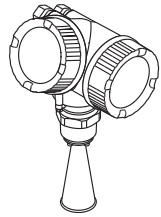
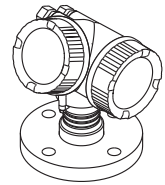
Brief Operating Instructions
Micropilot FMR51, FMR52 HART

Free space radar





These Instructions are Brief Operating Instructions; they are not a substitute for the Operating Instructions pertaining to the device.

Detailed information about the device can be found in the Operating Instructions and the other documentation:
Available for all device versions via:
– Internet: www.endress.com/deviceviewer
– Smart phone/tablet: *Endress+Hauser Operations App*

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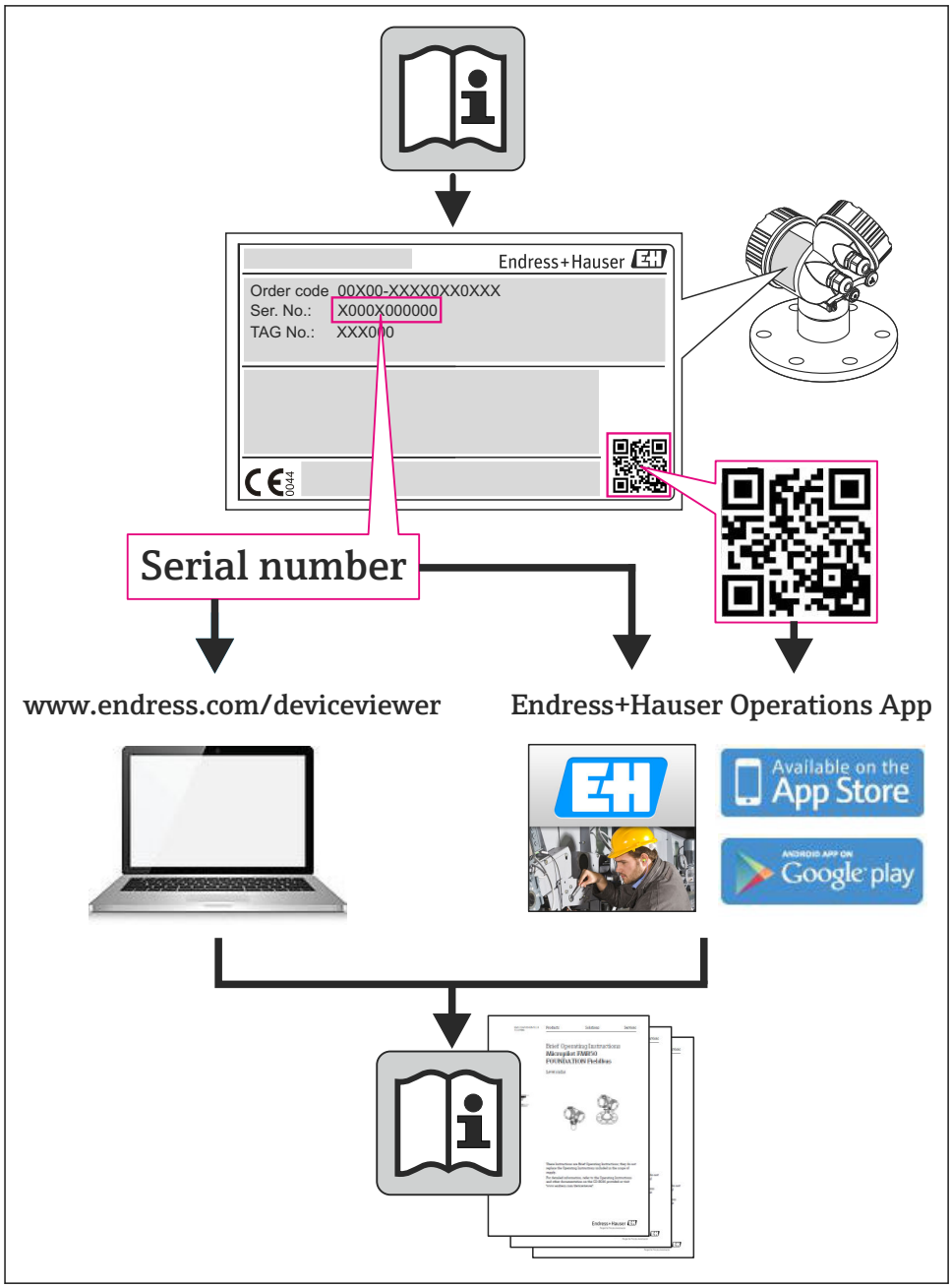
Endress+Hauser
Order code 00X00-XXXX0XX0XXX
Ser. No.: X000X000000
TAG No.: XXX000
0044
Serial number
www.endress.com/deviceviewer
Endress+Hauser Operations App
Available on the App Store
ANDROID APP ON Google play

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Table of contents

1 Important document information

1.1 Symbols

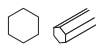
1.1.1 Safety symbols

Symbol	Meaning
DANGER	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
WARNING	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
CAUTION	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	**NOTE!** This symbol contains information on procedures and other facts which do not result in personal injury.

1.1.2 Electrical symbols

Symbol	Meaning	Symbol	Meaning
⎓	Direct current	~	Alternating current
⎓ ~	Direct current and alternating current	⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⏚	**Protective ground connection** A terminal which must be connected to ground prior to establishing any other connections.	⏚	**Equipotential connection** A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.

1.1.3 Tool symbols

 A0011219	 A0011220	 A0013442	 A0011221	 A0011222
Cross-head screwdriver	Flat blade screwdriver	Torx screwdriver	Allen key	Hexagon wrench

1.1.4 Symbols for certain types of information

Symbol	Meaning	Symbol	Meaning
	**Permitted** Procedures, processes or actions that are permitted.		**Preferred** Procedures, processes or actions that are preferred.
	**Forbidden** Procedures, processes or actions that are forbidden.		**Tip** Indicates additional information.
	Reference to documentation		Reference to page
	Reference to graphic	1., 2., 3. …	Series of steps
	Result of a sequence of actions		Visual inspection

1.1.5 Symbols in graphics

Symbol	Meaning
1, 2, 3 …	Item numbers
1., 2., 3. …	Series of steps
A, B, C, …	Views
A-A, B-B, C-C, …	Sections
	**Hazardous area** Indicates a hazardous area.
	**Safe area (non-hazardous area)** Indicates the non-hazardous area.

1.1.6 Symbols at the device

Symbol	Meaning
	**Safety instructions** Observe the safety instructions contained in the associated Operating Instructions.
	**Temperature resistance of the connection cables** Specifies the minimum value of the temperature resistance of the connection cables.

2 Basic safety instructions

2.1 Requirements for the personnel

The personnel must fulfill the following requirements for its tasks:
- Trained, qualified specialists must have a relevant qualification for this specific function and task
- Are authorized by the plant owner/operator
- Are familiar with federal/national regulations
- Before beginning work, the specialist staff must have read and understood the instructions in the Operating Instructions and supplementary documentation as well as in the certificates (depending on the application)
- Following instructions and basic conditions

2.2 Designated use

Application and measured materials
The measuring device described in these Operating Instructions is intended for the continuous, contactless level measurement of liquids, pastes and sludge. The device can also be freely mounted outside closed metal vessels because of its operating frequency of about 26 GHz, a maximum radiated pulsed power of 5.7 mW and an average power output of 0.015 mW (for the version with advanced dynamics: maximum pulse power: 23.3 mW; average power: 0.076 mW). Operation is completely harmless to humans and animals.

Observing the limit values specified in the "Technical data" and listed in the Operating Instructions and supplementary documentation, the measuring device may be used for the following measurements only:
- Measured process variables: level, distance, signal strength
- Calculated process variables: Volume or mass in arbitrarily shaped vessels; flow through measuring weirs or flumes (calculated from the level by the linearization functionality)

To ensure that the measuring device remains in proper condition for the operation time:
- Use the measuring device only for measured materials against which the process-wetted materials are adequately resistant.
- Observe the limit values in "Technical data".

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

Verification for borderline cases:
- For special measured materials and cleaning agents, Endress+Hauser is glad to provide assistance in verifying the corrosion resistance of wetted materials, but does not accept any warranty or liability.

Residual risk
The electronics housing and its built-in components such as display module, main electronics module and I/O electronics module may heat to 80 °C (176 °F) during operation through heat transfer from the process as well as power dissipation within the electronics. During operation the sensor may assume a temperature near the temperature of the measured material.

Danger of burns due to heated surfaces!
- ▶ For high process temperatures: Install protection against contact in order to prevent burns.

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 in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for interference-free operation of the device.

Conversions 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 the manufacturer.

Repair

To ensure continued operational safety and reliability,
- ▶ Carry out repairs on the device only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to repair of an electrical device.
- ▶ Use original spare parts and accessories from the manufacturer only.

Hazardous area

To eliminate a danger for persons or for the facility when the device is used in the hazardous area (e.g. explosion protection, pressure vessel safety):
- ▶ Based on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area.
- ▶ Observe the specifications in the separate supplementary documentation that is an integral part of these Instructions.

2.5 Product safety

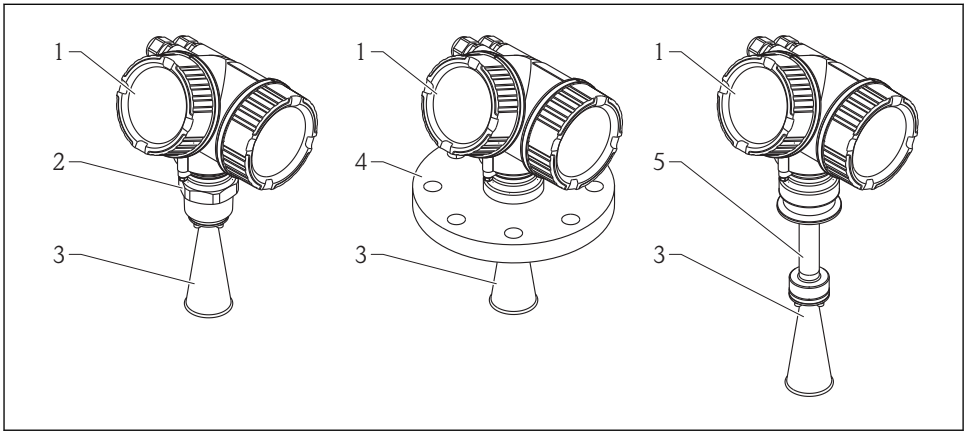
This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which they are safe to operate.

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

3 Product description

3.1 Product design

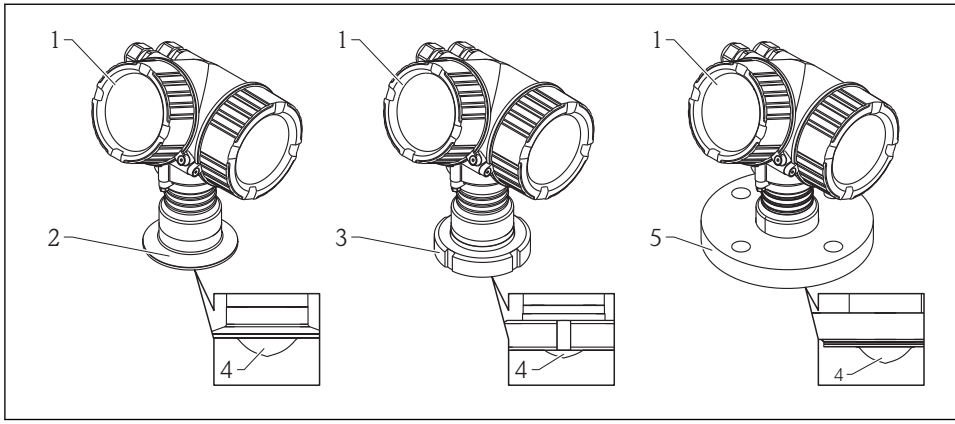
3.1.1 Micropilot FMR51



1 *Design of the Micropilot FMR51 (26 GHz)*

1 Electronics housing
2 Process connection (Thread)
3 Horn antenna
4 Flange
5 Antenna extension

3.1.2 Micropilot FMR52



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2 *Design of the Micropilot FMR52 (26 GHz)*

1 Electronics housing
2 Tri-Clamp process connection
3 Dairy coupling
4 PTFE cladding
5 Flange

4 Incoming acceptance and product identification

4.1 Incoming acceptance

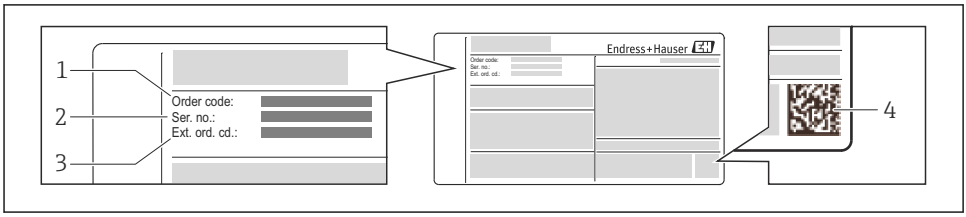
Upon receipt of the goods check the following:
- Are the order codes on the delivery note and the product sticker identical?
- Are the goods undamaged?
- Do the nameplate data match the ordering information on the delivery note?
- Is the DVD with the operating tool present?
  If required (see nameplate): Are the Safety Instructions (XA) present?

If one of these conditions is not satisfied, contact your Endress+Hauser Sales Center.

4.2 Product identification

The following options are available for identification of the measuring device:
- Nameplate specifications
- Extended order code with breakdown of the device features on the delivery note
- Enter serial numbers from nameplates in *W@M Device Viewer* (www.endress.com/deviceviewer): All information about the measuring device is displayed.
- Enter the serial number from the nameplates into the *Endress+Hauser Operations App* or scan the 2-D matrix code (QR code) on the nameplate with the *Endress+Hauser Operations App*: all the information for the measuring device is displayed.

4.2.1 Nameplate



3 Example of a nameplate

1 Order code
2 Serial number (Ser. no.)
3 Extended order code (Ext. ord. cd.)
4 2-D matrix code (QR code)

For detailed information about interpreting the nameplate specifications, refer to the Operating Instructions for the device.

Only 33 digits of the extended order code can be indicated on the nameplate. If the extended order code exceeds 33 digits, the rest will not be shown. However, the complete extended order code can be viewed in the operating menu of the device: **Extended order code 1 to 3** parameter

5 Storage, Transport

5.1 Storage conditions

- Permitted storage temperature: −40 to +80 °C (−40 to +176 °F)
- Use the original packaging.

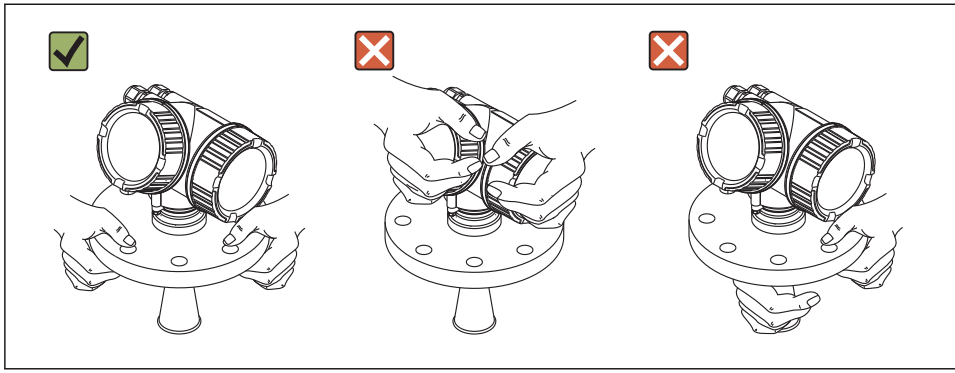
5.2 Transport product to the measuring point

NOTICE

Housing or antenna horn may be damaged or break away.

Risk of injury!

- ▶ Transport the measuring device to the measuring point in its original packaging or at the process connection.
- ▶ Do not fasten lifting devices (hoisting slings, lifting eyes etc.) at the housing or the antenna horn but at the process connection. Take into account the mass center of the device in order to avoid unintended tilting.
- ▶ Comply with the safety instructions, transport conditions for devices over 18kg (39.6lbs) (IEC61010).



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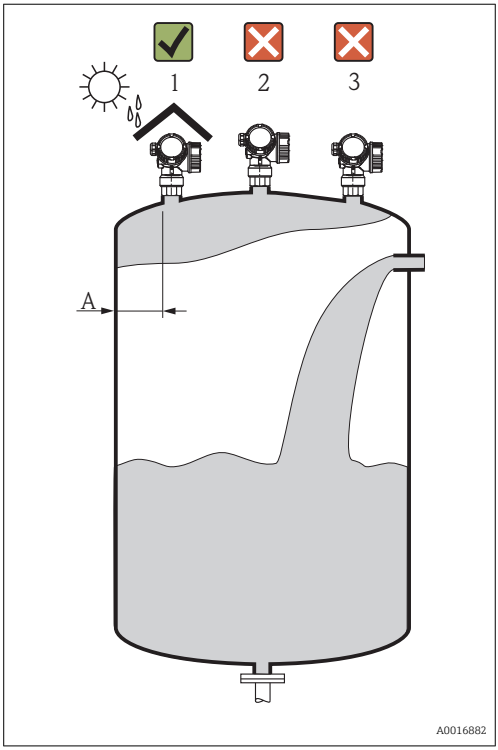
6 Installation

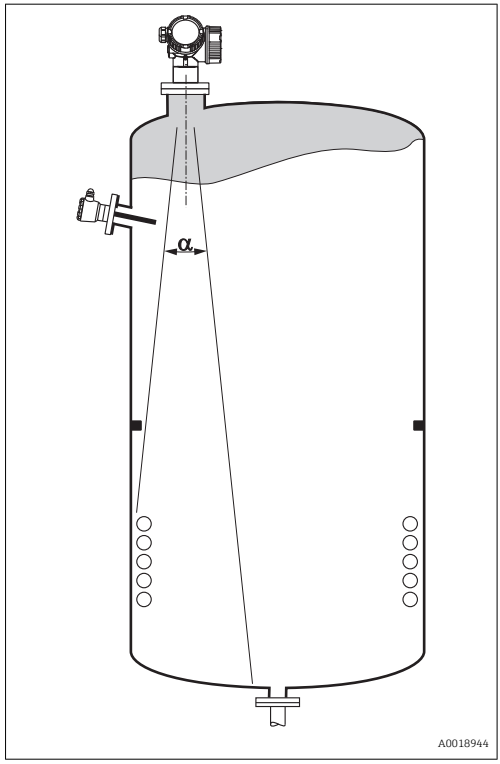
6.1 Installation conditions

6.1.1 Mounting position



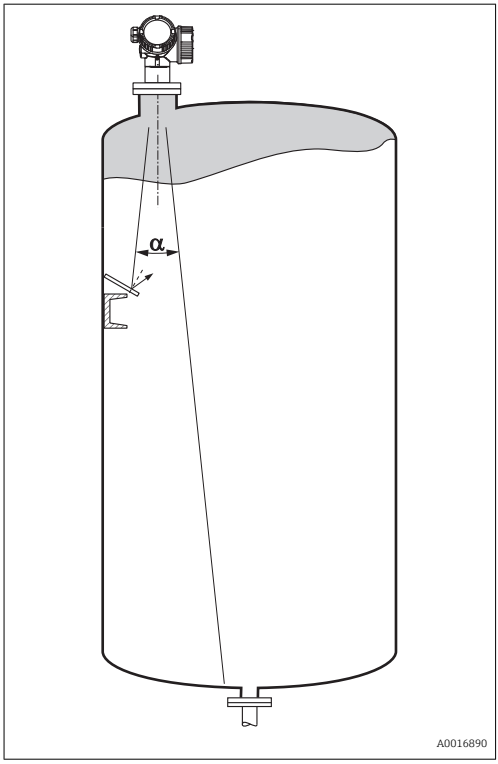
- Recommended distance **A** from wall to outer edge of nozzle: ~ 1/6 of tank diameter.
  Nevertheless the device should not be installed closer than 15 cm (5.91 in) to the tank wall.
- Not in the center (2), as interference can cause signal loss.
- Not above the fill stream (3).
- It is recommended to us a weather protection cover (1) in order to protect the device from direct sun or rain.

6.1.2 Vessel installations



Avoid any installations (point level switches, temperature sensors, braces, vacuum rings, heating coils, baffles etc.) inside the signal beam. Take into account the beam angle → 16.

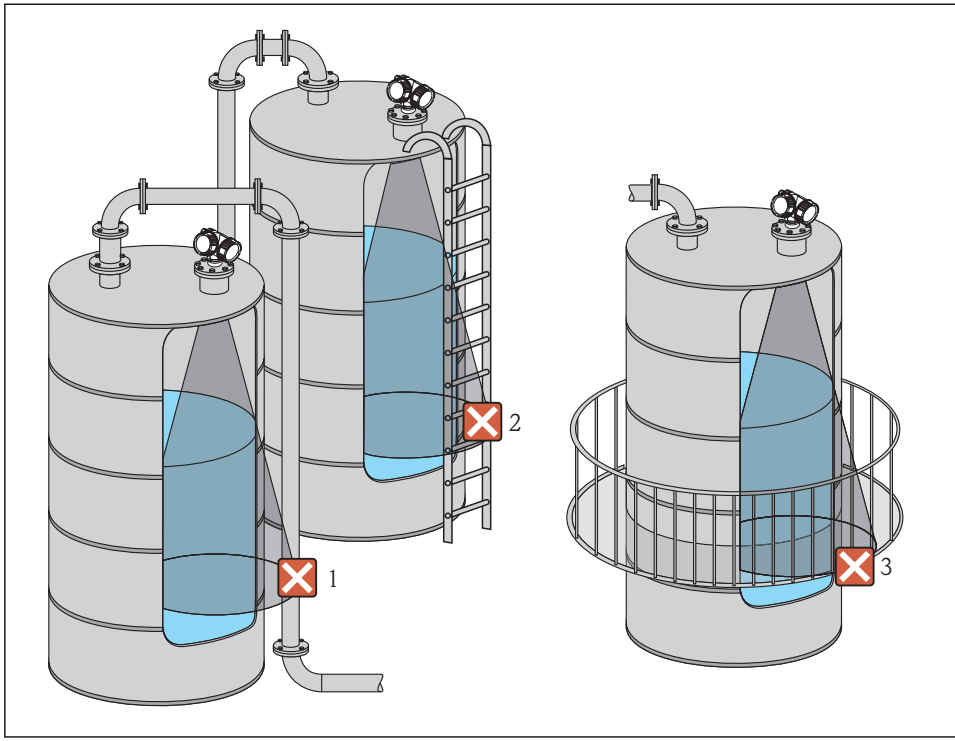
6.1.3 Reduction of interference echoes



Metallic screens mounted at a slope spread the radar signal and can, therefore, reduce interference echoes.

6.1.4 Measurement in a plastic vessel

If the outer wall of the vessel is made of a non-conductive material (e.g. GRP), microwaves can also be reflected off interfering installations outside the signal beam (e.g. metallic pipes (1), ladders (2), grates (3), ...). Therefore, there should be no such interfering installations in the signal beam. Please contact Endress+Hauser for further information.



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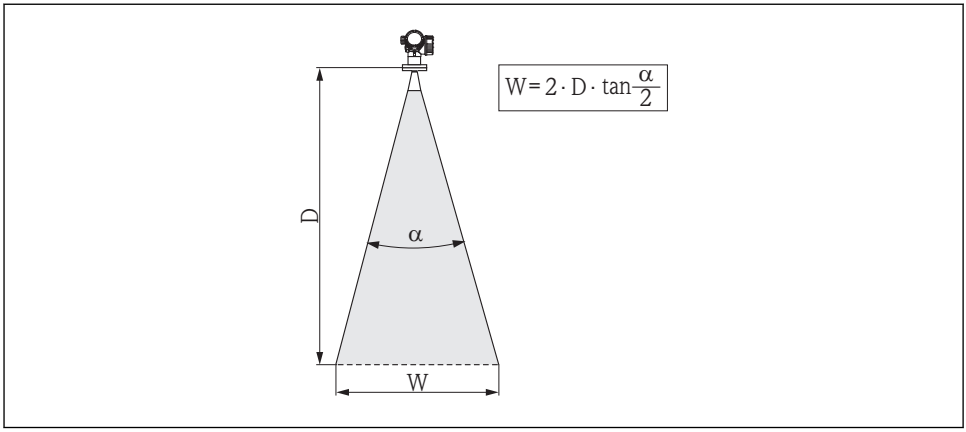
6.1.5 Optimization options

- Antenna size
  The bigger the antenna, the smaller the beam angle α and the fewer interference echoes → 16.
- Mapping
  The measurement can be optimized by means of electronic suppression of interference echoes.
- Antenna alignment
  Take into account the marker on the flange or threaded connection → 20 → 24 .
- Stilling well
  A stilling well can be applied to avoid interferences → 25.
- Metallic screens mounted at a slope
  They spread the radar signals and can, therefore, reduce interference echoes.

6.1.6 Beam angle



4 Relationship between beam angle a, distance D and beamwidth diameter W

The beam angle is defined as the angle α where the energy density of the radar waves reaches half the value of the maximum energy density (3-dB-width). Microwaves are also emitted outside the signal beam and can be reflected off interfering installations.

Beam diameter **W** as a function of beam angle **α** and measuring distance **D**:

FMR51				
Antenna size	40 mm (1½ in)	50 mm (2 in)	80 mm (3 in)	100 mm (4 in)
Beam angle α	23°	18°	10°	8°
Measuring distance (D)	**Beamwidth diameter W**			
3 m (9.8 ft)	1.22 m (4 ft)	0.95 m (3.1 ft)	0.53 m (1.7 ft)	0.42 m (1.4 ft)
6 m (20 ft)	2.44 m (8 ft)	1.9 m (6.2 ft)	1.05 m (3.4 ft)	0.84 m (2.8 ft)
9 m (30 ft)	3.66 m (12 ft)	2.85 m (9.4 ft)	1.58 m (5.2 ft)	1.26 m (4.1 ft)
12 m (39 ft)	4.88 m (16 ft)	3.80 m (12 ft)	2.1 m (6.9 ft)	1.68 m (5.5 ft)
15 m (49 ft)	6.1 m (20 ft)	4.75 m (16 ft)	2.63 m (8.6 ft)	2.10 m (6.9 ft)
20 m (66 ft)	8.14 m (27 ft)	6.34 m (21 ft)	3.50 m (11 ft)	2.80 m (9.2 ft)
25 m (82 ft)	10.17 m (33 ft)	7.92 m (26 ft)	4.37 m (14 ft)	3.50 m (11 ft)
30 m (98 ft)	-	9.50 m (31 ft)	5.25 m (17 ft)	4.20 m (14 ft)
35 m (115 ft)	-	11.09 m (36 ft)	6.12 m (20 ft)	4.89 m (16 ft)
40 m (131 ft)	-	12.67 m (42 ft)	7.00 m (23 ft)	5.59 m (18 ft)
45 m (148 ft)	-	-	7.87 m (26 ft)	6.29 m (21 ft)
60 m (197 ft)	-	-	10.50 m (34 ft)	8.39 m (28 ft)
70 m (230 ft)	-	-	-	9.79 m (32 ft)

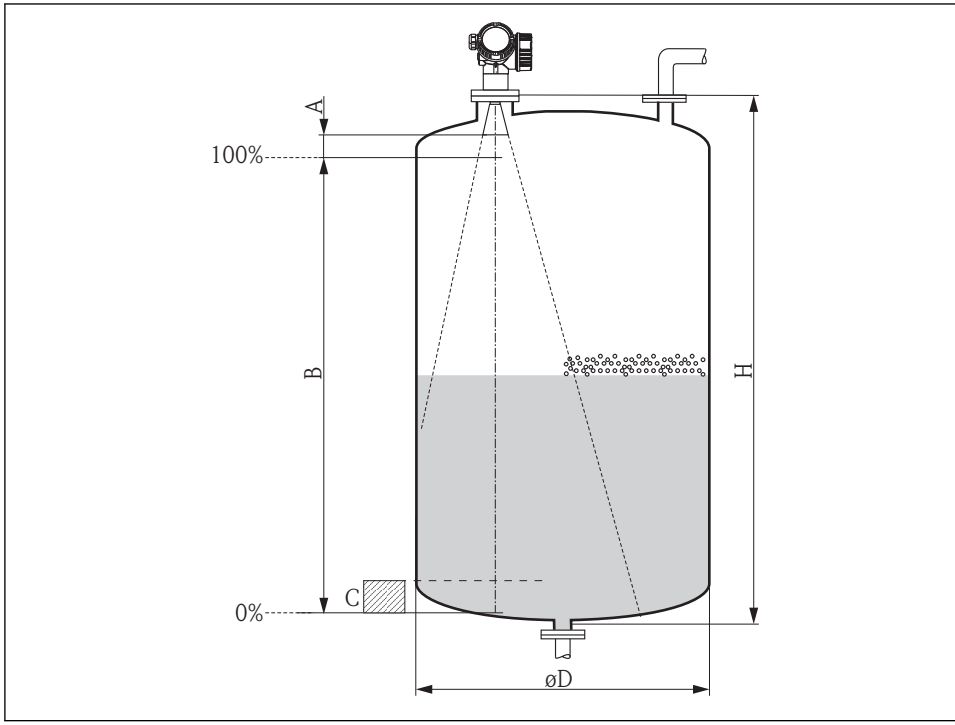
FMR52		
Antenna size	50 mm (2 in)	80 mm (3 in)
Beam angle α	18°	10°
Measuring distance (D)	**Beamwidth diameter W**	
3 m (9.8 ft)	0.95 m (3.1 ft)	0.53 m (1.7 ft)
6 m (20 ft)	1.9 m (6.2 ft)	1.05 m (3.4 ft)
9 m (30 ft)	2.85 m (9.4 ft)	1.58 m (5.2 ft)
12 m (39 ft)	3.80 m (12 ft)	2.1 m (6.9 ft)
15 m (49 ft)	4.75 m (16 ft)	2.63 m (8.6 ft)
20 m (66 ft)	6.34 m (21 ft)	3.50 m (11 ft)
25 m (82 ft)	7.92 m (26 ft)	4.37 m (14 ft)
30 m (98 ft)	9.50 m (31 ft)	5.25 m (17 ft)
35 m (115 ft)	11.09 m (36 ft)	6.12 m (20 ft)
40 m (131 ft)	12.67 m (42 ft)	7.00 m (23 ft)
45 m (148 ft)	-	7.87 m (26 ft)
60 m (197 ft)	-	10.50 m (34 ft)

6.2 Measuring conditions

- In case of **boiling surfaces**, **bubbling** or tendency for **foaming** use FMR53 or FMR54. Depending on its consistence, foam can either absorb microwaves or reflect them off the foam surface. Measurement is possible under certain conditions. For FMR50, FMR51 and FMR52, the additional option "Advanced dynamics" is recommended in these cases (feature 540: "Application Package", option EM).
- In case of heavy **steam development** or **condensate**, the maximum measuring range of FMR50, FMR51 and FMR52 may decrease depending on density, temperature and composition of the steam → use FMR53 or FMR54.
- For the measurement of absorbing gases such as **ammonia NH_3** or some **fluorocarbons** [1)], please use Levelflex or Micropilot FMR54 in a stilling well.
- The measuring range begins, where the beam hits the tank bottom. Particularly with dish bottoms or conical outlets the level cannot be detected below this point.
- For stilling well applications, the zero should be positioned at the end of the tube, as the electromagnetic waves do not propagate completely outside the tube. It must be taken into account that the accuracy may be reduced in the area **C**. In order to guarantee the required accuracy in these cases, it is recommended to position the zero-point at a distance **C** above the end of the tube (see figure).

1) Affected compounds are e.g. R134a, R227, Dymel 152a.

- In case of media with a low dielectric constant (ε_r = 1.5 to 4) [2] the tank bottom can be visible through the medium at low levels (low height **C**). Reduced accuracy has to be expected in this range. If this is not acceptable, we recommend positioning the zero point at a distance **C** (see figure) above the tank bottom in these applications.
- In principle it is possible to measure up to the tip of the antenna with FMR51, FMR53 and FMR54. However, due to considerations regarding corrosion and build-up, the end of the measuring range should not be chosen any closer than **A** (see figure) to the tip of the antenna.
- When using FMR54 with planar antenna, especially for media with low dielectric constants, the end of the measuring range should not be closer than **A: 1 m (3.28 ft)** to the flange.
- The smallest possible measuring range **B** depends on the antenna version (see figure).
- The tank height should be at least **H** (see table).



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Device	A [mm (in)]	B [m (ft)]	C [mm (in)]	H [m (ft)]
FMR51	50(1.97)	> 0.2 (0.7)	50 to 250 (1.97 to 9.84)	> 0.3 (1.0)
FMR52	200(7.87)			

2) Dielectric constants of important media commonly used in various industries are summarized in the DC manual (CP01076F) and in the Endress+Hauser "DC Values App" (available for Android and iOS).

6.3 Mounting cladded flanges

- Use flange screws according to the number of flange holes.
- Tighten the screws with the required torque (see table).
- Retighten the screws after 24 hours or after the first temperature cycle.
- Depending on process pressure and process temperature check and retighten the screws at regular intervals.

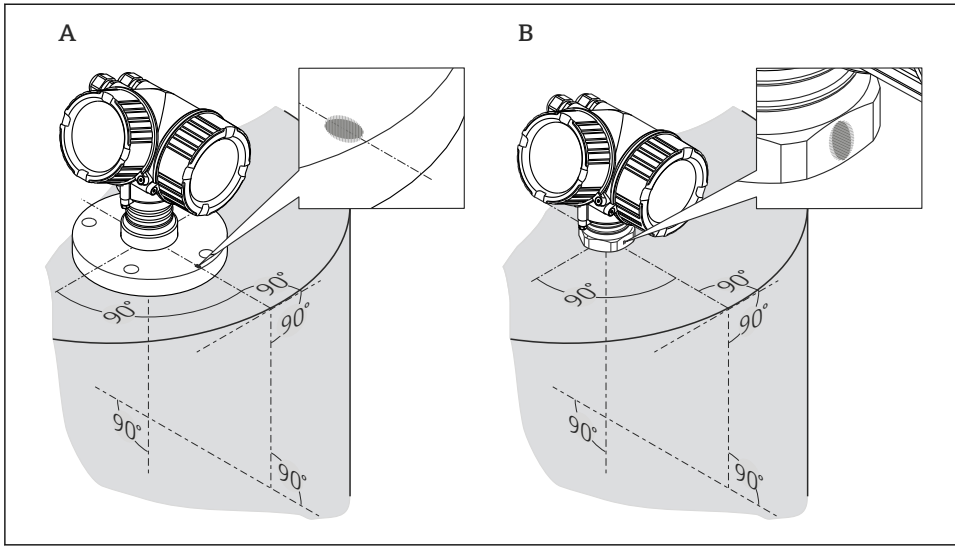
Flange size	Number of screws	Recommended torque [Nm]	
		minimum	maximum
EN			
DN50/PN16	4	45	65
DN80/PN16	8	40	55
DN100/PN16	8	40	60
DN150/PN16	8	75	115
ASME			
2"/150lbs	4	40	55
3"/150lbs	4	65	95
4"/150lbs	8	45	70
6"/150lbs	8	85	125
JIS			
10K 50A	4	40	60
10K 80A	8	25	35
10K 100A	8	35	55
10K 100A	8	75	115

6.4 Installation in vessel (free space)

6.4.1 Horn antenna (FMR51)

Alignment

- Align the antenna vertically to the product surface.
  The maximum range may be reduced if the horn antenna is not vertically aligned.
- A marking at the flange (somewhere between the flange holes) or the boss enables alignment of the antenna. This marking must be aligned towards the tank wall as well as possible.



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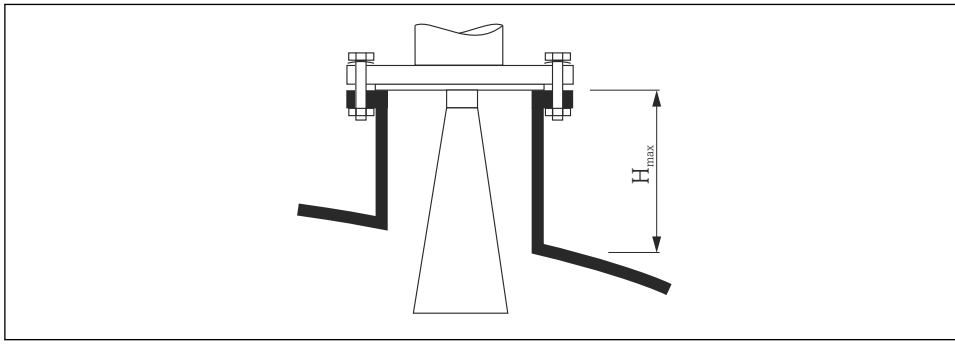
Depending on the device version the marking may be a circle or two short parallel lines.

Nozzle mounting

For optimum measurement, the tip of the antenna should extend below the nozzle.
Depending on the antenna size this is achieved by the following maximum nozzle heights:



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5 *Nozzle height for horn antenna (FMR51)*

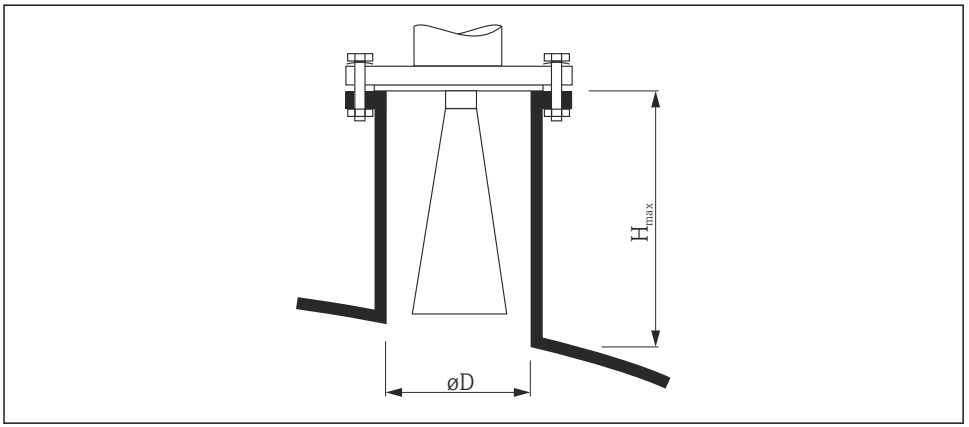
Antenna [1)]	**Maximum nozzle height** H_{max}
BA: Horn 40mm/1-1/2"	85 mm (3.35 in)
BB: Horn 50mm/2"	115 mm (4.53 in)

Antenna [1]	Maximum nozzle height H_{max}
BC: Horn 80mm/3"	210 mm (8.27 in)
BD Horn 100mm/4"	280 mm (11.0 in)

1) Feature 070 of the product structure

Conditions for longer nozzles

If the medium has good reflective properties, higher nozzles can be accepted. In this case the maximum nozzle height, H_{max}, is dependent on the nozzle diameter, D:



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Nozzle diameter D	Maximum nozzle height H_{max}	Recommended antenna [1]
40 mm (1.5 in)	100 mm (3.9 in)	BA: Horn 40mm/1-1/2"
50 mm (2 in)	150 mm (5.9 in)	BB: Horn 50mm/2"
80 mm (3 in)	250 mm (9.8 in)	BC: Horn 80mm/3"

Nozzle diameter D	Maximum nozzle height H_{max}	Recommended antenna [1]
100 mm (4 in)	500 mm (19.7 in)	BD: Horn 100mm/4"
150 mm (6 in)	800 mm (31.5 in)	BD: Horn 100mm/4"

1) Feature 070 of the product structure

If the antenna doesn't extend below the nozzle, observe the following:
- The nozzle end must be smooth and free of burrs. If possible its edge should be rounded.
- An interference echo suppression must be performed.
- Please contact Endress+Hauser for applications with higher nozzles than those indicated in the table.

- For mounting in heigh nozzles the device is available in a version with an antenna extension of up to 1000 mm (39.4 in) [3]
- The antenna extension may cause interference echoes in the near range. In this case it may occur that the maximum measurable level is reduced.

Threaded connection

For devices with a threaded connection it may be necessary - depending on the antenna size - to unmount the horn before fastening the device and to mount it again afterwards.

- Tighten with the hexagonal nut only.
- Tool : 55 mm hexagonal wrench
- Maximum permissible torque: 60 Nm (44 lbf ft)

6.4.2 Mesurement from the outside through plastic walls (FMR50/FMR51)

- Dielectric constant of the medium: $\varepsilon_r > 10$
- If possible, use an antenna 100 mm (4 in).
- The distance from the lower edge of the antenna to the tank ceiling should be about 100 mm (4 in).
- If possible, avoid mounting locations where condensation or build-up might occur.
- In case of outdoor mounting, the space between antenna and vessel has to be protected from the elements.
- Do not mount any potential reflectors (e.g. pipes) outside the tank in the signal beam.

Suitable thickness of the tank ceiling:

Penetrated material	PE	PTFE	PP	Perspex
DK / ε_r	2.3	2.1	2.3	3.1
Optimum thickness [1]	3.8 mm (0.15 in)	4.0 mm (0.16 in)	3.8 mm (0.15 in)	3.3 mm (0.13 in)

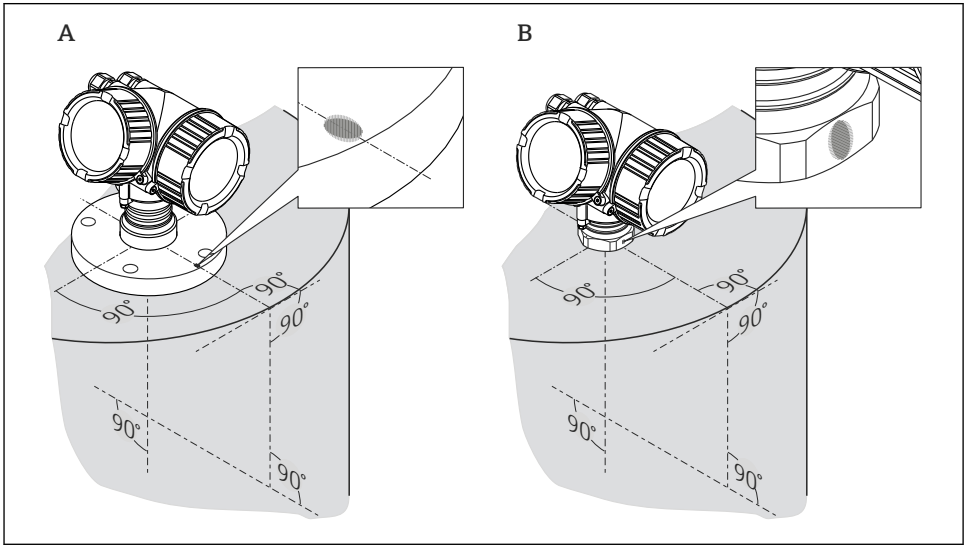
1) Other possible values for the thickness are multiples of the values listed (e.g. for PE: 7,6 mm (0.3 in), 11,4 mm (0.45 in)

3) Feature 610 "Accessory mounted" of the product structure.

6.4.3 Horn antenna, flush mount (FMR52)

Alignment

- Align the antenna vertically to the product surface.
  The maximum range may be reduced if the horn antenna is not vertically aligned.
- A marking at the flange (somwhere between the flange holes) or the boss enables alignment of the antenna. This marking must be aligned towards the tank wall as well as possible.



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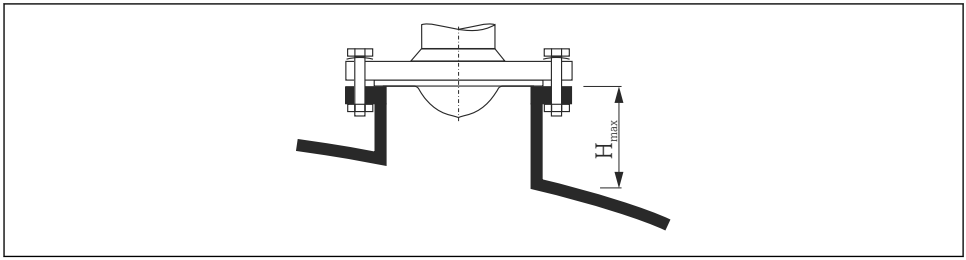
Depending on the device version the marking may be a circle or two short parallel lines.

Nozzle mounting



A0016819

6 *Nozzle height for horn antenna, flush mount (FMR52)*

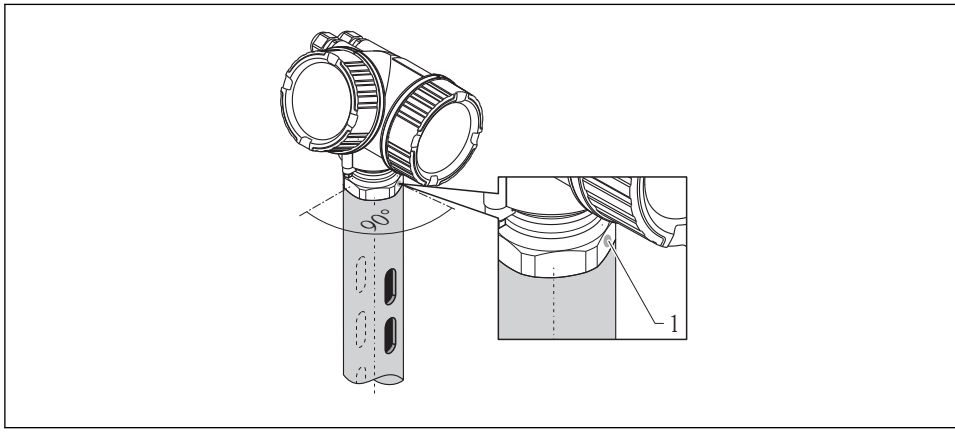
Antenna [1]	Maximum nozzle height H_{max}
BO: Horn 50mm/2"	500 mm (19.7 in)
BP: Horn 80mm/3"	500 mm (19.7 in)

1) Feature 070 of the product structure

Please contact Endress+Hauser for applications with higher nozzle.

- For flanges with PTFE cladding: Observe the notes on the mounting of cladded flanges → 20.
- Usually, the PTFE flange cladding also serves as a seal between the nozzle and the device flange.

6.5 Installation in stilling well



A0016841

7 *Installation in stilling well*

1 Marking for antenna alignment

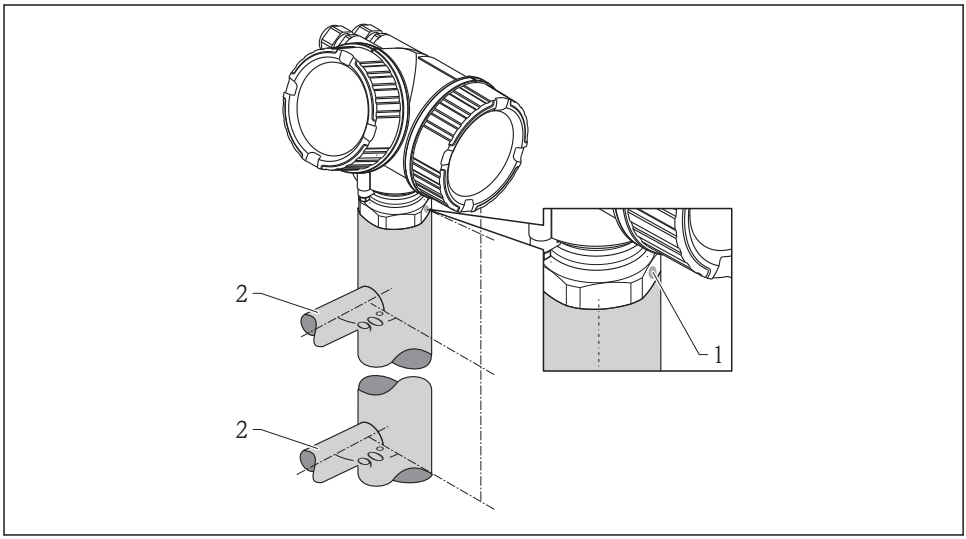
- For horn antenna: Align the marking towards the slots of the stilling well.
- Measurements can be performed through an open full bore ball valve without any problems.
- After mounting, the housing can be turned 350° in order to facilitate access to the display and the terminal compartment → 27.

6.5.1 Recommendations for the stilling well

- Metal (no enamel coating; plastic on request).
- Constant diameter.
- Diameter of stilling well not larger than antenna diameter.

- Diameter difference between horn antenna and inner diameter of the stilling well as small as possible.
- Weld seam as smooth as possible and on the same axis as the slots.
- Slots offset 180° (not 90°).
- Slot width or diameter of holes max. 1/10 of pipe diameter, de-burred. Length and number do not have any influence on the measurement.
- Select horn antenna as big as possible. For intermedaite sizes (e.g. 180 mm (7 in)) select next larger antenna and adapt it mechanically (for horn antennas)
- At any transition (i.e. when using a ball valve or mending pipe segments), no gap may be left exceeding 1 mm (0.04 in).
- The stilling well must be smooth on the inside (average roughness $R_z \leq 6.3$ µm (248 µin)). Use extruded or parallel welded metal pipe. An extension of the pipe is possible with welded flanges or pipe sleeves. Flange and pipe have to be properly aligned at the inside.
- Do not weld through the pipe wall. The inside of the stilling well must remain smooth. In case of unintentional welding through the pipe, the weld seam and any unevenness on the inside need to be carefully removed and smoothened. Otherwise, strong interference echoes will be generated and material build-up will be promoted.
- In the case of smaller nominal widths flanges must be welded to the pipe such that they allow for a correct orientation (marker aligned toward slots).

6.6 Installation in bypass



A0019446

8 Installation in bypass

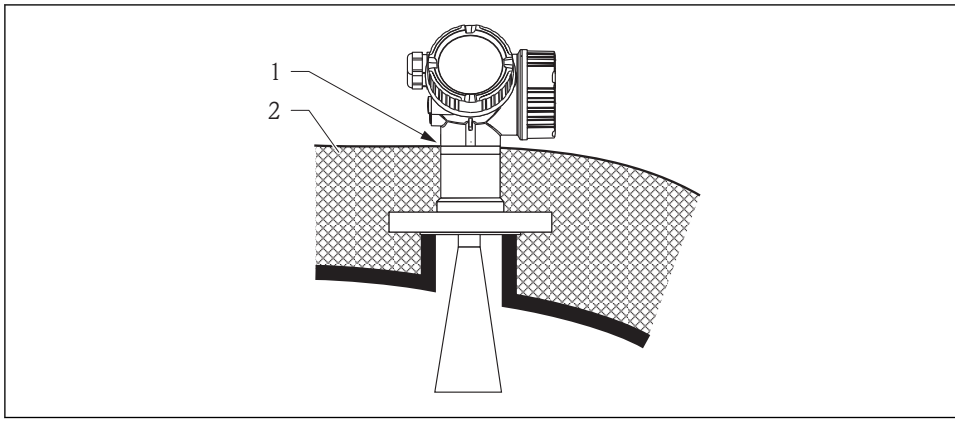
1 Marking for antenna alignment
2 Tank connectors

- Alighn the marker perpendicular (90°) to the tank connectors.
- Measurements can be performed through an open full bore ball valve without any problems.
- After mounting, the housing can be turned 350° in order to facilitate access to the display and the terminal compartment → 📄 27.

6.6.1 Recommendations for the bypass pipe

- Metal (no plastic or enamel coating).
- Constant diameter.
- Select horn antenna as big as possible. For intermediate sizes (e.g. 95 mm (3.5 in)) select next larger antenna and adapt it mechanically (for horn antennas).
- Diameter difference between horn antenna and inner diameter of the bypass as small as possible.
- At any transition (i.e. when using a ball valve or mending pipe segments), no gap may be created exceeding 1 mm (0.04 in).
- In the area of the tank connections (~ ±20 cm (7.87 in)) a reduced accuracy of the measurement has to be expected.

6.7 Vessels with heat insulation



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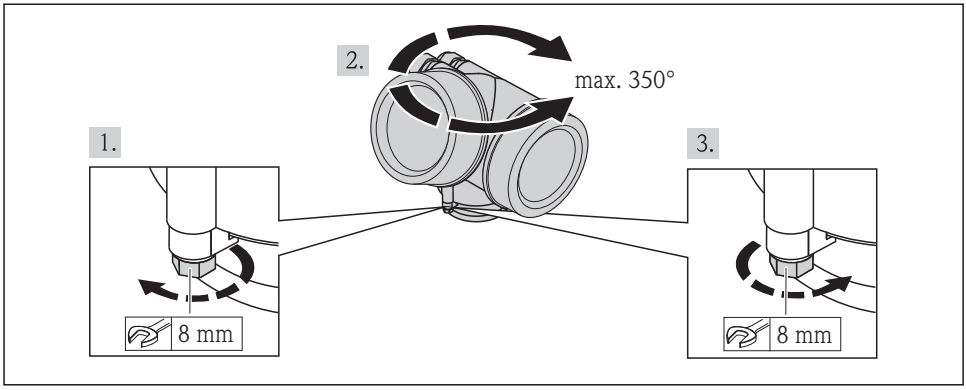
If process temperatures are high, the device must be included in normal tank insulation to prevent the electronics heating up as a result of heat radiation or convection. The insulation may not exceed beyond the neck of the housing.

6.8 Turning the transmitter housing

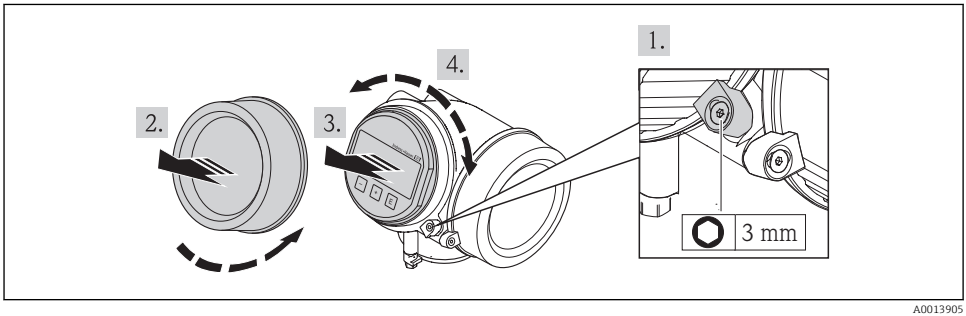
To provide easier access to the connection compartment or display module, the transmitter housing can be turned:



A0013713

1. Unscrew the securing screw using an open-ended wrench.
2. Rotate the housing in the desired direction.
3. Tighten the securing screw (1,5 Nm for plastics housing; 2,5 Nm for aluminium or stainless steel housing).

6.9 Turning the display module



A0013905

1. If present: Loosen the screw of the securing clamp of the electronics compartment cover using an Allen key and turn the clamp 90° conterclockwise.
2. Unscrew cover of the electronics compartment from the transmitter housing.
3. Pull out the display module with a gentle rotation movement.
4. Rotate the display module into the desired position: Max. 8 × 45 ° in each direction.
5. Feed the spiral cable into the gap between the housing and main electronics module and plug the display module into the electronics compartment until it engages.
6. Screw the cover of the electronics compartment firmly back onto the transmitter housing.

7. Tighten the securing clamp again using the Allen key (Torque: 2.5 Nm).

6.10 Post-installation check

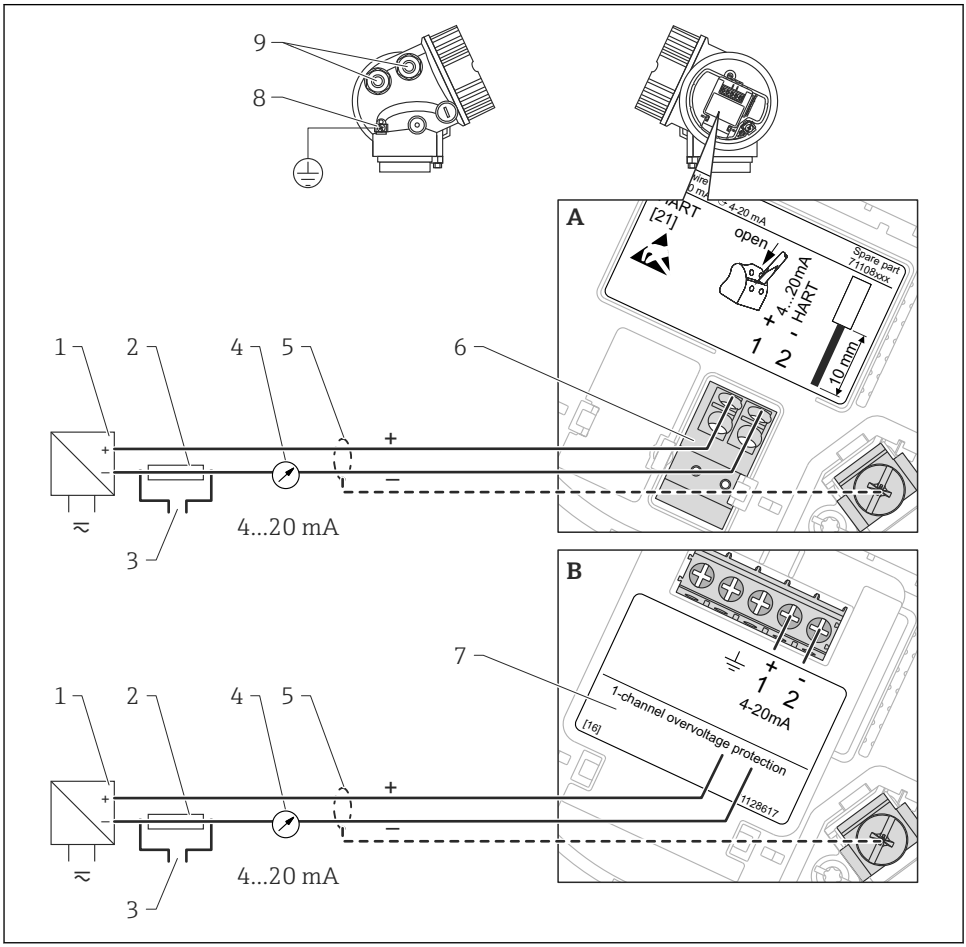
❍	Is the device undamaged (visual inspection)?
❍	Does the device conform to the measuring point specifications? For example: ▪ Process temperature ▪ Process pressure (refer to the chapter on "Material load curves" of the "Technical Information" document) ▪ Ambient temperature range ▪ Measuring range
❍	Are the measuring point identification and labeling correct (visual inspection)?
❍	Is the device adequately protected from precipitation and direct sunlight?
❍	Are the securing screw and securing clamp tightened securely?

7 Electrical connection

7.1 Connection conditions

7.1.1 Terminal assignment

2-wire: 4-20mA HART

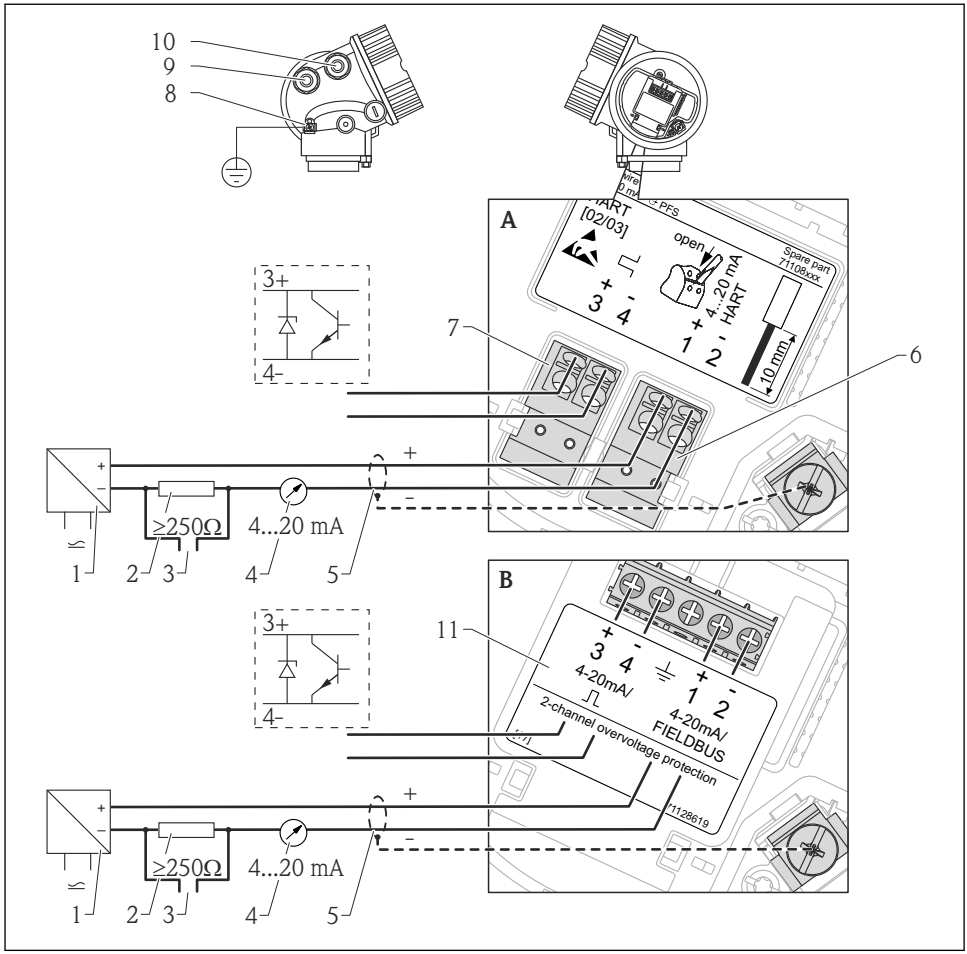


9 Terminal assignment 2-wire; 4-20mA HART

A Without integrated overvoltage protection
B With integrated overvoltage protection
1 Active barrier with power supply (e.g. RN221N): Observe terminal voltage
2 HART communication resistor (≥250 Ω): Observe maximum load
3 Connection for Commubox FXA195 or FieldXpert SFX350/SFX370 (via VIATOR Bluetooth modem)

4 Analog display device: Observe maximum load
5 Cable screen; observe cable specification
6 4-20mA HART (passive): Terminals 1 and 2
7 Overvoltage protection module
8 Terminal for potential equalization line
9 Cable entry

2-wire: 4-20mA HART, switch output

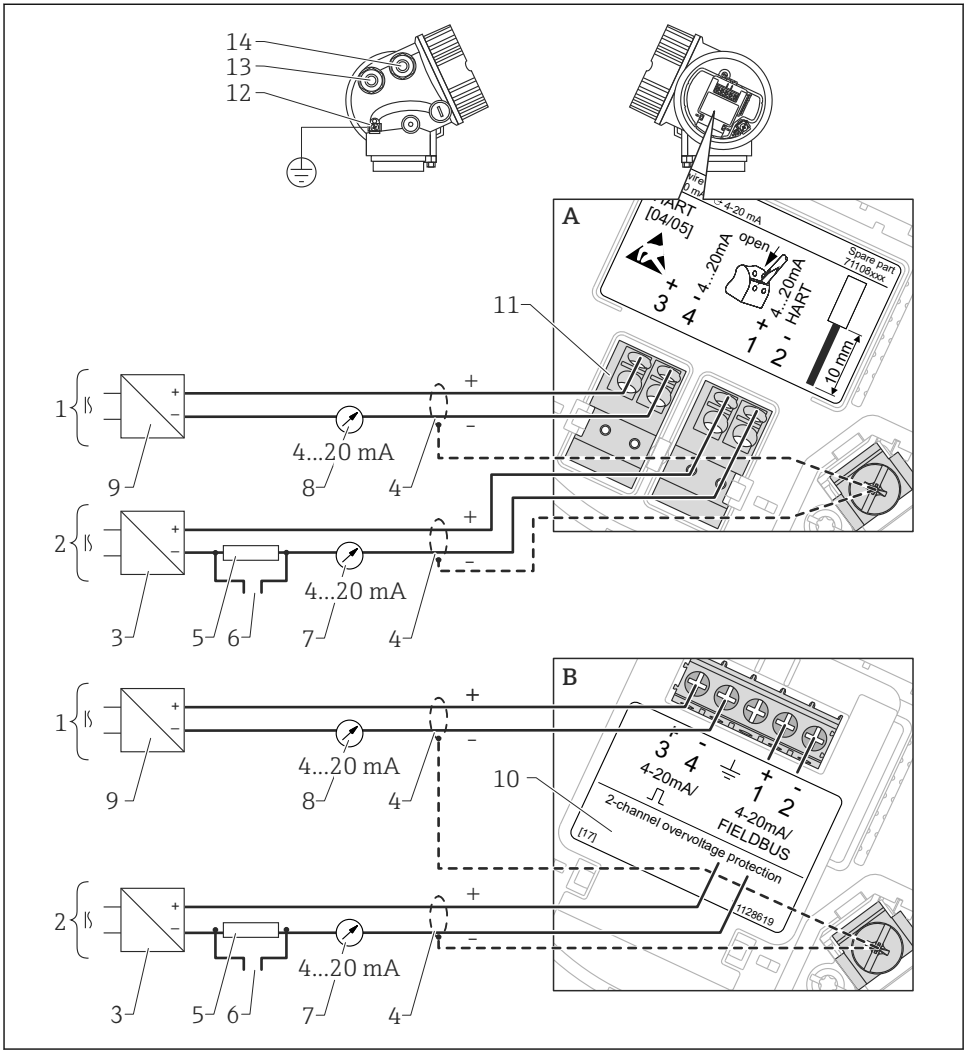


10 Terminal assignment 2-wire; 4-20mA HART, switch output

A Without integrated overvoltage protection
B With integrated overvoltage protection
1 Active barrier with power supply (e.g. RN221N): Observe terminal voltage
2 HART communication resistor (≥250 Ω): Observe maximum load
3 Connection for Commubox FXA195 or FieldXpert SFX350/SFX370 (via VIATOR Bluetooth modem)
4 Analog display device: Observe maximum load
5 Cable screen; observe cable specification
6 4-20mA HART (passive): Terminals 1 and 2
7 Switch output (open collector): Terminals 3 and 4
8 Terminal for potential equalization line

9 Cable entry for 4-20mA HART line
10 Cable entry for switch output line
11 Overvoltage protection module

2-wire: 4-20mA HART, 4-20mA



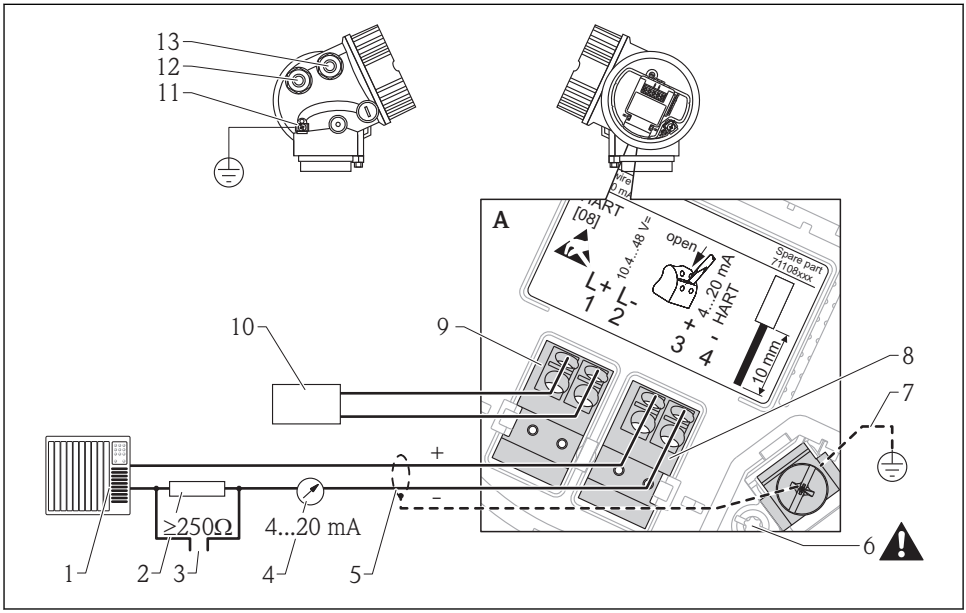
11 Terminal assignment 2-wire, 4-20 mA HART, 4...20mA

A Without integrated overvoltage protection
B With integrated overvoltage protection
1 Connection current output 2
2 Connection current output 1
3 Supply voltage for current output 1 (e.g. RN221N); Observe terminal voltage
4 Cable screen; observe cable specification
5 HART communication resistor (≥250 Ω): Observe maximum load
6 Connection for Commubox FXA195 or FieldXpert SFX350/SFX370 (via VIATOR Bluetooth modem)

7 Analog display device ; observe maximum load
8 Analog display device ; observe maximum load
9 Supply voltage for current output 2 (e.g. RN221N); Obeserve terminal voltage
10 Overvoltage protection module
11 Current output 2: Terminals 3 and 4
12 Terminal for the potential equalization line
13 Cable entry for current output 1
14 Cable entry for current output 2

This version is also suited for single-channel operation. In this case, current output 1 (terminals 1 and 2) must be used.

4-wire: 4-20mA HART (10.4 to 48 V_{DC})

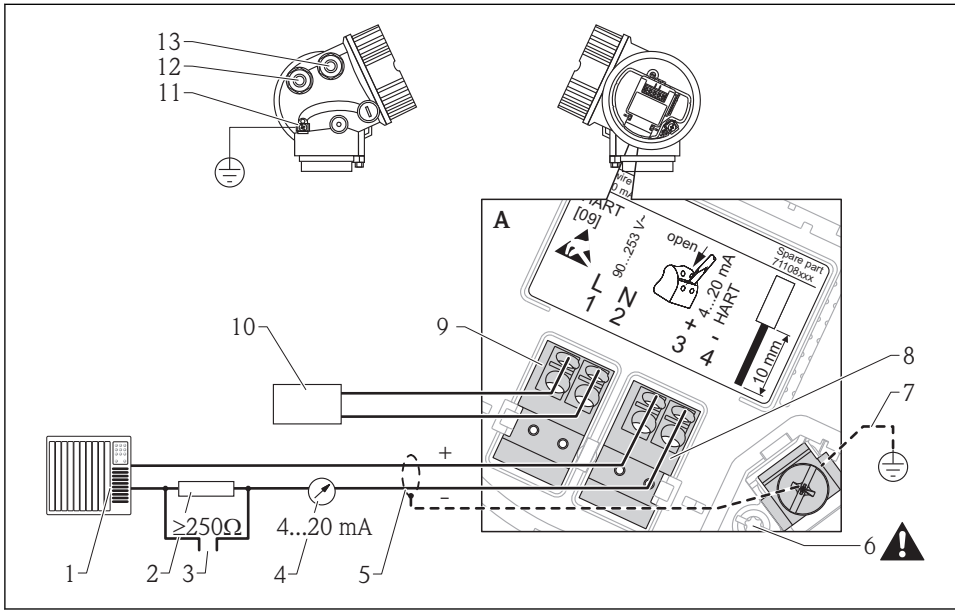


A0011340

12 *Terminal assignment 4-wire; 4-20mA HART (10.4 to 48 VDC)*

1 *Evaluation unit, e.g. PLC*
2 *HART communication resistor (≥250 Ω): Observe maximum load*
3 *Connection for Commubox FXA195 or FieldXpert SFX350/SFX370 (via VIATOR Bluetooth modem)*
4 *Analog display device: Observe maximum load*
5 *Signal cable including screening (if required), observe cable specification*
6 *Protective connection; do not disconnect!*
7 *Protective earth, observe cable specification*
8 *4...20mA HART (active): Terminals 3 and 4*
9 *Supply voltage: Terminals 1 and 2*
10 *Supply voltage: Observe terminal voltage, observe cable specification*
11 *Terminal for potential equalization*
12 *Cable entry for signal line*
13 *Cable entry for power supply*

4-wire: 4-20mA HART (90 to 253 V_{AC})



13 *Terminal assignment 4-wire; 4-20mA HART (90 to 253 VAC)*

1 *Evaluation unit, e.g. PLC*
2 *HART communication resistor (≥250 Ω): Observe maximum load*
3 *Connection for Commubox FXA195 or FieldXpert SFX350/SFX370 (via VIATOR Bluetooth modem)*
4 *Analog display device: Observe maximum load*
5 *Signal cable including screening (if required), observe cable specification*
6 *Protective connection; do not disconnect!*
7 *Protective earth, observe cable specification*
8 *4...20mA HART (active): Terminals 3 and 4*
9 *Supply voltage: Terminals 1 and 2*
10 *Supply voltage: Observe terminal voltage, observe cable specification*
11 *Terminal for potential equalization*
12 *Cable entry for signal line*
13 *Cable entry for power supply*

⚠ CAUTION

To ensure electrical safety:

- ▶ Do not disconnect the protective connection (6).
- ▶ Disconnect the supply voltage before disconnecting the protective earth (7).

Connect protective earth to the internal ground terminal (7) before connecting the supply voltage. If necessary, connect the potential matching line to the external ground terminal (11).

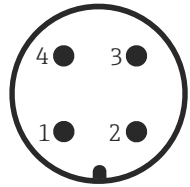
In order to ensure electromagnetic compatibility (EMC): Do not only ground the device via the protective earth conductor of the supply cable. Instead, the functional grounding must also be connected to the process connection (flange or threaded connection) or to the external ground terminal.

An easily accessible power switch must be installed in the proximity of the device. The power switch must be marked as a disconnector for the device (IEC/EN61010).

7.1.2 Device plug connectors

For the versions with fieldbus plug connector (M12 or 7/8"), the signal line can be connected without opening the housing.

Pin assignment of the M12 plug connector



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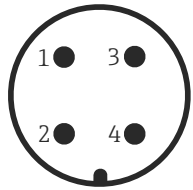
Pin	Meaning
1	Signal +
2	not connected
3	Signal -
4	Ground

Pin assignment of the 7/8" plug connector

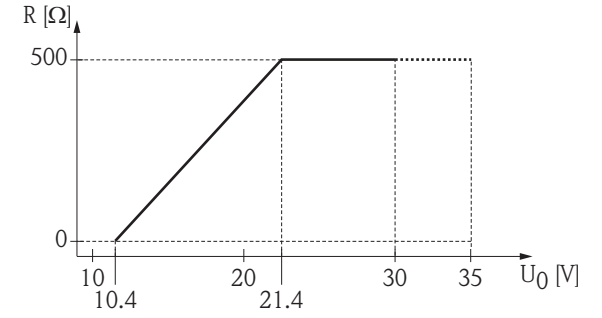
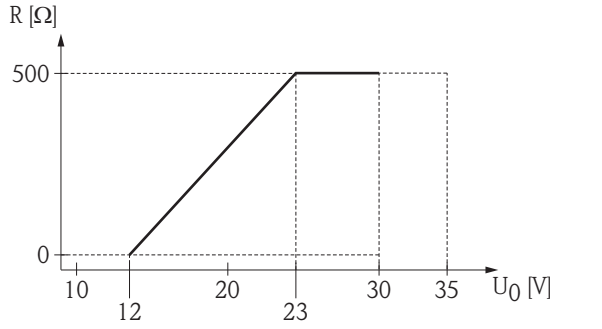


A0011176

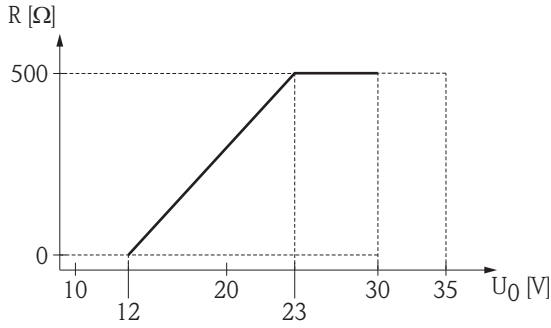
Pin	Meaning
1	Signal -
2	Signal +
3	Not connected
4	Screen

7.1.3 Supply voltage

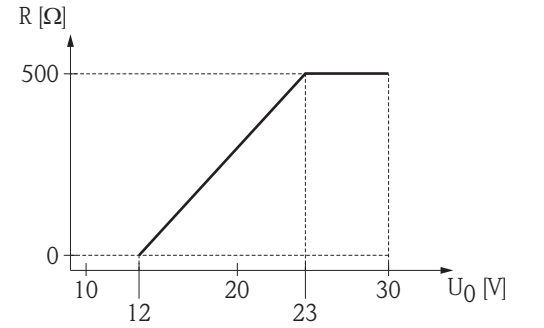
2-wire, 4-20mA HART, passive

"Power Supply, Output" [1]	"Approval" [2]	Terminal voltage U at the device	Maximum load R, depending on the supply voltage U_0 at the supply unit
A: 2-wire; 4-20mA HART	▪ Non-Ex ▪ Ex nA ▪ Ex ic ▪ CSA GP	10.4 to 35 V [3]	
	Ex ia / IS	10.4 to 30 V [3]	
	▪ Ex d(ia) / XP ▪ Ex ic(ia) ▪ Ex nA(ia) ▪ Ex ta / DIP	12 to 35 V [4]	
	Ex ia + Ex d(ia) / IS + XP	12 to 30 V [4]	

1) Feature 020 of the product structure
2) Feature 010 of the product structure
3) For ambient temperatures $T_a \leq$ -20 °C (-4 °F) a minimum voltage of 15 V is required for the sartup of the device at the MIN error current (3,6 mA). The startup current can be parametrized. If the device is operated with a fixed current I ≥ 5,5 mA (HART multidrop mode), a voltage of U ≥ 10,4 V is sufficient throughout the entire range of ambient temperatures.
4) For ambient temperatures $T_a \leq$ -20 °C (-4 °F) a minimum voltage of 16 V is required for the startup of the device at the MIN error current (3.6 mA).

"Power Supply, Output" [1]	"Approval" [2]	Terminal voltage U at the device	Maximum load R, depending on the supply voltage U_0 at the supply unit
B: 2-wire; 4-20 mA HART, switch output	▪ Non-Ex ▪ Ex nA ▪ Ex nA(ia) ▪ Ex ic ▪ Ex ic(ia) ▪ Ex d(ia) / XP ▪ Ex ta / DIP ▪ CSA GP	12 to 35 V [3]	
	▪ Ex ia / IS ▪ Ex ia + Ex d(ia) / IS + XP	12 to 30 V [3]	

1) Feature 020 of the product structure
2) Feature 010 of the product structure
3) For ambient temperatures $T_a \leq$ -30 °C (-22 °F) a minimum voltage of 16 V is required for the startup of the device at the MIN error current (3.6 mA).

"Power Supply, Output" [1]	"Approval" [2]	Terminal voltage U at the device	Maximum load R, depending on the supply voltage U_0 at the supply unit
C: 2-wire; 4-20mA HART, 4-20mA	any	12 to 30 V [3]	

1) Feature 020 of the product structure
2) Feature 010 of the product structure
3) For ambient temperatures $T_a \leq$ -30 °C (-22 °F) a minimum voltage of 16 V is required for the startup of the device at the MIN error current (3.6 mA).

Polarity reversal protection	Yes
Admissible residual ripple at f = 0 to 100 Hz	$U_{SS} < 1$ V
Admissible residual ripple at f = 100 to 10000 Hz	$U_{SS} < 10$ mV

4-wire, 4-20mA HART, active

"Power supply; Output" [1]	Terminal voltage	Maximum load R_{max}
K: 4-wire 90-253VAC; 4-20mA HART	90 to 253 V_{AC} (50 to 60 Hz), overvoltage category II	500 Ω
L: 4-wire 10,4-48VDC; 4-20mA HART	10.4 to 48 V_{DC}	

1) Feature 020 of the product structure

7.1.4 Overvoltage protection

If the measuring device is used for level measurement in flammable liquids which requires the use of overvoltage protection according to DIN EN 60079-14, standard for test procedures 60060-1 (10 kA, pulse 8/20 µs), overvoltage protection has to be ensured by an integrated or external overvoltage protection module.

Integrated overvoltage protection

An integrated overvoltage protection module is available for 2-wire HART as well as PROFIBUS PA and FOUNDATION Fieldbus devices.

Product structure: Feature 610 "Accessory mounted", option NA "Overvoltage protection".

Technical data	
Resistance per channel	2 * 0.5 Ω max
Threshold DC voltage	400 to 700 V
Threshold impulse voltage	< 800 V
Capacitance at 1 MHz	< 1.5 pF
Nominal arrest impulse voltage (8/20 µs)	10 kA

External overvoltage protection

HAW562 or HAW569 from Endress+Hauser are suited as external overvoltage protection.

For detailed information please refer to the following documents:
- HAW562: TI01012K
- HAW569: TI01013K

7.2 Connecting the device

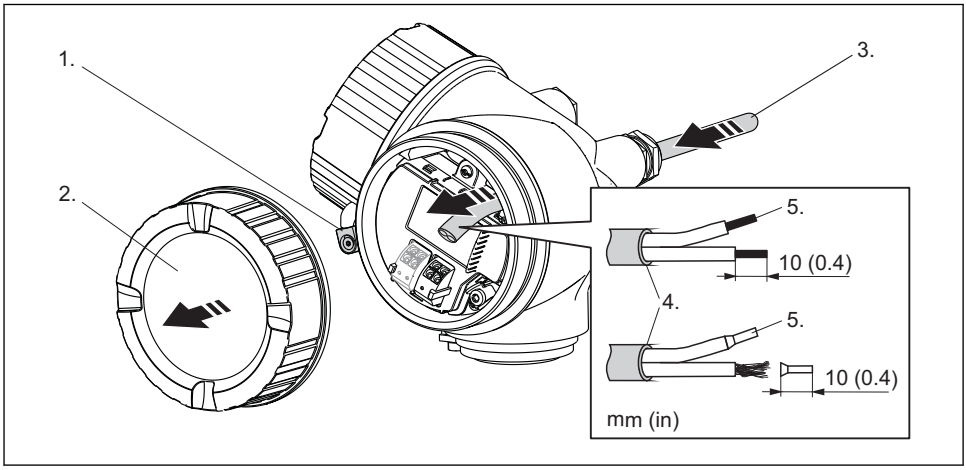
⚠ WARNING

Explosion hazard!

- ▶ Comply with the relevant national standards.
- ▶ Observe the specifications in the Safety Instructions (XA).
- ▶ Only use the specified cable glands.
- ▶ Check whether the supply voltage matches the specifications on the nameplate.
- ▶ Before connecting the device: Switch the supply voltage off.
- ▶ Before switching on the supply voltage: Connect the potential bonding line to the exterior ground terminal.

Required tools and accessories:

- For instruments with safety pin for the lid: AF 3 Allen key
- Wire stripping pliers
- When using stranded wires: Wire end sleeves.



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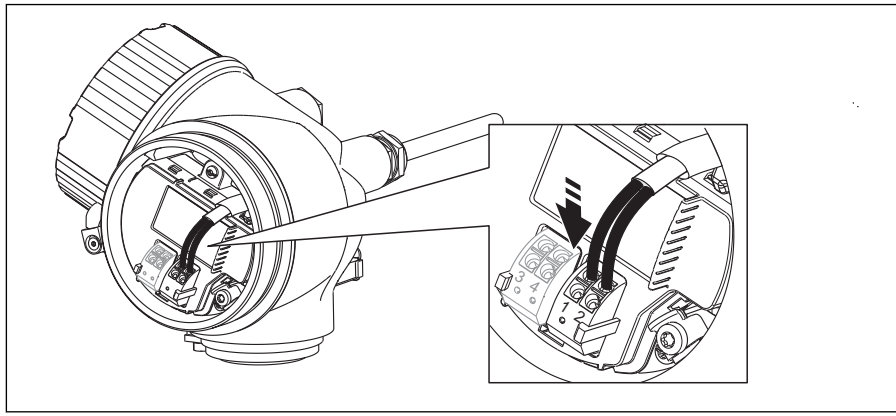
1. Loosen the screw of the securing clamp of the connection compartment cover and turn the clamp 90° counterclockwise.
2. Unscrew the connection compartment cover.
3. Push the cable through the cable entry. To ensure tight sealing, do not remove the sealing ring from the cable entry.
4. Strip the cable.
5. Strip the cable ends 10 mm (0.4 in). For stranded cables, also attach wire end ferrules.
6. Firmly tighten the cable glands.

7.



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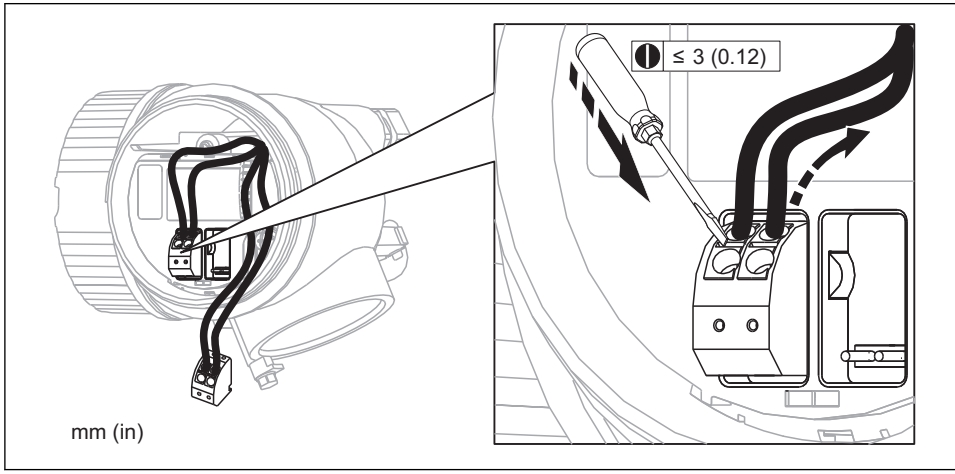
Connect the cable in accordance with the terminal assignment → 30.

8. When using screened cable: Connect the cable screen to the ground terminal.
9. Screw the cover onto the connection compartment.
10. For instruments with safety pin for the lid: Adjust the safety pin so that its edge is over the edge of the display lid. Tighten the safety pin.

7.2.1 Pluggable spring-force terminals

Instruments without integrated overvoltage protection have pluggable spring-force terminals. Rigid conductors or flexible conductors with cable sleeve can directly be inserted and are contacted automatically.

To remove cables from the terminal: Press on the groove between the terminals using a flat-tip screwdriver ≤ 3 mm (0.12 inch) while pulling the cables out of the terminals.



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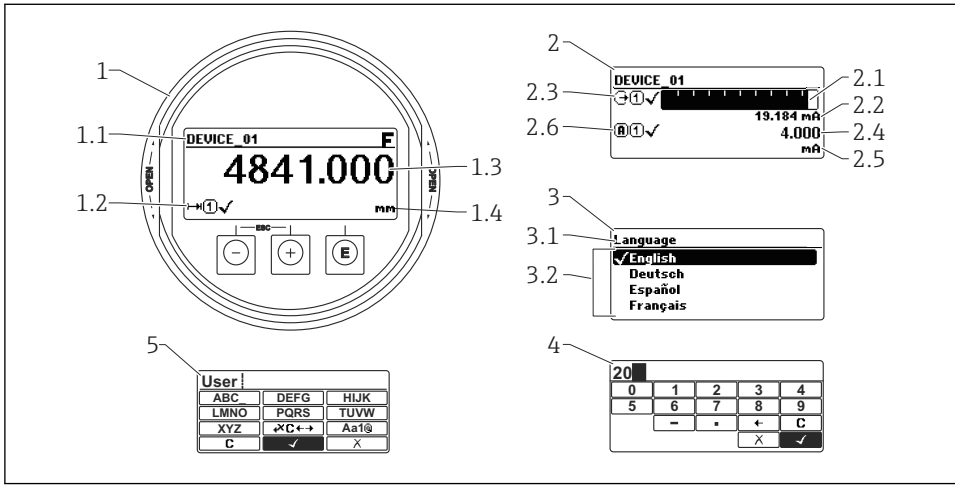
7.3 Post-connection check

❍	Are cables or the device undamaged (visual inspection)?
❍	Do the cables comply with the requirements?
❍	Do the cables have adequate strain relief?
❍	Are all cable glands installed, firmly tightened and correctly sealed?
❍	Does the supply voltage match the specifications on the transmitter nameplate?
❍	Is the terminal assignment correct → 🖹 30?
❍	If required: Is the protective earth connected correctly ?
❍	If supply voltage is present: Is the device ready for operation and do values appear on the display module?
❍	Are all housing covers installed and firmly tightened?
❍	Is the securing clamp tightened correctly?

8 Commissioning (via operating menu)

8.1 Display and operating module

8.1.1 Display appearance



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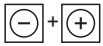
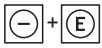
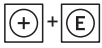
14 *Appearance of the display and operation module for on-site operation*

1 Measured value display (1 value max. size)
1.1 Header containing tag and error symbol (if an error is active)
1.2 Measured value symbols
1.3 Measured value
1.4 Unit
2 Measured value display (1 bargraph + 1 value)
2.1 Bargraph for measured value 1
2.2 Measured value 1 (including unit)
2.3 Measured value symbols for measured value 1
2.4 Measured value 2
2.5 Unit for measured value 2
2.6 Measured value symbols for measured value 2
3 Representation of a parameter (here: a parameter with selection list)
3.1 Header containing parameter name and error symbol (if an error is active)
3.2 Selection list; ☑ marks the current parameter value.
4 Input matrix for numbers
5 Input matrix for alphanumeric and special characters

8.1.2 Operating elements

Key	Meaning
 A0013969	**Minus key** *For menu, submenu* Moves the selection bar upwards in a picklist. *For text and numeric editor* In the input mask, moves the selection bar to the left (backwards).
 A0013970	**Plus key** *For menu, submenu* Moves the selection bar downwards in a picklist. *For text and numeric editor* In the input mask, moves the selection bar to the right (forwards).
 A0013952	**Enter key** *For measured value display* ▪ Pressing the key briefly opens the operating menu. ▪ Pressing the key for 2 s opens the context menu. *For menu, submenu* ▪ Pressing the key briefly Opens the selected menu, submenu or parameter. ▪ Pressing the key for 2 s for parameter: If present, opens the help text for the function of the parameter. *For text and numeric editor* ▪ Pressing the key briefly – Opens the selected group. – Carries out the selected action. ▪ Pressing the key for 2 s confirms the edited parameter value.
 A0013971	**Escape key combination (press keys simultaneously)** *For menu, submenu* ▪ Pressing the key briefly – Exits the current menu level and takes you to the next higher level. – If help text is open, closes the help text of the parameter. ▪ Pressing the key for 2 s returns you to the measured value display ("home position"). *For text and numeric editor* Closes the text or numeric editor without applying changes.
 A0013953	**Minus/Enter key combination (press and hold down the keys simultaneously)** Reduces the contrast (brighter setting).
 A0013954	**Plus/Enter key combination (press and hold down the keys simultaneously)** Increases the contrast (darker setting).
 A0013955	**Minus/Plus/Enter key combination (press and hold down the keys simultaneously)** *For measured value display* Enables or disables the keypad lock.

8.1.3 Opening the context menu

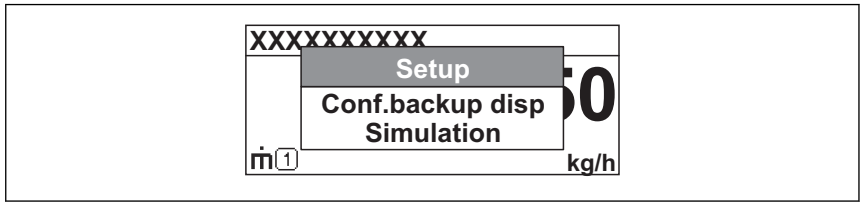
Using the context menu, the user can call up the following menus quickly and directly from the operational display:

- Setup
- Conf. backup disp.
- Simulation

Calling up and closing the context menu

The user is in the operational display.

1. Press E for 2 s.
   ↳ The context menu opens.



A0014003-EN

2. Press − + + simultaneously.
   ↳ The context menu is closed and the operational display appears.

Calling up the menu via the context menu

1. Open the context menu.
2. Press + to navigate to the desired menu.
3. Press E to confirm the selection.
   ↳ The selected menu opens.

8.2 Operating menu

Parameter/Submenu	Meaning	Description
Language [1]	Defines the operating language of the on-site display.	BA01049F (FMR51/FMR52, HART)
Setup	When appropriate values have been assigned toall setup parameters, the measured should be completely configured in a standard application.	
Setup → Mapping	Interference echo suppression	
Setup → Advanced setup	Contains further submenus and parameters: ▪ to adapt the device to special measuring conditions. ▪ to process the measured value (scaling, linearization). ▪ to configure the signal output.	
Diagnostics	Contains the most important parameters needed to detect and analyze operational errors.	
Expert [2]	Contains all parameters of the device (including those which are already contained in one of the above submenus). This menu is organized according to the function blocks of the device.	GP01014F/00/DE (Description of Device Parameters, FMR5x, HART)

1) In case of operation via operating tools (e.g. FieldCare), the "Language" parameter is located at "Setup → Advanced Setup → Display"
2) On entering the "Expert" menu, an access code is always requested. If a customer specific access code has not been defined, "0000" has to be entered.

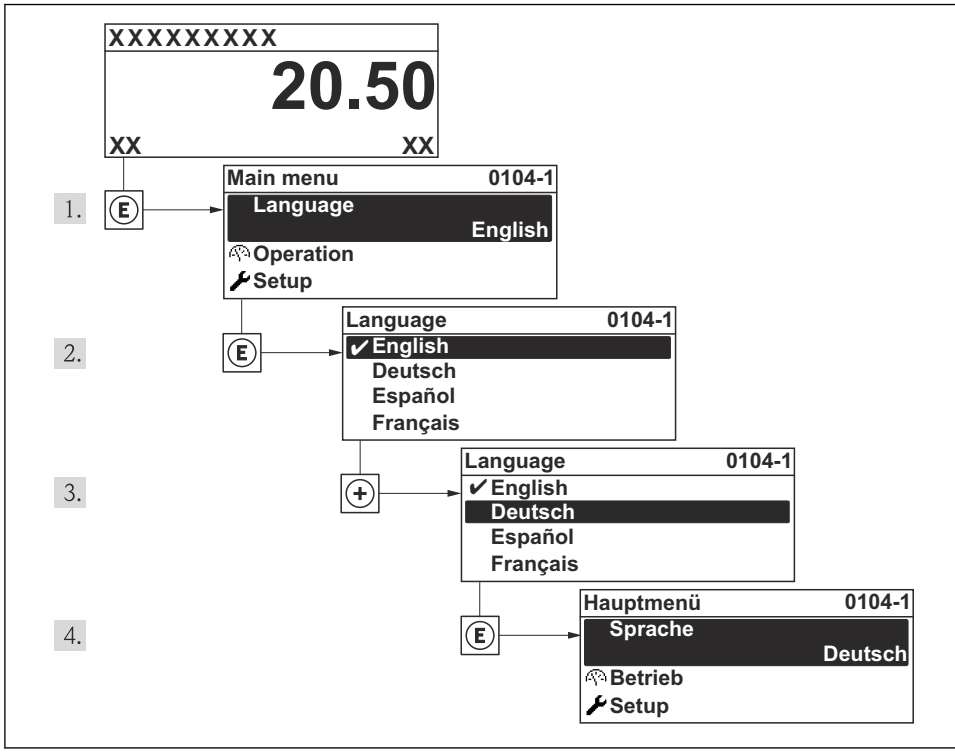
8.3 Unlock the device

If the device has been locked, it must be unlocked before the measurement can be configured.

For details refer to the Operating Instructions of the device:
BA01049F (FMR51/FMR52, HART)

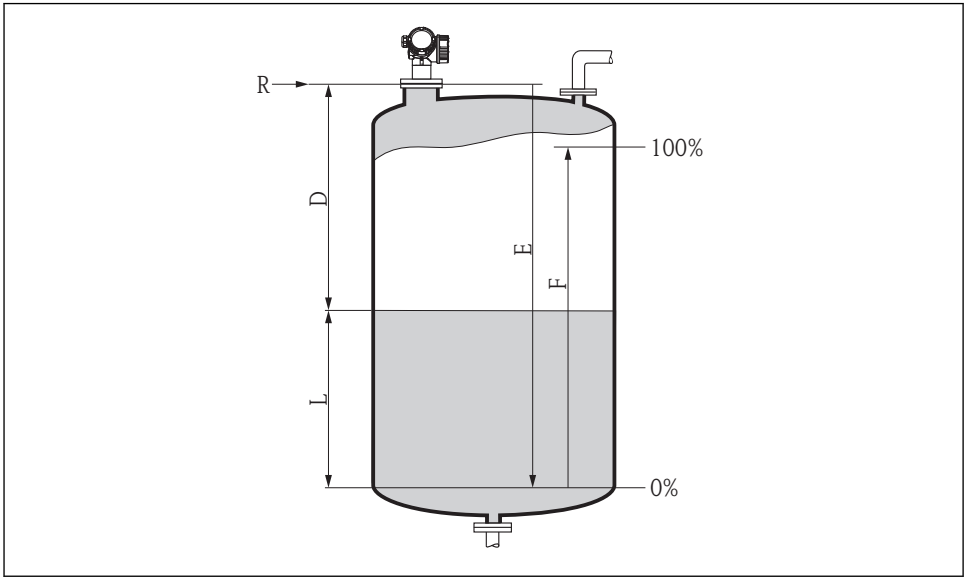
8.4 Setting the operating language

Factory setting: English or ordered local language



15 *Using the example of the local display*

8.5 Configuration of a level measurement



A0016933

1. **Setup → Device tag**
   ↳ Enter device tag.
2. **Setup → Distance unit**
   ↳ Select distance unit.
3. **Setup → Tank type**
   ↳ Select tank type.
4. **Setup → Tube diameter** (only for "Tank type" = "Bypass/pipe")
   ↳ Enter the diameter of the stilling well or bypass.
5. **Setup → Medium group**
   ↳ Specify medium group ("Water based": DC>4 or "Others": DC>1,9)
6. **Setup → Empty calibration**
   ↳ Enter empty distance E (Distance from reference point R to the 0% level) [4].
7. **Setup → Full calibration**
   ↳ Enter full distance F (Distance from the 0% to the 100% level).

4) If the measuring range covers only an upper part of the tank or silo (E << tank/silo height), it is mandatory to enter the acutal tank or silo height into the "Setup → Advanced Setup → Level → Tank/silo height" parameter. If there is an outlet cone, the tank or silo height should not be adjusted as usually E is not << tank/silo height in these applications.

8. **Setup → Level**
   ↳ Indicates the measrued level L.
9. **Setup → Distance**
   ↳ Indicates the measured distance from the reference point R to the level L.
10. **Setup → Signal quality**
    ↳ Indicates the quality of the evaluated level echo.
11. **Setup → Mapping → Confirm distance**
    ↳ Compare distance indicated on the display to real distance in order to start the recording of an interference echo map.
12. **Setup → Advanced setup →Level → Level unit**
    ↳ Select level unit: %, m, mm, ft, in (Factory setting: %)

The response time of the device is preset by the **Tank type** parameter. An enhanced setting is possible in the **Advanced setup** submenu.

8.6 User-specific applications

For details of setting the parameters of user-specific applications, see separate documentation:
BA01049F (Operating Instructions, FMR51/FMR52, HART)

For the **Expert** submenu refer to:
GP01014F/00/EN (Description of Device Parameters, FMR5x, HART)

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