Commissioning and Safety Instruction CI/FSS/FSV430/450-EN Rev. D

SwirlMaster FSS430, FSS450 VortexMaster FSV430, FSV450 Vortex & Swirl Flowmeter

Measurement made easy

Power and productivity
for a better world™

Short product description

Vortex & Swirl Flowmeter for flow measurement of liquid and gaseous measuring media.

Devices firmware version: 01.00.00

Further information

Additional documentation on SwirlMaster FSS430, FSS450 VortexMaster FSV430, FSV450 is available for download free of charge at www.abb.com/flow.
Alternatively simply scan these codes:

FSV430 FSV450 FSS430 FSS450

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Contents

1 Safety

1.1 General information and instructions

These instructions are an important part of the product and must be retained for future reference.
Installation, commissioning, and maintenance of the product may only be performed by trained specialist personnel who have been authorized by the plant operator accordingly. The specialist personnel must have read and understood the manual and must comply with its instructions.
For additional information or if specific problems occur that are not discussed in these instructions, contact the manufacturer.
The content of these instructions is neither part of nor an amendment to any previous or existing agreement, promise or legal relationship.
Modifications and repairs to the product may only be performed if expressly permitted by these instructions.
Information and symbols on the product must be observed. These may not be removed and must be fully legible at all times.
The operating company must strictly observe the applicable national regulations relating to the installation, function testing, repair and maintenance of electrical products.

1.2 Warnings

The warnings in these instructions are structured as follows:

⚠ DANGER

The signal word "DANGER" indicates an imminent danger. Failure to observe this information will result in death or severe injury.

⚠ WARNING

The signal word "WARNING" indicates an imminent danger. Failure to observe this information may result in death or severe injury.

⚠ CAUTION

The signal word "CAUTION" indicates an imminent danger. Failure to observe this information may result in minor or moderate injury.

ℹ NOTE

The signal word "NOTE" indicates useful or important information about the product.
The signal word "NOTE" is not a signal word indicating a danger to personnel. The signal word "NOTE" can also refer to material damage.

1.3 Intended use

This device is intended for the following uses:

- For conveying liquid and gaseous media (including unstable liquids and gases)
- For measuring the volume flow (directly by calculating the pressure / temperature effect)
- For measuring the mass flow (indirectly via volume flow, pressure / temperature and density)
- For measuring the energy flow (indirectly via volume flow, pressure / temperature and density)
- For measuring the temperature of the medium

The device has been designed for use exclusively within the technical limit values indicated on the identification plate and in the data sheets.

When using media for measurement the following points must be observed:

- Measuring media may only be used if, based on the state of the art or the operating experience of the user, it can be assured that the chemical and physical properties necessary for safe operation of the materials of transmitter components coming into contact with these will not be adversely affected during the operating period.
- Media containing chloride in particular can cause corrosion damage to stainless steels which, although not visible externally, can damage wetted parts beyond repair and lead to the measuring medium escaping. It is the operator's responsibility to check the suitability of these materials for the respective application.
- Measuring media with unknown properties or abrasive measuring media may only be used if the operator can perform regular and suitable tests to ensure the safe condition of the meter.

1.4 Improper use

The following are considered to be instances of improper use of the device:

- For operating as a flexible adapter in piping, e.g. for compensating pipe offsets, pipe vibrations, pipe expansions, etc.
- For use as a climbing aid, e.g. for mounting purposes
- For use as a support for external loads, e.g. as a support for piping, etc.
- Material application, e.g. by painting over the name plate or welding/soldering on parts
- Material removal, e.g. by spot drilling the housing

2 Use in potentially explosive atmospheres

⚠ DANGER

Danger of explosion if the device is operated with the transmitter housing or terminal box open!

Before opening the transmitter housing or the terminal box, note the following points:

- Check that a valid fire permit is available.
- Make sure that there is no explosion hazard.
- Before opening the device, switch off the power supply and wait for t > 2 minutes.

2.1 Obligations of the owner

2.1.1 ATEX, IECEx, NEPSI

The installation, commissioning, maintenance and repair of devices in areas with explosion hazard must only be carried out by appropriately trained personnel.
When operating the meter in the presence of combustible dusts, IEC 61241 ff must be complied with.
The safety instructions for electrical apparatus in potentially explosive areas must be complied with, in accordance with Directive 94/9/EC (ATEX) and IEC60079-14 (Installation of electrical equipment in potentially explosive areas).
To ensure safe operation, the requirements of EU Directive ATEX 118a (minimum requirements concerning the protection of workers) must be met.

2.1.2 FM, CSA

The installation, commissioning, maintenance and repair of devices in areas with explosion hazard must only be carried out by appropriately trained personnel.
The operator must strictly observe the applicable national regulations with regard to installation, function tests, repairs, and maintenance of electrical devices. (e.g. NEC, CEC).

2.2 Zone 2, 22 - type of protection "non-sparking"

2.2.1 Ex-marking

ATEX	
Order code	B1
Type examination certificate	FM13ATEX0056X
II 3G Ex nA IIC T4 to T6 Gc	
II 3 D Ex tc IIIC T85 °C DC	
For electrical parameters, see certificate FM13ATEX0056X	

IECEx	
Order code	N1
Certificate of conformity	IECEx FME 13.0004X
Ex nA IIC T4 to T6 Gc	
Ex tc IIIC T85 °C DC	
For electrical parameters, see certification IECEx FME 13.0004X	

FM approval for USA and Canada	
Order code	F3
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4	
CL I/DIV 2/GP ABCD	
NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	
Housing: TYPE 4X	

NEPSI	
Order code	S2
Ex nA IIC T4 to T6 Gc	
DIP A22 Ta 85 °C	
For electrical parameters, see certificate GYJ14.1088X	

Power supply

Ex nA U_B = 12 ... 42 V DC

Switch output

The switch output is designed as an optoelectronic coupler or a NAMUR contact (in accordance with DIN 19234).

- When the NAMUR contact is closed, the internal resistance is approx. 1000 Ω.
- When the contact is open, the internal resistance is > 10 kΩ.

The switch output can be changed over to "optoelectronic coupler" if required.

- NAMUR with switching amplifier
- Switch output
  Ex nA: U_B = 16 ... 30 V, I_B = 2 ... 30 mA

2.2.2 Electrical data

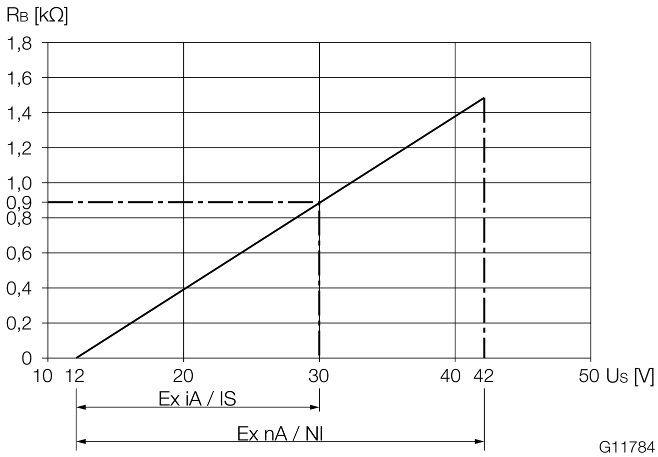

Fig. 1: Power supply in Zone 2, explosion protection, non-sparking

The minimum voltage U_S of 12 V is based on a load of 0 Ω.

U_S Supply voltage

R_B Maximum permissible load in the power supply circuit, e.g. indicator, recorder or power resistor.

Power supply / current output / HART output	
Terminals	PWR/COMM + / PWR/COMM -
U_M	45 V
Zone 2: Ex nA IIC T4 to T6 Gc T_{amb} = -40 ... 85 °C*	
Zone 22 Ex tc IIIC T85 °C Dc T_{amb} = -40 ... 75 °C	
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4 CL I/DIV 2/GP ABCD TYPE 4X NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG Housing: TYPE 4X	

Digital output	
Terminals	DIGITAL OUTPUT 1+ / DIGITAL OUTPUT 4-
U_M	45 V
Zone 2: Ex nA IIC T4 to T6 Gc	
Zone 22 Ex tc IIIC T85 °C Dc T_{amb} = -40 ... 75 °C [1]	
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4 CL I/DIV 2/GP ABCD TYPE 4X NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	

1) See temperature ranges in the chapter titled „Temperature data“ on page 6.

Analog input	
Terminals	ANALOG INPUT + / ANALOG INPUT -
U_M	45 V
Zone 2: Ex nA IIC T4 to T6 Gc	
Zone 22 Ex tc IIIC T85 °C Dc T_{amb} = -40 ... 85 °C	
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4 CL I/DIV 2/GP ABCD TYPE 4X NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	

Special Requirements

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate. Pollution degree 3 (see IEC 60664-1) must not be exceeded for the macro environment of the device.
The devices are in accordance with the IP rating IP66 / IP67. If the device is installed correctly, this requirement is met by the housing as standard.
When connected to the power supply / not connected to the power supply, the electrical circuits must not exceed overvoltage category III / II.

2.2.3 Temperature data

Operating temperature ranges:

- The ambient temperature range $T_{amb.}$ is -40 ... 85 °C (-40 ... 185 °F).
- This is dependent on the temperature class and measuring medium temperature, as listed in the following tables.
- The measuring medium temperature T_{medium} is -200 ... 400 °C (-328 ... 752 °F).

Without LCD indicator

Temperature class	$T_{amb.}$ max.	T_{medium} max.
T4	≤ 85 °C	90 °C
	≤ 82 °C	180 °C
	≤ 81 °C	280 °C
	≤ 79 °C	400 °C
T4	≤ 70 °C	90 °C
	≤ 67 °C	180 °C
	≤ 66 °C	280 °C
	≤ 64 °C	400 °C
T5	≤ 56 °C	90 °C
	≤ 53 °C	180 °C
	≤ 52 °C	280 °C
	≤ 50 °C	400 °C
T6	≤ 44 °C	90 °C
	≤ 41 °C	180 °C
	≤ 40 °C	280 °C
	≤ 38 °C	400 °C

With LCD indicator, order code L1

Temperature class	$T_{amb.}$ max.	T_{medium} max.
T4	≤ 85 °C	90 °C
	≤ 82 °C	180 °C
	≤ 81 °C	280 °C
	≤ 79 °C	400 °C
T4	≤ 70 °C	90 °C
	≤ 67 °C	180 °C
	≤ 66 °C	280 °C
	≤ 64 °C	400 °C
T5	≤ 40 °C	90 °C
	≤ 37 °C	180 °C
	≤ 36 °C	280 °C
	≤ 34 °C	400 °C
T6	≤ 40 °C	90 °C
	≤ 37 °C	180 °C
	≤ 36 °C	280 °C
	≤ 34 °C	400 °C

With LCD indicator, order code L2 (operation through the front glass)

Temperature class	$T_{amb.}$ max.	T_{medium} max.
T4	≤ 60 °C	90 °C
	≤ 57 °C	180 °C
	≤ 56 °C	280 °C
	≤ 54 °C	400 °C
T4	≤ 60 °C	90 °C
	≤ 57 °C	180 °C
	≤ 56 °C	280 °C
	≤ 54 °C	400 °C
T5	≤ 56 °C	90 °C
	≤ 53 °C	180 °C
	≤ 52 °C	280 °C
	≤ 50 °C	400 °C
T6	≤ 44 °C	90 °C
	≤ 41 °C	180 °C
	≤ 40 °C	280 °C
	≤ 38 °C	400 °C

2.3 Zone 0, 1, 20, 21 - type of protection "intrinsically safe"

2.3.1 Ex-marking

ATEX	
Order code	A4
Type examination certificate	FM13ATEX0055X
II 1 G Ex ia IIC T4 to T6 Ga	
II 1 D Ex ia IIIC T85 °C	
For electrical parameters, see certificate FM13ATEX0055X	

IECEx	
Order code	N2
Certificate of conformity	IECEx FME 13.0004X
Ex ia IIC T4 to T6 Ga	
Ex ia IIIC T85 °C	
For electrical parameters, see certificate IECEx FME 13.0004X	

FM approval for USA and Canada	
Order code	F4
IS/S. Intrinseque(Entity) CL I,	
Zone 0 AEx/Ex ia IIC T6, T5, T4	
Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X	
IS Control Drawing: 3KXF065215U0109	

NEPSI	
Order code	S6
Ex ia IIC T4 to T6 Ga	
Ex iaD 20 T85 °C	
For electrical parameters, see certificate GYJ14.1088X	

Power supply

Ex ia: U_i = 30 V DC

Switch output

The switch output is designed as an optoelectronic coupler or a NAMUR contact (in accordance with DIN 19234).

— When the NAMUR contact is closed, the internal resistance is approx. 1000 Ω.
— When the contact is open, the internal resistance is > 10 kΩ.

The switch output can be changed over to "optoelectronic coupler" if required.

— NAMUR with switching amplifier
— Switch output:
  Ex ia: U_i = 30 V DC

2.3.2 Electrical and temperature data

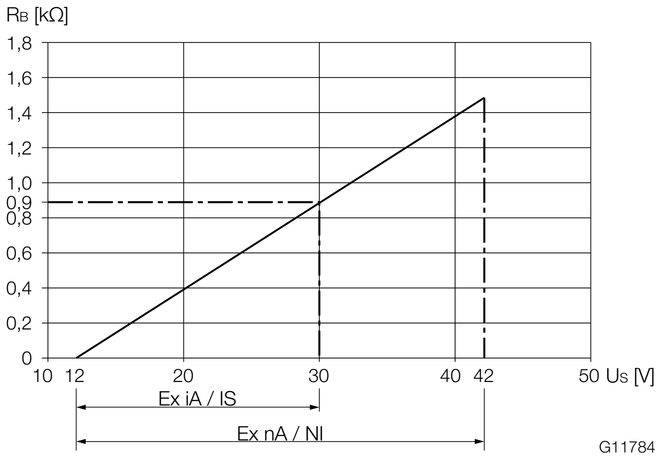

Fig. 2: Power supply in Zone 2, explosion protection, intrinsic safety

The minimum voltage U_S of 12 V is based on a load of 0 Ω.

U_S Supply voltage

R_B Maximum permissible load in the power supply circuit, e.g. indicator, recorder or power resistor.

Power supply / current output / HART output	
Terminals	PWR/COMM + / PWR/COMM -
Zone 0: Ex ia IIC T4 to T6 Ga T_{amb} = -40 ... 85 °C 1)	
U_{max}	30 V
I_{max}	See the chapter titled „Limit value tables“ on page
P_i	9
C_i	— 13 nF for indicator option L1 — 17 nF for all other options
L_i	10 µH
Zone 20: Ex ia IIIC T85 °C T_{amb} = -40 ... 85 °C 1)	
IS/S. Intrinseque (Entity) CL I, Zone 0 AEx/Ex ia IIC T6, T5, T4 Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X IS Control Drawing: 3KXF065215U0109	

1) See temperature ranges in the chapter titled „Limit value tables“ on page 9.

Digital output	
Terminals	DIGITAL OUTPUT 1+ / DIGITAL OUTPUT 4-
Zone 0: Ex ia IIC T4 to T6 Ga	
U_{max}	30 V
I_{max}	30 mA
C_i	7 nF
L_i	0 mH
Zone 20: Ex ia IIIC T85 °C Tamb = -40 ... 85 °C 1)	
IS/S. Intrinseque (Entity) CL I, Zone 0 AEx/Ex ia IIC T6, T5, T4 Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X IS Control Drawing: 3KXF065215U0109	

Analog input	
Terminals	ANALOG INPUT + / ANALOG INPUT -
Zone 0: Ex ia IIC T4 to T6 Ga	
U_{max}	See the chapter titled „Limit value tables“ on page
I_{max}	9
C_i	7 nF
L_i	0 mH
Zone 20: Ex ia IIIC T85 °C T_{amb} = -40 ... 85 °C 1)	
IS/S. Intrinseque (Entity) CL I, Zone 0 AEx/Ex ia IIC T6, T5, T4 Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X IS Control Drawing: 3KXF065215U0109	

1) See temperature ranges in the chapter titled „Limit value tables“ on page 9.

Special Requirements

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate.
Pollution degree 3 (see IEC 60664-1) must not be exceeded for the macro environment of the device.
The devices are in accordance with the IP rating IP66 / IP67. If the device is installed correctly, this requirement is met by the housing as standard.
When connected to the power supply / not connected to the power supply, the electrical circuits must not exceed overvoltage category III / II.
For input limits or analog input limits, see the chapter titled „Limit value tables“ on page 9.

2.3.3 Limit value tables

Operating temperature ranges:

- The ambient temperature range T_{amb} of the devices is -40 … 85 °C.
- The measuring medium temperature range T_{medium} is -200 … 400 °C.

Devices without LCD indicator

Power supply, current / HART output, analog input

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 85 °C	90 °C	30 V	100 mA	0.75 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	160 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	100 mA	1.4 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	50 mA	0.4 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Digital output

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 85 °C	90 °C	30 V	30 mA	1.0 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	30 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	30 mA	1.0 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	30 mA	1.0 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Devices with LCD indicator, order code L1

Power supply, current / HART output, analog input					
Temperature class	**T_{amb} max.**	**T_{medium} max.**	**U_{max}**	**I_{max}**	**P_i max**
T4	≤ 85 °C	90 °C	30 V	100 mA	0.75 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	160 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 40 °C	90 °C	30 V	100 mA	1.4 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			
T6	≤ 40 °C	90 °C	30 V	50 mA	0.4 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			

Digital output					
Temperature class	**T_{amb} max.**	**T_{medium} max.**	**U_{max}**	**I_{max}**	**P_i max**
T4	≤ 85 °C	90 °C	30 V	30 mA	1.0 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	30 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 40 °C	90 °C	30 V	30 mA	1.0 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			
T6	≤ 40 °C	90 °C	30 V	30 mA	1.0 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			

Devices with LCD indicator, order code L2 (operation through the front glass)

Power supply, current / HART output, analog input					
Temperature class	**T_{amb} max.**	**T_{medium} max.**	**U_{max}**	**I_{max}**	**P_i max**
T4	≤ 60 °C	90 °C	30 V	100 mA	0.75 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T4	≤ 60 °C	90 °C	30 V	160 mA	1.0 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	100 mA	1.4 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	50 mA	0.4 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Digital output					
Temperature class	**T_{amb} max.**	**T_{medium} max.**	**U_{max}**	**I_{max}**	**P_i max**
T4	≤ 60 °C	90 °C	30 V	30 mA	1.0 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T4	≤ 60 °C	90 °C	30 V	30 mA	1.0 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	30 mA	1.0 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	30 mA	1.0 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

2.4 Zone 1, 21 - type of protection "flameproof (enclosure)"

2.4.1 Ex-marking

ATEX	
Order code	A9
Type examination certificate	FM13ATEX0057X
II 2 G Ex d ia IIC T6 Gb/Ga – II 2 D Ex tb IIIC T85 °C Db (-40 °C < Ta < +75 °C) supply voltage 42 V DC, Um: 45 V	

IECEx	
Order code	N3
Certificate of conformity	IECEx FME 13.0004X
Ex d ia IIC T6 Gb/Ga-Ex tb IIIC T85 °C Db (-40 °C < Ta < +75 °C) supply voltage 42 V DC, Um = 45 V	

FM approval for USA and Canada	
Order code	F1
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/GP EFG XP-IS (Canada) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/GP EFG CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C TYPE 4X Tamb = 85 °C "Dual seal device"	

NEPSI	
Order code	S1
Ex d ia IIC T6 Gb / Ga DIP A21 Ta 85 °C For electrical parameters, see certificate GYJ14.1088X	

Power supply

Ex d ia Gb/Ga: U_B = 12 ... 42 V DC

Switch output

The switch output is designed as an optoelectronic coupler or a NAMUR contact (in accordance with DIN 19234).

- When the NAMUR contact is closed, the internal resistance is approx. 1000 Ω.
- When the contact is open, the internal resistance is > 10 kΩ.

The switch output can be changed over to "optoelectronic coupler" if required.

- NAMUR with switching amplifier
- Switch output:
  Ex d ia: Ui = 45 V

IMPORTANT

The power supply and the digital output must be either only intrinsically safe or only non-intrinsically safe. A combination of the two is not permitted.

Intrinsically safe circuits must have potential equalization in place along the entire length of the cable of the circuit.

2.4.2 Electrical and temperature data

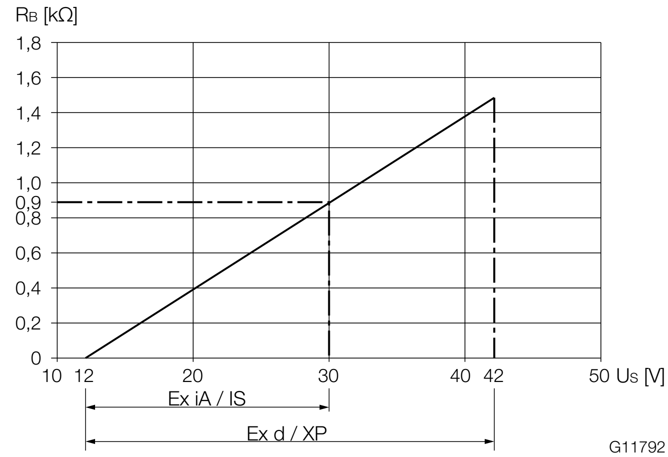

Fig. 3: Power supply in Zone 1, explosion protection

The minimum voltage U_S of 12 V is based on a load of 0 Ω.

U_S Supply voltage

R_B Maximum permissible load in the power supply circuit, e.g. indicator, recorder or power resistor.

Power supply / current output / HART output	
Terminals	PWR/COMM + / PWR/COMM -
U_M	45 V
Zone 1: Ex d ia IIC T6 Gb/Ga T_{amb} = -40 ... 75 °C	
Zone 21 Ex tb IIIC T85 °C Db T_{amb} = -40 ... 75 °C	
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/ GP EFG XP-IS (Kanada) CL I/DIV I/GP BCD, DIP CL II, III/ DIV I/GP EFG CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C TYPE 4X Tamb = 75 °C „Dual seal device“	

Digital output	
Terminals	DIGITAL OUTPUT 1+ / DIGITAL OUTPUT 4-
U_M	45 V
Zone 1: Ex d ia IIC T6 Gb/Ga T_{amb} = -40 … 75 °C	
Zone 21 Ex tb IIIC T85 °C Db T_{amb} = -40 … 75 °C	
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/ GP EFG XP-IS (Kanada) CL I/DIV I/GP BCD, DIP CL II, III/ DIV I/GP EFG CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C TYPE 4X Tamb = 75 °C „Dual seal device“	

Analog input	
Terminals	ANALOG INPUT + / ANALOG INPUT -
U_M	45 V
Zone 1: Ex d ia IIC T6 Gb/Ga T_{amb} = -40 … 75 °C	
Zone 21 Ex tb IIIC T85 °C Db T_{amb} = -40 … 75 °C	
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/ GP EFG XP-IS (Kanada) CL I/DIV I/GP BCD, DIP CL II, III/ DIV I/GP EFG CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C TYPE 4X Tamb = 75 °C „Dual seal device“	

Special Requirements

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate.
Pollution degree 3 (see IEC 60664-1) must not be exceeded for the macro environment of the device.
The devices are in accordance with the IP rating IP66 / IP67. If the device is installed correctly, this requirement is met by the housing as standard.
When connected to the power supply / not connected to the power supply, the electrical circuits must not exceed overvoltage category III / II.

2.5 Temperature resistance for the connecting cables

The temperature at the cable entries of the device is dependent on the measuring medium temperature T_{medium} and the ambient temperature $T_{amb.}$.
For electrical connection of the device, cables suitable for temperatures up to 110 °C (230 °F) can be used without restriction.

Use in category 2 / 3G

For cables suitable only for temperatures up to 80 °C (176 °F), the connection of both circuits must be checked in the event of a fault. Otherwise, the restricted temperature ranges listed in the following table shall apply.

Use in category 2D

For cables suitable only for temperatures up to 80 °C (176 °F), the restricted temperature ranges listed in the following table shall apply.

T_{amb} 1)	T_{medium} maximum	Maximum cable temperature
40 … 82 °C (-40 … 180 °F)2)	180 °C (356 °F)	110 °C (230 °F)
-40 … 40 °C (-40 … 104 °F)2)	272 °C (522 °F)	80 °C (176 °F)
-40 … 40 °C (-40 … 104 °F)	400 °C (752 °F)	
-40 … 67 °C (-40 … 153 °F)	180 °C (356 °F)	

1) The permissible limits for the ambient temperature are dependent on approval and design (default: -20 °C [-4 °F])
2) Category 2D (dust-ignition proof), maximum 60 °C (140 °F)

3 Product identification

3.1 Name plate

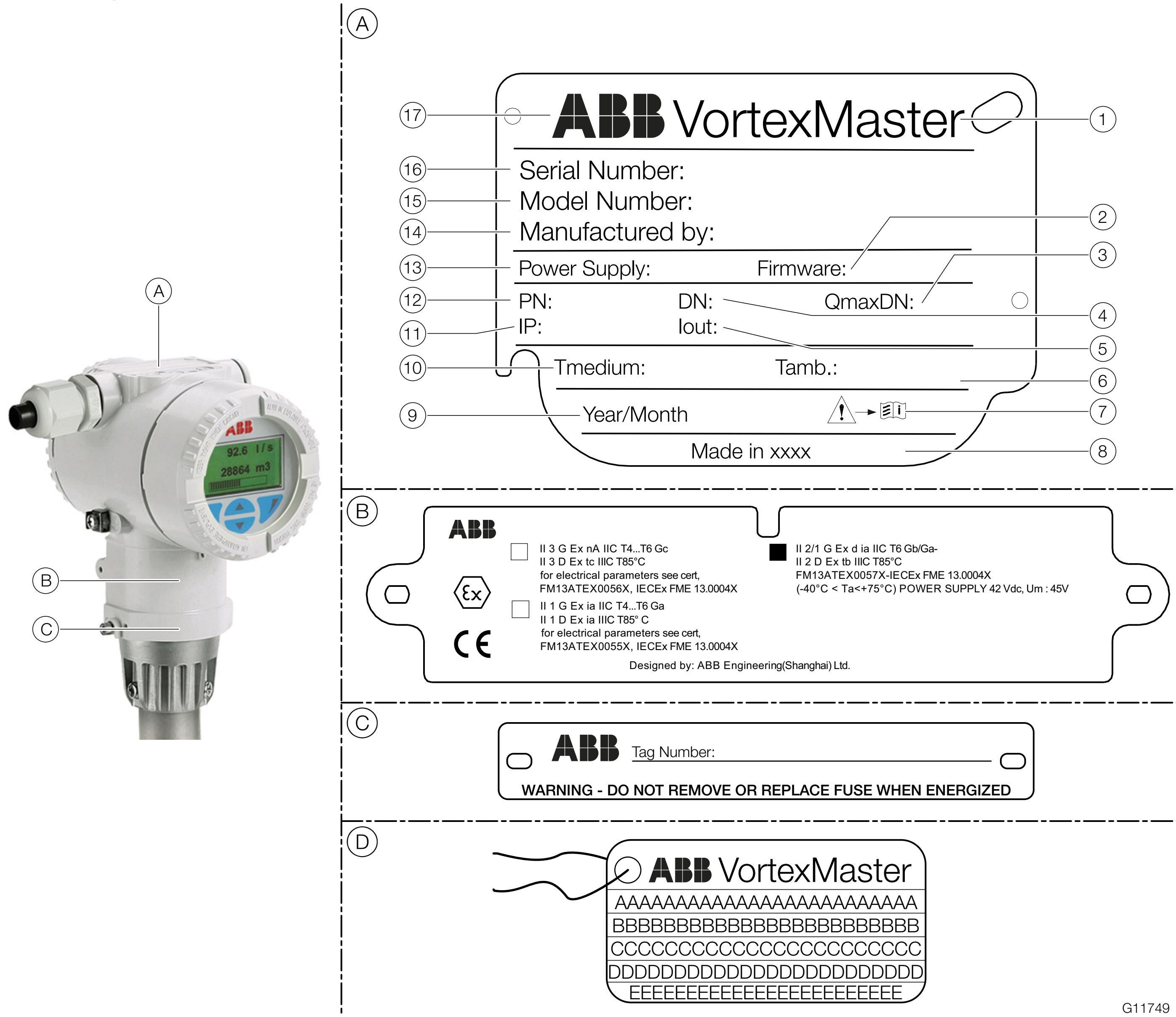

Fig. 4: Types and tag plates (example)

Ⓐ Name plate Ⓑ Special data plate with Ex-marking Ⓒ Plate with measuring point tagging (tag number)
Ⓓ Tag plate with customer data made from stainless steel (optional)
① Product name ② Firmware version ③ Maximum flow at nominal diameter ④ Nominal diameter ⑤ Current output
⑥ Maximum ambient temperature ⑦ Symbol: Read instructions before use ⑧ Country of manufacture ⑨ Date of production
⑩ Maximum measuring medium temperature ⑪ IP rating ⑫ Pressure rating ⑬ Power supply ⑭ Manufacturer address ⑮ Model number
Ⓟ Serial number ⑰ Manufacturer logo

NOTE

The device can optionally be delivered with a tag plate Ⓓ made from stainless steel and fastened with wire. Customer specific text that has been specified in the purchase order is laser printed on the tag plate.
For this, 4 lines of 32 characters each are provided.

4 Transport and storage

4.1 Inspection

Check the devices immediately after unpacking for possible damage that may have occurred from improper transport.
Details of any damage that has occurred in transit must be recorded on the transport documents.
All claims for damages must be submitted to the shipper without delay and before installation.

4.2 Transport

⚠ DANGER

Life-threatening danger due to suspended loads.

In the case of suspended loads, a danger of the load falling exists.
Remaining under suspended loads is prohibited.

⚠ WARNING

Risk of injury due to device slipping.

The device's center of gravity may be higher than the harness suspension points.

— Make sure that the device does not slip or turn during transport.
— Support the device laterally during transport.

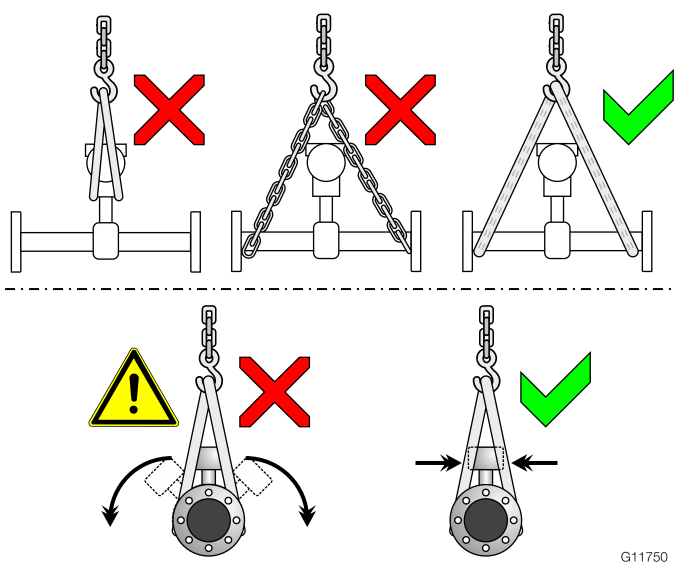

Fig. 5: Transport instructions

Flange devices ≤ DN 300

— Carrying straps must be used to transport flange designs smaller than DN 350
— Wrap the straps around both process connections when lifting the device Chains should not be used, since these may damage the housing.

Flange devices > DN 300

— Using a forklift to transport flange device can dent the housing
— Flange devices must not be lifted by the center of the housing when using a forklift for transport
— Flange devices must not be lifted by the terminal box or by the center of the housing
— Only the transport lugs fitted to the device can be used to lift the device and insert it into the piping

4.3 Storing the device

Bear the following points in mind when storing devices:

— Store the device in its original packaging in a dry and dust-free location.
— Observe the permitted ambient conditions for transport and storage.
— Avoid storing the device in direct sunlight.
— In principle, the devices may be stored for an unlimited period. However, the warranty conditions stipulated in the order confirmation of the supplier apply.

4.3.1 Ambient conditions

The ambient conditions for the transport and storage of the device correspond to the ambient conditions for operation of the device.
Adhere to the device data sheet!

4.4 Returning devices

Use the original packaging or a secure transport container of an appropriate type if you need to return the device for repair or recalibration purposes.
Include the return form once it has been properly filled out (see appendix in operating instructions) with the device.
According to the EU Directive governing hazardous materials, the owner of hazardous waste is responsible for its disposal or must observe the following regulations for shipping purposes:
All devices delivered to ABB must be free from any hazardous materials (acids, alkalis, solvents, etc.).

Please contact Customer Center Service acc. to page 1 for nearest service location.

5 Installation

⚠ DANGER

Danger of explosion if the device is operated with the transmitter housing or terminal box open!

Before opening the transmitter housing or the terminal box, note the following points:

— Check that a valid fire permit is available.
— Make sure that there is no explosion hazard.
— Switch off the power supply before opening and observe a waiting time of t > 20 minutes.

5.1 Installation conditions

5.1.1 General information

A Vortex or Swirl flowmeter can be installed at any point in the pipeline system. However, the following installation conditions must be considered:

— Compliance with the ambient conditions
— Compliance with the recommended inlet and outlet sections
— The flow direction must correspond to that indicated by the arrow on the sensor
— Compliance with the required minimum interval for removing the transmitter and replacing the sensor
— Avoidance of mechanical vibrations of the piping (by fitting supports if necessary)
— The inside diameter of the sensor and the piping must be identical
— Avoidance of pressure oscillations in long piping systems at zero flow by fitting gates at intervals
— Attenuation of alternating (pulsating) flow during piston pump or compressor conveying by using appropriate damping devices. The residual pulse must not exceed 10 %. The frequency of the conveying equipment must not be within the range of the measuring frequency of the flowmeter.
— Valves / gates should normally be arranged in the flow direction downstream of the flowmeter (typically: 3 x DN). If the measuring medium is conveyed through piston pumps / plunger pumps or compressors (pressures for fluids > 10 bar [145 psi]), it may be subject to hydraulic vibration in the piping when the valve is closed. If this does occur, the valve absolutely has to be installed in the flow direction upstream of the flowmeter. Suitable damping devices (e.g. air vessels) might need to be fitted.
— When fluids are measured, the sensor must always be filled with measuring medium and must not run dry.
— When fluids are measured and during damping, there must be no evidence of cavitation.
— The relationship between the measuring medium and the ambient temperature must be taken into consideration (see data sheet).
— At high measuring medium temperatures > 150 °C (> 302 °F), the sensor must be installed so that the transmitter or terminal box is pointing to the side or downward.

5.1.2 Inlet and outlet sections

Vortex flowmeters FSV430, FSV450

In order to maximize operational reliability, the flow profile at the inflow end must not be distorted if at all possible.
The figures below show the recommended inlet and outlet sections for various installations.

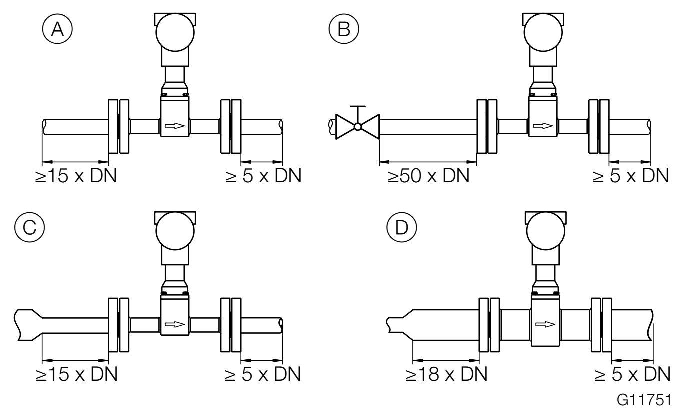

Fig. 6: Straight pipe sections

Installation	Inlet section	Outlet section
A Straight pipe section	min. 15 x DN	min. 5 x DN
B Valve upstream of the meter tube	min. 50 x DN	min. 5 x DN
C Pipe reduction	min. 15 x DN	min. 5 x DN
D Pipe extension	min. 18 x DN	min. 5 x DN

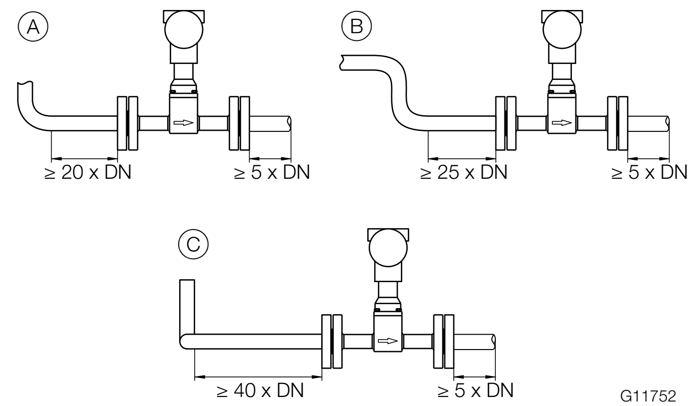

Fig. 7: **Pipe sections with pipe elbows**

Installation	Inlet section	Outlet section
(A) Single pipe elbow	min. 20 x DN	min. 5 x DN
(B) S-shaped pipe elbow	min. 25 x DN	min. 5 x DN
(C) Three-dimensional pipe elbow	min. 40 x DN	min. 5 x DN

Swirl flowmeters FSS430, FSS450

On account of its operating principle, the swirl flowmeter functions virtually without inlet and outlet sections.
The figures below show the recommended inlet and outlet sections for various installations.

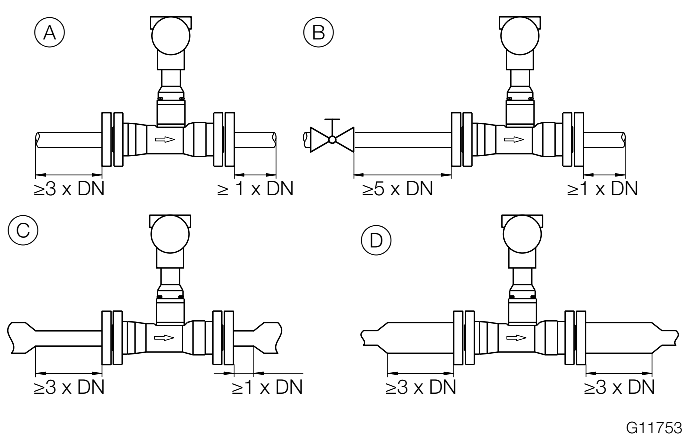

Fig. 8: **Straight pipe sections**

Installation	Inlet section	Outlet section
(A) Straight pipe section	min. 3 x DN	min. 1 x DN
(B) Valve upstream of the meter tube	min. 5 x DN	min. 1 x DN
(C) Pipe reduction	min. 3 x DN	min. 1 x DN
(D) Pipe extension	min. 3 x DN	min. 3 x DN

Additional inlet and outlet sections are not required downstream of reductions with flange transition pieces in accordance with DIN 28545 (α/2 = 8°).

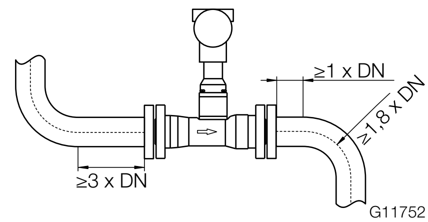

Fig. 9: **Pipe sections with pipe elbows**

Installation	Inlet section	Outlet section
Single pipe elbow upstream or downstream of the meter tube	min. 3 x DN	min. 1 x DN

If the elbow radius of single or double pipe elbows positioned upstream or downstream of the device is greater than 1.8 x DN, inlet and outlet sections are not required.

5.1.3 Installation at high measuring medium temperatures

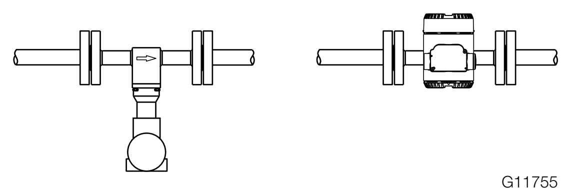

Fig. 10: **Installation at high measuring medium temperatures**

At high measuring medium temperatures > 150 °C (> 302 °F), the sensor must be installed so that the transmitter is pointing to the side or downward.

5.1.4 Installation for external pressure and temperature measurement

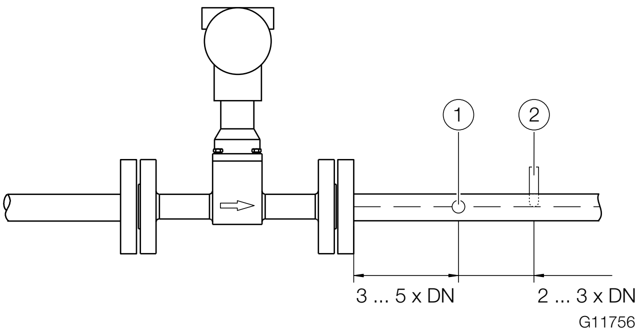

Fig. 11: Arrangement of the temperature and pressure measuring points
(1) Pressure measuring point (2) Temperature measuring point

As an option, the flowmeter can be fitted with a Pt100 for direct temperature measurement. This temperature measurement enables, for example, the monitoring of the measuring medium temperature or the direct measurement of saturated steam in mass flow units.
If pressure and temperature are to be compensated externally (e.g. with the flow computer unit), the measuring points must be installed as illustrated.

5.1.5 Installation of final controlling equipment

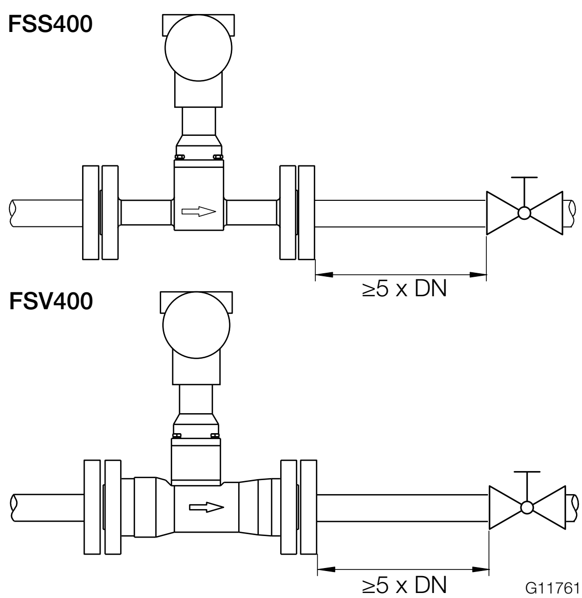

Fig. 12: Installation of final controlling equipment

Final controlling equipment must be arranged at the outflow end spaced at a minimum 5 x DN. If the measuring medium is conveyed through piston pumps / plunger pumps or compressors (pressures for fluids > 10 bar [145 psi]), it may be subject to hydraulic vibration in the piping when the valve is closed. If this does occur, it is essential that the valve be installed in the flow direction upstream of the flowmeter. The SwirlMaster FSS400 is particularly well suited for such arrangements. Suitable damping devices (such as air vessels if using a compressor for conveying) may need to be used.

5.1.6 Sensor insulation

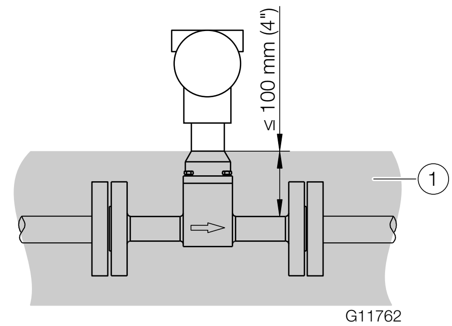

Fig. 13: Insulation of the meter tube
(1) Insulation

The piping can be insulated up to a thickness of 100 mm (4 inch).

5.1.7 Use of trace heating

Trace heating may be used under the following conditions:
— If it is installed directly on or around the piping
— If, in the case of existing pipeline insulation, it is installed inside the insulation (the maximum thickness of 100 mm [4 inch] must not be exceeded)
— If the maximum temperature the trace heating is able to produce is less than or equal to the maximum medium temperature.

NOTE
The installation requirements set out in EN 60079-14 must be observed.
Please note that the use of trace heaters will not impair EMC protection or generate additional vibrations.

5.2 Installing the sensor

Observe the following points during installation:

- The flow direction must correspond to the marking, if present
- The maximum torque for all flanged connections must be observed
- The devices must be installed without mechanical tension (torsion, bending)
- Wafer type devices with plane parallel counterflanges may only be installed with suitable gaskets
- Only gaskets made from a material that is compatible with the measuring medium and measuring medium temperature may be used
- The piping may not exert any inadmissible forces or torques on the device
- Do not remove the sealing plugs in the cable glands until you are ready to install the electrical leads
- Make sure the gaskets for the housing cover are seated correctly Carefully seal the cover. Tighten the cover fittings
- Do not expose the transmitter to direct sunlight and provide for appropriate sun protection where necessary
- When selecting the installation site, make sure that moisture cannot penetrate the terminal or transmitter compartment

The device can be installed at any location in a pipeline under consideration of the installation conditions.

1. Position the meter tube coplanar and centered between the piping.
2. Install gaskets between the sealing surfaces.

i NOTE

For achieve the best results, ensure the gaskets fit concentrically with the meter tube
To ensure that the flow profile is not distorted, the gaskets must not protrude into the piping.

3. Use the appropriate screws for the holes.
4. Slightly grease the threaded nuts.
5. Tighten the nuts in a crosswise manner as shown in the figure. First tighten the nuts to approx. 50 % of the maximum torque, then to 80 %, and finally a third time to the maximum torque.

i NOTE

Torques for screws depend on temperature, pressure, screw and gasket materials. The relevant applicable regulations must be taken into consideration.

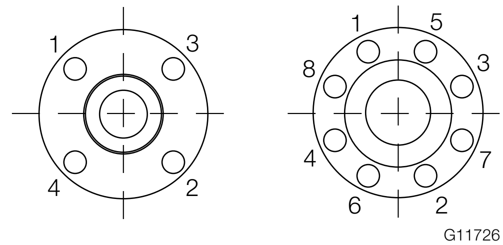

Fig. 14: Tightening sequence for the flange screws

5.2.1 Centering the wafer type design

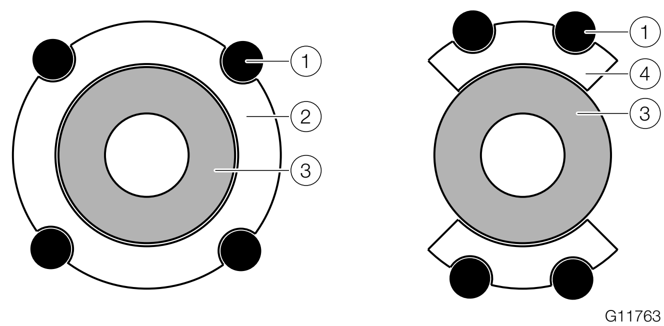

Fig. 15: Centering the wafer type design with the ring or segment
1 Bolt 2 Centering ring 3 Meter tube (wafer type)
4 Centering segment

Wafer type devices (FV400 only) are centered via the outside diameter of the flowmeter sensor body with the corresponding bolts.
Depending on the nominal pressure rating, sleeves for the bolts, a centering ring (up to DN 80 [3"]) or segments can be ordered as additional accessories.

5.2.2 Adjusting the transmitter position

Rotating the transmitter housing

⚠ DANGER

Risk of explosion!

When the screws for the transmitter housing are loosened, the explosion protection is suspended.

Tighten all screws for the transmitter housing prior to commissioning.

NOTE

Damage to components!

— The transmitter housing must not be lifted without pulling out the cable, otherwise the cable can tear off

— The transmitter housing must not be rotated more than 360 degrees

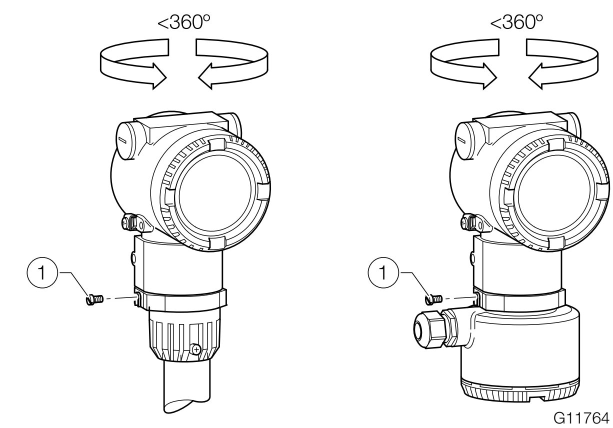

Fig. 16: Rotating the transmitter housing
1 Locking screw

1. Unscrew the locking screw on the transmitter housing with a 4 mm Allen key.
2. Rotate the transmitter housing in the direction required.
3. Tighten the locking screw.

Rotating the LCD indicator

⚠ WARNING

Risk of injury due to live parts!

When the housing is open, contact protection is not provided and EMC protection is limited.

Before opening the housing, switch off the power supply.

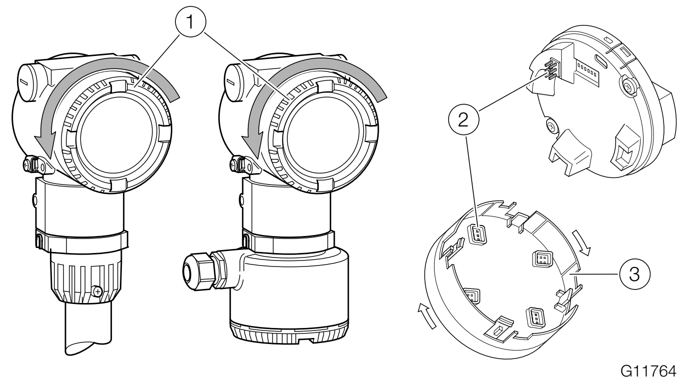

Fig. 17: Rotating the LCD indicator
1 Cover 2 Plug connection 3 LCD indicator

The LCD indicator can be rotated in 90° increments to make it easier to read and operate.

1. Unscrew the front housing cover.
2. Pull out the LCD indicator and place it in the desired position.
3. Tighten the screws on the front of the housing cover hand-tight.

NOTE

Potential adverse effect on the IP rating!

If the O-ring gasket is seated incorrectly or is damaged, this may have an adverse effect on the IP rating.

Check that the O-ring gasket is properly seated when closing the housing cover.

5.3 Electrical connections

DANGER

Danger of explosion if the device is operated with the transmitter housing or terminal box open!

Before opening the transmitter housing or the terminal box, note the following points:

- Check that a valid fire permit is available.
- Make sure that there is no explosion hazard.
- Before opening the device, switch off the power supply and wait for t > 2 minutes.

WARNING

Risk of injury due to live parts.

Improper work on the electrical connections can result in electric shock.

- Connect the device only with the power supply disconnected.
- Observe the applicable standards and regulations for the electrical connection.

NOTE

When using the device in hazardous areas, note the additional connection data in the chapter titled „Use in potentially explosive atmospheres“ on page 5!

The electrical connection may only be established by authorized specialist personnel and in accordance with the connection diagrams.
The electrical connection information in the manual must be observed; otherwise, the type of electrical protection may be adversely affected.
Ground the measurement system according to requirements.

5.3.1 Cable entries

The electrical connection is made via a 1/2" NPT or M20 x 1.5 cable gland.
To ensure the IP rating 4X / IP67 for the transmitter, the cable gland must be screwed into the housing (1/2" NPT female thread) using a suitable sealing compound. Devices with M20 x 1.5 are supplied with a cable gland installed.

If cable glands are not used, the red transport sealing plugs must be replaced with suitable sealing plugs when the transmitter is installed. This is because the transport sealing plugs are not certified as protected against explosion. This requirement is particularly relevant in hazardous areas.

Cable entries in potentially explosive atmospheres

For category 3 transmitters for use in Zone 2, a cable gland approved for this type of protection must be provided by the customer.
For this purpose, a corresponding M20 x 1.5 thread is provided in the electronics housing.
For transmitters with the type of protection "Ex d / XP, flameproof (enclosure)", the housing cover must be locked with the locking screw.
If the transmitter is supplied with a sealing plug, the sealing plug must be inserted on site with the sealing compound Molykote DX.
If a different sealant is used, the responsibility rests with the executing installer. At this point we expressly state that after several weeks the housing cover can only be unscrewed with an increased expenditure of force. This is not caused by the threads, but instead is due solely to the type of seal.

5.3.2 Earthing

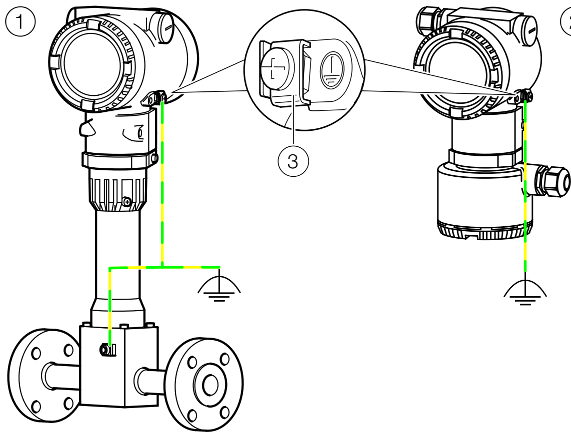

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Fig. 18: Earthing terminals
(1) Integral mount design and sensor in remote design
(2) Transmitter in remote mount design
(3) Earthing terminal

For the earthing (PE) of the transmitter or the connection of a protective earth, a connection is available both on the exterior of the housing and in the connection space. Both connections must be galvanically connected to one another.
These connection points can be used if grounding or the connection of a protective conductor is prescribed by national regulations for the selected type of supply or the type of protection used.

NOTE

In order to avoid external influences on the measurement, it is imperative to ensure that the transmitter and the separate flowmeter sensor are properly earthed.

1. Loosen the screw terminal on the transmitter housing or on the housing of the VortexMaster / SwirlMaster.
2. Insert the forked cable lug for functional earthing between the two metal tabs and into the loosened terminal.
3. Tighten the screw terminal.

5.3.3 Electrical connection

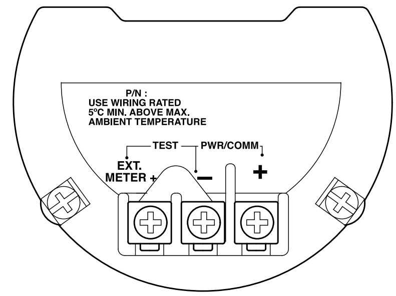

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Fig. 19: Terminals without digital output

Terminal	Function / comment
PWR/COMM +	Power supply, current output / HART output
PWR/COMM -	
EXT. METER	Not assigned

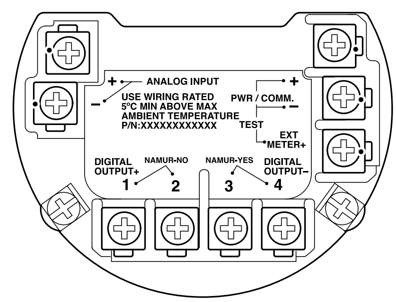

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Fig. 20: Terminals with digital output and analog input

Terminal	Function / comment
PWR/COMM +	Power supply, current output / HART output
PWR/COMM -	
EXT. METER +	Current output 4 ... 20 mA for external display
DIGITAL OUTPUT 1+	Digital output, positive pole
DIGITAL OUTPUT 2	Bridge after terminal 1+, NAMUR output deactivated
DIGITAL OUTPUT 3	Bridge after terminal 4-, NAMUR output activated
DIGITAL OUTPUT 4-	Digital output, negative pole
ANALOG INPUT +	Analog input 4 ... 20 mA for remote transmitter, e.g. for temperature, pressure, etc.
ANALOG INPUT -	

5.4 Connection examples

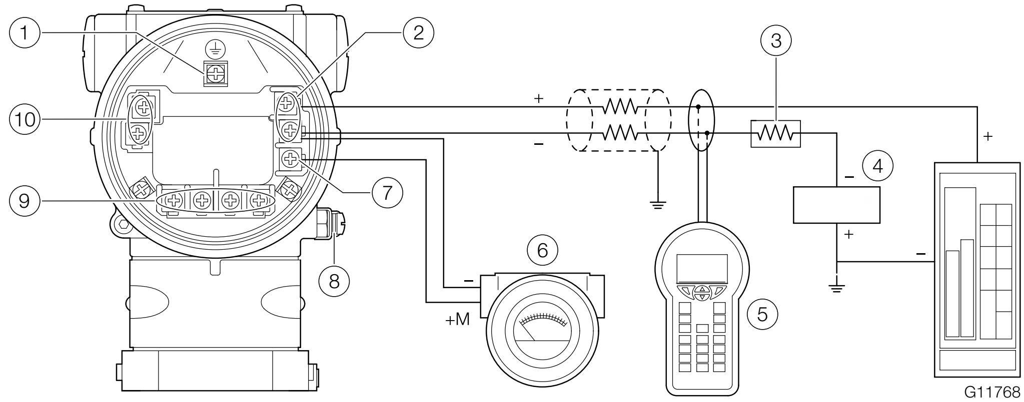


Fig. 21: Connection example

(1) Internal earthing terminal (2) Power supply, current / HART output (3) Load resistance (4) Power supply (5) Handheld terminal (6) External display (7) Terminal for external display (8) External earthing terminal (9) Digital output (10) Analog input

For connecting the signal voltage / supply voltage, twisted cables with a conductor cross-section of 18 … 22 AWG / 0.8 … 0.35 mm^2 and a maximum length of 1500 m (4921 ft) must be used. For longer leads a greater cable cross section is required.

For shielded cables the cable shielding must only be placed on one side (not on both sides).

For the earthing on the transmitter, the inner terminal with the corresponding marking can also be used.

The output signal (4 20 mA) and the power supply are conducted via the same conductor pair.

The transmitter works with a supply voltage between 12 … 42 V DC. For devices with the type of protection "Ex ia, intrinsic safety" (FM, CSA, and SAA approval), the supply voltage must not exceed 30 V DC. In some countries the maximum supply voltage is limited to lower values. The permissible supply voltage is specified on the name plate on the top of the transmitter.

The possible lead length depends on the total capacity and the total resistance and can be estimated based on the following formula.

$$L = \frac{65 \text{ x } 106}{R \text{ x } C} - \frac{Ci + 10000}{C}$$

L Lead length is meters

R Total resistance in Ω

C Lead capacity

C_i Maximum internal capacity in pF of the HART field devices in the circuit

Avoid installing the cable together with other power leads (with inductive load, etc.), as well as the vicinity to large electrical installations.

The HART handheld terminal can be connected to any connection point in the circuit if a resistance of at least 250 Ω is present in the circuit. If there is resistance of less than 250 Ω, an additional resistor must be provided to enable communication. The handheld terminal is connected between the resistor and transmitter, not between the resistor and the power supply.

5.4.1 Electrical data for inputs and outputs

Power supply, current output / HART output

Power supply, current output / HART output	
Supply voltage	12 ... 42 V DC
Residual ripple	Maximum 5 % or ±1.5 Vpp
Power consumption	< 1 W

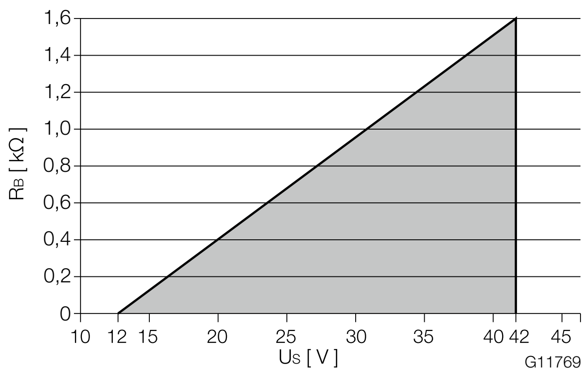


Fig. 22: Load diagram of the current output; load vs. supply voltage

In HART communication, the smallest load is 250 Ω. The load R_B is calculated as a function of the available supply voltage U_S and the selected signal current I_B as follows:

$R_B = U_S / I_B$

R_B Load resistance

U_S Supply voltage

I_B SignalStrom

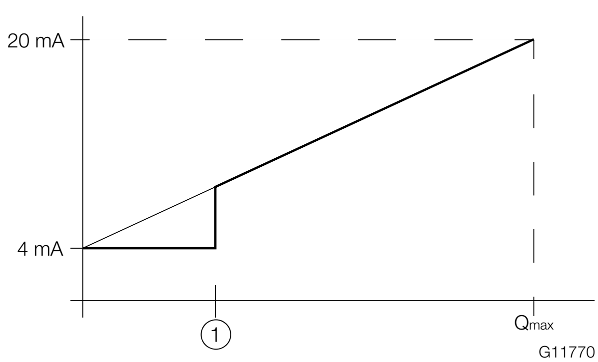


Fig. 23: Behavior of the current output

1 **Low flow cut-off**

The measured value at the current output behaves as shown in the figure.

The current curve proceeds above the low flow as a straight line, which in the Q = 0 operating mode has the value 4 mA and in the Q = Q_{max} operating mode has the value 20 mA.

Due to the low flow cut-off, the flow is set to below x % Qmax or the low flow is set to 0, meaning the current is 4 mA.

Digital output

The devices can be ordered with an optional digital output. This output can be configured by software as:

- Frequency output (up to 10.5 kHz)
- Pulse output (up to 2 kHz)
- Logic output (on / off, e.g. to display an alarm signal)

Digital output	
Operating voltage	16 ... 30 V DC
Output current	Maximum 20 mA
Output "closed"	$0 \text{ V} \leq U_{low} \leq 2 \text{ V}$ $2 \text{ mA} \leq I_{low} \leq 20 \text{ mA}$
Output "open"	$16 \text{ V} \leq U_{high} \leq 30 \text{ V}$ $0 \text{ mA} \leq I_{high} \leq 0.2 \text{ mA}$
Pulse output	f_{max}: 10 kHz Pulse width: 0.05 ... 2000 ms
Frequency output	f_{max}: 10.5 kHz

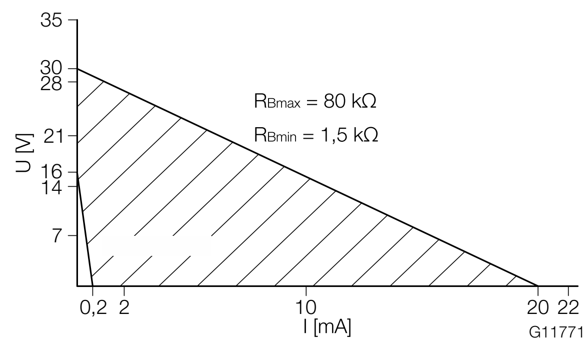


Fig. 24: Range of the external supply voltage and current

The external resistance R_B is in the range of $1.5 \text{ k}\Omega \leq R_B \leq 80 \text{ k}\Omega$, as shown in Fig. 24.

Analog input 4 ... 20 mA

An external pressure transmitter, an external temperature transmitter or a gas analyzer for a density signal can be connected onto the analog input (4 ... 20 mA). The analog input measures the current loop value.

— Temperature input for the return for power measurement
— Pressure input for pressure compensation for the flow measurement of gases and steam
— Concentration of gas for the net metering of methane (biogas)
— Density for calculating the mass flow

Current input	
Terminals	ANALOG INPUT+ / ANALOG INPUT-
Operating voltage	16 ... 30 V DC
Input current	3.8 ... 20.5 mA
Equivalent resistance	90 Ω

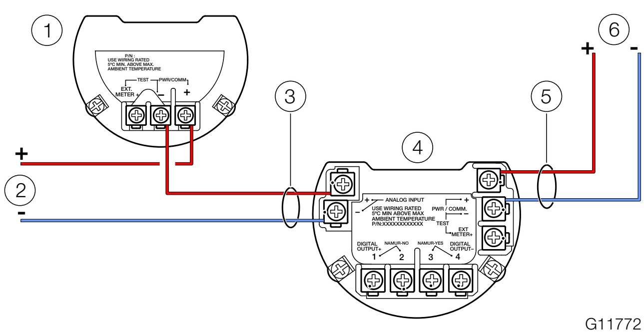


Fig. 25: Connection of transmitters at the analog input (example)

(1) Remote transmitter
(2) Power supply for the remote transmitter
(3) Cable entry for the analog input (4) FSS400 / FSV400
(5) Cable entry for the current output
(6) Power supply for FSS400 / FSV400

HART 7 communication with remote transmitter

Because the device is designed with two-wire technology, a pressure or temperature transmitter can also be connected to the power supply lead (4 ... 20 mA).
The transmitter connected must run in HART burst mode. The device supports remote transmitters with HART 7 communication.

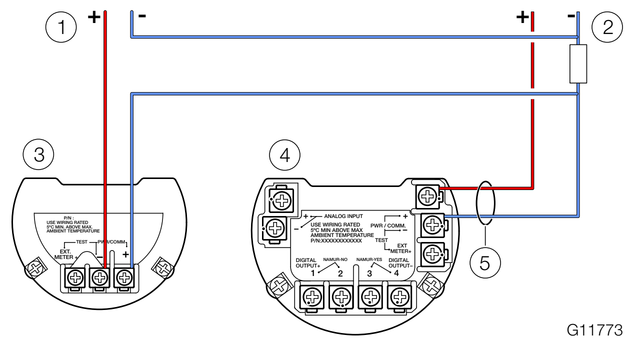


Fig. 26: Connection of transmitters with HART communication (example)

(1) Power supply for the remote transmitter
(2) Power supply for FSS400 / FSV400
(3) Remote transmitter (4) FSS400 / FSV400
(5) Cable entry for the current output

5.4.2 Connection to remote mount design

The remote mount designs are based on the integral mount designs of the devices with all options.
The transmitter is installed separately from the sensor, if this is positioned in a location which is difficult to access.
This design can also be advantageous if the measuring point is located in extreme ambient conditions.
The distance between the sensor and the transmitter must not exceed 30 m (99 ft).
A special cable connects the sensor to the transmitter. The cable is permanently connected to the transmitter.
Once installation is complete, cut the connecting cable to length as far as the flowmeter sensor.
The transmission signal between the sensor and the transmitter is not amplified, so the connections need to be routed carefully. Lay the wires in the terminal box so that they are not affected by vibration.

NOTE

- The signal cable carries a voltage signal of only a few millivolts. Therefore, it must be routed over the shortest possible distance. The maximum permissible signal cable length is 30 m (99 ft).
- Route all leads in such a way that they are shielded, and connect to the operational earth potential. For this purpose, the cable shield must be connected underneath the cable clamp.
- Avoid installing the signal cable in the vicinity of electrical equipment or switching elements that can create stray fields, switching pulses and induction. If this is not possible, run the signal cable through a metal pipe and connect this to the operational earth potential.
- Make sure during installation that the cable is fitted with a drip loop (water trap)
- For vertical installation of the meter tube, align the cable glands pointing downward

5.4.3 Cutting the signal cable to length and terminating it

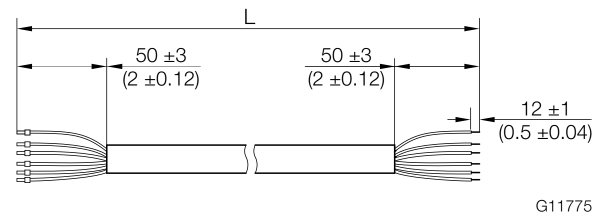


Fig. 27: Signal cable dimensions in mm (inch)

The signal cable is available in four standard lengths: 5 m (16.4 ft), 10 m (32.8 ft), 20 m (65.6 ft) and 30 m (98.4 ft).
The cable ends are already prepared for installation.
However, the cables can also be cut to any length.
For proper installation, the cable ends must be prepared as shown in Fig. 27.

5.4.4 Connecting the signal cable

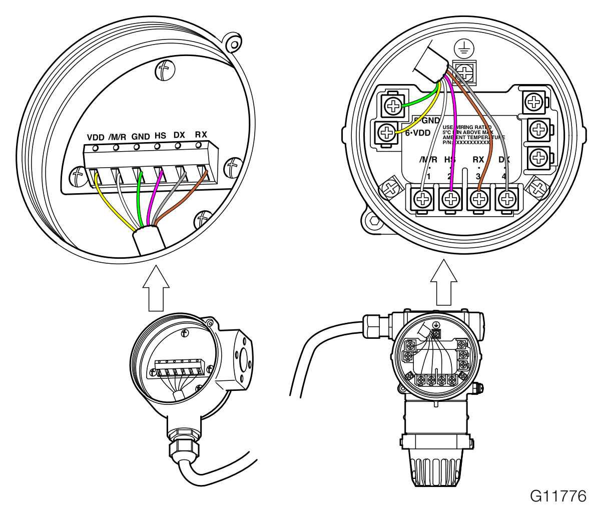


Fig. 28

Terminal	Color
VDD	Yellow
/M/R	White
GND	Green
HS	Pink
DX	Gray
RX	Brown

DANGER

Danger of explosion if the device is operated with the transmitter housing or terminal box open!

Before opening the transmitter housing or the terminal box, note the following points:

— Check that a valid fire permit is available.
— Make sure that there is no explosion hazard.
— Before opening the device, switch off the power supply and wait for t > 2 minutes.

NOTE

Damage to components!

If the cable is not fastened to the strain relief, the shielding will not have a functional earth. Furthermore, there is a risk of the cable being pulled completely out of the transmitter housing should there be accidental strain, which would interrupt the electrical connection. The sheath of the bus cable must not be damaged. Otherwise, the IP rating IP67 for the flowmeter cannot be ensured.

1. Use the cable connected to the sensor to make the electrical connection between the sensor and the transmitter.
2. Unscrew the cover from the terminal compartment at the rear of the transmitter.
3. Remove the insulation from the cable sheath, the shielding and the wires as specified (see Fig. 27).
4. Insert the cable into the terminal compartment through the cable gland and fasten the cable to the strain relief at a height level with the shielding to prevent accidental disconnection.
5. Tighten the cable gland.
6. Connect the bare wires to the corresponding terminals (see Fig. 28).
7. Screw on the cover for the terminal compartment fully and tighten hand-tight. Make sure the gaskets for the cover are seated properly.

6 Commissioning

6.1 Safety instructions

DANGER

Danger of explosion if the device is operated with the transmitter housing or terminal box open!

Before opening the transmitter housing or the terminal box, note the following points:

— Check that a valid fire permit is available.
— Make sure that there is no explosion hazard.
— Before opening the device, switch off the power supply and wait for t > 2 minutes.

CAUTION

Risk of burns on the sensor due to hot measuring media.

The surface temperature may exceed 70 °C (158 °F), depending on the measuring medium temperature!
Before starting work on the sensor, make sure that the device has cooled sufficiently.

6.2 Checks prior to commissioning

The following points must be checked before commissioning:

— The power supply must be switched off.
— The power supply must match the information on the name plate.
— The wiring must be correct in accordance with the chapter titled „Electrical connections“ on page 21.
— The earthing must correct in accordance with the chapter titled „Earthing“ on page 22.
— The ambient conditions must meet the requirements set out in the technical data.
— The sensor must be installed at a location largely free of vibrations.
— The housing cover and its safety locking device must be sealed before switching on the power supply.
— For devices with a remote mount design, ensure that the sensor and transmitter are assigned correctly.

6.2.1 Configuration of the outputs

Current output 4 ... 20 mA / HART

In the factory setting, the flow signal is emitted via the current output of 4 ... 20 mA. Alternatively, the temperature signal can be assigned to the current output.

Digital output

It is possible to use software to configure the optional digital output as an alarm, frequency or pulse output.
It is possible to use a bridge to configure the digital output as an optoelectronic coupler output or a NAMUR output.

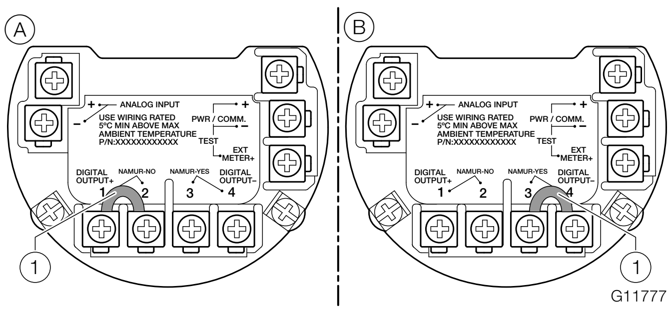


Fig. 29: Hardware configuration of the digital output
1 **Bridge**

Output configuration	Bridge
Optoelectronic coupler output	1—2
NAMUR output	3—4

In the factory setting, the output is configured as an optoelectronic coupler output.

NOTE

The type of protection of the outputs remains unchanged, regardless of the output configuration.
The devices connected to the digital output must conform to the current regulations for explosion protection.

Analog input 4 ... 20 mA

(for FSx450 only)
External devices can be connected to the passive analog input (4 ... 20 mA).
The function of the analog input can be selected via the software ("Input/Output" menu).
The analog input can be configured via the "Easy Setup" menu or the setup menu of the device. Before starting the configuration, select the type of the connected signal and then select the values for 4 mA and 20 mA that correspond to the relevant output values of the connected device.

HART Input

The HART input can be configured via the "Easy Setup" menu or the setup menu of the device. The device recognizes the value and the corresponding unit via the HART input.
If, for example, the pressure unit is set to psi in the setup menu of the device but the pressure unit of the connected pressure transmitter is set to kPa, the VortexMaster / SwirlMaster takes the pressure unit from the pressure transmitter.
The connected device must send the signals in burst mode. It is recommended to use an ABB pressure transmitter from the 2600T series (e.g. 261 or 266 series) and an ABB temperature transmitter from the TTH / TSP series. They can be switched to burst mode using the HART command.

6.3 Checking and configuring the basic settings

The device can be factory parameterized to customer specifications upon request. If no customer information is available, the device is delivered with factory settings.

Parameter	Factory setting
Active Mode	Liquid Volume
Output Value	Flow rate
DO Function	No function
Q_{max}	Actual value set to Q_{max}DN. Depending on the nominal diameter of the flowmeter.
Unit Q	m^3/h
Analog In Value	No function
Hart In Value	No function
Low Flow Cutoff	4 %
Iout at Alarm	Low Alarm Value
Low Alarm Value	3.55 mA
High Alarm Value	22 mA

Specific operating conditions

If the manufacturer of the device has not stated the type of protection on the name plate, the user must state the type of protection used on the name plate during installation.
The painted surface of the device can potentially store electrostatic charges and represent a potential ignition source during applications with low relative humidity. Therefore, the relative humidity must be below 30 % and the painted surface must be free of surface contaminants such as dirt, dust and oil. Guidelines on protection against the risk of ignition due to electrostatic discharge are presented in EN TR50404 and IEC TR60079-32 (in preparation). The painted surface must be cleaned using only a moist cloth.

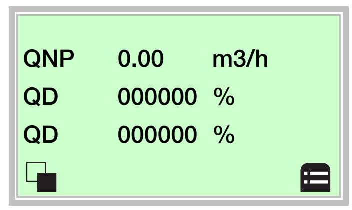
6.3.1 Parameterization via the "Easy Setup" menu function

Setting of the most current parameters is summarized in the "Easy Setup" menu. This menu provides the fastest way to configure the device.

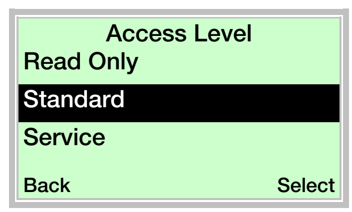
NOTE

The LCD display is provided with capacitive control buttons. These enable you to control the device through the closed housing cover.

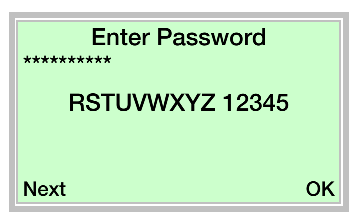
The following section describes parameterization via the "Easy Setup" menu function.



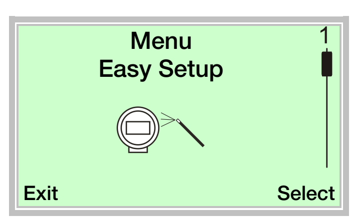
1. Use to switch to the configuration level.



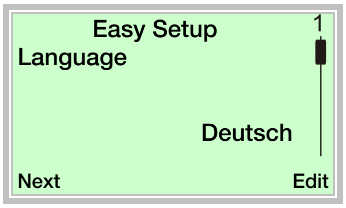
2. Use / to select "Standard".
3. Confirm the selection with .



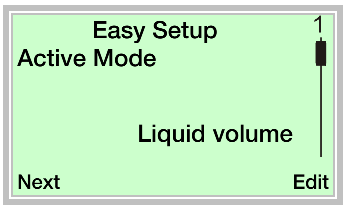
4. Use to confirm the password. A password is not available as factory default; you can continue without entering a password.



5. Use / to select "Easy Setup".
6. Confirm the selection with .

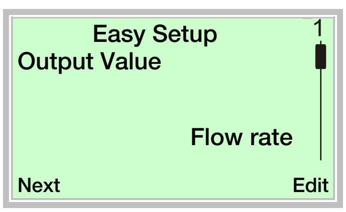


7. Use to call up the edit mode.
8. Use / to select the desired language.
9. Confirm the selection with .

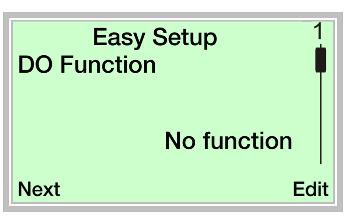


For more information on the operating mode, refer to the chapter titled „Operating mode“ on page 32.

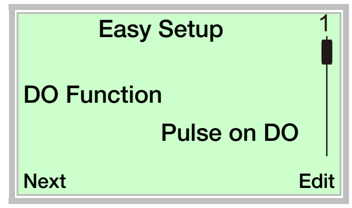
10. Use to call up the edit mode.
11. Use / to select the desired operating mode.
12. Confirm the selection with .



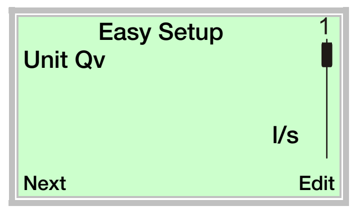
13. Use to call up the edit mode.
14. Use / to select the desired process value for the current output.
15. Confirm the selection with .



16. Use to call up the edit mode.
17. Use / to select the desired process value for the digital output.
18. Confirm the selection with .

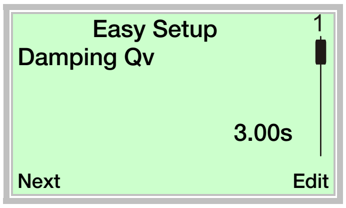


19. Use to call up the edit mode.
20. Use / to select the desired operating mode for the digital output.
    - DO Function: Operation as a switch output.
    - Pulse on DO: In pulse mode, pulses are emitted per unit.
    - Freq on DO : In frequency mode, a frequency proportional to the flow is emitted. The maximum frequency can be configured according to the flow measuring range
21. Confirm the selection with .



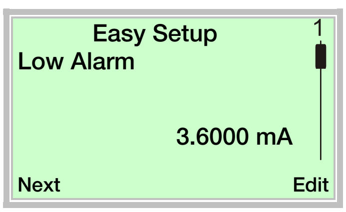
22. Use to call up the edit mode.
23. Use / to select the desired unit for the volume flow.
24. Confirm the selection with .

25. Use to call up the edit mode.
26. Use / to set the desired upper range value for the volume flow.
27. Confirm the selection with .

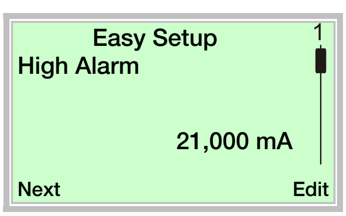


28. Use to call up the edit mode.
29. Use / to set the damping for the volume flow.
30. Confirm the selection with .

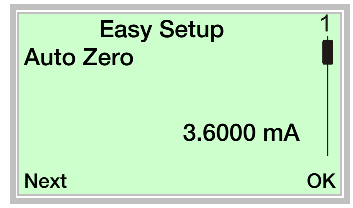
31. Use to call up the edit mode.
32. Use / to select the alarm current.
33. Confirm the selection with .



34. Use to call up the edit mode.
35. Use / to set the alarm current for "Low Alarm".
36. Confirm the selection with .



37. Use to call up the edit mode.
38. Use / to set the alarm current for "High Alarm".
39. Confirm the selection with .



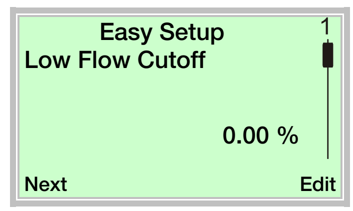
40. Use to start automatic balancing of the zero point for the system.

i NOTE

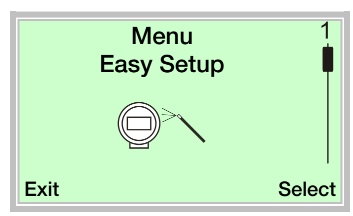
Prior to starting the zero point balancing, make sure that:

— There is no flow through the sensor (close all valves, shut-off devices, etc.)

— The sensor is completely filled with the medium to be measured



41. Use to call up the edit mode.
42. Use / to set the desired value for the low flow cut-off.
43. Confirm the selection with .



Once all parameter have been set, the main menu appears again. The most important parameters are now set.

44. Use to switch to the process display.

6.4 Operating mode

The parameters for the different operating modes are described in the following table.

Operating mode / (order code)	Description	Additional parameters required	Parameter setting
Liquid Volume / NL1	Actual volume flow of the liquid medium	—	—
Liquid Volume (temperature compensated) / NL2	Standard volume flow in the normal condition	Measuring medium temperature 1)	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
		Reference temperature in the normal condition	Device Setup / Plant/Customized / Compensation Setting -> Ref. Temperature
		Volume expansion coefficient	Device Setup / Plant/Customized / Compensation Setting -> Volume Exp.Coef.
Liquid Mass (no adjustment) / NL3	Liquid mass flow, based on direct determination of the operating density via analog input, HART input or default setting.	Operating density 2) 3)	Via analog input: Input/Output / Field Input / Analog In Value -> Density
			Via HART input: Input/Output / Field Input / Hart In Value -> Density
			Default setting for the density: Device Setup / Plant/Customized / Compensation Setting -> Preset Density
Liquid Mass (density adjustment) / NL3	Fluid mass flow, based on reference density and density expansion coefficient in the normal condition	Measuring medium temperature 1)	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
		Reference temperature in the normal condition	Device Setup / Plant/Customized / Compensation Setting -> Ref. Temperature
		Density expansion coefficient	Device Setup / Plant/Customized / Compensation Setting -> Density Exp.Coef.
		Reference density in the normal condition	Device Setup / Plant/Customized / Compensation Setting -> Ref. Density

1) The highest priority of the device is to record the operating temperature.
2) The highest priority of the device is to record the density via the analog input, as long as the analog input is activated as a density input. If the analog input is not available as a density input, the system attempts to record the density via the HART input. If both the analog input and the HART input are deactivated as a density input, the system uses the default density value.
3) The connection via the analog input or HART input is described in the chapter titled „Electrical connections“ on page 21.

Operating mode / (order code)	Description	Additional parameters required	Parameter setting
Liquid Mass (volume adjustment) / NL3	Fluid mass flow, based on reference density and volume expansion coefficient in the normal condition	Measuring medium temperature 1)	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
		Reference temperature in the normal condition	Device Setup / Plant/Customized / Compensation Setting -> Ref. Temperature
		Volume expansion coefficient	Device Setup / Plant/Customized / Compensation Setting -> Volume Exp.Coef.
		Reference density in the normal condition	Device Setup / Plant/Customized / Compensation Setting -> Ref. Density
Liquid Power / NL44)	Energy flow of the liquid medium, such as brine or condensate	Heat capacity	Device Setup / Plant/Customized / Compensation Setting -> Heat Capacity
		Measuring medium temperature at the inflow 1)	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
		Measuring medium temperature at the outflow 3), 5)	Via analog input: Input/Output / Field Input / Analog In Value -> Temperature
			Via HART input: Input/Output / Field Input / Hart In Value -> Temperature
			Default setting for the temperature: Device Setup / Plant/Customized / Compensation Setting -> Preset Ext.Temp
Gas Act. Volume / NG1	Actual volume flow rate of the gaseous medium	—	—

1) The highest priority of the device is to record the operating temperature.
3) The connection via the analog input or HART input is described in the chapter titled „Electrical connections“ on page 21.
4) In order to implement the "Liquid Power" mode, as a precondition the required parameters from one of the NL3 modes must be available. See chapter „Measuring the energy of liquids“ on page 37.
5) The highest priority of the device is to record the temperature via the analog input, as long as the analog input is activated as a temperature input. If the analog input is not available as a temperature input, the system attempts to record the temperature via the HART input. If both the analog input and the HART input are deactivated as a temperature input, the system uses the default density value.

Operating mode / (order code)	Description	Additional parameters required	Parameter setting
Gas Std/Norm Vol. / NG2	Standard volume flow	Operating pressure [3,5]	Via analog input: Input/Output / Field Input / Analog In Value -> Pressure
			Via HART input: Input/Output / Field Input / Hart In Value -> Pressure
			Default setting for the pressure value: Device Setup / Plant/Customized / Compensation Setting -> Preset Pressure
		Operating temperature [3,5]	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
		Reference compression factor in the normal condition (AGA / SGERG only)	Adjustment via DTM/EDD [7]
		Operating compression factor	Adjustment via DTM/EDD [7]
Gas Mass (reference density) / NG3	Gas mass flow, calculated using the reference density	Reference pressure and reference temperature in the normal condition	Device Setup / Plant/Customized / Gas Ref. Conditions
		Reference density	Device Setup / Plant/Customized / Gas Ref. Conditions, as a selection for "Ref. Density "
Gas Mass (actual density) / NG3	Gas mass flow, calculated using the actual density	Operating density [2,3]	Via analog input: Input/Output / Field Input / Analog In Value -> Density
			Via HART input: Input/Output / Field Input / Hart In Value -> Density
			Default setting for the density: Device Setup / Plant/Customized / Compensation Setting -> Preset Density

2) The highest priority of the device is to record the density via the analog input, as long as the analog input is activated as a density input. If the analog input is not available as a density input, the system attempts to record the density via the HART input. If both the analog input and the HART input are deactivated as a density input, the system uses the default density value.
3) The connection via the analog input or HART input is described in the chapter titled „Electrical connections“ on page 21.
5) The highest priority of the device is to record the temperature via the analog input, as long as the analog input is activated as a temperature input. If the analog input is not available as a temperature input, the system attempts to record the temperature via the HART input. If both the analog input and the HART input are deactivated as a temperature input, the system uses the default density value.
7) If the selection "Gas linear." is set for the menu item Device Setup / Plant/Customized -> Gas Std. Mode, the compression factor is reset to 1.0. See also the chapter titled "Special operating modes" in the operating instruction.

Operating mode / order code	Description	Additional parameters required	Parameter setting
Gas Power / NG4	Energy flow of the gaseous medium	Energy density	Device Setup / Plant/Customized / Compensation Setting -> Gas Energy Density
Bio Act. Volume / NG5	Partial actual volume flow of biogas	Biogas proportion [8]	Via analog input: Input/Output / Field Input / Analog In Value -> Gas Content
Bio Std/Norm Vol. 9) / NG6	Partial standard volume flow of biogas		Via HART input: Input/Output / Field Input / Hart In Value -> Gas Content
			Default setting for the density: Device Setup / Plant/Customized / Compensation Setting -> Preset Density
Steam Act. Volume / NS1	Actual volume flow of the vaporous medium	n/a	—
Steam Mass (internal density determination) [10] / NS2	Mass flow of the vaporous medium	Operating pressure [3] [6]	Via analog input: Input/Output / Field Input / Analog In Value -> Pressure
			Via HART input: Input/Output / Field Input / Hart In Value -> Pressure
			Default setting for the pressure value: Device Setup / Plant/Customized / Compensation Setting -> Preset Pressure
		Operating temperature [3] [5]	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
Steam Mass (external density determination) [11] / NS2	Mass flow of the vaporous medium	Operating density [2] [3]	Via analog input: Input/Output / Field Input / Analog In Value -> Density
			Via HART input: Input/Output / Field Input / Hart In Value -> Density
			Default setting for the density: Device Setup / Plant/Customized / Compensation Setting -> Preset Density

2) The highest priority of the device is to record the density via the analog input, as long as the analog input is activated as a density input. If the analog input is not available as a density input, the system attempts to record the density via the HART input. If both the analog input and the HART input are deactivated as a density input, the system uses the default density value.
3) The connection via the analog input or HART input is described in the chapter titled „Electrical connections“ on page 21.
5) The highest priority of the device is to record the temperature via the analog input, as long as the analog input is activated as a temperature input. If the analog input is not available as a temperature input, the system attempts to record the temperature via the HART input. If both the analog input and the HART input are deactivated as a temperature input, the system uses the default density value.
6) The highest priority of the device is to record the pressure via the analog input, as long as the analog input is activated as a pressure input. If the analog input is not available as a pressure input, the system attempts to record the pressure via the HART input. If both the analog input and the HART input are deactivated as a pressure input, the system uses the default pressure value.
8) The biogas proportion can be determined via the analog input, HART input or default setting. The highest priority of the device is to record the biogas proportion via the analog input, as long as the analog input is activated as a biogas proportion input. If the analog input is not available as a biogas proportion input, the system attempts to record the biogas proportion via the HART input. If both the analog input and the HART input are deactivated as a biogas proportion input, the system uses the default biogas proportion value.
9) In order to implement the "Bio Std/Norm Vol." mode, as a precondition the required parameters from one of the NG2 modes must be available.
10) In order to implement the "Steam Mass" mode with internal density determination, the selection "Calculated from..." must be set in the menu Device Setup / Plant/Customized / Compensation Setting -> Steam Density Selec..
11) In order to implement the "Steam Mass" mode with external density determination, the selection "Ext.-Density" must be set in the menu Device Setup / Plant/Customized / Compensation Setting -> Steam Density Selec..

Operating mode / order code	Description	Additional parameters required	Parameter setting
Steam Power 12) / NS3	Energy flow of the vaporous medium [13)]	Measuring medium temperature at the inflow [1)]	With internal temperature sensor. No information required, the measured value from the temperature sensor is used.
			Default setting for the temperature value: Device Setup / Plant/Customized / Compensation Setting -> Preset Int.Temp
		Measuring medium temperature at the outflow [1)]	Via analog input: Input/Output / Field Input / Analog In Value -> Temperature
			Via HART input: Input/Output / Field Input / Hart In Value -> Temperature
			Default setting for the temperature: Device Setup / Plant/Customized / Compensation Setting -> Preset Ext.Temp
		Operating pressure [3) 6)]	Via analog input: Input/Output / Field Input / Analog In Value -> Pressure
			Via HART input: Input/Output / Field Input / Hart In Value -> Pressure
			Default setting for the pressure value: Device Setup / Plant/Customized / Compensation Setting -> Preset Pressure

1) The highest priority of the device is to record the operating temperature.
2) The highest priority of the device is to record the density via the analog input, as long as the analog input is activated as a density input. If the analog input is not available as a density input, the system attempts to record the density via the HART input. If both the analog input and the HART input are deactivated as a density input, the system uses the default density value.
3) The connection via the analog input or HART input is described in the chapter titled „Electrical connections“ on page 21.
4) In order to implement the "Liquid Power" mode, as a precondition the required parameters from one of the NL3 modes must be available. See chapter „Measuring the energy of liquids“ on page 37.
5) The highest priority of the device is to record the temperature via the analog input, as long as the analog input is activated as a temperature input. If the analog input is not available as a temperature input, the system attempts to record the temperature via the HART input. If both the analog input and the HART input are deactivated as a temperature input, the system uses the default density value.
6) The highest priority of the device is to record the pressure via the analog input, as long as the analog input is activated as a pressure input. If the analog input is not available as a pressure input, the system attempts to record the pressure via the HART input. If both the analog input and the HART input are deactivated as a pressure input, the system uses the default pressure value.
7) If the selection "Gas linear." is set for the menu item Device Setup / Plant/Customized -> Gas Std. Mode, the compression factor is reset to 1.0. See also the chapter titled "Special operating modes" in the operating instruction.
8) The biogas proportion can be determined via the analog input, HART input or default setting. The highest priority of the device is to record the biogas proportion via the analog input, as long as the analog input is activated as a biogas proportion input. If the analog input is not available as a biogas proportion input, the system attempts to record the biogas proportion via the HART input. If both the analog input and the HART input are deactivated as a biogas proportion input, the system uses the default biogas proportion value.
9) In order to implement the "Bio Std/Norm Vol." mode, as a precondition the required parameters from one of the NG2 modes must be available.
10) In order to implement the "Steam Mass" mode with internal density determination, the selection "Calculated from..." must be set in the menu Device Setup / Plant/Customized / Compensation Setting -> Steam Density Selec..
11) In order to implement the "Steam Mass" mode with external density determination, the selection "Ext.-Density" must be set in the menu Device Setup / Plant/Customized / Compensation Setting -> Steam Density Selec..
12) In order to implement the "Steam Power" mode, as a precondition the required parameters from one of the NS2 modes must be available. See chapter „Measuring the energy of steam“ on page 37.
13) Two different properties of steam are supported: saturated steam and overheated steam. The end user can change this in the menu item Device Setup / Plant/Customized / Compensation Setting -> Steam Type.

6.5 Special operating modes

6.5.1 Measuring the energy of steam

Order code N1

The VortexMaster FSV450 and the SwirlMaster FSS450 with option N1 have an extended function for measuring the flow of steam, which is built into the transmitter.

Based on the values of pressure (external diaphragm seal, connected via HART or analog input, or a pre-set pressure value) and temperature (built-in Pt100 resistance thermometer), the transmitter calculates the actual volume flow, the mass flow and the energy flow.

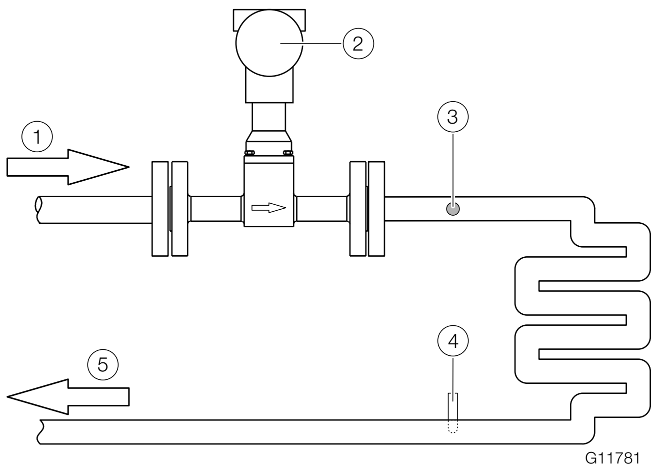


Fig. 30: Measuring the energy of steam

1. **Steam feed flow**
2. **VortexMaster / SwirlMaster with built-in temperature sensor**
3. **Pressure transmitter, via HART or analog input**
4. **Temperature transmitter, via HART or analog input**
5. **Condensate return**

6.5.2 Measuring the energy of liquids

Order code N2

The VortexMaster FSV450 and the SwirlMaster FSS450 with option N2 have an extended function for measuring energy flow for liquids (such as hot water or brine), which is built into the transmitter.

Based on the values for actual volume flow, density, heat capacity of the medium (energy unit / mass flow unit), temperature of the feed flow (built-in Pt100 resistance thermometer) and temperature of the return, the transmitter calculates the actual volume flow and the energy flow.

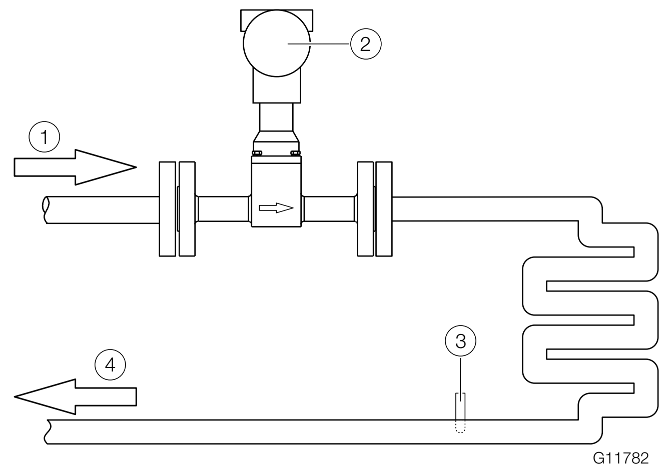


Fig. 31: Measuring the energy of liquids

1. **Feed flow**
2. **VortexMaster / SwirlMaster with built-in temperature sensor**
3. **Temperature transmitter, via HART or analog input**
4. **Return**

7 Operation

7.1 Safety instructions

If there is a chance that safe operation is no longer possible, take the device out of operation and secure it against unintended startup.

7.2 Parameterization of the device

The LCD indicator has capacitive operating buttons. These enable you to control the device through the closed housing cover.

NOTE

The transmitter automatically calibrates the capacitive buttons on a regular basis. If the cover is opened during operation, the sensitivity of the buttons is firstly increased to enable operating errors to occur. The button sensitivity will return to normal during the next automatic calibration.

7.2.1 Menu navigation

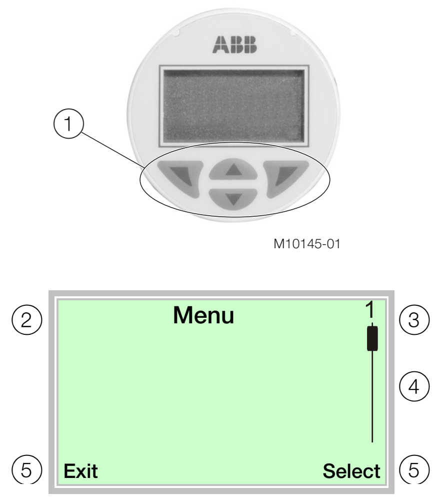


Fig. 32: LCD display

(1) Operating buttons for menu navigation
(2) Menu name display (3) Menu number display
(4) Marking to indicate the relative position within the menu
(5) Display of the current function of the operating buttons and

You can use the or operating buttons to browse through the menu or select a number or character within a parameter value.

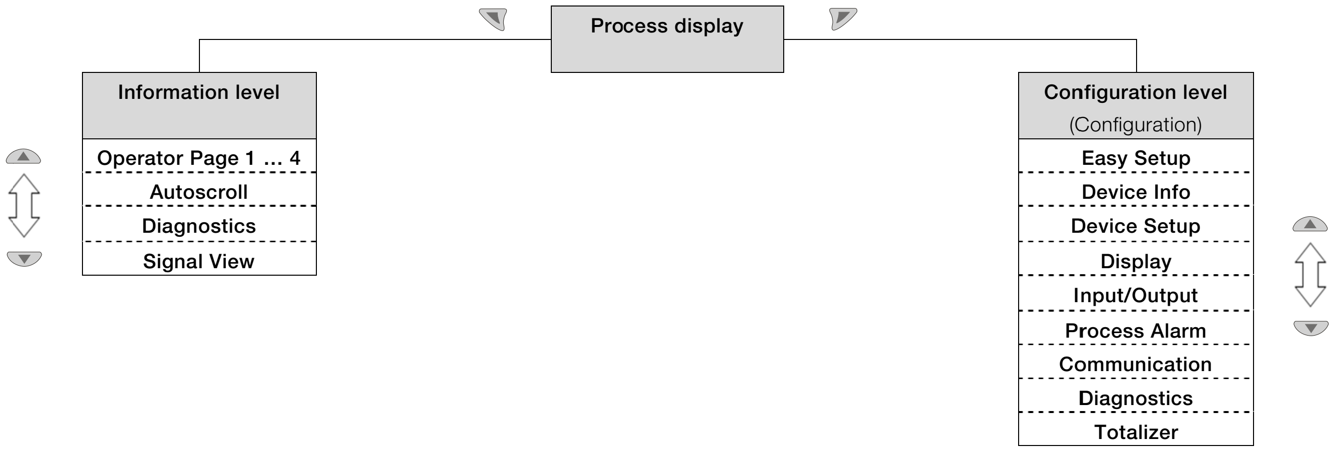
Different functions can be assigned to the and operating buttons. The function that is currently assigned (5) is shown on the LCD display.

Operating button functions

	Meaning
Exit	Exit menu
Back	Go back one submenu
Cancel	Cancel parameter entry
Next	Select the next position for entering numerical and alphanumeric values

	Meaning
Select	Select submenu / parameter
Edit	Edit parameter
OK	Save parameter entered

7.3 Menu levels



Process display

The process display shows the current process values.
There are two menu levels under the process display.

Information level (Operator Menu)

The information level contains the parameters and information that are relevant for the operator.
The device configuration cannot be changed on this level.

Configuration level (Configuration)

The configuration level contains all the parameters required for device commissioning and configuration. The device configuration can be changed on this level. For more detailed information about the parameters, refer to the chapter titled „Parameter descriptions in the operating instruction“ on page 47.

7.3.1 Process display

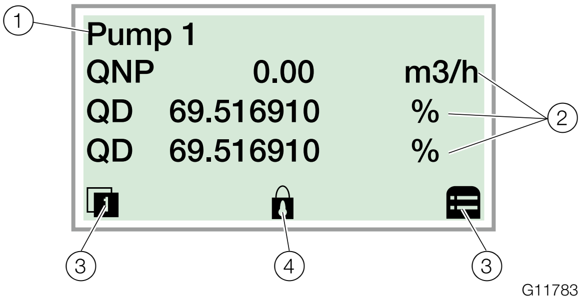


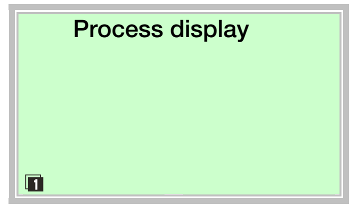
Fig. 33: Process display (example)
(1) Measuring point tagging (2) Current process values
(3) "Button function" symbol
(4) "Parameterization protected" symbol

The process display appears on the LCD display when the device is switched on. It shows information about the device and current process values.
The way in which the current process values are shown can be adjusted on the configuration level.
The symbols at the bottom of the process display are used to indicate the functions of the operating buttons and , in addition to other information.

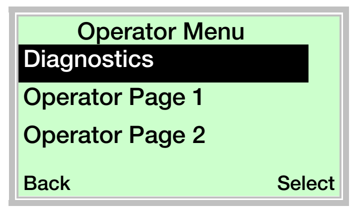
Symbol	Description
/	Call up information level. When Autoscroll mode is activated, the symbol appears here and the operator pages are automatically displayed one after the other.
	Call up configuration level.
	The device is protected against changes to parameterization.

7.3.2 Switching to the information level (operator menu)

On the information level, the operator menu can be used to display diagnostic information and choose which operator pages to display.



1. Open the Operator Menu using .



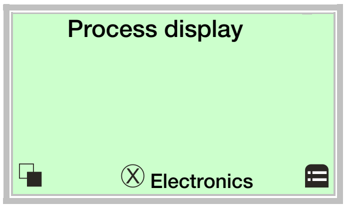
2. Select the desired submenu using / .
3. Confirm the selection with .

Menu	Description
... / Operator Menu	
Diagnostics	Selection of sub-menu "**„Diagnostics**"; see also chapter „Error messages on the LCD display“ on page 41.
Operator Page 1	Selection of operator page to be displayed.
Operator Page 2	
Operator Page 3	
Operator Page 4	
Autoscroll	When Autoscroll is activated, automatic switching of the operator pages is initiated on the process screen.
Signal view	Selection of submenu "**Signal view**" (only for service purposes).

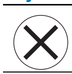
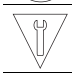
7.3.3 Error messages on the LCD display

In the event of an error, a message consisting of a symbol and text (e.g. Electronics) appears at the bottom of the process screen.

The text displayed provides information about the area in which the error has occurred.



The error messages are divided into four groups in accordance with the NAMUR classification scheme. The group assignment can only be changed using a DTM or EDD:

Symbol	Description
	Error / failure
	Function check
	Outside of the specification
	Maintenance required

The error messages are also divided into the following areas:

Range	Description
Operation	Error / alarm due to the current operating conditions.
Sensor	Error / alarm of the flowmeter sensor.
Electronics	Error / alarm of the electronics.
Configuration	Error / alarm due to device configuration.

IMPORTANT (NOTE)
For a detailed description of errors and information on troubleshooting, refer to the chapter titled "Error messages" in the operating instruction.

7.3.4 Parameter overview

NOTE

This overview of parameters shows all the menus and parameters available on the device. Depending on the version and configuration of the device, not all of the menus and parameters may be visible in it.

The various operating modes have different menu displays. In this overview, the menus that are displayed only in certain operating modes are marked with numbers. The numbers represent the operating modes as follows:

Operation modes	
1) Liquid Mass	8) Bio Act. Volume
2) Liquid Volume	9) Liquid Power
3) Gas Mass	10) Gas Act. Volume
4) Steam Mass	11) Gas Power
5) Gas Std/Norm Vol.	12) Steam Act. Volume
6) Bio Std/Norm Vol.	13) Steam Power
7) Liquid Std/Norm Vol.	

Easy Setup

- Language
- Active Mode
- Current Output
- DO Function
- Pulses Per Unit
- Pulse Width
- Lower Freqency
- Upper Freqency
- Logic on DO
- Unit Qv
- Unit Qm 1) 3) 4)
- Unit Qnv
- Unit Qpower
- Unit Density 1) 3) 4)
- Unit Temperature
- Unit Pressure 3) 4) 5) 6)
- Unit Volume
- Unit Mass
- Unit Std/Norm Vol.
- Unit Energy
- Hart In Value
- Analog In Value
- T Ext. Upper Range 1) 4) 5) 6) 7)
- T Ext. Lower Range 1) 3) 4) 5) 6) 7)
- Pressure Upper Range
- Pressure Lower Range
- P(abs) Upper Range
- P(abs) Lower Range
- Density Upper Range
- Density Lower Range
- Gas% Upper Range
- Gas% Lower Range

Continued on next page

- Continued
- Ext.Cutoff Trigger
- Liquid Mass Corr.
- Volume Exp.Coef. 1) 7)
- Density Exp.Coef. 1) 7)
- Heat Capacity
- Gas Density Selec.
- Gas Ref. Conditions 3) 5) 6)
- Gas Std. Mode
- Gas Energy Density
- Steam Type 4)
- Steam Density Selec.
- Ref. Density 1) 3)
- Preset Density 1) 3) 4)
- Ref. Temperature 1) 3) 6) 7)
- Preset Int.Temp 1) 3) 4) 5) 7)
- Preset Ext.Temp
- Preset Pressure 3) 4) 5) 6)
- Preset Gas Content
- Qvmax
- QnMax 3) 5) 6) 7)
- QvpMax 6) 8)
- QnpMax 6)
- QmMax 3) 4)
- QpowerMax
- Damping Qv
- Damping Qn 1) 3) 5) 6) 7)
- Damping Qvp 6) 8)
- Damping Qnp 6)
- Damping Qm 3) 4)
- Damping Qpower
- Temp->I=0%
- Damping Temperature
- Iout at Alarm
- Low Alarm Value
- High Alarm Value
- Auto Zero
- Low Flow Cutoff

Device Info

...Sensor

- Sensor Type
- Meter(V) Size
- QvMaxDN
- QvpMaxDN 6) 8)
- QmMaxDN 1) 3) 4)
- QnMaxDN 5) 6) 7)
- QnpMaxDN 6)
- QpowerMaxDN
- Sensor ID
- SAP/ERP No.
- Sensor Run Hours

...Calibration

- Cal. Date
- Cal. Cert. No.
- Cal. Location

- **...Transmitter**
  - Transmitter Type
  - Transmitter ID
  - SAP/ERP No.
  - **...Transmitter Version**
    - Transmitter Firmware Version
    - Transmitter Hardware Version
    - Frontend Firmware Version
    - Frontend Hardware Version
    - Bootloader Version
  - Transmitter Run Hours
  - **...Calibration**
    - Cal. Date
    - Cal. Cert. No.
    - Cal. Location
  - Manufacturer
  - Street
  - City
  - Phone

- **Device Setup**
  - **...Access Control**
    - Standard Password
    - Read Only Switch
  - **...Sensor**
    - QvMaxDN
    - QvpMaxDN 8)
    - QmMaxDN 1) 3) 4)
    - QnMaxDN 3) 5) 6) 7)
    - QnpMaxDN 6)
    - QpowerMaxDN
    - Qvmax
    - QvpMax 6) 8)
    - QmMax 1) 3) 4)
    - QnMax 3) 5) 6) 7)
    - QnpMax 6)
    - QpowerMax
    - Sensor Location Tag
    - Sensor TAG
  - **...Transmitter**
    - **...Units**
      - Unit Qv
      - Unit Qm 1) 3) 4)
      - Unit Qnv 3) 5) 6) 7)
      - Unit Qpower
      - Unit Density
      - Unit Temperature
      - Unit Pressure 3) 4) 5) 6)
      - Unit Volume
      - Unit Mass 1) 3) 4)
      - Unit Std/Norm Vol. 3) 5) 6) 7)
      - Unit Energy
    - Damping Qv 1)
    - Damping Qvp
    - Damping Qm
    - Damping Qn
    - Damping Qnp
    - Damping Qpower
    - Damping Temperature
    - Low Flow Cutoff

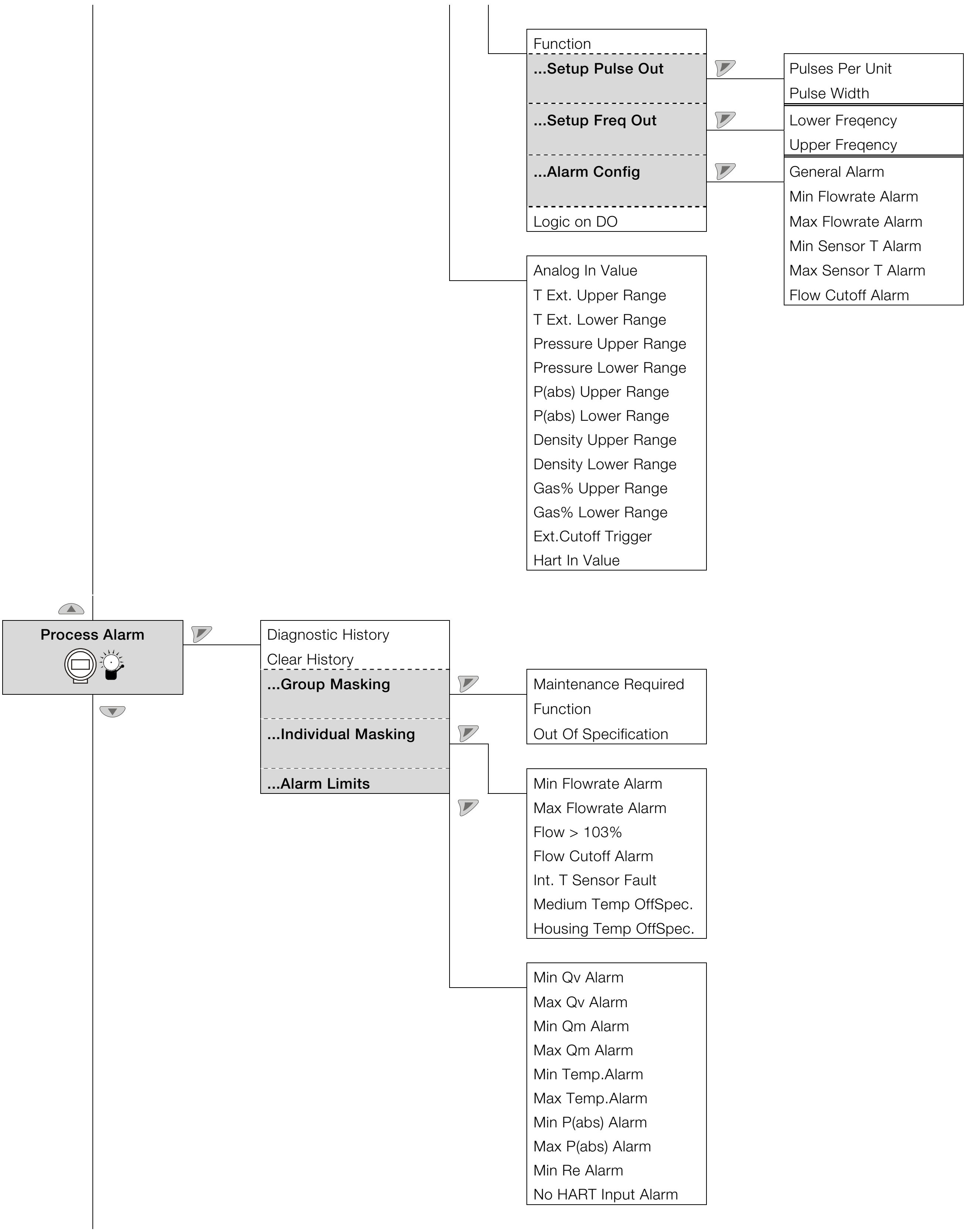
- **...Plant/Customized**
  - Active Mode
  - **...Compensation Setting**
    - Liquid Mass Corr. [1]
    - Volume Exp.Coef. [1] [7]
    - Density Exp.Coef. [1]
    - Heat Capacity
    - Gas Density Selec.
    - Gas Ref. Conditions [3] [5] [6]
    - Gas Std. Mode [3] [5] [6]
    - Gas Energy Density
    - Steam Type [4]
    - Steam Density Selec. [3]
    - Ref. Density [1] [3]
    - Preset Density [1] [3] [4]
    - Ref. Temperature [1] [3] [7]
    - Preset Int.Temp [1] [3] [4] [5] [6] [7]
    - Preset Ext.Temp
    - Preset Pressure [3] [4] [5] [6]
    - Preset Gas Content [6] [8]
    - Dynamic Viscosity
  - **...Field optimization**
    - Temperature Offset [1] [3] [4] [5] [6] [7]
    - Auto Zero

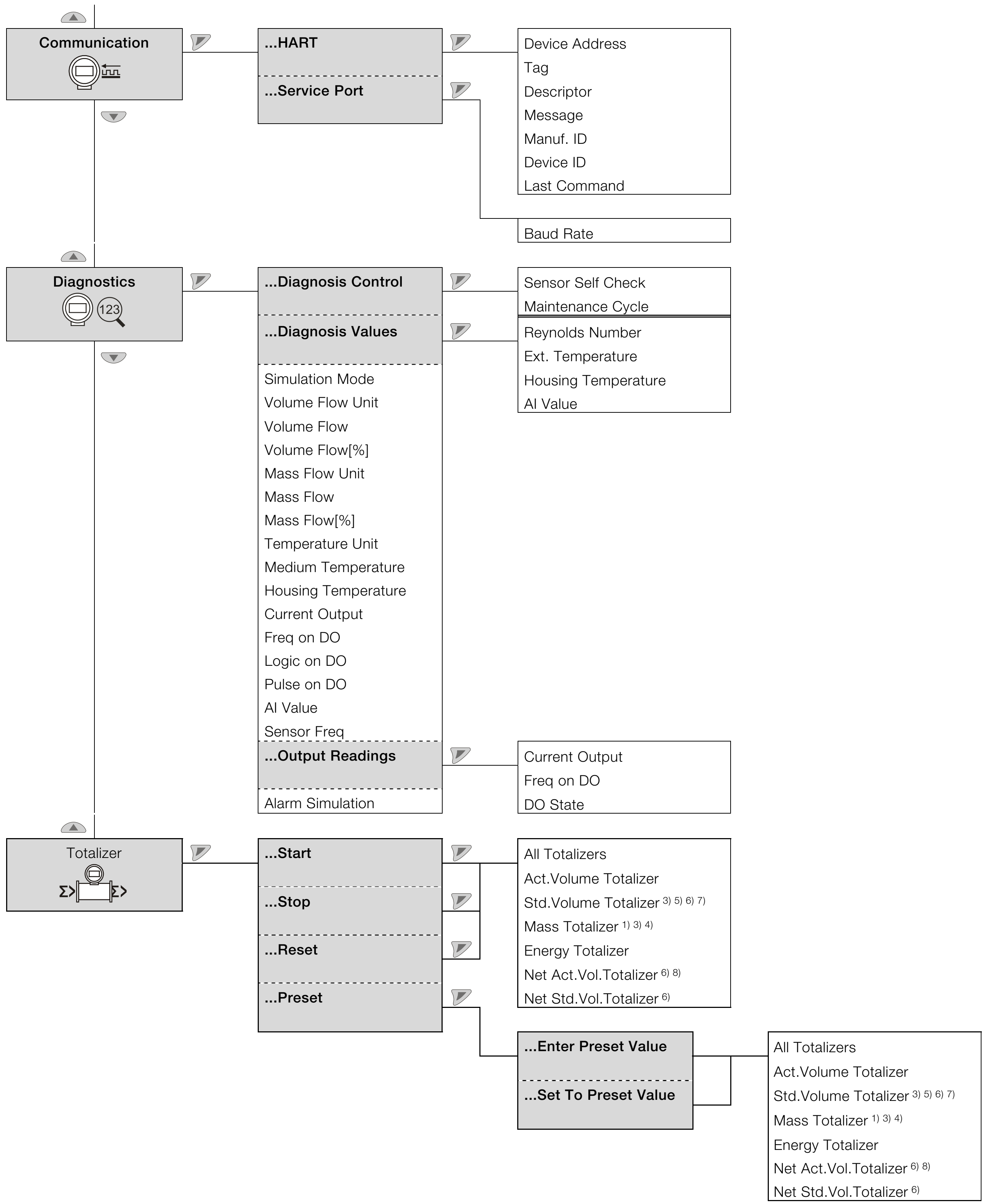
Display

- Language
- Contrast
- **...Operator Pages**
  - **...Operator Page 1**
  - **...Operator Page 2**
  - **...Operator Page 3**
  - **...Operator Page 4**
    - Display Mode
    - 1st Line
    - 2nd Line
    - 3rd Line
    - Bargraph
- Autoscroll
- Flowrate Format
- Totalizer Format
- Date/Time Format
- Display Test

Input/Output

- **...Current Output**
  - Output Value
  - Qv->I=100% [8]
  - Qvp->I=100% [5] [7]
  - Qn->I=100% [6]
  - Qnp->I=100% [1] [3] [4]
  - Qm->I=100%
  - Qpower->I=100%
  - Temp->I=100%
  - Temp->I=0%
  - Iout at Alarm
  - Low Alarm Value
  - High Alarm Value
  - Iout at Flow>103%
- **...DO Function**
- **...Field Input**


Function
...Setup Pulse Out
...Setup Freq Out
...Alarm Config
Logic on DO
Pulses Per Unit
Pulse Width
Lower Freqency
Upper Freqency
General Alarm
Min Flowrate Alarm
Max Flowrate Alarm
Min Sensor T Alarm
Max Sensor T Alarm
Flow Cutoff Alarm
Analog In Value
T Ext. Upper Range
T Ext. Lower Range
Pressure Upper Range
Pressure Lower Range
P(abs) Upper Range
P(abs) Lower Range
Density Upper Range
Density Lower Range
Gas% Upper Range
Gas% Lower Range
Ext.Cutoff Trigger
Hart In Value
Process Alarm
Diagnostic History
Clear History
...Group Masking
...Individual Masking
...Alarm Limits
Maintenance Required
Function
Out Of Specification
Min Flowrate Alarm
Max Flowrate Alarm
Flow > 103%
Flow Cutoff Alarm
Int. T Sensor Fault
Medium Temp OffSpec.
Housing Temp OffSpec.
Min Qv Alarm
Max Qv Alarm
Min Qm Alarm
Max Qm Alarm
Min Temp.Alarm
Max Temp.Alarm
Min P(abs) Alarm
Max P(abs) Alarm
Min Re Alarm
No HART Input Alarm



Trademarks

® HART is a registered trademark of the HART Communication Foundation

® Kalrez and Kalrez Spectrum™ are registered trademarks of DuPont Performance Elastomers.

™ Hastelloy C is a trademark of Haynes International

8 Appendix

8.1 Declarations of conformity

ABB

CE

EG-Konformitätserklärung
EC Declaration of Conformity

Hiermit bestätigen wir die Übereinstimmung der aufgeführten Geräte mit den Richtlinien des Rates der Europäischen Gemeinschaft, welche mit dem CE-Zeichen gekennzeichnet sind. Die Sicherheits- und Installationshinweise der Produktdokumentation sind zu beachten.

We herewith confirm that the listed devices are in compliance with the council directives of the European Community and are marked with the CE marking. The safety and installation requirements of the product documentation must be observed.

Hersteller: *Manufacturer:*	ABB Automation Products GmbH, Dransfelder Straße 2, 37079 Göttingen - Germany
Gerät: *Device:*	Durchflussmesser VortexMaster und SwirlMaster *Flowmeter VortexMaster and SwirlMaster*
Modelle.: *Models:*	FSV4_ ; FSS4_ ; FST4_
Richtlinie: *Directive:*	2004/108/EG * (EMV) *2004/108/EC * (EMC)*
Europäische Norm: *European Standard:*	EN 61326-1, 07/2013 * EN 61326-2-3, 07/2013 *EN 61326-1, 07/2013 * EN 61326-2-3, 07/2013*

* einschließlich Nachträge / *including alterations*

Göttingen, 11. September 2014

i.V. Klaus Schäfer
(IMS Manager)

i.V. Dr. Philipp Nenninger
(R&D Manager)

ABB Automation Products GmbH

3KXF002003G0021
Rev.01. 27763

EG-Konformitätserklärung
EC-Declaration of Conformity

0044

Hiermit bestätigen wir die Übereinstimmung des
Herewith we confirm that our

FSV 430 / 450 VortexMaster
FSS 430 / 450 SwirlMaster

mit den grundlegenden Sicherheits- und Gesundheitsanforderungen gem. der Richtlinie 94/9/EG des Rates der Europäischen Gemeinschaft. Die Sicherheits- und Installationshinweise der Produktdokumentation sind zu beachten.
are in compliance with the Essential Health and Safety Requirements with refer to the council directives 94/9/EC of the European Community. The safety and installation requirements of the product documentation must be observed.

Vortx/SwirlMaster Durchflussmesser dienen zur Messung des Durchflusses von Gasen, Dämpfen oder Flüssigkeiten.
Vortex/SwirlMaster flowmeters are utilized to meter the flowrate of gases, steam or liquids.

Zulassung und Kennzeichnung *Approval and Coding*	**Normen** *Standards*
FM13ATEX0057X ***FSV/ FSS 430 and 450 SwirlMaster*** II 2/1 G Ex d ia IIC T6 Gb/Ga Ta = -40°C to +75°C; IP66/67 II 2 D Ex tb IIIC T85°C Db Ta = -40°C to +75°C; IP66/67	EN 60079-0:2012 EN 60079-1:2007 EN 60079-11:2012 EN 60079-31:2009 EN 60529:1991 + A1:2000
FM13ATEX0055X ***FSV430 / 450 VortexMaster and FSS430 / 450 SwirlMaster*** II 1 G Ex ia IIC T6...T4 Ta = -40 °C to * IP66/67 II 1 D Ex ia IIIC T85°C Ta = -40 °C to * IP66/67 * see Description	EN 60079-0:2012 EN 60079-11:2012 EN 60529:1991 + A1:2000
FM13ATEX0056X ***FSV430 / 450 VortexMaster and FSS430 / 450 SwirlMaster*** II 3 G Ex nA IIC T6...T4 Gc Ta = -40°C to * II 3 D Ex tc IIIC T85°C Dc Ta = -40°C to 75°C *see Description	EN 60079-0:2012 EN 60079-15:2010 EN 60079-31:2009 EN 60529:1991 + A1:2000

Benannte Stelle: FM Approvals, No. 1725
Notified Body:

Sicherheitstechnische Daten: siehe EG-Baumusterprüfbescheinigung, Baumusterprüfbescheinigung, Betriebsanleitung

Safety values: *refer to EC-Type Examination Certificate, Type Examination Certificate, Operating Instruction*

Göttingen, 19.11.2014

i.V. Klaus Schäfer
(IMS Manager)

i.V. Dr. Philipp Nenninger
(R&D Manager)

3KXF002003G0026 Rev.01

EG-Konformitätserklärung
EC-Declaration of Conformity

0045

Hiermit bestätigen wir die Übereinstimmung des aufgeführten Gerätes mit den Richtlinien des Rates der Europäischen Gemeinschaft, welche mit dem CE-Zeichen gekennzeichnet sind. Die Sicherheits- und Installationshinweise der Produktdokumentation sind zu beachten.
Herewith we confirm that the listed instrument is in compliance with the council directives of the European Community and are marked with the CE marking. The safety and installation requirements of the product documentation must be observed.

Hersteller: *manufacturer:*	ABB Automation Products GmbH, 37079 Göttingen - Germany
Modell: *model:*	Dralldurchflussmesser FS4000 / FSS4.. *Swirl Flowmeter FS4000 / FSS4..*
Richtlinie: *directive:*	Druckgeräterichtlinie 97/23/EG *pressure equipment directive 97/23/EC*
Einstufung: *classification:*	Ausrüstungsteile von Rohrleitungen *piping accessories*
Normengrundlage: *technical standard:*	AD 2000 Merkblätter (2012) + DIN EN 12516 – 2 (2004)
Konformitätsbewertungsverfahren: *conformity assessment procedure:*	B (EG-Baumusterprüfung) + D (Qualitätssicherung Produktion) *B (EC-type-examination) + D (production quality assurance)*
EG-Baumusterprüfbescheinigung: Entwurfsprüfbericht: *EC type-examination certificates:* *Design-examination report:*	Nr. 1045 Z 0051/2/D0004 Nr. STK3 P 0356 3 01 *No. 1045 Z 0051/2/D0004* *No. STK3 P 0356 3 01*
benannte Stelle: *notified body:*	TÜV Nord Systems GmbH & Co. KG Große Bahnstr. 31 22525 Hamburg
Kennnummer: *identification no.*	0045

Göttingen, den 17.03.2014

ppa ....

(Volker Heine, Werksleiter / Site Manager)

BZ-11-0026 Rev.02 / 27111

EG-Konformitätserklärung
EC-Declaration of Conformity

0045

Hiermit bestätigen wir die Übereinstimmung des aufgeführten Gerätes mit den Richtlinien des Rates der Europäischen Gemeinschaft, welche mit dem CE-Zeichen gekennzeichnet sind. Die Sicherheits- und Installationshinweise der Produktdokumentation sind zu beachten.
Herewith we confirm that the listed instrument is in compliance with the council directives of the European Community and are marked with the CE marking. The safety and installation requirements of the product documentation must be observed.

Hersteller: *manufacturer:*	ABB Automation Products GmbH, 37079 Göttingen - Germany
Modell: *model:*	Wirbeldurchflussmesser FV4000 / FSV4.. *Vortex Flowmeter FV4000 / FSV4..*
Richtlinie: *directive:*	Druckgeräterichtlinie 97/23/EG *pressure equipment directive 97/23/EC*
Einstufung: *classification:*	Ausrüstungsteile von Rohrleitungen *piping accessories*
Normengrundlage: *technical standard:*	AD 2000 Merkblätter (2012) + DIN EN 12516 – 2 (2004)
Konformitätsbewertungsverfahren: *conformity assessment procedure:*	B (EG-Baumusterprüfung) + D (Qualitätssicherung Produktion) *B (EC-type-examination) + D (production quality assurance)*
EG-Baumusterprüfbescheinigung: Entwurfsprüfbericht: *EC type-examination certificates:* *Design-examination report:*	Nr. 1045 Z 0050/2/D0004 Nr. STK3 P 0008 4 01 *No. 1045 Z 0050/2/D0004* *No. STK3 P 0008 4 01*
benannte Stelle: *notified body:*	TÜV Nord Systems GmbH & Co. KG Große Bahnstr. 31 22525 Hamburg
Kennnummer: *identification no.*	0045

Göttingen, den 17.03.2014

ppa ....
(Volker Heine, Werksleiter / Site Manager)

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Translation of the original instruction

CI/FSS/FSV430/450-EN Rev. D 02.2015

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