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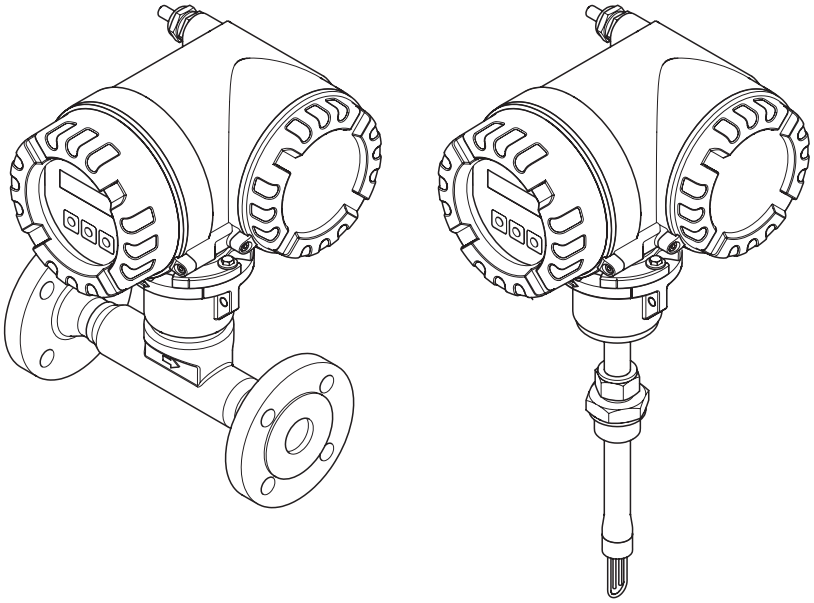
Operating Instructions

Proline t-mass 65
PROFIBUS DP

Thermal Mass Flow Measuring System



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Valid as of version
V 3.02.XX (Device software)

Endress+Hauser

People for Process Automation

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1 Safety instructions

1.1 Designated use

The measuring device described in these Operating Instructions is to be used only for measuring the mass flow rate of gases. At the same time, the system also measures gas temperature and calculates other variables such as corrected volume flow. The measuring device can be configured to measure pure gases or gas mixtures.

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

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

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

1.2 Installation, commissioning and operation

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

1.3 Operational safety

Note the following points:
- Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.
  The symbol on the front of this supplementary Ex documentation indicates the approval and the certification body (Ⓔx Europe, FM USA, Ⓒ Canada).
- The measuring device complies with the general safety requirements in accordance with EN 61010-1, the EMC requirements of EN 61326/A1, and NAMUR recommendation NE 21 and NE 53.
- The separate document on the Pressure Equipment Directive must be observed for devices used in Category II, III or IV installations in accordance with the Pressure Equipment Directive.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Operating Instructions.

1.4 Return

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

Note!
You will find a preprinted "Declaration of contamination" form at the back of this manual.

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

1.5 Notes on safety conventions and icons

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

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

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

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

2 Identification

2.1 Device designation

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

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

2.1.1 Nameplate of the transmitter

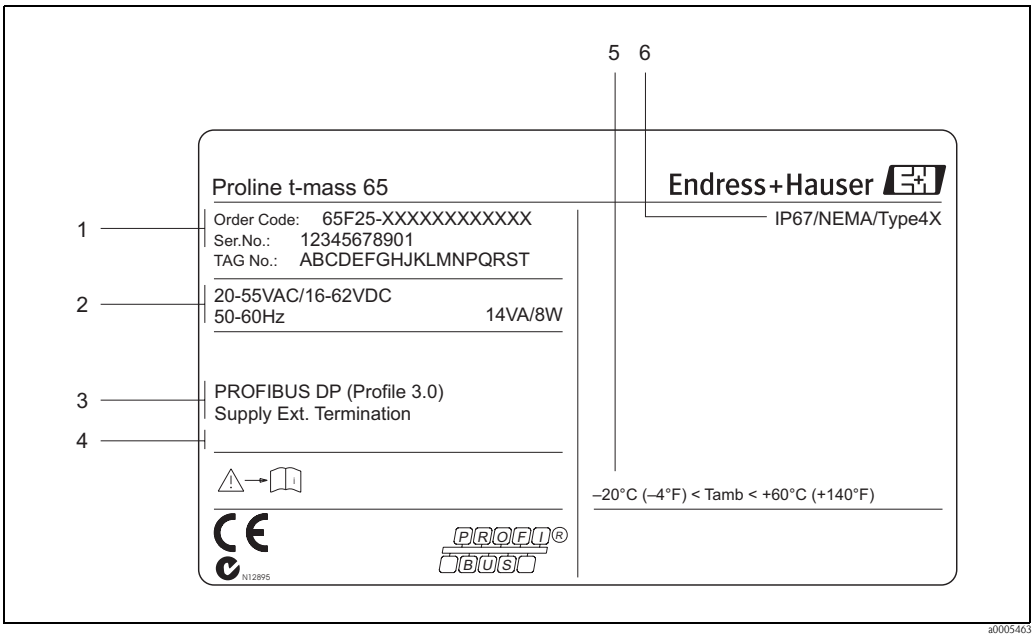


Fig. 1: Nameplate specifications for the “t-mass 65” transmitter (example)

1 Order code / serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
2 Power supply / frequency: 20 to 55 V AC /16 to 62 V DC / 50 to 60 Hz
Power consumption: 14 VA / 8 W
3 Available inputs / outputs
4 Reserved for information on special products
5 Ambient temperature range
6 Degree of protection

2.1.2 Nameplate of the sensor

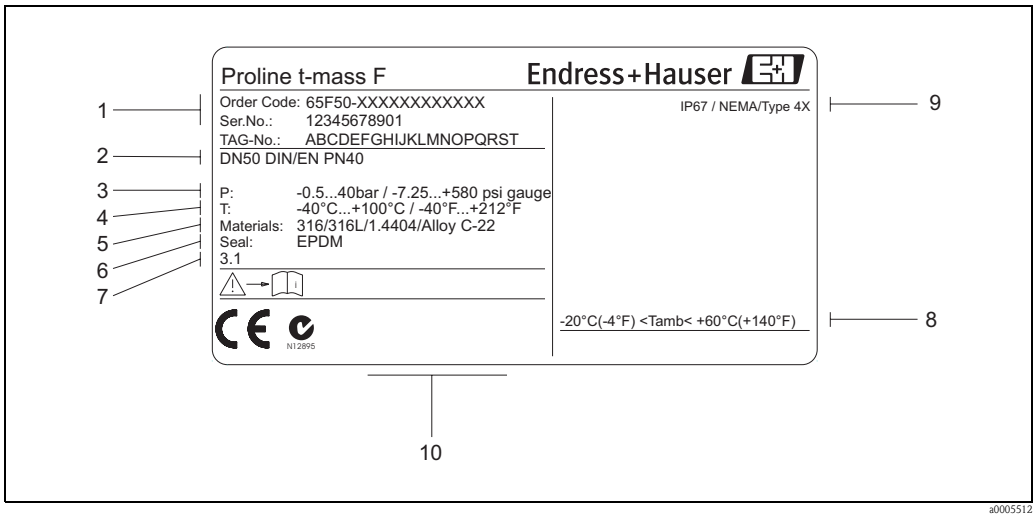


Fig. 2: Nameplate specifications for the "t-mass F" sensor (example)

1 Order code / serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
2 Nominal diameter device: DN 50
3 Pressure range: –0.5 to 40 bar / –7.25 to 580 psi (gauge)
4 Temperature range: –40 °C to +100 °C / –40 °F to +212 °F
5 Material of measuring tubes: Stainless steel 316/316L/1.4404/Alloy C-22
6 Seal material: EPDM
7 Reserved for information on special products (example):
– With material certificate for wetted materials
8 Ambient temperature range
9 Degree of protection
10 Reserved for additional information on device version (approvals, certificates)

2.1.3 Nameplate for connections

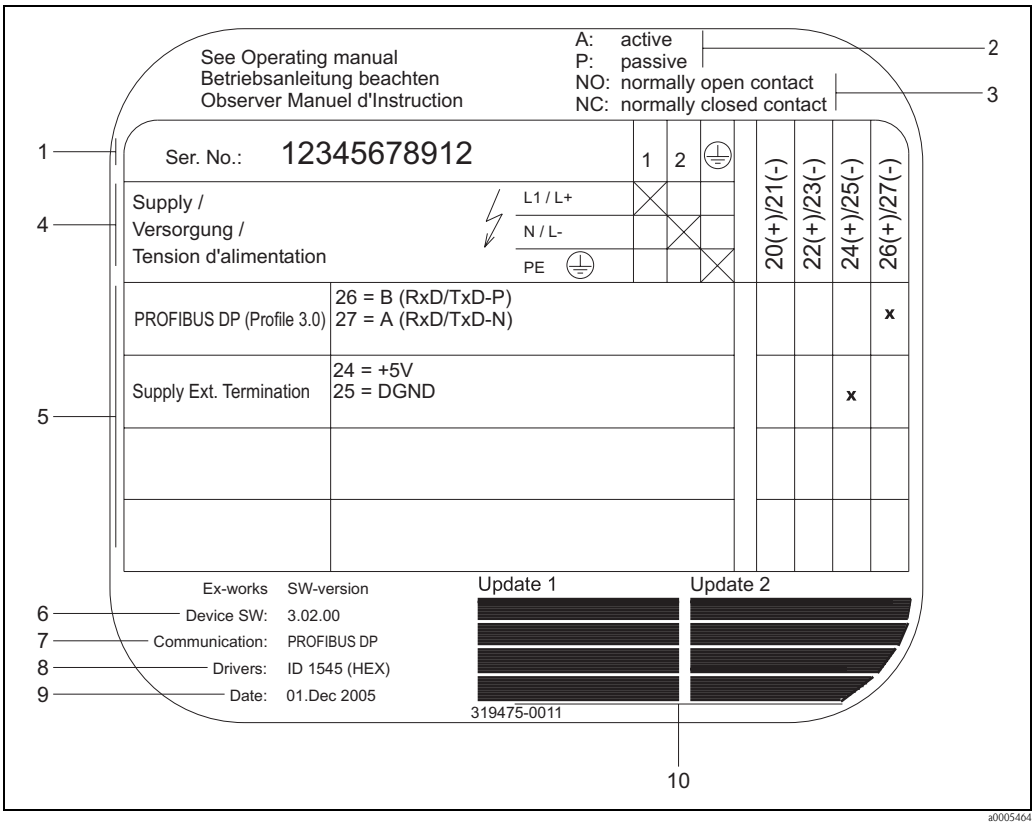


Fig. 3: Nameplate specifications for transmitter connections (example)

1 Serial number
2 Possible configuration of current output
3 Possible configuration of relay contacts
4 Terminal assignment, cable for power supply: 85 to 260 V AC, 20 to 55 V AC, 16 to 62 V DC
*Terminal **No. 1**: L1 for AC, L+ for DC*
*Terminal **No. 2**: N for AC, L– for DC*
5 Pending signals at inputs and outputs possible configurations and terminal assignment → Page 32
6 Version of device software currently installed
7 Installed communication type
8 PROFIBUS ID No.
9 Date of installation
10 Current updates to data specified in points 6 to 9

2.2 Certificates and approvals

The devices are designed in accordance with good engineering practice to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate. The devices comply with the applicable standards and regulations in accordance with EN 61010-1 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures" and with the EMC requirements of EN 61326/A1.

The measuring system described in these Operating Instructions thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

The measuring system complies with the EMC requirements of the "Australian Communications Authority (ACA)".

The measuring system has successfully passed all the test procedures carried out and is certified and registered by the PNO (PROFIBUS User Organisation).

The device thus meets all the requirements of the following specifications:
- Certified to PROFIBUS Specification Profile 3.0 version
  Device certification number: on request
- The measuring system can also be operated with certified devices of other manufacturers (interoperability).

2.3 Registered trademarks

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

PROFIBUS®
Registered trademark of the PROFIBUS User Organisation, Karlsruhe, D

HistoROM™, S-DAT®, T-DAT™, F-CHIP®, ToF Tool - Fieldtool® Package, Fieldcheck®, Applicator®, t-mass®
Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

3 Installation

3.1 Incoming acceptance, transport and storage

3.1.1 Incoming acceptance

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

3.1.2 Transport

The following instructions apply to unpacking and to transporting the device to its final location:
- Transport the devices in the containers in which they are delivered.
- The covers or caps fitted to the process connections prevent mechanical damage to the transducers during transportation and storage. Consequently, do not remove these covers or caps until immediately before installation.
- Do not lift measuring devices of nominal diameters DN 40 to 100 (1½" to 4") by the transmitter housing or the connection housing in the case of the remote version (Fig. 4). Use webbing slings slung round the two process connections. Do not use chains, as they could damage the housing.

⚠ Warning!
Risk of injury if the measuring device slips. The center of gravity of the assembled measuring device might be higher than the points around which the slings are slung.
At all times, therefore, make sure that the device does not unexpectedly turn around its axis or slip.

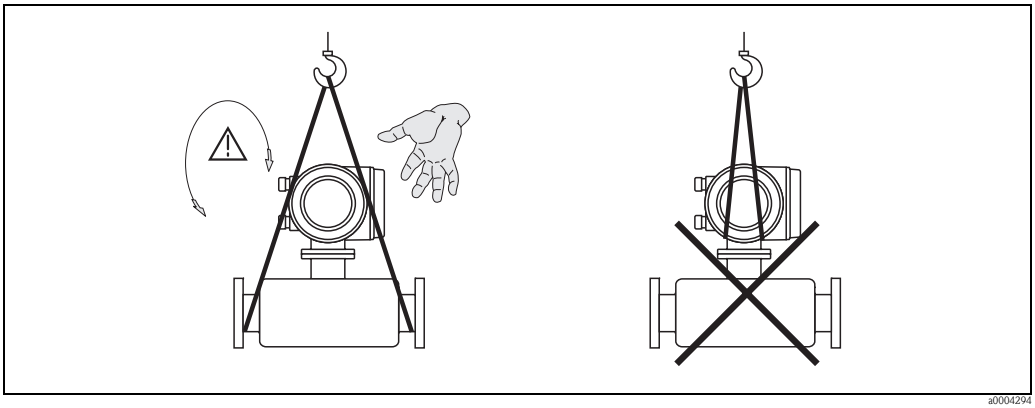


Fig. 4: Instructions for transporting sensors with DN 40 to 100 (1½" to 4")

3.1.3 Storage

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

3.2 Installation conditions

Note the following points:
- The thermal dispersion principle is very sensitive to low flow rates and disturbed flow conditions.
- Observe the recommended inlet and outlet requirements.
- Good engineering practice is necessary for the associated pipe work and installation.
- Ensure correct alignment and orientation of the sensor.
- Avoid condensation forming around the transducers.
- Consider the nature of the gas or gas mixture (dryness, cleanliness, stability, fraction, etc.)
- The maximum permitted ambient temperatures (→ Page 96) and the medium temperature range (→ Page 96) must be observed.
- If possible, locate the sensor to avoid extreme changes in ambient temperature and process condititons.
- For mechanical reasons, and in order to protect the pipe, it is advisable to support heavy sensors.

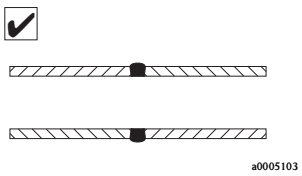
3.2.1 Dimensions

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

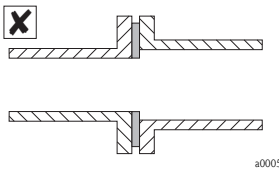
3.2.2 Pipework requirements

Good construction practice should be followed at all times:

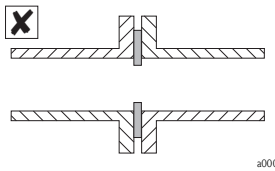
- Correct welding techniques
- Correctly sized gaskets
- Correctly aligned flanges and gaskets
- The use of seamless pipe immediately upstream of the flowmeter.
- The use of pipework with a matching internal diameter to that of the flowmeter to ensure that no step disturbance greater than 1 mm (0.04 inch) can occur at the meter inlet or outlet (3 mm (0.12 inch) for diameters > DN 200 (8")).
- As a general comment, anything that disturbs the smoothness of the internal pipe wall within the dimensions stated below should be eliminated; the goal should be a smooth uninterrupted internal surface.
  For further information please refer to ISO 14511.



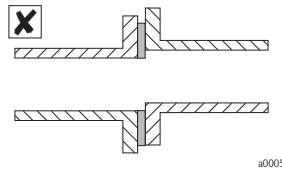
Butt welded joint



Pipe diameter one is not equal pipe diameter two



Incorrectly sized gaskets

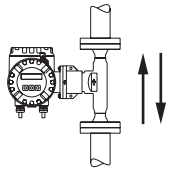
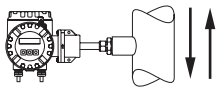
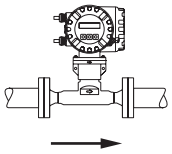
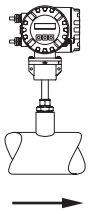
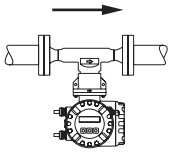
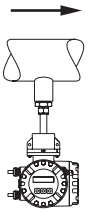


Incorrectly aligned flanges and gaskets

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

3.2.3 Orientation

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

	Flanged version			Insertion version	
Vertical orientation					
 a0005107	compact ✔✔	remote ✔✔	 a0005110	compact ✔	remote ✔✔
Horizontal orientation:					
 a0005108	compact ✔✔	remote ✔✔	 a0005111	compact ✔✔	remote ✔✔
Horizontal orientation:					
 a0005109	compact ✘	remote ✘	 a0005112	compact ✘	remote ✘

✔✔ = Recommended orientation
✔ = Orientation recommended in certain situations
✘ = Not recommended

3.2.4 Inlet and outlet runs

The sensitivity of the thermal dispersion principle to low flow rates means the flowmeter can also be sensitive to internal disturbances in the flowing gas stream (e.g. swirl), especially in the larger pipe diameters ≥ DN 150 (≥ 6").
As a general rule, the installed thermal flow sensor should always be installed as far away as possible from any flow disturbances (see ISO14511 for further information).

Process components or pipework configuration

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

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

Inlet runs:

Minimum 15 x DN for the flanged version (65F)
Minimum 20 x DN for the insertion version (65I)

Outlet runs:

Minimum 2 x DN for the flanged version (65F)
Minimum 5 x DN for the insertion version (65I)

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

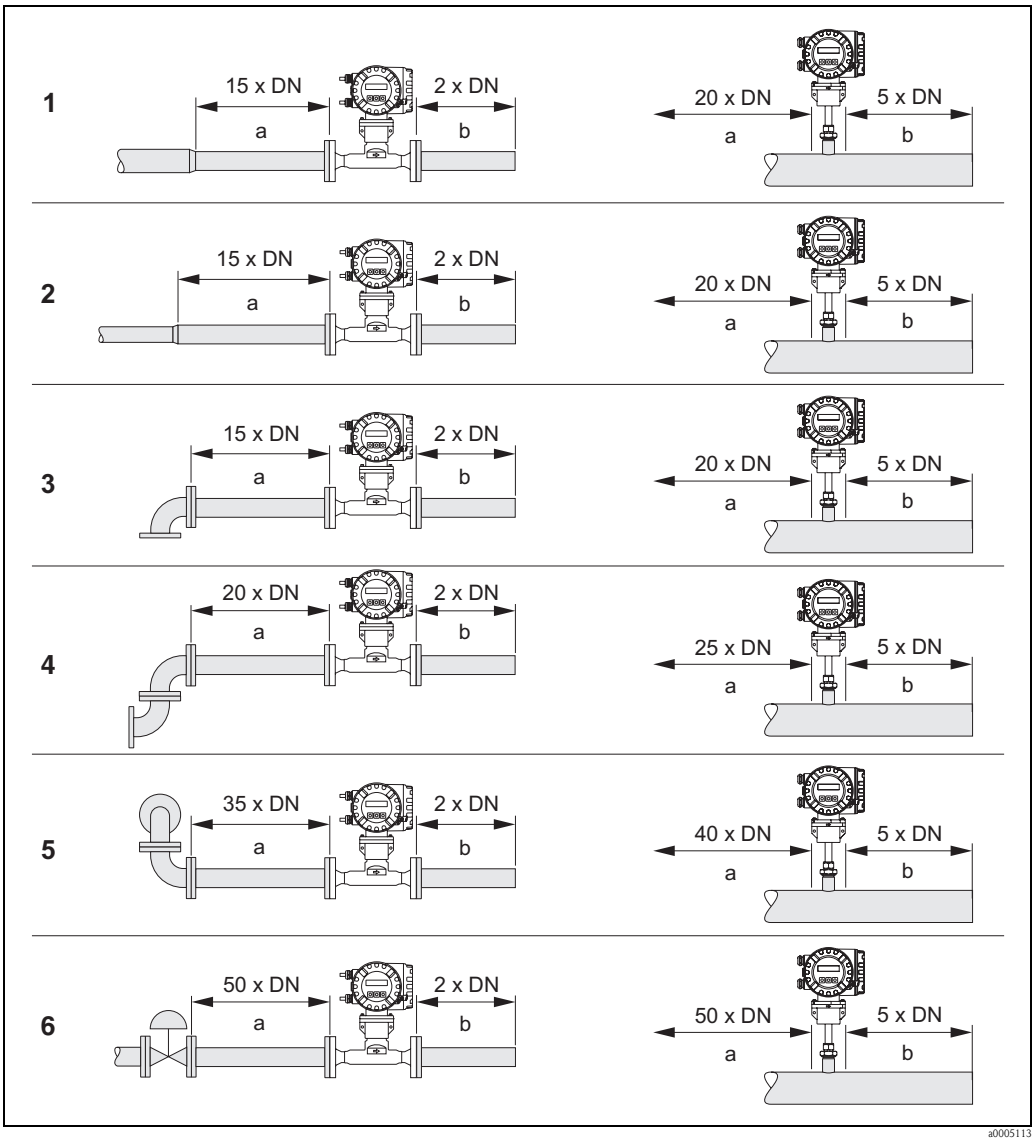


Fig. 5: The figure above illustrates the minimum recommended inlet und outlet runs expressed in multiples of the pipe diameter.

1 = Reduction
2 = Expansion
3 = 90° elbow or T-piece
4 = 2 x 90° elbow
5 = 2 x 90° elbow, 3-dimensional
6 = Control valve (where possible a modulating control valve should be mounted downstream of a flowmeter)

a = Inlet run
b= Outlet run

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

3.2.5 Outlet runs with pressure measuring points

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

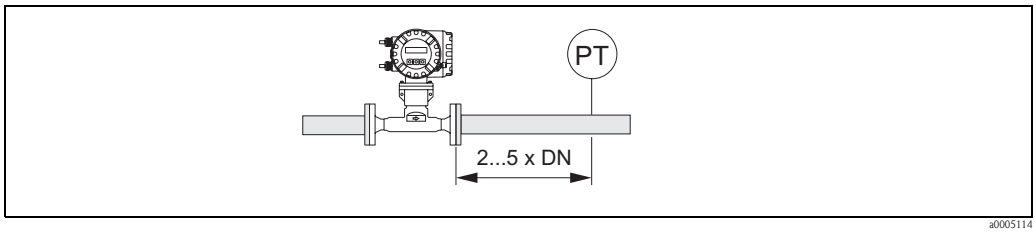


Fig. 6: Installing a pressure measuring point (PT = pressure transmitter)

3.2.6 Perforated plate flow conditioner

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

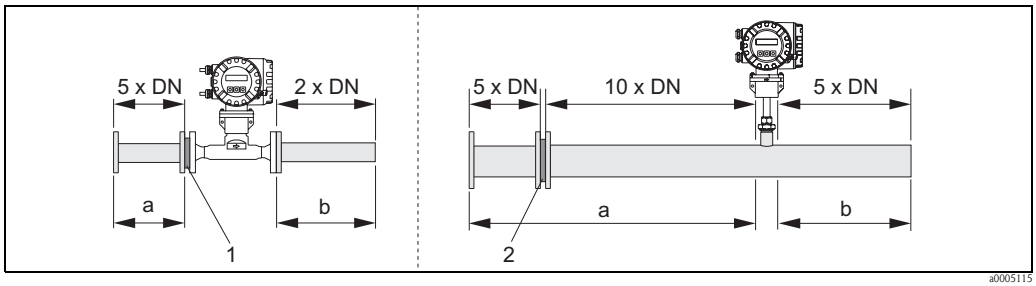


Fig. 7: The figure above illustrates the minimum recommended inlet and outlet runs expressed in multiples of the pipe diameter using a flow conditioner.

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

Flow conditioner (35 hole) for use with insertion sensors

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

Flow conditoner (19 hole) for use with flanged sensors

This is a special Endress+Hauser version designed specially for use with the t-mass F sensor (Sizes DN 25 to 100 /1" to 4"). The flow conditioner should be fitted immediately upstream of the flanged sensor. A further 5 pipe diameters inlet run is required upstream of the actual conditioner itself.

For optimum performance, it is advised that the t-mass F sensor and flow conditioner are ordered at the same time such that they are calibrated together. To retrospectively fit a flow conditioner will have a small effect on the measurement performance.

Note!
The use of other types of flow conditioners, other than the Endress+Hauser flow conditioner, with the t-mass F sensor will have an impact on the measurement performance due to the effects of flow profile and pressure drop.

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

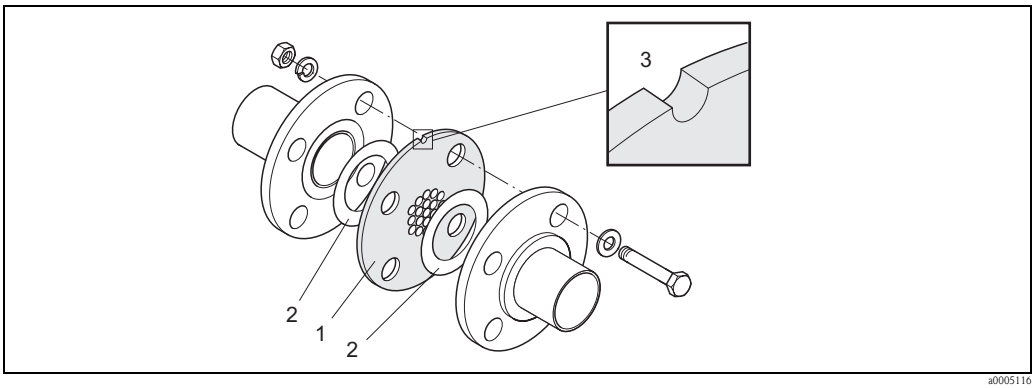


Fig. 8: Flow conditioner mounting arrangement (example)

1 = Perforated plate flow conditioner
2 = Seal/gasket
3 = Notch

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

3.2.7 Flow direction alignment for the flanged version

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

3.2.8 Flow direction alignment for the insertion version

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

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

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

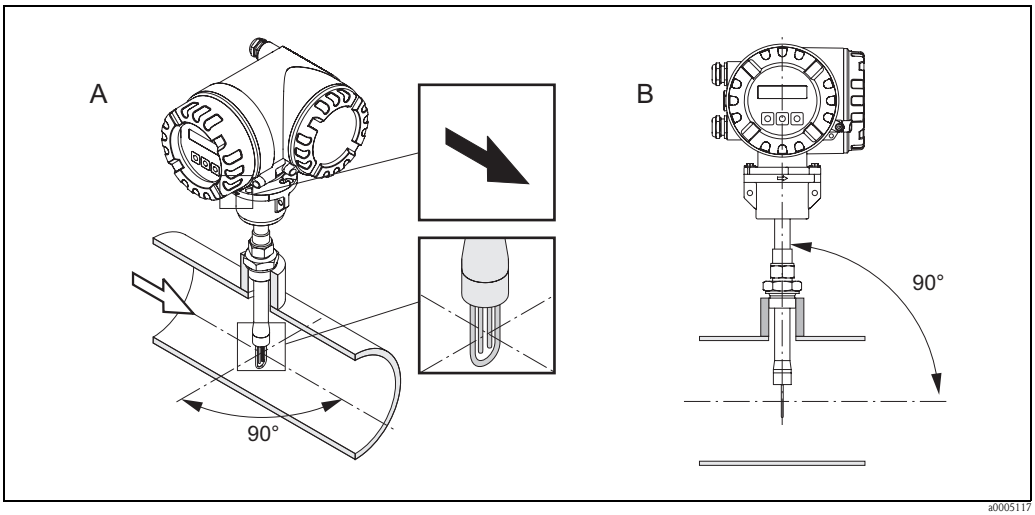


Fig. 9: It is important to keep the 90° degree angle

A = Flow direction alignment
B = Vertical alignment

Vertical alignment

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

Note!
The thermal sensor cannot differntiate between forward and reverse flow. These guidelines are only to ensure correct installation and aligment.

3.2.9 Insertion depth for the insertion version

Sensor installation - Adjustable insertion sensor

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

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

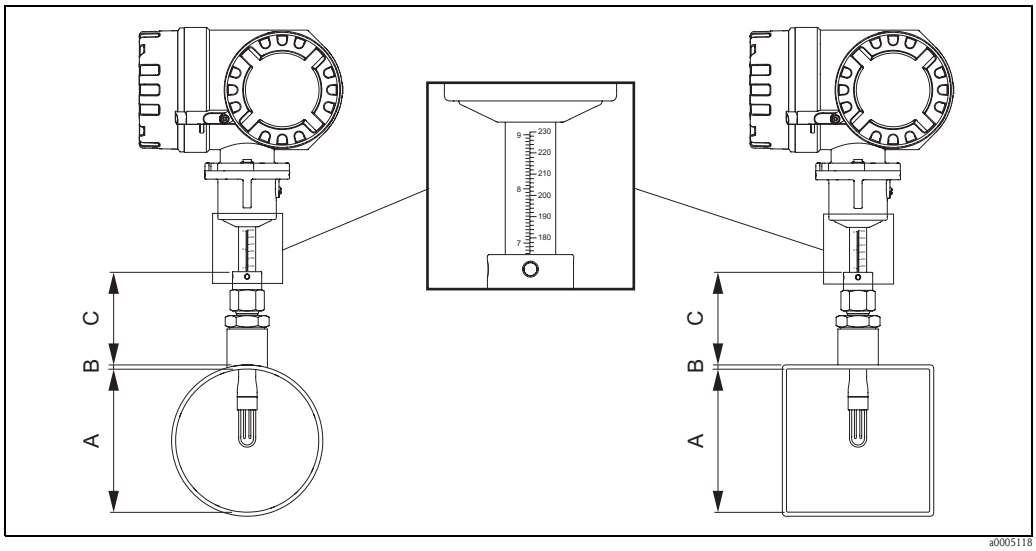


Fig. 10: Dimensions required to calculate the sensor insertion depth

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

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

For pipe diameter:
- = DN 80 (3"): (0.3 x A) + B + C + 2 mm (0.079 inch)
- ≥ DN 100 (4"): (0.2 x A) + B + C + 3 mm (0.12 inch)

For duct width (horizontal installation) or duct height (vertical installation):
- < DN 100 (4"): (0.3 x A) + B + C + 2 mm (0.079 inch)
- ≥ DN 100 (4"): (0.2 x A) + B + C + 3 mm (0.12 inch)

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

Note!
These mounting guidelines assume that a standard mounting boss provided by Endress+Hauser is being used (see Accessories on Page 70).

Warning!
The following tightening tensions for the compression fitting must be observed:
- Locking nut: Hand tight, then 1¼ turns with a wrench
- Anti-vibration screws: 5 Nm (3.89 lbf ft)

3.2.10 Low pressure retractable process connection

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

Cold Tap

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

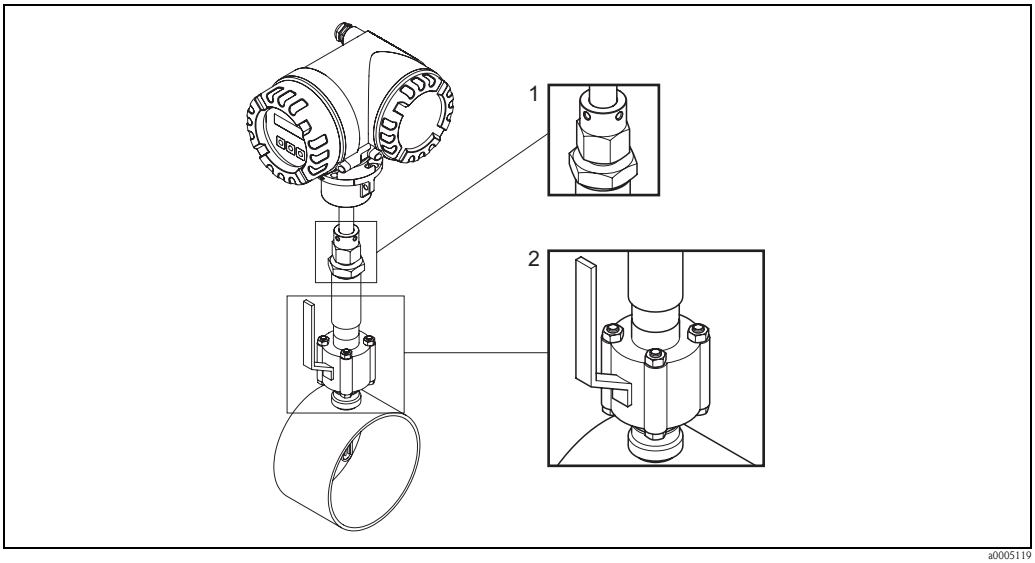


Fig. 11: Cold tap process connection

1 = Compression gland
2 = Isolation valve

Installing

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

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

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

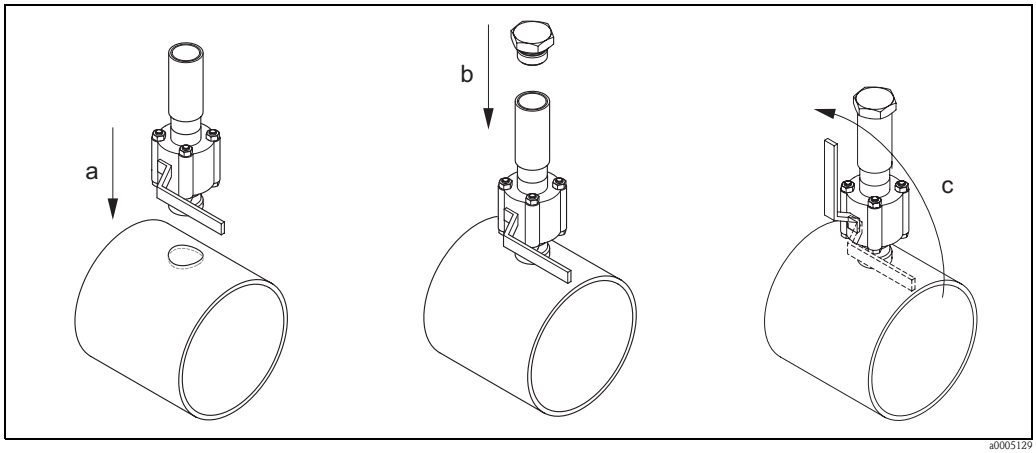


Fig. 12: Mounting the cold tap process connetction

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

   ✎ Note!
   – NPT threads: use thread tape
   – G 1 A threads: the provided bonded seal must be fitted
   – All threads are right hand (tighten clockwise)
6. Adjust the insertion sensor tube to the correct height (→ Page 17), ensure correct orientation and tighten the compression fitting upper nut with a wrench (f). Tighten the securing screws (g).
7. Apply process pressure and again do a final check for leaks.

(corresponding graphic see next page)

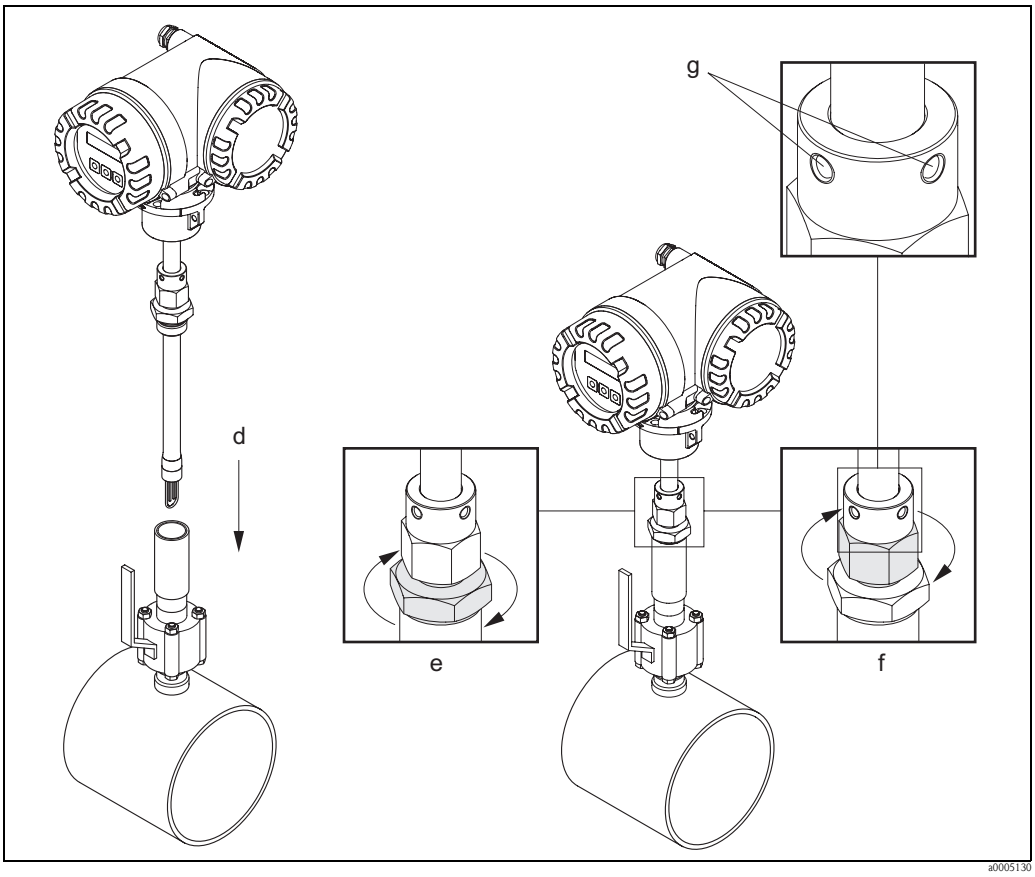


Fig. 13: Mounting the insertion sensor into the cold tap.

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

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

Removing

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

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

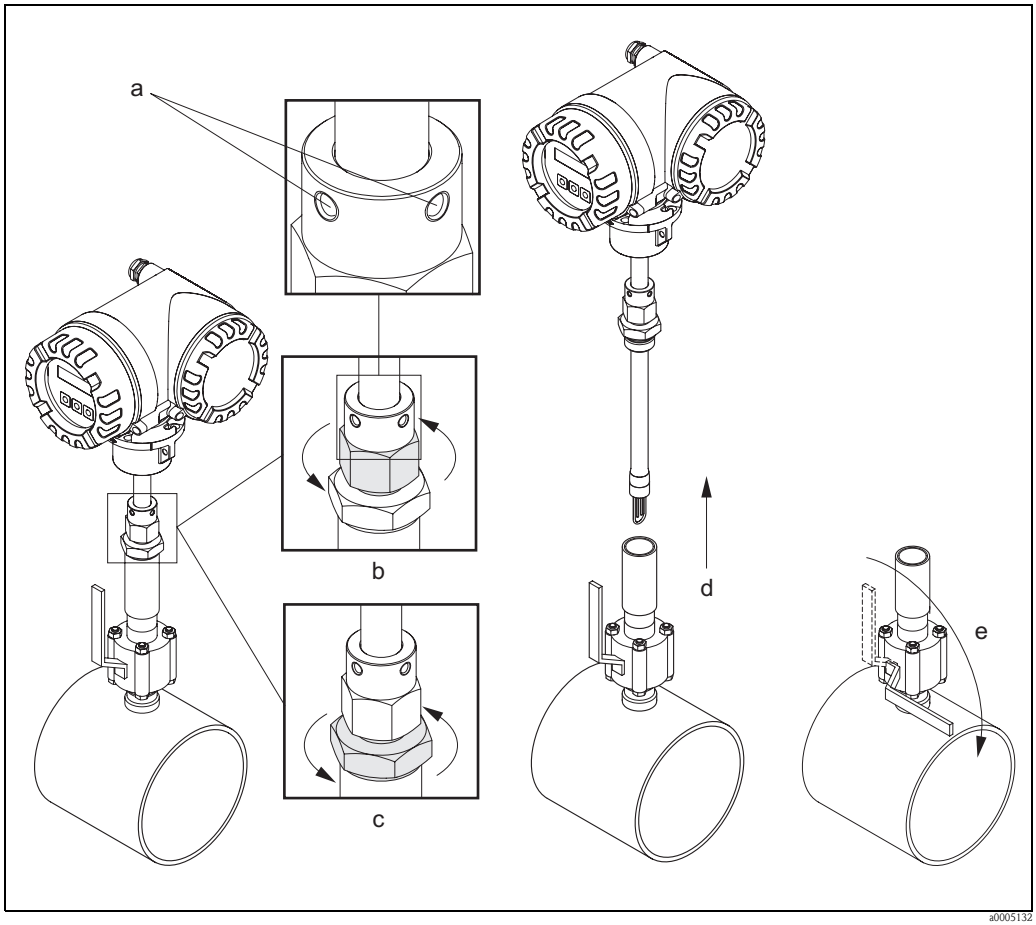


Fig. 14: Removing the insertion sensor from the cold tap.

3.2.11 System pressure

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

- Use of expansion tanks
- Use of inlet expanders
- Relocate the thermal measuring device

3.2.12 External pressure compensation

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

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

Transmission of pressure value via PROFIBUS:
The value of the process pressure can be cyclically transmitted from the PROFIBUS Master (class 1) to the measuring device by means of the PRESSURE_VALUE module (→ Page 63).

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

3.2.13 Temperature range

The following requirements and limits must be observed:

- It is recommended to install the sensor out of any direct sunlight or away from any extremes of temperature.
- The maximum approved ambient and process temperatures (see Page 96 ff.)
- Instructions on heating and thermal insulation (see Page 23 ff.)

3.2.14 Heating

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

Caution!
- Risk of electronics overheating! Consequently, make sure that the adapter between sensor and transmitter and the connection housing of the remote version always remain free of insulating material.
- When using electrical heat tracing whose heat is regulated using phase control or by pulse packs, it cannot be ruled out that the measured values are influenced by magnetic fields which may occur (i. e. at values greater than those permitted by the EC standard minus 30 A/m). In such cases, the sensor must be magnetically screened.

3.2.15 Thermal insulation

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

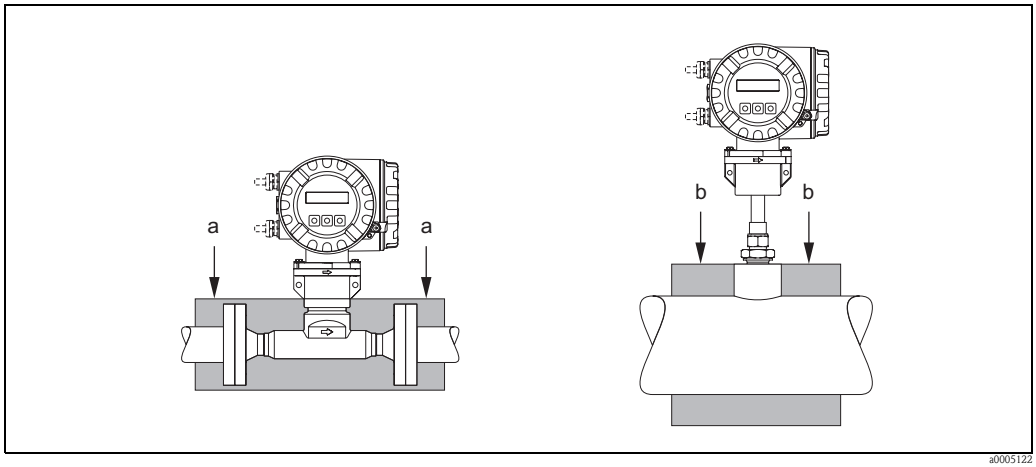


Fig. 15: Maximum thermal insulation for t-mass 65F and 65I

a = Maximum insulation height for the flanged version
b = Maximum insulation height for the insertion version

3.2.16 Vibrations

Caution!
Excessive vibration can result in mechanical damage to the measuring device and its mounting.
Observe the vibration specification in the technical data section → Page 96.

3.3 Installation instructions

3.3.1 Turning the transmitter housing

Turning the aluminium field housing

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

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

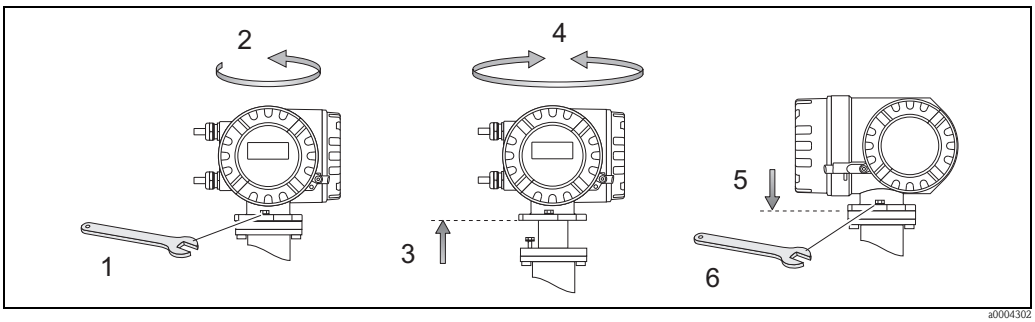


Fig. 16: Turning the transmitter housing (aluminium field housing)

3.3.2 Installing the wall-mount transmitter housing

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

- Mounted directly on the wall → Page 26
- Installation in control panel → Page 26 (separate mounting set, accessories → Page 70)
- Pipe mounting → Page 27 (separate mounting set, accessories → Page 70)

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

Mounted directly on the wall

1. Drill the holes as illustrated in the diagram.
2. Remove the cover of the connection compartment (a).
3. Push the two securing screws (b) through the appropriate bores (c) in the housing.
   – Securing screws (M6): max. Ø 6.5 mm (0.25 inch)
   – Screw head: max. Ø 10.5 mm (0.4 inch)
4. Secure the transmitter housing to the wall as indicated.
5. Screw the cover of the connection compartment (a) firmly onto the housing.

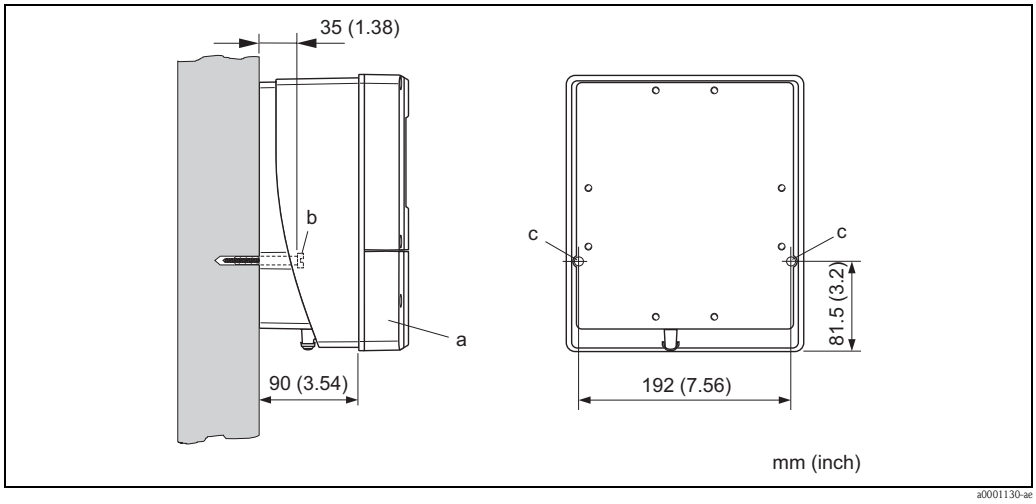


Fig. 17: Mounted directly on the wall

Installation in control panel

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

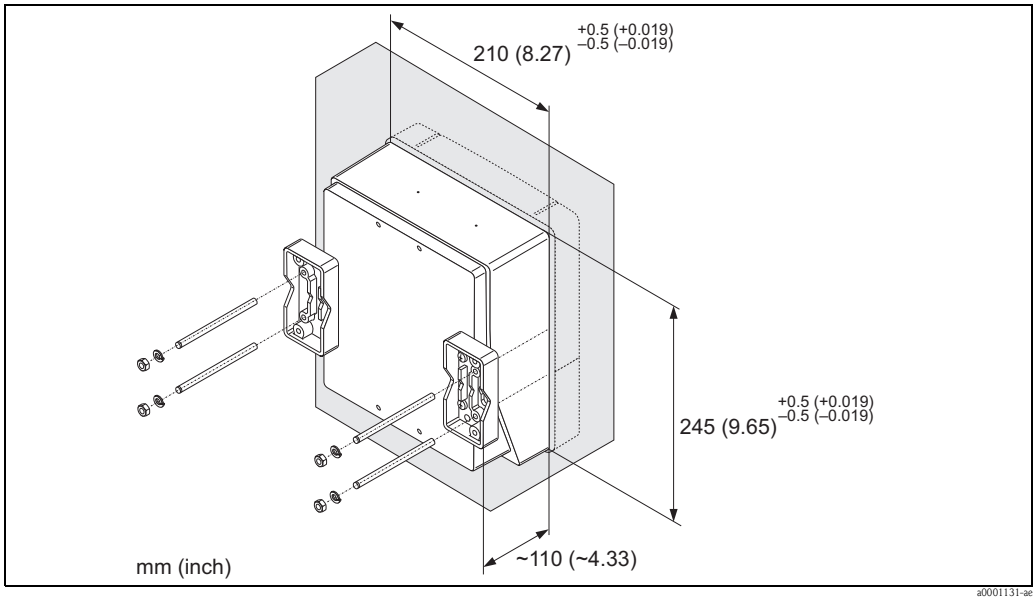


Fig. 18: Panel installation (wall-mount housing)

Pipe mounting

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

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

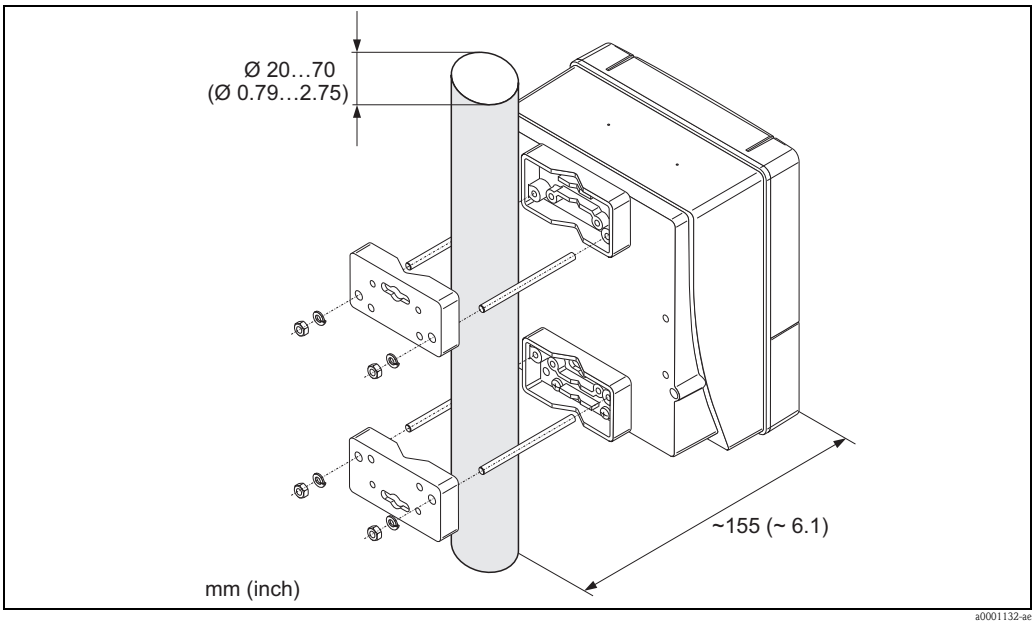


Fig. 19: Pipe mounting (wall-mount housing)

3.3.3 Turning the local display

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

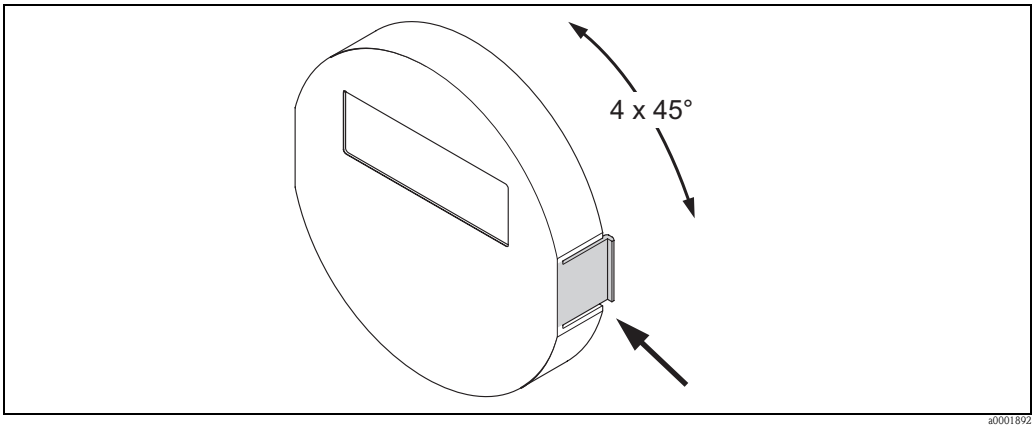


Fig. 20: Turning the local display (field housing)

3.4 Post-installation check

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

Device condition and specifications	Notes
Is the device damaged (visual inspection)?	–
Does the device correspond to specifications at the measuring point, including process temperature and pressure, ambient temperature, measuring range, etc.? Check the name plate.	→ Page 92 ff.
Installation	Notes
Correct alignment of pipe/gasket/flowmeter body?	→ Page 12
Correct pipe internal diameter and surface finish/quality?	→ Page 12
Is the orientation chosen for the sensor correct, in other words suitable for sensor type, fluid properties and fluid temperature?	→ Page 13
Is there sufficient upstream and downstream length from the measurement point?	→ Page 14 ff.
Correct installation of flow conditioner (if fitted)?	→ Page 16 ff.
Does the arrow on the sensor nameplate match the direction of flow through the pipe?	→ Page 17
Correct insertion sensor depth (insertion version only)?	→ Page 18
Process environment / process conditions	Notes
Is the measuring device protected against moisture and direct sunlight?	–
Is the measuring device protected against overheating?	→ Page 23
Is the measuring device protected against excessive vibration?	→ Page 24, 96
Check gas conditions (e. g. purity, dryness, cleanliness)	–

4 Wiring

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

4.1 PROFIBUS cable specifications

4.1.1 PROFIBUS DP cable specification

Cable type

Two versions of the bus line are specified in IEC 61158. Cable type A can be used for all transmission rates up to 12 Mbit/s. Please refer to the table for the cable parameters:

Cable type A	
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	<30 pF/m
Core cross-section	>0.34 mm², corresponds to AWG 22
Cable type	Twisted in pairs, 1 x 2, 2 x 2 or 1 x 4 wire
Loop-resistance	≤110 Ω/km
Signal damping	Max. 9 dB over the entire length of the cable section
Shielding	Copper braided shielding or braided shielding and foil shielding

Bus structure

Note the following points:
- The maximum line length (segment length) depends on the transmission rate.
  For cable type A, the maximum line length (segment length) is as follows:

Transmission rate [kBit/s]	9.6 to 93.75	187.5	500	1500	300 to 12000
Line length [m]	1200	1000	400	200	100

- A maximum of 32 users are permitted per segment.
- Each segment is terminated at either end with a terminating resistor.
- The bus length or the number of users can be increased by introducing a repeater.
- The first and last segment can comprise max. 31 devices.
  The segments between the repeaters can comprise max. 30 stations.
- The maximum distance between two bus users can be calculated as follows:
  (NO_REP + 1) x segment length

  ✎ Note!
  NO_REP = maximum number of repeaters that may be switched in series depending on the repeater in question.

Example

In accordance with manufacturer specifications, 9 repeaters can be switched in series when using a standard line.
The maximum distance between two bus users at a transmission rate of 1.5 MBit/s can be calculated as follows: (9 + 1) x 200 m = 2000 m

Spurs

Note the following points:
- Length of spurs < 6.6 m (at max.1.5 MBit/s)
- No spurs should be used for transmission rates >1.5 MBit/s. The line between the connector and the bus driver is described as a spur. Experience has shown that you should proceed with caution when configuring spurs. For this reason, you cannot assume that the sum of all spurs at 1.5 MBit/s will be 6.6 m. This is affected greatly by the arrangement of the field devices. Therefore, we recommend that if possible, you do not use any spurs at transmission rates >1.5 MBit/s.
- If you cannot avoid using spurs, then they may not include any bus terminators.

Bus termination

It is important to terminate the RS485 line correctly at the start and end of the bus segment, since impedance mismatch results in reflections on the line which can cause faulty data transmission → Page 45.

Further information

General information and further notes regarding the wiring are contained in BA034S/04: "Guidelines for planning and commissioning, PROFIBUS DP/PA, field communication"

4.1.2 Shielding and grounding

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

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

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

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

4.2 Connecting the remote version

4.2.1 Connecting connecting cable for sensor/transmitter

Warning!
- Risk of electric shock. Switch off the power supply before opening the device.
  Do not install or wire the device while it is connected to the power supply.
  Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock. Connect the protective earth to the ground terminal on the housing before the power supply is applied.

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

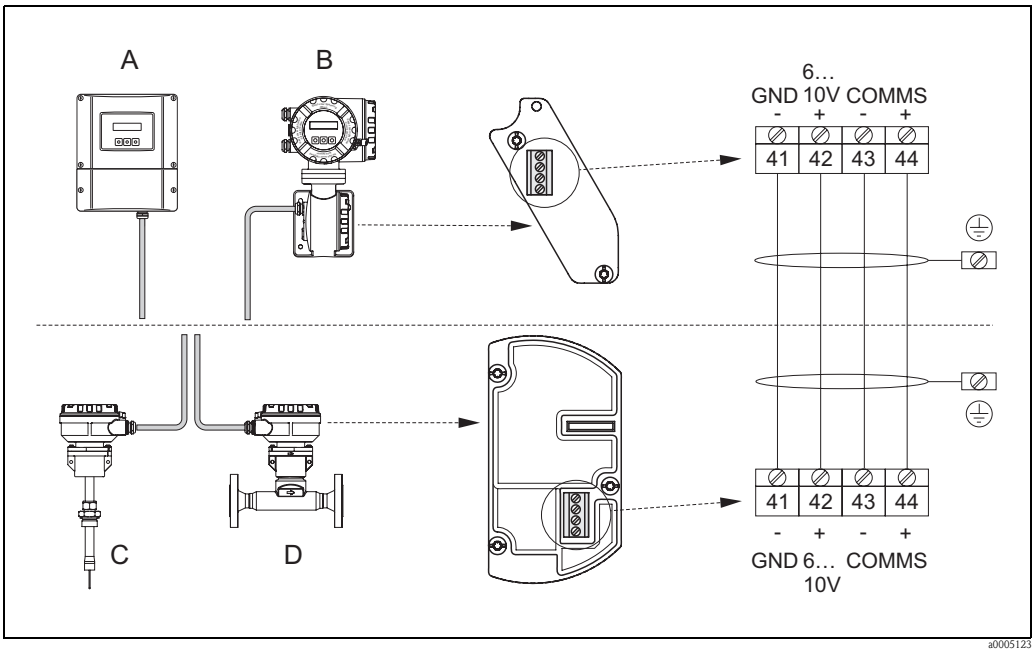


Fig. 21: Connecting the remote version

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

Wire colors (when supplied by Endress+Hauser):
Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow (color code according to DIN 47100)

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

4.2.2 Cable specification, connecting cable

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

- 2 x 2 x 0.5 mm² (AWG 20) PVC cable with common shield (2 twisted pairs)
- Conductor resistance: ≤ 40 Ω/km [≤ 131.2 Ω /1000 ft]
- Operating voltage: ≥ 250 V
- Temperature range: –40 to +105 °C [–40 to +221 °F]
- Overall nominal diameter: 8.5 mm [0.335"]
- Maximum cable length: 100 m [328 feet]

Note!
- The cable must be installed securely to prevent movement
- The cable should be of sufficient diameter to provide adequate sealing of the cable gland → Page 94.

4.3 Connecting the measuring unit

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

4.3.1 Terminal assignment

	Terminal No. (inputs/outputs)							
Order variant	**20 (+)**	**21 (–)**	**22 (+)**	**23 (–)**	**24 (+)**	**25 (–)**	**26 (+)**	**27 (–)**
65F**-**********J 65I-**********J	–		–		+5V power supply for external termination (optional)	DGND	B PROFIBUS DP A = RxD/TxD-N B = RxD/TxD-P	A

4.3.2 Transmitter connection

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

1. Unscrew the connection compartment cover from the transmitter housing.
2. Feed the power supply cable, the fieldbus cable and the power supply cable for external termination (optional) cable through the appropriate cable entries.
3. Perform wiring:
   – Wiring diagram → Page 33
   – Terminal assignment → see above

   Caution!
   – Risk of damage to the fieldbus cable!
     Observe the information about shielding and grounding the fieldbus cable → Page 30.
   – We recommend that the fieldbus cable not be looped using conventional cable glands. If you later replace even just one measuring device, the bus communication will have to be interrupted.
4. Screw the cover of the connection compartment back onto the transmitter housing.

4.3.3 PROFIBUS DP connection diagram

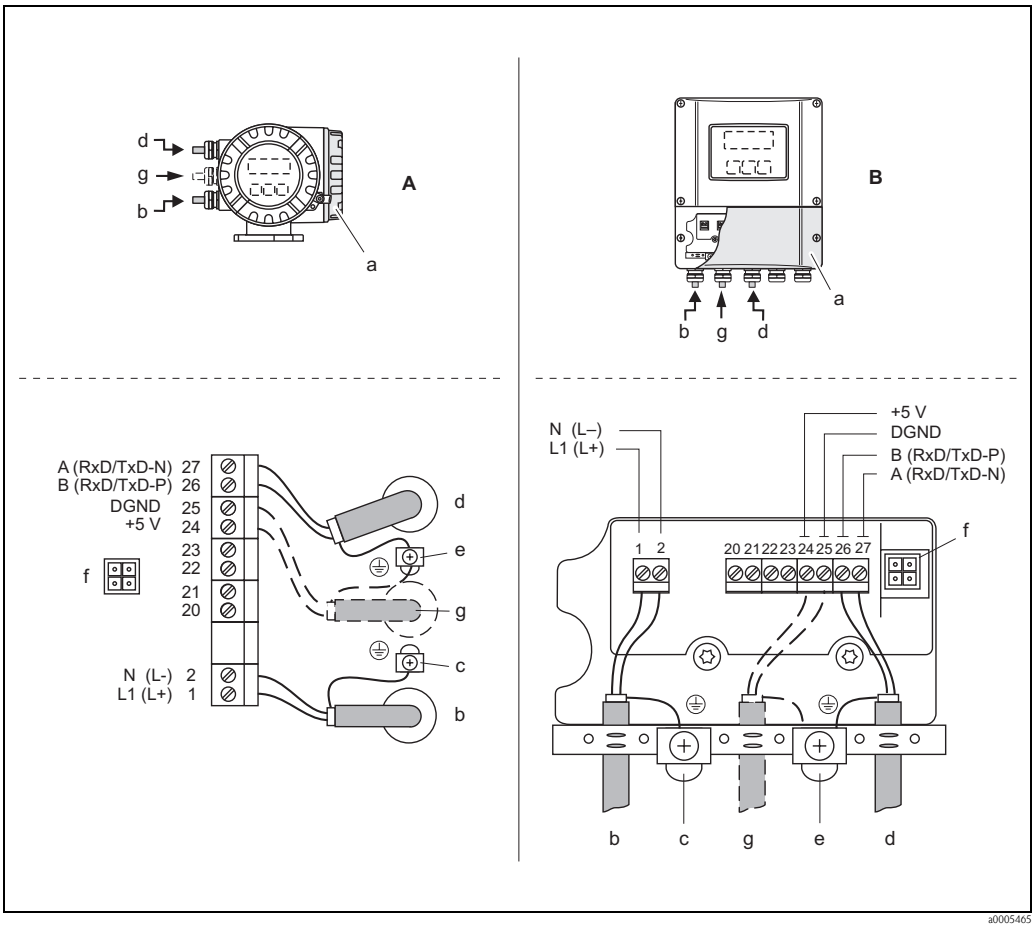


Fig. 22: Connecting the transmitter, cable cross-section: max. 2.5 mm² (AWG 13)

A Field housing
B Wall-mount housing

a Connection compartment cover
b Power supply cable: 85 to 260 V AC, 20 to 55 V AC,16 to 62 V DC
Terminal No. 1: L1 for AC, L+ for DC
Terminal No. 2: N for AC, L- for DC
c Ground terminal for protective earth
d Fieldbus cable:
Terminal No. 26: B (RxD/TxD-P)
Terminal No. 27: A (RxD/TxD-N)
e Ground terminal for fieldbus cable shield
Observe the following:
– the shielding and grounding of the fieldbus cable → Page 30
– that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible
f Service socket for connecting service interface FXA 193 (ToF Tool - Fieldtool Package or Fieldcheck)
g Power supply cable for external termination (optional):
Terminal No. 24: +5 V
Terminal No. 25: DGND

4.4 Degree of protection

The devices fulfill all the requirements for IP 67.

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

- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- All threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter, see Page 94 (Cable entry)
- Firmly tighten the cable entries.
- The cables must loop down before they enter the cable entries (“water trap”). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

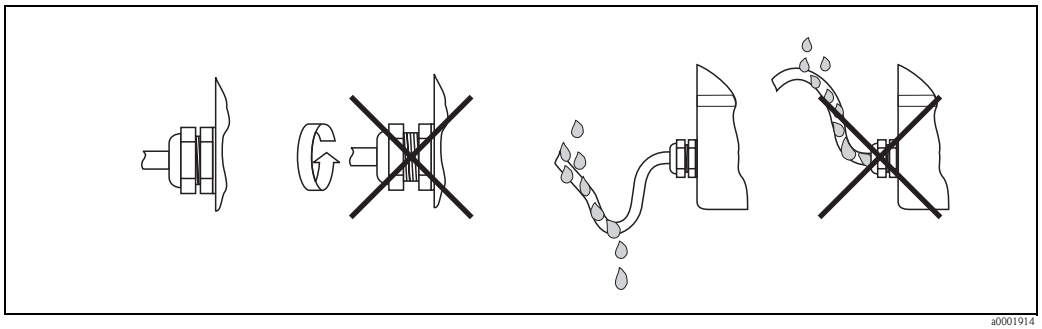


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Fig. 23: Installation instructions, cable entries

4.5 Post-connection check

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

Device condition and specifications	**Notes**
Are cables or the device damaged (visual inspection)?	-
Electrical connection	**Notes**
Does the supply voltage match the specifications on the nameplate?	85 to 260 V AC (45 to 65 Hz) 20 to 55 V AC (45 to 65 Hz) 16 to 62 V DC
Do the cables comply with the specifications?	PROFIBUS DP → Page 29 Connecting cable → Page 32
Do the cables have adequate strain relief?	-
Cables correctly segregated by type? Without loops and crossovers?	-
Are the power supply and fieldbus 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”?	→ Page 34
Are all housing covers installed and firmly tightened?	-
Electrical connection of PROFIBUS DP	**Notes**
Are all the connecting components (T-boxes, junction boxes, connectors, etc.) connected to each other correctly?	-
Has each fieldbus segment been terminated at both ends with a bus terminator?	→ Page 45
Has the max. length of the fieldbus cable been observed in accordance with the PROFIBUS specifications?	→ Page 29
Has the max. length of the spurs been observed in accordance with the PROFIBUS specifications?	→ Page 30
Is the fieldbus cable fully shielded and correctly grounded?	→ Page 30

5 Operation

5.1 Quick operation guide

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

1. **Local display (option)** → Page 37
   The local display enables you to read all important parameters directly at the measuring point, configure device parameters in the field and perform commissioning.
2. **Configuration programs** → Page 41
   The configuration of profile and device-specific parameters is primarily done via the PROFIBUS interface. You can obtain special configuration and operating programs from various manufacturers for these purposes.
3. **Jumpers/miniature switches for hardware settings**
   You can make the following hardware settings using a jumper or miniature switches on the I/O board:
   - Address mode configuration (select software or hardware addressing)
   - Device bus address configuration (for hardware addressing)
   - Hardware write protection enabling/disabling

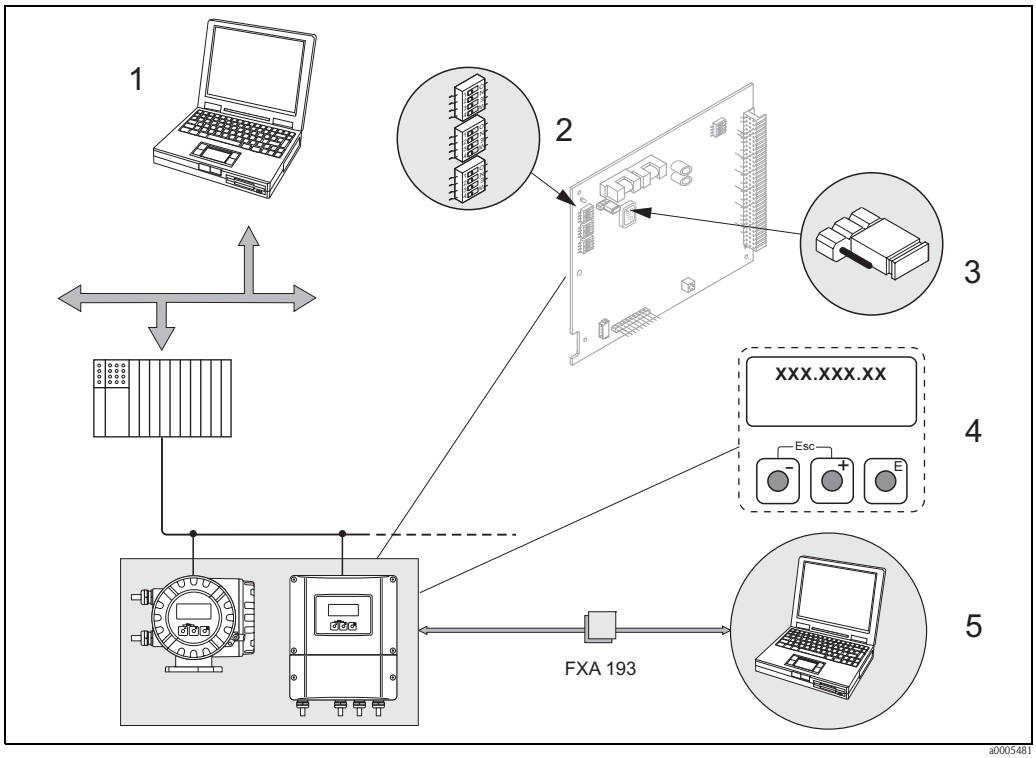


Fig. 24: Methods of operating PROFIBUS DP

1 Configuration/operating programs (e.g. FieldCare) for operation via PROFIBUS DP
2 Addressing the device address via miniature switches → Page 44
3 Setting the write protection via jumper → Page 43
4 Local display for device operation in the field (option)
5 Configuration/operating program for operating by means of the FXA 193 service interface (e.g. ToF Tool - Fieldtool Package)

5.2 Local display

5.2.1 Display and operating elements

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

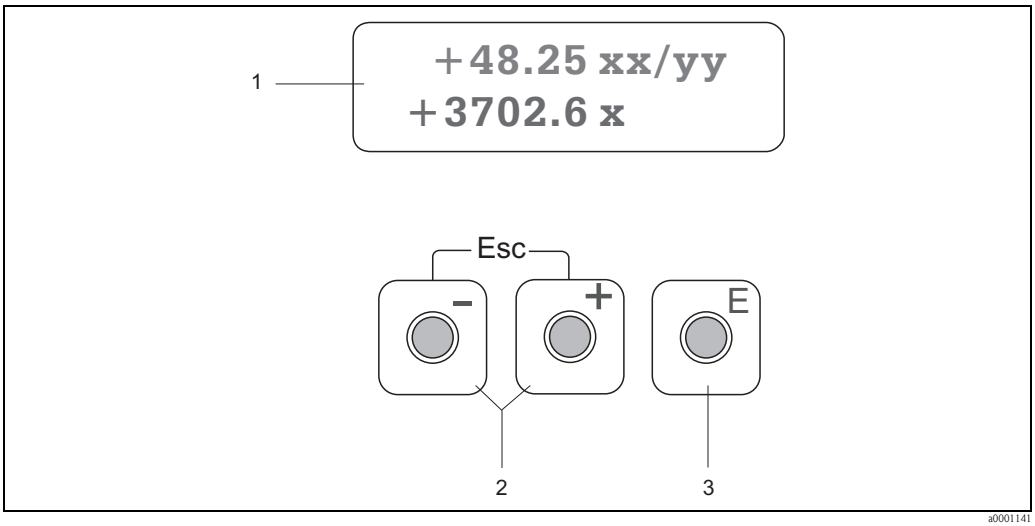


Fig. 25: Display and operating elements

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

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

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

5.2.2 Icons

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

Icons	Meaning
S	System error
!	Notice message
P	Process error
ϟ	Fault message
← →	Cyclic communication via PROFIBUS active, e.g. via PLC (Master Class 1) (alternating display ←/→)
	Acyclic communication via PROFIBUS active, e.g. via FieldCare (Master Class 2)

5.3 Brief operating instructions to the function matrix

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

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

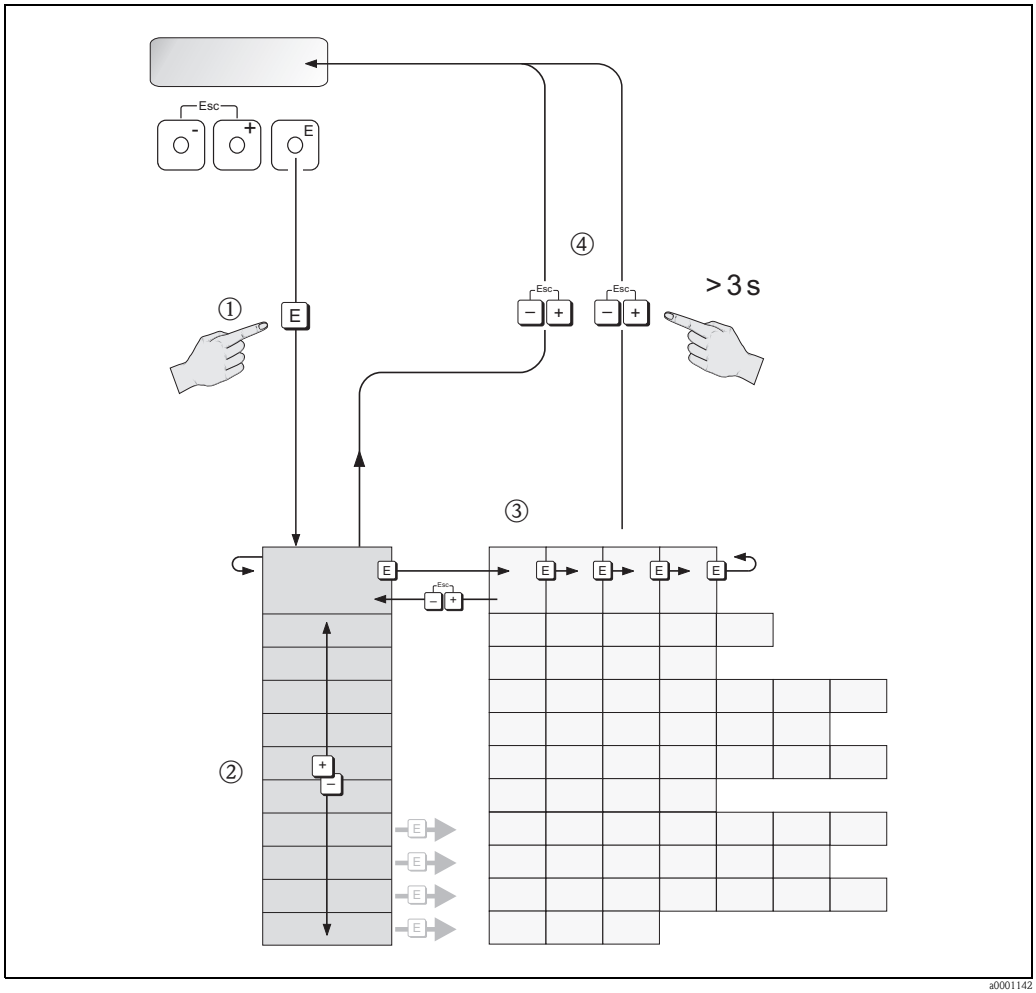


Fig. 26: Selecting functions and configuring parameters (function matrix)

5.3.1 General notes

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

Comply with the following instructions when configuring functions:
- You select functions as described already. → Page 37
- You can switch off certain functions (OFF). If you do so, related functions in other function groups will no longer be displayed.
- Certain functions prompt you to confirm your data entries. Press ▫ to select "SURE (YES)" and press E to confirm. This saves your setting or starts a function, as applicable.
- Return to the HOME position is automatic if no key is pressed for 5 minutes.
- Programming mode is disabled automatically if you do not press a key within 60 seconds following automatic return to the HOME position.

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

Note!
- The transmitter continues to measure while data entry is in progress, i.e. the current measured values are output via the signal outputs in the normal way.
- If the power supply fails all preset and parameterised values remain safely stored in the EEPROM.
- However, some functions may be affected (i. e. data/values not saved) if the power supply is interupted during editing or operation of those functions. More details are contained in the "Description of Device Functions" manual, BA114D/06/en/…

5.3.2 Enabling the programming mode

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

Comply with the following instructions when entering codes:
- If programming is disabled and the ▫ operating elements are pressed in any function, a prompt for the code automatically appears on the display.
- If "0" is entered as the customer's code, programming is always enabled.
- Your Endress+Hauser representative can be of assistance if you mislay your personal code.

Caution!
Changing certain parameters such as all sensor characteristics, for example, influences numerous functions of the entire measuring system, particularly measuring accuracy.
There is no need to change these parameters under normal circumstances and consequently, they are protected by a special code known only to the Endress+Hauser representative. Please contact Endress+Hauser if you have any questions.

5.3.3 Disabling the programming mode

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

5.4 Error messages

5.4.1 Type of error

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

The measuring system distinguishes between two types of error:
- *System error:* This group includes all device errors, e.g. communication errors, hardware errors, etc. → Page 73.
- *Process error:* This group includes all application errors, e.g. flow limit, etc. → Page 82.

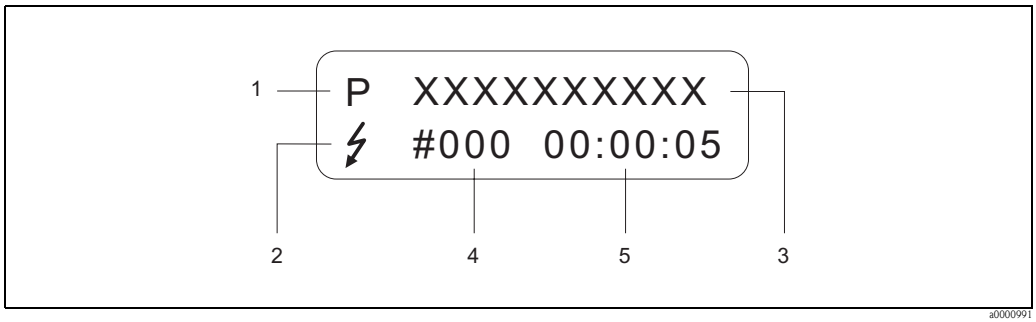


Fig. 27: Error messages on the display (example)

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

5.4.2 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. → Page 73 ff.
Serious system errors, e.g. module defects, are always identified and classed as "fault messages" by the measuring device.

Notice message (!)
- The error in question has no effect on the current operation.
- Displayed as → Exclamation mark (!), error type (S: system error, P: process error).
- Displaying the device status on PROFIBUS DP → Page 73 ff.

Fault message (ϟ)
- The error in question interrupts or stops the current operation.
- Displayed as → Lightening flash (ϟ), error type (S: system error, P: process error)
- Displaying the device status on PROFIBUS DP → Page 73 ff.

5.5 Operating options

For the complete operation of the measuring device, including device-specific parameters, there are device drivers available to the user to provide the following operating programs:

5.5.1 Operating program "ToF Tool - Fieldtool Package"

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

Contents of the "ToF Tool - Fieldtool Package":
- Commissioning, maintenance analysis
- Configuring flowmeters
- Service functions
- Visualization of process data
- Trouble-shooting
- Reading out the verification data and updating the software of the "Fieldcheck" flow simulator

5.5.2 Operating program "FieldCare"

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

5.5.3 Operating program "SIMATIC PDM" (Siemens)

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

5.5.4 Device drivers for operating programs

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

Valid for device software:	3.02.XX	→ Function “DEVICE SOFTWARE”
PROFIBUS DP device data:		
Profile Version:	3.0	→ Function “PROFILE VERSION”
t-mass 65 ID No.:	1545 (Hex)	→ Function “DEVICE ID”
Profile ID No.:	9740 (Hex)	
GSD file information:		
t-mass 65 GSD file:	Extended format (recommended): Standard format:	eh3x1545.gsd eh3_1545.gsd
	Note! When planning and configuring the PROFIBUS network, please observe the information on using GSD files → Page 54	
Bitmaps:	EH_1545_d.bmp/.dib EH_1545_n.bmp/.dib EH_1545_s.bmp/.dib	
Profile GSD file:	PA039740.gsd	
Software release:	12.2005	

Operating program/device driver:	Sources for obtaining device drivers/program updates:
t-mass 65 GSD file	■ www.endress.com (→ Download → Software → Device Drivers) ■ CD-ROM (Endress+Hauser order number: 56003894)
Profile GSD file	■ www.profibus.com
FieldCare/DTM	■ www.endress.com (→ Download → Software → Device Drivers) ■ CD-ROM (Endress+Hauser order number: 56004088)
SIMATIC PDM	■ www.endress.com (→ Download → Software → Device Drivers) ■ www.feldgeraete.de
ToF Tool - Fieldtool Package (operation via service protocol)	■ www.tof-fieldtool.endress.com ■ Update CD-ROM (Endress+Hauser order number: 50099820)

Tester/simulator:	
Device:	**How to acquire:**
Fieldcheck	■ Update by means of ToF Tool - Fieldtool Package via Fieldflash

Note!
The Fieldcheck tester/simulator is used for testing flowmeters in the field. When used in conjunction with the “ToF Tool - Fieldtool Package” software package, test results can be imported into a database, printed and used for official certification.

Contact your Endress+Hauser representative for more information.

5.6 PROFIBUS DP hardware settings

5.6.1 Configuring the write protection

A jumper on the I/O board provides the means of switching hardware write protection on or off. When the hardware write protection is switched on, it is **not** possible to write to the device parameters via PROFIBUS (acyclic data transmission, e.g. via operating program "FieldCare").

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

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

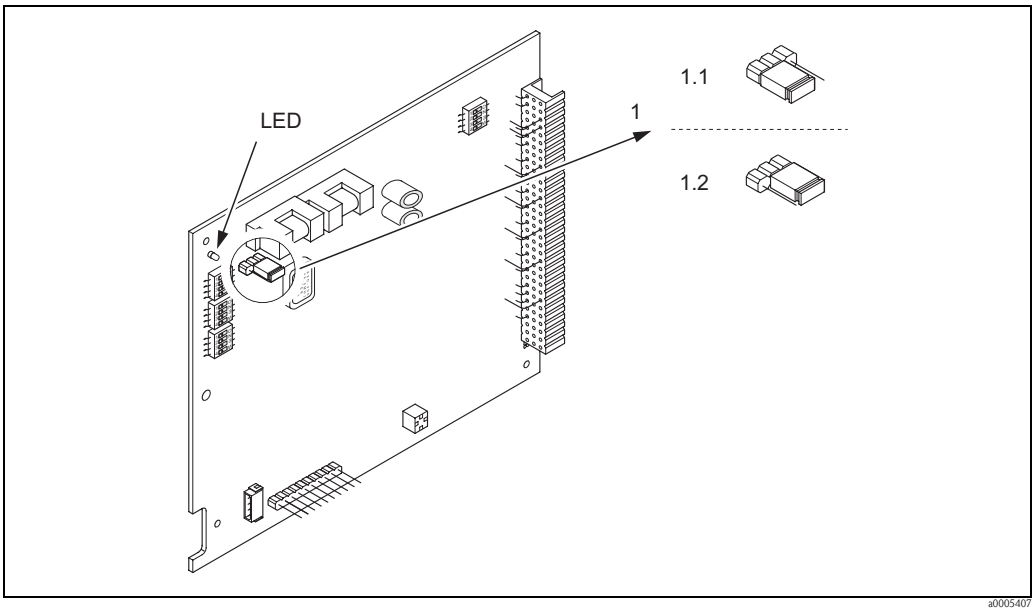


Fig. 28: Switching write protection on and off with the aid of a jumper on the I/O board

1 Jumper for switching write protection on and off
1.1 Write protection switched off (factory setting) = it is possible to write to the device parameters via PROFIBUS (acyclic data transmission, e.g. via operating program "FieldCare")
*1.2 Write protection switched on = it is **not** possible to write to the device parameters via PROFIBUS (acyclic data transmission, e.g. via operating program "FieldCare")*

LED Overview of LED status:
- *Lit continuously → Ready for operation*
- *Not lit → Not ready for operation*
- *Flashing → System or process error present → Page 72*

5.6.2 Configuring the device address

The address must always be configured for a PROFIBUS DP measuring device. The valid device addresses are in the range from 0 to 126. In a PROFIBUS DP network, each address can only be assigned once. If an address is not configured correctly, the device is not recognized by the master. All measuring devices are delivered from the factory with the address 126 and software addressing.

Addressing via local operation or operating program

Addressing takes place in the FIELDBUS ADDRESS function → see "Description of Device Functions" manual.

Addressing via miniature switches

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

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

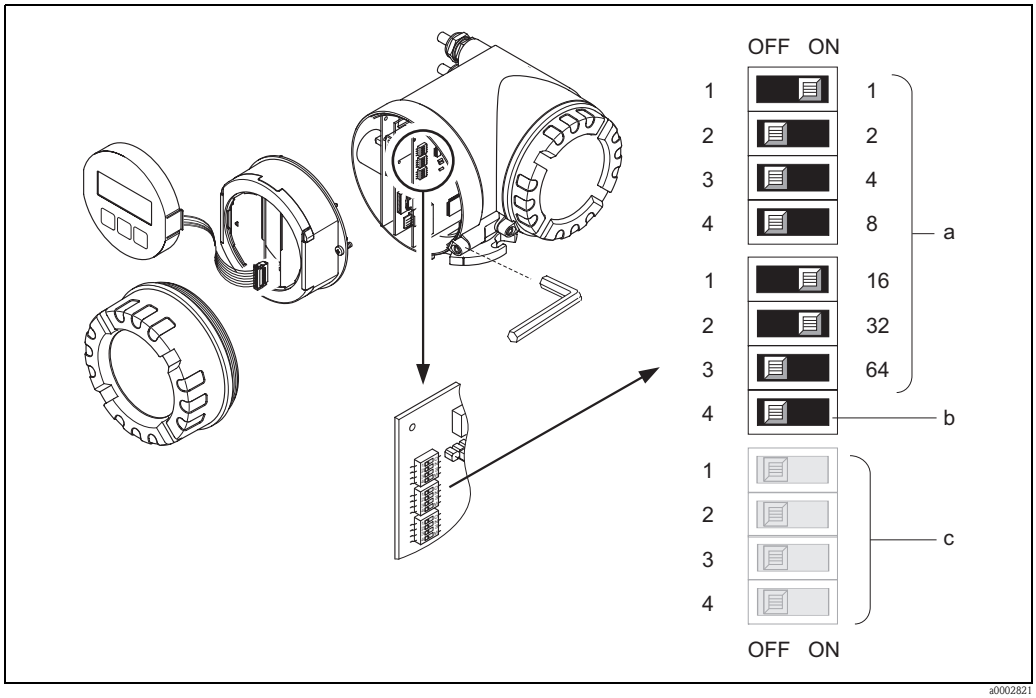


Fig. 29: Addressing with the aid of miniature switches on the I/O board

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

5.6.3 Configuring the terminating resistors

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

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

- For baudrates up to 1.5 MBaud, the termination is set via the terminating switch SW 1 for the last transmitter on the bus: ON – ON – ON – ON.
- The measuring device is operated with a baudrate >1.5 MBaud:
  Due to the capacitive load of the device and the line reflection generated as a result, make sure that external termination is used.

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

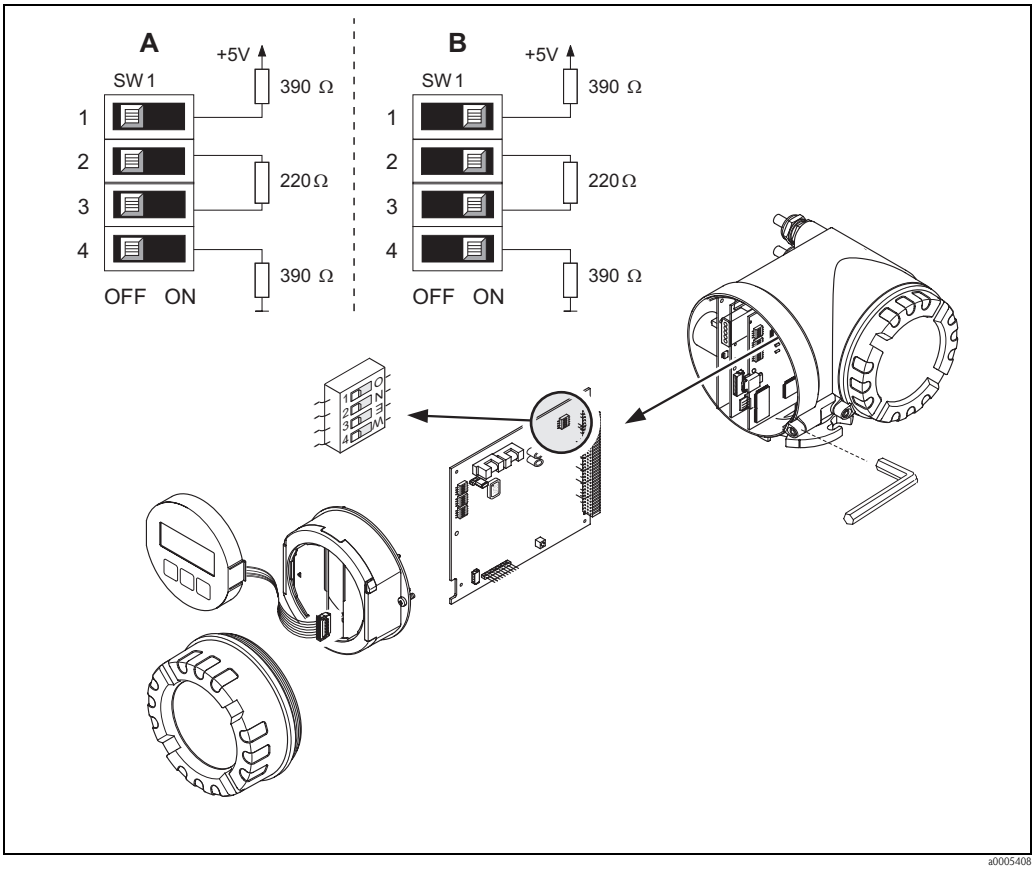


Fig. 30: Set terminating resistors (for baud rates < 1.5 MBaud)

A = Factory setting
B = Setting at the last transmitter

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

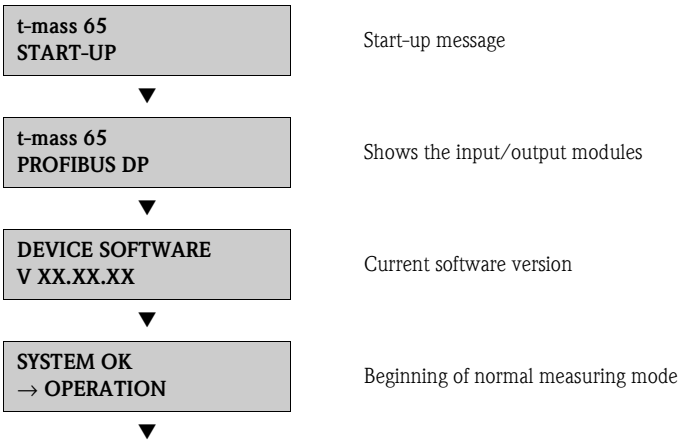
6 Commissioning

6.1 Function check

Make sure that all final checks have been completed before you start up your measuring point:
- Checklist for "Post-installation check" → Page 28
- Checklist for "Post-connection check" → Page 35

6.2 Switching on the measuring device

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



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

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

6.3 Quick Setup

6.3.1 Quick Setup "Commissioning"

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

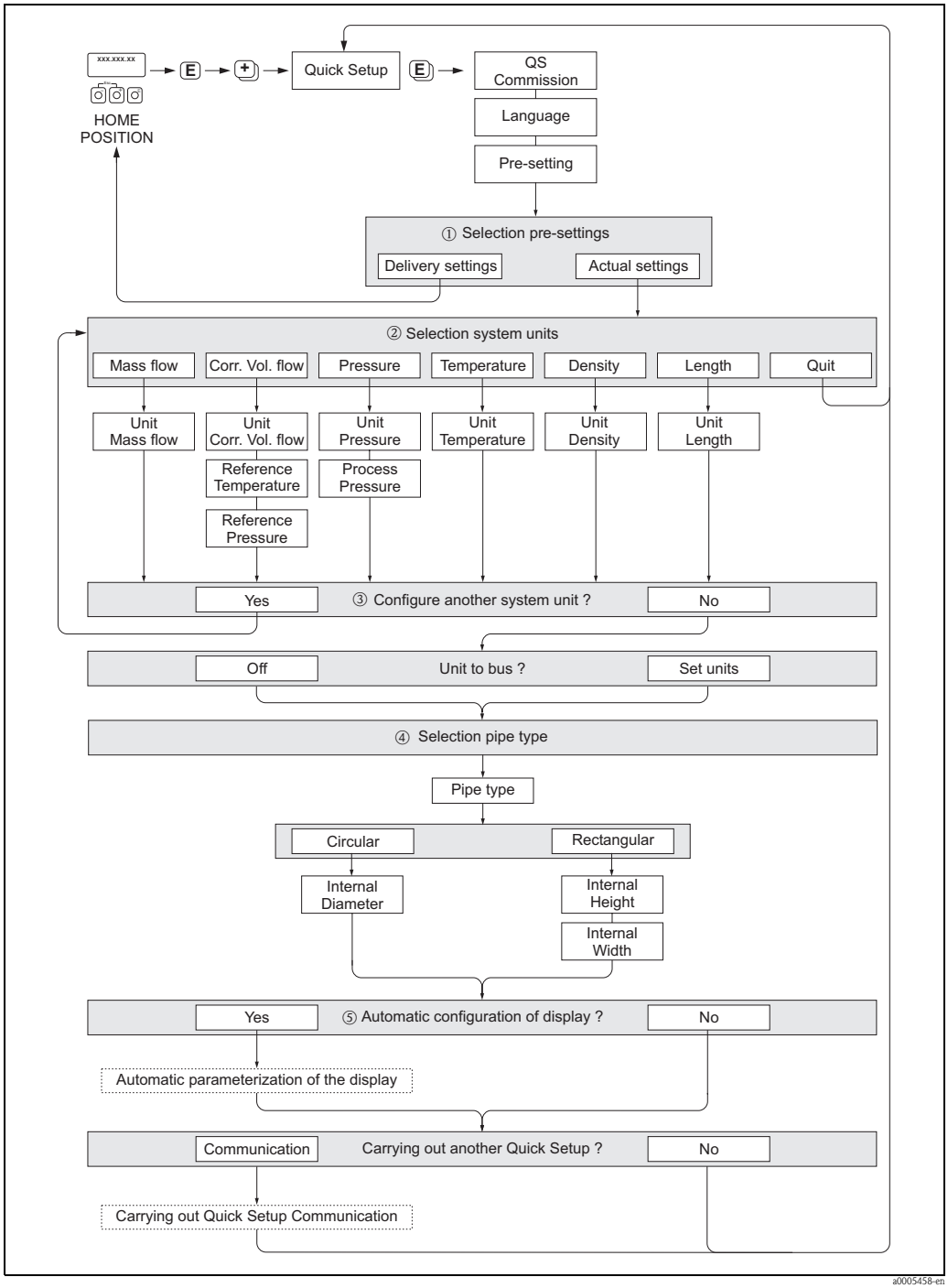


Fig. 31: Quick Setup Commissioning

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

QUICK SETUP - COMMISSION

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

LANGUAGE

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

PRE-SETTING

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

SYSTEM UNITS

Select required system unit function and carry out parameterization or select QUIT to return to the QUICK SETUP function if no further programming is required.
- ② Only units not yet configured in the current setup are available for selection in each cycle.
- ③ The "YES" option remains visible until all the units have been configured.
  "NO" is the only option displayed when no further units are available.

PIPE TYPE

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

Automatic configuration of the display

⑤ The "automatic parameterization of the display" option contains the following basic settings/factory settings.
- YES: main line = MASS FLOW, additional line = TOTALIZER 1.
- NO: The existing (selected) settings remain.

The Quick Setup is now complete.

Note!
- The PIPE TYPE function is only available if an insertion type sensor is in use.
- For more information, see function group SENSOR DATA (see "Description of Device Functions" manual, BA114D/06/…).
- The gas process pressure must be entered for all device types in the function PROCESS PRESSURE, except in case of a remote pressure input being used.
  For more information, see function group PROCESS PARAMETERS (see "Description of Device Functions" manual, BA114D/06/…).

① – ⑤: see previous page

6.3.2 Quick Setup "Communication"

To establish cyclic data transfer, various arrangements between the PROFIBUS Master (class 1) and the slave are required which have to be taken into consideration when configuring various functions. These functions can be configured quickly and easily by means of the Communication Quick Setup.

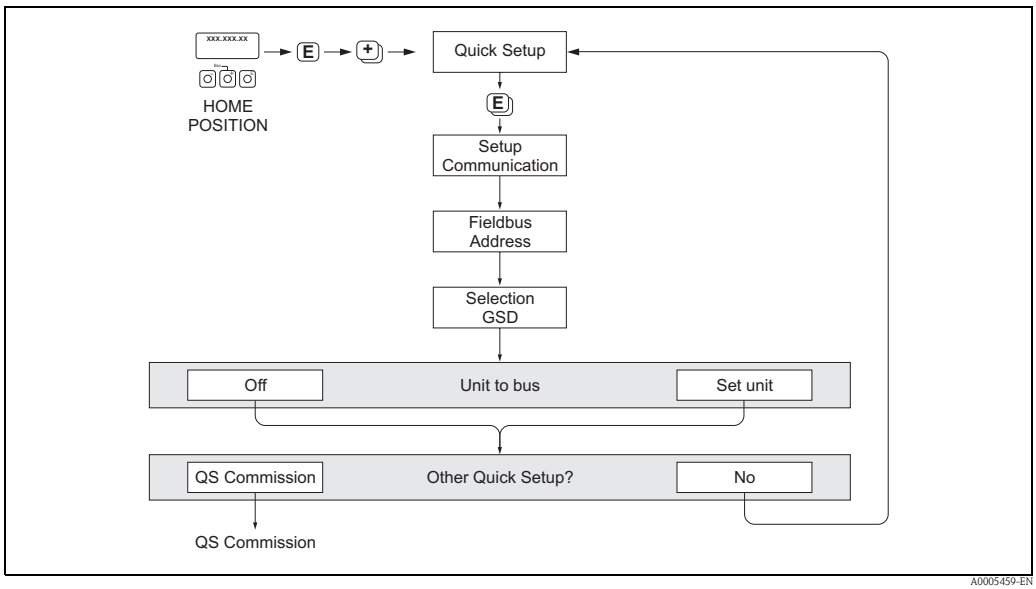


Fig. 32: Quick Setup Communication

QUICK SETUP - COMMUNICATION

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

FIELDBUS ADDRESS

Use the + or − key to enter the device address (0...126) and continue with E.

SELECTION GSD

Use the + or − key to select the operating mode (GSD file) which should be used for cyclic communication with the PROFIBUS Master (class 1) and continue with E.

- MANUFACT. SPEC. (factory setting): The measuring device is operated with complete device functionality.
- PROFILE-GSD The measuring device is operated in the PROFIBUS Profile mode.

Note!
For PROFIBUS network configuration, make sure that the right device master file (GSD file) of the measuring device is used for the selected operating mode. → page 54

UNIT TO BUS

If this function is executed, the measured variables (AI modules) transmitted cyclically are transmitted to the PROFIBUS Master (class 1) with the system unit configured in the measuring device.

Other Quick Setup?

To execute the Quick Setup Commission or back to the Quick Setup function group.

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

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

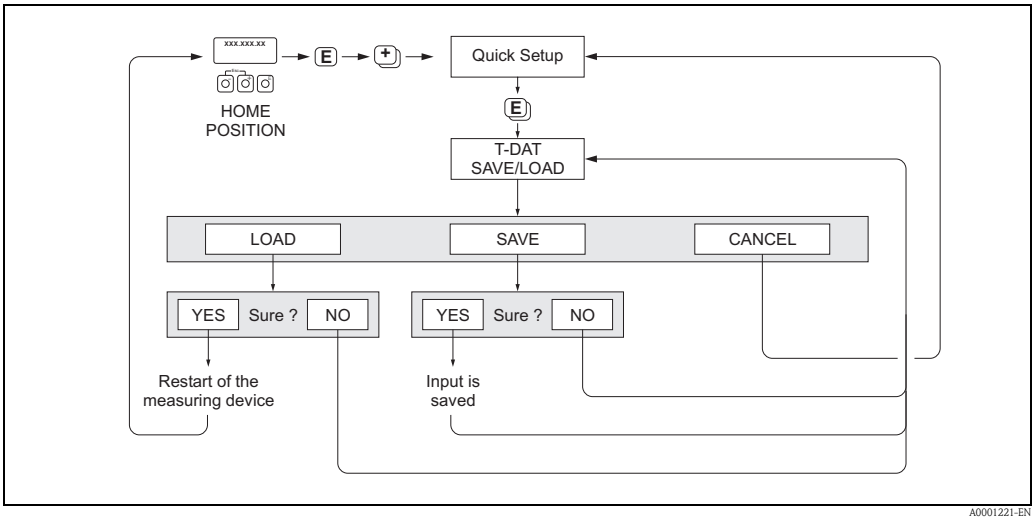


Fig. 33: Data back-up with T-DAT SAVE/LOAD function

Accessing T-DAT function

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

Application examples

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

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

6.4 Commissioning the PROFIBUS interface

Note!
- All functions required for commissioning are described in detail in the "Description of Device Functions" manual which is a separate part of this Operating Manual.
- A code (factory setting: 65) must be entered to change device functions, numerical values or factory settings → Page 39.

6.4.1 PROFIBUS DP commissioning

The following steps must be carried out in the sequence specified:

1. **Check the hardware write protection:**
   The WRITE PROTECT parameter indicates whether it is possible to write to the device parameters via PROFIBUS (acyclic data transmission, e.g. via operating program "FieldCare").

   Note!
   This check is not needed if operating via the local display.

   COMMUNICATION → WRITE PROTECT → Display of one of the following options:
   – OFF (factory setting) = write access via PROFIBUS possible
   – ON = write access via PROFIBUS not possible

   Deactivate the write protection if necessary → Page 43

2. **Enter the tag name (optional):**
   COMMUNICATION → TAG NAME

3. **Configuring the fieldbus address:**
   - Software addressing using the local display or operating program:
     COMMUNICATION → FIELDBUS ADDRESS
   - Hardware addressing via miniature switches → Page 44

4. **Select the system unit:**
   a. Determine the units by means of the system units group:
      SYSTEM UNITS → UNIT MASS FLOW / UNIT CORR. VOLUME FLOW/ UNIT...
   b. In the function UNIT TO BUS, select the option SET UNITS, so that the measured variables transmitted cyclically to the PROFIBUS Master (class 1) are transmitted with the system units set in the measuring device: COMMUNICATION → UNIT TO BUS

   Note!
   – The configuration of the system units for the totalizer is described separately → see step 6.
   – If the system unit of a measured variable is changed by means of the local operation or an operating program, this initially does not have any effect on the unit that is used to transmit the measured variable to the PROFIBUS Master (class 1). Changed system units of the measured variables are not transmitted to the PROFIBUS Master (class 1) until the SET UNITS option is activated in the function COMMUNICATION → UNIT TO BUS.

5. **Configuration of the Analog Input function blocks 1 to 3:**
The measuring device has three Analog Input function block (AI modules), through which the various measured variables can be cyclically transmitted to the PROFIBUS Master (class 1). The assignment of a measured variable to the Analog Input function block is shown below using the example of Analog Input function block 1 (AI module, slot 1).

Using the CHANNEL function, you can determine the measured variable (e.g. mass flow) to be cyclically transmitted to the PROFIBUS Master (class 1):

a. Select COMMUNICATION → BLOCK SELECTION
b. Select the option AI1 - OUT VALUE
c. Select the function CHANNEL
d. Select the option MASS FLOW

Possible setting

Measured variable	ID for CHANNEL function
MASS FLOW (factory setting AI function block 1)	277
CORR. VOLUME FLOW (factory setting AI function block 2)	398
TEMPERATURE (factory setting AI function block 3)	285
✎ Note! If, when the PROFIBUS network configuration, the module "AI" was integrated in slot 1, 2 or 3, the measured variable selected in the CHANNEL function is transmitted cyclically to the PROFIBUS Master (class 1) for the respective Analog Input function block 1 to 3 (→ Page 59).	

6. **Configuration of totalizers 1 to 2:**
The measuring device has two totalizers. The following example describes the configuration of the totalizer using totalizer 1 as an example.
Using the CHANNEL function, you can determine the measured variable (e.g. totalized mass flow) to be cyclically transmitted to the PROFIBUS Master (class 1) as a totalizer value:

a. Select TOTALIZER → SELECT TOTALIZER
b. Select the option TOTALIZER 1
c. Go to the function CHANNEL
d. Select the option MASS FLOW

Possible setting

Totalizer value / measured variable	ID for CHANNEL function
MASS FLOW (factory setting totalizer 1 to 2)	277
CORR. VOLUME FLOW	398
OFF	0
✎ Note! If, when the PROFIBUS network configuration, the module or the function "TOTAL" was integrated in slot 4 or 5, the measured variable selected in the CHANNEL function is transmitted cyclically to the PROFIBUS Master (class 1) for the respective totalizer 1 to 2 (→ Page 59).	

- Enter the desired unit for the totalizer: TOTALIZER → UNIT TOTALIZER
- Configure totalizer status (e.g. totalize): TOTALIZER → SET TOTALIZER → Option: TOTALIZE
- Set the totalizer mode: TOTALIZER → MODE TOTALIZER: Select one of the following options:
  – BALANCE (factory setting): calculates the positive and negative flow portions.
  – POSITIVE: calculates the positive flow portions.
  – NEGATIVE: calculates the positive flow portions.
  – HOLD VALUE: The totalizer remains at the last value.

✎ Note!
The device can't calculate negative flow portions.

7. **Select the operating mode:**
Select the operating mode (GSD file) which should be used for cyclic data transmission with the PROFIBUS Master.

COMMUNICATION → SELECTION GSD → Selection of one of the following options:
– MANUFACT. SPEC. (factory setting): the complete device functionality is available.
– PROFILE-GSD: The device is operated in the PROFIBUS Profile mode.

✎ Note!
For PROFIBUS network configuration, make sure that the right device master file (GSD file) of the measuring device is used for the selected operating mode → Page 54 ff.

8. **Configuration of cyclic data transmission in the PROFIBUS master:**
A detailed description of the cyclic data transmission is contained on → Page 57 ff.

6.5 PROFIBUS DP system integration

6.5.1 Device master file (GSD file)

For PROFIBUS network configuration, the device master file (GSD file) is needed for every bus participant (PROFIBUS slave). The GSD file contains a description of the properties of a PROFIBUS device, such as supported data transmission rate and number of input and output data.
Before configuration takes place, a decision should be made as to which GSD file should be used to operate the measuring device in the PROFIBUS DP Master (class 1) system.

The measuring device supports the following GSD files:
- t-mass GSD file (manufacturer-specific GSD file, complete device functionality)
- PROFIBUS Profile GSD file:

Below you will find a detailed description of the GSD files supported.

t-mass GSD file (manufacturer-specific GSD file, complete device functionality)

Use this GSD file to access the complete functionality of the measuring device. In this way, device-specific measured variables and functions are thus completely available in the PROFIBUS master system. An overview of the modules available (input and output data) is contained on Page 57 ff.

GSD file with standard or extended format

The GSD file with either the standard or the extended format must be used depending on the PROFIBUS Master used. When installing the GSD file, the GSD file with the extended format (EH3**x**15xx.gsd) should always be used first.
However, if the installation or the configuration of the measuring device fails with this format, then use the standard GSD (EH3_15xx.gsd). This differentiation is the result of different implementation of the GSD formats in the master systems. Note the specifications of the PROFIBUS Master.

Name of the t-mass GSD file

	ID No.	GSD file		Bitmaps
PROFIBUS DP	1545 (Hex)	Extended Format (recommended): Standard Format:	EH3x1545.gsd EH3_1545.gsd	EH_1545_d.bmp/.dib EH_1545_n.bmp/.dib EH_1545_s.bmp/.dib

Source

- Internet (Endress+Hauser) → www.endress.com (→ Download → Software → Device Drivers)
- CD-ROM with all GSD files for Endress+Hauser devices → Order No.: 56003894

Contents of the download file from the Internet and the CD-ROM

- All Endress+Hauser GSD files (standard and extended format)
- Endress+Hauser bitmap files
- Useful information relating to the devices

PROFIBUS Profile GSD file:

The function scope of the profile GSD file is defined by the PROFIBUS Profile Specification 3.0. The function scope is restricted compared to the manufacturer-specific GSD file (complete device functionality). However, similar devices from different manufacturers can be interchanged with the profile GSD file without the need to reconfigure (interchangeability).

The following modules are supported with the Profile GSD file:

- "AI Flow" module → Analog Input function block 1/output variable: mass flow
- "Totalizer" module → Totalizer function block 1/output variable: totalized mass flow

Name of the PROFIBUS Profile GSD file

	ID No.	Profile GSD file
PROFIBUS DP	9740 (Hex)	PA039740.gsd

Source

Internet (GSD library of the PROFIBUS User Organization) → www.PROFIBUS.com

6.5.2 Selection of the GSD file in the measuring device

Depending on which GSD file is used in the PROFIBUS Master (class 1) system, the corresponding GSD file has to be configured in the device by means of the COMMUNICATION → SELECTION GSD function.

- t-mass GSD file → Select: MANUFACT. SPEC. (factory setting)
- PROFIBUS Profile GSD file → Select: PROFILE-GSD

Example

Before configuration takes place, a decision should be made as to which GSD file should be used to configure the measuring device in the PROFIBUS master system. Below, the use of the manufacturer-specific GSD file (complete device functionality) is shown as an example:

Select the manufacturer-specific GSD file in the measuring device by means of the SELECTION GSD function.

COMMUNICATION → SELECTION GSD → Selection: MANUFACT. SPEC. (factory setting)

1. Before configuring the network, load the corresponding GSD file into the configuration system/master system.

   ✎ Note!
   When installing the GSD file, always first use the GSD file with the extended format (EH3x1545.gsd). However, if the installation or the configuration of the device fails with this format, then use the standard GSD (EH3_1545.gsd).

   E.g. for the configuration software Siemens STEP 7 of the Siemens PLC family S7-300/400: Use the GSD file with the extended format (EH3x1545.gsd). Copy the file to the subdirectory "...siemens\step7\s7data\gsd". The GSD files also include bitmap files. These bitmap files are used to display the measuring points in image form. The bitmap files must be saved to the directory "...siemens\step7\s7data\nsbmp".

   If you are using PROFIBUS Master other than that referred to above, ask your PROFIBUS Master system manufacturer which directory you should use.

2. The measuring device is a modular PROFIBUS slave, i.e. the desired module configuration (input and output data) must be performed in the next step. This can be done directly by means of the configuration software. An overview of the modules available is contained on Page 57 ff.

6.5.3 Maximum number of writes

If a non-volatile device parameter is modified via the cyclic or acyclic data transmission, this change is saved in the EEPROM of the measuring device. The number of writes to the EEPROM is technically restricted to a maximum of 1 million. Attention must be paid to this limit since, if exceeded, it results in data loss and measuring device failure. For this reason, avoid constantly writing non-volatile device parameters via the PROFIBUS!

6.6 PROFIBUS DP cyclic data transmission

Below is a description of the cyclic data transmission when using the t-mass GSD file (complete device functionality).

6.6.1 Block model

The block model illustrated shows which input and output data the measuring device provides for cyclic data transmission via PROFIBUS DP.

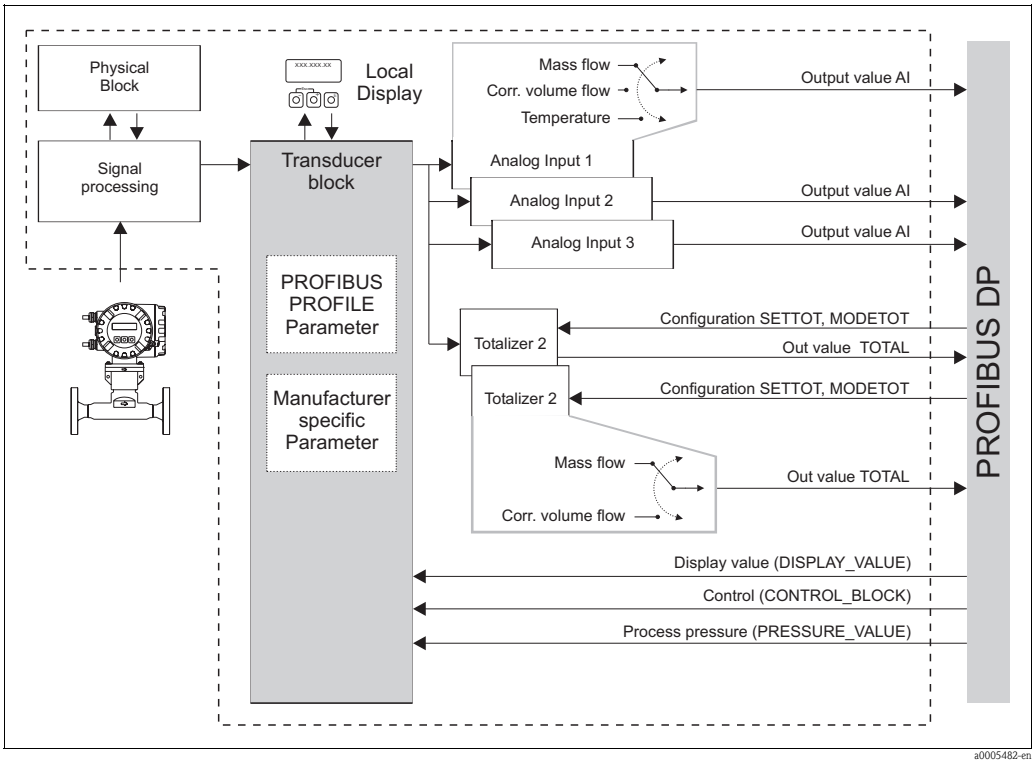


Fig. 34: Block model for t-mass PROFIBUS DP Profile 3.0

6.6.2 Modules for cyclic data transmission

The measuring device is a so-called modular PROFIBUS slave. In contrast to a compact slave, the structure of a modular slave is variable – it consists of several individual modules. In the GSD file, the individual modules (input and output data) are described with their individual properties. The modules are permanently assigned to the slots, i.e. the sequence or arrangement of the modules must be observed when configuring the modules (see following table). Gaps between configured modules have to be assigned the EMPTY_MODULE module.

To optimize the data throughput rate of the PROFIBUS network, it is recommended to only configure modules that are processed in the PROFIBUS master system.

It is essential to adhere to the following sequence/assignment when configuring the modules in the PROFIBUS master system:

Slot sequence	Module	Description
1	AI	**Analog Input function block 1** Output variable → Mass flow (factory setting)
2	AI	**Analog Input function block 2** Output variable → Corrected volume flow (factory setting)
3	AI	**Analog Input function block 3** Output variable → Temperature (factory setting)
4	TOTAL or SETTOT_TOTAL or SETTOT_MODETOT_TOTAL	**Totalizer function block 1** TOTAL → output variable = totalized mass flow (factory setting) SETTOT → totalizer control MODETOT → totalizer configuration
5	TOTAL or SETTOT_TOTAL or SETTOT_MODETOT_TOTAL	**Totalizer function block 2** TOTAL → output variable = totalized mass flow (factory setting) SETTOT → totalizer control MODETOT → totalizer configuration
6	DISPLAY_VALUE	Value for local display
7	CONTROL_BLOCK	Control of device functions
8	PRESSURE_VALUE	Process pressure

Note!

- The assignment of the measured variables for the Analog Input function blocks (1 to 3) and the totalizer function blocks (1 to 2) can be changed by means of the CHANNEL function.
  A detailed description of the individual modules is contained in the following section.
- The device has to be reset once a new configuration has been loaded to the automation system.
  This can be effected as follows:
  – By means of the local display
  – By means of an operating program (e.g. FieldCare)
  – By switching the supply voltage off and on again.

6.6.3 Description of the modules

AI (Analog Input) module

The AI module (slots 1...3) cyclically transmits the corresponding measured variable, including the status, to the PROFIBUS Master (class 1). The measured variable is represented in the first four bytes in the form of floating point numbers in accordance with the IEEE 754 standard. The fifth byte contains standardized status information corresponding to the measured variable. Further information on the device status → Page 73.

Input data

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
measured variable (IEEE 754 floating point number)				Status

Assignment of the measured variables to the AI module

The AI module can transmit different measured variables to the PROFIBUS Master (class 1).

The measured variables are assigned to the Analog Input function blocks 1 to 3 by means of the local display or with the aid of an operating program (e.g. FieldCare) in the CHANNEL function:
- COMMUNICATION → BLOCK SELECTION: Selection of an Analog Input function block
- COMMUNICATION → CHANNEL: Selection of a measured variable

Possible settings

Measured variable	ID for CHANNEL function
MASS FLOW	277
CORR. VOLUME FLOW	398
TEMPERATURE	285

Factory setting

Module	Analog Input function block	Measured variable	ID for CHANNEL function
AI (slot 1)	1	MASS FLOW	277
AI (slot 2)	2	CORR. VOLUME FLOW	398
AI (slot 3)	3	TEMPERATURE	285

TOTAL module

The measuring device has three totalizer function blocks. The totalizer values can be cyclically transmitted to the PROFIBUS Master (class 1) via the TOTAL module (slots 4 to 5). The totalizer value is represented in the first four bytes in the form of a floating point number in accordance with the IEEE 754 standard. The fifth byte contains standardized status information corresponding to the totalizer value. Further information on the device status → Page 73.

Input data

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Totalizer value (IEEE 754 floating point number)				Status

Assignment of the measured variables to the TOTAL module

The TOTAL module can transmit different totalizer variables to the PROFIBUS Master (class 1).

The measured variables are assigned to the totalizer function blocks 1 to 2 by means of the local display or with the aid of an operating program (e.g. FieldCare) in the CHANNEL function:
- TOTALIZER → SELECT TOTALIZER: Selection of a totalizer
- COMMUNICATION → CHANNEL: Selection of measured variable

Possible settings

Totalizer value/measured variable	ID for CHANNEL function
MASS FLOW	277
CORR. VOLUME FLOW	398
OFF	0

Factory setting

Module	Totalizer function block	Totalizer value/ Measured variable	ID for CHANNEL function
TOTAL (slot 4)	1	MASS FLOW	277
TOTAL (slot 5)	2	MASS FLOW	277

SETTOT_TOTAL module

The module combination SETTOT_TOTAL (slots 4 to 5) consists of the functions SETTOT and TOTAL. With this module combination:
- The totalizer can be controlled via the PROFIBUS Master (SETTOT).
- The totalizer value, is transmitted, including the status (TOTAL).

SETTOT function

In the SETTOT function, the totalizer can be controlled via control variables.
The following control variables are supported:
- 0 = Totalize (factory setting)
- 1 = Reset totalizer (the totalizer value is reset to 0)
- 2 = Accept totalizer preset

Note!
After the totalizer value has been reset to 0 or set to the preset value, the totalizing continues automatically. The control variable does not have to be changed to 0 again to restart totalizing. Stopping totalizing is controlled in the SETTOT_MODETOT_TOTAL module via the MODETOT function. → Page 61

TOTAL function

For a description of the TOTAL function, refer to TOTAL module → Page 59

Data structure of the SETTOT_TOTAL module combination

Output data

SETTOT
Byte 1
Control

Input data

TOTAL				
Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Totalizer value (IEEE 754 floating point number)				Status

SETTOT_MODETOT_TOTAL module

The module combination SETTOT_MODETOT_TOTAL (slots 4 to 5) consists of the functions SETTOT, MODETOT and TOTAL.
With this module combination:
- The totalizer can be controlled via the PROFIBUS Master (SETTOT).
- The totalizer can be configured via the PROFIBUS Master (MODETOT).
- The totalizer value, is transmitted, including the status (TOTAL).

SETTOT function

For a description of the SETTOT function, refer to SETTOT_TOTAL module → Page 60

MODETOT function

In the MODETOT function, the totalizer can be configured via control variables.
The following settings are possible:
- 0 = Balance (factory setting), calculates the positive and negative flow portions
- 1 = calculates the positive flow portions
- 2 = calculates the negative flow portions
- 3 = Totalizing is stopped

Note!
The device can't calculate negative flow portions.

TOTAL function

For a description of the TOTAL function, refer to TOTAL module → Page 59

Data structure of the SETTOT_MODETOT_TOTAL module combination

Output data

SETTOT	MODETOT
Byte 1	Byte 2
Control	Configuration

Input data

TOTAL				
Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Totalizer value (IEEE 754 floating point number)				Status

Example of using the SETTOT_MODETOT_TOTAL module

If the SETTOT function is set to 1 (= reset the totalizer), the value for the aggregated total is reset to 0. If the aggregated total of the totalizer should constantly retain the value 0, the MODETOT function must first be set to 3 (= totalizing is stopped) and then the SETTOT function must be set to 1 (= reset the totalizer).

DISPLAY_VALUE module

Any value (IEEE 754 floating point number), including status, can be cyclically transmitted via the PROFIBUS Master (class 1) directly to the local display using the DISPLAY_VALUE module (slot 6). Display value assignment to line 1 or line 2 can be configured via the local display itself or an operating program (e.g. FieldCare).

Output data

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Display value (IEEE 754 floating point number)				Status

Status

The status is not evaluated by the device.

CONTROL_BLOCK module

By means of the CONTROL_BLOCK module (slot 7), the measuring device is able to process device-specific control variables from the PROFIBUS Master (class 1) in cyclic data transmission (e.g. switching on positive zero return).

Supported control variables of the CONTROL_BLOCK module

The following device-specific control variables can be activated by changing the output byte from 0 → x:

Module	Control variables
CONTROL_BLOCK	0 → 2: Positive zero return ON 0 → 3: Positive zero return OFF 0 → 4: Carrying out the zero point adjustment 0 → 24: Run UNIT TO BUS function

Note!
The control (e.g. switching on positive zero return) is executed by cyclic data transmission if the output byte switches from “0” to the bit pattern in question. The output byte must always switch from “0”. A switchback to “0” does not have any effect.

Example (change the output byte)

From	→	To	Result
0	→	2	Positive zero return is switched on.
2	→	0	No effect.
0	→	3	Positive zero return is switched off.
3	→	2	No effect.

Output data

Byte 1
Control

PRESSURE_VALUE module

The process pressure value (IEEE 754 floating point number), including status, can be cyclically transmitted via the PROFIBUS Master (class 1) directly to the measuring device using the PRESSURE_VALUE module (slot 8).
The process pressure value is used to compensate for large variations in process pressure, e.g. Ammonid gas applications. The unit pressure selected in the measuring device is used.
More details to the PROCESS PRESSURE function are contained in the "Description of Device Functions" manual, BA114D/06/en/… .

Caution!
The process pressure is a non-volatile device parameter. A constant overwriting of this non-volatile device parameter via the PROFIBUS is to be avoided → Page 56.

Output data

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Process pressure (IEEE 754 floating point number)				Status

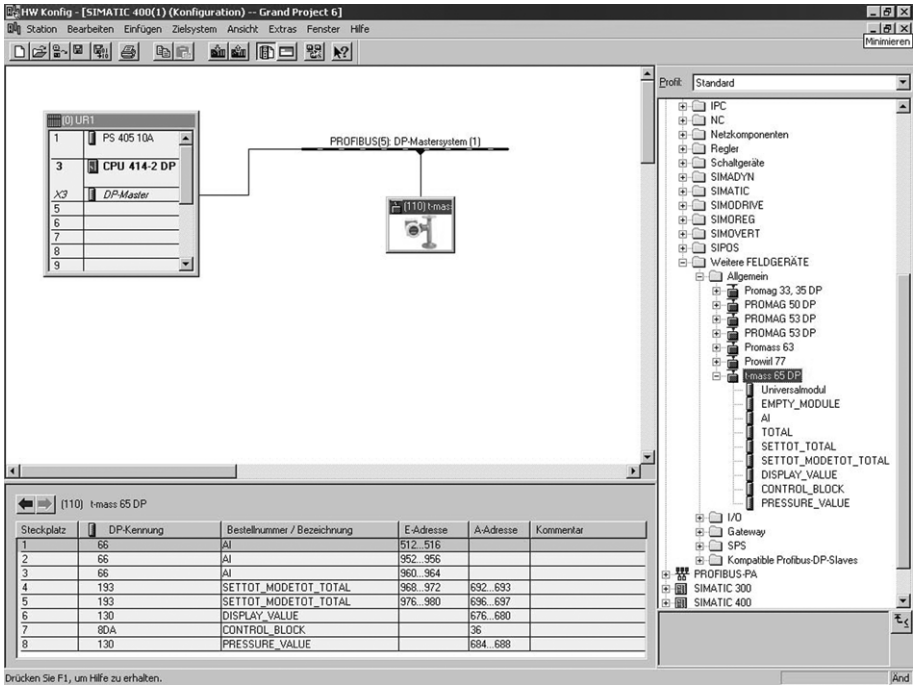
Note!
The status is not evaluated by the device.

EMPTY_MODULE module

The measuring device is a so-called modular PROFIBUS slave. In contrast to a compact slave, the structure of a modular slave is variable – it consists of several individual modules. In the GSD file, the individual modules are described with their individual properties. The modules are permanently assigned to the slots, i.e. the sequence or arrangement of the modules must be observed when configuring the modules. Gaps between configured modules have to be assigned to the EMPTY_MODULE module. For a more detailed description, see → Page 58.

6.6.4 Configuration examples with Simatic S7 HW-Konfig

Example 1



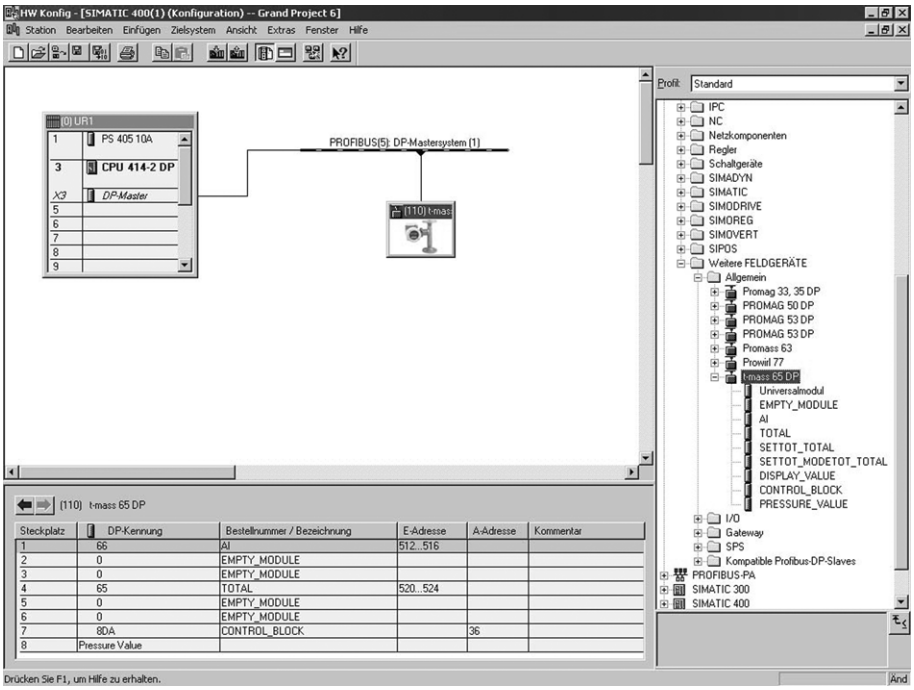
a0005497

Fig. 35: Complete configuration using the t-mass 65 GSD file

It is essential to adhere to the following sequence when configuring the modules in the PROFIBUS Master (class 1):

Slot sequence	Module	Byte length input data	Byte length output data	Description
1	AI	5	-	**Analog Input function block 1** Output variable → mass flow (factory setting)
2	AI	5	-	**Analog Input function block 1** Output variable → corr. volume flow (factory setting)
3	AI	5	-	**Analog Input function block 1** Output variable → temperature (factory setting)
4	SETTOT _MODETOT _TOTAL	5	2	**Totalizer function block 1** TOTAL → output variable = totalized mass flow (factory setting) SETTOT → totalizer control MODETOT → totalizer configuration
5	SETTOT _MODETOT _TOTAL	5	2	**Totalizer function block 2** TOTAL → output variable = totalized mass flow (factory setting) SETTOT → totalizer control MODETOT → totalizer configuration
6	DISPLAY _VALUE	-	5	Value for local display
7	CONTROL _BLOCK	-	1	Control of device functions
8	PRESSURE _VALUE	-	5	Process pressure

Example 2



a0005498

Fig. 36: In this example, modules that are not needed are replaced by the module EMPTY_MODULE. The t-mass 65 GSD file is used .

With this configuration, the Analog Input function block 1 (slot 1), the totalizer value TOTAL (slot 4) and the cyclic control of device functions CONTROL_BLOCK (slot 7) are activated.
The mass flow (factory setting) is read out cyclically by the measuring device by means of Analog Input function block 1. The totalizer is configured “without configuration”. In other words, in this example it only returns the totalizer value for the mass flow (factory setting) by means of the TOTAL module and cannot be controlled by the PROFIBUS Master (class 1).

Slot sequence	Module	Byte length input data	Byte length output data	Description
1	AI	5	-	**Analog Input function block 1** Output variable → mass flow (factory setting)
2	EMPTY _MODULE	-	-	Empty
3	EMPTY _MODULE	-	-	Empty
4	TOTAL	5	-	**Totalizer function block 1** TOTAL → output variable = totalized mass flow (factory setting)
5	EMPTY _MODULE	-	-	Empty
6	EMPTY _MODULE	-	-	Empty
7	CONTROL _BLOCK	-	1	Control of device functions

6.7 PROFIBUS DP acyclic data transmission

Acyclic data transmission is used to transmit parameters during commissioning or maintenance, or to display additional measured variables that are not included in data transmission. Thus parameters for identification, control or adjustment in the various blocks (physical block, transducer block, function block) can be changed while the device is in the process of data transmission with a PLC.

The measuring device supports the two basic types of acyclic data transmission:
- MS2AC communication with 2 available SAP´s
- MS1AC communication

6.7.1 Master class 2 acyclic (MS2AC)

MS2AC is acyclic data transmission between a field device and a Master (class 2), e.g. FieldCare, Siemens PDM etc. → Page 41. During this process, the master opens a communication channel via an SAP (Service Access Point) to access the device.
All parameters to be exchanged with a device via PROFIBUS must be made known to a Class 2 master. This assignment to each individual parameter takes place either in a device description (DD), a DTM (Device Type Manager), or inside a software component in the master via slot and index addressing.

When using MS2AC communication, note the following:
- As described above, a Master (class 2) accesses a device via special SAP´s.
  Therefore, the number of Master (class 2) that can communicate with a device simultaneously is limited to the number of SAPs available for this data transmission.
- The use of a Master (class 2) increases the cycle time of the bus system. This must be taken into account when programming the control system used.

6.7.2 Master class 1 acyclic (MS1AC)

In MS1AC, a cyclic master, that is already reading the cyclic data from the device or writing to the device opens the communication channel via the SAP 0x33 (special Service Access Point for MS1AC) and can then read or write a parameter acyclically like a Class 2 master via the slot and the index (if supported).
When using MS1AC communication, note the following:
- Currently, few PROFIBUS masters on the market support this data transmission.
- MS1AC is not supported by all PROFIBUS devices.
- In the user program, note that constant writing of parameters (for example, at every cycle of the program) can drastically reduce the service life of a device. Acyclically written parameters are written to voltage-resistant memory modules (EEPROM, Flash etc.). These memory modules are designed for a limited number of write operations. In normal operation without MS1AC (during parameter configuration), the number of write operations does not even come close to this number. If programming is incorrect, this maximum number can be reached quickly, drastically reducing a device's service life.

  ✎ Note!
  The memory module of the measuring device is designed for one million write operations.

6.8 Adjustment

6.8.1 Zero point adjustment

At zero flow conditions, the output of most thermal mass flow devices has a strong dependency on the process pressure.

The effect on the true zero point of the device, by the static line pressure, is dependant on the gas type and the application demands and in many cases the use of the low flow cut-off function is adequate to zero the device output. Consequently, the zero point adjustment is generally not necessary for t-mass!

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

Therefore, the zero point adjustment is advisable in the following special cases:
- To achieve highest measuring accuracy also with very small flow rates.
- Under process or operating conditions where the gas properties differ strongly from air properties e.g. Hydrogen and Helium.

Preconditions for a zero point adjustment

Note the following before you perform a zero point adjustment:
- A zero point adjustment can be performed only with gases that contain no solid contents.
- The adjustment is performed with the process gas at zero flow and at operating pressure. This can be achieved, for example, with shut-off valves upstream and/or downstream of the sensor.
  – Normal operation → valves 1 and 2 open
  – Zero point adjustment → valve 1 open / valve 2 closed
  – Zero point adjustment → valve 1 closed / valve 2 open

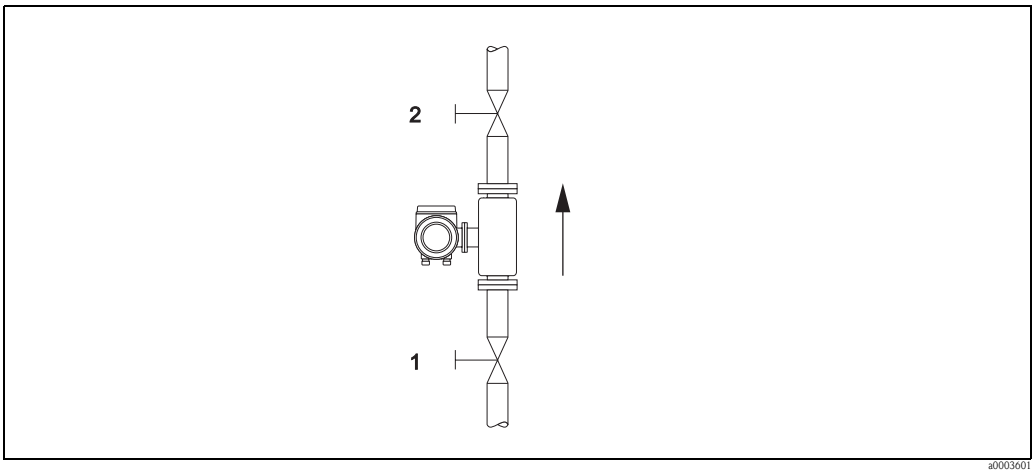


Fig. 37: Zero point adjustment and shut-off valves

Note!
You can view the currently valid zero point value using the ZERO POINT function in the SENSOR DATA group (see the “Description of Device Functions” manual, BA0114D/06/…).

Performing a zero point adjustment

1. Operate the system until operating conditions have settled.
2. Stop the flow (v = 0 m/s).
3. Check the shut-off valves for leaks.
4. Check that operating pressure is correct.
5. Using the local display, select the zero point adjustment function in the function matrix:
   PROCESS PARAMETER → ZERO POINT ADJUST
6. When you press ⊞ or ⊟ you are automatically prompted to enter the access code if the function matrix is still disabled. Enter the code (factory setting = 65).
7. Use ⊞ or ⊟ to select START and press Ⓔ to confirm. Select YES at the prompt SURE? and press Ⓔ again to confirm. Zero point adjustment now starts.
   – The message # 561 “ZERO-ADJ. RUN” appears on the display while adjustment is in progress.

   ✎ Note!
   – If the flow in the pipe is unstable, the following error message may appear on the display # 451 “ZERO-ADJ. N. OK”. The Zero point adjustment is not OK. The preconditions need to be stabilized before attempting a new adjustment.
8. Back to the HOME position:
   – Press and hold down Esc key (⊟ + ⊞) for longer than three seconds or
   – Repeatedly press and release the Esc key (⊟ + ⊞).

Resetting a zero point adjustment

The currently stored zero point can be reset to the original factory value by using the RESET option within ZERO POINT ADJUST function.
Use ⊞ or ⊟ to select RESET and press Ⓔ to confirm. Select YES at the prompt SURE? and press Ⓔ again to confirm. The zero point adjustment is now reset.

6.9 Data storage device (HistoROM)

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

6.9.1 HistoROM/S-DAT (sensor-DAT)

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

6.9.2 HistoROM/T-DAT (transmitter-DAT)

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

7 Maintenance

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

7.1 External cleaning

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

7.2 Pipe cleaning

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

Note!
The POSITIVE ZERO RETURN function maybe activated to set the measured variables (mass flow, corrected volume flow) to zero flow during such cycles. See "Description of Device Functions" manual for more information.

Caution!
Do not use a pipe cleaning pig.

7.3 Transducer cleaning

For gases that do carry impurities, it is recommended that the sensor be routinely inspected and cleaned to minimise any potential metering errors due to contamination or build-ups. The frequency of inspection and cleaning will depend upon the application and expected measurement performance. A suitable cleaning agent that does not attack the materials or seals maybe used.

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

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

7.4 Replacing seals

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

t-mass I sensor:
The transducer is welded to the insertion tube and has no exchangeable seals. The compression fitting contains wetted seals (non exchangeable) and a bonded seal is used on G 1 A threads. The compression fitting and bonded seal are available as spare parts.

7.5 In-situ calibration

The t-mass flowmeters are designed to support in-situ calibration using a reference meter signal, thus saving time and cost by reducing the need for factory re-calibration.
Please discuss your specific requirements with your Endress+Hauser service representative.

8 Accessories

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

8.1 Device-specific accessories

Accessory	Description	Order code
Mounting boss	Mounting boss for the t-mass insertion version	DK6MB - *
Cable remote version	Connecting cable for the remote version	DK6CA - *

8.2 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting set for transmitter	Mounting set for remote version. Suitable for: – Wall mounting – Pipe mounting – Installation in control panel Mounting set for aluminium field housing: Suitable for pipe mounting (3/4" to 3")	DK6WM - *
Flow conditioner	Perforated plate flow conditioner for various line sizes and schedules (t-mass F sensor only)	Contact your local Endress+Hauser representative for more information.
Cold Tap mounting set	Insertion mounting set for low pressure	DK6ML - *
Hot Tap mounting set	Insertion mounting set for high pressure	Contact your local Endress+Hauser representative for more information.

8.3 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and configuring flowmeters. Applicator can be downloaded from the Internet or ordered on CD-ROM for installation on a local PC. Contact your Endress+Hauser representative for more information.	DKA80 - *
ToF Tool - Fieldtool Package	Modular software package consisting of the service program "ToF Tool" for configuration and diagnosis of ToF level measuring devices (time-of-flight measurement) and the "Fieldtool" service program for the configuration and diagnosis of Proline flowmeters. The Proline flowmeters are accessed via a service protocol resp. via the service interface FXA 193. Contents of the "ToF Tool - Fieldtool Package": – Commissioning, maintenance analysis – Configuring flowmeters – Service functions – Visualisation of process data – Trouble-shooting – Controlling the "Fieldcheck" tester/simulator Contact your Endress+Hauser representative for more information.	DXS10 - * * * * *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "ToF Tool - Fieldtool Package" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	FieldCare is Endress+Hauser's FDT based Plant Asset Management Tool. It can configure all intelligent field devices in your plant and supports you in managing them. By using status information, it also provides a simple but effective means of checking their health.	Please refer to the product page of the Endress+Hauser Internet page: www.endress.com

9 Trouble-shooting

9.1 Trouble-shooting instructions

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

Check the display	
No display visible and no output signals present.	1. Check the supply voltage → Terminals 1, 2 2. Check device fuse → Page 90 85 to 260 V AC: 0.8 A slow-blow / 250 V 20 to 55 V AC and 16 to 62 V DC: 2 A slow-blow / 250 V 3. Measuring electronics defective → order spare parts → Page 84
No display visible, but output signals are present.	1. Check whether the ribbon-cable connector of the display module is correctly plugged into the amplifier board → Page 84 ff.. 2. Display module defective → order spare parts → Page 84 3. Measuring electronics defective → order spare parts → Page 84
Display texts are in a foreign language.	Switch off power supply. Press and hold down both the ⊟ keys and switch on the measuring device. The display text will appear in English (default) and is displayed at maximum contrast.
Measured value indicated, but no signal at the current or pulse output	Measuring electronics defective → order spare parts → Page 84

▼

Error messages on display
Errors that occur during commissioning or measuring are displayed immediately. Error messages consist of a variety of icons. The meanings of these icons are as follows (example): – Type of error: **S** = System error, **P** = Process error – Error message type: ϟ = Fault message, **!** = Notice message – **FLOW LIMIT** = Error designation, e.g. measured flow has exceeded the maximum limit. – **03:00:05** = Duration of error occurrence (in hours, minutes and seconds) – **#422** = Error number ☞ Caution! ■ See the information on → Page 40. ■ The measuring system interprets simulations and positive zero return as system errors, but displays them as notice message only.

▼

Faulty connection to PROFIBUS Master	
No connection can be made between the PROFIBUS Master and the device. Check the following points:	
Supply voltage Transmitter	Check the Supply voltage → Terminals 1/2
Device fuse	Check device fuse → Page 90 85 to 260 V AC: 0.8 A slow-blow / 250 V 20 to 55 V AC and 16 to 62 V DC: 2 A slow-blow / 250 V
Fieldbus connection	Check data line: Terminal 26 = B (RxD/TxD-P) Terminal 27 = A (RxD/TxD-N)

▼

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

▼

System or process error messages
System or process errors which occur during commissioning or operation can be displayed in ACTUAL SYSTEM CONDITION function via local display or by using an operating program → Page 41.

▼

Other error (without error message)	
Some other error has occurred	Diagnosis and rectification → Page 83.

9.2 System error messages

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

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Important procedures must be carried out before you return a flowmeter to Endress+Hauser. → Page 6. Always enclose a duly completed "Declaration of contamination" form. You will find a preprinted blank of this form at the back of this manual.

Note!
Also observe the information on the following pages → Page 40 ff.

9.2.1 Displaying the device status on PROFIBUS DP

Display in the operating program (acyclic data transmission)

The device status can be queried using an operating program (e.g. FieldCare):
Function block SUPERVISION → ACTUAL SYSTEM CONDITION

Display in the PROFIBUS master system (cyclic data transmission)

If the AI or TOTAL modules are configured for cyclic data transmission, the device status is coded in accordance with PROFIBUS Profile Specification 3.0 and transmitted with the variable to the PROFIBUS master by means of the quality byte (byte 5). The quality byte is split into the "quality status", "quality substatus" and "limits" segments.

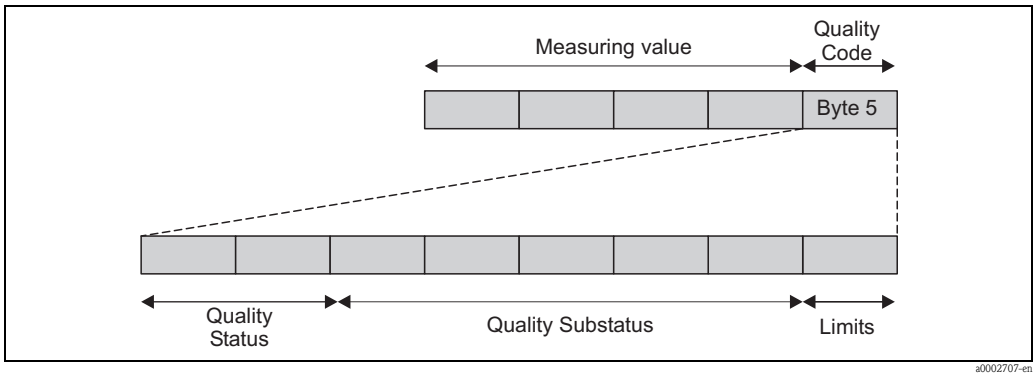


Fig. 38: Structure of the quality byte

The content of the quality byte depends on the failsafe mode error behavior configured in the corresponding Analog Input function block 1 to 3 or totalizer function block 1 to 2.
Depending on which failsafe mode has been set in the FAILSAFE_TYPE function, the following status information is transmitted to the PROFIBUS master via the quality byte:

- For the selection FAILSAFE_TYPE → FSAFE VALUE :

Quality code (HEX)	Quality status	Quality substatus	Limits
0x48 0x49 0x4A	UNCERTAIN	Substitute-Set	OK Low High

- For the selection FAILSAFE_TYPE → LAST GOOD VALUE (factory setting):

If a valid output value was available before the failure:

Quality code (HEX)	Quality status	Quality substatus	Limits
0x44 0x45 0x46	UNCERTAIN	Last usable value	OK Low High

If no valid output value was available before the failure:

Quality code (HEX)	Quality status	Quality substatus	Limits
0x4C 0x4D 0x4E	UNCERTAIN	Initial Value	OK Low High

- For FAILSAFE_TYPE → WRONG VALUE:
  For status information, see the table in the following section.

Note!
The FAILSAFE_TYPE function can be configured in the corresponding Analog Input function block 1 to 3 or Totalizer function block 1 to 2 by means of an operating program (e.g. FieldCare).

9.2.2 List of system error messages

No.	Device status message (local display)	PROFIBUS measured value status: Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits	Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
S = System error ϟ = Fault message (with an effect on the current operation) ! = Notice message (without any effect on the current operation)							
No. # 0xx → Hardware error							
001	S: CRITICAL FAIL ϟ: # 001	0x0F	BAD	Device Failure	Constant	ROM/RAM failure	*Cause:* Serious device error *Remedy:* Replace the amplifier board. Spare parts → Page 84
011	S: AMP HW EEPROM ϟ: # 011	0x0F	BAD	Device Failure	Constant	Amplifier EEPROM failure	*Cause:* Amplifier: Defective EEPROM *Remedy:* Replace the amplifier board. Spare parts → Page 84
012	S: AMP SW EEPROM ϟ: # 012	0x0F	BAD	Device Failure	Constant	Amp. EEPROM data inconsistent	*Cause:* Measuring amplifier: Error when accessing data of the EEPROM *Remedy:* Replace the amplifier board. Spare parts → Page 84
013	S: AMP HW-ROM/RAM ϟ: # 013	0x0F	BAD	Device Failure	Constant	Amplifier ROM/ RAM failure	*Cause:* Amplifier: Defective ROM/RAM *Remedy:* Replace the amplifier board. Spare parts → Page 84
014	S: AMP SW-ROM/RAM ϟ: # 014	0x0F	BAD	Device Failure	Constant	Amp. ROM/RAM data inconsistent	*Cause:* Amplifier: Defective ROM/RAM *Remedy:* Replace the amplifier board. Spare parts → Page 84
031	S: SENSOR HW DAT ϟ: # 031	0x10 0x11 0x12	BAD	Sensor Failure	O.K. Low High	S-DAT failure / not inserted	*Cause:* Sensor DAT: 1. HistoROM/S-DAT is defective. 2. HistoROM/S-DAT is not plugged into the amplifier board or is missing. *Remedy:* 1. Replace the S-DAT. Spare parts → Page 84 Check the spare parts set number to ensure that the new, replacement DAT is compatible with the measuring electronics. 2. Plug the S-DAT into the amplifier board → Page 85, Page 87

No.	Device status message (local display)	PROFIBUS measured value status				Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
		Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits		
032	S: SENSOR SW DAT ϟ: # 032	0x10 0x11 0x12	BAD	Sensor Failure	O.K. Low High	S-DAT data inconsistent	*Cause:* Error accessing the calibration values stored in the HistoROM/S-DAT. *Remedy:* 1. Check whether the HistoROM/S-DAT is correctly plugged into the amplifier board→ Page 85, Page 87 2. Replace the S-DAT if it is defective. Spare parts → Page 84 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare parts set number – Hardware revision code 3. Replace measuring electronics boards if necessary. Spare parts → Page 84
033	S: SENS HW-EEPROM ϟ: # 033	0x10 0x11 0x12	BAD	Sensor Failure	O.K. Low High	Amplifier: Defective EEPROM	*Cause:* Amplifier: Defective EEPROM *Remedy:* Replace the amplifier board. Spare parts → Page 84 – For remote version: replace pre-amplifier board – For compact version: replace pre-amplifier board
034	S: SENS SW-EEPROM ϟ: # 034	0x10 0x11 0x12	BAD	Sensor Failure	O.K. Low High	Amplifier: EEPROM data access error	*Cause:* Measuring amplifier: Error when accessing data of the EEPROM *Remedy:* Replace the amplifier board. Spare parts → Page 84 – For remote version: replace pre-amplifier board – For compact version: replace pre-amplifier board
035	S: SENS HW-ROM/RAM ϟ: # 035	0x10 0x11 0x12	BAD	Sensor Failure	O.K. Low High	Sensor: Defective ROM/ RAM	*Cause:* Sensor: Defective ROM/RAM *Remedy:* Replace the remote amplifier board. Spare parts → Page 84
036	S: SENS SW-ROM/RAM ϟ: # 036	0x10 0x11 0x12	BAD	Sensor Failure	O.K. Low High	Sensor: Defective ROM/ RAM	*Cause:* Sensor: Defective ROM/RAM *Remedy:* Replace the remote amplifier board. Spare parts → Page 84

No.	Device status message (local display)	PROFIBUS measured value status				Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
		Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits		
041	S: TRANSM. HW-DAT ϟ: # 041	0x0F	BAD	Device Failure	Constant	T-DAT failure	*Cause:* 1. HistoROM/T-DAT is defective. 2. HistoROM/T-DAT is not plugged into the amplifier board or is missing. *Remedy:* 1. Replace the HistoROM/T-DAT. Spare parts → Page 84 Check the spare parts set number to ensure that the new, replacement DAT is compatible with the measuring electronics. 2. Plug the HistoROM/T-DAT into the amplifier board → Page 85, Page 87
042	S: TRANSM. SW-DAT ϟ: # 042	0x0F	BAD	Device Failure	Constant	T-DAT data inconsistent	*Cause:* Error accessing the calibration values stored in the HistoROM/T-DAT. *Remedy:* 1. Check whether the HistoROM/T-DAT is correctly plugged into the amplifier board. → Page 85, Page 87 2. Replace the HistoROM/T-DAT if it is defective.→ Page 84 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare parts set number – Hardware revision code 3. Replace measuring electronics boards if necessary. → Page 84
051	AC COMPATIB. ϟ: # 051	0x0F	BAD	Device Failure	Constant	Compatibility Amp. I/O module	*Cause:* The I/O board and the amplifier board are not compatible. *Remedy:* Use only compatible modules and boards. Check the compatibility of the modules used. Check the: – Spare parts set number – Hardware revision code
052	S: HW-COMMODUL ϟ: # 052	0x0F	BAD	Device Failure	Constant	I/O module hardware failure	*Cause:* The I/O board is defective. *Remedy:* Replace the I/O board. Spare parts → Page 84
070	S: SENSOR DEFECT ϟ: # 070	0x13	BAD	Sensor Failure	Constant	Sensor failure	*Cause:* Flow sensors are likely to be defect, measurement is no longer possible. *Remedy:* Contact your Endress+Hauser representative.
071	S: SENSOR DRIFT ϟ: # 071	0x13	BAD	Sensor Failure	Constant	Sensor drift	*Cause:* Calibration drift has been detected. *Remedy:* Contact your Endress+Hauser representative.

No.	Device status message (local display)	PROFIBUS measured value status				Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
		Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits		
072	S: A/D REF ERROR ϟ: # 072	0x13	BAD	Sensor Failure	Constant	Drift in A/D ref. values	*Cause:* Measuring amplifier analogue to digital convertor circuitry faulty. *Remedy:* For remote sensor: replace the remote sensor electronic board. For compact sensor: replace the main amplifier electronic board. Spare parts → Page 84 ✎ Note! Ensure that the sensor and transmitter DAT's are transferred from the old circuit board to the new one.
No. # 1xx → Software error							
121	S: A/C SW COMPATI. ϟ: # 121	0x0F	BAD	Device Failure	Constant	Amp- I/O soft only part. comp.	*Cause:* Due to different software versions, I/O board and amplifier board are only partially compatible (possibly restricted functionality). ✎ Note! – This message is only listed in the error history. – Nothing is displayed on the display. *Remedy:* Module with lower software version has either to be actualized by ToF Tool - Fieldtool Package with the required software version or the module has to be replaced. Spare parts → Page 84
No. # 2xx → Error in DAT/no communication							
205	S: LOAD T-DAT !: # 205	0x0F	BAD	Device Failure	Constant	Save to T-DAT failed	*Cause:* Data backup (downloading) to HistoROM/T-DAT failed, or error when accessing (uploading) the calibration values stored in the HistoROM/T-DAT. *Remedy:* 1. Check whether the HistoROM/T-DAT is correctly plugged into the amplifier board. 2. Replace the HistoROM/T-DAT if it is defective.→ Page 84 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: – Spare parts set number – Hardware revision code 3. Replace measuring electronics boards if necessary. → Page 84
206	S: SAVE T-DAT !: # 206	0x0F	BAD	Device Failure	Constant	Restore from T-DAT failed	
211	S: S-DAT NO HW ϟ: # 211	0x0F	BAD	Device Failure	Constant	S-DAT no hardware	*Cause:* HistoROM/S-DAT is not fitted to amplifier board. *Remedy:* Check whether the S-DAT is correctly plugged into the amplifier board → Page 85 ff.

No.	Device status message (local display)	PROFIBUS measured value status				Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
		Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits		
215	S: LOAD S-DAT ϟ: # 215	0x0F	BAD	Device Failure	Constant	Save to S-DAT failed	*Cause:* Data backup (downloading) to HistoROM/S-DAT failed, or error when accessing (uploading) the calibration values stored in the HistoROM/S-DAT. *Remedy:* 1. Check whether the S-DAT is correctly plugged into the amplifier board → Page 85 ff. 2. Replace the S-DAT if it is defective. Spare parts → Page 84 Before replacing the DAT, check that the new, replacement DAT is compatible with the measuring electronics. Check the: - Spare parts set number - Hardware revision code 3. Replace measuring electronics boards if necessary. Spare parts → Page 84
216	S: SAVE S-DAT ϟ: # 216	0x0F	BAD	Device Failure	Constant	Restore from S-DAT failed	
251	S: COMMUNIC. SENS ϟ: # 251	0x0F	BAD	Device Failure	Constant	Communication sensor failure	*Cause:* Internal microprocessor communication fault on the amplifier board. *Remedy:* Remove the amplifier board. Spare parts → Page 84
261	S: COMMUNICAT. I/O ϟ: # 261	0x18 0x19 0x1A	BAD	No Communica-tion	O.K. Low High	Communication I/O failure	*Cause:* 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 → Page 84
262	S: COMMUNICAT. I/O ϟ: # 262	0x18 0x19 0x1A	BAD	No Communica-tion	O.K. Low High	Communication I/O failure	*Cause:* 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 → Page 84
No. # 3xx → System limits exceeded							
372	S: DIFF. TEMP. LOW ϟ: # 372	0x13	BAD	Sensor Failure	Constant	Diff. Temp. is below limit	*Cause:* The measured sensor differential temperature is below limit value. *Remedy:* Reduce the flow rate or consider replacing the instrument with a suitable size for the application if possible.
379	S: GAS MIX. CORR. !: # 379	0x40 0x41 0x42	UNCERTAIN	O.K.	O.K. Low High	Gas mixture data corrupted	*Cause:* The defined gas mixture has been corrupted. *Remedy:* Gas mixture needs to be re-entered.

No.	Device status message (local display)	PROFIBUS measured value status				Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
		Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits		
381	S: FLUIDTEMP.MIN. !: # 381	0x40 0x41 0x42	UNCERTAIN	O.K.	O.K. Low High	Fluid temperature min.	*Cause:* The minimum fluid temperature limit for the transducer has been exceeded. *Remedy:* Increase the process gas temperature. ☝ Achtung! Caution! In case of severe temperature exposure, the transducer may be damaged.
382	S: FLUIDTEMP.MAX. !: # 382	0x40 0x41 0x42	UNCERTAIN	O.K.	O.K. Low High	Fluid temperature max.	*Cause:* The minimum fluid temperature limit for the transducer has been exceeded. *Remedy:* Reduce the process gas temperature. ☝ Achtung! Caution! In case of severe temperature exposure, the transducer may be damaged.
No. # 5xx → Application error							
501	S: SW.-UPDATE ACT !: # 501	0x48 0x49 0x4A	UNCERTAIN	Substitute-Set	O.K. Low High	Software upload active	*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.
502	S: UP-/DOWL. ACT. !: # 502	0x48 0x49 0x4A	UNCERTAIN	Substitute-Set	O.K. Low High	Up-/Download active	*Cause:* Up- or downloading the device data via configuration program. Currently no other functions are possible. *Remedy:* Wait until process is finished.
561	P: ZERO-ADJ. RUN !: # 561	0x40 0x41 0x42	UNCERTAIN	O.K.	O.K. Low High	Zero adjust running	*Cause:* Zero point adjustment function is active. *Remedy:* Wait until process is finished.

No.	Device status message (local display)	PROFIBUS measured value status				Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
		Quality code (HEX) Measured variable status	Quality status	Quality substatus	Limits		
No. # 6xx → Simulation mode active							
601	S: POS. ZERO-RET. ! # 601	0x53	UNCERTAIN	Sensor conversion not accurate	Constant	Positive zero return active	*Cause:* Positive zero return is active. ✎ Note! This message has the highest display priority! *Remedy:* Switch off positive zero return. *Access:* SYSTEM PARAMETER → POS. ZERO RETURN (→ OFF)
691	S: SIM. FAILSAFE !: # 691	0x48 0x49 0x4A	UNCERTAIN	Substitute set	O.K. Low High	Simulation failsafe active	*Cause:* Simulation of failsafe mode (outputs) is active. *Remedy:* Switch off simulation. *Access:* SIMULAT. SYSTEM → FAILSAFE MODE (→ OFF)
692	S: SIM. MEASURAND !: # 692	0x60 0x61 0x62	UNCERTAIN	Simulated Value	O.K. Low High	Simulation measured value active	*Cause:* Simulation of the measured value is active. *Remedy:* Switch off simulation. *Access:* SIMULAT. SYSTEM → SIM. MEASURAND (→ OFF)
698	S: DEV. TEST ACT. !: # 698	0x60 0x61 0x62	UNCERTAIN	Simulated Value	O.K. Low High	Device test via Fieldcheck active	*Cause:* The measuring device is being checked on site via the test and simulation device.

9.3 Process error messages

Note!
Also observe the information on the following pages: → Page 40 and → Page 73

9.3.1 List of process error messages

No.	Device status message (local display)	PROFIBUS measured value status: Quality code (HEX) Measured variable status	PROFIBUS measured value status: Quality status	PROFIBUS measured value status: Quality substatus	PROFIBUS measured value status: Limits	Extended diagnostic message in the PROFIBUS master	Remedy / spare parts
P = Process error ϟ = Fault message (with **an** effect on the current operation) ! = Notice message (without **any** effect on the current operation)							
422	P: FLOW LIMIT ϟ: # 422	0x13	BAD	Sensor Failure	Constant	Meas. flow exceeded max limit	*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. Note! Error can be configured as a fault or notice message.
432	P: FLUID TEMP UNST. ϟ: # 432	0x13	BAD	Sensor Failure	Constant	Gas temperature unstable	*Cause:* The gas temperature is unstable. Measurement errors may have occured. *Remedy:* Stabilize process conditions or relocate the instrument to a more stable measuring location.
435	P: FLOW EXT !: # 435	0x40 0x41 0x42	UNCERTAIN	O.K.	O.K. Low High	Flow in extended mode	*Cause:* The flow is measured using extendend mode (beyond calibration). *Remedy:* Resume normal operation (accuracy of device maybe affected) or reduce the flow rate.
451	P: 0 ZERO-ADJ. N. OK. ϟ: # 451	0x13	BAD	Sensor Failure	Constant	Zero adjust is not ok	*Cause:* The saved zero point is inaccurate possibly due to unstable process or flow conditions. *Remedy:* Stabilize process conditions or relocate the instrument to a more stable measuring location.

9.4 Process errors without messages

Symptoms	Rectification
✎ Note! You may have to change or correct certain settings of the function matrix in order to rectify faults. The functions outlined below, such as DISPLAY DAMPING, for example, are described in detail in the "Description of Device Functions" manual.	
Displayed measured value fluctuates even though flow is steady.	1. Increase value of the DISPLAY DAMPING setting → USER INTERFACE function group. 2. The inlet and outlet lengths must be observed. See installation conditions → Page 12 3. Consider the use of a flow conditioner. See installation conditions → Page 16 4. Relocate the meter to a point where there is less flow disturbance
Device displays flow with no actual flow present.	1. The low flow cut off value is programmed too low. Increase value of the ON VALUE LOW FLOW CUT OFF setting → PROCESS PARAMETER function group (Factory setting = 1% of full scale value). 2. Check for leaks in the pipe line downsteam of the sensor. 3. Reduce or eliminate pressure pulsations in the line. 4. Check sensors for damage.
Device displays flow with no actual flow present - but with high static line pressure and thermally conductive gases present (e.g. Hydrogen, Helium, etc.). Line pressure is typically > 5 bar/ 75 psi	Start the ZERO POINT ADJUST function → PROCESS PARAMETER function group. See Zero Point Adjust function → Page 67 ✎ Note! Process preconditions are required before starting this function.
Measurement error due to installation conditions. 1. Gas condition: moisture content, cleanliness, mixture composition. 2. Pipework: inadequate upstream length, diameter mis-match between pipe and device, coupling or gasket mis-match.	Adjust the INSTALLATION FACTOR setting → PROCESS PARAMETER function group. (Factory setting = 1.0)
The fault cannot be rectified or some other fault not described above has occurred. In these instances, please contact your Endress+Hauser representative.	The following options are available for tackling problems of this nature: **Request the services of an Endress+Hauser service technician** If you contact our service representative to have a service technician sent out, please be ready with the following information: – Brief description of the fault – Nameplate specifications : Order code and serial number → Page 7 ff. **Returning devices to Endress+Hauser** The procedures on must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. → Page 6 Always enclose a duly completed "Declaration of contamination" form with the flowmeter. You will find a preprinted "Declaration of contamination" at the back of this manual. **Replace transmitter electronics** Components in the measuring electronics defective → order replacement → Page 84

9.5 Spare parts

The previous sections contain a detailed trouble-shooting guide. → Page 72 ff.
The measuring device, moreover, provides additional support in the form of continuous self-diagnosis and error messages.
Fault rectification can entail replacing defective components with tested spare parts.
The illustration below shows the available scope of spare parts.

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

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

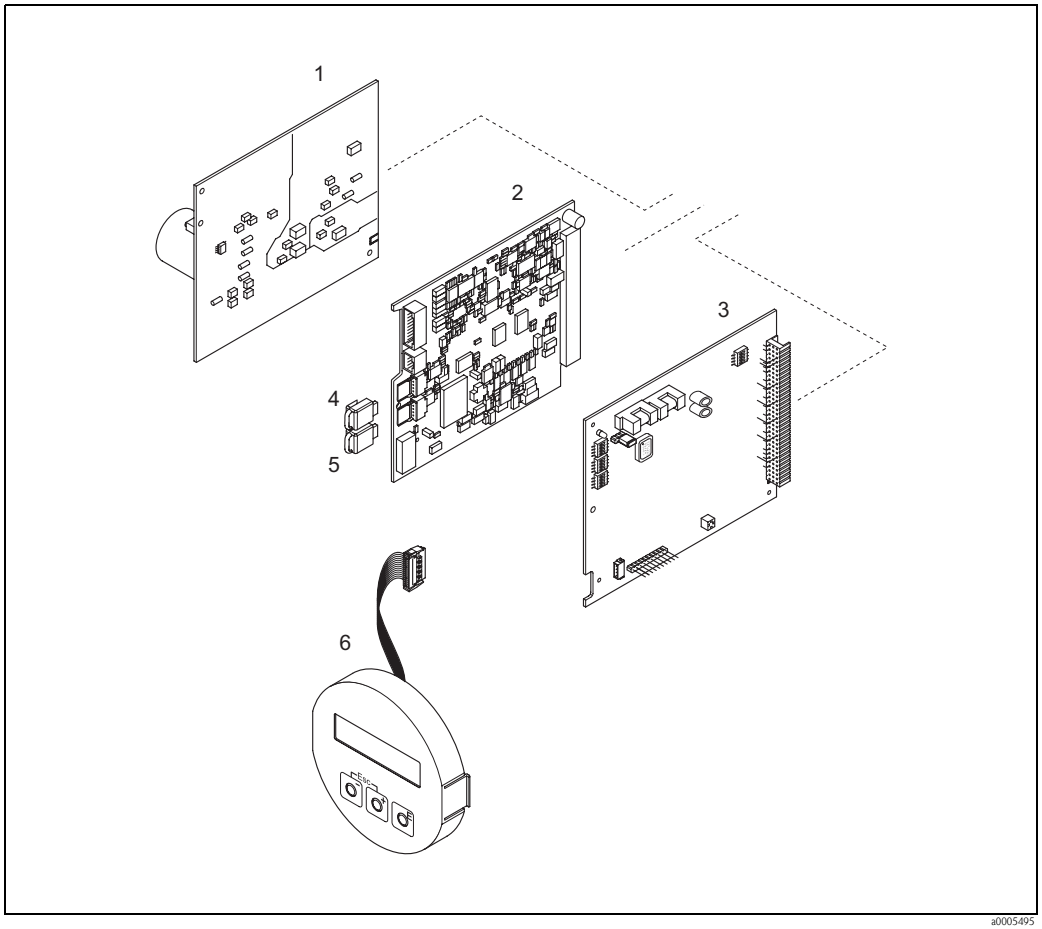


Fig. 39: Spare parts for transmitter 65 (field and wall-mount housings)

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

9.5.1 Removing and installing printed circuit boards

Field housing

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

Caution!
Use only original Endress+Hauser parts.

Fig. 40, installation and removal:

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

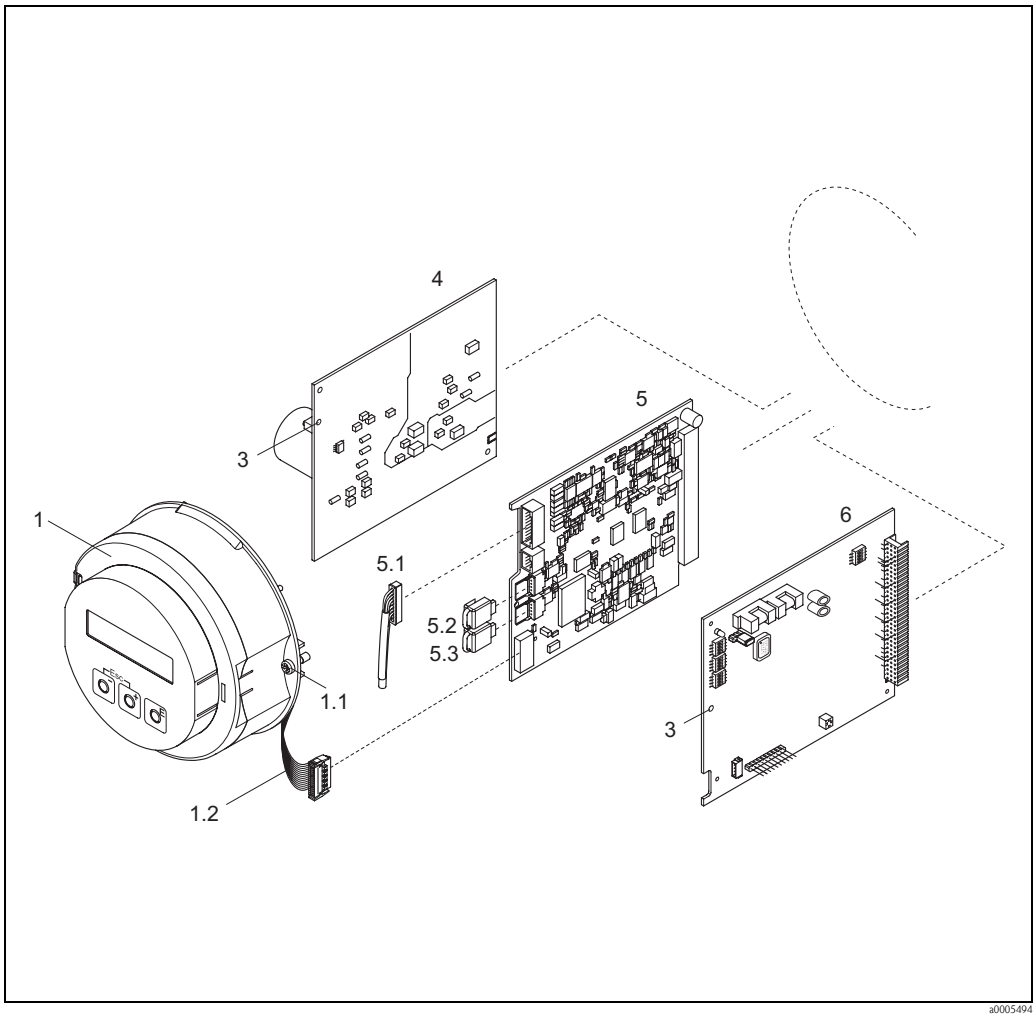


Fig. 40: Field housing: removing and installing printed circuit boards

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

Wall-mount housing

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

Caution!
Use only original Endress+Hauser parts.

Fig. 41, installation and removal:

1. Loosen the screws and open the hinged cover (1) of the housing.
2. Remove the screws securing the electronics module (2). Then push up electronics module and pull it as far as possible out of the wall-mount housing.
3. Disconnect the plug of the sensor signal cable (7.1) including , HistoROM/S-DAT (7.2) and HistoROM/T-DAT (7.3) from the board.
4. Remove the cover (4) from the electronics compartment by loosening the screws.
5. Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
6. Remove the boards (6, 7, 8):
   Insert a thin pin into the hole (5) provided for the purpose and pull the board clear of its holder.
7. Installation is the reverse of the removal procedure.

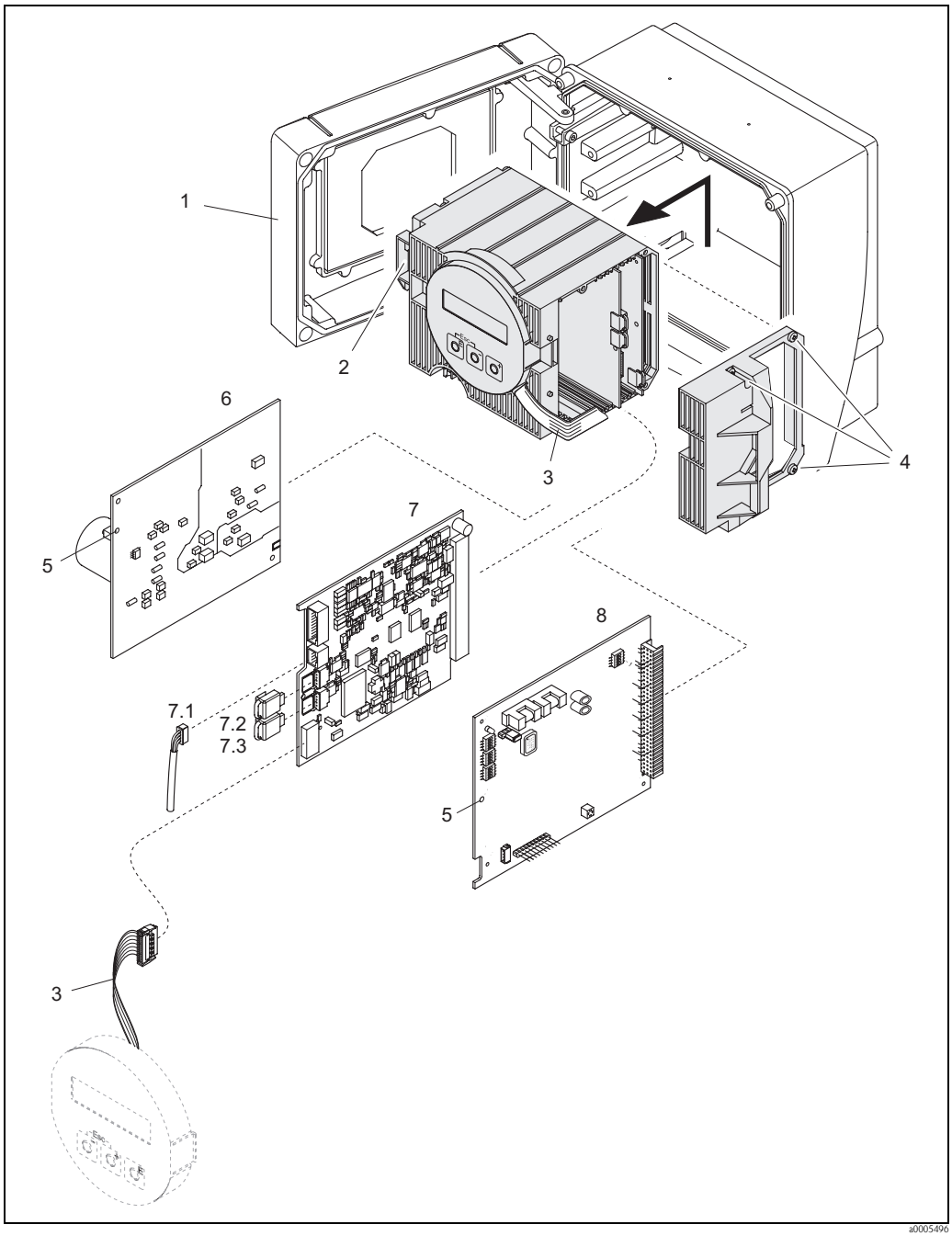


Fig. 41: Wall-mount housing: removing and installing printed circuit boards

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

Electronics housing sensor remote version

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

Caution!
Use only original Endress+Hauser parts.

Fig. 42, removal and installation:

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

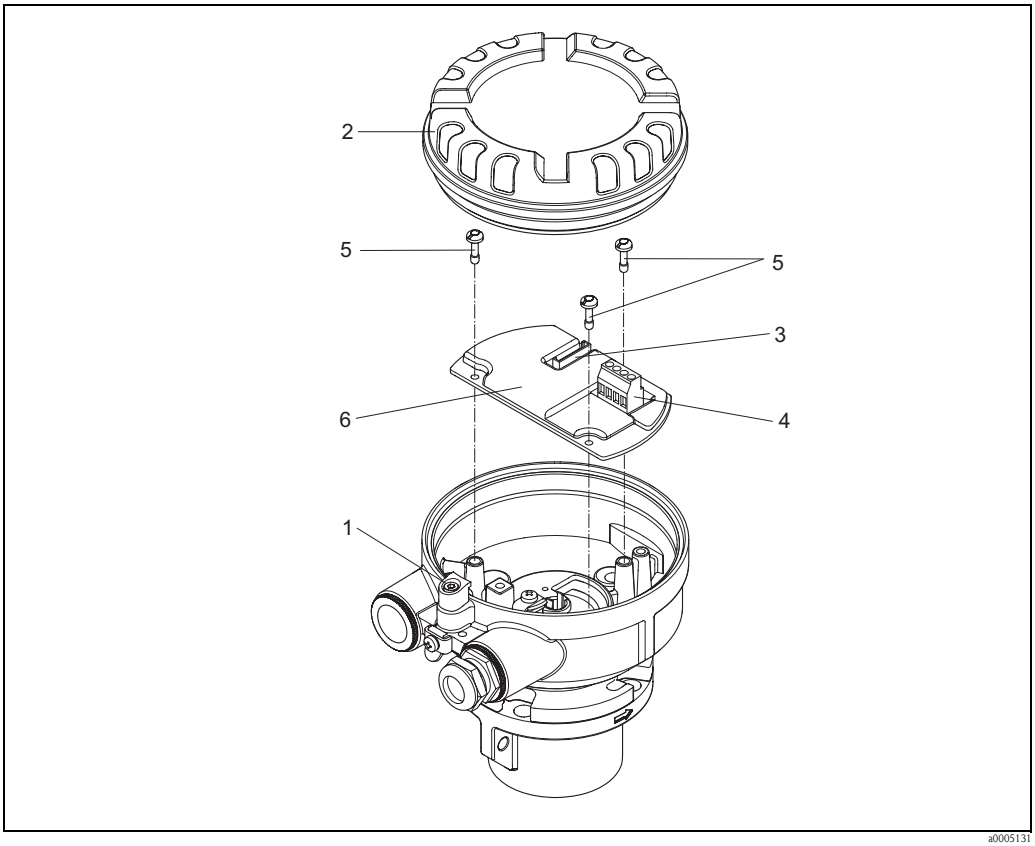


Fig. 42: Electronics compartment of the sensor housing remote version: removing and installing printed circuit board

Wire colors (when supplied by Endress+Hauser):
Terminal no. 41 = white; 42 = brown; 43 = green; 44 = yellow (color code according to DIN 47100)

9.5.2 Replacing the device fuse

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

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

1. Switch off power supply.
2. Remove the power unit board, → Page 85→ Page 87
3. Remove the protection cap (1) and replace the device fuse (2). Only use the following fuse type:
   Now remove the following cable connectors from the amplifier board (7):
   – 20 to 55 V AC / 16 to 62 V DC → 2.0 A slow-blow / 250 V; 5.2 x 20 mm
   – Power supply 85 to 260 V AC → 0.8 A slow-blow / 250 V; 5.2 x 20 mm
   – Ex-rated devices → see the Ex documentation.
4. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

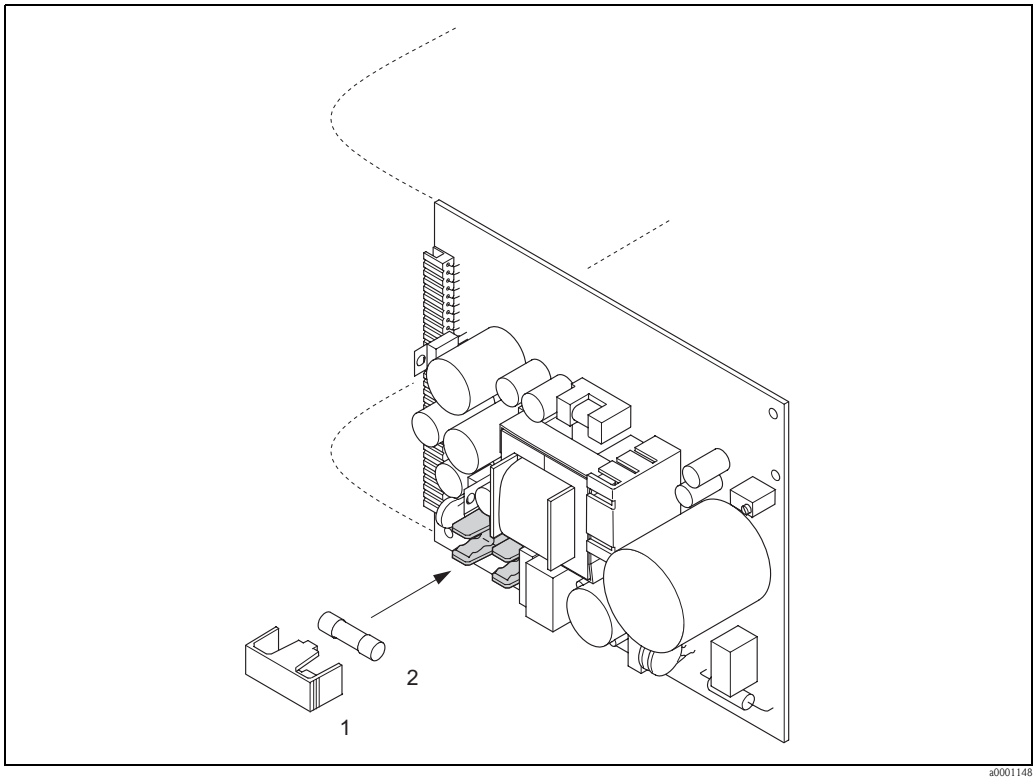


Fig. 43: Replacing the device fuse on the power unit board

1 Protective cap
2 Device fuse

9.6 Return

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

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

Note!
You will find a preprinted "Declaration of contamination" form at the back of this manual.

Warning!

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

9.7 Disposal

Observe the regulations applicable in your country!

9.8 Software history

Date	Software version	Changes to software	Operating Instructions
12.2005	3.02.XX	–	71021608/02.06

10 Technical data

10.1 Technical data at a glance

10.1.1 Applications

The measuring device described in these Operating Instructions is to be used only for measuring the mass flow rate of gases. At the same time, the system also measures corrected volume flow, temperature and calculated density.

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

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

10.1.2 Function and system design

Measuring principle

Mass flow measurement by the thermal dispersion principle.

Measuring system

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

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

10.1.3 Input

Measured variable

- Mass flow
- Gas temperature

Measuring range

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

Measuring range for the flanged version, metric units:

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

Measuring range for the flanged version, US units:

DN	lb/h		Sm³/h at 59 °F, 14.7 psi a		scf/min. at 59 °F, 14.7 psi a	
	minimum	maximum	minimum	maximum	minimum	maximum
1/2"	1.1	116	0.4	42	0.23	25
1"	4.4	440	1.6	160	1.0	96
1 1/2"	13.2	1220	4.8	450	3.0	266
2"	22	2002	8	740	5.0	436
3"	44	4466	16	1656	10	974
4"	84	8250	30	3060	18	1800

Measuring range for the insertion version, metric units:

DN	kg/h		Nm³/h at 0°C, 1.013 bar a		scf/min. at 15°C, 1.013 bar a	
	min.	max.	min.	max.	min.	max.
80	20	2030	15.5	1570	9.6	974
100	38	3750	29.0	2900	18	1800
150	50	7500	38	5800	24	3600
200	80	12500	62	9666	38	6000
250	120	20000	93	15468	58	9600
300	180	28000	139	21655	86	13440
400	300	50000	232	38670	144	24000
500	500	80000	386	61870	240	38400
600	700	115000	540	88940	336	55200
700	900	159000	696	122970	432	76300
1000	2000	320000	1546	247846	960	153600
1500	2500	720000	1933	556844	1200	345600

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

Measuring range for the insertion version, US units:

DN	lb/h		Sm³/h at 59°F, 14.7 psi a		scf/min. at 59°F, 14.7 psi a	
	minimum	maximum	minimum	maximum	minimum	maximum
3"	44	4466	16	1657	9	926
4"	84	8250	30	3060	17	1710
6"	110	16500	40	6120	22.8	3420
8"	176	27500	64	10200	36.5	5700
10"	264	44000	98	16300	55	9120
12"	396	61000	146	22855	82	12768
16"	660	110000	245	40810	136	22800
20"	1100	176000	408	65300	228	36480
24"	1540	253000	570	93870	319	52440
28"	1980	349800	735	129800	410	22504
40"	4400	704000	1630	261200	912	145920
60"	5500	1584000	2040	587750	1140	328320

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

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

Examples in metric units:

Line Size	Gas	Process pressure	Temperature	Max. Flowrate
DN		bar a	°C	kg/h
50	Air	1	25	910
50	Air	3	25	3300
50	CO_2	1	25	1300
50	CO_2	3	25	3950
50	Methane	1	25	795
50	Methane	3	25	1500

Examples in US units:

Line Size	Gas	Process pressure	Temperature	Max. Flowrate
DN		psi a	°F	lb/hr
2"	Air	14.7	77	2002
2"	Air	44.1	77	7260
2"	CO_2	14.7	77	2860
2"	CO_2	44.1	77	8690
2"	Methane	14.7	77	1749
2"	Methane	44.1	77	3300

10.1.4 Output

Output signal

PROFIBUS DP interface:

- PROFIBUS DP in accordance with IEC 61158, galvanically isolated
- Profile Version 3.0
- Data transmission rate: 9.6 kBaud to 12 MBaud
- Automatic identification of data transmission rate
- Signal coding: NRZ code
- Fieldbus address can be configured via miniature switches, via operating program or via the local display (optional)

Signal on alarm

Status and alarm messages in accordance with PROFIBUS Profile Version 3.0

Low flow cut off

Switch points for low flow cut off are programmable.

Galvanic isolation

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

10.1.5 Power supply

Electrical connections

→ Page 29 ff.

Supply voltage

85 to 260 V AC, 45 to 65 Hz
20 to 55 V AC, 45 to 65 Hz
16 to 62 V DC

Cable entry	Power supply and signal cables (inputs/outputs): ■ Cable entry M20 x 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½" Connecting cable for remote version: ■ Cable entry M20 x 1.5 (8 to 12 mm (0.31 to 0.47 inch)) ■ Threads for cable entries, ½" NPT, G ½"
Cable specifications (remote version)	see Page 32
Power consumption	AC: 85 to 260 V = 18.2 W ; 20 to 55 V = 14 W ; (including sensor) DC: 8 W (including sensor)
Power supply failure	Lasting min. 1 power cycle: ■ EEPROM/HistoROM T-DAT saves measuring system data if power supply fails. ■ HistoROM S-DAT is an exchangeable data storage chip with sensor specific data: (pipe type, nominal diameter, serial number, flow conditioner, zero point, etc). ■ Totalizer stops at the last value determined.
Potential equalisation	No measures necessary. For devices in hazardous areas please refer to the additional Ex documentation.

10.1.6 Performance characteristics

Reference calibrating conditions	■ Accredited according to ISO/IEC 17025 ■ Traceable to National Standards ■ Temperature controlled to within ±0.5 °C (±0.9 °F) ■ atmospheric pressure ■ humidity controlled
Maximum measured error	*Flanged version:* ±1.5 % of reading for 100 % to 20 % of full scale at reference conditions ±0.3 % of full scale for 20 % to 1 % of full scale at reference conditions *Insertion version:* ±1.5 % of reading plus ±0.5 % of full scale Note! ■ Calibration gas is normally air at reference calibration conditions and with a fully developed flow profile. ■ On site performance is dependent on the standard of installation.
Repeatability	±0.5 % of measured value for velocities above 0.2 m/s (0.65 ft/s)
Response time	Typically less than 2 seconds for 63 % of a given step change (in either direction).

10.1.7 Operating conditions: Installation

Installation instructions	see Page 12 ff.
Inlet and outlet runs	see Page 14 ff.
Length of connecting cable	Max. 100 meters (328 feet), remote version
System pressure	see Page 22

10.1.8 Operating conditions: Environment

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

10.1.9 Operating conditions: Process

Medium temperature range	*Sensor:* *t-mass F:* –40 °C to +100 °C (–40 °F to +212 °F) *t-mass I:* –40 °C to +130 °C (–40 °F to +266 °F) *Seals:* *t-mass F:* Viton –20°C to +100°C (–4°F to +212°F) Kalrez –20°C to +100°C (–4°F to +212°F) EPDM –40°C to +100°C (–40°F to +212°F) *t-mass I (bonded seals):* Kalrez –20°C to +130°C (–4°F to +266°F) Nitrile –35°C to +130°C (–31°F to +266°F) EPDM –40°C to +130°C (–40°F to +266°F)
Medium pressure range (nominal pressure)	*t-mass F:* –0.5 to 40 bar (–7.25 to 580 psi) gauge *t-mass I:* –0.5 to 20 bar (–7.25 to 290 psi) gauge
Limiting flow	See “Measuring range” section. → Page 92 ff.
Pressure loss	2 mbar (0.029 psi) maximum (without flow conditioner)

Limiting medium pressure range (rated pressure)

The material load diagrams (pressure-temperature diagrams) for the process connections are to be found in the following documents:

- Technical Information: Proline t-mass 65F, 65I (TI069D/06/en), with SI units
- Technical Information: Proline t-mass 65F, 65I (TI069D/06/ae), with US units

10.1.10 Mechanical construction

Design / dimensions

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

Weight (SI units)

- Compact version: see table below
- Remote version
  - Sensor: see table below
  - Wall-mount housing: 5 kg

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

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

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

Weight (US units)

- Compact version: see table below
- Remote version
  - Sensor: see table below
  - Wall-mount housing: 11 lb

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

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

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

Material

Transmitter housing:

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

Connection housing, sensor (remote version):

powder coated die-cast aluminium

t-mass F sensor:

Sensor body:

- DN 15 to 25 (DN 1/2" to DN 1"): stainless steel cast CF3M-A351
- DN 40 to 100 (DN 1 1/2" to DN 4"): 1.4404 to EN10216-5 and 316/316L to A312

Flanges (process connections):

- According to EN 1092-1 (DIN 2501/DIN 2512N) / ANSI B16.5 / JIS B2238
  → stainless steel 1.4404 to EN 10222-5 and 316L/316 to A182

Transducer body:

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

Transducer elements:

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

O-ring seals:

EPDM, Kalrez, Viton

t-mass I sensor:

Insertion tube:

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

Transducer body:

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

Transducer elements:

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

Compression fitting:

1.4404 to EN 10272 and 316/316L to A479

Compression fitting seal:

PEEK

Bonded seals:

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

Low pressure retractable insertion fitting (Cold tap):

Lower tube section:

1.4404 to EN 10272 and 316/316L to A479

Upper tube section:

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

Ball valve:

1.4408 to EN 10213-4 and CF8M

Seal:

PTFE

10.1.11 Human interface

Display elements	■ Liquid crystal display: illuminated, two lines with 16 characters per line ■ Selectable display of different measured values and status variables ■ At ambient temperatures below –20 °C (–4 °F) the readability of the display may be impaired.
Operating elements	■ Local operation with push buttons (−, +, E) ■ Quick Setup menus for straight forward commissioning
Languages	English, Deutsch, Francais, Espanol, Italiano, Nederlands, Norsk, Svenska, Suomi, Portugues, Polski, Cesky
Remote operation	Operation by means of PROFIBUS DP communication

10.1.12 Certificates and approvals

Ex approval

Information about currently available Ex versions (ATEX, FM, CSA) can be supplied by your Endress+Hauser representative on request. All explosion protection data are given in a separate documentation which is available upon request.

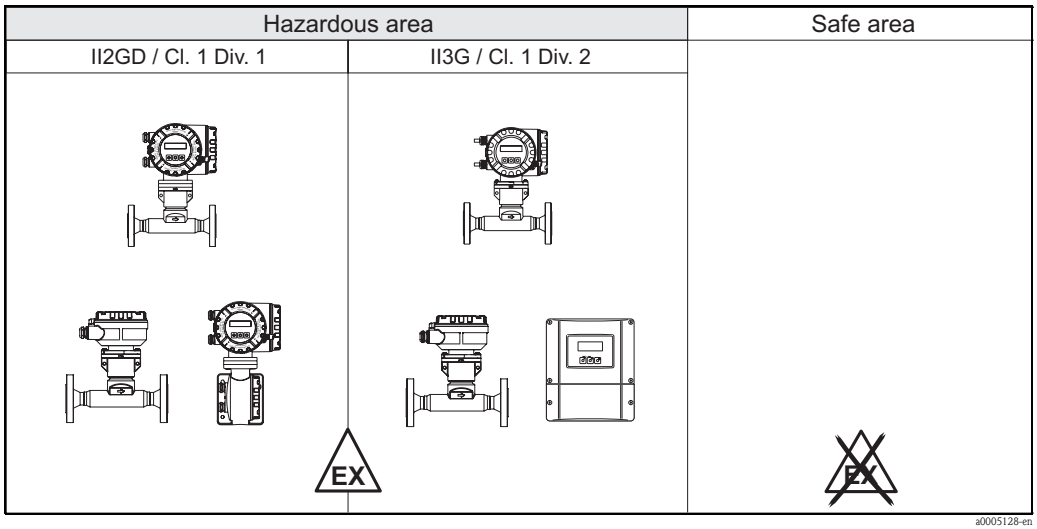


Fig. 44: Example of t-mass devices in the hazardous area (Example t-mass 65F)

PROFIBUS DP certification

The measuring system has successfully passed all the test procedures carried out and is 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 measuring system can also be operated with certified devices of other manufacturers (interoperability).

Pressure device approval

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

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-Tick mark

The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA).

Other standards and guidelines

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

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

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

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

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

10.1.13 Ordering information

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

10.1.14 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. → Page 70
Your Endress+Hauser representative can provide detailed information on the order codes of your choice.

10.1.15 Documentation

❑Technical Information t-mass 65F, 65I (TI069D/06/en)

❑Description of Device Functions t-mass 65 (BA114D/06/en)

❑Supplementary documentation on Ex-ratings: ATEX, FM, CSA

Index

Declaration of Contamination
Erklärung zur Kontamination

Endress+Hauser
People for Process Automation

Because of legal regulations and for the safety of our employees and operating equipment, we need the "declaration of contamination", with your signature, before your order can be handled. Please make absolutely sure to include it with the shipping documents, or – even better – attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination", bevor Ihr Auftrag bearbeitet werden kann. Legen Sie diese unbedingt den Versandpapieren bei oder bringen Sie sie idealerweise außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

Process data/ *Prozessdaten*

Temperature / *Temperatur* _____ [°C] Pressure / *Druck* _____ [Pa]

Conductivity / *Leitfähigkeit* _____ [S] Viscosity / *Viskosität* _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

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

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

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

Reason for return / *Grund zur Rücksendung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

Contact person / *Ansprechpartner* _____

Department / *Abteilung* _____

Phone number/ *Telefon* _____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

We hereby certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free from any residues in dangerous quantities.
Hiermit bestätigen wir, dass die zurückgesandten Teile sorgfältig gereinigt wurden, und nach unserem Wissen frei von Rückständen in gefahrbringender Menge sind.

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

_____
(Company stamp and legally binding signature)
(Firmenstempel und rechtsverbindliche Unterschrift)

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA113D/06/en/02.06
71021608
FM+SGML6.0 ProMoDo