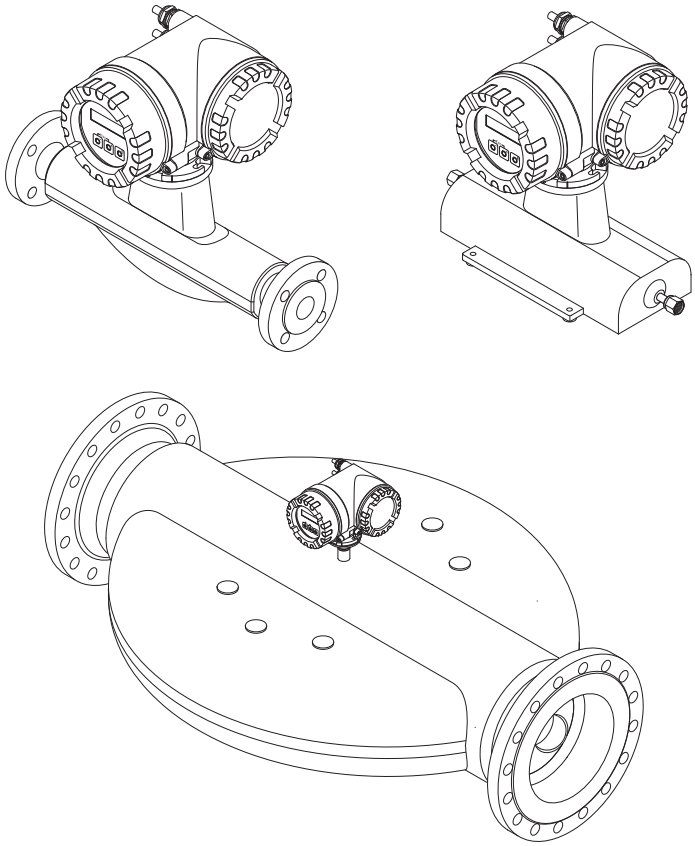
Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Operating Instructions

Proline Promass 84 Modbus RS485

Coriolis Mass Flow Measuring System for Custody Transfer



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

Endress+Hauser

People for Process Automation

Table of contents

1 Safety instructions

1.1 Designated use

The measuring device described in these Operating Instructions is to be used only for measuring the mass flow rate of liquids and gases. At the same time, the system also measures fluid density and fluid temperature. These parameters are then used to calculate other variables such as volume flow. Fluids with widely differing properties can be measured.

Examples:
- Oils, fats
- Acids, alkalis, lacquers, paints, solvents and cleaning agents
- Pharmaceuticals, catalysts, inhibitors
- Suspensions
- Gases, liquefied gases, etc.
- Chocolate, condensed milk, liquid sugar

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

1.2 Installation, commissioning and operation

Note the following points:
- Installation, connection to the electricity supply, commissioning and maintenance of the measuring instrument 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 they contain.
- The device must be operated by persons authorized and trained by the facility's owner-operator. Strict compliance with the instructions in the Operating Instructions is mandatory.
- Endress+Hauser will be happy to assist in clarifying the corrosion resistance properties of materials wetted by special fluids, including fluids used for cleaning. However, small changes of temperature, concentration or degree of contamination in the process can result in differences in corrosion resistance. Therefore, Endress+Hauser provides no warranty and assumes no liability with regard to corrosion resistance of fluid wetted materials in an application. The user is responsible for choosing suitable fluid wetted materials in the process.
- If carrying out welding work on the piping, the welding unit may not be grounded by means of the measuring device.
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams. The transmitter must be earthed unless special protection measures have been taken e.g. galvanically isolated power supply SELV or PELV (SELV = Save Extra Low Voltage; PELV = Protective Extra Low Voltage).
- 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 supplementary Ex documentation indicates the approval and the certification body (e.g ⟨Ex⟩ Europe, ⟨FM⟩ USA, ⟨SP⟩ Canada).
- The measuring device complies with the general safety requirements in accordance with EN 61010-1 , the EMC requirements of IEC/EN 61326, and NAMUR recommendations NE 21, NE 43 and NE 53.
- For measuring systems used in SIL 2 applications, the separate Manual on functional safety, must be observed.
- External surface temperature of the transmitter can increase by 10 K due to power consumption of internal electronical components. Hot process fluids passing through the measuring device will further increase the surface temperature of the measuring device. Especially the surface of the sensor can reach temperatures which are close to process temperature. Additionally safety precautions are required when increased process temperatures are present.
- The separate document on the Pressure Equipment Directive must be observed for devices used in Category II, III or IV installations in accordance with the Pressure Equipment Directive.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser representative will supply you with current information and updates to these Operating Instructions.

1.4 Return

- 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.
- Please note the measures on → 98

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 measuring instruments comply with the applicable standards and regulations in accordance with EN 61010-1, "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures". 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 measuring instrument. 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 measuring instrument.

2 Identification

The following options are available for identification of the measuring device:
- Nameplate specifications
- Order code with breakdown of the device features on the delivery note
- Enter serial numbers from nameplates in *W@M Device Viewer* (www.endress.com/deviceviewer): All information about the measuring device is displayed.

For an overview of the scope of the Technical Documentation provided, refer to the following:
- The chapters "Supplementary documentation" → 128
- Der *W@M Device Viewer*: Enter the serial number from the nameplate (www.endress.com/deviceviewer)

Reorder
The measuring device is reordered using the order code.

Extended order code:
- The device type (product root) and basic specifications (mandatory features) are always listed.
- Of the optional specifications (optional features), only the safety and approval-related specifications are listed (e.g. LA). If other optional specifications are also ordered, these are indicated collectively using the # placeholder symbol (e.g. #LA#).
- If the ordered optional specifications do not include any safety and approval-related specifications, they are indicated by the + placeholder symbol (e.g. 83F50-AACCCAAD2S1+).

2.1 Device designation

The "Promass 84" flow measuring system consists of the following components:
- Promass 84 transmitter
- Promass F, Promass A, Promass O or Promass X sensor

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

2.1.1 Nameplate of the transmitter

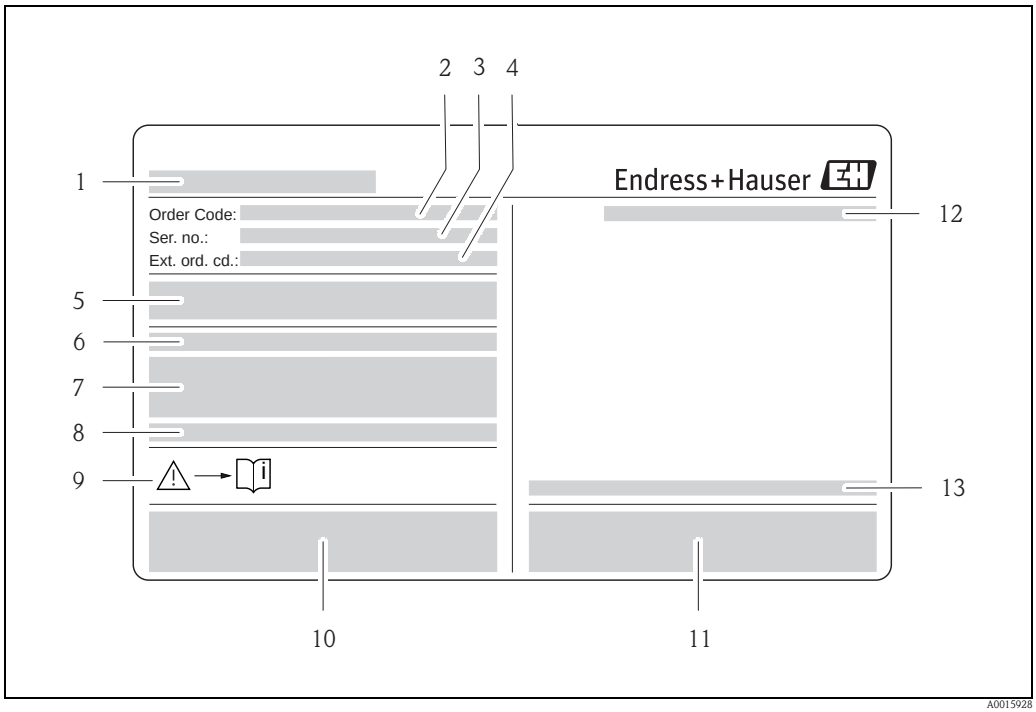

Fig. 1: Example of a transmitter nameplate

1 Name of the transmitter
2 Order code
3 Serial number (Ser. no.)
4 Extended order code (Ext. ord. cd.)
5 Power supply, frequency and power consumption
6 Additional function and software
7 Available inputs / outputs
8 Reserved for information on special products
9 Please refer to operating instructions / documentation
10 Reserved for certificates, approvals and for additional information on device version
11 Patents
12 Degree of protection
13 Ambient temperature range

2.1.2 Nameplate of the sensor

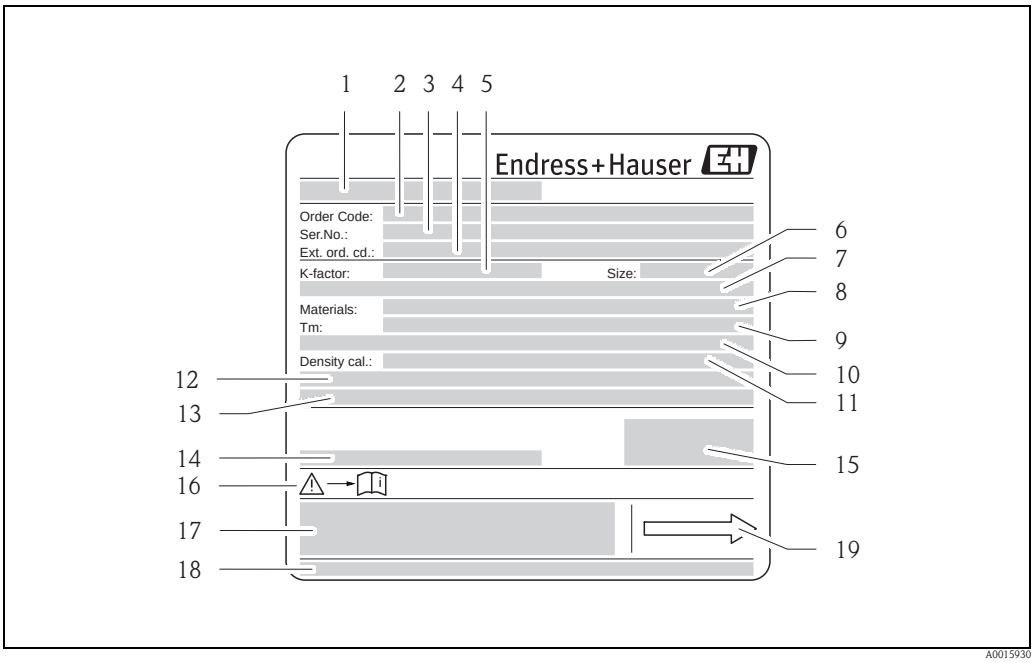

Fig. 2: Example of a sensor nameplate

1 Name of the sensor
2 Order code
3 Serial number (Ser. no.)
4 Extended order code (Ext. ord. cd.)
5 Calibration factor with zero point (K-factor)
6 Nominal diameter device (Size)
7 Flange nominal diameter/Nominal pressure
8 Material of measuring tubes (Materials)
9 Max. fluid temperature (Tm)
10 Pressure range of secondary containment
11 Accuracy of density measurement (Density cal.)
12 Additional information
13 Reserved for information on special products
14 Ambient temperature range
15 Degree of protection
16 Please refer to operating instructions / documentation
17 Reserved for additional information on device version (approvals, certificates)
18 Patents
19 Flow direction

2.1.3 Additional nameplate for suitability for custody transfer measurement

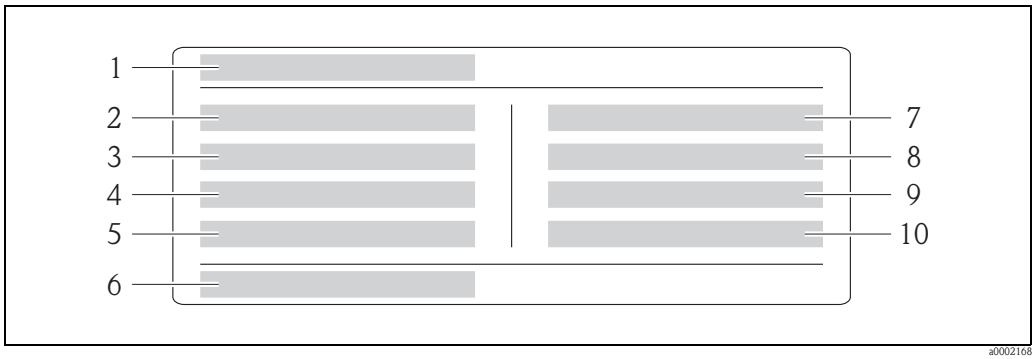

Fig. 3: Nameplate specifications for the suitability of "Promass 84" for custody transfer measurement (example)

1 Name of the device
2 Environmental class
3 Accuracy class
4 Minimum/Maximum measured quantity for liquids
5 Minimum/Maximum measured quantity for gases
6 Symbol for custody transfer consisting of the number and issue date
7 Gas temperature
8 Ambient temperature
9 Gas type
10 Pulse value

2.1.4 Nameplate for connections

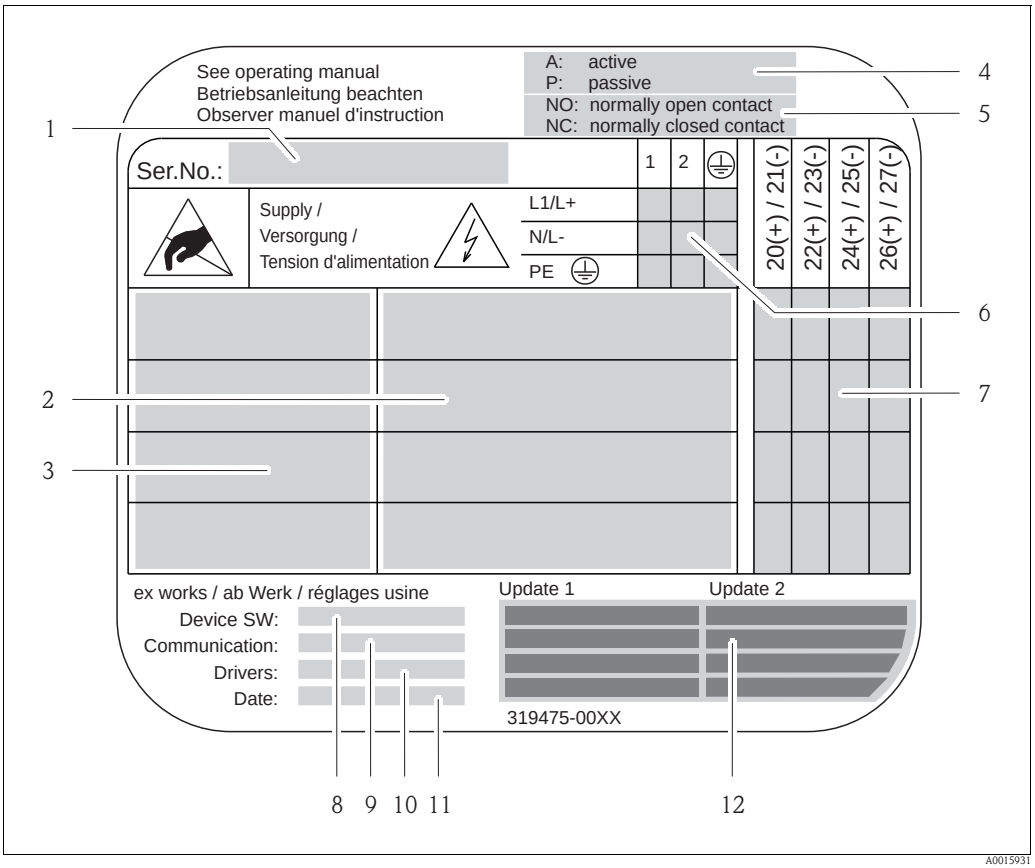

Fig. 4: Example of a connection nameplate

1 Serial number (Ser. no.)
2 Possible inputs and outputs
3 Signals present at inputs and outputs
4 Possible configuration of current output
5 Possible configuration of relay contacts
6 Terminal assignment, cable for power supply
7 Terminal assignment and configuration (see point 4 and 5) of inputs and outputs
8 Version of device software currently installed (Device SW)
9 Installed communication type (Communication)
10 Information on current communication software (Drivers: Device Revision and Device Description),
11 Date of installation (Date)
12 Current updates to data specified in points 8 to 11 (Update1, Update 2)

2.2 Certificates and approvals

The devices are designed in accordance with good engineering practice 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 measuring instruments comply with the applicable standards and regulations in accordance with EN 61010 -1, "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures" and with the EMC requirements of IEC/EN 61326.
The measuring system described in these Operating Instructions thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA).

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

2.3 Registered trademarks

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

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

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Registered trademark of the SCHNEIDER AUTOMATION, INC.

HistoROM™, S-DAT®, T-DAT™, FieldCare®, Fieldcheck®, Applicator®
Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

3 Installation

3.1 Incoming acceptance, transport and storage

3.1.1 Incoming acceptance

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

3.1.2 Transport

The following instructions apply to unpacking and to transporting the device to its final location:
- Transport the devices in the containers in which they are delivered.
- The covers or caps fitted to the process connections prevent mechanical damage to the sealing faces and the ingress of foreign matter to the measuring tube during transportation and storage. Consequently, do not remove these covers or caps until immediately before installation.
- Do not lift measuring devices of nominal diameters > DN 40 (> 1 ½") by the transmitter housing or the connection housing in the case of the remote version (→ 5). Use webbing slings slung round the two process connections. Do not use chains, as they could damage the housing.
- Promass X and Promass O sensor: see special instructions for transporting → 14.

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.

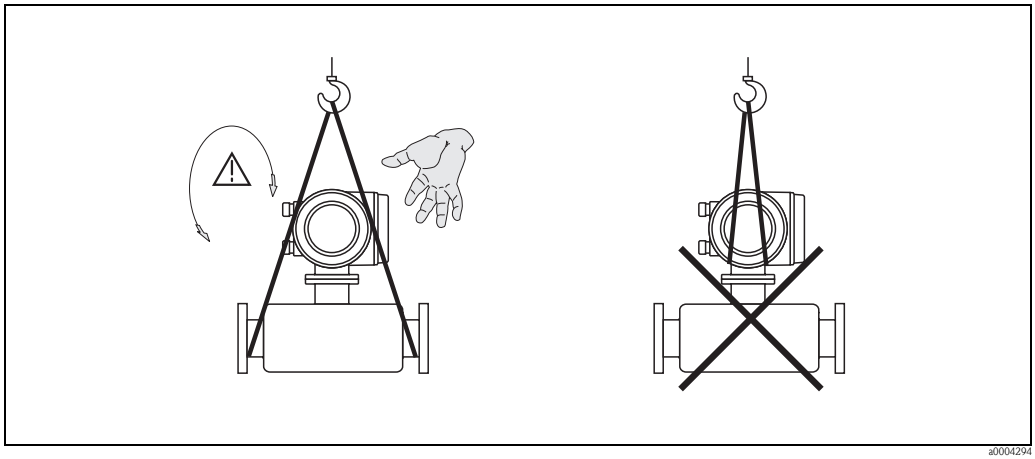


Fig. 5: Instructions for transporting sensors with > DN 40 (> 1 ½")

3.1.3 Special instructions for transporting Promass X and O

Warning!
- For transporting use only the lifting eyes on the flanges to lift the assembly.
- The assembly must always be attached to at least two lifting eyes.

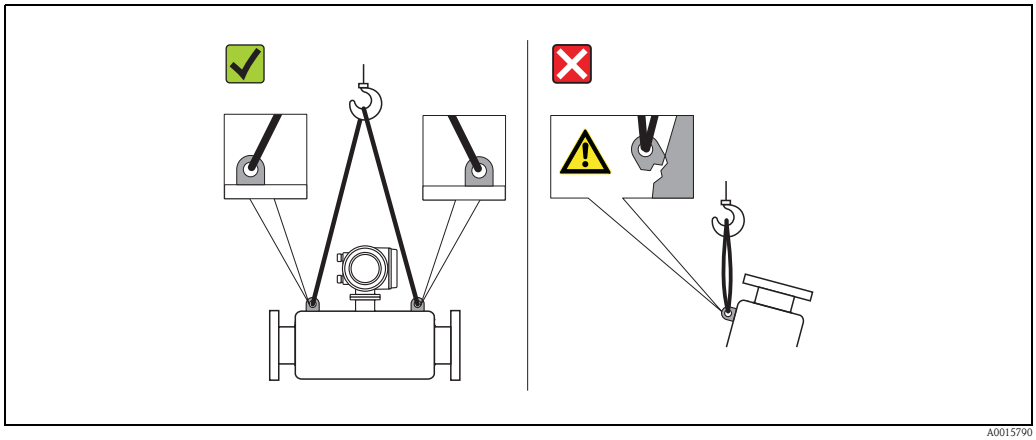


Fig. 6: Instructions for transporting Promass O

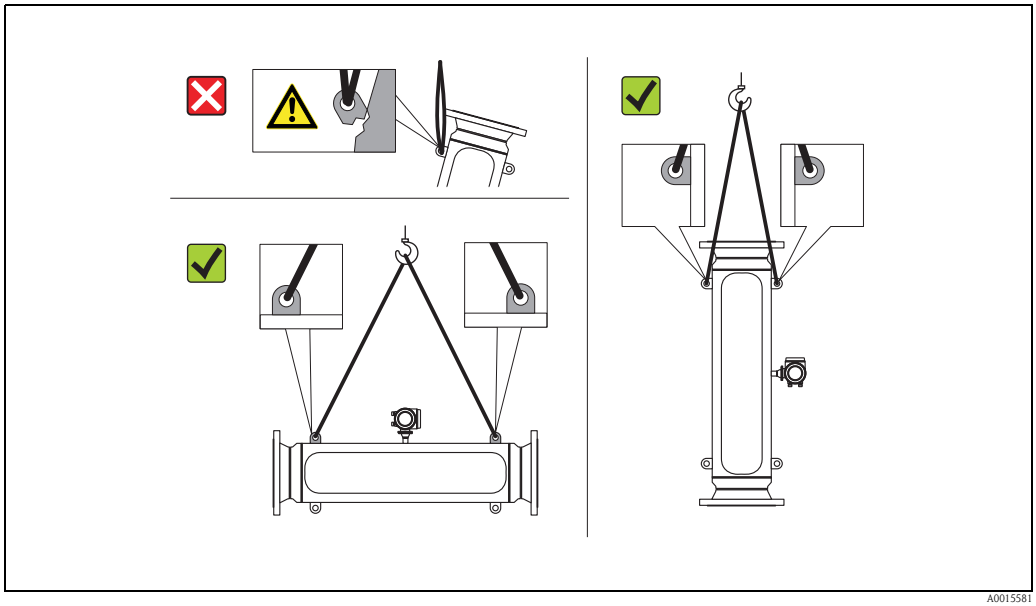


Fig. 7: Instructions for transporting Promass X

3.1.4 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 permitted storage temperature is range is –40 to +80 °C (–40 to +176 °F), preferably +20 °C (+68 °F).
- Do not remove the protective covers or caps on the process connections until you are ready to install the device.
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.

3.2 Installation conditions

Note the following points:
- No special measures such as supports are necessary. External forces are absorbed by the construction of the instrument, for example the secondary containment.
- The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by pipe vibrations.
- No special precautions need to be taken for fittings which create turbulence (valves, elbows, T-pieces, etc.), as long as no cavitation occurs.
- For mechanical reasons and in order to protect the pipe, it is advisable to support heavy sensors.

3.2.1 Dimensions

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

3.2.2 Mounting location

Entrained gas bubbles in the measuring tube can result in an increase in measuring errors.
Avoid the following locations:
- Highest point of a pipeline. Risk of air accumulating.
- Directly upstream of a free pipe outlet in a vertical pipeline.

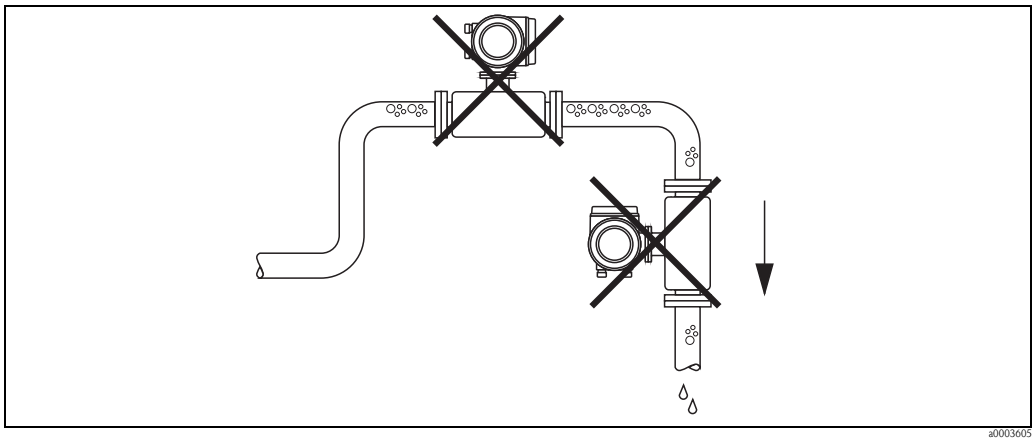


Fig. 8: Mounting location

Installation in a vertical pipe

The proposed configuration in the following diagram, however, permits installation in a vertical pipeline. Pipe restrictors or the use of an orifice plate with a smaller cross-section than the nominal diameter prevent the sensor from running empty during measurement.

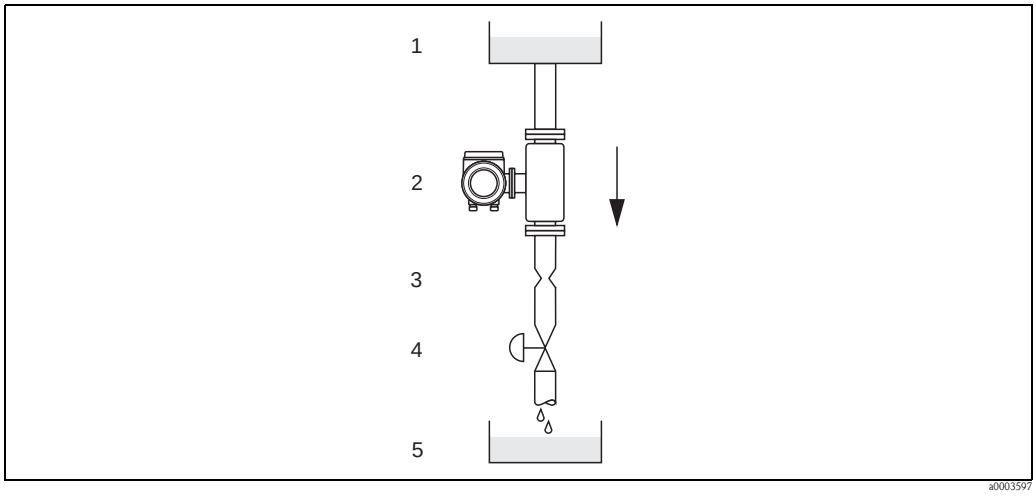


Fig. 9: Installation in a vertical pipe (e.g. for batching applications)

1 = Supply tank, 2 = Sensor, 3 = Orifice plate, pipe restrictions (see Table), 4 = Valve, 5 = Batching tank

DN		Ø Orifice plate, pipe restrictor	
		mm	inch
2	1/12"	1.5	0.06
4	1/8"	3.0	0.12
8	3/8"	6	0.24
15	1/2"	10	0.40
25	1"	14	0.55
40	1 ½"	22	0.87

DN		Ø Orifice plate, pipe restrictor	
		mm	inch
50	2"	28	1.10
80	3"	50	2.00
100	4"	65	2.60
150	6"	90	3.54
250	10"	150	5.91
350	14"	210	8.27

System pressure

It is important to ensure that cavitation does not occur, because it would influence the oscillation of the measuring tube. No special measures need to be taken for fluids which have properties similar to water under normal conditions.
In the case of liquids with a low boiling point (hydrocarbons, solvents, liquefied gases) or in suction lines, it is important to ensure that pressure does not drop below the vapor pressure and that the liquid does not start to boil. It is also important to ensure that the gases that occur naturally in many liquids do not outgas. Such effects can be prevented when system pressure is sufficiently high.

Consequently, it is generally best to install the sensor:
- downstream from pumps (no danger of vacuum),
- at the lowest point in a vertical pipe.

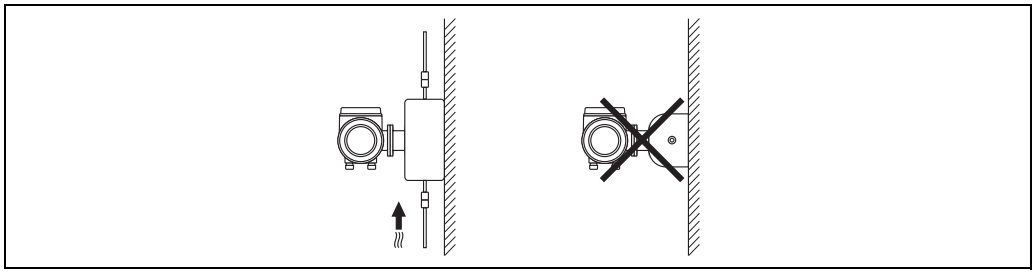
3.2.3 Orientation

Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow direction in which the fluid flows through the pipe.

Orientation Promass A

Vertical
Recommended orientation with direction of flow upwards. When fluid is not flowing, entrained solids will sink down and gases will rise away from the measuring tube. The measuring tubes can be completely drained and protected against solids build-up.

Horizontal
When installation is correct the transmitter housing is above or below the pipe. This means that no gas bubbles or solids deposits can form in the bent measuring tube (single-tube system).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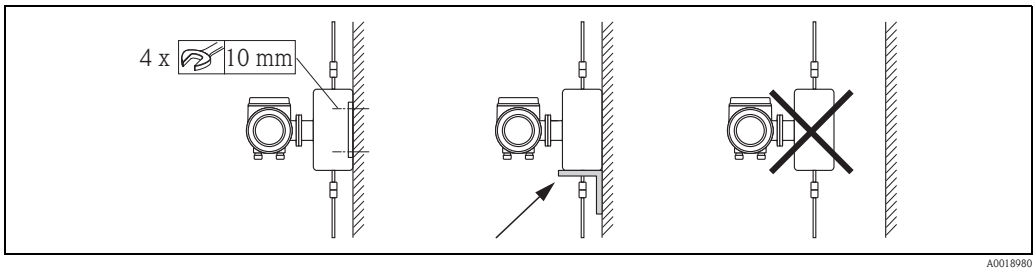
Special installation instructions for Promass A

Caution!
Risk of measuring pipe fracture if sensor installed incorrectly!
The sensor may not be installed in a pipe as a freely suspended sensor:
- Using the base plate, mount the sensor directly on the floor, the wall or the ceiling.
- Support the sensor on a firmly mounted support base (e.g. angle bracket).

Vertical
We recommend two installation versions when mounting vertically:
- Mounted directly on a wall using the base plate
- Measuring device supported on an angle bracket mounted on the wall



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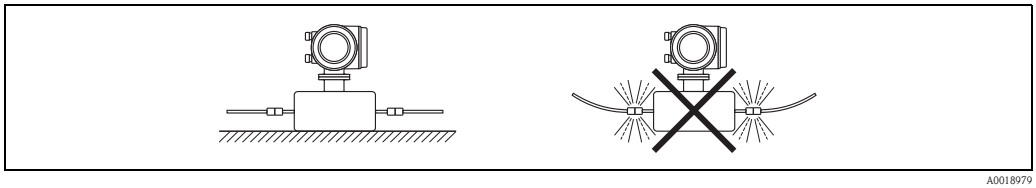
Horizontal
We recommend the following installation version when mounting horizontally:
- Measuring device standing on a firm support base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Orientation Promass F, O, X

Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow (direction in which the fluid flows through the pipe).

Vertical:

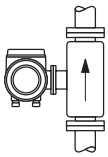
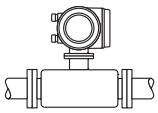
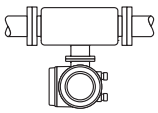
Recommended orientation with upward direction of flow (Fig. V). When fluid is not flowing, entrained solids will sink down and gases will rise away from the measuring tube. The measuring tubes can be completely drained and protected against solids buildup.

Horizontal (Promass F, O):

The measuring tubes of Promass F and O must be horizontal and beside each other. When installation is correct the transmitter housing is above or below the pipe (Fig. H1/H2). Always avoid having the transmitter housing in the same horizontal plane as the pipe.

Horizontal (Promass X):

Promass X can be installed in any orientation in a horizontal pipe run.

	Promass F, O Standard, compact	Promass F High-temperature, compact	Promass F High-temperature, remote	Promass X
Abb. V: Vertical orientation  a0004572	✔✔	✔✔	✔✔	✔✔
Abb. H1: Horizontal orientation Transmitter head up  a0004576	✔✔	✘ TM > 200 °C (392 °F)	✔ TM > 200 °C (392 °F)	✔✔
Abb. H2: Horizontal orientation Transmitter head down  a0004580	✔✔	✔✔	✔✔	✔✔
Abb. H3: Horizontal orientation Transmitter head to the side  A0015445	✘	✘	✘	✔ ①

✔✔ = Recommended orientation; ✔ = Orientation recommended in certain situations; ✘ = Impermissible orientation

① The measuring tubes are curved. Therefore the unit is installed horizontally, adapt the sensor position to the fluid properties:
- Suitable to a limited extent for fluids with entrained solids. Risk of solids accumulating
- Suitable to a limited extent for outgassing fluids. Risk of air accumulating

In order to ensure that the permissible ambient temperature range for the transmitter (→ 116) is not exceeded, we recommend the following orientations:

- For fluids with very high temperatures we recommend the horizontal orientation with the transmitter head pointing downwards (Fig. H2) or the vertical orientation (Fig. V).
- For fluids with very low temperatures, we recommend the horizontal orientation with the transmitter head pointing upwards (Fig. H1) or the vertical orientation (Fig. V).

Special installation instructions for Promass F and O

Caution!
If the measuring tube is curved and the unit is installed horizontally, adapt the sensor position to the fluid properties.

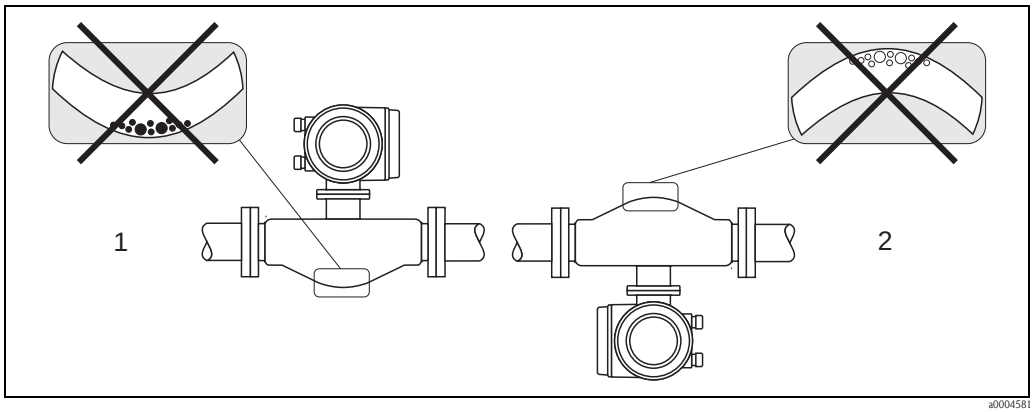


Fig. 10: Promass F, installed horizontally

1 Not suitable for fluids with entrained solids. Risk of solids accumulating.
2 Not suitable for outgassing fluids. Risk of air accumulating.

3.2.4 Heating

Some fluids require suitable measures to avoid loss of heat at the sensor. Heating can be electric, e.g. with heated elements, or by means of hot water or steam pipes made of copper or heating jackets.

Caution!
- Risk of electronics overheating! Make sure that the maximum permissible ambient temperature for the transmitter is not exceeded. Consequently, make sure that the adapter between sensor and transmitter and the connection housing of the remote version always remain free of insulating material. Note that a certain orientation might be required depending on the fluid temperature → 17.
- With a fluid temperature between +200 °C to +350 °C (+392 to +662 °F) the remote version of the high-temperature version is preferable.
- When using electrical heat tracing whose heat is regulated using phase control or by pulse packs, it cannot be ruled out that the measured values are influenced by magnetic fields which may occur, (i.e. at values greater than those permitted by the EC standard (Sinus 30 A/m)). In such cases, the sensor must be magnetically shielded.
  The secondary containment can be shielded with tin plates or electric sheets without privileged direction (e.g. V330-35A) with the following properties:
  – Relative magnetic permeability $\mu_r \geq 300$
  – Plate thickness $d \geq 0.35$ mm (≥ 0.014")
- Information on permissible temperature ranges → 117
- Promass X: Especially under critical climatic conditions it has to be ensured that the temperature difference between environment and measured medium does not exceed 100 K. Suitable measures, such as heating or thermal insulation, are to be taken.

Special heating jackets which can be ordered as accessories from Endress+Hauser are available for the sensors.

3.2.5 Thermal insulation

Some fluids require suitable measures to avoid loss of heat at the sensor. A wide range of materials can be used to provide the required thermal insulation.

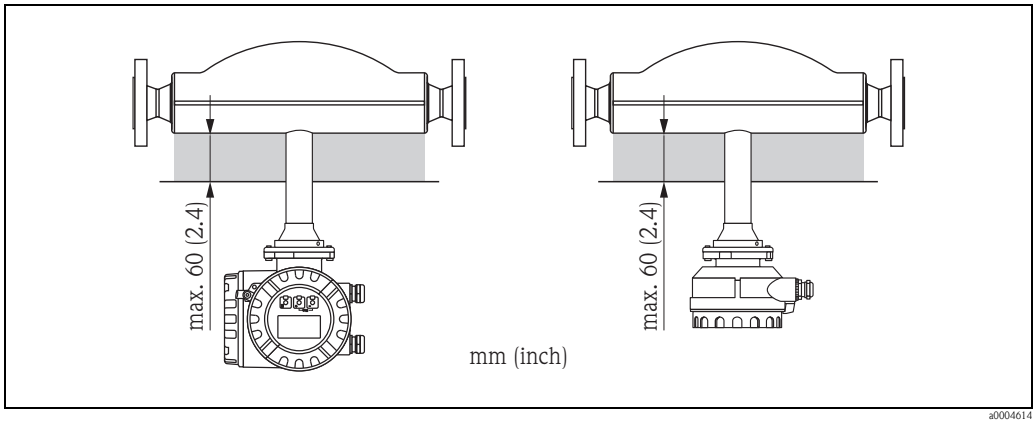


Fig. 11: In the case of the Promass F high-temperature version, a maximum insulation thickness of 60 mm (2.4") must be observed in the area of the electronics/neck.

If the Promass F high-temperature version is installed horizontally (with transmitter head pointing upwards), an insulation thickness of min. 10 mm (0.4") is recommended to reduce convection. The maximum insulation thickness of 60 mm (2.4") must be observed.

3.2.6 Inlet and outlet runs

There are no installation requirements regarding inlet and outlet runs. If possible, install the sensor well clear of fittings such as valves, T-pieces, elbows, etc.

3.2.7 Vibrations

The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by pipe vibrations. Consequently, the sensors require no special measures for attachment.

3.2.8 Limiting flow

For information on the limiting flows, refer to the technical data under the keyword "Measuring range in non-custody transfer mode" → 99, "Measuring range in custody transfer mode" → 101 or "Limiting flow" → 117.

3.3 Installation instructions

3.3.1 Turning the transmitter housing

Turning the aluminum field housing

⚠ Warning!
The turning mechanism in devices with Ex 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 × 90° in either direction).
5. Lower the housing into position and reengage the bayonet catch.
6. Retighten the two securing screws.

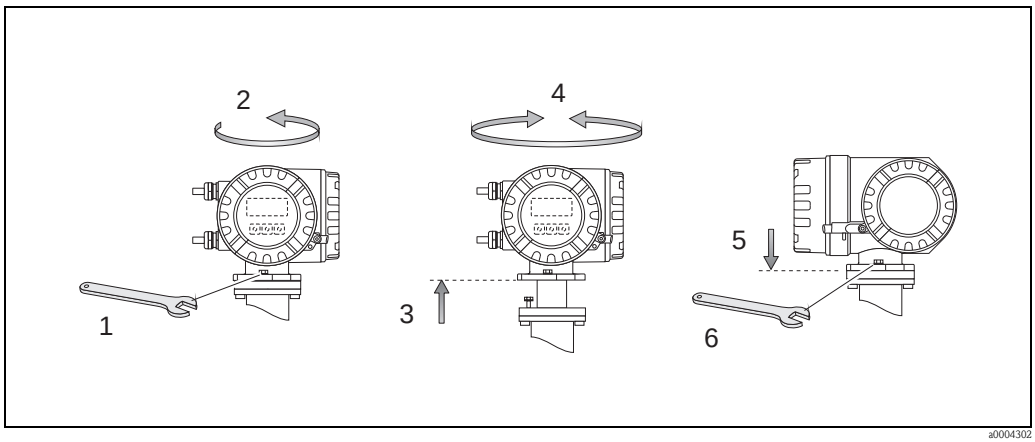


Fig. 12: Turning the transmitter housing (aluminum field housing)

Turning the stainless steel field housing (Promass X and O)

1. Unscrew the grub screw.
2. Rotate the transmitter housing cautiously clockwise until the end stop (end of the thread).
3. Rotate the transmitter housing counter-clockwise (max. 360°) in the wanted position.
4. Tighten the grub screw again.

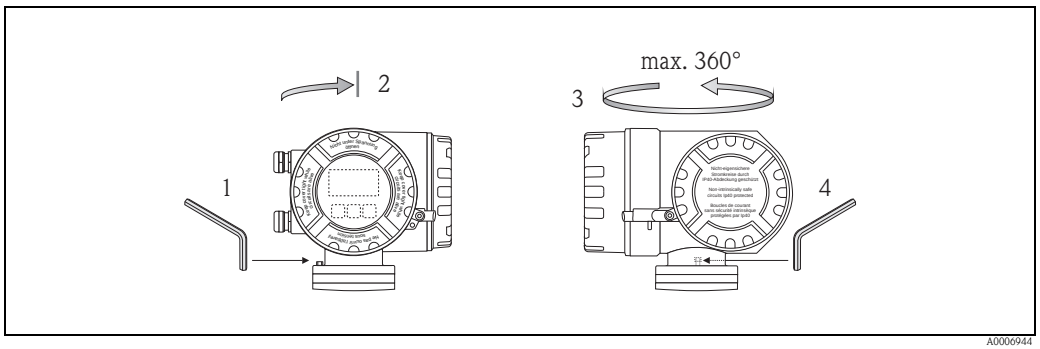


Fig. 13: Turning the transmitter housing of Promass X and O

Turning the stainless steel field housing

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

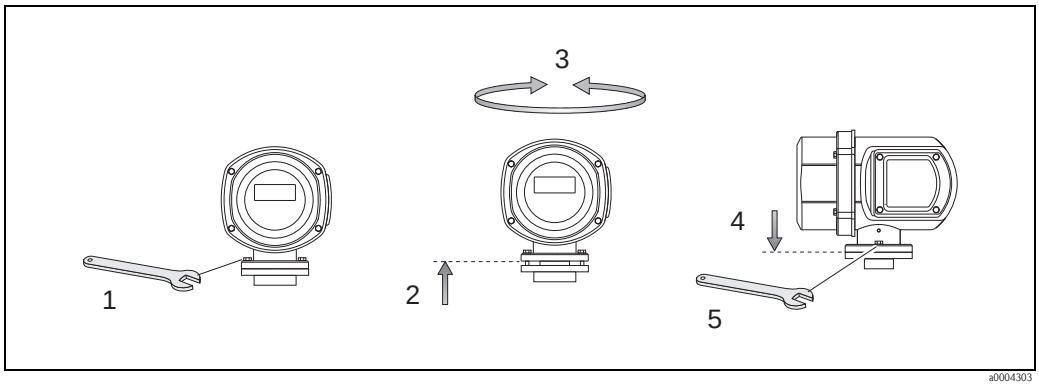


Fig. 14: Turning the transmitter housing (stainless steel field housing)

3.3.2 Installing the wall-mount housing

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

- Mounted directly on the wall
- Installation in control panel (separate mounting set, accessories) → 24
- Pipe mounting (separate mounting set, accessories) → 24

Caution!

- At the mounting location, ensure that the permitted ambient temperature range (–20 to +60 °C (–4 to +140 °F), optional –40 to +60 °C (–40 to +140 °F)) is not exceeded. Install the device in a shady location. Avoid direct sunlight.
- Always install the wall-mount housing in such a way that the cable entries are pointing down.

Mounted directly on the wall

1. Drill the holes as illustrated in the diagram.
2. Remove the cover of the connection compartment (a).
3. Push the two securing screws (b) through the appropriate bores (c) in the housing.
   – Securing screws (M6): max. Ø 6.5 mm (0.26")
   – Screw head: max. Ø 10.5 mm (0.41")
4. Secure the transmitter housing to the wall as indicated.
5. Screw the cover of the connection compartment (a) firmly onto the housing.

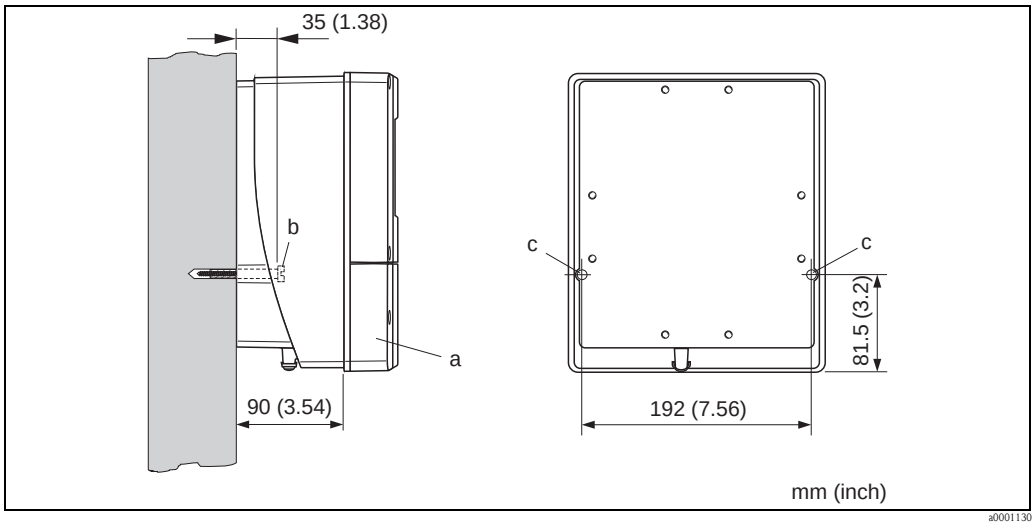


Fig. 15: Mounted directly on the wall

Panel mounting

1. Prepare the opening in the panel as illustrated in the diagram.
2. Slide the housing into the opening in the panel from the front.
3. Screw the fasteners onto the wall-mount housing.
4. Screw threaded rods into holders and tighten until
   the housing is solidly seated on the panel wall. Afterwards, tighten the locking nuts.
   Additional support is not necessary.

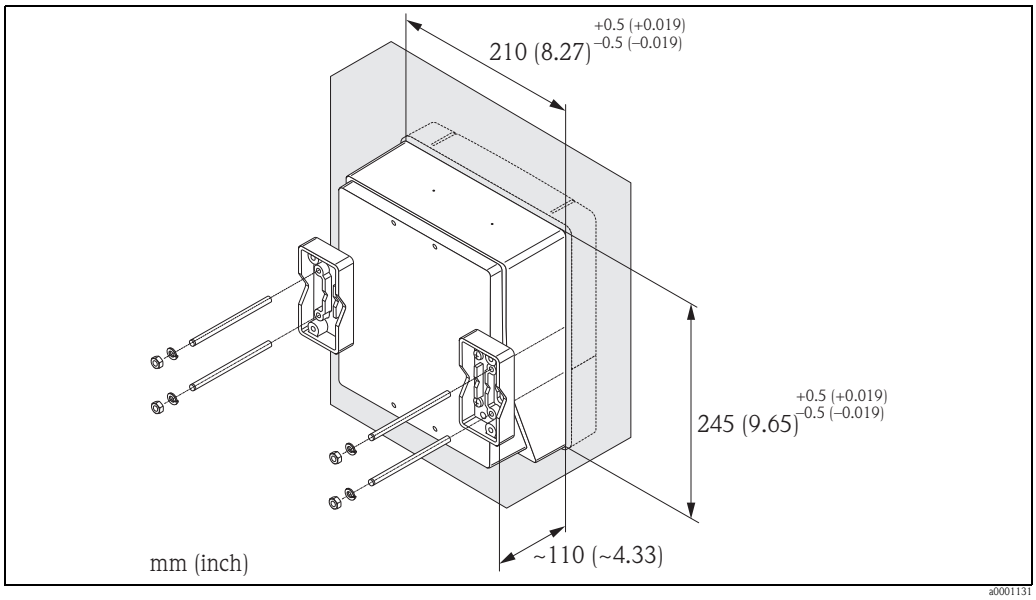


Fig. 16: Panel mounting (wall-mount housing)

Pipe mounting

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

Caution!
If a warm pipe is used for installation, ensure that the housing temperature does not exceed the permitted value of +60 °C (+140 °F).

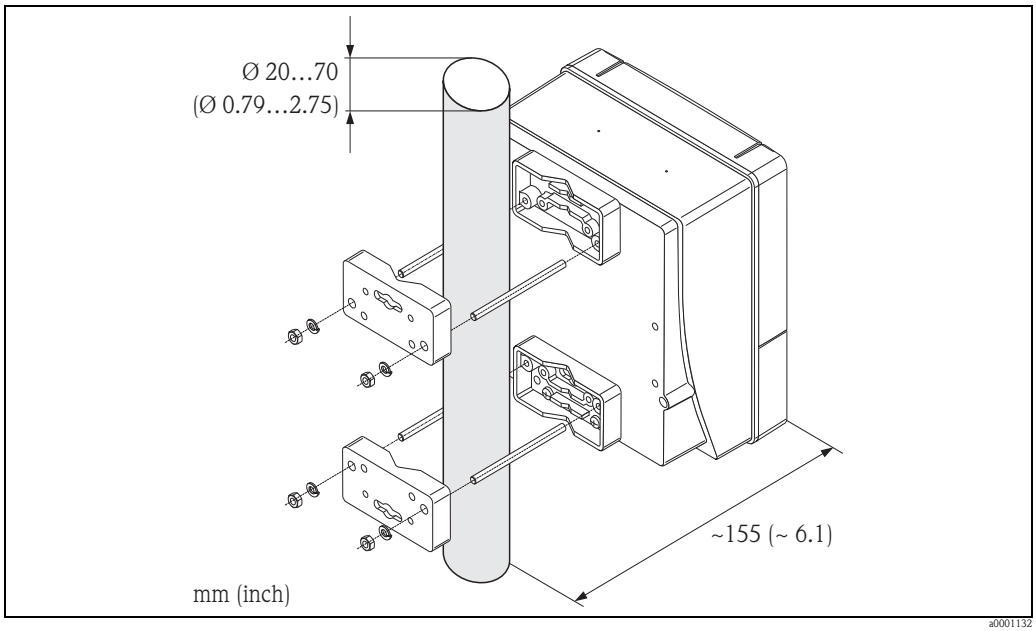


Fig. 17: Pipe mounting (wall-mount housing)

3.3.3 Turning the local display

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

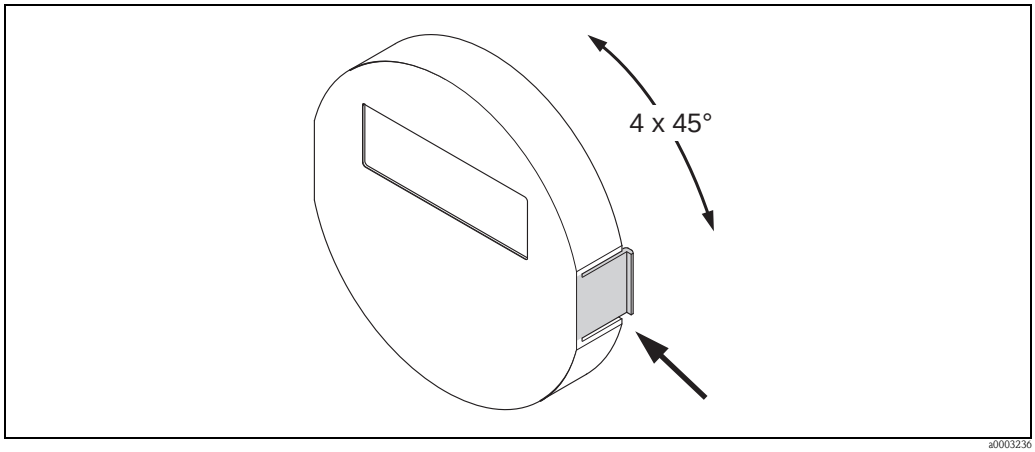


Fig. 18: Turning the local display (field housing)

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, measuring range, etc.?	→ 🖹 5
Installation instructions	Notes
Does the arrow on the sensor nameplate match the direction of flow through the pipe?	-
Are the measuring point number and labeling correct (visual inspection)?	-
Is the orientation chosen for the sensor correct, in other words suitable for sensor type, fluid properties (outgassing, with entrained solids) and fluid temperature?	→ 🖹 15
Process environment / process conditions	Notes
Is the measuring device protected against moisture and direct sunlight?	-

4 Wiring

Warning!
When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions. Please do not hesitate to contact your Endress+Hauser sales office if you have any questions.

Note!
The measuring instrument does not have an internal disconnecting device. Therefore, assign a switch or circuit breaker to the measuring instrument with which the voltage supply line can be disconnected from the power system.

4.1 Modbus RS485 cable specifications

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

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

Note the following points for the bus structure:
- All the measuring devices are connected in a bus structure (line).
- Using cable type A and with a transmission rate of 115200 Baud, the maximum line length (segment length) of the Modbus RS485 system is 1200 m (4000 ft). The total length of the spurs may not exceed a maximum of 6.6 m (21.7 ft) here.
- A maximum of 32 users are permitted per segment.
- Each segment is terminated at either end with a terminating resistor.
- The bus length or the number of users can be increased by introducing a repeater.

4.1.1 Shielding and grounding

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

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

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

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

4.2 Connecting the remote version

4.2.1 Connecting connecting cable for sensor/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 ground to the ground terminal on the housing before the power supply is applied.
- You may only connect the sensor to the transmitter with the same serial number. Communication errors can occur if this is not observed when connecting the devices.

1. Remove the connection compartment cover (d) by loosening the fixing screws on the transmitter and sensor housing.
2. Feed the connecting cable (e) through the appropriate cable runs.
3. Establish the connections between sensor and transmitter in accordance with the wiring diagram (→ 19 or see wiring diagram in screw cap).
4. Seal the connection compartment or the transmitter housing again.

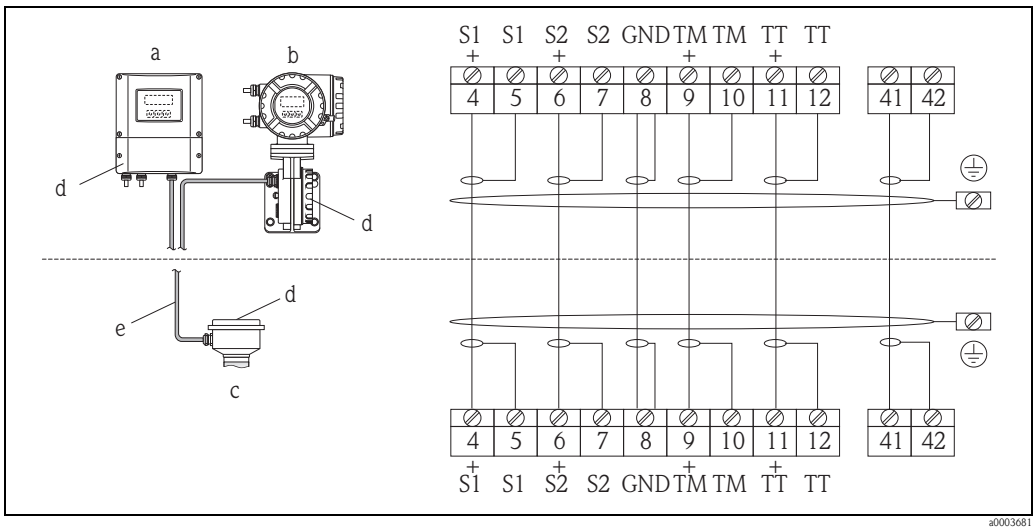


Fig. 19: Connecting the remote version

a Wall-mount housing: non-hazardous area and ATEX II3G / zone 2 → see separate "Ex documentation"
b Wall-mount housing: ATEX II2G / Zone 1 /FM/CSA → see separate "Ex documentation"
c Remote version, flanged version
d Cover of the connection compartment or connection housing
e Connecting cable

Terminal No.: 4/5 = gray; 6/7 = green; 8 = yellow; 9/10 = pink; 11/12 = white; 41/42 = brown

4.2.2 Cable specification, connecting cable

The specifications of the cable connecting the transmitter and the sensor of the remote version are as follows:
- 6 × 0.38 mm² PVC cable with common shield and individually shielded cores
- Conductor resistance: ≤ 50 Ω/km
- Capacitance core/shield: ≤ 420 pF/m
- Cable length: max. 20 m (65 ft)
- Permanent operating temperature: max. +105 °C (+221 °F)

Note!
The cable must be installed securely, to prevent movement.

4.3 Connecting the measuring unit

4.3.1 Transmitter connection

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

1. Unscrew the connection compartment cover (f) from the transmitter housing.
2. Feed the power supply cable (a) and the signal cable (b) through the appropriate cable entry.
3. Perform wiring:
   – Wiring diagram (aluminum housing) → 20
   – Wiring diagram (stainless steel housing) → 21
   – Wiring diagram (wall-mount housing) → 22
   – Terminal assignment → 28
4. Screw the cover of the connection compartment (f) back onto the transmitter housing.

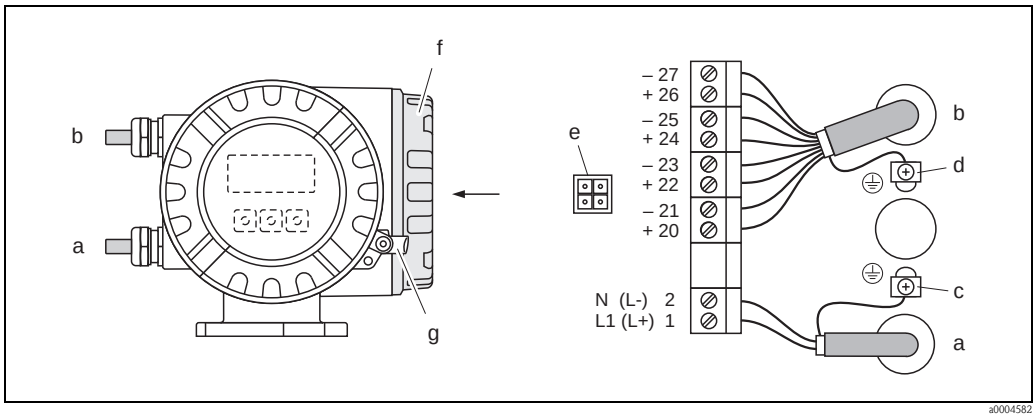


Fig. 20: Connecting the transmitter (aluminum field housing). Cable cross-section: max. 2.5 mm²

a Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L- for DC*
*b Signal cable: Terminals **Nos. 20–27** → 28*
c Ground terminal for protective ground
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA193 with Proline Adapter Cable (Fieldcheck, FieldCare)
f Cover of the connection compartment
g Securing clamp

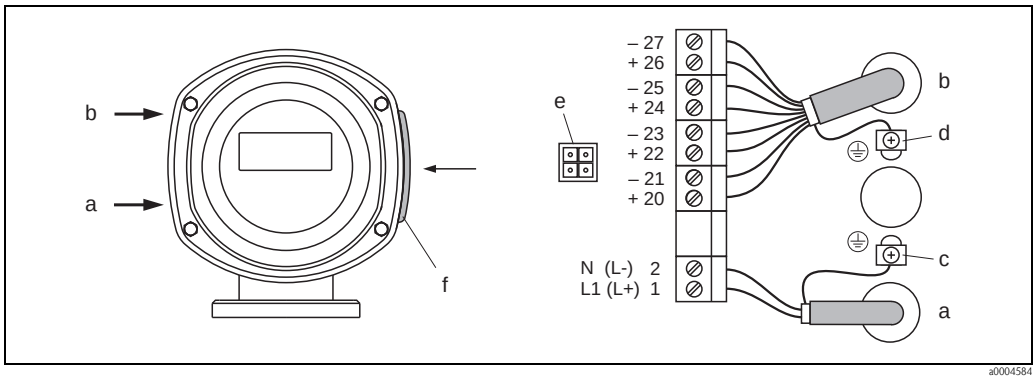


Fig. 21: Connecting the transmitter (stainless steel field housing); cable cross-section: max. 2.5 mm²

a Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L- for DC*
*b Signal cable: Terminals **Nos. 20–27** → 28*
c Ground terminal for protective ground
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA193 with Proline Adapter Cable (Fieldcheck, FieldCare)
f Cover of the connection compartment

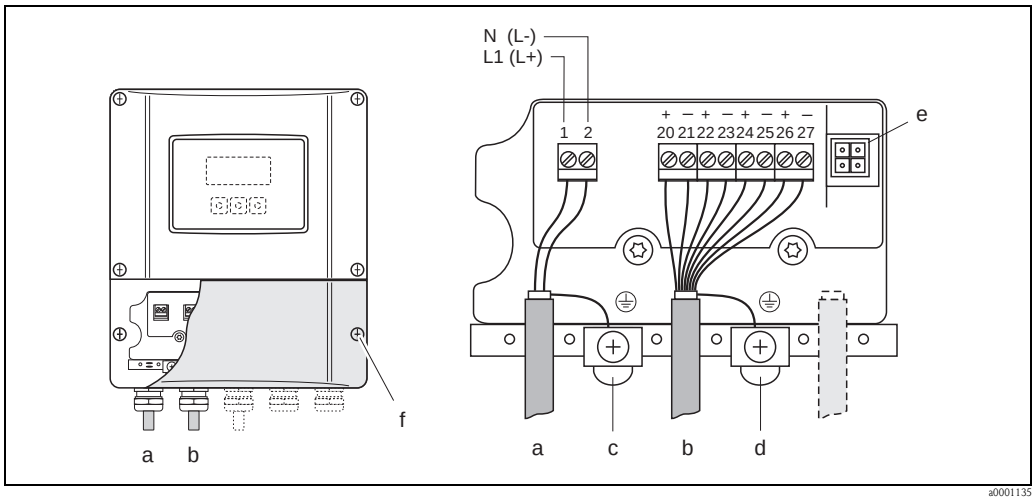


Fig. 22: Connecting the transmitter (wall-mount housing); cable cross-section: max. 2.5 mm²

a Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
*b Signal cable: Terminals **Nos. 20–27** → 🖹 28*
c Ground terminal for protective ground
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA193 with Proline Adapter Cable (Fieldcheck, FieldCare)
f Cover of the connection compartment

4.3.2 Terminal assignment

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

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

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

4.4 Degree of protection

The measuring device 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.
- The threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter → 106, cable entries.
- The cable entries must be firmly tighten (point **a** → 23).
- The cable must loop down in front of the cable entry ("water trap") (point **b** → 23). This arrangement prevents moisture penetrating the entry.

Note!
The cable entries may not be point up.

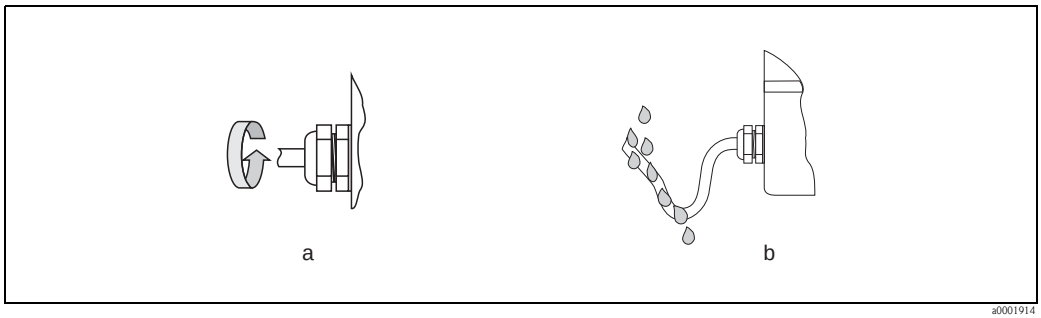


Fig. 23: Installation instructions, cable entries

- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

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

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 to 260 V AC (45 to 65 Hz) 20 to 55 V AC (45 to 65 Hz) 16 to 62 V DC
Do the cables comply with the specifications?	→ 29
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?	–
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ 32
Are all housing covers installed and firmly tightened?	–

5 Operation

5.1 Quick operation guide

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

1. **Local display (option)** → 📄 35
   The local display enables you to read all important variables directly at the measuring point, configure bus-specific and device-specific parameters in the field and perform commissioning.
2. **Configuration programs** → 📄 52
   Operation via:
   – FieldCare
   The Proline flowmeters are accessed via the service interface or via the service interface FXA193.
3. **Jumpers/miniature switches for hardware settings** → 📄 53
   You can make the following hardware settings using a jumper or miniature switches on the I/O board:
   - Address mode configuration (select software or hardware addressing)
   - Device bus address configuration (for hardware addressing)
   - Hardware write protection enabling/disabling

Note!
A description of the configuration of the current output (active/passive) and the relay output (NC contact/NO contact) can be found in the "Hardware settings" section → 📄 53.

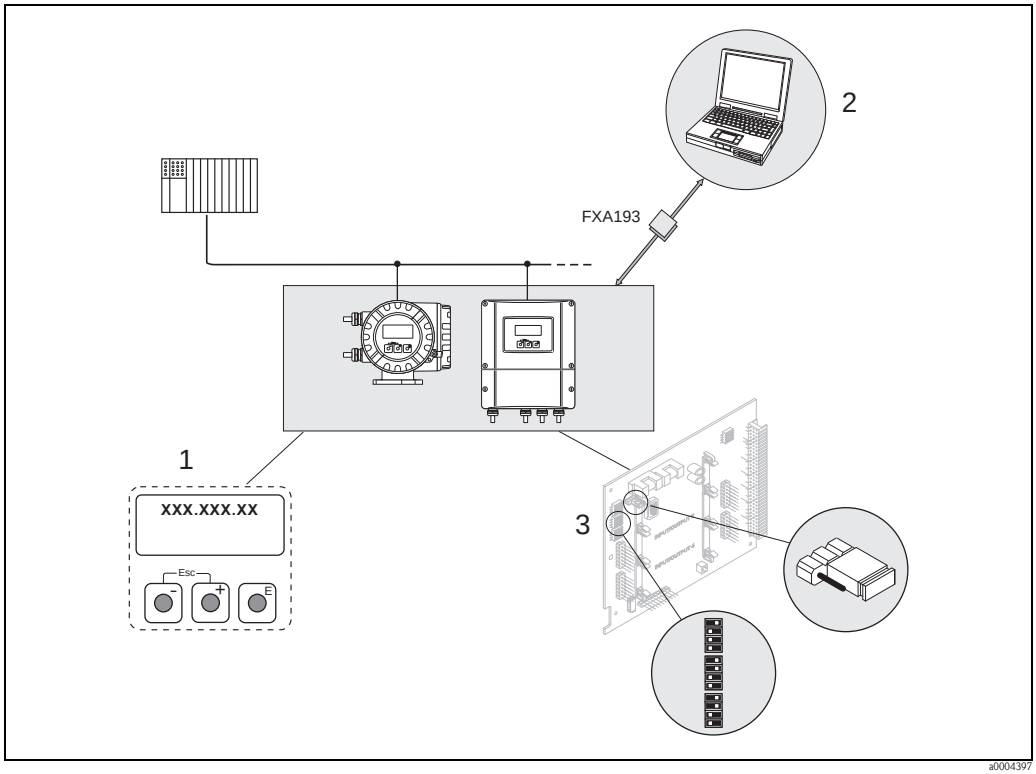


Fig. 24: Methods of operating Modbus RS485 devices

1 Local display for device operation in the field (option)
2 Configuration/operating program for operating via the service interface FXA193 (e.g. FieldCare)
3 Jumper/miniature switches for hardware settings (write protection, device address, address mode)

5.2 Display and operating elements

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

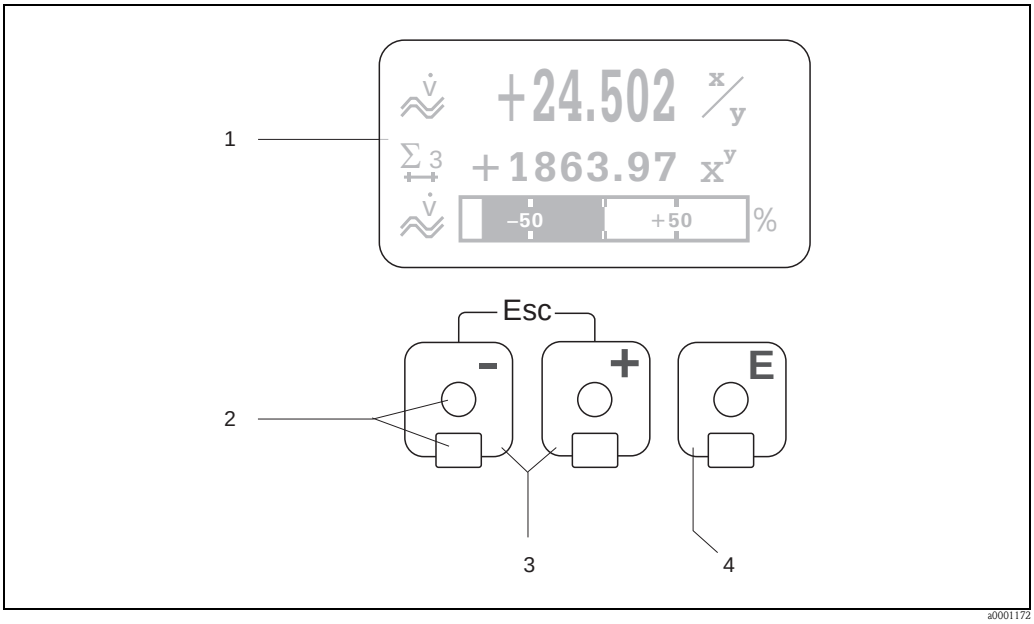


Fig. 25: Display and operating elements

1 Liquid crystal display
The backlit, four-line liquid crystal display shows measured values, dialog texts, fault messages and notice messages. HOME position (operating mode) is the term given to the display during normal operation.
Readings displayed
2 Optical sensors for "Touch Control"
3 Plus/minus keys
– HOME position → Direct access to totalizer values and actual values of inputs/outputs
– Enter numerical values, select parameters
– Select different blocks, groups and function groups within the function matrix
Press the +/- keys ( ) simultaneously to trigger the following functions:
– Exit the function matrix step by step → HOME position
– Press and hold the keys for longer than 3 seconds → Return directly to home position
– Cancel data entry
4 Enter key
– HOME position → Entry into the function matrix
– Save the numerical values you input or settings you change

5.2.1 Display (operating mode)

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

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

Error messages:
Display and presentation of system/process errors → 📄 40

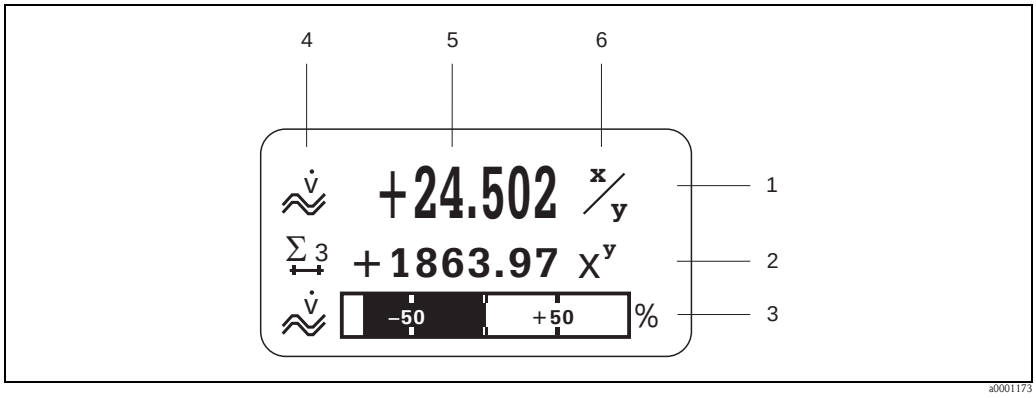


Fig. 26: Typical display for normal operating mode (HOME position)

1 Main display line: shows primary measured values, e.g. mass flow in [kg/h]
2 Additional line: shows measured variables and status variables, e.g. totalizer No. 3 in [t]
3 Information line: shows additional information on the measured variables and status variables, e.g. bar graph display of the full scale value achieved by the mass flow
4 "Info icons" field: icons representing additional information on the measured values are shown in this field. For a full list of the icons and their meanings see
5 "Measured values" field: the current measured values appear in this field
6 "Unit of measure" field: the units of measure and time defined for the current measured values appear in this field

5.2.2 Additional display functions

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

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

5.2.3 Icons

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

Icon	Meaning	Icon	Meaning
S	System error	P	Process error
ϟ	Fault message (with effect on outputs)	!	Notice message (without effect on outputs)
I 1 to n	Current output 1 to n	P 1 to n	Pulse output 1 to n
F 1 to n	Frequency output	S 1 to n	Status output/relay output 1 to n (or status input)
Σ 1 to n	Totalizer 1 to n	 a0001187	Status input
 a0001181	Measuring mode: PULSATING FLOW	 a0001182	Measuring mode: SYMMETRY (bidirectional)
 a0001183	Measuring mode: STANDARD	 a0001184	Totalizer counting mode: BALANCE (forward and reverse flow)
 a0001185	Totalizer counting mode: forward	 a0001186	Totalizer counting mode: reverse
 a0001188	Volume flow	 a0001206	Modbus communication active
 a0001200	Fluid density	 a0001208	Reference density
 a0001207	Medium temperature		

5.3 Brief operating instructions to the function matrix

Note!
- See the general notes → 39
- Function descriptions → see the "Description of Device Functions" manual

1. HOME position → E → Entry into the function matrix
2. Select a block (e.g. OUTPUTS)
3. Select a group (e.g. CURRENT OUTPUT 1)
4. Select a function group (e.g. SETTINGS)
5. Select a function (e.g. TIME CONSTANT)
   Change parameter / enter numerical values:
   ± → Select or enter enable code, parameters, numerical values
   E → Save your entries
6. 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

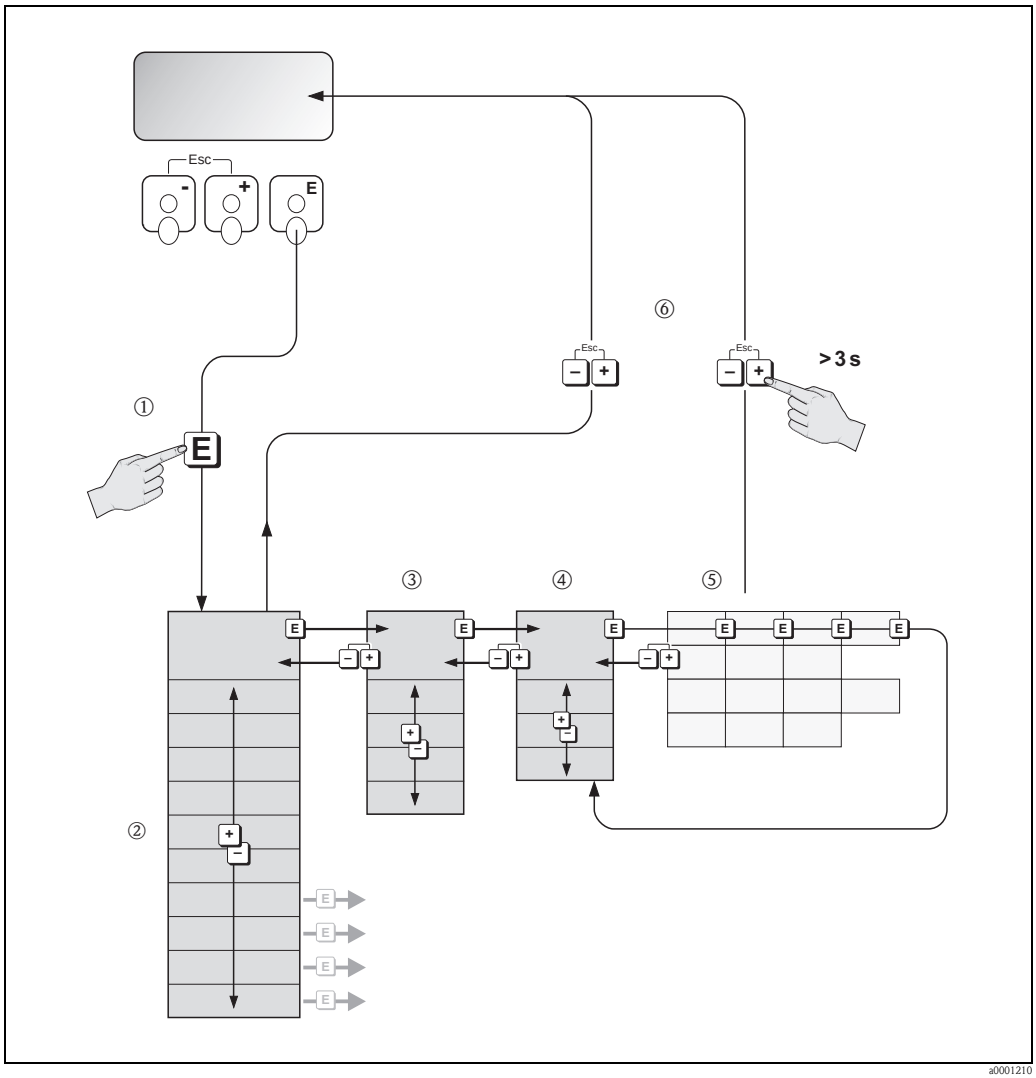


Fig. 27: Selecting functions and configuring parameters (function matrix)

5.3.1 General notes

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

Comply with the following instructions when configuring functions:
- You select functions as described already → 38.
  Each cell in the function matrix is identified by a numerical or letter code on the display.
- You can switch off certain functions (OFF). If you do so, related functions in other function groups will no longer be displayed.
- Certain functions prompt you to confirm your data entries.
  Press ± to select "SURE [YES]" and press E to confirm. This saves your setting or starts a function, as applicable.
- Return to the HOME position is automatic if no key is pressed for 5 minutes.
- Programming mode is disabled automatically if you do not press a key within 60 seconds following automatic return to the HOME position.

Caution!
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 these Operating Instructions.

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

5.3.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 84) 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 ± operating elements are pressed in any function, a prompt for the code automatically appears on the display.
- If "0" is entered as the customer's code, programming is always enabled!
- Your Endress+Hauser representative 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 Endress+Hauser representatives.
Please contact Endress+Hauser if you have any questions.

5.3.3 Disabling the programming mode

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

5.4 Error messages

5.4.1 Type of error

Errors 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.

The measuring system distinguishes between two types of error:
- *System errors:*
  Includes all device errors, e.g. communication errors, hardware errors, etc. → 📄 84
- *Process errors:*
  Includes all application errors, e.g. fluid not homogeneous, etc. → 📄 89

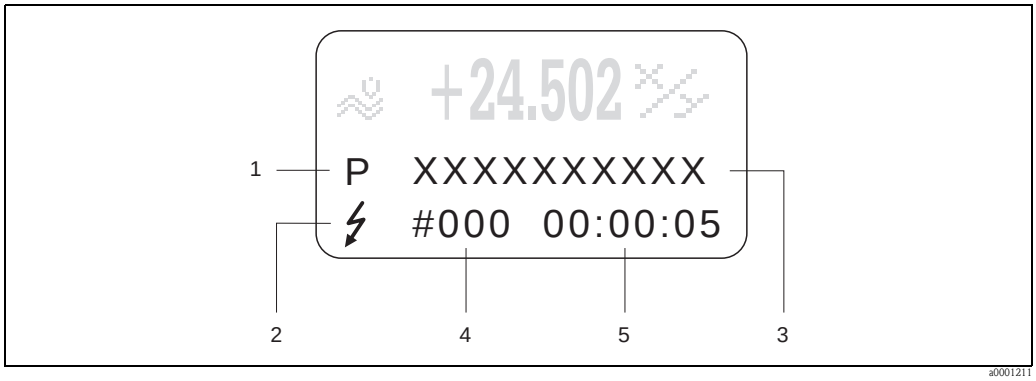


Fig. 28: Error messages on the display (example)

1 Error type: P = process error, S = system error
2 Error message type: $ = Fault message, ! = Notice message
3 Error designation: e.g. FLUID INHOM. = fluid is not homogeneous
4 Error number: e.g. #702
5 Duration of most recent error occurrence (in hours, minutes and seconds)

5.4.2 Error message type

The measuring device permanently assigns two types of error messages (**fault message** or **notice message**) to system errors and process errors, thereby giving them a different weighting.
Serious system errors, e.g. module defects, are always identified and classed as "fault messages" by the measuring device.

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

Fault message (ϟ)
- The error in question stops or interrupts running operation and has an immediate effect on the outputs. The response of the outputs (failsafe mode) can be defined by means of functions in the function matrix.
- Displayed as → Lightning flash (ϟ), type of error (S: system error, P: process error)

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

5.5 Modbus RS485 communication

5.5.1 Modbus RS485 technology

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

System architecture

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

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

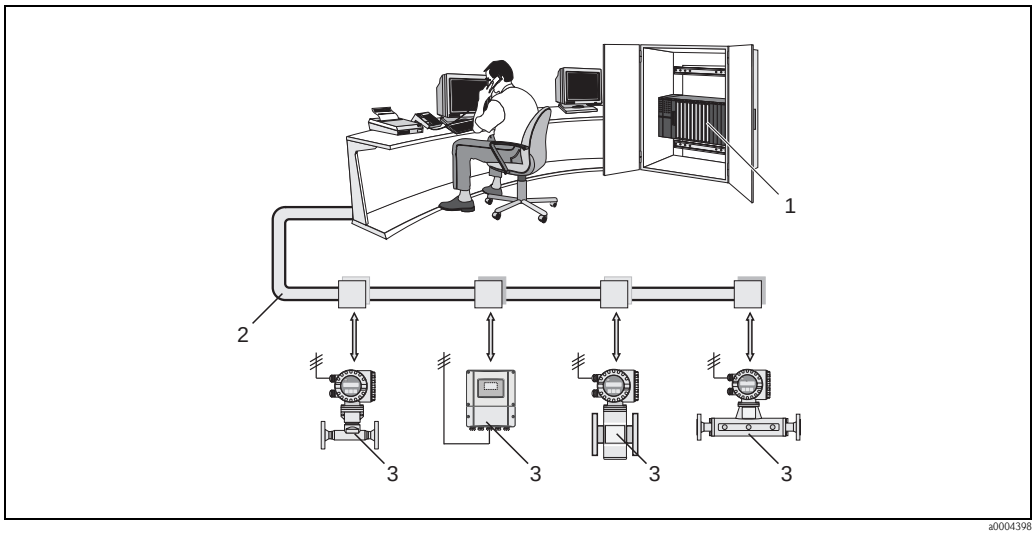


Fig. 29: Modbus RS485 system architecture

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

Master/slave communication

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

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

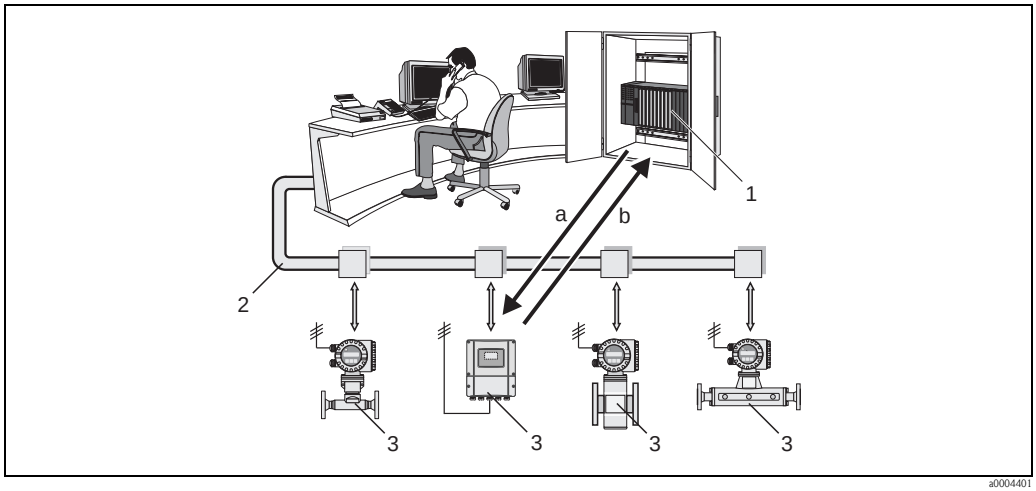


Fig. 30: Modbus RS485 polling data traffic

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

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

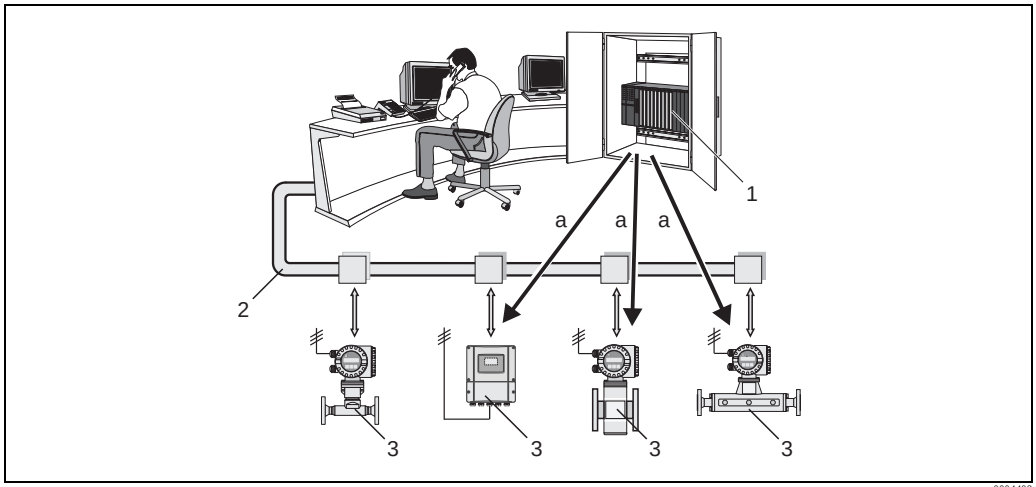


Fig. 31: Modbus RS485 polling data traffic

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

5.5.2 Modbus telegram

General

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

Telegram structure

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

Telegram structure:

Slave address	Function code	Data	Check sum

- Slave address
  The slave address can be in an address range from 1 to 247.
  The master talks to all the slaves simultaneously by means of the slave address 0 (broadcast message).
- Function code
  The function code determines which read, write and test operations should be executed by means of the Modbus protocol.
  Function codes supported by the measuring device → 📄 44
- Data
  Depending on the function code, the following values are transmitted in this data field:
  – Register start address (from which the data are transmitted)
  – Number of registers
  – Write/read data
  – Data length
  – etc.
- Check sum (CRC or LRC check)
  The telegram check sum forms the end of the telegram.

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

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

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

5.5.3 Modbus function codes

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

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

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

5.5.4 Maximum number of writes

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

5.5.5 Modbus register addresses

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

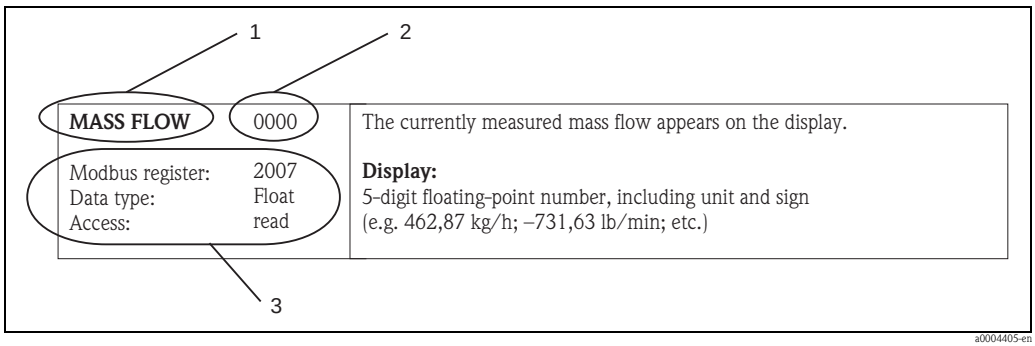


Fig. 32: Example of how a function description is illustrated in the "Description of Device Functions" manual

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

Modbus register address model

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

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

Function code	Access type	Register in accordance with: "Modbus Applications Protocol Specification"		Register in accordance with: "Modicon Modbus Protocol Reference Guide"
03 04 23	Read	XXXX Example: mass flow = 2007	→	3XXXX Example: mass flow = 32007
06 16 23	Write	XXXX Example: reset totalizer = 6401	→	4XXXX Example: reset totalizer = 46401

Response times

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

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

Data types

The following data types are supported by the measuring device:

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

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

S = sign
E = exponent
M = mantissa

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

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

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

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

Byte transmission sequence

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

The bytes are transmitted depending on the option selected in the "BYTE ORDER" parameter:

FLOAT:

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

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

INTEGER:

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

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

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

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

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

5.5.6 Modbus error messages

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

The following exception codes are supported by the measuring device:

Exception codes	Description
01	ILLEGAL_FUNCTION The function code sent by the master is not supported by the measuring device (slave). ✎ Note! Description of the function codes supported by the measuring device → 📄 44.
02	ILLEGAL_DATA_ADDRESS The register addressed by the master is not assigned (i.e. it does not exist) or the length of the requested data is too big.
03	ILLEGAL_DATA_VALUE ■ The master is attempting to write to a register which only allows read access. ■ The value that appears in the data field is not permitted: e.g. range limits overshot or incorrect data format.
04	SLAVE DEVICE FAILURE The slave did not respond to the request telegram from the master or an error occurred when processing the request telegram.

5.5.7 Modbus auto-scan buffer

Function description

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

Structure of the auto-scan buffer

The auto-scan buffer consists of two data records, the configuration area and the data area. In the configuration area, a list known as the scan list specifies which device parameters should be grouped. For this purpose, the corresponding register address, e.g. the register address 2007 for mass flow, is entered in the scan list. Up to 16 device parameters can be grouped.

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

Configuration of the scan list

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

The scan list can be configured by means of:

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

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

Scan list		
No.	Modbus configuration Register address (data type = Integer)	Configuration via local operation / configuration program (BASIC FUNCTION → Modbus RS485 →)
13	5013	SCAN LIST REG. 13
14	5014	SCAN LIST REG. 14
15	5015	SCAN LIST REG. 15
16	5016	SCAN LIST REG. 16

Access to data via Modbus

The Modbus master uses the register addresses 5051 to 5081 to access the data area of the auto-scan buffer. This data area contains the values of the device parameters defined in the scan list. For example, if the register 2007 was entered for mass flow in the scan list by means of the SCAN LIST REG. 1 function, the master can read out the current measured value of the mass flow in register 5051.

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

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

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

Response time

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

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

Example

The following device parameters should be grouped via the auto-scan buffer and read out by the master with just one request telegram:
- Mass flow → Register address 2007
- Temperature → Register address 2017
- Totalizer 1 → Register address 2610
- Actual system condition → Register address 6859

1. Configuration of the scan list

- With the local operation or a configuration program (via the function matrix):
  BASIC FUNCTION block → Modbus RS485 function group → SCAN LIST REG. function
  → Entry of the address 2007 under SCAN LIST REG. 1
  → Entry of the address 2017 under SCAN LIST REG. 2
  → Entry of the address 2610 under SCAN LIST REG. 3
  → Entry of the address 6859 under SCAN LIST REG. 4
- Via the Modbus master (the register addresses of the device parameters are written to the registers 5001 to 5004 via Modbus):
  1. Write address 2007 (mass flow) to register 5001
  2. Write address 2017 (temperature) to register 5002
  3. Write address 2610 (totalizer 1) to register 5003
  4. Write address 6859 (actual system condition) to register 5004

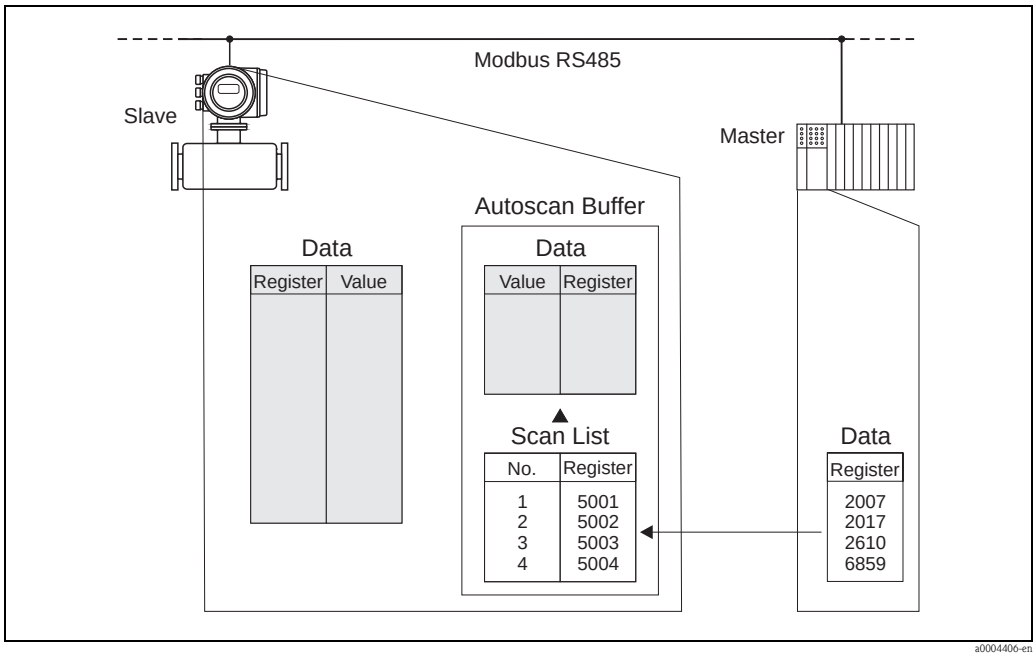


Fig. 33: Configuration of the scan list via the Modbus master

2. Access to data via Modbus

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

Data area			
Access via Modbus register address	Measuring values	Data type	Access
5051	Mass flow = 4567.67	Float	Read
5053	Temperature = 26.5	Float	Read
5055	Totalizer 1 = 56345.6	Float	Read
5057	Actual system condition = 1 (system ok)	Integer	Read

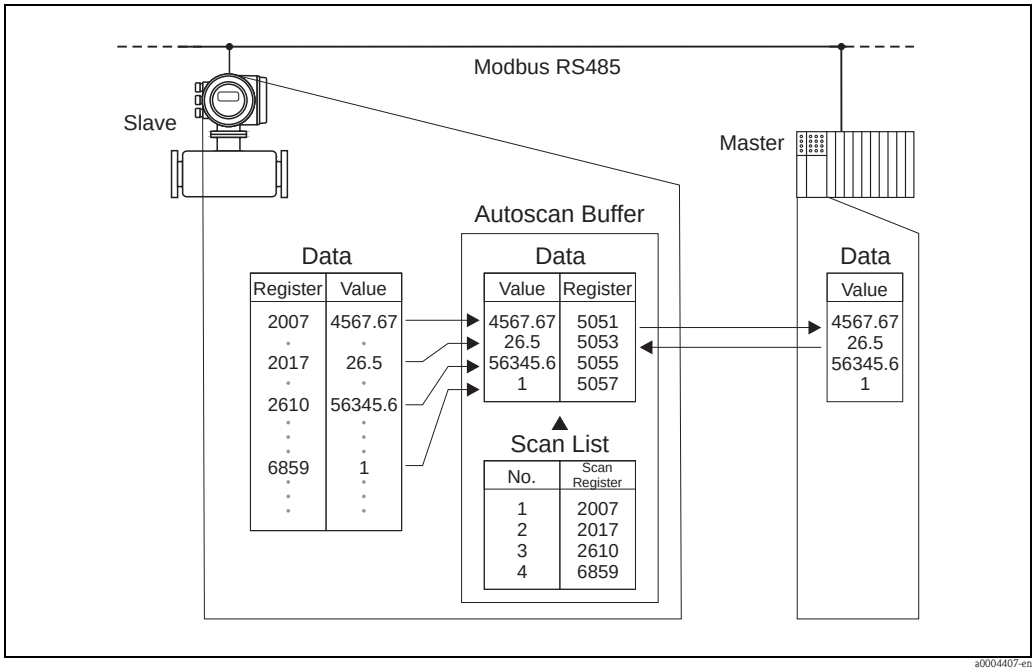


Fig. 34: With just one request telegram, the Modbus master reads out the measured values via the auto-scan buffer of the measuring device.

5.6 Operating options

5.6.1 Operating program "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 flowmeters are accessed via a service interface or via the service interface FXA193 with Proline Adapter Cable.

5.6.2 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.

Operation via Service-Protokoll:

Valid for device software:	3.06.00	→ DEVICE SOFTWARE function
Software release:	06.2010	
Operating program:	**Sources for obtaining device descriptions:**	
Handbediengerät Field Xpert	■ Use update function of handheld terminal	
Fieldcare / DTM	■ www.endress.com → Download-Area ■ CD-ROM (Endress+Hauser order number: 56004088) ■ DVD (Endress+Hauser order number: 70100690)	
AMS	■ www.endress.com → Download-Area	
SIMATIC PDM	■ www.endress.com → Download-Area	

Tester/simulator:	**Sources for obtaining device descriptions:**
Fieldcheck	■ Update by means of FieldCare via flow device FXA 193/291 DTM in the Fieldflash Module

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

5.7 Hardware settings

Warning!
In the case of explosion-protected equipment, observe a cooling or discharge time of 10 minutes before opening the device.

5.7.1 Switching hardware write protection on/off

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

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

1. Switch off power supply.
2. Remove the I/O board → 📄 93
3. Configure the hardware write protection accordingly with the aid of the jumpers (see Figure).
4. Installation is the reverse of the removal procedure.

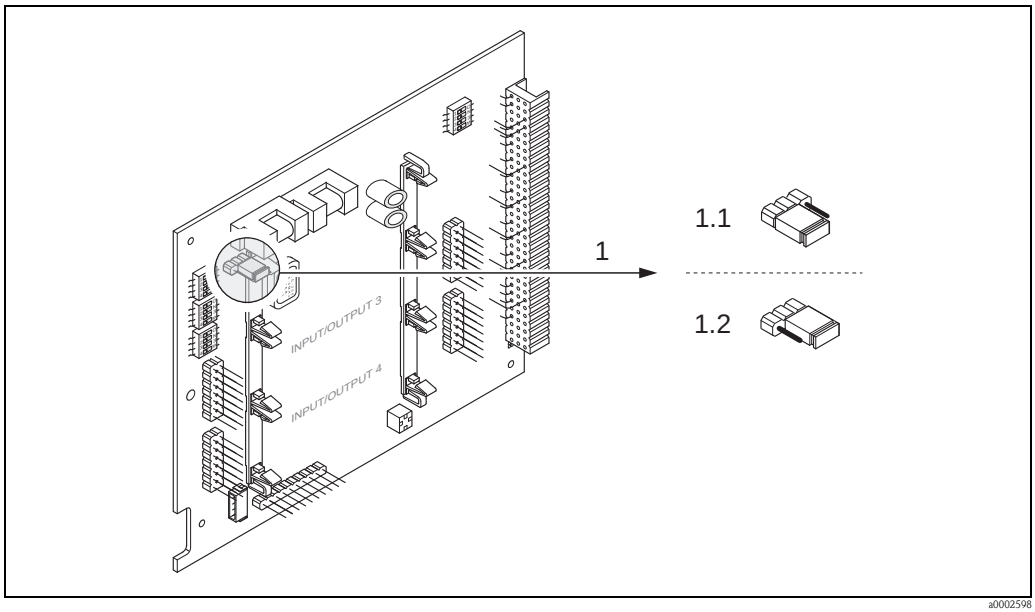


Fig. 35: Switching write protection on and off with the aid of a jumper on the I/O board

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

5.7.2 Configuring the device address

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

Addressing via local operation

More detailed explanations for addressing the measuring device via the local display → 📄 67.

Addressing via miniature switches

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

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

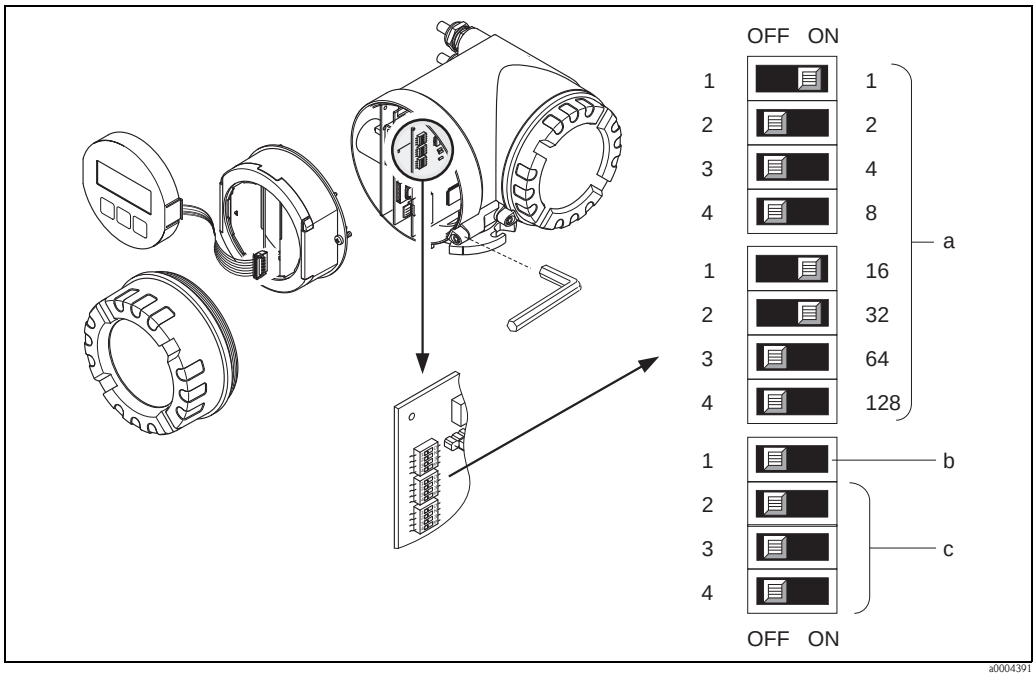


Fig. 36: Addressing with the aid of miniature switches on the I/O board

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

5.7.3 Configuring the terminating resistors

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

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

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

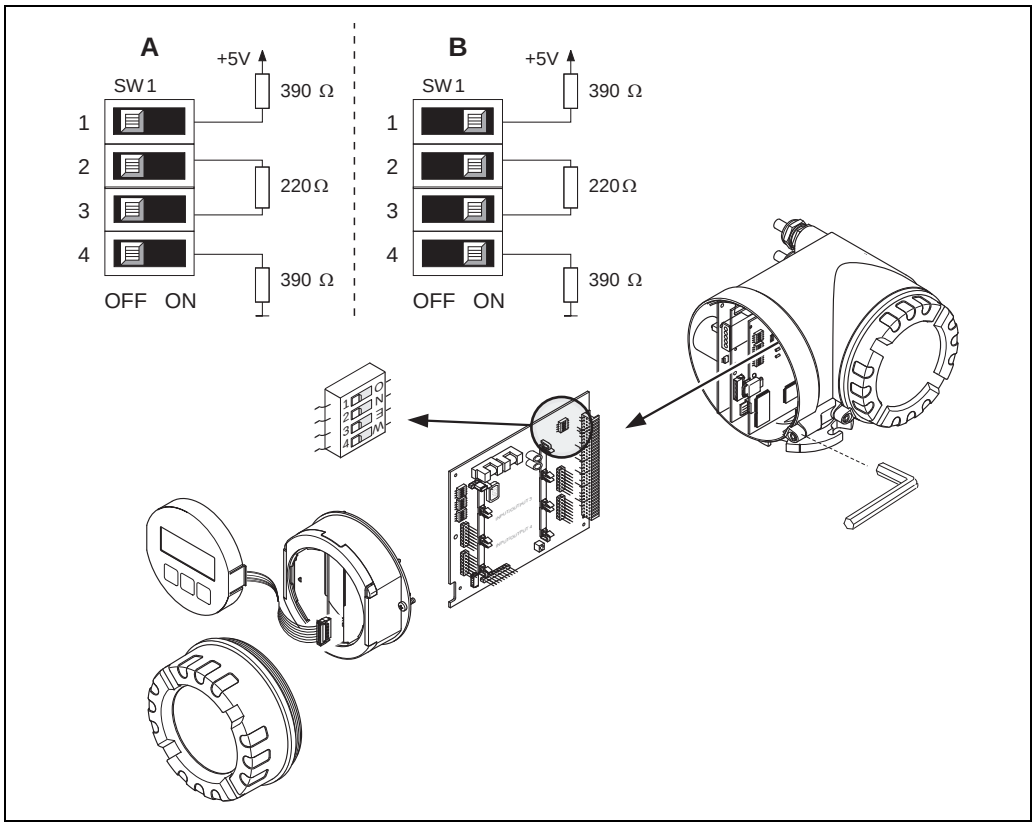


Fig. 37: Configuring the terminating resistors

A = Factory setting
B = Setting at the last transmitter

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

5.7.4 Current output configuration

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

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

1. Switch off power supply.
2. Remove the I/O board → 93.
3. Position the jumpers (see Figure).

Caution!
Risk of destroying the measuring device. Set the jumpers exactly as shown in the diagram.
Incorrectly set jumpers can cause overcurrents that would destroy either the measuring device or external devices connected to it.

4. Installation of the I/O board is the reverse of the removal procedure.

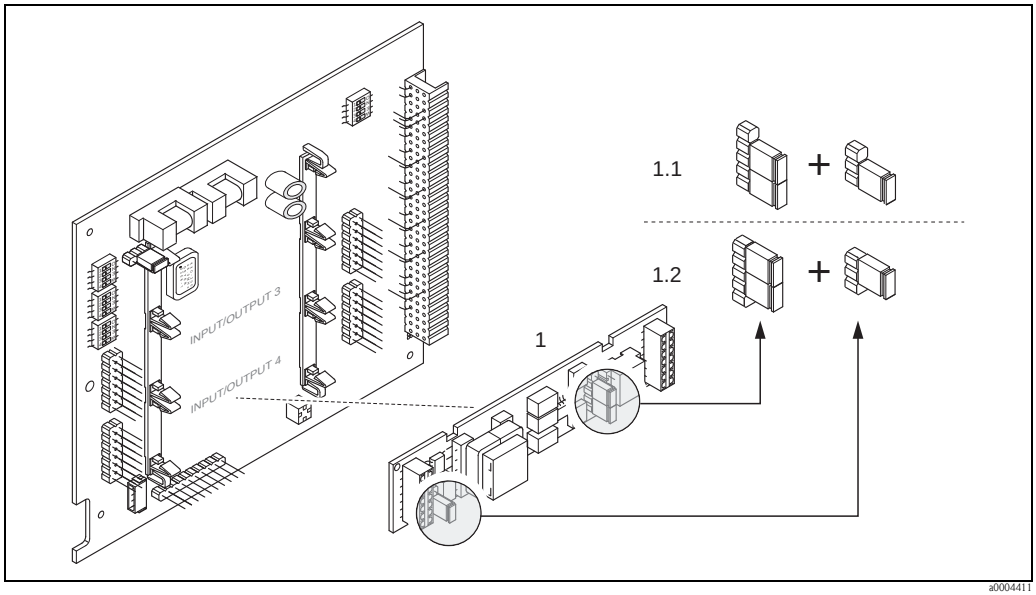


Fig. 38: Configuring the current input with the aid of jumpers (I/O board)

1 Current output
1.1 Active current output (default)
1.2 Passive current output

5.7.5 Relay output configuration

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

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

1. Switch off power supply.
2. Remove the I/O board → 93.
3. Position the jumpers (see Figure).

Caution!
If you change the setting you must always change the positions of **both** jumpers!
Note precisely the specified positions of the jumpers.

4. Installation of the I/O board is the reverse of the removal procedure.

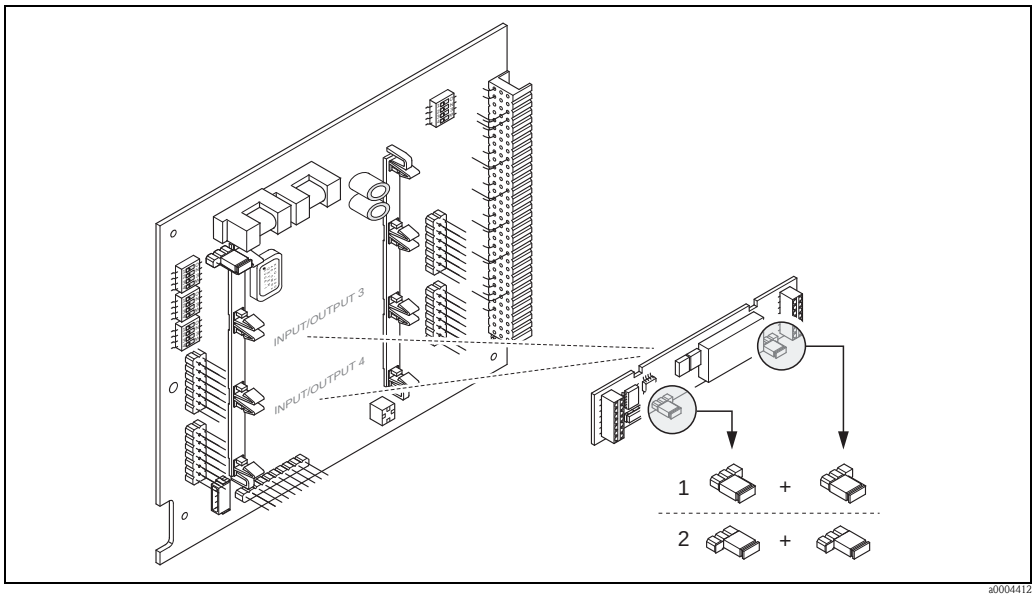


Fig. 39: Configuring relay contacts (NC / NO) on the convertible I/O board (submodule) with the help of jumpers.

1 Configured as NO contact (default, relay 1)
2 Configured as NC contact (default, relay 2)

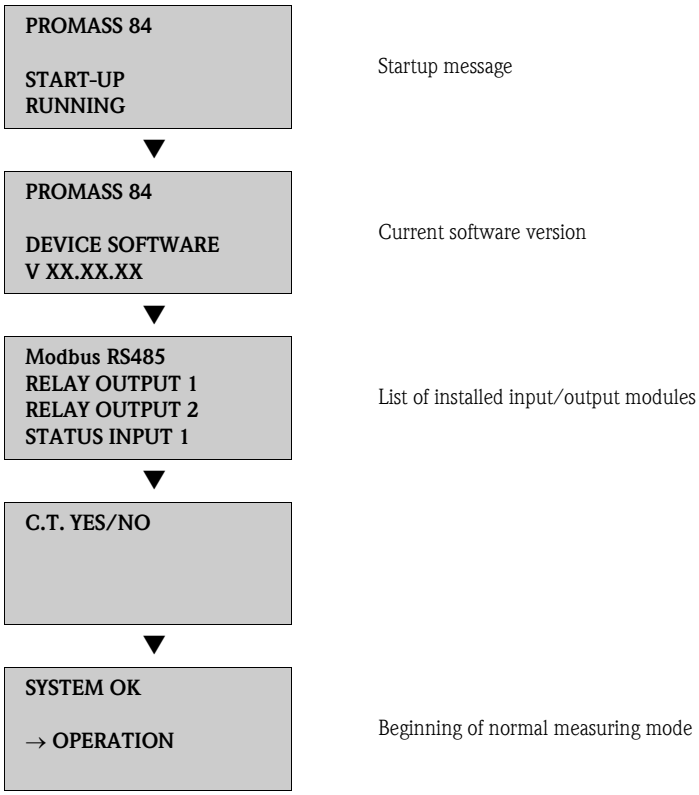
6 Commissioning

6.1 Function check

Make sure that all final checks have been completed before you start up your measuring point:
- Checklist for "Post-installation check" → 📄 25
- Checklist for "Post-connection check" → 📄 33

6.2 Switching on the measuring device

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



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

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

6.3 Quick Setup

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

6.3.1 Quick Setup "Commissioning"

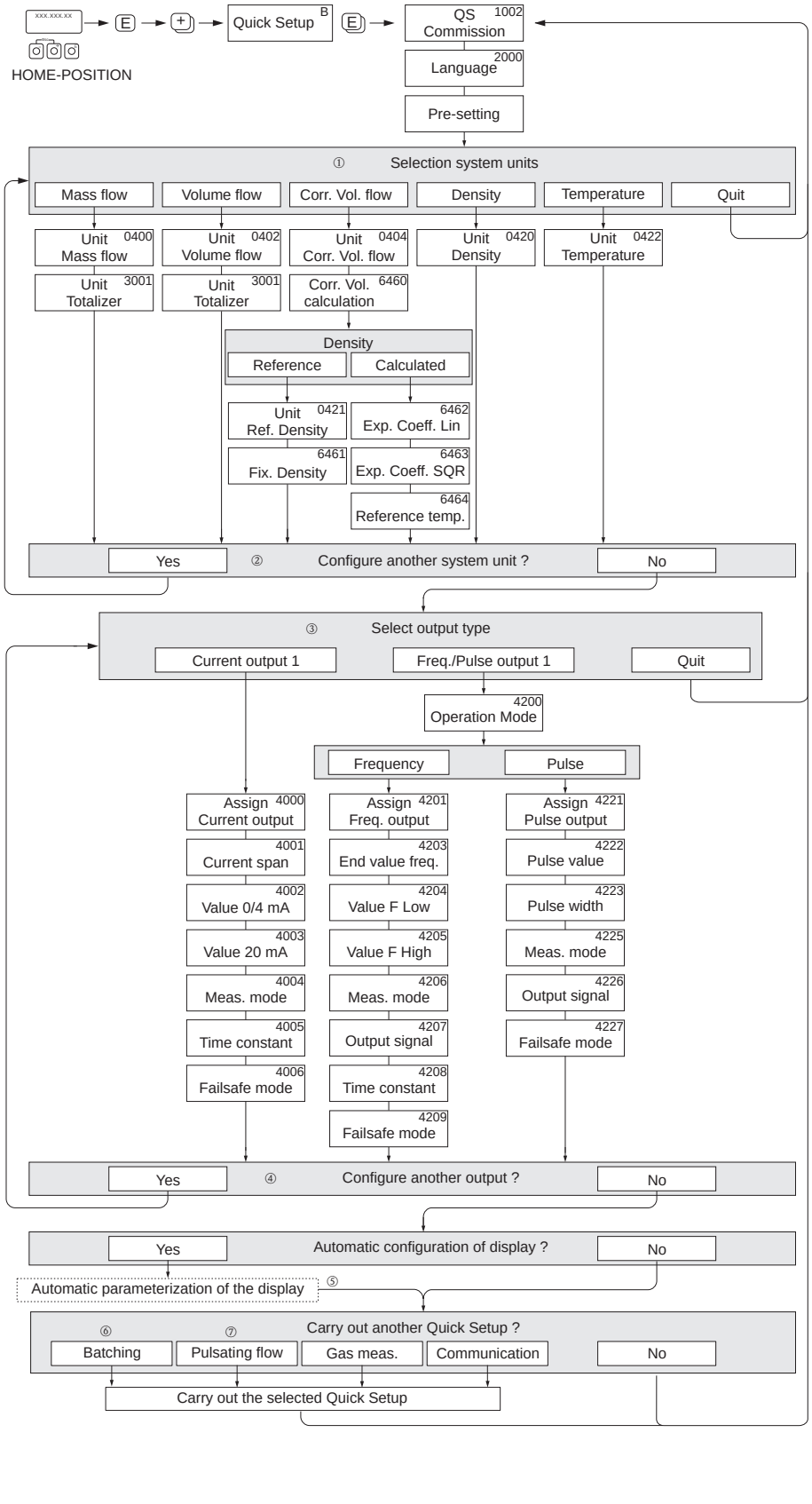


Fig. 40: "QUICK SETUP COMMISSIONING" menu for straightforward configuration of the major device functions

Note!
- The display returns to the function SETUP COMMISSIONING (1002) if you press the key combination during parameter interrogation. The stored parameters remain valid.
- The "COMMISSIONING" Quick Setup must be carried out before another Quick Setup is run.

① The "DELIVERY SETTINGS" option sets every selected unit to the factory setting.
The "ACTUAL SETTING" option accepts the units you previously configured.

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

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

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

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

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

YES Main line = Mass flow
Additional line = Totalizer 1
Information line = Operating/system condition

NO The existing (selected) settings remain.

⑦ The execution of other Quick Setups are described in the following chapters.

6.3.2 Quick Setup "Pulsating Flow"

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

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

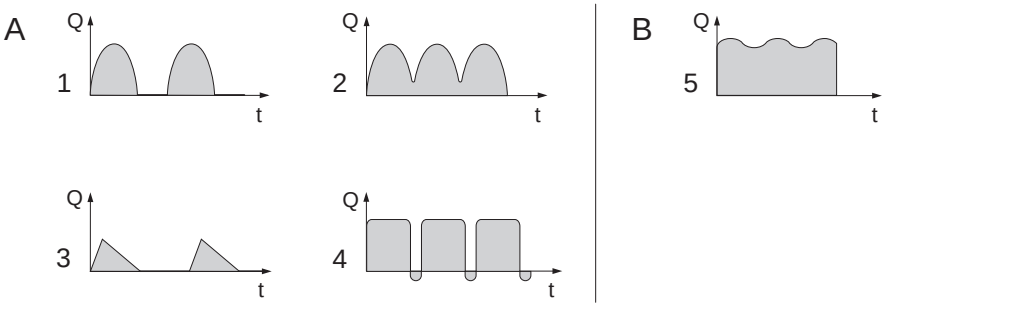


Fig. 41: Flow characteristics of various types of pump

A With severely pulsating flow
B With low pulsating flow

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

Note!
Before carrying out the Quick Setup "Pulsating Flow", the Quick Setup "Commissioning" has to be executed → 59.

Severely pulsating flow

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

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

Slightly pulsating flow

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

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

Performing the "Pulsating Flow" Quick Setup

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

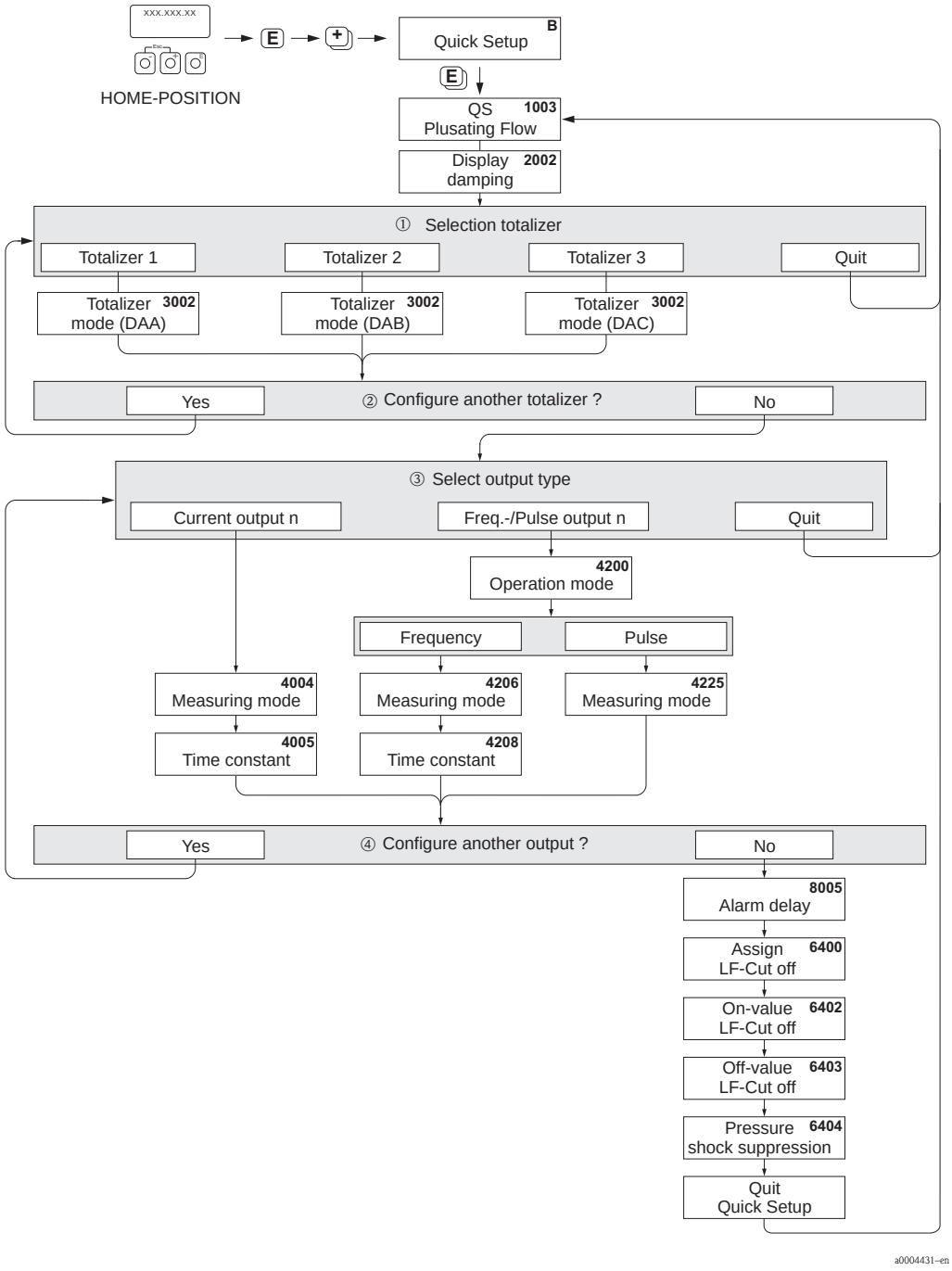


Fig. 42: Quick Setup for measuring severely pulsating flows.

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

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

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

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

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

Recommended Settings

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

▼

Basic configuration		
2002	DISPLAY DAMPING	1 s
3002	TOTALIZER MODE (DAA)	BALANCE (Totalizer 1)
3002	TOTALIZER MODE (DAB)	BALANCE (Totalizer 2)
3002	TOTALIZER MODE (DAC)	BALANCE (Totalizer 3)
Signal type for "CURRENT OUTPUT 1"		
4004	MEASURING MODE	PULSATING FLOW
4005	TIME CONSTANT	1 s
Signal type for "FREQ./PULSE OUTPUT 1" (for FREQUENCY operating mode)		
4206	MEASURING MODE	PULSATING FLOW
4208	TIME CONSTANT	0 s
Signal type for "FREQ./PULSE OUTPUT 1" (for PULSE operating mode)		
4225	MEASURING MODE	PULSATING FLOW
Other settings		
8005	ALARM DELAY	0 s
6400	ASSIGN LOW FLOW CUTOFF	MASS FLOW

Quick Setup "Pulsating Flow"		
6402	ON-VALUE LOW FLOW CUT OFF	Setting depends on diameter: DN 2 = 0.10 [kg/h] or [l/h] DN 4 = 0.45 [kg/h] or [l/h] DN 8 = 2.0 [kg/h] or [l/h] DN 15 = 6.5 [kg/h] or [l/h] DN 25 = 18 [kg/h] or [l/h] DN 40 = 45 [kg/h] or [l/h] DN 50 = 70 [kg/h] or [l/h] DN 80 = 180 [kg/h] or [l/h] DN 100 = 350 [kg/h] or [l/h] DN 150 = 650 [kg/h] or [l/h] DN 250 = 1800 [kg/h] or [l/h] DN 350 = 3250 [kg/h] or [l/h]
6403	OFF-VALUE LOW FLOW CUTOFF	50%
6404	PRESSURE SHOCK SUPPRESSION	0 s

▼

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

6.3.3 Quick Setup "Gas Measurement"

The measuring device is not only suitable for measuring liquid flow. Direct mass measurement based on the Coriolis principle is also possible for measuring the flow rate of gases.

Note!
- Before carrying out the Quick Setup "Gas Measurement", the Quick Setup "Commissioning" has to be executed → 59.
- Only mass and Corrected volume flow can be measured and output with the gas measurement mode. Note that direct density and/or volume measurement is not possible!
- The flow ranges and measuring accuracy that apply to gas measurement are not the same as those for liquids.
- If corrected volume flow (e.g. in Nm^3/h) is to be measured and output instead of the mass flow (e.g. in kg/h), change the setting for the CORRECTED VOLUME CALCULATION function to "FIXED REFERENCE DENSITY" in the "Commissioning" Quick Setup menu.
  Corrected volume flow can be assigned as follows:
  – to a display line,
  – to the current output,
  – to the pulse/frequency output.

Performing the "Gas Measurement" Quick Setup

This Quick Setup menu guides you systematically through the setup procedure for all the device functions that have to be parameterized and configured for gas measurement.

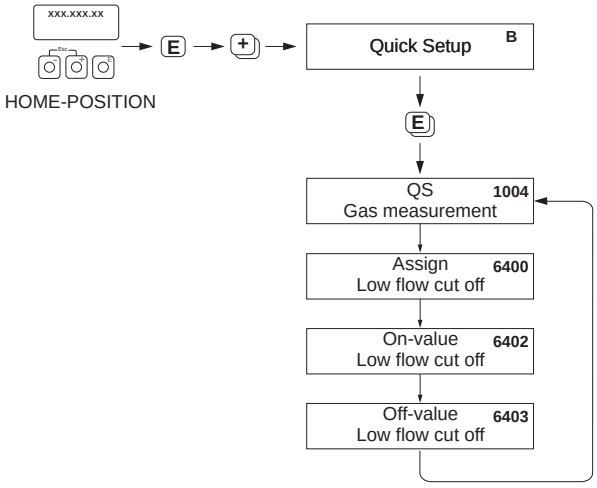


Fig. 43: Quick Setup "Gas Measurement"

Recommended settings are found on the following page.

Recommended Settings

Quick Setup "Gas Measurement"		
HOME position → E → MEASURED VARIABLE (A) MEASURED VARIABLE → + → QUICK SETUP (B) QUICK SETUP → E → QS-GAS MEASUREMENT (1004)		
Function No.	Function name	Setting to be selected (+) (to next function with E)
1004	QS GAS MEASUREMENT	YES After F is pressed by way of confirmation, the Quick Setup menu calls up all the subsequent functions in succession.
▼		
6400	ASSIGN LOW FLOW CUTOFF	On account of the low mass flow involved when gas flows are measured, it is advisable not use a low flow cut off. Setting: OFF
6402	ON-VALUE LOW FLOW CUT OFF	If the ASSIGNMENT LOW FLOW CUTOFF function was not set to "OFF", the following applies: Setting: 0.0000 [unit] User input: Flow rates for gas measurements are low, so the value for the switch-on point (= low flow cut off) must be correspondingly low.
6403	OFF-VALUE LOW FLOW CUTOFF	If the ASSIGNMENT LOW FLOW CUTOFF function was not set to "OFF", the following applies: Setting: 50% User input: Enter the switch-off point as a positive hysteresis in %, referenced to the switch-on point.
▼		
Back to the HOME position: → Press and hold down Esc key - + for longer than three seconds or → Repeatedly press and release Esc key - + → Exit the function matrix step by step		

Note!
Quick Setup automatically deactivates the function EMPTY PIPE DETECTION (6420) so that the instrument can measure flow at low gas pressures.

6.3.4 Quick Setup "Communication"

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

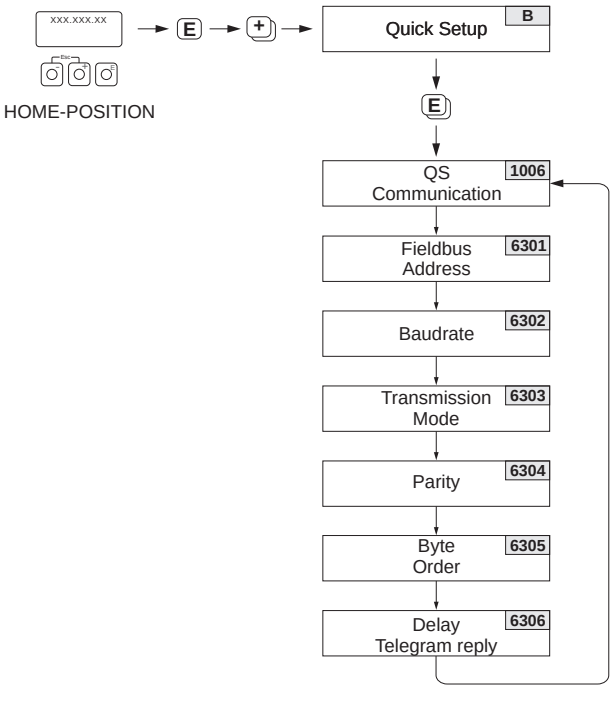


Fig. 44: Quick Setup communication

Settings are found on the following page.

Settings

Quick Setup "Communication"		
HOME position → E → MEASURAND → + → QUICK SETUP → E → QUICK SETUP COMMUNICATION		
Function No.	Function name	Setting to be selected (+ –) (to next function with E)
1006	QUICK SETUP COMMUNICATION	YES → After E is pressed by way of confirmation, the Quick Setup menu calls up all the subsequent functions in succession.
6301	FIELDBUS ADDRESS	Enter the device address (permitted address range: 1 to 247) **Factory setting:** 247
6302	BAUDRATE	Supported baudrates [BAUD]: 1200/2400/4800/9600/19200/38400/57600/115200 **Factory setting:** 19200 BAUD
6303	MODE DATA TRANSFER	Select the data transfer mode: ■ ASCII → Data transmission in the form of readable ASCII characters. Error protection via LRC. ■ RTU → Data transmission in binary form. Error protection via CRC16. **Factory setting:** RTU
6304	PARITY	Selection depends on the "Data transfer mode" function: NONE; EVEN; UNEVEN ■ Available in the ASCII transfer mode * even or uneven parity bit (EVEN, UNEVEN). ■ Available in the RTU transfer mode * no parity bit (NONE) or even or uneven parity bit (EVEN, UNEVEN). **Factory setting:** EVEN
6305	BYTE ORDER	Select the byte transmission sequence for the Integer, Float and String data types: 0 - 1 - 2 - 3 3 - 2 - 1 - 0 2 - 3 - 0 - 1 1 - 0 - 3 - 2 **Factory setting:** 1 - 0 - 3 - 2 Note! The transmission sequence must suit the Modbus master.
6306	DELAY TELE. REPLY	For entering a delay time after which the measuring device replies to the request telegram of the Modbus master. This allows communication to be adapted to slow Modbus masters: 0 to 100 ms **Factory setting:** 10 ms
Back to the HOME position: → Press and hold down Esc key for longer than three seconds or → Repeatedly press and release Esc keys = Exit the function matrix step by step		

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

6.3.5 Data back-up/transfer

You can use the T-DAT SAVE/LOAD function to transfer data (device parameters and settings) between the T-DAT (removable memory) and the EEPROM (device memory).

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

Note!
For information on installing and removing the T-DAT → 93.

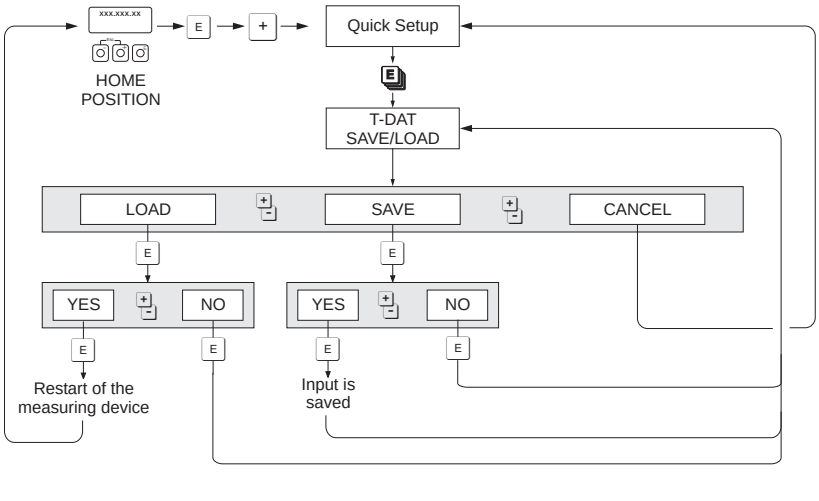


Fig. 45: Data storage/transmission with T-DAT SAVE/LOAD

Information on the LOAD and SAVE options available:

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

Note!
- Any settings already saved on the EEPROM are deleted.
- This option is only available if the T-DAT contains valid data.
- This option can only be executed if the software version of the T-DAT is the same as, or more recent than, that of the EEPROM. If this is not the case, the error message "TRANSM. SW-DAT" appears after restarting and the LOAD function is then no longer available.

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

6.4 Adjustment

6.4.1 Zero point adjustment

All Promass measuring devices are calibrated with state-of-the-art technology.
The zero point obtained in this way is printed on the nameplate.
Calibration takes place under reference operating conditions → 128.
Consequently, the zero point adjustment is generally **not** necessary for Promass!

Experience shows that the zero point adjustment is advisable only in special cases:
- To achieve highest measuring accuracy also at very small flow rates.
- Under extreme process or operating conditions (e.g. very high process temperatures or very high viscosity fluids).

Preconditions for a zero point adjustment

Note the following before you perform a zero point adjustment:
- A zero point adjustment can be performed only with fluids that contain no gas or solid contents.
- Zero point adjustment is performed with the measuring tubes completely filled and at zero flow (v = 0 m/s). This can be achieved, for example, with shutoff valves upstream and/or downstream of the sensor or by using existing valves and gates.
  – Normal operation → Valves 1 and 2 open
  – Zero point adjustment *with* pump pressure → Valve 1 open / valve 2 closed
  – Zero point adjustment *without* pump pressure → Valve 1 closed / valve 2 open

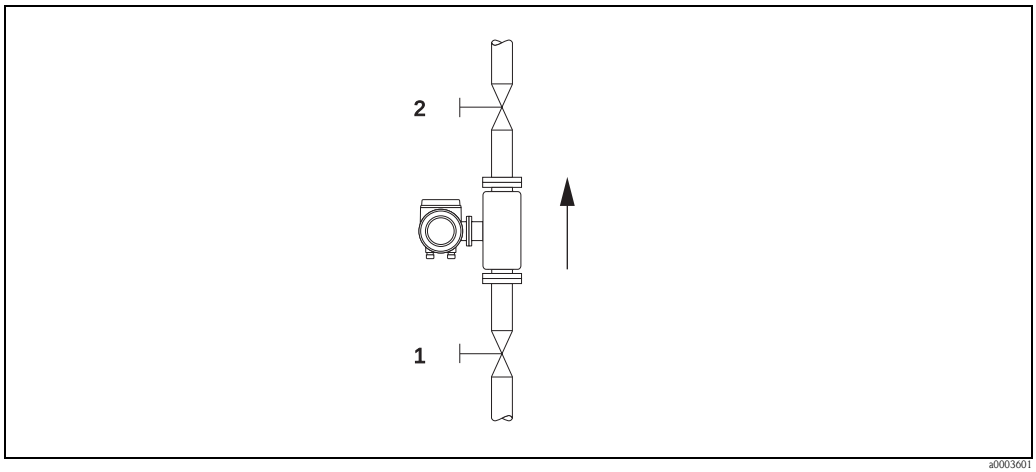


Fig. 46: Zero point adjustment and shutoff valves

Caution!
- If the fluid is very difficult to measure (e.g. containing entrained solids or gas) it may prove impossible to obtain a stable zero point despite repeated zero point adjustments. In instances of this nature, please contact your Endress+Hauser representative.
- You can view the currently valid zero point value using the "ZEROPOINT" function (see the "Description of Device Functions" manual).

Performing a zero point adjustment

1. Operate the system until operating conditions have settled.
2. Stop the flow (v = 0 m/s).
3. Check the shutoff valves for leaks.
4. Check that operating pressure is correct.
5. Now perform the adjustment as follows:

Key	Procedure	Display text
E	HOME position → enter the operating matrix.	> GROUP SELECTION < MEASURED VALUES
±	Select the "BASIC FUNCTION" block.	> GROUP SELECTION < BASIC FUNCTION
±	Select the "PROCESS PARAMETER" group.	> GROUP SELECTION < PROCESS PARAMETER
±	Select the "ADJUSTMENT" function group.	> GROUP SELECTION < ADJUSTMENT
E	Select the desired function "ZERO POINT ADJUST".	ZERO POINT ADJUST CANCEL
±	When you press ± you are automatically prompted to enter the access code if the function matrix is still disabled.	CODE ENTRY ***
±	Enter code (84 = factory setting)	CODE ENTRY 84
E	Confirm code entry. The "ZERO POINT ADJUST" function then appears again on the display.	PROGRAMMING ENABLED ZERO POINT ADJUST. CANCEL
±	Select "START"	ZERO POINT ADJUST. START
E	Confirm entry with the E-key. A security query appears on the display.	SURE? NO
±	Select "YES"	SURE? YES
E	Confirm entry with the E-key. Zero point adjustment is now started. The message on the right appears on the display for 30 to 60 seconds while zero point adjustment is in progress. If the flow in the pipe exceeds 0.1 m/s, the following error message appears on the display: "ZERO POINT ADJUST NOT POSSIBLE". When the zero point adjustment is completed, the "ZERO POINT ADJUST." function reappears on the display.	ZERO POINT ADJUST. RUNNING ZERO POINT ADJUST. CANCEL
E	The new zero point value is displayed when the Enter key is pressed.	ZERO POINT
±	Press ± simultaneously → HOME position	

6.4.2 Density adjustment

It is advisable to perform a density adjustment when optimum measuring accuracy is required for calculating density dependent values. The application may require a 1-point or 2-point density adjustment.

1-point density adjustment (with one fluid):
This type of density adjustment is necessary under the following circumstances:
- The sensor does not measure exactly the density value that the user expects on the basis of laboratory analyses.
- The fluid properties are outside the measuring points set at the factory, or the reference operating conditions used to calibrate the measuring device.
- The system is used exclusively to measure a fluid's density which must be registered to a high degree of accuracy under constant conditions.
  Example: Brix density measurement for apple juice.

2-point density adjustment (with two fluids):
This type of adjustment is always to be carried out if the measuring tubes have been mechanically altered by, e.g. material buildup, abrasion or corrosion. In such cases, the resonant frequency of the measuring tubes has been affected by these factors and is no longer compatible with the calibration data set at the factory. The 2-point density adjustment takes these mechanically-based changes into account and calculates new, adjusted calibration data.

Performing a 1-point or 2-point density adjustment

Caution!
- Onsite density adjustment can be performed only if the user has detailed knowledge of the fluid density, obtained for example from detailed laboratory analyses.
- The target density value specified in this way must not deviate from the measured fluid density by more than ±10%.
- An error in defining the target density affects all calculated density and volume functions.
- The 2-point density adjustment is only possible if both target density values are different from each other by at least 0.2 kg/l. Otherwise the error message #731 (adjustment is not possible) appears on the display.
- Density adjustment changes the factory density calibration values or the calibration values set by the service technician.
- The functions outlined in the following instructions are described in detail in the "Description of Device Functions" manual.

1. Fill the sensor with fluid. Make sure that the measuring tubes are completely filled and that liquids are free of gas bubbles.
2. Wait until the temperature difference between fluid and measuring tube has equalized. The time you have to wait for equalization depends on the fluid and the temperature level.
3. Using the local display, select the SETPOINT DENSITY function in the function matrix and perform density adjustment as follows:

Function No.	Function name	Setting to be selected (− or +) (to next function with E)
6482	DENSITY ADJUST MODE	Use ± to select a 1- or 2-point adjustment. Note! When you press ± you are automatically prompted to enter the access code if the function matrix is still disabled. Enter the code.
6483	DENSITY SET VALUE 1	Use ± to enter the target density of the first fluid and press E to save this value (input range = actual density value ±10%).

▼

Function No.	Function name	Setting to be selected (− or +) (to next function with E)
6484	MEASURE FLUID 1	Use ± to select START and press E . The message "DENSITY MEASUREMENT RUNNING" appears on the display for approximately 10 seconds. During this time Promass measures the current density of the first fluid (measured density value).

▼

For 2-point density adjustment only:

6485	DENSITY SET VALUE 2	Use ± to enter the target density of the second fluid and press E to save this value (input range = actual density value ±10%).
6486	MEASURE FLUID 2	Use ± to select START and press E . The message "DENSITY MEASUREMENT RUNNING" appears on the display for approximately 10 seconds. During this time Promass measures the current density of the second fluid (measured density value).

▼

6487	DENSITY ADJUSTMENT	Use ± to select DENSITY ADJUSTMENT and press E. The measuring device compares the measured density value and the target density value and calculates the new density coefficient.
6488	RESTORE ORIGINAL	If the density adjustment does not complete correctly, you can select the RESTORE ORIGINAL function to reactivate the default density coefficient.

▼

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

6.5 Rupture disk

Sensor housings with integrated rupture disks are optionally available.

Warning!
- Make sure that the function and operation of the rupture disk is not impeded through the installation. Triggering overpressure in the housing as stated on the indication label. Take adequate precautions to ensure that no damage occurs, and risk to human life is ruled out, if the rupture disk is triggered.
  Rupture disk: Burst pressure 10 to 15 bar (145 to 218 psi)
  (Promass X: 5,5 to 6,5 bar (80 to 94 psi))
- Please note that the housing can no longer assume a secondary containment function if a rupture disk is used.
- It is not permitted to open the connections or remove the rupture disk.

Caution!
- Rupture disks can not be combined with separately available heating jacket (except Promass A).
- The existing connection nozzles are not designed for a rinse or pressure monitoring function.

Note!
- Before commissioning, please remove the transport protection of the rupture disk.
- Please note the indication labels.

6.6 Purge and pressure monitoring connections

The sensor housing protects the inner electronics and mechanics and is filled with dry nitrogen. Beyond that, up to a specified measuring pressure it additionally serves as secondary containment.

Warning!
For a process pressure above the specified containment pressure, the housing does not serve as an additional secondary containment. In case a danger of measuring tube failure exists due to process characteristics, e.g. with corrosive process fluids, we recommend the use of sensors whose housing is equipped with special pressure monitoring connections (ordering option). With the help of these connections, fluid collected in the housing in the event of tube failure can be drained off. This diminishes the danger of mechanical overload of the housing, which could lead to a housing failure and accordingly is connected with an increased danger potential. These connections can also be used for gas purging (gas detection).

The following instructions apply to handling sensors with purge or pressure monitoring connections:
- Do not open the purge connections unless the containment can be filled immediately with a dry inert gas.
- Use only low gauge pressure to purge. Maximum pressure 5 bar (72.51 psi).

6.7 Memory (HistoROM)

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

6.7.1 HistoROM/S-DAT (sensor-DAT)

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

6.7.2 HistoROM/T-DAT (transmitter-DAT)

The T-DAT is an exchangeable data storage device in which all transmitter parameters and settings are stored. Storing of specific parameter settings from the EEPROM to the T-DAT and vice versa has to be carried out by the user (= manual save function). Detailed instructions regarding the appropriated function (T-DAT SAVE/LOAD) → 69.

7 Custody transfer measurement

Promass 84 is a flowmeter suitable for custody transfer measurement for liquids (other than water) and for gases.

7.1 Suitability for custody transfer, metrological control, obligation to subsequent verification

All Promass 84 flowmeters are verified on site using reference measurements.
Only once it has been verified on site by the Verification Authority for legal metrology controls may the measuring device be regarded as verified and used for applications subject to legal metrology controls. The associated seal (stamp) on the measuring device ensures this status.

Caution!
Only flowmeters verified by the Verification Authorities may be used for invoicing in applications subject to legal metrology controls. For all verification processes, both the corresponding approvals and the country-specific requirements resp. regulations (e.g. such as the German Verification Act) must be observed. The owner / user of the instrument is obliged to subsequent verification.

7.1.1 Approval for custody transfer

The following guidelines for the custody transfer process were developed in accordance with the following authorities for legal metrology controls:

- **PTB**, Germany
- **NMi**, The Netherlands
- **METAS**, Switzerland
- **BEV**, Austria
- **NTEP**, USA
- **MC**, Canada

7.1.2 Special features of working in the custody transfer mode

Switching on the power supply in custody transfer mode

If the measuring instrument is started in custody transfer mode, for example after a power outage, system error No. 271 "POWER BRK. DOWN" flashes on the local display.
The fault message can be acknowledged or reset using the "Enter" key or by means of the status input configured accordingly.

Note!
It is not mandatory to reset the fault message for correct operation.

7.2 Definition of terms

Terms used in the subject area "suitability for custody transfer measurement for liquids other than water

Verify	Inspection of a measuring system to determine the measured error from the "true" value with subsequent system sealing. Verification can only be carried out on site by the authority for legal metrology controls responsible.
Suitable for custody transfer measurement	A measuring system or a part of the system, for example counters or accessory equipment, has the (type) "approval for national verification" of a (national) approval center.
Verified	The measuring system has been inspected and sealed on site by a representative of the authority for legal metrology controls. This must be arranged by the facility's owner-operator.
Repair	Upon request, the authority responsible can give companies that repair verified measuring devices (repairers) the authority to mark repaired devices (repairer mark) if they have the equipment necessary for repair and adjustment and have properly trained specialist staff. Endress+Hauser is authorized to carry out repair work on verified measuring devices.
Adjust	Adjustment on site (zero point, density) under operating conditions. Is performed by the facility's owner-operator.
Calibrate	Determine and save correction values for the individual measuring instrument to get as close as possible to the "real" value with the measured value.
Quantity convertor	Unit for automatically converting the measured value determined to another variable (pressure, temperature, density, etc.) or nonvolatile saved conversion values for the fluid.
Measured error	(Also known as limit of permissible error, error limit or inaccuracy). Relative measurement error, derived from the quotient (measured value – "true" measured value) / "true" measured value in percent.
Measuring system	Measuring device that includes the counter and all the ancillary equipment and additional devices.
Reapproval	Verified measuring devices can be reapproved if they observe the applicable limits of error in legal metrology and meet any other requirements which applied when they were initially verified. The authority responsible provides you with information as to how long the verification is valid.
Q_{min}	Minimum flow as of which the counter must observe the error limits.
Q_{max}	Maximum flow of the counter while observing the error limits.
Stamp points	To be provided on all parts of the measuring system which cannot otherwise be protected against any alteration (=falsification) to measured value determination and processing. Lead stamping is preferably used, but adhesive seals are also permitted. They may only be affixed by an authorized party, namely authority for legal metrology controls or service team with field service mark.
Counter	Device for measuring, saving and displaying the variables subject to mandatory verification (mass, volume, density, etc.)
Additional devices	Equipment that does not have a direct effect on the measurement but which is needed to ensure correct measuring or make it easier (e.g. gas display units, filters, pumps, etc.)
Ancillary equipment	Equipment used for direct further processing of the measurement result (e.g. printers, quantity convertors, price calculators, preset devices, etc.)

7.3 Verification process

For all verification processes, both the corresponding approvals and the country-specific regulations must be observed.

For installation and commioning of the metrological gas meter read the document "Commissioning Instructions for PTB gas approval" (SD00128). The document can be obtained from your Endress+Hauser representative.

Please do not hesitate to contact your Endress+Hauser representative if you have any questions.

7.3.1 Setting up custody transfer mode

The measuring instrument has to be operational and not set to custody transfer mode.

1. Configure the functions important for custody transfer measurement, such as the output configuration, custody transfer variable and the measuring mode.
   In the "CUSTODY TRANSFER" block (function block Z; functions Z001 to Z008), the outputs relevant for custody transfer measurement can be set to custody transfer and the current custody transfer status can be displayed.

   In the "OUTPUTS" block (function block E), the custody transfer variables can be assigned to the existing outputs.

   In the "INPUTS" block (function block F), a switching behavior is assigned to the input.
   For NTEP and MC only: The "CUSTODY TRANSFER" block is hidden. All relevant outputs are set to custody transfer.

   ✎ Note!
   Please refer to the separate Device Functions manual for a detailed description of the functions.

2. Once all the functions relevant to custody transfer have been configured, the custody transfer code is entered in the "ACCESS CODE (2020)" cell.
   Custody transfer code: 8400
   The functions are locked once you enter the custody transfer code. These functions are marked with a keyhole symbol in the separate Device Functions manual (🔑).

3. The lead stamping of the measuring instrument (see illustration below)

4. The device is suitable for custody transfer measurement. The flow measurement may now be used in applications subject to legal metrology controls.

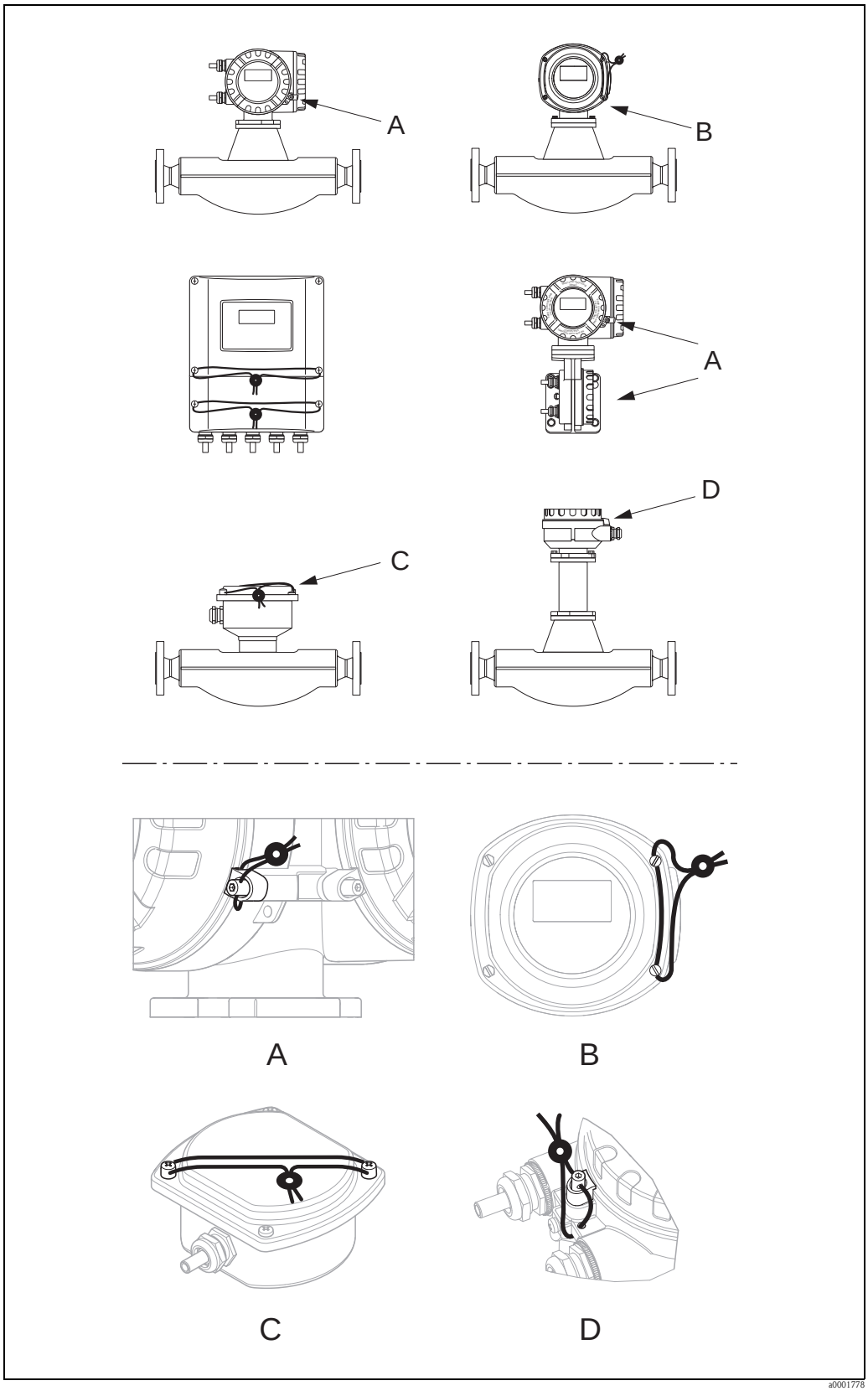


Fig. 47: Examples of how to seal the various device versions.

7.3.2 Disabling custody transfer mode

The measuring instrument has to be operational and already set to custody transfer mode.

1. Disconnect the device from the operating voltage.
2. Remove the custody transfer seals.

Warning!
In the case of explosion-protected equipment, observe a cooling or discharge time of 10 minutes before opening the device.

3. Open the cover of the transmitter housing electronics compartment.
   Detailed procedure for the compact version/wall-mount housing → 93.
4. Remove the S-DAT
5. Reconnect the device to the power supply.
6. The device runs through the startup cycle.
   After startup, the error message "#031 SENSOR HW-DAT" is displayed.

   Note!
   This error message appears because the S-DAT has been removed.
   This does not have any effect on the subsequent steps.
7. Disconnect the device from the power supply again.
8. Reinsert the S-DAT.
9. Screw the covers of the electronics compartment and the display module back on.
10. Reconnect the device to the power supply.
11. The device runs through the startup cycle.
    During startup, the message "CUSTODY TRANSFER NO" appears on the display.
12. The device is now operational and is not in custody transfer mode.

Note!
To set the device back to custody transfer mode → 77.

8 Maintenance

No special maintenance work is required.

8.1 External cleaning

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

8.2 Replacing seals

Under normal circumstances, fluid wetted seals of the Promass A sensor do not require replacement. Replacement is necessary only in special circumstances, for example if aggressive or corrosive fluids are incompatible with the seal material.

Note!
- The period between changes depends on the fluid properties and on the frequency of cleaning cycles in the case of CIP/SIP cleaning
- Replacement seals (accessories)

9 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Detailed information on the order code in question can be obtained from your Endress+Hauser representative.

9.1 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting set for transmitter	Mounting set for wall-mount housing (remote version). Suitable for: – Wall mounting – Pipe mounting – Installation in control panel Mounting set for aluminum field housing: Suitable for pipe mounting (3/4" to 3")	DK8WM – *
Post mounting set for the Promass A sensor	Post mounting set for the Promass A	DK8AS – * *
Mounting set for the Promass A sensor	Mounting set for Promass A, comprising: – 2 process connections – Seals	DK8MS – * * * * * *
Set of seals for sensor	For regular replacement of the seals of the Promass A sensor. Set consists of two seals.	DKS – * * *
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific power consumption, boiler efficiency and other parameters which are important for efficient energy management.	RSG40 – **********

9.2 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ■ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, accuracy or process connections ■ Graphic illustration of the calculation results Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ■ Via the Internet: https://wapps.endress.com/applicator ■ On CD-ROM for local PC installation.	DXA80 – *
W@M	Life cycle management for your plant W@M supports you with a wide range of software applications over the entire process: from planning and procurement, to the installation, commissioning and operation of the measuring devices. All the relevant device information, such as the device status, spare parts and device-specific documentation, is available for every device over the entire life cycle. The application already contains the data of your Endress+Hauser device. Endress+Hauser also takes care of maintaining and updating the data records. W@M is available: ■ Via the Internet: www.endress.com/lifecyclemanagement ■ On CD-ROM for local PC installation.	
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	FieldCare is Endress+Hauser's FDT-based plant asset management tool 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 flowmeters are accessed via a service interface or via the service interface FXA193.	→ Product page on the Endress+Hauser website: www.endress.com
FXA193	Service interface from the measuring device to the PC for operation via FieldCare.	FXA193 – *

10 Troubleshooting

10.1 Troubleshooting instructions

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

Check the display	
No display visible and no output signals present.	1. Check the supply voltage → Terminal 1, 2 2. Check device fuse → 📄 97 85 to 260 V AC: 0.8 A slow-blow / 250 V 20 to 55 V AC and 16 to 62 V DC: 2 A slow-blow / 250 V 3. Measuring electronics defective → order spare parts → 📄 92
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 → 📄 92 2. Display module defective → order spare parts → 📄 92 3. Measuring electronics defective → order spare parts → 📄 92
Display texts are in a foreign language.	Switch off power supply. Press and hold down both the ± keys and switch on the measuring device. The display text will appear in English (default) and is displayed at maximum contrast.
Measured value indicated, but no signal at the current or pulse output	Measuring electronics defective → order spare parts → 📄 92
▼	
Error messages on display	
Errors that occur during commissioning or measuring are displayed immediately. Error messages consist of a variety of icons. The meanings of these icons are as follows (example): – Type of error: **S** = System error, **P** = Process error – Error message type: ϟ = Fault message, **!** = Notice message – **FLUID INHOM.** = Error designation (e.g. fluid is not homogeneous) – **03:00:05** = Duration of error occurrence (in hours, minutes and seconds) – **#702** = Error number ☞ Caution! See the information → 📄 40	
Error number: No. 001 - 399 No. 501 - 699	System error (device error) has occurred → 📄 84
Error number: No. 400 - 499 No. 700 - 799	Process error (application error) has occurred → 📄 89
▼	
Other error (without error message)	
Some other error has occurred.	Diagnosis and rectification → 📄 90

10.2 System error messages

Serious system errors are **always** recognized by the instrument as "Fault message", and are shown as a lightning flash (ϟ) on the display!

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Important procedures must be carried out before you return a flowmeter to Endress+Hauser → 📄 98.
Always enclose a duly completed "Declaration of contamination" form. You will find a preprinted blank of this form at the back of this manual.

Note!
- The listed error message types below correspond to the factory setting.
- Also observe the information → 📄 40.

Modbus **Register: 6859 Data type: Integer**	**Register: 6821 Data type: String (18 byte)**	**No.**	**Device status message (local display)**	**Cause**	**Remedy / spare part**
Response to a fault message: The value "NaN" (not a number) is transmitted to the Modbus master instead of the current measured value.			**Depicted on the local display:** S = System error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without any effect on the outputs)		
1	SYSTEM OK	–	*There is no error present in the device*		
No. # 0xx → Hardware error					
2	CRITICAL FAIL.	**001**	S: CRITICAL FAILURE ϟ: # 001	Serious device error.	Replace the amplifier board.
3	AMP HW EEPROM	**011**	S: AMP HW EEPROM ϟ: # 011	Amplifier: Defective EEPROM.	Replace the amplifier board.
4	AMP SW EEPROM	**012**	S: AMP SW EEPROM ϟ: # 012	Amplifier: Error accessing EEPROM data.	The EEPROM data blocks in which an error has occurred are displayed in the "TROUBLESHOOTING" function. Press ENTER to acknowledge the errors in question; default values are automatically inserted instead of the erroneous parameter values. Note! The measuring device has to be restarted if an error has occurred in the totalizer block (see also error No. 111 / CHECKSUM TOTAL.).
11	SENSOR HW DAT	**031**	S: SENSOR HW DAT ϟ: # 031	Sensor DAT: 1. S-DAT is defective. 2. S-DAT is not plugged into the amplifier board or is missing.	1. Replace the S-DAT. 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.
12	SENSOR SW DAT	**032**	S: SENSOR SW DAT ϟ: # 032	Sensor DAT: Error accessing the calibration values stored in the S-DAT.	1. Check whether the S-DAT is correctly plugged into the amplifier board. 2. Replace the S-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary.

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
13	TRANSM. HW-DAT	**041**	S: TRANSM. HW DAT ϟ: # 041	Transmitter DAT: 1. T-DAT is defective. 2. T-DAT is not plugged into the amplifier board or is missing.	1. Replace the T-DAT. Check the spare part set number to ensure that the new, replacement DAT is compatible with the measuring electronics. 2. Plug the T-DAT into the amplifier board.
14	TRANSM. SW-DAT	**042**	S: TRANSM. SW DAT ϟ: # 042	Transmitter DAT: Error accessing the adjustment values stored in the T-DAT.	1. Check whether the T-DAT is correctly plugged into the amplifier board. 2. Replace the T-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary.
No. # 1xx → Software error					
143	A/C SW COMPATIB.	**121**	S: A / C COMPATIB. !: # 121	Due to different software versions, I/O board and amplifier board are only partially compatible (possibly restricted functionality). ✎ Note! – This message is only listed in the error history. – Nothing is displayed on the display.	Module with low software version has either to be actualized by ToF Tool - Fieldtool Package with the required SW version or the module has to be replaced.
No. # 2xx → Error in DAT / no communication					
22	LOAD T-DAT	**205**	S: LOAD T-DAT !: # 205	Transmitter DAT: Data backup (downloading) to T-DAT failed, or error when accessing (uploading) the calibration values stored in the T-DAT.	1. Check whether the T-DAT is correctly plugged into the amplifier board. 2. Replace the T-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary.
23	SAVE T-DAT	**206**	S: SAVE T-DAT !: # 206		
27	COMMUNIC. SENS	**251**	S: COMMUNICATION I/O ϟ: # 251	Internal communication fault on the amplifier board.	Remove the amplifier board.
28	COMMUNIC. I/O	**261**	S: COMMUNICATION I/O ϟ: # 261	No data reception between amplifier and I/O board or faulty internal data transfer.	Check the BUS contacts.
30	POWER BRK.DWN	**271**	S: POWER BRK. DOWN ϟ: # 271	Power supply interrupted. Error message appears during device startup in custody transfer mode after a power failure.	Confirm with the ENTER key or reset via the auxiliary input (status input).

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
No. # 3xx → System limits exceeded					
131 to 134	STACK CUR. OUT n	**339 to 342**	S: STACK CUR OUT n ϟ: # 339 to 342	The temporarily buffered flow portions (measuring mode for pulsating flow) could not be cleared or output within 60 seconds.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable. Recommendation: – Configure the fault response of the output to "ACTUAL VALUE", so that the temporary buffer can be cleared. – Clear the temporary buffer by the measures described under Item 1.
135 to 138	STACK FREQ. OUT n	**343 to 346**	S: STACK FREQ. OUT n ϟ: # 343 to 346		
139 to 142	STACK PULSE n	**347 to 350**	S: STACK PULSE OUT n ϟ: # 347 to 350	The temporarily buffered flow portions (measuring mode for pulsating flow) could not be cleared or output within 60 seconds.	1. Increase the setting for pulse weighting. 2. Increase the max. pulse frequency if the totalizer can still process the number of pulses. 3. Increase or reduce flow, as applicable. Recommendation: – Configure the fault response of the output to "ACTUAL VALUE", so that the temporary buffer can be cleared. – Clear the temporary buffer by the measures described under Item 1.
39 to 42	RANGE CUR. OUT n	**351 to 354**	S: CURRENT RANGE n !: # 351 to 354	Current output: The actual value for the flow lies outside the set limits.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable.
43 to 46	RANGE FREQ. OUT n	**355 to 358**	S: FREQ. RANGE n !: # 355 to 358	Frequency output: The actual value for the flow lies outside the set limits.	1. Change the upper or lower limit setting, as applicable. 2. Increase or reduce flow, as applicable.
47 to 50	RANGE PULSE n	**359 to 362**	S: PULSE RANGE !: # 359 to 362	Pulse output: Pulse output frequency is out of range.	1. Increase the setting for pulse weighting. 2. When entering the pulse width, select a value that can still be processed by an external totalizer (e.g. mechanical totalizer, PLC, etc.). *Determine the pulse width:* – Version 1: Enter the minimum duration that a pulse must be present at the connected counter to ensure its registration. – Version 2: Enter the maximum (pulse) frequency as the half "reciprocal value" that a pulse must be present at the connected counter to ensure its registration. Example: The maximum input frequency of the connected counter is 10 Hz. The pulse width to be entered is: $\frac{1}{2 \cdot 10\ \text{Hz}} = 50\ \text{ms}$ a0004437 3. Reduce flow.
52 to 53	LOW FREQ. LIM.	**379**	S: LOW FREQ. LIM ϟ: # 379	The measuring tube oscillation frequency is outside the permitted range. Causes: – Measuring tube damaged – Sensor defective or damaged	Contact your Endress+Hauser service organization.
53	UPPER FREQ. LIM.	**380**	S: UPPER FREQ. LIM ϟ: # 380		

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
54	FLUIDTEMP. MIN.	**381**	S: FLUIDTEMP.MIN. ϟ: # 381	The temperature sensor on the measuring tube is likely defective.	Check the following electrical connections before you contact your Endress+Hauser service organization: – Verify that the sensor signal cable connector is correctly plugged into the amplifier board. – Remote version: Check sensor and transmitter terminal connections No. 9 and 10.
55	FLUIDTEMP. MAX.	**382**	S: FLUIDTEMP.MAX. ϟ: # 382		
56	CARR.TEMP. MIN.	**383**	S: CARR.TEMP.MIN ϟ: # 383	The temperature sensor on the carrier tube is likely defective.	Check the following electrical connections before you contact your Endress+Hauser service organization: – Verify that the sensor signal cable connector is correctly plugged into the amplifier board. – Remote version: Check sensor and transmitter terminal connections No. 11 and 12.
57	CARR.TEMP. MAX.	**384**	S: CARR.TEMP.MAX ϟ: # 384		
58	INL. SENS DEF	**385**	S: INL.SENS.DEF. ϟ: # 385	One of the measuring tube sensor coils (inlet) is likely defective.	Check the following electrical connections before you contact your Endress+Hauser service organization: – Verify that the sensor signal cable connector is correctly plugged into the amplifier board. – Remote version: Check sensor and transmitter terminal connections No. 4, 5, 6 and 7.
59	OUTL. SENS. DEF	**386**	S: OUTL.SENS.DEF. ϟ: # 386	One of the measuring tube sensor coils (outlet) is likely defective.	
60	SEN. ASY. EXCEED	**387**	S: SEN.ASY.EXCEED ϟ: # 387	One of the measuring tube sensor coils is probably faulty.	
61 to 62	AMP. FAULT CH2 AMP. FAULT CH3	**388 to 390**	S: AMP. FAULT ϟ: # 388 to 390	Amplifier error	Contact your Endress+Hauser service organization.
No. # 5xx → Application error					
72	SW-DOWNLOAD	**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 process is finished. The device will restart automatically.
73	DOWN-UPLOAD ACTIVE	**502**	S: UP-/DOWNLOAD ACT. !: # 502	Up- or downloading the device data via configuration program. Currently no other functions are possible.	Wait until process is finished.
76	OSC.AMP.LIM	**586**	S: OSC. AMP. LIMIT ϟ: # 586	The fluid properties do not allow a continuation of the measurement. Causes: – Extremely high viscosity – Process fluid is very inhomogeneous (gas or solid content)	Change or improve process conditions.
77	TUBE NOT OSC.	**587**	S: TUBE OSC. NOT ϟ: # 587	Extreme process conditions exist. The measuring system can therefore not be started.	Change or improve process conditions.
78	GAIN RED.IMPOS	**588**	S: GAIN RED.IMPOS ϟ: # 588	Overdriving of the internal analog to digital converter. Possible causes are cavitation, extreme pressure shock and high flow velocity for gases A continuation of the measurement is no longer possible!	Change or improve process conditions, e.g. by reducing the flow velocity.

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
No. # 6xx → Simulation mode active					
79	POS.ZERO -RET.	**601**	S: POS. ZERO-RET. !: # 601	Positive zero return active. ☝ Caution! This message has the highest display priority.	Switch off positive zero return.
80 to 83	SIM. CURR. OUT n	**611 to 614**	S: SIM. CURR. OUT. n !: # 611 to 614	Simulation current output active.	Switch off simulation.
84 to 87	SIM FREQ. OUT 1…4	**621 to 624**	S: SIM. FREQ. OUT n !: # 621 to 624	Simulation frequency output active.	Switch off simulation.
88 to 91	SIM. PULSE n	**631 to 634**	S: SIM. PULSE n !: # 631 to 634	Simulation pulse output active.	Switch off simulation.
104 to 107	SIM. STATUS IN n	**671 to 674**	S: SIM. STAT. IN n !: # 671 to 674	Simulation status input active.	Switch off simulation.
108	SIM. FAILSAFE	**691**	S: SIM. FAILSAFE ϟ: # 691	Simulation of response to error (outputs) active.	Switch off simulation.
109	SIM MEASURAND	**692**	S: SIM. MEASURAND !: # 692	Simulation of measuring variables (e.g. mass flow).	Switch off simulation.
150	DEV. TEST ACT.	**698**	S: DEV. TEST AKT. !: # 698	The measuring device is being checked on site via the test and simulation device.	–

10.3 Process error messages

Note!
Further information → 📄 40.

Modbus Register: 6859 Data type: Integer	Modbus Register: 6821 Data type: String (18 byte)	No.	Device status message (local display)	Cause	Remedy / spare part
Response to a fault message: The value "NaN" (not a number) is transmitted to the Modbus master instead of the current measured value.			**Depicted on the local display:** S = System error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without any effect on the outputs)		
1	SYSTEM OK	–	*There is no error present in the device*		
No. # 7xx → Other process errors					
111	EMPTY PIPE	**700**	P: EMPTY PIPE !: # 700	The process fluid density is outside the upper or lower limit values set in the "EPD" function. Causes: – Air in the measuring tube – Partly filled measuring tube	1. Ensure that there is no gas content in the process liquid. 2. Adapt the values in the "EPD" function to the current process conditions.
112	EXC. CURR. LIM	**701**	P: EXC. CURR. LIM !: # 701	The maximum current value for the measuring tube exciter coils has been reached, since certain process fluid characteristics are extreme, e.g. high gas or solid content. The instrument continues to work correctly.	In particular with outgassing fluids and/or increased gas content, the following measures are recommended to increase system pressure: 1. Install the instrument at the outlet side of a pump. 2. Install the instrument at the lowest point of an ascending pipeline. 3. Install a flow restriction, e.g. reducer or orifice plate, downstream from the instrument
113	FLUID INHOM.	**702**	P: FLUID INHOM. !: # 702	Frequency control is not stable, due to inhomogeneous process fluid, e.g. gas or solid content.	
114	NOISE LIM. CH0	**703**	P: NOISE LIM. CH0 !: # 703	Overdriving of the internal analog to digital converter. Causes: – Cavitation – Extreme pressure pulses – High gas flow velocity A continuation of the measurement is still possible!	Change or improve process conditions, e.g. by reducing the flow velocity.
115	NOISE LIM. CH1	**704**	P: NOISE LIM. CH1 !: # 704		
116	FLOW LIMIT	**705**	P: FLOW LIMIT ϟ: # 705	The mass flow is too high. The electronics' measuring range will be exceeded.	Reduce flow
124	ADJ. ZERO FAIL.	**731**	P: ADJ. ZERO FAIL !: # 731	The zero point adjustment is not possible or has been canceled.	Make sure that zero point adjustment is carried out at "zero flow" only (v = 0 m/s).

10.4 Process errors without messages

Symptoms	Rectification
Comment: You may have to change or correct certain settings of the function matrix in order to rectify faults. The functions outlined below, such as DISPLAY DAMPING, are described in detail in the "Description of Device Functions" manual.	
Measured value reading fluctuates even though flow is steady.	1. Check the fluid for presence of gas bubbles. 2. "TIME CONSTANT" function → increase value (→ OUTPUTS / CURRENT OUTPUT / CONFIGURATION) 3. "DISPLAY DAMPING" function → increase value (→ USER INTERFACE / CONTROL / BASIC CONFIG.)
Flow values are negative, even though the fluid is flowing forwards through the pipe.	Change the "INSTALLATION DIRECTION SENSOR" function accordingly.
Measured-value reading or measured-value output pulsates or fluctuates, e.g. because of reciprocating pump, peristaltic pump, diaphragm pump or pump with similar delivery characteristic.	Run the "Pulsating Flow" Quick Setup. → 🖹 61 If the problem persists despite these measures, a pulsation damper will have to be installed between pump and measuring device.
There are differences between the flowmeter's internal totalizer and the external metering device.	This symptom is due primarily to backflow in the piping, because the pulse output cannot subtract in the "STANDARD" or "SYMMETRY" measuring modes. The problem can be solved as follows: Allow for flow in both directions. Set the "MEASURING MODE" function to "PULSATING FLOW" for the pulse output in question.
Measured value reading shown on display, even though the fluid is at a standstill and the measuring tube is full.	1. Check the fluid for presence of gas bubbles. 2. Activate the "ON-VAL. LF-CUTOFF" function, i.e. enter or increase the value for the low flow cut off (→ BASIC FUNCTION / PROCESSPARAMETER / CONFIGURATION).
The error cannot be eliminated or another error pattern is present. In these instances, please contact your Endress+Hauser service organization.	The following solutions are possible: **Request the services of an Endress+Hauser service technician** If you request the services of a service technician, please be ready with the following information: – Brief error description – Nameplate specifications: order code and serial number → 🖹 7 **Return the devices to Endress+Hauser** Procedures must be carried out before you return a flowmeter to Endress+Hauser for repair or calibration. Please see → 🖹 98. Always enclose a duly completed "Declaration of contamination" form with the flowmeter. You will find a master copy of the Dangerous Goods Sheet at the back of these Operating Instructions. **Replace the transmitter electronics** Parts of the measuring electronics defective → order spare part → 🖹 98

10.5 Response of outputs to errors

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

You can use positive zero return to set the signals of the current, pulse and status 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 present	Positive zero return is activated
Caution! System or process errors defined as "Notice messages" have no effect whatsoever on the inputs and outputs. See the information on → 40.		
Modbus RS485	In the event of faults, the value "NaN" (not a number) is transmitted instead of the current measured value.	–
Current output	MIN. 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 separate "Description of Device Functions" manual). MAX. 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 separate "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 HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Frequency output	FALLBACK VALUE Signal output → 0 Hz FAILSAFE VALUE Output of the frequency specified in the FAILSAFE VALUE function. HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Totalizer	STOP The totalizers are paused until the fault is rectified. ACTUAL VALUE The fault is ignored. The totalizer continues 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).	Totalizer stops

10.6 Spare parts

The previous sections contain detailed troubleshooting instructions → 📄 83.
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 representative by providing the serial number printed on the transmitter's nameplate → 📄 7.

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

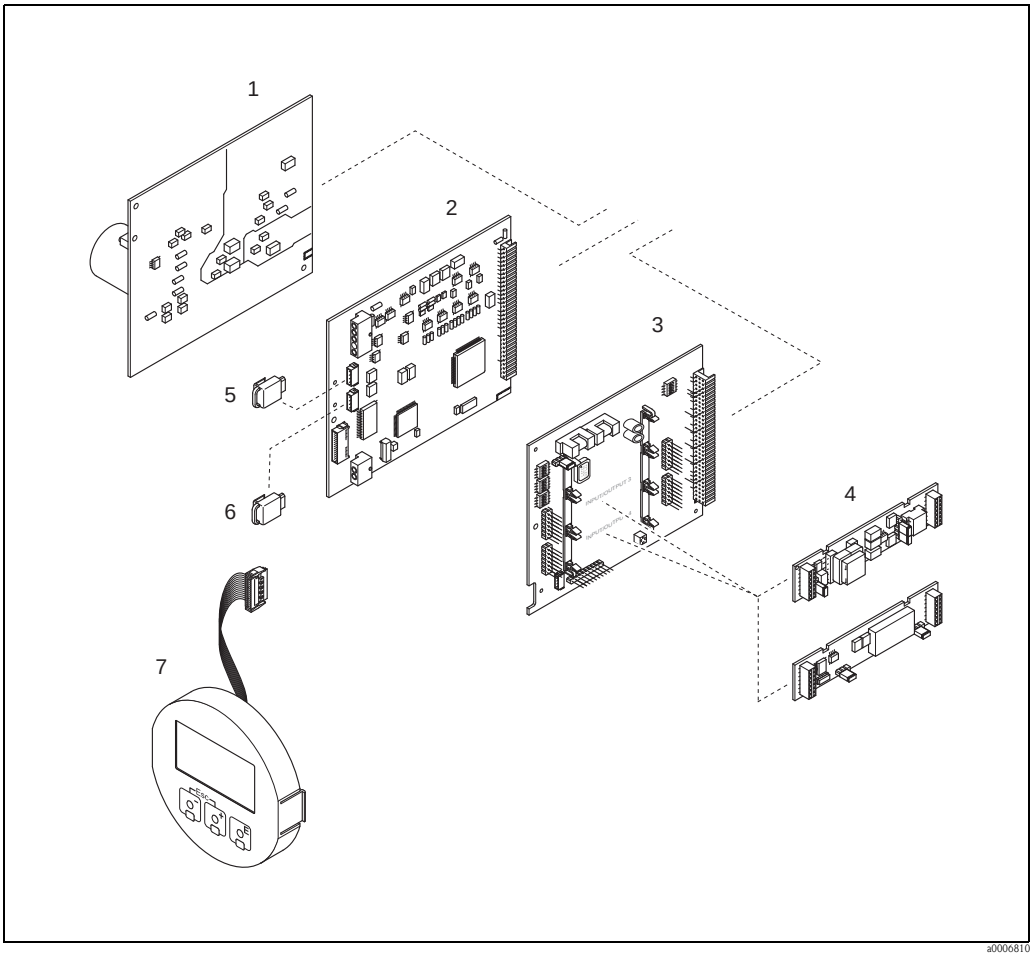


Fig. 48: Spare parts for transmitter 84 (field and wall-mount housings)

1 Power unit board (85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC)
2 Amplifier board
3 I/O board (COM module)
4 Pluggable input/output submodules; product structure → 📄 81
5 S-DAT (sensor data memory)
6 T-DAT (transmitter data memory)
7 Display module

10.6.1 Removing and installing printed circuit boards

Field housing

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

Caution!
Use only original Endress+Hauser parts.

Installing and removing printed circuit boards → 49:

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the local display (1) as follows:
   – Press in the latches (1.1) at the side and remove the display module.
   – Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
3. Remove the screws and remove the cover (2) from the electronics compartment.
4. Remove
   power unit board (4) and I/O board (6):
   Insert a thin pin into the hole (3) provided for the purpose and pull the board clear of its holder.
5. Remove submodules (6.1) (optional):
   No tools are required for removing the submodules (outputs) from the I/O board. Installation is also a no-tools operation.

   Caution!
   Only certain combinations of submodules on the I/O board are permissible → 32.
   The individual slots are marked and correspond to certain terminals in the connection compartment of the transmitter:
   – Slot "INPUT / OUTPUT 3" = Terminals 22/23
   – Slot "INPUT/OUTPUT 4" = Terminals 20/21
6. Remove amplifier board (5):
   – Disconnect the plug of the sensor signal cable (5.1) including S-DAT (5.3) from the board.
   – Gently disconnect the plug of the exciting current cable (5.2) from the board, i.e. without moving it back and forth.
   – Insert a thin pin into the hole (3) provided for the purpose and pull the board clear of its holder.
7. Installation is the reverse of the removal procedure.

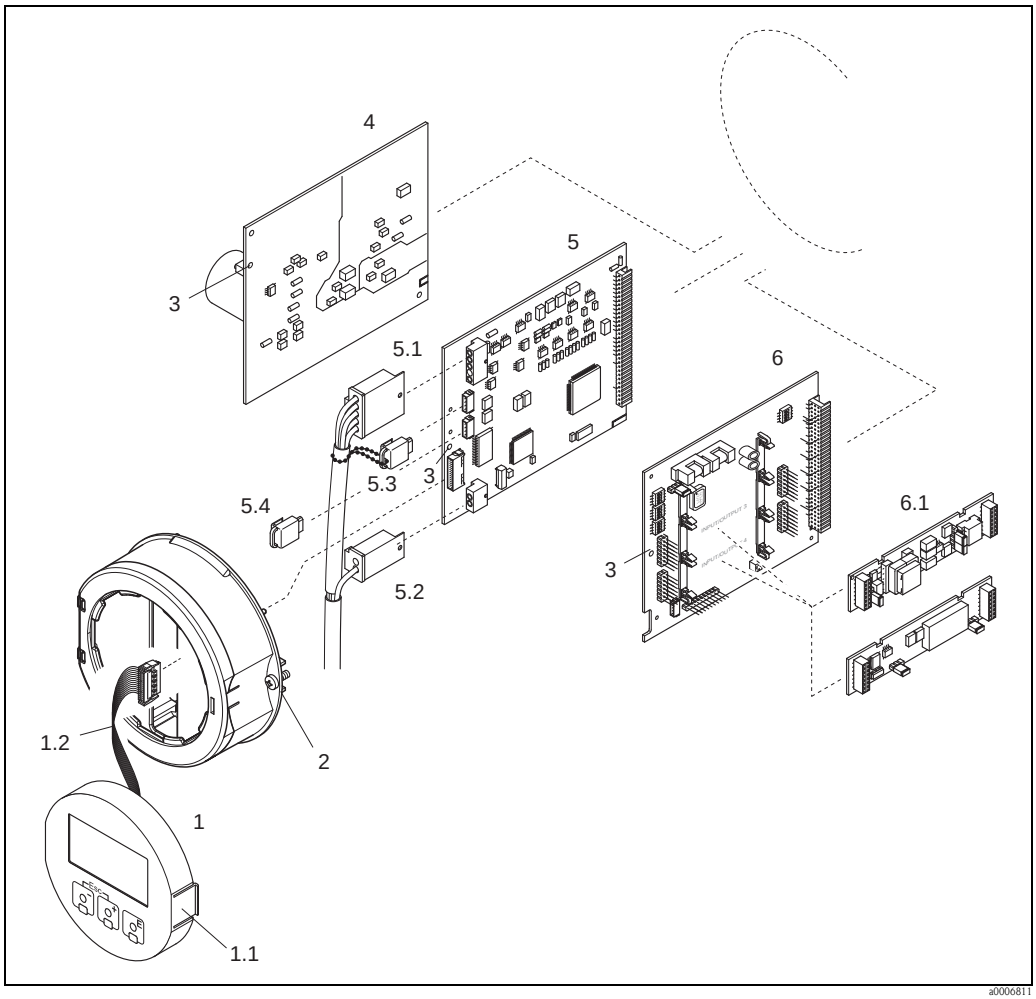


Fig. 49: Field housing: removing and installing printed circuit boards

1 Local display
1.1 Latch
1.2 Ribbon cable (display module)
2 Screws of electronics compartment cover
3 Aperture for installing/removing boards
4 Power unit board
5 Amplifier board
5.1 Signal cable (sensor)
5.2 Excitation current cable (sensor)
5.3 S-DAT (sensor data memory)
5.4 T-DAT (transmitter data memory)
6 I/O board (flexible assignment)
6.1 Optional: pluggable submodules (current output, pulse/frequency output and relay output)

Wall-mount housing

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

Caution!
Use only original Endress+Hauser parts.

Installing and removing printed circuit boards → 50:

1. Remove the screws and open the hinged cover (1) of the housing.
2. Remove the screws securing the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mount housing.
3. Disconnect the following cable plugs from amplifier board (7):
   – Sensor signal cable plug (7.1) including S-DAT (7.3)
   – Connector of exciting current cable (7.2):
     Gently disconnect the plug, i.e. without moving it back and forward.
   – Ribbon cable plug (3) of the display module.
4. Remove the cover (4) from the electronics compartment by loosening the screws.
5. Remove the boards (6, 7, 8):
   Insert a thin pin into the hole (5) provided for the purpose and pull the board clear of its holder.
6. Remove submodules (8.1) (optional):
   No tools are required for removing the submodules (outputs) from the I/O board. Installation is also a no-tools operation.

   Caution!
   Only certain combinations of submodules on the I/O board are permissible → 32.
   The individual slots are marked and correspond to certain terminals in the connection compartment of the transmitter:

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

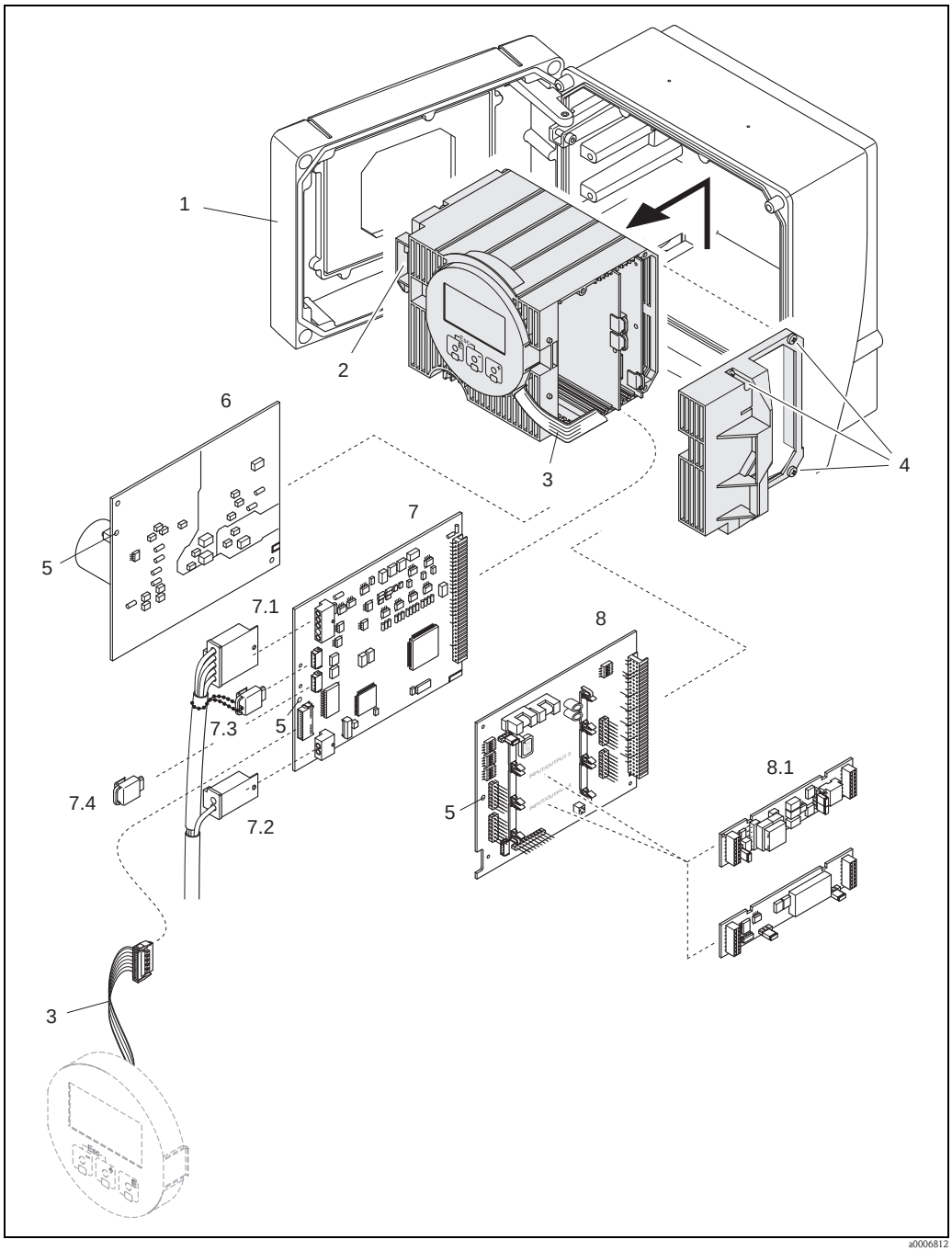


Fig. 50: Wall-mount housing: removing and installing printed circuit boards

1 Housing cover
2 Electronics module
3 Ribbon cable (display module)
4 Screws of electronics compartment cover
5 Aperture for installing/removing boards
6 Power unit board
7 Amplifier board
7.1 Signal cable (sensor)
7.2 Excitation current cable (sensor)
7.3 S-DAT (sensor data memory)
7.4 T-DAT (transmitter data memory)
8 I/O board (flexible assignment)
8.1 Optional: pluggable submodules (current output, pulse/frequency output and relay output)

10.6.2 Replacing the device fuse

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

The main fuse is on the power unit board → 51.
The procedure for replacing the fuse is as follows:

1. Switch off power supply.
2. Remove the power unit board → 93.
3. Remove the protection cap (1) and replace the device fuse (2).
   Only use the following fuse type:
   – 20 to 55 V AC / 16 to 62 V DC → 2.0 A slow-blow / 250 V; 5.2 × 20 mm
   – Power supply 85 to 260 V AC → 0.8 A slow-blow / 250 V; 5.2 × 20 mm
   – Ex-rated devices → see the Ex documentation
4. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

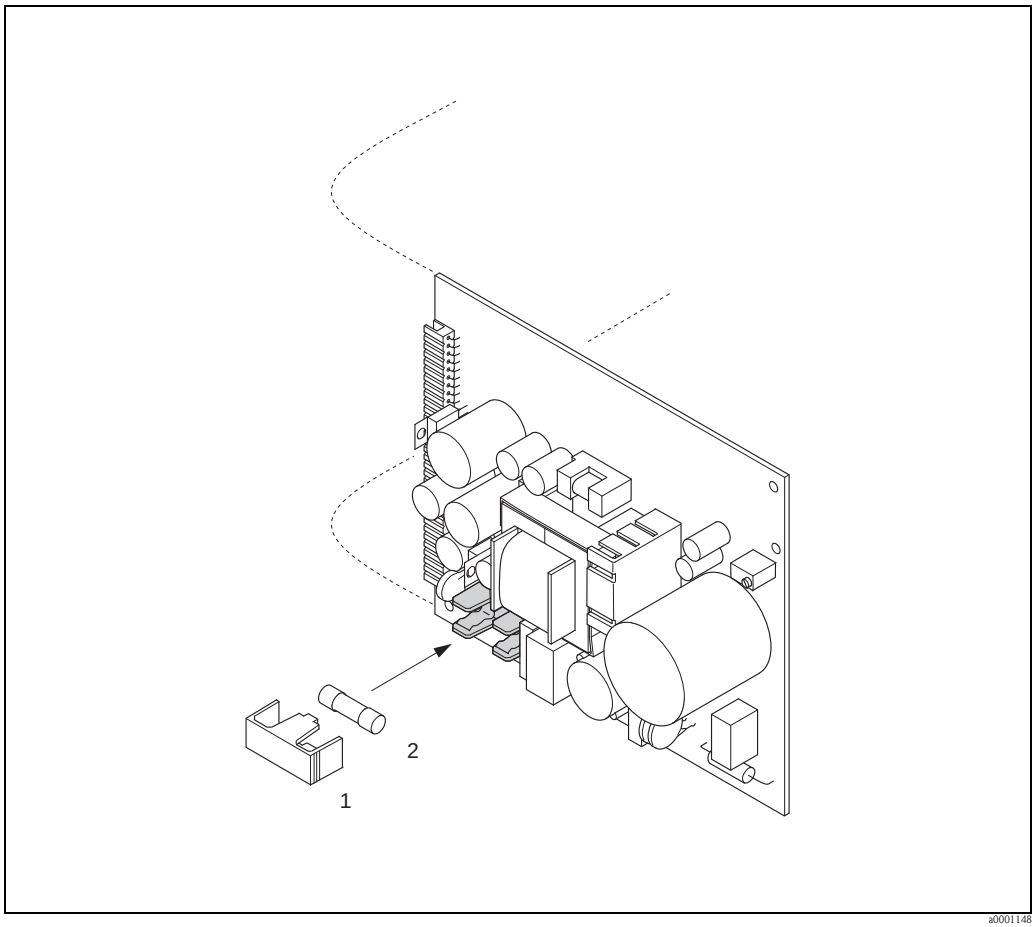


Fig. 51: Replacing the device fuse on the power unit board

1 Protective cap
2 Device fuse

10.7 Return

Caution!
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.

The following steps must be taken before returning a flow measuring device to Endress+Hauser, e.g. for repair or calibration:
- 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 EC REACH Regulation No. 1907/2006.
- 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 these Operating Instructions.

10.8 Disposal

Observe the regulations applicable in your country!

10.9 Software history

Date	Software version	Changes to software	Operating Instructions
10.2012	3.06.XX	–	71197494/14.12
03.2012		New Sensor: Promass O, Promass X	71157212/13.11
06.2010		Software adjustment	71116482/06.10
07.2007	3.04.XX	Software adjustment	71035275/12.06
12.2006	3.03.XX	Original software	

11 Technical data

11.1 Technical data at a glance

11.1.1 Applications

→ 7

11.1.2 Function and system design

Measuring principle

Mass flow measurement by the Coriolis principle

Measuring system

→ 7

11.1.3 Input

Measured variable

- Mass flow (proportional to the phase difference between two sensors mounted on the measuring tube to register a phase shift in the oscillation)
- Fluid density (proportional to resonance frequency of the measuring tube)
- Fluid temperature (via temperature sensors)/(not suitable for custody transfer measurement)

Measuring range in non-custody transfer mode

Measuring ranges for liquids

DN		Range for full scale values (liquids) $\dot{m}_{min(F)}$ to $\dot{m}_{max(F)}$	
[mm]	[inch]		
2	1/12	0 to 100 kg/h	0 to 3.7 lb/min
4	1/8	0 to 450 kg/h	0 to 16.5 lb/min
8	3/8	0 to 2000 kg/h	0 to 73.5 lb/min
15	½	0 to 6500 kg/h	0 to 238 lb/min
25	1	0 to 18000 kg/h	0 to 660 lb/min
40	1 ½	0 to 45000 kg/h	0 to 1650 lb/min
50	2	0 to 70000 kg/h	0 to 2570 lb/min
80	3	0 to 180000 kg/h	0 to 6600 lb/min
100	4	0 to 350000 kg/h	0 to 12860 lb/min
150	6	0 to 800000 kg/h	0 to 29400 lb/min
250	10	0 to 2200000 kg/h	0 to 80860 lb/min
350	14	0 to 4100 t/h	0 to 4520 tn. sh./h

Measuring ranges for gases, general

The full scale values depend on the density of the gas.
Use the formula below to calculate the full scale values:

$\dot{m}_{max(G)} = \dot{m}_{max(F)} \cdot \rho_{(G)} : x$ [kg/m³ (lb/ft³)]

$\dot{m}_{max(G)}$ = Max. full scale value for gas [kg/h (lb/min)]
$\dot{m}_{max(F)}$ = Max. full scale value for liquid [kg/h (lb/min)]
$\rho_{(G)}$ = Gas density in [kg/m³ (lb/ft³)] for process conditions

Here, $\dot{m}_{max(G)}$ can never be greater than $\dot{m}_{max(F)}$

Measuring ranges for gases (Promass F, O):

DN		x
[mm]	[inch]	
8	3/8	60
15	½	80
25	1	90
40	1½	90
50	2	90
80	3	110
100	4	130
150	6	200
250	10	200

Measuring ranges for gases (Promass A)

DN		x
[mm]	[inch]	
2	1/12"	32
4	1/8"	32

Measuring ranges for gases (Promass X)

DN		x
[mm]	[inch]	
350	14	200

Calculation example for gas:

- Sensor type: Promass F, DN 50
- Gas: air with a density of 60.3 kg/m³ (at 20 °C and 50 bar)
- Measuring range (liquid): 70000 kg/h
- x = 90 (for Promass F DN 50)

Max. possible full scale value:
$\dot{m}_{max(G)} = \dot{m}_{max(F)} \cdot \rho_{(G)} \div x$ [kg/m³] = 70000 kg/h · 60.3 kg/m³ ÷ 90 kg/m³ = 46900 kg/h

Recommended full scale values

See information on → 117 ("Limiting flow")

Measuring range in custody transfer mode PTP approval

The following are example data for German PTB approval (liquids other than water)

Measuring ranges for liquids in mass flow (Promass F)

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[kg/min]	[lbs/min]	[kg]	[lbs]
8	3/8	1.5 to 30	3.3075 to 66.15	0.5	1.10
15	1/2	5 to 100	11.025 to 220.5	2	4.41
25	1	15 to 300	33.075 to 661.5	5	11.0
40	1 1/2	35 to 700	77.175 to 1543.5	20	44.1
50	2	50 to 1000	110.25 to 2205.0	50	110.25
80	3	150 to 3000	330.75 to 6615.0	100	220.50
100	4	200 to 4500	441.00 to 9922.5	200	441.00
150	6	350 to 12000	771.75 to 26460	500	1102.5
250	10	1500 to 35000	3307.5 to 77175	1000	2205.0

Measuring ranges for liquids in mass flow (Promass A):

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[kg/min]	[lbs/min]	[kg]	[lbs]
2	1/12	0.1 to 2	0.2205 to 4.410	0.05	0.110
4	1/8	0.4 to 8	0.8820 to 17.64	0.20	0.0528

Measuring ranges for liquids in volume flow (also LPG) (Promass F):

DN		Volume flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[l/min]	[gal/hr]	[l]	[gal]
8	3/8	1.5 to 30	23.76 to 475.20	0.5	0.132
15	1/2	5 to 100	79.20 to 1584.0	2.0	0.528
25	1	15 to 300	237.6 to 4752.0	5.0	1.320
40	1 1/2	35 to 700	554.4 to 11088	20	5.280
50	2	50 to 1000	792.0 to 15840	50	13.20
80	3	150 to 3000	2376 to 47520	100	26.40
100	4	200 to 4500	3168 to 71280	200	52.80
150	6	350 to 12000	5544 to 190080	500	132.0
250	10	1500 to 35000	23760 to 554400	1000	264.0

Measuring ranges for liquids in volume flow (also LPG) (Promass A):

DN		Volume flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[l/min]	[gal/hr]	[l]	[gal]
2	1/12	0.1 to 2	1.52 to 31.680	0.05	0.0132
4	1/8	0.4 to 8	6.34 to 126.72	0.20	0.0528

Note!
For information about the other approvals → see corresponding certificate.

Measuring range in custody transfer mode
MI-005 Evaluation Certificate

The following are example data for MI-005 Evaluation Certificate (liquids other than water)

Measuring ranges for liquids in mass flow (Promass F)

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[kg/min]	[lbs/min]	[kg]	[lbs]
8	3/8	1.5 to 30	3.3075 to 66.15	2	4.41
15	1/2	5 to 100	11.025 to 220.5	2	4.41
25	1	15 to 300	33.075 to 661.5	5	11.0
40	1 1/2	35 to 700	77.175 to 1543.5	20	44.1
50	2	50 to 1000	110.25 to 2205.0	50	110.25
80	3	150 to 3000	330.75 to 6615.0	100	220.50
100	4	200 to 4500	441.00 to 9922.5	200	441.00
150	6	350 to 12000	771.75 to 26460	500	1102.5
250	10	1500 to 35000	3307.5 to 77175	1000	2205.0

Measuring ranges for liquids in mass flow (Promass A):

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[kg/min]	[lbs/min]	[kg]	[lbs]
2	1/12	0.1 to 2	0.2205 to 4.410	0.05	0.110
4	1/8	0.4 to 8	0.8820 to 17.64	0.20	0.0528

Measuring ranges for liquids in mass flow (Promass X)

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[t/h]	[tn. sh./h]	[kg]	[lbs]
350	14	90 to 3500	100 to 3850	1000	2210

Measuring ranges for liquids in mass flow (Promass O)

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[kg/min]	[lbs/min]	[kg]	[lbs]
80	3	150 to 3000	330.75 to 6615.0	100	220.50
100	4	200 to 4500	441.00 to 9922.5	200	441.00
150	6	350 to 12000	771.75 to 26460	500	1102.5

Measuring ranges for liquids in volume flow (Promass F):

DN		Volume flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[l/min]	[gal/hr]	[l]	[gal]
8	3/8	1.5 to 30	23.76 to 475.20	2.0	0.528
15	1/2	5 to 100	79.20 to 1584.0	2.0	0.528
25	1	15 to 300	237.6 to 4752.0	5.0	1.320
40	1 1/2	35 to 700	554.4 to 11088	20	5.280
50	2	50 to 1000	792.0 to 15840	50	13.20
80	3	150 to 3000	2376 to 47520	100	26.40
100	4	200 to 4500	3168 to 71280	200	52.80
150	6	350 to 12000	5544 to 190080	500	132.0
250	10	1500 to 35000	23760 to 554400	1000	264.0

Measuring ranges for liquids in mass flow (Promass A):

DN		Mass flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[kg/min]	[lbs/min]	[kg]	[lbs]
2	1/12	0.1 to 2	0.2205 to 4.410	0.05	0.110
4	1/8	0.4 to 8	0.8820 to 17.64	0.20	0.0528

Measuring ranges for liquids in volume flow (Promass X)

DN		Volume flow Q_{min} to Q_{max}		Kleinste Messmenge	
[mm]	[inch]	[m^3/h]	[gal/h]	[l]	[gal]
350	14	90 to 3500	23760 to 924600	1000	264

Measuring ranges for liquids in volume flow (Promass O):

DN		Volume flow (liquids) Q_{min} to Q_{max}		Smallest measured quantity	
[mm]	[inch]	[l/min]	[gal/hr]	[l]	[gal]
80	3	150 to 3000	2376 to 47520	100	26.40
100	4	200 to 4500	3168 to 71280	200	52.80
150	6	350 to 12000	5544 to 190080	500	132.0

Note!
For information about the other approvals → see corresponding certificate.

Operable flow range

Over 20 : 1 for verified device

Input signal

Status input (auxiliary input):

U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated.
Switch level: 3 to 30 V DC, independent of polarity.
Configurable for: totalizer reset, positive zero return, error message reset, start zero point adjustment

11.1.4 Output

Output signal

Current output

Active/passive selectable, galvanically isolated, time constant selectable (0.05 to 100 s), full scale value selectable, temperature coefficient: typically 0.005% o.f.s. / °C, resolution: 0.5 µA
- Active: 0/4 to 20 mA, $R_L < 700\ \Omega$
- Passive: 4 to 20 mA; supply voltage V_S 18 to 30 V DC; $R_i \geq 150\ \Omega$

o.f.s. = full scale value

Pulse/frequency output

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

Modbus RS485

- Modbus device type: slave
- Address range: 1 to 247
- Functions codes supported: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with standard EIA/TIA-485
- Baudrate supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU or ASCII
- Response time:
  Direct data access = typically 25 to 50 ms
  Auto-scan buffer (data area) = typically 3 to 5 ms
- Possible output combinations → 📄 32

Signal on alarm

Current output
Failsafe mode selectable (for example, according to NAMUR Recommendation NE 43)

Pulse/frequency output
Failsafe mode selectable

Relay output
De-energized in the event of fault or power supply failure

Modbus
If an error occurs, the value NaN (not a number) is output for the process variables.

Switching output

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

Load

See "Output signal"

Low flow cut off

Switch points for low flow cut off are selectable.

DN		Low flow cut off / factory settings (v ~ 0.04 m/s)	
[mm]	[inch]	[kg/h]	[lb/min]
2	1/12	0.40	0.015
4	1/8	1.80	0.066
8	3/8	8.00	0.300
15	1/2	26.0	1.000
25	1	72.0	2.600
40	1 1/2	180	6.600
50	2	300	11.00
80	3	720	26.00
100	4	1200	44.00
150	6	2600	95.00
250	10	7200	260.0
350	14	13000	478.0

Galvanic isolation

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

11.1.5 Power supply

Electrical connections	→ 📄 26
Supply voltage	85 to 260 V AC, 45 to 65 Hz 20 to 55 V AC, 45 to 65 Hz 16 to 62 V DC
Cable entries	Power supply and signal cables (inputs/outputs): ■ Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47 inch) ■ Threads for cable entries, 1/2" NPT, G 1/2" Connecting cable for remote version: ■ Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47 inch) ■ Threads for cable entries, 1/2" NPT, G 1/2"
Cable specifications, remote version	→ 📄 29
Power consumption	AC: <15 VA (including sensor) DC: <15 W (including sensor) Switch-on current ■ max. 13.5 A (< 50 ms) at 24 V DC ■ max. 3 A (< 5 ms) at 260 V AC
Power supply failure	Lasting min. 1 power cycle: ■ EEPROM or HistoROM T-DAT 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 equalization	No measures necessary. For explosion-protected equipment → see separate Ex-documentation supplied

11.1.6 Performance characteristics

Reference operating conditions

- Error limits following ISO/DIN 11631
- Water, typically +15 to +45 °C (+59 to +113 °F); 2 to 6 bar (29 to 87 psi)
- Data according to calibration protocol ±5 °C (±9 °F) and ±2 bar (±29 psi)
- Accuracy based on accredited calibration rigs according to ISO 17025

Performance characteristic Promass A

o.r. = of reading; 1 g/cm³ = 1 kg/l; T = medium temperature

Maximum measured error

The following values refer to the pulse/frequency output.
The additional measured error at the current output is typically ±5 µA.
Design fundamentals → 📄 108.

- Mass flow and volume flow (liquids): ±0.10% o.r.
- Mass flow (gases): ±0.50% o.r.
- Density (liquids)
  - Reference conditions: ±0.0005 g/cm³
  - Field density calibration: ±0.0005 g/cm³
    (valid after field density calibration under process conditions)
  - Standard density calibration: ±0.02 g/cm³
    (valid over the entire temperature range and density range → 📄 117)
  - Special density calibration: ±0.002 g/cm³
    (optional, valid range: +5 to +80 °C (+41 to +176 °F) and 0.0 to 2.0 g/cm³)
- Temperature: ±0.5 °C ± 0.005 · T °C; ±1 °F ± 0.003 · (T - 32) °F

Zero point stability

DN		Max. full scale value		Zero point stability	
[mm]	[inch]	[kg/h] or [l/h]	[lb/min]	[kg/h] or [l/h]	[lb/min]
2	1/12	100	3.70	0.0050	0.00018
4	1/8	450	16.5	0.0225	0.0008

Example for max. measured error

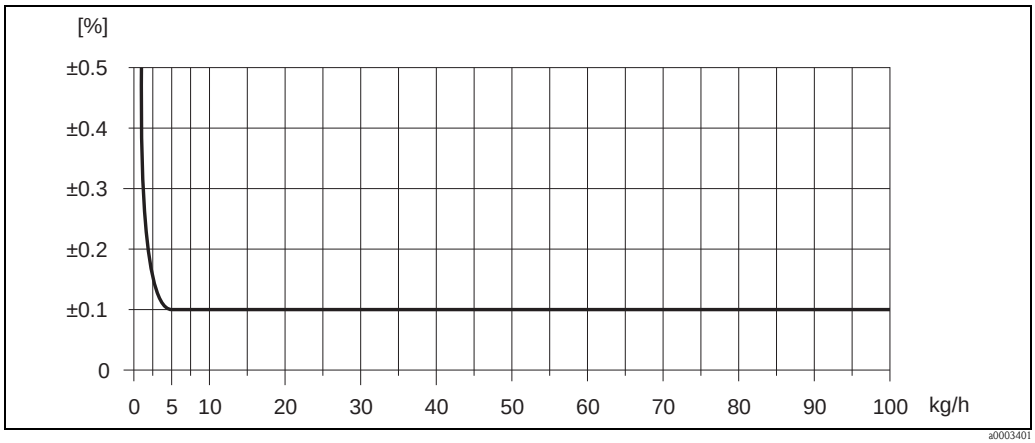


Fig. 52: Max. measured error in % o.r. (example: Promass A, DN 2)

Flow values (example)

Turn down	Flow		Max. measured error
	[kg/h]	[lb/min.]	[% o.r.]
250:1	0.4	0.0147	1.250
100:1	1.0	0.0368	0.500
25:1	4.0	0.1470	0.125
10:1	10	0.3675	0.100
2:1	50	1.8375	0.100

Design fundamentals → 108

Repeatability

Design fundamentals → 108

- Mass flow and volume flow (liquids): ±0.05% o.r.
- Mass flow (gases): ±0.25% o.r.
- Density (liquids): ±0.00025 g/cm^3
- Temperature: ±0.25 °C ± 0.0025 · T °C; ±0.5 °F ± 0.0015 · (T – 32) °F

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error of the sensor is ±0.0002% of the full scale value / °C (±0.0001% of the full scale value/°F).

Influence of medium pressure

A difference in pressure between the calibration pressure and the process pressure does not have any effect on the accuracy.

Design fundamentals

Dependent on the flow:

- Flow ≥ Zero point stability ÷ (Base accuracy ÷ 100)
  - Max. measured error: ±Base accuracy in % o.r.
  - Repeatability: ± ½ · Base accuracy in % o.r.
- Flow < Zero point stability ÷ (Base accuracy ÷ 100)
  - Max. measured error: ± (Zero point stability ÷ measured value) · 100% o.r.
  - Repeatability: ± ½ · (Zero point stability ÷ measured value) · 100% o.r.

Base accuracy for	
Mass flow liquids	0.10
Volume flow liquids	0.10
Mass flow gases	0.50

Performance characteristic Promass F

o.r. = of reading; 1 g/cm³ = 1 kg/l; T = medium temperature

Maximum measured error

The following values refer to the pulse/frequency output.
The additional measured error at the current output is typically ±5 µA.
Design fundamentals → 111.

- Mass flow and volume flow (liquids):
  ±0.05% o.r. (PremiumCal, for mass flow)
  ±0.10% o.r.
- Mass flow (gases): ±0.35% o.r.
- Density (liquids)
  – Reference conditions: ±0.0005 g/cm³
  – Field density calibration: ±0.0005 g/cm³
    (valid after field density calibration under process conditions)
  – Standard density calibration: ±0.01 g/cm³
    (valid over the entire temperature range and density range → 117)
  – Special density calibration: ±0.001 g/cm³
    (optional, valid range: +5 to +80 °C (+41 to +176 °F) and 0.0 to 2.0 g/cm³)
- Temperature: ±0.5 °C ± 0.005 · T °C; ±1 °F ± 0.003 · (T - 32) °F

Zero point stability Promass F (standard)

DN		Zero point stability Promass F (Standard)	
[mm]	[inch]	[kg/h] or [l/h]	[lb/min]
8	3/8	0.030	0.001
15	½	0.200	0.007
25	1	0.540	0.019
40	1½	2.25	0.083
50	2	3.50	0.129
80	3	9.00	0.330
100	4	14.00	0.514
150	6	32.00	1.17
250	10	88.00	3.23

Zero point stability Promass F (high-temperature version)

DN		Zero point stability Promass F (high-temperature version)	
[mm]	[inch]	[kg/h] or [l/h]	[lb/min]
25	1	1.80	0.0661
50	2	7.00	0.2572
80	3	18.0	0.6610

Example for max. measured error

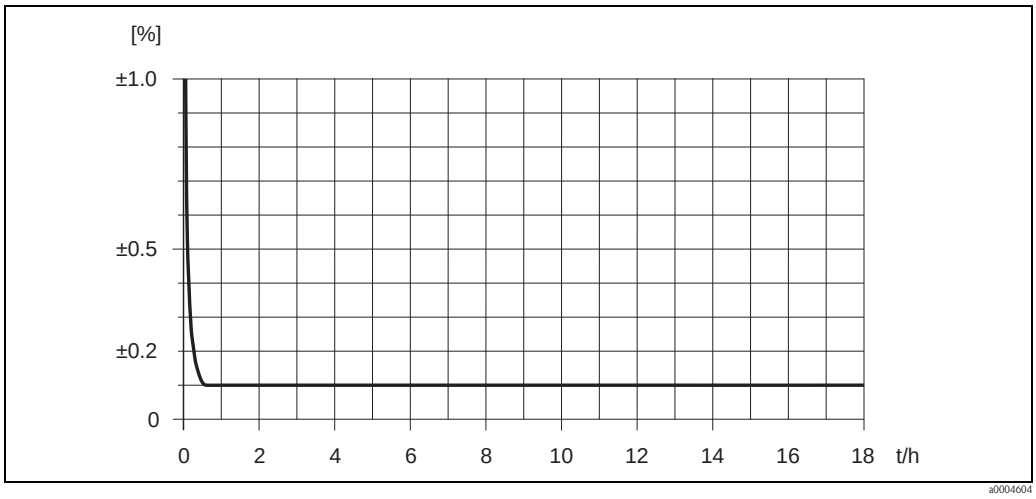


Fig. 53: Max. measured error in % o.r. (example: Promass F, DN 25)

Flow values (example)

Turn down	Flow		Maximum measured error
	[kg/h]	[lb/min]	[% o.r.]
500 : 1	36	1.323	1.5
100 : 1	180	6.615	0.3
25 : 1	720	26.46	0.1
10 : 1	1800	66.15	0.1
2 : 1	9000	330.75	0.1

Design fundamentals → 🖹 111

Repeatability

Design fundamentals → 🖹 111.

- Mass flow and volume flow (liquids):
  ±0.025% o.r. (PremiumCal, for mass flow)
  ±0.05% o.r.
- Mass flow (gases): ±0.25% o.r.
- Density (liquids): ±0.00025 g/cm^3
- Temperature: ±0.25 °C ± 0.0025 · T °C; ±0.5 °F ± 0.0015 · (T – 32) °F

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error of the sensor is ±0.0002% of the full scale value / °C (±0.0001% of the full scale value/°F).

Influence of medium pressure

The table below shows the effect on accuracy of mass flow due to a difference between calibration pressure and process pressure.

DN		Promass F (standard)	Promass F (high-temperature version)
[mm]	[inch]	[% o.r./bar]	[% o.r./bar]
8	3/8	no influence	–
15	½	no influence	–
25	1	no influence	no influence
40	1½	–0.003	–
50	2	–0.008	–0.008
80	3	–0.009	–0.009
100	4	–0.007	–
150	6	–0.009	–
250	10	–0.009	–

Design fundamentals

Dependent on the flow:

- Flow ≥ Zero point stability ÷ (Base accuracy ÷ 100)
  - Max. measured error: ±Base accuracy in % o.r.
  - Repeatability: ± ½ · Base accuracy in % o.r.
- Flow < Zero point stability ÷ (Base accuracy ÷ 100)
  - Max. measured error: ± (Zero point stability ÷ measured value) · 100% o.r.
  - Repeatability: ± ½ · (Zero point stability ÷ measured value) · 100% o.r.

Base accuracy for	
Mass flow liquids, PremiumCal	0.05
Mass flow liquids	0.10
Volume flow liquids	0.10
Mass flow gases	0.35

Performance characteristic Promass O

o.r. = of reading; 1 g/cm³ = 1 kg/l; T = medium temperature

Maximum measured error

The following values refer to the pulse/frequency output.
The additional measured error at the current output is typically ±5 µA.
Design fundamentals → 📄 113.

- Mass flow and volume flow (liquids):
  ±0.05% o.r. (PremiumCal, for mass flow)
  ±0.10% o.r.
- Mass flow (gases): ±0.35% o.r.
- Density (liquids)
  – Reference conditions: ±0.0005 g/cm³
  – Field density calibration: ±0.0005 g/cm³
    (valid after field density calibration under process conditions)
  – Standard density calibration: ±0.01 g/cm³
    (valid over the entire temperature range and density range → 📄 117)
  – Special density calibration: ±0.001 g/cm³
    (optional, valid range: +5 to +80 °C (+41 to +176 °F) and 0.0 to 2.0 g/cm³)
- Temperature: ±0.5 °C ± 0.005 · T °C; ±1 °F ± 0.003 · (T – 32) °F

Zero point stability

DN		Zero point stability	
[mm]	[inch]	[kg/h] or [l/h]	[lb/min]
80	3	9.00	0.330
100	4	14.00	0.514
150	6	32.00	1.17

Example for max. measured error

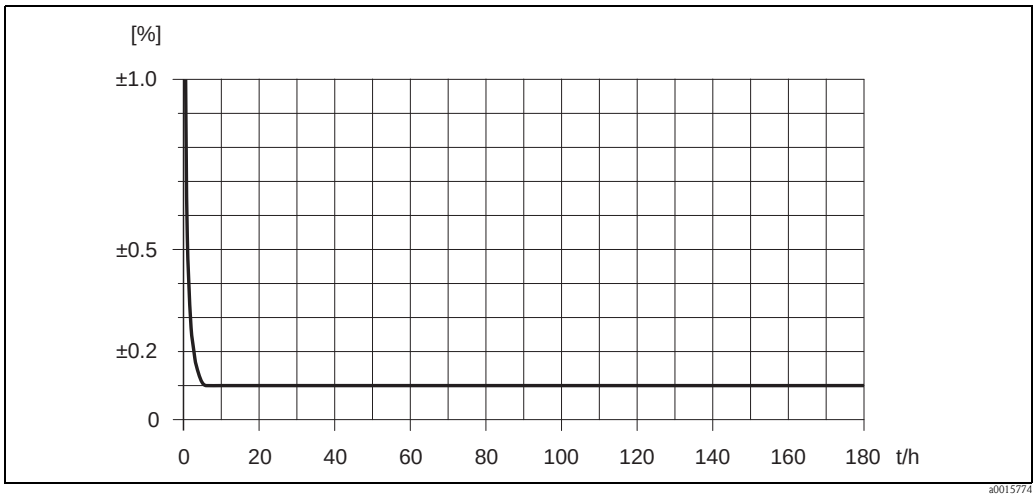


Fig. 54: Max. measured error in % o.r. (example DN 80)

Flow values (example DN 80)

Turn down	Flow		Maximum measured error
	[kg/h]	[lb/min]	[% o.r.]
500 : 1	360	13.23	1.5
100 : 1	1800	66.15	0.3
25 : 1	7200	264.6	0.1
10 : 1	18000	661.5	0.1
2 : 1	90000	3307.5	0.1

Design fundamentals → 113

Repeatability

Design fundamentals → 113.

- Mass flow and volume flow (liquids):
  ±0.025% o.r. (PremiumCal, for mass flow)
  ±0.05% o.r.
- Mass flow (gases): ±0.25% o.r.
- Density (liquids): ±0.00025 g/cm^3
- Temperature: ±0.25 °C ± 0.0025 · T °C; ±0.5 °F ± 0.0015 · (T – 32) °F

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error of the sensor is ±0.0002% of the full scale value / °C (±0.0001% of the full scale value/°F).

Influence of medium pressure

The table below shows the effect on accuracy of mass flow due to a difference between calibration pressure and process pressure.

DN		[% o.r./bar]
[mm]	[inch]	
80	3	–0.0055
100	4	–0.0035
150	6	–0.002

Design fundamentals

Dependent on the flow:

- Flow ≥ Zero point stability ÷ (Base accuracy ÷ 100)
  – Max. measured error: ±Base accuracy in % o.r.
  – Repeatability: ± ½ · Base accuracy in % o.r.
- Flow < Zero point stability ÷ (Base accuracy ÷ 100)
  – Max. measured error: ± (Zero point stability ÷ measured value) · 100% o.r.
  – Repeatability: ± ½ · (Zero point stability ÷ measured value) · 100% o.r.

Base accuracy for	
Mass flow liquids, PremiumCal	0.05
Mass flow liquids	0.10
Volume flow liquids	0.10
Mass flow gases	0.35

Performance characteristic Promass X

o.r. = of reading; 1 g/cm³ = 1 kg/l; T = medium temperature

Maximum measured error

The following values refer to the pulse/frequency output.
The additional measured error at the current output is typically ±5 µA.
Design fundamentals → 📄 115.

- Mass flow and volume flow (liquids):
  ±0.05% o.r. (PremiumCal, for mass flow)
  ±0.10% o.r.
- Mass flow (gases):
  ±0.35% o.r.
- Density (liquids)
  – Reference conditions: ±0.0005 g/cm³
  – Field density calibration: ±0.0005 g/cm³
    (valid after field density calibration under process conditions)
  – Standard density calibration: ±0.01 g/cm³
    (valid over the entire temperature range and density range → 📄 117)
  – Special density calibration: ±0.001 g/cm³
    (optional, valid range: +5 to +80 °C (+41 to +176 °F) and 0.0 to 2.0 g/cm³)
- Temperature: ±0.5 °C ± 0.005 · T °C; ±1 °F ± 0.003 · (T – 32) °F

Zero point stability

DN		Zero point stability	
[mm]	[inch]	[kg/h] or [l/h]	[lb/min]
350	14	175	6.42

Example for max. measured error

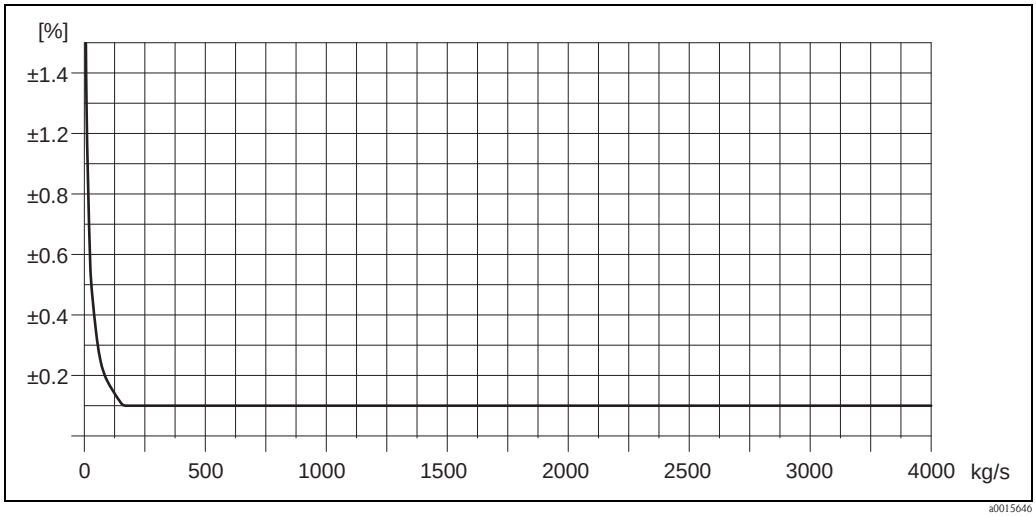


Fig. 55: Max. measured error in % o.r. (example: Promass 83X, DN 350)

Flow values (example)

Turn down	Flow		Maximum measured error
	[kg/h]	[lb/min]	[% o.r.]
500 : 1	8200	1.323	2.1
100 : 1	41 000	6.615	0.4
23 : 1	175000	28.23	0.1
10 : 1	410 000	66.15	0.1
2 : 1	2 050 000	330.75	0.1

Design fundamentals → 115

Repeatability

Design fundamentals → 115.

- Mass flow and volume flow (liquids):
  ±0.025% o.r. (PremiumCal, for mass flow)
  ±0.05% o.r.
- Mass flow (gases):
  ±0.25% o.r.
- Density (liquids): ±0.00025 g/cm^3
- Temperature: ±0.25 °C ± 0.0025 · T °C; ±0.5 °F ± 0.0015 · (T – 32) °F

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error of the sensor is ±0.0002% of the full scale value / °C (±0.0001% of the full scale value/°F).

Influence of medium pressure

The table below shows the effect on accuracy of mass flow due to a difference between calibration pressure and process pressure.

DN		[% o.r./bar]
[mm]	[inch]	
350	14	–0.009

Design fundamentals

Dependent on the flow:

- Flow ≥ Zero point stability ÷ (Base accuracy ÷ 100)
  – Max. measured error: ±Base accuracy in % o.r.
  – Repeatability: ± ½ · Base accuracy in % o.r.
- Flow < Zero point stability ÷ (Base accuracy ÷ 100)
  – Max. measured error: ± (Zero point stability ÷ measured value) · 100% o.r.
  – Repeatability: ± ½ · (Zero point stability ÷ measured value) · 100% o.r.

Base accuracy for	
Mass flow liquids, PremiumCal	0.05
Mass flow liquids	0.10
Volume flow liquids	0.10
Mass flow gases	0.35

11.1.7 Operating conditions: Installation

Installation instructions	→ 📄 15
Inlet and outlet runs	There are no installation requirements regarding inlet and outlet runs.
Connection cable length, remote version	max. 20 m (65 ft)
System pressure	→ 📄 16

11.1.8 Operating conditions: Environment

Ambient temperature range	Sensor and transmitter: ■ Standard: –20 to +60 °C (–4 to +140 °F) ■ Optional: –40 to +60 °C (–40 to +140 °F)  Note! ■ Install the device at a shady location. Avoid direct sunlight, particularly in warm climatic regions. ■ At ambient temperatures below –20 °C (–4 °F) the readability of the display may be impaired.
Storage temperature	–40 to +80 °C (–40 to +175 °F), preferably at +20 °C (+68 °F)
Ambient class	B, C, I
Degree of protection	Standard: IP 67 (NEMA 4X) for transmitter and sensor
Shock resistance	According to IEC 68-2-31
Vibration resistance	Acceleration up to 1 g, 10 to 150 Hz, following IEC 68-2-6
CIP cleaning	yes
SIP cleaning	yes
Electromagnetic compatibility (EMC)	To IEC/EN 61326 and NAMUR recommendation NE 21

11.1.9 Operating conditions: Process

Medium temperature range

Sensor

- Promass F, A: –50 to +200 °C (–58 to +392 °F)
- Promass F (high temperature version): –50 to +350 °C (–58 to +662 °F)
- Promass O: –40 to +200 °C (–40 to +392 °F)
- Promass X: –50 to +180 °C (–40 to +356 °F)

Seals

- Promass F, O, X: No internal seals
- Promass A (only for mounting sets with threaded connections):
  – Viton: –15 to 200 °C (–5 to +392 °F)
  – EPDM: –40 to +160 °C (–40 to +320 °F)
  – Silikon: –60 to +200 °C (–76 to +392 °F)
  – Kalrez: –20 to +275 °C (–4 to +527 °F)

Fluid density range

0 to 5000 kg/m^3 (0 to 312 lb/cf)

Limiting medium pressure range (rated pressure)

The material load diagrams (pressure-temperature diagrams) for the process connections are provided in the separate "Technical Information" document on the measuring instrument in question. This can be downloaded as a PDF file from www.endress.com.
A list of the "Technical Information" documents available is provided on → 128.

Pressure ranges of secondary containment:

- Promass F
  – DN 8 to 50 (3/8" to 2"): 40 bar (600 psi)
  – DN 80 (3"): 25 bar (375 psi)
  – DN 100 to 150 (4" to 6"): 16 bar (250 psi)
  – DN 250 (10"): 10 bar (150 psi)
- Promass A
  – 25 bar (375 psi)
- Promass O
  – 16 bar (232 psi)
- Promass X
  – Type approved, maximum allowable pressure according to ASME BPVC: 6 bar (87 psi)

Limiting flow

See the "Measuring range" section → 99

Select nominal diameter by optimizing between required flow range and permissible pressure loss. See the "Measuring range" section for a list of max. possible full scale values.
- The minimum recommended full scale value is approx. 1/20 of the max. full scale value.
- In most applications, 20 to 50% of the maximum full scale value can be considered ideal.
- Select a lower full scale value for abrasive substances such as liquids with entrained solids (flow velocity <1 m/s (<3 ft/s)).
- For gas measurement the following rules apply:
  – Flow velocity in the measuring tubes should not be more than half the sonic velocity (0.5 Mach).
  – The maximum mass flow depends on the density of the gas: Formula → 100

Pressure loss (SI units)

Pressure loss depends on the properties of the fluid and on its flow. The following formulas can be used to approximately calculate the pressure loss:

Pressure loss formulas for Promass F

Reynolds number	$Re = \frac{2 \cdot \dot{m}}{\pi \cdot d \cdot \nu \cdot \rho}$ a0004623
$Re \geq 2300$[1]	$\Delta p = K \cdot \nu^{0.25} \cdot \dot{m}^{1.85} \cdot \rho^{-0.86}$ a0004626
	Promass F DN 250 $\Delta p = K \cdot \left\{ 1 - a + \frac{a}{e^{b \cdot (\nu - 10^{-6})}} \right\} \cdot \nu^{0.25} \cdot \dot{m}^{1.85} \cdot \rho^{-0.86}$ a0012135
$Re < 2300$	$\Delta p = K1 \cdot \nu \cdot \dot{m} + \frac{K2 \cdot \nu^{0.25} \cdot \dot{m}^2}{\rho}$ a0004628
Δp = pressure loss [mbar] ν = kinematic viscosity [m2/s] $\dot{m}$ = mass flow [kg/s] ρ = fluid density [kg/m3]	d = inside diameter of measuring tubes [m] K to K2 = constants (depending on nominal diameter) a = 0.3 b = 91000
[1] To compute the pressure loss for gases, always use the formula for $Re \geq 2300$.	

Pressure loss formulas for Promass A

Reynolds number	$Re = \frac{4 \cdot \dot{m}}{\pi \cdot d \cdot \nu \cdot \rho}$ a0003381
$Re \geq 2300$[1]	$\Delta p = K \cdot \nu^{0.25} \cdot \dot{m}^{1.75} \cdot \rho^{-0.75}$ a0003380
$Re < 2300$	$\Delta p = K1 \cdot \nu \cdot \dot{m}$ a0003379
Δp = pressure loss [mbar] ν = kinematic viscosity [m^2/s] $\dot{m}$ = mass flow [kg/s]	ρ = density [kg/m^3] d = inside diameter of measuring tubes [m] K to K1 = constants (depending on nominal diameter)
[1] To compute the pressure loss for gases, always use the formula for $Re \geq 2300$.	

Pressure loss formulas for Promass O, X

Reynolds number	$Re = \frac{4 \cdot \dot{m}}{\pi \cdot d \cdot \nu \cdot \rho \cdot n}$ A0015582
Pressure loss	$\Delta p = (A_0 + A_1 \cdot Re^{A_2})^{1/A_3} \cdot \frac{1}{\rho} \cdot \left(\frac{2 \cdot \dot{m}}{5 \cdot \pi \cdot n \cdot d^2} \right)^2$ A0015583
Δp = pressure loss [mbar] ν = kinematic viscosity [m^2/s] $\dot{m}$ = mass flow [kg/s] ρ = density [kg/m^3]	d = inside diameter of measuring tubes [m] A_0 to A_3= constants (depending on nominal diameter) n = number of tubes

Pressure loss coefficient for Promass F

DN	d[m]	K	K1	K2
8	$5.35 \cdot 10^{-3}$	$5.70 \cdot 10^{7}$	$9.60 \cdot 10^{7}$	$1.90 \cdot 10^{7}$
15	$8.30 \cdot 10^{-3}$	$5.80 \cdot 10^{6}$	$1.90 \cdot 10^{7}$	$10.60 \cdot 10^{5}$
25	$12.00 \cdot 10^{-3}$	$1.90 \cdot 10^{6}$	$6.40 \cdot 10^{6}$	$4.50 \cdot 10^{5}$
40	$17.60 \cdot 10^{-3}$	$3.50 \cdot 10^{5}$	$1.30 \cdot 10^{6}$	$1.30 \cdot 10^{5}$
50	$26.00 \cdot 10^{-3}$	$7.00 \cdot 10^{4}$	$5.00 \cdot 10^{5}$	$1.40 \cdot 10^{4}$
80	$40.50 \cdot 10^{-3}$	$1.10 \cdot 10^{4}$	$7.71 \cdot 10^{4}$	$1.42 \cdot 10^{4}$
100	$51.20 \cdot 10^{-3}$	$3.54 \cdot 10^{3}$	$3.54 \cdot 10^{4}$	$5.40 \cdot 10^{3}$
150	$68.90 \cdot 10^{-3}$	$1.36 \cdot 10^{3}$	$2.04 \cdot 10^{4}$	$6.46 \cdot 10^{2}$
250	$102.26 \cdot 10^{-3}$	$3.00 \cdot 10^{2}$	$6.10 \cdot 10^{3}$	$1.33 \cdot 10^{2}$

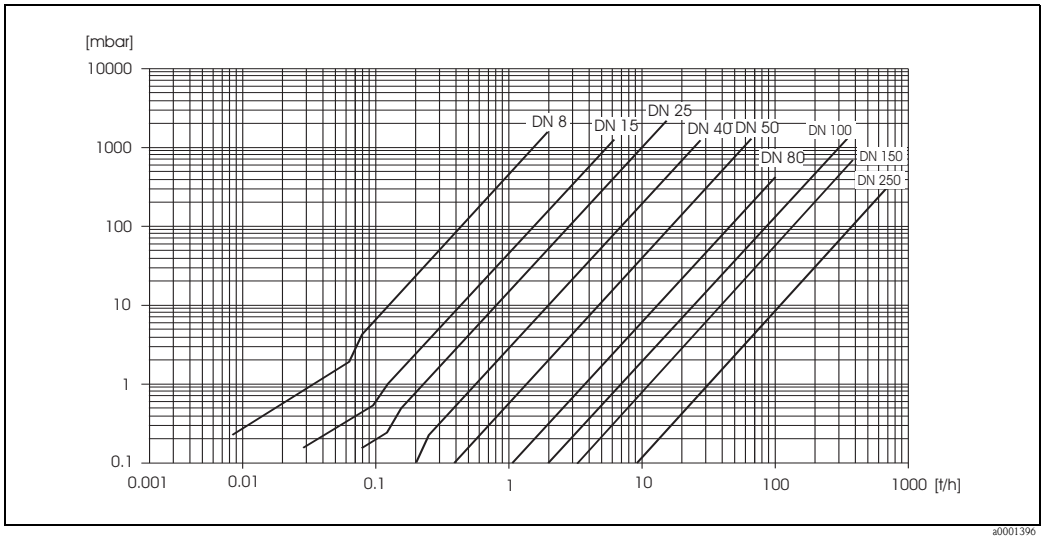


Fig. 56: Pressure loss diagram for water

Pressure loss coefficient for Promass A

DN	d[m]	K	K1
2	$1.8 \cdot 10^{-3}$	$1.6 \cdot 10^{10}$	$2.4 \cdot 10^{10}$
4	$3.5 \cdot 10^{-3}$	$9.4 \cdot 10^{8}$	$2.3 \cdot 10^{9}$
High pressure version			
2	$1.4 \cdot 10^{-3}$	$5.4 \cdot 10^{10}$	$6.6 \cdot 10^{10}$
4	$3.0 \cdot 10^{-3}$	$2.0 \cdot 10^{9}$	$4.3 \cdot 10^{9}$

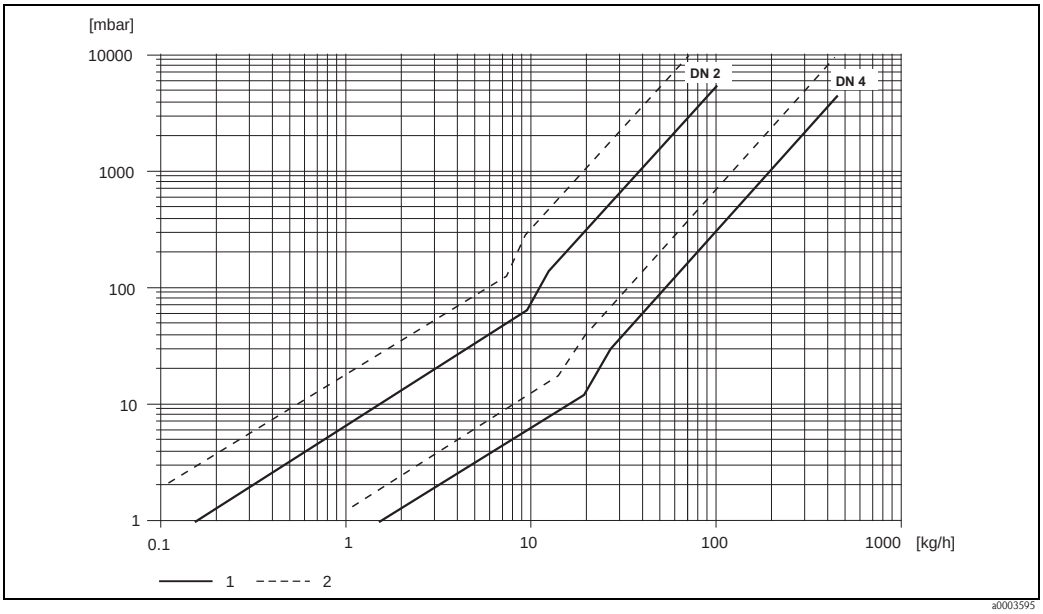


Fig. 57: Pressure loss diagram for water (1 = Standard version, 2 = High pressure version)

Pressure loss coefficient for Promass O

DN	d[mm]	A_0	A_1	A_2	A_3
80	38.5	0.72	4.28	– 0.36	0.24
100	49.0	0.70	3.75	– 0.35	0.22
150	66.1	0.75	2.81	– 0.33	0.19

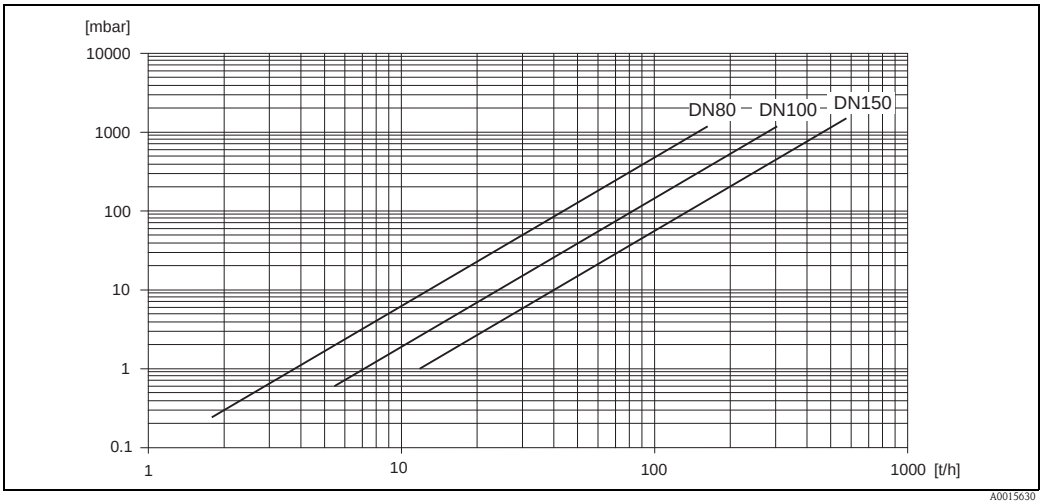


Fig. 58: Pressure loss diagram for water

Pressure loss coefficient for Promass X

DN	d[mm]	A_0	A_1	A_2	A_3
350	102.3	0.76	3.80	– 0.33	0.23

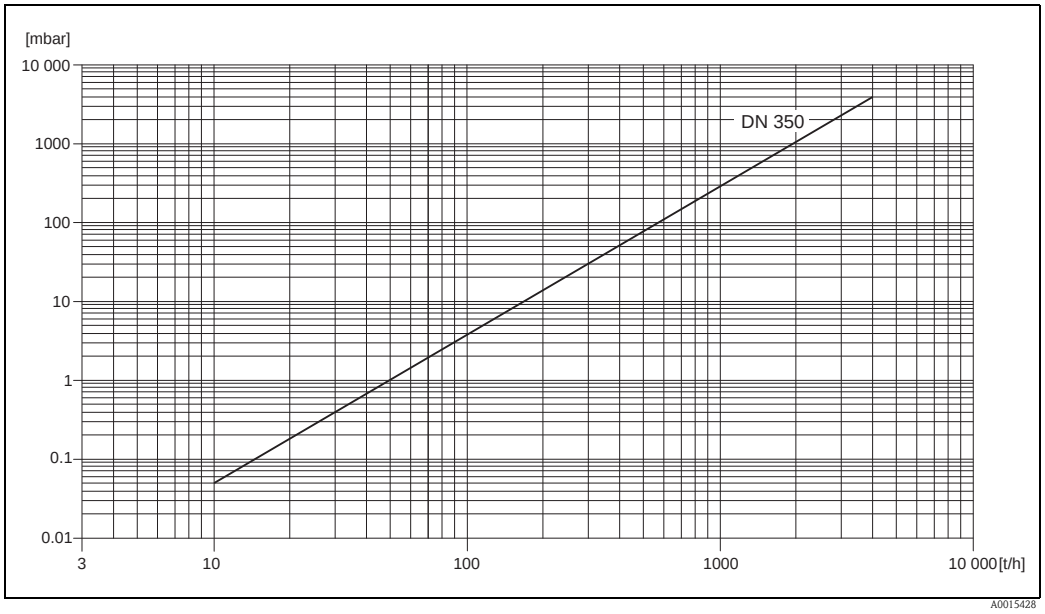


Fig. 59: Pressure loss diagram for water

Pressure loss (US units)

Pressure loss is dependent on the fluid properties and nominal diameter. Consult Endress+Hauser for Applicator PC software to determine pressure loss in US units. All important instrument data is contained in the Applicator software program in order to optimize the design of the measuring system.

The software is used for the following calculations:
- Nominal diameter of the sensor with fluid characteristics such as viscosity, density, etc.
- Pressure loss downstream of the measuring point.
- Converting mass flow to volume flow, etc.
- Simultaneous display of various meter sizes.
- Determining measuring ranges.

The Applicator runs on any IBM-compatible PC with Windows.

11.1.10 Mechanical construction

Design / dimensions

The dimensions and lengths of the sensor and transmitter are provided in the separate "Technical Information" document on the measuring instrument in question. This can be downloaded as a PDF file from www.endress.com.
List of the "Technical Information" documents available → 128.

Weight (SI units)

All values (weight) refer to devices with EN/DIN PN 40 flanges. Weights in [kg].

Promass F / DN	8	15	25	40	50	80	100	150	250 [1]
Compact version	11	12	14	19	30	55	96	154	400
Compact version, high-temperature	–	–	14.7	–	30.7	55.7	–	–	–
Remote version	9	10	12	17	28	53	94	152	398
Remote version, high-temperature	–	–	13.5	–	29.5	54.5	–	–	–

[1] with 10" ASME Cl 300 flanges

Promass A / DN	2	4
Compact version	11	15
Remote version	9	13

Promass O / DN [1]	80	100	150
Compact version	75	141	246
Remote version	73	139	244

[1] with Cl 900 flanges according to ASME B16.5

Promass X / DN [1]	350
Compact version	555
Remote version	553

[1] with 12" according to ASME B16.5 Cl 150 flanges

Weight (US units)

All values (weight) refer to devices with EN/DIN PN 40 flanges. Weights in [lb].

Promass F / DN	3/8"	1/2"	1"	1 1/2"	2"	3"	4"	6"	10" [1]
Compact version	24	26	31	42	66	121	212	340	882
Compact version, high-temperature	–	–	32	–	68	123	–	–	–
Remote version	20	22	26	37	62	117	207	335	878
Remote version, high-temperature	–	–	30	–	65	120	–	–	–

[1] with 10" ASME Cl 300 flanges

Promass A / DN	1/12"	1/8"
Compact version	24	33
Remote version	20	29

Promass O / DN [1]	3"	4"	6"
Compact version	165	311	542
Remote version	161	306	538

[1] with Cl 900 flanges according to ASME B16.5

Promass X / DN [1]	14"
Compact version	1224
Remote version	1219

[1] with 12" according to ASME B16.5 Cl 150 flanges

Material

Transmitter housing:

- Compact version
  - Compact version: powder coated die-cast aluminium
  - Stainless steel housing: stainless steel 1.4301/304
  - Stainless steel housing Ex d: stainless steel 1.4404/CF3M
  - Window material: glass or polycarbonate
- Remote version
  - Remote field housing: powder coated die-cast aluminium
  - Wall-mount housing: powder coated die-cast aluminium
  - Window material: glass

Connection housing, sensor (remote version):

- Standard: stainless steel 1.4301/304 (standard, not Promass X)
- High-temperature version and version for heating: powder coated die-cast aluminum

Sensor housing / secondary containment:

- Promass F: acid- and alkali-resistant outer surface
  - Stainless steel 1.4301/1.4307/304L
- Promass A: acid- and alkali-resistant outer surface
  - Stainless steel 1.4301/304
- Promass X, O: acid- and alkali-resistant outer surface
  - Stainless steel 1.4404/316L

Process connections

Process connections, Promass F	Material
Flanges according to EN 1092-1 (DIN 2501)/ according to ASME B16.5/JIS 2220	Alloy C-22 2.4602/N 06022, stainless steel 1.4404/316L
DIN 11864–2 Form A (flat flange with groove)	Stainless steel 1.4404/316L
Threaded hygienic connections DIN 11851 / SMS 1145 / ISO 2853 / DIN 11864-1	Stainless steel 1.4404/316L
Tri-Clamp (OD-tubes)	Stainless steel 1.4404/316L

Process connections, Promass A	Material
Mounting set for flanges EN 1092-1 (DIN 2501)/ ASME B16.5/JIS B2220	Stainless steel 1.4539/904L, Alloy C-22 2.4602/N 06022
Loose flanges	Stainless steel 1.4404/316L
VCO coupling	Stainless steel 1.4539/904L, Alloy C-22 2.4602/N 06022
Tri-Clamp (OD-tubes) (1/2")	Stainless steel 1.4404/316L
Mounting set for SWAGELOK (1/4", 1/8")	Stainless steel 1.4404/316L
Mounting set for NPT-F (1/4")	Stainless steel 1.4404/316L

Process connections, Promass O	Material
Flanges according to EN 1092-1 (DIN 2501)/ according to ASME B16.5	Stainless steel 25Cr duplex EN 1.4410/F53 (superduplex)

Process connections, Promass X	Material
Flanges according to EN 1092-1 (DIN 2501)/ according to ASME B16.5	Stainless steel 1.4404/316/316L

Measuring tube(s)

- Promass F
  – DN 8 to 100 (3/8" to 4"): stainless steel 1.4539/904L; manifold: 1.4404/316L
  – DN 150 (6"): stainless steel 1.4404/316L/1.4432
  – DN 250 (10"): stainless steel 1.4404/316L/1.4432; manifold: CF3M
  – DN 8 to 150 (3/8" to 6"): Alloy C-22 2.4602/N 06022
- Promass F (high-pressure version)
  – DN 25, 50, 80: Alloy C-22 2.4602/N 06022
- Promass A
  – Stainless steel 1.4539/904L, Alloy C-22 2.4602/N 06022
- Promass O
  – Stainless steel 25Cr Duplex EN 1.4410/F53/UNS S32750 (superduplex)
- Promass X
  – Stainless steel 1.4404/316/316L; manifold: 1.4404/316/316L

Seals

- Promass F, O, X: Welded process connections without internal seals
- Promass A
  – Viton
  – EPDM
  – Silicone
  – Kalrez

Material load diagram

The material load diagrams (pressure-temperature diagrams) for the process connections are provided in the separate "Technical Information" document on the measuring instrument in question. This can be downloaded as a PDF file from www.endress.com.
A list of the "Technical Information" documents available is provided in the "Documentation" section → 🖹 128.

Process connections

→ 🖹 123

11.1.11 Operability

Display elements	■ Liquid crystal display: illuminated, four lines with 16 characters per line ■ Selectable display of different measured values and status variables ■ At ambient temperatures below –20 °C (–4 °F), the readability of the display may be impaired.
Operating elements	■ Local operation with three optical sensors (⊟/⊞/E) ■ Application specific Quick Setup menus for straightforward commissioning
Language groups	Language groups available for operation in different countries: ■ Western Europe and America (WEA): English, German, Spanish, Italian, French, Dutch and Portuguese ■ Eastern Europe/Scandinavia (EES): English, Russian, Polish, Norwegian, Finnish, Swedish, Czech ■ South and East Asia (SEA): English, Japanese, Indonesian ■ China (CN): English, Chinese Note! You can change the language group via the operating program "FieldCare".

11.1.12 Certificates and approvals

CE mark	The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
C-tick mark	The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA).
Ex approval	Information about currently available Ex versions (ATEX, FM, CSA, IECEx, NEPSI etc.) can be supplied by your Endress+Hauser representative on request. All explosion protection data are given in a separate documentation which is also available upon request → 🖹 128.

Suitability for custody transfer measurement

MID approval, Annex MI-002 (gas meter)

The device is qualified to OIML R137/D11.

Promass	DN		OIML R137/MID Evaluation Certificate (Europe)		
				Gas	
	[mm]	[inch]	Mass	Volume	Density
F	8 to 250	3/8 to 10	YES	YES*	NO
A	2 to 4	1/12 to 1/8	YES	YES*	NO
X	350	14	YES	YES*	NO
O	80 to 150	3 to 6	YES	YES*	NO

* at pure gases only (invariable gas density)

MID approval, Annex MI-005 (for liquids other than water)

The device is qualified to OIML R117-1.

Promass	DN		OIML R117-1/MID Evaluation Certificate (Europe)		
			For liquids other than water		
	[mm]	[inch]	Mass	Volume	Density
F	8 to 250	3/8 to 10	YES	YES	YES
A	2 to 4	1/12 to 1/8	YES	YES	YES
X	350	14	YES	YES	YES
O	80 to 150	3 to 6	YES	YES	YES

PTB / METAS / BEV approval

PTB / METAS / BEV approval for determining the mass and volume of liquids, other than water, and of fuel gases. The device is qualified to OIML R117-1.

Promass	DN		PTB-/METAS-/BEV approval for			
			For liquids other than water			High-pressure gas
	[mm]	[inch]	Mass	Volume	Density	(CNG) Mass
F	8 to 250	3/8 to 10	YES	YES	YES	NO
A	2 to 4	1/12 to 1/8	YES	YES	YES	NO

NTEP approval

The measuring instrument is qualified in accordance with the National Type Evaluation Program (NTEP) Handbook 44 ("Specifications and Tolerances and other Technical Requirements for Weighing and Measuring Devices").

Promass	DN		NTEP approval for		
			For liquids other than water		High-pressure gas
	[mm]	[inch]	Mass	Volume	(CNG) Mass
F	15 to 150	½ to 6	YES	YES	NO

MC approval

The measuring instrument is qualified in accordance with "The Draft Ministerial Specifications – Mass Flow Meters" (1993-09-21).

Promass	DN		MC approval for	
			For liquids other than water	
	[mm]	[inch]	Mass	Volume
F	8 to 150	3/8 to 6	YES	YES

Sanitary compatibility	■ 3A approval ■ EHEDG-inspected
Measuring instrument approval	The flowmeter is a suitable component for quantity measurement in legal metrology controlled measuring systems in accordance with Annex MI-005 of the European Measuring Instruments Directive 2004/22/EC (MID). It is qualified to OIML R117-1 and has an MID Evaluation Certificate [1] which confirms compliance with the essential requirements of the Measuring Instruments Directive.  Note! According to the Measuring Instruments Directive, however, only the complete measuring system (e.g. gasoline pump) is licensable, covered by an EC-type examination certificate and bears the conformity marking.
Pressure measuring device approval	The measuring devices can be ordered with or without PED (Pressure Equipment Directive). If a device with PED is required, this must be ordered explicitly. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary. ■ With the identification PED/G1/III on the sensor nameplate, Endress+Hauser confirms conformity with the "Basic safety requirements" of Appendix I of the Pressure Equipment Directive 97/23/EC. ■ Devices with this identification (with PED) are suitable for the following types of fluid: – Fluids of Group 1 and 2 with a steam pressure of greater or less than 0.5 bar (7.3 psi) – Unstable gases ■ Devices without this identification (without PED) are designed and manufactured according to good engineering practice. They correspond to the requirements of Art. 3, Section 3 of the Pressure Equipment Directive 97/23/EC. Their application is illustrated in Diagrams 6 to 9 in Appendix II of the Pressure Equipment Directive 97/23/EC.
Modbus RS485	The measuring device meets all the requirements of the Modbus/TCP conformity and integration test and holds the "Modbus/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "Modbus/TCP Conformance Test Laboratory" of the University of Michigan.
Other standards and guidelines	EN 60529: Degrees of protection by housing (IP code) EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use IEC/EN 61326 "Emission in accordance with requirements for Class A". Electromagnetic compatibility (EMC- requirements) NAMUR NE 21: Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment NAMUR NE 43: Standardization of the signal level for the breakdown information of digital transmitters with analog output signal. NAMUR NE 53: Software of field devices and signal-processing devices with digital electronics

1) The Evaluation Certificate results from the WELMEC approach (cooperation between the legal metrology services of the member states of the European Union and EFTA) towards modular component certification for measuring systems in accordance with Annex MI-005 (measuring systems for the continuous and dynamic measurement of quantities of liquids other than water) of the Measuring Instruments Directive 2004/22/EC.

11.1.13 Ordering information

Your Endress +Hauser representative can provide detailed ordering information and information on the order codes on request.

11.1.14 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor → 81.

11.1.15 Supplementary documentation

- Flow measuring technology (FA00005D)
- Technical Information
  - Promass 84A (TI00067D)
  - Promass 84F (TI00103D)
  - Promass 84O (TI00113D)
  - Promass 84X (TI00111D)
- Description of Device Functions Promass 84 Modbus RS 485 (BA00130D)
- Document "Commissioning Instructions for PTB gas approval" (SD00128D)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA, IECEx, NEPSI

Index

T

V

W

Z

Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination

Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.
Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

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

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

Medium and warnings
Warnhinweise zum Medium

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

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

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

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

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

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."
"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

_____ _____ _____

(place, date / *Ort, Datum)* Name, dept./*Abt.* (please print / *bitte Druckschrift*) Signature / *Unterschrift*

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