



SMARTLINE® RM71 (TDR) Handbook

Guided Radar (TDR) Level Meter

for distance, level, volume and mass measurement of liquids, liquid interface, pastes and solids

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While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer to determine the suitability of the product in the application.

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Abstract

This document provides descriptions and procedures for the Installation, Configuration, Operation, and Troubleshooting of your device.

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The following lists Honeywell's World Wide Web sites that will be of interest to our customers.

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1.1 Intended use

This TDR level transmitter measures distance, level, mass and volume of liquids, pastes, slurries, granulates and powders. It can also measure level and interface of liquids at the same time.

It can be installed on tanks, silos and open pits.

1.2 Certification



DANGER!

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



In accordance with the commitment to customer service and safety, the device described in this document meets the following safety requirements:

- Electromagnetic Compatibility (EMC) Directive 2004/108/EC in conjunction with EN 61326-1 (2006) and EN 61326-2-3 (2006).

All devices are based on the CE marking and meet the requirements of NAMUR Guideline NE 21/07.

1.3 Electromagnetic compatibility

The device design agrees with European Standard EN 61326-1 and EN 61326-2-3 when installed in metallic tanks.

You can install the device on open-air tanks and tanks that are not made of metal. This agrees with Emissions requirements for industrial environments (class A). For data on Immunity requirements, refer 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. Use a device with a coaxial probe for this type of installation.



INFORMATION!

Device operation agrees with residential-class (class B) emissions and industrial-class (class A) immunity requirements if:

- *the device has a single or double probe (rod or cable probe) and is used in a closed tank made of metal or*
- *the device has a coaxial probe.*

1.4 Safety instructions from the manufacturer

1.4.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

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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1.4.2 Disclaimer

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

1.4.3 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 and 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.

1.4.4 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 underneath icons.

1.4.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.



DANGER!

This information 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.

1.5 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!

Check the packing list to check if you received completely all that you ordered.

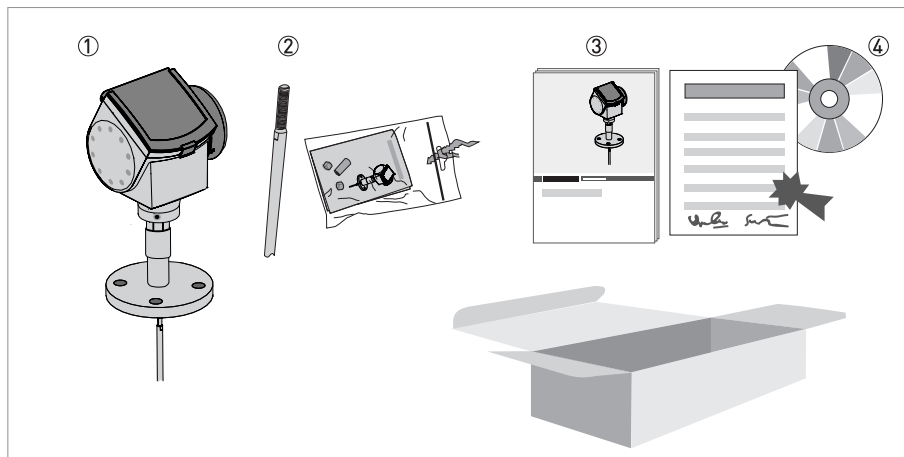


Figure 2-1: Scope of delivery for compact version

- ① Signal converter and probe - compact version.
- ② Probe segments. For the assembly procedure of the single rod probe, refer to *How to assemble the single rod probe (single-piece probe)* on page 39. If a single rod or coaxial probe is attached and you ordered the "segmented probe" option, only part of the probe is attached to the device. For the assembly procedure of the segmented single rod probe, refer to *How to assemble the single rod probe (segmented probe)* on page 43. For the assembly procedure of the segmented coaxial probe, refer to *How to assemble the segmented coaxial probe* on page 46. The assembly instructions and small parts are in a bag attached to the housing.
- ③ Quick Start
- ④ CD-ROM. This contains the Handbook, the Quick Start, the Technical Datasheet and related software.

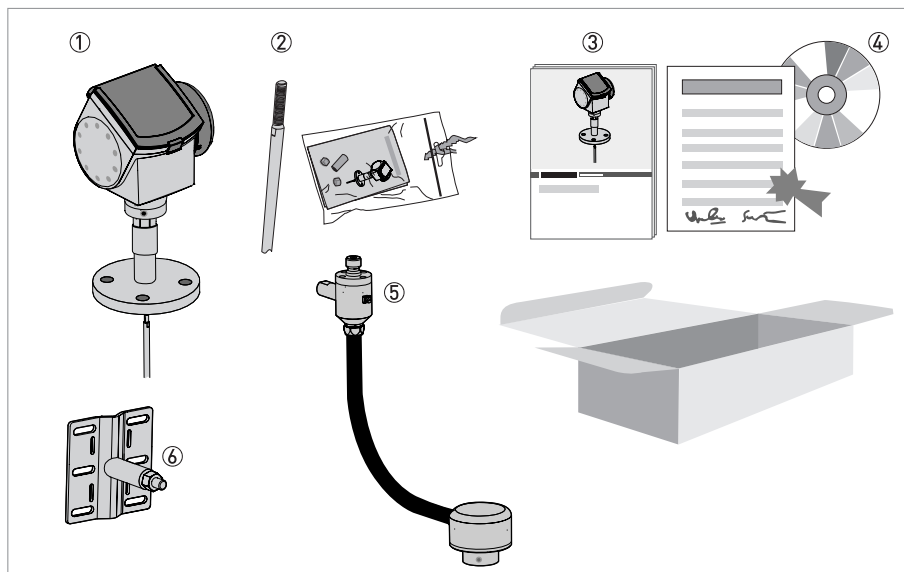


Figure 2-2: Scope of delivery for the remote housing version

- ① Signal converter and probe
- ② Probe segments. For the assembly procedure of the single rod probe, refer to *How to assemble the single rod probe (single-piece probe)* on page 39. If a single rod or coaxial probe is attached and you ordered the "segmented probe" option, only part of the probe is attached to the device. For the assembly procedure of the segmented single rod probe, refer to *How to assemble the single rod probe (segmented probe)* on page 43. For the assembly procedure of the segmented coaxial probe, refer to *How to assemble the segmented coaxial probe* on page 46. The assembly instructions and small parts are in a bag attached to the housing.
- ③ Quick Start
- ④ CD-ROM. This contains the Handbook, the Quick Start, the Technical Datasheet and related software.
- ⑤ Flexible conduit. For the assembly procedure, refer to *How to assemble the remote housing* on page 53.
- ⑥ Wall bracket (also for installation on pipes)



INFORMATION!

No special tools, no training required!

2.2 Device description

The TDR level transmitter is designed to measure the distance, level, interface, mass and volume of liquids, pastes, slurries, granulates and powders.

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 133.

The device has a set-up wizard, fully-potted electronic sub-assemblies and online help functions. You usually will not need this document to install, set up and operate the device.

You can order these accessories:

- Stainless steel weather protection.
- RS232 / HART® converter (VIATOR).
- USB / HART® converter.
- ESD protection (30 kV).
- Metaglas® dual process sealing system for dangerous products.



INFORMATION!

For more data on accessories, refer to List of accessories on page 126.

2.3 Visual Check



INFORMATION!

Inspect the cartons carefully for damage or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

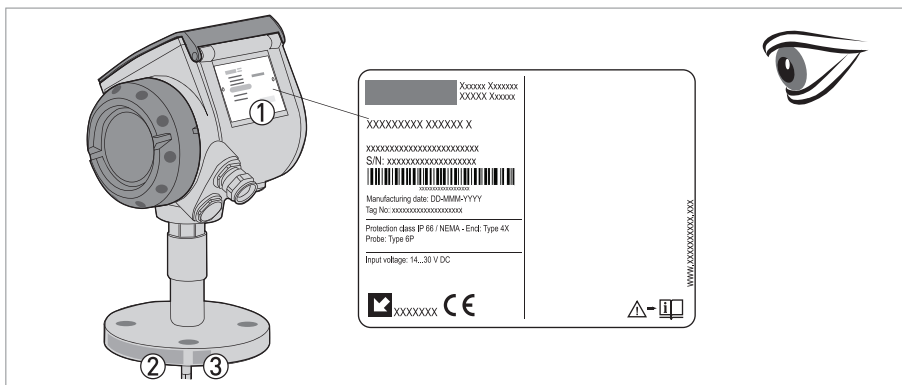


Figure 2-3: Visual check

- ① Device nameplate (for more data, refer to *Non-Ex nameplate* on page 17)
- ② Process connection data (size and pressure rating, material reference and heat number)
- ③ Gasket material data - refer to the illustration that follows



Figure 2-4: Symbols for the supplied gasket material (on the side of the process connection)

- ① EPDM
- ② Kalrez® 6375

If the device is supplied with an FKM/FPM gasket, there is no symbol on the side of the process connection.



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.



WARNING!

- If the display screen glass is broken, do not touch.
- If the device has to measure the level of dangerous products (ammonia etc.), we recommend that the device has the Metaglas® option.
- If the device has to measure the level of products where there is a risk of electrostatic discharge, we recommend that the device has the ESD (electrostatic discharge) protection option.

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

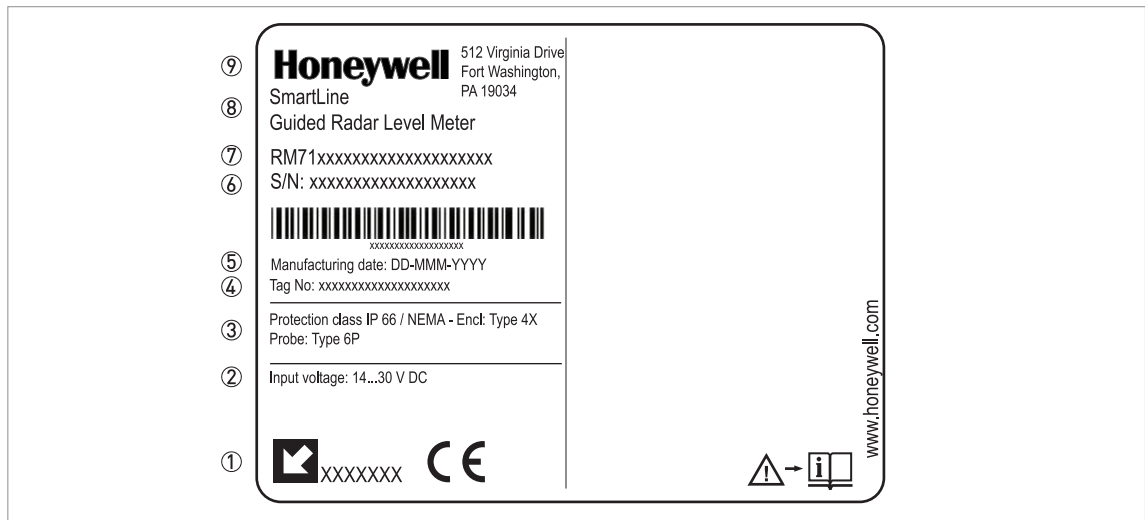


Figure 2-5: Non-Ex nameplate

- ① Indicator arrow to cable entry / cable entry size
- ② Nominal voltage for operation. For more data, refer to *Non-Ex* on page 60.
- ③ Degree of ingress protection (according to EN 60529 / IEC 60529)
- ④ Customer tag number
- ⑤ Date of manufacture
- ⑥ Order number
- ⑦ Type code (defined in order)
- ⑧ Model name and number
- ⑨ Company name and address

3.1 Notes on installation

**INFORMATION!**

Inspect the cartons carefully for damage or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

**INFORMATION!**

Check the packing list to check if you received completely all that you ordered.

**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.

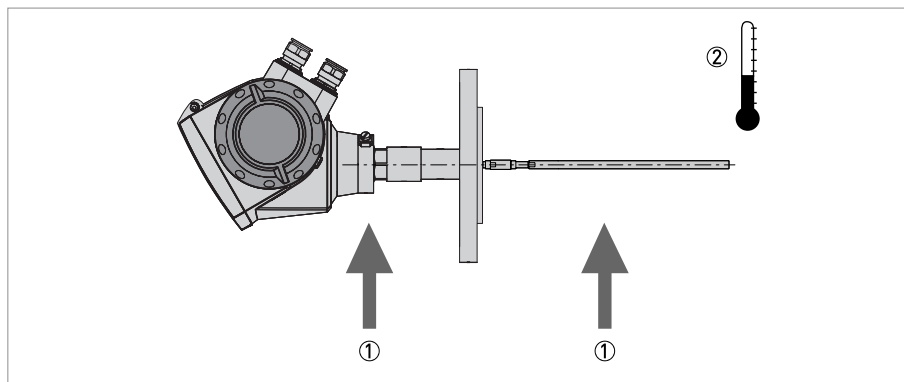


Figure 3-1: Storage conditions

- ① Do not bend rod and coaxial probes - support here
- ② Storage temperature range: -40...+85°C / -40...+185°F

- Store the device in a dry and dust-free location.
- Keep the housing out of the sunlight.
- Store the device in its original packing.

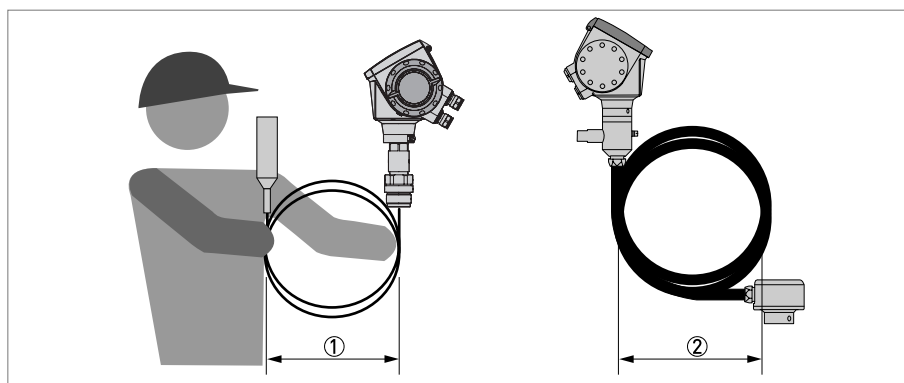


Figure 3-2: Wind cable probes and flexible conduits carefully

- ① Do not wind cable probes less than 400 mm / 16" in diameter.
- ② Do not wind the flexible conduit less than 330 mm / 13" in diameter.

3.3 Transport

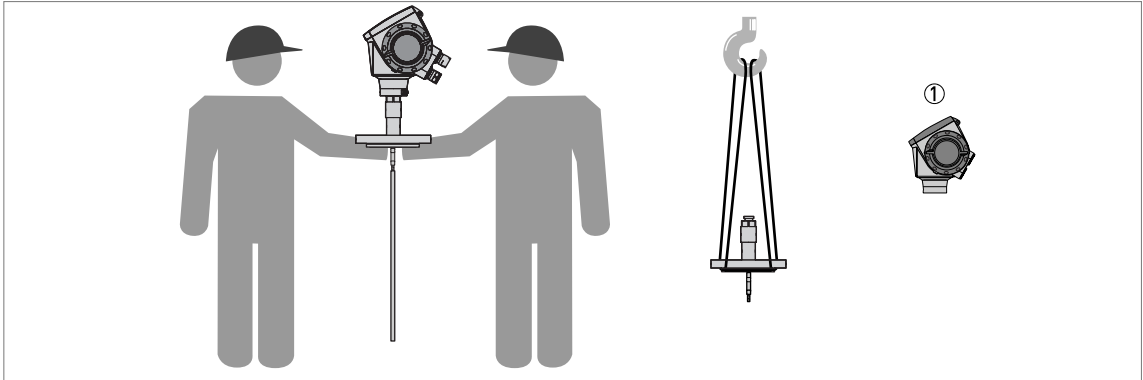


Figure 3-3: How to hold the device

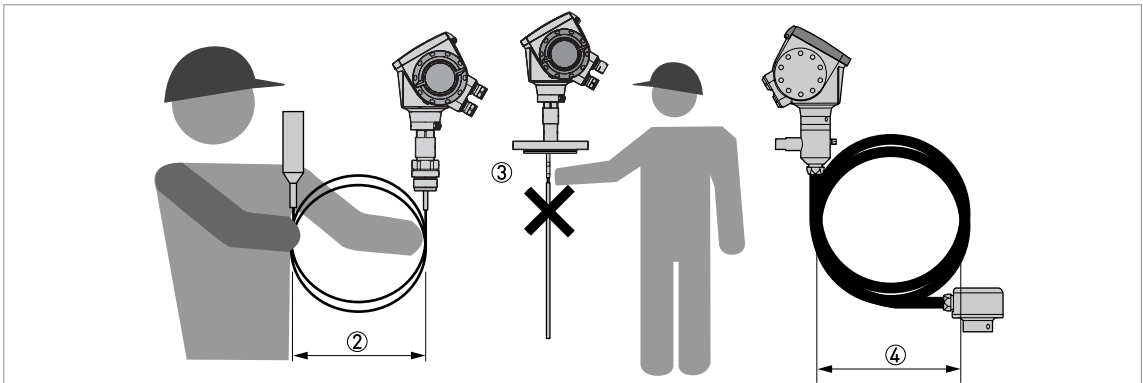


Figure 3-4: How to hold the device

- ① Remove the converter before you lift the device with a hoist.
- ② Wind cable probes greater than 400 mm / 16" in diameter.
- ③ Do not hold the probe when you lift the device.
- ④ Wind the flexible conduit greater than 330 mm / 13" 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.
- Protect the signal converter from direct sunlight. If necessary, install the weather protection accessory.
- Do not subject the signal converter to heavy vibrations. The devices are tested for vibration and agree with EN 50178 and IEC 60068-2-6.

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

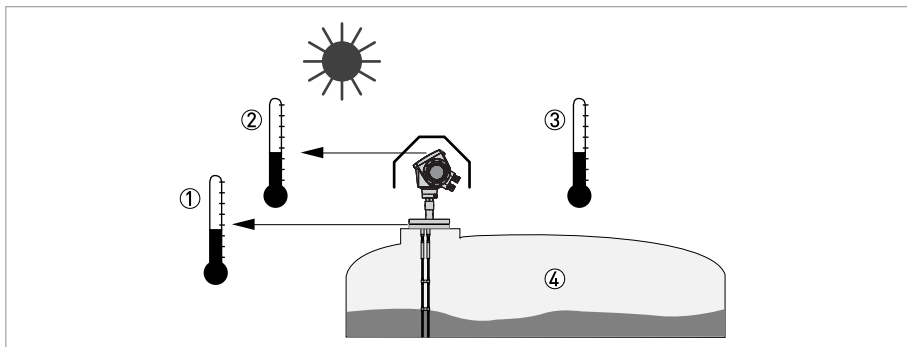


Figure 3-5: Pressure and temperature ranges

① Process connection temperature

The process connection temperature must stay in the temperature range of the gasket material unless the device is a High-Temperature version. Refer to the table "Temperature ranges for gaskets" that follows and to "Technical data" on page 136.

Ex devices: see supplementary operating 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...+175°F

Ex devices: see supplementary operating instructions

④ Process pressure

Refer to the table "Process pressure limits" that follows and "Pressure/temperature table for probe selection" on page 142.


WARNING!

The process connection temperature range must agree with the temperature limits of the gasket material. The operating pressure range is subject to the process connection used and the flange temperature.

Temperature ranges for gaskets

Gasket material	Process connection temperature					
	Standard version		High-Pressure version		High-Temperature and High-Temperature / High-Pressure versions	
	[°C]	[°F]	[°C]	[°F]	[°C]	[°F]
FKM/FPM	-40...+200	-40...+390	-40...+150	-40...+300	-40...+300	-40...+570
Kalrez® 6375	-20...+200	-4...+390	-20...+150	-4...+300	-20...+300	-4...+570
EPDM	-50...+150	-58...+300	-50...+150	-58...+300	-50...+250	-58...+480

**INFORMATION!**

Ø4 mm / 0.15" single cable probe with FEP coating option only: The process connection temperature range is -20...+150°C / -4...+300°F

**INFORMATION!**

Single rod probes with protective sheath option only: The process connection temperature range depends on the protective sheath material selected.

PP: -40...+90°C / -40...+194°F; PVDF: -50...+150°C / -58...+302°F; PVC: -15...+80°C / +5...+176°F

Process pressure limits

Device version	Maximum process pressure	
	[barg]	[psig]
Ø8 mm / 0.3" single cable	40 ①	580 ①
High-Pressure (HP) version	300 ①	4350 ①
All other probe types and device versions	100 ①	1450 ①

① Refer also to "Pressure / temperature table for probe selection" in the "Technical data" section

3.5.2 General information for nozzles

**CAUTION!**

Follow these recommendations to make sure that the device measures correctly.

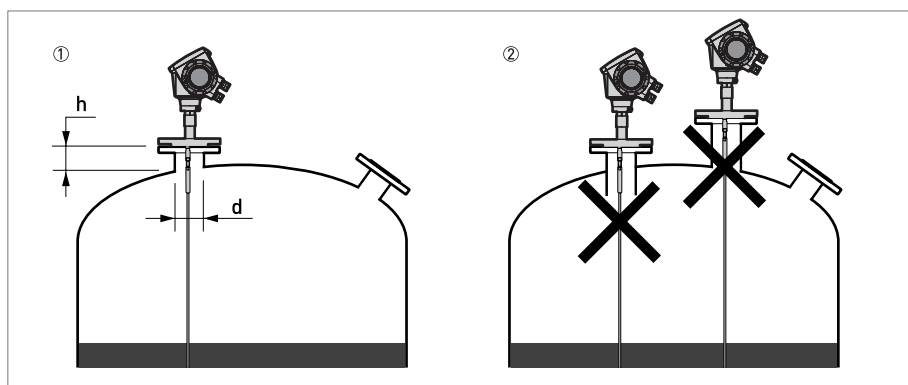


Figure 3-6: Recommended nozzle dimensions

- ① Recommended conditions: $h \leq d$, where h is the height of the tank nozzle and d is the diameter of the tank nozzle.
- ② The end of the nozzle must not have an extension into the tank. Do not install the device on a high nozzle.

**CAUTION!**

If the device is installed on a high nozzle, make sure that the probe does not touch the side of the nozzle (attach the probe end, ...).

**INFORMATION!**

It is possible to measure in these conditions with a minimum top dead zone. Use the snapshot function to filter the parasite signals from long nozzles. For more data, refer to How to use the snapshot function to filter parasitic signals on page 106.

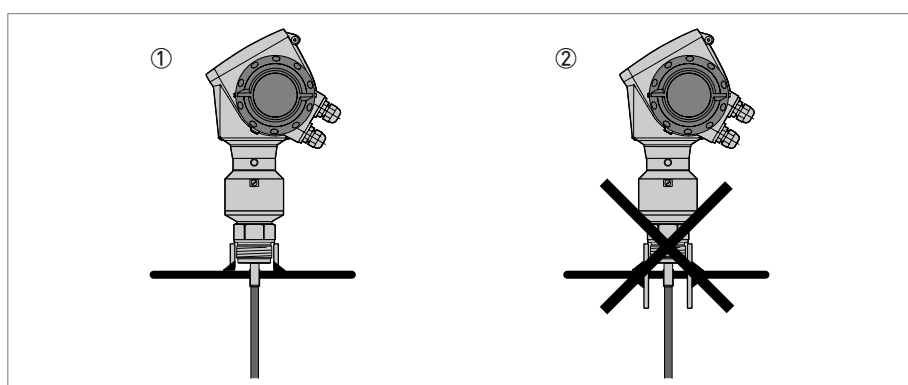


Figure 3-7: Sockets for threaded process connections

- ① Recommended installation
- ② The end of the socket must not have an extension into the tank

**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.

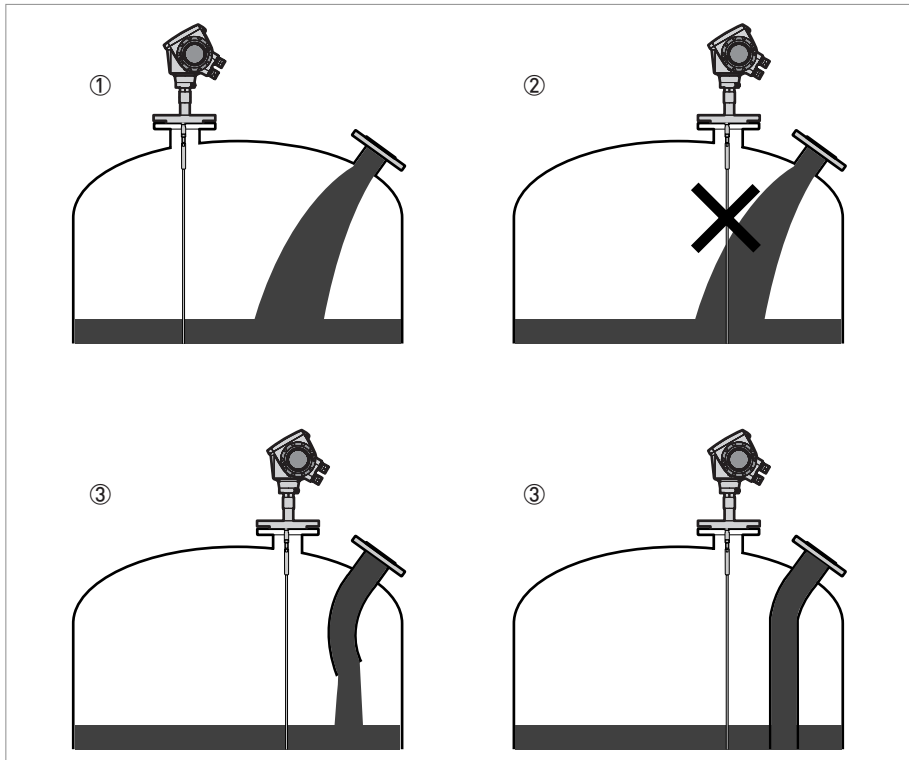


Figure 3-8: Do not put the device near to a product inlet

- ① The device is in the correct position.
- ② The device is too near to the product inlet.
- ③ If it is not possible to put the device in the recommended position, install a deflector pipe.

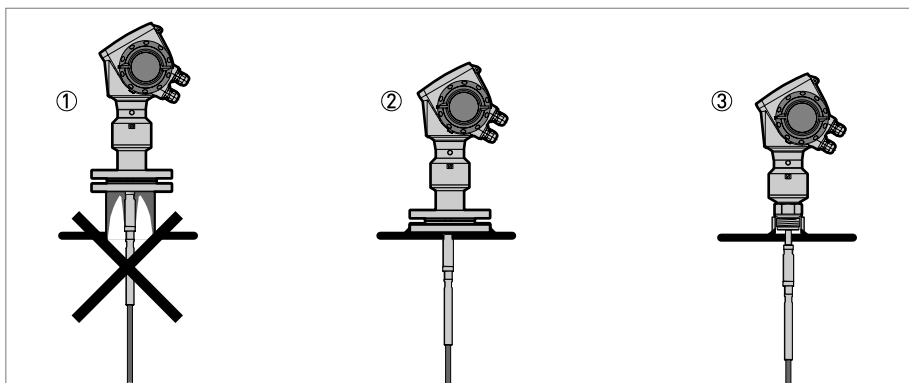


Figure 3-9: How to prevent build up of product around the process connection

- ① If product particles are likely to collect in holes, a nozzle is not recommended.
- ② Attach the flange directly to the tank.
- ③ Use a thread connection to attach the device to the tank.

3.5.3 Installation requirements for concrete roofs

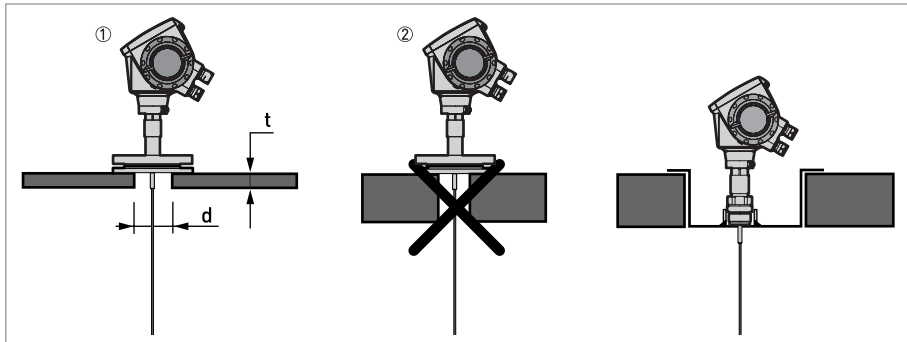


Figure 3-10: Installation on a concrete roof

- ① The diameter, d , of the hole must be greater than the thickness, t , of the concrete.
- ② If the thickness, t , of the concrete is greater than the diameter, d , of the hole, install the device in a recess.

3.6 Installation recommendations for liquids

3.6.1 General requirements

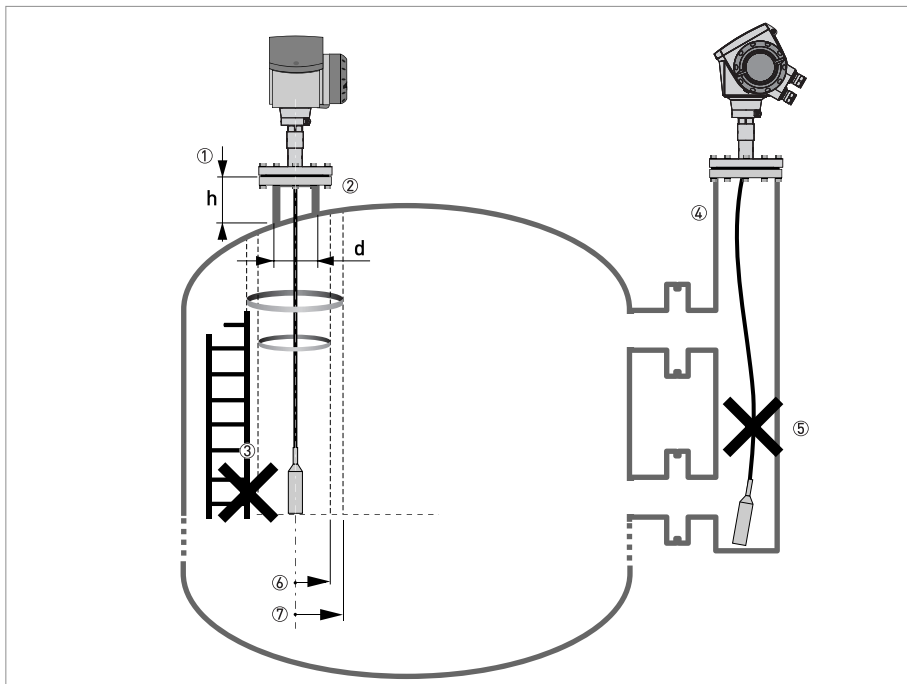


Figure 3-11: Installation recommendations for liquids

- ① $h \leq d$, where h is the height of the tank nozzle and d is its diameter.
- ② Make sure that the probe does not touch the nozzle. Attach the probe if the liquid is turbulent.
- ③ 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.
- ④ If there are too many objects in the tank, install a bypass chamber or stilling well.
- ⑤ Keep the probe straight. If the probe is too long, shorten the probe length. Make sure that the device is configured with the new probe length. For more data on the procedure, refer to *How to decrease the length of probes* on page 108.
- ⑥ Empty space necessary for double probes. Refer to the table that follows.
- ⑦ Empty space necessary for single probes. Refer to the table that follows.

**INFORMATION!**

If your device has a coaxial probe, you can ignore these installation recommendations.

**CAUTION!**

Install coaxial probes in clean liquids that are not too viscous.

**INFORMATION!**

If the device has to measure the level of dangerous products (ammonia etc.), we recommend that you use a device with the Metaglas® option.

Clearance between the probe and other objects in the tank

Probe type	Empty space (radius, R_{min}), around the probe	
	[mm]	[inches]
Coaxial	0	0
Double rod ⑥ Double cable Ø4 mm / 0.15" ⑥	100	4
Single rod ⑦ Single cable Ø4 mm / 0.15" ⑦ Single cable Ø2 mm / 0.08" ⑦	300	12

3.6.2 How to attach probes to the bottom of the tank

If the liquid is agitated or turbulent, you can attach the probe to the bottom of the tank. The procedure to attach the probe depends on the type of probe used.

**CAUTION!**

Keep the probe straight.

Double rod Ø8 mm / 0.3"

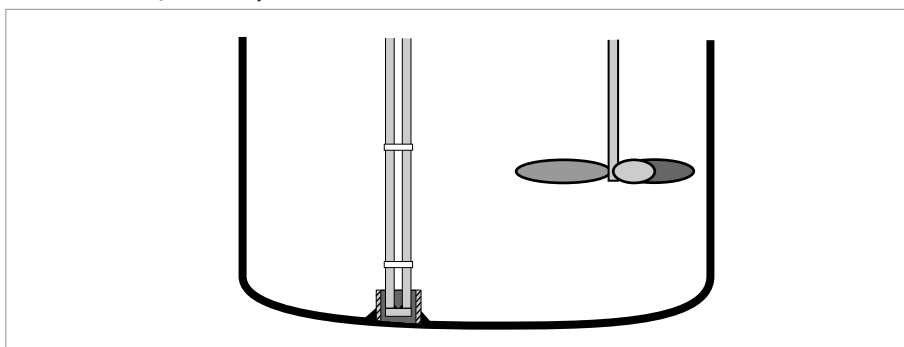


Figure 3-12: How to attach a double rod probe to keep it straight



- Weld a tube with an internal diameter of 28...30 mm / 1.1...1.2" to the bottom of the tank.
- ➡ Make sure the tube aligns with the process connection at the top of the tank.
- Lower the probe into the tank.
- Put the end of the probe into the tube.

Double cable Ø4 mm / 0.15"

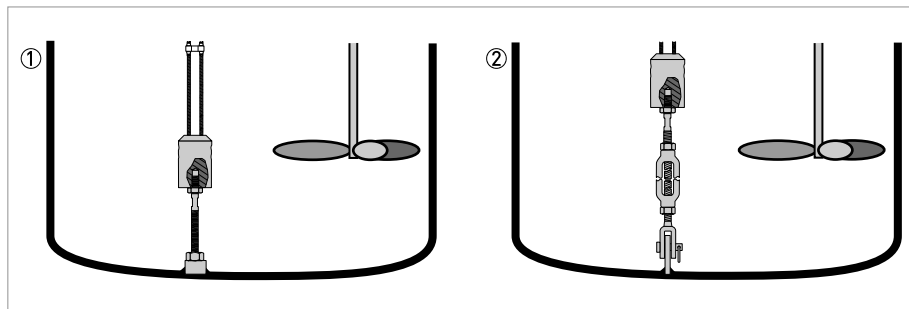


Figure 3-13: How to attach a double cable probe to keep it straight



The probe counterweight has a hole with an M8 internal thread. You can also select the appropriate options and attach:

- ① An anchoring rod
- ② A turnbuckle

For more data, contact your supplier.

Single rod Ø8 mm / 0.3"

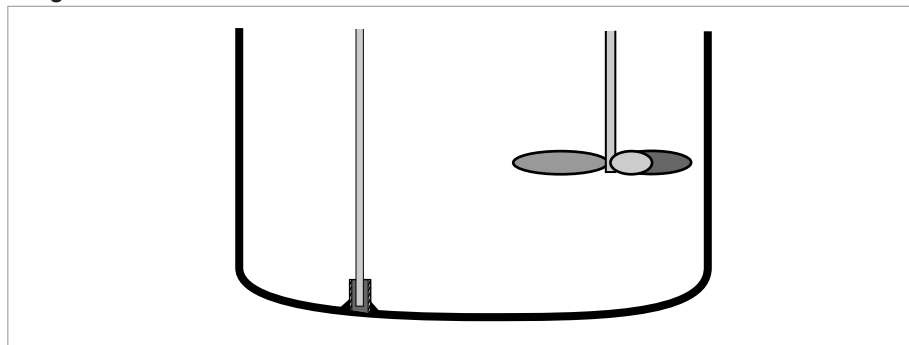


Figure 3-14: How to attach a single rod probe to keep it straight



- Weld a tube with an internal diameter of 12 mm / 0.5" to the bottom of the tank.
- ➡ Make sure the tube aligns with the process connection at the top of the tank.
- Lower the probe into the tank.
- Put the end of the probe into the tube.

Single cable Ø4 mm / 0.15"

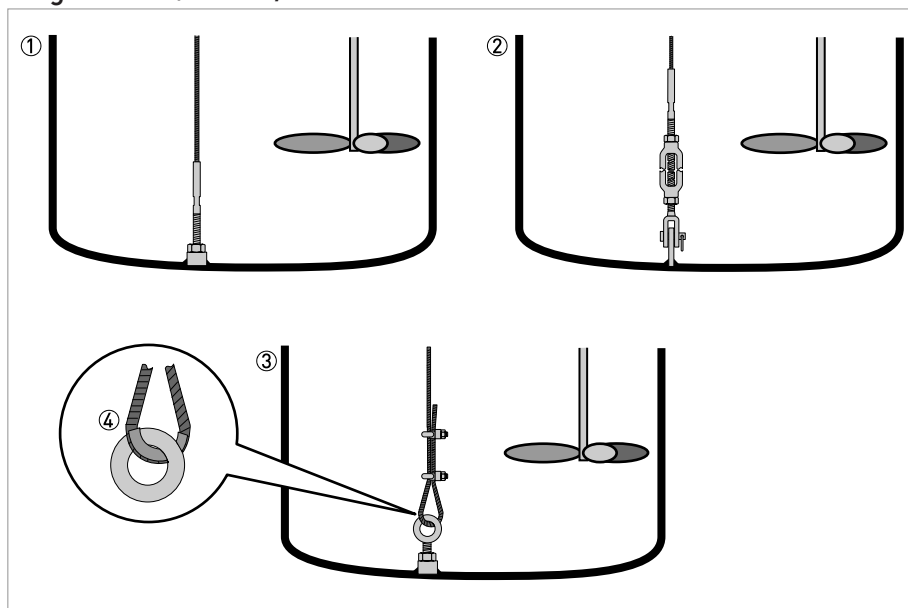


Figure 3-15: How to attach a Ø4 mm / 0.15" single cable probe to keep it straight



The probe counterweight has a hole with an M8 internal thread. You can also select the appropriate options and attach:

- ① A threaded end
- ② A turnbuckle
- ③ A chuck

If you chose a chuck to anchor the probe, we recommend that you fit a ferrule (metal sheath - not supplied) at the bottom of the loop to prevent cable wear.

**CAUTION!**

If your device has a chuck, you must make the device recalculate the probe length. For the procedure, refer to How to decrease the length of probes on page 108. If the device does not recalculate the probe length, it is possible that the device will not measure correctly.

Single cable Ø2 mm / 0.08"

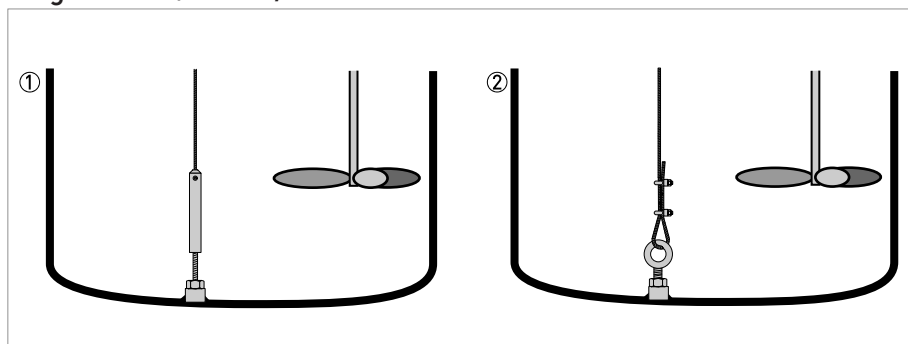


Figure 3-16: How to attach a Ø2 mm / 0.08" single cable probe to keep it straight



The probe counterweight has a hole with an M8 internal thread. You can attach:

- ① A threaded end
- ② A chuck

If you chose a chuck to anchor the probe, we recommend that you fit a ferrule (metal sheath) at the bottom of the loop to prevent cable wear. For more data, contact your supplier.

Coaxial Ø22 mm / 0.8"

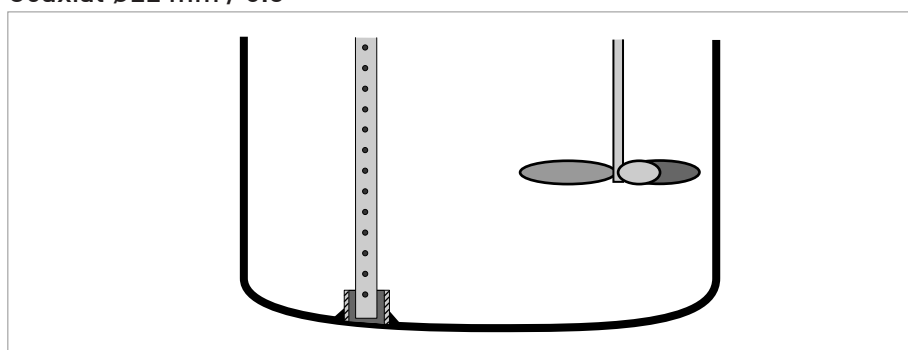


Figure 3-17: How to attach a coaxial probe to keep it straight



- Weld a tube with an internal diameter of 23...25 mm / 0.91...1" to the bottom of the tank.
- ➡ Make sure the tube aligns with the process connection at the top of the tank.
- Lower the probe into the tank.
- Put the end of the probe into the tube.

If this is not possible, you can attach braces to the probe.

3.6.3 Standpipes

Use a standpipe if:

- There is highly conductive foam in the tank.
- The liquid is very turbulent or agitated.
- There are too many other objects in the tank.
- The device is measuring a liquid (petro-chemicals) in a tank with a floating roof.

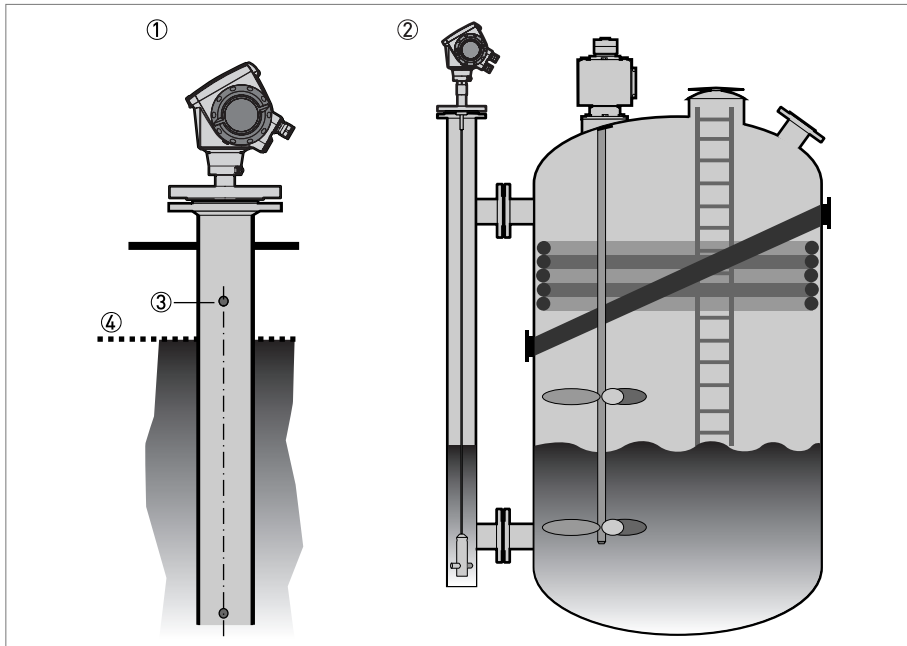


Figure 3-18: Basic installation recommendations for standpipes (stilling wells and bypass chambers)

- ① Stilling well
- ② Bypass chamber
- ③ Air circulation hole
- ④ Level of the liquid



CAUTION!

Installation requirements

- The standpipe must be electrically conductive.
- The inside diameter of the standpipe must not be more than 5 mm / 0.2" over the diameter of the antenna (for a high-dielectric constant liquid).
- The standpipe must be straight. There must be no sudden changes in internal diameter greater than 1 mm / 0.04".
- The standpipe must be vertical.
- Recommended surface roughness: $\leq \pm 0.1 \text{ mm} / 0.004''$.
- Stilling well only: The bottom of the stilling well must be open.
- Adjust the probe to the center of the standpipe.
- Make sure that there are no deposits at the bottom of the standpipe.
- Make sure that there is liquid in the standpipe.



INFORMATION!

Standpipes are not necessary for devices with coaxial probes. But if there is a sudden change in diameter in the standpipe, we recommend that you install a device with a coaxial probe.

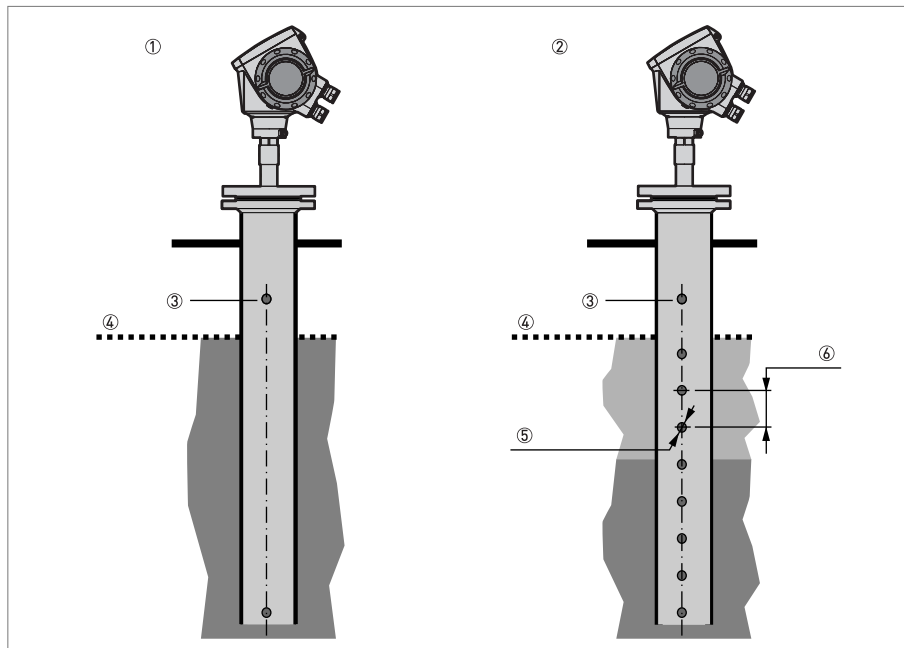


Figure 3-19: Installation recommendations for stilling wells

- ① Stilling well in tanks containing one liquid
- ② Stilling well in tanks containing more than one liquid
- ③ Air circulation hole
- ④ Maximum level of the liquid
- ⑤ Liquid circulation hole
- ⑥ Distance between holes $\geq 25 \text{ mm}/1''$ (depends on the minimum layer to be measured)



Installation in tanks containing one liquid and foam

- Drill a pressure equalization hole in the stilling well above the maximum level.
- Deburr the hole.
- If the probe has a counterweight, make sure that there is enough space between the counterweight and the wall of the stilling well.



Installation in tanks containing more than one liquid

- Drill a pressure equalization hole in the stilling well above the maximum level of the top liquid.
- Drill more holes along the length of the stilling well. Distance between holes $\geq 25 \text{ mm} / 1''$ (depends on the minimum layer to be measured)
- ➡ These holes help the liquids to move freely.
- Deburr the holes.
- If the probe has a counterweight, make sure that there is enough space between the counterweight and the wall of the stilling well.

Floating roofs

If the device is for a tank with a floating roof, install it in a stilling well.

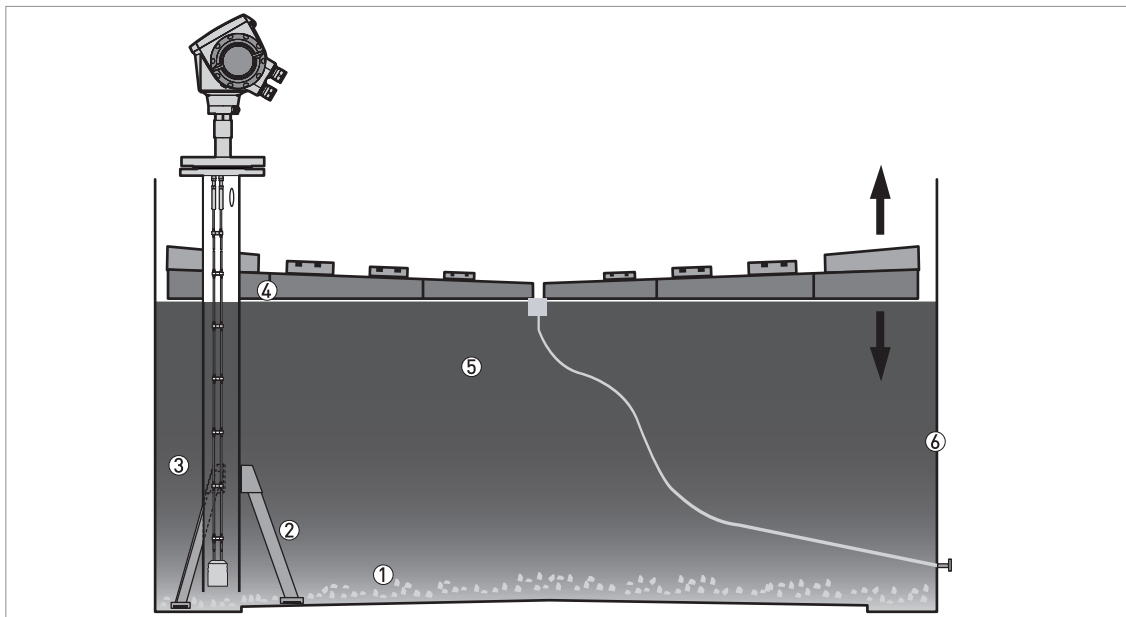


Figure 3-20: Floating roofs

- ① Sediment
- ② Support fixtures
- ③ Stilling well
- ④ Floating roof
- ⑤ Product
- ⑥ Tank

Bypass chamber - general notes

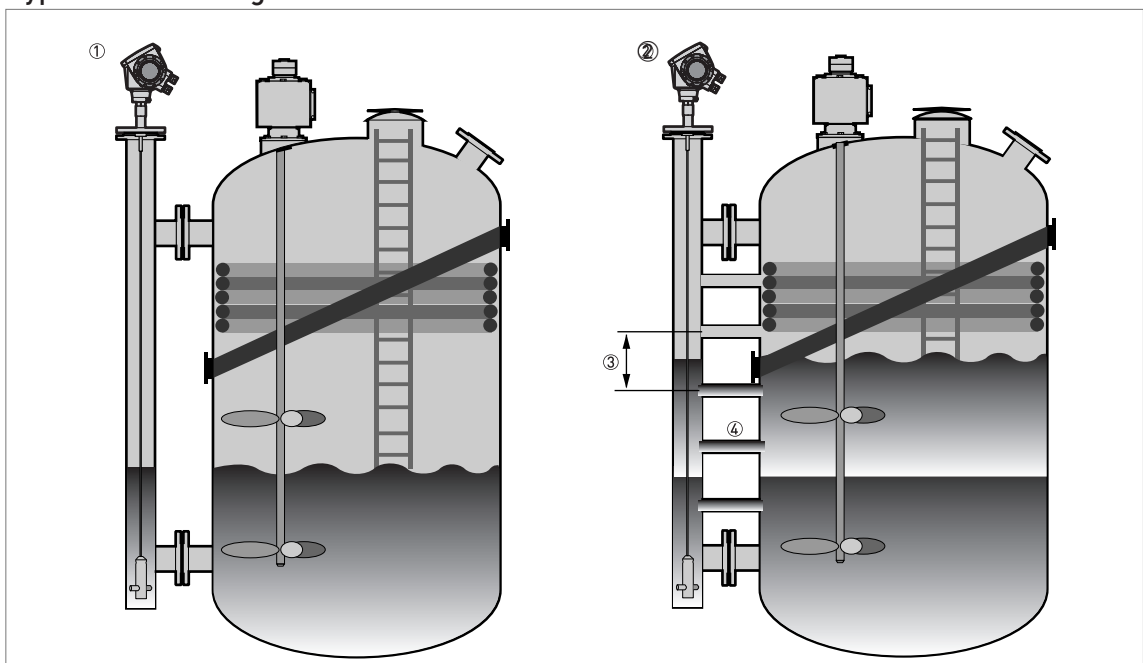


Figure 3-21: Installation recommendations for bypass chambers

- ① Bypass chamber for tanks that contain one liquid
- ② Bypass chamber for tanks that contain more than one liquid
- ③ Distance between holes \leq minimum level of each liquid in the tank
- ④ Additional process connection

Installation on tanks containing one liquid and foam

- The bypass chamber must have a process connection that is above the maximum level of liquid.
- The bypass chamber must have a process connection that is below the lowest measured level of liquid.

Installation on tanks containing more than one liquid

- The bypass chamber must have a process connection that is above the maximum level of liquid.
- The bypass chamber must have a process connection that is below the lowest measured level of liquid.
- There must be more process connections along the length of the bypass chamber. These must have a minimum diameter of 25 mm / 1" with a minimum distance of 100 mm / 4" between the holes.
- If the probe has a counterweight, make sure that there is enough space between the counterweight and the wall of the stilling well.
- If the interface liquid does not have a layer of air above it, fit a vent at the top of the bypass chamber. Refer to the illustration that follows:

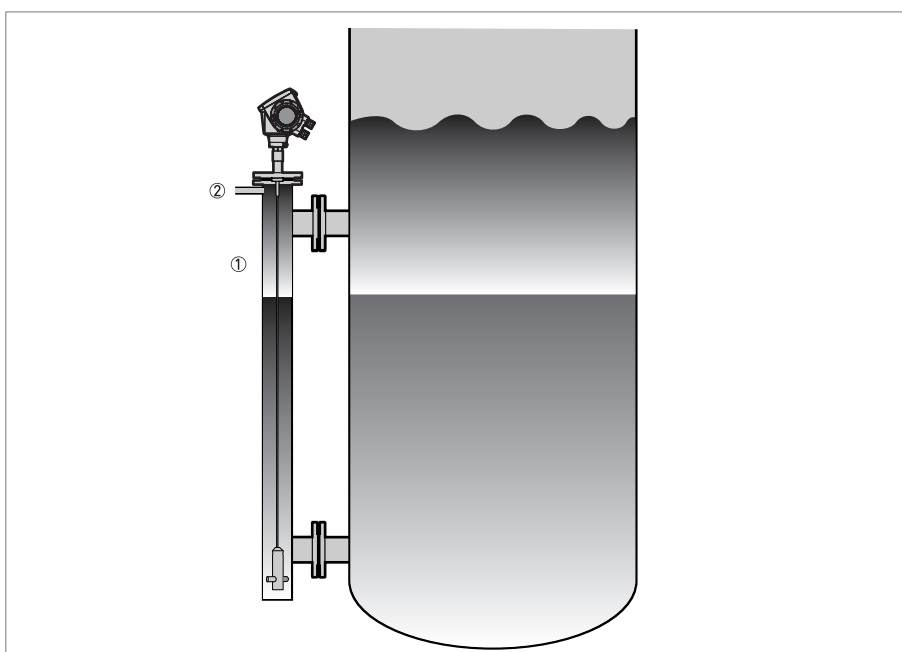


Figure 3-22: Installation recommendations for bypass chambers with no air gap

- ① Bypass chamber with no air gap
- ② Air vent

3.6.4 Typical applications

Spherical tanks

The device can measure liquid petroleum gas (LPG). This product is stocked in spherical tanks.

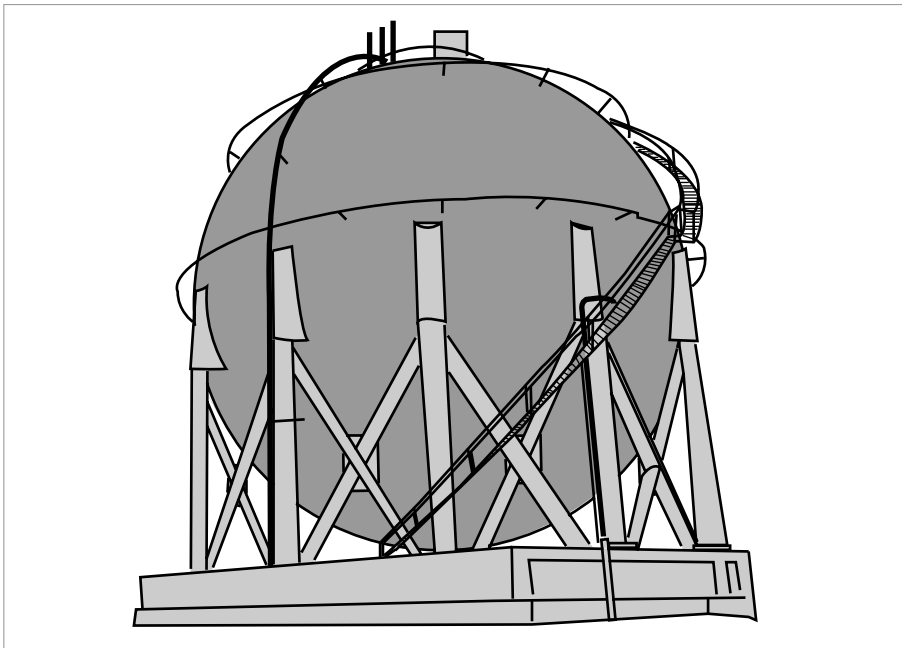


Figure 3-23: A spherical tank

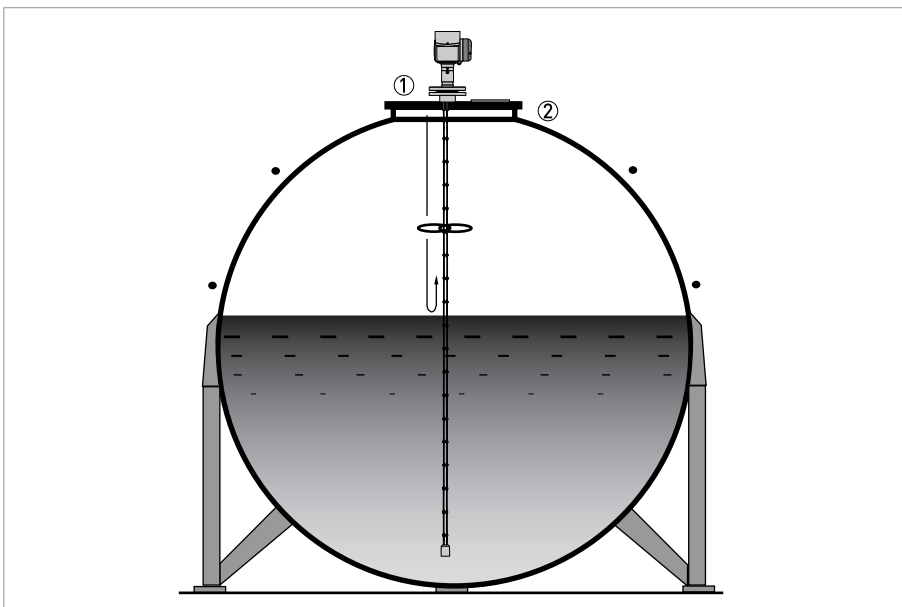


Figure 3-24: How to install the device on a spherical tank

- ① Install the device on top of the tank
- ② If the top platform has the shape of a nozzle, do not install the process connection too near to the wall. For more data, refer to *General requirements* on page 26.

Horizontal cylindrical tanks

Obey the instructions for installation in vertical tanks.

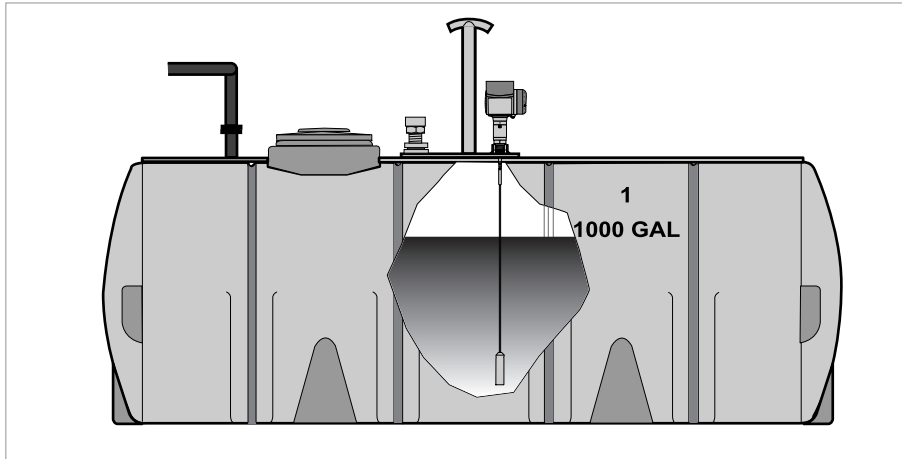


Figure 3-25: How to install the device in a horizontal cylindrical tank

3.7 Installation recommendations for solids

3.7.1 Nozzles on conical silos

We recommend that you prepare the installation when the silo is empty.



DANGER!

Risk of electrostatic discharge (ESD): The device is resistant to electrostatic discharges of up to 15 kV (30 kV with the ESD protection option - recommended for solid applications), but it is the responsibility of the fitter and the user to prevent ESD.



CAUTION!

Install the nozzle in the correct position to measure correctly and prevent too much bending and traction.

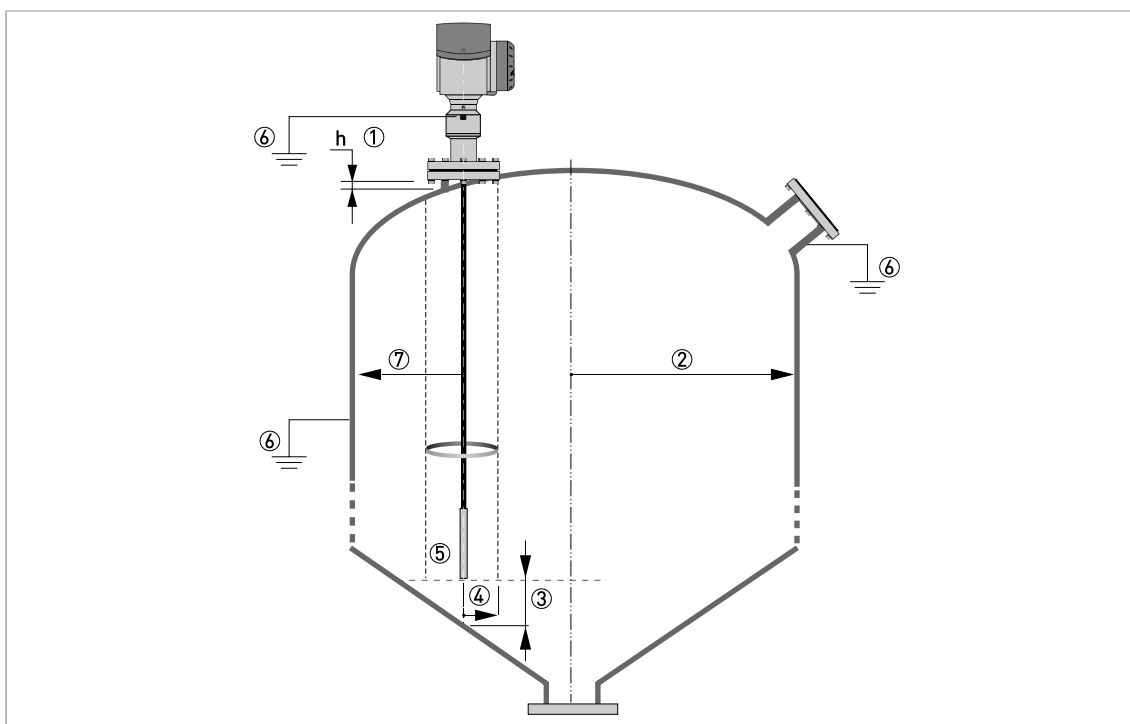


Figure 3-26: Installation recommendations for solids

- ① We recommend installation without a nozzle. If not, $h \leq 50 \text{ mm} / 2''$.
- ② Radius of the tank, r
- ③ The end of the probe must be more than 300 mm / 12" above the tank bottom.
- ④ Empty space (radius, R_{\min}) around the probe.
- ⑤ The electromagnetic (EM) field generated by the device. It is also the measurement zone of the probe. Make sure that the EM field is clear of objects and product flow.
- ⑥ Ground the tank, the product and the probe (if attached).
- ⑦ If possible, put the process fitting $\geq 300 \text{ mm} / 12''$ from the tank wall

Clearance between the probe and other objects in the tank

Probe type	Empty space (radius, R_{min}) around the probe	
	[mm]	[inches]
Single cable Ø4 mm / 0.15" ④	300	12
Single cable Ø8 mm / 0.3" ④	300	12



INFORMATION!

If the probe is longer than 10 m / 33 ft, we recommend that you do not attach the end of the probe.

3.7.2 Traction loads on the probe

Traction load depends on:

- The height and shape of the tank.
- The particle size and density.
- The rate at which the tank is emptied.



CAUTION!

Risk of damage to the cable probe. High loads can break the cable.

If the load on the Ø8 mm / 0.3" single cable probe is more than 3500 kg / 7700 lb, contact your supplier.



CAUTION!

Make sure that the tank roof is resistant to deformation at high loads.

Estimated traction load on the probe in kg

Material	Probe length, 10 m	Probe length, 20 m	Probe length, 30 m
	[kg]		
Cement	1000	2000	3000
Fly ash	500	1000	1500
Wheat	300	500	1200

Estimated traction load on the probe in lb

Material	Probe length, 33 ft	Probe length, 65 ft	Probe length, 98 ft
	[lb]		
Cement	2200	4410	6520
Fly ash	1100	2200	3300
Wheat	660	1100	2650

3.8 How to install the device on the tank

3.8.1 How to assemble the single rod probe (single-piece probe)

**INFORMATION!**

This procedure is for devices with single rod probes that are not segmented (single-piece probes).

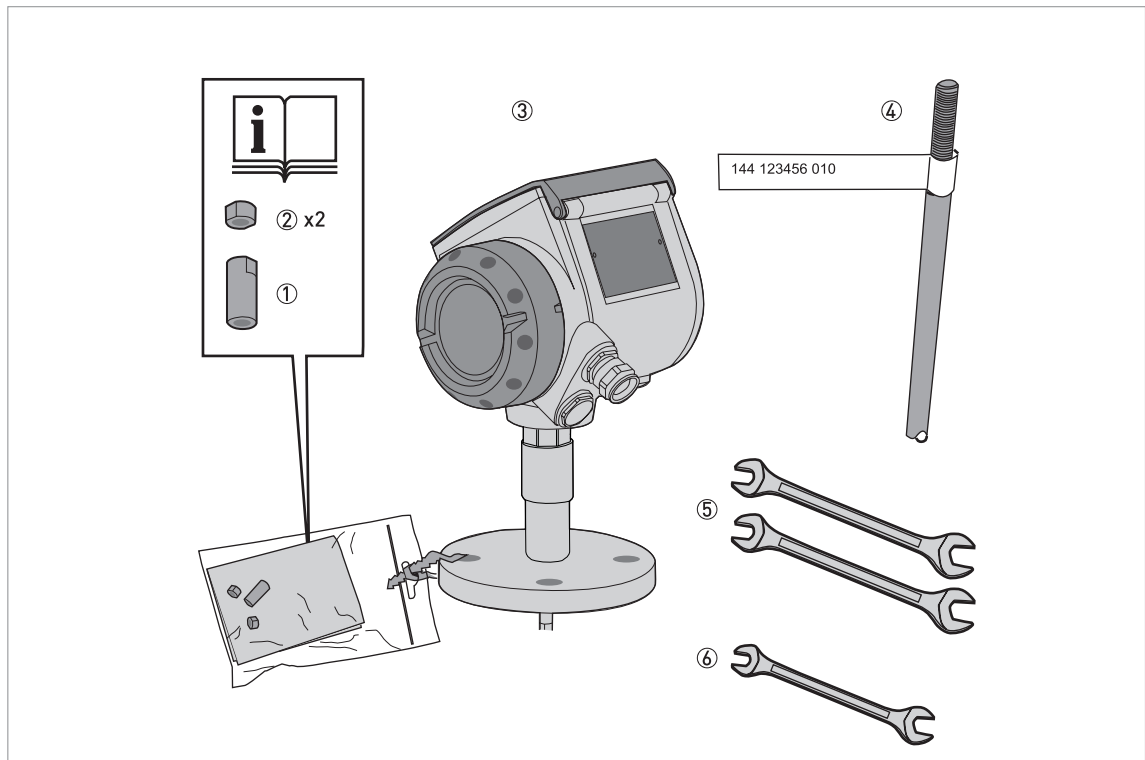


Figure 3-27: Equipment needed to assemble the device

- ① Union nut
- ② 2 locking nuts
- ③ Housing assembly
- ④ Single rod probe
- ⑤ Tools: two 8 mm open-ended wrenches (not supplied)
- ⑥ Tools: one 7 mm open-ended wrench (not supplied)

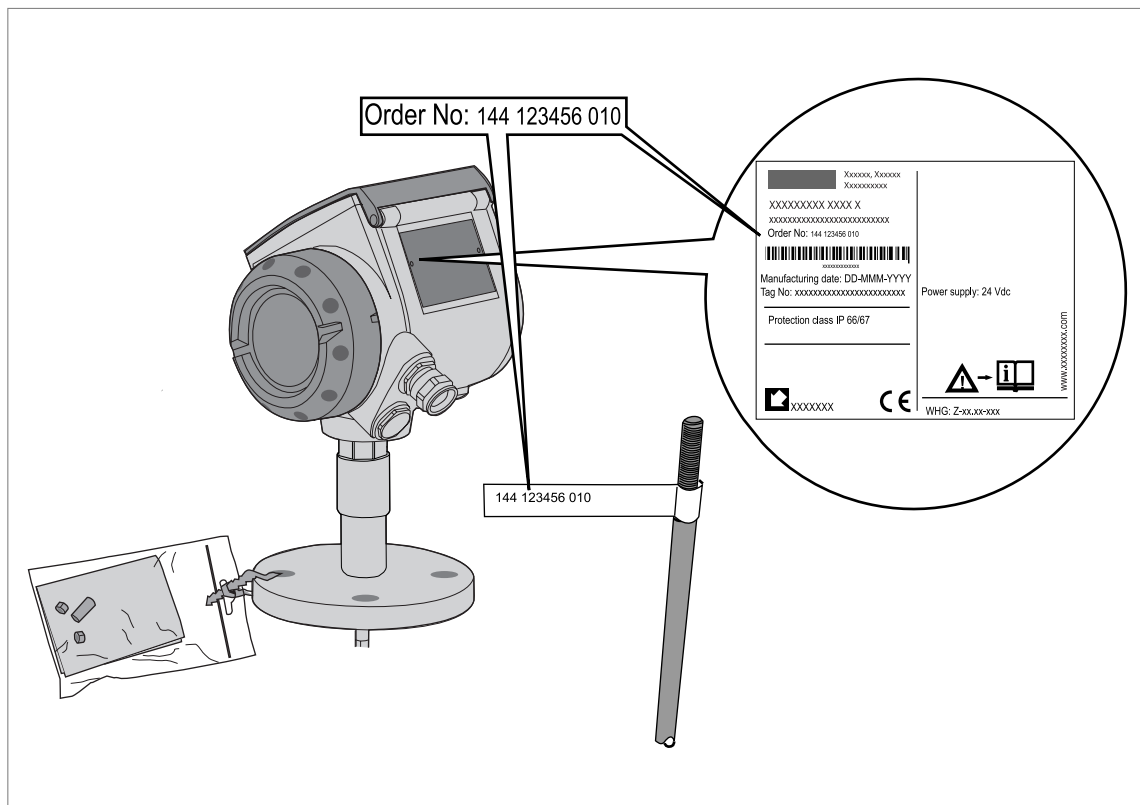


Figure 3-28: Check the order number on each component



- Make sure that the housing assembly and the single rod have the same ID numbers.
- Remove the sticker from the probe.

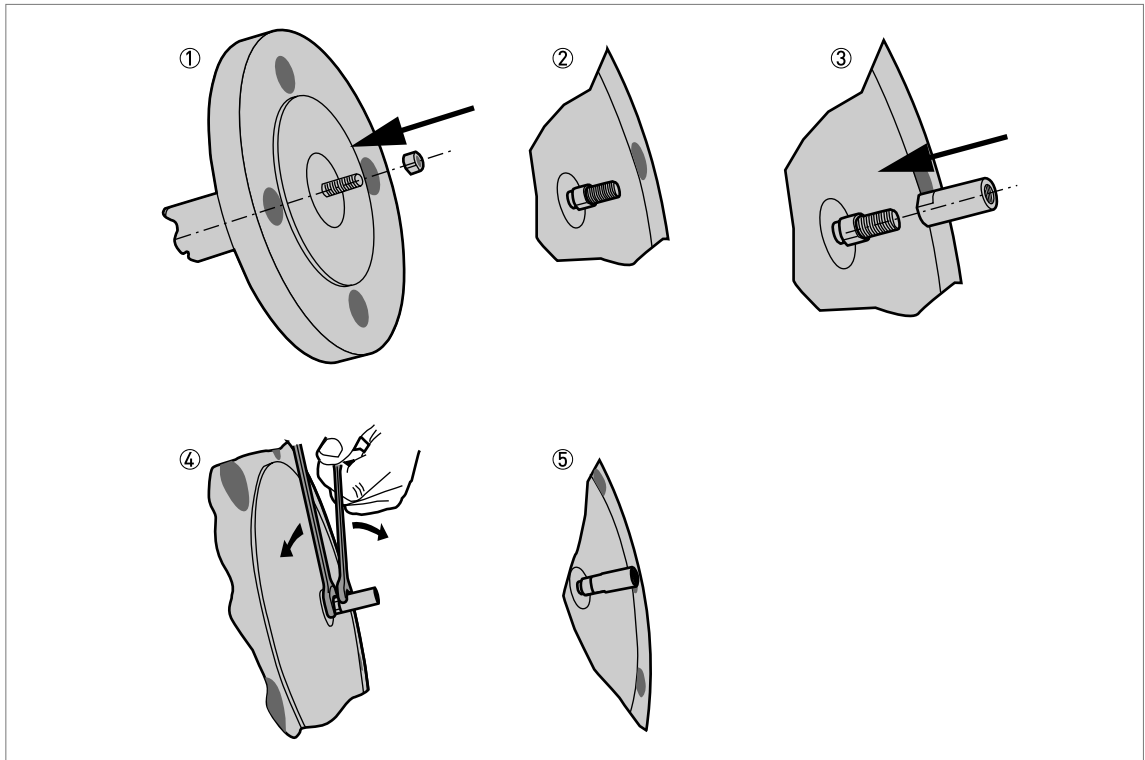


Figure 3-29: How to attach the locking nut and union nut



- Attach a locking nut and the union nut to the housing assembly.
- Tighten these nuts with the two 8 mm open-ended wrenches.

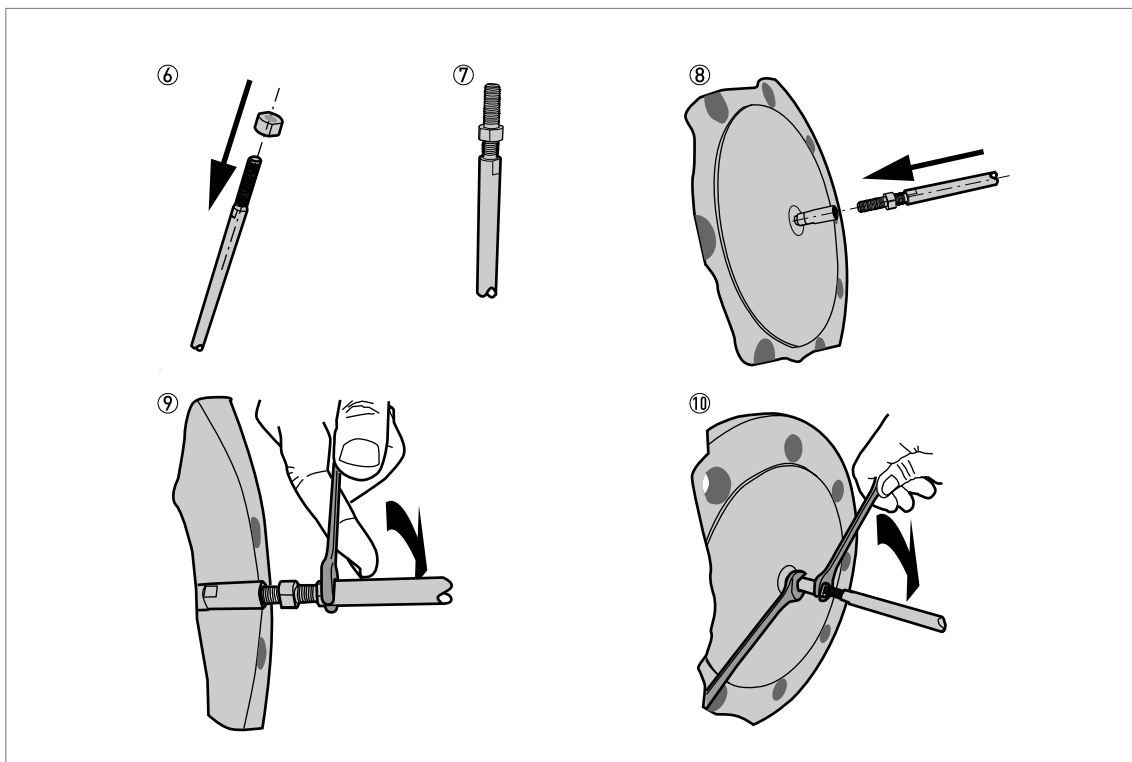


Figure 3-30: How to attach the single rod probe to the flange assembly



CAUTION!

Support the probe.



- Attach a locking nut to the single rod.
- Attach the single rod to the union nut. Make sure the probe touches the housing assembly.
- Tighten the single probe with a 7 mm open-ended wrench (step 9).
- Tighten the locking nut against the union nut with two 8 mm open-ended wrenches (step 10).

3.8.2 How to assemble the single rod probe (segmented probe)

**INFORMATION!**

This procedure is for devices with single rod probes that are segmented.

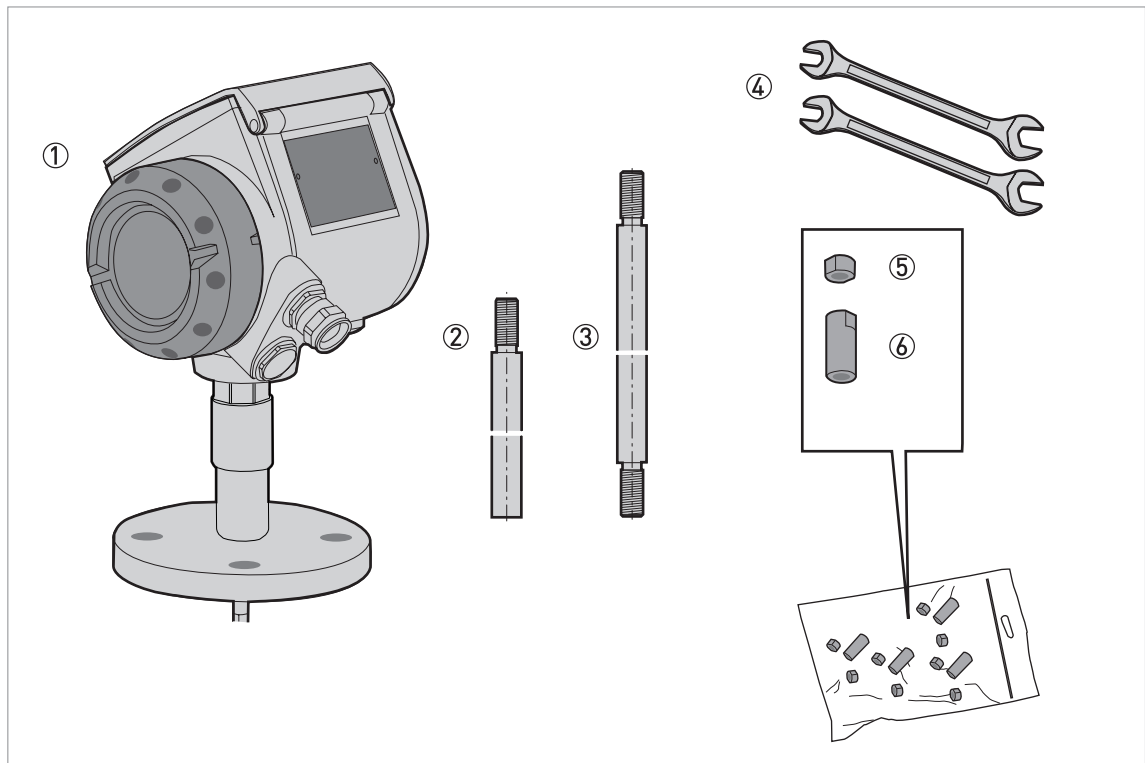


Figure 3-31: Equipment needed to assemble the single rod probe (segmented)

- ① Converter and process connection
- ② Bottom (quantity: 1) segment of the rod probe
- ③ Top and middle (if more than one) segments of the rod probe
- ④ Tools: two 8 mm open-end wrenches (not supplied)
- ⑤ Lock nuts (2 lock nuts per segment)
- ⑥ Union nut (1 union nut per segment)

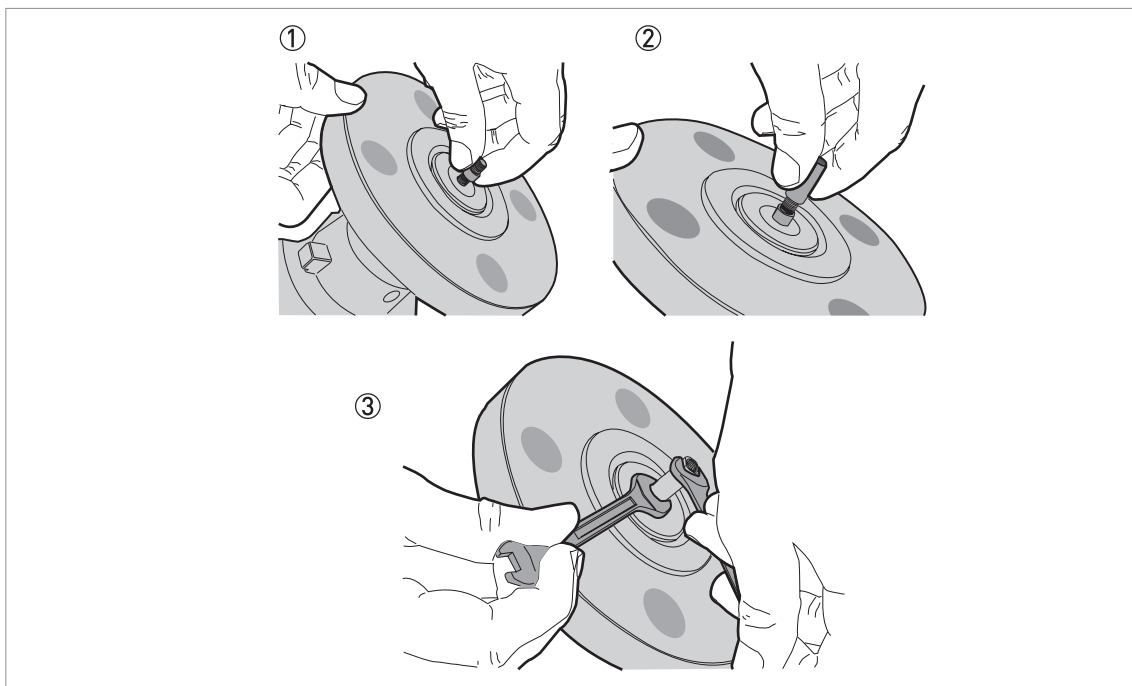


Figure 3-32: How to assemble the segmented single rod probe: part 1



CAUTION!

Make sure that the nuts are tight and the rod probe cannot loosen.



- Attach a lock nut to the threaded rod below the process connection. Turn the nut until it is $\frac{3}{4}$ along the length of the rod.
- Attach a union nut to the threaded rod below the process connection.
- Use two 8 mm open-end wrenches to tighten the union nut against the lock nut.

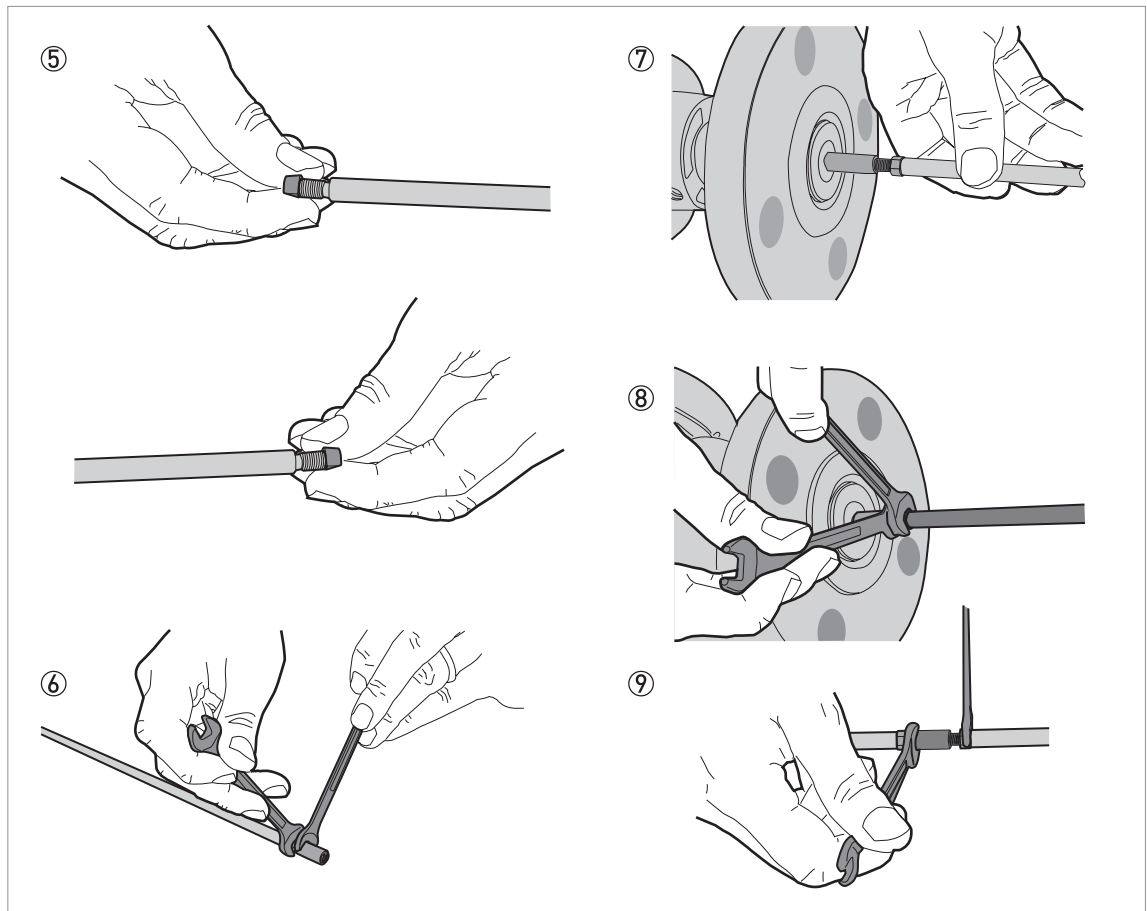


Figure 3-33: How to assemble the segmented single rod probe: part 2



WARNING!

Put a support below the probe to prevent deformation.



CAUTION!

Make sure that the nuts are tight and the rod probe cannot loosen.



- Attach a lock nut to each end of the rod probe segments.
- Attach a union nut to the bottom end of each rod probe segment, but not to the bottom segment. Use two 8 mm open-end wrenches to tighten the union nut against the lock nut.
- Attach the top segment of the rod probe to the union nut below the process connection. Use two 8 mm open-end wrenches to tighten the union nut against the lock nut on the rod probe.
- Attach the middle segment of the rod probe to the union nut on the top segment (if there are middle segments). Use two 8 mm open-end wrenches to tighten the union nut against the lock nut. Repeat this step for the other segments.
- Attach the bottom segment of the rod probe to the union nut on the top segment. Use two 8 mm open-end wrenches to tighten the union nut against the lock nut.

3.8.3 How to assemble the segmented coaxial probe

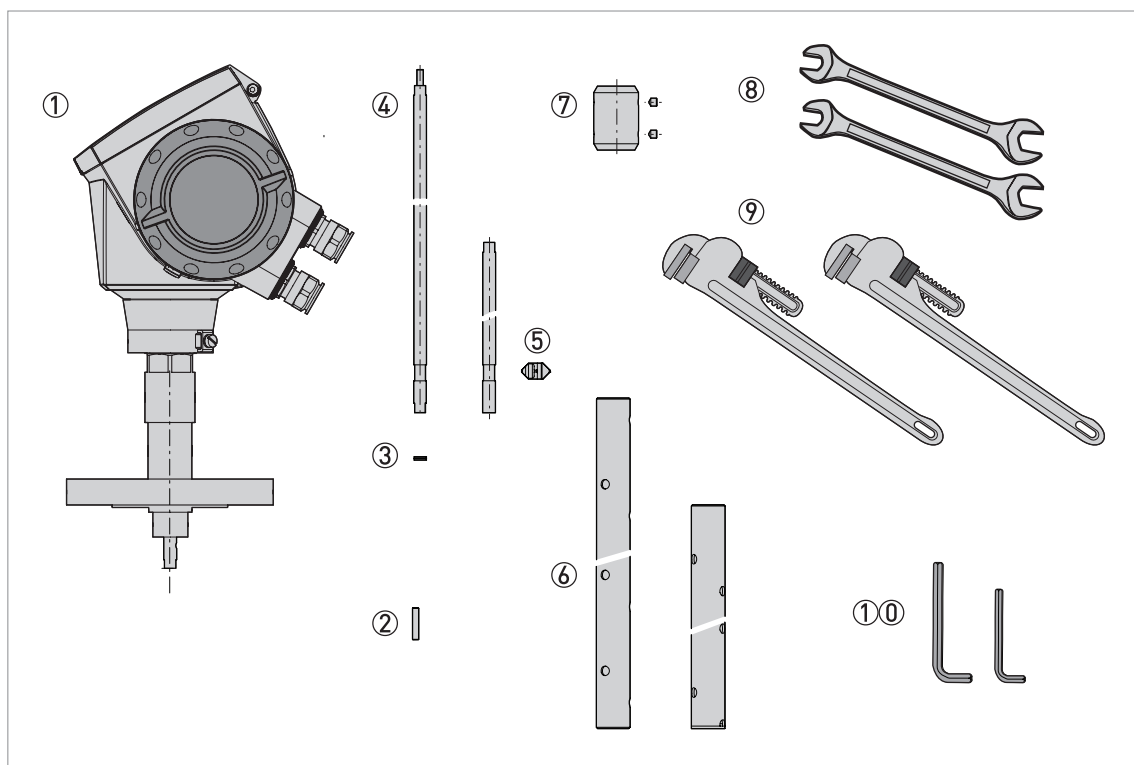


Figure 3-34: Equipment needed to assemble the coaxial probe

- ① Converter and process connection
- ② Top (quantity: 1), middle (quantity: 1 or more) and bottom (quantity: 1) segments of the signal rod
- ③ Lockwashers (1 pair of washers per probe segment)
- ④ HC M4×20 screws (1 screw per probe segment)
- ⑤ PTFE spacer (1 spacer per probe segment)
- ⑥ Union nut with 2 socket set screws M5×5 (1 union nut per segment of the coaxial tube)
- ⑦ Middle (quantity: 1 or more) and bottom (quantity: 1) segments of the coaxial tube
- ⑧ Tools: two 7 mm open-end wrenches (not supplied)
- ⑨ Tools: two pipe (Stillson) wrenches (not supplied)
- ⑩ Tools: one 2.5 mm Allen wrench and one 2 mm Allen wrench (not supplied)

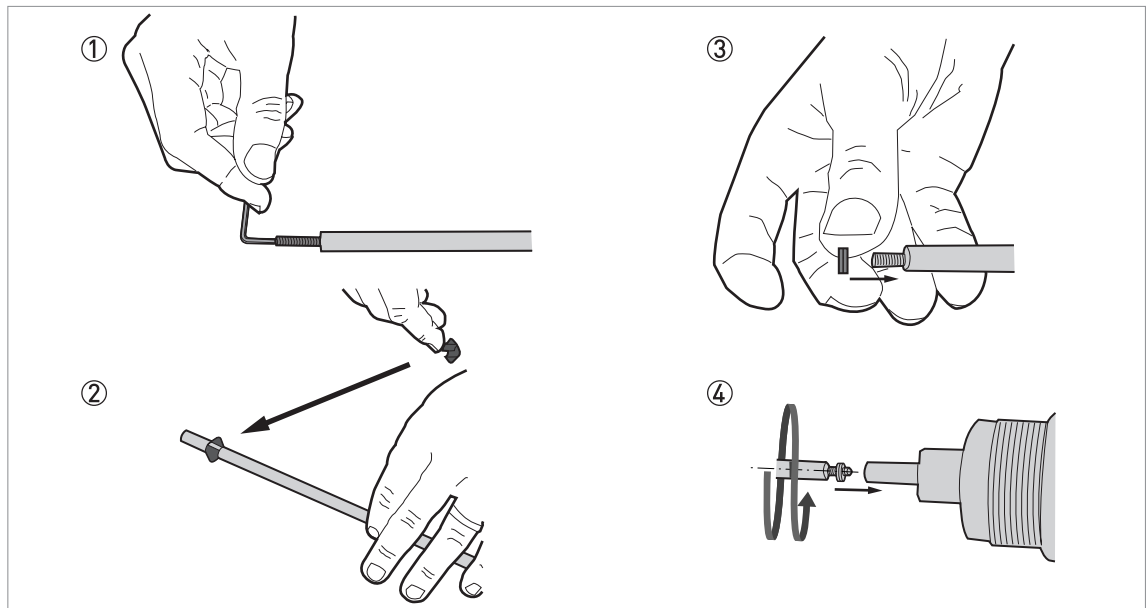


Figure 3-35: How to assemble the segmented coaxial probe: part 1



CAUTION!

Do not attach the screw to the end of the rod segment that has a groove for the attachment of a PTFE spacer.



- Use a 2 mm Allen wrench to attach and tighten a HC M4×20 screw at the top of each rod segment (intermediary and end rod segments)
- Attach a PTFE spacer to the end of each rod segment that has a groove.
- Attach a pair of lock washers at the top of each rod segment (intermediary and end rod segments)
- Assemble one of the middle rod segments (with a pair of lock washers on the attached screw) and the signal rod below. Use two 7 mm open-ended wrenches to tighten the assembled parts to a torque of 2...3 Nm.

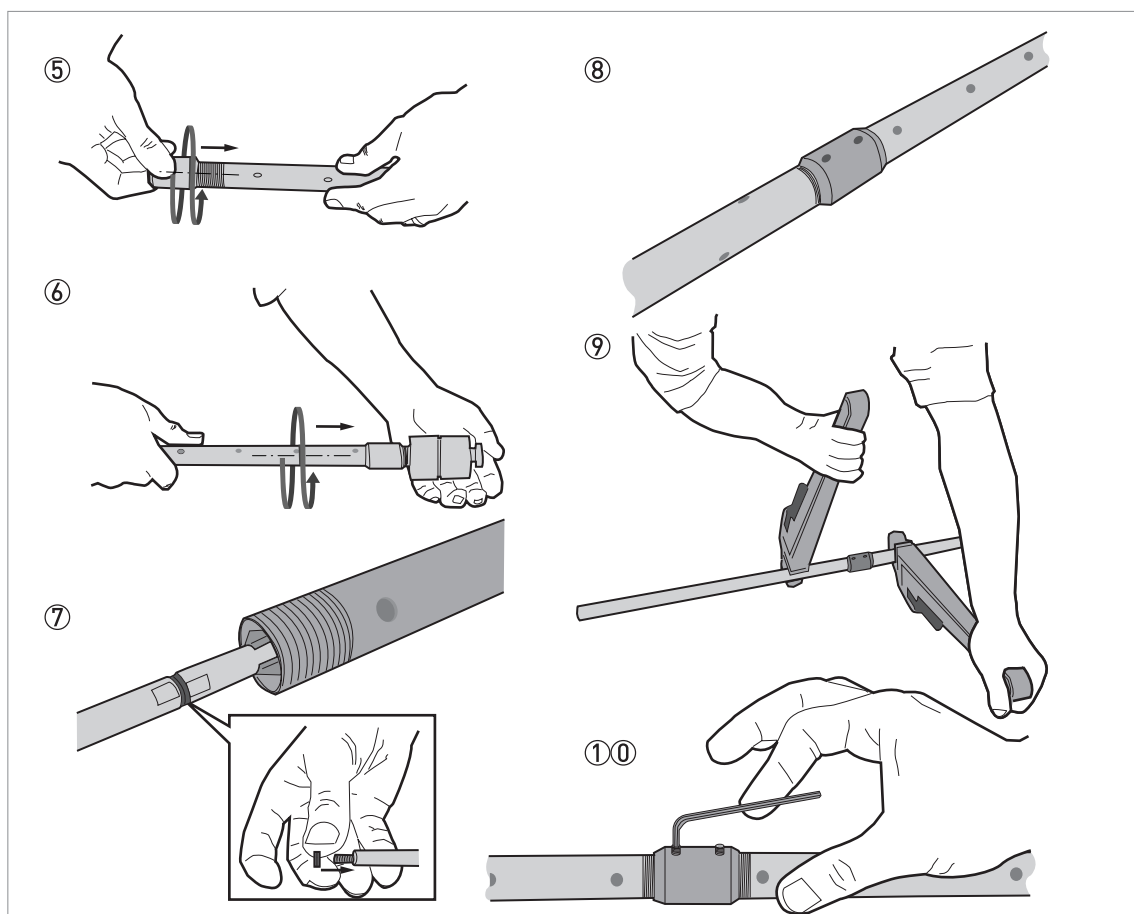


Figure 3-36: How to assemble the segmented coaxial probe: part 2



WARNING!

Be careful when you use the pipe wrenches. Make sure that the measuring tubes have no deformation.



CAUTION!

- *Make sure that the screws are tight and the measuring tube cannot loosen.*
- *Make sure that the fitting for the lock screw is not aligned with a hole in the coaxial tube.*



- Attach a union nut to each coaxial tube (middle and end tubes)
- Attach a middle tube segment to the coaxial probe stem. Do not use tools to tighten the assembled parts.
- Assemble the next middle rod segment (with a pair of lock washers on the attached screw) and the top rod segment. Use two 7 mm open-ended wrenches to tighten the assembled parts to a torque of 2...3 Nm.
- Assemble the next coaxial tube segment and the top coaxial tube segment. Do not use tools to tighten the assembled parts. Do steps (9) thru (10) again until the end rod segment and end coaxial tube are attached.
- Use the 2 pipe wrenches to tighten the coaxial tubes in the lock nuts.
- Use a 2.5 m Allen wrench to attach and tighten the two HC M5x5 screws (lock screws) to the union nut.

3.8.4 How to install a device with a flange connection

Equipment needed:

- Device
- Gasket (not supplied)
- Wrench (not supplied)

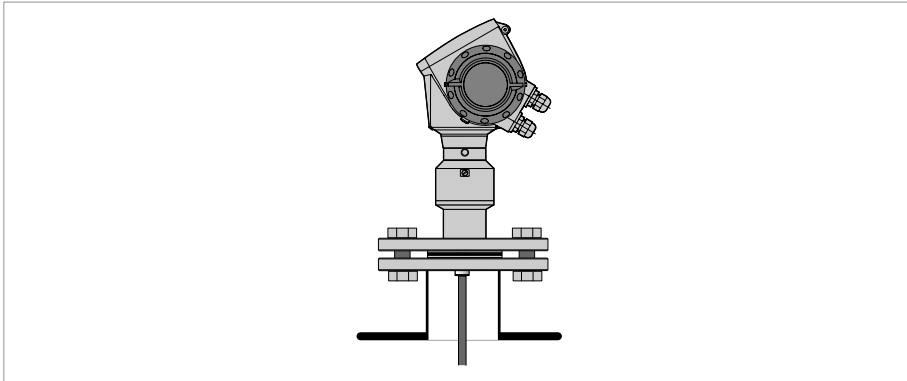


Figure 3-37: Flange connection



- Make sure the flange on the nozzle is level.
- Make sure that you use the applicable gasket for the flange and the process.
- Align the gasket correctly on the flange facing of the nozzle.
- Lower the probe carefully into the tank.
- ➔ For more data on cable probes, refer to *How to install a cable probe in the tank* on page 51.
- Tighten the flange bolts.
- ➔ Refer to local rules and regulations for the correct torque to apply to the bolts.

3.8.5 How to install a device with a threaded connection

Equipment needed:

- Device
- Gasket (not supplied with G (ISO 228) threaded connections)
- 50 mm / 2" wrench (not supplied)

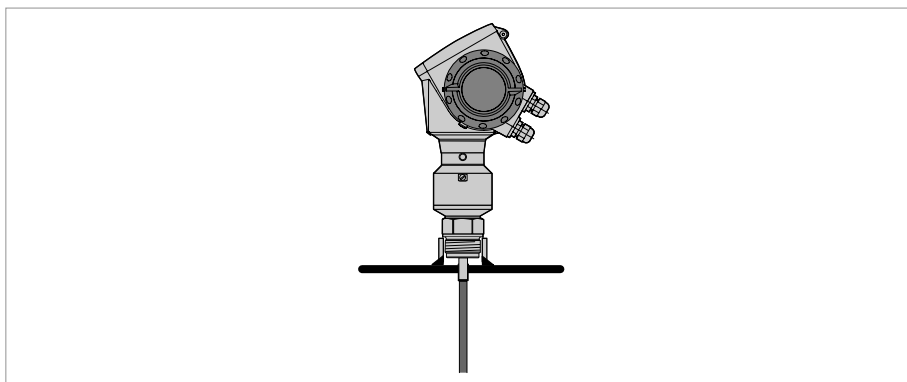


Figure 3-38: Threaded connection



- Make sure the tank connection is level.
- Make sure that you use the applicable gasket for the connection and the process.
- Align the gasket correctly.
- If installed on a tank made of plastic or other non-conductive material, refer to *Installation recommendations for non-metallic tanks and pits* on page 52.
- Lower the probe carefully into the tank
- ➔ For more data on cable probes, refer to *How to install a cable probe in the tank* on page 51.
- Turn the nut on the housing to attach the device to the process connection
- Tighten the nut.
- ➔ Refer to local rules and regulations for the correct torque to apply to the connection.

**INFORMATION!**

*If there is not sufficient clearance to install the device, remove the housing. Install the process connection and then put the housing back on the process connection. For more data, refer to *How to turn or remove the signal converter* on page 56.*

3.8.6 How to install a cable probe in the tank

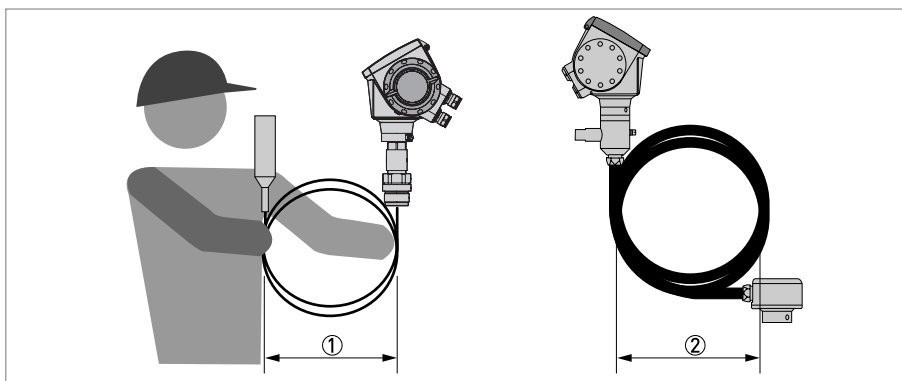


Figure 3-39: Wind cable probes and flexible conduits carefully

- ① Do not wind cable probes less than 400 mm / 16" in diameter.
- ② Do not wind the flexible conduit less than 330 mm / 13" in diameter.



WARNING!

If you bend the probe too much, you will damage the device and it will not measure accurately.

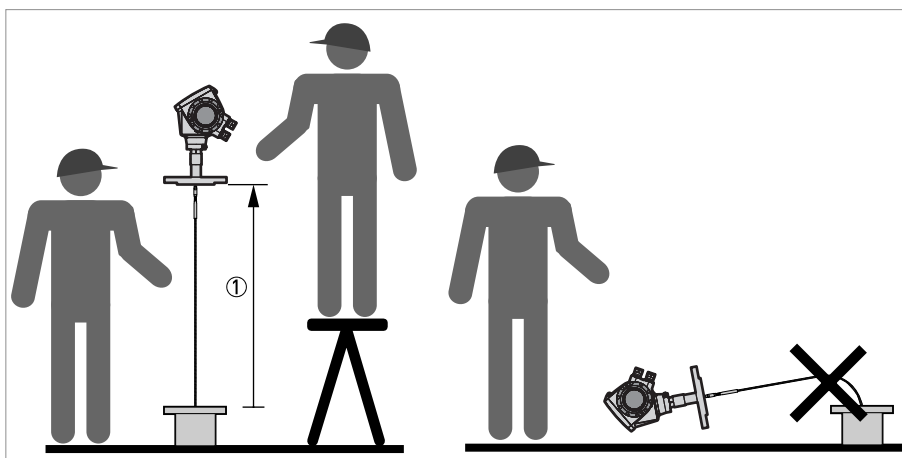


Figure 3-40: Installation of devices with cable probes

- ① >1 m / 3½ ft



- Use two persons to lift the housing and the probe above the process connection.
- Hold the device 1 m / 3½ ft above the tank.
- Unwind the probe carefully into the tank.

3.8.7 Installation recommendations for non-metallic tanks and pits



If you have a device with a single rod or a single cable probe and a thread connection, obey these instructions:

- Put a metal sheet between the device and the process connection.
- It must have a diameter greater than 200 mm / 8".
- Make sure that the metal sheet is in contact with the thread stop on the device.

We recommend that you use $DN \geq 200$ / $\geq 8''$ for flange connections.

If you have a device with a double rod, double cable or coaxial probe, you can ignore these instructions.

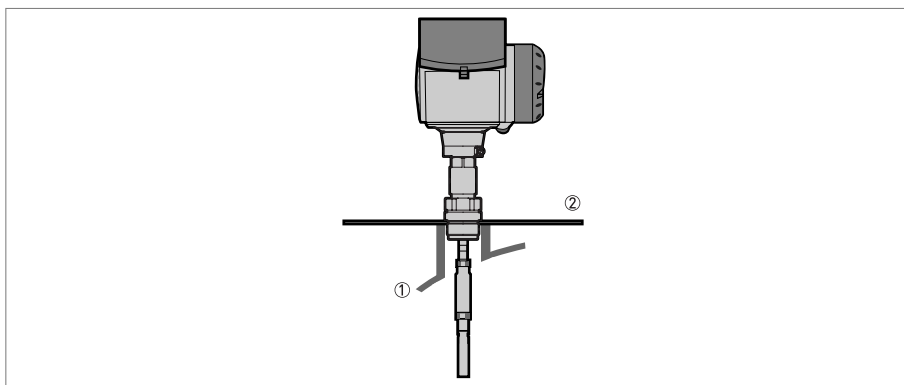


Figure 3-41: Installation in a non-metallic tank or pit with a thread connection

- ① Non-metallic (plastic...) tank or pit
- ② Metal sheet, $\varnothing \geq 200$ mm / 8"



CAUTION!

When the device is installed, make sure that the tank roof has no deformation.

3.8.8 How to assemble the remote housing

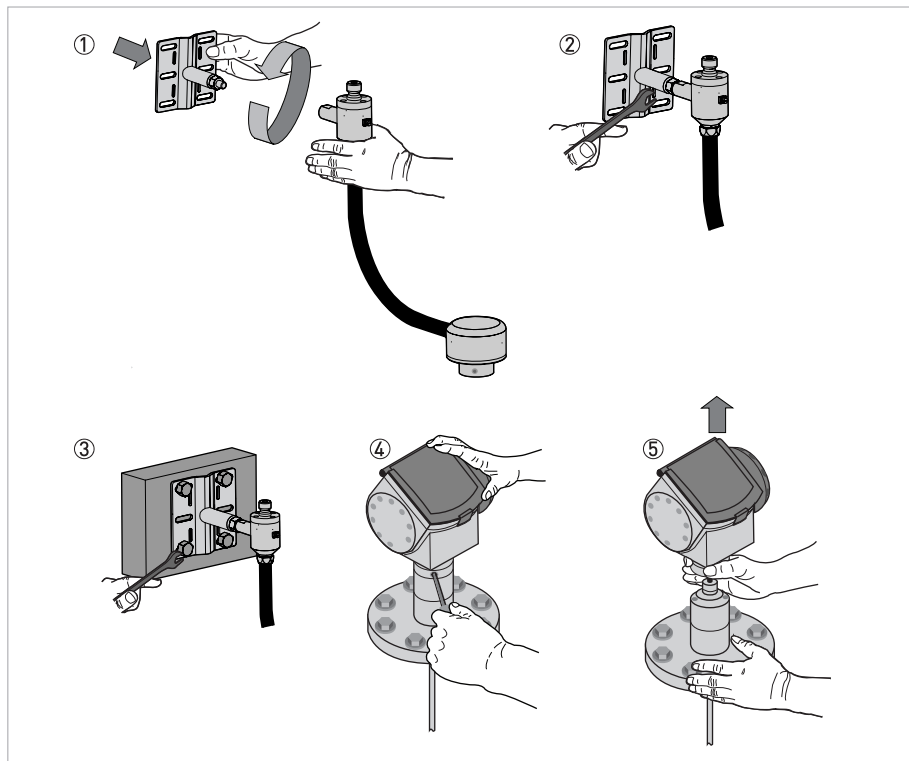


Figure 3-42: Part 1 of assembly procedure



- Attach the wall bracket ① to the flexible conduit.
- Tighten the locking nut ② with a 24 mm wrench.
- Attach the wall bracket to a wall or pipe (DN50...100 / 2"...4") ③.
- Loosen the housing locking screw ④ with a 5 mm Allen wrench.
- Remove the housing ⑤.

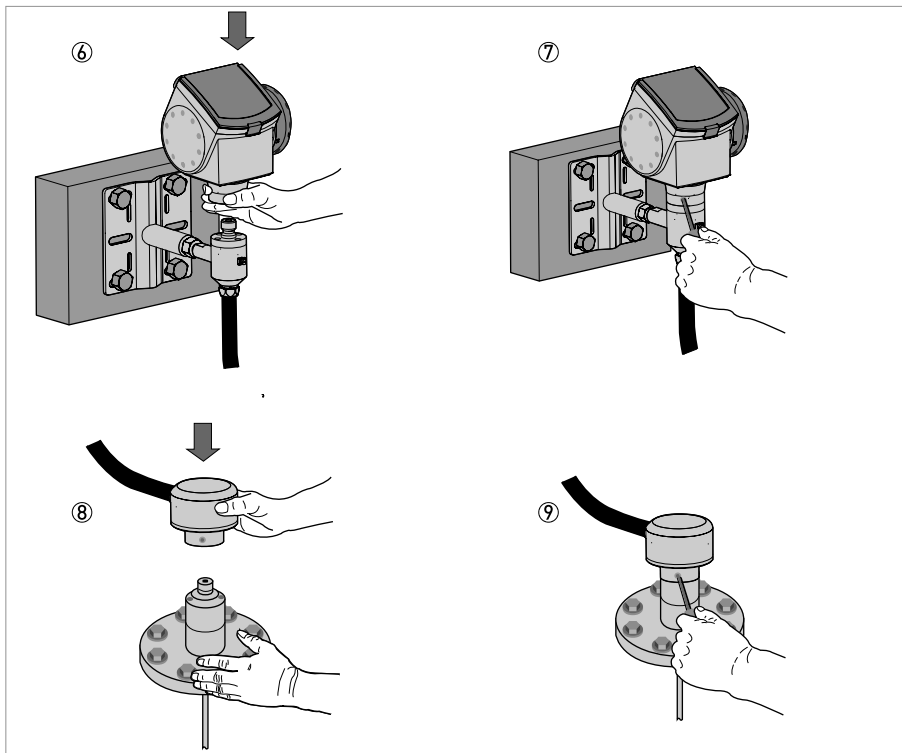


Figure 3-43: Part 2 of the assembly procedure



- Attach the housing to the flexible conduit ⑥.
- Tighten the housing locking screw ⑦.
- Attach the flexible conduit to the probe ⑧.
- Tighten the flexible conduit locking screw ⑨.

You can attach the wall bracket of the remote housing to a wall or pipe (DN50...100 / 2" ...4"). These are the dimensions:

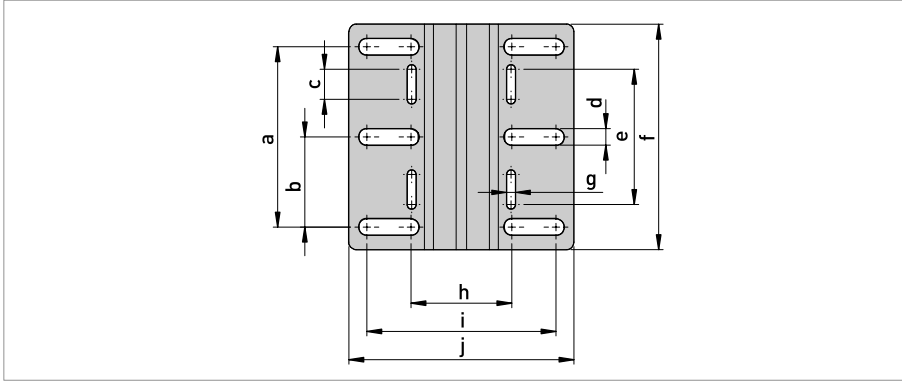


Figure 3-44: Dimensions of the wall bracket

Dimensions in mm

	Dimensions [mm]									
	a	b	c	d	e	f	g	h	i	j
Wall bracket	120	60	20	11	90	150	6	67.4	126.4	150.4

Dimensions in inches

	Dimensions [inches]									
	a	b	c	d	e	f	g	h	i	j
Wall bracket	4.7	2.4	0.8	0.4	3.5	5.9	0.2	2.65	4.98	5.92

3.8.9 How to turn or remove the signal converter

**INFORMATION!**

The converter turns 360°.

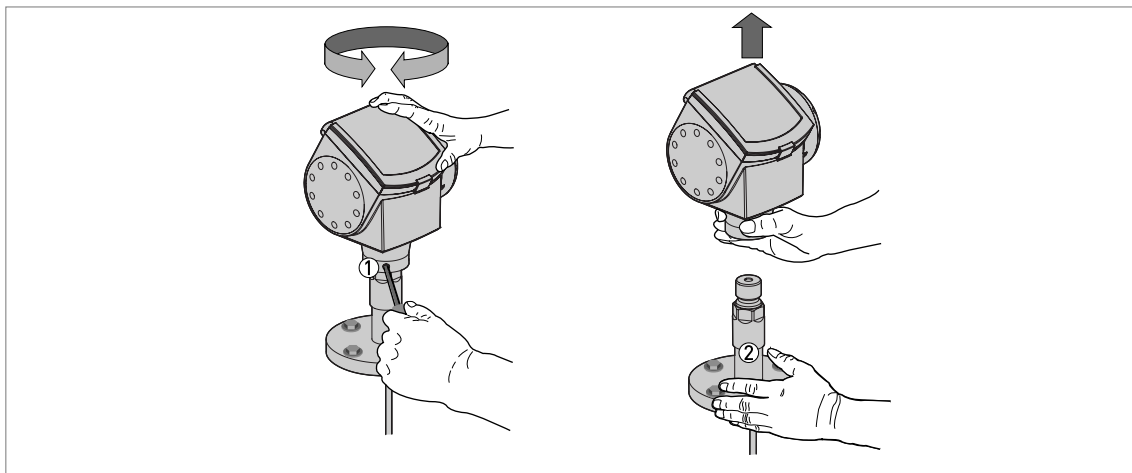


Figure 3-45: How to turn or remove the signal converter

Tool: 5 mm Allen wrench

**How to turn the signal converter**

- Loosen the housing locking screw ① with a 5 mm Allen wrench.
- Turn the housing to the correct position.
- Tighten the housing locking screw ①.

**How to remove the signal converter**

- Loosen the housing locking screw ① with a 5 mm Allen wrench.
- Remove the housing.
- Tighten the housing locking screw ①.

**How to attach the signal converter**

- Loosen the housing locking screw ① with a 5 mm Allen wrench.
- Attach the housing.
- Tighten the housing locking screw ①.

**CAUTION!**

If you remove the housing, put a cover on the coaxial hole on top of the flange assembly ②.

3.8.10 How to attach the weather protection to the device

Equipment needed:

- Device
- Weather protection (option)
- 10 mm wrench (not supplied)

Refer to "Technical data: Dimensions and weight", for the overall dimensions of the weather protection.

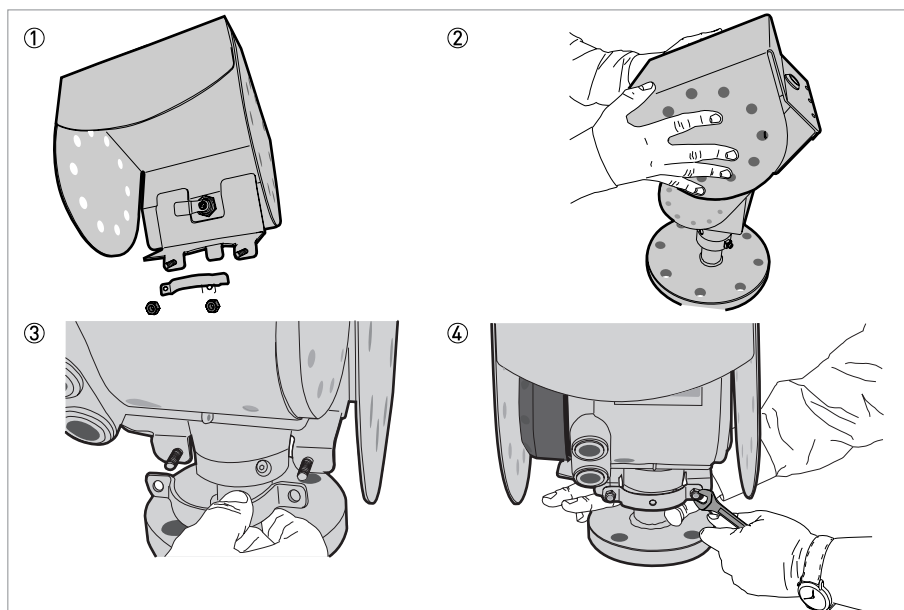


Figure 3-46: Installation of the weather protection



- Loosen the bracket nuts on the weather protection. Remove the bracket.
- Lower the weather protection onto the device. Turn the weather protection so that the keyhole points forward.
- Attach the bracket.
- Lift the weather protection to the top of the housing support pillar. Hold the weather protection in the correct position and tighten the bracket nuts.

3.8.11 How to open the weather protection

Equipment needed:

- Weather protection attached to the device.
- Large slotted tip screwdriver (not supplied).

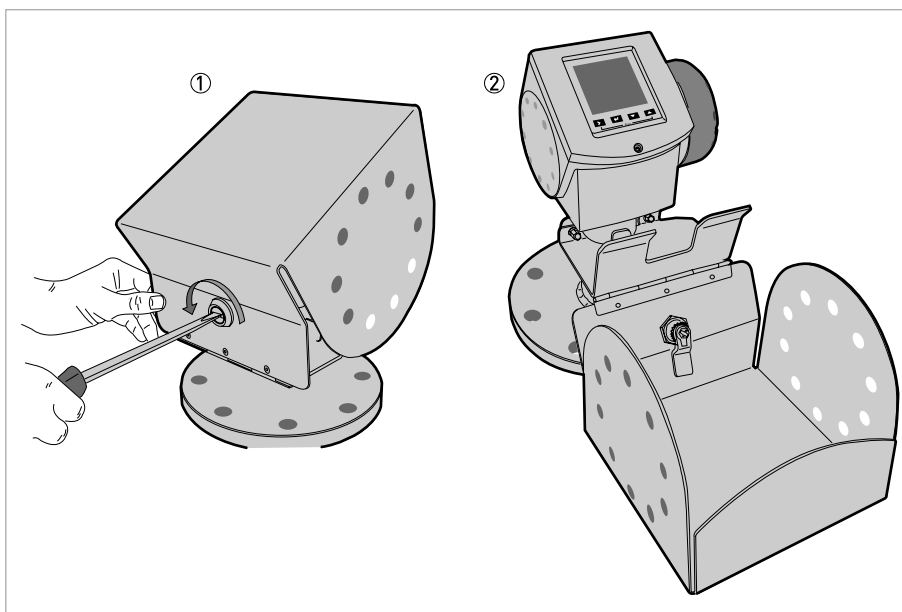


Figure 3-47: How to open the weather protection

- ① Weather protection in its closed position
- ② Weather protection in its open position. Minimum clearance in front of the device: 300 mm / 12".



- Put a large slotted tip screwdriver into the keyhole at the front of the weather protection. Turn the screwdriver counterclockwise.
- Pull the top of weather protection up and forward.
- ➡ This will open the weather protection.

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 Electrical installation: outputs 1 and 2

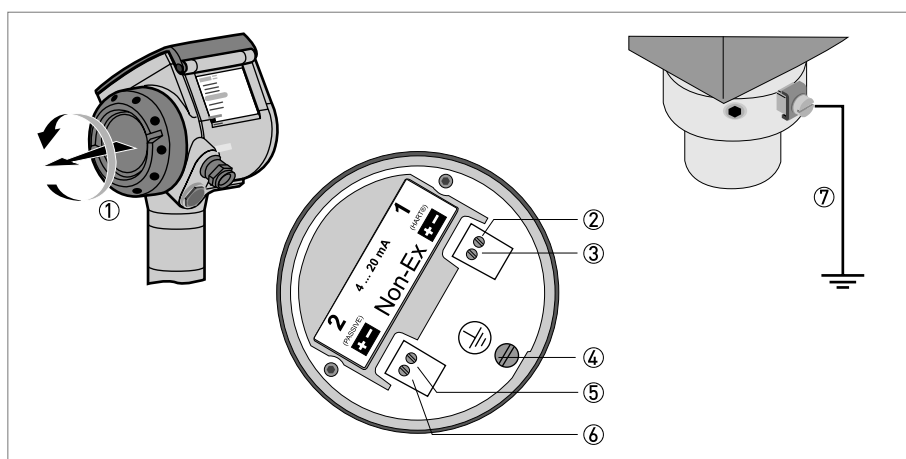


Figure 4-1: Electrical installation

- ① Terminal compartment cover
- ② Output 1: current output -
- ③ Output 1: current output +
- ④ Grounding terminal in the housing
- ⑤ Output 2: current output -
- ⑥ Output 2: current output +
- ⑦ Grounding terminal between the process connection and the converter

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.

**Procedure:**

- Remove the housing terminal compartment cover ①.
- Connect the wires to the device. Obey the national electrical codes.
- Make sure that the polarity of the wires is correct.
- Attach the ground to ④ or ⑦. Both terminals are technically equivalent.

**INFORMATION!**

If the polarity is not correct, this will not cause damage to the device. But the device will not operate and the output will be 0 mA.

4.3 Electrical connection for current output

4.3.1 Non-Ex

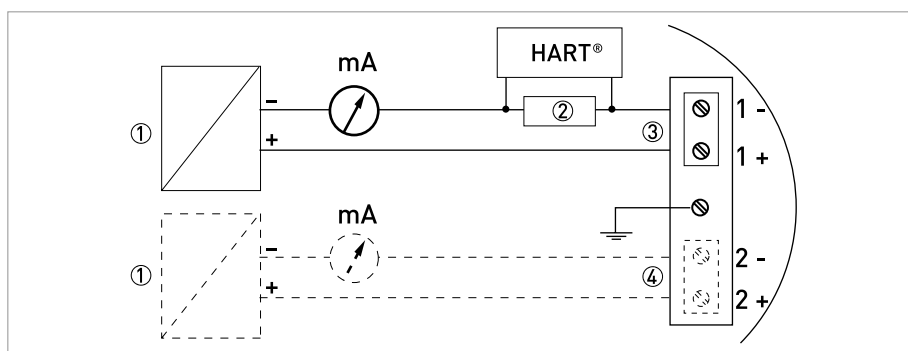


Figure 4-2: Electrical connections for non-Ex devices

- ① Power supply
- ② Resistor for HART® communication
- ③ Output 1: 14...30 VDC for an output of 22 mA at the terminal
- ④ Output 2: 10...30 VDC for an output of 22 mA at the terminal

4.3.2 Ex i

**DANGER!**

For electrical data for Ex i applications, refer to the Ex supplements. You can find this documentation on the CD-ROM delivered with the device or it can be downloaded free of charge from the website (Downloadcenter).

4.3.3 Ex d

**DANGER!**

For electrical data for Ex d applications, refer to the Ex supplements. You can find this documentation on the CD-ROM delivered with the device or it can be downloaded free of charge from the website (Downloadcenter).

4.3.4 PROFIBUS PA

For electrical data for PROFIBUS PA networks, refer to the PROFIBUS PA supplement. You can find this documentation on the CD-ROM delivered with the device or it can be downloaded free of charge from the website (Downloadcenter).

4.3.5 FOUNDATION Fieldbus

For electrical data for FOUNDATION Fieldbus networks, refer to the FOUNDATION Fieldbus supplement. You can find this documentation on the CD-ROM delivered with the device or it can be downloaded free of charge from the website (Downloadcenter).

4.4 Protection category



INFORMATION!

The device fulfills all requirements per protection class IP 66/67 (equivalent to NEMA type 4X (housing) and type 6P (probe)).



DANGER!

Make sure that the cable gland is watertight.

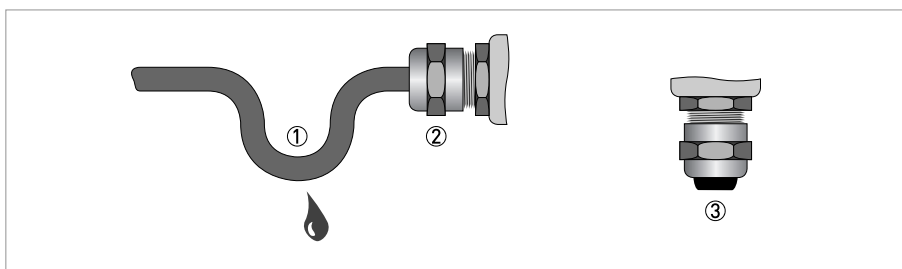


Figure 4-3: How to make the installation agree with protection category IP 67



- 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.

4.5 Networks

4.5.1 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 operate in a multi-drop network of up to 15 devices.

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 *Network configuration* on page 96.

4.5.2 Point-to-point networks

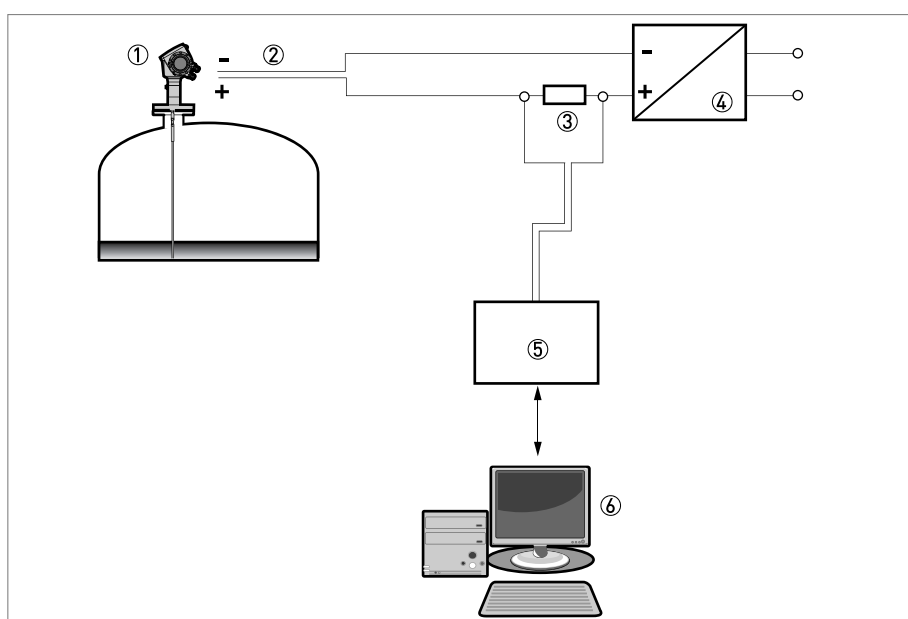


Figure 4-4: Point-to-point connection (non-Ex)

- 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

4.5.3 Multi-drop networks

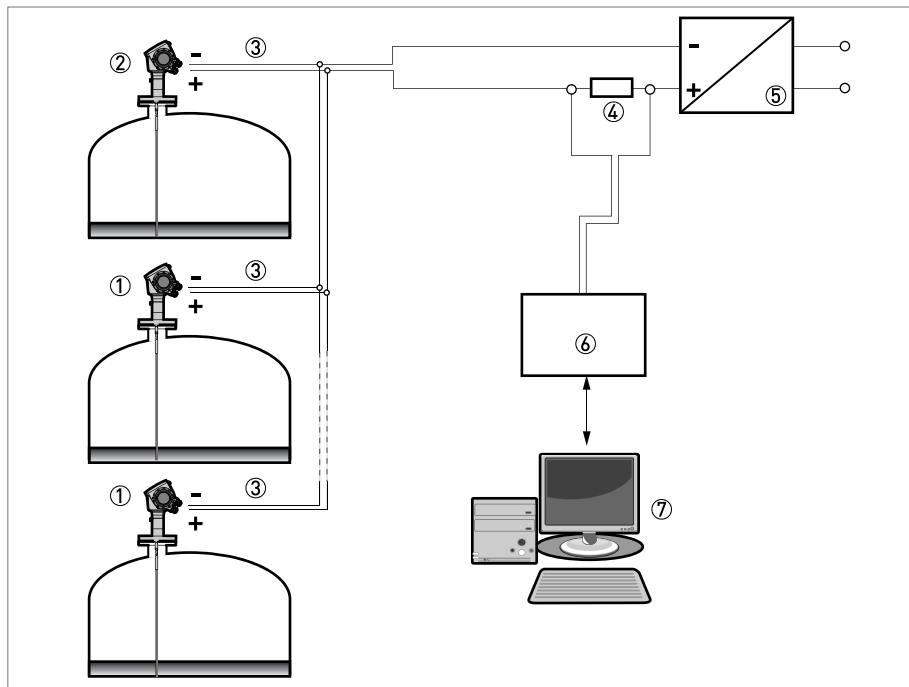


Figure 4-5: Multi-drop network (non-Ex)

- 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

4.5.4 Fieldbus networks

FOUNDATION Fieldbus™ network (non-Ex)

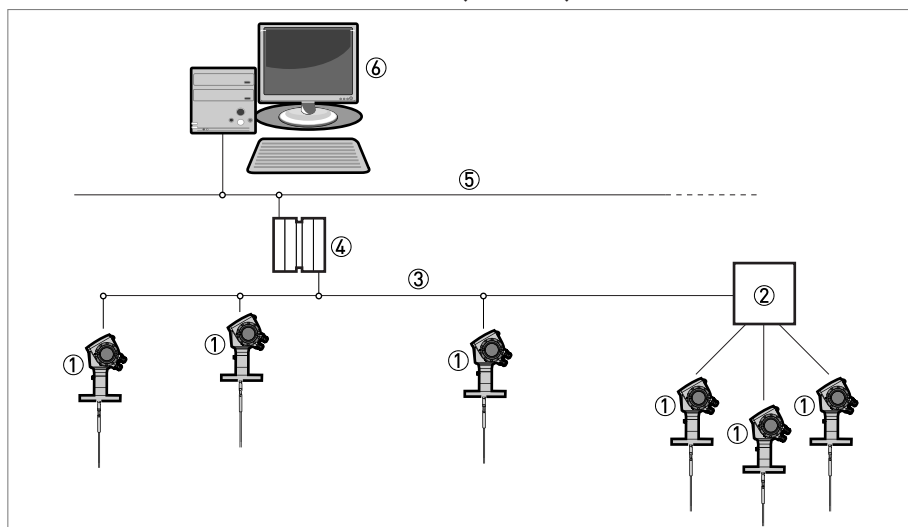


Figure 4-6: FOUNDATION Fieldbus™ network (non-Ex)

- ① Field device
- ② Junction box
- ③ H1 network
- ④ H1/HSE converter
- ⑤ High Speed Ethernet (HSE)
- ⑥ Workstation

**INFORMATION!**

It is necessary to have a separate power supply to energize devices with the FOUNDATION™ Fieldbus output option (4-wire device with local HART® connection). The FF terminal is connected to a Fieldbus Power Hub. The 24 VDC terminal energizes the device. The power supply is not shown in the illustration.

PROFIBUS PA/DP network (non-Ex)

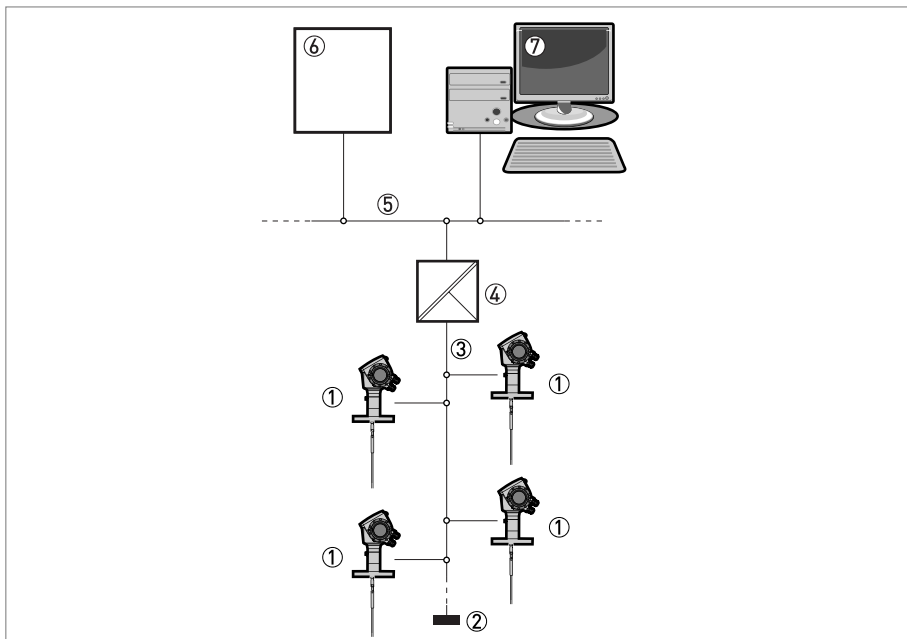


Figure 4-7: PROFIBUS PA/DP network (non-Ex)

- ① Field device
- ② Bus termination
- ③ PROFIBUS PA bus segment
- ④ Segment coupler (PA/DP link)
- ⑤ PROFIBUS DP bus line
- ⑥ Control system (PLC / Class 1 master device)
- ⑦ Engineering or operator workstation (Control tool / Class 2 master device)

**INFORMATION!**

*It is necessary to have a separate power supply to energize devices with the PROFIBUS PA output option (4-wire device with local HART® connection). The **PROFIBUS PA** terminal is connected to a segment coupler. The **24 VDC** terminal energizes the device. The power supply is not shown in the illustration.*

5.1 Start-up checklist

Check these points before you energize the device:

- Are all the wetted components (probe, flange and gaskets) 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!

Before you energize the device, make sure that the polarity and the supply voltage are correct.



DANGER!

Make sure that the device and the installation agrees with the requirements of the Ex certificate of compliance.

5.2 Operating concept

You can read measurements and configure the device with:

- A digital display screen (optional).
- A connection to a system or PC with PACTware™. You can download the Device Type Manager (DTM) file from the internet site. It is also supplied on the CD-ROM delivered with the device.
- A connection to a system or PC with AMS™. You can download the Device Description (DD) file from the internet site. It is also supplied on the CD-ROM delivered with the device.
- A connection to a HART® Handheld Communicator.

5.3 Digital display screen

5.3.1 Local display screen layout



Figure 5-1: Local display screen layout

- ① Error icon
- ② Tag number or menu name
- ③ Selected menu item (gray text cannot be selected)
- ④ \triangle ∇ : scroll up/scroll down
- ⑤ Keypad buttons (refer to the table below)

5.3.2 Keypad buttons

Keypad button	Description
	Right
	Return
	Down
	Up
	Esc (Escape)

For data on keypad functions, refer to *Operator mode* on page 71.

5.3.3 Help screens

When you are in supervisor mode, the local display helps you to configure the device. If you do not touch any keys after 30 seconds, a help message is displayed. This will explain what the menu is and what the parameters do. Press > and \triangle (Esc) at the same time to go back to the menu. If you do not touch the display for another 30 seconds, the message is shown again.

5.3.4 How to start the device



- Connect the converter to the power supply.
- Energize the converter.
- ➡ After 30 seconds the screen will display "booting up", "starting up" and then the default screen will appear.
- The device will display readings.
- ➡ Measurements agree with specifications given in the customer order.

**CAUTION!**

If the manufacturer received information about the installation, the device will display readings correctly. If not, refer to the quick setup procedures on page 79.

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 PAS 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...).
- The Device Type Manager for the device.

The software and installation instructions are given on the CD-ROM supplied with the device.

You can also download the latest version of PACTware™ and the DTM from our internet site.

Refer also to the PACTware™ consortium site at <http://www.pactware.de>.

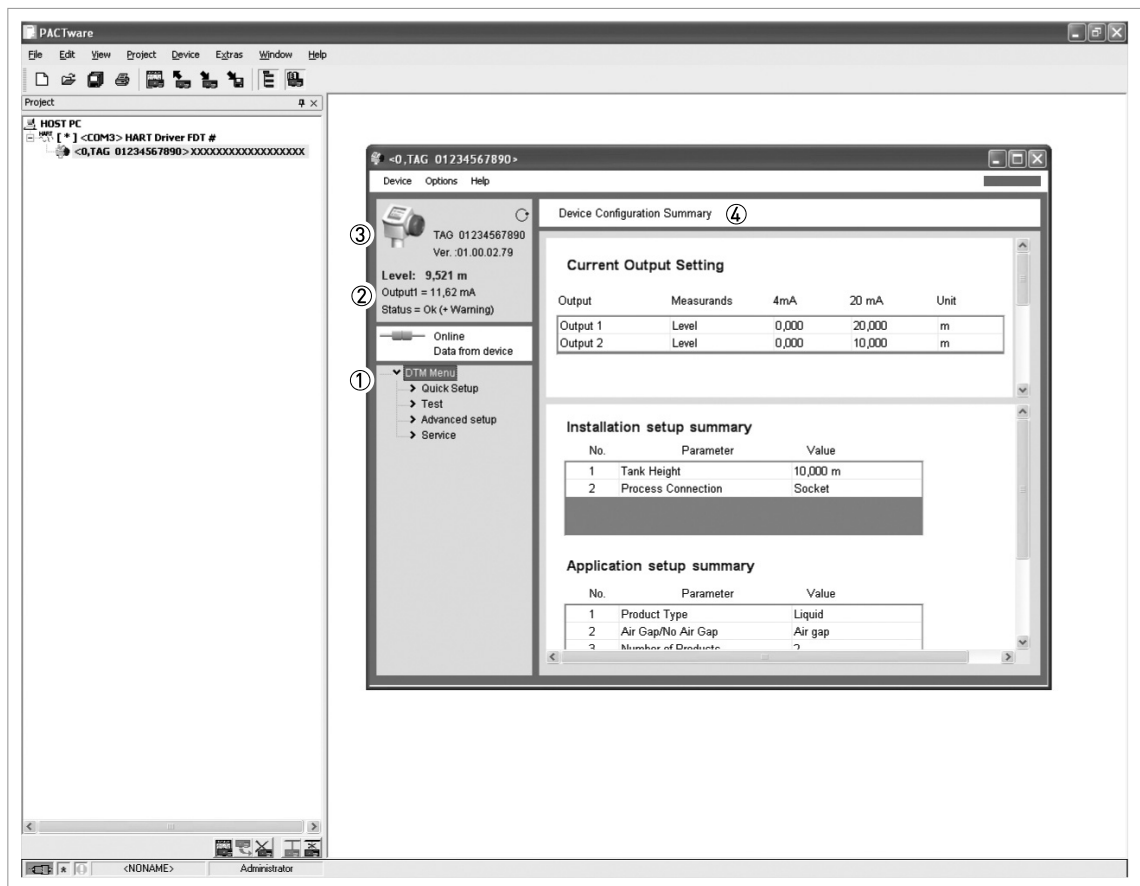


Figure 5-2: Screen from the PACTware™ user interface

- ① DTM menu
- ② Basic measurement information: level, current output and device status
- ③ Information for device identification
- ④ 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 Fieldbus FOUNDATION™ 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.

The DD file is given on the CD-ROM supplied with the device. You can also download it from our internet site.

6.1 User modes

There are 3 modes of operation:

- Operator.
- Supervisor.
- Service.

6.2 Operator mode

The operator can choose what information to display.





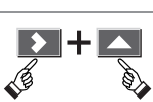
This section shows you:

- What each button does in operator mode.
- What special function each button has if it is pressed for more than 1 second.
- How to move from one screen of information to another.

Some data (volume, mass etc.) will only be available if the device is correctly configured by the supervisor, as described below.

Devices with the "second output" option can display 2 values on the % current output screen (for example: level and interface level). Devices must also have the "interface" option for interface measurement.

Functions of keypad buttons in operator mode

Keypad button	Description	Normal function	"Hot key" function
	Right	Change display style ①	Enter program mode ②
	Enter	-	Enter signal screen editing mode ③
	Down	Change measurement parameter ④	The screen shown at this time becomes the default screen ②
	Up	Change measurement parameter ④	Display language will change to English ⑤
	Esc (Escape)	-	-

① Value, value and picture, or value and bar graph

② Press this button for 1 second

③ Press this button after the selection of the signal screen. For more data, refer to "Operation: How to make the device follow the correct level or interface signal".

④ Level, distance, volume etc.

⑤ Press this button for 3 seconds. Press the button again and it will go back to the original language.

Information screens for a device with 1 output

Text and image screen	Go to	% current output screen	Go to	Text screen	Go to
△				△	
Level	>	<Output 1: Output Function> ①	>	Level	> (Text and image)
△ ▽				△ ▽	
Interface Level ②	>	<Output 1: Output Function> ①	>	Interface Level ②	> (Text and image)
△ ▽				△ ▽	
Distance	>	<Output 1: Output Function> ①	>	Distance	> (Text and image)
△ ▽				△ ▽	
Interface Distance ②	>	<Output 1: Output Function> ①	>	Interface Distance ②	> (Text and image)
△ ▽				△ ▽	
Layer ②	>	<Output 1: Output Function> ①	>	Layer ②	> (Text and image)
△ ▽				△ ▽	
Volume (Mass) ③	>	<Output 1: Output Function> ①	>	Volume (Mass) ③	> (Text and image)
△ ▽				△ ▽	
Interface Volume (Interface Mass) ④	>	<Output 1: Output Function> ①	>	Interface Volume (Interface Mass) ④	> (Text and image)
△ ▽				△ ▽	
Ullage Volume (Ullage Mass) ③	>	<Output 1: Output Function> ①	>	Ullage Volume (Ullage Mass) ③	
△ ▽				△ ▽	
Layer Volume (Layer Mass) ④	>	<Output 1: Output Function> ①	>	Layer Volume (Layer Mass) ④	
▽				△ ▽	
Back to the top of the list				Signal screen ⑤	
				▽	
				Back to the top of the list	

① Refer to the Operation: Function description section (Table C. Advanced setup, menu item C.3.1 Output Function)

② This screen is for devices with the "interface" option only

③ This data is only available if you created a volume table (or a mass table). Refer to the Conversion menu in supervisor mode (Quick Setup > Setup Mode > Conversion).

④ This screen is for devices with the "interface" option only. This data is only available if you created a volume table (or a mass table). Refer to the Conversion menu in supervisor mode (Quick Setup > Setup Mode > Conversion).

⑤ This screen shows voltage amplitude of return signals against distance. It is used for finding level and interface when there are interference signals. Press > to move the cursor from one signal peak to another.

Information screens for a device with the second output option

Text and image screen	Go to	% current output screen	Go to	Text screen	Go to
△				△	
Level	>	<Output 1: output function> <Output 2: Output Function> ①	>	Level	> (Text and image)
△ ▽				△ ▽	
Distance	>	<Output 1: Output Function> <Output 2: Output Function> ①	>	Distance	> (Text and image)
△ ▽				△ ▽	
Layer ②	>	<Output 1: Output Function> <Output 2: Output Function> ①	>	Layer ②	> (Text and image)
△ ▽				△ ▽	
Volume (Mass) ③	>	<Output 1: Output Function> <Output 2: Output Function> ①	>	Volume (Mass) ③	> (Text and image)
△ ▽				△ ▽	
Ullage Volume (Ullage Mass) ③	>	<Output 1: Output Function> <Output 2: Output Function> ①	>	Ullage Volume (Ullage Mass) ③	> (Text and image)
△ ▽				△ ▽	
Layer Volume (Layer Mass) ④	>	<Output 1: Output Function> <Output 2: Output Function> ①	>	Layer Volume (Layer Mass) ④	> (Text and image)
▽				△ ▽	
Back to the top of the list				Signal screen ⑤	
				▽	
				Back to the top of the list	

① Refer to the Operation: Function description section (Table C. Advanced setup, menu item C.3.1 Output Function (output 1) and C.4.1 Output Function (output2))

② This screen is for devices with the "interface" option only

③ This data is only available if you created a volume table (or a mass table). Refer to the Conversion menu in supervisor mode (Quick Setup > Setup Mode > Conversion).

④ This screen is for devices with the "interface" option only. This data is only available if you created a volume table (or a mass table). Refer to the Conversion menu in supervisor mode (Quick Setup > Setup Mode > Conversion).

⑤ This screen shows voltage amplitude of return signals against distance. This is used for finding level and interface when there are interference signals. Press > to move the cursor from one signal peak to another.

6.3 Supervisor mode

6.3.1 General notes

Configure your device in **Supervisor** mode. You can:

- Use the **Quick Setup** menus to configure your device quickly. For more data about Quick Setup menus, refer to *Function description* on page 79 (Table A. Quick setup).
- Use the **Advanced Setup** menu to find single items for device configuration. For more data about menu items, refer to *Function description* on page 79 (Table C. Advanced setup).
- Save **Quick Links** for items that you use regularly. For more data about quicklinks (menu items A.2 to A.6), refer to *Function description* on page 79 (Table A. Quick setup).
- Error finding and troubleshooting procedures are described in the **Test** menu. For more data about the test menu, refer to *Function description* on page 79 (Table B. Test).

6.3.2 How to get access to the supervisor mode



Do the steps that follow:

- Press the > button for one second.
➡ This displays the login screen.
- Press the Δ or ∇ buttons to select **supervisor** from the list.
- Press the ← button.
➡ The screen displays where to type in the password.
- Type in the password. The factory-set password is > ← ∇ Δ > ←.
- ➡ The device displays the message "Login successful" and then the main menu for supervisor mode.

You can change the password for the supervisor mode (menu item C.5.2.2). For more data, refer to *Function description* on page 79 (Table C. Advanced setup).

The main menu shows:

- Quick Setup menu.
- Test menu.
- Advanced Setup menu.

You cannot select "Service menu" in supervisor mode. Menus that can be selected are in black text. Menus that cannot be selected are in gray text.

If you go back to operator mode, you will have access to the supervisor mode, without password security, for 30 minutes.

6.3.3 Menu overview

A Quick Setup

A.1	Setup Mode
A.2	Quick Link 1 (default: Error Records)
A.3	Quick Link 2 (default: Contrast)
A.4	Quick Link 3 (default: Language)
A.5	Quick Link 4 (default: Length Unit)
A.6	Quick Link 5 (default: Display Mode)

B Test

B.1	Test
B.2	Information

C Advanced Setup

C.1	Installation Setup
C.3	Output 1 (HART)
C.4	Output 2 (Passive) ①
C.5	Device Setup
C.6	Reset

① Optional

6.3.4 Keypad functions

Menu navigation

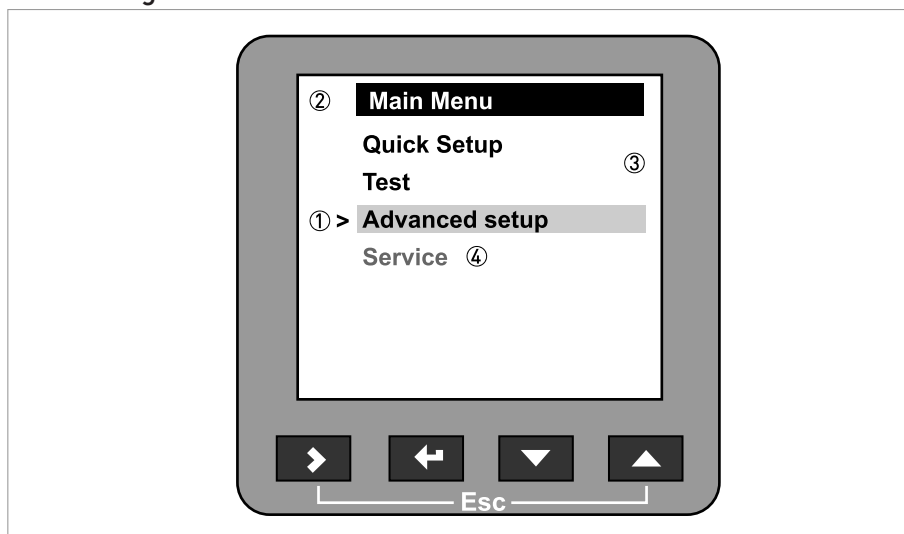


Figure 6-1: Menu navigation

- ① Menu selection bar
- ② Header bar
- ③ Menu list
- ④ Menu item that is not available (in gray text)

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

Function of keypad buttons in the menu lists

Keypad button	Description	Function
	Right	Go to the next menu level
	Enter	-
	Down	Move the menu selection bar down the list
	Up	Move the menu selection bar up the list
	Esc (Escape)	Go back to the menu level you were on before

Lists of parameters in menu items

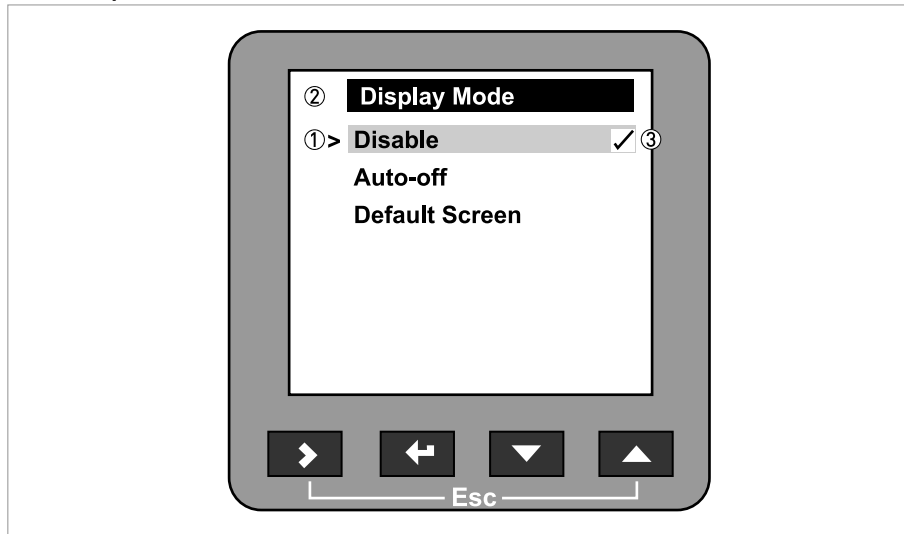




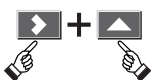


Figure 6-2: Lists of parameters in menu items

- ① Parameter selection bar
- ② Menu name
- ③ Parameter used at this time

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

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

Keypad button	Description	Function
	Right	-
	Enter	Select the parameter and go back to the menu
	Down	Move the menu selection bar down the list
	Up	Move the menu selection bar up the list
	Esc (Escape)	Go back to the menu ①

- ① This does not confirm that you selected a new parameter

Values in menu items

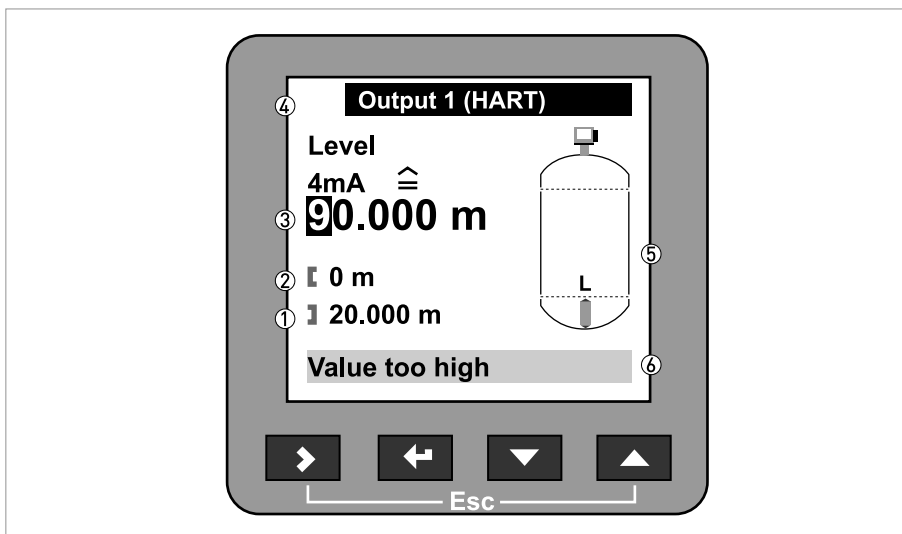


Figure 6-3: Values in menu items

- ① Maximum value
- ② Minimum value
- ③ Cursor on the digit to be changed
- ④ Menu name
- ⑤ Illustration of menu item
- ⑥ Error message

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





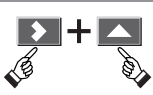
Function of keypad buttons in menu items that have values

Keypad button	Description	Function
	Right	Move the cursor to the next digit on the right
	Enter	Select the parameter and go back to the menu
	Down	Decrease the digit value
	Up	Increase the digit value
	Esc (Escape)	Go back to the menu ①

① This does not confirm that you selected a new parameter

If you press the buttons for 1 second, you can use these hotkey functions:

Hotkey functions in supervisor mode

Button	Description	Function
	Right	Create a quick link ①
	Enter	-
	Down	-
	Up	Screen displays information in English ②
	Esc (Escape)	Go back to the operator mode

① Make a selection from the Advanced Setup menu list

② Press this button for 3 seconds

How to save settings



- When you have changed parameters in all the necessary menu items, press \leftarrow to accept the new parameter.
- Press $>$ and \triangle at the same time to go back to the **Save settings** screen.
- The device will ask you to save or cancel your settings. Select **Save** to accept the new settings or **Cancel** to reject them.
- ➡ The display goes back to operator mode.

6.3.5 Function description

A. Quick Setup

Menu No.	Step	Function	Function description	Selection list	Default
A.0		Quick Setup			
A.1		Setup Mode			
A.1.1		Complete	This follows the steps given in the Application, Installation, Conversion and Output setup modes.		
A.1.2		Application	Follow this procedure to describe the tank contents.		
	1	Probe Type		Read only	
	2	Product Type: Which application do you have?	The application.	Liquid, Solid	Depends on the probe type
	3	Air Gap Flag: Do you have air or gas above the product?	This tells the device whether or not there is air or gas above the product.	Air Gap, No Air Gap ①	Air Gap
	4	Number Of Products: How many different products do you have in the tank?	The number of products in the tank.	1, 2, >2 ②	1

Menu No.	Step	Function	Function description	Selection list	Default
	5	Top Product		Liquid: Alcohol, Base, Hydrocarbon, Liquid Gas, Mineral Oil, Solvent, Aqueous Solution, Other Solid: Cereals, Minerals, Plastic, Other	
	6	Application Type: What do you want to measure?		Level, Interface, Level + Interface ③	Level
	7	Are the products mixed or unmixed?	If there are 2+ liquids in the tank, is there an emulsion in the tank. This tells the device to look for the interface when the two liquids have settled.	Mixed, Unmixed	Unmixed
	8	Settings summary			
	9	Current changes must be saved or cancelled before proceeding		Save, Cancel ④	
A.1.3		Installation	Follow this procedure to describe the process connection.		
	1	Tank Height	The distance from the tank connecting flange face/thread stop down to the tank bottom.	min-max: 0.165...60 m / 0.54...196.86 ft	⑤
	2	Installation Type	The type of process connection on the tank for the device.	Socket, Stillwell (A), Nozzle (B)	nozzle
	3A	Stillwell Height	The height from the tank connecting flange face/thread stop to the bottom of the stillwell.	min-max: 0...60 m / 0...196.86 ft	1.5 m / 4.92 ft
	4A	Stillwell Diameter	The inner diameter of the stillwell.	min-max: 20...1000 mm / 0.79...39.37 in	100 mm / 3.94 in
	3B	Nozzle Height	The height from the tank connecting flange face/thread stop to the bottom of the nozzle.	min-max: 0...60 m / 0...196.86 ft	0.1 m / 0.33 ft
	4B	Nozzle Diameter	The inner diameter of the nozzle.	min-max: 20...1000 mm / 0.79...39.37 in	100 mm / 3.94 in
	5	Settings summary			
	6	Current changes must be saved or cancelled before proceeding		Save, Cancel ④	Save
A.1.4		Conversion	Follow this procedure to set the device up to display readings in volume, mass or user-defined units.		

Menu No.	Step	Function	Function description	Selection list	Default
Sub-menu		Conversion submenu [Volume]			
	1	Do you want to use a free unit?	Select "No".	Yes, No	
	2	Table Length Unit		m, cm, mm, inch, ft, Free Unit	m
	3	Please select Volume / Mass	Select "Volume".	Volume	
	4	Product Type		Solid, Liquid	
	5	Tank Shapes	The Wizard adds this step if you select "Yes" in step 4. This sub-procedure uses the information given here to find the volume. You have to type in the tank shape, height, width and length.
	6	Conversion Unit	The displayed unit in operator mode.	m3, L, US gal, GB gal, ft3, bbl	m3
	7	Volume Table	A table that converts product level to product volume. Press Δ or ∇ to select a line and press > to change values automatically supplied by the device.		
Sub-menu		Conversion submenu [Mass]		-	
	1	Do you want to use a free unit?	Select "No".	Yes, No	
	2	Table Length Unit		m, cm, mm, inch, ft, Free Unit	m
	3	Please select Volume / Mass	Select "Mass".	Volume, Mass	
	4	Do you want to use density of the product?		Yes, No	
	5	Product Density		min-max: 0...20000 kg/m3	0
	6	Product Type		Solid, Liquid	
	7	Tank Shapes	The Wizard adds this step if you select "Yes" in step 4. This sub-procedure uses the information given here to find the volume. You have to type in the tank shape, height, width and length.
	8	Conversion Unit	The conversion unit is given as a volume if the product density is given. If not, choose a mass unit.	m3, L, US gal, GB gal, ft3, bbl or Tons, kg, US Tons, GB Tons	m3 or Tons

Menu No.	Step	Function	Function description	Selection list	Default
	9	Mass Table	A table that converts product level to product mass. If you selected "Yes" in step 4, make entries in the table in volume units. Press Δ or ∇ to select a line and press > to change values automatically supplied by the device.		
Sub-menu		Conversion submenu [Free Unit]	If you cannot find the units or tank shape in the menu, you can customize the conversion table.	-	
	1	Do you want to use a free unit?	Select "Yes".	Yes, No	
	2	Custom. Length Unit	A non-standard length unit for the conversion table. This is defined by the supervisor.		FREE_UNIT
	3	Custom. Length Ratio	The conversion factor between the length unit selected in C.5.1.4 (length unit) and C.5.1.7 (customer length unit). This ratio is a multiple of 1 mm.	min-max: 1...99999	1
	4	Custom. Conv. Unit	A non-standard conversion unit for the conversion table. This is defined by the supervisor.		FREE_UNIT
	5	No. of Entries	The number of lines in the conversion table.	min-max: 0...50	2
	6	Volume/Mass Table	A table that converts product level to another physical parameter. Press Δ or ∇ to select a line and press > to change values.		
	...	Current changes must be saved or cancelled before proceeding		Save, Cancel ④	Save
A.1.5		Outputs	Follow this procedure to describe the output characteristics.	-	
	1	Output 1: Output Function	Select an output function to scale the current values (output 1). This is not displayed in the operator mode.	1 solid/liquid: Level, Distance, Volume (Mass), Ullage Volume; 2+ liquids: Interface Level, Interface Distance, Interface Volume, Layer, Layer Volume	Level
	2	Output 1 (HART): <Function> 4 mA	This assigns a measurement value to 4 mA (output 1).	min.-max: 0...20 m / 0...65.62 ft	0 m / 0 ft

Menu No.	Step	Function	Function description	Selection list	Default
	3	Output 1 (HART): <Function> 20 mA	This assigns a measurement value to 20 mA (output 1).	min.-max: 0...90 m / 0...295.29 ft	Depends on the output function
	4	Output Range	This sets the effective range of output 1 with or without over-run.	3.8...20.5 mA (NAMUR), 4...20 mA	4...20 mA
	5	Error Handling	This sets the behaviour of current output 1 if an error occurs. Hold means that the output current stays at the value where the error occurred. Hold is not available if 3.8...20.5 mA (NAMUR) is the output range.	3.6 mA, 22 mA, Hold	22 mA
	6	Output 1 (HART): HART Address	Any HART® address greater than 0 will activate HART® multidrop mode. Current output stays constant at 4 mA.	min.-max: 0...15	0
	7	Output Function 2 ⑥	Select an output function to scale the current values (output 2). This is not displayed in the operator mode.	1 liquid: Level, Distance, Volume (Mass), Ullage Volume; 2+ liquids: Interface Level, Interface Distance, Interface Volume, Layer, Layer Volume	Depends on the number of outputs and if the device has the "interface" option
	8	Output 2 (Passive): <Function> 4 mA ⑥	This assigns a measurement value to 4 mA (output 2).	min.-max: 0...20 m / 0...65.62 ft	0 m / 0 ft
	9	Output 2 (Passive): <Function> 20 mA ⑥	This assigns a measurement value to 20 mA (output 2).	min.-max: 0...90 m / 0...295.29 ft	Depends on the output function
	10	OP2 Output Range ⑥	This sets the effective range of output 2 with or without over-run.	3.8...20.5 mA (NAMUR), 4...20 mA	4...20 mA
	11	OP2 Error Handling ⑥	This sets the behaviour of current output 2 if an error occurs. Hold means that the output current stays at the value where the error occurred. Hold is not available if 3.8...20.5 mA (NAMUR) is the output range.	3.6 mA, 22 mA, Hold	22 mA
	12	Settings summary		Read only	
		Current changes must be saved or cancelled before proceeding		Save, Cancel ④	Save

Menu No.	Step	Function	Function description	Selection list	Default
A.1.6		Snapshot	Use this to find and filter out parasite signals in user-defined areas along the probe. Partially empty or completely empty the tank before you do this procedure.		
		Warning, the level should be out of the snapshot area.			
	1	Snapshot Start Dist.	Snapshot start distance.	min-max: Detection Delay...Snapshot End Distance	0.1 m / 0.328 ft
	2	Snapshot End Dist.	Snapshot end distance.	min-max: Snapshot Start Distance...Sensor Length	Sensor Length
	3	Snapshot Recording	Is the tank empty? If not, empty the tank before taking a snapshot.	Yes, No	Yes
	4	Snapshot recording in progress...			
	5	Snapshot activation	Use this data to filter out parasitic signals.	Yes, No	Yes
	6	Settings summary			
A.1.7		Auto Probe Length	Use this to correct the length of the probe if it was shortened on site.		
		Warning: this function should be used only when the tank is empty and the device is installed on top of the tank.			
	1	Settings summary	A summary of probe data (probe type, counterweight type, probe end pulse).		
	2	Auto Probe Length	Do you want to start the scan?	Yes, No	Yes
	3	Auto probe length in progress...			
	4	Probe Length	Save the new value.	Yes, No	Yes
A.2		Quick Link 1	Direct link to an item in the Advanced Setup menu	Go to a function in the Advanced Setup menu and press > for 1 second. You can store up to 5 functions in this way.	Error Records
A.3		Quick Link 2	Direct link to an item in the Advanced Setup menu	Go to a function in the Advanced Setup menu and press > for 1 second. You can store up to 5 functions in this way.	Contrast

Menu No.	Step	Function	Function description	Selection list	Default
A.4		Quick Link 3	Direct link to an item in the Advanced Setup menu	Go to a function in the Advanced Setup menu and press > for 1 second. You can store up to 5 functions in this way.	Language
A.5		Quick Link 4	Direct link to an item in the Advanced Setup menu	Go to a function in the Advanced Setup menu and press > for 1 second. You can store up to 5 functions in this way.	Length Unit
A.6		Quick Link 5	Direct link to an item in the Advanced Setup menu	Go to a function in the Advanced Setup menu and press > for 1 second. You can store up to 5 functions in this way.	Display Mode

① Only "Air Gap" is available for solid applications

② Only "1" is available for solid applications

③ Only "Level" is available for tanks with one product. Only "Interface" is available for tanks with 2 or more products and no air gap. "Interface" and "Level + Interface" are only available if the device has the "interface" option.

④ This step is ignored if you use the "Complete" setup mode

⑤ This value agrees with the customer specification or probe length

⑥ Optional

B. Test

Menu No.	Function	Function description	Selection list	Default
B.0	Test			
B.1	Test	This checks the device outputs and performs common device tests.		
B.1.1	Show Output 1	This displays analogue output 1 value [mA].	Read only	
B.1.2	Set Output 1	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.	3.6, 4, 6, 8, 10, 12, 14, 16, 18, 20 or 22 mA	4 mA
B.1.3	Show Output 2	This displays analogue output 2 value [mA].	Read only	
B.1.4	Set Output 2	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.	3.6, 4, 6, 8, 10, 12, 14, 16, 18, 20 or 22 mA	4 mA
B.1.5	Internal Test	This initiates the hardware test. The device displays the results.	Read only	
B.2	Information	A summary of information relating to the device.		

Menu No.	Function	Function description	Selection list	Default
B.2.1	Outputs	Analogue output settings. This includes assigned functions, 4 ... 20 mA scale settings, error handling and HART® parameters.	Read only	
B.2.2	15 Min Log	A log of output values for the last 15 minutes. A log is taken every 10 seconds and displayed on a graph.	Read only	
B.2.3	Device ID	This displays device order no, V-no, service no, Ex approval, Main CPU version and Companion CPU version.	Read only	
B.2.4	Quick Setup Sum.	A summary of the parameters entered in the quick setup menu.	Read only	
B.2.5	TAG Number	The TAG number can be seen and updated here.	?	TAGN00123 4567890
B.2.6	Sensor Length	The distance from the flange face/thread stop down to the bottom end of the probe (excluding the counterweight for cable versions). The factory set value for probe length is displayed. If probe length has been modified, the new value is shown.	Read only (blocking distance...60 m / 197 ft)	
B.2.7	Probe Type	The mechanical design of the probe. The factory installed probe type is displayed.	Read only	
B.2.8	Counterweight Type	The mechanical design of a cable probe's bottom end. The device will not measure below the top of the counterweight. The factory-installed counterweight type is displayed.	Read only	
	Temperature	Temperature of the electronics block. The display will automatically switch off if the temperature is below -20°C / -4°F or above +60°C / +140°F.	Read only	
B.2.9	Calculated Er Value	Dielectric constant [ϵ_r] is a major parameter for TDR level measurement devices. This device is able to automatically calculate and display here the ϵ_r of the top product.	Read only	
B.2.10	Snapshot Information	A summary of snapshot data used by the device. Go to Snapshot setup menu to update this data.	Read only	
B.2.11	Application Mode	This displays the description of the algorithm applied to the measurement function and application conditions. This is configured in the Application setup menu.	Read only	

Menu No.	Function	Function description	Selection list	Default
B.2.12	Error Records	A log of device errors. Scroll down the list and press \leftarrow to display the error details. Opening a log will remove the error icon if it appeared in operator mode.	Read only	
B.2.14	Custom. Length Unit	Non-standard length unit for the conversion table. This is defined by the supervisor. Go to Supervisor > Advanced Setup > Device Setup > Display Settings > Custom. Length Unit or follow the procedure in the Conversion setup menu.	Read only	
B.2.15	Custom. Conv. Unit	Non-standard conversion unit for the conversion table. This is defined by the supervisor. Go to Supervisor > Advanced Setup > Device Setup > Display Settings > Custom. Conv. Unit or follow the procedure in the Conversion setup menu.	Read only	

C. Advanced setup

Menu No.	Function	Function description	Selection list	Default
C.0	Advanced Setup	Select single menu items to fine-tune the device.		
C.1	Installation Setup			
C.1.1	Installation Type	The installation on the tank for the device.	Socket, Stillwell, Nozzle	Nozzle
C.1.2	Tank Height	The distance from the tank connecting flange face / thread stop down to the tank bottom.	min-max: 0.165...60 m / 0.54...196.86 ft	3 m / 9.84 ft
C.1.4	Nozzle / Stillwell Height	The height from the tank connecting flange face / thread stop to the bottom of the nozzle or...the height from the tank connecting flange face / thread stop to the bottom of the stillwell.	min-max: 0...60 m / 0...196.86 ft	100 mm / 3.94 in
C.1.5	Nozzle / Stillwell Diameter	The inner diameter of the nozzle or stillwell.	min-max: 20...1000 mm / 0.79...39.37 in	100 mm / 3.94 in
C.1.6	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). If probe length has been modified, enter the new value here. For more data, refer to <i>How to decrease the length of probes</i> on page 108.	min-max: blocking distance...max. probe length for that type (single/double rod: 4 m / 13 ft, coaxial: 6 m / 20 ft, single cable: 35 m / 115 ft, double cable: 8 m / 26 ft)	Depends on the probe type.

Menu No.	Function	Function description	Selection list	Default
C.1.9	Blocking Distance	The non-measuring range at the top of the probe. It depends on the probe type and the installation.	min-max: 0...(probe length) m / 0...(probe length) ft	Depends on the probe type. For more data, refer to <i>Measurement limits</i> on page 143.
	Detection Delay	This forces the device not to analyse reflections in a defined zone immediately below the flange. Increase blocking distance to increase the maximum value.	min-max: 0...(blocking distance) m / 0...(blocking distance) ft	Depends on the "blocking distance". See C.1.9 (Blocking Distance)
C.1.10	Reference Offset	Offset relating to a reference location (distance). This value is positive when the reference location is above the device flange face and negative if below. For more data, refer to <i>Distance measurement</i> on page 97.	min-max: -tank height...50 m / -tank height...164.05 ft	0 m / 0 ft
C.1.11	Tank Bottom Offset	Offset relating to a reference location (level). The device reference point for this parameter is the bottom of the tank (set in menu item C.1.2.0). This value is positive when the reference location is below the tank bottom and negative if above. For more data, refer to <i>Level measurement</i> on page 98.	min-max: -tank height...3000 m / -tank height...9843 ft	0 m / 0 ft
C.1.12	Time Constant	Increasing the time constant will smoothen the integrated readings, decreasing will roughen the readings.	min-max: 0 to 100 seconds	20 seconds for solids 5 seconds for liquids
C.1.13	Measuring Mode	In Direct mode, the device measures the time it takes to receives a reflection of the signal from the surface of the tank contents. In TBF mode, the device measures the time it takes to receives a reflection of the signal from the end of the probe. TBF mode is used to measure one product with a low ϵ_r . Automatic mode automatically switches the measuring mode between Direct and TBF mode. This is sufficient for most applications. Direct mode is used for products with an $\epsilon_r \geq 1.6$ (this depends on the probe type). If $\epsilon_r \leq 1.4$, use TBF mode.	Automatic, Direct, TBF	Automatic
C.1.14	Product ϵ_r	This function is available if TBF or Automatic mode is selected in C.1.13. If possible, type in the exact value of the product's dielectric constant. If you do not know the exact value, use the default value. A new product ϵ_r that is too low will mean that level will read higher than its true value in TBF mode.	min-max: 1.10 to 115.00	2.4

Menu No.	Function	Function description	Selection list	Default
C.1.15	Gas Er	A major parameter for TDR level measurement devices. If the gas is not air, set the ϵ_r value to the ϵ_r value of the gas.	min-max: 0.8...115	1
C.1.16	Level Threshold	If it is difficult to identify the level signal (for example: too many parasitic signals), you can increase the level threshold and the amplification (Gain) of the signal. For more data, refer to <i>Thresholds and parasitic signals</i> on page 102.	7 Gains, min-max: 0...+1.25 V.	Depends on Gain (for example, 0.5 V Gain 6).
C.1.17	Interface Threshold	Devices for interface applications only. If it is difficult to identify the interface signal (for example: too many parasite signals), you can increase the interface threshold and the amplification (Gain) of the signal. For more data, refer to <i>Thresholds and parasitic signals</i> on page 102.	7 Gains, min-max: 0...+1.25 V.	Depends on Gain (for example, 0.5 V Gain 6).
C.1.18	Probe end Threshold	Used in TBF or Automatic mode. If it is difficult to identify the probe end signal (for example: too many parasite signals), you can increase the probe end threshold and the amplification (Gain) of the signal. For more data, refer to <i>Thresholds and parasitic signals</i> on page 102.	7 Gains, min-max: 0...+1.25 V or -1.25...0 V.	Depends on Gain (for example, 0.5 V Gain 6).
	Snapshot	Starts or stops the operation of the snapshot signal filter. Obey the instructions in the quick setup menu to get snapshot data. For more data, refer to <i>How to use the snapshot function to filter parasitic signals</i> on page 106.	Yes, No	No
C.1.19	Units For Tables	Sub-menu for volume and mass conversion operations.	Table Length Unit, Conversion Unit	
C.1.19.1	Table Length Unit	The length unit used in the conversion table. If "free unit" is selected, the unit device uses the unit name in menu item C.5.1.7.	m, cm, mm, inch, ft, Free Unit	m
C.1.19.2	Conversion Unit	The volume or mass unit used in the conversion table. If "Free Unit" is selected, the device uses the unit name in menu item C.5.1.9.	m3, L, US gal, GB gal, ft3, bbl, Tons, Kg, US Tons, GB Tons, Free Unit	m3
C.1.20	Product Density	A value greater than 0 that is used with a volume conversion table to calculate mass. This menu item is not available if you have selected a mass unit.	0...20000 kg/m3	0

Menu No.	Function	Function description	Selection list	Default
C.1.21	Volume / Mass Table	The device uses this table to display volume and mass readings. Give the number of entries on the table. Press \leftarrow . Type in the height and the corresponding volume / mass values. For more data, refer to <i>How to configure the device to measure volume or mass</i> on page 99.	Number of entries min.-max: 0...50	No table. Table units are selected in menu items C.1.19.1 and C.1.19.2.
C.1.22	Linearisation Table	The device uses this table to increase on-site accuracy. Give the number of entries plotted. Fill the tank. Make a reference measurement and type in the correct value next to the device reading. For more data, refer to <i>Linearisation</i> on page 97.	Number of entries min.-max: 0...50	No table
C.3	Output 1 (HART)			
C.3.1	Output Function	Select an output function to scale the current values. This is not displayed in the operator mode.	1 solid/liquid: Level, Distance, Volume (Mass), Ullage Volume; 2+ liquids: Interface Level, Interface Distance, Interface Volume, Layer, Layer Volume	Level
C.3.2	4 mA Setting	This gives a measurement value to 4 mA (output 1).	min.-max: ①	0 m / 0 ft
C.3.3	20 mA Setting	This gives a measurement value to 20 mA (output 1).	min.-max: ②	Depends on the output function
C.3.4	Output Range	Sets the effective range of output 1 either with or without over-run	3.8...20.5 mA (NAMUR), 4...20 mA	4...20 mA
C.3.5	Error Handling	This sets the behaviour of current output 1 if an error occurs. Hold means that the output current stays at the value where the error occurred. Hold is not available if 3.8...20.5 mA (NAMUR) is the output range.	3.6 mA, 22 mA, Hold	22 mA
	Error Handling Delay	The time after which the current output changes to an error value. It shows that there is a measurement error.	min.-max: 0...900 sec (seconds)	60 sec
C.3.6	HART Address	Any HART® address greater than 0 will activate HART® multidrop mode. The current output stays constant at 4 mA.	min.-max: 0...15	0
C.4	Output 2 (Passive)			
C.4.1	Output Function	Select an output function to scale the current values (output 2). This is not displayed in the operator mode.	1 solid/liquid: Level, Distance, Volume (Mass), Ullage Volume; 2+ liquids: Interface Level, Interface Distance, Interface Volume, Layer, Layer Volume	Level
C.4.2	4 mA Setting	This gives a measurement value to 4 mA (output 2).	min.-max: ①	0 m / 0 ft

Menu No.	Function	Function description	Selection list	Default
C.4.3	20 mA Setting	This gives a measurement value to 20 mA (output 2).	min.-max: ②	Depends on the output function
C.4.4	Output Range	Sets the effective range of output 2 either with or without over-run	3.8...20.5 mA (NAMUR), 4...20 mA	4...20 mA
C.4.5	Error Handling	This sets the behaviour of current output 2 if an error occurs. Hold means that the output current stays at the value where the error occurred. Hold is not available if 3.8...20.5 mA (NAMUR) is the output range.	3.6 mA, 22 mA, Hold	22 mA
	Error Handling Delay	The time after which the current output changes to an error value. It shows that there is a measurement error. This value is set in the output 1 menu.	Read only	Refer to function C.3.5
C.5	Device Setup	This menu covers all items directly related to the display of information and access to the supervisor menu		
C.5.1	Display Settings	To display the information you need, refer to these menu items.		
C.5.1.1	Language	Information can be displayed in any of the 9 languages stored in the device. If it is necessary to change the display quickly to English, press Δ for 3 seconds in operator mode.	English, French, German, Italian, Japanese, Mandarin, Portuguese, Russian, Spanish	
C.5.1.2	Display Mode	The display screen status will change after the time given in C.5.1.3. (time delay). Disable switches off this functionality, Auto-Off switches off the display and Default Screen will show the selected default screen. To set to the default screen, press ∇ for 1 second in the operator mode.	Disable, Auto-Off, Default Screen.	Disable
C.5.1.3	Time Delay	The time after which the display will switch to the status set in C.5.1.2 (Display Mode). You cannot select this menu if C.5.1.2 (Display Mode) is set to "Disable".	1, 3, 5, 10 minutes	1 minute
	Contrast	The contrast control for the display screen. You can select a shade of gray between light gray (level 1) and black (level 9).	Level 1, Level 2, Level 3, Level 4, Level 5, Level 6, Level 7, Level 8, Level 9	Level 5
C.5.1.4	Length Unit	The length unit displayed in operator mode.	m, cm, mm, inch, ft, ft-inch-1/16inch, ft-inch-1/32inch, Free Unit	m
C.5.1.5	Volume Unit	The volume unit displayed in operator mode.	m3, L, US gal, GB gal, ft3, bbl	m3
C.5.1.6	Mass Unit	The mass unit displayed in operator mode.	Tons, Kg, US Tons, GB Tons	Kg

Menu No.	Function	Function description	Selection list	Default
C.5.1.7	Custom. Length Unit	A non-standard length unit for the conversion table. This is defined by the supervisor.		FREE_UNIT
C.5.1.8	Custom. Length Ratio	The conversion factor between the length unit selected in C.5.1.4 (Length Unit) and C.5.1.7 (Custom. Length Unit). This ratio is a multiple of 1 mm.	min.-max: 1...99999	1
C.5.1.9	Custom. Conv. Unit	Non-standard conversion unit for the conversion table. This is defined by the supervisor.		FREE_UNIT
C.5.2	Passwords	To change user passwords, refer to these menu items.		
C5.2.2	Supervisor	This changes the supervisor password. Press the push 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.		>←▽△>←
C.6	Reset	To reset the device to default settings, refer to these menu items.		
C.6.3	Restart	If the device does not operate correctly, start the unit again. Press ← to confirm.		

- ① Units and range depend on the output function, length unit and volume unit selected. See also the table of data dependencies for the 4 mA settings in this section.
- ② Units and range depend on the output function, length unit and volume unit selected. See also the table of data dependencies for the 20 mA settings in this section.

Data dependencies for the 4 mA settings of outputs 1 and 2

Output function	Minimum value	Maximum value	Default
Level	0 m	<20 mA Setting for Level	0 m
Volume	0.00 m ³	<20 mA Setting for Volume	0 m ³
Mass	0.00 kg	<20 mA Setting for Mass	0 kg
Distance	0 m	<20 mA Setting for distance	0 m
Interface Level	0 m	<20 mA Setting for Interface Level	0 m
Interface Distance	0 m	<20 mA Setting for Interface Distance	0 m
Interface Volume	0.00 m ³	<20 mA Setting for Interface Volume	0 m ³
Interface Mass	0.00 kg	<20 mA Setting for Interface Mass	0 kg
Ullage Volume	0.00 m ³	<20 mA Setting for Ullage Volume	0 m ³
Ullage Mass	0.00 kg	<20 mA Setting for Ullage Mass	0 kg
Layer	0 m	<20 mA Setting for Layer	0 m
Layer Volume	0.00 m ³	<20 mA Setting for Layer Volume	0 m ³
Layer Mass	0.00 kg	<20 mA Setting for Layer Mass	0 m ³

Data dependencies for the 20 mA settings of outputs 1 and 2

Output function	Minimum value	Maximum value	Default
Level	>4 mA Setting for Level	Tank Height + TBO + RO ①	Tank height + TBO - BD ②
Volume	>4 mA Setting for Volume	Max. value in the volume table	Max. value in the volume table
Mass	>4 mA Setting for Mass	Max. value in the mass table	Max. value in the mass table
Distance	>4 mA Setting for Distance	Tank Height + TBO + RO ①	Tank height + RO ③
Interface Level	>4 mA Setting for Interface Level	Tank height + TBO + RO ①	Tank height + TBO - BD ②
Interface Distance	>4 mA Setting for Interface Distance	Tank height + TBO + RO ①	Tank height + RO ③
Interface Volume	>4 mA Setting for Interface Volume	Max. value in the volume table	Max. value in the volume table
Interface Mass	>4 mA Setting for Interface Mass	Max. value in the mass table	Max. value in the mass table
Ullage Volume	>4 mA Setting for Ullage Volume	Max. value in the volume table	Max. value in the volume table
Ullage Mass	>4 mA Setting for Ullage Mass	Max. value in the mass table	Max. value in the mass table
Layer	>4 mA Setting for Layer	Tank height + TBO + RO ①	Tank height - BD ④
Layer Volume	>4 mA Setting for Layer Volume	Max. value in the volume table	Max. value in the volume table
Layer Mass	>4 mA Setting for Layer Mass	Max. value in the mass table	Max. value in the mass table

① RO = Reference Offset (C1.10). TBO = Tank Bottom Offset (C.1.11).

② BD = Blocking Distance (C.1.9). TBO = Tank Bottom Offset (C.1.11).

③ RO = Reference Offset (C1.10)

④ BD = Blocking Distance (C.1.9)

6.4 Further information on device configuration

6.4.1 Quick Links

If you frequently use a menu item, you can create a Quick Link. This lets you quickly find and configure items in the advanced setup menu. Five Quick Link memory spaces are available in the **Quick Setup** submenu. Go to **Supervisor > Quick Setup**.

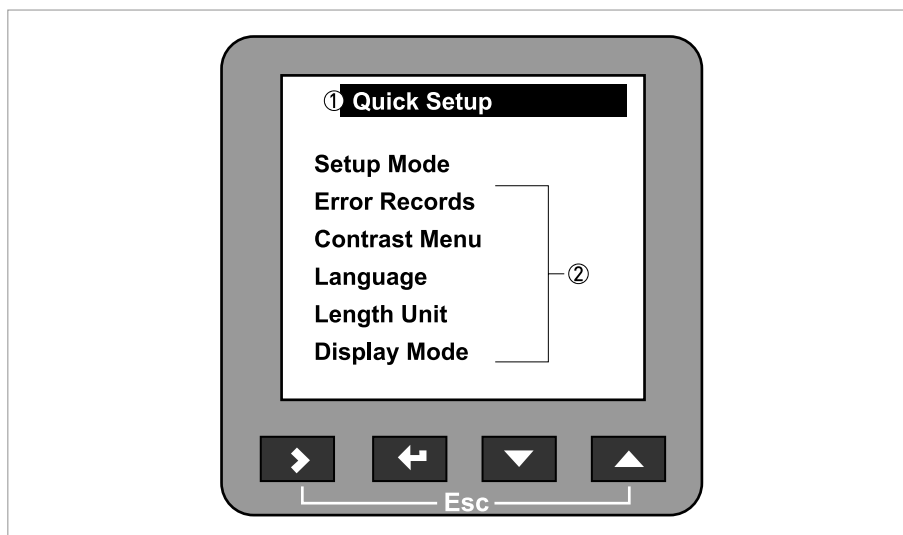


Figure 6-4: The list of quick links

- ① Menu name
- ② Quick links



How to create a Quick Link

- Go to **Supervisor > Advanced Setup**.
- Select a menu item with the Δ and ∇ buttons.
- Press the \blacktriangleright button for 1 second.
- ➡ The device saves this menu item as a Quick Link. Example text: Mass Unit has been assigned to Quick Link 2



INFORMATION!

The Quick Links are saved to one of the five memory spaces. They are saved in sequence. The first Quick Link is saved to Quick Link 1, the second to Quick Link 2 and so on. If you have already saved five Quick Links, the next Quick Link will be saved to Quick Link 1.



How to open a Quick Link

- Go to **Supervisor > Quick Setup**.
- Select a Quick Link with the Δ and ∇ buttons.
- Press the \blacktriangleright button.
- ➡ This opens the menu item. You can configure the device.

6.4.2 Protection of the device settings

The **Passwords** menu lets you change the supervisor password.



How to change the supervisor password

- Go to **Supervisor > Advanced setup > Device setup > Passwords > Supervisor**.
- Type in the new 6-character password (Press the 4 buttons in any sequence).
- Type in the new 6-character password again.
- ➡ If the second entry is not the same as the first, the device will display the error message "Password mismatch". Press > + △ at the same time and type in the new 6-character password again.
- Press > and △ (Esc) at the same time to go back to the "save settings" window.
- Select **Save** and press ↵.
- ➡ The device will go back to operator mode.



INFORMATION!

Make a note of the password and keep it in a safe place. If you lose the password, please contact your supplier.

6.4.3 Network configuration



INFORMATION!

For more data, refer to Networks on page 62.

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 HART® address of output 1.



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

- Enter supervisor mode.
- Go to **Advanced Setup > Output 1 (HART) > HART Address**.
- Enter a value between 1 and 15 and press **↵** to confirm (see the caution below).
- Press the Escape buttons(**> + Δ**) until you get the save/cancel screen.
- Select save.
- Press **↵**.
- ➔ Output 1 switches to multidrop mode. The current output is set to 4 mA. This value does not change in multidrop mode.



CAUTION!

Make sure that the HART® address for this device is different from others in the multidrop network.



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

- Enter supervisor mode.
- Go to **Advanced Setup > Output 1 (HART) > HART Address**.
- Enter the value **0** and then press **↵** to confirm.
- Press the Escape buttons(**> + Δ**) until you get the save/cancel screen.
- Select save.
- Press **↵**.
- ➔ Output 1 switches 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 specified in **Advanced Setup > Output 1 (HART) > Output Range**).

6.4.4 Linearisation

You can use the linearisation table given in function to make sure that readings are consistently accurate.



- Go to **Supervisor > Advanced Setup > Installation Setup > Linearisation Table**.
- Type in the number of reference points (up to 50 points). Press \leftarrow .
- ➡ This shows the linearisation table with default values.
- Press \rightarrow to type in new data. The device reading is given on the second line **Device distance**.
- Fill the to any given level.
- Make an appropriate reference measurement. Type this data on the line **Real distance**.
- Repeat these steps until all the cells in the linearisation table are completed.
- Press \leftarrow .
- Press \rightarrow and Δ (Esc) at the same time to exit to the "save settings" window.
- Select **Save** and press \leftarrow .
- ➡ The device will go back to operator mode.

6.4.5 Distance measurement

The device displays distance measurements when an output is set to distance. Menu items related to distance measurement are:

- Output Function (C.3.1 or C.4.1)
- Tank Height (C.1.2)
- Blocking Distance (C.1.9)

Use the flange facing 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. You can change the reference point from which distance is measured. Use this menu item:

- Reference Offset (C.1.10)



INFORMATION!

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.



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.

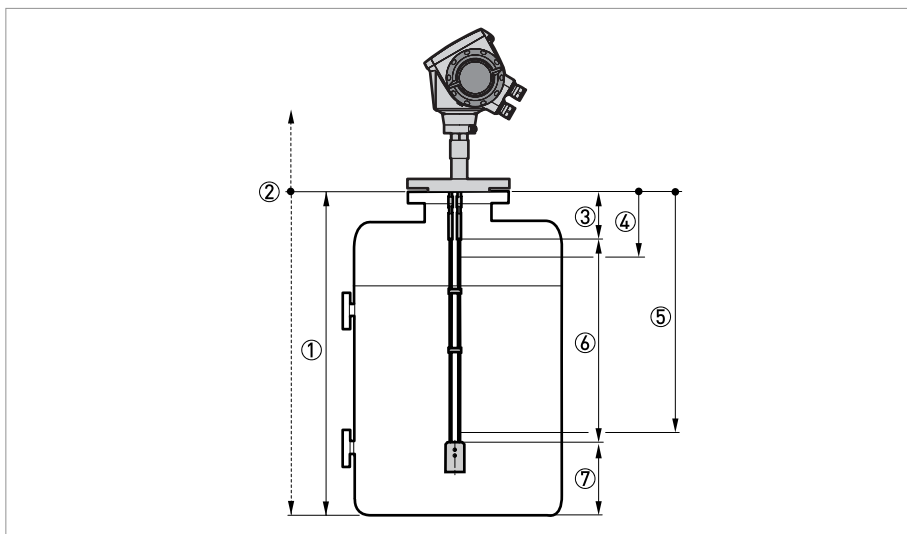


Figure 6-5: Distance measurement

- ① Tank Height [C.1.2]
- ② Reference Offset [C.1.10]
- ③ Blocking Distance [C.1.9]
- ④ 4 mA Setting [C.3.2 or C.4.2]
- ⑤ 20 mA Setting [C.3.3 or C.4.3]
- ⑥ Maximum effective measuring range
- ⑦ Non-measurement zone

For more data about the menu items, refer to *Function description* on page 79, table C. Advanced setup.

6.4.6 Level measurement

The device displays level measurements when an output is set to level. Menu items related to level measurement are:

- Output Function [C.3.1 or C.4.1]
- Tank Height [C.1.2]
- Blocking Distance [C.1.9]

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. You can change the reference point from which level is measured. Use this menu item:

- Tank Bottom Offset [C.1.11]



INFORMATION!

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.



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.

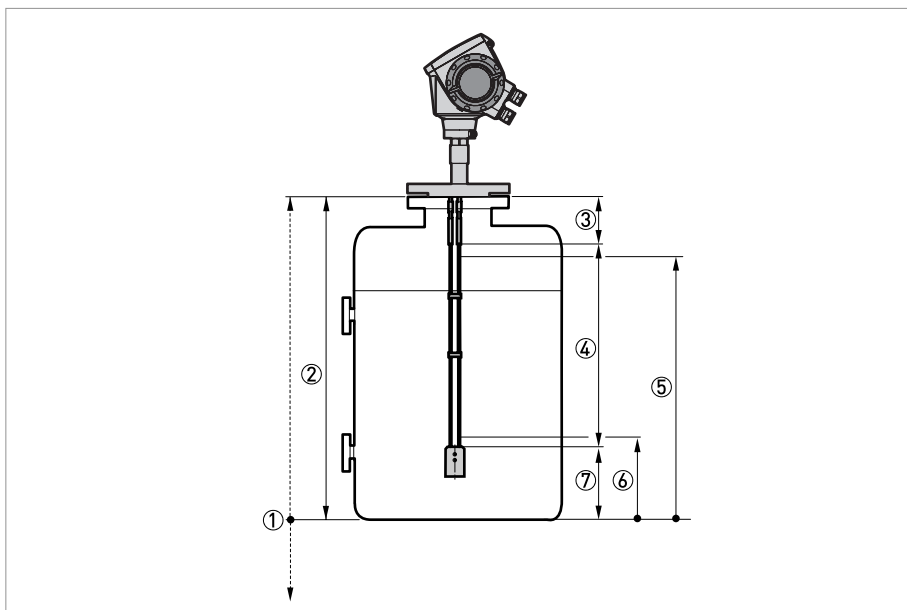


Figure 6-6: Level measurement

- ① Tank Bottom Offset [C.1.11]
- ② Tank Height [C.1.2]
- ③ Blocking Distance [C.1.9]
- ④ Maximum effective measuring range
- ⑤ 20 mA Setting [C.3.3 or C.4.3]
- ⑥ 4 mA Setting [C.3.2 or C.4.2]
- ⑦ Non-measurement zone

For more data about the menu items, refer to *Function description* on page 79, table C. Advanced setup.

6.4.7 How to configure the device to measure volume or mass

The device can be configured to measure volume or mass. The procedure for doing this is given in the device's **Quick Setup** menu.



How to create a volume or mass table.

- Go to **Supervisor > Quick setup > Setup mode > Conversion**.
- Complete all the steps in the set-up procedure.

The device creates a table of up to 50 pairs of data (level - volume or level - mass). The reference point for the table is the tank bottom (as given in menu item C.1.2 Tank height.).



INFORMATION!

*You can also create customized length and conversion units (free units) in the **Conversion** setup procedure.*

**INFORMATION!**

When you create a table, get more conversion data for parts of the tank where there are:

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

This will make volume measurement more accurate.

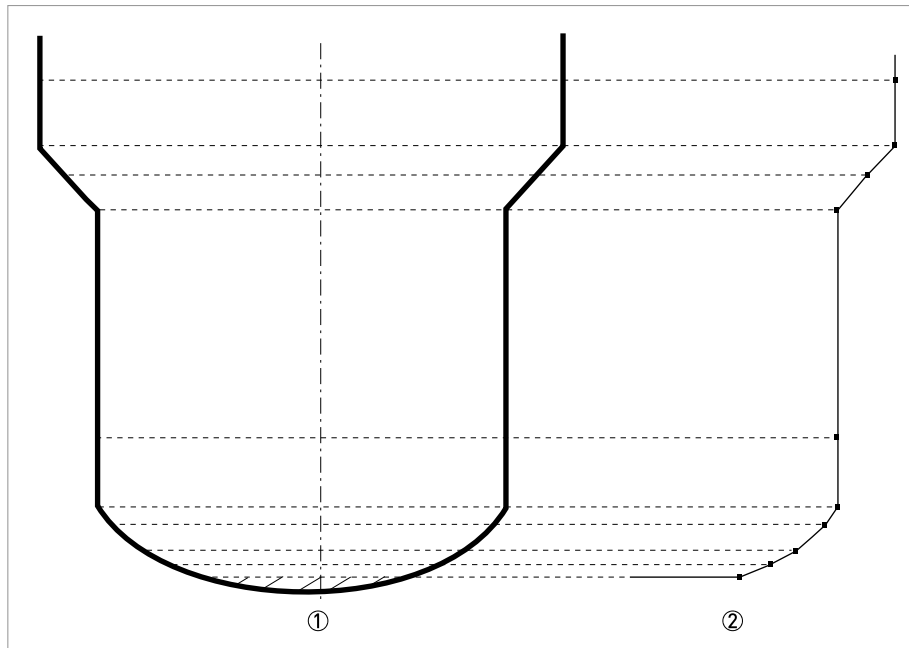


Figure 6-7: A plot of points for a volume or mass table

- ① Tank with reference points
- ② Tank model with plotted points

6.4.8 How to make the device follow the correct level or interface signal

If the distance measurement stays on one value when the level of the product changes, the device has probably selected a parasitic signal as the level signal. You can set the device to the correct value with the **Distance Input** function.

The **Distance Input** function, used with the signal screen, makes the device look for the level or the interface (if the device is configured for interface applications) at the correct point along the probe. A distance value must be given by the supervisor.

**INFORMATION!**

The distance is measured from the facing of the process connection to the surface of the product.

**CAUTION!**

Do not give a distance value that is in the dead zones of the device. For more data, refer to *Measurement limits* on page 143.

**INFORMATION!**

The signal screen is divided into 4 areas, as shown in the illustration that follows:

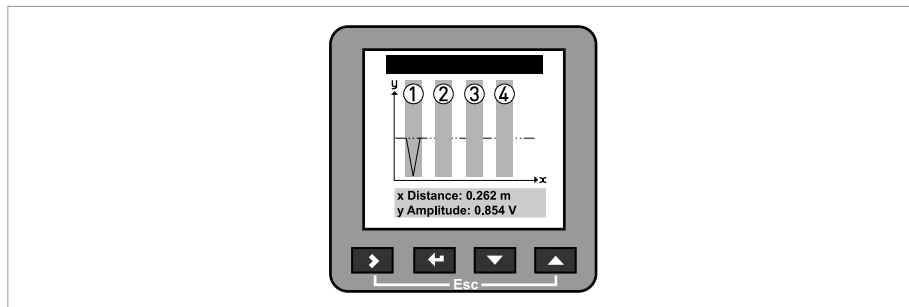


Figure 6-8: Areas on the signal screen

- ① Reference signal area (the value cannot be changed)
- ② Level signal area (use the distance input function to change the level value)
- ③ Interface signal area (use the distance input function to change the interface value)
- ④ Probe end area (in TBF mode only - this value cannot be changed)

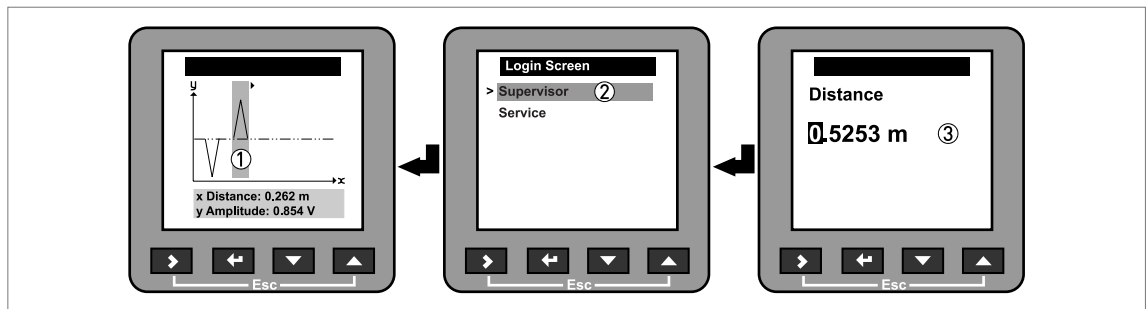


Figure 6-9: How to make the device follow the correct level signal



How to adjust the distance value to make the device measure level correctly

- Go to the signal screen in operator mode. For more data, refer to *Operator mode* on page 71.
- Press **>** one time to move the cursor right to select the level signal ①.
- Make a note of the distance value on the signal screen.
- Press **↵** for three seconds.
- ➡ The program mode screen is displayed.
- Move the cursor to **Supervisor** and press **↵** ②.
- ➡ Type in the supervisor password, if this is necessary. For more data, refer to *How to get access to the supervisor mode* on page 74.
- Type in the distance value ③.
- ➡ The selected signal is the level signal.
- Press **↵** to accept your new value or press **>** and **Δ** (Esc) at the same time to reject it.
- ➡ The display goes back to the signal screen.



How to adjust the interface distance value to make the device measure interface correctly (devices for interface measurement only).

- Go to the signal screen in operator mode. For more data, refer to *Operator mode* on page 71.
- Press **>** 2 times to move the cursor right to select the interface signal.
- Make a note of the distance value on the signal screen.
- Press **↵** for three seconds.
- ➡ The program mode screen is displayed.
- Select **Supervisor** and press **↵**②.
- ➡ Type in the supervisor password, if this is necessary.
- Type in the new interface distance value ③.
- ➡ The selected signal is the interface signal.
- Press **↵** to accept your new value or press **>** and **Δ** (Esc) at the same time to reject it.
- ➡ The display goes back to the signal screen.



INFORMATION!

If the device continues to select the parasitic signal for level or interface measurement, make sure that there are no obstructions in the tank. If you cannot remove the obstruction, use the snapshot function to filter the signal. For more data, refer to How to use the snapshot function to filter parasitic signals on page 106. If you cannot find the correct signal on the signal screen, contact the supplier.

6.4.9 Thresholds and parasitic signals

General notes

The low-power electromagnetic signal from the device goes down the probe. The surface of the process and objects in the tank make reflections. These reflections go back up the probe to the signal converter. The signal converter converts the reflections into voltage amplitudes. Reflections from objects in the tanks show as interference signals (parasites).

How thresholds work

Thresholds let the device ignore reflections with small amplitudes and monitor changes in level or interface. The voltage amplitude of signals depends on the distance of the reflection from the signal converter. Because the voltage amplitude decreases as distance increases, the threshold decreases logarithmically. The device uses largest signal that goes across the threshold.

The device uses the menu items that follow:

- Level Threshold (C.1.16) to monitor the level signal
- Level Threshold (C.1.16) and Interface Threshold (C.1.17) to monitor level and interface signals
- Probe End Threshold (C.1.18) to monitor the probe end signal in TBF or Automatic mode. If the device operates in TBF mode or must calculate the ϵ_r of the product, there must be a good probe end signal.

The electronics of the device amplify the signal. The amplification factor (level of Gain) depends on the strength of the signal. There are 7 levels (1 to 7). A strong signal is given Gain 1, while a weak signal is given Gain 7. When you fill or empty the tank, the device usually identifies the signal. It automatically changes the Gain to monitor the position of the signal. But the device cannot monitor the correct signal if:

- There are too many objects in the tank.
- There is an object that makes a large reflection in the tank.



INFORMATION!

Also refer to *How to use the snapshot function to filter parasitic signals on page 106* to use the snapshot function to filter parasite signals. For more data on menu items, refer to *Function description on page 79* (table C. Advanced setup).

How to use thresholds



INFORMATION!

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

If there is a parasite above the level and the threshold is too low, the device can incorrectly use it as the level signal.

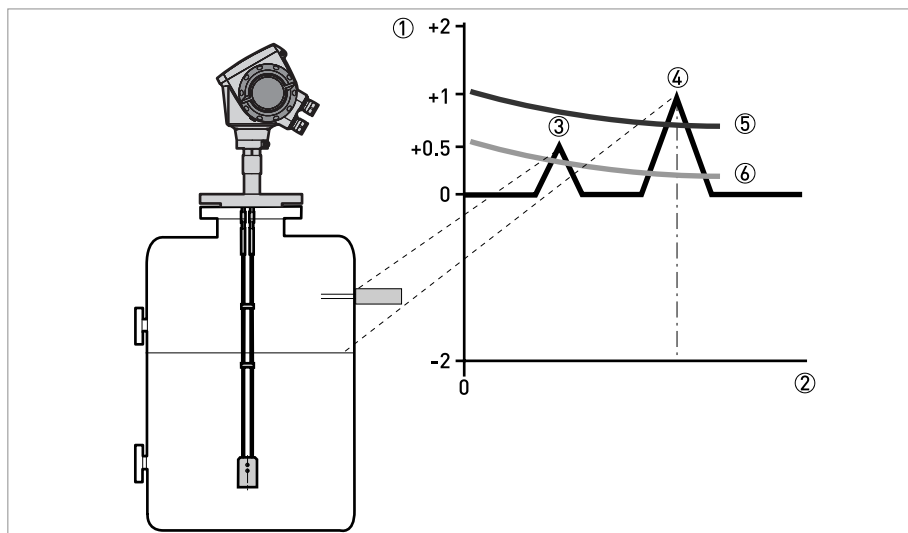


Figure 6-10: Voltage/distance graph: thresholds

- ① Voltage amplitude of the signal in Volts
- ② Distance from the process connection
- ③ Parasitic signal. A signal from a level switch that is in the limits of the electromagnetic field around the probe.
- ④ Level signal of the tank contents
- ⑤ The level threshold is correct. The device ignores the parasitic signal and measures level correctly.
- ⑥ The level threshold is too low. The device can use the parasitic signal as the level signal.



If the parasite is smaller than the correct level, you can manually change the threshold to find the signal. This procedure tells you how to change the level threshold to find the correct signal:

- Look at the signal screen in operator mode.
- ➡ Find the likely position of the parasite and the level signals. Make a note of the amplitude of each signal in volts.
- Go to **Supervisor > Advanced Setup > Installation Setup > Level Threshold**
- ➡ You will see this screen:

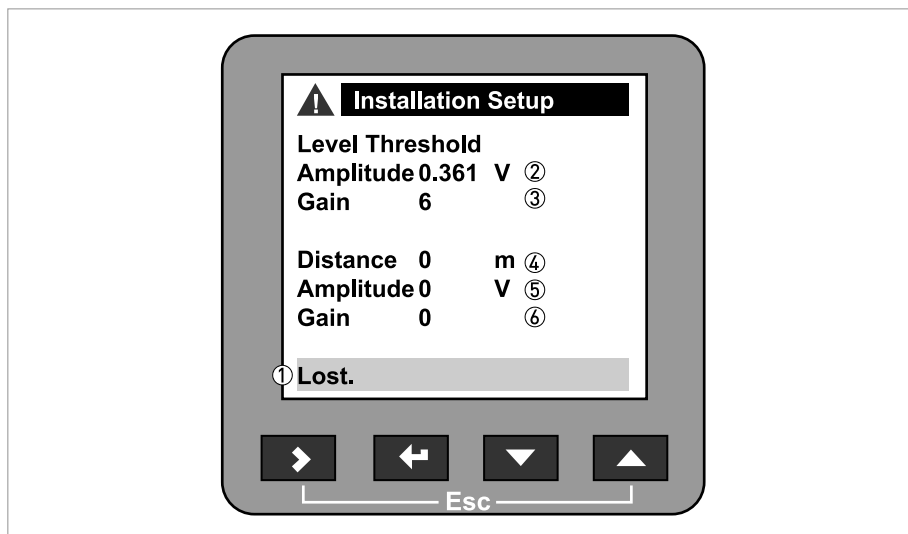


Figure 6-11: Threshold data on the device display screen

- ① Error message "Lost" if the device cannot find a signal
- ② Amplitude of the threshold (in volts)
- ③ Gain of the threshold
- ④ Distance of the monitored signal from the signal converter
- ⑤ Amplitude of the monitored signal (in volts)
- ⑥ Gain of the monitored signal



- Increase the amplitude of the level threshold.
- ➡ This value must be more than the incorrect signal. If there is no parasitic signal, we recommend that you set the level threshold at half the amplitude of the correct signal.
- Use the same gain as that used for the device.
- Save the settings.
- ➡ The threshold increases. It ignores the parasite signal and uses the first signal it finds.



INFORMATION!

If 2 or >2 products are selected in the **Application** setup mode, then the level is the first signal that goes across the level threshold.

Interface threshold

**INFORMATION!**

If the device is set at the factory to measure interface, you can change the interface threshold.

When there is more than one liquid in the tank, the device uses a second threshold to measure interface. The interface threshold identifies:

- The level signal (the first signal that goes across the Level threshold).
- If there are 2 liquids in the tank, the interface signal (the next largest signal). If there are more than 2 liquids in the tank, the next signal after the level signal.

This device uses this data to monitor the interface signal. When you change the interface threshold, refer to **How to use thresholds** in this section. For more data about the interface threshold, refer to *Function description* on page 79 (table C. Advanced setup, menu item C.1.17).

Probe end threshold

**INFORMATION!**

If the device is set at the factory to measure in Tank Bottom Following (TBF) mode or Automatic mode, you can change the probe end threshold.

Use this threshold when the device operates in TBF mode. The device uses 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 ignore parasites. Refer to the procedure in **How to use thresholds** to change the probe end threshold.

For more data about the probe end threshold, refer to *Function description* on page 79 (table C. Advanced setup, menu item C.1.18).

6.4.10 How to use the snapshot function to filter parasitic signals

The thresholds cannot find the level of the tank contents if it is below a large parasitic signal. This shows the signals as you can see them on an oscilloscope:

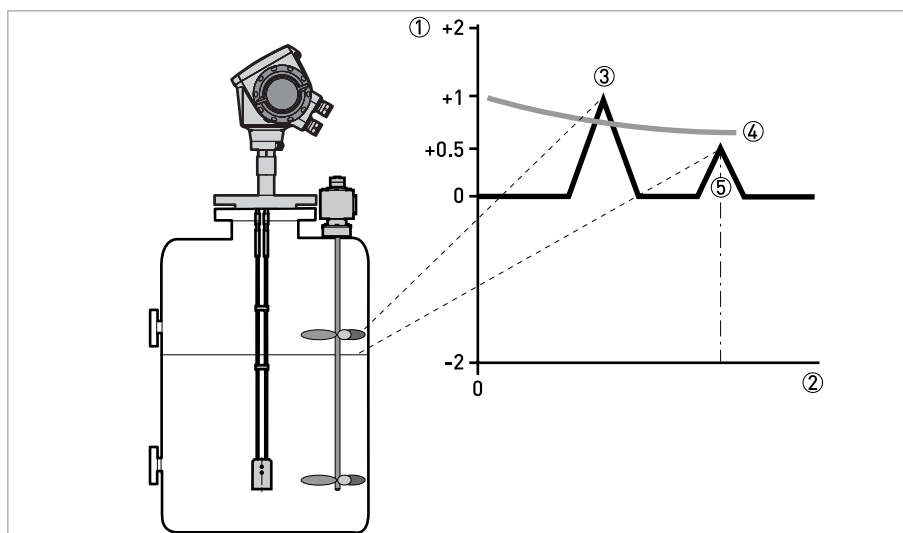


Figure 6-12: Voltage/distance graph: level below a large parasitic signal

- ① Voltage amplitude of the signal in Volts
- ② Distance from the process connection
- ③ Large parasitic signal (an agitator in this example)
- ④ Threshold
- ⑤ Level signal

But you can filter a parasite or an area of parasites with the snapshot function. This procedure tells you how to use the snapshot filter:



- Look at the signal screen in operator mode.
- ➡ Find the likely position of the parasite.
- Look in the tank or at a drawing of internal tank parts.
- ➡ Get the dimensions and position of the object that shows as the parasite.
- Empty the tank.
- Go to **Supervisor > Quick Setup > Setup Mode > Snapshot**
- Do the procedure.
- Save the settings.
- Make sure that the snapshot filter is on.
- Fill the tank.
- ➡ The device will ignore the large parasite signal and use the first signal it finds.

6.4.11 How to measure products with a low dielectric constant (ϵ_r)

The device can measure the level of liquids and solids with low dielectric constants. The minimum value depends on the probe type and the measuring mode.

Measuring mode limits

Measuring mode	Probe type	Minimum dielectric constant
Direct	Coaxial	1.4
	All other probes	1.6
TBF	All probes	1.1

In direct mode, the device directly receives the reflection of the signal from the surface of the tank contents.

TBF mode lets the device measure one product with low ϵ_r . Unlike direct mode, the signal travels through the liquid or solid to the end of the probe. It is reflected back to the electronics. The liquid or solid must have a stable dielectric constant for accurate measurement.



How to prepare an installation for a device that measures in TBF mode

- If the probe end is not attached, the minimum distance between the probe end (of single cable or rod probes) and the tank bottom must be 300 mm / 12". If the device has a coaxial, double rod or cable probe, it is not necessary to have a minimum distance between the probe end and the tank bottom.
- There must be no objects in a diameter of 600 mm / 24" around a single probe. There must be no objects in a diameter of 200 mm / 8" around a double probe. It is not necessary to have an empty space around a coaxial probe.



How to configure the device to measure in TBF mode

- Go to **Supervisor > Advanced Setup > Installation Setup > Measuring Mode**.
- Select TBF from the menu. Press \leftarrow .
- If you know the exact value of the product's dielectric constant, go to **Supervisor > Advanced Setup > Installation Setup > Product Er**.
- Type in the exact value. Press \leftarrow .



CAUTION!

Do not change the product ϵ_r value in **Product ϵ_r** (menu item C.1.14) unless the new value is known. If an incorrect value is used, the device will not measure accurately.



INFORMATION!

The device usually measures in **Automatic** mode. If it cannot find a signal in **Direct** mode, the device will switch automatically to **TBF** mode.

6.4.12 How to decrease the length of probes

**INFORMATION!**

This information is for:

- Ø4 mm / 0.15" double cable,
- single rod,
- Ø2 mm / 0.08" single cable and
- Ø4 mm / 0.15" single cable probes only

**WARNING!**

Do not change the length of coaxial, Ø8 mm / 0.3" single cable and double rod probes. This will damage the probe.

**How to decrease the length of single rod probes**

- Cut the rod to the correct length.
- Measure the length of the rod from the flange facing.
- Go to **Supervisor > Advanced Setup > Installation Setup > Probe Length**.
- Type in the new value. Press \leftarrow .
- Press \rightarrow and Δ (Esc) at the same time to exit to the "save settings" window.
- Select **Save** and press \leftarrow .

**INFORMATION!**

*If you cannot measure the length of the probe, you can use **Quick Setup > Setup Mode > Auto Probe Length** as an alternative. But you must do this procedure when the tank is empty and the device is installed on the tank.*

**How to decrease the length of cable probes**

- Cut the cable to the correct length.
- Attach the cable to the counterweight. Tighten the socket set screws.
- ➡ Use a 3 mm Allen wrench.
- Loosen the socket set screws that hold the counterweight.
- ➡ Use a 3 mm Allen wrench.
- Remove the counterweight.
- Measure the length of the cable from the flange facing to the bottom of the counterweight.
- ➡ Add the length of the counterweight to get the total probe length. Subtract the length of the cable engaged in the counterweight. Refer to the diagram after this procedure.
- Go to **Supervisor > Advanced Setup > Installation Setup > Probe Length**.
- Type in the new value. Press \leftarrow .
- Press \rightarrow and Δ (Esc) at the same time to exit to the "save settings" window.
- Select **Save** and press \leftarrow .

**INFORMATION!**

*If you cannot measure the length of the probe, you can use **Quick Setup > Setup Mode > Auto Probe Length** as an alternative. But you must do this procedure when the tank is empty and the device is installed on top of the tank.*

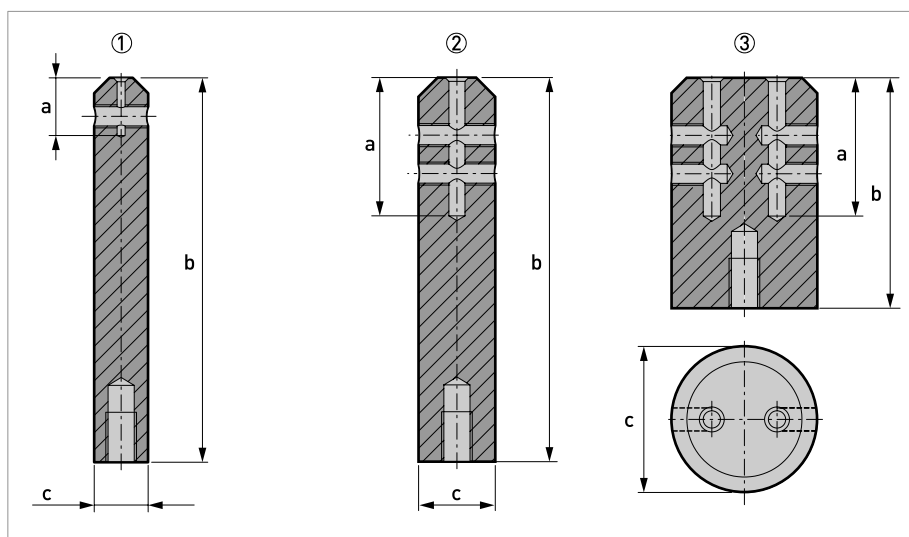


Figure 6-13: Dimensions of the counterweights

① Ø2 mm / 0.08" single cable probe

② Ø4 mm / 0.15" single cable probe

③ Ø4 mm / 0.15" double cable probe

Dimensions in mm

Probe type	Dimensions [mm]		
	a	b	Øc
Single cable Ø2 mm	15	100	14
Single cable Ø4 mm	36	100	20
Double cable Ø4 mm	36	60	38

Dimensions in inches

Probe type	Dimensions [inches]		
	a	b	Øc
Single cable Ø0.08"	0.6	3.9	0.5
Single cable Ø0.15"	1.4	3.9	0.8
Double cable Ø0.15"	1.4	2.4	1.5

6.5 Service mode

Service personnel use this mode to change advanced settings, particularly for difficult applications.



CAUTION!

If you are not an authorized service technician, do not change any values in the service mode menu.

This mode is locked with a password. Only approved persons are permitted to have the password for the service menu. Please contact your local sales office for further information.

6.6 Errors

6.6.1 General information

Indication of errors

When the device senses an error or warning condition, it displays an error / warning symbol in the top left corner of the display screen.



Figure 6-14: Indication of errors

① Error/ warning symbol



How to find the error records

- Enter supervisor mode.
- Go to **Test > Information > Error Records**.
- Use ▾ and ▴ to scroll the error list. There are 5 error messages per page.

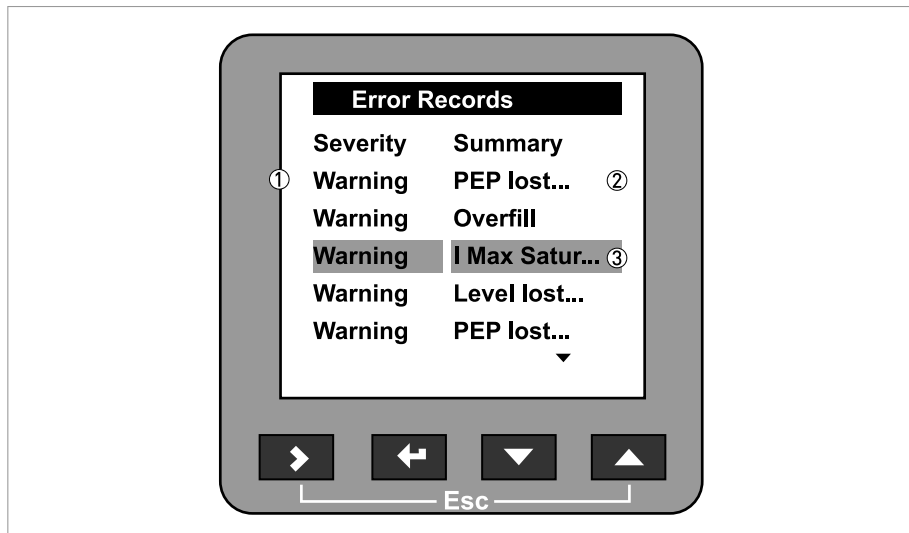


Figure 6-15: Error records in supervisor mode

- ① Type of error.
- ② Short description of the error
- ③ Selection bar



How to get more data about the error (error records function)

- Select an error log and press **←** to read the help text.
- Typical data is given in the illustration that follows.
- For solutions to the problem, refer to the "Error handling" section.

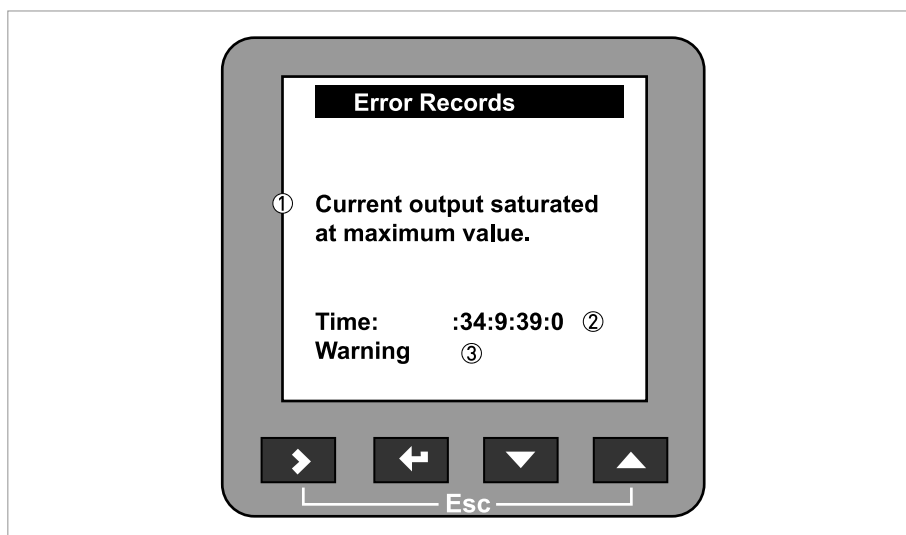


Figure 6-16: Description of the error

- ① Description of the error
- ② Time since error occurred in Days:Hours:Minutes:Seconds
- ③ Type of error

The time since the error occurred is measured in **Days:Hours:Minutes:Seconds**. It only includes the time when the device is energized. The error is saved in the memory of the device when it is switched off. The counter continues when the device is switched back on.

The error symbol is no longer displayed after you read the error record.

6.6.2 Error handling

Types of error message

Type of error	Error code	Description
Error	E	If an error message is displayed in the Error Records (menu item B.2.12), the measured value is not correct. The output current goes to the value set in menu items C.3.5 Error Handling (Output 1) and C.4.5 Error Handling (Output 2). For more data about the menu items, refer to <i>C. Advanced setup</i> on page 87.
Warning	W	A condition that may not have an immediate effect on device performance.

Description of errors and corrective actions

Error Message	Error code	Description	Corrective action
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Current output

Current output saturated at maximum value.	W	The output is at its maximum output value (20 or 20.5 mA) because the measured value is now out of the current output range.	Fill the tank or remove some of the product until the level is back in the configured range. Make sure that the 20 mA setting is correctly set for your installation. If not, change the value in menu item C.3.3 (Output 1) or C.4.3 (Output 2).
Current output saturated at minimum value.	W	The output is at its minimum output value (4 or 3.8 mA) because the measured value is now out of the current output range.	Fill the tank or remove some of the product until the level is back in the configured range. Make sure that the 4 mA setting is correctly set for your installation. If not, change the value in menu item C.3.2 (Output 1) or C.4.2 (Output 2).

External influences

Temperature is out of range for NAND Flash	W	The ambient temperature is outside the given range. This can cause loss or corruption of data.	Switch off the device until the ambient temperature is back in the given range.
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Self-test manager

Self Test has failed	E	The device did not self-test correctly.	Contact the supplier.
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Measurement status

Level measurement lost	E ①	The device can no longer find the product surface. The measurement is held at the last measured value.	Check the tank contents 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, contact your supplier.
		When the level return signal and the probe end return signal are lost. This is applicable to automatic (Direct/TBF) measurement mode only.	
			If the device is in direct mode, adjust the Level Threshold (menu item C.1.16). If the device is in TBF mode, adjust the Probe End Threshold (menu item C.1.18). For more data, refer to <i>Thresholds and parasitic signals</i> on page 102.

Error Message	Error code	Description	Corrective action
Level measurement low	W	The product is in the empty area. The measurement is held at the sensor length.	Fill the tank to at least the bottom of the measuring range to continue measurement.
		The product is outside the measuring range. The measurement is incorrect or held at the last measured value by the device.	
Measurement old	E	This error can occur if the power supply is not sufficient to operate the device correctly for 1 minute. After 1 minute the error message "Measurement old" is recorded. You can change this time in supervisor mode. Go to Advanced Setup > Output 1 > Error Handling Delay (5...300 seconds).	Make sure that the power supply for output 1 has a min./max. value of 14...30 VDC (20...36 VDC for Ex d-approved devices) when current output is at 22 mA.
Interface measurement lost ②	W ③	The device can no longer find the interface.	Check the tank contents using another procedure. If the interface is too low (the interface is below the end of the probe), then fill the tank with interface product until it is in the measurement range. If the interface too high (the interface is in blocking distance), then remove the contents from tank until the interface is back in the measuring range. If it is none of these two, then there is possibly an emulsion at the interface. Wait for the device to find the interface again.
Interface measurement low ②	W	The product is lost in the empty area. The measurement is held at the sensor length.	Fill the tank to at least the bottom of the measuring range to continue measurement.
Layer measurement low ②	W	The layer is less than 50 mm / 2" thick.	Fill the tank with top product until it is at least 50 mm / 2" thick.

Signal status

Reference pulse low amplitude	W	Reference amplitude is less than reference threshold 1. This fault could occur because of electrostatic discharge in solid applications.	Make sure that your installation has ESD protection. For more data, refer to <i>Installation</i> on page 19.
Reference pulse lost	E	Reference amplitude is less than reference threshold 2. This fault could occur because the device hardware is defective.	Make sure that your installation has ESD protection. For more data, refer to <i>Nozzles on conical silos</i> on page 37. Contact your supplier to check that the electronics are still functioning correctly.

Error Message	Error code	Description	Corrective action
Level pulse lost	W	This shows that the device lost the level signal in direct mode but finds the signal for the end of the probe. It will continue to measure level in tank bottom following (TBF) mode. This warning is only displayed in automatic measurement mode.	The device continues to measure in TBF mode. If the device does not measure correctly, make sure the amplitude of the level threshold is correct. For more data, refer to <i>Thresholds and parasitic signals</i> on page 102.
Probe end pulse lost	W	The probe end pulse amplitude is less than the probe end threshold. This means the device cannot find the probe end to measure level in TBF mode. The device uses direct mode as an alternative to TBF mode. This error is only displayed in automatic measurement mode.	The dielectric constant of the tank contents is too high. Check that the Measurement Mode (menu item C.1.13) is set to Direct or Automatic .

Operating status

Overfill	W ③	The tank is full. The level or the interface signal is lost in the full area. The measurement is held at the blocking distance value.	This is also used for applications with WHG approval. Danger of overflow! Remove the contents from the tank until it is at a safe level.
Dielectric constant out of range	W	The dielectric constant, ϵ_r , calculated by the device is outside the given range. This only occurs if the dielectric constant is automatically calculated (not set by default).	Check that the probe does not touch the process connection (short circuit). Attach the end of the probe or install it in a stilling well or bypass chamber. Check the programmed probe length in supervisor mode. Go to Supervisor > Test > Information > Probe Length . If the setting does not agree with the real value, change this value in Supervisor mode. Go to Supervisor > Advanced Setup > Installation Setup > Probe Length .

Hardware status

Front end out of order	E	The device's hardware is defective.	Contact your supplier.
5 volts faulty	E	The device's hardware is defective.	Contact your supplier.
Time base fault or not running	E	The device's hardware is defective.	Contact your supplier.
Electronic offset	W	The device's hardware is defective.	Contact your supplier.
Time out measurement cycle	E	The device's hardware is defective.	Contact your supplier.

- ① You can change the error code (E) to the warning code (W) in the service menu. For more data, contact your supplier.
- ② This message is available if the device has the "interface" option and "Interface" or "Level + Interface" is set in the Application quick setup menu
- ③ You can change the warning code (W) to the error code (E) in the service menu. For more data, contact your supplier.

7.1 Periodic maintenance

No maintenance is necessary.

7.2 Keep the device clean



DANGER!

Risk of electrostatic discharge from the plastic sun cover and the conduit of the remote housing option.



WARNING!

Do not clean plastic parts in a hazardous area.



Obey these instructions:

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

7.3 How to replace device components

7.3.1 Service warranty

Maintenance is not necessary for most applications.

Servicing by the customer is limited by warranty to:

- The removal and installation of the signal converter housing. For more data, refer to *How to turn or remove the signal converter* on page 56.
- The removal and installation of the complete electronic module.
- The removal and installation of the terminal module.
- The removal and installation of the HMI cover.

This housing can be detached from the flange system under process conditions.

Use only authorized service staff to repair the device.

7.3.2 Replacement of the display cover

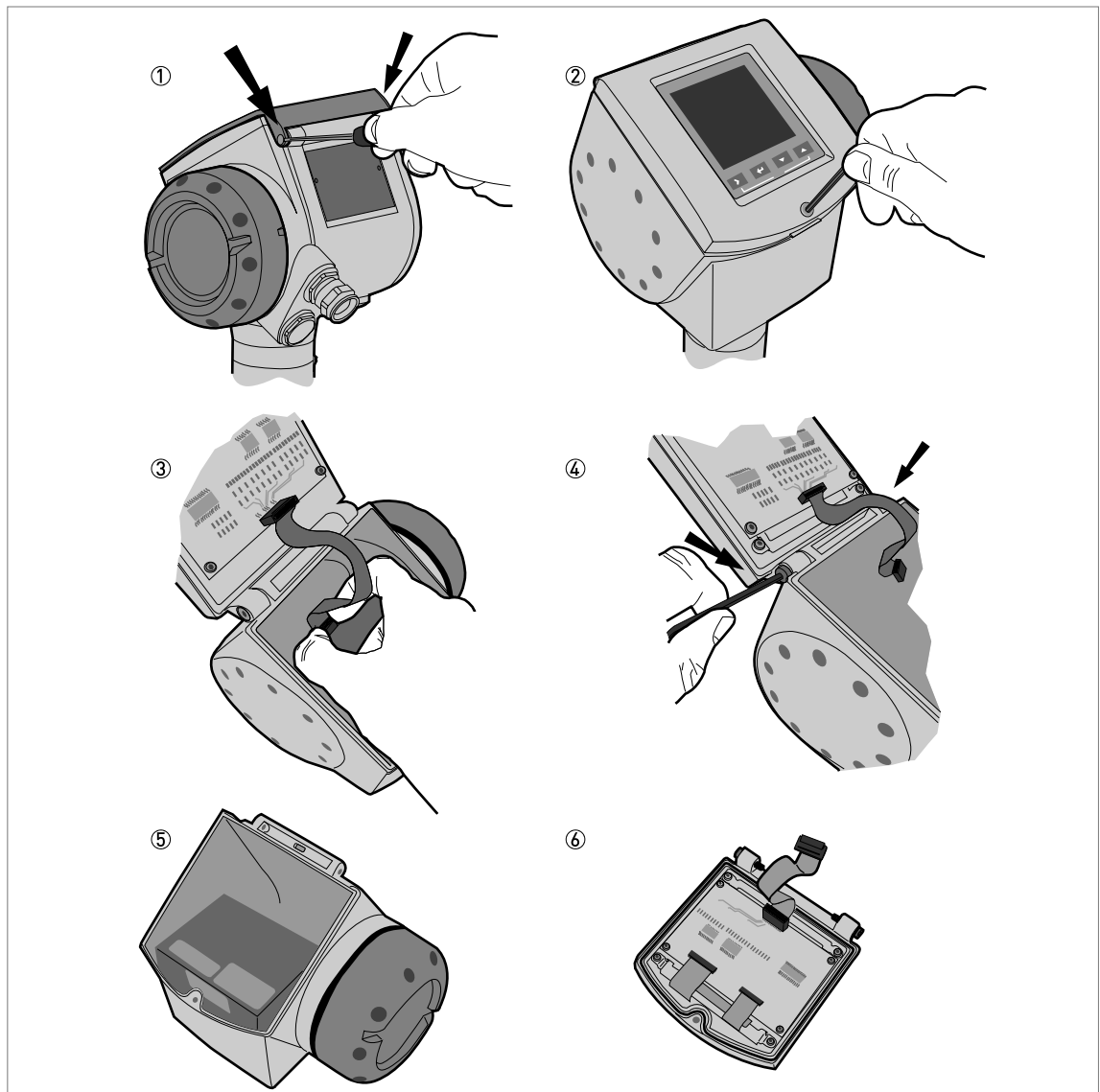


Figure 7-1: Removal of the device display cover

Equipment needed (not supplied):

- Slotted tip screwdriver.
- 3 mm Allen wrench (for steps 2 and 4).

**WARNING!**

Disconnect the power supply

**How to remove the display**

- ① Remove the 2 pins on the gray sun cover with a slotted tip screwdriver. Remove the sun cover.
- ② Loosen the screw on the display screen cover. Open the display.
- ③ Disconnect the ribbon cable from the back end electronics block.
➡ Keep the ribbon cable connected to the display screen cover.
- ④ Remove the 2 screws that keep the display attached to the housing.
- ⑤ Keep the remaining assembly and put it into storage. Make sure that the top of the housing has a protective cover.
- ⑥ Send the display to an authorized agent for maintenance.

**How to attach the display**

- Attach the display. Attach the 2 housing screws.
- Connect the ribbon cable to the back end electronics block.
➡ Make sure the connector is correctly turned. Do not use force to connect the ribbon cable.
- Close the display. Tighten the screw on the display.
- Attach the sun cover. Attach the 2 pins that keep the sun cover attached to the housing.

7.3.3 Replacement of the complete electronic module

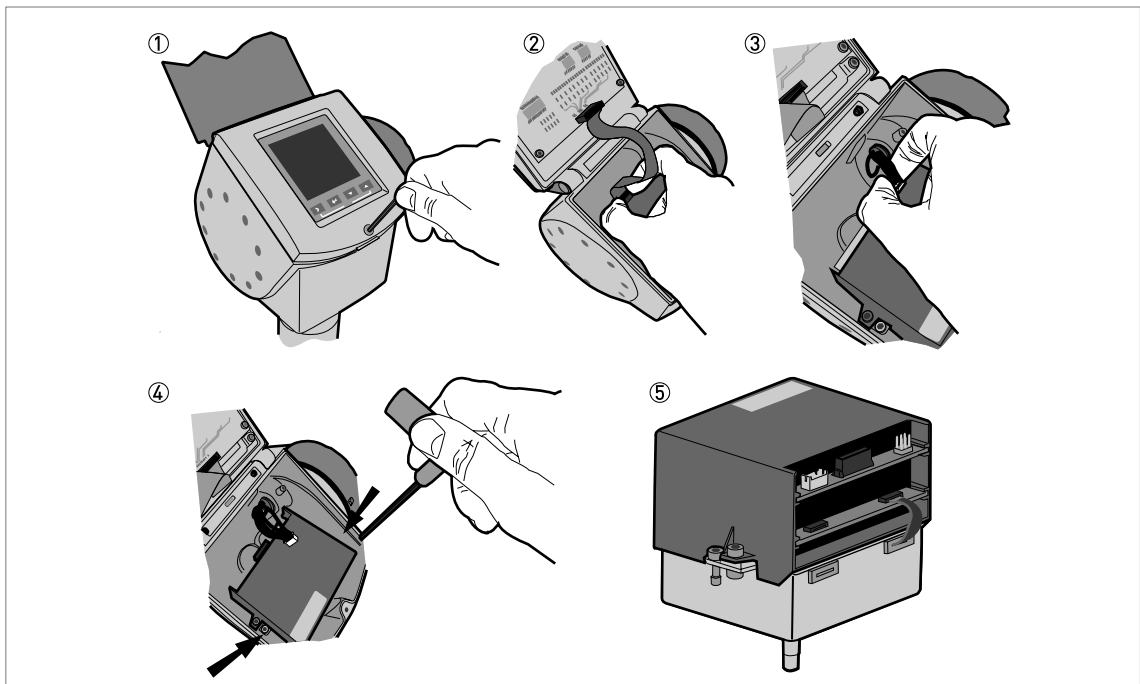


Figure 7-2: Removal of the complete electronic module

Equipment needed (not supplied):

- 3 mm Allen wrench (for steps 1 and 4).

**How to remove the back end and microwave unit**

- ① Loosen the screw on the display. Open the display.
- ② Disconnect the power supply connector from the electronics block.
- ③ Disconnect the display ribbon cable from the back end electronics block.
- ④ Loosen the 2 screws shown in the illustration.
- ➡ Do not loosen the other screws. You will disassemble the electronics block into 2 pieces. It is then difficult to remove these pieces from the housing.
- ⑤ Remove the back end and microwave unit from the housing. Send the electronics block to an authorized agent for maintenance.

**How to attach the back end and microwave unit**

- Open the display.
- Put the electronics block into the housing. Make sure that the wave guide engages in the mating part.
- Tighten the 2 screws to attach the electronics block to the bottom of the housing.
- Connect the display ribbon cable to the back end electronics block.
- Connect power supply connector to the back end electronics block.
- Close the display. Tighten the screw on the display.

7.3.4 Replacement of the terminal module

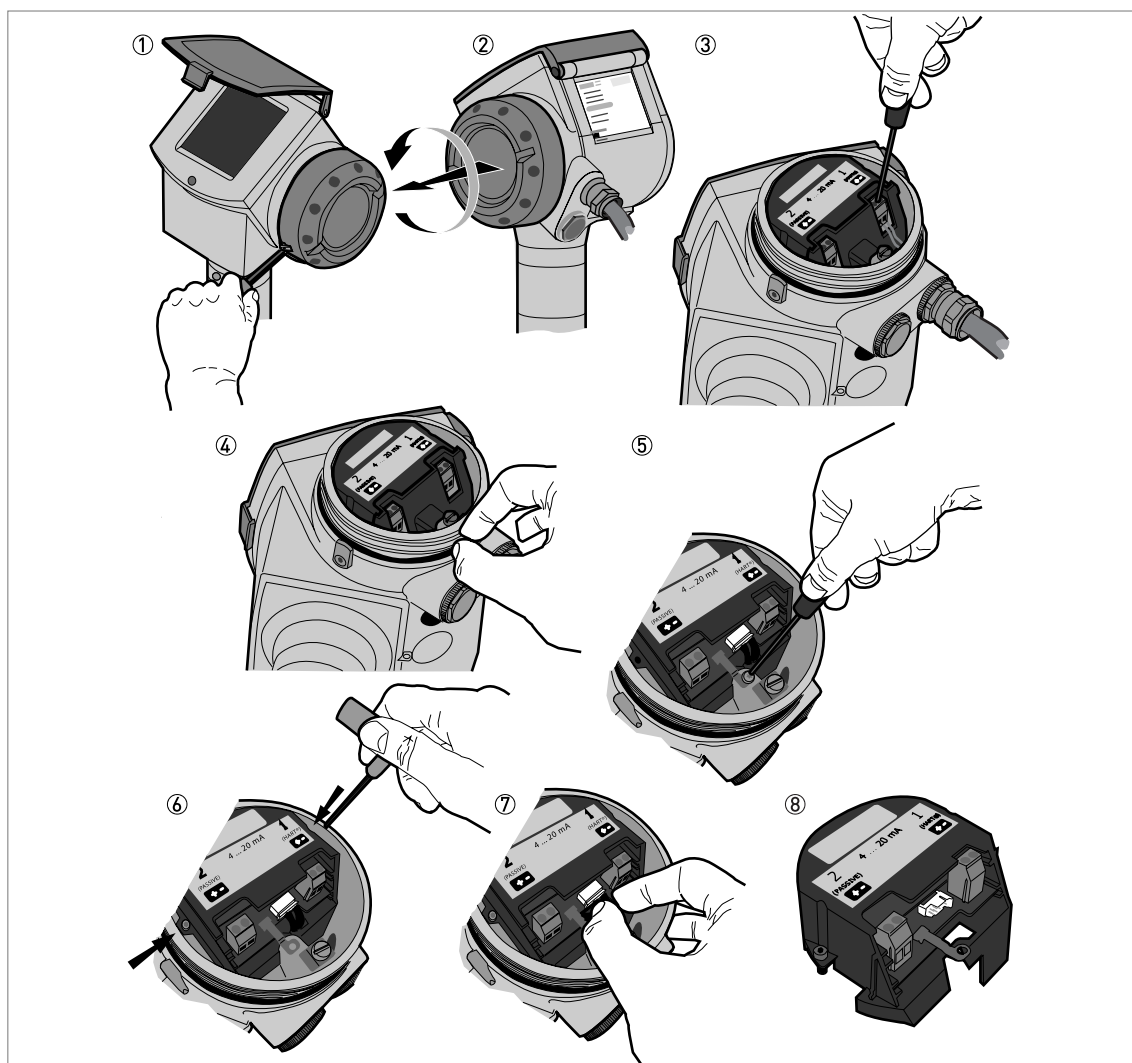


Figure 7-3: Removal of the terminal module

Equipment needed (not supplied):

- 2.5 mm Allen wrench for Aluminium (painted) housings; 3 mm Allen wrench for Stainless Steel housings (for step 1).
- Small slotted tip screwdriver (for step 3).
- TORX T10 wrench (for step 5).
- 2.5 mm Allen wrench (for step 6).

**WARNING!**

Disconnect the power supply.

**How to remove the terminal module**

- ① Loosen the cover stop screw on the terminal compartment cover.
- ② Remove the terminal compartment cover.
- ③ Disconnect the 2 wires from the power supply.
- ④ Remove the plastic terminal cover.
- ⑤ Loosen the screw for the earth terminal connection.
- ⑥ Loosen the 2 screws shown in the illustration.
- ⑦ Disconnect the wire connector from the terminal module.
- ⑧ Remove the terminal block from the housing. Send it to an authorized agent for maintenance.

**WARNING!**

If you do not push the wires away from the screw holes when you attach the terminal block, there is a risk of damage to the wires.

**How to attach the terminal module**

- Connect the wire connector to the terminal module.
- Push the wires into the slot below the connector on the terminal block.
- Turn the terminal block one time to twist the wires.
- Put the terminal block into the housing. Make sure that you push the wires away from the screw holes.
- Attach the terminal block to the housing with 2 screws supplied.
- Attach the earth terminal connection to the housing with the screw supplied.
- Attach the plastic terminal cover.
- Connect the 2 wires from the power supply. Make sure that the polarity of the wires is correct.
- Attach the terminal compartment cover.
- Tighten the cover stop screw.

7.4 Spare parts availability

The manufacturer adheres to the basic principle that functionally adequate spare parts for each device or each important accessory part will be kept available for a period of 3 years after delivery of the last production run for the device.

This regulation only applies to spare parts which are subject to wear and tear under normal operating conditions.

7.4.1 List of spare parts

We supply spare parts for this device. When you order spare parts, please give the reference numbers that follow:

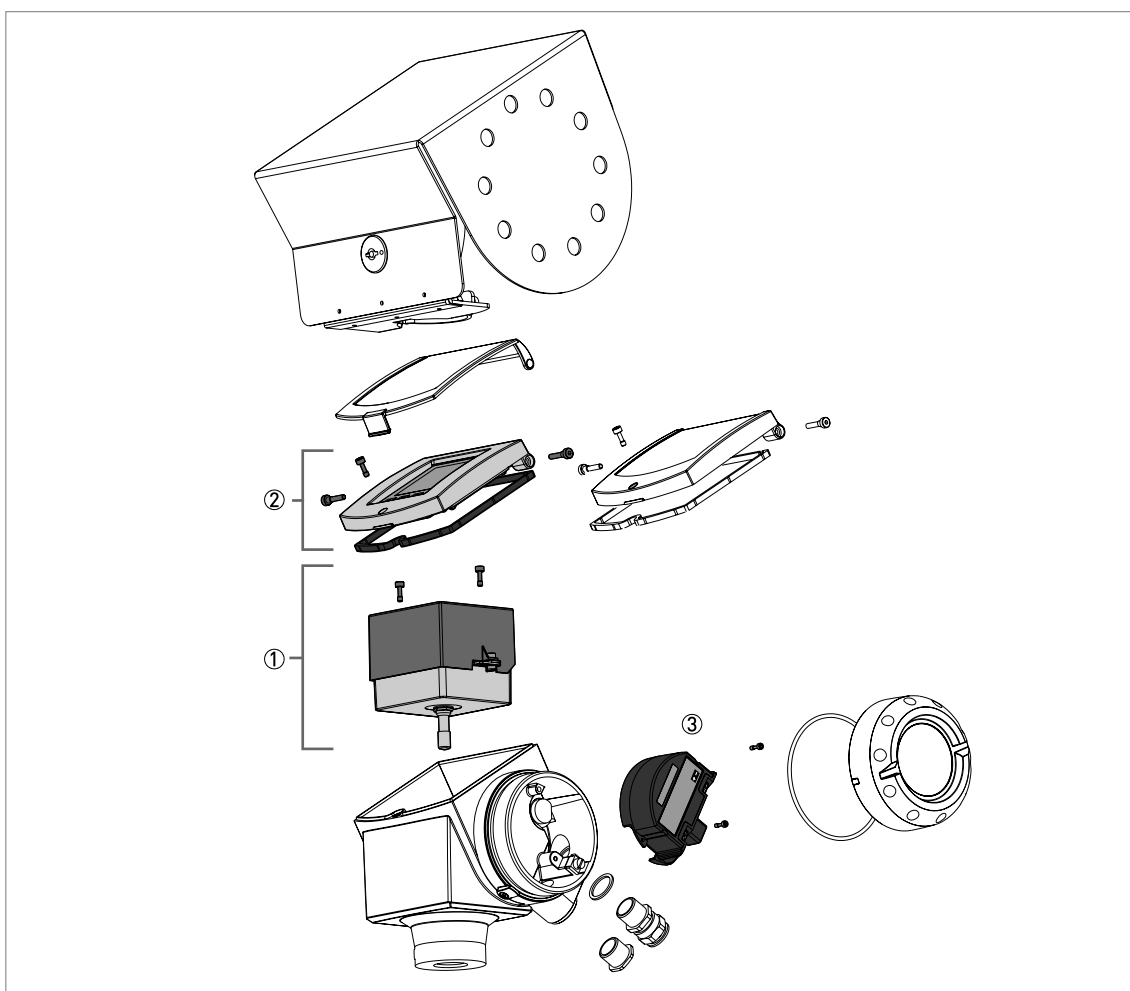


Figure 7-4: Spare parts

Part numbers for spare parts

Item number	Description	Quantity	Part reference
①	Complete electronic module ①	1	XM7140000000040000
	Screws for the combined back end and HF modules	2	F3177360000
②	HMI cover and cable (aluminium housing) ②	1	XM71400000000501V0
	HMI cover and cable (stainless steel housing) ②	1	XM71400000000F01V0
③	Terminal module with 1 output (non-Ex)	1	XM71400000000310V0
	Terminal module with 1 output (ATEX - Ex ia)	1	XM71420000000310V0
	Terminal module with 1 output (FM - IS) ③	1	XF71460000000310V0
	Terminal module with 1 output (CSA - IS) ③	1	XM714H0000000310V0
	Terminal module with 1 output (IECEX - Ex ia) ③	1	XM714M0000000310V0
	Terminal module with 1 output (ATEX - Ex d[ia])	1	XM71430000000E10V0
	Terminal module with 1 output (FM - XP) ③	1	XM71470000000E10V0
	Terminal module with 1 output (CSA - XP) ③	1	XM714K0000000E10V0
	Terminal module with 1 output (IECEX - Ex d[ia]) ③	1	XM714N0000000E1000
	Terminal module with 2 outputs (non-Ex)	1	XM7140000000032000
	Terminal module with 2 outputs (ATEX - Ex ia)	1	XM71420000000320V0
	Terminal module with 2 outputs (FM - IS) ③	1	XM71460000000320V0
	Terminal module with 2 outputs (CSA - IS) ③	1	XM714H0000000320V0
	Terminal module with 2 outputs (IECEX - Ex ia) ③	1	XM714M0000000320V0
	Terminal module with 2 outputs (ATEX - Ex d[ia])	1	XM71430000000E20V0
	Terminal module with 2 outputs (FM - XP) ③	1	XM71470000000E20V0
	Terminal module with 2 outputs (CSA - XP) ③	1	XM714K0000000E20V0
	Terminal module with 2 outputs (IECEX - Ex d[ia]) ③	1	XM714N0000000E20V0
	Terminal module with FOUNDATION Fieldbus output ④	1	XM714000000003A0V0
	Terminal module with PROFIBUS PA output ④	1	XM714000000003D0V0
	Screws for the terminal module	2	F3177350000

① The customer must send the original back end and HF module to the repair centre. Refer to the replacement procedure in this section. If the device is for an interface application, give this information in your request.

② This reference includes the gasket and screws

③ Pending

④ 4-wire + local HART

7.4.2 List of accessories

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

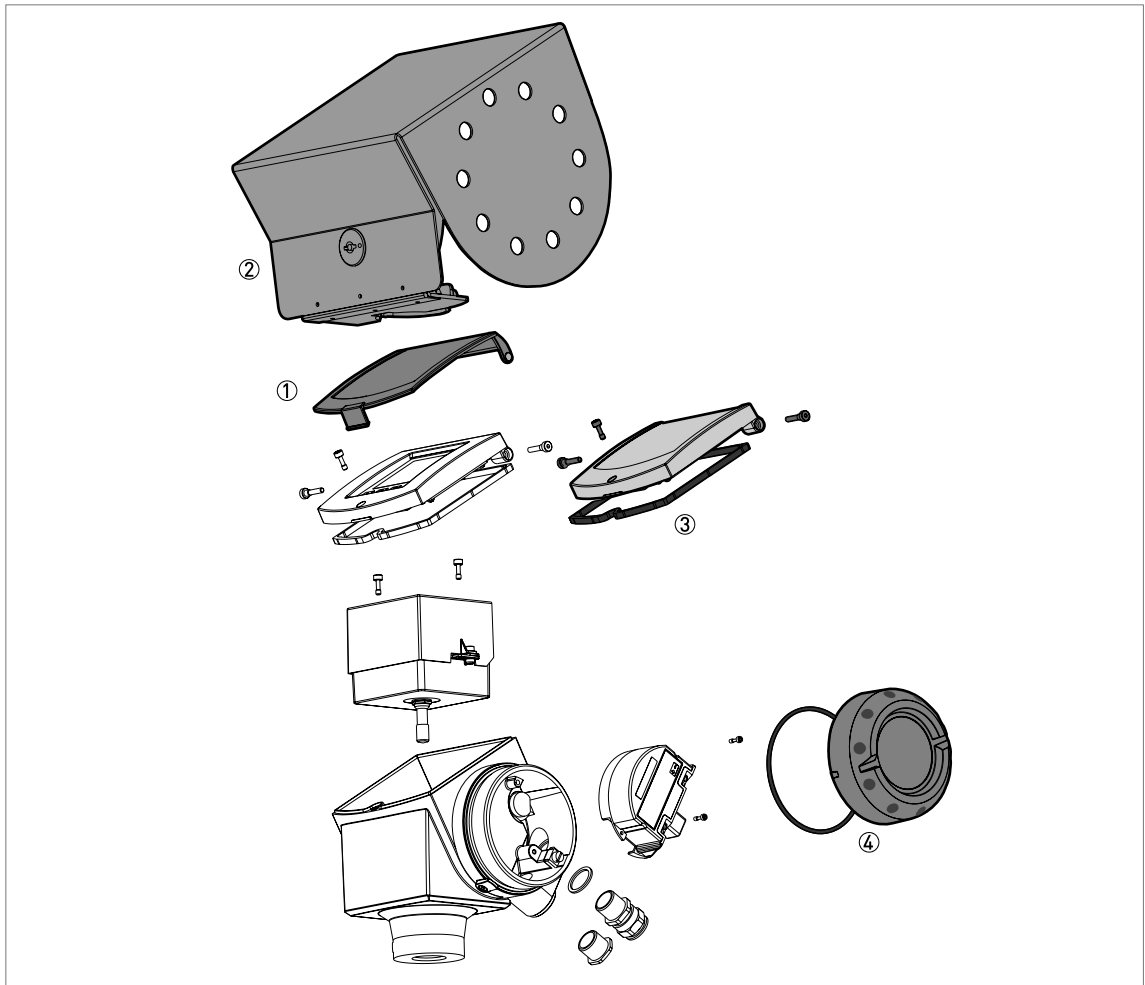


Figure 7-5: Accessories

Part numbers for accessories

Item number	Description	Quantity	Part reference
①	Plastic sun cover	1	XM71400000000000VA
	Pins for the plastic sun cover	2	F3179990000
②	Stainless steel weather protection	1	XM70400000000000V1
③	Blind cover (with a gasket and screws)	1	XM71400000000000VB
	Gasket for the blind cover	1	F3177420000
	Hinge screws for the blind cover	2	F3177340000
	Lock screw for the blind cover	1	F3177360000
④	Wiring compartment cover (with a gasket)	1	XM71400000000000V4
	Gasket for the wiring compartment cover	1	F5091150000
n/a	Converter VIATOR RS232 / HART® ①	1	XM71400000000000VC
	Converter USB / HART® ①	1	XM71400000000000VD

① This accessory is for HART® or PACTware™ communication

7.5 Availability of services

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



INFORMATION!

For more precise information, please contact your local representative.

7.6 Returning the device to the manufacturer

7.6.1 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.



CAUTION!

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 our personnel, 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.*



CAUTION!

If the device has been operated with toxic, caustic, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralizing, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that is safe to handle and stating the product used.*

7.6.2 Form (for copying) to accompany a returned device

Company:		Address:	
Department:		Name:	
Tel. no.:		Fax no.:	
Manufacturer's order no. or serial no.:			
The device has been operated with the following medium:			
This medium is:	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:			

7.7 Disposal

**CAUTION!**

Disposal must be carried out in accordance with legislation applicable in your country.

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 half a 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 meter converter at 80% of its original intensity).

The device measures the time from when the pulse is transmitted 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 and interface measurement principle (direct measurement)

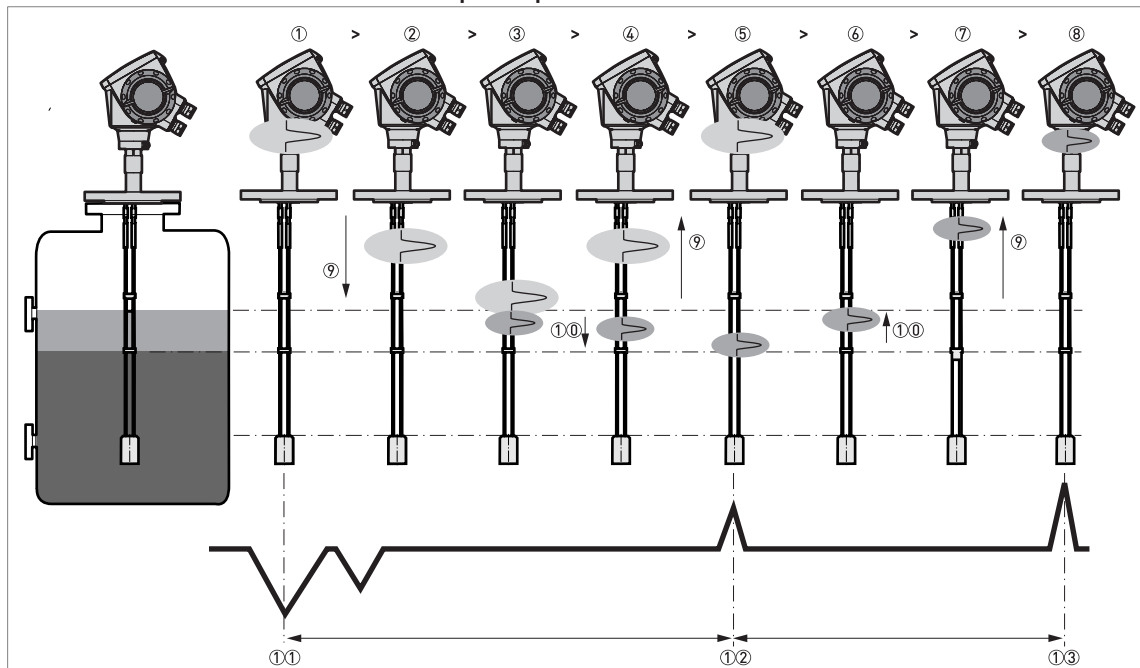


Figure 8-2: Level and interface measurement principle (2 liquids in the tank)

- 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)

If products have a very low dielectric constant ($\epsilon_r < 1.6$), 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 representative.
- Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website.

Measuring system

Measuring principle	2-wire loop-powered level transmitter; Time Domain Reflectometry (TDR)
Application range	Level measurement of liquids, pastes, slurries, powders and granulates
Primary measured value	Time between the emitted and received signal
Secondary measured value	Distance, level, volume, mass and/or interface

Design

Construction	The measurement system consists of a measuring sensor (probe) and a signal converter which is available in a compact or remote version
Options	Integrated LCD display with sun cover [-20...+60°C / -4...+140°F]; if the ambient temperature is not in these limits, the display switches off
	2nd current output
	ESD protection (max. 30 kV)
	Metaglas® (dual process sealing system for dangerous products (ammonia, chlorine, ...)) ①
	Remote housing connected to the probe via a flexible conduit Standard lengths: 2 m / 6.6 ft, 4.5 m / 14.8 ft, 9.5 m / 31.2 ft and 14.5 m / 47.6 ft
	Probe end types (not for rod and coaxial probes) Standard: Counterweights (refer to counterweight dimensions in "Technical data: Dimensions and weights".) Options: Turnbuckle, chuck, threaded end, crimped end, open end
Accessories	Weather protection
Max. measuring range	Double rod Ø8 mm / 0.3": 4 m / 13 ft
	Single rod Ø8 mm / 0.3": 4 m / 13 ft
	Single rod Ø8 mm / 0.3" (segmented): 6 m / 20 ft
	Coaxial Ø22 mm / 0.9": 6 m / 20 ft
	Coaxial Ø22 mm / 0.9" (segmented): 6 m / 20 ft
	Double cable Ø4 mm / 0.15": 8 m / 26 ft
	Single cable Ø2 mm / 0.08": 35 m / 115 ft (for liquids only)
	Single cable Ø4 mm / 0.15": 35 m / 115 ft (For liquids only. An angled probe is available on request for installations with very low ceilings or objects in the tank that prevent installation on top of the tank)
Dead zone	Single cable Ø8 mm / 0.3": 35 m / 115 ft (For solids only. Tolerance, probe length: -1%/+0%.)
	This depends on the type of probe. For more data, refer to <i>Measurement limits</i> on page 143.
Display and User interface	
Display	LCD display
	9 lines, 160×160 pixels in 8-step grayscale with 4-button keypad
Interface languages	English, German, French, Italian, Spanish, Portuguese, Japanese, Chinese (Mandarin) and Russian

Accuracy

Resolution	1 mm / 0.04"
Repeatability	±1 mm / ±0.04"
Accuracy (in direct mode)	Liquids: ±3 mm / ±0.12", when distance < 10 m / 33 ft; ±0.03% of measured distance, when distance > 10 m / 33 ft
	Powders: ±20 mm / ±0.8"
	Interface: ±10 mm / ±0.4" (ϵ_r constant)
Accuracy (in TBF mode)	±20 mm / ±0.8" (ϵ_r constant)
Minimum layer (interface)	50 mm / 2"
Reference conditions acc. to EN 60770	
Temperature	+20°C ±5°C / +68°F ±10°F
Pressure	1013 mbara ±20 mbar / 14.69 psia ±0.29 psi
Relative air humidity	60% ±15%

Operating conditions

Temperature	
Ambient temperature	-40...+80°C / -40...+175°F (Ex: see supplementary operating instructions or approval certificates)
Storage temperature	-40...+85°C / -40...+185°F
Process connection temperature	Standard -40...+200°C / -40...+390°F (according to the temperature limits of the gasket material. Refer to "Material" in this table.) (Ex: see supplementary operating instructions or approval certificates) ②
	High-Temperature (HT) and High-Temperature / High-Pressure (HT/HP) versions with FKM/FPM and Kalrez® 6375 gaskets +300°C / +570°F (single cable Ø2 mm / 0.08" probe only) (Ex: see supplementary operating instructions or approval certificates) ②
	HT and HT/HP versions with EPDM gaskets +250°C / +480°F (single cable Ø2 mm / 0.08" probe only) (Ex: see supplementary operating instructions or approval certificates) ②
Thermal shock resistance	100°C/min
Pressure	
Operating pressure	Single cable Ø8 mm / 0.3" probe -1...40 barg / -14.5...580 psig subject to process connection temperature and probe type used ②
	High-Pressure (HP) version max. 300 barg / 4350 psig (single cable Ø2 mm / 0.08" probe only) subject to process connection temperature and probe type used ②
	All other probe types -1...100 barg / -14.5...1450 psig subject to process connection temperature and probe type used ②

Other conditions	
Dielectric constant (ϵ_r)	Level in direct mode: ≥ 1.4 for coaxial probe; ≥ 1.6 for single and double probes
	Interface in direct mode: $\epsilon_r(\text{interface}) \gg \epsilon_r(\text{level})^2$
	Level in TBF mode: ≥ 1.1
Vibration resistance	IEC 60068-2-6 and EN 50178 (10...57 Hz: 0.075 mm / 57...150 Hz: 1g)
Protection category	IP 66/67 equivalent to NEMA 6-6X

Installation conditions

Process connection size	Refer to "Installation: How to prepare the tank before you install the device" and "Technical data: Measurement limits"
Process connection position	Make sure that there are not any obstructions directly below the process connection for the device.
Dimensions and weights	Refer to "Technical data: Dimensions and weights"

Material

Housing	Standard: Aluminium
	Option: Stainless steel (1.4404 / 316L)
Single rod (single-piece)	Standard: Stainless steel (1.4404 / 316L)
	Option: Hastelloy® C-22 [2.4602] ③
	On request: Stainless steel (1.4404 / 316L) in a PVC, PVDF or PP protective sheath
	On request: Monel; Tantalum; Titanium; Duplex
Single rod (segmented)	Standard: Stainless steel (1.4404 / 316L)
Double rod	Standard: Stainless steel (1.4404 / 316L)
	Option: Hastelloy® C-22 [2.4602]
	On request: Monel; Tantalum; Titanium; Duplex
Coaxial (single-piece)	Standard: Stainless steel (1.4404 / 316L)
	Option: Hastelloy® C-22 [2.4602]
Coaxial (segmented)	Standard: Stainless steel (1.4404 / 316L)
Single cable	Standard: Stainless steel (1.4401 / 316)
	Option: Hastelloy® C-22 [2.4602] - only for the Ø2 mm / 0.08" or Ø4 mm / 0.15" single cable probes
	On request: FEP-coated stainless steel (-20...+150°C / -4...+300°F) - only for the Ø4 mm / 0.15" single cable probe
Double cable	Stainless steel (1.4401 / 316)
Process fitting	Standard: Stainless steel (1.4404 / 316 L)
	Option: Hastelloy® C-22 [2.4602]
	On request: Monel; Tantalum; Titanium; Duplex
Gaskets	FKM/FPM (-40...+200°C / -40...+390°F); Kalrez® 6375 (-20...+200°C / -4...+390°F); EPDM (-50...+150°C / -58...+300°F) - all probes except single cable Ø8 mm / 0.3" ④
Weather protection (Option)	Stainless steel (1.4301 / 304)
Protective sheath (On request for single rod only)	PP (-40...+90°C / -40...+194°F); PVC (-15...+80°C / +5...+176°F); PVDF (-40...+150°C / -40...+300°F)
Conduit for remote housing (Option)	Zinc-coated steel in a PVC sheath (-40...+105°C / -40...+220°F)

Process connections

Thread	
Single cable Ø2 mm / 0.08"	G ½; ½ NPT; ½ NPTF (for the HT/HP version)
Single cable Ø8 mm / 0.3"	G 1½; 1½ NPT
All other probes	G ¾...1½; ¾...1½ NPT
Flange versions for single cable Ø8 mm / 0.3", double rod and double cable probes	
EN	DN40...150 in PN16, PN40, PN63 or PN100; others on request
ASME	1½"...8" in 150 lb, 1½"...6" in 300 lb, 1½"...4" in 600 lb or 900 lb; 1½"...2" in 1500 lb; others on request
JIS	40...100A in 10K; others on request
Flange versions for single cable Ø2 mm / 0.08" probe	
EN	DN25...150 in PN16, PN40, PN63 or PN100; others on request
ASME	1"...8" in 150 lb, 1½"...6" in 300 lb, 1"...4" in 600 lb or 900 lb, 1"...2" in 1500 lb, 1" in 2500 lb; others on request
JIS	40...100A in 10K; others on request
Flange versions for all other probes	
EN	DN25...150 in PN16, PN40, PN63 or PN100; others on request
ASME	1"...8" in 150 lb, 1½"...6" in 300 lb, 1"...4" in 600 lb or 900 lb, 1"...2" in 1500 lb; others on request
JIS	40...100A in 10K; others on request
Other options for single and double rod probes	
SMS	Available on request
Tri-clamp	Available on request
Others	Others on request

Electrical connections

Power supply	Terminals output 1 - Non-Ex / Ex i: 14...30 VDC; min./max. value for an output of 22 mA at the terminal
	Terminals output 1 - Ex d: 20...36 VDC; min./max. value for an output of 22 mA at the terminal
	Terminals output 2 - Non-Ex / Ex i / Ex d: 10...30 VDC; min./max. value for an output of 22 mA at the terminal (additional power supply needed - output only)
Cable entry	M20×1.5; ½ NPT
	G ½ (not for FM- and CSA-approved devices. Not for stainless steel housings.)
	M25×1.5 (for stainless steel housings only)
Cable gland	Standard: none
	Options: M20×1.5 (for non-Ex and Ex-approved devices with M20×1.5 and M25×1.5 cable entries); others are available on request
Cable entry capacity (terminal)	0.5...1.5 mm²

Input and output

Current output	
Output signal (Output 1)	4...20 mA HART® or 3.8...20.5 mA acc. to NAMUR NE 43 ⑤
Output signal (Output 2 - optional)	4...20 mA (no HART® signal) or 3.8...20.5 mA acc. to NAMUR NE 43 (optional)

Resolution	±3 µA
Temperature drift	Typically 50 ppm/K
Error signal	High: 22 mA; Low: 3.6 mA acc. to NAMUR NE 43
PROFIBUS PA	
Type	4-wire (+ local HART) level transmitter; Time Domain Reflectometry (TDR)
Function blocks	11 (level, distance, interface level, interface distance, layer, interface conversion, ullage conversion, layer conversion, level conversion, level mass and distance mass)
Protocol / Communication standard	PROFIBUS PA protocol that agrees with IEC 61158-2, galvanically isolated
Physical layer types	Standard power signaling, bus powered, non I.S.
Other features	Bus interface with integrated reverse polarity protection
Device power supply (24 V input)	18...30 VDC
Current consumption on PROFIBUS network	20 mA
Output data	Level, distance, interface level, interface distance, layer, interface conversion, ullage conversion, layer conversion, level conversion, level mass and distance mass
Input data	None
Error current FDE	Typically 0 mA (FDE =Fault Disconnection Electronic)
Address range	0...125. Default address: 126.
FOUNDATION Fieldbus	
Type	4-wire (+ local HART) level transmitter; Time Domain Reflectometry (TDR)
Function blocks	1 × Resource Block (RB), 4 × Analog Input Blocks (AI), 1 × Transducer Block (TB) Analog Input Block: 50 ms
Protocol / Communication standard	Foundation Fieldbus protocol that agrees with IEC 61158-2, galvanically isolated
ITK version	5.1
Physical layer types	Standard power signaling, bus powered, non I.S.
Other features	Bus interface with integrated reverse polarity protection
Device power supply (24 V input)	18...30 VDC
Bus power supply	9...32 VDC (non-Ex); 9...17.5 VDC (intrinsically-safe)
Basic current	20 mA
Maximum error current	20 mA
Start current after 10 ms	20 mA
Polar sensitivity	Yes
Minimum cycle time	100 ms
Output data	Level, distance, level conversion, interface level, interface distance, layer, interface conversion, ullage conversion, layer conversion, level conversion, level mass or distance mass
Input data	None
Error current FDE	Typically 0 mA (FDE =Fault Disconnection Electronic)
Link Master function	Not supported

Approvals and certification

CE	This device fulfills the statutory requirements of the EC directives. The manufacturer certifies successful testing of the product by applying the CE mark.
Explosion protection	
ATEX (approval for fieldbus outputs pending)	ATEX II 1 G, 1/2 G, 2 G Ex ia IIC T6...T2;
	ATEX II 1 D, 1/2 D, 2 D Ex iaD 20 or Ex iaD 20/21 IP6X T70°C...T95°C;
	ATEX II 1/2 G, 2 G Ex d[ia] IIC T6...T2;
	ATEX II 1/2 D, 2 D Ex tD[iaD] A21/20 IP6X T70°C...T95°C;
	ATEX II 3 G Ex nA IIC T6...T2
IECEx (pending)	Ex ia IIC T6...T3 Ga; Ex iaD 20 IP6X T70°C...T95°C;
	Ex d[ia] IIC T6...T3 Ga/Gb; Ex tD[iaD] A21/20 IP6X T70°C...T95°C
FM - Dual Seal-approved (pending)	NEC 500
	XP-IS, Cl. I, Div. 1, Gr. ABCD T6...T2;
	DIP, Cl. II/III, Div. 1, Gr. EFG T6...T2;
	IS, Cl. I/II/III, Div. 1, Gr. ABCDEFG T6...T2;
	NI, Cl. I, Div. 2, Gr. ABCD T6...T2
	NEC 505
	Cl. I, Zone 0, AEx d[ia] IIC T6...T2;
	Cl. I, Zone 0, AEx ia IIC T6...T2;
	Cl. I, Zone 2, AEx nA[ia] IIC T6...T2
	Hazardous (Classified) Locations, indoor/outdoor Type 4X and 6P, IP66, Dual Seal
CSA - Dual Seal-approved (pending)	CEC Section 18 (Zone ratings)
	Cl. I, Zone 1, Ex d, IIC (Probe: Zone 0) T6...T2;
	Cl. I, Zone 0, Ex ia, IIC T6...T2;
	Cl. I, Zone 2, Ex nA, IIC T6...T2
	CEC Section 18 and Annex J (Division ratings)
	XP-IS, Cl. I, Div. 2, Gr. ABCD; Cl. II, Div. 2, Gr. FG; Cl. III, Div. 2 T6...T2;
	IS, Cl. I, Div. 1, Gr. ABCD; Cl. II, Gr. EFG; Cl. III T6...T2
Other standards and approvals	
EMC	Electromagnetic Compatibility Directive 2004/108/EC in conjunction with EN 61326-1 (2006) and EN 61326-2-3 (2006). The device agrees with this standard if: - the device has a coaxial probe or - the device has a single / double probe that is installed in a metallic tank. For more data, refer to <i>Electromagnetic compatibility</i> on page 9.
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
Construction code	On request: NACE MR0175 / ISO 15156

① Metaglas® is a registered trademark of Herberts Industrieglas, GMBH & Co., KG

② Refer to the Pressure/Temperature table for probe selection

③ Hastelloy® is a registered trademark of Haynes International, Inc.

④ Kalrez® is a registered trademark of DuPont Performance Elastomers L.L.C.

⑤ HART® is a registered trademark of the HART Communication Foundation

8.3 Pressure/temperature table for probe selection

Make sure that the transmitters are used within their operating limits.

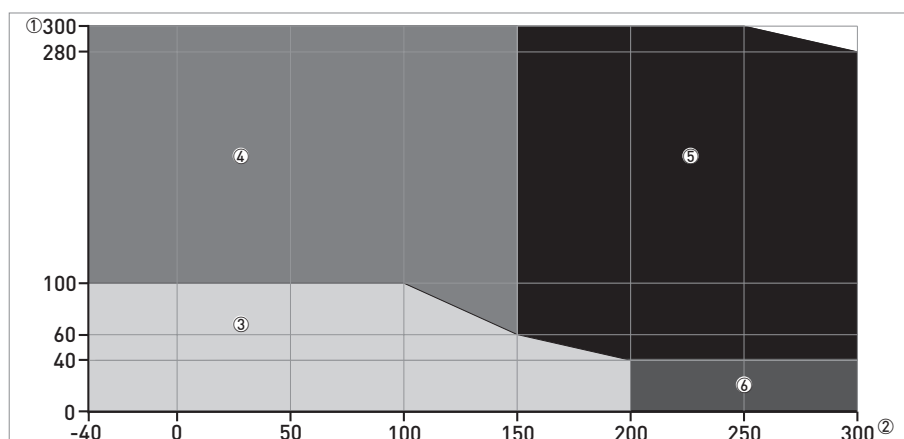


Figure 8-3: Pressure/temperature table for probe selection

- ① Process pressure, P_s [barg]
- ② Process connection temperature, T [°C]
- ③ All probes
- ④ High-Pressure (HP) version of the Ø2 mm single cable probe
- ⑤ High-Temperature/High-Pressure (HT/HP) version of the Ø2 mm single cable probe
- ⑥ High-Temperature (HT) version of the Ø2 mm single cable probe

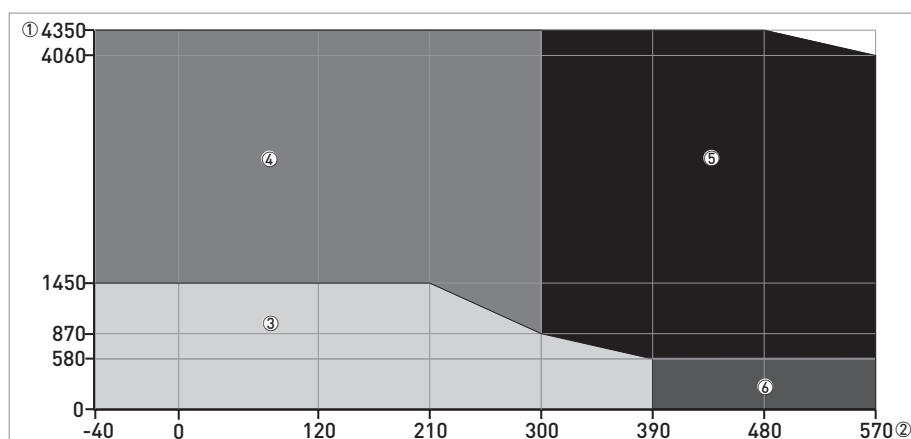


Figure 8-4: Pressure/temperature table for probe selection

- ① Process pressure, P_s [psig]
- ② Process connection temperature, T [°F]
- ③ All probes
- ④ High-Pressure (HP) version of the Ø0.08" single cable probe
- ⑤ High-Temperature/High-Pressure (HT/HP) version of the Ø0.08" single cable probe
- ⑥ High-Temperature (HT) version of the Ø0.08" single cable probe



WARNING!

The minimum and maximum process connection temperature and the minimum and maximum process pressure also depends on the gasket material selected. Refer to "Pressure and temperature ranges" on page 22.

8.4 Measurement limits

Double cable and double rod probes

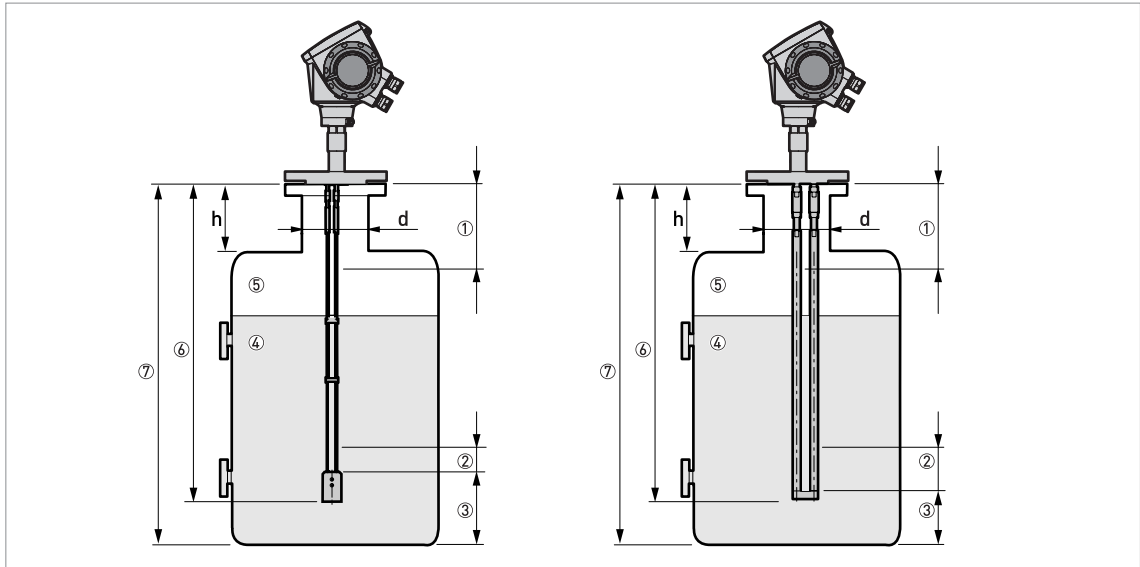


Figure 8-5: Measurement limits of the double cable probes (on the left side) and double rod probes (on the right side)

- ① **A1, Top dead zone:** Distance from the flange to the top limit of the measuring range. Refer to the notes and table that follow.
- ② **A2, Bottom dead zone:** Length at the end of the probe, where measurement is not linear.
- ③ **D, non measurement zone:** Zone where measurement cannot be taken.
- ④ **Product 1**
- ⑤ **Gas (Air)**
- ⑥ **L, Probe length:** Length specified by the customer in the order. This is also the maximum measuring length for some probe types in direct mode and all devices that operate in TBF mode.
- ⑦ **Tank Height**



INFORMATION!

***h** is the height of the nozzle. **d** is the diameter of the tank nozzle.*



INFORMATION!

- If $h < d$, then the top dead zone (A1) is equal to the top dead zone for the probe only. Refer to the table that follows.
- If $h \geq d$, then the top dead zone (A1) is equal to the tank nozzle height plus the top dead zone for the probe.

Measurement limits in mm and inches

Probes	Top dead zone, A1 $\epsilon_r = 80$		Bottom dead zone, A2 $\epsilon_r = 80$		Top dead zone, A1 $\epsilon_r = 2.3$		Bottom dead zone, A2 $\epsilon_r = 2.3$	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Double rod Double cable	125	4.9	10	0.4	165	6.5	50	1.95

80 is ϵ_r of water; 2.3 is ϵ_r of oil

Single cable and single rod probes

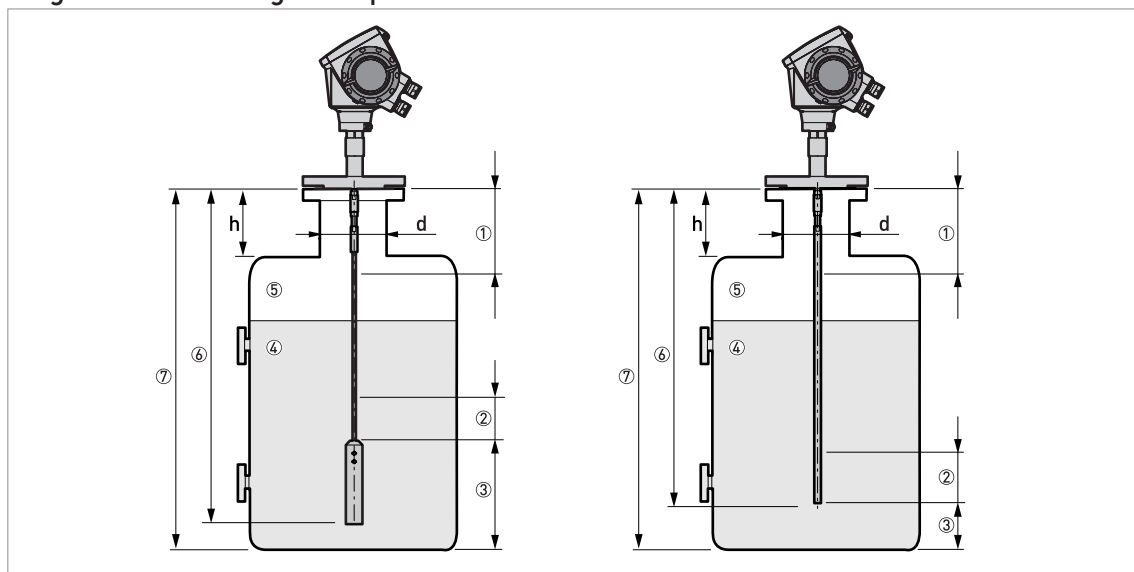


Figure 8-6: Measurement limits of the single cable probes (on the left side) and single rod probes (on the right side)

- ① **A1, Top dead zone:** Distance from the flange to the top limit of the measuring range. Refer to the notes and table that follow.
- ② **A2, Bottom dead zone:** Length at the end of the probe, where measurement is not linear.
- ③ **D, non measurement zone:** Zone where measurement cannot be taken.
- ④ **Product 1**
- ⑤ **Gas (Air)**
- ⑥ **L, Probe length:** Length specified by the customer in the order. This is also the maximum measuring length for some probe types in direct mode and all devices that operate in TBF mode.
- ⑦ **Tank Height**

**INFORMATION!**

h is the height of the nozzle. *d* is the diameter of the tank nozzle.

**INFORMATION!**

- If $h < d$, then the top dead zone (A1) is equal to the top dead zone for the probe only. Refer to the table that follows.
- If $h \geq d$, then the top dead zone (A1) is equal to the tank nozzle height plus the top dead zone for the probe.

Measurement limits in mm and inches

Probes	Top dead zone, A1 $\epsilon_r = 80$		Bottom dead zone, A2 $\epsilon_r = 80$		Top dead zone, A1 $\epsilon_r = 2.3$		Bottom dead zone, A2 $\epsilon_r = 2.3$	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Single rod	200	7.9	10	0.4	250	9.9	50	1.95
Single cable								

Coaxial probe

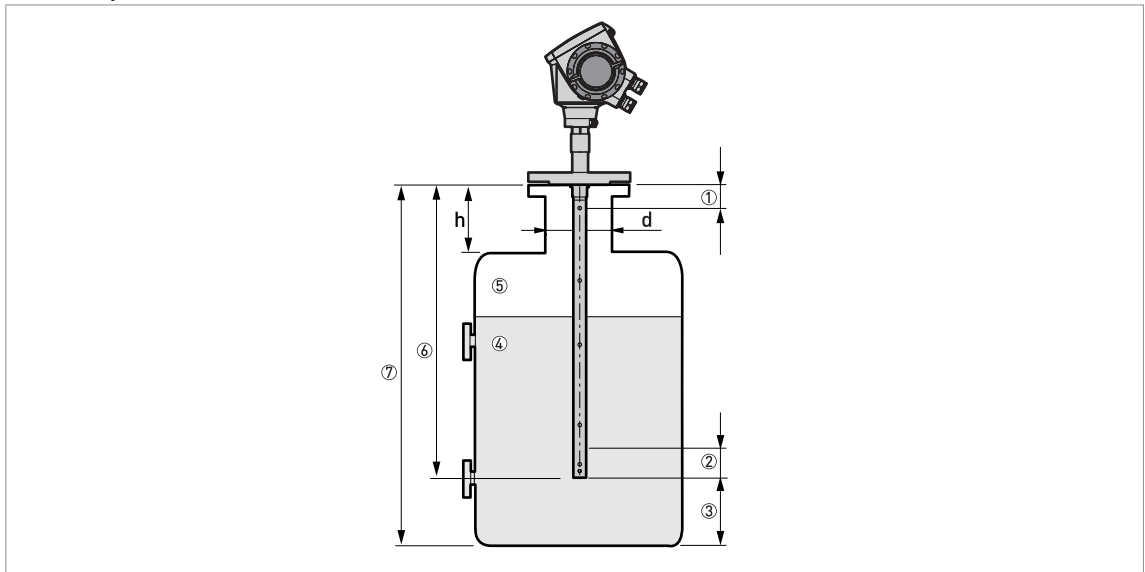


Figure 8-7: Measurement limits of the coaxial probe

- ① **A1, Top dead zone:** Distance from the flange to the top limit of the measuring range. Refer to the notes and table that follow.
- ② **A2, Bottom dead zone:** Length at the end of the probe, where measurement is not linear.
- ③ **D, non measurement zone:** Zone where measurement cannot be taken.
- ④ **Product 1**
- ⑤ **Gas (Air)**
- ⑥ **L, Probe length:** Length specified by the customer in the order. This is also the maximum measuring length for some probe types in direct mode and all devices that operate in TBF mode.
- ⑦ **Tank Height**

**INFORMATION!**

h is the height of the nozzle. *d* is the diameter of the tank nozzle.

**INFORMATION!**

The dimensions of the tank nozzle have no effect on the top dead zone of the coaxial probe.

Measurement limits in mm and inches

Probes	Top dead zone, A1 $\epsilon_r = 80$		Bottom dead zone, A2 $\epsilon_r = 80$		Top dead zone, A1 $\epsilon_r = 2.3$		Bottom dead zone, A2 $\epsilon_r = 2.3$	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Coaxial	10	0.4	10	0.4	10	0.4	50	1.95

8.5 Dimensions and weights

Standard converter

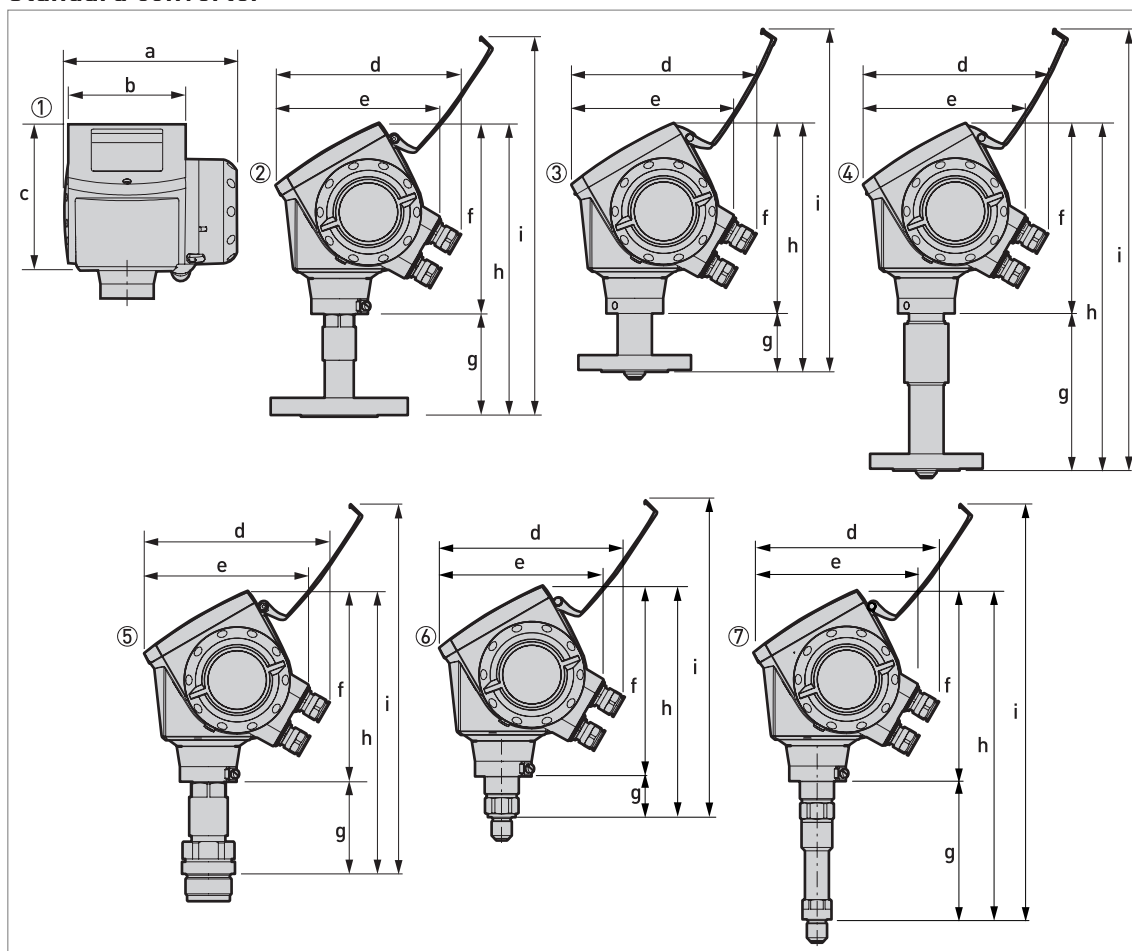


Figure 8-8: Standard converter

- ① Converter (front view)
- ② Flange version for all probes except the Ø2 mm / 0.08" single cable probe (right side)
- ③ Flange version for Ø2 mm / 0.08" single cable probe - High-Pressure (HP) version (right side)
- ④ Flange version for Ø2 mm / 0.08" single cable probe - High-Temperature (HT) and High-Temperature/High-Pressure (HT/HP) versions (right side)
- ⑤ Thread version for all probes except the Ø2 mm / 0.08" single cable probe (right side)
- ⑥ Thread version for Ø2 mm / 0.08" single cable probe - High-Pressure (HP) version (right side)
- ⑦ Thread version for Ø2 mm / 0.08" single cable probe - High-Temperature (HT) and High-Temperature/High-Pressure (HT/HP) versions (right side)

**CAUTION!**

- Cable glands are delivered on demand with non-Ex, Ex i- and Ex d-approved devices.
- Non-Ex and Ex i fittings are plastic and Ex d fittings are metallic. Non-Ex fittings are black and Ex i fittings are blue.
- The diameter of the outer sheath of the cable must be 6...12 mm or 0.2...0.5".
- Cable glands for FM- or CSA-approved devices must be supplied by the customer.

Dimensions and weights in mm and kg

	Dimensions [mm]									Weights [kg]
	a	b	c	d	e	f	g	h	i	
Converter	180	122	158.5	182 ①	170	197	-	-	-	3.3
Flange, single cable Ø2 - version HTor HT/HP	180	122	158.5	182 ①	170	197	59	357 ②	450 ②	6...15
Flange, single cable Ø2 - version HP	180	122	158.5	182 ①	170	197	160	256 ②	349 ②	5...14
Flange, all other probes	180	122	158.5	182 ①	170	197	123	320 ②	357 ②	4...12
Thread, single cable Ø2 - version HT or HT/HP	180	180	158.5	182 ①	170	197	144	341 ②	378 ②	4.5
Thread, single cable Ø2 - version HP	180	180	158.5	182 ①	170	197	43	240 ②	277 ②	4
Thread, all other probes	180	122	158.5	182 ①	170	197	95	292 ②	329 ②	3

① This dimension is subject to the size of the cable gland used

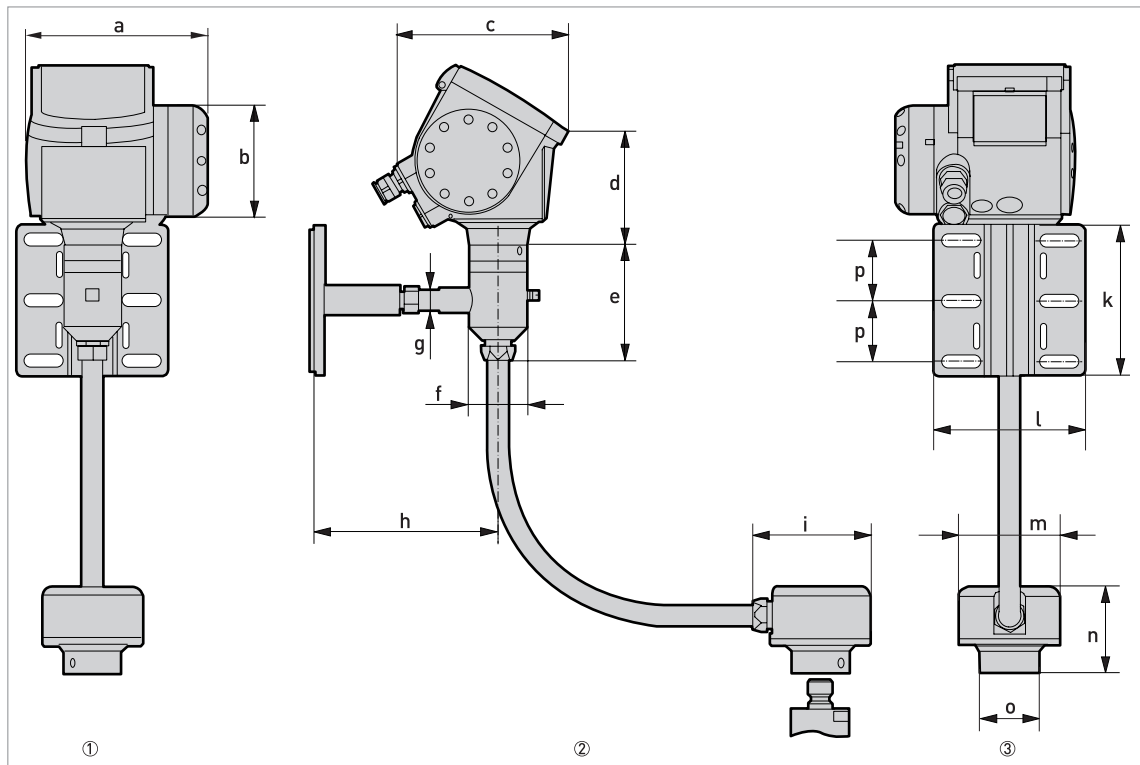
② With 30 kV ESD protection option: add 99 mm to this dimension. With Metaglas® option: add 43 mm to this dimension.

Dimensions and weights in inches and lb

	Dimensions [inches]									Weights [lb]
	a	b	c	d	e	f	g	h	i	
Converter	7.1	4.8	6.2	7.2 ①	6.7	7.8	-	-	-	7.3
Flange, single cable Ø0.08 - version HTor HT/HP	7.1	4.8	6.2	7.2 ①	6.7	7.8	2.3	14 ②	17.7 ②	13.2...33.1
Flange, single cable Ø0.08 - version HP	7.1	4.8	6.2	7.2 ①	6.7	7.8	6.3	10.1 ②	13.7 ②	11...30.9
Flange, all other probes	7.1	4.8	6.2	7.2 ①	6.7	7.8	4.8	12.6 ②	14.1 ②	8.8...26.5
Thread, single cable Ø0.08 - version HT or HT/HP	7.1	4.8	6.2	7.2 ①	6.7	7.8	5.7	13.4 ②	14.9 ②	9.9
Thread, single cable Ø0.08 - version HP	7.1	4.8	6.2	7.2 ①	6.7	7.8	1.7	9.4 ②	10.9 ②	8.8
Thread, all other probes	7.1	4.8	6.2	7.2 ①	6.7	7.8	3.7	11.5 ②	12.9 ②	6.6

① This dimension is subject to the size of the cable gland used

② With 30 kV ESD protection option: add 3.9" to this dimension. With Metaglas® option: add 1.7" to this dimension.

Remote converter**Figure 8-9: Remote housing option**

- ① Front view
- ② Left side
- ③ Rear view

Note:

- Refer to "ESD protection and Metaglas® (dual process sealing system for dangerous products) options" for the height to add to dimension "n".

Dimensions and weights in mm and kg

	Dimensions [mm]															Weights [kg]
	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	
Remote version	180	109	165	193	98.5	58	21	183	117	150	150.4	100	86	58	60	6.6... 12.8 ①

① Wall bracket (1.4 kg) + converter support (1.5 kg) + remote probe converter (2.7 kg) + flexible conduit (2 m: 1 kg; 4.5 m: 2.25 kg; 9.5 m: 4.75 kg; 14.5 m: 7.25 kg)

Dimensions and weights in inches and lb

	Dimensions [inches]															Weights [lb]
	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	
Remote version	7.09	4.29	6.50	7.60	3.88	2.28	0.83	7.20	4.60	5.91	5.92	3.94	3.39	2.28	2.36	14.6... 28.3 ①

① Wall bracket (3.1 lb) + converter support (3.3 lb) + remote probe converter (6.0 lb) + flexible conduit (6.6 ft: 2.2 lb; 14.8 ft: 5.0 lb; 31.2 ft: 10.5 lb; 47.6 ft: 16.0 lb)

Remote version limits

- For interface and solid (powder, granulate) applications, the maximum extension length is 4.5 m / 14.8 ft.
- For liquid level applications, the maximum measuring range is reduced according to the length of the coaxial cable between the flange and the converter (extension length).

Extension length		Max. measuring range (or sensor length, L)	
[m]	[ft]	[m]	[ft]
2	6.6	30	98
4.5	14.8	25	82
9.5	31.2	15	29
14.5	47.6	5	16.4

Applications

- Tanks which are subjected to a lot of vibration
- Limited space on the top of the tank or limited access (due to the size of the compact converter)
- Remote display at the bottom of the tank

Weather protection option

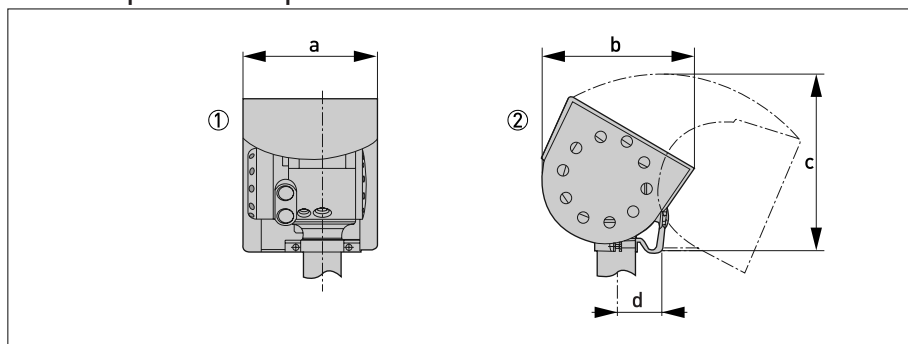


Figure 8-10: Weather protection option

① Weather protection (rear view)

② Weather protection (left side)

Dimensions and weights in mm and kg

	Dimensions [mm]				Weights [kg]
	a	b	c	d	
Weather protection	208	231.5	268 ①	66	2.9

① Radius

Dimensions and weights in inches and lb

	Dimensions [inches]				Weights [lb]
	a	b	c	d	
Weather protection	8.2	9.1	10.6 ①	2.6	6.4

① Radius

ESD protection and Metaglas® options

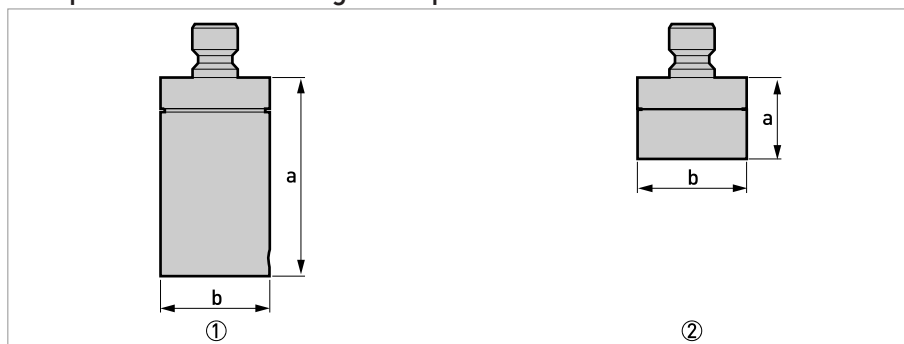


Figure 8-11: ESD protection and secondary Metaglas® seal options

- ① Optional ESD protection (30 kV) for solid applications
 ② Optional Metaglas® (dual process sealing system for dangerous products)

**CAUTION!**

The ESD protection and the Metaglas® options cannot be fitted to the same device.

Special options: Dimensions and weights in mm and kg

Options	Dimensions [mm]		Weights [kg]
	a	b	
ESD protection 30 kV	99	Ø58	0.85
Metaglas®	43	Ø58	0.83

Special options: Dimensions and weights in inches and lb

Options	Dimensions [inches]		Weights [lb]
	a	b	
ESD protection 30 kV	3.9	Ø2.3	1.87
Metaglas®	1.7	Ø2.3	1.82

Single probes

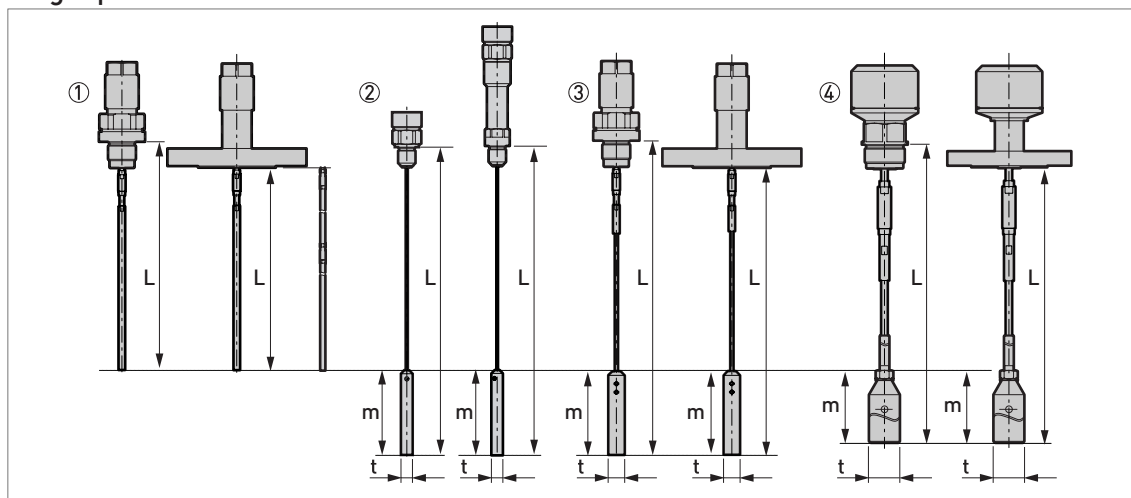


Figure 8-12: Single probe options

- ① Single rod $\varnothing 8$ mm / $\varnothing 0.3$ " (thread and flange versions). A segmented probe option shown on the right side. An optional protective sheath is available on request for the flange version.
- ② Single cable $\varnothing 2$ mm / $\varnothing 0.08$ " (the only thread version for the High-Pressure (HP) option and the only thread version for the High-Temperature (HT) and High-Temperature/High-Pressure (HT/HP) options)
- ③ Single cable $\varnothing 4$ mm / $\varnothing 0.15$ " (thread and flange versions - an optional FEP coating is available on request)
- ④ Single cable $\varnothing 8$ mm / $\varnothing 0.3$ " (thread and flange versions)

**INFORMATION!**

A wide range of counterweights and anchoring solutions are available. For dimensional data, refer to the pages that follow. For installation data, refer to How to attach probes to the bottom of the tank on page 27.

Single probes: Dimensions in mm

Probes	Dimensions [mm]			
	L min.	L max.	m	t
Single rod Ø8 mm ①	600 ②	4000	-	-
Single rod Ø8 mm (segmented) ③	600 ②	6000	-	-
Single cable Ø2 mm ④	600 ②	35000	100	Ø14
Single cable Ø4 mm ⑤	600 ②	35000	100	Ø20
Single cable Ø8 mm ⑤	600 ②	35000	0 ⑥	Ø38

① A device with this probe option must be assembled on site. For the assembly procedure, refer to "How to assemble the single rod probe (single-piece probe)" in the Installation chapter.

② A shorter probe length is available on request

③ A device with this probe option must be assembled on site. For the assembly procedure, refer to "How to assemble the single rod probe (segmented probe)" in the Installation chapter.

④ 1 counterweight option (Ø14×100 mm). No anchoring solution is available.

⑤ Refer to the end of this section for data about all the probe end options

⑥ This value is for the Ø12 mm counterweight. If you ordered the Ø38 mm counterweight: 245 mm

Single probes: Dimensions in inches

Probes	Dimensions [inches]			
	L min.	L max.	m	t
Single rod Ø0.3" ①	24 ②	158	-	-
Single rod Ø0.3" (segmented) ③	24 ②	236	-	-
Single cable Ø0.08" ④	24 ②	1378	3.9	Ø0.6
Single cable Ø0.15" ⑤	24 ②	1378	3.9	Ø0.8
Single cable Ø0.3" ⑤	24 ②	1378	0 ⑥	Ø1.5

① A device with this probe option must be assembled on site. For the assembly procedure, refer to "How to assemble the single rod probe (single-piece probe)" in the Installation chapter.

② A shorter probe length is available on request

③ A device with this probe option must be assembled on site. For the assembly procedure, refer to "How to assemble the single rod probe (segmented probe)" in the Installation chapter.

④ 1 counterweight option (Ø0.6×3.9"). No anchoring solution is available.

⑤ Refer to the end of this section for data about all the probe end options

⑥ This value is for the Ø0.5" counterweight. If you ordered the Ø1.5" counterweight: 9.6"

Double probes

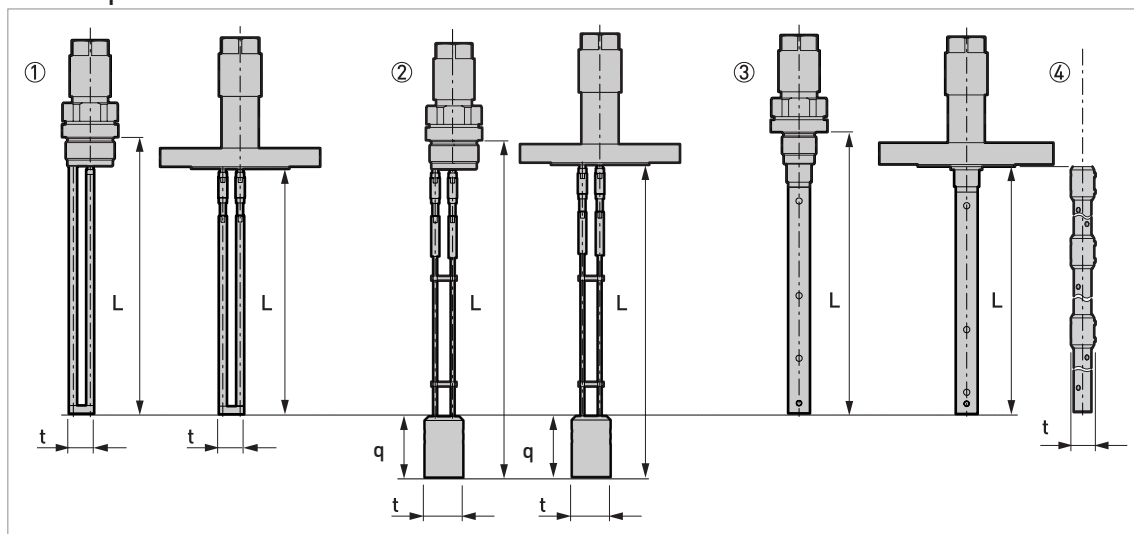


Figure 8-13: Double probe options

- ① Double rod $\varnothing 8$ mm / $\varnothing 0.3$ " (thread and flange versions)
- ② Double cable $\varnothing 4$ mm / $\varnothing 0.15$ " (thread and flange versions)
- ③ Coaxial $\varnothing 22$ mm / $\varnothing 0.9$ " (thread and flange versions)

**INFORMATION!**

A wide range of counterweights and anchoring solutions are available. For dimensional data, refer to the pages that follow. For installation data, refer to *How to attach probes to the bottom of the tank* on page 27.

Double probes: Dimensions in mm

Probes	Dimensions [mm]			
	L min.	L max.	q	t
Double rod Ø8 mm	1000 ①	4000	-	25
Double cable Ø4 mm ②	1000 ①	8000	60	Ø38
Coaxial Ø22 mm	500 ①	6000	-	-
Coaxial Ø22 mm (segmented) ③	500 ①	6000	-	Ø28

① A shorter probe length is available on request

② Refer to the end of this section for data about all the probe end options

③ A device with this probe option must be assembled on site. For the assembly procedure, refer to "How to assemble the segmented coaxial probe" in the Installation chapter.

Double probes: Dimensions in inches

Probes	Dimensions [inches]			
	L min.	L max.	q	t
Double rod Ø0.3"	40 ①	158	-	1.0
Double cable Ø0.15" ②	40 ①	315	2.4	Ø1.5
Coaxial Ø0.9"	20 ①	236	-	-
Coaxial Ø0.9" (segmented) ③	20 ①	236	-	Ø1.1

① A shorter probe length is available on request

② Refer to the end of this section for data about all the probe end options

③ A device with this probe option must be assembled on site. For the assembly procedure, refer to "How to assemble the segmented coaxial probe" in the Installation chapter.

Probe end options for cable probes: single cable Ø4 mm/0.15"

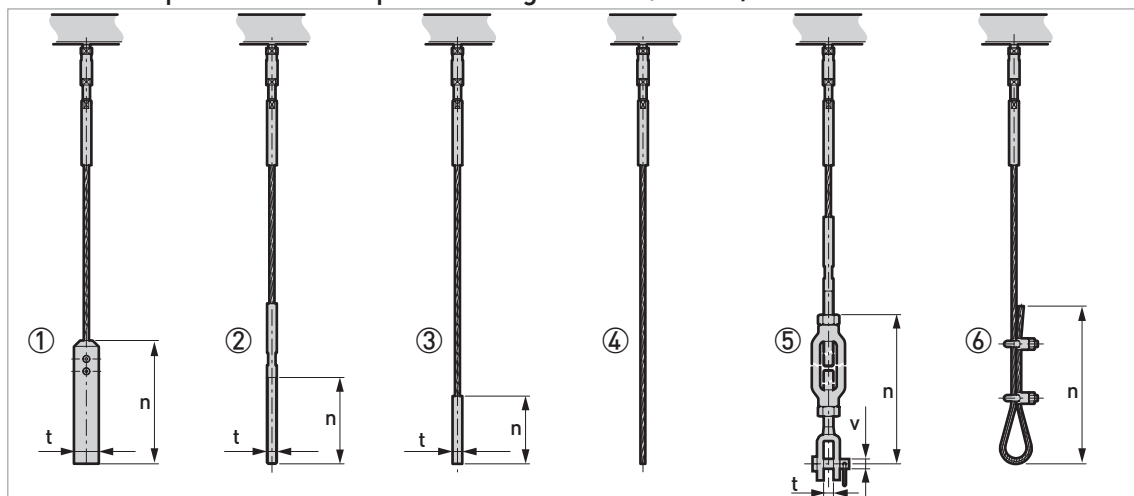


Figure 8-14: Probe end options for cable probes: single cable Ø4 mm/0.15"

- ① Standard counterweight
- ② Threaded end
- ③ Crimped end
- ④ Open end
- ⑤ Turnbuckle
- ⑥ Chuck

Dimensions in mm

Probe end type	Dimensions [mm]		
	n	t	v
Counterweight	100	Ø20	-
Threaded end	70	M8	-
Crimped end	55	Ø8	-
Open end	-	-	-
Turnbuckle	172 ①	11	Ø6
Chuck	300	-	-

① Minimum length

Dimensions in inches

Probe end type	Dimensions [inches]		
	n	t	v
Counterweight	3.9	Ø0.8	-
Threaded end	2.8	M8	-
Crimped end	2.2	Ø0.3	-
Open end	-	-	-
Turnbuckle	6.8 ①	0.4	Ø0.2
Chuck	11.8	-	-

① Minimum length

Probe end options for cable probes: single cable Ø8 mm/0.3"

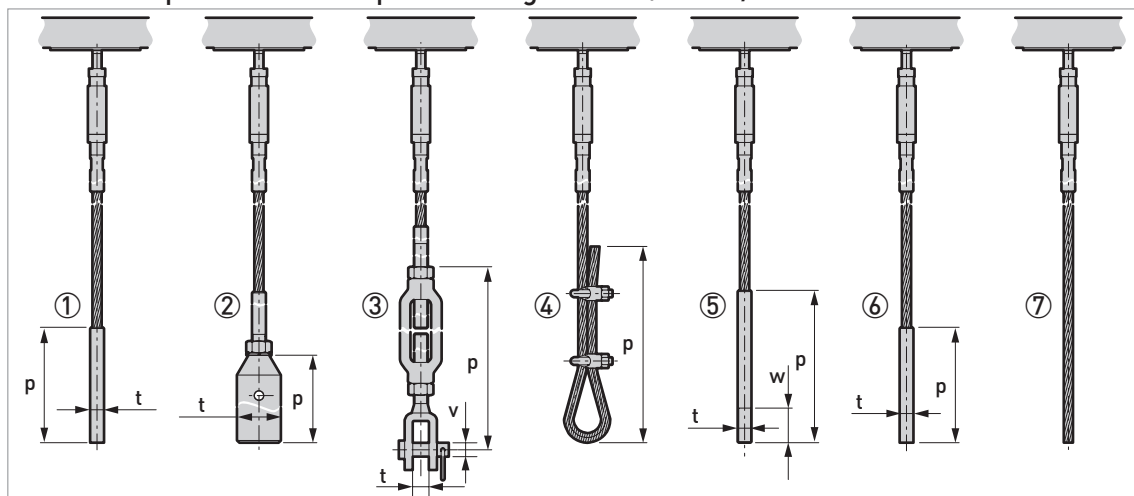


Figure 8-15: Probe end options for cable probes: single cable Ø8 mm/0.3"

- ① Standard counterweight 1
- ② Standard counterweight 2
- ③ Turnbuckle
- ④ Chuck
- ⑤ Threaded end
- ⑥ Crimped end
- ⑦ Open end

Dimensions in mm

Probe end type	Dimensions [mm]			
	p	t	v	w
Counterweight 1	100	Ø12	-	-
Counterweight 2	245	Ø38	-	-
Turnbuckle	293 ①	14	Ø12	-
Chuck	300	-	-	-
Threaded end	132	M12	-	30
Crimped end	100	Ø12	-	-
Open end	-	-	-	-

① Minimum length

Dimensions in inches

Probe end type	Dimensions [inches]			
	p	t	v	w
Counterweight 1	3.9	Ø0.5	-	-
Counterweight 2	9.6	Ø1.5	-	-
Turnbuckle	11.5 ①	0.6	Ø0.5	-
Chuck	11.8	-	-	-
Threaded end	5.2	M12	-	1.2
Crimped end	3.9	Ø0.5	-	-
Open end	-	-	-	-

① Minimum length

Probe end options for cable probes: double cable Ø4 mm/0.15"

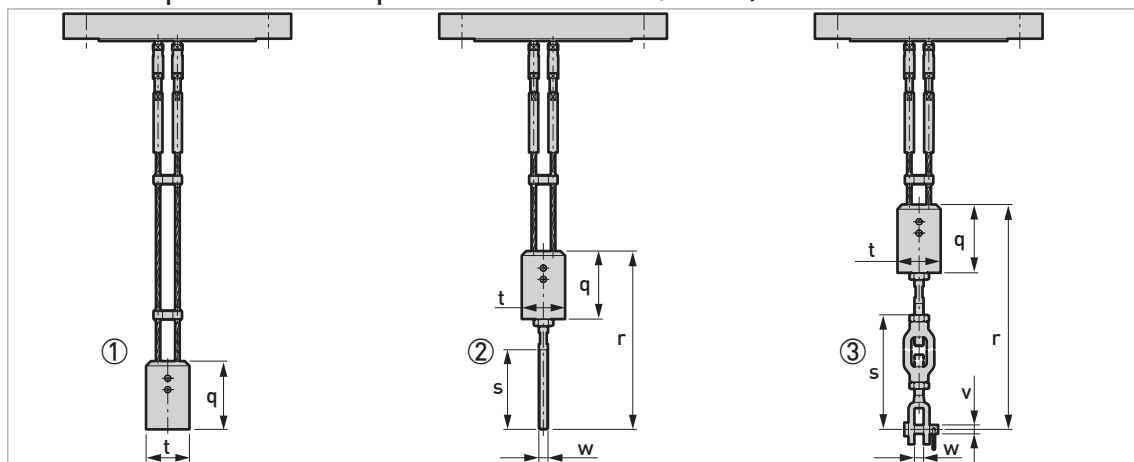


Figure 8-16: Probe end options for cable probes: double cable Ø4 mm/0.15"

- ① Standard counterweight
- ② Threaded end
- ③ Turnbuckle

Dimensions in mm

Probe end type	Dimensions [mm]					
	q	r	s	t	v	w
Counterweight	60			Ø38	-	-
Threaded end	60	157	70	Ø38	-	M8
Turnbuckle	60	289 ±46	172 ①	Ø38	Ø6	11

① Minimum length

Dimensions in inches

Probe end type	Dimensions [inches]					
	q	r	s	t	v	w
Counterweight	2.4			Ø1.5	-	-
Threaded end	2.4	6.2	2.8	Ø1.5	-	M8
Turnbuckle	2.4	11.4 ±1.8	6.8 ①	Ø1.5	Ø0.2	0.4

① Minimum length

Probe weights

Probes	Min. process connection size		Weights	
	Thread	Flange	[kg/m]	[lb/ft]
Single cable Ø2 mm / 0.08"	G ½A; ½ NPTF	DN25 in PN16, PN40, PN63 or PN100; 1" in 150 lb, 600 lb, 900 lb, 1500 lb or 2500 lb; 1½" in 300 lb	0.016	0.01
Single cable Ø4 mm / 0.15"	G ¾A; ¾ NPT	DN25 in PN16, PN40, PN63 or PN100; 1" in 150 lb, 600 lb, 900 lb or 1500 lb; 1½" in 300 lb	0.12	0.08
Single cable Ø8 mm / 0.3"	G 1½A; 1½ NPT	DN40 in PN16, PN40, PN63 or PN100; 1½" in 150 lb, 300 lb, 600 lb, 900 lb or 1500 lb	0.41	0.28
Double cable Ø4 mm / 0.15"	G 1½A; 1½ NPT	DN50 in PN16, PN40, PN63 or PN100; 2" in 150 lb, 300 lb, 600 lb, 900 lb or 1500 lb	0.24	0.16
Single rod Ø8 mm / 0.3"	G ¾A; ¾ NPT	DN25 in PN16, PN40, PN63 or PN100; 1" in 150 lb, 600 lb, 900 lb or 1500 lb; 1½" in 300 lb	0.41	0.28
Double rod Ø8 mm / 0.3"	G 1½A; 1½ NPT	DN50 in PN16, PN40, PN63 or PN100; 2" in 150 lb, 300 lb, 600 lb, 900 lb or 1500 lb	0.82	0.56
Coaxial Ø22 mm / 0.9"	G ¾A; ¾ NPT	DN25 in PN16, PN40, PN63 or PN100; 1" in 150 lb, 600 lb, 900 lb or 1500 lb; 1½" in 300 lb	0.79	0.53

9.1 Order form

You can help us to assist you as quickly as possible by giving us a few items of information.

Then just fax them to us. Your personal Honeywell consultant will contact you within 24 hours.

9.1.1 Device data

Connection type	<input type="checkbox"/> Flange	<input type="checkbox"/> Threaded ①	Specify size:
Connection material	<input type="checkbox"/> 316 L	<input type="checkbox"/> Hastelloy® C-22	
Probe end type (cable probes only)	<input type="checkbox"/> Counterweight	<input type="checkbox"/> Turnbuckle	<input type="checkbox"/> Chuck
	<input type="checkbox"/> Threaded end	<input type="checkbox"/> Crimped end	<input type="checkbox"/> Open end/None
Feedthrough/Sealing ②	<input type="checkbox"/> Standard / FKM/FPM (-40...+200°C)	<input type="checkbox"/> Standard / Kalrez® 6375 (-20...+200°C)	<input type="checkbox"/> Standard / EPDM (-50...+150°C)
Housing version ③	<input type="checkbox"/> Compact, standard (T _{max} = +200°C, P _{max} = 100 bar)	<input type="checkbox"/> Compact, high-pressure (T _{max} = +200°C, P _{max} = 300 bar)	<input type="checkbox"/> Compact, high-temperature (T _{max} = +300°C, P _{max} = 100 bar)
	<input type="checkbox"/> Compact, high-temperature / high-pressure (T _{max} = +300°C, P _{max} = 300 bar)	<input type="checkbox"/> Remote housing	Specify length of conduit for the remote housing (2 m, 4.5 m, 9.5 m or 14.5 m):
Outputs	<input type="checkbox"/> 1 output 4...20 mA/HART®	<input type="checkbox"/> 1 output 4...20 mA/HART® - for interface measurement	<input type="checkbox"/> 2 outputs 4...20 mA/HART® + 4...20 mA
	<input type="checkbox"/> 2 outputs 4...20 mA/HART® + 4...20 mA - for interface measurement	<input type="checkbox"/> PROFIBUS PA (4-wire + local HART®)	<input type="checkbox"/> FOUNDATION Fieldbus (4-wire + local HART®)
Display	<input type="checkbox"/> Without	<input type="checkbox"/> With	Specify language:
Approvals	<input type="checkbox"/> No Ex	<input type="checkbox"/> ATEX Ex ia	<input type="checkbox"/> ATEX Ex d[ia]
	<input type="checkbox"/> FM IS Class 1 Div. 1 (Dual Seal)	<input type="checkbox"/> FM XP-IS Class 1 Div. 1 (Dual Seal)	<input type="checkbox"/> CSA IS Class 1 Div. 1 (Dual Seal)
	<input type="checkbox"/> CSA XP-IS Class 1 Div. 2 (Dual Seal)	<input type="checkbox"/> IECEx Ex ia	<input type="checkbox"/> IECEx Ex d[ia] ④
	<input type="checkbox"/> ATEX Ex nA		

① This is necessary for a process connection temperature >200°C / 390°F

② The temperature limits for the feedthrough and gasket materials must agree with the temperature limits of the housing version.

③ Refer also to the Pressure / temperature table for probe selection in the "Technical data" section.

④ Pending

9.1.2 Rating data

Product name:	
Operating pressure:	
Rated pressure:	
Process connection temperature:	
Ambient temperature:	
Viscosity:	
Measurand (level, volume,...):	
Tank height:	
Comments (indoors, exposed to weather, ...):	

9.1.3 Contact data

Company:	
Contact person:	
Telephone number:	
Fax number:	
E-mail:	

9.2 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 ϵ_r , 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. This is for products with a dielectric constant >1.6 (this depends on the probe type). 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 *General requirements* on page 26.

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 and EN 61326-2-3 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.

If the emulsion separates gradually from 0 to 100% water, the device measures interface at the bottom of the emulsion.

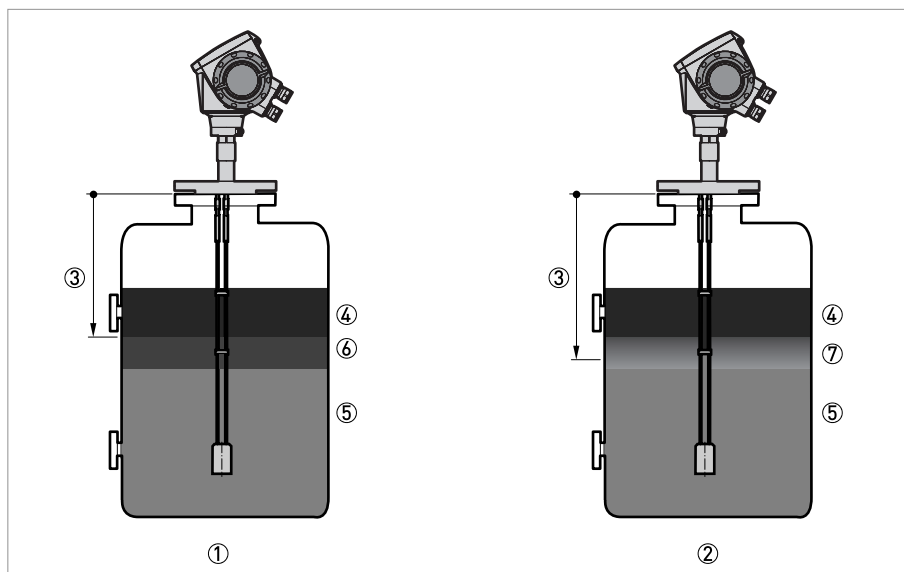


Figure 9-1: Types of emulsion

- ① Constant-mix emulsion
- ② Gradually mixed emulsion
- ③ Interface distance
- ④ Oil
- ⑤ Water
- ⑥ Emulsion (constant mix, >5% of water)
- ⑦ Emulsion (gradually mixes with water)

G

Gain

This is an amplification factor given by the signal converter to a signal that goes back to the device. The device can then use the signal to measure the product. Refer to **Threshold** for more data. Also refer to *Thresholds and parasitic signals* on page 102.

H**Hazardous area**

An area with a potentially explosive atmosphere. Trained personnel can install and use a device in this area. The device must be ordered with the appropriate options. The device requires approvals (ATEX, IEC Ex, FM, CSA, NEPSI etc.) related to site specifications. You can find more data about hazardous areas in the Ex Manuals and Ex Certificates of Compliance.

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 volume table and the product density to convert the tank content to a mass value.

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**Sensor length**

Length, L' , of from the face of the flange to end of the guide. If you ordered a cable probe, this does not include the counterweight. Refer to the diagram at the end of this section.

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 133

Top dead zone

The distance from the flange to the top limit of the measuring range. Also refer to *Measurement limits* on page 143.

Threshold

A number of limits set either manually or automatically by the signal converter to identify the reflected measurement pulses from the level, the interface and the probe end. Also refer to *Thresholds and parasitic signals* on page 102.

U**Ullage mass**

This is a display option. 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. 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.

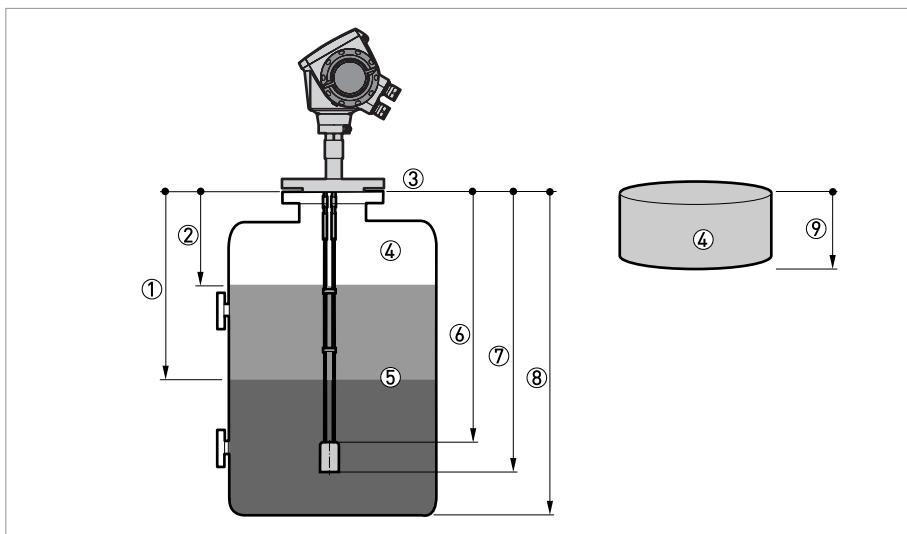


Figure 9-2: Measurement definitions 1

- ① Interface distance
- ② Distance
- ③ Flange facing
- ④ Gas (Air)
- ⑤ Interface
- ⑥ Sensor length, L'
- ⑦ Probe length, L
- ⑧ Tank height
- ⑨ Ullage volume or mass

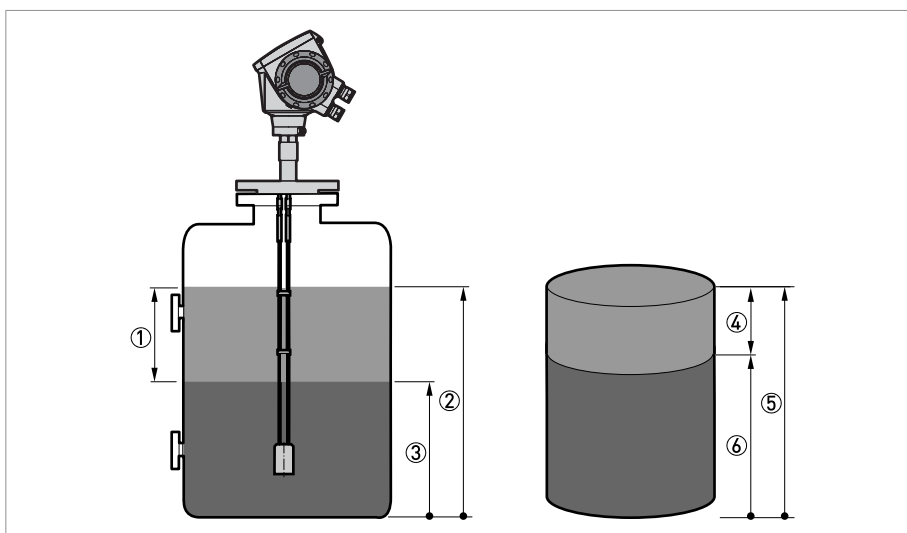


Figure 9-3: Measurement definitions 2

- 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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