



Level



Pressure



Flow



Temperature



Liquid
Analysis



Registration



Systems
Components



Services

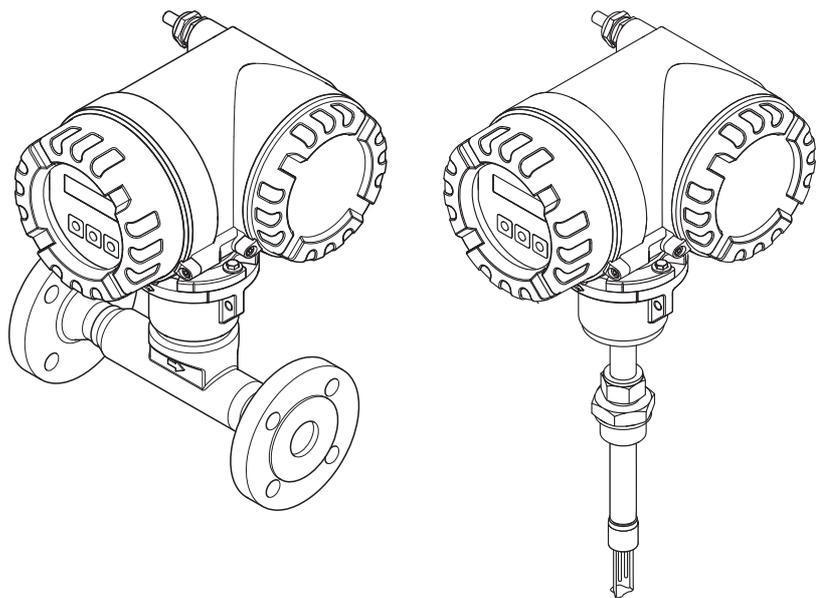


Solutions

Operating Instructions

Proline t-mass 65 MODBUS RS485

Thermal Mass Flow Measuring System



BA00115D/06/EN/13.10
71123865

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

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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 gases (e. g. kg, Nm³ scf). At the same time, the system also measures gas temperature. The measuring device can be configured to measure a standard range of pure gases or gas mixtures.

Examples:

- Air
- Oxygen
- Nitrogen
- Carbon Dioxide
- Argon, etc.

The use with corrosive, saturated or unclean gases should be treated with caution (contact your Endress+Hauser sales representative). The use with unstable gases or gases not deemed to be suitable by Endress+Hauser must be avoided. The measuring device is not designed to be used with liquids or fluids in the liquid phase.

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

1.2 Installation, commissioning and operation

Note the following points:

- Installation, connection to the electricity supply, commissioning and maintenance of the device must be carried out by trained, qualified specialists authorised 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 authorised and trained by the facility's owner-operator. Strict compliance with the instructions in the Operating Instruction is mandatory.
- Endress+Hauser is willing to assist in clarifying the chemical resistance properties of parts wetted by special fluids, including fluids used for cleaning. However small changes in temperature, concentration or the degree of contamination in the process can result in changes of the chemical resistance properties. Therefore, Endress+Hauser can not guarantee or accept liability for the chemical resistance properties of the fluid wetted materials in a specific application. The user is responsible for the choice of fluid wetted materials in regards to their in-process resistance to corrosion.
- If carrying out welding work on the piping, the welding unit should 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 = Safe 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.  Europe,  USA,  Canada).
- When hot fluid passes through the measuring tube, the surface temperature of the housing increases. In the case of the sensor, in particular, users should expect temperatures that can be close to the fluid temperature. If the temperature of the fluid is high, implement sufficient measures to prevent burning or scalding.
- The measuring device complies with the general safety requirements in accordance with EN 61010-1, the EMC requirements of IEC/EN 61326, and NAMUR recommendation NE 21, NE 43 and NE 53.
- The separate document on the Pressure Equipment Directive must be observed for devices used in Category II or III installations in accordance with the Pressure Equipment Directive.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Operating Instructions.

1.4 Return

- 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 →  89

1.5 Notes on safety conventions and icons

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

Consequently, always pay particular attention to the safety instructions indicated in these Operating Instructions by the following icons:



Warning!

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



Caution!

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



Note!

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

2 Identification

2.1 Device designation

The "t-mass 65" flow measuring system consists of the following components:

- t-mass 65 transmitter
- t-mass F, t-mass I sensors

Two versions are available:

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

2.1.1 Nameplate of the transmitter

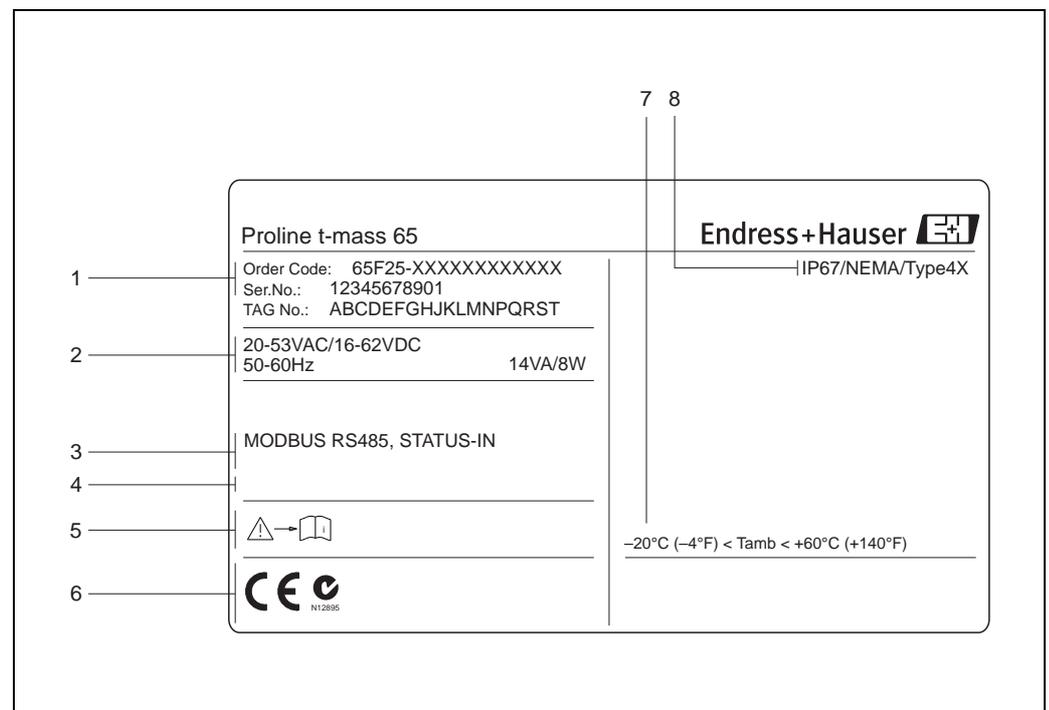


Fig. 1: Nameplate specifications for the "t-mass 65" transmitter (example)

- 1 Order code, serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
- 2 Power supply, frequency, power consumption
- 3 Available inputs/outputs:
- 4 Reserved for information on special products
- 5 Please refer to operating instructions / documentation
- 6 Reserved for certificates, approvals and for additional information on device version
- 7 Ambient temperature range
- 8 Degree of protection

2.1.2 Nameplate of the sensor

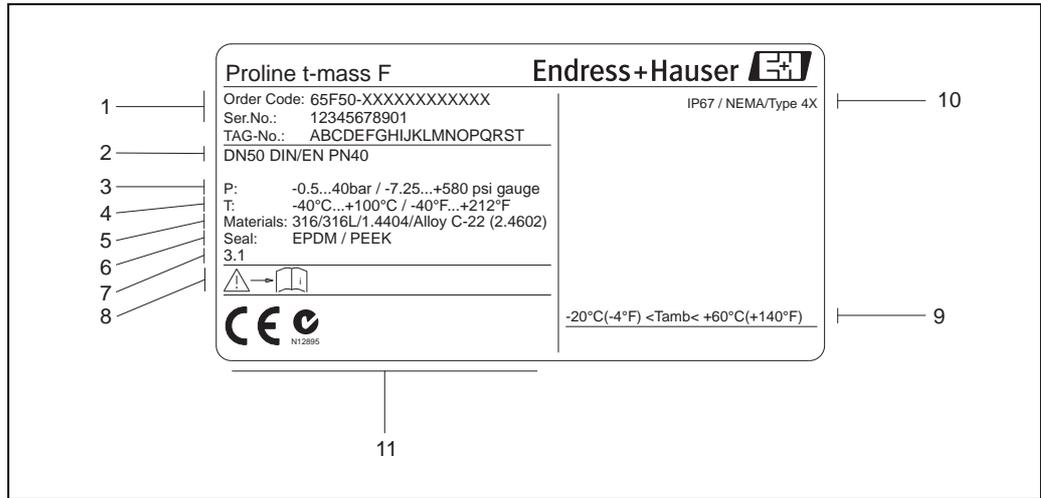


Fig. 2: Nameplate specifications for the "t-mass F" sensor (example)

- 1 Order code, serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
- 2 Nominal diameter device
- 3 Pressure range
- 4 Temperature range
- 5 Material of measuring tubes
- 6 Seal material
- 7 Reserved for information on special products
- 8 Please refer to operating instructions / documentation
- 9 Ambient temperature range
- 10 Degree of protection
- 11 Reserved for additional information on device version (approvals, certificates)

2.1.3 Nameplate for connections

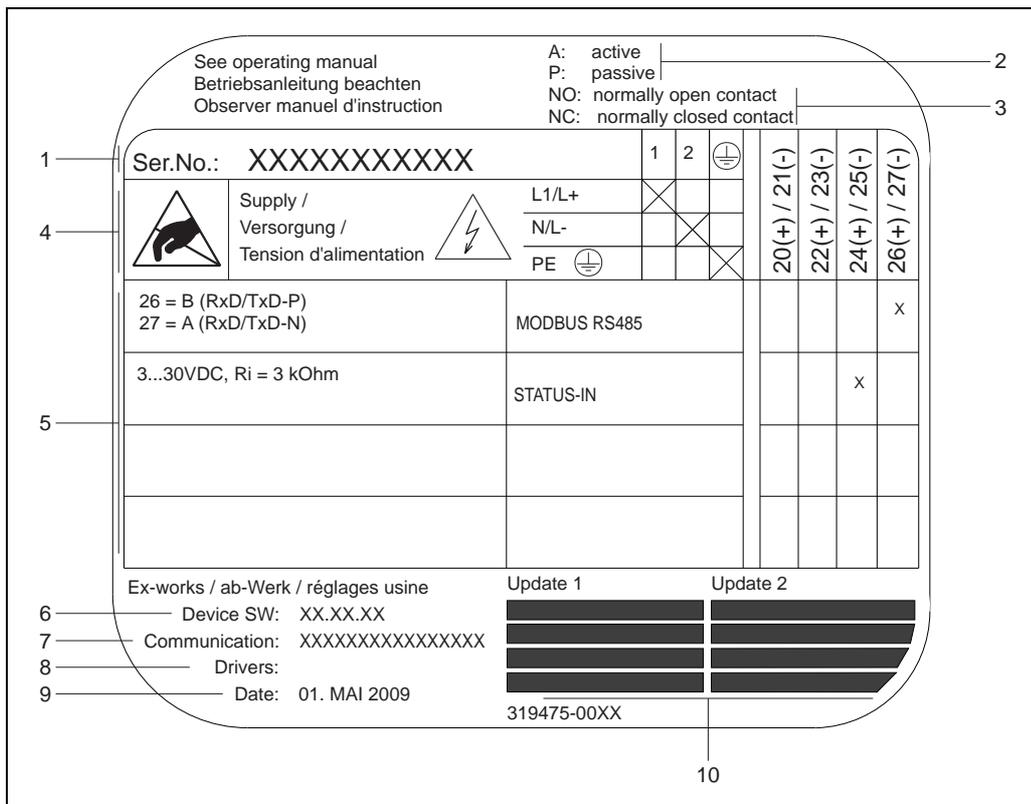


Fig. 3: Nameplate specifications for transmitter connections (example)

- 1 Serial number
- 2 Possible configuration of current output
- 3 Possible configuration of relay contacts
- 4 Terminal assignment, cable for power supply: 85 to 260 V AC, 16 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
- 5 Signals present at inputs and outputs, possible configuration and terminal assignment (20 to 27), see also "Electrical values of inputs/outputs", → 92
- 6 Version of device software currently installed
- 7 Installed communication type
- 8 Information on current communication software
- 9 Date of manufacture
- 10 Current updates to data specified in points 6 to 9

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

MODBUS™

Registered trademark of the MODBUS Organization

HistoROM™, S-DAT®, T-DAT™, F-CHIP®, FieldCare®, Fieldcheck®, Applicator®, t-mass®

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 transducers during transportation and storage. Consequently, do not remove these covers or caps until immediately before installation.
- Do not lift measuring devices of nominal diameters $> DN 40$ ($> 1\frac{1}{2}$ ") by the transmitter housing or the connection housing in the case of the remote version (\rightarrow  4). Use webbing slings slung round the two process connections. Do not use chains, as they could damage the housing.



Warning!

Risk of injury if the measuring device slips. The center of gravity of the assembled measuring device might be higher than the points around which the slings are slung.

At all times, therefore, make sure that the device does not unexpectedly turn around its axis or slip.

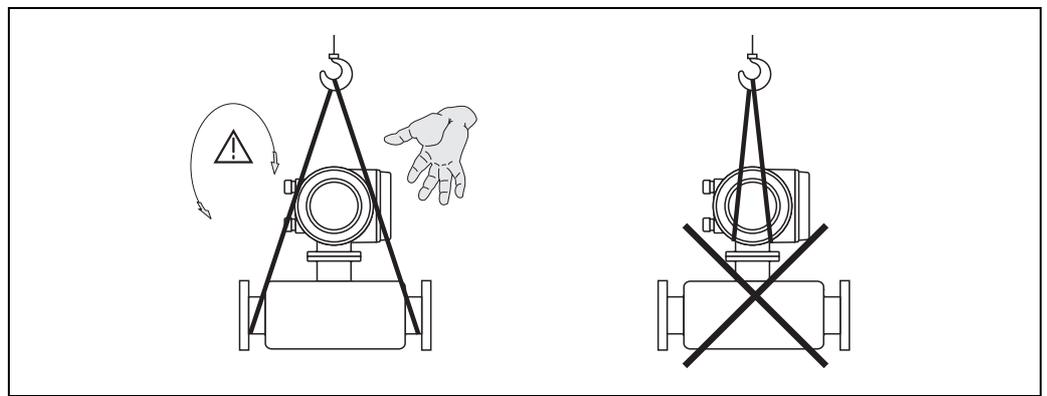


Fig. 4: Instructions for transporting sensors with $> DN 40$ ($> 1\frac{1}{2}$ ")

3.1.3 Storage

Note the following points:

- Pack the measuring device in such a way as to protect it reliably against impact for storage (and transportation). The original packaging provides optimum protection.
- The permissible storage temperature is -40 to $+80$ °C (-40 °F 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.
- Devices delivered with special sealing or bagging for oxygen service must remain sealed or bagged until ready for installation.

3.2 Installation conditions

Note the following points:

- The thermal dispersion principle is very sensitive to disturbed flow conditions.
- Observe the recommended inlet and outlet requirements.
- Good engineering practice is necessary for the associated pipe work and installation.
- Ensure correct alignment and orientation of the sensor.
- Take measures to reduce or avoid condensation (e.g. install a condensation trap, thermal insulation, etc.).
- The maximum permitted ambient temperatures and the medium temperature range (→  95) must be observed.
- Install the transmitter in a shaded location or use a protective sun shield.
- For mechanical reasons, and in order to protect the pipe, it is advisable to support heavy sensors.

3.2.1 Dimensions

The dimensions and installation lengths of the sensor and transmitter can be found in the "Technical Information" for the device in question. This document can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents available is provided in the "Documentation" section on →  100.

3.2.2 System pressure and pulsating flow

Reciprocating pumps and some compressor systems can create strong changes in process pressure that can induce spurious internal flow patterns and therefore cause additional measurement error. These pressure pulses must be reduced by the appropriate measures:

- Use of expansion tanks
- Use of inlet expanders
- Relocate the flowmeter further downstream

In compressed air systems, it is recommended to mount the flowmeter after the filter, dryer and buffer devices to avoid pulsations and oil/dirt contamination. Do not mount the flowmeter directly after the compressor outlet.

3.2.3 Pipework requirements

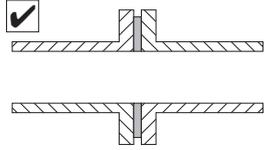
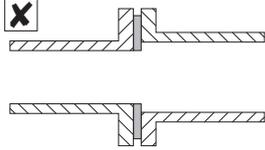
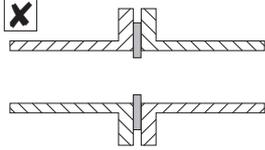
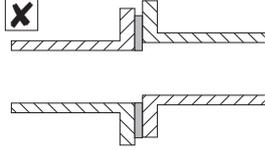
Good engineering practice should be followed at all times:

- Correct preparation, welding and finishing techniques
- Correctly sized gaskets
- Correctly aligned flanges and gaskets
- Connecting pipe work should match the internal diameter of the flowmeter.

Maximum pipe diameter mismatch should not exceed:

- 1 mm (0.04 inch) for diameters < DN 200 (8")
- 3 mm (0.12 inch) for diameters ≥ DN 200 (8")

For further information please refer to ISO 14511.

| | | |
|---|--|---|
|  <p style="text-align: right; font-size: small;">a0005103</p> | | |
| <p>Correctly aligned flanges and gaskets</p> | | |
|  <p style="text-align: right; font-size: small;">a0005104</p> |  <p style="text-align: right; font-size: small;">a0005105</p> |  <p style="text-align: right; font-size: small;">a0005106</p> |
| <p>Pipe diameter one is not equal pipe diameter two</p> | <p>Incorrectly sized gaskets</p> | <p>Incorrectly aligned flanges and gaskets</p> |

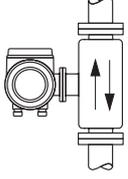
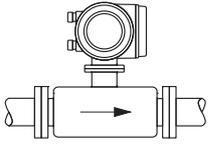
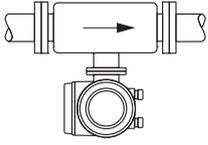
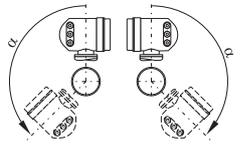


Caution!

New installations should be free of metallic and abrasive particles to prevent damage to the sensing elements on start-up.

3.2.4 Orientation

Make sure that the direction arrow on the sensor matches the direction of gas flow through the pipe.

| | Flanged sensor | | Insertion sensor | |
|---|----------------|---------|------------------|---------|
| Vertical orientation | | | | |
|  <p>A0013785</p> | compact | remote | compact | remote |
| | ✓✓ ① | ✓✓ ① | ✓ ①, ② | ✓✓ ① |
| Horizontal orientation, transmitter head up | | | | |
|  <p>A0013786</p> | compact/remote | | | |
| | ✓✓ ② | | | |
| Horizontal orientation, transmitter head down | | | | |
|  <p>A0013787</p> | compact/remote | | | |
| | ✓ ③ | | | |
| Inclined orientation, transmitter head down | | | | |
|  <p>A0009897</p> | compact/remote | | | |
| | ✓ ④ | | | |

✓✓ = Recommended orientation

✓ = Orientation recommended in certain situations

① In the case of saturated or unclean gases, upward flow in a vertical pipe section is preferred to minimize condensation/contamination.

② Not recommended if the vibrations are too high or if the installation is unstable.

③ Only suitable for clean/dry gases. Do not mount the sensor from the bottom, on horizontal pipes, if build-up or condensate are likely to be present. Mount the sensor in a position as indicated below

④ If the gas is very damp or saturated with water (e. g. Bio Gas), mount in inclined orientation ($\alpha = \max. 135^\circ$).

3.2.5 Inlet and outlet runs

The thermal dispersion principle is sensitive to disturbed flow conditions.

As a general rule, the thermal flowmeter should always be installed as far away as possible from any flow disturbances. For further information please refer to ISO 14511.

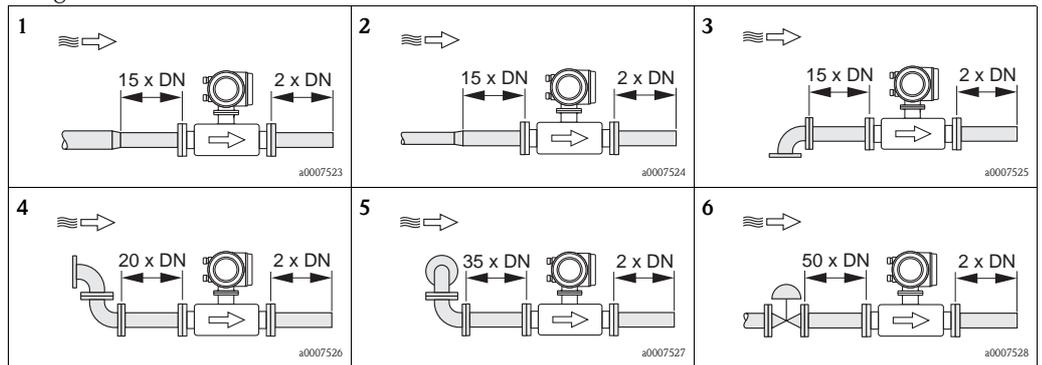


Note!

- Where two or more flow disturbances are located upstream of the meter, the longest indicated inlet length should prevail. For example if a control valve and a bend are mounted upstream of the flowmeter, the recommended inlet length should be according to the control valve (50 x DN).
- For very light gases such as Helium and Hydrogen all upstream distances should be doubled.

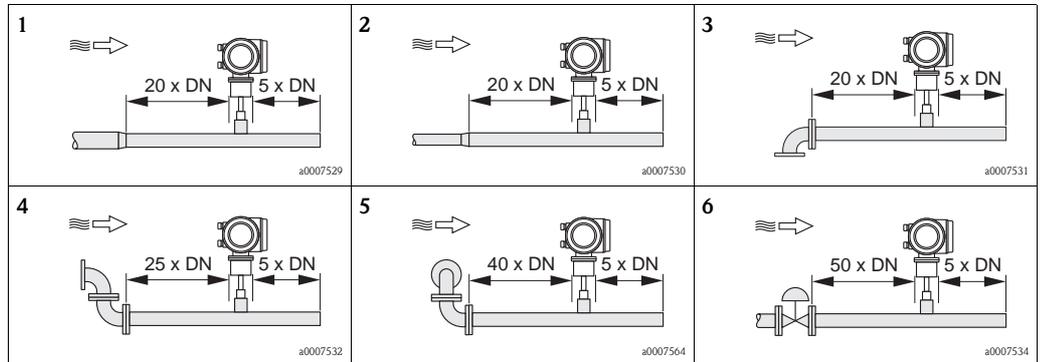
The minimum recommendations for inlet and outlet runs (without flow conditioner) are:

Flanged sensor



1 = Reduction, 2 = Expansion, 3 = 90° elbow or T-piece, 4 = 2 x 90° elbow, 5 = 2 x 90° elbow (3-dimensional), 6 = Control valve

Insertion sensor



1 = Reduction, 2 = Expansion, 3 = 90° elbow or T-piece, 4 = 2 x 90° elbow, 5 = 2 x 90° elbow (3-dimensional), 6 = Control valve or pressure regulator



Note!

A specially designed perforated plate flow conditioner can be installed if it is not possible to observe the inlet runs required (→ 16).

Outlet runs with pressure measuring points

The pressure measuring point should be installed downstream of the measuring device, so that there is no potential influence of the pressure transmitter process connection on the flow entering the measuring point.

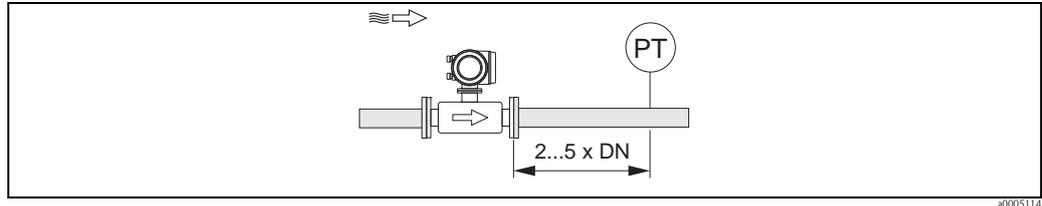


Fig. 5: Installing a pressure measuring point (PT = pressure transmitter)

Perforated plate flow conditioner

It is recommended to install a perforated plate flow conditioner if the recommended inlet runs are not available. See accessories → 71.

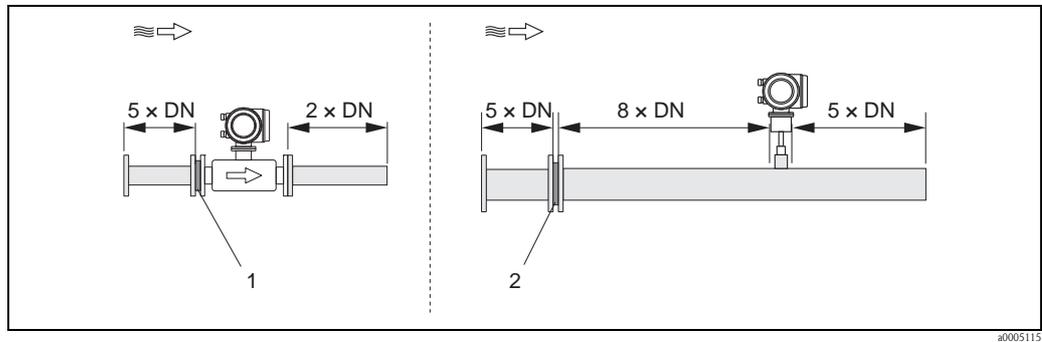


Fig. 6: The figure above illustrates the minimum recommended inlet and outlet runs expressed in multiples of the pipe diameter using a flow conditioner.

1 = Flow conditioner with the flanged sensor, 2 = Flow conditioner with the insertion sensor

Flow conditioner for use with insertion sensors

The well known "Mitsubishi" design is recommended for this application DN 80 mm (3") to DN 300 mm (12"). The flow conditioner must be installed at a distance of $8 \times DN$ upstream of the sensor. A further $5 \times DN$ inlet run is required upstream of the actual conditioner itself.

Flow conditioner for use with flanged sensors

This is a special Endress+Hauser version designed specially for use with the t-mass F sensor (sizes DN 25 to 100 / 1" to 4"). The mounting hole patterns and sizing are of a multi-variant design which means that one plate will fit different flange pressure classes e.g. Cl. 150 and Cl. 300.

The flow conditioner and gaskets are fitted between two pipe flange and the flow meter flange →  7.

Use only bolts which match to tehflange bolt hole and this will ensure that the correct positioning of the plate can be found. The alignment notch must also be pointing in the same plane as the transmitter.

Incorrect installation of the flow conditioner will have a small effect on the measurement accuracy.

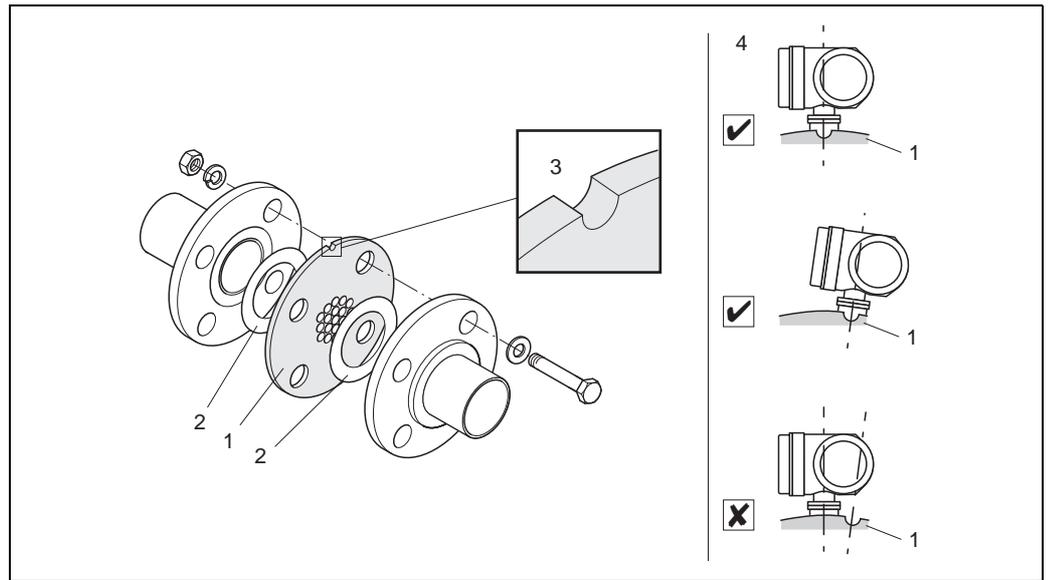


Fig. 7: Flow conditioner mounting arrangement (example)

1 = perforated plate flow conditioner, 2 = seal/gasket, 3 = alignment notch, 4 = alignment in the same plane as the transmitter



Note!

- For optimum performance, it is advised that the t-mass F sensor and flow conditioner are ordered at the same time such that they are calibrated together. To retrospectively fit a flow conditioner will have a small effect on the measurement performance.
- The use of other types of flow conditioners, other than the Endress+Hauser flow conditioner, with the t-mass F sensor will have an impact on the measurement performance due to the effects of flow profile and pressure drop.
- Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

3.2.6 Heating

Some applications require suitable measures to avoid heat loss (condensation). Heating can be electric, e. g. with heated elements, or by means of hot water, steam pipes or insulation.



Caution!

Risk of electronics overheating! Consequently, make sure that the adapter between sensor and transmitter and the connection housing of the remote version always remain free of insulating material.

3.2.7 Thermal insulation

When the gas is very damp or saturated with water (e. g. bio gas), the piping and flowmeter body should be insulated to prevent water droplets condensing on the measuring sensor.

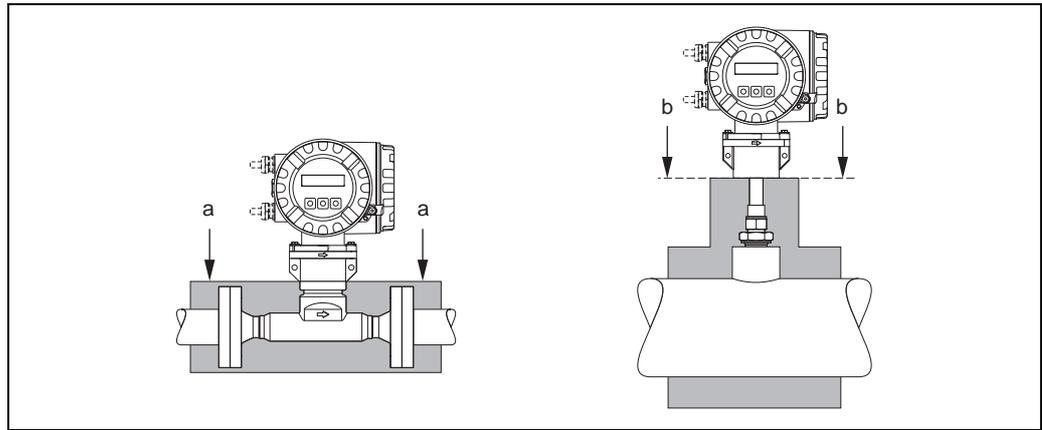


Fig. 8: Maximum thermal insulation for t-mass 65F and 65I

a Maximum insulation height for the flanged sensor

b Maximum insulation height for the insertion sensor

3.2.8 Vibrations



Caution!

Excessive vibration can result in mechanical damage to the measuring device and its mounting. Observe the vibration specification in the technical data section → 94

3.3 Installation instructions

3.3.1 Mounting the insertion sensor

The sensor can be mounted into a welding socket or a retractable mounting set. If a retractable mounting set is being used, then refer to the supplementary documentation delivered with the mounting set.

Mounting the welding socket

This instruction describes mounting of the Endress+Hauser welding socket. If an existing or customer-specific mounting set is being used, then go to the next section "Insertion depth calculation and adjustment".



Note!

- Take the orientation and inlet and outlet runs into account before mounting the welding socket → 14 ff.
- The welding socket is made of stainless steel 1.4404 (316/316L). Use appropriate welding technique.



Caution!

When mounting the fitting to a thin wall duct, use a suitable support bracket for the sensor and weld the welding socket to a base plate to spread the load. Otherwise, the mounting may be unstable and the duct wall can be damaged.



Warning!

- These instructions are only applicable to installation in an un-pressurized line, without gas present and at safe temperatures.

1. Drill or cut hole of $\text{Ø } 31.0 \text{ mm} \pm 0.5 \text{ mm}$ ($1.22" \pm 0.019"$) in the pipe.
2. Deburr the hole.
3. Fit the edge of the welding socket into hole, align it vertically and weld it on → 9.

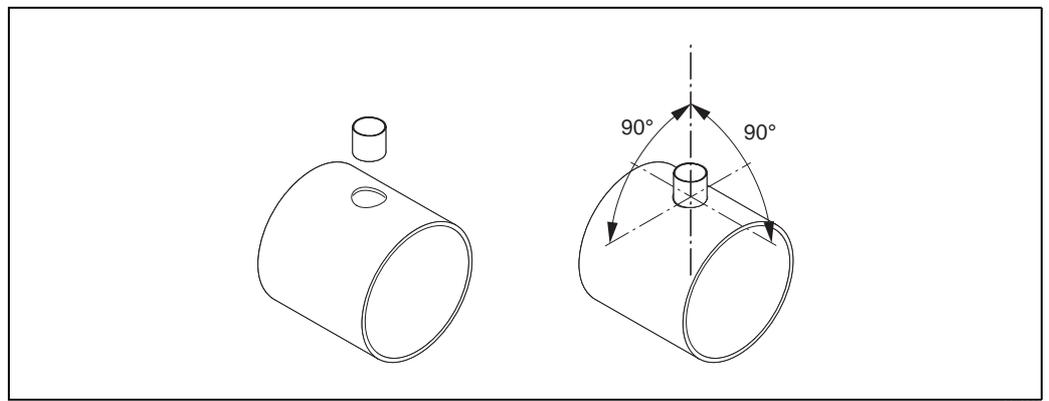


Fig. 9: Positioning the welding socket on the pipe (or duct)

Insertion depth calculation and adjustment

To obtain the best measurement results, it is important that the sensor is inserted at the right insertion depth in the pipe/duct. A millimeter and inch scale is provided along the entire length of the sensor tube. This makes it possible to align the sensor at the right depth.

4. Calculate the insertion depth:
 - with the help of the Quick Setup "Sensor" → 58 or
 - using the following dimensions and formulae

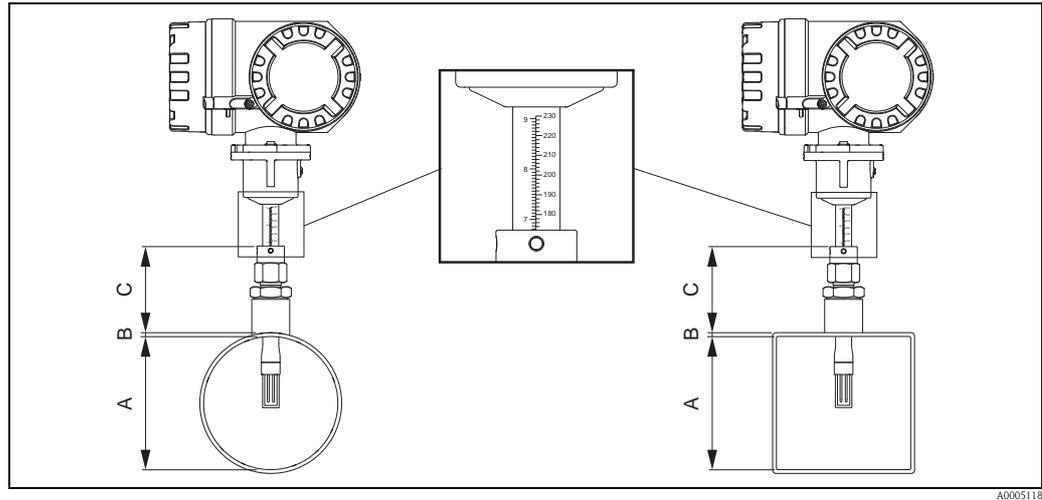


Fig. 10: Dimensions needed to calculate the insertion depth

- A Pipes: internal diameter
Ducts: internal dimension
B Wall thickness
C Dimension from pipe/duct to the compression fitting



Note!

For detailed remarks on calculation refer to Technical Information TI069D.

- Calculated insertion depth (SI units) = $0.3 \cdot A + B + C + 2$ mm
- Calculated insertion depth (US units) = $0.3 \cdot A + B + C + 0.079$ inch

Note down the calculated value.

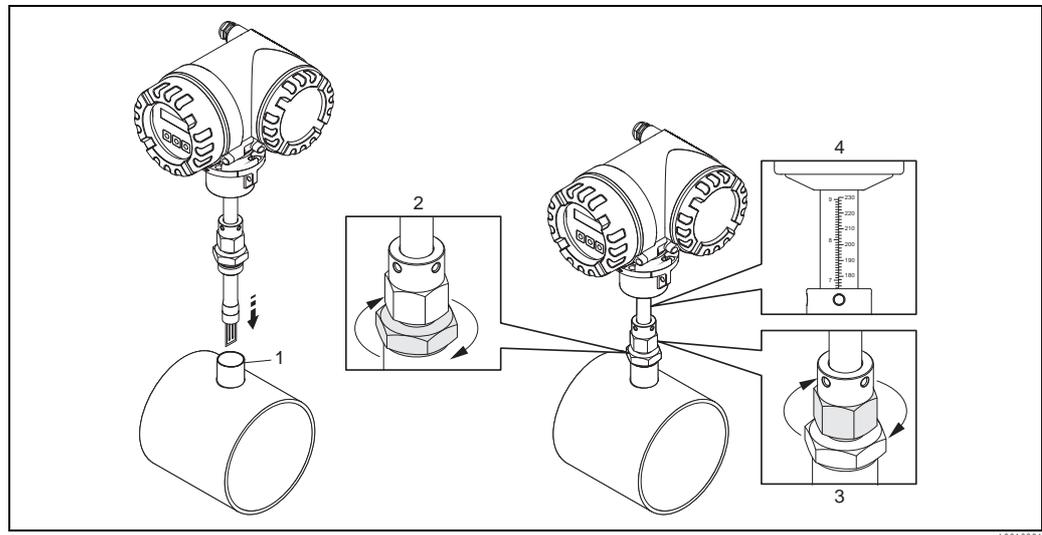


Fig. 11: Aligning the sensor to the calculated insertion depth

5. Insert the sensor into the socket (1) and tighten the lower nut of compression fitting (2) first by hand and then tighten it $1\frac{1}{4}$ revolutions using a wrench (42 mm).



Caution!

- NPT thread: use a thread sealing tape or paste
- G 1 A thread: the sealing ring supplied must be installed

6. Tighten the upper nut of compression fitting (3) such that the sensor can still be adjusted.
7. Read off the calculated insertion depth from the scale and adjust the sensor so that the value aligns with the upper end of the compression fitting (4).

Aligning the sensor with the flow direction

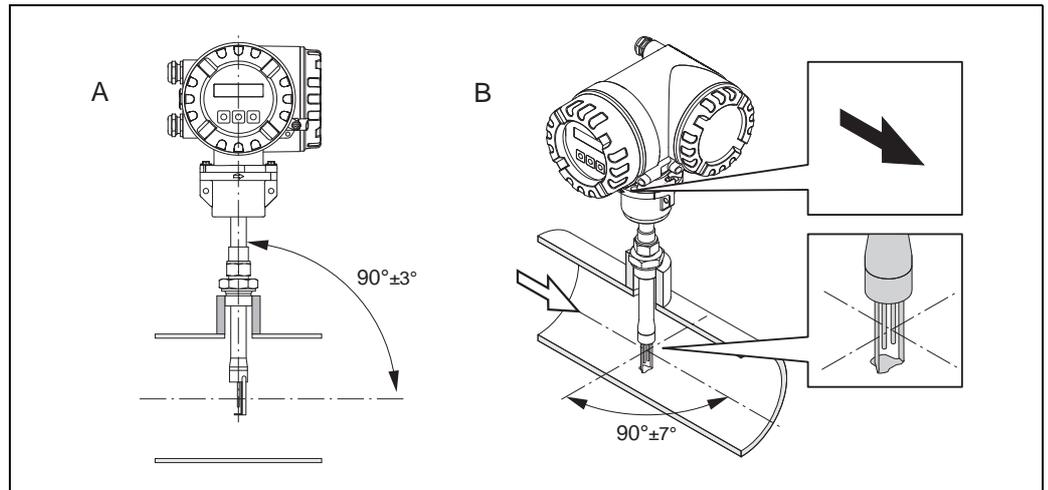


Fig. 12: Aligning the sensor with the flow direction

8. Check and ensure that the sensor is aligned vertically at a 90° angle on the pipe/duct. Turn the sensor so that the arrow marking matches the direction of flow.



Note!

To ensure optimum exposure of the measuring transducers to the flowing gas stream, the sensor must not be rotated more than 7 degrees from this alignment.

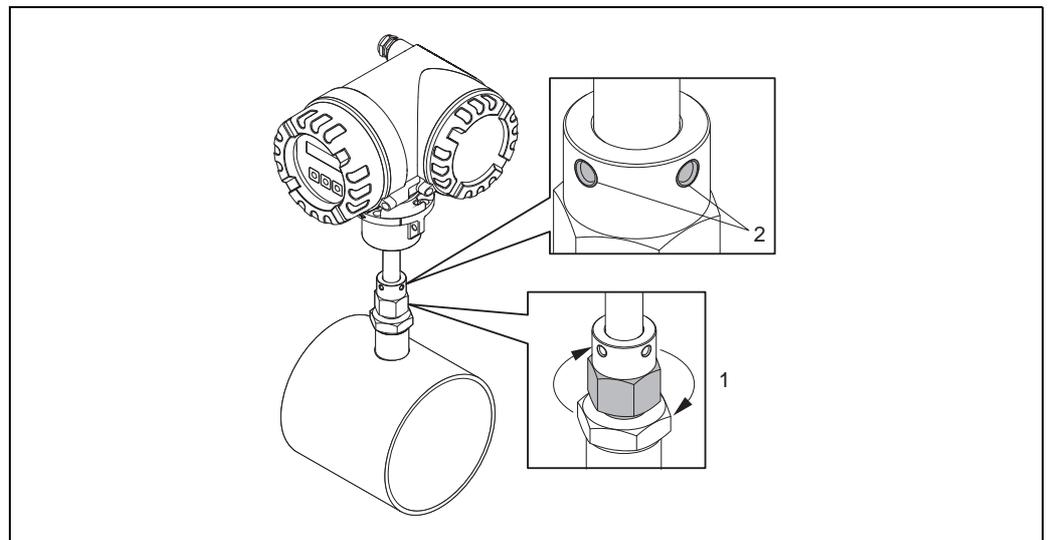


Fig. 13: Securing the position of the sensor

9. Tighten the compression fitting (1) by hand to secure the position of the sensor. Then, using an open-ended wrench, tighten another $1\frac{1}{4}$ revolutions in a clockwise direction.
10. Fix the two securing screws (2) (Allen key 3 mm; $1/8$ ").



Warning!

Observe torque: 4 Nm (2.95 lbf ft)

11. Check that the sensor and transmitter do not turn.
12. Check the measuring point for leaks at the maximum operating pressure.

3.3.2 Removing the insertion sensor



Warning!

- Do not remove the measuring device when it is pressurized! Stop the gas flow and unpressurize the process pipe.
- In the case of toxic, explosive or flammable gases, the pipe in which the measuring device is installed must be purged with an inert gas to remove all traces of the gas used.
- Make sure that the process cannot be resumed while removal work is in progress.
- Allow the system and device to cool to a safe temperature (i.e. $<50\text{ }^{\circ}\text{C}$, $<120\text{ }^{\circ}\text{F}$).

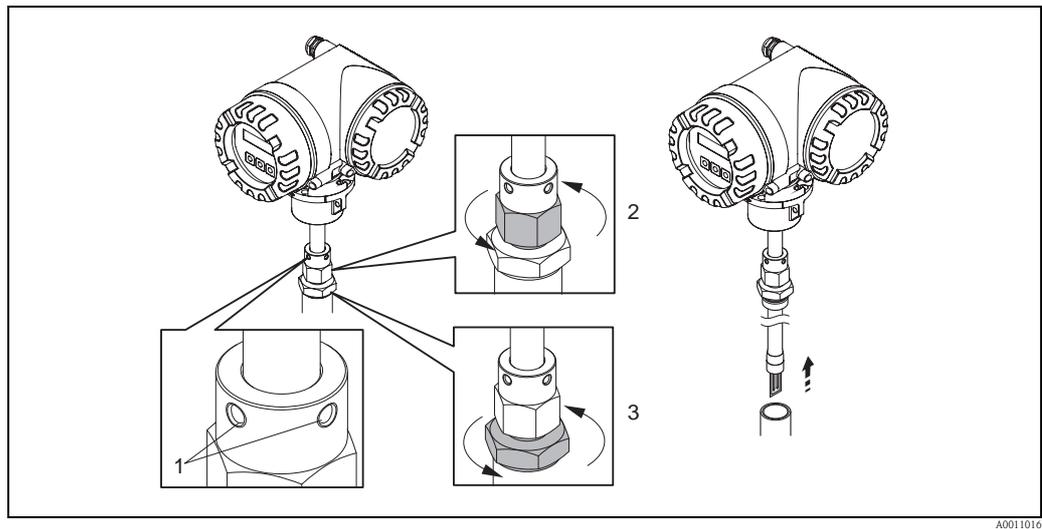


Fig. 14: Removing the insertion sensor

1. Release the securing screws (1).
2. Release the upper nut of compression fitting using a wrench, turning in a counterclockwise direction (2).



Caution!

In the case of vertical installation, do not drop the measuring device into the pipe.

3. Unscrew the lower nut of compression fitting (3) and remove the sensor.

3.3.3 Mounting the flanged sensor

The arrow on the sensor must match with the actual direction of flow through the pipe.

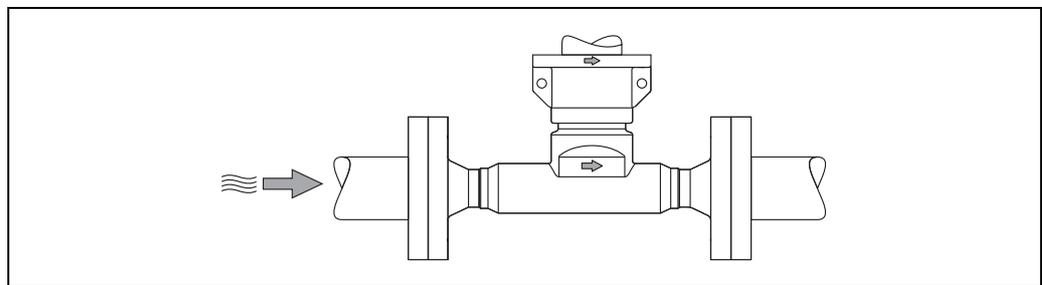


Fig. 15: Mounting in direction of flow

3.3.4 Turning the transmitter housing

Turning the aluminum field housing



Warning!

The rotating mechanism for devices for hazardous areas Zone 1 (ATEX/IEC Ex) or Class I Div. 1 (FM/CSA) is different to that described here. The procedure for turning these housings is described in the Ex-specific documentation → 100.

1. Loosen the two securing screws.



Caution!

Special screw! Do not loosen screw completely or replace with another screw.

Use only original parts from Endress+Hauser.

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. $2 \times 90^\circ$ in either direction).
5. Lower the housing into position and re-engage the bayonet catch.
6. Retighten the two securing screws.

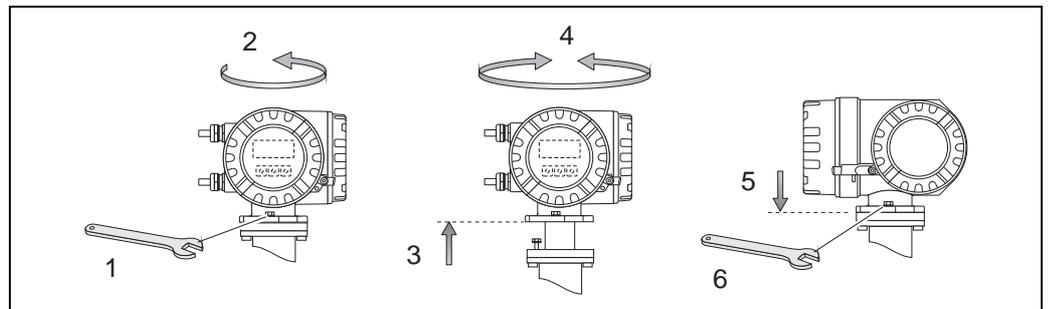


Fig. 16: Turning the transmitter housing (aluminum field housing)

3.3.5 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 ($4 \times 45^\circ$ 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.

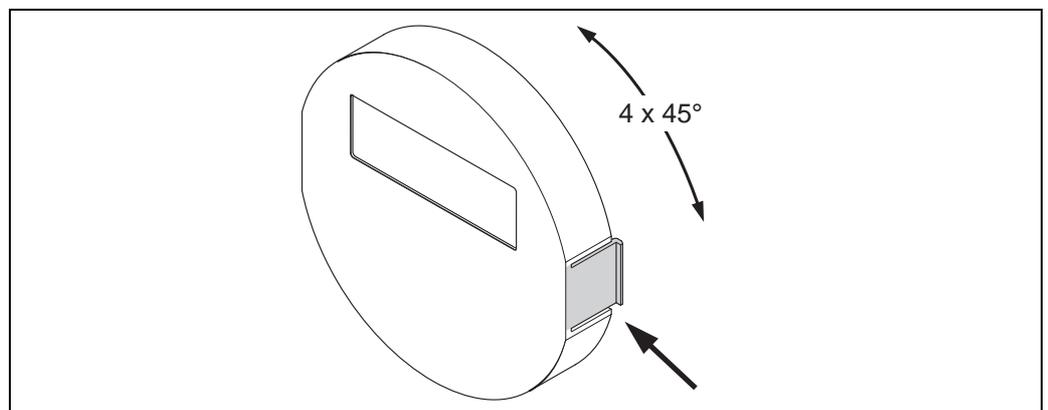


Fig. 17: Turning the local display (field housing)

3.3.6 Installing the wall-mount transmitter housing

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

- Mounted directly on the wall
- Installation in control panel → 25 (separate mounting set, accessories → 71)
- Pipe mounting → 25 (separate mounting set, accessories → 71)



Caution!

- Make sure that ambient temperature does not go beyond the permissible range of -20 °C to $+60\text{ °C}$ (-4 °F to $+140\text{ °F}$), optional -40 °C to $+60\text{ °C}$ (-40 °F to $+140\text{ °F}$).
- Install the device in a shaded location. Avoid direct sunlight on the display.
- 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. $\text{Ø } 6.5\text{ mm}$ (0.25 inch)
 - Screw head: max. $\text{Ø } 10.5\text{ mm}$ (0.4 inch)
4. Secure the transmitter housing to the wall as indicated.
5. Screw the cover of the connection compartment (a) firmly onto the housing.

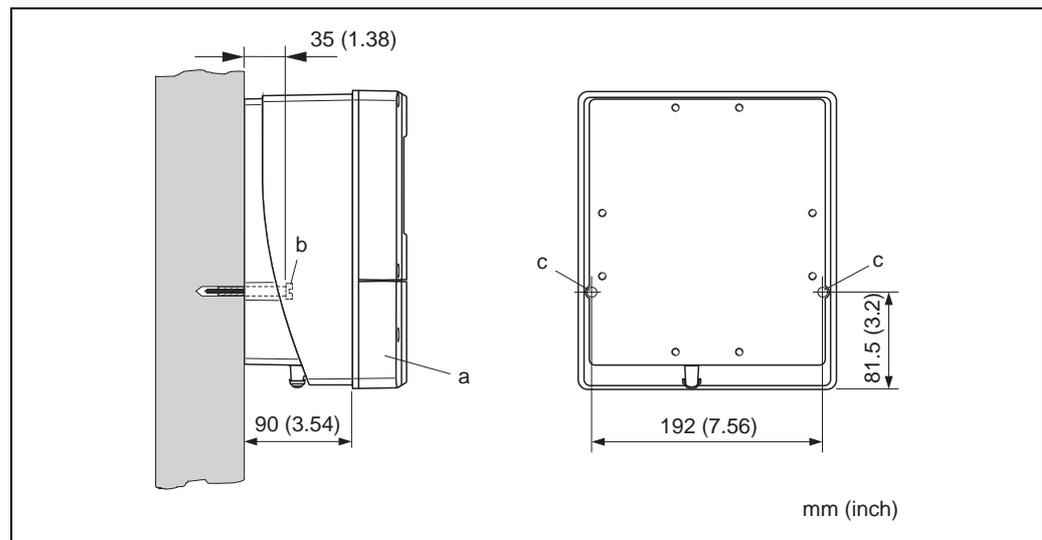


Fig. 18: Mounted directly on the wall

s0001130-ae

Installation in control panel

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.

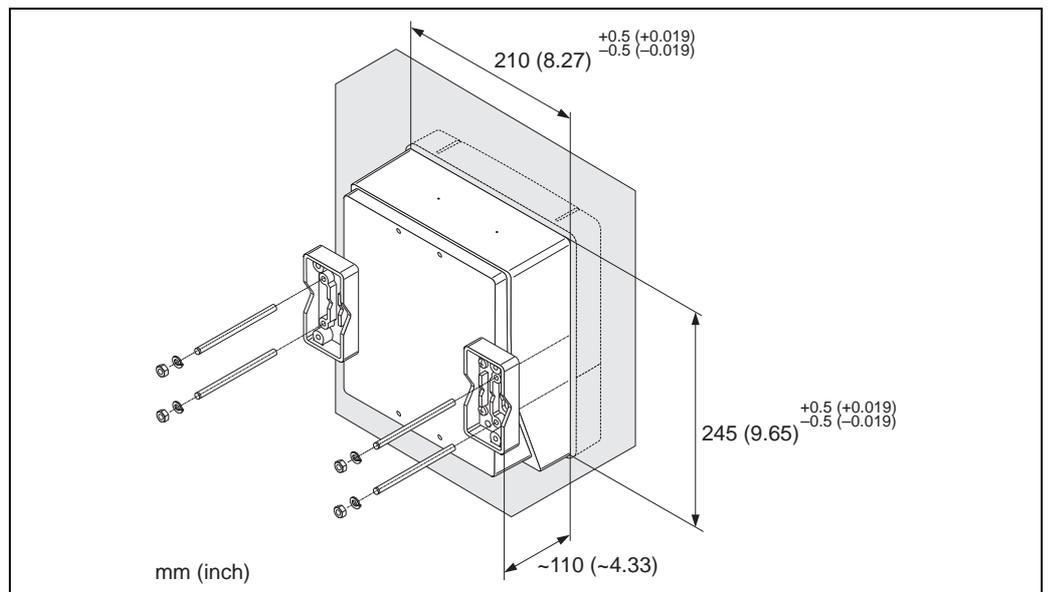


Fig. 19: Panel installation (wall-mount housing)

Pipe mounting

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



Caution!

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

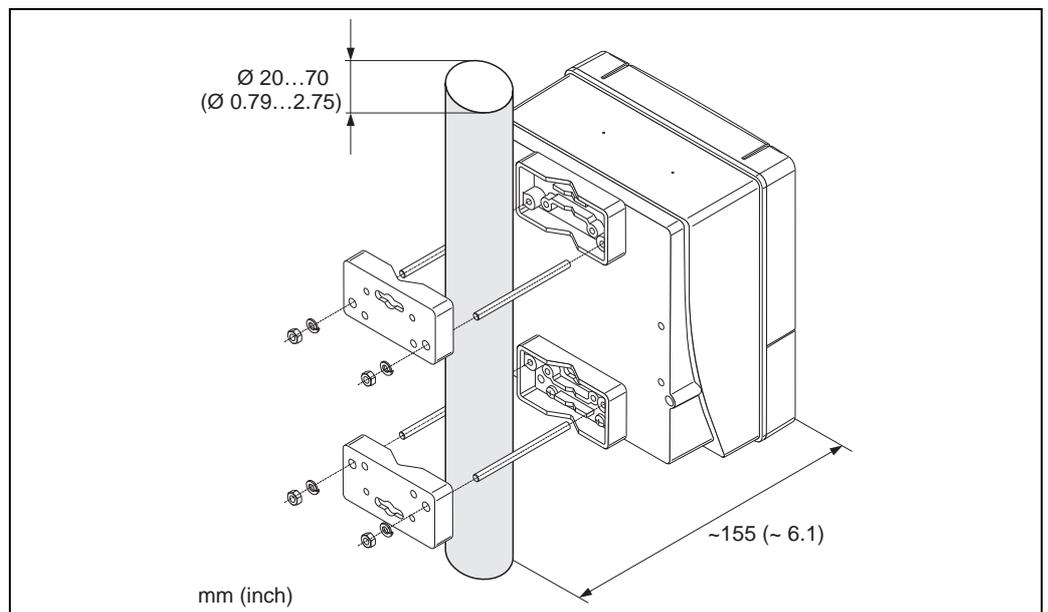


Fig. 20: Pipe mounting (wall-mount housing)

3.4 Post-installation check

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

| Device condition and specifications | Notes |
|---|---|
| Is the device damaged (visual inspection)? | – |
| Does the device correspond to specifications at the measurement point, including process temperature and pressure, ambient temperature, measuring range, etc.? Check the name plate. | → 7 |
| Installation | Notes |
| Correct alignment of pipe/gasket/flowmeter body? | → 13 |
| Professional installation (correct pipe internal diameter, correctly sized gaskets)? | → 13 |
| Is the position chosen for the sensor correct, in other words suitable for sensor type, fluid properties and fluid temperature? | → 14 |
| Is there sufficient upstream and downstream pipe sensor? | → 15 |
| Correct installation of flow conditioner (if fitted)? | → 16 |
| Does the arrow on the sensor match the direction of flow through the pipe? | → 14 |
| Correct sensor depth (insertion sensor only)? | → 19 |
| Process environment / process conditions | Notes |
| Is the measuring device protected against moisture and direct sunlight? | – |
| Is the measuring device protected against overheating? | → 18 |
| Is the measuring device protected against excessive vibration? | → 18 , → 94 |
| Check gas conditions (e. g. purity, dryness, cleanliness) | Select suitable orientation → 14 |

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 representative if you have any questions.



Note!

- The device does not have an internal power isolation switch. Therefore provide an isolation switch or circuit breaker which can be used to disconnect the power supply to the device.
- The electrical characteristic quantities are listed in the "Technical data" section.

4.1 Cable specification MODBUS RS485

4.1.1 Cable type

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

| Cable type A | |
|--------------------------|--|
| Characteristic impedance | 135 to 165 Ω at a measuring frequency of 3 to 20 MHz |
| Cable capacitance | <30 pF/m |
| Core cross-section | >0.34 mm ² , corresponds to AWG 22 |
| Cable type | Twisted pairs |
| Loop-resistance | \leq 110 Ω /km |
| Signal damping | Max. 9 dB over the entire length of the cable cross-section |
| Shielding | Copper braided shielding or braided shielding and foil shielding |

Note the following points for the bus structure:

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

4.1.2 Shielding and grounding

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

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

To ensure the optimum electromagnetic compatibility of systems, it is important that the system components and above all the cables, which connect the components, are shielded and that no portion of the system is unshielded. Ideally, the cable shields are connected to the normally metal housings of the connected field devices. Since these are generally connected to the protective earth, the shield of the bus cable is grounded many times. Keep the stripped and twisted lengths of cable shield to the terminals as short as possible.

This approach, which provides the best electromagnetic compatibility and personnel safety, can be used without restriction in systems with good potential matching.

In the case of systems without potential matching, a power supply frequency (50 Hz) equalizing current can flow between two grounding points which, in unfavorable cases (e.g. when it exceeds the permissible shield current) may destroy the cable.

To suppress the low frequency equalizing currents on systems without potential matching, it is therefore recommended to connect the cable shield directly to the building ground (or protective earth) at one end only and to use capacitive coupling to connect all other grounding points.



Caution!

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

4.2 Connecting the remote version

4.2.1 Connecting connecting cable for sensor/transmitter



Warning!

- After removing the electronics cover, there is a risk of electric shock as shock protection is removed! Switch off the measuring device before removing internal covers.
- Risk of electric shock. Connect the protective earth to the ground terminal on the housing before the power supply is applied.

1. Remove the connection compartment cover by loosening the fixing screws on the transmitter and sensor housing.
2. Feed the connecting cable through the appropriate cable entry.
3. Establish the connections between sensor and transmitter in accordance with the wiring diagram: (→  21 or see wiring diagram in screw cap; wire cross-section: max. 2.5 mm² / AWG 13).
4. Screw the connection compartment cover back onto the sensor and transmitter housing.

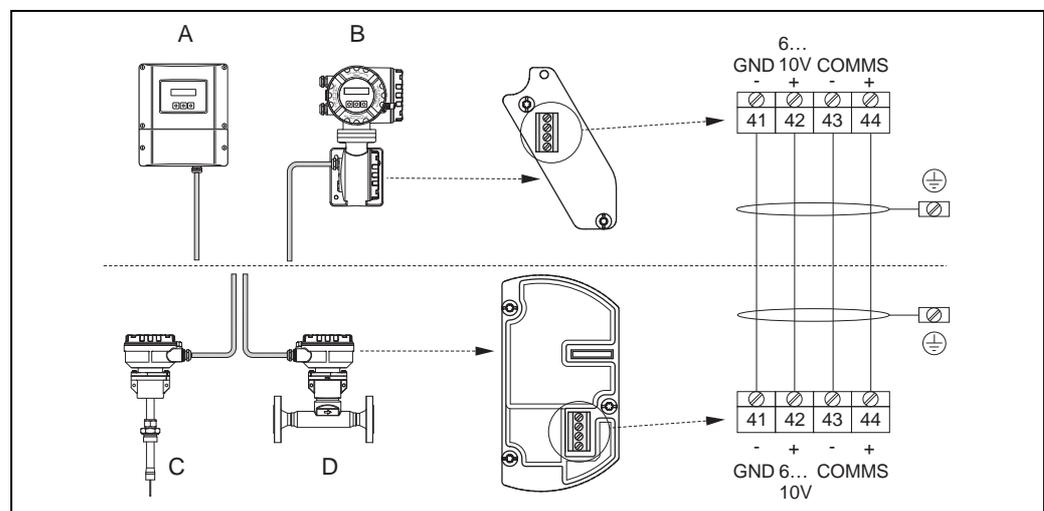


Fig. 21: Connecting the remote version

A Wallmount housing; Non-hazardous area and zone 2 (ATEX II3G, FM/CSA) → see separate "Ex documentation"

B Field housing; Zone 1 (ATEX II2GD, IECEx, FM/CSA) → see separate "Ex documentation"

C Remote sensor insertion

D Remote sensor flanged

Wire colors (when supplied by Endress+Hauser):

Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow

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:

- $2 \times 2 \times 0.5 \text{ mm}^2$ (AWG 20) PVC cable with common shield (2 twisted pairs)
- Conductor resistance: $\leq 40 \text{ } \Omega/\text{km}$ ($\leq 131.2 \text{ } \Omega / 1000 \text{ ft}$)
- Operating voltage: $\geq 250 \text{ V}$
- Temperature range: -40 to $+105 \text{ } ^\circ\text{C}$ (-40 to $+221 \text{ } ^\circ\text{F}$)
- Overall nominal diameter: 8.5 mm ($0.335''$)
- Maximum cable length: 100 m (328 feet)



Note!

- The cable must be installed securely to prevent movement
- The cable should be of sufficient diameter to provide adequate sealing of the cable gland → 92.

4.3 Connecting the measuring unit

4.3.1 Terminal assignment

| Order variant | Terminal No. (inputs/outputs) | | | | | | | |
|---------------|-------------------------------|--------|--------|--------|--------|--------|---------------|---------------|
| | 20 (+) | 21 (-) | 22 (+) | 23 (-) | 24 (+) | 25 (-) | 26 (+) | 27 (-) |
| 65F*_*****Q | - | - | - | - | - | - | B | A |
| 65L*_*****Q | | | | | | | MODBUS RS485 | |
| | | | | | | | A = RxD/TxD-N | B = RxD/TxD-P |

4.3.2 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 unless special protection measures have been taken (e.g. galvanically isolated power supply SELV or PELV).
- 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 from the transmitter housing.
2. Feed the power supply cable, the fieldbus cable and the signal cable through the appropriate cable entries.
3. Perform wiring:
 - Wiring diagram → [31](#)
 - Terminal assignment → see above



Caution!

- Risk of damage to the fieldbus cable!
Observe the information about shielding and grounding the fieldbus cable → [27](#).
 - We recommend that the fieldbus cable not be looped using conventional cable glands.
If you later replace even just one measuring device, the bus communication will have to be interrupted.
4. Screw the cover of the connection compartment back onto the transmitter housing.

4.3.3 MODBUS RS485 connection diagram

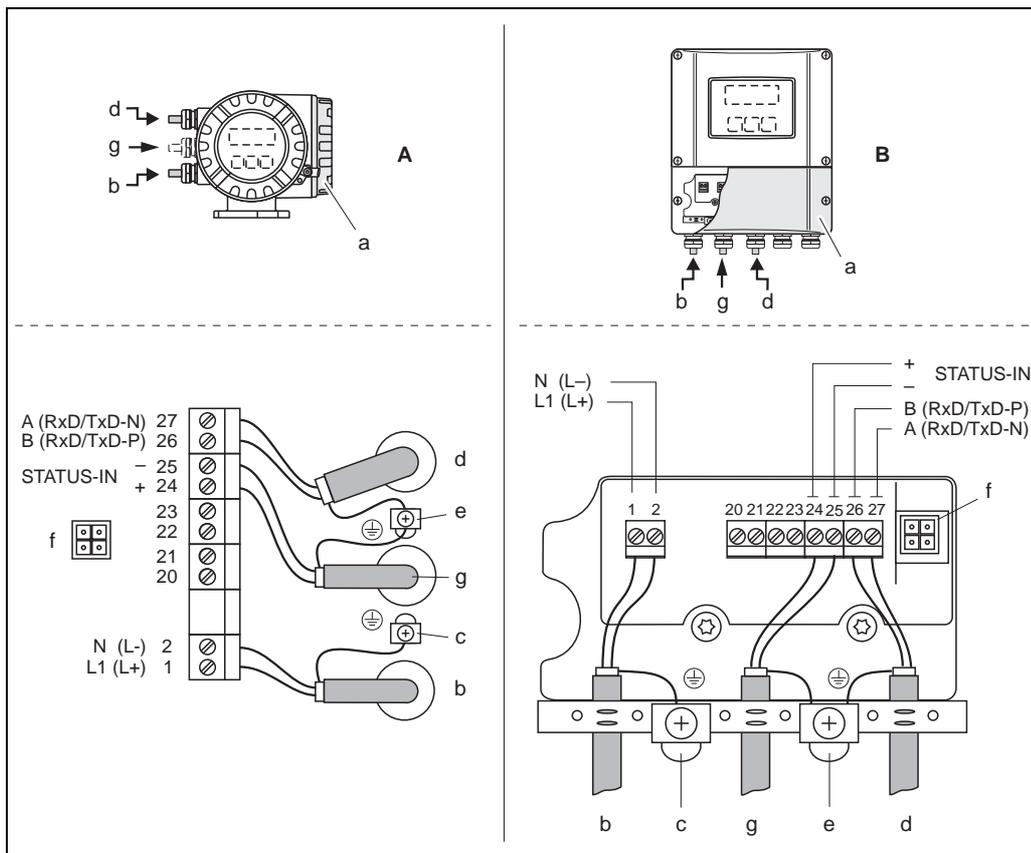


Fig. 22: Connecting the transmitter, cable cross-section: max. 2.5 mm² (AWG 13)

- A Field housing
- B Wall-mount housing
- a Connection compartment cover
- b Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
Terminal No. 1: L1 for AC, L+ for DC
Terminal No. 2: N for AC, L- for DC
- c Ground terminal for protective conductor
- d Fieldbus cable:
Terminal No. 26: B (RxD/TxD-P)
Terminal No. 27: A (RxD/TxD-N)
- e Ground terminal, for RS485 line / signal cable shield
Observe the following:
 - the shielding and grounding of the fieldbus cable → 27
 - that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible
- f Service socket for connecting service interface FXA 193 (FieldCare or Fieldcheck)
- g Signal cable: see Terminal assignment → 30

4.4 Degree of protection

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

Compliance with the following points is mandatory following installation in the field or servicing, in order to ensure that IP 67 (NEMA 4X) protection is maintained:

- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- All threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter (Cable entry → 92)
- Firmly tighten the cable entries (a).
- The cables must loop down before they enter the cable entries ("water trap") (b). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert blanking plugs instead.
- Do not remove the grommet from the cable entry.

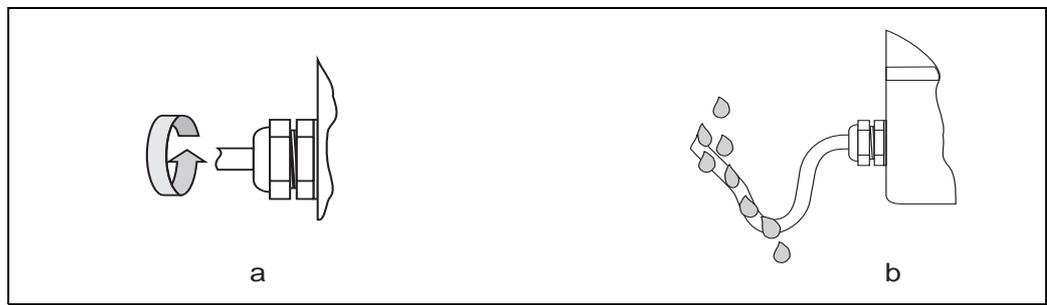


Fig. 23: Installation instructions, cable entries

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? | MODBUS RS485 → 27 Connecting cable → 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? | → 31 See the wiring diagram inside the cover of the terminal compartment |
| Only remote version: Is the flow sensor connected to the matching transmitter electronics? | Check serial number on nameplates of sensor and connected transmitter. |
| Only remote version: is the connecting cable between sensor and transmitter connected correctly? | → 29 |
| 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? | - |
| Electrical connection of MODBUS RS485 | Notes |
| Has each fieldbus segment been terminated at both ends with a bus terminator? | → 54 |
| Has the max. length of the fieldbus cable been observed in accordance with the MODBUS RS485 specifications? | → 27 |
| Has the max. length of the spurs been observed in accordance with the MODBUS RS485 specifications? | → 27 |
| Is the fieldbus cable fully shielded and correctly grounded? | → 27 |

5 Operation

5.1 Quick operation guide

The user has 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 device parameters in the field and perform commissioning.
2. **Configuration programs** →  51
Operation via FieldCare
The Proline flowmeters are accessed via the service interface or via the service interface FXA 193.
3. **Jumpers/miniature switches for hardware settings**
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

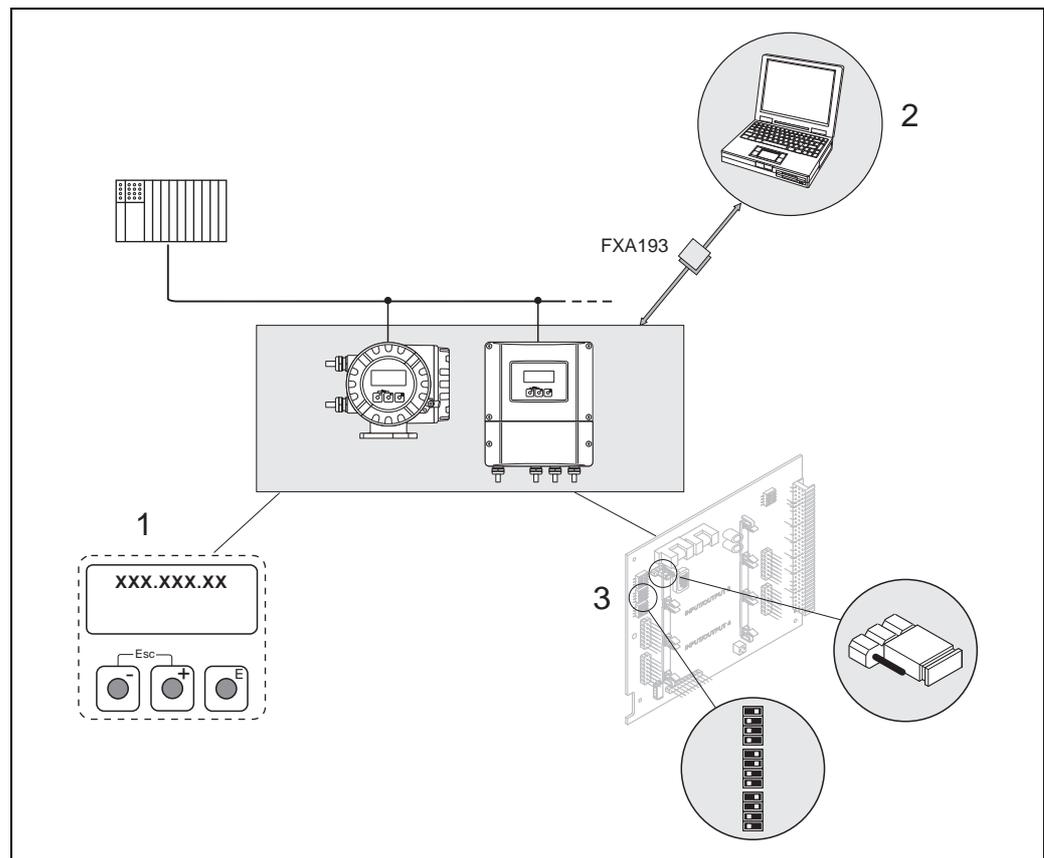


Fig. 24: Methods of operating MODBUS RS485 devices

- 1 Local display for device operation in the field (option)
- 2 Configuration/operating program for operating via the service interface FXA 193 (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 device using the function matrix.

The display consists of two lines; this is where measured values and/or status variables (process/system error messages, 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).

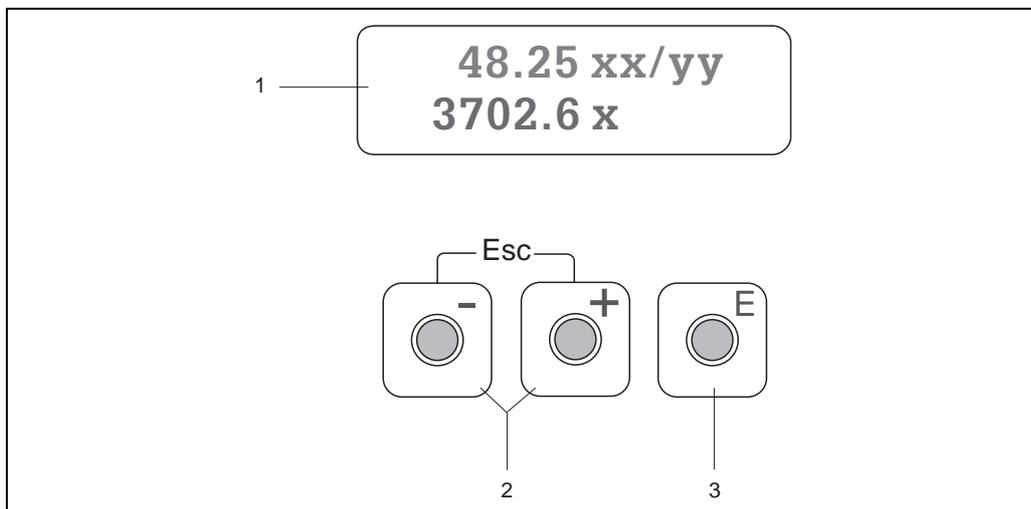


Fig. 25: Display and operating elements

- 1 **Liquid crystal display**
 The backlit, two-line liquid crystal display shows measured values, dialog texts, fault messages and notice messages. The display as it appears when normal measuring is in progress is known as the HOME position (operating mode).
 - Upper display line: shows primary measured values, e.g. mass flow in [kg/h] or in [%].
 - Lower display line: shows additional measured variables and status variables, e.g. totalizer reading in [kg], bar graph, measuring point designation.
- 2 **◀/▶ keys**
 - Enter numerical values, select parameters
 - Select different function groups within the function matrix
 Press the ◀/▶ keys simultaneously to trigger the following functions:
 - Exit the function matrix step by step → HOME position
 - Press and hold down ◀/▶ keys (◀/▶) for longer than 3 seconds → Return directly to HOME position
 - Cancel data entry
- 3 **⏎ Enter key**
 - HOME position → Entry into the function matrix
 - Save the numerical values you input or settings you change

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 |
| ⚡ | Fault message (with effect on outputs) | ! | Notice message (without effect on outputs) |
| ⊕ | Low flow cut off or extended flow function is active | | |
| | MODBUS communication active | | |

5.3 Brief operating instructions to the function matrix



Note!

- See the general notes → 37.
 - Function descriptions → see the "Description of Device Functions" manual
1. HOME position → **E** → Entry into the function matrix
 2. Select a function group (e.g. CURRENT OUTPUT 1)
 3. Select a function (e.g. TIME CONSTANT)
Change parameter / enter numerical values:
 - + -** → Select or enter enable code, parameters, numerical values
 - E** → Save your entries
 4. Exit the function matrix:
 - Press and hold down Esc key (**Esc**) for longer than 3 seconds → HOME position
 - Repeatedly press Esc key (**Esc**) → Return step by step to HOME position

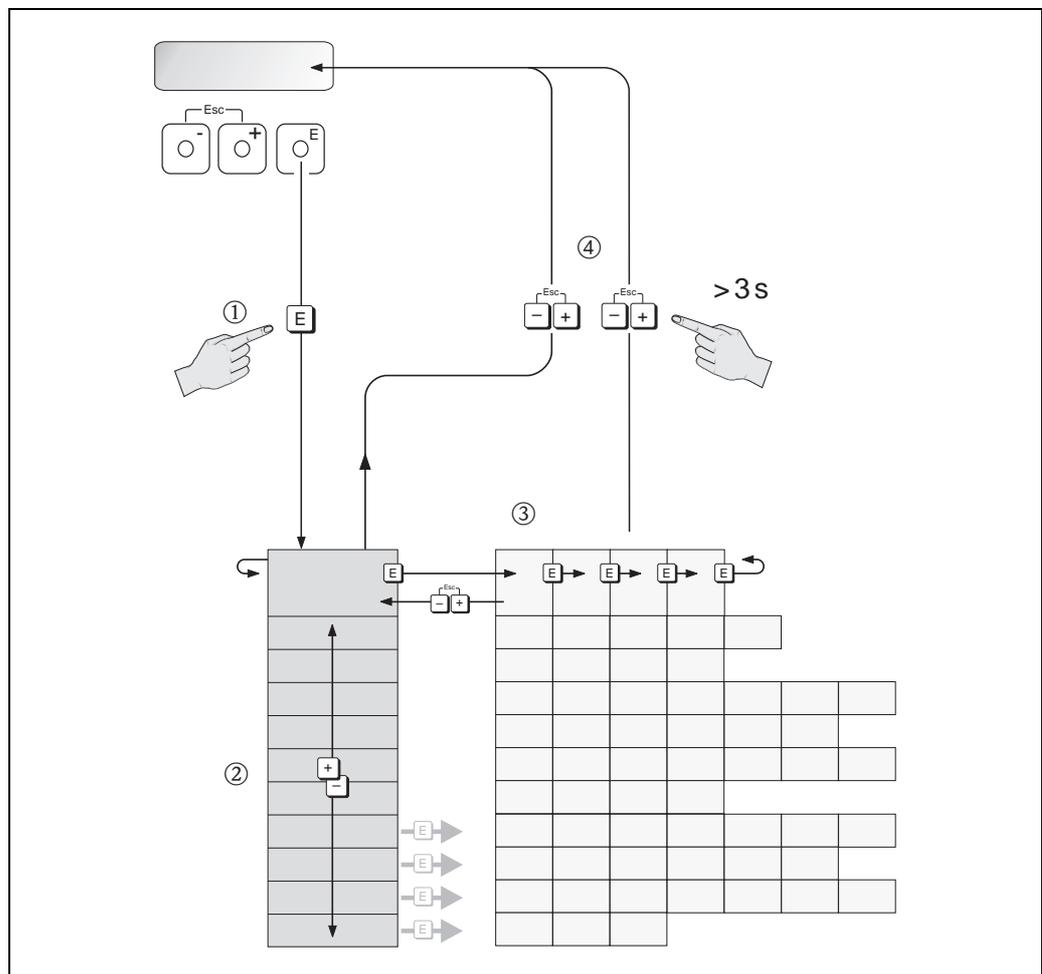


Fig. 26: Selecting functions and configuring parameters (function matrix)

a0001142

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 customise to suit your process parameters. The function matrix, therefore, comprises a multiplicity of additional functions which, for the sake of clarity, are arranged in a number of function groups.

Comply with the following instructions when configuring functions:

- You select functions as described already. →  36
- 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  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 parameterized, i.e. the current measured values are output via the signal outputs in the normal way.
- If the power supply fails, all preset and parameterized values remain safely stored in the EEPROM.

5.3.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 65) 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 the Endress+Hauser representative. 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 error:** This group includes all device errors, e.g. communication errors, hardware errors, etc. →  75
- **Process error:** This group includes all application errors, e.g. flow limit, etc. →  78

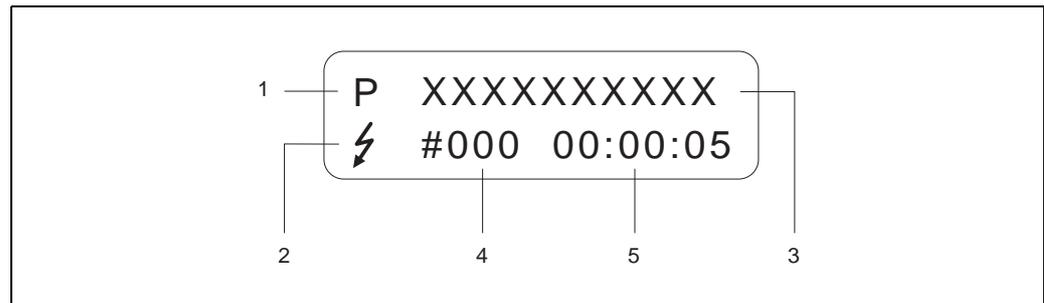


Fig. 27: Error messages on the display (example)

- 1 Error type: P = process error, S = system error
- 2 Error message type: ⚡ = fault message, ! = notice message, definition
- 3 Error designation: e.g. FLOW LIMIT = maximum flow limit exceeded
- 4 Error number: e.g. #422
- 5 Duration of most recent error occurrence (in hours, minutes and seconds)

5.4.2 Error message type

Users have the option of weighting system and process errors differently, by defining them as **Fault messages** or **Notice messages**. You can define messages in this way with the aid of the function matrix (see the "Description of Device Functions" manual).

Serious system errors, e.g. module defects, are always identified and classified as "fault messages" by the measuring device.

Notice message (!)

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

Fault message (⚡)

- Displayed as → Lightning flash (⚡), error designation (S: system error, P: process error).
- The error in question has a direct effect on the outputs.

The response of the outputs (failsafe mode) can be defined by means of functions in the function matrix. →  79



Note!

For safety reasons, error messages should be outputted via the status 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.

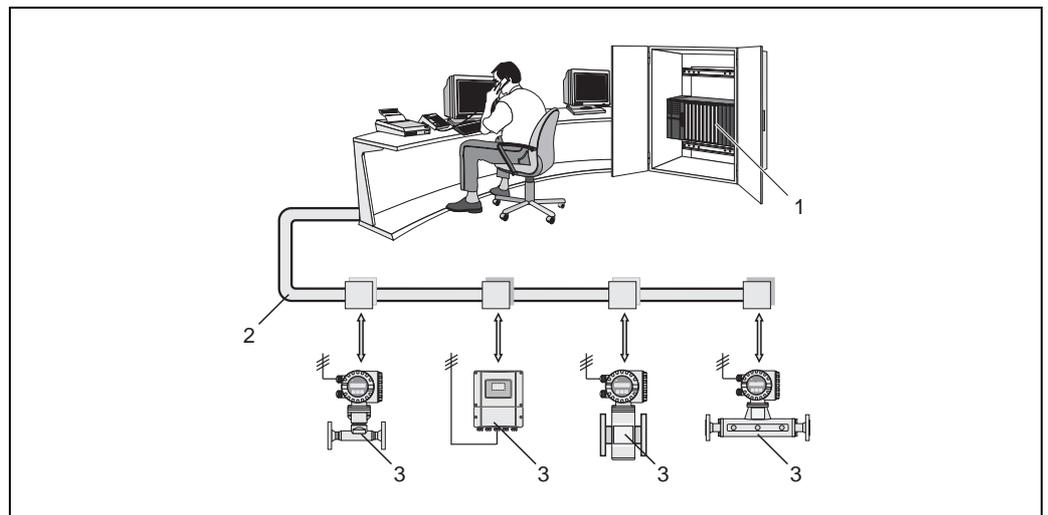


Fig. 28: MODBUS RS485 system architecture

- 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).

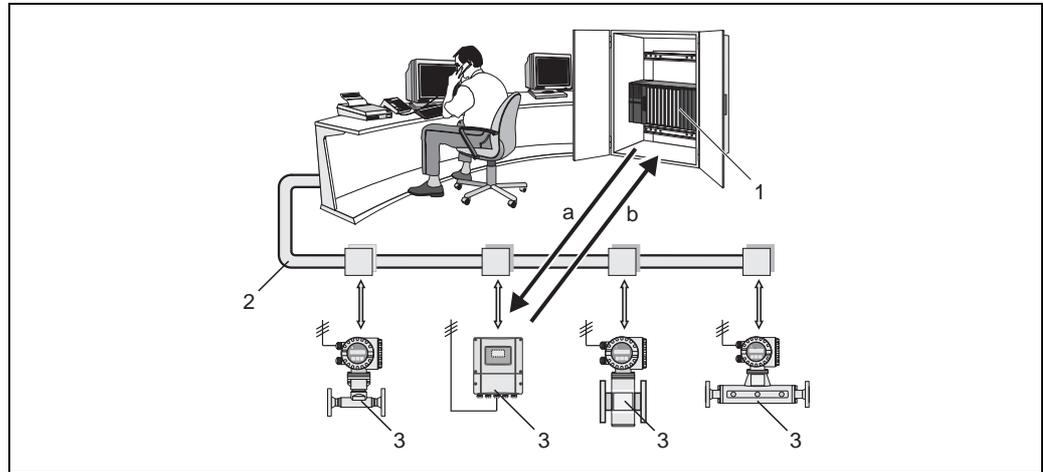


Fig. 29: MODBUS RS485 polling data traffic

- 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.

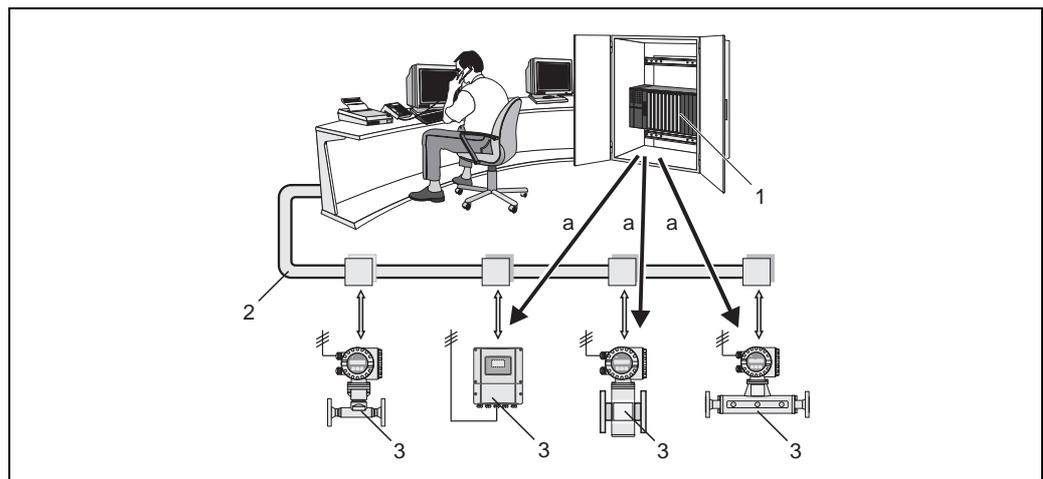


Fig. 30: MODBUS RS485 polling data traffic

- 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 → [42](#)

■ Data

Depending on the function code, the following values are transmitted in this data field:

- Register start address (from which the data is transmitted)
- Number of registers
- Write/read data
- Data length
- etc.

■ Check sum (CRC or LRC check)

The telegram check sum forms the end of the telegram.

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

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

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

5.5.3 MODBUS function codes

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

| Function code | Name in accordance with MODBUS specification | Description |
|---------------|--|--|
| 03 | READ HOLDING REGISTER | Reads one or more registers of the MODBUS slave. 1 to a maximum of 125 consecutive registers (1 register = 2 byte) can be read with a telegram. Application: For reading measuring device parameters with read and write access, such as reading the flow damping. |
| 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, totalizer value etc.). |
| 06 | WRITE SINGLE REGISTERS | Writes a slave register with a new value. Application: For writing just one measuring device parameter, such as 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: <ul style="list-style-type: none"> ■ 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 changing the totalizer mode 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 low flow cut off value, starting the zero point adjustment 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.

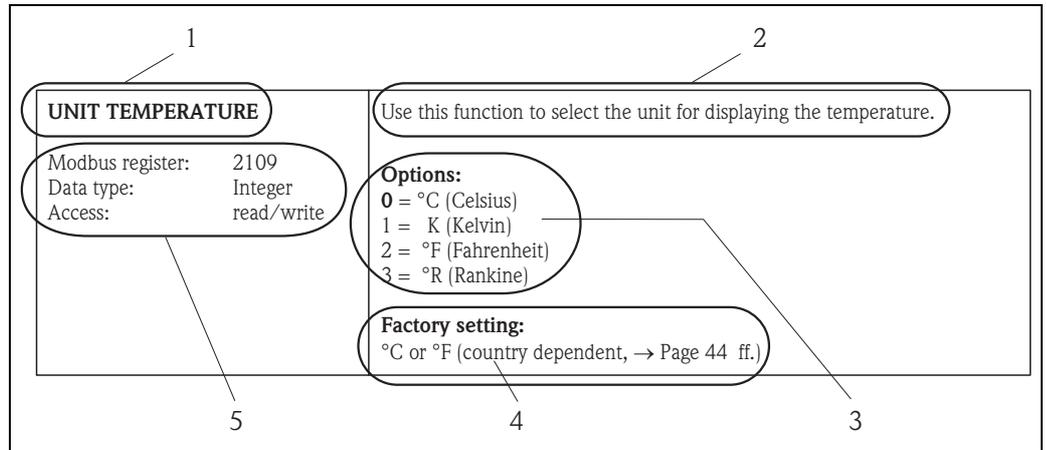


Fig. 31: Example of how a function description is illustrated in the "Description of Device Functions" manual

- 1 Name of the function
- 2 Description of the function
- 3 Selection or entry options or display
- 4 Factory setting (the measuring device is delivered with this setting/selected option)
- 5 Information on communication via MODBUS RS485
 - MODBUS register (information in decimal numerical format)
 - Data type: float (length = 4 bytes), integer (length = 2 bytes), string (length = depends on function)
 - Possible ways of accessing the function:
 - read = read access via function code 03, 04 or 23
 - write = write access via 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 |

| Function code | Access type | Register in accordance with: "MODBUS Applications Protocol Specification" | Register in accordance with: "Modicon MODBUS Protocol Reference Guide" |
|----------------|-------------|---|--|
| 06 16 23 | Write | XXXX Example: reset totalizer 1 = 2608 | → 4XXXX Example: reset totalizer 1 = 42608 |

Response times

The time it takes a measuring device to respond to a request telegram from the MODBUS master is typically 25 to 50 ms. If faster response times are needed for time-critical applications, 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).

Depending on the selection in the "BYTE ORDER" parameter, the bytes are transmitted as follows:

FLOAT

| Selection | Sequence | | | |
|----------------|----------------------|----------------------|----------------------|----------------------|
| | 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 (MMMMMMMM) | Byte 1 (MMMMMMMM) |
| 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 → 42. |
| 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 <ul style="list-style-type: none"> ■ The master is attempting to write to a register which only allows read access. ■ The value that appears in the data field is not permitted, e.g. range limits exceeded or incorrect data format. |
| 04 | SLAVE_DEVICE_FAILURE The slave did not respond to the request telegram from the master or an error occurred when processing the request telegram. |

5.5.7 MODBUS auto-scan buffer

Function description

The MODBUS master uses the request telegram to access the device parameters (data) of the measuring device. Depending on the function code, the master gains read or write access to a single device parameter or a group of consecutive device parameters. If the desired device parameters (registers) are not available as a group, the master has to send a request telegram to the slave for each parameter.

The measuring device has a special storage area, known as the auto-scan buffer, for grouping nonconsecutive device parameters. This can be used to flexibly group up to 16 device parameters (registers). The master can talk to this complete data block by means of just one request telegram.

Structure of the auto-scan buffer

The auto-scan buffer consists of two data records, the configuration area and the data area. In the configuration area, a list known as the scan list specifies which device parameters should be grouped. For this purpose, the corresponding register address, e.g. the register address 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 operating program (FieldCare).
The scan list is configured here by means of the function matrix:
COMMUNICATION → 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 / operating program (COMMUNICATION →) |
| 1 | 5001 | SCAN LIST REG. 1 |
| 2 | 5002 | SCAN LIST REG. 2 |
| 3 | 5003 | SCAN LIST REG. 3 |
| 4 | 5004 | SCAN LIST REG. 4 |
| 5 | 5005 | SCAN LIST REG. 5 |
| 6 | 5006 | SCAN LIST REG. 6 |
| 7 | 5007 | SCAN LIST REG. 7 |
| 8 | 5008 | SCAN LIST REG. 8 |
| 9 | 5009 | SCAN LIST REG. 9 |
| 10 | 5010 | SCAN LIST REG. 10 |
| 11 | 5011 | SCAN LIST REG. 11 |
| 12 | 5012 | SCAN LIST REG. 12 |
| 13 | 5013 | SCAN LIST REG. 13 |
| 14 | 5014 | SCAN LIST REG. 14 |
| 15 | 5015 | SCAN LIST REG. 15 |
| 16 | 5016 | SCAN LIST REG. 16 |

Access to data via MODBUS

The MODBUS master uses the register addresses 5051 to 5081 to access the data area of the auto-scan buffer. This data area contains the values of the device parameters defined in the scan list. For example, if the register 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 volume flow in register 5051.

| Data area | | | | |
|--|---|------------------------------------|-----------------|------------|
| Parameter value/Measured values | | Access via MODBUS register address | Data type * | Access** |
| Value of scan list entry No. 1 | → | 5051 | Integer / Float | Read/write |
| Value of scan list entry No. 2 | → | 5053 | Integer / Float | Read/write |
| Value of scan list entry No. 3 | → | 5055 | Integer / Float | Read/write |
| Value of scan list entry No. 4 | → | 5057 | Integer / Float | Read/write |
| Value of scan list entry No. 5 | → | 5059 | Integer / Float | Read/write |
| Value of scan list entry No. 6 | → | 5061 | Integer / Float | Read/write |
| Value of scan list entry No. 7 | → | 5063 | Integer / Float | Read/write |
| Value of scan list entry No. 8 | → | 5065 | Integer / Float | Read/write |
| Value of scan list entry No. 9 | → | 5067 | Integer / Float | Read/write |
| Value of scan list entry No. 10 | → | 5069 | Integer / Float | Read/write |
| Value of scan list entry No. 11 | → | 5071 | Integer / Float | Read/write |
| Value of scan list entry No. 12 | → | 5073 | Integer / Float | Read/write |
| Value of scan list entry No. 13 | → | 5075 | Integer / Float | Read/write |
| Value of scan list entry No. 14 | → | 5077 | Integer / Float | Read/write |
| Value of scan list entry No. 15 | → | 5079 | Integer / Float | Read/write |
| Value of scan list entry No. 16 | → | 5081 | Integer / Float | Read/write |
| * The data type depends on the device parameter entered in the scan list. | | | | |
| ** The data access depends on the device parameter entered in the scan list. If the device parameter entered supports read and write access, the parameter can also be accessed by means of the data area. | | | | |

Response time

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



Note!

It may take longer for a command to be executed in the device. The data is not updated until the command has been executed. Write commands are especially 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
- Totalizer 1 → Register address 2610
- Actual system condition → Register address 6859

1. Configuration of the scan list

- With the local operation or a operating program (via the function matrix):
COMMUNICATION function group → SCAN LIST REG. function:
→ Entry of the address 2007 under SCAN LIST REG. 1
→ Entry of the address 2610 under SCAN LIST REG. 2
→ Entry of the address 6859 under SCAN LIST REG. 3
- Via the MODBUS master (the register addresses of the device parameters are written to the registers 5001 to 5003 via MODBUS):
 1. Write address 2007 (mass flow) to register 5001
 2. Write address 2610 (totalizer 1) to register 5002
 3. Write address 6859 (actual system condition) to register 5003

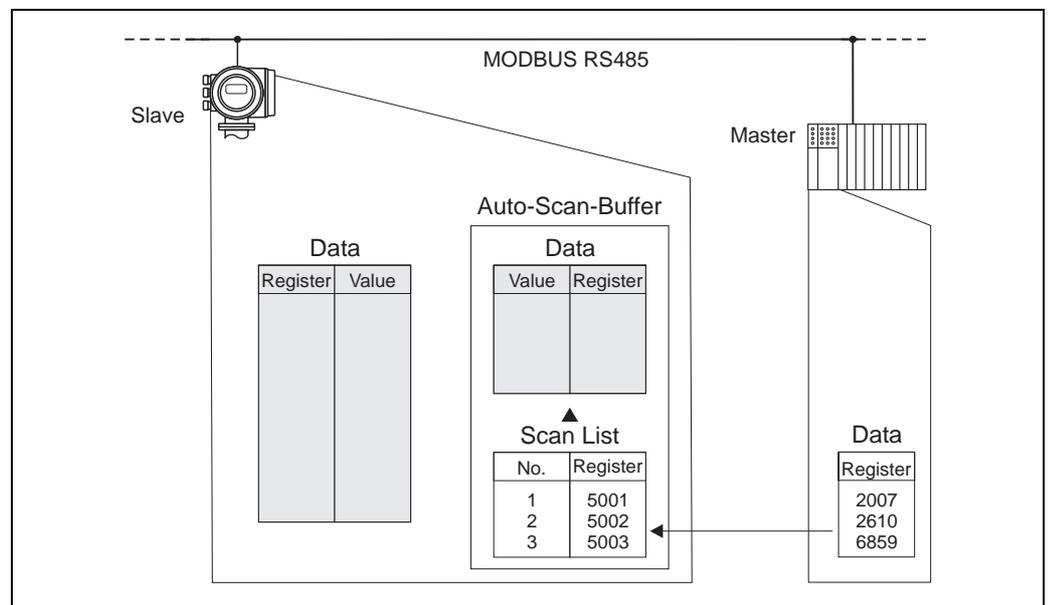


Fig. 32: Configuration of the scan list via the MODBUS master

2. Access to data via MODBUS

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

| Data area | | | |
|------------------------------------|---|-----------|--------|
| Access via MODBUS register address | Measured values | Data type | Access |
| 5051 | Mass flow = 4567.67 | Float | Read |
| 5053 | Totalizer 1 = 56345.6 | Float | Read |
| 5055 | Actual system condition = 1 (system ok) | Integer | Read |

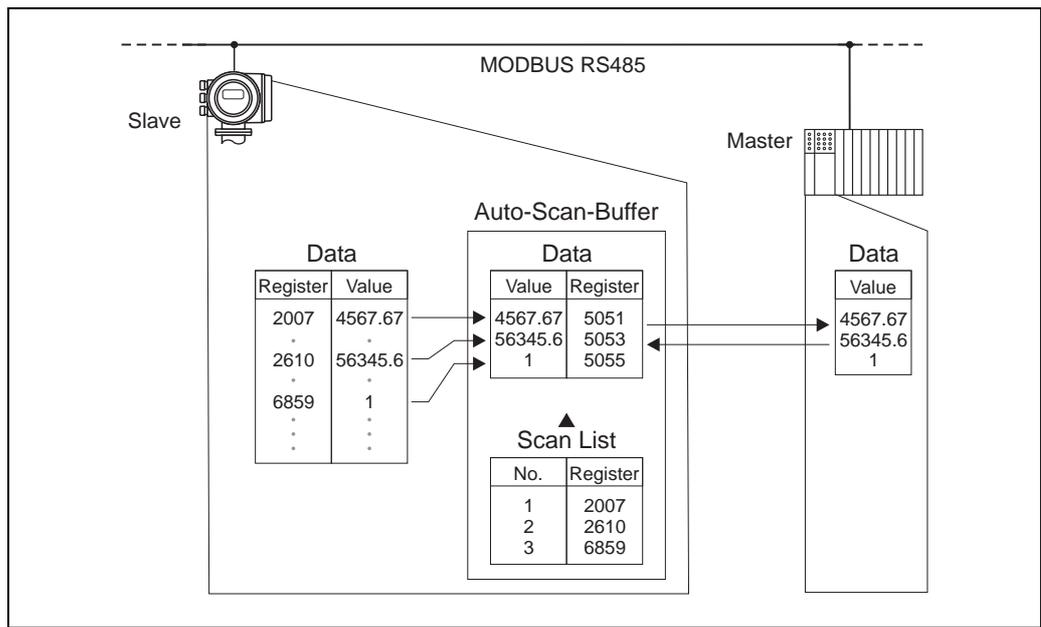


Fig. 33: With just one request telegram, the MODBUS master reads out the measured values via the auto-scan buffer of the measuring device.

5.6 Operating options

5.6.1 FieldCare

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

5.6.2 Device drivers for operating programs

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

Operation via service protocol:

| | |
|--|--|
| Valid for device software: 3.06.XX → "DEVICE SOFTWARE" function | |
| Software release: 10.2010 | |
| Operating program/Device drivers: | How to acquire: |
| FieldCare/DTM | <ul style="list-style-type: none"> ■ www.endress.com (→ Download → Software → Device Drivers) ■ CD-ROM (Endress+Hauser order number 56004088) |

| | |
|-------------------------|--|
| Tester/simulator | Sources for obtaining device descriptions |
| Fieldcheck | Update by means of FieldCare with the Flow Communication FXA193/291 DTM in the Fieldflash Module |



Note!

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

5.7 Hardware settings

5.7.1 Hardware write protection, switching on and off

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



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 → 83
3. Configure the hardware write protection accordingly with the aid of the jumpers (see Figure).
4. Installation is the reverse of the removal procedure.

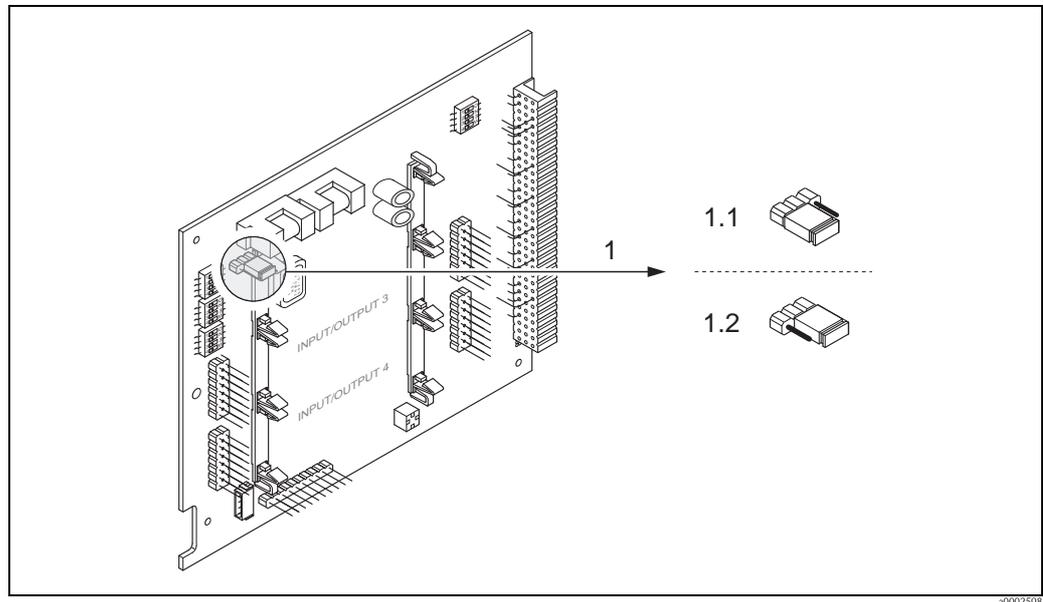


Fig. 34: Switching write protection on and off with the aid of a jumper on the I/O board

- 1 Jumper for switching write protection on and off
- 1.1 Write protection switched on [factory setting] = it is **not** possible to write to the device parameters via MODBUS communication
- 1.2 Write protection switched off = it is possible to write to the device parameters via MODBUS communication

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. 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 → 53

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.

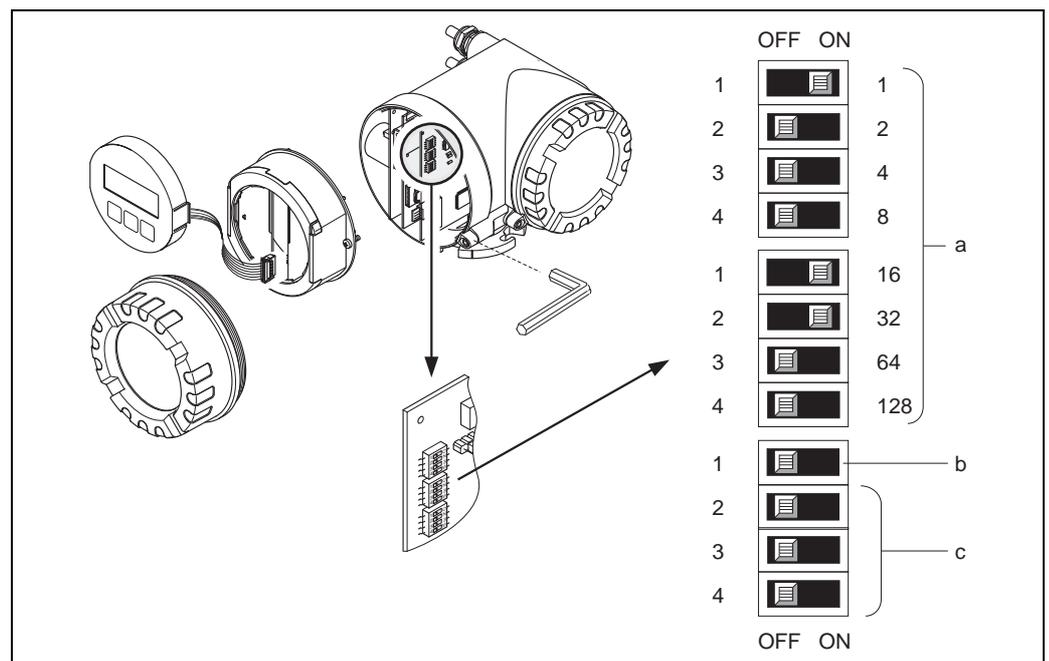


Fig. 35: Addressing with the aid of miniature switches on the I/O board

- 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 or operating program (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):

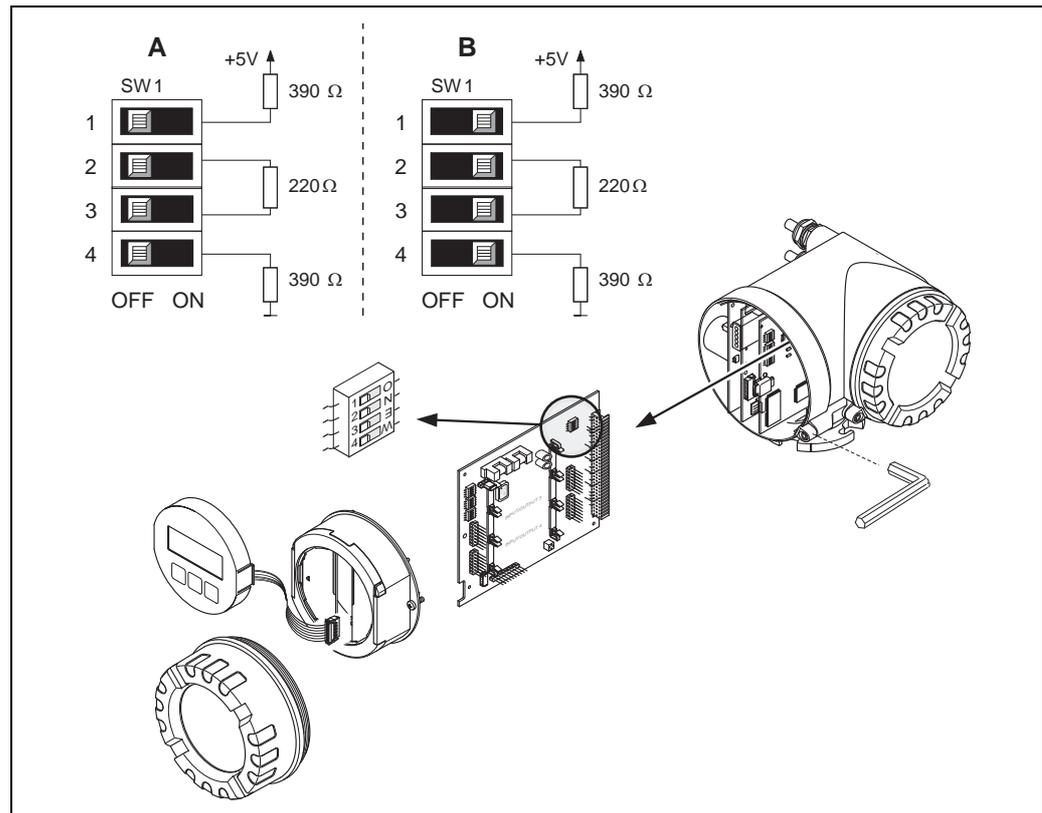


Fig. 36: Configuring the terminating resistors

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.

6 Commissioning

6.1 Function check

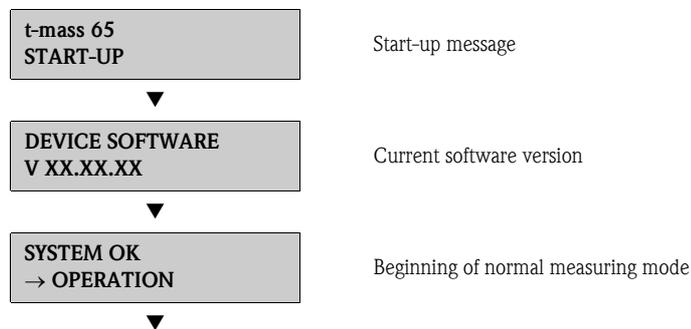
Make sure that all final checks have been completed before you start up your measuring point:

- Checklist for "Post-installation check" →  26
- 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 start-up completes.

Various measured values and/or status variables appear on the display (HOME position).



Note!

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

6.3 Quick Setup

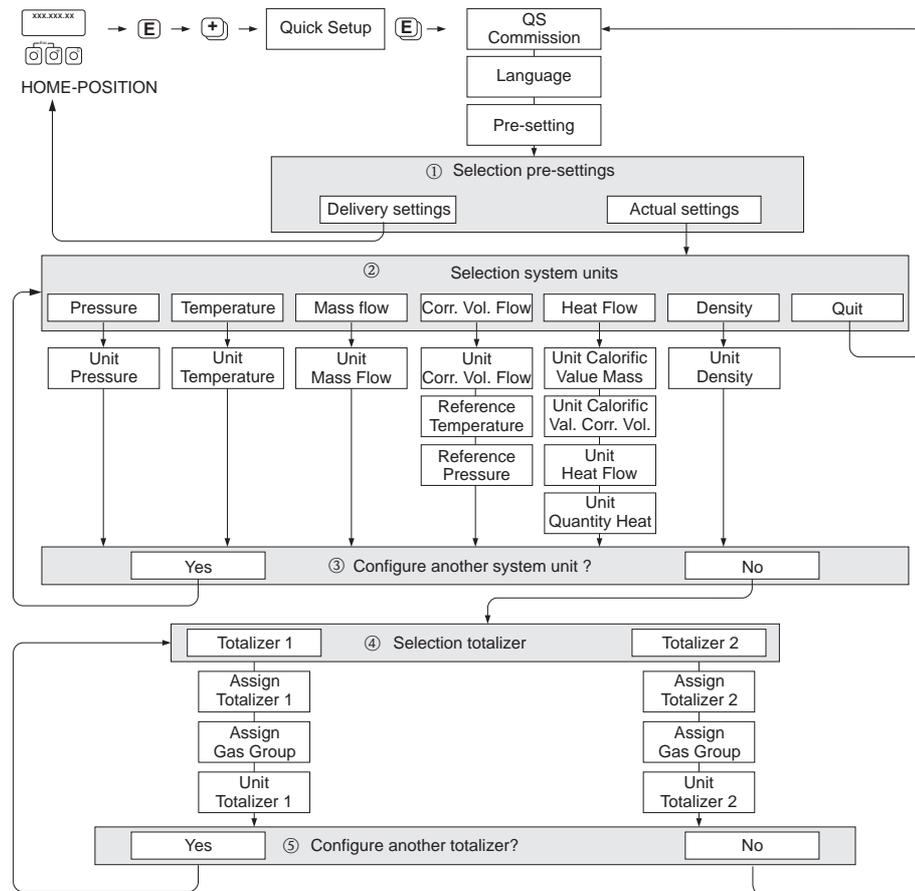
All important device parameters for standard operation can be configured quickly and easily by means of the Quick Setup menu, especially for devices that have been delivered with factory default settings



Note!

If the measuring device has been ordered with customer-specific settings then the Quick Setup is not necessary. Check that the parameterization protocol on the CD delivered with the device matches your required data.

6.3.1 Quick Setup "Commissioning"



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Fig. 37: QUICK SETUP COMMISSIONING- menu for straightforward configuration of the major device functions



Note!

The display returns to the QUICK SETUP cell if you press the ESC key combination (ESC) during programming of a parameter anywhere in the menu.

QUICK SETUP - COMMISSION

Use the or key at the prompt "QS-COMMISSION NO" and the device access code entry appears. Enter the device access code "65" and press ; programming is enabled. The prompt "QS-COMMISSION NO" appears. Use the or key to change NO to YES and press .

LANGUAGE

Use the or key to select the required language and continue with .

PRE-SETTING.

- ① Select ACTUAL SETTINGS to continue programming the device and go to the next level or select DELIVERY SETTINGS to reset the device. The device restarts and returns to the Home position.
 - ACTUAL SETTINGS are the actual programmed parameters in the device
 - DELIVERY SETTINGS are the programmed parameters (factory settings plus customer specific settings) originally delivered with the device

SYSTEM UNITS.

Select required system unit function and carry out parameterization or select QUIT to return to the QUICK SETUP function if no further programming is required.

- ② Only units not yet configured in the current setup are available for selection in each cycle.
- 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.

SELECTION TOTALIZER.

- ④ Select a totalizer and assign a flow variable, gas group and unit.
- ⑤ Configure another totalizer? Select YES to setup a second totalizer or NO to continue.

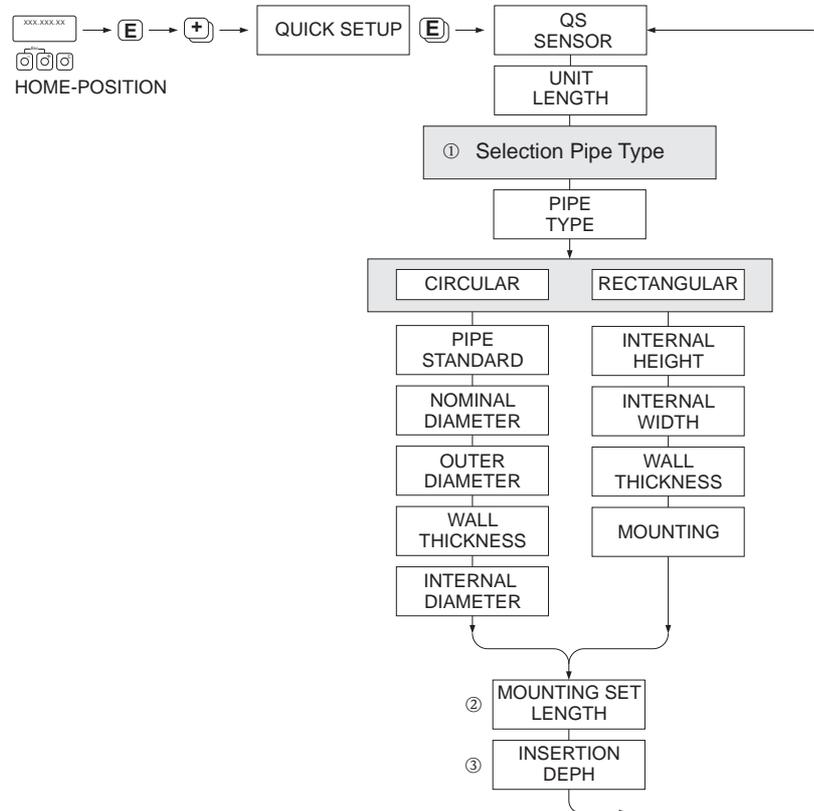
6.3.2 Quick Setup "Sensor"

It is essential that the insertion sensor is setup according to the actual pipe or duct and then installed at the calculated insertion depth. This Quick Setup guides you systematically through the procedure to setup the sensor.



Note!

The QUICK SETUP SENSOR function is not available for flanged type sensors.



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PIPE TYPE

- ① ■ CIRCULAR
 - in case that the pipe is of a standard type, then parameterize functions PIPE STANDARD and NOMINAL DIAMETER
 - In case that the pipe is a non-standard type, then select OTHERS in the function PIPE STANDARD and parameterize the functions WALL THICKNESS and OUTER DIAMETER.
 - The function INTERNAL DIAMETER displays the calculated internal diameter and is read only.
- RECTANGULAR
 - Enter the INTERNAL HEIGHT, INTERNAL WIDTH and WALL THICKNESS of the duct
 - Select the MOUNTING orientation of the sensor: HORIZONTAL or VERTICAL

MOUNTING SET LENGTH

- ② Enter the measured length of the mounting set (including the compression fitting) → 19.

INSERTION DEPTH

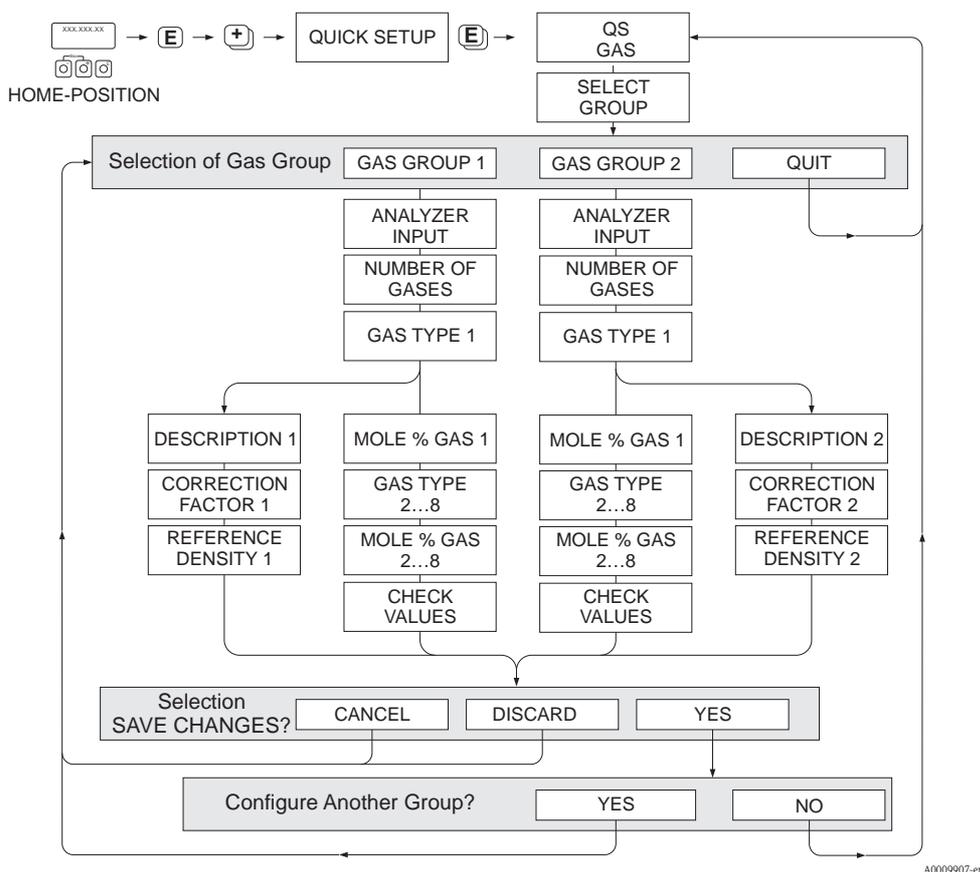
- ③ This function calculates the insertion depth value for the mounting of the sensor → 19. This function is read only.

Press **E** to save settings and return to QUICK SETUP SENSOR group.

6.3.3 "Gas" Quick Setup menu

The device can be setup with 1 or 2 individual gas groups in memory. This means that up to 2 different gas flow streams (e.g. nitrogen and argon) can be measured in a single pipe with one flowmeter.

In the case of 2 gas groups being used, a digital input can be assigned to switch between the gas groups or, alternatively, the switch can be done manually via a function in the device software. Furthermore, a programmed gas mixture can be dynamically updated, via a signal from a gas analyzer.



Programming a gas group

The device allows flexible change of the gas group parameters, independent of the original factory setup and calibration

A gas group can be programmed as:

- one single gas or
- one gas mixture (of up to 8 components)

A single gas can be:

- selected from a list of standard gases or
- setup for other suitable types of gases, such as Ozone, using manual correction factors and the option called SPECIAL GAS. This requires application evaluation at the factory - consult your Endress+Hauser representative prior to using this function.

Setting or viewing the active gas group

The active measuring group can be set via 2 methods:

1. Digital input: the status input can be configured to switch between the two groups. Select option GAS GROUP (see "Description of Device Functions" manual BA00116D/06).
2. Manual switch: go to the function SELECT GROUP and simply select 1 or 2 and then exit using ESC ( keys simultaneously). No save function is necessary.



Note!

This Quick Setup Gas function is not available if an in-situ calibration function has been performed on the device as the in-situ calibration curve refers to the sensor power at each recorded flow point. Therefore, the programmed gas settings become redundant.

Performing the Quick Setup

1. GAS GROUP
 - Use the  or  key to select the required GAS GROUP and continue with .
 - select the NUMBER OF GASES in the group from 1 to 8
 - select the GAS TYPE from the choose list.
 - enter the MOLE % for each GAS TYPE (only if NUMBER OF GASES is 2 and more).
 - The error message CHECK VALUES appears if the total mixture % does not equal 100%. Go back and check the mixture settings.
2. SAVE CHANGES?
 - Select YES to save changes to the GAS GROUP and activate them. Press  to continue or
 - Select CANCEL to save the entered settings in buffer memory but not activate them for measurement. If this function is selected, then it will be necessary to come back to this gas group and save it at a later stage.
 - Select DISCARD to clear the last changes and return to CONFIGURE GROUP to make new settings.
3. ANOTHER GAS GROUP?
 - Select YES to continue to the CONFIGURE GROUP function. Use the  or  key to select another group and proceed as per above instructions.
 - Select NO to exit to the Quick Setup.

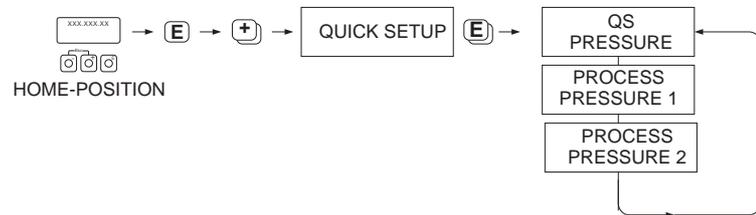


Note!

You can find more detailed information on the GAS GROUP programming in the separate "Description of Device Functions" manual BA00116D/06 see chapter GAS 1/2.

6.3.4 "Pressure" Quick Setup menu

Use this Quick Setup to program the individual process pressure for each gas group. If only one gas group is being used, then only the function PROCESS PRESSURE 1 needs to be programmed, PROCESS PRESSURE 2 can remain with default settings.



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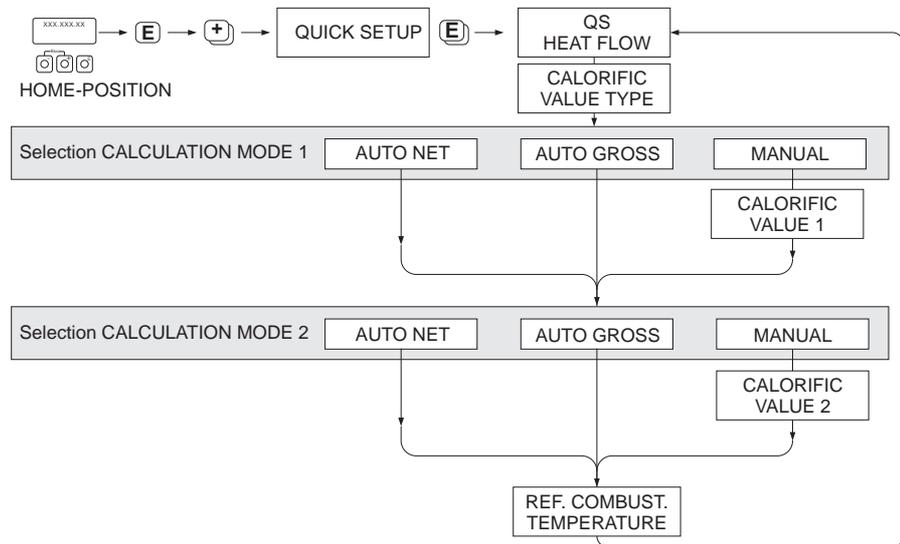
Note!

- The device operates with absolute pressure only. Convert any gauge pressures to absolute pressure.
- If a pressure compensating input is being used, then the input signal value overrides the manually programmed value. The pressure input value applies to both gas groups. i.e. 2 independent pressure values are no longer possible.
- This Quick Setup Gas function is not available if an in-situ calibration function has been performed on the device as the in-situ calibration curve refers to the sensor power at each recorded flow point. Therefore, the programmed pressure settings become redundant → 70.

6.3.5 "Heat Flow" Quick Setup menu

The device can calculate and output the heat of combustion of common fuel gases such as methane, natural gas, propane, butane, ethane and hydrogen.

Use this Quick Setup menu to program the method used to calculate the heating value or calorific value (CV). The device can be configured to give two independent heating value outputs and totalized values. For example, the pipeline has either natural gas or propane running at separate times and the heating value is required for both gases.



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Calculation mode 1 and 2

- The heating value for CALCULATION MODE 1 corresponds to the settings in the function GAS GROUP 1.
- The heating value for CALCULATION MODE 2 corresponds to the settings in the function GAS GROUP 2.



Note!

- If only one gas group is used, then leave mode 2 as default settings.
- The units of measure are selected in the system units section → 56.

Auto Gross

The gross heating value (or higher heating value) is the total heat obtained by complete combustion at constant pressure of a volume of gas in air, including the heat released by the water vapor in the combustion products (gas, air and combustion products taken at reference combustion temperature and standard pressure).

Auto Net

The net heating value (or lower heating value) is determined by subtracting the heat of vaporization of the water vapor from the higher heating value. This treats any water formed as water vapor. The energy required to vaporize the water therefore is not realized as heat.

Manual

This function allows entry of a user-specific heating value if the required value is different to the following table.

| Gas | Formula | Net/lower heating value | | Gross/upper heating value | |
|-------------------|--------------------------------|-------------------------|---------|---------------------------|---------|
| | | [Mj/kg] | MBtu/lb | [Mj/kg] | MBtu/lb |
| Hydrogen | H ₂ | 119.91 | 51.56 | 141.78 | 60.97 |
| Ammonia | NH ₃ | 18.59 | 7.99 | 22.48 | 9.67 |
| Carbon Monoxide | CO | 10.1 | 4.34 | 10.1 | 4.34 |
| Hydrogen Sulphide | H ₂ S | 15.2 | 6.54 | 19.49 | 8.38 |
| Methane | CH ₄ | 50.02 | 21.51 | 55.52 | 23.87 |
| Ethane | C ₂ H ₆ | 47.5 | 20.43 | 51.93 | 22.33 |
| Propane | C ₃ H ₈ | 46.32 | 19.92 | 50.32 | 21.64 |
| Butane | C ₄ H ₁₀ | 45.71 | 19.66 | 49.51 | 21.29 |
| Ethylene | C ₂ H ₄ | 47.16 | 20.28 | 50.31 | 21.63 |

* According to ISO 6976:1995(E) and GPA Standard 2172-96

Reference combustion temperature

The following reference temperatures are used:

| Country | reference combustion temperature |
|---|----------------------------------|
| Austria, Belgium, Denmark, Germany, Italy, Luxembourg, The Netherlands, Poland, Russia, Sweden, Switzerland | 25 °C |
| Brazil, China | 20 °C |
| France, Japan | 0 °C |
| Australia, Canada, Czech Republic, Hungary, India, Ireland, Malaysia, Mexico, South Africa, Great Britain | 15 °C |
| Slovakia | 25 °C |
| USA, Venezuela | 60 °F |

6.3.6 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.

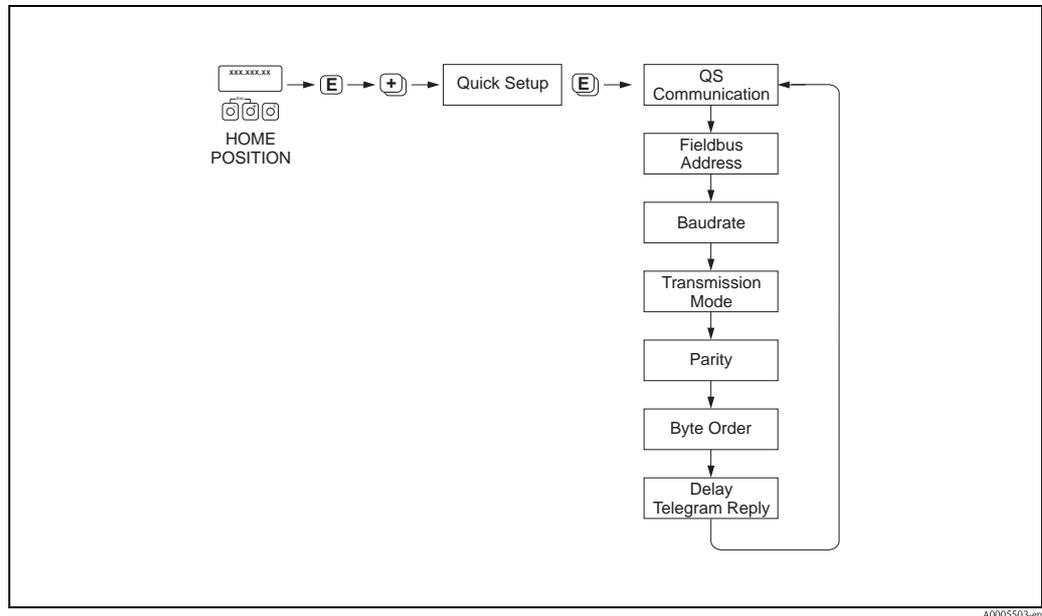


Fig. 38: Quick Setup communication



Note!

The parameters described in the following table can be found in the function group COMMUNICATION (see "Description of Device Functions" manual, BA00116D/06).

Functions of the Quick Setup "Communication"

| | |
|----------------------|--|
| SETUP COMMUNICATION | YES → After  is pressed by way of confirmation, the Quick Setup menu calls up all the subsequent functions in succession. |
| FIELD BUS ADDRESS | For entering the device address. User input: 1 to 247 Factory setting: 247 |
| BAUDRATE | For selecting the baud rate. Options: 1200 BAUD 2400 BAUD 4800 BAUD 9600 BAUD 19200 BAUD 38400 BAUD 57600 BAUD 115200 BAUD Factory setting: 19200 BAUD |
| TRANSMISSION MODE | For selecting the data transfer mode. Options: RTU ASCII Factory setting: RTU |
| PARITY | For selecting whether no parity bit or an even or odd parity bit should be transmitted. Options: EVEN ODD NONE/STOP BITS 2 NONE/STOP BITS 1 Factory setting: EVEN |
| BYTE ORDER | Select the byte transmission sequence for the Integer, Float and String data types. Options: 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. |
| DELAY TELEGRAM REPLY | For entering a delay time after which the measuring device replies to the request telegram of the MODBUS master. This allows communication to be adapted to slow MODBUS masters. Options: 0 to 100 ms Factory setting: 10 ms |

6.3.7 Data backup/transmission

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

This is required in the following instances:

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



Note!

For information on installing and removing the T-DAT → [83](#)

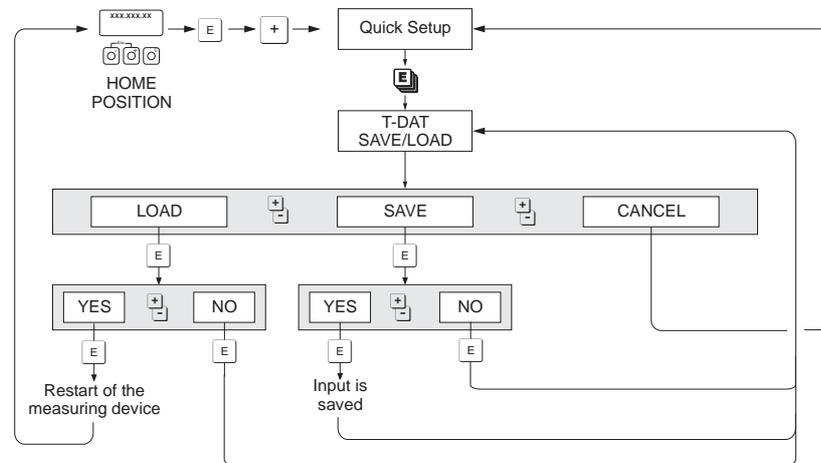


Fig. 39: Data backup/transmission with T-DAT SAVE/LOAD function

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Information on the LOAD and SAVE options available

LOAD:

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



Note!

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

SAVE:

Data are transferred from the EEPROM to the T-DAT

6.4 Adjustment

6.4.1 Zero point adjustment

Calibration takes place under reference operating conditions. (→ 93).

Consequently, the zero point adjustment is generally **not** necessary!

At zero flow conditions, the output of most thermal mass flow devices has a strong dependency on the process pressure. The effect on the true zero point of the device, by the static line pressure, is dependant on the gas type and the application demands and in many cases the use of the low flow cut-off function is adequate to zero the device output.

However, with some gases and /or a combination of high static line pressures, the zero point may need to be adjusted under process conditions to restore the very low measurement capability of the device.

Therefore, the zero point adjustment is advisable in the following special cases:

- To achieve highest measuring accuracy with very small flow rates.
- Under process or operating conditions where the gas properties (heat capacity and thermal conductivity) will change e.g. Hydrogen and Helium.

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 gases that contain no solid contents or condensate.
- The adjustment is performed with the process gas at zero flow and at operating pressure. This can be achieved, for example, with shut-off valves upstream and/or downstream of the sensor.
 - 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

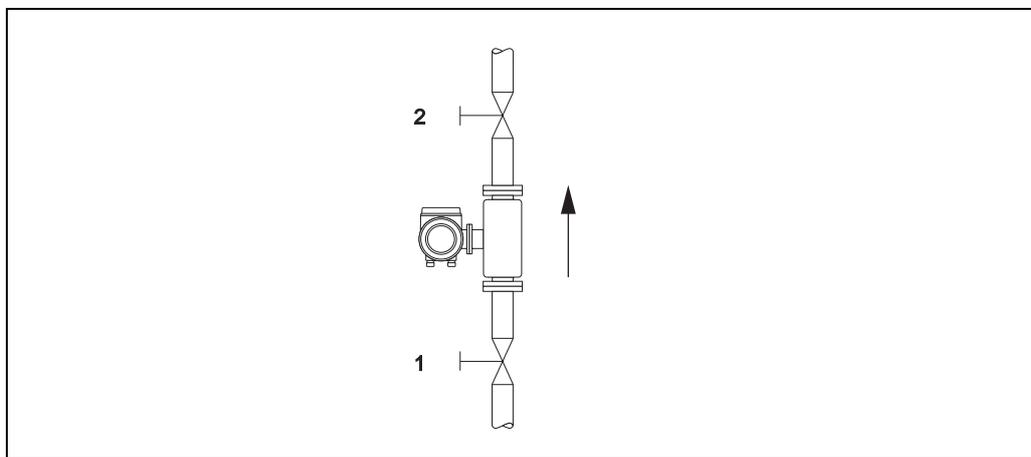


Fig. 40: Zero point adjustment and shut-off valves



Note!

You can view the currently valid zero point value using the ZERO POINT function in the SENSOR DATA group (see the "Description of Device Functions" manual, BA00116D/06).

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 shut-off valves for leaks.
4. Check that operating pressure is correct.
5. Using the local display, select the ZEROPOINT ADJUSTMENT function in the function matrix: PROCESS PARAMETER → ZERO POINT ADJUST
6. When you press \leftarrow or \rightarrow you are automatically prompted to enter the access code if the function matrix is still disabled. Enter the code (factory setting = 65).
7. Use \leftarrow or \rightarrow to select START and press [E] to confirm. The zero point adjustment now starts and is completed within a few seconds.



Note!

If the flow in the pipe is unstable, the following error message may appear on the display "ZERO ADJUST FAIL". The zero point adjustment has failed. The preconditions need to be stabilized before attempting a new adjustment.

8. Back to the HOME position:
 - Press and hold down Esc key ([Esc]) for longer than three seconds or
 - Repeatedly press and release the Esc key ([Esc]).

Resetting a zero point adjustment

The currently stored zero point can be reset to the original factory value by using the RESET option within ZERO POINT ADJUST.

Use \leftarrow or \rightarrow to select RESET and press [E] to confirm. The zero point adjustment is now reset.

6.5 Data storage device (HistoROM)

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

6.5.1 HistoROM/S-DAT (sensor-DAT)

The HistoROM/S-DAT is an exchangeable data storage device in which all sensor relevant parameters are stored, i.e., pipe type, diameter, serial number, flow conditioner, zero point.

6.5.2 HistoROM/T-DAT (transmitter-DAT)

The HistoROM/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 HistoROM/T-DAT and vice versa has to be carried out by the user (= manual save function). Detailed instructions regarding this can be found in the handbook "Description of Device Functions" (function T-DAT SAVE/LOAD).

7 Maintenance

Generally, the flowmeter requires no special maintenance work, particularly if the gas is clean and dry.



Warning!

Hazardous area approvals may demand that the device be returned to an Endress+Hauser production centre for service or that work can only be carried out by a qualified Endress+Hauser service person. Consult your Endress+Hauser service representative for more information.

7.1 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.

7.2 Pipe cleaning

The sensor is capable of withstanding clean in place (CIP) processes using heated liquids or steam (SIP), within the maximum specified temperature limits. However the sensor measurement will be adversely affected during the cleaning cycle and a settling down period will be required after the cycle to allow the process and sensor temperatures to re-stabilize.



Note!

The POSITIVE ZERO RETURN function maybe activated to set the current output to zero flow during such cycles. See "Description of Device Functions" manual for more information.



Caution!

Do not use a pipe cleaning pig.

7.3 Transducer cleaning

For gases that do carry impurities, it is recommended that the sensor be routinely inspected and cleaned to minimize any potential measuring errors due to contamination or build-ups. The frequency of inspection and cleaning will depend upon the application and expected measurement performance.

Cleaning is performed by applying a non-filming or oil-free type cleaning fluid to a soft brush or cloth and gently wiping over the surface until all build-ups and contaminants are removed.



Caution!

- Use care not to bend the sensing elements of the transducer during cleaning.
- Do not use abrasive materials or fluids corrosive to the sensor materials and seals.

Sensor-specific information:

- t-mass F sensor:

Removal of the transducer requires specialist knowledge, tools and parts. The process seal also may need to be tested and re-qualified. This procedure must be carried out by an Endress+Hauser production centre.

- t-mass I sensor:

When removing the measuring sensor, observe the safety guidelines in chapter → 19.

7.4 Replacing seals

Under normal circumstances, fluid wetted seals of the 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.

Sensor-specific information:

- t-mass F sensor:

The sensor contains o-rings seals and a bushing. In case of failure, the device must be returned to an Endress+Hauser production centre for inspection and repair.

- t-mass I sensor:

The transducer is welded to the insertion tube and has no exchangeable seals. The compression fitting contains wetted seals (ferrules) and a bonded seal is used on the G 1 A thread version.



Caution!

Do not reuse gaskets after removing sensors.

Use only original parts from Endress+Hauser. The compression fitting and gasket seals are deliverable as spare parts. The seal ring can be replaced easily on site

7.5 In-situ calibration

The t-mass flowmeters are designed to support in-situ calibration using a reference meter signal, thus saving time and cost by reducing the need for factory re-calibration.

Pre-requirements for in-situ calibration with adjustment:

1. Stable gas composition (operation with one gas group only; without gas analyzer input)
2. Stable pressure and temperature (without pressure compensation input)
3. Mass flow reference
 - a. mass flow reference meter, mounted in the measurement or bypass pipe, providing a mA signal to t-mass or
 - b. manual entry of known mass flow reference values. For example, the display value from the reference meter or a derived value from a pump curve)
4. Ability to control the flow range over a minimum of 5 control points

This function is activated using the service access code.

Please discuss your specific requirements with your Endress+Hauser service representative.

7.6 Recalibration

For thermal meters, the interval between calibrations is dependent on the application since calibration drift is predominantly caused by contamination of the sensor surface.

If the gas is not clean (i.e. contains particulates), then gentle cleaning of the sensor elements can be effective at regular intervals. The cleaning interval will depend upon the nature and extent of the contamination.

Determination of recalibration intervals:

- If the measurement is critical, then a calibration audit should be undertaken by performing recalibration checks once per year for a period of 2 years. Increase that period to twice per year if the application gas is not clean and dry. Depending on the results of the audit, the next recalibration check interval can be increased or decreased accordingly.
- For non-critical applications and or where the gas is clean and dry, a recalibration interval of every 2 to 3 years is recommended.

8 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.

8.1 Device-specific accessories

| Accessory | Description | Order code |
|-----------------------|---|-------------------|
| Mounting boss | Mounting boss for the t-mass insertion sensor <ul style="list-style-type: none"> ■ G 1 A thread ■ 1" NPT female thread | DK6MB - *** |
| Cable remote | Connecting cable for the remote version sensor and transmitter (per m (ft), up to 100m (328ft) max.) | DK6CA - ** |
| Transmitter t-mass 65 | Transmitter for replacement or for stock. Use the order code to define the following specifications: <ul style="list-style-type: none"> ■ Approvals ■ Degree of protection / version ■ Cable entries ■ Display / power supply / operation ■ Software ■ Outputs / inputs | 65XXX-XXXXXX***** |

8.2 Measuring principle-specific accessories

| Accessory | Description | Order code |
|----------------------------------|---|--|
| Mounting set for transmitter | Mounting set for remote version. Suitable for: <ul style="list-style-type: none"> - Wall mounting - Pipe mounting - Installation in control panel Mounting set for aluminum field housing: Suitable for pipe mounting (¾" to 3") | DK6WM - * |
| Flow conditioner | Perforated plate flow conditioner: <ul style="list-style-type: none"> ■ t-mass F sensor (DN25 to 100, 1" to 4") ■ t-mass I sensor (DN80 to 300, 3" to 12") | DK6ST-*** DK7ST-*** |
| Hot tap | Mounting set with ball valve and safety chain. Insertion or extraction of sensor under process pressure (max. 4 bar, 58 psi). Mounting set with ball valve and spindle retractor. Insertion or extraction of sensor under process pressure (max. 16 bar, 235 psi). | Please refer to the product page of the Endress+Hauser Internet page: www.endress.com |
| Graphic data manager Memograph M | The graphic data manager Memograph M 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 an SD 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 facilitate continuous monitoring, e.g. of specific energy consumption, boiler efficiency and other parameters which are necessary for efficient energy management. | RSG40 - ***** |

8.3 Service-specific accessories

| Accessory | Description | Order code |
|------------|--|---|
| Applicator | <p>Software for selecting and sizing Endress+Hauser measuring devices:</p> <ul style="list-style-type: none"> ■ 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 <p>Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project.</p> <p>Applicator is available:</p> <ul style="list-style-type: none"> ■ Via the Internet: https://wapps.endress.com/applicator ■ On CD-ROM for local PC installation. | DKA80 - * |
| Fieldcheck | <p>Tester/simulator for testing flowmeters in the field.</p> <p>When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification.</p> <p>Contact your Endress+Hauser representative for more information.</p> | 50098801 |
| FieldCare | <p>FieldCare is Endress+Hauser's FDT based Plant Asset Management Tool. It can configure all intelligent field devices in your plant and supports you in managing them. By using status information, it also provides a simple but effective means of checking their health.</p> | <p>Please refer to the product page of the Endress+Hauser Internet page: www.endress.com</p> |
| FXA193 | <p>The FXA193 service interface connects the device to the PC for configuration via FieldCare.</p> | FXA193 - * |

9 Trouble-shooting

9.1 Trouble-shooting instructions

Always start trouble-shooting 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. | <ol style="list-style-type: none"> 1. Check the supply voltage → Terminals 1, 2 2. Check device fuse → 88 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 → 82 |
| No display visible, but output signals are present. | <ol style="list-style-type: none"> 1. Check whether the ribbon-cable connector of the display module is correctly plugged into the amplifier board → 82. 2. Display module defective → order spare parts → 82 3. Measuring electronics defective → order spare parts → 82 |
| 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 → 82 |



| Error messages on display |
|--|
| <p>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):</p> <ul style="list-style-type: none"> – Type of error: S = System error, P = Process error – Error message type: ! = Fault message, ! = Notice message – FLOW LIMIT = Error designation, e.g. measured flow has exceeded the maximum limit. – 03:00:05 = Duration of error occurrence (in hours, minutes and seconds) – #422 = Error number <p> Caution!</p> <ul style="list-style-type: none"> ■ See the information on → 38. ■ The measuring system interprets simulations and positive zero return as system errors, but displays them as notice message only. |



| Faulty connection to MODBUS master | |
|---|---|
| No connection can be made between the MODBUS master and the device. Check the following points: | |
| Supply voltage Transmitter | Check the Supply voltage → Terminals 1, 2 |
| Device fuse | Check device fuse → 82 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 |
| Fieldbus connection | MODBUS RS485: Check data line Terminal 26 = B (RxD/TxD-P) Terminal 27 = A (RxD/TxD-N) |
| Network structure | Check permissible fieldbus length and number of spurs. |



| Faulty connection to MODBUS master (continued) | |
|---|--|
| Fieldbus address | Check fieldbus address: make sure there are no double assignments. |
| Bus termination | Has the MODBUS RS485 network been terminated correctly? Each bus segment must always be terminated with a bus terminator at both ends (start and finish). Otherwise there may be interference in communication. |



| System or process error messages |
|--|
| System or process errors which occur during commissioning or operation can be displayed in ACTUAL SYSTEM CONDITION function via local display or by using the operating program FieldCare. |



| Other error (without error message) | |
|--|--|
| Some other error has occurred | Diagnosis and rectification →  79 |

9.2 System error messages

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



Caution!

In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Important procedures must be carried out before you return a flowmeter to Endress+Hauser.

→ 89. 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!

Also observe the information on the following pages → 38

| MODBUS communication | | No. | Device status message (local display) | Cause | Remedy / (spare part → 82) |
|--|---|---|--|--|---|
| Register: 6859 Data type: Integer | Register: 6821 Data type: String (18 byte) | | | | |
| Response to a fault message: The value "NaN" (not a number) is transmitted to the MODBUS master instead of the current measured value. | | S = System error ⚡ = Fault message (with an effect on the current operation) ! = Notice message (without any effect on the current operation) | | | |
| 1 | SYSTEM OK | - | <i>There is no error present in the device</i> | | |
| No. # 0xx → Hardware error | | | | | |
| 2 | CRITICAL FAIL. | 001 | S: CRITICAL FAIL. ⚡: # 001 | Serious device error | Replace the amplifier board. |
| 3 | AMP HW-EEPROM | 011 | S: AMP HW EEPROM ⚡: # 011 | Amplifier: Defective EEPROM | Replace the amplifier board. |
| 4 | AMP SW-EEPROM | 012 | S: AMP SW EEPROM ⚡: # 012 | Measuring amplifier: Error when accessing data of the EEPROM | Replace the amplifier board. |
| 6 | AMP SW-ROM/RAM | 014 | S: AMP SW-ROM/RAM ⚡: # 014 | Amplifier: Defective ROM/RAM | Replace the amplifier board. |
| 7 | SENSOR HW-DAT | 031 | S: SENSOR HW DAT ⚡: # 031 | Sensor DAT: 1. HistoROM/S-DAT is defective. 2. HistoROM/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 → 83, → 85 |
| 8 | SENSOR SW-DAT | 032 | S: SENSOR SW DAT ⚡: # 032 | Sensor DAT: Error accessing the calibration values stored in the HistoROM/S-DAT. | 1. Check whether the S-DAT is correctly plugged into the amplifier board → 83, → 85 2. Replace the S-DAT if it is defective. → 82 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. |
| 11 | SENS HW-ROM/RAM | 035 | S: SENS HW-ROM/RAM ⚡: # 035 | Sensor: Defective ROM/RAM | Replace the remote amplifier board. |
| 12 | SENS SW-ROM/RAM | 036 | S: SENS SW-ROM/RAM ⚡: # 036 | Sensor: Defective ROM/RAM | Replace the remote amplifier board. |

| MODBUS communication | | No. | Device status message (local display) | Cause | Remedy / (spare part → 82) |
|--|---|-----|---------------------------------------|--|--|
| Register: 6859 Data type: Integer | Register: 6821 Data type: String (18 byte) | | | | |
| 14 | TRANSM. SW-DAT | 042 | S: TRANSM. SW-DAT #: # 042 | Sensor DAT: Error accessing the calibration values stored in the HistoROM/T-DAT. | <ol style="list-style-type: none"> 1. Check whether the T-DAT is correctly plugged into the amplifier board → 83, → 85 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: <ul style="list-style-type: none"> – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. |
| 15 | A/C COMPATIB. | 051 | AC COMPATIB. #: # 051 | The I/O board and the amplifier board are not compatible. | <p>Use only compatible modules and boards. Check the compatibility of the modules used.</p> <p>Check the:</p> <ul style="list-style-type: none"> – Spare part set number – Hardware revision code |
| 19 | SENSOR DEFECT | 070 | S: SENSOR DEFECT #: # 070 | Flow sensors are likely to be defect, measurement is no longer possible. | Contact your Endress+Hauser representative. |
| No. # 1xx → Software error | | | | | |
| 22 | CHECKSUM TOT. | 111 | S: CHECKSUM TOTAL #: # 111 | Totalizer checksum error | <ol style="list-style-type: none"> 1. Restart the measuring device 2. Replace the amplifier board if necessary. |
| 23 | A/C SW COMPATI | 121 | S: A/C SW COMPATI #: # 121 | <p>Due to different software versions, I/O board and amplifier board are only partially compatible (possibly restricted functionality).</p> <p> Note!</p> <ul style="list-style-type: none"> – This message is only listed in the error history. – Nothing is displayed on the display. | Module with lower software version has either to be actualized by FieldCare with the required software version or the module has to be replaced. |
| No. # 2xx → Error in DAT/no communication | | | | | |
| 25 | LOAD T-DAT | 205 | S: LOAD T-DAT !: # 205 | Transmitter DAT Data backup (downloading) to HistoROM/T-DAT failed, or error when accessing (uploading) the calibration values stored in the HistoROM/T-DAT. | <ol style="list-style-type: none"> 1. Check whether the T-DAT is correctly plugged into the amplifier board → 83, → 85 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: <ul style="list-style-type: none"> – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. |
| 26 | SAVE T-DAT | 206 | S: SAVE T-DAT #: # 206 | HistoROM/S-DAT is not fitted to amplifier board. | Check whether the HistoROM/S-DAT is correctly plugged into the amplifier board → 83 |
| 27 | S-DAT NO HW | 211 | S: S-DAT NO HW #: # 211 | HistoROM/S-DAT is not fitted to amplifier board. | Check whether the S-DAT is correctly plugged into the amplifier board → 83 |
| 30 | COMMUNIC.AMP. | 251 | S: COMMUNIC. SENS #: # 251 | Internal microprocessor communication fault on the amplifier board. | Remove the amplifier board. |

| MODBUS communication | | No. | Device status message (local display) | Cause | Remedy / (spare part → 82) |
|--|---|-----|---------------------------------------|--|---|
| Register: 6859 Data type: Integer | Register: 6821 Data type: String (18 byte) | | | | |
| 31 | COMMUNIC.I/O | 261 | S: COMMUNICAT. I/O !: # 261 | No data reception between amplifier and I/O board or faulty internal data transfer. | Check the BUS contacts |
| No. # 3xx → System limits exceeded | | | | | |
| 50 | DIFF TEMP LO | 372 | S: DIFF. TEMP. LOW !: # 372 | The measured sensor differential temperature is below limit value. | Reduce the flow rate or consider replacing the instrument with a suitable size for the application if possible. |
| 57 | FLUIDTEMP.MIN | 381 | S: FLUIDTEMP.MIN. !: # 381 | The minimum fluid temperature limit for the transducer has been exceeded. | Increase the process gas temperature. Caution! In case of severe temperature exposure, the transducer may be damaged. |
| 58 | FLUIDTEMP.MAX | 382 | S: FLUIDTEMP.MAX. !: # 382 | The minimum fluid temperature limit for the transducer has been exceeded. | Reduce the process gas temperature. Caution! In case of severe temperature exposure, the transducer may be damaged. |
| Application error | | | | | |
| 66 | SW.-UPDATE ACT | 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. |
| 67 | UP-/DOWNL. ACT | 502 | S: DOWN UPLD. ACT !: # 502 | Up- or downloading the device data via configuration program. Currently no other functions are possible. | Wait until process is finished. |
| No. # 6xx → Simulation mode active | | | | | |
| 69 | 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 |
| 94 | SIM.STATUS IN1 | 671 | S: SIM.STATUS IN 1 !: # 671 | Simulation status input active | Switch off simulation |
| 98 | SIM.FAILSAFE | 691 | S: SIM. FAILSAFE !: # 691 | Simulation of response to error (outputs) active | Switch off simulation |
| 99 | SIM. MEASURAND | 692 | S: SIM. MEASURAND !: # 692 | Simulation of measuring variables (e.g. mass flow) | Switch off simulation |
| 100 | DEV.TEST ACT. | 698 | S: DEV. TEST ACT. !: # 698 | The measuring device is being checked on-site via the test and simulation device (FieldCheck). | – |

9.3 Process error messages



Note!

Also observe the information on the following pages: → 38 and → 73

| MODBUS communication | | No. | Device status message (local display) | Cause | Remedy / spare part |
|--|---|--|--|---|--|
| Register: 6859 Data type: Integer | Register: 6821 Data type: String (18 byte) | | | | |
| Response to a fault message: The value "NaN" (not a number) is transmitted to the MODBUS master instead of the current measured value. | | P = Process error ⚡ = Fault message (with an effect on the current operation) ! = Notice message (without any effect on the current operation) | | | |
| 1 | SYSTEM OK | - | <i>There is no error present in the device</i> | | |
| 59 | FLOW LIMIT | 422 | P: FLOW LIMIT ⚡: # 422 | The measured flow has exceeded the maximum limit. | Reduce the flow rate or replace the instrument with a suitable size for the application. Note! Error can be configured as a fault or notice message. |
| 65 | ZERO-ADJ. N.OK | 731 | P: ZERO-ADJ. N.OK ⚡: # 731 | The saved zero point is inaccurate possibly due to unstable process or flow conditions. | Make sure that zero point adjustment is carried out at "zero flow" only (v = 0 m/s) → 67 |

9.4 Process errors without messages

| Symptoms | Rectification |
|--|---|
|  Note! You may have to change or correct certain settings of the function matrix in order to rectify faults. The functions outlined below, such as DISPLAY DAMPING, for example, are described in detail in the "Description of Device Functions" manual. | |
| Displayed measured value fluctuates even though flow is steady. | <ol style="list-style-type: none"> 1. Increase value of the TIME CONSTANT setting → CURRENT OUTPUT function group. 2. Increase value of the DISPLAY DAMPING setting → USER INTERFACE function group. 3. The inlet and outlet lengths must be observed. See installation conditions → 12 4. Consider the use of a flow conditioner. See installation conditions → 16 5. Relocate the meter to a point where there is less flow disturbance |
| Device displays flow with no actual flow present. | <ol style="list-style-type: none"> 1. The low flow cut off value is programmed too low. Increase value of the ON VALUE LOW FLOW CUT OFF setting → PROCESS PARAMETERS function group (Factory setting = 1% of 20mA value). 2. Check for leaks in the pipe line downstream of the sensor. 3. Reduce or eliminate pressure pulsations in the line. |
| Device displays flow with no actual flow present - but with high static line pressure and thermally conductive gases present (e.g. Hydrogen, Helium, etc.). Line pressure is typically > 5 bar / 75 psi | Start the ZERO POINT ADJUST function → PROCESS PARAMETERS function group. See Zero Point Adjust function → 67  Note! Process preconditions are required before starting this function. |
| Device displays zero flow but flow is present. | <ol style="list-style-type: none"> 1. The INSTALLATION FACTOR may have a wrong setting = 0 → PROCESS PARAMETERS function group (factory setting = 1.0). 2. The LOW FLOW CUT OFF setting may be too high. Adjust the function ON VALUE LOW FLOW CUT OFF to a lower value → PROCESS PARAMTERS function group (factory setting 1% of calibrated 20mA value). 3. The ZERO POINT ADJUST function may have been incorrectly carried out with flow present. RESET the zero point adjustment if necessary → PROCESS PARAMETERS function group. |

| Symptoms | Rectification |
|---|---|
| <p>Device displays incorrect flow value.</p> | <ol style="list-style-type: none"> 1. Check the basic parameters of the device (Quick Setup → 56) <p>Especially:</p> <ul style="list-style-type: none"> – Gas – Process pressure – Reference pressure and reference temperature – Flow units – Output assignment 2. Check the installation conditions (Post-installation check → 33) <ol style="list-style-type: none"> 1. The inlet and outlet lengths must be observed → 15. 2. Consider the use of a flow conditioner if the necessary inlet requirements cannot be met → 16. 3. t-mass F: Check for diameter mismatch between the flanges and check the gasket alignment → 13. t-mass I: Check the sensor orientation and insertion depth. → 19. 4. If the above actions do not resolve the problem, consider adjusting the INSTALLATION FACTOR so that the displayed flow rate matches the expected flow rate → PROCESS PARAMETERS function group (factory setting 1.0). 3. The flow rate maybe too high (i.e. above sensor calibration range) <ol style="list-style-type: none"> 1. Check the sensor measuring range using the Endress+Hauser Applicator program. 2. Check if the inverted plus sign "+" is shown on the display? If yes, reduce the velocity if possible. 4. The flow rate maybe too low <ol style="list-style-type: none"> 1. Check the sensor measuring range using the E+H Applicator program. 2. Increase the velocity if possible. 5. Check the condition of the transducer <ol style="list-style-type: none"> 1. Are the measuring elements bent? If yes, replacement is necessary. 2. Are build-ups present? If yes, clean the sensors (transducer cleaning → 69). 3. Has corrosion occurred? If yes, replacement is necessary. 6. Check if the gas is wet? Is condensate present on the sensors? If yes: <ol style="list-style-type: none"> 1. For horizontal pipes: Mount the sensor at 135° → 14 2. Install a condensate trap or filter upstream of the flowmeter 7. Check if heating devices are used upstream of the flowmeter causing possible temperature profile effects ? If yes: <ol style="list-style-type: none"> 1. Relocate the flowmeter further downstream or 2. Install a flow conditioner upstream of the flowmeter |
| <p>The fault cannot be rectified or some other fault not described above has occurred. In these instances, please contact your Endress+Hauser representative.</p> | <p>The following options are available for tackling problems of this nature:</p> <p>Request the services of an Endress+Hauser service technician If you contact our service representative to have a service technician sent out, please be ready with the following information:</p> <ul style="list-style-type: none"> – Brief description of the fault – Nameplate specifications : Order code and serial number → 7 <p>Returning devices to Endress+Hauser The procedures on must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. → 6 Always enclose a duly completed "Declaration of contamination" form with the flowmeter. You will find a preprinted "Declaration of contamination" at the back of this manual.</p> <p>Replace transmitter electronics Components in the measuring electronics defective → order replacement → 82</p> |

9.5 Response of totalizers and MODBUS communication to errors



Note!

The failsafe mode of totalizers can be customized by means of various functions in the FAILSAFE MODE function. You will find detailed information on these procedures in the "Description of Device Functions" manual.

You can use positive zero return to interrupt the evaluation of the flow measurement variables or reset measured value transmission via MODBUS communication to "0", for example when measuring has to be interrupted while a pipe is being cleaned. This function takes priority over all other device functions. Simulations, for example, are suppressed.

| Failsafe mode of totalizers and MODBUS communication | | |
|---|---|---|
| | System/process error is present | Positive zero return is activated |
| Caution! System or process errors defined as "Notice messages" have no effect whatsoever on the measurement operation. See the information on → 73 | | |
| Totalizer | STOP The totalizers are paused until the error is rectified. ACTUAL VALUE Fault is ignored, i.e. the totalizer continues to count according to the current flow value. HOLD VALUE The totalizers continue to count the flow in accordance with the last valid flow value (before the error occurred). | Totalizer stops |
| MODBUS RS485 | In the event of fault message, the value "NaN" (not a number) is transmitted instead of the current measured value. | No effect on MODBUS communication. The value "0" is outputted for the mass flow and corrected volume flow. |

9.6 Spare parts

The previous sections contain a detailed trouble-shooting guide. → [73](#)

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 (threaded fasteners, etc.)
- Mounting instructions
- Packaging

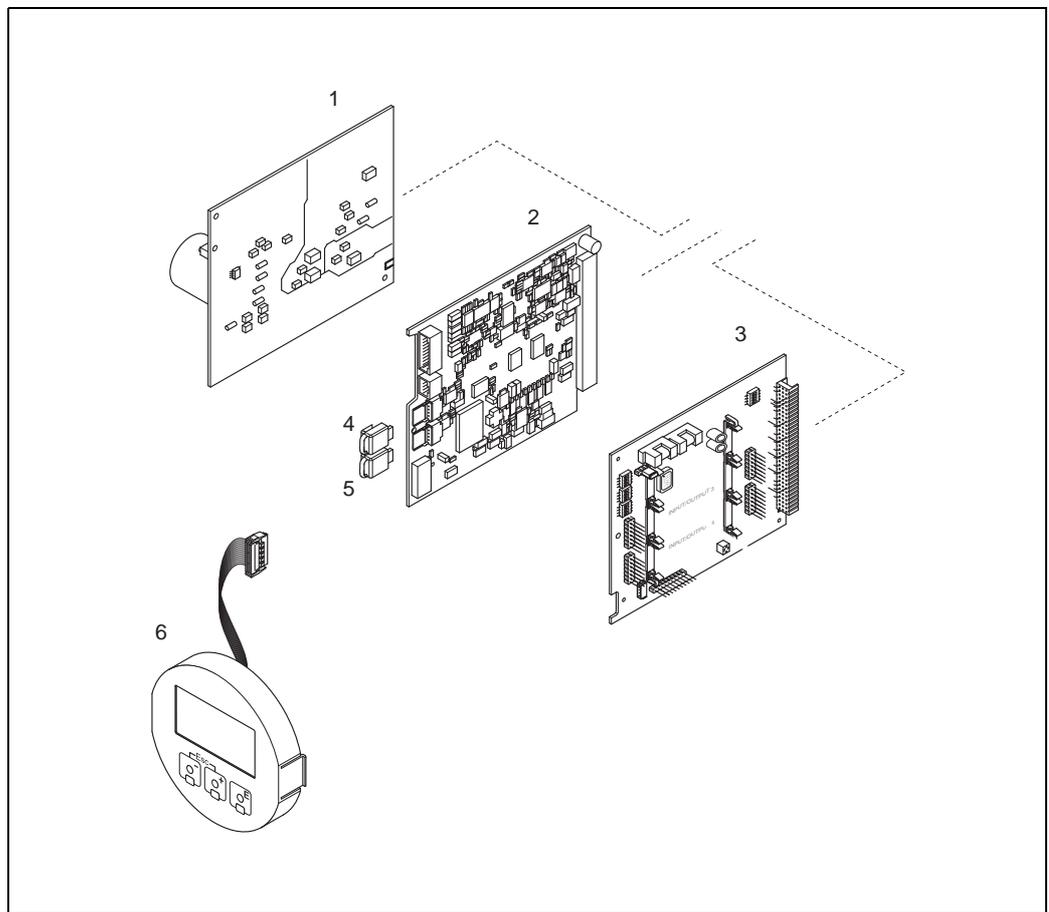


Fig. 41: Spare parts for transmitter 65 (field and wall-mount housings)

- 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 HistoROM/S-DAT (sensor data memory)
- 5 HistoROM/T-DAT (transmitter data memory)
- 6 Display module

9.6.1 Removing and installing printed circuit boards

Field housing



Warning!

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



Caution!

Use only original Endress+Hauser parts.

Installation and removal →  42

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the screws (1.1) and remove the cover (1) from the electronics compartment.
3. Disconnect the display ribbon cable (1.2) from the amplifier board.
4. Remove power supply board (3) and I/O board (5):
Insert a thin pin into the hole (2) provided for the purpose and pull the board clear of its holder.
5. Remove amplifier board (4):
 - Disconnect the plug of the sensor signal cable (4.1) including HistoROM/S-DAT (4.2) and HistoROM/T-DAT (4.3) from the board.
 - Insert a thin pin into the hole (2) provided for the purpose and pull the board clear of its holder.
6. Installation is the reverse of the removal procedure.

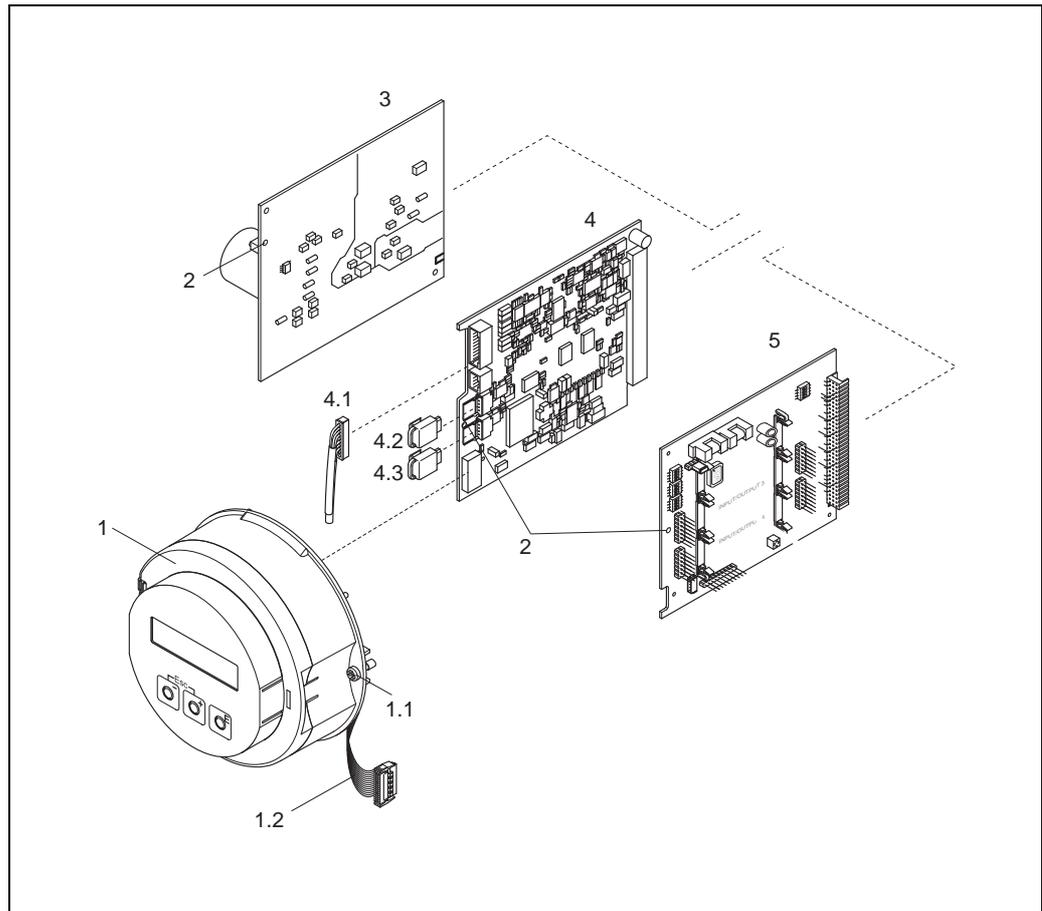


Fig. 42: Field housing: removing and installing printed circuit boards

- 1 Electronics compartment cover with local display
- 1.1 Screws of electronics compartment cover
- 1.2 Ribbon cable (display module)
- 2 Aperture for installing/removing boards
- 3 Power unit board
- 4 Amplifier board
- 4.1 Signal cable (sensor)
- 4.2 HistoROM/S-DAT (sensor data memory)
- 4.3 HistoROM/T-DAT (transmitter data memory)
- 5 I/O board

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 device can be maintained during the following steps, then an appropriate inspection test must be carried out in accordance with the manufacturer's specifications.
- When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions.



Caution!

Use only original Endress+Hauser parts.

Installation and removal →  43

1. Remove the screws and open the hinged cover (1) of the housing.
2. Loosen 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 sensor signal cable plug (7.1) including HistoROM/S-DAT (7.2) and HistoROM/T-DAT (7.3) from amplifier board (7).
4. Remove the cover (4) from the electronics compartment by removing the screws.
5. Disconnect the ribbon cable plug (3) of the display module from amplifier board (7).
6. 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.
7. Installation is the reverse of the removal procedure.

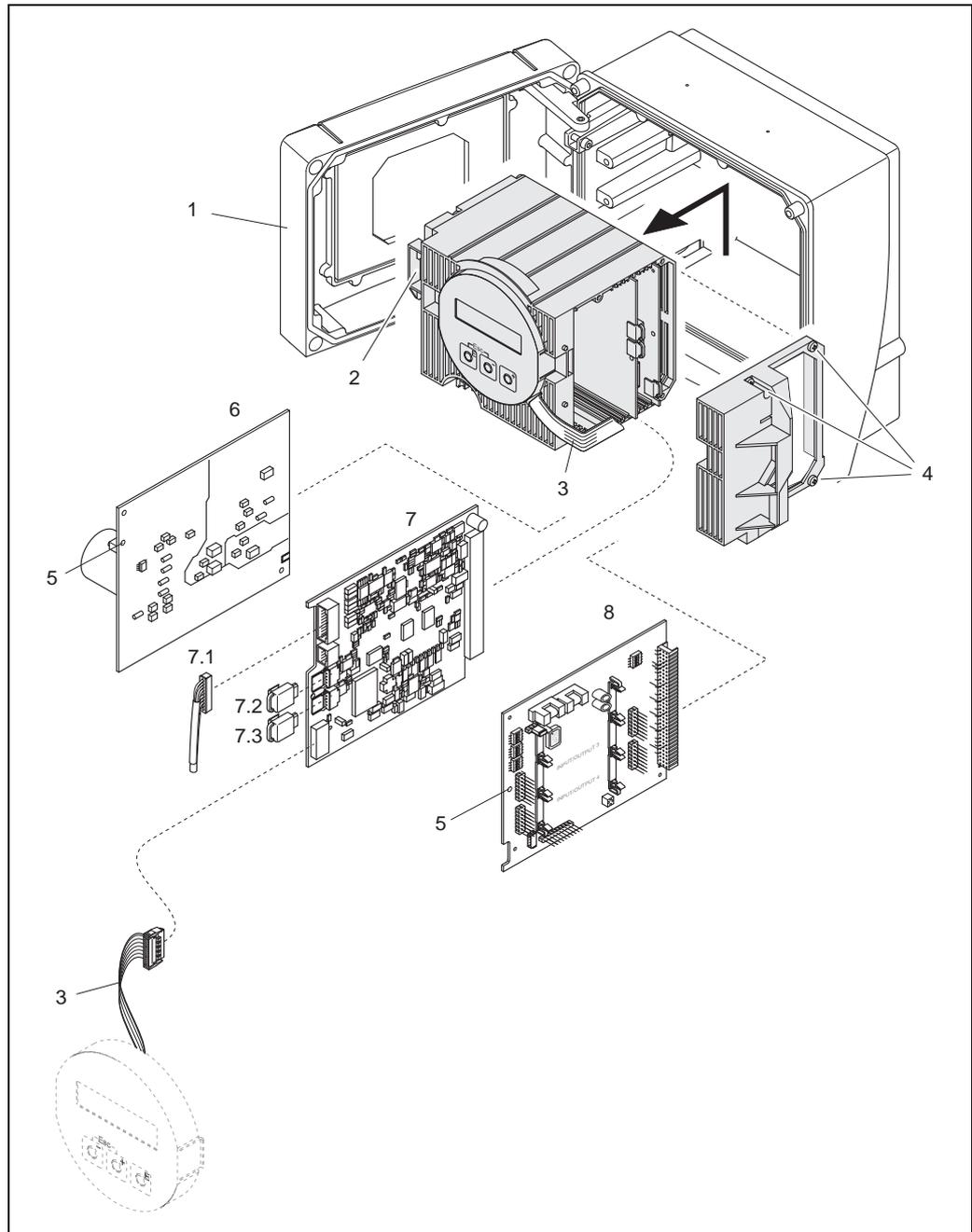


Fig. 43: Field housing: removing and installing printed circuit boards

- 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 HistoROM/S-DAT (sensor data memory)
 - 7.3 HistoROM/T-DAT (transmitter data memory)
- 8 I/O board

Electronics housing sensor remote version**Warning!**

- 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 device can be maintained during the following steps, then an appropriate inspection test must be carried out in accordance with the manufacturer's specifications.
- When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions.

**Caution!**

Use only original Endress+Hauser parts.

Removal and installation →  44

1. Remove the safety screw (1) and remove the cover (2) from the electronics compartment.
2. Disconnect the sensor cable plug (3).
3. Disconnect the remote cable from the terminal block (4).
4. Remove the two screws (5) from the printed circuit board
5. Remove printed circuit board (6)
6. Installation is the reverse of the removal procedure.

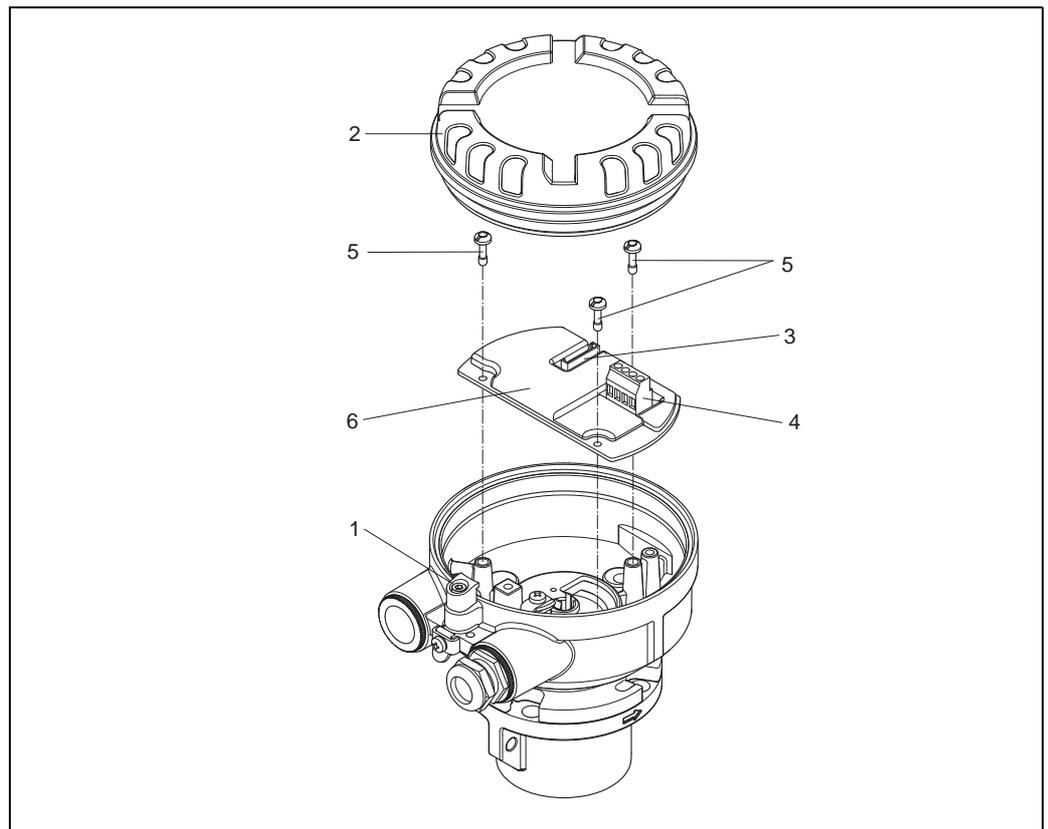


Fig. 44: Electronics compartment of the sensor housing remote version: removing and installing printed circuit board

Wire colors (when supplied by Endress+Hauser):

Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow

9.6.2 Replacing the device fuse



Warning!

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

The main fuse is on the power unit board.

The procedure for replacing the fuse is as follows:

1. Switch off power supply.
2. Remove the power unit board → 83
3. Remove the protection cap (1) and replace the device fuse (2).
Only use the following fuse type:
 - Power supply 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.

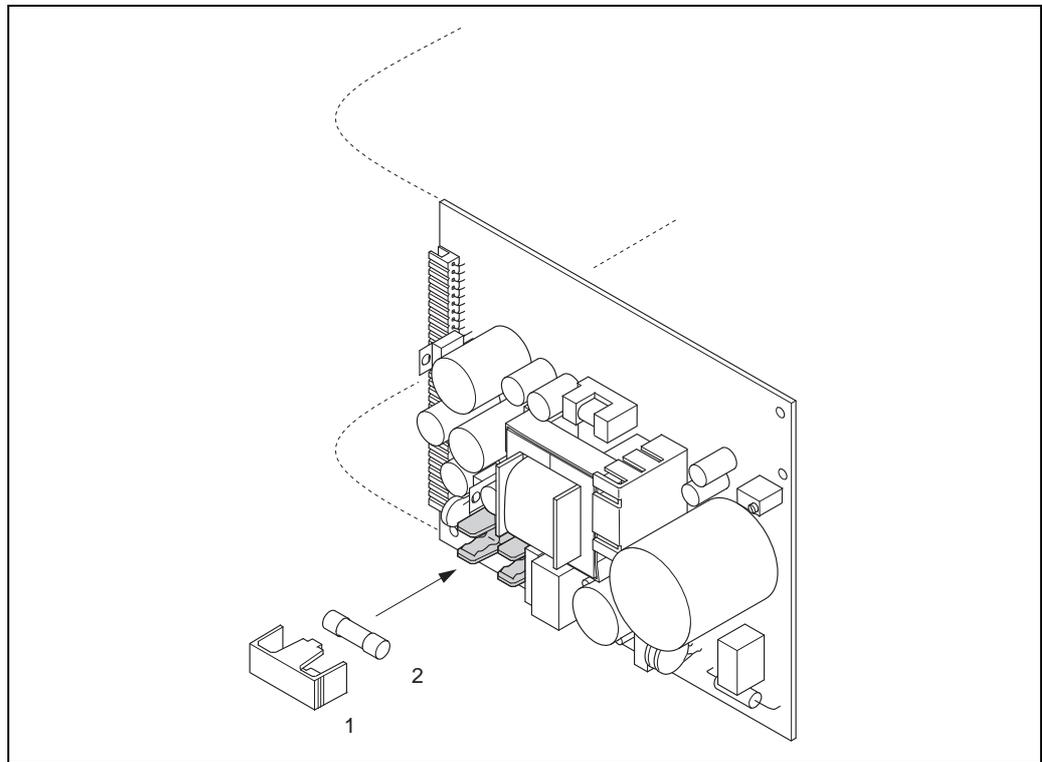


Fig. 45: Replacing the device fuse on the power unit board

- 1 Protective cap
2 Device fuse

9.7 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.

9.8 Disposal

Observe the regulations applicable in your country!

9.9 Software history



Note!

Up or downloading a software version normally requires a special service software.

| Date | Software version | Changes to software | Operating Instructions |
|---------|------------------|--|------------------------|
| 10.2010 | 3.06.XX | Software expansion: <ul style="list-style-type: none"> - second gas group in memory - gas heat flow and heat quantity - variable gas fraction input - revised diagnostics - Fieldcheck compatibility New functionalities: <ul style="list-style-type: none"> - Quick Setups for gas, pressure, heat flow and sensor - additional pressure units - system units for calorific value, heat flow and quantity heat - process pressure for gas group 1 + 2 - status input assignment for gas group - assignment of heat flow to display, totalizer and outputs - totalizer units for quantity heat flow - assignment of gas groups to outputs and totalizer - on/off delay for relay outputs - selection special gas with correction factors and reference density - insertion depth calculator - time stamping for process and system errors | 71123865/13.10 |
| 02.2006 | 3.02.XX | | 71021612/02.06 |

10 Technical data

10.1 Technical data at a glance

10.1.1 Applications

The measuring device described in these Operating Instructions is to be used only for measuring the mass flow rate of gases (e. g. kg, Nm³ scf). At the same time, the system also measures gas temperature. The measuring device can be configured to measure a standard range of pure gases or gas mixtures.

Examples:

- Air
- Oxygen
- Nitrogen
- Carbon Dioxide
- Argon, etc.

The use with corrosive, saturated or unclean gases should be treated with caution (contact your Endress+Hauser sales representative). The use with unstable gases or gases not deemed to be suitable by Endress+Hauser must be avoided. The measuring device is not designed to be used with liquids or fluids in the liquid phase.

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

10.1.2 Function and system design

| | |
|---------------------|--|
| Measuring principle | Mass flow measurement by the thermal dispersion principle. |
|---------------------|--|

| | |
|------------------|---|
| Measuring system | <p>The t-mass 65 flow measuring system consists of the following components:</p> <ul style="list-style-type: none"> ■ t-mass 65 transmitter ■ t-mass F, t-mass I sensor <p>Two versions are available:</p> <ul style="list-style-type: none"> ■ Compact version: transmitter and sensor form a single mechanical unit. ■ Remote version: transmitter and sensor are installed separately. |
|------------------|---|

10.1.3 Input

| | |
|-------------------|---|
| Measured variable | <ul style="list-style-type: none"> ■ Mass flow ■ Gas temperature ■ Gas heat flow |
|-------------------|---|

| | |
|-----------------|--|
| Measuring range | <p>The measuring range is dependent upon:</p> <ul style="list-style-type: none"> ■ Gas ■ Pressure ■ Temperature ■ Cross-sectional area of pipe or duct ■ Use of flow conditioner (t-mass F sensor) <p>Please refer to Applicator, the Endress+Hauser sizing and selection software, for calculation of the measuring range.</p> |
|-----------------|--|

| | |
|--------------|---|
| Input signal | <p><i>Status input (auxiliary input)</i></p> <p>U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated. Switch level ±3 to ±30 V DC. Configurable for: gas group, totalizer reset, positive zero return, start zero point adjustment</p> |
|--------------|---|

10.1.4 Output

| | |
|---------------|---|
| Output signal | <p><i>MODBUS RS485:</i></p> <ul style="list-style-type: none"> ■ MODBUS device type: slave ■ Address range: 1 to 247 ■ Functions codes supported: 03, 04, 06, 08, 16, 23 ■ Broadcast: supported with the function codes 06, 16, 23 ■ Physical interface: RS485 in accordance with standard EIA/TIA-485 ■ Baudrate supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud ■ Transmission mode: RTU or ASCII ■ Parity: NONE, EVEN, ODD ■ Response time: <ul style="list-style-type: none"> Direct data access = typically 25 to 50 ms Auto-scan buffer (data area) = typically 3 to 5 ms |
|---------------|---|

| | |
|-----------------|---|
| Signal on alarm | If an error occurs, the value NaN (not a number) is output for the measured values. |
|-----------------|---|

| | |
|------------------|---|
| Low flow cut off | <p>Switch points for low flow cut off are programmable. Factory setting = 1% of 20 mA Value</p> |
|------------------|---|

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

10.1.5 Power supply

| | |
|------------------------|--|
| Electrical connections | →  27 |
|------------------------|--|

| | |
|----------------|---|
| Supply voltage | <p>85 to 260 V AC, 45 to 65 Hz 20 to 55 V AC, 45 to 65 Hz 16 to 62 V DC</p> |
|----------------|---|

| | |
|-------------|---|
| Cable entry | <p>Power supply and signal cables (inputs/outputs):</p> <ul style="list-style-type: none"> ■ Cable entry M20 × 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½" <p>Connecting cable for remote version:</p> <ul style="list-style-type: none"> ■ Cable entry M20 × 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½" |
|-------------|---|

| | |
|--|--|
| Cable specifications (remote version) | →  29 |
|--|--|

| | |
|-------------------|---|
| Power consumption | <p>AC: 85 to 260 V = 18.2 W ; 20 to 55 V = 14 W ; (including sensor) DC: 8 W (including sensor)</p> |
|-------------------|---|

| | |
|----------------------|--|
| Power supply failure | <p>Lasting min. 1 power cycle:</p> <ul style="list-style-type: none"> ■ EEPROM/HistoROM T-DAT saves measuring system data if power supply fails. ■ HistoROM S-DAT is an exchangeable data storage chip with sensor specific data: (pipe type, nominal diameter, serial number, flow conditioner, zero point, etc). ■ Totalizer stops at the last value determined |
|----------------------|--|

| | |
|------------------------|---|
| Potential equalization | <p>No measures necessary. For devices in hazardous areas please refer to the additional Ex documentation.</p> |
|------------------------|---|

10.1.6 Performance characteristics

| | |
|----------------------------------|---|
| Calibration reference conditions | <ul style="list-style-type: none"> ■ Accredited according to ISO/IEC 17025 ■ Traceable to National Standards ■ Calibration gas: air ■ Temperature controlled to 24 °C ±0.5 °C (75.2 °F ± 0.9 °F) at atmospheric pressure ■ Humidity controlled < 40% RH |
|----------------------------------|---|

| | |
|------------------------|--|
| Maximum measured error | <p>t-mass 65F: ±1.5 % of reading for 100 % to 10 % of full scale (at reference conditions) ±0.15 % of full scale for 10 % to 1 % of full scale (at reference conditions)</p> <p>t-mass 65I: ±1.0% of reading ±0.5% of full scale (at reference conditions)</p> |
|------------------------|--|

| | |
|---------------|---|
| Repeatability | ±0.4 % of reading for velocities above 1.0 m/s (3.3 ft/s) |
|---------------|---|

| | |
|--|--|
| Influence of medium pressure (Pressure co-efficient) | <p>Air: 0.35% per bar (0.02% per psi) of process pressure change Other gases: on request</p> |
|--|--|

| | |
|---------------|--|
| Response time | Typically less than 2 seconds for 63 % of a given step change (in either direction). |
|---------------|--|

10.1.7 Operating conditions: Installation

Installation instructions →  12

Inlet and outlet runs →  15

Length of connecting cable Max. 100 m (328 feet), remote version

System pressure →  12

10.1.8 Operating conditions: Environment

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



Note!

- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions. (A protective sun cover is available on request)
- At ambient temperatures below -20 °C (-4 °F) the readability of the display may be impaired.

Storage temperature -40 to +80 °C (-40 to +176 °F), recommended +20 °C (+68 °F)

Degree of protection Standard: IP 67 (NEMA 4X) for transmitter and sensor

Shock resistance According to IEC 60068-2-31

Vibration resistance Acceleration up to 1 g, 10 to 150 Hz, following IEC 60068-2-6

Electromagnetic compatibility (EMC) To IEC/EN 61326 and NAMUR recommendation NE 21

10.1.9 Operating conditions: Process

| | |
|--|--|
| Medium temperature range | <p>Sensor</p> <p>t-mass F: -40 °C to +100 °C (-40 °F to +212 °F)</p> <p>t-mass I: -40 °C to +130 °C (-40 °F to +266 °F)</p> <p>Seals t-mass F</p> <p>O-rings: Viton FKM -20°C to +100°C (-4°F to +212°F) Kalrez -20°C to +100°C (-4°F to +212°F) EPDM -40°C to +100°C (-40°F to +212°F)</p> <p>Bushing: PEEK, PVDF -40°C to +100°C (-40°F to +212°F)</p> <p>Seals t-mass I</p> <p>Bonded seals: Kalrez -20°C to +130°C (-4°F to +266°F) EPDM -40°C to +130°C (-40°F to +266°F) Nitrile -35°C to +130°C (-31°F to +266°F)</p> <p>Ferrule: PEEK, PVDF -40°C to +130°C (-40°F to +266°F)</p> |
| Medium pressure range (nominal pressure) | <p>t-mass F: -0.5 to 40 bar gauge (-7.25 to 580 psi gauge)</p> <p>t-mass I: -0.5 to 20 bar gauge (-7.25 to 290 psi gauge)</p> |
| Flow limit | <p>See "Measuring range" section → 91. The velocity in the measuring tube should not exceed 130 m/s (427 ft/s).</p> |
| Pressure loss | <p>Negligible (without flow conditioner). Refer to Applicator for the precise calculation → 72</p> |
| Limiting medium pressure range (rated pressure) | <p>The material load diagrams (pressure-temperature diagrams) for the process connections are provided in the separate "Technical Information" document on the device in question. This can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents: → 100</p> |
| Process conditions for Hot tap | <p>The Hot tap is permitted for use only with non-toxic, innocuous gases classified as "Group II" in accordance with the European directive 67/548/EWG art. 2.</p> <p>Medium pressure version</p> <p>Max. process pressure: 20 bar (290 psig) Max. extraction press: 16 bar (230 psig) Max. extraction temperature: +50°C (+122°F) Min. sensor length: 435 mm (17 inch)</p> <p>Low pressure version</p> <p>Max. process pressure: 20 bar (290 psig) Max. extraction press: 4,5 bar (65 psig) Max. extraction temperature: +50°C (+122°F) Min. sensor length: 435 mm (17 inch)</p> |

10.1.10 Mechanical construction

Design / dimensions

Dimensions and the fitting lengths of the transmitter and sensor are provided in the separate "Technical Information" document on the device in question. This can be downloaded as a PDF file from www.endress.com.

A list of the "Technical Information" documents: →  100

Weight

- Compact version: see table below
- Remote version
 - Sensor: see table below
 - Wall-mount housing: 5 kg (11 lb)

Weight (SI units)

| t-mass F* / DN | 15 | 25 | 40 | 50 | 80 | 100 |
|------------------------------|-----|-----|------|------|------|------|
| Compact version | 7.5 | 8.0 | 12.5 | 12.5 | 18.7 | 27.9 |
| Remote version (sensor only) | 5.5 | 6.0 | 10.5 | 10.5 | 16.7 | 25.9 |

| t-mass I / sensor length [mm] | 235 | 335 | 435 | 608 |
|-------------------------------|-----|-----|-----|-----|
| Compact version | 6.4 | 6.6 | 7.0 | 7.4 |
| Remote version (sensor only) | 4.4 | 4.6 | 5.0 | 5.4 |

Weight dimensions in [kg].

* For flanged versions, all values (weight) refer to devices with EN/DIN PN 40 flanges.

Weight (US units)

| t-mass F* / DN [inch] | ½" | 1" | 1½" | 2" | 3" | 4" |
|------------------------------|------|------|------|------|------|------|
| Compact version | 16.5 | 17.6 | 27.5 | 27.5 | 41.2 | 61.5 |
| Remote version (sensor only) | 12.1 | 13.2 | 23.1 | 23.1 | 36.7 | 57.1 |

| t-mass I / sensor length [inch] | 9.25" | 13.2" | 17.1" | 24.0" |
|---------------------------------|-------|-------|-------|-------|
| Compact version | 14.1 | 14.5 | 15.4 | 16.3 |
| Remote version (sensor only) | 9.7 | 10.1 | 11.0 | 11.9 |

Weight dimensions in [lb].

* For flanged versions, all values (weight) refer to devices with CI 150 flanges.

Material

Transmitter housing

- Compact housing: powder coated die-cast aluminum
- Wall-mount housing: powder coated die-cast aluminum
- Remote field housing: powder coated die-cast aluminum

Connection housing, sensor (remote version)

Powder coated die-cast aluminum

t-mass F sensor

Sensor body:

- DN 15 to 25 (DN ½" to DN 1"): stainless steel cast CF3M-A351
- DN 40 to 100 (DN 1 ½" to DN 4"): 1.4404 to EN10216-5 and 316/316L to A312

Flanges (process connections):

According to EN 1092-1 (DIN 2501/DIN 2512N) / ANSI B16.5 / JIS B2220
→ stainless steel 1.4404 to EN 10222-5 and 316L/316 to A182

Transducer body:

- 1.4404 to EN10272 and 316L to A479
- Alloy C22 (2.4602) and UNS N06022 to B574

Transducer elements:

- 1.4404 to EN10217-7 and 316L to A249 or
- 1.4404 to EN 10216-5 and 316L to A213
- Alloy C22 (2.4602) and UNS N06022 to B626

Bushing:

PEEK GF30, PVDF

O-ring seals:

EPDM, Kalrez 6375, Viton FKM

t-mass I sensor

Insertion tube:

Sensor length 235 (9"), 335 (13"), 435 (17"), 608 (24")
1.4404 to EN 10216-5 and 316/316L to A312

Transducer body:

- 1.4404 to EN10272 and 316L to A479
- Alloy C22 (2.4602) and UNS N06022 to B574

Transducer elements:

- 1.4404 to EN10217-7 and 316L to A249 or
- 1.4404 to EN 10216-5 and 316L to A213
- Alloy C22 (2.4602) and UNS N06022 to B626

Protection guard:

1.4404 to EN 10088-1 and EN 10088-2 + 2B and 316L to A666

Compression fitting:

1.4404 to EN 10272 and 316/316L to A479

Ferrules:

PEEK 450G, PVDF

Bonded seals:

EPDM, Kalrez 6375, Nitrile and 316/316L (outer ring)

Hot tap

Lower tube section:

1.4404 to EN 10272 and 316/316L to A479

Upper tube section:

1.4404 to EN 10216-5 and 316/316L to A312

Ball valve:

CF3M and CF8M

Seal:

PTFE

10.1.11 Human interface

| | |
|--------------------|--|
| Display elements | <ul style="list-style-type: none"> ■ Liquid crystal display: illuminated, two lines with 16 characters per line ■ Selectable display of different measured values and status variables ■ At ambient temperatures below $-20\text{ }^{\circ}\text{C}$ ($-4\text{ }^{\circ}\text{F}$) the readability of the display may be impaired. |
| Operating elements | <ul style="list-style-type: none"> ■ Local operation with push buttons (◻, +, E) ■ Quick Setup menus for straight forward commissioning |
| Languages | English, German, French, Spanish, Italian, Dutch, Norwegian, Finnish, Swedish, Portuguese, Polish, Czech |

10.1.12 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) can be supplied by your Endress+Hauser representative on request. All explosion protection data are given in a separate documentation which is available upon request. |

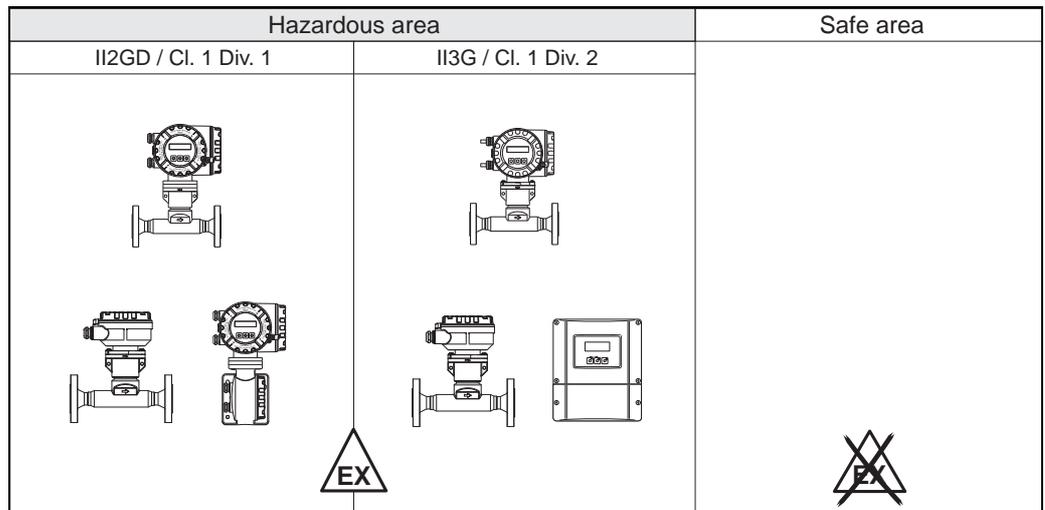


Fig. 46: Example of t-mass devices in the hazardous area (Example t-mass 65F)

| | |
|--------------|---|
| MODBUS RS485 | The measuring device meets all the requirements of the MODBUS/TCP conformity and integration test and holds the "MODBUS/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "MODBUS/TCP Conformance Test Laboratory" of the University of Michigan. |
|--------------|---|

| | |
|------------------------------------|---|
| Pressure measuring device approval | <p>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.</p> <ul style="list-style-type: none"> ■ 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: <ul style="list-style-type: none"> – 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. |
| Oxygen service | <p>We certify that the wetted parts of the flow sensor have been degreased in accordance with British Oxygen Company (BOC) specification 0000-N-S-430-00-01 and BS IEC 60877:1999. After final degreasing there shall be less than 100 milligram/m² (0.01 milligram/cm²) of oil/grease contamination on the degreased surface of the component.</p> |
| Other standards and guidelines | <p>BS IEC 60877:1999 Procedures for ensuring the cleanliness of industrial-process measurement and control equipment in oxygen service.</p> <p>EN 60529 Degrees of protection by housing (IP code)</p> <p>EN 61010-1 Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.</p> <p>IEC/EN 61326 "Emission in accordance with requirements for Class A". Electromagnetic compatibility (EMC-requirements).</p> <p>EN 91/155/EEC Safety Data Sheets Directive.</p> <p>ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories.</p> <p>ISO 14511 Measurement of fluid flow in closed conduits – Thermal mass flowmeters.</p> <p>NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.</p> <p>NAMUR NE 43 Standardization of the signal level for the breakdown information of digital transmitters with analogue output signal.</p> <p>NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics</p> |

10.1.13 Ordering information

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

10.1.14 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor →  71

10.1.15 Documentation

- Technical Information t-mass 65F, 65I (TI069D/06)
- Description of Device Functions t-mass 65 (BA00116D/06)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA, IECEx, NEPSI
- Flow measuring technology (FA005D/06/)

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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] _____ [mm²/s]

Medium and warnings

Warnhinweise zum Medium



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

* explosive; oxidising; dangerous for the environment; biological risk; radioactive

* explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.

Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / Fehlerbeschreibung _____

Company data / Angaben zum Absender

| | |
|-------------------------|---|
| Company / Firma _____ | Phone number of contact person / Telefon-Nr. Ansprechpartner: _____ |
| Address / Adresse _____ | 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 gefährlicher Menge sind."

(place, date / Ort, Datum)

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

Signature / Unterschrift

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