Data Sheet DS/FSS430/450-EN Rev. B

SwirlMaster FSS430, FSS450
Swirl flowmeter

Two-wire swirl flowmeter for measurement of the flow of gas, vapor and liquid

Measurement made easy

Easy assembly
- Only the shortest possible straight pipe lengths are required before and after the flowmeter.
- The measuring ranges have been well adapted to the flow rates common in piping systems today.

Intuitive operation
- "Easy Set-up" function
- Clear text display
- Meter configuration through the front glass with closed cover
- Meter diagnosis with help texts in the display

Approvals for explosion protection
- ATEX
- IECEx
- cFMus
- NEPSI

Optional binary output for use as a limit switch, pulse output or frequency output

Optional analog input for connecting external pressure and temperature transmitters or gas analyzers

Integrated flow measurement computer functionality
- Gas standard volume and mass flow
- Vapor mass flow
- Direct energy calculation for vapor and water
- Natural gas calculation in accordance with AGA / SGERG standards

SwirlMaster FSS430, FSS450
Swirl flowmeter

Overview – models

Fig. 1: FSS430 / FSS450
(1) Integral mount design (2) Remote mount design with transmitter (3) Remote mount design with double sensor

Sensor		
Model number	**FSS430**	**FSS450**
Design	Integral mount design, remote mount design	
IP degree of protection in accordance with EN 60529	IP 66 / 67, NEMA 4X	
Measuring accuracy for liquids [1]	≤ ±0.5 % under reference conditions	
Measuring accuracy for gases and vapors [1]	≤ ±0.5 % under reference conditions	
Repeatability [1]	DN 15 ≤ ±0.3 %, from DN 20 ≤ ±0.2 %	
Permissible viscosity for fluids	DN 15 ... 32 ≤ 5 mPa s, DN 40 ... 50 ≤ 10 mPa s, from DN 80 ≤ 30 mPa s	
Measuring span (typical)	1:25	
Process connections	Flange DN 15 .. 400 (0.5" ... 16")	Flange DN 15 .. 400 (0.5" ... 16")
Inlet / outlet sections (typical)	Inlet section: 3 x DN, outlet section 1 x DN, see also chapter „Inlet and outlet sections“ on page 9.	
Temperature measurement	Resistance thermometer Pt100 class A optional, installed in Piezo sensor, can be retrofitted	Resistance thermometer Pt100 class A standard, fixed installation in Piezo sensor
Permissible measuring medium temperature	-55 ... 280 °C (-67 ... 536 °F)	-55 ... 280 °C (-67 ... 536 °F)
Wetted material		
— Sensor	Stainless steel, optional Hastelloy C-276 / titanium	
— Inlet / outlet pipes	Stainless steel, optional Hastelloy C-276	
— Gasket	PTFE, optional Kalrez or graphite	
— Sensor housing	Stainless steel, optional Hastelloy C-276	
Sensor design	Piezo sensor with two pairs of sensors for flow measurement and vibration compensation	
Approvals for explosion protection	ATEX / IECEx, cFMus, NEPSI	

1) Indication of accuracy in % of the measured value (% of measured value)

Transmitter		
Model number	**FSS430**	**FSS450**
Display	Optional LCD indicator with 4 push buttons for operation through front glass (option)	Standard LCD indicator with 4 push buttons for operation through front glass
Digital output	Optional, can be configured as pulse output, frequency output, or alarm output via software	Standard, can be configured as pulse output, frequency output, or alarm output via software
Inputs for external sensors	— HART input (HART burst mode) for external pressure transmitter or temperature transmitter	— Analog input 4 ... 20 mA for external pressure transmitters- / temperature transmitter or gas analyzer — HART input (HART burst mode) for external pressure transmitter- / temperature transmitter or gas analyzer
Current output, communication	4 ... 20 mA, HART protocol (HART 7)	
Power supply	12 ... 42 V DC, for devices in explosion-proof design, see chapter „Use in potentially explosive atmospheres“ on page 19.	
SensorMemory	Saves sensor and process parameters for easy commissioning after transmitter replacement	
Housing material	— Aluminum (copper content < 0.3 %), component epoxy coating — Optional: stainless steel CF3M, corresponds to AISI 316L	
IP degree of protection in accordance with EN 60529	IP 66 / 67, NEMA 4X	

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Swirl flowmeter

Model variants

FSS430

Swirl flowmeter for vapor, liquid and gas, with optional graphical display, optional binary output and optional integrated temperature measurement.

FSS450

Swirl flowmeter for vapor, liquid, and gas, with integrated digital output, temperature compensation and flow computer functionality.
The device offers the option of directly connecting external temperature transmitters, pressure transmitters, or gas analyzers.

Measuring principle

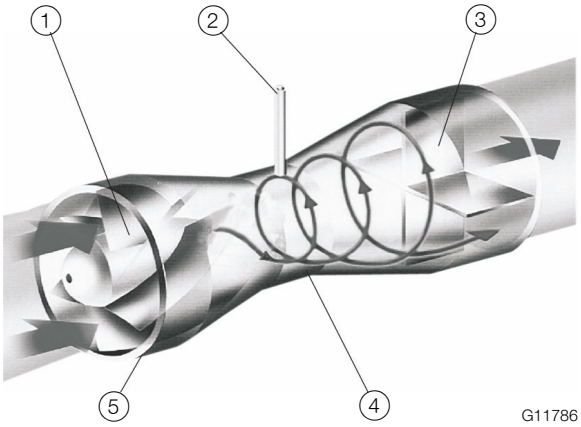

Fig. 2: Measuring principle
(1) Inlet pipe (2) Piezo sensor (3) Outlet pipe
(4) Housing (5) Stagnation point

The inlet pipe converts the axial flow of the incoming measuring medium into rotational movement. In the center of this rotation a vortex core is formed which is forced into a secondary spiral-shaped rotation by the backflow.

The frequency of this secondary rotation is proportional to the flow and, if the internal geometry of the meter measuring device exhibits an optimum design, will be linear over a wide measuring range.
This frequency is measured by a Piezo sensor. The frequency signal from the flowmeter sensor, which is proportional to the flow, undergoes downstream processing in the transmitter.

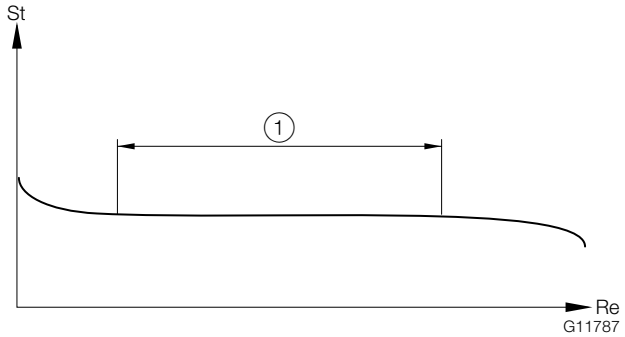

Fig. 3: Dependency of the Strouhal number on the Reynolds number
(1) Linear flow area

Due to the dimensions of the inlet pipe and the inner geometry, the Strouhal number (St) is constant over a very wide range of the Reynolds number (Re).

General data

Nominal diameter selection

The nominal diameter is selected on the basis of the maximum operating flow Qv max. If maximum [measuring] spans are to be achieved, this should not be less than half the maximum flow rate for each nominal diameter (QvmaxDN), although reduction to approx. 0.15 QvmaxDN is possible.
The linear lower range value is dependent on the Reynolds number (see chapter „Measured error and repeatability“ on page 6).

If the flow to be measured is present as a standard flow (standard status: 0 °C (32 °F), 1013 mbar) or mass flow, it must be converted into an operating flow and, from the measuring range tables (see chapter „Measuring range table“ on page 7), the most suited device nominal diameter must be selected.

Formula elements used	
ρ	Operating densities (kg/m^3)
ρ_N	Standard density (kg/m^3)
P	operating pressure (bar)
T	operating temperature (°C)
Q_v	Operating flow (m^3/h)
Q_n	Standard flow (m^3/h)
Q_m	mass flowrate (kg/h)
η	dynamic viscosity (Pas)
ν	Kinematic viscosity (m^2/s)

Conversion of standard density to operating density

$$\rho = \rho_n \times \frac{1{,}013 + \rho}{1{,}013} \times \frac{273}{273 + T}$$

Conversion to operating flow

1. From standard flow (Q_n)

$$Q_V = Q_n \frac{\rho_n}{\rho} = Q_n \frac{1{,}013}{1{,}013 + \rho} \times \frac{273 + T}{273}$$

2. From mass flow (Q_m)

$$Q_V = \frac{Q_m}{\rho}$$

Conversion of dynamic viscosity --> kinematic viscosity

$$\nu = \frac{\eta}{\rho}$$

Calculation of the Reynolds number

$$\mathrm{Re} = \frac{Q}{(2827 \cdot \nu \cdot d)}$$

Q Flow in m3/h
d Pipe diameter in m
ν kinematic viscosity (m^2/s)

The current Reynolds number can also be calculated using the ABB Product Selection Assistant (PSA tool).

Measuring accuracy
Reference conditions

Flow measurement	
Set flow range	0.5 ... 1 x Q_{vmax}DN
Ambient temperature	20 °C (68 °F) ±2 K
Relative humidity	65 %, ±5 %
Air pressure	86 ... 106 kPa
Power supply	24 V DC
Signal cable length (for remote mount design)	30 m (98 ft)
Current output load	250 Ω (only 4 ... 20 mA)
Measuring medium for calibration	Water, approx. 20 °C (68 °F), 2 bar (29 psi)
Calibration loop internal diameter	= internal diameter of meter
Unobstructed straight upstream section	3 x DN
Downstream section	1 x DN
Pressure measurement	3 x DN ... 5 x DN downstream of the flowmeter
Temperature measurement	2 x DN ... 3 x DN downstream after the pressure measurement

Measured error and repeatability

Flow measurement

Measured error in percentage terms from the measured value under reference conditions (including the transmitter) in the linear measuring range between R_{emin} and Q_{max} (see the chapter „Measuring range table“ on page 7).

Measured error (including transmitter)	
Fluids	≤ ± 0.5 %
Gases / Steam	≤ ± 0.5 %
Current output	Additional measuring error < 0.1 %
Temperature effect	< 0.05 % / 10 K

A pipe offset in the inlet or outlet can influence the measured error.
Additional measured errors may occur if there are deviations from the reference conditions.

Reproducibility	
DN 15 (1/2")	0.3 %
DN 25 ... 150 (1 ... 6")	0.2 %
DN 200 ... 400 (8 ... 12")	0.2 %

Temperature measurement

Measured error (including transmitter): ±1 K
Repeatability: ≤ 0.2 % of measured value.

Permitted pipe vibration

The values specified for acceleration g are intended as guide values.
The actual limits will depend on the nominal diameter and the measuring range within the entire [measuring span] and the frequency of the pipe vibration. Therefore, the acceleration value g has only limited meaning.

- Maximum acceleration 20 m/s, 2, 0 ... 150 Hz.
- Acceleration up to 1 g (10 ... 500 Hz) in accordance with IEC 60068-2-6

Ambient conditions

Ambient temperature

In accordance with IEC 60068-2-78

Explosion protection design	$T_{amb.}$
No explosion protection	-40 ... 85 °C (-40 ... 185 °F)
Ex ia, Ex nA	Ex ia and Ex nA: -40 °C < Ta < +85 °C, dependent on Tclass
Ex d, ia, XP	-40 ... 75 °C (-40 ... 167 °F)
IS, NI	-40 ... 75 °C (-40 ... 167 °F)

Relative humidity

Version	Relative humidity
Standard	Maximum 85 %, annual average ≤ 65 %

Measuring medium temperature range

T_{medium}: -55 ... 280 °C (-67 ... 536 °F)

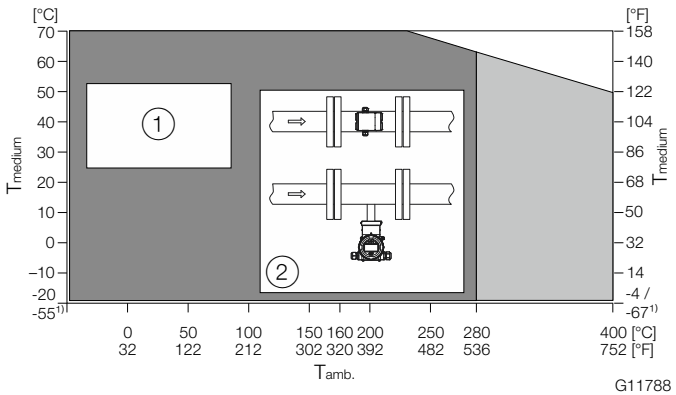

Fig. 4: Measuring medium temperature T_{medium} dependent on the ambient temperature $T_{amb.}$

(1) Permitted temperature range for standard design

(2) Installation for measuring medium temperatures > 150 °C (> 302 °F)

Measuring range table

Flow measurement for liquids

Nominal Diameter	Minimum Reynolds number		Q_{max}DN[3]		Frequency for Q_{max}[4]
	Re1[1]	Re2[2]	[m3/h]	[Usgpm]	[Hz, ±5 %]
DN 15 (1/2")	2100	5000	2.5	11	297
DN 20 (3/4")	3130	5000	4	18	194
DN 25 (1")	5000	7500	8	35	183
DN 32 (1 3/4")	6900	7500	16	70	150
DN 40 (1 1/2")	8400	10000	20	88	116
DN 50 (2")	6000	10000	30	132	100
DN 80 (3")	9000	10000	120	528	89
DN 100 (4")	17500	18000	180	793	80
DN 150 (6")	28500	28500	400	1760	51
DN 200 (8")	30300	30300	700	3082	37
DN 300 (12")	114000	114000	1,600	7045	24
DN 400 (16")	163000	163000	2,500	11000	19

1) Minimum Reynolds number from which the function takes effect. For the precise flowmeter dimensions, use the PSA selection and design tool.
2) Minimum Reynolds number from which the specified accuracy is achieved. Below this value, the measuring error is 0.5 % of Q_{max}.
3) Medium velocity approx. 10 m/s (33 ft/s).
4) For information only, precise values can be found in the test log delivered with the device.

Flow measurement of gases and vapors

Nominal Diameter	Minimum Reynolds number		Q_{max}DN[3]		Frequency for Q_{max}[4]
	Re1[1]	Re2[2]	[m3/h]	[ft3/min]	[Hz, ±5 %]
DN 15 (1/2")	2360	5000	20	12	2380
DN 20 (3/4")	3510	5000	44	26	2140
DN 25 (1")	4150	5000	90	53	2060
DN 32 (1 3/4")	3650	5000	230	135	2150
DN 40 (1 1/2")	6000	7500	300	177	1740
DN 50 (2")	7650	10000	440	259	1450
DN 80 (3")	16950	17000	1160	683	860
DN 100 (4")	11100	12000	1725	1015	766
DN 150 (6")	23300	24000	3800	2237	510
DN 200 (8")	18400	20000	5800	3414	340
DN 300 (12")	31600	32000	13600	8005	225
DN 400 (16")	33500	34000	21500	12655	180

1) Minimum Reynolds number from which the function takes effect. For the precise flowmeter dimensions, use the PSA selection and design tool.
2) Minimum Reynolds number from which the specified accuracy is achieved. Below this value, the measuring error is 0.5 % of Q_{max}.
3) Medium velocity approx. 90 m/s (295 ft/s). For devices with nominal diameter DN 15 (1/2"), the maximum medium velocity is 60 m/s (180 ft/s).
4) For information only, precise values can be found in the test log delivered with the device.

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Process connections

Nominal Diameter	Pressure rating
DN 15 ... 200 (1/2" ... 8")	Flange in accordance with DIN: PN 10 ... 40[1)] Flange in accordance with ASME: class 150 / 300[1)]
DN 300 ... 400 (12" ... 16")	Flange in accordance with DIN: PN 10 ... 16[1)] Flange according to ASME: class 150[1)]

1) Higher pressure ratings up to PN 160 / class 900 on request

Materials

Materials for the sensor

Wetted components	Temperature range
Meter tube / conduit body: — Stainless steel 1.4571 (AISI 316 Ti) / AISI 316L / CF8 / CF8C — Hastelloy C-276 (optional)	—
Sensor: — Stainless steel 1.4571 (AISI 316 Ti) — Hastelloy C-276 (optional)	—
Sensor gasket:[1)]	
— PTFE O-ring	-55 ... 260 °C (-67 ... 500 °F)
— Kalrez 6375 O-ring (optional)	-20 ... 275 °C (-4 ... 527 °F)
— Graphite (optional for high-temperature design)	-55 ... 280 °C (-67 ... 536 °F)

Housing	Temperature range
— Stainless steel 1.4571 (AISI 316 Ti) / AISI 316L / CF8 / CF8C — Hastelloy C-276 (optional)	-55 ... 280 °C (-67 ... 536 °F)

1) Other designs on request.

Transmitter

Housing	Temperature range
— Die-cast aluminum, copper content < 0.3 % — Stainless steel CF3M, corresponds to AISI 316L (optional)	-55 ... 85 °C (-67 ... 185 °F)

Material load for process connections

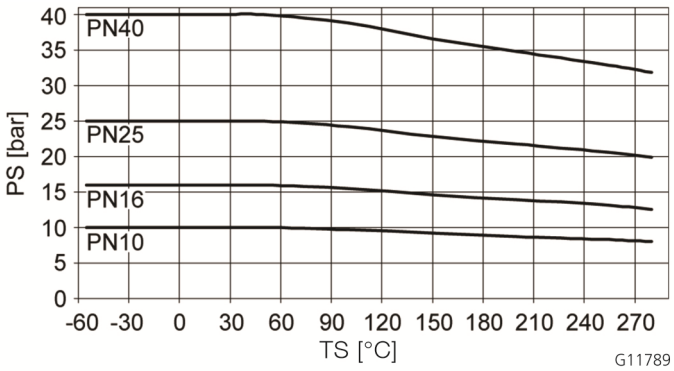

Fig. 5: DIN flange process connection

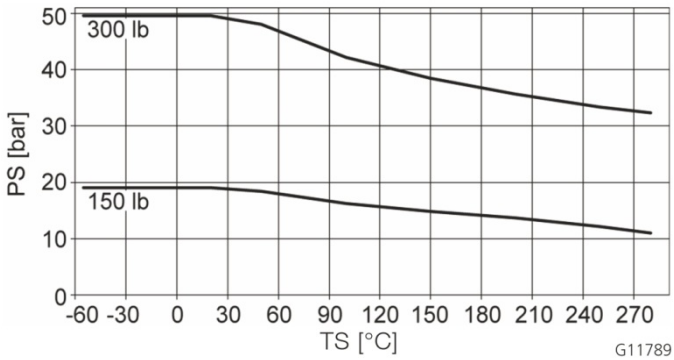

Fig. 6: ASME flange process connection

Installation conditions

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.

Inlet and outlet sections

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.

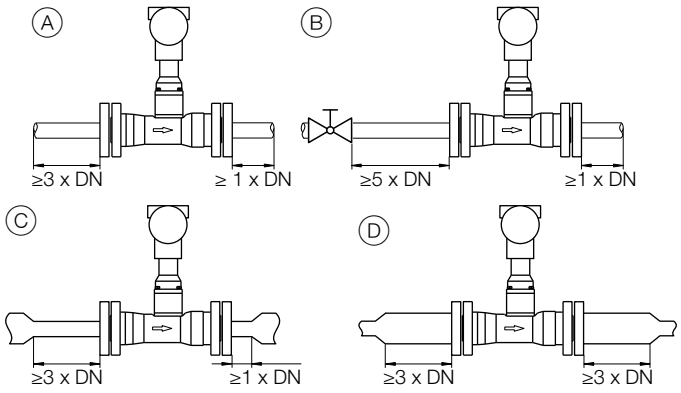

Fig. 7: Straight pipe sections

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°).

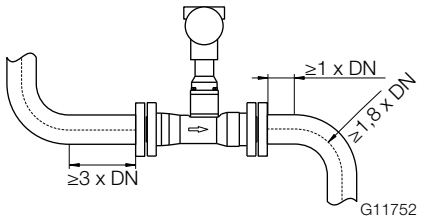

Fig. 8: Pipe sections with pipe elbows

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.

Avoiding cavitation

To avoid cavitation, a static overpressure is required downstream of the flowmeter (downstream pressure). This can be estimated using the following formula:

$$p_1 \geq 1{,}3 \times p_2 + 2{,}6 \times \Delta p'$$

ρ_1 Static gauge pressure downstream of the device (mbar)
ρ_2 Steam pressure of fluid at operating temperature (mbar)
$\Delta\rho'$ Pressure drop, measuring medium (mbar)

Installation at high measuring medium temperatures

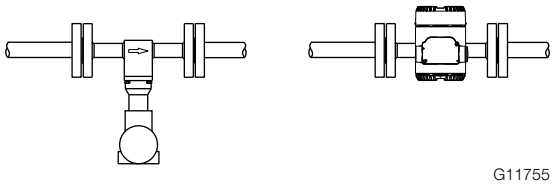

Fig. 9: Installation at high measuring medium temperatures

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.

Installation for external pressure and temperature measurement

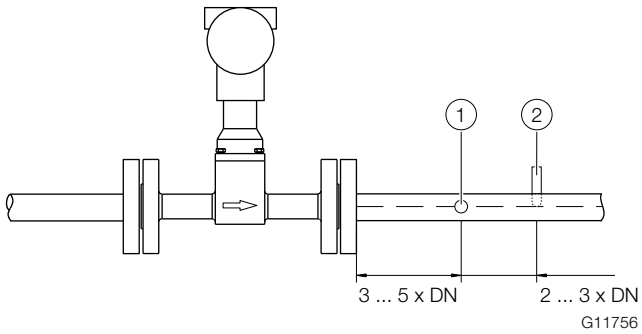

Fig. 10: Arrangement of the temperature and pressure measuring points
(1) Pressure measuring point (2) Temperature measuring point

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.

Installation of final controlling equipment

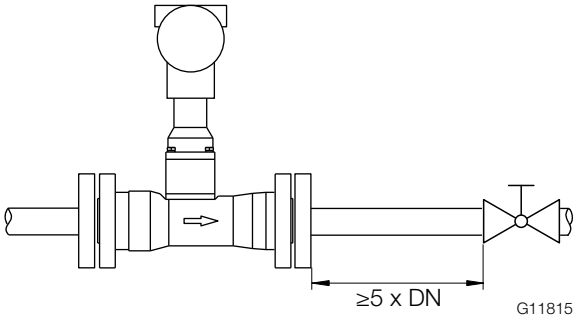

Fig. 11: Installation of final controlling equipment

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.
Suitable damping devices (such as air vessels if using a compressor for conveying) may need to be used.

The SwirlMaster FSS400 is particularly well suited for such arrangements.

Sensor insulation

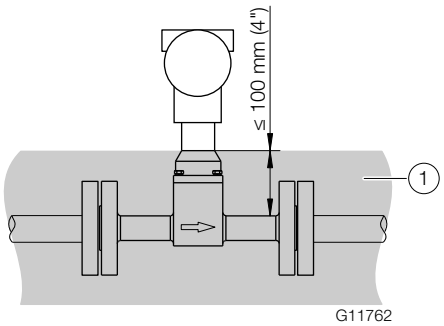

Fig. 12: Insulation of the meter tube
(1) Insulation

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

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.

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Dimensions

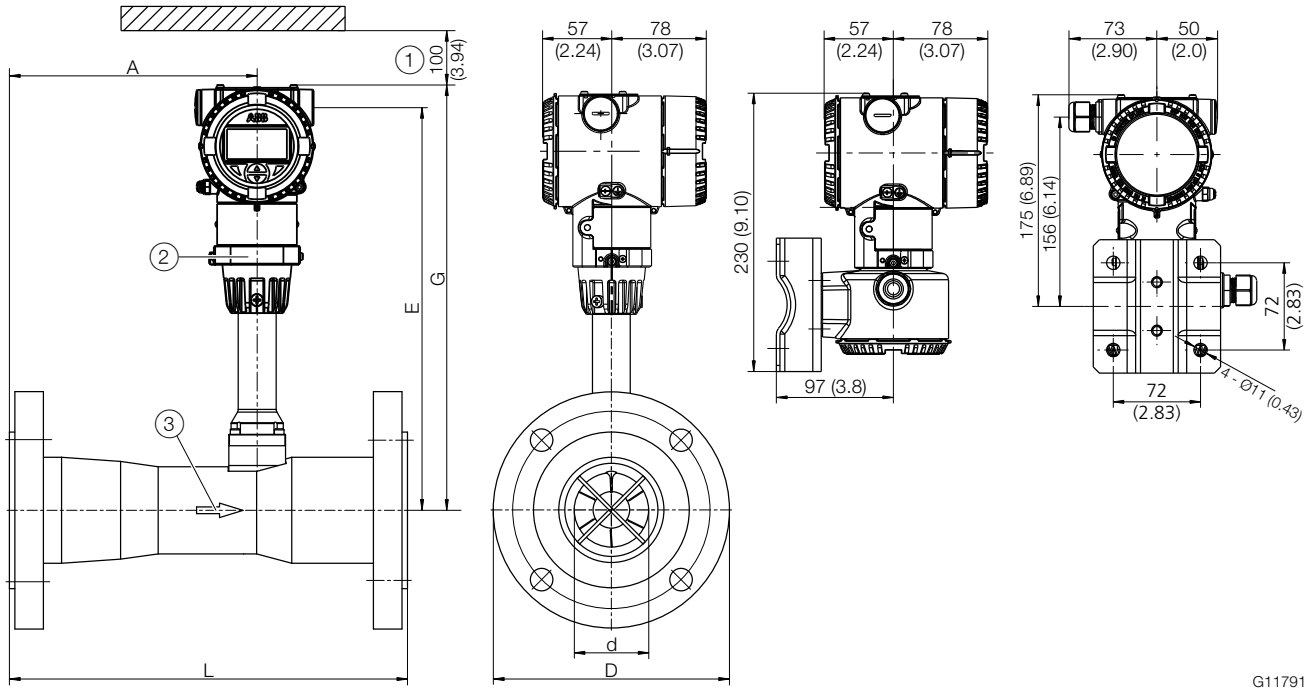

Fig. 13: Dimensions in mm (inches)
(1) **Required minimum distance for removal of the transmitter and removal of the sensor unit** (2) **Can be rotated up to 360°** (3) **Flow direction**

Dimensions for sensors with DIN flanges

Nominal Diameter	Pressure rating	L	G	E	A	D	d	Weight [kg (lb)]
DN 15	PN 10 ... 40	200 (7.87)	346 (13.62)	327 (12.87)	83 (3.27)	95 (3.74)	17.3 (0.68)	5.8 (12.8)
DN 20	PN 10 ... 40		349 (13.74)	330 (12.99)	68 (2.68)	105 (4.13)	22.6 (0.89)	2.4 (5.3)
DN 25	PN 10 ... 40	150 (5.91)	348 (13.70)	329 (12.95)	67 (2.64)	115 (4.53)	28.1 (1.11)	3.5 (7.7)
DN 32	PN 10 ... 40		346 (13.62)	327 (12.87)	68 (2.68)	140 (5.51)	37.1 (1.46)	4.7 (10.4)
DN 40	PN 10 ... 40	200 (7.87)	350 (13.78)	331 (13.03)	79 (3.11)	150 (5.91)	42.1 (1.66)	8 (17.6)
DN 50	PN 10 ... 40		353 (13.89)	334 (13.15)	106 (4.17)	165 (6.50)	51.1 (2.01)	7.2 (15.9)
DN 80	PN 10 ... 40	300 (11.81)	356 (14.01)	337 (13.26)	159 (6.26)	200 (7.87)	82.6 (3.25)	12.2 (26.9)
DN 100	PN 10 ... 16	350 (13.78)	360 (14.17)	341 (13.42)	189 (7.44)	220 (8.66)	101.1 (3.98)	14.2 (31.3)
	PN 25 ... 40					235 (9.25)	101 (3.98)	18 (39.7)
DN 150	PN 10 ... 16	480 (18.90)	384 (15.12)	365 (14.37)	328 (12.91)	285 (11.22)	150.1 (5.91)	28.5 (62.8)
	PN 25 ... 40					300 (11.81)	150.1 (5.91)	34.5 (76.1)
DN 200	PN 10 / PN 16	600 (23.62)	404 (15.90)	385 (15.15)	436 (17.17)	340 (13.39)	203.1 (8.00)	50 (110.2)
	PN 25 / PN 40					360 / 375 (14.17 / 14.76)	203.1 (8.00)	59 / 66 (130.1 / 145.5)
DN 300	PN 10 / PN 16	1000 (39.37)	450 (17.71)	431 (16.97)	662 (26.06)	445 / 460 (17.52 / 18.11)	309.7 (12.19)	171 / 186 (377.0 / 410.1)
DN 400	PN 10 / PN 16	1274 (50.16)	486 (19.13)	467 (18.38)	841 (33.11)	565 / 580 (22.24 / 22.83)	390.4 (15.37)	245 / 266 (540.1 / 586.4)

Tolerance for dimension L: DN 15 ... 200 +0 / -3 mm (+0 / -0.12 inch), DN 300 ... 400 +0 / -5 mm (+0 / -0.20 inch)

Dimensions for sensors with ASME flanges								
Nominal Diameter	Pressure rating	L	G	E	A	D	d	Weight [kg (lb)]
1/2"	CL 150	200 (7.87)	346 (13.62)	327 (12.87)	83 (3.27)	88.9 (3.5)	15.8 (0.62)	5.3 (11.7)
	CL 300					95.2 (3.75)		5.8 (12.8)
3/4"	CL 150	220 (8.66)	349 (13.74)	330 (12.99)	68 (2.68)	98.4 (3.87)	22.6 (0.89)	2.1 (4.6)
	CL 300	230 (9.06)				117.5 (4.63)		3.0 (6.6)
1"	CL 150	150 (5.91)	348 (13.70)	329 (12.95)	67 (2.64)	108 (4.25)	28.1 (1.1)	3.4 (7.5)
	CL 300					124 (4.88)		3.6 (7.9)
1 1/4"	CL 150	150 (5.91)	346 (13.62)	327 (12.87)	68 (2.68)	118 (4.65)	37.1 (1.46)	3.7 (8.2)
	CL 300					133 (5.24)		5.4 (11.9)
1 1/2"	CL 150	200 (7.87)	350 (13.78)	331 (13.03)	79 (3.11)	127 (5)	42.1 (1.66)	6.8 (15)
	CL 300					155.6 (6.13)		8.9 (19.6)
2"	CL 150	200 (7.87)	353 (13.89)	334 (13.15)	106 (4.17)	152.4 (6)	51.1 (2.01)	7.1 (15.7)
	CL 300					165 (6.5)		9.8 (21.61)
3"	CL 150	300 (11.81)	356 (14.01)	337 (13.26)	159 (6.26)	190.5 (7.5)	82.6 (3.25)	11.7 (25.8)
	CL 300					209.5 (8.25)		16.2 (35.7)
4"	CL 150	350 (13.78)	360 (14.17)	341 (13.26)	189 (7.44)	228.6 (9)	101.1 (3.98)	18.0 (39.7)
	CL 300					254 (10)		27.5 (60.6)
6"	CL 150	480 (18.9)	384 (15.12)	365 (14.37)	328 (12.9)	279.4 (11)	150.1 (5.91)	30.0 (66.1)
	CL 300					317.5 (12.5)		46.0 (101.4)
8"	CL 150	600 (23.62)	404 (15.90)	385 (15.15)	436 (17.17)	343 (13.5)	203.1 (8)	45.0 (99.2)
	CL 300					381 (15)		75 (165.4)
12"	CL 150	1000 (39.37)	450 (17.71)	431 (16.97)	662 (26.1)	482.6 (19)	309.7 (12.19)	182 (401.2)
16"	CL 150	1274 (50.16)	486 (19.13)	467 (18.38)	841 (33.1)	596.9 (23.5)	390.4 (15.37)	260 (573.2)

Tolerance for dimension L: 1/2" ... 8" +0 / -3 mm (+0 / -0.12 inch), 12" ... 16" +0 / -5 mm (+0 / -0.20 inch)

Transmitter specifications

General remarks

The transmitter uses two-wire technology. The same wires are used for the power supply and the analog and digital communication.

Features

- 4 ... 20 mA current / HART 7 output.
- Current output for an alarm can be configured to 21 ... 23 mA (NAMUR NE43).
- Measuring range: Can be configured between 0.15 ... 1 x Q_{max}DN.
- Operating mode can be configured for the flow measurement (see chapter „Operating modes“ on page 14).
- Programmable digital output. Can be configured as frequency output, pulse output or binary output (option for FSx430, standard for FSx450).
- Programmable analog input 4 ... 20 mA for connection of external sensors, e.g. pressure or temperature sensor (only for FSx450).
- Parameterization by means of HART communication.
- Damping: 0.2 ... 100 s configurable (1 τ).
- Low flow cut-off: 0 ... 5 % for current and pulse output.
- Measuring medium parameters can be changed at any time (pressure and temperature influence, density, units, etc.).
- Simulation of current and binary output (manual process execution).

Operating modes

The following operating modes can be selected depending on the design.

Liquid measuring medium	Gas / vapor measuring medium
— Liquid volumes	— Gas volumes
— Liquid standard volumes (temperature-compensated)	— Gas standard volumes
— Liquid mass	— Gas mass
— Liquid energy[1)]	— Gas energy[1)]
	— Biogas volumes
	— Biogas standard volumes
	— Vapor volumes
	— Vapor mass
	— Vapor energy[1)]

1) For FSx450 only

LCD indicator (option)

- High-contrast LCD indicator.
- Display of the current flow rate as well as the total flow rate or the temperature of the measuring medium (optional).
- Application-specific visualizations which the user can select. Four operator pages can be configured to display multiple values in parallel.
- Plain text fault diagnostics
- Menu-guided parameterization with four buttons.
- "Easy Set-up" function for fast commissioning.
- Parameterization of the device through the front glass with the housing closed.
- During ongoing operation, the LCD indicator can be connected or disconnected and therefore also used as a configuration tool for other devices.

IP decree of protection

- IP 66 / 67 in accordance with EN 60529
- NEMA 4x
- "Dual seal device" in accordance with ANSI/ISA 12.27.01. Only for devices with explosion-proof design with hazardous area electrical certification "Ex d" or "XP".

Electromagnetic compatibility

Electromagnetic compatibility of equipment for process and lab control technology 5/93 and EMC Directive 2004/108/EC (EN 61326-1).
The transmitter is optionally available with EMC protection in accordance with NAMUR NE 21.

NOTE

When the housing is open, EMC protection or protection against accidental contact is restricted.

EMC / HF effect on the current output

Tested in accordance with EN 61326.
Output error of less than ±0.025 % of the measuring range for twisted pair cables in the range:

- 80 ... 1000 MHz for radiated field strength of 10 V/m;
- 1.4 ... 2.0 GHz for radiated field strength of 3 V/m;
- 2.0 ... 2.7 GHz for radiated field strength of 1 V/m.

Magnetic field disruptions in the current output

Tested in accordance with EN 61326.
Output error of less than ±0.025% of the measuring range at 30 A/m (eff.).

Remote mount design

In remote mount design, the sensor and transmitter are connected by a signal cable up to 30 m (98 ft) long.
The signal cable is permanently connected to the transmitter and can be made shorter if required.

Electrical connections

Electrical connection

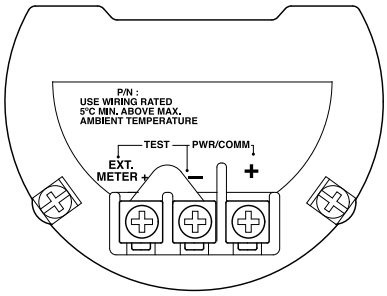

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Fig. 14: Terminals without digital output

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

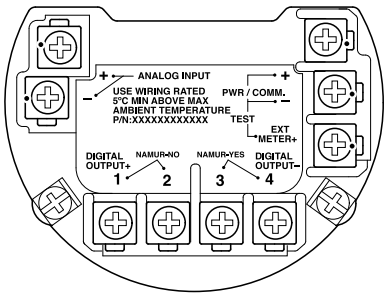

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Fig. 15: Terminals with digital output and analog input

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 -	

Connection examples

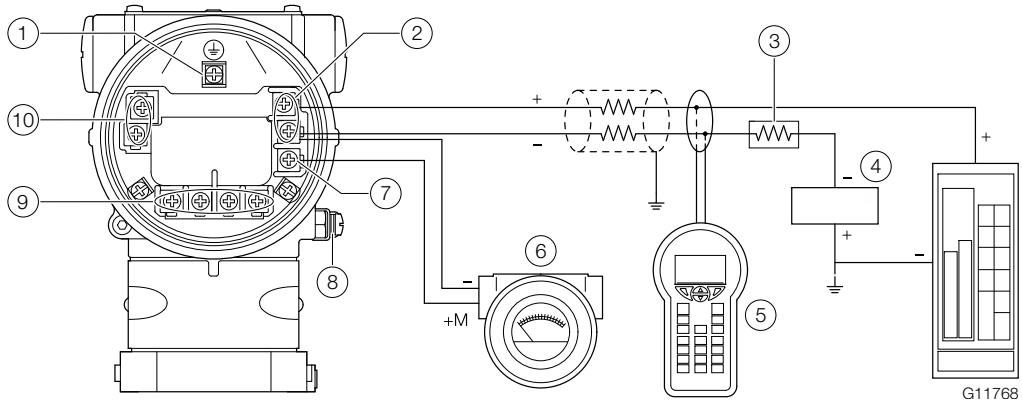

Fig. 16: Connection example
(1) **Internal earthing terminal** (2) **Power supply, current / HART output** (3) **Load resistance** (4) **Power supply** (5) **Handheld terminal** (6) **External display** (7) **Terminal for external display** (8) **External earthing terminal** (9) **Digital output** (10) **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.

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

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.

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

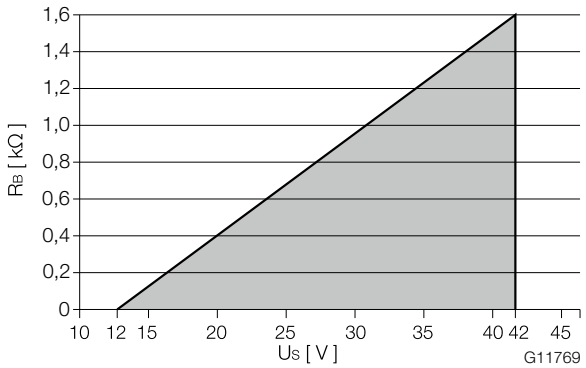

Fig. 17: Load diagram of the current output; load vs. supply voltage

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

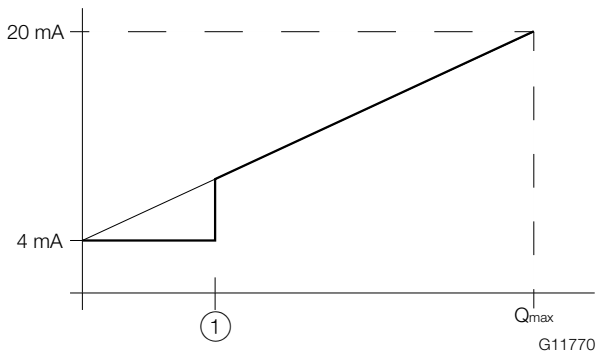

Fig. 18: Behavior of the current output
(1) Low flow cut-off

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"	$0 V \le U_{low} \le 2 V$ $2 mA \le I_{low} \le 20 mA$
Output "open"	$16 V \le U_{high} \le 30 V$ $0 mA \le I_{high} \le 0.2 mA$
Pulse output	f_{max}: 10 kHz Pulse width: 0.05 ... 2000 ms
Frequency output	f_{max}: 10.5 kHz

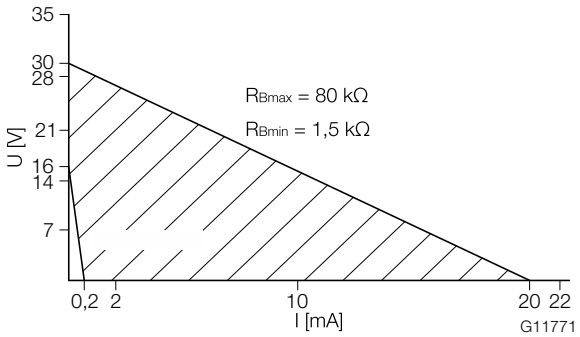

Fig. 19: Range of the external supply voltage and current

The external resistance R_B is in the range of $1.5 k\Omega \le R_B \le 80 k\Omega$, as shown in Fig. 19.

Analog input 4 ... 20 mA

At the analog input (4 ... 20 mA), an external pressure transmitter (e.g. ABB pressure transmitter model 261 / 266), an external temperature transmitter, a gas analyzer for the net methane content in the case of biogas, a density meter or a mass meter for a density signal can be connected.
The analog input can be configured using the relevant software as:

- Input for the pressure measurement for pressure compensation for the flow measurement of gases and vapor.
- Input for the return temperature measurement for energy measurement.
- Input for the gas content for the net metering of methane (biogas).
- Input for the density measurement for calculation of 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

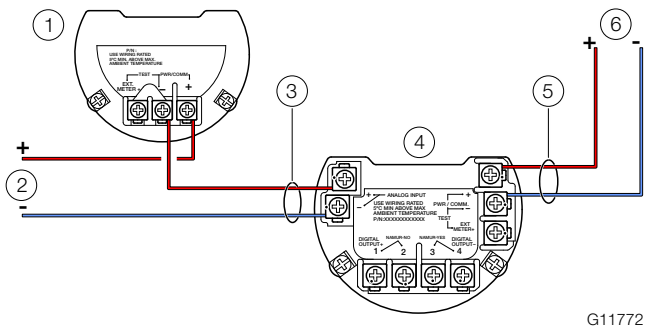

Fig. 20: Connection of transmitters at the analog input (example)

1. **Remote transmitter**
2. **Power supply for the remote transmitter**
3. **Cable entry for the analog input**
4. **SwirlMaster FSS430, FSS450**
5. **Cable entry for the current output**
6. **Power supply SwirlMaster FSS430, FSS450**

HART communication with remote transmitter

As the device has a two-wire technology design, an external pressure or temperature transmitter with HART communication (e.g. ABB pressure transmitter model 261 / 266) can be connected via the current / HART output (4 ... 20 mA).
The remote transmitter must be operated in HART burst mode.
The SwirlMaster FSS430, FSS450 transmitter supports HART communication up to the HART7 protocol.

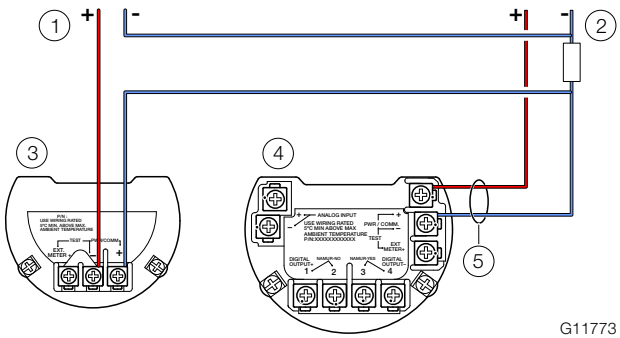

Fig. 21: Connection of transmitters with HART communication (example)

1. **Power supply for the remote transmitter**
2. **Power supply SwirlMaster FSS430, FSS450**
3. **Remote transmitter**
4. **SwirlMaster FSS430, FSS450**
5. **Cable entry for the current output**

Use in potentially explosive atmospheres

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

Electrical data

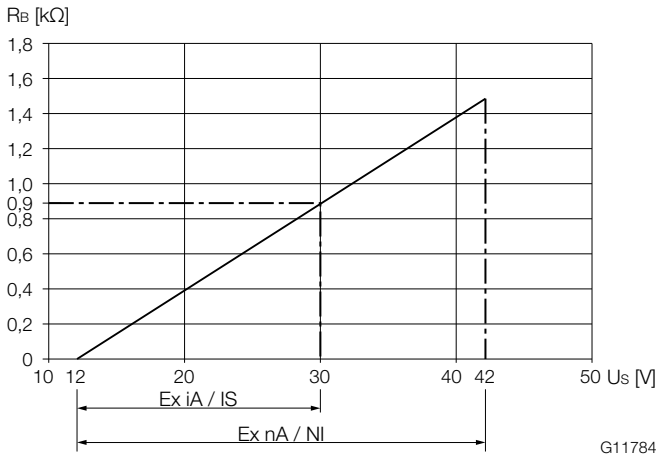

Fig. 22: Power supply in Zone 2, explosion protection, non-sparking

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 20.

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.

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

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

Electrical and temperature data

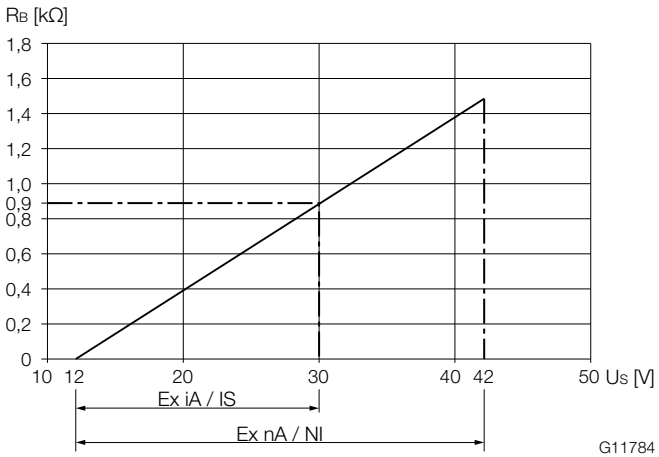

Fig. 23: Power supply in Zone 2, explosion protection, intrinsic safety

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} P_i	See the chapter titled „Limit value tables“ on page 23
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 23.

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} I_{max}	See the chapter titled „Limit value tables“ on page 23
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 23.

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 23.

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			

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

Electrical and temperature data

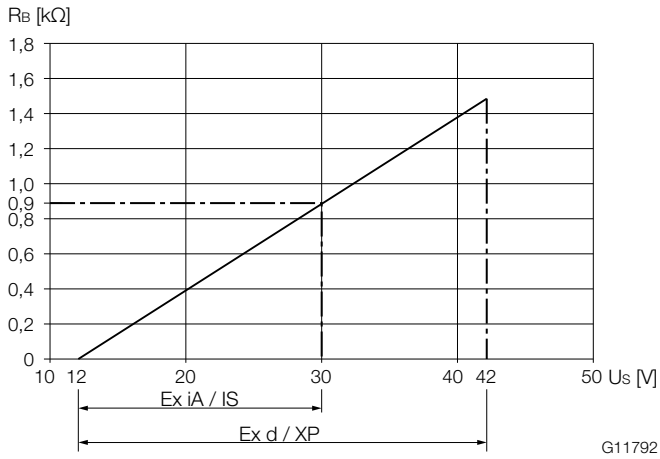

Fig. 24: Power supply in Zone 1, explosion protection

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.

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)

Ordering Information

Main ordering information SwirlMaster FSS430, FSS450

Base model

SwirlMaster FSS430 Swirl Flowmeter	FSS430	XX	XX	XXXXXX	XX	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	FSS450	XX	XX	XXXXXX	XX	XX	XX	XX
Explosion Protection Certification						Continued see next page		
Without		Y0						
ATEX Ex nA / Ex tc (Zone 2 and 22)		B1						
ATEX Ex ia / Ex ia (Zone 0 and 20)		A4						
ATEX Ex d ia / Ex tb (Zone 0/1 and 21)		A9						
IECEx Ex nA / Ex tc (Zone 2 and 22)		N1						
IECEx Ex ia / Ex ia (Zone 0 and 20)		N2						
IECEx Ex d ia / Ex tb (Zone 0/1 and 21)		N3						
cFMus XP Cl I,II,III Div 1 / Zone 1		F1						
cFMus IS Cl I,II,III Div 1 / Zone 0		F4						
cFMus NI Cl I Div 2, Cl II,III Div 1,2 / Zone 2		F3						
System Design								
Integral single sensor			C1					
Remote single sensor, 5 m (16 ft) signal cable included			R1					
Integral dual sensor			C2					
Remote dual sensor, 2 x 5 m (16 ft) signal cable included			R2					
Process Connection Type / Meter Size / Connection Size								
Flange / DN 15 (1/2 in.) / DN 15 (1/2 in.)				F015R0				
Flange / DN 20 (3/4 in.) / DN 20 (3/4 in.)				F020R0				
Flange / DN 25 (1 in.) / DN 25 (1 in.)				F025R0				
Flange / DN 32 (1-1/4 in.) / DN 32 (1-1/4 in.)				F032R0				
Flange / DN 40 (1-1/2 in.) / DN 40 (1-1/2 in.)				F040R0				
Flange / DN 50 (2 in.) / DN 50 (2 in.)				F050R0				
Flange / DN 80 (3 in.) / DN 80 (3 in.)				F080R0				
Flange / DN 100 (4 in.) / DN 100 (4 in.)				F100R0				
Flange / DN 150 (6 in.) / DN 150 (6 in.)				F150R0				
Flange / DN 200 (8 in.) / DN 200 (8 in.)				F200R0				
Flange / DN 300 (12 in.) / DN 300 (12 in.)				F300R0				
Flange / DN 400 (16 in.) / DN 400 (16 in.)				F400R0				
Pressure Rating								
PN 10					D1			
PN 16					D2			
PN 25					D3			
PN 40					D4			
PN 63					D5			
PN 100					D6			
PN 160					D7			
ASME CL 150					A1			
ASME CL 300					A3			
ASME CL 600					A6			
ASME CL 900					A7			
Others					Z9			

SwirlMaster FSS430, FSS450
Swirl flowmeter

Main ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XX	XX
Temperature Range of Measuring Medium			
Standard -55 ... 280 °C (-67 ... 536 °F)	A1		
Housing Material / Cable Glands			
Aluminium / 2 pcs. metric, M20 x 1.5, cable glands mounted		A1	
Aluminium / 2 pcs. 1/2 in. NPT threads, cable glands not included		B1	
Stainless steel 316L / 2 pcs. metric, M20 x 1.5, cable glands mounted		S1	
Stainless steel 316L / 2 pcs. 1/2 in. NPT threads, cable glands not included		T1	
Output Signal			
HART digital communication and 4 ... 20 mA		1)	H1
HART digital communication, 4 ... 20 mA + digital contact output			H5

Additional ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XXX	XXX	XXX	XX	XX	XXX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XXX	XXX	XXX	XX	XX	XXX
Integrated Digital Display (LCD)							
With Integrated LCD Display with Push Buttons TTG	1)	L2						
Piezo Sensor Sealing Material							
PTFE (-20 ... 260 °C / -4 ... 500 °F)	2)	SP0					
Kalrez 6375 (-20 ... 275 °C / -4 ... 527 °F)	3)	SP1					
Graphite (-55 ... 280 °C / -67 ... 536 °F)	4)	SP2					
Ambient Temperature Range							
Extended -40 ... 85 °C (-40 ... 185 °F)			TA4				
Signal Cable Length							
10 m (approx. 32 ft)			5)	SC2			
20 m (approx. 64 ft)			5)	SC4			
30 m (approx. 96 ft)			5)	SC6			
Others			5)	SCZ			
Calibration Type							
5-point calibration					R5		
3-point calibration including application-specific k-factor to Reynolds number optimization				6)	RR		
Surge / Transient Protector							
With integral surge / transient protector					1)	S1	
Sensor Material							
Piezo sensor material Hastelloy C-276							SM1
All inner parts material Hastelloy C-276							SM2
All wetted parts material Hastelloy C-276							SM3

Additional ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XXX	XX	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XXX	XX	XX	XX	XX
Certificates						
Material monitoring with inspection certificate 3.1 acc. EN 10204	C2					
Material monitoring NACE MR 01-75 with inspection certificate 3.1 acc. EN 10204	CN					
Declaration of compliance with the order 2.1 acc. EN 10204	C4					
Inspection certificate 3.1 acc. EN 10204 of visual, dimensional and functional test	C6					
Inspection certificate 3.1 acc. EN 10204 of positive material identification PMI with material analysis	C5					
Inspection certificate 3.1 acc. EN 10204 of positive material identification PMI	CA					
Pressure test acc. to factory test plan	CB					
Test package (pressure test, non-destructive test, welder an welding procedure certificate)	CT					
Device Identification Plate						
Stainless steel plate with TAG no.		TC1				
Adhesive label with TAG no.		TCC				
Supplemental wired-on stainless steel plate		TCS				
Others		TCZ				
Documentation Language						
German			M1			
English			M5			
Chinese			M6			
Russian			MB			
Language package Western Europe / Scandinavia			MW			
Language package Eastern Europe			ME			
Special Applications						
Degreased for oxygen applications				P1		
Hardware Options						
Integral RTD				1)	G1	
Operation Mode						
Steam energy flow					6)	N1
Water energy flow					6)	N2
Natural gas flow AGA / SGERG					6)	N3

1) Optional with SwirlMaster FSS430, standard with SwirlMaster FSS450
2) Application range -20 … 260 °C / -4 … 500 °F
3) Application range -20 … 275 °C / -4 … 527 °F
4) Application range -55 … 280 °C / -67 … 536 °F
5) For remote sensor only
6) Only available with SwirlMaster FSS450

SwirlMaster FSS430, FSS450
Swirl flowmeter

Main ordering information FST450 Transmitter for SwirlMaster FSS430, FSS450

Base model					
FST450 Transmitter	FST450	XX	XX	XX	XX
Explosion Protection Certification					
Without		Y0			
System Design					
FST450 transmitter kit 1; spare transmitter for FSS430 / FSS450			K1		
FST450 transmitter kit 2 for conversion of integral mount design to remote mount design			K2		
FST450 transmitter kit 3 for conversion of FS4000-ST4 to FSS450 integral mount design			K3		
FST450 transmitter kit 4 for conversion of FS4000-ST4 / SR4 to FSS450 remote mount design			K4		
FST450 transmitter kit 5 for conversion of 10ST1000 to FSS450 integral mount design			K5		
FST450 transmitter kit 6 for conversion of 10ST1000 / 10SR1000 / 10SM1000 to FSS450 remote mount design			K6		
Housing Material / Cable Glands					
Aluminium / 2 pcs. metric, M20 x 1.5, cable glands mounted				A1	
Aluminium / 2 pcs. 1/2 in. NPT threads, cable glands not included				B1	
Stainless steel 316L / 2 pcs. metric, M20 x 1.5, cable glands mounted				S1	
Stainless steel 316L / 2 pcs. 1/2 in. NPT threads, cable glands not included				T1	
Others				Z9	
Output Signal					
HART digital communication, 4 ... 20 mA + digital contact output					H5

Additional ordering information

FST450 Transmitter	XX	XXX	XXX	XXX
Integrated Digital Display (LCD)				
With Integrated LCD Display with Push Buttons TTG	L2			
Piezo Sensor Design				
Standard temperature, Pt100, PED design (-55 ... 280 °C / -67 ... 536 °F)	1)	SD1		
Standard temperature, Pt100, non PED (-55 ... 280 °C / -67 ... 536 °F)	2)	SD3		
Piezo Sensor Sealing Material				
PTFE (-20 ... 260 °C / -4 ... 500 °F)		3)	SP0	
Kalrez 6375 (-20 ... 275 °C / -4 ... 527 °F)		4)	SP1	
Graphite (-55 ... 400 °C / -67 ... 752 °F)		5)	SP2	
Signal Cable Length				
10 m (approx. 32 ft) (For remote sensor only)			12)	SC2
20 m (approx. 64 ft) (For remote sensor only)			12)	SC4
30 m (approx. 96 ft) (For remote sensor only)			12)	SC6
Others (For remote sensor only)			12)	SCZ

Additional ordering information						
FST450 Transmitter	XX	XX	XXX	XX	XX	XX
Surge / Transient Protector						
With integral surge / transient protector	S1					
Certificates						
Declaration of compliance with the order 2.1 acc. EN 10204		C4				
Device Identification Plate						
Stainless steel plate with TAG no.			TC1			
Adhesive label with TAG no.			TCC			
Supplemental wired-on stainless steel plate			TCS			
Others			TCZ			
Documentation Language						
German				M1		
English				M5		
Chinese				M6		
Russian				MB		
Language package Western Europe / Scandinavia				MW		
Language package Eastern Europe				ME		
Hardware Options						
Integral RTD					G1	
Analog input					G2	
HART Input					G3	
Operation Mode						
Steam energy flow						N1
Water energy flow						N2
Natural gas flow AGA / SGERG						N3

1) For VT4/ST4 delivered after 05/2002, 6 hole design
2) For VT4/ST4 delivered before 05/2002 and all VT1000 / ST1000, 4 hole design
3) Application range -20 ... 260 °C / -4 ... 500 °F
4) Application range -20 ... 275 °C / -4 ... 527 °F
5) Application range -55 ... 400 °C / -67 ... 752 °F
6) For remote sensor only

Trademarks

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Notes

Notes

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FSS430 FSS450 Service

DS/FSS430/450-EN Rev. B 02.2015

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