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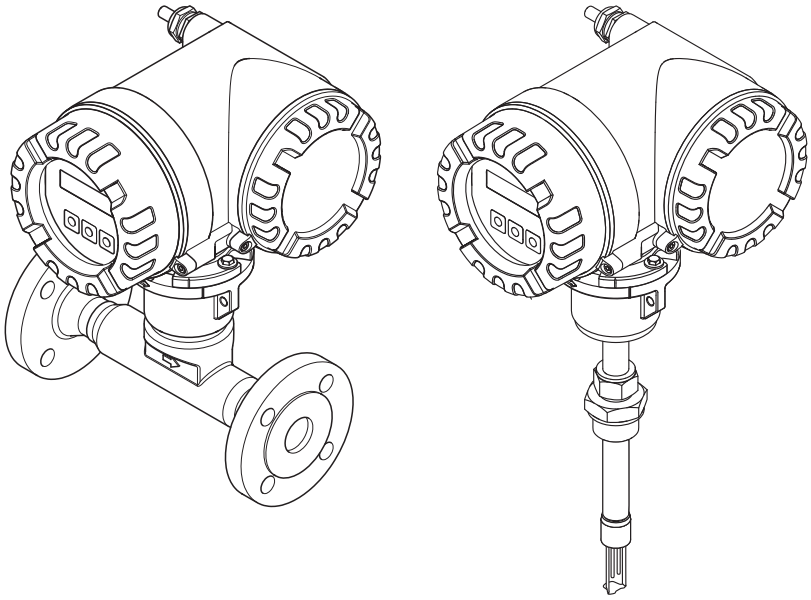
Valid as of version
V 3.00.XX (Device software)

Operating Instructions
Proline t-mass 65
FOUNDATION Fieldbus

Thermal mass flowmeter



Endress+Hauser
People for Process Automation

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1 Document information

1.1 Document conventions

1.1.1 Safety symbols

Symbol	Device particularities and document content
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.
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.
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.

1.1.2 Electrical symbols

Symbol	Meaning
A0011197	Direct current A terminal at which DC voltage is present or through which direct current flows.
A0011198	Alternating current A terminal at which alternating voltage (sinusoidal) is present or through which alternating current flows.
A0011200	Ground connection A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
A0011199	Protective ground connection A terminal which must be connected to ground prior to establishing any other connections.
A0011201	Equipotential connection A connection that must be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.

1.1.3 Symbols for types of information

Symbol	Meaning
 A0011182	Permitted Indicates procedures, processes or actions that are permitted.
 A0011183	Preferred Indicates procedures, processes or actions that are preferred.
 A0011200	Forbidden Indicates procedures, processes or actions that are forbidden.
 A0011193	Tip Indicates additional information.
 A0011194	Reference to documentation Refers to the corresponding device documentation.
 A0011195	Reference to page Refers to the corresponding page number.
1., 2., 3. etc.	Series of steps
✔	Result of a sequence of actions
 A0013562	Help in the event of a problem

1.1.4 Symbols for graphics

Symbol	Meaning
1, 2, 3 etc.	Item numbers
A, B, C etc.	Views
A-A, B-B, C-C etc.	Item numbers
 A0013441	Flow direction
 A0011187	Hazardous area Indicates the hazardous area.
 A0011187	Safe area (non-hazardous area) Indicates the non-hazardous area.

2 Safety instructions

2.1 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 sft^3). At the same time, it 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 In such cases, please contact your Endress+Hauser sales center for clarification. 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.

2.2 Installation, commissioning and operation

Note the following points:
- Installation, connection to the electricity supply, commissioning, operation and maintenance of the measuring device must be carried out by trained, qualified specialists authorized to perform such work by the facility's owner operator. The specialist must have read and understood these Operating Instructions and must follow the instructions they contain.
- 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 operator 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 device is correctly wired in accordance with the wiring diagrams. The transmitter must be grounded 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.

2.3 Operational safety

Note the following points:

- Measuring devices 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. Ⓔx Europe, FM USA, CSA Canada).
- Burn hazard! 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 measuring 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 sales center will supply you with current information and updates to these Operating Instructions.

2.4 Return

- Do not return a measuring device if it is not absolutely certain that it has been fully cleaned of all traces of hazardous substances, e.g. substances which have penetrated crevices or diffused through plastic.
- Costs incurred for waste disposal and injury (burns, etc.) due to inadequate cleaning of the measuring device will be charged to the owner-operator.
- Refer to the measures on → 🖹 87.

2.5 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. It complies with the applicable standards and regulations in accordance with EN 61010-1 "Safety requirements for electrical equipment for measurement, control and laboratory use". It can, however, be a source of danger if used incorrectly or for other than the designated use.

3 Identification

3.1 Device designation

The "t-mass 65" measuring device 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.

3.1.1 Nameplate of the transmitter

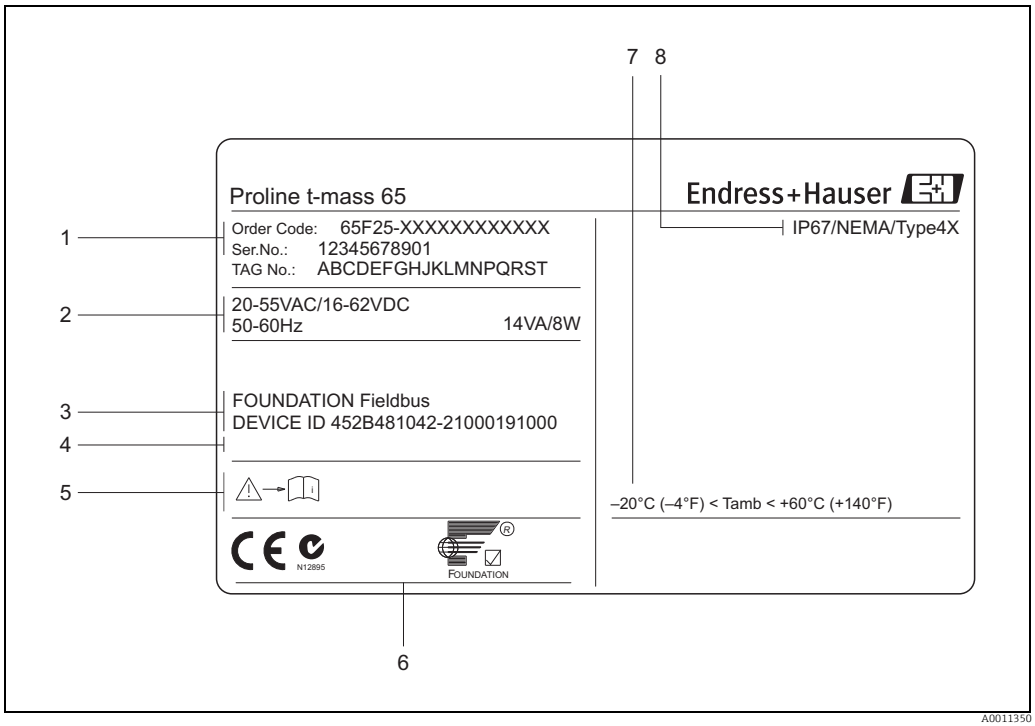


Fig. 1: Nameplate specifications for the "t-mass 65" transmitter (example)

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*

3.1.2 Nameplate of the sensor

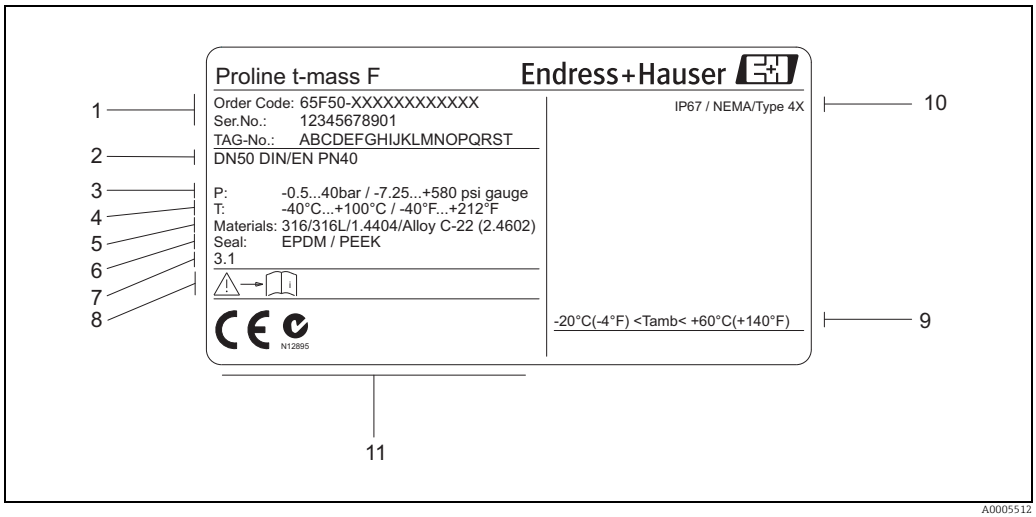


Fig. 2: Nameplate specifications for the "t-mass F" sensor (example)

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)*

3.1.3 Nameplate for connections

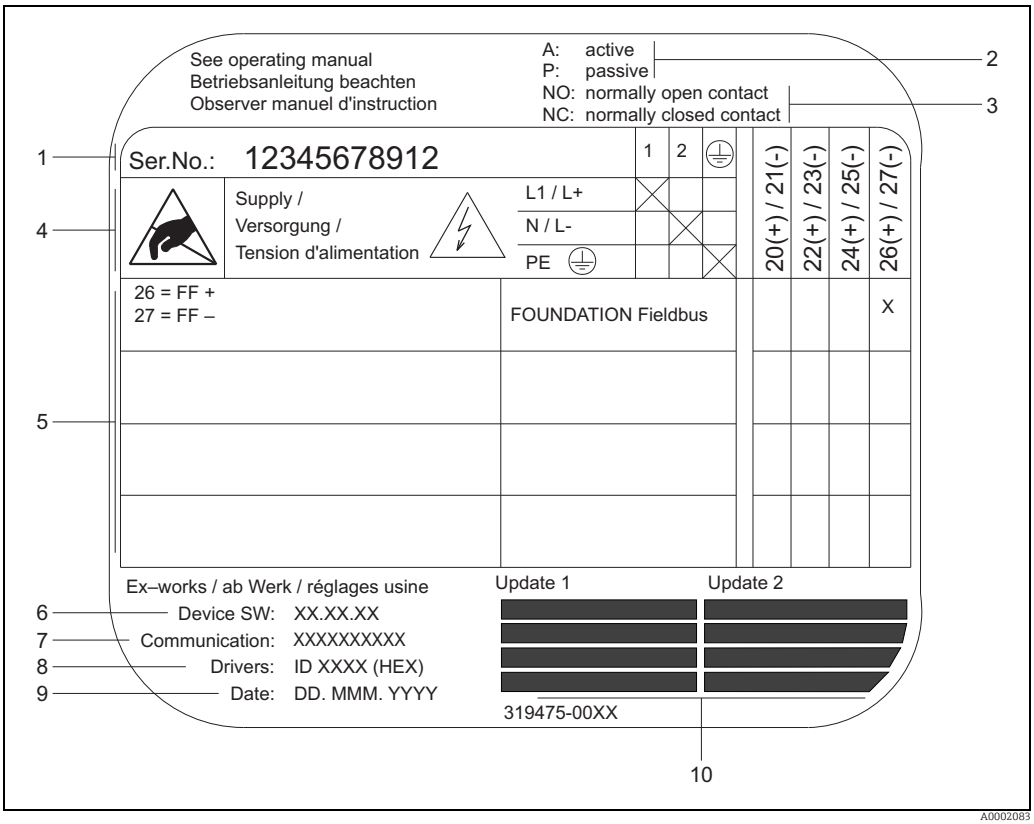


Fig. 3: Nameplate specifications for Proline transmitter (example)

1 Serial number
2 Possible configuration of current output
3 Possible configuration of relay contacts
4 Terminal assignment, cable for power supply: 85 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", → 🖹 88
6 Version of device software currently installed
7 Installed communication type
8 Information on current communication software
9 Date of installation
10 Current updates to data specified in points 6 to 9

3.2 Certificates and approvals

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. The measuring device complies with the applicable standards and regulations in accordance with EN 61010-1 "Safety requirements for electrical equipment for measurement, control and laboratory use" and with the EMC requirements of IEC/EN 61326.
The measuring device described in these Operating Instructions thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the measuring device by affixing to it the CE mark.
The measuring device meets the EMC requirements of the Australian Communications and Media Authority (ACMA).

3.3 FOUNDATION Fieldbus device certification

The measuring device has passed all the test procedures implemented and has been certified and registered by the Fieldbus FOUNDATION. The device thus meets all the requirements of the following specifications:

- Certified to FOUNDATION fieldbus specification
- The flowmeter meets all the specifications of the FOUNDATION Fieldbus-H1.
- Interoperability Test Kit (ITK), revision 5.0: The device can also be operated in conjunction with other-make certified devices.?
- Physical Layer Conformance Test by Fieldbus Foundation

3.4 Registered trademarks

KALREZ® and VITON®
Registered trademarks of DuPont Performance Elastomers L.L.C., 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 businesses in the Endress+Hauser Group

4 Installation

4.1 Incoming acceptance, transport and storage

4.1.1 Incoming acceptance

On receipt of the goods, check the following points:
- Is the packaging or content undamaged?
- Is the delivery complete and do the delivered goods match your order?

4.1.2 Transport

Observe the following instructions when unpacking and transporting the device to its final location:
- Transport the measuring device in the container in which it is delivered.
- The covers or caps fitted to the process connections prevent mechanical damage to the sealing surfaces and contamination in the measuring tube when the unit is being transported or in storage. 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. For transportation purposes, 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.
When transporting, make sure that the measuring device does not unexpectedly turn around its axis or slip.

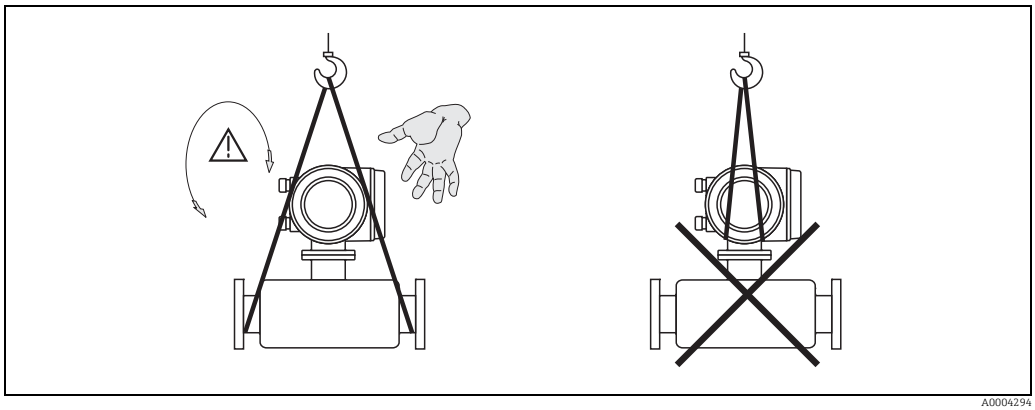


Fig. 4: Instructions for transporting sensors with > DN 40 (> 1½")

4.1.3 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 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.

4.2 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 → 94 and the medium temperature range → 94 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.

4.2.1 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 can be found in the "Documentation" section on → 100.

4.2.2 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

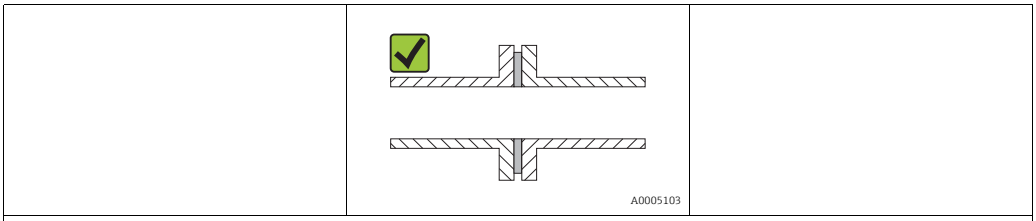
In compressed air systems, it is recommended to mount the flowmeter after the filter, dryer and buffer devices to avoid pulsations and oil/dirt contamination.
Do not mount the flowmeter directly after the compressor outlet.

4.2.3 Pipework requirements

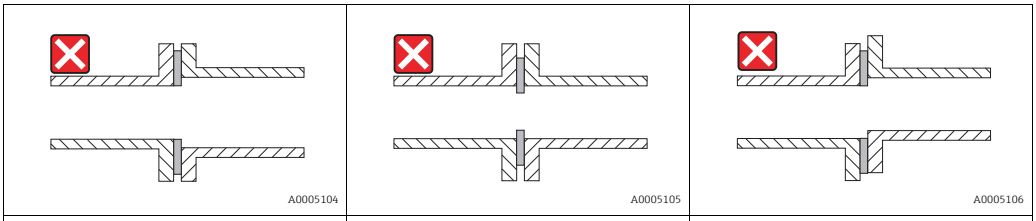
Good engineering practice should be followed at all times:

- 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 in) for diameters < DN 200 (8")
  - 3 mm (0.12 in) for diameters ≥ DN 200 (8")

Further information is provided in ISO Standard 14511.



Correctly aligned flanges and gaskets

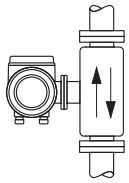
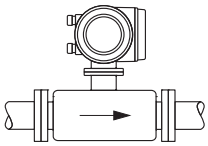
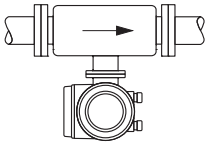
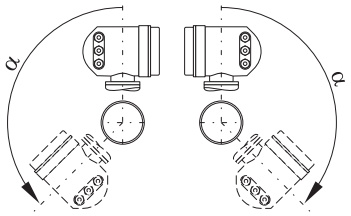


Pipe diameter one is not equal pipe diameter two	Incorrectly sized gaskets	Incorrectly aligned flanges and gaskets

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

4.2.4 Orientation

Make sure that the direction arrow on the sensor matches the direction of 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 wet or saturated with water (e. g. biogas, undried compressed air), mount in inclined orientation (α = approx. 135° ±10°).

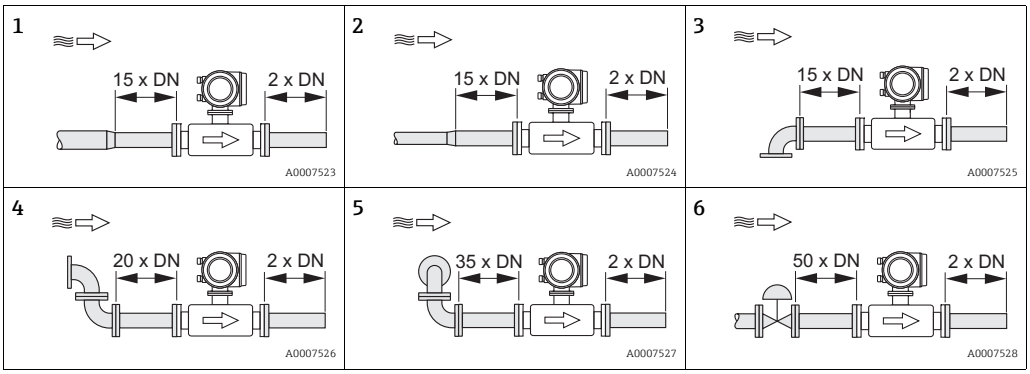
4.2.5 Inlet and outlet runs

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 → ISO Standard 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 is additionally mounted upstream from the measuring device and an elbow on the inlet side, select the recommended inlet length for control valves: 50 × DN
- For very light gases such as Helium and Hydrogen all upstream distances should be doubled.

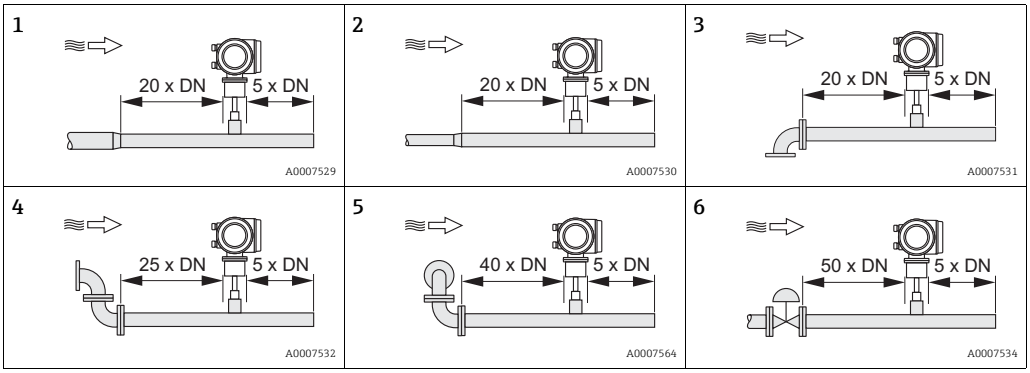
The minimum recommendations for inlet and outlet runs (without flow conditioner) are:

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.

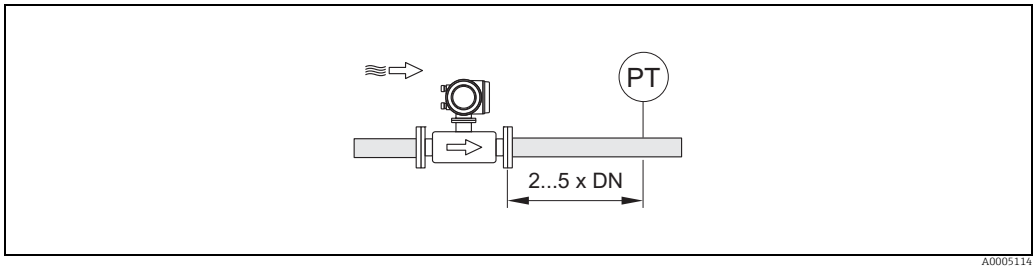


Fig. 5: Installing a pressure measuring point (PT = pressure transmitter)

Perforated plate flow conditioner

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

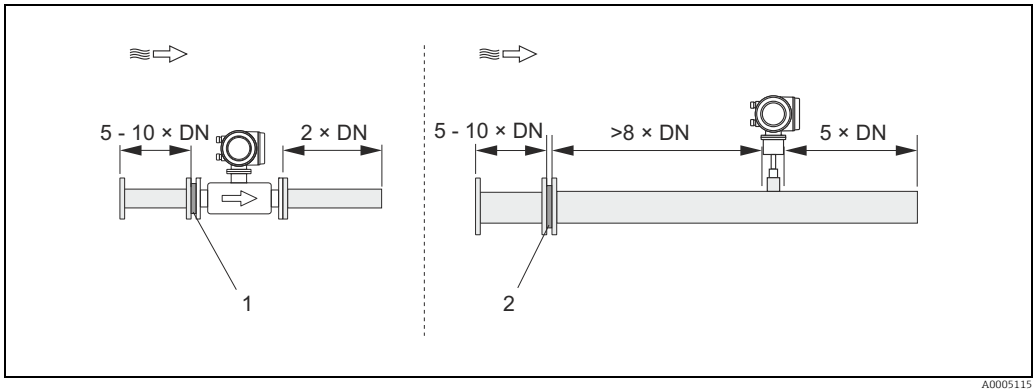


Fig. 6: The figure above illustrates the minimum recommended inlet and outlet runs expressed in multiples of the pipe diameter using a flow conditioner.

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

Flow conditioner for use with insertion sensors 65I
→ 📄 *67*

The well known "Mitsubishi" design is recommended for this application DN 80 mm to DN 300 mm (3" to 12"). The flow conditioner must be installed at a distance of 8 × DN upstream of the sensor. A further 5 pipe diameters minimum inlet run is required upstream of the actual conditioner itself.
Measured errors can occur depending on disturbances in the inlet run. Therefore it is advisable to choose inlet runs that are as long as possible.

Note!
In the case of insertion devices, the inlet run selected downstream of the conditioner should be as long as possible.

Perforated plate flow conditioners (19 hole) for use with flanged sensor 65F → 67

This is a special Endress+Hauser version designed especially 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 the pipe flange and the measuring device → 7. Use only standard bolts which match the flange bolt hole to guarantee that the flow conditioner is centered correctly.
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.

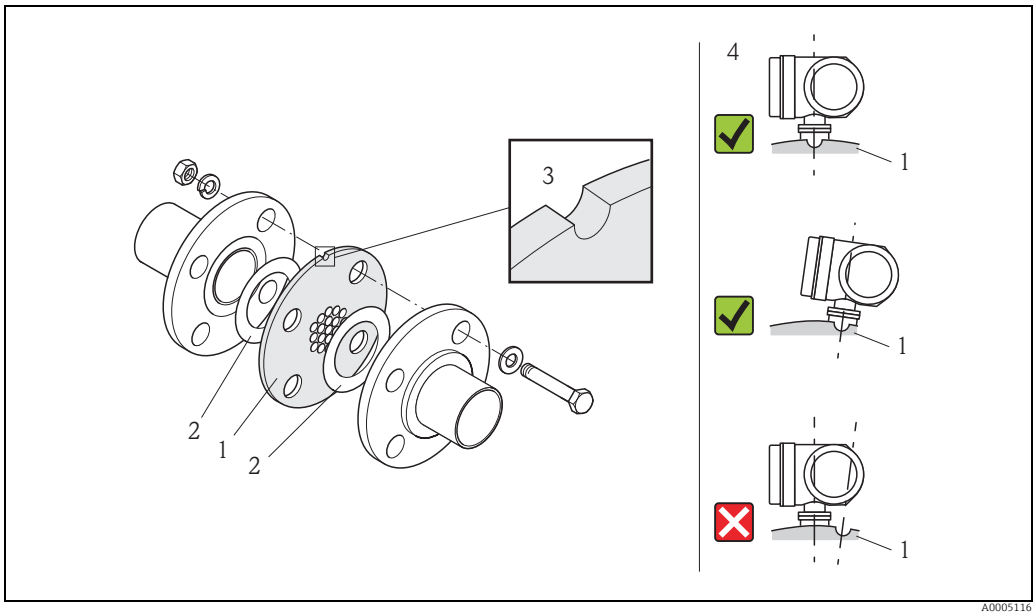


Fig. 7: Flow conditioner mounting arrangement (example)

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

Note

- Order the t-mass F sensor and the flow conditioner together to ensure that they are calibrated together. Joint calibration guarantees optimum performance. Ordering the flow conditioner separately and using it with the measuring device will further increase measurement uncertainty.
- The use of conditioners from other suppliers will affect the flow profile and pressure drop and will have an adverse effect on performance.
- Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

4.2.6 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.

4.2.7 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.

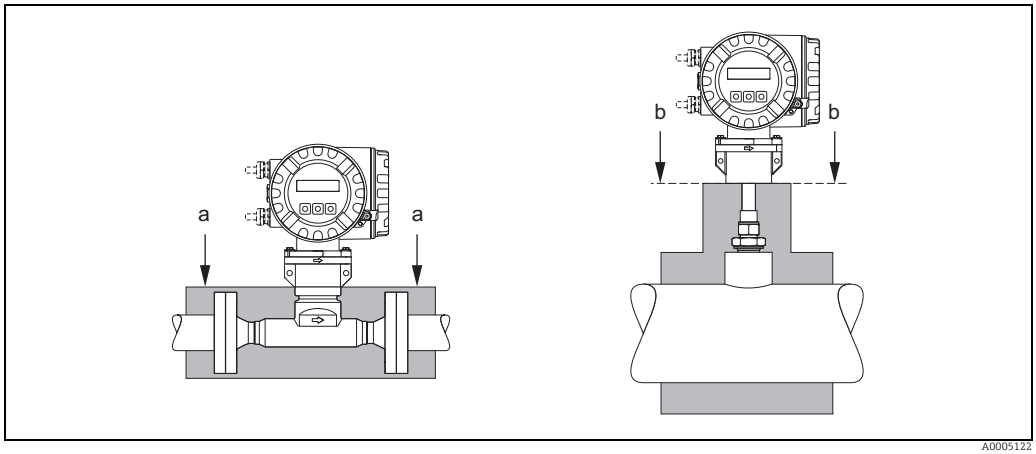


Fig. 8: Maximum thermal insulation for t-mass 65F and 65I

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

4.2.8 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 → 94

4.3 Installation

4.3.1 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 a welding boss is already available or a customer-specific one 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 a 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.

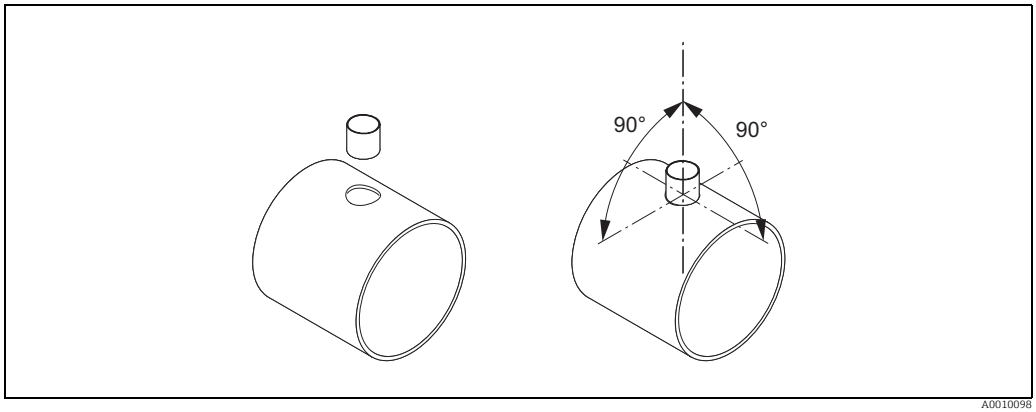


Fig. 9: Positioning the welding socket on the pipe (or duct)

Insertion depth calculation and adjustment

To ensure optimum measurement performance, the insertion sensor must be installed in the correct position in the pipe or duct (30% of the internal diameter).
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" → 55 or
   – using the following dimensions and formulae

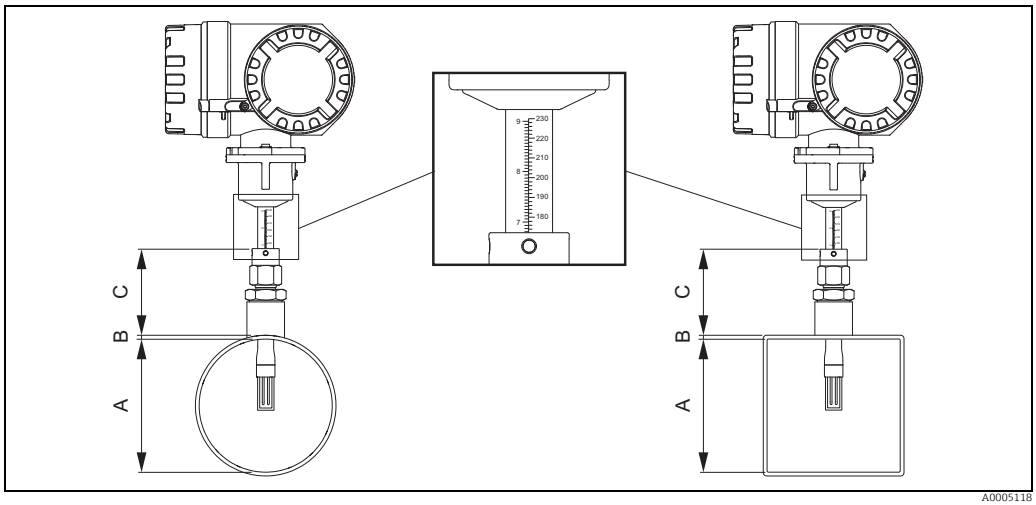


Fig. 10: Dimensions needed to calculate the insertion depth

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

The following dimensions are required to calculate the insertion depth:

A	• For circular pipes: the internal diameter (DN) • For rectangular ducts: – The internal duct height if the sensor is installed vertically – The internal duct width if the sensor is installed horizontally Note! Minimum length of dimension A = 80 mm (3.15 in)
B	Pipe / duct wall thickness
C	Height of the welding nozzle at the pipe/duct including the sensor compression fitting or low pressure mounting set (if used).

Note!
For detailed remarks on calculation refer to Technical Information TI00069D.

- Calculated insertion depth = (0.3 × A) + B + C + 2 mm (0.08 in)

Note down the calculated value.

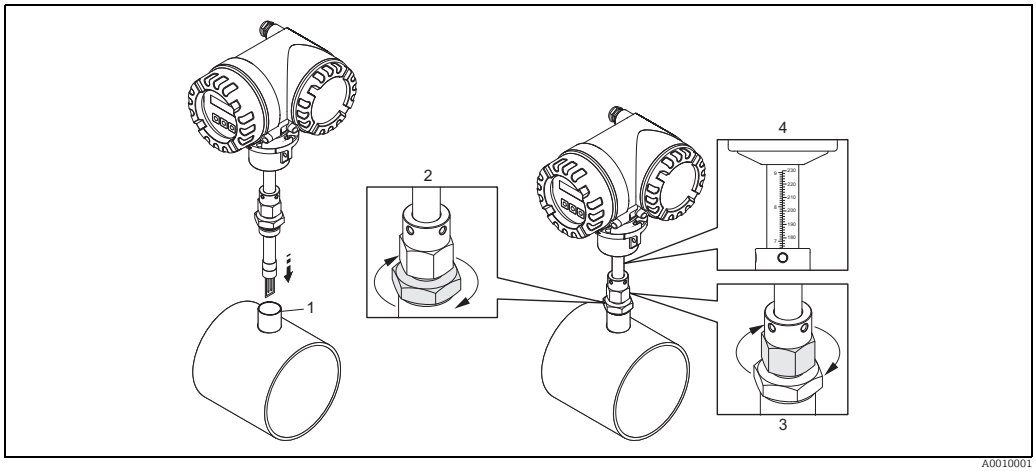


Fig. 11: Aligning the sensor to the calculated insertion depth

5. Insert the sensor in the nozzle (1) and tighten the lower nut of the compression fitting (2) finger-tight.

   ☝ 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).
8. Tighten the lower nut of the compression fitting 1¼ revolutions using a wrench (42 mm).

Aligning the sensor with the flow direction

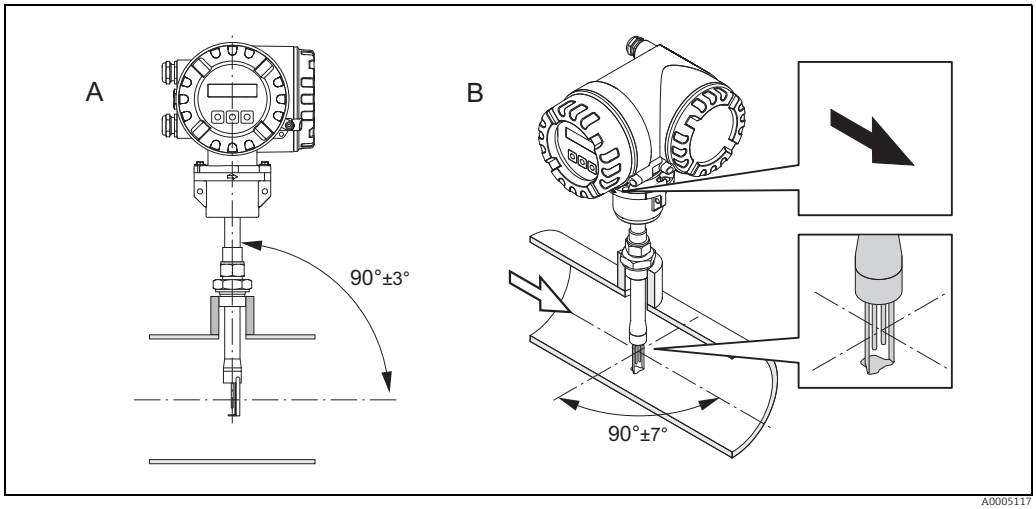


Fig. 12: Aligning the sensor with the flow direction

9. 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 transducer to the flowing gas stream, the sensor must not be rotated more than 7° from this alignment.

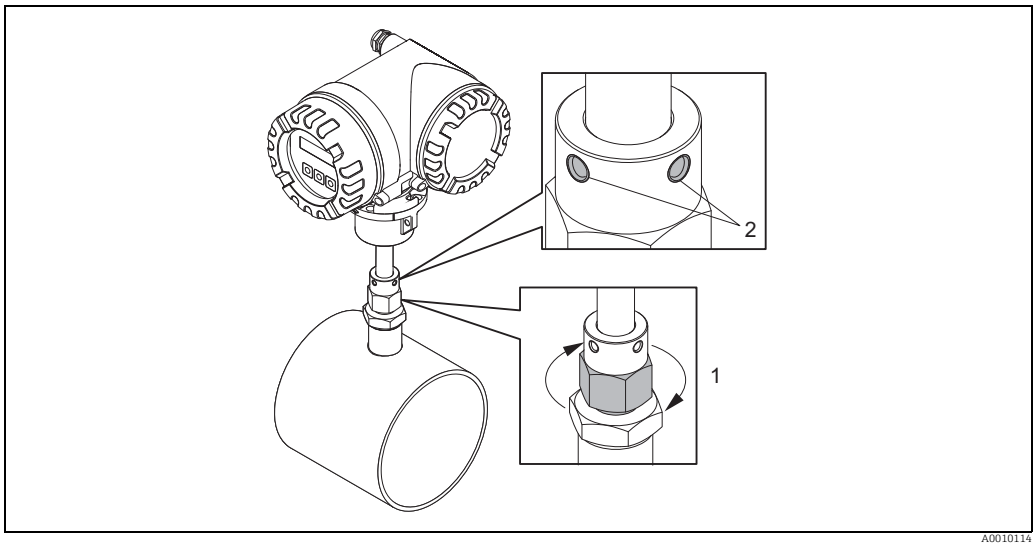


Fig. 13: Securing the position of the sensor

10. 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.
11. Fix the two securing screws (2) (Allen key 3 mm; (1/8")).

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

4.3.2 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)).

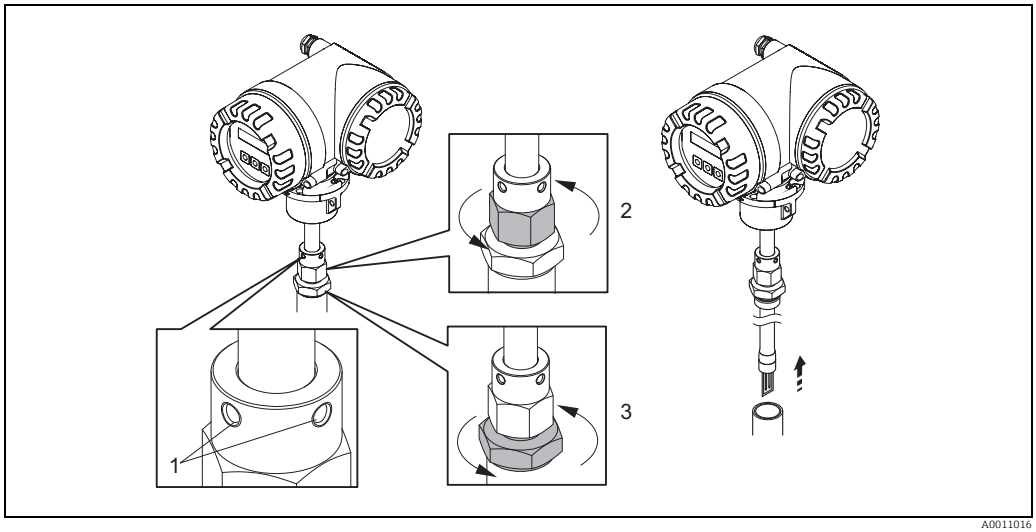


Fig. 14: Removing the insertion sensor

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.

4.3.3 Mounting the flanged sensor

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

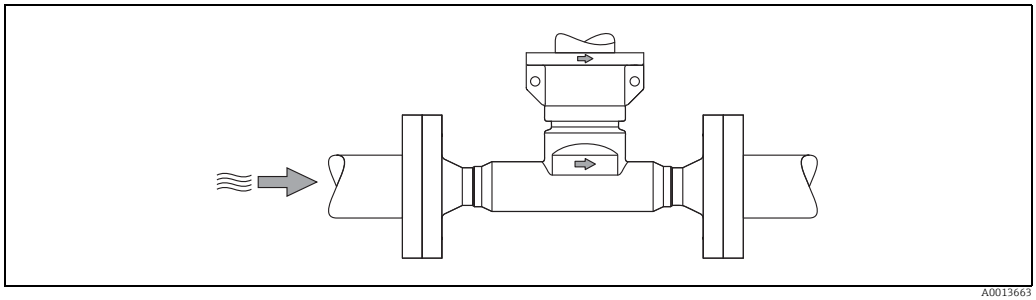


Fig. 15: Mounting in direction of flow

4.3.4 Turning the transmitter housing

Turning the aluminium field housing

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

1. Loosen the two securing screws.

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

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

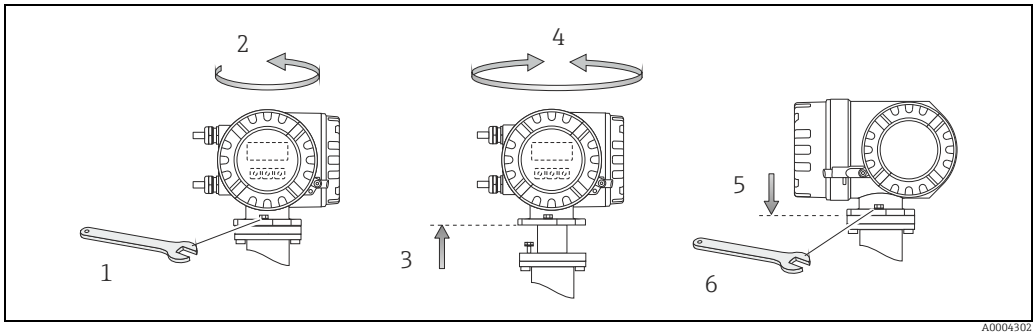


Fig. 16: Turning the transmitter housing (aluminium field housing)

4.3.5 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.

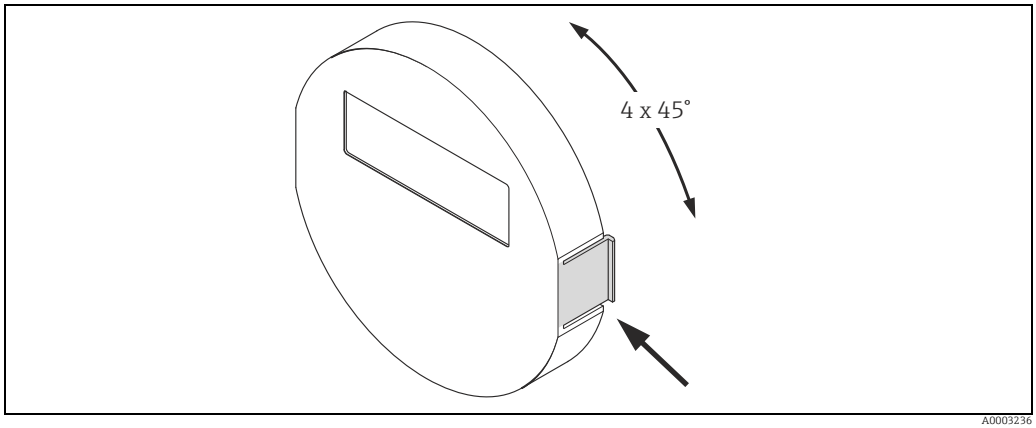


Fig. 17: Turning the local display (field housing)

4.3.6 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 → 📄 26 (separate mounting set, accessories → 📄 67)
- Pipe mounting → 📄 26 (separate mounting set, accessories → 📄 67)

Caution!

- The ambient temperature may not exceed the permissible range of −20 to +60 °C (−4 to +140 °F), optionally
  −40 to +60 °C (−40 to +140 °F), at the mounting location.
- Install the device in a shady 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 (0.26 inch)
   – Screw head: max. Ø 10.5 mm (0.41 inch)
4. Secure the transmitter housing to the wall as indicated.
5. Screw the cover of the connection compartment (a) firmly onto the housing.

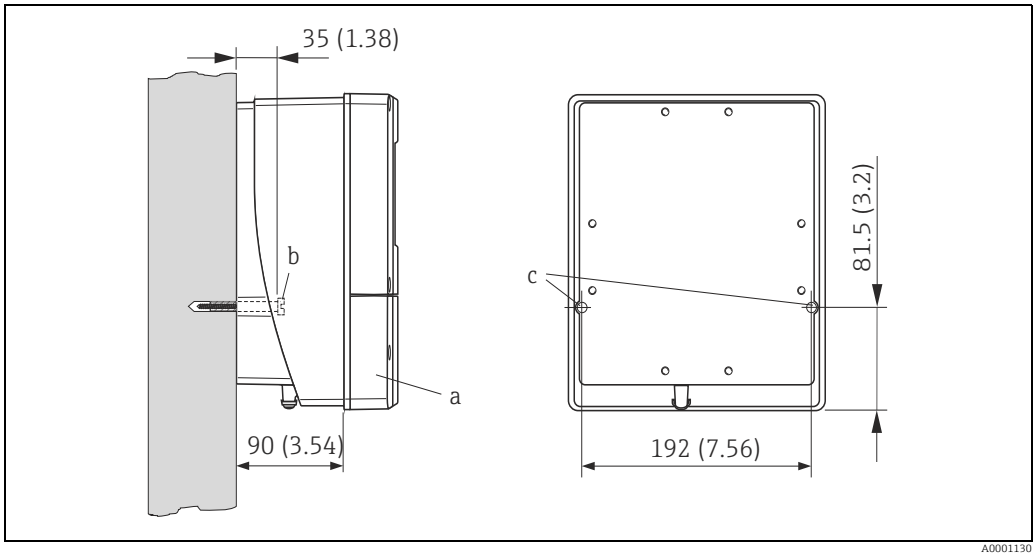


Fig. 18: Engineering unit mm (in)

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.

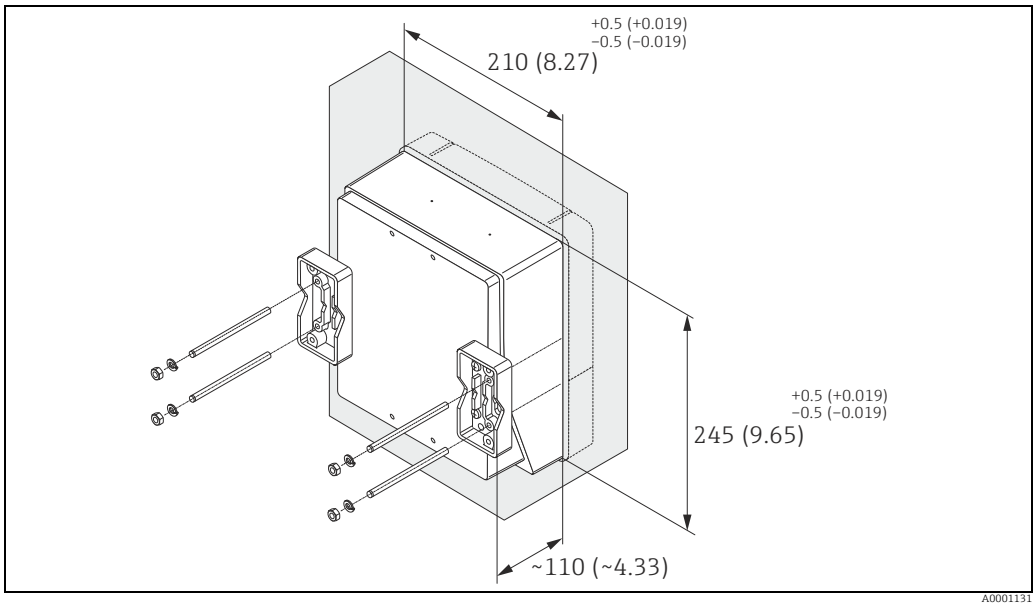


Fig. 19: Engineering unit mm (in)

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).

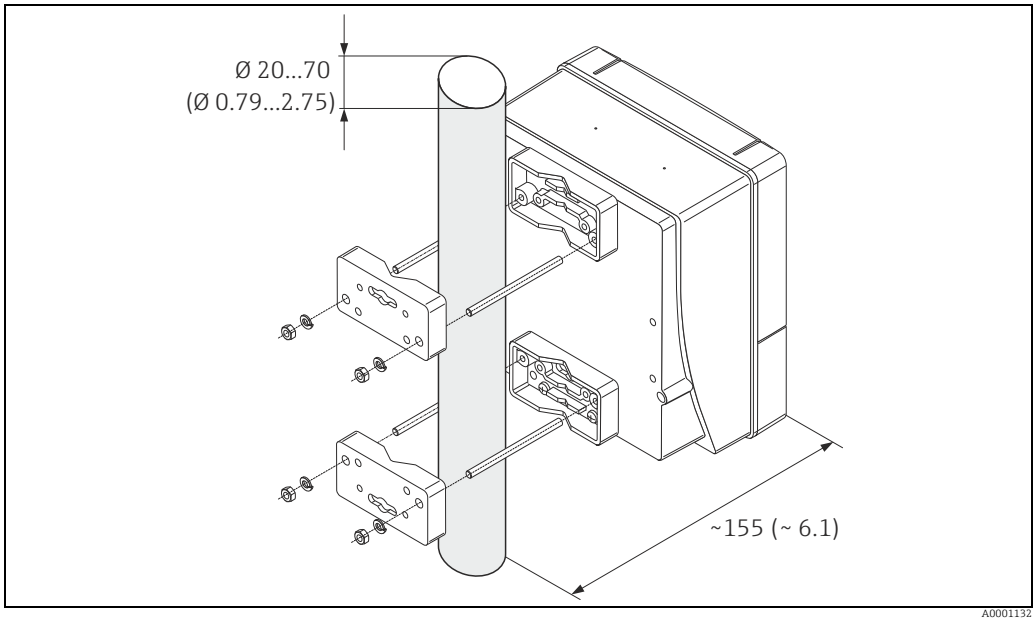


Fig. 20: Engineering unit mm (in)

4.4 Post-installation check

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

Device condition and specifications	Notes
Is the measuring device undamaged (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, e.g. correct pipe internal diameter, correctly sized gaskets?	→ 🖹 13
Is the position chosen for the sensor correct, in other words suitable for sensor type, fluid properties and fluid temperature?	→ 🖹 14
Is there sufficient upstream and downstream pipe sensor?	→ 🖹 15
Correct installation of flow conditioner (if fitted)?	→ 🖹 16
Does the arrow on the sensor match the direction of flow through the pipe?	→ 🖹 14
Correct sensor depth (insertion sensor only)?	→ 🖹 19
Process environment/process conditions	**Notes**
Is the measuring device protected against moisture and direct sunlight?	–
Is the measuring device protected against overheating?	→ 🖹 18
Is the measuring device protected against excessive vibration?	→ 🖹 18, → 🖹 94
Check gas conditions (e. g. purity, dryness, cleanliness)	Select suitable orientation → 🖹 14

5 Electrical connection

Warning!
When connecting Ex-certified measuring devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions. Please do not hesitate to contact your Endress+Hauser sales center 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 measuring device.

5.1 FOUNDATION Fieldbus cable specification

5.1.1 Cable type

Twin-core cables are recommended for connecting the flowmeter to the FOUNDATION Fieldbus H1. By analogy with IEC 61158-2 (MBP) protocol four different cable types (A, B, C, D) can be used with the FOUNDATION Fieldbus Protocol, only two of which (cable types A and B) are shielded.

- Cable types A or B are particularly preferable for new installations. Only these types have cable shielding that guarantees adequate protection from electromagnetic interference and thus the most reliable data transfer. With cable type B more than one fieldbus (with the same degree of protection) may be operated in a cable. No other circuits are permissible in the same cable.
- Practical experience has shown that cable types C and D should not be used due to the lack of shielding, since the freedom from interference generally does not meet the requirements described in the standard.

The electrical data of the fieldbus cable have not been specified but determine important characteristics of the design of the fieldbus, such as distances bridged, number of participants, electromagnetic compatibility, etc.

	Type A	Type B
Cable structure	twisted pair, shielded	one or more twisted pairs, fully shielded
Wire size	0.8 mm2 (18 AWG)	0.32 mm2 (22 AWG)
Loop resistance (DC)	44 W/km	112 W/km
Impedance at 31.25 kHz	100 W ± 20%	100 W ± 30%
Attenuation at 39 kHz	3 dB/km	5 dB/km
Capacitive asymmetry	2 nF/km	2 nF/km
Envelope delay distortion (7.9 to 39 kHz)	1.7 ms/km	*
Shield coverage	90%	*
Max. cable length (inc. spurs >1 m)	1900 m (6233 ft)	1200 m (3937 ft)
* not specified		

Suitable fieldbus cables (Type A) from various manufacturers for the non-hazardous area are listed below:
- Siemens: 6XV1 830-5BH10
- Belden: 3076F
- Kerpen: CeL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL

5.1.2 Maximum overall cable length

The maximum network expansion depends on the type of ignition protection and the cable specifications. The overall cable length is made up of the length of the main cable and the length of all spurs (>1 m/3.28 ft). Note the following points:

- The maximum permissible overall cable length depends on the cable type used → 🖹 28.
- If repeaters are used the maximum permissible cable length is doubled. A maximum of three repeaters are permitted between user and master.

5.1.3 Maximum spur length

The line between distribution box and field unit is described as a spur.
In the case of non Ex-rated applications the max. length of a spur depends on the number of spurs (>1 m/3.28 ft):

Number of spurs	1 to 12	13 to 14	15 to 18	19 to 24	25 to 32
Max. length per spur	120 m (393 ft)	90 m (295 ft)	60 m (196 ft)	30 m (98 ft)	1 m (3.28 ft)

5.1.4 Number of field devices

According to IEC 61158-2 (MBP) a maximum of 32 field devices may be connected per fieldbus segment. However, this number may be restricted in certain circumstances (type of ignition protection, bus power option, current consumption of field device).
A maximum of four field devices can be connected to a spur.

5.1.5 Shielding and grounding

The optimum electromagnetic compatibility of the fieldbus system is guaranteed only when system components and in particular lines are shielded and the shielding provides the most complete coverage possible. Shield coverage of 90% is ideal.

Shielding should be connected as often as possible with the reference ground. The national regulations and guidelines governing the installation of electrical equipment also apply where relevant!
Where there are large differences in potential between the individual grounding points, only one point of the shielding is connected directly with the reference ground. In systems without potential equalization, cable shielding of fieldbus systems should therefore only be grounded on one side, for example at the fieldbus supply unit or at safety barriers.

Caution!
If the cable shielding is grounded at more than one point in systems without potential equalization, network frequency equalization currents can occur that damage the bus cable or the bus shielding and substantially affect signal transmission.

5.1.6 Bus termination

The start and end of each fieldbus segment are always to be terminated with a bus terminator. With various junction boxes (not Ex-rated) the bus termination can be activated via a switch. If this is not the case a separate bus terminator must be installed. Note the following points in addition:

- In the case of a branched bus segment the device furthest from the segment connector represents the end of the bus.
- If the fieldbus is extended with a repeater then the extension must also be terminated at both ends.

5.1.7 Further information

General information and further notes on connections can be found on the website (www.fieldbus.org) of the Fieldbus Foundation or in the Operating Instructions "FOUNDATION Fieldbus Overview" (acquired at: ® www.endress.com ® Download).

5.2 Connecting the remote version

Note!
A cable is not supplied for the remote version.

5.2.1 Connecting connecting cable for sensor/transmitter

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

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 (14 AWG)).
4. Screw the connection compartment cover back onto the sensor and transmitter housing.

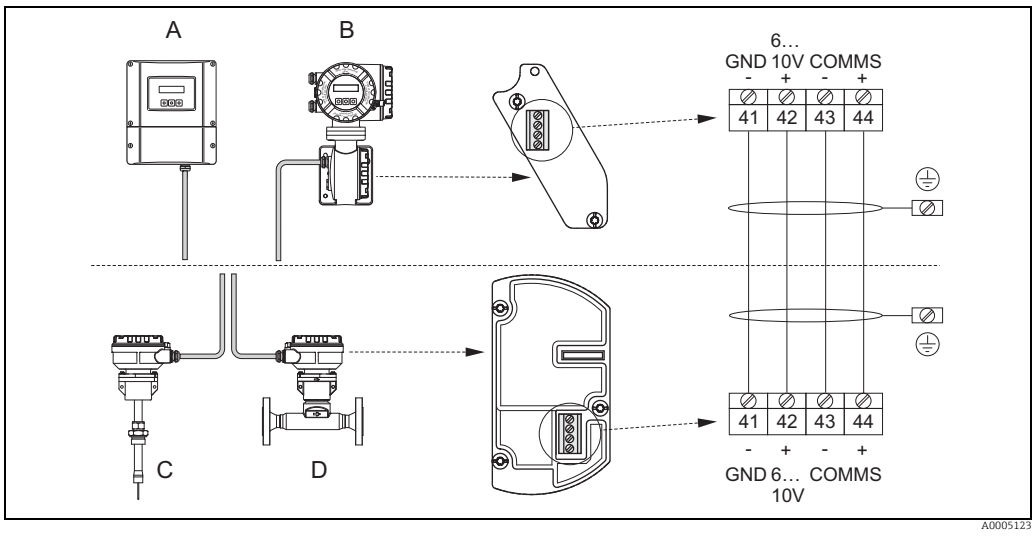


Fig. 21: Connecting the remote version

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

5.2.2 Cable specification, connecting cable

A cable with the following specifications must be used for the remote version:

- 2 × 2 × 0.5 mm² (AWG 20) PVC cable with common shield (2 twisted pairs)
- Conductor resistance: £ 40 /km (£ 131.2 /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 → 91.

5.3 Connecting the measuring unit

Field instruments can be connected to the FOUNDATION Fieldbus in two ways:

- Connection via conventional cable gland → 33
- Connection using prefabricated fieldbus connector (option) → 35

5.3.1 Terminal assignment

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

Order version	Terminal No. (inputs/outputs)			
	20 (+) / 21 (−)	22 (+) / 23 (−)	24 (+) / 25 (−)	26 = FF + [1] 27 = FF − [1]
65F**-**********G 65I-**********G	-	-	-	FOUNDATION Fieldbus Ex i
65F**-**********K 65I-**********K	-	-	-	FOUNDATION Fieldbus

[1] With integrated reverse polarity protection

5.3.2 Transmitter connection

Warning!
- Risk of electric shock. Switch off the power supply before opening the measuring device. Never mount or wire the measuring 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 → 32
4. Screw the cover of the connection compartment (f) back onto the transmitter housing.

Connecting the aluminum field housing

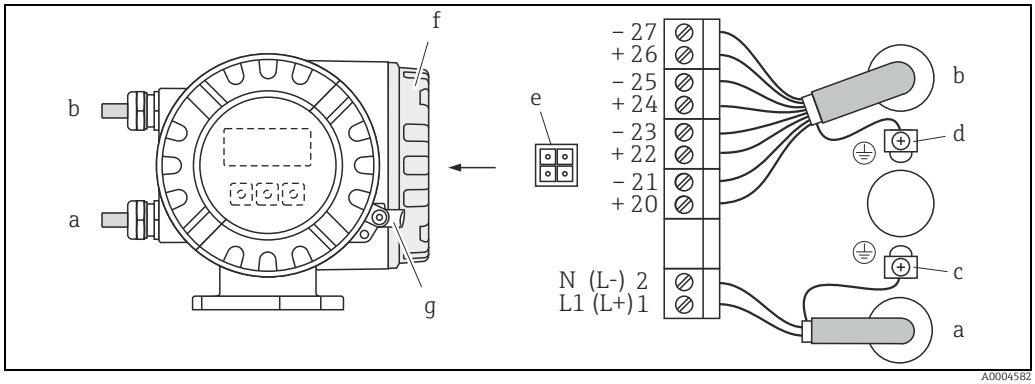


Fig. 22: Connecting the transmitter (aluminum field housing). Wire cross-section: max. 2.5 mm² (14 AWG)

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** → 32
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

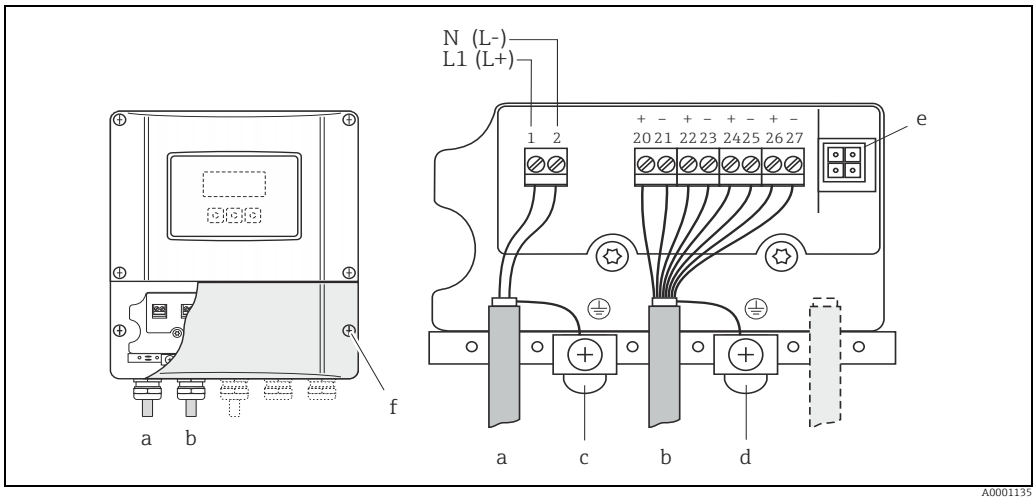


Fig. 23: Connecting the transmitter (wall-mount housing); wire cross-section: max. 2.5 mm² (14 AWG)

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** → 🖹 32*
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

Fieldbus connector

The connection technology of FOUNDATION Fieldbus allows measuring devices to be connected to the fieldbus via uniform mechanical connections such as T-boxes, junction boxes, etc.

This connection technology using prefabricated distribution modules and plug-in connectors offers significant advantages over conventional wiring:
- Field devices can be removed, replaced or added at any time during normal operation. Communication is not interrupted.
- This simplifies installation and maintenance significantly.
- Existing cable infrastructures can be used and expanded instantly, e.g. when constructing new star distributors using 4-channel or 8-channel junction boxes.

The device can therefore be supplied with a ready-mounted fieldbus connector. Fieldbus connectors for retrofitting can be ordered from Endress+Hauser as a spare part → 67.

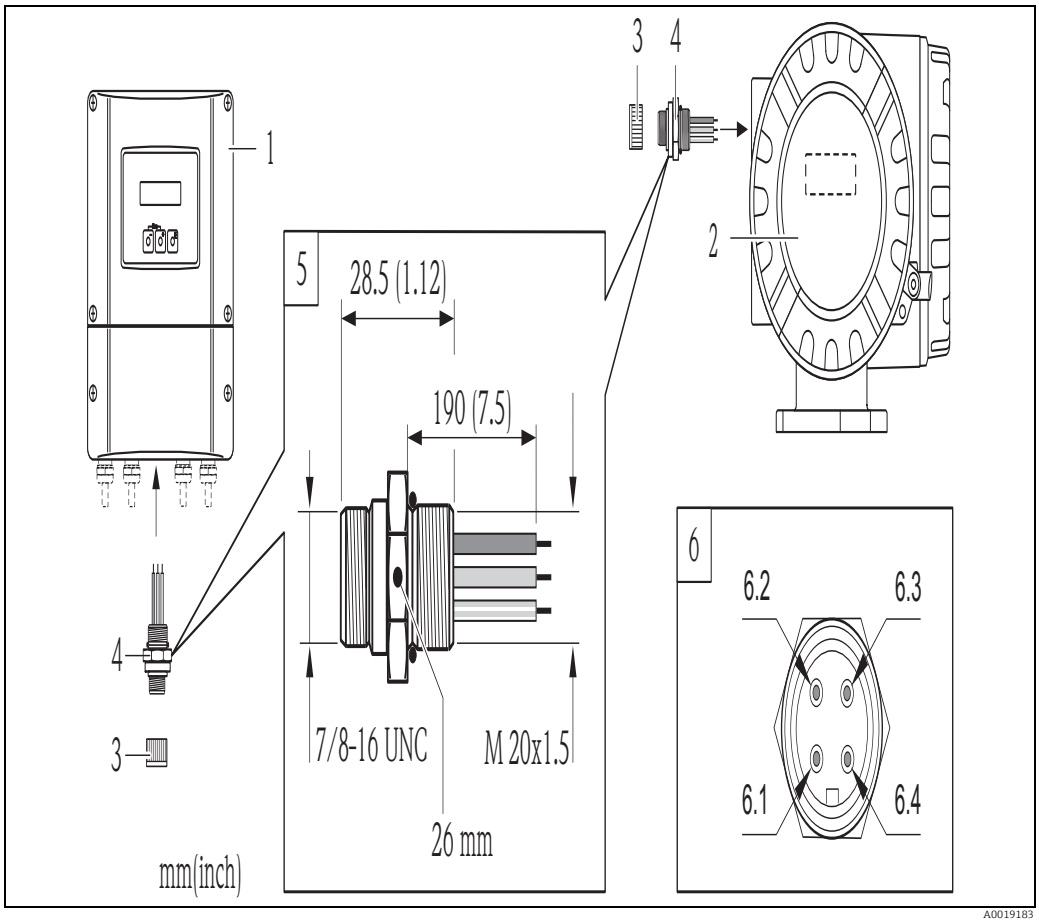


Fig. 24: Connector for connecting to the FOUNDATION Fieldbus

A Wall-mount housing
B Field housing
C Protective cap for connector
D Fieldbus connector

1 Protective cap for connector
2 Fieldbus connector (pin assignment/color codes)
2.1 Brown wire: FF + (terminal 26)
2.2 Blue wire: FF– (terminal 27)
2.3 Not assigned
2.4 Green/yellow: ground (notes on connection → 29, → 30)

Technical data, connector:
– Degree of protection IP 67
– Ambient temperature range: –40 to +150 °C (–40 to +302 °F)

5.4 Degree of protection

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

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

- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary. If the measuring device is used in a dusty atmosphere, only use the housing seals from Endress+Hauser.
- All threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter (Cable entry → 91)
- Firmly tighten the cable entries (point **a** → 25).
- The cables must loop down before they enter the cable entries ("water trap") (point **b** → 25). This arrangement prevents moisture penetrating the entry.
- Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

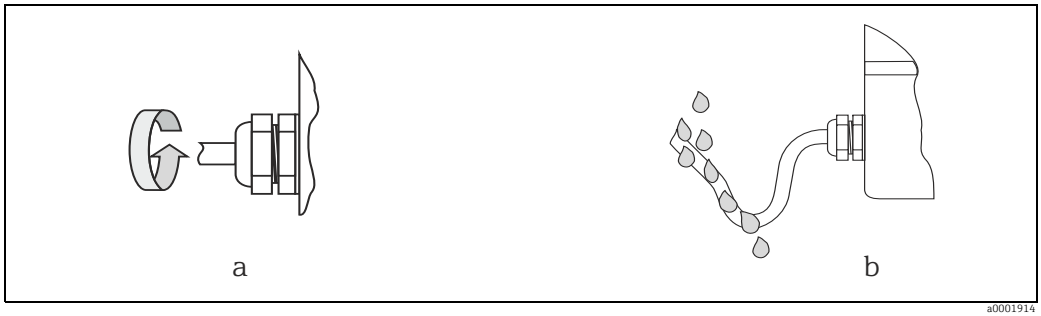


Fig. 25: Installation instructions, cable entries

5.5 Post-connection check

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

Measuring device condition and specifications	**Notes**
Are the measuring device or cables undamaged (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?	-
Is the cable type route completely isolated? Without loops and crossovers?	-
Are the power supply and signal cables correctly connected?	See the wiring diagram inside the cover of the terminal compartment
Are all screw terminals firmly tightened?	-
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ 🖹 36
Are all housing covers installed and firmly tightened?	-
Electrical connection of FOUNDATION Fieldbus-H1	Notes
Are all the connecting components (T-boxes, junction boxes, connectors, etc.) connected with each other correctly?	-
Has each fieldbus segment been terminated at both ends with a bus terminator?	-
Has the max. length of the fieldbus cable been observed in accordance with the FOUNDATION Fieldbus specifications?	→ 🖹 29
Has the max. length of the spurs been observed in accordance with the FOUNDATION Fieldbus specifications?	→ 🖹 29
Is the fieldbus cable fully shielded (90%) and correctly grounded?	→ 🖹 29

6 Operation

6.1 Quick operation guide

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

1. **Local display (option)**→ 📄 39
   The local display makes it possible to read all important variables directly at the measuring point, configure device-specific parameters in the field and perform commissioning.
2. **Operating programs**→ 📄 43
   FOUNDATION Fieldbus functions and device-specific parameters are configured primarily via the fieldbus interface. You can obtain special configuration and operating programs from various manufacturers for these purposes.
3. **Jumpers for diverse hardware settings** → 📄 45
   Jumpers on the I/O board provide the means of setting the following hardware parameters for the FOUNDATION Fieldbus:
   - Enabling/disabling the simulation mode in the function blocks (e.g. AI, DO function block)
   - Switching the hardware write protection on and off

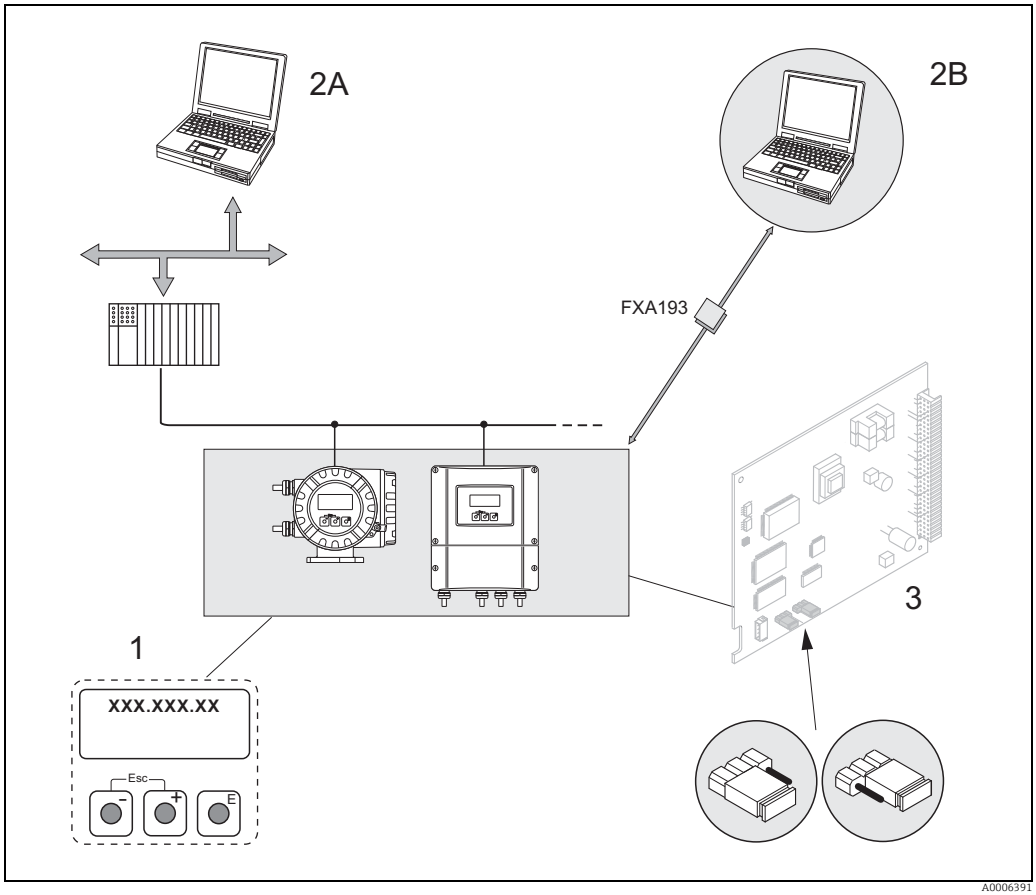


Fig. 26: FOUNDATION Fieldbus operating options

1 Local display for device operation in the field (option)
2A Configuration/operating programs for operating via the FOUNDATION Fieldbus (FF functions, device parameters)
2B Configuration/operating program for operation via service interface FXA193 (e.g. FieldCare)
3 Jumper/miniature switches for hardware settings (write protection, simulation mode)

6.2 Display and operating elements

The local display makes it possible to read all important parameters directly at the measuring point or configure the measuring device via the "Quick Setup" or 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).

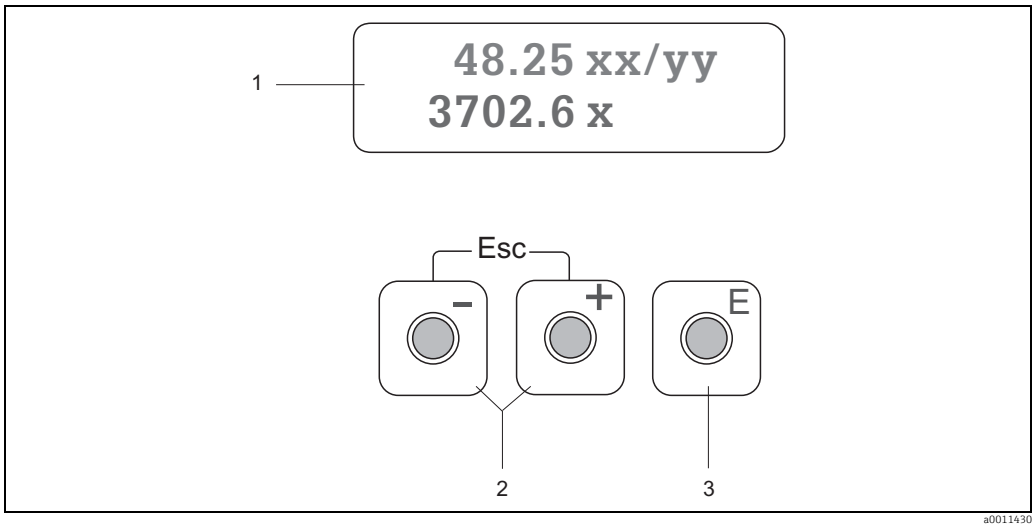


Fig. 27: Display and operating elements

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, measuring device status, and error messages.

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

6.3 Brief operating instructions for the function matrix

Note!
- See the general notes → 41
- 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

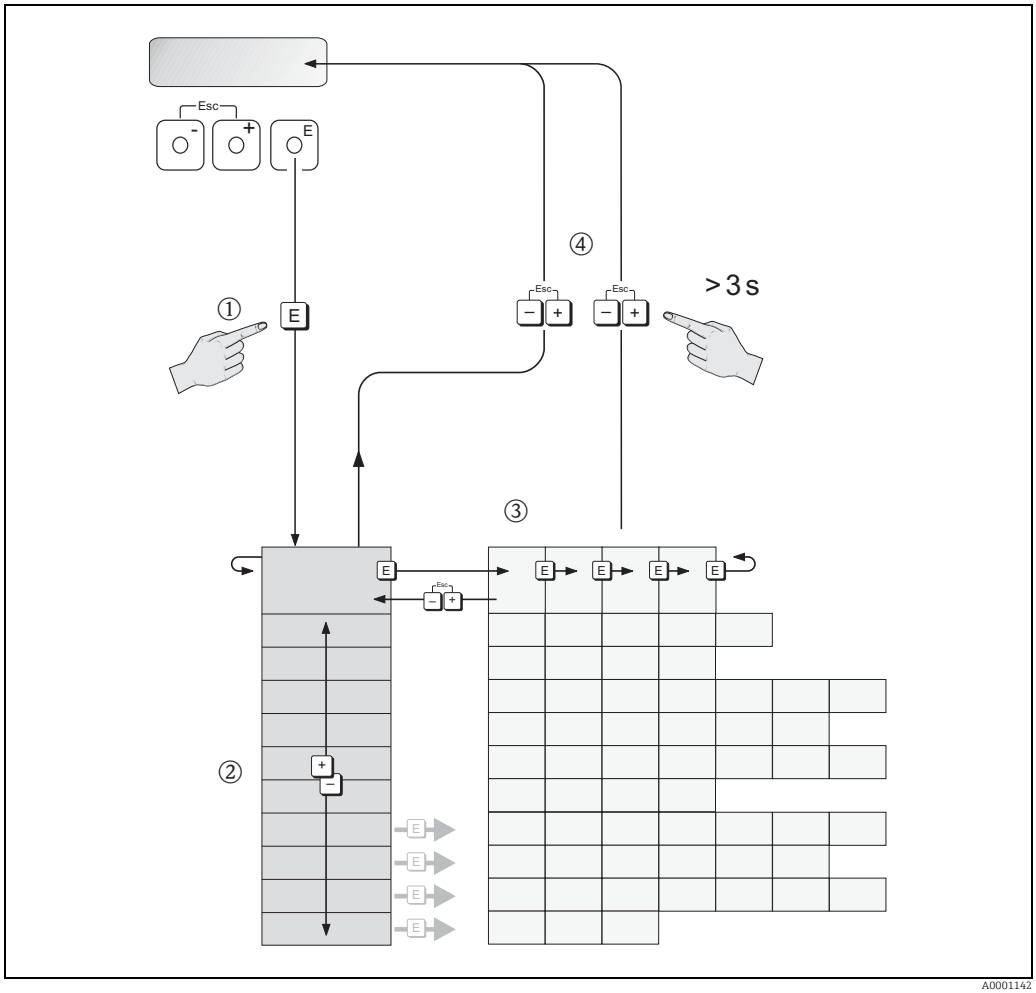


Fig. 28: Selecting functions and configuring parameters (function matrix)

6.3.1 General notes

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

Comply with the following instructions when configuring functions:
- You select functions as described already → 📖 40.
- 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 parameterized values remain safely stored in the EEPROM.

6.3.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 65) has to be entered before settings can be changed.
If you use a code number of your choice, you exclude the possibility of unauthorized persons accessing data (→ see the “Description of Device Functions” manual).

Comply with the following instructions when entering codes:
- If programming is disabled and the ± operating elements are pressed in any function, a prompt for the code automatically appears on the display.
- If “0” is specified as the customer's code, programming is always enabled.
- Your Endress+Hauser sales center can be of assistance if you mislay your private 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 sales center. Please contact Endress+Hauser first if you have any questions.

6.3.3 Disabling the programming mode

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

6.4 Error messages

6.4.1 Type of error

Errors that occur during commissioning or measuring are displayed immediately. If two or more system or process errors occur, the error with the highest priority is the one shown on the display.

The measuring device distinguishes between two types of error:
- *System error:* This group includes all device errors, e.g. communication errors, hardware errors etc. → 📄 73
- *Process error:* This group includes all application errors, e.g. flow limit etc. → 📄 78

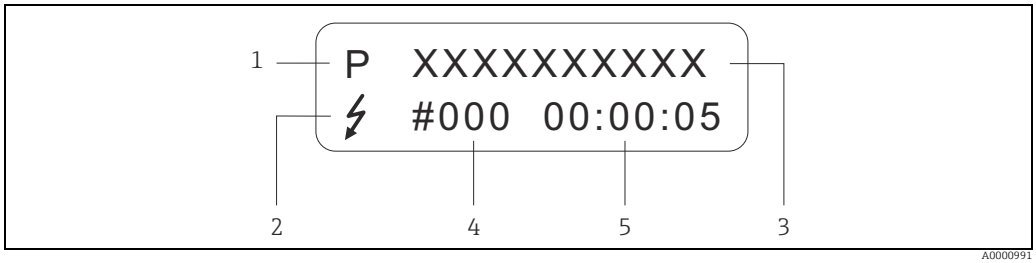


Fig. 29: Error messages on the display (example)

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)

6.4.2 Error message type

The measuring device always assigns system and process errors which occur to two types of error messages (**fault** or **notice messages**), resulting in different weightings → 📄 73. Serious system errors, e.g. module defects, are always identified and classed as "fault messages" by the measuring device.

Notice message (!)
- The error in question has no effect on measurement currently in progress.
- Displayed as → Exclamation mark (!), type of error (S: system error, P: process error)
- Presentation on the FOUNDATION Fieldbus → Notice messages are transmitted to subsequent Function Blocks or higher-level process control systems by means of the status "UNCERTAIN" of the output value OUT (AI Block).

Fault message ($)
- The error in question interrupts or stops measurement currently in progress.
- Displayed as → Lightning flash (ϟ), type of error (S: system error, P: process error)
- Presentation on the FOUNDATION Fieldbus → Fault messages are transmitted to subsequent function blocks or higher-level process control systems by means of the status "BAD" of the output value OUT (AI Block).

6.5 Operating programs

6.5.1 Operating program "FieldCare"

FDT-based plant asset management tool from Endress+Hauser. 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. The Proline flow measuring devices are accessed via a service interface or via the service interface FXA193.

6.5.2 Operating via FOUNDATION Fieldbus configuration programs

The operator can obtain special configuration and operating programs offered by the different manufacturers for use in configuration. These can be used for configuring both the FOUNDATION Fieldbus functions and all the device-specific parameters. The predefined Function Blocks allow uniform access to all the network and fieldbus device data.

A step-by-step description of the procedure for commissioning the FF functions is given on → 47, along with the configuration of device-specific parameters.
General information on FOUNDATION Fieldbus is provided in the Operating Instructions "FOUNDATION Fieldbus Overview" (BA00013S). Available at: → www.endress.com → Download.

System files

The following files are needed for commissioning and network configuration:
- Commissioning → Device description (Device Description: *.sym, *.ffo)
- Network configuration → CFF file (Common File Format: *.cff)

You can obtain these files as follows:
- Free of charge via the Internet → www.endress.com
- From Endress+Hauser stating the order number (No. 56003896)
- Via the Fieldbus Foundation Organization → www.fieldbus.org

Note!
Ensure that the correct system files have been used for linking the field devices into the host system. Appropriate version information can be called up via the following functions/ parameters:

Local display:
- HOME ® COMMUNICATION ® FOUND. FIELDBUS ® DEVICE REVISION
- HOME ® COMMUNICATION® FOUND. FIELDBUS ® DD REVISION

FOUNDATION Fieldbus interface
- Resource Block → Parameter DEV_REV
- Resource Block → Parameter DD_REV

Example (with local display):
Displayed in the DEVICE REVISION function → 01
Displayed in the DD REVISION function → 01
Device description file (DD) required → 0101.sym / 0101.ffo

6.5.3 Device description files

The device description files that suit the individual operating tools are listed in the following table.

FOUNDATION Fieldbus protocol:

Valid for software:	3.00.XX	→ Function "Device software"
Device data FOUNDATION Manufacturer ID: Device ID:	 11_{hex} (ENDRESS+HAUSER) 1065_{hex}	 → Function "Manufacturer ID" → Function "Device ID"
FOUNDATION Fieldbus version data:	Device Revison 6/ DD Revision 1	
Software release:	12.2010	

Operating program	**How to acquire:**
Device Description (DD) and Capability File (CFF)	▪ www.endress.com ▪ www.fieldbus.org
Device driver for FF host systems:	**How to acquire**:
ABB (FieldController 800)	see FF standard device driver
Allen Bradley (Control Logix)	see FF standard device driver
Emerson (Delta V)	www.easydeltav.com
Endress+Hauser (Control-Care)	see FF standard device driver
Honeywell (Experion PKS)	see FF standard device driver
SMAR (System 302)	see FF standard device driver
Yokogawa (CENTUM CS 3000)	www.yokogawa.com
Device drivers for additional FF operating programs:	**Sources for obtaining updates**:
Handheld terminal 375	www.fieldcommunicator.com ✎ Note! The device drivers can be added and updated via the update function of the handheld terminal 375.

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

6.6 FOUNDATION Fieldbus hardware settings

6.6.1 Switching hardware write protection on and off

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

⚠ Warning!
Risk of electric shock. Exposed components carry dangerous voltages. Switch off the power supply before you remove the cover of the electronics compartment.

1. Switch off the power supply.
2. Remove the I/O board → 🖹 81
3. Configure hardware write protection and simulation mode appropriately using the jumpers (see graphic).
4. Installation of the I/O board is the reverse of the removal procedure.

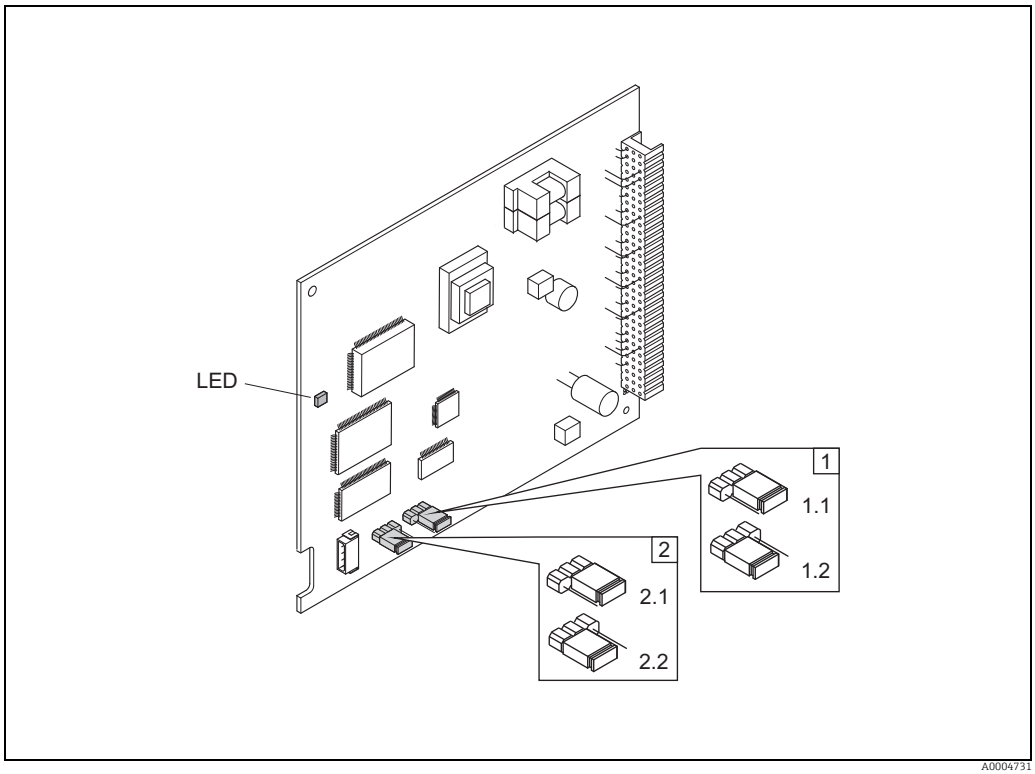


Fig. 30: Hardware configuration (I/O board)

1 Jumper for enabling/disabling write protection:
1.1 Write protection disabled (factory setting) = it is possible to write-access the device functions via the FF interface
*1.2 Write protection enabled = it is **not** possible to write-access the device functions via the FF interface*

2 Jumper for simulation mode:
2.1 Simulation mode enabled (factory setting) = simulation in the Analog Input Function Block and in the Discrete Output Function Block is possible
*2.2 Simulation mode disabled = simulation in the Analog Input Function Block and in the Discrete Output Function Block is **not** possible*

LED (light emitting diode):
- *Continuously lit → Ready (no communication via FF active)*
- *Not lit → Not ready*
- *Flashes slowly → Ready (communication via FF active)*
- *Flashes quickly → Device error present (error message type "fault message") → 🖹 69*

7 Commissioning

7.1 Function check

Perform all the final checks before putting the measuring point into operation:
- Checklist for "Post-installation check" → 27
- Checklist for "Post-connection check" → 37

7.2 Switching on the measuring device

Only switch on the supply voltage once all the final checks have been performed. The measuring 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:

t-mass 65 START-UP	Start-up message
▼	
t-mass 65 FOUND. FIELDBUS	Show the input/output modules
▼	
DEVICE SOFTWARE V XX.XX.XX	Current software version
▼	
SYSTEM OK → OPERATION	Beginning of normal measuring mode
▼	

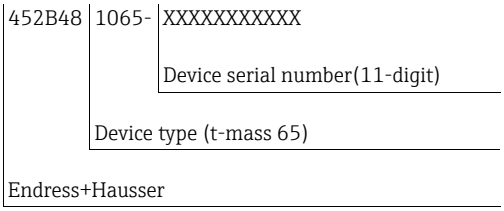
Normal measuring mode commences as soon as start-up completes.
Various measured values and/or status variables appear on the display (HOME position).

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

7.3 Commissioning with FOUNDATION Fieldbus

Note the following points:
- The files required for commissioning and network configuration can be obtained as described on → 🖹 43
- The device is identified by the FOUNDATION Fieldbus in the host or configuration system via the device ID (DEVICE_ID). The DEVICE_ID is a combination of the manufacturer ID, device type and device serial number. It is unique and can never be duplicated.

The DEVICE_ID is composed as follows:



7.3.1 Initial operation

The following description allows step-by-step commissioning of the measuring device and all the necessary configurations for the FOUNDATION Fieldbus:

1. Switch on the measuring device.
2. Note the DEVICE_ID on the device nameplate (→ 🖹 7).
3. Open the configuration program.
4. Load the device description file or CFF file into the host system or into the configuration program. Ensure that the correct system files have been used. Refer to the example on → 🖹 49.
   The first time it is connected the device reports as follows:

   – EH_TMASS_65_ xxxxxxxxxxx (tag name PD-TAG)
   – 452B481042- xxxxxxxxxxx (Device_ID)
   – Block structure:

Display text (xxx... = serial number)	Base index	Description
RESOURCE_ xxxxxxxxxxx	400	Resource Block
TRANSDUCER_FLOW_xxxxxxxxxxx	1400	"Flow" Transducer Block
TRANSDUCER_DIAG_xxxxxxxxxxx	1600	"Diagnosis" Transducer Block
TRANSDUCER_DISP_xxxxxxxxxxx	1800	"Display" Transducer Block
TRANSDUCER_TOT_xxxxxxxxxxx	1900	"Totalizer" Transducer Block
TRANSDUCER_GAS_xxxxxxxxxxx	2700	"Heat Flow" Transducer Block
ANALOG_INPUT_1_xxxxxxxxxxx	500	Analog Input function block 1
ANALOG_INPUT_2_xxxxxxxxxxx	550	Analog Input function block 2
ANALOG_INPUT_3_xxxxxxxxxxx	600	Analog Input function block 3
ANALOG_INPUT_4_xxxxxxxxxxx	650	Analog Input function block 4
ANALOG_INPUT_5_xxxxxxxxxxx	700	Analog Input function block 5
ANALOG_OUTPUT_xxxxxxxxxxx	2300	Analog Output function block (DO)
DISCRETE_OUTPUT_xxxxxxxxxxx	900	Discrete Output function block (DO)
PID_xxxxxxxxxxx	1000	PID function block (PID)
ARITHMETIC_xxxxxxxxxxx	1100	Arithmetic function block (ARTH)
INPUT_SELECTOR_xxxxxxxxxxx	1150	Input Selector function block (ISEL)
SIGNAL_CHARACT_xxxxxxxxxxx	1200	Signal Characterizer function block (CHAR)
INTEGRATOR_xxxxxxxxxxx	1250	Integrator function block (INTG)

Note!
The device is supplied with the bus address "250" and is thus in the address range reserved for readdressing field devices, between 248 and 251. This means that the LAS (Link Active Scheduler) automatically assigns the device a free bus address in the initialization phase.

5. Identify the field device using the DEVICE_ID that you noted down and assign the desired field device tag name (PD_TAG) to the fieldbus device in question.
   Factory setting: EH_TMASS_65_xxxxxxxxxxx

Configuration of the "Resource Block" (base index 400)

6. Open the Resource Block.
7. On delivery write protection is disabled so that you can access the write parameters via FF. Check this status via the parameter WRITE_LOCK:
   – Write protection activated = LOCKED
   – Write protection deactivated = NOT LOCKED

   Deactivate the write protection if necessary → 45.
8. Enter the desired block name (optional).
   Factory setting: RESOURCE_ xxxxxxxxxxx
9. Set the operating mode in the parameter group MODE_BLK (parameter TARGET) to AUTO.

Configuration of the "Transducer Blocks"

The individual Transducer Blocks comprise various parameter groups ordered by device-specific functions:

Transducer Block	Base index	Description
"Flow" Transducer Block	1400	Flow measurement
"Diagnosis" Transducer Block	1600	Diagnostic functions
"Display" Transducer Block	1800	Local display functions
"Totalizer" Transducer Block	1900	Totalizer 1 to 2
"Heat Flow" Transducer Block	2300	Heat flow measurement

The following description provides an example for the "Flow" Transducer Block (base index: 1400).

10. Enter the desired block name (optional).
    Factory setting: TRANSDUCER_FLOW_xxxxxxxxxxx
11. Open the "Flow" Transducer Block.
12. Now configure the relevant device-specific parameters for the desired application:

    Note!
    – Changes to the device parameters can only be made after entering a valid access code in the parameter "Access – Code".
    – The selection of the system units in the "Flow" Transducer Block has no effect on the output value OUT (AI Block). Units of the process variables which are transmitted via the FF-interface must be specified separately in the Analog Input function block via the XD_SCALE and OUT_SCALE parameter group.
13. Set the "Flow" and "Totalizer" Transducer Blocks to AUTO in the MODE_BLK parameter group (TARGET parameter). Only then is it ensured that the process variables can be processed correctly by the downstream AI function block.

Configuration of the "Analog Input function blocks"

The device has five Analog Input function blocks that can be assigned to the various process variables. The following description provides an example for the Analog Input function block 1 (base index: 500).

14. Enter the desired name for the Analog Input function block (optional).
    Factory setting: ANALOG_INPUT_1xxxxxxxxxx
15. Open the Analog Input function block 1.
16. Set the operating mode in the parameter group MODE_BLK (parameter TARGET) to OOS, i.e. block Out Of Service.
17. Using the parameter CHANNEL select the process variable that is to be used as the input value for the function block algorithm (scaling and limit value monitoring functions). The following settings are possible:

Process variable	Channel parameter
Mass flow	1
Corrected volume flow	2
Temperature	3
Totalizer 1	7
Totalizer 2	8
Heat flow	53

18. In the parameter group XD_SCALE select the desired engineering unit and the block input range (e.g. measurement range of the flow application) for the process variable in question (see the example below).

    ☝ Caution!
    Make sure that the selected unit is suitable for the measurement variable of the selected process variable. Otherwise, the BLOCK_ERROR parameter will display the error message "Block Configuration Error", and the block operating mode cannot be set to AUTO.

19. In the L_TYPE parameter, select the mode of linearization for the input variable (Direct, Indirect, Indirect Sq Root) → "Description of Device Functions" manual

    ☝ Caution!
    Note that with the type of linearization "Direct" the configuration of the parameter group OUT_SCALE must agree with the configuration of the parameter group XD_SCALE. Otherwise the block operating mode cannot be set to AUTO. Such incorrect configuration is indicated in the parameter BLOCK_ERROR via the "Block Configuration Error" message.

    Example:
    – The measurement range of the sensor is 0 to 30 m3/h.
    – The output range to the automation system should be 0 to 30 m3/h also.
    The following settings should be made:
    – Analog Input function block/parameter CHANNEL (selection of input value), selection: 2 → Volume flow
    – Parameter L_TYPE → Direct
    – Parameter group XD_SCALE
      XD_SCALE 0% = 0
      XD_SCALE 100% = 30
      XD_SCALE UNIT = m3/h
    – Parameter group OUT_SCALE
      OUT_SCALE 0% = 0
      OUT_SCALE 100% = 30
      OUT_SCALE UNIT = m3/h

20. The limit values for alarm and warning messages can be defined with the following parameters:
    – HI_HI_LIM → Limit value for the upper alarm
    – HI_LIM → Limit value for the upper warning
    – LO_LIM → Limit value for the lower warning
    – LO_LO_LIM → Limit value for the lower alarm
    The limit values entered must be within the value range specified in the parameter group OUT_SCALE.
21. In addition to the actual limit values you must also specify the action taken if a limit value is exceeded using so-called "alarm priorities" (parameters HI_HI_PRI, HI_PRI, LO_PR, LO_LO_PRI) → See the "Description of Device Functions" manual. Reporting to the fieldbus host system only takes place if the alarm priority is higher than 2.
22. System configuration/connection of function blocks:
    A concluding "overall system configuration" is essential so that the operating mode of the Analog Input function block can be set to AUTO and so that the field device is integrated into the system application. To do this, configuration software is used to connect the function blocks to the desired control strategy - generally graphically - and then the sequence of the individual process control functions is specified.
23. After specifying the active LAS, download all the data and parameters into the field device.
24. Set the operating mode in the parameter group MODE_BLK (parameter TARGET) to AUTO. This is only possible under two conditions, however.
    – The function blocks are correctly connected with each other.
    – The Resource Block is in operating mode AUTO.

Configuration of the "Analog Output function block" (base index 2300)

The measuring device has an Analog Output function block that can be assigned to the various process variables.

Note!
The process value transmitted to the Analog Output function block by the density measuring device must be greater than 0, in order to avoid the status BAD or UNCERTAIN.

The following example shows how the value of a gas analysor measuring device for operating "Mole % gas 1" parameter can be read in via the Analog Output function block.
Firstly, a connection must be established between the Analog Output function block and the "Mole % gas 1" parameter in the "Flow" Transducer Block. In addition, the value "39" (Mole Fraction) must be assigned to the CHANNEL parameter.

25. Enter the desired name for the Analog Output function block (optional). Factory setting: ANALOG_OUTPUT_xxxxxxxxxxx
26. Open the Analog Output function block.
27. Set the operating mode in the parameter group MODE_BLK (parameter TARGET) to OOS, i.e. block Out Of Service.
28. Using the CHANNEL parameter, select "Mole Fraction" which is to be used as the input value for the Transducer Block algorithm (scaling function). The following settings are possible:

Process variable	Channel parameter
Pressure	17
Mole Fraction	39

29. In the PV_SCALE parameter group, select the desired engineering unit and the block input range (measuring range of the gas analyzer application) for the relevant process variable (see the following example).

    Caution!
    Make sure that the selected unit is suitable for the measurement variable of the selected process variable. Otherwise, the BLOCK_ERROR parameter will display the error message "Block Configuration Error", and the block operating mode cannot be set to AUTO.

    Example:
    – The measuring range of the density application is 0 to 30 %.
    – The output range to the automation system should be 0 to 30 % also.
    – The following settings are required:
      - Analog Output function block / CHANNEL parameter (output value option), option 39 = Mole Fraction
      - SHED_OPTIONS parameter → e.g. Normal Shed Normal Return
      - PV_SCALE parameter group
        - PV_SCALE 0% = 0
        - PV_SCALE 100% = 30
        - PV_SCALE UNIT = %
      - OUT_SCALE parameter group
        - OUT_SCALE 0% = 0
        - OUT_SCALE 100% = 30
        - OUT_SCALE UNIT = %

30. Set the operating mode in the parameter group MODE_BLK (parameter TARGET) to AUTO.
31. System configuration / connection of function blocks

A concluding "overall system configuration" is essential so that the operating mode of the Analog Output function block can be set to AUTO and so that the device is integrated into the system application. To do this, configuration software is used to connect the function blocks to the desired control strategy - mainly graphically - and the sequence of the individual process control functions is then specified.

7.4 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.

7.4.1 Quick Setup "Commissioning"

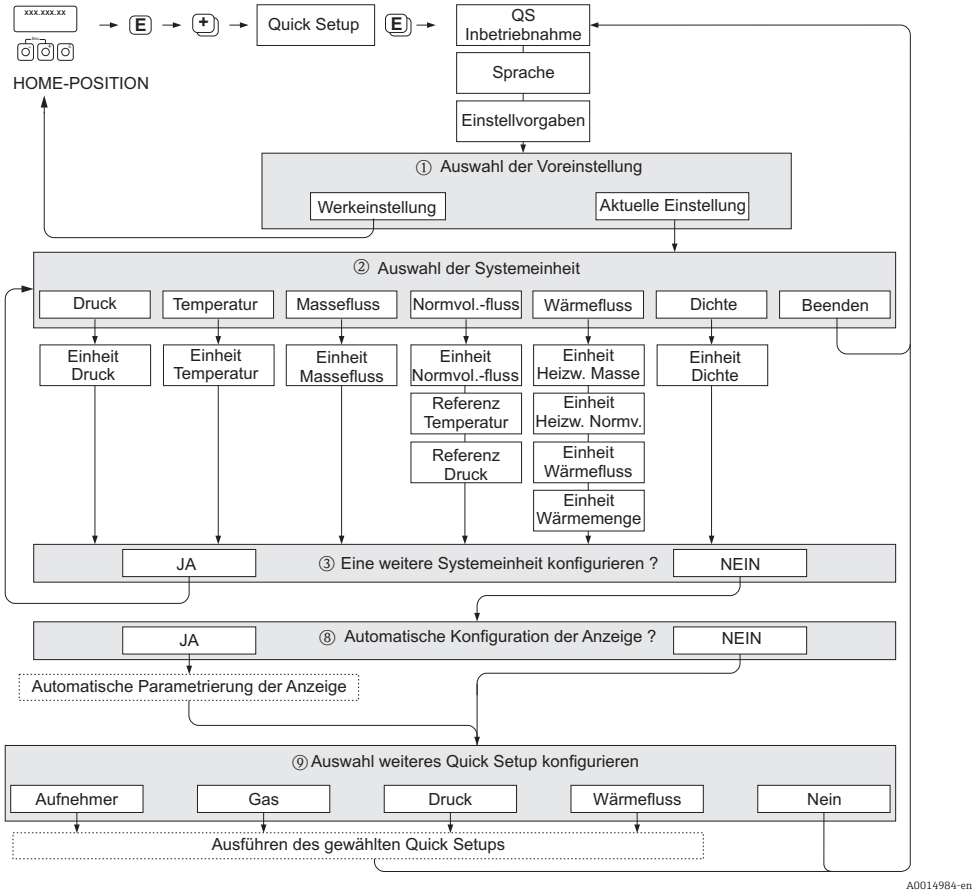


Fig. 31: QUICK SETUP COMMISSIONING- menu for straightforward configuration of the major device functions

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. The configuration settings already made remain valid, however.

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.

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.

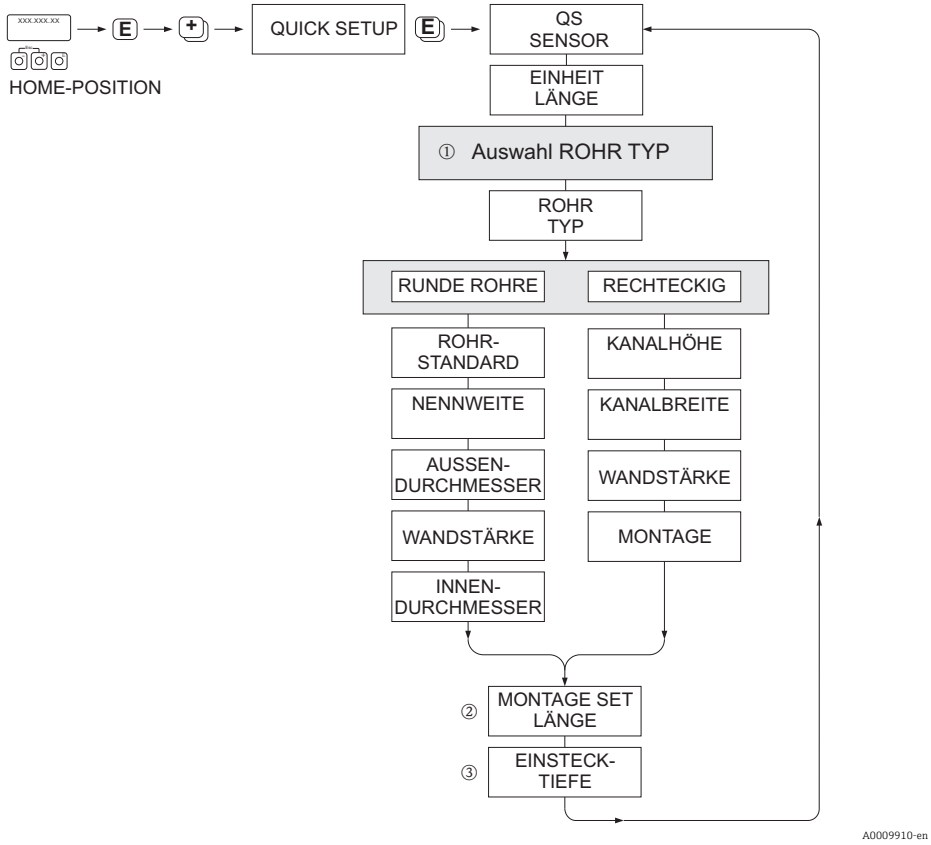
Carry out another Quick Setup?

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

7.4.2 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 the user 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.

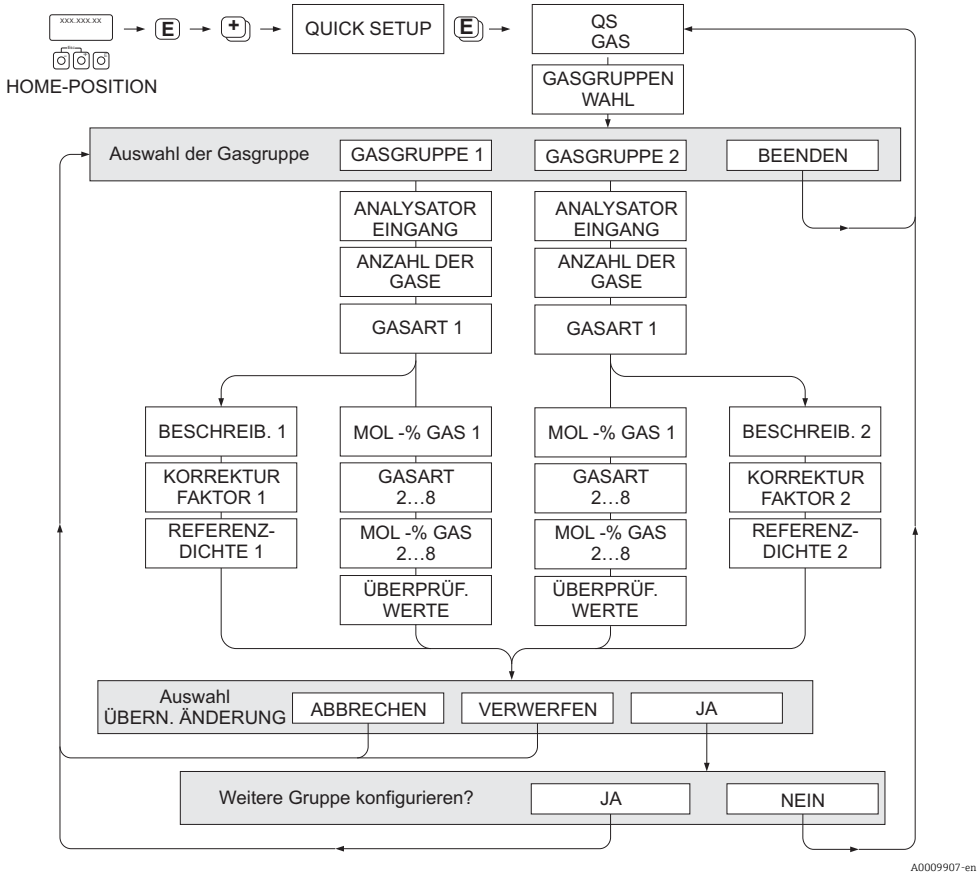
INSERTION DEPTH

③ This function calculates the insertion depth value for the mounting of the sensor → 🖹 19.

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

7.4.3 "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 - In this case, please contact your Endress+Hauser sales center for clarification.

Setting or viewing the active gas group

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. → 66

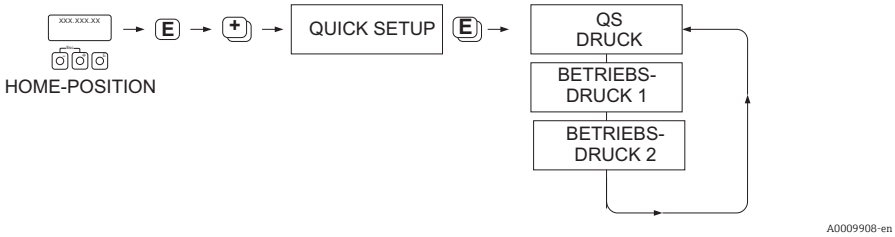
Performing the Quick Setup

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 → 61
   - 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 the settings in GAS GROUP 1 or 2 and activate the last gas group selected. 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 the desired GAS GROUP and proceed as per the above instructions.
   - Select NO to exit to the Quick Setup.

Note!
More detailed information on the GAS GROUP programming can be found in the separate "Description of Device Functions" manual (BA00135D/06/... see chapter GAS).

7.4.4 "Pressure" Quick Setup menu

The individual process pressure for every gas group can be programmed with this Quick Setup. 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.

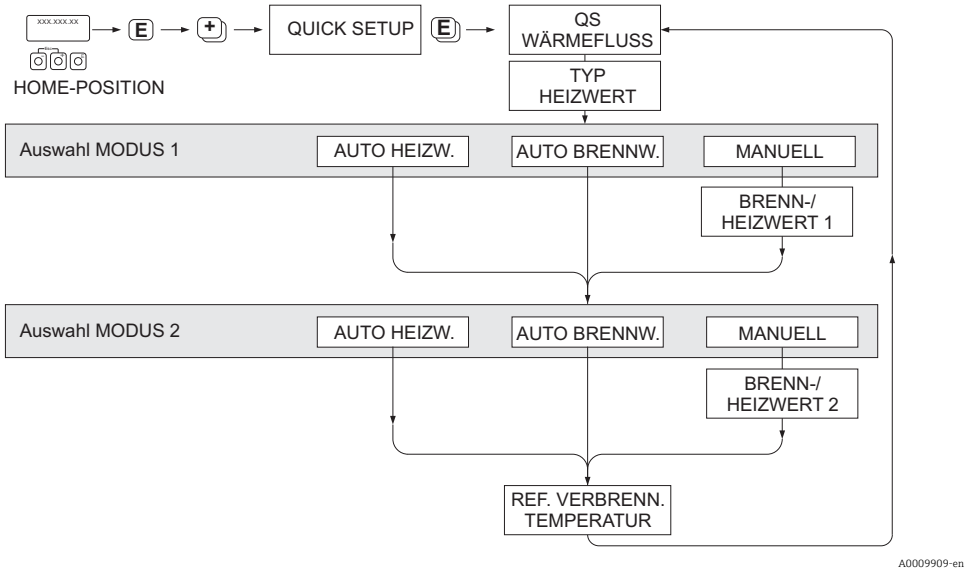


Note!

- The measuring device operates with absolute pressure only. All gauge pressure must be converted 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.
- The Quick Setup Gas function is not available if an in-situ calibration function has been performed on the measuring device as the in-situ calibration curve refers to the sensor power at each recorded flow point. Therefore, the programmed pressure settings become redundant → 66.

7.4.5 "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.
This Quick Setup menu can be used to program the method to calculate the net calorific value or gross calorific value. The measuring 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 → 53.

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 from the value in 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 Standard 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

7.4.6 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

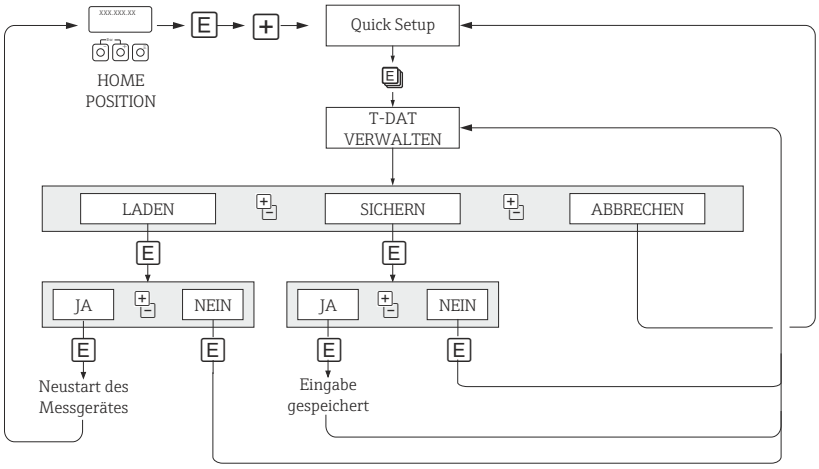


Fig. 32: Data backup/transmission with T-DAT SAVE/LOAD function

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

7.4.7 Gas compensation input

The flowmeter can read the composition of the gas from the gas analyzer and automatically update 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.

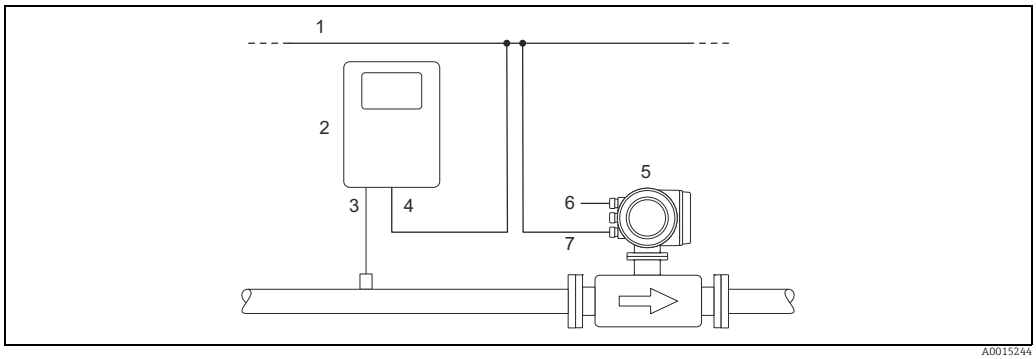


Fig. 33: Gas mixture compensation using a gas analyzer

1 Fieldbus
2 Gas analyzer
3 Gas detector
4 Gas analyzer output
5 t-mass
6 Power supply
7 Input/Output

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 (see BA00135D/06 "Description of Device Functions").
   - Select the NUMBER OF GASES in the group from 1 to 8.
   - Select the GAS TYPE from the choose list.
   - Enter the "MOLE %" value for each GAS TYPE.

   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 the settings in GAS GROUP 1 or 2 and activate the last gas group selected. 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.
   - Exit the function using ESC (− + keys simultaneously)
3. ANOTHER GAS GROUP?
   - Select YES to continue to the CONFIGURE GROUP function. Use the + or − key to select the desired GAS GROUP and proceed as per the above instructions.
   - Select NO to exit to the Quick Setup.

The following points should be observed or checked for correctness:
- Check in the function GAS → whether ANALYZER INPUT is ON (Function GAS → 56)
- Check the actual % value of the main gas component being transmitted from the analyzer: PROCESS PARAMETER → MOLE % GAS 1.
- A gas group must consist of at least 2 gas types (e.g. methane 60%, carbon dioxide 40%).
- By default, the first gas fraction is then updated continuously by the gas chromatograph and the content of the other gases is calculated dynamically

If the value is present and updating then the system is working correctly.

Note!
More detailed information on the GAS GROUP programming can be found in the separate "Description of Device Functions" manual (BA00135D/06/... see chapter GAS).

7.5 Adjustment

7.5.1 Zero point adjustment

Calibration takes place under reference operating conditions. (→ 🖹 91).
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 shutoff valves upstream and/or downstream of the sensor or by using existing valves and gates.
  - Normal operation → valves 1 and 2 open
  - Zero point adjustment *with* pump pressure → Valve 1 open / valve 2 closed
  - Zero point adjustment *without* pump pressure → Valve 1 closed / valve 2 open

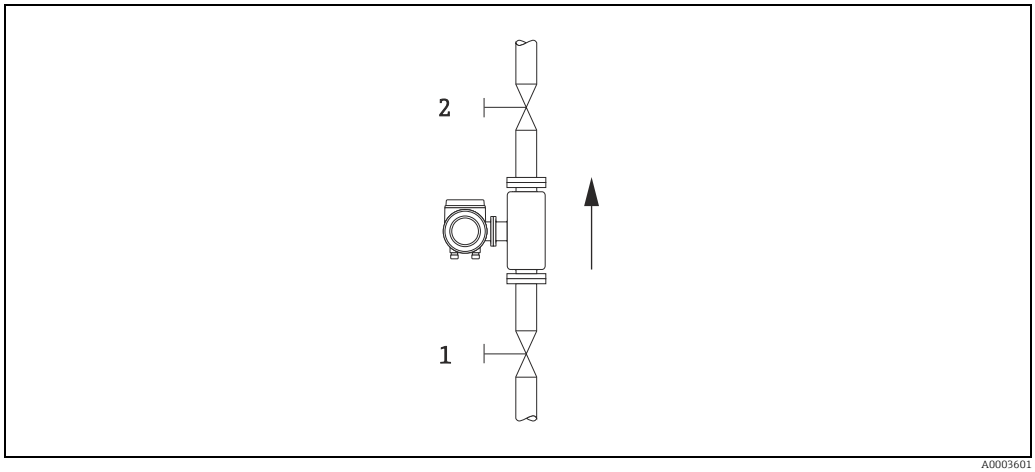


Fig. 34: Zero point adjustment and shut-off valves

Caution!
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, BA00135D/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/operating program, select the ZEROPOINT ADJUSTMENT function in the function matrix:
   PROCESS PARAMETER → ZEROPOINT ADJUSTMENT
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 E to confirm. The zero point adjustment now starts and is completed within a few seconds.

   ✎ Note!
   If the flow in the pipe is unstable, the following error message may appear on the display "ZERO ADJUST FAIL". The zero point adjustment has failed. The preconditions need to be stabilised before attempting a new adjustment.
8. Back to the HOME position:
   – Press and hold down Esc key (− + ESC) for longer than three seconds or
   – Repeatedly press and release the Esc key (− + ESC).

Resetting a zero point adjustment

The currently stored zero point can be reset to the original factory value by using the RESET option within ZERO POINT ADJUST.
Use + or − to select RESET and press E to confirm. The zero point adjustment is now reset.

7.6 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.

7.6.1 HistoROM/S-DAT (sensor-DAT)

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

7.6.2 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). For detailed information → 🖹 61.

8 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 sales center (→ 87) for service or that work can only be carried out by a qualified Endress+Hauser service person. Please contact your Endress+Hauser sales center if you have any questions.

8.1 External cleaning

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

8.2 Pipe cleaning

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

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

Caution!
Do not use a pipe cleaning pig.

8.3 Sensor 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:
  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 sales center.
- t-mass I:
  Follow the safety instructions in the "Installation" section when removing the sensor (→ 19).

8.4 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.
Only Endress+Hauser seals may be used.

Sensor-specific information:
- t-mass F:
  The sensor contains o-rings seals and a bushing. In case of failure, the device must be returned to an Endress+Hauser sales center for inspection and repair (→ 🖹 87).
- t-mass I:
  The transducer is welded to the insertion tube and has no exchangeable seals. The compression fitting contains wetted seals (ferrules) and a bonded seal is used on the G 1 A thread version.

Caution!
Do not reuse gaskets after removing sensors.
Use only original parts from Endress+Hauser. The compression fitting and gasket seals are deliverable as spare parts. The seal ring can be replaced easily on site

8.5 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 can only be activated with a special Endress+Hauser service code.
For specific applications, contact your Endress+Hauser sales center.

8.6 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.

9 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Your Endress +Hauser sales center can provide detailed information on the specific order code.

9.1 Device-specific accessories

Accessories	Description	Order code
Mounting boss	Mounting boss for the t-mass insertion version	DK6MB - *
Cable remote version	Connecting cable for the remote version	DK6CA - *
Mounting set for transmitter	Mounting set for remote version. Suitable for: – Wall mounting – Pipe mounting – Installation in control panel Mounting set for aluminum field housing: Suitable for pipe mounting (¾" to 3")	DK6WM - *
Hot tap, process pressure	Low-pressure version: Mounting kit with process connection, ball valve, safety chain and sensor connection. Insertion or extraction of sensor under process pressure (max. 4.5 barg (65 psig)).	DK6HT-***
	Medium-pressure version: Mounting kit with process connection, ball valve, sensor connection and extractor assembly. Insertion or extraction of sensor under process pressure (max. 16 barg (235 psi)).	
Cold tap, atmospheric pressure	Mounting kit with sensor connection, ball valve and weld socket. Insertion or extraction of sensor in unpressurized pipes (atmospheric pressure). In the absence of a measuring device, the mounting kit enables pipe resealing in order to resume the process.	DK6ML-***
Flow conditioner	▪ t-mass F: DN25 to 100 (1 to 4") ▪ t-mass I: DN 80 to 300 (3 to 12")	DK6ST-*** DK7ST-***
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. 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 - **********

9.2 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, accuracy or process connections ▪ Graphic illustration of the calculation results Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://wapps.endress.com/applicator ▪ On CD-ROM for local PC installation.	DKA80 - *

Accessory	Description	Order code
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. Further information is available from your Endress+Hauser sales center.	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 – *

10 Trouble-shooting

10.1 Troubleshooting instructions

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

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Make sure to follow the important procedures before you return a measuring device to Endress+Hauser. → 🖹 87
Always enclose a duly completed "Declaration of contamination" form with the measuring device. You will find a preprinted blank of this form at the back of this manual.

Check the display	
No display visible. No connection to the FF host system	1. Check the supply voltage → Terminals 1, 2 2. Check device fuse → 🖹 86 20 to 260 V AC and 20 to 64 V DC: 2 A slow-blow / 250 V 3. Measuring electronics defective → Order spare parts → 🖹 80
No display visible. Connection to the FF host system established however.	1. Check whether the ribbon cable connector of the display module is correctly plugged into the amplifier board → 🖹 81. 2. Display module defective → Order spare parts → 🖹 80 3. Measuring electronics defective → Order spare parts → 🖹 80
Display texts are in a foreign language.	Switch off the 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.
No connection can be established with the FF host system, even though measured value reading is visible.	Measuring electronics board defective → Order spare parts → 🖹 80

▼

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 – **EMPTY PIPE** = type of error, e.g. measuring tube is only partly filled or completely empty – **03:00:05** = duration of error occurrence (in hours, minutes and seconds) – **#401** = error number Caution! ▪ Also observe the information on the following pages: → 🖹 42 ▪ The measuring device interprets simulations and positive zero return as system errors, but displays them as a notice message only.	
Error number: No. 001 – 399 No. 501 – 699	System error (device error) has occurred → 🖹 73
Error number: No. 401 - 499	Process error (application error) has occurred → 🖹 78

▼

Faulty connection to the fieldbus host system	
No connection can be made between the fieldbus host system and the measuring device. Check the following points:	
Supply voltage Transmitter	Check the supply voltage → Terminals 1/2
Device fuse	Check device fuse → 🖹 86 20 to 260 V AC and 20 to 64 V DC: 2 A slow-blow / 250 V
Fieldbus connection	FOUNDATION Fieldbus: check the data cable Terminal 26 = FF + Terminal 27 = FF –
Fieldbus connector (Option)	▪ Check pin assignment/wiring → 🖹 35 ▪ Check connection between connector/fieldbus port. Is the coupling ring tightened correctly?
Fieldbus voltage	Check that a min. bus voltage of 9 V DC is present at terminals 26/27. Permissible range: 9 to 32 V DC
Network structure	Check permissible fieldbus length and number of spurs. → 🖹 35
Basic current	Is there a basic current of min. 12 mA?
Bus address	Check bus address: make sure there are no double assignments
Bus termination	Is the FOUNDATION Fieldbus-H1 network correctly terminated? Each bus segment must always be terminated with a bus terminator at both ends (start and finish). Otherwise there may be interference in communication.
Current consumption, permitted feed current	Check the current consumption of the bus segment: The current consumption of the bus segment in question (= total of basic currents of all bus users) must not exceed the max. permissible feed current of the bus power supply.
Device Description (DD)	Install the DD if you cannot access the manufacturer-specific parameters. ✎ Note! Ensure that the correct system files are used for linking the field devices into the host system. Appropriate version information can be called up in the device via the following functions/parameters: Local display: ▪ HOME ® COMMUNICATION ® FOUND. FIELDBUS ® DEVICE REVISION ▪ HOME ® COMMUNICATION ® FOUND. FIELDBUS ® DD REVISION FF configuration program: ▪ Resource Block → Parameter DEV_REV ▪ Resource Block → Parameter DD_REV Example (with local display): Displayed in the DEVICE REVISION function → 01 Displayed in the DD REVISION function → 01 Device description file (DD) required → 0101.sym / 0101.ffo

▼

Problems with configuration of function blocks	
Transducer Blocks: The operating mode cannot be set to AUTO.	Check whether the operating mode of the Resource Block is set to AUTO → MODE_BLK parameter group/TARGET parameter.
Analog Input function block: The operating mode cannot be set to AUTO.	There may be several reasons for this. Check the following in sequence: 1. Check whether the operating mode of the Analog Input function block is set to AUTO → MODE_BLK parameter group/TARGET parameter. If not and the mode cannot be set to AUTO, first check the following. 2. Make sure that the CHANNEL parameter (process variable selection) is already configured in the Analog Input function block → 🖹 47. CHANNEL = 0 (uninitialized) is not valid. 3. Make sure that the XD_SCALE parameter group (input range, unit) is already configured in the Analog Input function block → 🖹 49 (incl. configuration example). ☝ Caution! Make sure that the selected unit is suitable for the process variable selected in the CHANNEL parameter. Otherwise the parameter BLOCK_ERROR will display the error message "Block Configuration Error". In this status the block operating mode cannot be set to AUTO. 4. Make sure that the L_TYPE parameter (type of linearization) is already configured in the Analog Input function block → 🖹 49. ☝ Caution! Make sure that with the type of linearization "Direct" the scaling of the parameter group OUT_SCALE is identical to that of the parameter group XD_SCALE. If set incorrectly the parameter BLOCK_ERROR will display the error message "Block Configuration Error". In this status the block operating mode cannot be set to AUTO. Configuration example → 🖹 49 5. Check whether the operating mode of the Resource Block is set to AUTO → MODE_BLK parameter group/TARGET parameter. 6. Make sure that the function blocks are correctly interconnected and that this system configuration has been sent to the fieldbus users → 🖹 49.
Analog Input function block: The operating mode is set to AUTO but the status of the AI output value OUT is "BAD" or "UNCERTAIN".	1. Check whether the operating mode of the Transducer Blocks is set to AUTO → MODE_BLK parameter group / TARGET parameter. The following Transducer Blocks have to be set to AUTO by using the various CHANNEL parameters: Flow" Transducer Block (base index: 1400): – CHANNEL 1 (mass flow) – CHANNEL 2 (calculated volume flow) – CHANNEL 3 (temperature) – CHANNEL 53 (heat flow) "Totalizer" Transducer Block (base index: 1900): – – CHANNEL 7 (Totalizer 1) – – CHANNEL 8 (Totalizer 2) 2. Check whether an error is pending in the "Flow" (base index: 1400) or "Totalizer" (base index: 1900) Transducer Blocks ® "Diagnosis" Transducer Block (base index: 1600) ® "Diag. - Act.Sys.Condition" parameter. Error messages → 🖹 73

Parameters cannot be modified or no write access to parameters.	1. Parameters that only display values or settings cannot be modified! 2. Hardware write protection is enabled → Deactivate the write protection → 🖹 45 ✎ Note! The parameter WRITE_LOCK in the Resource Block can be used to check whether hardware write protection is activated or deactivated: LOCKED = write protection enabled (activated) UNLOCKED = no write protection (deactivated) 3. The block operating mode is wrong. Certain parameters can only be modified in the OOS (Out of Service) or MAN (MANual) mode ® Set the operating mode of the block to the required mode ® Parameter group MODE_BLK. 4. The value entered is outside the specified input range for the parameter in question: → Enter suitable value → Increase input range if necessary 5. Transducer Blocks: The programming level is not enabled → Enable by entering the code in the "Access – Code" parameter or by means of the service code in the service parameters.
Transducer Block: The manufacturer-specific parameters are not visible.	The device description file (Device Description, DD) has not been loaded into the host system or the configuration program → Load the file into the configuration system. Reference sources of the DD → 🖹 80 ✎ Note! Ensure that the correct system files are used for linking the field devices into the host system. Appropriate version information can be called up in the device via the following functions/parameters: Local display: ▪ HOME ® COMMUNICATION ® FOUND. FIELDBUS ® DEVICE REVISION ▪ HOME ® COMMUNICATION ® FOUND. FIELDBUS ® DD REVISION FF configuration program: ▪ Resource Block → Parameter DEV_REV ▪ Resource Block → Parameter DD_REV Example (with local display): Display in the DEVICE REVISION function ® 01 Display in the DD REVISION function ® 01 Required Device Description files (DD) ® 0101.sym / 0101.ffo
Analog Input function block: The output value OUT is not updated despite having a valid "GOOD" status.	Simulation is active → Deactivate simulation via parameter group SIMULATE.
Error messages	
Error messages in the FF configuration program → 🖹 73 Error messages on the local display → 🖹 73	
▼	
Other error (without error message)	
Some other error has occurred.	Diagnosis and rectification → 🖹 78

10.2 System/process error messages

General notes

The flowmeter assigns current system and process errors to two error message types in accordance with a predefined algorithm and classifies them accordingly:

"Fault message" error message type:
- A message of this type immediately interrupts or stops measurement.
- Presentation on the FOUNDATION Fieldbus → Fault messages are transmitted to downstream function blocks or higher-level process control systems by means of the status "BAD" of the AI output parameter OUT.
- Local display → A flashing lightning symbol (ϟ) is displayed

"Notice message" error message type:
- Measurement continues despite this message.
- Presentation on the FOUNDATION Fieldbus → Notice messages are transmitted to downstream function blocks or higher-level process control systems by means of the status "UNCERTAIN" of the AI output parameter OUT.
- Local display → A flashing exclamation mark (!) is displayed.

Critical system errors, e.g. module defects, are always identified and classed as "fault messages" by the measuring device. Simulations in the "Flow" Transducer Block and positive zero return, on the other hand, are identified as "notice messages" only.

Error messages in the FF configuration programs → See Table

System and process errors are recognized and reported in the Transducer Blocks. Such errors are displayed via the following parameters specified in the FOUNDATION Fieldbus specification:
- BLOCK_ERR
- Transducer Error

In the "Diagnosis" Transducer Block (base index: 1600), detailed reasons for errors and device status messages are displayed by means of the "Diag. - Act.Sys.Condition" parameter (manufacturer-specific) → Table.

Error messages on the local display → See Table

For more details on how error messages are presented, see → 🖹 42.

10.2.1 List of system error messages

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy (Spare parts → 🖹 80
* With FF, error messages are displayed in the "Diagnosis" Transducer Block (base index: 1600) by means of the "Diag. – Act.Sys.Condition" parameter (manufacturer-specific). S = System error ϟ = Fault message (with an effect on operation) ! = Notice message (without an effect on operation)				
No. # 0xx → Hardware error				
001	*Device status message (FF):* ROM/RAM failure – Err. No. 001 *Local display:* S: CRITICAL FAIL. ϟ: # 001	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* ROM/RAM error. Error when accessing the program memory (ROM) or random access memory (RAM) of the processor. *Remedy:* Replace the amplifier board.
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy (Spare parts → 🖹 80
011	*Device status message (FF):* Amplifier EEPROM failure – Err. No. 011 *Local display:* S: AMP HW EEPROM ϟ: # 011	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Measuring amplifier has faulty EEPROM *Remedy:* Replace the amplifier board.
		Transducer_Error = Data integrity error	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
012	*Device status message (FF):* Amplifier EEPROM data inconsistent – Err. No. 012 *Local display:* S: AMP SW EEPROM ϟ: # 012	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Error when accessing data of the measuring amplifier EEPROM *Remedy:* Perform a "warm restart" (start the measuring device without disconnecting mains power). ▪ FF: "Diagnosis" Transducer Block (base index: 1600) → "Sys. – Reset" parameter RESTART SYSTEM ▪ Local display: SUPERVISION ® SYSTEM ® OPERATION ® SYSTEM RESET (® RESTART SYSTEM)
		Transducer_Error = Data integrity error	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
031	*Device status message (FF):* S-DAT failure / S-DAT not inserted – Err. No. 031 *Local display:* S: SENSOR HW DAT ϟ: # 031	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* 1. S DAT is not correctly plugged into the amplifier board (or is missing). 2. S-DAT is defective. *Remedy:* 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 . 4. Plug the S-DAT into the amplifier board.
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
032	*Device status message (FF):* S-DAT data inconsistent – Err. No. 032 *Local display:* S: SENSOR SW DAT ϟ: # 032	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	
		Transducer_Error = Data integrity error	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
035	*Device status message (FF):* Sensor EEPROM failure – Err. No. 035 *Local display:* S: SEN HW-ROM/RAM ϟ: # 035	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Sensor: Defective ROM/RAM. *Remedy:* Replace the amplifier board.
		Transducer_Error = Data integrity error	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
036	*Device status message (FF):* Sensor EEPROM failure – Err. No. 036 *Local display:* S: SEN SW-ROM/RAM ϟ: # 036	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	
		Transducer_Error = Data integrity error	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy (Spare parts → 🖹 80
041	*Device status message (FF):* T-DAT failure – Err. No. 041 *Local display:* S: TRANSM. HW-DAT ϟ: # 041	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause*: 1. T DAT is not correctly plugged into the amplifier board (or is missing). 2. T-DAT is faulty. *Remedy:* 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 . 4. Plug the T-DAT into the amplifier board.
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
042	*Device status message (FF):* T-DAT data inconsistent – Err. No. 042 *Local display:* S: TRANSM. SW-DAT ϟ: # 042	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	
		Transducer_Error = Data integrity error	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
No. # 1xx → Hardware error				
070	*Device status message (FF):* Sensor Defect – Err. No. 070 *Local display:* S: SENSOR DEFECT ϟ: # 071	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Flow sensor are likely to be defect, measurement is no longer possible. *Remedy:* Contact your Endress+Hauser sales center.
		Transducer_Error = Mechanical failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
072	*Device status message (FF):* A to D Reference Error – Err. No. 072 *Local display:* S: A/D REF. ERROR . ϟ: # 072	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Measuring amplifier analougue to digital converter circuitry faulty. *Remedy:* Replace the amplifier board. ✎ Note! Ensure that the S-DAT's and T-DAT are transferred from old circuit board to the new one.
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
No. # 1xx → Software error				
121	*Device status message (FF):* Software compatibility problem amplifier – I/O module – Err. No. 121 *Local display:* S: A/C COMPATIB. !: # 121	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Due to different software versions, I/O board and amplifier board are only partially compatible (possibly restricted functionality). ✎ Note! – The indication on the display as notice message appears only for 30 seconds (with listing in "Previous system condition" function). – This Situation in which the software versions differ can occur if only one electronics board has been exchanged; the extended software functionality is not available. The previousiy existing software functionality is still available and measurement operation is possible.. *Remedy:* Module with lower software version must either be updated by FieldCare using the required (recommended) software version, or the module must be replaced.
		Transducer_Error = I/O failure (input/output error)	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy (Spare parts → 80
No. # 2xx → Error in DAT / no communication				
205	*Device status message (FF):* Save to T-DAT failed – Err. No. 205 *Local display:* S: LOAD T-DAT !: # 205	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Data backup (downloading) to T–DAT failed, or error when accessing (uploading) the calibration values stored in the T–DAT. *Remedy:* 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 .
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
206	*Device status message (FF):* Restore from T-DAT failed – Err. No. 206 *Local display:* S: SAVE T-DAT !: # 206	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
251	*Device status message (FF):* Communication failure amplifier – Err. No. 251 *Local display:* S: COMMUNICAT. AMP ϟ: # 251	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Internal communication fault on the amplifier board. *Remedy:* Replace the amplifier board.
		Transducer_Error = Electronics failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
261	*Device status message (FF):* Communication failure amplifier – Err. No. 261 *Local display:* S: COMMUNICAT. I/O ϟ: # 261	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* Communication error. No data reception between amplifier and I/O board or faulty internal data transfer. *Remedy:* Check whether the electronics boards are correctly inserted in their holders.
		Transducer_Error = I/O failure (communication problems)	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
No. # 3xx → System limits exceeded				
372	*Device status message (FF):* Diff. Temp. is below limit – Err. No. 372 *Local display:* S: DIFF.TEMP.LOW ϟ: # 372	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* The measured sensor differential temperature is below lirnit vaiue. *Remedy:* Reduce the flow rate or replace the instrument with a suitable size for the application.
		Transducer_Error = General failure	OUT. SUBSTATUS = Device Failure	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
381	*Device status message (FF):* Fluid temperature min. – Err. No. 381 *Local display:* S: FLUIDTEMP.MIN. ϟ: # 381	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	*Cause:* The temperature Sensor on the measuring tube is probably defective. *Remedy:* Check the following electrical connections: ▪ Verify that the signal cable connector is correctly plugged into the amplifier board → 81 ▪ Remote version: Check sensor and transrnitter terminal connections No. 9 and 10 → 31 Contact your Endress+Hauser sales center.
		Transducer_Error = General failure	OUT. SUBSTATUS = Sensor Failure	
382	*Device status message (FF):* Fluid temperature max. – Err. No. 382 *Local display:* S: FLUIDTEMP.MAX. ϟ: # 382	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = BAD	
		Transducer_Error = General failure	OUT. SUBSTATUS = Sensor Failure	

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy (Spare parts → 🖹 80
No. # 5xx → Application error				
501	*Device status message (FF):* Download device software active – Err. No. 501 *Local display:* S: SW.-UPDATE ACT. !: # 501	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = UNCERTAIN	*Cause:* New amplifier or communication (I/O module) software version is loaded. Currently no other functions are possible. *Remedy:* Wait until process is finished. The device will restart automatically.
		Transducer_Error = General Error	OUT. SUBSTATUS = Non specific	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
502	*Device status message (FF):* Up-/Download device software active – Err. No. 502 *Local display:* S: UP-/DOWNLO. ACT. !: # 502	BLOCK_ERR = Device needs maintenance now	OUT. QUALITY = UNCERTAIN	*Cause:* Uploading or downloading the device data via operating program. Currently no other functions are possible. *Remedy:* Wait until process is finished.
		Transducer_Error = General Error	OUT. SUBSTATUS = Non specific	
			BLOCK_ERR = Input Failure (faulty input value from Transducer Blocks)	
No. # 6xx → Simulation mode active				
601	*Device status message (FF):* Positive zero return active – Err. No. 601 *Local display:* S: POS. ZERO-RETURN !: # 601		OUT. QUALITY = UNCERTAIN	*Cause:* Positive zero return is active. ✎ Note! This message has the highest display priority. *Remedy:* Deactivate positive zero return: ▪ FF: "Flow" Transducer Block (base index: 1100) ® "System - Positive Zero Return" parameter ® OFF ▪ Local display: BASIC FUNCTIONS → SYSTEM PARAMETERS → CONFIGURATIONS → POS. ZERO RETURN (→ OFF)
			OUT. SUBSTATUS = Non specific	
691	*Device status message (FF):* Simulation failsafe active – Err. No. 691 *Local display:* S: SIM. FAILSAFE !: # 691	BLOCK_ERR = Simulation active	OUT. QUALITY = UNCERTAIN	*Cause:* Simulation of response to error (outputs) is active. *Remedy:* Switch off simulation: ▪ FF: "Diagnosis" Transducer Block (base index: 1600) → "Sys. – Sim.Failsafe Mode" parameter → OFF ▪ Local display: SUPERVISION → SYSTEM → OPERATION → SIM. FAILSAFE MODE (→ OFF)
			OUT. SUBSTATUS = Non specific	
			BLOCK_ERR = Simulation active	
692	*Device status message (FF):* Simulation Volume flow active – Err. No. 692 *Local display:* S: SIM. MEASURAND !: # 692	BLOCK_ERR = Simulation active	OUT. QUALITY = UNCERTAIN	*Cause:* Simulation of the measured value is active. *Remedy:* Switch off simulation: ▪ FF: "Flow" Transducer Block (base index: 1400) → "Simulation - Measurand" parameter → OFF ▪ Local display: SUPERVISION → SYSTEM → OPERATION → SIM. MEASURAND (→ OFF)
			OUT. SUBSTATUS = Non specific	
			BLOCK_ERR = Simulation active	

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy (Spare parts → 🖹 80
698	*Device status message (FF):* Simulation Volume flow active – Err. No. 698 *Local display:* S: DEV.TEST ACT. !: # 698	BLOCK_ERR = Simulation active	OUT. QUALITY = UNCERTAIN	*Cause:* The measuring device is being checked on site via the test and simulation device.
			OUT. SUBSTATUS = Non specific	

10.2.2 List of process error messages

No.	Error messages: FOUNDATION Fieldbus (FF)* (local display)	Transducer Block error messages	Analog Input function block error messages	Cause/remedy
* With FF, error messages are displayed in the "Diagnosis" Transducer Block (base index: 1600) by means of the "Diag. – Act.Sys.Condition" parameter (manufacturer-specific). P = Process error ϟ = Fault message (with an effect on operation) ! = Notice message (without an effect on operation)				
422	*Device status message (FF):* Massflow exceeded max limit – Err. No. 422 *Local display:* P: FLOW LIMIT ϟ: # 422		OUT. QUALITY = UNCERTAIN	*Cause:* The measured flow has exceeded the maximum limit. *Remedy:* Reduce the flow rate or replace the instrument with a suitable size for the application.
			OUT. SUBSTATUS = Non specific	
433	*Device status message (FF):* Zero point adjustment is not possible – Err. No. 731 *Local display:* P: ADJ. ZERO FAIL ϟ: # 731	Transducer_Error = Configuration error	OUT. QUALITY = UNCERTAIN	*Cause:* The zero point adjustment is not possible or has been cancelled. *Remedy:* Make sure that zero point adjustment is carried out at "zero flow" only (v = 0 m/s) → 🖹 63
			OUT. SUBSTATUS = Configuration error	

10.3 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 → 🖹 15 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.

Symptoms	Rectification
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 → 🖹 63 ✎ 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.
Device displays incorrect flow value.	1. Check the basic parameters of the device (Quick Setup → 🖹 53) Especially: – Gas – Process pressure – Reference presssure and reference temperature – Flow units – Output assignment 2. Check the installation conditions (Post-installation check → 🖹 27) a. The inlet and outlet lengths must be observed → 🖹 15. b. Consider the use of a flow conditioner if the necessary inlet requirements cannot be met → 🖹 16. c. 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. d. If the measures above cannot rectify the problem, the INSTALLATION FACTOR → PROCESS PARAMETER function group (factory setting = 1.0) must be configured in such a way that the flow rate displayed matches the anticipated flow rate. 3. The flow rate maybe too high (i.e. above sensor calibration range) 1. Check the measuring range that the Endress+Hauser Applicator program uses. 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 measuring range that the Endress+Hauser Applicator program uses. 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 (Sensor cleaning → 🖹 65). 3. Has corrosion occured? If yes, replacement is necessary. 6. Check if the gas is wet? Is condensate present on the sensors? If so: 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 so: 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 such cases, your Endress+Hauser sales center can help.	The following options are available for tackling problems of this nature: **Request the services of an Endress+Hauser service technician** If our service representative is contacted 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 → 🖹 6 must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. 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 → 🖹 80

10.4 Spare parts

The previous sections contain a detailed trouble-shooting guide. → 69
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 sales center 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

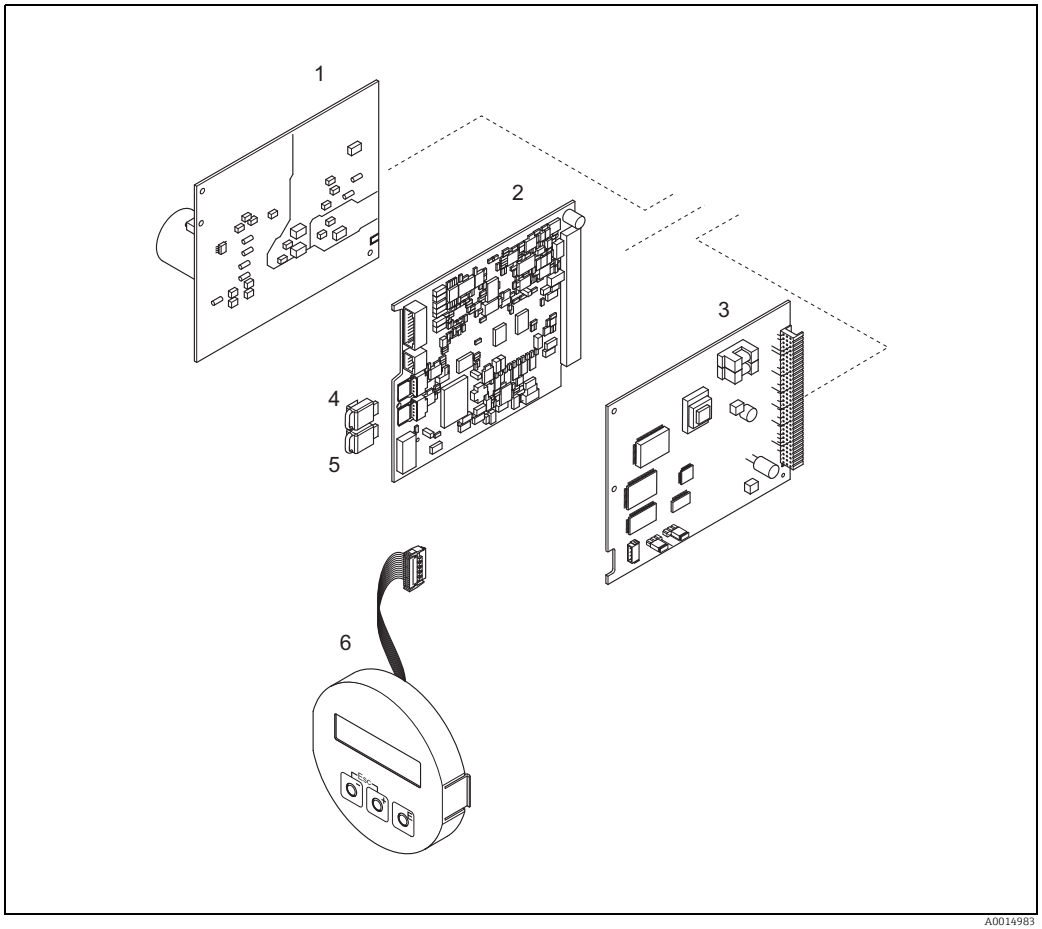


Fig. 35: Spare parts for transmitter 65 (field and wall-mount housings)

1 Power unit board (85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC)
2 Amplifier board
3 I/O board (COM module)
4 HistoROM/S-DAT (sensor data memory)
5 HistoROM/T-DAT (transmitter data memory)
6 Display module

10.4.1 Removing and installing printed circuit boards

Field housing

Warning!
- Risk of electric shock. Exposed components carry dangerous voltages. Switch off the power supply 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. Please do not hesitate to contact your Endress+Hauser sales center if you have any questions.

Caution!
Use only original Endress+Hauser parts.

Removal and installation → 36:

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the screws (1.1) and remove the cover (1) from the electronics compartment.
3. Disconnect the display ribbon cable (1.2) from the amplifier board.
4. Remove power supply board (3) and I/O board (5):
   Insert a thin pin into the hole (2) provided for the purpose and pull the board clear of its holder.
5. Remove amplifier board (4):
   - Disconnect the plug of the sensor signal cable (4.1) including HistoROM/S-DAT (4.2) and HistoROM/T-DAT (4.3) from the board.
   - Disconnect the plug of the excitation current cable (4.2) from the board carefully, i.e. without moving it to and fro.
   - Insert a thin pin into the hole (2) provided for the purpose and pull the board clear of its holder.
6. Installation is the reverse of the removal procedure.

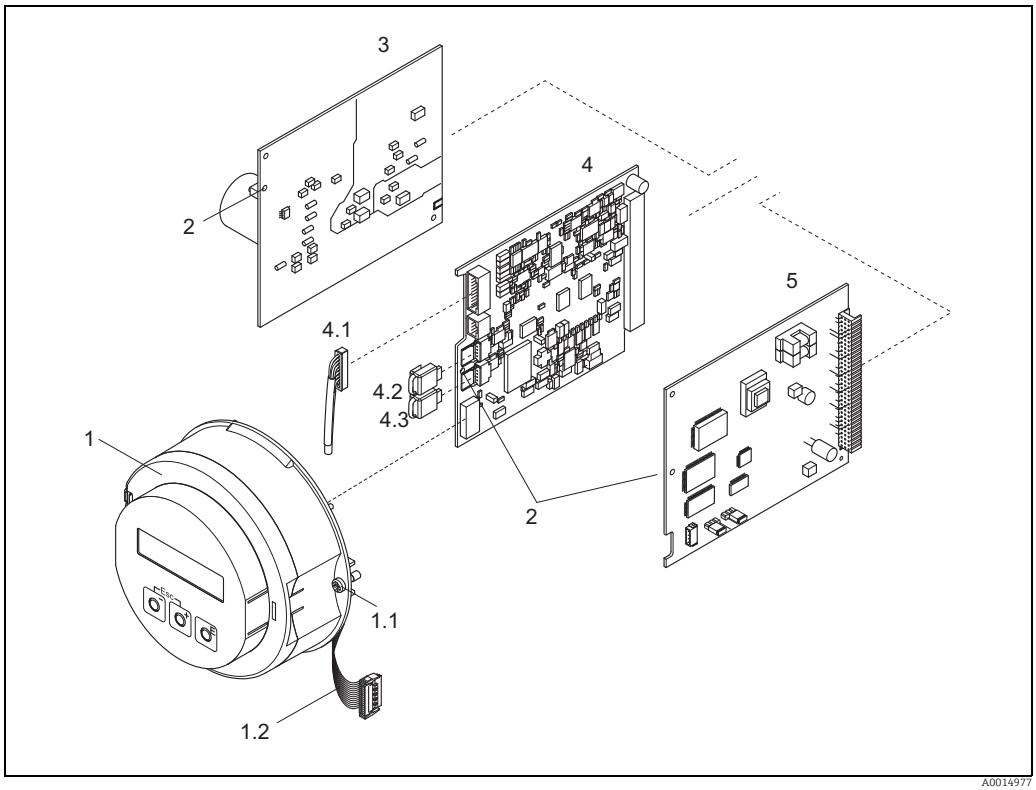


Fig. 36: Field housing: removing and installing printed circuit boards

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

Wall-mount housing

Warning!
- Risk of electric shock. Exposed components carry dangerous voltages. Switch off the power supply 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. Please do not hesitate to contact your Endress+Hauser sales center if you have any questions.

Caution!
Use only original Endress+Hauser parts.

Removal and installation → 37:

1. Remove the screws and open the hinged cover (1) of the housing.
2. Loosen the screws securing the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mount housing.
3. Disconnect the sensor signal cable plug (7.1) including HistoROM/S-DAT (7.2) and HistoROM/T-DAT (7.3) from amplifier board (7).
4. Remove the cover (4) from the electronics compartment by removing the screws.
5. Disconnect the ribbon cable plug (3) of the display module from amplifier board (7).
6. Remove the boards (6, 7, 8):
   Insert a thin pin into the hole (5) provided for the purpose and pull the board clear of its holder.
7. Installation is the reverse of the removal procedure.

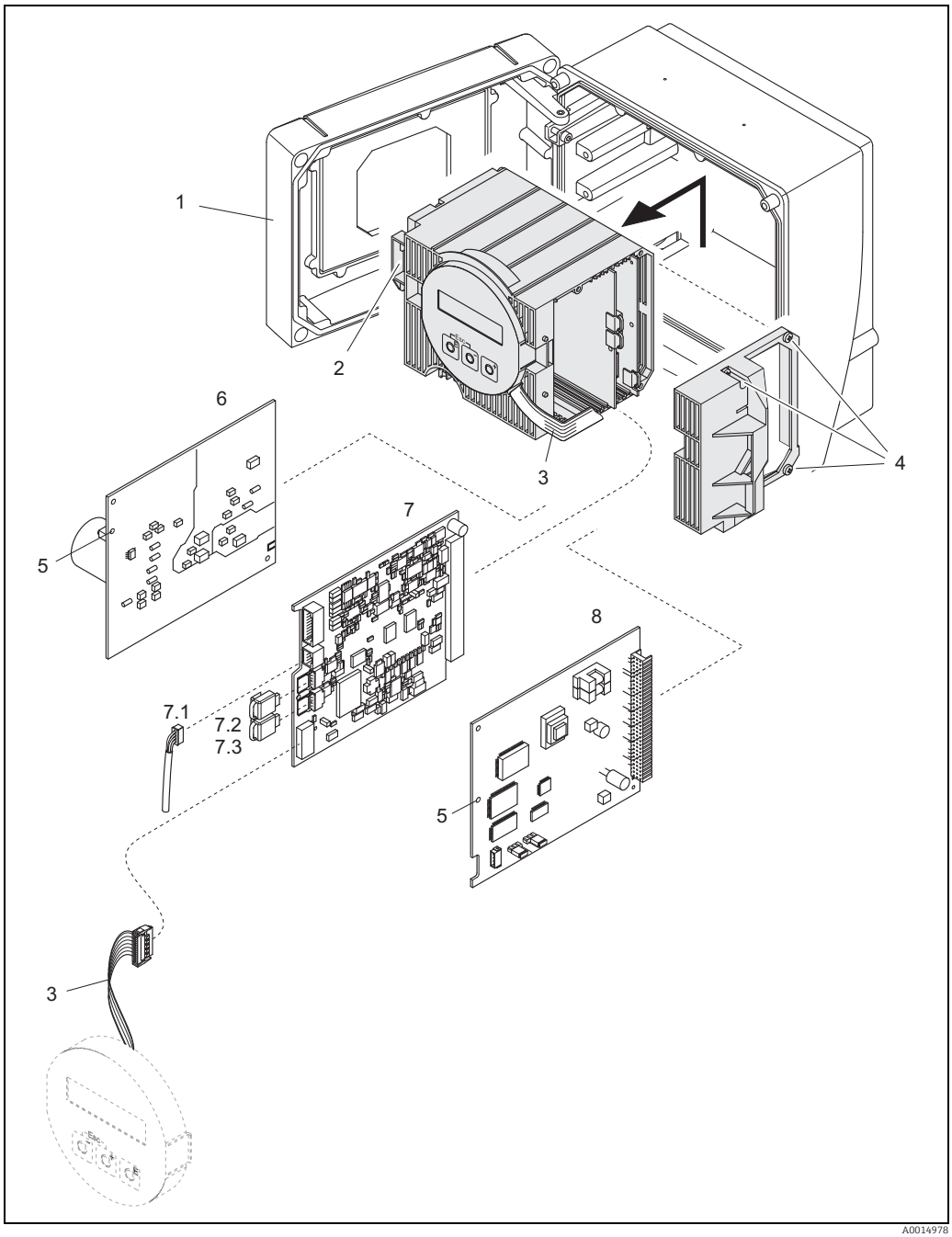


Fig. 37: Field housing: removing and installing printed circuit boards

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

Electronics housing sensor remote version

⚠ Warning!

- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purposely built for electrostatically sensitive devices!

- If you cannot guarantee that the dielectric strength of the device can be maintained during the following steps, then an appropriate inspection test must be carried out in accordance with the manufacturer's specifications.
- When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions. Please do not hesitate to contact your Endress+Hauser sales center if you have any questions.

Caution!
Use only original Endress+Hauser parts.

Removal and installation → 38:

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.

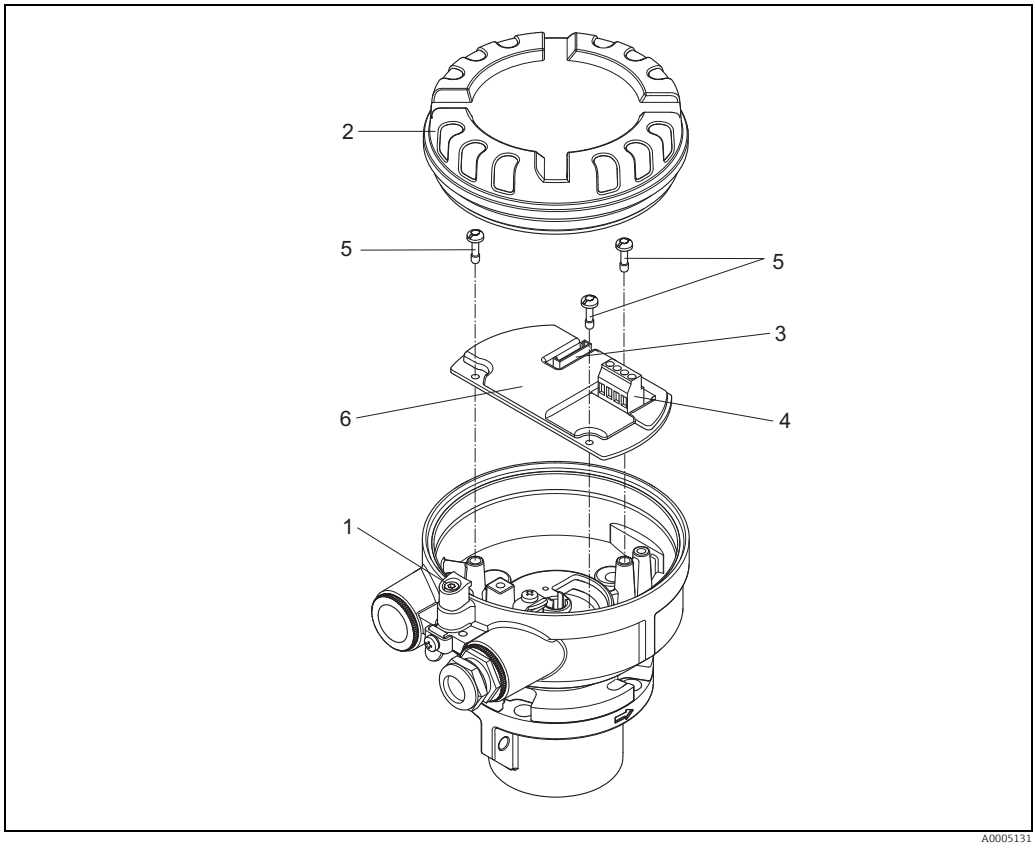


Fig. 38: Electronics compartment of the sensor housing remote version: removing and installing printed circuit board

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

10.4.2 Replacing the device fuse

Warning!
Risk of electric shock. Exposed components carry dangerous voltages. Switch off the power supply 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 the power supply.
2. Remove the power unit board → 81.
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 x 20 mm
   – Power supply 85 to 260 V AC → 0.8 A slow-blow / 250 V; 5.2 x 20 mm
   – Ex-rated devices → see the Ex documentation.
4. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

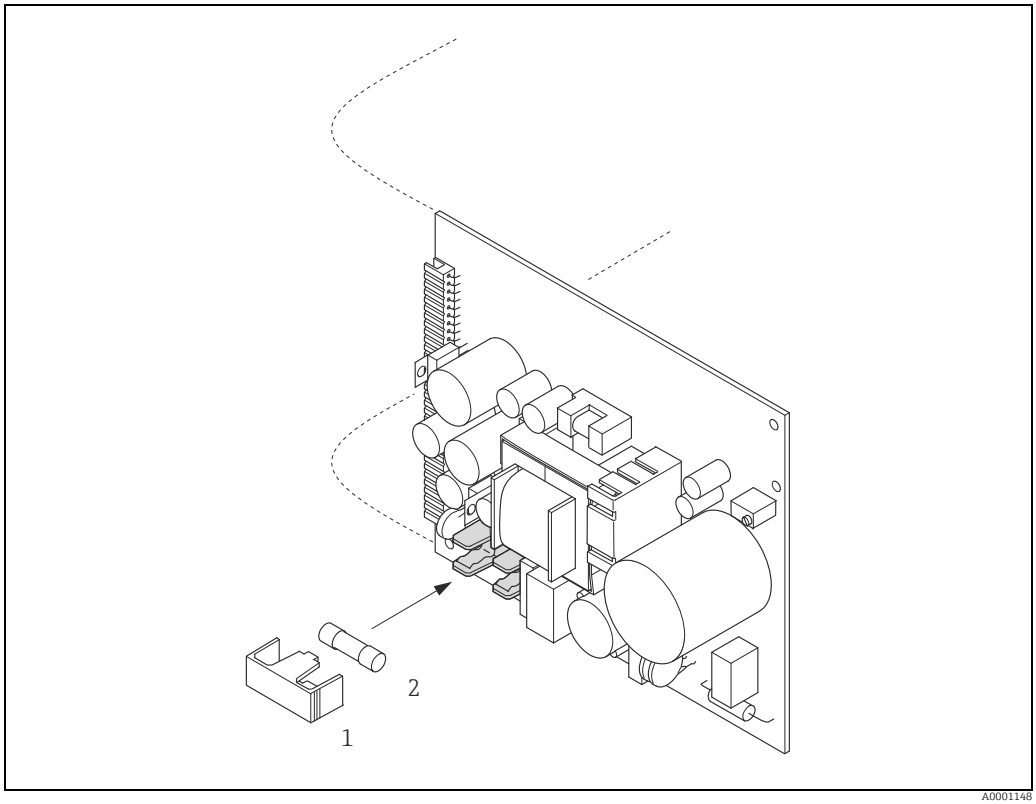


Fig. 39: Replacing the device fuse on the power unit board

1 Protective cap
2 Device fuse

10.5 Return

The measuring device must be returned if it is in need of repair or a factory calibration, or if the wrong measuring device has been delivered or ordered. According to legal regulations Endress+Hauser, as an ISO-certified company, is required to follow certain procedures when handling returned products that are in contact with the medium.
To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material

10.6 Disposal

10.6.1 Disassembling the measuring device

1. Switch off the device.
2. WARNING! Danger to persons from process conditions! Beware of hazardous process conditions such as pressure in the measuring device, high temperatures or aggressive fluids.

Carry out the mounting and connection procedure described in the "Mounting the measuring device" and "Connecting the measuring device" sections in the logically reverse order. Observe the safety instructions.

10.6.2 Disposing of the measuring device

Warning!
Hazardous fluids present a risk to humans and the environment!
- Ensure that the measuring device and all cavities are free of fluid residues that are hazardous to health or the environment, e.g. substances that have permeated into crevices or diffused through plastic.

Note the following when disposing of the device:
- Observe applicable national regulations.
- Separate and recycle the device components based on the materials.

10.7 Software history

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

Date	Software version	Changes to software	Documentation
12.2010	3.00.XX	Original software	71128089/13.10

11 Technical data

11.1 Applications

→ 🖹 5

11.2 Function and system design

Measuring principle

Mass flow measurement by the thermal dispersion principle.

Measuring system

The "t-mass 65" measuring device 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.

11.3 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.

Special applications

High gas velocities (>70 m/s)
In the event of high gas velocities, it is advisable to read in the process pressure dynamically or to enter the pressure very precisely as a velocity-dependent correction is performed.

Light gases

- Due to the very high thermal conductivity of hydrogen (H_2) (9 times that of air) and the fact that hydrogen is the lightest of all gases, it can prove very difficult to reliably measure this gas. Depending on the application, the flow rates of hydrogen are often particularly slow and the flow profiles are not sufficiently developed. It is not unusual for the flows to be in the laminar range, whereas a turbulent flow regime would be required for optimum measurement.
- Despite loss of accuracy and linearity in hydrogen applications with low flow rates, the t-mass 65 measures with good repeatability and is therefore suitable for monitoring flow conditions (e.g. leak detection).
- A linear, reliable measured value is difficult to obtain in applications with light gases with a Reynolds number below RE 4000. While this can be improved by making a special adjustment in the lower flow range, a loss of accuracy and linearity should be expected. It is advisable to contact your Endress+Hauser sales center if your application involves media with Reynolds numbers below RE 4000.

- When mounting, please note that the recommended upstream distances should be doubled for very light gases such as helium and hydrogen. → 15

11.4 Output

Output signal	**Physical data transmission (Physical Layer Type):** ▪ Fieldbus interface in accordance with IEC 61158-2 ▪ Corresponds to device version type 512 of the FOUNDATION Fieldbus specification: type 512 – standard data transfer (±9 mA, symmetrical), separate supply to field device (4-wire), intrinsically safe version of the FF interface, FISCO ▪ With integrated reverse polarity protection
Signal on alarm	Status messages as per FOUNDATION Fieldbus specification
Link Master (LM) support	Yes
Link Master	Selectable
Basic Device	Factory setting
Device basic current	12 mA
Device starting current	<12 mA
Device error current (FDE)	0 mA
Device (lift off) min. voltage	9 V (H1-segment)
Permissible fieldbus supply voltage	9 to 32 V
Integrated reverse polarity protection	Yes
ITK Version	5.0
Number of VCRs (total)	48
Number of link objects in VFD	40
Device capacitance	In accordance with IEC 60079-27, FISCO/FNICO

Galvanic isolation

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

Data transmission rate

31.25 kbit/s, voltage mode

Signal coding

Manchester II

Bus times

Min. idle time between two telegrams:
MIN_INTER_PDU_DELAY = 6 octet time (transfer time per octet)

Block information, execution time

Block	Base index	Execution time [ms]	Functionality
Resource Block	400	–	Enhanced
"Flow" Transducer Block	1400	–	Vendor specific
"Diagnosis" Transducer Block	1600	–	Vendor specific
"Display" Transducer Block	1800	–	Vendor specific
"Totalizer" Transducer Block	1900	–	Vendor specific
"Heat Flow" Transducer Block	2700	–	Vendor specific
Analog Input function block 1	500	20	Standard
Analog Input function block 2	550	20	Standard
Analog Input function block 3	600	20	Standard
Analog Input function block 4	650	20	Standard
Analog Input function block 5	700	20	Standard
Analog Output function block (AO)	2300	20	Standard
Discrete Output function block (DO)	900	20	Standard
PID function block (PID)	1000	50	Standard
Arithmetic function block (ARTH)	1100	20	Standard
Input Selector function block (ISEL)	1150	20	Standard
Signal Characterizer function block (CHAR)	1200	20	Standard
Integrator function block (INTG)	1250	25	Standard

Output data

Transducer Blocks / Analog Input Function Blocks

Block	Process variable	Channel parameter (AI Block)
"Flow" Transducer Block	Mass flow	1
	Calculated volume flow	2
	Temperature	6
	Heat flow	53
"Totalizer" Transducer Block	Totalizer 1	7
	Totalizer 2	8

11.5 Power supply

Electrical connections

→ 🖹 28

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

Power consumption

- AC: 85 to 260 V = 18.2 VA; 20 to 55 V = 14 VA ; (including sensor)
- DC: 8 W (including sensor)

Switch-on current:
- Max. 8 A (<5 ms) at 24 V DC
- Max. 4 A (<5 ms) at 260 V AC

Power supply failure

Lasting min. 1 power cycle:
- EEPROM/HistoROM/T-DAT saves measuring system data if the 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 measuring devices in hazardous areas please refer to the additional Ex documentation.

Cable entry

Power supply and signal cables (inputs/outputs):
- Cable entry M20 × 1.5 (8 to 12 mm (0.31 to 0.47 in))
- 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 in))
- Threads for cable entries, ½" NPT, G ½"

Cable specifications (remote version)

→ 🖹 32

11.6 Performance characteristics

Reference conditions

- Traceable to National Standards
- Accredited according to ISO/IEC 17025
- Air-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 and t-mass 65I
±1.5 % of reading for 100 % to 10 % of range (at reference conditions)
±0.15 % of full scale for 10 % to 1 % of range (at reference conditions)

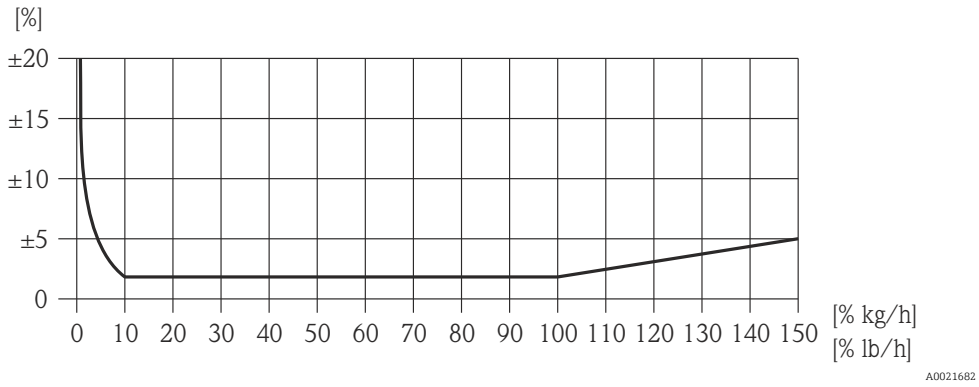


Fig. 40: Maximum measured error (% mass flow) as % of full scale value, see next table

Order code for "Calibration flow" (not verified)	Performance characteristics	Description
G	Q = 100 to 150 %: ±1.5 to ±5 % of the current measured value increasing linearly as expressed in the following equation: $\pm 1.5 \pm (X_n\text{-}100) \times 0.07$[% o.r.] (100 % < X_n ≤ 150 %; X_n = current flow in % o.f.s.) Q = 10 to 100 % of full scale value [1)] ±1.5 % o.r. Q = 1 to 10 % of full scale value [1)] ±0.15 % o.f.s. (all data under reference conditions)	Factory calibration: The measuring device is calibrated and adjusted on an accredited and traceable calibration rig and its accuracy is certified in a calibration report (3 control points).
H	Q = 100 to 150 %: ±1.5 to ±5 % of the current measured value increasing linearly as expressed in the following equation: $\pm 1.5 \pm (X_n\text{-}100) \times 0.07$[% o.r.] (100 % < X_n ≤ 150 %; X_n = current flow in % o.f.s.) Q = 10 to 100 % of full scale value [1)] ±1.5 % o.r. Q = 1 to 10 % of full scale value [1)] ±0.15 % o.f.s. (all data under reference conditions)	Factory calibration + flow conditioner[2)]: The measuring device is calibrated and adjusted on an accredited and traceable calibration rig with a flow conditioner and its accuracy is certified in a calibration report (3 control points).

Order code for "Calibration flow" (not verified)	Performance characteristics	Description
K	Q = 100 to 150 %: ±1.5 to ±5 % of the current measured value increasing linearly as expressed in the following equation: $\pm 1.5 \pm (X_n\text{-}100) \times 0.07 [\%\ o.r.]$ (100 % < X_n ≤ 150 %; X_n = current flow in % o.f.s.) Q = 10 to 100 % of full scale value [1] ±1.5 % o.r. Q = 1 to 10 % of full scale value [1] ±0.15 % o.f.s. (all data under reference conditions)	5-point, traceable ISO/IEC17025: The measuring device is calibrated and adjusted on an accredited and traceable calibration rig and its accuracy is certified in a Swiss Calibration Services (SCS) calibration report (5 control points), which confirms traceability to the national calibration standard.
L	Q = 100 to 150 %: ±1.5 to ±5 % of the current measured value increasing linearly as expressed in the following equation: $\pm 1.5 \pm (X_n\text{-}100) \times 0.07 [\%\ o.r.]$ (100 % < X_n ≤ 150 %; X_n = current flow in % o.f.s.) Q = 10 to 100 % of full scale value [1] ±1.5 % o.r.) Q = 1 to 10 % of full scale value [1] ±0.15 % o.f.s. (all data under reference conditions)	5-point, traceable ISO/IEC17025 + flow conditioner[2]: The measuring device is calibrated and adjusted on an accredited and traceable calibration rig with a flow conditioner and its accuracy is certified in a Swiss Calibration Services (SCS) calibration report (5 control points), which confirms traceability to the national calibration standard.

1. The full scale value depends on the nominal diameter of the device and the maximum flow capacity of the calibration rig. The full scale values are listed in the following section.
2. A flow conditioner is also supplied.

Repeatability

±0.5 % of reading for velocities above 1.0 m/s (0.3 ft/s)

Response time

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

Influence of medium pressure (Pressure co-efficient)

Air: 0.35 % per bar (0.02% per psi) of process pressure change

11.7 Installation

Installation section → 11

11.8 Environment

Ambient temperature range

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

11.9 Process

Medium temperature range

Sensor

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

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

Seals t-mass F

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

Bushing:
PEEK −40 to +100 °C (−40 to +212 °F)

Seals t-mass I

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

Ferrule:
PEEK, PVDF −40 to +130 °C (−40 to +266 °F)

Note
We recommend special materials (Alloy and PVDF) for aggressive media (e.g. chlorine or ozone). Please contact your Endress+Hauser sales center for clarification.

Media

The following media and media mixtures can be measured. A mixture can consist of up to 8 components from the following list.

AIR	ETHANE	METHANE
AMMONIA	ETHYLENE	NEON
ARGON	HELIUM 4	NITROGEN
BUTANE	HYDROGEN NORMAL	OXYGEN
CARBON DIOXIDE	HYDROGEN CHLORIDE	PROPANE
CARBON MONOXIDE	HYDROGEN SULFIDE	XENON
CHLORINE	KRYPTON	

Note
Other media (e.g. ozone) available on request. Contact your Endress+Hauser sales center for clarification.

Pressure-temperature ratings

Note!
An overview of the pressure-temperature ratings for the process connections is provided in the Technical Information

Flow limit

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

Pressure loss

Negligible (without flow conditioner).
Refer to Applicator for the precise calculation → 67

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)

Limiting medium pressure range (nominal pressure)

The material load diagrams (pressure-temperature ratings) for the process connections are provided in the separate "Technical Information" document for the particular measuring device. This can be downloaded as a PDF file at www.endress.com.
A list of the "Technical Information" documents: → 100

Hot tap, process pressure

The Hot tap for mounting and removal at process pressure may only be used with non-toxic, innocuous gases classified as "Group II" in accordance with European Directive 67/548/EEC Art. 2.

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

Low pressure version
Max. process pressure: 20 barg (290 psig)
Max. extraction press: 4.5 barg (65 psig)
Max. extraction temperature: +50 °C (+122 °F)
Min. sensor length: 335 mm (13 in)

Cold tap, atmospheric pressure

Cold tapfor mounting and removal at ambient pressure
Max. process pressure: 20 barg (290 psig)
Max. extraction pressure: 1 bar(a) (14.5 psia)
Max. extraction temperature: +50 °C (+122 °F)
Min. sensor length: 335 mm (13 in)

11.10 Mechanical construction

Design / dimensions

Dimensions and the fitting lengths of the transmitter and sensor are provided in the separate "Technical Information" document on the device in question. This can be downloaded as a PDF file from www.endress.com.
A list of the "Technical Information" documents: → 🖹 100

Weight

- Wall-mount housing of remote version: 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	5.5	6.0	10.5	10.5	16.7	25.9

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

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

Weight dimensions in [kg]

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	12.1	13.2	23.1	23.1	36.7	57.1

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

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

Weight dimensions in [lb]

Materials

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

Measuring tube:
- In contact with medium:
  - DN 15 to 25 (½ to 1"): stainless cast steel CF3M-A351
  - DN 40 to 100 (1 ½ to 4"): 1.4404 (316/316L)
- Not in contact with medium:
  - 1.4301 (304)

Flanges (process connections):
Stainless steel 1.4404 (316L/316)

Transducer:
- 1.4404 (316L)
- Alloy C22, 2.4602 (N06022)

Transducer elements:
- 1.4404 (316L) or
- 1.4404 (316L)
- Alloy C22, 2.4602 (N06022)

Bushing:
PEEK GF30, PVDF

O-rings:
EPDM, Kalrez 6375, Viton FKM

t-mass I sensor

Insertion tube:
- Sensor length 235 (9"), 335 (13"), 435 (17"), 608 (24")
- 1.4404 (316/316L)
- Special lengths and full Alloy C22 versions on request

Transducer:
- 1.4404 (316L)
- Alloy C22, 2.4602 (N06022)

Protection gaurd:
1.4404 (316L)

Compression fitting:
1.4404 (316/316L)

Ferrule:
PEEK 450G, PVDF (on request)

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

Hot tap, process pressure

Lower tube section:
1.4404 (316/316L)

Upper tube section:
1.4404 (316/316L)

Ball valve:
CF3M and CF8M

Seal:
PTFE

Cold tap, atmospheric pressure

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

Process connections

For both the flanged and insertion meters it is possible to have wetted parts degreased for oxygen service. Further information is available from your Endress+Hauser sales center.

t-mass F:
Flanges according EN 1092-1, JIS B2220 and ASME B16.5

t-mass I:
G 1A or 1" MNPT thread

11.11 Operability

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 three keys (−, +, E)
- Quick Setup menus for straight forward commissioning

Languages

English, German, French, Spanish, Italian, Dutch, Norwegian, Finnish, Swedish, Portuguese, Polish, Czech

11.12 Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the applicable EC Directives. These are listed in the corresponding EC Declaration of Conformity along with the standards applied.
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 etc.) is available from your Endress+Hauser sales center. All explosion protection data are given in a separate documentation which is available upon request.

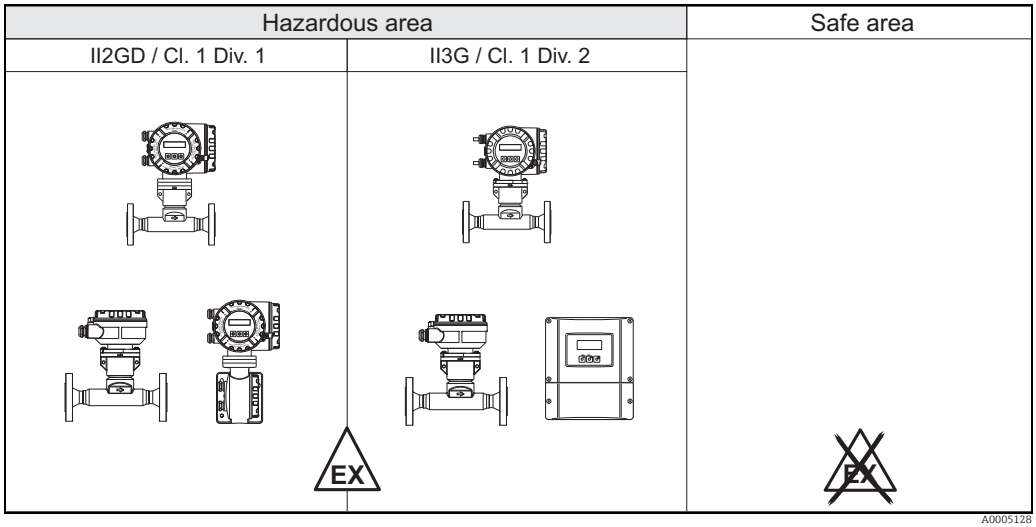


Fig. 41: Example of t-mass devices in the hazardous area (Example t-mass 65F)

PROFIBUS DP/PA certification

The flowmeter has passed all the test procedures implemented and has been certified and registered by the PNO (PROFIBUS User Organization). The device thus meets all the requirements of the following specifications:

- Certified in accordance with PROFIBUS Profile Version 3.0 (device certification number: available on request)
- The device can also be operated in conjunction with other-make certified devices (interoperability).

Pressure measuring device approval

- With the identification PED/G1/x (x = category) on the sensor nameplate, Endress+Hauser confirms conformity with the "Essential 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 than, or smaller and equal to 0.5 bar (7.3 psi).
- 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

For oxygen applications with the order code for "Surface cleaning" option B "Certified and cleaned of oil and grease"
We certify that the wetted parts of the flow sensor have been degreased in accordance with British Oxygen Company (BOC) specification 50000810 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

11.13 Ordering information

The Endress +Hauser sales center can provide detailed ordering information and information on the extended order code.

11.14 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor → 67

11.15 Documentation

- Technical Information t-mass 65F, 65I (TI069D/06)
- Description of Device Functions t-mass 65 (BA00114D/06)
- Supplementary documentation on Ex-ratings: ATEX, FM, CSA, IECEx, NEPSI
- Flow measuring technology (FA00005D/06/)

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