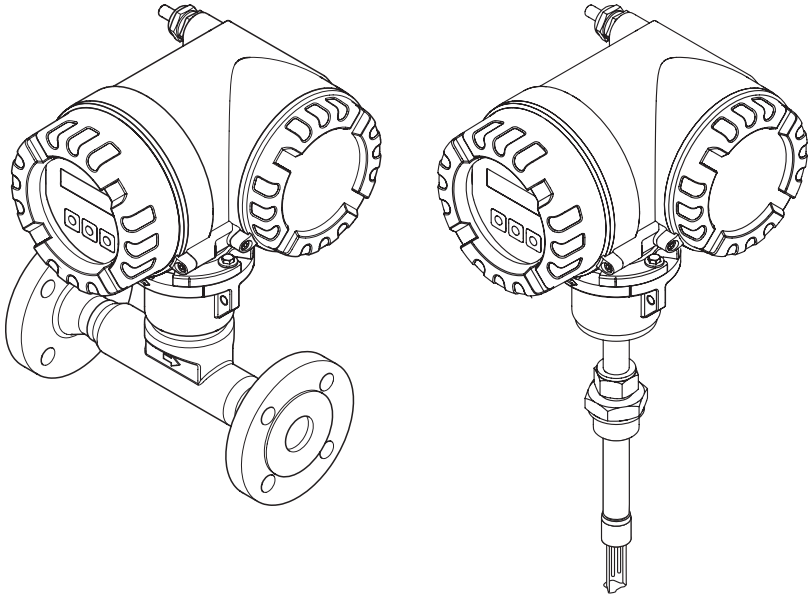
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Proline t-mass 65

Thermal Mass Flow Measuring System

HART® FIELD COMMUNICATION PROTOCOL



BA111D/06/en/06.10
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Valid as of version
V 1.01.00 (Device software)

Endress+Hauser

People for Process Automation

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1 Safety instructions

1.1 Designated use

The measuring device described in these Operating Instructions is to be used only for measuring the mass flow rate of gases (e. g. kg, Nm^3 scf). At the same time, the system also measures gas temperature. The measuring device can be configured to measure a standard range of pure gases or gas mixtures.

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

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

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

1.2 Installation, commissioning and operation

Note the following points:
- Installation, connection to the electricity supply, commissioning and maintenance of the device must be carried out by trained, qualified specialists authorised to perform such work by the facility's owner operator.
  The specialist must have read and understood these Operating Instructions and must follow the instructions they contain.
- The device must be operated by persons authorised and trained by the facility's owner-operator. Strict compliance with the instructions in the Operating Instruction is mandatory.
- Endress+Hauser is willing to assist in clarifying the chemical resistance properties of parts wetted by special fluids, including fluids used for cleaning. However small changes in temperature, concentration or the degree of contamination in the process can result in changes of the chemical resistance properties. Therefore, Endress+Hauser can not guarantee or accept liability for the chemical resistance properties of the fluid wetted materials in a specific application. The user is responsible for the choice of fluid wetted materials in regards to their in-process resistance to corrosion.
- If carrying out welding work on the piping, the welding unit should not be grounded by means of the measuring device.
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams. The transmitter must be earthed unless special protection measures have been taken e.g. galvanically isolated power supply SELV or PELV! (SELV = Safe Extra Low Voltage; PELV = Protective Extra Low Voltage)
- Invariably, local regulations governing the opening and repair of electrical devices apply.

1.3 Operational safety

Note the following points:

- Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory. The symbol on the front of this supplementary Ex documentation indicates the approval and the certification body (e.g. Ex Europe, FM USA, CSA Canada).
- When hot fluid passes through the measuring tube, the surface temperature of the housing increases. In the case of the sensor, in particular, users should expect temperatures that can be close to the fluid temperature. If the temperature of the fluid is high, implement sufficient measures to prevent burning or scalding.
- The measuring device complies with the general safety requirements in accordance with EN 61010-1, the EMC requirements of IEC/EN 61326, and NAMUR recommendation NE 21, NE 43 and NE 53.
- The separate document on the Pressure Equipment Directive must be observed for devices used in Category II or III installations in accordance with the Pressure Equipment Directive.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Operating Instructions.

1.4 Return

- Do not return a measuring device if you are not absolutely certain that all traces of hazardous substances have been removed, e.g. substances which have penetrated crevices or diffused through plastic.
- Costs incurred for waste disposal and injury (burns, etc.) due to inadequate cleaning will be charged to the owner-operator.
- Please note the measures on → 86

1.5 Notes on safety conventions and icons

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

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

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

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

2 Identification

2.1 Device designation

The "t-mass 65" flow measuring system consists of the following components:
- t-mass 65 transmitter
- t-mass F, t-mass I sensors

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

2.1.1 Nameplate of the transmitter

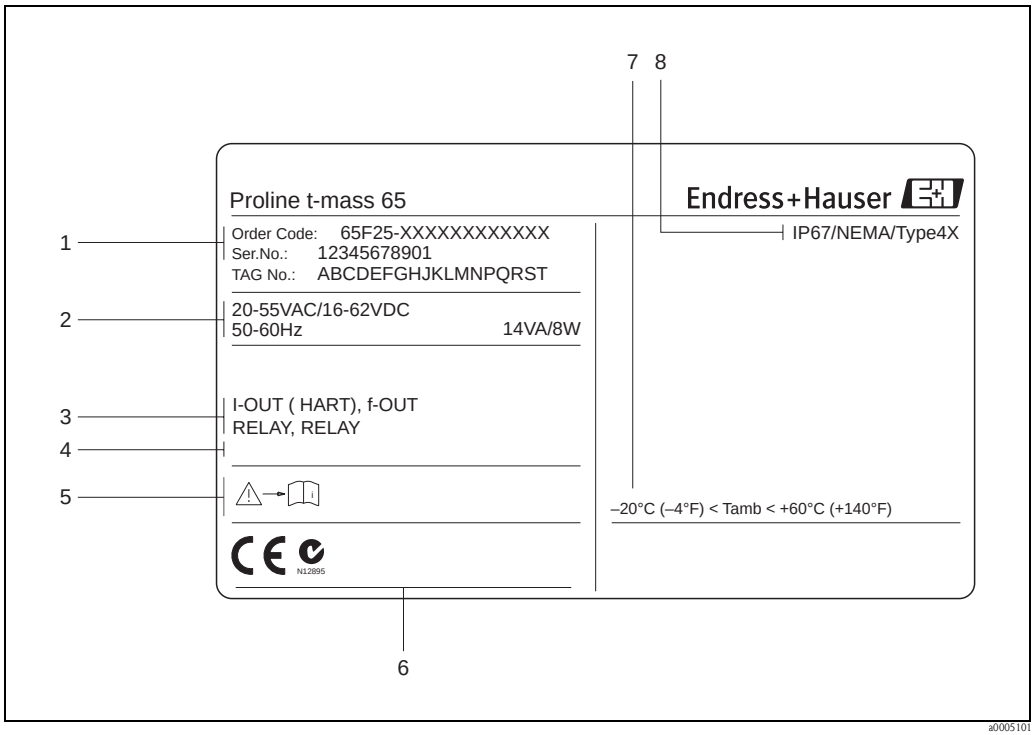


Fig. 1: Nameplate specifications for the "t-mass 65" transmitter (example)

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

2.1.2 Nameplate of the sensor

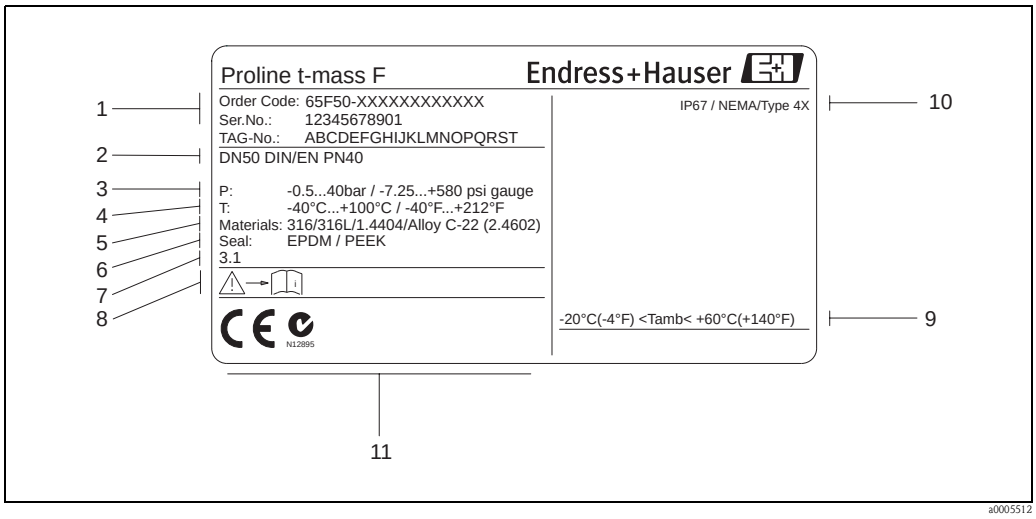


Fig. 2: Nameplate specifications for the "t-mass F" sensor (example)

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

2.1.3 Nameplate for connections

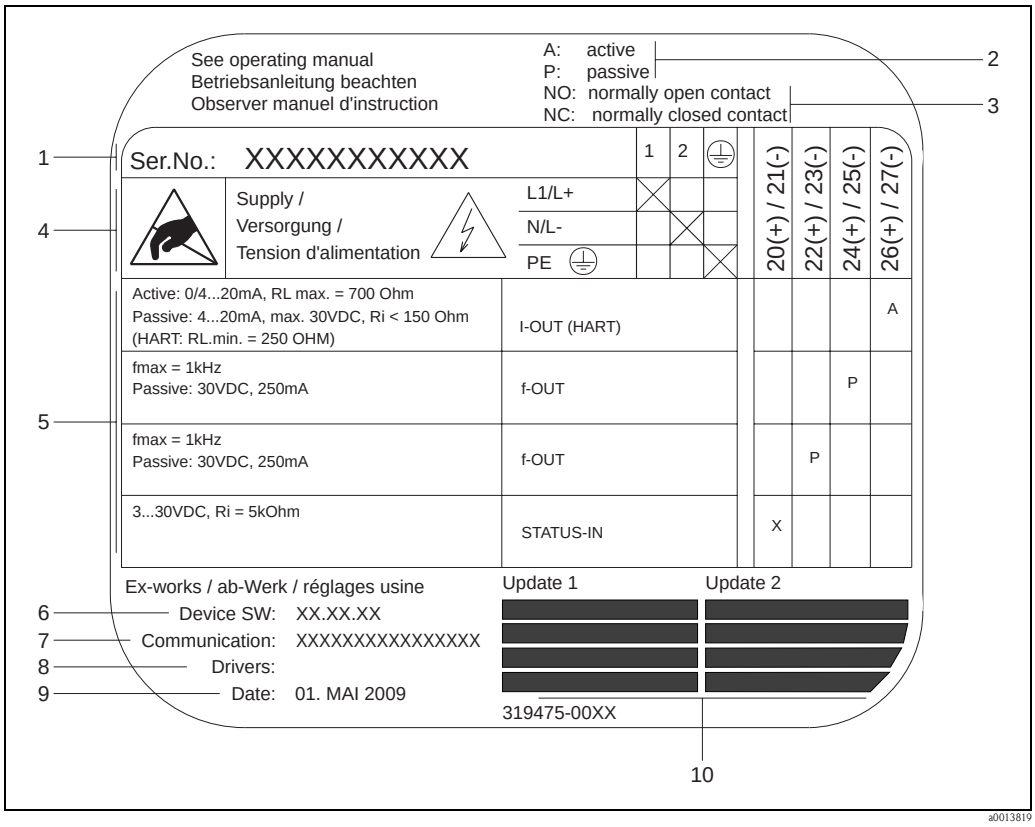


Fig. 3: Nameplate specifications for transmitter connections (example)

1 *Serial number*
2 *Possible configuration of current output*
3 *Possible configuration of relay contacts*
4 *Terminal assignment, cable for power supply: 85 to 260 V AC, 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 *Signals present at inputs and outputs, possible configuration and terminal assignment (20 to 27), see also "Electrical values of inputs/outputs",* → 🖹 89
6 *Version of device software currently installed*
7 *Installed communication type, e.g.: HART, PROFIBUS DP, etc.*
8 *Information on current communication software (Device Revision and Device Description), e.g.: Dev. 01 / DD 01 for HART*
9 *Date of manufacture*
10 *Current updates to data specified in points 6 to 9*

2.2 Certificates and approvals

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

2.3 Registered trademarks

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

AMS™
Registered trademark of Emmerson Process Management, St. Louis, USA

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

HistoROM™, S-DAT®, T-DAT™, F-CHIP®, FieldCare®, Field Xpert™, 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 (> 1½") by the transmitter housing or the connection housing in the case of the remote version (→ 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.

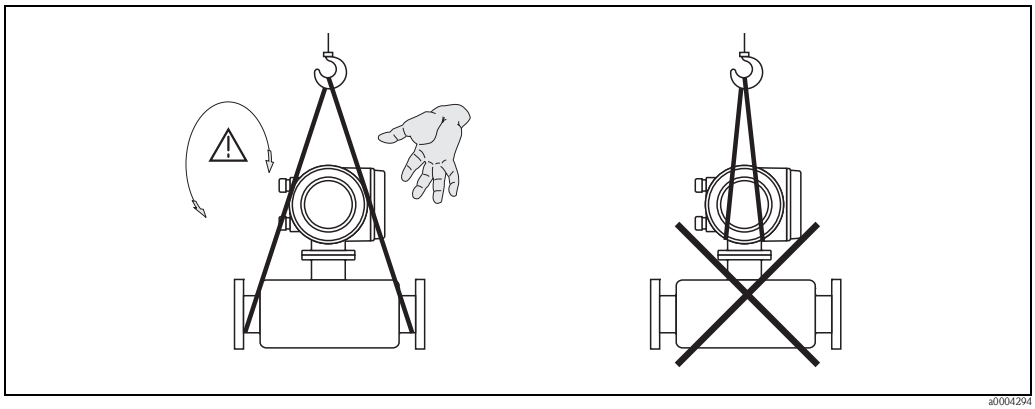


Fig. 4: Instructions for transporting sensors with > DN 40 (> 1½")

3.1.3 Storage

Note the following points:
- Pack the measuring device in such a way as to protect it reliably against impact for storage (and transportation). The original packaging provides optimum protection.
- The permissible storage temperature is –40 to +80 °C (–40 °F to +176 °F).
  Preferably +20 °C (+68 °F).
- Do not remove the protective covers or caps on the process connections until you are ready to install the device.
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Devices delivered with special sealing or bagging for oxygen service must remain sealed or bagged until ready for installation.

3.2 Installation conditions

Note the following points:
- The thermal dispersion principle is very sensitive to disturbed flow conditions.
- Observe the recommended inlet and outlet requirements.
- Good engineering practice is necessary for the associated pipe work and installation.
- Ensure correct alignment and orientation of the sensor.
- Take measures to reduce or avoid condensation (e.g. install a condensation trap, thermal insulation, etc.).
- The maximum permitted ambient temperatures and the medium temperature range (→ 92) must be observed.
- Install the transmitter in a shaded location or use a protective sun shield.
- For mechanical reasons, and in order to protect the pipe, it is advisable to support heavy sensors.

3.2.1 Dimensions

The dimensions and installation lengths of the sensor and transmitter can be found in the "Technical Information" for the device in question. This document can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents available is provided in the "Documentation" section on → 97.

3.2.2 System pressure and pulsating flow

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

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

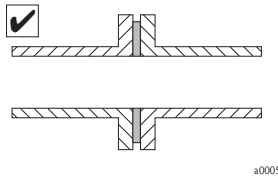
In compressed air systems, it is recommended to mount the flowmeter after the filter, dryer and buffer devices to avoid pulsations and oil/dirt contamination. Do not mount the flowmeter directly after the compressor outlet.

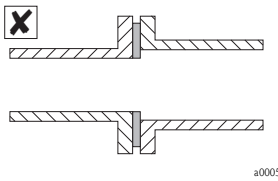
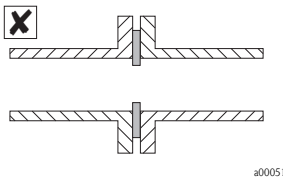
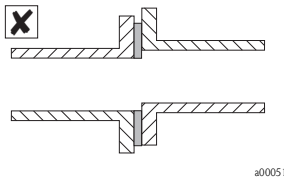
3.2.3 Pipework requirements

Good engineering practice should be followed at all times:

- Correct preparation, welding and finishing techniques
- Correctly sized gaskets
- Correctly aligned flanges and gaskets
- Connecting pipe work should match the internal diameter of the flowmeter.
  Maximum pipe diameter mismatch should not exceed:
  – 1 mm (0.04 inch) for diameters < DN 200 (8")
  – 3 mm (0.12 inch) for diameters ≥ DN 200 (8")

For further information please refer to ISO 14511.

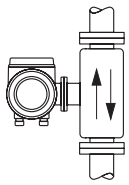
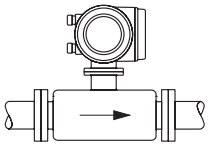
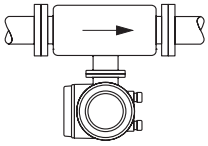
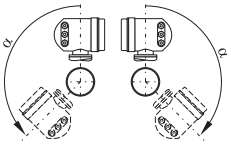
 a0005103		
Correctly aligned flanges and gaskets		

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

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

3.2.4 Orientation

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

	Flanged sensor		Insertion sensor	
Vertical orientation				
 A0013785	compact ✔✔ ①	remote ✔✔ ①	compact ✔ ①, ②	remote ✔✔ ①
Horizontal orientation, transmitter head up				
 A0013786	compact/remote ✔✔ ②			
Horizontal orientation, transmitter head down				
 A0013787	compact/remote ✔ ③			
Inclined orientation, transmitter head down				
 A0009897	compact/remote ✔ ④			

✔✔ = Recommended orientation
✔ = Orientation recommended in certain situations

① In the case of saturated or unclean gases, upward flow in a vertical pipe section is preferred to minimize condensation/contamination.
② Not recommended if the vibrations are too high or if the installation is unstable.
③ Only suitable for clean/dry gases. Do not mount the sensor from the bottom, on horizontal pipes, if build-up or condensate are likely to be present. Mount the sensor in a position as indicated below
④ If the gas is very damp or saturated with water (e. g. Bio Gas), mount in inclined orientation (α = max. 135°).

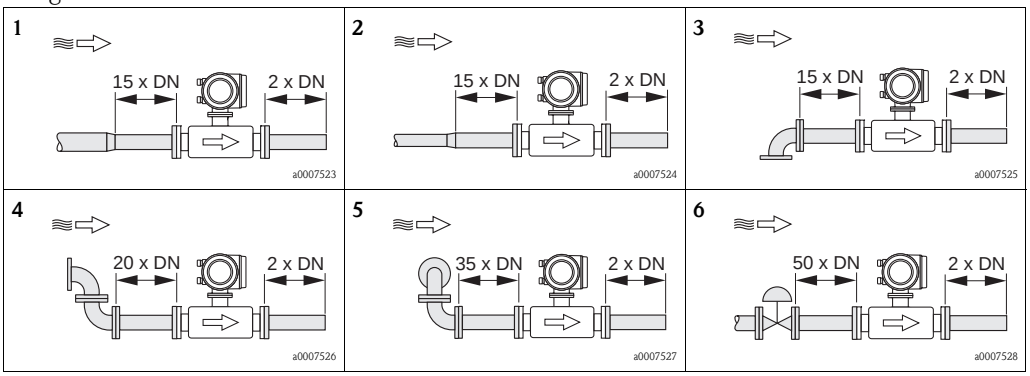
3.2.5 Inlet and outlet runs

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

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

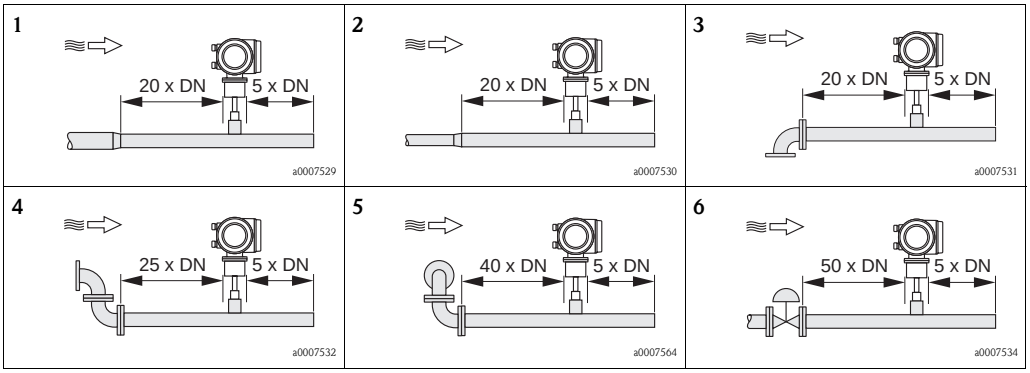
The minimum recommendations for inlet and outlet runs (without flow conditioner) are:

Flanged sensor



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

Insertion sensor



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

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

Outlet runs with pressure measuring points

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

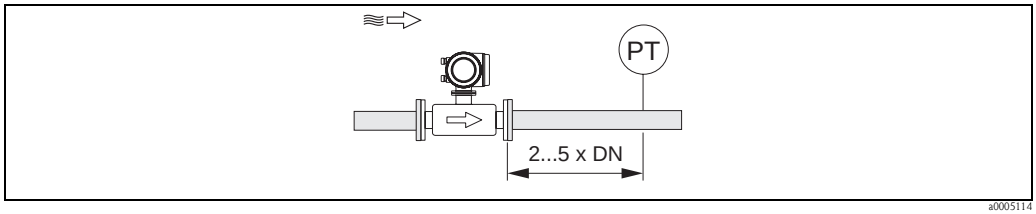


Fig. 5: Installing a pressure measuring point (PT = pressure transmitter)

Perforated plate flow conditioner

It is recommended to install a perforated plate flow conditioner if the recommended inlet runs are not available. See accessories → 📄 69.

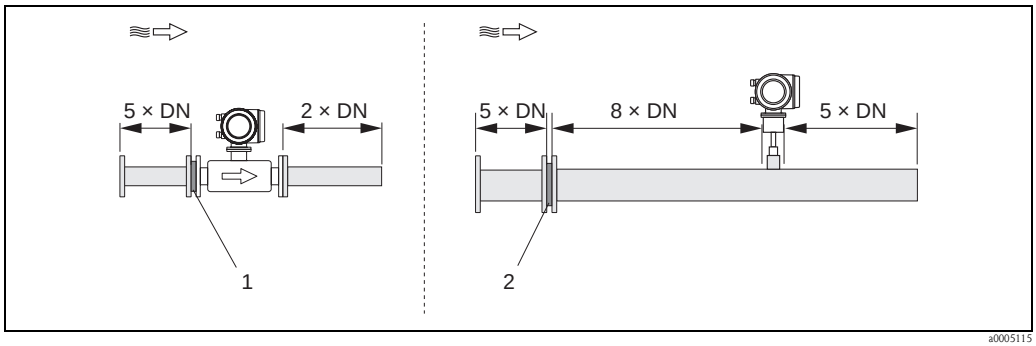


Fig. 6: The figure above illustrates the minimum recommended inlet and outlet runs expressed in multiples of the pipe diameter using a flow conditioner.

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

Flow conditioner for use with insertion sensors

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

Flow conditoner for use with flanged sensors

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

The flow conditioner and gaskets are fitted between two pipe flange and the flow meter flange → 7 .
Use only bolts which match to tehflange bolt hole and this will ensure that the correct positioning of the plate can be found. The alignment notch must also be pointing in the same plane as the transmitter.
Incorrect installation of the flow conditioner will have a small effect on the measurement accuracy.

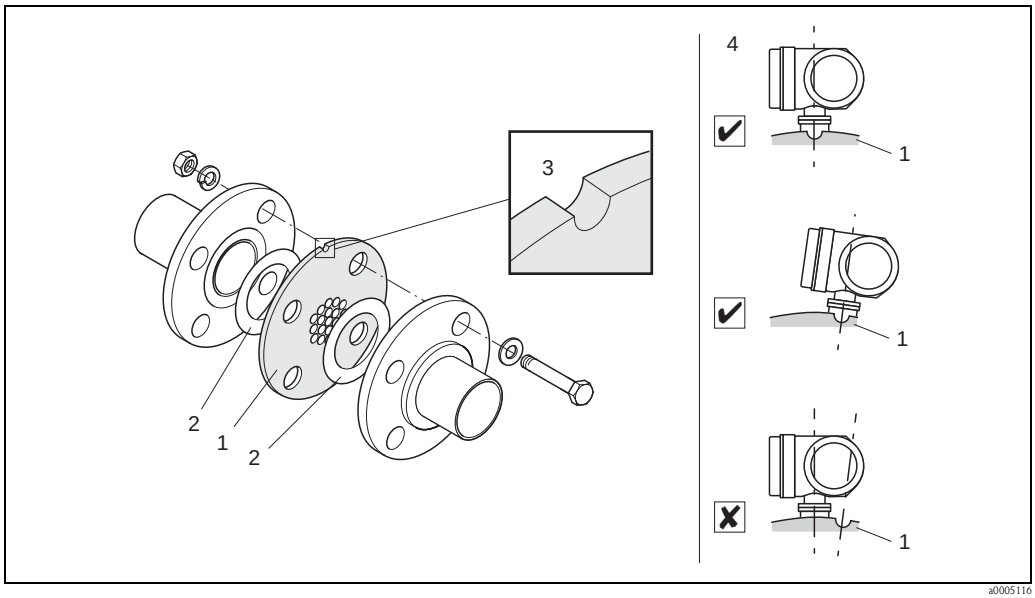


Fig. 7: Flow conditioner mounting arrangement (example)

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

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

3.2.6 Heating

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

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

3.2.7 Thermal insulation

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

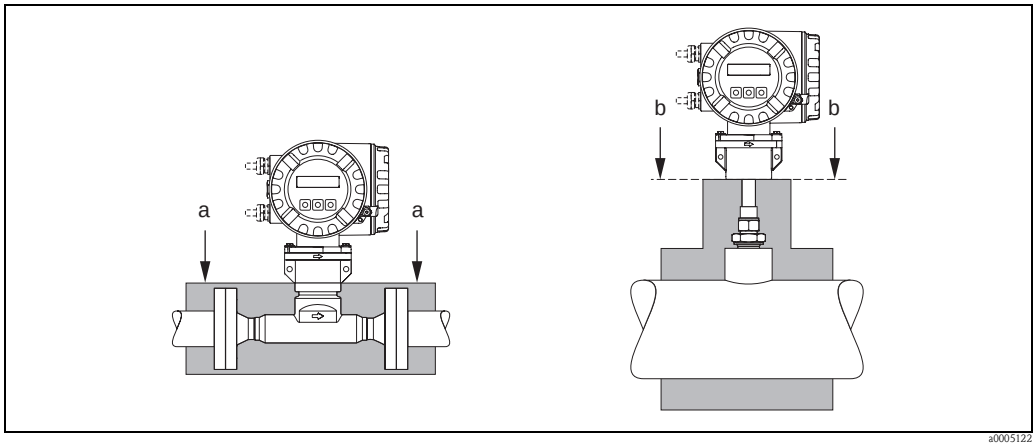


Fig. 8: Maximum thermal insulation for t-mass 65F and 65I

a Maximum insulation height for the flanged sensor
b Maximum insulation height for the insertion sensor

3.2.8 Vibrations

Caution!
Excessive vibration can result in mechanical damage to the measuring device and its mounting. Observe the vibration spezification in the technical data section → 91

3.3 Installation instructions

3.3.1 Mounting the insertion sensor

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

Mounting the welding socket

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

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

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

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

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

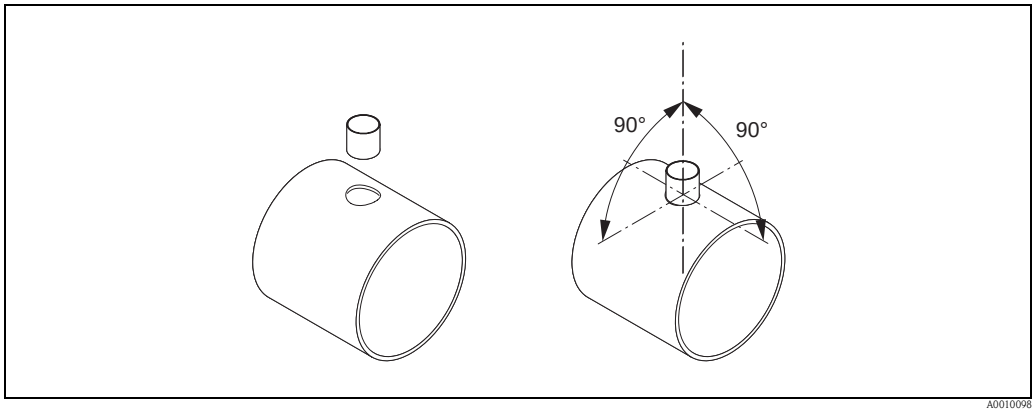


Fig. 9: Positioning the welding socket on the pipe (or duct)

Insertion depth calculation and adjustment

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

4. Calculate the insertion depth:
   – with the help of the Quick Setup "Sensor" → 52 or
   – using the following dimensions and formulae

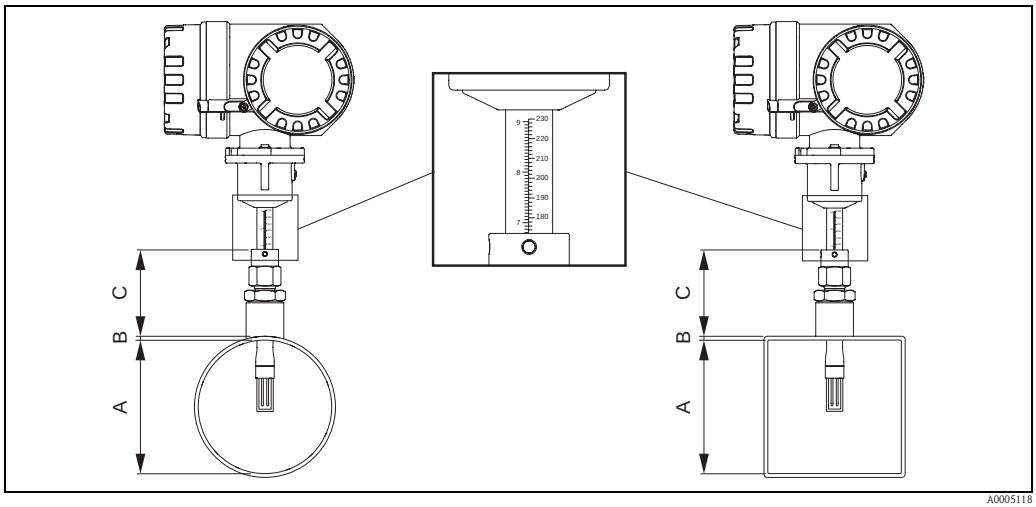


Fig. 10: Dimensions needed to calculate the insertion depth

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

Note!
For detailed remarks on calculation refer to Technical Information TI069D.

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

Note down the calculated value.

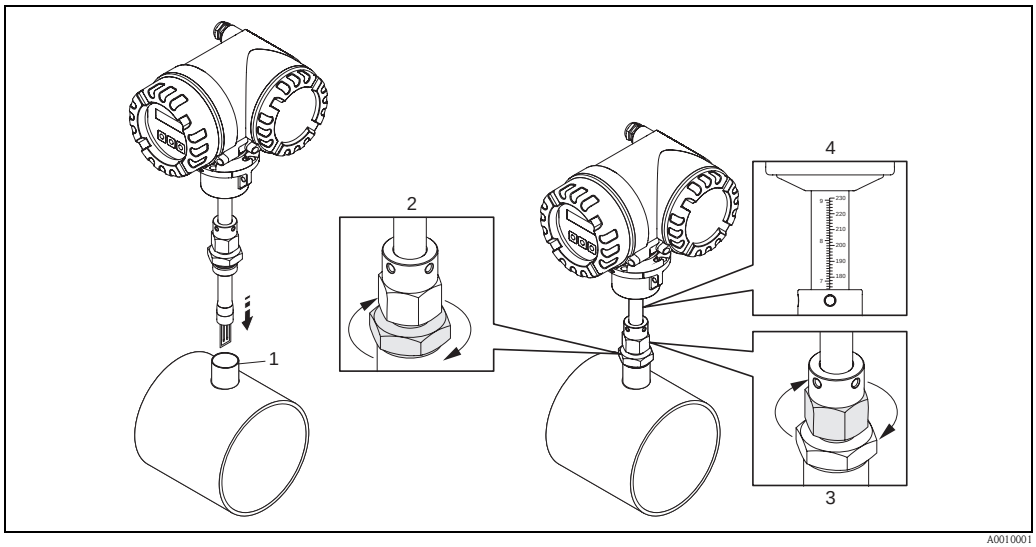


Fig. 11: Aligning the sensor to the calculated insertion depth

5. Insert the sensor into the socket (1) and tighten the lower nut of compression fitting (2) first by hand and then tighten it 1¼ revolutions using a wrench (42 mm).

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

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

Aligning the sensor with the flow direction

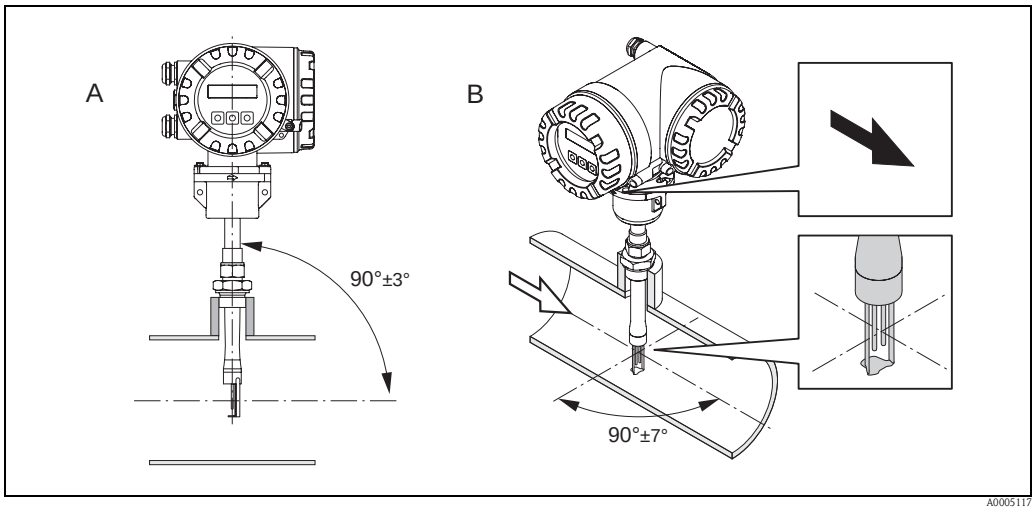


Fig. 12: Aligning the sensor with the flow direction

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

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

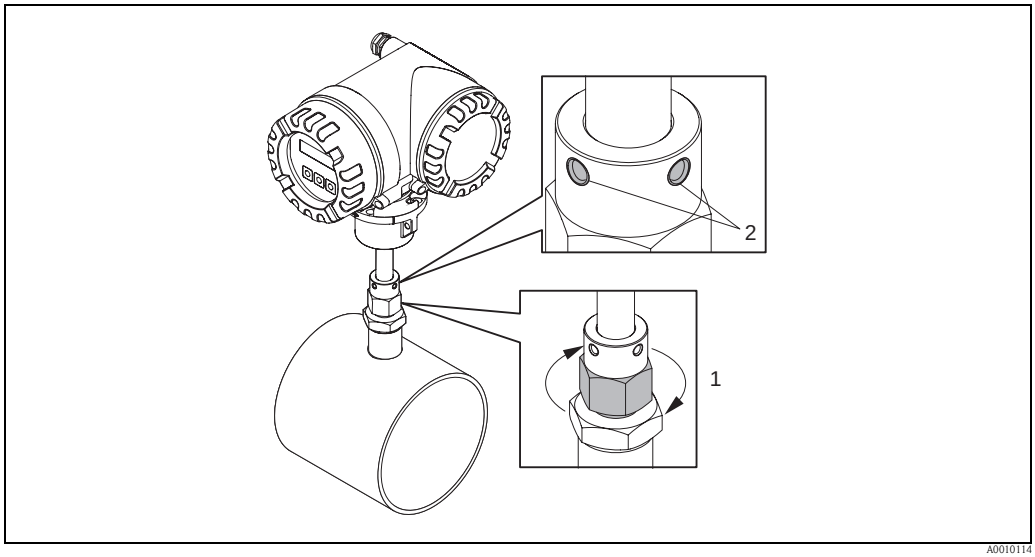


Fig. 13: Securing the position of the sensor

9. Tighten the compression fitting (1) by hand to secure the position of the sensor. Then, using an open-ended wrench, tighten another 1¼ revolutions in a clockwise direction.
10. Fix the two securing screws (2) (Allen key 3 mm; 1/8").

    ⚠ Warning!
    Observe torque: 4 Nm (2.95 lbf ft)
11. Check that the sensor and transmitter do not turn.
12. Check the measuring point for leaks at the maximum operating pressure.

3.3.2 Removing the insertion sensor

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

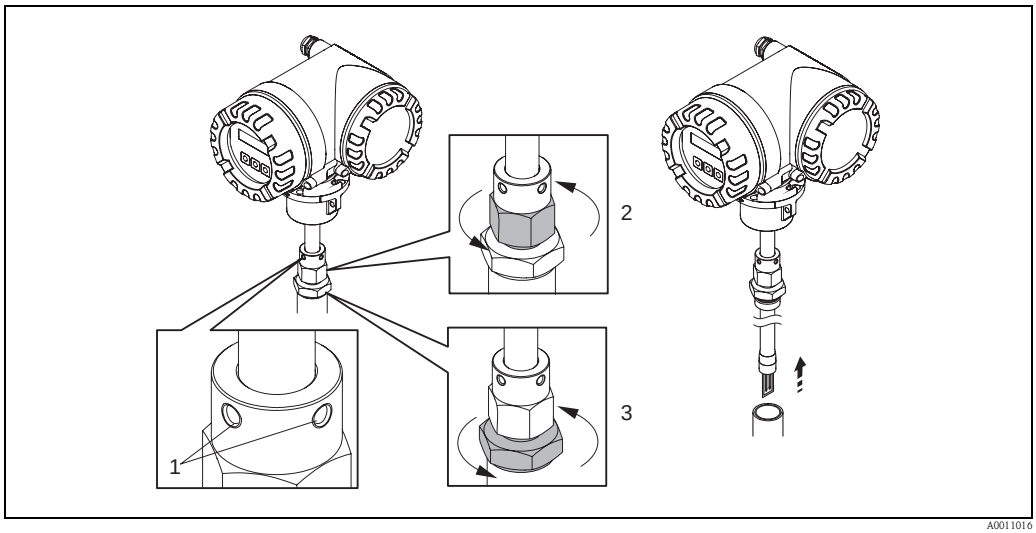


Fig. 14: Removing the insertion sensor

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

   Caution!
   In the case of vertical installation, do not drop the measuring device into the pipe.
3. Unscrew the lower nut of compression fitting (3) and remove the sensor.

3.3.3 Mounting the flanged sensor

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

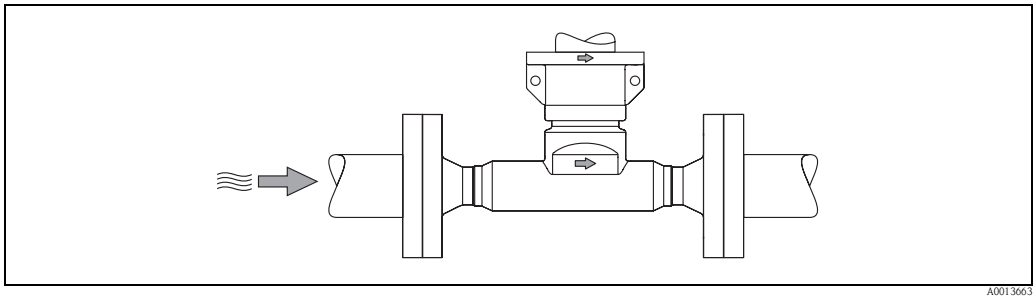


Fig. 15: Mounting in direction of flow

3.3.4 Turning the transmitter housing

Turning the aluminium field housing

Warning!
The rotating mechanism for devices for hazardous areas Zone 1 (ATEX/IEC Ex) or Class I Div. 1 (FM/CSA) is different to that described here. The procedure for turning these housings is described in the Ex-specific documentation → 97.

1. Loosen the two securing screws.

Caution!
Special screw! Do not loosen screw completely or replace with another screw.
Use only original parts from Endress+Hauser.

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

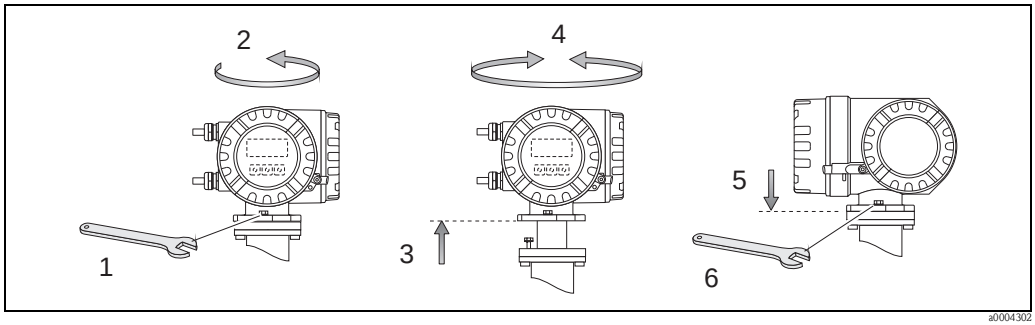


Fig. 16: Turning the transmitter housing (aluminium field housing)

3.3.5 Turning the local display

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Press the side latches on the display module and remove the module from the electronics compartment cover plate.
3. Rotate the display to the desired position (4 × 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.

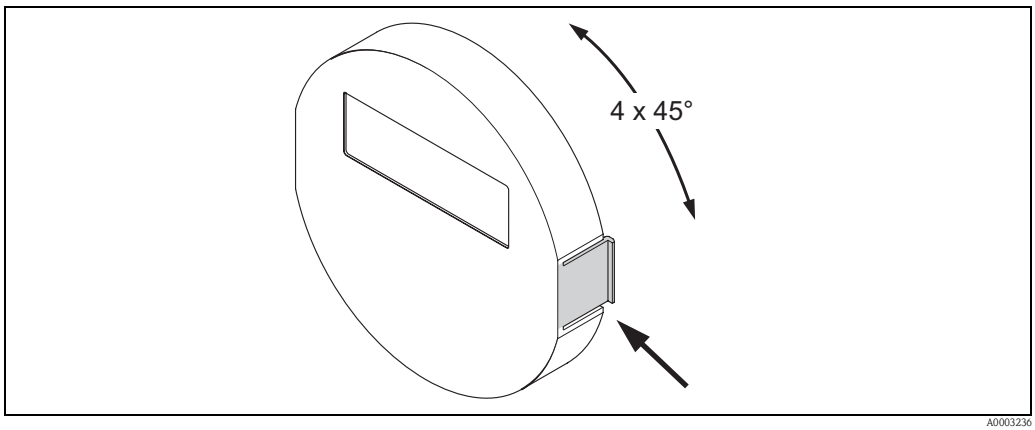


Fig. 17: Turning the local display (field housing)

3.3.6 Installing the wall-mount transmitter housing

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

- Mounted directly on the wall
- Installation in control panel → 📄 25 (separate mounting set, accessories → 📄 69)
- Pipe mounting → 📄 25 (separate mounting set, accessories → 📄 69)

Caution!
- Make sure that ambient temperature does not go beyond the permissible range of – 20 °C to +60 °C (–4 °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 on the display.
- Always install the wall-mount housing in such a way that the cable entries are pointing down.

Mounted directly on the wall

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

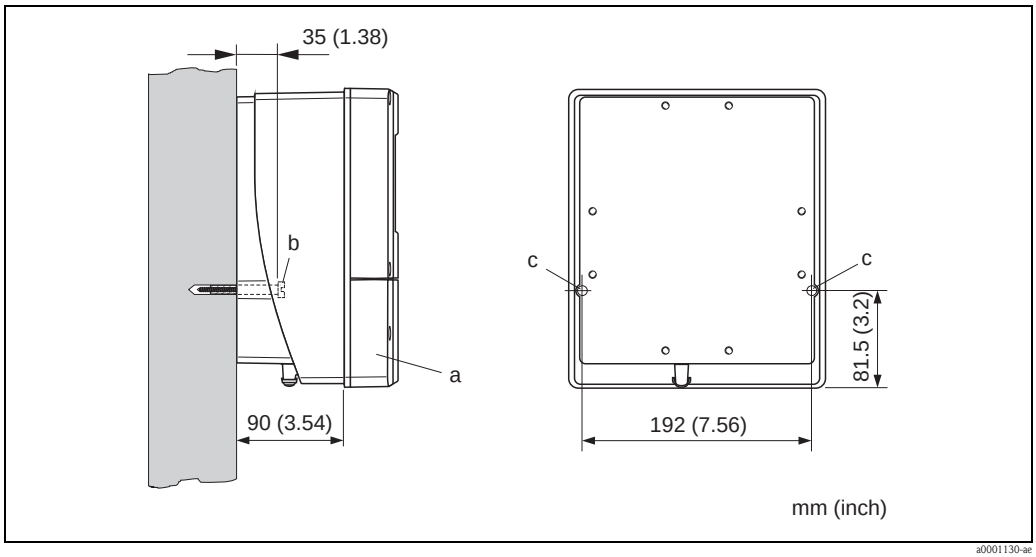


Fig. 18: Mounted directly on the wall

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.

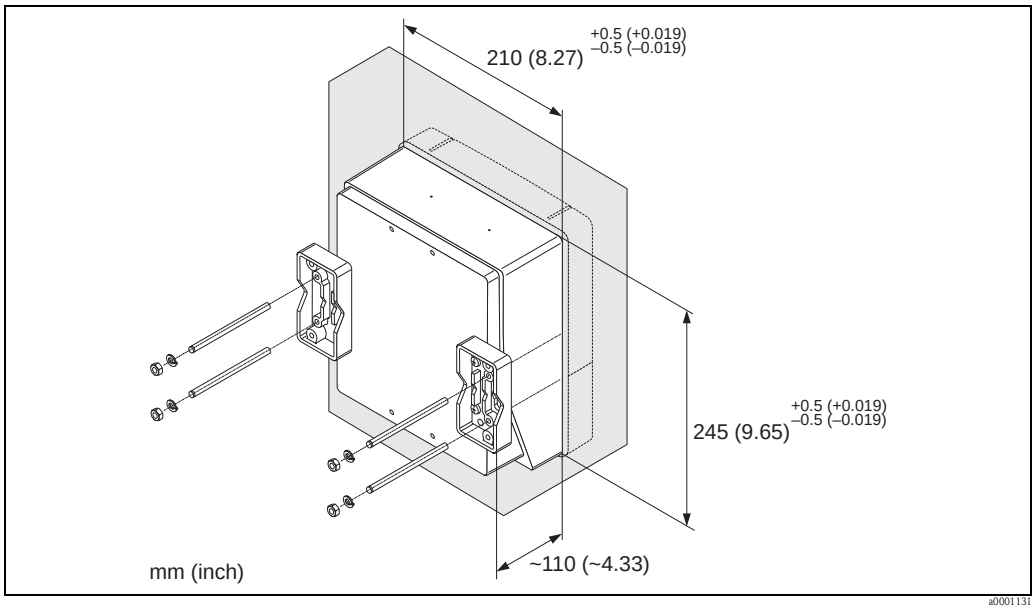


Fig. 19: Panel installation (wall-mount housing)

Pipe mounting

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

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

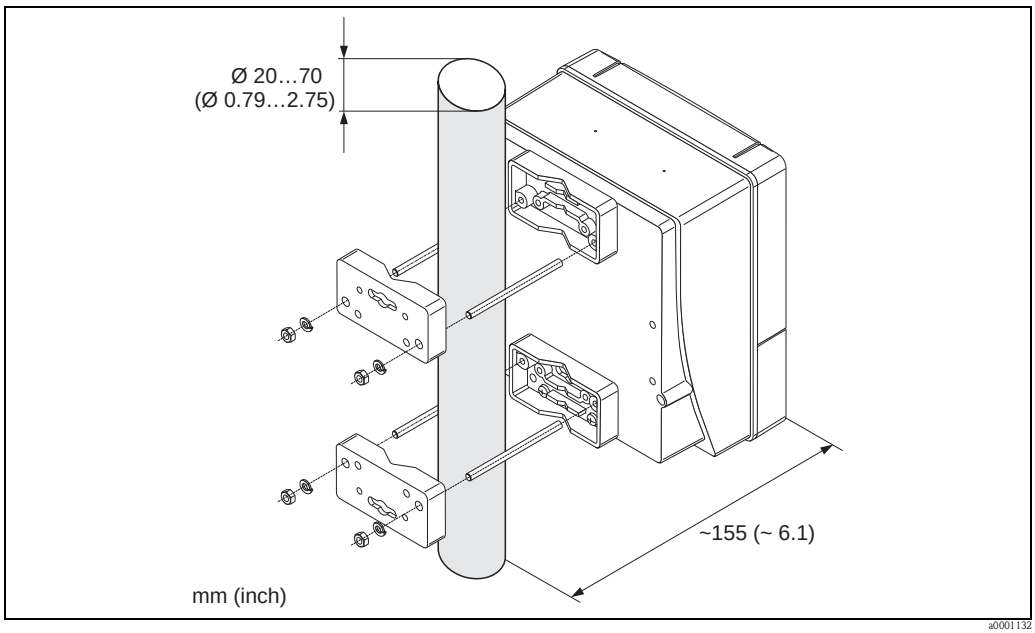


Fig. 20: Pipe mounting (wall-mount housing)

3.4 Post-installation check

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

Device condition and specifications	Notes
Is the device damaged (visual inspection)?	–
Does the device correspond to specifications at the measurement point, including process temperature and pressure, ambient temperature, measuring range, etc.? Check the name plate.	→ 🖹 7
Installation	Notes
Correct alignment of pipe/gasket/flowmeter body?	→ 🖹 13
Professional installation (correct pipe internal diameter, correctly sized gaskets)?	→ 🖹 13
Is the position chosen for the sensor correct, in other words suitable for sensor type, fluid properties and fluid temperature?	→ 🖹 14
Is there sufficient upstream and downstream pipe sensor?	→ 🖹 15
Correct installation of flow conditioner (if fitted)?	→ 🖹 16
Does the arrow on the sensor match the direction of flow through the pipe?	→ 🖹 14
Correct sensor depth (insertion sensor only)?	→ 🖹 19
Process environment / process conditions	Notes
Is the measuring device protected against moisture and direct sunlight?	–
Is the measuring device protected against overheating?	→ 🖹 18
Is the measuring device protected against excessive vibration?	→ 🖹 18, → 🖹 91
Check gas conditions (e. g. purity, dryness, cleanliness)	Select suitable orientation → 🖹 14

4 Wiring

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

Note!
The device does not have an internal power isolation switch. Therefore provide an isolation switch or circuit breaker which can be used to disconnect the power supply to the device.

4.1 Connecting the remote version

4.1.1 Connecting connecting cable for sensor/transmitter

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

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

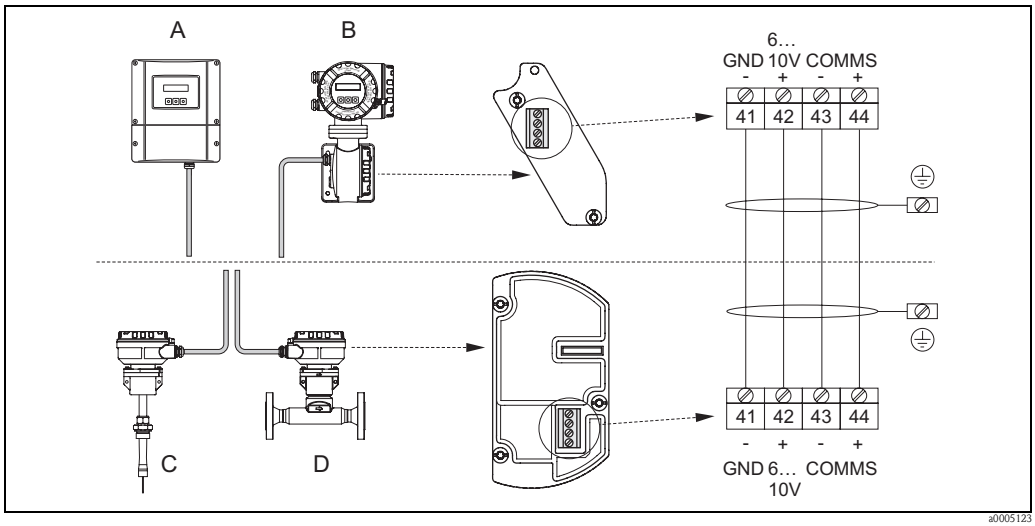


Fig. 21: Connecting the remote version

A Wallmount housing; Non-hazardous area and zone 2 (ATEX II3G, FM/CSA) → see separate "Ex documentation"
B Field housing; Zone 1 (ATEX II2GD, IECEx, FM/CSA) → see separate "Ex documentation"
C Remote sensor insertion
D Remote sensor flanged

Wire colors (when supplied by Endress+Hauser):
Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow

4.1.2 Cable specification, connecting cable

The specifications of the cable connecting the transmitter and the sensor of the remote version are as follows:

- 2 × 2 × 0.5 mm² (AWG 20) PVC cable with common shield (2 twisted pairs)
- Conductor resistance: ≤ 40 Ω/km (≤ 131.2 Ω /1000 ft)
- Operating voltage: ≥ 250 V
- Temperature range: –40 to +105 °C (–40 to +221 °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 → 90.

4.2 Connecting the measuring unit

4.2.1 Transmitter connection

Warning!
- Risk of electric shock. Switch off the power supply before opening the device. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock. Connect the protective earth to the ground terminal on the housing before the power supply is applied 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 (f) from the transmitter housing.
2. Feed the power supply cable (a) and the signal cable (b) through the appropriate cable entries.
3. Perform wiring:
   – Wiring diagram (aluminium housing) → 22
   – Wiring diagram (wall-mount housing) → 23
   – Terminal assignment → 31
4. Screw the cover of the connection compartment (f) back onto the transmitter housing.

Connecting the aluminum field housing

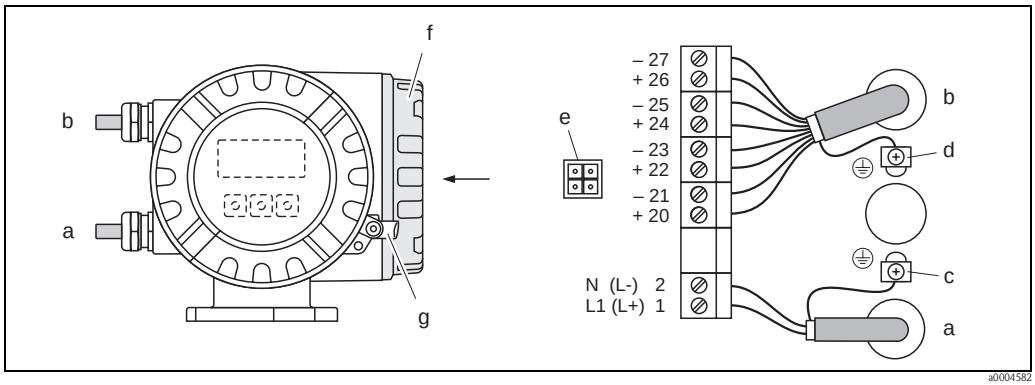


Fig. 22: Connecting the transmitter (aluminum field housing). Wire cross-section: max. 2.5 mm² (AWG 13)

a Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
*b Signal cable: Terminals **Nos. 20-27** → 31*
c Ground terminal for protective earth
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA193 (FieldCheck, FieldCare)
f Cover of the connection compartment
g Securing clamp

Connecting the wall-mount housing

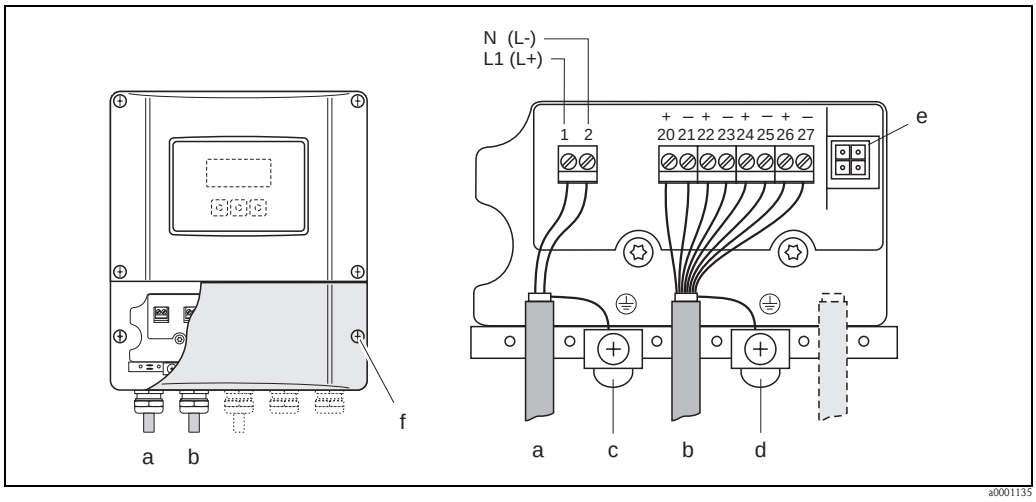


Fig. 23: Connecting the transmitter (wall-mount housing); wire cross-section: max. 2.5 mm² (AWG 13)

a Cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
*b Signal cable: Terminals **Nos. 20-27** → 31*
c Ground terminal for protective earth
d Ground terminal for signal cable shield
e Service adapter for connecting service interface FXA 193 (FieldCheck, FieldCare)
f Cover of the connection compartment

4.2.2 Terminal assignment

Electrical values for inputs

→ 89

Electrical values for outputs

→ 89

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
Fixed communication boards (permanent assignment)				
65F**-**********A 65I-**********A	–	–	Frequency output	Current output, HART
65F**-**********B 65I-**********B	Relay output	Relay output	Frequency output	Current output, HART
65F**-**********R 65I-**********R	–	–	Current output 2, Ex i, aktiv	Current output 1, Ex i, aktiv, HART
65F**-**********S 65I-**********S	–	–	Frequency output, Ex i, passiv	Current output, Ex i, aktiv, HART
65F**-**********T 65I-**********T	–	–	Frequency output, Ex i, passiv	Current output, Ex i, passiv, HART
65F**-**********U 65I-**********U	–	–	Current output 2, Ex i, passiv	Current output 1, Ex i, passiv, HART
Flexible communication boards				
65F**-**********C 65I-**********C	Relay output 2	Relay output 1	Frequency output	Current output, HART
65F**-**********D 65I-**********D	Status input	Relay output	Frequency output	Current output, HART
65F**-**********E 65I-**********E	Status input	Relay output	Current output 2	Current output 1, HART
65F**-**********L 65I-**********L	Status input	Relay output 2	Relay output 1	Current output, HART
65F**-**********2 65I-**********2	Relay output	Current output 2	Frequency output	Current output 1, HART
65F**-**********4 65I-**********4	Current input	Relay output	Frequency output	Current output, HART
65F**-**********5 65I-**********5	Status input	Current input	Frequency output	Current output, HART
65F**-**********6 65I-**********6	Status input	Current input	Current output 2	Current output, HART
65F**-**********8 65I-**********8	Status input	Frequency output	Current output 2	Current output, HART

4.2.3 HART connection

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

Note!
- The measuring circuit's minimum load must be at least 250 Ω.
- The CURRENT SPAN function must be set to "4-20 mA" (individual options see device function).

Connection of the HART handheld communicator

See also the documentation issued by the HART Communication Foundation, and in particular HCF LIT 20: "HART, a technical summary".

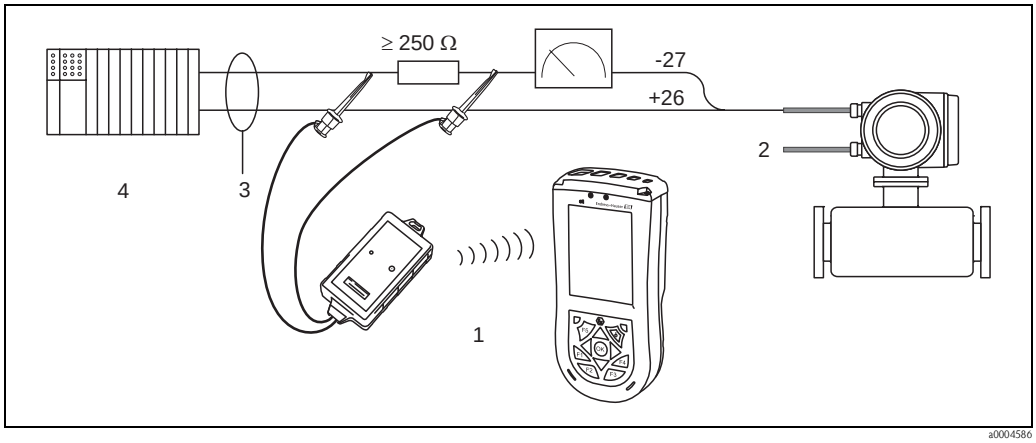


Fig. 24: Electrical connection of HART handheld Field Xpert SFX100

1 HART handheld Field Xpert SFX100
2 Auxiliary energy
3 Shielding
4 Other devices or PLC with passive input

Connection of a PC with an operating software

In order to connect a PC with operating software (e.g. "FieldCare"), a HART modem (e.g. "Commubox FXA191") is needed.

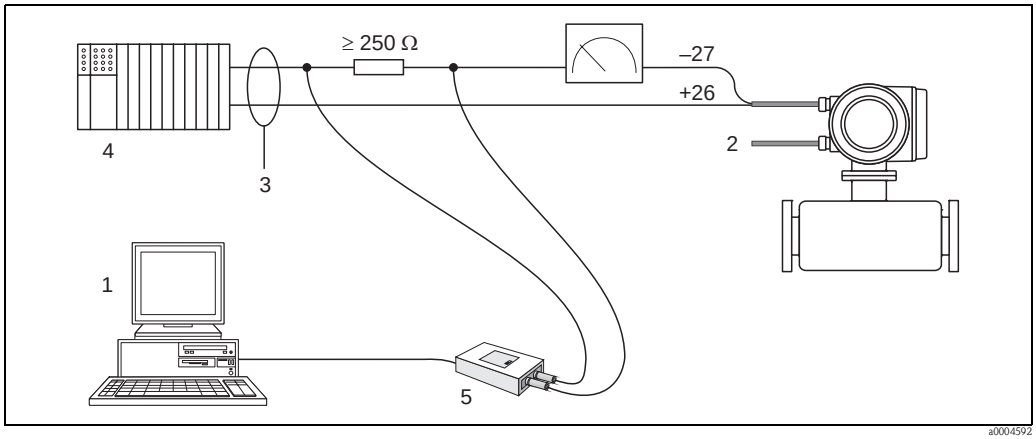


Fig. 25: Electrical connection of a PC with operating software

1 PC with operating software
2 Auxiliary energy
3 Shielding
4 Other devices or PLC with passive input
5 HART modem, e.g. Commubox FXA191

4.3 Degree of protection

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

Compliance with the following points is mandatory following installation in the field or servicing, in order to ensure that IP 67 (NEMA 4X) protection is maintained:
- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- All threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter (Cable entry → 📄 90)
- Firmly tighten the cable entries (a).
- The cables must loop down before they enter the cable entries ("water trap") (b). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert blanking plugs instead.
- Do not remove the grommet from the cable entry.

Fig. 26: Installation instructions, cable entries

4.4 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?	→ 📄 28
Do the cables have adequate strain relief?	-
Cables correctly segregated by type? Without loops and crossovers?	-
Are the power supply and signal cables correctly connected?	See the wiring diagram inside the cover of the terminal compartment
Only remote version: Is the flow sensor connected to the matching transmitter electronics?	Check serial number on nameplates of sensor and connected transmitter.
Only remote version: is the connecting cable between sensor and transmitter connected correctly?	→ 📄 27
Are all screw terminals firmly tightened?	-
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ 📄 33
Are all housing covers installed and firmly tightened?	-

5 Operation

5.1 Display and operating elements

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

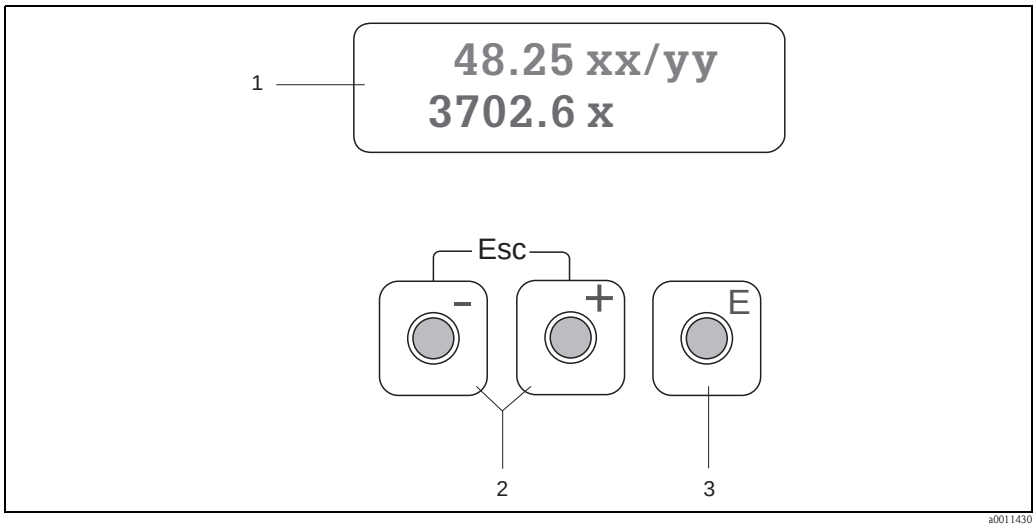


Fig. 27: Display and operating elements

1 Liquid crystal display
The backlit, two-line liquid crystal display shows measured values, dialog texts, fault messages and notice messages. The display as it appears when normal measuring is in progress is known as the HOME position (operating mode).
– Upper display line: shows primary measured values, e.g. mass flow in [kg/h] or in [%].
– Lower display line: shows additional measured variables and status variables, e.g. totalizer reading in [kg], bar graph, measuring point designation.

2 ±/– keys
– Enter numerical values, select parameters
– Select different function groups within the function matrix
Press the ±/– keys simultaneously to trigger the following functions:
– Exit the function matrix step by step → HOME position
– Press and hold down ±/– keys (±/–) for longer than 3 seconds → Return directly to HOME position
– Cancel data entry

3 E Enter key
– HOME position → Entry into the function matrix
– Save the numerical values you input or settings you change

Icons

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

Icon	Meaning	Icon	Meaning
S	System error	P	Process error
ϟ	Fault message (with effect on outputs)	!	Notice message (without effect on outputs)
✜	Low flow cut off or extended flow function is active		

5.2 Brief operating instructions to the function matrix

Note!
- See the general notes → 36.
- Function descriptions → see the "Description of Device Functions" manual

1. HOME position → E → Entry into the function matrix
2. Select a function group (e.g. CURRENT OUTPUT 1)
3. Select a function (e.g. TIME CONSTANT)
   Change parameter / enter numerical values:
   +/− → Select or enter enable code, parameters, numerical values
   E → Save your entries
4. Exit the function matrix:
   – Press and hold down Esc key (Esc) for longer than 3 seconds → HOME position
   – Repeatedly press Esc key (Esc) → Return step by step to HOME position

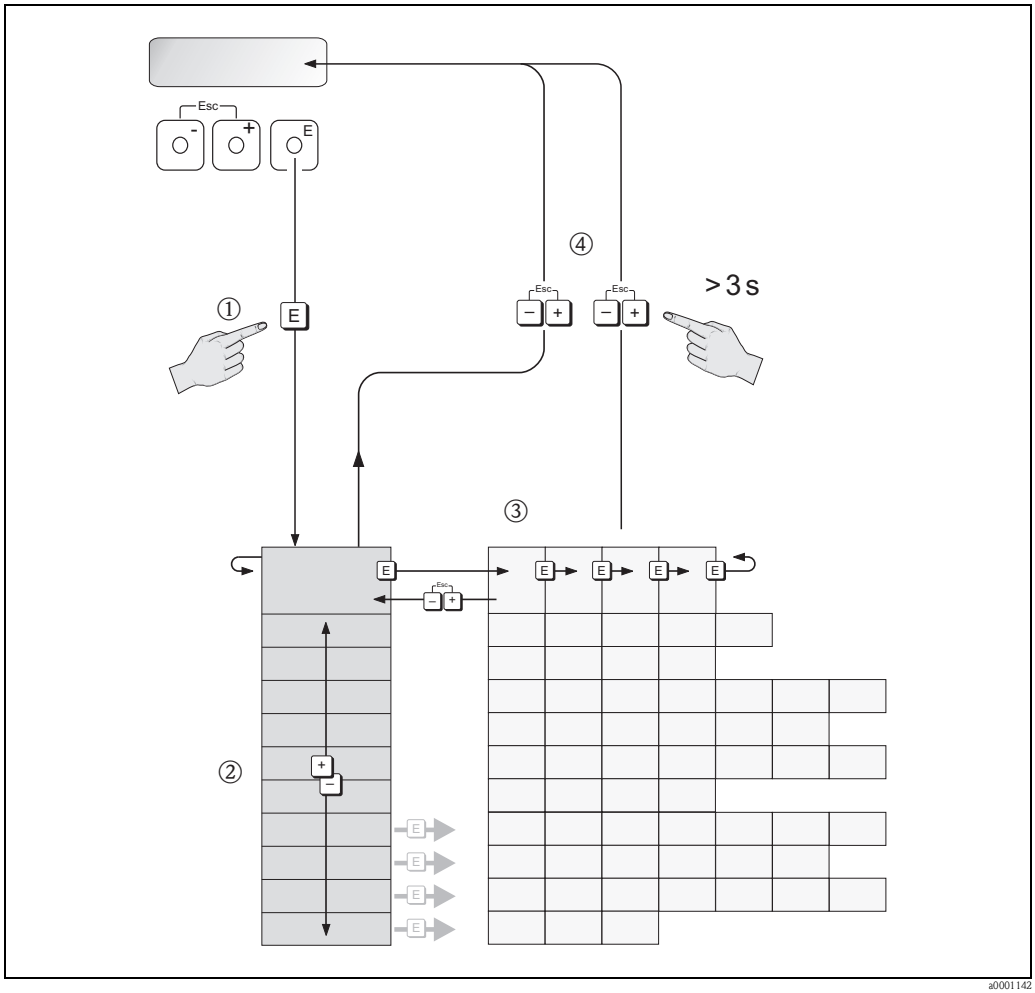


Fig. 28: Selecting functions and configuring parameters (function matrix)

5.2.1 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. → 📄 35
- You can switch off certain functions (OFF). If you do so, related functions in other function groups will no longer be displayed.
- Certain functions prompt you to confirm your data entries. Press ± to select "SURE (YES)" and press E to confirm. This saves your setting or starts a function, as applicable.
- Return to the HOME position is automatic if no key is pressed for 5 minutes.
- Programming mode is disabled automatically if you do not press a key within 60 seconds following automatic return to the HOME position.

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

Note!
- The transmitter continues to measure while data entry is in progress, i.e. the current measured values are output via the signal outputs in the normal way.
- If the 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 interupted during editing or operation of those functions. More details are contained in the "Description of Device Functions" manual, BA112D/06/…

5.2.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 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.

5.2.3 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).

5.3 Error messages

5.3.1 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. → 📄 72
- *Process error:* This group includes all application errors, e.g. flow limit, etc. → 📄 76

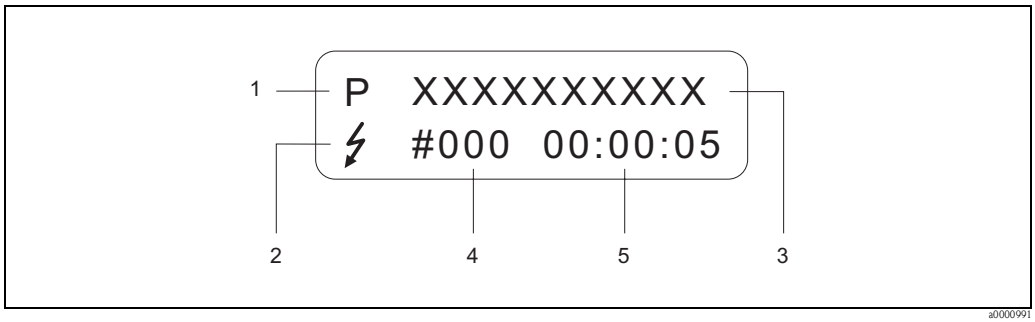


Fig. 29: Error messages on the display (example)

1 Error type: P = process error, S = system error
2 Error message type: ϟ = 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)

5.3.2 Error message type

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

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

Fault message (ϟ)
- Displayed as → Lightning flash (ϟ), error designation (S: system error, P: process error).
- The error in question has a direct effect on the outputs.
  The response of the outputs (failsafe mode) can be defined by means of functions in the function matrix.→ 📄 76

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

5.4 Communication

In addition to local operation, the measuring device can be configured and measured values can be obtained by means of the HART protocol. Digital communication takes place using the 4-20 mA current output HART.→ 32
The HART protocol allows the transfer of measuring and device data between the HART master and the field devices for configuration and diagnostics purposes. The HART master, e.g. a handheld terminal or PC-based operating programs (such as FieldCare), require device description (DD) files which are used to access all the information in a HART device. Information is exclusively transferred using so-called "commands". There are three different command groups:

There are three different command groups:
- *Universal Commands*
  These are associated with the following functionalities for example: Universal commands are supported and used by all HART devices.
  – Recognizing HART devices
  – Reading digital measured values (mass flow, totalizer, etc.)
- *Common practice commands:*
  Common practice commands offer functions which are supported and can be executed by most but not all field devices.
- *Device-specific commands:*
  These commands allow access to device-specific functions which are not HART standard. Such commands access individual field device information, amongst other things, such as low flow cut off settings, etc.

Note!
The measuring device has access to all three command classes.
List of all ''Universal Commands" and "Common Practice Commands": → 40

5.4.1 Operating options

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

Note!
The HART protocol requires the "4 to 20 mA HART" setting (individual options see device function) in the CURRENT SPAN function (current output 1).

Field Xpert HART Communicator

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

FieldCare

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

Operating program "SIMATIC PDM" (Siemens)

SIMATIC PDM is a standardised, manufacturer-independent tool for the operation, configuration, maintenance and diagnosis of intelligent field devices.

Operating program "AMS" device manager (Emerson Process Management)

AMS (Asset Management Solutions): program for operating and configuring field devices

5.4.2 Current device description files

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

HART protocol:

Valid for software:	1.01.XX	→Function "Device software"
Device data HART Manufacturer ID: Device ID:	 17_{hex} (ENDRESS+HAUSER) 65_{hex}	 → Function "Manufacturer ID" → Function "Device ID"
HART version data:	Device Revison 6/ DD Revision 1	
Software release:	10.2009	

Operating program	Sources for obtaining device descriptions
Handheld Field Xpert SFX100	Use update function of handheld terminal
FieldCare / DTM	■ www.endress.com → Download ■ CD-ROM (Endress+Hauser order number 56004088) ■ DVD (Endress+Hauser order number 70100690)
AMS	www.endress.com → Download
SIMATIC PDM	www.endress.com → Download

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

5.4.3 Device and process variables

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

Code (decimal)	Device variable
0	OFF (unassigned)
1	Mass flow
2	Corrected volume flow
3	Temperature
53	Heat flow
250	Totalizer 1
251	Totalizer 2

Process variables:

At the factory, the process variables are assigned to the following device variables:
- Primary process variable (PV) → Mass flow
- Second process variable (SV) → Totalizer 1
- Third process variable (TV) → Temperature
- Fourth process variable (FV) → Corrected volume flow

Note!
You can set or change the assignment of device variables to process variables using Command 51.
→ 40

5.4.4 Universal / Common practice HART commands

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

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
Universal Commands			
0	Read unique device identifier Access type = read	none	Device identification delivers information on the device and the manufacturer. It cannot be changed. The response consists of a 12 - byte- device ID: – Byte 0: fixed value 254 – Byte 1: Manufacturer ID, 17 = Endress+Hauser – Byte 2: Device type ID, e.g. 65 = t-mass 65 – Byte 3: Number of preambles – Byte 4: Universal commands rev. no. – Byte 5: Device-specific commands rev. no. – Byte 6: Software revision – Byte 7: Hardware revision – Byte 8: Additional device information – Byte 9-11: Device identification
1	Read primary process variable Access type = read	none	– Byte 0: HART unit code of the primary process variable – Bytes 1-4: Primary process variable *Factory setting:* Primary process variable = Mass flow Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ Manufacturer-specific units are represented using the HART unit code "240".
2	Read the primary process variable as current in mA and percentage of the set measuring range Access type = read	none	– Bytes 0-3: Actual current of the primary process variable in mA – Bytes 4-7: Percentage of the set measuring range *Factory setting:* Primary process variable = Mass flow Note! You can set the assignment of device variables to process variables using Command 51.
3	Read the primary process variable as current in mA and four (preset using Command 51) dynamic process variables Access type = read	none	24 bytes are sent as a response: – Bytes 0-3: Primary process variable current in mA – Byte 4: HART unit code of the primary process variable – Bytes 5-8: Primary process variable – Byte 9: HART unit code of the second process variable – Bytes 10-13: Second process variable – Byte 14: HART unit code of the third process variable – Bytes 15-18: Third process variable – Byte 19: HART unit code of the fourth process variable – Bytes 20-23: Fourth process variable *Factory setting:* ■ Primary process variable = Mass flow ■ Second process variable = Totalizer 1 ■ Third process variable = Temperature ■ Fourth process variable = Corrected volume flow Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ Manufacturer-specific units are represented using the HART unit code "240".

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
6	Set HART shortform address Access type = write	Byte 0: desired address (0 to 15) *Factory setting:* 0 ✎ Note! With an address >0 (multidrop mode), the current output of the primary process variable is set to 4 mA.	Byte 0: active address
11	Read unique device identification using the TAG (measuring point designation) Access type = read	Bytes 0-5: TAG	Device identification delivers information on the device and the manufacturer. It cannot be changed. The response consists of a 12 - byte- device ID if the given TAG agrees with the one saved in the device: – Byte 0: fixed value 254 – Byte 1: Manufacturer ID, 17 = Endress+Hauser – Byte 2: Device type ID, 65 = t-mass 65 – Byte 3: Number of preambles – Byte 4: Universal commands rev. no. – Byte 5: Device-specific commands rev. no. – Byte 6: Software revision – Byte 7: Hardware revision – Byte 8: Additional device information – Byte 9-11: Device identification
12	Read user message Access type = read	none	Bytes 0-24: User message ✎ Note! You can write the user message using Command 17.
13	Read TAG, descriptor and date Access type = read	none	– Bytes 0-5: TAG – Bytes 6-17: Descriptor – Byte 18-20: Date ✎ Note! You can write the TAG, descriptor and date using Command 18.
14	Read sensor information on primary process variable	none	– Bytes 0-2: Sensor serial number – Byte 3: HART unit code of sensor limits and measuring range of the primary process variable – Bytes 4-7: Upper sensor limit – Bytes 8-11: Lower sensor limit – Bytes 12-15: Minimum span ✎ Note! ■ The data relate to the primary process variable (= Mass flow). ■ Manufacturer-specific units are represented using the HART unit code "240".
15	Read output information of primary process variable Access type = read	none	– Byte 0: Alarm selection ID – Byte 1: Transfer function ID – Byte 2: HART unit code for the set measuring range of the primary process variable – Bytes 3-6: Upper range, value for 20 mA – Bytes 7-10: Start of measuring range, value for 4 mA – Byte 11-14: Attenuation constant in [s] – Byte 15: Write protection ID – Byte 16: OEM dealer ID, 17 = Endress+Hauser *Factory setting:* Primary process variable = Mass flow ✎ Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ Manufacturer-specific units are represented using the HART unit code "240".

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
16	Read the device production number Access type = read	none	Bytes 0–2: Production number
17	Write user message Access = write	You can save any 32-character long text in the device under this parameter: Bytes 0–23: Desired user message	Displays the current user message in the device: Bytes 0–23: Current user message in the device
18	Write TAG, descriptor and date Access = write	With this parameter, you can store an 8 character TAG, a 16 character descriptor and a date: – Bytes 0–5: TAG – Bytes 6–17: Descriptor – Byte 18–20: Date	Displays the current information in the device: – Bytes 0–5: TAG – Bytes 6–17: Descriptor – Byte 18–20: Date

The following table contains all the common practice commands supported by the device.

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
Common Practice Commands			
34	Write damping value for primary process variable Access = write	Bytes 0–3: Damping value of the primary process variable in seconds *Factory setting:* Primary process variable = Mass flow	Displays the current damping value in the device: Bytes 0–3: Damping value in seconds
35	Write measuring range of primary process variable Access = write	Write the desired measuring range: – Byte 0: HART unit code of the primary process variable – Bytes 1–4: Upper range, value for 20 mA – Bytes 5–8: Start of measuring range, value for 4 mA *Factory setting:* Primary process variable = Mass flow ✎ Note! ■ You can set the assignment of device variables to process variables using Command 51. ■ If the HART unit code is not the correct one for the process variable, the device will continue with the last valid unit.	The currently set measuring range is displayed as a response: – Byte 0: HART unit code for the set measuring range of the primary process variable – Bytes 1–4: Upper range, value for 20 mA – Bytes 5–8: Start of measuring range, value for 4 mA ✎ Note! Manufacturer-specific units are represented using the HART unit code "240".
38	Device status reset (Configuration changed) Access = write	none	none
40	Simulate output current of primary process variable Access = write	Simulation of the desired output current of the primary process variable. An entry value of 0 exits the simulation mode: Byte 0–3: Output current in mA *Factory setting:* Primary process variable = Mass flow ✎ Note! You can set the assignment of device variables to process variables with Command 51.	The momentary output current of the primary process variable is displayed as a response: Byte 0–3: Output current in mA
42	Perform master reset Access = write	none	none

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
44	Write unit of primary process variable Access = write	Set unit of primary process variable. Only unit which are suitable for the process variable are transferred to the device: Byte 0: HART unit code *Factory setting:* Primary process variable = Mass flow Note! ■ If the written HART unit code is not the correct one for the process variable, the device will continue with the last valid unit. ■ If you change the unit of the primary process variable, this has no impact on the system units.	The current unit code of the primary process variable is displayed as a response: Byte 0: HART unit code Note! Manufacturer-specific units are represented using the HART unit code "240".
48	Read additional device status Access = read	none	The device status is displayed in extended form as the response: Coding: see table → 45
50	Read assignment of the device variables to the four process variables Access = read	none	Display of the current variable assignment of the process variables: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable *Factory setting:* ■ Primary process variable: Code 1 for mass flow ■ Second process variable: Code 250 for totalizer 1 ■ Third process variable: Code 3 for temperature ■ Fourth process variable: Code 2 for corrected volume flow Note! You can set the assignment of device variables to process variables with Command 51.
51	Write assignments of the device variables to the four process variables Access = write	Setting of the device variables to the four process variables: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable *Code of the supported device variables:* See data → 39 *Factory setting:* ■ Primary process variable = Mass flow ■ Second process variable = Totalizer 1 ■ Third process variable = Temperature ■ Fourth process variable = Corrected volume flow	The variable assignment of the process variables is displayed as a response: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
53	Write device variable unit Access = write	This command sets the unit of the given device variables. Only those units which suit the device variable are transferred: – Byte 0: Device variable code – Byte 1: HART unit code *Code of the supported device variables:* See data → 39 Note! ■ If the written unit is not the correct one for the device variable, the device will continue with the last valid unit. ■ If you change the unit of the device variable, this has no impact on the system units.	The current unit of the device variables is displayed in the device as a response: – Byte 0: Device variable code – Byte 1: HART unit code Note! Manufacturer-specific units are represented using the HART unit code "240".
59	Write number of preambles in response message Access = write	This parameter sets the number of preambles which are inserted in the response messages: Byte 0: Number of preambles (2 to 20)	As a response, the current number of the preambles is displayed in the response message: Byte 0: Number of preambles

5.4.5 Device status / Error messages

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

Note!
You can find a detailed explanation of the device status and error messages and their elimination in the "System error messages" section. → 71

Byte-bit	Error No.	Short error description → 71
0-0	001	Serious device error
0-1	011	Measuring amplifier has faulty EEPROM
0-2	012	Error when accessing data of the measuring amplifier EEPROM
0-3	not assigned	–
0-4	014	Amplifier: Defective ROM/RAM
0-5	031	HistoROM/S-DAT: Defective or missing
0-6	032	HistoROM/S-DAT: Error accessing saved values
0-7	not assigned	–
1-0	not assigned	–
1-1	035	Sensor: Defective ROM/RAM
1-2	036	Sensor: Defective ROM/RAM
1-3	not assigned	–
1-4	042	HistoROM/T-DAT: Error accessing saved values
1-5	051	I/O board and the amplifier board are not compatible
1-6	not assigned	–
1-7	not assigned	–
2-0	not assigned	–
2-1	070	Flow sensors are likely to be defect, measurement is no longer possible
2-2	not assigned	–
2-3	not assigned	–
2-4	111	Totalizer checksum error
2-5	not assigned	–
2-6	not assigned	–
2-7	not assigned	–
3-0	not assigned	–
3-1	not assigned	–
3-2	not assigned	–
3-3	not assigned	–
3-4	251	Internal communication fault on the amplifier board
3-5	261	No data reception between amplifier and I/O board
3-6	not assigned	–
3-7	351	Current output: Flow is out of range
4-0	352	
4-1	not assigned	–
4-2	not assigned	–
4-3	355	Frequency output: Flow is out of range
4-4	356	

Byte-bit	Error No.	Short error description → 🖹 71
4-5	not assigned	–
4-6	not assigned	–
4-7	359	Pulse output: Pulse output frequency is out of range
5-0	360	Pulse output: Pulse output frequency is out of range
5-1	not assigned	–
5-2	not assigned	–
5-3	363	Current input: The actual value for the current input is outside the set range
5-4	not assigned	–
5-5	not assigned	–
5-6	not assigned	–
5-7	not assigned	–
6-0	372	The measured sensor differential temperature is below limit value
6-1	not assigned	–
6-2	not assigned	–
6-3	not assigned	–
6-4	not assigned	–
6-5	not assigned	–
6-6	not assigned	–
6-7	381	The minimum fluid temperature limit for the transducer has been exceeded
7-0	382	The maximum fluid temperature limit for the transducer has been exceeded
7-1	422	The flow has exceeded the maximum measuring limit
7-2	not assigned	–
7-3	not assigned	–
7-4	not assigned	–
7-5	not assigned	–
7-6	not assigned	–
7-7	451	The saved zero point is inaccurate possibly due to unstable process or flow conditions
8-0	501	New amplifier or communication (I/O module) software version is being loaded. Currently no other functions are possible
8-1	502	Up- or downloading the device data via configuration program. Currently no other functions are possible
8-2	561	Zero point adjustment function is active
8-3	601	Positive zero return active
8-4	611	Simulation current output active
8-5	612	Simulation current output active
8-6	not assigned	–
8-7	not assigned	–
9-0	621	Simulation frequency output active
9-1	622	Simulation frequency output active
9-2	not assigned	–
9-3	not assigned	–
9-4	631	Simulation pulse output active
9-5	632	Simulation pulse output active
9-6	not assigned	–

Byte-bit	Error No.	Short error description → 🗎 71
9-7	not assigned	–
10-0	641	Simulation status output active
10-1	642	Simulation status output active
10-2	not assigned	–
10-3	not assigned	–
10-4	651	Simulation relay output active
10-5	652	Simulation relay output active
10-6	not assigned	–
10-7	not assigned	–
11-0	661	Simulation current input active
11-1	not assigned	–
11-2	not assigned	–
11-3	not assigned	–
11-4	671	Simulation status input active
11-5	672	Simulation status input active
11-6	not assigned	–
11-7	not assigned	–
12-0	691	Simulation of response to error (outputs) active
12-1	692	Simulation of measuring variables (e.g. mass flow)
12-2	698	The measuring device is being checked on-site via the test and simulation device (FieldCheck)
12-3	not assigned	–
12-4	not assigned	–
12-5	not assigned	–
12-6	not assigned	–
12-7	not assigned	–

5.4.6 Switching HART write protection on and off

A jumper on the I/O board provides the means of switching HART write protection on or off.

Note!
This function is not available for the fixed I/O boards (see Terminal Assignment → 31). The write protection is OFF (default).

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 → 80
3. Switch HART write protection on or off, as applicable, by means of the jumper (→ 30).
4. Installation of the I/O board is the reverse of the removal procedure.

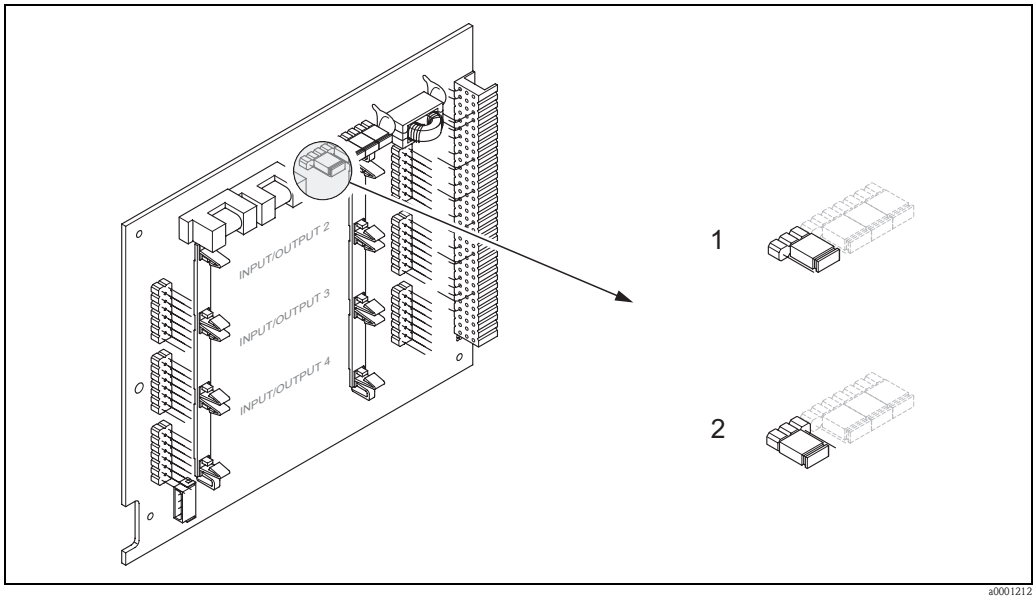


Fig. 30: Switching HART write protection on and off

1 Write protection OFF (default), that is: HART protocol unlocked
2 Write protection ON, that is: HART protocol locked

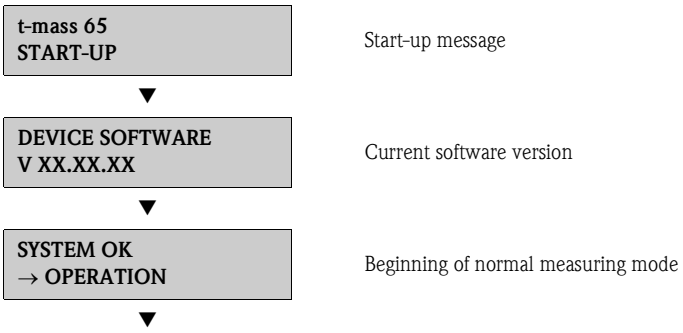
6 Commissioning

6.1 Function check

Make sure that all final checks have been completed before you start up your measuring point:
- Checklist for "Post-installation check" → 26
- Checklist for "Post-connection check" → 33

6.2 Switching on the measuring device

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



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

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

6.3 Quick Setup

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

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

6.3.1 Quick Setup "Commissioning"

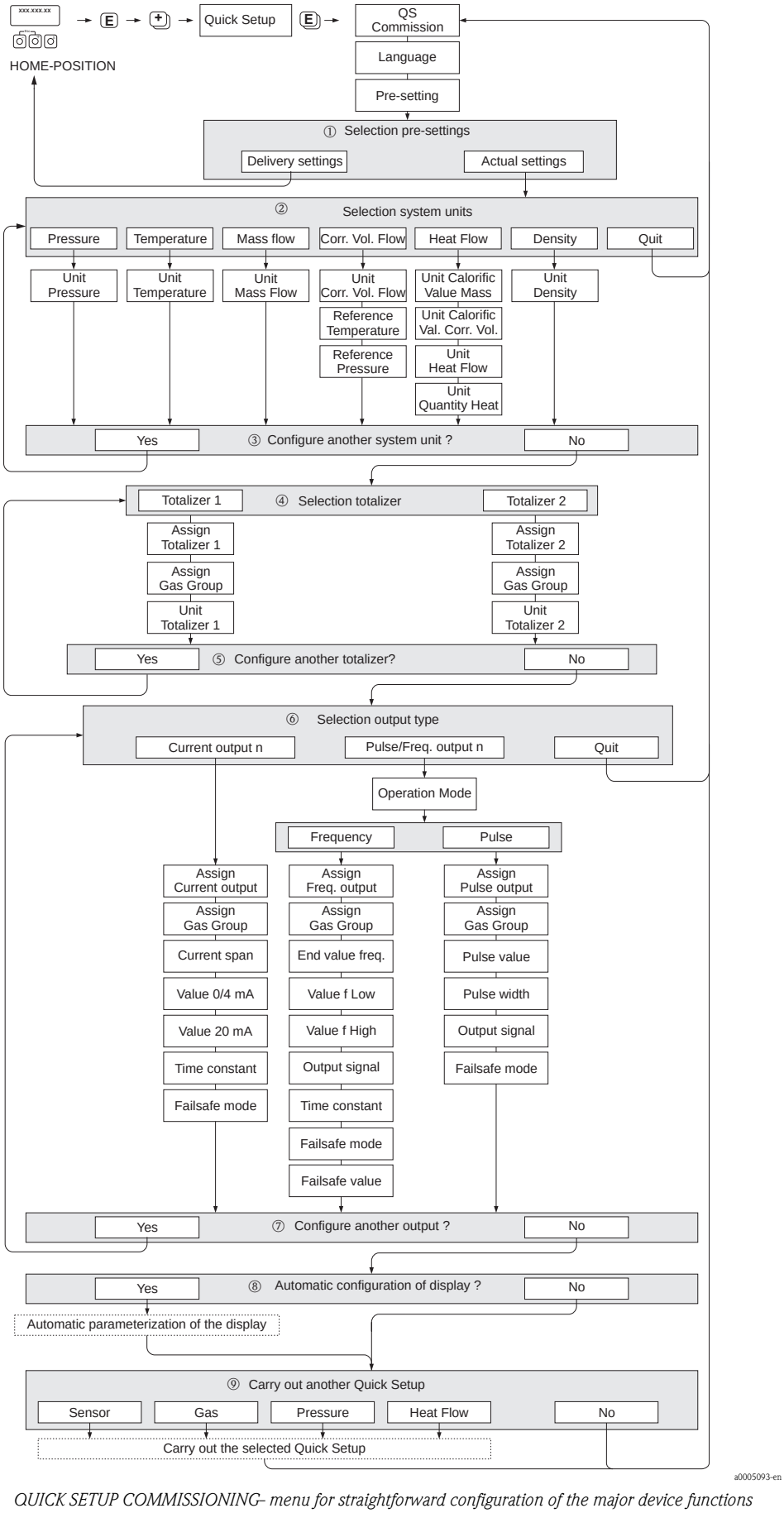


Fig. 31: QUICK SETUP COMMISSIONING- menu for straightforward configuration of the major device functions

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

QUICK SETUP - COMMISSION

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

LANGUAGE

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

SELECTION TOTALIZER.

④ Select a totalizer and assign a flow variable, gas group and unit.

⑤ Configure another totalizer? Select YES to setup a second totalizer or NO to continue.

SELECTION OUTPUT.

Select output type and parameterize available options or select QUIT to return to QUICK SETUP function.

Note!
With the function ASSIGN GAS GROUP, the measured value from each GAS GROUP can be assigned to an individual output or, alternatively, both gas groups can be assigned to one current output using the selection GAS GROUP 1 & 2.

⑥ Only the outputs not yet configured in the current setup are offered for selection in each cycle.
Additional outputs are available if fitted on the device.

⑦ The YES option remains visible until all the outputs have been parameterized. NO is the only option displayed when no further outputs are available.

Automatic configuration of the display

⑧ 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.

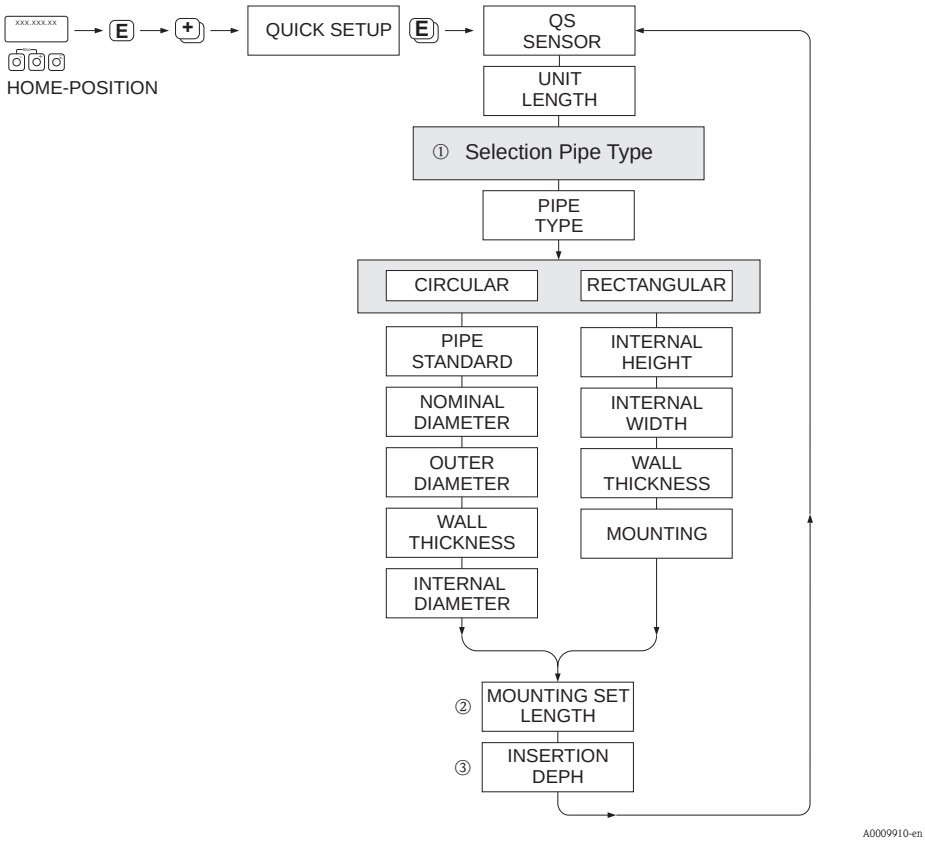
Carry out another Quick Setup?

⑨ Select additional Quick Setups to complete commissioning or select NO to exit.

6.3.2 Quick Setup "Sensor"

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

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



PIPE TYPE

① ■ CIRCULAR
- in case that the pipe is of a standard type, then parameterize functions PIPE STANDARD and NOMINAL DIAMETER
- In case that the pipe is a non-standard type, then select OTHERS in the function PIPE STANDARD and parameterize the functions WALL THICKNESS and OUTER DIAMETER.
- The function INTERNAL DIAMETER displays the calculated internal diameter and is read only.

■ RECTANGULAR
- Enter the INTERNAL HEIGHT, INTERNAL WIDTH and WALL THICKNESS of the duct
- Select the MOUNTING orientation of the sensor: HORIZONTAL or VERTICAL

MOUNTING SET LENGTH

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

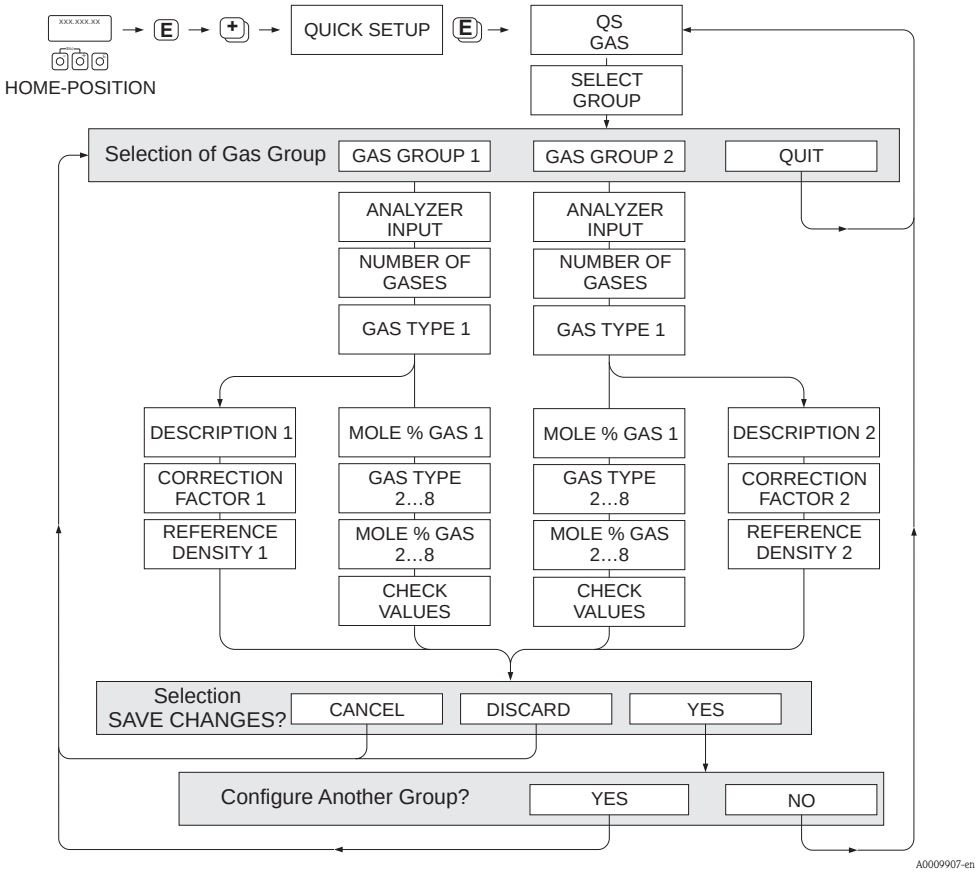
INSERTION DEPTH

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

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

6.3.3 "Gas" Quick Setup menu

The device can be setup with 1 or 2 individual gas groups in memory. This means that up to 2 different gas flow streams (e.g. nitrogen and argon) can be measured in a single pipe with one flowmeter.
In the case of 2 gas groups being used, a digital input can be assigned to switch between the gas groups or, alternatively, the switch can be done manually via a function in the device software. Furthermore, a programmed gas mixture can be dynamically updated, via a signal from a gas analyzer.



Programming a gas group

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

A gas group can be programmed as:
– one single gas or
– one gas mixture (of up to 8 components)

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

Setting or viewing the active gas group

The active measuring group can be set via 2 methods:

1. Digital input: the status input can be configured to switch between the two groups. Select option GAS GROUP (see "Description of Device Functions" manual BA112D/06/…).
2. Manual switch: go to the function SELECT GROUP and simply select 1 or 2 and then exit using ESC (+/- keys simultaneously). No save function is necessary.

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

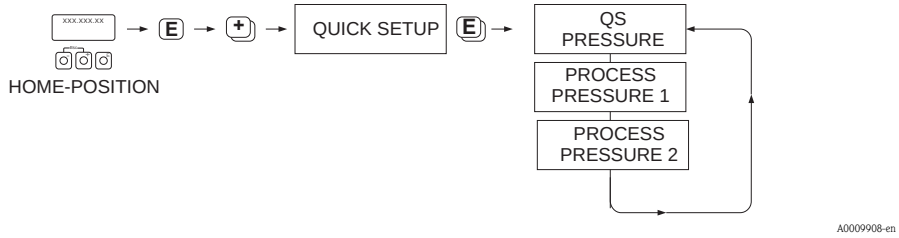
Performing the Quick Setup

1. GAS GROUP
   Use the + or - key to select the required GAS GROUP and continue with E.
   – Set the ANALYZER INPUT to ON if a gas compensation input is being used → 59
   – select the NUMBER OF GASES in the group from 1 to 8
   – select the GAS TYPE from the choose list.
   – enter the MOLE % for each GAS TYPE (only if NUMBER OF GASES is 2 and more).
   – The error message CHECK VALUES appears if the total mixture % does not equal 100%. Go back and check the mixture settings.
2. SAVE CHANGES?
   – Select YES to save changes to the GAS GROUP and activate them. Press E to continue or
   – Select CANCEL to save the entered settings in buffer memory but not activate them for measurement. If this function is selected, then it will be necessary to come back to this gas group and save it at a later stage.
   – Select DISCARD to clear the last changes and return to CONFIGURE GROUP to make new settings.
3. ANOTHER GAS GROUP?
   – Select YES to continue to the CONFIGURE GROUP function. Use the + or - key to select another group and proceed as per above instructions.
   – Select NO to exit to the Quick Setup.

Note!
You can find more detailed information on the GAS GROUP programming in the separate "Description of Device Functions" manual BA112D/06/… see chapter GAS 1/2.

6.3.4 "Pressure" Quick Setup menu

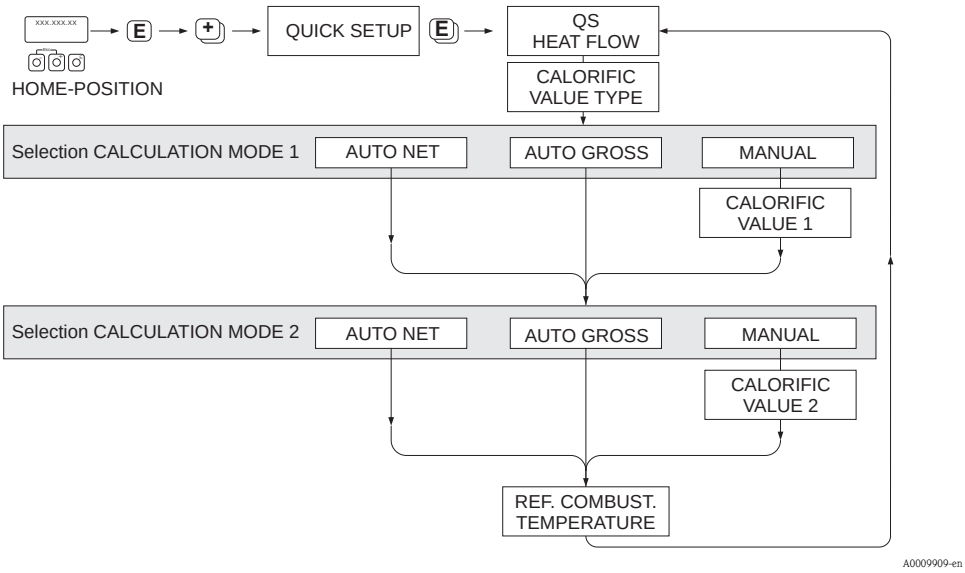
Use this Quick Setup to program the individual process pressure for each gas group. If only one gas group is being used, then only the function PROCESS PRESSURE 1 needs to be programmed, PROCESS PRESSURE 2 can remain with default settings.



Note!
- The device operates with absolute pressure only. Convert any gauge pressures to absolute pressure.
- If a pressure compensating input is being used, then the input signal value overrides the manually programmed value. The pressure input value applies to both gas groups. i.e. 2 independent pressure values are no longer possible.
- This Quick Setup Gas function is not available if an in-situ calibration function has been performed on the device as the in-situ calibration curve refers to the sensor power at each recorded flow point. Therefore, the programmed pressure settings become redundant → 68.

6.3.5 "Heat Flow" Quick Setup menu

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



Calculation mode 1 and 2

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

Note!
- If only one gas group is used, then leave mode 2 as default settings.
- The units of measure are selected in the system units section → 50.

Auto Gross

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

Auto Net

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

Manual

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

Gas	Formula	Net/lower heating value		Gross/upper heating value	
		[Mj/kg]	MBtu/lb	[Mj/kg]	MBtu/lb
Hydrogen	H_2	119.91	51.56	141.78	60.97
Ammonia	NH_3	18.59	7.99	22.48	9.67
Carbon Monoxide	CO	10.1	4.34	10.1	4.34
Hydrogen Sulphide	H_2S	15.2	6.54	19.49	8.38
Methane	CH_4	50.02	21.51	55.52	23.87
Ethane	C_2H_6	47.5	20.43	51.93	22.33
Propane	C_3H_8	46.32	19.92	50.32	21.64
Butane	C_4H_{10}	45.71	19.66	49.51	21.29
Ethylene	C_2H_4	47.16	20.28	50.31	21.63

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

Reference combustion temperature

The following reference temperatures are used:

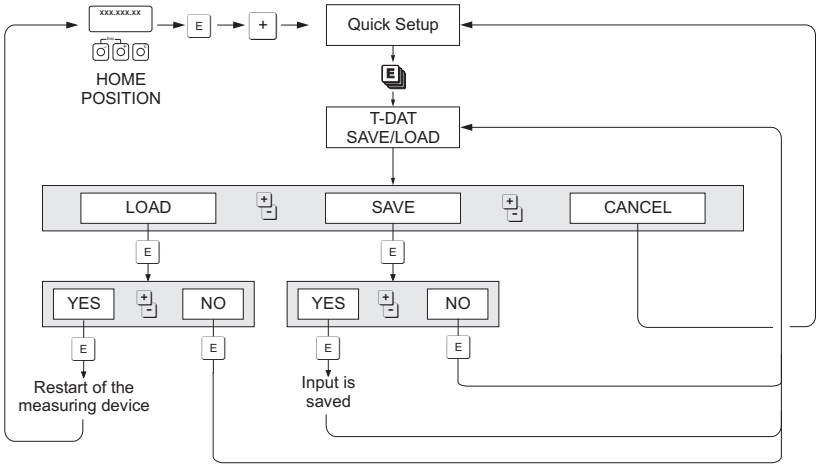
Country	reference combustion temperature
Austria, Belgium, Denmark, Germany, Italy, Luxembourg, The Netherlands, Poland, Russia, Sweden, Switzerland	25 °C
Brazil, China	20 °C
France, Japan	0 °C
Australia, Canada, Czech Republic, Hungary, India, Ireland, Malaysia, Mexico, South Africa, Great Britain	15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

6.3.6 Data backup/transmission

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

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

Note!
For information on installing and removing the T-DAT → 80



a0001221-en

Fig. 32: Data backup/transmission with T-DAT SAVE/LOAD function

Information on the LOAD and SAVE options available

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

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

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

6.3.7 External pressure compensation input

1. Install the pressure transmitter downstream of the flowmeter according to the pipe work requirements → 13. Use only an absolute range pressure cell.
2. Connect the signal circuit, noting the following:
   – Input signal information → 88
   – Configure the active/passive mode on the flexible I/O board → 61
   – The t-mass transmitter can power the current loop (active mode) or a separate 24 VDC power supply can be used (passive mode)
   – Refer to the terminal assignments and grounding for the current input → 29.
   – Use only a screened signal cable.
3. Turn on the power to the flowmeter and signal circuit.
4. Go to the CURRENT INPUT function in the software matrix and assign the option PRESSURE to the input and parameterize the remaining functions as required.
5. Check that the mA input signal is present from the pressure transmitter:
   go to the function ACTUAL CURRENT INPUT in the function group CURRENT INPUT

✎ Note!
This function will not compensate for extremely rapid pressure pulsations (<0.5 seconds).

6.3.8 Gas compensation input

The flowmeter can directly read a 4-20 mA output signal from a gas analyzer and automatically update the the first two gas components (e.g. GAS TYPE 1 and 2) in the programmed gas mixture. This provides a more accurate measurement in case of varying compositions. For example: varying methane and carbon dioxide components in a bio gas application.

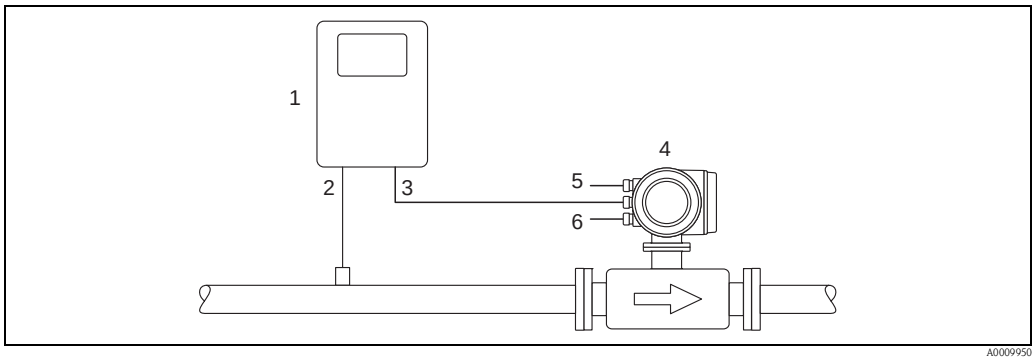


Fig. 33: Gas mixture compensation using a gas analyzer

1 Gas analyzer
2 Gas detector
3 Out/in 4-20 mA signal
4 t-mass
5 Power supply
6 Outputs

1. Route the analyzer output signal for the main gas component (e.g. Methane) to the t-mass transmitter current input.
2. Connect the signal circuit, noting the following:
   – Input signal information → 88
   – Configure the active/passive mode on the flexible I/O board → 61
   – Refer to the terminal assignments and grounding for the current input → 29.
   – Use only a screened signal cable.
3. Turn on the power to the flowmeter and analyzer signal circuit.
4. Go to the function CURRENT INPUT → ASSIGN CURRENT INPUT in the software matrix and assign the option GAS ANALYZER to the input. Parameterize the remaining functions as required.

5. Check that the mA input signal is present from the analyzer:
   go to the function ACTUAL CURRENT INPUT in the function group CURRENT INPUT
6. Check the actual % value of the main gas component being transmitted from the analyzer:
   – Go to the function MOLE % GAS 1 in the function group PROCESS PARAMETER.
   – If the value is present and updating then the system is working correctly.
   – If the value is not updating, check that the function ANALYZER INPUT is set to ON (function group GAS → 53).

✎ Note!
See Description of Device Functions BA112D/06 manual for details.

6.4 Configuration

6.4.1 One current output: active/passive

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

Note!
It is not possible to change the "active" or "passive" configuration of "Ex-i" outputs. See order variants → 31.

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 → 80
3. Set the jumpers in accordance with → 34

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

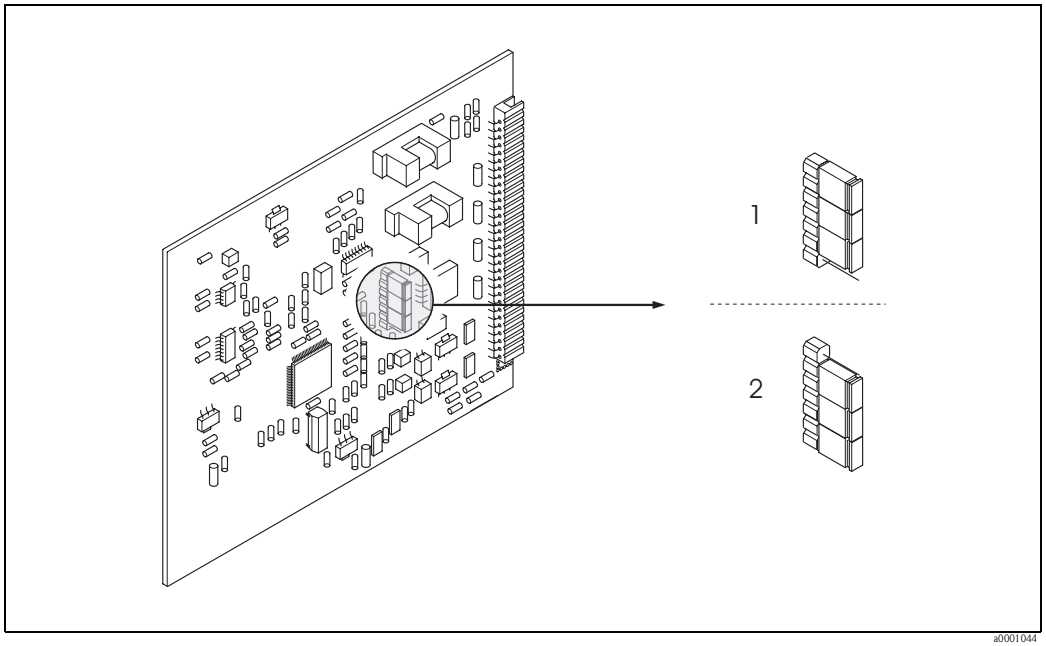


Fig. 34: Configuring the current output (fixed I/O board)

1 Active current output (default)
2 Passive current output

6.4.2 Two current outputs: active/passive

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

Note!
It is not possible to change the "active" or "passive" configuration of "Ex-i" outputs. See order variants → 31.

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 → 80
3. Set the jumpers → 35

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

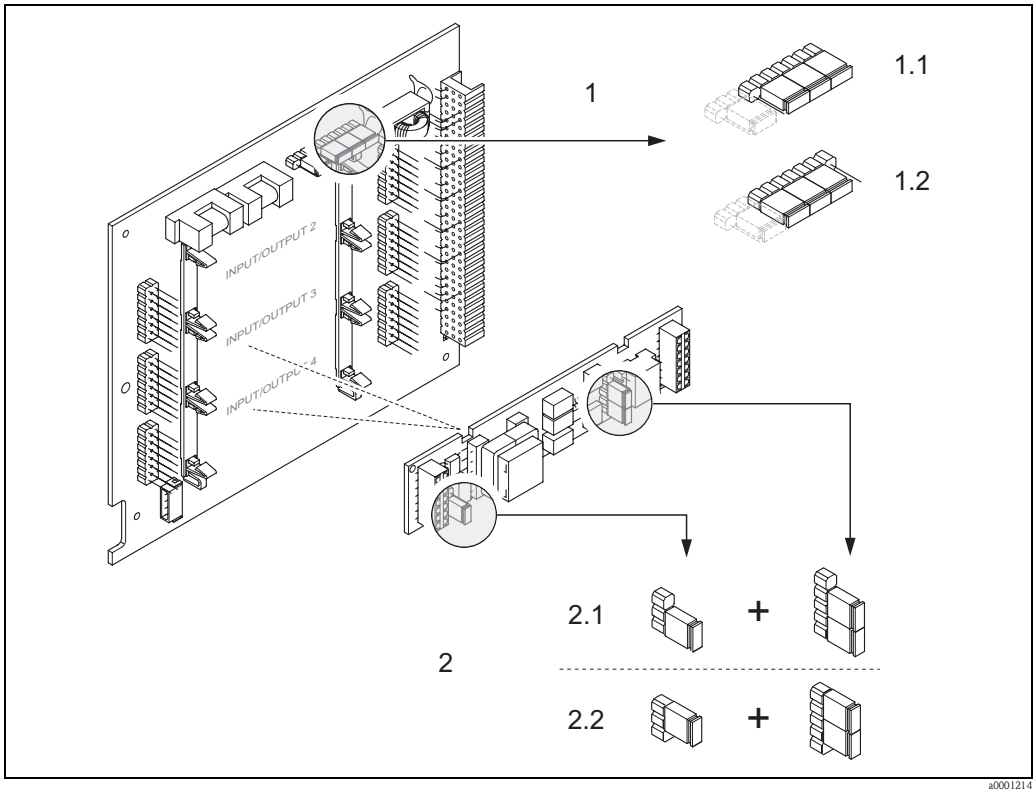


Fig. 35: Configuring current outputs with the aid of jumpers (flexible I/O board)

1 Current output 1 with HART
1.1 Active current output (default)
1.2 Passive current output
2 Current output 2 (optional, plug-in module)
2.1 Active current output (default)
2.2 Passive current output

6.4.3 Current input: active/passive

The current inputs are configured as "active" or "passive" by means of various jumpers on the current input submodule.

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

1. Switch off power supply
2. Remove the I/O board → 80
3. Set the jumpers → 36

   Caution!
   – Risk of destroying the measuring device. Set the jumpers exactly as shown in the diagram. Incorrectly set jumpers can cause overcurrents that would destroy either the measuring device or external devices connected to it.
   – Note that the position of the current submodule on the I/O board can vary, depending on the version ordered, and that the terminal assignment in the connection compartment of the transmitter varies accordingly. → 31
4. Installation of the I/O board is the reverse of the removal procedure.

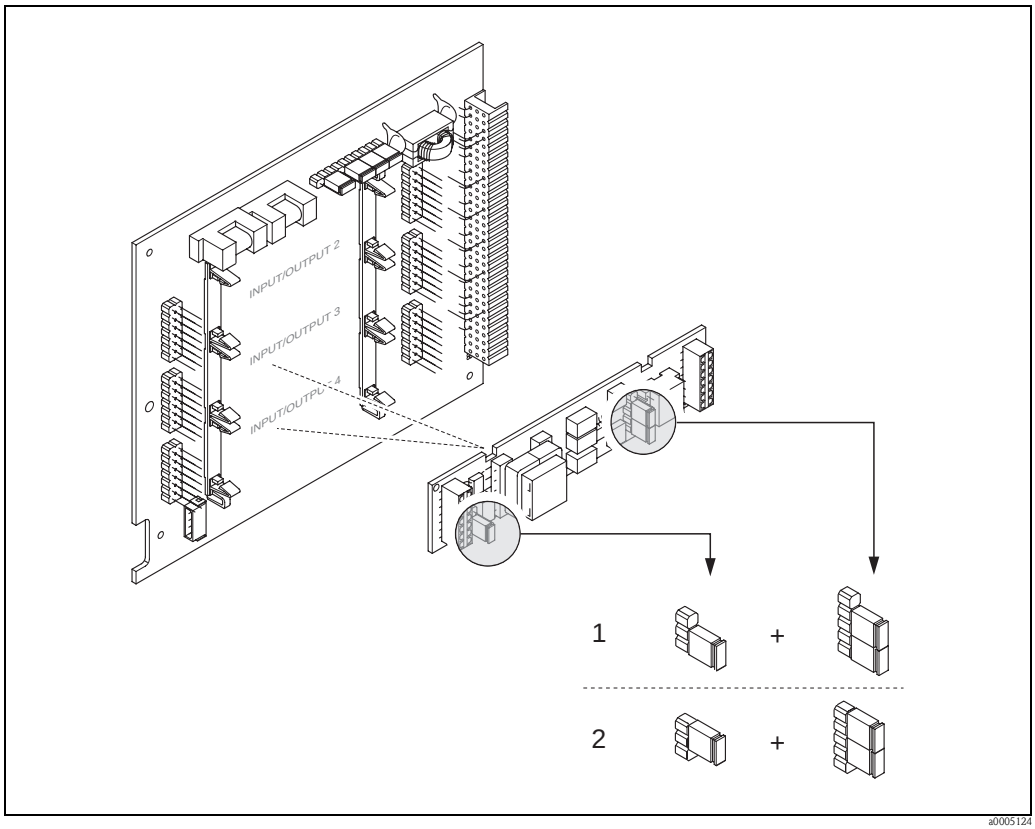


Fig. 36: Configuring current inputs with the aid of jumpers (flexible I/O board)

Current input 1 (optional, plug-in module)
1 Active current input (default)
2 Passive current input

6.4.4 Relay contacts: Normally closed/Normally open

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

⚠ 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 → 📄 80
3. Set the jumpers → 📄 37 or → 📄 38

   ☝ Caution!
   – If you change the setting you must always change the positions of **both** jumpers! Note precisely the specified positions of the jumpers.
   – Note that the position of the relay submodule on the flexible I/O board can vary, depending on the version ordered, and that the terminal assignment in the connection compartment of the transmitter varies accordingly. → 📄 31
4. Installation of the I/O board is the reverse of the removal procedure.

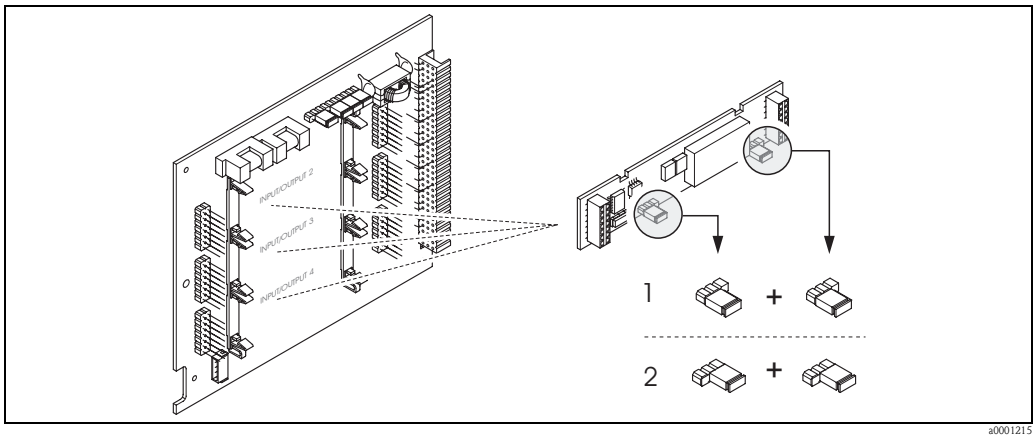


Fig. 37: Configuring relay contacts (NC / NO) on the flexible I/O board (submodule).

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

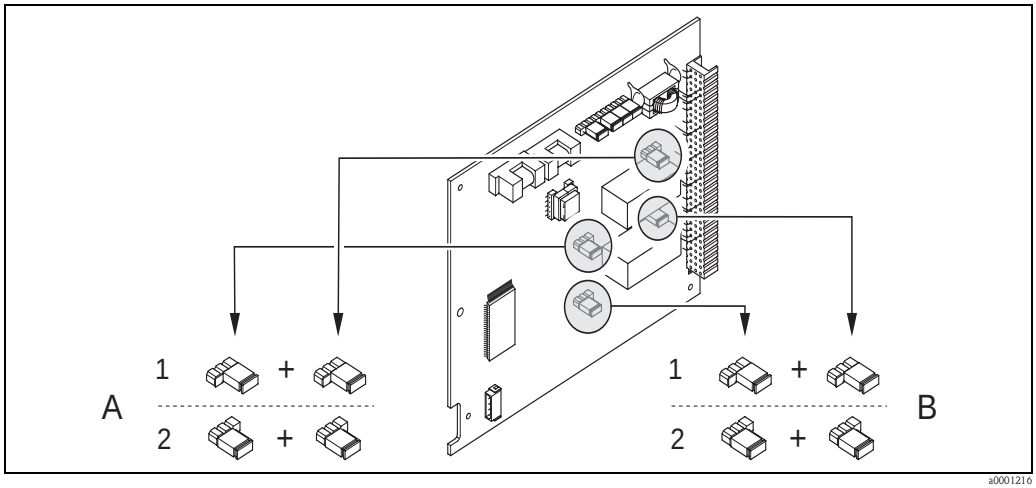


Fig. 38: Configuring relay contacts (NC / NO) on the fixed I/O board.A = relay 1; B = relay 2

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

6.5 Adjustment

6.5.1 Zero point adjustment

Calibration takes place under reference operating conditions. (→ 📄 90).
Consequently, the zero point adjustment is generally **not** necessary!
At zero flow conditions, the output of most thermal mass flow devices has a strong dependency on the process pressure. The effect on the true zero point of the device, by the static line pressure, is dependant on the gas type and the application demands and in many cases the use of the low flow cut-off function is adequate to zero the device output.

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

Therefore, the zero point adjustment is advisable in the following special cases:
- To achieve highest measuring accuracy with very small flow rates.
- Under process or operating conditions where the gas properties (heat capacity and thermal conductivity) will change e.g. Hydrogen and Helium.

Preconditions for a zero point adjustment

Note the following before you perform a zero point adjustment:
- A zero point adjustment can be performed only with gases that contain no solid contents or condensate.
- The adjustment is performed with the process gas at zero flow and at operating pressure. This can be achieved, for example, with shut-off valves upstream and/or downstream of the sensor.
  – Normal operation → valves 1 and 2 open
  – Zero point adjustment *with* pump pressure → Valve 1 open / valve 2 closed
  – Zero point adjustment *without* pump pressure → Valve 1 closed / valve 2 open

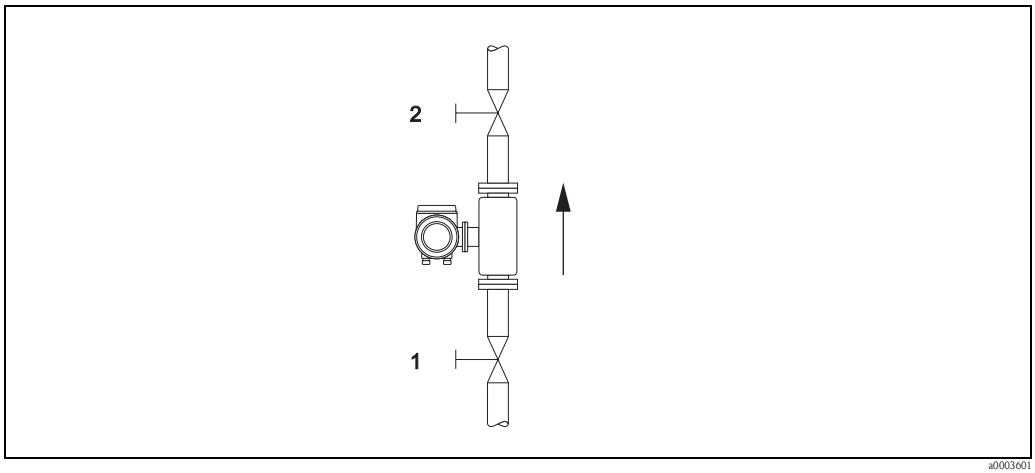


Fig. 39: Zero point adjustment and shut-off valves

Note!
You can view the currently valid zero point value using the ZERO POINT function in the SENSOR DATA group (see the "Description of Device Functions" manual, BA012D/06/…).

Performing a zero point adjustment

1. Operate the system until operating conditions have settled.
2. Stop the flow (v = 0 m/s).
3. Check the shut-off valves for leaks.
4. Check that operating pressure is correct.
5. Using the local display, select the ZEROPOINT ADJUSTMENT function in the function matrix: PROCESS PARAMETER → ZERO POINT ADJUST
6. When you press ⊞ 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. The zero point adjustment now starts and is completed within a few seconds.

   ✎ Note!
   If the flow in the pipe is unstable, the following error message may appear on the display "ZERO ADJUST FAIL". The zero point adjustment has failed. The preconditions need to be stabilised 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.
Use ⊞ or ⊟ to select RESET and press Ⓔ to confirm. The zero point adjustment is now reset.

6.6 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.

6.6.1 HistoROM/S-DAT (sensor-DAT)

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

6.6.2 HistoROM/T-DAT (transmitter-DAT)

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

7 Maintenance

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

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

7.1 External cleaning

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

7.2 Pipe cleaning

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

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

Caution!
Do not use a pipe cleaning pig.

7.3 Transducer cleaning

For gases that do carry impurities, it is recommended that the sensor be routinely inspected and cleaned to minimise any potential measuring errors due to contamination or build-ups. The frequency of inspection and cleaning will depend upon the application and expected measurement performance.
Cleaning is performed by applying a non-filming or oil-free type cleaning fluid to a soft brush or cloth and gently wiping over the surface until all build-ups and contaminants are removed.

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

Sensor-specific information:
- t-mass F sensor:
  Removal of the transducer requires specialist knowledge, tools and parts. The process seal also may need to be tested and re-qualified. This procedure must be carried out by an Endress+Hauser production centre.
- t-mass I sensor:
  Cleaning of this sensor is straight forward. Safely remove it from the process and clean it as per above instructions.

7.4 Replacing seals

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

Sensor-specific information:
- t-mass F sensor:
  The sensor contains o-rings seals and a bushing. In case of failure, the device must be returned to an Endress+Hauser production centre for inspection and repair.
- t-mass I sensor:
  The transducer is welded to the insertion tube and has no exchangeable seals. The compression fitting contains wetted seals (ferrules) and a bonded seal is used on the G 1 A thread version.

Caution!
These seals may become damaged with repeated use. Replace in case of gas leaks.

The compression fitting and bonded seal are available as spare parts → 79. For exchange of the compression fitting, refer to the relevant sensor exchange documentation → 97. The bonded seal can be easily exchanged on-site.

7.5 In-situ calibration

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

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

This function is activated using the service access code.
Please discuss your specific requirements with your Endress+Hauser service representative.

7.6 Recalibration

For thermal meters, the interval between calibrations is dependent on the application since calibration drift is predominantly caused by contamination of the sensor surface.
If the gas is not clean (i.e. contains particulates), then gentle cleaning of the sensor elements can be effective at regular intervals. The cleaning interval will depend upon the nature and extent of the contamination.

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

8 Accessories

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

8.1 Device-specific accessories

Accessory	Description	Order code
Mounting boss	Mounting boss for the t-mass insertion sensor ■ G 1 A thread ■ 1" NPT female thread	DK6MB - ***
Cable remote	Connecting cable for the remote version sensor and transmitter (per m (ft), up to 100m (328ft) max.)	DK6CA - **
Transmitter t-mass 65	Transmitter for replacement or for stock. Use the order code to define the following specifications: ■ Approvals ■ Degree of protection / version ■ Cable entries ■ Display / power supply / operation ■ Software ■ Outputs / inputs	65XXX-XXXXXX******
Inputs/outputs	Flexible I/O board conversion kit with appropriate plug-in sub I/O modules for converting the input/output configuration.	DK6UI-***

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: ■ t-mass F sensor (DN25 to 100, 1"to 4") ■ t-mass I sensor (DN80 to 300, 3" to 12")	DK6ST-*** DK7ST-***
Hot tap	Mounting set with ball valve and safety chain. Insertion or extraction of sensor under process pressure (max. 4 bar, 58 psi).	Please refer to the product page of the Endress+Hauser Internet page: www.endress.com
	Mounting set with ball valve and spindle retractor. Insertion or extraction of sensor under process pressure (max. 16 bar, 235 psi).	
Graphic data manager Memograph M	The graphic data manager Memograph M provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on an SD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available facilitate continuous monitoring, e.g. of specific energy consumption, boiler efficiency and other parameters which are necessary for efficient energy management.	RSG40 - **********

8.3 Communication-specific accessories

Accessory	Description	Order code
HART Communicator Field Xpert SFX 100	Handheld terminal for remote configuration and for obtaining measured values via the 4 to 20 mA HART current output. Contact your Endress+Hauser representative for more information.	SFX100 – *******

8.4 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ■ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, accuracy or process connections ■ Graphic illustration of the calculation results Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ■ Via the Internet: https://wapps.endress.com/applicator ■ On CD-ROM for local PC installation.	DKA80 - *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	FieldCare is Endress+Hauser's FDT based Plant Asset Management Tool. It can configure all 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
FXA193	The FXA193 service interface connects the device to the PC for configuration via FieldCare.	FXA193 – *

9 Trouble-shooting

9.1 Trouble-shooting instructions

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

Check the display	
No display visible and no output signals present.	1. Check the supply voltage → Terminals 1, 2 2. Check device fuse → 📄 85 85 to 260 V AC: 0.8 A slow-blow / 250 V 20 to 53 V AC and 16 to 62 V DC: 2 A slow-blow / 250 V 3. Measuring electronics defective → order spare parts → 📄 79
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 → 📄 79. 2. Display module defective → order spare parts → 📄 79 3. Measuring electronics defective → order spare parts → 📄 79
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 → 📄 79
▼	
Error messages on display	
Errors that occur during commissioning or measuring are displayed immediately. Error messages consist of a variety of icons. The meanings of these icons are as follows (example): – Type of error: **S** = System error, **P** = Process error – Error message type: ϟ = Fault message, **!** = Notice message – **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 → 📄 37. ■ The measuring system interprets simulations and positive zero return as system errors, but displays them as notice message only.	
System error (device error) has occurred → 📄 72	
Process error (application error) has occurred → 📄 76	
▼	
Other error (without error message)	
Some other error has occurred.	Diagnosis and rectification → 📄 76

9.2 System error messages

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

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Important procedures must be carried out before you return a flowmeter to Endress+Hauser.
→ 🖹 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!
- The listed error message types below correspond to the factory setting.
- Also observe the information on the following pages: → 🖹 37

No.	Error message / Type	Cause	Remedy (spare parts → 🖹 79)
S = System error ϟ = Fault message (with an effect on the inputs and outputs) ! = Notice message (without an effect on the inputs and outputs)			
No. # 0xx → Hardware error			
001	S: CRITICAL FAIL. ϟ: # 001	Serious device error	Replace the amplifier board.
011	S: AMP HW EEPROM ϟ: # 011	Amplifier: Defective EEPROM	Replace the amplifier board.
012	S: AMP SW EEPROM ϟ: # 012	Measuring amplifier: Error when accessing data of the EEPROM	The EEPROM data blocks in which an error has occurred are displayed in the "TROUBLE-SHOOTING" function. Press Enter to acknowledge the errors in question; default values are automatically inserted instead of the errored parameter values. Note! The measuring device has to be restarted if an error has occurred in a totalizer block (see error No. 111 / CHECKSUM TOTAL).
014	S: AMP SW-ROM/RAM ϟ: # 014	Amplifier: Defective ROM/RAM	Replace the amplifier board.
031	S: SENSOR HW DAT ϟ: # 031	Sensor DAT: 1. HistoROM/S-DAT is defective. 2. HistoROM/S-DAT is not plugged into the amplifier board or is missing.	1. Check whether the HistoROM/S-DAT is correctly plugged into the amplifier board. 2. Replace the S-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary.
032	S: SENSOR SW DAT ϟ: # 032	Sensor DAT: Error accessing the calibration values stored in the HistoROM/S-DAT.	
035	S: SEN HW-ROM/RAM ϟ: # 035	Sensor: Defective ROM/RAM	Replace the remote amplifier board.
036	S: SEN SW-ROM/RAM ϟ: # 036	Sensor: Defective ROM/RAM	Replace the remote amplifier board.
042	S: TRANSM. SW DAT ϟ: # 042	Sensor DAT: Error accessing the calibration values stored in the HistoROM/T-DAT.	1. Check whether the HistoROM/T-DAT is correctly plugged into the amplifier board 2. Replace the T-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code Replace measuring electronics boards if necessary.

No.	Error message / Type	Cause	Remedy (spare parts → 📄 79)
051	S: A / C COMPATIB. ϟ: # 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
070	S: SENSOR DEFECT ϟ: # 070	Flow sensors are likely to be defect, measurement is no longer possible.	1. Visual check of the sensors for damage. 2. The resistance of the sensors must be measured. Contact your Endress+Hauser service representative.
No. # 1xx → Software error			
111	S: CHECKSUM TOTAL ϟ: # 111	Totalizer checksum error	1. Restart the measuring device 2. Replace the amplifier board if necessary.
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 FieldCare with the required software version or the module has to be replaced.
No. # 2xx → Error in DAT / no communication			
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 HistoROM/T-DAT is correctly plugged into the amplifier board. 2. Replace the T-DAT if it is defective. Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare part set number – Hardware revision code 3. Replace measuring electronics boards if necessary.
206	S: SAVE T-DAT !: # 206		
211	S: S-DAT NO HW ϟ: # 211	HistoROM/S-DAT is not fitted to amplifier board.	Check whether the HistoROM/S-DAT is correctly plugged into the amplifier board.
251	S: COMMUNIC. SENS ϟ: # 251	Internal microprocessor communication fault on the amplifier board.	Remove the amplifier board.
261	S: COMMUNIC. I/O ϟ: # 261	No data reception between amplifier and I/O board or faulty internal data transfer.	Check the BUS contacts
No. # 3xx → System limits exceeded			
351 … 352	S: RANGE CUR.OUTn !: # 351…352	Current output: The actual value for the flow lies outside the set limits.	1. Change full scale value entered. 2. Reduce flow.
355 … 356	S: RANGE FREQ.OUTn !: # 355…356	Frequency output: The actual value for the flow lies outside the set limits.	1. Change full scale value entered. 2. Reduce flow.

No.	Error message / Type	Cause	Remedy (spare parts → 🖹 79)
359 … 360	S: RANGE PULSEn !: # 359…360	Pulse output: Pulse output frequency is outside the set range.	1. Increase pulse value 2. When selecting the pulse width, choose a value that can still be processed by a connected counter (e.g. mechanical counter, PLC etc.). *Determine the pulse width:* – Variant 1: Enter the minimum duration that a pulse must be present at the connected counter to ensure its registration. – Variant 2: Enter the maximum (pulse) frequency as the half "reciprocal value" that a pulse must be present at the connected counter to ensure its registration. Example: The maximum input frequency of the connected counter is 10 Hz. The pulse width to be entered is: $\frac{1}{2 \cdot 10\ \text{Hz}} = 50\ \text{ms}$ a0004437 3. Reduce flow.
363	S: RANGE CUR.IN1 !: # 363	Current input: The actual value for the current input is outside the set range.	1. Change set lower-range or upper-range value. 2. Check settings of the external current source.
372	S: DIFF TEMP LO ϟ: # 372	The measured sensor differential temperature is below limit value.	Reduce the flow rate.
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.
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.
No. # 5xx → Application error			
501	S: SW.-UPDATE ACT !: # 501	New amplifier or communication (I/O module) software version is loaded. Currently no other functions are possible.	Wait until process is finished. The device will restart automatically.
502	S: UP-/DOWNL. ACT !: # 502	Up- or downloading the device data via configuration program. Currently no other functions are possible.	Wait until process is finished.
No. # 6xx → Simulation mode active			
601	S: POS.ZERO-RET. !: # 601	Positive zero return active. ☝ Caution! This message has the highest display priority.	Switch off positive zero return
611 … 612	S: SIM. CURR.OUT. n !: # 611…612	Simulation current output active	Switch off simulation
621 … 622	S: SIM. FREQ.OUT. n !: # 621…622	Simulation frequency output active	Switch off simulation
631 … 632	S: SIM. PULSE n !: # 631…632	Simulation pulse output active	Switch off simulation
641 … 642	S: SIM. STAT.OUT n !: # 641…642	Simulation status output active	Switch off simulation
651 … 652	S: SIM.REL.OUT n !: # 651…652	Simulation relay output active	Switch off simulation
661	S: SIM.CURR. IN 1 !: # 661	Simulation current input active	Switch off simulation

No.	Error message / Type	Cause	Remedy (spare parts → 🖹 79)
671 … 672	S: SIM.STATUS IN n !: # 671…672	Simulation status input active	Switch off simulation
691	S: SIM. FAILSAFE !: # 691	Simulation of response to error (outputs) active	Switch off simulation
692	S: SIM. MEASURAND !: # 692	Simulation of measuring variables (e.g. mass flow)	Switch off simulation
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

Process errors can be defined as either "Fault" or "Notice" messages and can thereby be weighted differently. This is specified via the function matrix
(→ "Description of Device Functions" manual).

Note!
- The listed error message types below correspond to the factory setting.
- Also observe the information on the following pages: → 37

No.	Error message / Type	Cause	Remedy / spare part
P = Process error ϟ = Fault message (with an effect on the inputs and outputs) ! = Notice message (without an effect on the inputs and outputs)			
422	P: FLOW LIMIT ϟ: # 422	The measured flow has exceeded the maximum limit.	Reduce the flow rate. Note! Error can be configured as a fault or notice message.
731	P: ADJ. ZERO FAIL ϟ: # 731	The saved zero point is inaccurate possibly due to unstable process or flow conditions.	Make sure that zero point adjustment is carried out at "zero flow" only (v = 0 m/s) → 65.

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 TIME CONSTANT setting → CURRENT OUTPUT function group. 2. Increase value of the DISPLAY DAMPING setting → USER INTERFACE function group. 3. The inlet and outlet lengths must be observed. See installation conditions → 12 4. Consider the use of a flow conditioner. See installation conditions → 16 5. Relocate the meter to a point where there is less flow disturbance
Device displays flow with no actual flow present.	1. The low flow cut off value is programmed too low. Increase value of the ON VALUE LOW FLOW CUT OFF setting → PROCESS PARAMETERS function group (Factory setting = 1% of 20mA value). 2. Check for leaks in the pipe line downsteam of the sensor. 3. Reduce or eliminate pressure pulsations in the line.
Device displays flow with no actual flow present - but with high static line pressure and thermally conductive gases present (e.g. Hydrogen, Helium, etc.). Line pressure is typically > 5 bar / 75 psi	Start the ZERO POINT ADJUST function → PROCESS PARAMETERS function group. See Zero Point Adjust function → 65 Note! Process preconditions are required before starting this function.
Device displays zero flow but flow is present.	1. The INSTALLATION FACTOR may have a wrong setting = 0 → PROCESS PARAMETERS function group (factory setting = 1.0). 2. The LOW FLOW CUT OFF setting may be too high. Adjust the function ON VALUE LOW FLOW CUT OFF to a lower value → PROCESS PARAMTERS function group (factory setting 1% of calibrated 20mA value). 3. The ZERO POINT ADJUST function may have been incorrectly carried out with flow present. RESET the zero point adjustment if necessary → PROCESS PARAMETERS function group.
Measurement error possibly due to incorrect installation conditions.	1. The inlet and outlet lengths must be observed → 15. 2. Consider the use of a flow conditioner if the necessary inlet requirements cannot be met → 16. 3. t-mass F: Check for diameter mismatch between the flanges and check the gasket alignment→ 13. t-mass I: Check the sensor orientation and insertion depth. → 19. 4. If the above actions do not resolve the problem, consider adjusting the INSTALLATION FACTOR so that the displayed flow rate matches the expected flow rate PROCESS PARAMETERS function group (factory setting 1.0).

Symptoms	Rectification
Device displays incorrect flow value.	1. Check the basic parameters of the device (Quick Setup → 📄 49) Especially: – Gas – Process pressure – Reference presssure and reference temperature – Flow units – Output assignment 2. Check the installation conditions (Post-installation check → 📄 33) 1. The inlet and outlet lengths must be observed → 📄 15. 2. Consider the use of a flow conditioner if the necessary inlet requirements cannot be met → 📄 16. 3. t-mass F: Check for diameter mismatch between the flanges and check the gasket alignment→ 📄 13. t-mass I: Check the sensor orientation and insertion depth. → 📄 19. 4. If the above actions do not resolve the problem, consider adjusting the INSTALLATION FACTOR so that the displayed flow rate matches the expected flow rate → PROCESS PARAMETERS function group (factory setting 1.0). 3. The flow rate maybe too high (i.e. above sensor calibration range) 1. Check the sensor measuring range using the Endress+Hauser Applicator program. 2. Check if the inverted plus sign "+" is shown on the display? If yes, reduce the velocity if possible. 4. The flow rate maybe too low 1. Check the sensor measuring range using the E+H Applicator program. 2. Increase the velocity if possible. 5. Check the condition of the transducer 1. Are the measuring elements bent? If yes, replacement is necessary. 2. Are build-ups present? If yes, clean the sensors (transducer cleaning → 📄 67). 3. Has corrosion occured? If yes, replacement is necessary. 6. Check if the gas is wet? Is condensate present on the sensors? If yes: 1. For horizontal pipes: Mount the sensor at 135° → 📄 14 2. Install a condensate trap or filter upstream of the flowmeter 7. Check if heating devices are used upstream of the flowmeter causing possible temperature profile effects ? If yes: 1. Relocate the flowmeter further downstream or 2. Install a flow conditioner upstream of the flowmeter
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 → 📄 7 **Returning devices to Endress+Hauser** The procedures on must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. → 📄 6 Always enclose a duly completed "Declaration of contamination" form with the flowmeter. You will find a preprinted "Declaration of contamination" at the back of this manual. **Replace transmitter electronics** Components in the measuring electronics defective → order replacement → 📄 79

9.5 Failure mode of outputs

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

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

Failsafe mode of outputs and totalizers		
	Process/system error is present	Positive zero return is activated
Caution! System or process errors defined as "Notice messages" have no effect whatsoever on the inputs and outputs. See the information on → 37		
Current output 1, 2	MINIMUM CURRENT The current output will be set to the lower value of the signal on alarm level depending on the setting selected in the CURRENT SPAN (see the "Description of Device Functions" manual). MAXIMUM CURRENT The current output will be set to the higher value of the signal on alarm level depending on the setting selected in the CURRENT SPAN (see the "Description of Device Functions" manual). HOLD VALUE Measured value display on the basis of the last saved value preceding occurrence of the fault. ACTUAL VALUE Measured value display on the basis of the current flow measurement. The fault is ignored.	Output signal corresponds to "zero flow"
Pulse output	FALLBACK VALUE Signal output → no pulses ACTUAL VALUE Fault is ignored, i.e. normal measured value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Frequency output	FALLBACK VALUE Signal output → 0 Hz FAILSAFE LEVEL Output of the frequency specified in the FAILSAFE VALUE function. HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Totalizer 1, 2	STOP The totalizers are paused until the error is rectified. ACTUAL VALUE The fault is ignored. The totalizer continues to count in accordance with the current flow value. HOLD VALUE The totalizers continue to count the flow in accordance with the last valid flow value (before the error occurred).	Totalizer stops
Status output	Status output → non-conductive in the event of fault or power supply failure	No effect on status output
Relay output	In event of fault or power supply failure: relay → de-energised The "Description of Device Functions" manual contains detailed information on relay switching response for various configurations such as error message, flow limit, temperature limit, etc.	No effect on the relay output

9.6 Spare parts

The previous sections contain a detailed trouble-shooting guide. → 71
The measuring device, moreover, provides additional support in the form of continuous self-diagnosis and error messages.
Fault rectification can entail replacing defective components with tested spare parts. The illustration below shows the available scope of spare parts.

Note!
You can order spare parts directly from your Endress+Hauser representative by providing the serial number printed on the transmitter's nameplate. → 7

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

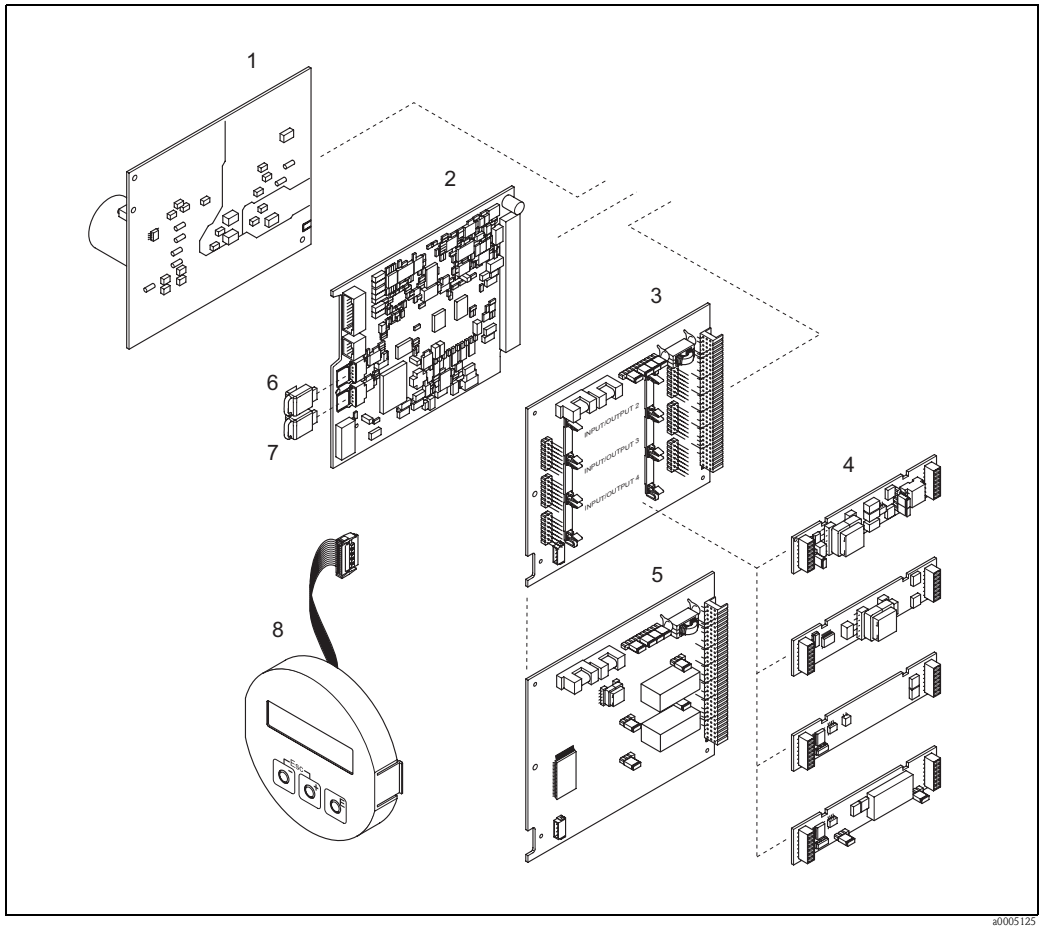


Fig. 40: Spare parts for transmitter 65 (field and wall-mount housings)

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), flexible assignment
4 Pluggable input/output submodules; ordering structure → 69
5 I/O board (COM module), permanent assignment
6 HistoROM/S-DAT (sensor data memory)
7 HistoROM/T-DAT (transmitter data memory)
8 Display module

9.6.1 Removing and installing printed circuit boards

Field housing

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

Caution!
Use only original Endress+Hauser parts.

Installation and removal → 41

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the screws (1.1) and remove the cover (1) from the electronics compartment.
3. Disconnect the display ribbon cable (1.2) from the amplifier board.
4. Remove power supply board (3) and I/O board (5 or 6):
   Insert a thin pin into the hole (2) provided for the purpose and pull the board clear of its holder.
5. Remove submodules (5.1):
   No tools are required for removing the submodules (inputs/outputs) from the I/O board. Installation is also a no-tools operation.

   Caution!
   Only certain combinations of submodules on the flexible I/O board are permissible. → 31
   The individual slots are marked and correspond to certain terminals in the connection compartment of the transmitter:

   Slot "INPUT / OUTPUT 2" = Terminals 24 / 25
   Slot "INPUT / OUTPUT 3" = Terminals 22 / 23
   Slot "INPUT / OUTPUT 4" = Terminals 20 / 21
6. Remove amplifier board (4):
   – Disconnect the plug of the sensor signal cable (4.1) including HistoROM/S-DAT (4.2) and HistoROM/T-DAT (4.3) from the board.
   – Insert a thin pin into the hole (2) provided for the purpose and pull the board clear of its holder.
7. Installation is the reverse of the removal procedure.

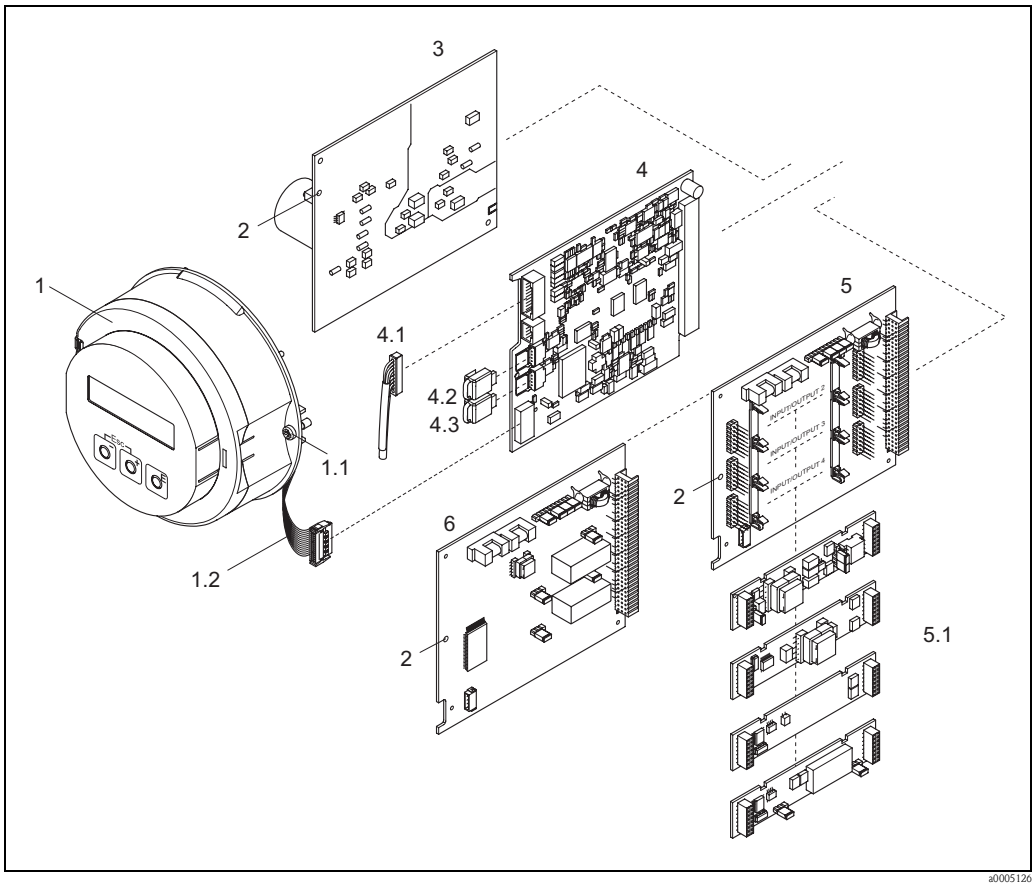


Fig. 41: Field housing: removing and installing printed circuit boards

1 Electronics compartment cover with local display
1.1 Screws of electronics compartment cover
1.2 Ribbon cable (display module)
2 Aperture for installing/removing boards
3 Power unit board
4 Amplifier board
4.1 Signal cable (sensor)
4.2 HistoROM/S-DAT (sensor data memory)
4.3 HistoROM/T-DAT (transmitter data memory)
5 I/O board (flexible assignment)
5.1 Pluggable submodules (status input and current input, current output, frequency output and relay output)
6 I/O board (permanent assignment)

Wall-mount housing

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

Caution!
Use only original Endress+Hauser parts.

Installation and removal → 42

1. Remove the screws and open the hinged cover (1) of the housing.
2. Loosen the screws securing the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mount housing.
3. Disconnect the sensor signal cable plug (7.1) including HistoROM/S-DAT (7.2) and HistoROM/T-DAT (7.3) from amplifier board (7).
4. Remove the cover (4) from the electronics compartment by removing the screws.
5. Disconnect the ribbon cable plug (3) of the display module from amplifier board (7).
6. Remove the boards (6, 7, 8, 9):
   Insert a thin pin into the hole (5) provided for the purpose and pull the board clear of its holder.
7. Remove submodules (8.1):
   No tools are required for removing the submodules (inputs/outputs) from the I/O board. Installation is also a no-tools operation.

   Caution!
   Only certain combinations of submodules on the I/O board are permissible. → 31
   The individual slots are marked and correspond to certain terminals in the connection compartment of the transmitter:

   Slot "INPUT / OUTPUT 2" = Terminals 24 / 25
   Slot "INPUT / OUTPUT 3" = Terminals 22 / 23
   Slot "INPUT / OUTPUT 4" = Terminals 20 / 21
8. Installation is the reverse of the removal procedure.

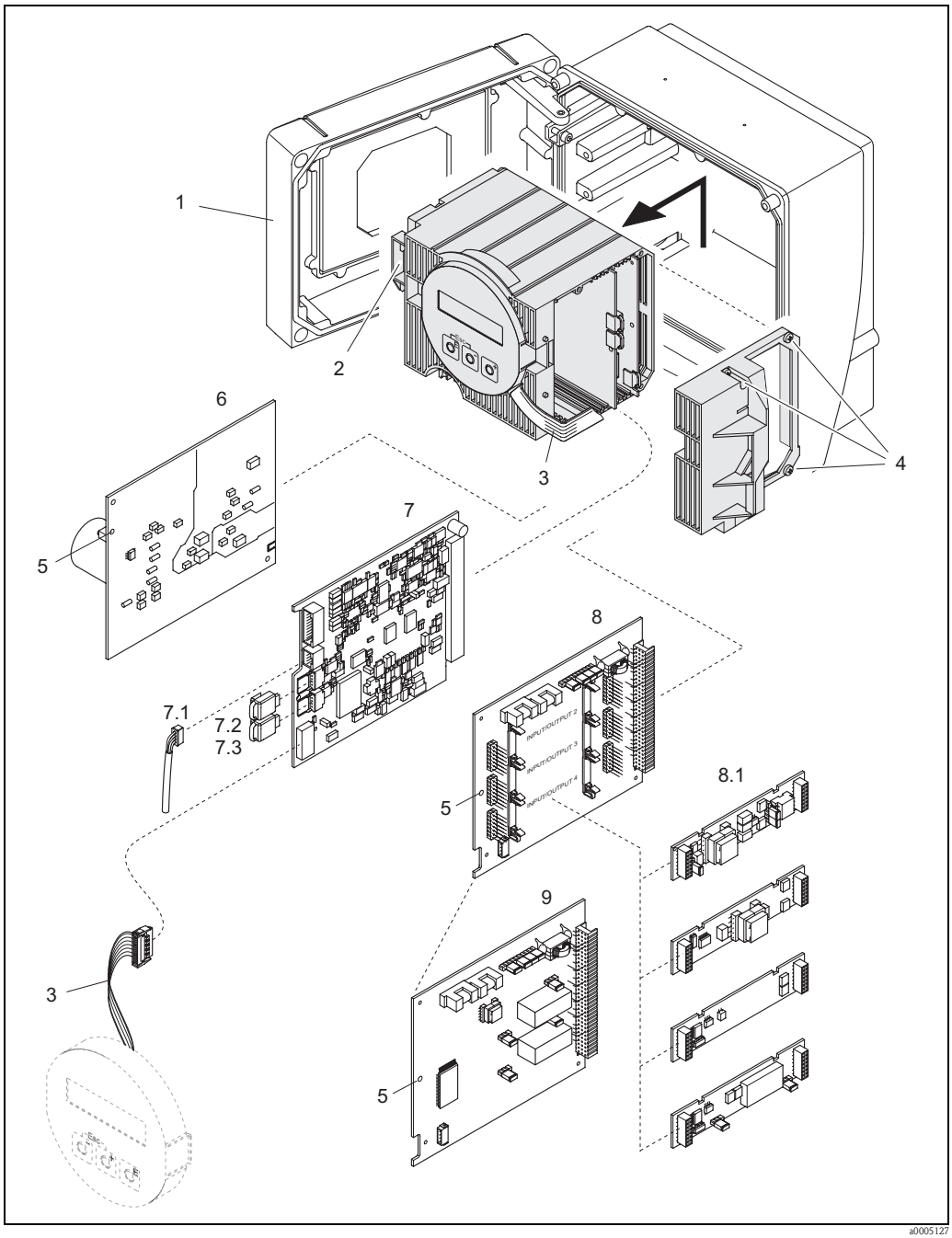


Fig. 42: Field housing: removing and installing printed circuit boards

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

Removal and installation → 43

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.

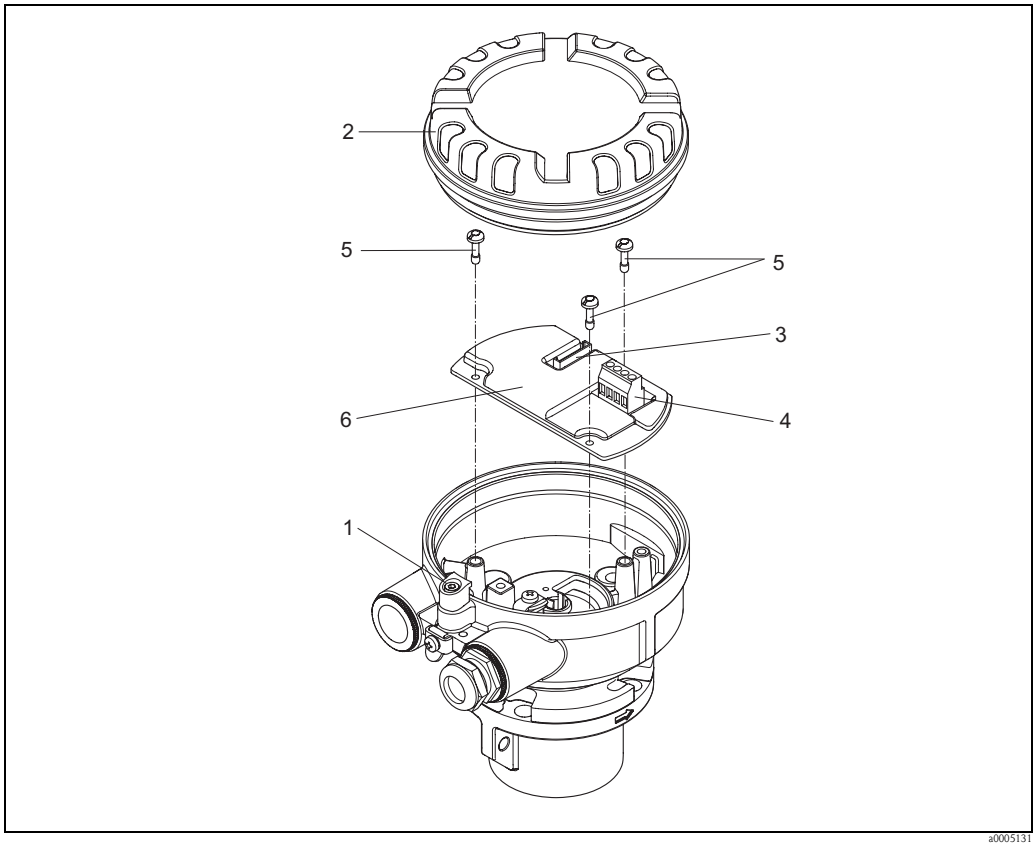


Fig. 43: Electronics compartment of the sensor housing remote version: removing and installing printed circuit board

Wire colors (when supplied by Endress+Hauser):
Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow

9.6.2 Replacing the device fuse

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

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

1. Switch off power supply.
2. Remove the power unit board → 📄 80
3. Remove the protection cap (1) and replace the device fuse (2).
   Only use the following fuse type:
   – Power supply 20 to 55 V AC / 16 to 62 V DC → 2.0 A slow-blow / 250 V; 5.2 × 20 mm
   – Power supply 85 to 260 V AC → 0.8 A slow-blow / 250 V; 5.2 × 20 mm
   – Ex-rated devices → see the Ex documentation.
4. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

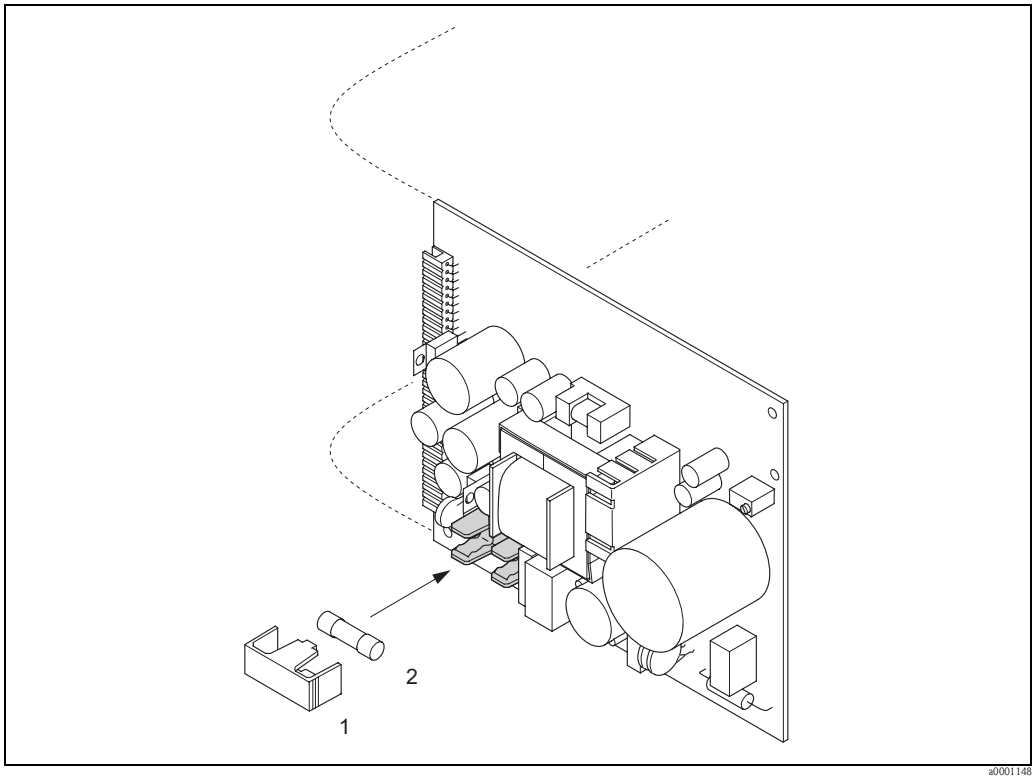


Fig. 44: Replacing the device fuse on the power unit board

1 Protective cap
2 Device fuse

9.7 Return

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

The following steps must be taken before returning a flow measuring device to Endress+Hauser, e.g. for repair or calibration:
- Always enclose a duly completed "Declaration of contamination" form. Only then can Endress+Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EC REACH Regulation No. 1907/2006.
- Remove all residues. Pay special attention to the grooves for seals and crevices which could contain residues. This is particularly important if the substance is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.

Note!
You will find a preprinted "Declaration of contamination" form at the back of these Operating Instructions.

9.8 Disposal

Observe the regulations applicable in your country!

9.9 Software history

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

Date	Software version	Changes to software	Operating Instructions
10.2009	1.01.XX	Software expansion: – second gas group in memory – gas heat flow and heat quantity – variable gas fraction input – revised diagnostics – Fieldcheck compatibility New functionalities: – Quick Setups for gas, pressure, heat flow and sensor – additional pressure units – system units for calorific value, heat flow and quantity heat – process pressure for gas group 1 + 2 – status input assignment for gas group – current input assignment for variable gas fraction – assignment of heat flow to display, totalizer and outputs – totalizer units for quantity heat flow – assignment of gas groups to outputs and totalizer – on/off delay for relay outputs – selection special gas with correction factors and reference density – insertion depth calculator – time stamping for process and system errors	71115126/06.10
11.2005	1.00.XX		71009069/12.05

10 Technical data

10.1 Technical data at a glance

10.1.1 Applications

The measuring device described in these Operating Instructions is to be used only for measuring the mass flow rate of gases (e. g. kg, Nm^3 scf). At the same time, the system also measures gas temperature. The measuring device can be configured to measure a standard range of pure gases or gas mixtures.

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

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

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

10.1.2 Function and system design

Measuring principle	Mass flow measurement by the thermal dispersion principle.
Measuring system	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 - Gas heat flow
Measuring range	The measuring range is dependent upon: - Gas - Pressure - Temperature - Cross-sectional area of pipe or duct - Use of flow conditioner (t-mass F sensor) Please refer to Applicator, the Endress+Hauser sizing and selection software, for calculation of the measuring range.

Input signal

Status input (auxiliary input)

U = 3 to 30 V DC, R_i = 5 kΩ, galvanically isolated. Switch level ±3 to ±30 V DC.
Configurable for: gas group, totalizer reset, positive zero return, start zero point adjustment

Current input

Active/passive selectable, galvanically isolated, resolution: 2 µA
- Active: 4 to 20 mA, $R_i \leq 150\ \Omega$, U_{out} = 24 V DC, short-circuit proof
- Passive: 0/4 to 20 mA, $R_i \leq 150\ \Omega$, U_{max} = 30 V DC

Configurable for: pressure, gas analyzer

10.1.4 Output

Output signal

Current output

Active/passive selectable, galvanically isolated, time constant selectable (0.0 to 100.0 s), full scale value selectable, temperature coefficient: typically 0.005% o.r./°C, resolution: 0.5 µA
- Active: 0/4 to 20 mA, $R_L < 700\ \Omega$ (for HART: $R_L \geq 250\ \Omega$)
- Passive: 4 to 20 mA; supply voltage V_S 18 to 30 V DC; $R_i \geq 150\ \Omega$

Pulse / frequency output

Active/passive selectable, galvanically isolated

- Active: 24 V DC, 25 mA (max. 250 mA during 20 ms), $R_L > 100\ \Omega$ (flexible I/O boards only, see terminal assignment → 📄 31)
- Passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2 to 1000 Hz (f_{max} = 1250 Hz), on/off ratio 1:1, pulse width max. 2 s, time constant selectable (0.0 to 100.0 s)
- Pulse output: pulse value and pulse polarity selectable, pulse width adjustable (0.5 to 2000 ms; factory setting = 20 ms)

Signal on alarm

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

Pulse/frequency output:
Failsafe mode selectable

Status output:
"Non-conductive" in the event of fault or power supply failure.

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

Current input:
Failsafe value selectable

Load

See "Output signal"

Switching output

Relay output: Normally closed (NC) or normally open (NO) contacts available
(factory setting: relay 1 = NO, relay 2 = NC), max. 30 V / 0.5 A AC; 60 V / 0.1 A DC, galvanically isolated.
Configurable for: error messages, limit values

Low flow cut off

Switch points for low flow cut off are programmable.
Factory setting = 1% of 20 mA Value

Galvanic isolation

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

10.1.5 Power supply

Electrical connections	→ 📄 27
Supply voltage	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 × 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 × 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½"
Cable specifications (remote version)	→ 📄 28
Power consumption	AC: 85 to 260 V = 18.2 W ; 20 to 55 V = 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

Calibration reference conditions	■ Accredited according to ISO/IEC 17025 ■ Traceable to National Standards ■ Calibration gas: air ■ Temperature controlled to 24 °C ±0.5 °C (75.2 °F ± 0.9 °F) at atmospheric pressure ■ Humidity controlled < 40% RH
Maximum measured error	t-mass 65F: ±1.5 % of reading for 100 % to 10 % of full scale (at reference conditions) ±0.15 % of full scale for 10 % to 1 % of full scale (at reference conditions) t-mass 65I: ±1.0% of reading ±0.5% of full scale (at reference conditions)
Repeatability	±0.4 % of reading for velocities above 1.0 m/s (3.3 ft/s)
Influence of medium pressure (Pressure co-efficient)	Air: 0.35% per bar (0.02% per psi) of process pressure change Other gases: on request
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	→ 19
Inlet and outlet runs	→ 15
Length of connecting cable	Max. 100 m (328 feet), remote version
System pressure	→ 12

10.1.8 Operating conditions: Environment

Ambient temperature	Standard: –20 to +60 °C (–4 to +140 °F) Optional: –40 to +60 °C (-40 to +140°F) Note! ■ Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions. (A protective sun cover is available on request) ■ At ambient temperatures below –20 °C (–4 °F) the readability of the display may be impaired.
Storage temperature	–40 to +80 °C (–40 to +176 °F), recommended +20 °C (+68 °F)
Degree of protection	Standard: IP 67 (NEMA 4X) for transmitter and sensor
Shock resistance	According to IEC 60068-2-31
Vibration resistance	Acceleration up to 1 g, 10 to 150 Hz, following IEC 60068-2-6
Electromagnetic compatibility (EMC)	To IEC/EN 61326 and NAMUR recommendation NE 21

10.1.9 Operating conditions: Process

Medium temperature range

Sensor

t-mass F:
–40 °C to +100 °C (–40 °F to +212 °F)

t-mass I:
–40 °C to +130 °C (–40 °F to +266 °F)

Seals t-mass F

O-rings:
Viton FKM –20°C…+100°C (–4°F…+212°F)
Kalrez –20°C…+100°C (–4°F…+212°F)
EPDM –40°C…+100°C (–40°F…+212°F)

Bushing:
PEEK, PVDF –40°C…+100°C (–40°F…+212°F)

Seals t-mass I

Bonded seals:
Kalrez –20°C…+130°C (–4°F…+266°F)
EPDM –40°C…+130°C (–40°F…+266°F)
Nitrile –35°C…+130°C (–31°F…+266°F)

Ferrule:
PEEK, PVDF –40°C…+130°C (–40°F…+266°F)

Medium pressure range (nominal pressure)

t-mass F:
–0.5 to 40 bar gauge (–7.25 to 580 psi gauge)

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

Flow limit

See "Measuring range" section → 📄 88.
The velocity in the measuring tube should not exceed 130 m/s (427 ft/s).

Pressure loss

Negligible (without flow conditioner).
Refer to Applicator for the precise calculation → 📄 70

Limiting medium pressure range (rated pressure)

The material load diagrams (pressure-temperature diagrams) for the process connections are provided in the separate "Technical Information" document on the device in question. This can be downloaded as a PDF file from www.endress.com.
A list of the "Technical Information" documents: → 📄 97

Process conditions for Hot tap

The Hot tap is permitted for use only with non-toxic, innocuous gases classified as "Group II" in accordance with the European directive 67/548/EWG art. 2.

Medium pressure version
Max. process pressure: 20 bar (290 psig)
Max. extraction press: 16 bar (230 psig)
Max. extraction temperature: +50°C (+122°F)
Min. sensor length: 435 mm (17 inch)

Low pressure version
Max. process pressure: 20 bar (290 psig)
Max. extraction press: 4,5 bar (65 psig)
Max. extraction temperature: +50°C (+122°F)
Min. sensor length: 435 mm (17 inch)

10.1.10 Mechanical construction

Design / dimensions

Dimensions and the fitting lengths of the transmitter and sensor are provided in the separate "Technical Information" document on the device in question. This can be downloaded as a PDF file from www.endress.com.
A list of the "Technical Information" documents: → 97

Weight

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

Weight (SI units)

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

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

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

Weight (US units)

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

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

Weight dimensions in [lb].
* For flanged versions, all values (weight) refer to devices with 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 B2220
→ stainless steel 1.4404 to EN 10222-5 and 316L/316 to A182

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

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

Bushing:
PEEK GF30, PVDF

O-ring seals:
EPDM, Kalrez 6375, Viton FKM

t-mass I sensor
Insertion tube:
Sensor length 235 (9"), 335 (13"), 435 (17"), 608 (24")
1.4404 to EN 10216-5 and 316/316L to A312

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

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

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

Compression fitting:
1.4404 to EN 10272 and 316/316L to A479

Ferrules:
PEEK 450G, PVDF

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

Hot tap
Lower tube section:
1.4404 to EN 10272 and 316/316L to A479

Upper tube section:
1.4404 to EN 10216-5 and 316/316L to A312

Ball valve:
CF3M and CF8M

Seal:
PTFE

10.1.11 Human interface

Display elements	■ 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, German, French, Spanish, Italian, Dutch, Norwegian, Finnish, Swedish, Portuguese, Polish, Czech
Remote operation	Operation by means of HART protocol

10.1.12 Certificates and approvals

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

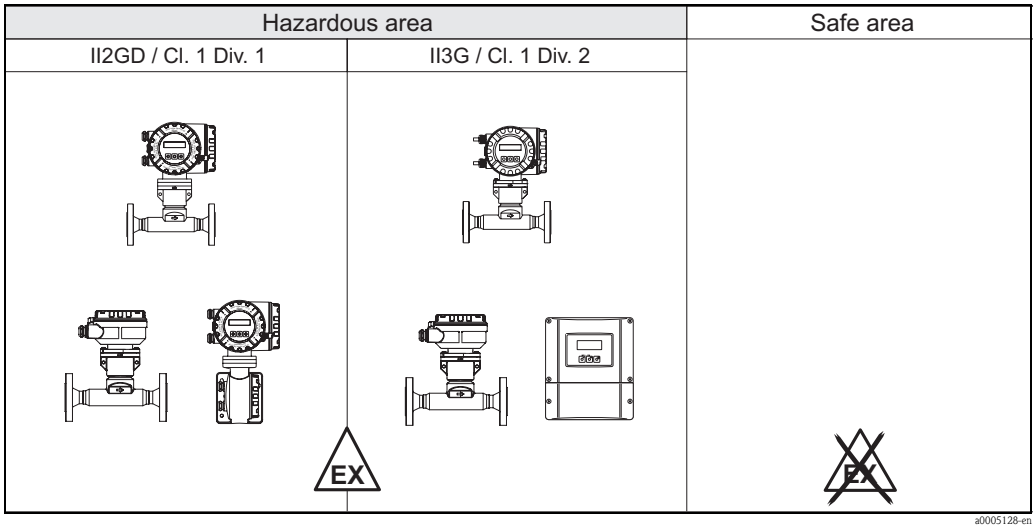


Fig. 45: Example of t-mass devices in the hazardous area (Example t-mass 65F)

Pressure measuring device approval	The measuring devices can be ordered with or without PED (Pressure Equipment Directive). If a device with PED is required, this must be ordered explicitly. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary. ■ With the identification PED/G1/III on the sensor nameplate, Endress+Hauser confirms conformity with the "Basic safety requirements" of Appendix I of the Pressure Equipment Directive 97/23/EC. ■ Devices with this identification (with PED) are suitable for the following types of fluid: – Fluids of Group 1 and 2 with a steam pressure of greater or less than 0.5 bar (7.3 psi) – Unstable gases ■ Devices without this identification (without PED) are designed and manufactured according to good engineering practice. They correspond to the requirements of Art. 3, Section 3 of the Pressure Equipment Directive 97/23/EC. Their application is illustrated in Diagrams 6 to 9 in Appendix II of the Pressure Equipment Directive 97/23/EC.
Oxygen service	We certify that the wetted parts of the flow sensor have been degreased in accordance with British Oxygen Company (BOC) specification 0000-N-S-430-00-01 and BS IEC 60877:1999. After final degreasing there shall be less than 100 milligram/m² (0.01 milligram/cm²) of oil/grease contamination on the degreased surface of the component.
Other standards and guidelines	BS IEC 60877:1999 Procedures for ensuring the cleanliness of industrial-process measurement and control equipment in oxygen service. EN 60529 Degrees of protection by housing (IP code) EN 61010-1 Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures. IEC/EN 61326 "Emission in accordance with requirements for Class A". Electromagnetic compatibility (EMC-requirements). EN 91/155/EEC Saftey Data Sheets Directive. ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories. ISO 14511 Measurement of fluid flow in closed conduits - Thermal mass flowmeters. NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment. NAMUR NE 43 Standardisation of the signal level for the breakdown information of digital transmitters with analogue output signal. NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics

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 → 69

10.1.15 Documentation

- Technical Information t-mass 65F, 65I (TI069D/06)
- Description of Device Functions t-mass 65 (BA112D/06)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA, IECEx, NEPSI
- Flow measuring technology (FA005D/06/)

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Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination

Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.

Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.

Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

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

Process data/ *Prozessdaten*

Temperature / *Temperatur*_____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [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 / *Medium im Prozess*								
Medium for process cleaning / *Medium zur Prozessreinigung*								
Returned part cleaned with / *Medium zur Endreinigung*								

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

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

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

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

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."

"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

_____ (place, date / *Ort, Datum*)

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

_____ Signature / *Unterschrift*

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BA111D/06/en/06.10
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