OPTIWAVE 1400 C Handbook

24 GHz Radar (FMCW) Level Transmitter for liquids
in the water and waste water industry

KROHNE

IMPRINT

1.1 Software history

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

Data about software revisions is shown in menu C5.1.2 Identification. For more data, refer to *Function description* on page 79. If it is not possible to refer to the device menu, record the serial number of the device (given on the device nameplate) and speak to the supplier.

Changes and effect on compatibility

1	Downwards compatible changes and fault repair with no effect on operation (e.g. spelling mistakes on display)	
2-_	Downwards compatible hardware and/or software change of interfaces:	
	H	HART®
	P	Profibus
	F	FOUNDATION fieldbus
3-_	Downwards compatible hardware and/or software change of inputs and outputs:	
	CO	Current output
	FO, PO	Frequency output / pulse output
	SO	Status output
	LS	Limit switch
	CI	Current input
	D	Display

Table 1-1: Changes and effect on compatibility

Release date	Printed circuit assembly	Firmware revision	Electronic revision	Hardware revision	Changes and compatibility	Documentation
2019-03-27	Main and Support	BL1.31.06	ER2.0.0_	4002815701f	—	MA OPTIWAVE 1400 R01
	Sensor			4002859301a		
2021-04-09	Main and Support	BL1.35.06	ER2.1.2	4002815705f	—	MA OPTIWAVE 1400 R02
	Sensor			4002859302_		

Table 1-2: Software history

1.2 Intended use

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

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

This radar level transmitter measures distance, level, volume, flow and reflectivity of liquids, pastes and slurries.

It can be installed on tanks, open channels and the sea.

1.3 Certification

CE marking

The device meets the essential requirements of the EU Directives:

- Electromagnetic Compatibility (EMC) directive
- The safety part of the Low-Voltage directive

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

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

1.4 Radio approvals

1.4.1 European Union (EU)

INFORMATION!
LPR (Level Probing Radar) *devices measure level in the open air or in a closed space (a metallic tank etc.). You can use LPR devices for TLPR applications. The LPR devices meet the requirements of the RED (Radio Equipment Directive) for use in the member countries of the EU.*

This level transmitter is approved to be used outside metallic tanks.

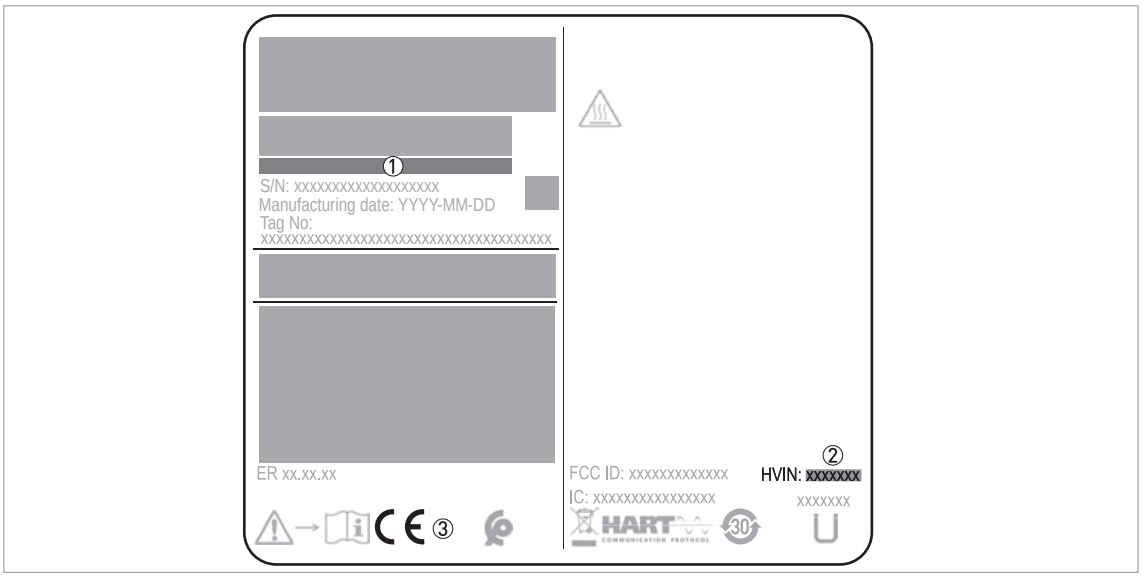

Figure 1-1: European Union: radio approval information on the nameplate

① Type code (defined in order)
② HVIN (Hardware Version Identification Number). This number gives the radar signal frequency (24G = 24 GHz), the location of the device (L=LPR) and the type of signal converter (compact (C))
LPR device: HVIN: 24G14-L-C
③ CE sign

LPR (Level Probing Radar) devices

Use approved personnel to install the device. If the device is operated in the open air (outdoors), it agrees with the RED (Radio Equipment Directive) if you obey these instructions:

- The antenna must always point downwards. The boresight direction of the antenna must be vertical. No other angles are permitted.
- Install the device more than 4 km / 2.485 mi away from radio astronomy sites.
- If the device is 4...40 km / 2.485...24.855 mi away from radio astronomy sites, do not install the device more than 15 m / 49.21 ft above the ground.

CAUTION!
If it is necessary to install the device less than 4 km / 2.485 mi from radio astronomy sites, you must get the approval of the national regulatory authority before installation (e.g. ANFR (France), Bundesnetzagentur (Germany), Ofcom (United Kingdom) etc.).

Radio quiet zones: locations of radio astronomy sites (stations) in Europe and northern Eurasia

Country	Name of the station	Location	
		Latitude, φ	Longitude, λ
Finland	Metsähovi	60°13'04" N	24°23'37" E
	Tuorla	60°24'56" N	22°26'31" E
France	Plateau de Bure	44°38'01" N	05°54'26" E
Germany	Effelsberg	50°31'32" N	06°53'00" E
Hungary	Penc	47°47'22" N	19°16'53" E
Italy	Medicina	44°31'14" N	11°38'49" E
	Noto	36°52'34" N	14°59'21" E
	Sardinia	39°29'50" N	09°14'40" E
Latvia	Ventspils	57°33'12" N	21°51'17" E
Poland	Kraków – Fort Skala	50°03'18" N	19°49'36" E
Russia	Dmitrov	56°26'00" N	37°27'00" E
	Kalyazin	57°13'22" N	37°54'01" E
	Pushchino	54°49'00" N	37°40'00" E
	Zelenchukskaya	43°49'53" N	41°35'32" E
Spain	Yebes	40°31'27" N	03°05'22" W
	Robledo	40°25'38" N	04°14'57" W
Switzerland	Bleien	47°20'26" N	08°06'44" E
Sweden	Onsala	57°23'45" N	11°55'35" E
UK	Cambridge	52°09'59" N	00°02'20" E
	Darnhall	53°09'22" N	02°32'03" W
	Jodrell Bank	53°14'10" N	02°18'26" W
	Knockin	52°47'24" N	02°59'45" W
	Pickmere	53°17'18" N	02°26'38" W

Table 1-3: Radio quiet zones: locations of radio astronomy sites (stations) in Europe and northern Eurasia

1.4.2 U.S.A. and Canada

INFORMATION!
LPR (Level Probing Radar) *devices measure level in the open air or in a closed space (a metallic tank etc.).*

This level transmitter is approved to be used outside metallic tanks.

LEGAL NOTICE!
FCC
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. *This device may not cause harmful interference, and*
2. *this device must accept any interference received, including interference which may cause undesired operation.*

Changes or modifications made to this equipment not expressly approved by the manufacturer may void the FCC authorizations to operate this equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

§

LEGAL NOTICE!

IC

This device complies with Industry Canada licence-exempt RSS standard(s).
Operation is subject to the following conditions:

1. *This device may not cause harmful interference, and*
2. *this device must accept any interference received, including interference that may cause undesired operation.*

This device and the handbook complies with the requirements of RSS-Gen. Operation is subject to the conditions that follow:

1. *The installation of the LPR/TLPR device shall be done by trained installers, in strict compliance with the manufacturer's instructions.*
2. *The use of this device is on a "no-interference, no-protection" basis. That is, the user shall accept operations of high-powered radar in the same frequency band which may interfere with or damage this device. However, devices found to interfere with primary licensing operations will be required to be removed at the user's expense.*
3. *LPR devices: Ensure a vertically downward orientation of the transmit antenna and an installation only at fixed locations.*
4. *The installer / user of this device shall ensure that it is at least 10 km from the Dominion Radio Astrophysical Observatory (DRAO) near Penticton, British Columbia. The coordinates of the DRAO are latitude 49° 19'15" N and longitude 119° 37'12" W. For devices not meeting this 10 km separation (e.g. those in the Okanagan Valley, British Columbia) the installer / user must coordinate with, and obtain the written concurrence of, the Director of the DRAO before the equipment can be installed or operated. The Director of the DRAO may be contacted at 250-497-2300 (tel.) or 250-497-2355 (fax). Alternatively, the Manager, Regulatory Standards, Industry Canada, may be contacted.*

The Product Marketing Name (PMN) of this device is "Optiwave Water".

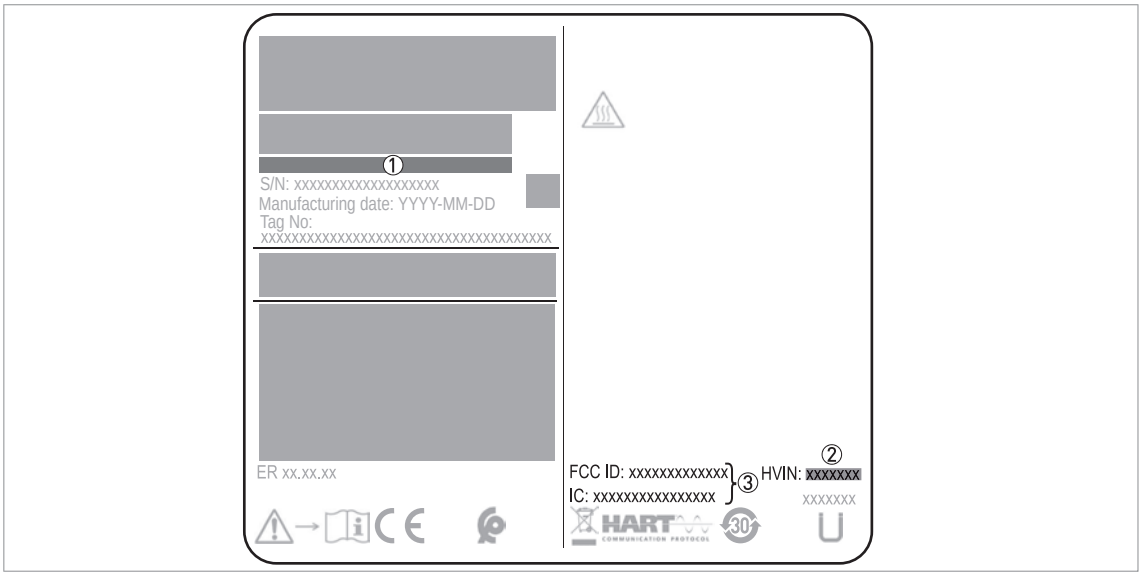

Figure 1-2: U.S.A. and Canada: radio approval information on the nameplate

① Type code (defined in order)
② HVIN (Hardware Version Identification Number). This number gives the radar signal frequency (24G = 24 GHz), the location of the device (L=LPR) and the type of signal converter (compact (C))
LPR device: HVIN: 24G14-L-C
③ FCC ID and IC number
LPR device: FCC-ID: Q6BFMCW24G14L, IC number: 1991D-FMCW24G14L

1.5 Safety instructions from the manufacturer

1.5.1 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.

The manufacturer tries always to observe the copyrights of others, and to draw on works created in-house or works in the public domain.

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

1.5.2 Disclaimer

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

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

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

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

1.5.3 Product liability and warranty

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

1.5.4 Information concerning the documentation

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

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

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

1.5.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.

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

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

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

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

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

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

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

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

- HANDLING
  This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➲ RESULT
This symbol refers to all important consequences of the previous actions.

1.6 Safety instructions for the operator

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

2.1 Scope of delivery

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

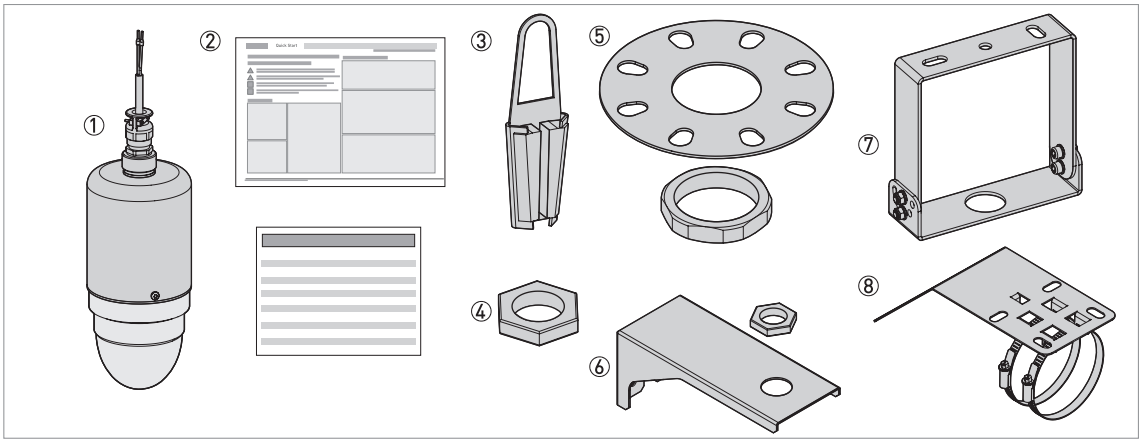

Figure 2-1: Scope of delivery

① Device
② Quick Start and supplementary instructions (if the device has the appropriate options)
③ Option: electrical cable clamp with a device hanger
④ Option: jam nut (attaches the top of the device to a support fitting)
⑤ Option: low-pressure flange with a jam nut (attaches the top or the bottom of the device to a counter flange)
⑥ Option: wall-mounted bracket
⑦ Option: orientable bracket (attaches the device to the ceiling or roof)
⑧ Option: 45° deflector plate (attaches the device to the ceiling)

2.2 Device description

This device is a 24 GHz FMCW-radar level transmitter. It is a non-contact technology and is 2-wire loop-powered. It is designed to measure the distance, level, volume, flow and reflectivity of liquids, pastes and slurries. For more data about the measuring principle, refer to *Measuring principle* on page 62.

Radar level transmitters use an antenna to emit a signal to the surface of the measured product.

2.3 Visual Check

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

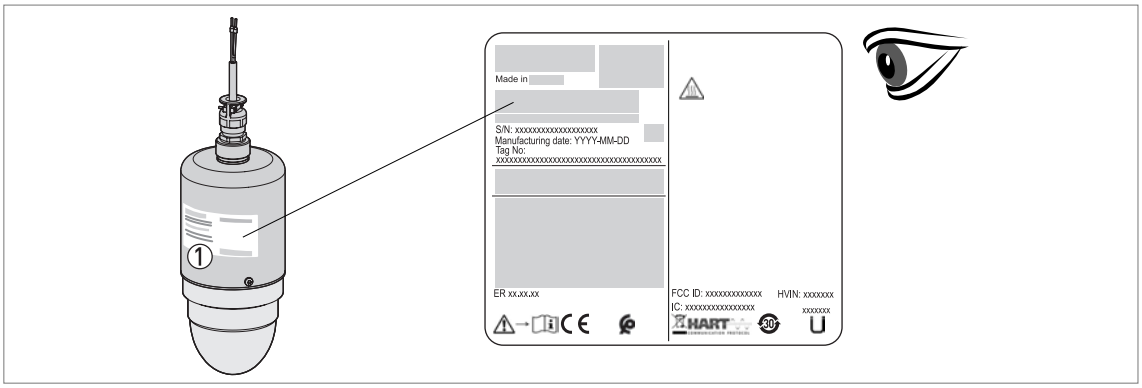

Figure 2-2: Visual check

① Device nameplate (for more data refer to *Nameplate (examples)* on page 18)

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 Nameplate (examples)

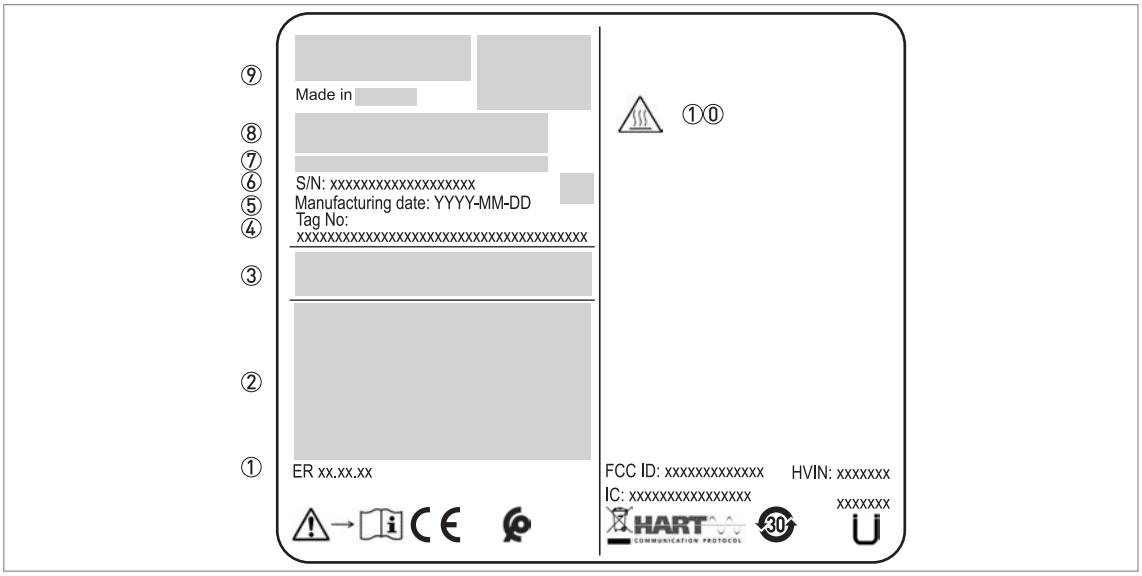

Figure 2-3: Non-Ex nameplate attached to the housing

① Electronic revision (according to NAMUR NE 53)
② Signal output (analog, HART®, fieldbus, etc.), input voltage and maximum current (fieldbus options: basic current)
③ Degree of ingress protection (according to EN 60529 / IEC 60529)
④ Customer tag number
⑤ Date of manufacture
⑥ Serial number
⑦ Type code (defined in order)
⑧ Model name and number. C = compact version.
⑨ Company logo, name and postal address
Country of manufacture / Company web address
①⓪ WARNING! Hot surface. If the device is connected to tank that operates at high temperature, there is a risk of injury.

3.1 Pre-installation requirements

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

- Heat sources (sunlight, adjacent system components etc.) can increase the internal temperature of the device and cause damage. Make sure that the internal temperature is not more than the maximum limit. The maximum permitted ambient temperature is +80°C / +176°F. The maximum permitted surface temperature is +80°C / +176°F.
- Do not subject the signal converter to heavy vibrations. The devices are tested for vibration and agree with EN 60068-2-6. If there is vibration, we recommend that you use the electrical cable clamp with a device hanger.

3.2 Pressure and temperature ranges

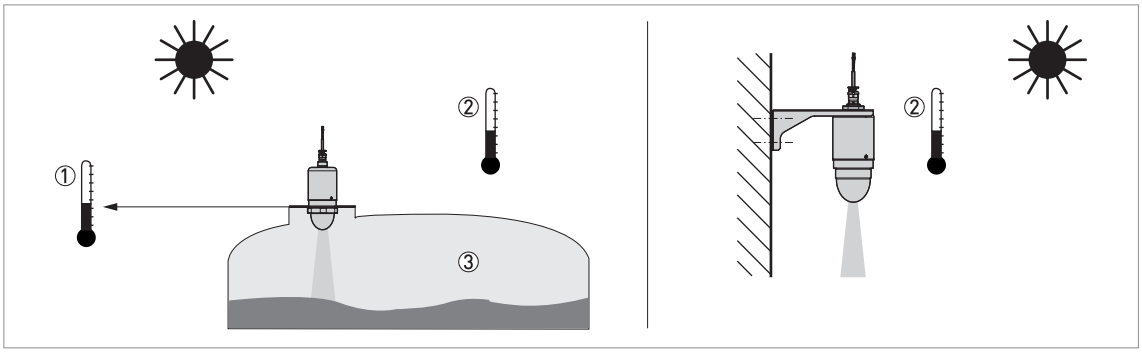

Figure 3-1: Pressure and temperature ranges

① Temperature at the process connection
Non-Ex devices: -40...+80°C / -40...+176°F
Devices with Hazardous Location approvals: see supplementary instructions
② Ambient temperature
Non-Ex devices: -20...+80°C / -4...+176°F
Devices with Hazardous Location approvals: see supplementary instructions
③ Process pressure
max. 3 barg / 43.5 psig (threaded connection on the antenna)

Maximum process connection temperature and operating pressure

Antenna type	Options	Maximum process connection temperature		Maximum operating pressure	
		[°C]	[°F]	[barg]	[psig]
Drop, PP	G 3 threaded connection ①	+80	+176	3	43.5
Drop, PP	Other process connections	+80	+176	1 ②	14.5 ②

Table 3-1: Maximum process connection temperature and operating pressure

① This process connection is on the antenna
② Atmospheric pressure

3.3 Recommended mounting position: tanks

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

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

Nozzle position

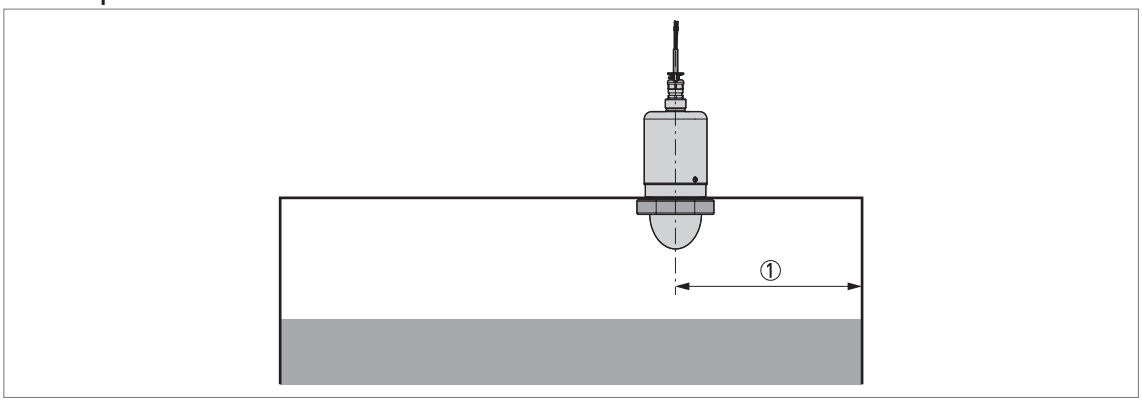

Figure 3-2: Nozzle position

① Minimum distance of the nozzle or socket from the tank wall: 200 mm / 7.9"

INFORMATION!
If there is a nozzle on the tank before installation, the nozzle must be a minimum of 200 mm / 7.9" from the tank wall. The tank wall must be flat and there must not be obstacles adjacent to the nozzle or on the tank wall.

Other mounting positions

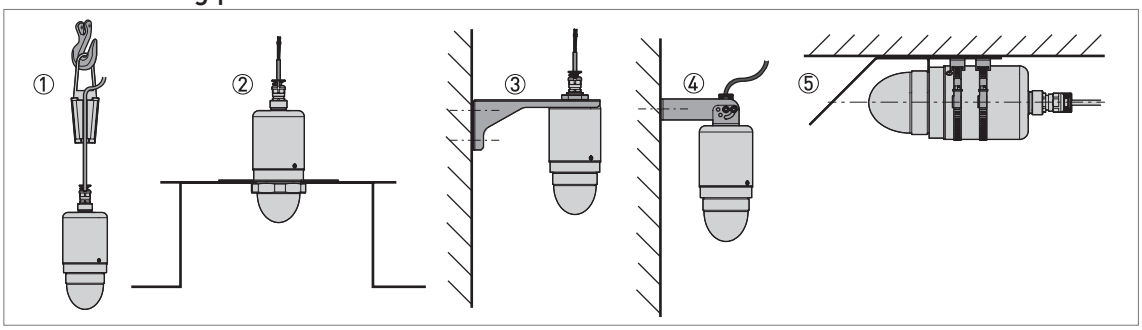

Figure 3-3: Other mounting positions

① Suspended device (electrical cable clamp with device hanger)
② Installation on a manhole. In this illustration, the device has the low-pressure flange option.
③ Device with the wall-mounted bracket
④ Device attached to a wall with the orientable bracket
⑤ Device attached horizontally to the ceiling with a 45° deflector plate. We recommend that the device has the 45° deflector plate option if there is only sufficient space to install the device horizontally.

3.4 Recommended mounting position: open-channel metering

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

CAUTION!
Do not use a device that uses an electrical cable clamp with a device hanger. Use a fixed, stable support.

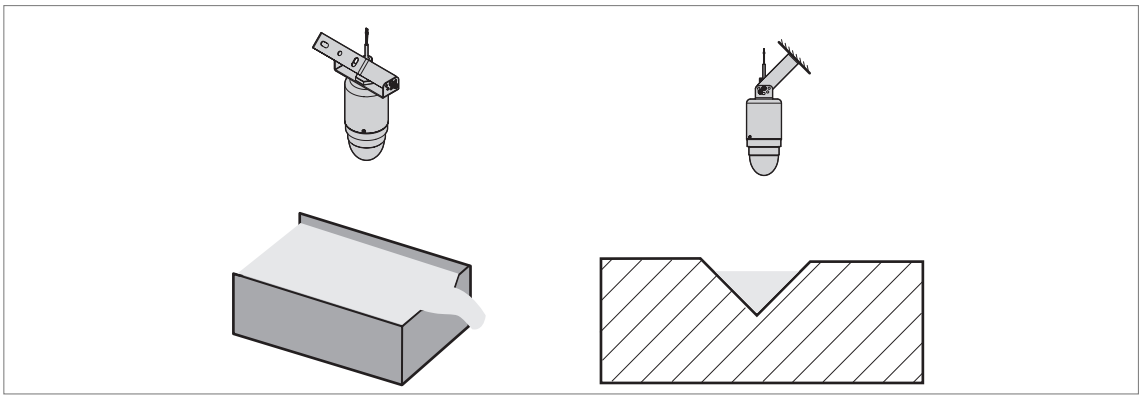

Figure 3-4: Recommended mounting position above a flume or a weir (open-channel flow)

If it is necessary to measure volumetric flow rate, use PACTware and the applicable DTM to configure the device. You can download this software free of charge from the website (Download Center).

- Make sure that the channel agrees with one of the open-channel metering options available in the device DTM (PACTware).
- Go to menu **C3.1 Conversion Dry** in the device DTM (PACTware) and set the conversion table to "Volume Flow"
- Measure the dimensions of the channel and the position of the device above the channel.
- Enter the measured values in the DTM and complete the procedure.

CAUTION!
Do the "A4.1 Standard Setup" procedure before you make a conversion table.

CAUTION!
Make sure that the device is at the correct distance upstream of the flume or weir.

3.5 Mounting restrictions

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

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

3.5.1 General notes

CAUTION!
Do not install the device above objects in the tank (ladder, supports etc.) or pit. Objects in the tank or pit can cause interference signals. If there are interference signals, the device will not measure correctly.
If it is not possible to install the device on another part of the tank or pit, do an empty spectrum scan. For more data, refer to How to make a filter to remove radar signal interference on page 41.

INFORMATION!
If possible, do not install a nozzle on the tank centerline.

Equipment and obstacles

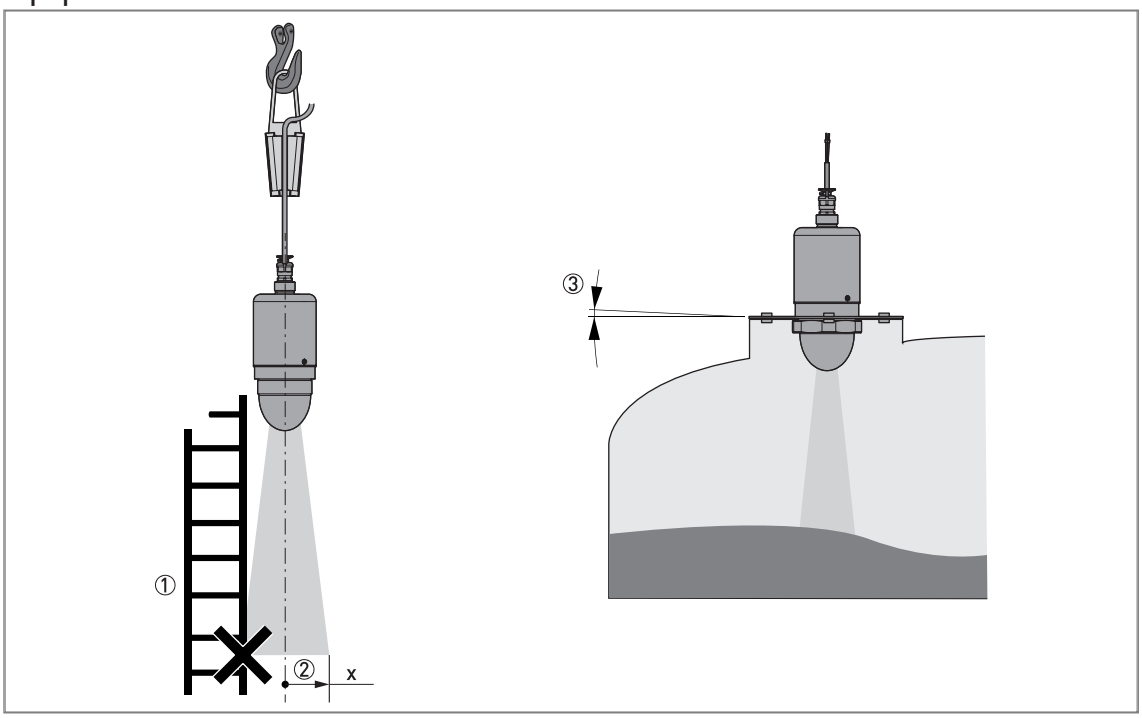

Figure 3-5: Equipment and obstacles: how to prevent measurement of interference signals

① We recommend that you do an empty spectrum recording if there are too many obstacles in the radar beam (for more data, refer to *How to make a filter to remove radar signal interference* on page 41).
② Beam radius of the antenna: refer to the table below. The beam radius increases by increments of "x" mm for each metre of distance from the antenna.
③ Do not tilt the device more than 2°

Beam radius of the antenna

Antenna type	Beam angle	Beam radius, x	
		[mm/m]	[in/ft]
PP Drop, DN100 (4¨)	8°	70	0.8

Table 3-2: Beam radius of the antenna

Product inlets

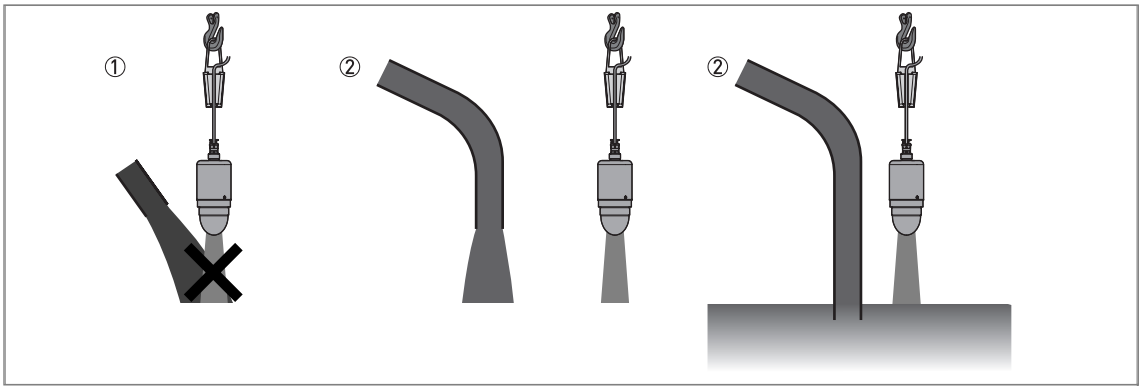

Figure 3-6: Product inlets

① The device is too near to the product inlet.
② The device is in the correct position.

CAUTION!
Do not put the device near to the product inlet. If the product that enters the tank touches the antenna, the device will measure incorrectly. If the product fills the tank directly below the antenna, the device will also measure incorrectly.

Installation height above mean sea level

Attach the weather protection accessory to the device if you install it more than 2000 m / 6560 ft above mean sea level.

3.5.2 Recommendations for pits and tanks made of non-conductive materials

WARNING!
These instructions are for LPR equipment only. For more data, refer to Radio approvals on page 8.

Device installation on tanks made of a non-conductive material

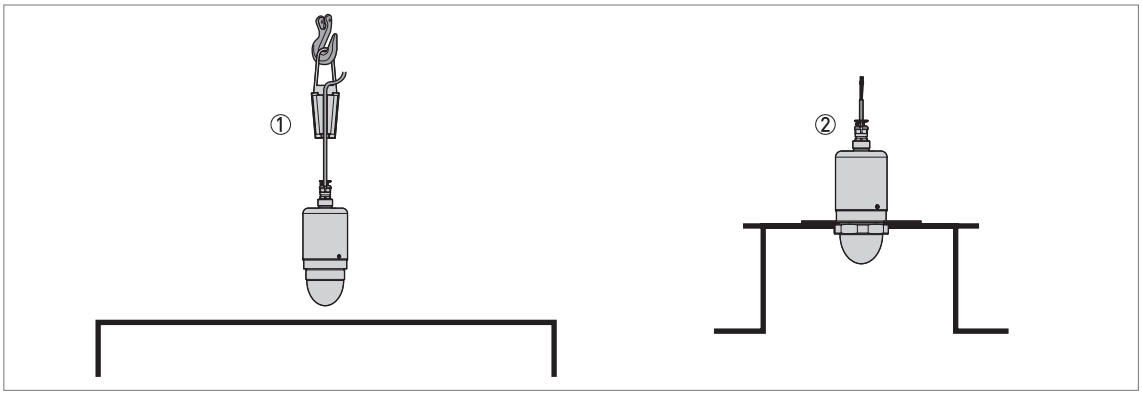

Figure 3-7: Device installation on tanks made of a non-conductive material

① Device hung above a plastic tank
② Device attached to a plastic tank

If the device cannot go in the tank and the tank is made of a non-conductive material (plastic etc.), you can attach a support to the top of the tank without a hole in the tank roof. We recommend that you put the antenna as near as possible to the top of the tank.

CAUTION!
Do not hang and use this device above a plastic tank in bad weather conditions (rain etc.). Bad weather conditions can have an effect on the device performance.

CAUTION!
We recommend that you do not hang and use this device above a plastic tank that has dust on it. Dust can have an effect on the device performance.

Open pits

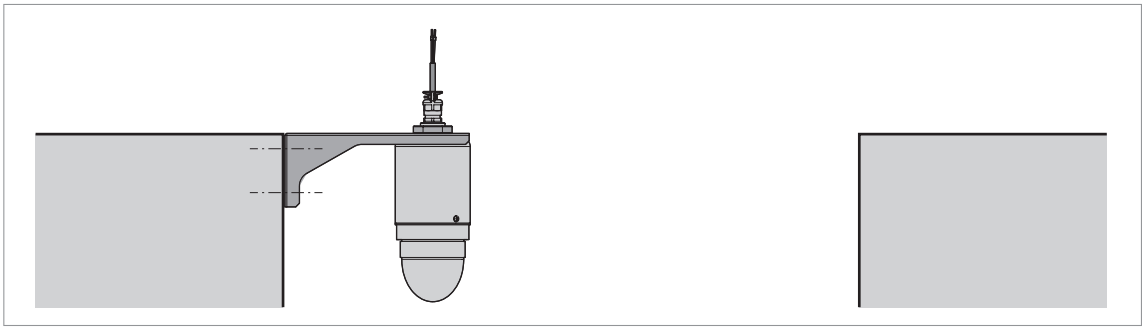

Figure 3-8: Open pits

If the device must measure the level of product in a pit, you can attach a support to the side of the pit or above the pit.

3.6 Orientable device collar

If it is necessary to attach the device to a fixed stable support on a roof or ceiling with a slope, then use an orientable device collar.

3.6.1 How to attach the orientable bracket to the device

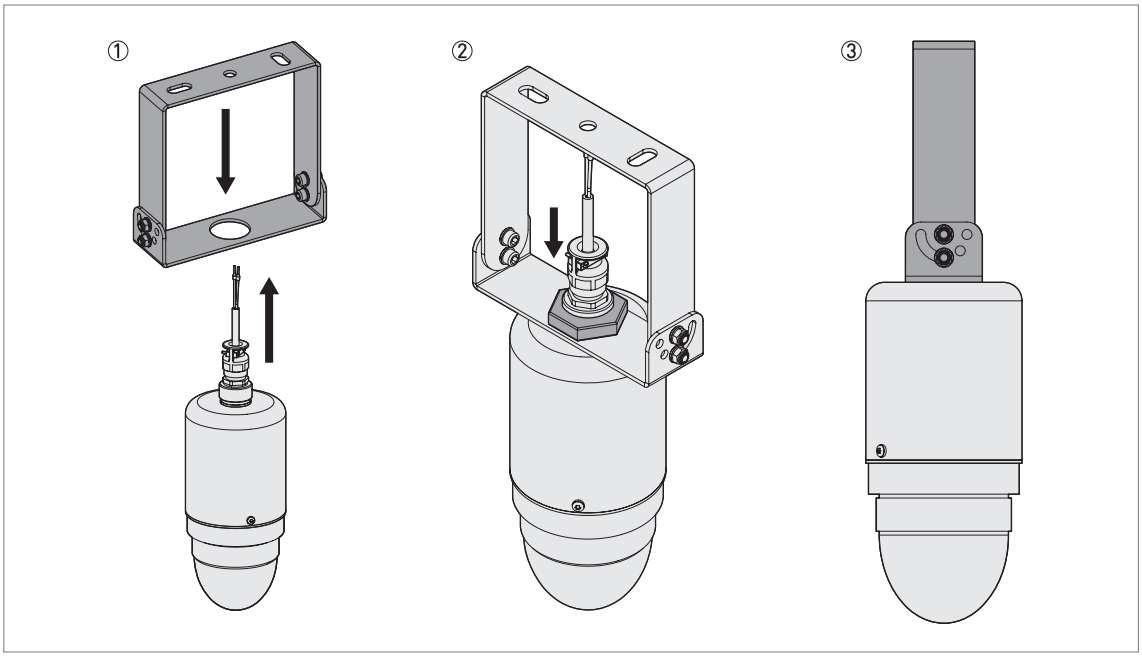

Figure 3-9: How to attach the orientable bracket to the device

Equipment needed:

- Device
- Orientable bracket with a jam nut
- 46-mm open wrench (not supplied)

- Put the top of the device through the hole at the bottom of the orientable bracket.
- Attach and tighten the jam nut with a 46-mm open wrench.

➲ The position and angle of the orientable bracket must give enough clearance above the cable gland to prevent damage to the electrical cable. For more data, refer to *Ingress protection* on page 28.

- Make sure that the device cannot move in the orientable bracket.

➲ End of the procedure.

INFORMATION!

If it is necessary to send an order for the orientable device collar, refer to Accessories on page 95.

3.6.2 How to tilt the orientable bracket

If the device is attached to a fixed, stable support on a roof or ceiling with a slope, then it is necessary to tilt the orientable bracket.

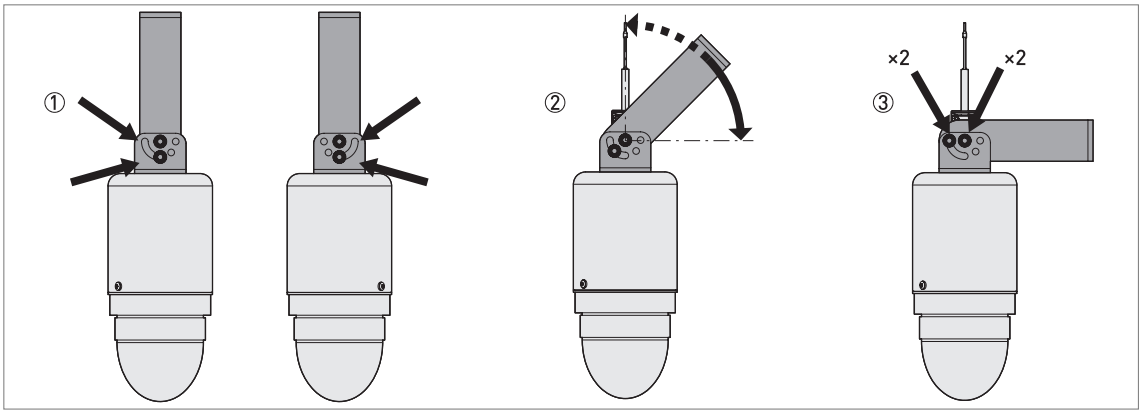

Figure 3-10: How to tilt the orientable bracket

Equipment needed:

- Device
- Orientable bracket
- 10-mm socket wrench (not supplied)
- 5-mm Allen wrench (not supplied)

- Loosen the four screws on the orientable bracket with the 10-mm socket wrench and 5-mm Allen wrench.
- Turn the device attached to the orientable bracket until the device is in a vertical position.
- Tighten the four screws on the orientable bracket until the device cannot move.

➲ End of the procedure.

4.1 Safety instructions

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

DANGER!
Observe the national regulations for electrical installations!

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

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

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

4.2 General notes

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

4.3 Electrical connection for current output

4.3.1 Non-Ex devices

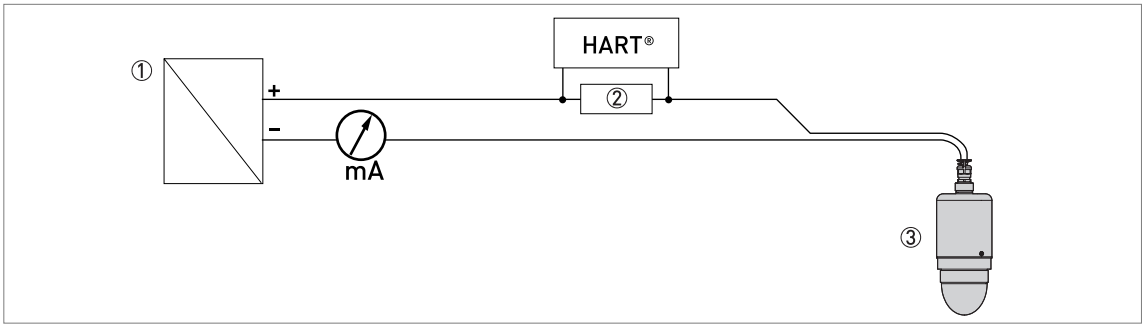

Figure 4-1: Electrical connections for non-Ex devices

① Power supply
② Resistor for HART® communication (typically 250 ohms)
③ Device

CAUTION!
Make sure that the brown wire (+) is connected to the positive terminal of the power supply and the blue wire (-) is connected to the negative terminal of the power supply. Connect the drain wire to ground.

CAUTION!
Give the electrical cable protection from damage from wildlife (rats etc.), if it is necessary.

INFORMATION!
Electrical power to the output terminals energizes the device. The output terminal is also used for HART® communication.

4.4 Ingress protection

INFORMATION!
The device fulfils all requirements per protection category IP66 / IP68 (continuous immersion at a depth of 2 m for 2 weeks).

DANGER!
Do not loosen or remove the cable gland.

WARNING!
Make sure that there is sufficient clearance between the top of the cable gland and the ceiling to prevent damage to the electrical cable. The minimum clearance is 30 mm / 1.2".

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 have a polling address of 1 to 63 in a multi-drop network.

The device output is factory-set to communicate point-to-point. To change the communication mode from **point-to-point** to **multi-drop**, enter the DTM and go to **C - Full Setup** menu and change the value of menu item **C5.1.2.1 Polling Address** from "0" to a value from "1" to "63".

4.5.2 Point-to-point connection

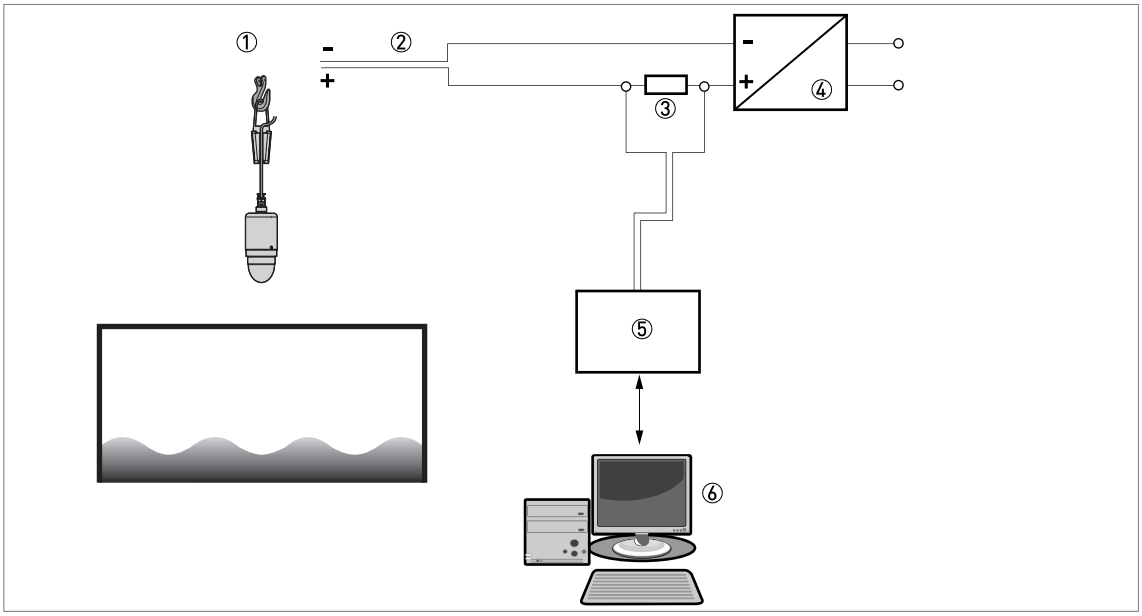

Figure 4-2: Point-to-point connection (non-Ex)

① Address of the device (0 for point-to-point connection)
② 4...20 mA + HART®
③ Resistor for HART® communication (typically 250 ohms)
④ Power supply
⑤ HART® converter
⑥ HART® communication software

4.5.3 Multi-drop networks

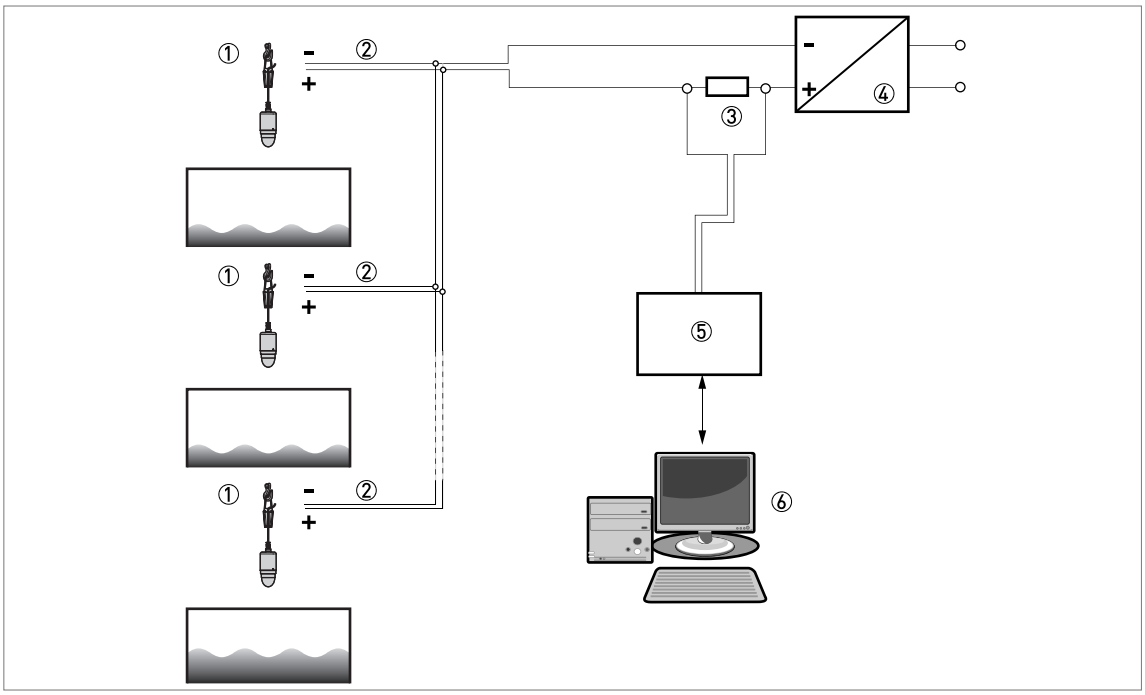

Figure 4-3: Multi-drop network (non-Ex)

① Address of the device (each device must have a different address in multidrop networks)
② 4 mA + HART®
③ Resistor for HART® communication (typically 250 ohms)
④ Power supply
⑤ HART® converter
⑥ HART® communication software

5.1 Start-up checklist

Check these points before you energize the device:

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

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

5.2 Operating concept

You can read measurements and configure the device with:

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

5.3 PACTware™: general notes

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

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

Refer also to the PACTware Consortium site at http://www.pactware.com.

5.4 PACTware: software installation

Equipment and software needed:

- A computer
- HART® converter (USB or RS232)
- A web browser
- A high-speed Internet connection
- Microsoft® .NET Framework 2.0 or a later version
- PACTware™ 4.1 SP5 or a later version
- DTM for OPTIWAVE x400/x500 (ER2.x.x)

Procedure

- Install Microsoft® .NET Framework 2.0 or a later version.
- Install PACTware™ 4.1 SP5 or a later version.
- Install the **OPTIWAVE x400/x500 DTM** on your workstation or your portable computer. Follow the instructions in the Installation wizard.

- Plug the HART modem into to your computer (Serial or USB HART® modem). If you are using a USB® HART modem, you must install the Driver for the USB HART® modem first. Make sure that the location of the port for the HART® modem is clearly identified.

➲ End of the procedure.

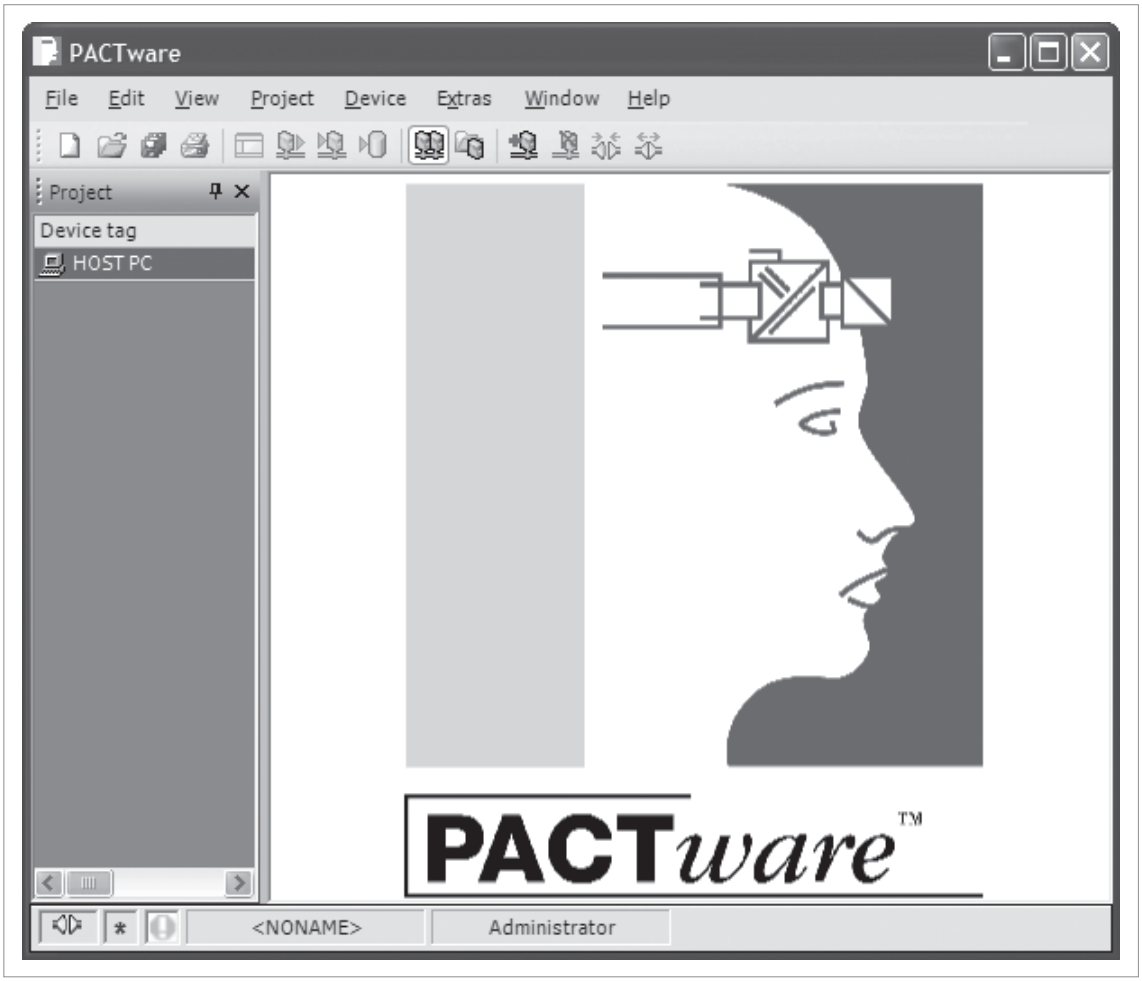

Figure 5-1: Start page for PACTware™

5.5 How to start the device

- Connect the converter to the power supply.
- Use a HART modem (USB / RS232) to connect the device to the workstation
- Energize the converter.

5.6 Software configuration

5.6.1 General notes

How to configure the software for device communication.

5.6.2 Procedure

INFORMATION!
*Before the program can send data to and receive data from the device, it is necessary to add elements to a project structure. The project structure is built in the PACTware™ **Project** pane. The **Project** pane is on the left side of the window.*

- HOST PC is shown in the **Project** pane. Go to the main toolbar and click on the **View** menu button. Click on “Device catalog F3” to open the **Device Catalog** pane.

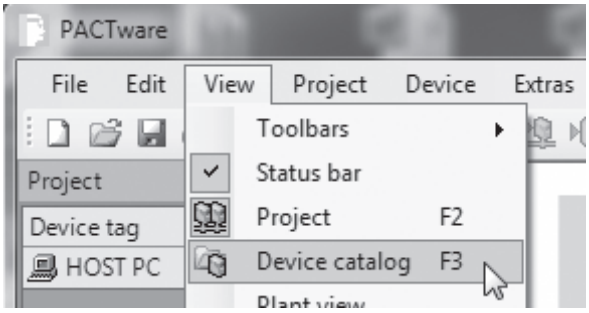

Figure 5-2: View menu in PACTware™

- Double click on “HART Communication” in the **Device Catalog** pane. The "COMx" element is added below "HOST PC” in the project structure.

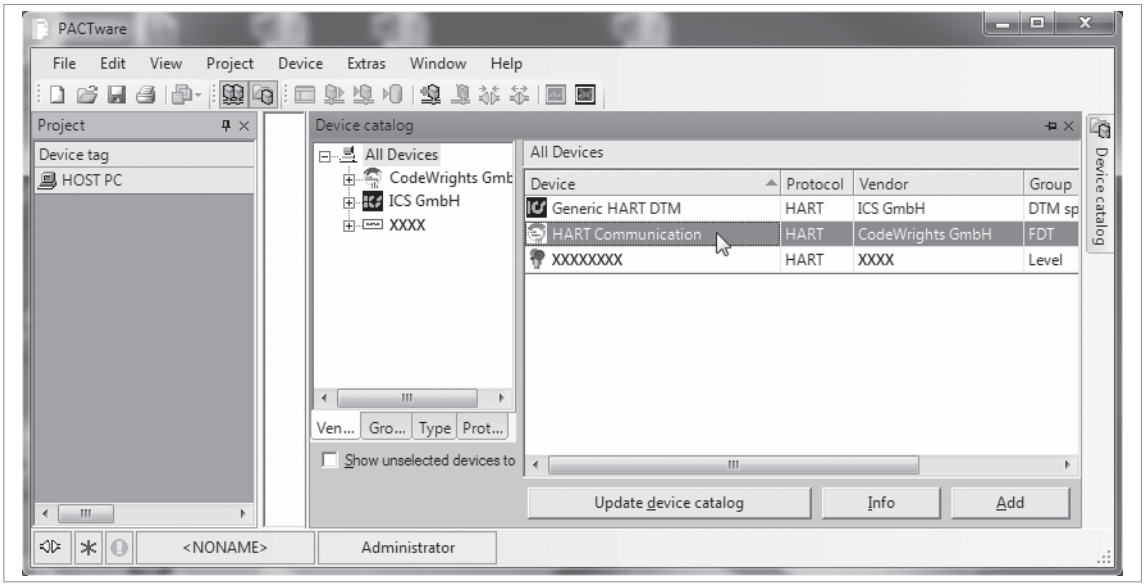

Figure 5-3: Select “HART Communication” in the Device Catalog pane

INFORMATION!
If you double click on the "COMx" element in the Project pane, you will open the COMx Parameter window where you can change HART® communication settings.

INFORMATION!
You can also change the port that is connected to the device.

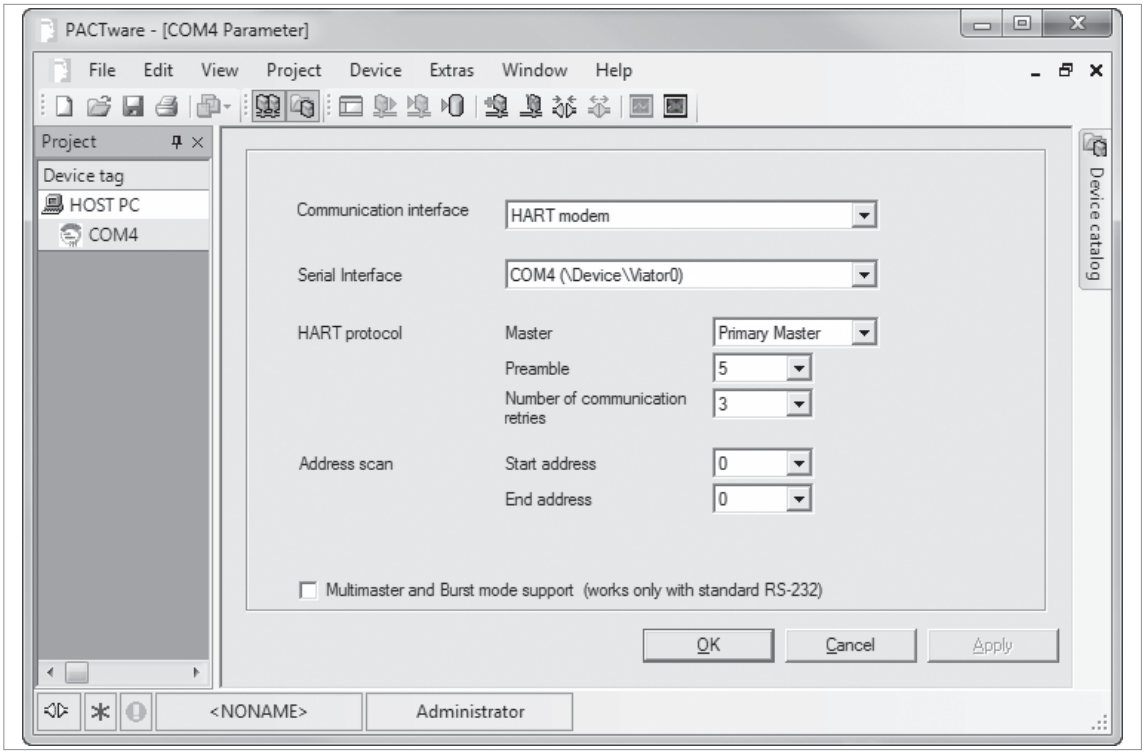

Figure 5-4: COMx Parameter window

- Click on "OK" to save changes or "Cancel" to cancel the new configuration.
- Right click on COMx in the project pane and then click on "Add device" in the list. This step will open a window with a list of DTMs.
- Select "OPTIWAVE x400/x500 (ER 2.x.x)". This step will add the device DTM to the project structure in the Project pane.

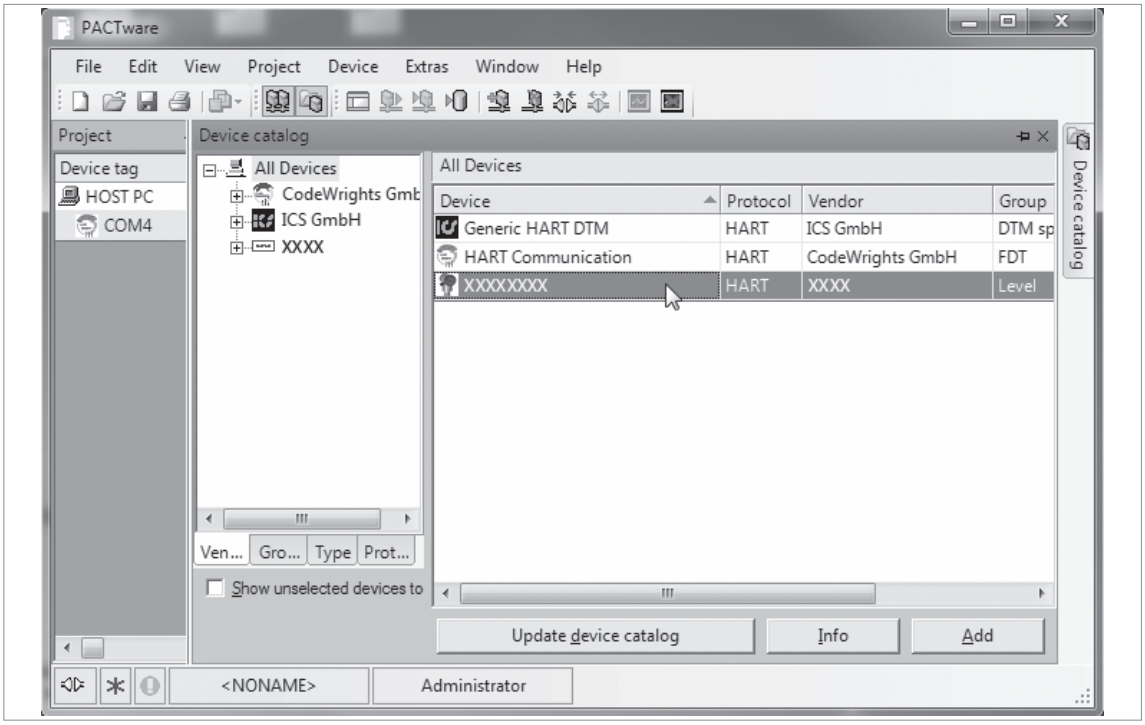

Figure 5-5: Select "OPTIWAVE x400/x500 (ER 2.x.x)" in the Device Catalog pane

- The software is correctly configured for device communication, but the port is not open and the device cannot communicate with the software at this time.
- a) Double click on the "OPTIWAVE x400/x500 (ER2.x.x)" element in the project structure (**Project pane**) or
  b) Right click on "OPTIWAVE x400/x500 (ER2.x.x)" element in the project structure (**Project pane**) and select "Parameter" in the drop-down list box.

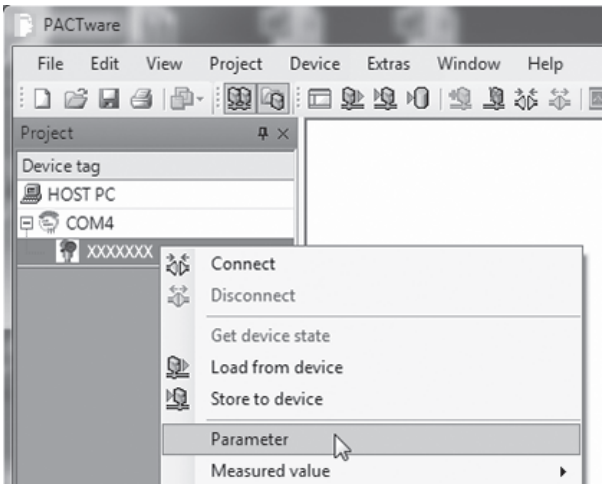

Figure 5-6: Select "Parameter" in the drop-down list box

- This step will open the **Parameter** (configuration) window.

- Right click on the "OPTIWAVE x400/x500 (ER2.x.x)" element in the Project pane and select "Connect" in the drop-down list box.

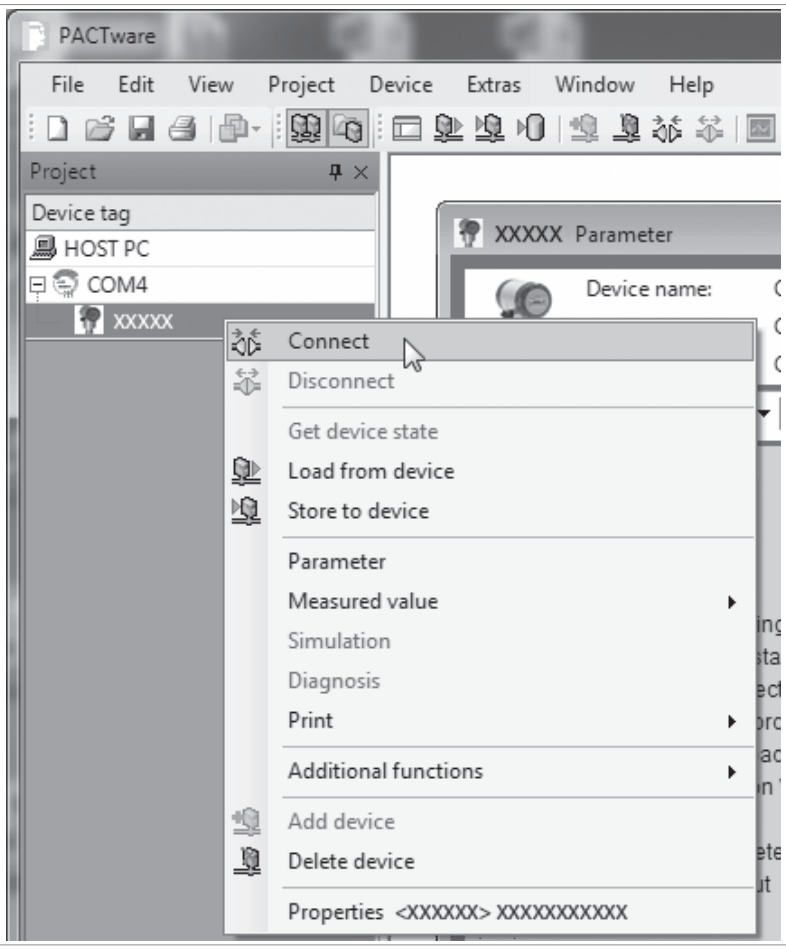

Figure 5-7: Select "Connect" in the drop-down list box

INFORMATION!
This will open the communication port, but does not start the communication with the device.

- The software is correctly configured for device communication and the port is open, but the device cannot communicate with the software at this time.
- End of the procedure.

6.1 How to load settings from the device

6.1.1 General notes

How to load the device settings from the device to PACTware™. There are 3 alternative procedures.

6.1.2 Procedure 1

CAUTION!
You must disconnect the communication port after you upload new data to the device. If you do not disconnect the communication port, error messages are shown and it is possible that there will be communication problems. If it is not possible to open the port again, you must restart the computer.

- Click on the Device button in the main toolbar.
- Select "Load from device" from the list.

➲ End of the procedure.

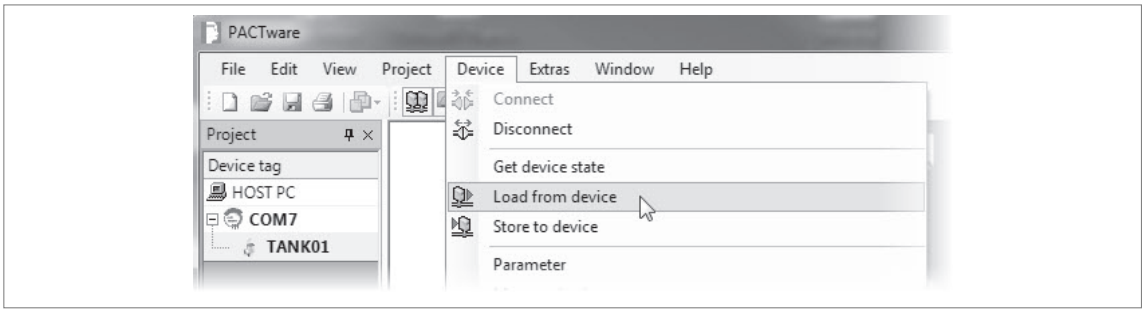

Figure 6-1: Click on "Load from Device" in the Device menu (Procedure 1)

6.1.3 Procedure 2

- Click on this icon (refer to the illustration – below you can find this icon below the main toolbar).

➲ End of the procedure.

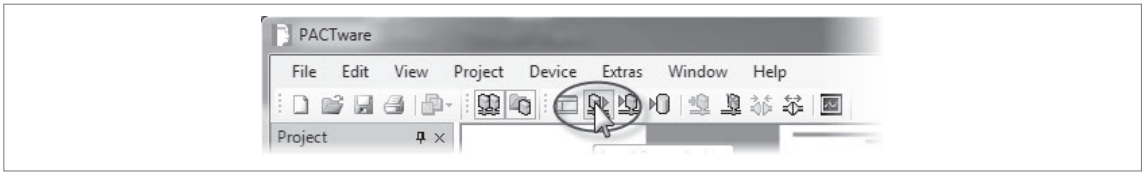

Figure 6-2: Click on the "Load from device" icon in the main toolbar (Procedure 2)

6.1.4 Procedure 3

- Right click on the "OPTIWAVE x400/x500 (ER 2.x.x)" element in the Project pane.
- Select "Load from device" from the list.

➲ End of the procedure.

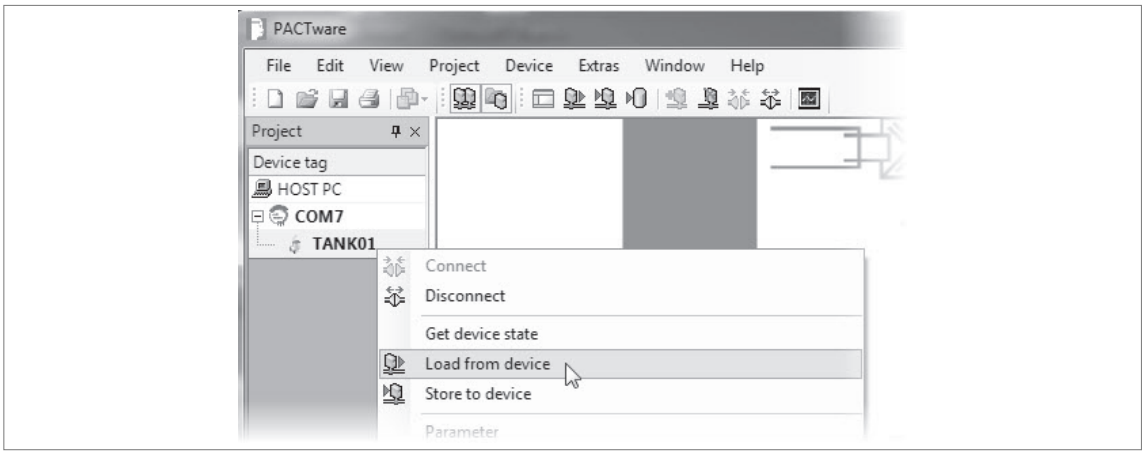

Figure 6-3: Right click on the "OPTIWAVE x400/x500" element in the Project pane (Procedure 3)

6.2 How to change device settings

6.2.1 Protection of the device settings (security roles)

The settings of this device have three different security roles: "User", "Operator" and "Expert". "Expert" is the highest security role. The highest security role lets you change all available functions.

INFORMATION!
Go to menu item A3 Login, set the security role to "Expert" and enter the password (0058) for the "Expert" security role before you change the device settings.

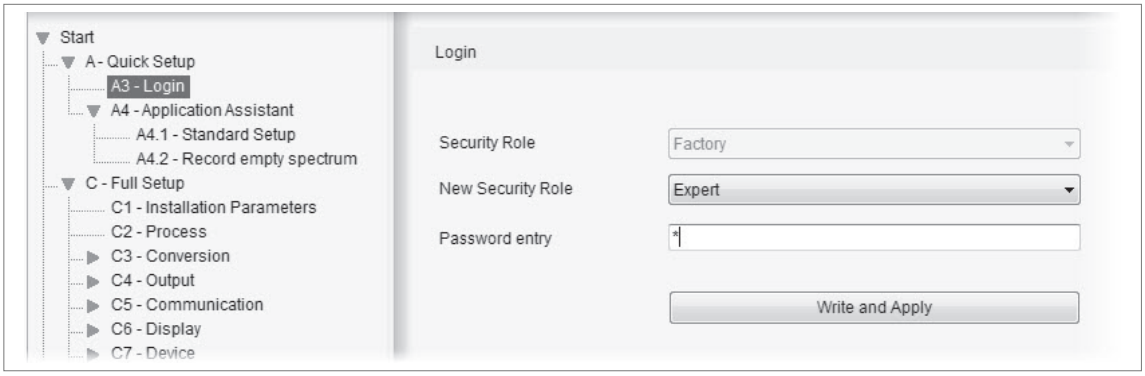

Figure 6-4: Change the security role to "Expert" before

Security roles and applicable functions in the DTM

Security roles	Default password	Applicable functions in the DTM (overview)
Expert	0058	• Read: Measurement data and error messages on the **Error monitor** pane and the **Diagnosis** tab • Change: All sub-menus in menus A Quick Setup and C Full Setup **NOTE:** You can change the password for the "Expert" security role in menu item C7.2.2 Change Password. Refer to the INFORMATION! note that follows.
Operator	0009	• Read: Measurement data and error messages on the **Error monitor** pane and the **Diagnosis** tab • Change: All HART® settings (C5) – but not C5.1.1 Current Loop Mode **NOTE:** You can change the password for the "Operator" security role in menu item C7.2.2 Change Password. Refer to the INFORMATION! note that follows.
User	—	• Read: Measurement data and error messages on the **Error monitor** pane and the **Diagnosis** tab • Read: All settings in menus A Quick Setup and C Full Setup • Change: All settings in menu item C7.5 Units (length, volume, mass and custom units) • Change: Security level. Go to menu item A3 Login or C7.2.1 Login to change from the "User" to the "Operator" or "Expert" security role.

INFORMATION!
If you de-energize the device and then energize it again, the security role will go back to "User".

6.2.2 Standard setup

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

- Go to the menu item **A4.1 - Standard Setup**.
- Click on the [**>>**] button to start the procedure.
- A4.1.1.1 Length. Make a selection from the list of length units (e.g. m, cm, mm, ft etc.).

➲ If you set this menu item to "Cst.", then you can make a custom length unit.

- **Custom length unit**: C7.5.2.1 Text. Enter a text (8 characters maximum) for the custom length unit.
- **Custom length unit**: C7.5.2.2 Offset. Enter an offset value.
- **Custom length unit**: C7.5.2.3 Factor. Enter a factor. Multiply the measured value by this factor to change m (metres) to the custom length unit.
- A4.1.2.1 Tank Type. This menu item gives the conditions in which the device is used (Storage, Process, Agitator, Stilling Well).

➲ If the surface of the product is flat, select "Storage". If the surface of the product is disturbed, select "Process". If the surface of the product is agitated with vortexes and foam, select "Agitator". If the device is installed on a bypass chamber or a stilling well, select "Stilling Well". If you select "Stilling Well", you must enter values in menu items A4.1.2.3 Stilling Well Height and A4.1.2.4 Stilling Well Diameter.

- A4.1.2.2 Tank Height. Tank height is the distance from the thread stop of the tank connection down to the tank bottom or the bottom of a flow channel.

- Make a selection from the list of parameters in menu item A4.1.3.1 Current Output 1 Variable (e.g. level, distance, reflection etc.).
- Enter the 0% range and 100% range values that agree with menu item A4.1.3.1 Current Output 1 Variable.
- Make a selection from the list of parameters in menu item A4.1.3.4 Current Output Range (e.g. 4...20 mA, 3.8...20.5 mA (NAMUR) etc.).
- Make a selection from the list of parameters in menu item A4.1.3.5 Error Function (Off, Low, High etc.).
- Click on the [√] button to save the changes. Click on the [X] button to cancel the changes.

➲ End of the procedure.

INFORMATION!
*If it is necessary to change the level value to volume, mass or volumetric flow rate values, go to menu **C3 Conversion** and do one of the procedures (**Conversion Dry** or **Conversion Wet**).*

INFORMATION!
Make sure that the security role of the device is set to "Expert" before you send data (device settings) to the device. For more data about the security role, refer to Protection of the device settings (security roles) on page 38.

CAUTION!
Changes to the settings are saved in the software when you click on the [√] button, but the software does not send the data to the device. To send the new device settings to the device, refer to How to send settings to the device (store to the device) on page 44.

6.2.3 How to make a filter to remove radar signal interference

If the device measures level in a tank that contains obstructions (agitator, supports, heating pipes etc.), these objects can cause radar signal interference (parasitic signals). You can use the empty spectrum function (menu A4.2) in the Quick Setup menu to make a filter to remove radar signal interference.

INFORMATION!
We recommend that you do an empty spectrum scan when the tank is empty and all the moving parts (agitators etc.) are in operation.

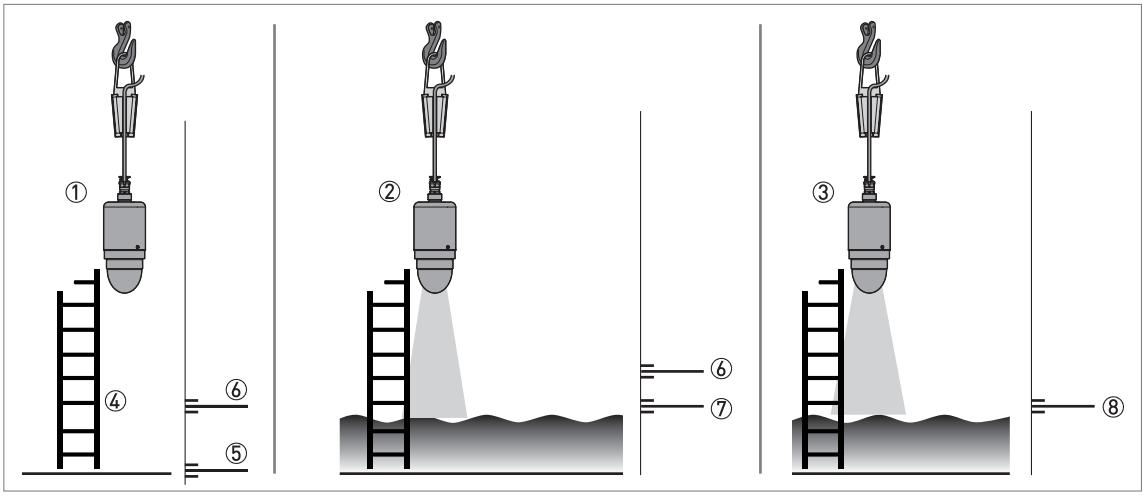

Figure 6-5: How to make a filter to remove radar signal interference

① Empty tank before the device uses the empty spectrum scan (with a graph of reflections shown)
② Partially filled tank before the device uses the empty spectrum scan (with a graph of reflections shown)
③ Partially filled tank after the device uses the empty spectrum scan (with a graph of reflections shown)
④ Obstruction, e.g. Ladder
⑤ Tank bottom signal
⑥ Ladder signal (interference signal) before the device does the empty spectrum scan
⑦ Signal of the liquid before the device does the empty spectrum scan
⑧ Reflected signal if the device uses the data from the empty spectrum scan. The device only uses the reflection on the surface of the liquid to measure distance.

INFORMATION!
Make sure that the security role of the device is set to "Expert" before you send data (device settings) to the device. For more data about the security role, refer to Protection of the device settings (security roles) on page 38.

CAUTION!
If the "partial distance" value is more than the distance to the product surface, then the device will put the level signal through the filter and the device will not measure the level of the product correctly.

- Go to the menu item A4.2 Record empty spectrum.
- Start the empty spectrum recording procedure. Set the parameter for the empty spectrum type.

➲ Make a selection from the list of parameters. If you can empty the tank, set this menu item to "Full, Average" or "Full, Max". If you cannot empty the tank, set this menu item to "Partial, Average" or "Partial, Max". If you set **Tank Type** in the Standard Setup procedure or in menu item C1.1 to "Agitator", set **Empty Spectrum Type** to "Full, Max" or "Partial, Max". If the device is near to a product inlet, set **Empty Spectrum Type** to "Full, Max" or "Partial, Max". Use the maximum value for tanks that have moving parts. Use the average value for tanks that do not have moving parts.

- Enter the value for the partial distance.

➲ If you set **Empty Spectrum Type** to "Partial, Average" or "Partial, Max", you will have one more step to do in this procedure. You must give a "partial distance" value less than or equal to the distance to the product surface from the flange facing or thread stop of the process connection.

- Click on the "Record empty spectrum" button.
- Do you want to load a preview of the new recorded empty spectrum? "Yes" or "No".

➲ If you select "Yes", then the device will show you a graph of the signals detected by the device. These signals will be put through a filter. If you select "No", then the DTM goes to the next step of the procedure.

- Accept new empty spectrum? "Yes" or "No".

➲ If you select "Yes", then the device will use the empty spectrum scan results to make a filter to remove radar signal interference.

INFORMATION!
For more data on empty spectrum scans, refer to Function description on page 79 – table A. Quick Setup menu (menu item A4.2).

6.2.4 Procedure: changing device settings

WARNING!
This procedure only changes and saves the device configuration in the computer database. It does not send the changes to the device. Use the procedure in chapter 6 to upload the new device configuration to the device.

CAUTION!
There are 3 buttons at the bottom right of the window. These buttons are used only to update the computer database. If you click on "OK" or "Apply", no data is sent to the device. This function obeys FDT guidelines for certification of the DTM.

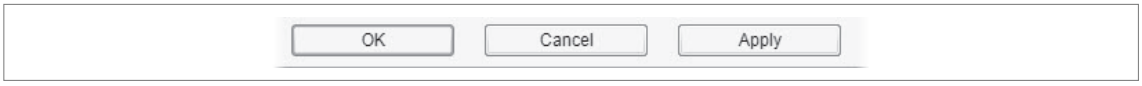

Figure 6-6: Use OK or Apply to update the computer database

When you change the value of a menu item, a pencil symbol shows adjacent to the changed value:

Figure 6-7: Pencil symbol: changed value

If the value is too large or too small, a red exclamation mark shows adjacent to the incorrect value:

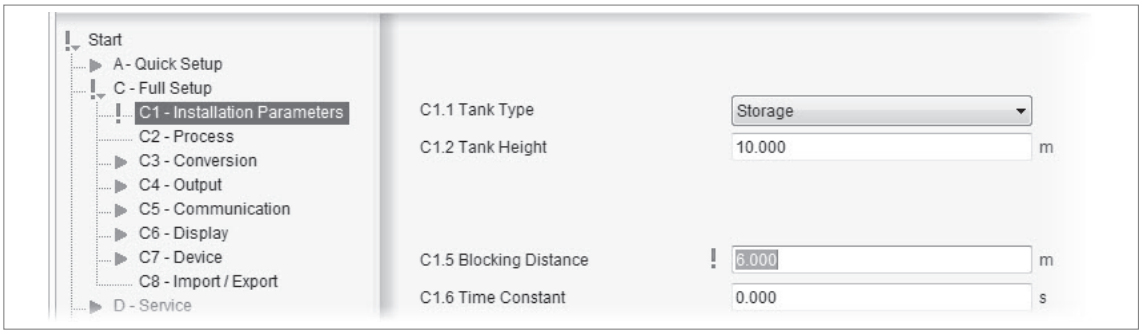

Figure 6-8: Exclamation mark: the value is too large or too small

6.2.5 Data about menu items and parameters (online Help)

More data is available for menu items in **C - Full Setup menu**.

Put the mouse pointer on a box in the menu. A tooltip gives a description of the menu item.

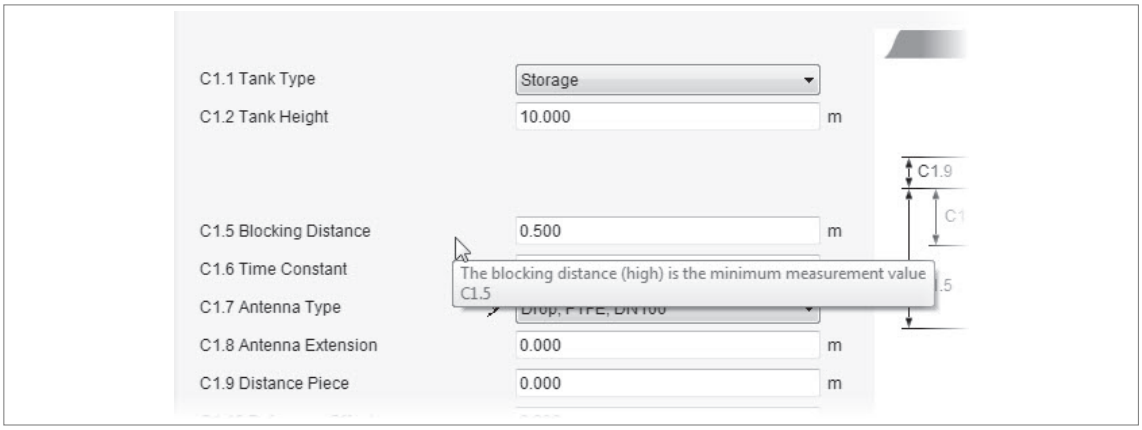

Figure 6-9: Data about parameters – part1: tooltip

Right click on the box for data about parameters. A tooltip shows the default value, data set value (new value), minimum value and maximum value of the menu item.

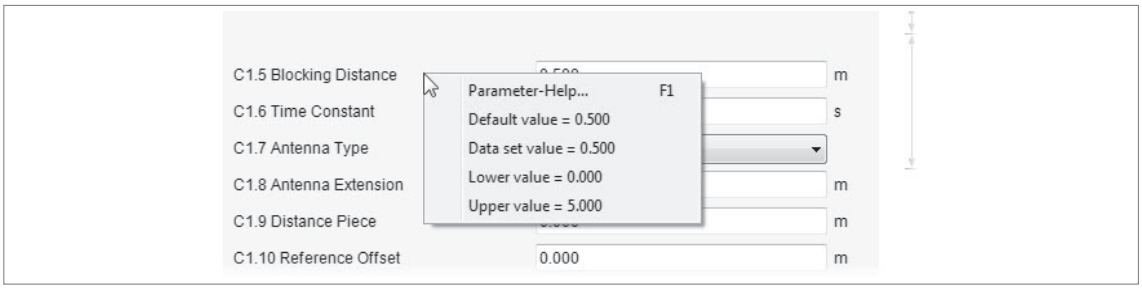

Figure 6-10: Data about parameters – part 2: values

6.3 How to send settings to the device (store to the device)

6.3.1 General notes

This chapter shows how to store the new settings from PACTware™ to the device. Changes to the device configuration are saved in the computer database, but the device cannot use the new settings at this time. You must store the new settings to the device.

6.3.2 Procedure 1

- Click on the Device button in the main toolbar.
- Select "Store to device" from the list. PACTware™ uploads the new device settings to the device.

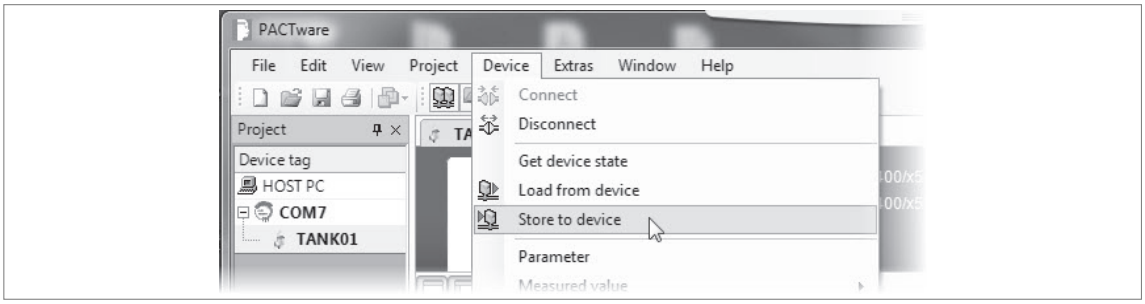

Figure 6-11: Select “Store to Device” in the Device menu

6.3.3 Procedure 2

CAUTION!
You must disconnect the communication port after you upload new data to the device. If you do not disconnect the communication port, error messages are shown and it is possible that there will be communication problems. If it is not possible to open the port again, you must restart the computer.

- Click on this icon (refer to the illustration that follows – you can find this icon below the main toolbar). PACTware™ uploads the new device settings to the device.

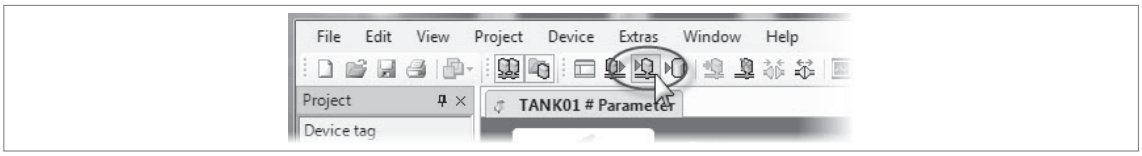

Figure 6-12: Click on the “Store to device” icon

6.3.4 Procedure 3

CAUTION!
You must disconnect the communication port after you upload new data to the device. If you do not disconnect the communication port, error messages are shown and it is possible that there will be communication problems. If it is not possible to open the port again, you must restart the computer.

- Right click on the "OPTIWAVE x400/x500 (ER 2.x.x)" or Tag Name" element.
- Select "Store to device" from the list. PACTware™ uploads the new device settings to the device.

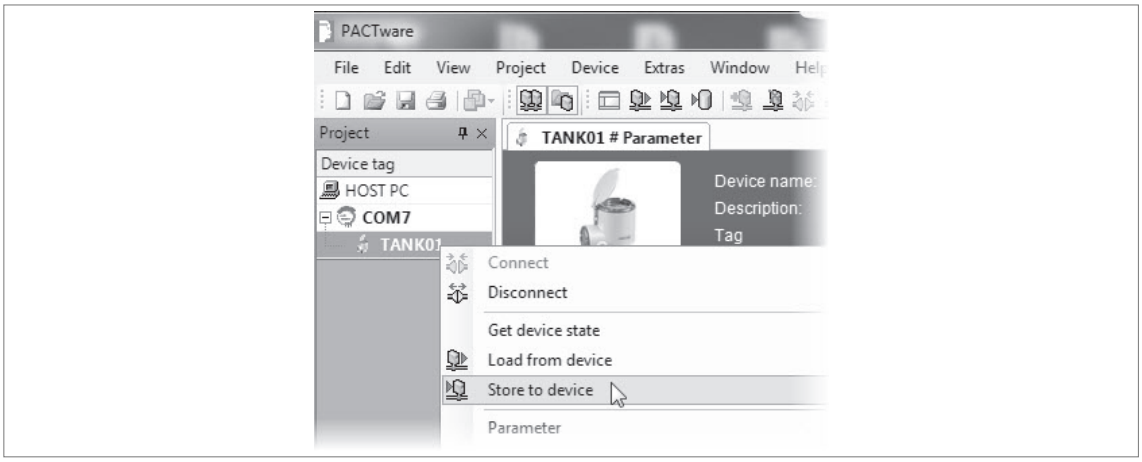

Figure 6-13: Right click on the “COM1” element in the Project pane and select “Disconnect”

6.4 Advanced configuration (C Full setup menu)

6.4.1 Level measurement

The device gives a current output signal that is related to level measurements when the menu item **C4.1.1 Current Out. 1 Var. (Current Output 1 Variable)** is set to "Level".

Menu items related to level measurement are:

- Current output 1 menu (C4.1)
- Tank Height (C1.2)
- Blocking Distance (C1.5)

The tank bottom (specified in menu item C1.2 Tank Height) is the reference point for level measurement (0 m / 0 ft / 0¨). The position of the measurement scale (specified by the 0% Range and 100% Range settings) is related to this reference point. If you configured a measurement scale for the current output signal in the C4.1 Current output 1 menu, you can use a "standard scale" or a "reversed scale". On the standard scale, the 0% Range measurement value agrees with an output of 4 mA and the 100% Range measurement value agrees with an output of 20 mA. On the reversed scale, the 0% Range measurement value agrees with an output of 20 mA and the 100% Range measurement value agrees with an output of 4 mA.

You can change the reference point from which level is measured. For more data, refer to *Function description* on page 79 - menu item C1.11 Tank Bottom Offset

CAUTION!
If C4.1.1 Current Out. 1 Var. is set to "Level" and C4.1.3 100% Range (standard scale) is set in the blocking distance, then the device will not be able to use the full current output range.

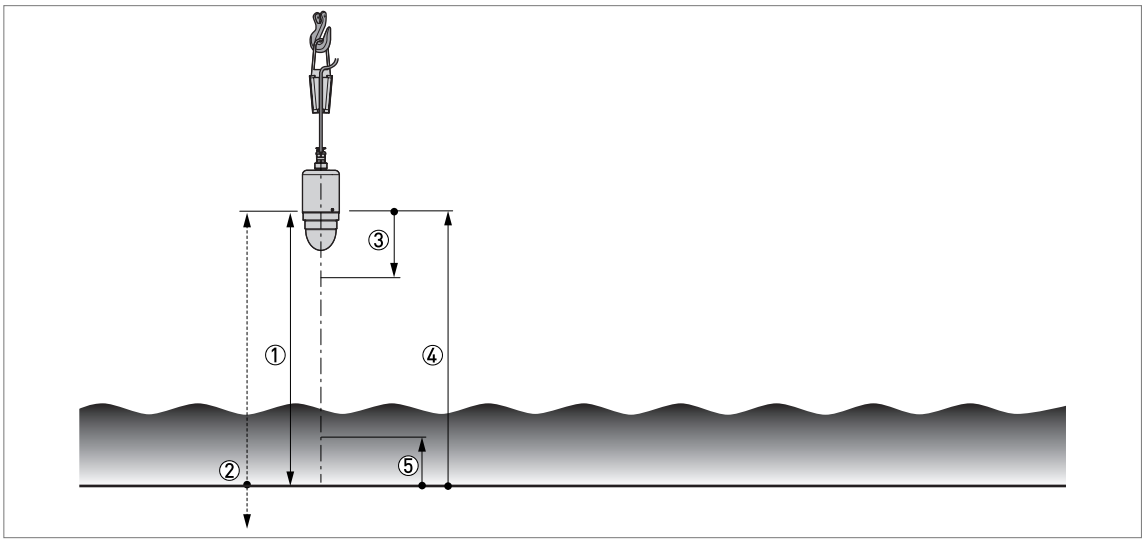

Figure 6-14: Level measurement

① Tank Height (C1.2) = h(max)
② Tank bottom reference point. You can use menu item C1.11 Tank Bottom Offset to move the position of the tank bottom reference point. Refer to "Function Description" in the Appendix.
③ Blocking Distance (C1.5)
④ 100% Range (C4.1.3), if menu item C4.1.4 Current Out. Range is set to "4-20mA" or "3.8-20.5mA"
⑤ 0% Range (C4.1.2), if menu item C4.1.4 Current Out. Range is set to "4-20mA" or "3.8-20.5mA"

For more data about the menu items, refer to *Function description* on page 79 – table C. Full Setup menu.

6.4.2 Distance measurement

The device gives a current output signal that is related to distance measurements when the menu item **C4.1.1 Current Out. 1 Var. (Current Output 1 Variable)** is set to "Distance".

Menu items related to distance measurement are:

- Current output 1 menu (C4.1)
- Tank Height (C1.2)

- Blocking Distance (C1.5)

. The position of the measurement scale (specified by the 0% Range and 100% Range settings) is related to this reference point. If you configured a measurement scale for the current output signal in the C4.1 Current output 1 menu, you can use a "standard scale" or a "reversed scale". On the standard scale, the 0% Range measurement value agrees with an output of 4 mA and the 100% Range measurement value agrees with an output of 20 mA. On the reversed scale, the 0% Range measurement value agrees with an output of 20 mA and the 100% Range measurement value agrees with an output of 4 mA.

You can change the reference point from which distance is measured. For more data, refer to *Function description* on page 79 - menu item C1.10 Reference Offset.

CAUTION!
If C4.1.1 Current Out. 1 Var. is set to "Distance" and C4.1.2 0% Range (standard scale) is set in the blocking distance, then the device will not be able to use the full current output range.

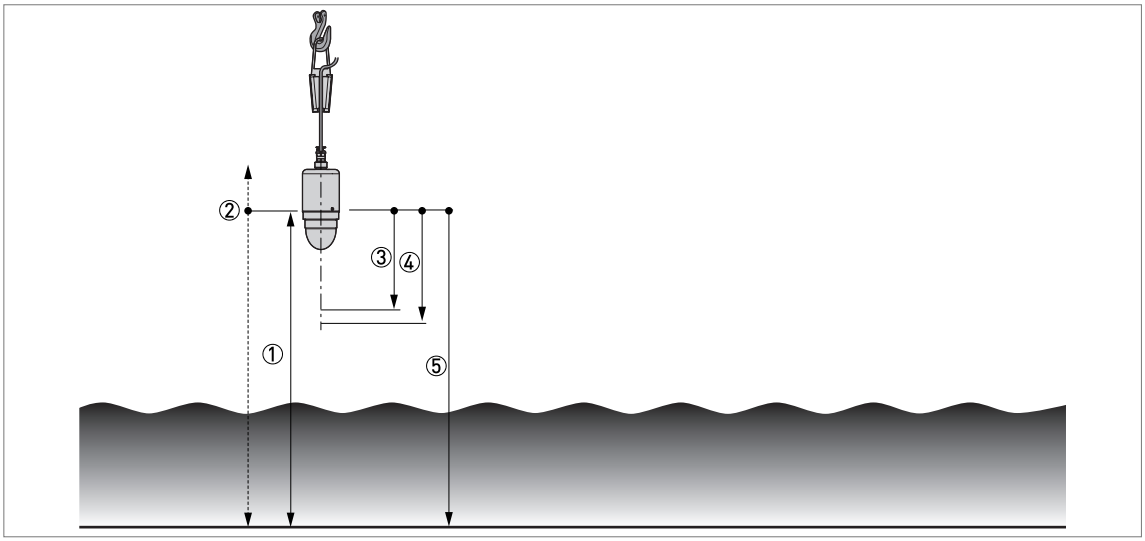

Figure 6-15: Distance measurement

① Tank Height (C1.2) = h(max)
② Reference point. You can use menu item C1.10 Reference Offset to move the position of the reference point. Refer to "Function Description" in the Appendix.
③ Blocking Distance (C1.5)
④ 0% Range (C4.1.2), if menu item C4.1.4 Current Out. Range is set to "4-20mA" or "3.8-20.5mA"
⑤ 100% Range (C4.1.3), if menu item C4.1.4 Current Out. Range is set to "4-20mA" or "3.8-20.5mA"

For more data about the menu items, refer to *Function description* on page 79 – table C. Full Setup menu.

6.4.3 Conversion tables

General notes

You can configure the device to measure volume, mass or volumetric flow rate. It can also be configured to measure a linearized level or distance value, or a custom quantity. You can set up a strapping table in the conversion menu (C3 Conversion). Each entry is a pair of data (level – volume, level – mass, level – linearized level, level – volumetric flow rate, level – custom measurement etc.). The strapping table can have a minimum of 2 entries and a maximum of 50. The reference point for the table is the bottom of the tank (as given in menu item Tank Height (C1.2) or Stilling Well Height (C1.3)).

INFORMATION!
Make sure that the security role of the device is set to "Expert" before you send data (device settings) to the device. For more data about the security role, refer to Protection of the device settings (security roles) on page 38.

CAUTION!
The total vertical dimension of the tank must be equal to the value given in menu item C1.2 Tank Height. If these values are not the same, then the conversion data in the strapping table cannot be used by the device.

Volume (Conversion, Dry)

If you prepare a "dry" conversion table, then you must specify the shape of the tank and its dimensions, and the measurement units. The device will then automatically calculate the level and the related volume values.

- Go to the menu item **C3.1 - Conversion Dry**.
- Click on the [**>>**] button to start the procedure.
- Make a selection from the list of length units (e.g. m, cm, mm, ft etc.).
- Set the conversion function to "Volume".
- Make a selection from the list of conversion units (e.g. m³, L, in³, gallons etc.).
- Make a selection from the list of tank shapes (e.g. cylindrical - horizontal, spherical etc.).

➲ If you set **Tank Shapes** to "User defined", then you must enter the values manually or import a CSV file that contains the level-volume data.

- Enter the values for the overall dimensions of the tank as shown on the illustration given for this step of the procedure.

➲ This step will automatically give 50 **level - volume** values at regular intervals.

- Click on the [**>>**] button to send the conversion table data to the device.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

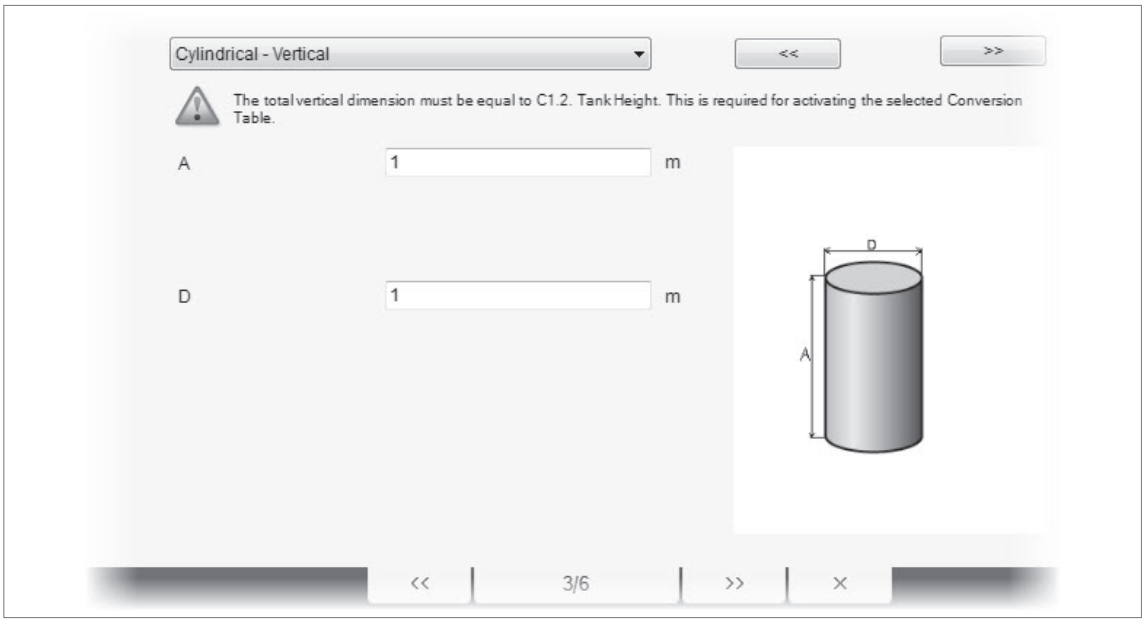

Figure 6-16: How to prepare a strapping table to measure volume in a tank

Volume (Conversion, Wet)

If you prepare a "wet" conversion table, then you must measure level with the device and enter a volume value on the table for the level measured at that time. You must continue to fill the tank and enter volume data until you have the necessary number of points.

- Go to the menu item **C3.2 - Conversion Wet**.
- Click on "Delete the current conversion table and create a new conversion table for wet calibration" and then click on the [>>] button to go to the next step.
- Set the conversion function to "Volume".
- Make a selection from the list of conversion units (e.g. m³, L, in³, gallons etc.).
- Fill the tank to the first point.
- Enter the volume value for the given level. Click on the "Add additional Point" button.

➲ This step adds a line of level - volume data to the table.

- Fill the tank to the next point. Enter the volume value for the given level. Click on the "Add additional Point" button.
- Continue the procedure until you have the necessary number of points.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

CAUTION!
The total vertical dimension of the device above the bottom of the flow channel, h(max), must be equal to the value given in menu item C1.2 Tank Height. If these values are not the same, then the conversion data in the strapping table cannot be used by the device.

Volumetric flow rate (Conversion, Dry)

If you prepare a "dry" conversion table, then you must specify the shape of the flow channel and its dimensions, and the measurement units. The device will then automatically calculate the level and the related volumetric flow rate values.

- Go to the menu item **C3.1 - Conversion Dry**.
- Click on the [**>>**] button to start the procedure.
- Make a selection from the list of length units (e.g. m, cm, mm, ft etc.).
- Set the conversion function to "Volume Flow".
- Make a selection from the list of conversion units (e.g. m³/s, ft³/min, L/h, gal/s etc.).
- Make a selection from the list of tank shapes (e.g. Venturi-Trapezoidal (ISO 4359), V-Notch (ISO 1438) etc.).

➲ If you set **Tank Shapes** to "User defined", then you must enter the values manually or import a CSV file that contains the level-volume flow data.

- Enter the values for the overall dimensions of the flow channel as shown on the illustration given for this step of the procedure.

➲ This step will automatically give 50 **level - volume flow** values at regular intervals.

- Click on the [**>>**] button to send the conversion table data to the device.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

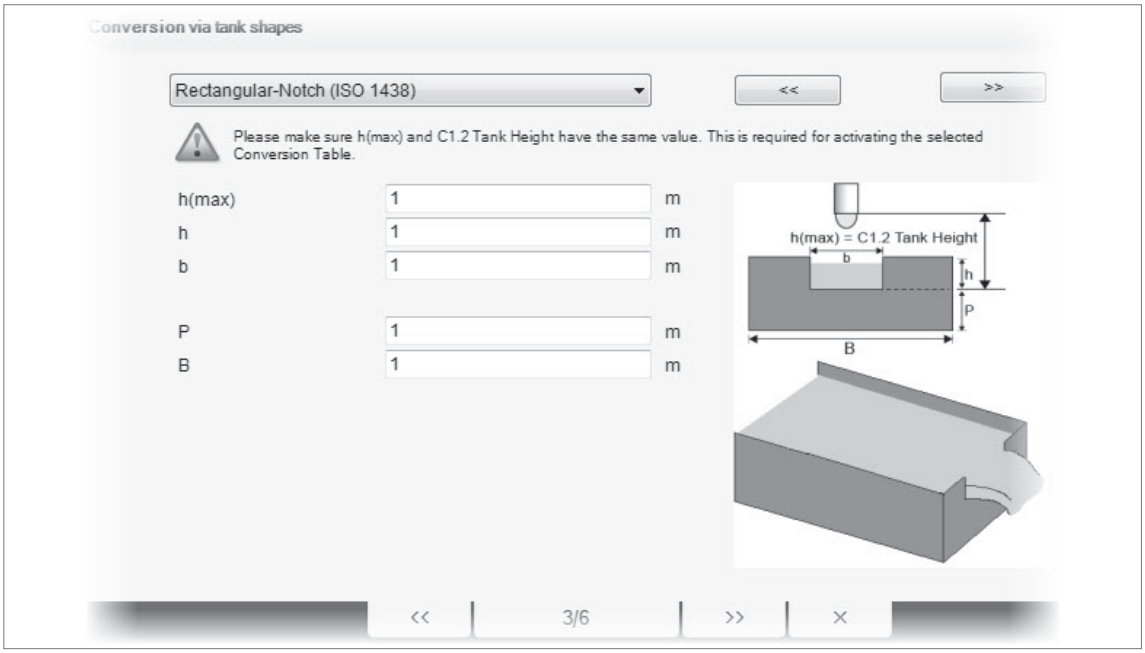

Figure 6-17: How to prepare a strapping table to measure volumetric flow rate in a flow channel

Volumetric flow rate (Conversion, Wet)

If you prepare a "wet" conversion table, then you must measure level with the device and enter a volumetric flow rate value on the table for the level measured at that time. You must continue to fill the tank and enter volumetric flow rate data until you have the necessary number of points.

- Go to the menu item **C3.2 - Conversion Wet**.
- Click on "Delete the current conversion table and create a new conversion table for wet calibration" and then click on the [**>>**] button to go to the next step.
- Set the conversion function to "Volume Flow".
- Make a selection from the list of conversion units (e.g. m³/s, ft³/min, L/h, gal/s etc.).
- Fill the tank to the first point.
- Enter the volumetric flow rate value for the given level. Click on the "Add additional Point" button.

➲ This step adds a line of level - volumetric flow rate data to the table.

- Fill the tank to the next point. Enter the volumetric flow rate value for the given level. Click on the "Add additional Point" button.
- Continue the procedure until you have the necessary number of points.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

Linearization (Conversion, Dry)

Linearization of level measurement data permits the user to correct measurement values in a given zone or convert the length unit to a custom unit.

- Go to the menu item **C3.1 - Conversion Dry**.
- Click on the [**>>**] button to start the procedure.
- Make a selection from the list of length units (e.g. m, cm, mm, ft etc.).
- Set the conversion function to "Linearization".
- Make a selection from the list of conversion units (e.g. mm, in, ft etc.).

➲ Enter the values manually or import a CSV file that contains the level-linearized level data.

- Click on the [**>>**] button to send the conversion table data to the device.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

Linearization (Conversion, Wet)

Linearization of level measurement data permits the user to correct measurement values in a given zone or convert the length unit to a custom unit.

If you prepare a "wet" conversion table, then you must measure level with the device and enter a linearized level (or custom unit) value on the table for the level measured at that time. You must continue to fill the tank and enter linearized level data until you have the necessary number of points.

- Go to the menu item **C3.2 - Conversion Wet**.
- Click on "Delete the current conversion table and create a new conversion table for wet calibration" and then click on the [**>>**] button to go to the next step.
- Set the conversion function to "Linearization".
- Make a selection from the list of conversion units (e.g. mm, in, ft etc.).
- Fill the tank to the first point.
- Enter the volumetric flow rate value for the given level. Click on the "Add additional Point" button.

➲ This step adds a line of level - volumetric flow rate data to the table.

- Fill the tank to the next point. Enter the volumetric flow rate value for the given level. Click on the "Add additional Point" button.
- Continue the procedure until you have the necessary number of points.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

Mass (Conversion, Dry)

If you prepare a "dry" conversion table, then you must specify the shape of the tank and its dimensions, and the measurement units. The device will then automatically calculate the level and the related mass values.

- Go to the menu item **C3.1 - Conversion Dry**.
- Click on the [**>>**] button to start the procedure.
- Make a selection from the list of length units (e.g. m, cm, mm, ft etc.).
- Set the conversion function to "Mass".
- Make a selection from the list of conversion units (e.g. kilogram, tonne, short ton etc.).
- Make a selection from the list of tank shapes (e.g. cylindrical - horizontal, spherical etc.).

➲ If you set **Tank Shapes** to "User defined", then you must enter the values manually or import a CSV file that contains the level-mass data.

- Enter the values for the overall dimensions of the tank as shown on the illustration given for this step of the procedure.
- Make a selection from the list of density units (e.g. kg/m³, lb/ft³ etc.). Enter the density value.

➲ This step will automatically give 50 **level** - **mass** values at regular intervals.

- Click on the [**>>**] button to send the conversion table data to the device.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

Mass (Conversion, Wet)

If you prepare a "wet" conversion table, then you must measure level with the device and enter a mass value on the table for the level measured at that time. You must continue to fill the tank and enter mass data until you have the necessary number of points.

- Go to the menu item **C3.2 - Conversion Wet**.
- Click on "Delete the current conversion table and create a new conversion table for wet calibration" and then click on the [**>>**] button to go to the next step.
- Set the conversion function to "Mass".
- Make a selection from the list of conversion units (e.g. kilogram, tonne, short ton etc.).
- Fill the tank to the first point.
- Enter the volume value for the given level. Click on the "Add additional Point" button.

➲ This step adds a line of level - volume data to the table.

- Fill the tank to the next point. Enter the volume value for the given level. Click on the "Add additional Point" button.
- Continue the procedure until you have the necessary number of points.
- Click on the [√] button to complete the procedure.

➲ End of the procedure.

6.5 How to measure distance with the 45° deflector plate option

We recommend that the device has the 45° deflector plate option if there is only sufficient space to install the device horizontally.

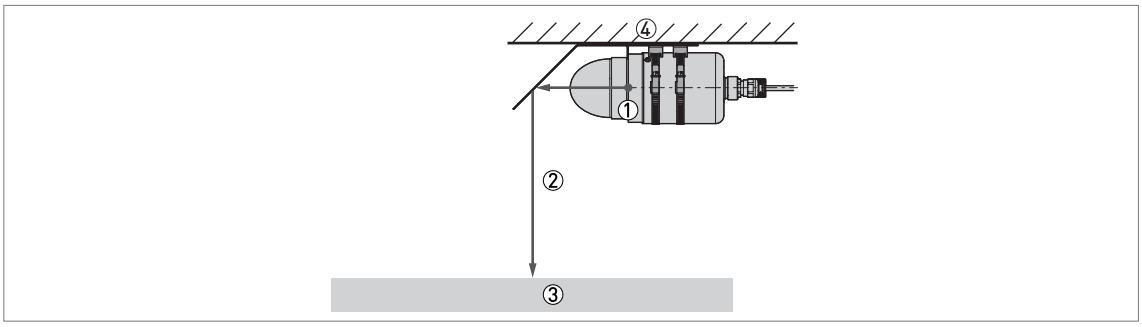

Figure 6-18: How to measure distance with the 45° deflector plate option

① Reference point. The distance is measured from this point
② Radar signal
③ Surface of the tank contents
④ Ceiling

The radar signal must travel horizontally for 133.5 mm / 5.26¨ before it is reflected vertically down to the product. For more dimensional data, refer to *Dimensions and weights* on page 69 (Device with 45° deflector plate).

6.6 How to close PACTware

When you close PACTware™, the computer will show a message: “You have changed PACTware data. Save changes?”. This step lets you save the project structure (bus architecture). You can then load this structure when you open the software again.

7.1 Periodic maintenance

In normal operational conditions, no maintenance is necessary. If it is necessary, maintenance must be done by approved personnel (the manufacturer or personnel approved by the manufacturer).

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

7.2 Service warranty

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

Servicing by the customer is limited by warranty to:

- The removal and installation of the device.

For more data on how to prepare the device before you send it back, refer to *Returning the device to the manufacturer* on page 55.

7.3 Availability of services

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

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

7.4 Returning the device to the manufacturer

7.4.1 General information

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

WARNING!
Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of the personnel, the manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*

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

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

7.4.2 Form (for copying) to accompany a returned device

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

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

7.5 Disposal

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

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

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

7.6 Disassembly and recycling

7.6.1 General notes

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

CAUTION!
Before you disassemble the device for disposal and recycling, make sure that the device is unserviceable.

INFORMATION!
The device does not contain dangerous gases or materials. If there is contamination from the process, refer to Returning the device to the manufacturer on page 55.

7.6.2 Compact version (C)

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

Product description

Product name and data

Type	OPTIWAVE
Model	1400 C (Compact)
Usage	Level measurement

Weight

Total weight	2.3 kg / 5.1 lb
Weight of parts (percentage of total weight)	Aluminium: 3%
	Stainless steel: 35%
	Plastic: 22%
	Cable: 22% ①
	Electronics: 18%

Dimensions

Volume	1.5097 dm³ / 92.13 in³

Table 7-1: Product description

① For a cable length of 10 m / 32.8 ft. The cable is made plastic, copper and steel.

Parts list

Item	Description	Material
(1)	Antenna	polypropylene
(2)	O-ring	EPDM
(3)	Screw (M4 × 6)	stainless steel
(4)	Support	stainless steel
(5)	O-ring	EPDM
(6)	Screw (M4 × 6)	stainless steel
(7)	**Sensor PCB**	—
(8)	Anti-vibration support	PA 66
(9)	Set screw (M3 × 12)	stainless steel
(10)	Screw (M3 × 8)	stainless steel
(11)	Spacer column	aluminium
(14)	Converter	—
(15)	Spacer	nickel-plated brass
(16)	**Electronics board**	—
(17)	Toothed lock washer	stainless steel
(18)	Desiccant bag	silica gel
(19)	Housing	stainless steel
(20)	Cable gland	polyamide
(21)	**Cable**	—

Table 7-2: Parts list

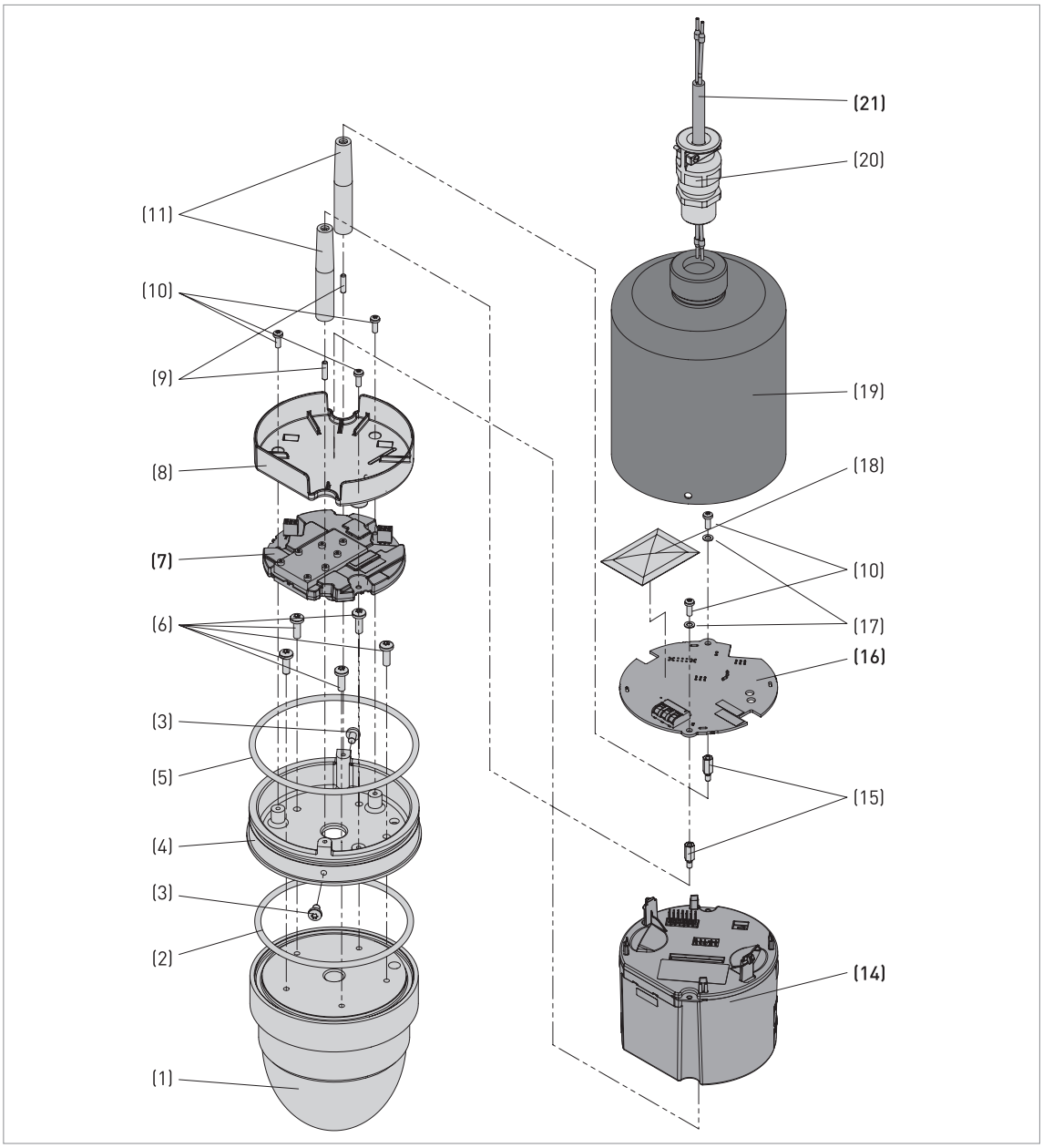

Figure 7-1: Parts of the device (refer to the "Parts list" table)

Equipment needed:

- 5-mm slotted tip screwdriver (not supplied)
- Pliers (not supplied)
- 1.5-mm Allen wrench (not supplied)
- 5.5-mm socket wrench (not supplied)
- T20 TORX® screwdriver (not supplied)
- T10 TORX® screwdriver (not supplied)
- Adjustable wrench (not supplied)

The product does not contain harmful gases or substances. There are no special precautions for disassembly of the device.

DANGER!
De-energize the device before you disconnect the electrical cable.

INFORMATION!
Numbers in parentheses (xx) refer to item numbers in the parts list. Refer to the "Parts list" table and the related illustration in this section.

How to remove the electrical cable

- Remove the 2 slotted screws from the cable gland (20) with a slotted tip screwdriver.
- Loosen the cable gland seal and remove the cable gland (20) with the adjustable wrench.
- Remove the two M4×6 screws (3) from the side of the housing (19) with a T20 TORX® screwdriver.
- Remove the housing (19).
- Push the button above each terminal on the terminal block to disconnect the electrical wires from the electronics board (16).

How to disassemble the device

- Remove the two M3×8 TORX® screws (10) from the electronics board (16) with a T10 TORX® screwdriver.
- Remove the electronics board (16).
- Remove with the two spacers (15) on top of the converter (14) with a 5.5-mm socket wrench.
- Pull the converter (14) away from the anti-vibration support (8). Remove the converter.
- Remove the three M3×12 TORX® set screws (10) from the anti-vibration support (8) with a T10 TORX® screwdriver.
- Remove the anti-vibration support (8).
- Disassemble the sensor PCB (7) from the anti-vibration support (8).
- Remove the seven socket head cap screws from the two aluminium blocks attached to the sensor PCB (7) with a 1.5-mm Allen wrench. Remove the two aluminium blocks.
- Remove the five M4×6 TORX® screws (6) on the stainless-steel support (4) with a T10 TORX® screwdriver.
- Disassemble the stainless-steel support (4) from the polypropylene antenna (1).
- Remove the two support columns (11) from the stainless-steel support (4) with a pair of pliers.
- Remove the O-ring (5) from the stainless-steel support (4).
- Remove the O-ring (2) from the groove at the top of the antenna (1).

➲ End of the procedure.

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

Material	Weight		Description
	[kg]	[lb]	
Printed circuit board (PCB)	0.121	0.267	area: ~334 cm² / 51.77 in²
Electrolytic capacitor	N/A	N/A	The PCBs in the electronics block have electrolytic capacitors that have a total volume of 3.8 cm³ / 0.23 in³
Battery	N/A	N/A	N/A
LCD screen (device) area > 100 cm² / > 15.5 in²	N/A	N/A	The device does not have a display screen option
Plastic that contains brominated flame retardants	N/A	N/A	N/A
Noble / precious metal	N/A	N/A	N/A
Silicon	0.202	0.445	—
Signal converter	0.063	0.139	—
Aluminium	0.013	0.029	—

Table 7-3: Materials and components that must be removed and independently prepared for treatment

Materials and components that can be recycled

Material	Percentage of total weight	Total weight		Description
	[%]	[kg]	[lb]	
Stainless steel	35	2.4	5.5	—
Aluminium	3			—
Polypropylene	19			Drop antenna
Electrical cable	22			—

Table 7-4: Materials and components that can be recycled

8.1 Measuring principle

A radar signal is emitted via an antenna, reflected from the product surface and received after a time t. The radar principle used is FMCW (Frequency Modulated Continuous Wave).

The FMCW-radar transmits a high frequency signal whose frequency increases linearly during the measurement phase (called the frequency sweep). The signal is emitted, reflected on the measuring surface and received with a time delay, t. Delay time, t=2d/c, where d is the distance to the product surface and c is the speed of light in the gas above the product.

For further signal processing the difference Δf is calculated from the actual transmitted frequency and the received frequency. The difference is directly proportional to the distance. A large frequency difference corresponds to a large distance and vice versa. The frequency difference Δf is transformed via a Fast Fourier Transform (FFT) into a frequency spectrum and then the distance is calculated from the spectrum. The level results from the difference between the tank height and the measured distance.

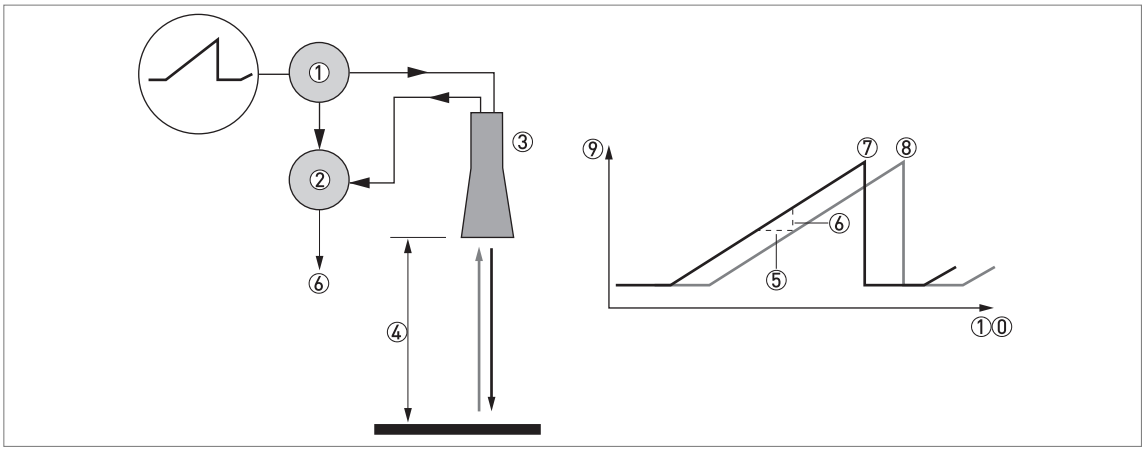

Figure 8-1: Measuring principle of FMCW radar

① Transmitter
② Mixer
③ Antenna
④ Distance to product surface, where change in frequency is proportional to distance
⑤ Differential time delay, Δt
⑥ Differential frequency, Δf
⑦ Frequency transmitted
⑧ Frequency received
⑨ Frequency
①⓪ Time

8.2 Technical data

INFORMATION!

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

Measuring system

Measuring principle	2-wire loop-powered level transmitter; FMCW radar
Frequency range	K-band (24...26 GHz)
Max. radiated power (EIRP)	< -41.3 dBm according to ETSI EN 302 729 (LPR)
Application range	Level measurement of liquids, pastes and slurries
Primary measured value	Distance and reflection
Secondary measured value	Level, volume, mass and flow rate

Design

Construction	The measurement system consists of a measuring sensor (antenna) and a signal converter
Max. measuring range (antenna)	20 m / 65.6 ft
Min. tank height	0.3 m / 11.8¨
Recommended minimum blocking distance	0.2 m / 7.9¨ – applicable if the device does a spectrum analysis and the interference signal filter (empty spectrum) is set to "Enabled" ①
Beam angle (antenna)	PP Drop, DN100 / 4¨: 8°
User interface	
User interface options	HART® Field Communicator. Download the Device Description (DD) file from the website.
	System or PC with PACTware™. Download the Device Type Manager (DTM) file from the website.

Measuring accuracy

Resolution	1 mm / 0.04¨
Repeatability	±1 mm / ±0.04¨
Accuracy	Standard: ±2 mm / ±0.08¨, when distance ≤ 10 m / 33 ft; ±0.02% of measured distance, when distance > 10 m / 33 ft. For more data, refer to *Measuring accuracy* on page 67.
Reference conditions acc. to EN 61298-1	
Temperature	+15...+25°C / +59...+77°F
Pressure	1013 mbara ±50 mbar / 14.69 psia ±0.73 psi
Relative air humidity (RH)	60% ±15%
Target	Metal plate in an anechoic chamber

Operating conditions

Temperature	
Ambient temperature	-20…+80°C / -4…+176°F
Relative humidity (RH)	0…99%
Storage temperature	-40…+85°C / -40…+185°F
Process connection temperature (higher temperature on request)	-40…+80°C / -40…+176°F
Pressure	
Process pressure	Subject to the process connection used and the process connection temperature. For more data, refer to *Pressure and temperature ranges* on page 19.
Other conditions	
Dielectric constant (ε_r)	Direct mode: ≥2
Ingress protection	IEC 60529: IP66 / IP68 (continuous immersion at a gauge pressure of 0.2 barg for 2 weeks)
	NEMA 250: NEMA type 4X/6
Maximum rate of change	60 m/min / 196 ft/min

Installation conditions

Process connection size	The nominal diameter (DN) should be equal to or larger than the antenna diameter.
Process connection position	Make sure that there are not any obstructions directly below the process connection for the device. For more data, refer to *Installation* on page 19.
Dimensions and weights	For dimensions and weights data, refer to *Dimensions and weights* on page 69.

Materials

Housing	Standard: Stainless steel (1.4404 / 316L)
Wetted parts, including antenna	PP and stainless steel (1.4404 / 316L)
Process connection	Standard: Stainless steel (1.4404 / 316L)
	Option: PP
Cable gland	M20×1.5 with aluminium clamp

Process connections

Bottom of housing	G 3 A (ISO 228)
Top of housing	G 1 A (ISO 228)
Flange version	
EN 1092-1	DN80…100 in PN01 (max. 3 bar)
ASME B16.5	3…4" in Class 150 (max. 15 psig)
Other	Others on request

Electrical connections

Power supply	12…30 V DC; min./max. value for an output of 21.5 mA at the terminals
Maximum current	21.5 mA
Current output load	R_L [Ω] ≤ ((U_{ext} -12 V)/21.5 mA). For more data, refer to *Minimum power supply voltage* on page 68.
Cable entry	M20×1.5
Cable entry capacity (terminal)	0.5…3.31 mm² (AWG 20...12)

Input and output

Current output	
Output signal	Standard: 4…20 mA
	Options: 3.8…20.5 mA acc. to NAMUR NE 43; 4…20 mA (reversed); 3.8…20.5 mA (reversed) acc. to NAMUR NE 43
Output type	Passive
Resolution	±5 µA
Temperature drift	Typically 50 ppm/K
Error signal	High: 21.5 mA; Low: 3.5 mA acc. to NAMUR NE 43
HART®	
Description	Digital signal transmitted with the current output signal (HART® protocol)
Version	7.4
Load	≥ 250 Ω
Digital temperature drift	Max. ±15 mm / 0.6¨ for the full temperature range
Multi-drop operation	Yes. Current output = 4 mA. Enter Program mode to change the polling address (1...63).
Available drivers	FC475, AMS, PDM, FDT/DTM

Approvals and certification

CE	The device meets the essential requirements of the EU Directives. The manufacturer certifies successful testing of the product by applying the CE marking.
	For more data about the EU Directives and European Standards related to this device, refer to the EU Declaration of Conformity. You can download this document free of charge from the website (Download Center).
Vibration resistance	EN 60068-2-6 (5...8.51 Hz: 3 mm / 8.51...200 Hz:1g)
Shock resistance	EN 60068-2-27 (25g shock ½ sinus: 6 ms)
Explosion protection	
ATEX (EU Type Approval)	II 1/2 G Ex ia IIC T6...T5 Ga/Gb
ATEX (Type Approval)	II 3 G Ex ic IIC T6...T5 Gc
IECEx	Ex ia IIC T6...T5 Ga/Gb;
	Ex ic IIC T6...T5 Gc
NEPSI (pending)	Ex ia IIC T5~T6 Ga/Gb
EAC-EX (pending)	Ga/Gb Ex ia IIC T6...T5 X

Other standards and approvals	
Electromagnetic compatibility	**EU**: Electromagnetic Compatibility directive (EMC)
Radio approvals	**EU**: Radio Equipment directive (RED)
	FCC Rules: Part 15, Class B
	Industry Canada: RSS-211
Electrical safety	**EU**: Agrees with the safety part of the Low Voltage directive (LVD)
NAMUR	NAMUR NE 43 Standardization of the Signal Level for the Failure Information of Digital Transmitters
	NAMUR NE 53 Software and Hardware of Field Devices and Signal Processing Devices with Digital Electronics
	NAMUR NE 107 Self-Monitoring and Diagnosis of Field Devices
WHG (Z-65.16-594)	In conformity with the German Federal Water Act, §9

Table 8-1: Technical data

① Do the "Empty Spectrum" procedure (menu A4.2) in the Quick Setup menu.

8.3 Measuring accuracy

Use these graphs to find the measuring accuracy for a given distance from the transmitter.

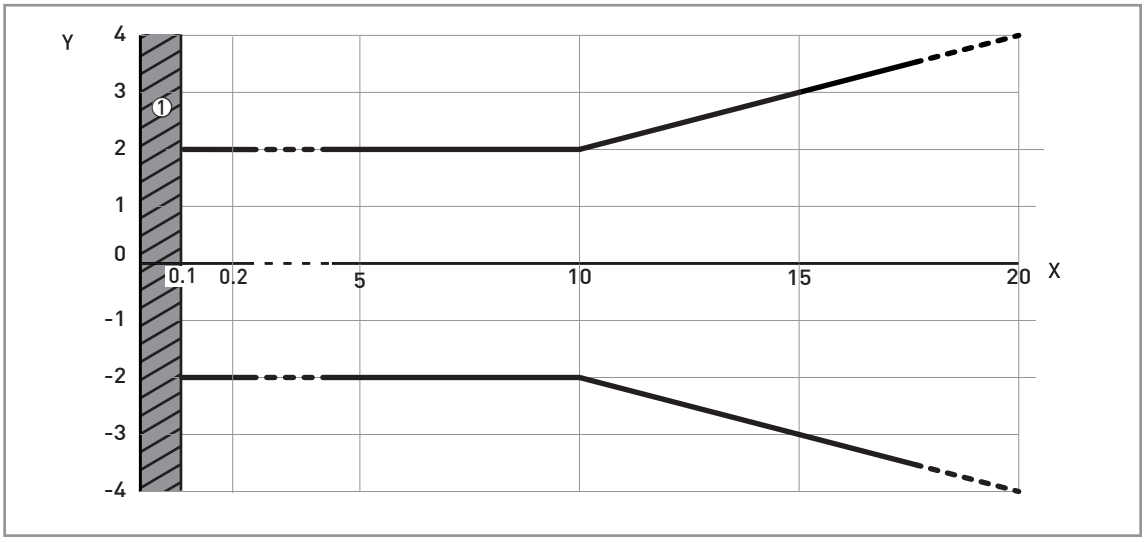

Figure 8-2: Measuring accuracy (graph of measuring accuracy in mm against measuring distance in m)

X: Measuring distance from the thread stop or flange facing of the process connection [m]
Y: Measuring accuracy [+yy mm / -yy mm]
① Minimum recommended blocking distance = 0.8 m

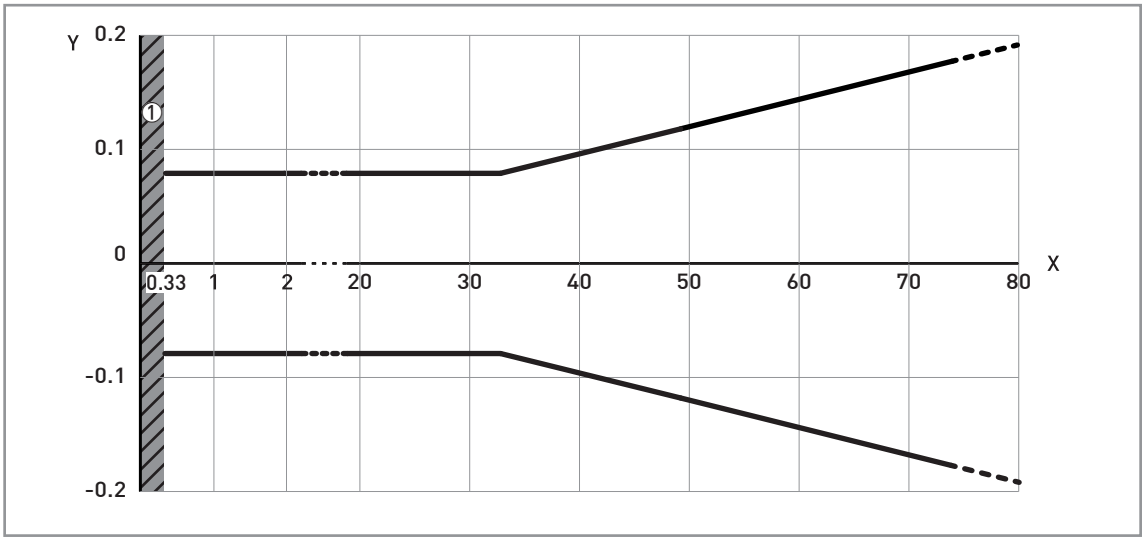

Figure 8-3: Measuring accuracy (graph of measuring accuracy in inches against measuring distance in ft)

X: Measuring distance from the thread stop or flange facing of the process connection [ft]
Y: Measuring accuracy [+yy inches / -yy inches]
① Minimum recommended blocking distance = 31.5¨

INFORMATION!
To calculate the accuracy at a given distance from the antenna, refer to Technical data on page 63 (measuring accuracy).

8.4 Minimum power supply voltage

Use this graph to find the minimum power supply voltage for a given current output load.

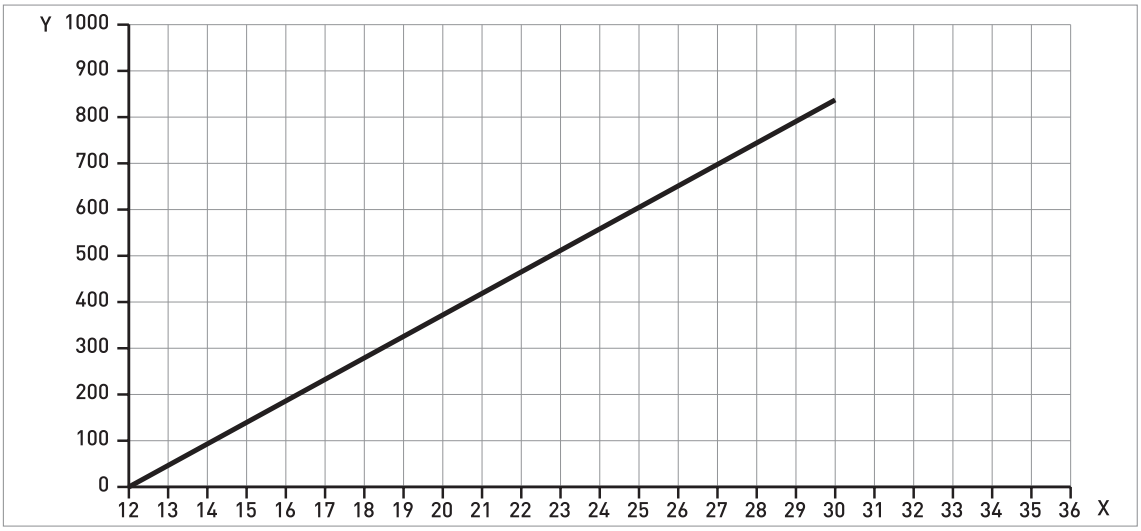

Figure 8-4: Minimum power supply voltage for an output of 21.5 mA at the terminals

X: Power supply U [V DC]
Y: Current output load R_L [Ω]

8.5 Dimensions and weights

Device with a top or bottom threaded connection

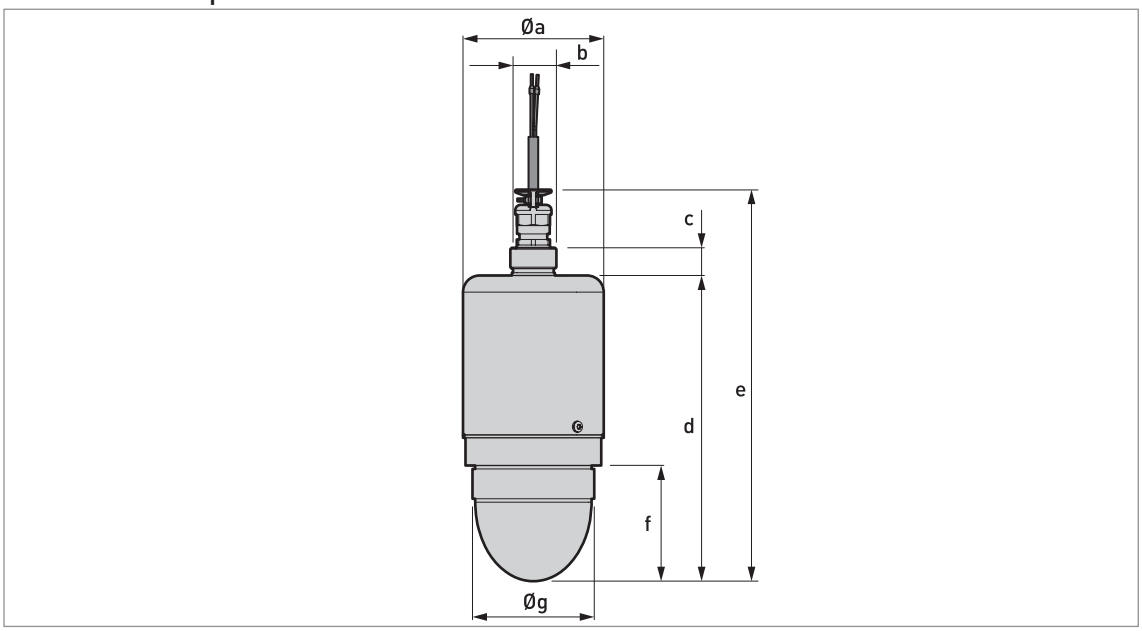

Figure 8-5: Device with a top or bottom threaded connection

Dimensions [mm]						
Øa	b	c	d	e	f	Øg
101.6	G 1	20	220.7	282.7	83.5	G 3

Table 8-2: Device with a top or bottom threaded connection: Dimensions in mm

Dimensions [inches]						
Øa	b	c	d	e	f	Øg
4.00	G 1	0.79	8.69	11.13	3.29	G 3

Table 8-3: Device with a top or bottom threaded connection: Dimensions in inches

Device with a top flange

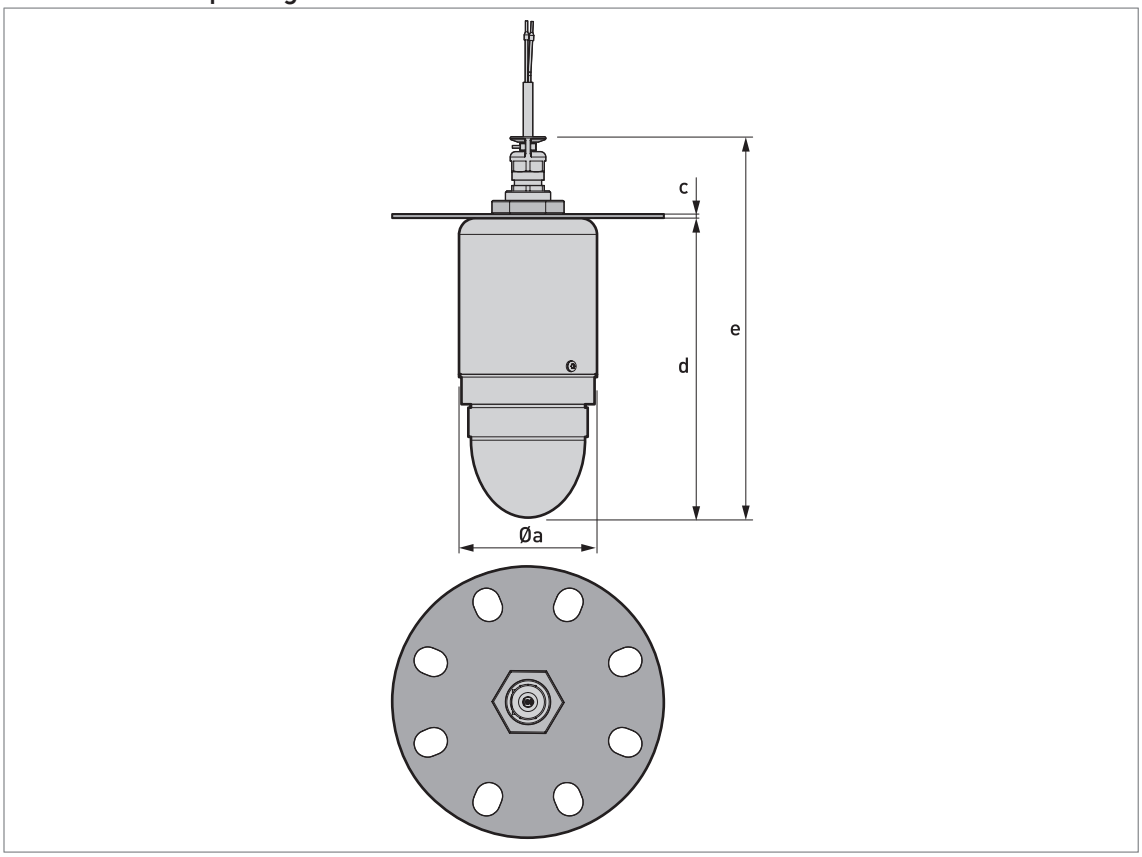

Figure 8-6: Device with a top flange

Dimensions [mm]			
Øa	c	d	e
101.6	3	220.7	282.7

Table 8-4: Device with a top flange: Dimensions in mm

Dimensions [inches]			
Øa	c	d	e
4.00	0.12	8.69	11.13

Table 8-5: Device with a top flange: Dimensions in inches

Device with a bottom flange

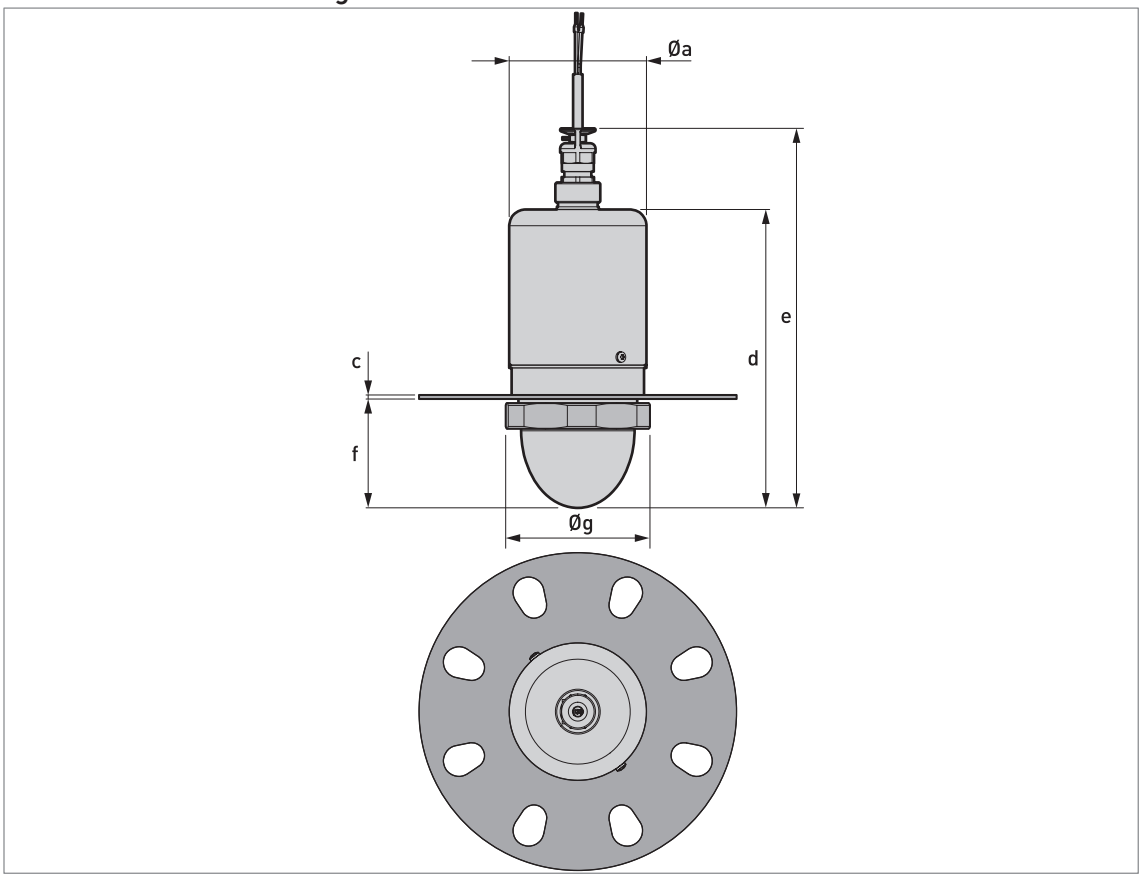

Figure 8-7: Device with a bottom flange

Dimensions [mm]					
Øa	c	d	e	f	Øg
101.6	3	220.7	282.7	80.5	H105

Table 8-6: Device with a bottom flange: Dimensions in mm

Dimensions [inches]					
Øa	c	d	e	f	Øg
4.00	0.12	8.69	11.13	3.17	H105

Table 8-7: Device with a bottom flange: Dimensions in inches

Device with an orientable bracket

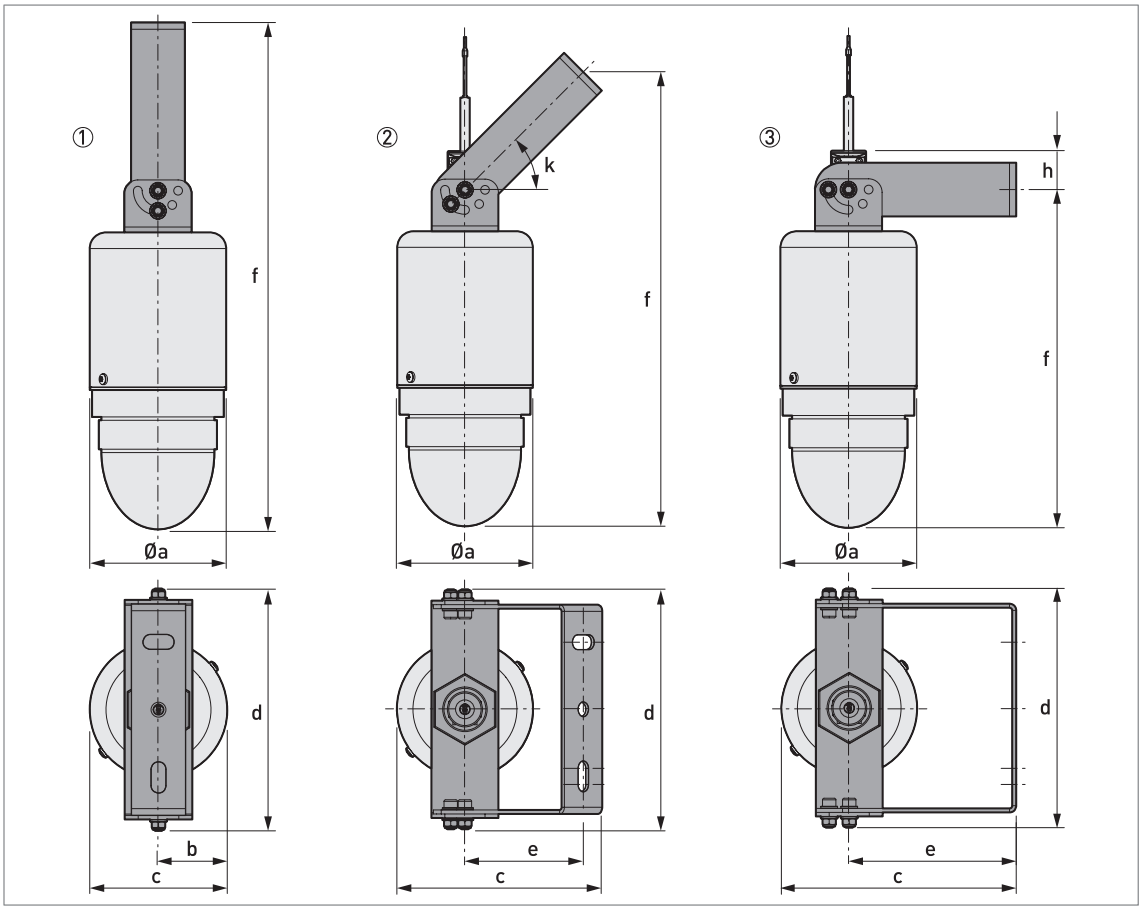

Figure 8-8: Device with an orientable bracket

① Device with orientable bracket (vertical)
② Device with orientable bracket (45°)
③ Device with orientable bracket (horizontal)

WARNING!

Make sure that there is sufficient clearance between the top of the cable gland and the ceiling to prevent damage to the electrical cable. The minimum clearance is 30 mm / 1.2".

Fixed support position	Dimensions [mm]							
	Øa	b	c	d	e	f	h	k
Vertical	102	51	102	179	—	377 ①	—	—
45°	102	—	154	179	134	344 ①	—	45°
Horizontal	102	—	176	179	125	252 ①	29	—

Table 8-8: Device with an orientable bracket: Dimensions in mm

① Make sure that there is sufficient clearance between the top of the cable gland and the ceiling to prevent damage to the electrical cable. The minimum clearance is 30 mm.

Fixed support position	Dimensions [inches]							
	Øa	b	c	d	e	f	h	k
Vertical	4.02	2.01	4.02	7.05	—	14.84 ①	—	—
45°	4.02	—	6.06	7.05	5.28	13.54 ①	—	45°
Horizontal	4.02	—	6.93	7.05	4.92	9.92 ①	1.14	—

Table 8-9: Device with an orientable collar: Dimensions in inches

① Make sure that there is sufficient clearance between the top of the cable gland and the ceiling to prevent damage to the electrical cable. The minimum clearance is 1.2¨.

Orientable bracket

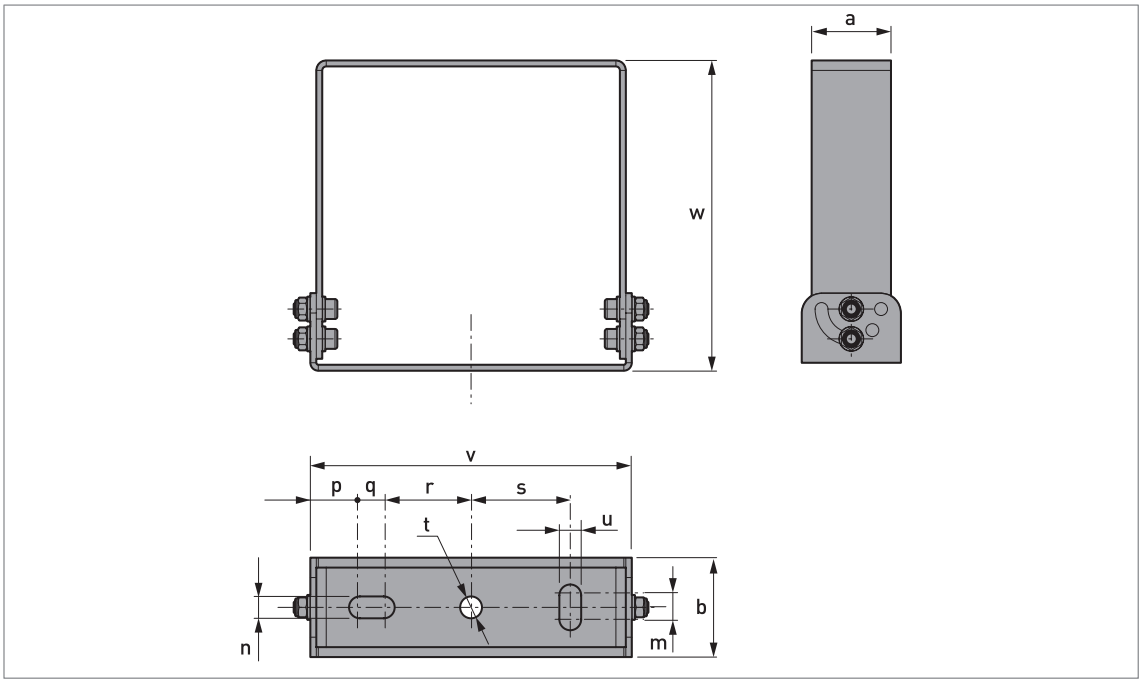

Figure 8-9: Orientable bracket

Dimensions [mm]											
a	b	m	n	p	q	r	s	Øt	u	v	w
40	50	12	11	25	12	44	50	11	11	156	156

Table 8-10: Orientable bracket: Dimensions in mm

Dimensions [inches]											
a	b	m	n	p	q	r	s	Øt	u	v	w
1.57	1.97	0.47	0.43	0.98	0.47	1.73	1.97	0.43	0.43	6.14	6.14

Table 8-11: Orientable bracket: Dimensions in inches

Device with a wall-mounted bracket

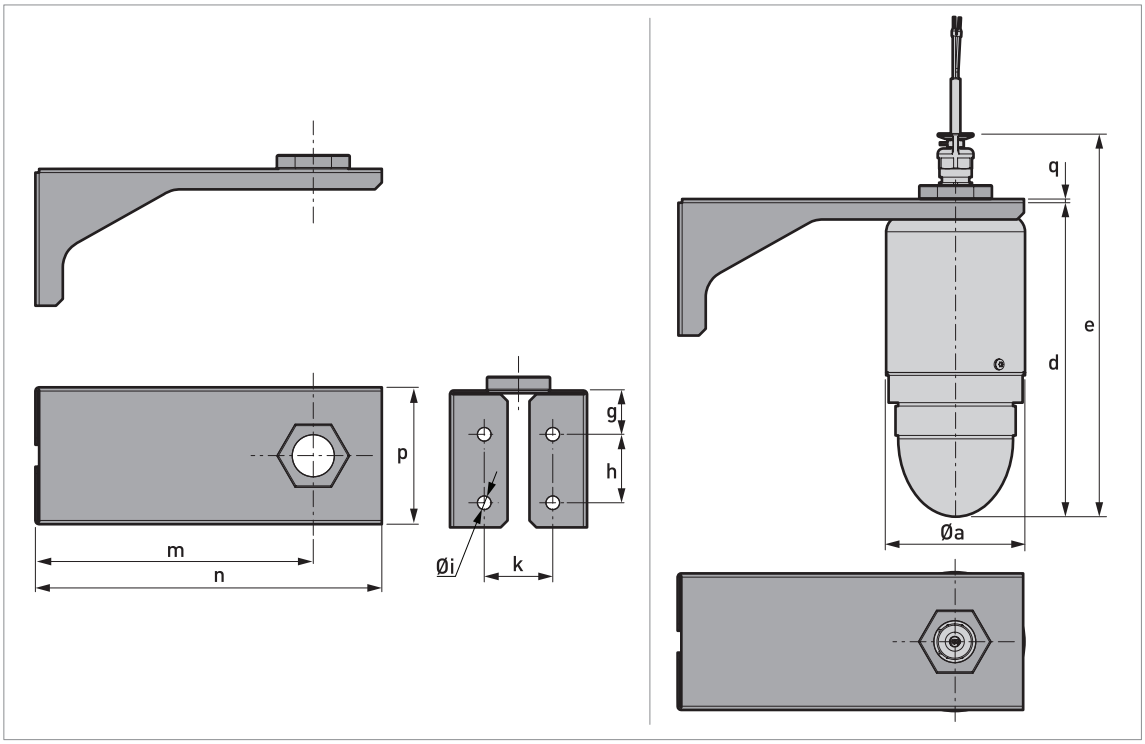

Figure 8-10: Device with a wall-mounted bracket

Dimensions [mm]										
Øa	d	e	g	h	Øi	k	m	n	p	q
101.6	220.7	282.7	32	50	10	50	202.7	252.7	100	2

Table 8-12: Device with a wall-mounted bracket: Dimensions in mm

Dimensions [inches]										
Øa	d	e	g	h	Øi	k	m	n	p	q
4.00	8.69	11.13	1.26	1.97	0.39	1.97	7.98	9.95	3.94	0.08

Table 8-13: Device with a wall-mounted bracket: Dimensions in inches

Device with a 45° deflector plate

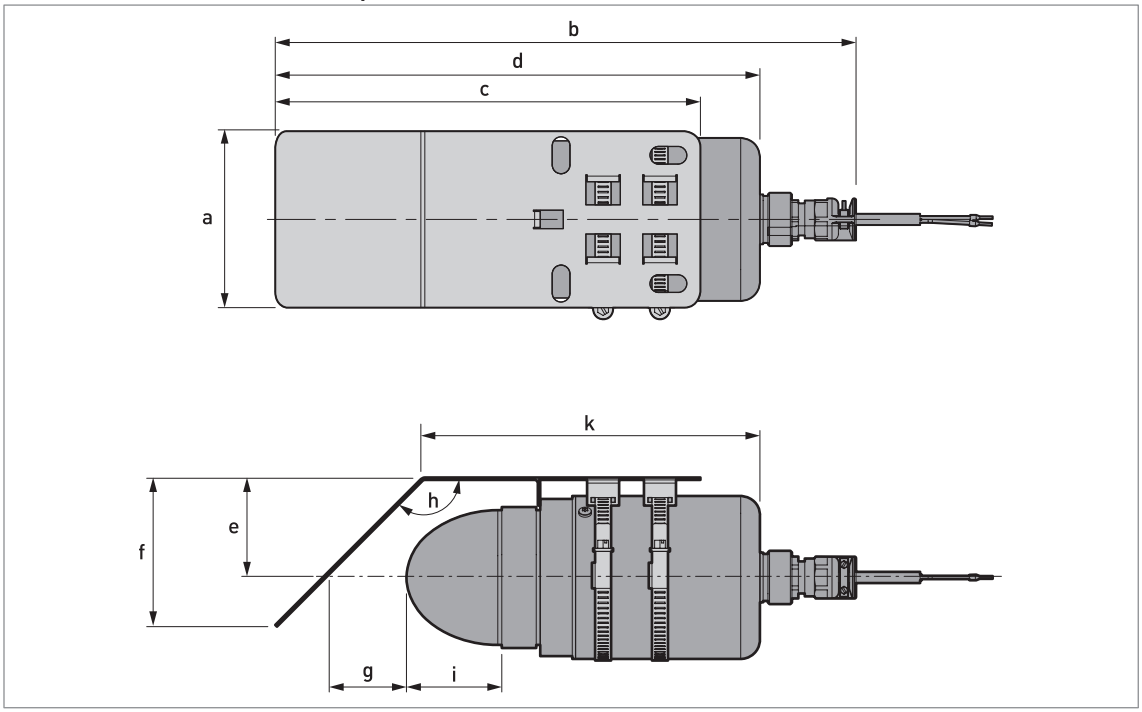

Figure 8-11: Device with a 45° deflector plate

Dimensions [mm]									
a	b	c	d	e	f	g	h (angle)	i	k
110	362	265	300	63	93	50	135°	83.5	207

Table 8-14: Device with a 45° deflector bracket: Dimensions in mm

Dimensions [inches]									
a	b	c	d	e	f	g	h (angle)	i	k
4.33	14.25	10.43	11.81	2.48	3.66	1.97	135°	3.29	8.15

Table 8-15: Device with a 45° deflector bracket: Dimensions in inches

45° deflector plate

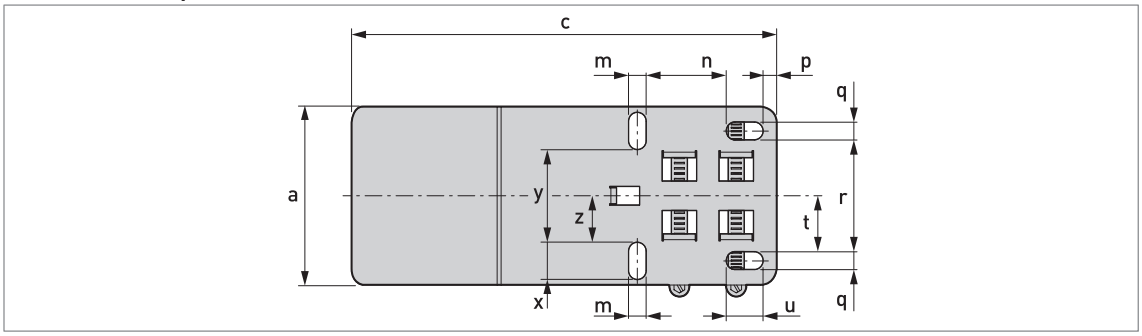

Figure 8-12: 45° deflector plate

Dimensions [mm]											
a	c	m	n	p	q	r	t	u	x	y	z
110	265	11	50	8.5	11	69	34.5	23	23	57	28.5

Table 8-16: 45° deflector bracket: Dimensions in mm

Dimensions [inches]											
a	c	m	n	p	q	r	t	u	x	y	z
4.33	10.43	0.43	1.97	0.33	0.43	2.72	1.36	0.91	0.91	2.24	1.12

Table 8-17: 45° deflector bracket: Dimensions in inches

Total weight

	Weights	
	[kg]	[lb]
Device with electrical cable (10 m / 32.8 ft), without options	2.3	5.1

Table 8-18: Total weight

Weight, process connection options

	Weights	
	[kg]	[lb]

Low-pressure flange

DN100 / NPS 4 ①	+1.44	+3.17
DN150 / NPS 6 ①	+1.76	+3.88
DN200 / NPS 8 ①	+2.22	+4.89

Other options

Orientable bracket	+0.78	+1.72
Wall-mounted bracket	+0.82	+1.81

Table 8-19: Weight, process connection options

① NPS = Nominal Pipe Size. For more data about the dimensions of ASME flanges, refer to the ASME B16.5 standard.

INFORMATION!
Low-pressure flange: *bolt hole positions and diameters agree with pressure rating PN2.5...PN40 (EN 1092-1) and Class 150 (ASME B16.5)*

9.1 Function description

A – Quick Setup menu

Menu No.	Function	Function description	Selection list	Default
A1	Language	This menu item is not available for this device.	—	—
A2	Tag	You can see the TAG name here. The tag name can be a maximum of 8 characters long and it can have numbers, upper-case and lower-case letters and special characters. **Minimum access level to change the setting:** Operator	Refer to "Function description"	TANK01
A3	Login	Enter the appropriate password here to change settings. If you do not enter the password, you can only change settings for the "user" access level. For more data, refer to *Protection of the device settings (security roles)* on page 38.	4-digit hexadecimal password	Refer to "Function description"
A4 Application Assistant				
A4.1	Standard Setup	This starts a quick set-up procedure applicable to most applications. You can set the length unit, installation specifications (tank type, tank height, stilling well height, stilling well diameter etc.) and current output specifications (0% range, 100% range, error function etc.). For more data about the functions, refer to Table C – Full Setup, in this section. For more data about the procedure, refer to *Standard setup* on page 39. If it is necessary to make a conversion table to measure volume, mass or flow rate, go to menu C3 Conversion. If it is necessary to make a linearization table, go to menu C3 Conversion. **Minimum access level to do the procedure:** Expert		
A4.2	Empty Spectrum	Fixed and moving objects in the tank cause interference signals. Put them through this filter to correctly measure the tank contents. This menu item starts a quick set-up procedure. We recommend that the tank is empty or only filled to the minimum level before you do the procedure. We also recommend that if you installed the device on a tank that has equipment with parts that move (e.g. agitators), start the equipment. Set the **Save Spectrum?** step to "Yes", **Empty Spectrum Enable** step to "Enable" at the end the procedure and set the Save Configuration? screen to "Yes" to use the data. For more data about the procedure, refer to *How to make a filter to remove radar signal interference* on page 41. **Minimum access level to do the procedure:** Expert		

Table 9-1: A – Quick Setup menu

C – Full Setup menu

Menu No.	Function	Function description	Selection list	Default
C1 Install. Parameters				
C1.1	Tank Type	The conditions in which the device is used. If the surface of the product is flat, select "Storage". If the surface of the product is disturbed, select "Process". If the surface of the product is agitated with vortexes and foam, select "Agitator". If the device is installed in a stilling well, select "Stilling Well". **Minimum access level to change the setting:** Expert	Agitator, Stilling Well, Process, Storage	Process ①
C1.2	Tank Height	Tank height is the distance from the flange face/thread stop of the process connection to the tank bottom. If you use the device for an LPR (open-air) application, this value is the maximum distance that the device must measure (the measuring range). Also identified as "hmax" **Minimum access level to change the setting:** Expert	min-max: 0.0...20.00^{+03} mm / 0.0...787.402¨ / 0.0...65.617 ft	10000 mm / 393.701¨ / 32.808 ft ①
C1.3	Stilling Well Height	The height of the stilling well. This menu item is available if you set "Stilling Well" in menu item C.1.1 Tank Type. **Minimum access level to change the setting:** Expert	min-max: 0.000...20.000 m / 0.0...787.40¨ / 0.0...65.617 ft	1.0000 m / 39.370¨ / 3.2808 ft ①
C1.4	Stilling Well Diameter	The inner diameter of the stilling well. This menu item is available if you set "Stilling Well" in menu item C.1.1 Tank Type. **Minimum access level to change the setting:** Expert	min-max: 22.0...999.0 mm / 866.14^{-03}...39.331¨ / 72.138$^{-0.3}$...3.2776 ft	100 mm / 3.937¨ ①
C1.5	Blocking Distance	The distance from the flange facing or the thread stop to the top limit of the measuring range (a zone given by the user where it is not possible to measure). We recommend a minimum blocking distance of 800 mm / 31.50¨ below the bottom of the antenna. If the distance is less than the blocking distance, the device continues to show the blocking distance on the display screen. **Minimum access level to change the setting:** Expert	min-max: 0.0...5000.0 mm / 0.0...196.85¨ / 0.0...16.404 ft	800 mm / 31.50¨
C1.6	Time Constant	Using this function, the device processes several measurement readings to filter out disturbances. Increasing the time constant will smoothen the integrated readings, decreasing will roughen the readings. s = seconds. **Minimum access level to change the setting:** Expert	min-max: 0....100.0 s	10 s

Menu No.	Function	Function description	Selection list	Default
C1.7	Antenna Type	The type of antenna attached to the device. If you change the antenna, this setting will have an effect on C1.2 Tank Height and C1.5 Blocking Distance. **Minimum access level to change the setting:** Expert	Drop (PP, DN100)	Drop (PP, DN100)
C1.8	Antenna Extension	Optional antenna extension. There is no antenna extension available for this device. **Minimum access level to change the setting:** Expert	min-max: 0.0…1050 mm / 0.0...41.339¨ / 0.0...3.4449 ft	0 mm /0¨
C1.9	Distance piece	Optional distance piece between the converter and the process connection. There is no distance piece available for this device. **Minimum access level to change the setting:** Expert	min-max: 0.0…2000 mm / 0.0...78.740¨ / 0.0...6.5617 ft	0 mm /0¨
C1.10	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 *Distance measurement* on page 46. **Minimum access level to change the setting:** Expert	min-max: -5000.0+0…+5000.0 m / -196.85^{+03}...$+196.85^{+03\cdot\cdot}$ / -16404...+16404 ft	0 m / 0 ft
C1.11	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 C1.2 Tank Height). This value is positive when the reference location is below the tank bottom and negative if above. For more data, refer to *Level measurement* on page 45. **Minimum access level to change the setting:** Expert	min-max: -5000.0+0…+5000.0 m / -196.85^{+03}...$+196.85^{+03\cdot\cdot}$ / -16404...+16404 ft	0 m / 0 ft

Menu No.	Function	Function description	Selection list	Default
C2 Process				
C2.1	Tracking Velocity	This menu item sets the maximum rate of change of level in metres per minute or feet per minute. The measured value cannot change faster than the tracking velocity. **Minimum access level to change the setting:** Expert	min-max: 1.2^{-03}...60.0 m/min / 3.94^{-03}...196.85 ft/min	500^{-03} m/min / 1.64042 ft/min
C2.2	Epsilon R Product	The device automatically calculates the level based on the product ε_r. If you select "TBF Full" or "TBF Auto" in menu item C2.4 Measuring Mode, you can change this value manually to adjust readings. **Minimum access level to change the setting:** Expert	1.1...20	2.0
C2.3	Epsilon R Gas	A major parameter for radar level measurement devices. This can be applicable to high pressure applications or tanks that contain a specified gas. If the gas is not 1.0, set the $\varepsilon_r$value to the ε_r value of the gas. **Minimum access level to change the setting:** Expert	1.0...20	1.0
C2.4	Measuring Mode	In "Direct" mode, the level signal is a reflection on the surface of the tank contents. If the dielectric constant is very low, the device uses "TBF Auto" or "TBF Full" mode. The device in "TBF" mode uses the radar reflection on the bottom of the tank (the signal goes through the tank contents). The tank must have a flat bottom for the device to operate correctly in TBF mode. This menu item is set by default to "Direct" for tank contents with an ε_r >1.4. If ε_r is very low (<1.4), use "TBF Full". If εr is low (ε_r = 1.4...1.5), use "TBF Auto" mode. "TBF Auto" is an automatic mode that lets the device make a selection between "Direct" mode and "TBF" mode. If you use "TBF Full" or "TBF Auto", enter the dielectric constant in menu item C2.2 Epsilon R Product. Refer also to "Measuring principle" on page 62. **Minimum access level to change the setting:** Expert	Direct, TBF Auto, TBF Full	Direct
C2.5	Overfill Detection	If this function is in operation, the device will monitor the level even if it is in the blocking distance. The output shown on the display screen stays fixed at the blocking distance, but an error message will warn the user that the tank is too full. **Minimum access level to change the setting:** Expert	Disabled, Enabled	Disabled ①

Menu No.	Function	Function description	Selection list	Default
C2.6	Overfill Threshold	If you have set menu item C2.5 Overfill Detection to "Enabled", this menu item will be available. If the device cannot easily measure in the blocking distance (see menu item C1.5), then you can change the overfill threshold. This value is a percentage of the radar signal amplitude. To enter the correct value, we recommend that you speak or write to your supplier. **Minimum access level to change the setting:** Expert	min-max: 0.0...100.0%	10%
C2.7	Mult. Refl. Enable	Multiple reflections will cause the device to display smaller level readings. Installation of the device on a manhole or at the centre of a dome roof, and high dielectric products (εr >5) can cause multiple reflections. A very calm surface or a tank with a small convex or flat roof can also cause multiple reflections. If this function is in operation, the device looks for the first signal peak below the process connection. This signal peak is then used to measure the level of the tank contents. If this function is not in operation, the device looks for the largest signal below the process connection. **Minimum access level to change the setting:** Expert	Disabled, Enabled	Disabled ①
C2.8	Empty Spectrum Enable	This function starts and stops the interference signal filter. Interference signals are the result of fixed and moving obstacles inside the tank. If you must do a spectrum analysis, record an empty spectrum first. Do the "Empty Spectrum" procedure (menu A4.2) in the Quick Setup menu. **Minimum access level to change the setting:** Expert	Disabled, Enabled	Enabled
C2.9	Minimum Peak required	This menu item is not available.	—	—
C2.10	Minimum Plausibility window	This menu item is not available.	—	—
C2.11	Error Delay	The time after which the current output changes to an error value. The error value shows that there is a measurement error. Min=minutes and Sec=seconds.	0 Sec, 10 Sec, 20 Sec, 30 Sec, 1 Min, 2 Min, 5 Min, 15 Min	20 Sec

Menu No.	Function	Function description	Selection list	Default

C3 Conversion

C3.1	Conversion Dry	If it is necessary to create a conversion table with computer-generated data, use "Conversion Dry".		
		Set the length unit.	m, cm, mm, ft, in	—
		Set the conversion function. If you must make a volume conversion table, set this menu item to "Volume". If you must make a mass conversion table, set this menu item to "Mass". If you must make a volumetric flow rate conversion table, set this menu item to "Volume Flow". If you must make a linearization table to make sure that the readings always agree with reference measurements, set this menu item to "Linearization".	Volume, Mass, Linearization, Volume Flow	—
		Set the conversion unit.	**Volume:** m³, L, hL, in³, ft³, gal, ImpGal, yd³, bbl, bbl (beer, US)	—
			Mass: kg, t, lb, tn.sh., tn.l.	—
			Linearization: m, cm, mm, ft, in	—
			Volume Flow: m³/h, m³/min, m³/h, m³/d, L/s, L/min, L/h, ft³/s, ft³/min, ft³/h, ft³/d, gal/s, gal/min, gal/min, gal/h, gal/d, IG/s, IG/min, IG/h, IG/d, bbl/s, bbl/min, bbl/h, bbl/d	—
		Set the tank shape (**Volume** or **Mass**) and enter the dimensions of the tank. If the conversion function is set to "Mass", then set the density unit (kg/m³, g/ml, g/L, g/cm³, kg/L, lb/gal, lb/in³ or lb/ft³) and enter the density value. The DTM will make a table with 50 values that are regular intervals.	Cylindrical - Horizontal, Cylindrical - Horizontal - Ellipsoidal - Ellipsoidal, Cylindrical - Horizontal - Hemispherical - Hemispherical, Cylindrical - Vertical, Cylindrical - Vertical - Ellipsoidal - Ellipsoidal, Cylindrical - Vertical - Conical, Cylindrical - Vertical - Slant, Spherical, Rectangular - Vertical -Flat - Flat, Rectangular - Vertical - Flat - Conical, Rectangular - Vertical - Flat - Slant, User-defined	—
		If you set the conversion function to 'Linearization", then enter the reference level values and corrected level values in the table.	—	—
		Set the flow channel shape (**Volume Flow**) and enter the dimensions of the flow channel. The DTM will make a table with 50 values that are regular intervals.	Venturi-Rectangular (ISO 4359), Venturi-Trapezoidal (ISO 4359), Venturi-U (ISO 4359), V-Notch (ISO 1438), Rectangular-Notch (ISO 1438), Parshall (ISO 9826)	—

Menu No.	Function	Function description	Selection list	Default
C3.2	Conversion Wet	If it is necessary to create a conversion table with measured values, use "Conversion Wet".		
		Set the conversion function. If you must make a volume conversion table, set this menu item to "Volume". If you must make a mass conversion table, set this menu item to "Mass". If you must make a volumetric flow rate conversion table, set this menu item to "Volume Flow". If you must make a linearization table to make sure that the readings always agree with reference measurements, set this menu item to "Linearization".	Volume, Mass, Linearization, Volume Flow	—
		Set the conversion unit.	**Volume:** m^3, L, hL, in^3, ft^3, gal, ImpGal, yd^3, bbl, bbl (beer, US)	—
			Mass: kg, t, lb, tn.sh., tn.l.	—
			Linearization: m, cm, mm, ft, in	—
			Volume Flow: m^3/s, m^3/min, m^3/h, m^3/min, m^3/h, m^3/d, L/s, L/min, L/h, ft^3/s, ft^3/min, ft^3/h, ft^3/d, gal/s, gal/min, gal/min, gal/h, gal/d, IG/s, IG/min, IG/h, IG/d, bbl/s, bbl/min, bbl/h, bbl/d	—
		Enter the level values and the volume / mass / linearization / volume flow values in the table.	—	—
C3.3	Conversion Edit	Change the values of the conversion table used by the DTM at this time.	—	—

C4 Output

C4.1 Current Output 1				
C4.1.1	Current Out. 1 Var.	Make a selection from the available output functions to scale the current output values. This is not shown in Normal mode. **Minimum access level to change the setting:** Expert	Level, Distance, Sensor Value, Reflection ②	Level ①
C4.1.2	0% Range	Give a measurement value to 0% output (refer also to menu item **C4.1.1 Current Out. 1 Var** for the output function). 0% output = 4 mA. It is possible to have an output less than 4 mA (<0%) if you set C4.1.4 Current Out. Range to "3.8-20.5 mA". **Minimum access level to change the setting:** Expert	min-max: -4.9^{+06}...$+5.1^{+06}$ mm / -192.91^{+03}...$+200.79^{+03}$ / -16076...+16732 ft	0.0 mm ①

Menu No.	Function	Function description	Selection list	Default
C4.1.3	100% Range	Give a measurement value to 100% output (refer also to menu item **C4.1.1 Current Out. 1 Var** for the output function). 100% output = 20 mA. It is possible to have an output more than 20 mA (>100%) if you set C4.1.4 Current Out. Range to "3.8-20.5 mA". **Minimum access level to change the setting:** Expert	min-max: -4.9^{+06}...$+5.1^{+06}$ mm / -192.91^{+03}...$+200.79^{+03}$ / -16076...+16732 ft	C1.2 Tank Height - C1.5 Blocking Distance ①
C4.1.4	Current Out. Range	This menu item sets the limits of the output current range to 1 of 4 available options: standard limits (4...20 mA), NAMUR NE 43-compliant limits (3.8...20.5 mA), reversed standard limits and reversed NAMUR NE 43-compliant limits. You use standard limits when you want the 0% output to be 4 mA and the 100% output to be 20 mA. You use reversed limits when you want the 0% output to be to be 20 mA and 100% output to be 4 mA. **Minimum access level to change the setting:** Expert	4-20 mA, 3.8-20.5 mA (NAMUR), 4-20 mA (reversed), 3.8-20.5 mA (reversed)	4-20 mA ①
C4.1.5	Error Function	This sets the behaviour of current output 1 if an error occurs. If this menu item is set to "Off", no signal is given (this parameter is not available if menu item C4.1.4 is set to "3.8-20.5 mA" (NAMUR) or "3.8-20.5 mA (reversed)"). If this menu item is set to "Hold", the output current stays at the value where the error occurred (this parameter is not available if menu item C4.1.4 is set to "3.8-20.5 mA" (NAMUR) or "3.8-20.5 mA (reversed)"). If this menu item is set to "Low", the output current changes to 3.5 mA (default value) if an error occurs. If this menu item is set to "High", the output current changes to 21.5 mA (default value) if an error occurs. You can change the low error current value in menu item C4.1.7. You can change the high error current value in menu item C4.1.8. **Minimum access level to change the setting:** Expert	Off, Low, High, Hold	Low ①
C4.1.7	Low Error Current	This menu item is available if C4.1.5 Error Function is set to "Low". You can change the value to which the current output will change if an error occurs. **Minimum access level to change the setting:** Expert	min-max: 3.5...3.6 mA	3.5 mA
C4.1.8	High Error Current	This menu item is available if C4.1.5 Error Function is set to "High". You can change the value to which the current output will change if an error occurs. **Minimum access level to change the setting:** Expert	min-max: 21.0...21.5 mA	21.5 mA

Menu No.	Function	Function description	Selection list	Default
C4.1.9	Trimming	Set the current output of the device to 0%. Record the current output value in mA. Measure the loop current again with a different device. If the value is not accurate, enter the measured value. Set the current output of the device to 100%. Record the current output value in mA. Measure the loop current again with a different device. If the value is not accurate, enter the measured value. **Minimum access level to change the setting:** Expert	min-max: 0.0...25.0 mA	4 mA

C5 Communication

C5.1 HART				
C5.1.1	Current Loop Mode	Set this menu item to "On" if the "Primary Variable" for current output 1 must also be transmitted as a 4...20 mA signal. If this menu item is set to "Off', this stops the 4...20 mA signal and starts HART® multi-drop mode. **Minimum access level to change the setting:** Expert	On, Off	On
C5.1.2 Identification				
C5.1.2.1	Polling Address	A polling address more than 0 will start HART® multi-drop mode. If you start HART® multi-drop mode, the current output stays constant at 4 mA. **Minimum access level to change the setting:** Operator	000...063	0
C5.1.2.2	Tag	Use this menu item to change the Tag name. It can have a maximum of 8 characters. **Minimum access level to change the setting:** Operator	—	TANK01 ①
C5.1.2.3	Long Tag	Use this menu item to change the long Tag name. It can have a maximum of 32 characters. **Minimum access level to change the setting:** Operator	—	—
C5.1.2.4	Manufacturer ID	This is the manufacturer ID number given to the supplier by the HART Foundation.	Read only	—
C5.1.2.5	Device Type	This is the device type number given to the supplier by the HART Foundation.	Read only	—
C5.1.2.6	Device ID	This is the device ID number given to the supplier by the HART Foundation. This shows that the HART Foundation registered the HART® device description (DD) file.	Read only	—
C5.1.2.7	Universal Revision	This is the version of the HART protocol used by the device.	Read only	—
C5.1.2.8	Device Revision	This is the revision number for the HART® device description.	Read only	—
C5.1.2.9	Software Revision	This is the revision number for the device software.	Read only	—

Menu No.	Function	Function description	Selection list	Default
C5.1.2.10	Hardware Revision	This is the revision number for the device hardware.	Read only	—
C5.1.3 Device Information				
C5.1.3.1	Descriptor	You can give a short description (16 characters maximum) of the device in this menu item. **Minimum access level to change the setting:** Operator	—	—
C5.1.3.2	Message	You can give more data in this menu item (32 characters maximum). **Minimum access level to change the setting:** Operator	—	—
C5.1.3.3	Date	You can enter the date in this menu item (Format: Year-Month-Day / YYYY-MM-DD) **Minimum access level to change the setting:** Operator	—	2014-01-01
C5.1.3.4	Cfg. Change Counter	This function counts the number of changes to the HART® device settings	Read only	—
C5.1.3.5	Conf. Change Counter Flag Reset	This function sets the number of changes to the HART® device settings to zero.	Execute	—
C5.1.3.6	Number Request Preambles	This gives the number of bytes before a request message to do a check to make sure that request messages are correctly received. This agrees with the FSK Physical Layer Specification (HCF_SPEC-54).	Read only	5
C5.1.3.7	Number Response Preambles	This gives the number of bytes before a request message to do a check to make sure that response messages are correctly transmitted. This agrees with the FSK Physical Layer Specification (HCF_SPEC-54).	5	5
C5.1.4 HART Variables				
C5.1.4.1	Current Out. 1 Var.	This is the first measurement type shown on HART® controllers. Make a selection from the list. **Minimum access level to change the setting:** Expert	Level, Distance, Sensor Value, Reflection ②	Distance
C5.1.4.2	HART/sec./CO2 Var.	This is the second measurement type shown on HART® controllers. Make a selection from the list. **Minimum access level to change the setting:** Expert	Level, Distance, Sensor Value, Reflection ②	Level

Menu No.	Function	Function description	Selection list	Default
C5.1.4.3	Tertiary Var.	This is the third measurement type shown on HART® controllers. Make a selection from the list. **Minimum access level to change the setting:** User	Level, Distance, Sensor Value, Reflection ②	Distance
C5.1.4.4	Quaternary Var.	This is the fourth measurement type shown on HART® controllers. Make a selection from the list. **Minimum access level to change the setting:** User	Level, Distance, Sensor Value, Reflection ②	Reflection
C5.1.5 Burst Mode				
C5.1.5.1	Burst Mode Information	Maximum number of Burst Messages	Read only	3
C5.1.5.2	Burst Mode	Burst message 0.	Off, On	Off
C5.1.5.16	Burst Mode	Burst message 1.	Off, On	Off
C5.1.5.31	Burst Mode	Burst message 2.	Off, On	Off
C5.1.6 Communication Statistics				
C5.1.6.1	Count of STX messages	Number of STX messages received by this device.	Read only	—
C5.1.6.2	Count of ACK messages	Number of ACK messages received by this device.	Read only	—
C5.1.6.3	Count of BACK messages	Number of BACK messages received by this device.	Read only	—

C6 Display

C6.1	Language	This menu item is not available.	—	—
C6.2	Backlight	This menu item is not available.	—	—
C6.4 1st Meas. Page				
C6.4.1	Function	This menu item is not available.	—	—
C6.4.2	1st Value Variable	This menu item is not available.	—	—
C6.4.3	0% Range	This menu item is not available.	—	—
C6.4.4	100% Range	This menu item is not available.	—	—
C6.4.5	Format 1st Value	This menu item is not available.	—	—
C6.5 2nd Meas. Page				
C6.5.1	Function	This menu item is not available.	—	—
C6.5.2	1st Value Variable	This menu item is not available.	—	—
C6.5.5	Format 1st Value	This menu item is not available.	—	—
C6.5.6	2nd Value Variable	This menu item is not available.	—	—
C6.5.7	Format 2nd Value	This menu item is not available.	—	—
C6.5.8	3rd Value Variable	This menu item is not available.	—	—
C6.5.9	Format 3rd Value	This menu item is not available.	—	—

Menu No.	Function	Function description	Selection list	Default
C7 Device				
C7.1 Information				
C7.1.1	Tag	Use this menu item to read the Tag name.	Read only	TANK01 ①
C7.1.2	Serial Number	This is the device fabrication number	Read only	—
C7.1.3	Device Name	This gives the device family name and model code.	Read only	—
C7.1.4	V Number	This is the manufacturer's option code for device configuration.	Read only	—
C7.1.5	Electronic Revision	This is the hardware revision number. This number agrees with NAMUR NE 53 Guidelines.	Read only	—
C7.1.6	Software Revision	This is the software revision number. This number agrees with NAMUR NE 53 Guidelines.	Read only	—
C7.1.7	Electronic Serial No.	This is the hardware fabrication number. This number agrees with NAMUR NE 53 Guidelines.	Read only	—
C7.1.8	Production Date	This is the date that the manufacturer finished the device. The date format is: Year-Month-Day.	Read only	—
C7.1.9	Calibration Date	This is the date that the manufacturer calibrated the device. The date format is: Year-Month-Day.	Read only	—
C7.1.10	Device Type	This gives the device operating frequency, the type of application and the model name.	Read only	—
C7.2 Security				
C7.2.1	Login	Enter the appropriate password here to change settings. If you do not enter the password, you can only change settings for the "user" access level. For more data and the default passwords for the "operator" and "expert" access levels, refer to *Protection of the device settings (security roles)* on page 38.	4-digit hexadecimal password	Refer to "Function description"
C7.2.2	Change Password	This changes the password for the "operator" and "expert" access levels. For the procedure to change the password, refer to *Protection of the device settings (security roles)* on page 38 (How to change the password).	4-digit hexadecimal password	Refer to "Function description"
C7.2.3	Reset Passwords	This is a special password that makes your passwords for the "operator" and "expert" access levels go back to the default passwords. This password is supplied on request by the after-sales service department.	—	—
C7.2.5	Lock Device	This menu item can only be unlocked at the factory.	—	—

Menu No.	Function	Function description	Selection list	Default
C7.3 Errors				
C7.3.2	Error-Mapping	A list of device errors. Scroll down the list and push [>] to show the error details. The error will have a letter code ("F", "S", "M", "C" and "I") that agrees with NAMUR NE 107 Guidelines. It also permits you to find a corrective action and change the error code that is given to an incident. For more data, refer to *Device status and error messages* on page 94. **Minimum access level to change the setting:** User	None, Information (I), Maintenance Request (M), Out of Specification (S), Function Check (C), Failure (F)	Information
C7.5 Units				
C7.5.1	Length	The volume flow unit shown in the "Measurements" window if you made a volume conversion table in the C3 Conversion menu. If you set this menu item to "Cst." (custom length unit), enter values in menu items C7.5.2.1 thru C7.5.2.3. **Minimum access level to change the setting:** User	m, cm, mm, ft, in, Cst.	m
C7.5.2 Custom Length Unit				
If you set menu item **C7.5.1 Length** to "Cst." (custom length unit), enter values in menu items C7.5.2.1 thru C7.5.2.3.				
C7.5.2.1	Text	Enter a text (8 characters maximum) for the custom length unit.	—	Cst.
C7.5.2.2	Offset	Enter an offset value.	—	0.0 m
C7.5.2.3	Factor	Enter a factor. Multiply the measured value by this factor to change m (metres) to the custom length unit.	—	1.0
C7.5.3	Volume	The volume flow unit shown in the "Measurements" window if you made a volume conversion table in the C3 Conversion menu. If you set this menu item to "Cst." (custom volume unit), enter values in menu items C7.5.4.1 thru C7.5.4.3. **Minimum access level to change the setting:** User	m^3, L, hL, in^3, ft^3, gal, ImpGal, yd^3, bbl, bbl (beer, US), Cst.	m^3
C7.5.4 Custom Volume Unit				
If you set menu item **C7.5.3 Volume** to "Cst." (custom volume unit), enter values in menu items C7.5.4.1 thru C7.5.4.3.				
C7.5.4.1	Text	Enter a text (8 characters maximum) for the custom volume unit.	—	Cst.
C7.5.4.2	Offset	Enter an offset value.	—	0.0 m^3
C7.5.4.3	Factor	Enter a factor. Multiply the measured value by this factor to change m^3 (cubic metres) to the custom volume unit.	—	1.0

Menu No.	Function	Function description	Selection list	Default
C7.5.5	Mass	The volume flow unit shown in the "Measurements" window if you made a mass conversion table in the C3 Conversion menu. If you set this menu item to "Cst." (custom mass unit), enter values in menu items C7.5.6.1 thru C7.5.6.3. **Minimum access level to change the setting:** User	kg, t, lb, tn.sh., tn.l., Cst.	kg
C7.5.6 Custom Mass Unit				
If you set menu item **C7.5.5 Mass** to "Cst." (custom mass unit), enter values in menu items C7.5.6.1 thru C7.5.6.3.				
C7.5.6.1	Text	Enter a text (8 characters maximum) for the custom volume unit.	—	Cst.
C7.5.6.2	Offset	Enter an offset value.	—	0.0kg
C7.5.6.3	Factor	Enter a factor. Multiply the measured value by this factor to change kg (kilogram) to the custom mass unit.	—	1.0
C7.5.7	Volume Flow	The volume flow unit shown in the "Measurements" window if you made a volumetric flow rate conversion table in the C3 Conversion menu. If you set this menu item to "Cst." (custom volumetric flow rate unit), enter values in menu items C7.5.8.1 thru C7.5.8.3. **Minimum access level to change the setting:** User	m^3/s, m^3/min, m^3/h, m^3/min, m^3/h, m^3/d, L/s, L/min, L/h, ft^3/s, ft^3/min, ft^3/h, ft^3/d, gal/s, gal/min, gal/min, gal/h, gal/d, IG/s, IG/min, IG/h, IG/d, bbl/s, bbl/min, bbl/h, bbl/d, Cst.	m^3/s
C7.5.8 Custom Volume Flow Unit				
If you set menu item **C7.5.7 Volume Flow** to "Cst." (custom volumetric flow rate unit), enter values in menu items C7.5.8.1 thru C7.5.8.3.				
C7.5.8.1	Text	Enter a text (8 characters maximum) for the custom volume flow unit.	—	Cst.
C7.5.8.2	Offset	Enter an offset value.	—	0.0 m^3/s
C7.5.8.3	Factor	Enter a factor. Multiply the measured value by this factor to change m^3/s to the custom volume flow unit.	—	1.0
C7.6 Factory Default				
C7.6.1	Reset to Fact. Def.?	If you set this menu item to "YES", the device goes back to its initial settings (set by the manufacturer in the factory). **Minimum access level to change the setting:** Expert	Execute	—
C7.7	Device Reset	This menu item starts the device again. **Minimum access level to change the setting:** Expert	Perform	—
C7.8	Cancel Pending Edit Session	This menu item cancels changes made to the settings in the DTM. If you have made a change that is less than or more than the permitted limits, you can use this menu item to make the settings go back to the initial values or parameters.	Perform	—

Menu No.	Function	Function description	Selection list	Default
C8	Import / Export	**Import**: Use this function to: • load conversion table and empty spectrum data from a CFG file into the DTM • load measurement data from a DAT file into the DTM for an analysis of the data **Export**: Use this function to: • save conversion table and empty spectrum data to a CFG file	—	—

Table 9-2: C – Full Setup menu

① If no value or parameter is specified in the customer order

② "Lin. Distance" and "Lin. Level" are available if you created a linearized value table in menu C3 Conversion. "Volume" and "Ullage Volume" are available if you created a level-volume table in menu C3 Conversion. "Mass" and "Ullage Mass" are available if you created a level-mass table in menu C3 Conversion.

DTM Settings

Function	Function description	Selection list	Default

Settings for the top status bar on the Parameter tab

Display device status when connected	This menu item shows the device status in the status bar at the top of the **Parameter** tab in the DTM.	on, off	on
Update interval for device status	Interval in seconds (s) to refresh the device status in the status bar at the top of the **Parameter** tab in the DTM.	min-max: 0...infinity s	30 s
Displayed measurement value in status area	The measurement type and measurement data shown in the status bar at the top of the **Parameter** tab in the DTM.	Level, Distance, Sensor Value, Reflection	Level

Parameter settings

Decimal places	This menu item sets the number of decimal places in all the menu items where you must enter a value.	.x, .xx, .xxx, .xxxx, .xxxxx, .xxxxxx, .xxxxxxx, .xxxxxxxx	.xxx

Table 9-3: DTM Settings

9.2 Device status and error messages

9.2.1 Error mapping (NAMUR NE 107)

Status messages are set in the DTM in menu item "C7.3.2 Error-Mapping" of the DTM. Messages shown agree with NAMUR Guidelines NE 107. The error messages for the device are divided into event groups, each with one status signal. There are 9 status groups with fixed status signals and 8 groups with status signals that can be changed. The event groups with fixed status signals are also divided into 4 groups: Sensor, Electronics, Configuration and Process.

Each status message (or status signal) has a special symbol which agrees with the NAMUR Guidelines. This symbol is shown in the Error Mapping list in menu item "C7.3.2 Error-Mapping".

NAMUR NE 107 symbol	Letter	Message	Description and effect
	F	Failure	No measurement is possible.
	S	Out of specification	Measurements are available but they are not sufficiently accurate. Do a check.
	M	Maintenance required	Measurements continue to be accurate but this could change after a short time.
	C	Function check	A test function is on. The value shown does not agree with the correct measured value.
	I	Information	This status message does not have an effect on device measurements.

Table 9-4: Error mapping (NAMUR NE 107)

9.2.2 Error monitor

General error messages for all field devices are shown on the **Error monitor** pane in the DTM.

How to find the error monitor in the DTM

- Go to the toolbar and click on "View".
- Click on "Error monitor".

➲ The error monitor is shown at the bottom of the DTM window.

9.2.3 Diagnosis tab

Status messages for a specific field device are shown on the **Diagnosis** tab in the DTM.

How to find the Diagnosis tab in the DTM

- Go to the Project pane and right click on the device tag name in the list.
- Click on "Diagnosis".

➲ A tab opens in the main window for the DTM.

- Click on "NE107 Diagnosis Messages" and then "Read from the device".

➲ A list of status messages is shown.

9.2.4 Solutions to errors

The status group name and the status signal (F/S/M/C) are also shown in the Error Mapping list in menu item "C7.3.2 Error-Mapping". You can click on each event group for a description and a solution for the status message.

9.3 Accessories

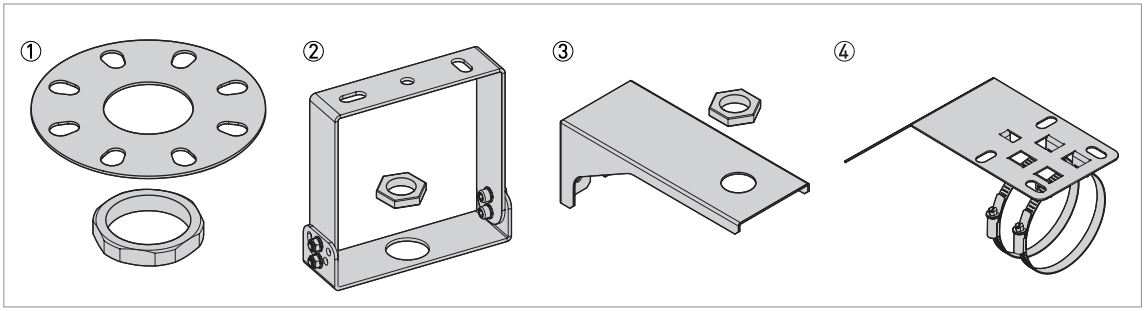

Figure 9-1: Accessories

① Low-pressure flange with a jam nut (attaches the bottom of the device to a counter flange)
② Orientable bracket with a jam nut (attaches the device to a ceiling or roof)
③ Wall-mounted bracket
④ 45° deflector plate

Item	Description	Bolt hole positions and diameters EN 1092-1 / ASME B16.5	Quantity
316L low-pressure flange for G 3 threaded process connection			
①	Low-pressure flange	DN100 PN2.5...PN40 / NPS 4 Class 150	1
		DN150 PN2.5...PN40 / NPS 6 Class 150	
		DN200 PN2.5...PN40 / NPS 8 Class 150	
Other accessories			
②	Orientable bracket	—	1
③	Wall-mounted bracket	—	1
④	45° deflector plate	—	1

Table 9-5: Accessories

9.4 Glossary

D

Dielectric constant An electrical property of the product. Also known as εr, DK and relative permittivity. This property defines the strength of the wave reflected back to the device's signal converter.

Distance The distance from the face of flange to the level (1 product) or the surface of the top product (2 or more products). See the diagrams at the end of this section.

Drop antenna A new generation of antenna made of PP. It has an ellipsoidal shape for a more precise emission of radar signals.

DTM Device Type Manager. A driver for use in the PACTware™ program. All data and functions of the device are included in it.

E

Electromagnetic compatibility (EMC) Defines how much a device influences or is influenced by other devices that generate electromagnetic fields during operation. Refer to European standard EN 61326-1 for further details.

F

FMCW Frequency-modulated continuous-wave radar technology. The signal is continuously present, but the frequency is modulated, usually in successive linear ramps over time (frequency sweeps).

I

Interference signals False radar reflections usually caused by equipment in the tank.

L

Level Height from the bottom of the tank (user-defined) to the surface of the top product (Tank height – distance). See the diagrams at the end of this section.

M

Mass Total mass of tank contents.

P

PACTware™ Software that operates and configures field devices from a remote workstation. It is not necessary to use fieldbus software or programs developed by the manufacturer.

R

Radar reflection Signal reflected from the surface of the tank contents.

S

Signal converter A set of electronic components in the device that send the measurement signal through some signal filters. They identify and measure the level of the tank contents.

U

Ullage volume Unfilled volume. See the diagrams at the end of this section.

V

Volume Total volume of tank contents.

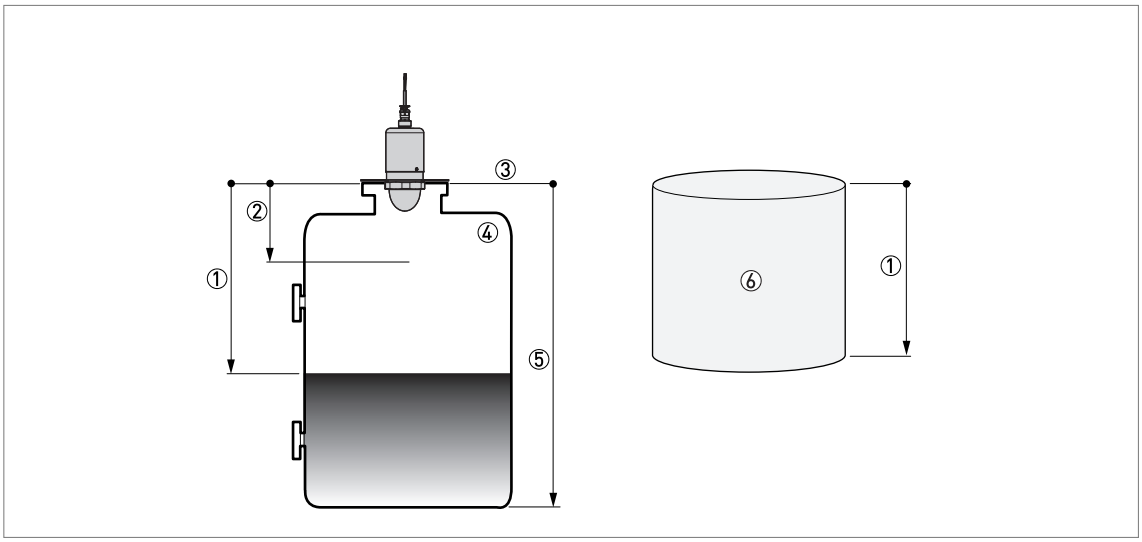

Figure 9-2: Measurement definitions: distance

① Distance
② Blocking distance
③ Flange facing
④ Gas (Air)
⑤ Tank height
⑥ Ullage volume or mass

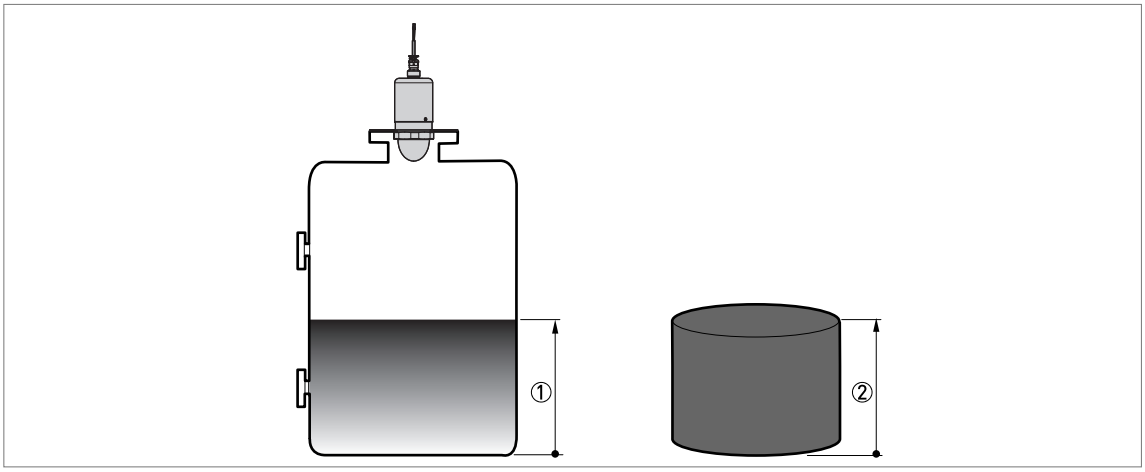

Figure 9-3: Measurement definitions: level

① Level
② Volume or mass

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