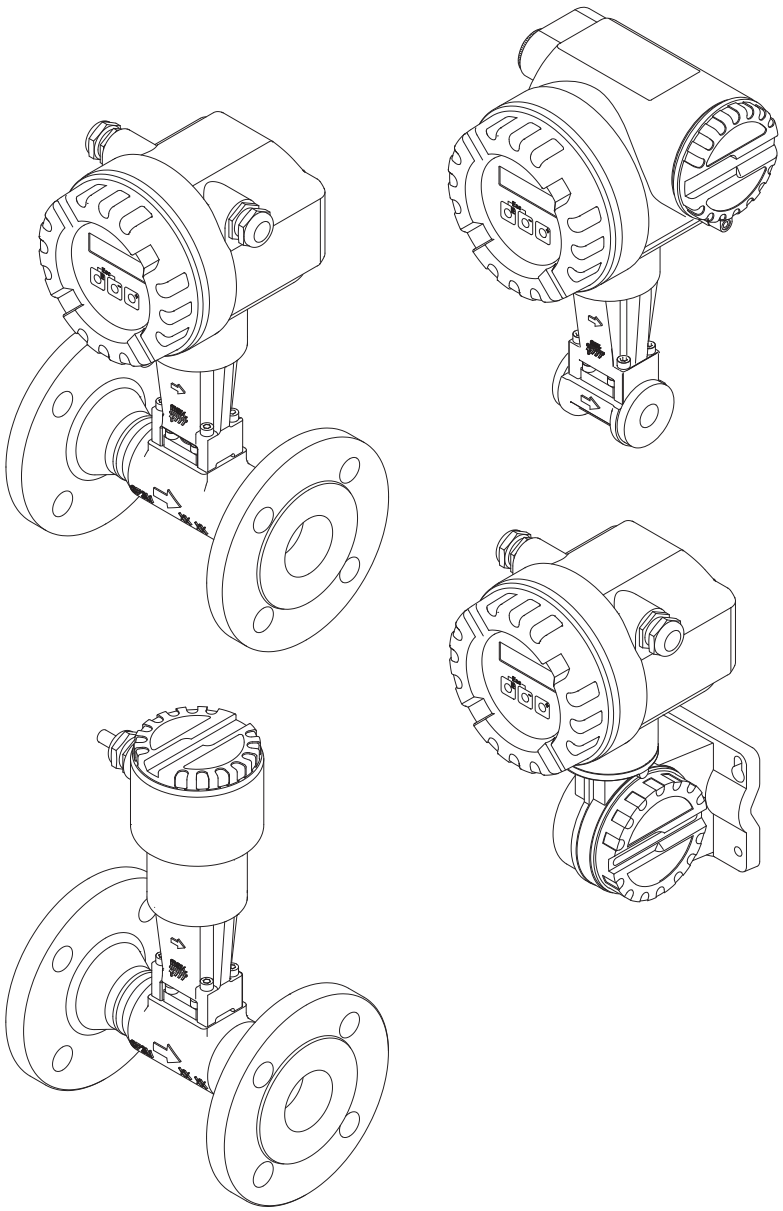
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Proline Prowirl 73

Vortex flow measuring system

HART® FIELD COMMUNICATION PROTOCOL



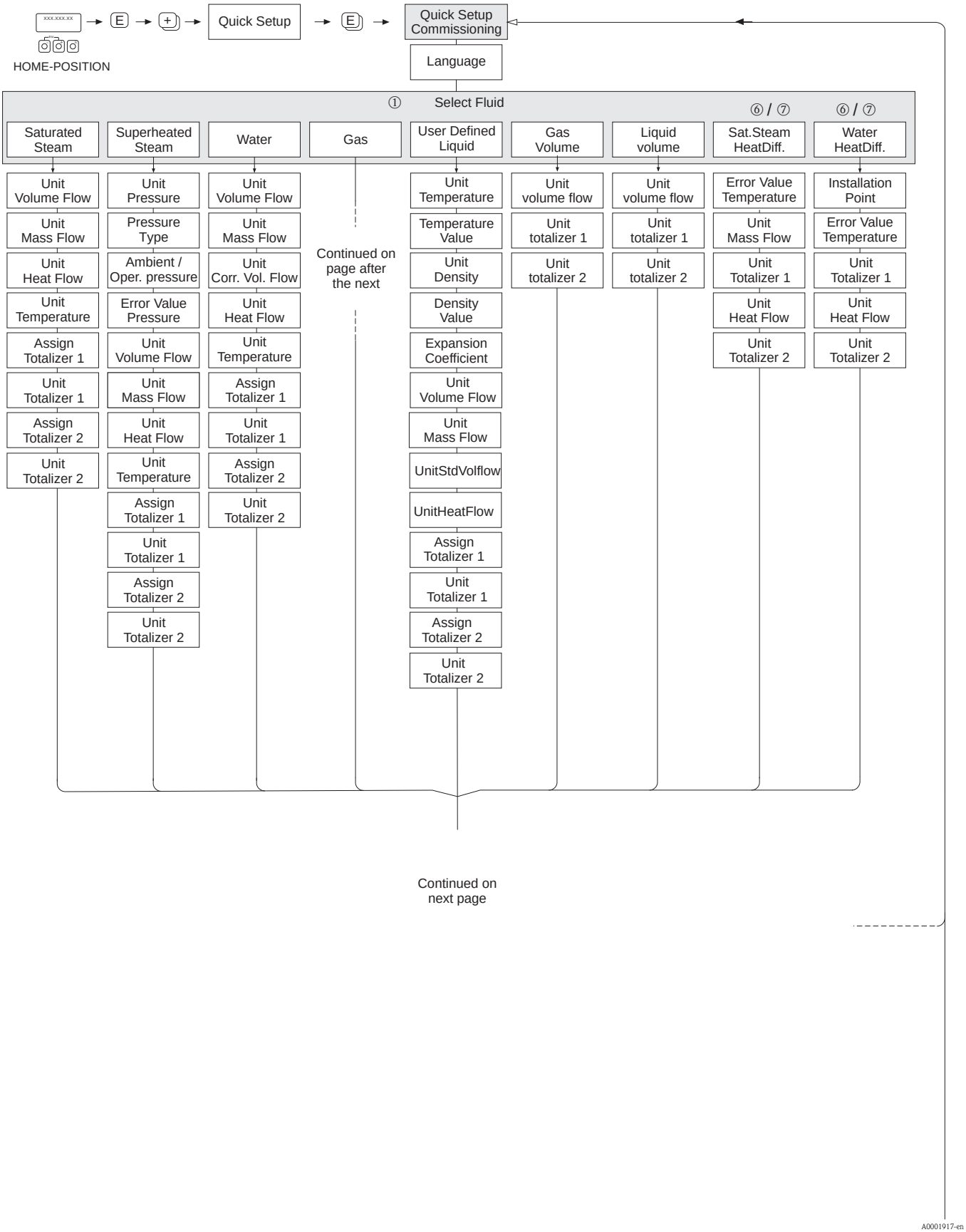
BA00094D/06/EN/14.11
71154517

Valid as of version
V 1.05.XX (device software)

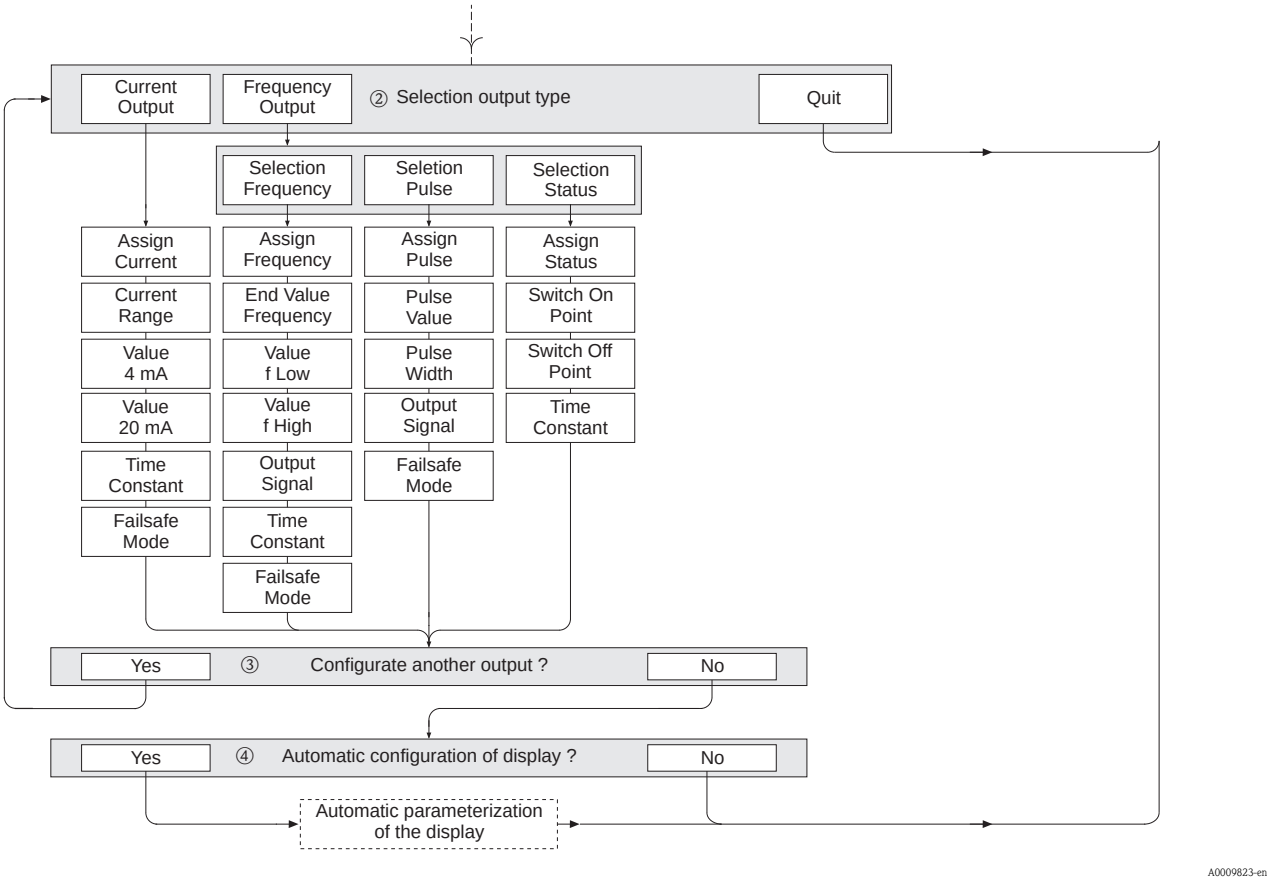
Endress+Hauser
People for Process Automation

QUICK SETUP for rapid commissioning

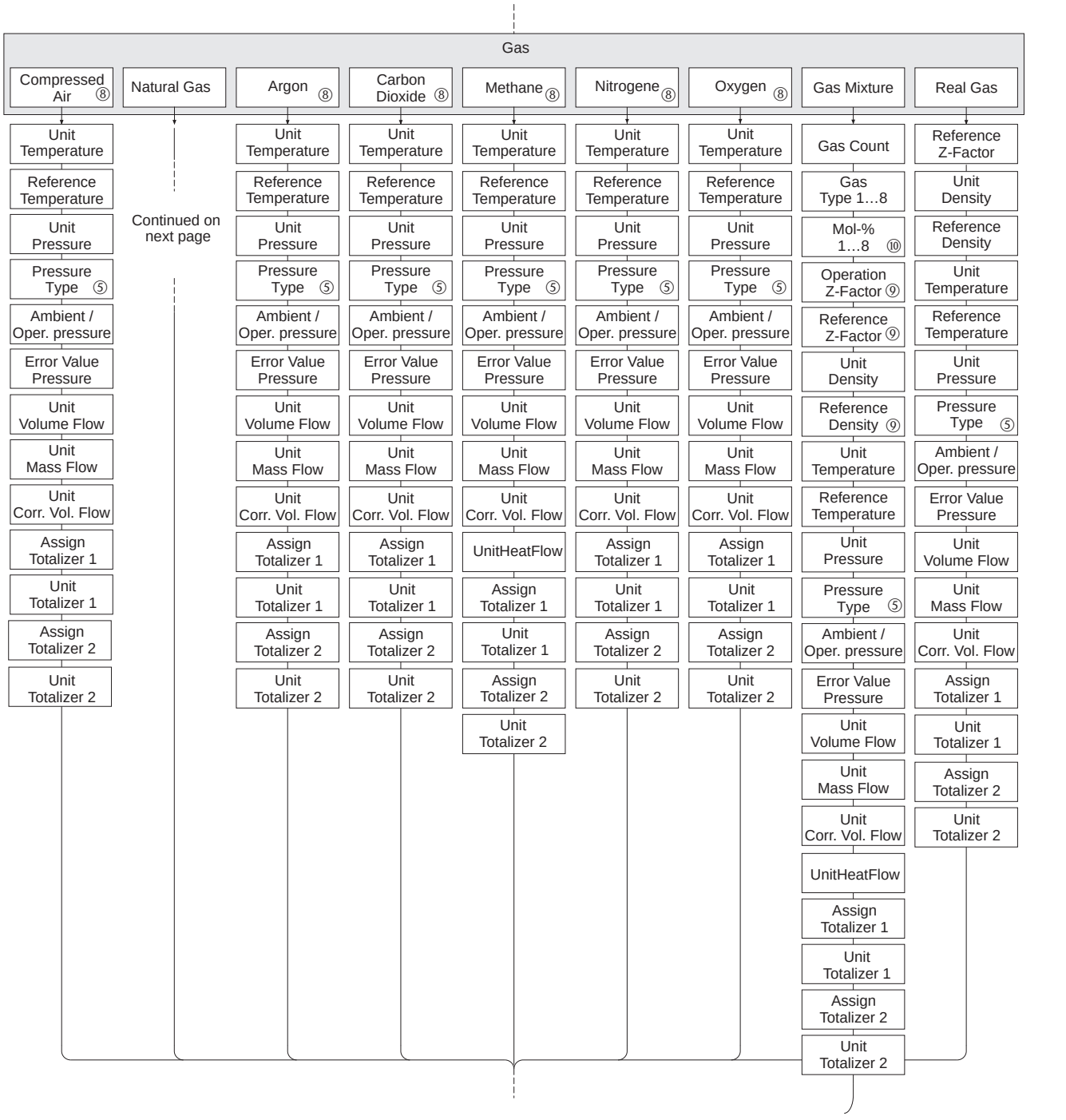
Note!
More detailed information on running Quick Setup menus can be found in the "Commissioning" section (→ 49).



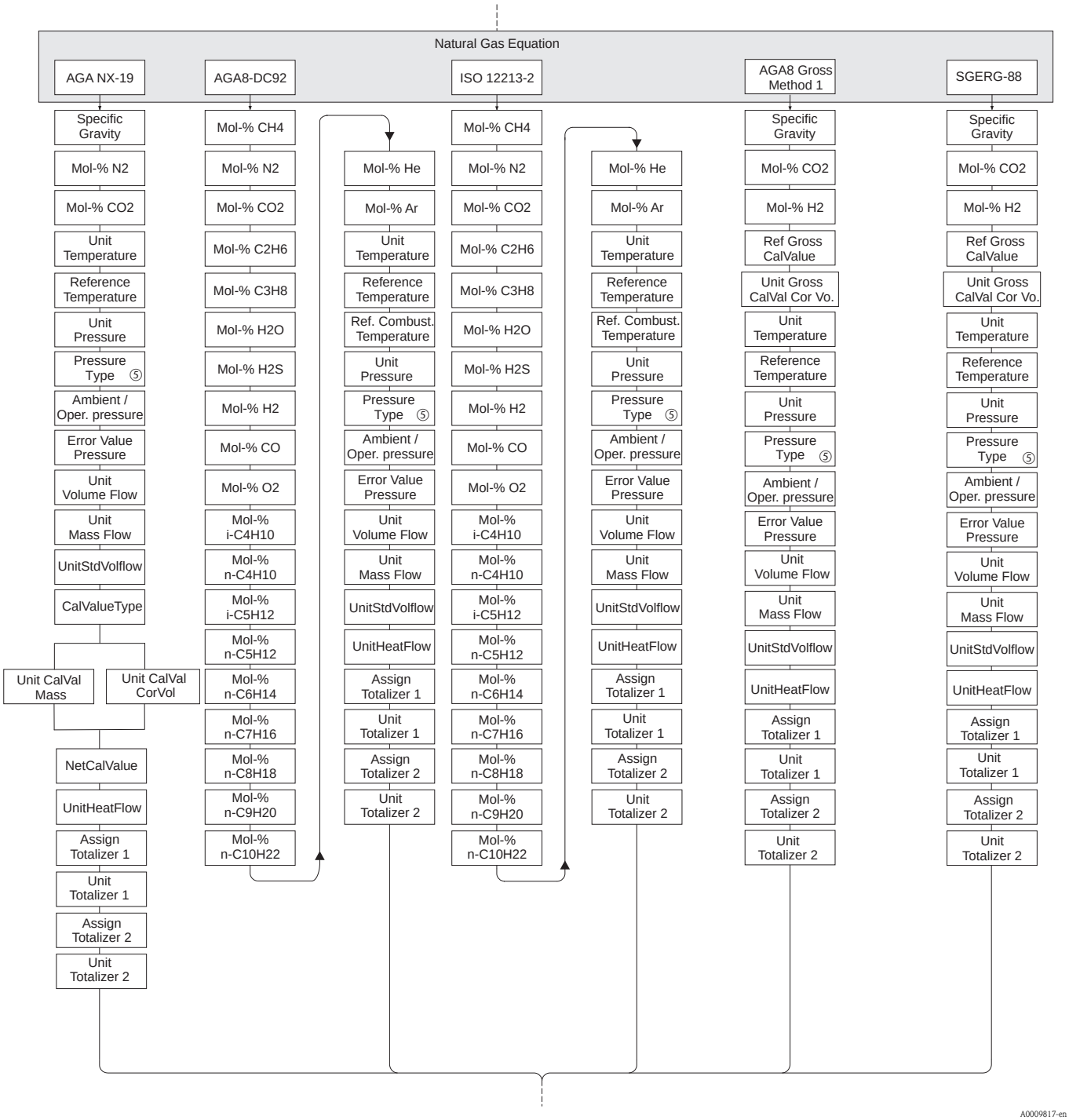
Continuation of the "Commissioning" Quick Setup in "Selection output type"



Continuation of the "Commissioning" Quick Setup in the GAS function



Continuation of the "Commissioning" Quick Setup in the NATURAL GAS function



✎ Note!
- The individual functions are described in the "Description of Device Functions" section (→ 95).
- The display returns to the QUICK SETUP COMMISSION cell (→ 109) if you press the key combination (Esc) during parameter interrogation. The configuration settings already made remain valid, however.

① The following parameters are reset to the factory setting if the fluid selected is changed:

In group	Parameter
User interface	→ 100% value line 1, 100% value line 2
Current output	→ All parameters
Frequency output	→ All parameters
Process parameter	→ All relevant parameters

② Only the output (current output or frequency output) not yet configured is offered for selection after the first cycle.

③ The "YES" option appears as long as a free output is available. "NO" is displayed when no further outputs are available.

④ When "YES" is selected, the volume flow is assigned to line 1 of the local display and the temperature to line 2.

⑤ If "HART INPUT GAUGE" or "HART INPUT ABSOLUTE" is selected in the PRESSURE TYPE function, the HART INPUT field automatically switches to "PRESSURE".
If "HART INPUT ABSOLUTE" or "PREDEFINED VALUE" is selected, the AMBIENT PRESSURE field is not displayed.
If "PREDEFINED VALUE" is selected, the OPERATING PRESSURE field is displayed.
If "PREDEFINED VALUE" is selected, the ERROR VAL. PRESS field is not displayed.

⑥ If "SATURATED STEAM DELTA HEAT" or "WATER DELTA HEAT" is selected, the following notice message is displayed: "EXTERNAL TEMPERATURE SENSOR REQUIRED".

⑦ If "SATURATED STEAM DELTA HEAT" or "WATER DELTA HEAT" is selected, the HART INPUT field automatically switches to "TEMPERATURE".

⑧ Only data for the gas phase are available for these fluids.

⑨ These functions are only called up if the OTHER option was selected in one of the functions GAS TYPE 1 to 8.

⑩ The entry only appears if ≥ 2 was selected in the GAS TYPE 1 to 8 function.

The totalizer assignment depends on the fluid selected:

Selected fluid:	Assignment for totalizer 1	Assignment for totalizer 2
SATURATED STEAM	Mass flow	Heat flow
SUPERHEATED STEAM	Mass flow	Heat flow
WATER DELTA HEAT	Mass flow	Heat flow
SATURATED STEAM DELTA HEAT	Mass flow	Heat flow
WATER	Mass flow	Volume flow
USER DEFINED LIQUID	Mass flow	Volume flow
COMPRESSED AIR	Corrected volume flow	Volume flow
NATURAL GAS AGA NX-19	Corrected volume flow	Volume flow
CARBON DIOXIDE	Corrected volume flow	Volume flow
OXYGEN	Corrected volume flow	Volume flow
NITROGEN	Corrected volume flow	Volume flow
NATURAL GAS AGA8-DC92	Corrected volume flow	Heat flow
NATURAL GAS ISO 12213-2	Corrected volume flow	Heat flow
NATURAL GAS AGA8 Gross Method 1	Corrected volume flow	Heat flow
NATURAL GAS SGERG-88	Corrected volume flow	Heat flow
GAS VOLUME	Volume flow	Volume flow
LIQUID VOLUME	Volume flow	Volume flow
REAL GAS	Corrected volume flow	Volume flow
GAS MIXTURE	Corrected volume flow	Volume flow
ARGON	Corrected volume flow	Volume flow
METHANE	Corrected volume flow	Volume flow

Note!
If the values assigned to the totalizers are not suitable, the assignment can be changed accordingly via the matrix in the TOTALIZER 1 and 2 function groups.

Table of contents

1 Safety instructions

1.1 Designated use

The measuring system is used to measure the flow of saturated steam, superheated steam, gases and liquids. The system primarily measures the measured variables volume flow and temperature. With these values, the device can use preprogrammed data on the density and enthalpy to calculate and output the mass flow and heat flow for example.

In the event of incorrect use or use other than that designated, the operational safety of the measuring devices can be suspended. The manufacturer accepts no liability for damage arising as a result.

1.2 Installation, commissioning and operation

Note the following points:
- Assembly, electrical installation, commissioning and maintenance of the device must be carried out by trained, qualified specialists authorized to perform such work by the facility's owner-operator. The specialist must have read and understood these Operating Instructions and must follow the instructions they contain.
- The device must be operated by persons authorized and trained by the facility's owner-operator. Strict compliance with the instructions in these Operating Instructions is mandatory.
- In the case of special fluids (incl. fluids for cleaning), Endress+Hauser will be happy to assist in clarifying the corrosion resistance properties of wetted materials. However, small changes in temperature, concentration or the degree of contamination in the process can result in changes to the corrosion resistance properties. Unsuitable material can lead to leakage of corrosive process media and injure personnel and/or cause damage in the plant. Therefore, Endress+Hauser cannot guarantee or accept liability for the corrosion resistance properties of wetted materials in a specific application. The user is responsible for choosing suitable wetted materials in the process.
- If carrying out welding work on the piping, the welding unit may 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.
- Always observe the regulations applicable in your country governing the operation, maintenance and repair of electrical devices. Special instructions relating to the device can be found in the relevant sections of this documentation.

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 the Ex documentation indicates the approval and the certification center (Ex Europe, FM USA, CSA Canada).
- The measuring system complies with the general safety requirements in accordance with EN 61010-1 and the EMC requirements of IEC/EN 61326 and NAMUR Recommendations NE 21, NE 43 and NE 53.
- For measuring systems used in SIL 1 applications, the separate manual on functional safety must be observed.
- 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 fully completed "Declaration of Contamination" form with the device. 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 Regulation (EC) No 1907/2006 REACH.
- Remove all fluid residues. Pay special attention to the grooves for seals and crevices which could contain residues.
  This is particularly important if the fluid is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.

Note!
You will find a *master copy* of the "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 (caustic 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 "Safety requirements for electrical equipment for measurement, control and laboratory use". The devices can, however, be a source of danger if used incorrectly or for anything other than their designated use.
Consequently, always pay particular attention to the safety instructions indicated in these Operating Instructions by the following symbols:

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 the 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 "Proline Prowirl 73" flow measuring system consists of the following components:
- Proline Prowirl 73 transmitter
- Prowirl F or Prowirl W sensor

Two versions are available:
- *Compact version*: transmitter and sensor form a single mechanical unit.
- *Remote version*: sensor is mounted separate from the transmitter.

2.1.1 Nameplate of the transmitter and sensor

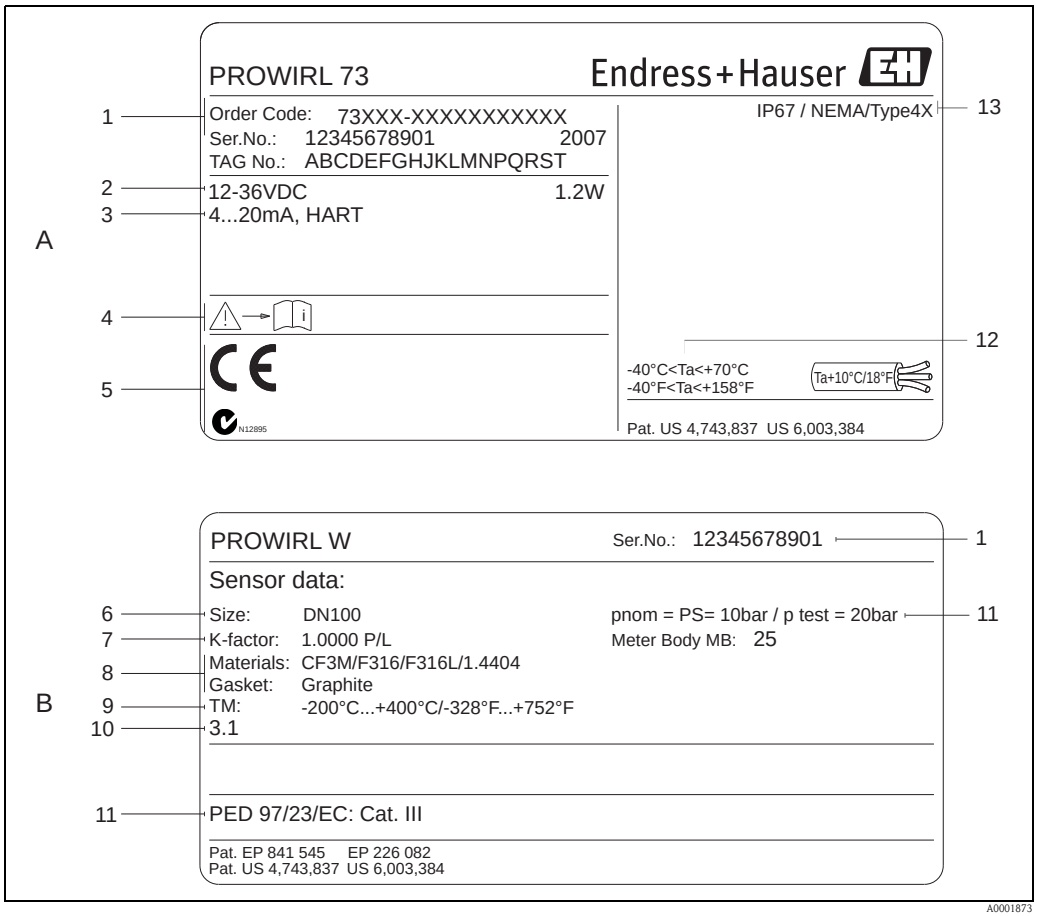


Fig. 1: Nameplate specifications for transmitter and sensor (example)
A = nameplate on transmitter, B = nameplate on sensor (only compact version)

1 Order code/serial number: see the specifications on the order confirmation for the meanings of the individual letters and digits
2 Power supply: 12 to 36 V DC, power consumption: 1.2 W
3 Available outputs: Current output 4 to 20 mA
4 Observe device documentation
5 Reserved for certificates, approvals and additional information on the device version
6 Nominal diameter
7 Calibration factor
8 Material of measuring tube and seal
9 Fluid temperature range
10 Reserved for information on special products
11 Data regarding Pressure Equipment Directive (optional)
12 Permitted ambient temperature range
13 Degree of protection

2.1.2 Sensor nameplate (remote)

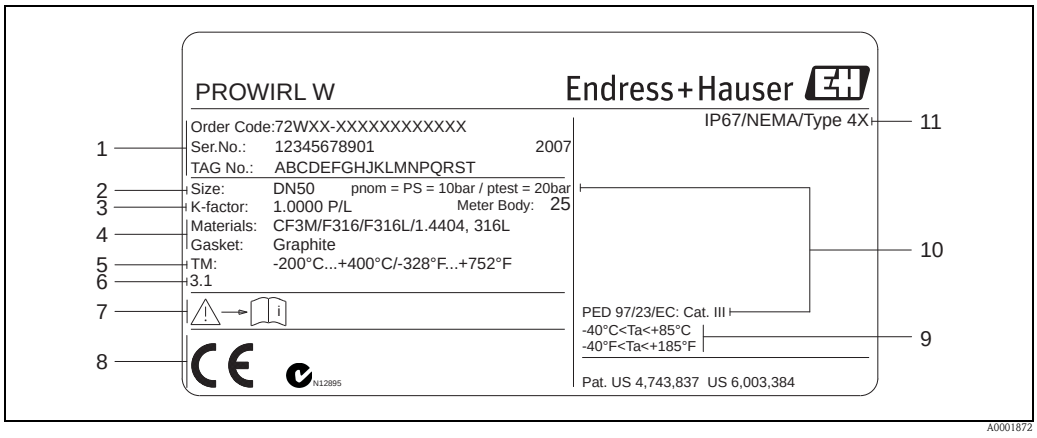


Fig. 2: Nameplate specifications for remote sensor version (example)

1 *Order code/serial number: see the specifications on the order confirmation for the meanings of the individual letters and digits.*
2 *Nominal diameter*
3 *Calibration factor*
4 *Material of measuring tube and seal*
5 *Fluid temperature range*
6 *Reserved for information on special products*
7 *Observe device documentation*
8 *Reserved for certificates, approvals and additional information on the device version*
9 *Permitted ambient temperature range*
10 *Data regarding Pressure Equipment Directive (optional)*
11 *Degree of protection*

2.1.3 Service nameplate

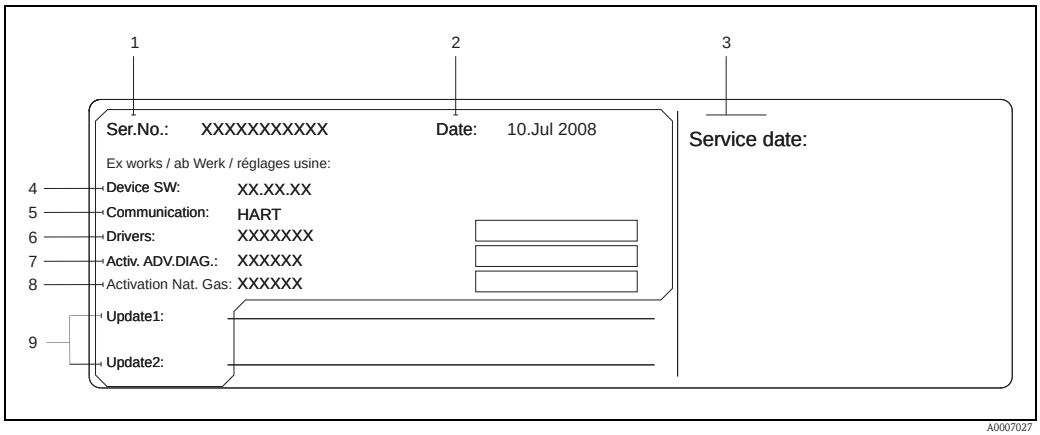


Fig. 3: Service nameplate specifications for transmitter (example)

1 *Serial number*
2 *Date of manufacturing*
3 *Service date*
4 *Device software*
5 *Type of device communication (e.g. HART)*
6 *Version of device software currently installed*
7 *Activation code for the "Advanced diagnostics" order option*
8 *Activation code for the "Natural gas (natural gas equation)" order option*
9 *Space for update entries*

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"Safety requirements for electrical equipment for measurement, control and laboratory use" and the EMC requirements as per IEC/EN 61326.
The measuring system described in these Operating Instructions thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark and issuing the CE Declaration of Conformity.
The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

2.3 Registered trademarks

GYLON®
Registered trademark of Garlock Sealing Technologies, Palmyar, NY, USA

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

INCONEL®
Registered trademark of Inco Alloys International Inc., Huntington, USA

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

Applicator®, FieldCare®, Fieldcheck®, Field Xpert™
Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

3 Installation

3.1 Incoming acceptance, transport, 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

Please note the following when unpacking or transporting to the measuring point:
- The devices must be transported in the container supplied.
- Devices with nominal diameters DN 40 to 300 (1½ to 12") may not be lifted at the transmitter housing or at the connection housing of the remote version when transporting (→ 4). Use carrier slings when transporting and put the slings around both process connections. Avoid chains as these could damage the housing.

Warning!
Risk of injury if the measuring device slips.
The center of gravity of the entire measuring device might be higher than the points around which the slings are slung.
Therefore, when transporting, make sure that the device does not unintentionally turn or slip.

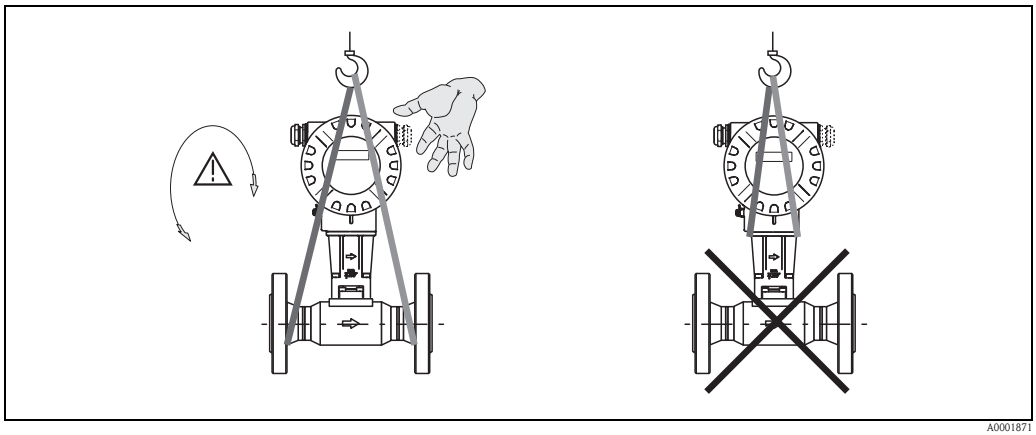


Fig. 4: Instructions for transporting sensors with DN 40 to 300 (1½ to 12")

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:
  – Standard: –40 to +80 °C (–40 to +176 °F)
  – ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C (–4 to +131 °F)
- Protect the measuring device against direct sunlight during storage in order to avoid unacceptably high surface temperatures.

3.2 Installation conditions

Note the following points:
- The measuring device requires a fully developed flow profile as a prerequisite for correct volume flow measurement. The inlet and outlet runs therefore have to be taken into account (→ 📄 20).
- The maximum permitted ambient temperatures (→ 📄 84) and fluid temperatures (→ 📄 85) must be observed.
- Pay particular attention to the notes on orientation and piping insulation (→ 📄 18).
- Verify that the correct nominal diameter and pipe standard (DIN/JIS/ANSI) were taken into account when ordering since the calibration of the device and the achievable accuracy depend on these factors. If the mating pipe and the device have different nominal diameters/pipe standards, an inlet correction can be made via the device software by entering the actual pipe diameter (→ 📄 140, D MATING PIPE function).
- The correct operation of the measuring system is not influenced by plant vibrations up to 1 g, 10 to 500 Hz.
- For mechanical reasons, and in order to protect the piping, 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 "Technical Information" document.

3.2.2 Installation location

We recommend you observe the following dimensions to guarantee problem-free access to the device for service purposes:
- Minimum spacing (A) in all directions = 100 mm (3.94")
- Necessary cable length (L): L + 150 mm (5.91")

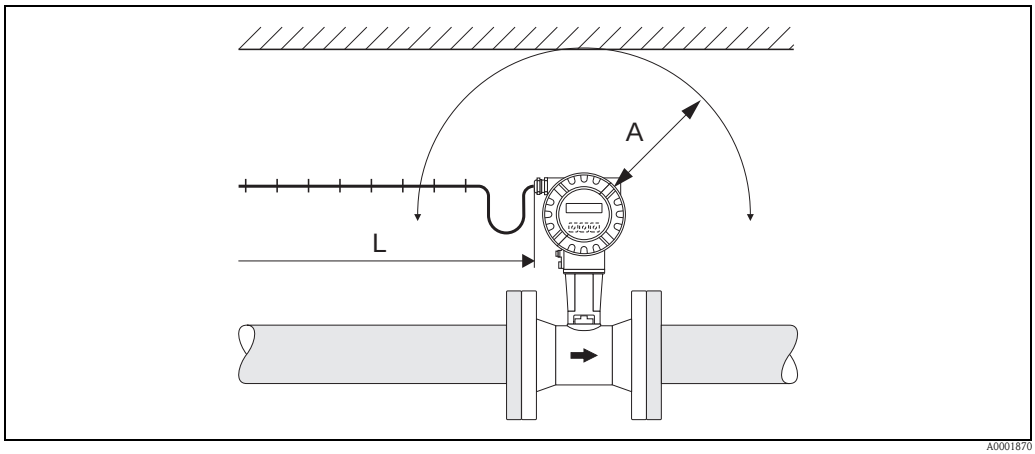


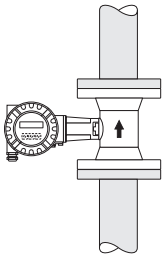
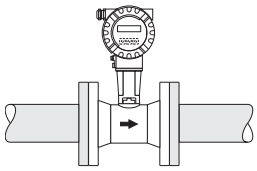
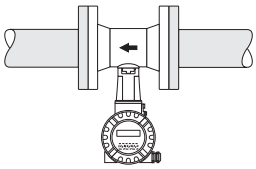
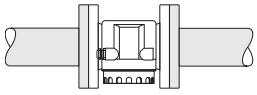
Fig. 5: Minimum spacing

A Minimum spacing in all directions
L Cable length

3.2.3 Orientation

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

The device can basically be installed in any orientation. However, note the following points:

Orientation		High fluid temperature (TM) ≥ 200 °C (392 °F)	Low fluid temperature (TM)
Fig. A: Vertical orientation	 A0009522	Recommended (①)	Recommended (①)
Fig. B: Horizontal orientation Transmitter head up	 A0009523	Not permitted for Prowirl 73W DN 100 (4") / DN 150 (6") (②)	Recommended (③)
Fig. C: Horizontal orientation Transmitter head down	 A0009524	Recommended (④)	
Fig. D: Horizontal orientation Transmitter head at front with display pointing downwards	 A0009525	Recommended (④)	Recommended (③)

① In the case of liquids, there should be upward flow in vertical pipes to avoid partial pipe filling (Fig. A).

Caution!
Disruption in flow measurement!
To guarantee the flow measurement of liquids, the measuring tube must always be completely full in pipes with vertical downward flow.

② Caution!
Danger of electronics overheating!
If fluid temperature is ≥ 200 °C (392 °F), orientation B is not permitted for the wafer version (Prowirl 73W) with nominal diameters DN 100 (4") and DN 150 (6").

In order to ensure that the maximum permissible ambient temperature for the transmitter is not exceeded (→ 84), we recommend the following orientations:

③ In the case of hot fluids (e.g. steam or fluid temperature (TM) ≥ 200 °C (392 °F)): orientation C or D

④ In the case of very cold fluids (e.g. liquid nitrogen): orientation B or D

3.2.4 Heat insulation

Some fluids require suitable measures to avoid heat transfer at the sensor to ensure optimum temperature measurement and mass calculation. A wide range of materials can be used to provide the required insulation.
When insulating, please ensure that a sufficiently large area of the housing support is exposed. The uncovered part serves as a radiator and protects the electronics from overheating (or undercooling). The maximum insulation height permitted is illustrated in the diagrams. These apply equally to both the compact version and the sensor in the remote version.

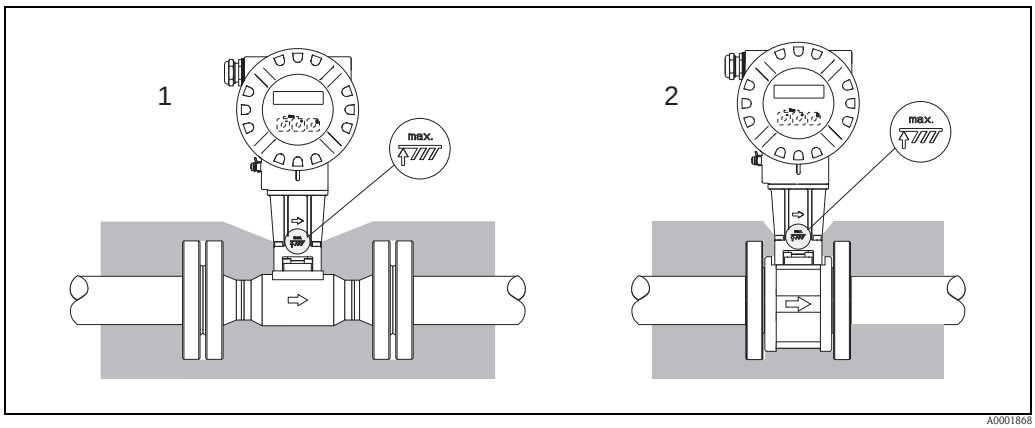


Fig. 6: 1 = Flanged version, 2 = Wafer version

Caution!
Danger of electronics overheating!
- Always keep the adapter between the sensor/transmitter and the connection housing of the remote version free of insulating material.
- Note that a certain orientation might be required, depending on the fluid temperature (→ 18).
- Observe information on the permissible temperature ranges (→ 84).

3.2.5 Inlet and outlet run

As a minimum, the inlet and outlet runs shown below must be observed to achieve the specified accuracy of the device. The longest inlet run shown must be observed if two or more flow disturbances are present.

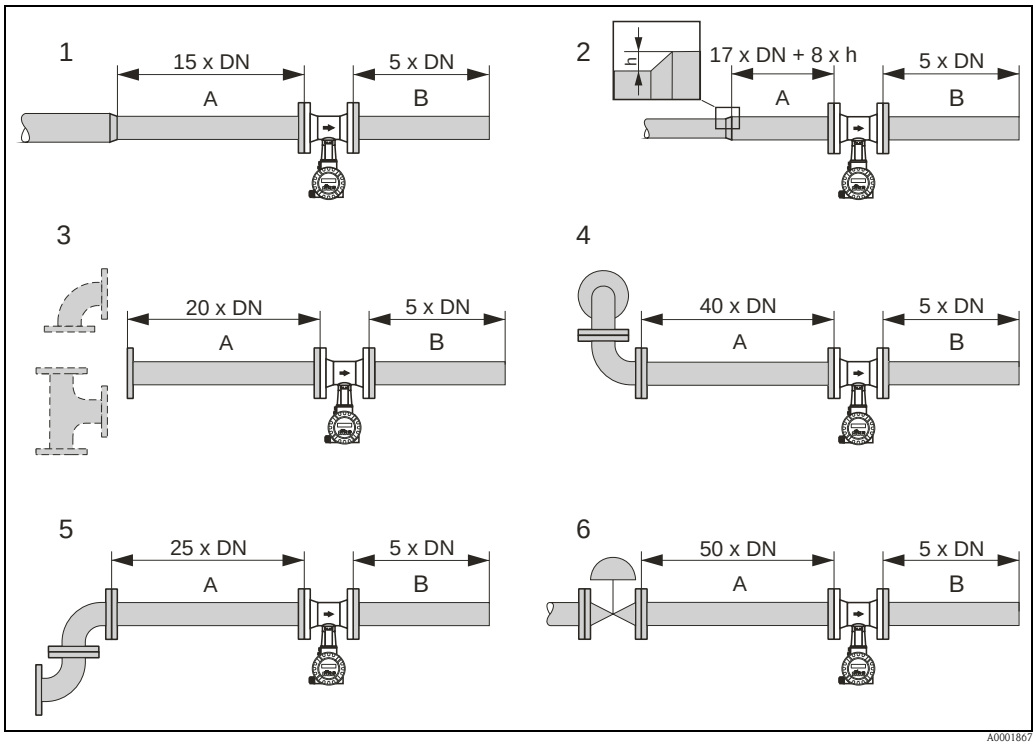


Fig. 7: Minimum inlet and outlet runs with various flow obstructions

A Inlet run
B Outlet run
h Difference in expansion
1 Reduction
2 Extension
3 90° elbow or T-section
4 2 × 90° elbow 3-dimensional
5 2 × 90° elbow
6 Control valve

Note!
A specially designed perforated plate flow conditioner can be installed if it is not possible to observe the inlet runs required (→ 21).

Outlet runs with pressure measuring points

If a pressure measuring point is installed after the device, please ensure there is a large enough distance between the device and the measuring point so there are no negative effects on vortex formation in the sensor.

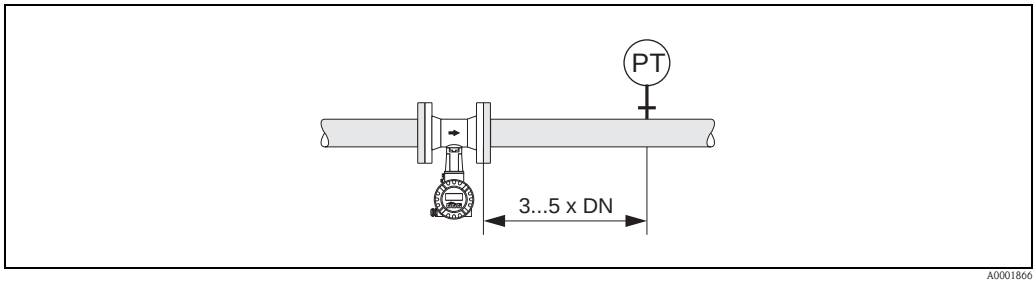


Fig. 8: Installation of pressure measuring point (PT)

Perforated plate flow conditioner

A specially designed perforated plate flow conditioner, available from Endress+Hauser, can be installed if it is not possible to observe the inlet runs required. The flow conditioner is fitted between two piping flanges and centered with mounting bolts. Generally, this reduces the inlet run required to 10 × DN with complete accuracy.

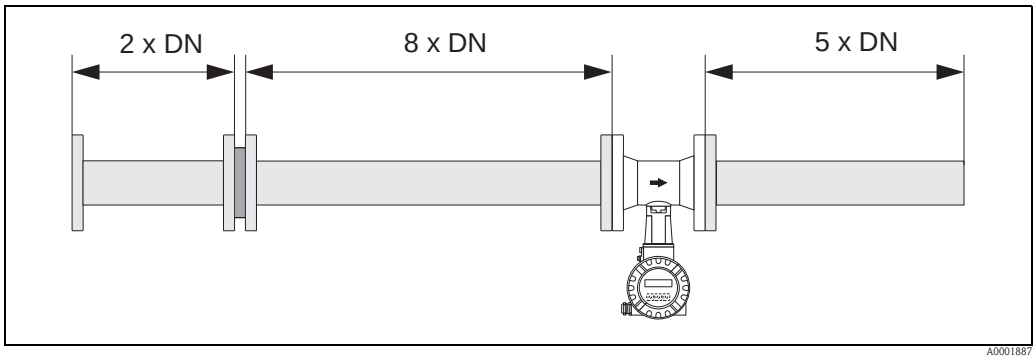


Fig. 9: Perforated plate flow conditioner

Calculation examples (SI units) for the pressure loss of flow conditioners:

The pressure loss for flow conditioners is calculated as follows:
Δp [mbar] = 0.0085 · ρ [kg/m³] · v² [m/s]

- Example with steam
  p = 10 bar abs
  t = 240 °C → ρ = 4.39 kg/m³
  v = 40 m/s
  Δp = 0.0085 · 4.39 · 40² = 59.7 mbar

- Example with H_2O condensate (80 °C)
  ρ = 965 kg/m³
  v = 2.5 m/s
  Δp = 0.0085 · 965 · 2.5² = 51.3 mbar

ρ : density of the process medium
v : average flow velocity

3.2.6 Vibrations

The correct operation of the measuring system is not influenced by plant vibrations up to 1 g, 10 to 500 Hz. Consequently, the sensors require no special measures for attachment.

3.2.7 Limiting flow

Information on limiting flow is provided under the "Measuring range" (→ 78) and "Limiting flow" (→ 86) sections in the Technical Data chapter.

3.3 Installation instructions

3.3.1 Mounting the sensor

Caution!
Please note the following prior to mounting:

- Prior to installing the measuring device in the piping, remove all traces of transport packaging and any protective covers from the sensor.
- Make sure that the internal diameters of seals are the same as, or greater than, those of the measuring pipe and piping. Seals projecting into the flow current have a negative effect on the vortex formation after the bluff body and cause inaccurate measurement. The seals provided by Endress+Hauser for the wafer version have therefore an inner diameter with a bigger inner diameter than the piping.
- Ensure that the arrow on the measuring pipe matches the direction of flow in the piping.
- Lengths:
  – Prowirl W (wafer version): 65 mm (2.56")
  – Prowirl F (flanged version) →See Technical Information TI00070D/06/EN.

Mounting Prowirl W

The centering rings supplied are used to mount and center the wafer-style devices.
A mounting kit consisting of tie rods, seals, nuts and washers can be ordered separately.

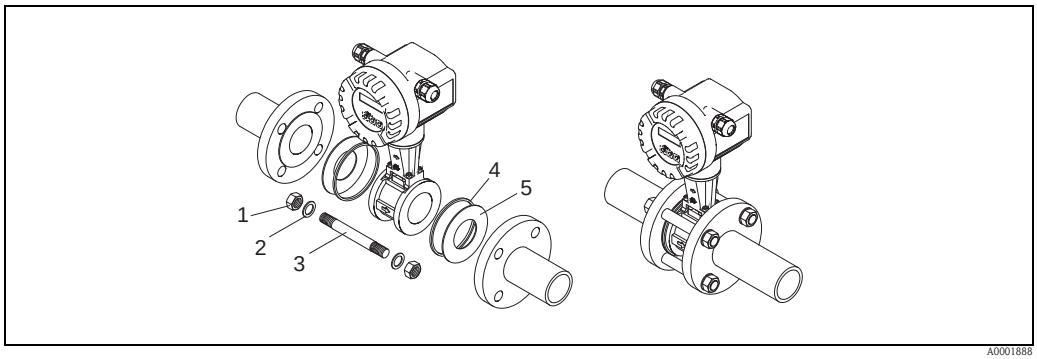


Fig. 10: Mounting the wafer version

1 Nut
2 Washer
3 Tie rod
4 Centering ring (is supplied with the device)
5 Seal

3.3.2 Rotating the transmitter housing

The electronics housing can be rotated continuously 360° on the housing support.

1. Release the lock screw.
2. Turn the transmitter housing to the desired position (max. 180° in each direction to the stop).

   ✎ Note!
   There are recesses in the rotating groove at 90° stages (only compact version). These help you align the transmitter easier.
3. Tighten the safety screw.

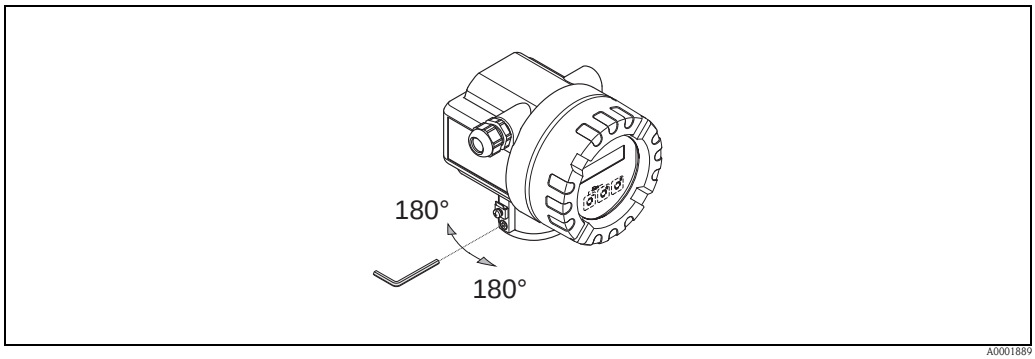


Fig. 11: Rotating the transmitter housing

3.3.3 Rotating the local display

1. Unscrew the cover of the electronics compartment from the transmitter housing.
2. Remove the display module from the transmitter retainer rails.
3. Turn the display to the desired position (max. 4 × 45° in each direction) and reset it onto the retaining rails.
4. Screw the cover of the electronics compartment firmly back onto the transmitter housing.

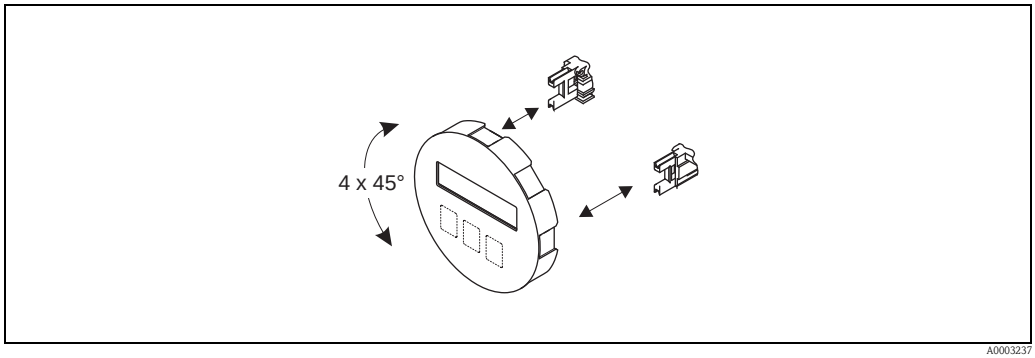


Fig. 12: Rotating the local display

3.3.4 Mounting the transmitter (remote)

The transmitter can be mounted in the following ways:
- Wall mounting
- Pipe mounting (with separate mounting kit, accessories → 59)

The transmitter and the sensor must be mounted separate in the following circumstances:
- poor accessibility,
- lack of space,
- extreme ambient temperatures.

Caution!
Danger of electronics overheating!
If the device is mounted to warm piping, make certain that the housing temperature does not exceed the max. permissible temperature value.
- Standard: –40 to +80 °C (–40 to +176 °F)
- EEx-d/XP version: –40 to +60 °C (–40 to +140 °F)
- ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C (–4 to +131 °F)

Mount the transmitter as illustrated in the diagram.

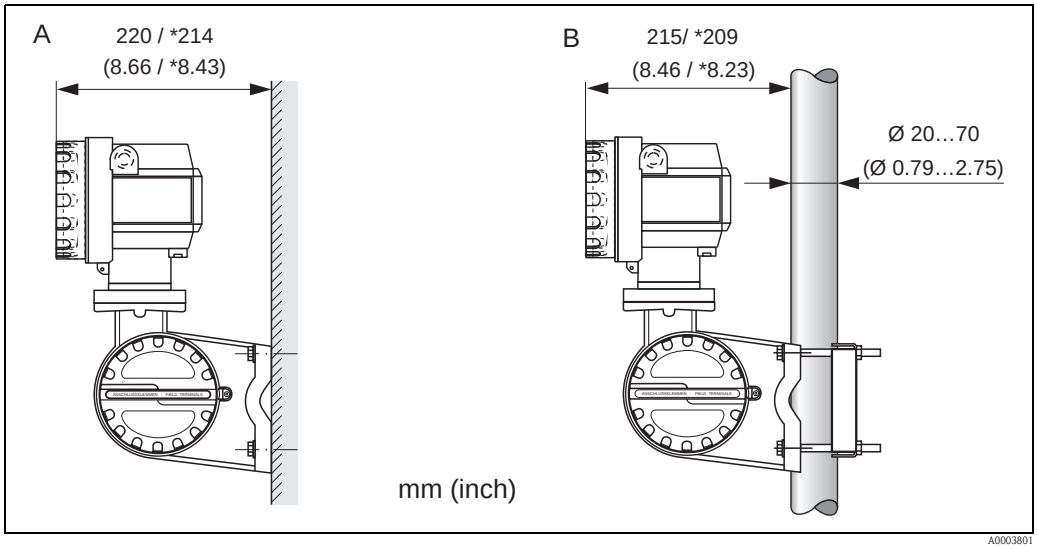


Fig. 13: Mounting the transmitter (remote version)

A Direct wall mounting
B Pipe mounting
** Dimensions for version without local operation*

3.4 Post-installation check

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

Device condition and specifications	Notes
Is the device damaged (visual inspection)?	-
Do the process temperature/pressure, ambient temperature, measuring range, etc. correspond to the specifications of the device?	→ 78
Installation	Notes
Does the arrow on the pipe or on the sensor match the direction of flow through the pipe?	-
Are the measuring point number and labeling correct (visual inspection)?	-
Is the orientation chosen for the sensor correct, in other words suitable for sensor type, fluid properties (outgassing, with entrained solids) and fluid temperature?	→ 17
Process environment/process conditions	Notes
Is the measuring device protected against moisture and direct sunlight?	-

4 Wiring

Warning!
When connecting Ex-certified devices, please refer to 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 Connecting the remote version

4.1.1 Connecting the sensor

Caution!
Risk of damaging the electronic components!
- Ground the remote version. In doing so, connect the sensor and transmitter to the same potential matching.
- When using the remote version, only connect the sensor to the transmitter with the same serial number.

1. Remove the cover of the connection compartment of the transmitter (a).
2. Remove the cover of the connection compartment of the sensor (b).
3. Feed the connecting cable (c) through the appropriate cable entries.
4. Wire the connecting cable between the sensor and transmitter in accordance with the electrical connection diagram: → 14, wiring diagram in screw cap.
5. Tighten the glands of the cable entries on the sensor housing and transmitter housing.
6. Screw the cover of the connection compartment (a/b) back onto the sensor housing or transmitter housing.

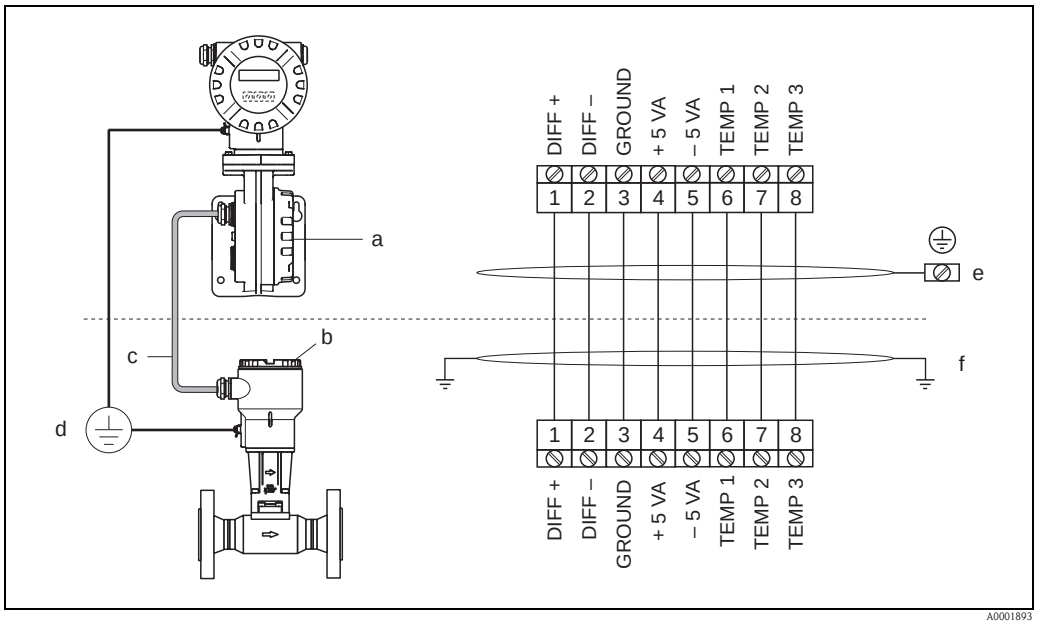


Fig. 14: Connecting the remote version

a Connection compartment cover (transmitter)
b Connection compartment cover (sensor)
c Connecting cable (signal cable)
d Identical potential matching for sensor and transmitter
e Connect shielding to ground terminal in transmitter housing and keep as short as possible
f Connect shielding to cable strain relief clamp in connection housing

Wire colors (color code in accordance with DIN 47100):
Terminal No.: 1 = white; 2 = brown; 3 = green; 4 = yellow; 5 = gray; 6 = pink; 7 = blue; 8 = red

4.1.2 Cable specifications, standard connecting cable

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

- 4 × 2 × 0.5 mm² (AWG 20) PVC cable with common shield (4 pairs, pair-stranded)

  ✎ Note!
  If the cross-section of a cable deviates from the specification, the value for the cable length has to be calculated. → See "Calculating and entering the cable length".

- Conductor resistance according to DIN VDE 0295 class 5 or IEC 60228 class 5: 39 Ω/km

  ✎ Note!
  The conductor resistance specified by the standard is compensated for.

- Capacity core/screen: < 400 pF/m (122 pF/ft)
- Cable length: max. 30 m (98 ft)
- Operating temperature: –40 to +105 °C (–40 to +221 °F)

4.1.3 Cable specification, armored connecting cable

The optionally available armored connecting cable between transmitter and sensor possesses the following specifications:

- 4 × 2 × 0.5 mm² (AWG 20) PVC cable with common shield (4 pairs, pair-stranded)

  ✎ Note!
  If the cross-section of a cable deviates from the specification, the value for the cable length has to be calculated. → See "Calculating and entering the cable length".

- Conductor resistance according to DIN VDE 0295 class 5 or IEC 60228 class 5: 39 Ω/km

  ✎ Note!
  The conductor resistance specified by the standard is compensated for.

- Extensively resistant against acids, bases and specific oils
- A galvanized braided steel wire forms the total shield
- Outer sheath version: smooth, uniform, round
- Cable length: max. 30 m (98 ft)
- Operating temperature: –30 to +70 °C (–22 to +158 °F)

4.1.4 Calculating and entering the cable length

1. Calculate the cable length as follows if the cross-section of the connecting cable deviates from the specification:

$$\frac{\text{Conductor resistance of the cable used [Ω/km]}}{\text{Conductor resistance as per specification [Ω/km]}} \cdot \text{Actual cable length [m]} = \text{cable length to be entered [m]}$$

Example:

$$\frac{26\ \Omega/\text{km}}{39\ \Omega/\text{km}} \cdot 15\ \text{m} = 10\ \text{m}$$

2. Enter the value for the cable length in the CABLE LENGTH function (→ 172) in accordance with the unit that was selected in the UNIT LENGTH function (→ 106).

4.2 Connecting the measuring unit

4.2.1 Connecting the transmitter

Warning!
- When connecting Ex-certified devices, please refer to the notes and diagrams in the Ex-specific supplement to these Operating Instructions.
- Ground the remote version. In doing so, connect the sensor and transmitter to the same potential matching.

Note!
- Observe national regulations governing the installation of electrical equipment.

Connecting the transmitter, non-Ex, Ex-i /IS and Ex-n version (→ 15)

1. Unscrew the cover (a) of the electronics compartment from the transmitter housing.
2. Remove the display module (b) from the retaining rails (c) and refit onto the right retaining rail with the left side. This secures the display module.
3. Loosen the screws of the cover of the connection compartment (d) and fold down the cover.
4. Push the cable for the power supply/current output through the cable gland (e).
   Optional: push the cable for the frequency output through the cable gland (f).
5. Tighten the cable glands (e/f) (→ 34).
6. Pull the terminal connector (g) out of the transmitter housing and connect the cable for the power supply/current output (→ 17).
   Optional: pull the terminal connector (h) out of the transmitter housing and connect the cable for the frequency output (→ 17).

   Note!
   The terminal connectors (g/h) are pluggable, i.e. they can be plugged out of the transmitter housing to connect the cables.
7. Plug the terminal connectors (g/h) into the transmitter housing.

   Note!
   The connectors are coded so you cannot mix them up.
8. Fold up the cover of the connection compartment and tighten the screws (d).
9. Remove the display module (b) and fit onto the retaining rails (c).
10. Screw the cover of the electronics compartment (a) onto the transmitter housing.
11. Only remote version: Secure the ground cable to the ground terminal (see → 17, C).

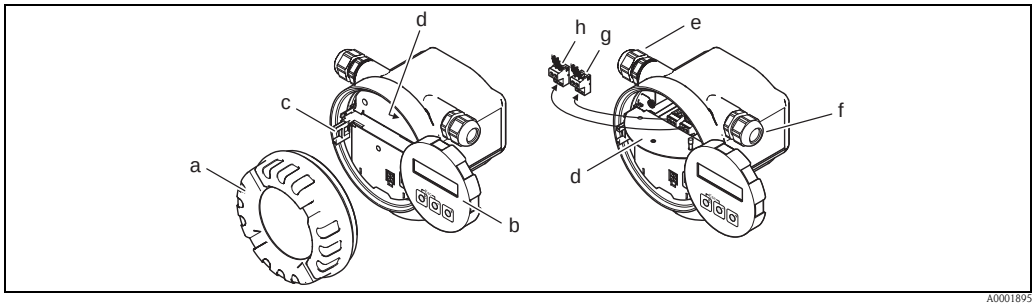


Fig. 15: Procedure for connecting the transmitter Non-Ex / Ex-i/IS and Ex-n version

a Cover of electronics compartment
b Display module
c Retaining rail for display module
d Cover of connection compartment
e Cable gland for power supply/current output cable
f Cable gland for frequency output cable (optional)
g Terminal connector for power supply/current output
h Terminal connector for frequency output (optional)

Connecting the transmitter, Ex-d/XP version (→ 16)

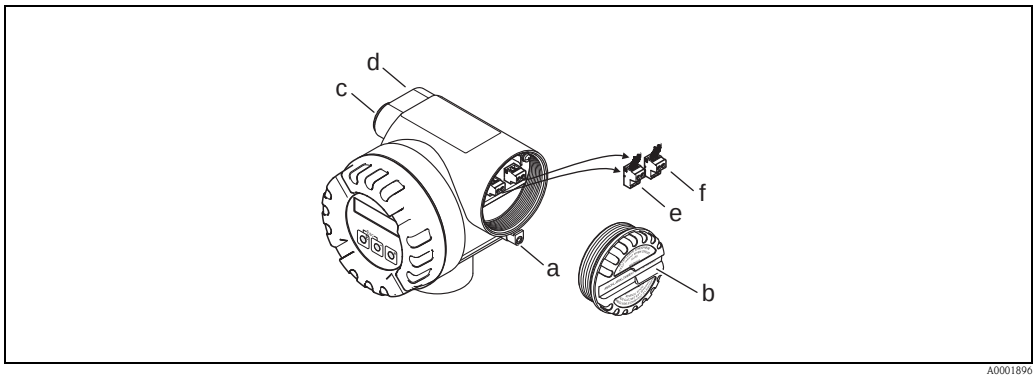
Warning!
When connecting Ex-certified devices, please refer to the notes and diagrams in the Ex-specific supplement to these Operating Instructions.

1. Open the clamp (a) securing the cover of the connection compartment.
2. Unscrew the cover (b) of the connection compartment from the transmitter housing.
3. Push the cable for the power supply/current output through the cable gland (c).
   Optional: push the cable for the frequency output through the cable gland (d).

   Note!
   Devices with a TIIS approval are equipped in general with one cable gland only.
4. Tighten the cable glands (c/d) (→ 34).
5. Pull the terminal connector (e) out of the transmitter housing and connect the cable for the power supply/current output (→ 17).
   Optional: pull the terminal connector (f) out of the transmitter housing and connect the cable for the frequency output (→ 17).

   Note!
   The terminal connectors (e/f) are pluggable, i.e. they can be plugged out of the transmitter housing to connect the cables.
6. Plug the terminal connectors (e/f) into the transmitter housing.

   Note!
   The connectors are coded so you cannot mix them up.
7. Screw the cover (b) of the connection compartment onto the transmitter housing.
8. Tighten the clamp (a) securing the cover of the connection compartment.
9. Only remote version: secure the ground cable to the ground terminal (→ 17, C).



A0001896

Fig. 16: Procedure for connecting the transmitter Ex-d/XP version

a Clamp securing cover of connection compartment
b Cover of connection compartment
c Cable gland for power supply/current output cable
d Cable gland for frequency output cable (optional)
e Terminal connector for power supply/current output
f Terminal connector for frequency output (optional)

Wiring diagram

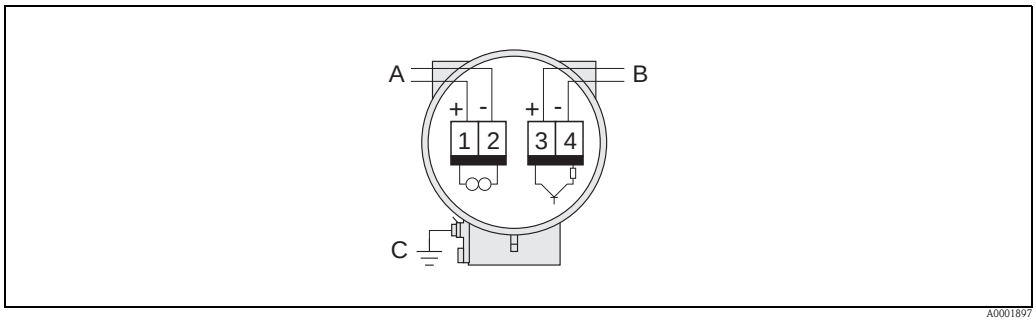


Fig. 17: Assignment of terminals

A Power supply/current output
B Optional frequency output can also be operated as:
– A pulse or status output
– A PFM output together with the RMC or RMS621 flow computer (see below)
C Ground terminal (only relevant for remote version)

Connecting the device to the RMC or RMS621 flow computer

The device can output PFM (pulse/frequency modulation) signals together with the RMC or RMS621 flow computer.

Note!
To output vortex pulses directly, the VORTEX FREQUENCY option must be selected in the OPERATION MODE function (→ 122).

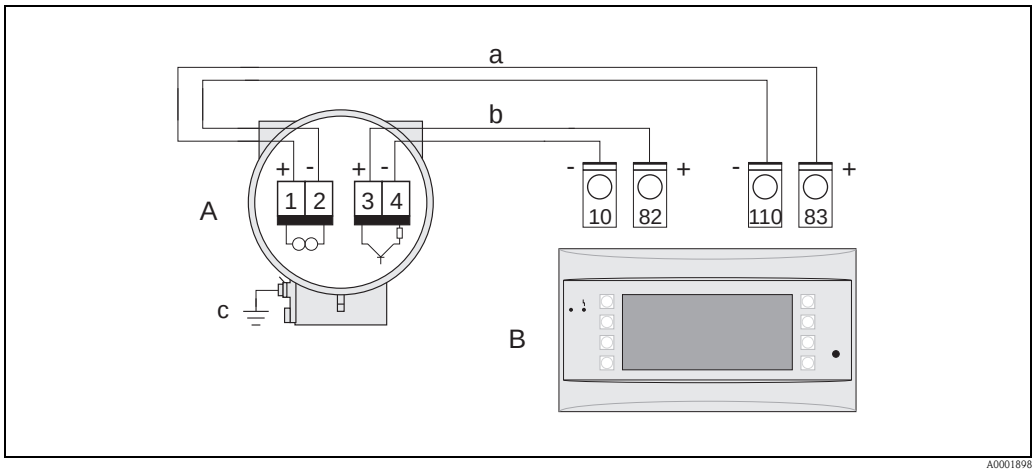


Fig. 18: Assignment of the terminals for connecting to the RMC or RMS621 flow computer

A Device
B RMC or RMS621 flow computer
a Terminal 83 (loop supply 2 +); terminal 110 (input 2 - mA/PFM/pulse), slot AII
b Terminal 82 (loop supply 1 +); terminal 10 (input 1 - mA/PFM/pulse), slot AI
c Ground terminal (only relevant for remote version)

Connection diagram for reading in external temperature/pressure values via the HART protocol

Note!
- For configuring and commissioning external temperature/pressure sensors, see → 📄 57
- The pulse/frequency output remains available in the following circuit diagrams and can be used to output the mass flow or the temperature for example. The external temperature sensor for delta heat measurements, e.g. Omnigrad TR10 with TMT182 head transmitter, is shown in gray.
- The minimum resistor power must be 1W.

PLC with common "plus"

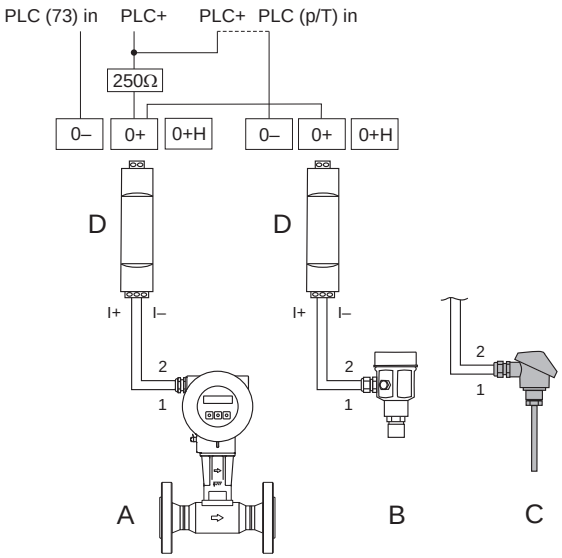


Fig. 19: Connection diagram for PLC with common "plus"

Dotted line = alternative wiring when only the signal of the Prowirl 73 is fed to the PLC.
A Prowirl 73
B Pressure sensor (Cerabar M, S HART with BURST OPTION = 1 and Burst-Mode = ON)
C Temperature sensor (Omnigrad TR10) or other external measuring devices (HART-enabled and burst-enabled)
D Active barrier RN221N

Note!
To be able to use the analog 4 to 20 mA device current output, e.g. for transmitting the measured value to a PLC, set the HART address of the device to "0" (factory setting).
Every address not equal to "0" results in a constant current of 4 mA at the output (COMMUNICATION, FIELDBUS ADDRESS → 📄 138).

PLC with common "minus"

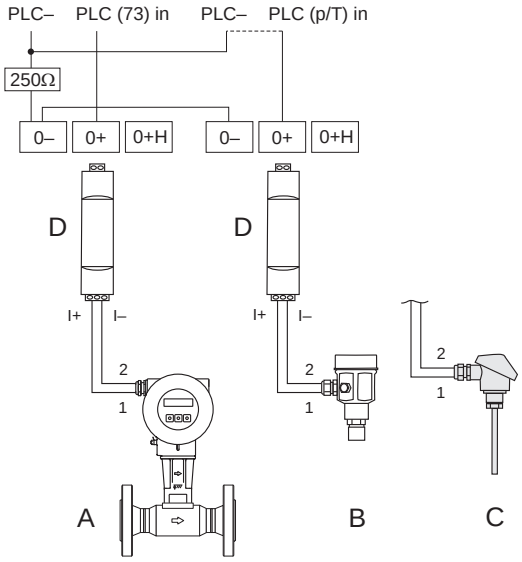


Fig. 20: Connection diagram for PLC with common "minus"

Dotted line = alternative wiring when only the signal of the Prowirl 73 is fed to the PLC.
A Prowirl 73
B Pressure sensor (Cerabar M, S HART with BURST OPTION = 1 and Burst-Mode = ON)
C Temperature sensor (Omnigrad TR10) or other external measuring devices (HART-enabled and burst-enabled)
D Active barrier RN221N

Note!
To be able to use the analog 4 to 20 mA device current output, e.g. for transmitting the measured value to a PLC, set the HART address of the device to "0" (factory setting).
Every address not equal to "0" results in a constant current of 4 mA at the output (COMMUNICATION, FIELDBUS ADDRESS → 138).

Connection diagram without PLC

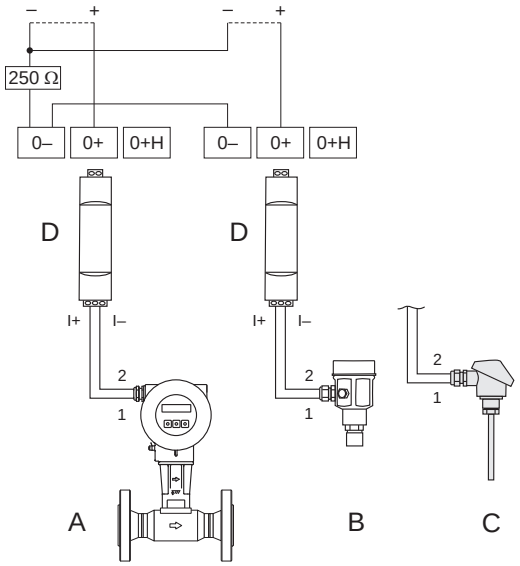


Fig. 21: Connection diagram without PLC

Dotted lines = wiring without connection to external components (e.g. recorder, displays, Fieldgate)
A Prowirl 73
B Pressure sensor (Cerabar M, S HART with BURST OPTION = 1 and Burst-Mode = ON)
C Temperature sensor (Omnigrad TR10) or other external measuring devices (HART-enabled and burst-enabled)
D Active barrier RN221N

4.2.2 Terminal assignment

Order variant	Terminal No. (inputs/outputs) 1-2	3-4
73***_**********W	HART current output	–
73***_**********A	HART current output	Frequency output
HART current output Galvanically isolated, 4 to 20 mA with HART Frequency output Open collector, passive, galvanically isolated, U_{max} = 30 V, with 15 mA current limiting, R_i = 500 Ω, can be configured as frequency, pulse or status output		

4.2.3 HART connection

Users have the following connection options at their disposal:
- Direct connection to transmitter by means of terminals 1 (+) / 2 (–)
- Connection across the 4 to 20 mA circuit.

Note!
- The measuring circuit's minimum load must be at least 250 Ω.
- For the connection, also refer to the documentation issued by the HART Communication Foundation, and in particular HCF LIT 20: "HART, a technical summary".

1. After commissioning: Switch HART write protection on or off (→ 📄 48).

Connecting the HART handheld terminal

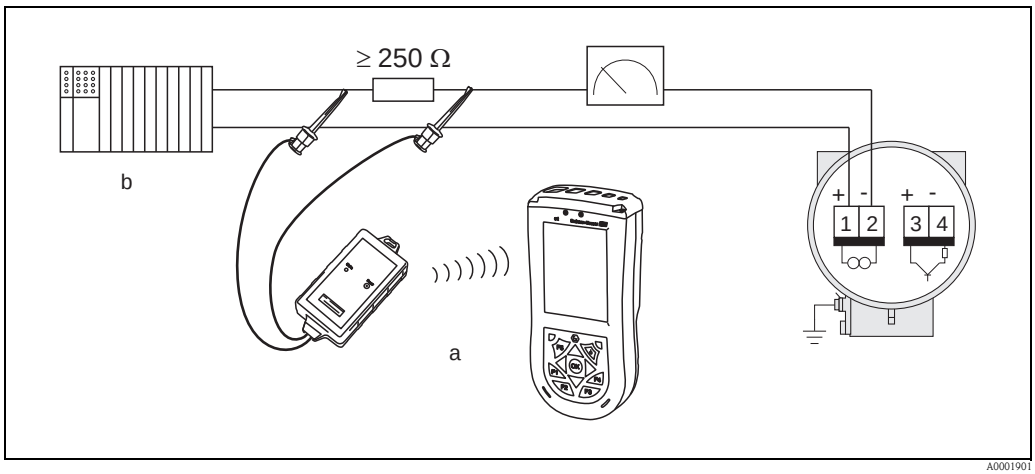


Fig. 22: Electrical connection of the HART handheld terminal Field Xpert SFX100

a HART handheld terminal Field Xpert SFX100
b Additional switching units or PLC with transmitter power supply

Connecting a PC with operating software

A HART modem (e.g. "Commubox FXA195") is required for connecting a PC with operating software (e.g. "FieldCare").

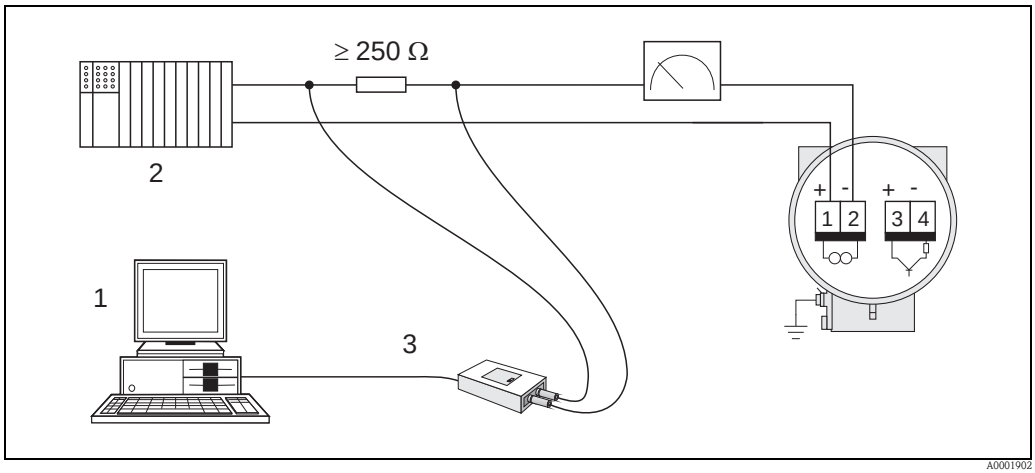


Fig. 23: Electrical connection of a PC with operating software

1 PC with operating software
2 Additional switching units or PLC with passive input
3 HART modem, e.g. Commubox FXA195

4.3 Degree of protection

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

Compliance with the following points is mandatory following installation in the field or servicing in order to ensure that IP 67 (NEMA 4X) protection is maintained:
- The housing seals must be clean and undamaged when inserted into their grooves. Dry, clean or replace the seals if necessary. If the device is used in a dust atmosphere, only use the associated Endress+Hauser housing seals.
- All housing screws and screw caps must be firmly tightened.
- The cables used for connection must be of the specified outside diameter (→ 82, cable entries).
- Tighten the cable entries to ensure they are leak-tight (Point **a** → 24).
- To prevent moisture from penetrating the entry (Point **b** → 24), the cables must form a loop hanging downwards ("water trap") upstream from the cable entry.
- Install the measuring device in such a way that the cable entries do not point upwards.
- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

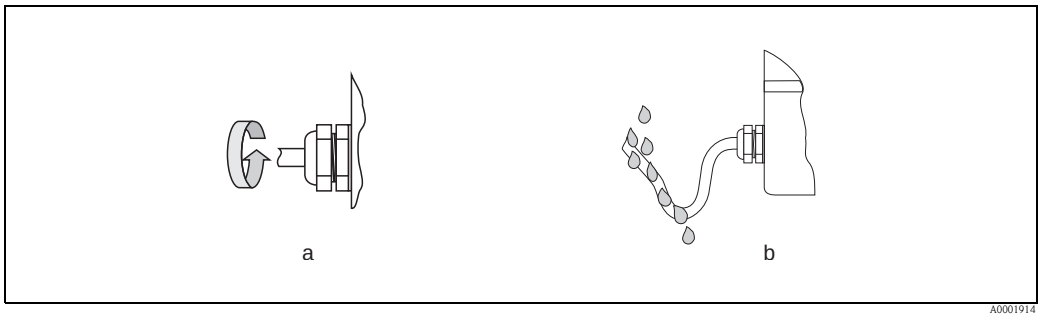


Fig. 24: Installation instructions for cable entries

4.4 Post-connection check

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

Device condition and specifications	**Notes**
Are cables or the device damaged (visual inspection)?	–
Electrical connection	**Notes**
Does the supply voltage match the specifications on the nameplate? Non-Ex: 12 to 36 V DC (with HART: 18 to 36 V DC) Ex-i/IS and Ex-n: 12 to 30 V DC (with HART 18 to 30 V DC) Ex-d/XP: 15 to 36 V DC (with HART 21 to 36 V DC)	–
Do the cables used comply with the specifications?	→ 26, → 82
Do the cables have adequate strain relief?	–
Are the cables for power supply/current output, frequency output (optional) and grounding connected correctly?	→ 27
Only remote version: is the connecting cable between sensor and transmitter connected correctly?	→ 25
Are all terminals firmly tightened?	–
Are all the cable entries installed, tightened and sealed? Cable run with "water trap"?	→ 34
Are all the housing covers installed and tightened?	–

5 Operation

5.1 Display and operating elements

The local display enables you to read all important parameters directly at the measuring point and configure the device using the "Quick Setup" or the function matrix.

The display consists of two lines; this is where measured values and/or status variables (e.g. bar graph) are displayed. You can change the assignment of the display lines to different variables to suit your needs and preferences (→ 📄 112, USER INTERFACE function group).

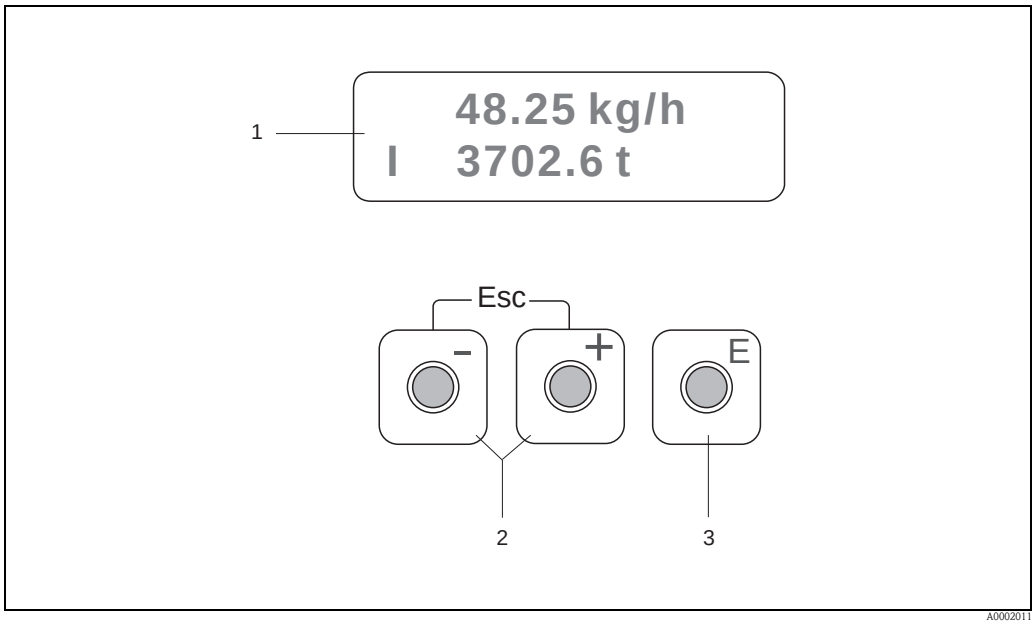


Fig. 25: Display and operating elements

1 Liquid crystal display
Two-line display of measured values, dialog texts and fault and notice messages. The display as it appears during standard measuring mode is known as the HOME position (operating mode).
- *Top line: shows main measured values, e.g. mass flow.*
- *Bottom line: shows additional measured variables and status variables, e.g. totalizer reading, bar graph, tag name.*

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 keys (Esc) longer than 3 seconds → return directly to the HOME position*
- *Cancel data entry*

3 Enter key
- *HOME position → Entry into the function matrix*
- *Save the numerical values you input or settings you changed*

5.2 The function matrix: layout and use

Note!
Note the following points:
- General notes and instructions → 37
- The function matrix → 95
- The detailed description of all the functions → 95

The function matrix consists of two levels:
- Function groups
  The function groups are the highest-level grouping of the control options for the measuring device. A number of functions is assigned to each function group.
- Functions
  You select a function group in order to access the individual functions for operating and configuring the measuring device.

Operate the function matrix as follows:

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

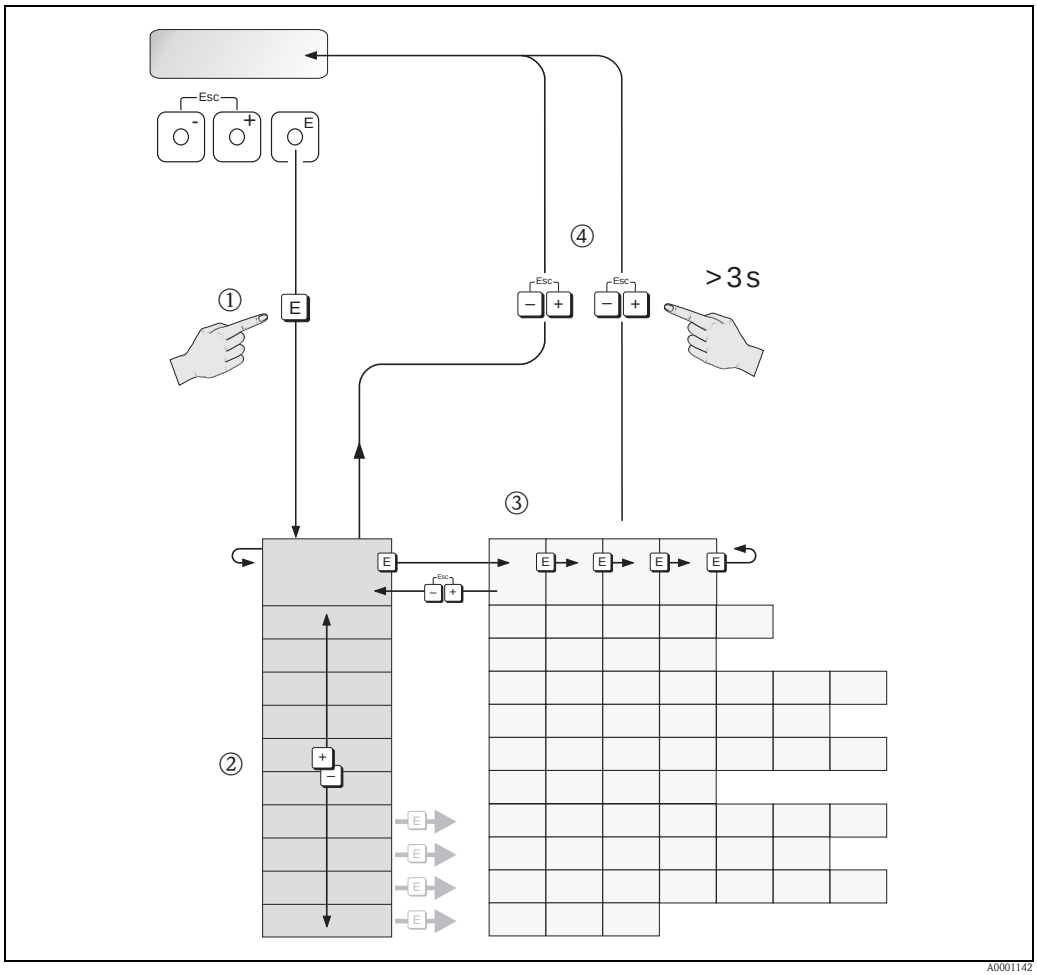


Fig. 26: Selecting and configuring functions (function matrix)

5.2.1 General notes

The Quick Setup menu (→ 📄 109 and → 📄 51) is adequate for commissioning with the necessary standard settings. Complex measuring operations on the other hand necessitate additional functions that you can configure as necessary and customize to suit your process parameters. The function matrix, therefore, comprises a multiplicity of additional functions which, for the sake of clarity, are arranged in a number of function groups.

Comply with the following instructions when configuring functions:
- You select functions as described (→ 📄 36).
- You can switch off certain functions (OFF). If you do so, related functions in other function groups will no longer be displayed.
- If an unassignable option is selected in the ASSIGN LINE 1 or ASSIGN LINE 2 function for the fluid selected (e.g. corrected volume flow option is selected for saturated steam), "----" appears on the display.
- Certain functions prompt you to confirm your data entries. Press ⊞ to select "SURE [YES]" and press the ⓔ key 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 automatically disabled if you do not press a key within 60 seconds following return to the HOME position.

Note!
- All functions are described in detail, as is the function matrix itself on → 📄 95.
- 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 configured values remain safely stored in the EEPROM.

5.2.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings.
A numerical code (factory setting = 73) has to be entered before settings can be changed. If you use a code number of your choice, you exclude the possibility of unauthorized persons accessing data. Function ACCESS CODE → Page 110.

Comply with the following instructions when entering codes:
- If programming is disabled and the ⊞ key combination is pressed in any function, a prompt for the code automatically appears on the display.
- If "0" is entered as the private code, programming is always enabled.
- Your Endress+Hauser service organization can be of assistance if you mislay your private code.

5.2.3 Disabling the programming mode

Programming is disabled if you do not press a key within 60 seconds following automatic return to the HOME position.
You can also disable programming by entering any number (other than the private code) in the ACCESS CODE function.

5.3 Error messages

5.3.1 Type of error

Errors which occur during commissioning or measuring operation are displayed immediately. If two or more system or process errors are present, 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, for example communication errors, hardware errors, etc. (→ 64).
- *Process error:* this group includes all application errors, for example, e.g. "DSC SENS LIMIT" (→ 68).

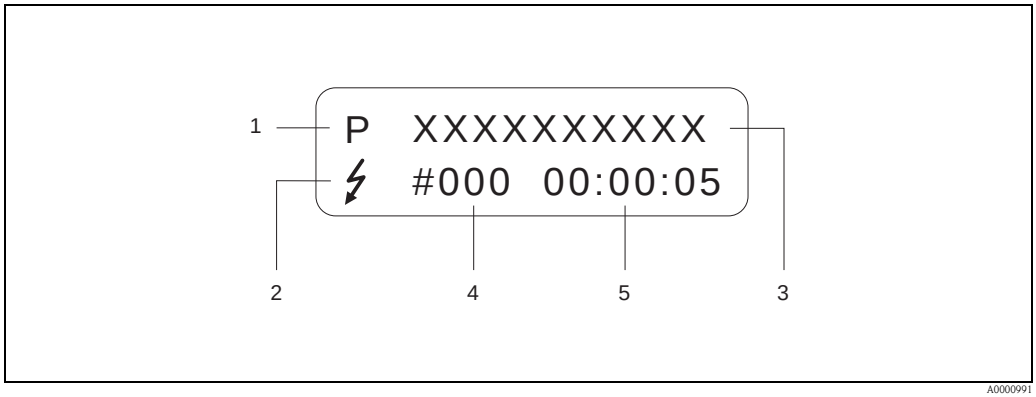


Fig. 27: Error messages on the display (example)

1 Error type: P = process error, S = system error
2 Error message type: ϟ = fault message, ! = notice message (definition: see below)
3 Error designation: e.g. DSC SENS LIMIT = device being operated near application limits
4 Error number: e.g. #395
5 Duration of last error to occur (in hours : minutes : seconds), display format, OPERATION HOURS function → 174

5.3.2 Types of error message

Users have the option of weighting system and process errors differently, by defining them as **Fault messages** or **Notice messages**. This is specified by means of the function matrix (→ 173, SUPERVISION function group).
Serious system errors, e.g. electronic 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 outputs of the measuring device.
- Displayed as → exclamation mark (!), type of error (S: system error, P: process error)

Fault message ( )ϟ
- The error in question has a direct effect on the outputs. The response of the outputs (failsafe mode) can be defined by means of functions in the function matrix (→ 71).
- Displayed as → lightning flash (ϟ), type of error (S: system error, P: process error)

Note!
Error messages can be output via the current output in accordance with NAMUR NE 43.

5.4 Communication

In addition to via local operation, the measuring device can also be configured and measured values obtained by means of the HART protocol. Digital communication takes place using the 4 to 20 mA HART current output → 33.
The HART protocol allows the transfer of measuring and device data between the HART master and the field devices for configuration and diagnostics purposes. HART masters, such as a handheld terminal or PC-based operating programs (such as FieldCare), require device description (DD) files. They are used to access all the information in a HART device. Such information is transferred solely via "commands".

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

Note!
The measuring device has access to all three command classes.
List of all ''Universal Commands" and "Common Practice Commands" → 42.

5.4.1 Operating options

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

Note!
If the transmitter is configured via HART, you have to disconnect a circuit for the HART input and achieve the connection according to → 22 or → 23.

Field Xpert HART Communicator

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

"FieldCare" operating program

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 a service interface or via the service interface FXA193.

"SIMATIC PDM" operating program (Siemens)

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

"AMS" operating program (Emerson Process Management)

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

5.4.2 Current device description files

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

HART protocol:

Valid for device software:	1.05.XX	→ DEVICE SOFTWARE function
HART device data Manufacturer ID: Device ID:	 11_{hex} (ENDRESS+HAUSER) 57_{hex}	 → MANUFACTURER ID function → DEVICE ID function
HART version data:	Device Revision 6/ DD Revision 1	
Software release:	06.2010	

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

Tester/simulator:	**Sources for obtaining device descriptions**
Fieldcheck	Update via FieldCare with the flow device FXA193/291 DTM in the Fieldflash module

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

5.4.3 Device variables and process variables

Device variables:

The following device variables are available via the HART protocol:

ID (decimal)	Device variable
0	OFF (not assigned)
1	Volume flow
2	Temperature
3	Mass flow
4	Corrected volume flow
5	Heat flow
6	Density
7	Specific enthalpy
8	Saturation steam pressure (saturated steam)
9	Vortex frequency
10	Electronics temperature
11	Reynolds number
12	Velocity
13	Density (external measured variable)
14	Pressure (external measured variable)
15	Temperature (external measured variable)
250	Totalizer 1
251	Totalizer 2

Process variables:

At the factory, the process variables are assigned to the following device variables:
- Primary process variable (PV) → volume flow
- Secondary process variable (SV) → temperature
- Third process variable (TV) → mass flow
- Fourth process variable (FV) → totalizer 1

5.4.4 Universal/common practice HART commands

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

Command No. HART command / access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
Universal commands			
0	Read the unique device identifier Access type = Read	None	The device identifier provides information on the device and manufacturer; it cannot be altered. The response consists of a 12-byte device ID: – Byte 0: fixed value 254 – Byte 1: manufacturer ID, 17 = Endress+Hauser – Byte 2: device type ID, 56 = Prowirl 73 – Byte 3: number of preambles – Byte 4: rev. no. universal commands – Byte 5: rev. no. device-spec. commands – Byte 6: software revision – Byte 7: hardware revision – Byte 8: additional device information – Byte 9-11: device identification
1	Read the primary process variable Access type = Read	None	– Byte 0: HART unit ID of the primary process variable – Byte 1-4: primary process variable (= volume flow) ✎ Note! Manufacturer-specific units are represented using the HART unit ID "240".
2	Read the primary process variable as current in mA and percentage of the set measuring range Access type = Read	None	– Byte 0-3: current current of the primary process variable in mA – Byte 4-7: percentage of the set measuring range Primary process variable (vol. flow)
3	Read the primary process variable as current in mA and four (preset using command 51) dynamic process variables Access type = Read	None	24 bytes are sent as a response: – Byte 0-3: current of the primary process variable in mA – Byte 4: HART unit ID of the primary process variable – Byte 5-8: primary process variable – Byte 9: HART unit ID of the secondary process variable – Byte 10-13: secondary process variable – Byte 14: HART unit ID of the third process variable – Byte 15-18: third process variable – Byte 19: HART unit ID of the fourth process variable – Byte 20-23: fourth process variable *Factory setting:* ■ Primary process variable (vol. flow) ■ Secondary process variable = temperature ■ Third process variable = mass flow ■ Fourth process variable = totalizer 1 ✎ Note! Manufacturer-specific units are represented using the HART unit ID "240".
6	Set HART short-form address Access type = Write	Byte 0: desired address (0 to 15) *Factory setting:* 0 ✎ Note! With an address > 0 (multidrop mode), the current output of the primary process variable is fixed to 4 mA.	Byte 0: active address

Command No. HART command / access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
11	Read unique device identification using the TAG (measuring point designation) Access type = Read	Byte 0-5: TAG	The device identifier provides information on the device and manufacturer; it cannot be altered. The response consists of a 12-byte device ID if the given TAG matches the one saved in the device: – Byte 0: fixed value 254 – Byte 1: manufacturer ID, 17 = Endress+Hauser – Byte 2: device type ID, 56 = Prowirl 73 – Byte 3: number of preambles – Byte 4: rev. no. universal commands – Byte 5: rev. no. device-spec. commands – Byte 6: software revision – Byte 7: hardware revision – Byte 8: additional device information – Byte 9-11: device identification
12	Read user message Access type = Read	None	Byte 0-24: user message ✎ Note! You can write the user message using command 17.
13	Read TAG, TAG description and date Access type = Read	None	– Byte 0-5: TAG – Byte 6-17: TAG description – Byte 18-20: date ✎ Note! You can write the TAG, descriptor and date using command 18.
14	Read sensor information on the primary process variable Access type = Read	None	– Byte 0-2: serial number of the sensor – Byte 3: HART unit ID of the sensor limits and measuring range of the primary process variable – Byte 4-7: upper sensor limit – Byte 8-11: lower sensor limit – Byte 12-15: minimum span ✎ Note! ■ The data relate to the primary process variable (= volume flow). ■ Manufacturer-specific units are represented using the HART unit ID "240".
15	Read output information of the primary process variable Access type = Read	None	– Byte 0: Alarm selection ID – Byte 1: ID for transfer function – Byte 2: HART unit ID for the set measuring range of the primary process variable (volume flow) – Byte 3-6: end of measuring range, value for 20 mA – Byte 7-10: start of measuring range, value for 4 mA – Byte 11-14: attenuation constant in [s] – Byte 15: ID for write protection – Byte 16: ID for OEM dealer, 17 = Endress+Hauser ✎ Note! Manufacturer-specific units are represented using the HART unit ID "240".
16	Read the device production number Access type = Read	None	Byte 0-2: production number
17	Write user message Access = Write	You can save any 32-character text in the device with this parameter. Byte 0-23: desired user message	Displays the current user message in the device: Byte 0-23: current user message in the device
18	Write TAG, TAG description and date Access = Write	You can save an 8-character TAG, a 16-character TAG description and a date with this parameter: – Byte 0-5: TAG – Byte 6-17: TAG description – Byte 18-20: date	Displays the current information in the device: – Byte 0-5: TAG – Byte 6-17: TAG description – Byte 18-20: date

Command No. HART command / access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
Common practice commands			
34	Write attenuation constant for primary process variable Access = Write	Byte 0-3: attenuation constant of the primary process variable in seconds *Factory setting:* Primary process variable (vol. flow)	Displays the current attenuation constant in the device: Byte 0-3: attenuation constant in seconds
35	Write measuring range of the primary process variable Access = Write	Write the desired measuring range: – Byte 0: HART unit ID for the primary process variable – Byte 1-4: end of measuring range, value for 20 mA – Byte 5-8: start of measuring range, value for 4 mA *Factory setting:* Primary process variable (vol. flow) ✎ Note! If the HART unit ID does not suit the process variable, the device will continue with the last valid unit.	The measuring range currently set is shown as the response: – Byte 0: HART unit ID for the set measuring range of the primary process variable – Byte 1-4: end of measuring range, value for 20 mA – Byte 5-8: start of measuring range, value for 4 mA (is always at "0") ✎ Note! Manufacturer-specific units are represented using the HART unit ID "240".
38	Device status reset "configuration changed" Access = Write	None	None
40	Simulate output current of the primary process variable Access = Write	Simulation of the desired output current of the primary process variable. An entry value of 0 exits the simulation mode: Byte 0-3: output current in mA *Factory setting:* Primary process variable (vol. flow)	The current output current of the primary process variable is displayed as a response: Byte 0-3: output current in mA
42	Perform device setting Access = Write	None	None
44	Write unit of the primary process variable Access = Write	Specify the unit of the primary process variable. Only units which are suitable for the process variable are accepted by the device: Byte 0: HART unit ID *Factory setting:* Primary process variable (vol. flow) ✎ Note! ■ If the HART unit ID written does not suit the process variable, the device will continue with the last valid unit. ■ If you change the unit of the primary process variable, this has an impact on the 4 to 20 mA output.	The current unit code of the primary process variable is displayed as a response: Byte 0: HART unit ID ✎ Note! Manufacturer-specific units are represented using the HART unit ID "240".
48	Read extended device status Access = Read	None	The current device status is displayed in extended form as the response: Coding: table → 🖹 46
50	Read assignment of the device variables to the four process variables Access = Read	None	Display of the current variable assignment of the process variables: – Byte 0: device variable ID to the primary process variable – Byte 1: device variable ID to the secondary process variable – Byte 2: device variable ID to the third process variable – Byte 3: device variable ID to the fourth process variable *Factory setting:* ■ Primary process variable: ID 1 for volume flow ■ Secondary process variable: ID 2 for temperature ■ Third process variable: ID 3 for mass flow ■ Fourth process variable: ID 250 for totalizer 1

Command No. HART command / access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
51	Write assignments of the device variables to the four process variables Access = Write	Set the assignment of the device variables to the four process variables: – Byte 0: device variable ID to the primary process variable – Byte 1: device variable ID to the secondary process variable – Byte 2: device variable ID to the third process variable – Byte 3: device variable ID to the fourth process variable *ID of the supported device variables:* See data → 41 *Factory setting:* ■ Primary process variable (vol. flow) ■ Secondary process variable = temperature ■ Third process variable = mass flow ■ Fourth process variable = totalizer 1	The current variable assignment of the process variables is displayed as a response: – Byte 0: device variable ID to the primary process variable – Byte 1: device variable ID to the secondary process variable – Byte 2: device variable ID to the third process variable – Byte 3: device variable ID to the fourth process variable
53	Write device variable unit Access = Write	This command sets the unit of the given device variables. Only those units which suit the device variable are transferred: – Byte 0: device variable ID – Byte 1: HART unit ID *ID of the supported device variables:* See data → 41 Note! If the written unit does not suit the device variable, the device will continue with the last valid unit.	The current unit of the device variables is displayed in the device as a response: – Byte 0: device variable ID – Byte 1: HART unit ID Note! Manufacturer-specific units are represented using the HART unit ID "240".
59	Specify number of preambles in message responses Access = Write	This parameter specifies the number of preambles which are inserted in the message responses: Byte 0: number of preambles (2 to 20)	As a response, the current number of the preambles is displayed in the response message: Byte 0: number of preambles
108	Burst mode CMD Access = Write	Select the process values that are cyclically transmitted to the HART master. Byte 0: ■ 1 = primary process variable ■ 2 = current and percentage of the measuring range ■ 3 = current and four (previously defined) measured variables	The value set in byte 0 is shown as the response.
109	Burst mode control Access = Write	This parameter switches the burst mode on and off. Byte 0: ■ 0 = burst mode off ■ 1 = burst mode on	The value set in byte 0 is shown as the response.

5.4.5 Device status/error messages

You can read the extended device status, in this case, current error messages, via Command "48". The command delivers bit-encoded information (see table below).

Note!
Detailed information on the device status messages and error messages, and how they are rectified, can be found on → 64.

Byte Bit	Error no.	Short error description → 64
0-0	001	Serious device error
0-1	011	Measuring amplifier has faulty EEPROM
0-2	012	Error when accessing data of the measuring amplifier EEPROM
0-3	021	COM module: faulty EEPROM
0-4	022	COM module: error when accessing data of the EEPROM
0-5	111	Totalizer checksum error
0-6	351	Current output: the current flow is outside the set range.
0-7	Not assigned	–
1-0	359	Pulse output: the pulse output frequency is outside the set range.
1-1	Not assigned	–
1-2	379	Device being operated in the resonance frequency.
1-3	Not assigned	–
1-4	Not assigned	–
1-5	394	DSC sensor defective, no measurement
1-6	395	DSC sensor being operated near application limits, device failure probable soon.
1-7	396	Device finds signal outside the set filter range.
2-0	Not assigned	–
2-1	Not assigned	–
2-2	399	Pre-amplifier disconnected
2-3	Not assigned	–
2-4	Not assigned	–
2-5	Not assigned	–
2-6	501	New amplifier software version or data being loaded into device. No other commands possible at this point.
2-7	502	Uploading the device data. No other commands possible at this point.
3-0	601	Positive zero return active
3-1	611	Current output simulation active
3-2	Not assigned	–
3-3	631	Simulation pulse output active
3-4	641	Simulation status output active
3-5	691	Simulation of response to error (outputs) active
3-6	692	Simulation measurand
3-7	Not assigned	–
4-0	Not assigned	–
4-1	Not assigned	–
4-2	699	Current adjustment active
4-3	698	Device test active
4-4	Not assigned	–
4-5	Not assigned	–
4-6	Not assigned	–

Byte Bit	Error no.	Short error description → 64
4-7	Not assigned	–
5-0	310	PT breakage
5-1	311	PT short-circuit
5-2	312	PT breakage
5-3	313	PT short-circuit
5-4	314	PT breakage, electronics
5-5	315	PT short-circuit, electronics
5-6	316	No T sensor
5-7	317	The self-monitoring function of the measuring device found an error in the DSC sensor which can affect temperature measurement.
6-0	318	The self-monitoring function of the measuring device found an error in the DSC sensor which can affect temperature and flow measurement.
6-1	355	Frequency output: the current flow is outside the set range.
6-2	Not assigned	–
6-3	381	The limit value for the minimum fluid temperature permitted is undershot.
6-4	382	The limit value for the maximum fluid temperature permitted is overshot.
6-5	397	The limit value for the minimum ambient temperature permitted is undershot.
6-6	398	The limit value for the maximum ambient temperature permitted is overshot.
6-7	412	No data are available in the measuring device for the combination of the current values for the fluid pressure and fluid temperature.
7-0	421	The current flow velocity exceeds the specified limit value.
7-1	494	The Reynolds number is lower than 20 000.
7-2	511	The current output is not receiving valid data.
7-3	512	The frequency output is not receiving valid data.
7-4	513	The pulse output is not receiving valid data.
7-5	514	The status output is not receiving valid data.
7-6	515	The display is not receiving valid data.
7-7	516	Totalizer 1 is not receiving valid data.
8-0	517	Totalizer 2 is not receiving valid data.
8-1	621	Simulation frequency output
8-2	520	The desired value has not been found in the HART telegram.
8-3	521	2 values of the same kind have been found in the HART telegram.
8-4	522	The checksum of the HART telegram is not correct.
8-5	523	The time-out for receiving HART telegrams has been exceeded.
8-6	524	An algebraic sign different from that expected has been measured for the delta heat.
8-7	525	Wet steam alarm
9-0	526	The temperature of the saturated steam is below 80 °C (176 °F).
9-1	Not assigned	–
9-2	Not assigned	–
9-3	Not assigned	–
9-4	Not assigned	–
9-5	Not assigned	–
9-6	Not assigned	–
9-7	Not assigned	–

5.4.6 Switching HART write protection on/off

A DIP switch on the amplifier board provides the means of activating or deactivating the HART write protection. If HART write protection is enabled, it is not possible to change parameters via the HART protocol.

⚠ 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. Unscrew the cover of the electronics compartment from the transmitter housing.
3. Remove the display module (a) from the retaining rails (b) and refit onto the right retaining rail with the left side. This secures the display module.
4. Fold up the plastic cover (c).
5. Set the DIP switch to the desired position.
   Position A (DIP switch at front) → HART write protection disabled
   Position B (DIP switch at rear) → HART write protection enabled

   ✎ Note!
   The current status of the HART write protection is displayed in the WRITE PROTECTION function → 📄 138.
6. Installation is the reverse of the removal procedure.

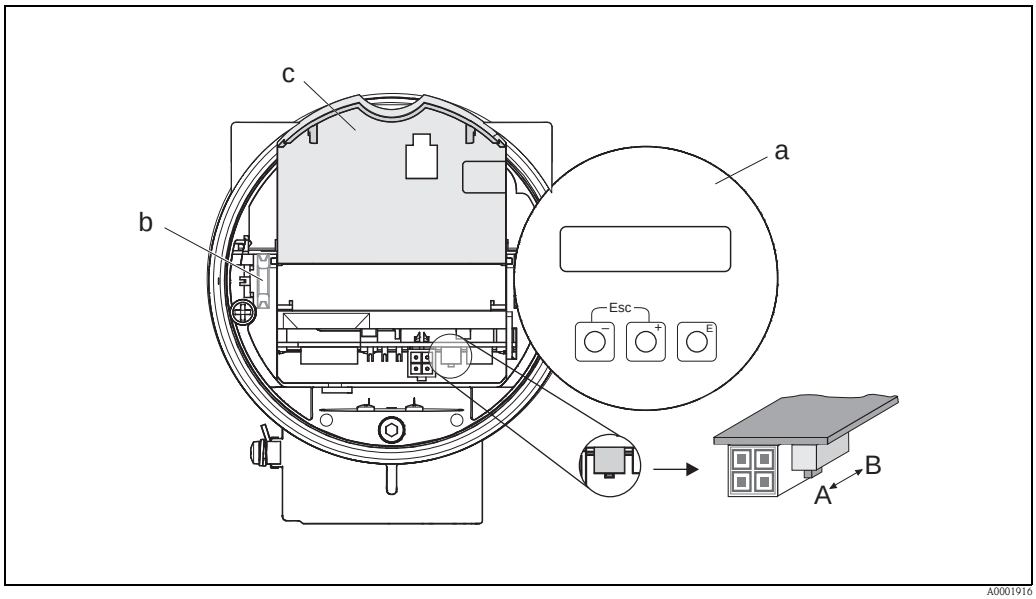


Fig. 28: DIP switch for switching HART write protection on and off

a Local display module
b Retaining rails of local display module
c Plastic cover
A Write protection disabled (DIP switch at front)
B Write protection enabled (DIP switch at rear)

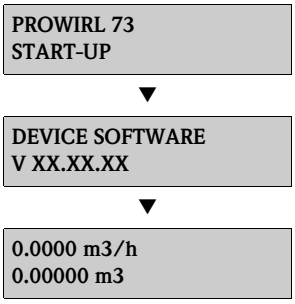
6 Commissioning

6.1 Function check

Make sure that all final checks have been completed before you commission your measuring point:
- Checklist for "post-installation check" → 📄 24
- Checklist for "post-connection check" → 📄 34

6.2 Switching on the measuring device

Having completed the function check, switch on the supply voltage.
After approx. 5 seconds, the device is ready for operation! The device then performs internal test functions and the following message is shown on the local display:



Start-up message

Display of current device software

Normal measuring mode commences

The measuring device starts operating once the startup process is completed.
Various measured values and/or status variables appear on the display (HOME position).

Note!
If startup fails, an appropriate error message is displayed, depending on the cause. The error messages that occur most frequently during commissioning are described in the "Troubleshooting" section (→ 📄 63).

6.3 Commissioning after installing a new electronics board

After startup the device checks whether a serial number is present. If this is not the case, the following setup is started. For information on how to install a new electronics board, please refer to → 🖹 73.

6.3.1 "Commissioning" setup

Note!

- As soon as a serial number has been entered and saved this setup is no longer available. If wrong information for a parameter is entered during the setup, it can be corrected in the appropriate function via the function matrix.
- The required information (apart from language) is indicated on the device's name plate and the inner side of the display cover (→ 🖹 13). Additionally, the meter body MB index and the calibration factor are indicated on the device's meter body.

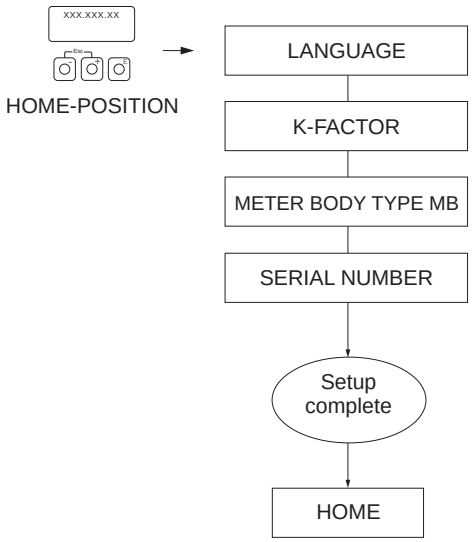
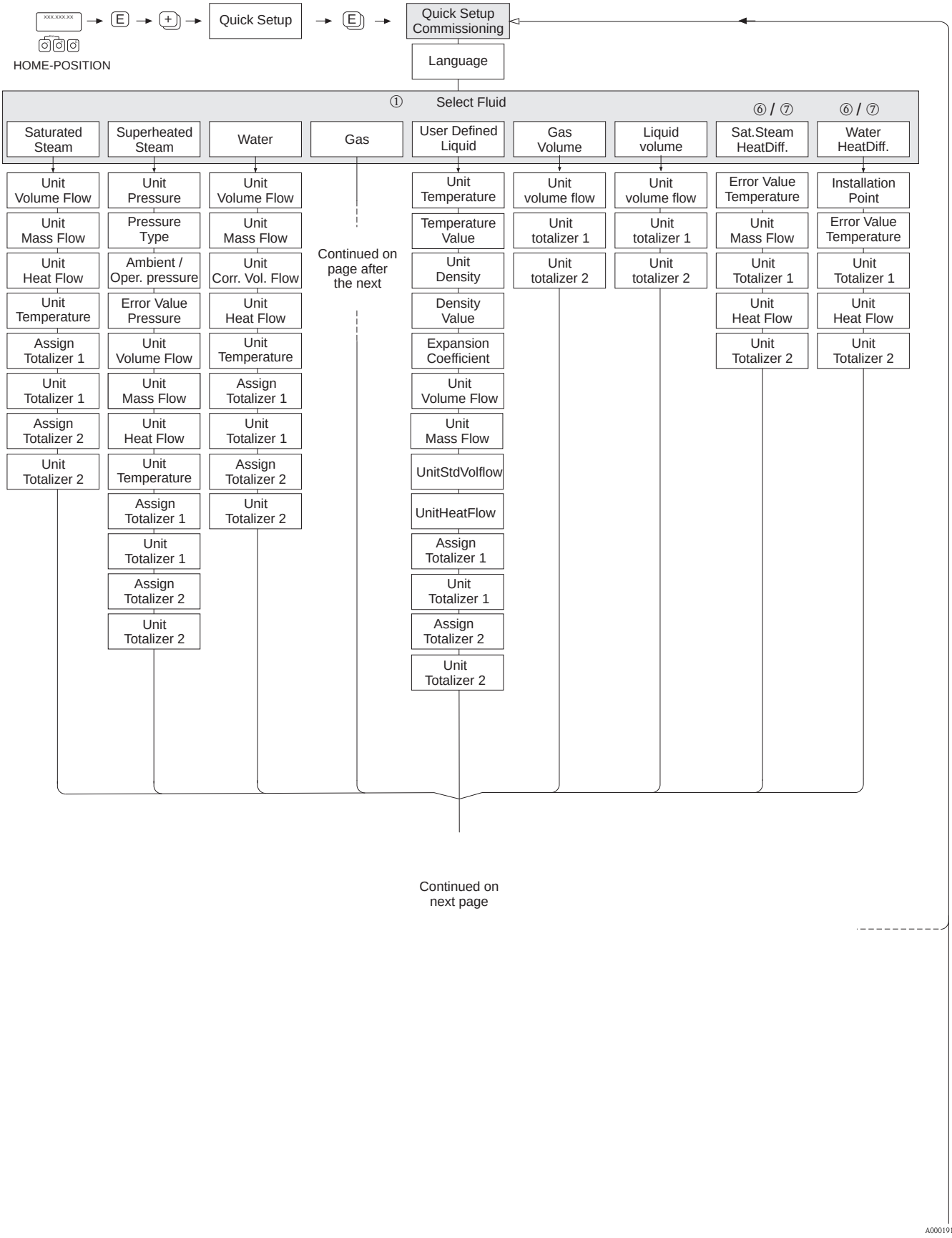


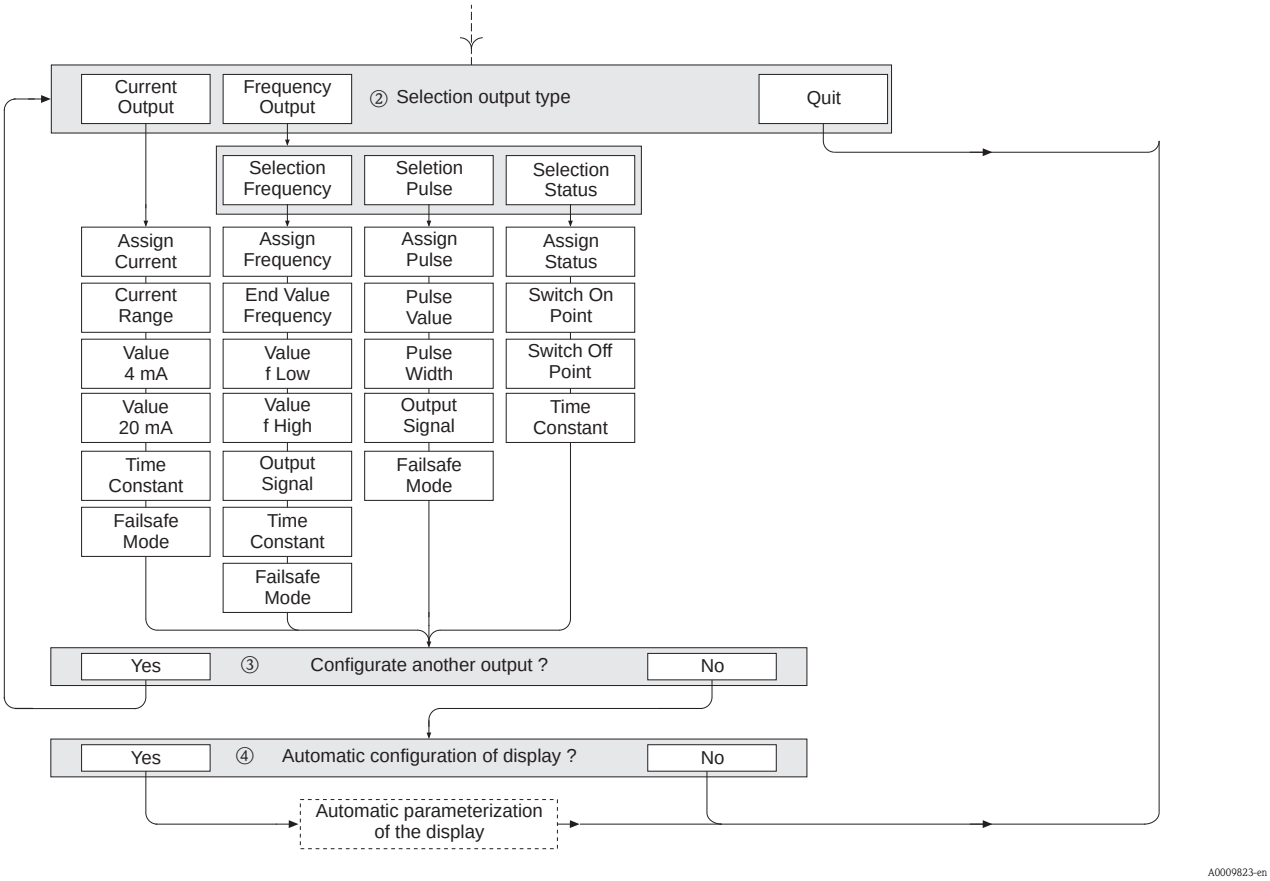
Fig. 29: The setup starts once a new electronics board is installed if no serial number is available.

6.4 "Commissioning" Quick Setup

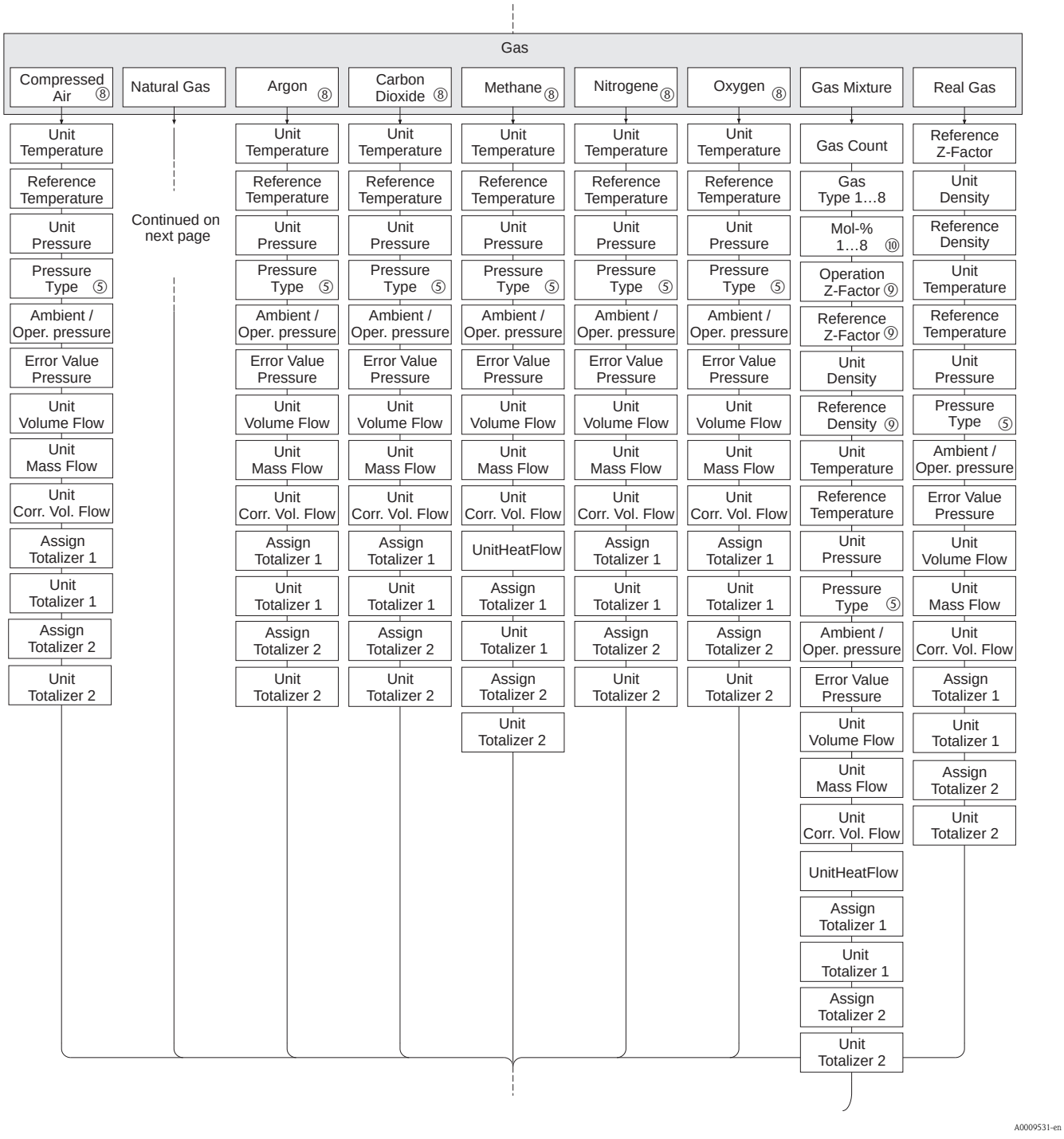
The "Commissioning" Quick Setup menu guides you systematically through all the important functions of the measuring device that have to be configured for standard measuring operation.



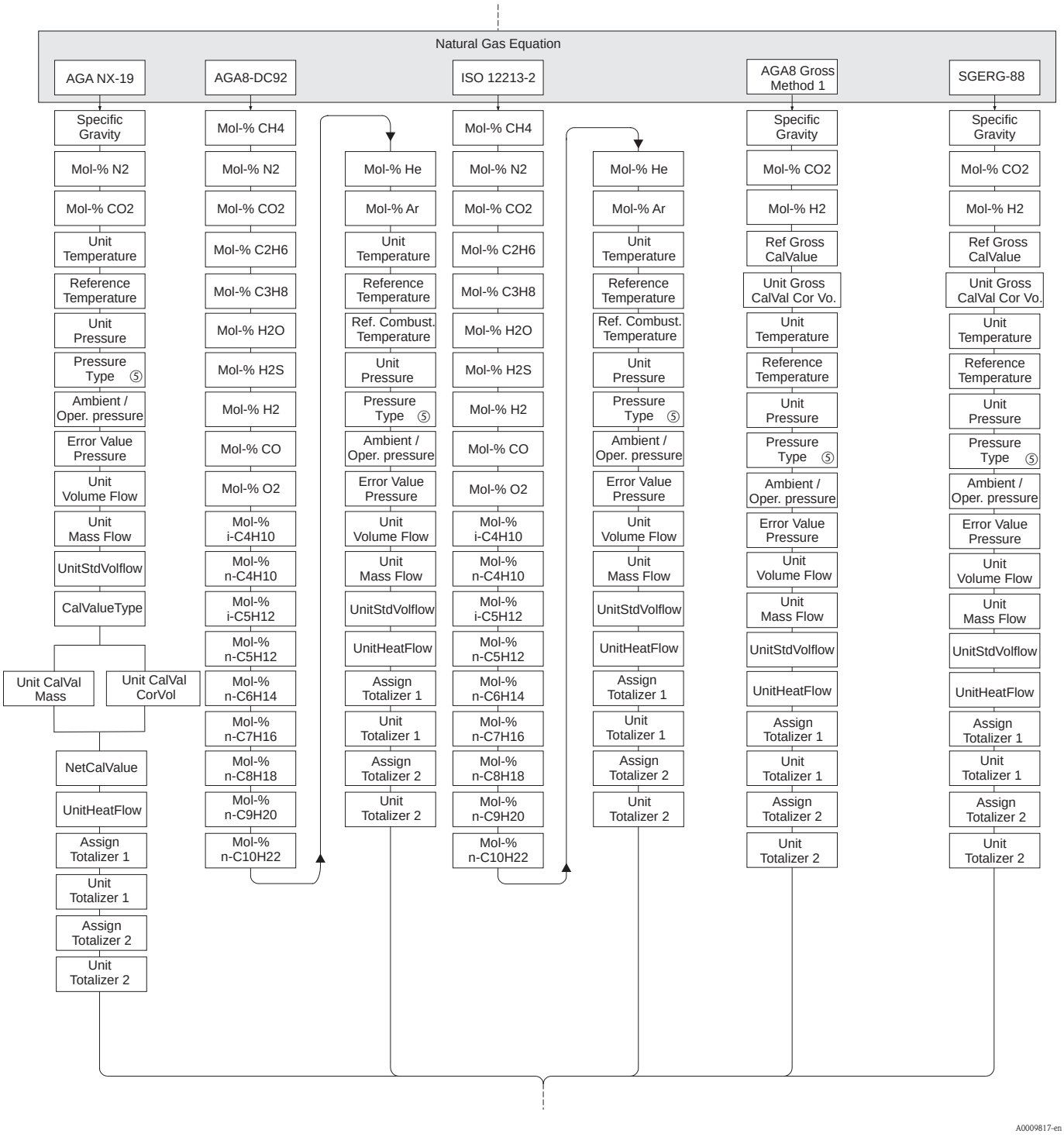
Continuation of the "Commissioning" Quick Setup in "Selection output type"



Continuation of the "Commissioning" Quick Setup in the GAS function



Continuation of the "Commissioning" Quick Setup in the NATURAL GAS function



✎ Note!
- The individual functions are described in the "Description of Device Functions" section (→ 95).
- The display returns to the QUICK SETUP COMMISSION cell (→ 109) if you press the key combination (Esc) during parameter interrogation. The configuration settings already made remain valid, however.

① The following parameters are reset to the factory setting if the fluid selected is changed:

In group	Parameter
Display	→ 100% value line 1, 100% value line 2
Current output	→ All parameters
Frequency output	→ All parameters
Process parameter	→ All relevant parameters

② Only the output (current output or frequency output) not yet configured is offered for selection after the first cycle.

③ The "YES" option appears as long as a free output is available. "NO" is displayed when no further outputs are available.

④ When "YES" is selected, the volume flow is assigned to line 1 of the local display and the temperature to line 2.

⑤ If "HART INPUT GAUGE" or "HART INPUT ABSOLUTE" is selected in the PRESSURE TYPE function, the HART INPUT field automatically switches to "PRESSURE".
If "HART INPUT ABSOLUTE" or "PREDEFINED VALUE" is selected, the AMBIENT PRESSURE field is not displayed.
If "PREDEFINED VALUE" is selected, the OPERATING PRESSURE field is displayed.
If "PREDEFINED VALUE" is selected, the ERROR VAL. PRESS field is not displayed.

⑥ If "SATURATED STEAM DELTA HEAT" or "WATER DELTA HEAT" is selected, the following notice message is displayed: "EXTERNAL TEMPERATURE SENSOR REQUIRED".

⑦ If "SATURATED STEAM DELTA HEAT" or "WATER DELTA HEAT" is selected, the HART INPUT field automatically switches to "TEMPERATURE".

⑧ Only data for the gas phase are available for these fluids.

⑨ These functions are only called up if the OTHER option was selected in one of the functions GAS TYPE 1 to 8.

⑩ The entry only appears if ≥ 2 was selected in the GAS TYPE 1 to 8 function.

The totalizer assignment depends on the fluid selected:

Selected fluid:	Assignment for totalizer 1	Assignment for totalizer 2
SATURATED STEAM	Mass flow	Heat flow
SUPERHEATED STEAM	Mass flow	Heat flow
WATER DELTA HEAT	Mass flow	Heat flow
SATURATED STEAM DELTA HEAT	Mass flow	Heat flow
WATER	Mass flow	Volume flow
USER DEFINED LIQUID	Mass flow	Volume flow
COMPRESSED AIR	Corrected volume flow	Volume flow
NATURAL GAS AGA NX-19	Corrected volume flow	Volume flow
CARBON DIOXIDE	Corrected volume flow	Volume flow
OXYGEN	Corrected volume flow	Volume flow
NITROGEN	Corrected volume flow	Volume flow
NATURAL GAS AGA8-DC92	Corrected volume flow	Heat flow
NATURAL GAS AGA8 Gross Method 1	Corrected volume flow	Heat flow
NATURAL GAS ISO 12213-2	Corrected volume flow	Heat flow
NATURAL GAS SGERG-88	Corrected volume flow	Heat flow
GAS VOLUME	Volume flow	Volume flow
LIQUID VOLUME	Volume flow	Volume flow
REAL GAS	Corrected volume flow	Volume flow
GAS MIXTURE	Corrected volume flow	Volume flow
ARGON	Corrected volume flow	Volume flow
METHANE	Corrected volume flow	Volume flow

Note!
If the values assigned to the totalizers are not suitable, the assignment can be changed accordingly via the matrix in the TOTALIZER 1 and 2 function groups.

6.5 External pressure/temperature sensors

Please note the following when reading in external pressure or temperature values via the HART input:

Note!
In the case of applications with external sensors, Prowirl 73 itself may not be set to the burst mode. If an external sensor (e.g. Cerabar HART) is to be set later locally, the following is mandatory: In order to be able to connect the FieldCare or FieldXpert in combination with the HART Commubox FXA195 to the external HART sensor, the BURST MODE of the external HART sensor must be switched off (OFF). Only after conclusion of the setting the BURST MODE may be configured to ON (the reason is that the HART communication between FieldCare or FieldXpert and external HART sensor can be disturbed by the HART burst pulses).

In order to connect Prowirl 73 HART with an external HART sensor, the following steps must be considered:

1. Wire Prowirl 73, active barrier RN221N and external pressure and temperature sensors → 19, → 20 and → 21.
2. Guarantee that with Prowirl 73 under GROUP SELECT\HART INPUT the function HART INPUT is set correctly according to the external sensor – thus setted to PRESSURE or TEMPERATURE.
3. The HART icon must be displayed in a steady condition. A flashing condition indicates a bad communication. In case of a bad communication please proceed as follow:

   – If the error #523 HART-IN:T.-OUT appears on the display of the Prowirl 73, it indicates that the BURST MODE of the external sensor is not activated (= OFF). In this case proceed as follows to eliminate the error:
     a. Establish a connection to the external HART sensor via FieldCare or FieldXpert in combination with the HART Commubox FXA195.
     b. Guarantee that it is set BURST OPTION = 1 in the function OPERATING MENU\TRANSMITTER INFO\HART DATA.
     c. Activate BURST MODE (= ON).
     d. Guarantee that with Prowirl 73 under GROUP SELECT\HART INPUT the function HART INPUT is set correctly to PRESSURE or TEMPERATURE (according to the external sensor). In the following function ERROR VAL. PRESS or ERROR VAL. TEMP the pressure or temperature is specified. This function is used for the density calculation, if the burst mode communication in the Prowirl 73 is incorrect. An incorrect communication between Prowirl 73 and the external sensor is displayed with the error messages #520 to #523.

   – If the error #521 HART-IN:DOUBLE appears on the display of the Prowirl 73, it indicates that the BURST MODE of the external sensor is activated (= ON), but sending more than one process data (BURST OPTION > 1). Therefore Prowirl 73 cannot decide to which value it has to be revert. In this case proceed as follows to eliminate the error:
     a. Reset the external HART sensor to the factory setting. This guarantees that the BURST MODE is deactivated to establish a interference-free connection to the sensor.
     E.g. Cerabar: reset via input of the reset code "7864" under OPERATING MENU\ OPERATION\ENTER RESET CODE.
     b. Establish a connection to the external HART sensor via FieldCare or FieldXpert in combination with the HART Commubox FXA195.
     c. Guarantee that it is set BURST OPTION = 1 in the function OPERATING MENU\TRANSMITTER INFO\HART DATA.
     d. Important: Reactivate (= ON) the BURST MODE at the end only.

7 Maintenance

The flow measuring system requires no special maintenance.

7.1 Exterior 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

Do **not** use a pipe cleaning pig!

7.3 Replacing seals

7.3.1 Replacing sensor seals

Under normal circumstances, wetted seals need not be replaced. Replacement is necessary only in special circumstances, for example if aggressive or corrosive fluids are incompatible with the seal material.

Note!
- The time span between the individual replacement procedures depends on the fluid properties.
- Replacement seals (accessory) (→ 59).
  Only Endress+Hauser sensor seals may be used.

7.3.2 Replacing housing seals

The housing seals must be clean and undamaged when inserted into their grooves.
The seals must be dried, cleaned or replaced if necessary.

Note!
If the device is used in a dust atmosphere, only use the associated Endress+Hauser housing seals.

8 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Your Endress+Hauser service organization can provide detailed information on the order codes in question.

8.1 Device-specific accessories

Accessory	Description	Order code
Proline Prowirl 73 transmitter	Transmitter for replacement or for stock. Use the order code to define the following specifications: ■ Approvals ■ Degree of protection / version ■ Cable entries ■ Display / operation ■ Software ■ Outputs / inputs	73XXX - XXXXX *******

8.2 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting kit for Prowirl 73W	Mounting kit for wafer comprising: ■ Threaded studs ■ Nuts incl. washers ■ Flange seals	DKW** - ***
Mounting kit for transmitter	Mounting kit for remote version, suitable for pipe and wall mounting.	DK6WM -B
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific power consumption, boiler efficiency and other parameters which are important for efficient energy management.	RSG40 - **********
Flow conditioner	To reduce the inlet run downstream of flow disturbances.	DK7ST - ***
Pressure transmitter Cerabar M	Cerabar M is used to measure the absolute and gauge pressure of gases, steams and liquids. The device can be used for reading the pressure into Prowirl 73 via the burst mode. Cerabar has to be ordered with the burst mode activated for this purpose. This is a special product with version 9=TSPSC2821.	PMC41 - ********** PMP41 - ********** PM*4* - ******H/J9***
Pressure transmitter Cerabar S	Cerabar S is used to measure the absolute and gauge pressure of gases, steams and liquids. The device can be used for reading the pressure into Prowirl 73 via the burst mode. Cerabar has to be ordered with the burst mode activated for this purpose. This is a special product with version 9=TSPSC2822.	PMC71 - ********** PMP71 - ********** PM*7* - *A/B/C********9
Pressure transmitter Cerabar T	Cerabar T is used to measure the absolute and gauge pressure of gases, steams and liquids (compensation with RMC621 for example).	PMC131 - **** PMP131 - ****

Accessory	Description	Order code
RTD temperature Omnigrad TR10	Multipurpose temperature sensor. Mineral-insulated insert with thermowell, terminal head and extension neck. Together with a HART-compatible transmitter, it can be used to read the temperature into Prowirl 73 in the burst mode.	TR10 - *******H****
Active barrier RN221N	Active barrier with power supply for safe separation of 4 to 20 mA standard signal circuits: ■ Galvanic isolation of 4 to 20 mA circuits ■ Elimination of ground loops ■ Power supply of two-wire transmitters ■ Can be used in Ex area (ATEX, FM, CSA, TIIS) ■ HART input-compatible (e.g. for reading in an external pressure value) ✎ Note! If RN221N - *3 is used for the HART input, this results in an error message for Prowirl 73 and is not recommended.	RN221N - *1
Process display RIA250	Multifunctional 1-channel display unit with universal input, transmitter power supply, limit relay and analog output.	RIA250 - ******
Process display RIA251	Digital display unit for looping into 4 to 20 mA current loop; can be used in Ex area (ATEX, FM, CSA).	RIA251 - **
Field display RIA261	Digital field display unit for looping into 4 to 20 mA current loop; can be used in Ex area (ATEX, FM, CSA).	RIA261 - ***
Process transmitter RMA422	Multifunctional 1-2 channel top-hat rail device with intrinsically safe current inputs and transmitter power supply, limit value monitoring, mathematic functions (e.g. difference ascertain) and 1-2 analog outputs. Optional: intrinsically safe inputs, can be used in Ex area (ATEX).	RMA422 - *******
Overvoltage protection HAW562Z	Overvoltage protection for restricting overvoltage in signal lines and components.	51003575
Overvoltage protection HAW569	Overvoltage protection for restricting overvoltage for direct mounting to Prowirl 73 and other devices.	HAW569 - **1A
Energy Manager RMC621	Universal Energy Manager for gas, liquids, steam and water. Calculation of volumetric flow and mass flow, corrected volume, heat flow and energy.	RMC621 - **********

8.3 Communication-specific accessories

Accessory	Description	Order code
Field Xpert	Handheld terminal for remote configuration and for obtaining measured values via the HART current output (4 to 20 mA). Contact your Endress+Hauser representative for more information.	SFX100 - *******
Fieldgate FXA320	Gateway for remote interrogation of HART sensors and actuators via Web browser: ■ 2-channel analog input (4 to 20 mA) ■ 4 binary inputs with event counter function and frequency measurement ■ Communication via modem, Ethernet or GSM ■ Visualization via Internet/Intranet in the web browser and/or WAP cellular phone ■ Limit value monitoring with alarm by e-mail or SMS ■ Synchronized time stamping of all measured values	FXA320 - *****
Fieldgate FXA520	Gateway for remote interrogation of HART sensors and actuators via Web browser: ■ Web server for remote monitoring of up to 30 measuring points ■ Intrinsically safe version [EEx ia]IIC for applications in hazardous areas ■ Communication via modem, Ethernet or GSM ■ Visualization via Internet/Intranet in the web browser and/or WAP cellular phone ■ Limit value monitoring with alarm signaling via e-mail or SMS ■ Synchronized time stamping of all measured values ■ Remote diagnosis and remote configuration of connected HART devices ✎ Note! If Fieldgate FXA520 is used for the HART input, this results in an error message for Prowirl 73 and is not recommended.	FXA520 - ****
FXA195	The Commubox FXA195 connects intrinsically safe Smart transmitters with HART protocol to the USB port of a personal computer. This makes the remote operation of the transmitters possible with the aid of configuration programs (e.g. FieldCare). Power is supplied to the Commubox by means of the USB port.	FXA195 – *

8.4 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and planning flowmeters. Applicator is available both via the Internet (www.applicator.com) and on a CD-ROM for local PC installation. Contact your Endress+Hauser representative for more information.	DXA80 - *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed out 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 units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition.	See the product page on the Endress+Hauser Web site: www.endress.com
FXA193	Service interface from the measuring device to the PC for operation via FieldCare.	FXA193 – *

9 Troubleshooting

9.1 Troubleshooting instructions

Always start troubleshooting with the following checklist if faults occur after commissioning or during operation. This takes you directly (via various queries) 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. Measuring electronics defective → order spare parts → 72
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 → 73 2. Display module defective → order spare parts → 72 3. Measuring electronics defective → order spare parts → 72
Display texts are in a foreign language.	1. Switch off power supply. 2. Press the keys simultaneously and switch on the measuring device again. The display text will appear in English and is displayed at 50% contrast.
Measured value indicated, but no signal output at the current or pulse output	Measuring electronics defective → order spare parts → 72
▼	
Error messages on display	
Errors which occur during commissioning or operation are displayed immediately or once the set delay time has elapsed (→ 174, ALARM DELAY function). 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 – **DSC SENS LIMIT** = Error designation (device being operated near application limits) – **03:00:05** = Duration of error to occur (in hours, minutes and seconds), display format, OPERATION HOURS function → 174 – **#395** = Error number Note! ■ See the information on → 38 ■ The measuring system interprets simulations and positive zero return as system errors, but displays them as notice messages only.	
Error message on display	System error (device error) → 64 Process error (application error) → 68
▼	
Other errors (without error message)	
Some other error has occurred.	Diagnosis and remedial measures → 69

9.2 System error messages

Serious system errors are **always** recognized by the device as "fault messages" and are indicated with a lightning flash (ϟ) on the display! Fault messages have a direct effect on the outputs. Simulations and positive zero return, on the other hand, are only 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 measuring device to Endress+Hauser (→ 🖹 12).
Always enclose a fully completed "Declaration of Contamination" form with the device. A copy of the form can be found at the end of these Operating Instructions.

Note!
Also observe the information on → 🖹 38 and → 🖹 71.

Type	Error message / No.	Cause	Remedy / spare part (→ 🖹 72)
S = System error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without an effect on the outputs)			
No. # 0xx → Hardware error			
S ϟ	CRITICAL FAIL. # 001	Serious device error	Replace the amplifier board.
S ϟ	AMP HW EEPROM # 011	Amplifier: faulty EEPROM	Replace the amplifier board.
S ϟ	AMP SW EEPROM # 012	Amplifier: error when accessing data of the EEPROM	Contact your Endress+Hauser service organization.
S ϟ	COM HW EEPROM # 021	COM module: faulty EEPROM	Replace COM module.
S ϟ	COM SW EEPROM # 022	COM module: error when accessing data of the EEPROM	Contact your Endress+Hauser service organization.
S ϟ	CHECKSUM ROM # 029	Checksum error of the ROM on the amplifier board	Contact your Endress+Hauser service organization.
S ϟ	CHECKSUM TOT. # 111	Totalizer checksum error	Contact your Endress+Hauser service organization.
S !	PT DSC BROKEN # 310	The temperature sensor PT1 is defective. The temperature measurement is becoming inaccurate and total temperature sensor failure (#316) can be expected.	Contact your Endress+Hauser service organization. Note! This error message may indicate that the maximum flow velocity permitted has been greatly exceeded. For the calculation of the density the temperature sensor PT2 is used automatically. If this is defective as well, the ERROR -> TEMPERATURE defined in the flow computer will consulted.
S !	SHORT C. PT DSC # 311	The temperature sensor is defective. The temperature measurement is becoming inaccurate and total temperature sensor failure (#316) can be expected.	Contact your Endress+Hauser service organization. Note! This error message may indicate that the maximum flow velocity permitted has been greatly exceeded.
S !	PT DSC BROKEN # 312	The temperature sensor PT2 is defective. The temperature measurement is becoming inaccurate and total temperature sensor failure (#316) can be expected.	Contact your Endress+Hauser service organization. Note! This error message may indicate that the maximum flow velocity permitted has been greatly exceeded. For the calculation of the density the temperature sensor PT1 is used automatically. If this is defective as well, the ERROR -> TEMPERATURE defined in the flow computer will consulted.
S !	SHORT C. PT DSC # 313	The temperature sensor is defective. The temperature measurement is becoming inaccurate and total temperature sensor failure (#316) can be expected.	Contact your Endress+Hauser service organization.

Type	Error message / No.	Cause	Remedy / spare part (→ 🖹 72)
S !	PT EL. BROKEN # 314	The temperature sensor is defective and temperature measurement is no longer possible. The measuring device uses the value specified in the ERROR → TEMPERATURE function → 🖹 149.	Replace the amplifier board. Spare parts.
S !	SHORT C. PT EL # 315		
S ϟ	NO T-SENSOR # 316	The temperature sensor has failed or no temperature sensor is available. The measuring device uses the value specified in the ERROR → TEMPERATURE function → 🖹 149.	Contact your E+H service organization. ✎ Note! ■ If the measuring device is intentionally operated with a Prowirl 72 DSC sensor (without a temperature sensor), this message has to be changed from a fault message to a notice message (→ 🖹 173, ASSIGN SYSTEM ERROR). ■ This error message may indicate that the maximum flow velocity permitted has been greatly exceeded.
S ϟ	CHECK T-SENSOR # 317	The self-monitoring function of the measuring device found an error in the DSC sensor which can affect temperature measurement. ✎ Note! The mass flow is calculated with the value entered in the ERROR → TEMPERATURE function → 🖹 149.	Contact your E+H service organization.
S $	CHECK SENSOR # 318	The self-monitoring function of the measuring device found an error in the DSC sensor which can affect flow and temperature measurement. ✎ Note! The mass flow is calculated with the value entered in the ERROR → TEMPERATURE function → 🖹 149.	Contact your Endress+Hauser service organization. ✎ Note! The error status can be changed from fault message to notice message in the ASSIGN SYSTEM ERROR function (→ 🖹 173). Please note that while this means a measured value is output again, the error still has to be eliminated.
S !	RANGE CUR.OUT # 351	Current output: the current flow is outside the set range.	1. Change full scale value entered. 2. Reduce flow.
S !	RANGE FRQ. OUT # 355	Frequency output: the current flow is outside the set range.	1. Change full scale value entered. 2. Reduce flow.
S !	RANGE PULSE # 359	Pulse output: the pulse output frequency is outside the set range.	1. Increase pulse value. 2. When entering the pulse width, select a value that can still be processed by a connected totalizer (e.g. mechanical totalizer, PLC, etc.). Determine pulse width: – Method 1: enter the minimum time for which a pulse has to be present at a connected totalizer in order to be recorded. – Method 2: enter the maximum (pulse) frequency as a half "reciprocal value" for which a pulse has to be present at a connected totalizer in order to be recorded. Example: The maximum input frequency of the connected counter is 10 Hz. The pulse width to be entered is: 1 / (2·10 Hz) = 50 ms. 3. Reduce flow.
S $	RESONANCE DSC # 379	The device is being operated in the resonance frequency. ☝ Caution! If the device is operated in the resonance frequency, this can result in damage which can lead to complete device failure.	Reduce flow.
S $	FLUIDTEMP. MIN # 381	The limit value for the minimum fluid temperature permitted is undershot.	Increase the fluid temperature.
S $	FLUIDTEMP. MAX # 382	The limit value for the maximum fluid temperature permitted is overshot.	Reduce the fluid temperature.
S $	DSC SENS DEFCT # 394	The DSC sensor is defective, measurement no longer takes place.	Contact your Endress+Hauser service organization.
S !	DSC SENS LIMIT # 395	The DSC sensor is being operated near application limits, device failure is probable soon.	If this message is permanently displayed, contact your Endress+Hauser service organization.

Type	Error message / No.	Cause	Remedy / spare part (→ 72)
S ϟ	SIGNAL>LOW PASS # 396	The device finds the signal outside the set filter range. Possible causes: ■ The flow is outside the measuring range. ■ The signal is caused by a strong vibration which is intentionally not measured and is outside the measuring range.	■ Check whether the device was installed in the flow direction. ■ Check whether the right option was selected in the SELECT FLUID function (→ 143). ■ Check whether the operating conditions are within the specifications of the measuring device. Example: flow is above measuring range which means that the flow may have to be reduced. If the checks do not solve the problem, please contact your Endress+Hauser service organization.
S ϟ	T ELECTR. MIN # 397	The limit value for the minimum ambient temperature permitted is undershot.	■ Check whether the device has been correctly insulated (→ 19). ■ Check whether the transmitter is pointing upwards or to the side (→ 18). ■ Increase the ambient temperature.
S ϟ	T ELECTR. MAX # 398	The limit value for the maximum ambient temperature permitted is overshot.	■ Check whether the device has been correctly insulated (→ 19). ■ Check whether the transmitter is pointing upwards or to the side (→ 18). ■ Reduce the ambient temperature.
S ϟ	PREAMP. DISCONN. # 399	Pre-amplifier disconnected.	Check the connection between the preamplifier and amplifier board and establish the connection if necessary.
S !	SW.-UPDATE ACT. # 501	New amplifier software version or data being loaded into device. No other commands possible at this point.	Wait until the procedure is complete. The device is automatically restarted.
S !	UP-/DOWNL. ACT # 502	Uploading the device data. No other commands possible at this point.	Wait until the procedure is complete.
S !	NO DATA - ϟ ->CURR. # 511	The current output is not receiving valid data.	1. Run the "Commissioning" Quick Setup (→ 50). 2. Check the option selected in the ASSIGN CURRENT function (→ 119).
S !	NO DATA - ϟ ->FREQ. # 512	The frequency output is not receiving valid data.	1. Run the "Commissioning" Quick Setup (→ 50). 2. Check the option selected in the ASSIGN FREQUENCY function. 3. Check the option selected in the ASSIGN FREQUENCY function (→ 122).
S !	NO DATA - ϟ ->PULSE # 513	The pulse output is not receiving valid data.	1. Run the "Commissioning" Quick Setup (→ 50). 2. Check the option selected in the ASSIGN PULSE function (→ 127).
S !	NO DATA - ϟ ->STAT. # 514	The status output is not receiving valid data.	1. Run the "Commissioning" Quick Setup (→ 50). 2. Check the option selected in the ASSIGN STATUS function (→ 132).
S !	NO DATA - ϟ ->DISP. # 515	The display is not receiving valid data.	1. Run the "Commissioning" Quick Setup (→ 50). 2. Check the option selected in the ASSIGN LINE 1 and ASSIGN LINE 2 function (→ 112).
516 to 517	S: NO DATA - ϟ ->TOT. n !: # 516 to 517	Totalizer 1 or totalizer 2 is not receiving valid data.	1. Run the "Commissioning" Quick Setup (→ 50). 2. Check the option selected in the ASSIGN TOTALIZER 1 or ASSIGN TOTALIZER 2 function (→ 116).
S ϟ	HART-IN: NO VAL # 520	The HART input functionality is enabled but the desired value (e.g. pressure value) is not found in the HART telegram.	■ Check if the pressure, temperature or density sensor is HART-enabled and is in the BURST mode. ■ Check if the wiring has been carried out according to the diagrams on → 30.
S ϟ	HART-IN: DOUBLE # 521	Two values of the same kind have been found in the burst telegram. Prowirl cannot decide which of these two values is to be used.	Make sure that only one pressure, temperature or density value is in the burst telegram (BURST-OPTION = 1).
S ϟ	HART-IN: CHKSUM # 522	The checksum of the burst telegram is not correct.	Check if the wiring has been carried out according to the diagrams on → 30.

Type	Error message / No.	Cause	Remedy / spare part (→ 72)
S ϟ	HART-IN: T.-OUT # 523	The HART input is activated but Prowirl has not found a burst telegram for some time. Note! The time limit for the occurrence of this error message is specified in the TIMEOUT HART COM function.	■ Check if the pressure, temperature or density sensor is HART-enabled and is in the BURST mode. ■ Check if the wiring has been carried out according to the diagrams on → 30.
S ϟ	SIGN DELTA HEAT # 524	The algebraic sign of the temperature differential is different to what Prowirl 73 expected.	■ If the error message occurs when commissioning the measurement, check the setting in the INSTALLATION POINT function (→ 157). ■ If the error message occurs during operation, check whether the algebraic sign for the temperature differential has changed. Note! Prowirl 73 cannot take a change in the algebraic sign for temperature measurement into account!
S !	POS. ZERO-RET. # 601	Positive zero return active. Caution! This message has the highest display priority.	Switch off positive zero return.
S !	SIM. CURR. OUT # 611	Current output simulation active.	Switch off simulation.
S !	SIM. FREQ. OUT # 621	Simulation frequency output active.	Switch off simulation.
S !	SIM. PULSE # 631	Pulse output simulation active.	Switch off simulation.
S !	SIM. STAT. OUT # 641	Status output simulation active.	Switch off simulation.
S ϟ	SIM. FAILSAFE # 691	Simulation of failsafe mode (outputs) active.	Switch off simulation.
S !	SIM. MEASURAND # 692	Simulation of a measured variable active (e.g. mass flow).	Switch off simulation.

9.3 Process error messages

Process errors can be defined as either "Fault" or "Notice" messages and can thereby be weighted differently. This is determined via the function matrix (→ 🖹 173, ERROR CATEGORY function).

Note!
- The listed error message types below correspond to the factory setting.
- Also observe the information on → 🖹 38 and → 🖹 71.

Type	Error message / No.	Cause	Remedy / spare part
P = Process error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without an effect on the outputs)			
P !	P, T -> NO DATA - ϟ # 412	No data are available in the measuring device for the combination of the current values for the fluid pressure and fluid temperature. Note! The measuring system outputs a notice message (!) if a calculated parameter is assigned to an output but the primary calculation data are missing (e.g. the density for the mass flow). Example: "#511 NO DATA - $ -> CURR."	■ Check whether the right fluid was selected in the SELECT FLUID function (→ 🖹 143). ■ Check whether the right pressure was entered in the OPERATING PRESSURE function (→ 🖹 150).
P !	FLOW RANGE # 421	The current flow velocity exceeds the limit value that is specified in the LIMIT VELOCITY function (→ 🖹 142).	Reduce the flow.
P !	REYNOLDS < 20000 # 494	The Reynolds number is lower than 20 000. The accuracy is reduced if the Reynolds number is < 20 000.	Increase the flow.
P !	WET STEAM # 525	The steam state for superheated steam, which is calculated from the temperature and pressure, is close (2 °C) to the saturated steam curve.	■ Check whether steam is actually present. ■ If you do not need the wet steam alarm, you can switch it off in the WET STEAM ALARM function (→ 🖹 156).
P !	NO STEAM # 526	The measured temperature suggests that there is no steam in the pipe. It is not possible to calculate the quantity of heat.	Check whether there is steam in the pipe.

9.4 Process errors without messages

You may have to change or correct settings in certain functions of the function matrix in order to rectify faults. The functions outlined below (e.g. FLOW DAMPING) are described in detail in the "Description of device functions" section (→ 95).

Symptoms	Remedial measures
No flow signal	■ In the case of liquids: check whether the piping is completely filled. The piping must always be completely filled for accurate and reliable flow measurement. ■ Check whether all the packaging material, including the meter body protective covers, was completely removed before mounting the device. ■ Check whether the desired electrical output signal was connected correctly.
Flow signal even though there is no flow	Check whether the device is exposed to particularly strong vibrations. If so, a flow can be displayed even if the fluid is at a standstill, depending on the frequency and direction of the vibration. Remedial measures at the device: ■ Turn the sensor 90°. Observe the installation conditions when doing so (→ 17). The measuring system is most sensitive to vibrations which follow in the direction of the sensor. Vibrations have less of an effect on the device in the other axes. ■ The amplification can be altered using the AMPLIFICATION function (→ 172). Remedy through constructive measures during installation: ■ If the source of the vibration (e.g. pump or a valve) has been identified, the vibrations can be reduced by decoupling or supporting the source. ■ Support the pipe near the measuring device. If these measures do not solve the problem, your Endress+Hauser service organization can adjust the filters of the device to suit your special application.
Incorrect or highly-fluctuating flow signal	■ The fluid is not sufficiently single-phase or homogeneous. Prerequisite for precise and reliable flow measurement: – Single-phase and homogeneous fluid – Completely full pipe ■ In many instances, the following measures can be taken to improve the measurement result even under non-ideal conditions: – In the case of liquids with a low gas content in horizontal pipes, install the device with the head pointing downwards or to the side. This improves the measuring signal since the sensor is not in the area where gas accumulates when this type of installation is used. – In the case of liquids with a low solids content, avoid installing the device with the electronics housing pointing downwards. – In the case of steam or gases with a low liquid content, avoid installing the device with the electronics housing pointing downwards. ■ The inlet and outlet runs must be present as per the installation instructions (→ 20). ■ Suitable seals with an internal diameter not smaller than the pipe internal diameter must be installed and correctly centered. ■ The static pressure must be large enough to rule out cavitation in the area of the sensor. ■ Check whether the correct fluid was selected in the SELECT FLUID function (→ 143). The setting in this function determines the filter settings and can thus have an effect on the measuring range. ■ Check whether the data for the K-factor on the nameplate match the data in the K-FACTOR functions (→ 171). ■ Check whether the device is correctly installed in the flow direction. ■ Check whether the nominal diameter of the mating pipe and the device match (→ 140). ■ The flow must be in the measuring range of the device (→ 78). The start of measuring range depends on the density and the viscosity of the fluid. Density and viscosity depend on temperature. Density also depends on the process pressure in the case of gases. ■ Check whether the operating pressure is affected by pressure pulsations (e.g. from piston pumps). The pulsations can affect vortex shedding if they have a frequency similar to the vortex frequency. ■ Check whether the correct engineering unit was selected for the flow or totalizer. ■ Check whether the current output or pulse value was correctly set.

Symptoms	Remedial measures
The fault cannot be rectified or some other fault not described above has occurred.	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 organization to have a service technician sent out, the following information is needed: – A brief description of the error with information on the application. – Nameplate specifications (→ 13): order code and serial number ■ Return devices to Endress+Hauser 1. The measured listed in the "Return" section (→ 12) must be carried out before you return a measuring device requiring repair or calibration to Endress+Hauser. 2. Enclose a fully completed "Declaration of Contamination" form with the flowmeter. A copy of the form can be found at the end of these Operating Instructions. ■ Replace the transmitter electronics Order spare parts for the meter electronics directly from your Endress+Hauser service organization (→ 72).
"– – – –" appears on the display.	The option selected in the ASSIGN LINE 1 or ASSIGN LINE 2 function (e.g. corrected volume flow) cannot be assigned to the fluid selected (e.g. saturated steam). In the ASSIGN LINE 1 or ASSIGN LINE 2 function, select an option that suits the fluid.

9.5 Response of outputs to errors

Note!
The failsafe mode of the totalizer, current output, pulse output and frequency output can be configured by means of various functions in the function matrix.

Positive zero return and error response:
You can use positive zero return to set the signals of the current, pulse and frequency outputs to their fallback value, for example when operation has to be interrupted while a pipe is being cleaned. This function has priority over all other device functions; simulations are suppressed, for example.

Response of outputs and totalizers to errors		
	Process/system error present	Positive zero return activated
Caution! System or process errors defined as "notice messages" have no effect whatsoever on the outputs. Refer also to the information on → 38.		
Current output	MIN. CURRENT Depends on the option selected in the CURRENT SPAN function. If the current span is: 4 to 20 mA HART NAMUR → output current = 3.6 mA 4 to 20 mA HART US → output current = 3.75 mA MAX. CURRENT 22.6 mA HOLD VALUE Measured value display on the basis of the last saved value preceding occurrence of the fault. ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored.	Output signal corresponds to zero flow.
Pulse output	FALLBACK VALUE Signal output → 0 pulse output HOLD VALUE Measured value display on the basis of the last valid flow value before the fault occurred. ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored.	Output signal corresponds to zero flow.
Frequency output	FALLBACK VALUE 0 Hz output. FAIL LEVEL Outputs the frequency specified in the FAILSAFE VALUE function. HOLD VALUE Measured value output is based on the last measured value saved before the error occurred. ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored.	Output signal corresponds to zero flow.
Status output	In the event of a fault or power supply failure: Status output → not conductive	No effect on the status output.
Totalizer 1 + 2	STOP The totalizers stop at the last value before the alarm condition occurred. HOLD VALUE The totalizers continue to count the flow on the basis of the last valid flow data (before the fault occurred). ACTUAL VALUE The totalizers continue to count the flow on the basis of the current flow data. The fault is ignored.	The totalizers stop.

9.6 Spare parts

Section 9.1 contains detailed troubleshooting instructions. The measuring device, moreover, provides additional support in the form of continuous self-diagnosis and error messages. Troubleshooting 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 service organization by providing the serial number printed on the transmitter's nameplate (→ 13).

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

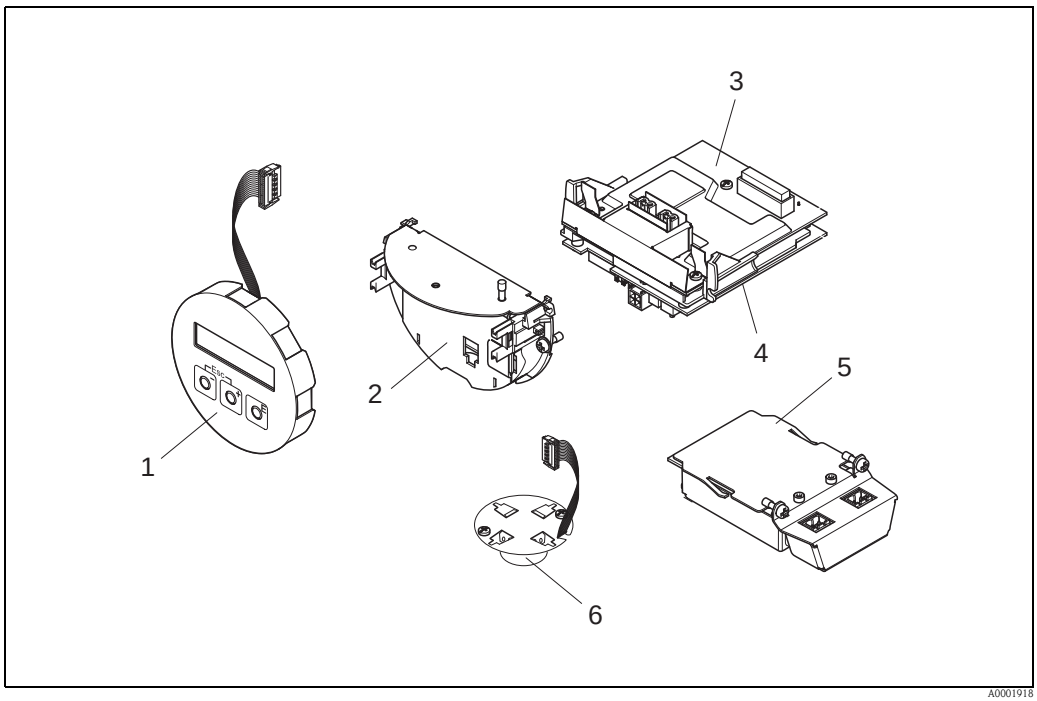


Fig. 30: Spare parts for transmitter Proline Prowirl 73

1 Local display module
2 Board holder
3 I/O board (COM module), Non-Ex, Ex-i/IS and Ex-n version
4 Amplifier board
5 I/O board (COM module), Ex-d /XP version
6 Pre-amplifier

9.6.1 Installing and removing electronics boards

For information on the software settings after installing a new electronics board: → 📄 50.

Non-Ex / Ex-i/IS and Ex-n version

⚠ Warning!
When connecting Ex-certified devices, please refer to 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.

☝ Caution!
Electrostatic charge!
Risk of damaging electronic components or impairing their function (ESD protection).
- Use a workplace with a grounded working surface, purpose-built for electrostatically sensitive devices!
- Use only genuine Endress+Hauser parts.

Procedure when installing/removing electronics boards (→ 31)

1. Unscrew the cover (a) of the electronics compartment from the transmitter housing.
2. Remove the local display module (b) from the retaining rails (c).
3. Attach the local display module (b) to the right retaining rail (c) with the left side. This secures the local display module.
4. Loosen the fixing screws (d) of the cover of the connection compartment (e) and fold down the cover.
5. Pull terminal connector (f) out of the I/O board (COM module) (q).
6. Fold up the plastic cover (g).
7. Remove the signal cable connector (h) from the amplifier board (s) and release from the cable holder (i).
8. Remove the ribbon cable connector (j) from the amplifier board (s) and release from the cable holder (k).
9. Remove the local display module (b) from the right retaining rail (c).
10. Fold down the plastic cover (g) again.
11. Release both screws (l) of the board holder (m).
12. Pull the board holder (m) out completely.
13. Press the side latches (n) of the board holder and separate the board holder (m) from the board body (o).
14. Replace the I/O board (COM module) (q):
    – Loosen the three fixing screws (p) of the I/O board (COM module).
    – Remove the I/O board (COM module) (q) from the board body (o).
    – Set a new I/O board (COM module) on the board body.
15. Replace the amplifier board (s):
    – Loosen fixing screws (r) of the amplifier board.
    – Remove the amplifier board (s) from the board body (o).
    – Set a new amplifier board on the board body.
16. Installation is the reverse of the removal procedure.

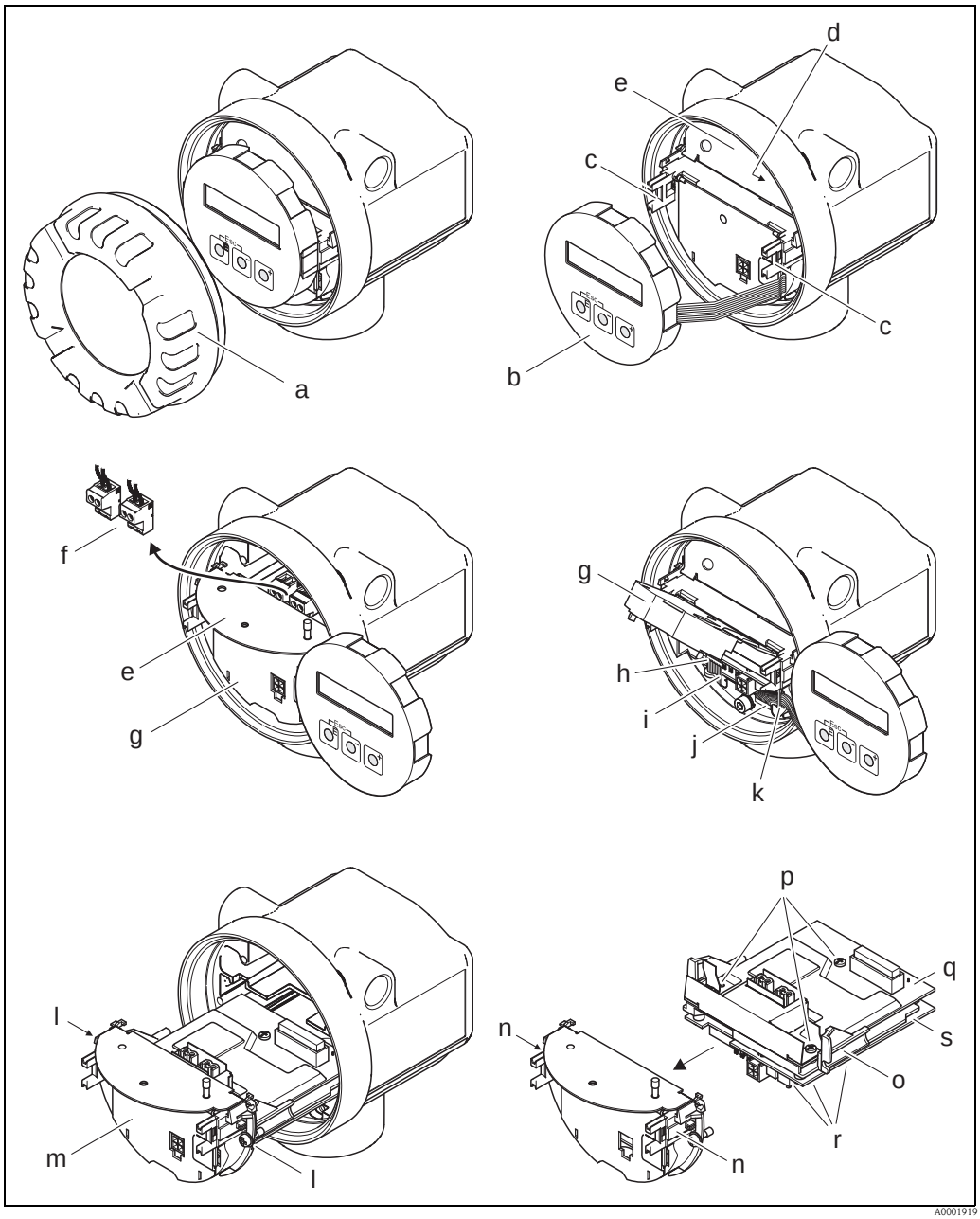


Fig. 31: Installing and removing electronics boards Non-Ex, Ex-i/IS and Ex-n version

a Cover of electronics compartment
b Local display module
c Retaining rails for local display module
d Fixing screws for cover of connection compartment
e Cover of connection compartment
f Terminal connector
g Plastic cover
h Signal cable connector
i Retainer for signal cable connector
j Display module ribbon-cable connector
k Retainer for ribbon-cable connector
l Board holder threaded connection
m Board holder
n Board holder latches
o Board body
p I/O board (COM module) threaded connection
q I/O board (COM module)
r Amplifier board threaded connection
s Amplifier board

Ex-d/XP version

Warning!
When connecting Ex-certified devices, please refer to 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.

Caution!
Electrostatic charge!
Risk of damaging electronic components or impairing their function (ESD protection).
- Use a workplace with a grounded working surface, purpose-built for electrostatically sensitive devices!
- Use only genuine Endress+Hauser parts.

Procedure when installing/removing electronics boards (→ 32)

Installing/removing the I/O board (COM module)

1. Release securing clamp (a) of the connection compartment cover (b).
2. Unscrew the cover (b) of the connection compartment from the transmitter housing.
3. Disconnect terminal connector (c) from the I/O board (COM module) (e).
4. Release threaded connection (d) of the I/O board (COM module) (e) and pull out the board slightly.
5. Disconnect connection cable plug (f) from the I/O board (COM module) (e) and remove the board completely.
6. Installation is the reverse of the removal procedure.

Installing/removing the amplifier board

1. Unscrew the cover (g) of the electronics compartment from the transmitter housing.
2. Remove the local display module (h) from the retaining rails (i).
3. Fold up the plastic cover (j).
4. Remove ribbon-cable connector of the local display module (h) from the amplifier board (t) and release from the cable holder.
5. Remove the signal cable connector (k) from the amplifier board (t) and release from the cable holder.
6. Release the fixing screw (l) and fold down the cover (m).
7. Release both screws (n) of the board holder (o).
8. Pull out the board holder (o) slightly and disconnect connecting cable plug (p) from the board body.
9. Pull the board holder (o) out completely.
10. Press the side latches (q) of the board holder and separate the board holder (o) from the board body (r).
11. Replace the amplifier board (t):
    – Loosen fixing screws (s) of the amplifier board.
    – Remove the amplifier board (t) from the board body (r).
    – Set a new amplifier board on the board body.
12. Installation is the reverse of the removal procedure.

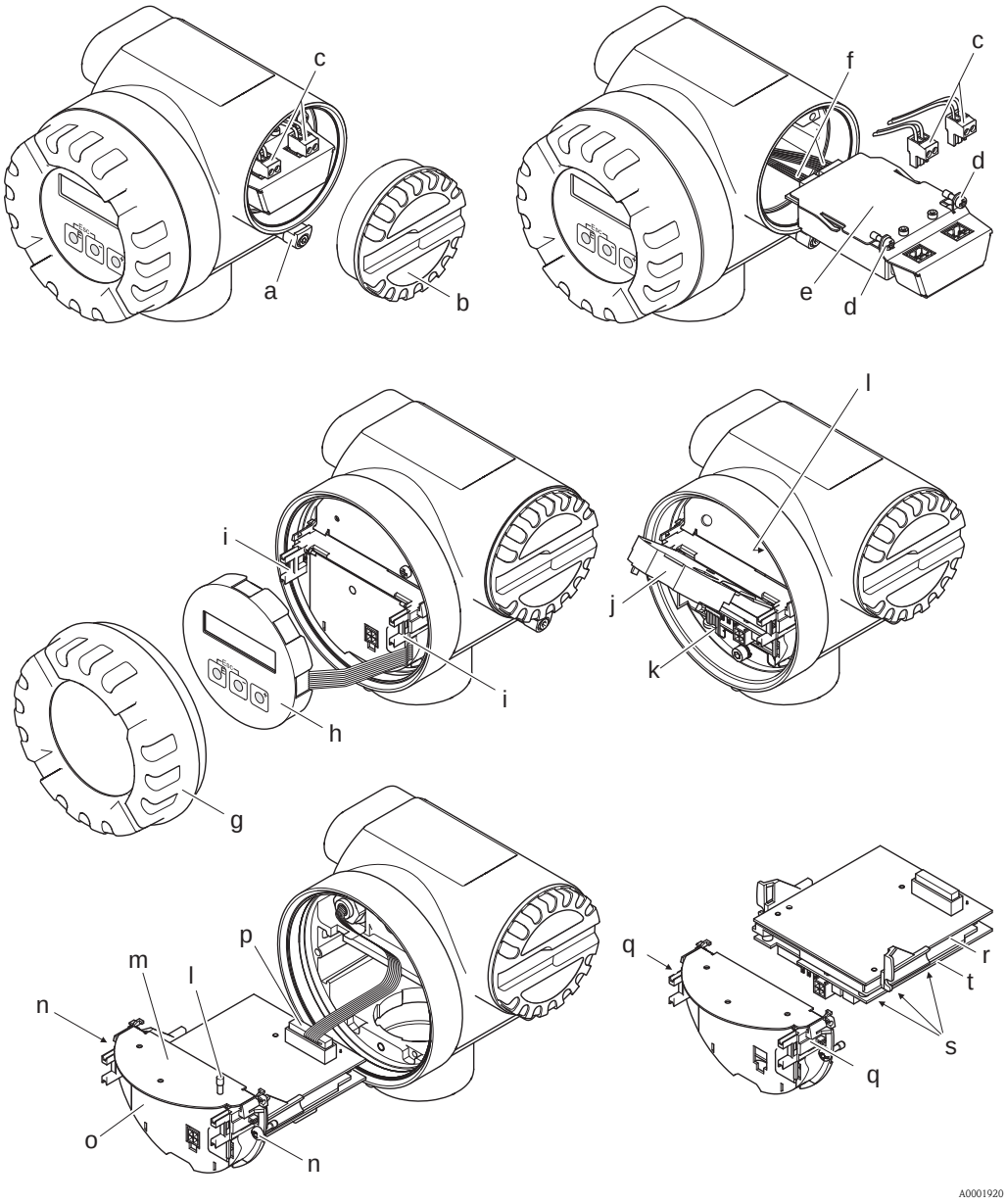


Fig. 32: Installing and removing electronics boards Ex-d/XP version

a Clamp securing the cover of the connection compartment
b Cover of connection compartment
c Terminal connector
d I/O board (COM module) threaded connection
e I/O board (COM module)
f Connecting cable plug I/O-module
g Cover of electronics compartment
h Local display module
i Retaining rails for local display module
j Plastic cover
k Signal cable connector
l Fixing screws for cover of connection compartment
m Connection compartment cover
n Board holder threaded connection
o Board holder
p Connecting cable plug
q Board holder latches
r Board body
s Amplifier board threaded connection
t Amplifier board

9.7 Return

→ 12

9.8 Disposal

Observe the regulations applicable in your country!

9.9 Software history

Note!
Upload/download between different software versions is normally only possible with special service software.

Date	Software version	Software modification	Documentation
06.2010	V 1.05.XX	Software extension: ■ Implementation of a calibration history	BA00094D/06/EN/01.11 71128083
05.2009	V 1.04.00	Software extension: New functionalities: ■ New gases and mixtures of same: NH_3, Ar, C_4H_{10}, CO_2, CO, Cl_2, C_2H_6, C_2H_4, He_4, H_2, HCl, H_2S, Kr, CH_4, Ne, N_2, O_2, C_3H_8, SO_2, C_2H_3Cl, Xe ■ New natural gas equations: AGA8 Gross Method 1, AGA8-DC92, SGERG-88, ISO 12213-2 ■ New user-defined units: "Mass", "Corrected volume" ■ New languages: Russian, Japanese, Chinese	BA094D/06/en/11.08 71081844
01.2007	V 1.03.00	Software extension: Flanged devices with reduced inner diameter (R Type, S Type) New functionalities: ■ Device software displayed (NAMUR Recommendation NE 53) ■ Supervision of maximum flow velocity in the device (incl. warning message) ■ Error handling changed for superheated steam	BA094D/06/en/01.07 71039098
03.2005	V 1.02.00	Software extension: Additional HART input	BA094D/06/en/03.05 50106434
11.2004	V 1.01.00	Welded flanges	BA094D/06/en/12.03 50106434
10.2003	V 1.00.00	Original software Compatible with: ■ ToF Tool - Fieldtool Package ■ HART Field Communicator DXR375	BA094D/06/en/12.03 50106434

10 Technical data

10.1 Technical data at a glance

10.1.1 Application

The measuring system is used to measure the flow of saturated steam, superheated steam, gases and liquids. The system primarily measures the measured variables volume flow and temperature. With these values, the device can use preprogrammed data on the density and enthalpy to calculate and output the mass flow and heat flow for example.

10.1.2 Function and system design

Measuring principle

Vortex flow measurement on the principle of the Karman vortex street.

Measuring system

The measuring system consists of a transmitter and a sensor:
- Transmitter Prowirl 73
- Prowirl F or W sensor

Two versions are available:
- Compact version: Transmitter and sensor form a single mechanical unit
- Remote version: Sensor is mounted separate from the transmitter

10.1.3 Input

Measured variable

- Volumetric flow (volume flow) → is proportional to the frequency of vortex shedding after the bluff body.
- Temperature → can be output directly and is used to calculate the mass flow for example.
- The measured process variables volume flow, temperature or the calculated process variables mass flow, heat flow or corrected volume flow can be output as the output variables.

Measuring range

The measuring range depends on the fluid and the pipe diameter.

Start of measuring range:

See Technical Information TI00070D/06/EN

Full scale value:

Liquids: v_{max} = 9 m/s (30 ft/s)
Gas/steam: see table

Nominal diameter	**v_{max}**
Standard version: DN 15 (½") R Style: DN 25 (1") > DN 15 (½") S Style: DN 40 (1½") >> DN 15 (½")	46 m/s (151 ft/s) or Mach 0.3 (depending on which value is smaller)
Standard version: DN 25 (1"), DN 40 (1½") R Style: ■ DN 40 (1½") > DN 25 (1") ■ DN 50 (2") > DN 40 (1½") S Style: ■ DN 80 (3") >> DN 40 (1½")	75 m/s (246 ft/s) or Mach 0.3 (depending on which value is smaller)

Nominal diameter	v_{max}
Standard version: DN 50 (2") to 300 (12") R Style: ■ DN 80 (3") > DN 50 (2") ■ Nominal diameters larger than DN 80 (3") S Style: ■ DN 100 (4") >> DN 50 (2") ■ Nominal diameters larger than DN 100 (4")	120 m/s (394 ft/s) or Mach 0.3 (depending on which value is smaller) Calibrated range: up to 75 m/s (246 ft/s)

Note!
By using the selection and planning program "Applicator", you can determine the exact values for the fluid you use. You can obtain the Applicator from your Endress+Hauser sales center or on the Internet under www.applicator.com.

K-factor range:

The table is used for orientation purposes. The range in which the K-factor can be is indicated for individual nominal diameters and designs.

Nominal diameter		K-factor range [pul./dm³]	
DIN	**ANSI**	**73F**	**73W**
DN 15	½"	390 to 450	245 to 280
DN 25	1"	70 to 85	48 to 55
DN 40	1½"	18 to 22	14 to 17
DN 50	2"	8 to 11	6 to 8
DN 80	3"	2.5 to 3.2	1.9 to 2.4
DN 100	4"	1.1 to 1.4	0.9 to 1.1
DN 150	6"	0.3 to 0.4	0.27 to 0.32
DN 200	8"	0.1266 to 0.1400	–
DN 250	10"	0.0677 to 0.0748	–
DN 300	12"	0.0364 to 0.0402	–

10.1.4 Output

Outputs, general

The following measured variables can generally be output via the outputs.

Measured variable	Current output	Frequency output	Pulse output	Status output
Volume flow	If configured	If configured	If configured	Limit value (flow or totalizer)
Temperature	If configured	If configured	–	Limit value
Mass flow	If configured	If configured	If configured	Limit value (flow or totalizer)
Corrected volume flow	If configured	If configured	If configured	Limit value (flow or totalizer)
Heat flow (power)	If configured	If configured	If configured	Limit value (flow or totalizer)
Saturation steam pressure (only for saturated steam)	If configured	If configured	–	Limit value (pressure)
Process pressure (if read in externally)	If configured	If configured	–	Limit value (pressure)

If configured, the following calculated measured variables can also be displayed via the local display:
- Density
- Specific enthalpy
- Saturation steam pressure (for saturated steam)
- Z-factor
- Flow velocity

Output signal

Current output:

- 4 to 20 mA with HART
- Full scale value and time constant (0 to 100 s) can be set
- Temperature coefficient: typically 0.005% o.r./°C (o.r. = of reading)

Frequency output, pulse/status output

Frequency output (optional): open collector, passive, galvanically isolated

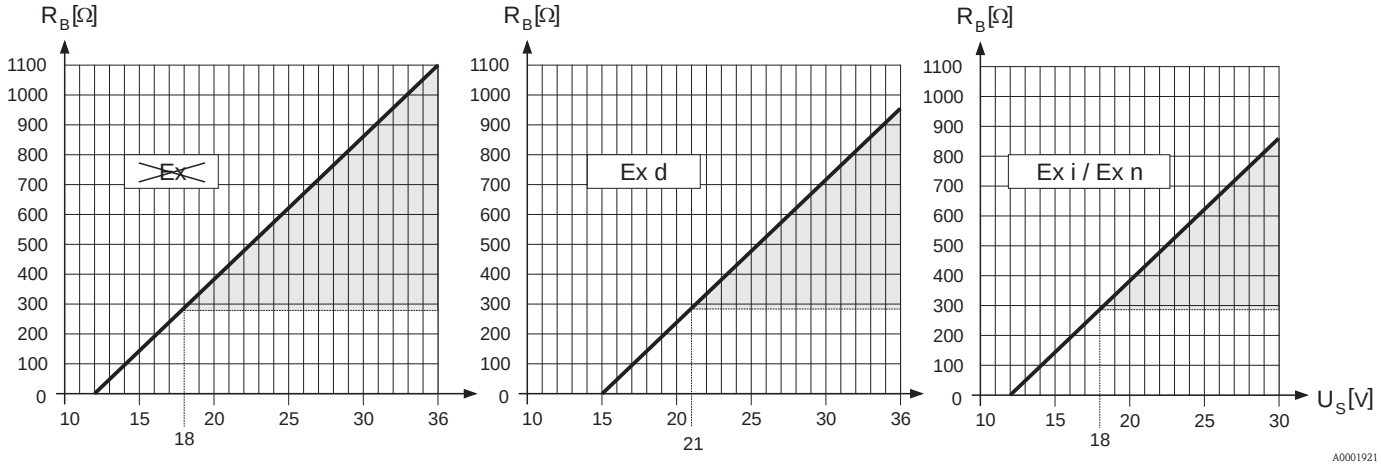
- Non-Ex, Ex-d/XP version: U_{max} = 36 V, with 15 mA current limiting, R_i = 500 Ω
- Ex-i/IS and Ex-n version: U_{max} = 30 V, with 15 mA current limiting, R_i = 500 Ω

The pulse/status output can be configured as:
- Frequency output:
  End frequency 0 to 1000 Hz (f_{max} = 1250 Hz)
- Pulse output:
  - Pulse value and polarity can be selected (→ 128)
  - Pulse width adjustable (0.005 to 2 s)
  - Pulse frequency max. 100 Hz
- Status output:
  Can be configured for error messages or flow values, temperature values and pressure limit values
- Vortex frequency:
  - Direct output of unscaled vortex pulses 0.5 to 2850 Hz
    (e.g. for connecting to a flow computer RMC621)
  - Pulse ratio 1:1
- PFM signal (pulse/frequency modulation):
  For external connection with flow computer RMC or RMS621 (→ 29).

Signal on alarm

- Current output: failsafe mode can be selected (e.g. in accordance with NAMUR Recommendation NE 43)
- Frequency output: failsafe mode can be selected
- Status output: "not conductive" during fault

Load



The area marked in gray indicates the permissible load (with HART: min. 250 Ω)

The load is calculated as follows:

$$R_B = \frac{(U_S - U_{KI})}{(I_{max} - 10^{-3})} = \frac{(U_S - U_{KI})}{0.022}$$

A0004059

R_B Load, load resistance
U_S Supply voltage:
- *Non-Ex = 12 to 36 V DC*
- *Ex-d /XP= 15 to 36 V DC*
- *Ex-i /IS and Ex-n = 12 to 30 V DC*

U_{KI} Terminal voltage:
- *Non-Ex = min. 12 V DC*
- *Ex-d/XP = min. 15 V DC*
- *Ex-i /IS and Ex-n = min. 12 V DC*

I_{max} Output current (22.6 mA)

Low flow cut off

Switch points for low flow cut off can be selected as required.

Galvanic isolation

All electrical connections are galvanically isolated themselves.

10.1.5 Power supply

Electrical connection

→ 📄 25

Supply voltage

Non-Ex: 12 to 36 V DC (with HART: 18 to 36 V DC)
Ex-i/IS and Ex-n: 12 to 30 V DC (with HART 18 to 30 V DC)
Ex-d/XP: 15 to 36 V DC (with HART: 21 to 36 V DC)

Cable entry

Power supply and signal cables (outputs):
- Cable entry M20 × 1.5 (6 to 12 mm / 0.24 to 0.47")
- Cable entry M20 × 1.5 for armored signal cable (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entry: ½" NPT, G ½", G ½" Shimada

Cable specification

- Permitted temperature range:
  – Standard cable: –40 °C (–40 °F) to max. permissible ambient temperature plus 10 °C (18 °F)
  – Armored cable: –30 to +70 °C (–22 to +158 °F)
- Remote version → 📄 27

Power supply failure

- Totalizer stops at the last value determined.
- All settings are kept in the EEPROM.
- Error messages (incl. value of operated hours counter) are stored.

10.1.6 Performance characteristics

Reference operating conditions

Error limits following ISO/DIN 11631:
- 20 to 30 °C (+68 to +86 °F)
- 2 to 4 bar (29 to 58 psi)
- Calibration rig traced to national standards.
- Calibration with the process connection corresponding to the particular standard.

Maximum measured error

- Volume flow (liquid):
  < 0.75% o.r. for Re > 20000
  < 0.75% o.f.s for Re between 4000 and 20000
- Volume flow (gas/steam):
  < 1% o.r. for Re > 20000 and v < 75 m/s (246 ft/s)
  < 1% o.f.s for Re between 4000 and 20000
- Temperature:
  < 1 °C (T > 100 °C / 212 °F, saturated steam and for liquids at ambient temperature);
  < 1% o.r. [K] (gas)
  Rise time 50% (agitated under water, following IEC 60751): 8 s
- Mass flow (saturated steam):
  – For flow velocities v = 20 to 50 m/s (66 to 164 ft/s), T > 150 °C / 302 °F (423 K)
    < 1.7% o.r. (2% o.r. for remote version) for Re > 20000
    < 1.7% o.f.s (2% o.f.s for remote version) for Re between 4000 and 20000
  – For flow velocities v = 10 to 70 m/s (33 to 230 ft/s), T > 140 °C / 284 °F (413 K)
    < 2% o.r. (2.3% o.r. for remote version) for Re > 20000
    < 2% o.f.s (2.3% o.f.s. for remote version) for Re between 4000 and 20000
- Mass flow of superheated steam and gas (air, natural gas AGA NX-19, AGA8-DC92, ISO 12213-2, AGA8 Gross Method 1, SGERG-88, preprogrammed gases – does not apply to the real gas equation):

  ✎ Note!
  A Cerabar S device has to be used for the measuring errors listed below. The measured error used to calculate the error in the measured pressure is 0.15%.

  < 1.7% o.r. (2.0% o.r. for remote version) for Re > 20000 and process pressure < 40 bar abs (580 psi abs)

< 1.7% o.f.s (2.0% for remote version) for Re between 4000 and 20000 and process pressure < 40 bar abs (580 psi abs)
< 2.6% o.r. (2.9% o.r. for remote version) for Re > 20000 and process pressure < 120 bar abs (1740 psi abs)
< 2.6% o.f.s (2.9% o.r. for remote version) for Re between 4000 and 20000 and process pressure < 120 bar abs (1740 psi abs)

- Mass flow (water):
  < 0.85% o.r. (1.15% o.r. for remote version) for Re > 20000
  < 0.85% o.f.s (1.15% o.f.s for remote version) for Re between 4000 and 20000
- Mass flow (customer-defined liquids):
  To specify the system accuracy, Endress+Hauser requires information on the type of liquid and its operating temperature, or information in tabular form on the dependency between the liquid density and temperature.
  Example:
  Acetone is to be measured at fluid temperatures between 70 and 90 °C. The parameters TEMPERATURE VALUE (here 80 °C), DENSITY VALUE (here 720.00 kg/m3) and EXPANSION COEFFICIENT (here 18.0298 × 10E-4 1/°C) have to be entered in the transmitter for this purpose. The overall system uncertainty, which is smaller than 0.9% for the example cited above, is made up of the following measuring uncertainties: Uncertainty of volume flow measurement, uncertainty of temperature measurement, uncertainty of the density-temperature correlation used (incl. the resulting uncertainty of density).
- Mass flow (other fluids):
  Depends on the pressure value specified in the OPERATING PRESSURE function (→ 📄 150). An individual error observation must be carried out.
  o.r. = of reading, o.f.s = of full scale value, Re = Reynolds number

Diameter mismatch correction

In the Prowirl 73 shifts in the calibration factor which are caused by a diameter mismatch between the device and the mating pipe can be corrected (→ 📄 140). The diameter mismatch should only be corrected within the limit values listed below for which test measurements have also been performed.

Flange connection:
- DN 15 (½"): ±20% of the internal diameter
- DN 25 (1"): ±15% of the internal diameter
- DN 40 (1½"): ±12% of the internal diameter
- DN ≥50 (2"): ±10% of the internal diameter

Wafer:
- DN 15 (½"): ±15% of the internal diameter
- DN 25 (1"): ±12% of the internal diameter
- DN 40 (1½"): ±9% of the internal diameter
- DN ≥50 (2"): ±8% of the internal diameter

Repeatability

±0.25% o.r. (of reading)

Reaction time/ step response time

If all configurable functions are set to 0, you must reckon with a reaction time/step response time of 200 ms for vortex frequencies as of 10 Hz. Other settings require a reaction time/step response time of 100 ms to be added to the total filter reaction time for vortex frequencies as of 10 Hz.

- FLOW DAMPING → 📄 170
- DISPLAY DAMPING → 📄 114
- TIME CONSTANT (current output) → 📄 120
- TIME CONSTANT (status output) → 📄 134

Influence of ambient temperature

Current output (additional error, in reference to the span of 16 mA)
- Zero point (4 mA): average Tk: 0.05%/10_K, max. 0.6% over the entire temperature range of –40 to +80 °C (–40 to +176 °F)
- Span (20 mA): average Tk: 0.05%/10_K, max. 0.6% over the entire temperature range of –40 to +80 °C (–40 to +176 °F)

Digital outputs (pulse output, frequency output, PFM, HART)

Due to the digital measuring signal (vortex pulse) and further digital processing, there is no interface-related error from changing ambient temperature.

10.1.7 Operating conditions: installation

Installation instructions

→ 17

Inlet and outlet run

→ 20

10.1.8 Operating conditions: environment

Ambient temperature range

Compact version
- Standard: –40 to +70 °C (–40 to +158 °F)
- EEx-d/XP version: –40 to +60 °C (–40 to +140 °F)
- ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C (–4 to +131 °F)
- Display can be read between –20 to +70 °C (–4 to +158 °F)

Remote version sensor
- Standard: –40 to +85 °C (–40 to +185 °F)
- ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C (–4 to +131 °F)

Remote version transmitter
- Standard: –40 to +80 °C (–40 to +176 °F)
- EEx-d/XP version: –40 to +60 °C (–40 to +140 °F)
- ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C (–4 to +131 °F)
- Display can be read between –20 to +70 °C (–4 to +158 °F)
- Version up to –50 °C (–58 °F) on request

To protect the measuring device from direct sunlight when installing the unit outdoors, a protective cover (order number 543199-0001) is recommended. This applies in particular to warmer climates with high ambient temperatures.

Storage temperature

Standard: –40 to +80 °C (–40 to +176 °F)
ATEX II 1/2 GD version/dust ignition-proof: –20 to +55 °C (–4 to +131 °F)
Version up to –52 °C (–62 °F) on request

Degree of protection

IP 67 (NEMA 4X) in accordance with EN 60529

Vibration resistance

Acceleration up to 1 g (with factory setting for amplification), 10 to 500 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

DSC sensor (differential switched capacitor; capacitive sensor)	
DSC standard sensor	–200 to +400 °C (–328 to +752 °F)
DSC sensor Inconel	–200 to +400 °C (–328 to +752 °F)

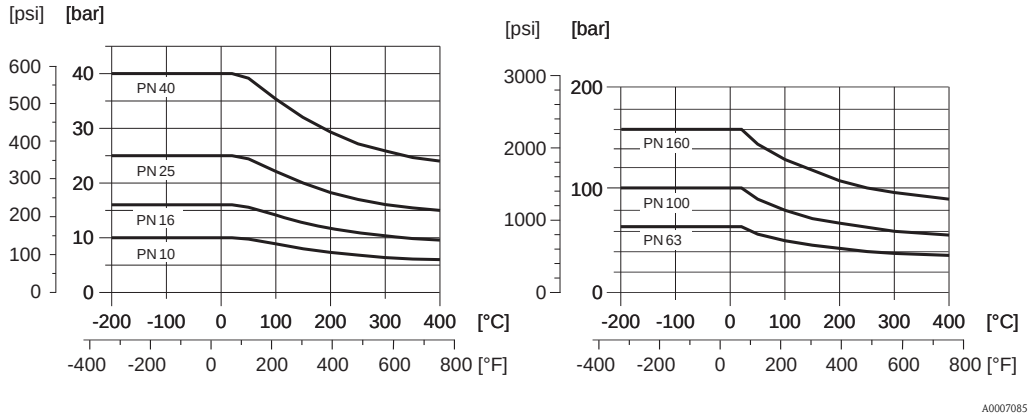
Seals	
Graphite	–200 to +400 °C (–328 to +752 °F)
Viton	–15 to +175 °C (+5 to +347 °F)
Kalrez	–20 to +275 °C (–4 to +527 °F)
Gylon (PTFE)	–200 to +260 °C (–328 to +500 °F)

Sensor	
Stainless steel	–200 to +400 °C (–328 to +752 °F)
Special version for high fluid temperatures (on request)	–200 to +450 °C (–328 to +842 °F) –200 to +440 °C (–328 to +824 °F), Ex version

Medium pressure

Pressure-temperature curve to EN (DIN), stainless steel

PN 10 to 40 → Prowirl 73W and 73F
PN 63 to 160 → Prowirl 73F



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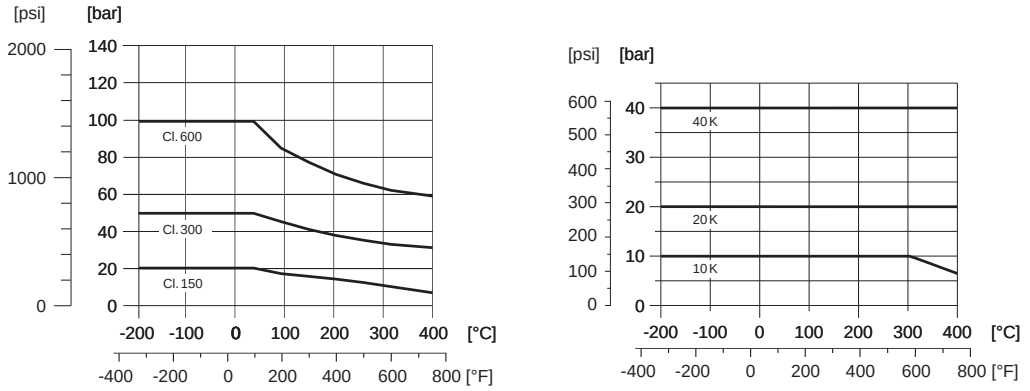
Pressure-temperature curve to ANSI B16.5 and JIS B2220, stainless steel

ANSI B16.5:
Class 150 to 300 → Prowirl 73W and 73F
Class 600 → Prowirl 73F

JIS B2220:
10 to 20K → Prowirl 73W and 73F
40K → Prowirl 73F



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Limiting flow

See information on → 78 ("Measuring range").

Pressure loss

The pressure loss can be determined with the aid of the Applicator. The Applicator is software for selecting and planning flowmeters. The software is available both via the Internet (www.applicator.com) and on a CD-ROM for local PC installation.

10.1.10 Frequency ranges for air and water

For further fluids, e.g. steam, you can find information in the Applicator.

Prowirl 73W (SI units)

DN (DIN)	Air (at 0 °C, 1.013 bar)			Water (at 20 °C)			K-factor
	Corrected volume flow ($\dot{V}$) in [m^3/h]			Volume flow ($\dot{V}$) in [m^3/h]			[Pulse/dm^3]
	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	Min. to max.
DN 15	4	35	330 to 2600	0.19	7	10.0 to 520	245 to 280
DN 25	11	160	180 to 2300	0.41	19	5.7 to 300	48 to 55
DN 40	31	375	140 to 1650	1.1	45	4.6 to 200	14 to 17
DN 50	50	610	100 to 1200	1.8	73	3.3 to 150	6 to 8
DN 80	112	1370	75 to 850	4.0	164	2.2 to 110	1.9 to 2.4
DN 100	191	2330	70 to 800	6.9	279	2.0 to 100	1.1 to 1.4
DN 150	428	5210	38 to 450	15.4	625	1.2 to 55	0.27 to 0.32

Prowirl 73W (US units)

DN (ANSI)	Air (at 32 °F, 14.7 psia)			Water (at 68 °F)			K-factor
	Corrected volume flow ($\dot{V}$) in [scfm]			Volume flow ($\dot{V}$) in [gpm]			[Pulse/dm^3]
	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	Min. to max.
½"	2.35	20.6	330 to 2600	0.84	30.8	10.0 to 520	245 to 280
1"	6.47	94.2	180 to 2300	1.81	83.7	5.7 to 300	48 to 55
1½"	18.2	221	140 to 1650	4.84	198	4.6 to 200	14 to 17
2"	29.4	359	100 to 1200	7.93	321	3.3 to 150	6 to 8
3"	65.9	806	75 to 850	17.6	722	2.2 to 110	1.9 to 2.4
4"	112	1371	70 to 800	30.4	1228	2.0 to 100	1.1 to 1.4
6"	252	3066	38 to 450	67.8	2752	1.2 to 55	0.27 to 0.32

Prowirl 73F (SI units)

DN (DIN)	Air (at 0 °C, 1.013 bar)			Water (at 20 °C)			K-factor
	Corrected volume flow ($\dot{V}$) in [m^3/h]			Volume flow ($\dot{V}$) in [m^3/h]			[Pulse/dm^3]
	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	Min. to max.
DN 15	3	25	330 to 2850	0.16	5	14.0 to 600	390 to 450
DN 25	9	125	200 to 2700	0.32	15	6.5 to 340	70 to 85
DN 40	25	310	150 to 1750	0.91	37	4.5 to 220	18 to 22
DN 50	42	510	120 to 1350	1.5	62	3.7 to 170	8 to 11
DN 80	95	1150	80 to 900	3.4	140	2.5 to 115	2.5 to 3.2
DN 100	164	2000	60 to 700	5.9	240	1.9 to 86	1.1 to 1.4
DN 150	373	4540	40 to 460	13.4	550	1.2 to 57	0.3 to 0.4
DN 200	715	8710	27 to 322	25.7	1050	1.0 to 39	0.1266 to 0.14
DN 250	1127	13740	23 to 272	40.6	1650	0.8 to 33	0.0677 to 0.0748
DN 300	1617	19700	18 to 209	58.2	2360	0.6 to 25	0.0364 to 0.0402

Prowirl 73F (US units)

DN (ANSI)	Air (at 32 °F, 14.7 psia)			Water (at 68 °F)			K-factor
	Corrected volume flow ($\dot{V}$) in [scfm]			Volume flow ($\dot{V}$) in [gpm]			[Pulse/dm^3]
	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	$\dot{V}_{min}$	$\dot{V}_{max}$	Frequency range [Hz]	Min. to max.
½"	1.77	14.7	380 to 2850	0.70	22.0	14.0 to 600	390 to 450
1"	5.30	73.6	200 to 2700	1.41	66.0	6.5 to 340	70 to 85
1½"	14.7	182	150 to 1750	4.01	163	4.5 to 220	18 to 22
2"	24.7	300	120 to 1350	6.6	273	3.7 to 170	8 to 11
3"	55.9	677	80 to 900	15.0	616	2.5 to 115	2.5 to 3.2
4"	96.5	1177	60 to 700	26.0	1057	1.9 to 86	1.1 to 1.4
6"	220	2672	40 to 460	59.0	2422	1.2 to 57	0.3 to 0.4
8"	421	5126	27 to 322	113	4623	1.0 to 39	0.1266 to 0.14
10"	663	8087	23 to 272	179	7265	0.8 to 33	0.0677 to 0.0748
12"	952	11 595	18 to 209	256	10 391	0.6 to 25	0.0364 to 0.0402

10.1.11 Mechanical construction

Design, dimensions

See Technical Information TI00070D/06/EN

Weight

See Technical Information TI00070D/06/EN

Material

Transmitter housing

- Powder-coated die-cast aluminum AlSi10Mg
  - In accordance with EN 1706/EN AC-43400 (EEx-d/XP version: cast aluminum EN 1706/EN AC-43000)

Sensor

Flanged version
- Pressure ratings up to PN 160, Class 600, 40K:
  - Stainless steel, A351-CF3M (1.4408), in compliance with AD2000 (temperature range –10 to +400 °C/ +14 to +752 °F) as well as in compliance with NACE MR0175-2003 and MR0103-2003

Wafer version
- Pressure ratings up to PN 40, Class 300, 20K:
  - Stainless steel, A351-CF3M (1.4408), in compliance with AD2000 (temperature range –10 to +400 °C/ +14 to +752 °F) as well as in compliance with NACE MR0175-2003 and MR0103-2003

Flanges

- EN (DIN)
  - Stainless steel, A351-CF3M (1.4404), in compliance with NACE MR0175-2003 and MR0103-2003
  - DN 15 to 150 with pressure ratings to PN 40 and all devices with integrated diameter reduction (R Style, S Style): construction with weld-on flanges made of 1.4404 (AISI 316L). All nominal diameters PN 63 to 160 as well as nominal diameters DN 200 to 300 to PN 40: fully cast construction A351-CF3M (1.4408), in compliance with NACE MR0175-2003 and MR0103-2003
- ANSI and JIS
  - Stainless steel, A351-CF3M, in compliance with NACE MR0175-2003 and MR0103-2003
  - ½ to 6" with pressure ratings to Class 300 and DN 15 to 150 with pressure ratings to 20 K and all devices with integrated diameter reduction (R Style, S Style): construction with weld-on flanges made of 316/316L, in compliance with NACE MR0175-2003 and MR0103-2003. All nominal diameters Class 600, 40K as well as nominal diameters DN 200 to 300 to Class 300, 20K: fully cast construction A351-CF3M, in compliance with NACE MR0175-2003 and MR0103-2003

DSC sensor (Differential Switched Capacitor)

- Wetted parts (marked as "wet" on the DSC sensor flange):
  - Standard for pressure ratings up to PN 40, Class 300, JIS 40K: Stainless steel 1.4435 (316/316L), in compliance with NACE MR0175-2003 and MR0103-2003
  - Pressure ratings PN 63 to 160, Class 600, 40K: Inconel 718 (2.4668/N07718, according to B637), in compliance with NACE MR0175-2003 and MR0103-2003

Non-wetted parts

- Stainless steel 1.4301 (304)

Support

- Stainless steel, 1.4308 (CF8)

Seals

- Graphite
  - Pressure rating PN 10 to 40, Class 150 to 300, JIS 10 to 20K:
    Sigraflex Foil Z (BAM-tested for oxygen applications)
  - Pressure rating PN 63 to 160, Class 600, JIS 40K:
    Sigraflex Hochdruck^{MT} with stainless steel sheet reinforcement made of 316(L) (BAM-tested for oxygen applications, "high quality in terms of TA Luft (German Clean Air Act)"
- Viton
- Kalrez 6375
- Gylon (PTFE) 3504 (BAM-tested for oxygen applications, "high quality in terms of TA Luft (German Clean Air Act)"

10.1.12 Human interface

Display elements	■ Liquid crystal display, double-spaced, plain text display, 16 characters per line ■ Display can be configured individually, e.g. for measured variables and status variables, totalizers
Operating elements	■ Local operation with three keys (⊞, ⊟, E) ■ Quick Setup for quick commissioning ■ Operating elements accessible also in Ex zones
Remote operation	Operation via: ■ HART protocol ■ FieldCare (software package from Endress+Hauser for complete configuration, commissioning and diagnosis)

10.1.13 Certificates and approvals

CE mark	→ 15
C-Tick mark	→ 15
Ex approval	More information on the Ex approvals can be found in the separate Ex documentation.
Pressure measuring device approval	The measuring devices can be ordered with or without PED (Pressure Equipment Directive). If a device with PED is required, this must be ordered explicitly. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary. ■ With the identification PED/G1/III on the sensor nameplate, Endress+Hauser confirms conformity with the "Basic safety requirements" of Appendix I of the Pressure Equipment Directive 97/23/EC. ■ Devices with this identification (with PED) are suitable for the following types of fluid: – Fluids of Group 1 and 2 with a steam pressure of greater or less than 0.5 bar (7.3 psi) – Unstable gases ■ Devices without this identification (without PED) are designed and manufactured according to good engineering practice. They correspond to the requirements of Art. 3, Section 3 of the Pressure Equipment Directive 97/23/EC. Their application is illustrated in Diagrams 6 to 9 in Appendix II of the Pressure Equipment Directive 97/23/EC.
Functional safety	SIL 1 Following the link http://www.endress.com/sil, you will find an overview of all Endress+Hauser devices for SIL applications including parameters like SFF, MTBF, PFD_{avg} etc.
Other standards and guidelines	■ EN 60529 Degrees of protection by housing (IP code) ■ EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use ■ IEC/EN 61326 Electromagnetic compatibility (EMC requirements) ■ NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment ■ NAMUR NE 43 Standardization of the signal level for the breakdown information of digital transmitters with analog output signal ■ NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics ■ NACE standard MR0103-2003 Standard Material Requirements - Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments ■ NACE standard MR0175-2003 Standard Material Requirements - Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment ■ VDI 2643 Measurement of fluid flow by means of vortex flowmeters ■ ANSI/ISA-S82.01 Safety Standard for Electrical and Electronic Test, Measuring, Controlling and Related Equipment - General Requirements. Pollution degree 2, Installation Category II

- CAN/CSA-C22.2 No. 1010.1-92
  Safety Standard for Electrical Equipment for Measurement and Control and Laboratory Use. Pollution degree 2, Installation Category II
- The International Association for the Properties of Water and Steam – Release on the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam
- ASME International Steam Tables for Industrial Use (2000)
- American Gas Association (1962)
  A.G.A. Manual for the Determination of Supercompressibility Factors for Natural Gas - PAR Research Project NX-19.
- American Gas Association Transmission Measurement Committee Report No. 8 (AGA8), November 1992. American Petroleum Institute MPMS Chapter 14.2: *Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases*.
- ISO 12213 Natural gas (2006) - Calculation of compression factor
  – Part 2: Calculation using molar composition analysis (ISO 12213-2)
  – Part 3: Calculation using physical properties (ISO 12213-2)
- GERG Groupe Européen des Recherches Gazières (1991): Technical Monograph TM 5 - Standard GERG Virial Equation for Field Use. Simplification of the input data requirements for the GERG Virial Equation - an alternative means of compressibility factor calculation for natural gases and similar mixtures. Publishing house of Verein Deutscher Ingenieure (Association of German Engineers), Düsseldorf
- ISO 6976-1995: Natural gas — Calculation of calorific values, density, relative density and Wobbe index from composition
- Gas Processors Association GPA Standard 2172-96
- American Petroleum Institute API MPMS 14.5 (1996). Calculation of Gross Heating Value, Relative Density and Compressibility Factor for Natural Gas Mixtures from Compositional Analysis

10.1.14 Ordering information

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

10.1.15 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor (→ 59). Your Endress+Hauser service organization can provide detailed information on the order codes of your choice.

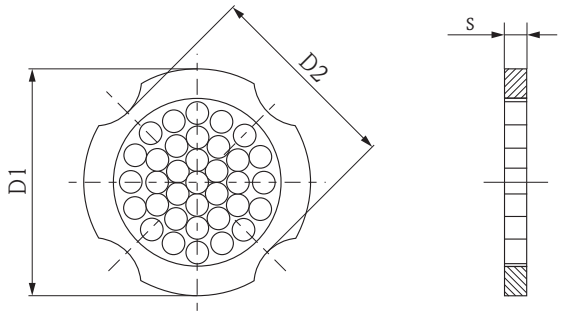
10.1.16 Documentation

- Flow measurement (FA005D/06)
- Technical Information Proline Prowirl 72F, 72W, 73F, 73W (TI00070/06/EN)
- Associated Ex documentation: ATEX, FM, CSA, etc.
- Related documentation for Pressure Equipment Directive Proline Prowirl 72/73 (SD072D/06/en)
- Functional Safety Manual (Safety Integrity Level)

10.2 Dimensions of flow conditioner

Dimensions according to:
- EN 1092-1 (DIN 2501)
- ANSI B16.5
- JIS B2220

Material 1.4404 (316/316L), in compliance with NACE MR0175-2003 and MR0103-2003



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D1: The flow conditioner is fitted at the outer diameter between the bolts.
D2: The flow conditioner is fitted at the indentations between the bolts.

Dimensions of flow conditioner according to EN (DIN)

DN	Pressure rating	Centering diameter [mm]	D1 / D2 *	s [mm]	Weight [kg]
15	PN 10 to 40 PN 63	54.3 64.3	D2 D1	2.0	0.04 0.05
25	PN 10 to 40 PN 63	74.3 85.3	D1 D1	3.5	0.12 0.15
40	PN 10 to 40 PN 63	95.3 106.3	D1 D1	5.3	0.3 0.4
50	PN 10 to 40 PN 63	110.0 116.3	D2 D1	6.8	0.5 0.6
80	PN 10 to 40 PN 63	145.3 151.3	D2 D1	10.1	1.4
100	PN 10/16 PN 25/40 PN 63	165.3 171.3 176.5	D2 D1 D2	13.3	2.4
150	PN 10/16 PN 25/40 PN 63	221.0 227.0 252.0	D2 D2 D1	20.0	6.3 7.8 7.8
200	PN 10 PN 16 PN 25 PN 40	274.0 274.0 280.0 294.0	D1 D2 D1 D2	26.3	11.5 12.3 12.3 15.9
250	PN 10/16 PN 25 PN 40	330.0 340.0 355.0	D2 D1 D2	33.0	25.7 25.7 27.5
300	PN 10/16 PN 25 PN 40	380.0 404.0 420.0	D2 D1 D1	39.6	36.4 36.4 44.7

* D1 → The flow conditioner is fitted at the external diameter between the bolts.
D2 → The flow conditioner is fitted at the indentations between the bolts.

Dimensions of flow conditioner according to ANSI

DN		Pressure rating	Centering diameter mm (inch)	D1 / D2 *	s mm (inch)	Weight kg (lbs)
15	½"	Cl. 150 Cl. 300	50.1 (1.97) 56.5 (2.22)	D1 D1	2.0 (0.08)	0.03 (0.07) 0.04 (0.09)
25	1"	Cl. 150 Cl. 300	69.2 (2.72) 74.3 (2.93)	D2 D1	3.5 (0.14)	0.12 (0.26)
40	1½"	Cl. 150 Cl. 300	88.2 (3.47) 97.7 (3.85)	D2 D2	5.3 (0.21)	0.3 (0.66)
50	2"	Cl. 150 Cl. 300	106.6 (4.20) 113.0 (4.45)	D2 D1	6.8 (0.27)	0.5 (1.1)
80	3"	Cl. 150 Cl. 300	138.4 (5.45) 151.3 (5.96)	D1 D1	10.1 (0.40)	1.2 (2.6) 1.4 (3.1)
100	4"	Cl. 150 Cl. 300	176.5 (6.95) 182.6 (7.19)	D2 D1	13.3 (0.52)	2.7 (6.0)
150	6"	Cl. 150 Cl. 300	223.9 (8.81) 252.0 (9.92)	D1 D1	20.0 (0.79)	6.3 (14) 7.8 (17)
200	8"	Cl. 150 Cl. 300	274.0 (10.8) 309.0 (12.2)	D2 D1	26.3 (1.04)	12.3 (27) 15.8 (35)
250	10"	Cl. 150 Cl. 300	340.0 (13.4) 363.0 (14.3)	D1 D1	33.0 (1.30)	25.7 (57) 27.5 (61)
300	12"	Cl. 150 Cl. 300	404.0 (15.9) 402.0 (16.5)	D1 D1	39.6 (1.56)	36.4 (80) 44.6 (98)

* D1 → The flow conditioner is fitted at the external diameter between the bolts.
D2 → The flow conditioner is fitted at the indentations between the bolts.

Dimensions of flow conditioner according to JIS

DN	Pressure rating	Centering diameter [mm]	D1 / D2 *	s [mm]	Weight [kg]
15	10K	60.3	D2	2.0	0.06
	20K	60.3	D2	2.0	0.06
	40K	66.3	D1	2.0	0.06
25	10K	76.3	D2	3.5	0.14
	20K	76.3	D2	3.5	0.14
	40K	81.3	D1	3.5	0.14
40	10K	91.3	D2	5.3	0.31
	20K	91.3	D2	5.3	0.31
	40K	102.3	D1	5.3	0.31
50	10K	106.6	D2	6.8	0.47
	20K	106.6	D2	6.8	0.47
	40K	116.3	D1	6.8	0.5
80	10K	136.3	D2	10.1	1.1
	20K	142.3	D1	10.1	1.1
	40K	151.3	D1	10.1	1.3
100	10K	161.3	D2	13.3	1.8
	20K	167.3	D1	13.3	1.8
	40K	175.3	D1	13.3	2.1
150	10K	221.0	D2	20.0	4.5
	20K	240.0	D1	20.0	5.5
	40K	252.0	D1	20.0	6.2
200	10K	271.0	D2	26.3	9.2
	20K	284.0	D1	26.3	9.2
250	10K	330.0	D2	33.0	15.8
	20K	355.0	D2	33.0	19.1
300	10K	380.0	D2	39.6	26.5
	20K	404.0	D1	39.6	26.5

* D1 → The flow conditioner is fitted at the external diameter between the bolts.
D2 → The flow conditioner is fitted at the indentations between the bolts.

11 Description of device functions

11.1 Illustration of the function matrix

Groups/function groups		Functions			
MEASURING VALUES	→ 98	VOLUME FLOW	TEMPERATURE	MASS FLOW	CORRECTED VOLUME FLOW
		HEAT FLOW	DENSITY	CORRECTED DENSITY	SPECIFIC ENTHALPY
↓		CALCULATED SATURATED STEAM PRESSURE	Z FACTOR	VORTEX FREQUENCY	FLOW VELOCITY
SYSTEM UNITS	→ 102	UNIT VOLUME FLOW	UNIT TEMPERATURE	UNIT MASS FLOW	UNIT CORRECTED VOLUME FLOW
		UNIT HEAT FLOW	UNIT DENSITY	UNIT SPECIFIC HEAT CAPACITY	UNIT SPECIFIC ENTHALPY
↓		UNIT CALORIFIC VALUE MASS	UNIT CALORIFIC VALUE CORRECTED VOLUME	UNIT PRESSURE	UNIT LENGTH
		FORMAT DATE/TIME			
SPECIAL UNITS	→ 107	TEXT ARBITRARY VOLUME UNIT	FACTOR ARBITRARY VOLUME	TEXT ARBITRARY MASS	FACTOR ARBITRARY MASS
		TEXT ARBITRARY CORRECTED VOLUME	FACTOR ARBITRARY CORRECTED VOLUME		
↓					
QUICK SETUP COMMISSIONING	→ 109	QUICK SETUP COMMISSIONING			
↓					
OPERATION	→ 110	LANGUAGE	ACCESS CODE	DEFINE PRIVATE CODE	STATUS ACCESS
		ACCESS CODE COUNTER	ACTIVATION CODE NATURAL GAS	ACTIVATION CODE EXTENDED DIAGNOSTICS	
↓					
USER INTERFACE	→ 112	ASSIGN LINE 1	ASSIGN LINE 2	100%-VALUE LINE 1	100%-VALUE LINE 2
		FORMAT	DISPLAY DAMPING	CONTRAST LCD	TEST DISPLAY
↓					
TOTALIZER 1 and 2	→ 116	ASSIGN TOTALIZER	SUM	OVERFLOW TOT.	UNIT TOTALIZER
		RESET TOTALIZER			
↓					
HANDLING TOTALIZER	→ 118	RESET ALL TOTALIZERS	FAILSAFE MODE		
CURRENT OUTPUT	→ 119	ASSIGN CURRENT	CURRENT SPAN	VALUE 4 mA	VALUE 20 mA
		TIME CONSTANT	FAILSAFE MODE	ACTUAL CURRENT	SIMULATION CURRENT
		VALUE SIMULATION CURRENT			
↓					

Groups/function groups		Functions			
PULSE, FREQUENCY, STATUS	→ 122	OPERATION MODE	ASSIGN FREQUENCY	START VALUE FREQUENCY	END VALUE FREQUENCY
		VALUE f LOW	VALUE f HIGH	OUTPUT SIGNAL	TIME CONSTANT
		FAILSAFE MODE	FAILSAFE VALUE	ACTUAL FREQUENCY	SIMULATION FREQUENCY
		ASSIGN PULSE	PULSE VALUE	PULSE WIDTH	OUTPUT SIGNAL
↓		FAILSAFE MODE	ACTUAL PULSE	SIMULATION PULSE	ASSIGN STATUS
		ON-VALUE	OFF-VALUE	TIME CONSTANT	ACTUAL STATUS OUTPUT
		SIMULATION SWITCH POINT	VALUE SIMULATION SWITCH POINT		
COMMUNICATION	→ 138	TAG NAME	TAG DESCRIPTION	FIELDBUS ADDRESS	WRITE PROTECTION
↓		BURST MODE	BURST MODE CMD	MANUFACTURER ID	DEVICE ID
PROCESS PARAMETER	→ 140	D MATING PIPE	ASSIGN LOW FLOW CUT OFF	ON-VALUE LOW FLOW CUT OFF	OFF-VALUE LOW FLOW CUT OFF
↓		VELOCITY WARNING	LIMIT VELOCITY		
FLOW COMPUTER	→ 143	SELECT FLUID	NATURAL GAS EQUATION	ERROR → TEMPERATURE	TEMPERATURE VALUE
		DENSITY VALUE	EXPANSION COEFFICIENT	OPERATING PRESSURE	OPERATING-Z-FACTOR
		REFERENCE PRESSURE	REFERENCE TEMPERATURE	REFERENCE DENSITY	ENERGY CALCULATION
		SPECIFIC HEAT CAPACITY	REFERENCE COMBUSTION TEMPERATURE	REFERENCE-Z-FACTOR	SPECIFIC DENSITY
↓		MOLE-% N2	MOLE-%-CO2	MOLE-% H2	REFERENCE GROSS CALORIFIC VALUE
		TYPE CALORIFIC VALUE	GROSS CALORIFIC VALUE	NET CALORIFIC VALUE	CALORIFIC VALUE -> ENERGY
		WET STEAM ALARM	INSTALLATION POINT	SATURATED STEAM PARAMETER	
GAS MIXTURE	→ 159	NUMBER OF GASES	GAS TYPE 1	MOLE % GAS 1	GAS TYPE n
		MOLE % GAS n	Z-FACTOR (OTHER)	REFERENCE Z-FACTOR (OTHER)	REFERENCE DENSITY (OTHER)
↓		CHECK VALUES	SAVE CHANGES		
NG AGA8-DC92/ISO 12213-2	→ 163	MOLE % CH4	MOLE % N2	MOLE % CO2	MOLE % C2H6
		MOLE % C3H8	MOLE % H2O	MOLE % H2S	MOLE % H2
		MOLE % CO	MOLE % O2	MOLE % i-C4H10	MOLE % n-C4H10
		MOLE % i-C5H12	MOLE % n-C5H12	MOLE % n-C6H14	MOLE % n-C7H16
↓		MOLE % n-C8H18	MOLE % n-C9H20	MOLE % n-C10H22	MOLE % He
		MOLE % Ar	CHECK VALUES	SAVE CHANGES	
HART INPUT	→ 167	HART INPUT	HART INPUT VALUE	PRESSURE TYPE	AMBIENT PRESSURE
↓		ERROR VALUE TEMPERATURE	ERROR VAL. PRESS	ERROR VALUE DENS	TIMEOUT HART COMMUNICATION

Groups/function groups		Functions			
SYSTEM PARAMETER	→ 170	POSITIVE ZERO RETURN	FLOW DAMPING		
SENSOR DATA	→ 171	CALIBRATION DATE	K-FACTOR	K-FACTOR COMPENSATED	NOMINAL DIAMETER
		METER BODY MB	TEMPERATURE COEFFICIENT	AMPLIFICATION	OFFSET T-SENSOR
		CABLE LENGTH			
SUPERVISION	→ 173	ACTUAL SYSTEM CONDITION	PREVIOUS SYSTEM CONDITIONS	ASSIGN SYSTEM ERROR	ERROR CATEGORY
		ASSIGN PROCESS ERROR	ERROR CATEGORY	ALARM DELAY	SYSTEM RESET
		TROUBLESHOOTING	OPERATION HOURS		
SIMULATION SYSTEM	→ 175	SIMULATION FAILSAFE MODE	SIMULATION MEASURAND	VALUE SIMULATION MEASURAND	
SENSOR VERSION	→ 176	SERIAL NUMBER	SENSOR TYPE	SERIAL NUMBER DSC SENSOR	
AMPLIFIER VERSION	→ 176	DEVICE SOFTWARE	HARDWARE REVISION NUMBER AMPLIFIER	SOFTWARE REVISION NUMBER AMPLIFIER	HARDWARE REVISION NUMBER I/O MODULE
EXTENDED DIAGNOSTIC	→ 177	MIN T FLUID	MAX T FLUID	RESET T FLUID	WARN T FLUID LO
		WARN T FLUID HI	TEMPRTRE ELECTR	MIN T ELECTRONCS	MAX T ELECTRONCS
		RESET T ELECTR.	WARN T ELECTR. LO	WARN T ELECTR. HI	SENSOR DIAGN.
		REYNOLDS-NO.	REYNOLDS WARNING		

11.2 MEASURING VALUES

Function description, MEASURING VALUES group	
VOLUME FLOW	**Description** The volume flow currently measured appears on the display. The appropriate unit is taken from the UNIT VOLUME FLOW function (→ 🖹 102). **Display** 5-digit floating-point number, including unit e.g. 5.545 dm^3/m; 731.63 gal/d
TEMPERATURE	**Description** The temperature currently measured appears on the display. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 🖹 102). **Display** Max. 4-digit fixed-point number, including unit and sign e.g. –23.4 °C, 160.0 °F, 295.4 K
MASS FLOW	**Prerequisite** The function is **not** available if GAS VOLUME or LIQUID VOLUME was selected in the SELECT FLUID function (→ 🖹 143). "– – – –" appears on the display if either of these two options is selected. **Description** The calculated mass flow appears on the display. ■ The mass flow is calculated using the measured volume flow and the measured temperature. ■ The appropriate unit is taken from the UNIT MASS FLOW function (→ 🖹 103). **Display** 5-digit floating-point number, including unit e.g. 462.87 kg/h; 731.63 lb/min
CORRECTED VOLUME FLOW	**Prerequisite** The function is **not** available if one of the following options was selected in the SELECT FLUID function (→ 🖹 143): ■ GAS VOLUME ■ LIQUID VOLUME ■ SATURATED STEAM ■ SUPERHEATED STEAM ■ SATURATED STEAM DELTA HEAT "– – – –" appears on the display if these options are selected. **Description** The calculated corrected volume flow appears on the display. ■ The corrected volume flow is calculated using the measured volume flow and the measured temperature. ■ The appropriate unit is taken from the UNIT CORRECTED VOLUME FLOW function (→ 🖹 103). **Display** 5-digit floating-point number, including unit e.g. 5.5445 Nm^3/min; 1.4359 Sm^3/h

Function description, MEASURING VALUES group	
HEAT FLOW	**Prerequisite** The function is **only** available ■ If one of the following options was selected in the SELECT FLUID function (→ 143): – SATURATED STEAM – SUPERHEATED STEAM – WATER – NATURAL GAS – METHANE – USER DEFINED LIQUID or ■ If a gas mixture was defined in the GAS MIXTURE function. **Description** The heat flow determined appears on the display. ■ The heat flow is determined using the fluid selected in the SELECT FLUID function and the measured temperature. ■ The appropriate unit is taken from the UNIT HEAT FLOW function (→ 104). **Display** 5-digit floating-point number, including unit e.g. 1.2345 MW
DENSITY	**Prerequisite** The function is **not** available if GAS VOLUME or LIQUID VOLUME was selected in the SELECT FLUID function (→ 143). **Description** The density determined appears on the display. ■ The density is determined using the fluid selected in the SELECT FLUID function and the measured temperature. ■ The appropriate unit is taken from the UNIT DENSITY function (→ 104). **Display** 5-digit floating-point number, including unit e.g. 1.2345 kg/dm³; 1.0015 SG 20 °C
CORRECTED DENSITY	**Prerequisite** The function is **not** available if GAS VOLUME or LIQUID VOLUME was selected in the SELECT FLUID function (→ 143). **Description** The corrected density appears on the display if the value entered in the D MATING PIPE function (→ 140) is not equal to 0. ■ The corrected density is determined from the density in the DENSITY function (→ 99) taking the diameter of the connected pipe into account. ■ The appropriate unit is taken from the UNIT DENSITY function (→ 104). **Display** 5-digit floating-point number, including unit e.g. 1.2345 kg/dm³; 1.0015 SG 20 °C

Function description, MEASURING VALUES group	
SPECIFIC ENTHALPY	**Prerequisite** The function is **only** available if one of the following options was selected in the SELECT FLUID function (→ 143): ■ SATURATED STEAM ■ WATER ■ SUPERHEATED STEAM ■ USER DEFINED LIQUID with DELTA HEAT option The function is **not** available if one of the following options was selected in the SELECT FLUID function (→ 143): ■ GAS VOLUME ■ LIQUID VOLUME **Description** The specific enthalpy determined appears on the display. ■ The enthalpy is determined using the fluid selected in the SELECT FLUID function and the measured temperature. ■ The appropriate unit is taken from the UNIT SPECIFIC ENTHALPY function (→ 105). ■ In accordance with IAPWS-IF97, the enthalpy output by the measuring device refers to the specific enthalpy of the boiling liquid at the triple point. This means that the specific inner enthalpy and the specific entropy of the boiling liquid are set to zero at the triple point. It follows that the specific enthalpy is 0.611783 J/g–1 at that point. ■ If the user selects USER DEFINED LIQUID with DELTA HEAT, the specific heat is displayed here: $c_p \cdot \Delta T = E \div (q \cdot \rho (T))$ **Display** 5-digit floating-point number e.g. 5.1467 kJ/kg
CALCULATED SATURATED STEAM PRESSURE	**Prerequisite** The function is **only** available if SATURATED STEAM was selected in the SELECT FLUID function (→ 143). **Description** The calculated steam pressure (of the saturated steam) appears on the display. ■ The steam pressure of the saturated steam is determined using the fluid selected in the SELECT FLUID function (→ 143) and the measured temperature. ■ The appropriate unit is taken from the UNIT SPECIFIC ENTHALPY function (→ 105). **Display** 5-digit floating-point number e.g. 1.2345 kg/dm³; 1.0015 SG 20 °C
Z FACTOR	**Prerequisite** The function is **only** available if one of the following options was selected in the SELECT FLUID function (→ 143): ■ COMPRESSED AIR ■ AGA NX-19 ■ AGA8-DC92 ■ ISO 12213-2 ■ AGA8 Gross Method 1 ■ SGERG-88 **Description** The density determined appears on the display. The real gas constant (Z factor) indicates the extent to which a real gas differs from an ideal gas that exactly satisfies the general gas law ($p \cdot V \div T$ = constant, $Z = 1$). The real gas constant approaches the value 1 the further the real gas is from its liquefaction point. – The calculated compressibility factor Z appears on the display if COMPRESSED AIR, AGA8-DC92, ISO 12213-2, AGA8 Gross Method 1 or SGERG-88 is selected. – The "supercompressibility factor" appears on the display if NATURAL GAS AGA NX-19 is selected. **Display** 5-digit floating-point number e.g. 0.9467

Function description, MEASURING VALUES group	
VORTEX FREQUENCY	**Description** The vortex frequency currently measured appears on the display. This function is only used for a plausibility check. **Display** 5-digit floating-point number, including unit Hz
FLOW VELOCITY	**Description** The flow velocity through the device appears on the display. This is calculated from the current flow through the device and the cross-sectional area flowed through. Unit on the display depends on UNIT LENGTH (→ 106) **Display** 5-digit floating point number, incl. unit: m/s; ft/s

11.3 SYSTEM UNITS

Function description, SYSTEM UNITS group	
UNIT VOLUME FLOW	**Description** For selecting the unit required and displayed for the volume flow. The unit you select here is also valid for: ■ Flow display ■ Current output (value 20 mA) ■ Frequency output (pulse value; value-f low, value-f high; on-value/off-value) ■ On-value low flow cut off ■ Simulation measurand The units for the totalizers are independent of the option selected here. They are selected in the UNIT TOTALIZER function (→ 117). The following time units can be selected: s = second, m = minute, h = hour, d = day **Options** SI: Cubic centimeter → cm³/time unit Cubic decimeter → dm³/time unit Cubic meter → m³/time unit Milliliter → ml/time unit Liter → l/time unit Hectoliter → hl/time unit Megaliter → Ml/time unit MEGA US: Cubic centimeter → cc/time unit Acre foot → af/time unit Cubic foot → ft³/time unit Fluid ounce → ozf/time unit Gallon → US gal/time unit Kilo gallon → US Kgal/time unit Mega gallon → US Mgal/time unit Barrel (normal fluids: 31.5 gal/bbl) → US bbl/time unit NORM. Barrel (beer: 31.0 gal/bbl) → US bbl/time unit BEER Barrel (petrochemicals: 42.0 gal/bbl) → US bbl/time unit PETR. Barrel (filling tanks: 55.0 gal/bbl) → US bbl/time unit TANK Imperial: Gallon → imp. gal/time unit Mega gallon → imp. Mgal/time unit Barrel (beer: 36.0 gal/bbl) → imp. bbl/time unit BEER Barrel (petrochemicals: 34.97 gal/bbl) → imp. bbl/time unit PETR. Arbitrary volume unit: This option does not appear unless a volume unit was defined via the TEXT ARBITRARY VOLUME UNIT function (→ 107). **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
UNIT TEMPERATURE	**Description** For selecting the unit required and displayed for the temperature. **Options** °C (CELSIUS) K (KELVIN) °F (FAHRENHEIT) R (RANKINE) **Factory setting** Depends on country → 180

Function description, SYSTEM UNITS group	
UNIT MASS FLOW	**Description** For selecting the unit required and displayed for the calculated mass flow. The unit you select here is also valid for: ■ Flow display ■ Current output (value 20 mA) ■ Frequency output (pulse value; value-f low, value-f high; on-value/off-value) ■ On-value low flow cut off ■ Simulation measurand The following time units can be selected: s = second, m = minute, h = hour, d = day **Options** SI: Gram → g/time unit Kilogram → kg/time unit Metric ton → t/time unit US: Ounce → oz/time unit Pound → lb/time unit Mega pound → Mlb/time unit Ton → ton/time unit **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
UNIT CORRECTED VOLUME FLOW	**Description** For selecting the unit required and displayed for the corrected volume flow. The unit you select here is also valid for: ■ Flow display ■ Current output (value 20 mA) ■ Frequency output (pulse value; value-f low, value-f high; on-value/off-value) ■ On-value low flow cut off ■ Simulation measurand The following time units can be selected: s = second, m = minute, h = hour, d = day **Options** SI: Standard liter →Nl/time unit Standard cubic meter → Nm^3/time unit US: Standard cubic meter → Sm^3/time unit Standard cubic feet → Scf/time unit **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.

Function description, SYSTEM UNITS group	
UNIT HEAT FLOW	**Description** For selecting the unit required and displayed for the heat flow. The unit you select here is also valid for: ■ Flow display ■ Current output (value 20 mA) ■ Frequency output (pulse value; value-f low, value-f high; on-value/off-value) ■ On-value low flow cut off ■ Simulation measurand The following time units can be selected: s = second, m = minute, h = hour, d = day **Options** SI: kW MW kJ/time unit MJ/time unit GJ/time unit kcal/time unit Mcal/time unit Gcal/time unit US: tons kBtu/time unit MBtu/time unit GBtu/time unit **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
UNIT DENSITY	**Description** For selecting the unit required and displayed for the density. **Options** SI: g/cm³ g/cc kg/dm³ kg/l kg/m³ SD* 4 °C, SD 15 °C, SD 20 °C SG* 4 °C, SG 15 °C, SG 20 °C US: lb/ft³ lb/US gal lb/US bbl NORM (normal fluids) lb/US bbl BEER (beer) lb/US bbl PETR. (petrochemicals) lb/US bbl TANK (filling tanks) IMPERIAL: lb/imp. gal lb/imp. bbl BEER (beer) lb/imp. bbl PETR. (petrochemicals) **Factory setting** Depends on country → 🖹 180 * SD = specific density, SG = specific gravity The specific density is the ratio of fluid density to water density (at water temperature = 4, 15, 20 °C).

Function description, SYSTEM UNITS group	
UNIT SPECIFIC HEAT CAPACITY	**Description** For selecting the unit required and displayed for the specific heat capacity of the USER DEFINED LIQUID. **Options** SI: kWh/(kg*K) kJ/(kg*K) kcal/(kg*°C) US: Btu/(lb*°F) Btu/(lb*°R) CANADA: CTU/(lb*°C) CHU/(lb*°C) **Factory setting** Depends on country → 180
UNIT SPECIFIC ENTHALPY	**Description** For selecting the unit required and displayed for the specific enthalpy of saturated steam, superheated steam or water. **Options** SI: kWh/kg kJ/kg MJ/kg kcal/kg US: Btu/lb **Factory setting** Depends on country → 180
UNIT CALORIFIC VALUE MASS	**Description** For selecting the unit required and displayed for the net calorific value based on the mass. **Options** SI: kJ/kg MJ/kg kWh/kg MWh/kg US: Btu/lb **Factory setting** MJ/kg (SI units) Btu/lb (US units)

Function description, SYSTEM UNITS group	
UNIT CALORIFIC VALUE CORRECTED VOLUME	**Description** For selecting the unit required and displayed for the net calorific value based on the corrected volume. **Options** SI: kJ/Nm^3 MJ/Nm^3 kWh/Nm^3 MWh/Nm^3 US: kJ/Sm^3 MJ/Sm^3 kWh/Sm^3 MWh/Sm^3 Btu/Scf **Factory setting** MJ/Nm^3 (SI units) Btu/Scf (US units)
UNIT PRESSURE	**Description** For selecting the unit required and displayed for the pressure and the relative pressure unit. **Options** bara (bar absolute) psia (pounds per square inch absolute) kPa a (Kilopascal absolute) MPa a (Megapascal absolute) kg/cm2 a (kilograms per square centimeter absolute) mmH20(4°C) a (millimeter of water absolute) inH20(39.2°F) a (inch of water absolute) mmHg(0°C) a (millimeter of mercury absolute) inHg(39.2°F) a (inch of mercury absolute) **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
UNIT LENGTH	**Description** For selecting the unit required and displayed for the length unit of the nominal diameter in the NOMINAL DIAMETER function (→ 171). The unit you select here also affects: ■ The unit in which the cable length is entered (→ 172) ■ The unit of the velocity on the local display (→ 101) **Options** MILLIMETER INCH **Factory setting** Depends on country → 180
FORMAT DATE/TIME	**Description** Selection of the format of date and time. This indicates or must be entered, if the calibration factor in function SENSOR DATA is changed (e.g. after a Re calibration). **Options** MM/DD/YY 24H DD.MM.YY 24H MM/DD/YY 12H A/P DD.MM.YY 12H A/P **Factory setting** DD.MM.YY 24H

11.4 SPECIAL UNITS

Function descriptions for SPECIAL UNITS group	
TEXT ARBITRARY VOLUME UNIT	**Description** For entering a text for a volume flow unit of the user's choice. The related time unit is selected in the UNIT VOLUME FLOW function (→ 🖹 102). The volume unit defined in this function is offered as a possible option (arbitrary volume unit) in the UNIT VOLUME FLOW function (→ 🖹 102). **User input** xxxx (max. 4 characters) Valid characters are A-Z, 0-9, +, -, decimal point, white space or underscore **Factory setting** "– – – –" (no text)
FACTOR ARBITRARY VOLUME	**Prerequisite** The function is **only** available if a text was entered in the TEXT ARBITRARY VOLUME UNIT function (→ 🖹 107). **Description** For entering a quantity factor (without time) for the arbitrary volume flow unit. The volume unit on which this factor is based is one liter. **User input** 5-digit floating-point number **Factory setting** Text arbitrary volume unit / liter
TEXT ARBITRARY MASS	**Description** For entering a text for a mass flow unit of the user's choice. Only the text is defined. The associated time unit is selected in the UNIT MASS FLOW function (→ 🖹 103). The mass unit defined in this function is offered as a possible option (arbitrary mass unit) in the UNIT MASS FLOW function (→ 🖹 103). **Options** xxxx (max. 4 characters) Valid characters are A-Z, 0-9, +, -, decimal point, white space or underscore. **Factory setting** "– – – –" (no text)
FACTOR ARBITRARY MASS	**Prerequisite** The function is **only** available if a text was entered in the TEXT ARBITRARY MASS function (→ 🖹 107). **Description** For entering a quantity factor (without time) for the arbitrary mass flow unit. The mass unit on which this factor is based is one kilogram. **User input** 5-digit floating-point number **Factory setting** Text arbitrary mass / kg
TEXT ARBITRARY CORRECTED VOLUME	**Description** For entering a text for a corrected volume flow unit of the user's choice. The related time unit is selected in the UNIT CORRECTED VOLUME FLOW function (→ 🖹 103). The corrected volume unit defined in this function is offered as a possible option (arbitrary corrected volume unit) in the UNIT CORRECTED VOLUME FLOW function. **Options** xxxx (max. 4 characters) Valid characters are A-Z, 0-9, +, -, decimal point, white space or underscore. **Factory setting** "– – – –" (no text)

Function descriptions for SPECIAL UNITS group	
FACTOR ARBITRARY CORRECTED VOLUME	**Prerequisite** The function is **only** available if a text was entered in the TEXT ARBITRARY CORRECTED VOLUME function (→ 107). **Description** For entering a quantity factor (without time) for the arbitrary corrected volume flow unit. The corrected volume unit on which this factor is based is one Nm^3. **User input** 5-digit floating-point number **Factory setting** Text arbitrary corrected volume unit / Nm^3

11.5 QUICK SETUP COMMISSIONING

Function description, QUICK SETUP COMMISSIONING group	
QUICK SETUP COMMISSIONING	**Description** Starts the Quick Setup menu for commissioning. For an exact description of the Commissioning Quick Setup, see → 📄 51: **Options** NO YES **Factory setting** NO

11.6 OPERATION

Function description, OPERATION group	
LANGUAGE	**Description** For selecting the language in which all messages are shown on the local display. If you press the ⊡ keys simultaneously at startup, the language defaults to "ENGLISH". **Options with standard display:** ENGLISH DEUTSCH FRANCAIS ESPANOL ITALIANO NEDERLANDS NORSK SVENSKA SUOMI PORTUGUES POLSKI CESKI **Available in addition with the graphical display option:** CHINESE JAPANESE RUSSIAN **Factory setting** Depends on country → 🖹 180
ACCESS CODE	**Description** All data of the measuring system are protected against inadvertent change. Programming is disabled and the settings cannot be changed until a code is entered in this function. If the ⊡ keys are pressed in any function, the measuring system automatically goes to the function. If programming is locked, a prompt to enter a code appears on the display. You can enable programming by entering the private code (factory setting = 73, → 🖹 110, DEFINE PRIVATE CODE function). ■ The programming levels are disabled if the operating elements are not pressed within 60 seconds following a return to the HOME position. ■ Programming can also be disabled by entering any number (other than the private code) in this function. ■ Your Endress+Hauser representative can be of assistance if you mislay your private code. **User input** Max. 4-digit number: 0 to 9999
DEFINE PRIVATE CODE	**Description** Use this function to specify the private code for enabling programming. ■ Programming is always enabled if the code defined = 0. ■ Programming has to be enabled before this code can be changed. When programming is disabled this function cannot be edited, thus preventing others from accessing your personal code. **User input** Max. 4-digit number: 0 to 9999 **Factory setting** 73
STATUS ACCESS	**Description** The access status for the function matrix appears on the display. **Display** ACCESS CUSTOMER (parameters can be modified) LOCKED (parameters cannot be modified)

Function description, OPERATION group	
ACCESS CODE COUNTER	**Description** The number of times the private and service code was entered to access the device appears on the display. **Display** Integer **Factory setting** 0
ACTIVATION CODE NATURAL GAS	**Description** For entering the activation code for the "Natural gas AGA NX-19/AGA8-DC92/ ISO 12213-2/AGA8 Gross Method 1/SGERG-88" software option (only relevant if replacing the amplifier board). If the measuring device was purchased with the software option, the activation code can be found on the service nameplate in the electronics compartment cover. **User input** 8-digit number: 0 to 99999999
ACTIVATION CODE EXTENDED DIAGNOSTICS	**Description** For entering the activation code for the "Advanced diagnostics" software option (only relevant if replacing the amplifier board). If the measuring device was purchased with the software option, the activation code can be found on the service nameplate in the electronics compartment cover. **User input** 8-digit number: 0 to 99999999

11.7 USER INTERFACE

Function description, USER INTERFACE group	
ASSIGN LINE 1	**Description** For assigning a display value to the main line (top line of the local display). This value is displayed during normal operation. ■ The appropriate unit is selected in the SYSTEM UNITS group (→ 102). ■ Totalizer 1 is indicated on the local display by "I" and totalizer 2 by "II". **Options** OFF VOLUME FLOW VOLUME FLOW IN % TEMPERATURE MASS FLOW MASS FLOW IN % CORRECTED VOLUME FLOW CORRECTED VOLUME FLOW IN % HEAT FLOW HEAT FLOW IN % TOTALIZER 1 TOTALIZER 2 **Factory setting** ■ If LIQUID VOLUME, GAS VOLUME or nothing was specified as the fluid when ordering, the factory setting is VOLUME FLOW ■ Otherwise the factory setting is MASS FLOW

Function description, USER INTERFACE group	
ASSIGN LINE 2	**Description** For assigning a display value to the additional line (bottom line of the local display). This value is displayed during normal operation. ■ The appropriate unit is selected in the SYSTEM UNITS group (→ 102). ■ Totalizer 1 is indicated on the local display by "I" and totalizer 2 by "II". ■ The CALCULATED SATURATED STEAM PRESSURE option only appears if SATURATED STEAM was selected in the SELECT FLUID function (→ 143). ■ The TEMPERATURE (EXTERNAL) option only appears if TEMPERATURE or TEMPERATURE 72 was selected in the HART INPUT function (→ 167). ■ The PRESSURE (EXTERNAL) option only appears if PRESSURE or PRESSURE 72 was selected in the HART INPUT function (→ 167). ■ The DENSITY (EXTERNAL) option only appears if DENSITY or DENSITY 72 was selected in the HART INPUT function (→ 167). **Options** OFF VOLUME FLOW VOLUME FLOW IN % BARGRAPH VOLUME FLOW IN % TEMPERATURE CALCULATED SATURATED STEAM PRESSURE TOTALIZER 1 TOTALIZER 2 TAG NAME OPERATING/SYSTEM CONDITIONS MASS FLOW MASS FLOW IN % BARGRAPH MASS FLOW IN % CORRECTED VOLUME FLOW CORRECTED VOLUME FLOW IN % BARGRAPH CORRECTED VOLUME FLOW IN % HEAT FLOW HEAT FLOW IN % BARGRAPH HEAT FLOW IN % VELOCITY VELOCITY IN % BARGRAPH VELOCITY IN % TEMPERATURE (EXTERNAL) PRESSURE (EXTERNAL) DENSITY (EXTERNAL) **Factory setting** TEMPERATURE
100%-VALUE LINE 1	**Prerequisite** The function is **only** available if one of the following options was selected in the ASSIGN LINE 1 function (→ 112): ■ VOLUME FLOW IN % ■ MASS FLOW IN % ■ CORRECTED VOLUME FLOW IN % ■ HEAT FLOW IN % **Description** Use this function to enter the flow value which should be shown on the display as the 100% value. If a value was specified for the VALUE 20 mA function (→ 120) when ordering, this value is also used here as the factory setting. **User input** 5-digit floating-point number **Factory setting** 10 l/s (for volume flow) 10 kg/h (for mass flow) 10 Nm³/h (for corrected volume flow) 10 kW (for heat flow)

Function description, USER INTERFACE group	
100%-VALUE LINE 2	**Prerequisite** The function is **only** available if one of the following options was selected in the ASSIGN LINE 2 function (→ 113): ■ VOLUME FLOW IN % ■ MASS FLOW IN % ■ CORRECTED VOLUME FLOW IN % ■ HEAT FLOW IN % ■ VELOCITY IN % ■ BARGRAPH VOLUME FLOW IN % ■ BARGRAPH MASS FLOW IN % ■ BARGRAPH CORRECTED VOLUME FLOW IN % ■ BARGRAPH HEAT FLOW IN % ■ BARGRAPH VELOCITY IN % **Description** Use this function to enter the flow value which should be shown on the display as the 100% value. If a value was specified for the VALUE 20 mA function (→ 120) when ordering, this value is also used here as the factory setting. **User input** 5-digit floating-point number **Factory setting** 10 l/s (for volume flow) 10 kg/h (for mass flow) 10 Nm^3/h (for corrected volume flow) 10 kW (for heat flow)
FORMAT	**Description** For selecting the number of decimal places for the display value in the main line. ■ Note that this setting only affects the reading as it appears on the display, it has no influence whatsoever on the accuracy of the system's calculations. ■ The places after the decimal point as computed by the measuring device cannot always be displayed, depending on this setting and the engineering unit. In these instances an arrow appears on the display between the measured value and the engineering unit (e.g. 1.2 →kg/h), indicating that the measuring system is computing with more decimal places than can be shown on the display. **Options** XXXXX. - XXXX.X - XXX.XX - XX.XXX -X.XXXX **Factory setting** X.XXXX
DISPLAY DAMPING	**Description** For entering a time constant defining how the display reacts to severely fluctuating flow variables, either very quickly (enter a low time constant) or with damping (enter a high time constant). ■ The setting 0 seconds switches off damping. ■ The reaction time of the function depends on the time specified in the FLOW DAMPING function (→ 170). ■ The damping of the display only affects the flows. ■ The damping of the temperature display is independent of the setting made here. **User input** 0 to 100 seconds **Factory setting** 5 seconds
CONTRAST LCD	**Description** For adjusting the display contrast to suit local operating conditions. If you press the keys simultaneously at startup, the language defaults to "ENGLISH" and the contrast is reset to the factory setting. **User input** 10 to 100% **Factory setting** 50%

Function description, USER INTERFACE group	
TEST DISPLAY	**Description** Use this function to test the operability of the local display and its pixels. Test sequence: 1. Start the test by selecting ON. 2. All pixels of the main line and additional line are darkened for minimum 0.75 seconds. 3. The main line and additional line show an "8" in each field for minimum 0.75 seconds. 4. The main line and additional line show a "0" in each field for minimum 0.75 seconds. 5. The main line and additional line show nothing (blank display) for minimum 0.75 seconds. 6. When the test is completed, the local display returns to its initial state and displays the option OFF. **Options** OFF ON **Factory setting** OFF

11.8 TOTALIZER 1 and 2

Function description, TOTALIZER 1 and 2 group	
ASSIGN TOTALIZER	**Description** Use this function to assign a measured variable to the totalizer. ■ If the option selected is changed, you are asked whether the totalizer in question should be reset. This prompt must be confirmed before the new option is accepted and the totalizer reset to the value "0". ■ If the option selected is changed, the associated unit has to be adapted in the UNIT TOTALIZER function (→ 117)! ■ If you select OFF, the only function shown in the Totalizer 1 or 2 group is the ASSIGN TOTALIZER function (→ 116). **Options (totalizer 1 and 2)** OFF VOLUME FLOW MASS FLOW CORRECTED VOLUME FLOW HEAT FLOW **Factory setting (totalizer 1)** ■ If LIQUID VOLUME, GAS VOLUME or nothing was specified as the fluid when ordering, the factory setting is VOLUME FLOW ■ Otherwise the factory setting is MASS FLOW **Factory setting (totalizer 2)** VOLUME FLOW
SUM	**Description** The total for the totalizer's measured variable aggregated since measuring commenced appears on the display. ■ The totalizers' response to errors is defined in the FAILSAFE MODE function (→ 118). ■ Totalizer 1 is indicated on the local display by "I" and totalizer 2 by "II". **Display** Max. 7-digit floating-point number, including unit e.g. 15467.04 m^3
OVERFLOW TOT.	**Description** The total for the totalizer's overflow aggregated since measuring commenced appears on the display. Total flow is represented by a floating-point number consisting of max. 7 digits. You can use this function to view higher numerical values (>9999999) as overflows. The effective quantity is thus the total of the SUM function (→ 116) plus the value displayed in the OVERFLOW function. **Display** Integer with exponent, including unit e.g. 2 E7 kg **Example** Reading after 2 overflows: 2 E7 kg (= 20000000 kg) The value displayed in the SUM function = 196845.7 kg Effective total quantity = 20196845.7 kg

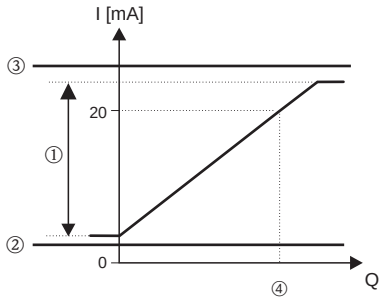
Function description, TOTALIZER 1 and 2 group	
UNIT TOTALIZER	**Description** For selecting the unit for the measured variable assigned to the totalizer. **Options** SI: Cubic centimeter → cm^3 Cubic decimeter → dm^3 Cubic meter → m^3 Milliliter → ml Liter → l Hectoliter → hl Megaliter → Ml US: Cubic centimeter → cc Acre foot → af Cubic foot → ft^3 Fluid ounce → ozf Gallon → US gal Kilo gallon → US Kgal Mega gallon → US Mgal Barrel (normal fluids: 31.5 gal/bbl) → US bbl NORM.FL. Barrel (beer: 31.0 gal/bbl) → US bbl BEER Barrel (petrochemicals: 42.0 gal/bbl) → US bbl PETR. Barrel (filling tanks: 55.0 gal/bbl) → US bbl TANK IMPERIAL: Gallon → imp. gal Mega gallon → imp. Mgal Barrel (beer: 36.0 gal/bbl) → imp. bbl BEER Barrel (petrochemicals: 34.97 gal/bbl) → imp. bbl PETR. Arbitrary volume unit: This option does not appear unless a volume unit was defined via the TEXT ARBITRARY VOLUME UNIT function (→ 107). **Factory setting** Depends on country → 180 **Options (ASSIGN TOTALIZER = MASS FLOW)** SI → g, kg, t US → oz, lb, ton, Mlb **Factory setting** Depends on country → 180 **Options (ASSIGN TOTALIZER = CORRECTED VOLUME FLOW)** SI → Nl, Nm^3 US → Sm^3, Scf **Factory setting** Depends on country → 180 **Options (ASSIGN TOTALIZER = HEAT FLOW)** SI → kWh, MWh, kJ, MJ, GJ, kcal, Mcal, Gcal US → kBtu, MBtu, GBtu, tonh **Factory setting** Depends on country → 180
RESET TOTALIZER	**Description** Resets the sum and overflow in the totalizer selected to 0 (=RESET). **Options** NO YES **Factory setting** NO

11.9 HANDLING TOTALIZER

Function description, HANDLING TOTALIZER group	
RESET ALL TOTALIZERS	**Description** Resets the sums and overflows of the two totalizers to 0 (=RESET). **Options** NO YES **Factory setting** NO
FAILSAFE MODE	**Description** For selecting the behavior of the totalizer in an alarm condition. **Options** STOP The totalizer does not continue to count the flow if a fault is present. The totalizer stops at the last value before the alarm condition occurred. HOLD VALUE The totalizer continues to count the flow on the basis of the last valid flow data (before the fault occurred). ACTUAL VALUE The totalizers continue to count on the basis of the current flow data. The fault is ignored. **Factory setting** STOP

11.10 CURRENT OUTPUT

Function description, CURRENT OUTPUT group	
ASSIGN CURRENT	**Description** Use this function to assign a measured variable to the current output. **Options** VOLUME FLOW TEMPERATURE MASS FLOW CORRECTED VOLUME FLOW HEAT FLOW CALCULATED SATURATED STEAM PRESSURE FLOW VELOCITY TEMPERATURE (EXTERNAL) PRESSURE (EXTERNAL) DENSITY (EXTERNAL) **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
CURRENT SPAN	**Description** Use this function to specify the current span. You can configure the current output either in accordance with the NAMUR recommendation or for the values common in the United States. **Options** 4-20 mA HART NAMUR 4-20 mA HART US **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions. **Current span, operational range and signal on alarm level**



A	①	②	③
4-20 mA HART NAMUR	3.8 - 20.5 mA	3.5	22.6
4-20 mA HART US	3.9 - 20.8 mA	3.75	22.6

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Fig. 33: Current span, operational range and signal on alarm level

A = Current span
① = Operational range
② = Lower signal on alarm level
③ = Upper signal on alarm level
④ = Scaled full scale value
Q = Flow

✎ Note!
- A notice message is generated if the measured value is outside the measuring range (defined in the VALUE 20 mA function, → 🖹 120).
- The current output's response to errors is defined in the central FAILSAFE MODE function (→ 🖹 118).

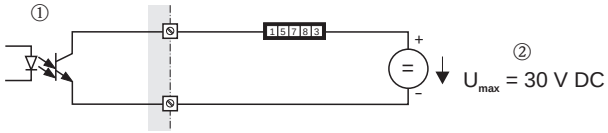
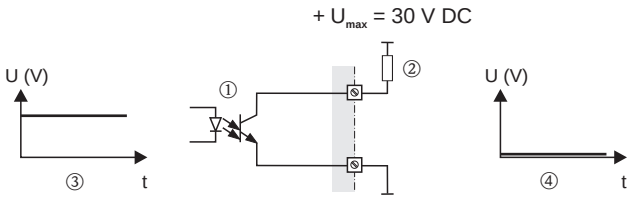
Function description, CURRENT OUTPUT group	
VALUE 4 mA	**Description** Use this function to assign a value to the 4 mA current. The value must be smaller than the value entered in the VALUE 20 mA function (→ 120). **User input** 5-digit floating-point number **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
VALUE 20 mA	**Description** Use this function to assign a value to the 20 mA current. **User input** 5-digit floating-point number **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
TIME CONSTANT	**Description** In selecting the time constant, you define how the current output signal reacts to severely fluctuating measured variables, either very quickly (low time constant) or with damping (high time constant). The reaction time of the function also depends on the time specified in the FLOW DAMPING function (→ 170). **User input** Fixed-point number: 0 to 100 s **Factory setting** 5 seconds
FAILSAFE MODE	**Description** Use this function to specify the response of the current output in the event of an error. The dictates of safety render it advisable to ensure that the current output assumes a predefined state in the event of a fault. The setting you select here affects only the current output. It has no effect on other outputs or the display (e.g. totalizers). **Options** MIN. CURRENT Depends on the option selected in the CURRENT SPAN function (→ 119). If the current span is: 4 to 20 mA HART NAMUR → output current = 3.6 mA 4 to 20 mA HART US → output current = 3.75 mA MAX. CURRENT 22.6 mA HOLD VALUE Measured value output is based on the last measured value saved before the error occurred. ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored. **Factory setting** MAX. CURRENT
ACTUAL CURRENT	**Description** The current computed actual value of the output current appears on the display. **Display** 3.60 to 22.60 mA

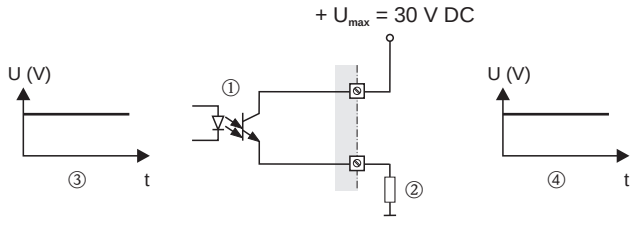
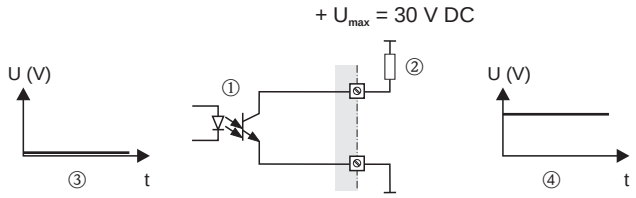
Function description, CURRENT OUTPUT group	
SIMULATION CURRENT	**Description** Activates simulation of the current output. ■ The notice message #611 "SIMULATION CURRENT OUTPUT" (→ 67) indicates that simulation is active. ■ The value which should be output at the current output is defined in the VALUE SIMULATION CURRENT function (→ 121). ■ The measuring device continues to measure while simulation is in progress, i.e. the current measured values are output correctly via the other outputs and the display. Note! The setting is not saved if the power supply fails. **Options** OFF ON **Factory setting** OFF
VALUE SIMULATION CURRENT	**Prerequisite** The function is **only** available if ON was selected in the SIMULATION CURRENT function (→ 121). **Description** Use this function to define an arbitrary value (e.g. 12 mA) to be output at the current output. This value is used to test downstream devices and the measuring device itself. Note! The setting is not saved if the power supply fails. **Procedure** ■ Simulation is started by confirming the simulation value with the E key. ■ If the E key is pressed again afterwards, the prompt "End simulation" (NO/YES) appears. ■ If you choose "NO", simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION CURRENT function. ■ If you choose "YES", you end the simulation and the group selection is called up. **User input** Floating-point number: 3.60 to 22.60 mA **Factory setting** 3.60 mA

11.11 PULSE, FREQUENCY, STATUS

Function description, PULSE, FREQUENCY, STATUS group	
OPERATION MODE	**Description** Use this function to specify whether the output functions as a frequency output, pulse output or status output. The functions available will vary in this function group, depending on which option you select here. ■ If PFM is selected, the CURRENT OUTPUT group (→ 119) is no longer available. Current simulation is automatically activated with a simulation value of 4 mA. If the transmitter was wired for pulse-frequency modulation (→ 29), the HART protocol is not available. ■ If VORTEX FREQUENCY and PFM are selected, the vortex pulses are passed on directly. The low flow cut off is taken into account. **Options** FREQUENCY PULSE STATUS VORTEX FREQUENCY (→ 80) PFM (→ 80) **Factory setting** PULSE
ASSIGN FREQUENCY	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to assign a measured variable to the frequency output. **Options** VOLUME FLOW TEMPERATURE MASS FLOW CORRECTED VOLUME FLOW HEAT FLOW CALCULATED SATURATED STEAM PRESSURE FLOW VELOCITY TEMPERATURE (EXTERNAL) PRESSURE (EXTERNAL) DENSITY (EXTERNAL) **Factory setting** VOLUME FLOW
START VALUE FREQUENCY	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to specify a start frequency for the frequency output. The associated measured value of the measuring range is specified in the VALUE f LOW function. Example: Start frequency = 0 Hz, VALUE f LOW. = 0 kg/h: i.e. a frequency of 0 Hz is output at a flow of 0 kg/h. Start frequency = 10 Hz, VALUE f LOW. = 1 kg/h: i.e. a frequency of 10 Hz is output at a flow of 1 kg/h. **User input** 5-digit fixed point number: 0 to 1000 Hz **Factory setting** 0 Hz

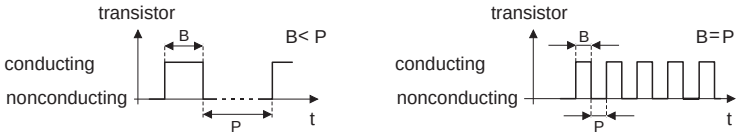
Function description, PULSE, FREQUENCY, STATUS group	
END VALUE FREQUENCY	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to specify an end value frequency for the frequency output. The associated measured value of the measuring range is specified in the VALUE f HIGH function (→ 123). The output signal is symmetrical in the FREQUENCY operating mode (on/off ratio = 1:1). Example: End frequency = 1000 Hz, VALUE f HIGH. = 1000 kg/h: i.e. a frequency of 1000 Hz is output at a flow of 1000 kg/h. End frequency = 1000 Hz, VALUE f HIGH. = 3600 kg/h: i.e. a frequency of 1000 Hz is output at a flow of 3600 kg/h. **User input** 5-digit fixed point number: 2 to 1000 Hz **Factory setting** 1000 Hz
VALUE f LOW	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to assign a value to the start frequency. The value entered here must be smaller than the value assigned to the VALUE f HIGH (→ 123). A negative value is only permitted if TEMPERATURE is selected in the ASSIGN FREQUENCY function (→ 122). The desired span is defined by specifying the VALUE f LOW and VALUE f HIGH. The appropriate unit is taken from the SYSTEM UNITS (→ 102) or MEASURING VALUES (VELOCITY) group. **User input** 5-digit floating-point number **Factory setting** Depends on the option selected in the ASSIGN FREQUENCY function. – 0 [UNIT VOLUME FLOW] – 0 °C (converted to the UNIT TEMPERATURE) – 0 [UNIT MASS FLOW]] – 0 [UNIT CORRECTED VOLUME FLOW]] – 0 [UNIT HEAT FLOW] – 0 [VELOCITY] – 0 [UNIT PRESSURE]
VALUE f HIGH	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to assign a value to the end frequency. The value entered here must be larger than the value assigned to the VALUE f LOW (→ 123). A negative value is only permitted if TEMPERATURE is selected in the ASSIGN FREQUENCY function (→ 122). The desired span is defined by specifying the VALUE f LOW and VALUE f HIGH. The appropriate unit is taken from the SYSTEM UNITS (→ 102) or MEASURING VALUES (VELOCITY) group. **User input** 5-digit floating-point number **Factory setting** Depends on the option selected in the ASSIGN FREQUENCY function. – 10 l/s (converted to the UNIT VOLUME FLOW) – 200 °C (converted to the UNIT TEMPERATURE) – 10 kg/h (converted to the UNIT MASS FLOW) – 10 Nm^3/h (converted to the UNIT CORRECTED VOLUME FLOW) – 10 kW (converted to the UNIT HEAT FLOW) – 10 m/s (converted to the unit of VELOCITY) – 10 bara (converted to the UNIT PRESSURE)

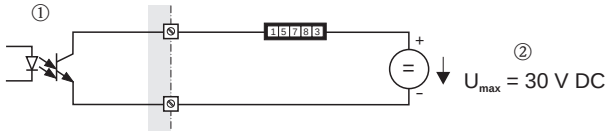
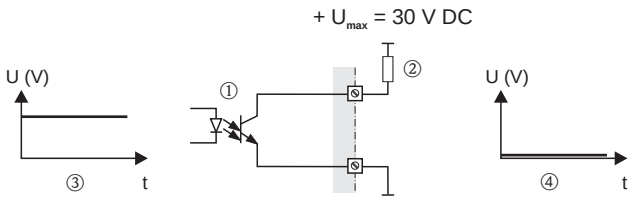
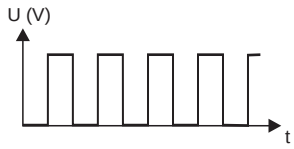
Function description, PULSE, FREQUENCY, STATUS group	
OUTPUT SIGNAL	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** For selecting the polarity of the frequency. **Options** PASSIVE – POSITIVE PASSIVE – NEGATIVE **Factory setting** PASSIVE – POSITIVE **Explanation** PASSIVE = power is supplied to the frequency output by means of an external power supply. Configuring the output signal level (POSITIVE or NEGATIVE) determines the quiescent behavior (at zero flow) of the frequency output. The internal transistor is activated as follows: ■ If POSITIVE is selected, the internal transistor is activated with a positive signal level ■ If NEGATIVE is selected, the internal transistor is activated with a negative signal level (0 V) Note! In the case of passive output configuration, the output signal levels of the frequency output depend on the external wiring (see examples). **Example for passive output circuit (PASSIVE)** If PASSIVE is selected, the frequency output is configured as an open collector.  A0001225 ① *Open collector* ② *External power supply* Note! For continuous currents up to 25 mA (I_{max} = 250 mA ÷ 20 ms). **Example for output configuration PASSIVE-POSITIVE** Output configuration with an external pull-up resistor. In the quiescent state (at zero flow), the output signal level at the terminals is 0 V.  A0004687 ① *Open collector* ② *Pull-up resistor* ③ *Transistor activation in "POSITIVE" quiescent state (at zero flow)* ④ *Output signal level in quiescent state (at zero flow)* In the operating state (flow present), the output signal level changes from 0 V to a positive voltage level.  A0001975 (Continued on next page)

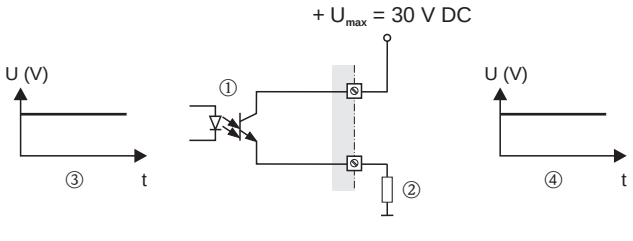
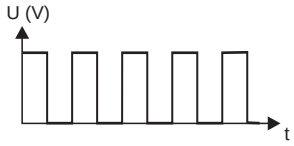
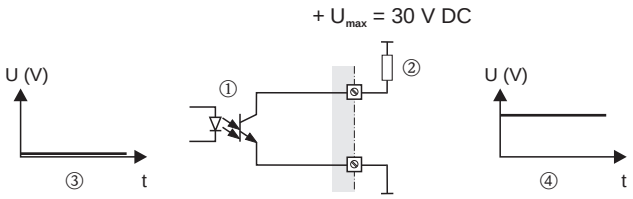
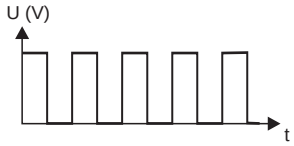
Function description, PULSE, FREQUENCY, STATUS group	
OUTPUT SIGNAL (continued)	**Example for output configuration PASSIVE-POSITIVE** Output configuration with an external pull-down resistor. In the quiescent state (at zero flow), a positive voltage level is measured via the pull-down resistor.  A0004689 ① *Open collector* ② *Pull-down resistor* ③ *Transistor activation in "POSITIVE" quiescent state (at zero flow)* ④ *Output signal level in quiescent state (at zero flow)* In the operating state (flow present), the output signal level changes from a positive voltage level to 0 V.  A0001981 **Example for output configuration PASSIVE-NEGATIVE** Output configuration with an external pull-up resistor. In the quiescent state (at zero flow), the output signal level at the terminals is at a positive voltage level.  A0004690 ① *Open collector* ② *Pull-up resistor* ③ *Transistor activation in "NEGATIVE" quiescent state (at zero flow)* ④ *Output signal level in quiescent state (at zero flow)* In the operating state (flow present), the output signal level changes from a positive voltage level to 0 V.  A0001981

Function description, PULSE, FREQUENCY, STATUS group	
TIME CONSTANT	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** In selecting the time constant, you define how the frequency output signal reacts to severely fluctuating measured variables, either very quickly (low time constant) or with damping (high time constant). **User input** Floating point number: 0 to 100 s **Factory setting** 5 seconds
FAILSAFE MODE	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to specify the response of the frequency output in the event of an error. The dictates of safety render it advisable to ensure that the frequency output assumes a predefined state in the event of a fault. The setting you select here affects only the frequency output. It has no effect on other outputs or the display (e.g. totalizers). **Options** FALLBACK VALUE 0 Hz output. FAIL LEVEL The frequency specified in the FAILSAFE VALUE function (→ 126) is output. HOLD VALUE Measured value output is based on the last measured value saved before the error occurred. ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored. **Factory setting** FALLBACK VALUE
FAILSAFE VALUE	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122) and FAIL LEVEL was selected in the FAILSAFE MODE function (→ 126). **Description** Use this function to define the frequency the measuring device should output in the event of a fault. **User input** Max. 4-digit number: 0 to 1250 Hz **Factory setting** 1250 Hz
ACTUAL FREQUENCY	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** The computed actual value of the output frequency appears on the display. **Display** 0 to 1250 Hz

Function description, PULSE, FREQUENCY, STATUS group	
SIMULATION FREQUENCY	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122). **Description** Use this function to activate simulation of the frequency output. ■ The notice message "SIMULATION FREQUENCY OUTPUT" (→ 67) indicates that simulation is active. ■ The measuring device continues to measure while simulation is in progress i.e. the current measured values are output correctly via the other outputs. Note! The setting is not saved if the power supply fails. **Options** OFF ON **Factory setting** OFF
VALUE SIMULATION FREQUENCY	**Prerequisite** The function is **only** available if FREQUENCY was selected in the OPERATION MODE function (→ 122) and ON was selected in the SIMULATION FREQUENCY function (→ 127). **Description** Use this function to specify an arbitrary frequency value (e.g. 500 Hz) to be output at the frequency output. This value is used to test downstream devices and the measuring device itself. Note! The setting is not saved if the power supply fails. **Procedure** ■ Simulation is started once the specified value is confirmed with the E key. ■ If the E key is pressed again afterwards, the prompt "End simulation" (NO/YES) appears. ■ If you choose "NO", simulation remains active and the group selection is called up. The simulation can be switched off again via diagnosis code "C 482– 2 Simulation Outp". ■ If you choose "YES", you end the simulation and the group selection is called up. **User input** 0 to 1250 Hz **Factory setting** 0 Hz
ASSIGN PULSE	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** Use this function to assign a measured variable to the pulse output. **Options** VOLUME FLOW MASS FLOW CORRECTED VOLUME FLOW HEAT FLOW **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.

Function description, PULSE, FREQUENCY, STATUS group	
PULSE VALUE	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** Use this function to define the flow at which a pulse should be output. These pulses can be totaled by an external totalizer and the total flow since measuring started can be recorded in this way. Select the pulse value in such a way that the pulse frequency does **not** exceed a value of 100 Hz with maximum flow. The appropriate unit is taken from the SYSTEM UNITS group (→ 102). **User input** 5-digit floating-point number **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions.
PULSE WIDTH	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** Use this function to enter the pulse width of the output pulses. When entering the pulse width, select a value that can still be processed by an external totalizer (e.g. mechanical totalizer, PLC, etc.). If the selected pulse width cannot be maintained (interval P < pulse width B entered), a system error message is generated after approx. 5 seconds buffer time/idling time: "#359 RANGE PULSE" (→ 65). The reason for not being able to maintain the pulse width could be that the pulse number or frequency, which result from the pulse value entered (→ 128, PULSE VALUE function) and the current flow, are too big. Pulses are **always** generated with the pulse width (B) entered in this function. The intervals (P) between the individual pulses are automatically configured. However, they must at least correspond to the pulse width (B = P).  *B = Pulse width entered (the illustration applies to positive pulses)* *P = Intervals between the individual pulses* **User input** 5 to 2000 ms **Factory setting** 20 ms

Function description, PULSE, FREQUENCY, STATUS group	
OUTPUT SIGNAL	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** For selecting the output configurations of the pulse output. **Options** PASSIVE – POSITIVE PASSIVE – NEGATIVE **Factory setting** PASSIVE – POSITIVE **Explanation** PASSIVE = power is supplied to the pulse output by means of an external power supply. Configuring the output signal level (POSITIVE or NEGATIVE) determines the quiescent behavior (at zero flow) of the pulse output. The internal transistor is activated as follows: ■ If POSITIVE is selected, the internal transistor is activated with a positive signal level ■ If NEGATIVE is selected, the internal transistor is activated with a negative signal level (0 V) Note! In the case of passive output configuration, the output signal levels of the pulse output depend on the external wiring (see examples). **Example for a passive output circuit (PASSIVE)** If PASSIVE is selected, the pulse output is configured as an open collector.  A0001225 ① *Open collector* ② *External power supply* Note! For continuous currents up to 25 mA (I_{max} = 250 mA ÷ 20 ms). **Example for output configuration PASSIVE-POSITIVE** Output configuration with an external pull-up resistor. In the quiescent state (at zero flow), the output signal level at the terminals is 0 V.  A0004687 ① *Open collector* ② *Pull-up resistor* ③ *Transistor activation in "POSITIVE" quiescent state (at zero flow)* ④ *Output signal level in quiescent state (at zero flow)* In the operating state (flow present), the output signal level changes from 0 V to a positive voltage level.  A0001975 (Continued on next page)

Function description, PULSE, FREQUENCY, STATUS group	
OUTPUT SIGNAL (continued)	**Example for output configuration PASSIVE-POSITIVE** Output configuration with an external pull-down resistor. In the quiescent state (at zero flow), a positive voltage level is measured via the pull-down resistor.  A0004689 ① *Open collector* ② *Pull-down resistor* ③ *Transistor activation in "POSITIVE" quiescent state (at zero flow)* ④ *Output signal level in quiescent state (at zero flow)* In the operating state (flow present), the output signal level changes from a positive voltage level to 0 V.  A0001981 **Example for output configuration PASSIVE-NEGATIVE** Output configuration with an external pull-up resistor. In the quiescent state (at zero flow), the output signal level at the terminals is at a positive voltage level.  A0004690 ① Open collector ② Pull-up resistor ③ Transistor activation in "NEGATIVE" quiescent state (at zero flow) ④ Output signal level in quiescent state (at zero flow) In the operating state (flow present), the output signal level changes from a positive voltage level to 0 V.  A0001981

Function description, PULSE, FREQUENCY, STATUS group	
FAILSAFE MODE	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** Use this function to specify the response of the pulse output in the event of an error. The dictates of safety render it advisable to ensure that the pulse output assumes a predefined state in the event of a fault. The setting you select here affects only the pulse output. It has no effect on other outputs or the display (e.g. totalizers). **Options** FALLBACK VALUE 0 pulse output. HOLD VALUE Measured value output is based on the last measured value saved before the error occurred. ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored. **Factory setting** FALLBACK VALUE
ACTUAL PULSE	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** The computed actual value of the output frequency appears on the display. **Display** 0 to 100 pulse/second
SIMULATION PULSE	**Prerequisite** The function is **only** available if PULSE was selected in the OPERATION MODE function (→ 122). **Description** Use this function to simulate the pulse output. The notice message #631 "SIM. PULSE" (→ 67) indicates that simulation is active. The on/off ratio is 1:1 for both types of simulation. The measuring device continues to measure while simulation is in progress, i.e. the measured values are output correctly via the other outputs. Note! The setting is not saved if the power supply fails. **Procedure** ■ Simulation is started by confirming the CONTINUOUSLY option with the E key. ■ If the E key is pressed again afterwards, the prompt "End simulation" (NO/YES) appears. ■ If you choose "NO", simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION PULSE function. ■ If you choose "YES", you end the simulation and the group selection is called up. **Options** OFF COUNTDOWN The pulses specified in the VALUE SIMULATION PULSE function (→ 132) are output. CONTINUOUSLY Pulses are continuously output with the pulse width specified in the PULSE WIDTH function (→ 128). Simulation is started once the CONTINUOUSLY option is confirmed with the E key. **Factory setting** OFF

Function description, PULSE, FREQUENCY, STATUS group	
VALUE SIMULATION PULSE	**Prerequisite** The function is **only** available if COUNTDOWN was selected in the SIMULATION PULSE function (→ 131). **Description** Use this function to specify the number of pulses (e.g. 50) which are output during the simulation. This value is used to test downstream devices and the measuring device itself. The pulses are output with the pulse width specified in the PULSE WIDTH function (→ 128). The on/off ratio is 1:1. Note! The setting is not saved if the power supply fails. **Procedure** ■ Simulation is started once the specified value is confirmed with the E key. The display remains at 0 if the specified pulses have been transmitted. ■ If the E key is pressed again afterwards, the prompt "End simulation" (NO/YES) appears. ■ If you choose "NO", simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION PULSE function. ■ If you choose "YES", you end the simulation and the group selection is called up. **User input** 0 to 10000 **Factory setting** 0
ASSIGN STATUS	**Prerequisite** The function is **only** available if STATUS was selected in the OPERATION MODE function (→ 122). **Description** Use this function to assign a switching function to the status output. ■ The status output displays quiescent current behavior, in other words the output is closed (transistor conductive) when normal, error-free operation is in progress. ■ Pay particular attention to the illustrations and detailed information on the switching behavior of the status output (→ 136). ■ If you select OFF, the only function shown in this function group is the ASSIGN STATUS function. **Options** OFF ON (operation) FAULT MESSAGE NOTICE MESSAGE FAULT MESSAGE & NOTICE MESSAGE LIMIT VOLUME FLOW LIMIT MASS FLOW LIMIT CORRECTED VOLUME FLOW LIMIT HEAT FLOW LIMIT TOTALIZER 1 LIMIT TOTALIZER 2 LIMIT CALCULATED SATURATED STEAM PRESSURE LIMIT VELOCITY LIMIT TEMPERATURE (EXTERNAL) LIMIT PRESSURE (EXTERNAL) LIMIT DENSITY (EXTERNAL) **Factory setting** FAULT MESSAGE

Function description, PULSE, FREQUENCY, STATUS group	
ON-VALUE	**Prerequisite** The function is **only** available if a limit value was selected in the ASSIGN STATUS function (→ 🖹 132). **Description** Use this function to assign a value to the switch-on point (status output pulls up). The value can be greater or less than the switch-off point. Only positive values are permitted (exception: LIMIT TEMPERATURE). The appropriate unit is taken from the SYSTEM UNITS (→ 🖹 102) or MEASURING VALUES (VELOCITY) group. **User input** 5-digit floating-point number [unit] **Factory setting** Depends on the option selected in the ASSIGN STATUS function. – If LIMIT VOLUME FLOW was selected: see table → 🖹 180 – If LIMIT TEMPERATURE was selected: 180 °C (converted to the selected UNIT TEMPERATURE) – If LIMIT MASS FLOW was selected: 10 kg/h (converted to the selected UNIT MASS FLOW) – If LIMIT CORRECTED VOLUME FLOW was selected: 10 Nm^3/h (converted to the selected UNIT CORRECTED VOLUME FLOW) – If LIMIT HEAT FLOW was selected: 10 kW (converted to the selected UNIT HEAT FLOW) – If LIMIT TOTALIZER 1 was selected: 0 (converted to the selected UNIT TOTALIZER 1) – If LIMIT TOTALIZER 2 was selected: 0 (converted to the selected UNIT TOTALIZER 2) – If LIMIT CALCULATED SATURATED STEAM PRESSURE was selected: 10 bar a (converted to the selected UNIT PRESSURE) – If LIMIT VELOCITY was selected: 10 m/s (converted to the selected unit of VELOCITY) – If LIMIT TEMPERATURE (EXTERNAL) was selected: 180 °C (converted to the selected UNIT TEMPERATURE) – If LIMIT PRESSURE (EXTERNAL) was selected: 10 bar a (converted to the selected UNIT PRESSURE) – If LIMIT DENSITY (EXTERNAL) was selected: 8 kg/m^3 (converted to the selected UNIT DENSITY)

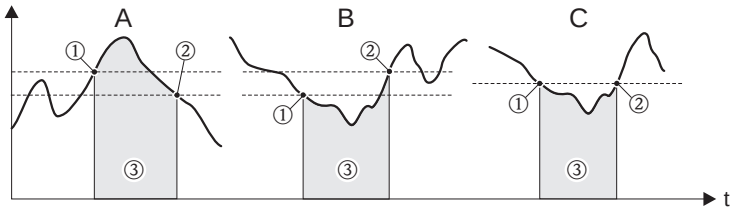
Function description, PULSE, FREQUENCY, STATUS group	
OFF-VALUE	**Prerequisite** The function is **only** available if a limit value was selected in the ASSIGN STATUS function (→ 🖹 132). **Description** Use this function to assign a value to the switch-off point (status output deenergized). The value can be greater or less than the switch-on point. Only positive values are permitted (exception: LIMIT TEMPERATURE). The appropriate unit is taken from the SYSTEM UNITS (→ 🖹 102) or MEASURING VALUES (VELOCITY) group. **User input** 5-digit floating-point number [unit] **Factory setting** Depends on the option selected in the ASSIGN STATUS function. – If LIMIT VOLUME FLOW was selected: see table → 🖹 180 – If LIMIT TEMPERATURE was selected: 170 °C (converted to the selected UNIT TEMPERATURE) – If LIMIT MASS FLOW was selected: 9 kg/h (converted to the selected UNIT MASS FLOW) – If LIMIT CORRECTED VOLUME FLOW was selected: 9 Nm^3/h (converted to the selected UNIT CORRECTED VOLUME FLOW) – If LIMIT HEAT FLOW was selected: 9 kW (converted to the selected UNIT HEAT FLOW) – If LIMIT TOTALIZER 1 was selected: 0 (converted to the selected UNIT TOTALIZER 1) – If LIMIT TOTALIZER 2 was selected: 0 (converted to the selected UNIT TOTALIZER 2) – If LIMIT CALCULATED SATURATED STEAM PRESSURE was selected: 9 bar a (converted to the selected UNIT PRESSURE) – If LIMIT VELOCITY was selected: 9 m/s (converted to the selected unit of VELOCITY) – If LIMIT TEMPERATURE (EXTERNAL) was selected: 170 °C (converted to the selected UNIT TEMPERATURE) – If LIMIT PRESSURE (EXTERNAL) was selected: 9 bar a (converted to the selected UNIT PRESSURE) – If LIMIT DENSITY (EXTERNAL) was selected: 7 kg/m^3 (converted to the selected UNIT DENSITY)
TIME CONSTANT	**Prerequisite** The function is **only** available if a limit value (apart from LIMIT TOTALIZER 1 or 2) was selected in the ASSIGN STATUS function (→ 🖹 132). **Description** In selecting the time constant, you define how the measuring signal reacts to severely fluctuating measured variables, either very quickly (low time constant) or with damping (high time constant). The purpose of damping, therefore, is to prevent the status output changing state continuously in response to fluctuations in flow. The reaction time of the function depends on the time specified in the FLOW DAMPING function (→ 🖹 170). **User input** 0 to 100 s **Factory setting** 0 s
ACTUAL STATUS OUTPUT	**Prerequisite** The function is **only** available if STATUS was selected in the OPERATION MODE function (→ 🖹 122). **Description** The current status of the status output appears on the display. **Display** NOT CONDUCTIVE CONDUCTIVE

Function description, PULSE, FREQUENCY, STATUS group	
SIMULATION SWITCH POINT	**Prerequisite** The function is **only** available if STATUS was selected in the OPERATION MODE function (→ 122). **Description** Use this function to activate simulation of the status output. The notice message #641 "SIMULATION STATUS OUTPUT" (→ 67) indicates that simulation is active. The measuring device continues to measure while simulation is in progress i.e. the current measured values are output correctly via the other outputs. Note! The setting is not saved if the power supply fails. **Options** OFF ON **Factory setting** OFF
VALUE SIMULATION SWITCH POINT	**Prerequisite** The function is **only** available if ON was selected in the SIMULATION SWITCH POINT function (→ 135). **Description** Use this function to specify the status output switching behavior during the simulation. This value is used to test downstream devices and the measuring device itself. You can change the switching behavior of the status output during the simulation. **Procedure** ■ The prompt "CONDUCTIVE" or "NOT CONDUCTIVE" appears if the + or − key is pressed. Select the desired switching behavior and start the simulation with the E key. ■ If the E key is pressed again afterwards, the prompt "End simulation" (NO/YES) appears. ■ If you choose "NO", simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION SWITCH POINT function. ■ If you choose "YES", you end the simulation and the group selection is called up. Note! The setting is not saved if the power supply fails. **User input** NOT CONDUCTIVE CONDUCTIVE **Factory setting** NOT CONDUCTIVE

11.12 Information on the response of the status output

General information
If you have configured the status output for "LIMIT VALUE" (→ 132, ASSIGN STATUS function) you can specify the required switch points in the ON-VALUE (→ 133) and OFF-VALUE functions (→ 134).
If the measured variable in question reaches these predefined values, the status output switches as shown in the illustrations below.

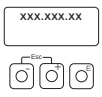
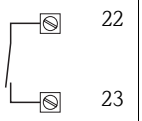
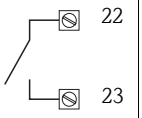
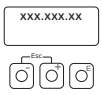
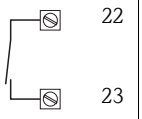
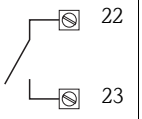
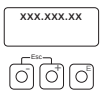
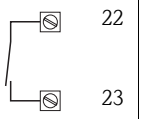
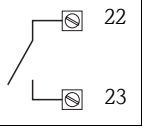
Status output configured for limit value
The status output switches as soon as the current measured variable undershoots or overshoots a defined switch point.
Application: monitoring flow or process-related boundary conditions.

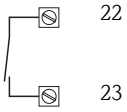
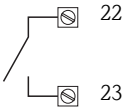
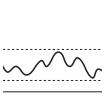
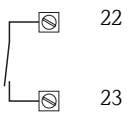
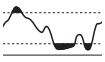
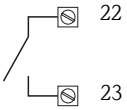


A0001235

① *ON ≤ SWITCH-OFF POINT (maximum safety)*
② *ON > SWITCH-OFF POINT (minimum safety)*
③ *Status output switched off (not conductive)*

Switching behavior of the status output

Function	Status		Open collector behavior (transistor)	
ON (operation)	System in operation		Conductive	
	System not in operation (power supply failed)		Not conductive	
Fault message	System OK		Conductive	
	(System or process error) Fault → failsafe mode of outputs/inputs and totalizers		Not conductive	
Notice message	System OK		Conductive	
	(System or process error) Fault → continuation of operation		Not conductive	

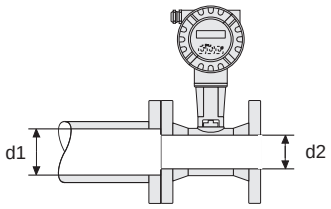
Function	Status		Open collector behavior (transistor)	
Fault message or notice message	System OK		Conductive	
	(System or process error) Fault → failsafe mode or Notice → continuation of operation		Not conductive	
Limit value ■ Volume flow ■ Totalizer	Limit value not overshot or undershot		Conductive	
	Limit value overshot or undershot		Not conductive	

11.13 COMMUNICATION

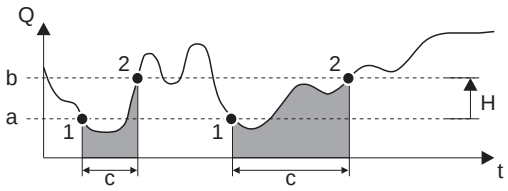
Function description, COMMUNICATION group	
TAG NAME	**Description** Use this function to enter a tag name for the measuring device. You can edit and read this tag name via the local display or the HART protocol **User input** Max. 8-character text, permitted characters are: A-Z, 0-9, +,–, punctuation marks **Factory setting** "– – – – – – – –" (no text)
TAG DESCRIPTION	**Description** Use this function to enter a tag description for the measuring device. You can edit and read this tag description via the local display or the HART protocol. **User input** Max. 16-character text, permitted characters are: A-Z, 0-9, +,–, punctuation marks **Factory setting** "– – – – – – – – – – – – – – – –" (no text)
FIELDBUS ADDRESS	**Description** Use this function to define an address for the exchange of data with the HART protocol. A constant 4 mA current is applied with addresses 1 to 15. **User input** 0 to 15 **Factory setting** 0
WRITE PROTECTION	**Description** Use this function to check whether the measuring device can be write-accessed. Write protection is activated and deactivated by means of DIP switches on the amplifier board (→ 🖹 48). **Display** OFF = Write access enabled ON = Write access disabled **Factory setting** OFF
BURST MODE	**Prerequisite** The BURST MODE function is **only** available if OFF was selected in the HART INPUT function (→ 🖹 167). **Description** Use this function to activate cyclic data exchange of the process variables selected in the BURST MODE CMD function (→ 🖹 139) to make communication faster. ✎ Note! If the BURST MODE function is switched on, the HART INPUT group is not active. **Options** OFF ON **Factory setting** OFF

Function description, COMMUNICATION group	
BURST MODE CMD	**Prerequisite** The BURST MODE CMD function is **only** available if OFF was selected in the BURST MODE function (→ 138). **Description** For selecting process values that are cyclically transmitted to the HART master in the burst mode. **Options** CMD 1 Read primary measured variable (e.g. volume flow). CMD 2 Read current and percentage of the measuring range CMD 3 Read current and four (previously defined) measured variables. (see HART Command No. 51, → 45). **Factory setting** CMD 1
MANUFACTURER ID	**Description** The manufacturer number in decimal numerical format appears on the display. **Display:** 17 = (11 hex) for Endress+Hauser
DEVICE ID	**Description** The device number in hexadecimal numerical format appears on the display. **Display:** 57 = (87 dec) for Prowirl 73

11.14 PROCESS PARAMETER

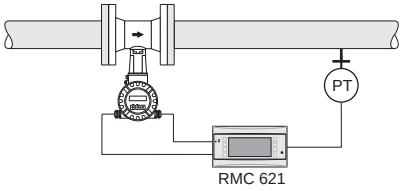
Function description, PROCESS PARAMETER group	
D MATING PIPE	**Description** The device has diameter mismatch correction. This can be activated by entering the actual value of the mating pipe (see Fig., d1) in this function. If the mating pipe (d1) and the measuring pipe (d2) have different diameters, this alters the flow profile. A diameter mismatch can occur if: ■ The mating pipe has a different pressure rating to that of the measuring device. ■ The mating pipe has another schedule to that of the measuring device (e.g. 80 instead of 40), for ANSI. To correct any resulting shift in the calibration factor, enter the actual value of the mating pipe (d1) in this function.  A0001982 *d1 > d2* *d1 = Mating pipe diameter* *d2 = Measuring pipe diameter* ■ The inlet correction is switched off if 0 is entered in the function. ■ The appropriate unit is taken from the UNIT LENGTH function (→ 106). ■ Mismatches between diameters can only be corrected within the same nominal diameter class (e.g. DN 50/2"). ■ If the internal diameter of the process mating flange is larger than the internal diameter ot the Vortex flange, you must reckon with an additional uncertainty of typically 0.1% (of the reading) per 1 mm deviation. ■ If the internal diameter of the process mating flange is smaller than the internal diameter ot the Vortex flange, you must reckon with an additional uncertainty of typically 0.2% (of the reading) per 1 mm deviation. ■ The diameter mismatch should only be corrected within the limit values listed below for which test measurements have also been performed. Flange connection: DN 15 (½"): ±20% of the internal diameter DN 25 (1"): ±15% of the internal diameter DN 40 (1½"): ±12% of the internal diameter DN ≥50 (2"): ±10% of the internal diameter Wafer: DN 15 (½"): ±15% of the internal diameter DN 25 (1"): ±12% of the internal diameter DN 40 (1½"): ±9% of the internal diameter DN ≥50 (2"): ±8% of the internal diameter **User input** 5-digit floating-point number **Factory setting** 0

Function description, PROCESS PARAMETER group	
ASSIGN LOW FLOW CUT OFF	**Description** For selecting the process variable on which low flow cut off should act. Low flow cut off is not taken into account if an option is selected which cannot be calculated for the fluid selected (e.g. corrected volume selected for saturated steam). **Options** OFF VOLUME FLOW MASS FLOW CORRECTED VOLUME FLOW HEAT FLOW REYNOLDS NUMBER* *This option is **not** available if – GAS VOLUME or LIQUID VOLUME was selected in the SELECT FLUID function (→ 143) or – REAL GAS was selected in the SELECT FLUID function (→ 143) or – OTHER was assigned to one of the components in the GAS MIXTURE option in the SELECT FLUID function (→ 143) – One of the natural gas equations AGA8-DC92, ISO 12213-2, AGA8 Gross Method 1 or SGERG-88 was selected in the NATURAL GAS option in the SELECT FLUID function (→ 143) **Factory setting** VOLUME FLOW
ON-VALUE LOW FLOW CUT OFF	**Prerequisite** The function is **not** available if OFF was selected in the ASSIGN LOW FLOW CUT OFF function (→ 141). **Description** Use this function to enter the on-value for low flow cut off. The appropriate unit is taken from the SYSTEM UNITS group (→ 102). **If VOLUME FLOW, MASS FLOW, CORRECTED VOLUME FLOW or HEAT FLOW is selected in the ASSIGN LOW FLOW CUT OFF function (→ 141):** Low flow cut off is switched on if the value entered is not equal to 0. As soon as the low flow cut off is active, an inverted plus sign is shown on the local display. **User input** 5-digit floating-point number **Factory setting** Below the standard measuring range **If REYNOLDS NUMBER is selected in the ASSIGN LOW FLOW CUT OFF function (→ 141):** Low flow cut off is activated if the Reynolds number entered here is undershot. When low flow cut off is active, an inverted plus sign is shown on the local display. **User input** 4000 to 99999 **Factory setting** 20000

Function description, PROCESS PARAMETER group	
OFF-VALUE LOW FLOW CUT OFF	**Description** Use this function to enter the off-value for low flow cut off. Enter the off-value as a positive hysteresis from the on-value.  A0001245 *Fig. 34: Example for the behavior of low flow cutoff* *Q Flow rate [volume/time]* *t Time* *a ON-VALUE LOW FLOW CUTOFF = 20 m³/h* *b OFF-VALUE LOW FLOW CUTOFF = 10%* *c Low flow cutoff active* *1 Low flow cutoff is switched on at 20 m³/h* *2 Low flow cutoff is switched off at 22 m³/h* *H Hysteresis* **User input** Integer 0 to 100% **Factory setting** 50%
VELOCITY WARNING	**Description** Use this function to activate flow velocity supervision (ON). If the fluid velocity exceeds the value entered in the LIMIT VELOCITY function (→ 142) the device issues the notice message "#421 FLOW RANGE" (→ 68). **Options** OFF (function switched off) ON **Factory setting** OFF
LIMIT VELOCITY	**Description** Enter the maximum allowable flow velocity (limit velocity). By switching on the VELOCITY WARNING function (→ 142), a warning message is output once the limit velocity is overshot. Unit on the display depends on UNIT LENGTH (→ 106). **User input** 5-digit floating-point number **Factory setting** 75 m/s

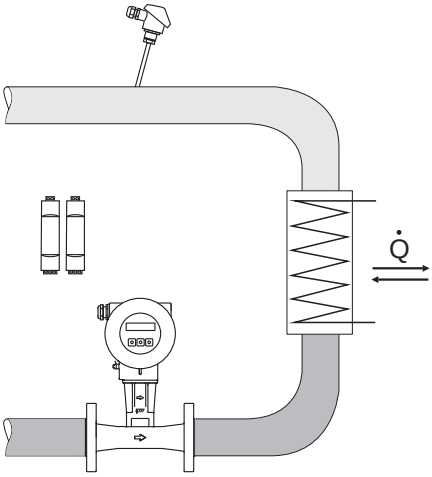
11.15 FLOW COMPUTER

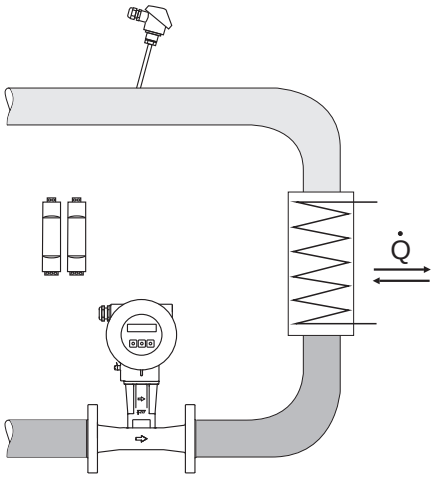
Function description, FLOW COMPUTER group	
SELECT FLUID	✎ Note! If you want to change the fluid selected, we recommend that you only do so via the Commissioning Quick Setup (→ 🖹 51). All the relevant parameters can be adapted to the new fluid in the Commissioning Quick Setup. **Options** SATURATED STEAM SUPERHEATED STEAM WATER (only volume and temperature measurement possible) COMPRESSED AIR (no data are recorded in the liquid state) ARGON (no data are recorded in the liquid state) CARBON DIOXIDE (no data are recorded in the liquid state) METHANE (no data are recorded in the liquid state) NITROGEN OXYGEN (no data are recorded in the liquid state) NATURAL GAS (only available as an option, ACTIVATION CODE NATURAL GAS (→ 🖹 111); please note that no data are recorded in the liquid state) GAS MIXTURE (no data are recorded in the liquid state) USER DEFINED LIQUID GAS VOLUME (only volume and temperature measurement possible) LIQUID VOLUME (only volume and temperature measurement possible) SATURATED STEAM DELTA HEAT (please observe "Note") WATER DELTA HEAT (please observe "Note") REAL GAS **Factory setting** See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions. **Information on the fluids available for selection** **Selected fluid: SATURATED STEAM** *Applications:* For calculating the mass flow and the quantity of heat the flow contains. *Calculated variables:* The mass flow, heat flow, density and the specific enthalpy are calculated from the measured volume flow and measured temperature using the saturated steam curve as per the international IAPWS-IF97 standard (ASME steam data). *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho\,(T)$ ■ Quantity of heat: $E = q \cdot \rho\,(T) \cdot h_D\,(T)$ m = Mass flow E = Quantity of heat q = Volume flow (measured) h_D = Specific enthalpy T = Operating temperature (measured) ρ = Density* * From the saturated steam curve as per IAPWS-IF97 (ASME) (Continued on next page)

Function description, FLOW COMPUTER group	
SELECT FLUID (contd.)	**Selected fluid: GAS VOLUME or LIQUID VOLUME** *Applications:* The measured volume flow and measured temperature are made available to an external flow computer (e.g. RMC621). In conjunction with an external pressure transmitter (PT), the flow can be calculated at a non-constant pressure. *Calculated variables:* No variables are calculated in the measuring device. Any calculations are made in the flow computer. Sample application:  A0001983 **Selected fluid: SUPERHEATED STEAM** *Applications:* For calculating the mass flow and the quantity of heat the flow contains. Note! The process pressure (p) in the process pipe is required to calculate the process variables and the measuring range limit values. The process pressure can be read in from an external pressure measuring device (e.g. Cerabar-M, for details on wiring → 27) via the HART INPUT (→ 167), or can be entered as a fixed value in the OPERATING PRESSURE function (→ 150). The following aspects are taken into account when calculating the values: ■ The device will calculate assuming superheated steam until the saturation point is reached. Notice message "#525 WET STEAM ALARM" → 68 is triggered at 2 °C above saturation. This alarm can be switched off via the WET STEAM ALARM function (→ 156). ■ If the temperature is lowered even further, the meter will calculate assuming saturated steam based on temperature down to 0 °C. If pressure is preferred as the measured variable, it can be selected in the SATURATED STEAM PARAMETER function (→ 157). ■ Below 0 °C the meter will continue calculating assuming saturated steam of 0 °C. *Calculated variables:* The mass flow, heat flow, density and the specific enthalpy are calculated from the measured volume flow and measured temperature using the saturated steam curve as per the international IAPWS-IF97 standard (ASME steam data). *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho (T, p)$ ■ Quantity of heat: $E = q \cdot \rho (T, p) \cdot h_D (T, p)$ m = Mass flow E = Quantity of heat q = Volume flow (measured) h_D = Specific enthalpy T = Operating temperature (measured) p = Process pressure (→ 150) ρ = Density* * from steam data as per IAPWS-IF97 (ASME), for the measured temperature and the specified pressure (Continued on next page)

Function description, FLOW COMPUTER group	
SELECT FLUID (contd.)	**Selected fluid: WATER** *Applications:* For calculating the quantity of heat in a flow of water, e.g. for determining the residual heat in the return line of a heat exchanger. ✎ Note! The process pressure (p) in the process pipe is required to calculate the process variables and the measuring range limit values. The process pressure can be read in from an external pressure measuring device (e.g. Cerabar-M, for details on wiring → 🖹 27) via the HART INPUT (→ 🖹 167), or can be entered as a fixed value in the OPERATING PRESSURE function (→ 🖹 150). *Calculated variables:* The mass flow, heat flow, density and the specific enthalpy are calculated from the measured volume flow, the measured temperature and the specified process pressure using water data as per the international IAPWS-IF97 standard (ASME water data). *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho\ (T, p)$ ■ Quantity of heat: $E = q \cdot \rho\ (T, p) \cdot h\ (T)$ ■ Corrected volume flow: $q_{ref} = q \cdot (\rho\ (T, p) \div \rho_{ref})$ m = Mass flow E = Quantity of heat q = Volume flow (measured) q_{ref} = Corrected volume flow h = Specific enthalpy T = Operating temperature (measured) p = Process pressure (→ 🖹 150) ρ = Density* ρ_{ref} = Reference density (→ 🖹 152) * from water data as per IAPWS-IF97 (ASME), for the measured temperature and the specified pressure. **Selected fluid: USER DEFINED LIQUID** *Applications:* For calculating the mass flow of a user-defined liquid, e.g. a thermal oil. *Calculated variables:* The mass flow, the density of the corrected volume flow and the quantity of heat are calculated from the measured volume flow and the measured temperature. Either the specific heat capacity or the gross calorific value has to be entered to calculate the quantity of heat. *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho\ (T)$ ■ Density: $\rho = \rho_1\ (T_1) \div (1 + \beta_p \cdot [\ T - T_1])$ ■ Corrected volume flow: $q_{ref} = q \cdot (\rho\ (T) \div \rho_{ref})$ ■ Quantity of heat: $E = q \cdot \rho\ (T) \cdot c_p \cdot \Delta T$ for delta heat Quantity of heat: $E = q \cdot \rho\ (T) \cdot h$ at combustion m = Mass flow q = Volume flow (measured) q_{ref} = Corrected volume flow T = Operating temperature (measured) T_1 = Temperature at which the value for ρ_1 applies (→ 🖹 149)* ρ = Density ρ_{ref} = Reference density (→ 🖹 152) ρ_1 = Density at which the value for T_1 applies (→ 🖹 150)* β_p = Expansion coefficient of the liquid at T_1 (→ 🖹 150)* * Possible combinations of these values → 🖹 158 (Continued on next page)

Function description, FLOW COMPUTER group	
SELECT FLUID (contd.)	**Selected fluid: COMPRESSED AIR, ARGON, CARBON DIOXIDE, METHANE, NATURAL GAS, NITROGEN, OXYGEN, GAS MIXTURE, REAL GAS** *Applications:* For calculating the mass flow and the corrected volume flow of gases. ✎ Note! The process pressure (p) in the process pipe is required to calculate the process variables and the measuring range limit values. The process pressure can be read in from an external pressure measuring device (e.g. Cerabar-M, for details on wiring → 🖹 27) via the HART INPUT (→ 🖹 167), or can be entered as a fixed value in the OPERATING PRESSURE function (→ 🖹 150). *Calculated variables:* The mass flow, the density and the corrected volume flow are calculated from the measured volume flow, the measured temperature and the specified process pressure using data saved in the measuring device. ✎ Note! ■ The NX-19 standard is suitable for natural gas at a specific density of between 0.554 and 0.75. The specific density describes the ratio between the reference density of the natural gas to the reference density of air (→ 🖹 152). ■ The AGA8, ISO 12213-2, SGERG-88 equation is suitable for pipeline-quality natural gas with an appropriate make-up (→ 🖹 182). *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho (T, p)$ ■ Density (real gas): $\rho (T, p) = \rho_{ref} (p \div p_{ref}) \cdot (T_{ref} \div T) \cdot (Z_{ref} \div Z)$ ■ Corrected volume flow: $q_{ref} = q \cdot (\rho (T, p) \div \rho_{ref})$ m = Mass flow q = Volume flow (measured) q_{ref} = Corrected volume flow T = Operating temperature (measured) T_{ref} = Reference temperature (→ 🖹 151) p = Process pressure (→ 🖹 150) p_{ref} = Reference pressure (→ 🖹 151) ρ = Density ρ_{ref} = Reference density (→ 🖹 152)* Z = Operating Z-factor (→ 🖹 151)* Z_{ref} = Reference Z-factor (→ 🖹 153)* * The values from the functions are only used if REAL GAS was selected in the SELECT FLUID function (→ 🖹 143). In Prowirl 73, these values are always available for the other gases. (Continued on next page)

Function description, FLOW COMPUTER group	
SELECT FLUID (contd.)	**Selected fluid: SATURATED STEAM DELTA HEAT** *Prerequisite:* This option requires Prowirl 73 to read in the temperature value of an external temperature transmitter, which is **HART-enabled** and **set to the burst mode**, via the HART input function. For a detailed connection diagram, see → 30 *Applications:*  A0001809 *Calculated variables:* 1. Calculation of the saturated steam mass flow and the heat withdrawn by a consumer load, taking the energy remaining in the condensate into account. 2. Calculation of the saturated steam mass flow and the energy supplied to the condensate in a boiler. *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho$ (T73) (at the point of Prowirl 73) ■ Delta heat: $E = q \cdot \rho$ (T73) · (h (T73) – h (T2)) m = Mass flow E = Delta heat q = Volume flow (measured) ρ(T73) = Density* h(T73) = Specific enthalpy of saturated steam* h(T2) = Specific enthalpy of condensate* * from water and saturated steam data as per IAPWS-IF97 (ASME) for the measured temperatures. Note! ■ For this type of measurement, it is essential Prowirl 73 be located on the steam side. ■ If the algebraic sign of the temperature differential changes, error message "#524 SIGN DELTA HEAT" is displayed (→ 67). ■ Prowirl 73 cannot take a change in the algebraic sign for the temperature differential into account! (Continued on next page)

Function description, FLOW COMPUTER group	
SELECT FLUID (contd.)	**Selected fluid: WATER DELTA HEAT** *Prerequesite* This option requires Prowirl 73 to read in the temperature value of an external temperature transmitter, which is **HART-enabled** and **set to the burst mode**, via the HART input function. For a detailed connection diagram, see → 30. *Applications:*  A0001809 *Calculated variables:* 1. Calculation of the water mass flow and the heat withdrawn by a consumer load. 2. Calculation of the water mass flow and the heat added. The water thus has a cooling effect. Specify the mounting location of the Prowirl 73 in the INSTALLATION POINT function. *Formulae for calculation:* ■ Mass flow: $m = q \cdot \rho$ (T73) (at the point of Prowirl 73) ■ Delta heat: $E = q \cdot \rho$ (T73) · (h (T73) – h (T2)) m = Mass flow E = Delta heat q = Volume flow (measured) ρ(T73) = Density* h(T73) = Specific enthalpy at the point of the measuring device h(T2) = Specific enthalpy at the point of T2 * from water and saturated steam data as per IAPWS-IF97 (ASME) for the measured temperatures. Note! ■ If the algebraic sign of the temperature differential changes, error message #524 "SIGN DELTA HEAT" is displayed. → 67 ■ Prowirl 73 cannot take a change in the algebraic sign for the temperature differential into account!

Function description, FLOW COMPUTER group	
NATURAL GAS EQUATION	**Prerequisite** The function is **only** available if NATURAL GAS was selected in the SELECT FLUID function (→ 143). If you want to change the fluid selected, we recommend that you only do so via the Commissioning Quick Setup (→ 51). All the relevant parameters can be adapted to the new fluid in the Commissioning Quick Setup. **Description** For selecting the standard to be used to calculate the mass flow of the natural gas. **Options** NATURAL GAS AGA NX-19 NATURAL GAS AGA8-DC92 NATURAL GAS ISO 12213-2 NATURAL GAS AGA8 Gross Method 1 NATURAL GAS SGERG-88 **Factory setting** NATURAL GAS AGA NX-19
ERROR → TEMPERATURE	**Description** Use this function to enter a temperature value for temperature measurement failure in the DSC sensor. If temperature measurement fails, the measuring device continues working with the temperature value entered here. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). **User input** 5-digit floating-point number **Factory setting** 20 °C
TEMPERATURE VALUE	**Prerequisite** The function is **only** available if USER DEFINED LIQUID was selected in the SELECT FLUID function (→ 143). **Description** Use this function to enter the fluid temperature for the fluid density entered in the DENSITY VALUE function (→ 150) to calculate the operating density of user-defined liquids (for formula for calculation, see SELECT FLUID function). ■ The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). ■ We recommend you reset the totalizer if the value in this function is changed. ■ A table with sample values for the TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT functions is available on → 158. Note! This setting does not change the permitted temperature range of the measuring system. Pay attention to the temperature application limits specified in the product specifications (→ 84). **User input** 5-digit floating-point number **Factory setting** 293.15 K (20 °C)

Function description, FLOW COMPUTER group	
DENSITY VALUE	**Prerequisite** The function is **only** available if USER DEFINED LIQUID was selected in the SELECT FLUID function (→ 143). **Description** Use this function to enter the fluid density at the fluid temperature specified in the TEMPERATURE VALUE function to calculate the operating density of user-defined liquids (for formula for calculation, see SELECT FLUID function). ■ The appropriate unit is taken from the UNIT DENSITY function (→ 104). ■ We recommend you reset the totalizer if the value in this function is changed. ■ A table with sample values for the TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT functions is available on → 158. **User input** 5-digit floating-point number **Factory setting** 1.0000 kg/dm³
EXPANSION COEFFICIENT	**Prerequisite** The function is **only** available if USER DEFINED LIQUID was selected in the SELECT FLUID function (→ 143). **Description** ■ Use this function to enter the expansion coefficient to calculate the operating density of user-defined liquids (for formula for calculation, see SELECT FLUID function). The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). ■ We recommend you reset the totalizer if the value in this function is changed. ■ The expansion coefficient can be determined using Applicator ("Fluid properties" tab). Applicator is an Endress+Hauser software application for selecting and configuring flowmeters. Applicator is available both via the Internet (www.applicator.com) and on a CD-ROM for local PC installation. ■ If two value pairs for the temperature and density are known (density ρ_1 at temperature T_1 and density ρ_2 at temperature T_2), the expansion coefficient can be calculated using the following formula: $\beta_p = ((\rho_1 \div \rho 2) - 1) \div (T_1 - T_2)$ ■ A table with sample values for the TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT functions is available on → 158. **User input** 5-digit floating-point number, incl. unit ($10^{-4} \cdot 1$/UNIT TEMPERATURE) **Factory setting** 2.0700 [$10^{-4} \cdot 1/K$] (expansion coefficient for water at 20 °C)
OPERATING PRESSURE	**Prerequisite** The function is **not** available if the following was selected in the SELECT FLUID function (→ 143): ■ GAS VOLUME ■ LIQUID VOLUME ■ SATURATED STEAM ■ This function is not available if PRESSURE was selected in the HART INPUT function (→ 167). **Description** Use this function to enter the fluid pressure to calculate the operating density (for formula for calculation, see SELECT FLUID function (→ 143). See the parameter printout provided. The parameter printout is an integral part of these Operating Instructions. **User input** 5-digit floating-point number **Factory setting** 10 bara

Function description, FLOW COMPUTER group	
OPERATING-Z-FACTOR	**Prerequisite** The function is **only** available if REAL GAS was selected in the SELECT FLUID function (→ 143). **Description** Use this function to enter the Z-factor for gas at operating conditions, i.e. for the average temperature to be expected (for formula for calculation, see SELECT FLUID function). The real gas constant Z indicates the extent to which a real gas differs from an ideal gas that exactly satisfies the general gas law ($p \cdot V \div T$ = constant, $Z = 1$). The real gas constant approaches the value 1 the further the real gas is from its liquefaction point. The Z-factor can be determined using the "Applicator" software (→ 62). **User input** 5-digit floating-point number **Factory setting** 1.000
REFERENCE PRESSURE	**Prerequisite** The function is **only** available if the following was selected in the SELECT FLUID function (→ 143): ■ COMPRESSED AIR ■ CARBON DIOXIDE ■ NITROGEN ■ OXYGEN ■ GAS MIXTURE ■ ARGON ■ METHANE ■ NATURAL GAS ■ REAL GAS **Description** Use this function to enter the reference pressure of the fluid to calculate the reference density. This is needed to calculate the corrected volume flow (→ 98). The appropriate unit is taken from the UNIT PRESSURE function (→ 106). **User input** 5-digit floating point number (value entered must be > 0) **Factory setting** 1.013 bara
REFERENCE TEMPERATURE	**Prerequisite** The function is **only** available if one of the following was selected in the SELECT FLUID function (→ 143): ■ COMPRESSED AIR ■ CARBON DIOXIDE ■ NITROGEN ■ OXYGEN ■ GAS MIXTURE ■ ARGON ■ METHANE ■ NATURAL GAS ■ REAL GAS **Description** Use this function to enter the reference temperature of the fluid to calculate the reference density. This is needed to calculate the corrected volume flow (→ 98). The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). Note! This setting does not change the permitted temperature range of the measuring system. Pay attention to the temperature application limits specified in the product specifications (→ 84). **User input** 5-digit floating-point number **Factory setting** 273.15 K

Function description, FLOW COMPUTER group	
REFERENCE DENSITY	**Prerequisite** The function is **not** available if the following was selected in the SELECT FLUID function (→ 143): ■ GAS VOLUME ■ LIQUID VOLUME ■ SATURATED STEAM DELTA HEAT ■ SATURATED STEAM ■ SUPERHEATED STEAM **Description** The reference density can be displayed or entered in this function for fluids other than those listed above: ■ The appropriate unit is taken from the UNIT DENSITY function (→ 104). ■ We recommend you reset the totalizer if the value in this function is changed. **User input** If REAL GAS, USER DEFINED LIQUID was selected: enter the reference density of a gas or liquid. This is needed to calculate the corrected volume flow. **Display** ■ If COMPRESSED AIR, WATER, WATER DELTA HEAT, ARGON, CARBON DIOXIDE, METHANE, NITROGEN, OXYGEN, NATURAL GAS, GAS MIXTURE was selected: The display shows the reference density calculated by Prowirl 73 based on the values entered in the REFERENCE TEMPERATURE (→ 151) and REFERENCE PRESSURE (→ 151) functions. ■ Otherwise "1" appears on the display.
ENERGY CALCULATION	**Prerequisite** The function is **only** available if USER DEFINED LIQUID was selected in the SELECT FLUID function (→ 143). **Description** For selecting the method for calculating the energy. **Options** ■ DELTA HEAT ■ COMBUSTION ■ NONE **Factory setting** NONE
SPECIFIC HEAT CAPACITY	**Prerequisite** The function is **only** available if USER DEFINED LIQUID was selected in the SELECT FLUID function (→ 143) and DELTA HEAT was selected in the ENERGY CALCULATION function. **Description** For defining the specific heat capacity of the user-defined liquid. **User input** 5-digit floating-point number **Factory setting** The corresponding unit is taken from the UNIT SPECIFIC HEAT CAPACITY function (→ 105).

Function description, FLOW COMPUTER group	
REFERENCE COMBUSTION TEMPERATURE	**Prerequisite** The function is **only** available if NATURAL GAS AGA8-DC92 or NATURAL GAS ISO 12213-2 was selected in the NATURAL GAS EQUATION function (→ 149). **Description** Use this function to enter the reference combustion temperature of natural gas to calculate the natural gas heat flow. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). Note! This setting does not change the permitted temperature range of the measuring system. Pay attention to the temperature application limits specified in the product specifications (→ 84). **User input** 5-digit floating-point number **Factory setting** Depends on country → 180
REFERENCE-Z-FACTOR	**Prerequisite** The function is **only** available if REAL GAS was selected in the SELECT FLUID function (→ 143). **Description** Use this function to enter the Z factor for gas under reference conditions. The values defined in the REFERENCE PRESSURE (→ 151) and REFERENCE TEMPERATURE (→ 151) functions apply as the reference conditions, (for formula for calculation, see the SELECT FLUID function). The real gas constant Z indicates the extent to which a real gas differs from an ideal gas that exactly satisfies the general gas law ($p \cdot V \div T$ = constant, $Z = 1$). The real gas constant approaches the value 1 the further the real gas is from its liquefaction point. The Z factor can be determined using the "Applicator" software. Applicator is an Endress+Hauser software application for selecting and planning flowmeters. Applicator is available both via the Internet (www.applicator.com) and on a CD-ROM for local PC installation. **User input** 5-digit floating-point number **Factory setting** 1.0000
SPECIFIC DENSITY	**Prerequisite** – The function is **only** available if NATURAL GAS was selected in the SELECT FLUID function (→ 143). – The specific density of natural gas is entered if NATURAL GAS AGA NX-19, NATURAL GAS AGA8 Gross Method 1 or NATURAL GAS SGERG-88 is selected in the NATURAL GAS EQUATION function (→ 149). – The specific density of natural gas is displayed if NATURAL GAS AGA8-DC92 or NATURAL GAS ISO 12213-2 was selected in the NATURAL GAS EQUATION function (→ 149). **Description** Use this function to enter the specific density of the natural gas. (Ratio of the density of natural gas at reference operating conditions to the density of air at reference operating conditions; corresponds to the "relative density" as per ISO 14532-2003.) ■ The values entered in the SPECIFIC DENSITY, MOL-% N2, MOL-% CO2 and MOL-% H2 functions are interdependent. For this reason, if the value in one of these functions is changed, the values in the other functions also have to be adapted accordingly. ■ The NX-19 standard is not defined for certain combinations of parameters (specific density, pressure, temperature, mole-% nitrogen and mole-% carbon dioxide) and the measuring device displays error message #412. In such instances, the mass flow can no longer be calculated with the NX-19 standard. **User input/user interface** 5-digit floating-point number **Factory setting** 0.6640

Function description, FLOW COMPUTER group	
MOLE-% N2	**Prerequisite** The function is **only** available if NATURAL GAS AGA NX-19 was selected in the NATURAL GAS EQUATION function (→ 149). **Description** Use this function to enter the mole-% of nitrogen in the expected natural gas mixture. ■ The values entered in the SPECIFIC DENSITY (→ 153), MOLE-% N2 (→ 154) and MOLE-%-CO2 (→ 154) functions are interdependent. For this reason, if the value in one of these functions is changed, the values in the other functions also have to be adapted accordingly. ■ According to the NX-19 standard, the maximum mole-% of nitrogen is 15%. ■ The NX-19 standard is not defined for certain combinations of parameters (specific density, pressure, temperature, mole-% nitrogen and mole-% carbon dioxide) and the measuring device displays error message #412. In such instances, the mass flow can no longer be calculated with the NX-19 standard. **User input** 5-digit floating-point number **Factory setting** 0.0000%
MOLE-%-CO2	**Prerequisite** The function is **only** available if the following was selected in the NATURAL GAS EQUATION function (→ 149): ■ NATURAL GAS AGA NX-19 ■ NATURAL GAS AGA8 Gross Method 1 ■ NATURAL GAS SGERG-88 **Description** Use this function to enter the mole-% of carbon dioxide in the expected natural gas mixture. ■ The values entered in the SPECIFIC DENSITY (→ 153), MOLE-% N2 (only NATURAL GAS AGA NX-19) (→ 154), MOLE-% H2 (only NATURAL GAS AGA8 Gross Method 1 and NATURAL GAS SGERG-88) (→ 154) and MOLE-%-CO2 (→ 154) are interdependent. For this reason, if the value in one of these functions is changed, the values in the other functions also have to be adapted accordingly. ■ According to the NX-19 standard, the maximum mole-% of carbon dioxide is 15%. ■ The NX-19 standard is not defined for certain combinations of parameters (specific density, pressure, temperature, mole-% nitrogen and mole-% carbon dioxide) and the measuring device displays error message #412. In such instances, the mass flow can no longer be calculated with the NX-19 standard. **User input** 5-digit floating-point number **Factory setting** 0.0000%
MOLE-% H2	**Prerequisite** The function is **only** available if NATURAL GAS AGA8 Gross Method 1 or NATURAL GAS SGERG-88 was selected in the NATURAL GAS EQUATION function (→ 149). **Description** Use this function to enter the mole-% of hydrogen in the expected natural gas mixture. The values entered in the SPECIFIC DENSITY (→ 153), MOLE-% H2 (→ 154) and MOLE-%-CO2 (→ 154) functions are interdependent. For this reason, if the value in one of these functions is changed, the values in the other functions also have to be adapted accordingly. **User input** 5-digit floating-point number **Factory setting** 0.0000%

Function description, FLOW COMPUTER group	
REFERENCE GROSS CALORIFIC VALUE	**Prerequisite** The function is **only** available if NATURAL GAS AGA8 Gross Method 1 or NATURAL GAS SGERG-88 was selected in the NATURAL GAS EQUATION function (→ 149). **Description** Use this function to enter the reference gross calorific value of the natural gas. The following reference operating conditions apply: reference temperature 0°C, reference pressure 1.013 bar abs, reference combustion temperature 25°C. The reference gross calorific value is used for the calculation of the compressibility of the natural gas with the natural gas equations AGA8 Gross Method 1 and SGERG-88. **User input** 5-digit floating-point number **Unit** The corresponding unit is taken from the UNIT CALORIFIC VALUE CORRECTED VOLUME function. **Factory setting** 34 MJ/Nm^3
TYPE CALORIFIC VALUE	**Prerequisite** The function is **only** available if the following was selected in the SELECT FLUID function (→ 143): ■ NATURAL GAS ■ METHANE ■ USER DEFINED LIQUID ■ GAS MIXTURE **Description** Use this function to define the type of unit for the net calorific values and gross calorific values: ■ "per mass", e.g. MJ/kg ■ "per corrected volume", e.g. kBtu/SCF **Options** MASS CORRECTED VOLUME **Factory setting** CORRECTED VOLUME
GROSS CALORIFIC VALUE	**Prerequisite** The function is **only** available if the following was selected in the SELECT FLUID function: ■ METHANE ■ USER DEFINED LIQUID with COMBUSTION option in the ENERGY CALCULATION function ■ GAS MIXTURE or if the selection NATURAL GAS and one of the following NATURAL GAS EQUATION was selected in the SELECT FLUID section: ■ AGA8-DC92 ■ ISO 12213-2 ■ AGA8 Gross Method 1 ■ SGERG 88 **Description** ■ A gross calorific value, which is used to calculate the heat flow, can be entered here for USER DEFINED LIQUIDS. ■ The gross calorific value of the gas is displayed here in the other cases described. The gross calorific value is calculated as per ISO 6976-1995. Note! Make sure that the correct reference combustion temperature was entered (→ 153) **User input/user interface** 5-digit floating-point number **Factory setting** 40MJ/kg ; the corresponding unit is taken from the UNIT CALORIFIC VALUE MASS or UNIT CALORIFIC VALUE CORRECTED VOLUME function.

Function description, FLOW COMPUTER group	
NET CALORIFIC VALUE	**Prerequisite** The function is **only** available if the following was selected in the SELECT FLUID function: ■ METHANE ■ USER DEFINED LIQUID with COMBUSTION option in the ENERGY CALCULATION function ■ GAS MIXTURE or if the selection NATURAL GAS and one of the following NATURAL GAS EQUATION was selected in the SELECT FLUID section: ■ AGA NX-19 ■ AGA8-DC92 ■ ISO 12213-2 ■ AGA8 Gross Method 1 ■ SGERG 88 **Description** ■ A net calorific value, which is used to calculate the heat flow, can be entered here for USER DEFINED LIQUIDS. ■ If the heat flow of natural gas is to be calculated, a net calorific value must be entered here for applications with natural gas AGA NX-19, AGA8 Gross Method 1 as well as SGERG-88. ■ The net calorific value of the gas is displayed here in the other cases described. The net calorific value is calculated as per ISO 6976-1995. ✎ Note! Make sure that the correct reference combustion temperature was entered (→ 153). **User input/user interface** 5-digit floating-point number **Factory setting** 40MJ/kg ; the corresponding unit is taken from the UNIT CALORIFIC VALUE MASS or UNIT CALORIFIC VALUE CORRECTED VOLUME function.
CALORIFIC VALUE -> ENERGY	**Prerequisite** The function is **only** available if the following was selected in the SELECT FLUID function: ■ NATURAL GAS ■ METHANE ■ USER DEFINED LIQUID ■ GAS MIXTURE **Description** Use this function to define whether the gross or net calorific value is to be used to calculate the heat flow (of the energy). The net calorific value is typically used here since it does not take the formation of water into consideration. The gross calorific value is more used for applications with condensing boilers. **Options** GROSS CALORIFIC VALUE NET CALORIFIC VALUE **Factory setting** NET CALORIFIC VALUE
WET STEAM ALARM	**Prerequisite** The function is **only** available if SUPERHEATED STEAM was selected in the SELECT FLUID function (→ 143). **Description** If the temperature comes within 2 °C of the saturated steam curve in steam applications, error message "#525 WET STEAM ALARM" (→ 68) is displayed. **Options** OFF ON **Factory setting** ON

Function description, FLOW COMPUTER group	
INSTALLATION POINT	**Prerequisite** The function is **only** available if WATER DELTA HEAT was selected in the SELECT FLUID function (→ 143), or if USER DEFINED LIQUID was selected in the SELECT FLUID function and the DELTA HEAT option was selected in the ENERGY CALCULATION function. **Description** Use this function to define the installation point of the measuring device (warm side or cold side). For a detailed description, see → 148 **Options** COLD SIDE WARM SIDE **Factory setting** WARM SIDE
SATURATED STEAM PARAMETER	**Prerequisite** The function is **only** available if SATURATED STEAM or SUPERHEATED STEAM was selected in the SELECT FLUID function (→ 143). **Description** Use this function to specify what parameter should be used to calculate the density and enthalpy if saturated steam is selected as the fluid. **Options** PRESSURE TEMPERATURE **Factory setting** TEMPERATURE

11.16 Sample values for the functions: TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT

The calculation of the density for user-defined liquids (→ 145) is better the closer the operating temperature is to the particular value in the "Temperature value" column. If the operating temperature deviates greatly from the value in the "Temperature value" column, the expansion coefficient should be calculated as per the formula on → 150.

Fluid (Liquid)	Temperature value [K]	Density value [kg/m3]	Expansion coefficient [10–4 1/K]
Air	123.15	594	18.76
Ammonia	298.15	602	25
Argon	133.15	1028	111.3
n-butane	298.15	573	20.7
Carbon dioxide	298.15	713	106.6
Chlorine	298.15	1398	21.9
Cyclohexane	298.15	773	11.6
n-decane	298.15	728	10.2
Ethane	298.15	315	175.3
Ethylene	298.15	386	87.7
n-heptane	298.15	351	12.4
n-hexane	298.15	656	13.8
Hydrogen chloride	298.15	796	70.9
i-butane	298.15	552	22.5
Methane	163.15	331	73.5
Nitrogen	93.15	729	75.3
n-octane	298.15	699	11.1
Oxygen	133.15	876	95.4
n-pentane	298.15	621	16.2
Propane	298.15	493	32.1
Vinyl chloride	298.15	903	19.3
Table values from Carl L. Yaws (2001): Matheson Gas Data Book, 7th edition			

11.17 GAS MIXTURE

Function description, GAS MIXTURE group

Prerequisite
The function is **only** available if GAS MIXTURE was selected in the SELECT FLUID function (→ 143).

Description
- Use this function to program a gas mixture consisting of a maximum of 8 individual gas constituents.
- General rules:
  - At the start, select the number of constituents.
  - The constituents entered for the gas mixture must have 100.00 Mol-% (=Vol-%) altogether.
  - A gas and its corresponding Vol-% value can be entered in any order.
  - If a certain gas is not listed, you can do either of the following:
    - Program the gas using the real gas equation
    - Enter the Vol.-% part with the gas type OTHER as well as the following functions: OPERATING-Z-FACTOR (OTHER) (→ 151), REFERENCE-Z-FACTOR (OTHER) (→ 153) and REFERENCE DENSITY (OTHER) (→ 152). Thereby the gas calculator with preset gases and the real gas equation can be combined.
  - The current gas mixture can be checked in the GAS MIXTURE function.
- Programming examples

a. Number of gas constituents: 1
Gas type 1: AIR
Mole-% Gas 1: 100.00%

b. Number of gas constituents: 3
Gas type 1: ARGON
Mole-% Gas 1: 004.00%
Gas type 2: OXYGEN
Mole-% Gas 2: 093.00%
Gas type 3: NITROGEN
Mole-% Gas 3: 003.00%

c. Number of gas constituents: 5
Gas type 1: CARBON DIOXIDE
Mole-% Gas 1: 036.00%
Gas type 2: METHANE
Mole-% Gas 2: 060.00%
Gas type 3: NITROGEN
Mole-% Gas 3: 002.00%
Gas type 4: CARBON MONOXIDE
Mole-% Gas 4: 001.00%
Gas type 5: OTHER
Mole-% Gas 5: 001.00%
OPERATING-Z-FACTOR
1.0000
REFERENCE-Z-FACTOR
1.0000
REFERENCE DENSITY
1.293 kg/m3

NUMBER OF GASES	**Description** Use this function to enter the number of gases that are used in the gas mixture. **User input** 1 to 8 **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "1" is the factory setting.

Function description, GAS MIXTURE group	
GAS TYPE 1	**Description** Use this function to select gas type 1. The NOT USED option is a placeholder and is not used for the calculation. **Options** AIR AMMONIA ARGON BUTANE CARBON DIOXIDE CARBON MONOXIDE CHLORINE ETHANE ETHYLENE HELIUM 4 HYDROGEN NORMAL HYDROGEN CHLORIDE HYDROGEN SULFIDE KRYPTON METHANE NEON NITROGEN OXYGEN PROPANE SULFUR DIOXIDE VINYL CHLORIDE XENON OTHER NOT USED **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "AIR" is the factory setting
MOLE % GAS 1	**Description** Use this function to display the mole-% for the gas selected in GAS TYPE 1. **Display** 000.00 % to 100.00 % **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "0 %" is the factory setting.
GAS TYPE n	**Prerequisite** This function is **not** available if the option selected in NUMBER OF GASES (→ 159) is < n (max. 8). **Description** Use this function to select the gas type n (max. 8). **Options** Options as for GAS TYPE 1 **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "NOT USED" is the factory setting.
MOLE % GAS n	**Description** Use this function to display the mole-% for the gas selected in GAS TYPE n (max. 8). **Display** 000.00 % to 100.00 % **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "0 %" is the factory setting.

Function description, GAS MIXTURE group	
Z-FACTOR (OTHER)	**Prerequisite** The function is **only** available if OTHER was selected in the GAS TYPE 1 to 8 function (→ 160). **Description** Use this function to enter the real gas factor (compressibility factor) for the OTHER option. The factor can only be entered as a fixed value and not as a function of the temperature and pressure. If OTHER was assigned several times in the GAS TYPE 1 to 8 function, the sensor calculates internally on the basis of the sum of these parts. **User input** 5-digit floating-point number **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "1" is the factory setting.
REFERENCE Z-FACTOR (OTHER)	**Prerequisite** The function is **only** available if OTHER was selected in the GAS TYPE 1 to 8 function (→ 160). **Description** Use this function to enter the reference real gas factor (compressibility factor) for the OTHER option. The factor can only be entered as a fixed value and not as a function of the temperature and pressure. If OTHER was assigned several times in the GAS TYPE 1 to 8 function, the sensor calculates internally on the basis of the sum of these parts. **User input** 5-digit floating-point number **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "1" is the factory setting.
REFERENCE DENSITY (OTHER)	**Prerequisite** The function is **only** available if OTHER was selected in the GAS TYPE 1 to 8 function (→ 160). **Description** Use this function to enter the reference density for the OTHER option. The appropriate unit is taken from the UNIT DENSITY function (→ 104). **User input** 5-digit floating-point number, with unit **Factory setting** ■ As per the parameter printout supplied with the device if Prowirl 73 was ordered with a preprogrammed mixture. ■ Otherwise "1" is the factory setting.
CHECK VALUES	**Prerequisite** The function is **only** available if an error has occurred with the mole-%. **Description** MIXTURE NOT 100 % appears on the display if the values entered do not total 100%. Check and correct the entries and save them in the function SAVE CHANGES (→ 162) by confirming with YES. **Display** MIXTURE NOT 100%

Function description, GAS MIXTURE group	
SAVE CHANGES	**Description** Use this function to select how the entries in the gas group are saved and used for flow measurement. **Options** CANCEL The modified parameters are saved in the gas group but are **not** used to calculate the flow. The gas group can be reactivated at a later stage. To do so, call up the gas group, check the entries and activate the group by selecting YES. YES The modified parameters are saved in the gas group and are used to calculate the flow. DISCARD The modified parameters are not saved. The previous values remain valid and are used to calculate the flow.

11.18 NG AGA8-DC92/ISO 12213-2

The mole-% of the following secondary constituents and trace elements are assigned to the constituents on the right-hand side of the table:

Secondary constituents and trace elements	Assignment
Oxygen	Oxygen
Argon, neon, krypton, xenon	Argon
Hydrogen sulfides	Hydrogen sulfides
Laughing gas (nitrous oxide)	Carbon dioxide
Ammonia	Methane
Ethylene, acetylene, menthol (methyl alcohol), hydrogen cyanide (hydrocyanic acid)	Ethane
Propylene, propadiene, methanethiol (methyl mercaptan)	Propane
Butane, butadiene, carbonyl sulfide (carbon oxysulfide), sulfur dioxide	n-butane
Neo-pentane, pentene, benzene, cyclopentane, carbon disulfide	n-pentane
All C_6 - isomers, cyclohexane, toluene, methylcyclopentane	n-hexane
All C_7 - isomers, ethylcyclopentane, methylcyclohexane, cycloheptane, ethylbenzene, xylene	n-heptane
All C_8 - isomers, ethylcyclohexane	n-octane
All C_9 - isomers	n-nonane
All C_{10} - isomers and higher hydrocarbons	n-decane

Function description, NG AGA8-DC92/ISO 12213-2 group	
✎ Note! The total amount of unspecified constituents may not fall below 0.01 mole-%.	
MOLE % CH4	**Description** Use this function to enter the methane mole-% in the expected natural gas mixture (min. 70%; "extended range" of the application: min 50 %). **User input** 5-digit floating-point number **Factory setting** 100 %
MOLE % N2	**Description** Use this function to enter the nitrogen mole-% in the expected natural gas mixture (max. 20%; "extended range" of the application: max. 50 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % CO2	**Description** Use this function to enter the carbon dioxide mole-% in the expected natural gas mixture (max. 20%; "extended range" of the application: max. 30 %). **User input** 5-digit floating-point number **Factory setting** 0 %

Function description, NG AGA8-DC92/ISO 12213-2 group	
MOLE % C2H6	**Description** Use this function to enter the ethane mole-% in the expected natural gas mixture (max. 10%; "extended range" of the application: max. 20 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % C3H8	**Description** Use this function to enter the propane mole-% in the expected natural gas mixture (max. 3.5%; "extended range" of the application: max. 5 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % H2O	**Description** Use this function to enter the water vapor mole-% in the expected natural gas mixture (max. 0.015 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % H2S	**Description** Use this function to enter the water vapor mole-% in the expected natural gas mixture (max. 0.02 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % H2	**Description** Use this function to enter the hydrogen mole-% in the expected natural gas mixture (max. 10 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % CO	**Description** Use this function to enter the carbon monoxide mole-% in the expected natural gas mixture (max. 3 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % O2	**Description** Use this function to enter the oxygen mole-% in the expected natural gas mixture (max. 0.02 %). **User input** 5-digit floating-point number **Factory setting** 0 %

Function description, NG AGA8-DC92/ISO 12213-2 group	
MOLE % i-C4H10	**Description** Use this function to enter the i-butane (iso-butane) mole-% in the expected natural gas mixture (total quantity of i-C4H10 and n-C4H10 max. 1.5 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % n-C4H10	**Description** Use this function to enter the n-butane mole-% in the expected natural gas mixture (total quantity of i-C4H10 and n-C4H10 max. 1.5 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % i-C5H12	**Description** Use this function to enter the i-pentane (iso-pentane) mole-% in the expected natural gas mixture (total quantity of i-C5H12 and n-C5H12 max. 0.5 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % n-C5H12	**Description** Use this function to enter the n-pentane mole-% in the expected natural gas mixture (total quantity of i-C5H12 and n-C5H12 max. 0.5 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % n-C6H14	**Description** Use this function to enter the n-hexane mole-% in the expected natural gas mixture (max. 0.1 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % n-C7H16	**Description** Use this function to enter the n-heptane mole-% in the expected natural gas mixture (max. 0.05 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % n-C8H18	**Description** Use this function to enter the n-octane mole-% in the expected natural gas mixture (total quantity of n-octane, n-nonane and n-decane max. 0.05 %). **User input** 5-digit floating-point number **Factory setting** 0 %

Function description, NG AGA8-DC92/ISO 12213-2 group	
MOLE % n-C9H20	**Description** Use this function to enter the n-nonane mole-% in the expected natural gas mixture (total quantity of n-octane, n-nonane and n-decane max. 0.05 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % n-C10H22	**Description** Use this function to enter the n-decane mole-% in the expected natural gas mixture (total quantity of n-octane, n-nonane and n-decane max. 0.05 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % He	**Description** Use this function to enter the helium mole-% in the expected natural gas mixture (max. 0.5 %). **User input** 5-digit floating-point number **Factory setting** 0 %
MOLE % Ar	**Description** Use this function to enter the argon mole-% in the expected natural gas mixture (max. 0.02 %). **User input** 5-digit floating-point number **Factory setting** 0 %
CHECK VALUES	**Prerequisite** The function is **only** available if the gas mixture is not equal to 100 %. **Description** Use this function to check the gas mixture values entered. **Options** OK MIXTURE NOT 100%
SAVE CHANGES	**Prerequisite** The function is **only** available if MIXTURE NOT 100% appears in the CHECK VALUES function (→ 161). **Description** Use this function to accept the changes in the gas mixture table. The setting is not saved if the power supply fails. **Options** CANCEL The modified parameters are saved but are **not** used to calculate the flow. YES The modified parameters are saved and are used to calculate the flow. DISCARD The modified parameters are not saved. The previous values remain valid and are used to calculate the flow.

11.19 HART INPUT

Function description, HART INPUT group

Prowirl can read in an external pressure, temperature or density value with the HART INPUT function. The external value can be read in at a rate of up to three values per second. For a detailed connection diagram, see → 30

Prerequisite
- This mode is not possible for transmitters that are HART-enabled but NOT burst-enabled (e.g. iTemp 162).
- The HART INPUT group is only available if OFF was selected in the BURST MODE function (→ 138).

HART INPUT

Description
For selecting the input variable.

Options
OFF
PRESSURE
TEMPERATURE
DENSITY
TEMPERATURE 72
PRESSURE 72
DENSITY 72

Factory setting
OFF

Note!
If you are using Prowirl 73 electronics on a Prowirl 72 meter body and DSC sensor, select the PRESSURE 72, TEMPERATURE 72 or DENSITY 72 setting. With these options, Prowirl 73 fluid temperature measurement is ignored.
Select the option depending on the sensor used or the setting in SELECT FLUID (→ 143):
Settings other than those indicated here are NOT possible in conjunction with the SELECT FLUID (→ 143) function.

Prowirl 73 - sensor[1]:

SELECT FLUID	DENSITY[3]	PRESSURE	TEMPERATURE	SELECTION
WATER, USER DEFINED LIQUID	X	–	–	DENSITY
SATURATED STEAM, SUPERHEATED STEAM, COMPRESSED AIR, NATURAL GAS AGA NX-19, CARBON DIOXIDE, NITROGEN, OXYGEN	X	X	–	PRESSURE or DENSITY
SATURATED STEAM DELTA HEAT, WATER DELTA HEAT	–	–	X	TEMPERATURE

Prowirl 72 - sensor:

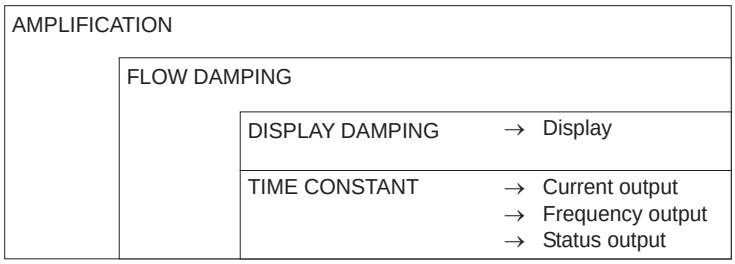
SELECT FLUID	DENSITY***	PRESSURE	TEMPERATURE	SELECTION
SATURATED STEAM	X	X (no temperature)	X** (no pressure)	DENSITY 72, TEMPERATURE 72 or PRESSURE 72
WATER, USER DEFINED LIQUID	X	–	X**	DENSITY 72 or TEMPERATURE 72
SUPERHEATED STEAM, COMPRESSED AIR, CARBON DIOXIDE, NITROGEN, OXYGEN, REAL GAS, GAS MIXTURE	X	Cannot be selected		DENSITY 72

[1] The internal temperature measurement is used to compensate the K-factor.
[2] The external temperature measurement is used to compensate the K-factor.
[3] If a density value is read in, it is not possible to output the heat flow.

Function description, HART INPUT group	
HART INPUT VALUE	**Prerequisite** The function is **not** available if OFF was selected in HART INPUT (→ 167). **Description** Use this function to display the value read in via HART INPUT. If a gauge pressure is read in, it is converted to absolute pressure with the AMBIENT PRESSURE (→ 168). **Display** 5-digit floating-point number, including unit Unit on the display depends on: ■ UNIT TEMPERATURE (→ 102) ■ UNIT DENSITY (→ 104) ■ UNIT PRESSURE (→ 106) **Factory setting** OFF
PRESSURE TYPE	**Prerequisite** The function is **only** available if PRESSURE or PRESSURE 72 was selected in the HART INPUT function (→ 167). **Description** For selecting whether the pressure value is read in as an absolute or gauge unit. **Options** GAUGE ABSOLUTE **Factory setting** ABSOLUTE
AMBIENT PRESSURE	**Prerequisite** The function is **only** available if GAUGE was selected in the PRESSURE TYPE function (→ 168). **Description** Use this function to enter the ambient pressure. The appropriate unit is taken from the UNIT PRESSURE function (→ 106). **User input** 5-digit floating-point number **Factory setting** 1.0000
ERROR VALUE TEMPERATURE	**Prerequisite** The function is **only** available if TEMPERATURE or TEMPERATURE 72 was selected in the HART INPUT function (→ 167). **Description** Use this function to enter a defined error value for the temperature process variable read in. If Prowirl does not receive a valid value from the external temperature transmitter, the process variable is set to the "error value" defined here and one of the error messages #520 - #523 (→ 66) is generated. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). **User input** 5-digit floating-point number **Factory setting** 75 °C

Function description, HART INPUT group	
ERROR VAL. PRESS	**Prerequisite** The function is **only** available if PRESSURE or PRESSURE 72 was selected in the HART INPUT function (→ 167). **Description** Use this function to enter a defined error value for the pressure process variable read in. If Prowirl does not receive a valid value from the external temperature transmitter, the process variable is set to the "error value" defined here and one of the error messages #520 - #523 (→ 66) is generated. Enter an absolute pressure in this function. If GAUGE was selected in the PRESSURE TYPE function, the gauge pressure is calculated with the value in the AMBIENT PRESSURE function. The appropriate unit is taken from the UNIT PRESSURE function (→ 106). **User input** 5-digit floating-point number **Factory setting** 10 bar a
ERROR VALUE DENS	**Prerequisite** The function is **only** available if DENSITY or DENSITY 72 was selected in the HART INPUT function (→ 167). **Description** Use this function to enter a defined error value for the density process variable read in. If Prowirl does not receive a valid value from the external temperature transmitter, the process variable is set to the "error value" defined here and one of the error messages #520 - #523 (→ 66) is generated. The appropriate unit is taken from the UNIT DENSITY function (→ 104). **User input** 5-digit floating-point number **Factory setting** 1 kg/l
TIMEOUT HART COMMUNICATION	**Prerequisite** The function is **not** available if OFF was selected in the HART INPUT function (→ 167). **Description** Use this function to enter the number of seconds that have to elapse before the external sensor outputs the error message "#523 TIMEOUT HART COM" (→ 66) if communication via HART fails or does not take place. **User input** 0 to 100 s **Factory setting** 60 seconds

11.20 SYSTEM PARAMETER

Function description, SYSTEM PARAMETER group	
POSITIVE ZERO RETURN	**Description** Use this function to interrupt evaluation of measured variables. This is necessary when a pipe is being cleaned, for example. The setting acts on all functions and outputs of the measuring device. If positive zero return is active, notice message #601 (→ 67) is displayed. **Options** OFF ON (signal output is set to the value for zero flow) **Factory setting** OFF
FLOW DAMPING	**Description** For setting the filter depth. This reduces the sensitivity of the measuring signal to interference peaks e.g. in the event of high solids content, gas bubbles in the fluid, etc. The measuring system reaction time increases with the filter setting. The flow damping acts on the following functions and outputs of the measuring device:  A0005914-en **User input** 0 to 100 s **Factory setting** 1 s

11.21 SENSOR DATA

Function description, SENSOR DATA group	
All sensor data, such as the calibration factor or nominal diameter, are set at the factory. ☝ Caution! Under normal circumstances these settings may not be changed because changes affect numerous functions of the entire measuring system, and the accuracy of the measuring system in particular. If you have any questions on these functions contact your Endress+Hauser service organization.	
CALIBRATION DATE	**Description** The alteration date and time, when the K-FACTOR was changed (e.g. after a Re calibration), appears on the display. **Display** e.g. 100 P/l (pulse per liter)
K-FACTOR	**Description** The current calibration factor of the sensor appears on the display. The K-factor is also given on the nameplate, the sensor and the calibration protocol under "K-fct.". **Display** e.g. 100 P/l (pulse per liter)
K-FACTOR COMPENSATED	**Description** The current compensated calibration factor of the sensor appears on the display. The following are compensated: ■ The temperature-dependent expansion of the sensor (→ 🖹 171, TEMPERATURE COEFFICIENT function). ■ Diameter steps in the inlet of the device (→ 🖹 140). **Display** e.g. 102 P/l (pulse per liter)
NOMINAL DIAMETER	**Description** The nominal diameter of the sensor appears on the display. **Display** e.g. DN 25
METER BODY MB	**Description** The type of meter body (MB) of the sensor appears on the display. ■ Use this function to specify the nominal diameter and the sensor type. ■ The meter body MB is also given on the parameter printout and the nameplate. **Display** e.g. 71
TEMPERATURE COEFFICIENT	**Description** The temperature effect on the calibration factor appears on the display. Due to changes in temperature, the meter body expands differently, depending on the material. The expansion has an effect on the K-factor. **Display** $4.8800*10^{-5}$ / K (stainless steel)

Function description, SENSOR DATA group	
AMPLIFICATION	**Description** Devices are always optimally configured for the process conditions you specified. Under certain process conditions, however, interference signals (e.g. strong vibrations) can be suppressed or the measuring range extended by adjusting the amplification. The amplification is configured as follows: ■ A larger value can be entered for the amplification if the fluid is slow-flowing, the density is low and there are minor disturbance influences (e.g. plant vibrations). ■ A smaller value can be entered for the amplification if the fluid is fast-flowing, the density is high and there are strong disturbance influences (e.g. plant vibrations). ✎ Note! Incorrectly configured amplification can have the following effects: ■ The measuring range is limited in such a way that small flows cannot be recorded or displayed. In this instance, the value for the amplification must be increased. ■ Undesired interference signals are registered by the device which means that a flow is recorded and displayed even if the fluid is at a standstill. In this instance, the value for the amplification must be reduced. **Options** 1 to 5 (1 = smallest amplification, 5= largest amplification) **Factory setting** 3
OFFSET T-SENSOR	**Description** Use this function to enter the zero point correction (offset) for the temperature sensor. The value entered in this function is added to the temperature value measured. **User input** –10 to 10 °C (–18 to 18°F; converted to the UNIT TEMPERATURE (→ 🖹 102)) **Factory setting** 0.00 °C
CABLE LENGTH	**Description** Use this function to enter the cable length for the remote version. ✎ Note! ■ A cable length of 0 m is prespecified for a compact version. ■ If the cable supplied is shortened for connecting the measuring device, the new cable length must be entered here in this function. The cable length can be rounded off since the value is entered in increments of one meter. Example: new cable length = 7.81 m ¨ entry = 8 m ■ If a cable is used that does not correspond to the cable specification, the value for this function must be calculated. See the note in the "Cable specifications" section → 🖹 26. **User input** 0–30 m (0–98 ft) **Unit** The unit depends on the option selected in the UNIT LENGTH function (→ 🖹 106): ■ Option selected in UNIT LENGTH = mm ¨ unit in this function = m ■ Option selected in UNIT LENGTH = inch ¨ unit in this function = ft **Factory setting** ■ For compact version: 0 m or 0 ft ■ For remote version: 10 m or 30 ft: 10 m or 30 ft ■ For remote version: 30 m or 98 ft: 30 m or 98 ft

11.22 SUPERVISION

Function description, SUPERVISION group	
ACTUAL SYSTEM CONDITION	**Description** The current system status appears on the display. **Display** SYSTEM OK or The fault/notice message with the highest priority.
PREVIOUS SYSTEM CONDITIONS	**Description** The last 16 fault and notice messages appear on the display.
ASSIGN SYSTEM ERROR	**Description** All system errors appear on the display. If you select an individual system error you can change its error category: ■ Each individual message can be selected using the + and − key. ■ If the E key is pressed twice, the ERROR CATEGORY function is called up. ■ Use the ESC key combination or select "CANCEL" (in the system error list) to exit the function. **Display** List of system errors
ERROR CATEGORY	**Description** Use this function to define whether a system error triggers a notice message or a fault message. If you select FAULT MESSAGES, all outputs respond to an error in accordance with their defined failsafe mode. ■ Press the E key twice to call up the ASSIGN SYSTEM ERROR function (→ 173). ■ Use the ESC key combination to exit the function. **Options** NOTICE MESSAGES (display only) FAULT MESSAGE (outputs and display)
ASSIGN PROCESS ERROR	**Description** All process errors appear on the display. If you select an individual process error you can change its error category: ■ Each individual message can be selected using the + and − key. ■ Press the E key twice to call up the ERROR CATEGORY function (→ 173). ■ Use the ESC key combination or select "CANCEL" (in the process error list) to exit the function. **Display** List of process errors
ERROR CATEGORY	**Description** Use this function to define whether a process error triggers a notice message or a fault message. If you select FAULT MESSAGES, all outputs respond to an error in accordance with their defined failsafe mode. ■ Press the E key twice to call up the ASSIGN SYSTEM ERROR function (→ 173). ■ Use the ESC key combination to exit the function. **Options** NOTICE MESSAGES (display only) FAULT MESSAGE (outputs and display)

Function description, SUPERVISION group	
ALARM DELAY	**Description** Use this function to enter a time span for which the criteria for an error always have to be satisfied before a fault or notice message is generated. Depending on the setting and the type of error, this suppression acts on the display, the current output and the frequency output. ✎ Note! If this function is used, fault and notice messages are delayed by the time corresponding to the setting before being forwarded to the higher-level controller (PCS, etc.). Therefore, check in advance whether a delay of this nature could affect the safety requirements of the process. If fault and notice messages may not be suppressed, a value of 0 seconds must be entered here. **User input** 0 to 100 s (in steps of one second) **Factory setting** 0 s
SYSTEM RESET	**Description** Use this function to restart (reset) the measuring device. **Options** NO The device is not restarted. RESTART SYSTEM Restart without disconnecting main power. In doing so, all the data (functions) are accepted unchanged. RESET DELIVERY Restart without disconnecting main power. In the process, all the data (functions) are reset to the factory setting apart from the sensor data. **Factory setting** NO
TROUBLESHOOTING	**Description** Use this function to acknowledge system errors for data/checksum errors. If a data/checksum error occurs (# 029, # 111 → 🖹 64), the associated error block is displayed in this function and the functions of the error block are reset to the factory setting. Only the system error in question is acknowledged if the error block is selected in this function. **Display** CANCEL The error block in which a data/checksum error occurred appears on the display.
OPERATION HOURS	**Description** The hours of operation of the device appear on the display. **Display** Depends on the number of hours of operation elapsed: Hours of operation < 10 hours → display format = 0:00:00 (hr:min:sec) Hours of operation 10 to 10 000 hours → display format = 0000:00 (hr:min) Hours of operation > 10 000 hours → display format = 000000 (hr)

11.23 SIMULATION SYSTEM

Function description, SIMULATION SYSTEM group	
SIMULATION FAILSAFE MODE	**Description** Use this function to switch all inputs, outputs and totalizers to their error-response modes, in order to check whether they respond correctly. During this time, the message #691 "SIMULATION FAILSAFE" appears on the display (→ 67). **Options** OFF ON **Factory setting** OFF
SIMULATION MEASURAND	**Description** Use this function to set all the inputs, outputs and the totalizer to their flow-response modes, in order to check whether they respond correctly. During this time, the message "#692 SIMULATION MEASURAND" appears on the display (→ 67). Note! ■ The measuring device can only be used for measuring to a certain extent while the simulation is in progress. ■ The setting is not saved if the power supply fails. **Options** OFF VOLUME FLOW TEMPERATURE MASS FLOW CORRECTED VOLUME FLOW HEAT FLOW FLOW VELOCITY CALCULATED SATURATED STEAM PRESSURE **Factory setting** OFF
VALUE SIMULATION MEASURAND	**Prerequisite** Function is **only** available if the SIMULATION MEASURAND function (→ 175) is active. **Description** Use this function to specify an arbitrary value (e.g. 12 dm^3/s) to check the assigned functions in the device itself and downstream signal circuits. The unit depends on the option selected in the SIMULATION MEASURAND function and is taken from the associated function (UNIT VOLUME FLOW, UNIT TEMPERATURE, UNIT MASS FLOW, UNIT PRESSURE, etc. (→ 102)). Note! The setting is not saved if the power supply fails. **User input** 5-digit floating-point number **Factory setting** 0

11.24 SENSOR VERSION

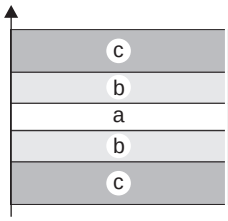
Function description, SENSOR VERSION group	
SERIAL NUMBER	**Description** The serial number of the sensor appears on the display.
SENSOR TYPE	**Description** The sensor type (e.g. Prowirl F) appears on the display.
SERIAL NUMBER DSC SENSOR	**Description** The serial number of the DSC sensor appears on the display.

11.25 AMPLIFIER VERSION

Function description, AMPLIFIER VERSION group	
DEVICE SOFTWARE	**Description** Use this function to display the current device software version.
HARDWARE REVISION NUMBER AMPLIFIER	**Description** Use this function to view the hardware revision number of the amplifier board.
SOFTWARE REVISION NUMBER AMPLIFIER	**Description** Use this function to view the software revision number of the amplifier board. The software revision number of the amplifier board is also provided on the service plate in the electronics compartment cover.
HARDWARE REVISION NUMBER I/O MODULE	**Description** Use this function to display the hardware revision number of the I/O module.

11.26 EXTENDED DIAGNOSTIC

Function description, EXTENDED DIAGNOSTIC group	
MIN T FLUID	**Description** Lowest fluid temperature measured since the last reset (RESET T FLUID function → 177). **Display** 5-digit floating-point number, incl. unit and sign e.g. 95.3 °C
MAX T FLUID	**Description** Highest fluid temperature measured since the last reset (RESET T FLUID function → 177). **Display** 5-digit floating-point number, incl. unit and sign e.g. 218.1 °C
RESET T FLUID	**Description** Reset the values in the MIN T FLUID (→ 177) and MAX T FLUID functions (→ 177). **Options** NO YES **Factory setting** NO
WARN T FLUID LO	**Description** Use this function to enter the lower limit value for monitoring the fluid temperature. This limit value is used to generate a fault message which is intended to indicate that the fluid temperature is changing in the direction of the specification limits of the device in order to prevent device failure or to prevent the process from overcooling. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). **User input** 5-digit floating-point number, including sign **Factory setting** –202 °C
WARN T FLUID HI	**Description** Use this function to enter the upper limit value for monitoring the fluid temperature. This limit value is used to generate a fault message which is intended to indicate that the fluid temperature is changing in the direction of the specification limits of the device in order to prevent device failure or to prevent the process from overcooling. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). **User input** 5-digit floating-point number, including sign **Factory setting** 402 °C °C
TEMPRTRE ELECTR	**Description** The temperature currently measured at the electronics board appears on the display. **Display** 4-digit floating-point number, incl. unit and sign e.g. –23.5 °C; 160.0 °F; 295.4 K
MIN T ELECTRONCS	**Description** Lowest temperature measured at the electronics board since the last reset (RESET T ELECTR. function → 178). **Display** 5-digit floating-point number, incl. unit and sign e.g. 20.2 °C

Function description, EXTENDED DIAGNOSTIC group	
MAX T ELECTRONCS	**Description** Highest temperature measured at the electronics board since the last reset (RESET T ELECTR. function → 178). **Display** 5-digit floating-point number, incl. unit and sign e.g. 65.3 °C
RESET T ELECTR.	**Description** Reset the values in the MIN T ELECTRONCS (→ 177) and MAX T ELECTRONCS functions (→ 178). **Options** NO YES **Factory setting** NO
WARN T ELECTR. LO	**Description** Use this function to enter the lower limit value for monitoring the temperature on the electronics board. This limit value is used to generate a fault message which is intended to indicate that the fluid temperature is changing in the direction of the specification limits of the device in order to prevent device failure or to prevent the process from overcooling. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). **User input** 5-digit floating-point number, including sign **Factory setting** –52 °C
WARN T ELECTR. HI	**Description** Use this function to enter the upper limit value for monitoring the temperature on the electronics board. This limit value is used to generate a fault message which is intended to indicate that the fluid temperature is changing in the direction of the specification limits of the device in order to prevent device failure or to prevent the process from overcooling. The appropriate unit is taken from the UNIT TEMPERATURE function (→ 102). **User input** 5-digit floating-point number, including sign **Factory setting** 86 °C
SENSOR DIAGN.	**Description** Use this function to monitor the capacitive signal of the DSC sensor. The monitoring function checks what range the capacitive signal of the DSC sensor is in.  A0001986 a = Signal correct b = Warning before measurement fails: error message #395 DSC SENS LIMIT (→ 65) c = Measurement failure: error message #394 DSC SENS DEFCT (→ 65) **Options** NO YES **Factory setting** NO

Function description, EXTENDED DIAGNOSTIC group	
REYNOLDS-NO.	**Prerequisite** ■ The function is **only** available if the following was selected in the SELECT FLUID function (→ 143): – SATURATED STEAM – SUPERHEATED STEAM – NATURAL GAS AGA NX-19 – ARGON – METHANE – WATER – COMPRESSED AIR – CARBON DIOXIDE – NITROGEN – OXYGEN ■ The function is **not** available if: – REAL GAS was selected in the SELECT FLUID function (→ 143) or – Any constituent was selected in the GAS MIXTURE function (→ 159) if OTHER was selected for the gas type **Description** The Reynolds number appears on the display. The Reynolds number is determined using the fluid selected and the measured temperature. **Display** 8-digit fixed-point number (e.g. 25800)
REYNOLDS WARNING	**Prerequisite** ■ The function is **only** available if one of the following was selected in SELECT FLUID (→ 143): – SATURATED STEAM – SUPERHEATED STEAM – NATURAL GAS AGA NX-19 – NATURAL GAS AGA8-DC92 – NATURAL GAS ISO 12213-2 – WATER – COMPRESSED AIR – CARBON DIOXIDE – NITROGEN – OXYGEN ■ The function is **not** available if: – REAL GAS was selected in SELECT FLUID (→ 143) or – Any constituent was selected in GAS MIXTURE (→ 159) if OTHER was selected for the gas type **Description** Use this function to activate monitoring of the Reynolds number. If monitoring is activated and a Reynolds number < 20 000 is found, notice message #494 RE < 20 000 (→ 68) appears on the display. ■ If the Reynolds number is < 20 000, the accuracy of the measuring device is reduced. ■ No fault message is output at zero flow. ■ The notice message is not displayed if REYNOLDS NO. was selected in the ASSIGN LOW FLOW CUT OFF function (→ 141). **Options** OFF (function switched off) ON **Factory setting** OFF

12 Factory settings

12.1 SI units (not for USA and Canada)

12.1.1 Units of temperature, density, length, spec. enthalpy

	Unit		Unit
Temperature	°C	Length	mm
Density	kg/m³	Specific enthalpy	kWh/kg

12.1.2 Language

Country	Language	Country	Language
Australia	English	Luxembourg	Francais
Austria	Deutsch	Malaysia	English
Belgium	English	The Netherlands	Nederlands
Czechia	Cesky	Norway	Norsk
Denmark	English	Poland	Polski
England	English	Portugal	Portugues
Finland	Suomi	Singapore	English
France	Francais	South Africa	English
Germany	Deutsch	Spain	Espanol
Hong Kong	English	Sweden	Svenska
Hungary	English	Switzerland	Deutsch
India	English	Thailand	English
Italy	Italiano	Other countries	English

12.1.3 Unit totalizer 1 + 2

Flow	Unit	Flow	Unit
Volume flow	m³	Corrected volume flow	Nm³/m
Calculated mass flow	kg	Heat flow	kWh

12.1.4 Switch-on point and switch-off point

The factory settings in the table are given in the dm³/s unit. If another unit is selected in the UNIT VOLUME FLOW function (→ 102), the corresponding value is converted and displayed in the selected unit.

Nominal diameter DN		Gas		Liquid	
DIN[mm]	ANSI[inch]	On-value [dm³/s]	Off-value [dm³/s]	On-value [dm³/s]	Off-value [dm³/s]
15	½"	7.7	6.3	1.5	1.2
25	1"	38	31	4.6	3.8
40	1½"	94	77	11	9.2
50	2"	160	130	19	15
80	3"	350	290	42	35
100	4"	610	500	73	60
150	6"	1400	1100	170	140
200	8"	2700	2200	320	260
250	10"	4200	3400	500	410
300	12"	6000	4900	720	590

12.2 US units (only for USA and Canada)

12.2.1 Units of temperature, density, length, spec. enthalpy

	Unit		Unit
Temperature	°F	Length	inch
Density	lb/ft³	Specific enthalpy	Btu/lb

12.2.2 Unit totalizer 1 + 2

Flow	Unit	Flow	Unit
Volume flow	USgal	Corrected volume flow	Sm³/ft
Calculated mass flow	lb	Heat flow	KBtu

12.2.3 Language

Country	Language
USA	English
Canada	English

12.2.4 Switch-on point and switch-off point

The factory settings in the table are given in the dm³/s unit. If another unit is selected in the UNIT VOLUME FLOW function (→ 102), the corresponding value is converted and displayed in the selected unit.

Nominal diameter DN		Gas		Liquid	
DIN[mm]	ANSI[inch]	On-value [US Gal/min]	Off-value [US Gal/min]	On-value [US Gal/min]	Off-value [US Gal/min]
15	½"	120	100	24	19
25	1"	610	500	73	60
40	1½"	1500	1200	180	150
50	2"	2500	2000	300	240
80	3"	5600	4600	6700	550
100	4"	9700	7900	1200	950
150	6"	22000	18000	2600	2200
200	8"	42000	35000	5100	4100
250	10"	67000	54000	8000	6500
300	12"	95000	78000	11000	9400

13 Appendix

13.1 Permitted limit values for molar fractions of individual constituent parts

Constituent part	Standard molar fraction	Extended application (reduced accuracy)
Methane	Min. 70%	Min. 50%
Nitrogen	Max. 20%	Max. 50%
Carbon dioxide	Max. 20%	Max. 30%
Ethane	Max. 10%	Max. 20%
Propane	Max. 3.5%	Max. 5%
Butane	Max. 1.5%	Max. 1.5%
Pentane	Max. 0.5%	Max. 0.5%
Hexane	Max. 0.1%	Max. 0.1%
Heptane	Max. 0.05%	Max. 0.05%
Octane and above	Max. 0.05%	Max. 0.05%
Hydrogen	Max. 10%	Max. 10%
Carbon monoxide	Max. 3%	Max. 3%
Helium	Max. 0.5%	Max. 0.5%
Water	Max. 0.015%	Max. 0.015%
Secondary constituents and trace elements		
Ethylene	Max. 0.1%	Max. 0.1%
Benzene	Max. 0.05%	Max. 0.05%
Toluene	Max. 0.02%	Max. 0.02%
Argon	Max. 0.02%	Max. 0.02%
Hydrogen sulfide	Max. 0.02%	Max. 0.02%
Oxygen	Max. 0.02%	Max. 0.02%
Non-specified constituents	Max. 0.01%	Max. 0.01%
Specific weight/ relative density	0.55 to 0.80	0.55 to 0.90
Gross calorific value	30 to 45 MJ/m3	20 to 48 MJ/m3
Pressure	Max. 120 bar abs	Max. 120 bar abs (AGA8-DC92 and ISO 12213-2: max. 650 bar abs)
Temperature	263 to 338 K	263 to 338 K (AGA8-DC92 and ISO 12213-2: 225 to 350 K)

13.2 Applicability of the standards

In accordance with ISO 15112, the following standards are used in different countries to convert the natural gas volume to the natural gas mass:

Country	SGERG-88	AGA8-DC92
Belgium	X	
China		X
France	X	
Germany *	X	
The Netherlands	X	X
Hungary	X	X
Italy		X
Russia **		X
Great Britain	X	X
USA		X
* In accordance with DVGW G486 and PTB, the SGERG–88 and AGA8-DC92 standards are used in Germany. ** In accordance with GOST 30319-2, the SGERG and AGA8-DC92 standards are used in Russia.		

The following reference temperatures are used:

Country	T1 (reference combustion temperature)	T2 (reference temperature, corrected volume flow)
Austria, Belgium, Denmark, Germany, Italy, Luxembourg, The Netherlands, Poland, Russia, Sweden, Switzerland	25 °C	0 °C (in Russia, T2 is also used with 20 °C)
China	20 °C	0 °C or 20 °C
Brazil	20 °C	20 °C
France, Japan	0 °C	0 °C
Australia, Canada, Czech Republic, Hungary, India, Ireland, Malaysia, Mexico, South Africa, Great Britain	15 °C	15 °C
Slovakia	25 °C	15 °C
USA, Venezuela	60 °F	60 °F

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People for Process Automation

Declaration of Hazardous Material and De-Contamination

Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

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

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

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

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

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

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

Process data/ *Prozessdaten*

Temperature / *Temperatur*_____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm²/s]

Medium and warnings
Warnhinweise zum Medium

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

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

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

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

Address / *Adresse*

_____

_____

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

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

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

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

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

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

_____ Signature / *Unterschrift*

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