POWERFLEX 2200 C/F/S/D

Technical Datasheet

Guided Radar (TDR) Level Transmitter for the nuclear industry

- Agrees with nuclear standards (e.g. ASME Section III, RCC-M)
- Qualified according to IEEE Std 323, IEEE Std 344 and RCC-E
- Remote converter can be installed up to 450 m / 1476 ft away from probe

HART COMMUNICATION PROTOCOL   NPT   RCC-M

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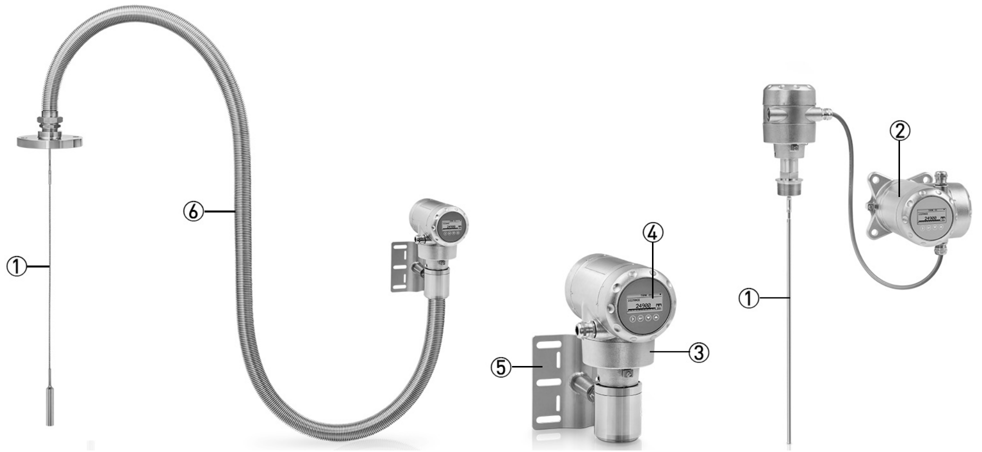
KROHNE

1.1 The TDR level transmitter designed for the nuclear industry

This 2-wire loop-powered HART® TDR level transmitter measures distance, level and volume of liquids. Its different versions, high resistance to radiation and seismic qualification make it the ideal TDR device for safety-related and non-safety-related nuclear applications.



① Large choice of probes to cover any nuclear application
② Remote converter can be installed up to 450 m / 1476 ft away from probe for high radiation conditions
③ Converter is rotatable and removable under process conditions
④ LCD display and 4-button keypad
⑤ Wall support
⑥ Coaxial cable protected by a flexible stainless steel jacket

Integrated display

The integrated display shows measurement data on a 128 × 64 pixel screen. The configuration menu permits the device to be set up in a small number of intuitive steps.

Highlights

- Product dedicated to the nuclear industry
- The result of over 15 years of experience in the nuclear market
- Referenced for many nuclear applications
- Different versions to suit any nuclear application
- For safety-related and non-safety-related applications
- Agrees with nuclear standards (e.g. ASME Section III, RCC-M)
- Remote converter can be installed up to 450 m / 1476 ft away from probe
- Qualified according to IEEE Std 323, IEEE Std 344 and RCC-E
- High resistance to radiation (probe and cable)
- Seismic qualification up to 300 m/s^2
- Thermal aging qualification: +107°C / +224.6°F for 196 days
- DPR (Dynamic Parasite Rejection): the software dynamically eliminates false reflections caused by environmental disturbances and product build-up
- Quick coupling system: converter is rotatable and removable under process conditions
- Display keypad directly accessible without opening the cover
- Measuring range up to 40 m / 131 ft
- Design agrees with IEC 61508
- Conforms to IEC 61513
- The device has FDT1.2 DTM certification

Industries

Nuclear industry

Applications

- Liquid level measurement in radiation environments
- Safety-related and non-safety-related applications
- LOCA (Loss of Coolant Accident)
- Liquid level measurement in pools (e.g. spent fuel pools) or pressurized tanks
- Examples of liquids that can be measured:
  - Borated water
  - Active waste water and concentrate
  - Chemicals (e.g. H_3BO_3, Na_2CO_3, NaOH, MnO_4, HNO_3, NH_4OH, N_2H_4, KOH)
  - Clean or impure condensate
  - Oil, diesel, kerosene
  - Spent resin and waste water
  - Acid and alkali decontamination solutions

1.2 Overview

POWERFLEX 2200 C – Compact version

- Signal converter (main electronics block) with display, located on top of the probe
- Version for low levels of radiation: TID (Total Integrated Dose) ≤5.7×10^3 rad
- Horizontal or vertical housing made of stainless steel

POWERFLEX 2200 S – Compact version with sensor extension

- Signal converter with display, located up to 100 m / 328 ft from the probe
- Passive remote of main electronics block using coaxial cable (TDR signal)
- Coaxial cable protected by a flexible stainless steel jacket
- Version for high levels of radiation: TID ≤2.7×10^8 rad (probe and coaxial cable)

POWERFLEX 2200 S LOCA – Compact version with LOCA sensor extension

This safety device continues to operate and transmit measurement data after a loss of coolant accident (LOCA) occurs.

- Signal converter with display, located up to 150 m / 492 ft from the probe
- Passive remote of main electronics block using LOCA coaxial cable (TDR signal)
- Coaxial cable protected by a flexible stainless steel jacket
- Version for high levels of radiation: TID ≤5×10^8 rad (probe and coaxial cable)

POWERFLEX 2200 F – Remote version

- Signal converter with display, located up to 300 m / 984 ft away from the probe
- Active remote of main electronics block using RS-485 cable (digital communication)
- Sensor electronics block located on top of the probe
- Version for low levels of radiation: TID ≤10.5×10^3 rad (probe and RS-485 cable)

POWERFLEX 2200 D – Remote version with sensor extension

- Signal converter with display, located up to 400 m / 1312 ft from the probe
- Active remote of main electronics block using a RS-485 cable (max. 300 m / 984 ft) combined with passive remote of sensor electronics block using a coaxial cable (max. 100 m / 328 ft)
- Version for high levels of radiation: TID ≤2.7×10^8 rad (probe and coaxial cable)

POWERFLEX 2200 D LOCA – Remote version with LOCA sensor extension

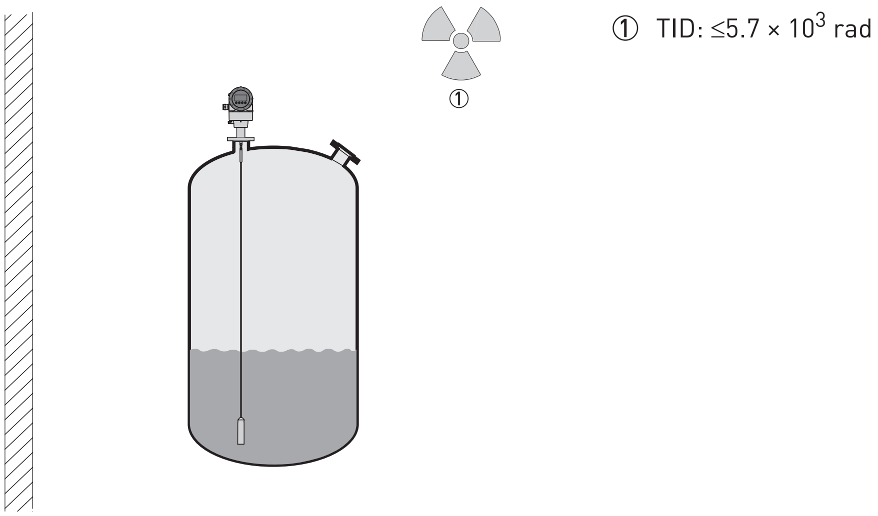
This safety device continues to operate and transmit measurement data after a loss of coolant accident (LOCA) occurs.

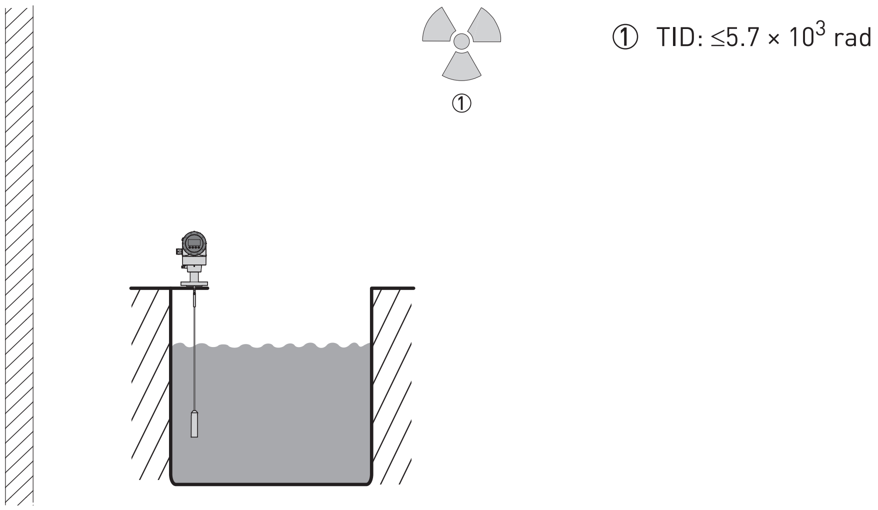
- Signal converter with display, located up to 450 m / 1476 ft from the probe
- Active remote of main electronics block using RS-485 cable (max. 300 m / 984 ft) combined with passive remote of sensor electronics block using a LOCA coaxial cable (max. 150 m / 492 ft)
- Version for high levels of radiation: TID ≤5×10^8 rad (probe and coaxial cable)

1.3 Applications

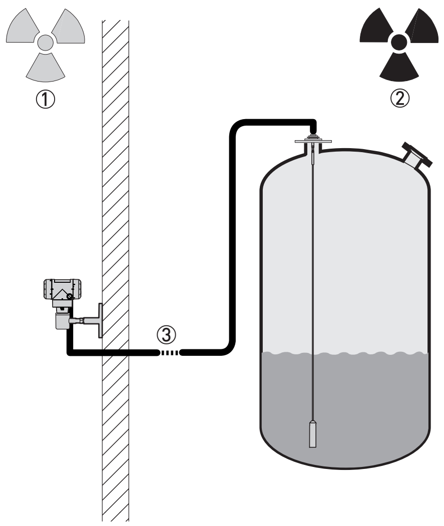
POWERFLEX 2200 C – Compact version

Signal converter (main electronics block) with display, located on top of the probe

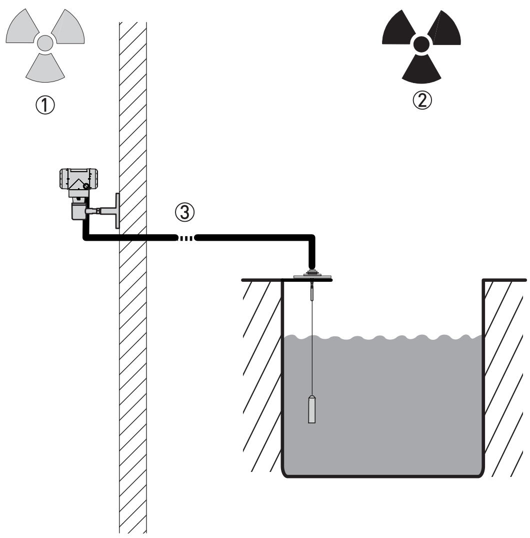




POWERFLEX 2200 S – Compact version with sensor extension
Signal converter with display, located up to 100 m / 328 ft from the probe

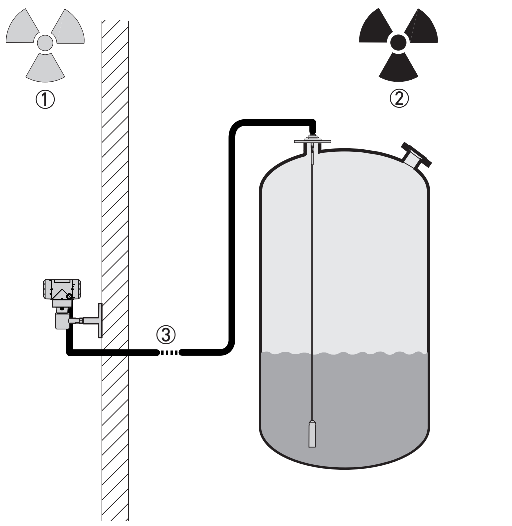


① TID: ≤5.7×10^3 rad
② TID: ≤2.7×10^8 rad
③ Coaxial cable (≤100 m / 328 ft)

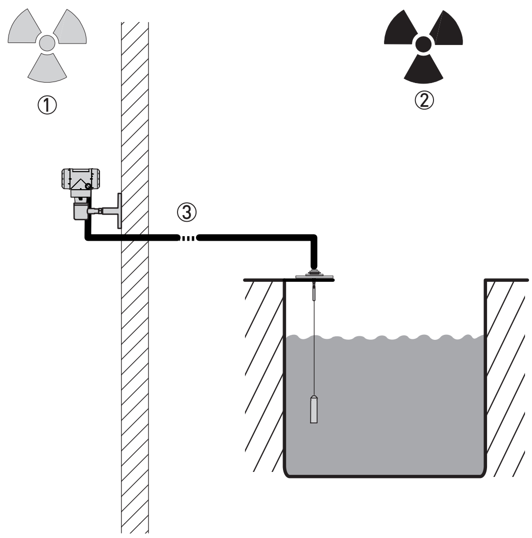


① TID: ≤5.7×10^3 rad
② TID: ≤2.7×10^8 rad
③ Coaxial cable (≤100 m / 328 ft)

POWERFLEX 2200 S LOCA – Compact version with LOCA sensor extension
Signal converter with display, located up to 150 m / 492 ft from the probe



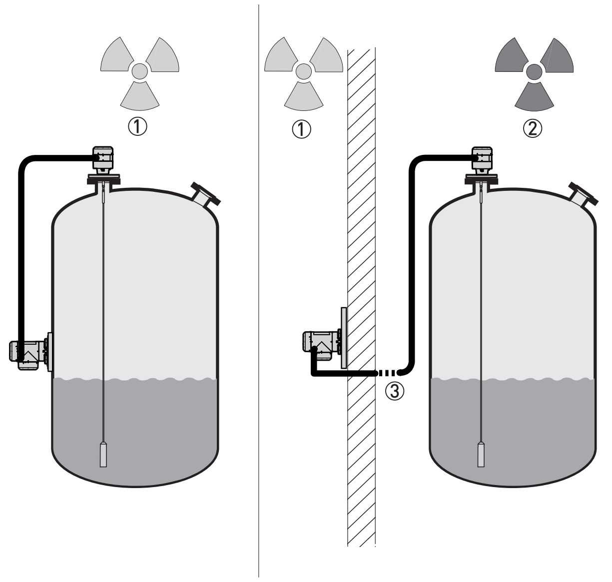
① TID: ≤5.7×10³ rad
② TID: ≤5×10⁸ rad
③ LOCA coaxial cable (≤150 m / 492 ft)



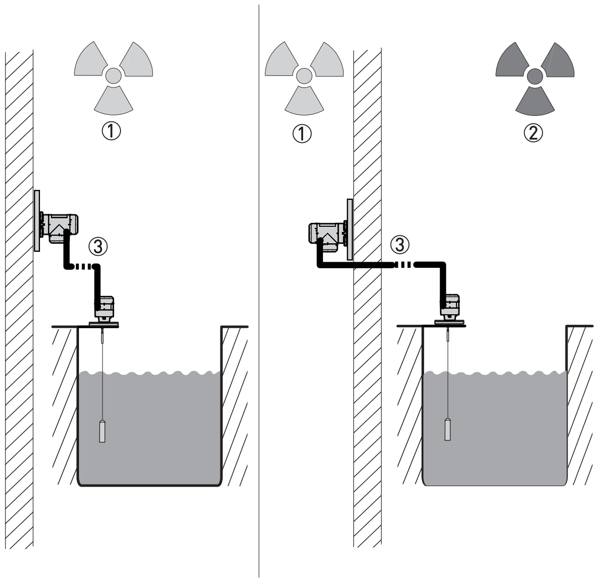
① TID: ≤5.7×10³ rad
② TID: ≤5×10⁸ rad
③ LOCA coaxial cable (≤150 m / 492 ft)

POWERFLEX 2200 F – Remote version

Signal converter with display, located up to 300 m / 984 ft away from the probe

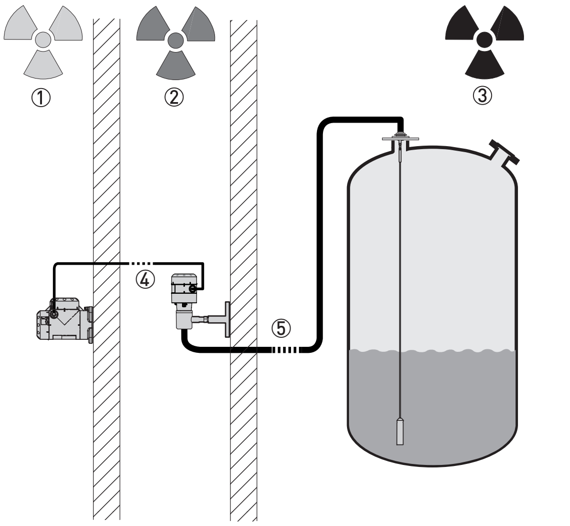


① TID: ≤5.7×10^3 rad
② TID: ≤10.5×10^3 rad
③ RS-485 cable (≤300 m / 984 ft)

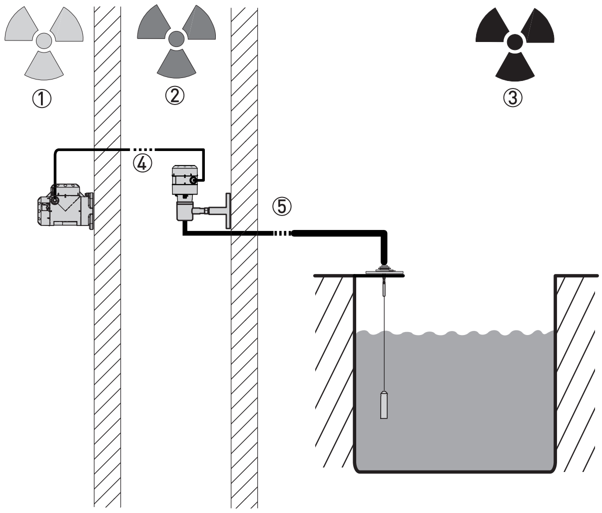


① TID: ≤5.7×10^3 rad
② TID: ≤10.5×10^3 rad
③ RS-485 cable (≤300 m / 984 ft)

POWERFLEX 2200 D – Remote version with sensor extension
Signal converter with display, located up to 400 m / 1312 ft from the probe

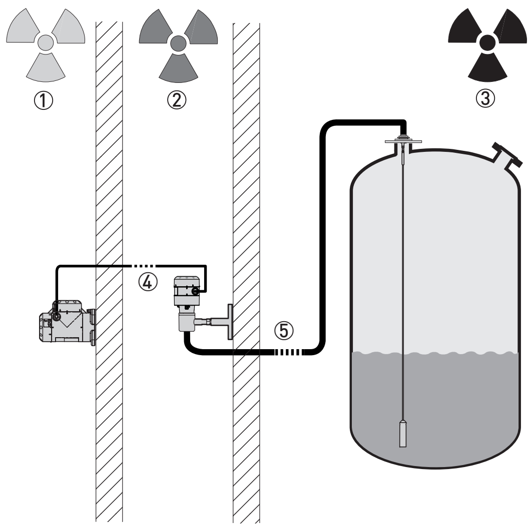


① TID: ≤5.7E×10^3 rad
② TID: ≤10.5×10^3 rad
③ TID: ≤2.7×10^8 rad
④ RS-485 cable (≤300 m / 984 ft)
⑤ Coaxial cable (≤100 m / 328 ft)

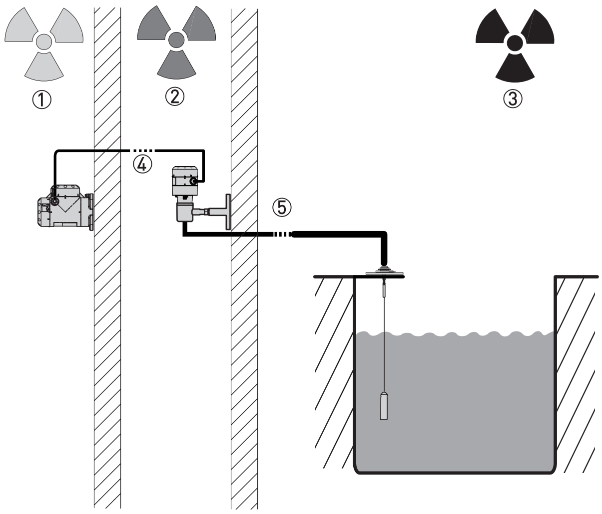


① TID: ≤5.7×10^3 rad
② TID: ≤10.5×10^3 rad
③ TID: ≤2.7×10^8 rad
④ RS-485 cable (≤300 m / 984 ft)
⑤ Coaxial cable (≤100 m / 328 ft)

POWERFLEX 2200 D LOCA – Remote version with LOCA sensor extension
Signal converter with display, located up to 450 m / 1476 ft from the probe



① TID: ≤5.7E×10^3 rad
② TID: ≤10.5×10^3 rad
③ TID: ≤5×10^8 rad
④ RS-485 cable (≤300 m / 984 ft)
⑤ LOCA coaxial cable (≤150 m / 492 ft)



① TID: ≤5.7×10^3 rad
② TID: ≤10.5×10^3 rad
③ TID: ≤5×10^8 rad
④ RS-485 cable (≤300 m / 984 ft)
⑤ LOCA coaxial cable (≤150 m / 492 ft)

1.4 Measuring principle

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

The device transmits low-intensity electromagnetic pulses of approximately one nanosecond width along a rigid or flexible conductor. These pulses move at the speed of light. When the pulses reach the surface of the product to be measured, the pulses are reflected back to the signal converter.

The device measures the time from when the pulse is emitted to when it is received: half of this time is equivalent to the distance from the reference point of the device to the surface of the product. The time value is converted into an output current of 4...20 mA.

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

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

TDR measurement of level

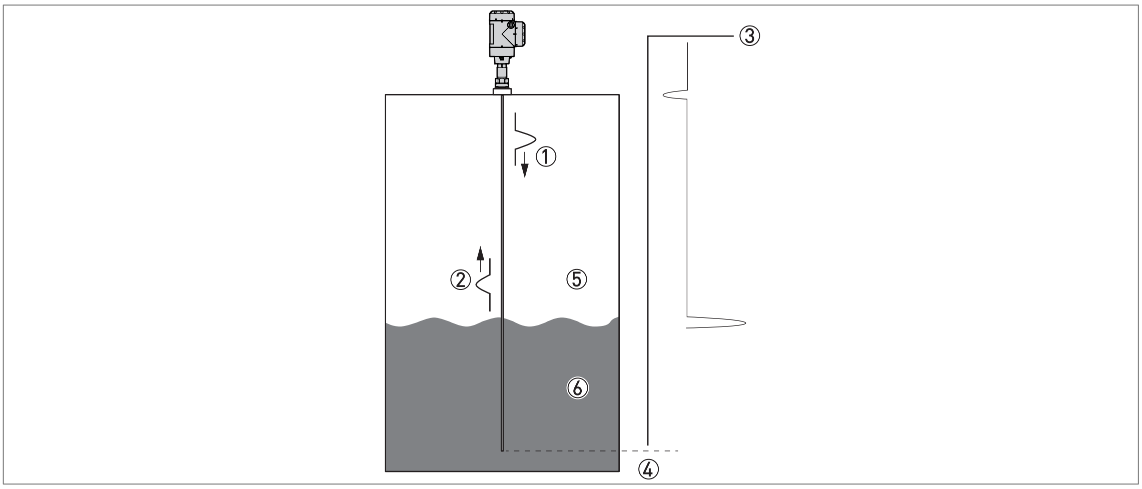


Figure 1-1: TDR measurement of level

① Transmitted pulses
② Reflected pulse
③ Pulse amplitude
④ Time of flight
⑤ Air, ε_r= 1
⑥ $\varepsilon_r \geq$ 1.4

2.1 Technical data

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

Converter

Measuring system

Application	Level and volume measurement of liquids and pastes
Measuring principle	TDR (time domain reflectometry)
Construction	**Compact version (C):** Measuring probe attached directly to a signal converter **Compact version with sensor extension (S):** Measuring probe with a sensor extension cable (max. length 100 m / 328 ft) attached to a signal converter **Compact version with LOCA sensor extension (S LOCA):** Measuring probe with a sensor extension cable (max. length 150 m / 492 ft) attached to a signal converter **Remote version (F):** Measuring probe with a signal cable (max. length 300 m / 984 ft) attached to a signal converter **Remote version with sensor extension (D):** Measuring probe with a sensor extension cable (max. length 100 m / 328 ft) and signal cable (max. length 300 m / 984 ft) attached to a signal converter **Remote version with LOCA sensor extension (D LOCA):** Measuring probe with a sensor extension cable (max. length 150 m / 492 ft) and signal cable (max. length 300 m / 984 ft) attached to a signal converter

Operating conditions

Ambient temperature	**Compact (C) and Remote (F) versions:** -40…+80°C / -40…+176°F Integrated LCD display: -20...+60°C / -4...+140°F; if the ambient temperature is not in these limits, the display switches off
	Compact version with sensor extension (S) and Remote version with sensor extension (D): Converter: -40…+80°C / -40…+176°F Integrated LCD display: -20...+60°C / -4...+140°F; if the ambient temperature is not in these limits, the display switches off Probe, process connection and sensor extension: -40…+85°C / -40…+185°F Probe, process connection and LOCA sensor extension: -40…+150°C / -40…+302°F
Storage temperature	-50…+85°C / -60…+185°F (min. -40°C / -40°F for devices with the integrated LCD display option)
Ingress protection	IEC 60529: IP66/67
	NEMA 250: NEMA type 4X (housing) and type 6P (probe)
Radioactivity	**C version** 57 Gy
	F, S and D versions Probe: 2700 kGy / Sensor electronics block: 105 Gy / Converter: 57 Gy
	S LOCA and D LOCA versions Probe: 5000 kGy / Sensor electronics block: 105 Gy / Converter: 57 Gy

Materials

Housing	Stainless steel (1.4404 / 316L)
Cable entry	Stainless steel (for RCC-E nuclear-qualified plug-in connectors etc.)

Electrical connections

Power supply (terminals)	11.5…30 VDC; min./max. value for an output of 22 mA at the terminal
Current output load	R_L [Ω] ≤ ((U_{ext} -11.5 V)/22 mA). For more data, refer to *Minimum power supply voltage* on page 19.
Cable entry	M20 × 1.5; ½ NPT
Cable gland	Standard: none
	Options: M20×1.5 (cable diameter: 6...7.5 mm / 0.24...0.3¨); others are available on request
Signal cable – remote (F) version	None (4-wire shielded cable of max. length 300 m / 984 ft to be supplied by the customer). For more data, refer to the handbook
Sensor extension ①	50-ohm cable of max. length 100 m / 328 ft, agrees with the standards and specifications that follow: – zero halogen – CST 74 C 068 Level K2, this includes thermal and radiation qualifications – NF C32-070 Class C1 – IEEE Std 1202; UL 1581
LOCA sensor extension ②	50-ohm cable of max. length 150 m / 492 ft, agrees with the standards and specifications that follow: – zero halogen – NF C32-070 Class C1 – IEC 60332-3-23 – radiation-hardened
Cable entry capacity (terminal)	0.5…2.5 mm²

Input and output

Measured variable	Time between the emitted and received signal
Current output / HART®	
Output signal	4…20 mA HART® or 3.8…20.5 mA acc. to NAMUR NE 43 ③
Resolution	±3 µA
Temperature drift (analog)	Typically 100 ppm/K
Temperature drift (digital)	Max. ±15 mm for the full temperature range
Error signal options	High: 22 mA; Low: 3.6 mA acc. to NAMUR NE 43; Hold (frozen value – not available if the output agrees with NAMUR NE 43)

Display and user interface

User interface options	LCD display (128 × 64 pixels in 8-step greyscale with 4-button keypad)
Languages	9 languages are available: English, German, French, Italian, Spanish, Portuguese, Japanese, Chinese (simplified) and Russian

Approvals and certification

CE	This device fulfils the statutory requirements of the EU directives. The manufacturer certifies successful testing of the product by applying the CE mark.
Nuclear	RCC-E (category K3ad equipment)
	IEEE Std 323 (class 1E equipment)
	OPB-88/97 (safety class 3N equipment)
	IEC 61513
	Others on request
Pressure safety (conformity to design and construction regulations)	RCC-M
	ASME Section III; B31.1; B31.3
	CODAP

Vibration resistance	EN 60721-3-4 (1...9 Hz: 3 mm / 10...200 Hz:1g; 10g shock ½sinus: 11 ms) For coaxial probes: <2 m / 6.56 ft, 0.5g or category 4M3 according to EN 60721-3-4 <6 m / 19.68 ft, 0.5g or category 4M1 according to EN 60721-3-4
Mechanical integrity	IEC 60068-2-57 / IEC 60068-2-6 (design and test conditions) – for cable probes only
Thermal aging tests	+107°C / +224.6°F for 196 days
Seismic tests	CRT 91 C 112 00 (EDF technical specification); RCC-E
	IEEE Std 344-1987; IEEE Std 344-2004
	IEC 60980:1989
Other standards and approvals	
EMC	Electromagnetic Compatibility Directive 2014/30/EU in conjunction with EN 61326-1 (2013). The device agrees with this standard if: – the device has a coaxial probe or – the device has a single / double probe that is installed in a metallic tank. For more data.
	IEC 61000-4
	MIL-STD-461F
NAMUR	NAMUR NE 21 Electromagnetic Compatibility (EMC) of Industrial Process and Laboratory Control Equipment
	NAMUR NE 43 Standardization of the Signal Level for the Failure Information of Digital Transmitters
	NAMUR NE 53 Software and Hardware of Field Devices and Signal Processing Devices with Digital Electronics
	NAMUR NE 107 Self-Monitoring and Diagnosis of Field Devices

① Cable for the compact version with a sensor extension (S) and the remote version with a sensor extension (D)
② Cable for the compact version with a sensor extension (S LOCA) and the remote version with a sensor extension (D LOCA)
③ HART® is a registered trademark of the HART Communication Foundation

Probe options

	Single cable Ø4 mm / 0.16¨	Single rod Ø8 mm / 0.32¨

Measuring system

Application	Liquids	
Measuring range	**Compact (C) and Remote (F) versions:** 1...40 m / 3.3...131 ft	1...4 m / 3.3...13.1 ft
	Compact version with sensor extension (S) and Remote version with sensor extension (D): 1...20 m / 3.3...65.6 ft	
Dead zone	This depends on the type of probe. For more data, refer to *Measurement limits* on page 20.	

Measuring accuracy

Accuracy	**Standard:** ±10 mm / ±0.4¨, when distance ≤ 10 m / 32.8 ft; ±0.1% of distance, when distance > 10 m / 32.8 ft ±0.1% of the coaxial cable length (if the device has a sensor extension option – device versions S or D)
	Optional: ±3 mm / ±0.1¨, when distance ≤ 10 m / 32.8 ft; ±0.03% of distance, when distance > 10 m / 32.8 ft ±0.1% of the coaxial cable length, if the device has a sensor extension option – device versions S or D

	Single cable Ø4 mm / 0.16¨	Single rod Ø8 mm / 0.32¨
Resolution	1 mm / 0.04¨	
Repeatability	Compact versions (C or S): ±2 mm / ±0.08¨	
	Remote versions (F or D): ±2 mm / ±0.08¨, if the ambient temperature is stable	
Maximum rate of change at 4 mA	60 m/min / 196.9 ft/min	

Operating conditions

Min./Max. temperature at the process connection	-50…+150°C / -58…+302°F; higher on request
Pressure	-1…100 barg / -14.5…1450 psig; higher on request
Viscosity	10000 mPa·s / 10000 cP
Dielectric constant	≥ 1.8

Materials

Probe	Stainless steel (1.4401 / 316)
Gasket (process seal)	EPDM (-50...+150°C / -58...+302°F)
Process connection	Stainless steel (1.4404 / 316L); HASTELLOY® C-22® (2.4602)

Process connections

Thread	1½ NPT; G 1½A	1½ NPT; G 1½A
Flange		
EN 1092-1	DN40...200 in PN10, PN16, PN25 or PN40 ①	
ASME B16.5	1½...8¨ in 150 lb or 300 lb ①	
JIS B2220	40...200A in 10 K	

① Other flange faces are available. Refer to your local supplier for more data.

	Double cable 2 × Ø4 mm / 0.16¨	Double rod 2 × Ø8 mm / 0.32¨	Coaxial Ø22 mm / 0.87¨

Measuring system

Application	Liquids		
Measuring range	Versions C or F: 1...40 m / 3.3...131.2 ft Versions S or D: 1...20 m / 3.3...65.6 ft	1...4 m / 3.3...13.1 ft	0.6...6 m / 2.0...19.7 ft
Dead zone	This depends on the type of probe. For more data, refer to *Measurement limits* on page 20.		

Measuring accuracy

Accuracy	**Standard:** ±10 mm / ±0.4¨, when distance ≤ 10 m / 32.8 ft; ±0.1% of distance, when distance > 10 m / 32.8 ft ±0.1% of the coaxial cable length (if the device has a sensor extension option – device versions S or D)
	Optional: ±3 mm / ±0.1¨, when distance ≤ 10 m / 32.8 ft; ±0.03% of distance, when distance > 10 m / 32.8 ft ±0.1% of the coaxial cable length, if the device has a sensor extension option – device versions S or D

	Double cable 2 × Ø4 mm / 0.16¨	Double rod 2 × Ø8 mm / 0.32¨	Coaxial Ø22 mm / 0.87¨
Resolution	1 mm / 0.04¨		
Repeatability	Compact versions (device versions C or S): ±2 mm / ±0.08¨		
	Remote versions (device versions F or D): ±2 mm / ±0.08¨, if the ambient temperature is stable		
Maximum rate of change at 4 mA	60 m/min / 196.8 ft/min		

Operating conditions

Min./Max. temperature at the process connection	-50…+150°C / -58…+302°F; higher on request		
Pressure	-1…100 barg / -14.5…1450 psig; higher on request		
Viscosity	≤ 5000 mPa·s / ≤ 5000 cP		500 mPa·s / 500 cP
Dielectric constant	≥ 1.6		≥ 1.4

Materials

Probe	Stainless steel (1.4404 / 316L)		Stainless steel (1.4401 / 316)
Gasket (process seal)	EPDM (-50...+150°C / -58...+302°F)		
Process connection	Stainless steel (1.4404 / 316L)		

Process connections

Thread	1½ NPT; G 1½A	1½ NPT; G 1½A	1½ NPT; G 1½A
Flange			
EN 1092-1	DN40...200 in PN10, PN16, PN25 or PN40 ①		
ASME B16.5	1½...8¨ in 150 lb or 300 lb ②		
JIS B2220	40...200A in 10 K ③		
Others	Others on request		

① DN50...200 for double cable and double rod probes. Other flange faces are available. Refer to your local supplier for more data.
② 2...8¨ for double cable and double rod probes
③ 50...200A for double cable and double rod probes

2.2 Minimum power supply voltage

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

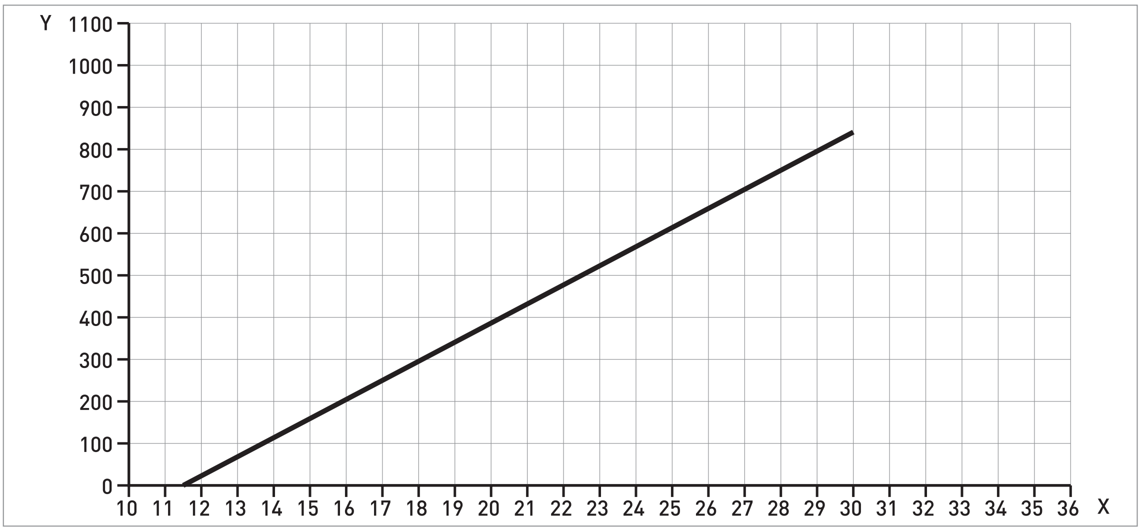


Figure 2-1: Minimum power supply voltage for an output of 22 mA at the terminals (Non-Ex and Hazardous Location approval (Ex i / IS))

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

2.3 Measurement limits

Double cable and double rod probes

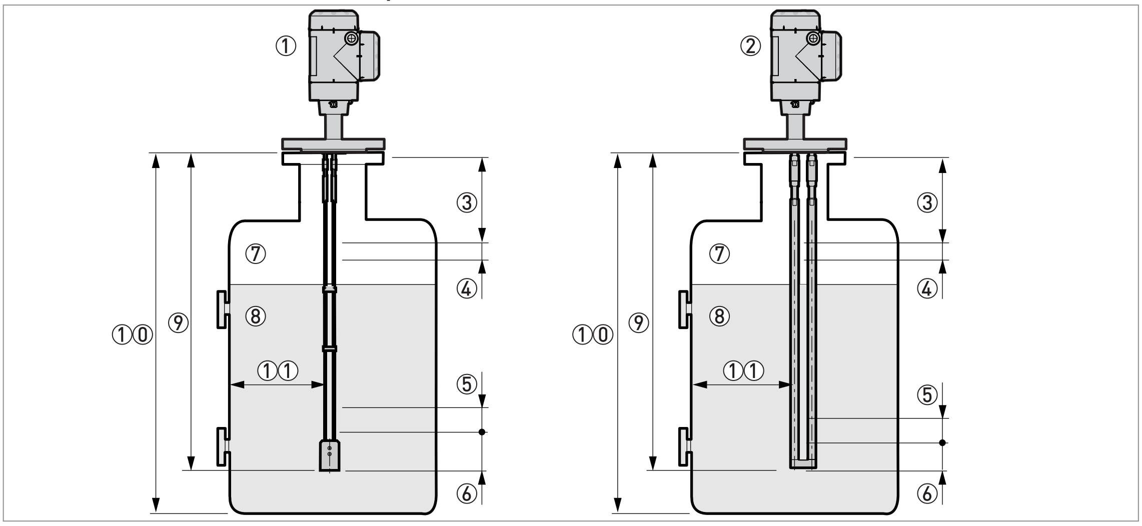


Figure 2-2: Measurement limits

① Device with a double cable probe
② Device with a double rod probe
③ **Top dead zone:** Top part of the probe where measurement is not possible
④ **Top non-linearity zone:** Top part of the probe with a lower accuracy of ±30 mm / ±1.18¨
⑤ **Bottom non-linearity zone:** Bottom part of the probe with a lower accuracy of ±30 mm / ±1.18¨
⑥ **Bottom dead zone:** Bottom part of the probe where measurement is not possible
⑦ **Gas (Air)**
⑧ **Product**
⑨ **L, Probe length**
①⓪ **Tank Height**
①① **Minimum distance from the probe to a metallic tank wall:** Double cable or double rod probes = 100 mm / 4¨

Measurement limits (dead zone) in mm and inches

Probes	ε_r = 80				ε_r = 2.5			
	Top ③		Bottom ⑥		Top ③		Bottom ⑥	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Double cable ①	120	4.72	20	0.78	120	4.72	150	5.91
Double rod	120	4.72	20	0.78	120	4.72	150	5.91

① If the cable probe does not have a counterweight, speak or write to your local supplier for more data

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

Probes	ε_r = 80				ε_r = 2.3			
	Top ④		Bottom ⑤		Top ④		Bottom ⑤	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Double cable ①	0	0	0	0	0	0	10	0.39
Double rod	0	0	0	0	0	0	10	0.39

① If the cable probe does not have a counterweight, speak or write to your local supplier for more data

80 is ε_r of water; 2.5 is ε_r of oil

The values in the tables are correct when the Snapshot function is on. If the snapshot function is not on, then the values for the dead zones and the non-linearity zones increase.

Single cable and single rod probes

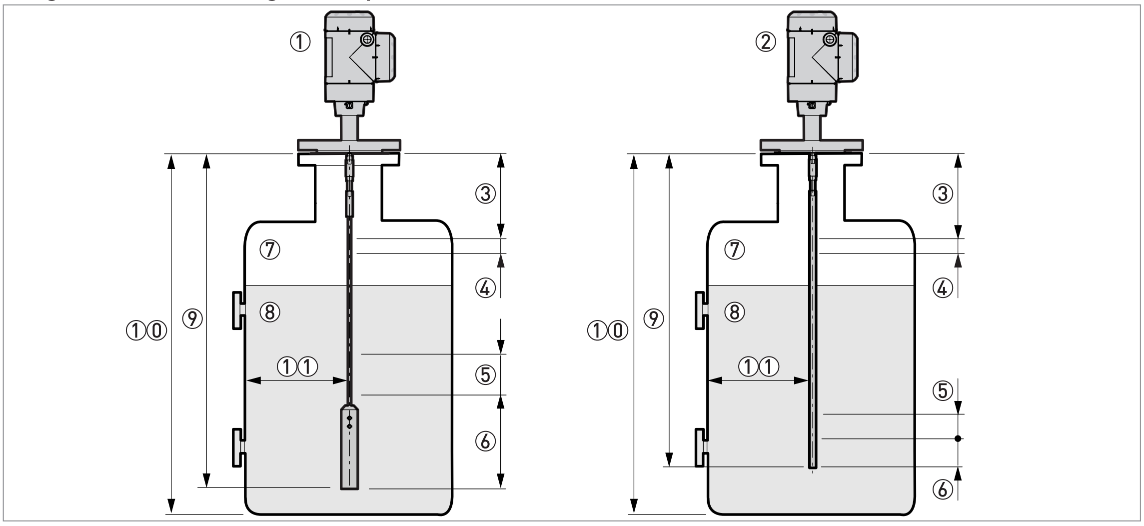


Figure 2-3: Measurement limits

① Device with a single cable probe
② Device with a single rod probe
③ **Top dead zone:** Top part of the probe where measurement is not possible
④ **Top non-linearity zone:** Top part of the probe with a lower accuracy of ±30 mm / ±1.18¨
⑤ **Bottom non-linearity zone:** Bottom part of the probe with a lower accuracy of ±30 mm / ±1.18¨
⑥ **Bottom dead zone:** Bottom part of the probe where measurement is not possible
⑦ **Gas (Air)**
⑧ **Product**
⑨ **L, Probe length**
①⓪ **Tank Height**
①① **Minimum distance from the probe to a metallic tank wall:** Single cable or single rod probes = 300 mm / 12¨

Measurement limits (dead zone) in mm and inches

Probes	ε_r = 80				ε_r = 2.5			
	Top ③		Bottom ⑥		Top ③		Bottom ⑥	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
4 mm / 0.16¨ single cable ①	120	4.72	200	7.87	120	4.72	240	9.45
Single rod	120	4.72	20	0.79	120	4.72	120	4.72

① If the cable probe does not have a counterweight, speak or write to your local supplier for more data

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

Probes	ε_r = 80				ε_r = 2.5			
	Top ④		Bottom ⑤		Top ④		Bottom ⑤	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Ø4 mm / 0.16¨ single cable ①	0	0	0	0	0	0	0	0
Single rod	50	1.97	0	0	0	0	0	0

① If the cable probe does not have a counterweight, speak or write to your local supplier for more data

80 is ε_r of water; 2.5 is ε_r of oil

The values in the tables are correct when the Snapshot function is on. If the snapshot function is not on, then the values for the dead zones and the non-linearity zones increase.

Coaxial probe

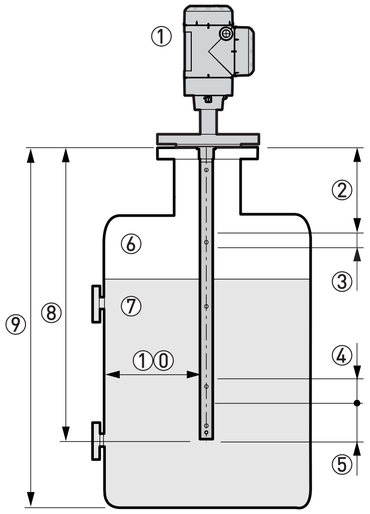


Figure 2-4: Measurement limits

① Device with a coaxial probe
② **Top dead zone:** Top part of the probe where measurement is not possible
③ **Top non-linearity zone:** Top part of the probe with a lower accuracy of ±30 mm / ±1.18¨
④ **Bottom non-linearity zone:** Bottom part of the probe with a lower accuracy of ±30 mm / ±1.18¨
⑤ **Bottom dead zone:** Bottom part of the probe where measurement is not possible
⑥ **Gas (Air)**
⑦ **Product**
⑧ **L, Probe length**
⑨ **Tank Height**
①⓪ **Minimum distance from the probe to a metallic tank wall:** Coaxial probe = 0 mm / 0¨

Measurement limits (dead zone) in mm and inches

Probe	ε_r = 80				ε_r = 2.5			
	Top ②		Bottom ⑤		Top ②		Bottom ⑤	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Coaxial	65	2.56	20	0.79	65	2.56	20	0.79

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

Probe	ε_r = 80				ε_r = 2.5			
	Top ③		Bottom ④		Top ③		Bottom ④	
	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]	[mm]	[inches]
Coaxial	0	0	0	0	0	0	0	0

80 is ε_r of water; 2.5 is ε_r of oil

The values in the tables are correct when the Snapshot function is on. If the snapshot function is not on, then the values for the dead zones and the non-linearity zones increase.

2.4 Dimensions and weights

General dimensions

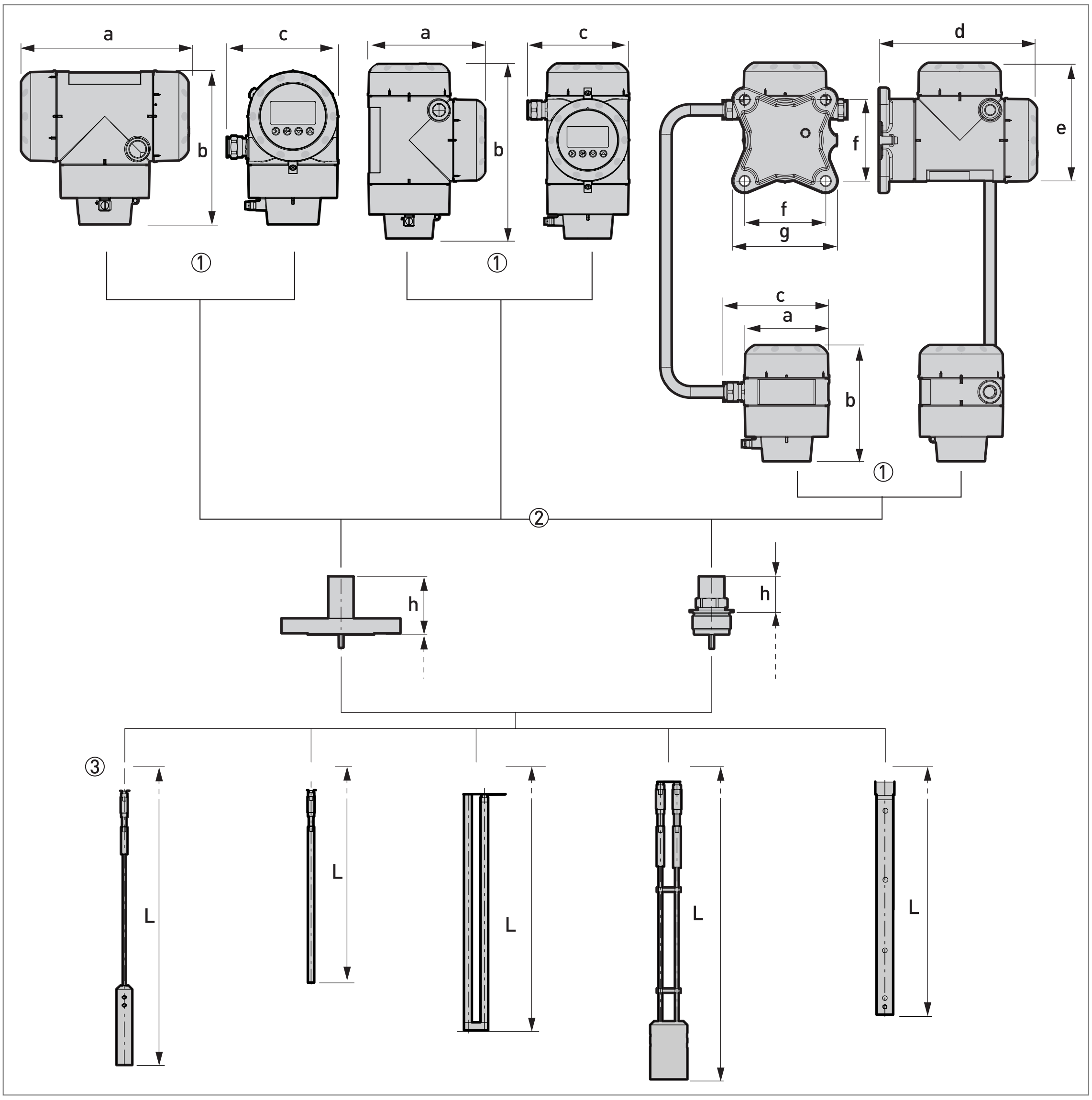


Figure 2-5: General dimensions

① **Housing options.** From left to right: compact converter with horizontal housing, compact converter with vertical housing, and remote converter (top) and probe housing (bottom)
② **Process connection options.** From left to right: flange connection for probes, threaded connection for probes
③ **Probe options.** From left to right: Ø4 mm / 0.16¨ single cable probe, single rod probe, double rod probe, Ø4 mm / 0.16¨ double cable probe and coaxial probe

Housing options: Dimensions in mm

Dimensions [mm]	Compact – horizontal	Compact – vertical	Remote
a	191	147	104
b	175	218	142
c	127	127	129
d	—	—	195
e	—	—	146
f	—	—	100
g	—	—	130

Housing options: Dimensions in inches

Dimensions [inches]	Compact – horizontal	Compact – vertical	Remote
a	7.5	5.79	4.09
b	6.89	8.23	5.59
c	5.00	5.00	5.08
d	—	—	7.68
e	—	—	5.75
f	—	—	3.94
g	—	—	5.12

Process connection and probe options: Dimensions

Dimensions [mm]	Probes with threaded connections		Probes with flange connections	
	[mm]	[inches]	[mm]	[inches]
h	45	1.77	73	2.87
L	For more data, refer to "Single probes" and "Double and coaxial probes" in this section.			

Weather protection option (vertical signal converters – for the compact version only)

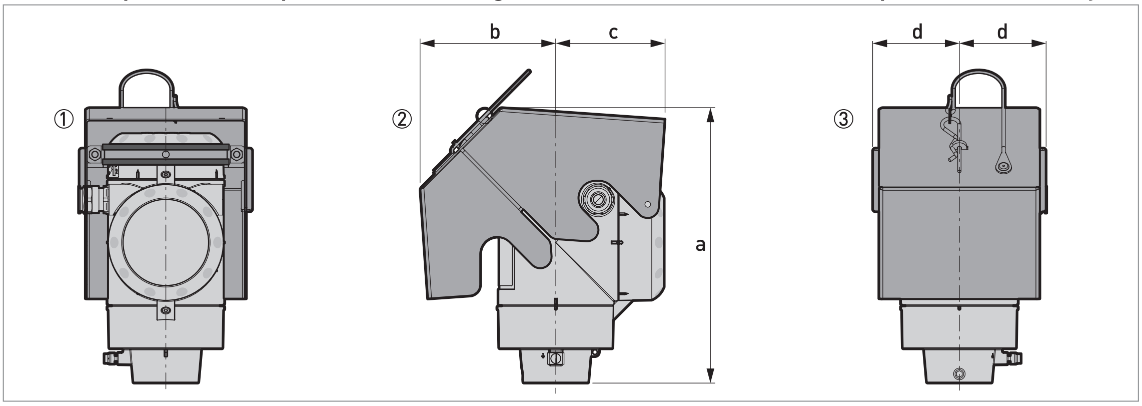


Figure 2-6: Weather protection option for vertical signal converter versions (compact version only)

① Rear view (with weather protection closed)
② Right side (with weather protection closed)
③ Front view (with weather protection closed)

Dimensions and weights in mm and kg

Weather protection	Dimensions [mm]				Weights [kg]
	a	b	c	d	
Vertical signal converter	241	120	96	77	1.3

Dimensions and weights in inches and lb

Weather protection	Dimensions [inches]				Weights [lb]
	a	b	c	d	
Vertical signal converter	9.5	4.7	3.8	3.0	2.9

Weather protection option (horizontal signal converters – for the compact version only)

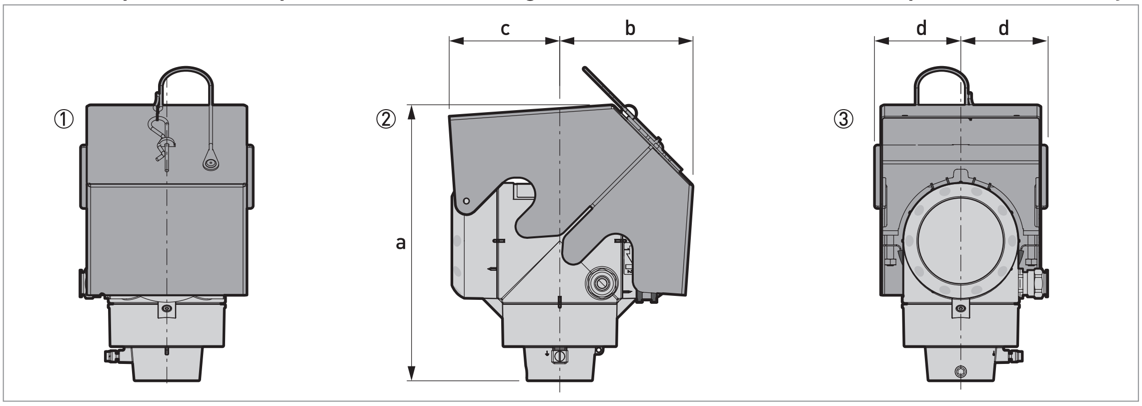


Figure 2-7: Weather protection option for horizontal signal converter versions (compact version only)

① Front view (with weather protection closed)
② Left side (with weather protection closed)
③ Rear view (with weather protection closed)

Dimensions and weights in mm and kg

Weather protection	Dimensions [mm]				Weights [kg]
	a	b	c	d	
Horizontal signal converter	243	118	98	77	1.3

Dimensions and weights in inches and lb

Weather protection	Dimensions [inches]				Weights [lb]
	a	b	c	d	
Horizontal signal converter	9.6	4.6	3.9	3.0	2.9

Sensor extension (option): Coaxial cable with flexible stainless steel jacket

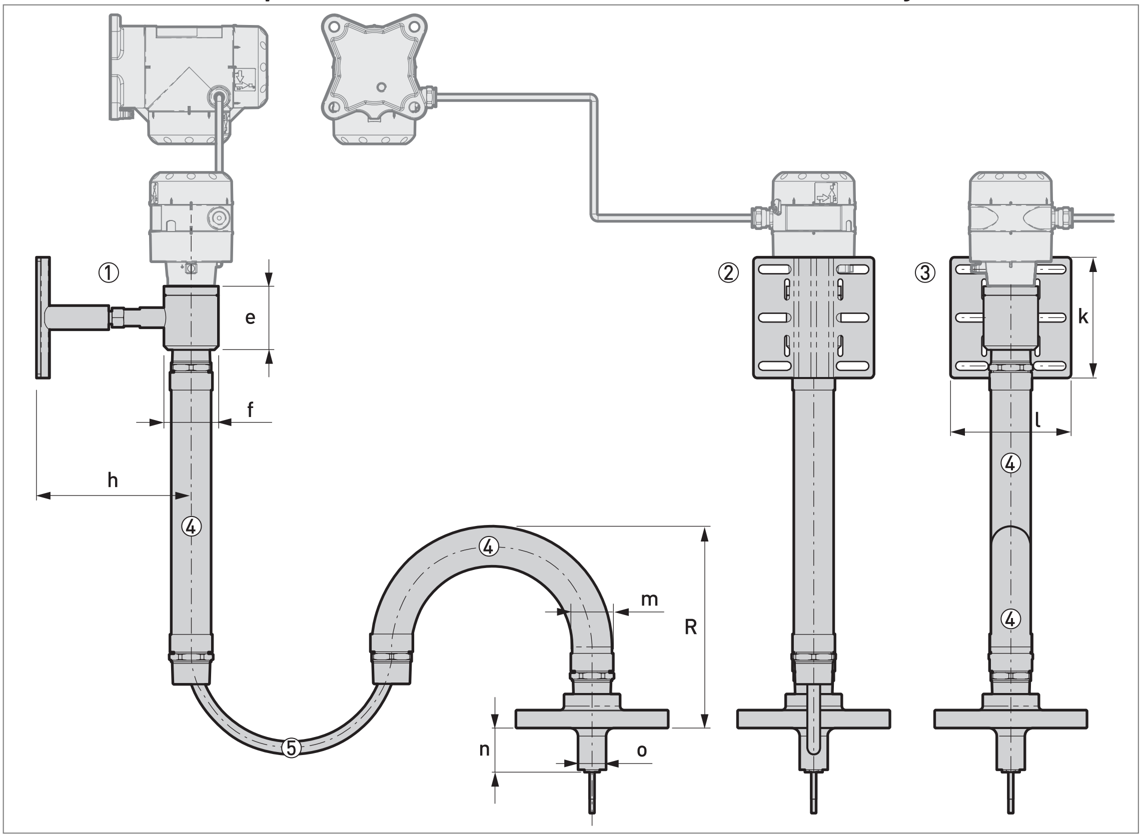


Figure 2-8: Sensor extension (option): Coaxial cable with flexible stainless steel jacket

① Left side
② Rear view
③ Front view
④ 1 or more lengths of flexible stainless steel jacket with male 1½ NPT threaded connection, maximum length 100 m / 328 ft (tolerance: +3% / -1%)
⑤ Coaxial cable, maximum length 100 m / 328 ft (tolerance: +3% / -1%)

There are 2 alternatives for the position of this subassembly in the device:

- If the device has a compact converter: The sensor extension is attached to the signal converter
- If the device has a remote converter: The sensor extension is attached to the probe housing

This option includes the process connection and the probe. The maximum length of the coaxial cable between the probe housing and the process connection is 100 m / 328 ft (tolerance: +3% / -1%). The coaxial cable has a protective flexible stainless steel jacket (refer to the illustration).

The coaxial cable and one length of the flexible stainless steel jacket are not attached to the process connection before delivery. For the assembly procedure, refer to the handbook.

For the wall bracket dimensions, refer to the handbook.

The length of the coaxial cable and the stainless steel jacket depends on the data given in the customer order.

Dimensions and weights in mm and kg

	Dimensions [mm]											Weights [kg]
	e	Øf	h	k	l	m	n	Øo	n	o	R	
Flexible jacket	79	68	193	150	150.4	49.7	55	35	86	58	250 ①	②

① Minimum radius of the flexible jacket
② Wall bracket (1.4 kg) + converter support (1.5 kg) + remote probe converter (2.7 kg) + coaxial cable (0.25 kg/m) + flexible jacket (6.9 kg)

Dimensions and weights in inches and lb

	Dimensions [inches]											Weights [lb]
	e	Øf	h	k	l	m	n	o	n	o	R	
Flexible jacket	3.11	2.68	7.60	5.91	5.92	1.96	2.17	1.38	3.39	2.28	17.72 ①	②

① Minimum radius of the flexible jacket
② Wall bracket (3.1 lb) + converter support (3.3 lb) + remote probe converter (6.0 lb) + coaxial cable (0.17 lb/ft) + flexible jacket (15.2 lb)

LOCA sensor extension (option): LOCA coaxial cable

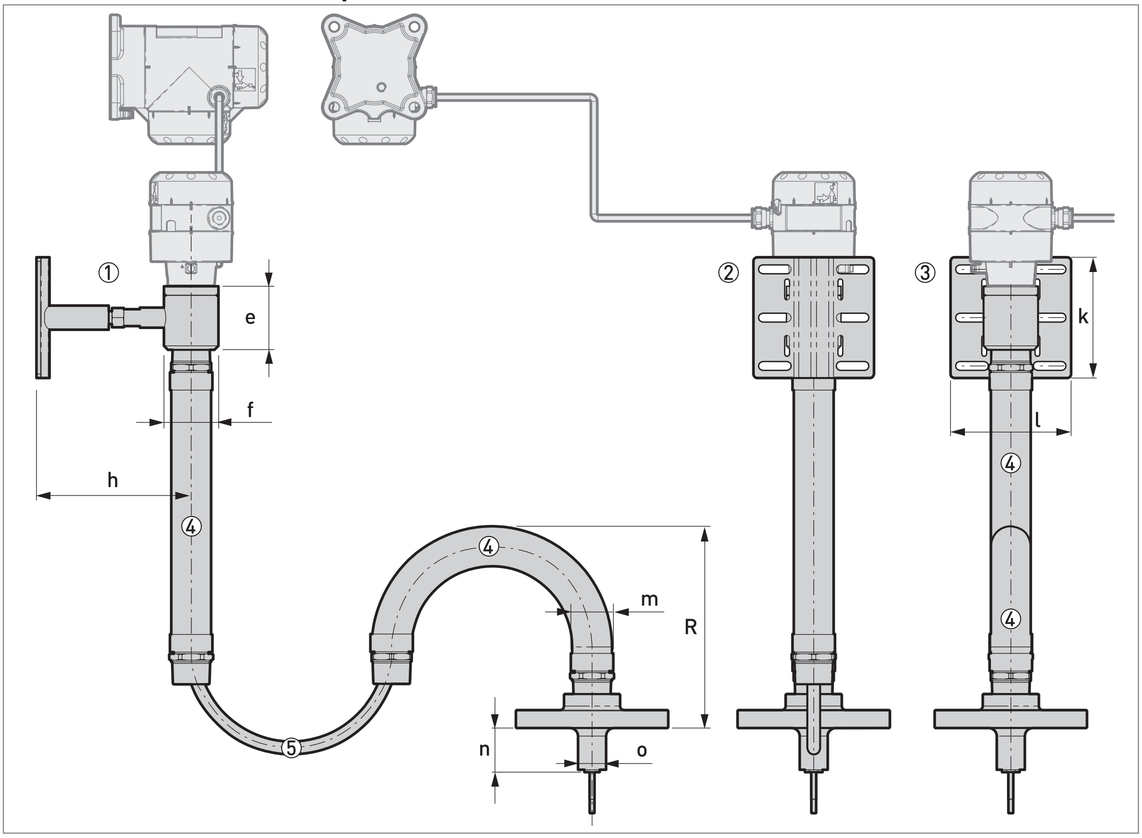


Figure 2-9: LOCA sensor extension (option): LOCA coaxial cable

① Left side
② Rear view
③ Front view
④ 1 or more lengths of flexible stainless steel jacket with male 1½ NPT threaded connection, maximum length 150 m / 492 ft (tolerance: +3% / -1%)
⑤ LOCA coaxial cable, maximum length 150 m / 492 ft (tolerance: +3% / -1%)

There are 2 alternatives for the position of this subassembly in the device:

- If the device has a compact converter: The sensor extension is attached to the signal converter
- If the device has a remote converter: The sensor extension is attached to the probe housing

This option includes the process connection and the probe. The maximum length of the LOCA coaxial cable between the probe housing and the process connection is 150 m / 492 ft (tolerance: +3% / -1%). If it is necessary to connect the LOCA coaxial cable to connectors on the containment system, then the LOCA coaxial cable is also available in 2 parts.

For the wall bracket dimensions, refer to the handbook.

The length of the coaxial cable and the stainless steel jacket depends on the data given in the customer order.

Dimensions and weights in mm and kg

	Dimensions [mm]											Weights [kg]
	e	Øf	h	k	l	m	n	Øo	n	o	R	
Flexible jacket	79	80	199	150	150.4	76	55	35	86	58	458	①

① Wall bracket (1.4 kg) + converter support (1.5 kg) + remote probe converter (2.7 kg) + coaxial cable (0.76 kg/m) + flexible jacket (6.9 kg)

Dimensions and weights in inches and lb

	Dimensions [inches]											Weights [lb]
	e	Øf	h	k	l	m	n	o	n	o	R	
Flexible jacket	3.1	3.14	7.83	5.91	5.92	2.99	2.17	1.38	3.39	2.28	18.03	①

① Wall bracket (3.1 lb) + converter support (3.3 lb) + remote probe converter (6.0 lb) + coaxial cable (0.51 lb/ft) + flexible jacket (15.2 lb)

Single probes

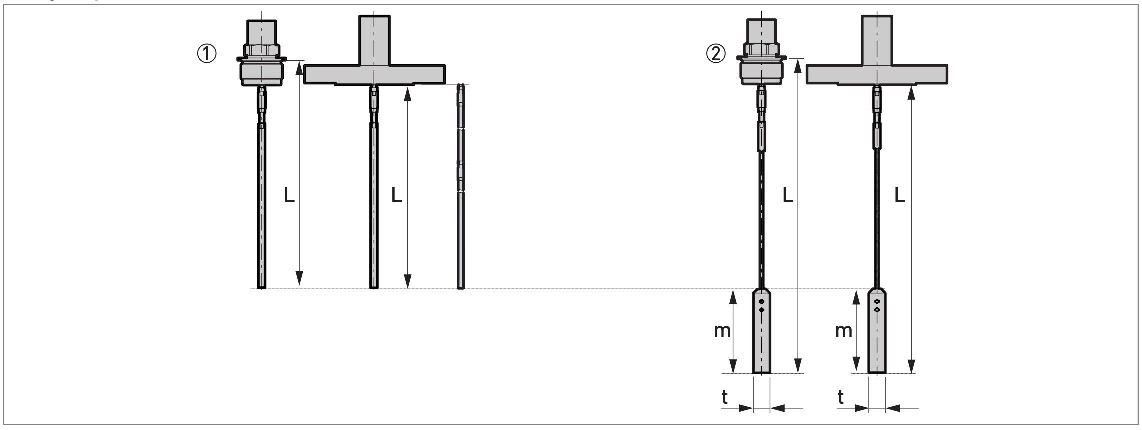


Figure 2-10: Single probe options

① Single rod Ø8 mm / Ø0.32¨ (thread and flange versions – segmented probe option shown on the right side)
② Single cable Ø4 mm / Ø0.16¨ (thread and flange versions)

Single probes: Dimensions in mm

Probes	Dimensions [mm]			
	L min.	L max.	m	t
Single rod Ø8 mm	1000 ①	4000	—	—
Single cable Ø4 mm	1000 ①	40000	100	Ø20

① A shorter probe length is available on request

Single probes: Dimensions in inches

Probes	Dimensions [inches]			
	L min.	L max.	m	t
Single rod Ø0.32¨	39 ①	158	—	—
Single cable Ø0.16¨	39 ①	1575	4.0	0.8

① A shorter probe length is available on request

Double and coaxial probes

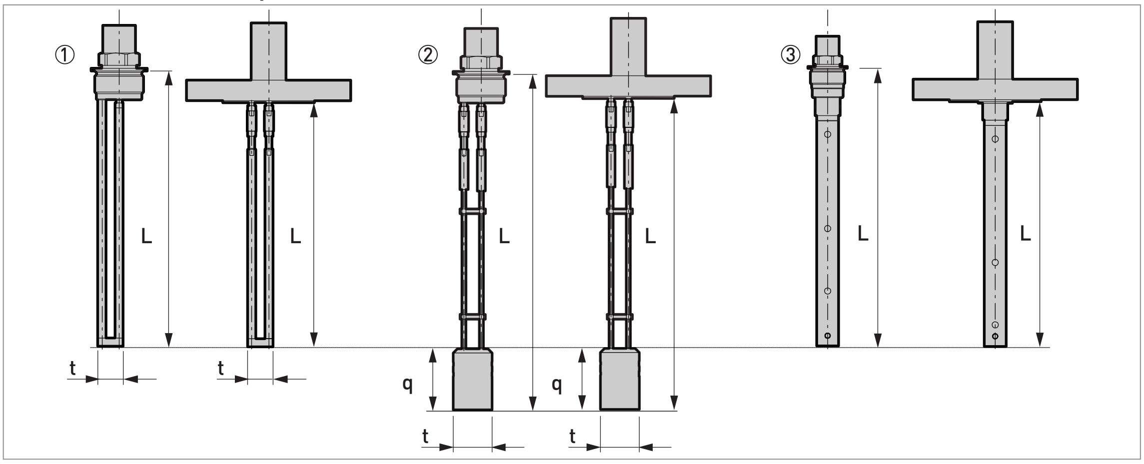


Figure 2-11: Double and coaxial probe options

① Double rod Ø8 mm / Ø0.32¨ (thread and flange versions)
② Double cable Ø4 mm / Ø0.16¨ (thread and flange versions)
③ Coaxial Ø22 mm / Ø0.87¨ (thread and flange versions)

Double probes: Dimensions in mm

Probes	Dimensions [mm]			
	L min.	L max.	q	t
Ø8 mm double rod	1000 ①	4000	—	25
Ø4 mm double cable	1000 ①	40000	60	Ø38
Ø22 mm coaxial	600 ①	6000	—	—

① A shorter probe length is available on request

Double probes: Dimensions in inches

Probes	Dimensions [inches]			
	L min.	L max.	q	t
Ø0.32¨ double rod	39 ①	158	—	1.0
Ø0.16¨ double cable	39 ①	1575	2.4	Ø1.5
Ø0.87¨ coaxial	24 ①	236	—	—

① A shorter probe length is available on request

Converter and probe housing weights

Type of housing	Weights	
	[kg]	[lb]
Compact	6.4	14.1
Remote converter ①	5.9	13.0
Probe housing ①	3.9	8.6

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

Probe weights

Probes	Min. process connection size		Weights	
	Thread	Flange	[kg/m]	[lb/ft]
Single cable Ø4 mm / 0.16¨	G 1½A; 1½ NPT	DN40 PN40; 1½¨ 150 lb; 1½¨ 300 lb	0.12 ①	0.08 ①
Double cable Ø4 mm / 0.16¨	G 1½A; 1½ NPT	DN50 PN40; 2¨ 150 lb; 2¨ 300 lb	0.24 ①	0.16 ①
Single rod Ø8 mm / 0.32¨	G 1½A; 1½ NPT	DN40 PN40; 1½¨ 150 lb; 1½¨ 300 lb	0.41 ②	0.28 ②
Double rod Ø8 mm / 0.32¨	G 1½A; 1½ NPT	DN50 PN40; 2¨ 150 lb; 2¨ 300 lb	0.82 ②	0.56 ②
Coaxial Ø22 mm / 0.87¨	G 1½A; 1½ NPT	DN40 PN40; 1½¨ 150 lb; 1½¨ 300 lb	0.79 ②	0.53 ②

① This value does not include the weights of the counterweight or the flange
② This value does not include the weight of the flange

3.1 Intended use

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.

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

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

It is for use in the nuclear industry and can be installed in spent fuel pools.

3.2 How to prepare the tank before you install the device

To avoid measuring errors and device malfunction, obey these precautions.

3.2.1 General information for nozzles

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

Do not put the process connection near to the product inlet. If the product that enters the tank touches the probe, the device will measure incorrectly.

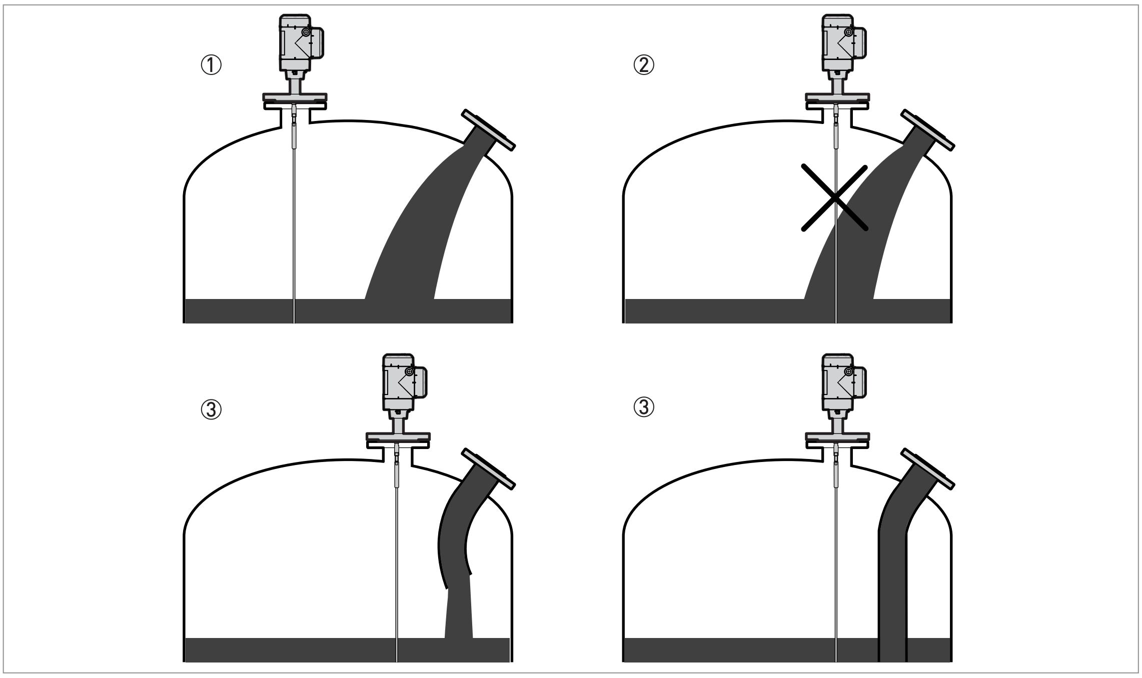


Figure 3-1: Do not put the device near to a product inlet

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

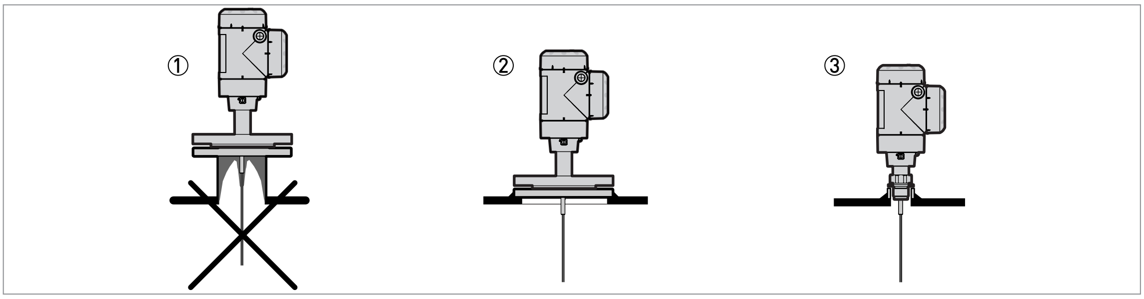


Figure 3-2: How to prevent build-up of product around the process connection

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

For single cable and single rod probes:

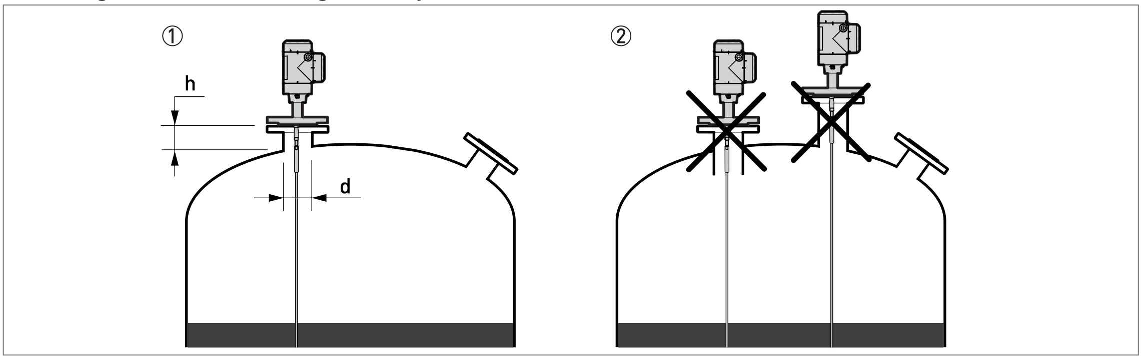


Figure 3-3: Recommended nozzle dimensions for single rod and single cable probes

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

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

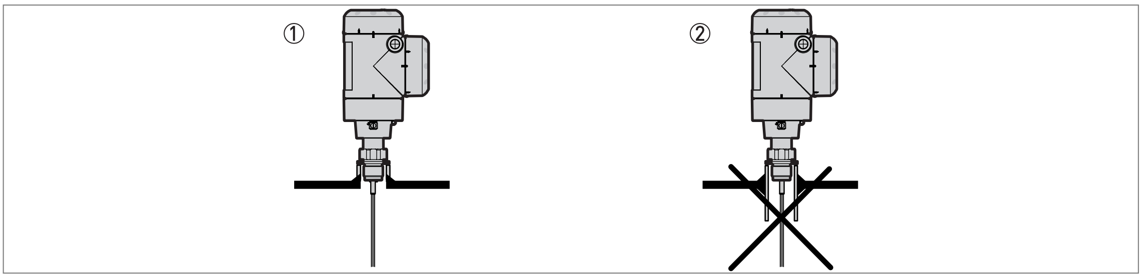


Figure 3-4: Sockets for threaded process connections

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

For double cable and double rod probes:

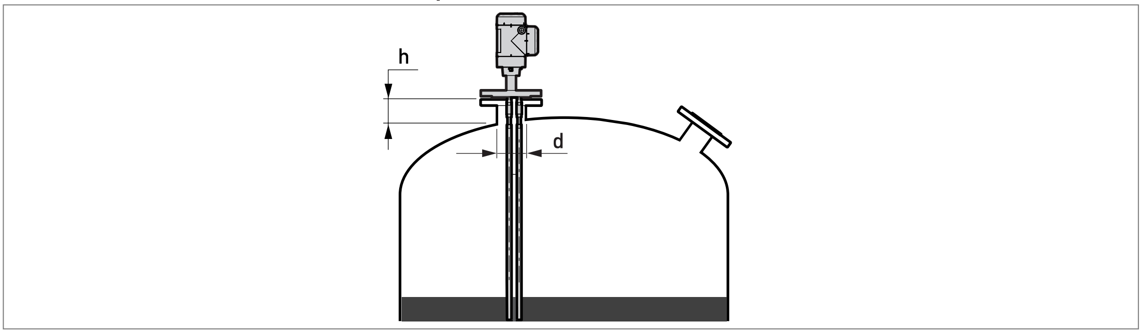


Figure 3-5: Recommended nozzle dimensions for double rod and double cable probes

d ≥ 50 mm / 2¨, where d is the diameter of the tank nozzle

For coaxial probes:

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

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

3.2.2 Installation requirements for concrete roofs

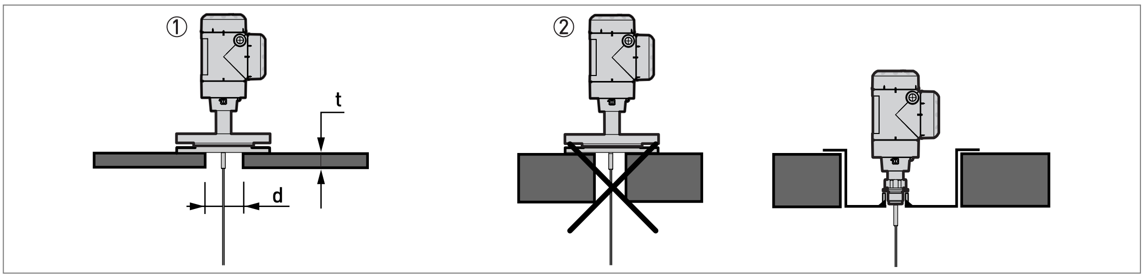


Figure 3-6: Installation on a concrete roof

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

3.3 Installation recommendations for liquids

3.3.1 General requirements

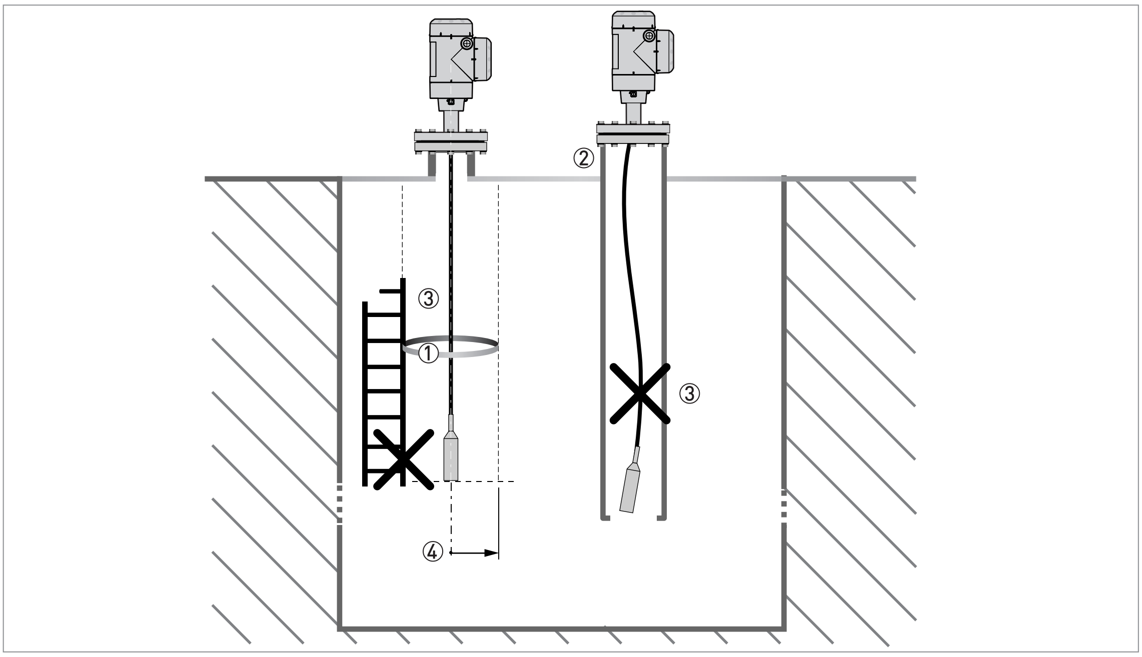


Figure 3-7: Installation recommendations for liquids

① The electromagnetic (EM) field generated by the device. It has a radius of R_{min}. Make sure that the EM field is clear of objects and product flow. Refer to the table that follows.
② If there are too many objects in the pool, install a stilling well
③ Keep the probe straight. If the probe is too long, shorten the probe length. Make sure that the device is configured with the new probe length. For more data on the procedure, refer to the handbook.
Keep the probe straight
④ Empty space. Refer to the table that follows.

Clearance between the probe and other objects in the tank

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

3.3.2 Installation in standpipes (stilling wells and bypass chambers)

Use a standpipe if:

- The liquid is very turbulent or agitated.
- There are too many other objects in the tank.
- The device is measuring a liquid in a tank with a floating roof.

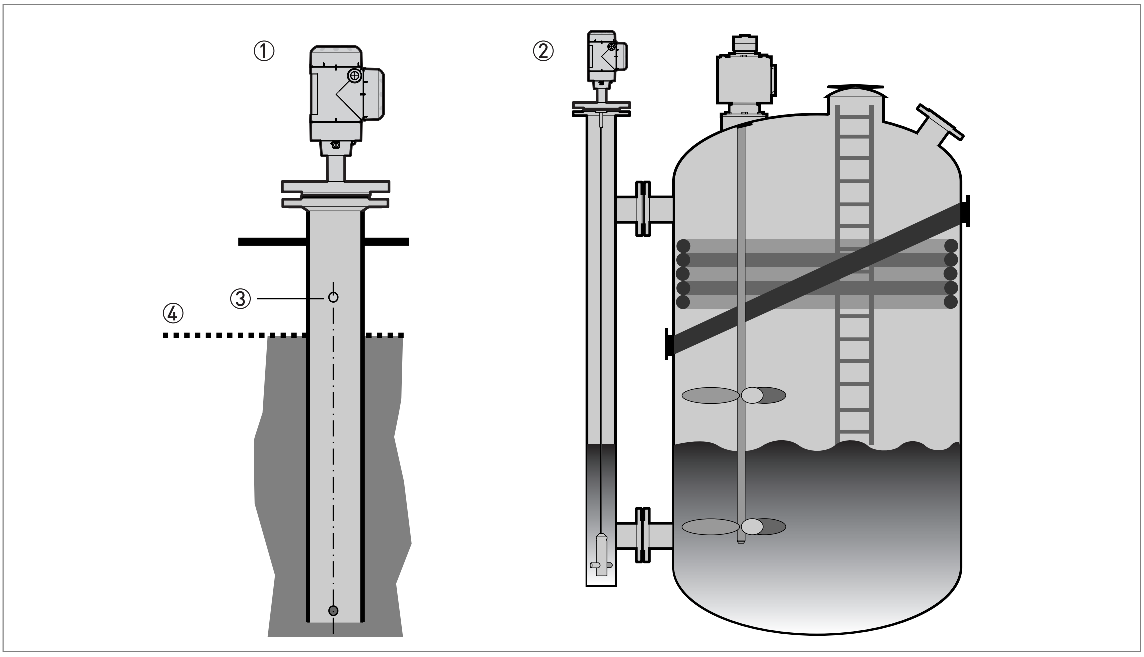


Figure 3-8: Installation recommendations for standpipes (stilling wells and bypass chambers)

① Stilling well
② Bypass chamber
③ Vent
④ Level of the liquid

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

- *The standpipe must be electrically conductive. If the standpipe is not made of metal, obey the instructions for empty space around the probe. For more data, refer to General requirements on page 40.*
- *The standpipe must be straight. There must be no changes in diameter from the device process connection to the bottom of the standpipe.*
- *The standpipe must be vertical.*
- *Recommended surface roughness: < ±0.1 mm / 0.004¨.*
- *The bottom of the stilling well must be open.*
- *Adjust the probe to the center of the standpipe.*
- *Make sure that there are no deposits at the bottom of the standpipe which can cause blockage of the process connections.*
- *Make sure that there is liquid in the standpipe.*

4.1 Electrical installation: 2-wire, loop-powered

4.1.1 Compact version

Terminals for electrical installation

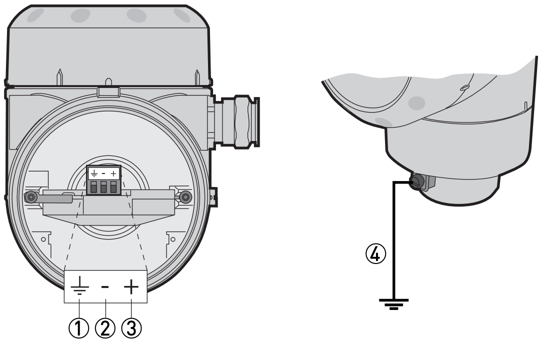


Figure 4-1: Terminals for electrical installation

① Grounding terminal in the housing (if the electrical cable is shielded)
② Current output -
③ Current output +
④ Location of the external grounding terminal (at the bottom of the converter)

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

4.1.2 Remote version

Terminals for electrical installation

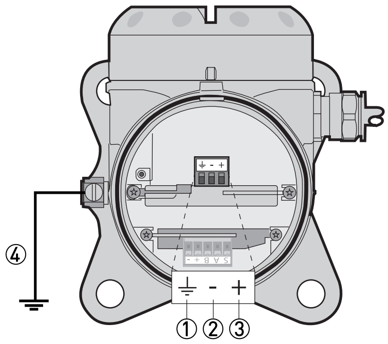


Figure 4-2: Terminals for electrical installation

① Grounding terminal in the housing (if the electrical cable is shielded)
② Current output -
③ Current output +
④ Location of the external grounding terminal (on the wall support)

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

Connections between the remote converter and the probe housing

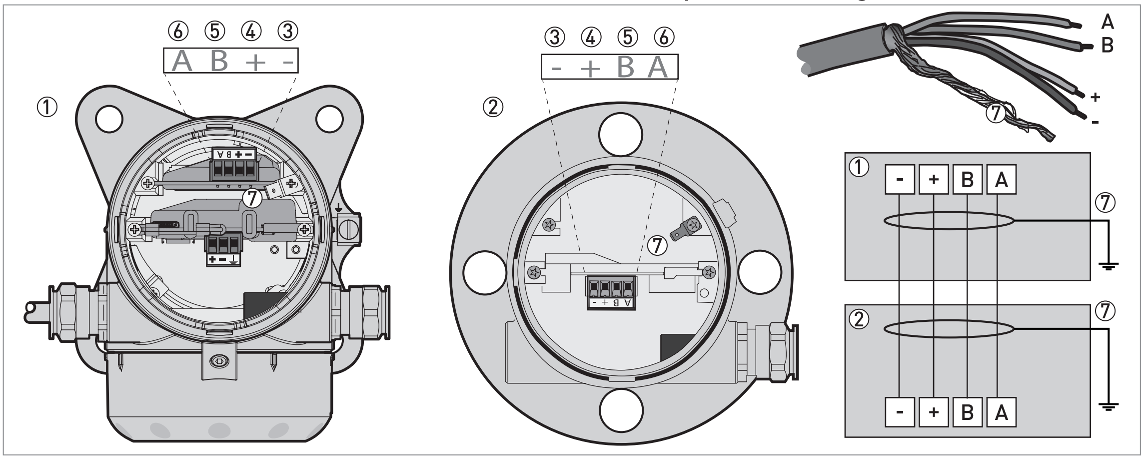


Figure 4-3: Connections between the remote converter and the probe housing

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

For more electrical installation data, refer to *Compact version* on page 42.

4.2 Electrical connection for current output

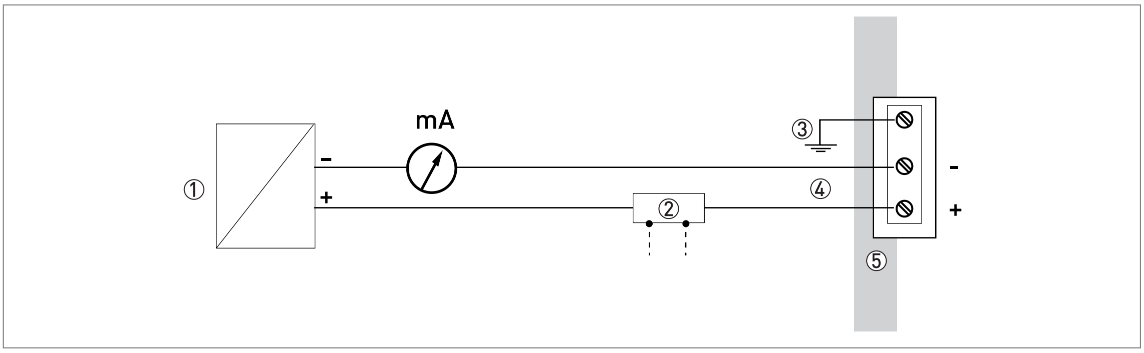


Figure 4-4: Electrical connections

① Power supply
② Optional junction box (ref. SJB 200W) for on-site readings of loop current
③ Optional connection to the grounding terminal
④ Output: 11.5...30 VDC for an output of 22 mA at the terminal
⑤ Device

4.3 Networks

4.3.1 General information

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

The device output is factory-set to communicate point-to-point. To change the communication mode from **point-to-point** to **multi-drop**, refer to "Network configuration" in the handbook.

4.3.2 Point-to-point networks

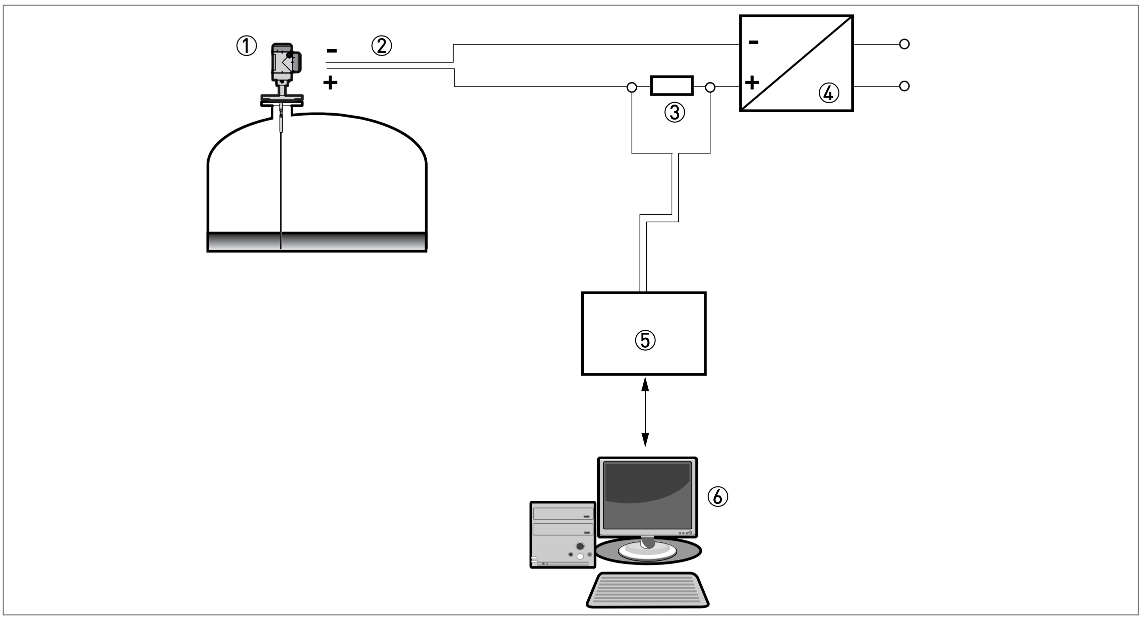


Figure 4-5: Point-to-point connection

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

4.3.3 Multi-drop networks

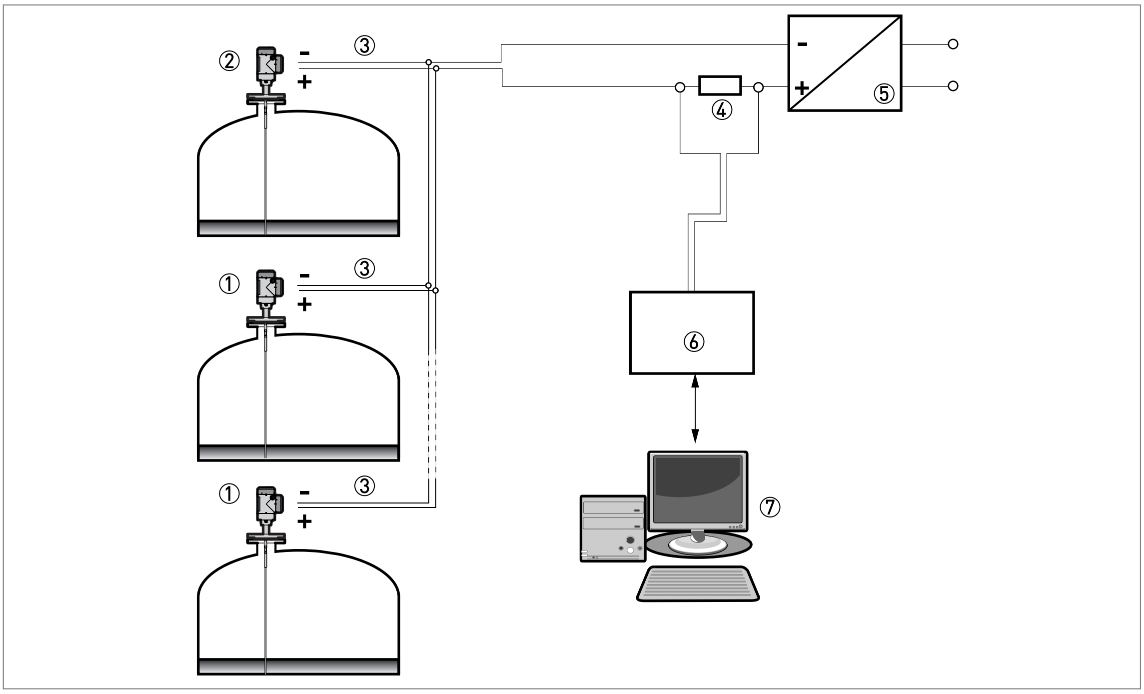


Figure 4-6: Multi-drop network

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

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