OPTIFLEX 3200 C/F Handbook

Guided radar (TDR) level transmitter for liquids with hygienic requirements

KROHNE

1.1 Software history

"Firmware revision" agrees with NAMUR NE 53. It is a series of numbers used to record the revision status of embedded software (firmware) in electronic equipment assemblies. It gives data on the type of changes made and the effect that changes have on compatibility.

Data about software revisions is shown in menu **2.1.0 Identification**. For more data, refer to *Function description* on page 61. If it is not possible to refer to the device menu, record the serial number of the device (given on the device nameplate) and speak or write to your supplier for more data.

INFORMATION!
The table that follows gives data about devices with the 4...20 mA + HART® output options. For software history data about MODBUS and fieldbus communication options, refer to the related supplementary instructions.

Release date	Printed circuit assembly	Firmware revision	Electronic revision	Hardware revision	Changes and compatibility	Documentation
2019-05-15	Converter	2.00.00	Non-Ex / Ex i: 02.01.00	4004031102 ①	—	HB OPTIFLEX 3200 R01 + R02
				4000679802 ②		
	Optional output		2 outputs / Ex d / cQPSus: 02.00.00	4004030802		
	Sensor	2.00.01		4003522502 ①		
				4000664602 ②		
	HMI (LCD display option)	1.12.00		4004676102		

① Hardware used for the compact version (C) of the device
② Hardware used for the remote version (F) version of the device

1.2 Intended use

CAUTION!
Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

INFORMATION!
The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

This TDR level transmitter measures distance, level, interface, mass and volume of liquids, pastes and slurries.

It can be installed on tanks and reactors.

1.3 Certification

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

CE marking

The device meets the essential requirements of the EU Directives:

• Electromagnetic Compatibility (EMC) directive
• For devices used in hazardous locations: ATEX directive

The manufacturer certifies successful testing of the product by applying the CE marking. For more data about the EU Directives and European Standards related to this device, refer to the EU Declaration of Conformity. You can download this document free of charge from the website (Download Center).

All devices are based on the CE marking and meet the requirements of NAMUR Recommendations NE 21, NE 43, NE 53 and NE 107.

1.4 Electromagnetic compatibility

The device design agrees with the Electromagnetic Compatibility (EMC) Directive and the related European Standard when installed in metallic tanks.

You can install the device on open-air tanks and tanks that are not made of metal. Refer also to the note that follows.

CAUTION!
If you install a device with a rod or cable probe in a non-metallic tank or open-air pit, a strong electromagnetic field near to the device can have an unwanted effect on the accuracy.

This device meets the essential requirements of the related European Standard:

• Emissions: class A and class B
• Immunity: basic, industrial and controlled environments

INFORMATION!
The device agrees with these conditions if the device has a single rod or single cable probe and is used in a closed tank made of metal.

1.5 Safety instructions from the manufacturer

1.5.1 Copyright and data protection

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The contents and works in this document are subject to copyright. Contributions from third parties are identified as such. Reproduction, processing, dissemination and any type of use beyond what is permitted under copyright requires written authorisation from the respective author and/or the manufacturer.

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We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.5.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect or incidental and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.5.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation or operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.5.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of icons as shown below.

1.5.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.

DANGER!
This warning refers to the immediate danger when working with electricity.

DANGER!
This warning refers to the immediate danger of burns caused by heat or hot surfaces.

DANGER!
This warning refers to the immediate danger when using this device in a hazardous atmosphere.

DANGER!
These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.

WARNING!
Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.

CAUTION!
Disregarding these instructions can result in damage to the device or to parts of the operator's plant.

INFORMATION!
These instructions contain important information for the handling of the device.

LEGAL NOTICE!
This note contains information on statutory directives and standards.

- HANDLING
  This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.
  ➲ RESULT
  This symbol refers to all important consequences of the previous actions.

1.6 Safety instructions for the operator

WARNING!
In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.
This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.

2.1 Scope of delivery

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

OPTIFLEX 3200 C — Compact version
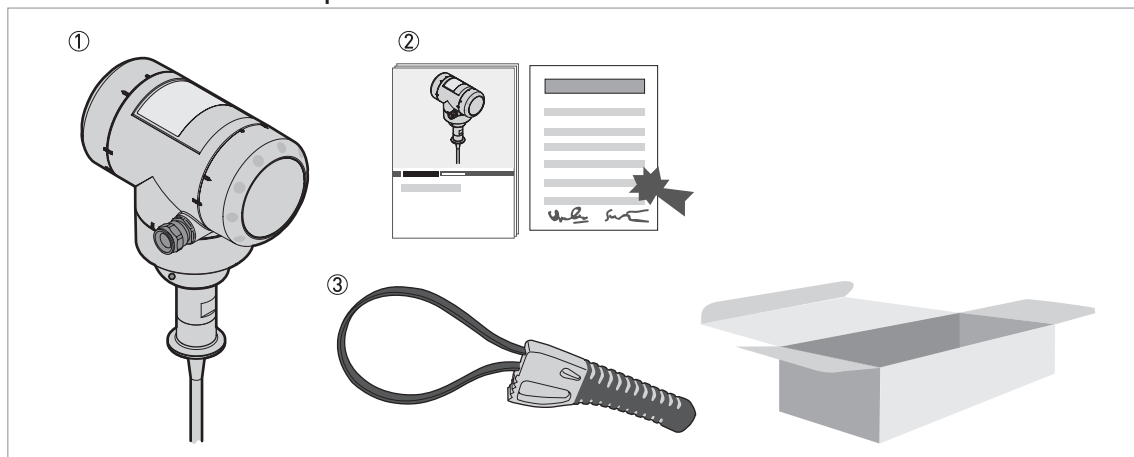
Figure 2-1: Scope of delivery (OPTIFLEX 3200 C — Compact version)

① Signal converter and probe (if supplied with the applicable probe option)
② Quick Start
③ Strap wrench

OPTIFLEX 3200 F — Remote version
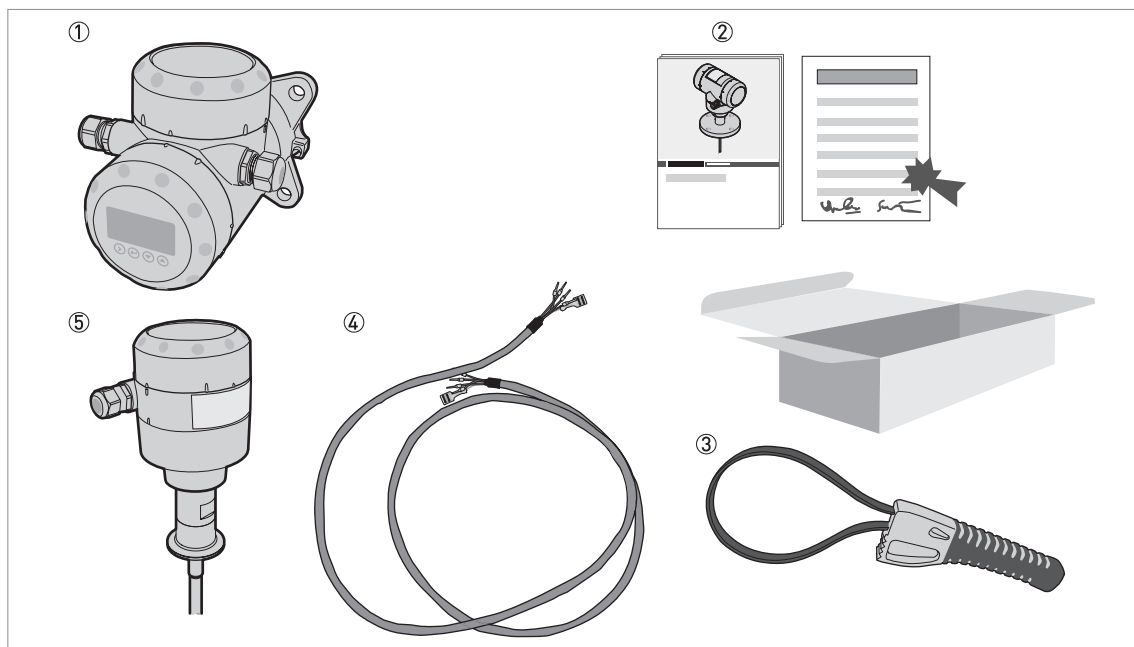
Figure 2-2: Scope of delivery (OPTIFLEX 3200 F — Remote version)

① Signal converter
② Quick Start
③ Strap wrench
④ RS-485 cable. A signal cable connects the signal converter to the probe electronics housing. This signal cable is supplied on request. For more data about the signal cable, refer to *Remote device data* on page 38.
⑤ Probe electronics housing, process connection and probe (if supplied with the applicable probe option)

2.2 Device description

This TDR level transmitter measures distance, level, interface, mass and volume of liquids, pastes and slurries.

TDR level transmitters use a probe to guide a signal to the surface of the measured product. The device has a large choice of probes. Thus, it can measure most products in difficult conditions. For more data, refer to *Technical data* on page 119.

The signal converter of the device has 2 versions: Compact version (C) and Remote version (F). The converter can also be ordered with horizontal or vertical housing options for easy access to the device terminals and the optional display.

Compact version (C)
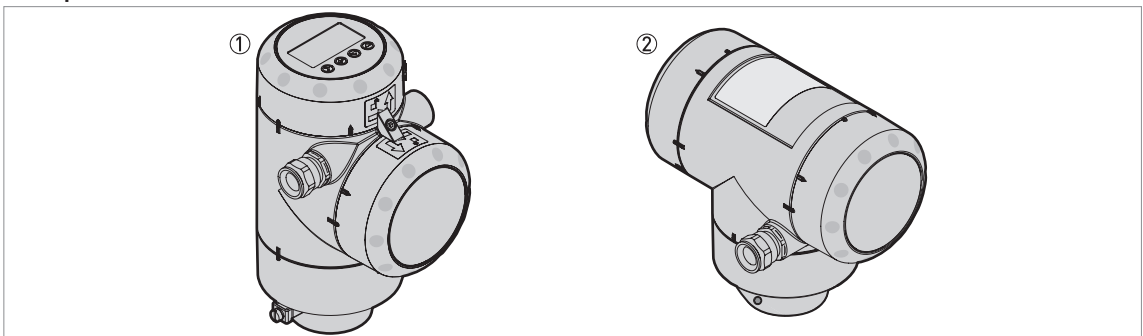
Figure 2-3: Compact version (C)
① Vertical housing option
② Horizontal housing option

The signal converter is attached directly to the process connection and the probe.

Remote version (F)
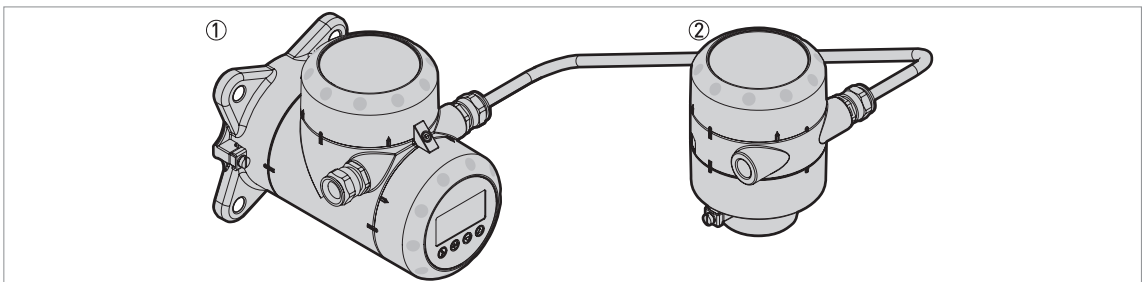
Figure 2-4: Remote version (F) with an RS-485 signal cable between the signal converter and the probe electronics housing
① Signal converter with wall support
② Probe electronics housing (attached to the process connection)

The signal converter is installed away from the process connection and the probe (for example: at the bottom of a tank). The RS-485 signal cable between the signal converter and the probe electronics housing has a maximum length of 100 m / 328 ft.

INFORMATION!
The length of the coaxial cable agrees with the data given in the customer order.

2.3 Visual check

> **INFORMATION!**
> *Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.*
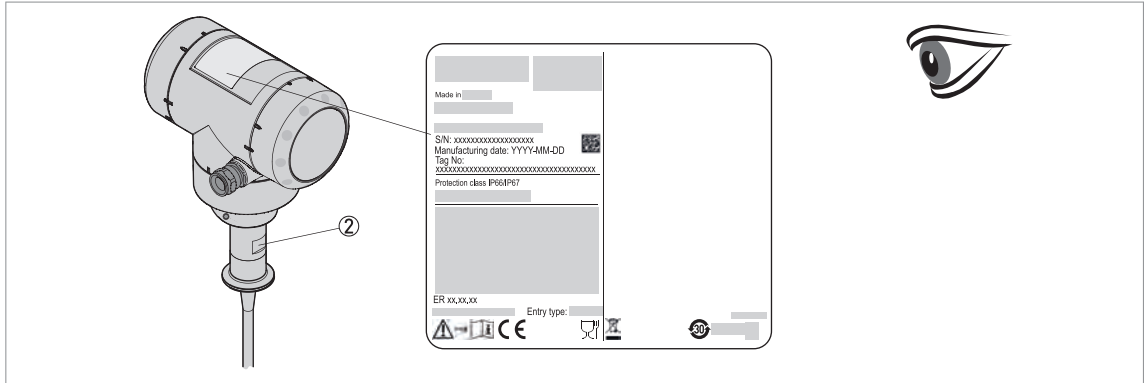
Figure 2-5: Visual check

① Device nameplate (for more data, refer to *Non-Ex nameplate* on page 15)
② Gasket material data — refer to the illustration that follows

> **WARNING!**
> *Devices delivered in wooden crates*
> *Make sure that you remove all the braces from the crate before you remove the device.*
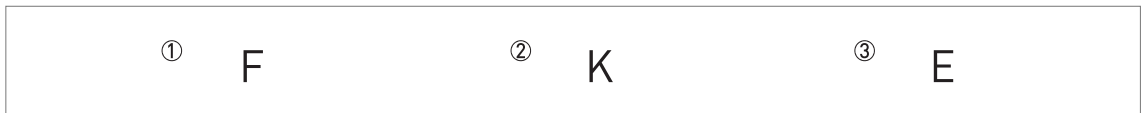
Figure 2-6: Symbols for the supplied gasket material (on the side of the process connection)

① FKM/FPM
② Kalrez® 6221
③ EPDM

2.4 Nameplates

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order.
Check for the correct supply voltage printed on the nameplate.

2.4.1 Non-Ex nameplate
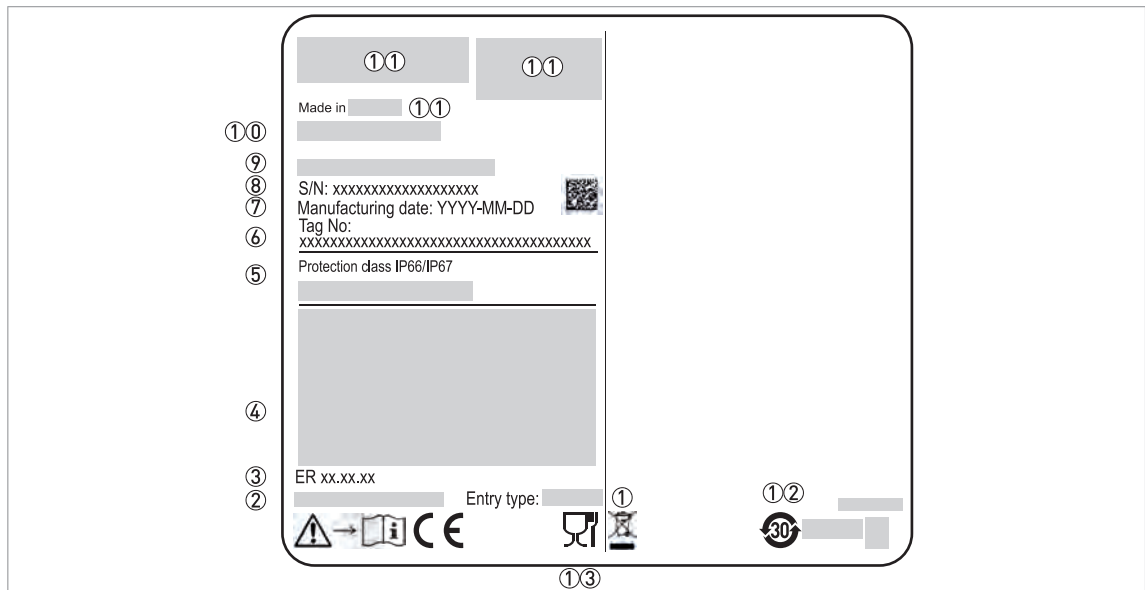
Figure 2-7: Compact version (C) and remote version (F): Non-Ex nameplate attached to the housing

① Cable entry size
② PROFIBUS Device ID (Profile ID) – only available with the PROFIBUS PA output option
③ Hardware revision / Software revision (according to NAMUR NE 53)
④ Signal output (analog, HART®, fieldbus, etc.), input voltage and maximum current (fieldbus options: basic current)
⑤ Degree of ingress protection (according to EN 60529 / IEC 60529)
⑥ Customer tag number
⑦ Date of manufacture
⑧ Serial number
⑨ Type code (defined in order)
⑩ Model name and number. The last letter "X" is either:
 C = compact version,
 F = remote version or
⑪ Company logo, name and postal address
 Country of manufacture / Company web address
⑫ Symbol to show that the device agrees with China RoHS (Chinese Government regulation to prevent contamination of the environment from materials used in the manufacture of electronic devices). The value given on the symbol is the time in years that the device is guaranteed to be environmentally safe.
⑬ Food safe symbol. This symbol agrees with the requirements of Regulation (EC) No 1935/2004.
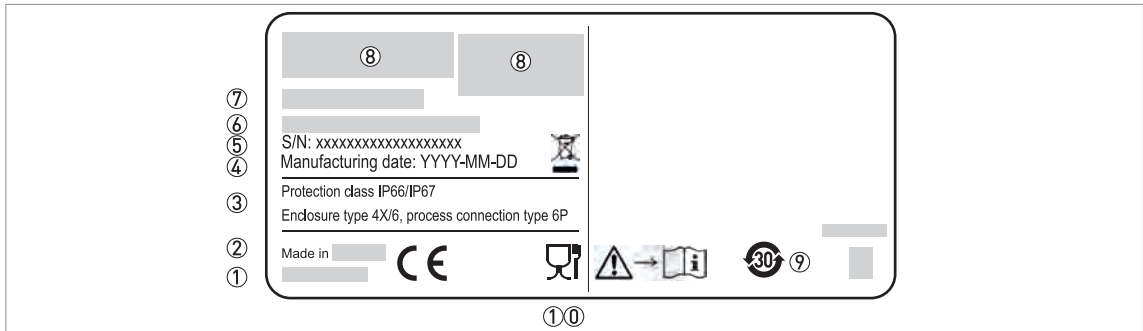
Figure 2-8: Remote version (F): Non-Ex nameplate attached to the probe assembly

① Company web address
② Country of manufacture
③ Degree of ingress protection (according to EN 60529 / IEC 60529)
④ Date of manufacture
⑤ Serial number
⑥ Type code (defined in order)
⑦ Model name and number. The last letter "X" = "F" remote version.
⑧ Company logo, name and postal address
⑨ Symbol to show that the device agrees with China RoHS (Chinese Government regulation to prevent contamination of the environment from materials used in the manufacture of electronic devices). The value given on the symbol is the time in years that the device is guaranteed to be environmentally safe.
⑩ Food safe symbol. This symbol agrees with the requirements of Regulation (EC) No 1935/2004.

3.1 General notes on installation

i *INFORMATION!*
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

i *INFORMATION!*
Do a check of the packing list to make sure that you have all the elements given in the order.

i *INFORMATION!*
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2 Storage

! *WARNING!*
Do not keep the device in a vertical position. This will damage the probe and the device will not measure correctly.
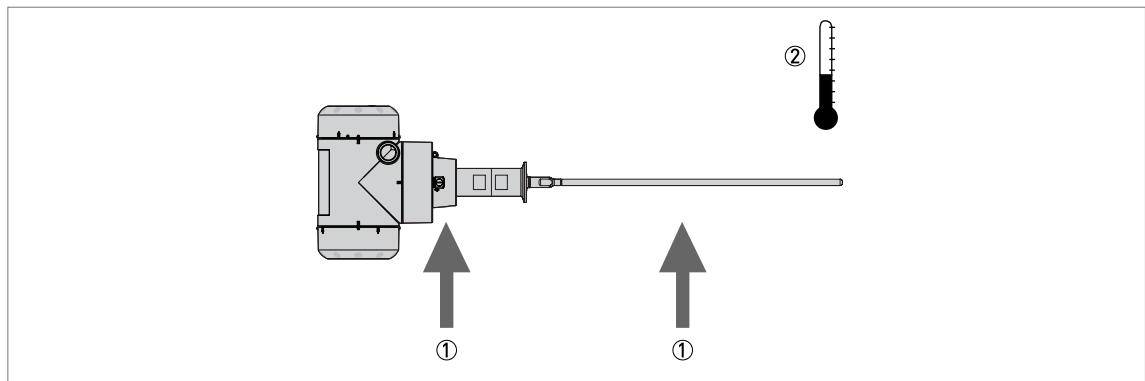
Figure 3-1: Storage conditions

① Do not bend rod — support here
② Storage temperature range: -50…+85°C / -58…+185°F (min. -40°C / -40°F for devices with the integrated LCD display option)

• Store the device in a dry and dust-free location.
• Store the device in its original packing.

3.3 Transport
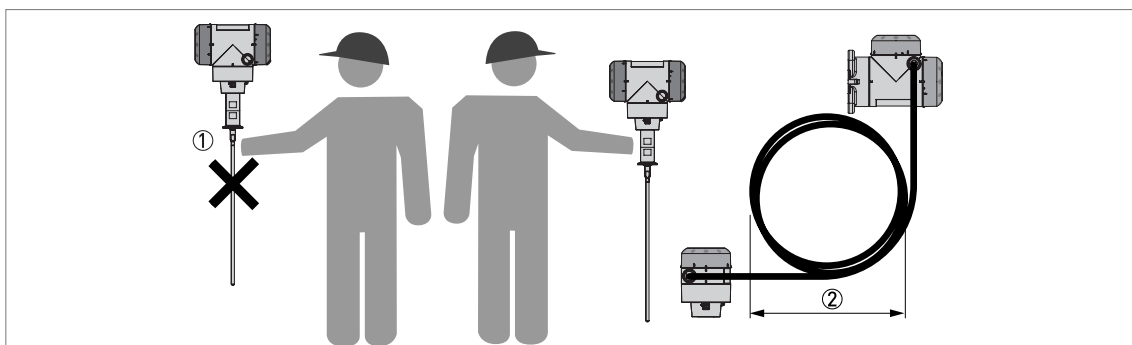
Figure 3-2: How to hold the device

① Do not hold the probe when you lift the device.
② Do not wind the electrical cable less than 400 mm / 16¨ in diameter.

> *WARNING!*
> *If you do not lift the device carefully, you can cause damage to the probe.*

3.4 Pre-installation requirements

> *INFORMATION!*
> *Obey the precautions that follow to make sure that the device is correctly installed.*

- Make sure that there is sufficient space on all sides.
- Heat sources (sunlight, adjacent system components etc.) can increase the internal temperature of the device and cause damage. Make sure that the internal temperature is not more than the maximum limit. The maximum permitted ambient temperature is +75°C / +167°F. The maximum permitted surface temperature is +80°C / +176°F. If it is necessary to decrease the internal temperature, install the weather protection accessory.
- Do not subject the signal converter to heavy vibrations.

3.5 How to prepare the tank before you install the device

⚠ *CAUTION!*
To avoid measuring errors and device malfunction, obey these precautions.

3.5.1 Pressure and temperature ranges
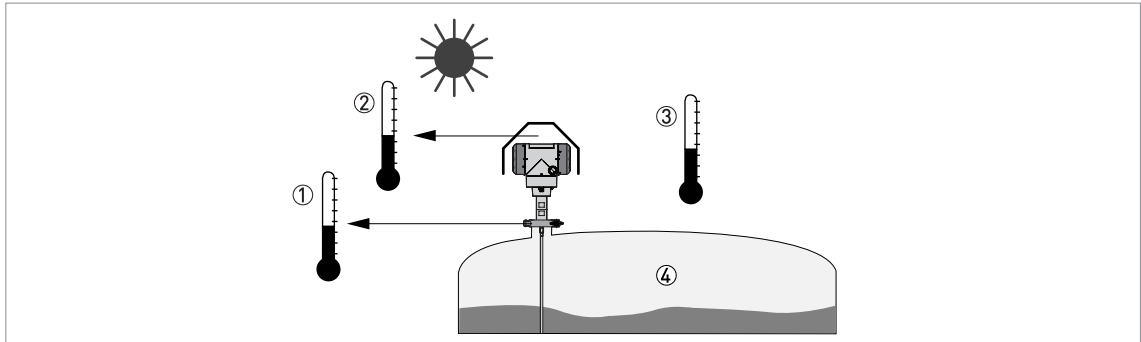
Figure 3-3: Pressure and temperature ranges

① Temperature at the process connection
   Refer to the table "Permitted temperature ranges for gaskets" that follows and to "Technical data" on page 122.
   Devices with Hazardous Location approvals: see supplementary instructions
② Ambient temperature for operation of the display
   -20...+60°C / -4...+140°F
   If the ambient temperature is not between these limits, the display screen switches off automatically
③ Ambient temperature
   Non-Ex devices: -40...+80°C / -40...+176°F
   Devices with Hazardous Location approvals: see supplementary instructions
④ Process pressure
   -1...40 barg / -14.5...580 psig

⚠ *WARNING!*
The process connection temperature range must agree with the temperature limits of the gasket material.

Permitted temperature ranges for gaskets

Gasket material	Permitted temperature ranges for gaskets	
	[°C]	[°F]
FKM/FPM	-40…+200	-40…+392
Kalrez® 6221	-20…+150	-4…+302
EPDM	-50…+150	-58…+302
TFM-T62 ①	-50…+150	-58…+302

① PTFE-coated process connection and probe

3.5.2 General information for nozzles

⚠️ *CAUTION!*
Follow these recommendations to make sure that the device measures correctly. They have an effect on the performance of the device.

⚠️ *CAUTION!*
Do not put the process connection near to the product inlet. If the product that enters the tank touches the probe, the device will measure incorrectly.
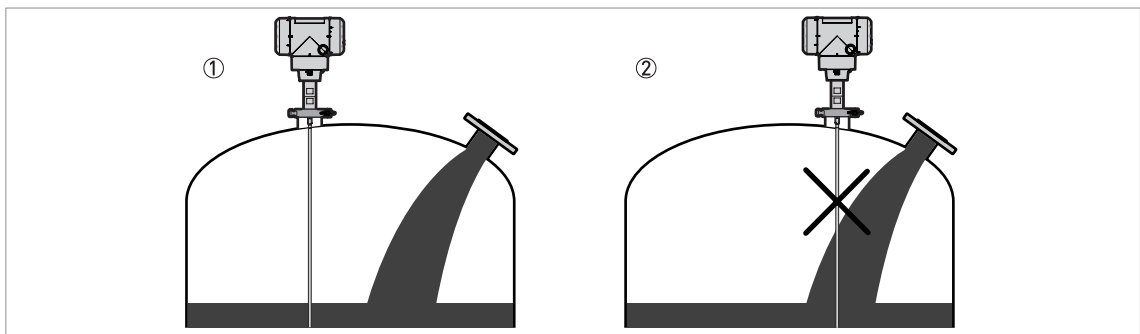
Figure 3-4: Do not put the device near to a product inlet
① The device is in the correct position
② The device is too near to the product inlet

3.6 Installation recommendations
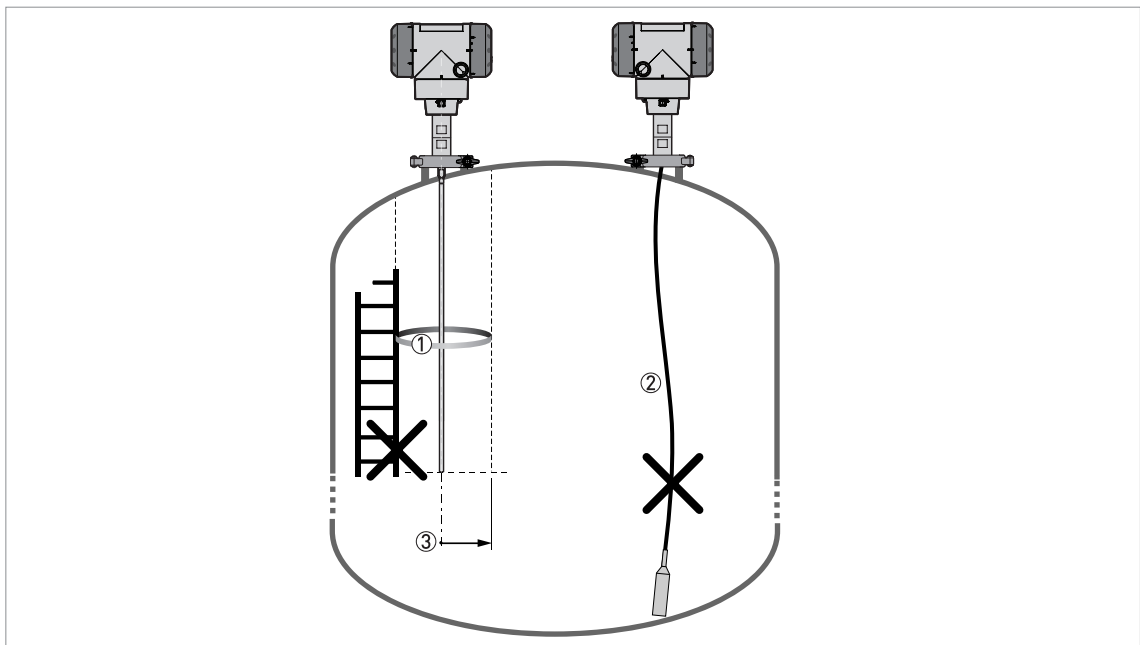
Figure 3-5: Installation recommendations for liquids

① The electromagnetic (EM) field generated by the device. It has a radius of R_{min}. Make sure that the EM field is clear of objects and product flow. Refer to the table that follows.
② Keep the probe straight.
③ Empty space. Refer to the table that follows.

Clearance between the probe and other objects in the tank

Probe type	Empty space (radius, R_{min}), around the probe	
	[mm]	[inches]
Single rod	300	12

3.7 How to install the device on the tank: general notes

3.7.1 Process connections

Requirements for hygienic connections: General notes

⚠ *WARNING!*
Make sure that you do not damage the polished parts.

⚠ *WARNING!*
Installation conditions for EHEDG-approved devices
- *To prevent contamination of the tank contents by microorganisms, make sure that the facing of the process connection is flush with the inner surface of the tank.*
- *The probe must be accessible for cleaning.*
- *Process connections must agree with EHEDG guidelines. Refer to the Position Paper of the EHEDG Test Institutes Working Group: "Easy cleanable Pipe couplings and Process connections" on this website: https://www.ehedg.org/. Go to Guidelines > Free Documents, find "EHEDG Position Paper" in the list of documents and make a selection from the language options. Refer also to EHEDG Document 8 (Hygienic equipment design criteria), Document 16 (Hygienic pipe couplings) and Document 2 (A method for assessing the in-place cleanability of food processing equipment).*
- *Make sure that you do not damage parts made of PEEK, polished parts and the O-ring. Use standard CIP-SIP process conditions. Make sure that the wetted parts (probe, gaskets and other process seals) are resistant to the tank contents and the product used for the cleaning process.*

ℹ️ *INFORMATION!*
Nozzles and sockets
To make the cleaning of the wetted parts easier, attach the device to a short process connection. The height of the process connection must be equal or less than its diameter.

Tri-Clamp® (hygienic) connections: installation procedure
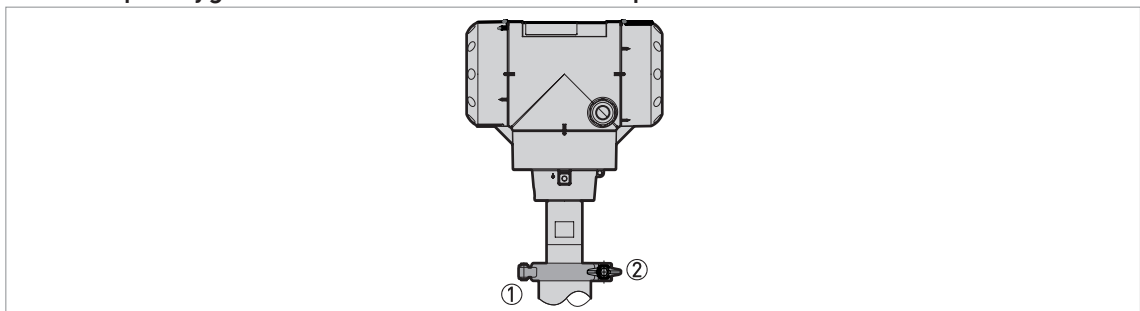
Figure 3-6: Tri-Clamp® connection: installation procedure
① Tank socket
② Clamp

⚠️ **WARNING!**
EHEDG-approval
You can only use EHEDG-approved devices that have a Tri-Clamp® connection with an EHEDG-approved seal (e.g. Combifit T-seal).

Equipment needed:

- Device
- Gasket (not supplied)
- Clamp (not supplied)

How to attach a device with a Tri-Clamp® connection

- Make sure that you use the applicable gasket for the connection dimensions and the process.
- Align the gasket correctly.
- Lower the device with the Tri-Clamp® adaptor carefully on the tank process connection.
- Attach the clamp to the process connection.
- Tighten the clamp.

DIN 11851 (hygienic) connections: installation procedure
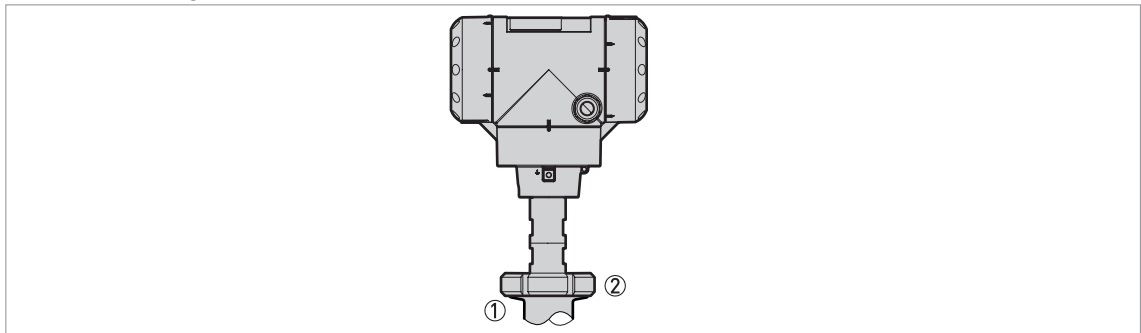
Figure 3-7: DIN 11851 connection: installation procedure

① Tank socket
② Union nut for DIN 11851 connection

⚠️ **WARNING!**
EHEDG-approval
*You can only use EHEDG-approved devices that have a DIN 11851 connection with EHEDG-approved seals (e.g. **ASEPTO-STAR, type k-flex upgrade** gasket from Kieselmann GmbH or an EPDM or FKM/FPM inner gasket from SKS B.V.).*

Equipment needed:

- Device
- Gasket (not supplied)
- DIN 11851 union nut

How to attach a device with a DIN 11851 connection

- Make sure that you use the applicable gasket for the connection dimensions and the process.
- Align the gasket correctly.
- Carefully put the device on the tank process connection.
- Turn the nut on the device process connection to attach the device to the tank.
- Tighten the connection.

→   Refer to local rules and regulations for the correct torque to apply to the connection.

SMS connections: installation procedure
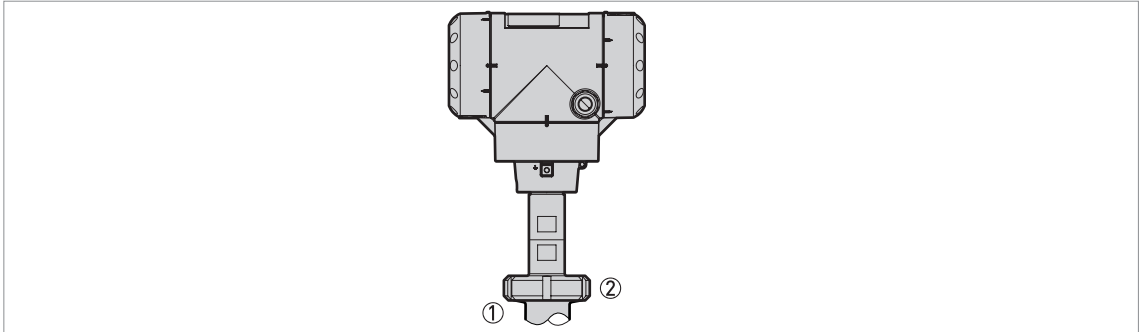
Figure 3-8: SMS connection: installation procedure

① Tank socket
② Union nut for SMS connection

INFORMATION!
The SMS connection does not agree with 3-A® and EHEDG sanitary design standards.

Equipment needed:

- Device
- Gasket (not supplied)
- SMS union nut

How to attach a device with a SMS connection

- Make sure that you use the applicable gasket for the connection dimensions and the process.
- Align the gasket correctly.
- Carefully put the device on the tank process connection.
- Turn the nut on the device process connection to attach the device to the tank.
- Tighten the connection.
→   Refer to local rules and regulations for the correct torque to apply to the connection.

3.7.2 How to turn or remove the signal converter

The converter turns 360°. The converter can be removed from the process connection assembly under process conditions.
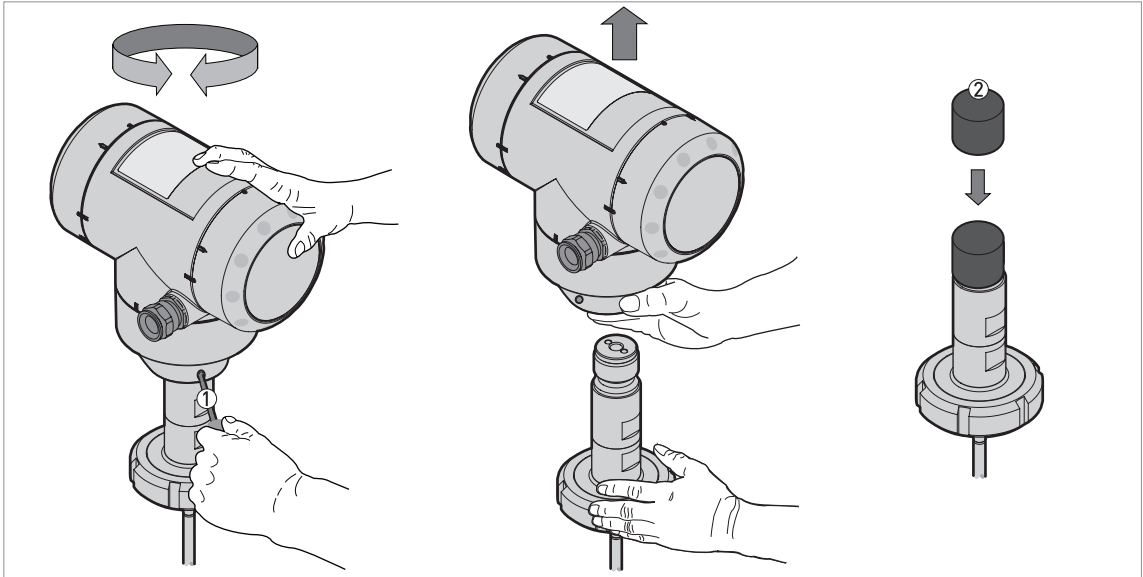
Figure 3-9: How to turn or remove the signal converter

① Tool: 5 mm Allen wrench (not supplied) for the lock screw on the signal converter
② Cover for the coaxial hole on top of the process connection assembly (not supplied)

CAUTION!
If you remove the housing, put a cover on the coaxial hole on top of the process connection assembly.
Make sure that the housing is fully engaged to the process connection before you tighten the lock screw with the 5 mm Allen wrench ①.

3.7.3 How to install the wall support for the remote converter (version "F")
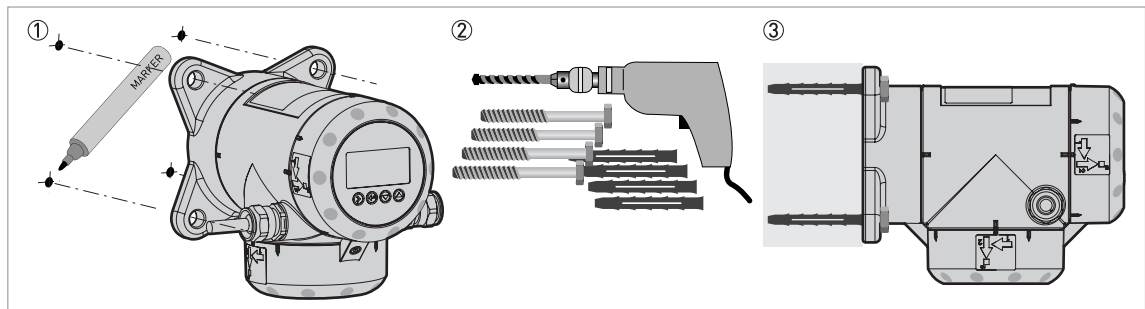
Figure 3-10: Wall support for the remote version (attached to the remote converter)

① Use marks on the wall to help you put the wall support in the correct position. For more data, refer to *Dimensions and weights* on page 134.

② Use equipment and tools that agree with health and safety regulations and good engineering practice.

③ Make sure that the wall support is correctly attached to the wall.

3.7.4 How to attach the weather protection to the device

The device and the weather protection option are supplied disassembled in the same box. The weather protection can also be supplied as an accessory. You must attach the weather protection when you install the device.
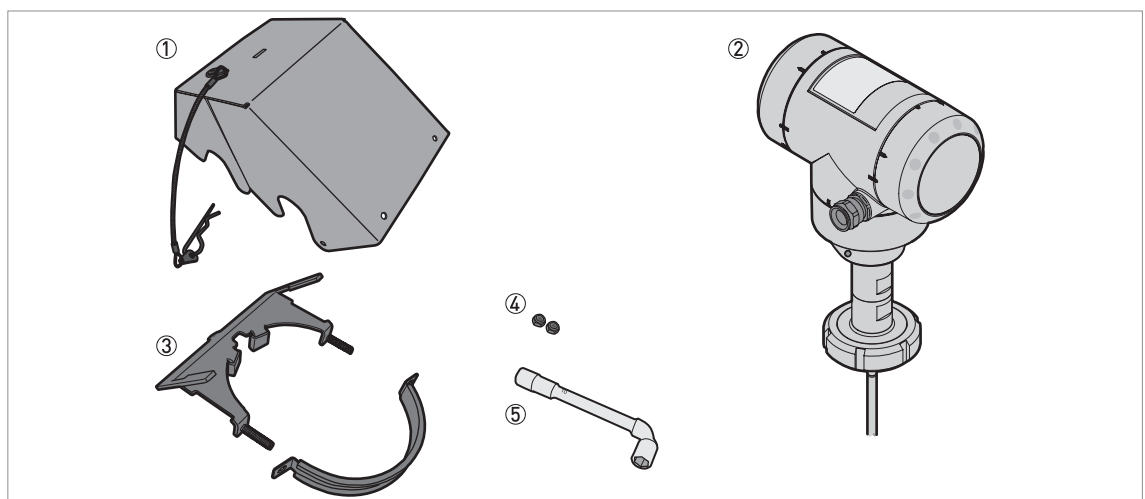
Figure 3-11: Equipment needed

① Weather protection cover (with an R-clip to hold the cover on the clamp)
② Device (with or without the optional display screen)
③ Weather protection clamp (2 parts)
④ 2 locking nuts
⑤ 10 mm socket wrench (not supplied)
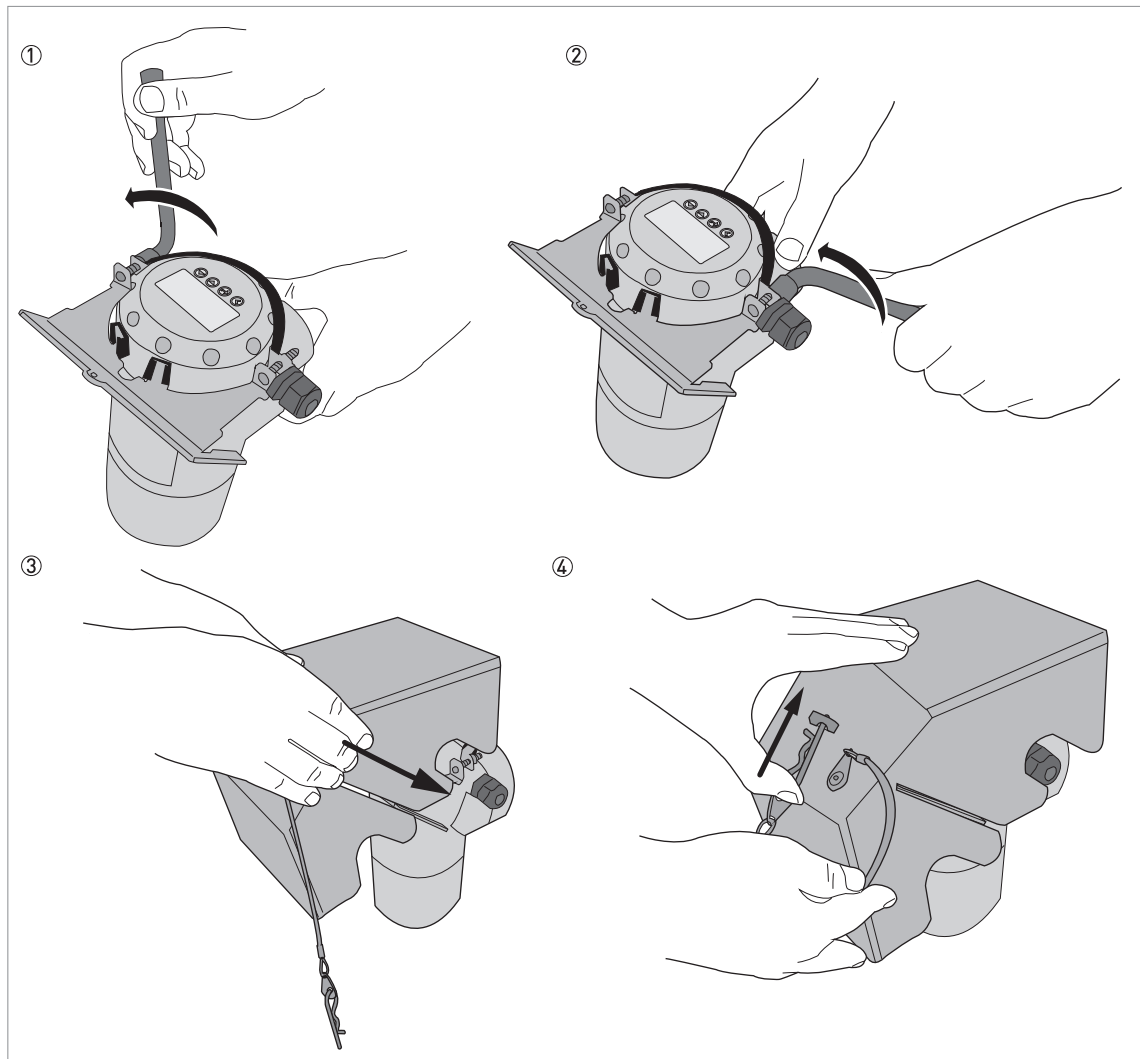
Figure 3-12: Installation of the weather protection on a vertical signal converter

INFORMATION!
Install the weather protection after you connect the device to the power supply.

① Put the weather protection clamp around the top of the device. Make sure that the locking nuts on the clamp are aligned with the cable entries.
② Attach the two locking nuts to the threads on the weather protection clamp. Tighten the locking nuts with a 10 mm socket wrench.
③ Lower the weather protection cover onto weather protection clamp until the hole for the lock is in the slot at the front of the cover.
④ Put the R-clip into the hole at the front of the weather protection cover.
➲   End of the procedure.
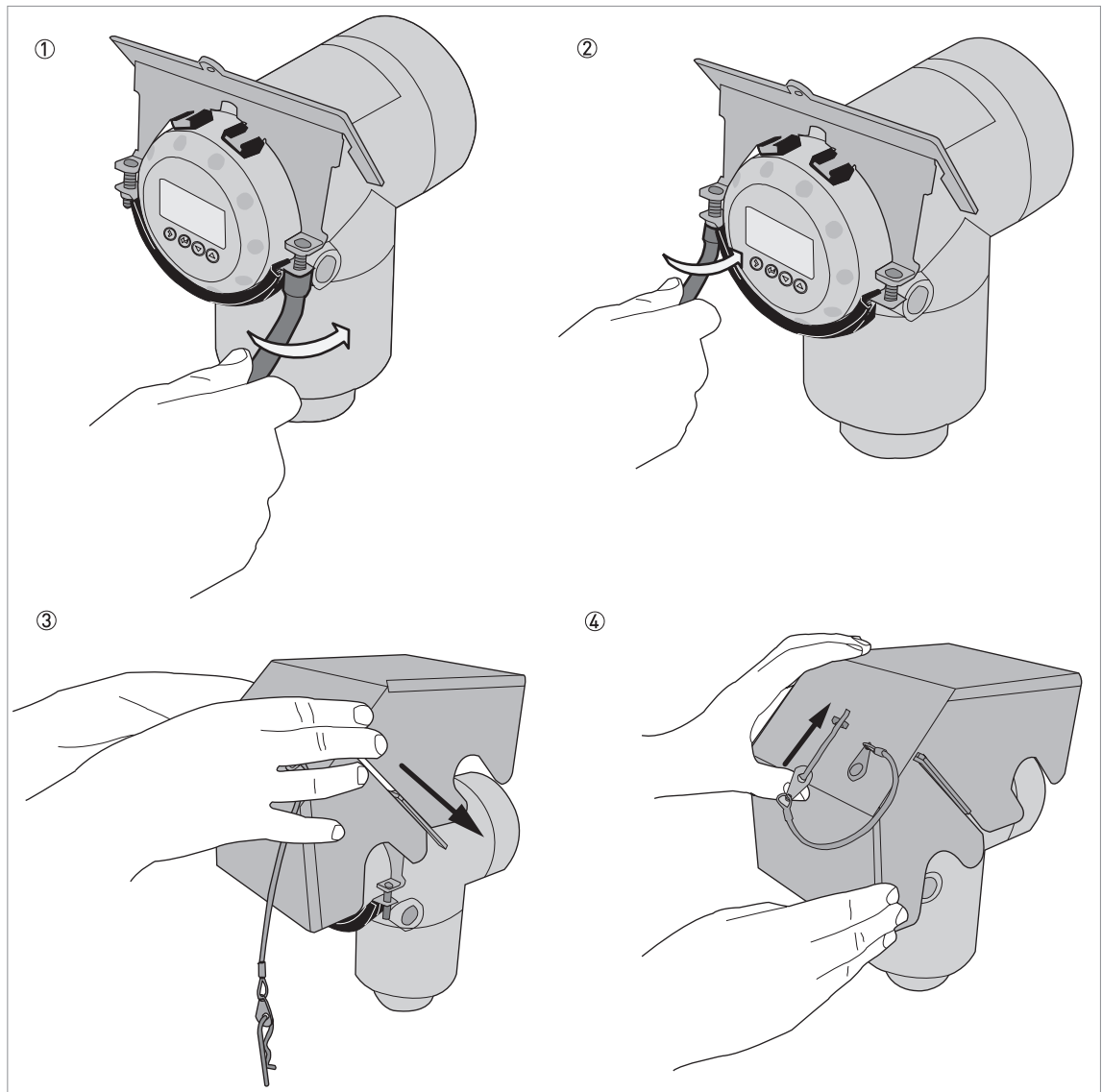
Figure 3-13: Installation of the weather protection on a horizontal signal converter

INFORMATION!
Install the weather protection after you connect the device to the power supply.

① Put the weather protection clamp around the front of the device (the end of the device that is nearest to the cable entry).
② Attach the two locking nuts to the threads on the weather protection clamp. Tighten the locking nuts with a 10 mm socket wrench.
③ Lower the weather protection cover onto weather protection clamp until the hole for the lock is in the slot at the front of the cover.
④ Put the R-clip into the hole at the front of the weather protection cover.
➲ End of the procedure.

The overall dimensions of the weather protection are on page 134.

3.7.5 How to open the weather protection
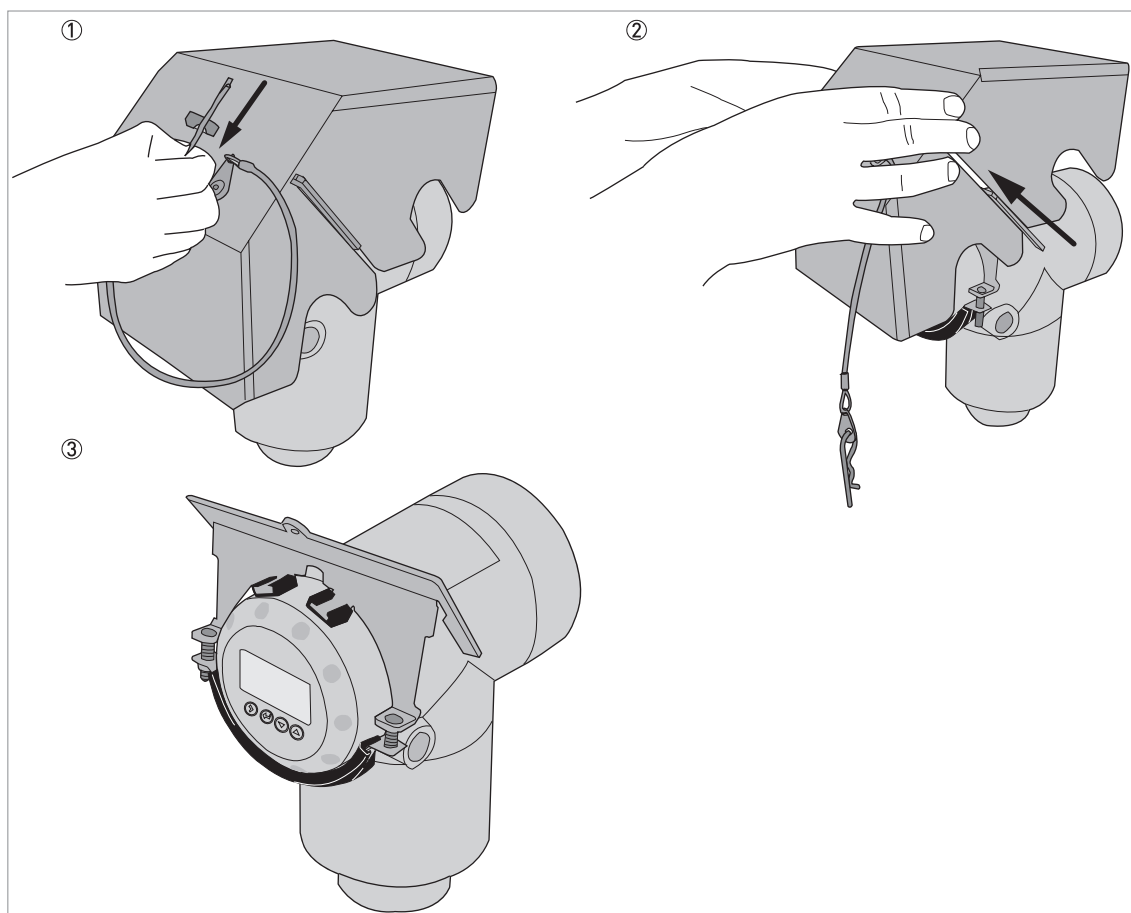
Figure 3-14: How to open the weather protection

INFORMATION!
Electrical installation: Remove the weather protection before you open the terminal compartment cover.

① Remove the R-clip from the hole at the front of the weather protection cover.
② Remove the weather protection cover.
➲   End of the procedure.

4.1 Safety instructions

DANGER!
All work on the electrical connections may only be carried out with the power disconnected.
Take note of the voltage data on the nameplate!

DANGER!
Observe the national regulations for electrical installations!

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex
documentation.

WARNING!
Observe without fail the local occupational health and safety regulations.
Any work done on the electrical components of the measuring device may only be carried out by
properly trained specialists.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order.
Check for the correct supply voltage printed on the nameplate.

4.2 General notes

This chapter includes electrical connection data about devices with the 4…20 mA output and
HART® communication options. These are 2-wire, loop-powered devices.

4.3 Electrical installation: 2-wire, loop-powered

4.3.1 Compact version

CAUTION!
Output 1 energizes the device and is used for HART® communication. If the device has the second current output option, use a separate power supply to energize output 2. If the device has a switch output - relay option, use a separate power supply (connect the power supply to the switch power supply terminals).

Terminals for electrical installation (one output)
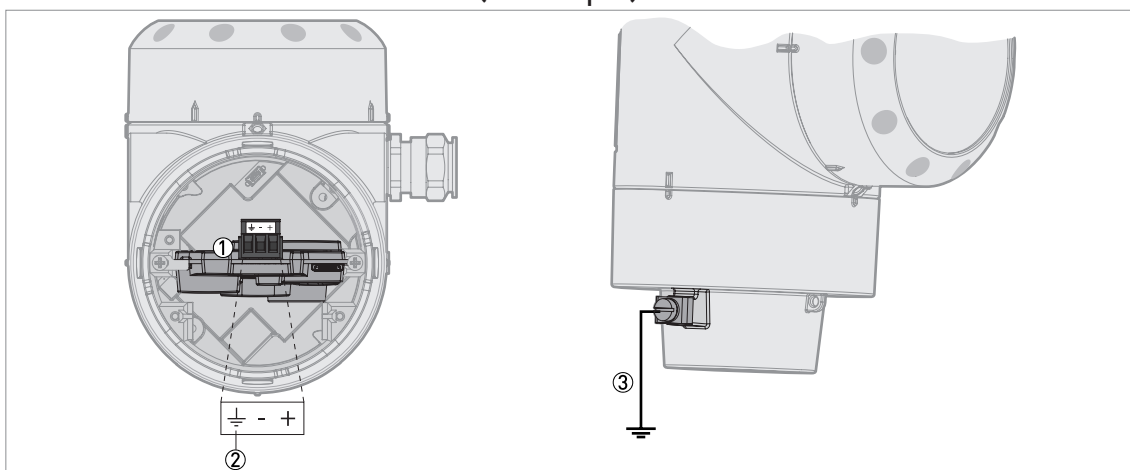
Figure 4-1: Terminals for electrical installation (one output)
① Current output 1
② Grounding terminal in the housing (if the electrical cable is shielded)
③ Location of the external grounding terminal (at the bottom of the converter)

CAUTION!
- *Use the applicable electrical cables with the cable glands.*
- *Make sure that the current is not more than 4 A or that there is 4 A-rated fuse in the electrical circuit that energizes the device.*
- *Make sure that the polarity of the power supply is correct. If the polarity is incorrect, you will not cause damage to the device but the device will not operate.*

Terminals for electrical installation (two current outputs)
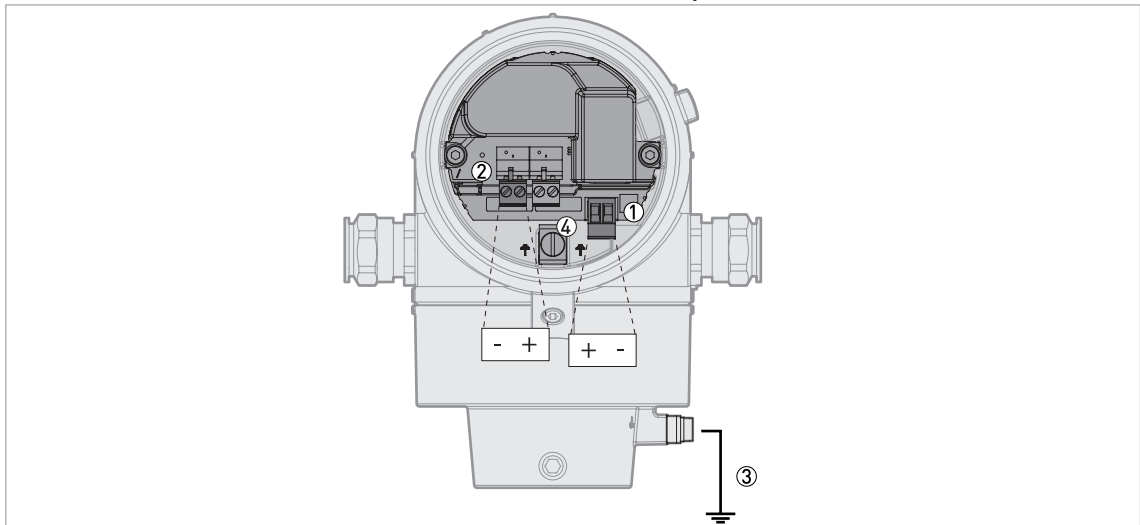
Figure 4-2: Terminals for electrical installation (two current outputs)

① Output 1: Terminals
② Output 2: Terminals
③ Location of the external grounding terminal (at the bottom of the converter)
④ Grounding terminal in the housing (if the electrical cable is shielded)

CAUTION!
- *Use the applicable electrical cables with the cable glands.*
- *Make sure that the current is not more than 4 A or that there is 4 A-rated fuse in the electrical circuit that energizes the device.*
- *Make sure that the polarity of the power supply is correct. If the polarity is incorrect, you will not cause damage to the device but the device will not operate.*

Terminals for electrical installation (one current output and one switch output - relay)
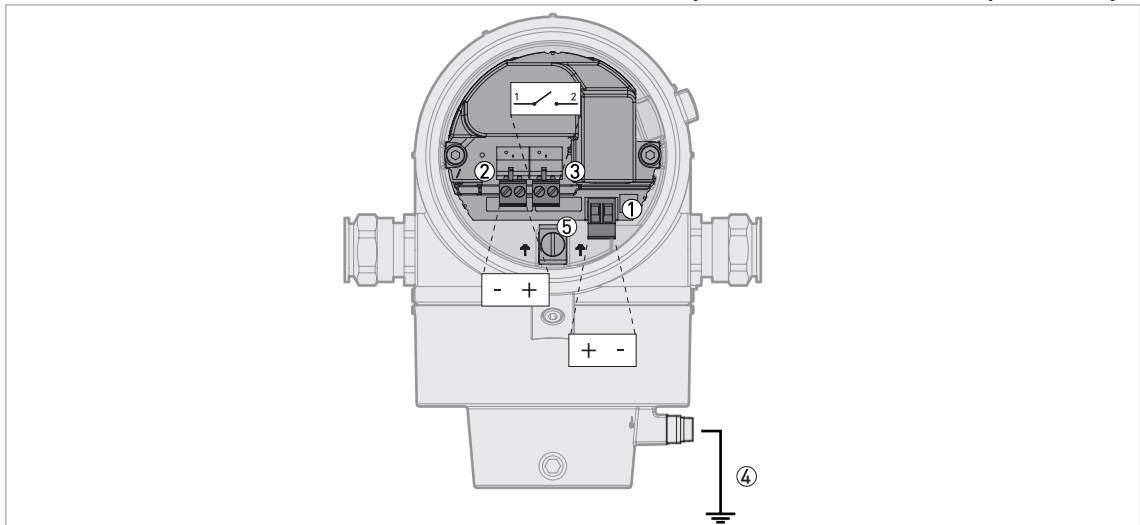
Figure 4-3: Terminals for electrical installation (one current output and one switch output - relay)

① Current output 1: Terminals
② Switch power supply: Terminals
③ Switch output - relay: Terminals
④ Location of the external grounding terminal (at the bottom of the converter)
⑤ Grounding terminal in the housing (if the electrical cable is shielded)

CAUTION!
- *Use the applicable electrical cables with the cable glands.*
- ***Current output:*** *Make sure that the current is not more than 4 A or that there is 4 A-rated fuse in the electrical circuit that energizes the device.*
- ***Switch output - relay:*** *Make sure that the current is not more than 6 A or that there is 6 A-rated fuse in the electrical circuit that energizes the device.*
- *Make sure that the polarity of the power supply is correct. If the polarity is incorrect, you will not cause damage to the device but the device will not operate.*
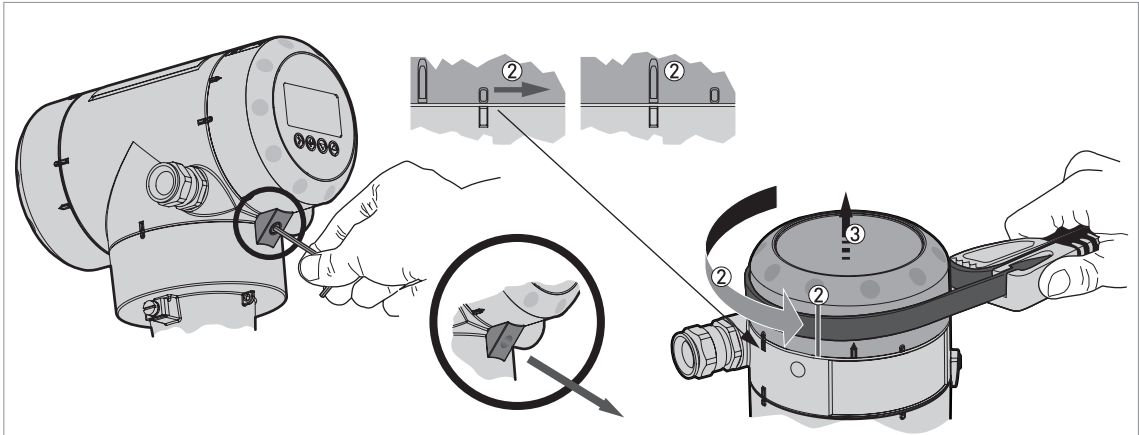
Figure 4-4: How to open the terminal compartment cover (one output)

① Loosen the lock screw with a 2.5 mm Allen wrench.
② Turn the cover counterclockwise with a strap wrench.
③ Remove the cover.
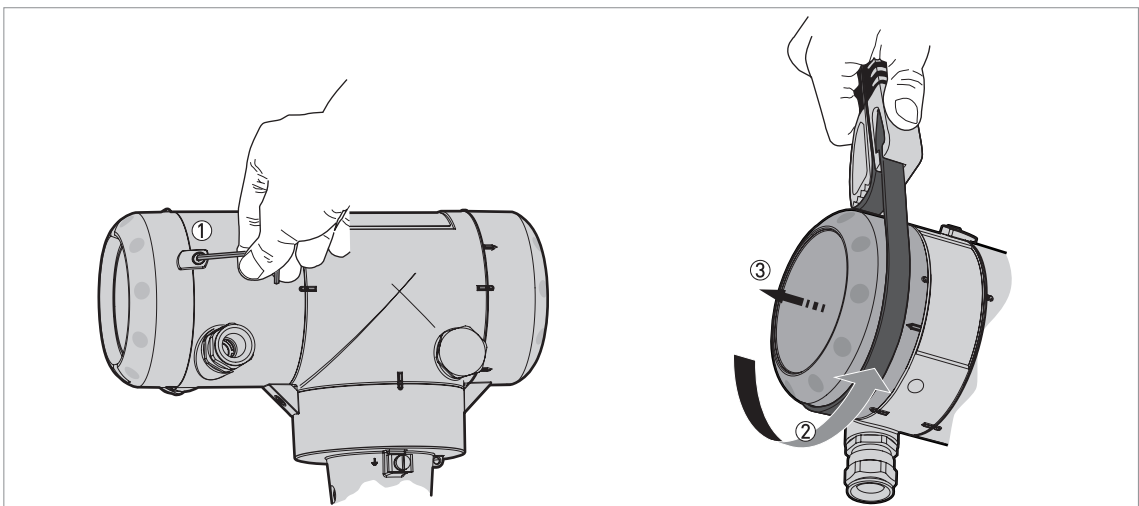
Figure 4-5: How to open the terminal compartment cover (two outputs)

① Loosen the lock screw with a 2.5 mm Allen wrench.
② Turn the cover counterclockwise with a strap wrench.
③ Remove the cover.
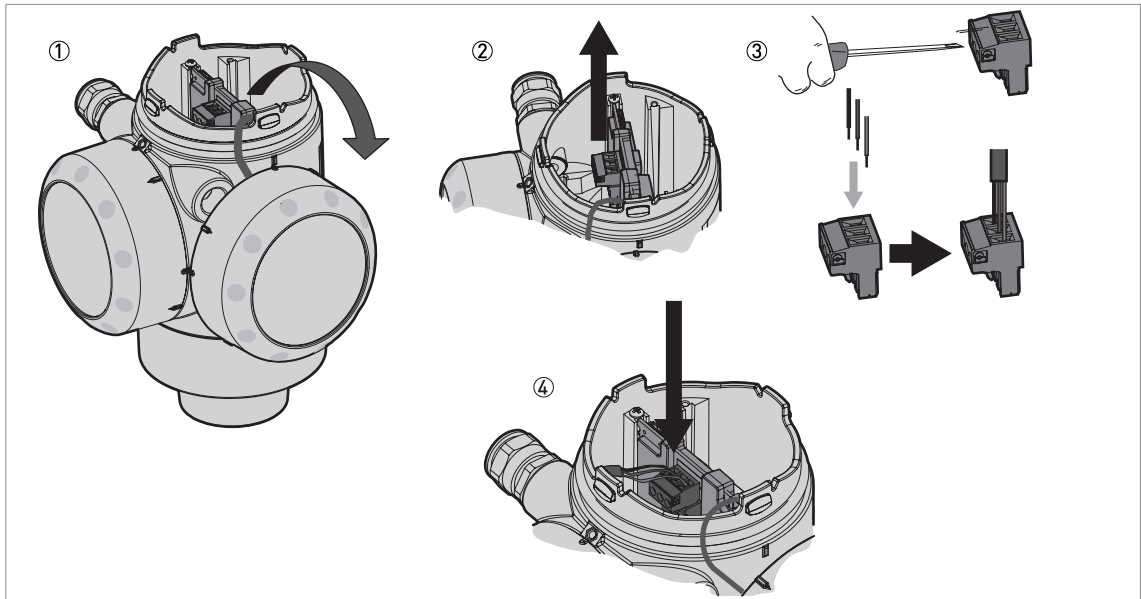
Figure 4-6: Procedure for electrical installation (one output)

Equipment needed:

- Small slotted tip screwdriver (not supplied)

Procedure:

① Do not disconnect the safety cord from the terminal compartment cover. Put the terminal compartment cover adjacent to the housing.
② Remove the connector from the circuit board.
③ Connect the electrical wires to the connector.
④ Attach the connector to the circuit board. Tighten the cable entry glands.
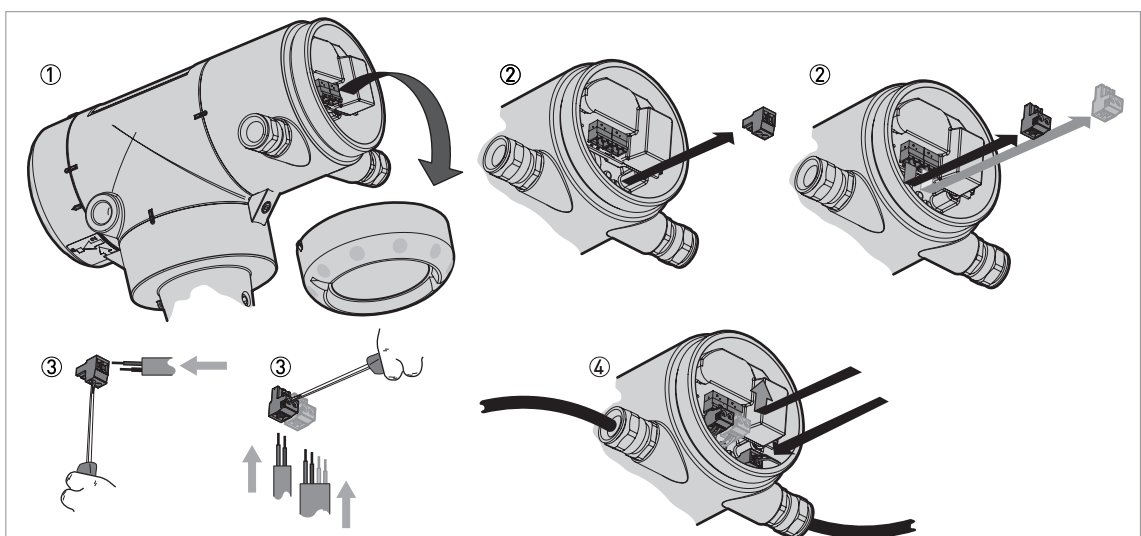
Figure 4-7: Procedure for electrical installation (two outputs)

Equipment needed:

• Small slotted tip screwdriver (not supplied)

Procedure:

① Put the terminal compartment cover adjacent to the housing.
② Remove the connectors from the circuit board. If the device has the optional switch output, remove the connector for the switch output.
③ Put the electrical cables in the cable entries. Connect the electrical wires to the connectors. If the device has the optional switch output, use a 4-wire electrical cable for the switch power supply connector and the output connector.
④ Attach the connectors to the circuit board. Tighten the cable entry glands.

Close the terminal compartment cover (one output)
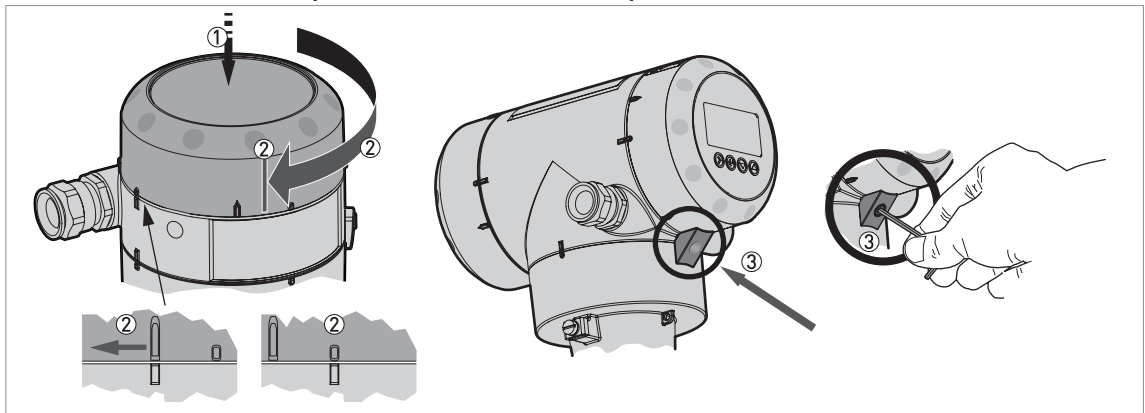
Figure 4-8: How to close the terminal compartment cover (one output)

• Put the cover on the housing and push it down.
• Turn the cover clockwise until it is fully engaged.
• Tighten the lock screw.

Close the terminal compartment cover (two outputs)
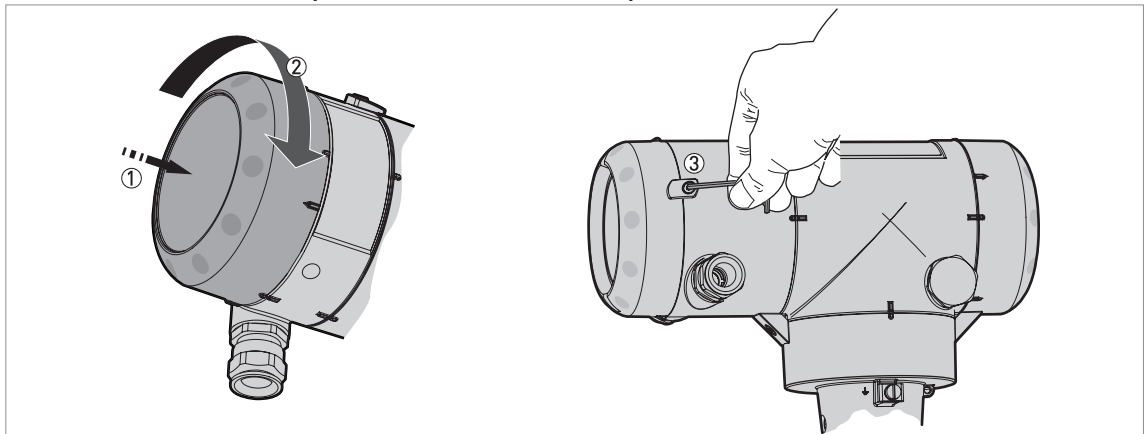
Figure 4-9: How to close the terminal compartment cover (two outputs)

• Put the cover on the housing and push it down.
• Turn the cover clockwise until it is fully engaged.
• Tighten the lock screw.

4.3.2 Remote version

⚠ *CAUTION!*
Output 1 energizes the device and is used for HART® communication. If the device has the second current output option, use a separate power supply to energize output 2. If the device has a switch output - relay option, use a separate power supply (connect the power supply to the switch power supply terminals).

Terminals for electrical installation (one output)
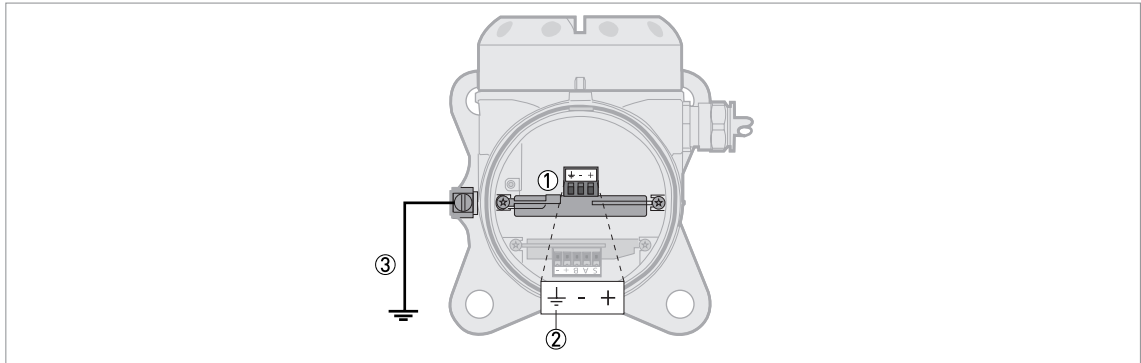
Figure 4-10: Terminals for electrical installation (one output)

① Current output 1: Terminals
② Grounding terminal in the housing (if the electrical cable is shielded)
③ Location of the external grounding terminal (on the wall support)

⚠ *CAUTION!*
- *Use the applicable electrical cables with the cable glands.*
- *Make sure that the current is not more than 4 A or that there is 4 A-rated fuse in the electrical circuit that energizes the device.*
- *Make sure that the polarity of the power supply is correct. If the polarity is incorrect, you will not cause damage to the device but the device will not operate.*

Terminals for electrical installation (two current outputs)
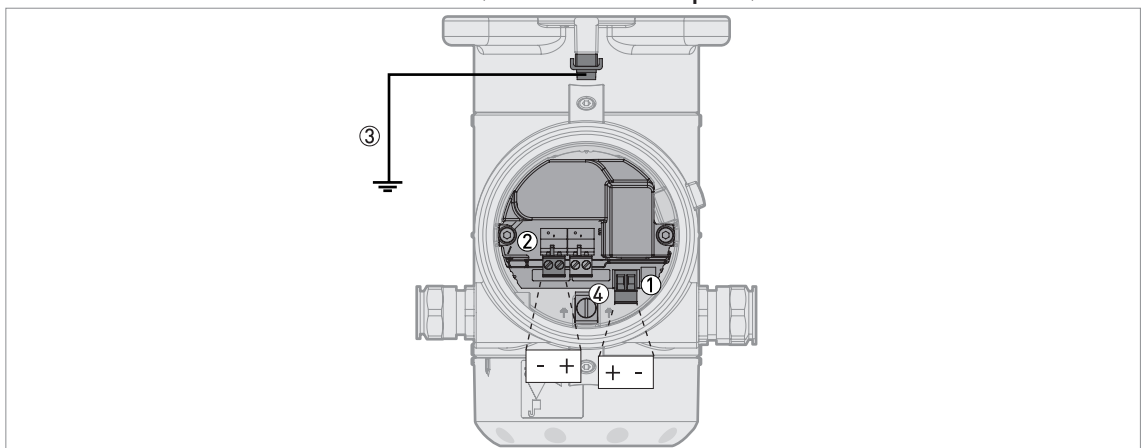
Figure 4-11: Terminals for electrical installation (two current outputs)

① Output 1: Terminals
② Output 2: Terminals
③ Location of the external grounding terminal (on the wall support)
④ Grounding terminal in the housing (if the electrical cable is shielded)

Terminals for electrical installation (one current output / one switch output - relay)
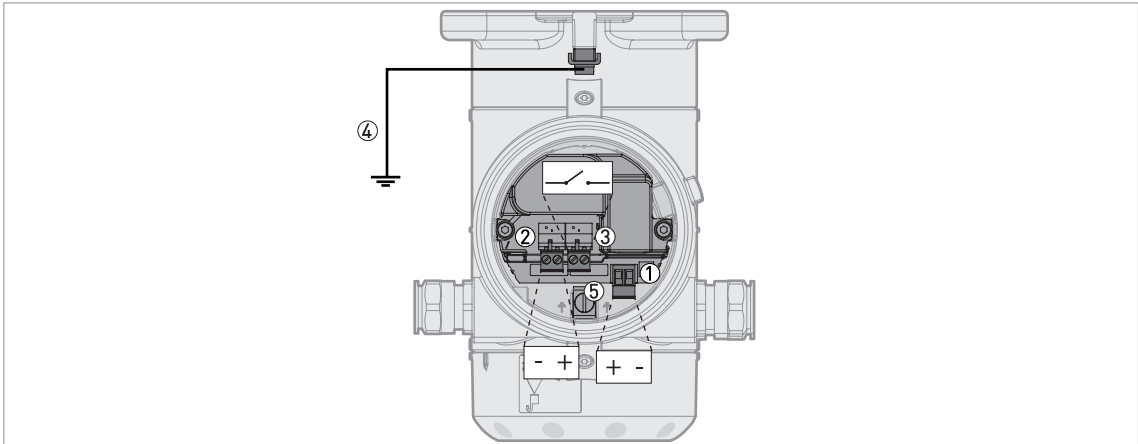
Figure 4-12: Terminals for electrical installation (one current output / one switch output - relay)

① Current output 1: Terminals
② Switch power supply: Terminals
③ Switch output - relay: Terminals
④ Location of the external grounding terminal (on the wall support)
⑤ Grounding terminal in the housing (if the electrical cable is shielded)

CAUTION!

- *Use the applicable electrical cables with the cable glands.*

- *Current outputs: Make sure that the current is not more than 4 A or that there is 4 A-rated fuse in the electrical circuit that energizes the device.*

- *Switch output - relay: Make sure that the current is not more than 5 A or that there is 5 A-rated fuse in the electrical circuit that energizes the device.*

- *Make sure that the polarity of the power supply is correct. If the polarity is incorrect, you will not cause damage to the device but the device will not operate.*

4.4 Remote device data

4.4.1 Requirements for signal cables supplied by the customer

The signal cable is an option for non-Ex devices. If the signal cable is not supplied by the device manufacturer, the cable must have properties that follow:

Basic properties

- Twisted cable 2 by 2, shielded or screened.

Maximum length of the signal cable

- 100 m / 328 ft

Temperature

- Use electrical cable with the applicable temperature rating for the operating conditions.
- Ambient temperature range: -40...+80°C / -40...+176°F
- We recommend that the cable agrees with UL 94V-0.

Dimensions of the insulated conductors

- Min.-max. cross-sectional area of the conductors: 4×0.326...4×2.5 mm² (22....14 AWG), shielded cable
- Use the applicable cable for the cable glands (Ø6....10 mm / 0.24...0.39¨).
- Use the applicable cable glands for the cable entry openings in the housing.

Electrical characteristics

- Test voltage: Insulated conductor / shield (screen) $\geq$ 500 VAC
- Line resistance: < 55 Ω/km
- The cable must agree with EN 60811 (Low Voltage Directive) or equivalent national regulations.

4.4.2 How to prepare a signal cable supplied by the customer
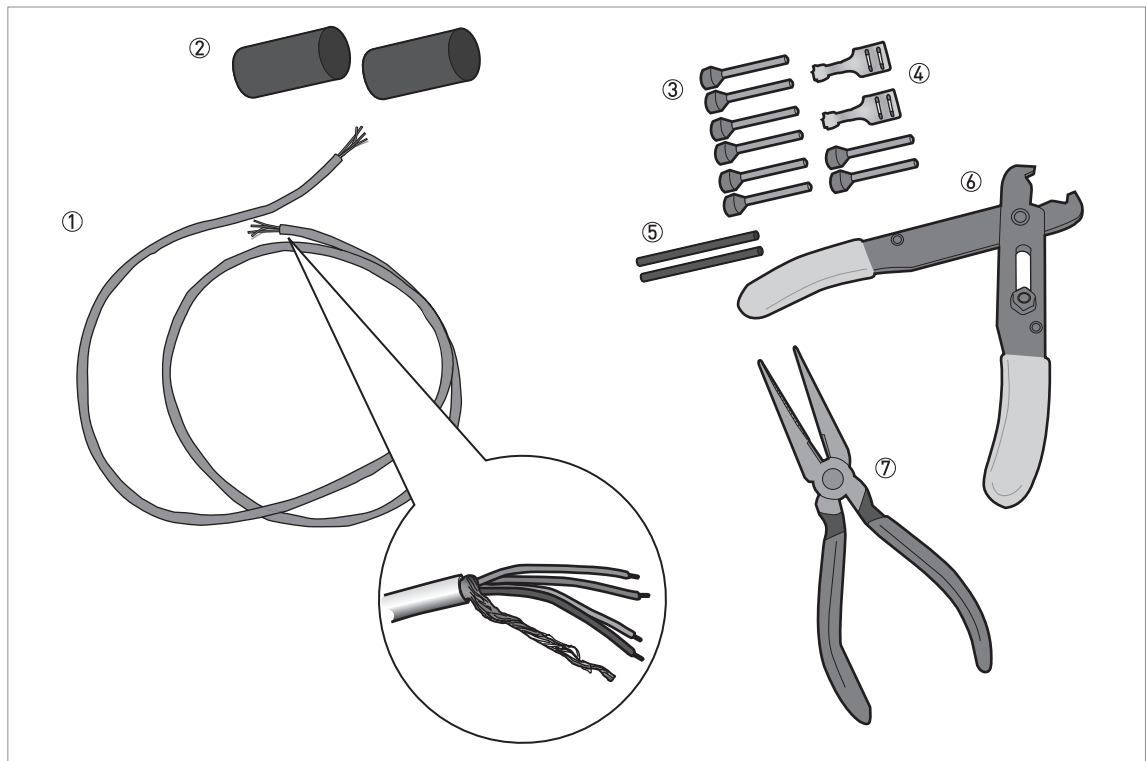
Figure 4-13: Equipment needed to prepare the signal cable

① Signal cable (supplied on request)
② 2 heat-shrinkable sleeves for the jacket (not supplied)
③ 8 ferrules for the end of the conductors (not supplied)
④ 2 Faston connectors for the shield wires
⑤ Shield wire insulation, 2 sleeves
⑥ Wire stripper (not supplied)
⑦ Crimping pliers (not supplied)

INFORMATION!
- *The Faston connector for the stranded drain wire must agree with DIN 46 228: E 1.5-8*
- *The wire end ferrules for the twisted pair of conductors must agree with DIN 46 228: E 0.5-8*
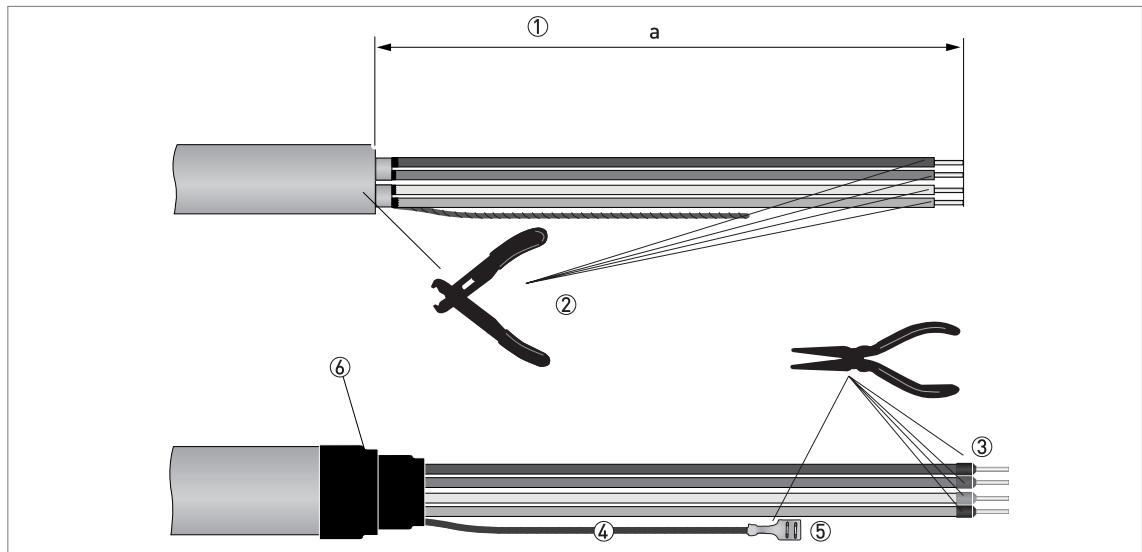
Figure 4-14: How to prepare the signal cable

① Remove the jacket from the wire to dimension "a". a = 50 mm / 2¨.
② Remove the insulation from the wire. Obey national regulations for electrical wiring.
③ Crimp the wire end ferrules on the conductors.
④ Install shield wire insulation on the 2 ends of the shield wire.
⑤ Crimp the Faston connectors on the 2 ends of the shield wire.
⑥ Install a heat-shrinkable sleeve on the jacket.

4.4.3 How to connect the signal cable to the device

DANGER!
Cables may only be connected when the power is switched off.

DANGER!
The device must be grounded in accordance with regulations in order to protect personnel against electric shocks.

WARNING!
Observe without fail the local occupational health and safety regulations.
Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

CAUTION!
Do not wind the signal cable. This configuration will prevent interference from electromagnetic fields.

Equipment needed
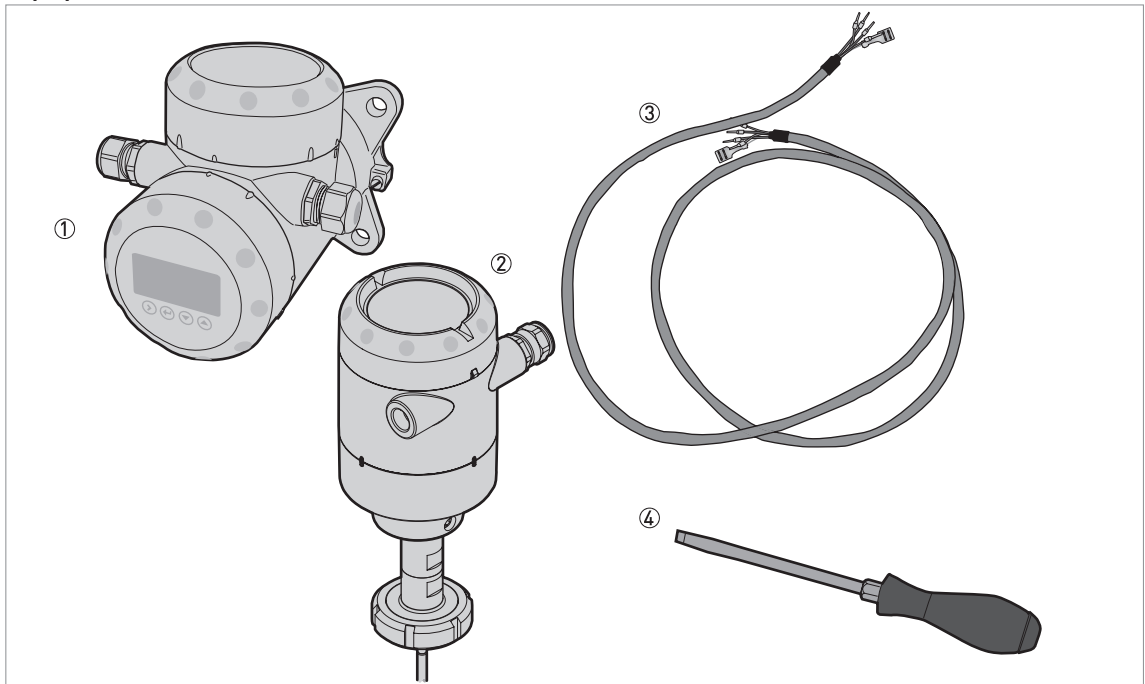
Figure 4-15: Equipment needed to prepare the signal cable

① Remote converter
② Probe electronics housing
③ Signal cable (supplied on request for non-Ex devices) — for more data, refer to *How to prepare a signal cable supplied by the customer* on page 39
④ Small slotted-tip screwdriver (not supplied)

Connections between the remote converter and the probe electronics housing
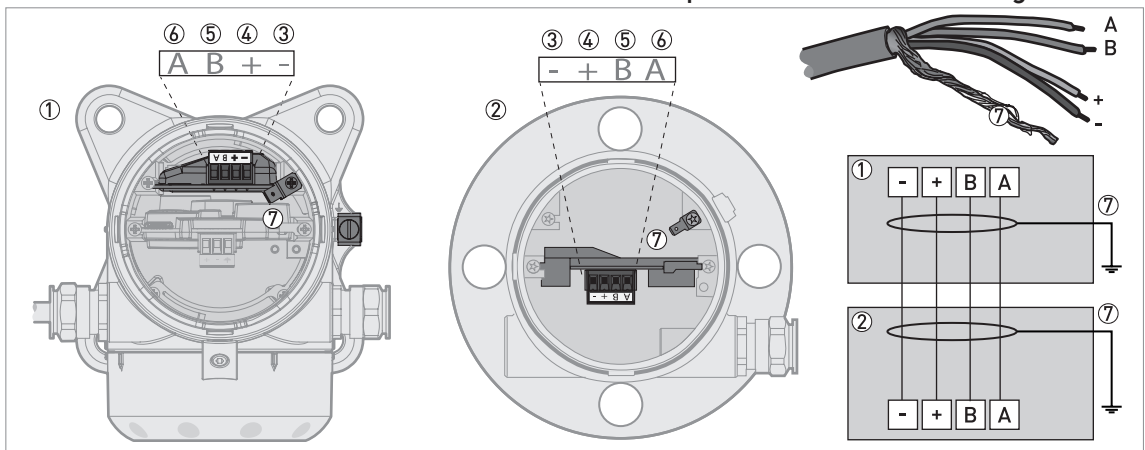
Figure 4-16: Connections between the remote converter and the probe electronics housing

① Remote converter
② Probe electronics housing
③ Power supply: voltage in -
④ Power supply: voltage in +
⑤ Signal cable B
⑥ Signal cable A
⑦ Shielding wire (attached to Faston connectors in the housings of the remote converter and the probe electronics housing)

How to connect the signal cable to the remote converter
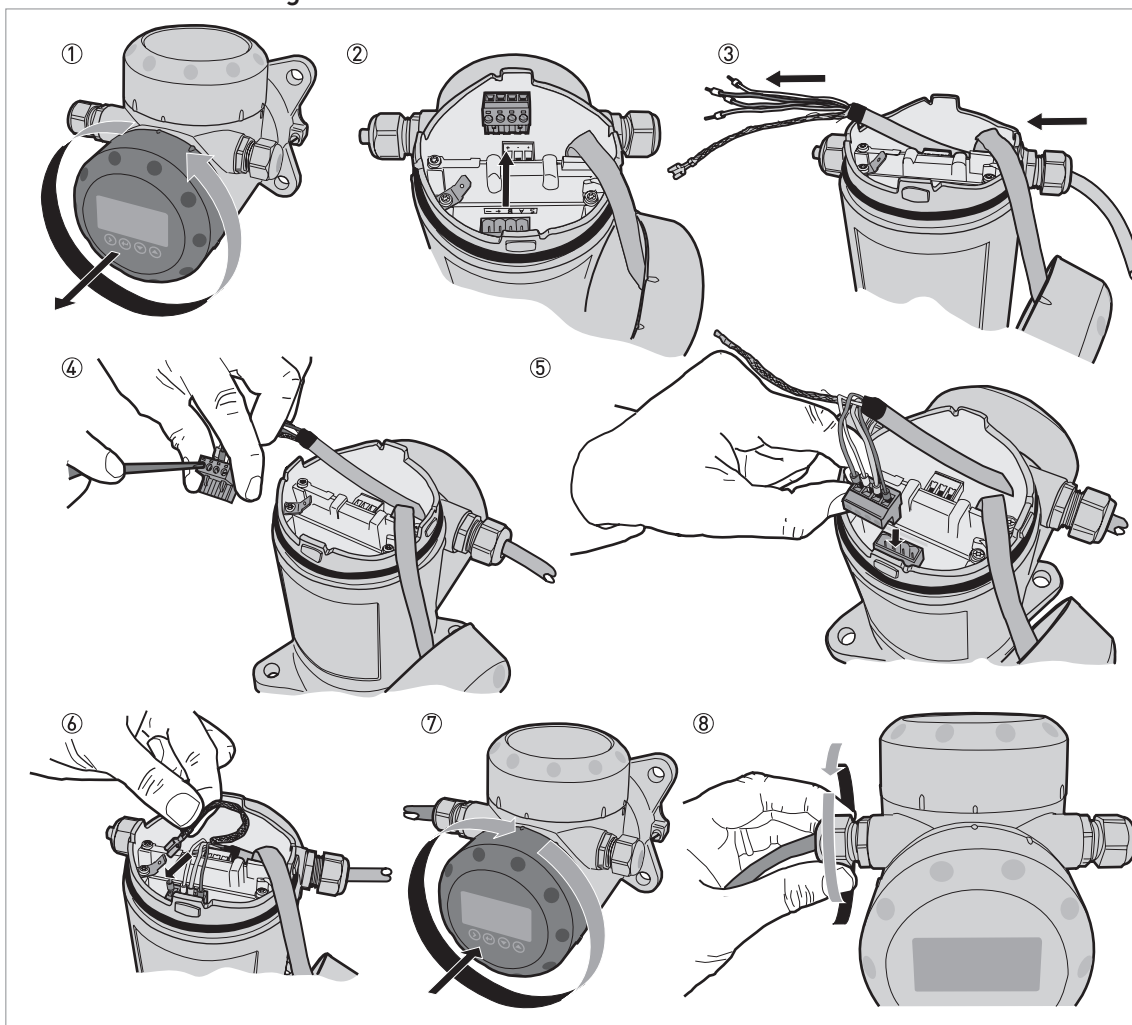
Figure 4-17: How to connect the signal cable to the remote converter

CAUTION!
Bending radius of the signal cable: ≥ 50 mm / 2"

① Remove the terminal compartment cover.
② Remove the 4-pin connector.
③ Put the signal cable into the opening of the cable gland.
④ Put the electrical wires in the connector terminals. Tighten the terminal screws with a small slotted-tip screwdriver. Make sure that the electrical wires agree with the terminals. For more data, refer to the electrical schematic diagram in this section.
⑤ Put the connector into the 4-pin socket.
⑥ Attach the Faston connector (drain wire).
⑦ Attach the terminal compartment cover.
⑧ Tighten the cable gland. Make sure that the remote converter is correctly sealed.

How to connect the signal cable to the probe electronics housing
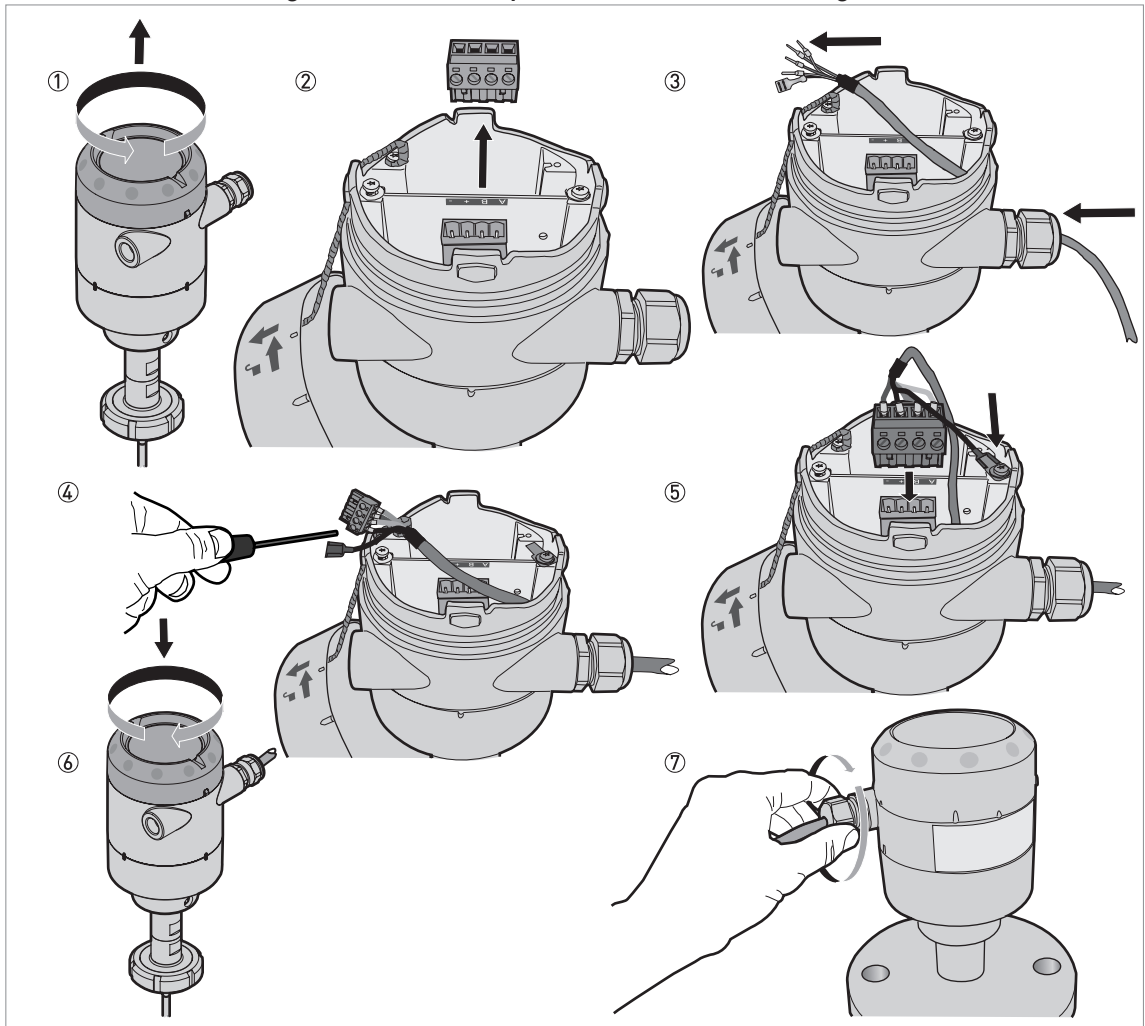
Figure 4-18: How to connect the signal cable to the probe electronics housing

⚠️ *CAUTION!*
Bending radius of the signal cable: ≥ 50 mm / 2"

① Remove the terminal compartment cover.
② Remove the 4-pin connector.
③ Put the signal cable into the opening of the cable gland.
④ Put the electrical wires in the connector terminals. Tighten the terminal screws with a small slotted-tip screwdriver. Make sure that the electrical wires agree with the terminals. For more data, refer to the electrical schematic diagram in this section.
⑤ Put the connector into the 4-pin socket. Attach the Faston connector (drain wire).
⑥ Attach the terminal compartment cover.
⑦ Tighten the cable gland. Make sure that the probe electronics housing is correctly sealed.

4.5 Electrical connection for current output

4.5.1 Non-Ex devices

> **i** *INFORMATION!*
> *Two current outputs and the switch output - relay are supplied together as a device option. Two current outputs or the switch output - relay are only available if you send an order for a device with these options.*

> **i** *INFORMATION!*
> *For more data about current output functions, the switch function and related settings, refer to Operation on page 53.*

One current output
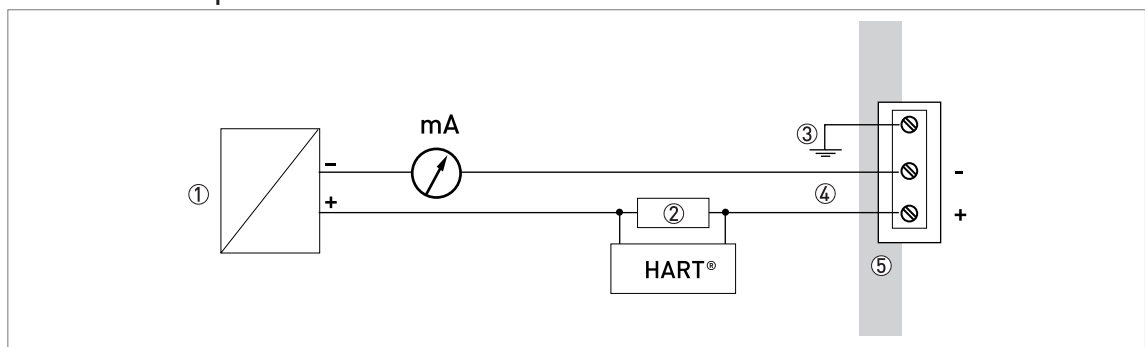
Figure 4-19: Electrical connections for non-Ex devices (one current output)

① Power supply
② Resistor for HART® communication
③ Optional connection to the grounding terminal
④ Output: 11.5...30 V DC for an output of 22 mA at the terminal
⑤ Device

Two current outputs
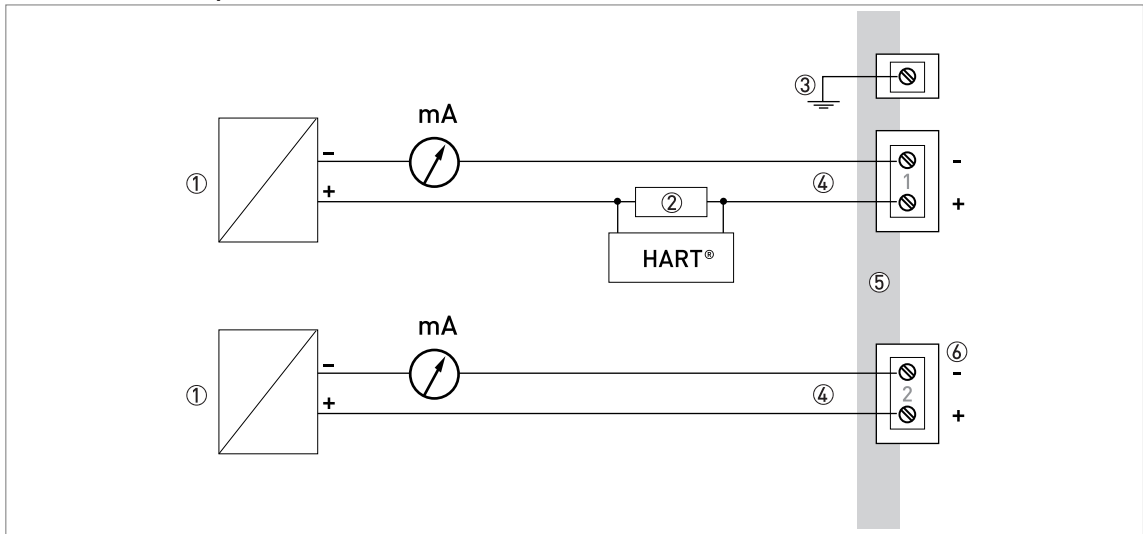
Figure 4-20: Electrical connections for non-Ex devices (two current outputs)

① Power supply
② Resistor for HART® communication
③ Optional connection to the grounding terminal
④ Output 1 and 2: 11.5...30 V DC for an output of 22 mA at the terminals
    NOTE: Use a separate power supply to energize output 2
⑤ Device
⑥ Connector for the optional second output

One current output and one switch output - relay
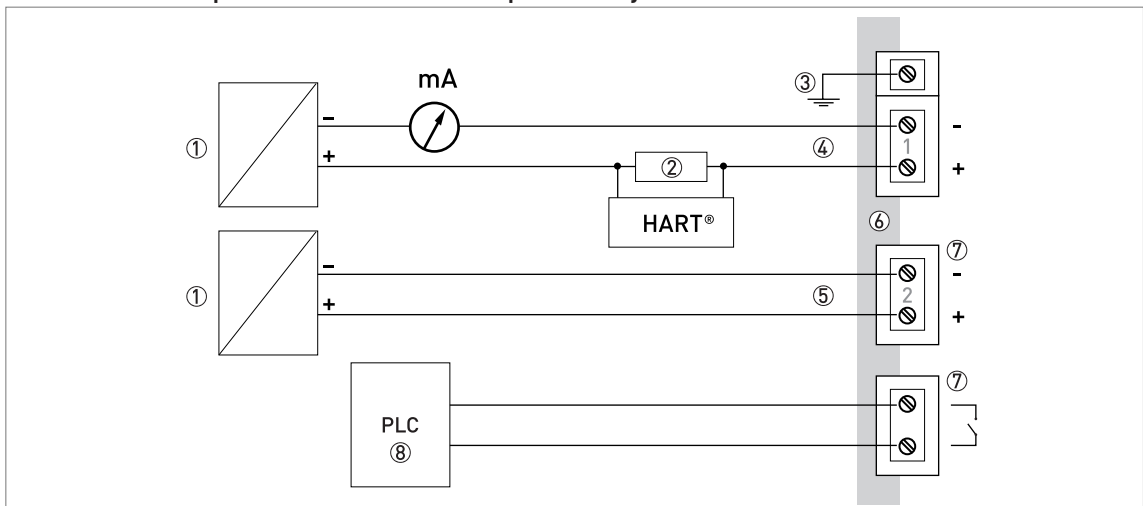
Figure 4-21: Electrical connections for non-Ex devices (one current output and one switch output - relay)

① Power supply
② Resistor for HART® communication
③ Optional connection to the grounding terminal
④ Output 1: 11.5...30 V DC for an output of 22 mA at the terminals
⑤ Switch power supply (2): 11.5...34 V DC / 30 mA
    NOTE: Use a separate power supply to energize the switch output - relay option
⑥ Device
⑦ Connector for the switch output - relay
⑧ PLC (for example)

4.5.2 Devices for hazardous locations

DANGER!
For electrical data for device operation in hazardous locations, refer to the related certificates of compliance and supplementary instructions (ATEX, IECEx etc.). This documentation can be downloaded from the website (Download Center).

4.6 Protection category

INFORMATION!
The device fulfils all requirements per protection category IP66 / IP68 (continuous immersion at a depth of 1.5 m for 2 weeks). It also fulfils all requirements per NEMA type 4X / 6 (housing) and type 6P (probe).

DANGER!
Make sure that the cable gland is watertight.
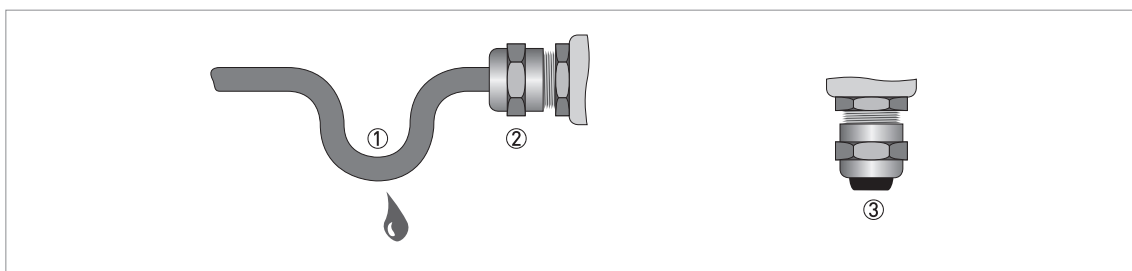
Figure 4-22: How to make the installation agree with protection category IP67

- Make sure that the gaskets are not damaged.
- Make sure that the electrical cables are not damaged.
- Make sure that the electrical cables agree with the national electrical code.
- The cables are in a loop in front of the device ① so water does not go into the housing.
- Tighten the cable feedthroughs ②.
- Close unused cable feedthroughs with dummy plugs ③.

Refer to the table that follows for the diameter of the outer sheath of the electrical cable:

Min. / Max. diameter of the electrical cable

Type of electrical cable	Approval	Min. / Max. diameter of the electrical cable	
		[mm]	[inches]
Power supply / output 1	non-Ex / Ex i	6...7.5 ①	0.24...0.3 ①
	Ex d	7...10	0.28...0.39
Optional output 2	non-Ex / Ex i	6...12 ①	0.24...0.47 ①
	Ex d	7...12	0.28...0.47

Type of electrical cable	Approval	Min. / Max. diameter of the electrical cable	
		[mm]	[inches]
Signal cable (for the remote version "F") ②	non-Ex / Ex i	6...12 ①	0.24...0.39 ①
	Ex d	7...12	0.28...0.47

① If the device has a stainless steel cable gland, the minimum diameter of the electrical cable is 7 mm / 0.28¨
② This electrical cable is connected between the remote converter and the probe electronics housing

4.7 Networks

4.7.1 General information

The device uses the HART® communication protocol. This protocol agrees with the HART® Communication Foundation standard. The device can be connected point-to-point. It can also have a polling address of 1 to 63 in a multi-drop network.

The device output is factory-set to communicate point-to-point. To change the communication mode from **point-to-point** to **multi-drop**, refer to *HART®* network configuration on page 83.

4.7.2 Point-to-point networks
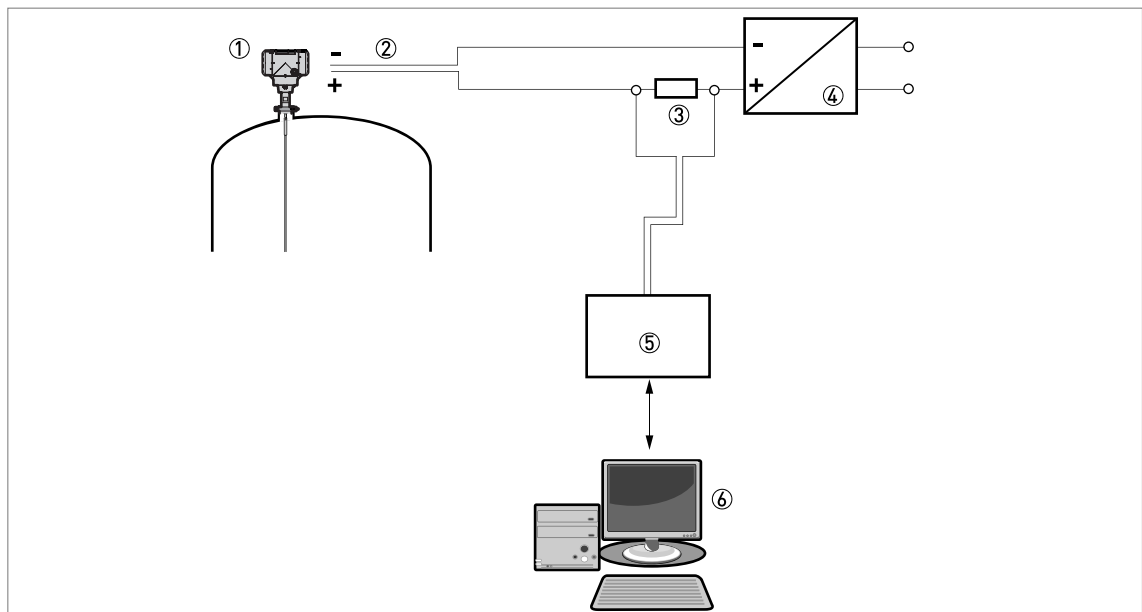
Figure 4-23: Point-to-point connection (non-Ex)

① Address of the device (0 for a point-to-point connection)
② 4...20 mA + HART®
③ Resistor for HART® communication
④ Power supply
⑤ HART® modem
⑥ HART® communication device

4.7.3 Multi-drop networks
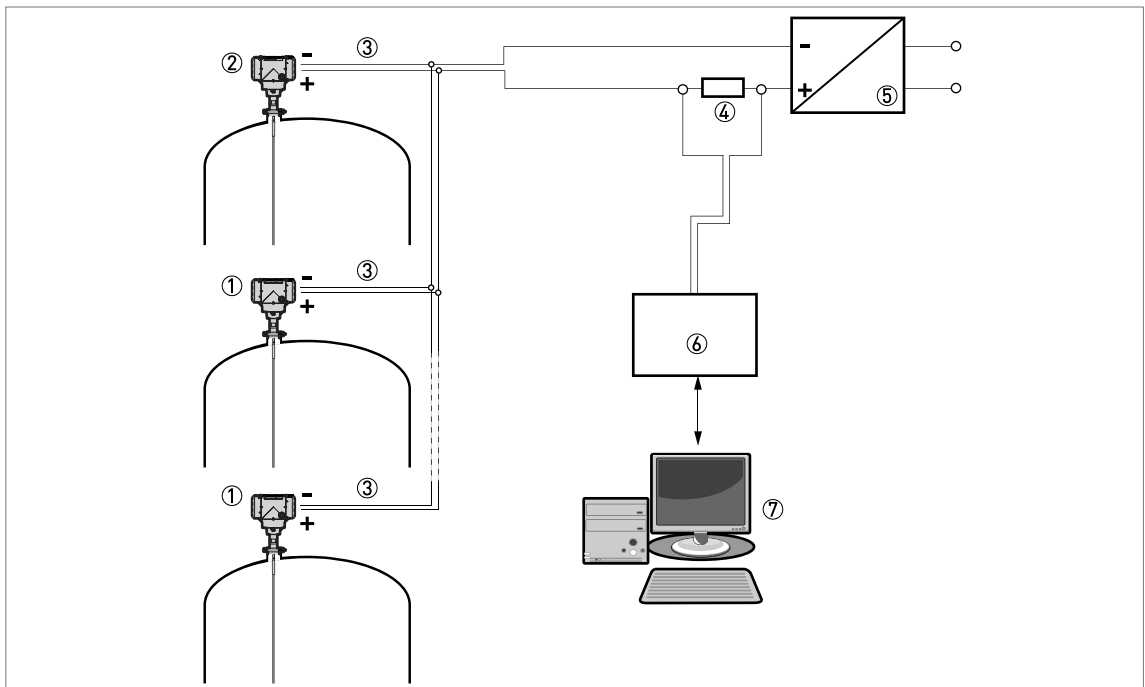
Figure 4-24: Multi-drop network (non-Ex)

① Address of the device (n+1 for multidrop networks)
② Address of the device (1 for multidrop networks)
③ 4 mA + HART®
④ Resistor for HART® communication
⑤ Power supply
⑥ HART® modem
⑦ HART® communication device

5.1 How to start the device

5.1.1 Start-up checklist

Check these points before you energize the device:

- Are all the wetted components (probe, process connection and gaskets) chemically resistant to the product in the tank?
- Does the information on the signal converter nameplate agree with the operating data?
- Did you correctly install the device on the tank?
- Do the electrical connections agree with the national electrical codes?

DANGER!
If the device has a Hazardous Locations approval, make sure that the device and the installation agrees with the requirements of the certificate of compliance.

5.1.2 How to start the device

- Connect the converter to the power supply.
- Energize the converter.
- ⮑ **Devices with the LCD display option only:** After 5 seconds the screen will show the device name and the logo of the manufacturer. After 10 seconds the device display screen shows measurements. Measurements agree with specifications given in the customer order.

INFORMATION!
This chapter and the start of the chapter that follows tell you what data is given on the device display in normal mode and how to change device settings in configuration mode. If you know about how this device operates, you can ignore this data. Continue with the Auto Setup procedure. For more data about this procedure.

5.2 Operating concept

You can read measurements and configure the device with:

- A connection to a system or PC with PACTware™. You can download the Device Type Manager (DTM) file from the website.
- A connection to a system or PC with AMS™. You can download the Device Description (DD) file from the website.
- A connection to a HART® Field Communicator. You can download the Device Description (DD) file from the website.

5.3 Digital display screen

5.3.1 Local display screen layout
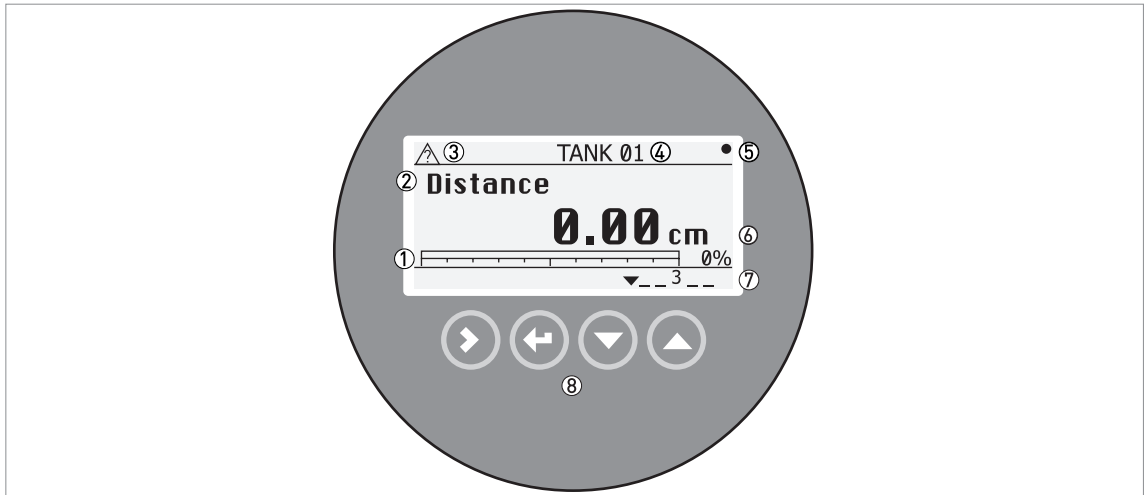
Figure 5-1: Local display screen layout in Normal mode

① Current output percentage (bar graph and text — only shown if the current output function is the same as the measurement on the screen in normal mode)
② Measurement type (in this example, distance)
③ Device status (NE 107 symbols)
④ Device tag name
⑤ Updated measurement data symbol (the symbol flashes each time the measurement data is updated)
⑥ Measurement value and units
⑦ Device status (markers)
⑧ Keypad buttons (refer to the table in the section that follows)

The current output percentage is only shown if the measurement type (refer to item ② in the illustration) is the same as the output function. The parameter is set in menu item 2.4.1 (Output Functions I1). For example, if the output function is set to "Level" and the device shows "Level" measurements in normal mode, the bar graph and value is shown (refer to item ① in the illustration).
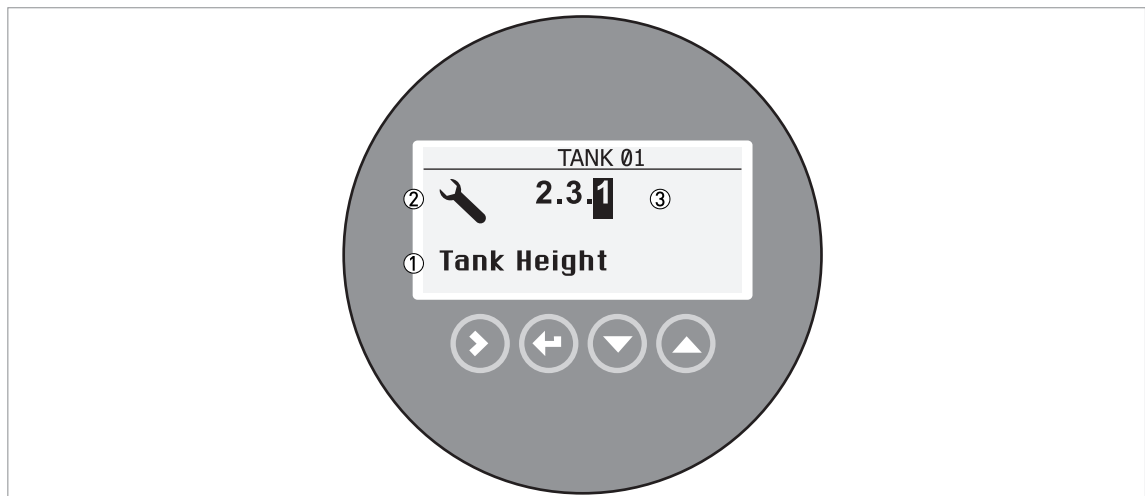
Figure 5-2: Local display screen layout in configuration mode
① Function name
② Configuration mode symbol
③ Menu number

5.3.2 Functions of keypad buttons

For data on keypad functions, refer to *Normal mode* on page 53.

5.4 Remote communication with PACTware™

PACTware™ displays measurement information clearly and lets you configure the device from a remote location. It is an Open Source, open configuration software for all field devices. It uses Field Device Tool (FDT) technology. FDT is a communication standard for sending information between the system and the field device. This standard agrees with IEC 62453. Field devices are easily integrated. Installation is supported by a user-friendly Wizard.

Install these software programs and equipment:

• Microsoft® .NET Framework version 1.1 or later.

• PACTware.

• HART® converter (USB, RS232 etc.).

• The Device Type Manager (DTM) for the device.

INFORMATION!
The DTM for this device agrees with the FDT1.2 specification. For more data, refer to the related certificate in the Product Catalog on the FDT Group website (http://www.fdtgroup.org/product-catalog/certified-dtms).

You can download the latest version of PACTware™ and the DTM from our website.

Refer also to the PACTware™ consortium site at http://www.pactware.com.
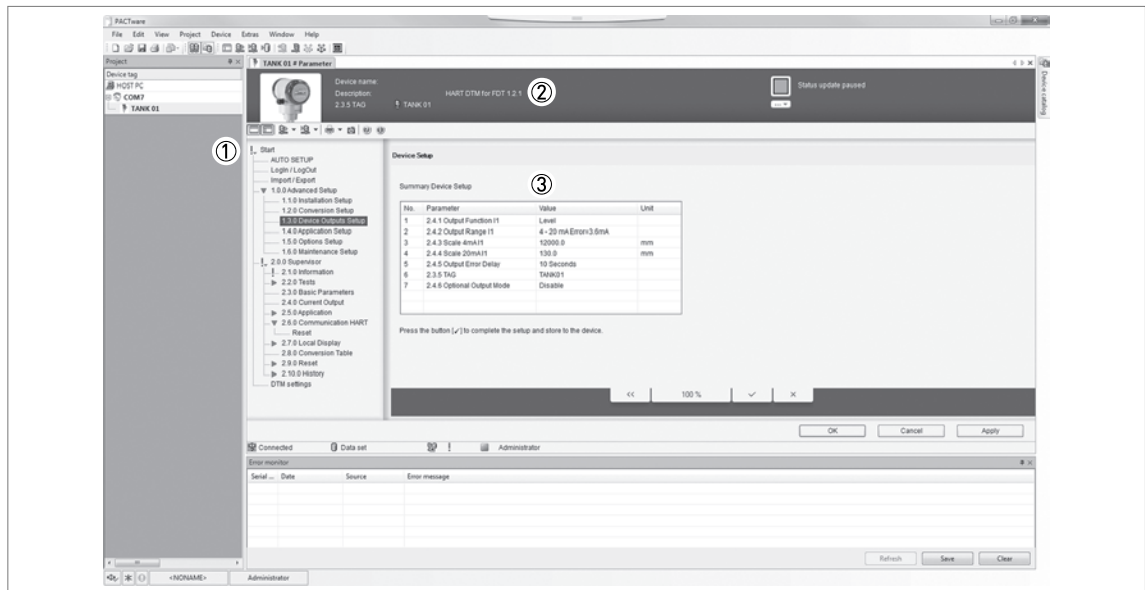
Figure 5-3: Screen from the PACTware™ user interface
① DTM menu
② Information for device identification
③ Configuration summary

5.5 Remote communication with the AMS™ Device Manager

The AMS™ Device Manager is an industrial Plant Asset Management (PAM) software tool. Its role is to:

- Store configuration information for each device.
- Support HART® and FOUNDATION™ fieldbus devices.
- Store and read process data.
- Store and read diagnostic status information.
- Help plan preventive maintenance to reduce a plant's downtime to a minimum.

You can download the DD file from our website.

6.1 User modes

Normal mode   This mode displays measurement data. For more data, refer to *Normal mode* on page 53.

Configuration mode   Use this mode to view parameters, create tables for volume or mass measurement, and change critical values to measure in difficult process conditions. To get access to supervisor menu refer to *Protection of the device settings* on page 82. For more data on menu items, refer to *Function description* on page 61.

6.2 Normal mode

This mode shows measurement data. Use the table that follows:

- for the selection of the measurement type (distance, level, sensor temperature, converter temperature, output, percentage output, dielectric gas, dielectric product and conversion) and
- for the selection of the measurement units

Some measurement types will only be available if the device has the correct parameters entered in the configuration mode.

INFORMATION!
If you push a keypad button for less than 2 seconds, then you can use the standard function. If you push a keypad button for more than 2 seconds, then you can use the "Hot key" function. For more data, refer to the "Keypad function" table in this section.

Keypad functions

Button	Description	Standard function	"Hot key" function
☞ ▶	Right	Enter configuration mode.	Software versions installed on the device (converter firmware version, sensor firmware version and the HMI (device display screen) firmware version)
☞ ⏎	Return / Escape	Change the measurement units.	Enter Auto Setup menu. Enter the supervisor password. You can set the time, date, probe length, tank height, tank type, application type, top product data, current output function, 4 mA value and 20 mA value.
☞ ▼	Down	Change the measurement type.	Setup summary (output function, 4 mA value, 20 mA value and output range). Push [>] again and again to read the installation summary, application summary and probe summary. Push [▲] or [▼] to scroll up or down the list. Push [>] again to go back to normal mode.
☞ ▲	Up	Change the measurement type.	Enter the display language menu. Enter the supervisor password. You can change the display screen language.

Measurement definitions

Measurement type	Description	Available units
LEVEL	This is a display and an output function option. It is the height from the bottom of the tank to the surface of the liquid contents (tank height – distance).	m, cm, mm, in (inches), ft (feet)
DISTANCE	This is a display and an output function option. It is the distance from the face of the flange to the surface of the liquid contents of the tank.	m, cm, mm, in (inches), ft (feet)
INTERFACE LEVEL ①	This is a display and an output function option. If the tank contains 2 liquids, it is the height from the bottom of the tank to the interface between the top liquid and the bottom liquid (tank height - interface distance)	m, cm, mm, in (inches), ft (feet)
INTERFACE DISTANCE ①	This is a display and an output function option. If the tank contains 2 liquids, is the distance from the face of the flange to the interface between the top liquid and the bottom liquid.	m, cm, mm, in (inches), ft (feet)
LAYER ①	This is a display and an output function option. If the tank contains 2 liquids, it gives the thickness of top product. The layer must be more than 50 mm or 2¨ for accurate measurement of level and/or interface.	m, cm, mm, in (inches), ft (feet)
LAYER CONVERSION ①	This is a display and an output function option. It gives the volume or mass of the top liquid when there are 2 or more liquids in the tank. This data is available if you prepare a volume or mass table in configuration mode. For data on how to prepare the conversion table, refer to *How to configure the device to measure volume or mass* on page 86.	kg, t, Ston, Lton, m, cm, mm, in, ft, m3, L, gal, Imp, ft3, bbl, m3/h, ft3/h
SENSOR TEMPERATURE	This is a display and an output function option. The temperature of the sensor electronics.	°C, K, °F, °R
CONV. TEMPERATURE	This is a display and an output function option. The temperature in the signal converter housing.	°C, K, °F, °R
OUTPUT %	The percentage of the current output. 0% = 4 mA. 100% = 20 mA.	%
OUTPUT I	The current output of the device.	mA
DIELECTRIC GAS	This is a display and an output function option. The dielectric constant (ε_r) of the gas in the tank. This value is calculated automatically if the device has the **Dynamic Gas-phase Compensation** option. Go to menu item 1.5.2 Gas Phase Comp.. If this option does not show the message "Option is active", enter a code. You must buy this option from your supplier. Your supplier will then give you the code.	—
DIELECTRIC PRODUCT	This is a display and an output function option. The dielectric constant of the contents of the tank. An electrical property of the liquid contents of the tank. An electrical property of the product to be measured. Also known as ε_r, DK and relative permittivity. This can have an effect on the accuracy of the device.	—
DISTANCE CONV.	Distance conversion. This is a display and an output function option. It gives the empty volume or remaining mass that can be put in the tank. This data is available if you prepare a volume or mass table in configuration mode. For data on how to prepare the conversion table, refer to *How to configure the device to measure volume or mass* on page 86.	kg, t, Ston, Lton, m, cm, mm, in, ft, m3, L, gal, Imp, ft3, bbl, m3/h, ft3/h

Measurement type	Description	Available units
CONVERSION	This is a display and an output function option. It gives the volume or mass of the tank contents. This data is available if you prepare a volume or mass table in configuration mode. For data on how to prepare the conversion table, refer to *How to configure the device to measure volume or mass* on page 86.	kg, t, Ston, Lton, m, cm, mm, in, ft, m3, L, gal, Imp, ft3, bbl, m3/h, ft3/h
RELAY STATE	This is a display and an output function option. This gives the condition of the relay function, if the output function of the optional second output is set to "RELAY".	Open, Closed
TIME	This is a display option. The time format and the time can be set in the Auto Setup procedure and 2.0.0 Supervisor menu.	—
DATE	This is a display option. The date format and the date can be set in the Auto Setup procedure and 2.0.0 Supervisor menu.	—

① This measurement type is shown if you select "LEVEL + INTERFACE MIXED, LEVEL + INTERFACE UNMIXED" or "IN-TERFACE (FULLY SUBMERGED PROBE)" in menu 1.4.0 Application Setup

6.3 Configuration mode

6.3.1 General notes

Change the settings of your device in **Configuration** mode. Data about the menus is given. You can:

- Use the **Auto Setup** menu to commission the device and set basic parameters (tank height etc.).
- Use the **1.0.0 Advanced Setup** menu to commission the device for use in difficult conditions. For more data about the Advanced Setup menu, refer to Table 1: Advanced Setup.
- Use the **2.0.0 Supervisor** menu to commission the device, to run diagnostic tests, set up a conversion table for volume or mass measurement, change output settings, enter a tag name, change output mode, change critical parameters for difficult process conditions, reset the device and change basic parameters (tank height etc.), output settings, polling address etc. For more data about the Supervisor menu, refer to Table 2: Supervisor.

⚠ *CAUTION!*
*The **Auto Setup** procedure is mandatory.*

⚠ *CAUTION!*
***SIL-approved devices:** For data about critical device parameters, refer to the Safety Manual.*

ⓘ *INFORMATION!*
It is not possible to enter the 3.0.0 Service and 4.0.0 Master menus. These menus are for factory calibration and approved personnel only.

6.3.2 How to get access to the Auto Setup procedure

Do the steps that follow:

- Push the [↵] button for more than two seconds.
- ➲ The screen shows a line. You must enter the password. Push the buttons under the display screen 6 times (in total and in a given order) to get access to Configuration mode.
- Type in the password. The factory-set password is [>], [↵], [▼], [▲], [>] and [↵].
- Push the [>] button (YES) to start the Auto Setup procedure.
- Push the [▲] button one time to scroll up to the **Supervisor** menu.

ⓘ *INFORMATION!*
HOW TO SET THE SUPERVISOR PASSWORD TO "ON" OR "OFF"
The supervisor password is set to "on" by default. If it is necessary to set this function to "off", refer to Function description on page 61, Table 2: Supervisor menu, menu item Password Yes/No (2.7.4).

ⓘ *INFORMATION!*
HOW TO CHANGE THE SUPERVISOR PASSWORD
You can change the password for the supervisor menu. For more data, refer to Function description on page 61, Table 2: Supervisor menu, menu item Password (2.7.5).

6.3.3 Menu overview

Auto Setup

1.0.0 Advanced Setup

1.1.0	Installation Setup
1.2.0	Conversion Setup
1.3.0	Device Setup
1.4.0	Application Setup
1.5.0	Options Setup
1.6.0	Maintenance Setup

2.0.0 Supervisor

2.1.0	Identification
2.2.0	Tests
2.3.0	Basic Parameters
2.4.0	Output
2.5.0	Application
2.6.0	Communication
2.7.0	Display
2.8.0	Conversion Table
2.9.0	Reset
2.10.0	History

3.0.0 Service

n/a	Password locked. Menus for factory calibration and qualified service personnel only.

4.0.0 Master

n/a	Password locked. Menus for factory calibration and qualified service personnel only.

INFORMATION!
Auto Setup: *Push the [↵] button for more than two seconds in normal mode to start the procedure.*

6.3.4 Keypad functions
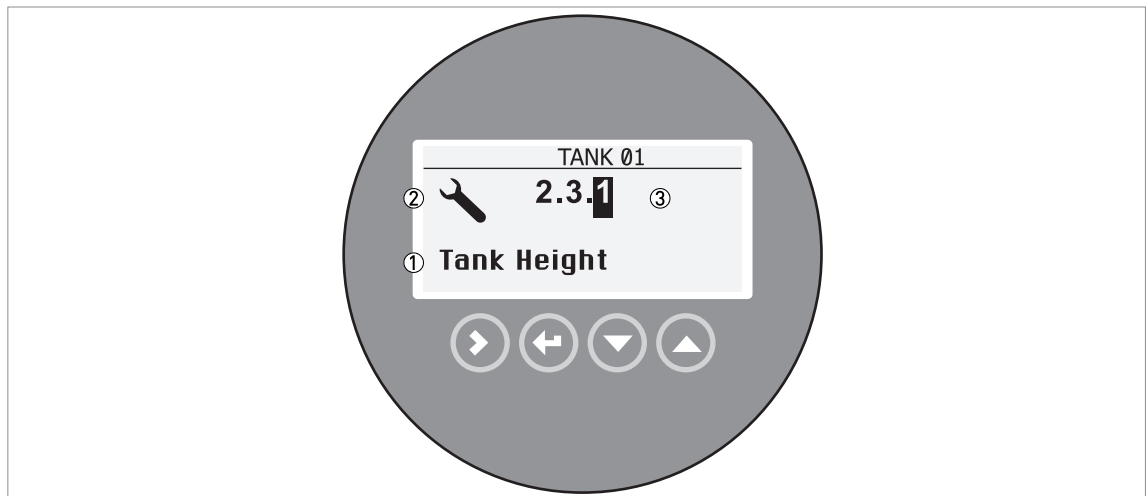
Figure 6-1: Local display screen layout in configuration mode
① Function name
② Configuration mode symbol
③ Menu number

This is what you see when you are in Configuration mode. The functions of the buttons are given in the table that follows:

Functions of buttons for menu navigation

Button	Description	Function
☞ ❯	Right	• Go down to the sub-menu level (for example, from menu 1.0.0 to sub-menu 1.1.0). • Enter the menu item
☞ ↵	Enter / Esc (Escape)	• Go up to the menu level (for example, from sub-menu 1.1.0 to menu 1.0.0). • Go to Normal mode. If you changed settings in Configuration mode, you must save or cancel your new settings. For more data, refer to the end of this section.
☞ ▼	Down	• Scroll down the menu list (for example, from menu 2.0.0 to menu 1.0.0). • Scroll down the sub-menu list (for example, from sub-menu 2.2.0 to sub-menu 2.1.0).
☞ ▲	Up	• Scroll up the menu list (for example, from menu 1.0.0 to menu 2.0.0). • Scroll up the sub-menu list (for example, from sub-menu 2.1.0 to sub-menu 2.2.0).

Lists of parameters in menu items
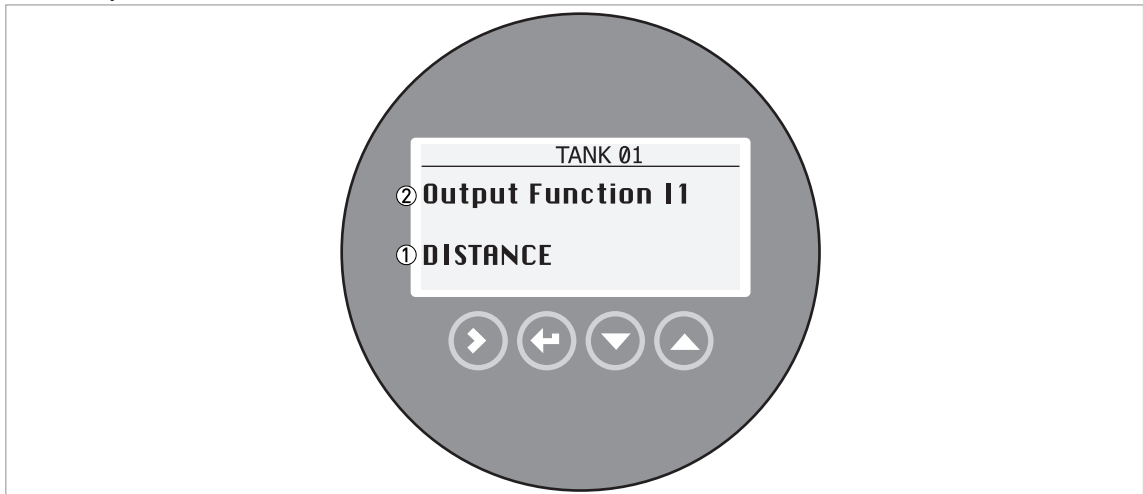
Figure 6-2: Lists of parameters in menu items

① Parameter
② Menu name

This is what you see when you select a menu item that has a list of parameters. The functions of the buttons are given in the table that follows:

Function of buttons in menu items that have a list of parameters

Button	Description	Function
☞ ▶	Right	n/a
☞ ◀	Enter / Esc (Escape)	Select the parameter and go back to the menu
☞ ▼	Down	Move down the list
☞ ▲	Up	Move up the list

Values in menu items
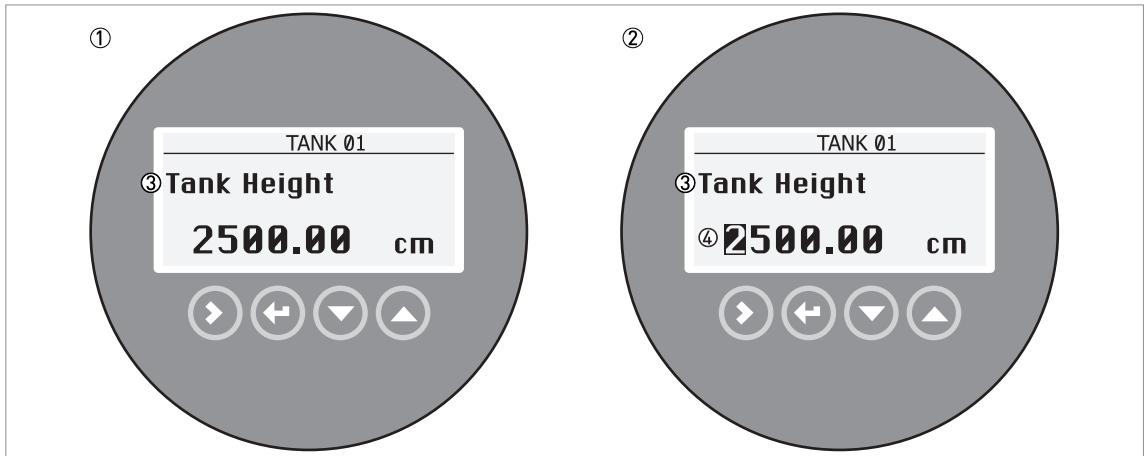
Figure 6-3: Values in menu items

① Menu item with values stored at this time (first screen)
② Push [>] again to change the values. A cursor shows on the first digit.
③ Menu item name
④ Cursor on the selected digit

This is what you see when you select a menu item that has a value. The functions of the buttons are given in the table that follows:

Function of buttons in menu items that have values

Button	Description	Function
☞ ⊙	Right	• Enter the menu item and see the value stored at this time. • Enter the menu item configuration level to change the value. • Move the cursor to the next digit on the right. If the cursor is on the last digit, push [>] again to go back to the first digit.
☞ ⊙	Enter / Esc (Escape)	Accept the value and go back to the sub-menu.
☞ ⊙	Down	Decrease the digit value.
☞ ⊙	Up	Increase the digit value.

How to save settings changed in the advanced setup menu (menu 1.0.0) and the supervisor menu (menu 2.0.0)

• When you have changed parameters in all the necessary menu items, push [↵] to accept the new parameter.
• Push [↵] to go back to the "STORE" screen.
• The device will ask you to save or cancel your settings. Push [▲] or [▼] to select **STORE YES** or **STORE NO**. Push [↵] to accept or reject the new settings.
➥ The display goes back to Normal mode.

6.3.5 Function description

Auto Setup procedure

Auto Setup procedure is available in measurement mode. Push the [↵] button for more than 3 seconds to start the Auto Setup procedure. Enter the Supervisor password.

This procedure is applicable to most applications.

⚠ *CAUTION!*
*Make sure that you do the **Auto Setup** procedure before you use the device. The settings in this procedure have an effect on the performance of the device.*

Function	Function description	Selection list or range of values	Default

Auto Setup

Function	Function description	Selection list or range of values	Default
	Use the Auto Setup menu to commission the device. Follow the procedure and give the correct values for each step. You must do this procedure before the device starts to measure the level of the product. At the end of the procedure the device will do a series of checks (identification of the process connection (flange analysis) and probe signals (probe analysis. It will also do a scan for interference signals along the probe (snapshot).		
Date/Clock format		YYYY/MM/DD 24h, DD/MM/YYYY 12h, DD/MM/YYYY 24h, YYYY/MM/DD 12h	DD/MM/YYYY 24h
Set Clock	Give the time. If the device stays de-energized for more than two weeks, it will be necessary to set the time and date again.	—	—
Set Date	Give the date. If the device stays de-energized for more than two weeks, it will be necessary to set the time and date again.	—	—
Probe Length	Probe length is the distance from the flange face / thread stop of the device down to the bottom end of the probe (including counterweight for cable versions).	min: 2.3.2 Blocking Distance + 3.1.1 Counterweight max: Probe length depends on the measuring range for each type of probe. For more data about probe length, refer to *Technical data* on page 122 (Probe options / Measuring range).	This value is given in the customer order
Installation Type	The conditions in which the device is used. If the device is installed on a tank, set this step to "TANK". If the device is installed in a stilling well or bypass chamber, set this step to "STILLING WELL / BYPASS".	TANK, STILLING WELL / BYPASS	TANK
Tank Height	The distance from the tank connecting flange face / thread stop down to the tank bottom. If **Installation Type** is set to "STILLING WELL / BYPASS", **Tank Height** is replaced by two steps: **Stilling Well Height** and **Internal Diameter**.	min-max: 0.0...99999 mm	Probe length or value specified by the customer

Function	Function description	Selection list or range of values	Default
Stilling Well Height	The distance from the tank connecting flange face / thread stop down to the bottom of the stilling well or the bottom process connection of the bypass chamber. This function replaces **Tank Height**. It is available if **Installation Type** is set to "STILLING WELL / BYPASS".	min-max: 0.0...99999 mm	Probe length or value specified by the customer
Internal Diameter	The internal diameter of the stilling well or bypass chamber. It is available if **Installation Type** is set to "STILLING WELL / BYPASS".	min-max: 40...1000 mm	200 mm
Application Type	This function tells the device what to look for in the tank and what to do with the measurement signals.	LEVEL, LEVEL + INTERFACE MIXED, LEVEL + INTERFACE UNMIXED, INTERFACE (FULLY SUBMERGED PROBE)	LEVEL
Epsilon R Product	This is the dielectric constant of the top product.	Known, Unknown	
	If Epsilon R Product is "Known"	min-max: 1....115	Enter the value
	If Epsilon R Product is "Unknown". What is the product family?	ACIDS, ALCOHOL, BASE, HYDROCARBON, LIQUID GAS, MINERAL OIL, SOLVENT, WATER-BASED, OTHER	OTHER
Output Function I1	The output function for output 1. Make a selection from a list of output functions to scale the current values in relation to a given point (usually the device process connection or the tank bottom). The output current value is shown on a bar graph in normal mode if the measurement name (displayed measurement) is the same as the output function. Conversion parameters (DISTANCE CONV., LEVEL CONVERSION etc.) are shown if there is volume or mass data in menu item **1.2.0 Conversion Setup**.	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	LEVEL
Scale 4mA I1	This function gives a measurement value to 4 mA (output 1).	min-max: ②	③
Scale 20mA I1	This function gives a measurement value to 20 mA (output 1).	min-max: ②	③
Optional Output mode	This function operates the optional second output (output 2). If you set this function to "CURRENT", the second output supplies 4...20 mA. Give the settings for this current output in **Output Function I2**, **Scale 4mA I2** and **Scale 20mA I2**. If you set this function to "RELAY", the second output supplies a switch signal. Give the settings for this relay signal in **Switch Function**, **Set Point/Threshold**, **Alarm Mode** and **Hysteresis**. If **Switch Function** is set to "ERROR LIST", set a condition in **Error List** only.	DISABLE, CURRENT, RELAY ④	③

Function	Function description	Selection list or range of values	Default
Output Function I2	The output function for output 2. Make a selection from a list of output functions to scale the current values in relation to a given point (usually the device process connection or the tank bottom). The output current value is shown on a bar graph in normal mode if the measurement name (displayed measurement) is the same as the output function. Conversion parameters (DISTANCE CONV., LEVEL CONVERSION etc.) are shown if there is volume or mass data in menu item **1.2.0 Conversion Setup**. This function is available if **Optional Output Mode** is set to "CURRENT".	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	DISTANCE
Scale 4mA I2	This function gives a measurement value to 4 mA (output 2). This function is available if **Optional Output Mode** is set to "CURRENT".	min-max: ②	③
Scale 20mA I2	This function gives a measurement value to 20 mA (output 2). This function is available if **Optional Output Mode** is set to "CURRENT".	min-max: ②	③
Switch Function	The switch function for output 2. Make a selection from a list of switch functions to set the switch signal to the function that the device must monitor. For more data about the switch function, refer to *Relay output* on page 81. This function is available if **Optional Output Mode** is set to "RELAY".	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE, CURRENT mA, CURRENT %, ERROR LIST ①	
Set Point/Threshold	This function gives the point or threshold (level, distance etc.) when the device will send the relay signal. This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is not set to "ERROR LIST".	min-max: ②	—
Alarm Mode	"LOW LEVEL ALARM" tells the device to send the relay signal when the quantity of product in the tank is less than the threshold. "HIGH LEVEL ALARM" tells the device to send the relay signal when the quantity of product in the tank is more than the threshold. This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is not set to "ERROR LIST".	LOW LEVEL ALARM, HIGH LEVEL ALARM	—
Hysteresis	If **Alarm Mode** is set to "LOW LEVEL ALARM", this gives the quantity of product above the threshold where the relay goes back to "off". If **Alarm Mode** is set to "HIGH LEVEL ALARM", this gives the quantity of product below the threshold where the relay goes back to "off". This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is not set to "ERROR LIST".	min-max: ②	—

Function	Function description	Selection list or range of values	Default
Error List	If **Switch Function** is set to "ERROR LIST", **Error List** replaces the Point/Threshold, Alarm Mode and Hysteresis steps in this procedure. This tells the device to send a relay signal if the error condition specified in this step occurs.	OVERFILL, TANK EMPTY, INTERFACE LOST, CONV. TEMP. < MINI, CONV. TEMP. > MAXI, SNSR. TEMP. < MINI, SNSR. TEMP. > MAXI, DIELCT. CALC. FROZ., LEVEL LOST	—
Process analysis...	The device automatically does this step.		
Is your tank partially filled or empty?	It is necessary to give this data to tell the device where to do a scan for interference signals along the probe (snapshot). We recommend that the tank is empty when you do the scan.	Partially, Empty	—
Probe analysis...	The device automatically does this step.		
Snapshot...	The device automatically does this step.		
Store configuration...	The display screen shows the summary of the Auto Setup procedure. Push a button to confirm the settings.		

① "INTERFACE LEVEL", "INTERFACE CONVERSION", "INTERFACE DISTANCE", "INTERFACE DIST. CONV.", "LAYER" and "LAYER CONVERSION" are only available if you set Application Type to "LEVEL + INTERFACE MIXED", "LEVEL + INTERFACE UNMIXED" or "INTERFACE (FULLY SUBMERGED PROBE)". "LEVEL CONVERSION", "DISTANCE CONV.", "INTERFACE CONVERSION", "INTERFACE DIST. CONV." and "LAYER CONVERSION" are only available if you made a conversion table (strapping table).

② Units and range depend on the output function, length unit and volume unit selected

③ This depends on the data given in the customer order

④ "CURRENT" and "RELAY" are only available if a second output option is in the customer order

Advanced Setup

The Advanced Setup menu is a list of procedures that have more functions than the Auto Setup procedure.

Push the [>] to go to Configuration mode. Enter the Supervisor password.

Menu No.	Function	Function description	Selection list or range of values	Default

1.0.0 Advanced Setup

1.1.0 Installation Setup				
	This starts a quick setup procedure to give the device data about the tank. This data includes installation type and tank height. If the device is installed in stilling well or a bypass chamber, give the height and the internal diameter of the chamber.			
	Installation Type	The conditions in which the device is used. If the device is installed on a tank, set this step to "TANK". If the device is installed in a stilling well or bypass chamber, set this step to "STILLING WELL / BYPASS".	TANK, STILLING WELL / BYPASS	TANK
	Tank Height	The distance from the tank connecting flange face / thread stop down to the tank bottom. If **Installation Type** is set to "STILLING WELL / BYPASS", **Tank Height** is replaced by two steps: **Stilling Well Height** and **Internal Diameter**.	min-max: 0.0...99999 mm	Probe length or value specified by the customer
	Stilling Well Height	The distance from the tank connecting flange face / thread stop down to the bottom of the stilling well or the bottom process connection of the bypass chamber. This function replaces **Tank Height**. It is available if **Installation Type** is set to "STILLING WELL / BYPASS".	min-max: 0.0...99999 mm	Probe length or value specified by the customer
	Internal Diameter	The internal diameter of the stilling well or bypass chamber. It is available if **Installation Type** is set to "STILLING WELL / BYPASS".	min-max: 40...1000 mm	200 mm
1.2.0 Conversion Setup				
	Use this quick setup procedure to make a conversion table (strapping table) to measure volume or mass. The device uses a conversion table (strapping table) to convert measurements to volume and mass readings. The readings are shown in normal mode. Go to this menu item and give the length unit and then the conversion unit. Push the [>] button to enter the first level-conversion values. Then [>] again to enter the next point. Continue the procedure until the device has data for all the entries. For more data, refer to *How to configure the device to measure volume or mass* on page 86.			

Menu No.	Function	Function description	Selection list or range of values	Default
1.3.0 Device Setup				
		Use this quick setup procedure to give settings for output 1 and output 2		
1.3.1	Output I1 Setup	Use this quick set-up procedure to give the settings for the current output of output 1. These settings include the output function, output range, 4 mA setting, 20 mA setting, output error delay and the tag name.		
	Output Function I1	The output function for output 1. Make a selection from a list of output functions to scale the current values in relation to a given point (usually the device process connection or the tank bottom). The output current value is shown on a bar graph in normal mode if the measurement name (displayed measurement) is the same as the output function. Conversion parameters (DISTANCE CONV., LEVEL CONVERSION etc.) are shown if there is volume or mass data in menu item **1.2.0 Conversion Setup**.	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	LEVEL
	Output Range I1	This menu item sets the limits of the output current range to 1 of the 2 available options: standard limits (4...20 mA) or NAMUR NE 43-compliant limits (3.8...20.5 mA). It also tells the device what to do if an error occurs. If you set **Output Range I1** to "4-20/22E" and an error occurs (e.g. the tank is too full etc.), the device output current will change to an error value of 22 mA. If you set **Output Range I1** to "4-20/3.6E" and an error occurs (e.g. the tank is empty etc.), the device output current will change to an error value of 3.6 mA. If you set **Output Range I1** to "4-20/HOLD" and the device senses a measurement error, the value will stop at the last correct measurement.	4-20/3.6E, 3.8-20.5/22E, 3.8-20.5/3.6E, 4-20/HOLD, 4-20/22E	4-20/3.6E
	Scale 4mA I1	This function gives a measurement value to 4 mA (output 1).	min-max: ②	③
	Scale 20mA I1	This function gives a measurement value to 20 mA (output 1).	min-max: ②	③
	Output Error Delay	The time after which the current output changes to an error value. The error value shows that there is a measurement error. MN=minutes and S=seconds.	0 S, 10 S, 20 S, 30 S, 1 MN, 2 MN, 5 MN, 15 MN	10 S
	Tag Name	The device has a code (tag name) to identify it. If the tag name is given in the customer order data, it will be set at the factory. A maximum of 8 characters can be used.		TANK 01

Menu No.	Function	Function description	Selection list or range of values	Default
1.3.2	Output I2 Setup	Use this quick set-up procedure to give the settings for optional output 2.		
1.3.2	Optional Output mode	This function operates the optional second output (output 2). If you set this function to "CURRENT", the second output supplies 4...20 mA. Give the settings for this current output in **Output Function I2**, **Scale 4mA I2** and **Scale 20mA I2**. If you set this function to "RELAY", the second output supplies a switch signal. Give the settings for this relay signal in **Switch Function**, **Set Point/Threshold**, **Alarm Mode** and **Hysteresis**. If **Switch Function** is set to "ERROR LIST", set a condition in the menu item **Error List** only.	DISABLE, CURRENT, RELAY ④	③
1.3.2	Output Function I2	The output function for output 2. Make a selection from a list of output functions to scale the current values in relation to a given point (usually the device process connection or the tank bottom). The output current value is shown on a bar graph in normal mode if the measurement name (displayed measurement) is the same as the output function. Conversion parameters (DISTANCE CONV., LEVEL CONVERSION etc.) are shown if there is volume or mass data in menu item **1.2.0 Conversion Setup**. This function is available if **Optional Output Mode** is set to "CURRENT".	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ⑤	DISTANCE
	Scale 4mA I2	This function gives a measurement value to 4 mA (output 2). This function is available if **Optional Output Mode** is set to "CURRENT".	min-max: ②	③
	Scale 20mA I2	This function gives a measurement value to 20 mA (output 2). This function is available if **Optional Output Mode** is set to "CURRENT".	min-max: ②	③

Menu No.	Function	Function description	Selection list or range of values	Default
1.3.2	Switch Function	The switch function for output 2. Make a selection from a list of switch functions to set the switch signal to the function that the device must monitor. For more data about the switch function, refer to *Relay output* on page 81. This function is available if **Optional Output Mode** is set to "RELAY".	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE, CURRENT mA, CURRENT %, ERROR LIST ⑤	LEVEL
	Set Point/Threshold	This function gives the switching point or threshold (level, distance etc.) where the device will send the relay signal. This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is not set to "ERROR LIST".	min-max: ②	—
	Hysteresis	If **Alarm Mode** is set to "LOW LEVEL ALARM", this gives the quantity of product above the threshold where the relay goes back to "off". If **Alarm Mode** is set to "HIGH LEVEL ALARM", this gives the quantity of product below the threshold where the relay goes back to "off". This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is not set to "ERROR LIST".	min-max: ②	—
	Alarm Mode	"LOW LEVEL ALARM" tells the device to send the relay signal when the quantity of product in the tank is less than the threshold. "HIGH LEVEL ALARM" tells the device to send the relay signal when the quantity of product in the tank is more than the threshold. This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is not set to "ERROR LIST".	LOW LEVEL ALARM, HIGH LEVEL ALARM	—
	Error List	If **Error Function** is set to "ERROR LIST", **Error List** replaces the **Set Point/Threshold**, **Alarm Mode** and **Hysteresis** steps in this procedure. This tells the device to send a relay signal if the error condition specified in this step occurs. This function is available if **Optional Output Mode** is set to "RELAY" and **Switch Function** is set to "ERROR LIST".	OVERFILL, TANK EMPTY, INTERFACE LOST, CONV. TEMP. < MINI, CONV. TEMP. > MAXI, SNSR. TEMP. < MINI, SNSR. TEMP. > MAXI, DIELCT. CALC. FROZ., LEVEL LOST	—

Menu No.	Function	Function description	Selection list or range of values	Default
1.4.0 Application Setup				
	Use this quick set-up procedure to give the settings about the application type and the dielectric constant of the top product.			
	Application Type	This function tells the device what to look for in the tank and what to do with the measurement signals.	LEVEL, LEVEL + INTERFACE MIXED, LEVEL + INTERFACE UNMIXED, INTERFACE (FULLY SUBMERGED PROBE)	LEVEL
	Epsilon R Product	This is the dielectric constant of the top product.	Known, Unknown	
		If **Epsilon R Product** is "Known", give the correct value for the dielectric constant.	min-max: 1....115	2.5
		If **Epsilon R Product** is "Unknown". What is the product family?	ACIDS, ALCOHOL, BASE, HYDROCARBON, LIQUID GAS, MINERAL OIL, SOLVENT, WATER-BASED, OTHER	OTHER
1.5.0 Options				
	Options can be included in the customer order or you can buy this option after delivery. For more data, speak or write to your supplier.			
1.5.1	Interface	This option is in operation.		
1.6.0 Maintenance Setup				
	Converter Type	The signal converter is available in 2 versions. Make a selection from the list.	C: COMPACT, F: REMOTE CONVERTER	③
	Process Type	The process seal option for the device.	STANDARD CLAMP, STANDARD LIQUID FLANGE, OTHER PROCESS	③
	Probe Type	The probe option for the device. If the measurement screen is set to SI units, then probe dimensions are given in millimetres. If the measurement screen is set to Imperial / US Customary units, then probe dimensions are given in inches.	**SI units:** OTHER PROBE, SINGLE ROD Ø8, SINGLE ROD Ø8 COATED, CABLE Ø4 C/W 20x100 COATED **Imperial / US Customary units:** OTHER PROBE, SINGLE ROD Ø0.32¨, SINGLE ROD Ø0.32¨ COATED, CABLE Ø0.16¨ C/W 0.79x3.94¨ COATED	③

① "INTERFACE LEVEL", "INTERFACE CONVERSION", "INTERFACE DISTANCE", "INTERFACE DIST. CONV.", "LAYER" and "LAYER CONVERSION" are only available if you set 1.4.0 Application Type to "LEVEL + INTERFACE MIXED", "LEVEL + INTERFACE UNMIXED" or "INTERFACE (FULLY SUBMERGED PROBE)". "LEVEL CONVERSION", "DISTANCE CONV.", "INTERFACE CONVERSION", "INTERFACE DIST. CONV." and "LAYER CONVERSION" are only available if you made a conversion table (strapping table).

② Units and range depend on the output function, length unit and volume unit selected

③ This depends on the data given in the customer order

④ "CURRENT" and "RELAY" are only available if a second output option is in the customer order

⑤ "INTERFACE LEVEL", "INTERFACE CONVERSION", "INTERFACE DISTANCE", "INTERFACE DIST. CONV.", "LAYER" and "LAYER CONVERSION" are only available if you set Application Type to "LEVEL + INTERFACE MIXED", "LEVEL + INTERFACE UNMIXED" or "INTERFACE (FULLY SUBMERGED PROBE)". "LEVEL CONVERSION", "DISTANCE CONV.", "INTERFACE CONVERSION", "INTERFACE DIST. CONV." and "LAYER CONVERSION" are only available if you made a conversion table (strapping table).

Supervisor menu

The Advanced Setup menu is a list of procedures that have a more functions than the Auto Setup procedure.

Push the [>] to go to Configuration mode. Enter the Supervisor password.

Menu No.	Function	Function description	Selection list or range of values	Default

2.0.0 Supervisor

2.1.0 Identification

2.1.1	Serial Number	The device serial number.	Read only.	
2.1.2	Conv Firm Version	The converter firmware version.	Read only.	
2.1.3	Sens Firm Version	The sensor firmware version.	Read only.	
2.1.4	HMI Firm Version	The HMI (device display screen) firmware version.	Read only.	
2.1.5	Electronic Revision	**Electronic Revision** is a series of numbers used to record the revision status of embedded software (firmware) in electronic equipment assemblies. It gives data on the type of changes made and the effect that changes have on compatibility.	Read only.	
2.1.6	Mechanical Traceability	The serial number for the probe and process connection.	Read only.	
2.2.0 Tests				
2.2.1	Set Curr.Output I1	Set Current Output. This sets analogue output 1 to a test value [mA] selected from a list. Output will change to the selected value, independent of the measured value.	3.5, 4, 6, 8, 10, 12, 14, 16, 18, 20 or 22 mA	3.5 mA
2.2.2	Diagnostic	This starts the hardware test. Push [▲] and [▼] many times to show: the functioning time, converter temperature, sensor temperature, current on loop, voltage 5.3 V, voltage on capacitors, voltage 3.3 V, reference pulse amplitude, flange pulse amplitude, level pulse amplitude, probe end pulse amplitude, reset counter and device status (this includes warning and error messages that are "on" at this time).	Read only.	
2.2.3	Set Current Output I2	Set Current Output. This sets analogue output 2 to a test value [mA] selected from a list. Output will change to the selected value, independent of the measured value.	3.5, 4, 6, 8, 10, 12, 14, 16, 18, 20 or 22 mA	3.5 mA
2.2.4	Switch Output test	This function sends a test signal to show that the relay is open or closed.	OPEN, CLOSE	OPEN
2.2.5	Proof Test	If the device has the SIL option, it is necessary to do proof tests to make sure that the safety function is applicable to the full measuring range. We recommend that you do a proof test immediately after you install and start the device.		

Menu No.	Function	Function description	Selection list or range of values	Default
2.3.0 Basic Parameters				
2.3.1	Tank Height	The distance from the tank connecting flange face / thread stop down to the tank bottom.	min-max: 0…99.999 m / 0…328.08 ft	Probe length or value specified by the customer
2.3.2	Blocking Distance	The maximum non-measuring range at the top of the probe. It depends on the probe type and the installation.\n\nRefer to the "Default values for menu item **2.3.2 Blocking Distance**" table at the end of this section.	min.: 0 m / 0 ft max: (2.3.4 Probe Length)	This depends on the probe type
2.3.3	Time Constant	This function gives the time over which the device will use readings to calculate the average measurement value.\n\nThe device will show a smooth change in the readings if you increase the time constant. It is possible that the device will show sudden, irregular changes in the readings if you decrease the time constant.	min-max: 0…100 s (seconds)	5 s
2.3.4	Probe Length	Probe length is the distance from the flange face / thread stop of the device down to the bottom end of the probe (including counterweight for cable versions).	min-max: Probe length depends on the measuring range for each type of probe. For more data about probe length, refer to *Technical data* on page 122 (Probe options / Measuring range).	This value is given in the customer order
2.3.5	Tag Name	The device has a code (tag name) to identify it. If the tag name is given in the customer order data, it will be set at the factory. A maximum of 8 characters can be used.		TANK 01 or text specified by the customer
2.3.6	Detection Delay	This parameter makes the device ignore reflections in a specified area immediately below the process connection. We recommend that this value is 50 mm / 2¨ less than the value in menu item **2.3.2 Blocking Distance**.	min.: 0 mm / 0¨ max.: (2.3.4 Probe Length)	0 mm / 0¨
2.3.7	Reference Offset	Offset in relation to a reference location (distance). The device reference point for this parameter is the flange face of the flange (or thread stop, if the device has a thread connection). This value is positive when the reference location is above the device flange face and negative if below. For more data, refer to *Distance and Interface Distance measurement* on page 83.	min-max: -(tank height)… +3000 m / -(tank height)… +9842.52 ft	0 m / 0 ft
2.3.8	Tank Bottom Offset	Offset in relation to a reference location (level). The device reference point for this parameter is the bottom of the tank (set in menu item **2.3.1 Tank Height**). This value is positive when the reference location is below the tank bottom and negative if above. For more data, refer to *Level and Interface Level measurement* on page 85.	min-max: -(probe length)… +3000 m / -(probe length)… +9842.52 ft	0 m / 0 ft

Menu No.	Function	Function description	Selection list or range of values	Default
2.4.0 Outputs				
2.4.1	Output Function I1	The output function for output 1. Make a selection from a list of output functions to scale the current values in relation to a given point (usually the device process connection or the tank bottom). The output current value is shown on a bar graph in normal mode if the measurement name (displayed measurement) is the same as the output function. Conversion parameters (DISTANCE CONV., LEVEL CONVERSION etc.) are shown if there is volume or mass data in menu item **1.2.0 Conversion Setup** or **2.8.3 Input Table** (Conversion Table).	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	LEVEL
2.4.2	Output Range I1	This menu item sets the limits of the output current range to 1 of the 2 available options: standard limits (4…20 mA) or NAMUR NE 43-compliant limits (3.8…20.5 mA). It also tells the device what to do if an error occurs. If you set **Output Range I1** to "4-20/22E" and an error occurs (e.g. the tank is too full etc.), the device output current will change to an error value of 22 mA. If you set **Output Range I1** I to "4-20/HOLD" and the device senses a measurement error, the value will stop at the last correct measurement.	4-20/3.6E, 3.8-20.5/22E, 3.8-20.5/3.6E, 4-20/HOLD, 4-20/22E	4-20/3.6E
2.4.3	Scale 4mA I1	This function gives a measurement value to 4 mA (output 1).	min-max: ②	③
2.4.4	Scale 20mA I1	This function gives a measurement value to 20 mA (output 1).	min-max: ②	③
2.4.5	Output Error Delay	The time after which the current output changes to an error value. The error value shows that there is a measurement error. MN=minutes and S=seconds.	0 S, 10 S, 20 S, 30 S, 1 MN, 2 MN, 5 MN,15 MN	10 S
2.4.6	Optional Output Mode	This function operates the optional second output (output 2). If you set this function to "CURRENT", the second output supplies 4…20 mA. Give the settings for this current output in **2.4.7 Output Function I2**, **2.4.9 Scale 4mA I2** and **2.4.10 Scale 20mA I2**. If you set this function to "RELAY", the second output supplies a switch signal. Give the settings for this relay signal in **2.4.11 Switch Function**, **2.4.12 Set Point/Threshold**, **2.4.13 Alarm Mode** and **2.4.14 Hysteresis**. If **2.4.11 Switch Function** is set to "ERROR LIST", give the settings for this relay signal in **2.4.12 Error List** and **2.4.14 Delay**.	DISABLE, CURRENT, RELAY ④	③

Menu No.	Function	Function description	Selection list or range of values	Default
2.4.7	Output Function I2	The output function for output 2. Make a selection from a list of output functions to scale the current values in relation to a given point (usually the device process connection or the tank bottom). Conversion parameters (DISTANCE CONV., LEVEL CONVERSION etc.) are shown if there is volume or mass data in menu item **1.2.0 Conversion Setup**. This function is available if menu item **2.4.6 Optional Output Mode** is set to "CURRENT".	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	DISTANCE
2.4.8	Output Range I2	This menu item sets the limits of the output current range to 1 of the 2 available options: standard limits (4…20 mA) or NAMUR NE 43-compliant limits (3.8…20.5 mA). It also tells the device what to do if an error occurs. If you set **2.4.8 Output Range I2** to "4-20/22E" and an error occurs (e.g. the tank is too full etc.), the device output current will change to an error value of 22 mA. If you set **2.4.8 Output Range I2** to "4-20/HOLD" and the device senses a measurement error, the value will stop at the last correct measurement. This function is available if menu item **2.4.6 Optional Output Mode** is set to "CURRENT".	4-20/3.6E, 3.8-20.5/22E, 3.8-20.5/3.6E, 4-20/HOLD, 4-20/22E	4-20/3.6E
2.4.9	Scale 4mA I2	This function gives a measurement value to 4 mA (output 2). This function is available if menu item **2.4.6 Optional Output Mode** is set to "CURRENT".	min-max: ②	③
2.4.10	Scale 20mA I2	This function gives a measurement value to 20 mA (output 2). This function is available if menu item **2.4.6 Optional Output Mode** is set to "CURRENT".	min-max: ②	③
2.4.11	Switch Function	The switch function for output 2. Make a selection from a list of switch functions to set the switch signal to the function that the device must monitor. For more data about the switch function, refer to *Relay output* on page 81. This function is available if menu item **2.4.6 Optional Output Mode** is set to "RELAY".	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE, CURRENT mA, CURRENT %, ERROR LIST ①	CURRENT mA or parameter specified by the customer

Menu No.	Function	Function description	Selection list or range of values	Default
2.4.12	Set point	This function gives the switching point or threshold (level, distance etc.) where the device will send the relay signal. This function is available if menu item **2.4.6 Optional Output Mode** is set to "Relay" and menu item **2.4.11 Switch Function** is not set to "Error List".	min-max: ②	3.6 mA or value specified by the customer
	Error list	If **2.4.11 Switch Function** is set to "ERROR LIST", **2.4.12 Error List** and **2.4.14 Delay** replaces the **2.4.12 Set Point/Threshold**, **2.4.13 Alarm Mode** and **2.4.14 Hysteresis**. This tells the device to send a relay signal if the error condition specified in this step occurs. This function is available if menu item **2.4.6 Optional Output Mode** is set to "RELAY" and menu item **2.4.11 Switch Function** is set to "ERROR LIST".	OVERFILL, TANK EMPTY, INTERFACE LOST, CONV. TEMP. < MINI, CONV. TEMP. > MAXI, SNSR. TEMP. < MINI, SNSR. TEMP. > MAXI, DIELCT. CALC. FROZ., LEVEL LOST	—
2.4.13	Alarm Mode	"LOW LEVEL ALARM" tells the device to send the relay signal when the quantity of product in the tank is less than the threshold. "HIGH LEVEL ALARM" tells the device to send the relay signal when the quantity of product in the tank is more than the threshold. This function is available if **2.4.6 Optional Output Mode** is set to "RELAY" and **2.4.11 Switch Function** is not set to "ERROR LIST".	LOW LEVEL ALARM, HIGH LEVEL ALARM	—
2.4.14	Hysteresis	If **2.4.13 Alarm Mode** is set to "LOW LEVEL ALARM", this gives the quantity of product above the threshold where the relay goes back to "off". If **2.4.13 Alarm Mode** is set to "HIGH LEVEL ALARM", this gives the quantity of product below the threshold where the relay goes back to "off". This function is available if **2.4.6 Optional Output Mode** is set to "RELAY" and **2.4.11 Switch Function** is not set to "ERROR LIST".	min-max: ②	1 mA
	Delay	If the device senses an error, **2.4.14 Delay** is the interval (time limit) in seconds necessary for the device to record a change in status (from "off" to "on", or from "on" to "off"). If the device changes status again before the end of this time limit, then the device will not record the change. This function is available if menu item **2.4.6 Optional Output Mode** is set to "RELAY" and menu item **2.4.11 Switch Function** is set to "ERROR LIST".	min-max: 0...99 s (seconds)	1 s or value specified by the customer

Menu No.	Function	Function description	Selection list or range of values	Default
2.5.0 Application				
2.5.1	Tracking Velocity	This value must agree with the maximum rate of change of the level of the liquid contents in the tank.	min-max: 0.1…100 m/min	1.0 m/min
2.5.2	Epsilon R Gas	Dielectric constant (ε_r) of the gas in the tank. A major parameter for TDR level measurement devices. If the dielectric constant of the gas is very different from the default value (air), set **2.5.2 Epsilon R Gas** to the ε_r value of the gas.	min-max: 1.0…115.00	1
2.5.3	Epsilon R Product	You can use this menu item to automatically or manually calculate the dielectric constant (ε_r value) of the liquid contents in the tank. If it is necessary to change the value, do the **Auto Setup** procedure.	MANUAL, AUTO	This depends on the parameter set in the Auto Setup procedure.
2.5.4	Level Threshold	If it is difficult to identify the level signal (for example: too many interference signals), you can increase the detection threshold. This value is measured in thousandths (1…1000). A threshold of 100 is equivalent to 10% of the amplitude of the reference pulse at a distance of 1 m / 3.3 ft from the flange facing or thread stop. For more data, refer to *Thresholds and interference signals* on page 89. Refer to the "Default values for menu item 2.5.4 Level Threshold" table at the end of this section.	min-max: 0…1000	This depends on the process connection type, the probe type, the converter type and the product epsilon R.
2.5.5	Interface Threshold	If it is difficult to identify the interface signal (for example: too many interference signals), you can increase the detection threshold. This value is measured in thousandths (1…1000). A threshold of 100 is equivalent to 10% of the amplitude of the reference pulse at a distance of 1 m / 3.3 ft from the flange facing or thread stop. For more data, refer to *Thresholds and interference signals* on page 89. Refer to the "Default values for menu item 2.5.5 Interface Threshold." table at the end of this section.	min-max: 0…1000	This depends on the process connection type, the probe type, the converter type and the product epsilon R.
2.5.6	Probe End Threshold	For measurement in AUTOMATIC mode. If it is difficult to identify the probe end signal (for example: too many interference signals), you can increase the detection threshold of the signal. A threshold of 100 is equivalent to 10% of the amplitude of the reference pulse at a distance of 1 m / 3.3 ft from the flange facing or thread stop. For more data, refer to *Thresholds and interference signals* on page 89. Refer to the "Default values for menu item 2.5.6 Probe End Threshold" table at the end of this section.	min-max: 0…1000	This depends on the process connection type, the probe type and the converter type.

Menu No.	Function	Function description	Selection list or range of values	Default
2.5.7	Measuring Mode	In DIRECT mode, the device measures the time it takes to receive a reflection of the signal from the surface of the tank contents. Direct mode is used for products with an $\varepsilon r \geq 1.6$ (this value depends on the probe type). AUTOMATIC mode automatically switches the measuring mode between Direct and TBF mode. TBF mode is used to measure one product with a low εr. In TBF mode, the device measures the time it takes to receive a reflection of the signal from the end of the probe.	DIRECT, AUTOMATIC	AUTOMATIC
2.5.8	Snapshot Mode	STATIC mode uses data from the quick setup procedure in the **Auto Setup** procedure. This mode identifies and filters interference signals from objects that do not move in the tank. Snapshot function data is saved if you de-energize the device. **CAUTION!** Do not set this menu item to STATIC mode before you do the quick setup procedure.	STATIC, DISABLE	STATIC
2.6.0 Communication				
2.6.1	Polling Address	Any HART® address greater than 0 will activate HART® multidrop mode. The current output stays constant at 4 mA. If **2.6.1 Polling Address** is set to 0, the device will operate in point-to-point mode.	min-max: 0…63	0
2.6.2	SV function	This is the second measurement type shown on HART® controllers. Make a selection from the list.	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	DISTANCE
2.6.3	TV function	This is the third measurement type shown on HART® controllers. Make a selection from the list.	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	LEVEL

Menu No.	Function	Function description	Selection list or range of values	Default
2.6.4	FV function	This is the fourth measurement type shown on HART® controllers. Make a selection from the list.	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, CONVERTER TEMPERATURE, SENSOR TEMPERATURE ①	DISTANCE
2.7.0 Display				
2.7.1	Language	Data can be shown in one of the languages stored in the device. Make a selection from the list.	English, German, French, Italian, Portuguese, Spanish, Czech, Polish, Chinese (simplified), Japanese, Russian, Turkish	English or language specified by the customer
2.7.2	Display Length Unit	The length unit shown in normal mode.	m, cm, mm, in (inches), ft (feet)	mm or units specified by the customer
2.7.3	Display Conversion Unit	The length, volume or mass conversion unit for the conversion table and shown in normal mode.	kg, t, Ston, Lton, m, cm, mm, in (inches), ft (feet), m3, L (litre), gal (US gallon), Imp (imperial gallon), ft3, bbl, , m3/h, ft3/h	L (litre) or units specified by the customer
2.7.4	Password Yes/No	If it is necessary to protect your settings in the supervisor menu with a password, set this menu item to **YES**.	YES, NO	YES
2.7.5	Password	This changes the password for the supervisor menu. Push the buttons up to 6 times in any order. This will be the new password. To confirm the change, enter the new password a second time. For more data, refer to *Protection of the device settings* on page 82.		[>], [↵], [▼], [▲], [>] and [↵]
2.7.6	Contrast	The contrast control for the display screen. You can select a shade of grey between "no contrast" (level "0") and "black" (level "9").	min-max: 0…9	6
2.7.7	Clock setting	Give the time format, date format, time and date. If the device stays de-energized for more than two weeks, it will be necessary to set the time and date again.	Date/Clock format: YYYY/MM/DD 24h, DD/MM/YYYY 12h, DD/MM/YYYY 24h, YYYY/MM/DD 12h	YYYY/MM/DD 24h
			Set Clock	—
			Set Date	—

Menu No.	Function	Function description	Selection list or range of values	Default
2.7.8	Display Mode	The measurement type shown in normal mode. If this function is set to a measurement type (e.g. Level), the device will always go back to this default measurement type in normal mode after 15 minutes. If this function is set to "DISABLE" and the device is set to a measurement type in normal mode, the device will not go back to the default measurement type after 15 minutes.	LEVEL, LEVEL CONVERSION, DISTANCE, DISTANCE CONV., INTERFACE LEVEL, INTERFACE CONVERSION, INTERFACE DISTANCE, INTERFACE DIST. CONV., LAYER, LAYER CONVERSION, DIELECTRIC PRODUCT, DIELECTRIC GAS, OUTPUT I, OUTPUT %, RELAY STATE, CONVERTER TEMPERATURE, SENSOR TEMPERATURE, TIME, DATE ⑤	LEVEL
2.8.0 Conversion Table				
2.8.1	Length unit	The length unit used to make the conversion table.	m, cm, mm, in (inches), ft (feet)	
2.8.2	Conversion unit	The conversion unit used to make the conversion table.	kg, t, Ston, Lton, m, cm, mm, in (inches), ft (feet), m3, L (litre), gal (US gallon), Imp (imperial gallon), ft3, bbl, , m3/h, ft3/h	
2.8.3	Input Table	The device uses a conversion table (strapping table) to convert measurements to volume and mass readings. The readings are shown in normal mode. Go to this menu item and enter the entry number (01…30). Then enter the level and the related volume / mass value for that entry. Push [↵] to confirm the entry values. Continue the procedure until the device has data for all the entries. For more data, refer to *How to configure the device to measure volume or mass* on page 86.	min. 2 entries max. 30 entries (level / volume or mass)	0 entries
2.8.4	Delete Table	This menu item erases the data in the conversion table.	YES, NO	NO
2.9.0 Reset				
2.9.1	Restart Device	This menu item starts the device again.	YES, NO	NO
2.9.2	Reset Factory	If you set this menu item to "YES", the device goes back to its initial settings (set by the manufacturer in the factory).	YES, NO	NO

Menu No.	Function	Function description	Selection list or range of values	Default
2.10.0 History				
		A log of device errors. Push [>] to read the errors. Push [▲] or [▼] to scroll up or down the list. Each error is identified by a code. Push [>] again to show the number of incidents and the time since the last incident in days, hours, minutes and seconds. For more data about errors, refer to *Status and error messages* on page 93.		

① "INTERFACE LEVEL", "INTERFACE CONVERSION", "INTERFACE DISTANCE", "INTERFACE DIST. CONV.", "LAYER" and "LAYER CON-VERSION" are only available if you set Application Type to "LEVEL + INTERFACE MIXED", "LEVEL + INTERFACE UNMIXED" or "INTER-FACE (FULLY SUBMERGED PROBE)". "LEVEL CONVERSION", "DISTANCE CONV.", "INTERFACE CONVERSION", "INTERFACE DIST. CONV." and "LAYER CONVERSION" are only available if you made a conversion table (strapping table).
② Units and range depend on the output function, length unit and volume unit selected
③ This depends on the data given in the customer order
④ "CURRENT" and "RELAY" are only available if a second output option is in the customer order
⑤ "INTERFACE LEVEL", "INTERFACE CONVERSION", "INTERFACE DISTANCE", "INTERFACE DIST. CONV.", "LAYER" and "LAYER CON-VERSION" are only available if you set Application Type to "LEVEL + INTERFACE MIXED", "LEVEL + INTERFACE UNMIXED" or "INTER-FACE (FULLY SUBMERGED PROBE)". "LEVEL CONVERSION", "DISTANCE CONV.", "INTERFACE CONVERSION", "INTERFACE DIST. CONV." and "LAYER CONVERSION" are only available if you made a conversion table (strapping table). "RELAY STATE" is only available if menu item 2.4.6 Optional Output Mode is set to "RELAY".

Default values for menu item 2.3.2 Blocking Distance

Probe type	Blocking distance	
	[mm]	[inches]
Ø8 mm / 0.32¨single rod, PTFE-coated	50	1.97
Ø8 mm / 0.32¨single rod	50	1.97
Device without a probe (spare part)	50	1.97

Default values for menu items 2.4.3 SCALE 4mA and 2.4.4 SCALE 20mA

Probe type	SCALE 4mA		SCALE 20mA	
	[mm]	[inches]	[mm]	[inches]
Device with a probe	Value given in the customer order or (2.3.1 TANK HEIGHT - 2.3.4 PROBE LENGTH) ①		Value given in the customer order or (2.3.1 TANK HEIGHT - 2.3.2 BLOC. DIST. - 50) ②	Value given in the customer order or (2.3.1 TANK HEIGHT - 2.3.2 BLOC. DIST. - 1.97) ②
Device without a probe	0	0	9600	377.95

① This value is the first entry in the strapping table (2.8.0 CONV. TAB)
② This value is the last entry in the strapping table (2.8.0 CONV. TAB)

3. Service menu

Menu No.	Function	Function description	Selection list	Default
3.0.0	SERVICE	Advanced settings. The settings in this menu are protected with a password. Only approved personnel can change the parameters in this menu. For more data, speak or write to your local sales office.		

4. Master menu

Menu No.	Function	Function description	Selection list	Default
4.0.0	MASTER	Factory settings. The settings in this menu are protected with a password. Only approved personnel can change the parameters in this menu. For more data, speak or write to your local sales office.		

6.4 Further information on device configuration

6.4.1 Second output

General notes

A second output is available as an option for this device. If the device has a second output, then you can make a selection from three output modes:

• DISABLE (no output)
• CURRENT (4...20 mA current output)
• RELAY (50 V DC / 6 A)

Electrical installation

For more data about electrical connection of the second output, refer to *Electrical connections* on page 29.

How to change the output mode

You can change the output mode in:

• the Auto Setup procedure (Optional Output mode),
• the Advanced Setup menu (sub-menu 1.3.2 Output I2 Setup / Optional Output mode) or
• the Supervisor menu (menu item 2.4.6 Optional Output mode).

Current output

If the Optional Output mode is set to "CURRENT", then use the same procedures for output 1 for the current output settings:

• You will find data about device settings for level or level interface measurement on page 85
• You will find data about device settings for distance or distance interface measurement on page 83
• You will find data about device settings for volume, ullage volume, mass and ullage mass measurement on page 86

Relay

If the Optional Output mode is set to "RELAY", refer to *Relay output* on page 81.

6.4.2 Relay output

General notes

The relay output is available as an output mode for the optional second output. The relay sends an output signal when the switch function (level, distance, volume, current mA, converter temperature etc.) is at a specified value. It can also send a signal if an error occurs (overfill, level lost, converter temperature above the maximum limit etc.).

How to change the output mode

You can change the output mode to "RELAY" in:

- the Auto Setup procedure (Optional Output mode),
- the Advanced Setup menu (sub-menu 1.3.2 Output I2 Setup / Optional Output mode) or
- the Supervisor menu (menu item 2.4.6 Optional Output mode).

Switching capacity

For technical data about the relay output, refer to *Technical data* on page 122.

Electrical installation

For more data about electrical connection of the relay output, refer to *Electrical connections* on page 29.

Threshold

The threshold is the value at which the device sets the relay to "on" and sends a signal. To set the threshold, you must set **Switch Function** to the correct parameter (level, distance, volume, current mA, converter temperature etc.) and then give a value in **Set Point/Threshold**.

Alarm modes

There are two alarm modes: 'high level alarm" and "low level alarm". "Low level alarm" tells the device to set the relay to "on" and send a signal when the quantity of product in the tank is less than the threshold. "High level alarm" tells the device to set the relay to "on" and send a signal when the quantity of product in the tank is more than the threshold.

You can change the alarm mode in:

- the Auto Setup procedure (Alarm mode),
- the Advanced Setup menu (sub-menu 1.3.2 Output I2 Setup / Alarm mode) or
- the Supervisor menu (menu item 2.4.13 Alarm mode).

Hysteresis

Hysteresis specifies the conditions when the relay status goes back to "off". If **Alarm Mode** is set to "HIGH LEVEL ALARM", then hysteresis is the quantity below the threshold where the relay status goes back to "off". If **Alarm Mode** is set to "LOW LEVEL ALARM", then hysteresis is the quantity above the threshold where the relay status goes back to "off".

For example, if **Switch Function** is "CURRENT mA", **Set Point/Threshold** is "12.00 mA", **Hysteresis** is "1 mA" and **Alarm Mode** is "LOW LEVEL ALARM", then the relay status goes back to "off" when the measured current is 13 mA.
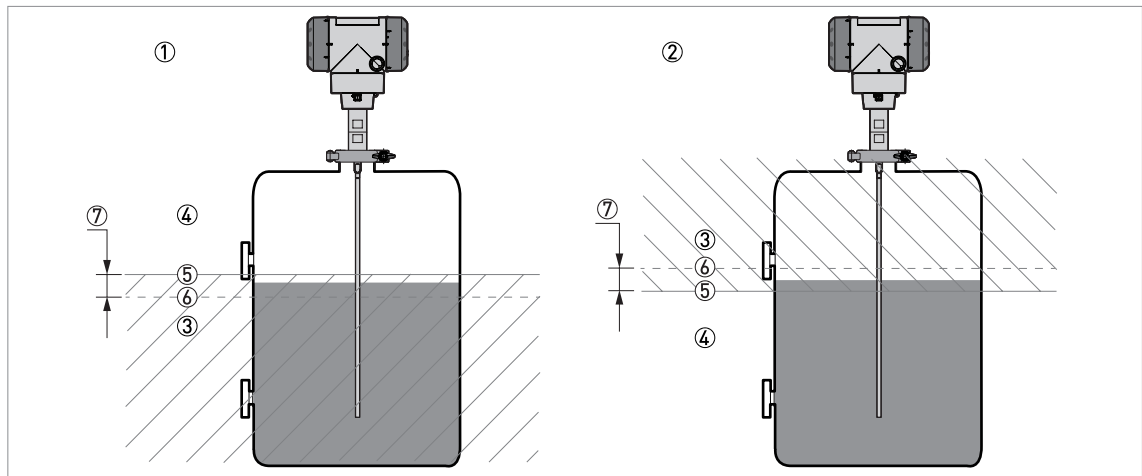
Figure 6-4: Relay output: alarm mode, threshold and hysteresis

① Device with relay output in "high alarm" mode
② Device with relay output in "low alarm" mode
③ Zone where the relay output is set to "off"
④ Zone where the relay output is set to "on"
⑤ Continuous line: Level (threshold) at which the relay output changes to "on" (if **Switch Function** is set to "LEVEL"). The position of this threshold is specified in **Set Point/Threshold**.
⑥ Dotted line: Level at which the relay output goes back to "off" (if **Switch Function** is set to "LEVEL"). The position of this limit is specified in **Hysteresis**.
⑦ Dimension given in **Hysteresis**

INFORMATION!
Example
If the Switch Function is "LEVEL", Alarm Mode is "LOW LEVEL ALARM", Threshold is set to "1500 mm" and Hysteresis is set to "10 mm", then the relay output is set to "on" when the level of the tank contents is more than 1500 mm. The relay output goes back to "off" when the level of the tank contents is less than 1490 mm.

6.4.3 Protection of the device settings

The menu item **2.7.5 Password** lets you change the supervisor menu password.

How to change the supervisor menu password
- After you enter the supervisor menu, push [▲], [>], 6 × [▲], [>] and 4 × [▲] to go to the menu item **2.7.5 Password**.
- Push [>] to start the procedure.
- Enter the old 6-character password. The factory-set password is [>], [↵], [▼], [▲], [>] and [↵].
- Enter the new 6-character password (push the 4 buttons in any sequence).
- Enter the new 6-character password again.
➲ If the second entry is the same as the first, the device will go back to the sub-menu list (2.7). If the second entry is not the same as the first, the device will start the password sequence again.

- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
➲ The device will save the new password and go back to normal mode.

INFORMATION!
Make a note of the password and keep it in a safe place. If you lose the password, please speak or write to your supplier.

How to set the supervisor password to "on" or "off"

The supervisor password is set to "on" by default. If it is necessary to set this function to "off", refer to *Function description* on page 61, Supervisor menu, menu item **2.7.4 Password Yes/No**.

6.4.4 HART® network configuration

INFORMATION!
For more data, refer to Networks on page 47.

The device uses HART® communication to send information to HART®-compatible equipment. It can operate in either point-to-point or multidrop mode. The device will communicate in multidrop mode if you change the address.

CAUTION!
Make sure that the address for this device is different from others in the multi-drop network.

How to change from point-to-point to multidrop mode

- Enter 2.0.0 Supervisor menu.
- Push [>], 5 × [▲] and [>] to go to menu item **2.6.1 Polling Address**.
- Push [>] to change the value. Enter a value between "001" and "063" and push [↵] to confirm (refer to the caution before this procedure).
- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
- ➲ The output is set to multidrop mode. The current output is set to 4 mA. This value does not change in multidrop mode.

How to change from multidrop to point-to-point mode

- Enter 2.0.0 Supervisor menu.
- Push [>], 5 × [▲] and [>] to go to menu item **2.6.1 Polling Address**.
- Push [>] to change the value. Enter the value "000" and push [↵] to confirm.
- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
- ➲ The output is set to point-to-point mode. The current output changes to a range of 4…20 mA or 3.8…20.5 mA (this range is set in menu item **2.4.2 Output Range I1**).

6.4.5 Distance and Interface Distance measurement

An output agrees with distance measurement when the output function is set to measure "DISTANCE". Menu items used for distance measurement are:

- 2.4.1 Output Function I1 (output 1)
- 2.4.7 Output Function I2 (optional output 2)
- 2.3.1 Tank Height
- 2.3.2 Blocking Distance

An output agrees with interface distance measurement when the output function is set to "INTERFACE DISTANCE". Menu items used for interface distance measurement are:

- 2.4.1 Output Function I1 (output 1)
- 2.4.7 Output Function I2 (optional output 2)
- 2.3.1 Tank Height
- 2.3.2 Blocking Distance

Use the flange facing or thread stop as the reference point for the 4 and 20 mA current output settings. The 4 and 20 mA current output settings are the minimum and maximum points of the measurement scale.

CAUTION!
If the distance for 4 mA is set in the blocking distance, the device will not be able to use the full current output range.

You can change the reference point from which distance is measured. Use the menu item **2.3.7 Reference Offset**. If you move the reference point above the flange, add this value when give a distance for the 4 and 20 mA current output settings. If you move the reference point below the flange, subtract this value when you give a distance for the 4 and 20 mA current output settings.
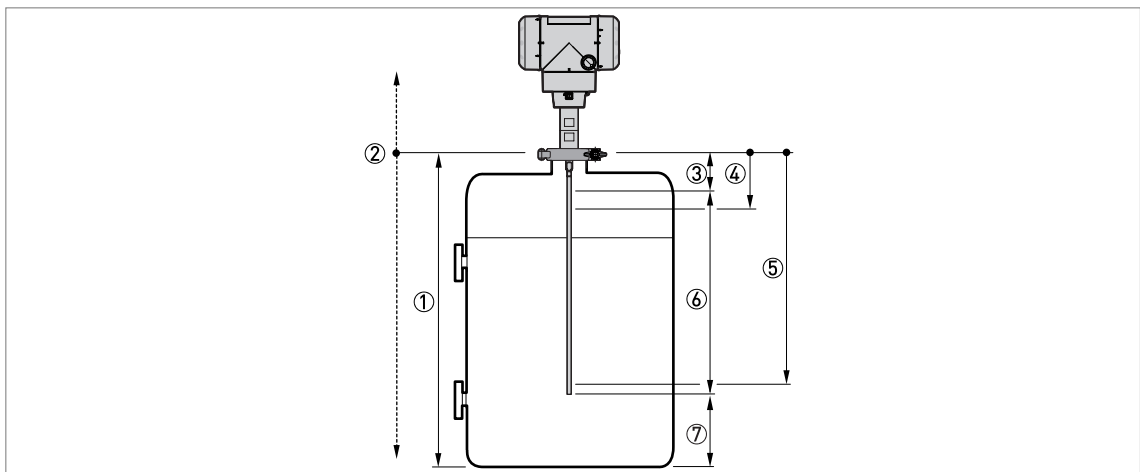
Figure 6-5: Distance or Interface Distance measurement

① 2.3.1 Tank height
② 2.3.7 Reference Offset
③ 2.3.2 Blocking Distance
④ 2.4.3 Scale 4mA I1 (4 mA setting for output 1)
   2.4.9 Scale 4mA I2 (4 mA setting for optional output 2)
⑤ 2.4.4 Scale 20mA I1 (20 mA setting for output 1)
   2.4.10 Scale 20mA I2 (20 mA setting for optional output 2)
⑥ Maximum effective measuring range
⑦ Non-measurement zone

For more data about the menu items, refer to *Function description* on page 61.

6.4.6 Level and Interface Level measurement

An output agrees with level measurement when the output function is set to "LEVEL". Menu items related to level measurement are:

- 2.4.1 Output Function I1 (output 1)
- 2.4.7 Output Function I2 (optional output 2)
- 2.3.1 Tank Height
- 2.3.2 Blocking Distance

An output agrees with interface level measurement when the output function is set to "INTERFACE LEVEL". Menu items used for interface level measurement are:

- 2.4.1 Output Function I1 (output 1)
- 2.4.7 Output Function I2 (optional output 2)
- 2.3.1 Tank Height
- 2.3.2 Blocking Distance

Use the tank bottom as the reference point for the 4 and 20 mA current output settings. The 4 and 20 mA current output settings are the minimum and maximum points of the measurement scale.

CAUTION!
If the level for 20 mA is set in the blocking distance, the device will not be able to use the full current output range.

You can change the reference point from which level is measured. Use the menu item**2.3.8 Tank Bottom Offset**. If you move the reference point below the tank bottom, add this value when give a level for the 4 and 20 mA current output settings. If you move the reference point above the tank bottom, subtract this value when you give a level value for the 4 and 20 mA current output settings.
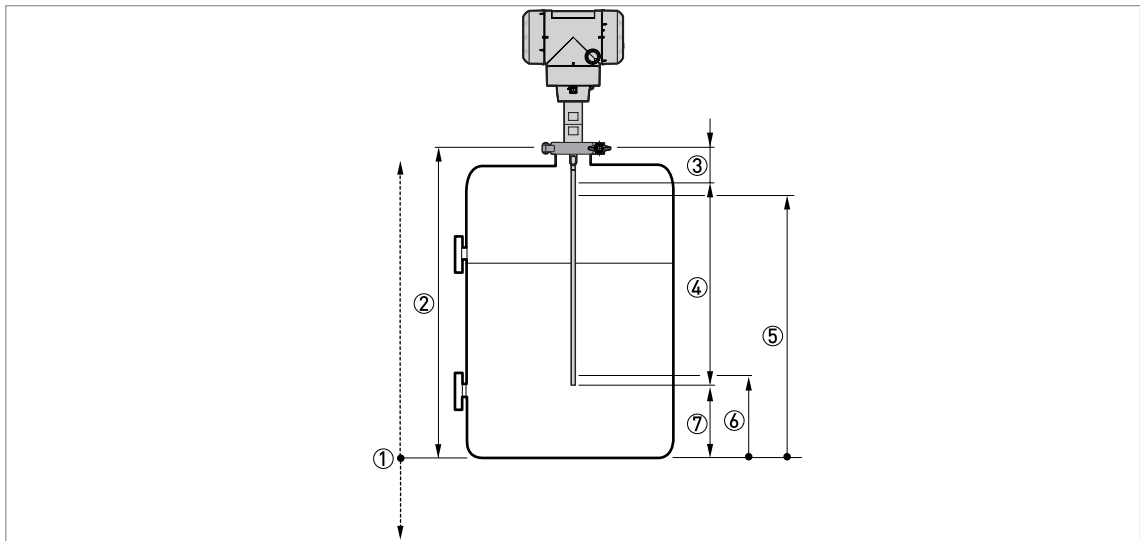
Figure 6-6: Level measurement

① 2.3.8 Tank Bottom Offset
② 2.3.1 Tank Height
③ 2.3.2 Blocking Distance
④ Maximum effective measuring range
⑤ 2.4.4 Scale 20mA I1 (20 mA setting for output 1)
   2.4.10 Scale 20mA I2 (20 mA setting for output 2)
⑥ 2.4.3 Scale 4mA I1 (4 mA setting for output 1)
   2.4.9 Scale 4mA I2 (4 mA setting for output 2)
⑦ Non-measurement zone

For more data about the menu items, refer to *Function description* on page 61.

6.4.7 How to configure the device to measure volume or mass

The device can be configured to measure volume and mass. You can set up a strapping table in the **1.2.0 Conversion Setup** procedure or the **2.8.0 Conversion Table** menu. Each entry is a pair of data (level – volume or level – mass). The strapping table must have a minimum of 2 entries and a maximum of 50. The reference point for the table is the bottom of the tank (as given in menu item **2.3.1 Tank height**).

⚠️ *CAUTION!*
Enter the data in numerical sequence (strapping table entry number 01, 02 etc.).
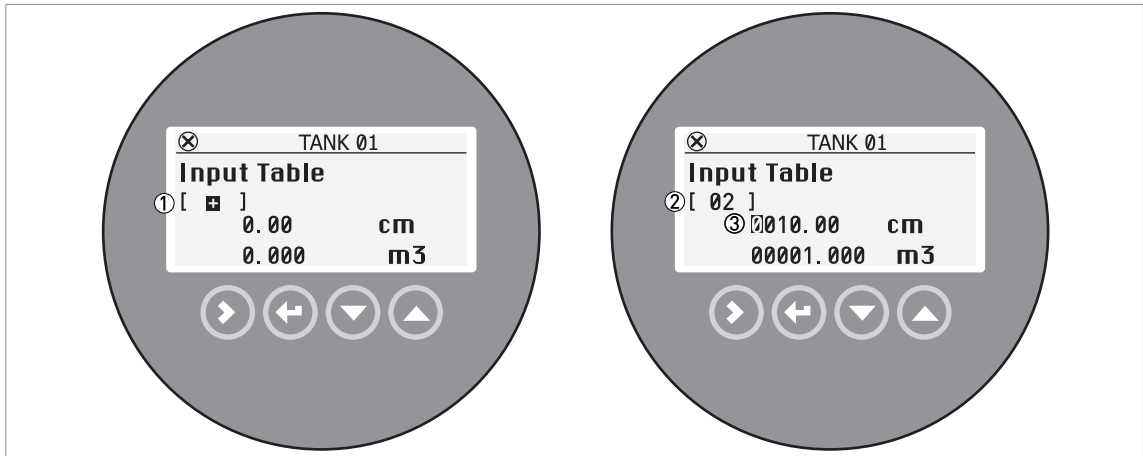
Figure 6-7: How to make a strapping table in Configuration mode

① The "+" sign is shown if there are no points on the conversion table. Push [▲] when the cursor is on this sign to add a point on the table.
② The conversion table is set to point "2".
③ The position of the cursor shows which digit can be changed

How to prepare a strapping table (conversion table)

- After you enter **1.0.0 Advanced Setup** menu, push [▲] and [>] to start to the **1.2.0 Conversion Setup** procedure.
- Push [▲] and [▼] to find the length unit (m, cm, mm, in or ft) that you will use in the table. Push [↵] to go to the next step.
- Push [▲] and [▼] to find the conversion unit (m³, L, gal, Imp, ft³, bbl, kg, t, Ston, Lton, m, cm, mm, in or ft) that you will use in the table. Push [↵] to go to the next step.
- Push [>] to make the first point on strapping table.
- The cursor moves to the length value (default value: 0000.00). Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵] to go to the next step.
- The cursor moves to the conversion value (default value: 00000.000) Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵], [>] and [▲] to make the second point on strapping table.
- The cursor moves to the length value (default value: 0000.00). Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵] to go to the next step.
- The cursor moves to the conversion value (default value: 00000.000) Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵], [>] and [▲] to make the subsequent point on strapping table. Repeat the last 2 steps to add more points to the table. If you have a sufficient number of points, push [↵] to complete the procedure.
- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
- ➲ The device will store the data for the strapping table and go back to normal mode.

An output agrees with volume measurement when the output function is set to "Level conversion", "Interface conversion" or "Layer conversion". Menu items related to volume measurement are:

- 1.3.1 Output 1 Setup and 2.4.1 Output Function I1 (output 1)
- 1.3.2 Output 1 Setup and 2.4.7 Output Function I2 (optional output 2)
- 2.3.1 Tank Height

- 2.3.2 Blocking Distance

An output agrees with ullage volume (empty volume) measurement when the output function is set to "Distance conv." or "Interface dist. conv.". Menu items related to ullage volume measurement are:

- 1.3.1 Output 1 Setup and 2.4.1 Output Function I1 (output 1)
- 1.3.2 Output 1 Setup and 2.4.7 Output Function I2 (optional output 2)
- 2.3.1 Tank Height
- 2.3.2 Blocking Distance

The device will give more accurate volume readings if you give more conversion data in these areas:

- Surfaces with curves.
- Sudden changes in the cross section.

Refer also to the illustration that follows:
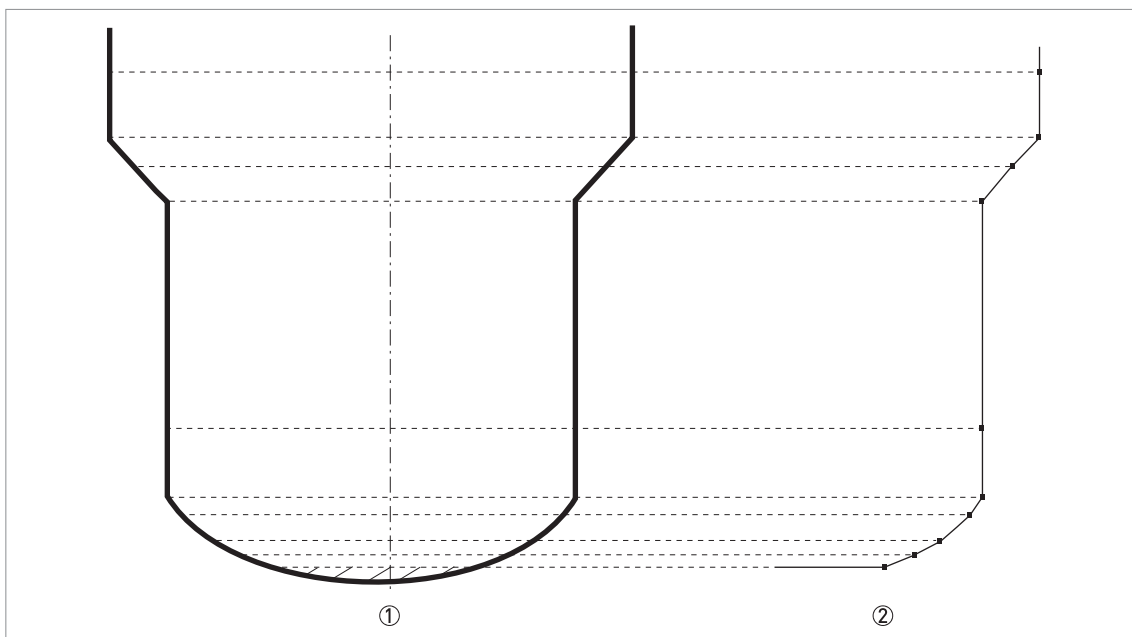
Figure 6-8: A plot of points for a volume or mass table

① Tank with reference points
② Tank model with plotted points

How to change values in a strapping table (conversion table)

- After you enter the **1.0.0 Advanced Setup** menu, push [▲] and [>] to start to the **1.2.0 Conversion Setup** procedure.
- Push 2 × [↵] to go to the conversion table.
- Push [▲] and [▼] to find the correct point in the table.
- Push [>]. The cursor moves to the length value. Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵] to go to the next step.

- The cursor moves to the conversion value. Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵] and then [▲] or [▼] to find a different point in the table. If you have completed the changes to the conversion table, the push [↵] to complete the procedure.
- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
- ➲   The device will store the data for the strapping table and go back to normal mode.

How to delete a volume or mass table

- Enter 2.0.0 Supervisor menu.
- After you enter **2.0.0 Supervisor** menu, push 7 × [▲],[>], and 3 ×[▲] to go to **2.8.4 Delete Table**.
- Push [>] and [▲] to set the parameter to "YES".
- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
- ➲   The device will delete the data for the strapping table and go back to normal mode. The device will not show Level Conversion, Distance Conversion, Interface Conversion, Interface Distance Conversion and Layer Conversion measurements in normal mode.

6.4.8 Thresholds and interference signals

General notes

The low-power electromagnetic signal from the device goes down the probe. The surface of the liquid products, and objects in the tank, make reflections. These reflections go back up the probe to the signal converter. The signal converter changes the reflections into voltage amplitudes. Reflections from objects in the tanks are interference signals.

CAUTION!
If the device cannot measure level correctly, make sure that you do the Auto Setup procedure with a snapshot analysis first to find and remove signal interference. If the device continues to measure level incorrectly, change the thresholds.

For more data about snapshot, refer to the Auto Setup procedure on page 61.

How thresholds work

Thresholds let the device ignore reflections with small amplitudes and monitor changes in level and interface.

The device uses the menu items that follow:

- **2.5.4 Level Threshold** to set the threshold for the reflection on the top surface of the liquid products.
- **2.5.5 Interface Threshold** to set the threshold for the reflection on the interface between two liquid products.
- **2.5.9 Probe End Threshold** to set the threshold for the reflection on the end of the probe. If you must calculate the ε_r of the product or operate the device in AUTOMATIC mode, there must be a good probe end signal.

The user can do a check of the signal amplitude after reflection on the surface of the liquid product or the liquid interface:

2.5.4 Level Threshold. Level threshold is the value that permits the device to find and measure the level of the tank contents. The level threshold must be set lower than the amplitude of the level signal. It is measured in thousandths (1...1000) of the reference pulse amplitude (value= 1000). The device measures the distance from the process connection to the level signal, and the signal amplitude. The signal converter then does a mathematical conversion (that agrees with a law of signal attenuation) to show the signal amplitude at a standard distance of 1 m / 3.3 ft from the process connection. This value helps you to set the level threshold in this menu item.

2.5.5 Interface Threshold. Interface threshold is the value that permits the device to find and measure the interface between two liquid products in the tank. The interface threshold must be set lower than the amplitude of the interface signal. It is measured in thousandths (1...1000) of the reference pulse amplitude (value= 1000). The device measures the distance from the process connection to the interface signal, and the signal amplitude. The signal converter then does a mathematical conversion (that agrees with a law of signal attenuation) to show the signal amplitude at a standard distance of 1 m / 3.3 ft from the process connection. This value helps you to set the interface threshold in this menu item.

2.5.6 Probe End Threshold. Probe end threshold is the value that permits the device to find the end of the probe. The probe end threshold must be set lower than the amplitude of the probe end signal. This value is measured in thousandths (1...1000) of the reference pulse amplitude (value= 1000). The device measures the distance from the process connection to the probe end signal, and the signal amplitude. The signal converter then does a mathematical conversion (that agrees with a law of signal attenuation) to show the signal amplitude at a standard distance of 1 m / 3.3 ft from the process connection. This value helps you to set the probe end threshold in this menu item.

INFORMATION!
For more data on menu items, refer to Function description on page 61.

How to use thresholds

Although the data that follows refers to the level threshold, it is applicable for the interface threshold and the probe end threshold.

If there is an interference signal above the level and the threshold is too low, the device can incorrectly use it as the level signal.
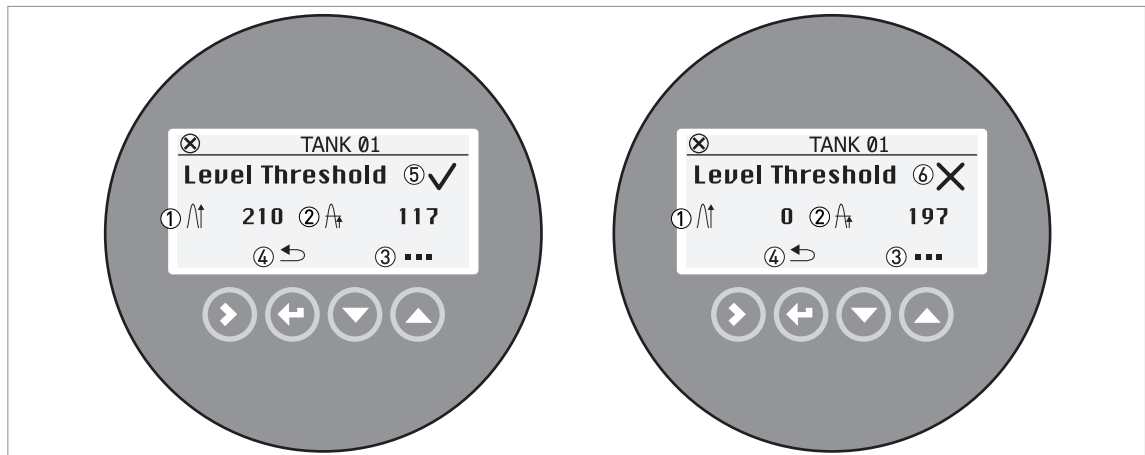
Figure 6-9: How to use thresholds (level signal and threshold data shown in this example)

① Signal amplitude
② Threshold
③ Push [▲] to change the threshold value. Push [>] to change the position of the cursor and then push [▲] and [▼] to change the value of each digit. Push [↵] to set the value and go back to the first screen.
④ Push [↵] to go back to the sub-menu level.
⑤ The signal amplitude and the threshold are correct. The device can find the level signal.
⑥ The signal amplitude and the threshold are incorrect. The device cannot find the level signal.
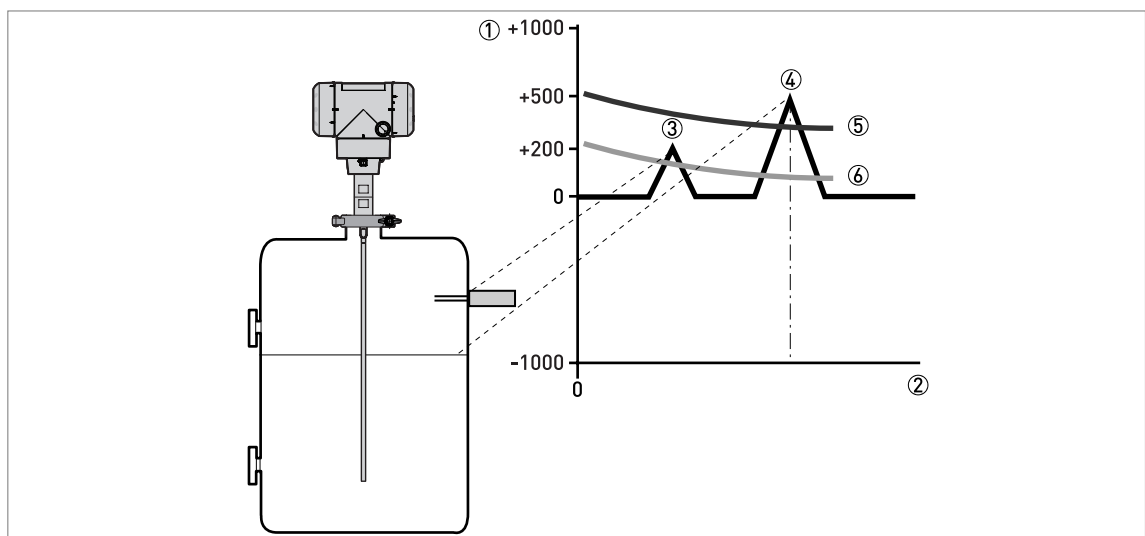
Figure 6-10: Signal intensity/distance graph: thresholds

① Signal intensity given as a fraction of the reference pulse (measured in thousandths)
② Distance from the process connection
③ Interference signal. A signal from a level switch that is in the limits of the electromagnetic field around the probe.
④ Level signal of the liquid products
⑤ The level threshold is correct. The device ignores the interference signal and measures level correctly.
⑥ The level threshold is too low. The device can use the interference signal as the level signal. Do the Auto Setup procedure to make sure that the device ignores the interference signal.

We recommend that you do the procedure in menu item 1.4.0 Application Setup to find the level signal:

- After you enter **1.0.0 Advanced Setup** menu, 3 × [▲] to go to the menu item **1.4.0 Application Setup**.
- Push [>] to start the procedure.
- Push [▲] or [▼] to change the **Application Type** parameter. Push [↵] to go to the next step.
- **ALTERNATIVE STEP A:** If you know the dielectric constant value of the tank contents, then push [>] (Known) to enter the value. Push [>] to move the cursor to the next digit on the right. If the cursor is on the last digit, push [>] again to go back to the first digit. Push [▼] to decrease the digit value and [▲] to increase the digit value. Push [↵] to go to the next step.
- **ALTERNATIVE STEP B:** If you do not know the dielectric constant value of the tank contents, then push [▲] (Unknown) to give the product family. Push [▲] or [▼] to change the **Product Family** parameter. Push [↵] to go to the next step.
- Push [↵] again and again to go back to the **Store** screen.
- Push [▲] or [▼] to set the screen to "STORE YES" and push [↵].
- ➲ The device will save the new settings and go back to normal mode.

If the device cannot find the level signal after you do the procedure in menu item **1.4.0 Application Setup**, then you can also manually change the threshold to find the signal. Do this procedure:

- Look at the level pulse amplitude value on left side of the first screen in menu item **2.5.4 Level Threshold**.
- ➲ Make a note of the amplitude of the correct level signal. Use this value to calculate the new value for the level threshold. The level threshold value used at this time is shown on right side of the first screen.

- Push [▲] to change the level threshold value.
- Increase the amplitude of the level threshold value. Push [>] to move the cursor to the next digit on the right. If the cursor is on the last digit, push [>] again to go back to the first digit. Push [▼] to decrease the digit value and [▲] to increase the digit value.
- ➲ This value must be more than the incorrect signal. We recommend that you set the level threshold at half the amplitude of the correct signal.

- Push [↵] again and again to go back to the **Store** screen. Save the settings.
- ➲ The threshold increases. The device ignores the interference signal and uses the first signal that it finds.

Interface threshold

The device uses Direct mode to measure the level and interface level of products. If there are objects in the tank that can cause signal interference, change the interface threshold to ignore them. Use the same procedure in **How to use thresholds** to change the interface threshold, but go to menu item **2.5.5 Interface Threshold**.

For more data about the interface threshold, refer to *Function description* on page 61 (menu item 2.5.5).

Probe end threshold

The device uses Tank Bottom Following (TBF) mode to measure the level of products with low dielectric constants. It uses the probe end as a reference. If the reflection is very weak, change the probe end threshold to measure the probe end location. Use the same procedure in **How to use thresholds** to change the probe end threshold, but go to menu item **2.5.6 Probe End Threshold**.

For more data about the probe end threshold, refer to *Function description* on page 61 (menu item 2.5.6).

6.5 Status and error messages

6.5.1 Device status (markers)

Menu item **2.2.2 Diagnostic** (Configuration mode / Supervisor menu) supplies more data. This includes internal voltages, the loop current and the reset counter. You can see this data on the device display screen and in the DTM.
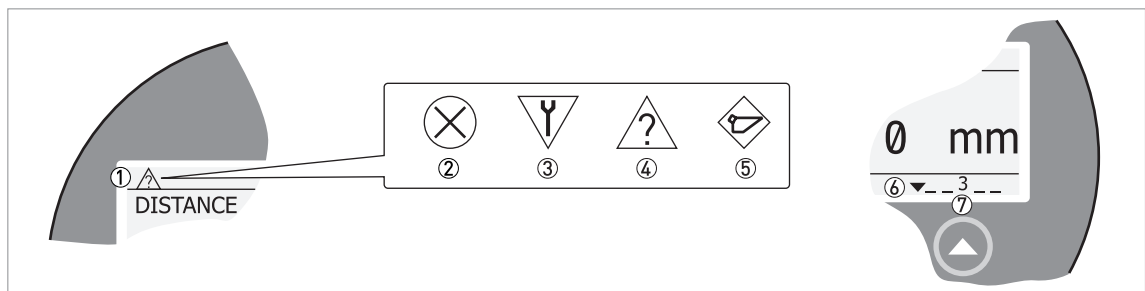
Figure 6-11: Status markers

① Device status (NAMUR NE 107 symbols)
② Symbol: Failure
③ Symbol: Function check
④ Symbol: Out of specification
⑤ Symbol: Maintenance
⑥ Status marker line (marker 3 is shown)
⑦ When the status marker is on, a number is shown

Types of error message

NE 107 status	Type of error	Description
Failure	Error	If an error message is shown in menu item **2.10.0 History**, the current output goes to the error signal value set in menu item **2.4.2 Output Range I1** (and **2.4.8 Output Range I2** if the device has the optional second output) after the time set in menu item **2.4.5 Output Error Delay**. For more data about menu items, refer to *Function description* on page 61.
Out of specification	Warning	If a warning message is shown, there is no effect on the current output value.
Maintenance		

NE 107 symbol shown	NE 107 Status	Description	Status marker shown	Error code (Type)	Possible errors
⊗	Failure	The device does not operate correctly. The fault message stays on. The user cannot remove the "Failure" message from the Normal mode screen.	1	101 (Error)	Current Output Drift
			3	102 (Error)	Temperature Out of Range
			1	103 (Error)	Converter EEPROM
			1	103 (Error)	Converter RAM
			1	103 (Error)	Converter ROM
			1	104 (Error)	Converter Voltage
			2	200 (Error)	Reference Lost
			2	202 (Error)	Peak Lost (Level Lost)
			3	203 (Error)	Sensor Processing Failure
			2	204 (Error)	Overfill
			3	205 (Error)	Internal Communication
			1	206 (Error)	No Probe detected
			1	207 (Error)	Sensor EEPROM
			1	207 (Error)	Sensor RAM
			1	207 (Error)	Sensor ROM
			1	208 (Error)	Oscillator Frequency
			3	209 (Error)	Sensor Not compatible
			2, 4	210 (Error)	Empty
				211 (Error)	Sensor Hardware Failure
			4	214 (Error)	Interface Measurement Failure
			1	501 (Error)	Optional Output Failure
▽	Function check	The device operates correctly, but the measured value is incorrect. This fault message is only temporary. This symbol is shown when the user configures the device with the DTM or a HART® Communicator.	—	—	—
⚠?	Out of specification	It is possible that the measured value is unstable if the operating conditions do not agree with the device specification.	4	(Warning)	Peak Lost
			4	(Warning)	Overfill
			4	(Warning)	Empty
			4	(Warning)	Temperature out of range
◇	Maintenance	The device does not operate correctly because of bad environmental conditions. The measured value is correct, but maintenance is necessary a short time after this symbol is shown.	5	(Warning)	Snapshot Invalid
			4	(Warning)	Flange Lost
			4	(Warning)	Reference Position Outside Range
			4	(Warning)	Audio Signal Offset Outside Range
			3	(Warning)	Temperature <-35°C / -31°F ①
			3	(Warning)	Temperature >+75°C / +167°F ①
—	—	—	6	(Warning)	Probe End Analysis Not Valid

① CAUTION! The device display screen does not operate at this temperature

If an "Out of specification" status symbol is shown, refer to menu item **2.2.2 Diagnostic** (Configuration mode / Supervisor menu) for more data.

For data on errors, error records and error codes, refer to *Error handling* on page 95.

6.5.2 Error handling
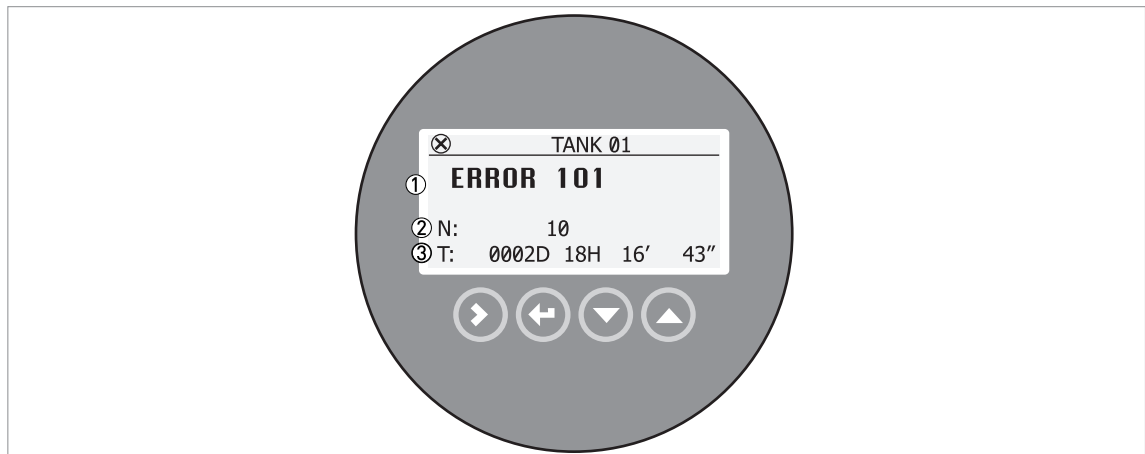
Figure 6-12: Error record data

① Error code for the error
② Number of times the error occurred
③ Time since the last error record (2 days, 18 hours, 16 minutes and 43 seconds shown in this example)

How to find an error record

- Push [>] and [▲] to enter configuration mode from normal mode.
- Push [>], 9 × [▲] and [>] to go to menu item **2.10.0 History**.
- Push [>] to look at errors recorded by the device. Push [▲] or [▼] for the selection of an error.
- ⮕ The error record gives the number of times the error occurred and the time since the last error message.

INFORMATION!
The time since the error occurred is measured in Days (D), Hours (H), Minutes (') and Seconds ("). It only includes the time when the device is energized. The error is saved in the memory of the device when it is de-energized. The counter continues when the device is energized again.

Description of data in menu item 2.2.2 Diagnostic

Hardware test	Description	Normal operating range	Full range	Cause	Corrective action
Functioning time	This shows the time in hours that the device is energized.	—	—	—	For information only.
Reset counter	This shows the number of times that the device starts again.	—	—	—	For information only.
Temperature, converter	This shows the temperature (in °C) of the converter board.	-40...+80°C	-50...+85°C	See error **102** in the table that follows.	See error **102** in the table that follows.

Hardware test	Description	Normal operating range	Full range	Cause	Corrective action
Loop current	This shows the current output of the device (in mA).	4...20 mA	—	—	—
Voltage 5.3 V	Voltage transmitted to the sensor board	5.2...5.6 V	5.2...5.6 V	—	If the device senses a hardware error, give this data to your supplier.
Voltage on capacitors	Voltage transmitted to the capacitor on the converter board	10...19 V	10...19 V	—	If the device senses a hardware error, give this data to your supplier.
Voltage 3.3 V	Voltage transmitted to the sensor board and the converter board	3.2...3.5 V	3.2...3.5 V	—	If the device senses a hardware error, give this data to your supplier.
Amplitude, reference pulse	Absolute amplitude of the reference signal converted to a digital sample.	1000...5000	0...6000	—	If the device senses a hardware error, give this data to your supplier.
Amplitude, flange pulse	Absolute amplitude of the flange signal converted to a digital sample.	0...1000	0...1000	—	If the device senses a hardware error, give this data to your supplier.
Amplitude, level pulse	Absolute amplitude of the level signal converted to a digital sample.	0...1000	0...1000	—	If the device senses a hardware error, give this data to your supplier.
Amplitude, interface pulse	Absolute amplitude of the interface signal converted to a digital sample.	0...1000	0...1000	—	If the device senses a hardware error, give this data to your supplier.
Amplitude, probe end pulse	Absolute amplitude of the probe end signal converted to a digital sample.	0...1000	0...1000	—	This is not applicable to this version of the device.

Description of errors and corrective actions

Error code	Error Message	Status marker shown	Cause	Corrective action

Back end errors

Error code	Error Message	Status marker shown	Cause	Corrective action
100	Device reset	1	The device detected an internal error.	Record the data that is in menu item **2.2.2 Diagnostic** (Configuration mode / Supervisor menu). Speak or write to your supplier.
101	Current output drift	1	The current output is not calibrated.	Speak or write to your supplier to get the calibration procedure.
		1	Hardware error.	Replace the device.
102	Temperature out of range	3	The ambient temperature is outside the given range. This can cause loss or corruption of data.	Measure the ambient temperature. De-energize the device until the ambient temperature is back in the given range. If the temperature does not stay in the correct range, make sure that there is insulation around the signal converter.
103	Converter memory failure	1	The device's hardware is defective.	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.
104	Converter voltage failure	1	The device's hardware is defective.	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.

Sensor errors

Error code	Error Message	Status marker shown	Cause	Corrective action
200	Reference pulse lost	2	Reference amplitude is less than reference threshold. This fault could occur because the device hardware is defective.	Speak or write to your supplier to make sure that the electronics are still functioning correctly. Make sure that your installation has ESD protection.
201	Sensor voltage failure	1	The device's hardware is defective.	Do a check of the power supply at the device terminals. Make sure that voltage values are in the specified limits in menu item **2.2.2 Diagnostic** (Configuration mode / Supervisor menu). If the voltage is correct, replace the signal converter. For more data on how to replace the signal converter, refer to *How to turn or remove the signal converter* on page 24.

Error code	Error Message	Status marker shown	Cause	Corrective action
203	Level lost error	2, 4	The device cannot find the product surface. The measurement stops at the last measured value.	Measure the level of the contents in the tank using another method of measurement. If the tank is empty (the level is below the end of the probe), then fill the tank until product level is in the measurement range. If the tank is full (the level is in the blocking distance), then remove the contents from the tank until the level is back in the measuring range. If the product was lost and the tank is neither full nor empty, wait for the device to find the level again.
		2, 4	The device cannot find the level return signal and the probe end return signal.	
				If the device has to measure a product with $\varepsilon_r \geq 1.6$, refer to the level signal value in menu item **2.5.4 Level Threshold** and then adjust the level threshold. If the product has a low dielectric constant ($\varepsilon_r < 1.6$) and the device is in "Automatic" measurement mode, refer to the probe end signal value in menu item **2.5.6 Probe End Threshold** and then adjust the probe end threshold. For more data, refer to *Thresholds and interference signals* on page 89.
				Make sure that the signal converter is correctly attached to the probe. For more data, refer to *How to turn or remove the signal converter* on page 24.
204	Overfill error	2, 4	The level is in the blocking distance. There is a risk that the product will overflow and/or cover the device.	Remove some of the product until the level is below the blocking distance.
205	Internal Communication	3	The device's hardware or software is defective. The converter cannot transmit signals to or receive signals from the probe electronics.	De-energize the device. Make sure that the signal cable engages in the terminal and the screw connection is tight. Energize the device. If the problem continues, replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.
206	No sensor detected	2	The device's hardware is defective.	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.
207	Sensor memory failure	1	The device's hardware is defective.	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.
208	Oscillator Frequency	1	The device's hardware is defective.	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.

Error code	Error Message	Status marker shown	Cause	Corrective action
209	Sensor not compatible	1	The software version of the sensor is not compatible with the software version of the signal converter.	Go to menu **2.1.0 Identification** in Configuration mode. Record the version numbers of the device software given in menu items 2.1.2, 2.1.3 and 2.1.4. Give this data to your supplier.
		1	Defective wiring.	
210	Empty	2, 4	The level is in the bottom dead zone. There is a risk that the tank is empty.	Add some of the product until the level is above the bottom dead zone.
211	Sensor Hardware Failure	1	The device's hardware is defective.	Replace the probe. For more data, refer to *How to turn or remove the signal converter* on page 24.
214	Interface Measurement Failure	4	The device cannot find the interface. The measurement stops at the last measured value. The interface is in the measuring range.	If the product was lost and the tank is neither full nor empty, wait for the device to find the level again.

If the device has to measure a product with a small difference between the dielectric constant (ε_r) of the top product and the bottom product, refer to the interface signal value in menu item **2.5.4 InterfaceThreshold** and then adjust the interface threshold. For more data, refer to *Thresholds and interference signals* on page 89. |
				Make sure that the signal converter is correctly attached to the probe. For more data, refer to *How to turn or remove the signal converter* on page 24.
		4	The device cannot find the interface. The measurement stops at the last measured value. The interface is in the top dead zone.	Remove the contents from the tank until the interface is back in the measurement range.
		4	The device cannot find the interface. The measurement stops at the last measured value. There is no interface (there is no top product or bottom product) or the layer is less than 50 mm / 2¨.	If there is no top product in the tank, then fill the tank until the layer of top product is more than 50 mm / 2¨.
		4	The device cannot find the interface. The measurement stops at the last measured value. The tank is empty or the interface is in the bottom dead zone.	If the tank is empty (the level is below the end of the probe), then fill the tank until product level is in the measurement range.
501	Optional Output Failure	1	The current output is not calibrated.	Speak or write to your supplier to get the calibration procedure.
		1	Hardware error.	Replace the device.

Error code	Error Message	Status marker shown	Cause	Corrective action

Maintenance (NE 107 status signal)

Error code	Error Message	Status marker shown	Cause	Corrective action
—	Snapshot Invalid	5	The "static" snapshot data stored in the device does not agree with the installation. If you change the device configuration (probe length etc.), this message will be shown. The recorded "static" snapshot data will not be used by the device while this error message is shown. ①	Do the **Auto Setup** procedure again.
—	Flange Lost	4	The signal converter cannot find the probe below the flange. Is the signal converter attached to the process connection?	Make sure that the signal converter is attached to the process connection. If this status does not change, speak or write to your supplier.
—	Reference Position Outside Range	4	The device's hardware is defective. ①	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.
—	Audio Signal Offset Outside Range	4	The device's hardware is defective. ①	Replace the signal converter. For more data, refer to *How to turn or remove the signal converter* on page 24.
—	Temperature <-35°C / -31°F ②	3	The ambient temperature is less than -35°C / -31°F. This temperature is near to the minimum limit for device operation. ①	Measure the ambient temperature. If the temperature does not stay in the correct range, make sure that there is insulation around the signal converter.
—	Temperature >+75°C / +167°F ②	3	The ambient temperature is more than +75°C / +167°F. This temperature is near to the maximum limit for device operation. ①	Measure the ambient temperature. If the temperature does not stay in the correct range, make sure that there is insulation around the tank.

Other warnings

Error code	Error Message	Status marker shown	Cause	Corrective action
—	Probe End Analysis Not Valid	6	This warning is shown if you decrease the probe length and it is not the same as the value used in the device settings (menu item **2.3.4 Probe Length**). The recorded probe length calculation will not be used by the device while this error message is shown.	Do the **Auto Setup** procedure again.
			This warning is shown if the value set at this time in menu item **2.5.2 Epsilon R Gas** is different from the dielectric constant of the gas in the tank. The recorded probe length calculation will not be used by the device while this error message is shown.	

① This error message does not have an effect on the current output signal
② CAUTION! The device display screen does not operate at this temperature

7.1 Periodic maintenance

In normal operational conditions, no maintenance is necessary. Only the manufacturer can repair the device and replace components. If it is necessary, maintenance must be done by approved personnel (the manufacturer or personnel approved by the manufacturer).

INFORMATION!
For more data about regular inspections and maintenance procedures for devices with Ex and other approvals, refer to the related supplementary instructions.

WARNING!
Do not use bleach to clean the signal converter.

7.2 Keep the device clean

Obey these instructions:

- Keep the thread of the terminal compartment cover clean.
- If dirt collects on the device, clean it with a damp cloth.

7.3 Service warranty

WARNING!
Only approved personnel can do an inspection of the device and repairs. If you find a problem, send the device back to your supplier for inspection and/or repairs.

INFORMATION!
The converter housing (compact or remote version) can be detached from the process connection assembly under process conditions. For more data, refer to How to turn or remove the signal converter on page 24.

Servicing by the customer is limited by warranty to:

- The removal and installation of the device.
- **Compact version:** The removal and installation of the signal converter (with the weather protection, if this option is attached). For more data, refer to *How to turn or remove the signal converter* on page 24.
- . For more data, refer to *How to turn or remove the signal converter* on page 24.

For more data on how to prepare the device before you send it back, refer to *Returning the device to the manufacturer* on page 102.

7.4 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, maintenance, technical support and training.

> *INFORMATION!*
> *For more precise information, please contact your local sales office.*

7.5 Returning the device to the manufacturer

7.5.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.

> *WARNING!*
> *Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:*
> - *Due to statutory regulations on environmental protection and safeguarding the health and safety of the personnel, the manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
> - *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*

> *WARNING!*
> *If the device has been operated with toxic, caustic, radioactive, flammable or water-endangering products, you are kindly requested:*
> - *to check and ensure, if necessary by rinsing or neutralising, that all cavities are free from such dangerous substances,*
> - *to enclose a certificate with the device confirming that it is safe to handle and stating the product used.*

7.5.2 Form (for copying) to accompany a returned device

⚠️ *CAUTION!*
To avoid any risk for our service personnel, this form has to be accessible from outside of the packaging with the returned device.

Company:	Address:	
Department:	Name:	
Tel. no.:	Fax no. and/or Email address:	
Manufacturer's order no. or serial no.:		
The device has been operated with the following medium:		
This medium is:	radioactive	
	water-hazardous	
	toxic	
	caustic	
	flammable	
	We checked that all cavities in the device are free from such substances.	
	We have flushed out and neutralized all cavities in the device.	
We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.		
Date:	Signature:	
Stamp:		

7.6 Disposal

§ *LEGAL NOTICE!*
Disposal must be carried out in accordance with legislation applicable in your country.

Separate collection of WEEE (Waste Electrical and Electronic Equipment) in the European Union:

According to the directive 2012/19/EU, the monitoring and control instruments marked with the WEEE symbol and reaching their end-of-life **must not be disposed of with other waste**.
The user must dispose of the WEEE to a designated collection point for the recycling of WEEE or send them back to our local organisation or authorised representative.

7.7 Disassembly and recycling

This section shows you how to handle the device if it is unserviceable (i.e. it is at the end of its product life cycle) or if it must be discarded. Information given in this section agrees with the EU Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) and the EU Directive 2008/98/EC on waste (Waste Framework Directive) . Refer to the data and obey the instructions that follow to disassemble and prepare components for waste treatment.

CAUTION!
Before you disassemble the device for disposal and recycling, make sure that the device is unserviceable. For more data about replacement parts, refer to Spare parts on page 161, or speak to the manufacturer.

INFORMATION!
The device product does not contain dangerous gases or materials. If there is contamination from the process, refer to Returning the device to the manufacturer on page 102.

7.7.1 Compact version (C)

INFORMATION!
*Words in **bold text** refer to electrical and electronic equipment.*

Product description

Product name and data

Type	OPTIFLEX
Model	X200 C (Compact)
Usage	Level measurement
Recycling pass number	XXXXX

Weight

Total weight	Aluminium housing: 2.3...3.1 kg / 5.1...6.8 lb ①
	Stainless steel housing: 5.8...7.7 kg / 12.8...17.0 lb ①
Weight of metal parts	Aluminium housing: 2.0...2.6 kg / 4.4...5.7 lb ①
	Aluminium housing: 5.5...7.2 kg / 12.1...15.9 lb ①
Weight of plastic parts	approx. 0.05 kg / 0.11 lb

Dimensions

Volume	1.1 to 1.5 dm³ / 67.1...91.5 in³ ①

① The options for the housing will have an effect on the dimensions and weight

Parts list

Item	Description	Material
(1)	Nut	stainless steel
(2)	Washer	stainless steel
(3)	Gasket	EPDM
(4)	Screw	stainless steel
(5)	Washer	stainless steel
(6)	Stirrup	stainless steel
(7)	Screw	stainless steel
(8)	Housing base	aluminium or stainless steel ①
(9)	Spring	CuBe2
(10)	Screw	stainless steel
(11)	Gasket	neoprene + Ni-Cu
(12)	**PCB ②**	**③**
(13)	Gasket	silicone
(14)	Cable gland	PEBD or PA or nickel-brass or stainless steel and/or ferrite ①
(15)	Blocker	PA 66
(16)	"T" housing	aluminium or stainless steel ①
(17)	**PCB types 1, 2 or 3 ④**	**③**
(18)	Brace ①	PA 66
(19)	Guide ①	EPDM
(20)	**PCB for display screen ①**	**③**
(21)	Cover	aluminium or stainless steel + PC
(22)	**Feedthrough for Ex d /second output compartment ①**	**ferrite + rubber + cables**
(23)	Ex d housing ①	aluminium or stainless steel ①
(24)	**PCB types 1, 2, 3, 4 or 5 ①**	**③**
(25)	Brace ①	brass CW614N M nickel finish
(26)	Cover	aluminium or stainless steel ①

① This depends on the device options
② PCB = Printed circuit board
③ PCBs are potted with polyamide
④ This depends on the output option
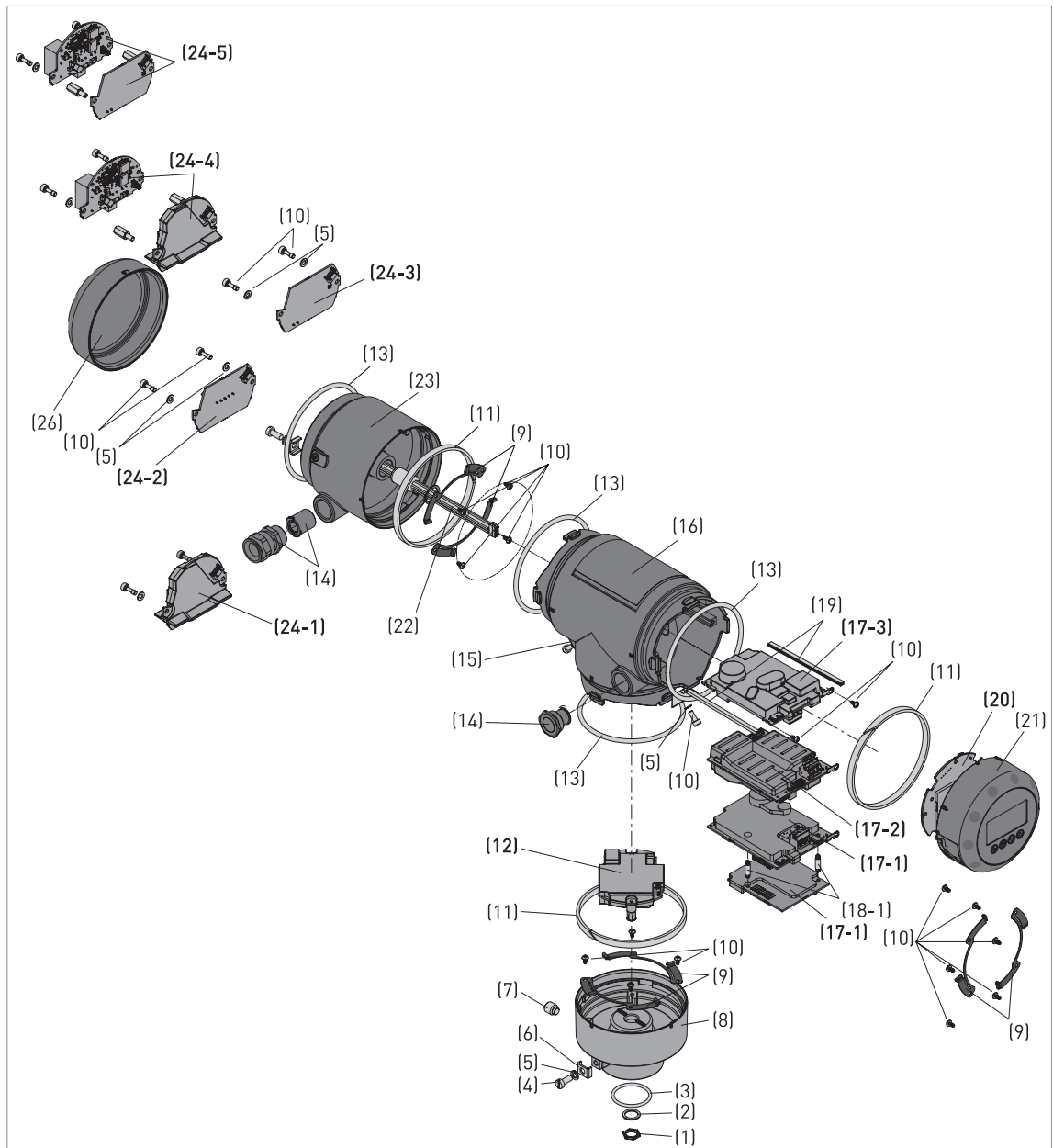
Figure 7-1: Parts of the device (refer to "Parts list" table)

Procedure: how to disassemble the compact version

- Remove the housing base (8) and the parts attached to the housing base. Remove the **PCB (12)**.
- If the device has the display screen option, remove the housing cover (21) and the parts attached to the housing cover. Remove the **PCB (20)** and the attached **display screen**.
- Remove the **PCB (17)** from the housing tee (16).
- If the device has an Ex d approval or the second output option, remove the Ex d housing (23) and the parts contained in the Ex d housing. Remove the **PCB (24)** from the Ex d housing.
- ⮕   You can send the parts to the approved location for waste treatment or recycling.

Materials and components which must be removed and independently prepared for treatment

Material	Weight		Description
	[kg]	**[lb]**	
Polychlorinated biphenyl	N/A	N/A	N/A
Mercury	N/A	N/A	N/A
Printed circuit boards, area > 10 cm² / > 1.55 in² - locations:			
housing base (12)	**0.08**	**0.18**	PCBs are potted with polyamide
"T" housing (17)	**0.14...0.16 ①**	**0.31...0.35 ①**	
cover (20)	**0.09**	**0.20**	
Ex d housing (24)	**0.02...0.16 ①**	**0.04...0.35 ①**	
Toner cartridge	N/A	N/A	N/A
LCD screen (device) area > 100 cm² / > 15.5 in²	N/A	N/A	The display screen option has an area of < 15 cm² / < 2.3 in²
Plastic that contains brominated flame retardants	N/A	N/A	< 0.1% in weight for PBB and PBDE. This agrees with the EU Directive 2011/65/EU (RoHS).
Asbestos	N/A	N/A	N/A
Cathode ray tube	N/A	N/A	N/A
CFC, HCFC, HFC or HC	N/A	N/A	N/A
Gas discharge lamp	N/A	N/A	N/A
External electric cable	N/A	N/A	N/A
Refractory ceramic fibers	N/A	N/A	N/A
Radioactive substance	N/A	N/A	N/A
Electrolyte capacitor > 25 mm / > 0.98¨	N/A	N/A	N/A

① This depends on the device options

Materials and components which can cause problems in the recycling process

Material	Part (item number)	Weight [kg]	Weight [lb]	Description
different metals and plastics (sub-assembly)	PCB, housing base (12)	0.08	0.18	FR-4, electronic components, polyamide potting
	PCB, "T" housing (17)	0.14... 0.16 ①	0.31... 0.35 ①	
	PCB, cover (20)	0.09	0.20	
	PCB, Ex d housing (24)	0.02... 0.16 ①	0.04... 0.35 ①	
different metals and plastics (sub-assembly)	cable gland (14)	~0.01	~0.02	PEBD or PA or nickel-brass or stainless steel and/or ferrite ①
different metals and plastics (sub-assembly)	**feedthrough (22)**	**~0.04**	**~0.09**	**Ferrite + rubber + cables**
different metals and plastics (sub-assembly)	cover, aluminium (21)	0.19	0.42	Aluminium or stainless steel + polycarbonate ①
	cover, stainless steel (21)	0.63	1.39	
different metals	housing	2.0... 2.6	4.40... 5.73	If the housing is made of aluminium, the screws and the washers are made of stainless steel
different plastics	N/A	N/A	N/A	N/A

① This depends on the device options

Materials and components which can be recycled

Stainless steel housing				
Material	Part (item number)	Weight		Description
		[kg]	[lb]	
Stainless steel	nut (1)	5.5...7.2 ①	12.12...15.87 ①	N/A
	washer (2)			
	screw (4)			
	washer (5)			
	stirrup (6)			
	screw (7)			
	housing base (8)			
	screw (10)			
	"T" housing (16)			
	cover (21)			
	Ex d housing (23)			
	cover (26)			
Plastic	gasket (11)	~0.05	~0.11	neoprene + Ni-Cu
	gasket (13)			silicone
	blocker (15)			PA 66
	brace (18)			PA 66
Rubber	gasket (3)	< 0.02	< 0.04	EPDM
	gasket (19)			EPDM
Noble metals	spring (9)	< 0.02	< 0.04	CuBe2
	brace (25)			FR-4, brass CW614N M nickel finish
PCB	**PCB (12)**	**0.22...0.5 ①**	**0.48...1.10 ①**	**FR-4, electronic components, polyamide potting**
	PCB (17)			
	PCB (20)			
	PCB (24)			
Total (average weight)	—	~5.8...7.7 ①	~12.79...16.98 ①	N/A

① This depends on the device options

Aluminium housing				
Material	Part (item number)	Weight		Description
		[kg]	[lb]	
Stainless steel	nut (1)	~0.05	~0.11	N/A
	washer (2)			
	screw (4)			
	washer (5)			
	stirrup (6)			
	screw (7)			
	screw (10)			
Aluminium	housing base (8)	2.0...2.6 ①	4.41...5.73 ①	External surfaces are painted
	"T" housing (16)			
	cover (21)			
	Ex d housing (23)			
	cover (26)			
Plastic	gasket (11)	~0.05	~0.11	neoprene + Ni-Cu
	gasket (13)			silicone
	blocker (15)			PA 66
	brace (18)			PA 66
Rubber	gasket (3)	< 0.02	< 0.04	EPDM
	gasket (19)			EPDM
Noble metals	spring (9)	< 0.02	< 0.04	CuBe2
	brace (25)			FR-4, brass CW614N M nickel finish
PCB	**PCB (12)**	**0.22...0.5 ①**	**0.48...1.10 ①**	**FR-4, electronic components, polyamide potting**
	PCB (17)			
	PCB (20)			
	PCB (24)			
Total (average weight)	—	~2.3...3.1 ①	~5.07...6.83 ①	N/A

① This depends on the device options

7.7.2 Remote version (F)

ℹ️ *INFORMATION!*
*Words in **bold text** refer to electrical and electronic equipment.*

Product description

Product name and data

Type	OPTIFLEX
Model	X200 F (Remote version)
Usage	Level measurement
Recycling pass number	XXXXX

Weight

Total weight	Aluminium housing: ~3.5...4.8 kg / ~7.72...10.58 lb ①
	Stainless steel housing: ~9.1...12.7 kg / ~20.06...28.00 lb ①
Weight of metal parts	Aluminium housing: ~2.9...4.0 kg / ~7.72...10.58 lb ①
	Stainless steel housing: ~7.8...11.2 kg / ~17.20...24.69 lb ①
Weight of plastic parts	~0.1 kg / ~0.23 lb + weight of the cable ②

Dimensions

Volume	~1.9...2.3 dm³ / 115.9...140.4 in³ ③

① The options for the housing will have an effect on the dimensions and weight
② The coaxial cable length will have an effect on the dimensions and weight
③ The sensor extension length will have an effect on the dimensions and weight

Parts list

Item	Description	Material
(1)	Nut	stainless steel
(2)	Washer	stainless steel
(3)	Gasket	EPDM
(4)	Screw	stainless steel
(5)	Washer	stainless steel
(6)	Stirrup	stainless steel
(7)	Screw	stainless steel
(8)	Housing base	aluminium or stainless steel ①
(9)	Spring	CuBe2
(10)	Screw	stainless steel
(11)	Gasket	neoprene + Ni-Cu
(12)	**PCB** ②	③
(13)	Gasket	silicone
(14)	Cable gland	PEBD or PA or nickel-brass or stainless steel and/or ferrite ①

Item	Description	Material
(15)	Blocker	PA 66
(16)	"T" housing	aluminium or stainless steel ①
(17)	**PCB types 1, 2 or 3 ④**	③
(18)	Brace type 1 ①	PA 66
(19)	Guide ①	EPDM
(20)	**PCB for display screen ①**	③
(21)	Cover	aluminium or stainless steel + PC
(22)	**Feedthrough for Ex d /second output compartment ①**	**ferrite + rubber + cables**
(23)	Ex d housing ①	aluminium or stainless steel ①
(24)	**PCB types 1, 2, 3, 4 or 5 ①**	③
(25)	Brace type 4 or 5 ①	brass CW614N M nickel finish
(26)	Cover	aluminium or stainless steel ①
(27)	Blocking part	stainless steel
(28)	Housing wall support	aluminium or stainless steel ①
(29)	**Cable**	**Option 1** **Wire: tinned copper wire (24AWG)** **Insulation: datalene** **Core: two twisted pairs individually shielded with Beldfoil aluminium-polyester) ①**
		Option 2 **Wire: bare copper wire (22AWG)** **Insulation: foamed Polyethylene (PE) with skin Ø2.1mm / 0.08"** **Core: 4 wires** **Jacket: Polyvinylchloride (PVC) ①**
(30)	**PCB ①**	③
(31)	**PCB ①**	③
(32)	Probe electronics housing	aluminium or stainless steel ①

① This depends on the device options
② PCB = Printed circuit board
③ PCBs are potted with polyamide
④ This depends on the output option
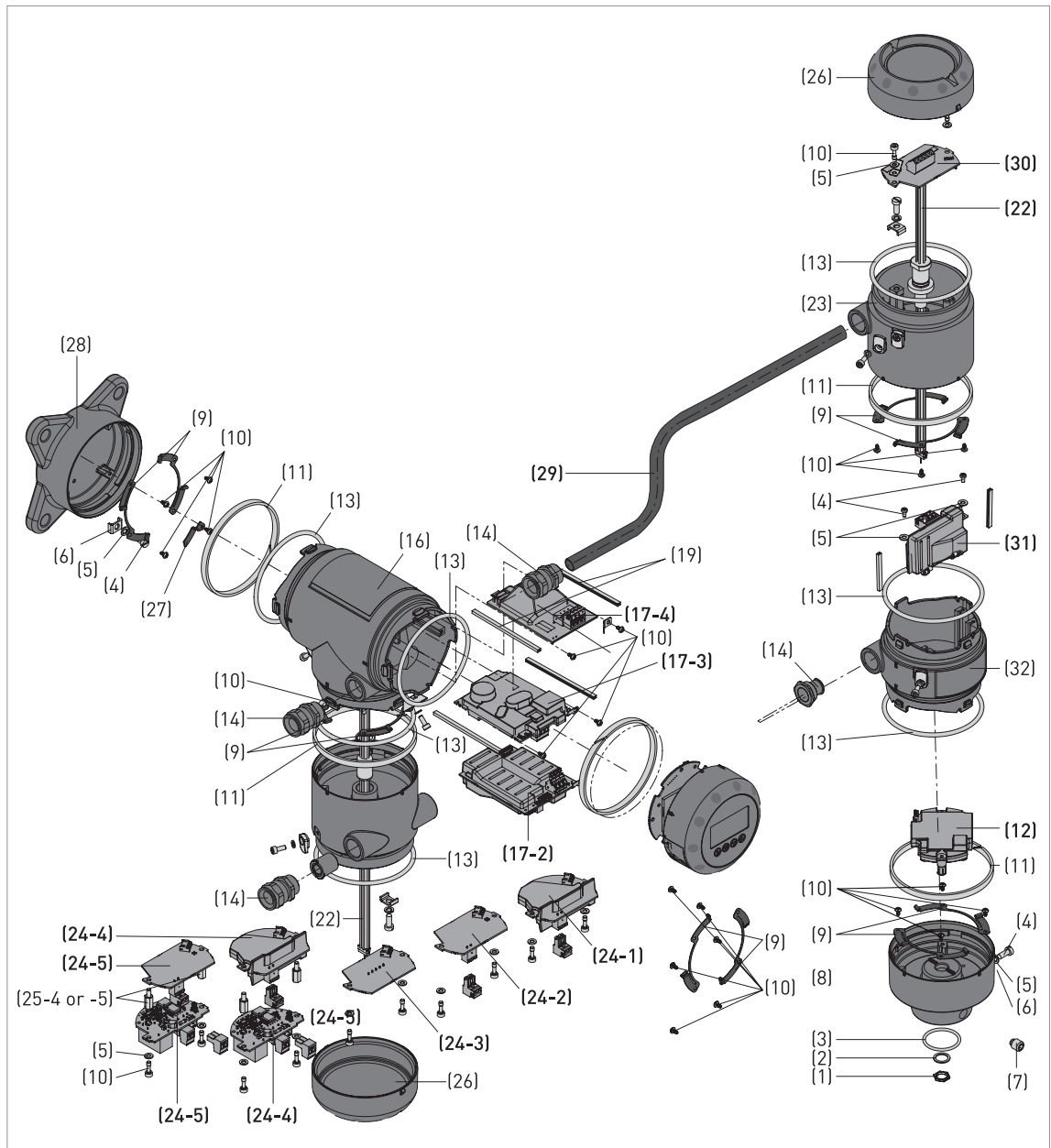
Figure 7-2: Parts of the device (refer to "Parts list" table)

Procedure: how to disassemble the remote version

- Remove the housing base (8) and the parts attached to the housing base. Remove the **PCB (12)**.
- Remove the probe electronics housing (32) and the parts attached to the probe electronics housing. Remove the **PCB (31)**.
- If the device has an Ex d approval or the second output option, remove the Ex d housing (23) and the parts contained in the Ex d housing. Remove the **PCB (30)** from the Ex d housing.
- Remove the housing wall support (28) and the parts attached to the housing wall support.
- If the device has the display screen option, remove the housing cover (21) and the parts attached to the housing cover. Remove the **PCB (20)** and the attached **display screen**.
- Remove the **PCB (17)** from the "T" housing (16).
- If the device has an Ex d approval or the second output option, remove the Ex d housing (23) and the parts contained in the Ex d housing. Remove the **PCB (24)** from the Ex d housing.

➲   You can send the parts to the approved location for waste treatment or recycling.

Materials and components which must be removed and independently prepared for treatment

Material	Weight		Description
	[kg]	[lb]	
Polychlorinated biphenyl	N/A	N/A	N/A
Mercury	N/A	N/A	N/A
Battery	N/A	N/A	N/A
Printed circuit boards, area > 10 cm² / > 1.55 in² - locations:			
housing base (12)	**0.08**	**0.18**	PCBs are potted with polyamide
"T" housing (17)	**0.14...0.16** ①	**0.31...0.35** ①	
cover (20)	**0.09**	**0.20**	
Ex d housing (24)	**0.02...0.16** ①	**0.04...0.35** ①	
Ex d probe electronics housing (30)	**0.01**	**0.02**	
Probe electronics housing (31)	**0.06**	**0.13**	
Toner cartridge	N/A	N/A	N/A
LCD screen (device) area > 100 cm² / > 15.5 in²	N/A	N/A	The display screen option has an area of < 15 cm² / < 2.3 in²
Plastic that contains brominated flame retardants	N/A	N/A	< 0.1% in weight for PBB and PBDE. This agrees with the EU Directive 2011/65/EU (RoHS).
Asbestos	N/A	N/A	N/A
Cathode ray tube	N/A	N/A	N/A
CFC, HCFC, HFC or HC	N/A	N/A	N/A
Gas discharge lamp	N/A	N/A	N/A
External electric cable	②	②	**Discard the cable or collect the cable for treatment. This procedure must agree with EU Directive 2008/98/EC.**
Refractory ceramic fibers	N/A	N/A	N/A
Radioactive substance	N/A	N/A	N/A
Electrolyte capacitor > 25 mm / > 0.98¨	N/A	N/A	N/A

① This depends on the device options
② The coaxial cable length will have an effect on the weight

Materials and components which can cause problems in the recycling process

Material	Part (item number)	Weight [kg]	Weight [lb]	Description
different metals and plastics (sub-assembly)	PCB, housing base (12)	0.08	0.18	FR-4, electronic components, polyamide potting
	PCB, "T" housing (17)	0.14...0.16 ①	0.31...0.35 ①	
	PCB, cover (20)	0.09 ①	0.20 ①	
	PCB, Ex d housing (24)	0.02...0.16 ①	0.04...0.35 ①	
	PCB, probe electronics (30)	0.01 ①	0.02 ①	
	PCB, probe electronics (31)	0.06 ①	0.13 ①	
different metals and plastics (sub-assembly)	cable gland (14)	~0.01	~0.02	PEBD or PA or nickel-brass or stainless steel and/or ferrite ①
different metals and plastics (sub-assembly)	**feedthrough (22)**	**~0.04**	**~0.09**	**Ferrite + rubber + cables**
different metals and plastics (sub-assembly)	cover, aluminium (21)	0.19	0.42	Aluminium or stainless steel + polycarbonate ①
	cover, stainless steel (21)	0.63	1.39	
different metals and plastics (sub-assembly)	**cable (29)**	②	②	**Option 1** **Wire: tinned copper wire (24AWG)** **Insulation: datalene** **Core: two twisted pairs individually shielded with Beldfoil aluminium-polyester) ①**
				Option 2 **Wire: bare copper wire (22AWG)** **Insulation: foamed Polyethylene (PE) with skin Ø2.1mm / 0.08"** **Core: 4 wires** **Jacket: Polyvinylchloride (PVC) ①**
different metals	housing	3.4...4.0	7.50...8.82	If the housing is made of aluminium, the screws and the washers are made of stainless steel
different plastics	N/A	N/A	N/A	N/A

① This depends on the device options
② The coaxial cable length will have an effect on the weight

Materials and components which can be recycled

Stainless steel housing				
Material	Part (item number)	Weight		Description
		[kg]	[lb]	
Stainless steel	nut (1)	7.8... 11.2 ①	17.20... 24.69 ①	N/A
	washer (2)			
	screw (4)			
	washer (5)			
	stirrup (6)			
	screw (7)			
	housing base (8)			
	screw (10)			
	"T" housing (16)			
	cover (21)			
	Ex d housing (23)			
	cover (26)			
	blocking part (27)			
	housing wall support (28)			
	probe electronics housing (32)			
Plastic	gasket (11)	~0.1 ②	~0.22 ②	neoprene + Ni-Cu
	gasket (13)			silicone
	blocker (15)			PA 66
	brace (18)			PA 66
	cable (29)			**PVC, PE**
Rubber	gasket (3)	< 0.05	< 0.11	EPDM
	gasket (19)			EPDM
Noble metals	spring (9)	< 0.05 ②	< 0.11 ②	CuBe2
	brace (25)			brass CW614N M nickel finish
	cable (29)			copper
PCB	**PCB (12)**	0.3... 0.6 ①	0.66... 1.32 ①	**FR-4, electronic components, polyamide potting**
	PCB (17)			
	PCB (20)			
	PCB (24)			
	PCB (30)			
	PCB (31)			
Total (average weight)	—	~9.1... 12.7 ①	~20.06... 28.00 ①	N/A

① This depends on the device options
② The coaxial cable length will have an effect on the weight

Aluminium housing				
Material	**Part (item number)**	**Weight**		**Description**
		[kg]	**[lb]**	
Stainless steel	nut (1)	~0.1	~0.22	N/A
	washer (2)			
	screw (4)			
	washer (5)			
	stirrup (6)			
	screw (7)			
	housing base (8)			
	screw (10)			
	blocking part (27)			
Aluminium	housing base (8)	2.9...4.0 ①	6.39...8.82 ①	External surfaces are painted
	"T" housing (16)			
	cover (21)			
	Ex d housing (23)			
	cover (26)			
	housing wall support (28)			
	probe electronics housing (32)			
Plastic	gasket (11)	~0.1 ②	~0.22 ②	neoprene + Ni-Cu
	gasket (13)			silicone
	blocker (15)			PA 66
	brace (18)			PA 66
	cable (29)			**PVC, PE**
Rubber	gasket (3)	< 0.05	< 0.11	EPDM
	gasket (19)			EPDM
Noble metals	spring (9)	< 0.05 ②	< 0.11 ②	CuBe2
	brace (25)			brass CW614N M nickel finish
	cable (29)			copper
PCB	**PCB (12)**	0.3...0.6 ①	0.66...1.32 ①	**FR-4, electronic components, polyamide potting**
	PCB (17)			
	PCB (20)			
	PCB (24)			
	PCB (30)			
	PCB (31)			
Total (average weight)	—	~3.5...4.8 ①	~7.72...10.58 ①	N/A

① This depends on the device options
② The coaxial cable length will have an effect on the weight

8.1 Measuring principle

This Guided Radar (TDR) level meter has been developed from a proven technology called Time Domain Reflectometry (TDR).

The device transmits low-intensity electromagnetic pulses of approximately one nanosecond width along a rigid or flexible conductor. These pulses move at the speed of light. When the pulses reach the surface of the product to be measured, the pulses are reflected with an intensity that depends on the dielectric constant, ε_r, of the product (for example, water has a high dielectric constant and reflects the pulse back to the signal converter at 80% of its original intensity).

The device measures the time from when the pulse is emitted to when it is received: half of this time is equivalent to the distance from the reference point of the device (the flange facing) to the surface of the product. The time value is converted into an output current of 4...20 mA and/or a digital signal.

Dust, foam, vapor, agitated surfaces, boiling surfaces, changes in pressure, changes in temperature and changes in density do not have an effect on device performance.

The illustration that follows shows a snapshot of what a user would see on an oscilloscope, if the level of one product is measured.

Level measurement principle (direct mode)
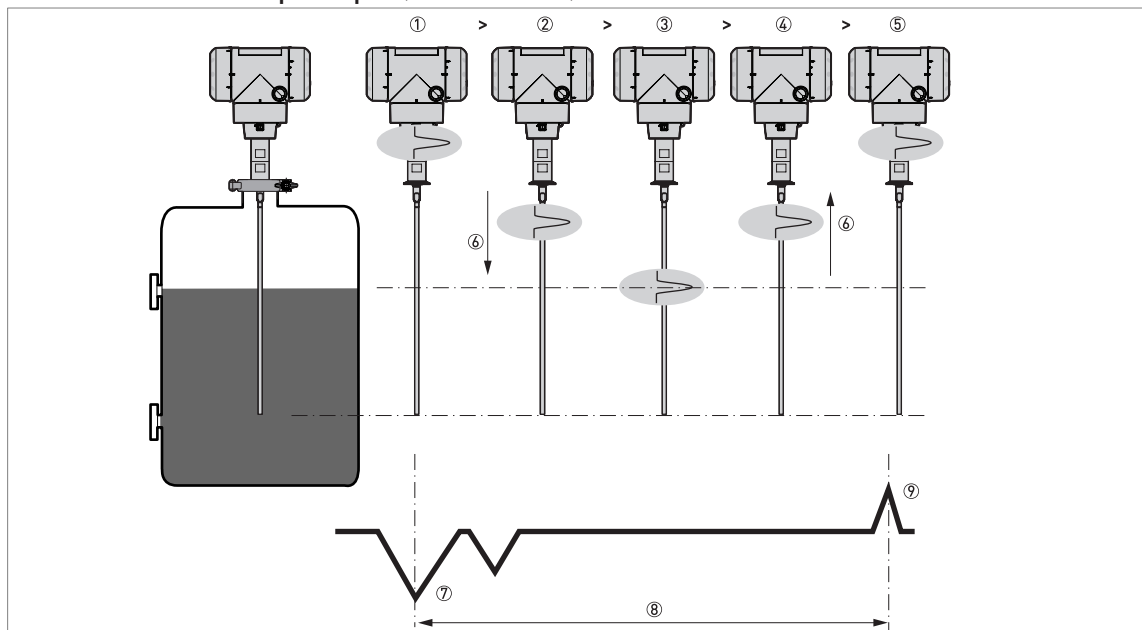
Figure 8-1: Level measurement principle

① Time 0: The electromagnetic (EM) pulse is transmitted by the converter
② Time 1: The pulse goes down the probe at the speed of light in air, V1
③ Time 2: The pulse is reflected
④ Time 3: The pulse goes up the probe at speed, V1
⑤ Time 4: The converter receives the pulse and records the signal
⑥ The EM pulse moves at speed, V1
⑦ Transmitted EM pulse
⑧ Half of this time is equivalent to the distance from the reference point of the device (the flange facing) to the surface of the product
⑨ Received EM pulse

Level and interface measurement principle (direct measurement)

The illustration that follows shows a snapshot of what a user would see on an oscilloscope, if the level and/or interface of products are measured.

CAUTION!
The dielectric constant of the top liquid must be less than the dielectric constant of the bottom liquid. If not, or if there is too small a difference, the device may not measure correctly.
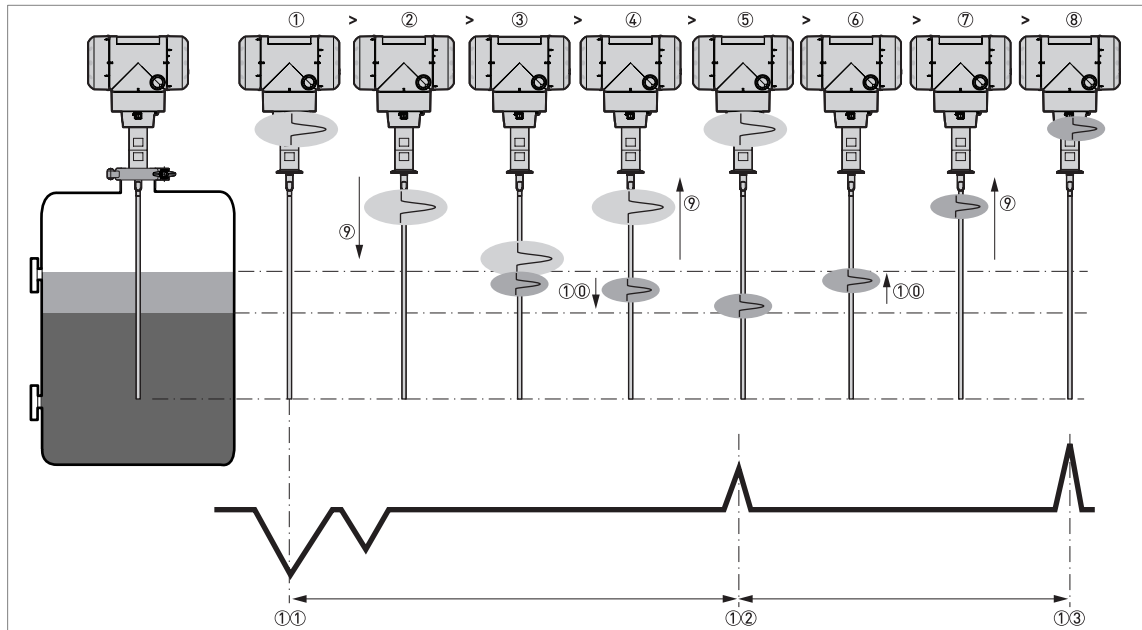
Figure 8-2: Level and interface measurement principle (2 liquids in the tank)

① Time 0: The electromagnetic (EM) pulse is transmitted by the converter
② Time 1: The pulse goes down the probe at the speed of light in air, V1
③ Time 2: Part of the pulse is reflected at the surface of the top liquid, the remaining pulse goes down the probe
④ Time 3: Part of the pulse goes up the probe at speed, V1. The remaining pulse goes down the probe at the speed of light in the top product, V2
⑤ Time 4: The converter receives part of the pulse and records the signal. The remaining pulse is reflected at the interface of the 2 liquids
⑥ Time 5: The remaining pulse goes up the probe at speed, V2
⑦ Time 6: The remaining pulse goes up the probe at speed, V1
⑧ Time 7: The converter receives the remaining pulse and records the signal
⑨ The EM pulse moves at speed, V1
⑩ The EM pulse moves at speed, V2
⑪ Transmitted EM pulse
⑫ Received EM pulse (distance to the top liquid)
⑬ Received EM pulse (distance to the interface of 2 liquids)

Level measurement principle (TBF measurement)

If products have a very low dielectric constant (ε_r <1.6), only a small part of the EM pulse is reflected at the surface of the product. Most of the pulse is reflected at the probe end. TBF (tank bottom following) mode is used to measure the distance to the product surface.

TBF mode (indirect measurement) compares:

- The time for the pulse to go to the probe end and go back to the converter when the tank is empty.
- The time for the pulse to go to the probe end and go back to the converter when the tank is full or partially filled.

The level of the product in the tank can be calculated from the time difference.

8.2 Technical data

INFORMATION!
- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).*

Converter

Measuring system

Application	Level and interface measurement of liquids and pastes
Measuring principle	TDR (time domain reflectometry)
Primary measured value	Distance and interface distance
Secondary values	Level, interface level, volume and mass
Construction	Compact (C) version: Measuring probe attached directly to a signal converter Remote (F) version: Measuring probe installed on a tank and connected by a signal cable (max. length 100 m / 328 ft) to a signal converter

Operating conditions

Ambient temperature	-40…+80°C / -40…+176°F Integrated LCD display: -20…+60°C / -4...+140°F; if the ambient temperature is not in these limits, the display switches off. The device continues to operate correctly.
Storage temperature	-50…+85°C / -58…+185°F (min. -40°C / -40°F for devices with the integrated LCD display option)
Ingress protection	IEC 60529: IP66 / IP68 (continuous immersion at a depth of 1.5 m for 2 weeks)
	NEMA 250: NEMA type 4X / 6 (housing) and type 6P (probe)

Materials

Housing	Polyester-coated aluminium or stainless steel (1.4404 / 316L)
Cable entry	Plastic; nickel-plated brass, stainless steel

Electrical connections

Power supply, output 1 (4...20 mA/HART output)	**Non-Ex / Ex i:** 11.5…30 V DC; min./max. value for an output of 22 mA at the terminals
	Ex d: 13.5…34 V DC; min./max. value for an output of 22 mA at the terminals
Power supply, optional output 2 (4...20 mA output)	**Non-Ex / Ex i:** 11.5…30 V DC; min./max. value for an output of 22 mA at the terminals (additional power supply needed — output only)
	Ex d: 11.5…34 V DC; min./max. value for an output of 22 mA at the terminals (additional power supply needed — output only)
Power supply, optional input 2 (switch output - relay)	**Non-Ex / Ex d:** 11.5…34 V DC / 30 mA
	Ex i: 11.5…30 V DC / 30 mA

Current output load	**Non-Ex / Ex i:** R_L [Ω] ≤ ((U_{ext} -11.5 V)/22 mA). For more data, refer to *Minimum power supply voltage* on page 131.
	Ex d, output 1: R_L [Ω] ≤ ((U_{ext} -13.5 V)/22 mA). For more data, refer to *Minimum power supply voltage* on page 131.
	Ex d, output 2: R_L [Ω] ≤ ((U_{ext} -11.5 V)/22 mA). For more data, refer to *Minimum power supply voltage* on page 131.
Cable entry	M20×1.5; ½ NPT
Cable gland	Standard: none
	Options: M20×1.5, others are available on request
	Cable diameter, output 1: non-Ex / Ex i: 6…7.5 mm / 0.24…0.30¨; Ex d: 7…10 mm / 0.28…0.39¨; Cable diameter, output 2: non-Ex / Ex i: 6…12 mm / 0.24…0.47¨; Ex d: 7…12 mm / 0.28…0.47¨
Signal cable – remote version	None for non-Ex devices (4-wire shielded cable of max. length 100 m / 328 ft to be supplied by the customer). Supplied with all Ex-approved devices. For more data, refer to *Remote device data* on page 38
Cable entry capacity (terminal)	0.5…2.5 mm²

Input and output

Measured variable	Time between the emitted and received signal
Current output / HART®	
Output 1 signal	4…20 mA HART® or 3.8…20.5 mA acc. to NAMUR NE 43 ①
Output 2 signal	4…20 mA or 3.8…20.5 mA acc. to NAMUR NE 43
Resolution	±3 µA
Temperature drift (analog)	Typically 50 ppm/K
Temperature drift (digital)	Max. ±15 mm for the full temperature range
Error signal options	High: 22 mA; Low: 3.6 mA acc. to NAMUR NE 43; Hold (frozen value – not available if the output agrees with NAMUR NE 43 or the device is approved for safety-related systems (SIL))
Switch output - relay (option)	
Description	Relay (1 contact, normally open). SIS 2 Sensitive Series (ELESTA GmbH).
Maximum switching capacity	48 V AC / 6 A; 24 V DC / 6 A (according to IEC 60947-5-1)
Voltage range	**Non-Ex / Ex d**: Category AC-1: 5…48 V AC / Category DC-1: 2…24 V DC
	Ex i: Category AC-1: 5…24 V AC / Category DC-1: 2…24 V DC
Current range	0.003…6 A
$R_{on-state}$	< 100 mΩ at 6 V / 100 mA
Switching capacity range	0.04…288 W (VA)

Display and user interface

User interface options	LCD display (128 × 64 pixels in 8-step greyscale with 4-button keypad)
Languages	English, German, French, Italian, Spanish, Portuguese, Japanese, Chinese (simplified), Russian, Czech, Polish and Turkish

Approvals and certification

CE	The device meets the essential requirements of the EU Directives. The manufacturer certifies successful testing of the product by applying the CE marking.
	For more data about the EU Directives and European Standards related to this device, refer to the EU Declaration of Conformity. You can download this document free of charge from the website (Download Center).

Vibration resistance	Housing: EN 60721-3-4, Category 4M4 (5...8.51 Hz: ±3.5 mm / 8.51...200 Hz: 1g; 15g shock ½sinus: 6 ms) Refer to "Probe options" in this section for the vibration resistance of probes
Conformity to sanitary regulations (wetted parts)	FDA 21 CFR 177.2600 and CFR 177.2415
	Regulation (EC) No 1935/2004, Commission Regulation (EC) No 2023/2006, Commission Regulation (EU) No 10/2011
Explosion protection	
ATEX (Ex ia, Ex ia/db or Ex ia/tb) EU Type Approval	**Compact version**
	II 1/2 G Ex ia IIC T6...T3 Ga/Gb;
	II 1/2 D Ex ia IIIC T85°C...T150°C Da/Db;
	or...
	II 1/2 G Ex ia/db IIC T6...T3 Ga/Gb;
	II 1/2 D Ex ia/tb IIIC T85°C...T150°C Da/Db
	Remote version, converter
	II 2 (1) G Ex ia [ia Ga] IIC T6...T4 Gb;
	II 2 (1) D Ex ia [ia Da] IIIC T85°C...T135°C Db
	or...
	II 2 (1) G Ex db ia [ia Ga] IIC T6...T4 Gb;
	II 2 (1) D Ex ia tb [ia Da] IIIC T85°C...T135°C Db
	Remote version, sensor
	II 1/2 G Ex ia IIC T6...T3 Ga/Gb;
	II 1/2 D Ex ia IIIC T85°C...T150°C Da/Db
ATEX (Ex ic or Ex ic nA) Type Approval	**Compact version**
	II 3 G Ex ic IIC T6...T3 Gc;
	II 3 D Ex ic IIIC T85°C...T150°C Dc
	or...
	II 3 G Ex ic nA IIC T6...T3 Gc
	Remote version, converter
	II 3 G Ex ic [ic] IIC T6...T4 Gc;
	II 3 D Ex ic [ic] IIIC T85°C...T135°C Dc
	or...
	II 3 G Ex ic nA [ic] IIC T6...T4 Gc
	Remote version, sensor
	II 3 G Ex ic IIC T6...T3 Gc;
	II 3 D Ex ic IIIC T85°C...T150°C Dc

IECEx	Compact version		
	Ex ia IIC T6...T3 Ga/Gb;		
	Ex ia IIIC T85°C...T150°C Da/Db		
	or...		
	Ex ia/db IIC T6...T3 Ga/Gb;		
	Ex ia/tb IIIC T85°C...T150°C Da/Db		
	or...		
	Ex ic IIC T6...T3 Gc;		
	Ex ic IIIC T85°C...T150°C Dc		
	or...		
	Ex ic nA IIC T6...T3 Gc		
	Remote version, converter		
	Ex ia [ia Ga] IIC T6...T4 Gb;		
	Ex ia [ia Da] IIIC T85°C...T135°C Db		
	or...		
	Ex db ia [ia Ga] IIC T6...T4 Gb;		
	Ex ia tb [ia Da] IIIC T85°C...T135°C Db		
	or...		
	Ex ic [ic] IIC T6...T4 Gc;		
	Ex ic [ic] IIIC T85°C...T135°C Dc		
	or...		
	Ex ic nA [ic] IIC T6...T4 Gc		
	Remote version, sensor		
	Ex ia IIC T6...T3 Ga/Gb;		
	Ex ia IIIC T85°C...T150°C Da/Db		
	or...		
	Ex ic IIC T6...T3 Gc;		
	Ex ic IIIC T85°C...T150°C Dc		

cQPSus – Dual Seal-approved	NEC 500 and CEC Section 18 and Annex J (Division ratings)
	Compact version
	IS, Class I, Div 1, GPS ABCD, T6...T3;
	IS, Class II/III, Div 1, GPS EFG, T85°C...T150°C
	or...
	XP-IS, Class I, Div 1, GPS A (US only) BCD, T6...T3;
	DIP-IS, Class II/III, Div 1, GPS EFG, T85°C...T150°C
	or...
	NI, Class I, Div 2, GPS ABCD, T6...T3;
	NI, Class II/III, Div 2, GPS FG, T85°C...T150°C
	Remote version, converter
	IS, Class I, Div 1, GPS ABCD, T6...T4;
	IS, Class II/III, Div 1, GPS EFG, T85°C...T135°C
	or...
	XP-IS, Class I, Div 1, GPS A (US only) BCD, T6...T4;
	DIP-IS, Class II/III, Div 1, GPS EFG, T85°C...T135°C
	or...
	NI, Class I, Div 2, GPS ABCD, T6...T4;
	NI, Class II/III, Div 2, GPS FG, T85°C...T135°C
	Remote version, sensor
	IS, Class I, Div 1, GPS ABCD, T6...T3;
	IS, Class II/III, Div 1, GPS EFG, T85°C...T150°C
	or...
	NI, Class I, Div 2, GPS ABCD, T6...T3;
	NI, Class II/III, Div 2, GPS FG, T85°C...T150°C
	NEC 505 and NEC 506 (Zone ratings)
	Compact version
	Class I, Zone 0 AEx ia IIC T6...T3 Ga;
	Zone 20, AEx ia IIIC T85°C...T150°C Da
	or...
	Class I, Zone 1 AEx db ia [ia Ga] IIC T6...T3 Gb;
	Zone 21, AEx ia tb [ia Da] IIIC T85°C...T150°C Db
	Remote version, converter
	Class I, Zone 1 AEx ia [ia Ga] IIC T6...T4 Gb;
	Zone 21, AEx ia [ia Da] IIIC T85°C...T135°C Db
	or...
	Class I, Zone 1 AEx db ia [ia Ga] IIC T6...T4 Gb;
	Zone 21, AEx ia tb [ia Da] IIIC T85°C...T135°C Db
	Remote version, sensor
	Class I, Zone 0 AEx ia IIC T6...T3 Ga;
	Zone 20, AEx ia IIIC T85°C...T150°C Da

	CEC Section 18 (Zone ratings)
	Compact version
	Ex ia IIC T6...T3 Ga;
	Ex ia IIIC T85°C...T150°C Da
	or...
	Ex db ia [ia Ga] IIC T6...T3 Gb;
	Ex ia tb [ia Da] IIIC T85°C...T150°C Db
	Remote version, converter
	Ex ia [ia Ga] IIC T6...T4 Gb;
	Ex ia [ia Da] IIIC T85°C...T135°C Db
	or...
	Ex db ia [ia Ga] IIC T6...T4 Gb;
	Ex ia tb [ia Da] IIIC T85°C...T135°C Db
	Remote version, sensor
	Ex ia IIC T6...T3 Ga;
	Ex ia IIIC T85°C...T150°C Da
NEPSI	**Compact version**
	Ex ia IIC T3~T6 Ga/Gb;
	Ex iaD 20/21 T85~T150
	or...
	Ex ia/d IIC T3~T6 Ga/Gb;
	Ex iaD 20 tD A21 IP6X T85°C~T150°C
	Remote version, converter
	Ex ia [ia Ga] IIC T4~T6 Gb;
	Ex iaD [iaD 20] 21 T85~T135
	or...
	Ex d ia [ia Ga] IIC T4~T6 Gb;
	Ex iaD 21 tD A21 [iaD 20] IP6X T85°C~T135°C
	Remote version, sensor
	Ex ia IIC T3~T6 Ga/Gb;
	Ex iaD 20/21 T85~T150

EAC-EX (pending)	Compact version
	Ga/Gb Ex ia IIC T6...T3 X;
	Da/Db Ex ia IIIC T85°C...T150°C X
	or...
	Ga/Gb Ex ia/db IIC T6...T3 X;
	Da/Db Ex ia/tb IIIC T85°C...T150°C X
	Remote version, converter
	1Ex ia [ia Ga] IIC T6...T4 Gb X;
	Ex ia [ia Da] IIIC T85°C...T135°C Db X
	or...
	1Ex db ia [ia Ga] IIC T6...T4 Gb X;
	Ex ia tb [ia Da] IIIC T85°C...T135°C Db X
	Remote version, sensor
	Ga/Gb Ex ia IIC T6...T3 X;
	Da/Db Ex ia IIIC T85°C...T150°C X
Hygienic	
EHEDG	For Tri-Clamp® and DIN 11851 process connections when fitted with an alternative gasket (which agrees with the latest edition of the EHEDG Position paper "Easy cleanable pipe couplings and process connections" - available on this website: https://www.ehedg.org/)
Other standards and approvals	
SIL	C (Compact) version only: SIL 2/3 (SIL3: 1oo2 architecture is necessary for homogeneous redundancy) — certified according to all the requirements in EN 61508 (Full Assessment) and for high/low continuous demand mode operation. HFT=0, SFF=93% (for non-Ex / Ex i devices with one output), 94% (for non-Ex / Ex i devices with two outputs) or 95% (for Ex d devices), type B device
EMC	Electromagnetic Compatibility (EMC) directive. The device agrees with this directive and its related standard if the device has a single probe that is installed in a metallic tank. For more data, refer to *Electromagnetic compatibility* on page 8. SIL 2-approved devices agree with EN 61326-3-1 and EN 61326-3-2.
NAMUR	NAMUR NE 21 Electromagnetic Compatibility (EMC) of Industrial Process and Laboratory Control Equipment
	NAMUR NE 43 Standardization of the Signal Level for the Failure Information of Digital Transmitters
	NAMUR NE 53 Software and Hardware of Field Devices and Signal Processing Devices with Digital Electronics
	NAMUR NE 107 Self-Monitoring and Diagnosis of Field Devices

① HART® is a registered trademark of the FieldComm Group™

Probe options

	Single rod Ø8 mm / 0.32¨	Single rod Ø10 mm / 0.39¨ (fully TFM-T62 PTFE-coated)

Measuring system

Application	Liquids	
Measuring range	0.6...4 m / 1.97...13.12 ft	0.6...4 m / 1.97...13.12 ft
Dead zone	This depends on the type of probe. For more data, refer to "Measurement limits" in this chapter.	

Measuring accuracy

Accuracy (in direct mode)	**Standard** ±2 mm / ±0.08¨	
	Interface ±10 mm / ±0.4¨ (εr constant)	
Accuracy (in TBF mode)	±20 mm / ±0.8¨	
Minimum layer (interface)	50 mm / 2¨	
Resolution	0.1 mm / 0.004¨	
Repeatability	±1 mm / ±0.04¨	
Maximum rate of change at 4 mA	100 m/min / 328 ft/min	
Reference conditions acc. to EN 61298-1		
Temperature	+15...+25°C / +59...+77°F	
Pressure	1013 mbara ±50 mbar / 14.69 psia ±0.73 psi	
Relative air humidity	60% ±15%	

Operating conditions

Min./Max. temperature at the process connection ①	-50…+150°C / -58…+302°F	
Pressure	-1…40 barg / -14.5…580 psig	
Viscosity (liquids only)	10000 mPa·s / 10000 cP	
Dielectric constant	$\geq$ 1.6 in direct mode (interface: ε_r(interface) >> ε_r(level)²); $\geq$ 1.1 in TBF mode	
Vibration resistance	EN 60721-3-4, Category 4M3 (5...8.22 Hz: ±0.75 mm / 8.22...200 Hz:0.2g; 5g shock ½sinus: 6 ms)	

Materials

Probe	Stainless steel (1.4404 / 316L)	TFM-T62 PTFE-coated stainless steel (1.4404 / 316L)
Gasket (process seal)	FKM/FPM (-40…+150°C / -40…+302°F); Kalrez® 6221 (-20…+150°C / -4…+302°F); EPDM (-50…+150°C / -58…+302°F) Also applicable to CIP and SIP cycles ②	None. TFM-T62 PTFE layer: (-50…+150°C / -4…+302°F)
Process connection	Stainless steel (1.4404 / 316L)	TFM-T62 PTFE-coated stainless steel (1.4404 / 316L)
Other wetted parts	PEEK Victrex 450G	PTFE

	Single rod Ø8 mm / 0.32¨	Single rod Ø10 mm / 0.39¨ (fully TFM-T62 PTFE-coated)
Surface roughness of metallic wetted parts	For hygienic applications only: Ra <0.76 µm	—

Process connections

Hygienic	For more data on options, refer to *Order code* on page 157

① Also depends on the temperature limits of the gasket material. Refer to "Materials" in this table.

② Kalrez® is a registered trademark of DuPont Performance Elastomers L.L.C.

Process connection options: flange facing finish

Type (flange facing)	Flange facing finish, R_a (min...max)	
	[µm]	[µin − AARH]

ISO 2852 / DIN 32676 (Tri-Clamp®)

—	≤ 0.76	30

DIN 11851

—	≤ 0.76	30

SMS 1145

—	≤ 0.76	30

8.3 Minimum power supply voltage

Use these graphs to find the minimum power supply voltage for a given current output load.

Non-Ex and Hazardous Location approved (Ex i / IS / NI) devices
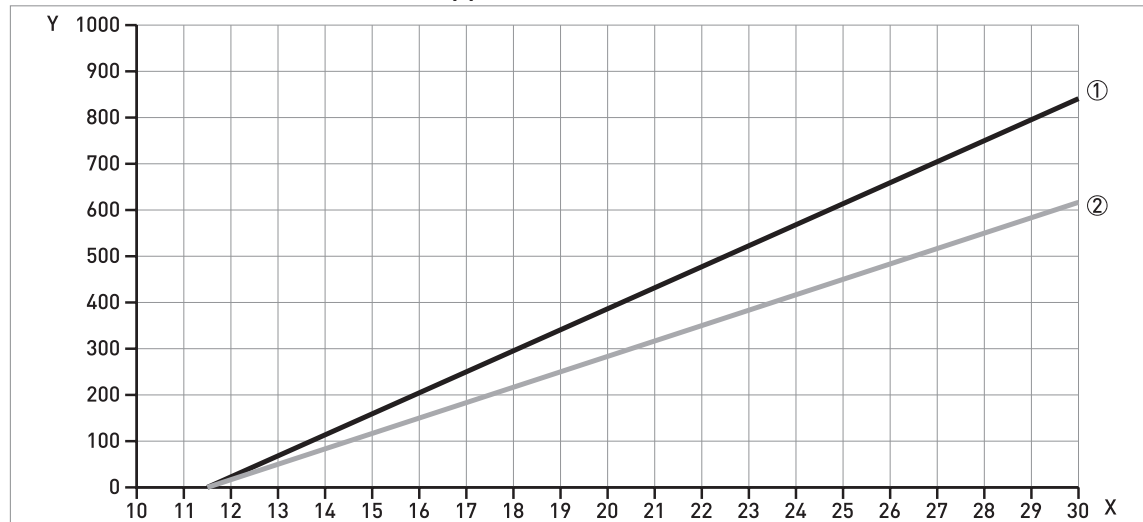
Figure 8-3: Non-Ex and Hazardous Location approval (Ex i / IS / NI): minimum power supply voltage for an output of 22 mA (switch output - relay option: 30 mA) at the terminals

X: Power supply U [V DC]
Y: Current output load R_L [Ω]
① Output 1: 4...20 mA/HART
   Output 2: 4...20 mA (NOTE: use a separate power supply to energize output 2)
② Input 2: switch output - relay option

Hazardous Location (Ex d / XP/ DIP) approved devices
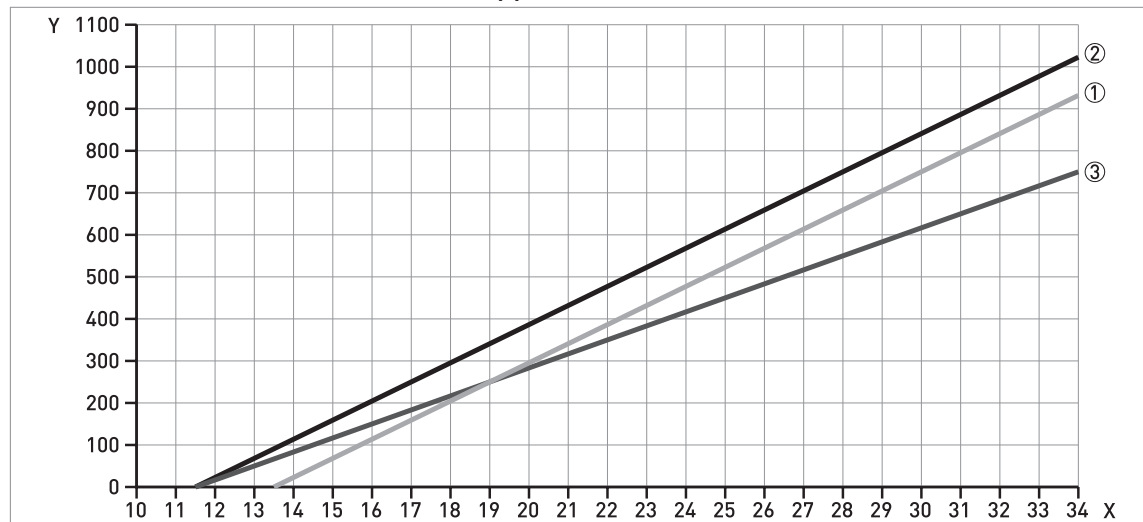
Figure 8-4: Non-Ex and Hazardous Location approval (Ex d / XP/ DIP): minimum power supply voltage for an output of 22 mA (switch output - relay option: 30 mA) at the terminals

X: Power supply U [V DC]
Y: Current output load R_L [Ω]
① Output 1: 4...20 mA/HART
② Output 2: 4...20 mA (NOTE: use a separate power supply to energize output 2)
③ Input 2: switch output - relay option

8.4 Measurement limits

Single rod probes
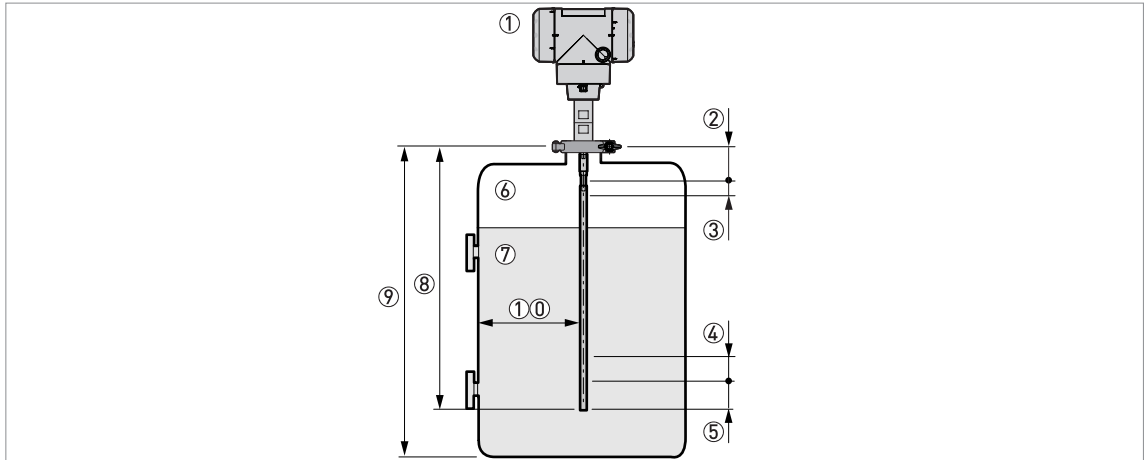
Figure 8-5: Measurement limits

① Device with a single rod probe
② **Top dead zone:** Top part of the probe where measurement is not possible
③ **Top non-linearity zone:** Top part of the probe with a lower accuracy of ±30 mm / ±1.18¨
④ **Bottom non-linearity zone:** Bottom part of the probe with a lower accuracy of ±30 mm / ±1.18¨
⑤ **Bottom dead zone:** Bottom part of the probe where measurement is not possible
⑥ **Gas (Air)**
⑦ **Product**
⑧ **L, Probe length**
⑨ **Tank Height**
⑩ **Minimum distance from the probe to a metallic tank wall:** 300 mm / 12¨

Measurement limits (dead zone) in mm and inches

Probe	ε_r = 80				ε_r = 2.5			
	Top ②		Bottom ⑤		Top ②		Bottom ⑤	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Ø8 mm / 0.32¨ single rod	50	1.97	20	0.79	50	1.97	60	2.36
Ø10 mm / 0.39¨ single rod (PTFE-coated)	50	1.97	20	0.79	50	1.97	60	2.36

Measurement limits (non-linearity zone) in mm and inches

Probe	ε_r = 80				ε_r = 2.5			
	Top ③		Bottom ④		Top ③		Bottom ④	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Ø8 mm / 0.32¨ single rod	150	5.91	0	0	150	5.91	0	0
Ø10 mm / 0.39¨ single rod (PTFE-coated)	150	5.91	0	0	150	5.91	0	0

80 is ε_r of water; 2.5 is ε_r of oil

INFORMATION!
If you did the Auto Setup procedure after you installed the device, the values in the tables are correct. If you did not do the Auto Setup procedure, then the values for the dead zones and the non-linearity zones increase. If the cable probe does not have a counterweight, speak or write to your local supplier for more data.

Menu item **2.3.2 Blocking Distance** is set at the factory to 50 mm / 1.97¨, which is higher than or equal to the largest dead zone. This value agrees with the minimum dielectric constant at which the device can measure the level of a product. You can adjust **2.3.2 Blocking Distance** to agree with the dead zone (for this data, refer to the measurement limits table). For more data about the menu item, refer to *Function description* on page 61.

8.5 Dimensions and weights

INFORMATION!
All housing covers have bayonet connectors unless it is an explosion-proof (XP / Ex d-approved) device or has the second current output / switch output (relay) option. If the device has the second current output / switch output (relay) option or has an Ex d / XP (explosion-proof) approval, the terminal compartment cover has a thread with a flame path.

Overall dimensions
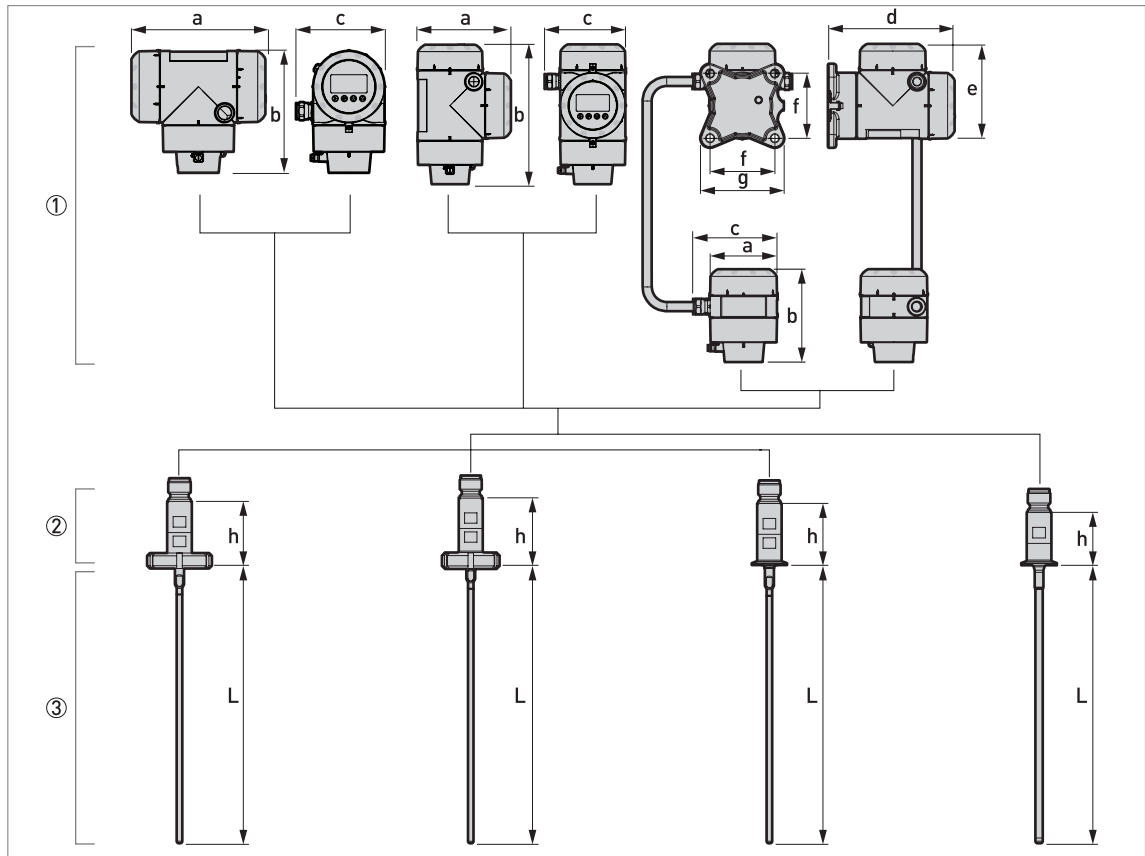
Figure 8-6: Overall dimensions
① **Housing options.** From left to right:
   compact converter with horizontal housing, compact converter with vertical housing, and remote converter (top) and probe electronics housing (bottom)
② **Process connection options.** From left to right:
   — DIN 11851 connection, SMS 1145 coupling and Tri-Clamp® for polished Ø8 mm / 0.32¨ single rod probe;
   — Tri-Clamp® for Ø8 mm / 0.32¨ single rod probe with PTFE coating
③ **Probe options.** From left to right:
   Polished Ø8 mm / 0.32¨ single rod probe, Ø10 mm / 0.39¨ single rod probe with PTFE coating

Housing options: Dimensions in mm

Dimensions [mm]	Compact – horizontal		Compact – vertical		Remote	
	Non-Ex / Ex i / IS	Optional output / Ex d / XP	Non-Ex / Ex i / IS	Optional output / Ex d / XP	Non-Ex / Ex i / IS	Optional output / Ex d / XP
a	191	258	147	210	104	104
b	175	175	218	218	142	
c	127	127	127	127	129	129
d	—	—	—	—	195	195
e	—	—	—	—	146	209
f	—	—	—	—	100	100
g	—	—	—	—	130	130

Housing options: Dimensions in inches

Dimensions [inches]	Compact – horizontal		Compact – vertical		Remote	
	Non-Ex / Ex i / IS	Optional output / Ex d / XP	Non-Ex / Ex i / IS	Optional output / Ex d / XP	Non-Ex / Ex i / IS	Optional output / Ex d / XP
a	7.52	10.16	5.79	8.27	4.09	4.09
b	6.89	6.89	8.23	8.23	5.59	5.59
c	5.00	5.00	5.00	5.00	5.08	5.08
d	—	—	—	—	7.68	7.68
e	—	—	—	—	5.75	8.23
f	—	—	—	—	3.94	3.94
g	—	—	—	—	5.12	5.12

Process connection and probe options: Dimensions in mm

Dimensions [mm]	Polished Ø8 mm single rod probe			Ø8 mm single rod probe with PTFE coating
	DIN 11851	SMS 1145	Tri-Clamp®	Tri-Clamp®
h	88	88	88	75
L	For more data, refer to "Probe options" in this section.			

Process connection and probe options: Dimensions in inches

Dimensions [inches]	Polished Ø0.32¨ single rod probe			Ø0.32¨ single rod probe with PTFE coating
	DIN 11851	SMS 1145	Tri-Clamp®	Tri-Clamp®
h	3.46	3.46	3.46	2.95
L	For more data, refer to "Probe options" in this section.			

Weather protection option (vertical signal converters – for the compact version only)
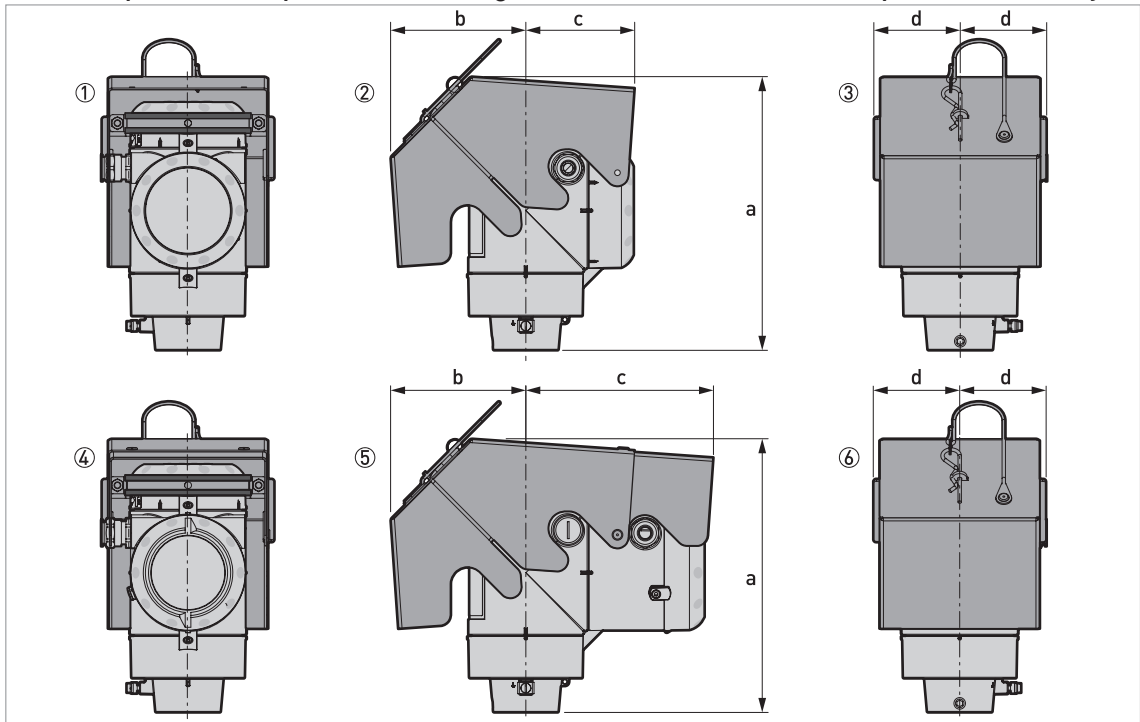
Figure 8-7: Weather protection option for vertical signal converter versions (compact version only)

① Non-Ex / Ex i / IS: Rear view (with weather protection closed)
② Non-Ex / Ex i / IS: Right side (with weather protection closed)
③ Non-Ex / Ex i / IS: Front view (with weather protection closed)
④ Optional output / Ex d / XP: Rear view (with weather protection closed)
⑤ Optional output / Ex d / XP: Right side (with weather protection closed)
⑥ Optional output / Ex d / XP: Front view (with weather protection closed)

Dimensions and weights in mm and kg

Weather protection	Version	Dimensions [mm]				Weights [kg]
		a	b	c	d	
Vertical signal converter	Non-Ex / Ex i / IS	241	118	96	77	1.3
	Optional output / Ex d / XP	241	118	166	77	1.5

Dimensions and weights in inches and lb

Weather protection	Version	Dimensions [inches]				Weights [lb]
		a	b	c	d	
Vertical signal converter	Non-Ex / Ex i / IS	9.5	4.6	3.8	3.0	2.9
	Optional output / Ex d / XP	9.5	4.6	6.5	3.0	3.3

Weather protection option (horizontal signal converters – for the compact version only)
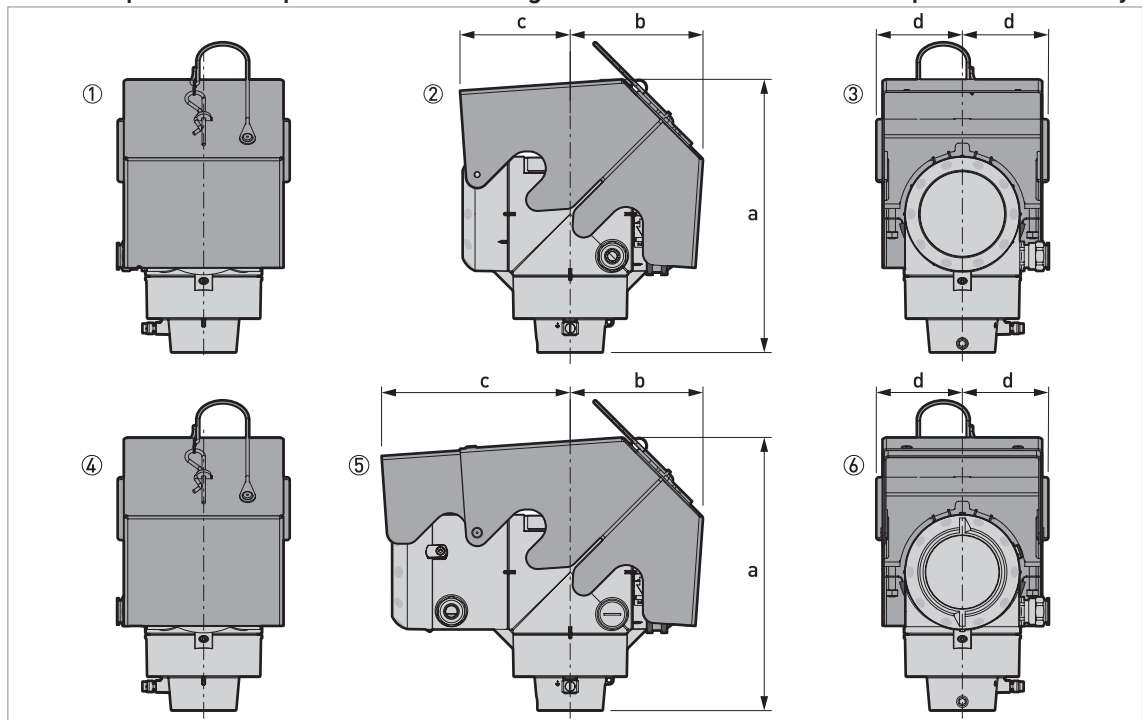
Figure 8-8: Weather protection option for horizontal signal converter versions (compact version only)

① Non-Ex / Ex i / IS: Front view (with weather protection closed)
② Non-Ex / Ex i / IS: Left side (with weather protection closed)
③ Non-Ex / Ex i / IS: Rear view (with weather protection closed)
④ Optional output / Ex d / XP: Front view (with weather protection closed)
⑤ Optional output / Ex d / XP: Left side (with weather protection closed)
⑥ Optional output / Ex d / XP: Rear view (with weather protection closed)

Dimensions and weights in mm and kg

Weather protection	Version	Dimensions [mm]				Weights [kg]
		a	b	c	d	
Horizontal signal converter	Non-Ex / Ex i / IS	243	118	96	77	1.3
	Optional output / Ex d / XP	243	118	166	77	1.5

Dimensions and weights in inches and lb

Weather protection	Version	Dimensions [inches]				Weights [lb]
		a	b	c	d	
Horizontal signal converter	Non-Ex / Ex i / IS	9.6	4.6	3.8	3.0	2.9
	Optional output / Ex d / XP	9.6	4.6	6.5	3.0	3.3

Probe options
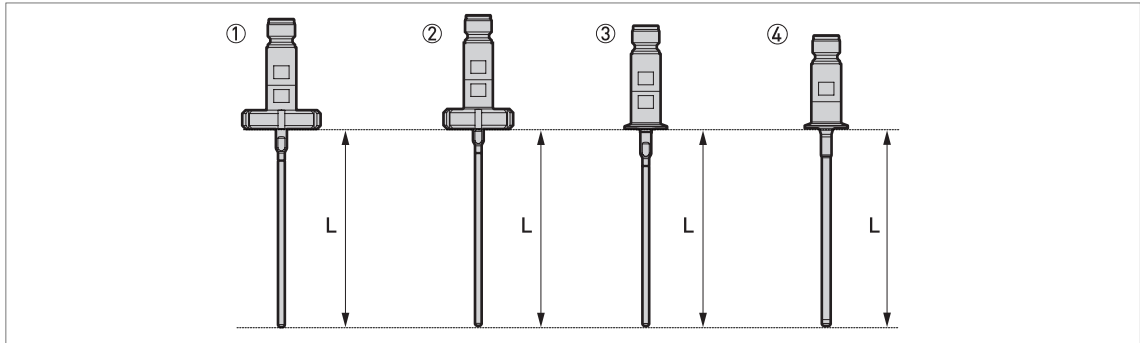
Figure 8-9: Probe options

L = probe length
① Polished single rod Ø8 mm / Ø0.32¨. SMS connection.
② Polished single rod Ø8 mm / Ø0.32¨. DIN ¨11851 connection.
③ Polished single rod Ø8 mm / Ø0.32¨. Tri-Clamp® connection.
④ Single rod Ø10 mm / Ø0.39¨ with TFM-T62 (PTFE) coating. Tri-Clamp® connection.

Single probes: Dimensions in mm

Probes	Dimensions [mm]	
	L min.	L max.
Polished single rod Ø8 mm	600 ①	4000
Single rod Ø10 mm with TFM-T62 (PTFE) coating	600 ①	4000

① A shorter probe length is available on request

Single probes: Dimensions in inches

Probes	Dimensions [inches]	
	L min.	L max.
Polished single rod Ø0.32¨	24 ①	158
Single rod Ø0.39¨ with TFM-T62 (PTFE) coating	24 ①	158

① A shorter probe length is available on request

Converter and probe electronics housing weights

Type of housing	Weights			
	Aluminium housing		Stainless steel housing	
	[kg]	[lb]	[kg]	[lb]

One output / Non-Ex / intrinsically-safe (Ex i / IS)

Compact converter	2.8	6.2	6.4	14.1
Remote converter ①	2.5	5.5	5.9	13.0
Probe electronics housing ①	1.8	4.0	3.9	8.6

Optional output / Explosion proof (Ex d / XP)

Compact converter	3.2	7.1	7.5	16.5
Remote converter ①	2.9	6.40	7.1	15.65
Probe electronics housing ①	1.8	4.0	3.9	8.6

① The remote version of the device has a "remote converter" and a "probe electronics housing". For more data, refer to "Housing dimensions" at the start of this section.

Probe weights

Probes	Process connection	Process connection weights		Probe Weights	
		[kg]	[lb]	[kg/m]	[lb/ft]
Polished single rod Ø8 mm / Ø0.32	Tri-Clamp®	1.2...1.5	2.6...3.3	0.41 ①	0.28 ①
	SMS 1145	1.2...1.5	2.6...3.3		
	DIN 11851	1.3...1.6	2.9...3.5		
Single rod Ø10 mm / Ø0.39¨ with TFM-T62 (PTFE) coating	Tri-Clamp®	0.6...1	1.3...2.2	0.5 ①	0.34 ①

① This value does not include the weight of the process connection

9.1 General description

The HART® Protocol is an open digital communication protocol for industry. It is free to use by anyone. It is included in the software embedded in signal converters of HART-compatible devices.

There are 2 classes of devices which support the HART® Protocol: operating devices and field devices. There are 2 classes of operating devices (Master): PC-supported workstations (Primary Master) and manual control units (Secondary Master). These can be used in control centres and other locations. HART® field devices include sensors, converters and actuators. Field devices include 2-wire and 4-wire devices, and also intrinsically-safe versions for use in hazardous areas.

There are 2 primary operation modes for HART-compatible devices: point-to-point mode and multi-drop mode.

If the device is used in point-to-point mode, the HART® Protocol uses the Bell 202 Frequency Shift Keying (FSK) standard to put a digital signal on top of the 4...20 mA signal. The connected device sends and receives digital signals that agree with the HART® Protocol, and sends analog signals at the same time. Only 1 device can be connected to the signal cable.

If the device is used in multi-drop mode, the network only uses a digital signal that agrees with the HART® Protocol. The loop current is set to 4 mA. You can connect a maximum of 63 devices to the signal cable.

An FSK or HART® modem is included in field devices and manual control units. It is necessary to have an external modem for PC-supported workstations. The external modem is connected to the serial or USB interface.

9.2 Software description

HART® identification codes and revision numbers

Manufacturer ID:	0x45
Device:	0xAE
Device Revision:	1
DD Revision	1
HART® Universal Revision:	7
FC 475 system SW.Rev.:	≥ 3.9
AMS version:	≥ 13.1
PDM version:	≥ 9.0
FDT version:	1.2

9.3 Connection variants

The signal converter is a 2-wire device with 4...20 mA current output and HART® interface.

- **Multi-Drop Mode is supported**
  In a Multi-Drop communication system, more than 1 device is connected to a common transmission cable.
- **Burst Mode is not supported**

There are two ways of using the HART® communication:
- as Point-to-Point connection and
- as Multi-Drop connection with 2-wire connection.

9.3.1 Point-to-Point connection — analogue / digital mode

Point-to-Point connection between the signal converter and the HART® Master.

The current output of the device is passive.

Also refer to *Point-to-point networks* on page 47.

9.3.2 Multi-Drop connection (2-wire connection)

Up to 63 devices may be installed in parallel (this signal converter and other HART® devices).

For an illustration of multi-drop networks, refer to *Multi-drop networks* on page 48.

For data on communication in multi-drop mode, refer to *HART*® network configuration on page 83.

9.4 HART® device variables

HART® device variable	Code	Type
Level	1	linear
Distance	2	linear
Level Conversion	3	linear ①
Distance Conversion	4	linear ①
Interface Level	5	linear
Interface Distance	6	linear
Interface Layer	7	linear
Interface Level Conversion	8	linear ①
Interface Distance Conversion	9	linear ①
Layer Conversion	10	linear ①
Dielectric Constant (product)	11	linear
Converter Temperature	12	linear
Sensor Temperature	13	linear
Dielectric Constant (gas)	14	linear

① This depends on the values entered in the conversion table

"Interface level", "Interface Distance", "Interface Layer", "Interface Level Conversion", "Interface Distance Conversion" and "Layer Conversion" are available if you set Application Type to "LEVEL + INTERFACE MIXED", "LEVEL + INTERFACE UNMIXED" or "INTERFACE (FULLY SUBMERGED PROBE)". "Level Conversion", "Distance Conversion", "Interface Level Conversion", "Interface Distance Conversion" and "Layer Conversion" are HART® device variables if you created a strapping table in the conversion menu.

The HART® dynamic variables PV (Primary Variable), SV (Secondary Variable), TV (Third Variable) and 4V (Fourth Variable) can be assigned to any of the device variables.

The HART® dynamic variable PV is always connected to the HART® current output which is, for example, assigned to level measurement.

9.5 Field Communicator 475 (FC 475)

The Field Communicator is a hand terminal from Emerson Process Management that is designed to configure HART® and Foundation Fieldbus devices. Device Descriptions (DDs) are used to integrate different devices into the Field Communicator.

9.5.1 Installation

⚠ *CAUTION!*
The Field Communicator cannot be used to correctly configure, operate or read data from the device unless the Device Description (DD) file is installed.

System and software requirements for the Field Communicator
- System card that includes the "Easy Upgrade Option"
- Field Communicator Easy Upgrade Programming Utility
- HART® Device Description file

For more data, refer to the Field Communicator User's Manual.

9.5.2 Operation

ⓘ *INFORMATION!*
The Field Communicator will not give you access to the service menu. A simulation is only possible for current outputs.

The Field Communicator and the device's local display use almost the same procedures to operate the signal converter. The online help for each menu item refers to the function number given to each menu item on the local device display. Protection of settings is the same as on the device's local display.

The Field Communicator always saves a complete configuration for communication with AMS.

9.6 Asset Management Solutions (AMS®)

The Asset Management Solutions Device Manager (AMS®) is a PC program from Emerson Process Management which is designed to configure and manage HART®, PROFIBUS and Foundation Fieldbus devices. Device Descriptions (DDs) are used to integrate different devices into the AMS®.

9.6.1 Installation

Please read the README.txt file in the Installation Kit.

If the Device Description has not been installed at this time, install the Installation Kit HART® AMS. You can download this .exe file from our website.

For installation data, refer to the "AMS Intelligent Device Manager Books Online" section "Basic AMS Functionality > Device Configurations > Installing Device Types > Procedures > Install device types from media".

9.6.2 Operation

INFORMATION!
For more data, refer to HART® menu tree for AMS on page 148.

9.6.3 Parameter for the basic configuration

Due to AMS requirements and conventions, there are differences when operating the signal converter with AMS and operating using the local keyboard. The service menu parameters are not supported and simulation is only possible for current outputs. The online help for each parameter contains its function number as a reference to the local device display.

9.7 Field Device Tool / Device Type Manager (FDT / DTM)

9.7.1 Installation

Before you operate the device, the Device Type Manager (Device DTM) must be installed in the Field Device Tool Container. You can download this .msi file from our website. For installation and configuration data, refer to the documentation that is supplied with the Device DTM in the "Downloads" section of the website.

9.7.2 Operation

The DTM and the device's local display use almost the same procedures to operate the signal converter. For more data, refer to *Operation* on page 53.

9.8 Process Device Manager (PDM)

The Process Device Manager (PDM) is a Siemens PC program designed to configure HART® and PROFIBUS devices. Device Descriptions (DDs) are used to integrate different devices into the PDM.

9.8.1 Installation

Install Device Description files supplied in the Device Install HART® PDM folder. This is necessary for each type of field device that is used with SIMATIC PDM. This folder is available for download from the website.

If you use PDM version 5.2, refer to PDM manual, section 11.1 - Install device / Integrate device into SIMATIC PDM with Device Install.

If you use PDM version 6.0, refer to PDM manual, section 13 - Integrating devices.

For more data, refer to "readme.txt". You can find this file in the Installation Kit.

9.8.2 Operation

INFORMATION!
For more data, refer to HART® menu tree for PDM on page 152.

There can be differences between the names of menus in the SIMATIC PDM software tool and menus shown on the device display screen. Refer to the online help in SIMATIC PDM to find the function number of each menu item. This function number agrees with the function number in the device menus.

Use the same procedure for the protection of parameters in the supervisor menu.

9.9 HART® menu tree for Basic-DD

Abbreviations of the following tables:

- ᴼᵖᵗ Optional, depending on device version and configuration
- ᴿᵈ Read only

9.9.1 Overview Basic-DD menu tree (positions in menu tree)

1 Measured Values	1 Output, HART Dynamic Vars	
	2 Measured Values	
	3 Measured Values (Bar)	
	3 Measured Values (Scope)	
2 Diag/Service	1 Status	1 Standard Status
		2 Device-Specific Status
	2 Test / Reset	

3 Basic Set-up	0 Auto Setup	
	1 Basic Parameters	
	2 Outputs	
4 Detailed Set-up	1 Advanced Setup	1 LogIn / Logout
		2 Setups
		3 (Device Image)
		4 (Manufacturer logo)
	2 Info.	1 Identification
		2 Installation
		3 Application
		4 Probe
		5 (Device Image)
		6 (Manufacturer logo)
	3 Basic Parameters	
	4 Outputs	Output 1
		Output 2
	5 Application	
	6 HART Variables	
	7 Display	
	8 Conversion Table (1-10) / Conversion Table (11-20) / Conversion Table (21-30) / Conversion Table (31-40) / Conversion Table (41-50)	
	9 Service	
	10 Master	
	11 Support	

9.9.2 Basic-DD menu tree (details for settings)

1 Measured Values

1 Output, HART Dynamic Vars	1 Primary	1 PV is / 2 PV / 3 PV PDQ / 4 PV LS
	2 Secondary	1 SV is / 2 SV / 3 SV PDQ / 4 SV LS
	3 Tertiary	1 TV is / 2 TV / 3 TV PDQ / 4 TV LS
	4 Fourth	1 QV is / 2 4V / 3 4V PDQ / 4 4V LS
	5 Current Output	1 PV % rnge / 2 PV Loop current
	6 Current output	1 SV % rnge / 2 SV Loop current
	7 (time stamp)	
	6 (device image)	
	7 (manufacturer logo)	
2 Measured Values	1 LevelRd / 2 DistanceRd / 3 InterfaceRd / 4 Interface DistanceRd / 5 LayerRd / 6 ConversionRd / 7 Interface ConversionRd / 8 Conversion LayerRd / 9 Ullage ConversionRd / 10 Interface Ullage ConversionRd / 11 Epsilon R Product CalculatedRd / 13 Temperature ConverterRd / 14 Temperature SensorRd / (device image) / (manufacturer logo) ①	
3 Measured Values (Bar)	1 Current OutputRd / 2 Level / DistanceRd / 3 ConversionsRd	
4 Measured Values (Scope)	1 Current OutputRd / 2 Level / DistanceRd / 3 ConversionsRd	

2 Diag/Service

1 Status	1 Standard Status	1 Device statusRd / 2 Write protectRd
	2 Device-Specific Status	1 FailuresRd / 2 Warning Maintenance RequiredRd / 3 Warning Out Of SpecificationRd / 4 InfoRd
2 Test / Reset	1 Main Loop Test / 2 Optional Loop Test / 3 Switch Output Test / 4 Diagnostic / 5 Restart Device / 6 Reset Factory / 7 Reset Conf.Flag	
3 Date and Time	1 Current DateRd / 2 Current TimeRd / 3 Set Date and Time	
4 Read Error History		

3 Basic Set-up

0 Auto Setup	1 Access LevelRd / 2 LogIn / LogOut / 3 Auto Setup		
1 Basic Parameters	1 Tank Height / 2 Block Distance / 3 Time Constant / 4 Tag / 5 (device image) / 6 Length Unit (HART) / 7 Conversion Unit (HART) / 8 (manufacturer logo)		
2 Outputs	Output 1	1 Output Function / 2 Output Range / 3 PV LRV / 4 PV URV / 5 Output Error Delay / 6 Loop Current Mode / Main Loop Test / Current Output 1 Calibration ②	
	Output 2	1 Optional Output Mode	
		2 Optional Current Output	1 Optional Output Function / 2 Optional Output Range / 3 LRV / 4 URV / Current Output 2 Test / Current Output 2 Calibration ③
		3 Optional Relay Output	1 Switch Output Function / 2 Relay Threshold / 3 Relay Hysteresis / 4 Relay Output Mode / 5 Relay Bit Tracked / 6 Switch Output Test ④

4 Detailed Setup

1 Advanced Setup	1 LogIn / LogOut	1 Access LevelRd / 2 LogIn / LogOut / 3 Change/Activate Supervisor Password	
	2 Setups	1 Installation Setup	
		2 Device Outputs Setup	
		3 Applications Setup	
		4 Options Setups	1 Dynamic Precision Monitoring / 4 Interface
		5 Maintenance Setups	1 Maintenance Converter Setup / 2 Maintenance Mechanic Setup
	3 (device image)		
	4 (manufacturer logo)		

2 Info.	1 Identification	1 Serial Number[Rd] / 2 Converter Firmware Version[Rd] / 3 Sensor Firmware Version[Rd] / 4 HMI Firmware Version[Rd] / 5 Electronic Version[Rd] / 6 Mechanical Traceability[Rd]	
	2 Installation	1 Installation Type[Rd] / 2 Tank Height[Rd] / 3 Stilling Well Height[Rd] / 4 Stilling Well Diameter[Rd]	
	3 Application	1 Application Type[Rd] / 2 Product Family[Rd] / 3 Auto Epsilon R Product[Rd] / 4 Epsilon R Product[Rd] / 5 Epsilon R Product Minimum[Rd] / 6 Epsilon R Product Maximum[Rd]	
	4 Probe	1 Probe Length[Rd] / 2 Process Type[Rd] / 3 Probe Type[Rd] / 4 Converter Version[Rd] / 5 Remote Cable Length[Rd]	
	5 (device image)		
	6 (manufacturer logo)		
3 Basic Parameters	1 Tank Height / 2 Block Distance / 3 Time Constant / 4 Probe Length / 5 Detection Delay / 6 Reference Offset / 7 Tank Bottom Offset / 8 Length Unit (HART) / 9 Conversion Unit (HART) / 10 Electronic Temperature Unit / 11 (device image) / 12 Tag Name		
4 Outputs	Output 1	1 Output Function / 2 PV Length Unit / 3 Output Range / 4 PV LRV / 5 PV URV / 6 Output Error Delay / 7 Loop Current Mode / 8 Loop Test / 9 Current Output 1 Calibration ②	
	Output 2	1 Optional Output Mode	
		2 Optional Current Output	1 Optional Output Function / 2 Optional Output Range / 3 LRV / 4 URV / Current Output 2 Test / Current Output 2 Calibration ③
		3 Optional Relay Output	1 Switch Output Function / 2 Set/Point/Threshold / 3 Hysteresis/Delay / 4 Alarm Mode / 5 Error List / 6 Switch Output Test ⑤
5 Application	1 Tracking Velocity		
	2 Epsilon R Gas	1 Application Type / 2 Epsilon R Gas (manual mode)	
	3 Auto Epsilon R Product		
	4 Threshold Settings	1 Level Threshold / 2 Probe End Threshold / 3 Interface Threshold / 4 Level Pulse Distance[Rd] / 5 Level Pulse Amplitude[Rd] / 6 Probe End Pulse Amplitude[Rd] / 7 Interface Pulse Distance[Rd] / 8 Interface Pulse Amplitude[Rd] / 9 Flange Pulse Amplitude[Rd]	
	5 Measuring Mode / 6 Snapshot Mode / 9 WHG Mode		
6 HART Variables	1 Manufacturer[Rd] / 2 Model[Rd] / 3 Dev id[Rd] / 4 Hardware rev[Rd] / 5 Software rev[Rd] / 6 Fld dev rev[Rd] / 7 Production Number[Rd] / 8 Final asmbly num[Rd] / Poll addr / Descriptor / Date / Message / PV is / SV is / TV is / QV is / Num req preams / Num resp preams[Rd]		
7 Display	1 Language / 2 Length Unit (value shown on the optional display screen) / 3 Conversion Unit (value shown on the optional display screen) / 4 (device image) / 5 Display Mode		

8 Conversion Table (1-10)	1 Add One Point / 2 Modify One Point / 3 Delete Last Point / 4 Delete Table / 5 (device image)	
	6 Pt 1	1 LevelRd / 2 ConversionRd
	7 Pt 2	1 LevelRd / 2 ConversionRd
	…	1 LevelRd / 2 ConversionRd
Conversion Table (11-20)	…	…
Conversion Table (21-30)	…	…
Conversion Table (31-40)	…	…
Conversion Table (41-50)	…	…
9 Service ⑥		
10 Master ⑦		
11 Support ⑦		

① "Interface" and "Interface Distance" and "Layer" are shown if the device has the interface measurement option. "Conversion" and "Ullage Conversion" are shown if the device uses a conversion table. "Interface Conversion", "Conversion Layer" and "Interface Conversion Layer" are shown if the device uses a conversion table and has the interface measurement option.

② Current Output 1 Calibration is shown if the Access Level is "Service"

③ Current Output 2 Calibration is shown if the Access Level is "Service"

④ Relay Bit Tracked is shown if Switch Output Function is set to "Status List"

⑤ Error List is shown if Switch Output Function is set to "Status List"

⑥ This menu is only available if Access Level is set to "Service"

⑦ This menu is only available if Access Level is set to "Master"

9.10 HART® menu tree for AMS

Abbreviations of the following tables:

- ^{Opt} Optional, depending on device version and configuration
- Rd Read only

9.10.1 Overview AMS menu tree (positions in menu tree)

Process variables	Output HART Dynamic Vars	
	Measured Values	
	Measured Values (Bar)	
	Measured Values (Scope)	
Device Diagnostics (Diag/Service)	Status	Standard Status
		Device Specific Status
	Test/Reset	
	Date and Time	

Configure / Setup	Basic Setup	Auto Setup
		Basic Parameters
		Outputs
	Detailed Setup	Advanced Setups
		Info.
		Basic Parameters
		Outputs
		Application
		HART Variables
		Display
		Conversion Table (1-10)
		Service
		Master
		Support

9.10.2 AMS menu tree (details for settings)

Process Variables

Output. HART Dynamic Vars	Primary (PV is / PV / PV PDQ / PV LS)Rd / Secondary (SV is / SV / SV PDQ / SV LS)Rd / Tertiary (TV is / TV / TV PDQ / TV LS)Rd / Fourth (QV is / 4V / 4V PDQ / 4V LS)Rd / Current Output (PV % rnge / PV Loop current / SV % rnge / SV Loop current)Rd
Measured Values	Level (Level / PDQ / LS)Rd / Distance (Distance / PDQ / LS)Rd / Interface (Interface / PDQ / LS)Rd / Interface Distance (Int. Dist. / PDQ / LS)Rd / Layer (Layer / PDQ / LS)Rd / Epsilon R Product Calculated (EpsR Calc. / PDQ / LS)Rd / Temperature Converter (Temp. Conv. / PDQ / LS)Rd / Temperature Sensor (Temp. Sensor / PDQ / LS)Rd
Measured Values (Bar)	Current OutputRd / Level/DistanceRd
Measured Values (Scope)	Current OutputRd / Level/DistanceRd

Device Diagnostics (Diag/Service)

Status	Standard Status	Primary variable out of limits / Non-primary variable out of limits / PV Analog Channel Saturated / PV Analog Channel Fixed / More status available / Cold start / Configuration changed / Field device malfunction
		Write protect

Status	Device Specific Status	Failures: Oscillator Frequency Failure / Current Output Drift / Sensor ROM error / Sensor RAM error / Sensor EEPROM error / Converter ROM error / Converter RAM error / Converter EEPROM error / Sensor Processing Failure / Sensor Not Compatible / Temperature Out of Range / Internal Communication Error / Sensor Voltage Error / Converter Voltage Error / Reference Pulse Lost Error / Level Pulse Lost Error / Overfill (Error) / Empty (Error) / Analog Output 2 Drift / Sensor - Time Out DMA / Sensor - Time Out Lock PLL / Sensor - Time Out SPI Read / Sensor - Time Out SPI Write / Sensor - Time Out Switch Clock / Sensor - Time out Load ASIC / Sensor - Time Out SPI R/W / Sensor - Voltage 5V Error / Sensor - Voltage 2.5V Error / Sensor - 1.5V Error / Sensor - Time Out Power Good / Relay State Not Correct / Clock Pulse Generator KO / Clock Sampler & Hold KO / RTC Failure - Time Stamp KO
		Maintenance Required: Flange Lost / Snapshot Invalid / Auto Probe Length Invalid / Reference Position Outside Range / Audio Signal Offset Outside Range / Temperature Below -35°C / Temperature Above +75°C / Leak Detected (Warning) / Sensor - Temperature Too Low / Sensor - Temperature Too High / Auto Setup Required / Reference Pulse Amplitude Anomaly / Reference Pulse Width Anomaly
		Out Of Specification: Level Empty (Warning) / Local Operation on the device (Warning) / Overfill (Warning) / Level Lost (Warning) / Temperature Out of Range (Warning) / Interface - Lost (Warning) / Interface - Empty (Warning) / Interface - Overfill (Warning) / Layer Empty
		Info: First Start / Epsilon R Calculation Frozen / Epsilon R Value Low / Epsilon R Value High / Temperature Outside Operating Range of HMI / Measure Not Updated / Snapshot: Distance Validation Not Required / Analysis Data Available / Dielectric Gas - Value Low / Dielectric Gas - Value High / Dielectric Gas - Calcul.Frozen / FPGA Update / Optional Output Detected / Relay State: Closed
Test/Reset	Loop Test / Restart Device / Reset Factory / Reset Configuration Changed Flag	

Configure / Setup

Basic Setup	Basic Parameters	Tank Height / Block Distance / Time Constant / Length Unit (HART) / Conversion Unit (HART) / Tag
	Current Output	Output Function / Output Range / PV LRV / PV URV / Output Error Delay / Loop current mode
	LogIn / LogOut	Access Level / LogIn/LogOut / Change/Activate Supervisor Password

Detailed Setup	Advanced Setups	Language / Length Unit (On Local Display) / Conversion Unit (On Local Display) / Display Mode
		Conversion Table (Add One Point / Modify One Point / Delete Last Point / Delete Table)
		Counter Weight Height / Probe End Pulse Type / Electronic Offset / Mechanical Offset / Calspeed Elec. / Calspeed Meca. / Minimum Window / Calspeed Installation / Flange Threshold / Flange Detection Delay / Noise Cancelling / Epsilon R Product / Epsilon R Product mini. / Epsilon R Product maxi. / Product Family / Level Lost Alarm / Overfill Alarm / Temperature Out Of Range Alarm / Empty Alarm / Interface Lost Alarm / Leak Detection Alarm / Probe Analysis / Snapshot Recording / Output Calibration I1 / Output Calibration I2 / Reset Error records / Event Log Filter / Erase Probe Analysis / Erase Snapshot Record / Auto Offset Calculation
		Full Area / Empty Area / Minimum Layer / Pulse Search Mode / Attenuation Factor / Bottom Blocking Distance Direct / Bottom Blocking Distance TBF / Option 1 / Option 2 / Option 3 / Option 4 / Option 5 / Option 6 / Option 7 / Option 8 / Option 9 / Option 10 / WHG Mode / Reference Point 1 / Correction Point 1 / Reference Point 2 / Correction Point 2 / Reference Point 3 / Correction Point 3 / Reference Point 4 / Correction Point 4 / Parasite Threshold / Min. Layer for Prod. Recognition / Probe Head Attenuation / Impedance Ratio / Number of Point for Leak Detection / Number of Singular Value for Leak Detection / Snapshot Size / Save as Factory Config. / ASIC Pulse Selection Mode / ASIC Pulse Width / ASIC Pulse Amplitude / ASIC Pulse Sign / ASIC Gain Amplifier Linear / ASIC Gain Amplifier Log / ASIC LoW Pass Filter / ADC Sampling Rate / Log Compensation
	Info.	Identification: Serial Number[Rd] / Converter Firmware Version[Rd] / Sensor Firmware Version[Rd] / HMI Firmware Version[Rd]
		Current Output: Output Function[Rd] / Output Range[Rd] / PV LRV[Rd] / PV URV[Rd] / Output Error Delay[Rd]
	Basic Parameters	Tank Height / Block Distance / Time Constant / Length Unit (HART) / Conversion Unit (HART) / Tag
	Current Output	Output Function / Output Range / PV LRV / PV URV / Output Error Delay / Loop current mode

Detailed Setup	Application	Tracing Velocity / Auto product epsilon R / Epsilon R gas / Epsilon R Product / Thresholds Setting (Level Threshold / Probe End Threshold / Level Pulse Distance / Level Pulse Amplitude / Probe End Pulse Amplitude / Refresh) / Measuring Mode / Snapshot Mode / Snapshot Size
	HART Variables	Manufacturer / Model / Dev id / Hardware rev / Software rev / Universal rev / Fld dev rev / Production Number / Final asmbly num / Poll addr / Descriptor / Date / Message / PV is / SV is / TV is / QV is / Num req preams / Num resp preams
	Display	Language / Length Unit (On Local Display) / Conversion Unit (On Local Display)
	Conversion Table (1-10)	Add One Point / Modify One Point / Delete Last Point / Delete table Pt 1 (Level / Conversion), Pt 2 (Level / Conversion) etc.

9.11 HART® menu tree for PDM

Abbreviations of the following tables:

- ^{Opt} Optional, depending on device version and configuration

- Rd Read only

- ^{Cust} Custody lock protection

- ^{Loc} Local PDM, affects only PDM views

9.11.1 Overview PDM menu tree (positions in menu tree)

Overview: Menu Device

Communication Path
Download To Device...
Upload To PG/PC...
Update Diagnosis Status
Configuration and Test
Access Rights
watch status

Overview: PDM parameters

Measured Values	Output HART Dynamic Vars	
	Measured Values	
	Measured Values (Bar)	
	Measured Values (Scope)	
Diagnostics	Status	Standard Status
		Device Specific Status
	Test/Reset	

Configure / Setup	Basic Setup	Auto Setup
		Basic Parameters
		Outputs
	Detailed Setup	Advanced Setups
		Info.
		Basic Parameters
		Outputs
		Application
		HART Variables
		Display
		Conversion Table (1-10)
		Service
		Master
		Support

9.11.2 PDM menu tree (details for settings)

Device Menu

Measured Values

Output. HART Dynamic Vars	Primary (PV is / PV / PV PDQ / PV LS)[Rd] / Secondary (SV is / SV / SV PDQ / SV LS)[Rd] / Tertiary (TV is / TV / TV PDQ / TV LS)[Rd] / Fourth (QV is / 4V / 4V PDQ / 4V LS)[Rd] / Current output (PV % rnge / PV Loop current)[Rd] / Current output (SV % rnge / SV Loop current)[Rd] / Time Stamp
Measured Values	Level (Level / PDQ / LS)[Rd] / Distance (Distance / PDQ / LS)[Rd] / Interface (Interface / PDQ / LS)[Rd] / Interface Distance (Int.Dist. / PDQ / LS)[Rd] / Layer (Layer / PDQ / LS)[Rd] / Conversion (Conv. / PDQ / LS)[Rd] / Interface Conversion (Int.Conv. / PDQ / LS)[Rd] / Conversion Layer (Conv.Layer / PDQ / LS)[Rd] / Ullage Conversion (Ullage / PDQ / LS)[Rd] / Interface Ullage Conversion (Int.Ullage / PDQ / LS)[Rd] / Epsilon R Product Calculated (EpsR Calc. / PDQ / LS)[Rd] / Temperature Converter (Temp.Conv. / PDQ / LS)[Rd] / Temperature Sensor (Temp.Sensor / PDQ / LS)[Rd] / Time Stamp[Rd]
Measured Values (Bar)	Current Output[Rd] / Level/Distance[Rd]
Measured Values (Scope)	Current Output[Rd] / Level/Distance[Rd]

Diagnostics

| Status | Standard Status | Primary variable is outside the operating limits / Non-primary variable outside the operating limits / PV Analog Channel Saturated / PV Analog Channel Fixed / More status available / Cold start occurred / Configuration changed / Field device malfunctioned |
| | | Write protection |

Status	Device Specific Status	Failures: Oscillator Frequency Failure / Current Output Drift / Sensor ROM error / Sensor RAM error / Sensor EEPROM error / Converter ROM error / Converter RAM error / Converter EEPROM error / Sensor Processing Failure / Sensor Not Compatible / Temperature Out of Range / Internal Communication Error / Sensor Voltage Error / Converter Voltage Error / Reference Pulse Lost Error / Level Pulse Lost Error / Overfill (Error) / Empty (Error) / Analog Output 2 Drift / Sensor - Time Out DMA / Sensor - Time Out Lock PLL / Sensor - Time Out SPI Read / Sensor - Time Out SPI Write / Sensor - Time Out Switch Clock / Sensor - Time Out Load ASIC / Sensor - Time Out SPI R/W / Sensor - Voltage 5V Error / Sensor - Voltage 2.5V Error / Sensor - Voltage 1.5V Error / Sensor - Time Out Power Good / Relay State Not Correct / Clock Pulse Generator KO / Clock Sampler & Hold KO / RTC Failure - Time Stamp KO / Interface - Lost (Error) / Interface - Overfill (Error) / Interface - Empty (Error) / Leak Detected (Error)
		Warning Maintenance Required: Flange Lost / Snapshot Invalid / Auto Probe Length Invalid / Reference Position Outside Range / Audio Signal Offset Outside Range / Temperature Below -35°C / Temperature Above +75°C / Leak Detected (Warning) / Sensor - Temperature Too Low / Sensor - Temperature Too High / Auto Setup Required / Reference Pulse Amplitude Anomaly / Reference Pulse Width Anomaly
		Warning Out Of Specification: Level Empty (Warning) / Local Operation on the device (Warning) / Overfill (Warning) / Level Lost (Warning) / Temperature Out of Range (Warning) / Interface - Lost (Warning) / Interface - Empty (Warning) / Interface - Overfill Warning / Layer Empty
		Info: First Start / Epsilon R Calculation Frozen / Epsilon R Value Low / Epsilon R Value High / Temperature Outside Operating Range of HMI / Measure Not Updated / Snapshot Distance Validation Not Required / Dielectric Gas - Value Low / Dielectric Gas - Calcul.Frozen / FPGA Update / Optional Output Detected / Relay State Closed
Test/Reset	Loop Test / Loop Test I2 / Diagnostic / Restart Device / Reset Factory / Reset Configuration Changed Flag	
Date and Time	Current Date[Rd] / Current Time[Rd] / Set Date and Time	
Read Error History		

Configure / Setup

Basic Setup	Auto Setup	Access Level / LogIn/LogOut / Auto Setup	
	Basic Parameters	Tank Height / Block Distance / Time Constant / Length Unit (HART) / Conversion Unit (HART) / Elect temp unit / TAG	
	Outputs	Output 1	Output Function / Lev / Output Range / PV Lower Value / PV Upper Value / Output Error Delay / Loop current mode / Loop test / Output Calibration I1
		Output 2	Optional Output Mode (Current) Optional Output Function / Optional Output Range / Lower Value / Upper Value / Loop test I2 / Output Calibration I2
	Advanced Setups	LogIn/LogOut (Access Level / LogIn/LogOut / Change/Activate Supervisor Password) / Setups (Installation Setup / Device Outputs Setup / Application Setup / Options Setup / Maintenance Setups)	

Detailed Setup	Info.	Identification: Serial Number[Rd] / Converter Firmware Version[Rd] / Sensor Firmware Version[Rd] / HMI Firmware Version[Rd] / Electronic Revision[Rd] / Mechanical Traceability[Rd]	
		Installation: Installation Type[Rd] / Tank Height[Rd]	
		Application: Application Type[Rd] / Product Family[Rd] / Auto product epsilon R[Rd] / Epsilon R Product[Rd] / Epsilon R Product mini[Rd] / Epsilon R Product maxi[Rd]	
		Probe: Probe Length[Rd] / Process Type[Rd] / Probe Type[Rd] / Converter Version[Rd]	
		Remote: Remote Cable Length[Rd]	
	Basic Parameters	Tank Height / Block Distance / Time Constant / Probe Length / Detection Delay / Reference Offset / Tank Bottom Offset Length Unit (HART) / Conversion Unit (HART) / Elect temp unit / TAG	
	Outputs	Output 1	Output Function / Lev / Output Range / PV Lower Value / PV Upper Value / Output Error Delay / Loop current mode / Loop test / Output Calibration I1
		Output 2	Optional Output Mode (Current) Optional Output Function / Optional Output Range / Lower Value / Upper Value / Loop test I2 / Output Calibration I2
	Application	Tracing Velocity / Epsilon R gas / Set Epsilon R Product / Thresholds Settings / Measuring Mode / Snapshot Mode / Dynamic Precision Monitoring	
	HART Variables	Manufacturer / Device Type / HART Device ID / Hardware Revision / Software Revision / Universal Revision / Device Revision / Production Number / Final Assembly Number / Polling Address / Descriptor / Date / Message / PV is / SV is / TV is / QV is / Num Request Preambles / Num Response Preambles	
	Display	Language / Length Unit (On Local Display) / Conversion Unit (On Local Display) / Display Mode	
	Conversion Table (1-10)	Add One Point / Modify One Point / Delete Last Point / Delete table Pt 1 (Level / Conversion), Pt 2 (Level / Conversion) etc.	
	Service		
	Master		
	Support		

10.1 Order code

Make a selection from each column to get the full order code. The characters of the order code highlighted in light grey describe the standard.

VFAD	4	0		OPTIFLEX 3200 C/F Guided Radar (TDR) level transmitter for liquids with hygienic requirements up to 40 barg (580 psig) and +150°C (+302°F)
				Regional directives or approvals
			1	Europe
			2	China
			3	USA
			4	Canada
			5	Brazil
			6	Australia
			A	Russia
			B	Kazakhstan
			C	Belarus
			W	Worldwide
				Ex approval ①
			0	Without
			1	ATEX II 1/2 G Ex ia IIC T6…T3 Ga/Gb + II 1/2 D Ex ia IIIC T85°C…T150°C Da/Db
			2	ATEX II 1/2 G Ex ia/db IIC T6…T3 Ga/Gb + II 1/2 D Ex ia/tb IIIC T85°C…T150°C Da/Db
			3	ATEX II 3 G Ex ic IIC T6…T3 Gc + II 3 D Ex ic IIIC T85°C…T150°C Dc
			4	ATEX II 3 G Ex ic nA T6…T3 Gc
			5	NEPSI Ex ia IIC T3~T6 Ga/Gb + Ex iaD 20/21 T85~T150
			6	NEPSI Ex d ia IIC T3~T6 Ga/Gb + Ex iaD 20 tD A21 IP6X T85°C~T150°C
			A	cQPSus IS CL I/II/III DIV 1 GP A-G + CL I Z0 AEx ia/Ex ia IIC T6…T3 Ga + Z20 AEx ia/Ex ia IIIC T85°C…T150°C Da
			B	cQPSus XP-IS/DIP-IS CL I DIV 1 GP A-G + CL I Z1 AEx db ia/Ex db ia IIC T6…T3 Gb + Z21 AEx ia tb/Ex ia tb IIIC T85°C…T150°C Db
			C	cQPSus NI CL I/II/III DIV 2 GP ABCDFG
			K	IECEx Ex ia IIC T6…T3 Ga/Gb + Ex ia IIIC T85°C…T150°C Da/Db
			L	IECEx Ex ia/db IIC T6…T3 Ga/Gb + Ex ia/tb IIIC T85°C…T150°C Da/Db
			M	IECEx Ex ic IIC T6…T3 Gc + Ex ic IIIC T85°C…T150°C Dc
			N	IECEx Ex ic nA IIC T6…T3 Gc
			P	EAC Ex Ga/Gb Ex ia T6…T3 X + Da/Db Ex ia IIIC T85°C…T150°C X ②
			R	EAC Ex Ga/Gb Ex ia/db IIC T6...T3 X + Da/Db Ex ia/tb IIIC T85°C…T150°C X ②
VFAD	**4**	**0**		**Order code (complete this code on the pages that follow)**

							Industry / safety		
					0		Without		
					1		SIL2/3 – only available for the compact version (C)		
					A		Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)		
					C		EHEDG + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011))		
					D		SIL 2/3 (only for converter version C) + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)		
					F		EHEDG + SIL 2/3 (only for converter version C) + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)		
				0			Converter version (Housing material / IP class)		
					2		C / Compact version (aluminium housing - IP66/IP68)		
					3		C / Compact version (stainless steel housing - IP66/IP68)		
					7		F / Remote version (converter and sensor: aluminium housing - IP66/IP68) ③		
					8		F / Remote version (converter and sensor: stainless steel housing - IP66/IP68) ③		
							Outputs		
						1	2-wire / 4...20 mA passive HART®		
						2	2 × 2-wire / 4...20 mA passive HART® + 4...20 mA passive		
						3	2-wire + 4-wire / 4...20 mA passive HART® + switch output - relay (48 V AC / 6 A; 24 V DC / 6 A)		
							Cable entry / cable gland		
						1	M20×1.5 / without		
						2	M20×1.5 / 1 × plastic + plug ④		
						3	M20×1.5 / 1 × nickel-plated brass + plug ⑤		
						4	M20×1.5 / 1 × stainless steel + plug ⑤		
						6	M20×1.5 / 2 × plastic ⑥		
						7	M20×1.5 / 2 × nickel-plated brass ⑦		
						8	M20×1.5 / 2 × stainless steel ⑦		
						C	½ NPT / without		
						D	½ NPT / 1 × nickel-plated brass + plug ⑤		
						E	½ NPT / 1 × stainless steel + plug ⑤		
						F	½ NPT / 2 × nickel-plated brass ⑦		
						G	½ NPT / 2 × stainless steel ⑦		
							Display / Housing orientation		
							1	No Display / Vertical	
							2	No Display / Horizontal	
							4	Display / Vertical top	
							5	Display / Vertical side	
							6	Display / Horizontal side	
VFAD	4	0			0				Order code (complete this code on the pages that follow)

							Display - Documentation language						
							1	English ⑧					
							2	German					
							3	French					
							4	Italian					
							5	Spanish					
							6	Portuguese					
							7	Japanese					
							8	Chinese (simplified)					
							A	Russian					
							B	Czech					
							C	Turkish					
							D	Polish					
							Enhanced functions						
							0	Without					
							1	Interface capability					
								Process conditions /Process seal					
								0	Without				
								1	-1…40 barg (-14.5…580 psig) / -40°C…+150°C (-40°F…+302°F) / PEEK seal system with FKM/FPM gasket				
								2	-1…40 barg (-14.5…580 psig) / -20°C...+150°C (-4°F…+302°F) / PEEK seal system with Kalrez® 6221 gasket				
								3	-1…40 barg (-14.5…580 psig) / -50°C...+150°C (-58°F…+302°F) / PEEK seal system with EPDM gasket				
								4	-1…40 barg (-14.5…580 psig) / -50°C...+150°C (-58°F…+302°F) / Fully TFM-T62 PTFE-coated				
								Probe / Probe end / Material					
								0	Without				
								1	Single rod - Ø8 mm (0.32¨) Ra≤0.76 µm / none / 316L - 1.4404 / 0.6...4 m (1.97...13.12 ft)				
								4	Single rod - Ø10 mm (0.39¨) / none / fully TFM-T62 PTFE-coated / 0.6...4 m (3.28...13.12 ft)				
									0	**Process connection : Size / Pressure class / Sealing face**			
									0	0	0	Without	
									Hygienic Ra≤0.76 µm (≤30 µin - AARH)				
									E	F	S	1¨ Tri-Clamp® ISO 2852 DN25	
									G	F	S	1½¨ Tri-Clamp® ISO 2852 DN38	
									H	F	S	2¨ Tri-Clamp® ISO 2852 DN51	
									E	F	T	DN25 DIN 11851	
									G	F	T	DN40 DIN 11851	
									H	F	T	DN50 DIN 11851	
									G	F	U	DN38 SMS 1145	
									H	F	U	DN51 SMS 1145	
VFAD	4	0			0				0			**Order code (complete this code on the pages that follow)**	

																		Calibration certificate		
																	0	Without (accuracy ±2 mm (0.08¨) up to 10 m (32.81 ft))		
																	1	Calibration certificate ±2 mm (0.08¨), 2 factory default points		
																	2	Calibration certificate ±2 mm (0.08¨), 5 factory default points		
																	3	Calibration certificate ±2 mm (0.08¨), 5 points specified by customer		
																0		Accessories / Tag plate		
																		0	Without
																		1	Weather protection
																		3	Stainless steel tag plate (18 characters max.)
																		6	Weather protection + stainless steel tag plate (18 characters max.)
VFAD	4	0			0								0			0				Order code

① For more data, refer to the Technical data section (Approvals and certification)
② Pending
③ Length of RS-485 cable between the remote converter and the probe: 1...100 m / 3.28...328.08 ft
④ This option is available if the device has one output. This option is not available for devices with an Ex d ia approval.
⑤ This option is available if the device has one output
⑥ This option is available if the device has two outputs. This option is not available for devices with an Ex d ia approval.
⑦ This option is available if the device has two outputs
⑧ If no language is selected or the selected language is not available, the device is supplied with documentation in English

10.2 Spare parts

We supply spare parts for this device. When you send an order for a mechanical spare part, use the XFADXFAD order code in the "Mechanical spare parts" table that follows. When you send an order for an electronic spare part, use the VFADVFAD order code in the "Converter spare parts" table that follows.

Converter spare parts

VFAD	4	0		OPTIFLEX 3200 C/F Guided Radar (TDR) level transmitter for liquids with hygienic requirements up to 40 barg (580 psig) and +150°C (+302°F)
				Regional directives or approvals
			1	Europe
			2	China
			3	USA
			4	Canada
			5	Brazil
			6	Australia
			A	Russia
			B	Kazakhstan
			C	Belarus
			W	Worldwide
				Ex approval ①
			0	Without
			1	ATEX II 1/2 G Ex ia IIC T6…T3 Ga/Gb + II 1/2 D Ex ia IIIC T85°C…T150°C Da/Db
			2	ATEX II 1/2 G Ex ia/db IIC T6…T3 Ga/Gb + II 1/2 D Ex ia/tb IIIC T85°C…T150°C Da/Db
			3	ATEX II 3 G Ex ic IIC T6…T3 Gc + II 3 D Ex ic IIIC T85°C…T150°C Dc
			4	ATEX II 3 G Ex ic nA T6…T3 Gc
			5	NEPSI Ex ia IIC T3~T6 Ga/Gb + Ex iaD 20/21 T85°C~T150°C ②
			6	NEPSI Ex d ia IIC T3~T6 Ga/Gb + Ex iaD 20 tD A21 IP6X T85°C~T150°C ②
			A	cQPSus IS CL I/II/III DIV 1 GP A-G + CL I Z0 AEx ia/Ex ia IIC T6…T3 Ga + Z20 AEx ia/Ex ia IIIC T85°C…T150°C Da
			B	cQPSus XP-IS/DIP-IS CL I DIV 1 GP A-G + CL I Z1 AEx db ia/Ex db ia IIC T6…T3 Gb + Z21 AEx ia tb/Ex ia tb IIIC T85°C…T150°C Db
			C	cQPSus NI CL I/II/III DIV 2 GP ABCDFG
			K	IECEx Ex ia IIC T6…T3 Ga/Gb + Ex ia IIIC T85°C…T150°C Da/Db
			L	IECEx Ex ia/db IIC T6…T3 Ga/Gb + Ex ia/tb IIIC T85°C…T150°C Da/Db
			M	IECEx Ex ic IIC T6…T3 Gc + Ex ic IIIC T85°C…T150°C Dc
			N	IECEx Ex ic nA IIC T6…T3 Gc
			P	EAC Ex Ga/Gb Ex ia T6…T3 X + Da/Db Ex ia IIIC T85°C…T150°C X ②
			R	EAC Ex Ga/Gb Ex ia/db IIC T6…T3 X + Da/Db Ex ia/tb IIIC T85°C…T150°C X ②
VFAD	**4**	**0**		**Order code (complete this code on the pages that follow)**

				Industry/Safety					
				0	Without				
				1	SIL2/3 – only available for the compact version (C)				
				A	Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)				
				C	EHEDG + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)				
				D	SIL 2/3 (only for converter version C) + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)				
				F	EHEDG + SIL 2/3 (only for converter version C) + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)				
				0	**Converter version (Housing material / IP class)**				
					2	C / Compact version (aluminium housing - IP66/IP68)			
					3	C / Compact version (stainless steel housing - IP66/IP68)			
					7	F / Remote version (converter and sensor: aluminium housing - IP66/IP68) ③			
					8	F / Remote version (converter and sensor: stainless steel housing - IP66/IP68) ③			
						Outputs			
						1	2-wire / 4...20 mA passive HART®		
						2	2 × 2-wire / 4...20 mA passive HART® + 4...20 mA passive		
						3	2-wire + 4-wire / 4...20 mA passive HART® + switch output - relay (48 V AC / 6 A; 24 V DC / 6 A)		
							Cable entry / cable gland		
							1	M20×1.5 / without	
							2	M20×1.5 / 1 × plastic + plug ④	
							3	M20×1.5 / 1 × nickel-plated brass + plug ④	
							4	M20×1.5 / 1 × stainless steel + plug ④	
							6	M20×1.5 / 2 × plastic ⑤	
							7	M20×1.5 / 2 × nickel-plated brass ⑤	
							8	M20×1.5 / 2 × stainless steel ⑤	
							C	½ NPT / without	
							D	½ NPT / 1 × nickel-plated brass + plug ④	
							E	½ NPT / 1 × stainless steel + plug ④	
							F	½ NPT / 2 × nickel-plated brass ⑤	
							G	½ NPT / 2 × stainless steel ⑤	
								Display / Housing orientation	
								1	No Display / Vertical
								2	No Display / Horizontal
								4	Display / Vertical top
								5	Display / Vertical side
								6	Display / Horizontal side
VFAD	4	0			0				**Order code (complete this code on the pages that follow)**

																		Display - Documentation language
												1						English ⑥
												2						German
												3						French
												4						Italian
												5						Spanish
												6						Portuguese
												7						Japanese
												8						Chinese (simplified)
												A						Russian
												B						Czech
												C						Turkish
												D						Polish
																		Enhanced functions
													0					Without
													1					Interface capability
														0 0 0 0 0 0				**Calibration certificate**
															0			Without (accuracy ±2 mm (0.08¨) up to 10 m (32.81 ft))
																0		**Accessories / Tag plate**
																	0	Without
																	1	Weather protection
																	3	Stainless steel tag plate (18 characters max.)
																	6	Weather protection + stainless steel tag plate (18 characters max.)
VFAD	4	0			0								0	0 0 0 0 0	0	0	0	**Order code**

① For more data, refer to the Technical data section (Approvals and certification)

② Pending

③ Length of RS-485 cable between the remote converter and the probe: 1...100 m / 3.28...328.08 ft

④ This option is available if the device has one output

⑤ This option is available if the device has two outputs

⑥ If no language is selected or selected language is not available, English language documentation will be delivered

Mechanical spare parts

XFAD	4	0	0	0	OPTIFLEX 3200 C/F Guided Radar (TDR) level transmitter for liquids with hygienic requirements up to 40 barg (580 psig) and +150°C (+302°F)							
					Industry / safety							
				0	Without							
				1	SIL2/3 – only available for the compact version (C)							
				A	Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)							
				C	EHEDG + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)							
				D	SIL 2/3 (only for converter version C) + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)							
				F	EHEDG + SIL 2/3 (only for converter version C) + Food contact (FDA rules, EC 1935/2004, EC 2023/2006 and EU 10/2011)							
					0 0 0 0 0 0 0	**Process conditions /Process seal**						
						0	Without					
						1	-1…40 barg (-14.5…580 psig) / -40°C…+150°C (-40°F…+302°F) / PEEK seal system with FKM/FPM gasket					
						2	-1…40 barg (-14.5…580 psig) / -20°C…+150°C (-4°F…+302°F) / PEEK seal system with Kalrez® 6221 gasket					
						3	-1…40 barg (-14.5…580 psig) / -50°C…+150°C (-58°F…+302°F) / PEEK seal system with EPDM gasket					
						4	-1…40 barg (-14.5…580 psig) / -50°C…+150°C (-58°F…+302°F) / Fully TFM-T62 PTFE-coated					
							Probe / Probe end / Material					
						0	Without					
						1	Single rod - Ø8 mm (0.32¨) Ra≤0.76 µm / none / 316L - 1.4404 / 0.6…4 m (1.97…13.12 ft)					
						4	Single rod - Ø10 mm (0.39¨) / none / fully TFM-T62 PTFE-coated / 0.6…4 m (3.28…13.12 ft)					
							0	**Process connection : Size / Pressure class / Sealing face**				
								0	0	0	Without	
								Hygienic Ra≤0.76 µm (≤30 µin - AARH)				
								E	F	S	1¨ Tri-Clamp® ISO 2852 DN25	
								G	F	S	1½¨ Tri-Clamp® ISO 2852 DN38	
								H	F	S	2¨ Tri-Clamp® ISO 2852 DN51	
								E	F	T	DN25 DIN 11851	
								G	F	T	DN40 DIN 11851	
								H	F	T	DN50 DIN 11851	
								G	F	U	DN38 SMS 1145	
								H	F	U	DN51 SMS 1145	
									0	0	**Accessories / tag plate**	
										0	Without	
										3	Stainless steel tag plate (18 characters max.)	
XFAD	**4**	**0**	**0**	**0**	**0 0 0 0 0 0 0**		**0**		**0**	**0**	**Order code**	

INFORMATION!
The single rod probe for hygienic applications is welded to the process connection. If it is necessary change the probe then you must also order the process connection.

DANGER!
Remote version: Make sure that replacement signal cables for Ex-approved devices are supplied by the manufacturer. Use of this signal cable is mandatory.

Other spare parts
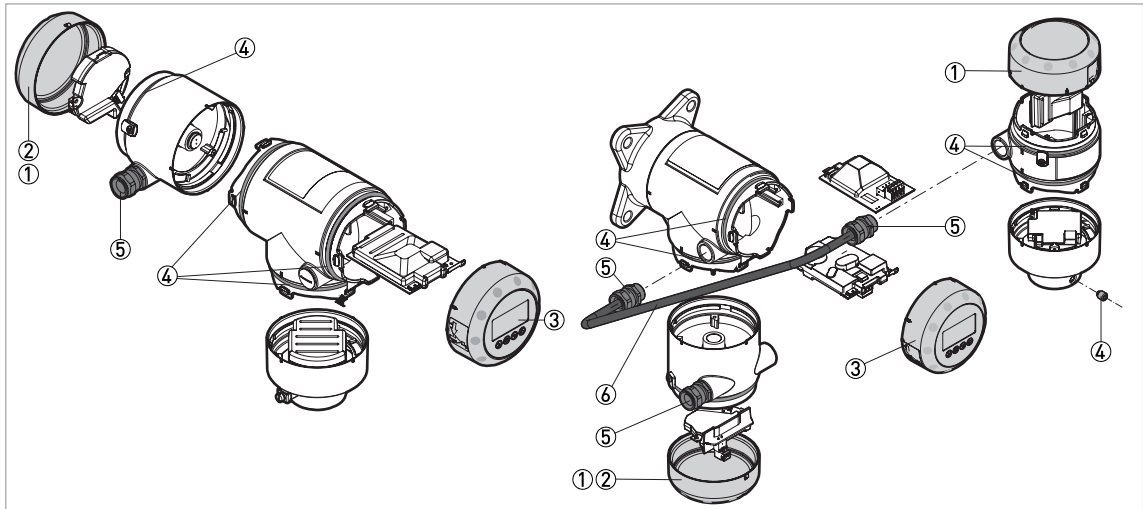
Figure 10-1: Other spare parts

① Cover without LCD display
② Cover for Ex d module
③ Cover with LCD display
④ Set of screws and gaskets for the housing
⑤ Cable gland / M20×1.5
⑥ Signal cable (non-Ex: grey, Ex: blue)

Item	Description	Quantity	Part reference
①	Cover without LCD display, aluminium	1	XFDA010100
	Cover without LCD display, stainless steel	1	XFDA011100
②	Cover for Ex d module, aluminium ①	1	XFDA010200
	Cover for Ex d module, stainless steel ①	1	XFDA011200
③	Cover with LCD display (12 languages - English by default), aluminium	1	XFDA020100
	Cover with LCD display (12 languages - English by default), stainless steel	1	XFDA021100
④	Set of screws and gaskets for the housing	10 screws, 10 gaskets	XF20010900

Item	Description	Quantity	Part reference
⑤	Cable gland / M20×1.5; Plastic; Black; non-Ex (GP)	10	XF20030100
	Cable gland / M20×1.5; Plastic; Blue; Ex i (IS)	10	XF20030200
	Cable gland / M20×1.5; Brass; Ex d (XP)	5	XF20030300
	Cable gland / M20×1.5; Stainless Steel; Ex d (XP)	2	XF20030400
	Cable gland / M20×1.5; Brass; non-Ex / Ex i (IS)	5	XF20030500
	Cable gland / M20×1.5; Stainless Steel; non-Ex / Ex i (IS)	2	XF20030600
	Cable entry / ½ NPT; Brass; non-Ex (GP) / Ex i	5	XF20030700
	Cable entry / ½ NPT; Brass; Ex d	5	XF20030800
	Cable entry / ½ NPT; Brass; cQPSus	5	XF20030900
	Cable entry / ½ NPT; Stainless Steel; non-Ex (GP) / Ex i	2	XF20031000
	Cable entry / ½ NPT; Stainless Steel; Ex d	2	XF20031100
	Cable entry / ½ NPT; Stainless Steel; cQPSus	2	XF20031200
⑥	Signal cable ②	1	③

① For devices with the second output, switch output - relay or Ex d approval options

② For the remote version. Make sure that replacement signal cables for Ex-approved devices are supplied by the manufacturer. Use of this signal cable is mandatory.

③ Length of RS-485 cable between the remote converter and the probe: 1...100 m / 3.28...328.08 ft

10.3 Accessories

We supply accessories for this device. When you send orders for accessories, please give the reference numbers that follow:
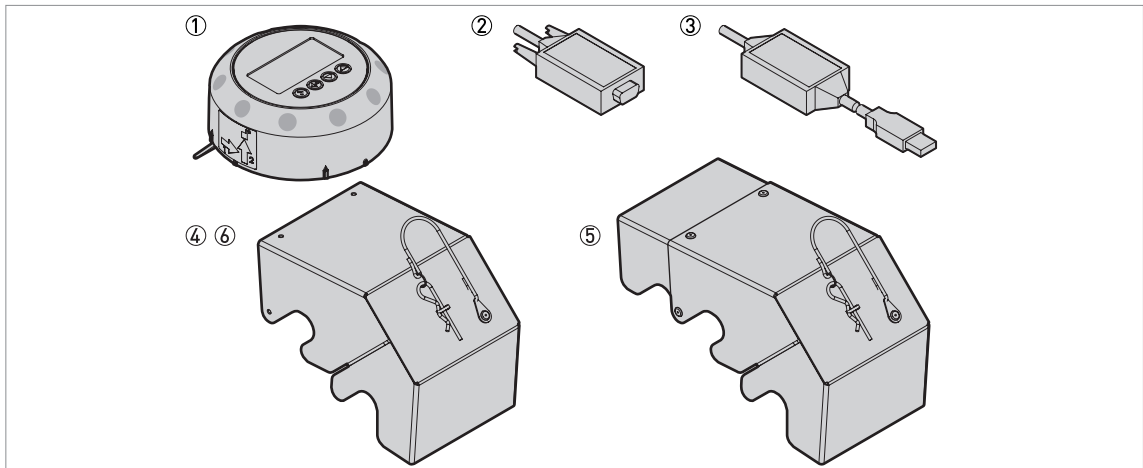

Figure 10-2: Accessories

① HMI service tool
② Viator RS232 / HART converter
③ Viator USB / HART converter
④ Weather protection, compact converter version — non-Ex or Ex i-approved
⑤ Weather protection, compact converter version — Devices with Ex d- or cQPSus-approvals, or with a second current output or relay option
⑥ Weather protection, remote converter version — probe electronics housing

Item	Description	Quantity	Part reference
①	HMI service tool (12 languages - English by default), aluminium ①	1	XFDA010600
②	Viator RS232 / HART converter	1	XF20020600
③	Viator USB / HART converter	1	XF20020700
④	Weather protection, compact version (C) — non-Ex or Ex i-approved	1	XF20050800
⑤	Weather protection, compact version (C) — Ex d- / cQPSus-approved devices or devices with the second output option	1	XF20050900
⑥	Weather protection, remote version (F) — probe electronics housing	1	XF20051000

① If the device does not have the LCD display option, use this accessory to change the device configuration

⚠ *CAUTION!*
If it is necessary to protect the remote converter from direct sunlight, speak or write to your supplier.

10.4 Glossary

C

Cable	This is a wire rope. It is used as a measurement pulse guide.

D

Dielectric constant	An electrical property of the product to be measured used in TDR measurement. Also known as εr, DK and relative permittivity. This gives the strength of the measurement pulse reflected back to the device's signal converter.
Direct mode	The device sends a signal along the probe. It receives the reflection of the signal from the surface of the tank contents. The device uses an algorithm to convert the time it takes to receive the signal into a distance. Use of this measurement mode depends on the minimum dielectric constant limit of the probe type. For more data, refer to *Technical data* on page 122. Refer also to **TBF mode**.
Discontinuities	These are objects or parts of objects (including the tank) that are in the tank, are possibly in the probe's empty space and can potentially influence the electromagnetic field around the probe. This can cause a measurement error. Also refer to *Installation recommendations* on page 20.
Distance	This is a display option. It is the distance from the face of flange to the level (1 product) or the surface of the top product (2 or more products). Refer to the diagrams at the end of this section.

E

Electromagnetic compatibility	Defines how much a device influences or is influenced by other devices that generate electromagnetic fields during operation. Refer to European standard EN 61326-1 for further details.
Electromagnetic field	This is a physical field that is produced by electrically-charged objects and which may affect the behaviour of other objects near to the field.
Empty space	A minimum diameter around a probe that should have no objects in it for the device to work correctly. This depends on the probe type. Refer to **Installation** for more details.
Emulsion	These are small particles of one liquid that readily disperse in another liquid. An emulsion is usually a dispersion of water in oil or a dispersion of oil in water. Possible causes are mixing or tank filling. Emulsions usually separate back into their constituent parts over time. For accurate interface measurement to be possible, the top product and emulsion must have stable dielectric constant values. The way the device measures interface will depend on the type of emulsion: If the emulsion is a constant mix of more than 5% water, the device measures interface from the top of the emulsion.

I

Interface

A surface where two liquids meet.

Interface distance

This is a display option. It is the distance from the face of the flange to the interface. See the diagram at the end of this section.

Interface level

This is a display option. It is the height from the bottom of the tank (user-defined) to the interface (or tank height - interface distance). Refer to the diagrams at the end of this section.

L

Layer

This is a display option. It gives the thickness of top product. The layer must be more than 50 mm or 2¨ for accurate measurement of level and/or interface. Refer to the diagrams at the end of this section.

Level

This is a display option. It is the height from the bottom of the tank (user-defined) to the surface of the top product (Tank height – distance). Refer to the diagrams at the end of this section.

M

Mass

This is a display option. It shows the total mass of tank contents. Use a mass table or a volume table to display measurement data with mass units.

Measurement pulse

The device transmits a short, low-powered electrical pulse or wave transmitted down a guide to the process. The process (or the probe end if in TBF measurement mode) reflects the pulse back to the device.

O

Operators

Users who can choose how to display measurements. They cannot configure the device in supervisor mode.

P

Probe

This is either a metallic cable or rod used to guide the measurement pulse to the process.

Probe length

Ordered length of probe, L, from the face of the flange to end of the guide. If you ordered a cable probe, this includes the counterweight. Refer to the diagrams at the end of this section.

S

Supervisors

Users who can configure the device in supervisor mode. They cannot configure the device in service mode.

T

TBF mode
Tank Bottom Following (TBF) mode. If the product has a low dielectric constant, use this mode. TBF mode uses the end of the probe to indirectly measure the tank contents.

TDR
Time domain reflectometry (TDR). The principle used by the device to measure level and interface. For more data, refer to *Measuring principle* on page 119.

Threshold
A number of limits set either manually or automatically by the signal converter to identify the reflected measurement pulses from the level, and the probe end. For configuration data, refer to *Thresholds and interference signals* on page 89.

Top dead zone
The distance from the flange to the top limit of the measuring range. Also refer to *Measurement limits* on page 132.

U

Ullage mass
This is a display option (parameter name: distance conversion). It shows empty mass or mass of the product that can be put into the tank. Refer to the diagrams at the end of this section.

Ullage volume
This is a display option (parameter name: distance conversion). It shows the unfilled volume. Refer to the diagrams at the end of this section.

V

Volume
Total volume of tank contents. Calculated with a volume table.
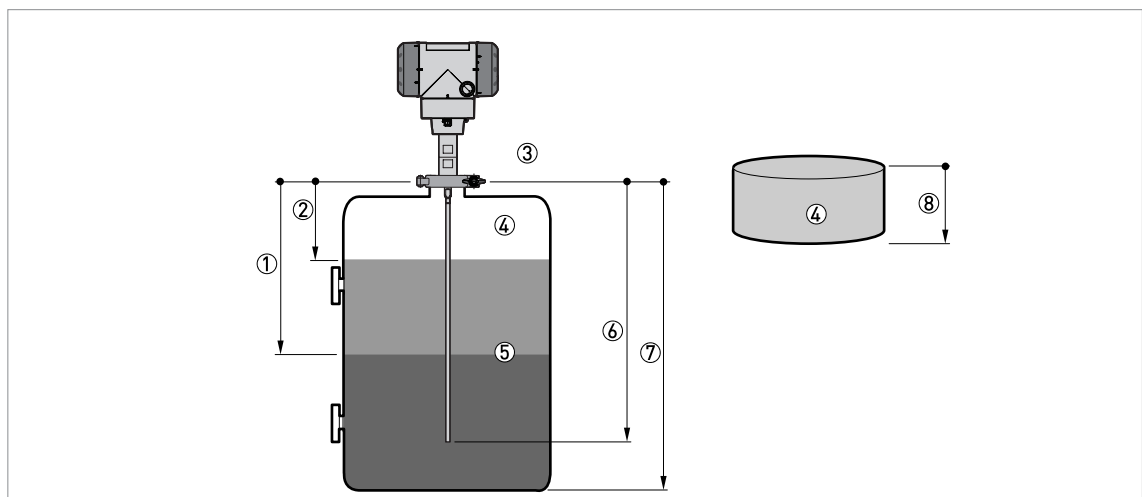

Figure 10-3: Measurement definitions 1

① Interface distance
② Distance
③ Flange facing
④ Gas (Air)
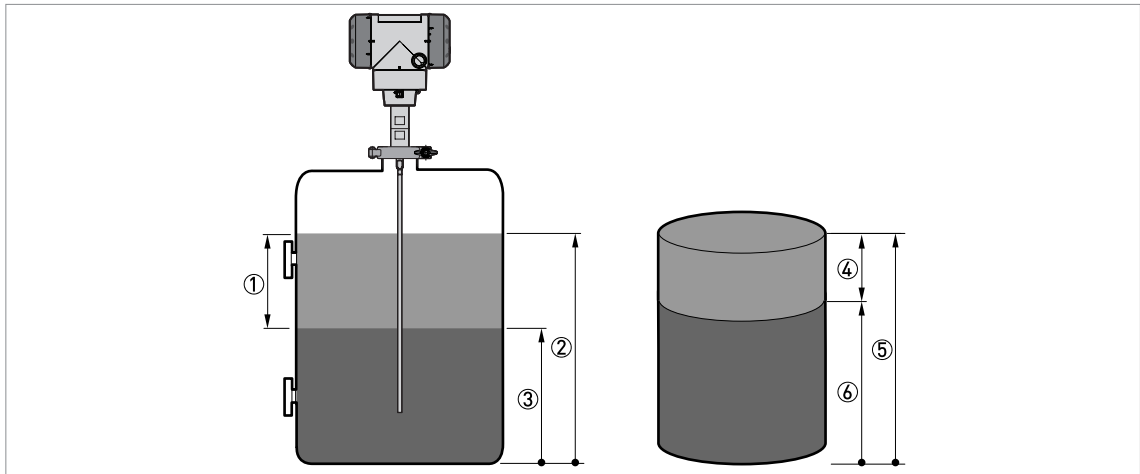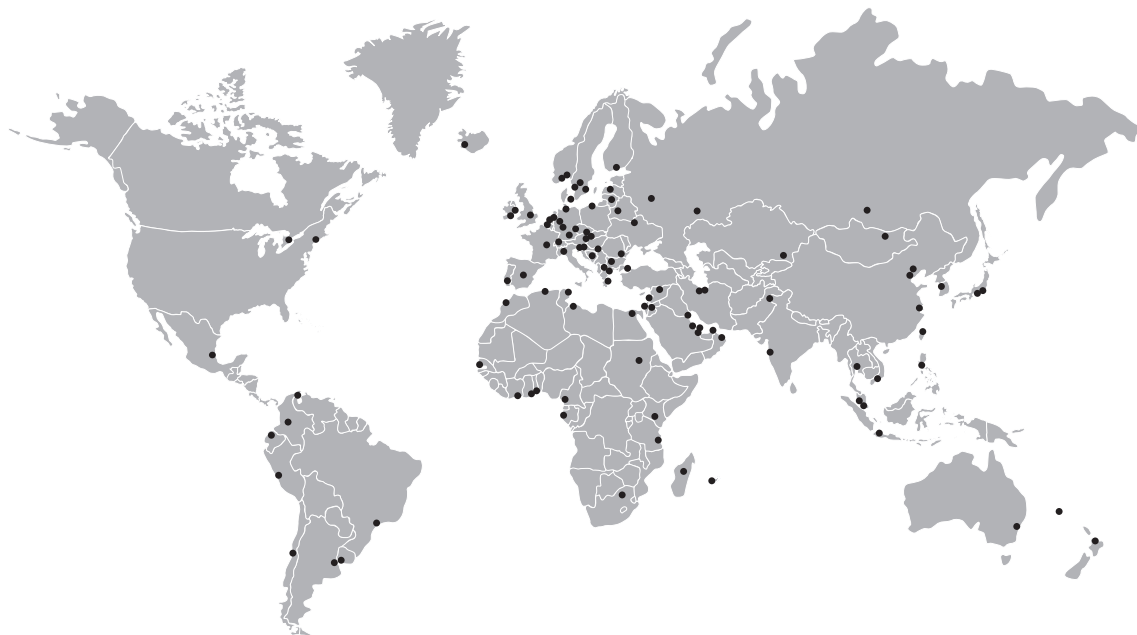⑤ Interface
⑥ Probe length, L
⑦ Tank height
⑧ Ullage volume or mass

Figure 10-4: Measurement definitions 2

① Layer
② Level
③ Interface level
④ Layer volume or mass
⑤ Volume or mass
⑥ Interface volume or mass

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