



Level



Pressure



Flow



Temperature



Liquid
Analysis



Registration



Systems
Components



Services



Solutions

Operating Instructions

Proline t-mass 65 MODBUS RS485

Thermal Mass Flow Measuring System

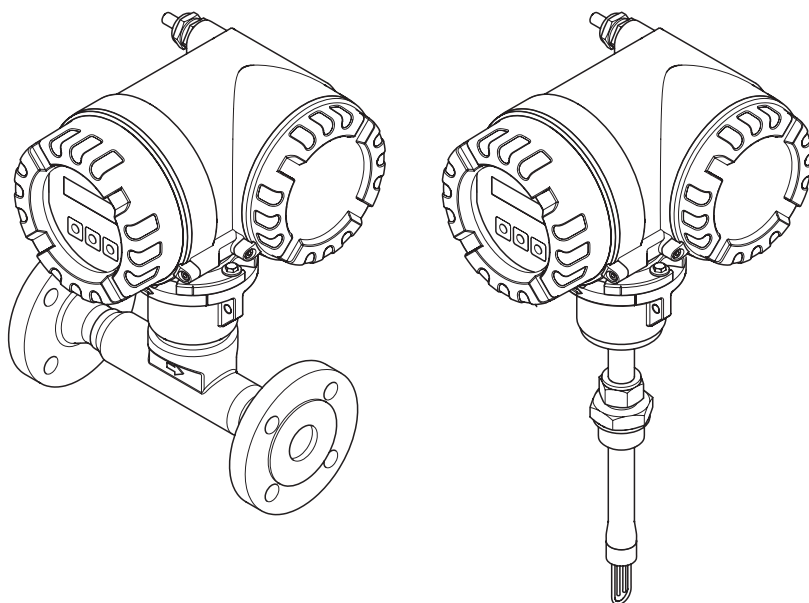


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1 Safety instructions

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. At the same time, the system also measures gas temperature and calculates other variables such as corrected volume flow. The measuring device can be configured to measure pure gases or gas mixtures.

Examples:

- Compressed air
- Oxygen
- Nitrogen
- Carbon Dioxide
- Argon, etc.

The use with saturated and wet/dirty gases should be treated with caution (contact your Endress+Hauser representative). The use with unstable gases should be avoided.

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 ( Europe,  USA,  Canada).
- The measuring device complies with the general safety requirements in accordance with EN 61010-1, the EMC requirements of EN 61326/A1, and NAMUR recommendation NE 21 and NE 53.
- The separate document on the Pressure Equipment Directive must be observed for devices used in Category II, III or IV installations in accordance with the Pressure Equipment Directive.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Operating Instructions.

1.4 Return

The following procedures must be carried out before a flowmeter requiring repair or calibration, for example, is returned to Endress+Hauser:

- Always enclose a duly completed “Declaration of contamination” form. Only then can Endress+Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.
- Remove all residues. Pay special attention to the grooves for seals and crevices which could contain residues. This is particularly important if the substance is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.



Note!

You will find a preprinted “Declaration of contamination” form at the back of this manual.



Warning!

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

1.5 Notes on safety conventions and icons

The devices are designed to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate. The devices comply with the applicable standards and regulations in accordance with EN 61010-1 “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

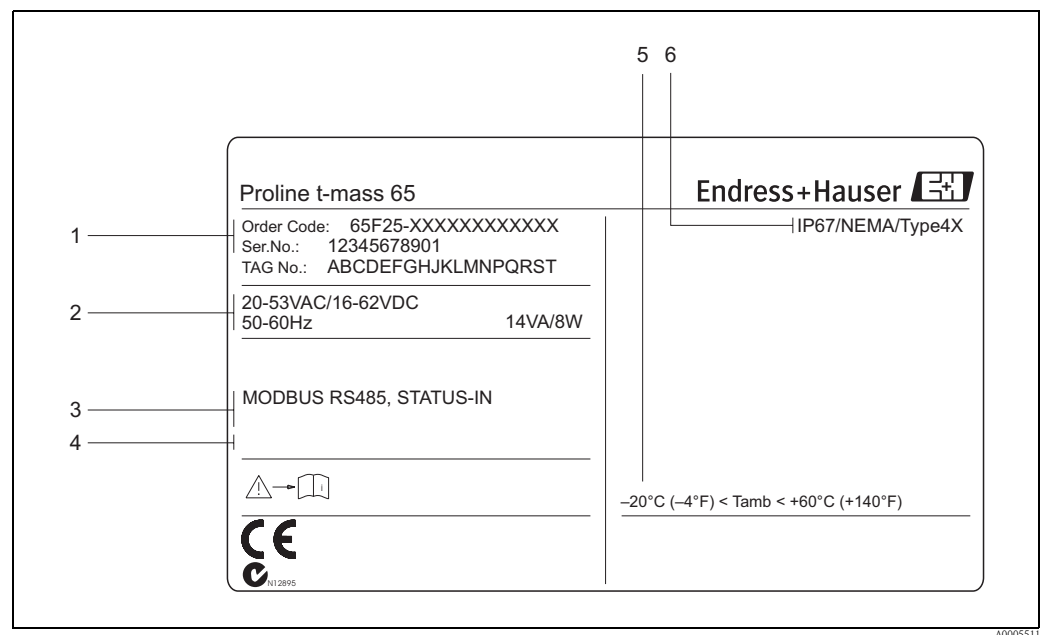
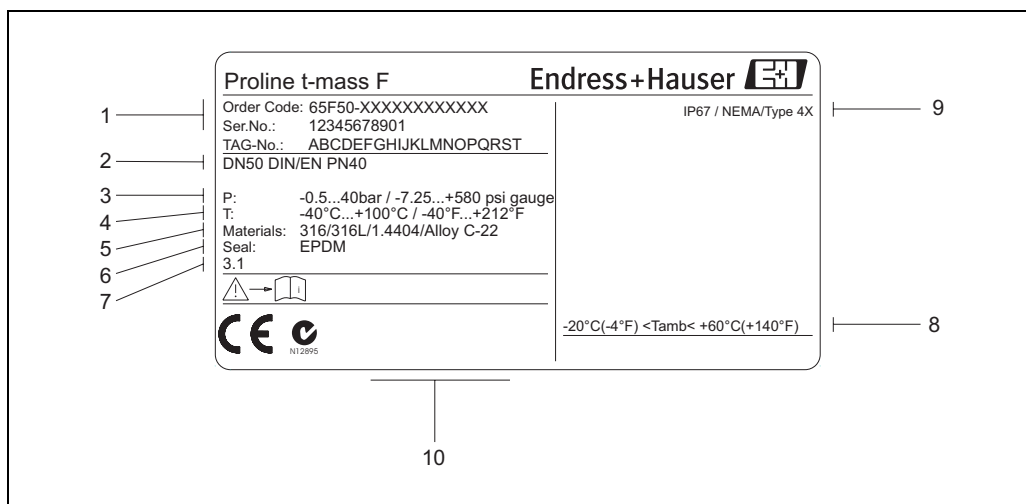


Fig. 1: Nameplate specifications for the “t-mass 65 MODBUS RS485” transmitter (example)

- 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: 20 to 55 V AC / 16 to 62 V DC / 50 to 60 Hz
Power consumption: 14 VA / 8 W
- 3 Available inputs / outputs
- 4 Reserved for information on special products
- 5 Ambient temperature range
- 6 Degree of protection

2.1.2 Nameplate of the sensor



A0005512

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: DN 50
Nominal pressure: EN (DIN) PN 40 bar
- 3 Pressure range: -0.5 to 40 bar / -7.25 to 580 psi (gauge)
- 4 Temperature range: -40 °C to +100 °C / -40 °F to +212 °F
- 5 Material of measuring tubes: Stainless steel 316/316L/1.4404/Alloy C-22
- 6 Seal material: EPDM
- 7 Reserved for information on special products (example):
– With material certificate for wetted materials
- 8 Ambient temperature range
- 9 Degree of protection
- 10 Reserved for additional information on device version (approvals, certificates)

2.1.3 Nameplate for connections

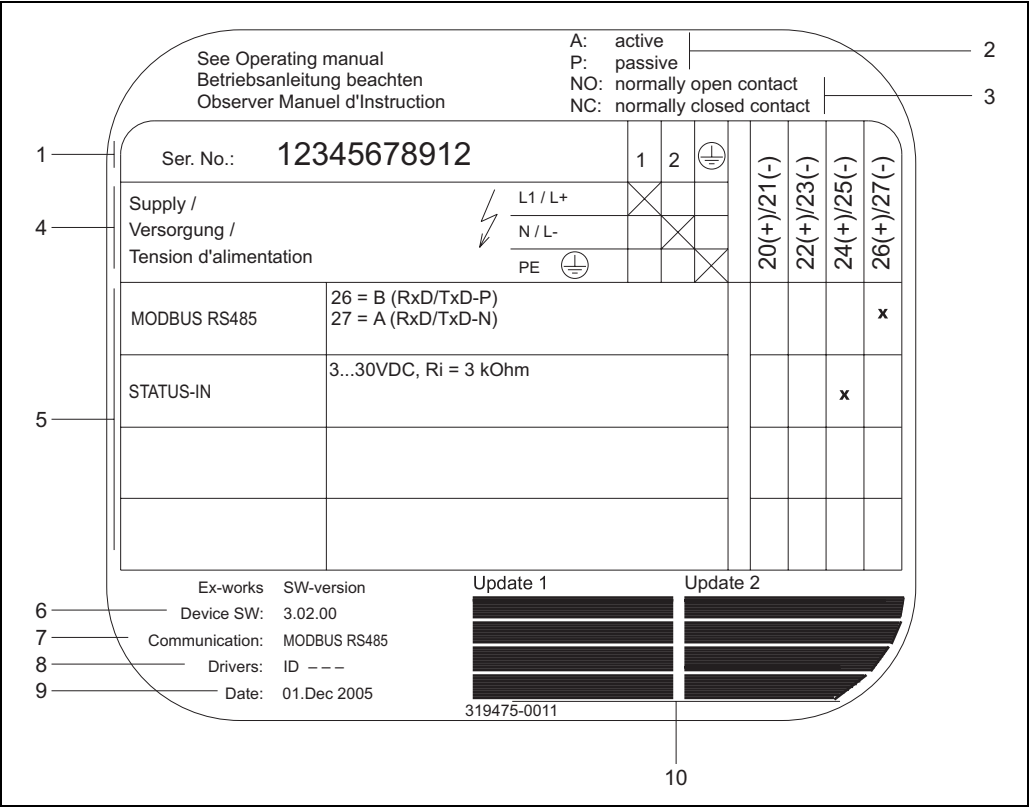


Fig. 3: Nameplate specifications for transmitter connections (example)

- 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, 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
- 5 Pending signals at the inputs and outputs possible configurations and terminal assignment → Page 32
- 6 Version of device software currently installed
- 7 Installed communication type
- 8 Information on communication driver
- 9 Date of installation
- 10 Current updates to data specified in 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 EN 61326/A1.

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 complies with the EMC requirements of the “Australian Communications Authority (ACA)”.

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®, ToF Tool – Fieldtool® Package, 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 to 100 (1½" to 4") by the transmitter housing or the connection housing in the case of the remote version (Fig. 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.

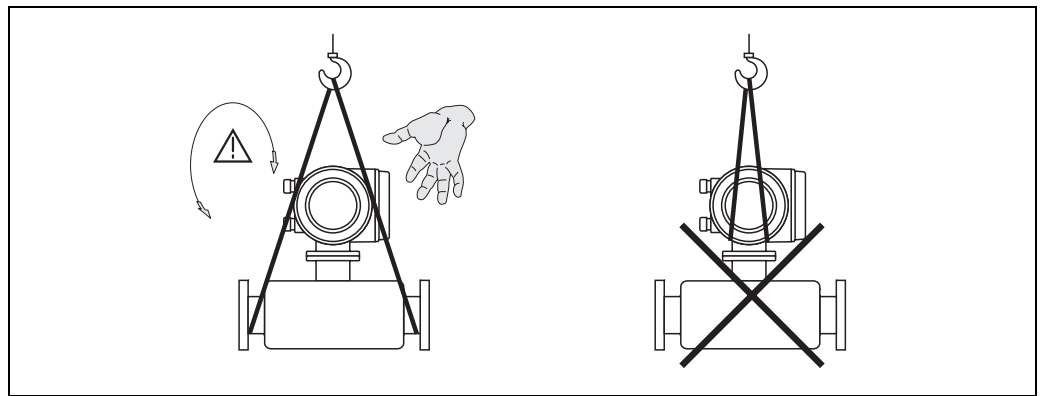


Fig. 4: Instructions for transporting sensors with DN 40 to 100 (1½" to 4")

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.

3.2 Installation conditions

Note the following points:

- The thermal dispersion principle is very sensitive to low flow rates and 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.
- Avoid condensation forming around the transducers.
- Consider the nature of the gas or gas mixture (dryness, cleanliness, stability, fraction, etc.)
- The maximum permitted ambient temperatures (→ Page 89) and the medium temperature range (→ Page 89) must be observed.
- If possible, locate the sensor to avoid extreme changes in ambient temperature and process conditions.
- For mechanical reasons, and in order to protect the pipe, it is advisable to support heavy sensors.

3.2.1 Dimensions

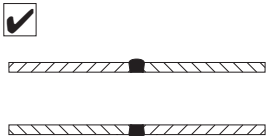
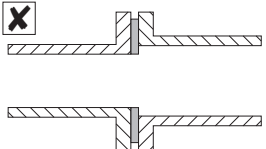
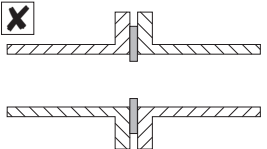
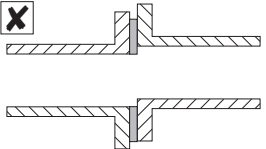
All the dimensions and lengths of the sensor and transmitter are provided in the separate documentation “Technical Information”.

3.2.2 Pipework requirements

Good construction practice should be followed at all times:

- Correct welding techniques
- Correctly sized gaskets
- Correctly aligned flanges and gaskets
- The use of seamless pipe immediately upstream of the flowmeter.
- The use of pipework with a matching internal diameter to that of the flowmeter to ensure that no step disturbance greater than 1 mm (0.04 inch) can occur at the meter inlet or outlet (3 mm (0.12 inch) for diameters > DN 200 (8")).
- As a general comment, anything that disturbs the smoothness of the internal pipe wall within the dimensions stated below should be eliminated; the goal should be a smooth uninterrupted internal surface.

For further information please refer to ISO 14511.

 a0005103		
Butt welded joint		
 a0005104	 a0005105	 a0005106
Pipe diameter one is not equal pipe diameter two	Incorrectly sized gaskets	Incorrectly aligned flanges and gaskets

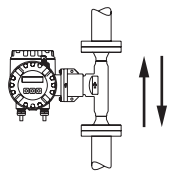
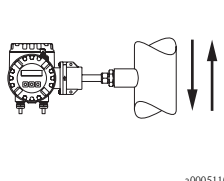
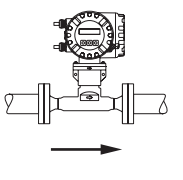
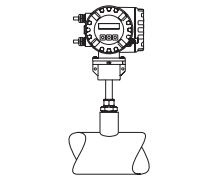
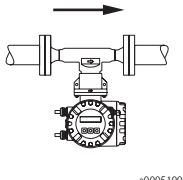
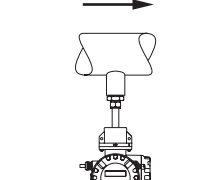


Caution!
Newly installed piping should be free of contaminants and particles to prevent damage to the sensing elements.

3.2.3 Orientation

The device can generally be installed in any position in the piping. In the case of wet/dirty gases, upward flow is preferred in vertical pipes to minimise condensation/contamination. Where free condensation can occur (e.g. Biogas) the sensor should be orientated to prevent water collecting on or around the transducer.

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

		Flanged version		Insertion version	
Vertical orientation					
 a0005107	compact ✓✓	remote ✓✓	 a0005110	compact ✓	remote ✓✓
Horizontal orientation:					
 a0005108	compact ✓✓	remote ✓✓	 a0005111	compact ✓✓	remote ✓✓
Horizontal orientation:					
 a0005109	compact ✗	remote ✗	 a0005112	compact ✗	remote ✗
✓✓ = Recommended orientation ✓ = Orientation recommended in certain situations ✗ = Not recommended					

3.2.4 Inlet and outlet runs

The sensitivity of the thermal dispersion principle to low flow rates means the flowmeter can also be sensitive to internal disturbances in the flowing gas stream (e.g. swirl), especially in the larger pipe diameters $\geq$ DN 150 ($\geq$ 6").

As a general rule, the installed thermal flow sensor should always be installed as far away as possible from any flow disturbances (see ISO14511 for further information).

Process components or pipework configuration

When disturbances (e. g. pipe elbows, reducers, valves, T-pieces etc.) are located upstream of the thermal meter, precautions must be taken to minimise any effects on the measuring performance. The figure on the following page illustrates the minimum recommended inlet and outlet runs, expressed in multiples of the pipe diameter. Longer lengths should always be used if they are available.

Regardless of any other consideration, the minimum recommendations for inlet and outlet runs on either side of the sensor are:

Inlet runs:

Minimum 15 x DN for the flanged version (65F)

Minimum 20 x DN for the insertion version (65I)

Outlet runs:

Minimum 2 x DN for the flanged version (65F)

Minimum 5 x DN for the insertion version (65I)



Note!

- These are minimum values, increasing these dimensions will often improve the flowmeter performance.
- Where two or more disturbances are located upstream of the meter, the longest recommended upstream pipe run is to be observed as an absolute minimum.
- It is always recommended to install control valves downstream of the flowmeter.
- For very light gases such as Helium and Hydrogen all upstream distances should be doubled.

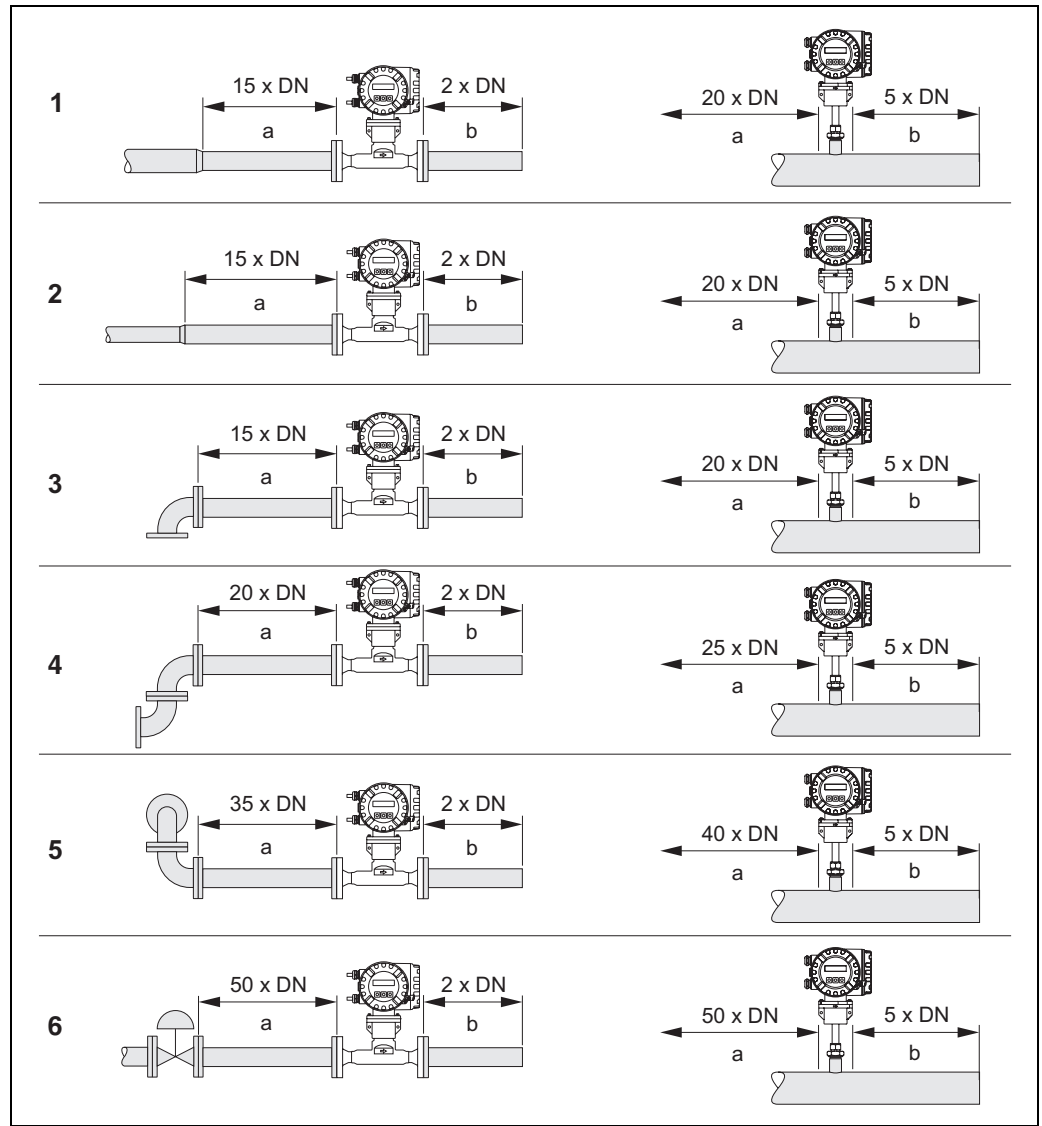


Fig. 5: The figure above illustrates the minimum recommended inlet und outlet runs expressed in multiples of the pipe diameter.

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 (where possible a modulating control valve should be mounted downstream of a flowmeter)

a = Inlet run

b = Outlet run



Note!

Wherever possible mount any control and butterfly shut off valves downstream of the flowmeter.

3.2.5 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.

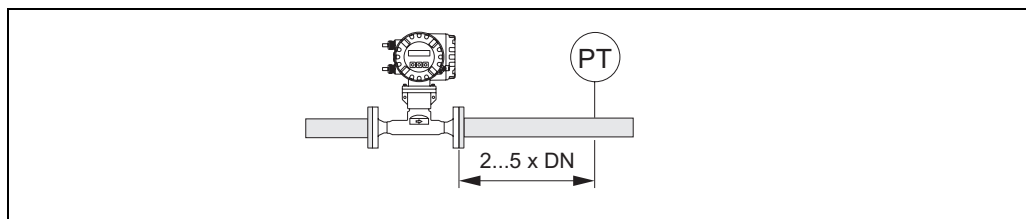


Fig. 6: Installing a pressure measuring point (PT = pressure transmitter)

3.2.6 Perforated plate flow conditioner

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

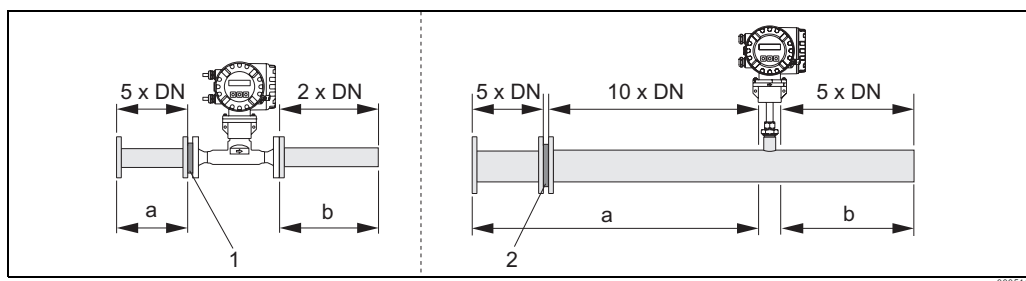


Fig. 7: The figure above illustrates the minimum recommended inlet and outlet runs expressed in multiples of the pipe diameter using a flow conditioner.

1 = Flow conditioner with the flanged version / 2 = Flow conditioner with the insertion version
a = Inlet run / b = Outlet run

Flow conditioner (35 hole) for use with insertion sensors

The well known "Mitsubishi" design is recommended for this application DN 80 mm (3") to DN 300 mm (12"). For the majority of gas types, the flow conditioner must be installed at a distance of 10 x DN upstream of the sensor. A further 5 pipe diameters inlet run is required upstream of the actual conditioner itself.

Flow conditioner (19 hole) 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 flow conditioner should be fitted immediately upstream of the flanged sensor. A further 5 pipe diameters inlet run is required upstream of the actual conditioner itself.

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.



Note!

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.

The flow conditioner is fitted between two piping flanges and centered with mounting bolts.

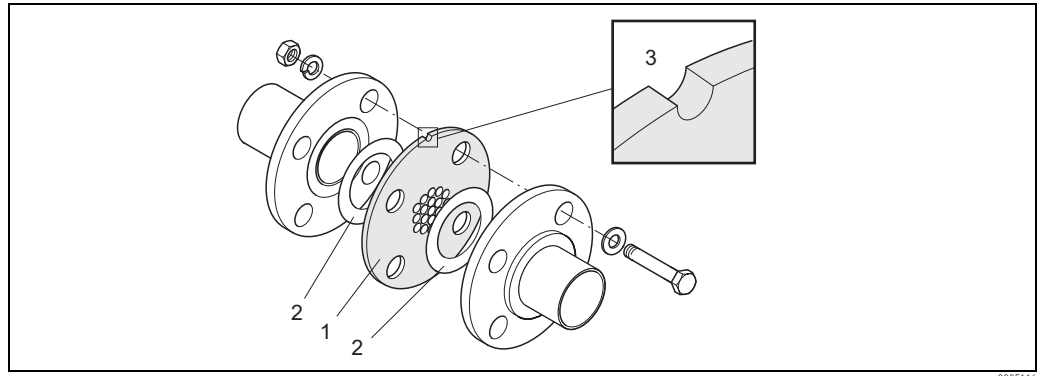


Fig. 8: Flow conditioner mounting arrangement (example)

1 = Perforated plate flow conditioner

2 = Seal/gasket

3 = Notch



Note!

The flow conditioner has a notch to indicate the alignment position (mount vertically).

3.2.7 Flow direction alignment for the flanged version

The arrows on the sides of the sensor housing assembly are pointing in the same direction as the flow.

3.2.8 Flow direction alignment for the insertion version

It is very important that the sensor is aligned correctly with the direction of flow. There are two guidelines for correct alignment:

- The arrows on the sides of the sensor housing assembly are pointing in the same direction as the flow.
- The graduated scale on the insertion tube section should be aligned directly upstream of the flow direction.

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.

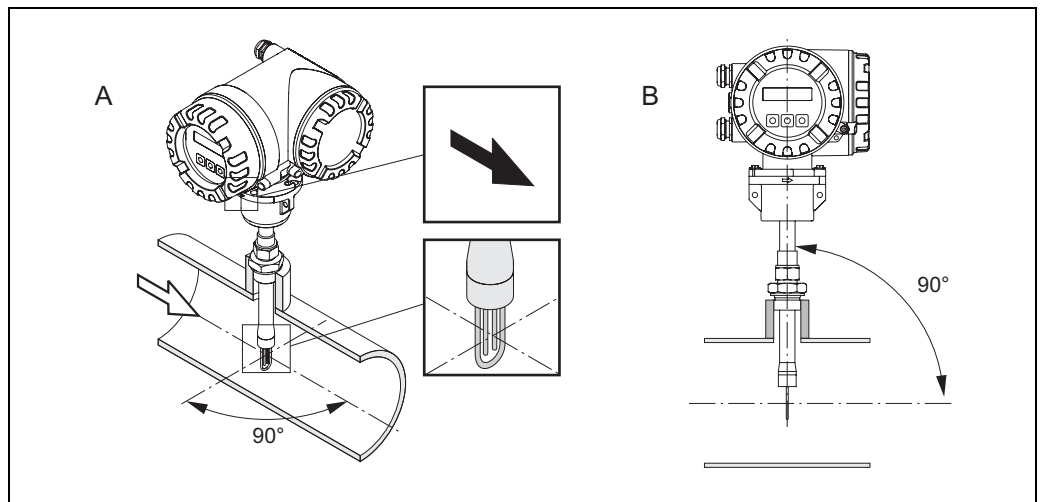


Fig. 9: It is important to keep the 90° degree angle

A = Flow direction alignment

B = Vertical alignment

Vertical alignment

It is important that the sensor mounting boss is welded to the pipe or duct such that the sensor is mounted at 90 degrees to the flow direction. Any deviation from this angle in any plane may cause flow disturbances around the measuring point that could cause errors.



Note!

The thermal sensor cannot differentiate between forward and reverse flow. These guidelines are only to ensure correct installation and alignment.

3.2.9 Insertion depth for the insertion version

Sensor installation - Adjustable insertion sensor

When installing the sensor, the following three dimensions need to be taken into account to allow the correct insertion length to be specified:

- A = Internal diameter of the circular pipe. For a rectangular duct; the duct height if the sensor is to be mounted vertically or duct width if it is to be mounted horizontally
- B = Pipe wall or duct wall thickness
- C = Depth of mounting boss on the pipe or duct, including the sensor compression fitting and cold tap (if used).

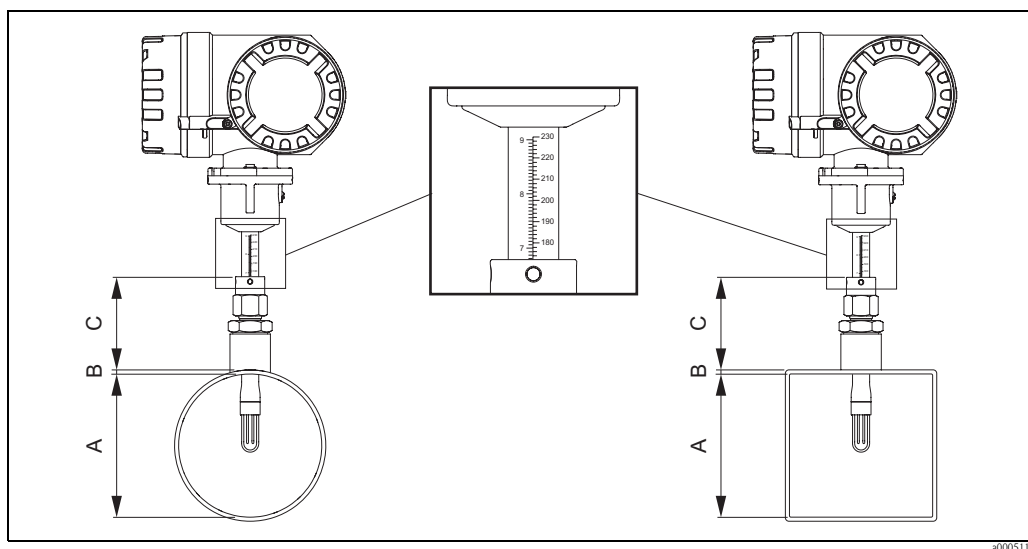


Fig. 10: Dimensions required to calculate the sensor insertion depth

Insertion sensors fitted with an adjustable insertion probe depth (i. e. screwed process connection)

The tube section is supplied with a graduated scale along its length (in millimetres or inches). It is important that the sensor be installed so that the top of the compression fitting is aligned with the value on the scale that is equal to the following calculated value:

For pipe diameter:

- = DN 80 (3"): $(0.3 \times A) + B + C + 2 \text{ mm}$ (0.079 inch)
- $\geq$ DN 100 (4"): $(0.2 \times A) + B + C + 3 \text{ mm}$ (0.12 inch)

For duct width (horizontal installation) or duct height (vertical installation):

- $<$ DN 100 (4"): $(0.3 \times A) + B + C + 2 \text{ mm}$ (0.079 inch)
- $\geq$ DN 100 (4"): $(0.2 \times A) + B + C + 3 \text{ mm}$ (0.12 inch)

When the sensor is at the correct insertion depth the sensor must next be aligned for the correct flow direction detection. After alignment, the compression fitting must be tightened to secure and seal the insertion tube. Tighten the two securing screws.

**Note!**

These mounting guidelines assume that a standard mounting boss provided by Endress+Hauser is being used (see Accessories on Page 66).

**Warning!**

The following tightening tensions for the compression fitting must be observed:

- Locking nut: Hand tight, then 1 ¼ turns with a wrench
- Anti-vibration screws: 5 Nm (3.89 lbf ft)

3.2.10 Low pressure retractable process connection

The insertion sensor can be mounted in a “cold tap” process connection.

Cold Tap

It allows the removal of an insertion sensor from a pipe or duct when the process is stopped and no pressure and extreme temperature are present. Following removal, closure of the isolation valve permits the restarting of the process.

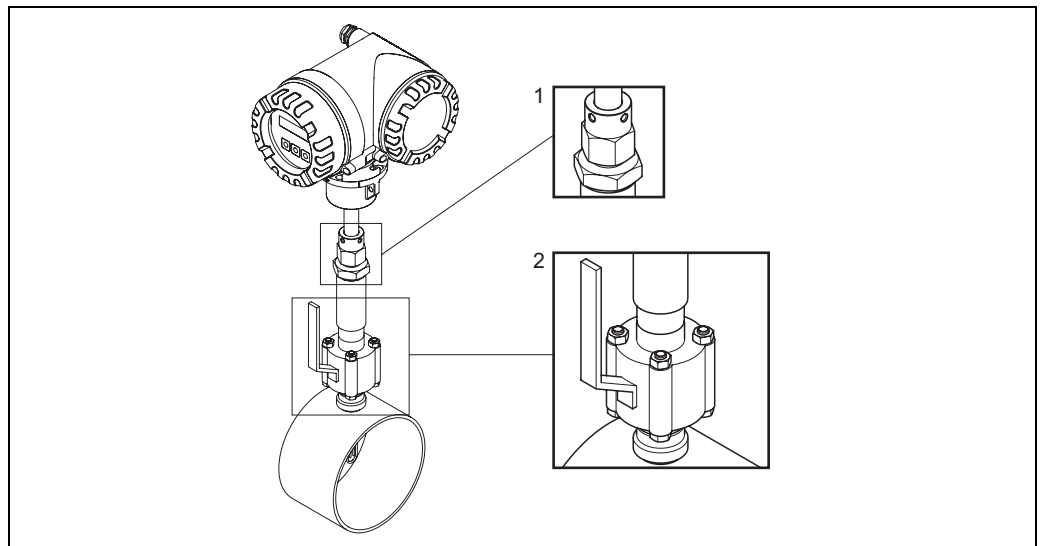


Fig. 11: Cold tap process connection

1 = Compression gland

2 = Isolation valve

a0005119

Installing

The mounting location is determined by the installation requirements for an insertion type sensor. Pay particular attention to mounting orientation and inlet and outlet length. See this chapter for details.



Warning!

Stop the process gas flow and de-pressurize the process line. Purge the line with an inert gas to remove any hazardous or toxic gases. Allow the installation to cool to a safe temperature. Check and verify that this is so before handling any metal parts. Ensure that the process cannot be re-started during the installation procedure.

1. A cut-out of 31.0 mm $\pm$ 0.5 mm (1.22" $\pm$ 0.019") is required for the process fitting. Mark the pipe accordingly and cut the hole with a suitable tool.
2. Finish the edges of the hole to ensure that all burrs are removed and that the required tolerance is met. Remove any particles that may have fallen into the pipe.
3. Insert the process fitting into the pipe (a) and support it such that it is vertically aligned. Weld the fitting to the pipe.
4. Check the integrity of the installation by running a static pressure test. Insert a blanking plug into the screwed fitting end of the tube (b), open the ball valve (c) and apply pressure. Check for leaks and, if necessary, correct the installation fault and repeat static pressure test.

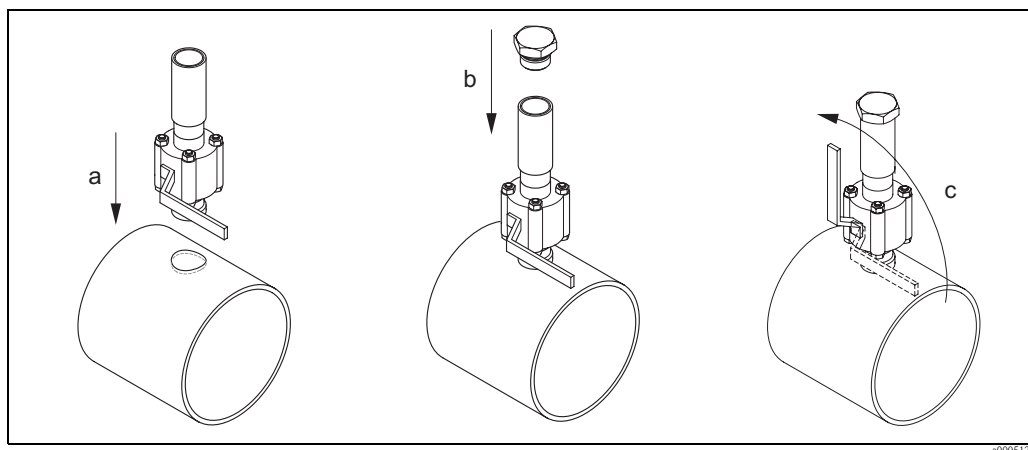


Fig. 12: Mounting the cold tap process connection

5. If this static pressure test passes, de-pressurize the line and the insertion sensor can now be installed. Open the ball valve and insert the sensor tube into the cold tap (d). Screw the compression fitting into the threaded socket and tighten the lower nut with a wrench (e).



Note!

- NPT threads: use thread tape
- G 1 A threads: the provided bonded seal must be fitted
- All threads are right hand (tighten clockwise)

6. Adjust the insertion sensor tube to the correct height ($\rightarrow$ Page 17), ensure correct orientation and tighten the compression fitting upper nut with a wrench (f). Tighten the securing screws (g).
7. Apply process pressure and again do a final check for leaks.

(corresponding graphic see next page)

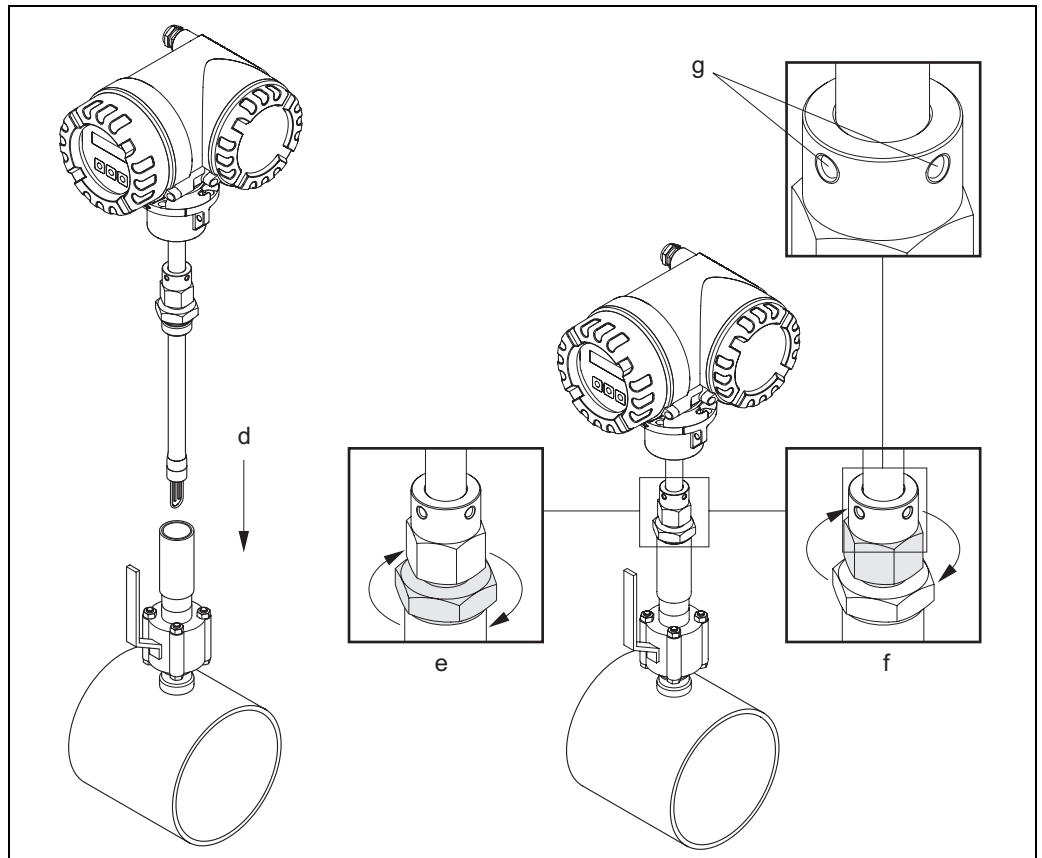


Fig. 13: Mounting the insertion sensor into the cold tap.



Warning!

The following tightening tensions for the compression fitting must be observed:

- Locking nut: Hand tight, then 1¼ turns with a wrench
- Securing screws: 5 Nm (3.89 lbf ft)



Removing

Warning!

- The insertion sensor can only be safely removed at atmospheric conditions.
- Stop the process gas flow and de-pressurize the process line. Purge the line with an inert gas to remove any hazardous or toxic gases. Allow the installation to cool to a safe temperature before handling any metal parts. Check and verify that this is so. Ensure that the process cannot be re-started during the removal procedure.

1. Loosen the securing screws (a).
2. Loosen the upper compression fitting nut with a wrench (b) and then undo the lower compression fitting nut (c).
3. Remove the insertion sensor completely from the cold tap (d).
4. Close the ball valve before re-starting the process (e).

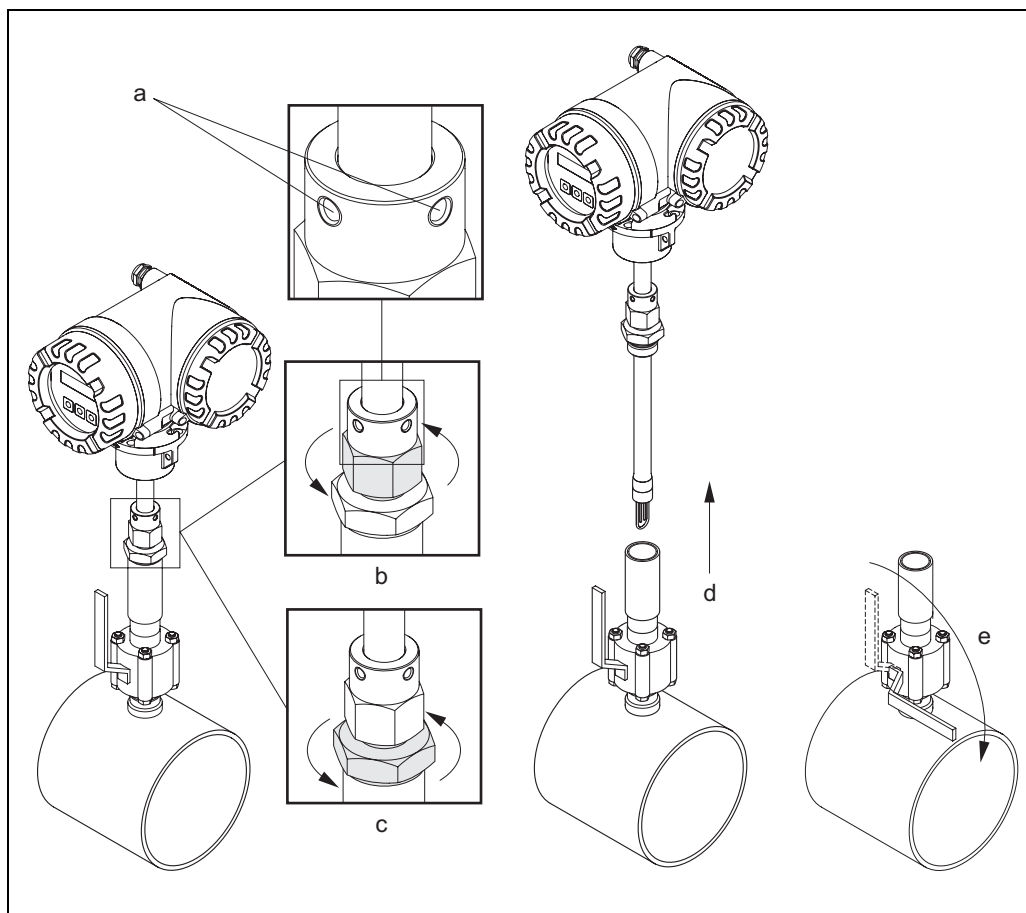


Fig. 14: Removing the insertion sensor from the cold tap.

3.2.11 System pressure

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 thermal measuring device

3.2.12 External pressure compensation

An external pressure compensating via MODBUS communication is useful in cases where:

- Large variations of pressure are likely to occur e.g. 2 to 8 bar (30 to 120 psi) with air applications
- The thermal properties of the gas are likely to vary e.g. Ammonia gas

Transmission of pressure value via MODBUS:

The value of the process pressure can be transmitted via MODBUS communication to the measuring device. See Description of Device Functions manual, PROCESS PRESSURE function, for more information.



Note!

- A pressure transmitter with an absolute pressure range must be used.
- In-situ calibration is not possible if an external pressure compensation is being used.
In-situ calibration writes a new calibration curve at the actual process condition, pressure compensation is disabled.

3.2.13 Temperature range

The following requirements and limits must be observed:

- It is recommended to install the sensor out of any direct sunlight or away from any extremes of temperature.
- The maximum approved ambient and process temperatures (see Page 89 ff.)
- Instructions on heating and thermal insulation (see Page 23 ff.)

3.2.14 Heating

Some gases require suitable measures to avoid loss of heat at the sensor and therefore condensation. Heating can be electric, e. g. with heated elements, or by means of hot water or steam pipes.



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.
- When using electrical heat tracing whose heat is regulated using phase control or by pulse packs, it cannot be ruled out that the measured values are influenced by magnetic fields which may occur (i. e. at values greater than those permitted by the EC standard minus 30 A/m). In such cases, the sensor must be magnetically screened.

3.2.15 Thermal insulation

When the gas is very humid or saturated with water (eg. Bio Gas) the pipeline and flowmeter body should be insulated to prevent water droplets condensing on the pipe wall and/or flow transducer. In extreme cases of moisture and temperature variation, it may be advisable to provide trace heating of the pipework and/or sensor body.

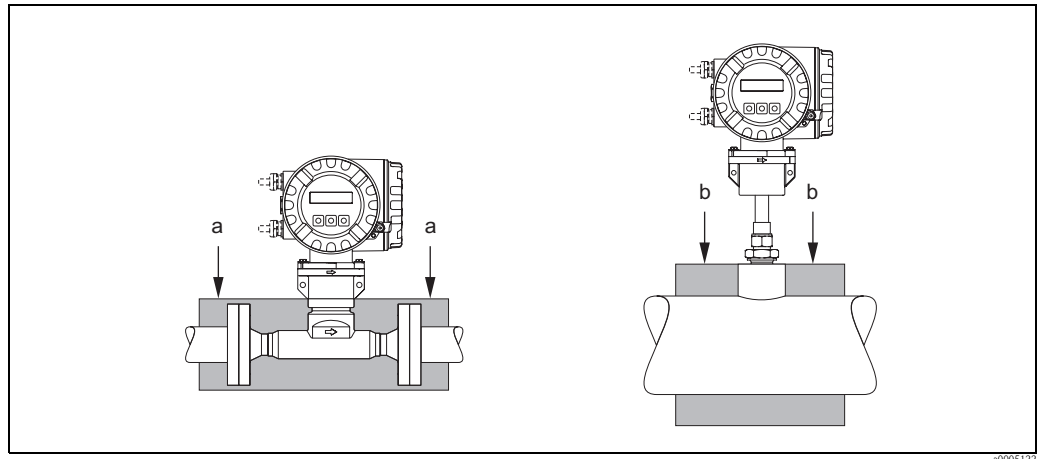


Fig. 15: Maximum thermal insulation for t-mass 65F and 65I

a = Maximum insulation height for the flanged version

b = Maximum insulation height for the insertion version

3.2.16 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 → Page 89.

3.3 Installation instructions

3.3.1 Turning the transmitter housing

Turning the aluminium field housing



Warning!

The rotating mechanism for devices for hazardous areas Zone 1 (ATEX) 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.

1. Loosen the two securing screws.
2. Turn the bayonet catch as far as it will go.
3. Carefully lift the transmitter housing as far as it will go.
4. Turn the transmitter housing to the desired position (max. 2 x 90° in either direction).
5. Lower the housing into position and re-engage the bayonet catch.
6. Retighten the two securing screws (only Endress+Hauser screws to be used).

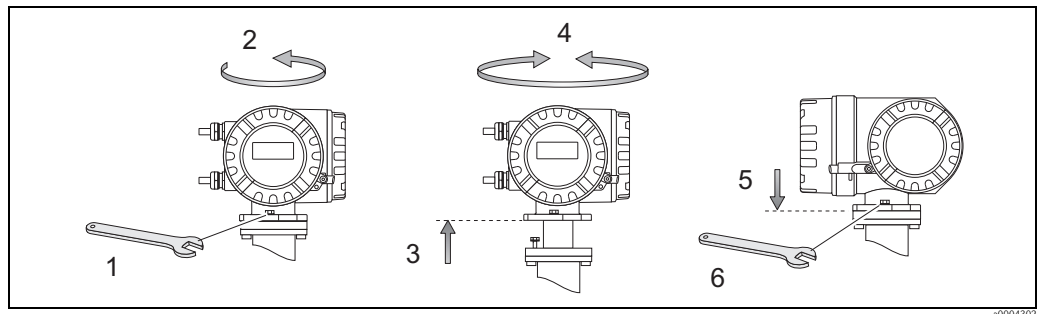


Fig. 16: Turning the transmitter housing (aluminium field housing)

3.3.2 Installing the wall-mount transmitter housing

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

- Mounted directly on the wall → Page 26
- Installation in control panel → Page 26 (separate mounting set, accessories → Page 66)
- Pipe mounting → Page 27 (separate mounting set, accessories → Page 66)

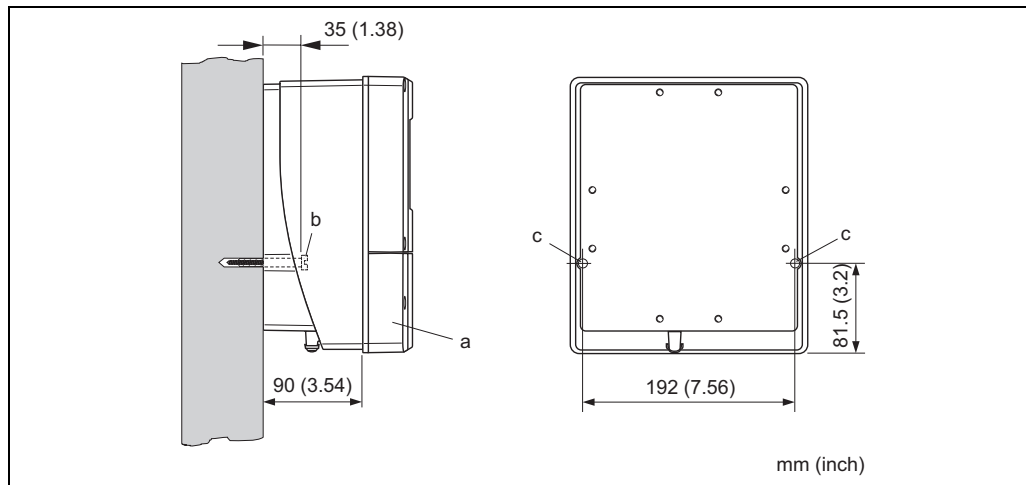


Caution!

- Make sure that ambient temperature does not go beyond the permissible range of – 20 °C to +60 °C (–2 °F to +140 °F), optional – 40 °C to +60 °C (–40 °F to +140 °F). Install the device in a shaded location. Avoid direct sunlight.
- Always install the wall-mount housing in such a way that the cable entries are pointing down.

Mounted directly on the wall

1. Drill the holes as illustrated in the diagram.
2. Remove the cover of the connection compartment (a).
3. Push the two securing screws (b) through the appropriate bores (c) in the housing.
 - Securing screws (M6): max. $\varnothing$ 6.5 mm (0.25 inch)
 - Screw head: max. $\varnothing$ 10.5 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.

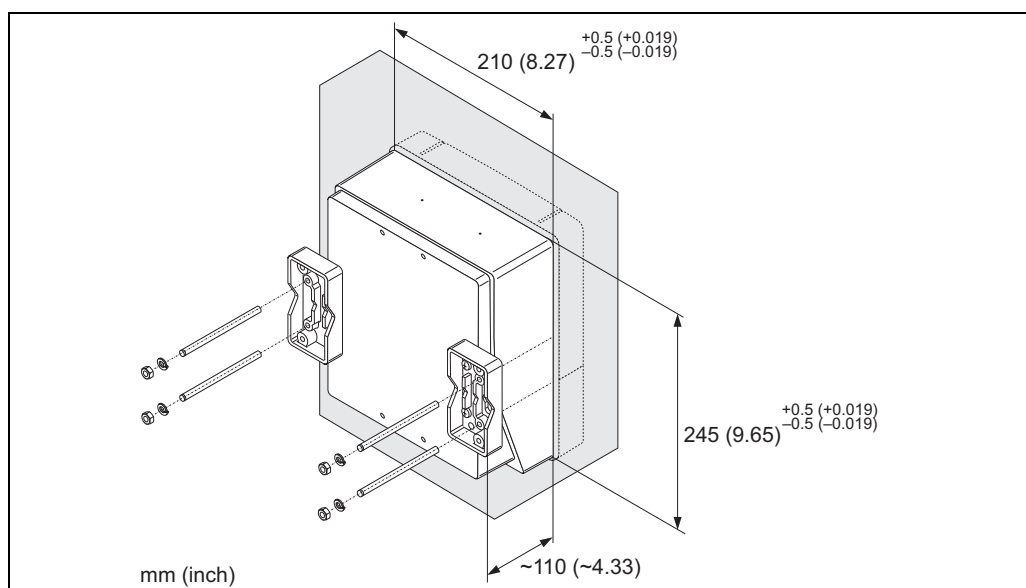


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Fig. 17: Mounted directly on the wall

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.



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Fig. 18: 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).

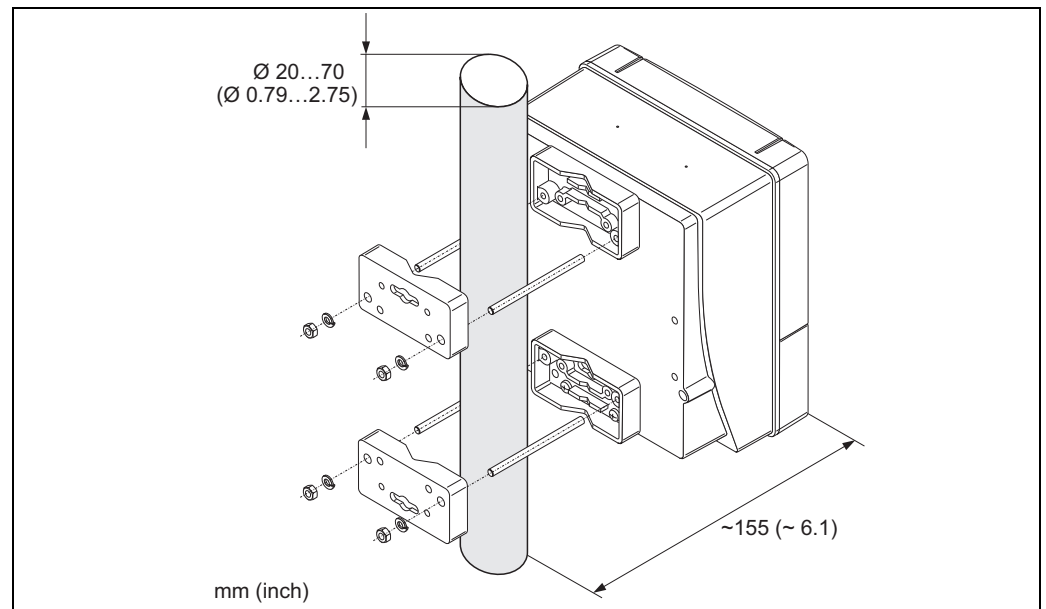


Fig. 19: Pipe mounting (wall-mount housing)

3.3.3 Turning the local display

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

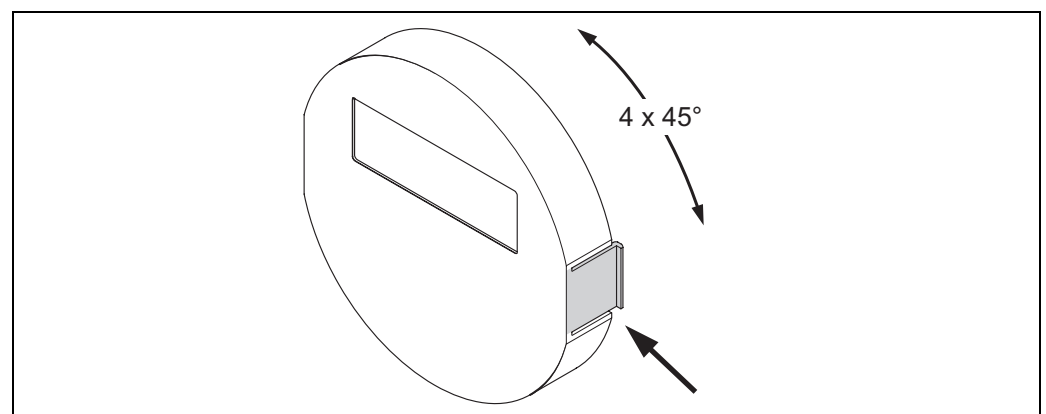


Fig. 20: Turning the local display (field housing)

3.4 Post-installation check

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

Device condition and specifications	Notes
Is the device damaged (visual inspection)?	–
Does the device correspond to specifications at the measuring point, including process temperature and pressure, ambient temperature, measuring range, etc.? Check the name plate.	→ Page 88 ff.
Installation	Notes
Correct alignment of pipe/gasket/flowmeter body?	→ Page 12
Correct pipe internal diameter and surface finish/quality?	→ Page 12
Is the orientation chosen for the sensor correct, in other words suitable for sensor type, fluid properties and fluid temperature?	→ Page 13
Is there sufficient upstream and downstream length from the measurement point?	→ Page 14 ff.
Correct installation of flow conditioner (if fitted)?	→ Page 16 ff.
Does the arrow on the sensor nameplate match the direction of flow through the pipe?	→ Page 17
Correct insertion sensor depth (insertion version only)?	→ Page 18
Process environment / process conditions	Notes
Is the measuring device protected against moisture and direct sunlight?	–
Is the measuring device protected against overheating?	→ Page 23
Is the measuring device protected against excessive vibration?	→ Page 24, 89
Check gas conditions (e. g. purity, dryness, cleanliness)	–

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.

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	$\leq 110 \Omega/\text{km}$
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!

- 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.

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 (cable cross-section: max. 2.5 mm² / AWG 13).
3. Establish the connections between sensor and transmitter in accordance with the wiring diagram:
 - See Fig. 21
 - See wiring diagram in screw cap
4. Screw the connection compartment cover back onto the sensor and transmitter housing.

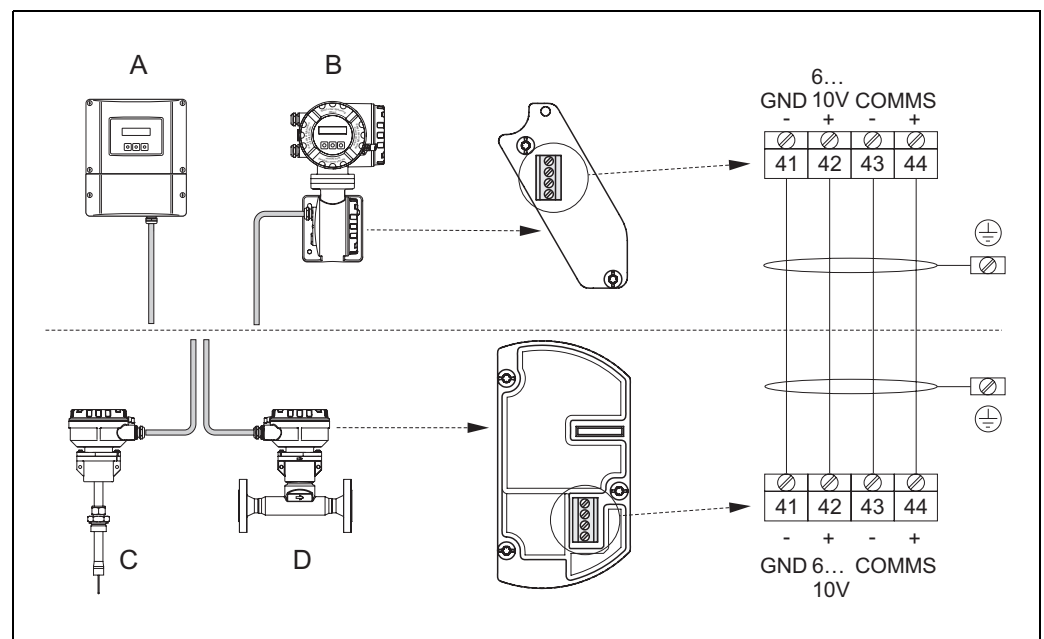


Fig. 21: Connecting the remote version

- A Wallmount housing; Non-hazardous area and zone 2 (ATEX II3G, FM/CSA Cl. I Div. 2)
 B Field housing; Zone 1 (ATEX II2G, FM/CSA Cl. I Div. 1)
 C Remote sensor insertion version
 D Remote sensor flanged version

Wire colors (when supplied by Endress+Hauser):

Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow (color code according to DIN 47100)



Warning!

Do not provide a separate power supply to the remote sensor.
The power supply must be provided by the transmitter.

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 x 2 x 0.5 mm² (AWG 20) PVC cable with common shield (2 twisted pairs)
- Conductor resistance: $\leq 40 \Omega/\text{km}$ [$\leq 131.2 \Omega/1000 \text{ ft}$]
- 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
→ Page 88.

4.3 Connecting the measuring unit



Note!

The electrical characteristic quantities are listed in the "Technical data" section.

4.3.1 Terminal assignment

Order variant	Terminal No. (inputs/outputs)							
	20 (+)	21 (-)	22 (+)	23 (-)	24 (+)	25 (-)	26 (+)	27 (-)
65F*.....Q	—	—	—	—	Status input		B	A
65L*.....Q							MODBUS RS485 A = Rx/D/TxD-N B = Rx/D/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 → Page 33
 - Terminal assignment → see above



Caution!

- Risk of damage to the fieldbus cable!
Observe the information about shielding and grounding the fieldbus cable → Page 30.
- 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

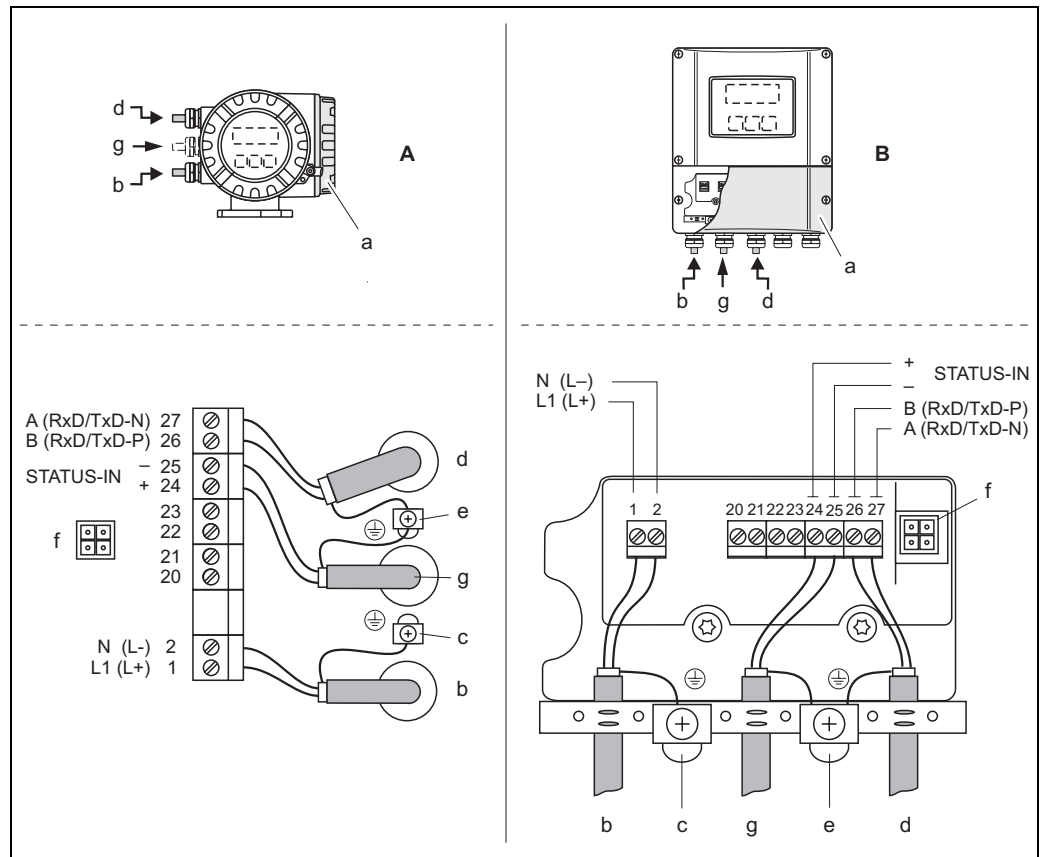


Fig. 22: Connecting the transmitter, cable cross-section: max. 2.5 mm² (AWG 13)

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 → Page 30

– 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 (ToF Tool - Fieldtool Package or Fieldcheck)

g Signal cable: see Terminal assignment → Page 32

4.4 Degree of protection

The devices fulfill all the requirements for IP 67.

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

- The housing seals must be clean and undamaged when inserted into their grooves.
The seals must be dried, cleaned or replaced if necessary.
- All threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter, see Page 88 (Cable entry)
- Firmly tighten the cable entries.
- The cables must loop down before they enter the cable entries ("water trap").
This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

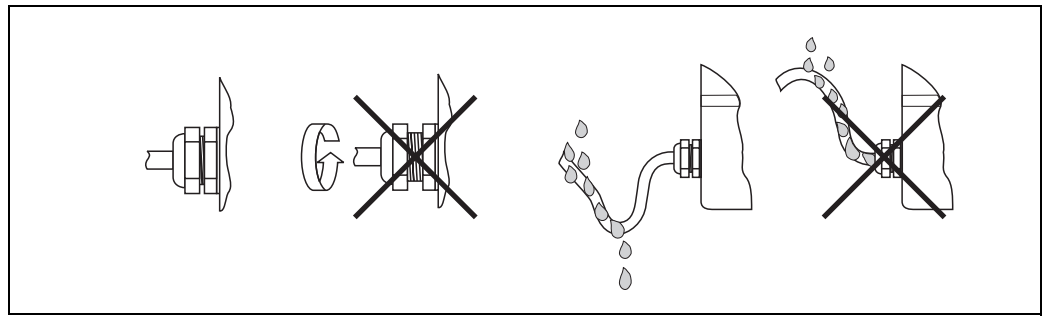


Fig. 23: Installation instructions, cable entries



Caution!

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

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 → Page 29 Connecting cable → Page 32
Do the cables have adequate strain relief?	-
Cables correctly segregated by type? Without loops and crossovers?	-
Are the power supply, fieldbus and signal cables correctly connected?	→ Page 33 or see the wiring diagram inside the cover of the terminal compartment
Are all screw terminals firmly tightened?	-
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ Page 34
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?	→ Page 56
Has the max. length of the fieldbus cable been observed in accordance with the MODBUS RS485 specifications?	→ Page 29
Has the max. length of the spurs been observed in accordance with the MODBUS RS485 specifications?	→ Page 29
Is the fieldbus cable fully shielded and correctly grounded?	→ Page 30

5 Operation

5.1 Quick operation guide

The user has a number of options for configuring and commissioning the device:

1. **Local display (option)** → Page 37
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** → Page 53
Operation via:
 - ToF Tool – Fieldtool Package
 - 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

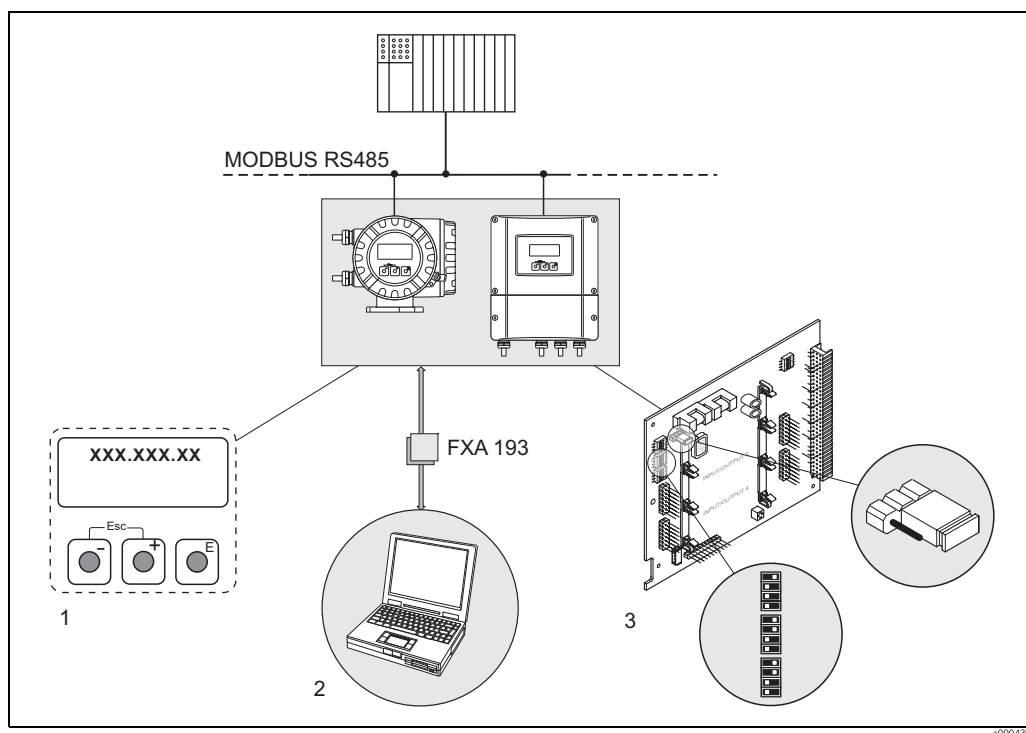


Fig. 24: Methods of operating MODBUS RS485 devices

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

5.2 Local display

5.2.1 Display and operating elements

The local display enables you to read 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

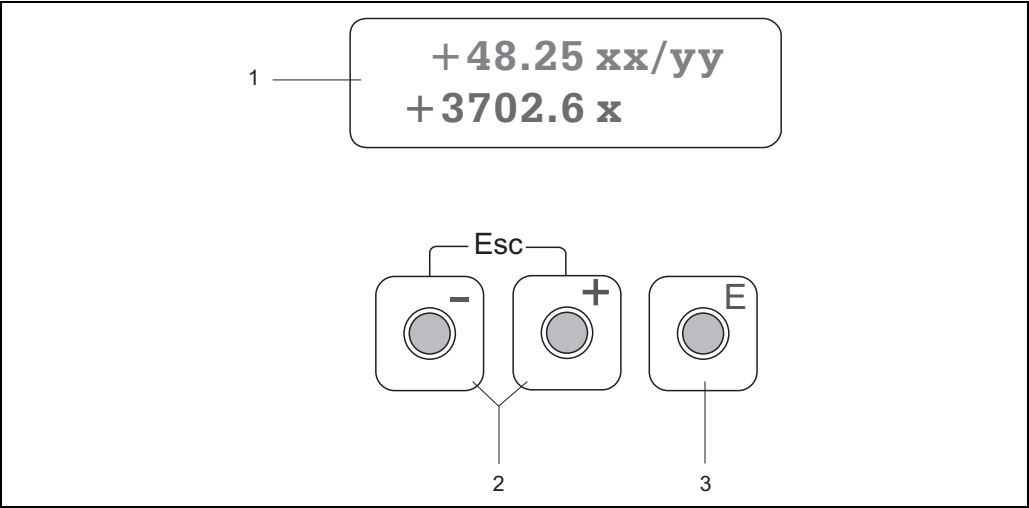


Fig. 25: Display and operating elements

- 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 Plus/minus 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

5.2.2 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.

Icons	Meaning
S	System error
!	Notice message
P	Process error
⚡	Fault message
	MODBUS communication active

5.3 Brief operating instructions to the function matrix



Note!

- See the general notes → Page 39.
 - 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. OPERATION)
 3. Select a function (e.g. LANGUAGE)
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

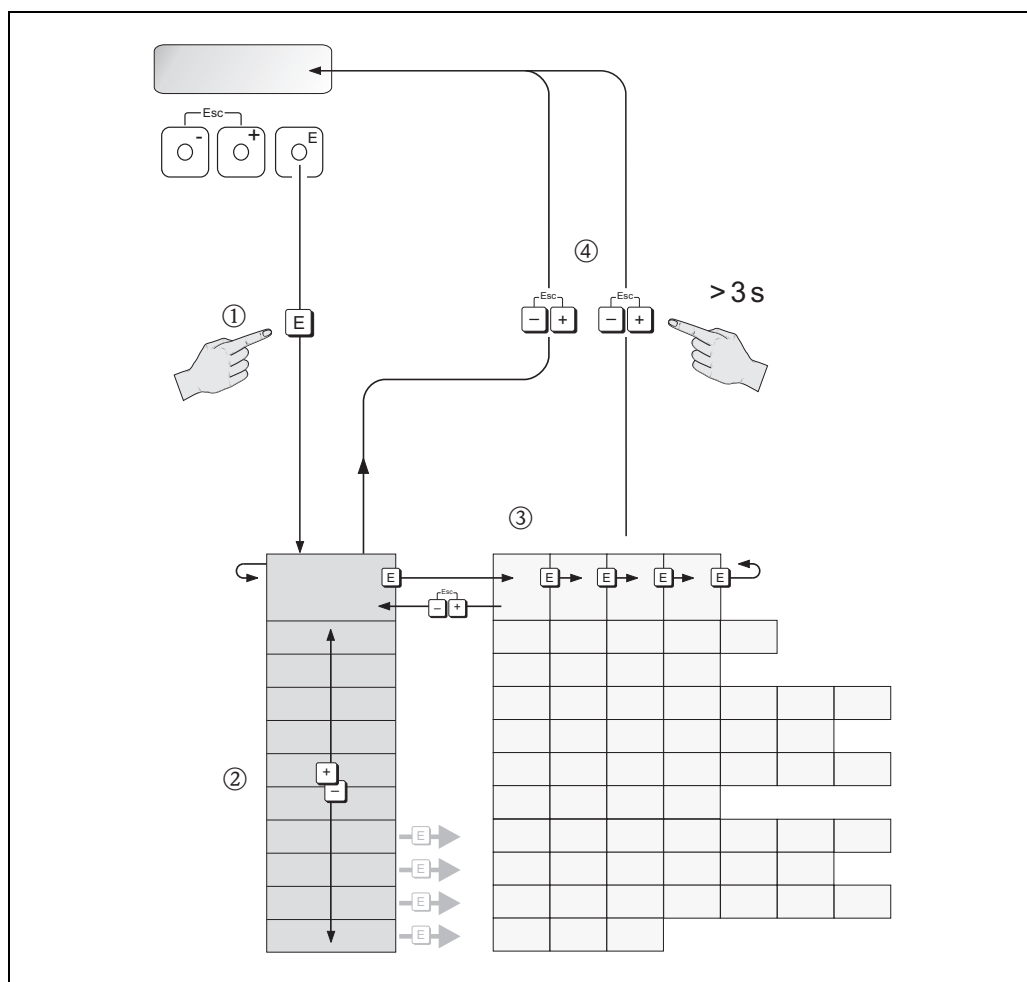


Fig. 26: Selecting functions and configuring parameters (function matrix)

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. → Page 37
- 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, i.e. the current measured values are output via the signal outputs in the normal way.
- If the power supply fails all preset and parameterised values remain safely stored in the EEPROM.
- However, some functions may be affected (i. e. data/values not saved) if the power supply is interrupted during editing or operation of those functions. More details are contained in the “Description of Device Functions” manual, BA116D/06/en/... .

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 unauthorised 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. → Page 70 ff..
- **Process error:** This group includes all application errors, e.g. flow limit, etc. → Page 74 ff..

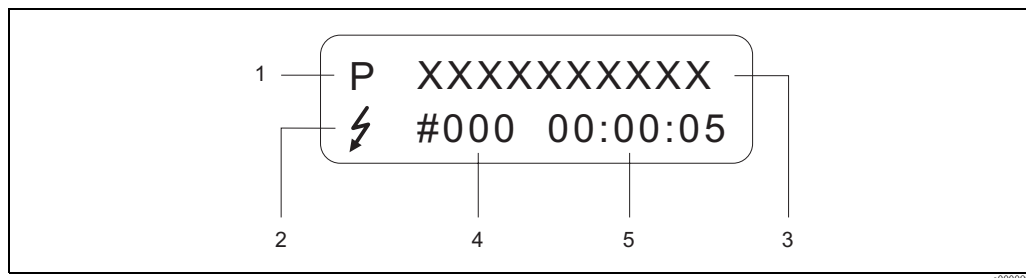


Fig 27: Error messages on the display (example)

- 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

The measuring system always assigns system and process errors which occur to two types of error messages (**fault** or **notice messages**) resulting in different weightings → Page 69 ff.

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

Notice message (!)

- Displayed as → Exclamation mark (!), error designation (S: system error, P: process error).
- The error in question has no effect on the current operation.
- MODBUS communication device status display, fault display → Page 70 ff.

Fault message (⚡)

- Displayed as → Lightning flash (⚡), error designation (S: system error, P: process error).
- The error in question interrupts or stops the current operation.
- MODBUS communication device status display, fault display → Page 70 ff.

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.

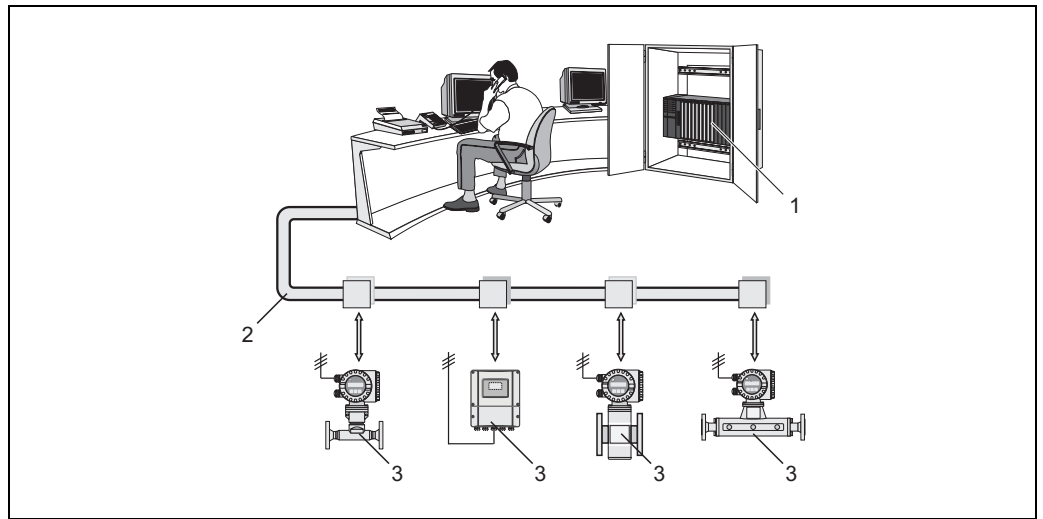


Fig. 28: MODBUS RS485 system architecture

- 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).

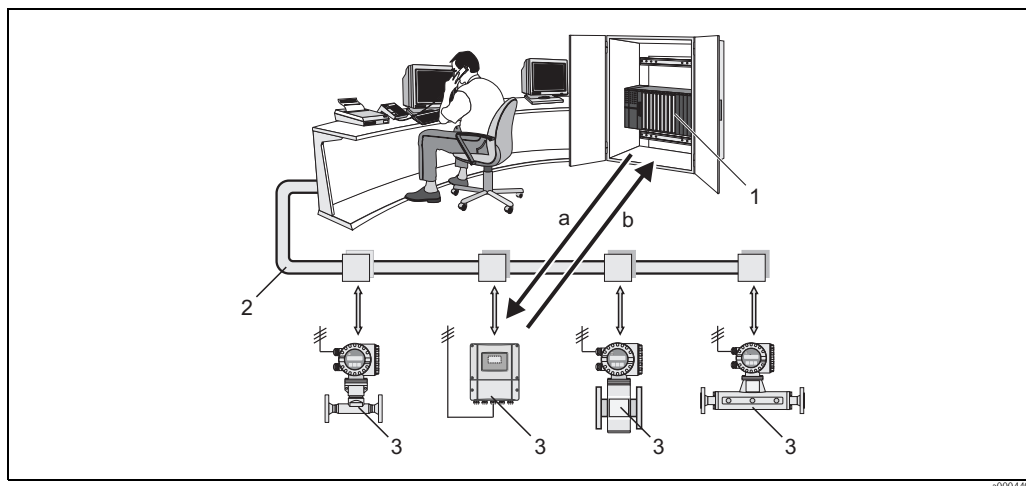


Fig. 29: MODBUS RS485 polling data traffic

- 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.

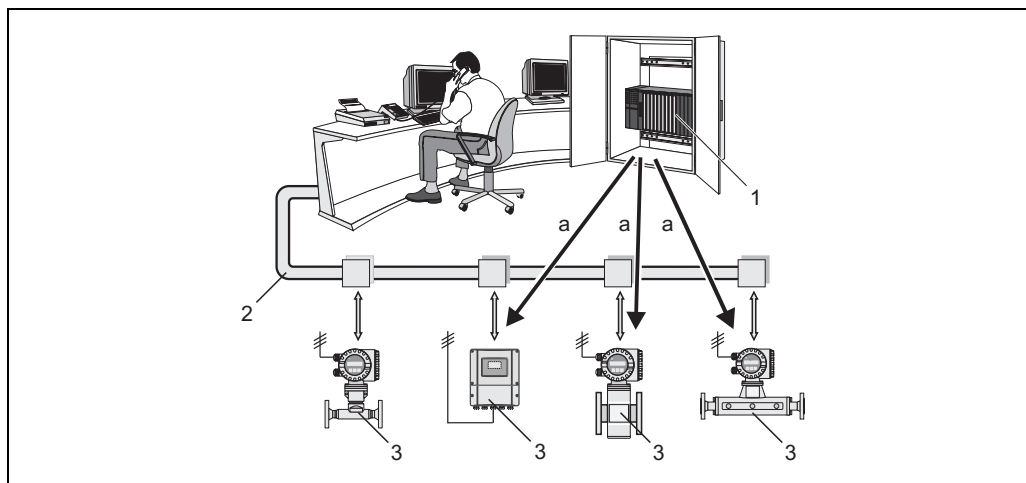


Fig. 30: MODBUS RS485 polling data traffic

- 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 → Page 44

■ 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: ■ 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.

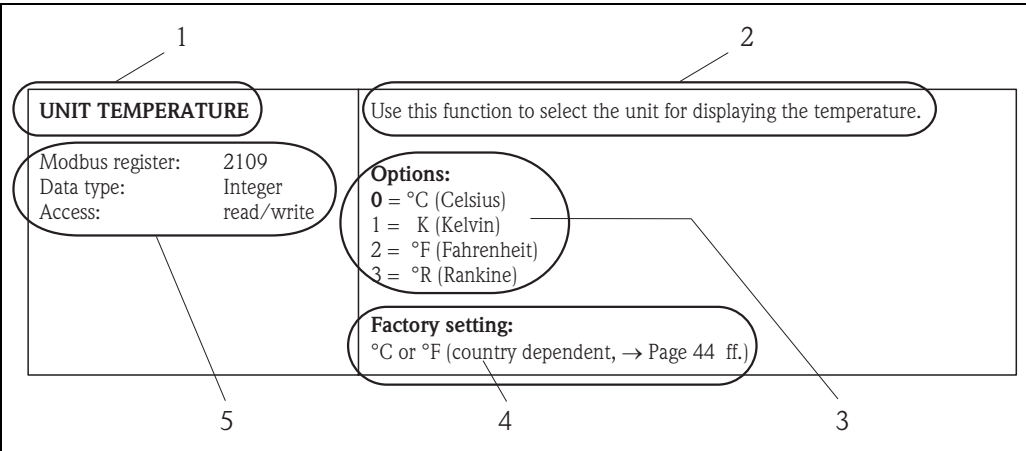


Fig. 31: Example of how a function description is illustrated in the “Description of Device Functions” manual

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 → Page 44.
02	ILLEGAL_DATA_ADDRESS The register addressed by the master is not assigned (i.e. it does not exist) or the length of the requested data is too big.
03	ILLEGAL_DATA_VALUE ■ The master is attempting to write to a register which only allows read access. ■ The value that appears in the data field is not permitted, e.g. range limits 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 (e.g. ToF Tool - Fieldtool Package or 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

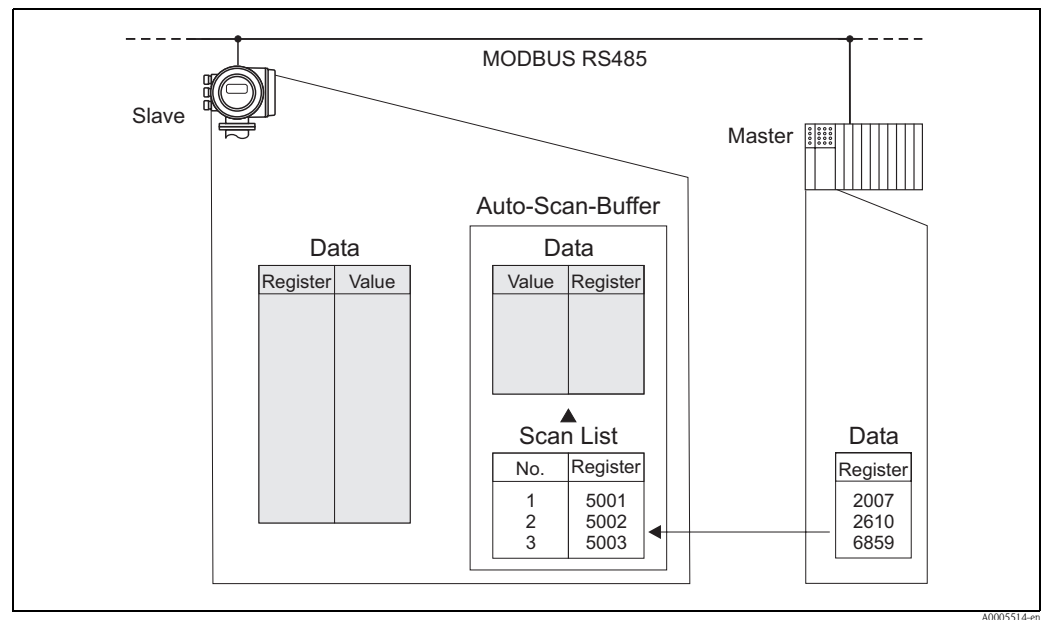


Fig. 32: Configuration of the scan list via the MODBUS master

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

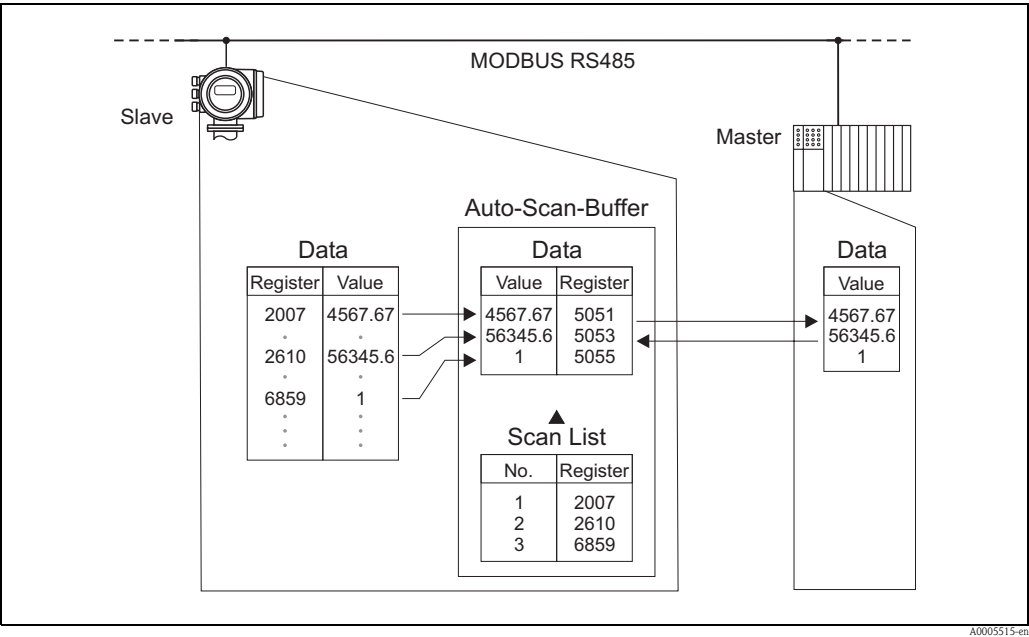


Fig. 33: With just one request telegram, the MODBUS master reads out the measured values via the auto-scan buffer of the measuring device.

5.6 Operating options

For the complete operation of the measuring device there are device drivers available to the user to provide the following operating programs:

5.6.1 Operating program “ToF Tool – Fieldtool Package”

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

Contents of the “ToF Tool – Fieldtool Package”:

- Commissioning, maintenance analysis
- Configuring flowmeters
- Service functions
- Visualization of process data
- Trouble-shooting
- Reading out the verification data and updating the software of the “Fieldcheck” flow simulator

5.6.2 Operating program “FieldCare”

FieldCare is Endress+Hauser’s FDT-based plant Asset Management Tool and allows the configuration and diagnosis of intelligent field devices. By using status information, you also have a simple but effective tool for monitoring devices. The Proline flowmeters are accessed via the service interface FXA 193.

5.6.3 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: 3.02.XX Software release: 12.2005		→ “DEVICE SOFTWARE” function
Operating program/Device drivers:	How to acquire:	
ToF Tool – Fieldtool Package	■ www.tof-fieldtool.endress.com ■ Update CD-ROM (Endress+Hauser order number: 50099820)	
FieldCare/DTM	■ www.endress.com (→ Download → Software → Device Drivers) ■ CD-ROM (Endress+Hauser order number 56004088)	

Tester/simulator:

Device:	How to acquire:
Fieldcheck	■ Update by means of ToF Tool – Fieldtool Package via Fieldflash module



Note!

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

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 → Page 78
3. Configure the hardware write protection accordingly with the aid of the jumpers (see Figure).
4. Installation is the reverse of the removal procedure.

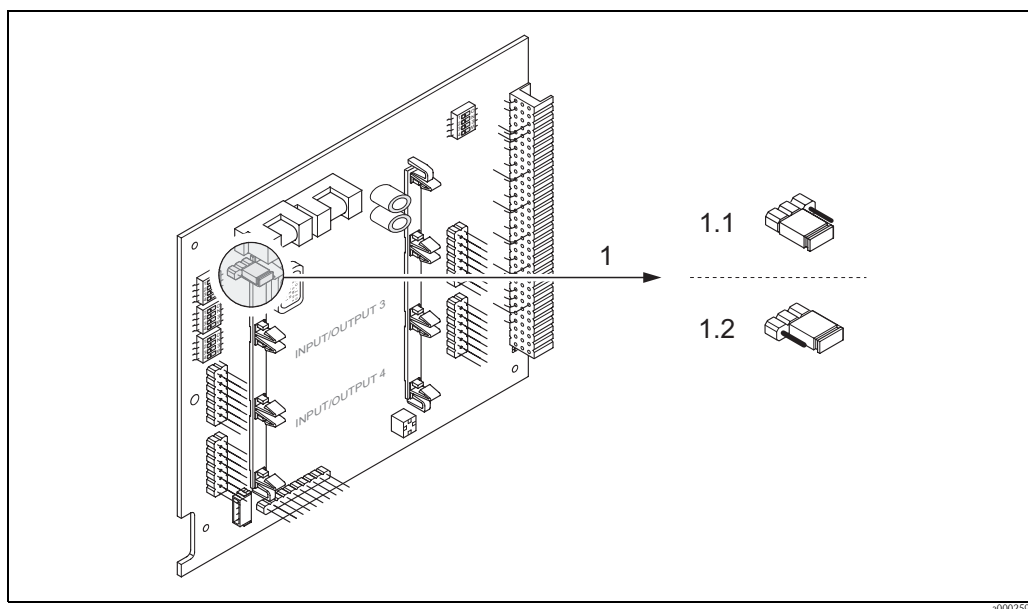


Fig. 34: Switching write protection on and off with the aid of a jumper on the I/O board

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

Addressing via local operation

More detailed explanations for addressing the measuring device via the local display → Page 60

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.

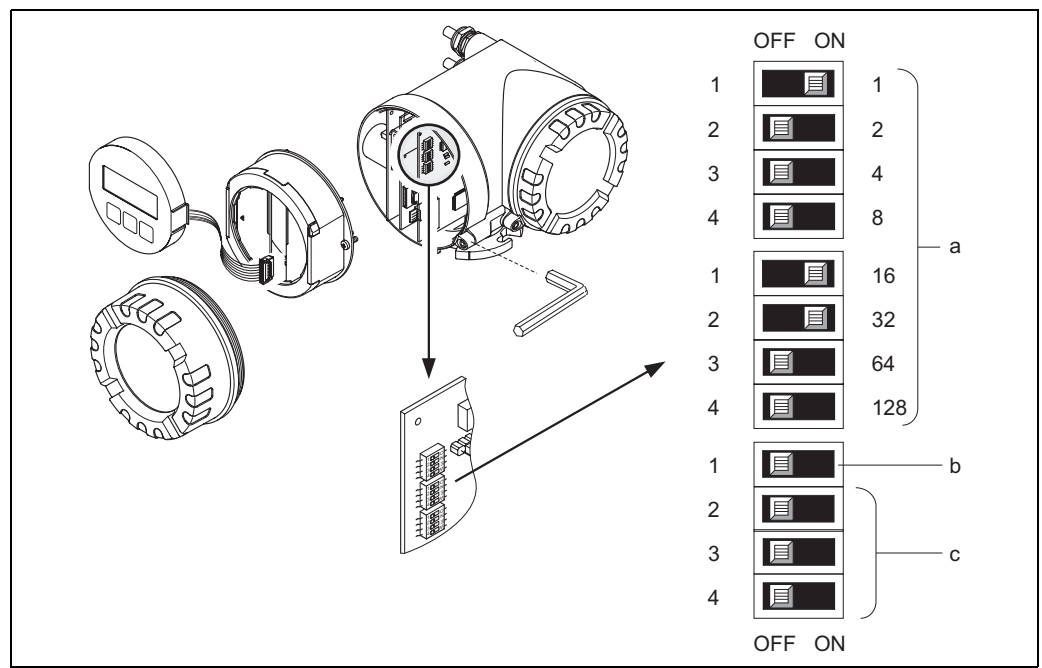


Fig. 35: Addressing with the aid of miniature switches on the I/O board

- a Miniature switches for setting the device address (illustrated: $1 + 16 + 32 = \text{device address } 49$)
- 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):

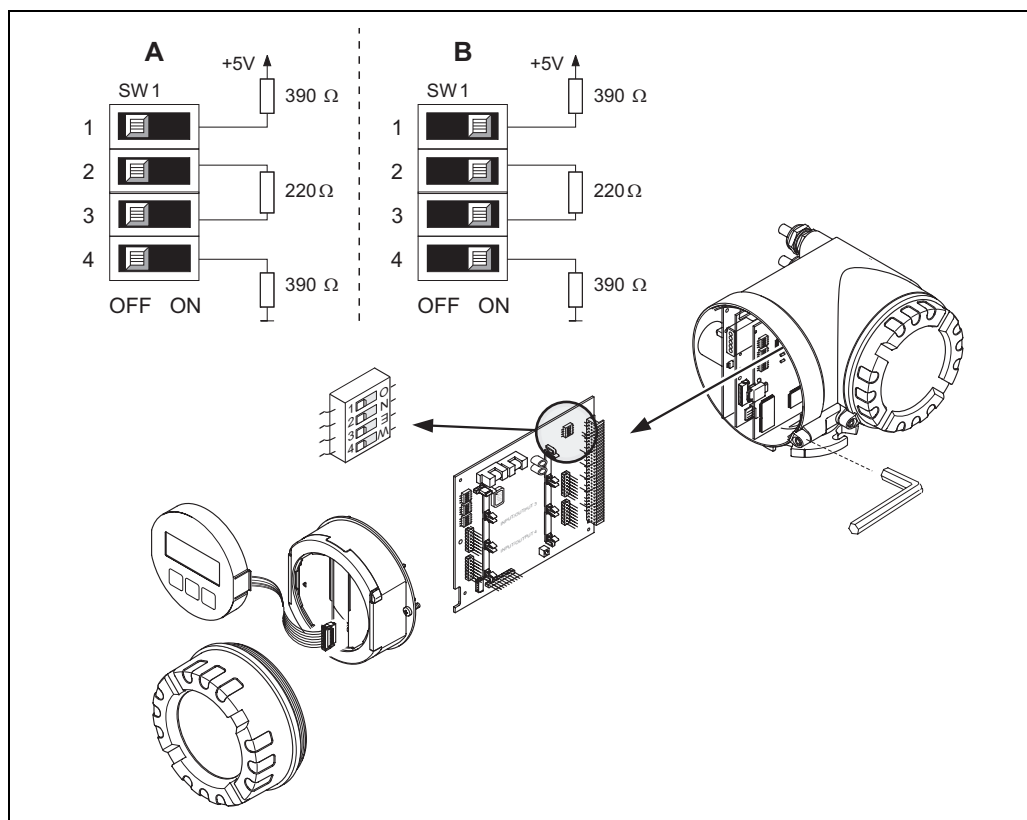


Fig. 36: Configuring the terminating resistors

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

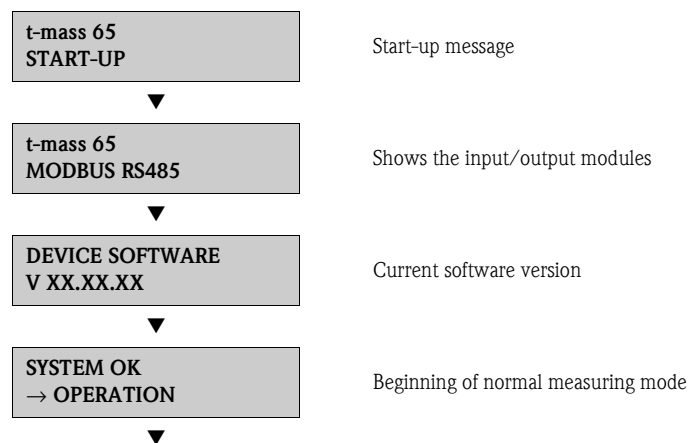
Make sure that all final checks have been completed before you start up your measuring point:

- Checklist for “Post-installation check” → Page 28
- Checklist for “Post-connection check” → Page 35

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

6.3.1 Quick Setup “Commissioning”

If the device is equipped with a local display, the Commissioning Quick Setup menu can be used to configure all the important device parameters for standard measuring quickly and easily. In the case of measuring devices without a local display, the individual parameters and functions must be configured by means of a operating program, (ToF Tool - Fieldtool Package, FieldCare).

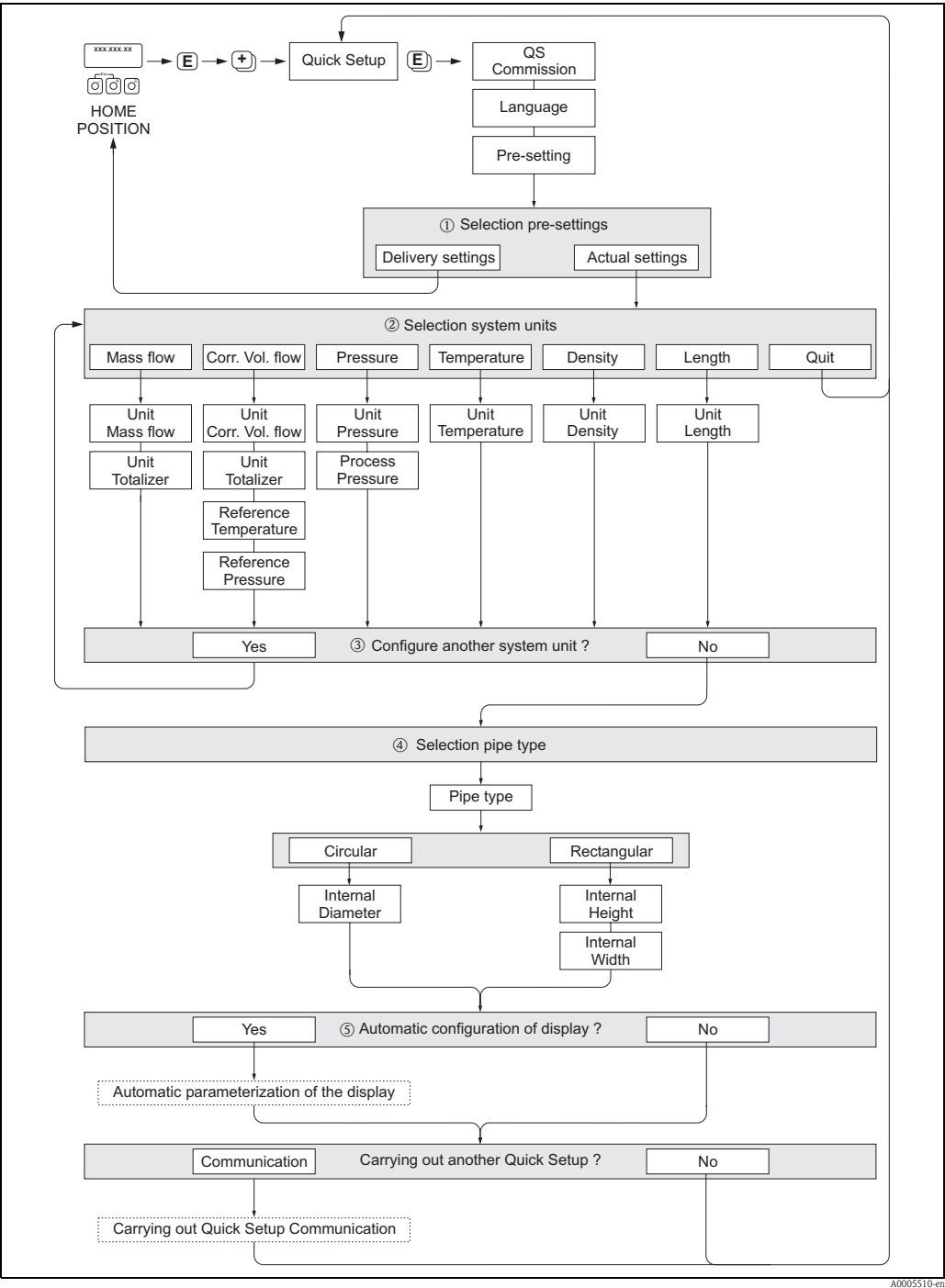


Fig. 37: Quick Setup Commissioning



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

QUICK SETUP - COMMISSION

Use the $\boxed{+}$ or $\boxed{-}$ key at the prompt “QS-COMMISSION NO” and the device access code entry appears. Enter the device access code “65” and press $\boxed{E}$; programming is enabled. The prompt “QS-COMMISSION NO” appears. Use the $\boxed{+}$ or $\boxed{-}$ key to change “NO” to “YES” and press $\boxed{E}$.

LANGUAGE

Use the $\boxed{+}$ or $\boxed{-}$ key to select the required language and continue with $\boxed{E}$.

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.

PIPE TYPE

- ④ Select the type of pipe for setting up the insertion sensor.
- Select CIRCULAR for round pipes or RECTANGULAR for duct systems.
- Use internal dimensions only.

Automatic configuration of the display

⑤ The “automatic parameterization of the display” option contains the following basic settings/factory settings.

- YES: main line = MASS FLOW, additional line = TOTALIZER 1.
- NO: The existing (selected) settings remain.

The Quick Setup is now complete.



Note!

- The PIPE TYPE function is only available if an insertion type sensor is in use.
- For more information, see function group SENSOR DATA (see “Description of Device Functions” manual, BA116D/06/...).
- The gas process pressure must be entered for all device types in the function PROCESS PRESSURE except in case of an external pressure compensation via MODBUS communication being used. For more information, see function group PROCESS PARAMETERS (see “Description of Device Functions” manual, BA116D/06/...).

① – ⑤: see previous page

6.3.2 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.

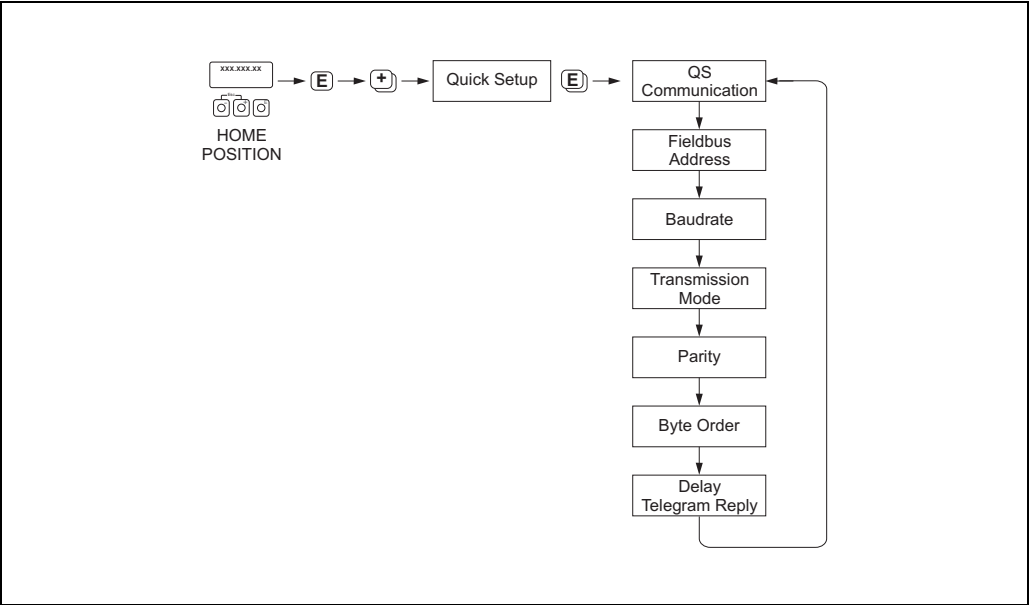


Fig. 38: Quick Setup communication



Note!
The parameters described in the following table can be found in the function group COMMUNICATION (see “Description of Device Functions” manual, BA116D/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  Note! The transmission sequence must suit the MODBUS Master.
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
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

6.3.3 Data back-up with T-DAT SAVE/LOAD function

The T-DAT SAVE/LOAD function can be used to store all the settings and parameters of the device to the HistoROM/T-DAT data storage device.

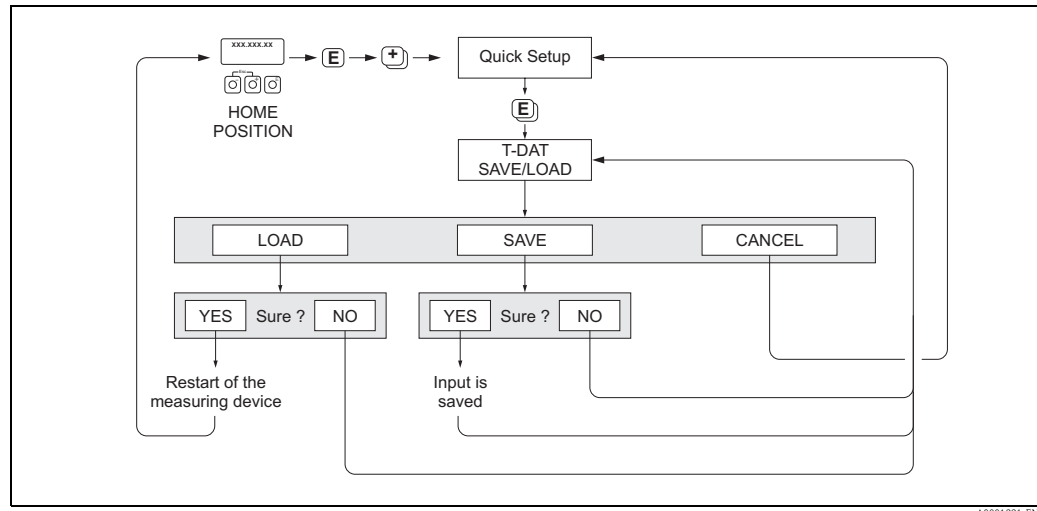


Fig. 39: Data back-up with T-DAT SAVE/LOAD function

A0001221-EN

Accessing T-DAT function

The T-DAT SAVE/LOAD function is accessed via the QUICK SETUP function.

- Press [E] until the prompt “QS-COMMISSION NO” appears.
- Press [E] until “QS-COMMUNICATION NO” appears.
- Press [E] and the prompt “T-DAT SAVE/LOAD CANCEL” appears.
- Press [+] or [-] key and the device access code entry appears.
- Enter the device access code “65” and Press [E]; programming is enabled
- Use [+] or [-] key to select the following options:
 - LOAD
Data on the HistoROM/T-DAT data storage device are copied to the device memory (EEROM). This overwrites any settings and parameters of the device. The measuring device is restarted.
 - SAVE
Settings and parameters are copied from the device memory (EEPROM) to the HistoROM/T-DAT.
 - CANCEL
Cancels the option selection and returns you to the higher selection level.

Application examples

- After commissioning, the current measuring point parameters can be saved to the HistoROM/T-DAT as a backup.
- If the transmitter is replaced for some reason, the data from the HistoROM/T-DAT can be loaded into the new transmitter-EEPROM.



Note!

- If the target device has an older software version, the message #042 “TRANSM.SW-DAT” is displayed during startup. Then only the SAVE option is available.
- LOAD → This option is only possible if the target device has the same software version as, or a more recent software version than, the source device
- SAVE → This option is always available.

6.4 Adjustment

6.4.1 Zero point adjustment

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. Consequently, the zero point adjustment is generally not necessary for t-mass!

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 also with very small flow rates.
- Under process or operating conditions where the gas properties differ strongly from air properties 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.
- 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 → valve 1 open / valve 2 closed
 - Zero point adjustment → valve 1 closed / valve 2 open

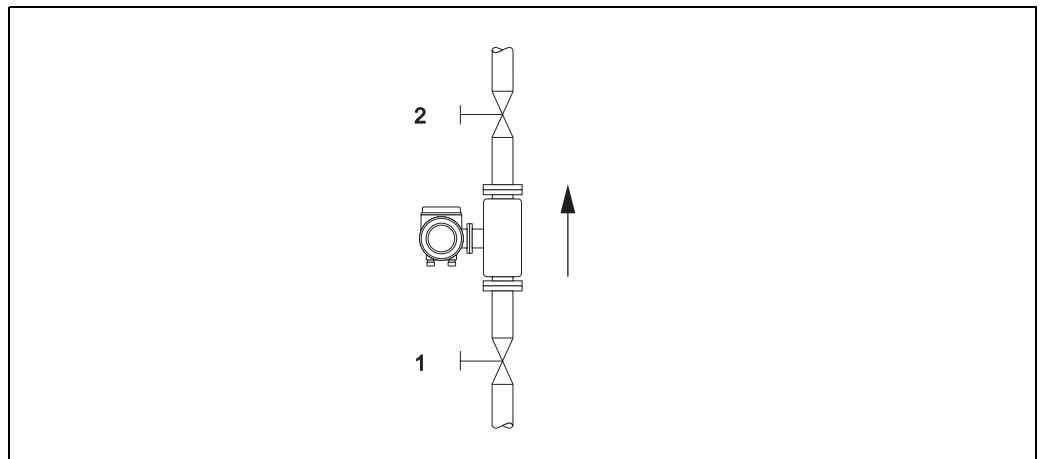


Fig. 40: Zero point adjustment and shut-off valves



Note!

You can view the currently valid zero point value using the ZERO POINT function in the SENSOR DATA group (see “Description of Device Functions” manual, BA116D/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 zero point adjustment function in the function matrix:
PROCESS PARAMETER → ZERO POINT ADJUST
6. When you press  or  you are automatically prompted to enter the access code if the function matrix is still disabled. Enter the code (factory setting = 65).
7. Use  or  to select START and press  to confirm. Select YES at the prompt SURE? and press  again to confirm. Zero point adjustment now starts.
 - The message # 561 “ZERO-ADJ. RUN” appears on the display while adjustment is in progress.
-  Note!
 - If the flow in the pipe is unstable, the following error message may appear on the display # 451 “ZERO-ADJ. N. OK”. The Zero point adjustment is not OK. The preconditions need to be stabilized before attempting a new adjustment.
8. Back to the HOME position:
 - Press and hold down Esc key () for longer than three seconds or
 - Repeatedly press and release the Esc key (.

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 function.

Use  or  to select RESET and press  to confirm. Select YES at the prompt SURE? and press  again 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 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 T-DAT is an exchangeable data storage device in which all transmitter parameters and settings are stored.

Storing of specific parameter settings from the EEPROM to the T-DAT and vice versa has to be carried out by the user (= manual save function). Detailed instructions regarding 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.

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-stabilise.



Note!

The POSITIVE ZERO RETURN function maybe activated to set the measured variables (mass flow, corrected volume flow) 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 minimise any potential metering errors due to contamination or build-ups. The frequency of inspection and cleaning will depend upon the application and expected measurement performance. A suitable cleaning agent that does not attack the materials or seals maybe used.

- t-mass F sensor: Removal of the transducer may be carried out subject to the requirements of Pressure Equipment Directive, CRN approvals, and relevant hazardous area standards. In case of EX approved versions, the o-ring seals must be replaced at the same time. Please consult your Endress+Hauser service representative.
- t-mass I sensor: Cleaning of this sensor is straight forward – no special limitations.



Note!

Use care not to bend the sensing elements of the transducer.

7.4 Replacing seals

t-mass F sensor:

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.

t-mass I sensor:

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

The compression fitting and bonded seal are available as spare parts.

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.

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

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 version	DK6MB - *
Cable remote version	Connecting cable for the remote version	DK6CA - *

8.2 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting set for transmitter	Mounting set for remote version. Suitable for: – Wall mounting – Pipe mounting – Installation in control panel Mounting set for aluminium field housing: Suitable for pipe mounting (¾" to 3")	DK6WM - *
Flow conditioner	Perforated plate flow conditioner for various line sizes and schedules (t-mass F sensor only)	Contact your local Endress+Hauser representative for more information.
Cold Tap mounting set	Insertion mounting set for low pressure	DK6ML - *
Hot Tap mounting set	Insertion mounting set for high pressure	Contact your local Endress+Hauser representative for more information.

8.3 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and configuring flowmeters. Applicator can be downloaded from the Internet or ordered on CD-ROM for installation on a local PC. Contact your Endress+Hauser representative for more information.	DKA80 - *
ToF Tool - Fieldtool Package	Modular software package consisting of the service program "ToF Tool" for configuration and diagnosis of ToF level measuring devices (time-of-flight measurement) and the "Fieldtool" service program for the configuration and diagnosis of Proline flowmeters. The Proline flowmeters are accessed via a service protocol resp. via the service interface FXA 193. Contents of the "ToF Tool - Fieldtool Package": - Commissioning, maintenance analysis - Configuring flowmeters - Service functions - Visualisation of process data - Trouble-shooting - Controlling the "Fieldcheck" tester/simulator Contact your Endress+Hauser representative for more information.	DXS10 - * * * * *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "ToF Tool - Fieldtool Package" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	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.	Please refer to the product page of the Endress+Hauser Internet page: www.endress.com

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.	1. Check the supply voltage → Terminals 1, 2 2. Check device fuse → Page 83 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 → Page 77
No display visible, but output signals are present.	1. Check whether the ribbon-cable connector of the display module is correctly plugged into the amplifier board → Page 77 ff.. 2. Display module defective → order spare parts → Page 77 3. Measuring electronics defective → order spare parts → Page 77
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 → Page 77
▼	
Error messages on display	
Errors that occur during commissioning or measuring are displayed immediately. Error messages consist of a variety of icons. The meanings of these icons are as follows (example): – Type of error: S = System error, P = Process error – Error message type:  = 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  Caution! ■ See the information on → Page 40. ■ 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 → Page 83 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 (Rx/D/TxD-P) Terminal 27 = A (Rx/D/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 ToF Tool - Fieldtool Package or FieldCare.	



Other error (without error message)	
Some other error has occurred	Diagnosis and rectification → Page 75

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.
→ Page 6. 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 → Page 40 ff.

9.2.1 List of system error messages

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.		S = System error ⚡ = Fault message (with an effect on the current operation) ! = Notice message (without any effect on the current operation)			
1	SYSTEM OK	-	There is no error present in the device		
		No. # 0xx → Hardware error			
2	CRITICAL FAIL.	001	S: CRITICAL FAIL. ⚡: # 001	Serious device error	Replace the amplifier board. Spare part → Page 77
3	AMP HW-EEPROM	011	S: AMP HW EEPROM ⚡: # 011	Amplifier: Defective EEPROM	Replace the amplifier board. Spare parts → Page 77
4	AMP SW-EEPROM	012	S: AMP SW EEPROM ⚡: # 012	Measuring amplifier: Error when accessing data of the EEPROM	Replace the amplifier board. Spare parts → Page 77
5	AMP HW-ROM/RAM	013	S: AMP HW-ROM/RAM ⚡: # 013	Amplifier: Defective ROM/RAM	Replace the amplifier board. Spare parts → Page 77
6	AMP SW-ROM/RAM	014	S: AMP SW-ROM/RAM ⚡: # 014	Amplifier: Defective ROM/RAM	Replace the amplifier board. Spare parts → Page 77
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. Spare parts → Page 77 Check the spare part set number to ensure that the new, replacement DAT is compatible with the measuring electronics. 2. Plug the S-DAT into the amplifier board → Page 78, Page 80
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→ Page 78, Page 80 2. Replace the S-DAT if it is defective. Spare parts → Page 77 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. Spare parts → Page 77
9	SENS HW-EEPROM	033	S: SENS HW-EEPROM ⚡: # 033	Measuring amplifier: Error when accessing data for EEPROM.	Replace the amplifier board. Spare parts → Page 77 - For remote version: replace pre-amplifier board - For compact version: replace pre-amplifier board
10	SENS SW-EEPROM	034	S: SENS SW-EEPROM ⚡: # 034	Amplifier: Defective EEPROM	Replace the amplifier board. Spare parts → Page 77 - For remote version: replace pre-amplifier board - For compact version: replace pre-amplifier board
11	SENS HW-ROM/RAM	035	S: SENS HW-ROM/RAM ⚡: # 035	Sensor: Defective ROM/RAM	Replace the remote amplifier board. Spare parts → Page 77
12	SENS SW-ROM/RAM	036	S: SENS SW-ROM/RAM ⚡: # 036	Sensor: Defective ROM/RAM	Replace the remote amplifier board. Spare parts → Page 77

MODBUS communication		No.	Device status message (local display)	Cause	Remedy / spare part
Register: 6859 Data type: Integer	Register: 6821 Data type: String (18 byte)				
13	TRANSM. HW-DAT	041	S: TRANSM. HW-DAT #: # 041	Transmitter DAT 1. HistoROM/T-DAT is defective. 2. HistoROM/T-DAT is not plugged into the amplifier board or is missing.	1. Replace the T-DAT. Spare parts → Page 77 Check the spare part set number to ensure that the new, replacement DAT is compatible with the measuring electronics. 2. Plug the T-DAT into the amplifier board → Page 78, Page 80
14	TRANSM. SW-DAT	042	S: TRANSM. SW-DAT #: # 042	Sensor DAT: Error accessing the calibration values stored in the HistoROM/T-DAT.	1. Check whether the T-DAT is correctly plugged into the amplifier board → Page 78, Page 80 2. Replace the T-DAT if it is defective. Spare parts → Page 77 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. Spare parts → Page 77
15	A/C COMPATIB.	051	AC COMPATIB. #: # 051	The I/O board and the amplifier board are not compatible.	Use only compatible modules and boards. Check the compatibility of the modules used. Check the: – Spare part set number – Hardware revision code
16	HW-COMMODUL	052	S: HW-COMMODUL #: # 052	The I/O board is defective.	Replace the I/O board. Spare parts → Page 77
18	HW-I.SUBMODUL	054	S: HW-I SUB MODULS #: # 054	The I/O board is defective.	Replace the I/O board. Spare parts → Page 77
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.
20	SENSOR DRIFT	071	S: SENSOR DRIFT #: # 071	Calibration drift has been detected.	Contact your Endress+Hauser representative.
21	A/O REF ERROR	072	S: A/D REF ERROR #: # 072	Measuring amplifier analogue to digital convertor circuitry faulty.	For remote sensor: replace the remote sensor electronic board. For compact sensor: replace the main amplifier electronic board. Spare parts → Page 77 Note! Ensure that the sensor and transmitter DAT's are transferred from the old circuit board to the new one.
No. # 1xx → Software error					
22	CHECKSUM TOT.	111	S: CHECKSUM TOTAL #: # 111	Totalizer checksum error	1. Restart the measuring device 2. Replace the amplifier board if necessary. Spare parts → Page 77
23	A/C SW COMPATI	121	S: A/C SW COMPATI #: # 121	Due to different software versions, I/O board and amplifier board are only partially compatible (possibly restricted functionality).  Note! – This message is only listed in the error history. – Nothing is displayed on the display.	Module with lower software version has either to be actualized by ToF Tool - Fieldtool Package with the required software version or the module has to be replaced. Spare parts → Page 77

MODBUS communication		No.	Device status message (local display)	Cause	Remedy / spare part
Register: 6859 Data type: Integer	Register: 6821 Data type: String (18 byte)				
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.	1. Check whether the T-DAT is correctly plugged into the amplifier board → Page 78, Page 80 2. Replace the T-DAT if it is defective. Spare parts → Page 77 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. Spare parts → Page 77
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 → Page 78 ff.
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 → Page 78 ff.
28	LOAD S-DAT	215	S: LOAD S-DAT !: # 215	Sensor DAT: Data backup (downloading) to HistoROM/S-DAT failed, or error when accessing (uploading) the calibration values stored in the HistoROM/S-DAT.	1. Check whether the HistoROM/S-DAT is correctly plugged into the amplifier board → Page 78 ff. 2. Replace the HistoROM/S-DAT if it is defective. Spare parts → Page 77 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary. Spare parts → Page 77
29	SAVE S-DAT	216	S: SAVE S-DAT !: # 216		
30	COMMUNIC.AMP.	251	S: COMMUNIC. SENS !: # 251	Internal microprocessor communication fault on the amplifier board.	Remove the amplifier board. Spare parts → Page 77
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.
51	GAS MIX. CORR.	379	S: GAS MIX. CORR. !: # 379	The defined gas mixture has been corrupted.	Gas mixture needs to be re-entered.
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.

MODBUS communication		No.	Device status message (local display)	Cause	Remedy / spare part
Register: 6859 Data type: Integer	Register: 6821 Data type: String (18 byte)				
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.
68	ZERO-ADJ. RUN	561	P: ZERO-ADJ. RUN !: # 561	Zero point adjustment function is active.	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: → Page 40 and → Page 68

9.3.1 List of process error messages

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.
62	FL TEMP UNST.	432	P: FL. TEMP UNST. ⚡: # 432	The gas temperature is unstable. Measurement errors may have occurred.	Stabilize process conditions or relocate the instrument to a more stable measuring location.
64	FLOW EXT	435	P: FLOW EXT !: # 435	The flow is measured using extendend mode (beyond calibration).	Resume normal operation (accuracy of device maybe affected) or reduce the flow rate.
65	ZERO-ADJ. N.OK	451	P: ZERO-ADJ. N.OK ⚡: # 451	The saved zero point is inaccurate possibly due to unstable process or flow conditions.	Stabilize process conditions or relocate the instrument to a more stable measuring location.

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.	1. Increase value of the DISPLAY DAMPING setting → USER INTERFACE function group. 2. The inlet and outlet lengths must be observed. See installation conditions → Page 12 3. Consider the use of a flow conditioner. See installation conditions → Page 16 4. Relocate the meter to a point where there is less flow disturbance
Device displays flow with no actual flow present.	1. The low flow cut off value is programmed too low. Increase value of the ON VALUE LOW FLOW CUT OFF setting → PROCESS PARAMETER function group (Factory setting = 1% of full scale value). 2. Check for leaks in the pipe line downstream of the sensor. 3. Reduce or eliminate pressure pulsations in the line. 4. Check sensors for damage.
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 PARAMETER function group. See Zero Point Adjust function → Page 63  Note! Process preconditions are required before starting this function.
Measurement error due to installation conditions. 1. Gas condition: moisture content, cleanliness, mixture composition. 2. Pipework: inadequate upstream length, diameter mis-match between pipe and device, coupling or gasket mis-match.	Adjust the INSTALLATION FACTOR setting → PROCESS PARAMETER function group. (Factory setting = 1.0)
The fault cannot be rectified or some other fault not described above has occurred. In these instances, please contact your Endress+Hauser representative.	The following options are available for tackling problems of this nature: Request the services of an Endress+Hauser service technician If you contact our service representative to have a service technician sent out, please be ready with the following information: – Brief description of the fault – Nameplate specifications : Order code and serial number → Page 7 ff. Returning devices to Endress+Hauser The procedures on must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. → Page 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. Replace transmitter electronics Components in the measuring electronics defective → order replacement → Page 77

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 → Page 68 ff.		
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. → Page 68 ff.

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. → Page 7

Spare parts are shipped as sets comprising the following parts:

- Spare part
- Additional parts, small items (threaded fasteners, etc.)
- Mounting instructions
- Packaging

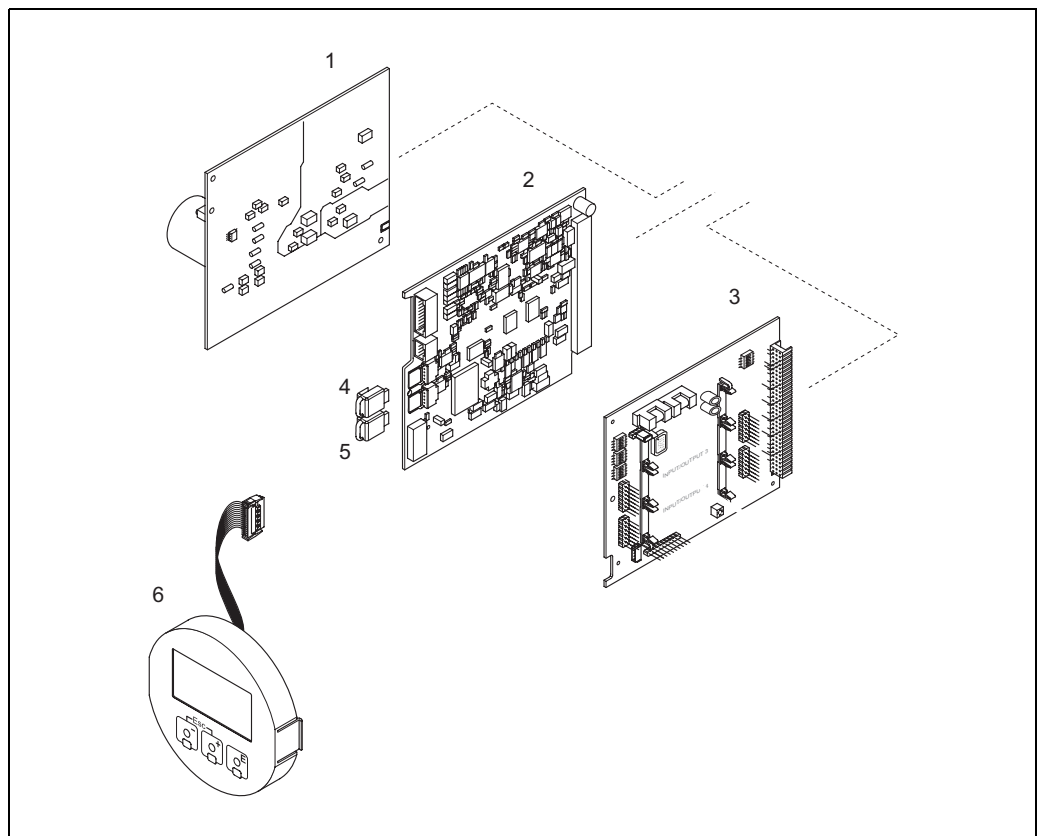


Fig. 41: Spare parts for transmitter 65 (field and wall-mount housings)

- 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.

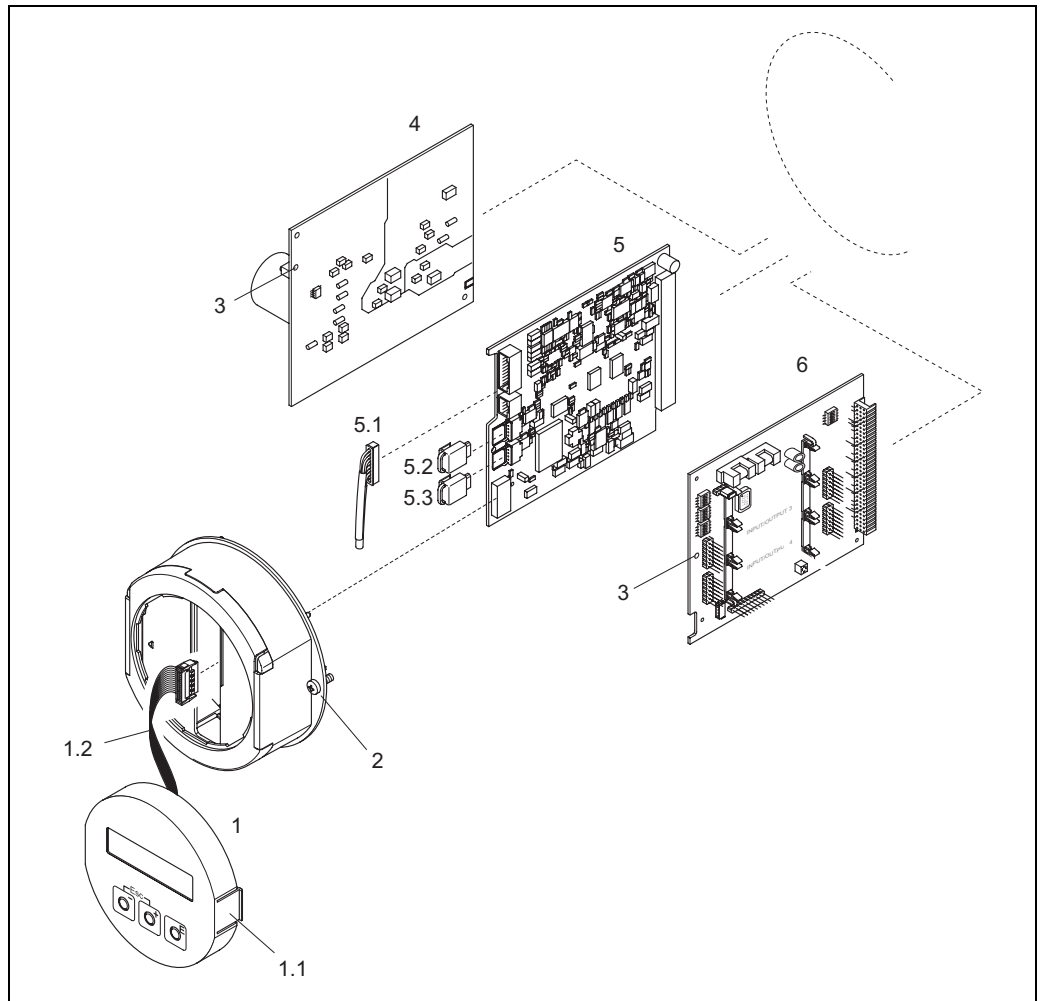


Caution!

Use only original Endress+Hauser parts.

Fig. 42, installation and removal:

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the screws and remove the cover (2) from the electronics compartment.
3. Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
4. Remove power unit board (4) and I/O board (6):
Insert a thin pin into the hole (3) provided for the purpose and pull the board clear of its holder.
5. Remove amplifier board (5):
 - Disconnect the plug of the sensor signal cable (5.1) including , HistoROM/S-DAT (5.2) and HistoROM/T-DAT (5.3) from the board.
 - Insert a thin pin into the hole (3) provided for the purpose and pull the board clear of its holder.
6. Installation is the reverse of the removal procedure.



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

- 1 Local display
- 1.1 Latch
- 1.2 Ribbon cable (display module)
- 2 Screws of electronics compartment cover
- 3 Aperture for installing/removing boards
- 4 Power unit board
- 5 Amplifier board
- 5.1 Signal cable (sensor)
- 5.2 HistoROM/S-DAT (sensor data memory)
- 5.3 HistoROM/T-DAT (transmitter data memory)
- 6 I/O board (COM module)

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.

Fig. 43, installation and removal:

1. Loosen the screws and open the hinged cover (1) of the housing.
2. Remove the screws securing the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mount housing.
3. Disconnect the plug of the sensor signal cable (7.1) including , HistoROM/S-DAT (7.2) and HistoROM/T-DAT (7.3) from the board.
4. Remove the cover (4) from the electronics compartment by loosening the screws.
5. Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
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.

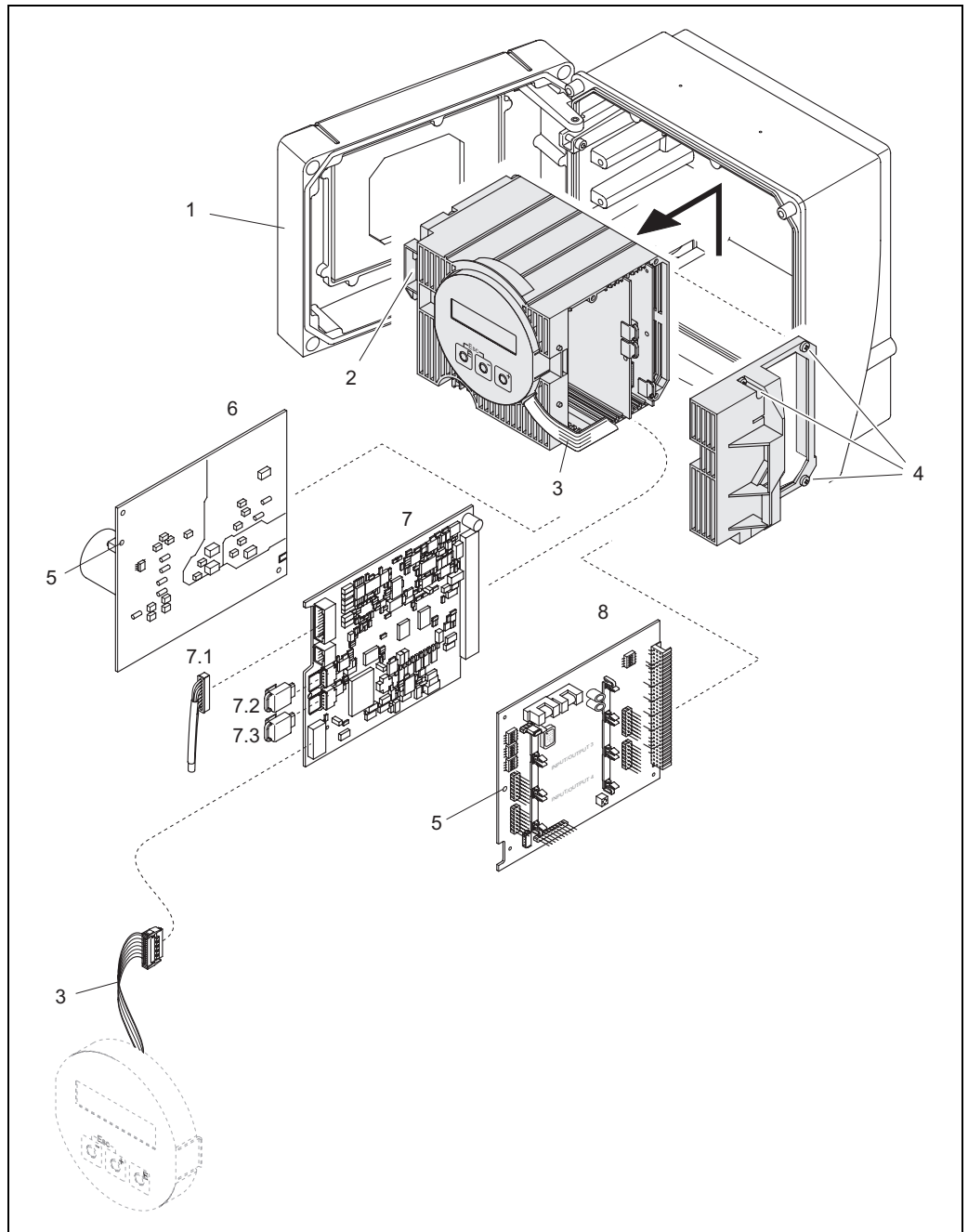


Fig. 43: Wall-mount housing: removing and installing printed circuit boards

- 1 Housing cover
- 2 Electronics module
- 3 Ribbon cable (display module)
- 4 Screws of electronics compartment cover
- 5 Aperture for installing/removing boards
- 6 Power unit board
- 7 Amplifier board
 - 7.1 Signal cable (sensor)
 - 7.2 HistoROM/S-DAT (sensor data memory)
 - 7.3 HistoROM/T-DAT (transmitter data memory)
- 8 I/O board (COM module), permanent assignment)

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.

Fig. 44, removal and installation:

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.

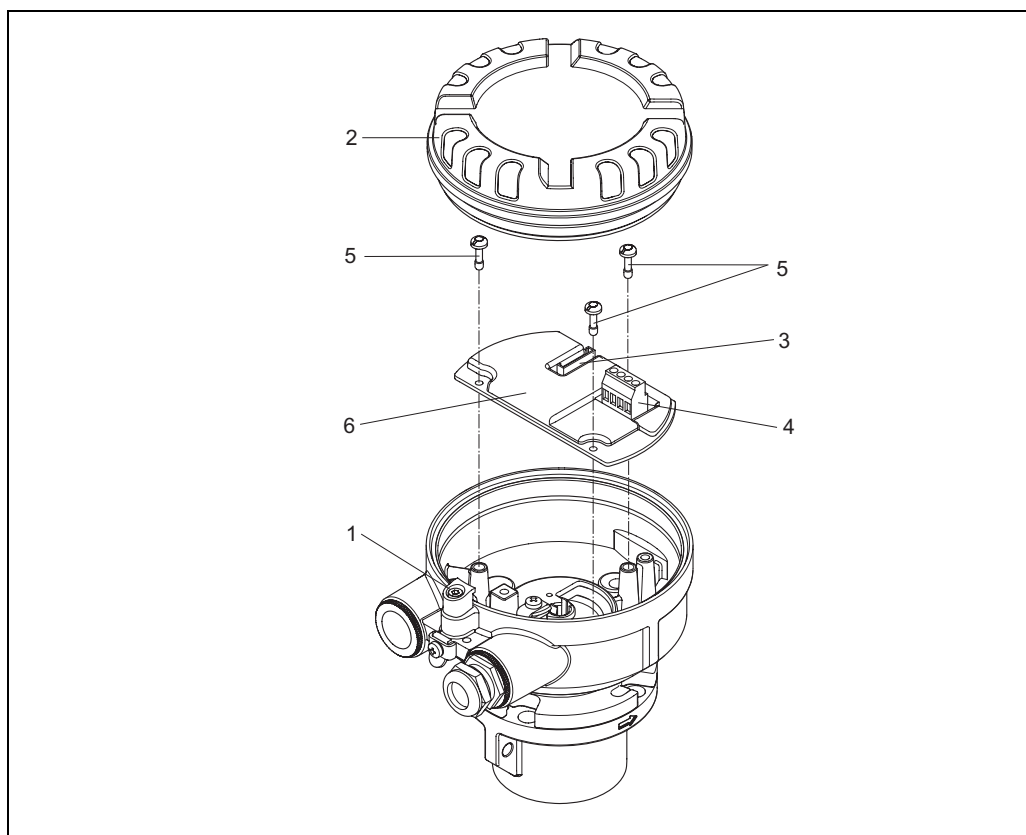


Fig. 44: Electronics compartment of the sensor housing remote version: removing and installing printed circuit board

Wire colors (when supplied by Endress+Hauser):

Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow (color code according to DIN 47100)

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, → Page 78→ Page 80
3. Remove the protection cap (1) and replace the device fuse (2). Only use the following fuse type:
Now remove the following cable connectors from the amplifier board (7):
 - 20 to 55 V AC / 16 to 62 V DC → 2.0 A slow-blow / 250 V; 5.2 x 20 mm
 - Power supply 85 to 260 V AC → 0.8 A slow-blow / 250 V; 5.2 x 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.

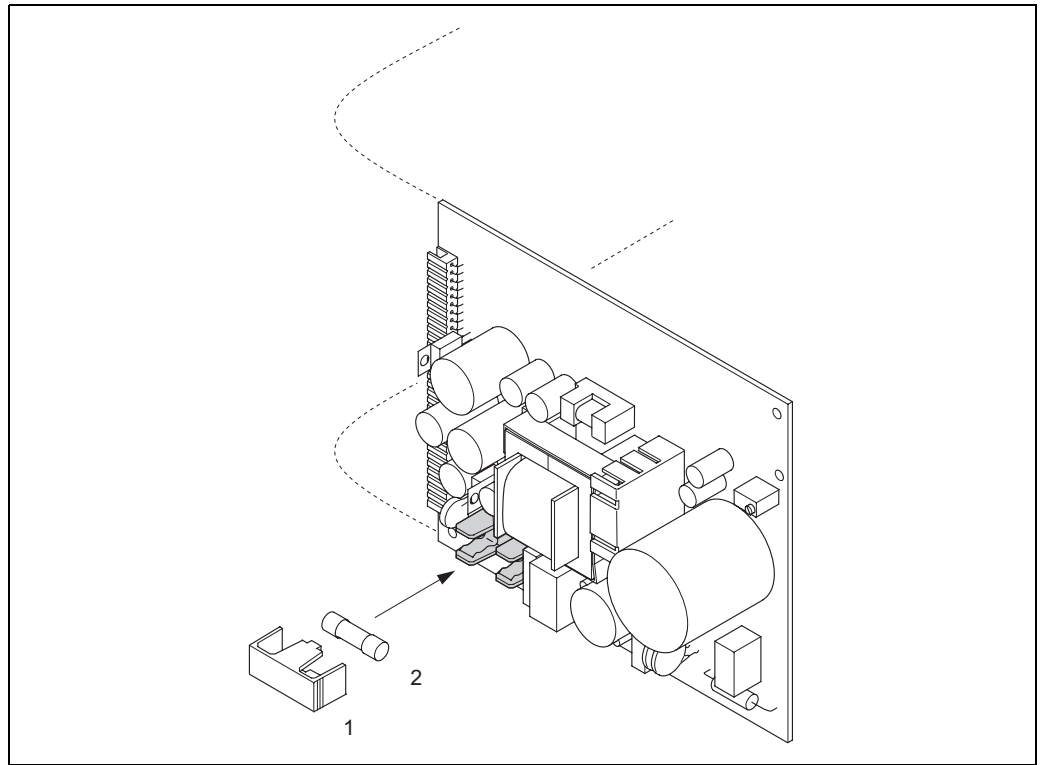


Fig. 45: Replacing the device fuse on the power unit board

- 1 Protective cap
- 2 Device fuse

9.7 Return

The following procedures must be carried out before a flowmeter requiring repair or calibration, for example, is returned to Endress+Hauser:

- Always enclose a duly completed “Declaration of contamination” form. Only then can Endress+Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.
- Remove all residues. Pay special attention to the grooves for seals and crevices which could contain residues. This is particularly important if the substance is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.



Note!

You will find a preprinted “Declaration of contamination” form at the back of this manual.



Warning!

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

9.8 Disposal

Observe the regulations applicable in your country!

9.9 Software history

Date	Software version	Changes to software	Operating Instructions
12.2005	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. At the same time, the system also measures corrected volume flow, temperature and calculated density.

Examples:

- Compressed air
- Oxygen
- Nitrogen
- Carbon dioxide
- Bio gas, etc.

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	The t-mass 65 flow measuring system consists of the following components: ■ t-mass 65 transmitter ■ t-mass F, t-mass I sensor Two versions are available: ■ Compact version: transmitter and sensor form a single mechanical unit. ■ Remote version: transmitter and sensor are installed separately.

10.1.3 Input

Measured variable	■ Mass flow ■ Gas temperature
Measuring range	The measuring range is dependent on the gas selection, line size and use of flow conditioner. Each meter is individually calibrated on air and mathematically converted to suit the customer specific gas, where required. The tables below define the ranges available for air without flow conditioner. Please refer to your Endress+Hauser representative or to Applicator (the Endress+Hauser sizing and selection software) for other gases and process conditions.

Measuring range for the flanged version, metric units:

DN	kg/h		Nm ³ /h at 0°C, 1.013 bar a		scf/min. at 15°C, 1.013 bar a	
	min.	max.	min.	max.	min.	max.
15	0.5	53	0.38	41	0.23	25
25	2	200	1.5	155	1.0	96
40	6	555	4.6	429	3.0	266
50	10	910	7.7	704	5.0	436
80	20	2030	15.5	1570	10	974
100	38	3750	29	2900	18	1800

Measuring range for the flanged version, US units:

DN	lb/h		Sm ³ /h at 59 °F, 14.7 psi a		scf/min. at 59 °F, 14.7 psi a	
	min.	max.	min.	max.	min.	max.
½"	1.1	116	0.4	42	0.23	25
1"	4.4	440	1.6	160	1.0	96
1 ½"	13.2	1220	4.8	450	3.0	266
2"	22	2002	8	740	5.0	436
3"	44	4466	16	1656	10	974
4"	84	8250	30	3060	18	1800

Measuring range for the insertion version, metric units:

DN	kg/h		Nm ³ /h at 0°C, 1.013 bar a		scf/min. at 15°C, 1.013 bar a	
	min.	max.	min.	max.	min.	max.
80	20	2030	15.5	1570	9.6	974
100	38	3750	29.0	2900	18	1800
150	50	7500	38	5800	24	3600
200	80	12500	62	9666	38	6000
250	120	20000	93	15468	58	9600
300	180	28000	139	21655	86	13440
400	300	50000	232	38670	144	24000
500	500	80000	386	61870	240	38400
600	700	115000	540	88940	336	55200
700	900	159000	696	122970	432	76300
1000	2000	320000	1546	247846	960	153600
1500	2500	720000	1933	556844	1200	345600

In order to achieve optimum performance, it is recommended that under operating conditions the maximum velocity is limited to a value below 70 m/sec.

Measuring range for the insertion version, US units:

DN	lb/h		Sm ³ /h at 59°F, 14.7 psi a		scf/min. at 59°F, 14.7 psi a	
	min.	max.	min.	max.	min.	max.
3"	44	4466	16	1657	9	926
4"	84	8250	30	3060	17	1710
6"	110	16500	40	6120	22.8	3420
8"	176	27500	64	10200	36.5	5700
10"	264	44000	98	16300	55	9120
12"	396	61000	146	22855	82	12768
16"	660	110000	245	40810	136	22800
20"	1100	176000	408	65300	228	36480
24"	1540	253000	570	93870	319	52440
28"	1980	349800	735	129800	410	22504
40"	4400	704000	1630	261200	912	145920
60"	5500	1584000	2040	587750	1140	328320

In order to achieve optimum performance, it is recommended that under operating conditions the maximum velocity is limited to a value below 230 ft/sec.

**Caution!**

The flowrates shown are representative of the calibrated conditions only and do not necessarily reflect what the meter can measure under operating conditions and actual internal pipe dimensions found on site. To correctly size and select a meter, it is recommended that you either contact your local Endress+Hauser representative or refer to Applicator (the Endress+Hauser sizing and selection software).

Examples in metric units:

Line Size	Gas	Process pressure	Temperature	Max. Flowrate
DN		bar a	°C	kg/h
50	Air	1	25	910
50	Air	3	25	3300
50	CO ₂	1	25	1300
50	CO ₂	3	25	3950
50	Methane	1	25	795
50	Methane	3	25	1500

Examples in US units:

Line Size	Gas	Process pressure	Temperature	Max. Flowrate
DN		psi a	°F	lb/hr
2"	Air	14.7	77	2002
2"	Air	44.1	77	7260
2"	CO ₂	14.7	77	2860
2"	CO ₂	44.1	77	8690
2"	Methane	14.7	77	1749
2"	Methane	44.1	77	3300

Input signal*Status input (auxiliary input):*

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

10.1.4 Output**Output signal***MODBUS RS485:*

- MODBUS device type: slave
- Address range: 1 to 247
- Functions codes supported: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with standard EIA/TIA-485
- Baudrate supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU or ASCII
- Parity: NONE, EVEN, ODD
- Response time:
 - 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

Switch points for low flow cut off are programmable.

Galvanic isolation

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

10.1.5 Power supply

Electrical connections	→ Page 29 ff.
Supply voltage	85 to 260 V AC, 45 to 65 Hz 20 to 55 V AC, 45 to 65 Hz 16 to 62 V DC
Cable entry	Power supply and signal cables (inputs/outputs): ■ Cable entry M20 x 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½" Connecting cable for remote version: ■ Cable entry M20 x 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½"
Cable specifications (remote version)	see Page 32
Power consumption	AC: 85 to 260V = 18.2 W; 20 to 55V = 14 W; (including sensor) DC: <8 W (including sensor)
Power supply failure	Lasting min. 1 power cycle: ■ 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 equalisation	No measures necessary. For devices in hazardous areas please refer to the additional Ex documentation.

10.1.6 Performance characteristics

Reference calibrating conditions	■ Accredited according to ISO/IEC 17025 ■ Traceable to National Standards ■ Temperature controlled to within ± 0.5 °C (± 0.9 °F) ■ atmospheric pressure ■ humidity controlled
Maximum measured error	<i>Flanged version:</i> ± 1.5 % of reading for 100 % to 20 % of full scale at reference conditions ± 0.3 % of full scale for 20 % to 1 % of full scale at reference conditions <i>Insertion version:</i> ± 1.5 % of reading plus ± 0.5 % of full scale  Note! ■ Calibration gas is normally air at reference calibration conditions and with a fully developed flow profile. ■ On site performance is dependant on the standard of installation.
Repeatability	± 0.5 % of measured value for velocities above 0.2 m/s (0.65 ft/s)
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	see Page 12 ff.
Inlet and outlet runs	see Page 14 ff.
Length of connecting cable	Max. 100 meters (328 feet), remote version
System pressure	see Page 22

10.1.8 Operating conditions: Environment

Ambient temperature	Standard: -20 to +60 °C (-4 to +140 °F), available on request -40 to +60 °C (-40 °F to +140 °F)
	Note! ■ Install the device at a shady location. Avoid direct sunlight, particularly in warm climatic regions. (A protective hood 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	Sensor: <i>t-mass F:</i> -40 °C to +100 °C (-40 °F to +212 °F) <i>t-mass I:</i> -40 °C to +130 °C (-40 °F to +266 °F) Seals: <i>t-mass F:</i> Viton -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) <i>t-mass I (bonded seals):</i> Kalrez -20°C to +130°C (-4°F to +266°F) Nitrile -35°C to +130°C (-31°F to +266°F) EPDM -40°C to +130°C (-40°F to +266°F)
--------------------------	--

Medium pressure range
(nominal pressure) *t-mass F:*
–0.5 to 40 bar (–7.25 to 580 psi) gauge

t-mass I:
–0.5 to 20 bar (–7.25 to 290 psi) gauge

Limiting flow See “Measuring range” section. → Page 85 ff.

Pressure loss 2 mbar (0.029 psi) maximum (without flow conditioner)

Limiting medium pressure range (rated pressure) The material load diagrams (pressure–temperature diagrams) for the process connections are to be found in the following documents:
 ■ Technical Information: Proline t-mass 65F, 65I (TI069D/06/en), with SI units
 ■ Technical Information: Proline t-mass 65F, 65I (TI069D/06/ae), with US units

10.1.10 Mechanical construction

Design / dimensions Dimensions and the fitting lengths of the transmitter and sensor are given in the Technical Information. See Technical Information Documentation TI069D/06/en/...

Weight
(SI units) ■ Compact version: see table below
 ■ Remote version
 – Sensor: see table below
 – Wall-mount housing: 5 kg

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	5.5	6.0	10.5	10.5	16.7	25.9

t-mass I / sensor length	235	335	435	608
Compact version	6.4	6.6	7.0	7.4
Remote version	4.4	4.6	5.0	5.4

Weight data in [kg].
For flanged versions, all values (weight) refer to devices with EN/DIN PN 40 flanges.

Weight
(US units) ■ Compact version: see table below
 ■ Remote version
 – Sensor: see table below
 – Wall-mount housing: 11 lb

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	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	9.7	10.1	11.0	11.9

Weight data in [lb].
For flanged versions, all values (weight) refer to devices with Cl 150 flanges.

Material

Transmitter housing:

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

Connection housing, sensor (remote version):

powder coated die-cast aluminium

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 B2238
→ stainless steel 1.4404 to EN 10222-5 and 316L/316 to A182

Transducer body:

- 1.4404 to EN10272 and 316L to A479
- Alloy C-22 and UNS N06022 to B574

Transducer elements:

- 1.4404 to EN10217-7 / 316L to A249 or
- 1.4404 to EN 10216-5 / 316L to A213
- Alloy C-22 and UNS N06022 to B626

O-ring seals:

EPDM, Kalrez, Viton

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 C-22 and UNS N06022 to B574

Transducer elements:

- 1.4404 to EN10217-7 / 316L to A249 or
- 1.4404 to EN 10216-5 / 316L to A213
- Alloy C-22 and UNS N06022 to B626

Compression fitting:

1.4404 to EN 10272 and 316/316L to A479

Compression fitting seal:

PEEK

Bonded seals:
EPDM, Kalrez, Nitrile
316/316L (outer ring)

Low pressure retractable insertion fitting (Cold 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:
1.4408 to EN 10213-4 and CF8M

Seal:
PTFE

10.1.11 Human interface

Display elements	■ 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 °C (–4 °F) the readability of the display may be impaired.
Operating elements	■ Local operation with push buttons (–, +, E) ■ Quick Setup menus for straight forward commissioning
Languages	English, Deutsch, Francais, Espanol, Italiano, Nederlands, Norsk, Svenska, Suomi, Portugues, Polski, Cesky
Remote operation	Operation by means of MODBUS R485 communication

10.1.12 Certificates and approvals

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.

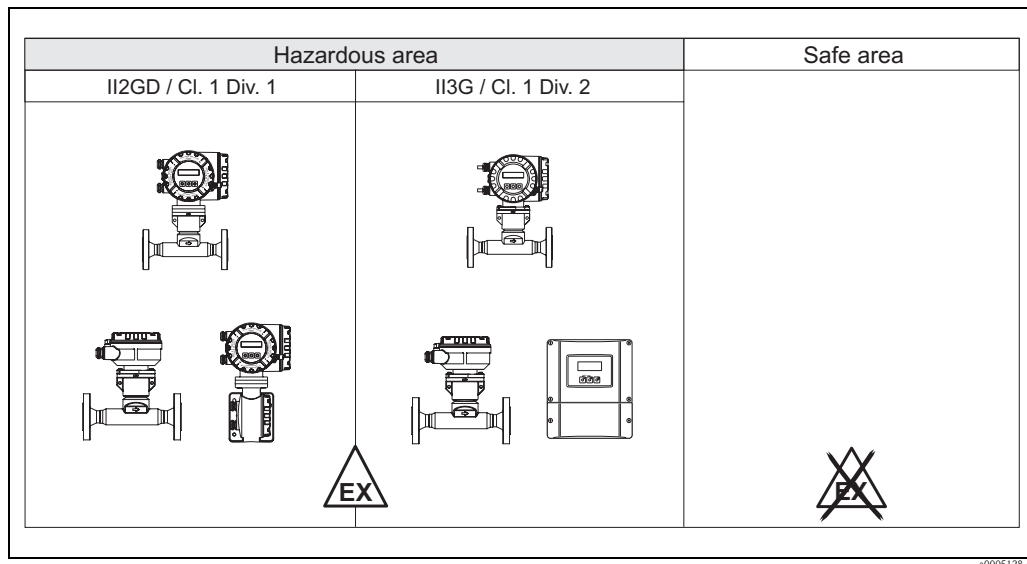


Fig. 46: Example of t-mass devices in the hazardous area (Example t-mass 65F)

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 device approval

Flowmeters with a nominal diameter smaller or equal DN 25 are covered by Art. 3(3) of the European directive 97/23/EC (Pressure Equipment Directive) and are designed according to sound engineering practice. For larger nominal diameters, optional approvals according to Cat. III are available when required (dependent on fluid and process pressure).

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).

Other standards and guidelines

EN 60529:
Degrees of protection by housing (IP code)

EN 61010-1
Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.

EN 61326/A1 (IEC 1326)
"Emission in accordance with requirements for Class A". Electromagnetic compatibility (EMC-requirements)

NAMUR NE 21:
Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.

NAMUR NE 53:
Software of field devices and signal-processing devices with digital electronics

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. → Page 66

Your Endress+Hauser representative can provide detailed information on the order codes of your choice.

10.1.15 Documentation

- ☐ Technical Information t-mass 65F, 65I (TI069D/06/en)
- ☐ Description of Device Functions t-mass 65 (BA116D/06/en)
- ☐ Supplementary documentation on Ex-ratings: ATEX, FM, CSA

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Declaration of Contamination

Erklärung zur Kontamination

Because of legal regulations and for the safety of our employees and operating equipment, we need the "declaration of contamination", with your signature, before your order can be handled. Please make absolutely sure to include it with the shipping documents, or – even better – attach it to the outside of the packaging.

Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination", bevor Ihr Auftrag bearbeitet werden kann. Legen Sie diese unbedingt den Versandpapieren bei oder bringen Sie sie idealerweise außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

Process data / Prozessdaten Temperature / Temperatur _____ [°C] Pressure / Druck _____ [Pa]
Conductivity / Leitfähigkeit _____ [S] Viscosity / Viskosität _____ [mm²/s]

Medium and warnings

Warnhinweise zum Medium



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

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

* explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv

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

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

Reason for return / Grund zur Rücksendung _____

Company data / Angaben zum Absender

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

We hereby certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free from any residues in dangerous quantities.

Hiermit bestätigen wir, dass die zurückgesandten Teile sorgfältig gereinigt wurden, und nach unserem Wissen frei von Rückständen in gefährbringender Menge sind.

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