IFC 400 Handbook

Signal converter for electromagnetic flowmeters

Electronic revision:
ER 1.0.x

The documentation is only complete when used in combination with the relevant documentation for the flow sensor.

KROHNE

IMPRINT

1.1 Software history

The "Electronic Revision" (ER) is consulted to document the revision status of electronic equipment according to NE 53 for all devices. It is easy to see from the ER whether troubleshooting or larger changes in the electronic equipment have taken place and how that has affected the 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®
	X	all interfaces
3-_	Downwards compatible hardware and/or software change of inputs and outputs:	
	CO	Current output
	FO, PO	Frequency output, pulse output
	SO	Status output
	L	Limit switch
	Ctl	Control input
	X	all inputs and outputs
4	Downwards compatible changes with new functions	
5	Incompatible changes, i.e. electronic equipment must be changed	

Table 1-1: Description of changes

INFORMATION!
In the table below, "x" is a placeholder for possible multi-digit alphanumeric combinations, depending on the available version.

Release date (ER)	Electronic revision (ER)	Changes and compatibility	Documentation
01/2022	ER 1.0.x	Initial version	MA IFC 400 R01

Table 1-2: Changes and effect on compatibility

1.2 Intended use

The electromagnetic flowmeters are designed exclusively to measure the flow and conductivity of electrically conductive, liquid media.

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

WARNING!
If the device is not used according to the operating conditions (refer to chapter "Technical data"), the intended protection could be affected.

INFORMATION!
This device is a Group 1, Class A device as specified within CISPR11. It is intended for use in industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

1.3 Certification

Product marking

Figure 1-1: Examples of marking logo

The manufacturer certifies successful testing of the product by applying the conformity mark on the device.

This device fulfils the statutory requirements of the relevant directives.

For more information on the directives, standards and the approved certifications, please refer to the declaration of conformity supplied with the device or downloadable from the manufacturer's website.

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

1.4 Safety instructions from the manufacturer

1.4.1 Copyright and data protection

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1.4.2 Disclaimer

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

1.4.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation 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.

1.4.4 Information concerning the documentation

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

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer 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.

1.4.5 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.

1.5 Safety instructions for the operator

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

2.1 Scope of delivery

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

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

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.

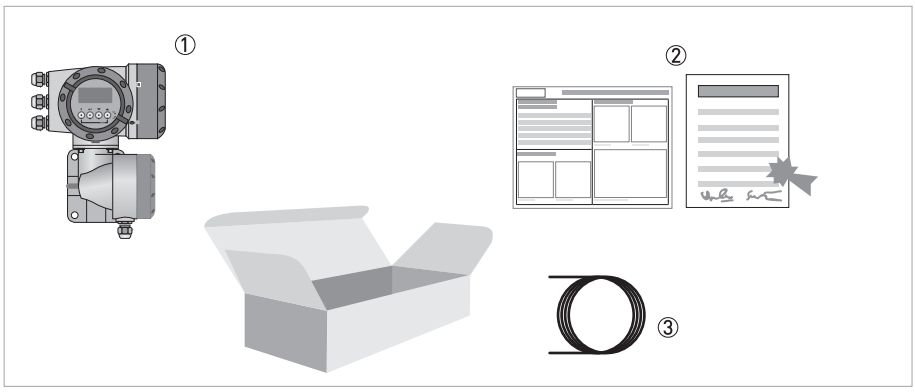


Figure 2-1: Scope of delivery

① Device in the version as ordered
② Product documentation
③ Signal cable (only for remote version)

Flow sensor	Flow sensor + signal converter IFC 400	
	Compact version	Remote field housing
OPTIFLUX 4000	OPTIFLUX 4400 C	OPTIFLUX 4400 F

Table 2-1: Signal converter/flow sensor combination possibilities

2.2 Device description

Electromagnetic flowmeters are designed exclusively to measure the flow and conductivity of electrically conductive, liquid media.

The following versions are available:

- Compact version (the signal converter is mounted directly on the flow sensor)
- Remote version (electrical connection to the flow sensor via field current and signal cable)

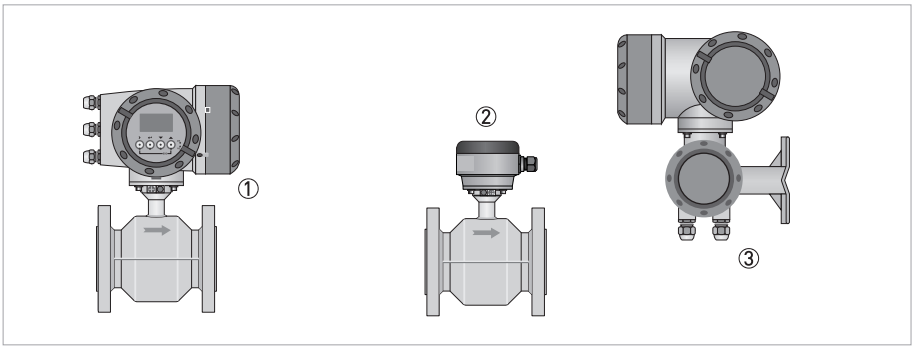


Figure 2-2: Device versions

① Compact version
② Flow sensor with connection box
③ Field housing

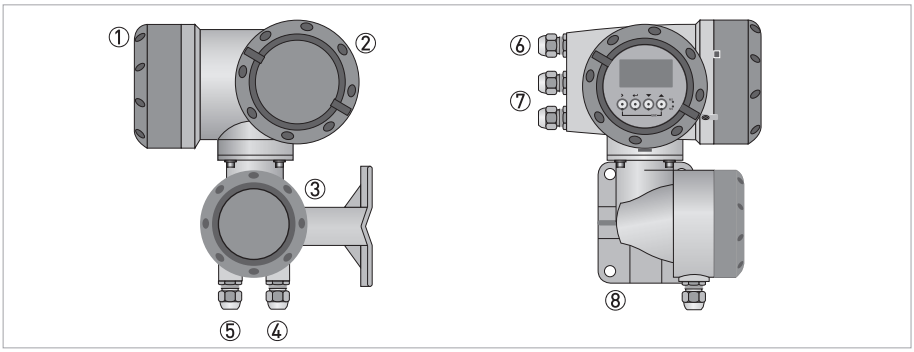


Figure 2-3: Construction of the field housing

① Cover for electronics and display
② Cover for power supply and inputs/outputs terminal compartment
③ Cover for flow sensor terminal compartment
④ Cable entry for flow sensor signal cable
⑤ Cable entry for flow sensor field current cable
⑥ Cable entry for power supply
⑦ Cable entry for inputs and outputs
⑧ Mounting plate for pipe and wall mounting

INFORMATION!
Each time a housing cover is opened, the thread should be cleaned and greased.
Use only resin-free and acid-free grease.
Ensure that the housing gasket is properly fitted, clean and undamaged.

2.3 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.

2.3.1 Description of the nameplate

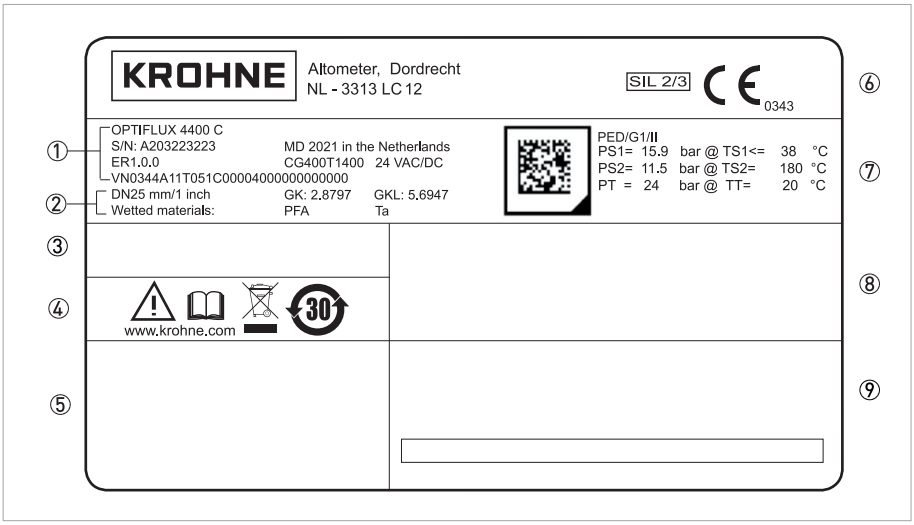


Figure 2-4: Example of a nameplate for a compact version

① Product type
Serial number, manufacturing date and country
Electronic revision (ER), CG number and power supply
Article code
② Size (mm/inch) and GK/GKL values (flow sensor constants)
Wetted materials
③ Approvals-related information: Ex approval (if applicable)
④ Safety instructions, disposal and China RoHs marking
⑤ Approvals-related information: hygienic approvals, etc. (if applicable)
⑥ Approvals-related information: SIL, EC type test certificate, etc. (if applicable)
⑦ Auto ID according to DIN SPEC 91406 and PED data
⑧ Approvals-related data (e.g. accuracy class, temperature and pressure thresholds) (if applicable)
⑨ Custody transfer related information (if applicable)

Auto ID according to DIN SPEC 91406

The auto ID code guides you directly to the PICK server (Product Information Center KROHNE). Scan the code on the nameplate to download all available product documentation and software:

- Handbooks
- Quick Starts
- Supplementary manuals
- Calibration certificates
- Factory settings as .bin file
- Parameter datasheets
- Digital nameplates
- ...

2.3.2 Electrical connection data of inputs and outputs

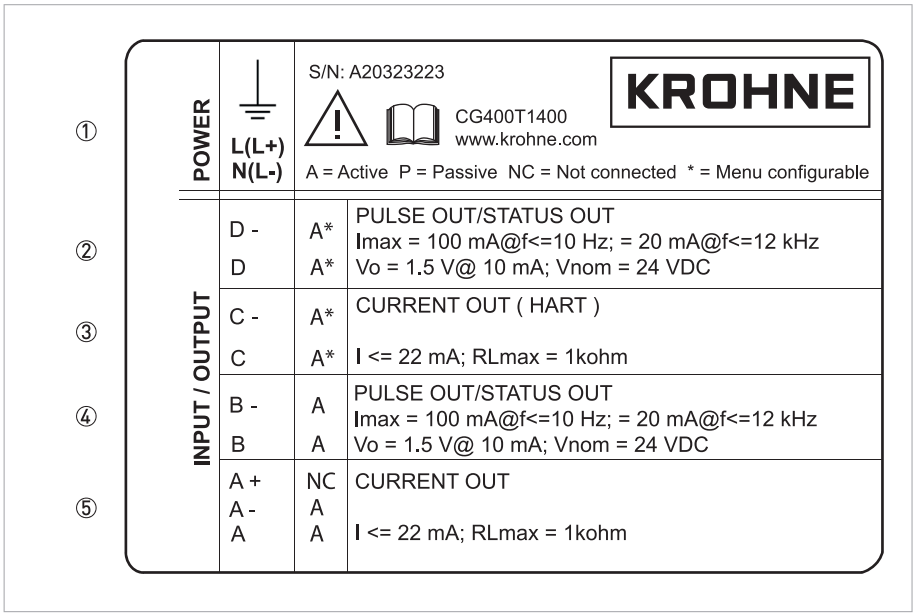


Figure 2-5: Example of a nameplate for electrical connection data of inputs and outputs

① Power supply (230 VAC: L and N; 24 VAC: L+ and L-; 24 DC: + and -)
② Connection data of connection terminal D/D-
③ Connection data of connection terminal C/C-
④ Connection data of connection terminal B/B-
⑤ Connection data of connection terminal A/A-

- A = active mode; the signal converter supplies the power for connection of the subsequent devices
- P = passive mode; external power supply required for operation of the subsequent devices
- NC = connection terminals not connected
- * = Menu configurable; active mode or passive mode marked with * indicates the delivery status. The mode can be changed in menu C2.1.x.

3.1 General notes on installation

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.

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

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

3.2 Storage

- Store the device in a dry, dust-free location.
- Avoid continuous direct sunlight.
- Store the device in its original packing.
- Storage temperature: -40...+70°C / -40...+158°F

3.3 Transport

Signal converter

- No special requirements.

Compact version

- Do not lift the device by the signal converter housing.
- Do not use lifting chains.
- To transport flange devices, use lifting straps. Wrap these around both process connections.

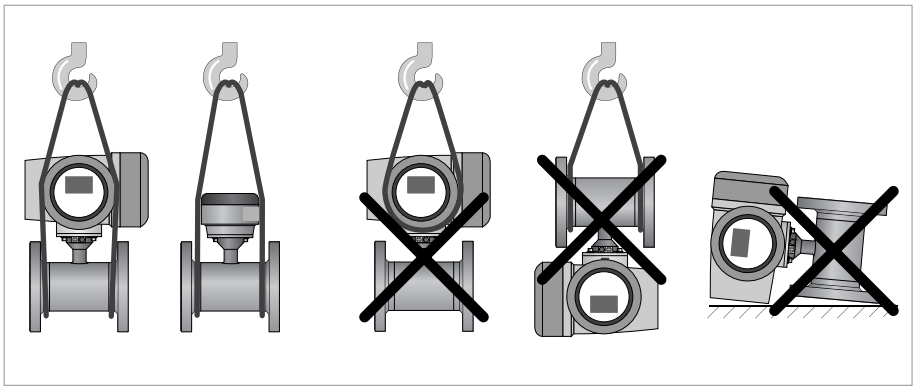


Figure 3-1: Transport

3.4 Installation specifications

INFORMATION!
The following precautions must be taken to ensure reliable installation.

- *Make sure that there is adequate space to the sides.*
- *The device must not be heated by radiated heat (e.g. exposure to the sun) to an electronics housing surface temperature above the maximum permissible ambient temperature. If it is necessary to prevent damage from heat sources, a heat protection (e.g. sunshade) has to be installed.*
- *Signal converters installed in control cabinets require adequate cooling, e.g. by fan or heat exchanger.*
- *Do not expose the signal converter to intense vibrations. The devices are tested for a vibration level as described in the chapter "Technical data".*

3.5 Mounting of the compact version

CAUTION!
Turning the housing of the compact version is not permitted.

INFORMATION!
The signal converter is mounted directly on the flow sensor.
For installation of the flowmeter, please observe the instructions in the supplied product documentation for the flow sensor.

3.6 Mounting the field housing, remote version

CAUTION!
Remarks for sanitary applications

- *To prevent contamination and dirt deposits behind the mounting plate, a cover plug must be installed between the wall and the mounting plate.*
- *Pipe mounting is not suitable for sanitary applications!*

Remarks concerning vibration on process line

Due to excessive vibration impact, the mounting of the signal converter on the process pipe is not allowed.

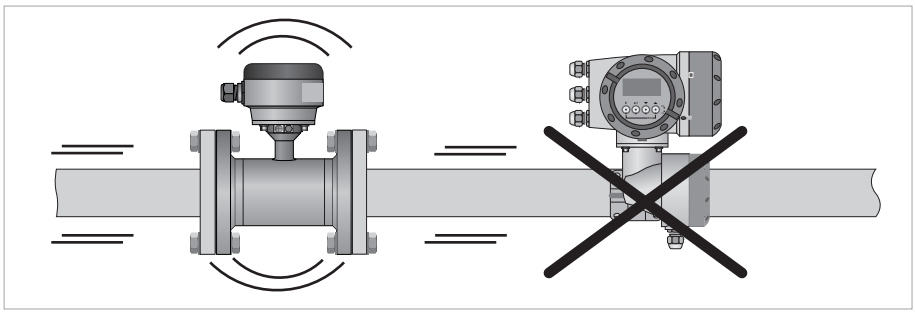


Figure 3-2: Not allowed mounting of the remote signal converter on the process pipe

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

3.6.1 Pipe mounting

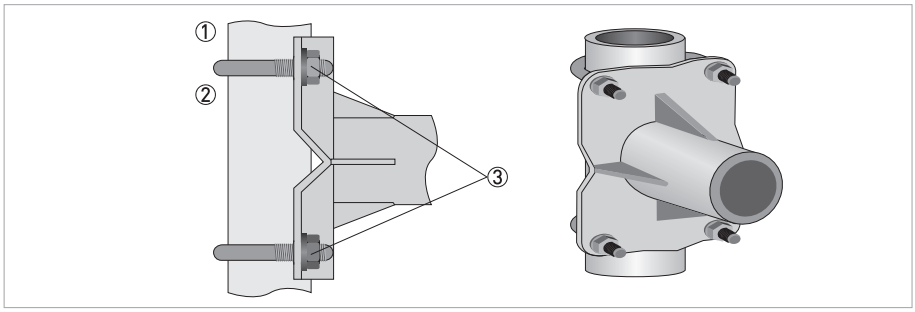


Figure 3-3: Pipe mounting of the field housing

① Fix the mounting bracket of the signal converter to the pipe.
② Fasten the mounting bracket of the signal converter using standard U-bolts and washers.
③ Tighten the nuts.

3.6.2 Wall mounting

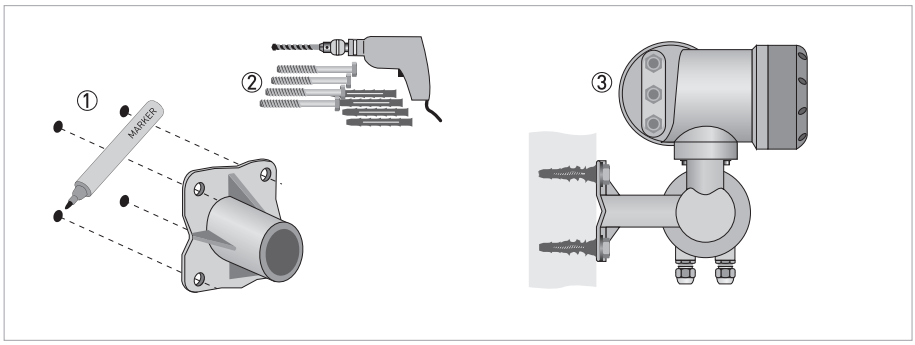


Figure 3-4: Wall mounting of the field housing

① Prepare the holes with the aid of the mounting plate. For further information refer to *Mounting plate of field housing* on page 133.
② Fasten the mounting plate securely to the wall.
③ Screw the mounting bracket of the signal converter to the mounting plate with the nuts and washers.

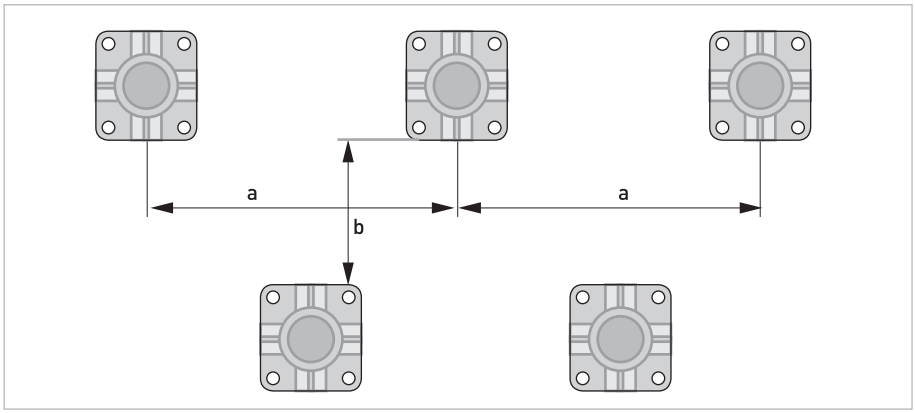


Figure 3-5: Mounting multiple devices next to each other

a ≥ 600 mm / 23.6"
b ≥ 250 mm / 9.8"

3.6.3 Turning the display (field and compact version only)

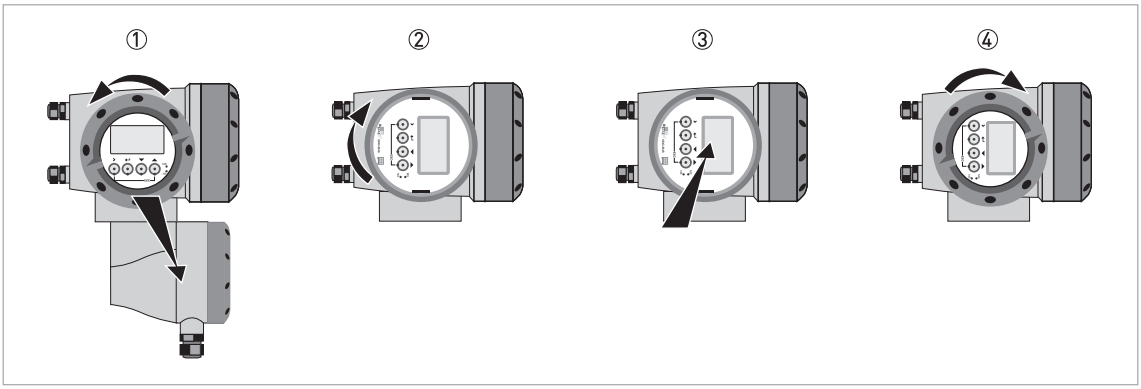


Figure 3-6: Turning the display (field and compact version only)

The display of the field housing version can be turned in 90° increments

① Unscrew the cover from the display and operation control unit.
② Pull out the display and rotate it to the required position.
③ Slide the display back into the housing.
④ Re-fit the cover and tighten it by hand.

CAUTION!
The ribbon cable of the display must not be folded or twisted repeatedly.

INFORMATION!
Each time a housing cover is opened, the thread should be cleaned and greased.
Use only resin-free and acid-free grease.
Ensure that the housing gasket is properly fitted, clean and undamaged.

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 Important notes on electrical connection

DANGER!
Electrical connection is carried out in conformity with the VDE 0100 directive "Regulations for electrical power installations with line voltages up to 1000 V" or equivalent national regulations.

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

CAUTION!
- *Use suitable cable entries for the various electrical cables.*
- *The flow sensor and signal converter have been configured together at the factory.*
  For this reason, please connect the devices in pairs.
  Ensure that the flow sensor serial number (refer to nameplates) is identical.

4.3 Electrical cables for remote device versions, notes

4.3.1 Notes on signal cables A and B

CAUTION!
SIL devices:
Only the signal cable B (BTS 300-3) with triple shield is allowed!

INFORMATION!
The signal cables A (type DS 300) with double shield and B (type BTS 300) with triple shield ensure proper transmission of measured values.

Observe the following notes:

- Lay the signal cable with fastening elements.
- It is permissible to lay the signal cable in water or in the ground.
- The insulating material is flame-retardant.
- The signal cable does not contain any halogens and is unplasticized and remains flexible at low temperatures.
- The connection of the inner shield (10) is carried out via the stranded drain wire (1).
- The connection of the outer shield is carried out via the shield (60) or the stranded drain wire (6), depending on the housing version. Observe the following notes.
- The signal cable type B cannot be used with options with "virtual reference"!

4.3.2 Notes on field current cable C

DANGER!

- *SIL devices:*
  A shielded 3-wire copper cable is required for the field current cable.
  *The shield **MUST** be connected in the housing of the signal converter.*
- *Non-SIL devices:*
  *A shielded field current cable is **not** required.*

INFORMATION!
The field current cable is not part of the scope of delivery.

4.3.3 Requirements for signal cables provided by the customer

CAUTION!
SIL devices:
Only the signal cable B (BTS 300-3) with triple shield is allowed!

INFORMATION!
If the signal cable was not ordered, it is to be provided by the customer.
The following requirements regarding the electrical values of the signal cable must be observed:

Electrical safety

- According to low voltage directive or equivalent national regulations.

Capacitance of the insulated conductors

- Insulated conductor / insulated conductor < 50 pF/m
- Insulated conductor / shield < 150 pF/m

Insulation resistance

- R_{iso} > 100 GΩ x km
- U_{max} < 24 V
- I_{max} < 100 mA

Test voltages

- Insulated conductor / inner shield 500 V
- Insulated conductor / insulated conductor 1000 V
- Insulated conductor / outer shield 1000 V

Twisting of the insulated conductors

- At least 10 twists per meter, important for screening magnetic fields.

4.4 Preparing the signal and field current cables

CAUTION!
SIL devices:
The DS 300 signal cable cannot be used for SIL devices.

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

The electrical connection of the outer shield is different for the various housing variants. Please observe the corresponding instructions.

4.4.1 Signal cable A (type DS 300), construction

- Signal cable A is a double-shielded cable for signal transmission between the flow sensor and signal converter.
- Bending radius: ≥ 50 mm / 2"

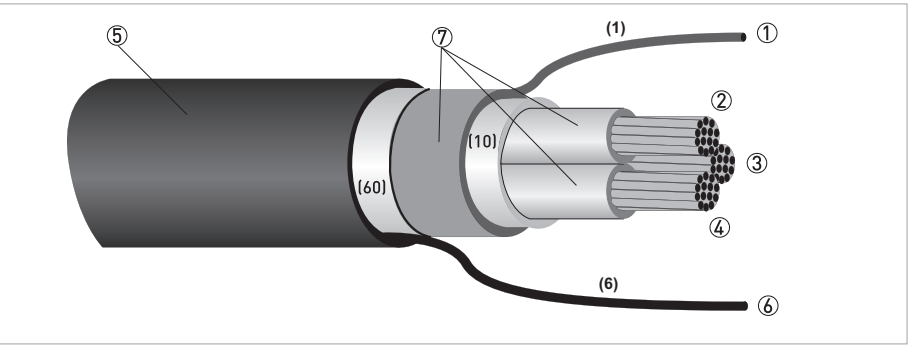


Figure 4-1: Construction of signal cable A

① Stranded drain wire (1) for the inner shield (10), 1.0 mm² Cu / AWG 17 (not insulated, bare)
② Insulated wire, 0.5 mm² Cu / AWG 20
③ Insulated wire, 0.5 mm² Cu / AWG 20
④ Insulated wire, 0.5 mm² Cu / AWG 20
⑤ Outer sheath
⑥ Stranded drain wire (6) for the outer shield (60)
⑦ Insulation layers

4.4.2 Preparing the signal cable A

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

- Bending radius: ≥ 50 mm / 2"

Required materials for flow sensor (1x) and signal converter (1x):

- 2x PVC insulating tube, Ø2.5 mm / 0.1"
- 2x heat-shrinkable tubing
- 2x wire end ferrule to DIN 46228: E 1.5-8 for the stranded drain wire (1)
- 2x 3 wire end ferrules to DIN 46228: E 0.5-8 for the insulated conductors (2, 3, 4)

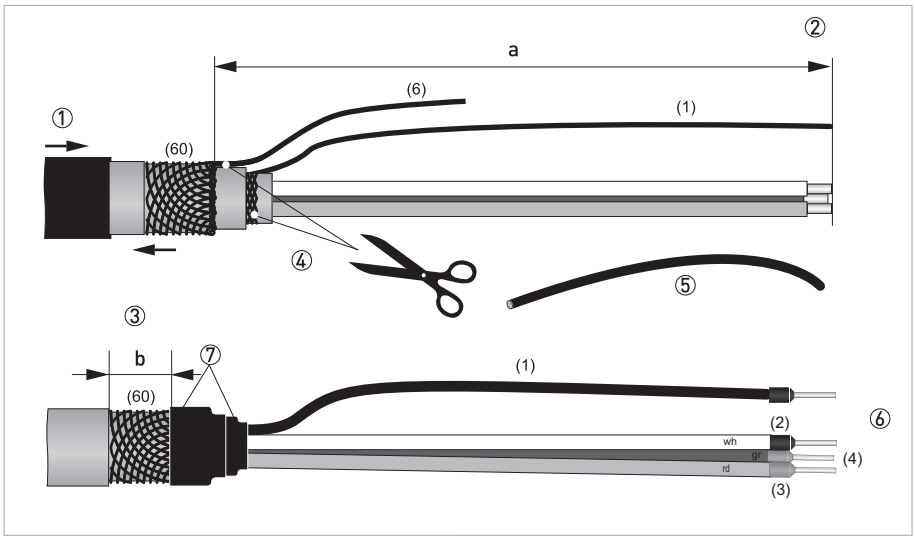


Figure 4-2: Preparing the signal cable A for the field housing of the signal converter and the connection box of the flow sensor

$a_{Signal\ converter}$ = 80 mm / 3.15"; $a_{Flow\ sensor}$ = 50 mm / 2"; b = 10 mm / 0.4"
Wire coding: wh = white; rd = red; gr = green

① Pull the heat-shrinkable tubing over the signal cable.
② Strip the conductor to dimension a.
③ Trim the outer shield to dimension b and pull it over the outer sheath.
④ Remove the stranded drain wire (6) of the outer shield and the inner shield. Make sure not to damage the stranded drain wire (1).
⑤ Slide the insulating tube over the stranded drain wire (1).
⑥ Crimp the wire end ferrules onto the conductors (2), (3) and (4) and stranded drain wire (1).
⑦ Shrink the heat-shrinkable tubing.
⑧ The outer shield (60) is connected in the terminal compartment directly via the shield and a clip.

4.4.3 Length of signal cable A

INFORMATION!
For temperatures of the medium above 150°C / 300°F, a special signal cable and a ZD intermediate socket are necessary. These are available including the changed electrical connection diagrams.

Flow sensor	Nominal size		Min. electrical conductivity [µS/cm]	Curve for signal cable A
	DN [mm]	[inch]		
OPTIFLUX 4000 F	2.5...150	1/10...6	1	A1
	200...2000	8...80	1	A2

Table 4-1: Length of signal cable A

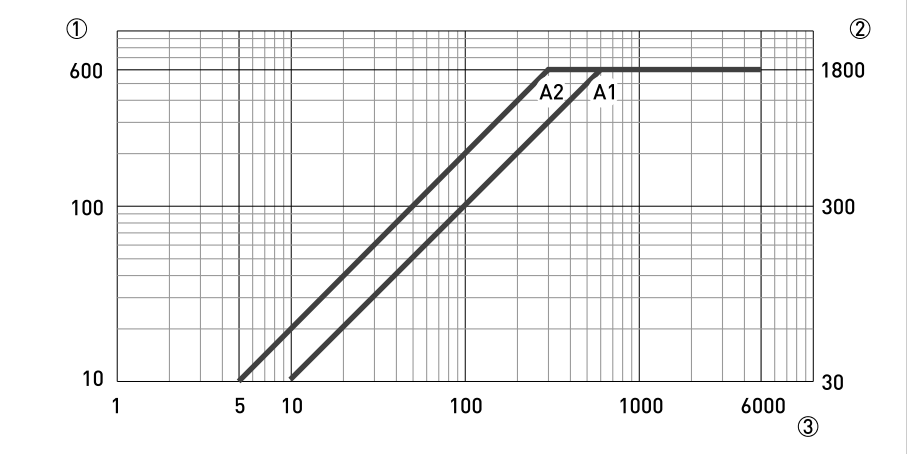


Figure 4-3: Maximum length of signal cable A

① Maximum length of signal cable A between the flow sensor and signal converter [m]
② Maximum length of signal cable A between the flow sensor and signal converter [ft]
③ Electrical conductivity of the medium being measured [µS/cm]

4.4.4 Signal cable B (type BTS 300), construction

CAUTION!
SIL devices:
For cable lengths > 50 m / 164 ft used with SIL devices refer to the "OPTIFLUX x400 Safety manual".

- Signal cable B is a triple-shielded cable for signal transmission between the flow sensor and signal converter.
- Bending radius: ≥ 50 mm / 2"

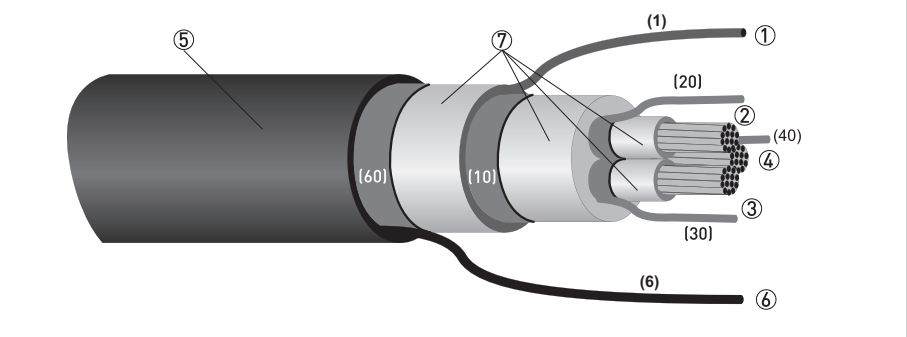


Figure 4-4: Construction of signal cable B

① Stranded drain wire (1) for the inner shield (10), 1.0 mm^2 Cu / AWG 17 (not insulated, bare)
② Insulated wire (2), 0.5 mm^2 Cu / AWG 20 with stranded drain wire (20) of shield
③ Insulated wire (3), 0.5 mm^2 Cu / AWG 20 with stranded drain wire (30) of shield
④ Insulated wire (4), 0.5 mm^2 Cu / AWG 20 with stranded drain wire (40) of shield
⑤ Outer sheath
⑥ Stranded drain wire (6) for the outer shield (60), 0.5 mm^2 Cu / AWG 20 (not insulated, bare)
⑦ Insulation layers

4.4.5 Preparing the signal cable B

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

- Bending radius: ≥ 50 mm / 2"

Required materials for flow sensor (1x) and signal converter (1x):

- 2x PVC insulating tube, Ø2.0...2.5 mm / 0.08...0.1"
- 2x heat-shrinkable tubing
- 2x wire end ferrule to DIN 46228: E 1.5-8 for the stranded drain wire (1)
- 2x 6 wire end ferrules to DIN 46228: E 0.5-8 for the insulated conductors 2, 3 and 4 and the stranded drain wires (20, 30, 40)

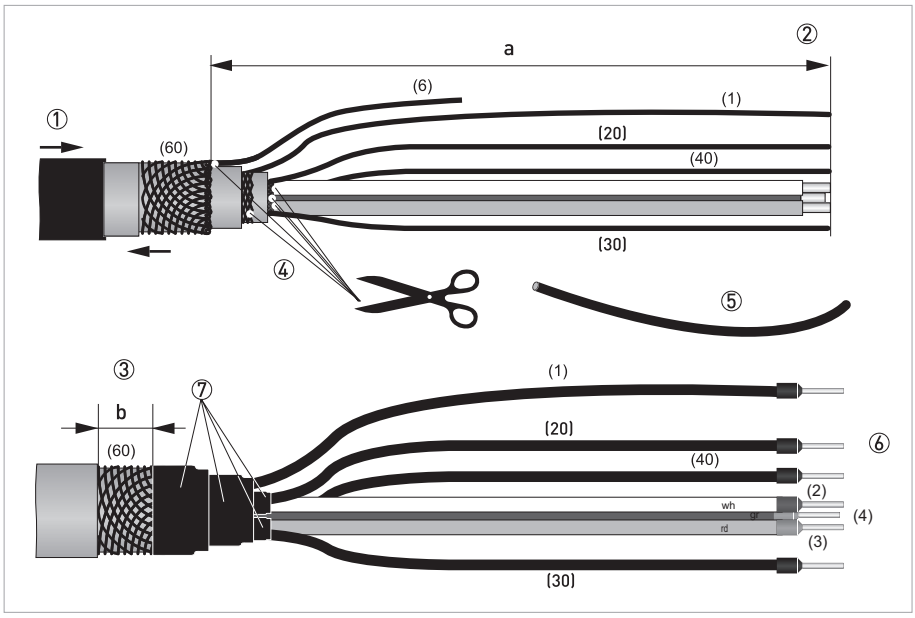


Figure 4-5: Preparing the signal cable B for the field housing of the signal converter and the connection box of the flow sensor

$a_{Signal\ converter}$ = 80 mm / 3.15"; $a_{Flow\ sensor}$ = 50 mm / 2"; b = 10 mm / 0.4"
Wire coding: wh = white; rd = red; gr = green

① Pull the heat-shrinkable tubing over the signal cable.
② Strip the conductor to dimension a.
③ Trim the outer shield (60) to dimension b and pull it over the outer sheath.
④ Remove the inner shield, the stranded drain wire (6) and the shields of the insulated conductors. Make sure not to damage the stranded drain wires (1), (20), (30), (40).
⑤ Slide the insulating tube over the stranded drain wires (1), (20), (30), (40).
⑥ Crimp the wire end ferrules onto the conductors and stranded drain wires.
⑦ Shrink the heat-shrinkable tubing.
⑧ The outer shield (60) is connected in the terminal compartment directly via the shield and a clip.

4.4.6 Length of signal cable B

CAUTION!
SIL devices:
For cable lengths > 50 m / 164 ft used with SIL devices refer to the "OPTIFLUX x400 Safety manual".

INFORMATION!
For temperatures of the medium above 150°C / 300°F, a special signal cable and a ZD intermediate socket are necessary. These are available including the changed electrical connection diagrams.

Flow sensor	Nominal size		Min. electrical conductivity [µS/cm]	Curve for signal cable B
	DN [mm]	[inch]		
OPTIFLUX 4000 F	2.5...6	1/10...1/6	10	B1
	10...150	3/8...6	1	B3
	200...2000	8...80	1	B4

Table 4-2: Length of signal cable B

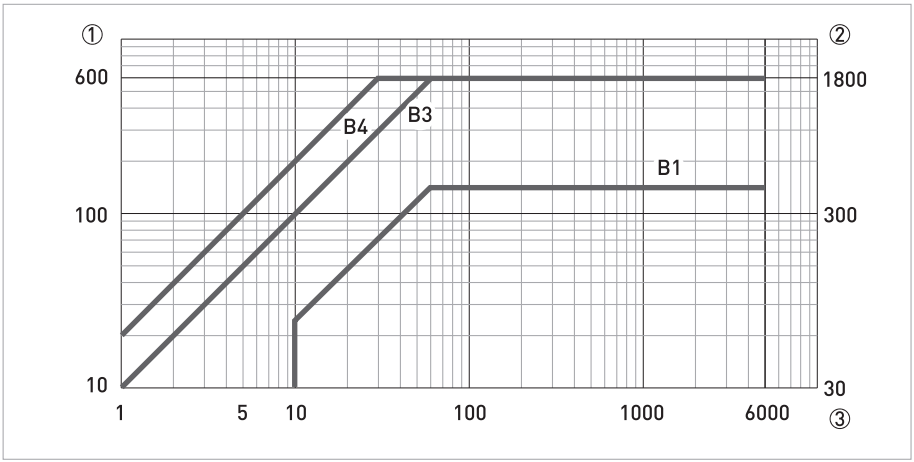


Figure 4-6: Maximum length of signal cable B

① Maximum length of signal cable B between the flow sensor and signal converter [m]
② Maximum length of signal cable B between the flow sensor and signal converter [ft]
③ Electrical conductivity of the medium being measured [µS/cm]

4.4.7 Preparing the field current cable C

DANGER!

- *SIL devices:*
  A shielded 3-wire copper cable is required for the field current cable.
  *The shield **MUST** be connected in the housing of the signal converter.*
- *Non-SIL devices:*
  *A shielded field current cable is **not** required.*

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

- Field current cable C is not part of the scope of delivery.
- Bending radius: ≥ 50 mm / 2"

Required materials for flow sensor (1x) and signal converter (1x):

- For **SIL devices**: 1x shielded 3-wire copper cable with suitable heat-shrinkable tubing
- For **non-SIL devices**: 1x either non-shielded or shielded 3-wire copper cable with suitable heat-shrinkable tubing
- 2x 3 wire end ferrules to DIN 46228: size according to the cable being used

Length		Cross-section A_F (Cu)	
[m]	[ft]	[mm^2]	[AWG]
0...150	0...492	3 x 0.75 Cu ①	3 x 18
150...300	492...984	3 x 1.5 Cu ①	3 x 14
300...600	984...1968	3 x 2.5 Cu ①	3 x 12

Table 4-3: Length and cross-section of field current cable C

① Cu = copper cross-section

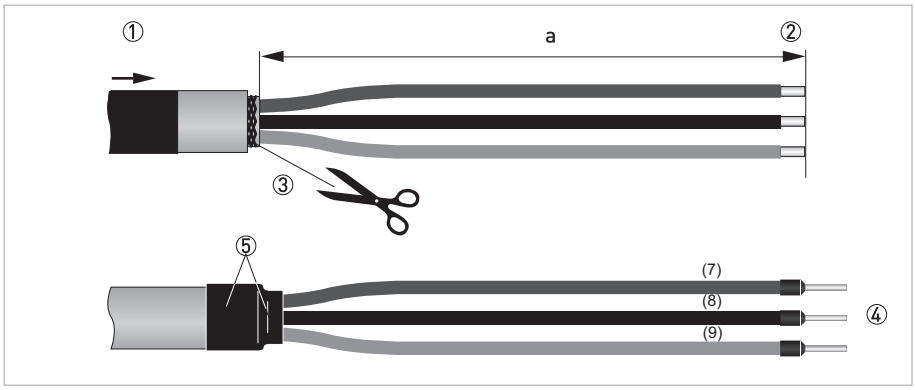


Figure 4-7: Preparing the field current cable C for the field housing of the signal converter and the connection box of the flow sensor

$a_{Signal\ converter}$ = 80 mm / 3.15"; $a_{Flow\ sensor}$ = 50 mm / 2"

① Pull the heat-shrinkable tubing over the field current cable.
② Strip the conductor to dimension a.
③ **SIL devices:** Strip the shield to the necessary length.
Non-SIL devices: remove any shield that is present.
④ Crimp the wire end ferrules onto the conductors (7), (8) and (9).
⑤ Shrink the heat-shrinkable tubing.

4.5 Connecting the signal and field current cables

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

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

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.

4.5.1 Connecting the signal and field current cables, field housing

- The outer shield of signal cable A and/or B is connected electrically with the housing via the clip of the strain relief.
- **SIL devices:** The shielded field current cable **MUST** be connected in the housing of the signal converter.
  Non-SIL devices: if a shielded field current cable is used, the shield must **NOT** be connected in the housing of the signal converter.
- Bending radius: ≥ 50 mm / 2"

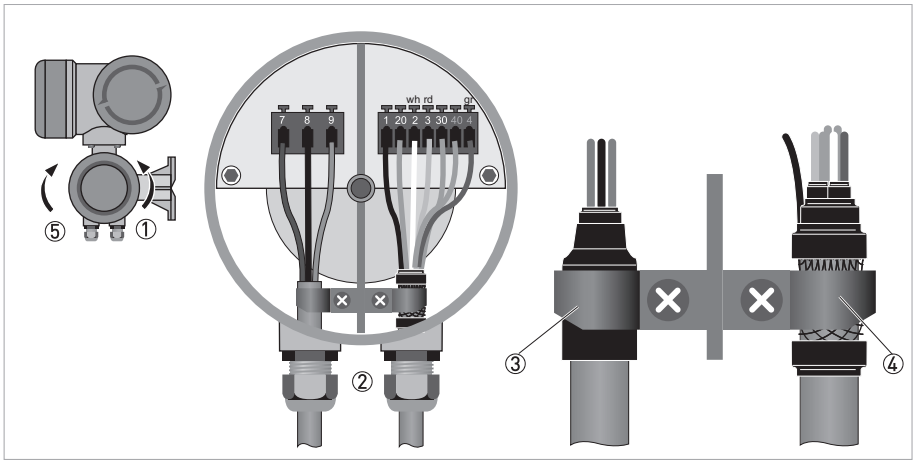


Figure 4-8: Electrical connection of the signal and field current cables, field housing

Wire coding: wh = white; rd = red; gr = green

① Unscrew the terminal compartment cover.
② Pass the prepared signal and field current cables through the cable entries and connect the corresponding stranded drain wires and conductors.
③ Secure the field current cable using the clip.
For SIL devices the shield MUST be connected.
④ Secure the signal cable using the clip. This also connects the outer shield to the housing.
⑤ Re-fit the cover and tighten it by hand.

INFORMATION!
Each time a housing cover is opened, the thread should be cleaned and greased.
Use only resin-free and acid-free grease.
Ensure that the housing gasket is properly fitted, clean and undamaged.

4.5.2 Connection diagram for flow sensor, field housing

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

- **SIL devices:**
  A shielded 3-wire copper cable is required for the field current cable.
  The shield **MUST** be connected in the housing of the signal converter.
- **Non-SIL devices:**
  A shielded field current cable is **not** required.
- The outer shield of signal cable A or B in the signal converter housing is connected via the strain relief terminal.
- Bending radius of signal and field current cable: ≥ 50 mm / 2"
- The following illustration is schematic. The positions of the electrical connection terminals may vary depending on the device variant.

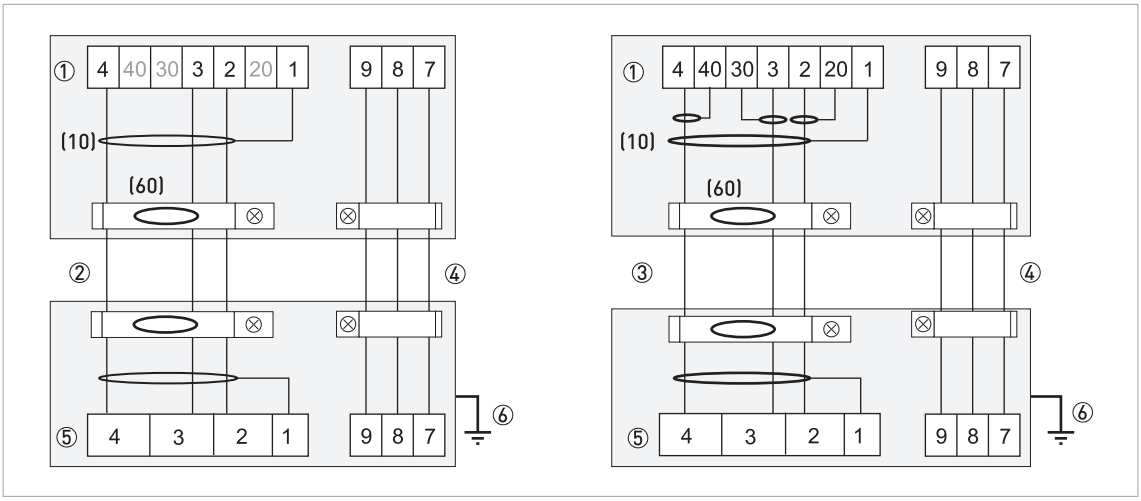


Figure 4-9: Connection diagram for flow sensor in combination with field housing

① Electrical terminal compartment in housing of the signal converter for signal and field current cable
② Signal cable A (type DS 300)
③ Signal cable B (type BTS 300)
④ Field current cable C
⑤ Connection box of flow sensor
⑥ Functional ground FE
(10) inner cable shield
(60) outer cable shield

4.6 Grounding the flow sensor

4.6.1 Classical method

CAUTION!
There should be no difference in potential between the flow sensor and the housing or protective earth of the signal converter!

- The flow sensor must be properly grounded.
- The grounding cable should not transmit any interference voltages.
- Do not use the grounding cable to connect any other electrical devices to ground at the same time.
- In hazardous areas, grounding is used at the same time for equipotential bonding. Additional grounding instructions are provided in the supplementary "Ex documentation", which are only supplied together with hazardous area equipment.
- The flow sensors are connected to ground by means of a functional grounding conductor FE.
- Special grounding instructions for the various flow sensors are provided in the separate documentation for the flow sensor.
- The documentation for the flow sensors also contains descriptions on how to use grounding rings and how to install the flow sensor in metal or plastic pipes or in pipes which are coated on the inside.

4.6.2 Virtual reference

For pipelines which are electrically insulated on the inside (e.g. have an inner liner or are made completely out of plastic), it is also possible to measure without additional grounding rings or electrodes. This virtual reference feature is available as a buyable feature.

The signal converter's input amplifier records the potentials of both measuring electrodes and a patented method is used to create a voltage which corresponds to the potential of the ungrounded medium. This voltage is then the reference potential for signal processing.
That means there are no interfering potential differences between the reference potential and the measuring electrodes during signal processing. Ungrounded use is also possible for systems with voltages and currents in the pipelines, e. g. electrolysis and galvanic systems.

INFORMATION!
Virtual reference cannot be activated in SIL mode.

Size	≥ DN10/ ≥ 3/8"
Electrical conductivity	≥200 µS/cm
Signal cable	use only A (type DS 300)
Signal cable length	≤ 50 m / ≤ 150 ft

Table 4-4: Limits for measurement with the virtual reference

4.7 Power supply connection

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

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

- The ingress protection depends on the available housing versions.
- The housings of the devices, which are designed to protect the electronic equipment from dust and moisture, should be kept well closed at all times. Creepage distances and clearances are dimensioned to VDE 0110 and IEC 60664 for pollution severity 2.
  Supply circuits are designed for overvoltage category III and the output circuits for overvoltage category II.
- Fuse protection ($I_N \leq 16$ A) for the infeed power circuit, as well as a separator (switch, circuit breaker) to isolate the signal converter should be provided for the device in accordance with applicable regulations.
  The separator must be marked as the separator for this device.

100...230 VAC (tolerance range: -15% / +10%)

- Note the power supply voltage and frequency (50...60 Hz) on the nameplate.
- Colour of connector: green

24 VAC/DC (tolerance range: AC: -15% / +10%; DC: -55% / +30%)

- AC: Note the power supply voltage and frequency (50...60 Hz) on the nameplate.
- DC: Note the power supply voltage on the nameplate.
- Colour of connector: red
- 24 VAC/DC OVCIII, test voltage 1400 VAC

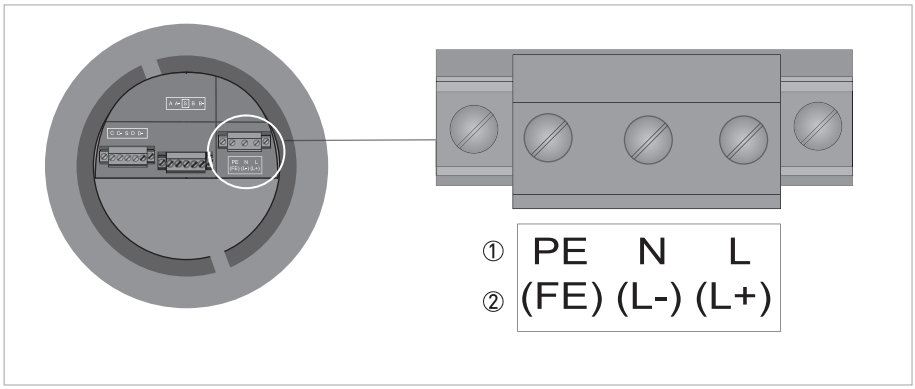


Figure 4-10: Power supply connection

① 100...230 VAC (-15% / +10%), 22 VA
② 24 VAC/DC (AC: -15% / +10%; DC: -55% / +30%), 22 VA or 12 W

4.8 Inputs and outputs, overview

4.8.1 Combinations of the inputs/outputs (I/Os)

This signal converter is available with various input/output combinations.

Ex i version

- Depending on the task, the device can be configured with various output modules.
- Current outputs can be active or passive.

Modular version

- Depending on the task, the device can be configured with various output modules.

Ex option

- For hazardous areas, all of the input/output variants for the housing designs C and F with terminal compartment in the Ex d (pressure-resistant casing) or Ex e (increased safety) versions can be delivered.
- Please refer to the separate instructions for connection and operation of the Ex devices.

4.8.2 Description of the CG number

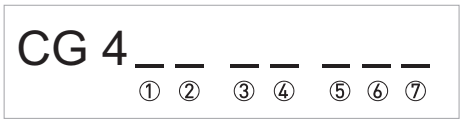


Figure 4-11: Marking (CG number) of the electronics module and input/output options

① ID number: 0
② ID number: 0 = standard; 9 = special
③ Power supply option / flow sensor option
④ Display option
⑤ Input/output option (I/O)
⑥ 1st optional module for connection terminal A
⑦ 2nd optional module for connection terminal B

The last 3 digits of the CG number (⑤, ⑥ and ⑦) indicate the assignment of the terminal connections. Please refer to the following examples.

CG 400 31 4AC	100...230 VAC & advanced HMI; modular I/O: I_a & P_a/S_a
CG 400 T1 320	24 VAC/DC & advanced HMI; I_p & P_N/S_N and Ex i option I_p & P_p/C_p

Table 4-5: Examples for CG number

Marking for ③	Power supply options
1...6	Standard: 100...230 VAC (-15% / +10%), 50/60 Hz
R...W	Option: 24 VAC/DC (AC: -15% / +10%, 50/60 Hz; DC: -55% / +30%)

Table 4-6: Power supply options

Marking for ④	Display options
G...L	Standard display
1...4	Advanced display with additional mechanical keys, Bluetooth® interface (optional), colour status backlight and real time clock for logging

Table 4-7: Display options

Abbreviation	Identifier for CG no.	Description
I_a	A	Active current output
I_p	B	Passive current output
P_a / S_a	C	Active pulse output, frequency output, status output or limit switch (changeable)
P_p / S_p	E	Passive pulse output, frequency output, status output or limit switch (changeable)
P_N / S_N	F	Passive pulse output, frequency output, status output or limit switch according to NAMUR (changeable)
C_a	G	Active control input
C_p	K	Passive control input
C_N	H	Active control input to NAMUR Signal converter monitors cable breaks and short circuits according to IEC 60947-5-6.
-	8	No additional module installed
-	0	No further module possible

Table 4-8: Description of abbreviations and CG identifier for possible optional modules on terminals A and B

4.8.3 Fixed, non-alterable input/output versions

This signal converter is available with various input/output combinations.

- The grey boxes in the tables denote unassigned or unused connection terminals.
- In the table, only the final digits of the CG number are depicted.

CG no.	Connection terminals							
	A	A-	B	B-	C	C-	D	D-
Ex i I/Os (option)								
2 0 0					I_a + HART® active		P_N / S_N NAMUR ①	
3 0 0					I_p + HART® passive		P_N / S_N NAMUR ①	
2 1 0	I_a active		P_N / S_N NAMUR C_p passive ①		I_a + HART® active		P_N / S_N NAMUR ①	
3 1 0	I_a active		P_N / S_N NAMUR C_p passive ①		I_p + HART® passive		P_N / S_N NAMUR ①	
2 2 0	I_p passive		P_N / S_N NAMUR C_p passive ①		I_a + HART® active		P_N / S_N NAMUR ①	
3 2 0	I_p passive		P_N / S_N NAMUR C_p passive ①		I_p + HART® passive		P_N / S_N NAMUR ①	

Table 4-9: Fixed, non-alterable input/output versions
① Menu configurable

4.8.4 Alterable input/output versions

This signal converter is available with various input/output combinations.

- In the table, only the final digits of the CG number are depicted.
- The signal converter is delivered preset with respect to active / passive / NAMUR according to the customer order.

CG no.	Connection terminals							
	A	A-	B	B-	C	C-	D	D-
Modular I/Os (option)								
4 _ _	max. 2 optional modules for terminal A + B				I + HART® active/passive ①		P/S active/passive/ NAMUR ①	

Table 4-10: Alterable input/output versions
① Software configurable

4.9 Description of the inputs and outputs

4.9.1 Current output

INFORMATION!
The current outputs must be connected depending on the version! The I/O version and inputs/outputs installed in the signal converter are indicated on the sticker in the cover of the terminal compartment.

For Modular I/Os, the current output at terminal C must be configured to active/passive before connecting it.

- All outputs are electrically isolated from each other and from all other circuits.
- All operating data and functions can be adjusted.
- Passive mode:
  External power $V_{ext} \leq 30$ VDC at $I \leq 22$ mA
- Active mode:
  Load impedance $R_L \leq 1$ kΩ at $I \leq 22$ mA;
  $R_L \leq 400$ Ω at $I \leq 22$ mA for Ex i outputs
- Current output at terminal C (active and passive): minimum load is 250 Ohm
- Self-monitoring: interruption or load impedance too high in the current output loop
- Error message possible via status output, error indication on LC display.
- Current value error detection can be adjusted.

INFORMATION!
For further information refer to Connection diagrams of inputs and outputs on page 46 and refer to *Technical data on page 123*.

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

4.9.2 Pulse output and frequency output

INFORMATION!
Depending on the version, the pulse and frequency outputs must be connected passively or actively or according to IEC 60947-5-6 (NAMUR)! The I/O version and inputs/outputs installed in the signal converter are indicated on the sticker in the cover of the terminal compartment.

For Modular I/Os, the pulse output or frequency output at terminal D must be configured to active/passive/NAMUR before connecting it.

- All outputs are electrically isolated from each other and from all other circuits.
- All operating data and functions can be adjusted.
- Passive mode:
  External power supply required: $V_{ext} \leq 32$ VDC;
  $I \leq 20$ mA at $f \leq 10$ kHz (over range up to $f_{max} \leq 12$ kHz);
  $I \leq 100$ mA at $f \leq 100$ Hz
- Active mode:
  Use of the internal power supply: $V_{nom} = 24$ VDC;
  $I \leq 20$ mA at $f \leq 10$ kHz (over range up to $f_{max} \leq 12$ kHz)
- NAMUR mode:
  Passive in accordance with IEC 60947-5-6;
  $f \leq 5$ kHz
- Scaling:
  Frequency output: in pulses per time unit (e.g. 1000 pulses/s at $Q_{100\%}$);
  Pulse output: value per pulse.
- Pulse width:
  - symmetric (pulse duty factor 1:1, independent of output frequency)
  - automatic (with fixed pulse width, duty factor approx. 1:1 at $Q_{100\%}$)
  - fixed (configurable pulse width which must be below 50% of configured inverse max. pulse rate)
- All pulse and frequency outputs can also be used as a status output / limit switch.

INFORMATION!
For further information refer to Connection diagrams of inputs and outputs on page 46 and refer to *Technical data on page 123*.

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

4.9.3 Status output and limit switch

INFORMATION!
Depending on the version, the status outputs and limit switches must be connected passively or actively or according to IEC 60947-5-6 (NAMUR)! The I/O version and inputs/outputs installed in the signal converter are indicated on the sticker in the cover of the terminal compartment.

For Modular I/Os, the status output at terminal D must be configured to active/passive/NAMUR before connecting it.

- The status outputs / limit switches are electrically isolated from each other and from all other circuits.
- The output stages of the status outputs / limit switches during simple active or passive operation behave like relay contacts and can be connected with any polarity.
- Passive mode:
  External power supply required: $V_{ext} \leq 32$ VDC at $I \leq 100$ mA
- Active mode:
  Use of the internal power supply: $V_{nom} = 24$ VDC at $I \leq 20$ mA
- NAMUR mode:
  Passive in accordance with IEC 60947-5-6

INFORMATION!
For further information refer to Connection diagrams of inputs and outputs on page 46 and refer to *Technical data on page 123*.

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

4.9.4 Control input

INFORMATION!
Depending on the version, the control inputs must be connected passively or actively or according to IEC 60947-5-6 (NAMUR)! The I/O version and inputs/outputs installed in the signal converter are indicated on the sticker in the cover of the terminal compartment.

- All control inputs are electrically isolated from each other and from all other circuits.
- All operating data and functions can be adjusted.
- Passive mode:
  External power supply required: $V_{ext} \leq 32$ VDC
- Active mode:
  Use of the internal power supply: $V_{nom} = 24$ VDC
- NAMUR mode:
  Passive in accordance with IEC 60947-5-6;
  Active control input to IEC 60947-5-6 (NAMUR): signal converter monitors cable breaks and short circuits according to IEC 60947-5-6.
  Errors indicated on LC display. Error messages possible via status output.
- For information on the adjustable operating states refer to *Function tables* on page 71.

INFORMATION!
For further information refer to Connection diagrams of inputs and outputs on page 46 and refer to *Technical data on page 123*.

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

4.10 Electrical connection of the inputs and outputs

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

4.10.1 Field housing, electrical connection of the inputs and outputs

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!

Terminal	Description
A, B, C, D	Positive pole for I/O terminal
A-, B-, C-, D-	Negative pole for I/O terminal
S	Shield connection

Table 4-11: Terminal description

The I/Os depend on the ordered option.
For further information refer to *Fixed, non-alterable input/output versions* on page 39 and refer to *Alterable input/output versions* on page 39.

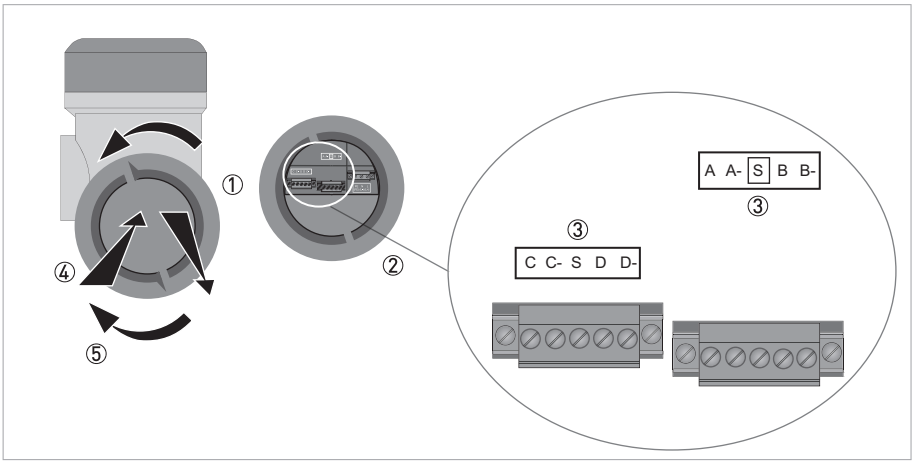


Figure 4-12: Terminal compartment for inputs and outputs in field housing

① Open the housing cover
② Push the prepared cable through the cable entry and connect the necessary conductors.
③ Connect the shield if necessary. Tighten all screws of the clamps.
④ Close the cover of the terminal compartment.
⑤ Close the housing cover.

INFORMATION!
Each time a housing cover is opened, the thread should be cleaned and greased.
Use only resin-free and acid-free grease.
Ensure that the housing gasket is properly fitted, clean and undamaged.

4.10.2 Laying electrical cables correctly

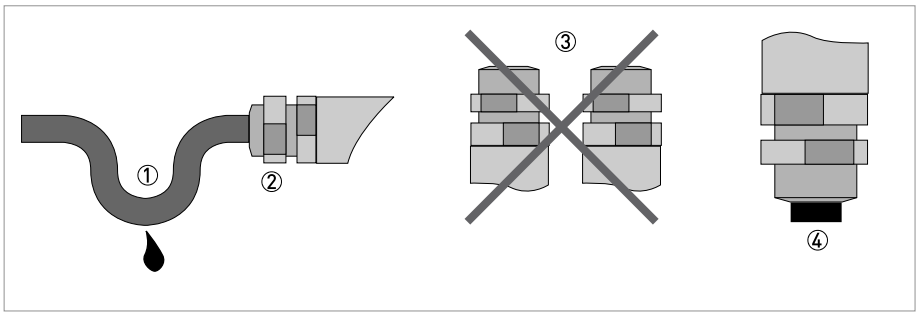


Figure 4-13: Protect housing from dust and water

① Lay the cable in a loop just before the housing.
② Tighten the screw connection of the cable entry securely.
③ Never mount the housing with the cable entries facing upwards.
④ Seal cable entries that are not needed with a plug.

4.11 Connection diagrams of inputs and outputs

4.11.1 Important notes

INFORMATION!
Depending on the version, the inputs/outputs must be connected passively or actively or according to IEC 60947-5-6 (NAMUR)! The I/O version and inputs/outputs installed in the signal converter are indicated on the sticker in the cover of the terminal compartment.

- All groups are electrically isolated from each other and from all other input and output circuits.
- Passive mode: An external power supply is necessary to operate (activation) the subsequent devices (V_{ext}).
- Active mode: The signal converter supplies the power for operation (activation) of the subsequent devices, observe max. operating data.
- Terminals that are not used should not have any conductive connection to other electrically conductive parts.

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

I_a	I_p	Current output active or passive
P_a	P_p	Pulse/frequency output active or passive
P_N		Pulse/frequency output passive according to IEC 60947-5-6 (NAMUR)
S_a	S_p	Status output/limit switch active or passive
S_N		Status output/limit switch passive according to IEC 60947-5-6 (NAMUR)
C_a	C_p	Control input active or passive
C_N		Control input active according to IEC 60947-5-6 (NAMUR) Signal converter monitors cable breaks and short circuits according to IEC 60947-5-6. Errors indicated on LC display. Error messages possible via status output.

Table 4-12: Description of the used abbreviations

4.11.2 Description of the electrical symbols

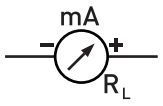
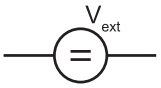
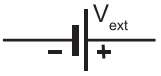
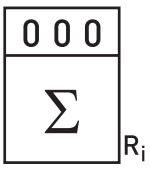
	mA meter 0...20 mA or 4...20 mA and other R_L is the internal resistance of the measuring point including the cable resistance
	DC voltage source (V_{ext}), external power supply, any connection polarity
	DC voltage source (V_{ext}), observe connection polarity according to connection diagrams
	Internal DC voltage source
	Controlled internal current source in the device
	Electronic or electromagnetic counter At frequencies above 100 Hz, shielded cables must be used to connect the counters. R_i Internal resistance of the counter
	Button, N/O contact or similar

Table 4-13: Description of the electrical symbols

4.11.3 Modular inputs/outputs

CAUTION!
Observe connection polarity.

INFORMATION!
For further information on electrical connection refer to Description of the inputs and outputs on page 40.

Current output active (only current output terminals C/C- have HART® capability), modular I/Os

- V_{int} = 24 VDC
- I ≤ 22 mA
- Terminals A and B: $R_L \leq 1\ k\Omega$
  Terminals C: $R_L \leq 250\ \Omega$
- X designates the connection terminals A, B or C, depending on the version of the signal converter.

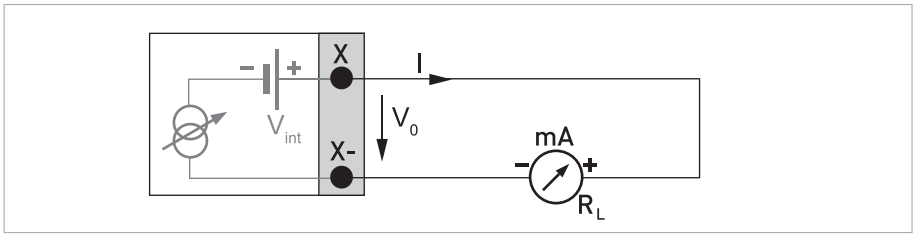


Figure 4-14: Current output active I_a

Current output passive (only current output terminals C/C- have HART® capability), modular I/Os

- $V_{ext} \leq 30$ VDC
- I ≤ 22 mA
- $V_0 \geq 2.3$ V
- Terminals C: $R_L \leq 250\ \Omega$
- $R_{L,\ max} = (V_{ext} - V_0) / I_{max}$
- X designates the connection terminals A, B or C, depending on the version of the signal converter.

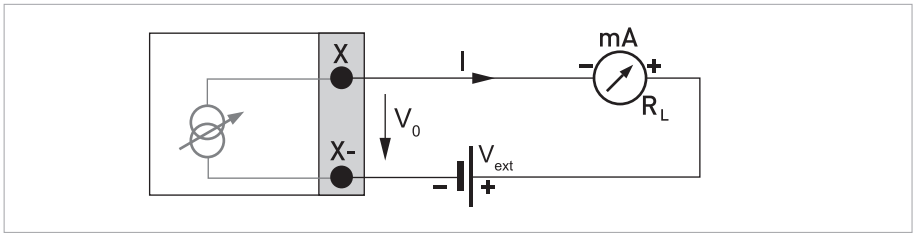


Figure 4-15: Current output passive I_p

INFORMATION!

- ***Compact and field housing versions:*** *Shield connected via the cable terminals in the terminal compartment.*
- *Any connection polarity.*

Pulse/frequency output active, modular I/Os

- V_{nom} = 24 VDC
- f_{max} in the operating menu set to $f_{max} \leq 100$ Hz:
  I ≤ 20 mA
  open:
  I ≤ 0.05 mA
  closed:
  $V_{0, nom}$ = 24 V at I = 20 mA
- f_{max} in operating menu set to 100 Hz < $f_{max} \leq 10$ kHz:
  I ≤ 20 mA
  open:
  I ≤ 0.05 mA
  closed:
  $V_{0, nom}$ = 22.5 V at I = 1 mA
  $V_{0, nom}$ = 21.5 V at I = 10 mA
  $V_{0, nom}$ = 19 V at I = 20 mA
- If the following maximum load impedance $R_{L, max}$ is exceeded, the overall load impedance R_L must be reduced accordingly by parallel connection of R:
  f ≤ 100 Hz: $R_{L, max}$ = 47 kΩ
  f ≤ 1 kHz: $R_{L, max}$ = 10 kΩ
  f ≤ 10 kHz: $R_{L, max}$ = 1 kΩ
- The minimum load impedance $R_{L, min}$ is calculated as follows:
  $R_{L, min} = V_0 / I_{max}$
- X designates the connection terminals A, B or D, depending on the version of the signal converter.

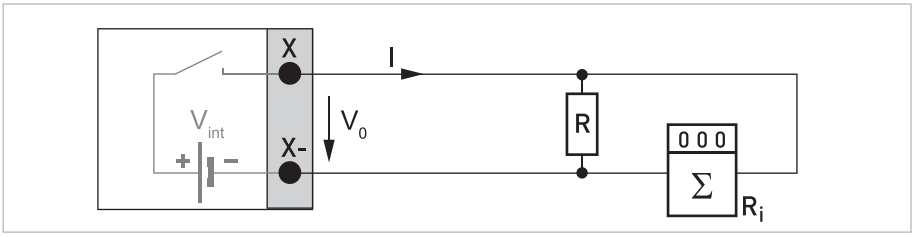


Figure 4-16: Pulse/frequency output active P_a

Pulse/frequency output passive, modular I/Os

- $V_{ext} \leq 32$ VDC
- f_{max} in the operating menu set to $f_{max} \leq 100$ Hz:
  $I \leq 100$ mA
  open:
  $I \leq 0.05$ mA at $V_{ext} = 32$ VDC
  closed:
  $V_{0, max} = 0.2$ V at $I \leq 10$ mA
  $V_{0, max} = 2$ V at $I \leq 100$ mA
- f_{max} in operating menu set to 100 Hz < $f_{max} \leq 10$ kHz:
  open:
  $I \leq 0.05$ mA at $V_{ext} = 32$ VDC
  closed:
  $V_{0, max} = 1.5$ V at $I \leq 1$ mA
  $V_{0, max} = 2.5$ V at $I \leq 10$ mA
  $V_{0, max} = 5$ V at $I \leq 20$ mA
- If the following maximum load impedance $R_{L, max}$ is exceeded, the overall load impedance R_L must be reduced accordingly by parallel connection of R:
  $f \leq 100$ Hz: $R_{L, max} = 47$ kΩ
  $f \leq 1$ kHz: $R_{L, max} = 10$ kΩ
  $f \leq 10$ kHz: $R_{L, max} = 1$ kΩ
- The minimum load impedance $R_{L, min}$ is calculated as follows:
  $R_{L, min} = (V_{ext} - V_0) / I_{max}$
- Can also be set as status output; for the electrical connection refer to status output connection diagram.
- X designates the connection terminals A, B or D, depending on the version of the signal converter.

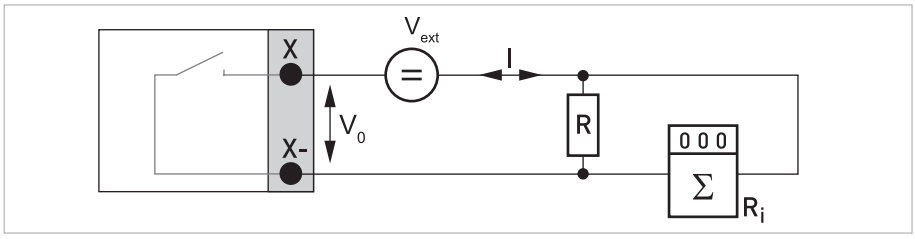


Figure 4-17: Pulse/frequency output passive P_p

INFORMATION!

- ***Compact and field housing versions:*** *Shield connected via the cable terminals in the terminal compartment.*
- *Any connection polarity.*

Pulse/frequency output passive P_N NAMUR, modular I/O

- Connection according to IEC 60947-5-6:
  V_{ext} = 8.2 V ± 0.1 VDC
  R = 1 kΩ ± 10 Ω
- Nominal current for
  open: I = 0.6 mA
  closed: I = 3.8 mA
- X designates the connection terminals A, B or D, depending on the version of the signal converter.

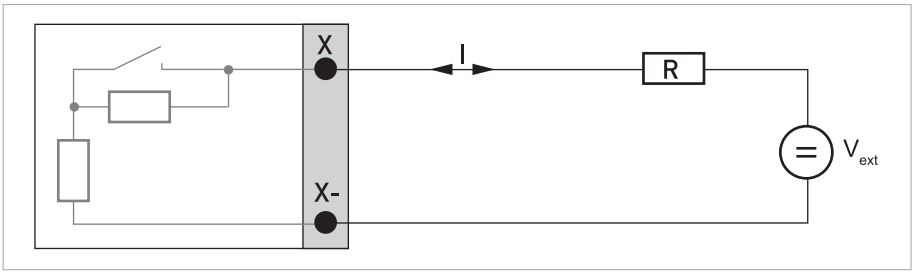


Figure 4-18: Pulse/frequency output passive P_N according to IEC 60947-5-6 (NAMUR)

Status output / limit switch active, modular I/Os

- Observe connection polarity.
- V_{int} = 24 VDC
- I ≤ 20 mA
- R_L ≤ 47 kΩ
- open:
  I ≤ 0.05 mA
  closed:
  $V_{0, nom}$ = 24 V at I = 20 mA
- X designates the connection terminals A, B or D, depending on the version of the signal converter.

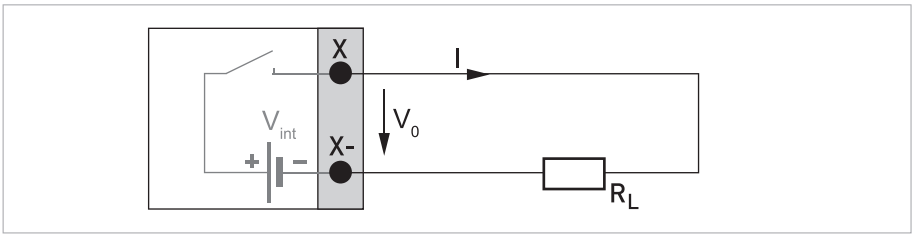


Figure 4-19: Status output / limit switch active S_a

Status output / limit switch passive, modular I/Os

- Any connection polarity.
- V_{ext} = 32 VDC
- I ≤ 100 mA
- $R_{L, max}$ = 47 kΩ
  $R_{L, min} = (V_{ext} - V_0) / I_{max}$
- open:
  I ≤ 0.05 mA at V_{ext} = 32 VDC
  closed:
  $V_{0, max}$ = 0.2 V at I ≤ 10 mA
  $V_{0, max}$ = 2 V at I ≤ 100 mA
- The output is open when the device is de-energised.
- X designates the connection terminals A, B or D, depending on the version of the signal converter.

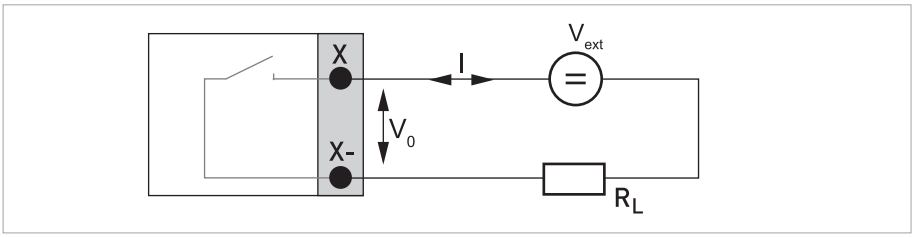


Figure 4-20: Status output / limit switch passive S_p

Status output / limit switch S_N NAMUR, modular I/Os

- Any connection polarity.
- Connection according to IEC 60947-5-6:
  V_{ext} = 8.2 V ± 0.1 VDC
  R = 1 kΩ ± 10 Ω
- Nominal current for
  open: I = 0.6 mA
  closed: I = 3.8 mA
- The output is open when the device is de-energised.
- X designates the connection terminals A, B or D, depending on the version of the signal converter.

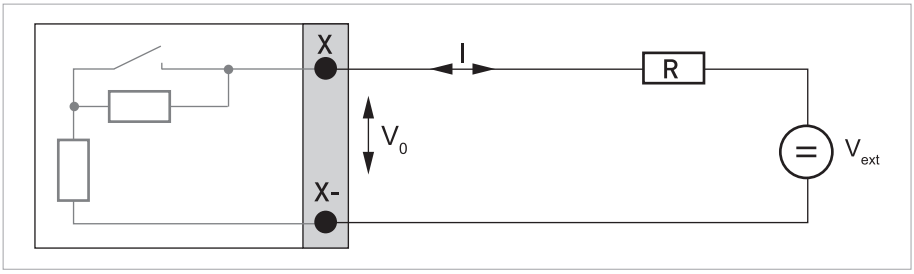


Figure 4-21: Status output / limit switch S_N according to IEC 60947-5-6 (NAMUR)

CAUTION!
Observe connection polarity.

Control input active, modular I/Os

- V_{int} = 24 VDC
- External contact open:
  $V_{0, nom}$ = 22 V
  External contact closed:
  I_{nom} = 4 mA
- Switching point for identifying "contact open or closed":
  Contact closed (on): $V_0 \leq 10$ V at I_{nom} = 1.9 mA
  Contact open (off): $V_0 \geq 12$ V at I_{nom} = 1.9 mA
- X designates the connection terminals A or B, depending on the version of the signal converter.

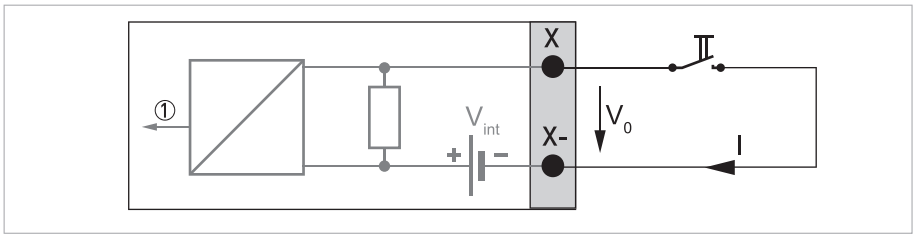


Figure 4-22: Control input active C_a

① Signal

Control input passive, modular I/Os

- $3 V \leq V_{ext} \leq 32$ VDC
- I_{max} = 9.5 mA at $V_{ext} \leq 24$ V
  I_{max} = 9.5 mA at $V_{ext} \leq 32$ V
- Switching point for identifying "contact open or closed":
  Contact open (off): $V_0 \leq 2.5$ V at I_{nom} = 1.9 mA
  Contact closed (on): $V_0 \geq 3$ V at I_{nom} = 1.9 mA
- X designates the connection terminals A or B, depending on the version of the signal converter.

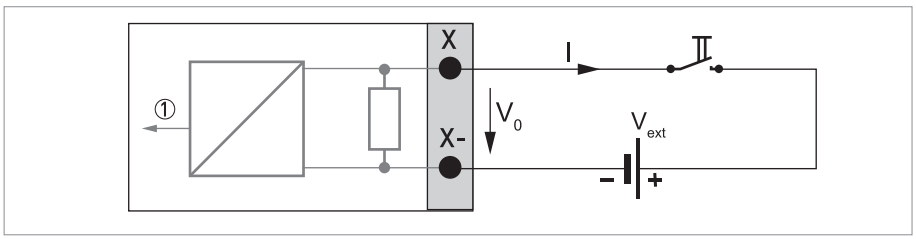


Figure 4-23: Control input passive C_p

① Signal

CAUTION!
Observe connection polarity.

Control input active C_N NAMUR, modular I/Os

- Connection according to IEC 60947-5-6.
- Switching point for identifying "contact open or closed":
  Contact open (off): $V_{0, nom}$ = 6.3 V at I_{nom} < 1.9 mA
  Contact closed (on): $V_{0, nom}$ = 6.3 V at I_{nom} > 1.9 mA
- Detection of cable break:
  $V_0 \geq 8.1$ V at $I \leq 0.1$ mA
- Detection of cable short circuit:
  $V_0 \leq 1.2$ V at $I \geq 6.7$ mA
- X designates the connection terminals A or B, depending on the version of the signal converter.

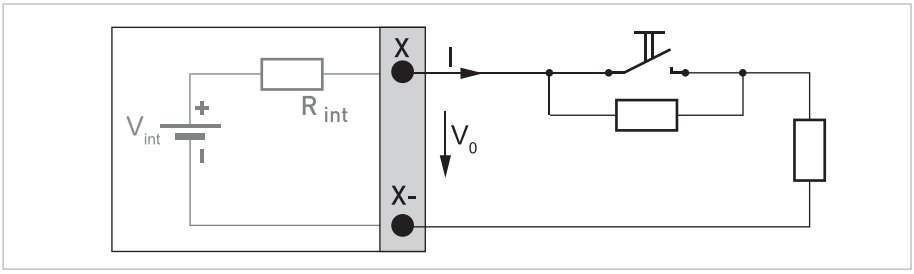


Figure 4-24: Control input active C_N according to IEC 60947-5-6 (NAMUR)

4.11.4 Ex i inputs/outputs

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

INFORMATION!
For further information on electrical connection refer to Description of the inputs and outputs on page 40.

Current output active (only current output terminals C/C- have HART® capability), Ex i I/Os

- Observe connection polarity.
- V_{int} = 21 VDC
- I ≤ 22 mA
- $R_L \leq 400\ \Omega$
- X designates the connection terminals A or C, depending on the version of the signal converter.

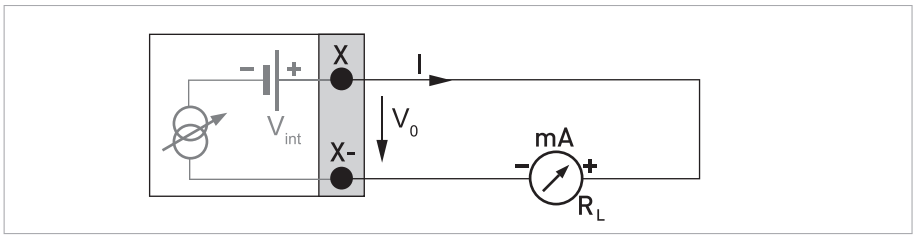


Figure 4-25: Current output active I_a Ex i

Current output passive (only current output terminals C/C- have HART® capability), Ex i I/Os

- Any connection polarity.
- $V_{ext} \leq 30$ VDC
- I ≤ 22 mA
- $V_0 \geq 4$ V
- $R_{L,\,max} = (V_{ext} - V_0) / I_{max}$
- X designates the connection terminals A or C, depending on the version of the signal converter.

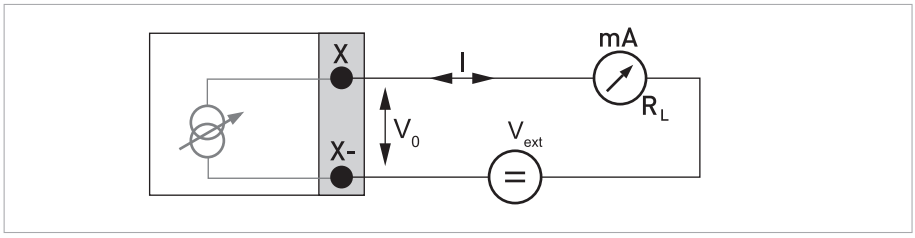


Figure 4-26: Current output passive I_p Ex i

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

INFORMATION!
- *For frequencies above 100 Hz, shielded cables are to be used in order to reduce effects from electrical interferences (EMC).*
- *Compact and field housing versions: Shield connected via the cable terminals in the terminal compartment.*
- *Any connection polarity.*

Pulse/frequency output passive P_N NAMUR, Ex i I/Os

- Connection according to IEC 60947-5-6:
  V_{ext} = 8.2 V ± 0.1 VDC
  R = 1 kΩ ± 10 Ω
- Nominal current for
  open: I = 0.43 mA
  closed: I = 4.5 mA
- X designates the connection terminals B or D, depending on the version of the signal converter.

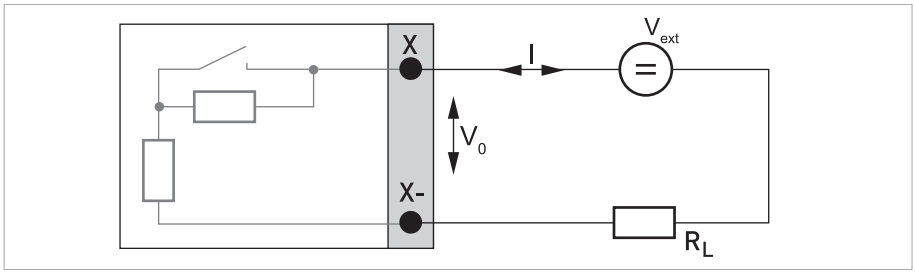


Figure 4-27: Pulse/frequency output passive P_N according to IEC 60947-5-6 (NAMUR) Ex i

INFORMATION!
- *Any connection polarity.*

Status output / limit switch S_N NAMUR, Ex i I/Os

- Connection according to IEC 60947-5-6:
  V_{ext} = 8.2 V ± 0.1 VDC
  R = 1 kΩ ± 10 Ω
- Nominal current for
  open: I = 0.43 mA
  closed: I = 4.5 mA
- The output is closed when the device is de-energised.
- X designates the connection terminals B or D, depending on the version of the signal converter.

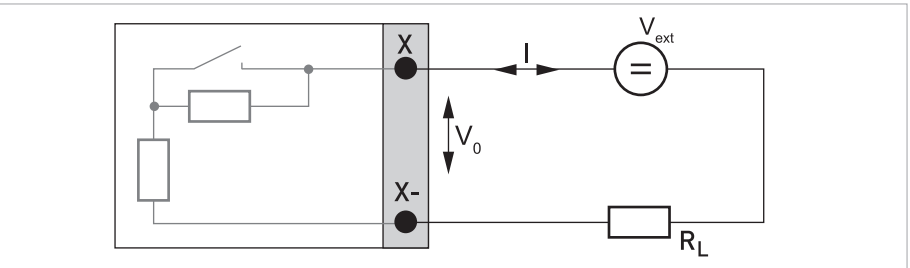


Figure 4-28: Status output / limit switch S_N according to IEC 60947-5-6 (NAMUR) Ex i

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

INFORMATION!
- *Any connection polarity.*

Control input passive, Ex i I/Os

- 5.5 V ≤ U_{ext} ≤ 30 VDC
- I_{max} = 6 mA at V_{ext} ≤ 24 V
  I_{max} = 6.5 mA at V_{ext} ≤ 30 V
- Switching point for identifying "contact open or closed":
  Contact open (off): V_0 ≤ 3.5 V at I ≤ 0.5 mA
  Contact closed (on): V_0 ≥ 5.5 V at I ≥ 4 mA
- X designates the connection terminals B, if available.

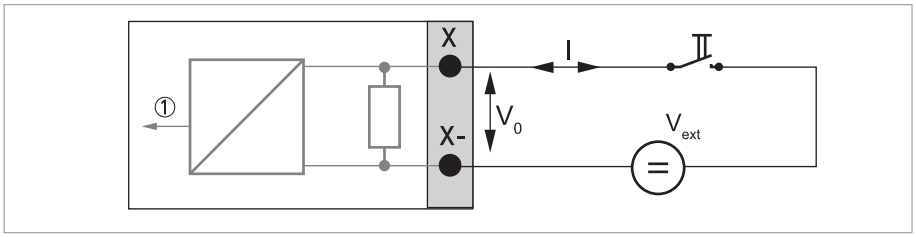


Figure 4-29: Control input passive C_p Ex i

① Signal

5.1 Switching on the power

Before connecting to power, please check that the system has been correctly installed. This includes:

- The device must be mounted in compliance with the regulations.
- The power connections must have been made in compliance with the regulations.
- The electrical terminal compartments must be secured and the covers have been screwed on.
- Check that the electrical operating data of the power supply are correct.

- Switching on the power.

5.2 Starting the signal converter

The measuring device, consisting of the flow sensor and the signal converter, is supplied ready for operation. All operating data have been set at the factory in accordance with the order specifications.

When the power is switched on a self-test is carried out. After that the device immediately begins measuring, and the current values are displayed.

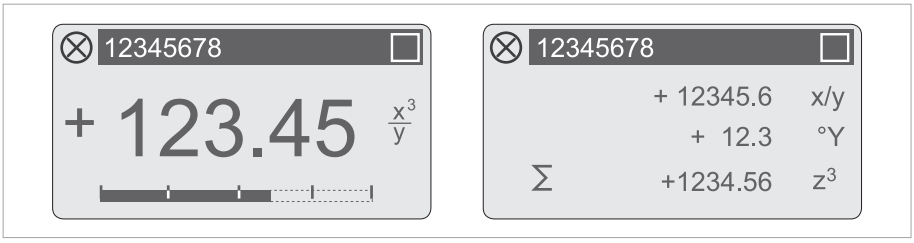


Figure 5-1: Displays in measuring mode (examples for 2 or 3 measured values)
x, y and z denote the units of the measured values displayed

It is possible to change between two measured value pages, a trend page and a status page containing status messages from continuously running diagnostic functions by pressing the keys ↑ and ↓.

6.1 Display and operating elements

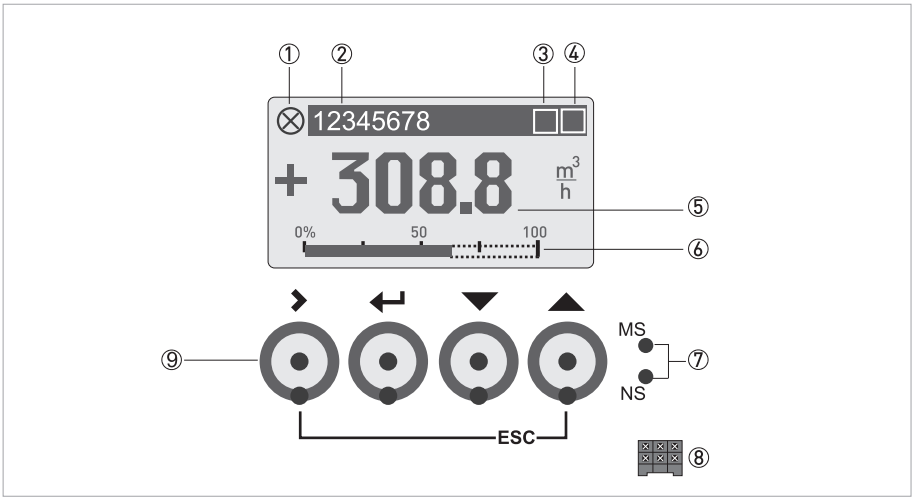


Figure 6-1: Display and operating elements (Example: flow indication with 2 measuring values)

① Indicates the device status
② Tag number (is only indicated if this number was entered previously by the operator)
③ Wireless interface indicator (e.g. Bluetooth®)
④ Indicates the key and lock status
⑤ 1st measured variable in large representation
⑥ Bargraph indication
⑦ Status LEDs MS (S1) and NS (S2) (interface status, functionality depends on signal converter version)
⑧ Interface to the service interface (GDC bus)
⑨ Operating keys, optical and mechanical (see table below for function and representation in text)

INFORMATION!

- *The switching point for the 4 optical keys is located directly in front of the glass. It is recommended to activate the keys at right angles to the front. Touching them from the side can cause incorrect operation.*
- *After 5 minutes of inactivity, there is an automatic return to measuring mode. Previously changed data is not saved.*

The device user interface provides several display modes. In measuring mode the following display pages are available:

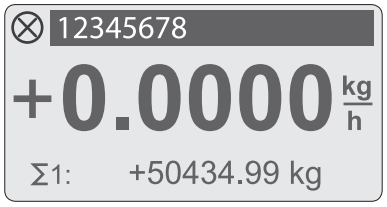
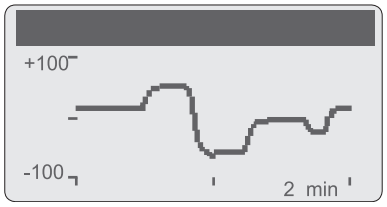
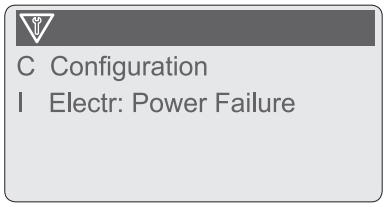
Display page in measuring mode	Screen
1st measuring page	
2nd measuring page	
Graphic page	
Status page	

Table 6-1: Indication of display pages

The following display modes are available:

Display modes and functionality	> key	↵ key	↓ or ↑ key	Esc (> + ↑) key
Measuring mode Display of measurement values	Press key (optical keys for 2.5 s) At measuring pages or graphic page enters device menu for configuration. At status page enters menu for status messages and details	Reset display; "Quick Access" function (depends on C6.4.2)	Switch between display pages: 1st and 2nd measuring page, graphic page and status page	-
Menu mode Navigation through device menu or active status messages	Access to displayed menu, then 1st submenu is displayed	Either return to menu level above or to measuring mode but prompt whether the data should be saved	Select menu item	Move up to the top menu item
Parameter and data mode Changing parameter values or starting function	For numerical values, move cursor (highlighted in **black**) one position to the right	Return to menu mode	Use cursor (highlighted in **black**) to change number, unit, property and to move the decimal point	Return to menu mode without acceptance of data

Table 6-2: Description of display modes and operating keys

Icon	Description
	Optical or mechanical operating key pressed
	Optical operating keys disabled (only displayed while pressed)
	Lock jumper set
	Device in SIL mode (unverified safe configuration)
	Device in SIL mode (verified locked safe configuration)
	Configuration checked and stored

Table 6-3: Indication of key and lock status

Icon	Description
<None>	Wireless interface turned off
	Bluetooth® interface ready for connection, read & write mode
	Bluetooth® interface connected, read & write mode
	Bluetooth® interface ready for connection, read-only mode
	Bluetooth® interface connected, read-only mode

Table 6-4: Wireless interface indicator

6.1.1 Display in measuring mode with 2 or 3 measured values

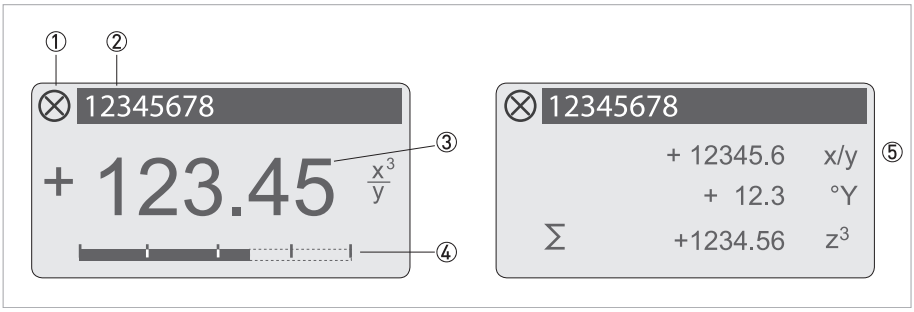


Figure 6-2: Example for display in measuring mode with 2 or 3 measured values

① Indicates a possible status message in the status page
② Tag (is only indicated if this string was entered previously by the operator)
③ 1st measured variable in large representation
④ Bargraph indication
⑤ Depiction with 3 measured values

6.1.2 Display for selection of submenu and functions in menu mode

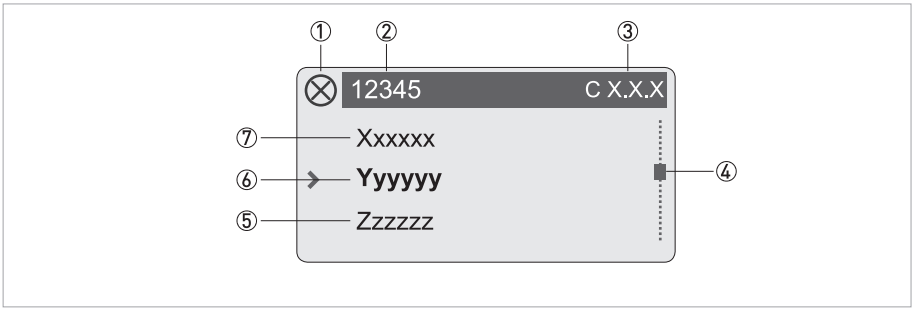


Figure 6-3: Display for selection of submenu and functions in menu mode

① Indicates a possible status message in the status page
② Menu, submenu or function name
③ Number relating to ⑥
④ Indicates position within menu, submenu or function list
⑤ Next menu(s), submenu or function
(_ _ _ signals in this line the end of the list)
⑥ Current menu(s), submenu or function
⑦ Previous menu(s), submenu or function
(_ _ _ signals in this line the beginning of the list)

6.1.3 Display when setting a parameter in parameter and data mode

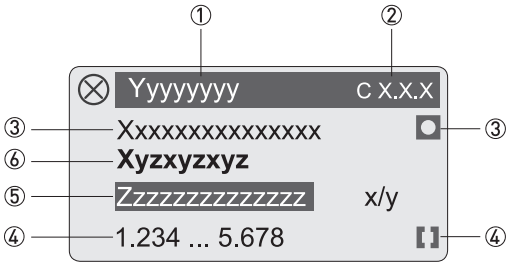


Figure 6-4: Display when setting a parameter in parameter and data mode

① Current menu(s), submenu or function
② Number related to this parameter
③ Factory setting of this parameter
④ Permissible value range for this parameter
⑤ Currently set value, unit or function (when selected, appears with white text, black background); this is where the parameter value is changed
⑥ Name of this parameter

6.1.4 Display for selection of submenu and functions with preview

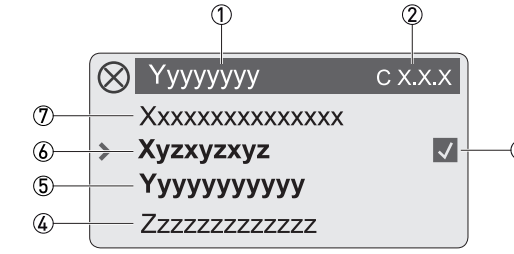


Figure 6-5: Display for selection of submenu and functions with preview

① Current menu(s), submenu or function
② Number related to ⑥
③ Denotes a changed parameter (simple check of changed data when browsing through lists)
④ Next parameter
⑤ Current value of parameter from ⑥
⑥ Current parameter (for selection press key >; then see previous chapter)
⑦ Previous parameter

Icon	Description
	Changed parameter
	Not changeable parameter or measurement
	Lock parameter by write access authentication
	Lock parameter by jumper or SIL Mode

Table 6-5: Description of parameter icons

6.2 Menu structure

A Quick Setup		
	A1 Language	
	A2 Reset	
		A2.1 Reset Errors
		A2.2 Stop All Simulations
		A2.3 All Totalisers
		A2.4 Totaliser 1
		A2.5 Totaliser 2
		A2.6 Totaliser 3*
	A3 Configuration	
		A3.1 Tag
		A3.2 Measurement
		A3.3 Range
		A3.4 Alarm Code
		A3.5 Low Flow Cutoff
		A3.6 Damping
		A3.7 Flow Direction
		A3.8 Line Frequency
		A3.9 Menu Display
	A4 Safety Mode**	
	A5 SIL Verification**	
	A6 Unlock Device**	

Table 6-6: Menu "Quick Setup"

* optionally available
** only available in device variants certified according to IEC 61508

B Test		
	B1 Status	
		B1.1 Status Log
		B1.2 Change Log
		B1.3 Safety State*
		B1.4 Bluetooth*
	B2 Actual Values	
		B2.1 Operating Hours
		B2.2 Date and Time
		B2.3 Volume Flow
		B2.4 Mass Flow
		B2.5 Flow Velocity
		B2.6 Coil Temperature
		B2.7 Conductivity
		B2.12 Electronics Temp.
		B2.13 Terminal 2 DC Volt.
		B2.14 Terminal 3 DC Volt.
	B3 Simulation	
		B3.1 Stop All Simulations
		B3.2 Volume Flow
		B3.3 Mass Flow
		B3.4 Flow Velocity
		B3.5 Coil Temperature
		B3.6 Conductivity
		B3.11 Current Output A*
		B3.11 Frequency Output A*
		B3.11 Pulse Output A*
		B3.11 Status Output A*
		B3.11 Limit Switch A*
		B3.11 Control Input A*
		B3.12 Pulse Output B*
		B3.12 Frequency Output B*
		B3.12 Status Output B*
		B3.12 Limit Switch B*
		B3.12 Control Input B*
		B3.13 Current Output C*
		B3.14 Pulse Output D*
		B3.14 Frequency Output D*
		B3.14 Status Output D*
		B3.14 Limit Switch D*

	B4 Sensor Information	
		B4.1 Sensor Type
		B4.2 Device Serial No.
		B4.3 V No. Sensor
		B4.4 Liner
		B4.5 Electr. Material
		B4.6 Calibration Date
	B5 Electr. Information	
		B5.1 C Number
		B5.2 Electronics Serial No.
		B5.3 Sensor Electr. Info
		B5.4 V No. Converter
		B5.5 Electronic Revision
		B5.6 Current Output C
		B5.7 Bluetooth
		B5.8 Software Checks.
		B5.9 Display Test

Table 6-7: Menu "Test"

* optionally available

C Setup		
	C1 Process Input	
		C1.1 Flow
		C1.2 Conductivity
		C1.3 Coil Temperature***
		C1.4 Diagnostics***
		C1.5 Calibration
	C2 I/O	
		C2.1 Hardware
		C2.2 Current Output A*
		C2.2 Frequency Output A*
		C2.2 Pulse Output A*
		C2.2 Limit Switch A*
		C2.2 Status Output A*
		C2.2 Control Input A*
		C2.3 Current Out B*
		C2.3 Freq. Output B*
		C2.3 Pulse Output B*
		C2.3 Status Output B*
		C2.3 Limit Switch B*
		C2.3 Control Input B*
		C2.4 Current Out C*
		C2.5 Freq. Output D*
		C2.5 Pulse Output D*
		C2.5 Status Output D*
		C2.5 Limit Switch D*
	C3 Totalisers	
		C3.1 Totaliser 1
		C3.2 Totaliser 2
		C3.3 Totaliser 3*
	C4 HART	
		C4.1 HART
		C4.2 Loop Current Mode
		C4.3 Identification
		C4.4 HART Dyn. Variables
	C5 Display	
		C5.1 Language
		C5.2 Contrast
		C5.3 Optical Keys***
		C5.4 Backlight***
		C5.5 Default Display***
		C5.6 1st Meas. Page***
		C5.7 2nd Meas. Page***
		C5.8 Graphic Page***

	C6 Device	
		C6.1 Tag
		C6.2 Reset Errors
		C6.3 Config. Management
		C6.4 Special Functions
		C6.5 Units
		C6.6 Status Groups
		C6.7 OPTICHECK Verification*
	C7 SIL**	
		C7.1 Configuration
		C7.2 Safety Mode
		C7.3 SIL Verification
		C7.4 Unlock Device
		C7.5 Unlock Password

Table 6-8: Menu "Setup"

* optionally available
** only available in device variants certified according to IEC 61508
*** only available if "C6.4.5 Menu Display" is set to "Advanced"

6.3 Function tables

INFORMATION!

- *The following tables describe the functions of the device variants with HART® interface.*
- *Depending on the device version, not all functions are available.*
- *Some menu entries suited for advanced users are by default hidden in the menu. They can be shown if "C6.4.5 Menu Display" is set to "Advanced".*

6.3.1 Menu "A Quick Setup"

Function	Description or requested action	Settings and/or range
A Quick Setup		
A1 Language	Set language of the menu.	-
A2 Reset		
A2.1 Reset Errors	Reset errors.	Selection: Reset? / No / Yes (further information on page 110)
A2.2 Stop All Simulations	Stop all running simulation functions.	Selection: Stop All Simulations / No / Yes
A2.3 All Totalisers	Reset all totalisers.	Selection: Reset Totaliser? / No / Yes
A2.4 Totaliser 1	Reset totaliser.	Selection: Reset Totaliser? / No / Yes
A2.5 Totaliser 2	Reset totaliser.	Selection: Reset Totaliser? / No / Yes
A2.6 Totaliser 3	Reset totaliser.	Selection: Reset Totaliser? / No / Yes
A3 Configuration		
A3.1 Tag	Set measuring point identifier.	Measuring point identifier (= Tag number) (also for HART® operation) will be displayed in the LCD header (max. 8 digits).
A3.2 Measurement	Selection of measurement for output C.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity
A3.3 Range	Set range of measurement for output.	Selection depends on the measurement value.
A3.4 Alarm Code	Set error current for current output.	Selection: High / Low Range: 3...22 mA
A3.5 Low Flow Cutoff	Set low flow cutoff for output in percent of 100%-value.	Range: 0...20%
A3.6 Damping	Set damping for output.	Range: 0...100 s
A3.7 Flow Direction	Set the direction of flow in relation to the arrow on the flow sensor.	Selection: Normal Direction / Reverse Direction
A3.8 Line Frequency	Set the line frequency of device or in environment.	Selection: 50Hz / 60Hz
A3.9 Menu Display		Selection: Basic / Advanced
A4 Safety Mode	Select safety mode of the device.	Selection: non-SIL Mode / SIL Mode Note: Only available in device variants certified according to IEC 61508.

Function	Description or requested action	Settings and/or range
A Quick Setup		
A5 SIL Verification	Verification of safety relevant parameters and lock of the device.	Note: Only available if "Safety Mode" is changed! For detailed information refer to the "Safety manual".
A6 Unlock Device	Unlock device.	For detailed information refer to the "Safety manual".

Table 6-9: Description of menu "A Quick Setup"

6.3.2 Menu "B Test"

Function	Description or requested action	Settings and/or range
B Test		
B1 Status		
B1.1 Status Log	Log with date and time of status messages that occurred.	(further information on page 110)
B1.2 Change Log	Display log containing the checksum over the entire configuration.	(further information on page 104)
B1.3 Safety State	Display of the current state of functional safety configuration (only for SIL device).	-
B1.4 Bluetooth	Display of the information of the Bluetooth® interface.	-
B2 Actual Values		
B2.1 Operating Hours	Display of the operating hours of the device.	-
B2.2 Date and Time	Display of the date and time.	-
B2.3 Volume Flow	Display of the current volume flow.	-
B2.4 Mass Flow	Display of the current mass flow.	-
B2.5 Flow Velocity	Display of the current flow velocity.	-
B2.6 Coil Temperature	Display of the current coil temperature.	-
B2.7 Conductivity	Display of the current not temperature corrected conductivity.	-
B2.12 Electronics Temp.	Display of electronics temperature.	-
B2.13 Terminal 2 DC Volt.	Display the current electrode voltage at terminal 2.	-
B2.14 Terminal 3 DC Volt.	Display the current electrode voltage at terminal 3.	-
B3 Simulation (further information on page 107)		
B3.1 Stop All Simulations	Stop all running simulation functions.	Selection: No / Yes
B3.2 Volume Flow		-
B3.3 Mass Flow		-
B3.4 Flow Velocity		-
B3.5 Coil Temperature		-
B3.6 Conductivity		-
B3.11 IO A	Sets simulated value of output on terminals A.	-
B3.12 IO B	Sets simulated value of output on terminals B.	-
B3.13 IO C	Sets simulated value of output on terminals C.	-
B3.14 IO D	Sets simulated value of output on terminals D.	-

Function	Description or requested action	Settings and/or range
B Test		
B4 Sensor Information		
B4.1 Sensor Type	Display of the flow sensor type.	-
B4.2 Device Serial No.	Display of the serial number of the flow sensor.	-
B4.3 V No. Sensor	Display of the V-number of the flow sensor.	-
B4.4 Liner	Display of the liner material.	-
B4.5 Electr. Material	Display of the electrode material.	-
B4.6 Calibration Date	Display of the date of calibration of the flow sensor.	-
B5 Electr. Information		
B5.1 C Number	Display of the C-number of the signal converter.	-
B5.2 Electronics Serial No.	Display of the serial number of the signal converter.	-
B5.3 Sensor Electr. Info	Display information of the sensor electronics.	-
B5.4 V No. Converter	Display of V-number of the signal converter.	-
B5.5 Electronic Revision	Display of the electronic revision of the signal converter.	-
B5.6 Current Output C	Display information of the current output C.	-
B5.7 Bluetooth	Display of the information of the Bluetooth® interface.	-
B5.8 Software Checks.	Displays the checksums of the device firmware.	-
B5.9 Display Test	The display test shows a timed sequence with all pixels on and off.	-

Table 6-10: Description of menu "B Test"

6.3.3 Menu "Setup"

Function	Description or requested action	Settings and/or range
C Setup - C1 Process Input		
C1.1 Flow (further information on page 90)		
C1.1.1 Flow Direction	Set the direction of flow in relation to the arrow on the flow sensor.	Selection: Normal Direction / Reverse Direction
C1.1.2 Damping	Set damping for all flow measurements.	Range: 0...100 s Note: Only access with authorisation.
C1.1.3 Process Noise Suppr.	Set level of process noise suppression.	Selection: Off / Low / High Note: Only access with authorisation.
C1.1.4 Low Flow Cutoff	Sets the flow measurement to "0" for low values.	Range: 0...10 m/s Note: Only access with authorisation.
C1.1.5 LFC Hold Time	Set minimum time that the low flow cutoff will be active.	Range: 0...10 s Note: Only access with authorisation.
C1.1.6 Density	Set density value for calculation of mass flow.	Range: 0.1...5 kg/l
C1.1.7 Line Frequency	Set the line frequency of device or in environment.	Selection: 50Hz / 60Hz
C1.1.8 Line Frequency Sync.	Enable or disable line frequency synchronisation.	Selection: Off / On
C1.1.9 Zero Calibration	Perform zero calibration / display current zero calib. value.	Range: -11...11 m/s Note: Only access with authorisation.
C1.1.10 Limitation	Set limitation for flow velocity measurement.	Range: -100...+100 m/s Note: Only access with authorisation.

Function	Description or requested action	Settings and/or range
C Setup - C1 Process Input		
C1.2 Conductivity (further information on page 92)		
C1.2.1 Electrode Impedance	Enable or disable electrode impedance measurement. This enables or disables the interaction with the measurement electrodes to measure the electrode impedance.	Selection: Off / On Note: Only access with authorisation.
C1.2.2 Conductivity	Enable or disable conductivity measurement. This does not change the interaction with the measurement electrodes. This enables or disables the calculation of the conductivity and the related status.	Selection: Off / On: With Status / On: No Status
C1.2.3 Limitation	Set limitation for conductivity measurement.	Range: 0...10000 mS/cm
C1.2.4 Damping	Set damping for conductivity measurement.	Range: 0...100 s
C1.2.5 Cond. Correction	Set correction scheme for conductivity measurement.	Selection: Automatic / Low Conduct. / High Conduct.
C1.2.6 Cable Resistance	Display or set manually or calibrate cable resistance.	Available for remote devices only.
C1.2.7 EF Electr. Factor	Calibrate or set manually or display electrode factor.	Range: 0.1...30 mm
C1.3 Coil Temperature (further information on page 93)		
C1.3.1 Limitation	Set limitation for coil temp. measurement.	Range: -50...190°C Note: Only access with authorisation.
C1.3.2 Calib. Coil Temp.	Display or calibrate coil resistance at 20°C / 68°F.	-
C1.4 Diagnostics (further information on page 93)		
C1.4.1 Virtual Reference	Enable or disable virtual reference of flow sensor.	Note: Only access with authorisation.
C1.4.2 Limit Empty Pipe	Set limit for impedance-based empty-pipe detection.	Range: 0...50 S/cm
C1.4.3 DC Empty Pipe Detection	Configure DC-current based empty-pipe detection.	Selection: Off / Low Current / High Current Note: Only access with authorisation.
C1.4.4 Full Pipe Detect	Enable or disable full pipe detection.	Selection: Off / On
C1.4.5 Linearity	Enable or disable flow sensor transfer function linearity check.	Selection: Off / On
C1.4.6 Linearity Limit %	Set relative limit for linearity check.	Range: 0...100%
C1.4.7 Linearity Limit	Set limit for linearity check.	Range: 0...1 m/s
C1.4.8 Electr. Noise Limit %	Set relative limit for electrode noise detection.	Range: 0...200%
C1.4.9 Electrode Noise Limit	Set relative limit for electrode noise detection.	Range: 0...1 m/s
C1.4.10 Flow Noise Limit %	Set relative limit for electrode noise detection.	Range: 0...200%
C1.4.11 Flow Noise Limit	Set limit for flow noise detection.	Range: 0...1 m/s
C1.4.12 Field Coil Ratio	Display or set manually or calibrate field coil ratio.	-

Function	Description or requested action	Settings and/or range
C Setup - C1 Process Input		
C1.4.13 Field Coil Ratio Limit	Set limit for field coil ratio.	Range: 0...100% Note: Only access with authorisation.
C1.4.14 Electr. Sym. Limit %	Set rel. limit for electrode asym. detection.	Range: 0...100% Note: Only access with authorisation.
C1.5 Calibration (further information on page 96)		
C1.5.1 Zero Calibration	Perform zero calibration / display current zero calib. value.	-
C1.5.2 Size Type	Select size type for flow sensor size config.	Selection: Custom / Table Note: Only access with authorisation.
C1.5.3 Size	Set flow sensor size.	Selection: 2.5mm / 1/10inch...3000mm / 120inch Note: Only access with authorisation.
C1.5.4 GK Type	Select field current and active GKx values.	Selection: GK And GKL / GK / GKL Note: Only access with authorisation.
C1.5.5 GK	Set GK factor of flow sensor.	Range: 0.5...12 Note: Only access with authorisation.
C1.5.6 GKL	Set GKL factor of flow sensor.	Range: 0.5...20 Note: Only access with authorisation.
C1.5.7 GKL Shift	Set offset for GKL when linearity check is enabled.	Range: -1...1% Note: Only access with authorisation.
C1.5.8 Field Frequency	Set field frequency relative to line frequency.	Selection: 1/2*Line Frequency / 1/4*Line Frequency / 1/6*Line Frequency / 1/8*Line Frequency / 1/12*Line Frequency / 1/18*Line Frequency / 1/36*Line Frequency / 1/50*Line Frequency Note: Only access with authentication level "Expert".
C1.5.9 Settling Mode	Set mode for defining the settling time. The coil needs to settle its magnetic field after switching the field polarity.	Selection: Standard / Manual / Maximum Note: Only access with authorisation.
C1.5.10 Settling Time	Set manual settling time for field current.	Range: 1...250 ms Note: Only access with authorisation.
C1.5.11 Calib. Coil Temp.	Display or set manually or calibrate coil resistance at 20°C / 68°F.	-
C1.5.12 EF Electr. Factor	Calibrate or set manually or display electrode factor.	-
C1.5.13 Electrode Config.	Set configuration of electrodes of the flow sensor.	Selection: 2 Electrodes / 3 Electrodes / 4 Electrodes / 2 Electr. + 2x Ground Note: Only access with authorisation.
C1.5.14 Field Coil Config.	Set configuration of field coils of the flow sensor.	Selection: Without Mid Point / With Mid Point Note: Only access with authorisation.

Table 6-11: Description of menu "Setup - C1 Process Input"

Function	Description or requested action	Settings and/or range
C Setup - C2 I/O		
C2.1 Hardware		
C2.1.1 Terminals A	Set the output mode of terminal A.	Available selections depend on the selected I/O option.
C2.1.2 Terminals A Type	Set or show the output type of terminal A.	Available selections depend on the selected I/O option.
C2.1.3 Terminals B	Set the output mode of terminal B.	Available selections depend on the selected I/O option.
C2.1.4 Terminals B Type	Set or show the output type of terminal B.	Available selections depend on the selected I/O option.
C2.1.5 Terminals C	Set the output mode of terminal C.	Available selections depend on the selected I/O option.
C2.1.6 Terminals C Type	Set or show the output type of terminal C.	Available selections depend on the selected I/O option.
C2.1.7 Terminals D	Set the output mode of terminal D.	Available selections depend on the selected I/O option.
C2.1.8 Terminals D Type	Set or show the output type of terminal D.	Available selections depend on the selected I/O option.
C2._ Current Out X (further information on page 101)		
X represents one of the connection terminals A, B or C. _ represents: 1 = Terminals A, 2 = Terminals B, 3 = Terminals C		
C2._.1 Measurement	Selection of measurement for output.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity
C2._.2 Range	Set range of measurement for output.	-
C2._.3 Low Flow Cutoff	Set low flow cutoff for output in percent of 100%-value.	Range: 0...20% 1st value = switching point / 2nd value = hysteresis; Condition: 2nd value ≤ 1st value (further information on page 100)
C2._.4 Damping	Set damping for output.	Range: 0...100 s (further information on page 99)
C2._.5 Polarity	Set response of output to measurement polarity.	Selection: Both Polarities / Positive Polarity / Negative Polarity / Absolute Value Note: Only access with authorisation. (further information on page 100)
C2._.6 Current Span	Selection of current output span.	Selection: 4-20 mA / 0-20 mA / Custom
C2._.7 Range 0%...100%	Set current for 0% and 100% of measurement value.	Range: 0...15 mA Note: Only available if "Custom" is selected for "Current Span" in C2._.6! Note: Only access with authorisation.
C2._.8 Extended Range	Set current limits for current output.	Range: 3.5...15 mA Condition: 0 mA ≤ 1st value ≤ 2nd value ≤ 21.5 mA and out of current range Note: Only access with authorisation.

Function	Description or requested action	Settings and/or range
C Setup - C2 I/O		
C2._.9 Alarm Code	Set error current for current output.	Selection: High / Low (if "4-20 mA" is selected for "Current Span") or Range: 0...22 mA (if "Custom" is selected for "Current Span")
C2._.10 Alarm Condition	Set condition for error current.	Selection: Safety Rel. Failures / Failure / Out of Specification (further information on page 102)
C2._.11 4mA Trimming	Trimming of current output at 4 mA.	Range: 3.6...5.5 mA Note: Only access with authorisation.
C2._.12 20mA Trimming	Trimming of current output at 20mA.	Range: 18.5...21.5 mA Note: Only access with authorisation.
C2._.13 Special Function	Set range change for current output.	Selection: Off / Automatic Range / External Range Note: Only access with authorisation.
C2._.14 Threshold	Set threshold value for range change setting for current output.	Available only when C2._.11 is activated. Defines the threshold between extended and normal range. The automatic range function always changes from the extended to the normal range when the 100% current is reached. The upper 100% value of the hysteresis is then = 0. The threshold is then the hysteresis value, instead of "Threshold ± Hysteresis" as shown in the display. Range: 5...80% 1st value = switching point / 2nd value = hysteresis; Condition: 2nd value ≤ 1st value Note: Only access with authorisation.

Function	Description or requested action	Settings and/or range
C Setup - C2 I/O		
C2._ Pulse Output X (further information on page 102)		
X represents one of the connection terminals A, B or D. _ represents: 1 = Terminals A, 2 = Terminals B, 4 = Terminals D		
C2._.1 Measurement	Selection of measurement for output.	Selection: Volume Flow / Mass Flow
C2._.2 Pulse Value Unit	Set unit for pulse value.	-
C2._.3 Value Per Pulse	Set pulse value for pulse output.	-
C2._.4 Low Flow Cutoff	Set low flow cutoff for output in percent of 100%-value.	(further information on page 100)
C2._.5 Damping	Set damping for output.	Range: 0...100 s (further information on page 99)
C2._.6 Polarity	Set response of output to measurement polarity.	Selection: Both Polarities / Positive Polarity / Negative Polarity / Absolute Value (further information on page 100)
C2._.7 Pulse Shape	Set pulse shape of frequency/pulse output.	Selection: Symmetric / Automatic / Fixed
C2._.8 Pulse Width	Set pulse width (<50% inv. max. pulse rate) of freq./ pulse output.	Only available if set to "Fixed" in C2._.7. Range: 0.05...2000 ms
C2._.9 Max. Pulse Rate	Set pulse rate for 100% of measuring range of pulse output.	Range: 0.01...10000 Hz (1...5000 Hz for phase-shifted outputs)
C2._.10 Invert Signal	Inverts signal at output.	Selection: Off / On
C2._.11 Phase Shift w.r.t. B	Set phase shift relative to output B.	Only available when configuring the terminal A or D and only if output B is a pulse or frequency output. If setting in C2._.6 is "Both Polarities", the phase shift is prefixed by a symbol, e.g. -90° and +90°. Note: Maximum frequency is 5000 Hz when used in phase-shifted mode. Selection: Off / 0° Phase Shift / 90° Phase Shift / 180° Phase Shift
C2._.11 Special Function	Enable phase shift relative to output A or D.	This function is only available at the pulse output of terminal B. At the same time, 2 pulse outputs must be available. Setting: 1st output at terminal A or D / 2nd output at terminal B The output B is operated as a slave output, controlled and set using master output A or D. Selection: Off / Phase Shift w.r.t. D / Phase Shift w.r.t. A

Function	Description or requested action	Settings and/or range
C Setup - C2 I/O		
C2._ Freq. Output X		
X represents one of the connection terminals A, B or D. _ represents: 1 = Terminals A, 2 = Terminals B, 4 = Terminals D		
C2._.1 Measurement	Selection of measurement for output.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity
C2._.2 Range	Set range of measurement for output.	-
C2._.3 Low Flow Cutoff	Set low flow cutoff for output in percent of 100%-value.	Range: 0...20% 1st value = switching point / 2nd value = hysteresis; Condition: 2nd value ≤ 1st value (further information on page 100)
C2._.4 Damping	Set damping for output.	Range: 0...100 s
C2._.5 Polarity	Set response of output to measurement polarity.	Selection: Both Polarities / Positive Polarity / Negative Polarity / Absolute Value (further information on page 100)
C2._.6 Pulse Shape	Set pulse shape of frequency/pulse output.	Selection: Symmetric / Automatic / Fixed
C2._.7 Pulse Width	Set pulse width (<50% inv. max. pulse rate) of freq./ pulse output.	Only available if set to "Fixed" in C2._.6. Range: 0.05...2000 ms
C2._.8 100% Pulse Rate	Set pulse rate for 100% of measuring range for frequency output.	Range: 0.01...10000 Hz (1...5000 Hz for phase-shifted outputs)
C2._.9 Invert Signal	Inverts signal at output.	Selection: Off / On
C2._.10 Phase Shift w.r.t. B	Set phase shift relative to output B.	Only available when configuring the terminal A or D and only if output B is a pulse or frequency output. If setting in C2._.5 is "Both Polarities", the phase shift is prefixed by a symbol, e.g. -90° and +90°. Note: Maximum frequency is 5000 Hz when used in phase-shifted mode. Selection: Off / 0° Phase Shift / 90° Phase Shift / 180° Phase Shift
C2._.10 Special Function	Enable phase shift relative to output A or D.	This function is only available at the frequency output of terminal B. At the same time, 2 frequency outputs must be available. Setting: 1st output at terminal A or D / 2nd output at terminal B The output B is operated as a slave output, controlled and set using master output A or D Selection: Off / Phase Shift w.r.t. D / Phase Shift w.r.t. A

Function	Description or requested action	Settings and/or range
C Setup - C2 I/O		
C2._ Status Output X		
X represents one of the connection terminals A, B or D. _ represents: 1 = Terminals A, 2 = Terminals B, 4 = Terminals D		
C2._.1 Mode	Set mode for status output.	Selection: Off / Failure / Out Of Specification / Maintenance Required / Flow Polarity / Flow Over Range / Conductivity Overrange/ Totaliser 1 Preset / Totaliser 2 Preset / Totaliser 3 Preset / Empty Pipe / High Noise / Output A / Output B / Output C
C2._.3 Invert Signal	Inverts signal at output.	Selection: Off / On
C2._ Limit Switch X		
X represents one of the connection terminals A, B or D. _ represents: 1 = Terminals A, 2 = Terminals B, 4 = Terminals D		
C2._.1 Measurement	Selection of measurement for output.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity
C2._.2 Threshold	Switching level, set threshold with hysteresis.	1st value = switching point / 2nd value = hysteresis; Condition: 2nd value ≤ 1st value
C2._.3 Damping	Set damping for output.	Range: 0...100 s (further information on page 99)
C2._.4 Polarity	Set response of output to measurement polarity.	Selection: Both Polarities / Positive Polarity / Negative Polarity / Absolute Value (further information on page 100)
C2._.5 Invert Signal	Inverts signal at output.	Selection: Off / On
C2._ Control Input X		
X represents one of the connection terminals A or B. _ represents: 1 = Terminals A, 2 = Terminals B		
C2._.1 Mode	Set action for control input A.	Selection: Off / Hold All Outputs / Hold Output A / Hold Output C / Hold Output D / All Outputs To Zero / Output A To Zero / Output C To Zero / Output D To Zero / Reset All Totalisers / Reset Totaliser 1 / Reset Totaliser 2 / Stop All Totalisers / Stop Totaliser 1 / Stop Totaliser 2 / Zero Outp.+Stop Tot. / Range Change A / Range Change C / Error Reset
C2._.2 Invert Signal	Inverts signal at output.	Selection: Off / On

Table 6-12: Description of menu "Setup - C2 I/O"

Function	Description or requested action	Settings and/or range
C Setup - C3 Totalisers		
C3.1 Totaliser 1		
C3.1.1 Totaliser Function	Set function for totaliser.	Selection: Off / Absolute Total / Incremental Total / Decremental Total
C3.1.2 Measurement	Set measurement for totaliser.	Selection: Volume Flow / Mass Flow
C3.1.3 Low Flow Cutoff	Set low flow cutoff for totaliser.	-
C3.1.4 Damping	Set damping for totaliser.	Range: 0...100 s
C3.1.5 Preset Value	Preset value for totaliser.	-
C3.1.6 Reset Totaliser	Reset totaliser.	Selection: Reset Totaliser? /No / Yes
C3.1.7 Set Totaliser	Set totaliser to desired value.	Selection: Set Totaliser / Set Value / Cancel / Set Totaliser? / No / Yes
C3.1.8 Stop Totaliser	Stop totaliser and holds current.	Selection: Stop Totaliser? / No / Yes
C3.1.9 Start Totaliser	Start totaliser after it has bee.	Selection: Start Totaliser? / No / Yes
C3.2 Totaliser 2		
C3.2.1 Totaliser Function	Set function for totaliser.	Selection: Off / Absolute Total / Incremental Total / Decremental Total
C3.2.2 Measurement	Set measurement for totaliser.	Selection: Volume Flow / Mass Flow
C3.2.3 Low Flow Cutoff	Set low flow cutoff for totaliser.	-
C3.2.4 Damping	Set damping for totaliser.	Range: 0...100 s
C3.2.5 Preset Value	Preset value for totaliser.	-
C3.2.6 Reset Totaliser	Reset totaliser.	Selection: Reset Totaliser? / No / Yes
C3.2.7 Set Totaliser	Set totaliser to desired value.	Selection: Set Totaliser / Set Value / Cancel / Set Totaliser? / No / Yes
C3.2.8 Stop Totaliser	Stop totaliser and holds current.	Selection: Stop Totaliser? / No / Yes
C3.2.9 Start Totaliser	Start totaliser after it has been stopped.	Selection: Start Totaliser? / No / Yes
C3.3 Totaliser 3		
C3.3.1 Totaliser Function	Set function for totaliser.	Selection: Off / Absolute Total / Incremental Total / Decremental Total
C3.3.2 Measurement	Set measurement for totaliser.	Selection: Volume Flow / Mass Flow
C3.3.3 Low Flow Cutoff	Set low flow cutoff for totaliser.	-
C3.3.4 Damping	Set damping for totaliser.	Range: 0...100 s
C3.3.5 Preset Value	Preset value for totaliser.	-
C3.3.6 Reset Totaliser	Reset totaliser.	Selection: Reset Totaliser? / No / Yes
C3.3.7 Set Totaliser	Set totaliser to desired value.	Selection: Set Totaliser / Set Value / Cancel / Set Totaliser? / No / Yes
C3.3.8 Stop Totaliser	Stop totaliser and holds current.	Selection: Stop Totaliser? / No / Yes
C3.3.9 Start Totaliser	Start totaliser after it has bee.	Selection: Start Totaliser? / No / Yes

Table 6-13: Description of menu "Setup - C3 Totalisers"

Function	Description or requested action	Settings and/or range
C Setup - C4 HART		
C4.1 HART	Enable/Disable HART communication.	Selection: Disabled / Enabled
C4.2 Loop Current Mode	Disable loop current mode for Multi-Drop Mode.	Selection: Disabled / Enabled Note: Only access with authorisation.
C4.3 Identification		
C4.3.1 Address	Set HART address for multidrop operation.	Range: 0...63
C4.3.2 Tag	Set measuring point identifier.	-
C4.3.3 HART long tag	Set HART long tag.	-
C4.3.4 Manufacturer ID	Display the HART manufacturer ID.	-
C4.3.5 Device Type	Display the HART device type.	-
C4.3.6 Electronics Serial No.	Display of serial number of the signal converter.	-
C4.3.7 Description	Set HART description.	-
C4.3.8 Message	Set HART message.	-
C4.3.9 HART Version	Display the HART version.	-
C4.3.10 Device Revision	Display the HART device revision.	-
C4.4 HART Dyn. Variables		
C4.4.1 PV	Display the primary variable.	-
C4.4.2 SV	Display or set the secondary variable.	-
C4.4.3 TV	Display or set the tertiary variable.	-
C4.4.4 QV	Display or set the quaternary variable.	-

Table 6-14: Description of menu "Setup - C4 HART"

Function	Description or requested action	Settings and/or range
C Setup - C5 Display		
C5.1 Language	Set language of the menu.	Language selection depends on the device version.
C5.2 Contrast	Adjust display contrast.	-
C5.3 Optical Keys	Turn optical keys on/off.	Selection: Disabled / Enabled (further information on page 103)
C5.4 Backlight	Configure display backlight.	Selection: Off / White / Red - Failure / NE107 Color (further information on page 103)
C5.5 Default Display	Set default page of display on reset.	Selection: None / 1st Meas. Page / 2nd Meas. Page / Status Page / Graphic Page
C5.6 1st Meas. Page		
C5.6.1 Function	Set number of lines of display on measuring page.	Selection: One Line / Two Lines / Three Lines
C5.6.2 1st Line Variable	Set measurement for 1st line of measuring page.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity
C5.6.3 Range	Set range for 1st line of measuring page.	-
C5.6.4 Limitation	Set Min/Max for 1st line of measuring page.	Range: -150...150%
C5.6.5 Low Flow Cutoff	Low flow cutoff for 1st line of measuring page.	Range: 0...20%
C5.6.6 Damping	Set damping for 1st line of measuring page.	Range: 0.1...100 s
C5.6.7 1st Line Format	Set no. of decimal places for 1st line of measuring page.	Selection: X. / X.X / X.XX / X.XXX / X.XXXX / X.XXXXX / X.XXXXXX / X.XXXXXXX / X.XXXXXXXX / Automatic
C5.6.8 2nd Line Variable	Set measurement for 2nd line of measuring page.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity / Totaliser 1 Volume / Totaliser 1 Mass / Totaliser 2 Volume / Totaliser 2 Mass / Totaliser 3 Volume / Totaliser 3 Mass / Operating Hours / Bargraph
C5.6.9 2nd Line Format	Set no. of decimal places for 2nd line of measuring page.	Selection: X. / X.X / X.XX / X.XXX / X.XXXX / X.XXXXX / X.XXXXXX / X.XXXXXXX / X.XXXXXXXX / Automatic
C5.6.10 3rd Line Variable	Set measurement for 3rd line of measuring page.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity / Totaliser 1 Volume / Totaliser 1 Mass / Totaliser 2 Volume / Totaliser 2 Mass / Totaliser 3 Volume / Totaliser 3 Mass / Operating Hours
C5.6.11 3rd Line Format	Set no. of decimal places for 3rd line of measuring page.	Selection: X. / X.X / X.XX / X.XXX / X.XXXX / X.XXXXX / X.XXXXXX / X.XXXXXXX / X.XXXXXXXX / Automatic

Function	Description or requested action	Settings and/or range
C Setup - C5 Display		
C5.7 2nd Meas. Page		
C5.7.1 Function	Set number of lines of display on measuring page.	Selection: One Line / Two Lines / Three Lines
C5.7.2 1st Line Variable	Set measurement for 1st line of measuring page.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity
C5.7.3 Range	Set range for 1st line of measuring page.	-
C5.7.4 Limitation	Set Min/Max for 1st line of measuring page.	Range: -150...150%
C5.7.5 Low Flow Cutoff	Low flow cutoff for 1st line of measuring page.	Range: 0...20%
C5.7.6 Damping	Set damping for 1st line of measuring page.	Range: 0.1...100 s
C5.7.7 1st Line Format	Set no. of decimal places for 1st line of measuring page.	Selection: X. / X.X / X.XX / X.XXX / X.XXXX / X.XXXXX / X.XXXXXX / X.XXXXXXX / X.XXXXXXXX / Automatic
C5.7.8 2nd Line Variable	Set measurement for 2nd line of measuring page.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity / Totaliser 1 Volume / Totaliser 1 Mass / Totaliser 2 Volume / Totaliser 2 Mass / Totaliser 3 Volume / Totaliser 3 Mass / Operating Hours / Bargraph
C5.7.9 2nd Line Format	Set no. of decimal places for 2nd line of measuring page.	Selection: X. / X.X / X.XX / X.XXX / X.XXXX / X.XXXXX / X.XXXXXX / X.XXXXXXX / X.XXXXXXXX / Automatic
C5.7.10 3rd Line Variable	Set measurement for 3rd line of measuring page.	Selection: Volume Flow / Mass Flow / Flow Velocity / Coil Temperature / Conductivity / Level / Pressure / Temperature / Comp. Conductivity / Totaliser 1 Volume / Totaliser 1 Mass / Totaliser 2 Volume / Totaliser 2 Mass / Totaliser 3 Volume / Totaliser 3 Mass / Operating Hours
C5.7.11 3rd Line Format	Set no. of decimal places for 3rd line of measuring page.	Selection: X. / X.X / X.XX / X.XXX / X.XXXX / X.XXXXX / X.XXXXXX / X.XXXXXXX / X.XXXXXXXX / Automatic
C5.8 Graphic Page		
C5.8.1 Select Range	Select range mode for graphic page.	Selection: Manual / Automatic
C5.8.2 Range	Set scaling for graphic page Y-axis.	Range: -100...100%
C5.8.3 Time Scale	Time scale for graphic page X-axis.	Range: 1...100 min

Table 6-15: Description of menu "Setup - C5 Display"

Function	Description or requested action	Settings and/or range
C Setup - C6 Device		
C6.1 Tag	Set measuring point identifier.	-
C6.2 Reset Errors	Reset errors.	Selection: Reset? / No / Yes
C6.3 Config. Management		
C6.3.1 Save Settings	Save settings to backup storage.	Selection: Save Settings / Cancel / Backup 1 / Backup 2 / Continue To Copy? / No / Yes Note: Only access with authorisation. (further information on page 104)
C6.3.2 Load Settings	Load settings from backup storage.	Selection: Load Settings / Cancel / Backup 1 / Backup 2 / Continue To Copy? / No / Yes Note: Only access with authorisation. (further information on page 104)
C6.3.3 Factory Reset	Reset to factory settings.	Selection: Reset? / Cancel / Factory Settings / Yes Note: Only access with authorisation. (further information on page 104)
C6.3.4 Set Operator Passw.	Enable Authentication for Operator role.	Range: 0...9999
C6.3.5 Set Expert Password	Enable Authentication for Expert role.	Range: 0...9999 Note: Only access with authorisation.
C6.3.6 Password Reset	Reset of all passwords. Contact Device Supplier for password.	Selection: Password? / Password Reset
C6.3.7 Write Lock Selection	Selection of locked parameter groups for lock jumper.	Selection: None / Term. C+S / Term. D+S / Term. BD+S / Term. CD+S / Term. ABD+S / Term. BCD+S / Term. ABCD+S / HMI+S+Tot.1 / Term. C+S+HMI+Tot.1 / Term. D+S+HMI+Tot.1 / Term. BD+S+HMI+Tot.1 / Term. CD+S+HMI+Tot.1 / Term. ABD+S+HMI+Tot.1 / Term. BCD+S+HMI+Tot.1 / Term. ABCD+S+HMI+Tot.1 (further information on page 104)
C6.4 Special Functions (further information on page 106)		
C6.4.1 Set Date and Time	Set device date & time (yyyy-mm-dd hh:mm).	-
C6.4.2 Quick Access	Configure quick access function.	Selection: Off / Reset all Totalisers / Reset Totaliser 1 / Reset Totaliser 2 / Reset Totaliser 3
C6.4.4 Cold Start	Reboot device.	Selection: Cold Start / No / Yes
C6.4.5 Menu Display		Selection: Basic / Advanced

Function	Description or requested action	Settings and/or range
C Setup - C6 Device		
C6.5 Units		
C6.5.1 Vol. Flow Timebase	Set timebase for volume flow unit.	Selection: .../s / .../min / .../h / .../d
C6.5.2 Volume Flow	Set displayed units for volume flow.	Selection: L/s; L/min; L/h; m³/s; m³/min; m³/h; cf/s; cf/min; cf/h; gal/s; gal/min; gal/h; IG/s; IG/min; IG/h; barrel/h; barrel/day; Free Unit (set factor and text in the next two functions, sequence see below)
C6.5.3 Text Free Unit	Set free unit text for volume flow.	For text to be specified refer to *Set free units* on page 89:
C6.5.4 [m³/s]*Factor	Set free unit factor for volume flow.	Specification of the conversion factor, based on m³/s: For further information refer to *Set free units* on page 89.
C6.5.5 Mass Flow	Set displayed units for mass flow.	Selection: g/s; g/min; g/h; kg/s; kg/min; kg/h; t/min; t/h; lb/s; lb/min; lb/h; ST/min; ST/h; LT/h; Free Unit (set factor and text in the next two functions, sequence see below)
C6.5.6 Text Free Unit	Set free unit text for mass flow.	For text to be specified refer to *Set free units* on page 89:
C6.5.7 [kg/s]*Factor	Set free unit factor for mass flow.	Specification of the conversion factor, based on kg/s: For further information refer to *Set free units* on page 89.
C6.5.8 Flow Velocity	Set displayed units for flow velocity.	Selection: m/s; ft/s
C6.5.9 Conductivity	Set displayed units for conductivity.	Selection: mS/cm; µS/cm
C6.5.10 Temperature	Set displayed units for temperature.	Selection: °C; °F; K; °R
C6.5.11 Volume	Set displayed units for volume.	Selection: ml; L; hl; m³; in³; cf; yd³; gal; IG; barrel; Free Unit (set factor and text in the next two functions, sequence see below)
C6.5.12 Text Free Unit	Set free unit text for volume.	For text to be specified refer to *Set free units* on page 89:
C6.5.13 [m³]*Factor	Set free unit factor for volume.	Specification of the conversion factor, based on m³: For further information refer to *Set free units* on page 89.
C6.5.14 Mass	Set displayed units for mass.	Selection: mg; g; kg; t; oz; lb; ST; LT; Free Unit (set factor and text in the next two functions, sequence see below)
C6.5.15 Text Free Unit	Set free unit text for mass.	For text to be specified refer to *Set free units* on page 89:
C6.5.16 [kg]*Factor	Set free unit factor for mass.	Specification of the conversion factor, based on kg: For further information refer to *Set free units* on page 89.
C6.5.17 Density	Set displayed units for density.	kg/m³; kg/L; lb/cf; lb/gal; SG; Free Unit (set factor and text in the next two functions, sequence see below)
C6.5.18 Text Free Unit	Set free unit text for density.	For text to be specified refer to *Set free units* on page 89:

Function	Description or requested action	Settings and/or range
C Setup - C6 Device		
C6.5.19 [kg/m³]*Factor	Set free unit factor for density.	Specification of the conversion factor, based on kg/m³: For further information refer to *Set free units* on page 89.
C6.5.20 Pressure	Set displayed units for pressure.	Selection: mH2O(4°C); psi; mbar; bar; kPa; Pa; Free Unit (set factor and text in the next two functions, sequence see below)
C6.5.21 Text Free Unit	Set free unit text for pressure.	For text to be specified refer to *Set free units* on page 89:
C6.5.22 [Pa]*Factor	Set free unit factor for pressure.	Specification of the conversion factor, based on Pa: For further information refer to *Set free units* on page 89.
C6.6 Status Groups (further information on page 109)		
C6.6.1 Proc: Empty Pipe	Change NE107 status signal for status group Process: Empty Pipe.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.2 Sensor: Diagnostics	Change NE107 status signal for status group Sensor: Diagnostics.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.3 Electr: Power Failure	Change NE107 status signal for status group Electr: Power Failure.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.4 Config: Totaliser	Change NE107 status signal for status group Config: Totaliser.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.5 Proc: Pipe not Full	Change NE107 status signal for status group Proc: Pipe not full.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.6 Sensor: Linearity Fail	Change NE107 status signal for status group Sensor: Linearity Fail.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.7 Proc: Flow Condition	Change NE107 status signal for status group Proc: Flow Condition.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.6.8 Electr: IO Connection	Change NE107 status signal for status group Electr: IO Connection.	Selection: Information / Maintenance Required / Function Check / Out Of Specification / Failure
C6.7 OPTICHECK Verification	Activation of OPTICHECK verification feature. Activation code can be obtained by local sales representative.	

Table 6-16: Description of menu "Setup - C6 Device"

Function	Description or requested action	Settings and/or range
C Setup - C7 SIL		
C7.1 Configuration		
C7.1.1 Tag	Set measuring point identifier.	-
C7.1.2 Measurement	Selection of measurement for output C.	Selection: Volume Flow / Mass Flow
C7.1.3 Range	Set range of measurement for output.	-
C7.1.4 Alarm Code	Set error current for current output.	Selection: High / Low
C7.1.5 Low Flow Cutoff	Set low flow cutoff for output in percent of 100%-value.	Range: 0...20%
C7.1.6 Damping	Set damping for output.	Range: 0...100 s
C7.1.7 Terminals C Type	Set or show the output type of terminal C.	Selection: Passive / Active
C7.1.8 Flow Direction	Set the direction of flow in relation to the arrow on the flow sensor.	Selection: Normal Direction / Reverse Direction
C7.1.9 Line Frequency	Set the line frequency of device or in environment.	Selection: 50Hz / 60Hz
C7.1.10 Density	Set density value for calculation of mass flow.	Range: 0.1...5 kg/l
C7.2 Safety Mode	Select safety mode of the device.	Selection: non-SIL Mode / SIL Mode
C7.3 SIL Verification	Verification of safety relevant parameters and lock of the device.	Note: Only available if "Safety Mode" is changed! For detailed information refer to the "Safety manual".
C7.4 Unlock Device	Unlock device.	For detailed information refer to the "Safety manual".
C7.5 Unlock Password	Set unlock password for SIL operation.	Range: 0...9999 Note: Only access with authorisation.

Table 6-17: Description of menu "Setup - C7 SIL"

6.3.4 Set free units

Free units	Sequences to set texts and factors
Texts	
Volume flow, mass flow, mass, volume, density and pressure	3 digits before and after the slash xxx/xxx (max. 6 characters plus a "/")
Permissible characters	A...Z; a...z; 0...9; / - + , . *; @ $ % ~ () [] _
Conversion factors	
Desired unit	= base unit * conversion factor
Conversion factor	Max. 9 digits
Shift decimal point	↑ to the left and ↓ to the right

Table 6-18: Sequences to set texts and factors

6.4 Measurement functions

6.4.1 Flow (C1.1 Flow)

In this menu all settings related to the flow measurement are summarised. These settings are meant to adapt the flow measurement to the application condition. Changes have effect to the flow velocity, the volume flow and the mass flow values.

Flow direction (C1.1.1 Flow Direction)

This function allows the operator to set the direction of flow in relation to the arrow on the flow sensor housing. If "Normal Direction" is selected, a flow in direction of the arrow results in a positive flow rate; if "Reverse Direction" is selected, a flow in direction of the arrow results in a negative flow rate.

Damping (C1.1.2 Damping)

The flow measurements are filtered in order to reduce process noise.
The time constant of this filter can be changed in C1.1.2.

If you require a faster response of the device, e.g. for short batches, you could reduce this time constant.

Process noise suppression (C1.1.3 Process Noise Suppr.)

The signal converter can filter out short pulses in the flow. The strength of this filter can be configured in C1.1.3 (off, low or high).

Low flow cutoff (C1.1.4 Low Flow Cutoff)

The signal converter provides a low flow cutoff (C1.1.4) which is configured using a threshold and a hysteresis value in the unit of the flow velocity.

The low flow cutoff is enabled by default and sets all flow measurement variables to zero when the flow is below the low flow cutoff value entered.
A hysteresis value for the low flow cutoff can be set to avoid that the flow rate toggles between zero and the actual value when the flow rate is close to the low flow cutoff value.

Low flow cutoff hold time (C1.1.5 LFC Hold Time)

The signal converter will hold the flow rate at zero using the low flow cutoff (C1.1.4) for at least the low flow cutoff hold time (C1.1.5), i.e. even if the flow rate falls below the low flow cutoff value only shortly, the flow rate will still be set to zero for the low flow cutoff hold time.

This is useful for applications where the flow rate oscillates rapidly after the flow has been cut off for example using a valve.

Density (C1.1.6 Density)

The signal converter can calculate the mass flow rate from the measured volume flow rate if the density of the process medium is known and constant. The density can be changed in C1.1.6.

Line frequency (C1.1.7 Line Frequency)

The signal converter synchronises the flow measurement to the line frequency in order to suppress line frequency-induced noise (refer to C1.1.8). When the signal converter cannot determine the line frequency automatically (e.g. because a DC power supply is used), the fallback line frequency set in C1.1.7 is used.

In order to optimise signal quality, make sure to use a line frequency matching your environment even when the signal converter is supplied with DC voltage.

Line frequency synchronisation (C1.1.8 Line Frequency Sync.)

The signal converter measures the frequency of the line voltage supplied to the converter and can synchronise the flow measurement to that (refer to C1.1.7). The synchronisation to the measured line frequency can be turned on or off in C1.1.8. If it is turned off, the fallback line frequency (C1.1.7) is used for the synchronisation.

This can also be used to suppress the "No Line Frequency Signal" message when using a DC power supply.

Zero flow calibration (C1.1.9 Zero Calibration)

Refer to calibration section, menu item C1.5.1.

Flow limitation (C1.1.10 Limitation)

The flow measurements are limited to minimum and maximum values: When the flow velocity is higher than the maximum flow velocity configured here, the flow velocity will be set to the maximum flow velocity and the "flow out of range" event is generated. Similarly, when the flow velocity is lower than the minimum flow velocity, the flow velocity is set to the minimum flow velocity and the event is generated.

6.4.2 Conductivity (C1.2 Conductivity)

This menu summarises all settings related to the conductivity measurement. These settings are meant to adapt to the application condition.

Electrode impedance measurement (C1.2.1 Electrode Impedance)

The signal converter can measure the impedance between the electrodes. This is used for several diagnostic functions and the conductivity measurement. The impedance measurement can be turned off in C1.2.2. This activates or deactivates the interaction with the measurement electrodes in order to measure the electrode impedance.

Conductivity measurement (C1.2.2 Conductivity)

The signal converter calculates the conductivity based on the electrode impedance measurement (refer to C1.2.1). This calculation can be turned off completely or any status messages related to the conductivity measurement can be suppressed in C.1.2.2. The interaction with the measurement electrodes is not affected by this setting.

Conductivity limitation (C1.2.3 Limitation)

The conductivity measurements are limited to minimum and maximum values.
When the conductivity is higher than the maximum conductivity configured here, the conductivity will be set to the maximum conductivity and the "conductivity out of range" event is generated. Similarly, when the conductivity is lower than the minimum conductivity, the conductivity is set to the minimum conductivity and the event is generated.
In addition to these fixed settings for the limits, there is an automatic detection for a "conductivity out of range" based on the impedance measurement results. For example long cables may increase the lower limit for the conductivity measurement.

Damping (C1.2.4 Damping)

The conductivity measurements are filtered in order to reduce process noise.
The time constant of this filter can be changed in C1.2.4.

If you require a faster response of the device, e.g. for short batches, you could reduce this time constant.

Conductivity correction scheme (C1.2.5 Cond. Correction)

The signal converter provides two different correction schemes for calculating the conductivity from the electrode impedance.
The correction scheme can be changed in C1.2.5 (automatic, low conductivity or high conductivity).
This manual selection may be used in the rare cases, where the default automatic selection is not working correctly.

Signal cable resistance (C1.2.6 Cable Resistance)

To improve the accuracy of the conductivity measurement at high conductivities, the resistance of the signal cable can be set in C1.2.6.
For installations that have the ground loop connection between terminal 1 and 4 at the flow sensor, an automatic calibration of the cable resistance can be performed in C1.2.6.

Note: The cable resistance entered and shown here is twice the resistance of a single wire in the signal cable.

Electrode factor / conductivity calibration (C1.2.7 EF Electr. Factor)

Refer to calibration section, menu item C1.5.12.

6.4.3 Coil temperature (C1.3 Coil Temperature)

This menu summarises all settings related to the coil temperature.

Coil temperature limitation (C1.3.1 Limitation)

The coil temperature measurements are limited to minimum and maximum values.
When the coil temperature is higher than the maximum coil temperature configured here, the coil temperature will be set to the maximum coil temperature and the "coil temperature out of range" event is generated. Similarly, when the coil temperature is lower than the minimum coil temperature, the coil temperature is set to the minimum coil temperature and the event is generated.

Coil temperature calibration (C1.3.2 Calib. Coil Temp.)

Refer to calibration section, menu item C1.5.11.

6.4.4 Diagnostics (C1.4 Diagnostics)

This menu summarises all parameters related to the diagnostic functions of the signal converter. These values are preset in the factory and there is normally no need to change them.

Virtual reference (C1.4.1 Virtual Reference)

The signal converter can measure the flow rate even without proper grounding by deriving a virtual reference potential from the measured electrode potentials (for details refer to *Virtual reference* on page 35).
The virtual reference functionality is available as a buyable feature. If you have purchased this feature, you can enable the virtual reference in C1.4.1.

Limit for conductivity-based empty-pipe detection (C1.4.2 Limit Empty Pipe)

The signal converter can detect that the pipe is empty based on the conductivity measurement: When the measured conductivity is below the limit configured in C1.4.2, the signal converter will generate the "empty pipe" event.
To disable this kind of empty-pipe detection, set the value to zero.

Note: To disable empty-pipe detection completely, the DC-current-based empty-pipe detection has to be disabled as well (refer to C1.4.3).

DC-current-based empty-pipe detection (C1.4.3 DC Empty Pipe Detection)

The signal converter can detect that the pipe is empty using a small DC current at the electrodes. The signal converter will generate the "empty pipe" event when empty pipe is detected. The level of the current can be configured in C1.4.3 or it can be disabled completely here.

Note: To disable empty-pipe detection completely, the conductivity-based empty-pipe detection has to be disabled as well (refer to C1.4.2).

Full pipe detection (C1.4.4 Full Pipe Detection)

For flow sensors with a full-pipe electrode, the signal converter can detect that the pipe is not completely filled which will generate the "pipe not full" event. The full-pipe detection can be disabled in C1.4.4.

Flow sensor transfer function linearity check (C1.4.5 Linearity)

The signal converter can periodically switch between using the high field current and using the low field current to determine any changes in the linearity of the flow sensor transfer function. The flow sensor transfer function describes how the field current is translated into an electrode voltage by the sensor.
Any change in the linearity of this function indicates a failure in the flow sensor or sensor electronics.
The check is only available for flow sensors that actually can be driven and have been calibrated using both the high and the low field current. The check can be disabled in C1.4.5.

If the difference between measurement using the high current and using the low current is higher than the limit, the event "linearity failure" is generated. The limit consists of a fixed part (refer to C1.4.7) and a part relative to the flow velocity (refer to C1.4.6).

Relative limit for linearity check (C1.4.6 Linearity Limit %)

This is the part of the limit for the linearity check that is relative to the flow velocity (refer to C1.4.5), i.e. this value is irrelevant at zero flow and becomes more important at high flows.

Limit for linearity check (C1.4.7 Linearity Limit)

This is the fixed part of the limit for the linearity check (refer to C1.4.7), i.e. this is an offset to the limit relevant at all flow velocities.

Relative limit for electrode noise (C1.4.8 Electr. Noise Limit %)

The signal converter can measure the noise of the electrode voltage measurement and generate an "electrode noise too high" event if the noise exceeds a limit. The limit consists of a fixed part (refer to C1.4.9) and a part relative to the flow velocity (C1.4.8). The relative part is irrelevant at zero flow and becomes more important at high flows.

Too high electrode noise can be an indication for soiled electrodes, electrode corrosion, too low conductivity of the medium or for gas bubbles, solids or chemical reactions in the medium.

Limit for electrode noise (C1.4.9 Electrode Noise Limit)

This is the fixed part of the limit for the electrode noise (refer to C1.4.8), i.e. this is an offset to the limit relevant at all flow velocities.

Relative limit for flow noise (C1.4.10 Flow Noise Limit %)

The signal converter can measure the noise of the flow measurement and generate a "flow noise too high" event if the noise exceeds a limit. The limit consists of a fixed part (refer to C1.4.11) and a part relative to the flow velocity (C1.4.10).
The relative part is irrelevant at zero flow and becomes more important at high flows.

Too high flow noise is related to the flow changes. These are defined by the process and the type of the used pump.

The relative limit for the flow noise is by default set high enough to practically deactivate these diagnostics.

Limit for flow noise (C1.4.11 Flow Noise Limit)

This is the fixed part of the limit for the flow noise (refer to C1.4.8), i.e. this is an offset to the limit relevant at all flow velocities.

Field coil resistance ratio (C1.4.12 Field Coil Ratio)

When a flow sensor with a field coil mid-point is used, the signal converter can detect failures in the field coils by measuring the resistances of both halves of the field coils.
From these resistances, a ratio is calculated. The ratio is compared against a known good value usually determined during production of the flow sensor. The value can also be determined automatically or changed manually in C1.4.12.

Limit for field coil resistance ratio check (C1.4.13 Field Coil Ratio Limit)

In C1.4.13, the maximum allowed deviation for the field coil ratio from the stored good value can be set (refer to C1.4.12). When the allowed deviation is exceeded, a "coil unsymmetrical" event is generated.

Relative limit for electrode asymmetry detection (C1.4.14 Electr. Sym. Limit %)

The signal converter can detect asymmetries in the flow measurement of each electrode measurement and generate an "electrodes unsymmetrical" event if the asymmetry exceeds a limit. The limit consists of a fixed part and a part relative to the flow velocity (C1.4.11).
The relative part is irrelevant at zero flow and becomes more important at high flows.

6.4.5 Calibration (C1.5 Calibration)

This menu summarises all values, which are calibrated during the factory calibration.
These values may be inspected here. Normally there is no need to change them.

Zero flow calibration (C1.5.1 Zero Calibration)

To ensure that the signal converter shows zero flow rate when there is really no flow in the pipe, a zero flow offset is used. This offset is determined during production of the device but it can also be set or automatically determined in C1.5.1.
Three different calibration modes are available:

Calibration mode	Description
Manual	Enter a zero flow offset (e.g. from a calibration certificate) manually.
Automatic	Let the signal converter determine the zero flow offset automatically. Make sure that the actual flow rate in the pipe is zero and that all valves are closed during the calibration.
Factory	Reset the zero flow offset to the value determined during production of the device.

Table 6-19: Calibration modes for zero flow calibration

Type of flow sensor size configuration (C1.5.2 Size Type)

The size of the flow sensor pipe (i.e. the diameter) can be configured in two different ways: Either the size is selected from a pre-defined list of sizes or entered directly. Which option is used to set the flow sensor size in C1.5.3 can be chosen in C1.5.2.

Flow sensor size (C1.5.3 Size)

The signal converter calculates the volume flow rate from the flow velocity using the flow sensor size entered in C1.5.3. There are two different ways of configuring the flow sensor size (refer to C1.5.2).

Field current level selection (C1.5.4 GK Type)

The signal converter can provide two different levels of field current to the sensor (high using GK current and low using GKL current). Which current levels to use can be set in C1.5.4.
When using "GK and GKL", the signal converter can periodically switch between the high and the low field current (refer to C1.4.5).

Device-specific constant for high current (C1.5.5 GK)

The device-specific constant GK describes how the flow sensor translates field current into flow velocity when using the high field current. It is determined during calibration of the flow sensor and printed on the nameplate of the flow sensor.
The value of GK can be inspected and edited in C1.5.5.

Device-specific constant for low current (C1.5.6 GKL)

The device-specific constant GKL describes how the flow sensor translates field current into flow velocity when using the low field current. It is determined during calibration of the flow sensor and printed on the nameplate of the flow sensor.
The value of GKL can be inspected and edited in C1.5.5.

Offset for GKL with linearity check (C1.5.7 GKL Shift)

Some sensors show a slight shift in the value of the device-specific constant GKL (refer to C1.5.6) when the linearity check (refer to C1.4.5) is enabled. This effect can be compensated by setting an offset in C1.5.7.

Field frequency (C1.5.8 Field Frequency)

The frequency of the field current can be set in C1.5.8. The setting is relative to the line frequency (refer to C1.1.7 and C1.1.8). A higher field frequency implies a higher update rate of the flow measurement whereas a lower field frequency offers a flow measurement that is more stable due to increased averaging time.

Not all flow sensors can be driven using the highest field frequencies; the signal converter will generate a "field frequency too high" event to indicate that.

Settling mode (C1.5.9 Settling Mode)

In order to measure the flow rate, the signal converter uses a constant magnetic field whose polarity is switched periodically. After a polarity switch, it takes some time for the magnetic field to stabilise. Ideally, the flow rate is only measured when the magnetic field is stable.
The settling mode (C1.5.9) determines how long the signal converter waits for the magnetic field to become stable.

Settling mode	Description
Standard	Allows for high number of samples (less noise).
Maximum	Uses the highest settling time possible (less samples).
Manual	Uses a fixed settling time (refer to C1.5.10).

Table 6-20: Settling modes

Settling time (C1.5.10 Settling Time)

The settling time that will be used when the settling mode is set to "Manual" (refer to C1.5.9) can be set in C1.5.10.

Coil temperature calibration (C1.5.11 Calib. Coil Temp.)

To ensure a correct coil temperature measurement, the resistance of the field coils at +20°C / +68°F needs to be correctly set in the signal converter. This nominal resistance is determined during production of the device but it can also be set or automatically determined in C1.5.11.

Three different calibration modes are available:

Calibration mode	Description
Manual	Enter a nominal field coil resistance manually.
Automatic	Let the signal converter determine the nominal field resistance automatically. The current coil temperature needs to be entered as the target value at the start of the calibration.
Factory	Reset the nominal field coil resistance to the value determined during production of the device.

Table 6-21: Calibration modes for coil temperature calibration

Electrode factor / conductivity calibration (C1.5.12 EF Electr. Factor)

To ensure a correct conductivity measurement, the electrode factor of the flow sensor needs to be correctly set in the signal converter. The electrode factor is determined during production of the device but it can also be set or automatically determined in C1.5.12.

Three different calibration modes are available:

Calibration mode	Description
Manual	Enter an electrode factor (e.g. from a calibration certificate) manually.
Automatic	Let the signal converter determine the electrode factor automatically. The current conductivity of the process medium needs to be entered as the target value at the start of the calibration.
Factory	Reset the electrode factor to the value determined during production of the device.

Table 6-22: Calibration modes for conductivity calibration

Electrode configuration (C1.5.13 Electrode Config.)

The configuration of the electrodes in the flow sensor can be set in C1.5.13.
The possible values are:

- 2 Electrodes
- 3 Electrodes (2 measurement electrodes + reference electrode)
- 4 Electrodes (2 measurement electrodes + reference electrode + full-pipe electrode)
- 2 Electrodes + 2 Ground connections

Field coil configuration (C1.5.14 Field Coil Config.)

The configuration of the field coils in the flow sensor can be set in C1.5.14.
The possible values are:

- With Mid Point
- Without Mid Point

6.5 I/O configuration

6.5.1 Damp output signals

All digital and analogue outputs provide damping with a digital filter which allows to stabilise the output. The damping can be individually set for each output by a time constant. However, keep in mind that the degree of filtration affects the response time of the device in the event of rapid changes.

The general behaviour of the damping value is:

- Small damping:
  - Fast response times
  - Fluctuating reading
- Large damping:
  - Slow response time
  - Stable reading

The damping corresponds to the elapsed time until 63% of the end value has been reached according to a step function. The time until 90% of the end value is reached in case of a step response is T90 = τ * 1.8 (τ = damping).

6.5.2 Suppress small flow rates

All digital and analogue outputs provide a low flow cutoff for flow measurements in order to suppress small flow rates.
If the low flow cutoff has been activated, the respective output is set to zero when the flow is below the low flow cutoff value entered. The value can be entered as a percentage of the upper range value or in the case of a pulse output as a discrete flow value.

Two values must be entered. The first is for the threshold for low flow rates of the flow sensor and the second is for hysteresis.
Condition: 2nd value ≤ 1st value

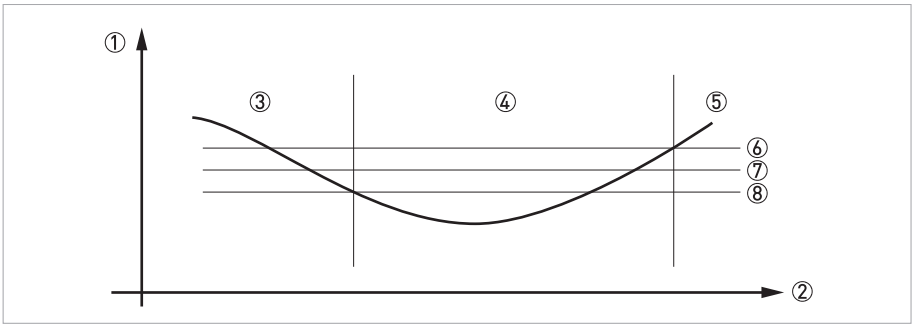


Figure 6-6: Indication of low flow cutoff

① Flow
② Time
③ Currently indicated flow
④ Display set to zero
⑤ Currently indicated flow
⑥ Positive hysteresis
⑦ Threshold
⑧ Negative hysteresis

6.5.3 Polarity of measurement

All digital and analogue outputs provide a polarity setting for flow measurements which allows:

Polarity	Function
Both	Polarity function does not affect output values.
Positive	Positive values passed to output, negative values set to 0.
Negative	Absolute value of negative values passed to output, positive values set to 0.
Absolute	Absolute value of input values.

Table 6-23: Description of polarities

INFORMATION!
For reverse flow detection at a current output set polarity to "Both" and select the lower and upper flow range values for your application.

6.5.4 Current output

The current outputs of the signal converter have several operation modes which can be configured by the current span and the alarm signal. The lower and upper range value is mapped to the lower and upper endpoint as depicted in the following figure:

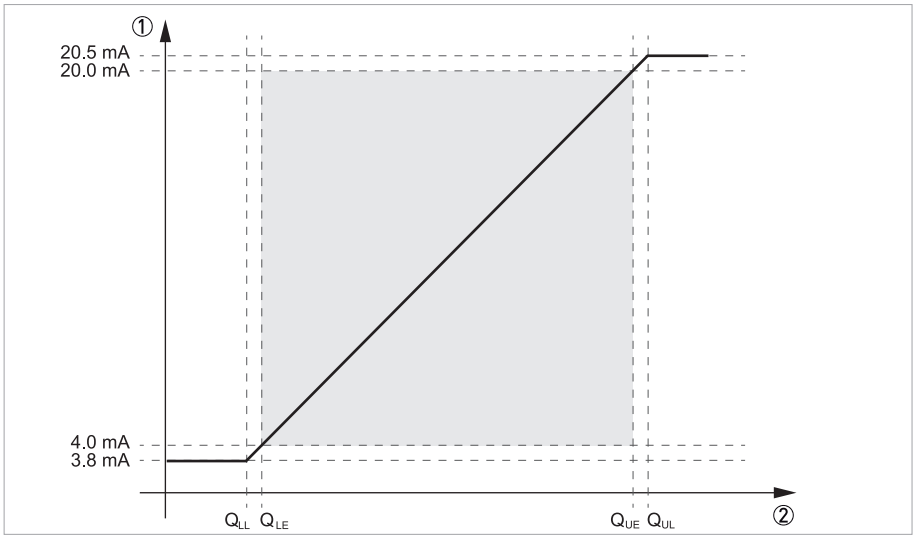


Figure 6-7: Operation modes of the current output

① Output current
② Measuring value

Current span	Lower limit (Q_{LL})	Lower end point (Q_{LE})	Upper end point (Q_{UE})	Upper limit (Q_{UL})	Low alarm	High alarm
4...20	3.8 mA	4.0 mA	20.0 mA	20.5 mA	3.5 mA	21.5 mA
0...20 ①	0 mA	0 mA	20.0 mA	20.0 mA	0 mA ②	21.5 mA
Custom	Custom value (C2._.8)	Custom value (C2._.7)	Custom value (C2._.7)	Custom value (C2._.8)	Custom value (C2._.9)	

Table 6-24: Limit values

① Only available if HART is disabled or not available for respective current output
② Low alarm signalling is not recommended for current span 0...20 mA

Reaching the lower or upper limit is signalled by the status "Out of Specification" but does not set an alarm signal. All current outputs detect an open loop or output current errors due to exceeded load values.

6.5.5 Alarm signalling via current outputs

Current outputs provide an alarm signalling via upper or lower failure current.
The alarm signal is set by default in case of device failure, i.e. if the status signal failure is set.
If additional status signals should be considered, the error condition can be changed:

Alarm condition	Evaluated status signals
Failure	Failure
Out of Spec	Failure or Out of Spec
Safety Rel. Failure	Failures in sensor electronics or current output C

Table 6-25: Alarm conditions

6.5.6 Pulse output and batching applications

Pulse outputs of the signal converter are designed for minimum latency and suited for use with pulse counters (mechanical, digital) or provers (e.g. small volume provers).
Select the maximum output frequency according to your counter.

Some custody transfer applications require dual phase pulse outputs. For this purpose pulse outputs from two terminals can be paired. Terminal pairs A and B or D and B can be used.
In this case, the frequency is limited to a maximum of 5000 Hz.

In this case, perform the following settings:

- Configure pulse output terminal A or D
- Set "Output B" to phase shifted mode in menu C2.3.10 by choosing the base pulse output (A or D). All functions for output B are set using output D or output A.
- Phase shift relative to output A: set phase shift (0°, 90° or 180°) in menu C2.2.10
  Phase shift relative to output D: set phase shift (0°, 90° or 180°) in menu C2.4.10

6.6 Display configuration

6.6.1 Optical keys (C5.3 Optical Keys)

This function can deactivate the optical operating keys. In this case, the device may only be operated using the push buttons. In the display, the switched off state of the optical keys is represented the following symbol in the upper right corner:

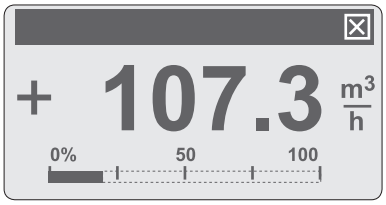


Figure 6-8: Indication of optical keys in switched off state

This functionality is only available if "C6.4.5 Menu Display = Advanced".

6.6.2 Backlight (C5.4 Backlight)

The signal converter local display has a colour backlight which can be used to show the NE 107 status. In menu C5.4 its behaviour can be configured as described in the following table:

Backlight settings	Description
Off	Backlight always turned off.
White	Backlight colour is always white.
Red - Failure	Backlight colour is set to red in case of a device failure.
NE107 Color	Backlight colour is set according to the NE 107 status of the device.

Table 6-26: Description of backlight settings

The following table lists the colours and the NE 107 status signal for the setting “NE107 Color”:

Status signal	Backlight colour
Failure	Red
Function check	Orange
Out of specification	Yellow
Maintenance required	Blue
Good	White

Table 6-27: Description of backlight colours and status signals for backlight setting “NE107 Color”

This functionality is only available if "C6.4.5 Menu Display = Advanced".

6.7 Configuration management

6.7.1 Load and save configuration (C6.3.1 Save Settings & C6.3.2 Load Settings)

The signal converter provides functions to store and restore sets of configurations (Backup 1 and Backup 2). Using the functions in C6.3.1 the present configuration can be stored for later restoration via C6.3.2.

For documentation purposes please note the checksum for the present configuration (B1.2 Change Log).

6.7.2 Factory reset (C6.3.3 Factory Reset)

The signal converter configuration can be reset to factory configuration.

INFORMATION!
Be careful with this function because this process cannot be reverted.

6.7.3 Change log (B1.2 Change Log)

Any configuration change of the signal converter is logged within a change log (B1.2) with date and time and a checksum of the signal converter configuration. The change log covers all device parameters (including factory parameters) and provides 128 entries.

6.7.4 Locking of configuration

Access authentication

The signal converter has a multilevel access authentication concept which allows to protect the entire configuration against unauthorised write accesses. The access authentication is disabled by default, however can be enabled by setting an operator password that is not equal to 0000. In case of an enabled access authentication, write accesses via any interface (local display, HART®, ...) can only be performed after authentication by entering the respective access level password (refer to next table). Entering this password only unlocks the currently used interface but no other interfaces.

Level	Description	Authentication
0	User / Free	No authentication necessary.
1	Operator	Operator password (C6.3.4 Set Operator Passw.) or no authentication necessary if operator password not set (0000).
2	Expert	Expert password (C6.3.5 Set Expert Passw.). Default password is 9999.
2	Service	Service password.
Jumper	Application Specific Lock	Remove jumper.

Table 6-28: Available access levels

A lock of parameters and functions via access authentication is indicated as depicted in the following figure:

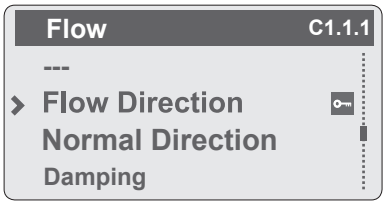


Figure 6-9: Indication of access authentication

Application specific lock (C6.3.7 Write Lock Selection)

Custody transfer (CT) applications require a lock for all parameters and functions which affect the relevant measurement and outputs. For this purpose the signal converter provides an application specific lock which can be enabled by a jumper. The lock mechanism can be configured before applying the jumper in order to lock only CT relevant functions and parameters. The following table shows the locking combinations which can be selected in C6.3.7 and the respective locked functionalities and parameters:

x = locked configuration

Selection in C6.3.7 / Locked entries	Terminal A	Terminal B	Terminal C	Terminal D	Sensor	Totaliser 1	HMI
None	-	-	-	-	-	-	-
Term. C+S	-	-	x	-	x	-	-
Term. D+S	-	-	-	x	x	-	-
Term. BD+S	-	x	-	x	x	-	-
Term. CD+S	-	-	x	x	x	-	-
Term. ABD+S	x	x	-	x	x	-	-
Term. BCD+S	-	x	x	x	x	-	-
Term. ABCD+S	x	x	x	x	x	-	-
HMI+S+Tot.1	-	-	-	-	x	x	x
Term. C+S+HMI+Tot.1	-	-	x	-	x	x	x
Term. D+S+HMI+Tot.1	-	-	-	x	x	x	x
Term. BD+S+HMI+Tot.1	-	x	-	x	x	x	x
Term. CD+S+HMI+Tot.1	-	-	x	x	x	x	x
Term. ABD+S+HMI+Tot.1	x	x	-	x	x	x	x
Term. BCD+S+HMI+Tot.1	-	x	x	x	x	x	x
Term. ABCD+S+HMI+Tot.1	x	x	x	x	x	x	x

Table 6-29: Possible locking combinations

The lock is enabled directly after applying the jumper and is indicated by a lock icon in the upper right corner or at the locked parameter or function.

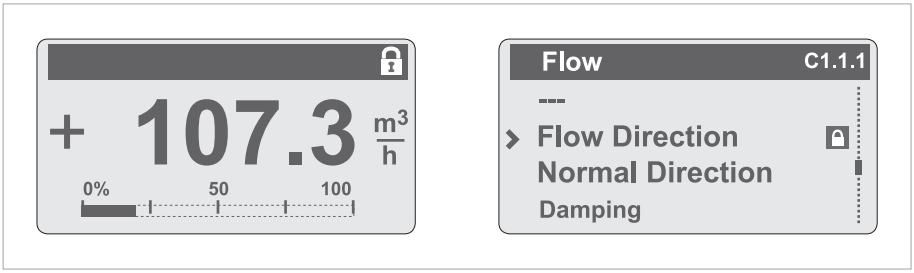


Figure 6-10: Indication of lock icon

Changes to these parameters only can be performed after removal of the lock jumper.

6.8 Special functions

Quick access (C6.4.2 Quick Access)

The local display provides a quick access function which can be used to reset totaliser 1, 2, 3 or all totalisers. Pressing the "↵" key (press 2.5 seconds for the optical key) carries out the "Quick Access" function.
By default, if the menu C6.4.2 is set to "Off", the quick access function is connected to the "Display Test".

Date and time (C6.4.1 Set Date and Time)

The signal converter has a real time clock which is used for all of the log functions in the device. This function can be used to set the date and time of the real time clock.

This functionality is only available if "C6.4.5 Menu Display = Advanced".

Menu display (C6.4.5 Menu Display)

The signal converter local menu is designed to show by default only commonly used functions and parameters. For some applications additional functions (e.g. damping, ...) are required which are only available if C6.4.5 is set to "Advanced".

Some of these functions and parameters require the authentication for the Expert role. They will be reset to factory values when the device is set to SIL mode (only SIL capable device).

6.9 Safe configuration (only for SIL capable devices)

Refer to "OPTIFLUX x400 Safety manual" in case of functional safe device variant.

6.10 Testing of device installation (B3 Simulation)

During installation of the device, the configuration should be tested using simulation functions of the signal converter (B3). The following simulation functions are available:

Function	Description
B3.2 Volume Flow	Simulation of process variable volume flow.
B3.3 Mass Flow	Simulation of process variable mass flow.
B3.4 Flow Velocity	Simulation of process variable flow velocity.
B3.5 Coil Temperature	Simulation of process variable coil temperature.
B3.6 Conductivity	Simulation of process variable conductivity.
B3.7 I/O A to B3.10 I/O D	Simulation of output signals for I/Os.

Table 6-30: Available simulation functions

INFORMATION!

- *Several simulation functions can run in parallel.*
- *Simulations affect all process variables calculated from the simulated process variable: "mass flow" is calculated from "volume flow" which is calculated from "flow velocity". Thus simulation of "flow velocity" has effect on "volume flow" and "mass flow" and all outputs connected to them.*

WARNING!

Once started simulation functions continue until they are stopped or the device performs a power cycle. The device status "Function Check" indicates running simulation functions. Use function "B3.1 Stop all Simulations" to stop all running simulation functions simultaneously.

6.11 Diagnostic information and status messages

The signal converter continuously carries out various diagnostic functions during operation. The diagnostic functions are e.g.:

- Redundant sensor signal monitoring
- Monitoring of internal voltages and validation against references
- CPU memory, instruction and register checks
- Logical and temporal monitoring
- Internal communication monitoring
- Electronics temperature monitoring
- Current loop monitoring
- Sensor integrity monitoring (noise detection, sensor linearity check, electrode asymmetry check)
- Process conditions monitoring (empty-pipe detection, full-pipe detection, noise detection, flow profile asymmetry check)
- Sensor cable monitoring (short or open circuits)

This diagnostic information is displayed in accordance with NAMUR standard NE 107.

To facilitate identification of the problem source, all messages are sorted into the status groups:

- Sensor
- Configuration
- Electronics
- Process

Each status group has one status signal. There are 16 status groups with fixed status signals and 8 groups with variable status signals.

INFORMATION!
As status message always the name of the relevant status group and the status signal is displayed.

The variable status signal can be changed in menu C6.6. Changing the status signal to "Information" switches off the message.

6.11.1 Status groups (C6.6 Status Groups)

Each status group has a defined status signal and contains several status messages.

*: Status signal cannot be changed.
F: Failure
C: Function Check
S: Out of Specification
M: Maintenance Required

	Status group	Description
F*	Sensor	"Failure" in sensor.
F*	Electronics	"Failure" in electronics.
F*	Configuration	"Failure" in configuration.
F*	Process	"Failure" in process.
C*	Sensor	"Function Check" in sensor.
C*	Electronics	"Function Check" in electronics.
C*	Configuration	"Function Check" in configuration.
C*	Process	"Function Check" in process.
S*	Sensor	"Out of Specification" in sensor.
S*	Electronics	"Out of Specification" in electronics.
S*	Configuration	"Out of Specification" in configuration.
S*	Process	"Out of Specification" in process.
M*	Sensor	"Maintenance Required" in sensor.
M*	Electronics	"Maintenance Required" in electronics.
M*	Configuration	"Maintenance Required" in configuration.
M*	Process	"Maintenance Required" in process.
S	Electr: IO Connection	Open circuit or too big load at current output.
S	Proc: Flow Condition	Flow or electrode noise exceeds limit. Causes: soiled electrodes, too low conductivity of the medium or by gas bubbles, solids or chemical reactions in the medium.
S	Sensor: Linearity Fail	Sensor linearity check fails. Measured flow values for different field current levels are not equal. Causes: strong external magnetic fields, or a defect in the sensor electronics.
S	Proc: Pipe not full	Pipe not completely filled (only available in 4 electrode flow sensors).
S	Config: Totaliser	Overflow of any totaliser.
I	Electr: Power Failure	Power failure occurred.
S	Sensor: Diagnostics	Sensor diagnostics for field coils or electrodes.
I	Proc: Empty Pipe	Empty pipe.
I*	Sensor Operation	Sensor operation information.
I*	Config:No Meas.Val.	No measurement value.
I*	Electr: Operation	Electronics operation information.

Table 6-31: Description of status groups

6.11.2 Status log (B1.1 Status Log)

The history of status messages is logged by the signal converter with date and time. Menu B1.1 shows the log of a status event.

↦	Shows the beginning of a status event.
⇥	Shows the end of a status event.

Table 6-32: Symbols for the log of a status event

6.11.3 Reset errors (A2.1 Reset Errors)

Some diagnostic functions generate latching status messages which need to be acknowledged by the operator. For this purpose use "Reset Errors" in A2.1.

7.1 Replacing the signal converter electronics

DANGER!
Work on the signal converter electronics may only be performed when disconnected from the power supply.

DANGER!
Electrical connection is carried out in conformity with the VDE 0100 directive "Regulations for electrical power installations with line voltages up to 1000 V" or equivalent national regulations.

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

DANGER!
Observe the waiting period for Ex devices.

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.

- Remove the front panel. Use a small screwdriver to open the plastic clips that hold the display.
- Remove the 2 locking screws.
- Carefully pull the electronics almost completely out of the housing.
- Remove the sensor cable from the electronics before removing the signal converter electronics to be replaced.

- To insert the new electronics, first connect sensor cable to the electronics.
- Carefully push the electronics back into the housing.
- Tighten the 2 locking screws again and secure the display.

➲ The signal converter recognises the hardware replacement when the power supply is switched on.

7.2 Spare parts availability

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

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

7.3 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 Repairs

Repairs must be carried out exclusively by the manufacturer or the manufacturer authorised specialist companies.

7.5 Returning the device to the manufacturer

7.5.1 General information

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

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

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

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

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

7.5.2 Form (for copying) to accompany a returned device

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

Company:		Address:
Department:		Name:
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:		

7.6 Disposal

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

Separate collection of WEEE (Waste Electrical and Electronic Equipment):

According to the directive 2012/19/EU or UK Regulation 2013 No. 3113, the monitoring and control instruments marked with the WEEE symbol and reaching their end-of-life **must not be disposed of with other waste**.
The user must dispose of the WEEE to a designated collection point for the recycling of WEEE or send them back to our local organisation or authorised representative.

7.7 Disassembling the signal converter

This section briefly describes the instructions of handling and disassembling the device when it has reached the end of its useful life (EOL) or is disposed of after usage. The information given is sufficient to gather the most important parts of the device (by the end-user) which can be used for recycling.

Detailed information needed by WEEE collection and/or dismantling centre and recycling operators (and companies) is available on request at the support centre.

The signal converter is available in different versions and variants. The housing of the device and its components inside are broadly used. Therefore this handbook describes the main, standard versions. Where available, additional data will be mentioned. For specific data concerning versions, please contact the support centre.

Product description and data/info:

Measuring device: Electromagnetic signal converter for flow measurement

Depending on version: (values ± 5%)		**Type**			
L x W x H:		**Field version**		**Compact version**	
		[mm]	[inch]	[mm]	[inch]
		215 x 300 x 277	8.5 x 11.8 x 10.9	215 x 260 x 155	8.5 x 10.2 x 6.1
Volume:		0.006 m³	370 inch³	0.0053 m³	325 inch³
Total weight:	Aluminium version	6.1 kg	13.5 lb	4.3 kg	9.5 lb
Weight%; metal parts:		87%		89%	
Weight%; plastic parts:		5%		4%	
Weight%; electronics; PCB		8%		7%	

Table 7-1: Field & compact version

INFORMATION!
The device has to be de-installed from the piping-circuit and cleaned properly before disassembling is possible. The device is RoHS compliant.

DANGER!
The device MUST be disconnected from mains power before disassembling.

CAUTION!
- *Wear personal protective equipment.*
- *Make sure that you use a stable workplace/bench to do the disassembly actions.*

INFORMATION!
Before disassembling the device, make sure you have the proper tools needed:
- *Torx screwdriver set*
- *Pozidriv screwdriver set*
- *Adjustable wrench or wrench set (e.g. 10-27 mm)*

There are no special guidance or actions necessary to disassemble the device.

7.7.1 Aluminum or stainless steel C (compact) version

Disassembling the device

- Remove the covers (③ - ⑥) of the housing ① by unscrewing them.
  Non-standard versions can have interlocking heads screws which then have to be unscrewed first with 4 mm Allen key.
- Disconnect all electric cables from connection terminals (if still attached).
- Remove all the cable glands, (stopping) plug and plastic insert(s) of the housing.
- Remove the PC board with connection terminals and connectors ② (IFC 400 only).
- Remove the electronics insert and display ⑤.
- Unscrew the backplane PC board ⑦ inside the housing, together with the terminal block (T20) and disconnect all the wiring from the terminal block.
- Remove both the plastic cable covers and backplane and push the cabling (feed-through) inside the housing ① and remove it then completely.

➲ All main parts are now disassembled and can be shipped separately for reuse and/or recycling.

Exploded view

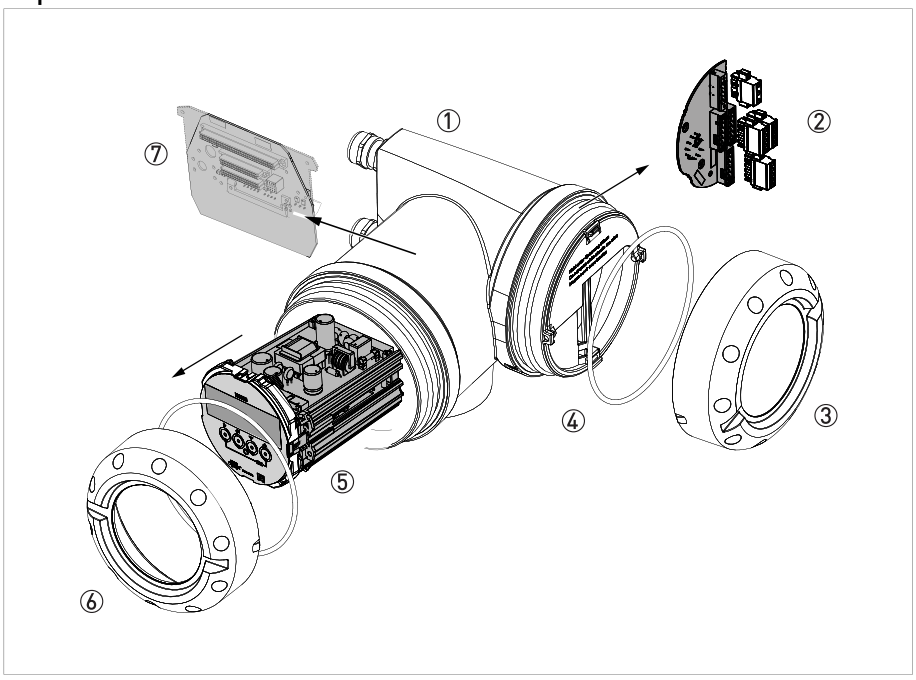


Figure 7-1: Disassembled compact device

① Signal converter housing
② PC board with terminals and connectors (only for IFC 400)
③ Cover of electric and I/O connections compartment
④ Plastic housing insert with rubber ring
⑤ Electronic insert with display unit
⑥ Cover of electronic insert/display compartment and rubber ring (depending on version; glass window)
⑦ Backplane PC board for connection inside the housing (varies per version ordered)

7.7.2 Aluminium or stainless steel F (remote) version

Disassembling the device

- Remove the covers (③ - ⑥) of the housing ⑧ by unscrewing them.
  Non-standard versions can have interlocking heads screws which then have to be unscrewed first with 4 mm Allen key.
- Disconnect all electric cables from connection terminals (if still attached).
- Remove all the cable glands, (stopping) plug and plastic insert(s) of the housing.
- Remove the PC board with connection terminals and connectors ① (IFC 400 only).
- Remove the electronics insert and display ⑤.
- Unscrew the cable terminal in the console ④ and remove the terminal and cable.
- Unscrew the backplane PC board ⑦ inside the housing, together with the terminal block (T20) and disconnect all the wiring from the terminal block.
- Remove both the plastic cable covers and backplane and push the cabling (feed-through) inside the housing ⑧ and remove it then completely.
- By unscrewing of the four M10 bolts, the housing and console ④ can also be separated.

➲ All main parts are now disassembled and can be shipped separately for reuse and/or recycling.

Exploded view

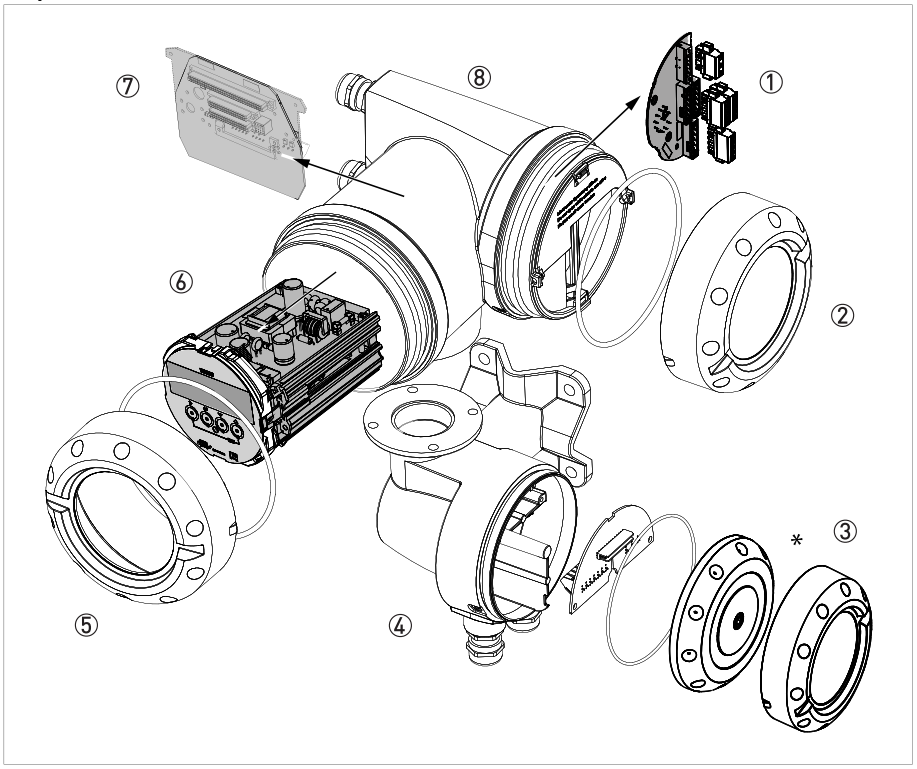


Figure 7-2: Disassembled field device

① PC board with terminals and connectors (only for IFC 400)
② Cover of electric and I/O connections compartment
③ Cover of sensor connections compartment (* "old" version with Allen bolt mount)
④ Console sensor connection part
⑤ Cover of electronic insert/display compartment (depending on version; glass window)
⑥ Electronic insert with display unit
⑦ Backplane PC board for connection inside the housing (varies per version ordered)
⑧ Signal converter housing

7.7.3 Location of battery (only for advanced HMI)

The battery is located on the PCB as shown in the following figure.

- Remove the battery ⑤ by taking out of the holder.
- Lead it to the re-usage and/or recycling process.

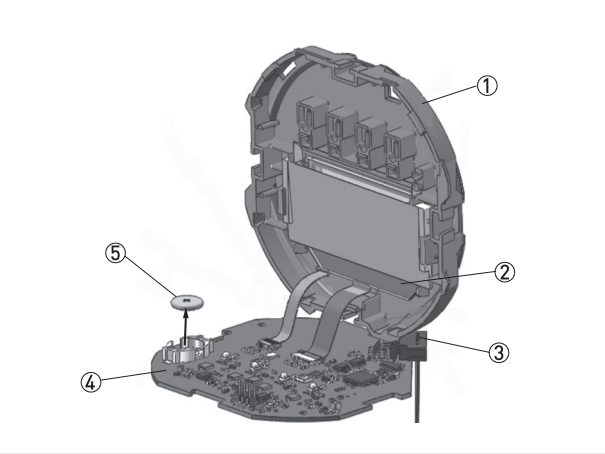


Figure 7-3: Location of battery on display unit

① Front panel
② LCD display
③ Pre-assembled cable
④ PCB
⑤ Battery

7.7.4 Overview of the signal converter materials and components

The items mentioned in the listing below are the main parts of the device.

The signal converter can be ordered in different versions. The next tables show the data of the normal (standard) versions in compact and F (field) housing. Please contact our Support Service for details of special versions with additional features on I/O and/or Ex.

Materials/components, which must be removed and treated separately

Material (or material code)	Weight		Additional information
	[kg]	[lb]	
Printed circuit boards	0.64	1.4	Average size: 600 cm^2 / 9.8 $inch^2$ (± 5%)
Electrolyte capacitor	*	*	* The PC boards of the electronic insert contains totally 20 cm^3 of electrolytic capacitors (depending on I/O configuration)
Battery	0.0009**	0.002**	** Only for advanced HMI (IFC 400)
LCD screen/glass	0.09	0.2	Screen size < 25 cm^2 The cover contains a glass screen 70 g / 0.16 lb
Plastics with brominated flame retardance	-	-	-
Noble/precious metal	-	-	-

Table 7-2: Signal converter in compact version

Material (or material code)	Weight		Additional information
	[kg]	[lb]	
Printed circuit boards	0.64	1.4	Average size: 600 cm^2 / 9.8 $inch^2$ (± 5%)
Electrolyte capacitor	*	*	* The PC boards of the electronic insert contains totally 20 cm^3 of electrolytic capacitors (depending on I/O configuration)
Battery	0.0009**	0.002**	** Only for advanced HMI (IFC 400)
LCD screen/glass	0.09	0.2	Screen size < 25 cm^2 The cover contains a glass screen 70 g / 0.16 lb Note: for Ex versions ~300 g / 0.66 lb
Plastics with brominated flame retardance	-	-	-
Noble/precious metal	-	-	-

Table 7-3: Signal converter in field version

Material/components, which can disturb recycling processes

Material (or material code)	Weight		Additional information
	[kg]	[lb]	
Mixture ABS / steel	-	-	-
Metal mixture	0.09	0.20	e.g. bolts, washers, screws, cable clamp
Plastics mixture	-	-	-
Silicon / rubber	0.02	0.04	O-rings
PVC & connector parts	0.01	0.02	e.g. cabling and foils (display)
Copper, brass	0.024	0.053	Gold-plated connector, copper wire

Table 7-4: Signal converter in compact version

Material (or material code)	Weight		Additional information
	[kg]	[lb]	
Mixture ABS / steel	-	-	-
Metal mixture	0.111	0.244	e.g. bolts, washers, screws, cable clamp, terminal plate
Plastics mixture	-	-	-
Silicon / rubber	0.030	0.07	O-rings
PVC & connector parts	0.013	0.03	e.g. cabling and foils (display)
Copper, brass and other	0.024	0.053	Gold-plated connector, copper wire

Table 7-5: Signal converter in field version

Beneficial material/components, useful for recycling

Material (or material code)	Weight		Additional information
	[kg]	[lb]	
Stainless steel	10.94 ①	24.12 ①	① Data only applicable for stainless steel housing (incl. covers)
Aluminium	3.6 ②	7.9 ②	② Data only applicable for aluminum housing (incl. covers)
Polyamide	0.36	0.79	Plastic screens and sections inside housing
Printed circuit boards	0.64	1.4	Separate electronic units
Cabling	*	*	All cables are detachable from the device
Ferrite	negligible		-
Copper, brass	negligible		-

Table 7-6: Signal converter in compact version

Material (or material code)	Weight		Additional information
	[kg]	[lb]	
Stainless steel	12.24 ①	27.0 ①	① Data only applicable for stainless steel housing (incl. covers)
Aluminium	4.8 ②	10.6 ②	② Data only applicable for aluminum housing (incl. covers)
Polyamide	0.36	0.79	Plastic screens and sections inside housing
Printed circuit boards	0.64	1.4	Separate electronic units
Cabling	*	*	All cables are detachable from the device
Ferrite	negligible		-
Copper, brass	negligible		-

Table 7-7: Signal converter in field version

Total (average) *	[kg] *	[lb] *	* depending on version (± 5%)
Compact version (aluminum)	4.85	10.7	Aluminum content ± 80%
Field version (aluminum)	6.1	13.5	Aluminum content ± 80%

Table 7-8: Total weight

8.1 Measuring principle

An electrically conductive fluid flows inside an electrically insulated pipe through a magnetic field. This magnetic field is generated by a current, flowing through a pair of field coils. Inside of the fluid, a voltage U is generated:
U = v * k * B * D

in which:
v = mean flow velocity
k = factor correcting for geometry
B = magnetic field strength
D = inner diameter of flowmeter

The signal voltage U is picked off by electrodes and is proportional to the mean flow velocity v and thus the flow rate Q. A signal converter is used to amplify the signal voltage, filter it and convert it into signals for totalizing, recording and output processing.

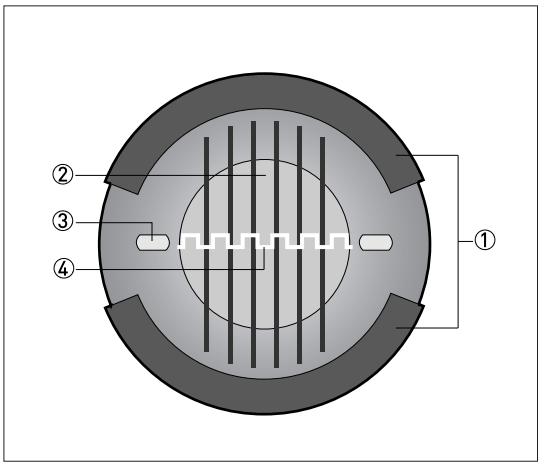


Figure 8-1: Measuring principle

① Field coils
② Magnetic field
③ Electrodes
④ Induced voltage (proportional to flow velocity)

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	Faraday's law of induction
Application range	Continuous measurement of current volume flow, flow velocity, conductivity, mass flow (at constant density), coil temperature of the flow sensor

Design

Modular design	The measuring system consists of a flow sensor and a signal converter.
Flow sensor	
OPTIFLUX 4000	DN2.5...3000 / 1/10...120"
	The flow sensors are also available as Ex versions.
Signal converter	
Compact version (C)	OPTIFLUX 4400 C
Field housing (F) - remote version	IFC 400 F
	Compact and field housing versions are also available as Ex versions.
Options	
Outputs / inputs	Current output (including HART®), pulse output, frequency output and/or status output, limit switch and/or control input (depending on the I/O version)
Totaliser	2 (optional 3) internal totalisers with a max. of 8 counter places (e.g. for counting volume and/or mass units)
Verification	Integrated verification, diagnostic functions: measuring device, process, measured value, empty pipe detection, stabilisation
Communication interface	HART® as standard
Display and user interface	
Standard display	LC display, backlit white.
	Size: 128 x 64 pixels, corresponds to 59 x 31 mm = 2.32" x 1.22"
	Display module can be positioned/rotated in 90° increments.
	4 optical keys for operator control of the signal converter without opening the housing.
	Ambient temperatures below -25°C / -13°F, may affect the readability of the display.
Advanced display	LC display, backlit white, red, orange, yellow or blue depending on the device status according to NE 107:2017
	Size: 256 x 128 pixels, corresponds to 59 x 31 mm = 2.32" x 1.22"
	Display module can be positioned/rotated in 90° increments.
	4 push buttons and 4 optical keys for operator control of the signal converter without opening the housing.
	Ambient temperatures below -25°C / -13°F, may affect the readability of the display.

Remote operation	PACTware™ (including Device Type Manager (DTM))
	HART® Handheld Communicator from Emerson Process
	AMS® from Emerson Process
	PDM® from Siemens
	All DTMs and drivers are available free of charge from the manufacturer's website.
Display functions	
Operating menu	Setting the parameters using 2 measured value pages, status page, graphics page (measured values and graphics are freely adjustable)
Language display texts	Available languages: English, German, French, Danish, Spanish, Italian, Dutch, Polish, Portuguese, Swedish, Turkish, Norwegian, Russian, Chinese
Measurement functions	**Units:** Metric, British and US units selectable as desired from lists for volume/mass flow and counting, velocity, temperature, pressure
	Measured values: Volume flow, flow velocity, conductivity, mass flow (at constant density), coil temperature, flow direction (not a displayed unit – but available via outputs)
Diagnostic functions	**Standards:** VDI / NAMUR / WIB 2650 and NE 107 / IEC 61508
	Status messages: Output of status messages optional via display, current and/or status output, HART® or bus interface
	Sensor and sensor electronics diagnosis: Redundant sensor signal monitoring, sensor and process diagnostics (empty-pipe detection, full-pipe detection, noise detection, sensor linearity check, asymmetry detection), sensor cable monitoring, monitoring of internal signals, CPU diagnostics, internal data integrity checks, internal communication monitoring
	Signal converter and inputs/outputs: Data bus monitoring, current output connections, current readback with redundant calibration, factory calibration integrity, electronics temperature monitoring, CPU diagnostics, supply voltage monitoring

Measuring accuracy

Flow measurement	
Reference conditions	Medium: water
	Temperature: +5...+35°C / +41...+95°F
	Pressure: 0.1...5 bar / 1.5...72.5 psi
Maximum measuring error	±0.2% of the measured value ±1 mm/s, depending on the flow sensor. For further information refer to the technical data of the respective flow sensor.
	Current output electronics: ±5 µA
Repeatability	±0.06%
Conductivity measurement	
Conductivity range	DN2.5...6 / 1/10...1/4": 20...2000 µS/cm
	DN10...125 / 3/8...5": 20...10000 µS/cm
	DN150...600 / 6...24": 20...50000 µS/cm
Maximum measuring error	±10% of the measured value
Repeatability	±5%
Cable length (in field housing)	≤ 30 m / 98 ft

Operating conditions

Temperature	
Process temperature	Refer to the technical data of the flow sensor.
Humidity	Annual average ≤ 90% RH (no condensation)
Ambient temperature	Depending on the version and combination of outputs.
	It is advised to protect the signal converter from external heat sources such as direct sunlight as higher temperatures reduce the life cycle of electronic components.
	Standard version: Without second I/O module:-40...+60°C / -40...+140°F With second I/O module:-40...+50°C / -40...+122°F
	Version with extended temperature: Without second I/O module: -40...+65°C / -40...+149°F With second I/O module:-40...+60°C / -40...+140°F
	Ambient temperatures below -25°C / -13°F, may affect the readability of the display.
Storage temperature	-40...+70°C / -40...+158°F
Pressure	
Medium	Refer to the technical data of the flow sensor.
Ambient pressure	Atmosphere: altitude up to 2000 m / 6561.7 ft above sea level
Chemical properties	
Electrical conductivity	All media except for water: ≥ 1 µS/cm (also refer to the technical data of the flow sensor)
	Water: ≥ 20 µS/cm
Type of measurement	Electrically conductive liquids
Solid content (volume)	Up to 70%
	The greater the solid content, the less accurate the measurements!
Gas content (volume)	Up to 5%
	The greater the gas content, the less accurate the measurements!
Flow rate	For detailed information, refer to chapter "Flow tables".
Other conditions	
Ingress protection	IP66/67, NEMA4/4X/6

Installation conditions

Installation	For detailed information, refer to chapter "Installation".
Inlet / outlet sections	Refer to the technical data of the flow sensor.
Dimensions and weight	For detailed information refer to chapter "Dimensions and weight".

Materials

Signal converter housing	Die-cast aluminium powder coated (Epoxy primer and Polyester topcoat)
Flow sensor	For housing materials, process connections, liners, grounding electrodes and gaskets, refer to the technical data of the flow sensor.

Electrical connection

General	Electrical connection is carried out in conformity with the VDE 0100 directive "Regulations for electrical power installations with line voltages up to 1000 V" or equivalent national specifications.
Power supply	100...230 VAC (-15% / +10%), 50/60 Hz
	24 VAC/DC (AC: -15% / +10%, 50/60 Hz; DC: -55% / +30%)
Power consumption	AC: 22 VA
	DC: 12 W
Signal cable	Only for remote versions.
	DS 300 (type A): Max. length: 600 m / 1968 ft (depending on electrical conductivity and flow sensor version) **Note:** The DS 300 signal cable cannot be used for SIL devices.
	BTS 300 (type B): Max. length: 600 m / 1968 ft (depending on electrical conductivity and flow sensor version) **Note:** For cable lengths > 50 m / 164 ft used with SIL devices refer to the "OPTIFLUX x400 Safety manual".
Field current cable	**SIL devices:** A shielded 3-wire copper cable is required! The shield **MUST** be connected in the housing of the signal converter.
	Non-SIL devices: A shielded cable is not required.
Cable entries	Standard: M20 x 1.5 (8...12 mm)
	Option: 1/2 NPT, PF 1/2

Inputs and outputs

General	All outputs are electrically isolated from each other and from all other circuits.	
	All operating data and output values can be adjusted.	
Description of used abbreviations	V_{ext} = external voltage; R_L = load + resistance; V_0 = terminal voltage; I_{nom} = nominal current Safety limit values (Ex i): V_i = max. input voltage; I_i = max. input current; P_i = max. input power rating; C_i = max. input capacity; L_i = max. input inductivity	
Current output		
Output data	Volume flow, mass flow, diagnostic value, flow velocity, coil temperature, conductivity	
Settings	Without HART®: Q = 0%: 0...20 mA; Q = 100%: 10...20 mA Alarm signal: selectable 0...22 mA	
	With HART®: Q = 0%: 4...20 mA; Q = 100%: 10...20 mA Alarm signal: selectable 3...22 mA	
Operating data	**Modular I/Os**	**Ex i I/Os**
Active	V_{int} = 24 VDC I ≤ 22 mA Terminals A and B: $R_L \leq 1\ k\Omega$ Terminals C: $R_L \leq 250\ \Omega$	V_{int} = 21 VDC I ≤ 22 mA $R_L \leq 400\ \Omega$
		V_0 = 21 V I_0 = 90 mA P_0 = 0.5 W C_0 = 90 nF / L_0 = 2 mH C_0 = 110 nF / L_0 = 0.5 mH Linear characteristics
	Observe connection polarity.	
Passive	$V_{ext} \leq 30$ VDC I ≤ 22 mA $V_0 \geq 2.3$ V Terminals C: $R_L \leq 250\ \Omega$ $R_{L, max} = (V_{ext} - V_0) / I_{max}$	$V_{ext} \leq 30$ VDC I ≤ 22 mA $V_0 \geq 4$ V $R_{L, max} = (V_{ext} - V_0) / I_{max}$
		V_i = 30 V I_i = 100 mA P_i = 1 W C_i = 10 nF L_i ~ 0 mH
	Observe connection polarity.	Any connection polarity.

HART®		
Description	HART® protocol via active and passive current output	
	HART® version: 7	
	Universal HART® parameter: completely integrated	
Load	≥ 230 Ω at HART® test point; Note maximum load for current output!	
Multi-Drop operation	Disabled loop current mode, output current = 0%, e.g. 4 mA	
	Multi-Drop address adjustable in operation menu 0...63	
Device drivers	Available for FC 375/475, AMS, PDM, FDT/DTM	
Registration	At HART Communication Foundation	
	Yes	
Pulse output or frequency output		
Output data	Pulse output: volume flow, mass flow	
	Frequency output: volume flow, mass flow, diagnostic value, flow velocity, coil temperature, conductivity	
Function	Can be set as a pulse output or frequency output	
Pulse rate/frequency	Up to 10000 pulses/s or Hz (5000 pulses/s or Hz for the phase-shifted or NAMUR output)	
Settings	Either mass or volume per pulse or max. frequency for 100% flow	
	Pulse width: adjustable as automatic, symmetric or fixed (0.05...2000 ms)	
Operating data	**Modular I/Os**	**Ex i I/Os**
Active	V_{nom} = 24 VDC	-
	f_{max} in operating menu set to f_{max} ≤ 100 Hz: I ≤ 20 mA open: I ≤ 0.05 mA closed: $V_{0, nom}$ = 24 V at I = 20 mA	
	f_{max} in operating menu set to 100 Hz < f_{max} ≤ 10 kHz: I ≤ 20 mA open: I ≤ 0.05 mA closed: $V_{0, nom}$ = 22.5 V at I = 1 mA $V_{0, nom}$ = 21.5 V at I = 10 mA $V_{0, nom}$ = 19 V at I = 20 mA	
	Any connection polarity.	

Operating data	**Modular I/Os**	**Ex i I/Os**
Passive	$V_{ext} \leq 32$ VDC	-
	f_{max} in operating menu set to $f_{max} \leq 100$ Hz: $I \leq 100$ mA $R_{L, max} = 47$ kΩ $R_{L, min} = (V_{ext} - V_0) / I_{max}$ open: $I \leq 0.05$ mA at $V_{ext} = 32$ VDC closed: $V_{0, max} = 0.2$ V at $I \leq 10$ mA $V_{0, max} = 2$ V at $I \leq 100$ mA	
	f_{max} in operating menu set to 100 Hz < $f_{max} \leq$10 kHz: $I \leq 20$ mA $R_{L, max} = 47$ kΩ $R_{L, min} = (V_{ext} - V_0) / I_{max}$ open: $I \leq 0.05$ mA at $V_{ext} = 32$ VDC closed: $V_{0, max} = 1.5$ V at $I \leq 1$ mA $V_{0, max} = 2.5$ V at $I \leq 10$ mA $V_{0, max} = 5.0$ V at $I \leq 20$ mA	
	Any connection polarity.	
NAMUR	Passive to IEC 60947-5-6 $V_{ext} = 8.2$ V ± 0.1 VDC R = 1 kΩ ± 10 Ω Nominal current for open: I = 0.6 mA closed: I = 3.8 mA	Passive to IEC 60947-5-6 $V_{ext} = 8.2$ V ± 0.1 VDC R = 1 kΩ ± 10 Ω Nominal current for open: I = 0.43 mA closed: I = 4.5 mA
		$V_i = 30$ V $I_i = 100$ mA $P_i = 1$ W $C_i = 10$ nF $L_i \sim 0$ mH
	Any connection polarity.	
Low flow cut-off		
Function	Switching point and hysteresis separately adjustable for each output, counter and the display	
Switching point	Set in increments of 0.1%.	
	0...20% (current output, frequency output)	
Hysteresis	Set in increments of 0.1%.	
	0...20% (current output, frequency output)	
Time constant		
Function	The time constant corresponds to the elapsed time until 63% of the end value has been reached according to a step function.	
Settings	Set in increments of 0.1 seconds.	
	0...100 seconds	

Status output / limit switch		
Function and settings	Adjustable as automatic measuring range conversion, display of flow direction, counter overflow, error, switching point or empty pipe detection	
	Valve control with activated dosing function	
	Status and/or control: ON or OFF	
Operating data	**Modular I/Os**	**Ex i I/Os**
Active	V_{int} = 24 VDC I ≤ 20 mA open: I ≤ 0.05 mA closed: $V_{0, nom}$ = 24 V at I = 20 mA	-
	Observe connection polarity.	
Passive	V_{ext} = 32 VDC I ≤ 100 mA $R_{L, max}$ = 47 kΩ $R_{L, min} = (V_{ext} - V_0) / I_{max}$ open: I ≤ 0.05 mA at V_{ext} = 32 VDC closed: $V_{0, max}$ = 0.2 V at I ≤ 10 mA $V_{0, max}$ = 2 V at I ≤ 100 mA	-
	Any connection polarity.	
NAMUR	Passive to IEC 60947-5-6 V_{ext} = 8.2 V ± 0.1 VDC R = 1 kΩ ± 10 Ω Nominal current for open: I = 0.6 mA closed: I = 3.8 mA	Passive to IEC 60947-5-6 V_{ext} = 8.2 V ± 0.1 VDC R = 1 kΩ ± 10 Ω Nominal current for open: I = 0.43 mA closed: I = 4.5 mA
		V_i = 30 V I_i = 100 mA P_i = 1 W C_i = 10 nF L_i = 0 mH
	Any connection polarity.	

Control input		
Function	Hold value of the outputs (e.g. for cleaning work), set value of the outputs to "zero", counter and error reset, range change.	
	Start of dosing when dosing function is activated.	
Operating data	**Modular I/Os**	**Ex i I/Os**
Active	V_{int} = 24 VDC Ext. contact open: $V_{0, nom}$ = 22 V Ext. contact closed: I_{nom} = 4 mA Switching point for identifying "contact open or closed": Contact closed (on): $V_0 \leq 10$ V at I_{nom} = 1.9 mA Contact open (off): $V_0 \geq 12$ V at I_{nom} = 1.9 mA	-
	Observe connection polarity.	
Passive	3 V ≤ V_{ext} ≤ 32 VDC I_{max} = 9.5 mA at $V_{ext} \leq 24$ V I_{max} = 9.5 mA at $V_{ext} \leq 32$ V Switching point for identifying "contact open or closed": Contact open (off): $V_0 \leq 2.5$ V at I_{nom} = 1.9 mA Contact closed (on): $V_0 \geq 3$ V at I_{nom} = 1.9 mA	5.5 V ≤ V_{ext} ≤ 30 VDC I_{max} = 6 mA at $V_{ext} \leq 24$ V I_{max} = 6.5 mA at $V_{ext} \leq 30$ V Switching point for identifying "contact open or closed": Contact open (off): $V_0 \leq 3.5$ V at I ≤ 0.5 mA Contact closed (on): $V_0 \geq 5.5$ V at I ≥ 4 mA
		V_i = 30 V I_i = 100 mA P_i = 1 W C_i = 10 nF L_i = 0 mH
	Observe connection polarity.	Any connection polarity.
NAMUR	Active to IEC 60947-5-6 Switching point for identifying "contact open or closed": Contact open (off): $V_{0, nom}$ = 6.3 V at I_{nom} < 1.9 mA Contact closed (on): $V_{0, nom}$ = 6.3 V at I_{nom} > 1.9 mA Detection of cable break: $V_0 \geq 8.1$ V at I ≤ 0.1 mA Detection of cable short circuit: $V_0 \leq 1.2$ V at I ≥ 6.7 mA	-
	Observe connection polarity.	

Approvals and certificates

Declaration of conformity	This device fulfils the statutory requirements of the relevant directives. The manufacturer certifies successful testing of the product by applying the conformity mark on the device.
	For more information on the directives, standards and the approved certifications, please refer to the declaration of conformity supplied with the device or downloadable from the manufacturer's website.
Standard version	Non-Ex
Functional safety according to IEC 61508	Depends on I/O variant and flow sensor. For detailed information refer to the "OPTIFLUX x400 Safety manual".
Hazardous areas	
Compact flowmeter version	
ATEX	II 2(1)G Ex db eb [ia Ga] mb IIC T6...T3 Gb (DN2.5...15)
	II 2(1)G Ex db eb [ia Ga] mb IIC T6...T3 Gb (DN10...20)
	II 2(1)G Ex db eb [ia Ga] IIC T6...T3 Gb (DN25...150)
	II 2(1)G Ex db eb [ia Ga] q IIC T5...T3 Gb (DN25...150 special)
	II 2(1)G Ex db eb [ia Ga] q IIC T6...T3 Gb (DN200...300)
	II 2(1)G Ex db eb [ia Ga] IIC T6...T3 Gb (DN350...3000)
	II 2D Ex tb IIIC T85...T150°C Db (DN2.5...3000)
IECEx	Ex db eb [ia Ga] mb IIC T6...T3 Gb (DN2.5...15)
	Ex db eb [ia Ga] mb IIC T6...T3 Gb (DN10...20)
	Ex db eb [ia Ga] IIC T6...T3 Gb (DN25...150)
	Ex db eb [ia Ga] q IIC T5...T3 Gb (DN25...150 special)
	Ex db eb [ia Ga] q IIC T6...T3 Gb (DN200...300)
	Ex db eb [ia Ga] IIC T6...T3 Gb (DN350...3000)
	Ex tb IIIC T85...T150°C Db (DN2.5...3000)
Field version of signal converter	
ATEX	II 2G Ex db eb [ia Ga] IIC T6 Gb
	II 2D Ex tb IIIC T85°C Db
IECEx	Ex db eb [ia Ga] IIC T6 Gb
	Ex tb IIIC T85°C Db
Other standards and approvals	
Vibration resistance	**IEC 60068-2-64, Vibration (broadband random)** 5...200 Hz, ASD 0.01 g^2/Hz, 3 directions, each 120 minutes
	IEC 60068-2-27, Shock (IEC 60721-3-4, Class 4M12) Half sine wave, 2 g, pulse duration 6 ms, 3 directions, positive and negative sense, each 100 times
NAMUR	NE 21, NE 43, NE 53, NE 107, NE 131

Table 8-1: Technical data

8.3 Dimensions and weight

8.3.1 Housing

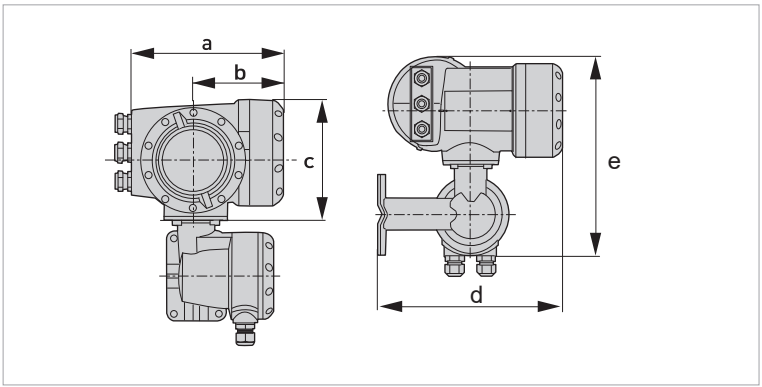


Figure 8-2: Dimensions of field housing (F) - remote version

Dimensions [mm / inch]					Weight [kg / lb]
a	b	c	d	e	
215 / 8.46	120 / 4.75	155 / 6.10	277 / 10.90	300 / 11.81	6.1 / 13.5

Table 8-2: Dimensions and weight

INFORMATION!
The total dimensions and weight of the compact device are depending on the nominal diameter and the material of the flow sensor.
For detailed information please refer to the relevant flow sensor documentation.

8.3.2 Mounting plate of field housing

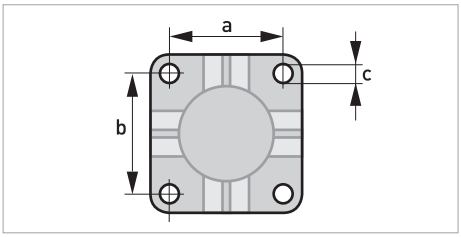


Figure 8-3: Dimensions for mounting plate of field housing

	[mm]	[inch]
a	72	2.8
b	72	2.8
c	Ø9	Ø0.4

Table 8-3: Dimensions in mm and inch

8.4 Flow tables

	$Q_{100\ \%}$ in m^3/h			
v [m/s]	0.3	1	3	12
DN [mm]	Minimum flow	Nominal flow		Maximum flow
2.5	0.005	0.02	0.05	0.21
4	0.01	0.05	0.14	0.54
6	0.03	0.10	0.31	1.22
10	0.08	0.28	0.85	3.39
15	0.19	0.64	1.91	7.63
20	0.34	1.13	3.39	13.57
25	0.53	1.77	5.30	21.21
32	0.87	2.90	8.69	34.74
40	1.36	4.52	13.57	54.29
50	2.12	7.07	21.21	84.82
65	3.58	11.95	35.84	143.35
80	5.43	18.10	54.29	217.15
100	8.48	28.27	84.82	339.29
125	13.25	44.18	132.54	530.15
150	19.09	63.62	190.85	763.40
200	33.93	113.10	339.30	1357.20
250	53.01	176.71	530.13	2120.52
300	76.34	254.47	763.41	3053.64
350	103.91	346.36	1039.08	4156.32
400	135.72	452.39	1357.17	5428.68
450	171.77	572.51	1717.65	6870.60
500	212.06	706.86	2120.58	8482.32
600	305.37	1017.90	3053.70	12214.80
700	415.62	1385.40	4156.20	16624.80
800	542.88	1809.60	5428.80	21715.20
900	687.06	2290.20	6870.60	27482.40
1000	848.22	2827.40	8482.20	33928.80
1200	1221.45	3421.20	12214.50	48858.00
1400	1433.52	4778.40	14335.20	57340.80
1600	2171.46	7238.20	21714.60	86858.40
1800	2748.27	9160.9	27482.70	109930.80
2000	3393.00	11310.00	33930.00	135720.00
2200	4105.50	13685.00	41055.00	164220.00
2400	4885.80	16286.00	48858.00	195432.00
2600	5733.90	19113.00	57339.00	229356.00
2800	6650.10	22167.00	66501.00	266004.00
3000	7634.10	25447.00	76341.00	305364.00

Table 8-4: Flow rate in m/s and m^3/h

	$Q_{100\ \%}$ in US gallons/min			
v [ft/s]	1	3.3	10	40
DN [inch]	Minimum flow	Nominal flow		Maximum flow
1/10	0.02	0.09	0.23	0.93
1/6	0.06	0.22	0.60	2.39
1/4	0.13	0.44	1.34	5.38
3/8	0.37	1.23	3.73	14.94
1/2	0.84	2.82	8.40	33.61
3/4	1.49	4.98	14.94	59.76
1	2.33	7.79	23.34	93.36
1.25	3.82	12.77	38.24	152.97
1.5	5.98	19.90	59.75	239.02
2	9.34	31.13	93.37	373.47
2.5	15.78	52.61	159.79	631.16
3	23.90	79.69	239.02	956.09
4	37.35	124.47	373.46	1493.84
5	58.35	194.48	583.24	2334.17
6	84.03	279.97	840.29	3361.17
8	149.39	497.92	1493.29	5975.57
10	233.41	777.96	2334.09	9336.37
12	336.12	1120.29	3361.19	13444.77
14	457.59	1525.15	4574.93	18299.73
16	597.54	1991.60	5975.44	23901.76
18	756.26	2520.61	7562.58	30250.34
20	933.86	3112.56	9336.63	37346.53
24	1344.50	4481.22	13445.04	53780.15
28	1829.92	6099.12	18299.20	73196.79
32	2390.23	7966.64	23902.29	95609.15
36	3025.03	10082.42	30250.34	121001.37
40	3734.50	12447.09	37346.00	149384.01
48	5377.88	17924.47	53778.83	215115.30
56	6311.60	21038.46	63115.99	252463.94
64	9560.65	31868.51	95606.51	382426.03
72	12100.27	40333.83	121002.69	484010.75
80	14938.92	49795.90	149389.29	597557.18
88	18075.97	60252.63	180759.73	723038.90
96	21511.53	71704.38	215115.30	860461.20
104	25245.60	84151.16	252456.02	1009824.08
112	29279.51	97597.39	292795.09	1171180.37
120	33611.93	112038.64	336119.31	1344477.23

Table 8-5: Flow rate in ft/s and US gallons/min

9.1 General description

The open HART® protocol, which can be used freely, is integrated into the signal converter for communication.

Devices which support the HART® protocol are classified as either operating devices or field devices. When it comes to operating devices (Master), both manual control units (Secondary Master) and PC-supported workstations (Primary Master) are used in, for example, a control centre.

HART® field devices include flow sensors, signal converters and actuators. The field devices range from 2-wire to 4-wire to intrinsically safe versions for use in hazardous areas.

The HART® data are superimposed over the analogue 4...20 mA signal via FSK modem.
This way, all of the connected devices can communicate digitally with one another via the HART® protocol while simultaneously transmitting the analogue signals.

When it comes to the field devices and secondary masters, the FSK or HART ® modem is integrated, whereas with a PC communication takes place via an external modem which must be connected to the serial interface. There are, however, other connection variants which can be seen in the following connection diagrams.

9.2 Software history

INFORMATION!
In the table below, "x" is a placeholder for possible multi-digit alphanumeric combinations, depending on the available version.

Release date	Electronic revision (ER)	HART®	
		Device revision	DD revision
01/2022	ER 1.0.x	1	1

Table 9-1: Software history for HART® interface

Manufacturer ID:	69 (0x45)
Extended Device Type:	17833 (0x45A9)
Device revision:	1
DD revision:	1
HART® Universal Revision:	7
FC 375/475 system SW.Rev.:	≥ 3.3
AMS version:	≥ 11.0
PDM version:	≥ 8.0
FDT version:	≥ 1.2

Table 9-2: HART® identification codes and revision numbers

9.3 Connection variants

The signal converter is a 4-wire device which is available in a variant with 4...20 mA current output and HART® interface.
Depending on the version, the settings and the wiring, the current output can operate as passive or active output.

- **Multi-drop mode is supported**
  In a multi-drop communication system, more than 2 devices are connected to a common transmission cable.
- **Burst mode is not supported**
  In the Burst mode a slave device transfers cyclic pre-defined response telegrams, to get a higher rate of data transfer.

INFORMATION!

For detailed information about the electrical connection of the signal converter for HART®, refer to the section "Electrical connection".

There are two ways of using the HART® communication:

- as Point-to-Point connection and
- as multi-drop connection, with 2-wire connection or
  as multi-drop connection, with 3-wire connection.

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

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

The current output of the device may be active or passive.

INFORMATION!
Only the output module for the connection terminals C/C- has HART® capability.

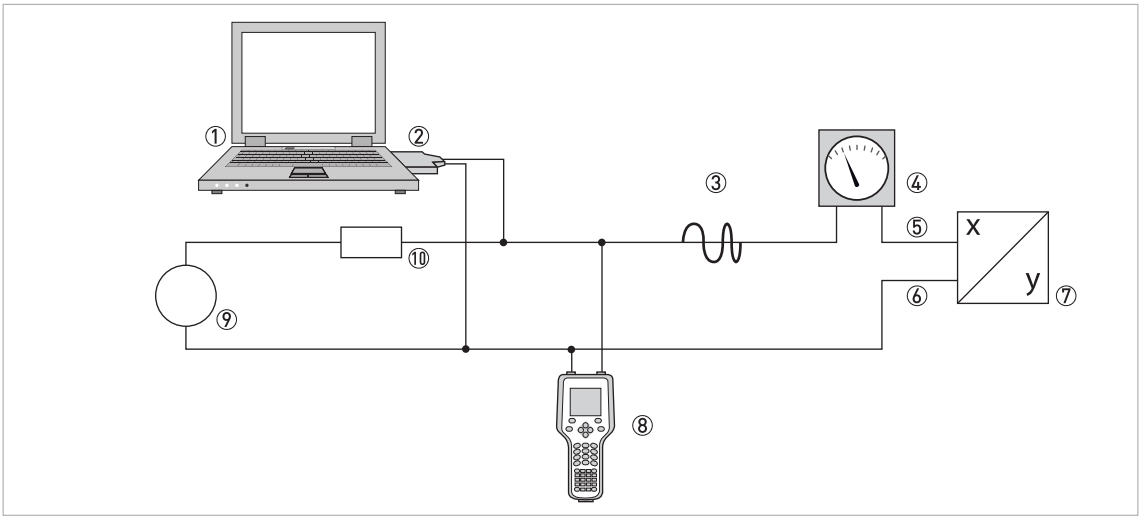


Figure 9-1: Point-to-Point connection

① Primary master
② FSK modem or HART® modem
③ HART® signal
④ Analogue indication
⑤ Signal converter terminals C
⑥ Signal converter terminals C-
⑦ Signal converter with address = 0 and passive or active current output
⑧ Secondary Master
⑨ Power supply for devices (slaves) with passive current output
①⓪ Load ≥ 230 Ω

9.3.2 Multi-drop connection (2-wire connection)

In the case of a multi-drop connection, up to 15 devices may be installed in parallel (this signal converter and other HART® devices).

The device must be configured to multi-drop mode by:

- disabling the loop current mode (C4.2) – the output current will be $I_{0\%} \geq 4$ mA
- setting the HART® device address (C4.3.1)

The current outputs of the devices must be passive!

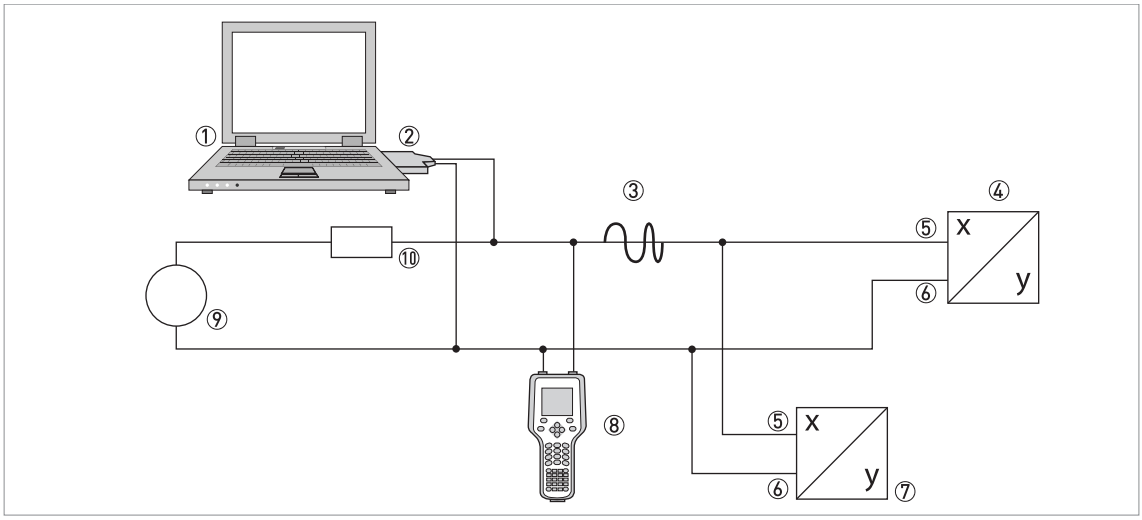


Figure 9-2: Multi-drop connection (2-wire connection)

① Primary Master
② HART® modem
③ HART® signal
④ Other HART® devices or this signal converter (refer also to ⑦)
⑤ Signal converter terminals C
⑥ Signal converter terminals C-
⑦ Signal converter with address > 0 and passive current output, connection of max. 15 devices (slaves) with 4...20 mA
⑧ Secondary Master
⑨ Power supply
①⓪ Load ≥ 230 Ω

9.3.3 Multi-drop connection (3-wire connection)

Connection of 2-wire and 4-wire devices in the same network. In order that the current output of the signal converter is working continuously active, an additional third wire must be connected to the devices in the same network. These devices must be powered via a 2-wire loop.
For each of the devices the current output must be configured as described in the previous section.

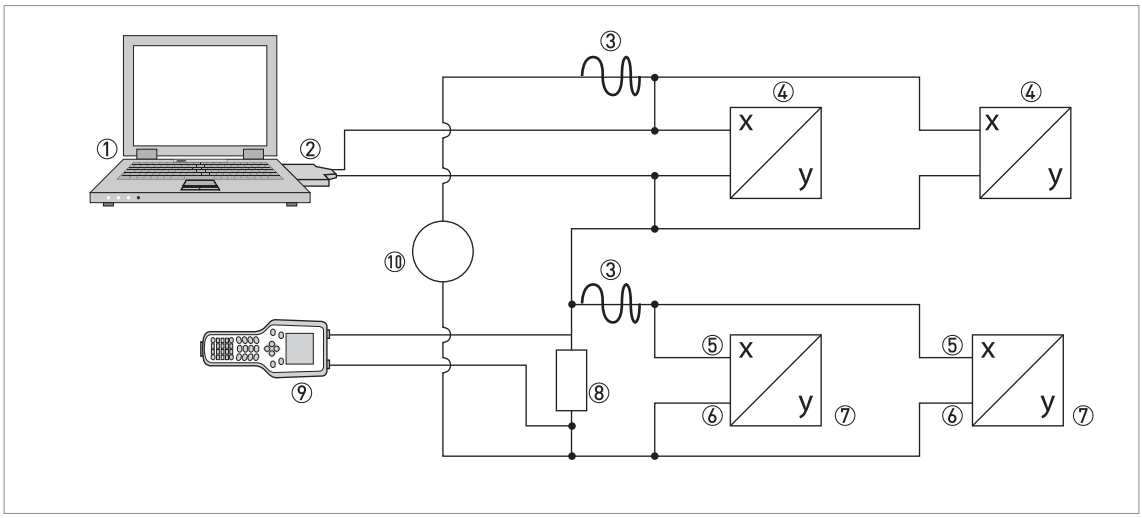


Figure 9-3: Multi-drop connection (3-wire connection)

① Primary Master
② HART® modem
③ HART® signal
④ 2-wire external devices (slaves) with 4...20 mA, addresses > 0, powered by current loop
⑤ Signal converter terminals C
⑥ Signal converter terminals C-
⑦ Connection of active or passive 4-wire devices (slaves) with 4...20 mA, addresses > 0
⑧ Load ≥ 230 Ω
⑨ Secondary Master
①⓪ Power supply

9.4 Inputs/outputs and HART dynamic variables and device variables

The following table describes the assignment of the terminals A to D to the HART® dynamic variables PV, SV, TV and QV (PV = Primary Variable; SV = Secondary Variable; TV = Tertiary Variable; QV = Quaternary Variable).

	HART® dynamic variable			
	PV	SV	TV	QV
Terminal	C	D	A	B

Table 9-3: Connection of the terminals to the HART® dynamic variables

The signal converter can provide up to 15 measured values. The measured values are accessible as so-called HART® device variables and can be connected to the HART® dynamic variables. The availability of these variables depends on the device versions and the settings.

HART® device variable	Code ①	Type	Explanation
Volume Flow	0	linear	-
Mass Flow	1	linear	
Flow Velocity	2	linear	
Coil Temperature	3	linear	
Conductivity	4	linear	
Pressure	6	linear	Only available for devices with additional sensors (P/T option, pressure and temperature).
Temperature	7	linear	
Compensated Conductivity	8	linear	
Totaliser 1 Volume	9	totaliser	-
Totaliser 1 Mass	10	totaliser	
Totaliser 2 Volume	11	totaliser	
Totaliser 2 Mass	12	totaliser	
Totaliser 3 Volume	13	totaliser	Only available for devices with additional I/O option (modular version or Ex option).
Totaliser 3 Mass	14	totaliser	Only available for devices with additional I/O option (modular version or Ex option).

Table 9-4: Description of the HART® device variables
① Code = device variable code

For the dynamic variables connected to the linear analogue outputs for current and/or frequency, the assignment of the device variables takes place by selecting the linear measurement for these outputs under the appropriate function of the signal converter.
It follows that the dynamic variables connected to current or frequency outputs can only be assigned to the linear HART® device variables.

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

A totaliser device variable can thus not be assigned to the dynamic variable PV because it cannot be output with the current output.

Such correlations do not exist for dynamic variables not connected to linear analogue outputs. Both linear and totaliser device variables can be assigned.

The totaliser device variables can only be assigned to the dynamic variables SV, TV and QV if the connected output is not a current output or frequency output.

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