MFC 400 Handbook

Signal converter for mass 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

1.1 Software history

The "Electronic Revision" (ER) is consulted to document the revision status of electronic equipment according to NE 53 for all GDC 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®
	P	PROFIBUS
	F	Foundation Fieldbus
	M	Modbus
	X	all interfaces
3-_	Downwards compatible hardware and/or software change of inputs and outputs:	
	I	Current output
	F, P	Frequency / pulse output
	S	Status output
	C	Control input
	CI	Current 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, "_" is a placeholder for possible multi-digit alphanumeric combinations, depending on the available version.

Release date	Electronic revision (ER)	Changes and compatibility	Documentation
2012-09-06	ER 1.0.0_	-	MA MFC400 R01
2013-03-12	ER 1.0.1_	1	MA MFC400 R02
2013-06-27	ER 1.0.2_	1; 2-M; 2-H	MA MFC400 R02
2013-06-27	ER 1.0.3_	1; 2-F; 2-P; 2-X	MA MFC400 R02
2013-11-04	ER 1.0.4_	2-H; 3-P; 3-F	MA MFC400 R03
2014-05-06	ER 1.0.5_	1	MA MFC400 R03
2014-08-08	ER 1.0.6_	1; 3-P; 3-I; 2-H	MA MFC400 R03
2017-08	ER 1.0.7_	1	MA MFC400 R04
2017-10	ER 1.0.8_	1	MA MFC400 R04

Table 1-2: Changes and effect on compatibility

1.2 Intended use

The mass flowmeters are designed exclusively to directly measure mass flow rates, product density and temperature as well to indirectly measure parameters such as the total volume and concentration of dissolved substances as well as the volume flow rate.

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

CAUTION!
For devices used in SIL applications, additional safety notes apply. For detailed information refer to the "Safety manual".

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 CISPR11:2009. 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 CE certification

CE marking

CE

This device conforms with the most recent and up to date versions of the following:

- EMC Directive
- ATEX Directive
- Low Voltage Directive
- Pressure Equipment Directive

The manufacturer declares conformity and the device carries the CE mark.

1.4 Safety instructions from the manufacturer

1.4.1 Copyright and data protection

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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 can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

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

1.4.5 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

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

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

i *INFORMATION!*
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.
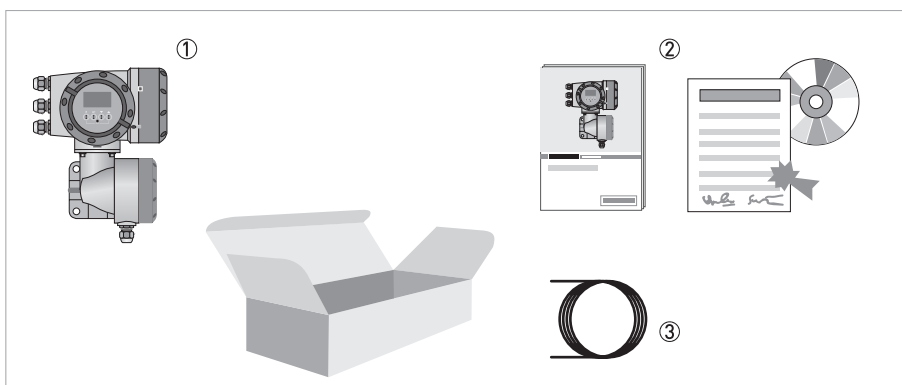
Figure 2-1: Scope of delivery

① Device in the version as ordered
② Documentation (calibration protocol, factory and material certification if ordered, CD-ROM with product documentation for flow sensor and signal converter)
③ Signal cable (only for remote version)

Flow sensor	Flow sensor + signal converter MFC 400	
	Compact version	Remote field housing
OPTIMASS 1000	OPTIMASS 1400 C	OPTIMASS 1400 F
OPTIMASS 2000	OPTIMASS 2400 C	OPTIMASS 2400 F
OPTIMASS 3000	OPTIMASS 3400 C	OPTIMASS 3400 F
OPTIMASS 6000	OPTIMASS 6400 C	OPTIMASS 6400 F
OPTIMASS 7000	OPTIMASS 7400 C	OPTIMASS 7400 F

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

2.2 Device description

The mass flowmeters are designed exclusively to directly measure mass flow rates, product density and temperature as well to indirectly measure parameters such as the total volume, concentration of dissolved substances and the volume flow rate.

Your measuring device is supplied ready for operation. The factory settings for the operating data have been made in accordance with your order specifications.

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)
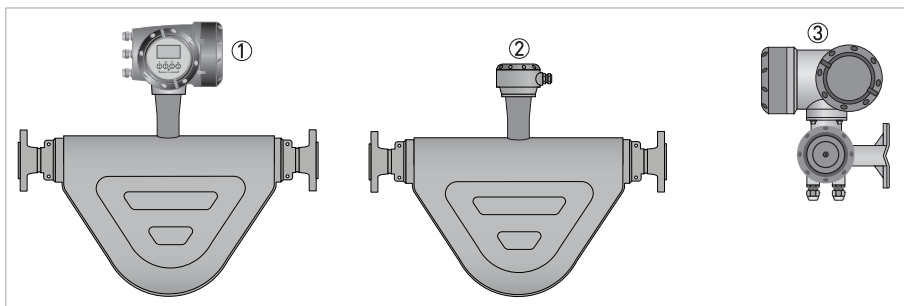
Figure 2-2: Versions with bent tube

① Compact version
② Flow sensor with connection box
③ Field housing
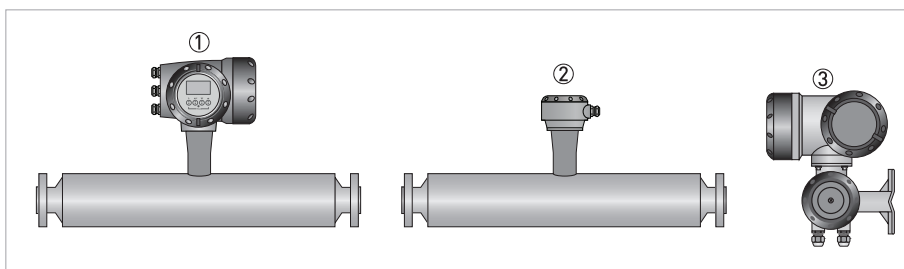
Figure 2-3: Versions with straight tube

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

2.2.1 Field housing
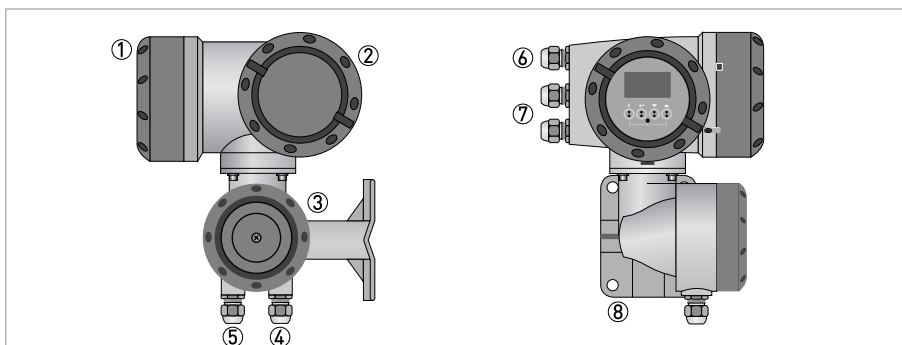
Figure 2-4: Construction of the field housing

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 Example of a nameplate
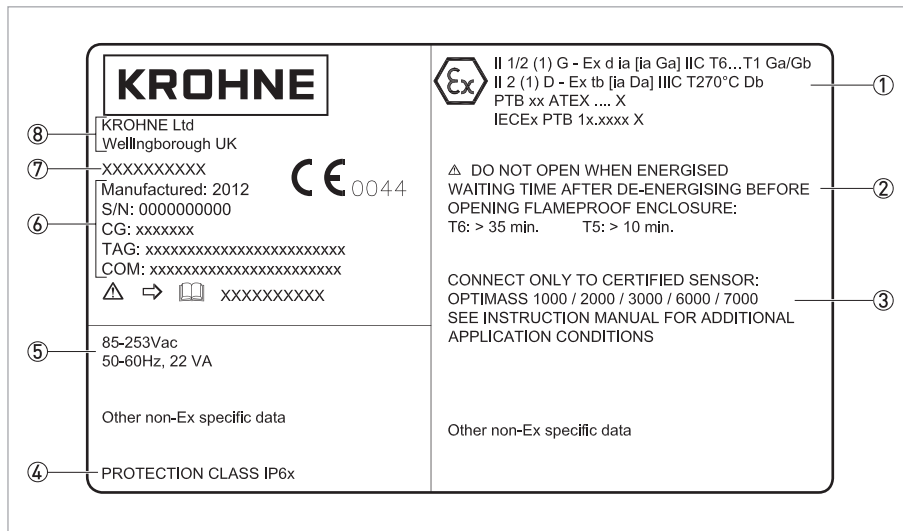
Figure 2-5: Example of a nameplate

① Approvals-related information: Ex approval, EC type test certificate, hygienic approvals, etc.
② Approvals-related thresholds
③ Additional information on documentation, calibration and patents
④ Protection category
⑤ Electrical connection data
⑥ Software and hardware revision (Electronics Revision), CG number, order number for signal converter and flow sensor
⑦ Product designation
⑧ Manufacturer address

2.3.2 Electrical connection data of inputs/outputs (example of basic version)

Figure 2-6: Example of a nameplate for electrical connection data of inputs and outputs
① Power supply (AC: L and N; DC: L+ and L–; PE for ≥ 24 VAC; FE for ≤ 24 VAC and DC)
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+ only operable in the basic version

- 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
- N/C = connection terminals not connected

WARNING!
Do not use the terminals A+ and A– at the same time. The system will be damaged by the direct voltage of 24 VDC and a 1 A peak current.

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: -50...+70°C / -58...+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.

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. sun shade) 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.*

3.5 Mounting of the compact version

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

ℹ️ *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!*

ℹ️ *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
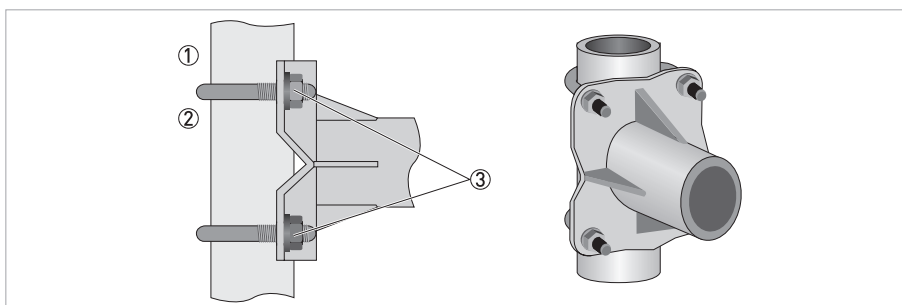
Figure 3-1: Pipe mounting of the field housing

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

3.6.2 Wall mounting
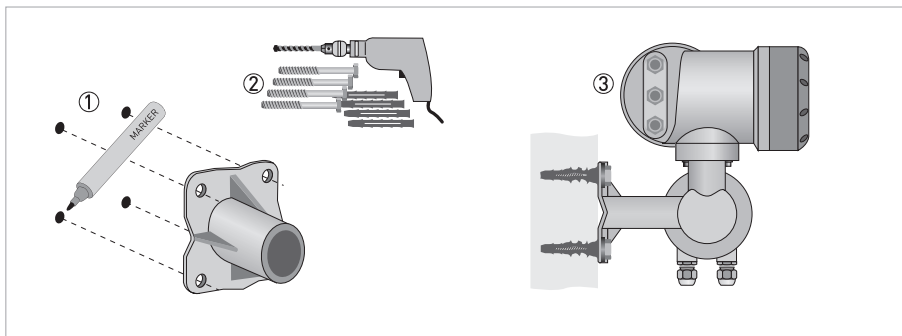
Figure 3-2: Wall mounting of the field housing

① Prepare the holes with the aid of the mounting plate. For further information refer to *Mounting plate of field housing* on page 135.
② Fasten the mounting plate securely to the wall.
③ Screw the signal converter to the mounting plate with the nuts and washers.
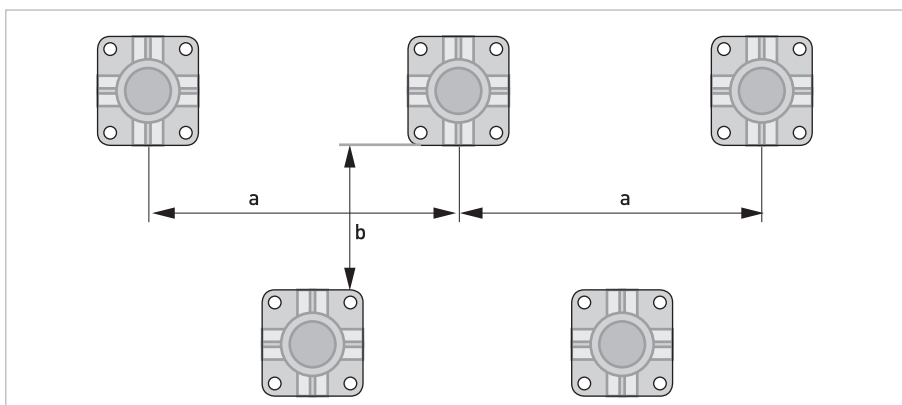
Figure 3-3: Mounting multiple devices next to each other

a ≥ 600 mm / 23.6"
b ≥ 250 mm / 9.8"

3.6.3 Turning the display of the field housing version
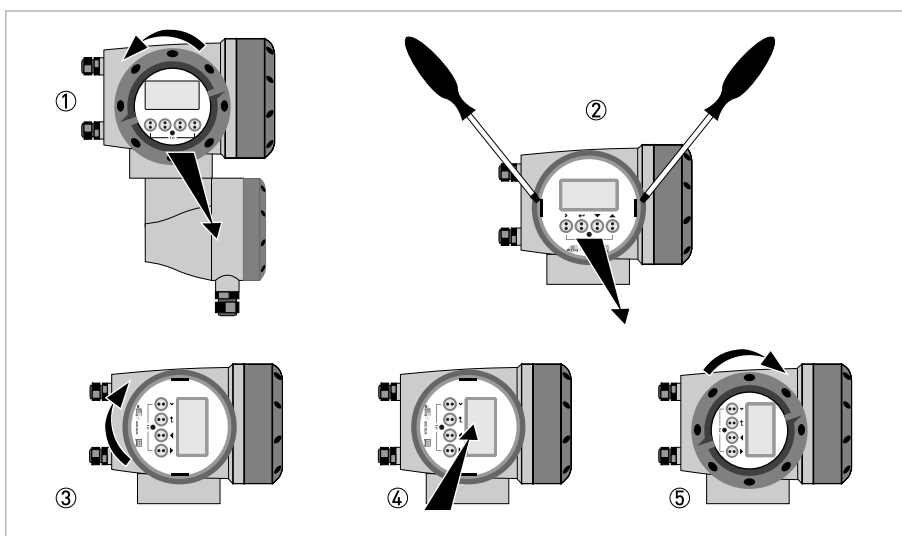
Figure 3-4: Turning the display of the field housing version

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 Using a suitable tool, pull out the two metal puller devices to the left and right of the display.
③ Pull out the display between the two metal puller devices and rotate it to the required position.
④ Slide the display and then the metal puller devices back into the housing.
⑤ 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.*

4.3 Signal cable requirements

CAUTION!
It is strongly recommended that the signal cable for remote meters is provided by the manufacturer.

Specifications for standard signal cables

- 5 twisted pair circuits (24 AWG)
- Insulation thickness of cables: ≥ 0.2 mm / 0.008"
- Each cable pair shielded with foil and drain wire
- Overall foil/braid shield
- Casing colour: grey
- Colour of wires:
  Pair 1: yellow/black
  Pair 2: green/black
  Pair 3: blue/black
  Pair 4: red/black
  Pair 5: white/black
- Test voltage: ≥ 100 VAC
- Temperature range: -40...+85°C / -40...+185°F
- Capacity between cables: ≤ 41 pF/m
- Capacity compared to shielding: ≤ 73 pF/m
- Inductance: ≤ 0.8 μH/m

Specifications for cables in hazardous areas

- 5 twisted pair circuits (24 AWG)
- Insulation thickness of cables: ≥ 0.2 mm / 0.008"
- Each cable pair shielded with foil and drain wire
- Overall foil/braid shield
- Casing colour: blue
- Colour of wires:
  Pair 1: yellow/black
  Pair 2: green/black
  Pair 3: blue/black
  Pair 4: red/black
  Pair 5: white/black
- Test voltage: ≥ 100 VAC
- Temperature range: -40...+85°C / -40...+185°F
- Capacity between cables: ≤ 41 pF/m
- Capacity compared to shielding: ≤ 73 pF/m
- Inductance: ≤ 0.8 μH/m

4.4 Connecting the signal 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.

EX *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.

4.4.1 Connection of signal cable - field housing and connection box for flow sensor
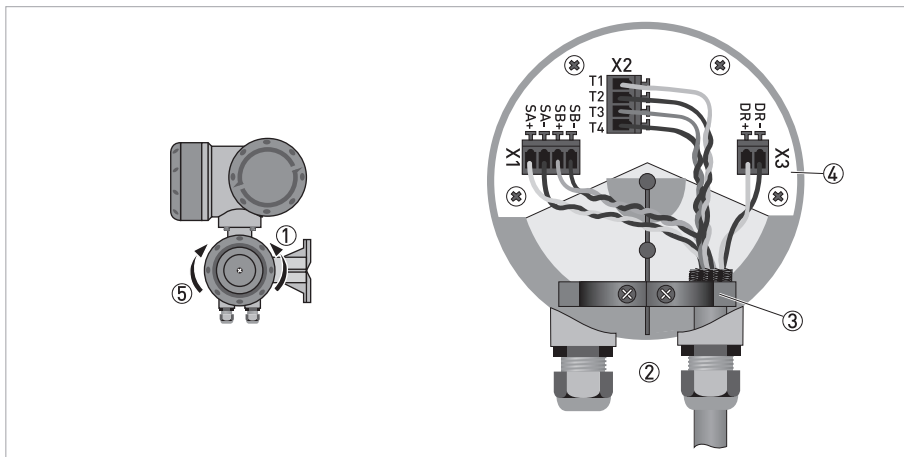
Figure 4-1: Connection of signal cable – field housing and connection box for flow sensor

① Unscrew the terminal compartment cover.
② Pass the prepared signal cable through the cable entry.
③ Secure the signal cable using the clip.
④ Connect the electrical conductors as shown. The shielding must also be connected to the spring terminal.
⑤ Re-fit the cover and tighten it by hand.

Cable		Connection terminal
Cable pair	Colour	
1	yellow	X1 SA+
1	black	X1 SA-
2	green	X1 SB+
2	black	X1 SB-
3	blue	X2 T1
3	black	X2 T2
4	red	X2 T3
4	black	X2 T4
5	white	X3 DR+
5	black	X3 DR-

Table 4-1: Colour coding of cables

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.

4.4.2 Connection diagram

⚡ *DANGER!*
The device must be grounded in accordance with regulations in order to protect personnel against electric shocks.
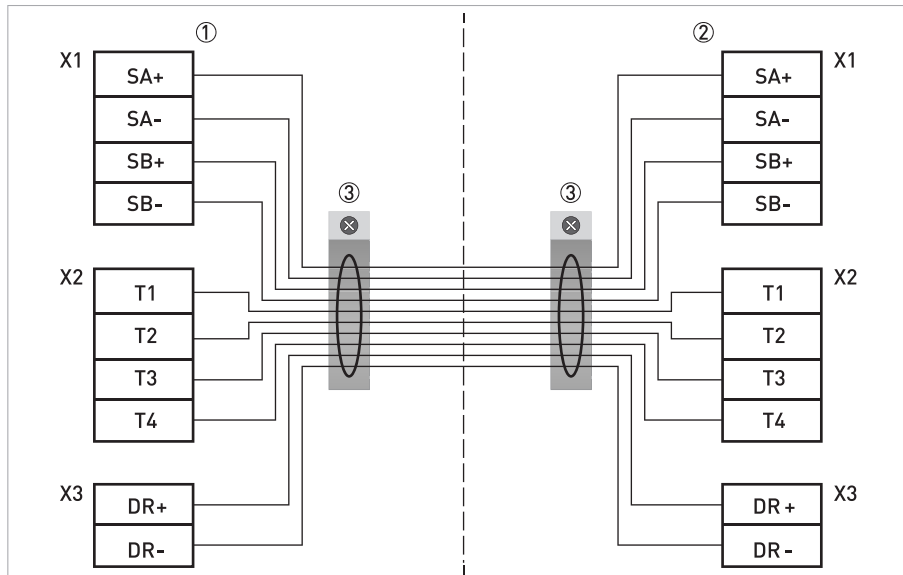
Figure 4-2: Connection diagram

① Terminal compartment for signal converter
② Terminal compartment for flow sensor
③ Connect shielding to spring terminal (drain wire and overall shield)

4.5 Grounding the flow sensor

⚡ *DANGER!*
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 more than one device to ground.
- The flow sensors are connected to ground by means of a functional grounding conductor FE.
- 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.

4.6 Connecting power - all housing variants

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 protection category depends on the housing versions (IP65...67 or NEMA4/4X/6).
- 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 must be provided close to the device. 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.
- The protective ground terminal **PE** of the power supply must be connected to the separate U-clamp terminal in the terminal compartment of the signal converter

INFORMATION!
240 VAC + 5% is included in the tolerance range.

24 VDC (tolerance range: -55% / +30%)
24 VAC/DC (tolerance range: AC: -15% / +10%; DC: -25% / +30%)
- Note the data on the nameplate!
- For measurement process reasons, a functional ground **FE** must be connected to the separate U-clamp terminal in the terminal compartment of the signal converter.
- When connecting to functional extra-low voltages, provide a facility for protective separation (PELV) (acc. to VDE 0100 / VDE 0106 and/or IEC 60364 / IEC 61140 or relevant national regulations).

INFORMATION!
For 24 VDC, 12 VDC - 10% is included in the tolerance range.
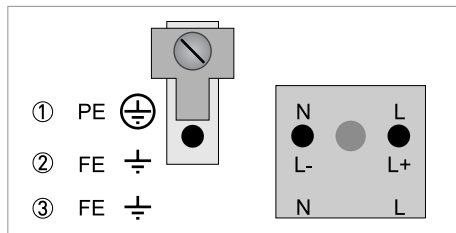
Figure 4-3: Power supply connection
① 100...230 VAC (-15% / +10%), 22 VA
② 24 VDC (-55% / +30%), 12 W
③ 24 VAC/DC (AC: -15% / +10%; DC: -25% / +30%), 22 VA or 12 W

4.7 Inputs and outputs, overview

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

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

Basic version

- Has 1 current output, 1 pulse output and 2 status outputs / limit switches.
- The pulse output can be set as status output/limit switch and one of the status outputs as a control input.

Ex i version

- Depending on the task, the device can be configured with various output modules.
- Current outputs can be active or passive.
- Optionally available also with Foundation Fieldbus and Profibus PA

Modular version

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

Bus systems

- The device allows intrinsically safe and non intrinsically safe bus interfaces in combination with additional modules.
- For connection and operation of bus systems, note the supplementary instructions.

Ex option

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

4.7.2 Description of the CG number

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

① ID number: 3
② ID number: 0 = standard; 9 = special
③ Power supply option
④ Display (language versions)
⑤ Input/output version (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 330 11 100	100…230 VAC & standard display; basic I/O: I_a or I_p & S_p/C_p & S_p & P_p/S_p
CG 330 11 7FK	100…230 VAC & standard display; modular I/O: I_a & P_N/S_N and optional module P_N/S_N & C_N
CG 330 81 4EB	24 VDC & standard display; modular I/O: I_a & P_a/S_a and optional module P_p/S_p & I_p

Table 4-2: Examples for CG number

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 EN 60947-5-6. Errors indicated on LC display. Error messages possible via status output.
-	8	No additional module installed
-	0	No further module possible

Table 4-3: Description of abbreviations and CG identifier for possible optional modules on terminals A and B

4.7.3 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 no. are depicted.
- Connection terminal A+ is only operable in the basic input/output version.

CG no.	Connection terminals								
	A+	A	A-	B	B-	C	C-	D	D-

Basic I/Os (standard)

CG no.	A+	A	A-	B	B-	C	C-	D	D-
1 0 0		I_p + HART® passive ①		S_p / C_p passive ②		S_p passive		P_p / S_p passive ②	
		I_a + HART® active ①							

Ex i I/Os (option)

CG no.	A+	A	A-	B	B-	C	C-	D	D-
2 0 0						I_a + HART® active		P_N / S_N NAMUR ②	
3 0 0						I_p + HART® passive		P_N / S_N NAMUR ②	
2 1 0		I_a active		P_N / S_N NAMUR C_p passive ②		I_a + HART® active		P_N / S_N NAMUR ②	
3 1 0		I_a active		P_N / S_N NAMUR C_p passive ②		I_p + HART® passive		P_N / S_N NAMUR ②	
2 2 0		I_p passive		P_N / S_N NAMUR C_p passive ②		I_a + HART® active		P_N / S_N NAMUR ②	
3 2 0		I_p passive		P_N / S_N NAMUR C_p passive ②		I_p + HART® passive		P_N / S_N NAMUR ②	

PROFIBUS PA (Ex i) (option)

CG no.	A+	A	A-	B	B-	C	C-	D	D-
D 0 0						PA+	PA-	PA+	PA-
						FISCO Device		FISCO Device	
D 1 0		I_a active		P_N / S_N NAMUR C_p passive ②		PA+	PA-	PA+	PA-
						FISCO Device		FISCO Device	
D 2 0		I_p passive		P_N / S_N NAMUR C_p passive ②		PA+	PA-	PA+	PA-
						FISCO Device		FISCO Device	

FOUNDATION Fieldbus (Ex i) (option)

CG no.	A+	A	A-	B	B-	C	C-	D	D-
E 0 0						V/D+	V/D-	V/D+	V/D-
						FISCO Device		FISCO Device	
E 1 0		I_a active		P_N / S_N NAMUR C_p passive ②		V/D+	V/D-	V/D+	V/D-
						FISCO Device		FISCO Device	
E 2 0		I_p passive		P_N / S_N NAMUR C_p passive ②		V/D+	V/D-	V/D+	V/D-
						FISCO Device		FISCO Device	

① Function changed by reconnecting
② Changeable

4.7.4 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 no. are depicted.
- Term. = (connection) terminal

CG no.	Connection terminals								
	A+	A	A-	B	B-	C	C-	D	D-

Modular I/Os (option)

CG no.						C	C-
4 _ _		max. 2 optional modules for term. A + B				I_a + HART® active	P_a / S_a active ①
8 _ _		max. 2 optional modules for term. A + B				I_p + HART® passive	P_a / S_a active ①
6 _ _		max. 2 optional modules for term. A + B				I_a + HART® active	P_p / S_p passive ①
B _ _		max. 2 optional modules for term. A + B				I_p + HART® passive	P_p / S_p passive ①
7 _ _		max. 2 optional modules for term. A + B				I_a + HART® active	P_N / S_N NAMUR ①
C _ _		max. 2 optional modules for term. A + B				I_p + HART® passive	P_N / S_N NAMUR ①

PROFIBUS PA (option)

CG no.					C	C-	D	D-
D _ _		max. 2 optional modules for term. A + B			PA+ (2)	PA- (2)	PA+ (1)	PA- (1)

FOUNDATION Fieldbus (option)

CG no.					C	C-	D	D-
E _ _		max. 2 optional modules for term. A + B			V/D+ (2)	V/D- (2)	V/D+ (1)	V/D- (1)

PROFIBUS DP (option)

CG no.		A	A-	B	B-	C	C-	D	D-
F _ 0		1 optional module for term. A	Termina-tion P	RxD/TxD-P(2)	RxD/TxD-N(2)	Termina-tion N	RxD/TxD-P(1)	RxD/TxD-N(1)

Modbus (option)

CG no.					B-	C	C-	D	D-
G _ _ ②		max. 2 optional modules for term. A + B				Common	Sign. B (D1)	Sign. A (D0)
H _ _ ③		max. 2 optional modules for term. A + B				Common	Sign. B (D1)	Sign. A (D0)

① Changeable
② Not activated bus terminator
③ Activated bus terminator

4.8 Description of the inputs and outputs

4.8.1 Current output

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

- 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 $U_{ext} \leq 32$ VDC at $I \leq 22$ mA
- Active mode:
  Load impedance $R_L \leq 1$ kΩ at $I \leq 22$ mA;
  $R_L \leq 450$ Ω at $I \leq 22$ mA for Ex i outputs
- 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. Default setting: 3.6 mA
- Automatic range conversion via threshold or control input. The setting range for the threshold is between 5 and 80% of $Q_{100\%}$, $\pm$ 0...5% hysteresis (corresponding ratio from smaller to larger range of 1:20 to 1:1.25).
  Signaling of the active range possible via a status output (adjustable).
- Forward/reverse flow measurement (F/R mode) is possible.

INFORMATION!
For further information refer to Description of the inputs and outputs on page 37 and refer to Technical data on page 124.

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

4.8.2 Pulse output and frequency output

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

- 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: $U_{ext} \leq 32$ 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: $U_{nom} = 24$ VDC
  $I \leq 20$ mA at $f \leq 10$ kHz (over range up to $f_{max} \leq 12$ kHz)
  $I \leq 20$ mA at $f \leq 100$ Hz
- NAMUR mode:
  Passive in accordance with EN 60947-5-6;
  $f \leq 10$ kHz (over range up to $f_{max} \leq 12$ kHz)
- Scaling:
  Frequency output: in pulses per time unit (e.g. 1000 pulses/s at $Q_{100\%}$);
  Pulse output: quantity 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 $Q_{100\%}$) or
  fixed (pulse width adjustable as required from 0.05 ms...2 s)
- When pulse shape is set to fixed, then the maximum pulse rate/frequency is limited to 1/(1.5 * pulse width).
- If output pulse rate is limited, pulses are cached and will continue to be transmitted even when the flow rate falls to zero.
- Forward/reverse flow measurement (F/R mode) is possible.
- All pulse and frequency outputs can also be used as a status output / limit switch.

INFORMATION!
For further information refer to Description of the inputs and outputs on page 37 and refer to Technical data on page 124.

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

4.8.3 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 NAMUR EN 60947-5-6! Which I/O version and inputs/outputs are installed in your signal converter are indicated on the sticker in the cover of the terminal compartment.

- 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.
- All operating data and functions can be adjusted.
- Passive mode:
  External power supply required: $U_{ext} \leq 32$ VDC; $I \leq 100$ mA
- Active mode:
  Use of the internal power supply: $U_{nom} = 24$ VDC; $I \leq 20$ mA
- NAMUR mode:
  Passive in accordance with EN 60947-5-6
- For information on the adjustable operating states refer to *Function tables* on page 67.

INFORMATION!
For further information refer to Description of the inputs and outputs on page 37 and refer to Technical data on page 124.

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

4.8.4 Control input

INFORMATION!
Depending on the version, the control inputs must be connected passively or actively or according to NAMUR EN 60947-5-6! Which I/O version and inputs/outputs are installed in your 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: $U_{ext} \leq 32$ VDC
- Active mode:
  Use of the internal power supply: $U_{nom} = 24$ VDC
- NAMUR mode:
  In accordance with EN 60947-5-6
  (Active control input to NAMUR EN 60947-5-6: signal converter monitors cable breaks and short circuits acc. to EN 60947-5-6. Errors indicated on LC display. Error messages possible via status output.

INFORMATION!
For further information refer to Description of the inputs and outputs on page 37 and refer to Technical data on page 124.

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

4.9 Electrical connection of the inputs and outputs

CAUTION!
I/O connections must not be connected to DC power supply networks.

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.

4.9.1 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!

INFORMATION!
For frequencies above 100 Hz, shielded cables are to be used in order to reduce effects from electrical interferences (EMC).
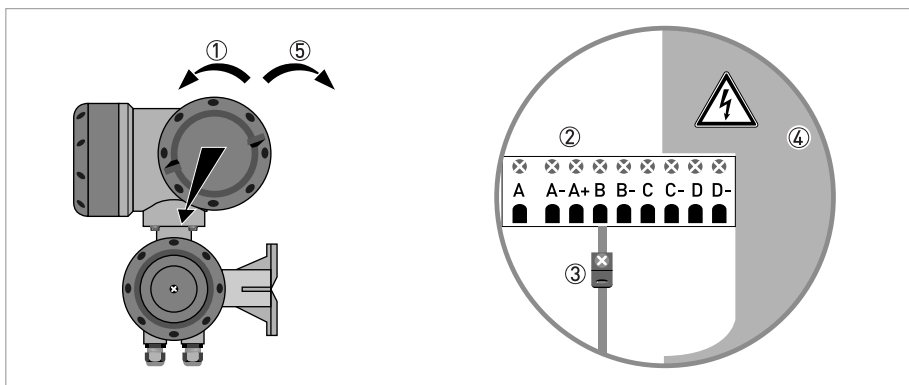
Figure 4-5: Terminal compartment for inputs and outputs in field housing

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.
④ Close the touch guard.
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.

4.9.2 Laying electrical cables correctly
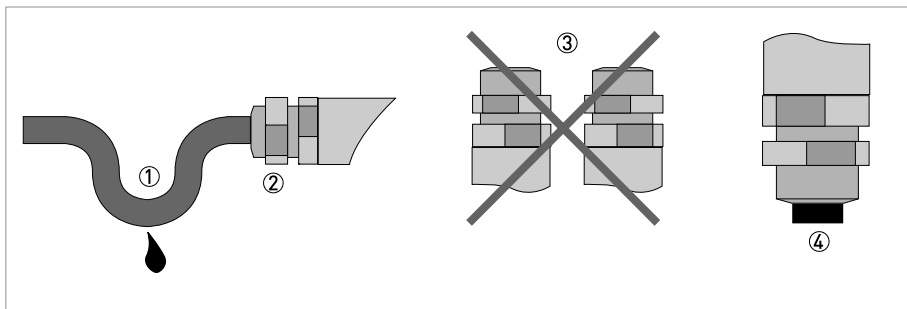
Figure 4-6: Protect housing from dust and water

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.

4.10 Description of the inputs and outputs

4.10.1 Important notes

INFORMATION!
Depending on the version, the inputs/outputs must be connected passively or actively or according to NAMUR EN 60947-5-6! Which I/O version and inputs/outputs are installed in your 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 (U_{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 NAMUR EN 60947-5-6
S_a	S_p	Status output/limit switch active or passive
S_N		Status output/limit switch passive according to NAMUR EN 60947-5-6
C_a	C_p	Control input active or passive
C_N		Control input active according to NAMUR EN 60947-5-6: Signal converter monitors cable breaks and short circuits according to EN 60947-5-6. Errors indicated on LC display. Error messages possible via status output.

Table 4-4: Description of used abbreviations

4.10.2 Description of the electrical symbols
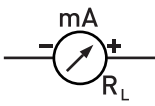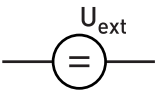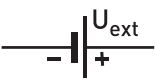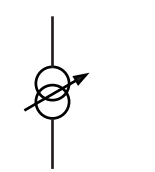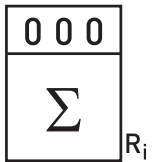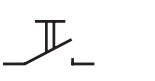
	mA meter 0...20 mA or 4...20 mA and other R_L is the internal resistance of the measuring point including the cable resistance
	DC voltage source (U_{ext}), external power supply, any connection polarity
	DC voltage source (U_{ext}), observe connection polarity according to connection diagrams
	Internal DC voltage source
	Controlled internal power 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 4-5: Description of the electrical symbols

4.10.3 Basic inputs/outputs

CAUTION!
Observe connection polarity.

INFORMATION!
For further information refer to Description of the inputs and outputs on page 31 and refer to HART® connection on page 54.

Current output active (HART®), basic I/Os

- $U_{int, nom}$ = 24 VDC nominal
- $I \leq 22$ mA
- $R_L \leq 1$ kΩ
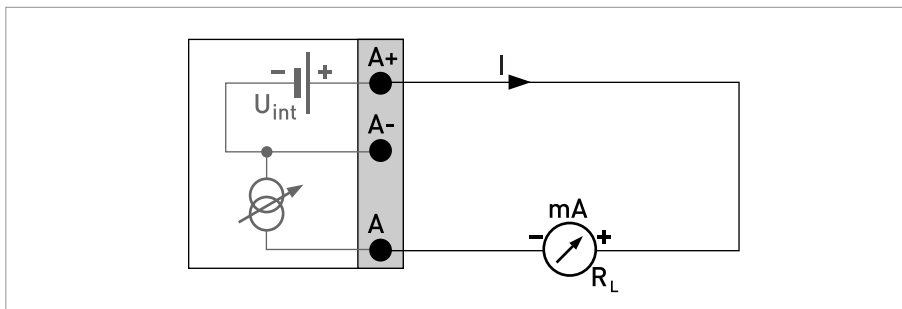
Figure 4-7: Current output active I_a

Current output passive (HART®), basic I/Os

- $U_{int, nom}$ = 24 VDC nominal
- $U_{ext} \leq 32$ VDC
- $I \leq 22$ mA
- $U_0 \geq 1.8$ V
- $R_L \leq (U_{ext} - U_0) / I_{max}$
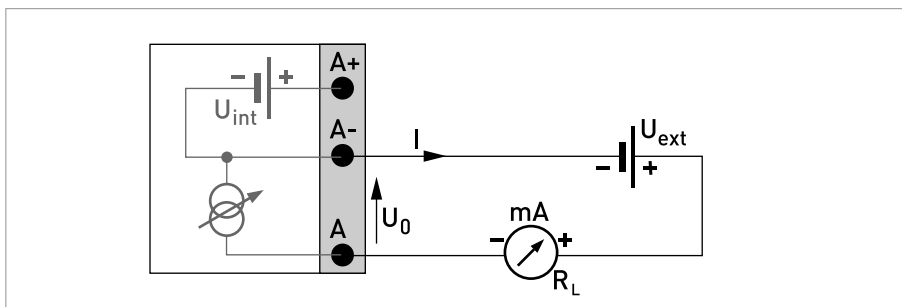
Figure 4-8: Current output passive I_p

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

Pulse/frequency output passive, basic I/Os

- $U_{ext} \leq 32$ 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 $U_{ext} = 32$ VDC
  closed:
  $U_{0, max} = 0.2$ V at $I \leq 10$ mA
  $U_{0, max} = 2$ V at $I \leq 100$ mA

- f_{max} in operating menu set to 100 Hz $< f_{max} \leq 10$ kHz:
  $I \leq 20$ mA
  open:
  $I \leq 0.05$ mA at $U_{ext} = 32$ VDC
  closed:
  $U_{0, max} = 1.5$ V at $I \leq 1$ mA
  $U_{0, max} = 2.5$ V at $I \leq 10$ mA
  $U_{0, max} = 5.0$ V at $I \leq 20$ mA

- If the following maximum load impedance $R_{L, max}$ is exceeded, the 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:
  $R_{L, min} = (U_{ext} - U_0) / I_{max}$

- Can also be set as a status output. For the electrical connection refer to status output connection diagram.
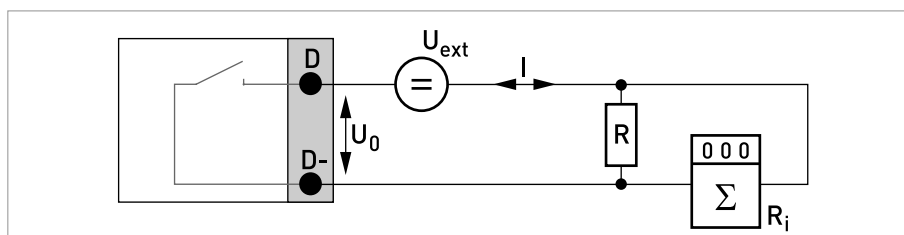
Figure 4-9: Pulse/frequency output passive P_p

INFORMATION!
- *Any connection polarity.*

Status output / limit switch passive, basic I/Os

- $U_{ext} \leq 32$ VDC

- $I \leq 100$ mA

- $R_{L, max} = 47$ kΩ
  $R_{L, min} = (U_{ext} - U_0) / I_{max}$

- open:
  $I \leq 0.05$ mA at $U_{ext} = 32$ VDC
  closed:
  $U_{0, max} = 0.2$ V at $I \leq 10$ mA
  $U_{0, max} = 2$ V at $I \leq 100$ mA

- The output is open when the device is de-energised.

- X stands for the connection terminals B, C or D. The functions of the connection terminals depend on the settings (for details refer to *Function tables* on page 67).
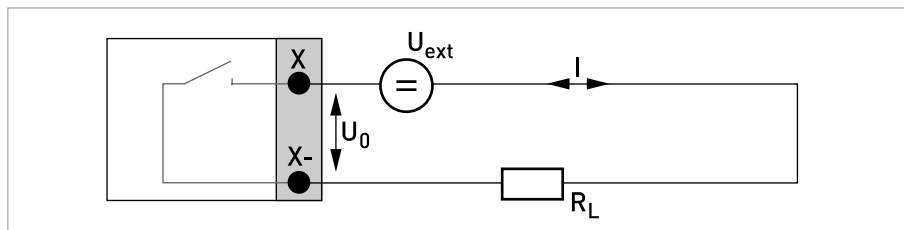
Figure 4-10: Status output / limit switch passive S_p

Control input passive, basic I/Os

- 8 V $\leq U_{ext} \leq 32$ VDC

- $I_{max} = 6.5$ mA at $U_{ext} \leq 24$ VDC
  $I_{max} = 8.2$ mA at $U_{ext} \leq 32$ VDC

- Switching point for identifying "contact open or closed":
  Contact open (off): $U_0 \leq 2.5$ V with $I_{nom} = 0.4$ mA
  Contact closed (on): $U_0 \geq 8$ V with $I_{nom} = 2.8$ mA

- Can also be set as a status output. For the electrical connection refer to status output connection diagram.
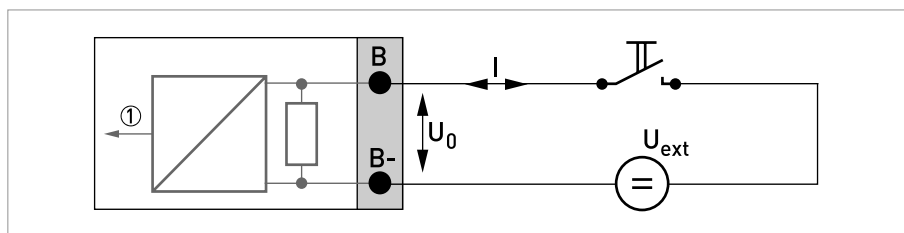
Figure 4-11: Control input passive C_p

① Signal

4.10.4 Modular inputs/outputs and bus systems

CAUTION!
Observe connection polarity.

INFORMATION!
- *For further information refer to Description of the inputs and outputs on page 31.*
- *The electrical connection of the bus systems are described in the supplementary instructions of the respective bus system.*

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

- $U_{int, nom}$ = 24 VDC
- $I \leq 22$ mA
- $R_L \leq 1$ kΩ
- X designates the connection terminals A, B or C, depending on the version of the signal converter.
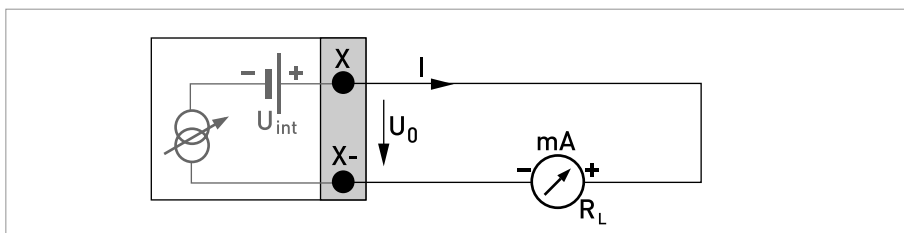
Figure 4-12: Current output active I_a

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

- $U_{ext} \leq 32$ VDC
- $I \leq 22$ mA
- $U_0 \geq 1.8$ V
- $R_L \leq (U_{ext} - U_0) / I_{max}$
- X designates the connection terminals A, B or C, depending on the version of the signal converter.
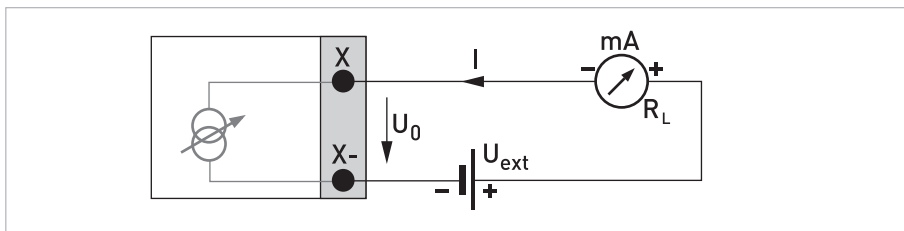
Figure 4-13: Current output passive I_p

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

- U_{nom} = 24 VDC

- f_{max} in the operating menu set to $f_{max} \leq 100$ Hz:
  I $\leq$ 20 mA
  open:
  I $\leq$ 0.05 mA
  closed:
  $U_{0, nom}$ = 24 V at I = 20 mA

- f_{max} in operating menu set to 100 Hz < $f_{max} \leq 10$ kHz:
  I $\leq$ 20 mA
  open:
  I $\leq$ 0.05 mA
  closed:
  $U_{0, nom}$ = 22.5 V at I = 1 mA
  $U_{0, nom}$ = 21.5 V at I = 10 mA
  $U_{0, nom}$ = 19 V at I = 20 mA

- If the following maximum load impedance $R_{L, max}$ is exceeded, the 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:
  $R_{L, min}$ = U_0 / I_{max}

- X designates the connection terminals A, B or D, depending on the version of the signal converter.
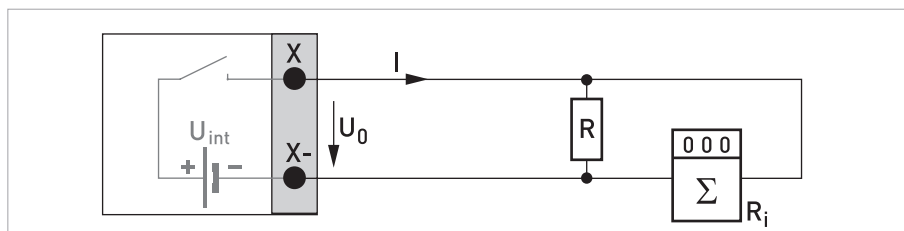
Figure 4-14: Pulse/frequency output active P_a

Pulse/frequency output passive, modular I/Os

- $U_{ext} \leq 32$ 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 $U_{ext} = 32$ VDC
  closed:
  $U_{0,\,max} = 0.2$ V at $I \leq 10$ mA
  $U_{0,\,max} = 2$ 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 $U_{ext} = 32$ VDC
  closed:
  $U_{0,\,max} = 1.5$ V at $I \leq 1$ mA
  $U_{0,\,max} = 2.5$ V at $I \leq 10$ mA
  $U_{0,\,max} = 5$ V at $I \leq 20$ mA

- If the following maximum load impedance $R_{L,\,max}$ is exceeded, the 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:
  $R_{L,\,min} = (U_{ext} - U_0) / I_{max}$

- 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.
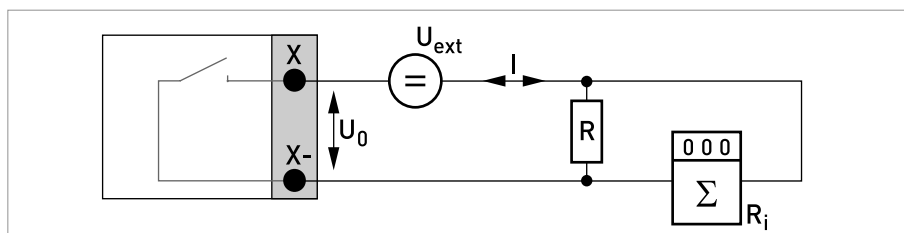
Figure 4-15: Pulse/frequency output passive P_p

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

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

- Connection acc. to EN 60947-5-6
- open:
  I_{nom} = 0.6 mA
  closed:
  I_{nom} = 3.8 mA
- X designates the connection terminals A, B or D, depending on the version of the signal converter.
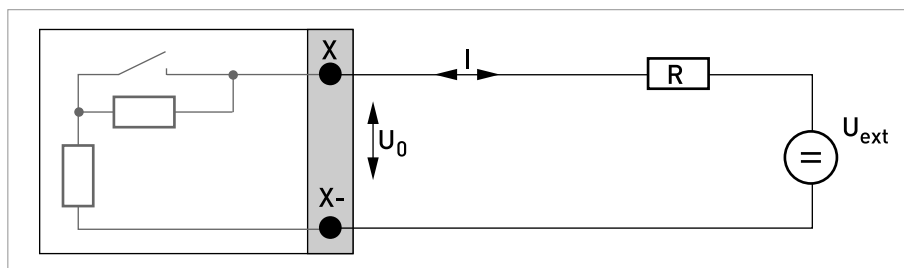
Figure 4-16: Pulse/frequency output passive P_N according to NAMUR EN 60947-5-6

Status output / limit switch active, modular I/Os

- Observe connection polarity.
- U_{int} = 24 VDC
- $I \leq 20$ mA
- $R_L \leq 47$ kΩ
- open:
  $I \leq 0.05$ mA
  closed:
  $U_{0,\,nom}$ = 24 V at I = 20 mA
- X designates the connection terminals A, B or D, depending on the version of the signal converter.
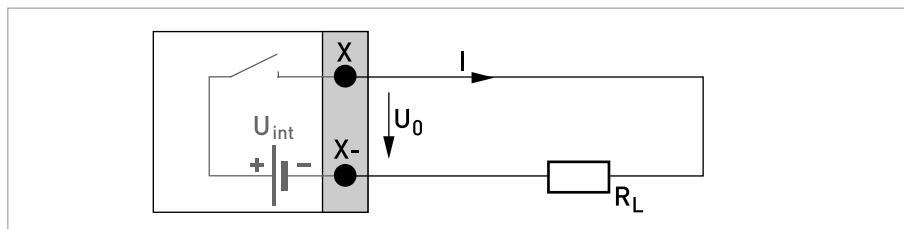
Figure 4-17: Status output / limit switch active S_a

Status output / limit switch passive, modular I/Os

- Any connection polarity.
- U_{ext} = 32 VDC
- $I \leq 100$ mA
- $R_{L,\,max}$ = 47 kΩ
  $R_{L,\,min}$ = $(U_{ext} - U_0)$ / I_{max}
- open:
  $I \leq 0.05$ mA at U_{ext} = 32 VDC
  closed:
  $U_{0,\,max}$ = 0.2 V at $I \leq 10$ mA
  $U_{0,\,max}$ = 2 V at $I \leq 100$ 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.
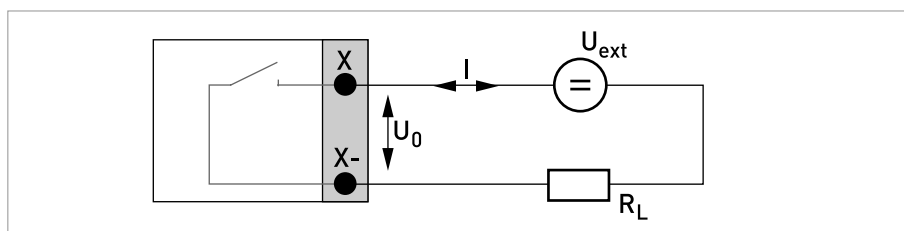
Figure 4-18: Status output / limit switch passive S_p

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

- Any connection polarity.
- Connection acc. to EN 60947-5-6
- open:
  I_{nom} = 0.6 mA
  closed:
  I_{nom} = 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.
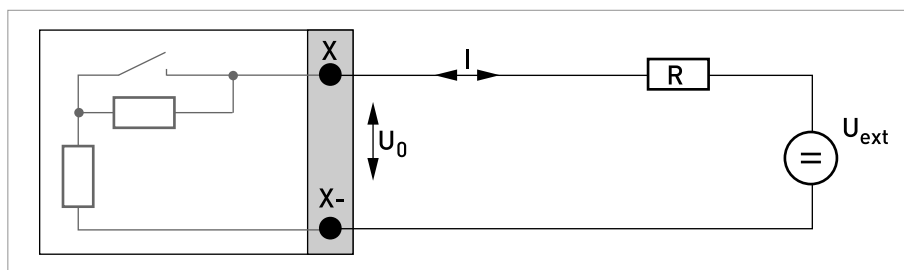
Figure 4-19: Status output / limit switch S_N according to NAMUR EN 60947-5-6

CAUTION!
Observe connection polarity.

Control input active, modular I/Os

- U_{int} = 24 VDC

- External contact open:
  $U_{0, nom}$ = 22 V
  External contact closed:
  I_{nom} = 4 mA

- Switching point for identifying "contact open or closed":
  Contact closed (on): $U_0 \leq 10$ V with I_{nom} = 1.9 mA
  Contact open (off): $U_0 \geq 12$ V with I_{nom} = 1.9 mA

- X designates the connection terminals A or B, depending on the version of the signal
  converter.
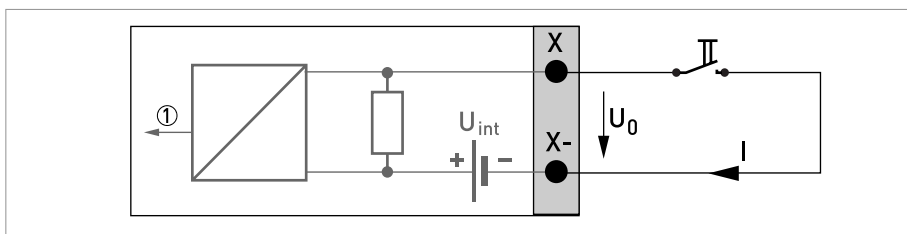
Figure 4-20: Control input active C_a

① Signal

Control input passive, modular I/Os

- $3 \text{ V} \leq U_{ext} \leq 32$ VDC

- I_{max} = 9.5 mA at $U_{ext} \leq 24$ V
  I_{max} = 9.5 mA at $U_{ext} \leq 32$ V

- Switching point for identifying "contact open or closed":
  Contact open (off): $U_0 \leq 2.5$ V with I_{nom} = 1.9 mA
  Contact closed (on): $U_0 \geq 3$ V with I_{nom} = 1.9 mA

- X designates the connection terminals A or B, depending on the version of the signal
  converter.
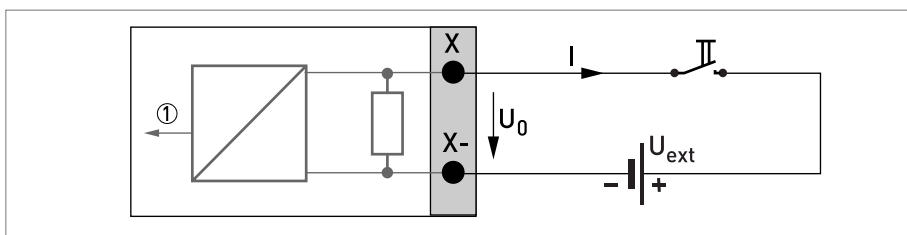
Figure 4-21: Control input passive C_p

① Signal

<table>
<tr><td>⚠</td><td>CAUTION!
Observe connection polarity.</td></tr>
</table>

Control input active C_N NAMUR, modular I/Os

- Connection acc. to EN 60947-5-6

- Switching point for identifying "contact open or closed":
  Contact open (off): $U_{0, nom}$ = 6.3 V with I_{nom} < 1.9 mA
  Contact closed (on): $U_{0, nom}$ = 6.3 V with I_{nom} > 1.9 mA

- Detection of cable break:
  $U_0 \geq 8.1$ V with $I \leq 0.1$ mA

- Detection of cable short circuit:
  $U_0 \leq 1.2$ V with $I \geq 6.7$ mA

- X designates the connection terminals A or B, depending on the version of the signal converter.
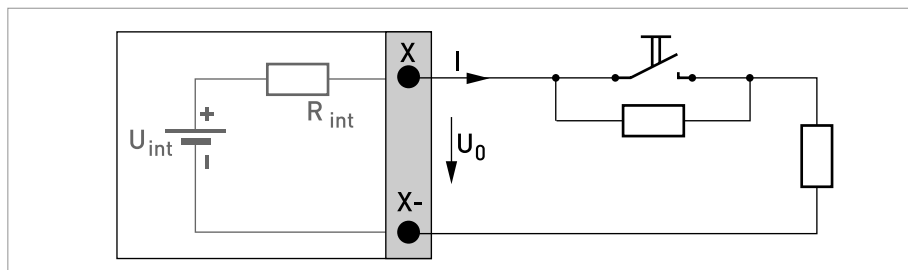
Figure 4-22: Control input active C_N according to NAMUR EN 60947-5-6

4.10.5 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 refer to Description of the inputs and outputs on page 31.

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

- Observe connection polarity.
- $U_{int,\ nom} = 20\ VDC$
- $I \leq 22\ mA$
- $R_L \leq 450\ \Omega$
- X designates the connection terminals A or C, depending on the version of the signal converter.
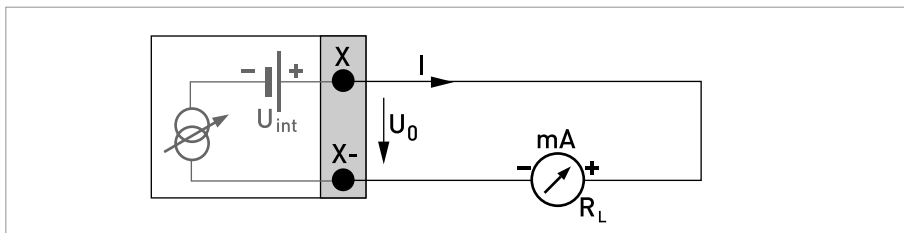
Figure 4-23: Current output active I_a Ex i

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

- Any connection polarity.
- $U_{ext} \leq 32\ VDC$
- $I \leq 22\ mA$
- $U_0 \geq 4\ V$
- $R_L \leq (U_{ext} - U_0)\ /\ I_{max}$
- X designates the connection terminals A or C, depending on the version of the signal converter.
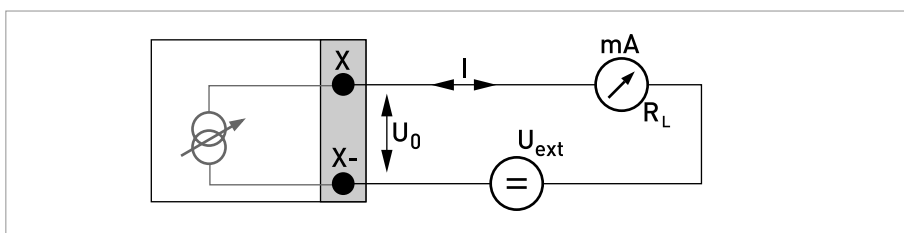
Figure 4-24: Current output passive I_p Ex i

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

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

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

- Connection acc. to EN 60947-5-6
- open:
  I_{nom} = 0.43 mA
  closed:
  I_{nom} = 4.5 mA
- X designates the connection terminals B or D, depending on the version of the signal converter.
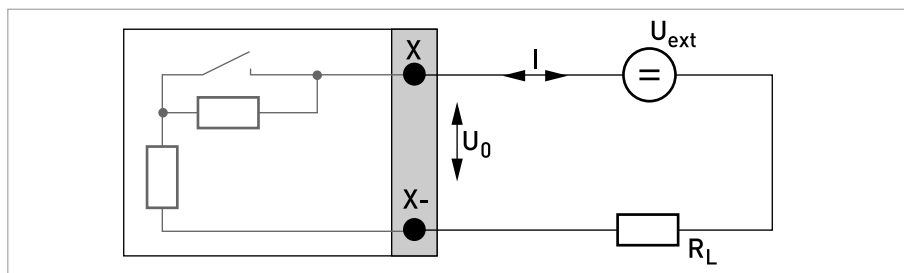
Figure 4-25: Pulse/frequency output passive P_N according to NAMUR EN 60947-5-6 Ex i

INFORMATION!
- *Any connection polarity.*

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

- Connection acc. to EN 60947-5-6
- open:
  I_{nom} = 0.43 mA
  closed:
  I_{nom} = 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.
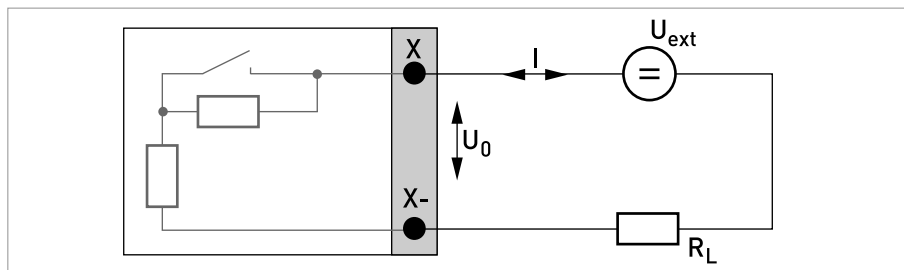
Figure 4-26: Status output / limit switch S_N according to NAMUR EN 60947-5-6 Ex i

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

- $5.5\ V \leq U_{ext} \leq 32\ VDC$

- $I_{max} = 6$ mA at $U_{ext} \leq 24$ V
  $I_{max} = 6.5$ mA at $U_{ext} \leq 32$ V

- Switching point for identifying "contact open or closed":
  Contact open (off): $U_0 \leq 3.5$ V with $I \leq 0.5$ mA
  Contact closed (on): $U_0 \geq 5.5$ V with $I \geq 4$ mA

- X designates the connection terminals B, if available.
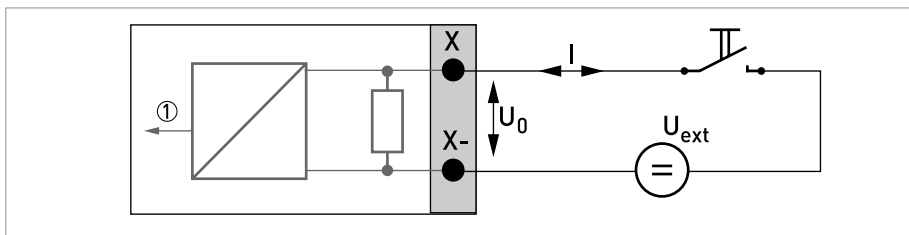
Figure 4-27: Control input passive C_p Ex i

① Signal

4.10.6 HART® connection

INFORMATION!
- *In the basic I/O the current output at connection terminals A+/A-/A always has HART® capability.*
- *For modular I/O and Ex i I/O, only the output module for the connection terminals C/C- has HART® capability.*

HART® connection active (point-to-point)
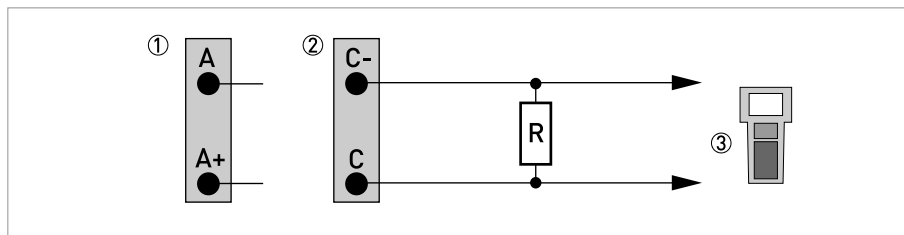
Figure 4-28: HART® connection active (I$_a$)

① Basic I/O: terminals A and A+
② Modular I/O: terminals C- and C
③ HART® communicator

The parallel resistance to the HART® communicator must be R $\geq$ 230 Ω.

HART® connection passive (Multi-Drop mode)

- I: $I_{0\%} \geq 4$ mA

- Multi-Drop mode I: $I_{fix} \geq 4$ mA $= I_{0\%}$

- $U_{ext} \leq 32$ VDC

- $R \geq 230 \; \Omega$
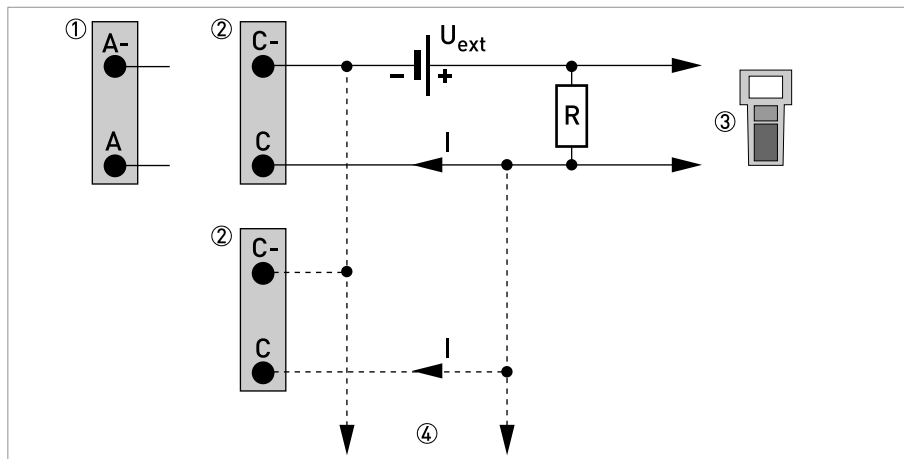
Figure 4-29: HART® connection passive (I_p)

① Basic I/O: terminals A- and A
② Modular I/O: terminals C- and C
③ HART® communicator
④ Other devices with HART® capability

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 mechanically safe and 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 measuring sensor and the signal converter, is supplied ready for operation. All operating data have been set at the factory in accordance with your 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.
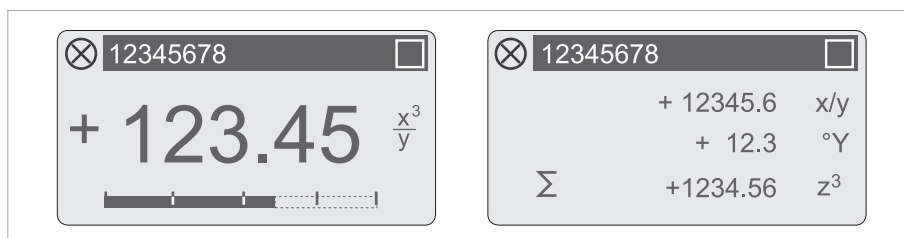
Figure 5-1: Displays in measuring mode (examples for 2 or 3 measured values)
x, y and z denote the units of the measured values displayed

It is possible to change between the two measured value windows, the trend display and the list with the status messages by pressing the keys ↑ and ↓. For possible status messages, their meaning and cause refer to *Status messages and diagnostic information* on page 103.

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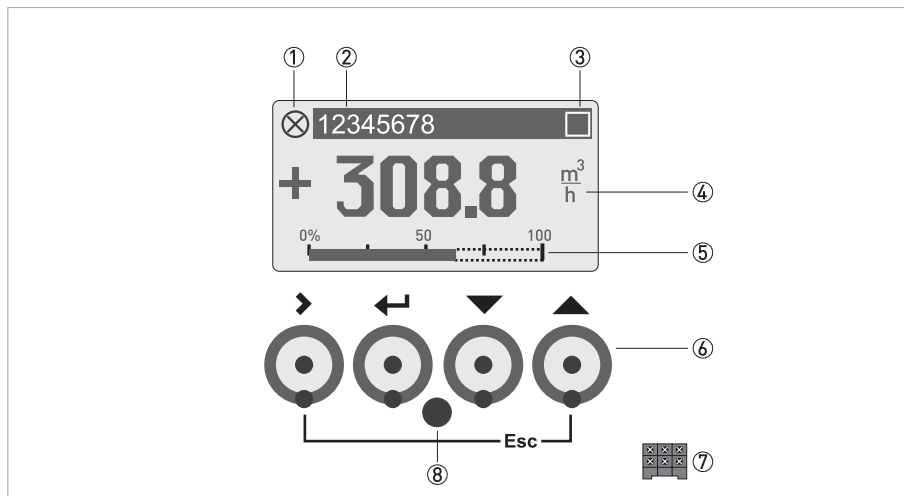
Figure 6-1: Display and operating elements (Example: flow indication with 2 measuring values)

① Indicates a possible status message in the status list
② Tag number (is only indicated if this number was entered previously by the operator)
③ Indicates when a key has been pressed
④ 1st measured variable in large representation
⑤ Bargraph indication
⑥ Operating keys, optical and mechanical (see table below for function and representation in text)
⑦ Interface to the GDC bus (not present in all signal converter versions)
⑧ Infrared sensor (not present in all signal converter versions)

CAUTION!
The use of a jumper is only permitted for custody transfer devices to block access to parameters relevant to custody transfer. When the jumper is set to or removed from the "protected" position, the signal converter restarts to switch into the protected or unprotected operating mode.

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.*

Key	Measuring mode	Menu mode	Submenu or function mode	Parameter and data mode
>	Switch from measuring mode to menu mode; press key for 2.5 s, "quick start" menu is then displayed	Access to displayed menu, then 1st submenu is displayed	Access to displayed submenu or function	For numerical values, move cursor (highlighted in blue) one position to the right
↵	Reset display; "Quick Access" function	Return to measuring mode but prompt whether the data should be saved	Press 1 to 3 times, return to menu mode, data saved	Return to submenu or function, data saved
↓ or ↑	Switch between display pages: measured value 1 + 2, trend page and status page	Select menu	Select submenu or function	Use cursor highlighted in blue to change number, unit, property and to move the decimal point
Esc (> + ↑)	-	-	Return to menu mode without acceptance of data	Return to submenu or function without acceptance of data

Table 6-1: Description of functionality of operating keys

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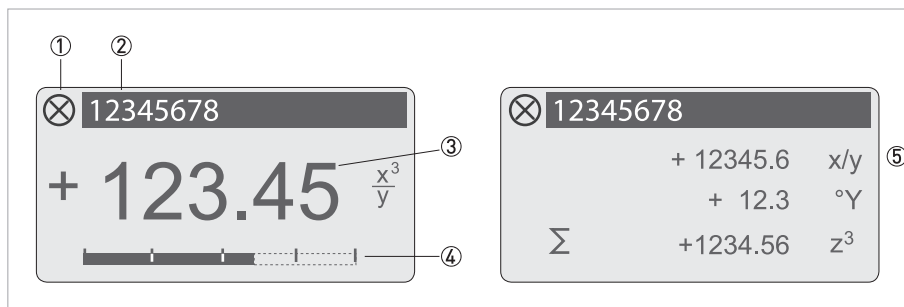
Figure 6-2: Example for display in measuring mode with 2 or 3 measured values

① Indicates a possible status message in the status list
② Tag number (is only indicated if this number 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, 3 lines
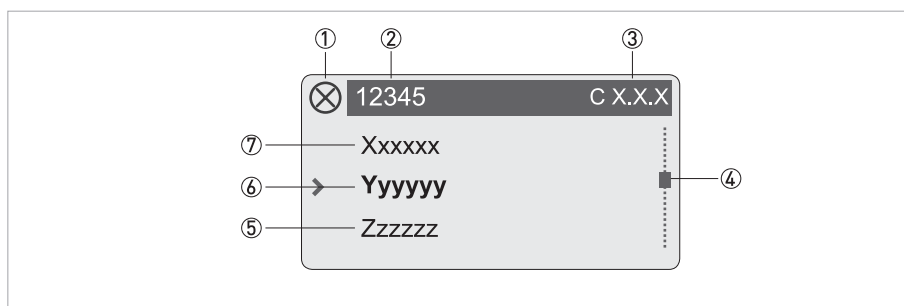
Figure 6-3: Display for selection of submenu and functions, 3 lines

① Indicates a possible status message in the status list
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 parameters, 4 lines
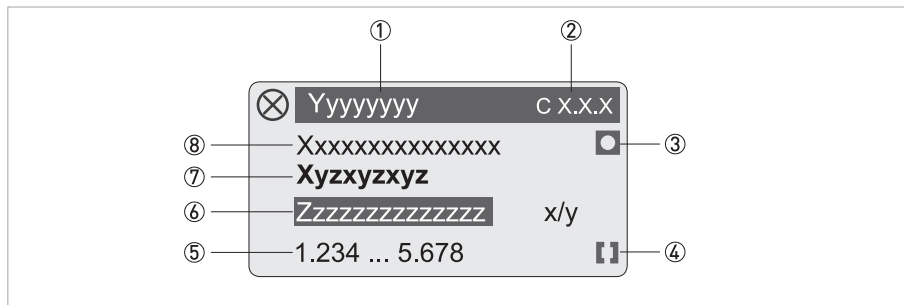
Figure 6-4: Display when setting parameters, 4 lines

① Current menu(s), submenu or function
② Number relating to ⑦
③ Denotes factory setting
④ Denotes permissible value range
⑤ Permissible value range for numeric values
⑥ Currently set value, unit or function (when selected, appears with white text, blue background)
   This is where the data is changed.
⑦ Current parameter
⑧ Factory setting of parameter

6.1.4 Display when previewing parameters, 4 lines
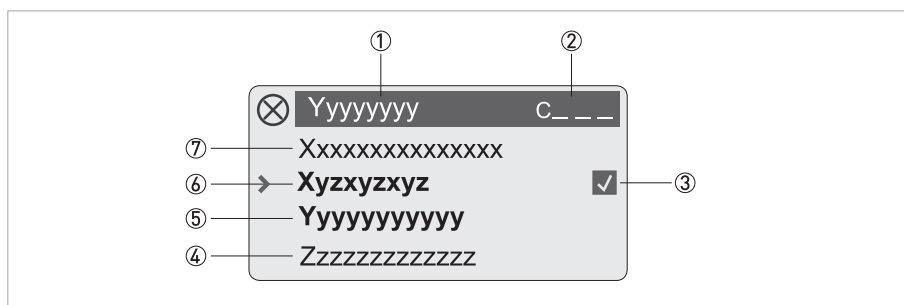
Figure 6-5: Display when previewing parameters, 4 lines

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

6.1.5 Using an IR interface (option)

The optical IR interface serves as an adapter for PC-based communication with the signal converter without opening the housing.

INFORMATION!
- *This device is not part of the scope of delivery.*
- *For more information about activation with the functions A6 or C6.6.7.*
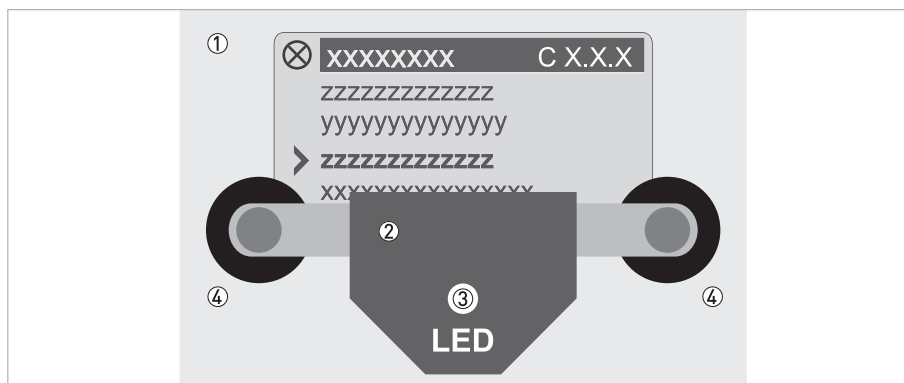
Figure 6-6: IR interface
① Glass panel in front of the control and display panel
② IR interface
③ LED lights up when IR interface is activated.
④ Suction cups

Timeout function

Following activation of the IR interface in Fct. A6 or C6.6.7 the interface must be properly positioned and attached to the housing with the suction cups within 60 seconds. If this does not happen within the specified time period, the device can be operated using the optical keys again. Upon activation, the LED ③ lights up and the optical keys no longer function.

6.2 Zero calibration (menu C1.1.1)

Following installation, perform zero calibration prior to commissioning the device. Finalise the installation before performing zero calibration. Changes (pipe system or calibration factor) made after the zero calibration may affect the accuracy, making it necessary to perform zero calibration again.

Observe the following for reliable zero calibration:

- The measuring sensor should be completely filled with the product at the expected process pressure and temperature.
- The product may contain no air or gas, especially when it comes to horizontal installations. Prior to zero calibration, it is recommended that the product be flushed at a high flow rate (>50%), for 2 minutes.
- After flushing, re-establish zero flow by closing off the corresponding valves.

Set zero calibration automatically or manually using the operating controls. The converter cover must be installed on the display for automatic calibration.

Key	Screen		Description and setting
>	A	Quick Setup	Press and hold for 2.5 s, then release the key.
2 x ↓	C	Setup	
3 x >	C1.1.1	Zero Calibration	
>		Calibrate zero? Automatic	
↵		Please Wait Countdown from 40 s	
		Calibrate zero Passed	
↵		Zero Calibration +XX.XXX%	Display of measured zero calibration in %.
5 x ↵		Save Configuration? Yes	
↵		Display page	

Table 6-2: Procedure for "Automatic calibration"

Key	Screen		Description and setting
>	A	Quick Setup	Press and hold for 2.5 s, then release the key.
2 x ↓	C	Setup	
3 x >	C1.1.1	Zero Calibration	
>		Calibrate zero? Automatic	
2 x ↓		Calibrate zero? Manual	
		Zero Calibration +XX.XXX%	Display currently stored zero calibration in %. (Warning, value can be changed!)
			Possible manual entry of zero calibration.
			Storing the displayed zero calibration.
5 x ↵		Save Configuration? Yes	
↵		Display page	

Table 6-3: Procedure for "Manual calibration"

Zero calibration log (C1.1.5)

Zero calibrations are recorded in the zero calibration log. Log information includes zero offset, temperature, date and time. Navigate using the ↑ and ↓ keys. Exit the menu using the ↵ key.

Under certain conditions, zero calibration is not possible and will be cancelled:

- The product is still flowing. The shut-off valves are not closed tightly enough.
- There are still gas bubbles in the measuring sensor.
  Remedy: Flush measuring sensor and repeat calibration

With some media, it may be difficult to perform zero calibration. In such cases, there are various methods to still achieve good zero calibration:

Medium	Possible solutions
Media that tend to evaporate or outgas	Increase pressure.
Two-phase media (slurries), that contain solids that may fall out.	Only fill the measuring sensor with the carrier medium.
Two-phase media in which the solids or gas-forming components cannot be separated.	Fill measuring sensor with another liquid, e.g. water.

Table 6-4: Zero calibration for difficult media

6 OPERATION   MFC 400

6.3 Menu structure

> **INFORMATION!**
> *Note the key function within and between the columns.*

Measure mode	Select menu	↓ ↑	Select menu and/or submenu ↓ ↑			Select function and set data ↓ ↑ >
↵	Press > 2.5 s					
	A Quick Setup	> ↵	A1 Language			> ↵
			A2 Tag			
			A3 Reset	> ↵	A3.1 Reset Errors	
					A3.2 All Totalisers	
					A3.3 Totaliser 1	
					A3.4 Totaliser 2	
					A3.5 Totaliser 3	
			A4 Analogue Outputs		A4.1 Measurement	
					A4.2 Units	
					A4.3 Range	
					A4.4 Low Flow Cutoff	
					A4.5 Time Constant	
			A5 Digital Outputs		A5.1 Measurement	
					A5.2 Pulse Value Unit	
					A5.3 Value p. Pulse	
					A5.4 Low Flow Cutoff	
			A6 GDC IR interface			
			A7 Flow Direction			
			A8 Zero Calibration			
			A9 Operation Mode			
	↓ ↑		↓ ↑		↓ ↑	↓ ↑ >

Measuring mode	Select menu	↓ ↑	Select menu and/or submenu ↓ ↑			Select function and set data ↓ ↑ >
↵	Press > 2.5 s					
	B Test	> ↵	B1 Simulation	> ↵	B1.1 Mass Flow	> ↵
					B1.2 Volume Flow	
					B1.3 Density	
					B1.4 Temperature	
					B1._ Current Output X	
					B1._ Status Output X	
					B1._ Control Input X	
					B1._ Pulse Output X	
			B2 Actual Values	> ↵	B2.1 Operating Hours	
					B2.2 Date and Time	
					B2.3 Mass Flow	
					B2.4 Volume Flow	
					B2.5 Velocity	
					B2.6 Density	
					B2.7 Temperature	
					B2.8 Strain 1	
					B2.9 Strain 2	
					B2.10 Tube Frequency	
					B2.11 Drive Level	
					B2.12 Sensor A Level	
					B2.13 Sensor B Level	
					2.14 2 Phase Signal	
					B2.15 SE PCB Temperature	
					B2.16 Act. Operat. Mode	
			B3 Information	> ↵	B3.1 Status Log	
					B3.2 Status Details	
					B3.3 C Number	
					B3.4 Sensor Electronics	
					B3.6 Electronic Revision	
					B3.7 Sensor Revision	
					B3.8 Change Log	
	↓ ↑		↓ ↑		↓ ↑	↓ ↑ >

Measure mode	Select menu	↓↑	Select menu and/or submenu ↓↑				Select function and set data ↓↑>
↵	Press > 2.5 s						
	C Setup	>↵	C1 Process Input	>↵	C1.1 Zero and Offset	>↵	
					C1.2 Density		
					C1.3 Filter		
					C1.4 System Control		
					C1.5 Diagnosis		
					C1.6 Information		
					C1.7 Flow Calibration		
					C1.8 Density Calib.		
					C1.9 Simulation		
		>↵	C2 Concentration			>↵	
↵		>↵	C3 I/O (Inputs/Outputs)	>↵	C3.1 Hardware	>↵	
					C3._ Current Output X		
					C3._ Frequency Output X		
					C3._ Pulse Output X		
					C3._ Status Output X		
					C3._ Limit Switch X		
					C3._ Control Input X		
↵		>↵	C4 I/O Totalisers	>↵	C4.1 Totaliser 1	>↵	
					C4.2 Totaliser 2		
					C4.3 Totaliser 3		
↵		>↵	C5 I/O HART	>↵	C5.1 PV is	>↵	
					C5.2 SV is		
					C5.3 TV is		
					C5.4 4V is		
					C5.5 HART Units		
↵		>↵	C6 Device	>↵	C6.1 Device Info	>↵	
					C6.2 Display		
					C6.3 1st Meas. Page		
					C6.4 2nd Meas. Page		
					C6.5 Graphic Page		
					C6.6 Special Functions		
					C6.7 Units		
					C6.8 HART		
					C6.9 Quick Setup		
		↓↑			↓↑		↓↑>

6.4 Function tables

INFORMATION!
-
- *Depending on the device version, not all functions are available.*

6.4.1 Menu A, Quick Setup

No.	Function	Setting / Description

A1 Language

No.	Function	Setting / Description
A1	Language	Language selection depends on the device version.

A2 Tag

No.	Function	Setting / Description
A2	Tag	Measuring point identifier (Tag no.) (also for HART$^®$ operation) appears in the LCD header (max. 8 digits).

A3 Reset

No.	Function	Setting / Description
A3	Reset	
A3.1	Reset Errors	Reset Errors? Select: No / Yes
A3.2	All Totalisers	Reset Totaliser? Select: No / Yes (available if activated in C6.9.4)
A3.3	Totaliser 1	Reset Totaliser? Select: No / Yes (available if activated in C6.9.1)
A3.4	Totaliser 2	Reset Totaliser? Select: No / Yes (available if activated in C6.9.2)
A3.5	Totaliser 3	Reset Totaliser? Select: No / Yes (available if activated in C6.9.3)

A4 Analogue Outputs (only for HART$^®$)

No.	Function	Setting / Description
A4	Analogue Outputs	Applicable to all current outputs (terminals A, B and C), frequency outputs (terminals A, B and D), limit switch (terminals A, B, C, and / or D) and the 1st display page / line 1.
A4.1	Measurement	Select: Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal Depending on the settings for the concentration measurement, the following measurements are possible: Concentration 1 / Concentration 2 / Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2
		Use for all outputs? (also use this setting for Fct. A4.2...A4.5!) Setting: No (applies only to the main current output) / Yes (applies to all analogue outputs)
A4.2	Unit	Selection of the unit from a list, depending on the "measurement"
A4.3	Range	Setting for main current output (range: 0...100%) Setting: 0…x.xx (format and unit, depending on measurement, see A4.1 and A4.2 above)
		Use for all outputs? Make setting, see Fct. A4.1 above!
A4.4	Low Flow Cutoff	1) Setting for main current output (sets output value to "0") Setting: x.xxx ± x.xxx% (range: 0.0...20%) (1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
		2) Use for all outputs? Make setting, see Fct. A4.1 above!

No.	Function	Setting / Description
A4.5	Time Constant	1) Setting for main current output (applicable to all flow measurements) Setting: xxx.x s (range: 000.1…100 s)
		2) Use for all outputs? Make setting, see Fct. A4.1 above!

A4 Station Address

No.	Function	Setting / Description
A4	Station Address	For Profibus / FF / Modbus devices.

A5 Digital Outputs

No.	Function	Setting / Description
A5	Digital Outputs	Valid for all pulse outputs (terminals A, B and/or D) and totaliser 1.
A5.1	Measurement	1) Select: Volume Flow / Mass Flow / Concentration Flow 1
		2) Use for all outputs? (also use this setting for Fct. A5.2…A5.4!) Setting: No (only for pulse output D) / Yes (for all digital outputs)
A5.2	Pulse Value Unit	Selection of the unit from a list, depending on the "measurement"
A5.3	Value Per Pulse	1) Setting for pulse output D (volume or mass value per pulse) Setting: xxx.xxx in l/s or kg/s
		2) Use for all outputs? Make setting, see Fct. A5.1 above!
A5.4	Low Flow Cutoff	1) Setting for pulse output D (sets output value to "0") Setting: x.xxx ± x.xxx% (range: 0.0…20%) (1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
		2) Use for all outputs? Make setting, see Fct. A5.1 above!

A6 GDC IR interface

No.	Function	Setting / Description
A6	GDC IR Interface	After this function has been activated an optical GDC adapter can be connected to the LC display. After 60 seconds pass without a connection being established or after the adapter is removed, the function is exited and the optical keys are active again.
		Break (exit function without connection)
		Activate (the IR interface adapter and interrupt the optical keys)

A7 Flow Direction

No.	Function	Setting / Description
A7	Flow Direction	Forwards (according to the arrow on the measuring sensor) or backwards (in the opposite direction to the arrow)

A8 Zero Calibration

No.	Function	Setting / Description
A8	Zero Calibration	Zero calibration; calibration sequence as described in Fct. C1.1.1…1.1.4

A9 Operation Mode

No.	Function	Setting / Description
A9	Operation Mode	Set the operating mode.
		Setting: Measure / Stop / Standby
		For detailed information refer to *Operation Mode (menu A9)* on page 88.

6.4.2 Menu B, test

No.	Function	Setting / Description

B1 Simulation

No.	Function	Setting / Description
B1	Simulation	Displayed values are simulated.
B1.1	Mass Flow	Simulation of mass flow
		Set value (range and units depend on measurement)
		Break (exit function without simulation)
		Query: start simulation?
		Settings: Yes (start simulation) / No (exit function without simulation)
B1.2	Volume Flow	Sequence and settings similar to B1.1, see above!
B1.3	Density	[X stands for one of the connection terminals A, B, C or D]
B1.4	Temperature	_ stands for Fct. B1.4...1.7
B1._	Current Output X	Simulation X
B1._	Pulse Output X	[X stands for one of the connection terminals A, B, C or D]
B1._	Frequency Output X	Sequence and settings similar to B1.1, see above!
B1._	Control Input X	For the pulse output the set number of pulses are displayed once in a second!
B1._	Limit Switch X	
B1._	Status Output X	

B2 Actual Values

No.	Function	Setting / Description
B2	Actual Values	Display of actual values; Exit the displayed function with the ↵ key.
B2.1	Operating Hours	Device operating hours
B2.2	Date and Time	Date and time of real time clock
B2.3	Mass Flow	Current unfiltered mass flow
B2.4	Volume Flow	Current unfiltered volume flow
B2.5	Velocity	Current unfiltered velocity
B2.6	Density	Current unfiltered density
B2.7	Temperature	Current unfiltered temperature
B2.8	Strain 1	Current value for the first strain
B2.9	Strain 2	Current value for the second strain
B2.10	Tube Frequency	Current vibration frequency of the measuring tube
B2.11	Drive Level	Current drive level to activate vibration
B2.12	Sensor A Level	Current vibration amplitude
B2.13	Sensor B Level	
B2.14	2 Phase Signal	2 phase indicator value
B2.15	SE PCB Temperature	Temperature of measuring sensor electronics
B2.16	Act. Operat. Mode	Current operation mode

B3 Information

B3	Information	
B3.1	Status Log	Log with date and time of status messages that occurred
B3.2	Status Details	Details about the status messages displayed
B3.3	C Number	CG number, cannot be changed (input/output version)
B3.4	Sensor Electronics	Displays the version of the measuring sensor electronics
B3.5	"Bus interface"	Only appears with Profibus, Modbus and FF
B3.6	Electronic Revision	Displays the version of the signal converter. Includes all hardware and software changes.
B3.7	Sensor Revision	Revision of measuring sensor
B3.8	Change Log	The check sum across all settings is displayed directly below the menu item. Shows the changes including date, time and check sum for all settings and parameters in the converter, regardless of the interface (display, HART®, PROFIBUS, …) used.

6.4.3 Menu C, Setup

No.	Function	Settings / descriptions

C1 Process Input

C1.1 Zero and Offset

C1.1	Zero and Offset	–
C1.1.1	Zero Calibration	Start zero calibration
		Query: calibrate zero?
		Setting: Automatic / Factory Settings / Manual (display last value; set new value, range: -10…+10%) / Break (return with ↵ key)
C1.1.2	Zero Add. Offset	Direct setting of zero offset
C1.1.3	Pipe Diameter	Set the pipe diameter in mm to calculate flow velocity
C1.1.4	Flow Correction	Defines additional correction for mass flow; Range: -100…+100%
C1.1.5	Zero Calibration Log	Log of last zero calibration including zero point, temperature, date and time

C1.2 Density

C1.2.1	Density Calib.	Start density calibration
		For detailed information refer to *Density calibration (menu C1.2.1)* on page 89.
C1.2.2	Density Mode Sel.	Selection of density mode: Process (return with ↵ key) / Fixed (a fixed value is used for the density (e.g. standard density)) / Referred (calculates process density based on a reference temperature) / Standard (calculates standard density based on a reference temperature and the correction factors)
C1.2.3	Fixed Density Value	Set the fixed value (e.g. standard density) for the density.
		Appears only if density mode "Fixed" has been selected in Fct. C1.2.2.
C1.2.3	Density Ref. Temp.	Set the reference temperature for the reference density option
		Appears only if density mode "Referred" has been selected in Fct. C1.2.2.

No.	Function	Settings / descriptions
C1.2.4	Ref. Density Slope	Set the slope for the reference density option
		Appears only if density mode "Referred" has been selected in Fct. C1.2.2.
C1.2.5	Standard Density Temp.	Appears only if density mode "Standard" has been selected in Fct. C1.2.2. Density reference temperature to calculate standard density
C1.2.6	Standard Density k0	Appears only if density mode "Standard" has been selected in Fct. C1.2.2. Coefficient k_0 to calculate standard density
C1.2.7	Standard Density k1	Appears only if density mode "Standard" has been selected in Fct. C1.2.2. Coefficient k_1 to calculate standard density
C1.2.8	Standard Density k2	Appears only if density mode "Standard" has been selected in Fct. C1.2.2. Coefficient k_2 to calculate standard density
C1.2.9	Last Density Cal.	Date of last density calibration

C1.3 Filter

C1.3	Filter	-
C1.3.1	Flow Direction	Define polarity of flow direction.
		Forwards (according to the arrow on the measuring sensor) or backwards (in the opposite direction to the arrow)
C1.3.2	Press. Supp. Time	Set the pressure suppression time; range: 0.0...20.0 s
C1.3.3	Press. Supp. Cutoff	Low flow cutoff settings for the pressure suppression; range: 0.0...10.0%
C1.3.4	Low Flow Cutoff	Set the low flow cutoff; range: 00.0...10.0%

C1.4 System Control

C1.4	System Control	-
C1.4.1	Function	Set the system control. Select: Inactive (off) / Flow = 0 (flow to zero)
C1.4.2	Sys. Ctrl. Condition	Set the condition for activating the system control. Selection: density or temperature
C1.4.3	Sys. Ctrl. Max Limit	Defines the upper limit for the condition selected in C1.4.2
C1.4.4	Sys. Ctrl. Min Limit	Defines the lower limit for the condition selected in C1.4.2

C1.5 Diagnosis

C1.5	Diagnosis	-
C1.5.1	Max. Rec. Temp.	Display of maximum recorded sensor temperature
C1.5.2	Min. Rec. Temp.	Display of minimum recorded sensor temperature
C1.5.3	2 Ph. Threshold	Defines the process-dependent sensitivity for 2 phase signal error message.
C1.5.4 & C1.5.5 & C1.5.6 Function		
C1.5.4	Diagnosis 1	Defines the parameter for the respective diagnosis value. Select: Off (goes to zero) / Sensor Average (sensor amplitude A+B) / Sensor Deviation / Drive Level / MT Frequency / Strain 1 / Strain 2 / 2 Phase Signal
C1.5.5	Diagnosis 2	
C1.5.6	Diagnosis 3	
C1.5.7	Proc: Signal Low	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Proc: Signal Low"
C1.5.8	Proc: Signal Search	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Proc: Signal Search"
C1.5.9	Proc: Current Input	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Proc: Current Input"
C1.5.10	Proc: 2 Phase Flow	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Proc: 2 Phase Flow"

No.	Function	Settings / descriptions
C1.5.11	Proc: System Control	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Proc: System Control"
C1.5.12	Config: Totaliser	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Config: Totaliser"
C1.5.13	Electr: Power Failure	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Electr: Power Failure"
C1.5.14	Electr: IO Connection	Selection of status signal (Failure, Out of Specification, Function Check, Maintenance Required and Information) for the group "Electr: IO Connection"

C1.6 Information

C1.6	Information	-
C1.6.1	Sensor Name	Name of measuring sensor
C1.6.2	Sensor ID	ID of measuring sensor
C1.6.3	Nominal Mass Flow	Nominal mass flow of measuring sensor
C1.6.4	Max. Allowed Temp.	Displays the maximum permitted temperature for the measuring sensor
C1.6.5	Min. Allowed Temp.	Displays the minimum permitted temperature for the measuring sensor
C1.6.6	Calibration Date	Date of factory calibration
C1.6.7	V No. Sensor	V number of the measuring sensor
C1.6.8	Serial No. Sensor	Serial number of the measuring sensor
C1.6.9	V No. Converter	V number of the signal converter
C1.6.10	Sensor Electronics	Displays the version of the measuring sensor electronics

C1.7 Flow Calibration

C1.7	Flow Calibration	-
C1.7.1... 1.7.25	CF1...CF27	Displays the measuring sensor calibration coefficients (not CF9 or CF10) for the flow measurement

C1.8 Density Calib.

C1.8	Density Calib.	-
C1.8.1... 1.8.8	DCF1...DCF8	Displays the measuring sensor calibration coefficients for density measurement

C1.9 Simulation

C1.9	Simulation	-
C1.9.1	Mass Flow	As in B1.1
C1.9.2	Volume Flow	As in B1.2
C1.9.3	Density	As in B1.3
C1.9.4	Temperature	As in B1.4

No.	Function	Settings / descriptions

C2 Concentration

C2	Concentration	See supplementary concentration manual

C3 I/O (Inputs/Outputs)

C3.1 Hardware

C3.1	Hardware	Configuration of connection terminals. Selection depends on signal converter version.
C3.1.1	Terminal A	Select: Off (switched off) / Current Output / Frequency Output / Pulse Output / Status Output / Limit Switch / Control Input
C3.1.2	Terminal B	Select: Off (switched off) / Current Output / Frequency Output / Pulse Output / Status Output / Limit Switch / Control Input
C3.1.3	Terminal C	Select: Off (switched off) / Current Output / Status Output / Limit Switch
C3.1.4	Terminal D	Select: Off (switched off) / Frequency Output / Pulse Output / Status Output / Limit Switch

C3._ Current Output X

C3._	Current Output X	X stands for one of the connection terminals A, B or C _ stands for Fct. C3.2 (A) / C3.3 (B) / C3.4 (C)
C3._.1	Range 0%…100%	HART® current output: 4…20 mA
		Current range for the selected measurement, e.g. 4…20 mA, corresponds to 0…100%
		Note: with a 0…20 mA current output, "HART" in Fct. C6.8.1 must be switched off!
		xx.x … xx.x mA; range: 0.00…20 mA (condition: 0 mA ≤ 1st value ≤ 2nd value ≤ 20 mA)
C3._.2	Extended Range	Min. and max. limits of current values. If the current range is exceeded, the current is set to these limits.
		xx.x … xx.x mA; range: 03.5…21.5 mA (Condition: 0 mA ≤ 1st value ≤ 2nd value ≤ 21.5 mA and out of current range)
C3._.3	Error Current	Specify error current (default setting: 3.6 mA)
		xx.x mA; range: 3…22 mA (condition: outside of extended range)
C3._.4	Error Condition	The following error conditions can be selected:
		Select: Failure / Maintenance Required / Out Of Specification (error category [S])
C3._.5	Measurement	Measurements for activating the output
		Select: Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal
		Depending on the settings for the concentration measurement, the following measurements are possible: Concentration 1 / Concentration 2 / Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2
C3._.6	Range	0…100% of the measurement set in Fct. C3._.5
		x.xx…xx.xx _ _ _ (format and unit depend on the "measurement", see above)

No.	Function	Settings / descriptions
C3._.7	Polarity	Set polarity; the flow direction in C1.3.2 must be noted!
		Select: Both Polarities (plus and minus values are displayed) / Positive Polarity (display for negative values = 0) / Negative Polarity (display for positive values = 0) / Absolute Value (always displays positive, with both negative and positive values)
C3._.8	Limitation	Limitation before applying the time constant
		±xxx … ±xxx%; range: -150…+150%
C3._.9	Low Flow Cutoff	Sets the measurement to "0" for low values
		x.xxx ± x.xxx%; range: 0.0…20%
		(1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
C3._.10	Time Constant	Range: 000.1…100 s
C3._.11	Special Function	Automatic Range;
		Select: Off (switched off) / Automatic Range (range is changed automatically, extended lower range, only makes sense in combination with a status output) / External Range (change by control input, extended lower range; control input must also be activated)
C3._.12	Threshold	Appears only when Fct. C3._.11 "Threshold" is activated 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: 5.0…80%
		(1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
C3._.13	Information	Serial no. of the I/O board, software version no. and production date of the circuit board
C3._.14	Simulation	Sequence see B1._ current output X
C3._.15	4mA Trimming	Trimming of the current at 4 mA
		Reset to 4 mA restores the factory calibration.
		Used for HART® setting.
C3._.16	20mA Trimming	Trimming of the current at 20 mA
		Reset to 20 mA restores the factory calibration.
		Used for HART® setting.

C3._ Frequency Output X

C3._	Frequency Output X	X stands for one of the connection terminals A, B or D _ stands for Fct. C3.2 (A) / C3.3 (B) / C3.5 (D)
C3._.1	Pulse Shape	Specify the pulse shape
		Select: Symmetric (about 50% on and 50% off) / Automatic (constant pulse with about 50% on and 50% off at 100% pulse rate) / Fixed (fixed pulse rate, setting see below Fct. C3._.3 100% pulse rate)
C3._.2	Pulse Width	Only available if set to "Fixed" in Fct. C3._.1.
		Range: 0.05…2000 ms
		Note: max. setting value Tp [ms] ≤ 500 / max. pulse rate [1/s], gives the pulse width = time where the output is activated
C3._.3	100% Pulse Rate	Pulse rate for 100% of the measuring range
		Range: 1…10000 Hz
		Limitation 100% pulse rate ≤ 100/s: I_{max} ≤ 100 mA Limitation 100% pulse rate > 100/s: I_{max} ≤ 20 mA
C3._.4	Measurement	Measurements for activating the output
		Select: Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal Depending on the settings for the concentration measurement, the following measurements are possible: Concentration 1 / Concentration 2 / Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2
C3._.5	Range	0…100% of the measurement set in Fct. C3._.4
		x.xx…xx.xx _ _ _ (format and unit depend on the "measurement", see above)
C3._.6	Polarity	Set polarity; the flow direction in C1.3.1 must be noted!
		Select: Both Polarities (plus and minus values are displayed) / Positive Polarity (display for negative values = 0) / Negative Polarity (display for positive values = 0) / Absolute Value (always displays positive, with both negative and positive values)
C3._.7	Limitation	Limitation before applying the time constant
		±xxx … ±xxx%; range: –150…+150%
C3._.8	Low Flow Cutoff	Sets the measurement to "0" for low values
		x.xxx ± x.xxx%; range: 0.0…20%
		(1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
C3._.9	Time Constant	Range: 000.1…100 s
C3._.10	Invert Signal	Select: Off (activated output: switch closed) / On (activated output: switch open)
C3._.11	Phase Shift w.r.t. B	Only available when configuring the terminal A or D and only if output B is a pulse or frequency output. If setting in Fct. C3._.6 is "Both Polarities", the phase shift is prefixed by a symbol, e.g. -90° and +90°
		Select: Off (no phase shift) / 0° Phase Shift (between outputs A or D and B, inversion possible) / 90° Phase Shift (between outputs A or D and B, inversion possible) / 180° Phase Shift (between outputs A or D and B, inversion possible)

C3.3.11	Special Functions	This function is only available at the terminal B frequency output. At the same time, 2 frequency outputs must be available: 1st output at terminal A or D / 2nd output at terminal B
		The B output is operated as a slave output, controlled and set using master output A or D
		Select: Off (no phase shift) / Phase Shift w.r.t. D or A (slave output is B and master output is D or A)
C3._.12	Information	Serial no. of the I/O board, software version no. and production date of the circuit board
C3._.13	Simulation	Sequence see B1._ Frequency Output X

C3._ Pulse Output X

C3._	Pulse Output X	X stands for one of the connection terminals A, B or D _ stands for Fct. C3.2 (A) / C3.3 (B) / C3.5 (D)
C3._.1	Pulse Shape	Specify the pulse shape
		Select: Symmetric (about 50% on and 50% off) / Automatic (constant pulse with about 50% on and 50% off at 100% pulse rate) / Fixed (fixed pulse rate, setting see below Fct. C3._.3 100% pulse rate)
C3._.2	Pulse Width	Only available if set to "Fixed" in Fct. C3._.1.
		Range: 0.05…2000 ms
		Note: max. setting value Tp [ms] ≤ 500 / max. pulse rate [1/s], gives the pulse width = time where the output is activated
C3._.3	Max. Pulse Rate	Pulse rate for 100% of the measuring range
		Range: 0.0…10000 1/s
		Limitation 100% pulse rate ≤ 100/s: $I_{max} \le 100$ mA Limitation 100% pulse rate > 100/s: $I_{max} \le 20$ mA
C3._.4	Measurement	Measurements for activating the output
		Select: Volume Flow / Mass Flow
C3._.5	Pulse Value Unit	Selection of the unit from a list, depending on the "measurement"
C3._.6	Value Per Pulse	Set value for volume or mass per pulse
		xxx.xxx, measured value in unit depending on setting in C3._.5
		At max. pulse rate see above 3._.3 "Pulse Output"
C3._.7	Polarity	Set polarity; the flow direction in C1.3.1 must be noted!
		Select: Both Polarities (plus and minus values are displayed) / Positive Polarity (display for negative values = 0) / Negative Polarity (display for positive values = 0) / Absolute Value (always displays positive, with both negative and positive values)
C3._.8	Low Flow Cutoff	Sets the measurement to "0" for low values
		x.xxx ± x.xxx%; range: 0.0…20%
		(1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
C3._.9	Time Constant	Range: 000.1…100 s
C3._.10	Invert Signal	Select: Off (activated output: switch closed) / On (activated output: switch open)

C3._.11	Phase Shift w.r.t. B	Only available when configuring the terminal A or D and only if output B is a pulse or frequency output. If setting in Fct. C3._.7 is "Both Polarities", the phase shift is prefixed by a symbol, e.g. -90° and +90°
		Select: Off (no phase shift) / 0° Phase Shift (between outputs A or D and B, inversion possible) / 90° Phase Shift (between outputs A or D and B, inversion possible) / 180° Phase Shift (between outputs A or D and B, inversion possible)
C3.3.11	Special Functions	This function is only available at the pulse output of terminal B. At the same time, 2 pulse outputs must be available: 1st output at terminal A or D / 2nd output at terminal B
		The B output is operated as a slave output, controlled and set using master output A or D
		Select: Off (no phase shift) / Phase Shift w.r.t. D or A (slave output is B and master output is D or A)
C3._.12	Information	Serial no. of the I/O board, software version no. and production date of the circuit board
C3._.13	Simulation	Sequence see B1._ Pulse Output X

C3._ Status Output X

C3._	Status Output X	X (Y) stands for one of the connection terminals A, B, C or D _ stands for Fct. C3.2 (A) / C3.3 (B) / C3.4 (C) / C3.5 (D)
C3._.1	Mode	The output shows the following measuring conditions:
		Failure (output set, signals status of the category "Failure" refer to *Status messages and diagnostic information* on page 103) / Out Of Specification (output set, signals status of category "Failure" or "Maintenance Required" or "Out Of Specification" refer to *Status messages and diagnostic information* on page 103) / Maintenance Required (output set, signals status of category "Failure" or "Maintenance Required" refer to *Status messages and diagnostic information* on page 103) / Flow Polarity (polarity of the current flow) / Flow Over Range (over range of the flow) / Totaliser 1 Preset (activates when totaliser X preset value is reached) / Totaliser 2 Preset (activates when totaliser X preset value is reached) / Totaliser 3 Preset (activates when totaliser X preset value is reached) / Output A (activated by the status of output Y, additional output data see below) / Output B (activated by the status of output Y, additional output data see below) / Output C (activated by the status of output Y, additional output data see below) / Output D (activated by the status of output Y, additional output data see below) / Off (switched off)
C3._.2	Current Output Y	Only appears if output A...C is set under "Mode" (see above), and this output is a "Current Output".
		Polarity (is signalled)
		Over Range (is signalled)
		Automatic Range signals lower range
C3._.2	Frequency Output Y and Pulse Output Y	Only appears if output A, B or D is set under "Mode" (see above), and this output is a "Frequency/Pulse Output".
		Polarity (is signalled)
		Over Range (is signalled)
C3._.2	Status Output Y	Only appears if output A...D is set under "Mode" (see above), and this output is a "Status Output".
		Same Signal (like other connected status output, signal can be inverted, see below)
C3._.2	Limit Switch Y and Control Input Y	Only appears if output A...D / input A or B is set under "Mode" (see above), and this output / input is a "Limit Switch / Control Input".
		Status Off (is always selected here if Status Output X is connected with a Limit Switch / Control Input Y).
C3._.2	Output Y	Only appears if output A...D is set under "Mode" (see above) and this output is switched off.
C3._.3	Invert Signal	Select: Off (activated output: switch closed) / On (activated output: switch open)
C3._.4	Information	Serial no. of the I/O board, software version no. and production date of the circuit board
C3._.5	Simulation	Sequence see B1._ Status Output X

C3._ Limit Switch X

C3._	Limit Switch X	X stands for one of the connection terminals A, B, C or D _ stands for Fct. C3.2 (A) / C3.3 (B) / C3.4 (C) / C3.5 (D)
C3._.1	Measurement	Select: Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal
C3._.2	Threshold	Switching level, set threshold with hysteresis
		xxx.x ±x.xxx (format and unit depend on the measurement, see above)
		(1st value = threshold / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
C3._.3	Polarity	Set polarity; the flow direction in C1.3.1 must be noted!
		Select: Both Polarities (plus and minus values are displayed) / Positive Polarity (display for negative values = 0) / Negative Polarity (display for positive values = 0) / Absolute Value (always displays positive, with both negative and positive values)
C3._.4	Time Constant	Range: 000.1…100 s
C3._.5	Invert Signal	Select: Off (activated output: switch closed) / On (activated output: switch open)
C3._.6	Information	Serial no. of the I/O board, software version no. and production date of the circuit board
C3._.7	Simulation	Sequence see B1._ Limit Switch X

C3._ Control Input X

C3._	Control Input X	
C3._.1	Mode	X stands for connection terminal A or B _ stands for Fct. C3.2 (A) / C3.3 (B)
		Off (control input switched off) / Hold All Outputs (hold actual values, not display and totalisers) / Hold Output Y (hold actual values) / All Outputs To Zero (actual values = 0%, not display and totalisers) / Output Y To Zero (actual value = 0%) / All Totalisers (reset all totalisers to "0") / Totaliser "Z" Reset (set totaliser 1, 2 or 3 to "0") / Stop All Totalisers / Stop Totaliser "Z" (stops totaliser 1, 2 or 3) / Zero Outp.+Stop Tot. (all outputs 0%, stop all totalisers, not the display) / External Range Y (control input for external range of current output Y) - also make this setting on current output Y (no check if current output Y is available) / Error Reset (all resettable errors are deleted) / Calibrate zero
C3._.2	Invert Signal	Select: Off (activated output: switch closed) / On (activated output: switch open)
C3._.3	Information	Serial no. of the I/O board, software version no. and production date of the circuit board
C3._.4	Simulation	Sequence see B1._ Control Input X

No.	Function	Settings / descriptions

C4 I/O Totalisers

No.	Function	Settings / descriptions
C4.1	Totaliser 1	Set function of counter. _ stands for 1, 2, 3 (= Totaliser 1, 2, 3) The basic version (standard) has only 2 totaliser!
C4.2	Totaliser 2	
C4.3	Totaliser 3	
C4._.1	Totaliser Function	Select: Absolute Total (counts positive + negative values) / Incremental Total (counts only the positive values) / Decremental Total (counts only the negative values) / Off (Totaliser is switched off)
C4._.2	Measurement	Selection of the measurement for Totaliser _
		Select: Volume Flow / Mass Flow / (depends on the settings for the concentration measurement): Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2
C4._.3	Low Flow Cutoff	Sets the measurement to "0" for low values
		Range: 0.0…20%
		(1st value = switching point / 2nd value = hysteresis), condition: 2nd value $\leq$ 1st value
C4._.4	Time Constant	Range: 0.1…100 s
C4._.5	Preset Value	If this value is reached, positive or negative, a signal is generated that can be used for a status output at which "Preset Totaliser X" has to be set.
		Preset Value (max. 8 digits) x.xxxxx in selected unit, see C6.7.10 + 13
C4._.6	Reset Totaliser	Sequence see Fct. A3.3, A3.4 and A3.5
C4._.7	Set Totaliser	Set Totaliser _ to the desired value
		Select: Break (exit function) / Set Value (opens the editor to make the entry)
		Query: Set Totaliser?
		Select: Select: No (exit function without setting the value) / Yes (sets the totaliser and exits the function)
C4._.8	Stop Totaliser	Totaliser _ is stopped and holds the actual value
		Select: No (exit the function without stopping the totaliser) / Yes (stop the totaliser and exit the function)
C4._.9	Start Totaliser	Start Totaliser _ after that totaliser is stopped
		Select: No (exits the function without starting the totaliser) / Yes (starts the totaliser and exits the function)
C4._.10	Information	Serial no. of the I/O board, software version no. and production date of the circuit board

No.	Function	Settings / descriptions

C5 I/O HART

No.	Function	Settings / descriptions
C5	I/O HART	Selection or display of the 4 dynamic variables (DV) for HART$^{\circledR}$
		The HART$^{\circledR}$ current output (terminal A basic I/Os or terminal C modular I/Os) always has a fixed link to the primary variables (PV). Fixed links of the other DVs (1-3) are only possible if additional analogue outputs (current and frequency output) are available. If not, the measured value can be freely selected from the values in the list in Fct. A4.1 "Measurement".
		_ stands for 1, 2, 3 or 4
		X stands for connection terminals A...D
C5.1	PV is	Current output (primary variable)
C5.2	SV is	(secondary variable)
C5.3	TV is	(tertiary variable)
C5.4	4V is	(4th variable)
C5.5	HART Units	Changes units of DVs (dynamic variables) in the display
		Break: return with ↵ key
		HART$^{\circledR}$ display: copies the settings for the display units to the settings for DVs
		Standard: factory settings for DVs
C5._.1	Current Output X	Shows the current analogue measured value of the linked current output. The "measurement" cannot be changed!
C5._.1	Frequency Output X	Shows the current analogue measured value of the linked frequency output, if present. The "measurement" cannot be changed!
C5._.1	HART Dynamic Var.	Measurements of the dynamic variables for HART$^{\circledR}$.
		Select: Volume Flow / Mass Flow / Diagnosis Value / Flow Velocity / Totaliser 1 / Totaliser 2 / Totaliser 3 / Operating Hours

No.	Function	Settings / descriptions

C6 Device

C6.1 Device Info

No.	Function	Settings / descriptions
C6.1	Device Info	-
C6.1.1	Tag	Settable characters (max. 8 digits): A…Z; a…z; 0…9; / - + , .
C6.1.2	V No. Sensor	V number of the measuring sensor, cannot be changed
C6.1.3	Serial No. Sensor	Serial no. of the measuring sensor, cannot be changed
C6.1.4	Sensor Revision	Revision of the measuring sensor, cannot be changed
C6.1.5	V No. Converter	V number of the signal converter, cannot be changed
C6.1.6	Converter Serial No.	Serial no. of the signal converter, cannot be changed
C6.1.7	C Number	CG number, cannot be changed; describes the signal converter version
C6.1.8	Electronics Serial No.	Serial no. of the electronic assembly, cannot be changed
C6.1.9	Electronic Revision	Displays the version of the signal converter. Includes all hardware and software changes.

C6.2 Display

No.	Function	Settings / descriptions
C6.2	Display	-
C6.2.1	Language	Language selection depends on the device version.
C6.2.2	Contrast	Adjust display contrast for extreme temperatures. Setting: -9…0…+9
		This change takes place immediately, not just when setting mode is exited!
C6.2.3	Default Display	Specification of the default display page that is returned to after a short delay period.
		Select: None (the current page is always active) / 1st Meas. Page (show this page) / 2nd Meas. Page (show this page) / Status Page (show only status messages) / Graphic Page (trend display of the 1st measurement)
C6.2.4	Optical Keys	Activate or deactivate the optical keys
		Select: On / Off

C6.3 & C6.4 1st Meas. Page & 2nd Meas. Page

No.	Function	Settings / descriptions
C6.3	1st Meas. Page	_ stands for 3 = 1st Meas. Page and 4 = 2nd Meas. Page
C6.4	2nd Meas. Page	
C6._.1	Function	Specify number of measured value lines (font size)
		Select: One Line / Two Lines / Three Lines
C6._.2	1st Line Variable	Specify measurement for 1st line
		Select: Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal Depending on the settings for the concentration measurement, the following measurements are possible: Concentration 1 / Concentration 2 / Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2
C6._.3	Range	0…100% of the measurement set in Fct. C5._.2
		x.xx…xx.xx _ _ _ (format and unit depend on the "measurement")

No.	Function	Settings / descriptions
C6._.4	Limitation	Limitation before applying the time constant
		±xxx ... ±xxx%; range: -150…+150%
C6._.5	Low Flow Cutoff	Sets low flow values to "0"
		x.xxx ± x.xxx %; Range: 0.0…20 %
		(1st value = switching point / 2nd value = hysteresis), condition: 2nd value ≤ 1st value
C6._.6	Time Constant	Range: 0.1…100 s
C6._.7	1st Line Format	Specify decimal places
		Select: Automatic (adaptation is carried out automatically) / X°(=°none)°…X.XXXXXXX°(max.°8°digits) depends on size of font
C6._.8	2nd Line Variable	Specify 2nd Line Variable (only available if this 2nd line is activated)
		Select: Bargraph (for the "measurement" selected in the 1st line) / Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal / Totaliser 1 / Totaliser 2 / Totaliser 3 / Operating Hours

Depending on the settings for the concentration measurement, the following measurements are possible: Concentration 1 / Concentration 2 / Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2 |
C6._.9	2nd Line Format	Specify decimal places
		Select: Automatic (adaptation is carried out automatically) / X°(=°none)°…X.XXXXXXX°(max.°8°digits) depends on size of font
C6._.10	3rd Line Variable	Specify 3rd Line Variable (only available if this 3rd line is activated)
		Select: Volume Flow / Mass Flow / Temperature / Density / Velocity / Sensor Average / Sensor Deviation / Drive Level / Tube Frequency / Strain 1 / Strain 2 / 2 Phase Signal / Totaliser 1 / Totaliser 2 / Totaliser 3 / Operating Hours

Depending on the settings for the concentration measurement, the following measurements are possible: Concentration 1 / Concentration 2 / Conc. mass flow 1 / Conc. mass flow 2 / Conc. volume flow 1 / Conc. volume flow 2 |
| C6._.11 | 3rd Line Format | Specify decimal places |
| | | Select: Automatic (adaptation is carried out automatically) / X°(=°none)°…X.XXXXXXX°(max.°8°digits) depends on size of font |

C6.5 Graphic Page

C6.5	Graphic Page	-
C6.5.1	Select Range	Graphic page always shows trend curve of the measurement of the 1st page / 1st line, see Fct. C6.3.2
		Select: Manual (set range in Fct. C6.5.2) / Automatic (automatic depiction based on the measured values)
		Reset only after parameter change or after switching off and on.
C6.5.2	Range	Set the scaling for the Y axis. Only available if "Manual" is set in C6.5.1.
		±xxx ±xxx%; range: -100…+100%
		(1st value = lower limit / 2nd value = upper limit), condition: 1st value ≤ 2nd value

No.	Function	Settings / descriptions
C6.5.3	Time Scale	Set the time scaling for the X axis, trend curve
		xxx min; range: 0...100 min

C6.6 Special Functions

No.	Function	Settings / descriptions
C6.6	Special Functions	-
C6.6.1	Reset Errors	Reset Errors?
		Select: No / Yes
C6.6.2	Save Settings	Save current settings Select: Break (exit function without saving) / Backup 1 (save in storage location 1) / Backup 2 (save in storage location 2)
		Query: Continue To Copy? (cannot be undone) Select: No (exit function without saving) / Yes (copy current settings to storage backup 1 or backup 2)
C6.6.3	Load Settings	Load saved settings Select: Break (exit function without loading) / Factory Settings (restore factory settings) / Backup 1 (load data from storage location 1) / Backup 2 (load data from storage location 2)
		Query: Continue To Copy? (cannot be undone) Select: No (exit the function without saving) / Yes (load data from the selected storage location)
C6.6.4	Password Quick Set	Password required to change data in the menu "Quick Setup"
		0000 (= to menu "Quick Setup" without password)
		xxxx (password required); range 4 digits: 0001...9999
C6.6.5	Password Setup	Password required to change data in the menu "Setup"
		0000 (= to menu "Quick Setup" without password)
		xxxx (password required); range 4 digits: 0001...9999
C6.6.6	Date and Time	Set real time clock
C6.6.7	Quick Access	Set "Quick Access" function;
		Select: Off (deactivated) / Reset Totaliser 1, 2, 3 or All Totalisers
C6.6.8	GDC IR Interface	After this function has been activated an optical GDC adapter can be connected to the LC display. After 60 seconds pass without a connection being established or after the adapter is removed, the function is exited and the optical keys are active again.
		Select: Break (exit function without connection) / Activate (the IR interface adapter and interrupt the optical keys)
		After 60 seconds pass without a connection being established, the function is exited and the optical keys are active again.

C6.7 Units

No.	Function	Settings / descriptions
C6.7	Units	
C6.7.1	Volume Flow	m³/h; m³/min; m³/s; L/h; L/min; L/s (L = litres); IG/s; IG/min; IG/h cf/h; cf/min; cf/s; gal/h; gal/min; gal/s; barrel/h; barrel/day Free Unit (set factor and text in the next two functions, sequence see below)
C6.7.2	Text Free Unit	For text to be specified refer to *Set free units* on page 86:
C6.7.3	[m³/s]*Factor	Specification of the conversion factor, based on m³/s:
		xxx.xxx refer to *Set free units* on page 86

No.	Function	Settings / descriptions
C6.7.4	Mass Flow	kg/s; kg/min; kg/h; t/min; t/h; g/s; g/min; g/h; lb/s; lb/min; lb/h; ST/min; ST/h (ST = Short Ton); LT/h (LT = Long Ton); Free Unit (set factor and text in the next two functions, sequence see below)
C6.7.5	Text Free Unit	For text to be specified refer to *Set free units* on page 86:
C6.7.6	[kg/s]*Factor	Specification of the conversion factor, based on kg/s:
		xxx.xxx refer to *Set free units* on page 86
C6.7.7	Velocity	m/s; ft/s
C6.7.9	Temperature	°C; °F; K
C6.7.10	Volume	m³; L; hL; mL; gal; IG; in³; cf; yd³; barrel Free Unit (set factor and text in the next two functions, sequence see below)
C6.7.11	Text Free Unit	For text to be specified refer to *Set free units* on page 86:
C6.7.12	[m³]*Factor	Specification of the conversion factor, based on m³:
		xxx.xxx refer to *Set free units* on page 86
C6.7.13	Mass	kg; t; mg; g; lb; ST; LT; oz; Free Unit (set factor and text in the next two functions, sequence see below)
C6.7.14	Text Free Unit	For text to be specified refer to *Set free units* on page 86:
C6.7.15	[kg]*Factor	Specification of the conversion factor, based on kg:
		xxx.xxx refer to *Set free units* on page 86
C6.7.16	Density	kg/L; kg/m³; lb/cf; lb/gal; SG Free Unit (set factor and text in the next two functions, sequence see below)
C6.7.17	Text Free Unit	For text to be specified refer to *Set free units* on page 86:
C6.7.18	[kg/m³]*Factor	Specification of the conversion factor, based on kg/m³:
		xxx.xxx refer to *Set free units* on page 86
C6.7.19	Pressure	Pa; kPa; bar; mbar; psi (no free units possible); only if current input available

C6.8 HART

C6.8	HART	
C6.8.1	HART	Switch HART® communication on/off:
		Select: On (HART® activated) possible current range for current output 4…20 mA / Off (HART® not activated) possible current range for current output 0…20 mA
	Loop Current Mode	Configure loop current mode: Disabled = Multidrop Mode / Enabled = Current Signal Mode
C6.8.2	Address	Set address for HART® operation:
		Select: 00 (Point-to-Point operation,;current output has normal function; current = 4…20 mA) / 01…15 (Multi-Drop operation; current output has a constant setting of 4 mA)
C6.8.3	Message	Set required text: A…Z ; a…z ; 0…9 ; / - + , . *
C6.8.4	Description	Set required text: A…Z ; a…z ; 0…9 ; / - + , . *
C6.8.5	HART Long tag	Set the HART Long tags

C6.9 Quick Setup

C6.9	Quick Setup	Activate quick access in the menu "Quick Setup"
		Select: Yes (activated) / No (switched off)
C6.9.1	Reset Totaliser 1	Reset Totaliser 1 in menu "Quick Setup"
		Select: Yes (activated) / No (switched off)
C6.9.2	Reset Totaliser 2	Reset Totaliser 2 in menu "Quick Setup"
		Select: Yes (activated) / No (switched off)
C6.9.3	Reset Totaliser 3	Reset Totaliser 3 in menu "Quick Setup"
		Select: Yes (activated) / No (switched off)
C6.9.4	Reset All Totalisers	Reset all Totaliser in menu "Quick Setup"
		Select: Yes (activated) / No (switched off)

6.4.4 Set free units

Free units	Sequences to set texts and factors
Texts	
Volume flow, mass flow and density	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	= [unit see above] * conversion factor
Conversion factor	Max. 9 digits
Shift decimal point	↑ to the left and ↓ to the right

6.5 Description of functions

6.5.1 Reset totaliser in the menu "Quick Setup"

INFORMATION!
It may be necessary to activate resetting of the totaliser in the menu "Quick Setup".

Key	Display	Description and setting
>	Quick Setup	Press and hold for 2.5 s, then release the key.
>	Language	-
2 x ↓	Reset	-
>	Reset Errors	-
↓	All Totaliser	Select desired totaliser. (Totaliser 3 is optional)
↓	Totaliser 1	
↓	Totaliser 2	
↓	Totaliser 3	
>	Reset Totaliser No	-
↓ or ↑	Reset Totaliser Yes	-
↵	Totaliser 1,2 (or 3)	Totaliser has been reset.
3 x ↵	Measuring mode	-

6.5.2 Deleting error messages in the menu "Quick Setup"

INFORMATION!
The detailed list of the possible error messages.

Key	Display	Description and setting
>	Quick Setup	Press and hold for 2.5 s, then release the key.
>	Language	-
2 x ↓	Reset	-
>	Reset Errors	-
>	Reset? No	-
↓ or ↑	Reset? Yes	-
↵	Reset Errors	Error has been reset.
3 x ↵	Measuring mode	-

6.5.3 Operation Mode (menu A9)

The device can be switched to "Standby". In this mode, all flow values are set to zero and the counter values are "frozen". The temperature and density values are displayed normally and output via the outputs. The "Standby" indicator on the display shows either the "frozen" counter value or simply "Standby". In this mode, the measuring tubes continue to vibrate and the device can immediately return to "Measuring" mode if necessary.

There is also a "Stop" mode. In this mode, the measuring sensor is switched off and is no longer vibrating. To return to measuring mode from this mode, the measuring device **must** go through the complete "start-up" phase again before measurement continues.

The measuring device can be switched into "Standby" mode either using the operating keys on the display or using the control input. You can only switch to "Stop" mode using the operating keys.

Key	Display		Description and setting
>	A	Quick Setup	Press and hold for 2.5 s, then release the key.
> ↑	A9	Operation Mode Measuring	
>		Operation Mode Measuring	
↑		Operation Mode Standby	
↑		Operation Mode Stop	
3 x ↵		Save Configuration? Yes	
↵		Display page	

Table 6-5: Setting the operation mode (from measuring mode)

If "Standby" or "Stop" is selected, the device immediately switches to this operating state. To return to the measuring mode, go to menu A9 and select "Measuring".

INFORMATION!
When changing from the "Stop" to "Standby" mode, the device goes through the entire start-up phase.

In addition to the "Standby" mode, the system control function also allows you to switch to a comparable "Standby" status completely automatically depending on the current operating temperature or density.

6.5.4 Density calibration (menu C1.2.1)

Mass flowmeters are calibrated for density in the factory. Density calibration is based on 2 calibration points. In the factory, air and water are used under reference conditions. The result of this calibration is saved in the converter electronics and stored in the factory settings. Regardless, various applications require maximum accuracy which can only be achieved with on-site calibration.

Option	Explanation
1 Point Calibration	One of the 2 saved calibration points is replaced by customer calibration. The signal converter decides which of the 2 calibration points is modified.
2nd Calibration Point	Calibration of the 2nd point.
Factory Calib.	The signal converter reactivates the factory settings for the density calibration.

Table 6-6: Available options for density calibration

Key	Display		Description and setting
>	A	Quick Setup	Press and hold for 2.5 s, then release the key.
2 x ↓	C1	Setup	
↓	C1.2	Density	
2 x >	C1.2.1	Density Calibration? 1 Point Calibration	
↵	C1.2.1	Density Calib. Product XXXXXXX	
Press ↓ until	C1.2.1	Density Calib. Product Town Water	
↵	C1.2.1	Density Calibration? OK	
↵		Please Wait Countdown from 20 s	
		Density Calib. Passed	
5 x ↵		Save Configuration? Yes	
↵		Display page	

Table 6-7: Example of 1 point calibration with town water

On-site density calibration:

- Ensure that the device has been properly installed and functions smoothly.
- If air (empty) is used as the medium, the measuring tube must be completely dry and free of liquids and solids. If possible, blow dry air into the measuring tube to empty it.
- If liquids are used, flush for a few minutes at a high flow rate to remove gas bubbles.
- Set the flow rate to a typical value (50% of the nominal flow is ideal).
- If the process temperature is higher than the ambient temperature, wait until the system has stabilised.
- When it comes to 1 point and 2 point calibration, you can choose from the options "empty", "pure water", "town water" and "other". The reference values for the specified products are stored in the converter.

Density calibration has failed if "Density Calib. Error" is displayed. The reason for the error may be indicated on the display. Possible reasons for failed density calibration:

- The device is not in "Measuring" mode.
- The calibration points are too close together.
- One or more calibration points did not pass the plausibility test.
- Flow, pressure, temperature or system are not stable?
- Please check your system and try again.
- If this results in another failed calibration, please contact the manufacturer.

1 Point Calibration

- See examples for "Calibration with town water and other".
- Select the function using ↓ and ↑ and then confirm with ↵.
- If "Other" is selected, the product density must be entered.
- 1 point calibration is generally sufficient for most applications, such as adapting the density measurement to a new installation.
- Make sure that prior to calibrating the 2nd point that 1 point calibration was carried out and that the result was saved with the dialog "Save Configuration?".

2 Point Calibration

- In this case, both reference points are recalibrated (with the products of the system).
- With 2 point calibration, ensure that both calibration points entered by the user are accepted.

If the 2nd point cannot be calibrated immediately after the first one, because the 2nd product is not yet available, the device continues to function normally as after the 1 point calibration. In other words, there can be weeks or even months between the calibration of the two measuring points.

6.5.5 Temperature/density tables

Temperature		Density		Temperature		Density	
°C	°F	kg/m^3	lb/ft^3	°C	°F	kg/m^3	lb/ft^3
0	32	999.8396	62.41999	0.5	32.9	999.8712	62.42197
1	33.8	999.8986	62.42367	1.5	34.7	999.9213	62.42509
2	35.6	999.9399	62.42625	2.5	36.5	999.9542	62.42714
3	37.4	999.9642	62.42777	3.5	38.3	999.9701	62.42814
4	39.2	999.972	62.42825	4.5	40.1	999.9699	62.42812
5	41	999.9638	62.42774	5.5	41.9	999.954	62.42713
6	42.8	999.9402	62.42627	6.5	43.7	999.9227	62.42517
7	44.6	999.9016	62.42386	7.5	45.5	999.8766	62.4223
8	46.4	999.8482	62.42053	8.5	47.3	999.8162	62.4185
9	48.2	999.7808	62.41632	9.5	49.1	999.7419	62.41389
10	50	999.6997	62.41125	10.5	50.9	999.6541	62.40840
11	51.8	999.6051	62.40535	11.5	52.7	999.5529	62.40209
12	53.6	999.4975	62.39863	12.5	54.5	999.4389	62.39497
13	55.4	999.3772	62.39112	13.5	56.3	999.3124	62.38708
14	57.2	999.2446	62.38284	14.5	58.1	999.1736	62.37841
15	59	999.0998	62.3738	15.5	59.9	999.0229	62.36901
16	60.8	998.9432	62.36403	16.5	61.7	998.8607	62.35887
17	62.6	998.7752	62.35354	17.5	63.5	998.687	62.34803
18	64.4	998.596	62.34235	18.5	65.3	998.5022	62.3365
19	66.2	998.4058	62.33047	19.5	67.1	998.3066	62.32428
20	68	998.2048	62.31793	20.5	68.9	998.1004	62.31141
21	69.8	997.9934	62.30473	21.5	70.7	997.8838	62.29788
22	71.6	997.7716	62.29088	22.5	72.5	997.6569	62.28372
23	73.4	997.5398	62.27641	23.5	74.3	997.4201	62.26894
24	75.2	997.2981	62.26132	24.5	76.1	997.1736	62.25355
25	77	997.0468	62.24563	25.5	77.9	996.9176	62.23757
26	78.8	996.7861	62.22936	26.5	79.7	996.6521	62.22099
27	80.6	996.5159	62.21249	27.5	81.5	996.3774	62.20384
28	82.4	996.2368	62.19507	28.5	83.3	996.0939	62.18614
29	84.2	995.9487	62.17708	29.5	85.1	995.8013	62.16788
30	86	995.6518	62.15855	30.5	86.9	995.5001	62.14907
31	87.8	995.3462	62.13947	31.5	88.7	995.1903	62.12973
32	89.6	995.0322	62.11986	32.5	90.5	994.8721	62.10987

33	91.4	994.71	62.09975	33.5	92.3	994.5458	62.08950
34	93.2	994.3796	62.07912	34.5	94.1	994.2113	62.06861
35	95	994.0411	62.05799	35.5	95.9	993.8689	62.04724
36	98.6	993.6948	62.03637	36.5	97.7	993.5187	62.02537
37	98.6	993.3406	62.01426	37.5	99.5	993.1606	62.00302
38	100.4	992.9789	61.99168	38.5	101.3	992.7951	61.98020
39	102.2	992.6096	61.96862	39.5	103.1	992.4221	61.95692
40	104	992.2329	61.9451	40.5	104.9	992.0418	61.93317
41	105.8	991.8489	61.92113	41.5	106.7	991.6543	61.90898
42	107.6	991.4578	61.89672	42.5	108.5	991.2597	61.88434
43	109.4	991.0597	61.87186	43.5	110.3	990.8581	61.85927
44	111.2	990.6546	61.84657	44.5	112.1	990.4494	61.83376
45	113	990.2427	61.82085	45.5	113.9	990.0341	61.80783
46	114.8	989.8239	61.79471	46.5	115.7	989.6121	61.78149
47	116.6	989.3986	61.76816	47.5	117.5	989.1835	61.75473
48	118.4	988.9668	61.7412	48.5	119.3	988.7484	61.72756
49	120.2	988.5285	61.71384	49.5	121.1	988.3069	61.70
50	122	988.0839	61.68608	50.5	122.9	987.8592	61.67205
51	123.8	987.6329	61.65793	51.5	124.7	987.4051	61.64371
52	125.6	987.1758	61.62939	52.5	126.5	986.945	61.61498
53	127.4	986.7127	61.60048	53.5	128.3	986.4788	61.58588
54	129.2	986.2435	61.57118	54.5	130.1	986.0066	61.5564
55	131	985.7684	61.54153	55.5	131.9	985.5287	61.52656
56	132.8	985.2876	61.5115	56.5	133.7	985.0450	61.49636
57	134.6	984.8009	61.48112	57.5	135.5	984.5555	61.4658
58	136.4	984.3086	61.45039	58.5	137.3	984.0604	61.43489
59	138.2	983.8108	61.41931	59.5	139.1	983.5597	61.40364
60	140	983.3072	61.38787	60.5	140.9	983.0535	61.37203
61	141.8	982.7984	61.35611	61.5	142.7	982.5419	61.34009
62	143.6	982.2841	61.324	62.5	144.5	982.0250	61.30783
63	145.4	981.7646	61.29157	63.5	146.3	981.5029	61.27523
64	147.2	981.2399	61.25881	64.5	148.1	980.9756	61.24231
65	149	980.7099	61.22573	65.5	149.9	980.4432	61.20907

66	150.8	980.1751	61.19233	66.5	151.7	979.9057	61.17552
67	152.6	979.6351	61.15862	67.5	153.5	979.3632	61.14165
68	154.4	979.0901	61.1246	68.5	155.3	978.8159	61.10748
69	156.2	978.5404	61.09028	69.5	157.1	978.2636	61.07300
70	158	977.9858	61.05566	70.5	158.9	977.7068	61.03823
71	159.8	977.4264	61.02074	71.5	160.7	977.145	61.00316
72	161.6	976.8624	60.98552	72.5	162.5	976.5786	60.96781
73	163.4	976.2937	60.95002	73.5	164.3	976.0076	60.93216
74	165.2	975.7204	60.91423	74.5	166.1	975.4321	60.89623
75	167	975.1428	60.87816	75.5	167.9	974.8522	60.86003
76	168.8	974.5606	60.84182	76.5	169.7	974.2679	60.82355
77	170.6	973.9741	60.80520	77.5	171.5	973.6792	60.7868
78	172.4	973.3832	60.76832	78.5	173.3	973.0862	60.74977
79	174.2	972.7881	60.73116	79.5	175.1	972.489	60.71249
80	176	972.188	60.69375				

6.5.6 Density mode (menu C1.2.2)

There are 4 available operating modes for density that can be set here:

- Process:
  The device measures and displays the current operating density of the product.
- Fixed:
  The device displays a fixed density value. This value must be entered in menu C1.2.3.
- Referred:
  The device calculates the density based on a set reference temperature.
- Standard:
  The device calculates the standard density based on a set reference temperature and the correction factors $k_0...k_2$, so that a standard volume can be output.

The following equation is used for the "Referred" mode:

$$\rho_r = \rho_a + a\,(t_a - t_r)$$

ρ_r = Density at reference temperature
ρ_a = Current measured operating density at current operating temperature
a = Programmed temperature coefficient/density gradient
t_a = Current measured operating temperature
t_r = Reference temperature

The reference temperature must be entered in menu item C1.2.3. The density gradient is set in C1.2.4.
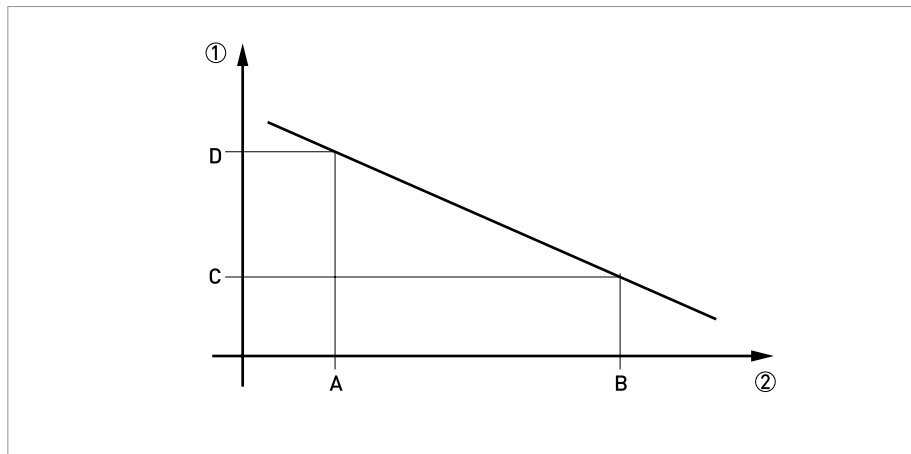
Figure 6-7: Calculating the density gradient
① Density
② Temperature

The following equation is used to calculate the density gradient:

$$a = (\rho_D - \rho_C)\,/\,(T_B - T_A)$$

The value for the density gradient is generally positive as an increase in temperature usually reduces the measured density(exception: water anomaly).

Calculating the standard density

The measuring device can display a density which has been corrected in terms of the standard temperature in accordance with API 11.1. Standard 2540.

The corresponding reference temperature is entered in menu C1.2.5. The correction factors $k_0...k_2$ are entered in menu C1.2.6...C1.2.8.

Standard factors for gasolines are: $k_0 = 346.4228$; $k_1 = 0.4388$; $k_2 = 0$

6.5.7 Pipe diameter (menu C1.1.3)

The converter can also provide the flow velocity based on a pipe diameter which the customer can freely program. This value can either be the inner diameter of the measuring tube (factory default) or the inner diameter of the process pipe.

6.5.8 Concentration measurement (menu C2)

This menu is used to enter the password to activate concentration measurement (in case the concentration option is purchased) after the meter is delivered.

INFORMATION!
Please refer to the separate concentration manual for further details of concentration measurement.

6.5.9 Flow direction (menu C1.3.1)

This function allows the operator to set the direction of flow in relation to the arrow on the housing. If "Forwards" is selected, the flow direction corresponds to the "+" arrow and with "Backwards" the flow direction corresponds to the "-" arrow on the housing.

6.5.10 Pressure suppression

The pressure suppression eliminates any disruption in the measurement in the event of an abrupt flow switch-off e.g. when valves are suddenly closed. In such cases, surges may occur in the pipe and in the measuring device which could lead to over-vibration. The flow then "swings" back and forth before a stable zero flow is established, as shown in the figure below. This effect occurs mainly in high pressure applications.
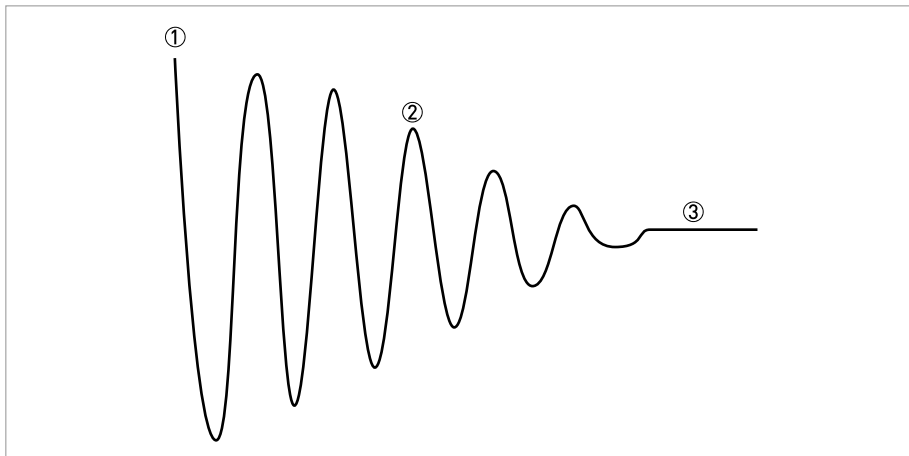
Figure 6-8: Vibration behaviour during pressure suppression
① Flow switched off
② Sinusoidal vibration ("over-vibration")
③ Stable zero flow

In most cases, the amplitude of this vibration is below the low flow cutoff and thus does not affect the measurement. In very few cases, the amplitude is greater than the low flow cutoff (over-vibration) and can cause errors with the counter values.
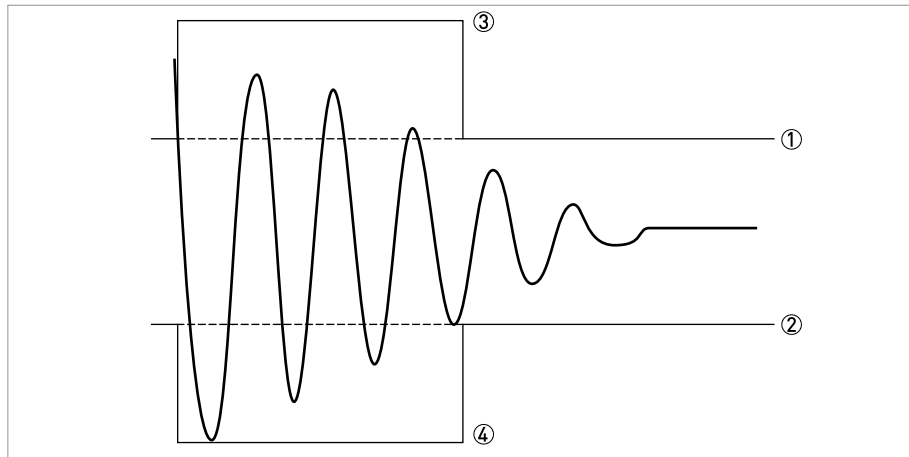
Figure 6-9: Amplitude behaviour

① Low flow cutoff
② Low flow cutoff
③ Pressure suppression
④ Pressure suppression

The pressure suppression function eliminates this effect by activating a larger low flow cutoff level for a short period of time. The pressure suppression is activated when the flow falls below the standard low flow cutoff level for the first time. For a programmable period of time, (can be programmed in menu C1.3.2), the pressure suppression threshold is added to the standard low flow threshold (can be set in menu C1.3.3).

The optimal setting values for pressure suppression depend on the current operating conditions and can thus only be determined on-site through testing.

6.5.11 System control

Menu C1.4.1 - Function

This menu makes it possible to switch off certain measuring functions depending on a programmable process state. When this system state occurs (as set in Fct. C1.4.2), the following options can be activated:

- Inactive: system control is off
- Flow = 0: Flow set to zero

Menu C1.4.2 - Condition

Selecting the process measurement which activates the system control. Density and temperature can be selected.

Menu C1.4.3 — Max Limit
Menu C1.4.4 — Min Limit

Setting the limit values to activate system control. Current measuring values outside of this range activate this function.

6.5.12 2 Ph. Threshold (menu C1.5.3)

The threshold for the 2 phase signal can be set in this menu item. This makes it possible to output a status signal indicating the presence of gas bubbles in the process. There are no default values for this threshold. This means that the operator must adapt this value to suit his application. This can be done, for example, by programming the 2 phase signal at the current output and registering which threshold makes sense for the respective process for a certain time period.

Fct.	Display	Description and setting
B2.14	2 Phase Signal	The 2-phase signal value in % can be read and transferred to Diagnosis 1.
C1.5.3	2 Ph. Threshold	Only input a value here if an error message is to be generated. This error message can be displayed via the status outputs. The error message is then indicated on the display as **S: Out Of Specification** and **S: 2 Phase Flow** indicated on the display. Caution: Take into account the setting of the error conditions of the current output!
C1.5.4	Diagnosis 1	Set "2 Phase Signal".
C3.1.3	Terminals C	Set "Limit Switch".
C3.4.1	Measurement	Set "Diagnosis 1".
C3.4.2	Threshold	e.g. set to "2.0 ± 0.2%".
C3.4.3	Polarity	e.g. set to "Absolute Value".
C3.4.4	Time Constant	Set as needed.
C3.4.4	Invert Signal	Set as needed.
C6.4.1	2nd Meas. Page	Set "Three Lines".
C6.4.10	3rd Line Variable	Set "Diagnosis 1".
C6.4.11	3rd Line Format	Set "X.XX".

Table 6-8: Example regarding the detection and notification of a two-phase disturbed flow (e.g. gas bubbles in paints)

The 2 phase signal is displayed on the 2nd measuring page at the bottom with e.g.: 0.02%. If the threshold is exceeded (C3.4.2), a message is sent via terminals C.

6.5.13 Diagnosis messages (menu C1.5.7....C1.5.14)

These settings make it possible to change the status signal of the respective diagnosis message (status group).

6.5.14 Optical keys (C6.2.4)

This function can deactivate the optical keys. In the display, the switched off state of the optical keys is represented by a lock ①.
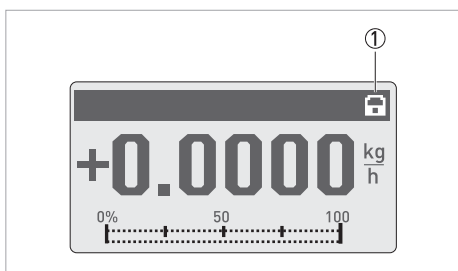
Figure 6-10: Indication of optical keys in switched off state

In this case, the device may only be operated using the push buttons.

6.5.15 Graphic page (menu C6.5)

With this converter, the trend of the main measurement can be graphically displayed. The first measurement on display page 1 is always defined as the main measurement.

- Menu C6.5.1 defines the range for the trend indicator (manual or automatic).
- Menu C6.5.2 defines the range for manual setting.
- Menu C6.5.3 defines the time span for the trend indicator.

6.5.16 Save settings (menu C6.6.2)

This function allows all settings to be stored in a memory.

- Backup 1: Saves settings in backup memory area 1
- Backup 2: Saves settings in backup memory area 2

6.5.17 Load settings (menu C6.6.3)

This function allows the complete stored settings to be loaded again.

- Backup 1: Loading from backup - memory 1
- Backup 2: Loading from backup - memory 2
- Factory: Uploading the original factory settings

6.5.18 Passwords (Menu 6.6.4 Quick Set; Menu 6.6.5 Setup)

To create a password for the Quick Set menu or Setup menu, you must enter a 4-digit code into the menu. You are then prompted for this password every time changes are to be made to the corresponding menus. There is a hierarchy. The Setup password can also be used to perform changes in the Quick Setup menu. Enter 0000 in each menu to disable the password.

6.5.19 Date and time (C6.6.6)

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.

6.5.20 Quick Access (C6.6.7)

In measuring mode, pressing the ↵ key for 2.5 seconds carries out the "Quick Access" function. Totalisers 1, 2, 3 and All Totalisers can be reset.

6.5.21 Low flow cutoff

The low flow cutoff can be individually set for each output and each display line. If the low flow cutoff has been activated, the respective output or display is set to zero when the flow is below the low flow cutoff value entered.

The value can either be entered as a percentage of the nominal flow of the sensor or, in the case of a pulse output, as a discrete flow value.

Two values must be entered. The first is for the operating point of the sensor and the second is for hysterisis. Condition: 1st value > 2nd value
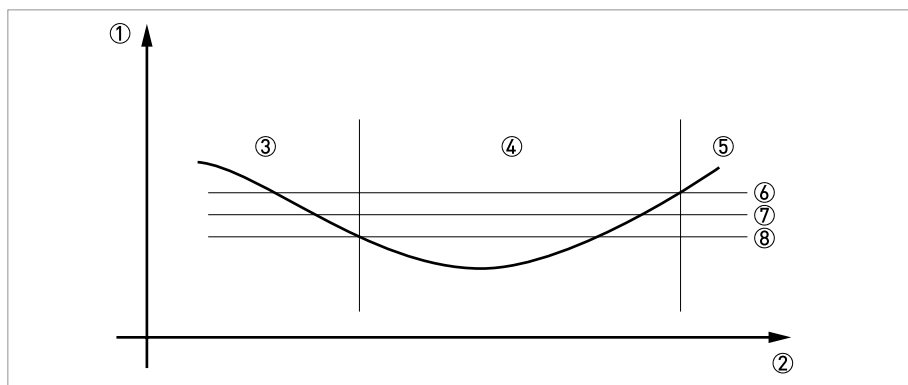
Figure 6-11: Indication of low flow cutoff

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

6.5.22 Time constant

To better process widely fluctuating measured values in the device, the measured values are digitally filtered to stabilise the output. The time constant can be individually set for each output, the first line of the display and the density measurement. However, keep in mind that the degree of filtration affects the response time of the device in the event of rapid changes.

Short time constant	Fast response times
	Fluctuating reading
Long time constant	Slow response time
	Stable reading

The time constant corresponds to the elapsed time until 67% of the end value has been reached according to a step function.

6.5.23 Dual phase pulse output

A dual phase pulse or frequency output is often required for custody transfer applications. This operating mode requires 2 terminal pairs. Terminal pairs A and B or D and B can be used.

In this case, perform the following settings:

- C3.3.11: Phase shift to D or shift to A
- All functions for output B are set using output D or output A.
- C3.5.11: Setting phase shift from output B relative to D, if terminal pair D was selected in C3.3.11. 0°, 90° or 180° are offered as options.
- C3.2.11: Setting the phase shift from output B relative to A, if terminal pair A was selected in C3.3.11 0°, 90° or 180° are offered as options.

6.5.24 Timeouts in programming mode

Normal menu function: If no key has been pressed for 5 minutes in a normal menu function, the display automatically switches to measuring mode. All changes are lost.

Test function: In test mode, the test function is finished after 60 minutes.

GDC IR Interface: If the GDC-IR connection is activated, it is cancelled after 60 seconds if no connection is established. If the connection is interrupted, the display can be operated again after 60 seconds using the optical keys.

6.5.25 Output hardware

Depending on the hardware modules used (see CG number), it may be possible to change the output options on terminals A, B, C or D in the menus C3.1.x. For example: A pulse output to a frequency output or a status output to a control input.

The available options are determined by the hardware module used. It is not possible to change the type of output, e.g. from active to passive or to NAMUR.

6.6 Status messages and diagnostic information

The diagnostic messages are displayed in accordance with NAMUR standard NE 107. The error messages for the device are divided into status groups, each with one status signal. There are 16 status groups with fixed status signals and 8 groups with variable status signals. To facilitate identification of the problem source, the status groups are then divided into the groups: Sensor, Electronics, Configuration and Process.

The variable status signal can be changed in menu C1.5.7...C1.5.14. Changing the status signal to "Information" switches off the message.

INFORMATION!
As status message always the name of the relevant status group and the status signal (F/S/M/C) is displayed.

Each status message (= status signal) has a specific symbol, determined by NAMUR, which is displayed with the message. The length of each message is limited to one line.

Symbol	Letter	Status signal	Description and consequence
⊗	F	Failure	No measurement possible.
⚠?	S	Out of specification	Measurements are available but are no longer sufficiently accurate and should be checked
◇	M	Maintenance required	Measurements are still accurate but this could soon change
▽	C	Function check	A test function is active; The displayed or transferred measured value does not correspond to the actual measured value.
	I	Information	No direct influence on the measurements

Table 6-9: Description of status messages

All status messages are saved in the status log (menu B3.1). Use the ↑ and ↓ keys to navigate through this list. Use the ↵ key to exit the list.

The status screen shows the status groups of all errors that have occurred since the last time the status screen was opened. All errors that are not current disappear after 2 seconds. They are shown in the list in brackets.

Legend

	Fixed status signal
	Variable status signal

Error type	Event group	Single event	Description	Actions to eliminate the event
F	F Sensor			
		Sensor Containment Dam.	High pressure detected in housing. Faulty measuring tube.	Exchange measuring sensor.
		Sensor Error	The measuring sensor signals are out of range. Flow measurements are not possible.	Check connection between measuring sensor and signal converter (remote version) or replace measuring sensor.
F	F Electronics			
		System Error	Electronics error in internal bus communication or due to a hardware error.	Perform cold start. If message reappears, contact manufacturer.
		System Error A		
		System Error C		
		HW Combination Error		
		BM Failure		
		DM Failure		
		Process Input Failure		
		IO 1 Failure		
		IO 2 Failure		
		Tot 1 Failure		
		Tot 2 Failure		
		Tot 3 Failure		
		IO A Failure		
		IO B Failure		
		IO C Failure		
F	F Configuration			
		BM Configuration	Error detected when starting device. Possible causes: inadmissible parameter settings or fault with electronics component.	Check settings of appropriate function or load factory settings. If the error persists, contact manufacturer.
		DM Configuration		
		Process Input Config.	Settings for process input invalid.	Check settings for process input or load factory settings.
		Density Calib.	Density calibration parameters invalid.	Perform density calibration. Check product and function mode.

Error type	Event group	Single event	Description	Actions to eliminate the event
		Fieldbus Config.	Inadmissible Fieldbus settings	Check Fieldbus settings or load factory settings.
		PROFIBUS Config.	Inadmissible Profibus settings	Check PROFIBUS settings or load factory settings.
		Tot 1 FB4 Unit Error	Totaliser is out of operation due to inadmissible unit.	Check unit in totaliser 1 FB4 or load factory settings.
		Tot 2 FB5 Unit Error		Check unit in totaliser 2 FB5 or load factory settings.
		Tot 3 FB6 Unit Error		Check unit in totaliser 3 FB6 or load factory settings.
		Modbus Config.	Inadmissible Modbus settings	Check Modbus settings or load factory settings.
		Display Config.	Inadmissible settings for the display	Check display settings or load factory settings.
		IO1 Configuration	Inadmissible settings for IO1	Check settings for IO1 or load factory settings.
		IO2 Configuration	Inadmissible settings for IO2	Check settings for IO2 or load factory settings.
		Tot 1 Configuration	Inadmissible settings for totaliser 1	Check settings for totaliser 1 or load factory settings.
		Tot 2 Configuration	Inadmissible settings for totaliser 2	Check settings for totaliser 2 or load factory settings.
		Tot 3 Configuration	Inadmissible settings for totaliser 3	Check settings for totaliser 3 or load factory settings.
		IO A Configuration	Inadmissible settings for IO A	Check settings for IO A or load factory settings.
		IO B Configuration	Inadmissible settings for IO B	Check settings for IO B or load factory settings.
		IO C Configuration	Inadmissible settings for IO C	Check settings for IO C or load factory settings.
		IO D Configuration	Inadmissible settings for IO D	Check settings for IO D or load factory settings.
F	F Process			
C	C Sensor			
C	C Electronics			

C	C Configuration				
		Sensor in Stop Mode	The device is in stop mode. No flow measurement is being performed. All flow-related values displayed are substitute values. The measuring tube is not vibrating.	Switch to measuring mode for normal operation.
		Sensor in Standby Mode	The device is in standby mode. No flow measurement is being performed. All flow-related values displayed are substitute values. The measuring tube continues to vibrate.	
		Sensor Simulation Active	Simulation of mass flow, volume flow, density or temperature.	Switch off measured value simulation.
		Sensor Starting up	The sensor is in start-up mode. This is a normal state following a switch from stop mode to measuring mode. The error message "Sensor: Startup" becomes active when this state goes on too long or is unexpected.	
		Fieldbus Sim. Active	The simulation function in the Foundation Fieldbus module is active and being used.	Check Fieldbus settings.
		PROFIBUS Sim/Man Active	The simulation function in the PROFIBUS module is active and being used.	Check PROFIBUS settings.
		Totaliser 1 FB4 Sim. Active	The simulation function in the PROFIBUS module is active and being used.	Switch off simulation.
		Totaliser 2 FB5 Sim. Active		
		Totaliser 3 FB6 Sim. Active		
		Totaliser 1 FB4 Man. Active	The manual mode in the PROFIBUS module is active.	Switch of manual mode.
		Totaliser 2 FB5 Man. Active		
		Totaliser 3 FB6 Man. Active		
		IO A Simulation Active	IO A simulation is active.	Switch off simulation.
		IO B Simulation Active	IO B simulation is active.	
		IO C Simulation Active	IO C simulation is active.	
		IO D Simulation Active	IO D simulation is active.	
C	C Process			
S	S Sensor			
		Temp. Or Strain Res. Def.	The resistance network for temperature and strain measurement is operated outside of specifications and is possibly faulty. The measured values for flow and density remain valid however the accuracy is undetermined. The temperature measurement has failed.	Check connection between measuring sensor and signal converter (remote version) or replace measuring sensor.

S	S Electronics			
		Electr.Temp.A Out of Spec	Temperature of the signal converter electronics is out of range.	Protect signal converter from process effects and sunlight.
		Electr.Temp.C Out of Spec		
		Electr.Temp. Out of Spec		
S	S Configuration			
		IO A Overrange	The output value is limited by a filter.	When limiting the input value, refer to the actions listed there. Check the range setting of the output.
		IO B Overrange		
		IO C Overrange		
		IO D Overrange		
S	S Process			
		Proc.Temp.Out of Range	The process temperature is out of range. The measurement continues but the accuracy is undetermined.	Check process conditions.
		Flow Out of Range	The flow is out of range. The actual flow is higher than the displayed value.	
		Prod.Density Out of Range	The density is out of range. The measurement continues but the accuracy of the density and flow is undetermined.	Check process conditions and density calibration.
		Velocity Out of Range	The flow is out of range. The actual flow is higher or lower than the value displayed.	Check process conditions and pipe diameter setting.
M	M Sensor			
M	M Electronics			
		Backplane Data Faulty	The backplane data record is faulty.	Check the correct installation of the signal converter electronics. After changing one parameter, the message should disappear within one minute. If not, contact the manufacturer.
		Factory Data Faulty	Factory settings are invalid.	Contact manufacturer.
		Backplane Difference	The data on the backplane differ from the data in the device.	After changing one parameter, the message should disappear within one minute. If not, contact the manufacturer.
		Mem. Life Exceeded	The number of maximum write cycles is exceeded for the memory component.	Exchange the signal converter electronics.

M	M Configuration			
		Backup 1 Data Faulty	Error when checking the data record for Backup 1.	Use "Setup > Device > Special Functions > Save Settings" to save the data record. If the message continues to appear, contact the manufacturer.
		Backup 2 Data Faulty	Error when checking the data record for Backup 2.	
M	M Process			
F	F Proc: Current Input			
		IO A Error Current	Error current is detected at current input A.	Check device connected to current input A. This devices submits an error current.
		IO B Error Current	Error current is detected at current input B.	Check device connected to current input B. This devices submits an error current.
S	S Electr: IO Connection			
		IO A Connection	Current output A cannot provide the necessary current. The current provided is too low. The current at input A is below 0.5 mA or above 23 mA.	Check connection at A. Measure resistance of current loop at A. Check current at A.
		IO A Connection	Open circuit or short circuit at IO A.	
		IO B Connection	Current output B cannot provide the necessary current. The current provided is too low. The current at input B is below 0.5 mA or above 23 mA.	Check connection at B. Measure resistance of current loop at B. Check current at B.
		IO B Connection	Open circuit or short circuit at IO B.	
		IO C Open Connector	Current output C cannot provide the necessary current. The current provided is too low.	Check connection at C. Measure resistance of current loop at C.
F	F Proc: Signal Search			
		Sensor signal search	The measuring sensor signals are too small for an accurate flow measurement. The cause is typically too much damping, e.g. due to gas bubbles or the viscosity is too high.	Check process conditions. In the case of a measuring sensor in remote version, check the electrical connection between the field housing and the measuring sensor.
S	S Proc: 2 Phase Flow			
		2 Phase Flow Detected	2 phase flow has been detected. The accuracy of the flow and density measurement is undetermined.	Check product for gas bubbles.

S	S Proc: Signal Low			
		Sensor signal low	The sensor signals do not reach the expected amplitude. This can influence the measuring accuracy.	Check the product for viscosity and gas bubbles.
S	S Config: Totaliser			
		Tot 1 FB4 Overflow	Totaliser 1 FB4 has overflowed and started again at zero.	Check totaliser format.
		Tot 2 FB5 Overflow	Totaliser 2 FB5 has overflowed and started again at zero.	
		Tot 3 FB6 Overflow	Totaliser 3 FB6 has overflowed and started again at zero.	
		Tot 1 Overflow	Totaliser 1 has overflowed and started again at zero.	
		Tot 2 Overflow	Totaliser 2 has overflowed and started again at zero.	
		Tot 3 Overflow	Totaliser 3 has overflowed and started again at zero.	
I	I Proc: System Control			
		System Control Active	System control is active.	
I	I Electr: Power Failure			
		Tot 1 Power Failure	Totaliser 1 invalid due to power failure.	Check the value of the totaliser.
		Tot 2 Power Failure	Totaliser 2 invalid due to power failure.	
		Tot 3 Power Failure	Totaliser 3 invalid due to power failure.	
		Tot 1 FB4 Power Failure	Totaliser 1 FB4 invalid due to power failure.	
		Tot 2 FB5 Power Failure	Totaliser 2 FB5 invalid due to power failure.	
		Tot 3 FB6 Power Failure	Totaliser 3 FB6 invalid due to power failure.	
		Power Failure Detected	Power failure has occurred. The totaliser state may be invalid.	

I	I Config: No Meas.Value			
		IO A No Meas. Values	The measurement value for the IO terminals A is not active.	Select another measurement for IO A in menu C3.2 or activate the measurement in C5.1 for diagnosis values or in menu C2 for concentration values.
		IO B No Meas. Values	The measurement value for the IO terminals B is not active.	Select another measurement for IO B in menu C3.3 or activate the measurement in C5.1 for diagnosis values or in menu C2 for concentration values.
		IO C No Meas. Values	The measurement value for the IO terminals C is not active.	Select another measurement for IO C in menu C3.4 or activate the measurement in C5.1 for diagnosis values or in menu C2 for concentration values.
		IO D No Meas. Values	The measurement value for the IO terminals D is not active.	Select another measurement for IO D in menu C3.5 or activate the measurement in C5.1 for diagnosis values or in menu C2 for concentration values.
		Tot 1 No Meas. Values	The measurement value for the totaliser 1 is not active.	Select another measurement for totaliser 1 in menu C4.1 or activate the measurement in C1.5 for diagnosis values or in menu C2 for concentration values.
		Tot 2 No Meas. Values	The measurement value for the totaliser 2 is not active.	Select another measurement for totaliser 2 in menu C4.2 or activate the measurement in C1.5 for diagnosis values or in menu C2 for concentration values.
		Tot 3 No Meas. Values	The measurement value for the totaliser 3 is not active.	Select another measurement for totaliser 3 in menu C4.3 or activate the measurement in C1.5 for diagnosis values or in menu C2 for concentration values.
		Disp. 1 No Meas. Values	Measurement value at 1st measuring page is not active.	Select another measurement for 1st measuring page or activate the measurement in C1.5 for diagnosis values or in menu C2 for concentration values.
		Disp. 2 No Meas. Values	Measurement value at 2nd measuring page is not active.	Select another measurement for 2nd measuring page or activate the measurement in C1.5 for diagnosis values or in menu C2 for concentration values.

I	I Electr. Operation Info.			
		Zero Calibr. Running	A zero calibration is performed.	
		PROFIBUS No Data	No data exchange via PROFIBUS.	Set up cyclical PROFIBUS communication.
		PROFIBUS Baudrate	PROFIBUS searches for the current Baudrate.	Check PROFIBUS terminal and connection.
		PROFIBUS Passivated	PROFIBUS module is passivated.	Disable PROFIBUS passivation.
		PROFIBUS Clear Data	PROFIBUS Clear Data is active	Start of cyclic PROFIBUS communication
		PROFIBUS Sync Mode	PROFIBUS Sync Mode is active.	Disable Sync Mode.
		PROFIBUS Freeze Mode	PROFIBUS Freeze Mode is active.	Disable Freeze Mode.
		Tot 1 Stopped	Totaliser 1 was stopped.	If totaliser is to continue counting, select "Yes" in Fct. C.y.9 (Start Totaliser).
		Tot 2 Stopped	Totaliser 2 was stopped.	
		Tot 3 Stopped	Totaliser 3 was stopped.	
		Tot 1 FB4 Threshold	Tot 1 FB4 Threshold exceeded.	Reset Totaliser 1 FB4.
		Tot 2 FB5 Threshold	Tot 2 FB5 Threshold exceeded.	Reset Totaliser 2 FB5.
		Tot 3 FB6 Threshold	Tot 3 FB6 Threshold exceeded.	Reset Totaliser 3 FB6.
		Control In A Active		
		Control In B Active		
		Status Out A Active		
		Status Out B Active		
		Status Out C Active		
		Status Out D Active		
		Fieldbus No Connection	Check Fieldbus terminal and connection.	
		Disp. 1 Overrange	The value in the 1st measurement line of the display page is limited.	Check setting for 1st measurement line.
		Disp. 2 Overrange	The value in the 2nd measurement line of the display page is limited.	Check setting for 2nd measurement line.
		Optical Interf. Active	The optical interface is being used. The optical keys are deactivated.	The keys are ready for operation again approx. 60 seconds after the end of the data transfer/removal of the optical interface.

6.7 Function tests and troubleshooting

Min. and max. recorded temperature (menu C1.5.1 / C1.5.2)

Stores the minimum and maximum value for the temperature occurring during sensor operating time.

Flow sensor type	Operating temperature	
	Minimum	Maximum
OPTIMASS 1000	-40°C / -40°F	+130°C / +266°F
OPTIMASS 2000		
OPTIMASS 3000 (Stainless steel or Hastelloy®)		+150°C / +302°F
OPTIMASS 6000 (standard version)	-70°C / -94°F	+230°C / +446°F
OPTIMASS 6000 (cryogenic version)	-200°C / -328°F	+40°C / +104°F
OPTIMASS 6000 (high temperature version)	-50°C / -58°F	+400°C / +752°F
OPTIMASS 6000 (Hastelloy C)	-70°C / -94°F	+230°C / +446°F
OPTIMASS 6000 (Duplex)	-50°C / -58°F	+230°C / +446°F
OPTIMASS 7000 (titanium)	-40°C / -40°F	+150°C / +302°F
OPTIMASS 7000 (Hastelloy®/tantalum)	0°C / +32°F	+100°C / +212°F
OPTIMASS 7000 (stainless steel)	0°C / +32°F	+100°C / +212°F +130°C / +266°F

Application problems that may indicate errors in the signal converter:

- An improperly closed shut-off valve during zero calibration results in high calibration values
- Air/gas bubbles result in high energy levels and high calibration values
- Product deposits on the inside of the measuring tube lead to higher/lower density indications and high calibration values

Common errors (with corresponding symptoms):

- Slightly eroded or corroded measuring tube
  - Erroneous density measurement
  - High frequency
  - Measurement error at low mass flow
- Eroded or corroded measuring tube (product in the housing)
  - Measuring tube does not start
  - Low resistance to earth with conducting product
- Open circuits of drive and sensor coils or resistance thermometers (RTD)
  - Can be measured with ohmmeter

Typical frequency values (at +20°C / +68°F)

Size	Titanium		Stainless steel		Hastelloy®		Tantalum	
	Empty	Water	Empty	Water	Empty	Water	Empty	Water
1000 - 15			438±10	412±10				
1000 - 25			605±20	523±20				
1000 - 40			494±10	414±10				
1000 - 50			583±10	453±10				
2000 - 100			341±6	267±6				
2000 - 150			330±6	259±6				
2000 - 250			299±6	227±6				
3000 - 01			258±6	251±6	266±6	258±6		
3000 - 03			320±6	310±6	320±6	310±6		
3000 - 04			455±6	435±6	455±6	435±6		
6000 - 08			220	205	220	205		
6000 - 10			187	172	187	172		
6000 - 15			212	191	212	191		
6000 - 25			266	231	266	231		
6000 - 50			262	230	262	230		
6000 - 80			234	203	234	203		
6000 - 100			257	221	257	221		
6000 - 150			245	208	245	208		
6000 - 200			218	184	218	184		
6000 - 250			187	160	187	160		
7000 - 06	316±10	301±10	374±10	362±10				
7000 - 10	406±10	371±10	441±10	417±10	439±10	416±10	348±10	330±10
7000 - 15	502±10	432±10	578±10	519±10	566±10	509±10	430±10	394±10
7000 - 25	614±10	483±10	692±10	580±10	687±10	581±10	515±10	449±10
7000 - 40	462±10	367±10	558±10	467±10	556±10	468±10	417±10	360±10
7000 - 50	488±10	357±10	514±10	418±10	539±10	431±10	403±10	333±10
7000 - 80	480±10	338±10	490±10	370±10	493±10	381±10		

Problems with zero calibration

① Stop the flow.
② Set the totaliser in Fct. C3.y.1 to "Absolute Total".
③ Set the low flow cutoff in Fct. C3.y.3 to zero.
④ Perform automatic zero calibration.
⑤ Reset totaliser and count for 2 minutes.
⑥ Compare the added value to the specified zero calibration stability.

INFORMATION!
For best results, perform zero calibration with the medium at operating temperature.

Possible causes of poor zero calibration:

• Valves not completely closed, air or gas bubbles or deposits on measuring tube

6.8 Diagnostic functions

The following diagnostic functions are available in test menu B2.

6.8.1 Temperature (menu B2.7)

Temperature display in °C or °F.

- This value should be steadily displayed.
- Unstable values may mean a faulty Pt500 or that liquid is in the outer housing.

6.8.2 Frequency (menu B2.10)

- Fluctuation in the first decimal places indicate gas or air bubbles in the product.
- Worn or eroded measuring tube: frequency increases by around 2…4 Hz; recalibration required.
- Formation of a coating can reduce vibration frequency, depending on the type of coating and the layer thickness. If, however, the density of the coating is the same as for the flowing medium, no frequency change is observed.
- Large fluctuations in frequency occur in the "start-up" phase.

6.8.3 Drive level (menu B2.11)

Display of the drive energy in percent.

Typical values for drive energy in water and with no gas inclusions

All meters	All sizes	0…25

INFORMATION!
Higher values for drive energy can occur when the product contains air or gas bubbles or when measuring products with high viscosity or density.

6.8.4 Sensor levels A and B (menu B2.12, B2.13)

Display of the sensor reading in percent.

Typical values

Size	Standard (+230°C / +446°F) / Cryogenic	+400°C / +752°F
6000 - 08	60	TBD
6000 - 10	55	TBD
6000 - 15	60	TBD
6000 - 25	80	25
6000 - 50	80	25
6000 - 80	70	25
6000 - 100	80	30
Size	Standard	
1000 - 15/25/40	80	
1000 - 50	60	
2000 - 100	60	
2000 - 150/250	50	
7000 - 06/10/15/25/40	80	
7000 - 50/80	60	

INFORMATION!
- *This value should correspond to the amplitude setting in menu D1.4.1 and should not be more than 2% apart.*
- *Low sensor A/B value indicate damping of the transducer due to air entrainment or poor mixed solids. The accuracy of the meter may be affected.*
- *Significant differences between the two sensor values could indicate a problem with one of the sensors, coating/erosion towards one side of the measuring tube or process related issue.*

6.8.5 2 phase signal (menu B2.14)

The value of the 2 phase signal can be read in this function. For applications that must detect 2 phase flow, an alarm level can be programmed. This alarm level depends on the application and the process and can thus only be set on-site under current operating conditions during flow. For detailed information refer to *2 Ph. Threshold (menu C1.5.3)* on page 99.

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 2 connecting cables from the electronics before removing the signal converter electronics to be replaced.

- To insert the new electronics, first connect the 2 connecting cables to the electronics.
- Carefully push the electronics back into the housing.
- Tighten the 2 locking screws again and secure the display.
  - ➲ The measuring system recognises the hardware replacement when the power supply is switched on.

7.2 Driver or sensor coil fault

Typical inductance and resistance values

7.2.1 OPTIMASS 1000

The specified values are for guidance only.

Size (DN)	Resistance (Ω)	
	Driver	Sensor A/B
15	68	84
25	68	64
40	68	84
50	68	64

Table 7-1: Typical resistance values

- Driver = black and grey
- Sensor A = green and purple
- Sensor B = white and yellow
- Pt500 = red and blue (530…550 Ω) at ambient temperature
- Strain values measuring tube = 420...560 Ω
- Resistance values outside of the ranges specified above may indicate a circuit error. The device may be in "start-up" mode or indicate measuring errors.
- All circuits should be isolated with respect to earth (device housing) and each other >20 MΩ.
- A driver/sensor coil short circuit may cause the meter to be in "start-up" mode.

INFORMATION!
Failure of two or more of the upper circuits may indicate a measuring tube error. There may be product in the housing. If this is the case, **depressurise** *the process line and immediately remove the measuring device from the process line.*

7.2.2 OPTIMASS 2000

The specified values are for guidance only.

Size (DN)	Resistance (Ω)	
	Driver	Sensor A/B
100	41	108
150	46	87
250	40	87
400	46	84

Table 7-2: Typical resistance values

- Driver = black and grey
- Sensor A = green and purple
- Sensor B = white and yellow
- Pt500 = red and blue (530...550 Ω) at ambient temperature
- Strain 1 and strain 2 values = 420...580 Ω
- Resistance values outside of the ranges specified above may indicate a circuit error.
  The device may be in "start-up" mode or indicate measuring errors.
- All circuits should be isolated with respect to earth (device housing) and each other >20 MΩ.
- A driver/sensor coil short circuit may cause the meter to be in "start-up" mode.

INFORMATION!
*Failure of two or more of the upper circuits may indicate a measuring tube error. There may be product in the housing. If this is the case, **depressurise** the process line and immediately remove the measuring device from the process line.*

7.2.3 OPTIMASS 3000

The specified values are for guidance only.

Size (DN)	Resistance (Ω)	
	Driver	Sensor A/B
01	94	140
03 / 04	92	140

Table 7-3: Typical resistance values

- Driver = black/violet and grey/orange
- Sensor A = green and purple
- Sensor B = white and yellow
- Pt500 = red and blue (530…550 Ω) at ambient temperature
- Resistance values outside of the ranges specified above may indicate a circuit error.
  The device may be in "start-up" mode or indicate measuring errors.
- All circuits should be isolated with respect to earth (device housing) and each other >20 MΩ.
- A driver/sensor coil short circuit may cause the meter to be in "start-up" mode.

INFORMATION!
Failure of two or more of the upper circuits may indicate a measuring tube error. There may be product in the housing. If this is the case, **depressurise** *the process line and immediately remove the measuring device from the process line.*

7.2.4 OPTIMASS 6000

The specified values are for guidance only.

Size (DN)	Resistance (Ω)			
	Driver		Sensor A - Sensor B	
	black/grey		purple/green - white/yellow	
	Cryo +230°C / +446°F	+400°C / +752°F	Cryo +230°C / +446°F	+400°C / +752°F
6000 - 08	72	12	273	49
6000 - 10	68	12	273	49
6000 - 15	68	6	273	49
6000 - 25	42	12	185	22.5
6000 - 50	42	52	185	22.5
6000 - 80	42	52	185	22.5
6000 - 100	42	54	185	22.5
6000 - S150	42	70	185	22.5
6000 - S200	69	68	185	22.5

Table 7-4: Typical resistance values

	Resistance (Ω)	
	Pt500	Compensation lines
	red-blue	red-brown/orange
6000 - all sizes	540 at +20°C / +68°F	0.1

Table 7-5: Typical RTD resistances

• Resistance values outside of the ranges specified above may indicate a circuit error.
  The device may be in "start-up" mode or indicate measuring errors.
• All circuits should be isolated with respect to earth (device housing) and each other >20 MΩ.
• A driver/sensor coil short circuit may cause the meter to be in "start-up" mode.

INFORMATION!
Failure of two or more of the upper circuits may indicate a measuring tube error. There may be product in the housing. If this is the case, depressurise the process line and immediately remove the measuring device from the process line.

7.2.5 OPTIMASS 7000

The specified values are for guidance only.

Size (DN)	Resistance (Ω)	
	Driver	Sensor A/B
06 / 10	91	142
15	73	142
25	69	142
40 / 50 / 80	48	142

Table 7-6: Typical resistance values

- Driver = black and grey
- Sensor A = green and purple
- Sensor B = white and yellow
- Pt500 = red and blue (530…550 Ω) at ambient temperature
- Resistance values outside of the ranges specified above may indicate a circuit error.
  The device may be in "start-up" mode or indicate measuring errors.
- All circuits should be isolated with respect to earth (device housing) and each other >20 MΩ.
- A driver/sensor coil short circuit may cause the meter to be in "start-up" mode.

Strain 1 = red and brown	OPTIMASS 7000 - all sizes	420…600 Ω at ambient temperature
Strain 2 = brown and orange	OPTIMASS 7000 - 06…10	215…300 Ω at ambient temperature
	OPTIMASS 7000 - 15…80	Short circuited

INFORMATION!
*Failure of two or more of the upper circuits may indicate a measuring tube error. There may be product in the housing. If this is the case, **depressurise** the process line and immediately remove the measuring device from the process line.*

7.3 Spare parts availability

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

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

7.4 Availability of services

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

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

7.5 Returning the device to the manufacturer

7.5.1 General information

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

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

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

7.5.2 Form (for copying) to accompany a returned device

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

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

This medium is:	
	radioactive
	water-hazardous
	toxic
	caustic
	flammable
	We checked that all cavities in the device are free from such substances.
	We have flushed out and neutralized all cavities in the device.

We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.	
Date:	Signature:
Stamp:	

7.6 Disposal

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

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

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

8.1 Measuring principle

The signal converter has been designed to work with all the measuring tube designs used in the mass flowmeters. For information regarding the measuring principle for a specific measuring tube design, please refer to the technical documentation of the relevant flow sensor.

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	Coriolis principle
Application range	Measurement of mass flow, density, temperature, volume flow, flow velocity, concentration

Design

Modular construction	The measuring system consists of a flow sensor and a signal converter.
Flow sensor	
OPTIMASS 1000	DN15…50 / 1/2…2"
OPTIMASS 2000	DN100…250 / 4...10"
OPTIMASS 3000	DN01…04 / 1/25...4/25"
OPTIMASS 6000	DN08…250 / 3/8...10"
OPTIMASS 7000	DN06…80 / 1/4…3"
	All flow sensors are also available in an Ex version.
Signal converter	
Compact version (C)	OPTIMASS x400 C (x = 1, 2, 3, 6 or 7)
Field housing (F) - remote version	MFC 400 F
	Compact and field housing versions are also available in an Ex version.
Options	
Outputs / inputs	Current output (incl. 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, stabilisation
Concentration measurement	Universal concentration measurement, °Brix, °Baume, °Plato, alcohol concentration, NaOH and API density
Communication interfaces	HART®, Foundation Fieldbus, Profibus PA and DP, Modbus

Display and user interface	
Graphic display	LC display, backlit white.
	Size: 128 x 64 pixels, corresponds to 59 x 31 mm = 2.32" x 1.22"
	Display turnable in 90° steps.
	Ambient temperatures below -25°C / -13°F may affect the readability of the display.
Operating elements	4 push buttons/optical keys for operator control of the signal converter without opening the housing.
	Infrared interface for reading and writing all parameters with IR interface (option) without opening the housing.
Remote operation	PACTware^{TM} (incl. Device Type Manager (DTM))
	HART$^®$ Hand Held 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 measuring pages, 1 status page, 1 graphic page (measured values and graphics are freely adjustable)
Language display texts (as language package)	Standard: English, French, German, Dutch, Portuguese, Swedish, Spanish, Italian
	Eastern Europe (in preparation): English, Slovenian, Czech, Hungarian
	Northern Europe: English, Danish, Polish
	Southern Europe: English, Turkish
	China (in preparation): English, Chinese
	Russia: English, Russian
Measurement functions	**Units:** Metric, British and US units selectable as desired from lists for volume/mass flow and counting, velocity, temperature, pressure
	Measured values: Mass flow, total mass, temperature, density, volume flow, total volume, velocity, flow direction (not displayed unit ⎯ but available via outputs), BRIX, Baume, NaOH, Plato, API, mass concentration, volume concentration
Diagnostic functions	**Standards:** VDI / NAMUR / WIB 2650 and NE 107
	Status messages: Output of status messages optional via display, current and/or status output, HART$^®$ or bus interface
	Sensor diagnosis: Sensor values, drive level, measuring tube frequency, 2 phase signal, drive coil impedance, insulation fault, circuit interruption, exceeding the maximum flow, process temperature
	Self-diagnosing sensor electronics: Electronics temperature, input gains, driver amplifier
	Signal converter and inputs/outputs: Data bus monitoring, current output connections, electronics temperature, voltage drop, parameter and data integrity

Measuring accuracy

Reference conditions	Medium: water
	Temperature: +20°C / +68°F
	Pressure: 1 bar / 14.5 psi
Maximum measuring error	Refer to technical data for the flow sensor.
Current output electronics	±5 µA

Operating conditions

Temperature	
Process temperature	Refer to technical data for the flow sensor.
Ambient temperature	Depending on the version and combination of outputs.
	It is a good idea to protect the signal converter from external heat sources such as direct sunlight as higher temperatures reduce the life cycle of all electronic components.
	-40…+65°C / -40…+149°F
	Stainless steel housing: -40…+60°C / -40…+140°F
	Ambient temperatures below -25°C / -13°F may affect the readability of the display.
Storage temperature	-50…+70°C / -58…+158°F
Pressure	
Medium	Refer to technical data for the flow sensor.
Ambient pressure	Atmospheric
Chemical properties	
State of aggregation	Liquids, gases and slurries
Flow rate	Refer to technical data for the flow sensor.
Other conditions	
Ingress protection acc. to IEC 60529	IP66/67 (acc. to NEMA 4/4X)

Installation conditions

Installation	For detailed information, refer to chapter "Installation".
Dimensions and weights	For detailed information refer to chapter "Dimensions and weights".

Materials

Signal converter housing	Standard: die-cast aluminium (polyurethane coated)
	Option: stainless steel 316 (1.4408)
Flow sensor	For housing material, process connections, measuring tubes, accessories and gaskets, refer to technical data for 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	Standard: 100…230 VAC (-15% / +10%), 50/60 Hz
	Option 1: 24 VDC (-55% / +30%)
	Option 2: 24 VAC/DC (AC: -15% / +10%, 50/60 Hz; DC: -25% / +30%)
Power consumption	AC: 22 VA
	DC: 12 W
Signal cable	Only for remote versions.
	10 core shielded cable. Detailed specifications are available on request.
	Length: max. 20 m / 65.6 ft
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 abbreviations	U_{ext} = external voltage; R_L = load + resistance; U_0 = terminal voltage; I_{nom} = nominal current
	Safety limit values (Ex i): U_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, temperature, density, flow velocity, diagnostic value, 2-phase signal		
	Concentration and concentration flow are also possible with available concentration measurement (optional).		
Temperature coefficient	Typically ±30 ppm/K		
Settings	**Without HART®**		
	Q = 0%: 0…20 mA; Q = 100%: 10…20 mA		
	Error identification: selectable 3…22 mA		
	With HART®		
	Q = 0%: 4…20 mA; Q = 100%: 10…20 mA		
	Error identification: selectable 3…22 mA		
Operating data	**Basic I/Os**	**Modular I/Os**	**Ex i**
Active	$U_{int, nom}$ = 24 VDC		$U_{int, nom}$ = 20 VDC
	I ≤ 22 mA		I ≤ 22 mA
	R_L ≤ 1 kΩ		R_L ≤ 450 Ω
			U_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
Passive	U_{ext} ≤ 32 VDC		U_{ext} ≤ 32 VDC
	I ≤ 22 mA		I ≤ 22 mA
	U_0 ≥ 1.8 V		U_0 ≥ 4 V
	R_L ≤ (U_{ext} - U_0) / I_{max}		R_L ≤ (U_{ext} - U_0) / I_{max}
			U_i = 30 V I_i = 100 mA P_i = 1 W C_i = 10 nF L_i ~ 0 mH

HART®			
Description	HART® protocol via active and passive current output		
	HART® version: V7		
	Universal HART® parameter: completely integrated		
Load	$\geq 250\ \Omega$ at HART® test point; Note maximum load for current output!		
Multidrop operation	Yes, current output = 10%, 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 (HART Communication Foundation)	Yes		
Pulse output or frequency output			
Output data	Pulse output: volume flow, mass flow, mass or volume of dissolved substance during activated concentration measurement		
	Frequency output: flow velocity, mass flow, temperature, density, diagnostic value Optional: concentration, flow of the dissolved substance		
Function	Can be set as a pulse output or frequency output		
Pulse rate/frequency	0.01...10000 pulses/s or Hz		
Settings	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	Basic I/Os	Modular I/Os	Ex i
Active	-	U_{nom} = 24 VDC	-
		f_{max} in operating menu set to $f_{max} \leq 100$ Hz: $I \leq 20$ mA open: $I \leq 0.05$ mA closed: $U_{0,\ nom}$ = 24 V at I = 20 mA	
		f_{max} in operating menu set to 100 Hz < $f_{max} \leq 10$ kHz: $I \leq 20$ mA open: $I \leq 0.05$ mA closed: $U_{0,\ nom}$ = 22.5 V at I = 1 mA $U_{0,\ nom}$ = 21.5 V at I = 10 mA $U_{0,\ nom}$ = 19 V at I = 20 mA	

Passive	$U_{ext} \leq 32$ VDC	-
	f_{max} in operating menu set to $f_{max} \leq 100$ Hz: $I \leq 100$ mA open: $I \leq 0.05$ mA at $U_{ext} = 32$ VDC closed: $U_{0, max} = 0.2$ V at $I \leq 10$ mA $U_{0, max} = 2$ V at $I \leq 100$ mA	
	f_{max} in operating menu set to 100 Hz $< f_{max} \leq 10$ kHz: $I \leq 20$ mA open: $I \leq 0.05$ mA at $U_{ext} = 32$ VDC closed: $U_{0, max} = 1.5$ V at $I \leq 1$ mA $U_{0, max} = 2.5$ V at $I \leq 10$ mA $U_{0, max} = 5.0$ V at $I \leq 20$ mA	

NAMUR	-	Passive to EN 60947-5-6 open: $I_{nom} = 0.6$ mA closed: $I_{nom} = 3.8$ mA	Passive to EN 60947-5-6 open: $I_{nom} = 0.43$ mA closed: $I_{nom} = 4.5$ mA
			$U_i = 30$ V $I_i = 100$ mA $P_i = 1$ W $C_i = 10$ nF $L_i \sim 0$ mH

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…5% (current output, frequency output)

Time constant

Function	The time constant corresponds to the elapsed time until 67% 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, overflow, error or switching point.		
	Valve control with activated dosing function		
	Status and/or control: ON or OFF		
Operating data	**Basic I/Os**	**Modular I/Os**	**Ex i**
Active	-	U_{int} = 24 VDC I ≤ 20 mA open: I ≤ 0.05 mA closed: $U_{0, nom}$ = 24 V at I = 20 mA	-
Passive	U_{ext} ≤ 32 VDC I ≤ 100 mA open: I ≤ 0.05 mA at U_{ext} = 32 VDC closed: $U_{0, max}$ = 0.2 V at I ≤ 10 mA $U_{0, max}$ = 2 V at I ≤ 100 mA	U_{ext} ≤ 32 VDC I ≤ 100 mA $R_{L, max}$ = 47 kΩ $R_{L, min}$ = $(U_{ext} - U_0) / I_{max}$ open: I ≤ 0.05 mA at U_{ext} = 32 VDC closed: $U_{0, max}$ = 0.2 V at I ≤ 10 mA $U_{0, max}$ = 2 V at I ≤ 100 mA	-
NAMUR	-	Passive to EN 60947-5-6 open: I_{nom} = 0.6 mA closed: I_{nom} = 3.8 mA	Passive to EN 60947-5-6 open: I_{nom} = 0.43 mA closed: I_{nom} = 4.5 mA U_i = 30 V I_i = 100 mA P_i = 1 W C_i = 10 nF L_i = 0 mH

Control input			
Function	Hold value of the outputs (e.g. for cleaning work), set value of the outputs to "zero", counter and error reset, stop counter, range conversion, zero calibration		
	Start of dosing when dosing function is activated.		
Operating data	**Basic I/Os**	**Modular I/Os**	**Ex i**
Active	-	U_{int} = 24 VDC Ext. contact open: $U_{0, nom}$ = 22 V Ext. contact closed: I_{nom} = 4 mA Contact open (Off): $U_0 \geq 12$ V with I_{nom} = 1.9 mA Contact closed (On): $U_0 \leq 10$ V with I_{nom} = 1.9 mA	-
Passive	$8 \text{ V} \leq U_{ext} \leq 32$ VDC I_{max} = 6.5 mA at $U_{ext} \leq 24$ VDC I_{max} = 8.2 mA at $U_{ext} \leq 32$ VDC Contact closed (On): $U_0 \geq 8$ V with I_{nom} = 2.8 mA Contact open (Off): $U_0 \leq 2.5$ V with I_{nom} = 0.4 mA	$3 \text{ V} \leq U_{ext} \leq 32$ VDC I_{max} = 9.5 mA at $U_{ext} \leq 24$ V I_{max} = 9.5 mA at $U_{ext} \leq 32$ V Contact closed (On): $U_0 \geq 3$ V with I_{nom} = 1.9 mA Contact open (Off): $U_0 \leq 2.5$ V with I_{nom} = 1.9 mA	$U_{ext} \leq 32$ VDC $I \leq 6$ mA at U_{ext} = 24 V $I \leq 6.6$ mA at U_{ext} = 32 V On: $U_0 \geq 5.5$ V or $I \geq 4$ mA Off: $U_0 \leq 3.5$ V or $I \leq 0.5$ mA U_i = 30 V I_i = 100 mA P_i = 1 W C_i = 10 nF L_i = 0 mH
NAMUR	-	Active to EN 60947-5-6 Terminals open: $U_{0, nom}$ = 8.7 V Contact closed (On): $U_{0, nom}$ = 6.3 V with $I_{nom} > 1.9$ mA Contact open (Off): $U_{0, nom}$ = 6.3 V with $I_{nom} < 1.9$ mA Detection of cable break: $U_0 \geq 8.1$ V with $I \leq 0.1$ mA Detection of cable short circuit: $U_0 \leq 1.2$ V with $I \geq 6.7$ mA	-

PROFIBUS DP	
Description	Galvanically isolated acc. to IEC 61158
	Profile version: 3.02
	Automatic data transmission rate recognition (max. 12 MBaud)
	Bus address adjustable via local display at the measuring device
Function blocks	8 x analogue input, 3 x totaliser
Output data	Mass flow, volume flow, mass counter 1 + 2, volume counter, product temperature, several concentration measurements and diagnostic data

PROFIBUS PA	
Description	Galvanically isolated acc. to IEC 61158
	Profile version: 3.02
	Current consumption: 10.5 mA
	Permissible bus voltage: 9…32 V; in Ex application: 9...24 V
	Bus interface with integrated reverse polarity protection
	Typical error current FDE (Fault Disconnection Electronic): 4.3 mA
	Bus address adjustable via local display at the measuring device
Function blocks	8 x analogue input, 3 x totaliser
Output data	Mass flow, volume flow, mass counter 1 + 2, volume counter, product temperature, several concentration measurements and diagnostic data

FOUNDATION Fieldbus	
Description	Galvanically isolated acc. to IEC 61158
	Current consumption: 10.5 mA
	Permissible bus voltage: 9…32 V; in Ex application: 9...24 V
	Bus interface with integrated reverse polarity protection
	Link Master function (LM) supported
	Tested with Interoperable Test Kit (ITK) version 6.01
Function blocks	6 x analogue input, 2 x integrator, 1 x PID
Output data	Mass flow, volume flow, density, temperature of tube, several concentration measurements and diagnostic data

Modbus	
Description	Modbus RTU, Master/Slave, RS485
Address range	1…247
Supported function codes	01, 03, 04, 05, 08, 16, 43
Supported Baudrate	1200, 2400, 3600, 4800, 9600, 19200, 38400, 57600, 115200 Baud

Approvals and certificates

CE	The device fulfils the statutory requirements of the EU directives. The manufacturer certifies that these requirements have been met by applying the CE marking.
Non-Ex	Standard
Hazardous areas	
Option (C version only)	
ATEX	II 1/2 (1) G - Ex d ia [ia Ga] IIC T6…T1 Ga/Gb
	II 1/2 (1) G - Ex de ia [ia Ga] IIC T6…T1 Ga/Gb
	II 2 (1) G - Ex d ia [ia Ga] IIC T6…T1 Gb
	II 2 (1) G - Ex de ia [ia Ga] IIC T6…T1 Gb
	II 2 (1) D - Ex t [ia Da] IIIC Txxx°C Db
	II 1/2 G - Ex d ia IIC T6…T1 Ga/Gb; II 1/2 G - Ex de ia IIC T6…T1 Ga/Gb
	II 2 G - Ex d ia IIC T6…T1 Gb; II 2 G - Ex de ia IIC T6…T1 Gb
	II 2 D - Ex t IIIC Txxx°C Db
Option (F version only)	
ATEX	II 2 (1) G - Ex d [ia Ga] IIC T6 Gb
	II 2 (1) G - Ex de [ia Ga] IIC T6 Gb
	II 2 (1) D - Ex t [ia Da] IIIC T75°C Db
	II 2 G - Ex d [ia] IIC T6 Gb; II 2 G - Ex de [ia] IIC T6 Gb
	II 2 D - Ex t IIIC T75°C Db
NEPSI	Ex d ia [ia Ga] IIC T6…T1 Ga/Gb; Ex de ia [ia Ga] IIC T6…T1 Ga/Gb
Option	
FM / CSA	FM: Class I, Div 1 groups A, B, C, D CSA: Class I, Div 1 groups C, D
	Class II, Div 1 groups E, F, G
	Class III, Div 1 hazardous areas
	FM: Class I, Div 2 groups A, B, C, D CSA: Class I, Div 2 groups C, D
	Class II, Div 2 groups E, F, G
	Class III, Div 2 hazardous areas
IECEx	Ex zone 1 + 2
Custody transfer	
Without	Standard
Option	Liquids other than water 2004/22/EC (MID MI005) according to OIML R 117-1
	Gases 2004/22/EC (MID MI002) according to OIML R 137
Other standards and approvals	
Vibration resistance	IEC 60068-2-6
NAMUR	NE 21, NE 43, NE 53, NE 107

8.3 Dimensions and weight

8.3.1 Housing
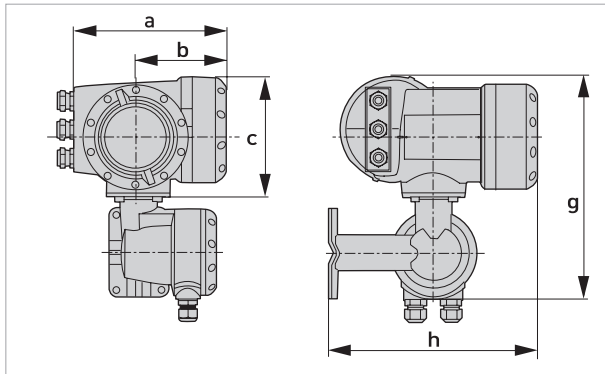
Figure 8-1: Dimensions for field housing (F) - remote version

Dimensions [mm / inch]					Weight [kg / lb]
a	b	c	g	h	
202 / 7.75	120 / 4.75	155 / 6.10	295.8 / 11.60	277 / 10.90	5.7 / 12.60

Table 8-1: Dimensions and weight
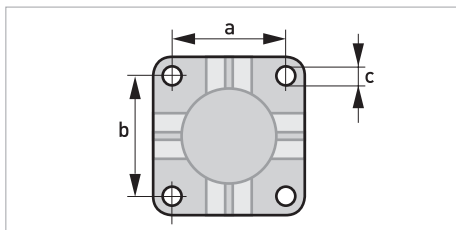
8.3.2 Mounting plate of field housing

Figure 8-2: Dimensions for mounting plate of field housing

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

Table 8-2: Dimensions in mm and inch

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 figures.

9.2 Software history

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

Release date	Electronic Revision	HART®	
		Device Revision	**DD Revision**
2012-xx-xx	1.0.0_	1	1

Table 9-1: Software history for HART® interface

Manufacturer ID:	69 (0x45)
Device:	204 (0xCC)
Device Revision:	1
DD Revision:	1
HART® Universal Revision:	7
FC 375/475 system SW.Rev.:	≥ 3.3
AMS version:	≥ 8.0
PDM version:	≥ 6.0
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 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.
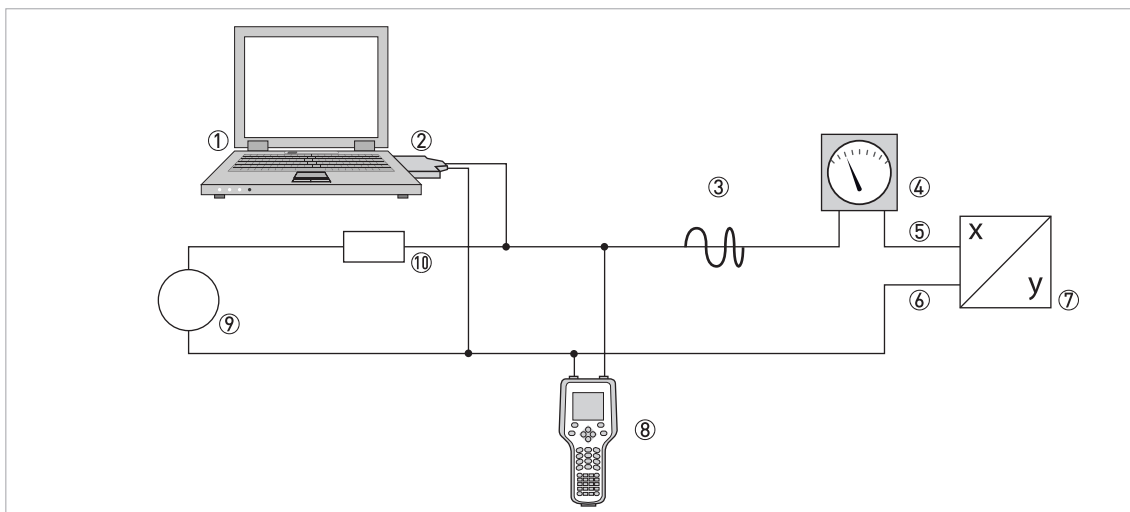
The current output of the device may be active or passive.

Figure 9-1: Point-to-Point connection

① Primary master
② FSK modem or HART® modem
③ HART® signal
④ Analog indication
⑤ Signal converter terminals A (C)
⑥ Signal converter terminals A- (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).
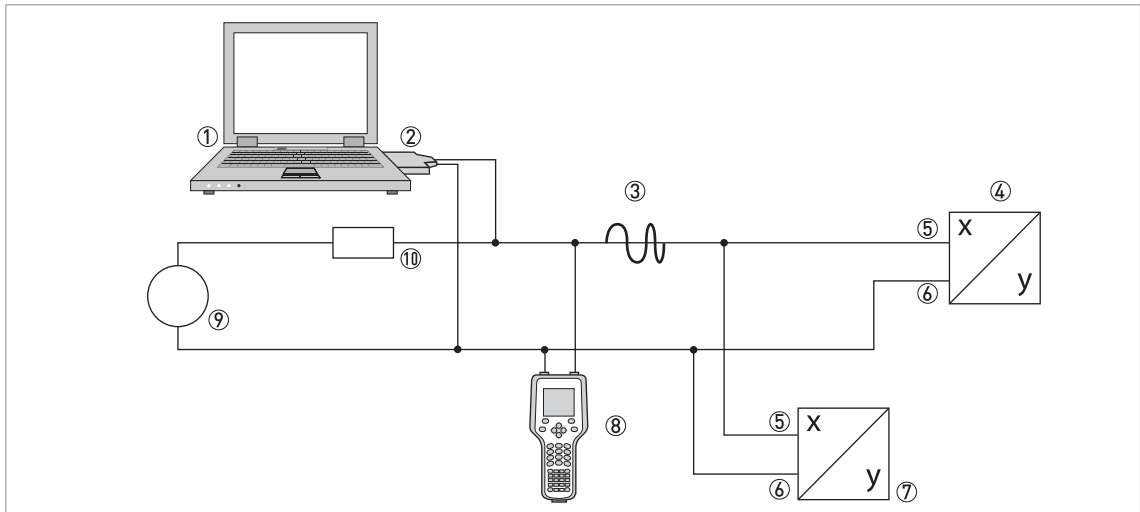
The current outputs of the devices must be passive!

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 (see also ⑦)
⑤ Signal converter terminals A (C)
⑥ Signal converter terminals A- (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.
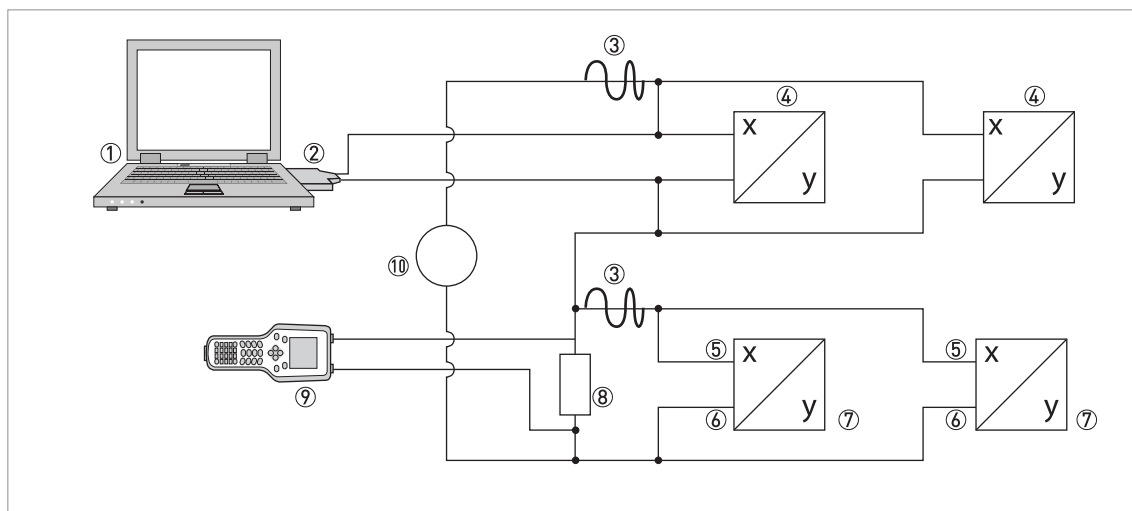

Figure 9-3: Multi-Drop connection (3-wire connection)

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 A (C)
⑥ Signal converter terminals A- (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 signal converter is available with various input/output combinations.

The connection of the terminals A…D to the HART® dynamic variables PV, SV, TV and 4V depends on the device version.

PV = Primary Variable; SV = Secondary Variable; TV = Tertiary Variable; 4V = Fourth Variable

Signal converter version	HART® dynamic variable			
	PV	SV	TV	4V
Basic I/O, connection terminals	A	D	-	-
Modular I/O and Ex i I/O, connection terminals	C	D	A	B

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

The signal converter can provide up to 14 measurement-related 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.

Code = device variable code

HART® device variable	Code	Type	Explanations
Flow Velocity	0	linear	
Volume Flow	1	linear	
Mass Flow	2	linear	
Temperature	3	linear	
Density	4	linear	
Sensor Average	5	linear	Diagnostic value, optional, available when one of the diagnostic channels (1, 2, 3) is set to "Sensor Average".
Sensor Deviation	6	linear	Diagnostic value, optional, available when one of the diagnostic channels (1, 2, 3) is set to "Sensor Deviation".
Drive Level	7	linear	Diagnostic value, optional, available when one of the diagnostic channels (1, 2, 3) is set to "Drive Level".
Tube Frequency	8	linear	Diagnostic value, optional, available when one of the diagnostic channels (1, 2, 3) is set to "Tube Frequency".
	9	linear	
	10	linear	
2 Phase Signal	11	linear	Diagnostic value, optional, available when one of the diagnostic channels (1, 2, 3) is set to "2 Phase Signal".
Concentration 1	12	linear	Available when concentration measurement is switched on.

HART® device variable	Code	Type	Explanations
Concentration 2	13	linear	Available when concentration measurement is switched on and Concentration 2 is not switched off.
Concentration Flow 1 Mass	14	linear	Available when concentration measurement is switched on and concentration mode 1 does not measure % volume or % alcohol per volume.
Concentration Flow 1 Volume	15	linear	Available when concentration measurement is switched on and Concentration mode 1 measures % volume or % alcohol per volume.
Concentration Flow 2 Mass	16	linear	Available when concentration measurement is switched on and Concentration 2 is not switched off and Concentration mode 1 does not measure % volume or % alcohol per volume.
Concentration Flow 1 Volume	17	linear	Available when concentration measurement is switched on and Concentration 2 is not switched off and Concentration mode 2 measures % volume or % alcohol per volume.
Totaliser 1 Mass	18	Totaliser	
Totaliser 1 Volume	19	Totaliser	
Totaliser 2 Mass	20	Totaliser	
Totaliser 2 Volume	21	Totaliser	
Totaliser 3 Mass	22	Totaliser	Depends on hardware configuration
Totaliser 3 Volume	23	Totaliser	Depends on hardware configuration

Table 9-4: Description of the HART® device variables

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.

A totaliser device variable can thus not be assigned to the dynamic variable PV because the PV is always connected to the HART® 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 4V if the connected output is not a current or frequency output.

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Head Office KROHNE Messtechnik GmbH
Ludwig-Krohne-Str. 5
47058 Duisburg (Germany)
Tel.: +49 203 301 0
Fax: +49 203 301 10389
info@krohne.com

The current list of all KROHNE contacts and addresses can be found at:
www.krohne.com

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