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

SwirlMaster FSS430, FSS450
Swirl flowmeter

Reliable measurement of liquids, gases and steam in volume, mass or energy units

Measurement made easy

Compact, space-saving installation
— Shortest inlet and outlet sections

Measuring accuracy of 0.5 % of measured value in steam measurements

Reduction of piping can be avoided
— Measuring ranges are ideally adapted to common flow velocities

ABB common look and feel
— Easy Set-up
— Operation through the front glass via capacitive buttons

Automated zero point adjustment
— AutoZero function for zero point adjustment

Drift-free sensor design for high long-term stability

Integrated online self-diagnosis
— Preventive maintenance in the process
— Extended maintenance cycles
— Reduced maintenance effort

Reduction of the external measuring components by integrated temperature compensation

Reduction of investment costs by integrated flow computer
— Direct mass and energy calculating for steam and water in accordance with IAPWS-IF97
— Natural gas compensation factors in accordance with AGA / GERG standards

SensorMemory technology
— Safe electronics replacement
— Storage of the device and application data in the sensor and transmitter

Simplified spare parts handling
— Common electronic components and Piezo sensors for all nominal diameters and applications

Maximum 4 internal totalizers for highest transparency
— Depending on the operation mode maximum 4 internal totalizers are available for volume, standard volume, mass and energy

Global approvals for explosion protection

SIL 2 approval in accordance with IEC 61508 optional

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Overview – models

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

Sensor		
Model number	**FSS430**	**FSS450**
Design	Compact design, remote mount design	
IP degree of protection in accordance with EN 60529	IP 66, IP 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	
Reproducibility[1)]	DN 15 ≤ ±0.3 %, from DN 20 ≤ ±0.2 %	
Permissible viscosity for liquids	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 section (typical)	Inlet section: 3 x DN, outlet section 1 x DN, see also chapter "Inlet and outlet sections" on page 10.	
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	
— Inlet / outlet guide bodies	Stainless steel, optional Hastelloy C	
— Gasket	PTFE, optional Kalrez or graphite	
— Sensor housing	Stainless steel, optional Hastelloy C	
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 four operating buttons for operation through front glass (option)	Standard LCD indicator with four operating buttons for operation through front glass
Operating modes		
— Liquids	Operating volume, standard volume, mass	Operating volume, standard volume, mass, energy
— Gases	Operating volume, standard volume, mass	Operating volume, standard volume, mass, energy
— Biogas	—	Operating volume, standard volume
— Steam	Operating volume, mass	Operating volume, mass, energy
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[1)]	— HART input for external pressure or temperature transmitter communicating in HART burst mode	— Analog input 4 ... 20 mA for external pressure- / temperature transmitter or gas analyzer — HART input for external pressure- / temperature transmitter or gas analyzer communicating in HART burst mode
Current output, communication	4 ... 20 mA, HART protocol (HART 7), Modbus RTU-RS485	4 ... 20 mA, HART protocol (HART 7)
Power supply	HART communication: 12 ... 42 V DC, Modbus communication: 9 ... 30 V DC For devices with an explosion-proof design, see chapter "Use in potentially explosive atmospheres" on page 22.	
SensorMemory	Saves sensor & process parameters for easy start up after transmitter exchange	
Housing material	— Aluminum (copper content < 0.3 %), coated in epoxy resin — Optional: stainless steel CF3M, corresponds to AISI 316L — Tower: CF8, complies with AISI 304	
IP rating in accordance with EN 60529	IP 66, IP 67, NEMA 4X	

1) Only for devices with HART communication

SwirlMaster FSS430, FSS450
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

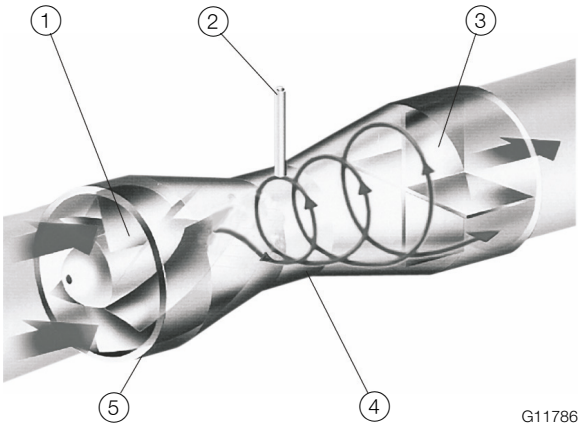

Fig. 2: Measuring principle
(1) Inlet pipe (2) Piezo sensor (3) Outlet pipe
(4) Housing (5) Stagnation point

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.

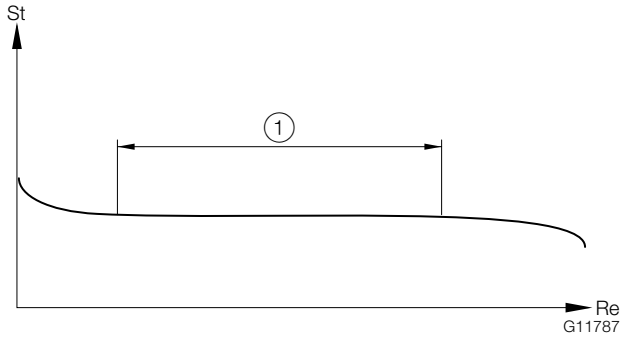

Fig. 3: Dependency of the Strouhal number on the Reynolds number
(1) Linear flow area

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).

Flowmeter sensor

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 figure should not be less than half the maximum flow rate for each nominal diameter ($Qv_{max}DN$), although it is possible to reduce this value to approx. 0.15 $Qv_{max}DN$.
The linear lower range value is dependent on the Reynolds number (see chapter "Measuring error and repeatability" on page 6).

If the flow to be measured is present as a standard flow (standard condition: 0 °C [32 °F], 1013 mbar) or mass flow, it must be converted into an operating flow and, based on the measuring range tables (see chapter "Measuring range table" on page 8), the most appropriate nominal device diameter must be selected.

Formula elements used	
ρ	Operating densities (kg/m³)
ρ_N	Standard density (kg/m³)
P	operating pressure (bar)
T	operating temperature (°C)
Q_v	Operating flow (m³/h)
Q_n	Standard flow (m³/h)
Q_m	mass flowrate (kg/h)
η	dynamic viscosity (Pas)
ν	Kinematic viscosity (m²/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 Reynolds number

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

Q Flow in m³/h
d Pipe diameter in m
ν Kinematic viscosity (m²/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)
	Air, 960 mbar abs. ±50 mbar (14 psia ±0.7 psi), 24 °C ±4 °C (75 °F ±7 °F)
Calibration loop internal diameter	Corresponds to 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

Measuring 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 8).

Measured error (including transmitter) depending on the measuring medium and operating mode	
Fluid	
Operating volume flow	±0,5 %
Standard volume flow	±0,6 %
Mass flow measurement	±0,6 %
Gas	
Operating volume flow	±0,50 %
Standard volume flow	±0,64 %
Mass flow measurement	±0,64 %
Steam	
Operating volume flow	±0,50 %
Measurement of steam / saturated steam mass (with internal temperature measurement)	±2,50 %
Measurement of steam / saturated steam mass (with internal temperature measurement and external pressure measurement)	±0,71 %
Measurement of steam / saturated steam mass (with external temperature and pressure measurement)	±0,57 %

Measured error for current output	
Additional measured error	< 0,1 %
At zero-point:	< 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 value deviation (including transmitter)

— ± 1°C or 1% of the measured value (in °C), whichever is greater

Reproducibility

— ≤ 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

Environmental conditions

Ambient temperature

In accordance with IEC 60068-2-78

Explosion protection	Ambient temperature range $T_{amb.}$	
	Standard	Advanced mode
No explosion protection	-20 ... 85 °C (-4 ... 185 °F)	-40 ... 85 °C (-40 ... 185 °F)
Ex ia, Ex nA	-20 °C < Ta < xx°C[1)] (-4°F < Ta < xx °F)[1)]	-40 °C < Ta < xx °C[1)] (-40°F < Ta < xx °F)[1)]
Ex d ia, XP-IS	-20 ... 75 °C (-4 ... 167 °F)	-40 ... 75 °C (-40 ... 167 °F)
IS, NI	-20 °C < Ta < xx°C[1)] (-4°F < Ta < xx °F)[1)]	-40 °C < Ta < xx °C[1)] (-40°F < Ta < xx °F)[1)]

1) The temperature xx °C(xx °F) depends on the temperature class T_{class}

Relative humidity

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

Temperature range of the medium being measured

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

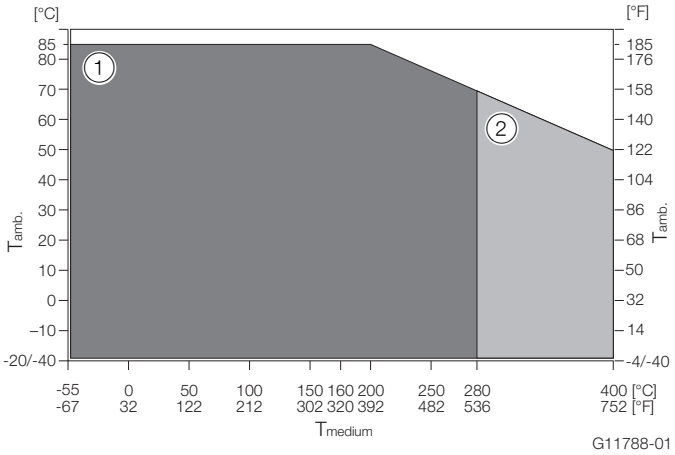

Fig. 4: Measuring medium temperature T_{medium} dependent on the ambient temperature $T_{amb.}$

(1) Permissible temperature range standard version (2) Permissible temperature range high temperature version (in preparation)

SIL-functional safety

Overall safety accuracy

The rated value of the "Total-Safety Accuracy" of the device's safety function is ±4% of the measuring range (±4 % of 16 mA).

Device specific data related to functional safety

Characteristic in accordance with IEC 61508	Value
Valid software-version of the frontend boards	1.4.2
Valid software-version of the communication boards	1.4.0
Valid hardware-version of the frontend boards	1.5.0
Valid software-version of the communication boards	1.3.0
Type of Assessment	Complete assessment in accordance with IEC 61508
SIL	2
Systematic ability	2
HFT	0
Component Type	B
Measuring mode	Low Demand Mode
Recommended time interval for inspection test T1	2 years
SFF[1)]	97.07%
PFD_{AVG} for T[Proof] = 2 years 1)	2.47E-03
λ_{sd}[1)]	1.52E-06
λ_{su}[1)]	2.73E-06
λ_{dd}[1)]	5.08E-06
λ_{du}[1)]	2.82E-07

1) Calculated at an ambient temperature of 100°C (212°F) in accordance with Siemens SN29500

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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]	[m^3/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	1600	7045	24
DN 400 (16")	163000	163000	2500	11000	19

1) Minimum Reynolds number from which the function takes effect. For the precise flowmeter dimensions, please 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]	[m^3/h]	[ft^3/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, please 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.

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 (optional)	—
Sensor: — Stainless steel 1.4571 (AISI 316 Ti) — Hastelloy C (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 (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) — Tower: CF8, complies with AISI 304	-55 ... 85 °C (-67 ... 185 °F)

Material loads for process connections

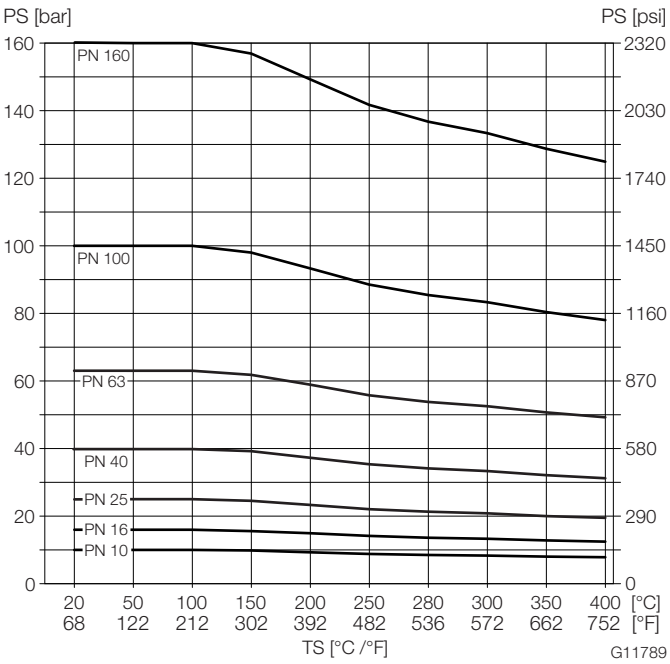

Fig. 5: DIN flange process connection

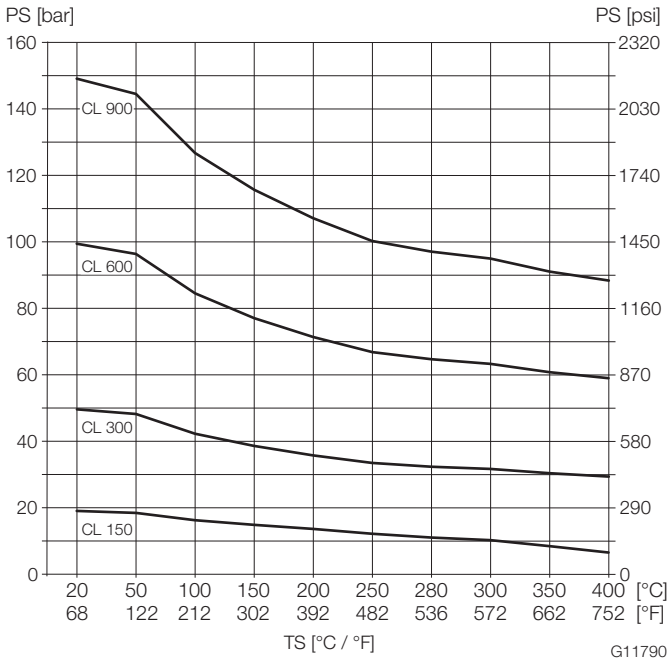

Fig. 6: ASME flange process connection

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 / 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.

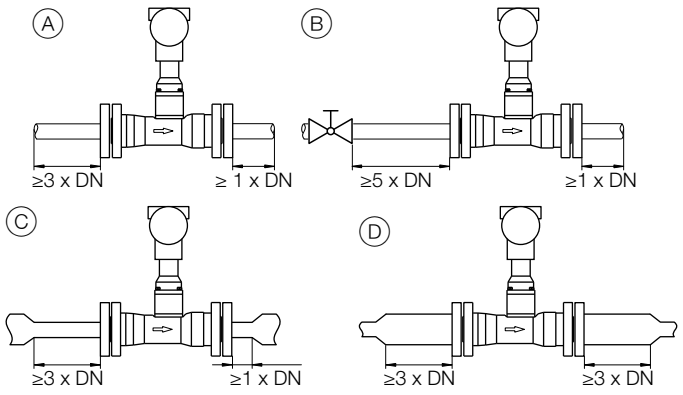

Fig. 7: Straight pipe sections

Installation	Inlet section	Outlet section
(A) Straight pipe	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°).

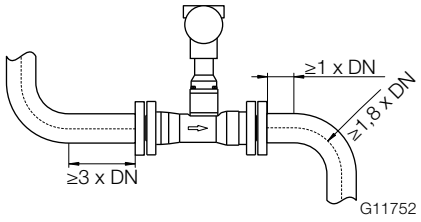

Fig. 8: Pipe sections with pipe elbows

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

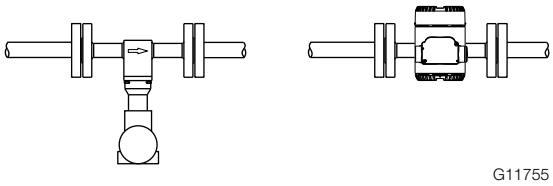

Fig. 9: Installation at high measuring medium temperatures

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

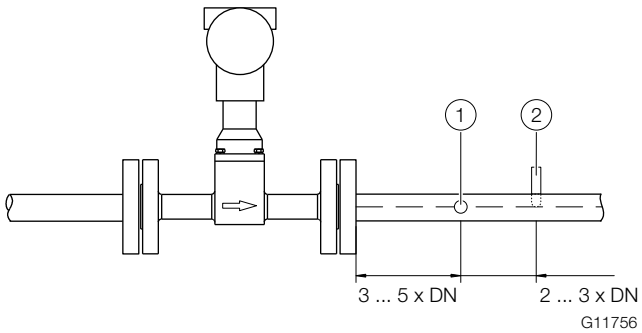

Fig. 10: Arrangement of the temperature and pressure measuring points

(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

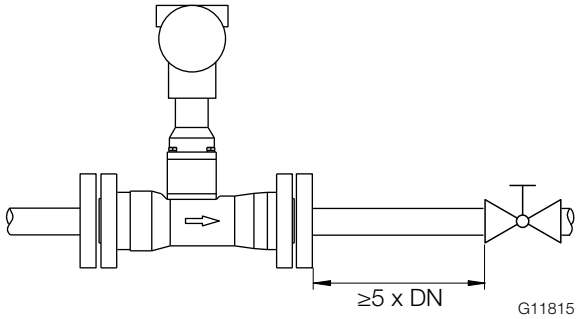

Fig. 11: Installation of final controlling equipment

Final controlling equipment must be arranged **downstream** of the flowmeter in forward flow direction 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 forward 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

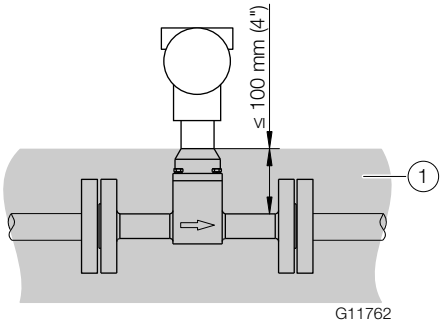

Fig. 12: Insulation of the meter tube
(1) Insulation

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.

NOTICE
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.

Dimensions

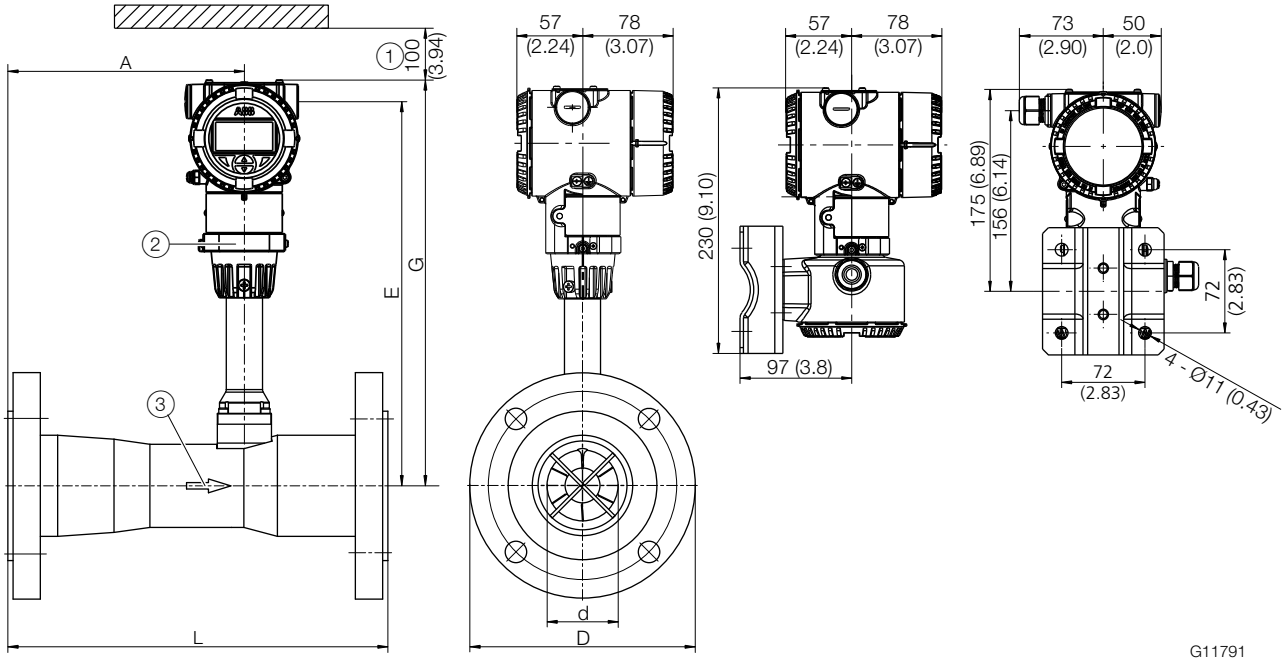

Fig. 13: Dimensions in mm (inches)

(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

Model variants

The transmitter is available in two versions:
With 4 ... 20 mA current output and HART communication, or with Modbus communication.

Features — devices with current output and HART communication

- 4 ... 20 mA current / HART 7 output.
- Current output in the event of 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 for flow measurement can be configured.
- 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 connecting external sensors, e.g. pressure or temperature sensor (optional for FSx430, standard for FSx450).
- HART communication with external sensors, e.g. pressure or temperature sensor.
- Parameterization by means of HART communication.
- Damping: 0 ... 100 s configurable (1 τ).
- Low flow cut-off: 0 ... 20 % 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).

Features — devices with Modbus communication

- Modbus interface.
- Operating mode for flow measurement can be configured.
- Programmable digital output. Can be configured as a frequency, pulse or binary output.
- Damping: 0 ... 100 s configurable (1 τ).
- Low flow cut-off: 0 ... 20 % for pulse output.
- Measuring medium parameters can be changed at any time (pressure and temperature influence, density, units, etc.).
- Simulation of binary output (manual process execution).

Operating modes

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

Measuring medium	FSS430	FSV450
Fluids	Liquid Volume, Liquid Std/Norm Vol., Liquid Mass	Liquid Volume, Liquid Std/Norm Vol., Liquid Mass, Liquid Energy
Gases	Gas Act. Volume, Gas Std/Norm Vol., Gas Mass	Gas Act. Volume, Gas Std/Norm Vol., Gas Mass, Gas Power
Biogas	—	Bio Act. Volume, Bio Std/Norm Vol.
Steam	Steam Act. Volume, Steam/Water Mass	Steam Act. Volume, Steam/Water Mass, Steam/Water Energy

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 (optional).
- During ongoing operation, the LCD indicator can be connected or disconnected and therefore also used as a configuration tool for other devices.

IP rating

- 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 type of protection "Ex d ia" or "XP-IS").

Response time
200 ms (1 tau) or 3/f in seconds
(In the case of a deactivated damping, whichever is greater).

The response time depends on the respective vortex shedding frequency f. At low flow rates, this can lead to a higher response time.

Example:
Vortex shedding frequency f: 2.4 Hz (nominal diameter DN 300, approx. 10% flow rate)
Response time: 3/2.4 Hz = 1.25 seconds

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

EMC / HF effect on the current output[1)]
Tested per 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[1)]
Tested per EN 61326.
Output error of less than ±0.025% of the measuring range at 30 A/m (eff.).

1) Only for devices with HART communication

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

Devices with HART communication
Current output / HART output

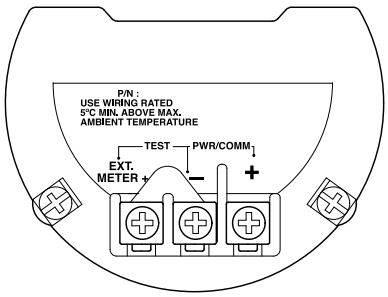

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Fig. 14: Terminals

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

Current output / HART output, digital output and analog input

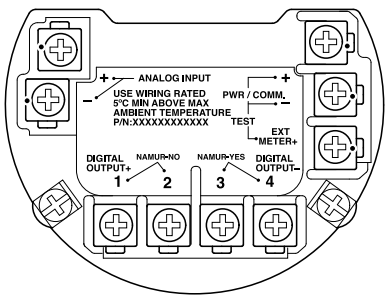

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Fig. 15: Terminals

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 example
HART communication

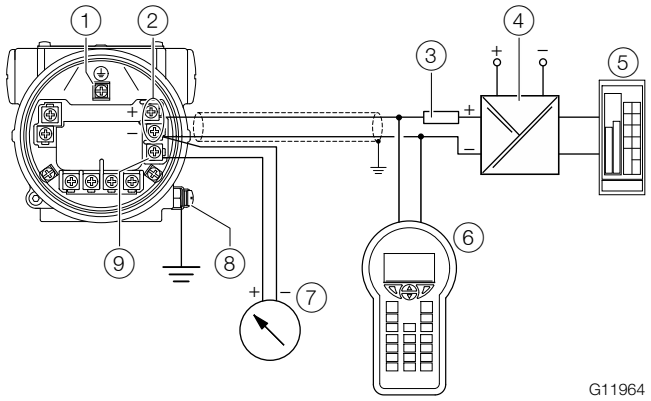


Fig. 16: HART communication (example)
(1) Internal earthing terminal
(2) Power supply, current output / HART output
(3) Load resistance (4) Power supply / supply isolator
(5) PLC / DCS (6) HART Handheld terminal (7) External indicator
(8) External earthing terminal (9) Terminal for external indicator

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.

NOTICE

Any configuration changes are saved in sensor memory only if no HART communication is taking place. To ensure that changes are safely stored, make sure that HART communication has ended before disconnecting the device from the network.

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.

Devices with Modbus communication

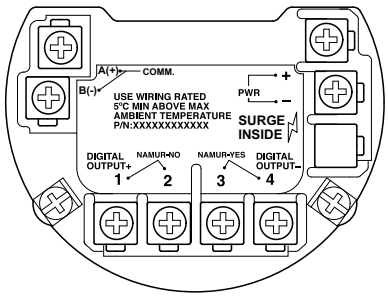


Fig. 17: Terminals

Terminal	Function / comment
PWR +	Power supply
PWR -	
A (+)	Modbus interface RS485
B (-)	
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

Connection example

Modbus communication

Using the Modbus protocol allows devices made by different manufacturers to exchange information via the same communication bus, without the need for any special interface devices to be used.

Up to 32 devices can be connected on one Modbus line. The Modbus network can be expanded using repeaters.

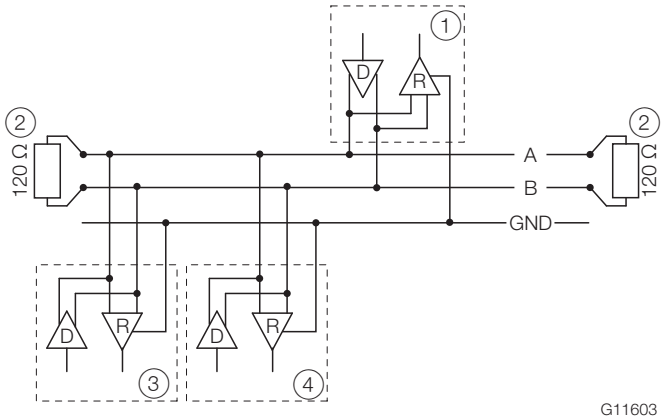


Fig. 18: Modbus network (example)
(1) Modbus master (2) Terminating resistor (3) Modbus slave 1 (4) Modbus slave n ... 32

Modbus interface	
Configuration	Via the Modbus interface in connection with Asset Vision Basic (DAT200) and a corresponding Device Type Manager (DTM)
Transmission	Modbus RTU - RS485 serial connection
Baud rate	1200, 2400, 4800, 9600 bps Factory setting: 9600 bps
Parity	None, even, odd Factory setting: none
Typical response time	< 100 milliseconds
Response Delay Time	0 ... 200 milliseconds Factory setting: 50 milliseconds
Device address	1 ... 247 Factory setting: 247
Register address offset	One base, Zero base Factory setting: One base

Cable specification

The maximum permissible length depends on the baud rate, the cable (diameter, capacity and surge impedance), the number of loads in the device chain, and the network configuration (2-core or 4-core).

- At a baud rate of 9600 and with a conductor cross section of at least 0.14 mm^2 (AWG 26), the maximum length is 1000 m (3280 ft).
- If a 4-core cable is used in a 2-wire system, the maximum length must be halved.
- The spur lines must be short (maximum of 20 m [66 ft]).
- When using a distributor with "n" connections, the maximum length of each branch is calculated as follows: 40 m (131 ft) divided by "n".

The maximum cable length depends on the type of cable used. The following standard values apply:

- Up to 6 m (20 ft): cable with standard shielding or twisted-pair cable.
- Up to 300 m (984 ft): double twisted-pair cable with overall foil shielding and integrated earth cable.
- Up to 1200 m (3937 ft): double twisted-pair cable with individual foil shielding and integrated earth cables. Example: Belden 9729 or equivalent cable.

A category 5 cable can be used for Modbus RS485 up to a maximum length of 600 m (1968 ft). For the symmetrical pairs in RS485 systems, a surge impedance of more than 100 Ω is preferred, especially at a baud rate of 19,200 and above.

Electrical data for inputs and outputs

Power supply

Devices with HART communication	
Terminals	PWR/COMM + / PWR/COMM –
Supply voltage	12 ... 42 V DC
Residual ripple	Maximum 5 % or Uss = ±1.5 V
Power consumption	< 1 W

Devices with Modbus communication	
Terminals	PWR + / PWR –
Supply voltage	9 ... 30 V DC
Residual ripple	Maximum 5 % or Uss = ±1.5 V
Power consumption	< 1 W

Uss Peak-to-peak value of voltage

Current output / HART output

Only for devices with HART communication.

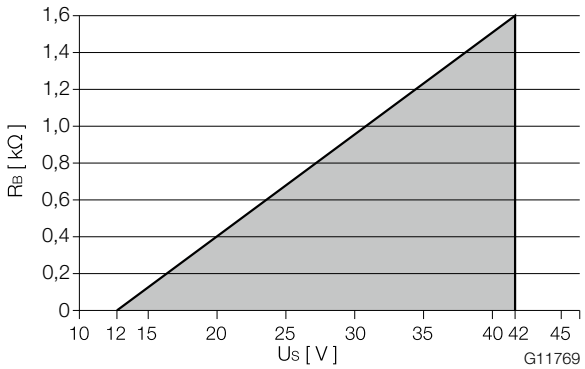


Fig. 19: Load diagram of current output; load depending on supply voltage

Terminals: PWR/COMM + / PWR/COMM –

In HART communication, the smallest load is R_B = 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:

$R_{B\,S} = U_B / I$

R_B Load resistance

U_S Supply voltage

I_B Signalstrom

Low flow cut-off

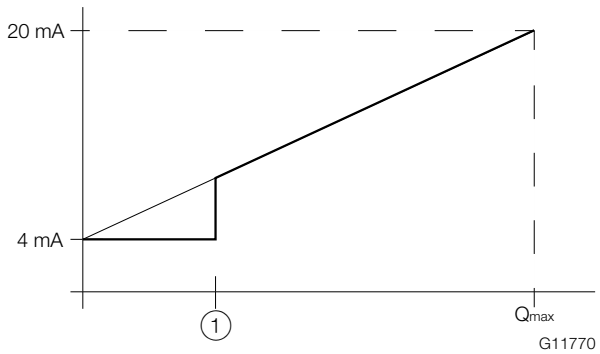


Fig. 20: Behavior of the current output
(1) Low flow

The current output behaves as shown in the figure.
Above the low flow, the current curve proceeds as a straight line in accordance with the flow rate.

— Flow rate = 0, current output = 4 mA
— Flow rate = Q_{max}, current output = 20 mA

If the low flow cut-off is activated, flow rates below the low flow are set to 0 and the current output set to 4 mA.

Analog input 4 ... 20 mA

Only for devices with HART communication.

A remote transmitter with current output 4 ... 20 mA can be connected to the analog input:

— Pressure transmitter e.g. ABB model 261 / 266
— Temperature transmitter
— Gas analyzer for the net methane content of biogas
— Density meter or mass meter for a density signal

The analog input can be configured using the relevant software:

— 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 net methane content of biogas.
— Input for the density measurement for calculation of the mass flow.

Analog input 4 ... 20 mA	
Terminals	ANALOG INPUT+ / ANALOG INPUT-
Operating voltage	16 ... 30 V DC
Input current	3.8 ... 20.5 mA
Equivalent resistance	90 Ω

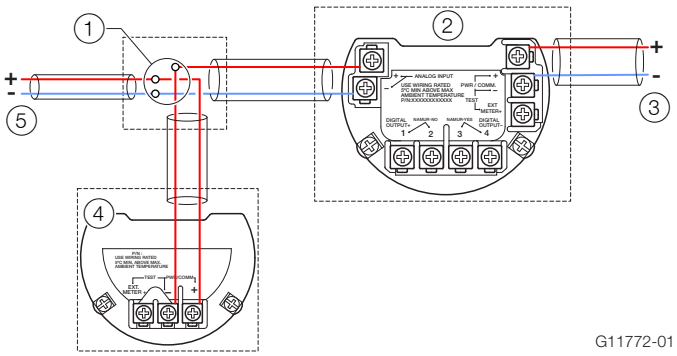


Fig. 21: Connection of transmitters at the analog input (example)
(1) Terminal points in separate cable junction box (2) SwirlMaster FSS430, FSS450 (3) Power supply SwirlMaster FSS430, FSS450 (4) Remote transmitter (5) Power supply of remote transmitter

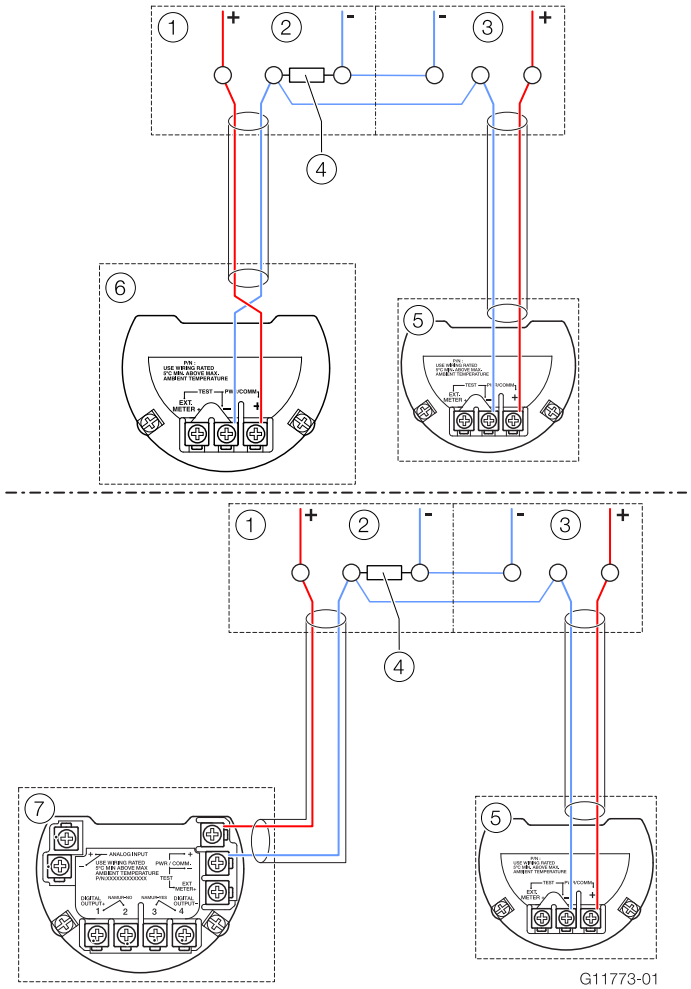
HART communication with remote transmitter

Only for devices with HART communication.

An remote pressure transmitter with HART communication can be connected via the current/HART output (4 ... 20 mA). The remote transmitter must be operated in the HART burst mode, e.g. the ABB pressure transmitter model 266 or model 261 with the ordering option "P6 HART Burst Mode".

The SwirlMaster FSS430, FSS450 transmitter supports HART communication up to the HART7 protocol.

Connection FSx430 with output option H1



Connection FSx450 or FSx430 with output option H5

Fig. 22: Connection of transmitters with HART communication (example)

(1) Control cabinet (2) Power supply (3) Power supply of remote transmitter (4) load resistance (5) Remote pressure transmitter (6) FSx430 with output option H1 (7) FSx450 or FSx430 with output option H5

NOTICE

The VortexMaster / SwirlMaster cannot communicate with a control system or configuration tool via HART while the pressure transmitter is communicating in BURST mode, because the BURST signal has priority over cyclical HART communication.

Digital output

For devices with HART communication or Modbus communication.

The digital output can be configured using the relevant software:

- Frequency output
- Pulse output
- Binary output (in / out, e.g. 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

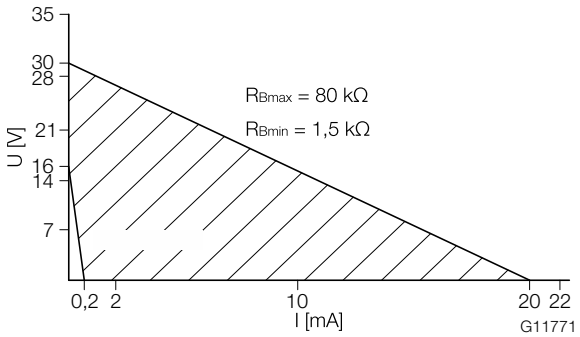


Fig. 23: Range of the external supply voltage and current

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. 23.

Use in potentially explosive atmospheres

Overview

The following tables provide an overview of the approvals available for explosion protection.

Type of protection "intrinsic safety" (Ex ia / IS)

Approval	Order code
ATEX (Europe)	A4
IECEx	N2
NEPSI (China)	S6
FM (USA and Canada)	F4

Type of protection "flameproof enclosure" (Ex d ia / XP-IS)

Approval	Order code
ATEX (Europe)	A9
IECEx	N3
NEPSI (China)	S1
FM (USA and Canada)	F1

Type of protection "non-sparking" (Ex n / NA)

Approval	Order code
ATEX (Europe)	B1
IECEx	N1
NEPSI (China)	S2
FM (USA and Canada)	F3

Combined approvals

In the case of combined approvals, the user decides on the type of protection during installation.

Type of protection	Order code
ATEX Ex n + Ex ia	B8 = B1 + A4
ATEX Ex n + Ex ia + Ex d	B9 = B1 + A4 + A9
IEC Ex Ex n + Ex ia	N8 = N1 + N2
IEC Ex Ex n + Ex ia + Ex d	N9 = N1 + N2 + N3
NEPSI Ex n + Ex ia	S8 = S2 + S6
NEPSI Ex n + Ex ia + Ex d	S9 = S2 + S1 + S6
cFMus NA + IS	F8 = F3 + F4
cFMus NA + IS + XP-IS	F9 = F3 + F4 + F1

Cable glands

NOTICE

Devices with a 1/2" NPT thread are supplied without cable glands.

The devices are supplied with cable glands certified according to ATEX or IECEx.
The cable glands supplied are approved for use in Zone 1.

Please observe the following points:

- The use of standard cable glands and seals is prohibited.
- The black plugs in the cable glands are intended to provide protection during transport. Any unused cable entries must be sealed securely before commissioning.
- The outside diameter of the connection cable must measure between 6 mm (0.24 inch) and 12 mm (0.47 inch) to ensure the necessary seal integrity.

Use of the devices in Zone 0 / 20

If the devices are used in Zone 0 / 20, the cable glands supplied must be replaced with cable glands approved for use in Zone 0.

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)

Electrical connections

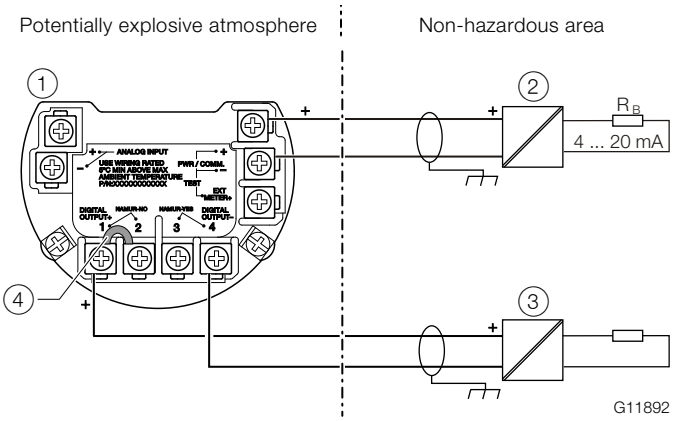


Fig. 24: Electrical connection (example)
(1) **SwirlMaster FSS430, FSS450**
(2) **Supply isolator** (3) **Switching amplifier** (4) **Bridge**

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

Terminal	Function
PWR/COMM + / PWR/COMM -	Power supply / current output / HART output
DIGITAL OUTPUT+ / DIGITAL OUTPUT-	Digital output as optoelectronic coupler or NAMUR output

In the factory setting, the output is configured as an optoelectronic coupler output.
If the digital output is configured as a NAMUR output, a suitable NAMUR switching amplifier must be connected.

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

Ex-marking

ATEX	
Order code	B1, B8, B9
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, N8, N9
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, F8, F9
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, S8, S9
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

Digital output

The digital output is designed as an optoelectronic coupler or 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 digital output can be changed over to "optoelectronic coupler" if required.

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

Electrical data

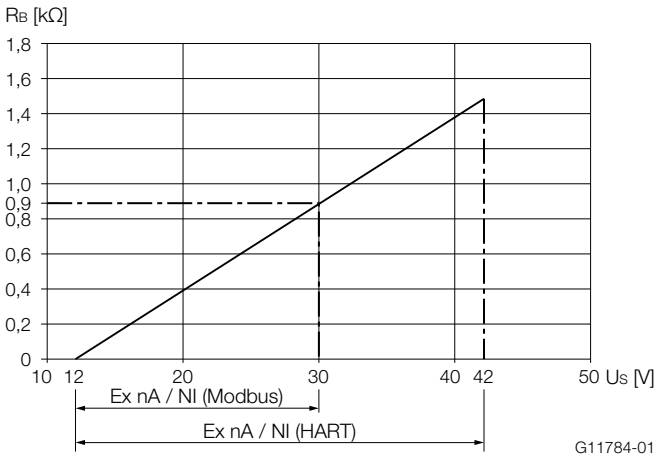


Fig. 25: Power supply in zone 2, explosion protection, non-sparking

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 / Modbus	
HART terminals	PWR/COMM + / PWR/COMM -
Modbus terminals	A (+), B (-) / PWR +, PWR -
U_S	HART: 45 V, Modbus: 30 V
Zone 2: Ex nA IIC T4 to T6 Gc T_{amb} = -40 ... xx °C[1)]	
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	

1) The temperature xx °C depends on the temperature class T_{class}

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 25.

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 ... 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	

Special conditions

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate.
Pollution degree 3 (in accordance with IEC 60664-1) should not be exceeded for the macro environment of the device.
The devices are in accordance with IP degree of protection IP 66 / IP 67. If the device is installed properly, 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.

Overvoltage protection

For the devices, the client must provide an external overvoltage protection.
It must be ensured that the overvoltage is limited to 140 % (HART: 63 V DC or Modbus: 42 V DC) of the maximum operating voltage U_S.

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).

Devices without LCD indicator and with HART communication

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

Devices without LCD indicator and with Modbus communication

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

Devices 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

Devices with LCD indicator and HART communication, 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

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

Temperaturklasse	$T_{amb.}$ 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	≤ 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

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

Only for devices with HART communication!

Ex-marking

ATEX	
Order code	A4, B8, B9
Type Examination Test 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, N8, N9
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, F8, F9
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, S8, S9
Ex ia IIC T4 to T6 Ga	
Ex iaD 20 T85 °C	
For electrical parameters, see certificate GYJ14.1088X	

Digital output

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

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

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

- NAMUR with switching amplifier
- Digital output: Ex ia: U_i = 30 V DC

Electrical and temperature data

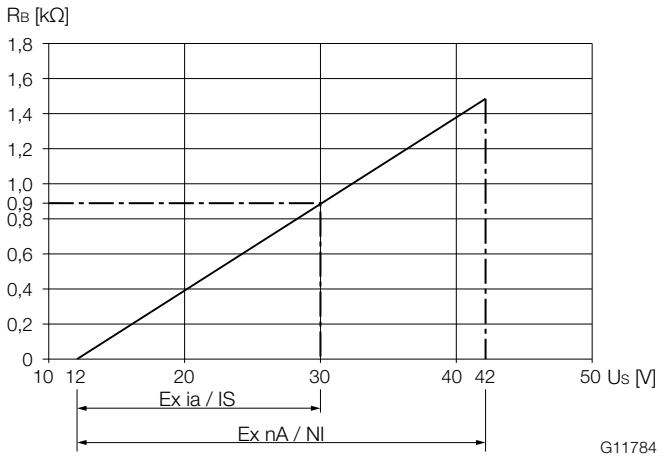


Fig. 26: Power supply in zone 0, 1, 2, explosion protection "intrinsic safety / Intrinsically safe"

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 29
P_i	
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 29.

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 29
I_{max}	
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 29.

Special conditions

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate.
Pollution degree 3 (in accordance with IEC 60664-1) should not be exceeded for the macro environment of the device.
The devices are in accordance with IP degree of protection IP 66 / IP 67. If the device is installed properly, 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 29.

Devices with extended EMC-protection

(SIL and NAMUR design)
For the operation in the ignition protection type "Intrinsic safety / Intrinsically safe", the current circuits on the device must be connected over approved, electrically isolated safety barriers.

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, B9
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, N9
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, F9
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 = 75 °C "Dual seal device"	

NEPSI	
Order code	S1, S9
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

Digital output

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

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

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

- NAMUR with switching amplifier
- Digital output: Ex d ia: U_m = 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

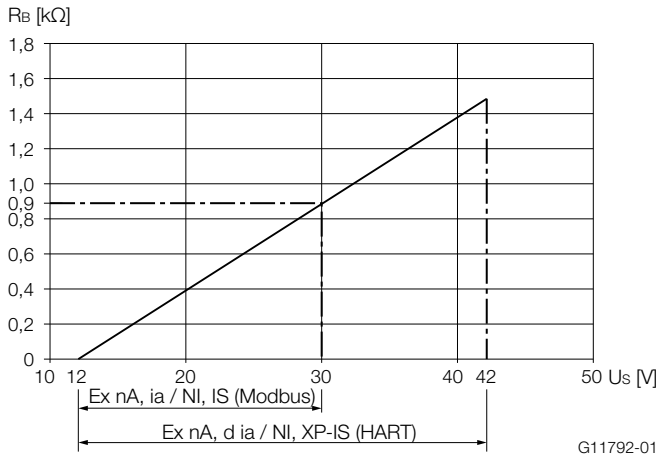


Fig. 27: Power supply in Zone 1, explosion protection

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 / Modbus	
HART terminals	PWR/COMM + / PWR/COMM –
Modbus terminals	A (+), B (–) / PWR +, PWR –
U_M	HART: 45 V, Modbus: 30 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 (in accordance with IEC 60664-1) must not be exceeded for the macro environment of the device.

The devices are in accordance with IP rating IP 66 / IP 67. If the device is installed properly, 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.

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									
Ohne		Y0							
ATEX Ex nA / Ex tc (Zone 2 und 22)		B1							
ATEX Ex ia / Ex ia (Zone 0 und 20)		A4							
ATEX Ex d ia / Ex tb (Zone 0/1 und 21)		A9							
ATEX kombiniert B1 + A4 (Ex n + Ex ia)	10)	B8							
ATEX kombiniert B1 + A4 + A9 (Ex n + Ex ia + Ex d)	10)	B9							
IECEx Ex nA / Ex tc (Zone 2 und 22)		N1							
IECEx Ex ia / Ex ia (Zone 0 und 20)		N2							
IECEx Ex d ia / Ex tb (Zone 0/1 und 21)		N3							
IECEx kombiniert N1 + N2 (Ex n + Ex ia)	10)	N8							
IECEx kombiniert N1 + N2 + N3 (Ex n + Ex ia + Ex d)	10)	N9							
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							
cFMus kombiniert F3 + F4 (Ex n + Ex ia)	10)	F8							
cFMus kombiniert F3 + F4 + F1 (Ex n + Ex ia + Ex d)	10)	F9							
NEPSI Ex nA / DIP A22 (Zone 2 und 22)		S2							
NEPSI Ex ia / Ex iaD (Zone 0 und 20)		S6							
NEPSI Ex d ia / DIP A21 (Zone 0/1 und 21)		S1							
NEPSI kombiniert N1 + N2 (Ex n + Ex ia)	10)	S8							
NEPSI kombiniert N1 + N2 + N3 (Ex n + Ex ia + Ex d)	10)	S9							
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					

Continued see next page

Main ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XX	XX	XX
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			
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
Modbus communication with digital contact output			1)	M4

SwirlMaster FSS430, FSS450
Swirl flowmeter

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 Display and Glass Cover	L1						
With Integrated LCD Display with Push Buttons TTG	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						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	XX	XX	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter		XX	XX	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					
SIL2 - certified acc. to IEC61508	8)	CS					
Device Identification Plate / Certification and Tag Plate							
Stainless steel / Stainless steel			T1				
Stainless steel / Adhesive label plus wired-on SST plate			TC				
Stainless steel / Stainless steel plate plus wired-on SST plate			TS				
Others			TZ				
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					7)	G1	
Increased EMC protection acc. to NAMUR NE21					9)	G4	
Operation Mode							
Steam energy flow						6)	N1
Water energy flow						6)	N2
Natural gas flow AGA / SGERG							N3

1) Only available with SwirlMaster FSS430
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 or FSS430 with Modbus communication
7) Optional with SwirlMaster FSS430, standard with SwirlMaster FSS450
8) Only available with Output Signal H5 and Hardware Option G4
9) Only available with Output Signal H5
10) In preparation

Trademarks

SwirlMaster FSS430, FSS450
Swirl flowmeter

Questionnaire

Customer:	**Date:**
Ms. / Mr.:	**Department:**
Telephone:	**Fax:**

Measuring system:	☐ SwirlMaster FSS430	**Optional** ☐ Integrated resistance thermometer Pt100 ☐ Digital output (switch, pulse, frequency output)
	☐ SwirlMaster FSS450	(with integrated resistance thermometer Pt100, binary output, analog input and flow computer unit functionality)

Measuring medium (Aggregate state)	_____	☐ Liquid	☐ Gas	☐ Saturated steam	☐ Overheated steam
Flow rate: (min., max., operating point)	_____	**Operating condition** ☐ m^3/h ☐ US gal/min	**Standard condition** ☐ m^3/h ☐ ft^3/h	**Mass** ☐ kg/h ☐ lb/h	**Energy** ☐ kW ☐ MJ/h
Density: (min., max., operating point)	_____	☐ kg/m^3 ☐ lb/ft^3	☐ Operating condition ☐ Standard condition		
Viscosity:	_____	☐ mPas/cP ☐ cst			
Measuring medium temperature: (min., max., operating point)	_____	☐ °C ☐ °F			
Ambient temperature:	_____	☐ °C ☐ °F			
Pressure: (min., max., operating point)	_____	☐ bar ☐ psi			
Nominal diameter / pressure rating of the piping:	_____	☐ DN ☐ PN			
Effective inside diameter of the piping:	_____	☐ mm			

Transmitter design / communication:	☐ 4 ... 20 mA, HART (FSS430 / FSS450)	☐ Modbus RTU (FSS430)	☐ PROFIBUS PA (in preparation)	☐ FOUNDATION Fieldbus (in preparation)
Explosion protection:	☐ Without ☐ Zones 2, 22 / Cl. 1 Div.2		☐ Zone 0, 1, 20, 21 / Div.1 (Ex ia / IS) ☐ Zone 0, 1, 20, 21 / Div.1 (Ex d / XP)	

NOTICE

If a Vortex- / Swirl flowmeter with PROFIBUS PA or FOUNDATION Fieldbus communication is needed, please select model FV4000 / FS4000.

Notes

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3KXF320001R1001

FSS430 FSS450 Service

DS/FSS430/450-EN Rev. E 08.2017