

Operating Instructions

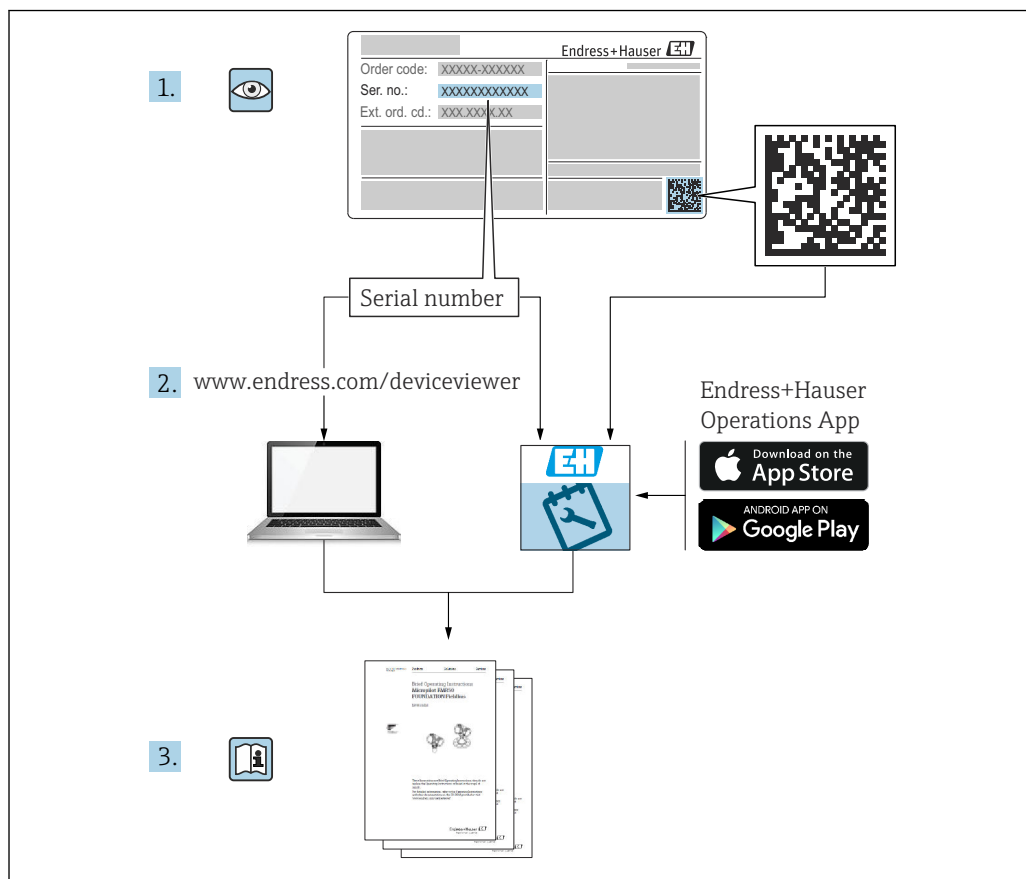
Liquiphant FTL62

Vibronic

HART

Point level switch with highly corrosion-resistant coating
for liquids





A0023555

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1 About this document

1.1 Purpose of this document

These Operating Instructions contain all the information that is required in the various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

1.2 Symbols

1.2.1 Safety symbols



This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.



This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

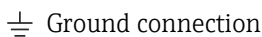


This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.



This symbol contains information on procedures and other facts which do not result in personal injury.

1.2.2 Electrical symbols



Grounded clamp, which is grounded via a grounding system.



Ground terminals, which must be grounded prior to establishing any other connections. The ground terminals are located on the inside and outside of the device.

1.2.3 Tool symbols



Flat-blade screwdriver



Allen key



Open-ended wrench

1.2.4 Communication-specific symbols



Bluetooth

Wireless data transmission between devices over a short distance.

1.2.5 Symbols for certain types of information






Permitted

Procedures, processes or actions that are permitted.





Forbidden

Procedures, processes or actions that are forbidden.

-  **Tip**
Indicates additional information
-  **Reference to documentation**
-  **Reference to another section**
- 1., 2., 3.** Series of steps

1.2.6 Symbols in graphics

- A, B, C ...** View
- 1, 2, 3 ...** Item numbers
-  **Hazardous area**
-  **Safe area (non-hazardous area)**

1.2.7 Registered trademarks

HART®

Registered trademark of the FieldComm Group, Austin, Texas, USA

Bluetooth®

The *Bluetooth®* word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Endress+Hauser is under license. Other trademarks and trade names are those of their respective owners.

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Android®

Android, Google Play and the Google Play logo are trademarks of Google Inc.



2 Basic safety instructions

2.1 Requirements for the personnel

The personnel must fulfill the following requirements to carry out the necessary tasks, e. g., commissioning and maintenance:

- ▶ Trained, qualified specialists must have a relevant qualification for the specific function and task
- ▶ Are authorized by the plant owner/operator
- ▶ Are familiar with federal/national regulations
- ▶ Must have read and understood the instructions in the manual and supplementary documentation
- ▶ Follow instructions and comply with conditions

2.2 Intended use

- Only use the device for liquids
- Improper use can pose hazards
- Ensure that the measuring device is free of defects while it is in operation
- Use the device only for media to which the wetted materials have an adequate level of resistance
- Do not exceed or drop below the relevant limit values for the device
 -  For more details, see the "Technical data" section
 -  See the Technical Documentation

2.2.1 Incorrect use

The manufacturer is not liable for damage caused by improper or non-intended use.

Residual risks

Due to heat transfer from the process, the temperature of the electronics housing and the assemblies contained therein may rise to 80 °C (176 °F) during operation.

Danger of burns from contact with surfaces!

- ▶ If necessary, ensure protection against contact to prevent burns.

For requirements concerning functional safety in accordance with IEC 61508, the associated SIL documentation must be observed.

2.3 Workplace safety

For work on and with the device:

- ▶ Wear the required personal protective equipment according to federal/national regulations.

2.4 Operational safety

Risk of injury!

- ▶ Operate the device only if it is in proper technical condition, free from errors and faults.
- ▶ The operator is responsible for ensuring the interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.

- ▶ If, despite this, modifications are required, consult with Endress+Hauser.

Repair

To ensure continued operational safety and reliability:

- ▶ Only perform repair work on the device if this is expressly permitted.
- ▶ Observe federal/national regulations pertaining to the repair of an electrical device.
- ▶ Use original spare parts and accessories from Endress+Hauser only.

Hazardous area

To eliminate danger to persons or the facility when the device is used in the hazardous area (e.g. explosion protection):

- ▶ Check the nameplate to verify whether the ordered device can be used for the intended purpose in the hazardous area.
- ▶ Observe the specifications in the separate supplementary documentation that is an integral part of this manual.

2.5 Product safety

This device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets the general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

2.6 Functional Safety SIL (optional)

The Functional Safety Manual must be strictly observed for devices that are used in functional safety applications.

2.7 IT security

We only provide a warranty if the device is installed and used as described in the Operating Instructions. The device has safety mechanisms integrated to prevent users from inadvertently changing settings.

Provide additional protection for the device and data transfer to/from the device

- ▶ IT security measures defined in the plant owner/operator's own security policy must be implemented by plant owners/operators themselves.

2.8 Device-specific IT security

The device offers specific functions to support protective measures by the operator. These functions can be configured by the user and guarantee greater in-operation safety if used correctly. An overview of the most important functions is provided in the following section:

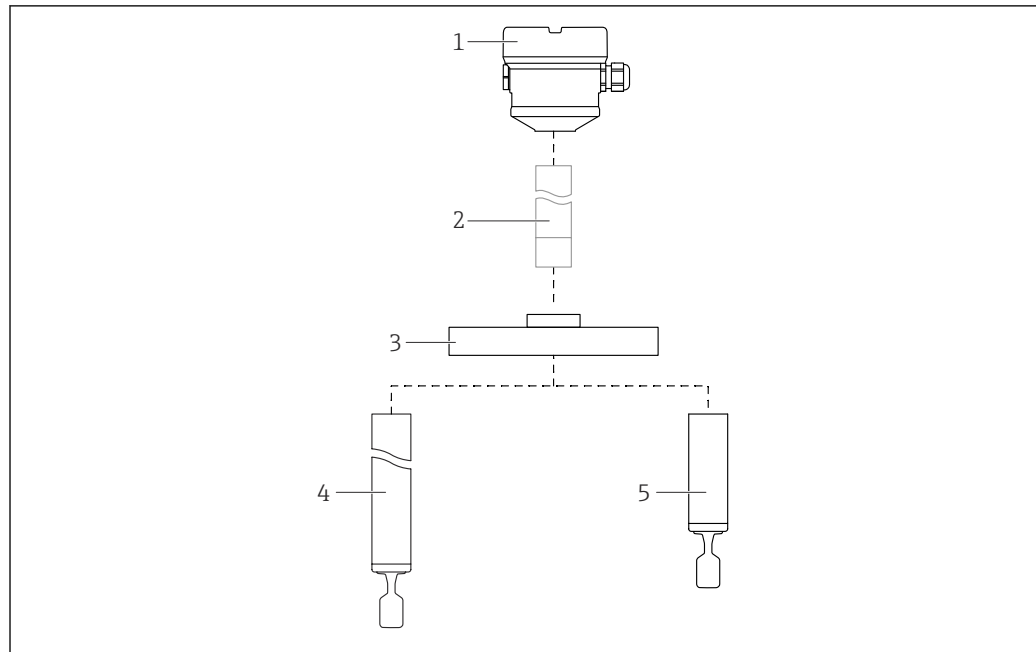
- Write protection via hardware write protection switch
- Access code (applies for operation via display, Bluetooth or FieldCare, DeviceCare, AMS, PDM)

3 Product description

Point level switch for all liquids, for minimum or maximum detection in tanks, vessels and piping, even in hazardous areas.

Different coatings (plastic or enamel) offer a high degree of corrosion protection for applications in aggressive media.


3.1 Product design



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1 Product design

- 1 Housing with electronic insert and cover
- 2 Temperature spacer, pressure-tight feedthrough (second line of defense), optional
- 3 Process connection flange
- 4 Pipe extension probe with tuning fork
- 5 Short pipe probe with tuning fork

-  Plastic-coated or enamel-coated: flange, pipe extension and tuning fork
No enamel coating: temperature spacer, pressure-tight feedthrough

4 Incoming acceptance and product identification

4.1 Incoming acceptance

Check the following during incoming acceptance:

- ☐ Are the order codes on the delivery note and the product sticker identical?
- ☐ Are the goods undamaged?
- ☐ Do the data on the nameplate match the ordering information on the delivery note?
- ☐ If required (see nameplate): are the Safety Instructions e.g. XA provided?

-  If one of these conditions is not met, please contact the manufacturer's sales office.

4.2 Product identification

The following options are available for identification of the device:

- Nameplate data
- Extended order code with breakdown of the device features on the delivery note
- Enter serial number from nameplates in *W@M Device Viewer* www.endress.com/deviceviewer. All of the information on the measuring device is displayed along with an overview of the scope of technical documentation provided.
- Enter the serial number on the nameplate into the *Endress+Hauser Operations app* or scan the 2-D matrix code on the nameplate with the *Endress+Hauser Operations app*

4.2.1 Nameplate

The information that is required by law and is relevant to the device is shown on the nameplate, e.g.:

- Manufacturer identification
- Order number, extended order code, serial number
- Technical data, degree of protection
- Firmware version, hardware version
- Approval-related information, reference to Safety Instructions (XA)
- DataMatrix code (information about the device)

4.2.2 Manufacturer address

Endress+Hauser SE+Co. KG
Hauptstraße 1
79689 Maulburg, Germany
Place of manufacture: See nameplate.

4.3 Storage and transport

4.3.1 Storage conditions

Use original packaging.

Storage temperature

–40 to +80 °C (–40 to +176 °F)
Optional –50 °C (–58 °F) or –60 °C (–76 °F)

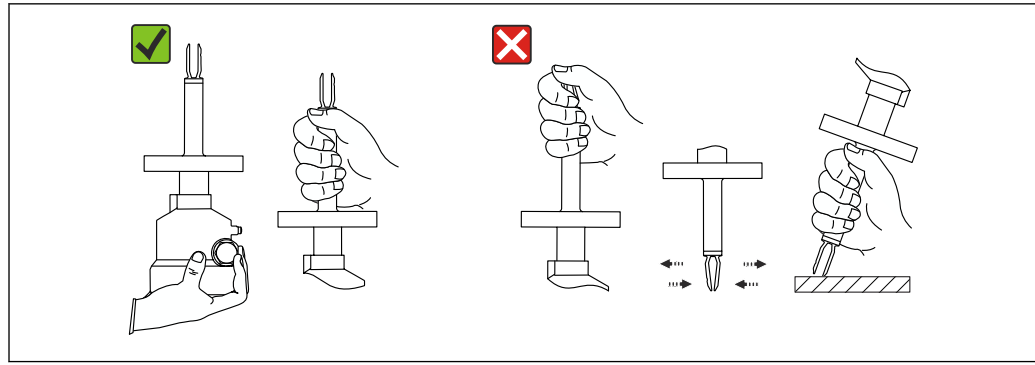
4.3.2 Transporting the device

NOTICE

Flange, pipe extension and tuning fork are either plastic-coated or enamel-coated. Scratches or impacts may cause damage to the coated surface of the device.

- ▶ Hold the device only by the housing, flange or extension pipe, protect coated surface appropriately.
- ▶ Transport the device to the measuring point in the original packaging.

Do not bend, shorten or extend the tuning fork



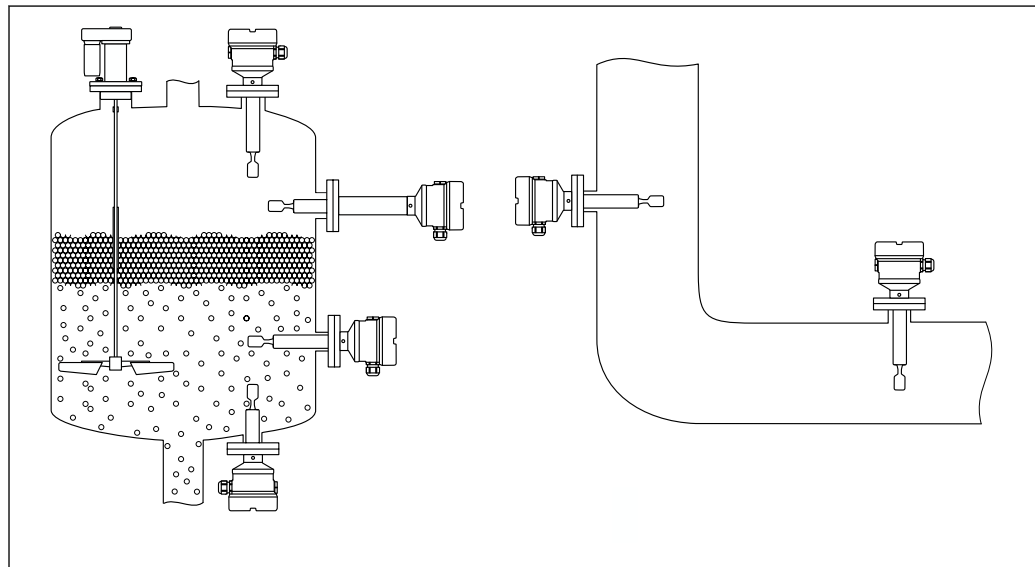
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2 Handling the device during transportation

5 Mounting

Mounting instructions

- Any orientation for device with a pipe length of up to 500 mm (19.7 in) approx.
- Vertical orientation from above for device with long pipe
- Minimum distance between the tuning fork and the tank wall or pipe wall:
10 mm (0.39 in)



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3 Installation examples for a vessel, tank or pipe

5.1 Mounting requirements

NOTICE

Scratches or impacts damage the coated surface of the device.

- Ensure the device is handled properly and professionally during all mounting work.

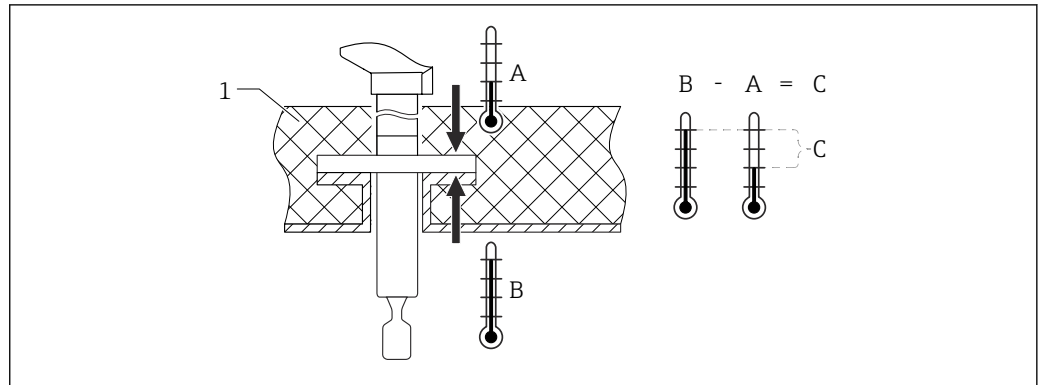


In the case of sensors with an ECTFE or PFA coating, a PTFE seal is fixed on the flange.

5.1.1 Pay attention to the temperature for devices with a PFA coating (conductive)

The difference in temperature between the outer and inner side of the flange may not exceed 60 °C (140 °F).

If necessary, use external insulation.



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4 Difference in temperature between outer and inner side of flange

1 Insulation

A Temperature of flange, outer side

B Temperature of flange, inner side, for ECTFE maximum 120 °C (248 °F)

C Temperature difference for ECTFE, PFA maximum 60 °C (140 °F)

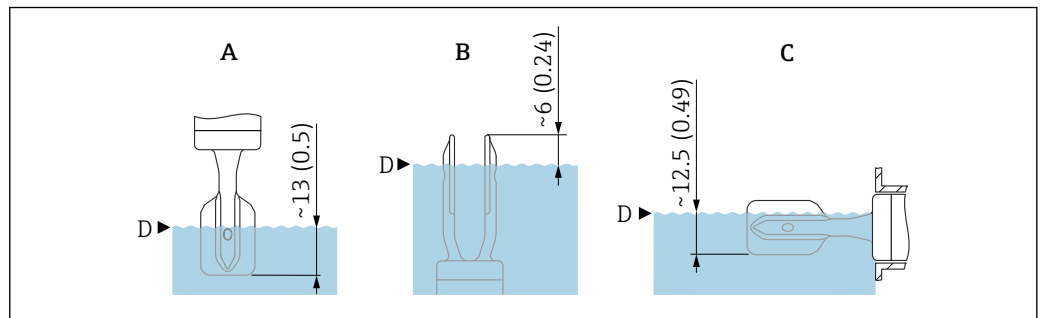
5.1.2 Take switch point into consideration

The following are typical switch points, depending on the orientation of the point level switch and coating.

Water +23 °C (+73 °F)

i Minimum distance between the tuning fork and the tank wall or pipe wall:
10 mm (0.39 in)

Plastic-coated tuning fork (ECTFE, PFA)



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5 Typical switch points, plastic-coated tuning fork (ECTFE, PFA). Unit of measurement mm (in)

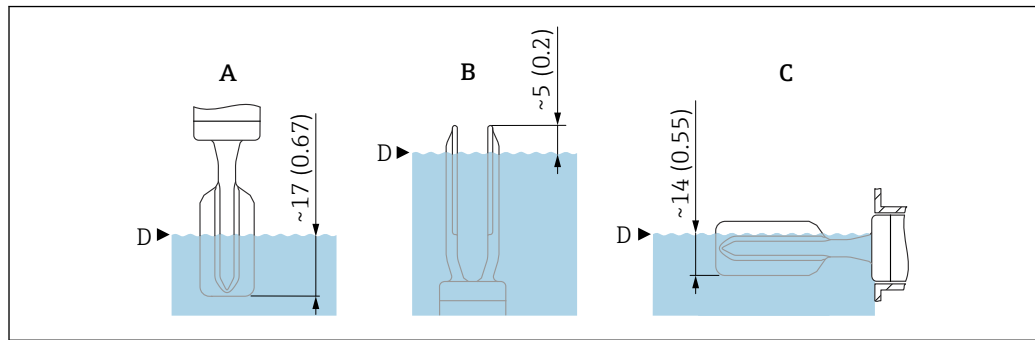
A Installation from above

B Installation from below

C Installation from the side

D Switch point

Enamel-coated tuning fork



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6 Typical switch points, enamel-coated tuning fork. Unit of measurement mm (in)

- A Installation from above
 B Installation from below
 C Installation from the side
 D Switch point

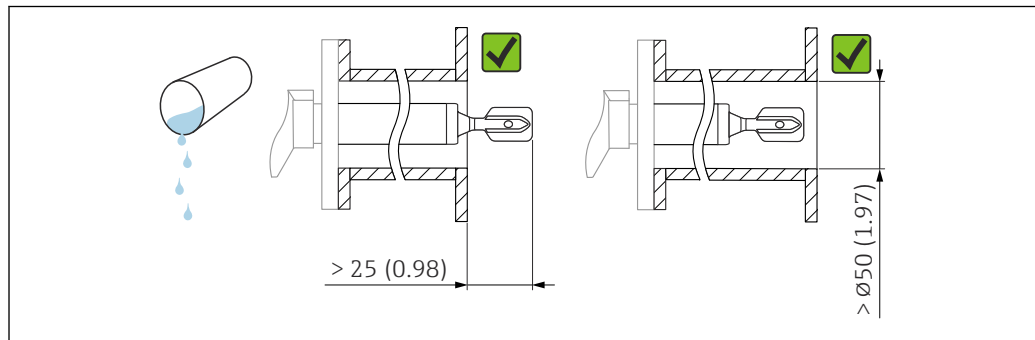
5.1.3 Take viscosity into consideration

- i** Viscosity values
- Low viscosity: < 2 000 mPa·s
 - High viscosity: > 2 000 to 10 000 mPa·s

Low viscosity

- i** Low viscosity, e.g. water: < 2 000 mPa·s

It is permitted to position the tuning fork within the installation socket.



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7 Installation example for low-viscosity liquids. Unit of measurement mm (in)

High viscosity

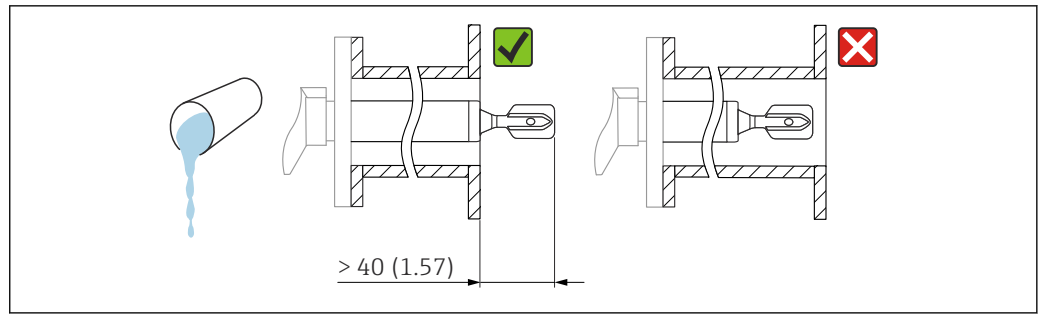
NOTICE

Highly viscous liquids may cause switching delays.

- Make sure that the liquid can run off the tuning fork easily.
- Deburr the socket surface.

- i** High viscosity, e.g. viscous oils: ≤ 10 000 mPa·s

The tuning fork must be located outside the installation socket!

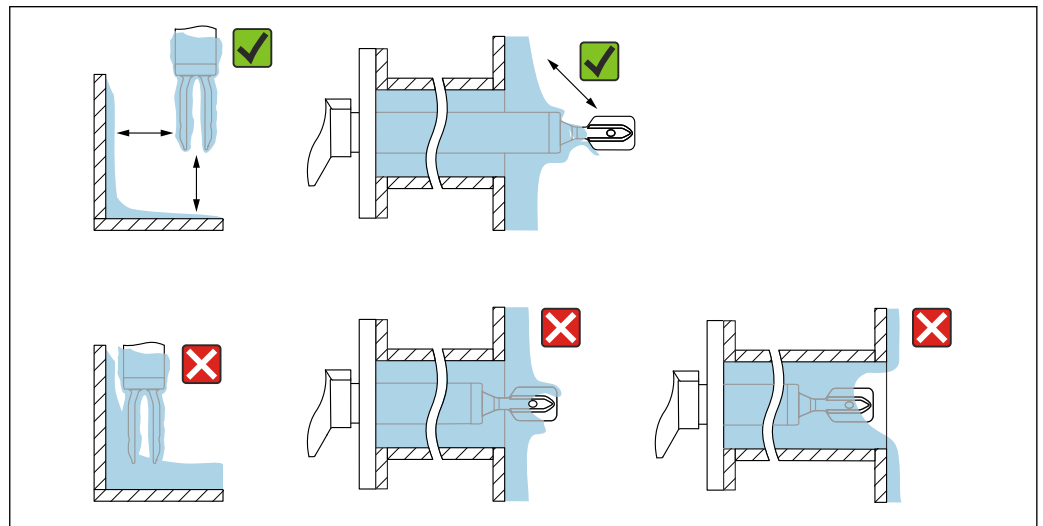


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8 Installation example for a highly viscous liquid. Unit of measurement mm (in)

5.1.4 Avoid buildup

- Use short installation sockets to ensure that the tuning fork projects freely into the vessel
- Leave sufficient distance between the buildup expected on the tank wall and the tuning fork

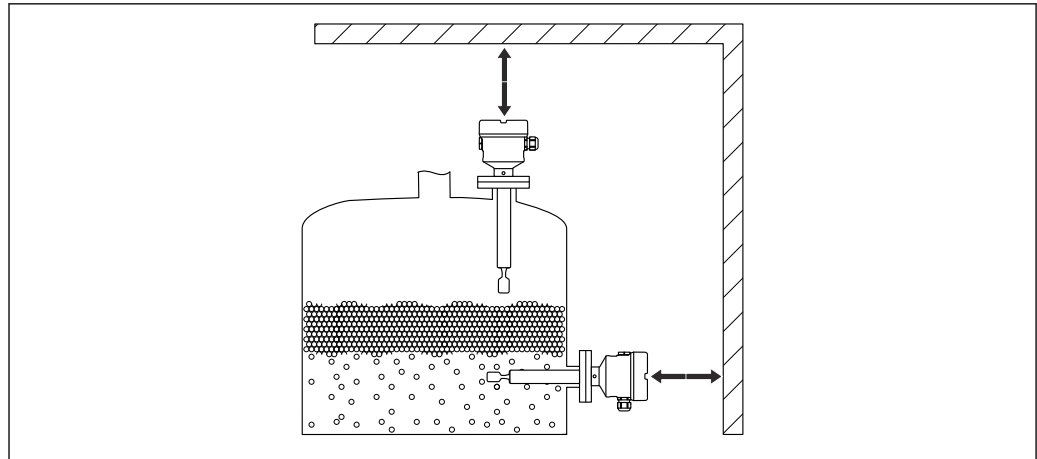


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9 Installation examples for a highly viscous process medium

5.1.5 Take clearance into consideration

Allow sufficient space outside the tank for mounting, connection and settings involving the electronic insert.



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10 Take clearance into consideration

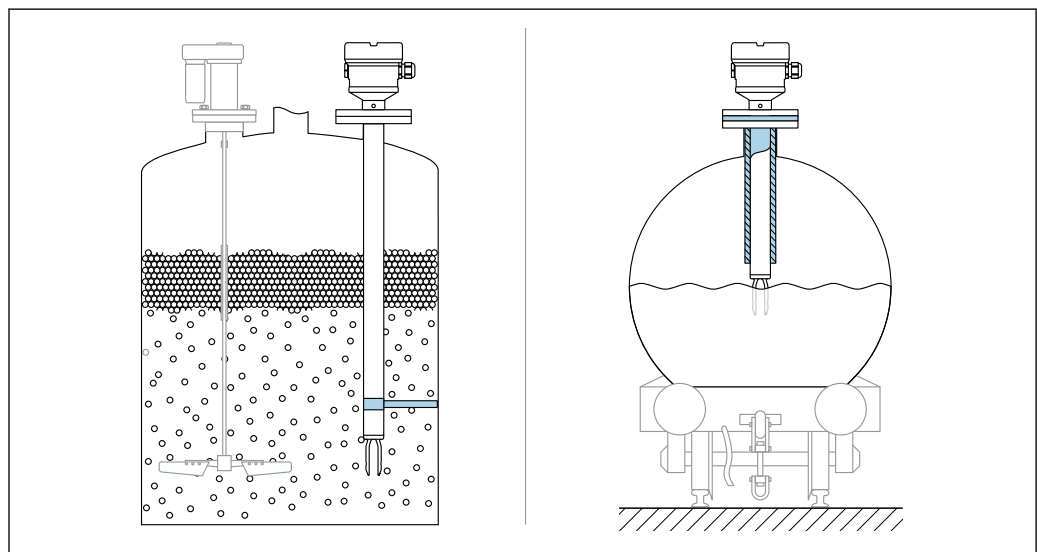
5.1.6 Support the device

NOTICE

If the device is supported incorrectly, shocks and vibrations can damage the coated surface.

- Only use a support in conjunction with ECTFE or PFA plastic coating.
- Use suitable supports only.

Support the device in the event of severe dynamic load. Maximum lateral loading capacity of the pipe extensions and sensors: 75 Nm (55 lbf ft).



A0031874

11 Examples of support in the event of dynamic load

i Marine approval: In the case of pipe extensions or sensors longer than 1 600 mm (63 in), a support is needed at least every 1 600 mm (63 in).

5.2 Mounting the device

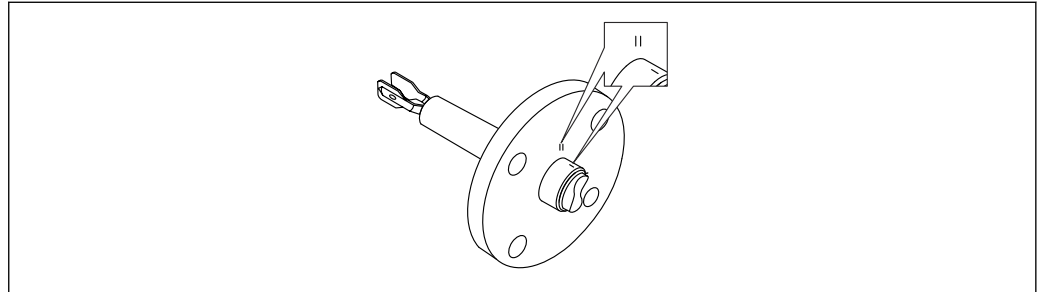
5.2.1 Required tool

- Open-ended wrench for securing the flange
- Allen key for housing locking screw

5.2.2 Installation

Aligning the tuning fork using the marking

The tuning fork can be aligned using the marking in such a way that the medium drains off easily and buildup is avoided.



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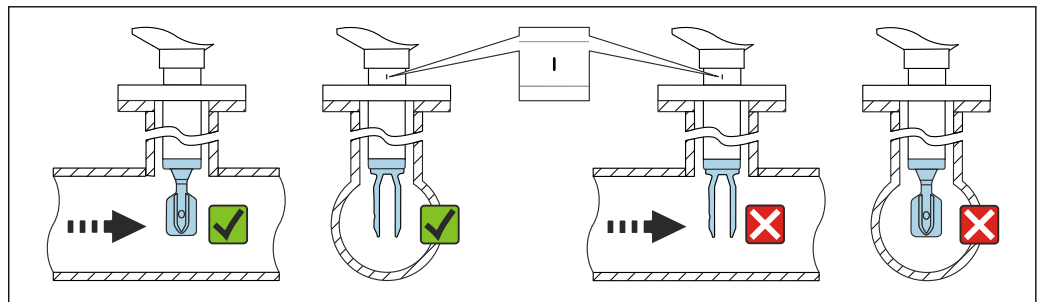
12 Position of the tuning fork when installed horizontally in the vessel using the marking

Installing the device in piping

- Flow velocity up to 5 m/s with a viscosity of 1 mPa·s and density of 1 g/cm³ (62.4 lb/ft³) (SGU).

Check for correct functioning in the event of other process medium conditions.

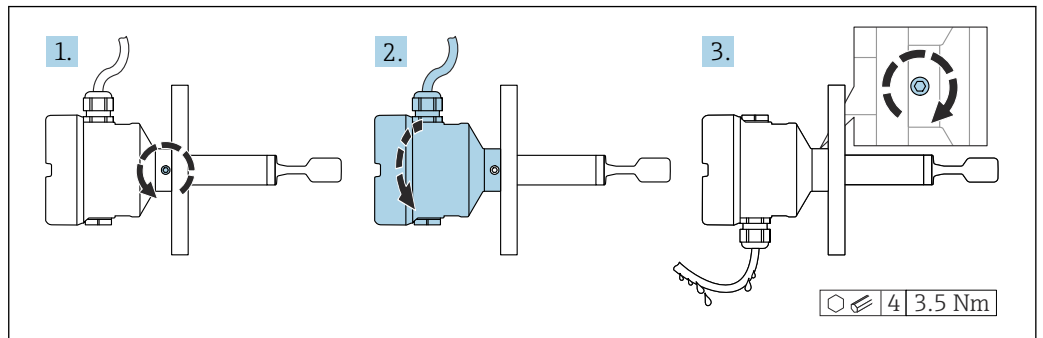
- The flow will not be significantly impeded if the tuning fork is correctly aligned and the marking is pointing in the direction of flow.
- The marking is visible when installed.



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13 Installation in pipes (take fork position and marking into consideration)

Aligning the cable entry



A0042214

14 Housing with external locking screw and drip loop

Housings with locking screw:

- The housing can be turned and the cable aligned by turning the locking screw.
- The locking screw is not tightened when the device is delivered.

1. Loosen the external locking screw (maximum 1.5 turns).
2. Turn the housing, align the cable entry.
↳ Avoid moisture in the housing, provide a loop to allow moisture to drain off.
3. Tighten the external locking screw.

Turning the housing

The housing can be rotated up to 380° by loosening the locking screw.

NOTICE

The housing cannot be unscrewed fully.

- ▶ Loosen the external locking screw by a maximum of 1.5 turns. If the screw is unscrewed too much or completely (beyond the screw anchor point), small parts (counter disk) can become loose and fall out.
- ▶ Tighten the securing screw (hexagon socket 4 mm (0.16 in)) with maximum 3.5 Nm (2.58 lbf ft) ± 0.3 Nm (± 0.22 lbf ft).

Closing the housing covers

NOTICE

Thread and housing cover damaged from dirt and fouling!

- ▶ Remove dirt (e.g. sand) on the thread of the covers and housing.
- ▶ If you continue to encounter resistance when closing the cover, check the thread again for fouling.



Housing thread

The threads of the electronics and connection compartment can be coated with an anti-friction coating.

The following applies for all housing materials:

❌ Do not lubricate the housing threads.

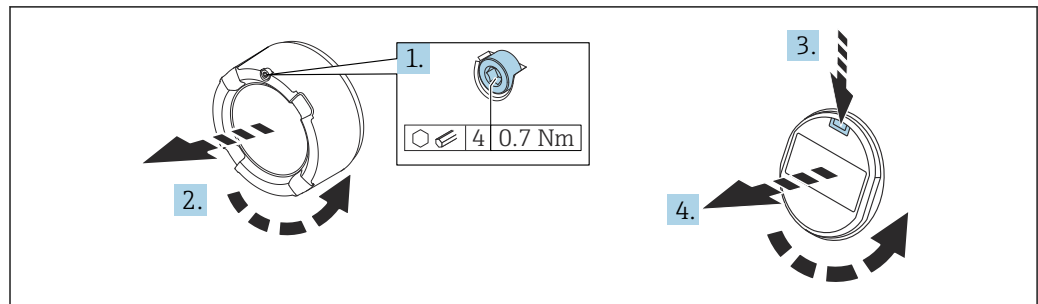
Turning the display module

⚠ WARNING

Supply voltage switched on!

Risk of electric shock and/or explosion!


- ▶ Switch off the supply voltage before opening the device.



A0038224

1. If fitted: release the screw of the cover lock for the electronics compartment cover using the Allen key.
2. Unscrew the cover from the housing and inspect the cover seal.
3. Press the release mechanism and remove the display module.

4. Turn the display module to the desired position: maximum $4 \times 90^\circ$ in each direction. Insert the display module into the desired position until it clicks into place. Screw the cover tightly back onto the housing. If fitted: tighten the screw of the cover lock using the Allen key 0.7 Nm (0.52 lbf ft) ± 0.2 Nm (± 0.15 lbf ft).

 In the case of a dual-compartment housing, the display can be mounted in the electronics compartment as well as in the connection compartment.

5.3 Post-mounting check

- ☐ Is the device undamaged (visual inspection)?
- ☐ Does the measuring device meet the measuring point specifications?

For example:

- Process temperature
 - Process pressure
 - Ambient temperature
 - Measuring range
- ☐ Are the measuring point number and labeling correct (visual inspection)?
 - ☐ Is the device adequately protected from wet conditions and direct sunlight?
 - ☐ Is the device properly secured?

6 Electrical connection

6.1 Required tool

- Screwdriver for electrical connection
- Allen key for screw of cover lock

6.2 Connecting requirements

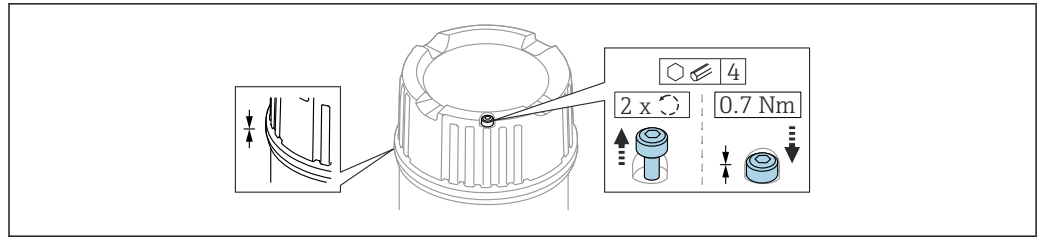
6.2.1 Cover with securing screw

The cover is locked by a securing screw in devices for use in hazardous areas with certain explosion protection.

NOTICE

If the securing screw is not positioned correctly, the cover cannot provide secure sealing.

- Open the cover: slacken the screw of the cover lock with a maximum of 2 turns so that the screw does not fall out. Fit the cover and check the cover seal.
- Close the cover: screw the cover securely onto the housing, making sure that the securing screw is positioned correctly. There should not be any gap between the cover and housing.



A0039520

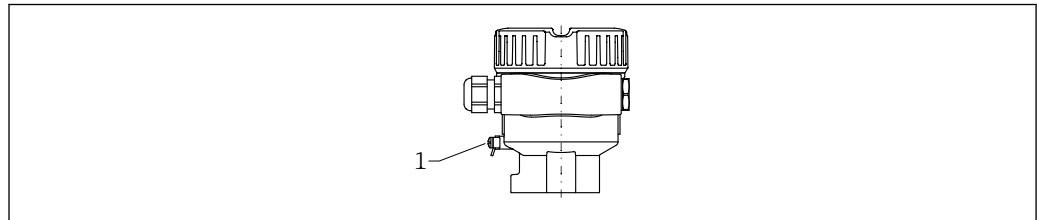
15 Cover with securing screw

6.2.2 Potential equalization

WARNING

Explosion Hazard!

- Please refer to the separate documentation on applications in hazardous areas for the safety instructions.

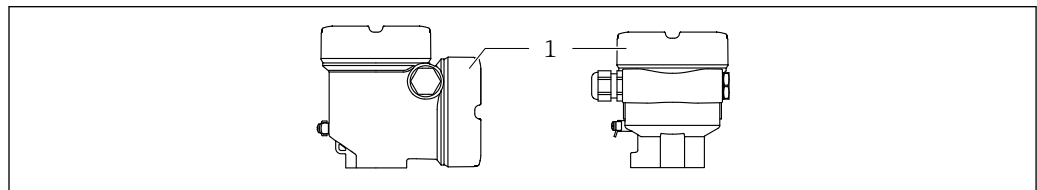


A0045830

1 Ground terminal for connecting the potential matching line

- i** If necessary, the potential matching line can be connected to the external ground terminal of the transmitter before the device is connected.
- i** For optimum electromagnetic compatibility:
 - Potential matching line as short as possible
 - Observe a cross-section of at least 2.5 mm² (14 AWG)

6.3 Connecting the device



A0046355

1 Connection compartment cover

i Housing thread

The threads of the electronics and connection compartment can be coated with an anti-friction coating.

The following applies for all housing materials:

✗ Do not lubricate the housing threads.

6.3.1 Supply voltage

- $U = 10.5$ to 35 V_{DC} (Ex d, Ex e, non-Ex)
 - $U = 10.5$ to 30 V_{DC} (Ex i)
 - Rated current: 4 to 20 mA HART
- i** ▪ The power unit must be tested to ensure it meets safety requirements (e.g. PELV, SELV, Class 2) and must comply with the relevant protocol specifications.
- Comply with the following according to IEC/EN61010-1: provide a suitable circuit breaker for the device.

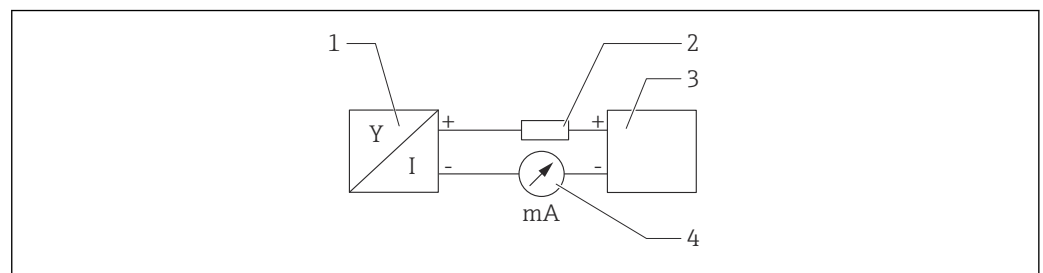
6.3.2 Terminals

- Supply voltage and internal ground terminal: 0.5 to 2.5 mm² (20 to 14 AWG)
- External ground terminal: 0.5 to 4 mm² (20 to 12 AWG)

6.3.3 Cable specification

- The cable outer diameter depends on the cable entry used
- Cable outer diameter
 - Plastic: $\varnothing 5$ to 10 mm (0.2 to 0.38 in)
 - Nickel-plated brass: $\varnothing 7$ to 10.5 mm (0.28 to 0.41 in)
 - Stainless steel: $\varnothing 7$ to 12 mm (0.28 to 0.47 in)

6.3.4 4 to 20 mA HART



16 Block diagram of HART connection

- 1 Device with HART communication
- 2 HART communication resistor
- 3 Power supply
- 4 Multimeter or ammeter

- i** The HART communication resistor of 250 Ω in the signal line is always necessary in the case of a low-impedance power supply.

Take the voltage drop into consideration:

Maximum 6 V for a 250 Ω communication resistor

6.3.5 Overvoltage protection

Devices without optional overvoltage protection

Equipment from Endress+Hauser fulfills the requirements of the product standard IEC/DIN EN 61326-1 (Table 2 Industrial Environment).

Depending on the type of port (DC supply, input/output port) different test levels according to IEC/DIN EN 61326-1 against transient overvoltages (Surge) are applied (IEC/DIN EN 61000-4-5): Test level on DC power ports and input/output ports is 1 000 V line to earth

Devices with optional overvoltage protection

- Spark-over voltage: min. 400 V_{DC}
- Tested: According to IEC/DIN EN 60079-14 sub chapter 12.3 (IEC/DIN EN 60060-1 chapter 7)
- Nominal discharge current: 10 kA

Overvoltage category

Overvoltage category II

Pollution degree

Pollution degree 2

6.3.6 Wiring**⚠ WARNING****Supply voltage might be connected!**

Risk of electric shock and/or explosion!

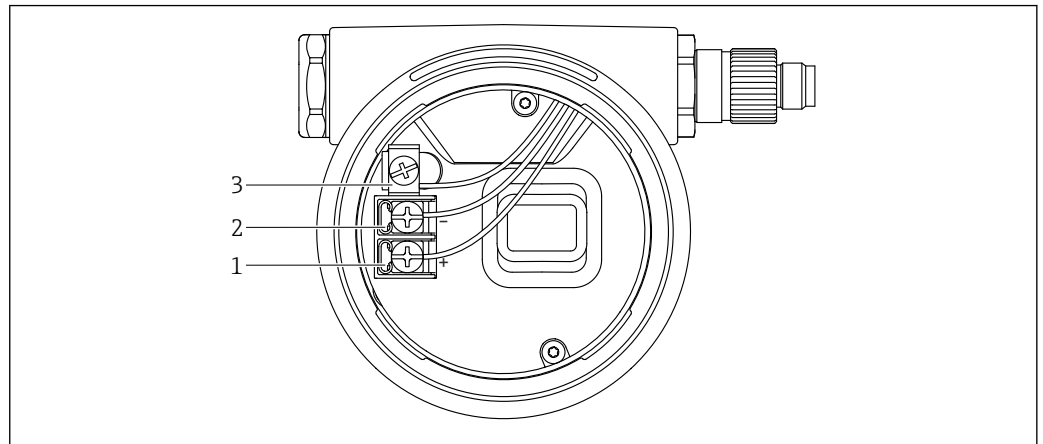
- ▶ If the device is used in hazardous areas, make sure to comply with national standards and the specifications in the Safety Instructions (XAs). The specified cable gland must be used.
- ▶ The supply voltage must match the specifications on the nameplate.
- ▶ Switch off the supply voltage before connecting the device.
- ▶ If necessary, the potential matching line can be connected to the outer ground terminal of the transmitter before the device is connected.
- ▶ A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.
- ▶ The cables must be adequately insulated, with due consideration given to the supply voltage and the overvoltage category.
- ▶ The connecting cables must offer adequate temperature stability, with due consideration given to the ambient temperature.
- ▶ Only operate the device with the covers closed.

Connect the device in the following order:

1. Release the cover lock (if provided).
2. Unscrew the cover.
3. Guide the cables into the cable glands or cable entries. Use a suitable tool with width across flats AF24/25 (8 Nm (5.9 lbf ft)) for the M20 cable gland.
4. Connect the cable.
5. Tighten the cable glands or cable entries so that they are leak-tight. Counter-tighten the housing entry.
6. Screw the cover securely back onto the connection compartment.
7. If fitted: tighten the screw of the cover lock using the Allen key 0.7 Nm (0.52 lbf ft) ±0.2 Nm (0.15 lbf ft).

6.3.7 Terminal assignment

Single compartment housing

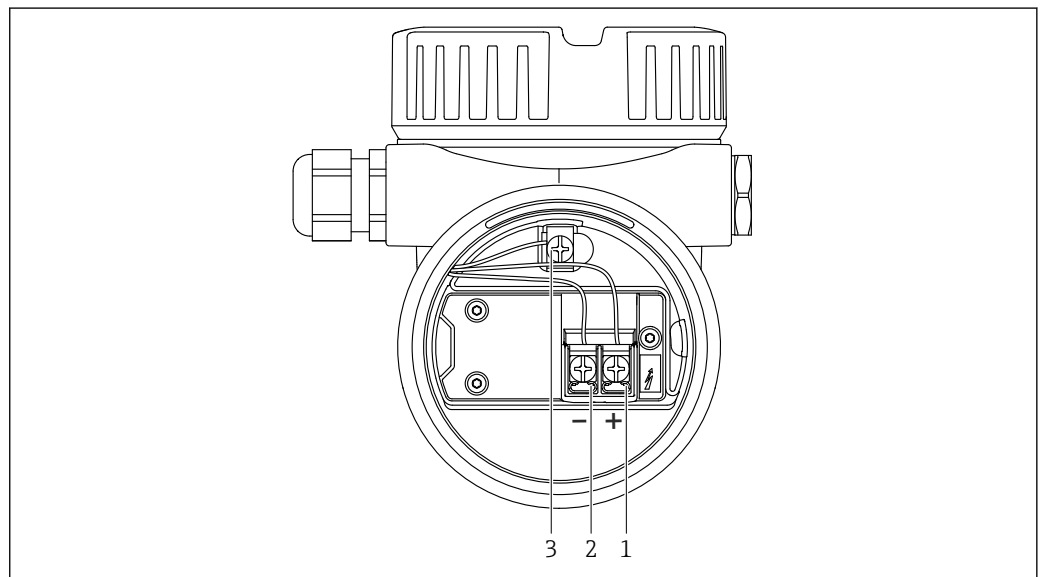


A0042594

17 Connection terminals and ground terminal in the connection compartment

- 1 Positive terminal
- 2 Negative terminal
- 3 Internal ground terminal

Dual compartment housing, L-form

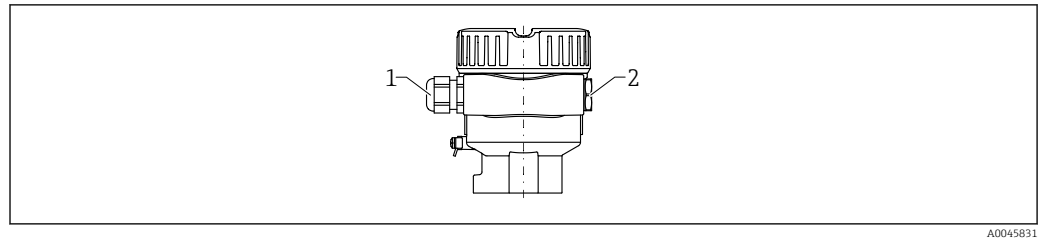


A0045842

18 Connection terminals and ground terminal in the connection compartment

- 1 Positive terminal
- 2 Negative terminal
- 3 Internal ground terminal

6.3.8 Cable entries



A0045831

- 1 Cable entry
2 Dummy plug

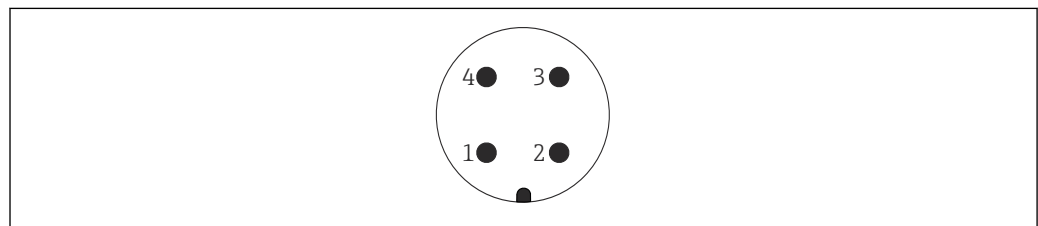
The type of cable entry depends on the device version ordered.

6.3.9 Available device plugs



In the case of devices with a plug, it is not necessary to open the housing for connection purposes.


M12 plug



A0011175

19 M12 plug, pin assignment

- 1 Signal +
2 Not assigned
3 Signal -
4 Ground

 For more details, see the "Accessories" section.

6.4 Ensuring the degree of protection

6.4.1 Degree of protection

Test as per IEC 60529 and NEMA 250

IP68 test condition: 1.83 m H₂O for 24 h

Housing

See cable entries

Cable entries

- M20 threaded joint, plastic, IP66/68 NEMA Type 4X/6P
- M20 threaded joint, nickel-plated brass, IP66/68 NEMA Type 4X/6P
- M20 threaded joint, 316L, IP66/68 NEMA Type 4X/6P
- M20 thread, IP66/68 NEMA Type 4X/6P
- Thread G ½, NPT ½, IP66/68 NEMA Type 4XXX

Degree of protection for M12 plug

- When housing is closed and connecting cable is plugged in: IP66/67 NEMA Type 4X
- When housing is open or connecting cable is not plugged in: IP20, NEMA Type 1

NOTICE**M12 plug: Loss of IP protection class due to incorrect installation!**

- ▶ The degree of protection only applies if the connecting cable used is plugged in and screwed tight.
- ▶ The degree of protection only applies if the connecting cable used is specified according to IP67 NEMA Type 4X.



If the "M12 plug" option is selected as the electrical connection, **IP66/67 NEMA Type 4X** applies for all housing types.

6.5 Post-connection check

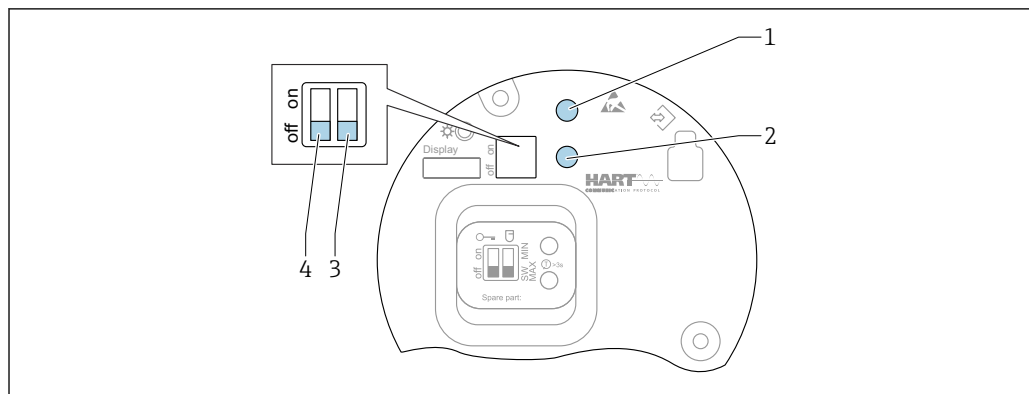
- ☐ Are the device and cables free from damage (visual check)?
- ☐ Do the cables used meet the requirements?
- ☐ Do the mounted cables have adequate strain relief?
- ☐ Are the cable glands mounted and firmly tightened?
- ☐ Does the supply voltage match the information on the nameplate?
- ☐ No reverse polarity, is terminal assignment correct?
- ☐ Are all housing covers installed and firmly tightened?
- ☐ Optional: Are covers tightened with a securing screw?

7 Operation options

7.1 Overview of operating options

- Operation via operating keys and DIP switches on the electronic insert
- Operation via optical operating keys on the device display (optional)
- Operation via Bluetooth® wireless technology (with optional device display with Bluetooth) with Smartblue app or FieldXpert, DeviceCare
- Operation via operating tool (Endress+Hauser FieldCare/DeviceCare, handheld terminal, AMS, PDM, ...)

7.2 FEL60H electronic insert



A0046129

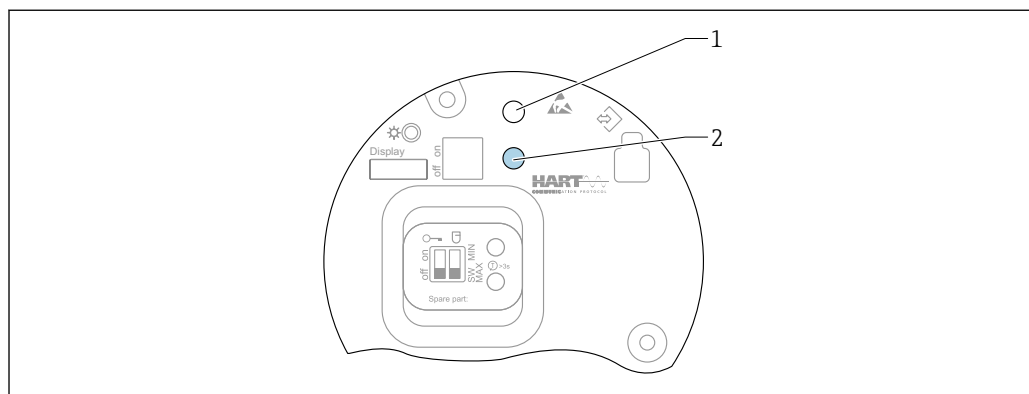
20 Operating keys and DIP switch on FEL60H electronic insert

- 1 Operating key for reset password (for Bluetooth login and Maintenance user role)
- 1+2 Operating keys for device reset (as-delivered state)
- 2 Operating key for "Proof test" wizard (> 3 s)
- 3 DIP switch for safety function, software-defined (SW, default = MAX) or permanently MIN (in the SW switch position, the MIN or MAX setting is defined by the software. MAX is the default value. In the MIN switch position, the setting is permanently MIN irrespective of the software).
- 4 DIP switch for locking and unlocking the device

- Minimum/maximum quiescent current safety can be switched at the electronic insert
- MAX = maximum safety: when the tuning fork is covered the output switches to demand mode, e.g. use for overfill protection
- MIN = minimum safety: when the tuning fork is uncovered, the output switches to demand mode, e.g. use to prevent pumps from running dry

The setting of the DIP switches on the electronic insert has priority over the settings made via other operation methods (e.g. FieldCare/DeviceCare).

7.3 Function test using operating key on electronic insert

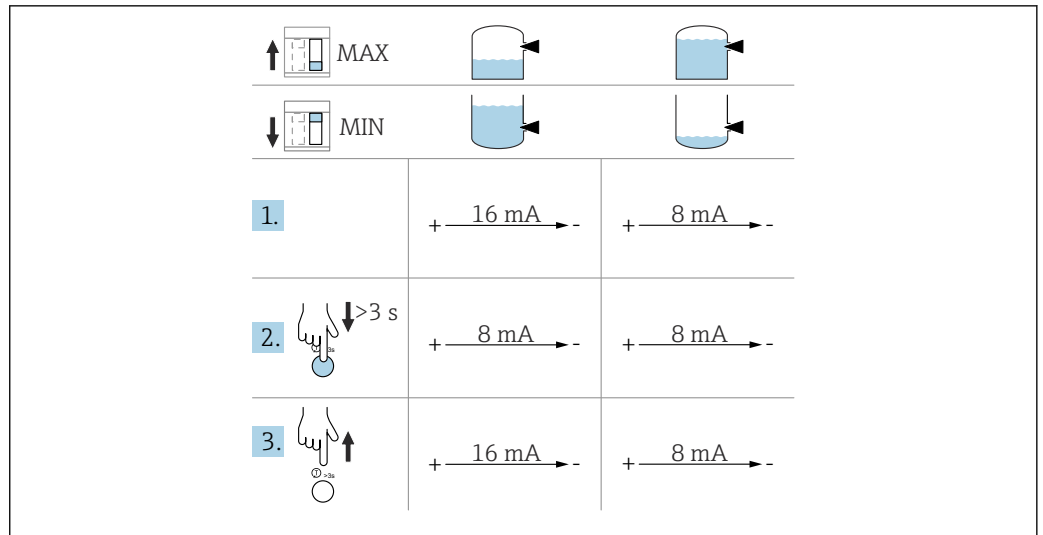


A0046571

21 Operating keys on the FEL60H electronic insert

- 1 Operating key for reset password
- 2 Operating key for proof test (> 3 s)


When performing the proof test in safety instrumented systems according to SIL or WHG: comply with the instructions in the Safety Manual.



A0046500

1. Make sure that no undesired switching operations are triggered!
 - ↳ The function test must take place when the device condition is OK: MAX safety and sensor uncovered or MIN safety and sensor covered.
2. Press the operating key for the proof test on the electronic insert for at least 3 s.
 - ↳ The device function check is performed.
The output changes from the OK state to the demand state.
3. Release the operating key.
 - ↳ If the internal test is passed, the device switches back to normal operation.

Duration of the function check: at least 10 s or if the key is pressed for longer than 10 s, the check lasts until the key is released.

 If the housing may not be opened during operation due to explosion protection requirements, e.g. Ex d /XP, the function test can also be started via the digital communication interfaces (HART, CDI, Bluetooth) with the aid of the appropriate operating tool (FieldCare, DeviceCare, SmartBlue, AMS, PDM, etc.).

7.4 Structure and function of the operating menu

The differences between the structure of the operating menus of the local display and the Endress+Hauser FieldCare or DeviceCare operating tools can be summarized as follows:

The local display is suitable for configuring simple applications.

The operating tools (FieldCare, DeviceCare, SmartBlue, AMS, PDM, ...) can be used to configure the parameters of wide-ranging applications.

Wizards help the user to commission the various applications. The user is guided through the individual configuration steps.

7.4.1 User roles and related access authorization

The two user roles **Operator** and **Maintenance** (as-delivered state) have different write access to the parameters if a device-specific access code has been defined. This access code protects the device configuration from unauthorized access.

If an incorrect access code is entered, the user obtains the access rights of the **Operator** role.

7.5 Access to the operating menu via the onsite display

7.5.1 Device display (optional)

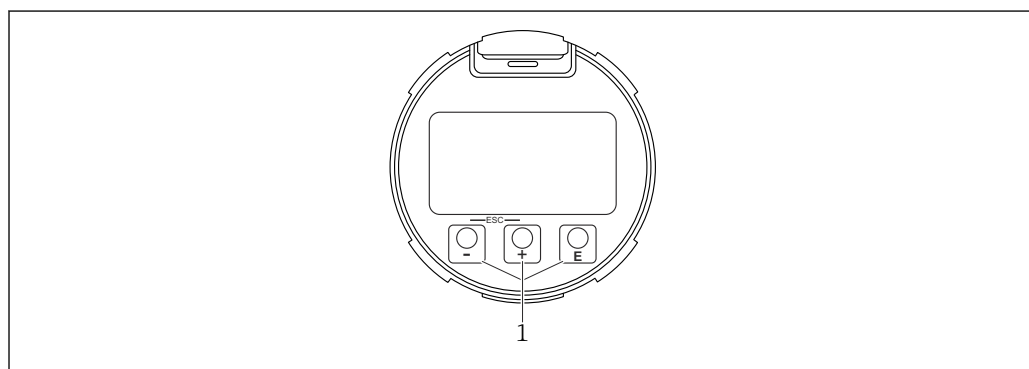
Possible to operate the optical operating keys through the cover. No need to open the device.

Functions:


- Display of measured values and fault and notice messages
- Background lighting, which switches from green to red in the event of an error
- The device display can be removed for easier operation







 Backlighting is switched on or off depending on the supply voltage and the current consumption.

 The device display is also optionally available with Bluetooth® wireless technology.



A0039284

 22 Graphic display with optical operating keys (1)

- Key 
 - Navigate downwards in the picklist
 - Edit the numerical values or characters within a function
- Key 
 - Navigate upwards in the picklist
 - Edit the numerical values or characters within a function
- Key 
 - Change from main display to main menu
 - Confirm entry
 - Jump to the next item
 - Select a menu item and activate the edit mode
 - Unlock/lock the display operation
 - Press and hold the  key to display a short description of the selected parameter (if available)
-  key and  key (ESC function)
 - Exit edit mode for a parameter without saving the changed value
 - Menu at a selection level: pressing the keys simultaneously takes the user back up a level in the menu
 - Press and hold the keys simultaneously to return to the upper level

7.5.2 Operation via Bluetooth® wireless technology (optional)

Prerequisite

- Device with device display including Bluetooth
- Smartphone or tablet with Endress+Hauser SmartBlue app or PC with DeviceCare from version 1.07.05 or FieldXpert SMT70

The connection has a range of up to 25 m (82 ft). The range can vary depending on environmental conditions such as attachments, walls or ceilings.

i The operating keys on the display are locked as soon as the device is connected via Bluetooth.

A flashing Bluetooth symbol indicates that a Bluetooth connection is available.

SmartBlue app

1. Scan the QR code or enter "SmartBlue" in the search field of the App Store or Google Play.



2. Start the SmartBlue app.
3. Select device from livelist displayed.
4. Login:
 - ↳ Enter the user name: admin
Password: serial number of the device.
5. Change the password after logging in for the first time!

Prerequisites

System requirements

The SmartBlue app is available to download for smartphones or tablets. Please see the "App Store (Apple)" or "Google Play Store" for information regarding the compatibility of the SmartBlue app with mobile terminals.

Initial password

The serial number of the device serves as the initial password when the connection is established for the first time.

i Please note the following

- If the Bluetooth display is removed from one device and installed in another device:
 - All the log-in data are only saved in the Bluetooth display and not in the device
 - The password changed by the user is also saved in the Bluetooth display

7.6 Access to the operating menu via the operating tool

Access via the operating tool is possible:

- Via HART communication, e.g. Commubox FXA195
- Via Endress+Hauser Commubox FXA291
With the Commubox FXA291, a CDI connection can be established with the device interface and a Windows PC/notebook with a USB port

7.7 HistoROM data management

When replacing the electronic insert, the stored data is transferred by reconnecting the HistoROM.

The device serial number is saved in the HistoROM. The electronics serial number is saved in the electronics.

8 System integration

8.1 Overview of device description files


- Manufacturer ID: 17 (0x11)
- Device type code: 0x11C4
- Device revision: 1
- HART specification: 7
- DD revision: 1
- Device description files (DTM, DD) information and files at:
 - www.endress.com
 - www.fieldcommgroup.org
- HART load: min. 250 Ω

8.2 Measured variables via HART protocol


The following measured values are assigned to the device variables at the factory:

Device variable	Measured value
Primary variable (PV) parameter (Primary variable) ¹⁾	Level limit detection ²⁾
Secondary variable (SV) parameter (Secondary variable)	Sensor frequency ³⁾
Tertiary variable (TV) parameter (Third variable)	Fork state ⁴⁾
Quaternary variable (QV) parameter (Quaternary variable)	Sensor temperature

- 1) **Primary variable (PV)** parameter is always applied to the current output.
- 2) Level limit detection is the initial state depending on the fork state (uncovered/covered) and the safety function (MIN/MAX)
- 3) Sensor frequency is the oscillation frequency of the fork
- 4) Fork state is the fork state (Fork covered/Fork uncovered)

 The assignment of the measured values to the device variables can be changed in the following submenu:

Navigation: Application → HART output → HART output

 In a HART Multidrop loop, only one device may use the analog current value for signal transmission. For all other devices in the **Loop current mode** parameter, select the **Disable** option.

Navigation: Application → HART output → Configuration → Loop current mode → **Disable** option

8.2.1 Device variables and measured values

The following codes are assigned to the device variables at the factory:

Device variable	Device variable code
Level limit detection	0
Sensor frequency	1
Fork state	2
Sensor temperature	3

Device variable	Device variable code
Terminal current	5
Terminal voltage	6

i The device variables can be queried by a HART® master using HART® command 9 or 33.

8.2.2 System units

The oscillation frequency is specified in Hz. The temperature can be displayed in °C, °F or K.

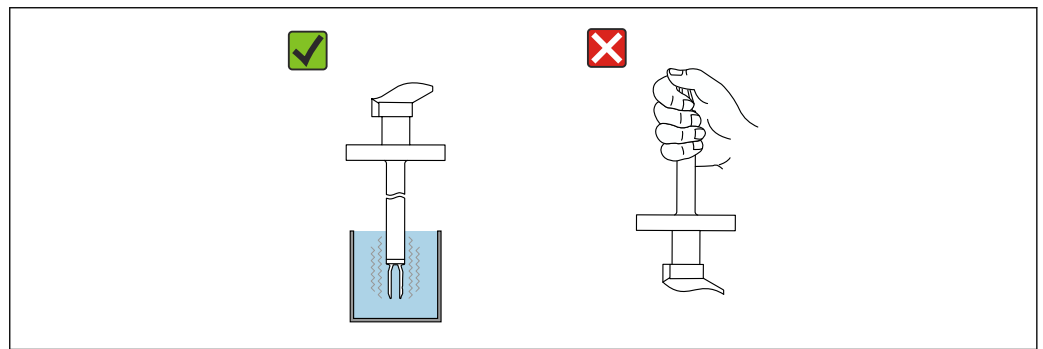
9 Commissioning

NOTICE


Do not check correct functioning of the tuning fork by hand.

The coating of the tuning fork may become damaged and impair correct functioning.

- Immerse the tuning fork in a container with liquid, e.g. in water.



A0051290

 23 Functional test of the tuning fork

9.1 Preparations

⚠ WARNING

The settings of the current output are relevant for safety!

Incorrect settings may cause the product to overflow or a pump to run dry.

- The setting for the current output depends on the setting in the **Assign PV** parameter.
- After changing the setting of the current output: check the settings for the range (Lower range value output (LRV) and Upper range value output (URV)) and reconfigure them if necessary!

9.1.1 As-delivered state

If no customized settings were ordered:

- **Assign PV** parameter Level limit detection (8/16 mA mode)
- MAX safety mode
- Alarm condition set to min. 3.6 mA
- DIP switch for locking in OFF position
- Bluetooth switched on
- Density range > 0.7 g/cm³ (43.7 lb/ft³)
- Switching times 0.5 s when the fork is covered and 1.0 s when it is uncovered
- HART burst mode switched off

9.2 Function check

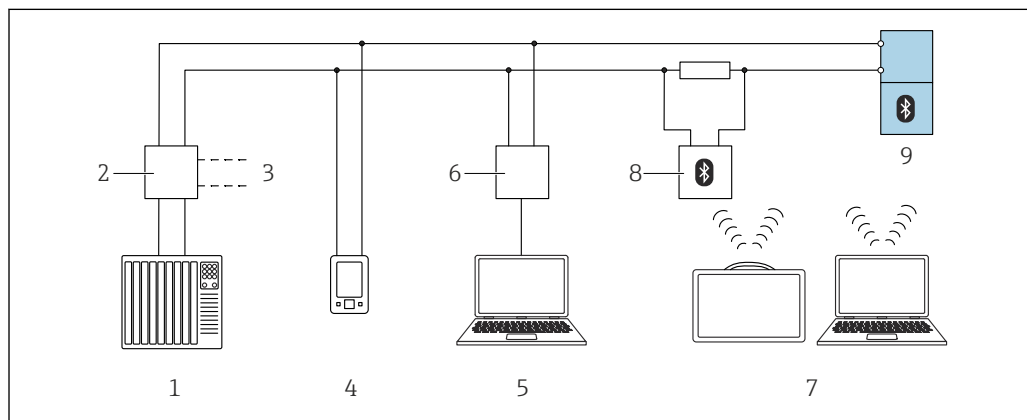
Before commissioning the measuring point, check whether the post-installation and post-connection checks have been performed.



- → Post-installation check
- → Post-connection check

9.3 Connecting via FieldCare and DeviceCare

9.3.1 Via HART protocol

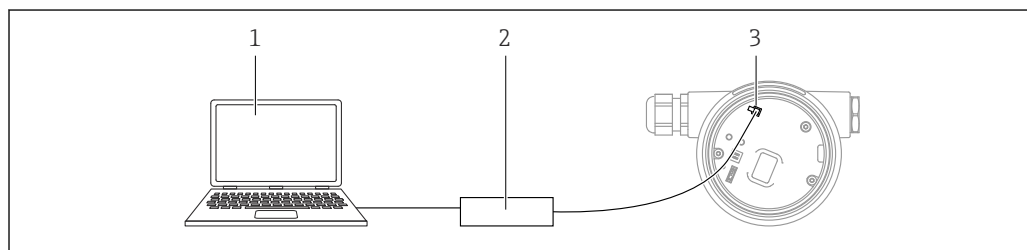


A0044334

24 Options for remote operation via HART protocol

- 1 PLC (programmable logic controller)
- 2 Transmitter power supply unit, e.g., RN42
- 3 Connection for Commubox FXA195 and AMS Trex™ device communicator
- 4 AMS Trex™ device communicator
- 5 Computer with operating tool (e.g., DeviceCare/FieldCare, AMS Device View, SIMATIC PDM)
- 6 Commubox FXA195 (USB)
- 7 Field Xpert SMT70
- 8 Bluetooth modem with connecting cable (e.g., VIATOR)
- 9 Transmitter

9.3.2 FieldCare/DeviceCare via service interface (CDI)



A0039148

- 1 Computer with FieldCare/DeviceCare operating tool
- 2 Commubox FXA291
- 3 Service interface (CDI) of the device (= Endress+Hauser Common Data Interface)



At least 22 mA is required to update (flash) the device firmware.

9.4 Configuring the device address via software


See **HART address** parameter.






Navigation: Application → HART output → Configuration → HART address

9.5 Setting the operating language

9.5.1 Local display

Setting the operating language

 To set the operating language, the display first needs to be unlocked:

1. Press the  key for at least 2 s.
↳ A dialog box appears.
2. Unlock the display operation.
3. Select the **Language** parameter in the main menu.
4. Press the  key.
5. Select the desired language with the  or  key.
6. Press the  key.

9.5.2 FieldCare

1. In the "Extras" menu, click "Options".
2. Set the preferred language for FieldCare in the "Language" section.

Setting the language for the local display via FieldCare

Navigation: System → Display → Language

- Set the desired language in the **Language** parameter.

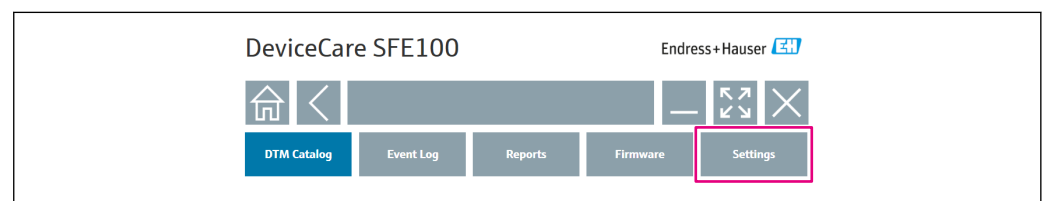
9.5.3 DeviceCare

Click the menu icon:



A0046404

Click "Settings" and select the desired language:



A0046406

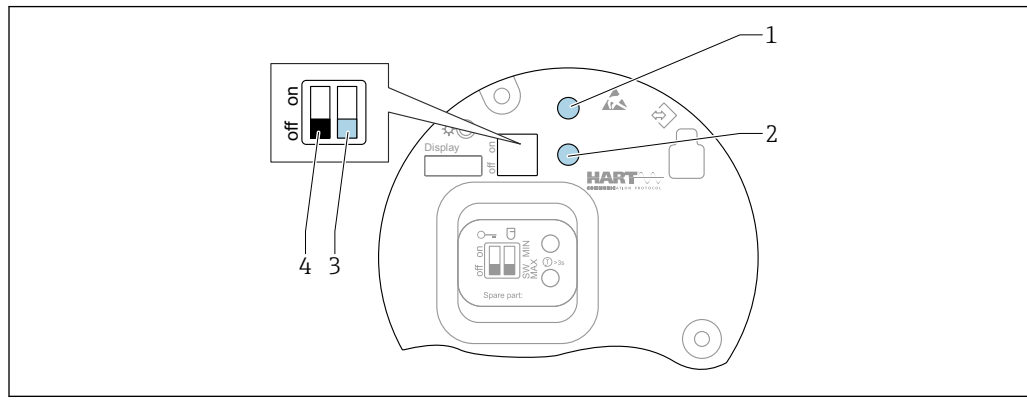
Setting the language for the local display via DeviceCare

Navigation: System → Display → Language

- Set the desired language in the **Language** parameter.

9.6 Configuring the device

9.6.1 Commissioning with DIP switch and operating keys on the electronic insert



25 Operating keys and DIP switch on FEL60H electronic insert

- 1 Operating key for resetting password (for Bluetooth login and Maintenance user role)
- 1+2 Operating keys for device reset (as-delivered state)
- 2 Operating key for Proof test (> 3 s)
- 3 DIP switch for safety function, software-defined (SW, default=MAX) or set permanently to MIN
- 4 DIP switch for locking and unlocking the device

Setting the MIN or MAX safety mode via the DIP switch

- When the switch is set to "SW", the MIN or MAX setting is defined by the software, with MAX being the default value.
- In the "MIN" switch position, the setting is permanently MIN irrespective of the software.

9.6.2 Resetting the password or device via operating keys

Resetting the password

1. Briefly press operating key I 3 times within 4 seconds.
 - ↳ The (green) LED flashes twice repeatedly at short intervals.
2. Press operating key I again to confirm and release the key.
 - ↳ The password has been reset.
 - ↳ The LED stops flashing.

i If the time until confirmation is longer than 15 s, the device quits the "Reset Password" state and the LED stops flashing. The password is not reset. Repeat procedure if necessary.

Resetting the device (order configuration)

- ▶ Press both operating keys simultaneously for at least 12 s.
 - ↳ The device has been reset (as-delivered state).

9.6.3 Commissioning with "Commissioning" wizard

In FieldCare, DeviceCare ¹⁾, SmartBlue and on the display, the **Commissioning** wizard is available to guide the user through the initial commissioning steps.

1. Connect the device to the operating tool.

1) DeviceCare is available for download at www.software-products.endress.com. You must register in the Endress+Hauser software portal to download the product.

2. Open the device in the operating tool.
↳ The dashboard (homepage) of the device is displayed:
3. Open the wizard: **Guidance** menu → **Commissioning** wizard
4. Enter the appropriate value in each parameter or select the appropriate option. These values are written directly to the device.
5. Click "Next" to go to the next page.
6. Once all the pages have been completed, click "End": the **Commissioning** wizard is closed.

i If the **Commissioning** wizard is cancelled before all the necessary parameters have been configured, the device may be in an undefined state. In such situations, it is advisable to reset the device to the factory default settings.

9.6.4 Storing the oscillation frequencies

Two frequencies (uncovered/covered) can be stored in the device so that the current oscillation frequency can be compared later on to the condition at the time of commissioning.

The frequencies can only be stored in the respective fork state. For example, if the fork is covered it is only possible to save the frequency when the fork is covered (**Stored covered frequency** parameter).

The value is saved via the **Commissioning** wizard or via

Navigation: Application → Sensor → Stored frequency

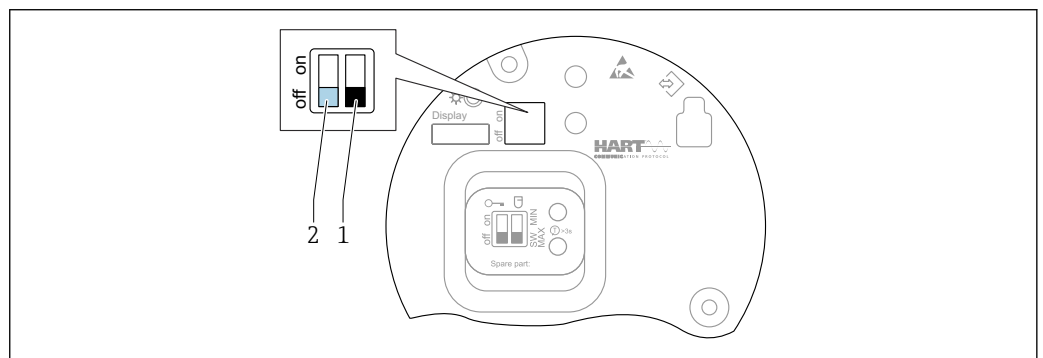
9.7 Simulation

In the **Simulation** submenu the user can simulate with the options Fork state (uncovered/covered), Sensor frequency, Current output and Diagnostic event simulation.

Navigation: Diagnostics → Simulation → Simulation

9.8 Protecting settings from unauthorized access



9.8.1 Locking or unlocking the hardware



26 Functions of DIP switches on the FEL60H electronic insert


- 1 DIP switch for safety function, software-defined (SW, default=MAX) or set permanently to MIN
- 2 DIP switch for locking and unlocking the device (hardware)

DIP switch (2) on the electronic insert is used to lock or unlock operation.

-  ■ If operation is locked via the DIP switch, you can only unlock operation again via the DIP switch.
- If operation is locked via the operating menu, you can only unlock operation again via the operating menu.
- If operation is locked via the DIP switch, the lock icon  appears on the local display.

9.8.2 Locking or unlocking the display operation


Lock or unlock display operation:

1. Press the  key for at least 2 s.
 - ↳ A dialog box appears.
2. Lock or unlock display operation.

Display operation locks automatically (except in the SIL wizard):

- After 1 minute on the main page if no key has been pressed
- After 10 minutes within the operating menu if no key has been pressed

9.8.3 Parameter configuration - locking or enabling

-  If operation is locked by means of the DIP switch, you can only unlock operation again by means of the DIP switch.

Software - via password in FieldCare, DeviceCare, SmartBlue app

As-delivered state:

The user role is set to **Maintenance** when the device is delivered to the customer.

Parameter configuration (Maintenance user role):

The device can be fully configured with the **Maintenance** user role.

Locking access:

After configuring with the **Maintenance** user role, access can be locked by assigning a password. The lock changes the **Maintenance** user role to the **Operator** user role.

Parameter configuration (Operator user role):

Parameter configuration of the device is locked in the **Operator** user role.

Unlocking access:

Access to parameter configuration can be unlocked by entering the password. The user role changes back to **Maintenance**.

Navigation for assigning the password and changing the user role: System → User management

Delete password:




If necessary, the password can be deleted in the **User management**.

Navigation: System → User management → Delete password → Start

10 Operation

10.1 Reading off the device locking status

Displaying active write protection in the **Locking status** parameter

- Local display :
The  symbol appears on the main page
- Operating tool (FieldCare/DeviceCare) :
Navigation: System → Device management → Locking status

10.2 Reading off measured values

All the measured values can be read off using the **Measured values** submenu.

Navigation: **Application** menu → **Measured values** submenu

10.3 Adapting the device to process conditions

The following menus are available for this purpose:

- Basic settings in the **Guidance** menu
- Advanced settings in:
 - **Diagnostics** menu
 - **Application** menu
 - **System** menu

10.3.1 Level limit detection

Operating as a point level switch in the 8/16 mA mode.

Output of point level:

- 8 mA (demand mode: MIN uncovered or MAX covered)
 - 16 mA (OK status: MIN covered or MAX uncovered)
1. Navigation: Application → Sensor → Sensor configuration
 2. Set the Mode of operation to Level limit detection.
 3. Set the Safety function to MIN (dry-running prevention) or MAX (overfill protection), according to the application.
 4. Set the **Density setting** parameter according to the application ($> 0.4 \text{ g/cm}^3$, $> 0.5 \text{ g/cm}^3$, $> 0.7 \text{ g/cm}^3$).
 5. Optionally: Set the **Switching delay uncovered to covered** parameter and the **Switching delay covered to uncovered** parameter.

10.3.2 Sensor frequency

Continuous operation in the 4 to 20 mA mode. Loop current proportional to oscillation frequency of fork.

1. Navigation: Application → Sensor → Sensor configuration
2. Set the **Mode of operation** parameter to the **Sensor frequency** option.
3. Set the **Density setting** parameter according to the application ($> 0.4 \text{ g/cm}^3$, $> 0.5 \text{ g/cm}^3$, $> 0.7 \text{ g/cm}^3$).
 - ↳ This is used to ensure that the **Fork state** parameter (covered/uncovered) continues to be displayed correctly.
4. Navigation: Guidance → Commissioning

5. Set the **Lower range value output** parameter to the frequency that should correspond to a 4 mA output current.
6. Set the **Upper range value output** parameter to the frequency that should correspond to a 20 mA output current.


10.4 Heartbeat Technology (optional)


10.4.1 Heartbeat Verification

The "Heartbeat Verification" module contains the **Heartbeat Verification** wizard, which verifies the current instrument health and creates the Heartbeat Technology verification report:

- The wizard can be used via the operating tools (SmartBlue app, DTM, display ²⁾).
- The wizard guides the user through the entire process for creating the verification report.
- The operating hours counter, minimum/maximum temperature indicator and minimum/maximum frequency indicator are displayed.
- If the oscillation frequency of the fork increases, a corrosion warning appears.
- The as-delivered state of the oscillation frequency in air is indicated on the verification report. A high oscillation frequency is an indicator of corrosion. A lower oscillation frequency indicates buildup or a sensor covered by the medium. Deviations of the oscillation frequency from the oscillation frequency in the as-delivered state can be caused by the process temperature and process pressure.

10.4.2 Heartbeat Verification/Monitoring

 The **Heartbeat** submenu is only available when operating via FieldCare, DeviceCare or the SmartBlue app. It contains the wizards that are provided with the Heartbeat Verification and Heartbeat Monitoring application packages.

 Documentation on the Heartbeat Technology: Endress+Hauser website: www.endress.com → Downloads.

10.5 Proof testing for SIL/WHG devices (optional) ³⁾

The "Proof test" module contains the **Proof test** wizard, which must be performed at appropriate intervals in the following applications: SIL (IEC61508), WHG (German Water Resources Act (Gesetz zur Ordnung des Wasserhaushalts)):

- The wizard can be used via the operating tools (SmartBlue app, DTM).
- The wizard guides the user through the entire process for creating the verification report.
- The verification report can be saved as a PDF file.

2) The wizard can be started on the display but it only shows the **Passed** option or **Failed** option result.

3) Available only for devices with SIL or WHG approval

11 Diagnosis and troubleshooting

11.1 General troubleshooting

11.1.1 General errors

Device not responding

- Possible cause: Supply voltage does not match the specification on the nameplate
Remedial action: Apply the correct voltage
- Possible cause: The polarity of the supply voltage is wrong
Remedial action: Correct the polarity
- Possible cause: The cables do not contact the terminals properly
Remedial action: Check the electrical contact between cables and correct if necessary
- Possible cause: Load resistance too high
Remedial action: Increase the supply voltage to reach the minimum terminal voltage

No values visible on the display

- Possible cause: Graphic display is set too bright or too dark
Remedial action: Increase or decrease the contrast with the **Contrast display** parameter
Navigation path: System → Display → Contrast display
- Possible cause: The plug of the display cable is not connected correctly
Remedial action: Connect the plug correctly
- Possible cause: Display is defective
Remedial action: Replace the display

No background lighting on the graphic display

Possible cause: There is insufficient power available
Remedial action: Increase the supply voltage

"Communication error" is indicated on the display when the device is started or the display is connected

- Possible cause: Electromagnetic interference influence
Remedial action: Check grounding of the device
- Possible cause: Defective cable connection or display plug
Remedial action: Replace the display

HART communication not working

- Possible cause: Communication resistor missing or incorrectly installed
Remedial action: Install the communication resistor (250 Ω) correctly
- Possible cause: The HART modem is not properly connected
Remedial action: Connect the HART modem correctly

Communication via CDI interface not working

Possible cause: Wrong setting of the COM port on the computer
Remedial action: Check the setting of the COM port on the computer and correct it if necessary

Device measures incorrectly

Possible cause: Parametrization error
Remedial action: Check and correct the parameter configuration

No communication with device via SmartBlue

- Possible cause: No Bluetooth connection available
Remedial action: Enable the Bluetooth function on the smartphone, tablet and device
- Possible cause: The device is already connected with another smartphone/tablet
Remedial action: Disconnect the device from the other smartphone/tablet
- Ambient conditions (e.g. walls/tanks) disturbing the Bluetooth connection
Remedial action: Establish direct line-of-sight connection
- Display does not have Bluetooth

Login via SmartBlue not possible

- Possible cause: Device is being put into operation for the first time
Remedial action: Enter the user name ("admin") and the password (device serial number)
- Possible cause: There is insufficient power available.
Remedial action: Increase the supply voltage.

Device cannot be operated via SmartBlue

- Possible cause: Incorrect password entered
Remedial action: Enter the correct password
- Possible cause: Forgotten password
Remedial action: Use the operating key on the electronic insert to reset the password or contact Endress+Hauser Service (www.addresses.endress.com)
- Possible cause: Operator user role has no authorization
Remedial action: Change to the Maintenance user role

11.1.2 Error - SmartBlue operation with Bluetooth®**Device is not visible in the live list**

- Possible cause: No Bluetooth connection available
Remedial action: Enable Bluetooth in the field device via display or software tool and/or in the smartphone/tablet
- Possible cause: Bluetooth signal outside of range
Remedial action: Reduce distance between field device and smartphone/tablet
The connection has a range of up to 25 m (82 ft).
Operating radius with intervisibility 10 m (33 ft)
- Possible cause: Geopositioning is not enabled on Android devices or is not permitted for the SmartBlue app
Remedial action: Activate/allow geopositioning service on Android device for the SmartBlue app

Device appears in the live list but a connection cannot be established

- Possible cause: The device is already connected with another smartphone/tablet via Bluetooth
Only one point-to-point connection is permitted
Remedial action: Disconnect the smartphone/tablet from the device
- Possible cause: Incorrect user name and password
Remedial action: The standard user name is "admin" and the password is the device serial number indicated on the device nameplate (only if the password was not changed by the user beforehand)
If you have forgotten the password, use the operating key on the electronic insert to reset the password or
contact Endress+Hauser Service (www.addresses.endress.com)

Connection via SmartBlue not possible

Possible cause: Incorrect password entered

Remedial action: Enter the correct password, paying attention to lower/upper case

Connection via SmartBlue not possible

Possible cause: Forgotten password

Remedial action: Use the operating key on the electronic insert to reset the password or contact Endress+Hauser Service (www.addresses.endress.com)

11.1.3 Additional tests

If no clear cause of the error can be identified or the source of the problem can be both the device and the application, the following additional tests can be performed:

1. Reset the device to the factory setting.
2. Check the digital point level or sensor frequency (display, HART, ..).
3. Check that the device concerned is functioning correctly. If the digital value does not correspond to the anticipated point level or sensor frequency, replace the device.

4.
- Switch on simulation and check the current output. Replace the main electronics if the current output does not correspond to the simulated value.

11.1.4 Behavior of current output in the event of a fault

The behavior of the current output in the event of faults is defined by the **Failure behavior current output** parameter.

Parameter overview with brief description

Parameter	Description	Selection / User entry
Failure behavior current output	Defines which current the output assumes in the case of an error. Min: < 3.6 mA Max: >21.5 mA	<div><div>■</div> Min.<div>■</div> Max.</div>
Failure current	Enter current output value in alarm condition.	21.5 to 23 mA

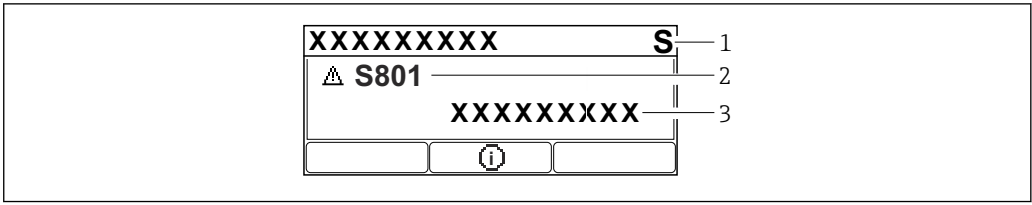
11.2 Diagnostic information on local display

11.2.1 Diagnostic message

Measured value display and diagnostic message in the event of a fault

Faults detected by the device's self-monitoring system are displayed as a diagnostic message in alternating sequence with the unit.

Faults detected by the device's self-monitoring system are displayed as a diagnostic message in alternating sequence with the measured value display.



A0043103

- 1
- Status signal
- 2
- Status symbol with diagnostic event
- 3
- Event text

Status signal

F

Failure (F)

A device error has occurred. The measured value is no longer valid.

C

Function check (C)

The device is in the service mode (e.g. during a simulation).

S

Out of specification (S)

Device operation:

- Outside of the technical specifications (e.g. during startup or a cleaning)
- Outside of the configuration performed by the user (e.g. sensor frequency outside the configured span)

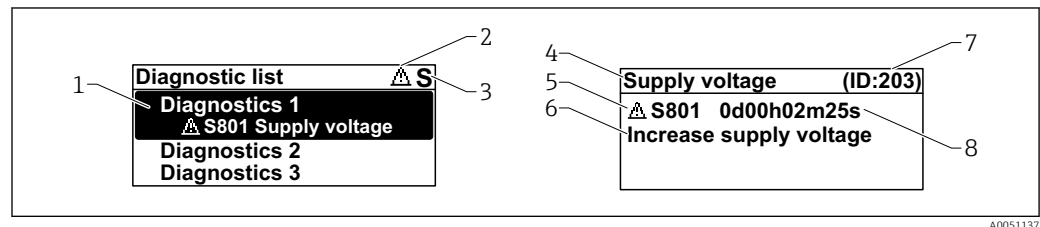
M

Maintenance required (M)

Maintenance required. The measured value is still valid.

Diagnostic event and event text

The fault can be identified by means of the diagnostic event. The event text helps you by providing information about the fault. In addition, the associated status symbol is displayed in front of the diagnostic event.



A0051137

- 1 Diagnostic message
- 2 Symbol for event level
- 3 Status signal
- 4 Short text
- 5 Symbol for event level, status signal, diagnostic number
- 6 Remedial measure
- 7 Service ID
- 8 Operating time of occurrence

Symbol for event level**⊗ "Alarm" status**

Measurement is interrupted. The signal outputs adopt the defined alarm state. A diagnostic message is generated.

⚠ "Warning" status

The device continues to measure. A diagnostic message is generated.

"Active diagnostics" parameter**⊕ operating key**

Opens the message about the remedial measures.

⊖ operating key

Acknowledge warnings.

⌂ operating key

Back to operating menu.

11.3 Diagnostic event in the operating tool

If there is a diagnostic event in the device, the status signal appears on the top left in the status section of the operating tool together with the associated icon for event behavior according to NAMUR NE 107:

- Failure (F)
- Function check (C)
- Out of specification (S)
- Maintenance required (M)

Click the status signal to see the detailed status signal.

The diagnostic events and remedial measures can be printed in the **Diagnostic list** submenu.

11.4 Adapting the diagnostic information

The event level can be configured:

Navigation: Diagnostics → Diagnostic settings → Configuration

11.5 Queued diagnostic messages

The display alternates between the queued diagnostic messages and the measured value.

Queued diagnostic messages can also be displayed in the **Active diagnostics** parameter.

Navigation: Diagnostics → Active diagnostics

11.6 Diagnostic list

All the diagnostic messages that are currently queued can be displayed in the **Diagnostic list** submenu.

Navigation: Diagnostics → Diagnostic list

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
Diagnostic of sensor				
004	Sensor defective	1. Restart device 2. Replace electronics 3. Replace device	F	Alarm
007	Sensor defective	1. Check fork 2. Replace device	F	Alarm
042	Sensor corroded	1. Check fork 2. Replace device	F	Alarm
049	Sensor corroded	1. Check fork 2. Replace device	M	Warning ¹⁾
061	Sensor electronics faulty	Replace electronics	F	Alarm
062	Sensor connection faulty	1. Check Main to sensor connection 2. Replace electronics	F	Alarm
081	Sensor initialization faulty	1. Restart device 2. Contact service	F	Alarm
Diagnostic of electronic				
201	Electronics faulty	1. Restart device 2. Replace electronics	F	Alarm
203	HART Device Malfunction	Check device specific diagnosis.	S	Warning
204	HART Electronic Defect	Check device specific diagnosis.	F	Alarm
242	Firmware incompatible	1. Check software 2. Flash or change main electronic module	F	Alarm
252	Module incompatible	1. Check if correct electronic module is plugged 2. Replace electronic module	F	Alarm

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
263	Electronic incompatible	Check electronic module type	F	Alarm
270	Main electronics defective	Replace main electronics	F	Alarm
272	Main electronics faulty	1. Restart device 2. Contact service	F	Alarm
273	Main electronics defective	Replace main electronics	F	Alarm
282	Data storage inconsistent	Restart device	F	Alarm
283	Memory content inconsistent	1. Restart device 2. Contact service	F	Alarm
287	Memory content inconsistent	1. Restart device 2. Contact service	M	Warning
388	Electronics and HistoROM defective	1. Restart device 2. Replace electronics and HistoROM 3. Contact service	F	Alarm
Diagnostic of configuration				
410	Data transfer failed	1. Retry data transfer 2. Check connection	F	Alarm
412	Processing download	Download active, please wait	C	Warning
420	HART Device Configuration Locked	Check device locking configuration.	S	Warning
421	HART Loop Current fixed	Check Multi-drop mode or current simulation.	S	Warning
431	Trim required	Carry out trim	M	Warning
437	Configuration incompatible	1. Update firmware 2. Execute factory reset	F	Alarm
438	Dataset different	1. Check dataset file 2. Check device parameterization 3. Download new device parameterization	M	Warning
441	Current output 1 saturated	1. Check process 2. Check current output settings	S	Warning
484	Failure mode simulation active	Deactivate simulation	C	Alarm
485	Process variable simulation active	Deactivate simulation	C	Warning
491	Current output simulation active	Deactivate simulation	C	Warning
495	Diagnostic event simulation active	Deactivate simulation	S	Warning
538	Configuration Sensor Unit invalid	1. Check sensor configuration 2. Check device configuration	M	Warning
Diagnostic of process				
801	Supply voltage too low	Increase supply voltage	F	Alarm
802	Supply voltage too high	Decrease supply voltage	S	Warning
805	Loop current faulty	1. Check wiring 2. Replace electronics	F	Alarm
806	Loop diagnostics	1. Check supply voltage 2. Check wiring and terminals	M	Warning ¹⁾

Diagnostic number	Short text	Remedy instructions	Status signal [from the factory]	Diagnostic behavior [from the factory]
807	No Baseline due to insuf. volt. at 20 mA	Increase supply voltage	M	Warning
825	Electronics temperature	1. Check ambient temperature 2. Check process temperature	S	Warning ¹⁾
826	Sensor temperature out of range	1. Check ambient temperature 2. Check process temperature	S	Warning ¹⁾
842	Process limit	1. Check process density 2. Check fork	F	Alarm
846	HART Non-Primary Variable Out of Limit	Check device specific diagnosis.	S	Warning
847	HART Primary Variable Out of Limit	Check device specific diagnosis.	S	Warning
848	HART Device Variable Alert	Check device specific diagnosis.	S	Warning
900	Process alert frequency too low	Check process conditions	M	Warning ¹⁾
901	Process alert frequency too high	Check process conditions	M	Warning ¹⁾

1) Diagnostic behavior can be changed.

11.7 Event logbook

11.7.1 Event history

The **Event list** submenu provides a chronological overview of the event messages that have occurred ⁴⁾.

Navigation: Diagnostics → Event logbook

A maximum of 100 event messages can be displayed in chronological order.

The event history includes entries for:

- Diagnostic events
- Information events

In addition to the operating time when the event occurred, each event is also assigned a symbol that indicates whether the event has occurred or is finished:

- Diagnostic event
 - ☹: Occurrence of the event
 - ☺: End of the event
- Information event
 - ☹: Occurrence of the event

11.7.2 Filtering the event logbook

Filters can be used to determine which category of event messages is displayed in the **Event list** submenu.

Navigation: Diagnostics → Event logbook

4) If operating via FieldCare, the event list can be displayed with the "Event List/HistoROM" function in FieldCare.

Filter categories

- All
- Failure (F)
- Function check (C)
- Out of specification (S)
- Maintenance required (M)
- Information


11.7.3 Overview of information events

Info number	Info name
I1000	----- (Device ok)
I1089	Power on
I1090	Configuration reset
I1091	Configuration changed
I11074	Device verification active
I1110	Write protection switch changed
I11104	Loop diagnostics
I11284	DIP MIN setting to HW active
I11285	DIP SW setting active
I1151	History reset
I1154	Reset terminal voltage min/max
I1155	Reset electronics temperature
I1157	Memory error event list
I1256	Display: access status changed
I1264	Safety sequence aborted
I1335	Firmware changed
I1397	Fieldbus: access status changed
I1398	CDI: access status changed
I1440	Main electronic module changed
I1444	Device verification passed
I1445	Device verification failed
I1461	Sensor verification failed
I1512	Download started
I1513	Download finished
I1514	Upload started
I1515	Upload finished
I1551	Assignment error fixed
I1552	Failed: Main electronic verification
I1554	Safety sequence started
I1555	Safety sequence confirmed
I1556	Safety mode off
I1956	Reset

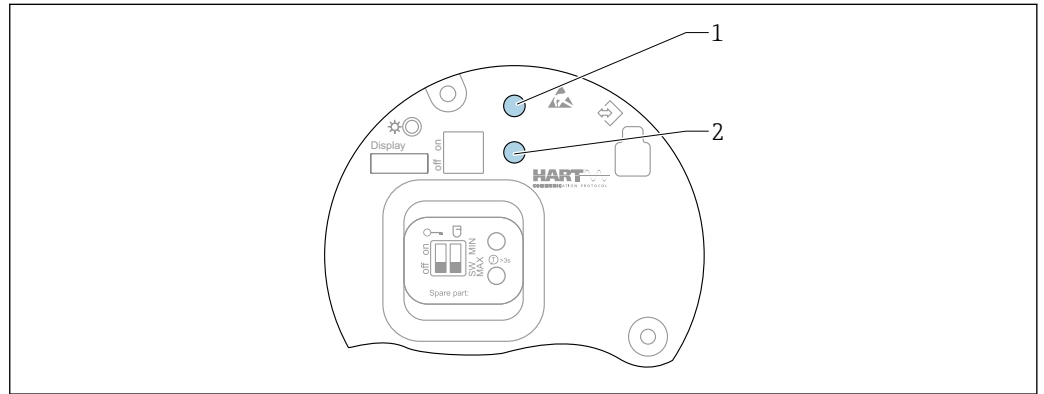
11.8 Resetting the device


11.8.1 Resetting the device via the operating software or display

Navigation: System → Device management **Device reset** parameter

 For details see the "Description of device parameters" documentation.

11.8.2 Resetting the device via operating keys on the electronic insert



 27 Operating keys on the FEL60H electronic insert

1+2 Press simultaneously: operating keys for resetting the device (as-delivered state)


Resetting the device (order configuration)

- Press both operating keys simultaneously for at least 12 s.
 - ↳ The device has been reset (as-delivered state).


11.9 Device information

All the device information is contained in the **Information** submenu.

Navigation: System → Information

 For details see the "Description of device parameters" documentation.

11.10 Firmware history

 The firmware version can explicitly be ordered via the product structure. This makes it possible to ensure the compatibility of the firmware version with an existing or planned system integration.

11.10.1 Version 01.00.zz

Original software

12 Maintenance

No special maintenance work is required.

12.1 Maintenance tasks

12.1.1 Cleaning

It is not permitted to use the device with abrasive media. Material abrasion on the tuning fork can result in the device malfunctioning.

- Clean the tuning fork as necessary
- Cleaning is also possible in the installed state, e. g. CIP Cleaning in Place and SIP Sterilization in Place

13 Repair

13.1 General notes

13.1.1 Repair concept

Endress+Hauser repair concept

- The devices have a modular design
- Customers can carry out repairs

 For more information on service and spare parts, please contact your Endress+Hauser sales representative.

13.1.2 Repairs to Ex-approved devices

WARNING


Incorrect repair can compromise electrical safety!

Explosion hazard!

- ▶ Only specialist personnel or the manufacturer's service team may carry out repairs on Ex-certified devices in accordance with national regulations.
- ▶ Relevant standards and national regulations on hazardous areas, safety instructions and certificates must be observed.
- ▶ Only use original spare parts from the manufacturer.
- ▶ Please note the device designation on the nameplate. Only identical parts may be used as replacements.
- ▶ Carry out repairs according to the instructions.
- ▶ Only the manufacturer's service team is permitted to modify a certified device and convert it to another certified version.

13.2 Spare parts

- Some replaceable device components are identified by a spare part nameplate. This contains information about the spare part.
- All the spare parts for the measuring device, along with the order code, are listed in the *W@M Device Viewer* (www.endress.com/deviceviewer) and can be ordered. If available, users can also download the associated Installation Instructions.

 Device serial number or QR code:
Located on the device and spare part nameplate.

13.3 Replacement

CAUTION

Data upload/download is not permitted if the device is used for safety-related applications.

- ▶ After an entire device or an electronics module has been replaced, the parameters can be downloaded to the device again via the communication interface. For this, the data must have been uploaded to the PC beforehand using the "FieldCare/DeviceCare" software.

13.3.1 HistoROM

It is not necessary to perform a new device calibration after replacing the display or transmitter electronics.



The spare part is supplied without HistoROM.

After removing the transmitter electronics, remove HistoRom and insert it into the new spare part.

13.4 Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Refer to the web page for information:
<http://www.endress.com/support/return-material>
↳ Select the region.
2. Return the device if repairs or a factory calibration are required, or if the wrong device was ordered or delivered.

13.5 Disposal



If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

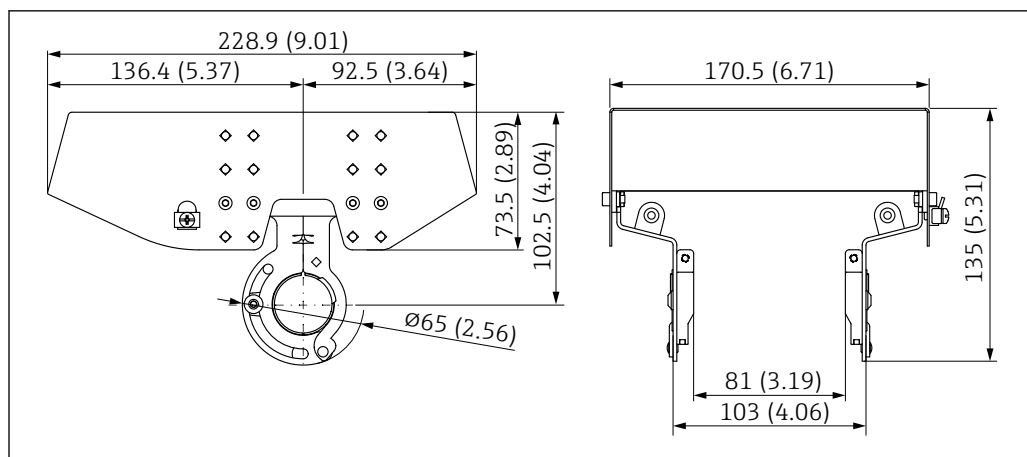
14 Accessories

14.1 Device Viewer

All the spare parts for the device, along with the order code, are listed in the *Device Viewer* (www.endress.com/deviceviewer).

14.2 Weather protection cover for dual compartment housing

- Material: stainless steel 316L
- Order number: 71438303

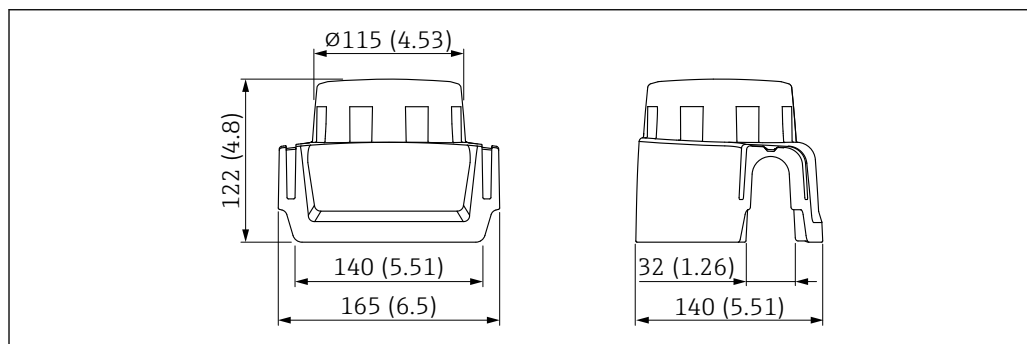


A0039231

28 Weather protection cover for dual compartment housing. Unit of measurement mm (in)

14.3 Protective cover for aluminum single compartment housing

- Material: plastic
- Order number: 71438291



A0038280

29 Protective cover for aluminum single compartment housing. Unit of measurement mm (in)

14.4 M12 socket

i The M12 sockets listed are suitable for use in the temperature range -25 to $+70$ °C (-13 to $+158$ °F).

M12 socket IP69

- Terminated at one end
- Angled
- 5 m (16 ft) PVC cable (orange)
- Slotted nut 316L (1.4435)
- Body: PVC
- Order number: 52024216

M12 socket IP67

- Angled
- 5 m (16 ft) PVC cable (gray)
- Slotted nut Cu Sn/Ni
- Body: PUR
- Order number: 52010285

15 Technical data

15.1 Input

15.1.1 Measured variable

Level (point level), MAX or MIN safety

15.1.2 Measuring range

Depends on the installation location and the pipe extension ordered

Sensor length:

- With plastic coating, maximum 3 m (9.8 ft)
- With enamel coating, maximum 1.2 m (3.9 ft)

15.2 Output

15.2.1 Output signal

SIO (FEL60H electronic insert)

8/16 mA (SIO) with superimposed digital communication protocol HART, 2-wire

Continuous operation (FEL60H electronic insert)

4 to 20 mA proportional to the oscillation frequency with superimposed digital communication protocol HART, 2-wire

For continuous current output, one of the following modes of operation can be selected:

- 4.0 to 20.5 mA
- NAMUR NE 43: 3.8 to 20.5 mA (factory setting)
- US mode: 3.9 to 20.8 mA

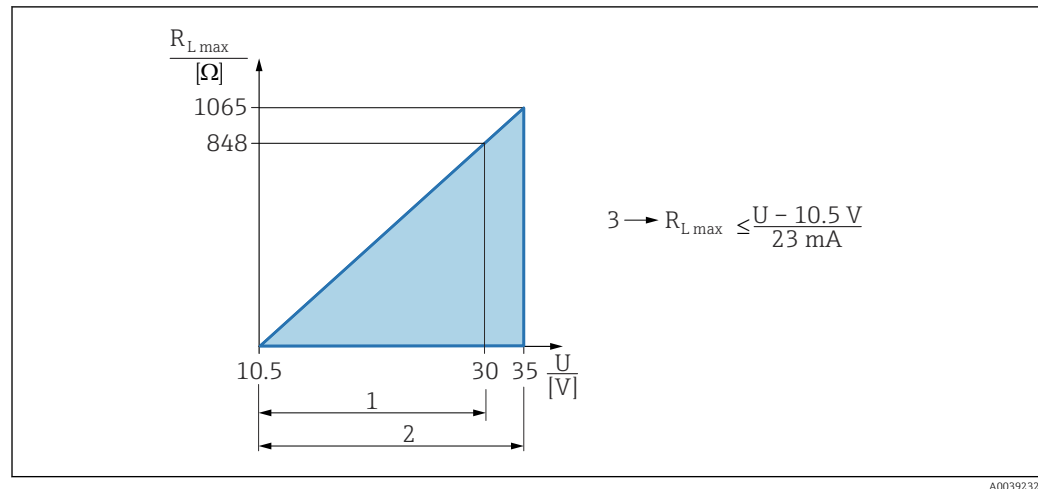
15.2.2 Signal on alarm

Signal on alarm in accordance with NAMUR recommendation NE 43.

4 to 20 mA HART:

- Max. alarm: can be set from 21.5 to 23 mA
- Min. alarm: < 3.6 mA (factory setting)

15.2.3 Load



30 Load 4 to 20 mA HART

- 1 Power supply 10.5 to 30 V_{DC} Ex i
 2 Power supply 10.5 to 35 V_{DC}, for other types of protection and for non-certified device versions
 3 $R_{L\max}$ maximum load resistance
 U Supply voltage

i Operation via handheld terminal or PC with operating program: take minimum communication resistance of 250 Ω into consideration.

15.2.4 Damping

Damping affects all the outputs (output signal, display) and is only available in the continuous 4 to 20 mA mode.

i Damping has no effect on the SIO.

Activating damping:

Via local display, Bluetooth, handheld terminal or PC with operating program, continuous from 0 to 999 s

Factory setting: 1 s

15.2.5 Switch output

Preset switching delay times can be ordered:

- 0.5 s when the tuning fork is covered and 1.0 s when the tuning fork is uncovered (factory setting)
- 0.25 s when the tuning fork is covered and 0.25 s when the tuning fork is uncovered
- 1.5 s when the tuning fork is covered and 1.5 s when the tuning fork is uncovered
- 5.0 s when the tuning fork is covered and 5.0 s when the tuning fork is uncovered

i The user can also set the switching delays for when the fork is covered and uncovered in the range from 1 to 60 seconds independently of one another.

(Operation via display, Bluetooth or FieldCare, DeviceCare, AMS, PDM)

15.2.6 Ex connection data

See safety instructions (XA): All data relating to explosion protection are provided in separate Ex documentation and are available from the Downloads area of the Endress+Hauser website. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.

15.2.7 Protocol-specific data

HART

- Manufacturer ID: 17 (0x11)
- Device type code: 0x11C4
- Device revision: 1
- HART specification: 7
- DD revision: 1
- Device description files (DTM, DD) information and files at:
 - www.endress.com
 - www.fieldcommgroup.org
- HART load: min. 250 Ω

HART device variables (preset at the factory)

The following measured values are assigned to the device variables at the factory:

Device variable	Measured value
Primary variable (PV) parameter (Primary variable) ¹⁾	Point level detection ²⁾
Secondary variable (SV) parameter (Secondary variable)	Sensor frequency ³⁾
Tertiary variable (TV) parameter (Third variable)	Fork state ⁴⁾
Quaternary variable (QV) parameter (Quaternary variable)	Sensor temperature

- 1) The PV is always applied to the current output.
- 2) Point level detection is the initial state depending on the fork state (uncovered/covered) and the safety function (MIN/MAX)
- 3) Sensor frequency is the oscillation frequency of the fork
- 4) Fork state is the fork state (**Fork covered** option/**Fork uncovered** option)

Choice of HART device variables

- Level limit detection
- Sensor frequency
- Fork state
- Sensor temperature
- Terminal current

The terminal current is the read-back current on terminal block. Visibility depends on order options or device settings

- Terminal voltage

Visibility depends on order options or device settings

Supported functions

- Burst mode
- Additional transmitter status
- Device locking

15.2.8 Wireless HART data

- Minimum start-up voltage: 10.5 V
- Start-up current: > 3.6 mA
- Start-up time: < 8 s
- Minimum operating voltage: 10.5 V
- Multidrop current: 4 mA

15.2.9 Heartbeat Technology

Heartbeat Technology module

The software package consists of 3 modules. These three modules combined check, evaluate and monitor device functionality and process conditions.



- Heartbeat Diagnostics
- Heartbeat Verification
- Heartbeat Monitoring


15.3 Environment

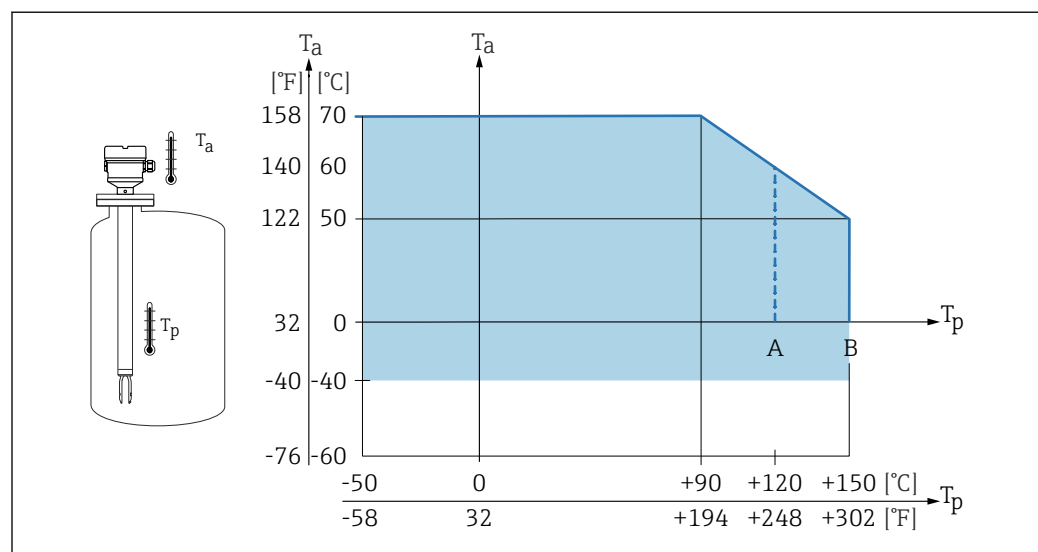
15.3.1 Ambient temperature range


The following values apply up to a process temperature of +90 °C (+194). At higher process temperatures, the permitted ambient temperature is reduced (see diagram).

- Without LCD display: -40 to +70 °C (-40 to +158)
- With LCD display: -40 to +70 °C (-40 to +158) with limitations in optical properties, such as display speed and contrast
- Can be used without limitations: -20 to +60 °C (-4 to +140 °F)

Optionally available:

- -50 °C (-58 °F) with restricted operating life and performance
- -60 °C (-76 °F) with restricted operating life and performance,
-  Below -50 °C (-58 °F): devices can be permanently damaged



 31 Permitted ambient temperature T_a at the housing as a function of the process temperature T_p in the vessel

A ECTFE-coated

B PFA- or enamel-coated

The following ambient temperature applies over the entire process temperature range for devices with a temperature spacer: +70 °C (+158 °F)

Outdoor operation in strong sunlight:

- Mount the device in a shaded location
- Avoid direct sunlight, particularly in warmer climatic regions
- Use a weather protection cover, can be ordered as an accessory

Hazardous area

In the hazardous area, the permitted ambient temperature can be limited depending on the zones and gas groups. Pay attention to the information in the Ex documentation (XA).

15.3.2 Storage temperature

–40 to +80 °C (–40 to +176 °F)

Optional –50 °C (–58 °F) or –60 °C (–76 °F)

15.3.3 Humidity

Operation up to 100 %. Do not open in a condensing atmosphere.

15.3.4 Operating height

Up to 5 000 m (16 404 ft) above sea level.

15.3.5 Climate class

As per IEC 60068-2-38 test Z/AD

15.3.6 Degree of protection

Test as per IEC 60529 and NEMA 250

IP68 test condition: 1.83 m H₂O for 24 h

Housing

See cable entries

Cable entries

- M20 threaded joint, plastic, IP66/68 NEMA Type 4X/6P
- M20 threaded joint, nickel-plated brass, IP66/68 NEMA Type 4X/6P
- M20 threaded joint, 316L, IP66/68 NEMA Type 4X/6P
- M20 thread, IP66/68 NEMA Type 4X/6P
- Thread G ½, NPT ½, IP66/68 NEMA Type 4XXX

Degree of protection for M12 plug

- When housing is closed and connecting cable is plugged in: IP66/67 NEMA Type 4X
- When housing is open or connecting cable is not plugged in: IP20, NEMA Type 1

NOTICE**M12 plug: Loss of IP protection class due to incorrect installation!**

- The degree of protection only applies if the connecting cable used is plugged in and screwed tight.
- The degree of protection only applies if the connecting cable used is specified according to IP67 NEMA Type 4X.



If the "M12 plug" option is selected as the electrical connection, **IP66/67 NEMA Type 4X** applies for all housing types.

15.3.7 Vibration resistance

As per IEC60068-2-64-2008

a(RMS) = 50 m/s², f = 5 to 2 000 Hz, t = 3 axes x 2 h

15.3.8 Shock resistance

In accordance with IEC60068-2-27-2008: 300 m/s² [= 30 g_n] + 18 ms

g_n: standard acceleration of gravity

15.3.9 Mechanical load

Support the device in the event of severe dynamic load. Maximum lateral loading capacity of the pipe extensions and sensors: 75 Nm (55 lbf ft).

 For more details, see the "Supporting the device" section.

15.3.10 Pollution degree

Pollution level 2

15.3.11 Electromagnetic compatibility (EMC)


- Electromagnetic compatibility as per EN 61326 series and NAMUR recommendation EMC (NE21)
- With regard to the safety function (SIL), the requirements of EN 61326-3-x are satisfied
- Maximum deviation under disturbance: < 0.5% of span

 For more details, refer to the EU Declaration of Conformity.

15.4 Process

15.4.1 Process temperature range

- ECTFE: -50 to +120 °C (-58 to +248 °F)
- PFA: -50 to +150 °C (-58 to +302 °F)
- Enamel: -50 to +150 °C (-58 to +302 °F)

Pay attention to the pressure and temperature dependency.  "Process pressure range" section.


15.4.2 Thermal shock

≤ 120 K/s

15.4.3 Process pressure range

WARNING

The maximum pressure for the device depends on the lowest-rated element, with regard to pressure, of the selected component. This means that it is necessary to pay attention to the process connection as well as the sensor.

- ▶ Pressure specifications,  Technical Information, "Mechanical construction" section.
- ▶ Only operate the device within the specified limits!
- ▶ The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the device.

Refer to the following standards for the permitted pressure values of the flanges at higher temperatures:

- pR EN 1092-1: With regard to its stability-temperature property, the material 1.4435 is identical to 1.4404, which is classed as 13E0 in EN 1092-1 Tab. 18. The chemical composition of the two materials can be identical.
- ASME B 16.5
- JIS B 2220

The following data apply over the entire temperature range. Pay attention to exceptions for flange process connections!

- ECTFE, PFA: -1 to 40 bar (-14.5 to 580 psi)
- Enamel: max. -1 to 25 bar (-14.5 to 363 psi)

In each case, the lowest value from the derating curves of the device and the selected flange applies.



Canadian CRN approval: more details about the maximum pressure values are available in the download area of the product page under: www.endress.com → Downloads.

15.4.4 Overpressure limit

- Overpressure limit = $1.5 \cdot P_N$
 - ECTFE, PFA: $P_N = 40 \text{ bar (580 psi)}$
 - Enamel: $P_N = 25 \text{ bar (362.5 psi)}$
- Membrane burst pressure at 200 bar (2 900 psi)

The device function is limited during the pressure test.

Mechanical integrity is guaranteed up to 1.5 times the process nominal pressure P_N .

15.4.5 Medium density

Liquids with density $> 0.7 \text{ g/cm}^3$ (43.7 lb/ft³)

Setting $> 0.7 \text{ g/cm}^3$ (43.7 lb/ft³), as supplied to the customer

Liquids with density 0.5 g/cm^3 (31.2 lb/ft³)

Setting $> 0.5 \text{ g/cm}^3$ (31.2 lb/ft³), can be ordered as preset value or configurable

Liquids with density $> 0.4 \text{ g/cm}^3$ (25.0 lb/ft³)

- Setting $> 0.4 \text{ g/cm}^3$ (25.0 lb/ft³), can be ordered as preset value or configurable
- SIL for defined media and process parameters on request



For information on medium differentiation/density detection: Documentation Liquiphant density (FEL60D) with density computer FML621 (Endress+Hauser website www.endress.com → Downloads)

15.4.6 Viscosity

$\leq 10\,000 \text{ mPa}\cdot\text{s}$

15.4.7 Pressure tightness

Up to vacuum



In vacuum evaporation plants, select the 0.4 g/cm^3 (25.0 lb/ft³) / density setting.

15.4.8 Solids contents

$\varnothing \leq 5 \text{ mm (0.2 in)}$

15.5 Additional technical data



Current Technical Information: Endress+Hauser website: www.endress.com → Downloads.

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