cable entries.
3. Connect the cables in accordance with the wiring diagram:
   – Wiring diagram (aluminium housing) → Fig. 29
   – Wiring diagram (wall-mount housing) → Fig. 30
   – Terminal assignment → Page 44
4. Screw the cover of the connection compartment (f) firmly onto the transmitter housing.

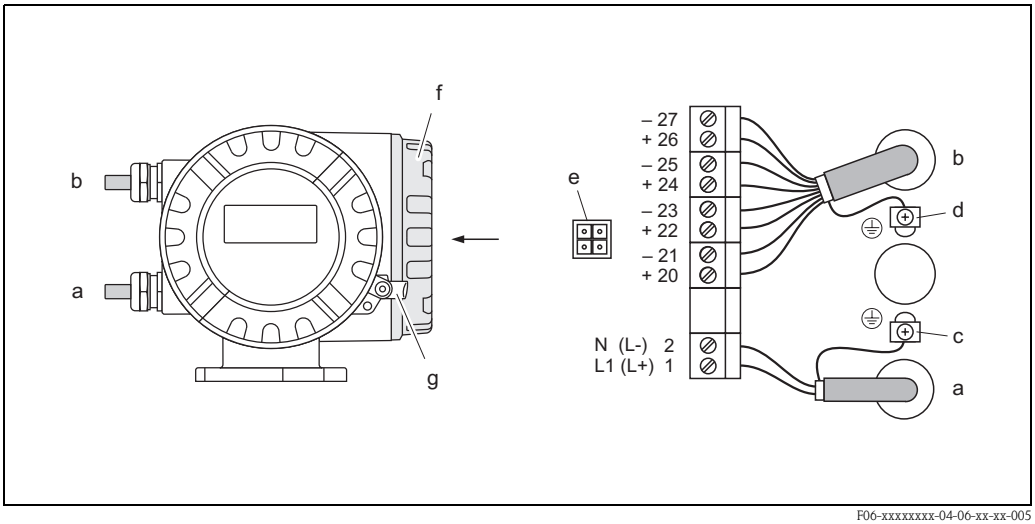

Fig. 29: Connecting the transmitter (aluminium field housing). Cable cross-section: max. 2.5 mm²

a Cable for power supply: 85…260 V AC, 20…55 V AC, 16…62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
*b Signal cable: Terminals **Nos. 20–27** → Page 44*
c Ground terminal for protective conductor (Please also observe company-internal grounding concepts)
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA 193 (Fieldcheck, ToF Tool – Fieldtool Package)
f Cover of the connection compartment
g Securing clamp

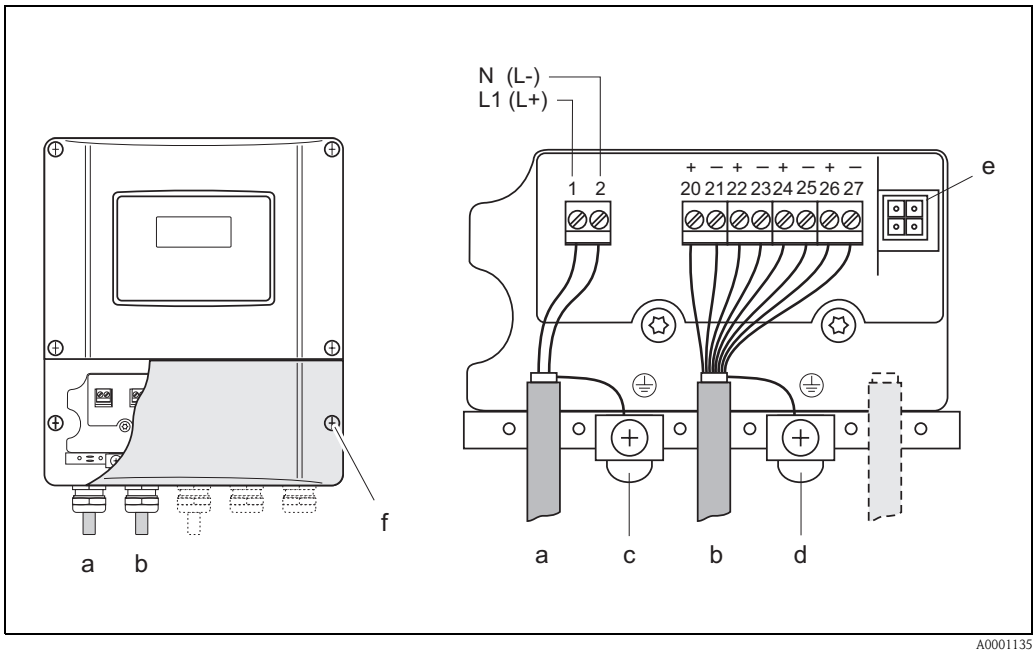

Fig. 30: Connecting the transmitter (wall-mount housing). Cable cross-section: max. 2.5 mm²

a Cable for power supply: 85…260 V AC, 20…55 V AC, 16…62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
*b Signal cable: Terminals **Nos. 20–27** → Page 44*
c Ground terminal for protective conductor (Please also observe company-internal grounding concepts)
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA 193 (Fieldcheck, ToF Tool - Fieldtool Package)
f Cover of the connection compartment

4.2.2 Terminal assignment

Order variant	Terminal No. (inputs / outputs)			
	20 (+) / 21 (–)	**22 (+) / 23 (–)**	**24 (+) / 25 (–)**	**26 (+) / 27 (–)**
51***-**********D	Status input	Status output	Frequency output	Current output HART
51***-**********P	Status input	Status output	Pulse output	Current output HART

Status input (auxiliary input)
galvanically isolated, 3...30 V DC, R_i = 5 kΩ
- Self-test function of the display (over 10 s)
- External reset on error

Status output
Open collector, max. 30 V DC / 250 mA, galvanically isolated, freely configurable

Frequency output (passive)
Open collector, galvanically isolated, full scale frequency 2...1000 Hz (f_{max} = 1.25 kHz)
30 V DC, 250 mA

Current output (active/passive)
galvanically isolated, active: 0/4...20 mA, R_L < 700 Ω (HART: $R_L \geq 250$ Ω)
passive: 4...20 mA, supply voltage V_S = 18...30 V DC, $R_i \geq 150$ Ω

Ground connection, power supply → Page 43 ff.

4.2.3 Connecting a “reset key” (for error messages)

In custody transfer mode, error messages occurring during operation must be reset or confirmed manually via the status input (auxiliary input) using a voltage pulse, e.g. via external switches or reset buttons provided for this purpose.
The power is supplied either by means of an external power source or the current output (Fig. 31).

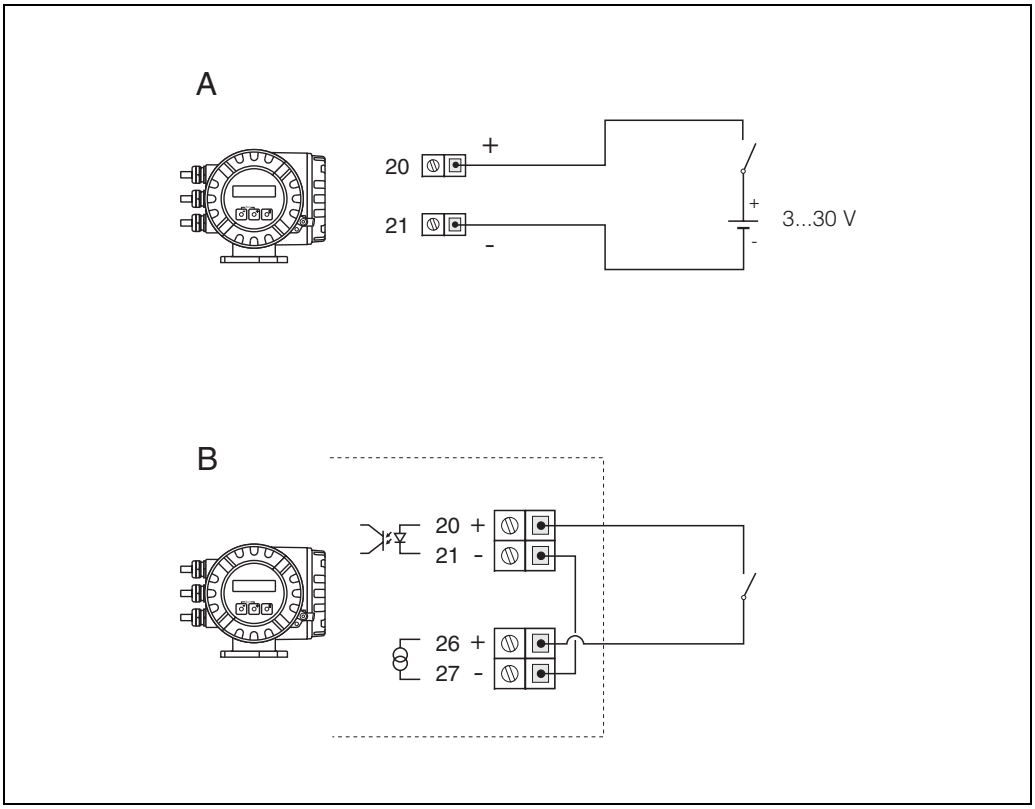

Fig. 31: Wiring versions for connecting a “reset” key (for resetting errors)

A = Wiring version with an external voltage supply (3...30 V)
B = Wiring version with the current output as voltage supply (4...20 mA)

Terminal No. 20 / 21 = Status input
Terminal No. 26 / 27 = Current output

4.2.4 HART connection

Users have the following connection options at their disposal:
- Direct connection to transmitter by means of terminals 26(+) / 27(–)
- Connection by means of the 4...20 mA circuit

Note!
- The measuring loop's minimum load must be at least 250 Ω.
- After commissioning, make the following settings:
  CURRENT SPAN function → "4–20 mA HART" or "4–20 mA (25 mA) HART"
- See also the documentation issued by the HART Communication Foundation, and in particular HCF LIT 20: "HART, a technical summary".

Connection of the HART handheld communicator

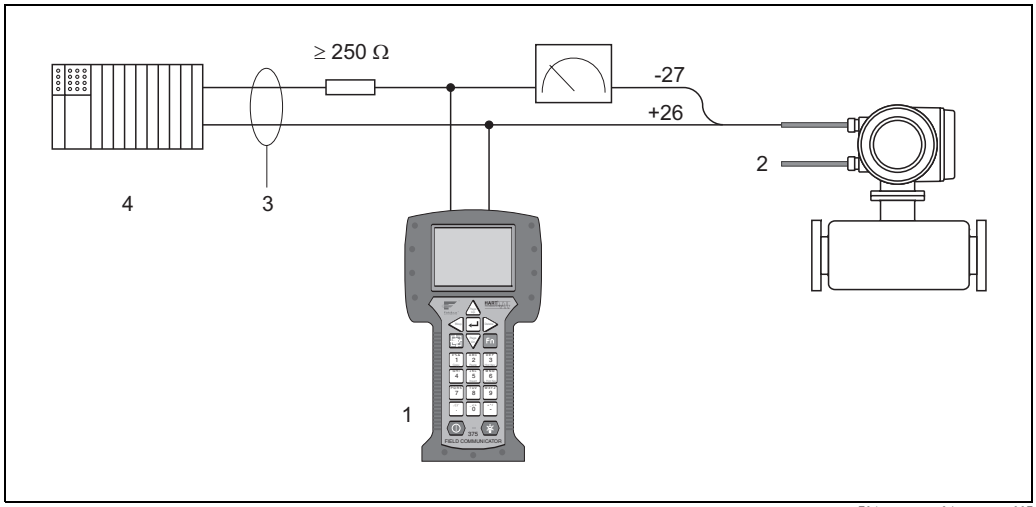

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Fig. 32: Electrical connection of the HART handheld communicator:
1 = HART communicator, 2 = power supply, 3 = shield, 4 = other evaluation devices or PLC with passive input

Connection of a PC with an operating software
In order to connect a PC with an operating software (e.g. "ToF Tool – Fieldtool Package"), a HART modem (e.g. "Commubox FXA 191") is needed.

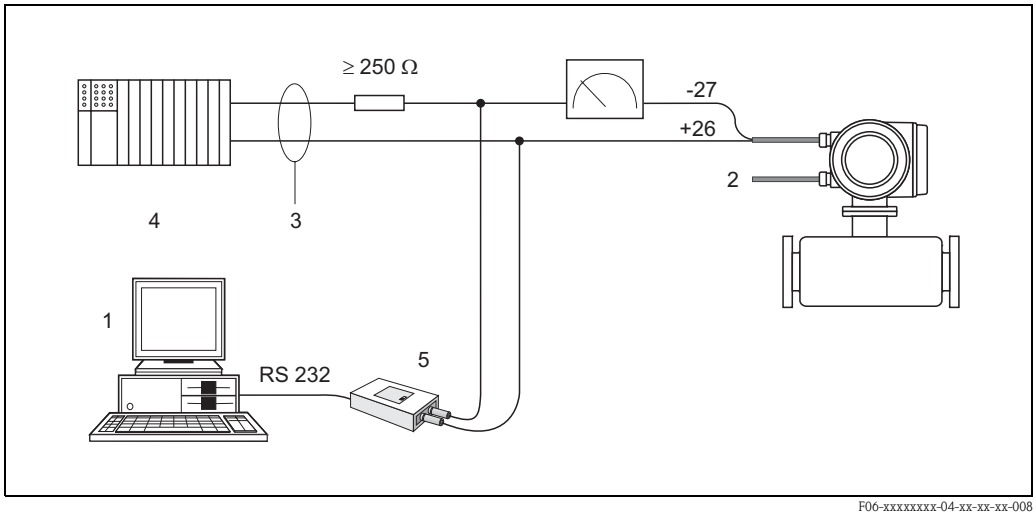

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Fig. 33: Electrical connection of a PC with an operating software:
1 = PC with an operating software, 2 = power supply, 3 = shield, 4 = other evaluation devices or PLC with passive input, 5 = HART modem, e.g. Commubox FXA 191

4.3 Potential equalisation

4.3.1 Standard case

Perfect measurement is only ensured when the medium and the sensor have the same electrical potential. Most Promag sensors have a standard installed reference electrode which guarantees the required connection. This usually means that no ground disks or additional potential matching measures are necessary.

Note!
For installation in grounded metal pipes, it is advisable to connect the ground terminal of the transmitter housing to the piping. Also, observe company-internal grounding guidelines.

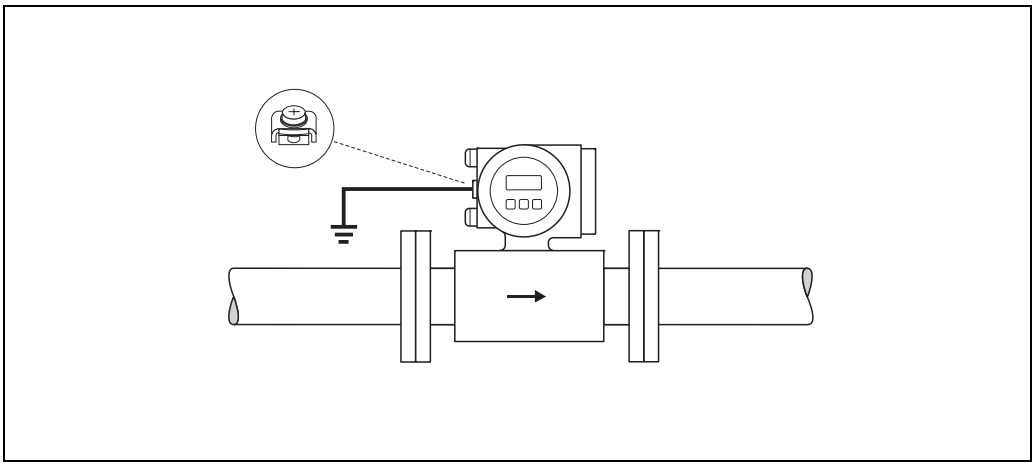

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Fig. 34: Potential equalisation by means of the transmitter's ground terminal

Caution!
For sensors without reference electrodes or without metal process terminals, carry out potential equalisation as per the instructions for special cases described below. These special measures are particularly important when standard grounding practice cannot be ensured or extremely strong equalising currents are expected.

4.3.2 Special cases

Metal, ungrounded piping
In order to prevent outside influences on measurement, it is advisable to use ground cables to connect each sensor flange to its corresponding pipe flange and ground the flanges. Connect the transmitter or sensor connection housing, as applicable, to ground potential by means of the ground terminal provided for the purpose (Fig. 35).

Caution!
Also, observe company-internal grounding guidelines.

Note!
The ground cable for flange-to-flange connections can be ordered separately as an accessory from Endress+Hauser → Page 81.
- DN ≤ 300: The ground cable is in direct connection with the conductive flange coating and is secured by the flange screws.
- DN ≥ 350: The ground cable connects directly to the metal transport bracket.

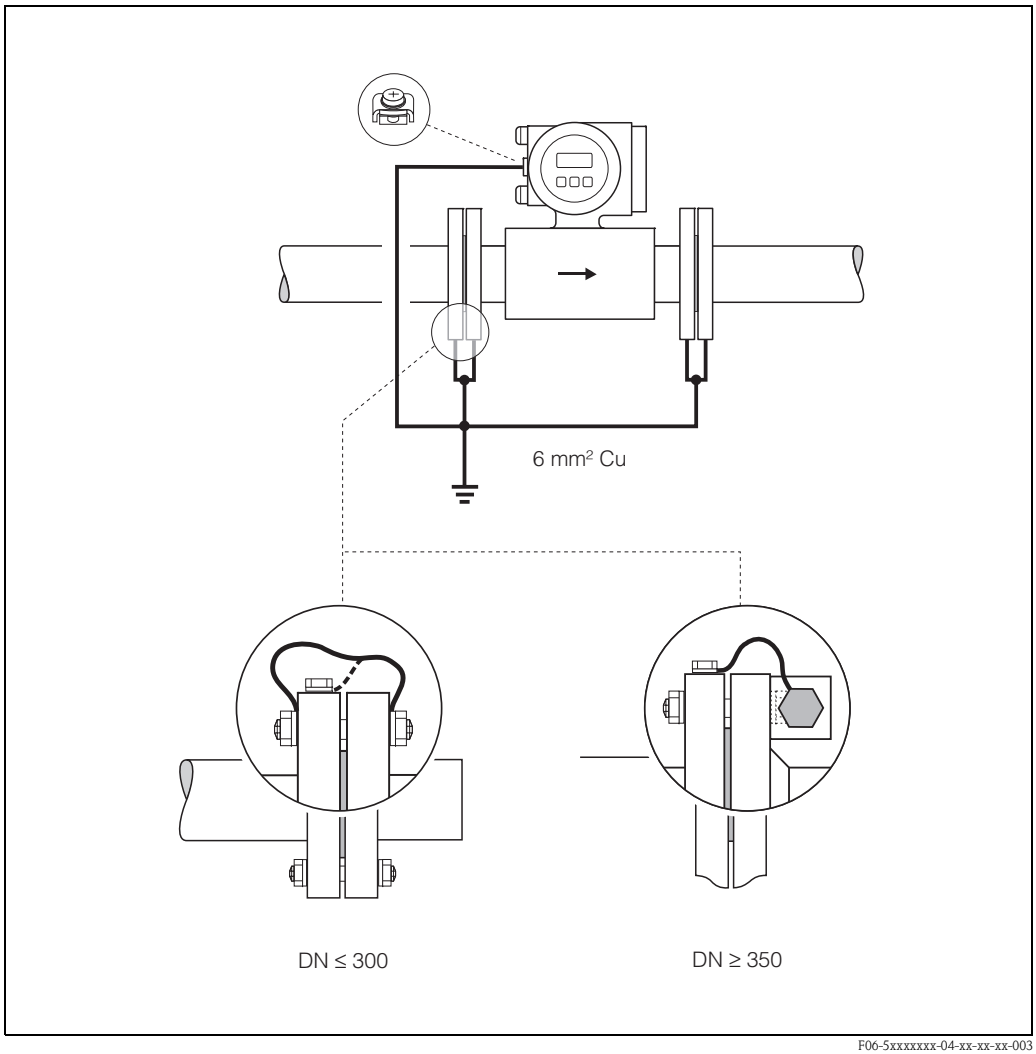

Fig. 35: Potential equalisation with equalising currents in metallic, non-grounded piping systems

Plastic pipes and isolating lined pipes
Normally, potential is matched using the reference electrodes in the measuring tube. However, in exceptional cases it is possible that, due to the grounding plan of a system, large matching currents flow over the reference electrodes. This can lead to destruction of the sensor, e.g. through electrochemical decomposition of the electrodes. In such cases, e.g. for fibre-glass or PVC piping, it is recommended that you use additional ground disks for potential matching (Fig. 36).

Mounting of ground disks → Page 29, 33

Caution!
- Risk of damage by electrochemical corrosion. Note the electrochemical insulation rating, if the ground disks and measuring electrodes are made of different materials.
- Also, observe company-internal grounding guidelines.

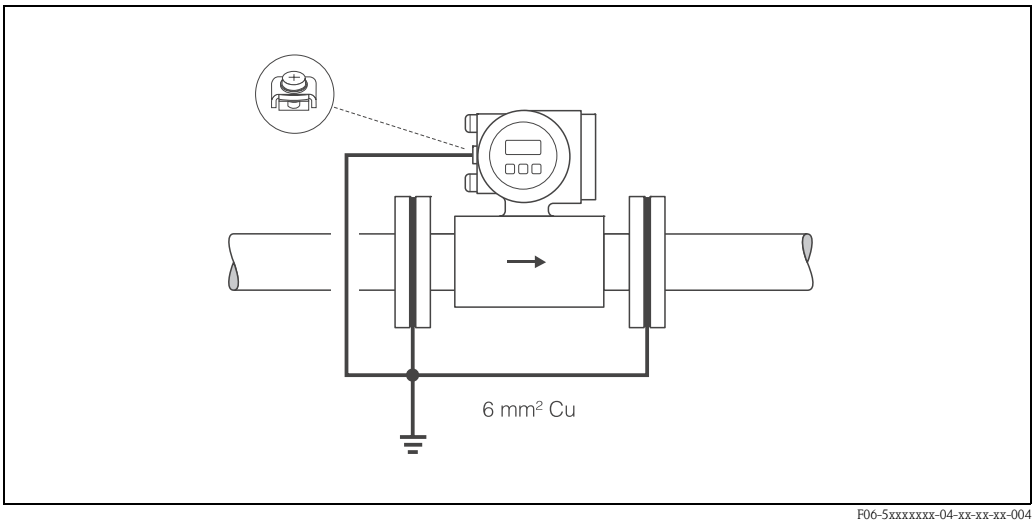

Fig. 36: Potential equalisation/ground disks with plastic pipes or lined pipes

Lined pipes (cathodic protection)
In such cases, install the measuring instrument without potential in the piping:
- When installing the measuring device, make sure that there is an electrical connection between the two piping runs (copper wire, 6 mm^2).
- Make sure that the installation materials do not establish a conductive connection to the measuring device and that the installation materials withstand the tightening torques applied when the threaded fasteners are tightened.
- Also comply with the regulations applicable to potential-free installation.

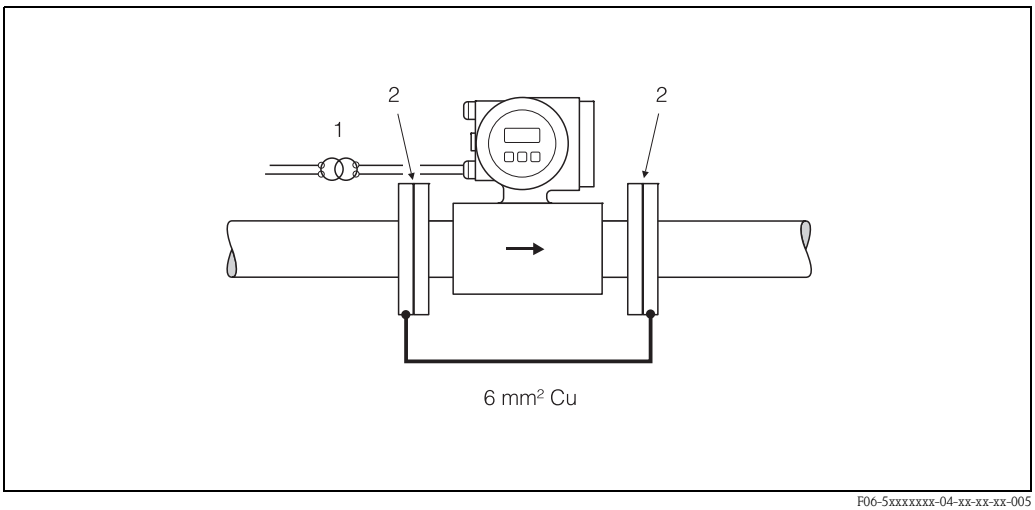

Fig. 37: Potential equalisation and cathode protection
1 = isolating transformer power supply, 2 = electrically insulated

4.4 Degree of protection

The devices fulfill all the requirements for IP 67. Compliance with the following points is mandatory following installation in the field or servicing, in order to ensure that IP 67 protection 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 threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter (see Page 107).
- Firmly tighten the cable entries (Fig. 38).
- The cables must loop down before they enter the cable entries ("water trap", Fig. 38). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

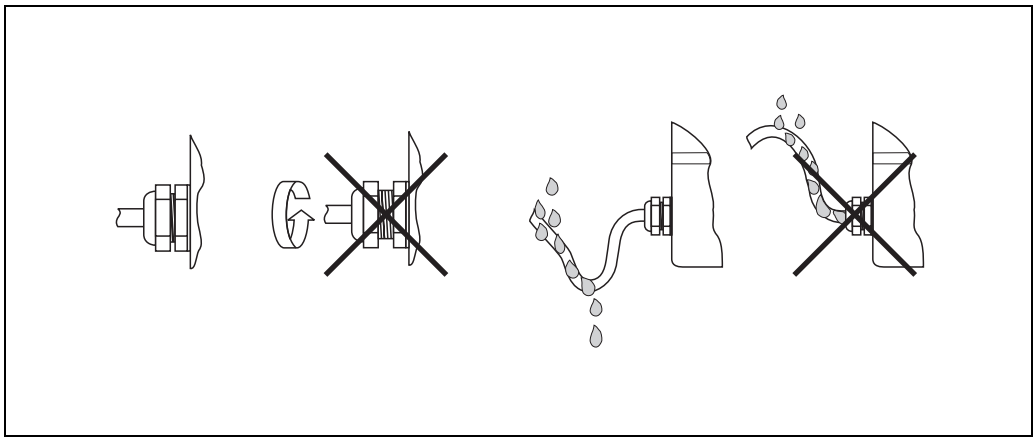

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Fig. 38: Installation instructions, cable entries

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

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

4.5 Post-connection check

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

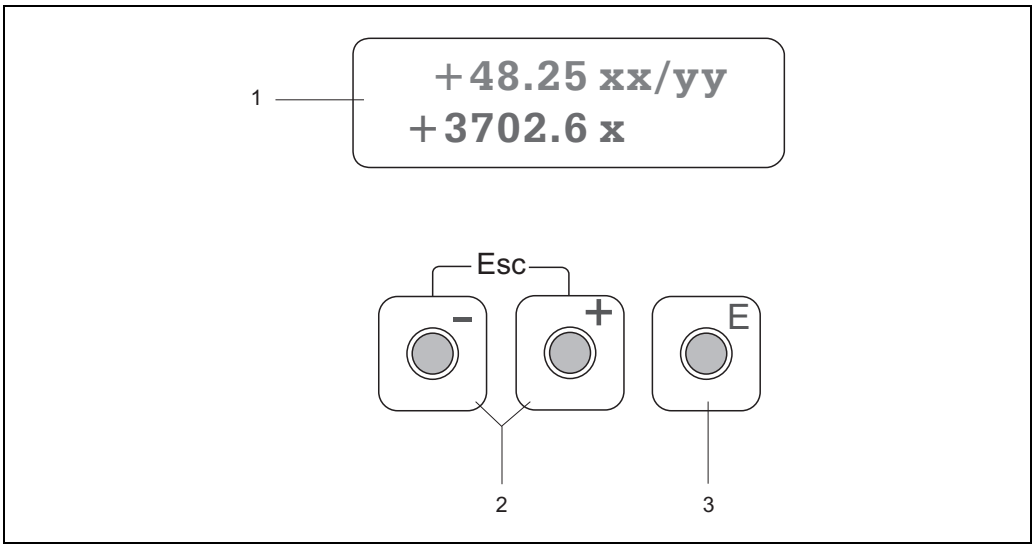
Device condition and specifications	Notes
Are cables or the device damaged (visual inspection)?	–
Electrical connection	Notes
Does the supply voltage match the specifications on the nameplate?	85...260 V AC (45...65 Hz) 20...55 V AC (45...65 Hz) 16...62 V DC
Do the cables comply with the specifications?	see Page 42, 107
Do the cables have adequate strain relief?	–
Cables correctly segregated by type? Without loops and crossovers?	–
Are the power supply and signal cables correctly connected?	See the wiring diagram inside the cover of the terminal compartment
Are all screw terminals firmly tightened?	–
Have the measures for grounding/potential equalisation been correctly implemented?	see Page 47 ff.
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as “water traps”?	see Page 50
Are all housing covers installed and firmly tightened?	–

5 Operation

5.1 Display and operating elements

The local display enables you to read all important parameters directly at the measuring point and configure the device.

The display area consists of two lines; this is where measured values are displayed, and/or status variables (direction of flow, partially filled pipe, 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).



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Liquid crystal display (1)
The backlit, two-line liquid crystal display shows measured values, dialog texts, error messages and information messages. The display as it appears when normal measuring is in progress is known as the HOME position (operating mode).

Upper display line: Shows primary measured values, e.g. volume flow in [ml/min] or in [%].
Lower display line: Shows supplementary measured variables and status variables, e.g. totalizer reading in [m^3], bar graph, measuring point designation

Push buttons (2)
- *Enter numerical values, select parameters*
- *Select different 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 +/– keys for longer than 3 seconds → Return directly to HOME position*
- *Cancel data entry*

Enter push button (3)
- *HOME position → Entry into the function matrix*
- *Save the numerical values you input or settings you change*

5.2 Brief operating instruction to the function matrix

Note!
- See the general notes on Page 55.
- Function descriptions → see the "Description of Device Functions" manual

1. HOME position → E → Enter the function matrix
2. Select a function group (e.g. CURRENT OUTPUT 1)
3. Select a function (e.g. TIME CONSTANT)

   Change parameter / enter numerical values:
   ± → select or enter enable code, parameters, numerical values
   E → save your entries
4. Exit the function matrix:
   – Press and hold down Esc key (esc) for longer than 3 seconds → HOME position
   – Repeatedly press Esc key (esc) → return step by step to HOME position

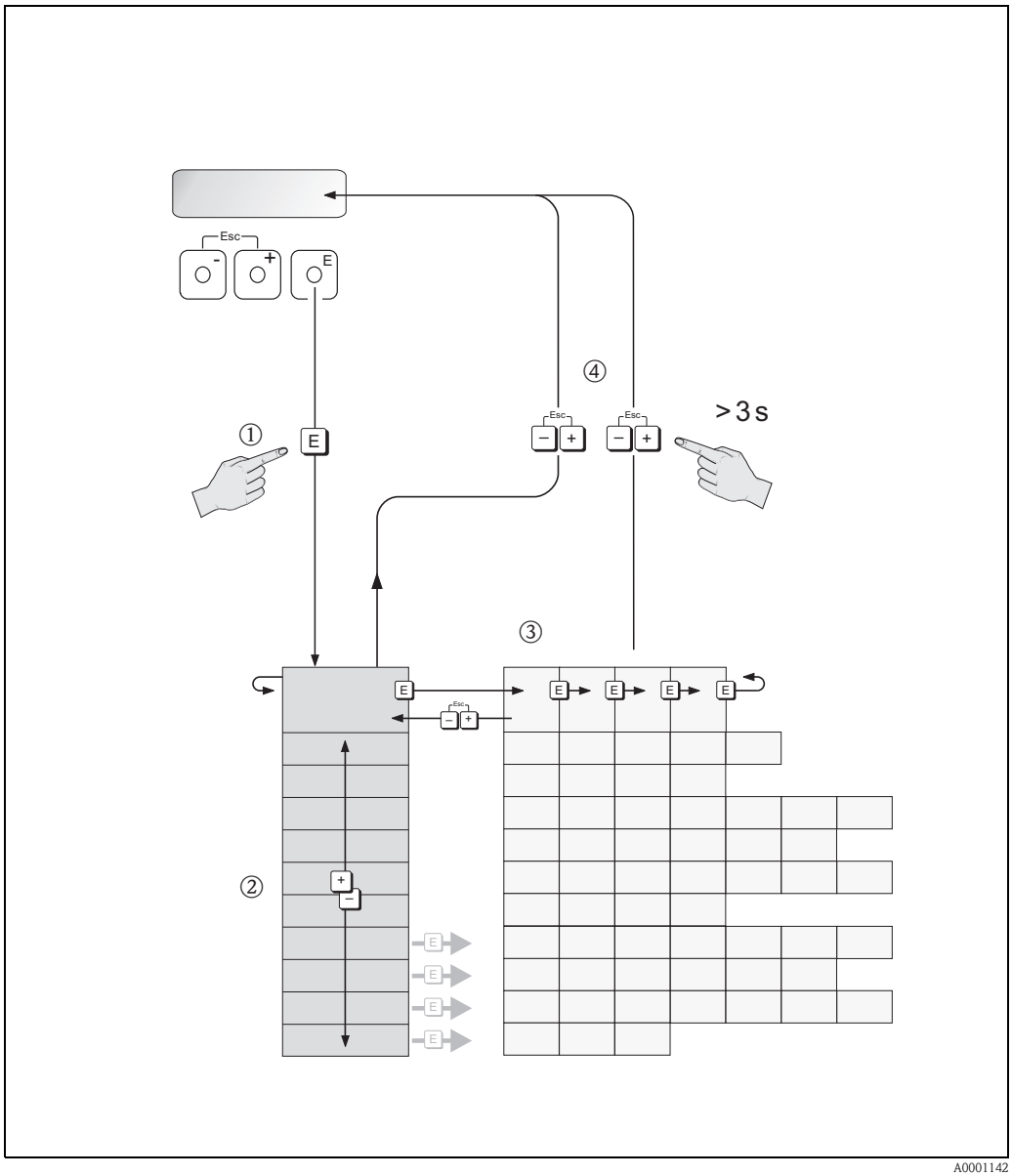


Fig. 39: Selecting functions and configuring parameters (function matrix)

5.2.1 General notes

The Quick Setup menu (see Page 76) is adequate for commissioning in most instances. 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 in a number of function groups.

Comply with the following instructions when configuring functions:
- You select functions as described on Page 54.
- 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.

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.

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 this Operating Instruction.

5.2.2 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 = 51) 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 (→ see the "Description of Device Functions" manual).

Comply with the following instructions when entering codes:
- If programming is disabled and the ⊞ key is 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 organisation 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 if you have any questions.

5.2.3 Disabling the programming mode

Programming 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).

5.3 Error messages

Type of error
Errors that occur during commissioning or measuring 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.

Tthe measuring system distinguishes between two types of error:
- *System errors:* This group comprises all device errors, e.g. communication errors, hardware faults, etc. → see Page 85
- *Process errors:* This group comprises all application errors, e.g. empty pipe, etc. → see Page 90

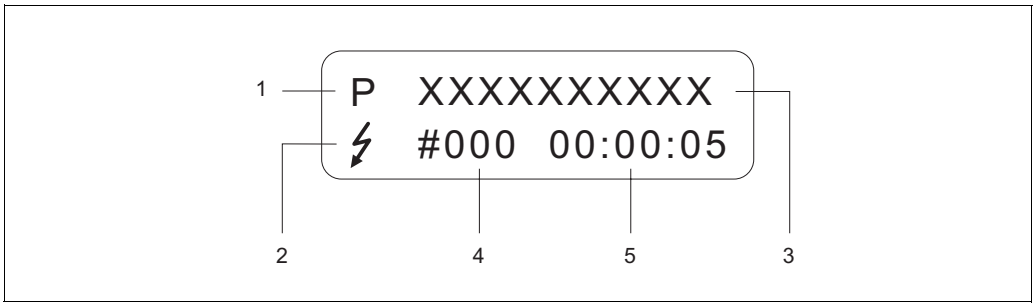


Fig. 40: Error messages on the display (example)

1 Error type: P = process error, S = system error
2 Error message type: ϟ = fault message; ! = notice message
3 Error designation: e.g. EMPTY PIPE = measuring tube is only partly filled or completely empty
4 Error number: e.g. #401
5 Duration of most recent error occurrence in hours / minutes / seconds

Error message types
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.
- Not available in custody transfer mode (notice messages are always classified and treated as fault messages in custody transer mode).

Fault message (ϟ)
- Displayed as → Lightning 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 corresponding functions in the function matrix (see Page 92).

✎ Note!
In custody transfer mode, error messages are always issued via the local display and, as an option, via the outputs. The error message can be sent via the status output, current output or frequency output to the subsequent system units.

5.4 Communication

In addition to local operation, the measuring device can be configured and measured values can be obtained by means of the HART protocol. Digital communication takes place using the 4–20 mA current output HART (see Page 46).

The HART protocol allows the transfer of measuring and device data between the HART master and the field devices for configuration and diagnostics purposes. The HART master, e.g. a handheld terminal or PC-based operating programs (such as ToF Tool – Fieldtool Package), require device description (DD) files which are used to access all the information in a HART device.
Information is exclusively transferred using so-called “commands”. There are three different command groups:

Universal commands:
All HART device support and use universal commands. The following functionalities are linked to them:
- Identify HART devices
- Reading digital measured values (volume flow, totalizer, etc.)

Common practice commands:
Common practice commands offer functions which are supported and can be executed by most but not all field devices.

Device-specific commands:
These commands allow access to device-specific functions which are not HART standard. Such commands access individual field device information, amongst other things, such as empty/full pipe adjustment values, low flow cutoff settings, etc.

✎ Note!
Promag 51 has access to all three command classes. On Page 61, you will find a list with all the supported “Universal Commands” and “Common Practice Commands”.

5.4.1 Operating options

For the complete operation of the measuring device, including device-specific commands, there are DD files available to the user to provide the following operating aids and programs:

Note!
The HART protocol requires the "4…20 mA HART" setting (individual options see device function) in the CURRENT SPAN function (current output).

HART handheld terminal DXR 375
Selecting device functions with a HART Communicator is a process involving a number of menu levels and a special HART function matrix.
The HART manual in the carrying case of the HART Communicator contains more detailed information on the device.

Operating program "ToF Tool - Fieldtool Package"
Modular software package consisting of the service program "ToF Tool" for configuration and diagnosis of ToF level measuring devices (time-of-flight measurement) and evolution of pressure measuring instruments as well as the "Fieldtool" service program for the configuration and diagnosis of Proline flow measuring devices. The Proline flow measuring devices are accessed via a service interface or via the service interface FXA 193 or the HART protocol.

Contents of the "ToF Tool - Fieldtool Package":
- Commissioning, maintenance analysis
- Configuring flowmeters
- Service functions
- Visualisation of process data
- Trouble-shooting
- Controlling the "Fieldcheck" tester/simulator

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 FXA 193.

Operating program "SIMATIC PDM" (Siemens)
SIMATIC PDM is a standardised, manufacturer-independent tool for the operation, configuration, maintenance and diagnosis of intelligent field devices.

Operating program "AMS" (Emerson Process Management)
AMS (Asset Management Solutions): program for operating and configuring devices

5.4.2 Current device description files

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

HART protocol:

Valid for software:	2.00.XX	→Function "Device software"
Device data HART Manufacturer ID: Device ID:	 11_{hex} (ENDRESS+HAUSER) 43_{hex}	 → Function "Manufacturer ID" → Function "Device ID"
HART version data:	Device Revison 5 / DD Revision 1	
Software release:	03.2005	

Operating program:	**Sources for obtaining device descriptions:**
Handheld terminal DXR 375	■ Use update function of handheld terminal
ToF Tool - Fieldtool Package	■ www.tof-fieldtool.endress.com (→ Download → Software → Device driver) ■ CD-ROM (Endress+Hauser order number 50097200)
Fieldcare / DTM	■ www.endress.com (→ Download → Software → Device driver) ■ CD-ROM (Endress+Hauser order number 50097200)
AMS	■ www.endress.com (→ Download → Software → Device driver) ■ CD-ROM (Endress+Hauser order number 50097200)
SIMATIC PDM	■ www.endress.com (→ Download → Software → Device driver) ■ CD-ROM (Endress+Hauser order number 50097200)

Operation via the service protocol

Valid for device software:	2.00.XX	→Function "Device software"
Software release:	03.2005	

Operating program:	**Sources for obtaining device descriptions:**
ToF Tool - Fieldtool Package	■ www.tof-fieldtool.endress.com (→ Download → Software → Device driver) ■ CD-ROM (Endress+Hauser order number 50097200)

Tester/simulator:	**Sources for obtaining device descriptions:**
Fieldcheck	■ Update by means of ToF Tool - Fieldtool Package via Fieldflash module

5.4.3 Device and process variables

Device variables:
The following device variables are available using the HART protocol:

Code (decimal)	Device variable
0	OFF (not assigned)
1	Volume flow
250	Totalizer 1
251	Totalizer 2

Process variables:
At the factory, the process variables are assigned to the following device variables:

- Primary process variable (PV) → Volume flow
- Second process variable (SV) → Totalizer 1
- Third process variable (TV) → not assigned
- Fourth process variable (FV) → not assigned

Note!
You can set or change the assignment of device variables to process variables using Command 51 (see Page 65).

5.4.4 Universal / Common practice HART commands

The following table contains all the universal and common practice commands supported by Promag 51.

Command No. **HART command / Access type**		**Command data** (numeric data in decimal form)	**Response data** (numeric data in decimal form)
Universal Commands			
0	Read unique device identifier Access type = read	none	Device identification delivers information on the device and the manufacturer. It cannot be changed. The response consists of a 12 byte device ID: – Byte 0: fixed value 254 – Byte 1: Manufacturer ID, 17 = E+H – Byte 2: Device type ID, 67 = Promag 51 – Byte 3: Number of preambles – Byte 4: Universal commands rev. no. – Byte 5: Device-specific commands rev. no. – Byte 6: Software revision – Byte 7: Hardware revision – Byte 8: Additional device information – Bytes 9–11: Device identification
1	Read primary process variable Access type = read	none	– Byte 0: HART unit code of the primary process variable – Bytes 1–4: Primary process variable *Factory setting:* Primary process variable = Volume flow ✎ Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ Manufacturer-specific units are represented using the HART unit code “240”.
2	Read the primary process variable as current in mA and percentage of the set measuring range Access type = read	none	– Bytes 0–3: actual current of the primary process variable in mA – Bytes 4–7: Percentage of the set measuring range *Factory setting:* Primary process variable = Volume flow ✎ Note! You can set the assignment of device variables to process variables using Command 51.

Command No. **HART command / Access type**		**Command data** (numeric data in decimal form)	**Response data** (numeric data in decimal form)
3	Read the primary process variable as current in mA and four (preset using Command 51) dynamic process variables Access type = read	none	24 bytes are sent as a response: – Bytes 0–3: primary process variable current in mA – Byte 4: HART unit code of the primary process variable – Bytes 5–8: Primary process variable – Byte 9: HART unit code of the second process variable – Bytes 10–13: Second process variable – Byte 14: HART unit code of the third process variable – Bytes 15–18: Third process variable – Byte 19: HART unit code of the fourth process variable – Bytes 20–23: Fourth process variable *Factory setting:* ■ Primary process variable = Volume flow ■ Second process variable = Totalizer 1 ■ Third process variable = not assigned ■ Fourth process variable = not assigned ✎ Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ Manufacturer-specific units are represented using the HART unit code “240”.
6	Set HART shortform address Access type = write	Byte 0: desired address (0...15) *Factory setting:* 0 ✎ Note! With an address >0 (multidrop mode), the current output of the primary process variable is set to 4 mA.	Byte 0: active address
11	Read unique device identification using the TAG (measuring point designation) Access type = read	Bytes 0–5: TAG	Device identification delivers information on the device and the manufacturer. It cannot be changed. The response consists of a 12 byte device ID if the given TAG agrees with the one saved in the device: – Byte 0: fixed value 254 – Byte 1: Manufacturer ID, 17 = E+H – Byte 2: Device type ID, 67 = Promag 51 – Byte 3: Number of preambles – Byte 4: Universal commands rev. no. – Byte 5: Device-specific commands rev. no. – Byte 6: Software revision – Byte 7: Hardware revision – Byte 8: Additional device information – Bytes 9–11: Device identification
12	Read user message Access type = read	none	Bytes 0–24: User message ✎ Note! You can write the user message using Command 17.
13	Read TAG, descriptor and date Access type = read	none	– Bytes 0–5: TAG – Bytes 6–17: descriptor – Bytes 18–20: Date ✎ Note! You can write the TAG, descriptor and date using Command 18.

Command No. **HART command / Access type**		**Command data** (numeric data in decimal form)	**Response data** (numeric data in decimal form)
14	Read sensor information on primary process variable	none	– Bytes 0–2: Sensor serial number – Byte 3: HART unit code of sensor limits and measuring range of the primary process variable – Bytes 4–7: Upper sensor limit – Bytes 8–11: Lower sensor limit – Bytes 12–15: Minimum span ✎ Note! ■ The data relate to the primary process variable (= volume flow). ■ Manufacturer-specific units are represented using the HART unit code “240”.
15	Read output information of primary process variable Access type = read	none	– Byte 0: Alarm selection ID – Byte 1: Transfer function ID – Byte 2: HART unit code for the set measuring range of the primary process variable – Bytes 3–6: upper range, value for 20 mA – Bytes 7–10: lower range, value for 4 mA – Bytes 11–14: Damping constant in [s] – Byte 15: Write protection ID – Byte 16: OEM dealer ID, 17 = E+H *Factory setting:* Primary process variable = Volume flow ✎ Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ Manufacturer-specific units are represented using the HART unit code “240”.
16	Read the device production number Access type = read	none	Bytes 0–2: Production number
17	Write user message Access = write	You can save any 32-character long text in the device under this parameter: Bytes 0-23: Desired user message	Displays the current user message in the device: Bytes 0-23: Current user message in the device
18	Write TAG, descriptor and date Access = write	With this parameter, you can store an 8 character TAG, a 16 character descriptor and a date: – Bytes 0–5: TAG – Bytes 6–17: descriptor – Bytes 18–20: Date	Displays the current information in the device: – Bytes 0–5: TAG – Bytes 6–17: descriptor – Bytes 18–20: Date
Common Practice Commands			
34	Write damping value for primary process variable Access = write	Bytes 0–3: Damping value of the primary process variable in seconds *Factory setting:* Primary process variable = Volume flow	Displays the current damping value in the device: Bytes 0–3: Damping value in seconds

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
35	Write measuring range of primary process variable Access = write	Write the desired measuring range: – Byte 0: HART unit code of the primary process variable – Bytes 1–4: upper range, value for 20 mA – Bytes 5–8: lower range, value for 4 mA *Factory setting:* Primary process variable = Volume flow ✎ Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ If the HART unit code is not the correct one for the process variable, the device will continue with the last valid unit.	The currently set measuring range is displayed as a response: – Byte 0: HART unit code for the set measuring range of the primary process variable – Bytes 1–4: upper range, value for 20 mA – Bytes 5–8: lower range, value for 4 mA ✎ Note! Manufacturer-specific units are represented using the HART unit code “240”.
38	Device status reset (Configuration changed) Access = write	none	none
40	Simulate output current of primary process variable Access = write **Custody transfer mode:** Disabled in custody transfer mode	Simulation of the desired output current of the primary process variable. An entry value of 0 exits the simulation mode: Bytes 0–3: Output current in mA *Factory setting:* Primary process variable = Volume flow ✎ Note! You can set the assignment of device variables to process variables using Command 51.	The momentary output current of the primary process variable is displayed as a response: Bytes 0–3: Output current in mA
42	Perform master reset Access = write **Custody transfer mode:** Disabled in custody transfer mode	none	none
44	Write unit of primary process variable Access = write	Set unit of primary process variable. Only unit which are suitable for the process variable are transferred to the device: Byte 0: HART unit code *Factory setting:* Primary process variable = Volume flow ✎ Note! ■ If the written HART unit code is not the correct one for the process variable, the device will continue with the last valid unit. ■ If you change the unit of the primary process variable, this has no impact on the system units.	The current unit code of the primary process variable is displayed as a response: Byte 0: HART unit code ✎ Note! Manufacturer-specific units are represented using the HART unit code “240”.
48	Read additional device status Access = read	none	The device status is displayed in extended form as the response: Coding: see table on Page 66

Command No. **HART command / Access type**		**Command data** (numeric data in decimal form)	**Response data** (numeric data in decimal form)
50	Read assignment of the device variables to the four process variables Access = read	none	Display of the current variable assignment of the process variables: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable *Factory setting:* ■ Primary process variable: Code 1 for volume flow ■ Second process variable: Code 250 for totalizer 1 ■ Third process variable: Code 0 for OFF (not assigned) ■ Fourth process variable: Code 0 for OFF (not assigned) ✎ Note! You can set or change the assignment of device variables to process variables using Command 51.
51	Write assignments of the device variables to the four process variables Access = write	Setting of the device variables to the four process variables: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable *Code of the supported device variables:* See data on Page 60 *Factory setting:* ■ Primary process variable = Volume flow ■ Second process variable = Totalizer 1 ■ Third process variable = OFF (not assigned) ■ Fourth process variable = OFF (not assigned)	The variable assignment of the process variables is displayed as a response: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable
53	Write device variable unit Access = write **Custody transfer mode:** In custody transfer mode, the device variable “Totalizer” is locked.	This command set the unit of the given device variables. Only those units which suit the device variable are transferred: – Byte 0: Device variable code – Byte 1: HART unit code *Code of the supported device variables:* See data on Page 60 ✎ Note! ■ If the written unit is not the correct one for the device variable, the device will continue with the last valid unit. ■ If you change the unit of the device variable, this has no impact on the system units.	The current unit of the device variables is displayed in the device as a response: – Byte 0: Device variable code – Byte 1: HART unit code ✎ Note! Manufacturer-specific units are represented using the HART unit code “240”.
59	Write number of preambles in response message Access = write	This parameter sets the number of preambles which are inserted in the response messages: Byte 0: Number of preambles (2...20)	As a response, the current number of the preambles is displayed in the response message: Byte 0: Number of preambles

5.4.5 Device status / Error messages

You can read the extended device status, in this case, current error messages, via Command “48”. The command delivers information which are partly coded in bits (see table below).

✎ Note!
You can find a detailed explanation of the device status and error messages and their elimination on Page 85 ff.

Byte-Bit	Error No.	Short error description (→ Page 85 ff.)
0-0	001	Serious device error
0-1	011	Measuring amplifier has faulty EEPROM
0-2	012	Error when accessing data of the measuring amplifier EEPROM
0-3	not assigned	–
0-4	not assigned	–
0-5	not assigned	–
0-6	not assigned	–
0-7	not assigned	–
1-0	not assigned	–
1-1	031	S-DAT: defective or missing
1-2	032	S-DAT: Error accessing saved values
1-3	not assigned	–
1-4	not assigned	–
1-5	051	I/O board and the amplifier board are not compatible.
1-6	not assigned	–
1-7	not assigned	–
2-0	not assigned	–
2-1	not assigned	–
2-2	not assigned	–
2-3	not assigned	–
2-4	not assigned	–
2-5	not assigned	–
2-6	not assigned	–
2-7	not assigned	–
3-0	not assigned	–
3-1	not assigned	–
3-2	101	Serious component fault on the amplifier board
3-3	111	Totalizer checksum error
3-4	121	I/O board and the amplifier board are not compatible.

Byte-Bit	Error No.	Short error description (→ Page 85 ff.)
3-5	not assigned	–
3-6	not assigned	–
3-7	not assigned	–
4-0	not assigned	–
4-1	not assigned	–
4-2	not assigned	–
4-3	251	Internal communication fault on the measuring amplifier
4-4	261	No data reception between amplifier and I/O board
4-5	not assigned	–
4-6	271	Power supply to amplifier interrupted
4-7	not assigned	–
5-0	321	Coil current of the sensor is outside the tolerance.
5-1	not assigned	–
5-2	not assigned	–
5-3	not assigned	–
5-4	not assigned	–
5-5	not assigned	–
5-6	not assigned	–
5-7	not assigned	–
6-0	not assigned	–
6-1	not assigned	–
6-2	not assigned	–
6-3	not assigned	–
6-4	not assigned	–
6-5	not assigned	–
6-6	not assigned	–
6-7	not assigned	–
7-0	not assigned	–
7-1	not assigned	–
7-2	not assigned	–
7-3	351	Current output: flow is out of range.
7-4	352	
7-5	353	
7-6	354	

Byte-Bit	Error No.	Short error description (→ Page 85 ff.)
7-7	355	Frequency output: flow is out of range.
8-0	356	
8-1	357	
8-2	358	
8-3	359	Pulse output: the pulse output frequency is out of range.
8-4	360	
8-5	361	
8-6	362	
8-7	not assigned	–
9-0	not assigned	–
9-1	not assigned	–
9-2	not assigned	–
9-3	not assigned	–
9-4	not assigned	–
9-5	not assigned	–
9-6	not assigned	–
9-7	not assigned	–
10-0	not assigned	–
10-1	not assigned	–
10-2	not assigned	–
10-3	not assigned	–
10-4	not assigned	–
10-5	not assigned	–
10-6	not assigned	–
10-7	401	Measuring tube partially filled or empty
11-0	not assigned	–
11-1	not assigned	–
11-2	461	EPD adjustment not possible because the fluid's conductivity is either too low or too high.
11-3	not assigned	–
11-4	463	The EPD adjustment values for empty pipe and full pipe are identical, therefore incorrect.
11-5	not assigned	–
11-6	not assigned	–
11-7	not assigned	–

Byte-Bit	Error No.	Short error description (→ Page 85 ff.)
12-0	not assigned	–
12-1	not assigned	–
12-2	not assigned	–
12-3	not assigned	–
12-4	not assigned	–
12-5	not assigned	–
12-6	not assigned	–
12-7	501	New amplifier software version is loaded. Currently no other commands are possible.
13-0	not assigned	–
13-1	not assigned	–
13-2	not assigned	–
13-3	not assigned	–
13-4	not assigned	–
13-5	not assigned	–
13-6	not assigned	–
13-7	not assigned	–
14-0	not assigned	–
14-1	not assigned	–
14-2	not assigned	–
14-3	601	Positive zero return active
14-4	not assigned	–
14-5	not assigned	–
14-6	not assigned	–
14-7	611	Simulation current output active
15-0	not assigned	–
15-1	not assigned	–
15-2	not assigned	–
15-3	621	Simulation frequency output active
15-4	not assigned	–
15-5	not assigned	–
15-6	not assigned	–
15-7	631	Simulation pulse output active
16-0	not assigned	–
16-1	not assigned	–

Byte-Bit	Error No.	Short error description (→ Page 85 ff.)
16-2	not assigned	–
16-3	641	Simulation status output active
16-4	642	
16-5	643	
16-6	644	
16-7	not assigned	–
17-0	not assigned	–
17-1	not assigned	–
17-2	not assigned	–
17-3	not assigned	–
17-4	not assigned	–
17-5	not assigned	–
17-6	not assigned	–
17-7	671	Simulation status input active
18-0	672	Simulation status input active
18-1	673	Simulation status input active
18-2	674	Simulation status input active
18-3	691	Simulation of response to error (outputs) active
18-4	692	Simulation of volume flow active
18-5	not assigned	–
18-6	not assigned	–
18-7	not assigned	–
19–24 / 0–7	not assigned	–

6 Commissioning

6.1 Custody Transfer Measurement

The Promag 51 flowmeter is suitable for custody transfer measurement with cold water. The measuring system operates within a temperature range of 0...+30 °C and can be used, for example, in drinking water supplies. Examples are given on Page 7. The Promag 51 is operated with a totalizer display suitable for custody transfer and, optionally, with a pulse output suitable for custody transfer. Measuring points for custody transfer for water are considered or approved by the certifying authorities as "entire plants". Promag 51 including the inlet and outlet sections are, therefore, considered as a part of this entire plant. To ensure correct measurement in custody transfer procedures, the piping and the measuring tube must always be filled with liquid.

When installing a certified measuring system, please also note the regulations for custody transfer (Deutscher Eichverlag GmbH – Braunschweig):
- Allgemeine Vorschriften (AV) zur Eichordnung (EO)
- Anlage 6 zur Eichordnung (EO 6-1): Vorschriften für Volumen-Messgeräte für strömendes Wasser
- PTB-A6.1: Volumen-Messgeräte für Kaltwasser

6.1.1 Suitability for custody transfer, custody transfer approval, reapproval

With flowmeters suitable for custody transfer, approval by the standards authorities has not yet been carried out. Flowmeters suitable for custody transfer may not be used for custody transfer procedures until approved. However, such flowmeters can either be approved at a later date by a certification body or, with the agreement of the authorities, calibrated for custody transfer on site. The leaded seal of the certified instruments confirms this status.
The operator of an approved Promag 51 measuring system is required to apply for reapproval and to comply with current regulations set by the standards authorities. The date for reapproval (year number) is given on a special seal.

Note!
- Flowmeters suitable for custody transfer are technically identical to flowmeters approved for "custody transfer".
- In contrast to mechanical counters, magnetic flowmeters approved by the standards authorities may be in continuous operation at Q_{max} (= 100%).
- Flowmeters with a max. flow rate of $Q > 2000\ m^3/h$ are exempted from custody transfer approval. Such instruments are not approved but however can still be used as suitable for custody transfer measurement.

Caution!
Only flowmeters approved by the standard authorities may be used for regulatory fiscal metering.

6.1.2 Setting-up / Deactivating custody transfer mode

Setting-up custody transfer mode	Deactivating custody transfer mode
1. Open the transmitter's electronics compartment cover by loosening the corresponding sealing screws (A). 2. First of all, configure all functions important for custody transfer mode, such as "PULSE CT TRANSFER", etc. 3. Now enter the custody transfer code "5100" in the "CODE ENTRY" function. The device is then in custody transfer mode. "CUSTODY TRANSFER YES" appears on the display. This "fixes" and saves the custody transfer mode internally in the measuring system. Caution! – In custody transfer mode, all functions relevant to custody transfer are automatically locked. These functions can not be changed later on sealed measuring devices; they are marked in the "Description of Device Functions" Manual with a key-hole symbol ( ). – Additional particularities in custody transfer mode are described on Page 73. 4. Tightly screw the electronics compartment cover back onto the transmitter housing (for the compact version also the retaining claw). 5. The measuring device now has to be sealed with the sealing screws (A, B, see Fig. 41).	1. Switch the power supply off. 2. Break the leaded sealing (A) and open the transmitter's electronics compartment cover by loosening the sealing screws. 3. Remove the display module by pressing the side latches and pull the S-DAT off the amplifier board → Page 96, 98. 4. Reinsert the display and close the electronics compartment cover onto the transmitter housing. 5. Restart the measuring system by switching on the power supply: – When started, the "CUSTODY TRANSFER NO" message appears on the display. Custody transfer mode is now deactivated. All functions in the programming matrix are now accessible again. – Now, the error message No. #031 "SENSOR HW-DAT" (see Page 85) will appear because the S-DAT is not connected. To remedy this, proceed as follows. 6. Switch the power supply off again! Now complete the following procedure: – Remove electronics compartment cover – Remove display module – Put S-DAT back onto the amplifier board → Page 96, 98 – Reinsert display – Mount electronics compartment cover back onto the transmitter housing – Switch power supply on Normal operation in "non-custody transfer mode" is now fully possible.

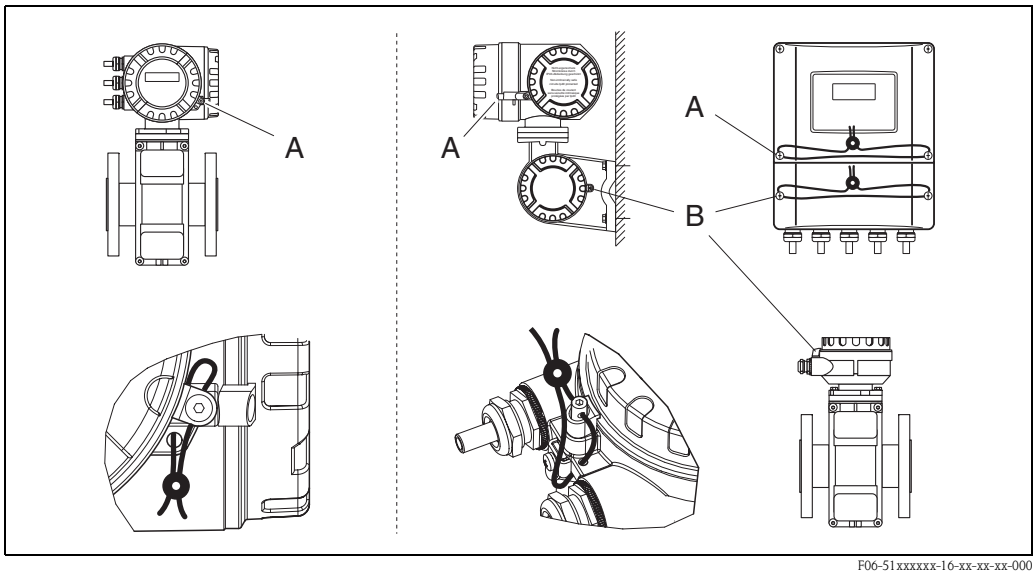


Fig. 41: Sealing of a certified Promag 51 measuring system by standards authorities.

Left: Compact version / Right: Remote version (Ex zone 1 housing and standard housing)
A = Sealing of the electronics compartment
B = Sealing of the connection housing (remote version) after installation

In collaboration with the standards authorities, Promag 51 instruments are sealed before delivery. With the remote version, the connection between sensor and transmitter is to be sealed on site.

6.1.3 Special features of custody transfer measurement

Approved Promag 51 flowmeters differ from non-approved flowmeters as follows:
- After official approval or leaded sealing, configuration can no longer be carried out using the local display.
- Approved flowmeters totalize bidirectional flow, i.e. all outputs consider flow shares in positive (forward) and negative (backward) flow direction.
- The wiring of the status output and status input must be done by the user of the system.
- Diameters DN 700...2000 can also be approved.
  However, measuring points with these diameters are not normally subject to metrological regulations ($Q_{max} = 2 \times Q_n > 2000\ m^3/h$).
- Instruments suitable for custody transfer and for certifying at a later date are normally removed from the piping.

Function settings:
Certain function settings are to be stated when ordering a Promag 51 flowmeter. For the parameters marked with " * ", delivery is made with the factory settings if no corresponding order data is given.
- Nominal flow rate Q_n → Page 23, 74
- Metrological class → Page 23, 74
- Full scale value, current output * → Page 24 ff.
- Current range *: 0/4...20 mA
- Pulse value → Page 24 ff. (if a pulse output for custody transfer mode is used)

For custody transfer measurement, settings for the functions below are fixed:
- Totalizer → 7-digit, without decimal point
- Low flow cut-off → always activated (VOLUME FLOW)
- In contrast to "normal" operation, the status input is only configured for resetting alarm messages on the display (see below) or else for activating the display test function. Creep suppression or resetting the totalizer via the status input is not possible in custody transfer mode.

Error messages on the display
In custody transfer mode, all system and process errors are classified and treated as "fault messages". Error messages appear on the local display and can be output and evaluated - given the appropriate configuration - also via the status output.
On the local display, errors are indicated by flashing, i.e. alternating with the measured value display. The error display can only be reset by means of a pulse via the status input.

Note!
Detailed information on errors for all outputs of Promag 51 can be found on Page 92.

Switching on power supply in custody transfer mode:
After each application of the power supply, including initial start-up, the system error "NETWORK FAILURE" flashes on the local display. The device continues to measure normally despite this display. The fault message can be deleted via the status input.

6.1.4 Definitions

Cold water
Fluid temperature between 0...+30 °C

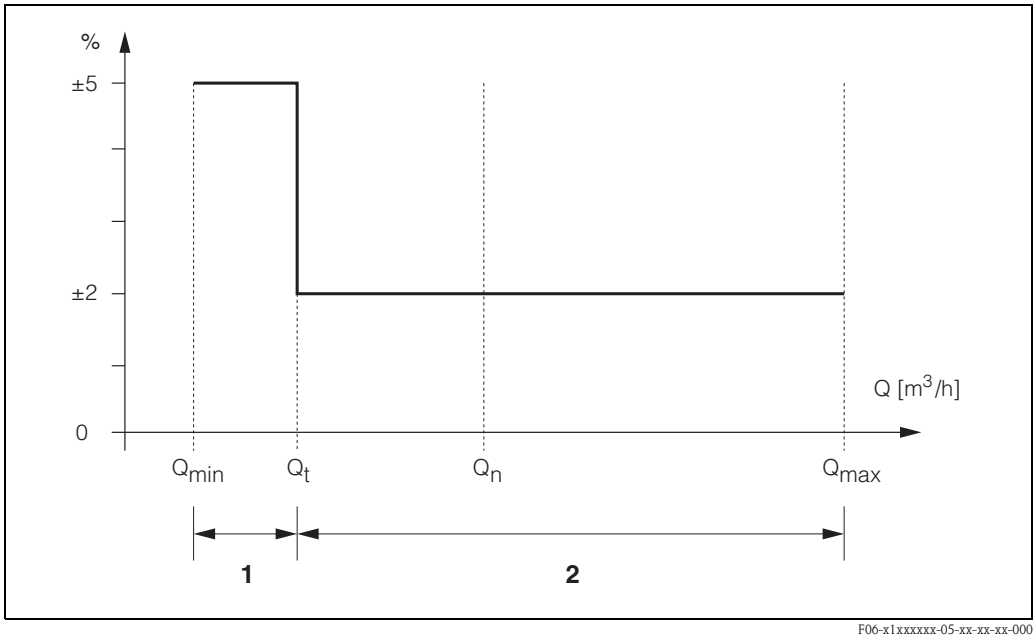
Flow ranges

Q_{max} Maximum flow of the flowmeter without exceeding the maximum permissible error.

Q_n Nominal flow rate is half the value of the maximum flow rate Q_{max} and characterises the flowmeter (see Page 23).

Q_{min} Minimum flow rate above which the totalizer is within the error limits.
It is dependent on the nominal flow rate (Q_n) and the metrological class.

Q_t "Transitional flow rate", which separates the lower from the upper maximum permissible range. Lower or upper range differ from each other by the permitted error limits for custody transfer measurements (Fig. 42):
- Lower range (Q_{min}...Q_t) → Error limits: ±5%
- Upper range (Q_t...Q_{max}) → Error limits: ±2%



F06-x1xxxxxx-05-xx-xx-xx-000

Fig. 42: Flow ranges and error limits in custody transfer mode for cold water

1 = Lower range (error limit: ±5%)
2 = Upper range (error limit: ±2%)

Metrological classes
Metrological classes A / B indicate the range in which the approved custody transfer flowmeter can measure, from full scale value (Q_{max}) down to Q_{min}. The error limits within this range are set by the standards authorities and must not be exceeded.

	Nominal flow rate Q_n	
	< 15 m³/h	**≥ 15 m³/h**
Class A	$Q_{min} = Q_n$ x 0.04 $Q_t = Q_n$ x 0.10	$Q_{min} = Q_n$ x 0.08 $Q_t = Q_n$ x 0.30
Calss B	$Q_{min} = Q_n$ x 0.02 $Q_t = Q_n$ x 0.08	$Q_{min} = Q_n$ x 0.03 $Q_t = Q_n$ x 0.20

6.2 Function check

Make sure that all final checks have been completed before you start up your measuring point:
- Checklist for "Installation check" → Page 38
- Checklist for "Electrical connection check" → Page 51

6.3 Switching on the measuring device

Once the connection checks (see Page 51) have been successfully completed, it is time to switch on the power supply. 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:

PROMAG 51 **START UP ...**	Start-up message
▼	
DEVICE SOFTWARE **V XX.XX.XX**	Current software version (example)
▼	
CUSTODY TRANSFER **NO / YES**	Status display of the custody transfer mode
▼	
SYSTEM OK **→ OPERATION**	Beginning of normal measuring mode
▼	

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

Note!
If start-up fails, an error message indicating the cause is displayed.

6.4 Application-specific commissioning

In the case of measuring devices without a local display, the individual parameters and functions must be configured via the configuration program, e.g. ToF Tool – Fieldtool Package. If the measuring device is equipped with a local display, all the important device parameters for standard operation can be configured quickly and easily by means of the "Commissioning" Quick Setup menu.

6.4.1 "Commissioning" Quick Setup menu

This Quick Setup menu guides you systematically through the setup procedure for all the major device functions that have to be configured for standard measuring operation.

✎ Note!
In the case of measuring devices **without** a local display, the individual parameters and functions must be configured by means of a configuration program, such as ToF Tool – Fieldtool Package from Endress+Hauser.

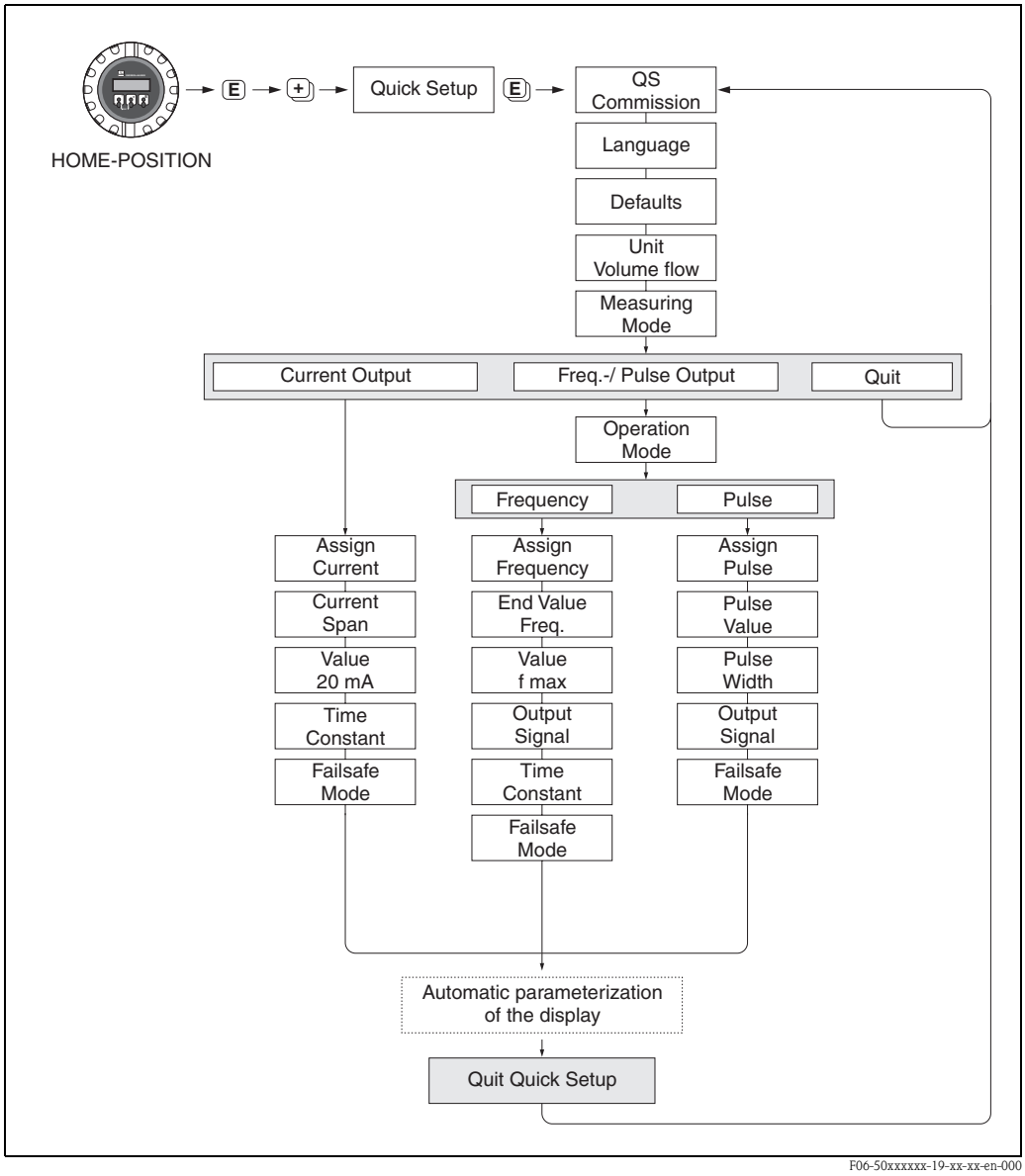


Fig. 43: Quick Setup for commissioning

6.4.2 Empty-pipe/full-pipe adjustment

Flow cannot be measured correctly unless the measuring tube is completely full. This status can be permanently monitored using the Empty Pipe Detection:
- 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 → Carrying out the adjustment.
- EPD → Switching on and off EPD/OED.
- EPD RESPONSE TIME → 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 fluid 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 status output.

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

1. Select the appropriate function in the function matrix:
   HOME → E → + → PROCESS PARAMETER → 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. 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:
   – FULL = EMPTY
     The adjustment values for empty pipe and full pipe are identical. In cases of this nature you **must** repeat empty-pipe or full-pipe adjustment!
   – ADJUSTMENT NOT OK
     Adjustment is not possible because the fluid's conductivity is out of range.
     Current output: active/passive

The current output is configured as "active" or "passive" by means of various jumpers on the I/O board.

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.
- Wait at least 10 minutes for heat to dissipate before opening an Ex-rated device.

1. Switch off power suppy.
2. Remove the I/O board → Page 95, 97
3. Position the jumper according to Fig. 46.

   Caution!
   Risk of destroying the measuring device. Set the jumpers exactly as shown in Fig. 46. 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.

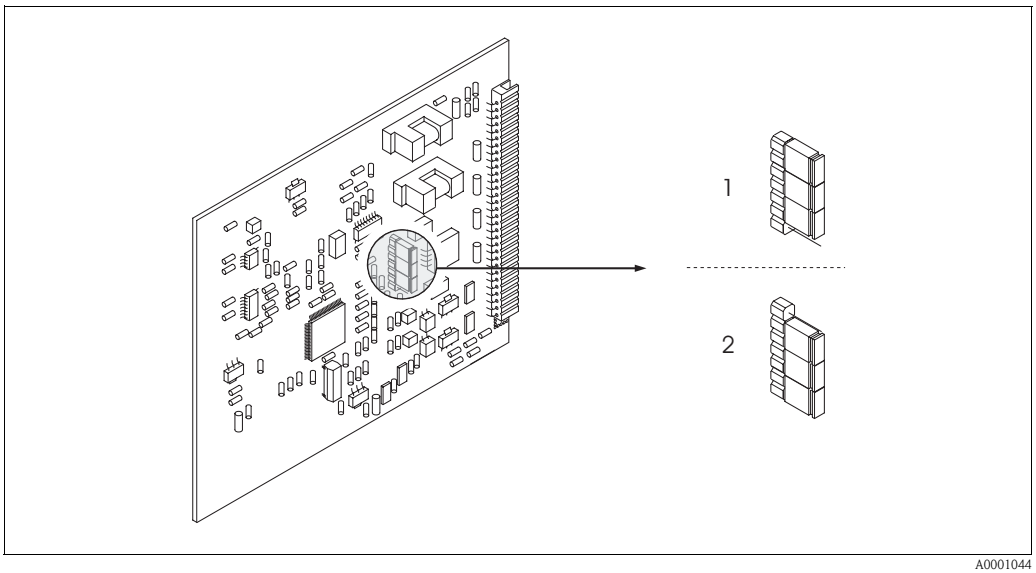


Fig. 44: Configuring the current output (I/O board)

1 Active current output (Factory setting)
2 Passive current output

6.5 Data storage device (HistoROM)

At Endress+Hauser, the term HistoROM refers to various types of data storage modules on which process and measuring device data are stored.

6.5.1 HistoROM/S-DAT (sensor-DAT)

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

7 Maintenance

The Promag 51 flow measuring system requires no special maintenance.

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.

8 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. The Endress+Hauser service organisation can provide detailed information on the order codes of your choice.

8.1 Device-specific accessories

Accessory	Description	Order code
Transmitter Promag 51	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	51XXX - XXXXX * * * * * * * *

8.2 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting kit for transmitter Promag 51	Mounting kit for wall-mounted housing (remote version). Suitable for: – Wall mounting – Post mounting – Installation in control panel Mounting set for aluminium housings: Suitable for pipe mounting (3/4"...32")	DK5WM – *
Cable for remote version	Coil and signal cables, various lengths. Reinforced cable on request.	DK5CA – * *
Ground cable for Promag W/P	A set consists of two ground cables.	DK5GC – * * *
Ground disk for Promag W, P	Ground disk for potential equalisation	DK5GD – * * *

8.3 Communication-specific accessories

Accessory	Description	Order code
HART Communicator DXR 375 hand-held terminal	Hand-held terminal for remote parameterisation and for fetching measured values via the current output HART (4...20 mA). Contact your Endress+Hauser representative for more information.	DXR375 – * * * *

8.4 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 – *
ToF Tool - Fieldtool Package	Configuration and service software for flowmeters in the field: – Commissioning, maintenance analysis – Configuring flowmeters – Service functions – Visualisation of process data – Trouble-shooting – Control of the “Fieldcheck” tester/simulator Contact your Endress+Hauser representative for more information.	DXS10 – * * * * *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the “ToF Tool - Fieldtool Package” software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.	DXC10 – * *

9 Trouble-shooting

Caution!
- In custody transfer mode, error messages must be reset or confirmed manually. Error messages are reset via the status input by applying a pulse.
- For certified instruments, faults can only be corrected by breaking the seal. After repair by an Endress+Hauser service technician (provisional seal), the device must be resealed by the appropriate standards authority.
- In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. The procedures on Page 8 must be carried out before you return a flowmeter to Endress+Hauser. Always enclose a duly completed "Declaration of contamination" form. You will find a preprinted blank of the this form at the back of this manual.

9.1 Trouble-shooting instructions

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

Caution!
For certified instruments, faults can only be corrected by breaking the seal. After repair by an Endress+Hauser service technician (provisional seal), the device must be resealed by the appropriate standards authority.

Check the display	
No display visible and no output signals present.	1. Check the power supply → terminals 1, 2 2. Check the power line fuse → Page 99 85...260 V AC: 0.8 A slow-blow / 250 V 20...55 V AC and 16...62 V DC: 2 A slow-blow / 250 V 3. Measuring electronics defective → order spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
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 → Page 96, 98 2. Display module defective → order spare parts → Page 94 3. Measuring electronics defective → order spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
Display texts are in a foreign language.	**Custody transfer mode / Non-custody transfer mode:** You can alter the language setting via the HART interface or the ToF Tool - Fieldtool Package user software, independently of the custody transfer. In non-custody transfer mode, the following option is also available → Switch off power supply. Press and hold down both the ± buttons 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 → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!

▼ (continued on next page)

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): – Error type: **S** = system error, **P** = process error – Error message type: ↯ = fault message, **!** = notice message – **EMPTY PIPE** = Error designation (e.g. measuring tube is only partly filled) – **03:00:05** = duration of error occurrence (in hours, minutes and seconds) – **# 401** = error number Caution! ■ Also observe the information on Page 56! ■ Simulation and positive zero return are not possible in custody transfer mode!	
Error number: No. 001 – 399 No. 501 – 699	System error (device error) has occurred → Page 85
Error number: No. 401 - 499	Process error (application error) has occurred → Page 90

▼

Other error (without error message)	
Some other error has occurred.	Diagnosis and rectification → Page 91

9.2 System error messages

Serious system errors are **always** recognised by the instrument as "Fault message", and are shown as a lightning symbol (ϟ) on the display. Fault messages immediately affect the inputs and outputs. Simulations and positive zero return(not available with custody transfer mode), on the other hand, are classed and displayed as notice messages.

No.	Error message / Type	Cause	Remedy / spare part
S = System error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without an effect on the outputs) ✎ Note! ■ In custody transfer mode, "notice messages" of Promag 51 are always classified and treated as "fault messages". ■ Error response of the outputs → Page 92			
No. # 0xx → Hardware error			
001	S: CRITICAL FAILURE ϟ: # 001	Serious device error	Replace the amplifier board. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
011	S: AMP HW EEPROM ϟ: # 011	Amplifier: Defective EEPROM	Replace the amplifier board. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
012	S: ϟAMP SW EEPROM ϟ: # 012	Amplifier: Error accessing EEPROM data	**Without custody transfer mode:** The EEPROM data blocks in which an error has occurred are displayed in the "TROUBLESHOOTING" function. Press Enter to acknowledge the errors in question; default values are automatically inserted instead of the errored parameter values. **Custody transfer mode:** To eliminate fault, lead seal must be broken! ✎ Note! The measuring device must be restarted after fault elimination.
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. Replace the S-DAT. Spare parts → Page 94 Check the spare part set number to ensure that the new, replacement DAT is compatible with the measuring electronics. 2. Plug the S-DAT into the amplifier board → Page 96, 98 **Custody transfer mode:** To eliminate fault, lead seal must be broken!

No.	Error message / Type	Cause	Remedy / spare part
032	S: SENSOR SW DAT ϟ: # 032	Sensor: Error accessing the calibration values stored in the S-DAT.	1. Check whether the S-DAT is correctly plugged into the amplifier board → Page 96, 98 2. Replace the S-DAT if it is defective. Spare parts → Page 94 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. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
No. # 1xx → Software error			
101	S: GAIN ERROR AMP. ϟ: # 101	Gain deviation compared to reference gain is greater than 2%.	Replace the amplifier board. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
111	S: CHECKSUM TOTAL ϟ: # 111	Totalizer checksum error	1. Restart the measuring device 2. Replace the amplifier board if necessary. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault (point 2), lead seal must be broken!
121	S: A / C COMPATIB. ϟ: # 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 actualizied by ToF Tool - Fieldtool Package with the required software version or the module has to be replaced. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
No. # 2xx → Error in DAT / no communication			
251	S: COMMUNICATION I/O ϟ: # 251	Internal communication error on the amplifier board.	Remove the amplifier board. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!

No.	Error message / Type	Cause	Remedy / spare part
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 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
271	S: POWER BRK. DWN ϟ: # 271	Amplifier: Power supply is interrupted. ✎ Note! This error message is only displayed or output in custody transfer mode.	**Custody transfer mode:** Reset error message via the status input (auxiliary input).
No. # 3xx → System limits exceeded			
321	S: TOL. COIL CURR. ϟ: # 321	Sensor: Coil current is out of tolerance.	1. Remote version: Switch off power supply and check wiring of terminals 41/42 → Page 39 2. Switch off the power supply and check the connectors of the coil cable → Page 96, 98 3. Replace measuring electronics boards if necessary. Spare parts → Page 94 **Custody transfer mode:** To eliminate fault, lead seal must be broken!
351 **...** **354**	S: CURRENT RANGE n !: # 351...354	Current output: Flow is out of range.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable. **Custody transfer mode:** Change the upper or lower limit setting via the HART interface or by means of the ToF Tool - Fieldtool Package.
355 **...** **358**	S: FREQ. RANGE n !: # 355...358	Frequency output: Flow is out of range.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable. **Custody transfer mode:** Change the upper or lower limit setting via the HART interface or by means of the ToF Tool - Fieldtool Package software.

No.	Error message / Type	Cause	Remedy / spare part
359 … 362	S: PULSE RANGE n !: # 359…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:* – Variant 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: $\frac{1}{2 \cdot 10\ \text{Hz}} = 50\ \text{ms}$ 3. Reduce flow. **Custody transfer mode:** If the pulse output is not suitable for custody transfer mode, the pulse value can be altered via the HART interface or the ToF Tool - Fieldtool Package. The pulse width can be altered independently of custody transfer mode.
No. # 5xx → Application error			
501	S: SW.-UPDATE ACT. !: # 501	New amplifier or communication (I/O module) software version is loaded. Currently no other functions are possible.	Wait until the procedure is finished. The device will restart automatically. **Custody transfer mode:** In custody transfer mode, no software version can be loaded.
502	S: UP-/DOWNLOAD ACT !: # 502	Up- or downloading the device data via configuration program. Currently no other functions are possible.	Wait until the procedure is finished. **Custody transfer mode:** In custody transfer mode, no up- or downloading possible.
No. # 6xx → Simulation mode active			
601	S: POS. ZERO RETURN !: # 601	Positive zero return active ☝ Caution! This message has the highest display priority!	Switch off positive zero return **Custody transfer mode:** In custody transfer mode, positive zero return cannot be activated.
611 … 614	S: SIM. CURR. OUT. n !: # 611...614	Simulation current output active	Switch off simulation **Custody transfer mode:** Simulation not possible

No.	Error message / Type	Cause	Remedy / spare part
621 … 624	S: SIM. FREQ. OUT. n !: # 621…624	Simulation frequency output active	Switch off simulation **Custody transfer mode:** Simulation not possible
631 … 634	S: SIM. PULSE n !: # 631…634	Simulation pulse output active	Switch off simulation **Custody transfer mode:** Simulation not possible
641 … 644	S: SIM. STAT. OUT n !: # 641…644	Simulation status output active	Switch off simulation **Custody transfer mode:** Simulation not possible
671 … 674	S: SIM. STATUS IN !: # 671…674	Simulation status input active	Switch off simulation **Custody transfer mode:** Simulation not possible
691	S: SIM. FAILSAFE !: # 691	Simulation of response to error (outputs) active	Switch off simulation **Custody transfer mode:** Simulation not possible
692	S: SIM. VOL. FLOW !: # 692	Simulation of volume flow active	Switch off simulation **Custody transfer mode:** Simulation not possible
698	S: DEV. TEST ACT. !: # 698	The measuring device is being checked on site via the test and simulation device.	**Custody transfer mode:** Checking via a test device is not possible.

9.3 Process error messages

Process errors can be defined as either “Fault” or “Notice” messages and can thereby be weighted differently. Determination of this is done via the function matrix (see the “Description of Device Functions” Manual).

✎ Note!
The error types listed in the following correspond to the factory settings.
Also observe the information on Page 56 ff. and 92

No.	Error message / Type	Cause	Remedy
P = Process error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without an effect on the outputs) ✎ Note! ▪ In custody transfer mode, “notice messages” of Promag 51 are always classified and treated as “fault messages”. ▪ Error response of the outputs → Page 92			
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 **Custody transfer mode:** Reset error message via the status input or via the “reset key”.
461	P: ADJ. NOT 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.
463	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 → Page 77 **Custody transfer mode:** In custody transfer mode, an EPD/OED adjustment is not possible.

9.4 Process errors without messages

Symptoms	Rectification
Remarks: You may have to change or correct certain settings in functions in the function matrix in order to rectify the fault. The functions outlined below, such as DISPLAY DAMPING, for example, are described in detail in the "Description of Device Functions" manual. ☞ Caution! For certified instruments, faults can only be corrected by breaking the seal. After repair by an Endress+Hauser service technician (provisional seal), the device must be resealed by the appropriate standards authority.	
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 → Page 39 ff. – 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 equalization → Page 47 ff. 2. Check the fluid for presence of gas bubbles. 3. In the "TIME CONSTANT" function (current output) → increase the value 4. In the "DISPLAY DAMPING" function → increase the value
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 equalization → Page 47 ff. 2. Check the fluid for presence of gas bubbles. 3. Activate the "LOW FLOW CUTOFF" function, i.e. enter or increase the value for the switching point (not possible in **custody transfer mode**).
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 → Page 77 2. Remote version: Check the terminals of the EPD cable → Page 39 ff. 3. Fill the measuring tube.
The current output signal is always 4 mA, irrespective of the flow signal at any given time.	1. Select the "BUS ADDRESS" function and change the setting to "0". 2. Value for creepage too high. Reduce corresponding value in the "Low flow cut-off" functions (not possible in **custody transfer mode**).
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 (Page 11 ff.): order code, serial number **Returning devices to Endress+Hauser** The procedures on Page 8 must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. Always enclose a duly completed "Declaration of Conformity" form with the flowmeter. You will find a preprinted form at the back of this manual. **Replace transmitter electronics** Components in the measuring electronics defective → order spare parts → Page 94

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.
- In custody transfer mode, positive zero return cannot be activated.

Positive zero return and failsafe mode:
You can use positive zero return to set the signals of the current, pulse and frequency outputs to their fallback value, 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

	Process/system error is current	Positive zero return is activated (Not possible in **custody transfer mode**)
Caution! ■ In non-custody transfer mode the following applies: System or process errors that have been defined as "notice messages" have no effect on the inputs and outputs. Please refer to the information on Page 56. ■ In **custody transfer mode** the following applies: Promag 51 always classifies and treats "notice messages" as "fault messages". If the status output, in contrast to the factory setting (= FAULT MESSAGE), is set to "NOTICE MESSAGE", the status output no longer switches in the event of notice/fault messages.		
Current output	*MINIMUM CURRENT* The current output will be set to the lower value of the signal on alarm level depending on the setting selected in the CURRENT SPAN (see the "Description of Device Functions" manual). *MAXIMUM CURRENT* The current output will be set to the higher value of the signal on alarm level depending on the setting selected in the CURRENT SPAN (see the "Description of Device Functions" manual). *HOLD VALUE* Measured value display on the basis of the last saved value preceding occurrence of the fault. *ACTUAL VALUE* Measured value display on the basis of the current flow measurement. The fault is ignored.	Output signal corresponds to "zero flow"
Pulse output	*FALLBACK VALUE *)* Signal output → no pulses *ACTUAL VALUE* Fault is ignored, i.e. normal measured value output on the basis of ongoing flow measurement. * fixed setting in **custody transfer mode**	Output signal corresponds to "zero flow"

Failsafe mode of outputs and totalizers		
	Process/system error is current	Positive zero return is activated (Not possible in **custody transfer mode**)
Frequency output	*FALLBACK VALUE* Signal output → 0 Hz *FAILSAFE LEVEL* Output of the frequency specified in the FAILSAFE VALUE function (No. 4211). *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"
Totalizer	*STOP *)* The totalizers are paused until the error is rectified. *ACTUAL VALUE* The fault is ignored. The totalizers continue to count in accordance with 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). * fixed setting in **custody transfer mode**	Totalizer stops
Status output	In the event of a fault or power supply failure: Status output → non-conductive	No effect on status output

9.6 Spare parts

Chap. 9.1 contains a detailed trouble-shooting guide. 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 organisation by providing the serial number printed on the transmitter's nameplate (Page 11 ff.).

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

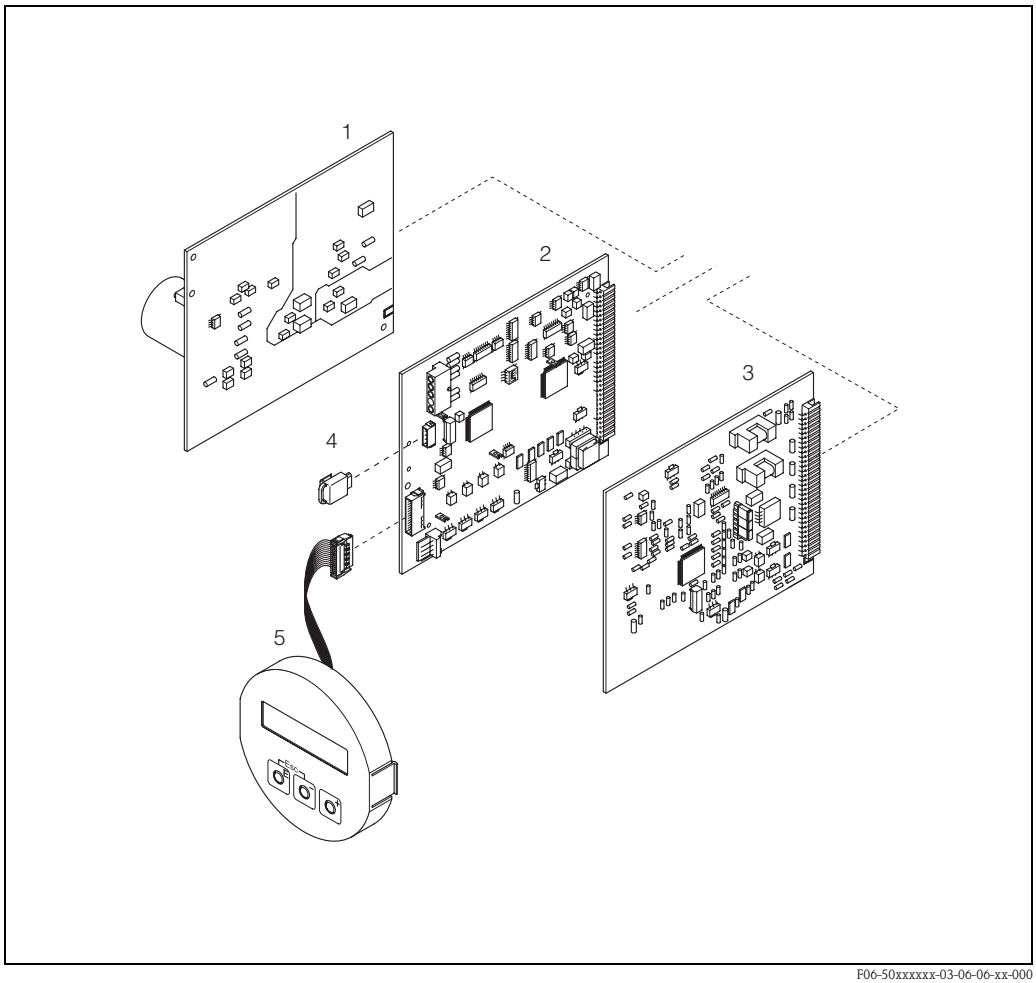


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Fig. 45: Spare parts for Promag 51 transmitter (field and wall-mounted housings)

1 Power supply board (85...260 V AC, 20...55 V AC, 16...62 V DC)
2 Amplifier board
3 I/O board
4 S-DAT (sensor data memory)
5 Display module

9.7 Removing and installing printed circuit boards

Field housing: removing and installing printed circuit boards (Fig. 46)

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!
With certified devices, the exchange of transmitter electronics is only possible by breaking the leaded seal. After exchange by an Endress+Hauser service technician (provisional seal), the device must be resealed by the appropriate standards authority.

1. Unscrew cover 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 supply board and I/O board (4, 6):
   Insert a suitable tool into the holes (3) provided for the purpose and pull the board clear of its holder.
5. Remove amplifier board (5):
6. Disconnect the plug of the electrode signal cable (5.1) including S-DAT (5.3) from the board.
7. Loosen the plug locking of the coil current cable (5.2) and gently disconnect the plug from the board, i.e. without moving it to and fro.
8. Insert a thin pin into the holes (3) provided for the purpose and pull the board clear of its holder.
9. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

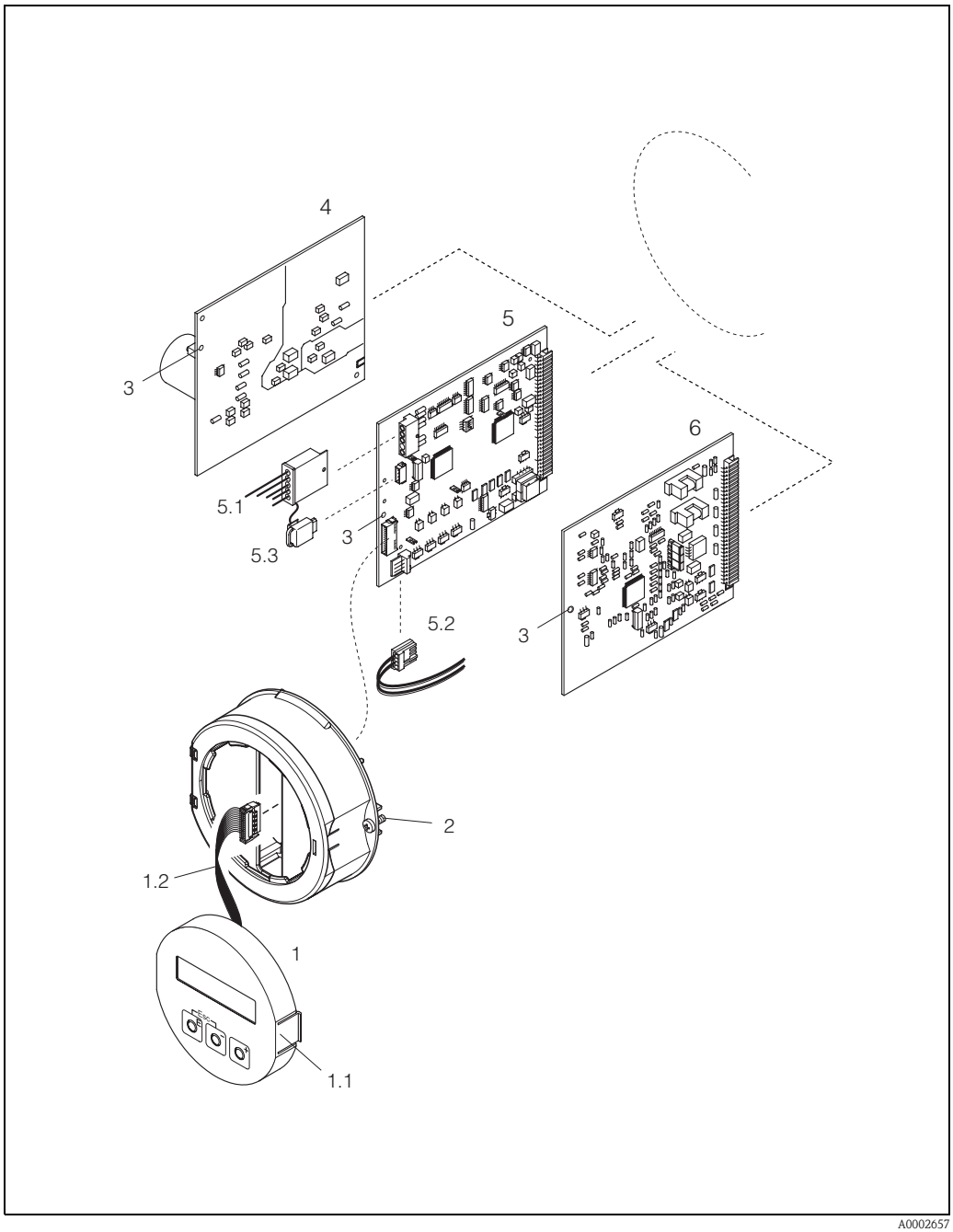

Fig. 46: Field housing: removing and installing printed circuit boards

1 Local display
1.1 Latch
1.2 Ribbon cable (display module)
2 Screws of electronics compartment cover
3 Aperture for tool, removal/installation
4 Power supply board
5 Amplifier board
5.1 Electrode signal cable (sensor)
5.2 Coil current cable (sensor)
5.3 S-DAT (sensor data memory)
6 I/O board

Wall-mounted housing: removing and installing printed circuit boards (Fig. 47)

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!
With certified devices, the exchange of transmitter electronics is only possible by breaking the leaded seal. After exchange by an Endress+Hauser service technician (provisional seal), the device must be resealed by the appropriate standards authority.

1. Remove the screws and open the hinged cover (1) of the housing.
2. Remove screws of the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mounted housing.
3. Disconnect the following cable plugs from amplifier board (7):
4. Electrode signal cable plug (7.1) including S-DAT (7.3)
5. Plug of coil current cable (7.2). To do so, loosen the plug locking of the coil current cable and gently disconnect the plug from the board, i.e. without moving it to and fro.
6. Ribbon-cable plug (3) of the display module
7. Remove the screws and remove the cover (4) from the electronics compartment.
8. Remove the boards (6, 7, 8):
   Insert a suitable tool into the hole (5) provided for the purpose and pull the board clear of its holder.
9. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

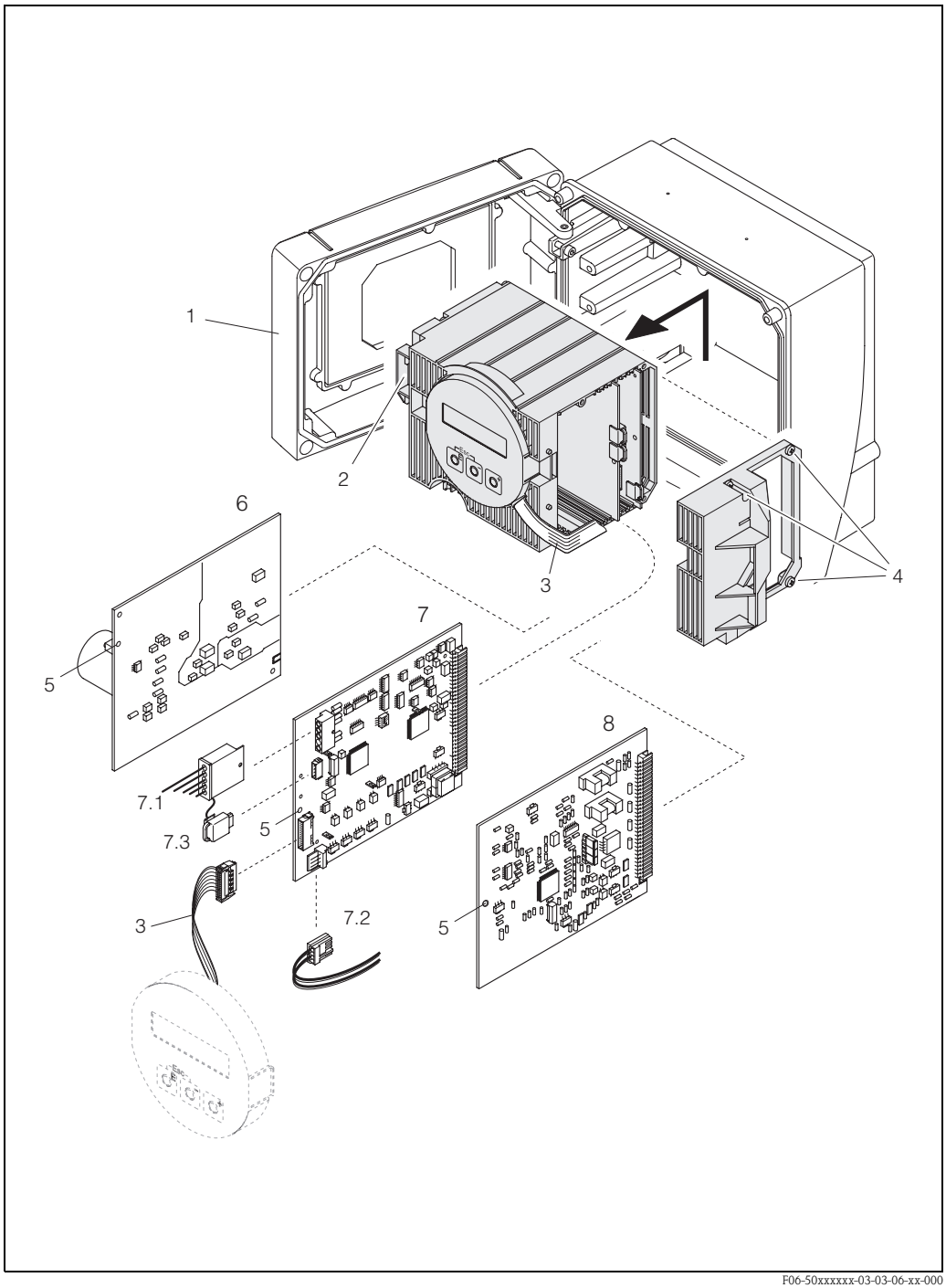

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Fig. 47: Wall-mounted housing: removing and installing printed circuit boards

1 Housing cover
2 Electronics module
3 Ribbon cable (display module)
4 Cover of electronics compartment (3 screws)
5 Aperture for tool, removal/installation
6 Power supply board
7 Amplifier board
7.1 Electrode signal cable (sensor)
7.2 Coil current cable (sensor)
7.3 S-DAT (sensor data memory)
8 I/O board

9.8 Replacing the device fuse

The main fuse is on the power supply board (Fig. 48).
The procedure for replacing the fuse is as follows:

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.

Caution!
With certified devices, the exchange of the device fuse is only possible by breaking the leaded seal. After exchange by an Endress+Hauser service technician (provisional seal), the device must be resealed by the appropriate standards authority.

1. Switch off power supply.
2. Remove the power supply board → Page 95, 97
3. Remove cap (1) and replace the device fuse (2).
   Use only fuses of the following type:
   – Power supply 20...55 V AC / 16...62 V DC → 2.0 A slow-blow / 250 V; 5.2 x 20 mm
   – Power supply 85...260 V AC → 0.8 A slow-blow / 250 V; 5.2 x 20 mm
   – Ex-rated devices → see the Ex documentation.
4. Assembly is the reverse of the disassembly procedure.

   Caution!
   Use only original Endress+Hauser parts.

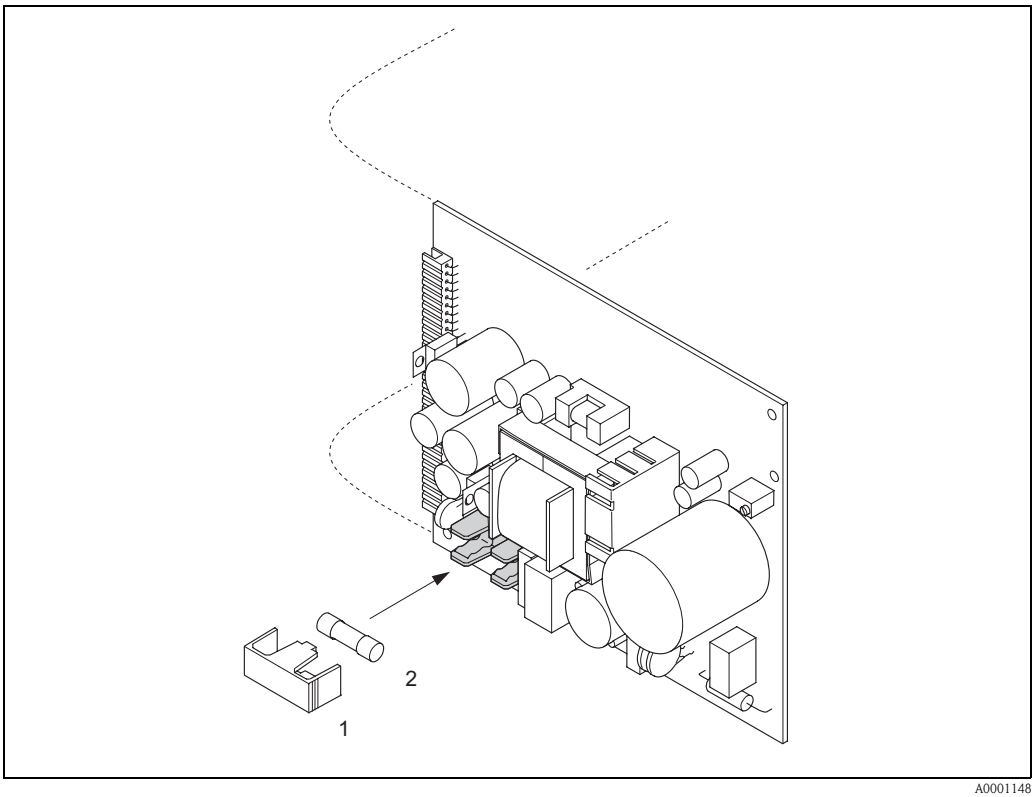

Fig. 48: Replacing the device fuse on the power supply board

1 Protective cap
2 Device fuse

9.9 Replacing exchangeable measuring electrodes (not in custody transfer mode)

The Promag W sensor (DN 350...2000) is available with exchangeable measuring electrodes as an option. This design permits the measuring electrodes to be replaced or cleaned under process conditions (see Page 101).

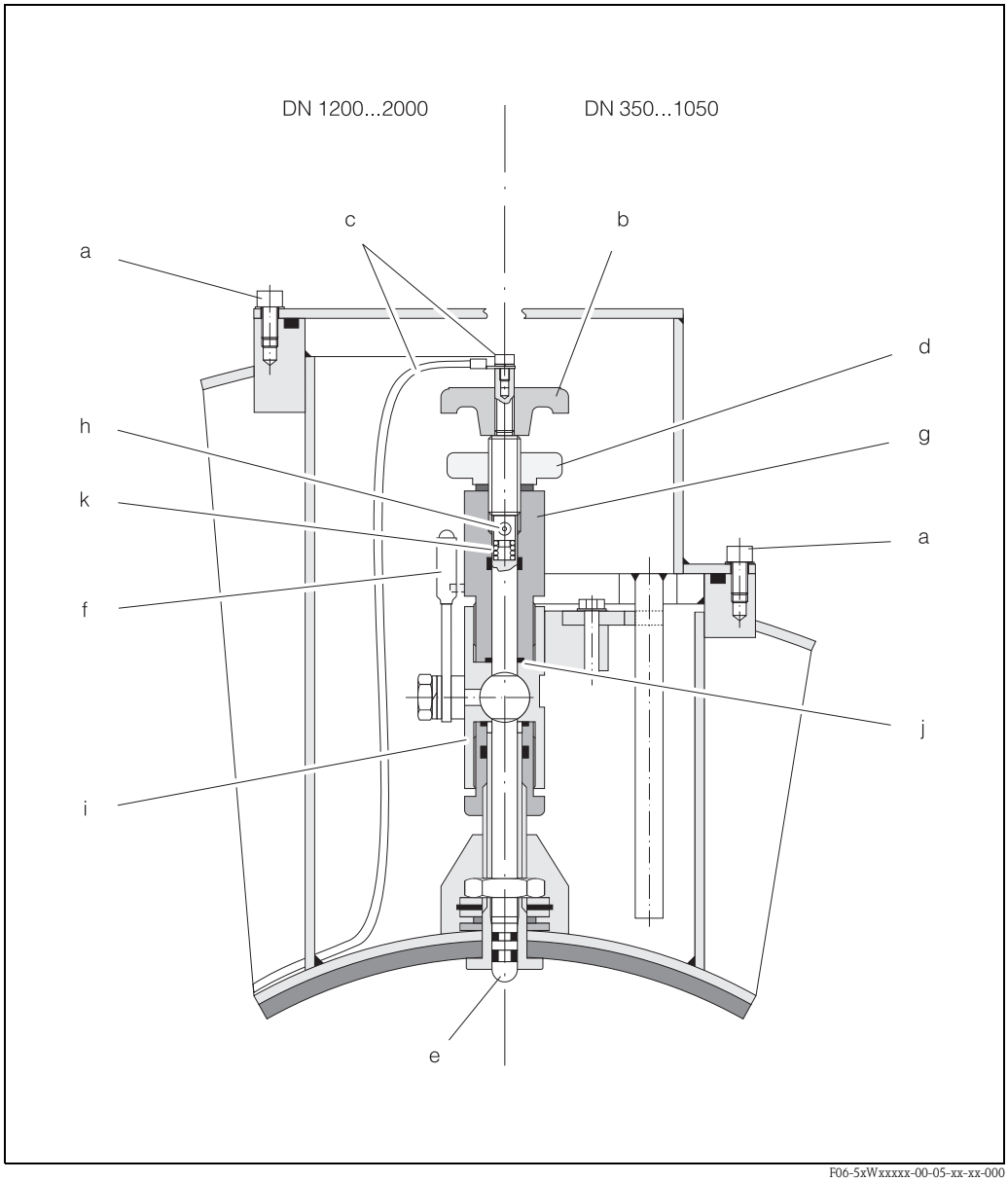

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Fig. 49: Apparatus for replacing exchangeable measuring electrodes (Replacing → Page 101)

a Allen screw
b Handle
c Electrode cable
d Knurled nut (locknut)
e Measuring electrode
f Stop cock
g Retaining cylinder
h Locking pin (for handle)
i Ball-valve housing
j Seal (retaining cylinder)
k Coil spring

Removing the electrode		Installing the electrode	
1	Loosen Allen screw (a) and remove the cover.	1	Insert new electrode (e) into retaining cylinder (g) from below. Make sure that the seals at the tip of the electrode are clean.
2	Remove electrode cable (c) secured to handle (b).	2	Mount handle (b) on the electrode and insert locking pin (h) to secure it in position. Caution! Make sure that coil spring (k) is inserted. This is essential to ensure correct electrical contact and correct measuring signals.
2	Loosen knurled nut (d) by hand. This knurled nut acts as a locknut.	2	Pull the electrode back until the tip of the electrode no longer protrudes from retaining cylinder (g).
3	Remove electrode (e) by turning handle (b). The electrode can now be pulled out of retaining cylinder (g) as far as a defined stop. Warning! Risk of injury. Under process conditions (pressure in the piping system) the electrode can recoil suddenly against its stop. Apply counter-pressure while releasing the electrode.	3	Screw the retaining cylinder (g) onto ball-valve housing (i) and tighten it by hand. Seal (j) on the cylinder must be correctly seated and clean. Note! Make sure that the rubber hoses on retaining cylinder (g) and stop cock (f) are of the same color (red or blue).
4	Close stop cock (f) after pulling out the electrode as far as it will go. Warning! Do not subsequently open the stop cock, in order to prevent fluid escaping.	4	Open stop cock (f) and turn handle (b) to screw the electrode all the way into the retaining cylinder.
5	Remove the electrode complete with retaining cylinder (g).	5	Screw knurled nut (d) onto the retaining cylinder. This firmly locates the electrode in position.
6	Remove handle (b) from electrode (e) by pressing out locking pin (h). Take care not to lose coil spring (k).	6	Use the Allen screw to secure electrode cable (c) to handle (b). Caution! Make sure that the machine screw securing the electrode cable is firmly tightened. This is essential to ensure correct electrical contact and correct measuring signals.
7	Remove the old electrode and insert the new electrode. Replacement electrodes can be ordered separately from Endress+Hauser.	7	Reinstall the cover and tighten (a) Allen screw.

9.10 Software history

Date	Software version	Changes to software	Operating Instructions
03.2005	2.00.XX	Software expansion: – New / revised functionalities New functionalities: – DEVICE SOFTWARE → Device software displayed (NAMUR-recommendation 53) – Unit US kgal	50097089/03.05
11.2004	Amplifier: 1.06.01 Communication module: 1.04.00	Software update relevant only for production	50097089/11.04
10.2003	Amplifier: 1.06.00 Communication module: 1.03.00	Software expansion: – Language groups – Flow direction pulse output selectable New functionalities: – Second Totalizer – Adjustable backlight (display) – Operation hours counter – Simulation function for pulse output – Access code for counter – Reset function (fault history) – Up-/download with FieldTool	50097089/10.03
08.2003	Communication module: 1.02.01	Software expansion: – New / revised functionalities Special documentation: – Current span NAMUR NE 43 – Failsafe mode function – Trouble-shooting function – System and process error messages – Response of status output	50097089/08.03
08.2002	Amplifier: 1.04.00	Software expansion: – New / revised functionalities Special documentation: – Current span NAMUR NE 43 – EPD (new mode) – Failsafe mode function – Acknowledge fault function – Trouble-shooting function – System and process error messages – Response of status output	50097089/08.02
03.2002	Amplifier: 1.03.00	Software expansion: For custody transfer Promag 50/51	none
06.2001	Amplifier: 1.02.00 Communication module: 1.02.00	Software expansion: – New / revised functionalities Neue Funktionalitäten: – Gerätefunktionen allgemein – Software-Funktion “OED” – Software-Funktion “Impulsbreite”	50097089/06.01

Date	Software version	Changes to software	Operating Instructions
09.2000	Amplifier: 1.01.01 Communication module: 1.01.00	Software expansion – functional adaptations	none
08.2000	Amplifier: 1.01.00	Software expansion – functional adaptations	none
04.2000	Amplifier: 1.00.00 Communication module: 1.00.00	Original software. Compatible with: – FieldTool – HART interface via service interface FXA 193 – HART Communicator DXR 275 (from OS 4.6) with Rev. 1, DD 1.	50097089/04.00

✎ Note!
Usually, an upload or download between the different software versions is only possible with a special service software.

10 Technical data

10.1 Technical data at a glance

10.1.1 Application

Application

- Flow measurement of liquids for custody transfer with cold water in closed pipings.
- A minimum conductivity of ≥ 5 µS/cm is required for measuring; the minimum conductivity required in the case of demineralised water is ≥ 20 µS/cm.
- Applications in measuring, control and regulation technology

Liner specific applications:
- Promag W (DN 25...2000):
  - Polyurethane lining for applications with cold water and for slightly abrasive fluids.
  - Hard rubber lining for all applications with water (especially for trinking water)
- Promag P (DN 15...600):
  - PTFE lining for standard applications in chemical and process industries.
  - PFA lining for all applications in chemical and process industries; especially for high process temperatures and applications with temperature shocks.

10.1.2 Function and system design

Measuring principle

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

Measuring system

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

Transmitter:
- Promag 51

Sensor:
- Promag W (DN 25…2000)
- Promag P (DN 15…600)

10.1.3 Input

Measured variable

Flow rate (proportional to induced voltage)

Measuring range

Typically v = 0.01…10 m/s with the specified measuring accuracy

Operable flow range

Not in custody transfer mode → 1000 : 1
In custody transfer mode → max. 250 : 1 (corresponding to 0.04...10 m/s)

Input signals	Status input (auxiliary input): U = 3…30 V DC, R_i = 5 kΩ, galvanically isolated Configurable for: totalizer reset, positive zero return With custody transfer measurement, error messages can only be reset and a display test function activated via the status input!

10.1.4 Output

Output signal	Current output: active/passive selectable, galvanically isolated, time constant selectable (0.01…100 s), full scale value selectable, temperature coefficient: typically 0.005 % o.f.s./°C; resolution: 0.5 µA ■ active: 0/4…20 mA, R_L < 700 Ω (for HART: $R_L \geq 250$ Ω) ■ passive: 4…20 mA, supply voltage V_s = 18...30 V DC, $R_i \geq 150$ Ω Pulse / frequency output: passive, open collector, 30 V DC, 250 mA, galvanically isolated ■ Frequency output: full scale frequency 2…1000 Hz (f_{max} = 1250 Hz), on/off ratio 1:1, pulse width max. 10 s ■ Pulse output: pulse value and pulse polarity selectable, pulse width configurable (0.5…2000 ms)
Signal on alarm	Certifiable instruments: ■ Current output → failsafe mode selectable (see Page 92), e.g. to NAMUR recommendation NE 43 ■ Pulse/frequency output → failsafe mode selectable (see Page 92) ■ Status output → "non-conductive" by fault or power supply failure (see Page 92) Certified instruments: ■ Current output → failsafe mode selectable (see Page 92) ■ Pulse/frequency output → fallback value (only with certified pulse output) ■ Status output → "non-conductive" by fault or power supply failure. Switching response selectable (see Page 92) ■ In custody transfer mode, error messages can be reset via the status input once the fault has been cleared. Resetting error messages → Page 73
Load	see "output signal"
Switching output	Status output: Open collector, max. 30 V DC / 250 mA, galvanically isolated Configurable for: error messages, Empty Pipe Detection (EPD/OED), flow direction, limit values
Low flow cutoff	■ Certifiable instruments: Switch points for low flow cutoff are selectable ■ Certified instruments: Switch points permanently set (On at 0.02 m/s; Off at 0.04 m/s)
Galvanic isolation	All circuits for inputs, outputs, and power supply are galvanically isolated from each other.

10.1.5 Power supply

Electrical connections	see Page 39 ff.
Cable entry	Power supply and signal cables (inputs/outputs): ■ Cable entry M20 x 1.5 (8…12 mm) ■ Sensor cable entry for armoured cables M20 x 1.5 (9.5...16 mm) (not in custody transfer mode) ■ Threads for cable entries 1/2" NPT, G 1/2" Connecting cable for remote version: ■ Cable entry M20 x 1.5 (8…12 mm) ■ Sensor cable entry for armoured cables M20 x 1.5 (9.5...16 mm) (not in custody transfer mode) ■ Threads for cable entries, 1/2" NPT, G 1/2"
Cable specifications	see Page 42
Supply voltage	85…260 V AC, 45…65 Hz 20…55 V AC, 45…65 Hz 16…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 saves measuring system data if power supply fails ■ S-DAT: exchangeable data storage chip which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point, etc.)
Potential equalisation	see Page 47 ff.

10.1.6 Performance characteristics

Reference operating conditions	To DIN EN 29104 and VDI/VDE 2641: ■ Fluid temperature: +28 °C ± 2 K ■ Ambient temperature: +22 °C ± 2 K ■ Warm-up time: 30 minutes Installation: ■ Inlet run >10 x DN ■ Outlet run > 5 x DN ■ Sensor and transmitter grounded. ■ Sensor centered relative to the pipe.

Maximum measured error

Pulse output:
- ± 0.5% o.r. ± 1 mm/s (o.r. = of reading)
- Option: ± 0.2% o.r. ± 2 mm/s (o.r. = of reading)

Current output: plus typically ± 5 µA
Supply voltage fluctuations have no effect within the specified range.

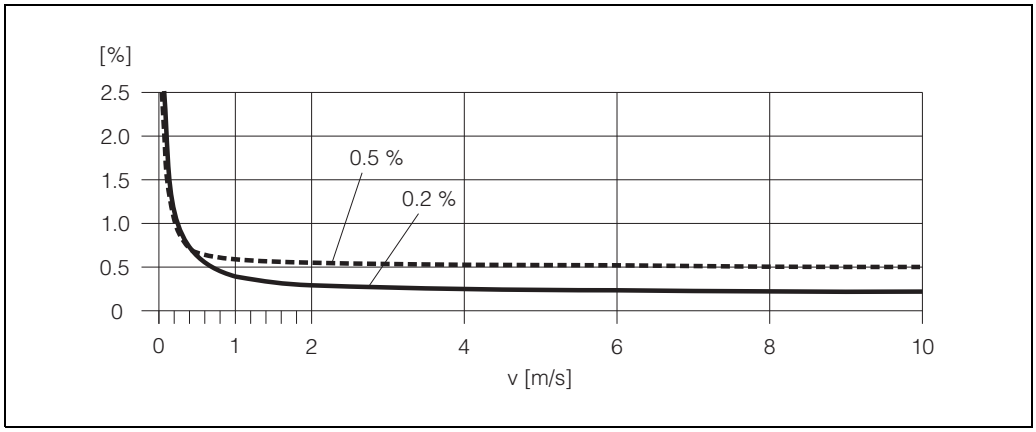

Fig. 50: Max. measured error in % of reading

Repeatability

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

10.1.7 Operating conditions

Installation

Installation instructions

Any orientation (vertical, horizontal)
Restrictions and additional installation instructions → see Page 17 ff.

Inlet and outlet runs

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

Custody transfer mode: see remarks on Page 20

Length of connecting cable

For the remote version the permissible cable length L_{max} depends on the conductivity of the medium → Page 27.
A minimum conductivity of 20 µS/cm is required for measuring demineralized water.

Environment

Ambient temperature

Transmitter:
- Standard: –20...+60 °C (Custody transfer mode)
- Optional: –40...+60 °C (Usual transfer mode)

Note!
At ambient temperatures below –20 °C the readability of the display may be impaired. (not in custody transfer mode)

Sensor:
- Flange material carbon steel: –10...+60 °C
- Flange material stainless steel: –40...+60 °C

Caution!
It is not allowed to use the device beyond the min. and max. lining specified temperature values (→ "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 measuring transmitter and the appropriate measuring sensors.
Degree of protection	■ Standard: IP 67 (NEMA 4X) for transmitter and sensor ■ Optional: IP 68 (NEMA 6P) for remote version of Promag W and P sensor
Shock and vibration resistance	Acceleration up to 2 g by analogy with IEC 60068-2-6 (high-temperature version: no data available)
CIP cleaning	Promag W: not possible Promag P: possible (note max. temperature)
SIP cleaning	Promag W: not possible Promag P: possible with PFA (note max. temperature)
Electromagnetic compatibility (EMC)	To EN 61326/A1 and NAMUR recommendation NE 21.

Process

Medium temperature range	**Certified instruments:** 0...+30 °C (cold water) **Certifiable instruments:** The permissible fluid temperature depends on the lining of the measuring tube: Promag W: 0…+80 °C for hard rubber (DN 65…2000) –20…+50 °C for polyurethane (DN 25…1000) Promag P: –40…+130 °C for PTFE (DN 15…600), for restrictions → refer to diagrams –20…+180 °C for PFA (DN 25…200), for restrictions → refer to diagrams **Promag P** –40…+130 °C for PTFE (DN 15…600), for restrictions → refer to diagrams –20…+180 °C for PFA (DN 25…200), for restrictions → refer to diagrams

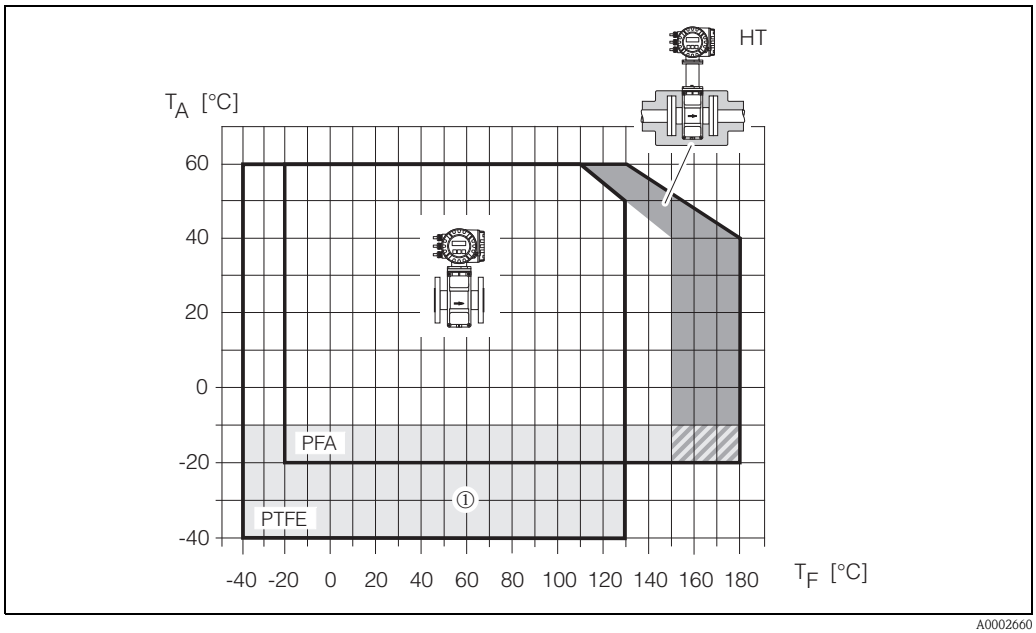

Fig. 51: Compact version Promag P (with PFA or PTFE lining)
T_A = ambient temperature, T_F = fluid temperature, HT = high-temperature version, with insulation
① = Temperature range from –10 °C to –40 °C is valid for stainless steel flanges only

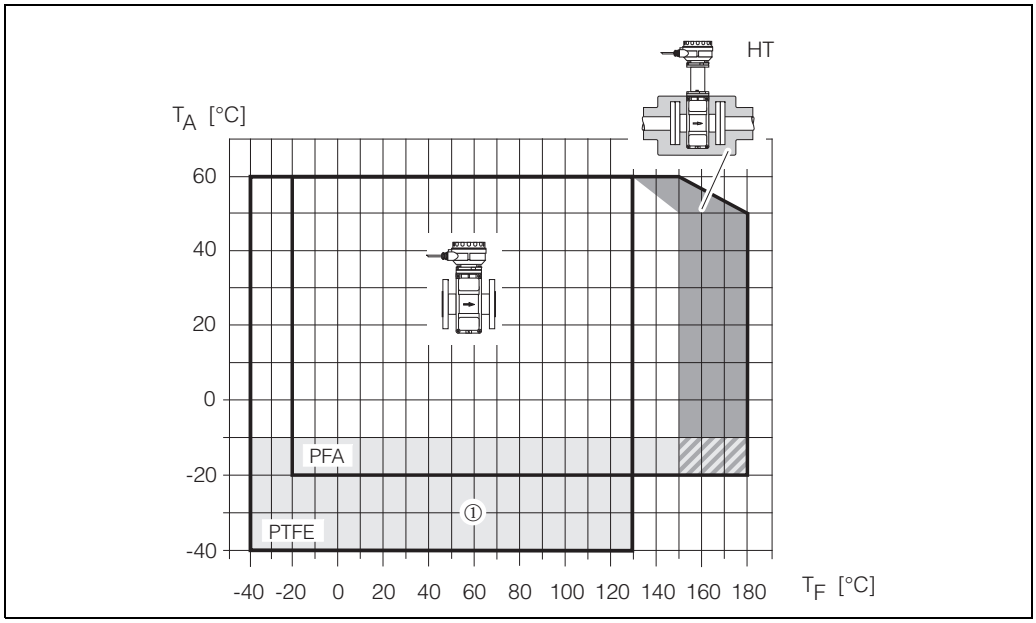

Fig. 52: Remote version Promag P (with PFA or PTFE lining)
T_A = ambient temperature, T_F = fluid temperature, HT = high-temperature version, with insulation
① = Temperature range from –10 °C to –40 °C is valid for stainless steel flanges only

Conductivity

Minimum conductivity:
- ≥ 5 µS/cm for fluids generally
- ≥ 20 µS/cm for demineralised water

Note that in the case of the remote version, the requisite conductivity is also influenced by the length of the connecting cable → Page 27.

Limiting medium pressure range (nominal pressure)

The material load diagrams (pressure-temperature graphs) for the process connections are to be found in the following documents:
- Technical Information “Promag 50/53W” (TI 046D/06/en)
- Technical Information “Promag 50/53P” (TI 047D/06/en)

Promag W:
EN 1092-1 (DIN 2501): PN 6 (DN 1200...2000), PN 10 (DN 200...2000), PN 16 (DN 65...2000), PN 25 (DN 200...1000), PN 40 (DN 25...150)

Promag P:
EN 1092-1 (DIN 2501): PN 10 (DN 200...600), PN 16 (DN 65...600), PN 25 (DN 200...600), PN 40 (DN 15...150)

Pressure tightness (liner)

Promag W Nominal diameter		**Measuring tube lining**	**Resistance of measuring tube lining to partial vacuum** Limit values for abs. pressure [mbar] at various fluid temperatures						
[mm]	[inch]		25 °C	50 °C	80° C	100 °C	130 °C	150 °C	180 °C
25…1000	1…40"	Polyurethane	0	0	–	–	–	–	–
65…2000	3…78"	Hard rubber	0	0	0	–	–	–	–

Promag P Nominal diameter		**Measuring tube lining**	**Resistance of measuring tube lining to partial vacuum** Limit values for abs. pressure [mbar] at various fluid temperatures					
[mm]	[inch]		25 °C	80 °C	100 °C	130 °C	150 °C	180 °C
15	1/2"	PTFE	0	0	0	100	–	–
25	1"	PTFE / PFA	0 / 0	0 / 0	0 / 0	100 / 0	– / 0	– / –
32	–	PTFE / PFA	0 / 0	0 / 0	0 / 0	100 / 0	– / 0	– / –
40	1 1/2"	PTFE / PFA	0 / 0	0 / 0	0 / 0	100 / 0	– / 0	– / –
50	2"	PTFE / PFA	0 / 0	0 / 0	0 / 0	100 / 0	– / 0	– / –
65	–	PTFE / PFA	0 / 0	*	40 / 0	130 / 0	– / 0	– / –
80	3"	PTFE / PFA	0 / 0	*	40 / 0	130 / 0	– / 0	– / –
100	4"	PTFE / PFA	0 / 0	*	135 / 0	170 / 0	– / 0	– / –
125	–	PTFE / PFA	135 / 0	*	240 / 0	385 / 0	– / 0	– / –
150	6"	PTFE / PFA	135 / 0	*	240 / 0	385 / 0	– / 0	– / –
200	8"	PTFE / PFA	200 / 0	*	290 / 0	410 / 0	– / 0	– / –
250	10"	PTFE	330	*	400	530	–	–
300	12"	PTFE	400	*	500	630	–	–
350	14"	PTFE	470	*	600	730	–	–
400	16"	PTFE	540	*	670	800	–	–
450	18"	PTFE	Partial vacuum is impermissible					
500	20"	PTFE						
600	24"	PTFE						
* No value can be quoted.								

Limiting flow

see Page 24

Pressure loss

- No pressure loss if the sensor is installed in a pipe of the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 → Page 22

10.1.8 Mechanical construction

Design / dimensions

All the dimensions and lengths of the sensor and transmitter are provided in the separate documentation “Technical Information”.

Weight

Weight data of Promag W in kg

Nominal diameter		Compact version		Remote version (without cable)		
				Sensor		Wall housing
[mm]	[inch]	EN (DIN)		EN (DIN)		
25	1"	PN 40	7.3	PN 40	5.3	6.0
32	1 1/4"		8.0		6.0	6.0
40	1 1/2"		9.4		7.4	6.0
50	2"		10.6		8.6	6.0
65	2 1/2"	PN 16	12.0	PN 16	10.0	6.0
80	3"		14.0		12.0	6.0
100	4"		16.0		14.0	6.0
125	5"		21.5		19.5	6.0
150	6"		25.5		23.5	6.0
200	8"	PN 10	45	PN 10	43	6.0
250	10"		65		63	6.0
300	12"		70		68	6.0
350	14"		115		113	6.0
400	16"		135		133	6.0
450	18"		175		173	6.0
500	20"		175		173	6.0
600	24"		235		233	6.0
700	28"		355		353	6.0
–	30"		–		–	6.0
800	32"		435		433	6.0
900	36"		575		573	6.0
1000	40"		700		698	6.0
–	42"	PN 6	–	PN 6	–	6.0
1200	48"		850		848	6.0
–	54"		–		–	6.0
1400	–		1300		1298	6.0
–	60"		–		–	6.0
1600	–		1700		1698	6.0
–	66"		–		–	6.0
1800	72"		2200		2198	6.0
–	78"		–		–	6.0
2000	–		2800		2798	6.0

Transmitter Promag (compact version): 3.4 kg
(Weight data valid for standard pressure ratings and without packaging material)

Weight data of Promag P in kg

Nominal diameter		Compact version		Remote version (without cable)		
				Sensor		Wall housing
[mm]	[inch]	EN (DIN)		EN (DIN)		
15	1/2"	PN 40	6.5	PN 40	4.5	6.0
25	1"		7.3		5.3	6.0
32	1 1/4"		8.0		6.0	6.0
40	1 1/2"		9.4		7.4	6.0
50	2"		10.6		8.6	6.0
65	2 1/2"	PN 16	12.0	PN 16	10.0	6.0
80	3"		14.0		12.0	6.0
100	4"		16.0		14.0	6.0
125	5"		21.5		19.5	6.0
150	6"		25.5		23.5	6.0
200	8"	PN 10	45	PN 10	43	6.0
250	10"		65		63	6.0
300	12"		70		68	6.0
350	14"		115		113	6.0
400	16"		135		133	6.0
450	18"		175		173	6.0
500	20"		175		173	6.0
600	24"		235		233	6.0

Transmitter Promag (compact version): 3.4 kg
(Weight data valid for standard pressure ratings and without packaging material)

Materials

Promag W

Transmitter housing:
- Compact housing: powder coated die-cast aluminium
- Wall-mounted housing: powder coated die-cast aluminium

Sensor housing:
- DN 25…300: powder-coated die-cast aluminium
- DN 350…2000: painted steel (Amerlock 400)

Measuring tube:
- DN < 350: stainless steel 1.4301 or 1.4306/304L;
  non-stainless flange material with Al/Zn protective coating
- DN > 300: stainless steel 1.4301/304;
  non-stainless flange material with Amerlock 400 paint

Flange:
- EN 1092-1 (DIN 2501): 316L / 1.4571; RSt37-2 (S235JRG2) / C22 / FE 410W B
  (DN < 350: with Al/Zn protective coating; DN > 300 with Amerlock 400 paint)

Ground disks: 1.4435/316L or Alloy C-22
Electrodes: 1.4435 or Alloy C-22, tantalum
Seals: Seals to DIN 1514-1

Promag P

Transmitter housing:
- Compact housing: powder coated die-cast aluminium or stainless steel field housing
- Wall-mounted housing: powder coated die-cast aluminium

Sensor housing:
- DN 15…300: powder-coated die-cast aluminium
- DN 350…600: painted steel (Amerlock 400)

Measuring tube:
- DN < 350: stainless steel 1.4301 or 1.4306/304L;
  non-stainless flange material with
  Al/Zn protective coating
- DN > 300: stainless steel 1.4301/304;
  non-stainless flange material with Amerlock 400 paint

Flange:
- EN 1092-1 (DIN 2501): Stainless steel 1.4571, ST37 / FE 410W B
  (DN < 350 with Al/Zn protective coating, DN > 300 with Amerlock 400 paint)

Ground disks: 1.4435/316L or Alloy C-22
Electrodes: 1.4435, platinum/rhodium 80/20 or Alloy C-22, tantalum
Seals: Seals to DIN EN 1514-1

Material load diagram	The material load diagrams (pressure temperature graphs) for the process connections are to be found in the following documents: ■ Technical Information “Promag 50/53 W” (TI 046D/06/en) ■ Technical Information “Promag 50/53 P” (TI 047D/06/en)
Fitted electrodes	Promag W: Measuring, reference and EPD electrodes ■ Standard available with 1.4435, Alloy C-22, tantalum ■ Optional: exchangeable measuring electrodes made of 1.4435 (DN 350…2000) Promag P: Measuring, reference and EPD electrodes as standard with ■ 1.4435, Alloy C-22, tantalum, platinum/rhodium 80/20
Process connections	Promag W: Flange connection: EN 1092-1 compliant (dimensions to DIN 2501; DN 65 PN 16 and DN 600 PN 16 exclusively to EN 1092-1) Promag P: Flange connection: EN 1092-1 compliant (dimensions to DIN 2501; DN 65 PN 16 and DN 600 PN 16 exclusively to EN 1092-1)
Surface roughness	■ PFA liner: ≤ 0.4 µm ■ Electrodes: – 1.4435, Alloy C-22: 0.3...0.5 µm – Tantalum, platinum/rhodium: 0.3...0.5 µm (all data relate to parts in contact with medium)

10.1.9 Human interface

Display elements	■ Liquid crystal display: illuminated, two lines with 16 characters per line ■ Custom configurations for presenting different measured values and status variables ■ 2 totalizers ■ At ambient temperatures below –20 °C the readability of the display may be impaired (not in custody transfer mode)
Operating elements	■ Local operation with three push buttons (–, +, E) ■ “Quick Setup” menus for straightforward commissioning
Language group	Language groups for operation in different countries: ■ Western Europe and America: English, German, Spanish, Italian, French, Dutch and Portuguese ■ Northern/eastern Europe: English, Russian, Polish, Norwegian, Finnish, Swedish and Czech ■ Southern/eastern Asia: English, Japanese and Indonesian You can change the language group via the operating program “ToF Tool - Fieldtool Package.”
Remote operation	Operation via HART protocol

10.1.10 Certificates and approvals

Ex Approvals

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

Custody transfer

PTB approval for custody transfer with cold water

PTB

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

Innerstaatliche Bauartzulassung

Type-approval certificate under German law

Zulassungsinhaber:
Issued to:
Endress + Hauser Flowtec AG
Kägenstrasse 7
4153 Reinach BL 1
Schweiz

Rechtsbezug:
In accordance with:
§ 13 des Gesetzes über das Mess- und Eichwesen (Eichgesetz) vom 23. März 1992 (BGBl. I S. 711)

Bauart:
In respect of:
MID für Kaltwasser
Promag 51 P/W

Zulassungszeichen:
Approval mark:
6.221
02.20

Gültig bis:
Valid until:
unbefristet

Anzahl der Seiten:
Number of pages:
11

Geschäftszeichen:
Reference No.:
1.32 – 02000088

Im Auftrag
By order

Dipl.-Ing. Thomas Brennecke

Braunschweig, 2002-03-27

Siegel
Seal

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 53

394 00 c-rb

Merkmale zur Bauart sowie ggf. inhaltliche Beschränkungen, Auflagen und Bedingungen sind in der Anlage festgelegt, die Bestandteil der innerstaatlichen Bauartzulassung ist. Hinweise und eine Rechtsbehelfsbelehrung befinden sich auf der ersten Seite der Anlage.

Characteristics of the instrument type approved, restrictions as to the contents, special conditions and approval conditions, if any, are set out in the Annex which forms an integral part of the type-approval certificate under German law. For notes and information on legal remedies, see first page of the Annex.

Sanitary compatibility	Drinking water suitability, WRAS - Approved Product, KTW (for hard rubber)
Pressure Equipment Directive	Measuring devices with a nominal diameter smaller than or equal to DN 25 correspond to Article 3(3) of the EC Directive 97/23/EC (Pressure Equipment Directive) and have been designed and manufactured according to good engineering practice. Where necessary (depending on the medium and process pressure), there are additional optional approvals to Category II/III for larger nominal diameters.
CE mark	The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
Other standards and guidelines	EN 60529 Degrees of protection by housing (IP code) EN 61010 Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures EN 61326/A1 (IEC 6326) Electromagnetic compatibility (EMC requirements) NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment. NAMUR NE 43 Standardisation of the signal level for the breakdown information of digital transmitters with analogue output signal. NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics. Regulations for custody transfer: – Allgemeine Vorschriften (AV) zur Eichordnung (EO) – Anlage 6 zur Eichordnung (EO 6-1): Vorschriften für Volumen-Messgeräte für strömendes Wasser – PTB-A6.1: Volumen-Messgeräte für Kaltwasser

10.1.11 Ordering information

The Endress+Hauser service organisation can provide detailed ordering information and information on specific order codes on request.

The following values are to be stated when ordering an instrument with “Custody transfer approval”:
- Nominal flow rate Q_n → Page 23, 74
- Metrological Class → Page 23, 74
- If a certified pulse output is required for the custody transfer mode: Pulse value, pulse width, output signal type (passive-positive, passive-negative)

The flowmeter is delivered with appropriate factory settings if no information is given on the full scale value for current output, the current range (0/4...20 mA), pulse value, display mode or totalizer units!

10.1.12 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor (see Page 81). The Endress+Hauser service organisation can provide detailed information on request.

10.1.13 Supplementary documentation

- System Information Promag (SI 028D/06/en)
- Technical Information Promag 51 W/P (TI 058D/06/en)
- Technical Information Promag 50/53 W (TI 046D/06/en)
- Technical Information Promag 50/53 P (TI 047D/06/en)
- Description of Device Functions Promag 51 (BA 081D/06/en)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA, etc.

11 Index

Declaration of Contamination
Erklärung zur Kontamination

Endress+Hauser
People for Process Automation

Because of legal regulations and for the safety of our employees and operating equipment, we need the "declaration of contamination", with your signature, before your order can be handled. Please make absolutely sure to include it with the shipping documents, or – even better – attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination", bevor Ihr Auftrag bearbeitet werden kann. Legen Sie diese unbedingt den Versandpapieren bei oder bringen Sie sie idealerweise außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

Process data/ *Prozessdaten*
Temperature / *Temperatur* _____ [°C] Pressure / *Druck* _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [S] Viscosity / *Viskosität* _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

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

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

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

Reason for return / *Grund zur Rücksendung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____
_____
Address / *Adresse*
_____
_____

Contact person / *Ansprechpartner* _____
Department / *Abteilung* _____
Phone number/ *Telefon* _____
Fax / E-Mail _____
Your order No. / *Ihre Auftragsnr.* _____

We hereby certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free from any residues in dangerous quantities.
Hiermit bestätigen wir, dass die zurückgesandten Teile sorgfältig gereinigt wurden, und nach unserem Wissen frei von Rückständen in gefahrbringender Menge sind.

_____ _____
(place, date / *Ort, Datum*) (Company stamp and legally binding signature)
(Firmenstempel und rechtsverbindliche Unterschrift)

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA080D/06/en/03.05
50101924
FM+SGML6.0