

FV4000, FS4000

Vortex Flowmeter / Swirl Flowmeter

2-wire Compact Design
Digital Signal Processor
Converter Technology



For metering liquids, gases and steam

FV4000 Vortex flowmeter

FS4000 Swirl flowmeter for very short steadying zones

Approvals for explosion protection

- ATEX
- IEC
- cFM_{us}
Zone 1, Zone 2, dust ignition protection

Magnetic pen operation

- Configuration also possible with closed housing

Integrated switching output

- Used as limit contact or pulse output

Compensation of temperature influences by means of
temperature measurement integrated as an option

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1 Principles of measurement

1.1 Principle of measurement for Vortex flowmeter

The operating principle of the Vortex flowmeter is based on the Karman street. As the fluid flows over and under the solid body, vortices are shed alternately above and below. The shedding of these vortices due to the flow forms a vortex trail (Karman street).

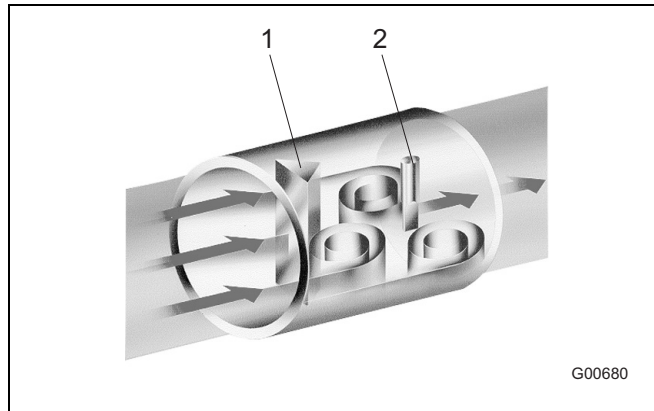


Fig. 1: Principle of measurement, FV4000

- 1 Solid body 2 Piezo sensor

The frequency f of vortex shedding is proportional to the flow velocity v and inversely proportional to the width of the solid body d :

$$f = St \times \frac{v}{d}$$

St , known as the Strouhal number, is a dimensionless number which has a decisive impact on the quality of vortex flow measurement.

If the solid body is dimensioned appropriately, the Strouhal number St will be constant across a very wide range of the Reynolds number Re (Fig. 2).

$$Re = \frac{v \times D}{\vartheta}$$

= Kinematic viscosity

D = Nominal size of meter tube

Consequently, the vortex shedding frequency to be evaluated is dependent solely upon the flow velocity and not at all upon media density and viscosity.

The local changes in pressure induced by vortex shedding are detected by a piezo sensor and converted into electrical pulses corresponding to the vortex frequency.

The frequency signal from the flowmeter sensor, which is proportional to the flow, undergoes downstream processing in the transmitter.

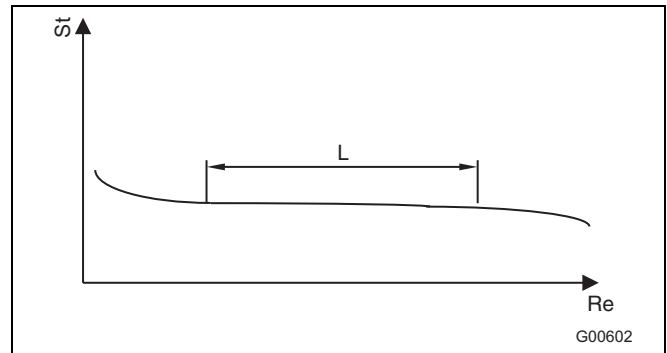


Fig. 2: How the Strouhal number is dependent upon the Reynolds number

- St Strouhal number Re Reynolds number
 L Linear flow area

1.2 Principle of measurement for Swirl flowmeter

The inlet pipe converts the axial flow of the incoming media 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 exhibits an optimum design, will be linear over a wide flow 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.

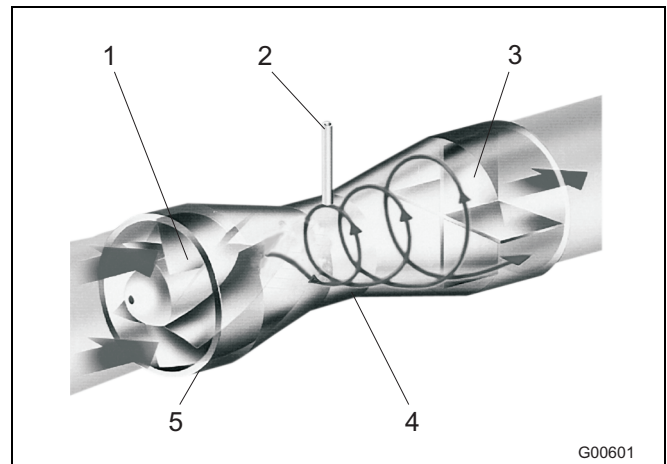
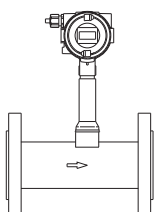
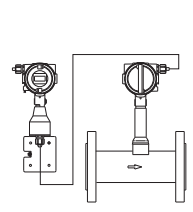
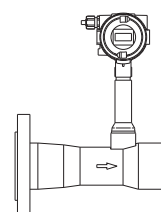
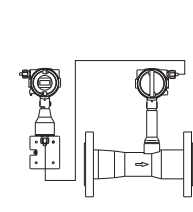


Fig. 3

- 1 Inlet pipe 4 Stagnation point
 2 Piezo sensor 5 Housing
 3 Outlet pipe

2 Overview of flowmeters

		FV4000-VT4 (TRIO-WIRL VT)	FV4000-VR4 (TRIO-WIRL VR)	FS4000-ST4 (TRIO-WIRL ST)	FS4000-SR4 (TRIO-WIRL SR)
					
		G00740	G00742	G00741	G00743
Measured value error	Fluids	≤ ± 0.75 % of flow rate under reference conditions		≤ ± 0.5 % of flow rate under reference conditions	
	Gases and steam	≤ ± 1 % of flow rate under reference conditions			
Reproducibility		DN 15 ≤ ± 0.3 % of flow rate		DN 15 ≤ ± 0.3 % of flow rate DN 20 or higher ≤ ± 0.2 of flow rate	
		DN 15 to DN 150 ≤ ± 0.2 of flow rate			
		DN 200 or higher ≤ ± 0.25 % of flow rate			
Permissible viscosity for fluids (> 7.5 mPa s, field calibration required for FS4000)		DN 15 ≤ 4 mPa s		DN 15 to DN 32 ≤ 5 mPa s	
		DN 25 ≤ 5 mPa s		DN 40 to DN 50 ≤ 10 mPa s	
		DN 40 or higher ≤ 7.5 mPa s		DN 80 or higher ≤ 30 mPa s	
Typical span		1:20		1:25	
Typical inflow / outflow sections		15 x DN / 5 x DN		3 x DN / 1 x DN	

Sensor

Process connection (DIN, ANSI, JIS)	Flange	DN 15 to DN 300 (1/2" to 12")		DN 15 to DN 400 (1/2" to 16")	
	Wafer flange	DN 15 to DN 150 (1/2" to 6")		-	
Sensor design	Single sensor	Yes, optional with integrated temperature measurement (DN 50 or higher)			
	Double sensor				
Fluid temperature	Standard	-55 ... 280 °C (-67 ... 536 °F)		-55 ... 280 °C (-67 ... 536 °F)	
	High temperature (DN 25 or higher)	-55 ... 400 °C (-67 ... 752 °F)		-	
Ingress protection		IP 65 / IP 67 / Nema 4X			
Materials	Sensor	Stainless steel opt. Hast. C / Titan		Stainless steel opt. Hast. C / Titan	
	Inlet / outlet pipe	-		Stainless steel opt. Hast. C	
	Solid body	Stainless steel opt. Hast. C		-	
	Meter housing	Stainless steel opt. Hast. C		Stainless steel opt. Hast. C	
	Sensor gasket	Graphite, Kalrez, Viton, PTFE		Graphite, Kalrez, Viton, PTFE	
Only FVR4000 or FSR4000	Signal cable length between sensor and transmitter	-	max. 10 m (32.8 ft)	-	max. 10 m (32.8 ft)

Transmitter

Supply power	For analog output 4 ... 20 mA	14 ... 46 V (Ex ib ≤ 28 V)			
	For PROFIBUS PA and FOUNDATION fieldbus	I < 10 mA (9 ... 32 V; Ex ia ≤ 24 V)			
Sealing concept		Dual sealing acc. to ANSI / ISA-12.27.01 (VT43/VR43/ST43/SR43)			
Display	2 x 8-digit / 2 x 16-digit	Local display / totalization with magnetic pen operation / Parameters via HART protocol / PROFIBUS PA / FOUNDATION fieldbus adjustable			
External FRAM		Yes, for saving transmitter parameterization data as well as flowmeter sensor calibration data			
Contact output	(Optocoupler for standard) NAMUR contact (Ex ia / ib)	Can be parameterized as limit contact (flow, temperature), alarm output or pulse output			
Saturated steam calculation / Temperature compensation		Yes, if sensor is fitted with temperature measurement device			
Communication		HART protocol, PROFIBUS PA (Profile 3.0), FOUNDATION fieldbus			

Designs

There are generally two different designs.

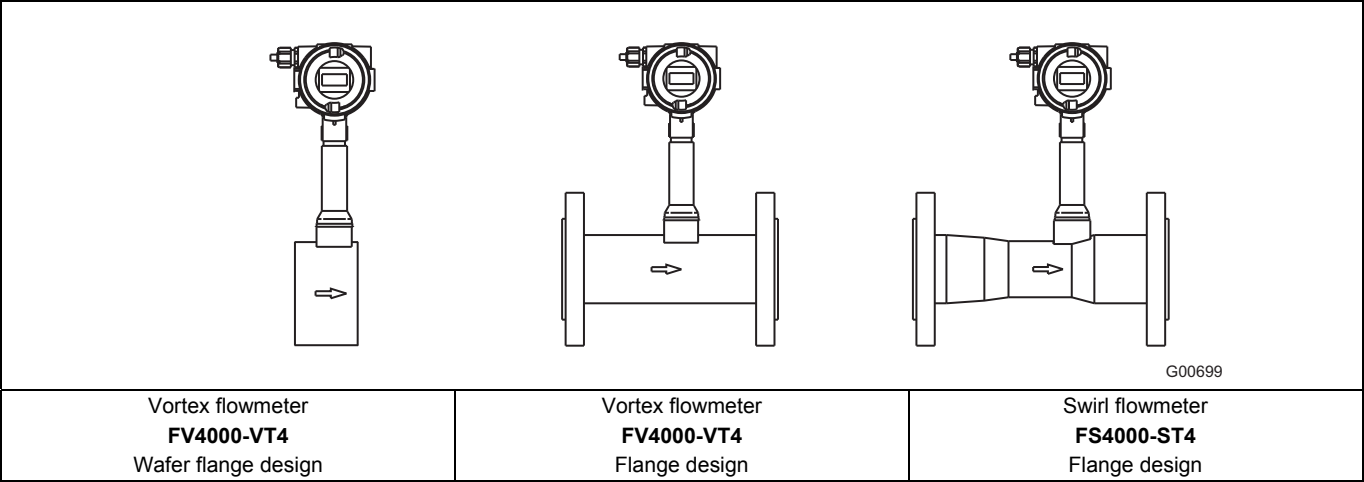


Fig. 4: Integral mount design: The transmitter is installed directly on the sensor.

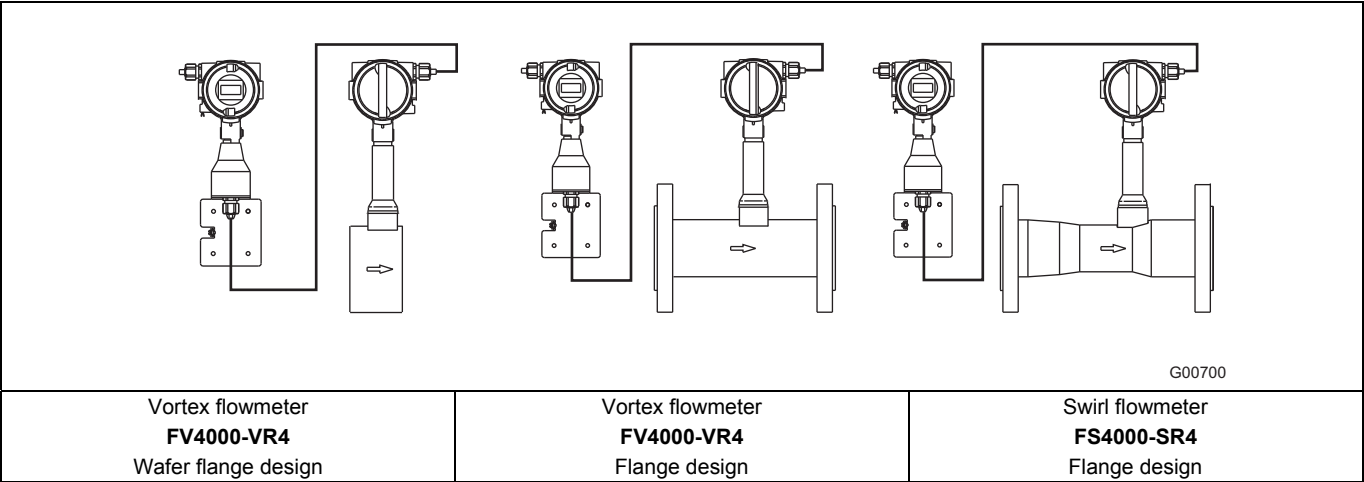


Fig. 5: Remote mount design: The transmitter can be installed up to 10 m away from the flowmeter sensor. The cable is permanently connected to the transmitter. It can be made shorter if required.

3 General specifications

3.1 Nominal diameter selection

The nominal diameter is selected on the basis of the maximum operating flow Q_v max. If maximum spans are to be achieved, this should not be less than half the maximum flowrate for each nominal diameter (Q_v max DN), although reduction to approx. 0.15 Q_v max DN is possible. The linear lower range limit value is dependent upon the Reynolds number (see accuracy information).

If the flow to be measured is the standard flow (standard condition: 0 °C (32 °F), 1,013 mbar) or mass flowrate, this must be converted to the operating flow and the most appropriate nominal device diameter must be selected from the flow range tables (Tables 1, 2, 3).

- ρ = Operating density (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)

1. Conversion of standard density (ρ_n) --> operating density (ρ)

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

2. Conversion to operating flow (Q_v)

a) From standard flow (Q_n) -->

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

b) From mass flowrate (Q_m) -->

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

3. Dynamic viscosity (η) --> kinematic viscosity (ν)

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

Calculating the Reynolds number:

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

Q = Flow in m³/h

d = Pipe diameter in m

= Kinematic viscosity m²/s (1 cst = 10⁻⁶ m²/s)

The current Reynolds number can also be calculated using our AP-Calc calculation program.

3.2 Measured value deviation for flow measurement

Deviation in percentage terms from the measured value under reference conditions (including the transmitter) in the linear measuring range between Re_{min} and Q_{max} (see "Measuring ranges" table).

	FV4000-VT4/VR4	FS4000-ST4/SR4
Fluids	≤ ± 0,75 %	± 0,5 %
Gases / Steam	≤ ± 1 %	
Current output		
Additional measurement uncertainty	< 0,1 %	
Temperature effect	< 0,05 % / 10 K	

Misalignment associated with installation or deinstallation may affect the measuring error.

Additional measuring errors may occur if there are deviations from the reference conditions.

3.2.1 Reproducibility as a percentage of the measured value

DN	Inch	FV4000-VT4/VR4	FS4000-ST4/SR4
15	1/2"	0,3 %	
25 ... 250	1" ... 6"	0,2 %	
200 ... 300	8" ... 12"	0,25 %	0,2 %

3.3 Measured value deviation for temperature

Measured value deviation (including transmitter)

$\pm 2 \text{ }^{\circ}\text{C}$

Reproducibility

$\leq 0.2 \%$ of measured value

Product selection and dimensioning program



Important

The ABB "AP-Calc" program can be used free of charge when selecting an appropriate flowmeter for a given application. The program runs in a Microsoft WINDOWS® environment.

3.4 Permissible pipeline vibrations

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

FV4000:

Fluid: max. 1.0 g, 0 ... 130 Hz

Gas / steam: max. 0.3 g, 0 ... 130 Hz

FS4000:

Fluid: max. 0.3 g, 0 ... 130 Hz

Gas / steam: max. 0.3 g, 0 ... 130 Hz

3.5 Reference conditions for flow measurement

	FV4000-VT4/VR4	FS4000-ST4/SR4
Set flow range	0.5 ... 1 x Q _{vmax} DN	
Ambient temperature	20 °C (68 °F) ± 2K	
Humidity	65 % rel. humidity ± 5 %	
Air pressure	86 ... 106 kPa	
Supply power	24 V DC	
Signal cable length	10 m (32.8 ft) (FV4000-VR or FS4000-SR only)	
Current output load	250 Ω (4 ... 20 mA only)	
Fluid for calibration	Water: approx. 20 °C (68 °F), 2 bar (29 psi)	
Calibration loop internal diameter	= internal diameter of meter	
Unobstructed straight upstream section	15 x DN	3 x DN
Downstream section	5 x DN	1 x DN
Pressure measurement	3 ... 5 x DN downstream of meter	
Temperature measurement	2 ... 3 x DN downstream after pressure measurement	

3.6 FV4000-VT4 / VR4 flowrates

3.6.1 Fluid flowrates

DN		DIN pipe			ANSI pipe			
		Re min	Q _{v,max} DN (m³/h)	Frequency (Hz) at Q _{v,max}	Re min	Q _{v,max} DN (m³/h)	Q _{v,max} DN (US gal/min)	Frequency (Hz) at Q _{v,max}
15	1/2"	10000	6	370	11000	5,5	24	450
25	1"	20000	18	240	23000	18	79	400
40	1 1/2"	20000	48	270	23000	48	211	270
50	2"	20000	70	180	22000	66	291	176
80	3"	43000	170	140	48000	160	704	128
100	4"	33000	270	100	44000	216	951	75
150	6"	67000	630	50	80000	530	2334	50
200	8"	120000	1100	45	128000	935	4117	40
250	10"	96000	1700	29	115000	1445	6362	36
300	12"	155000	2400	26	157000	2040	8982	23

The flowrates apply for fluids at 20 °C (68 °F), 1,013 mbar (14.69 psi), ρ = 998 kg/m³ (62.30 lb/ft³).

3.6.2 Gas / Steam flowrates

DN		DIN pipe			ANSI pipe			
		Re min	Q _{v,max} DN (m³/h)	Frequency (Hz) at Q _{v,max}	Re min	Q _{v,max} DN (m³/h)	Q _{v,max} DN (ft³/min)	Frequency (Hz) at Q _{v,max}
15	1/2"	10000	24	1520	11000	22	13	1980
25	1"	20000	150	2040	23000	82	48	1850
40	1 1/2"	20000	390	2120	23000	340	200	1370
50	2"	20000	500	1200	22000	450	265	1180
80	3"	43000	1200	1000	48000	950	559	780
100	4"	33000	1900	700	44000	1800	1059	635
150	6"	67000	4500	480	80000	4050	2384	405
200	8"	120000	8000	285	128000	6800	4002	240
250	10"	96000	14000	260	115000	12000	7063	225
300	12"	155000	20000	217	157000	17000	10006	195

The flowrates apply for gas at ρ = 1.2 kg/m³ (0.075 lb/ft³).

3.7 FS4000-ST4 / SR4 flowrates

3.7.1 Fluid flowrates

DN		Re min	Q _{V,max} DN (m ³ /h)	Q _{V,max} DN (US gal/min)	Frequency (Hz) at Q _{V,max} DN
15	1/2"	2100	1,6	7,0	185
20	3/4"	3500	2	8,8	100
25	1"	5200	6	26	135
32	1 1/4"	7600	10	44	107
40	1 1/2"	13500	16	70	110
50	2"	17300	25	110	90
80	3"	15000	100	440	78
100	4"	17500	150	660	77
150	6"	43000	370	1620	50
200	8"	44000	500	2200	30
300	12"	115000	1000	4400	16
400	16"	160000	1800	7920	13

The flowrates apply for fluids at 20 °C (68 °F), 1,013 mbar (14.69 psi), $\rho = 1 \text{ cSt}$, $\rho = 998 \text{ kg/m}^3$ (62.30 lb/ft³).

3.7.2 Gas / Steam flowrates

DN		Q _{V,min} (m ³ /h)	Q _{V,max} DN (m ³ /h)	Q _{V,min} (ft ³ /min)	Q _{V,max} DN (ft ³ /min)	Frequency (Hz) at Q _{V,max} DN
15	1/2"	2.5	16	1.4	9.4	1900
20	3/4"	5	25	2.9	14	1200
25	1"	5	50	2.9	29	1200
32	1 1/4"	8	130	4.7	76	1300
40	1 1/2"	12	200	7.0	117	1400
50	2"	18	350	10	206	1200
80	3"	60	850	35	500	690
100	4"	65	1500	38	882	700
150	6"	150	3600	88	2110	470
200	8"	200	4900	117	2880	320
300	12"	530	10000	311	5880	160
400	16"	1050	20000	618	11770	150

The flowrates apply for gas / steam at $\rho = 1.2 \text{ kg/m}^3$ (0.075 lb/ft³).

The frequency information is for orientation purposes only. For individual nominal diameters and designs, ranges are supplied in which typical frequencies lie.

3.8 Static overpressure in the case of fluids

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

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

p_2 = Static overpressure downstream of the flowmeter (mbar)

p_{Dampf} = Steam pressure of fluid at operating temperature (mbar)

$\Delta p'$ = Pressure drop, medium (mbar)

3.9 Overload capability

Gases

15 % above maximum flow

Fluids

15 % above maximum flow (no cavitation permitted!)

3.10 Temperature of medium



Important

Please note the information in the section titled "Explosion protection".

Compliance with the permissible temperature range for the gaskets is mandatory.

	FV4000-VT4/VR4	FS4000-ST4/SR4
Standard	-55 ... 280 °C (-67 ... 536 °F)	
HT design	-55 ... 400 °C (-67 ... 752 °F)	-

3.11 Flowmeter insulation

The pipeline may be insulated up to a maximum of 100 mm (4 inch) upper edge.

Use of trace heating

Trace heating may be used under the following conditions:

- If it is fixed directly on or around the pipeline
- If, in the case of existing pipeline insulation, it is installed inside the insulation (the maximum height of 100 mm (4 inch) must not be exceeded)
- If the maximum temperature the trace heating is able to produce ≤ the maximum temperature of the medium

The requirements to be met by integrators set out in EN 60079-14 must be complied with!

Please note that the use of trace heaters will not impair EMC protection or generate additional vibrations.

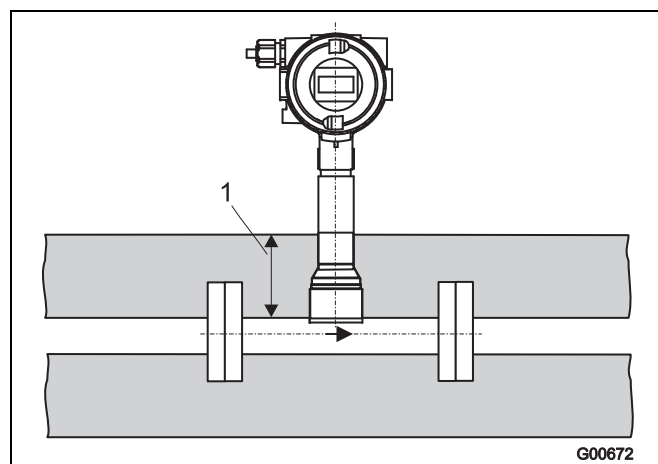


Fig. 6: Flowmeter insulation

- 1 Maximum 100 mm (4 inch)

3.12 Ambient conditions

Resistance to climate to DIN 40040

Permissible ambient temperature range

Explosion protection / Model	Temperature range
None / VT40 and VR40 / ST40 and SR40	-20 ... 70 °C (-4 ... 158 °F)
	-55 ... 70 °C (-67 ... 158 °F)
Ex ib / VT41 and VR41 / ST41 and SR41	-20 ... 70 °C (-4 ... 158 °F) 1)
	-40 ... 70 °C (-67 ... 158 °F) 1)
Ex ia / VT4A and VR4A / ST4A and SR4A	-20 ... 60 °C (-4 ... 140 °F)
	-30 ... 60 °C (-40 ... 140 °F)
Ex d / VT42 and VR42 / ST42 and SR42	-20 ... 60 °C (-4 ... 140 °F)
	-40 ... 60 °C (-40 ... 140 °F)
cFM _{US} / VT43 and VR43 / ST43 and SR43	-20 ... 70 °C (-4 ... 158 °F)
	-45 ... 70 °C (-49 ... 158 °F)

1) Category 2D (dust-ignition proof) maximum 60° C (140° F)

Permissible air humidity

Design	Humidity
Standard	Relative humidity max. 85 %, annual mean ≤ 65 %
Climate-proof	Relative humidity ≤ 100 % permanent

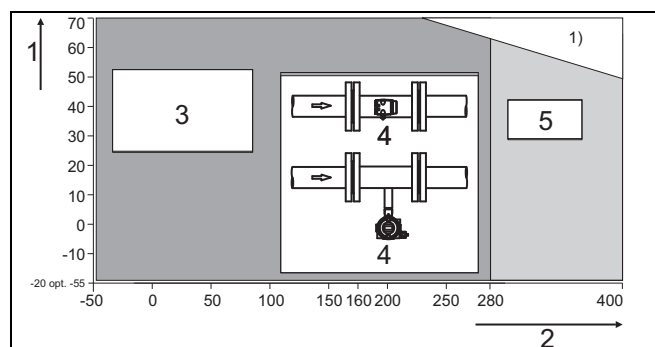


Fig. 7: Relationship between the temperature of the fluid and the ambient temperature

- | | |
|---|---|
| 1 Ambient temperature | 4 Installation for medium temperature > 150 °C (302 °F) |
| 2 Media temperature | |
| 3 Permissible temperature range for standard design (≤ 280 °C (≤ 536 °F)) | 5 HT design (≤ 400 °C (≤ 752 °F)), FV4000-VT4 only |

1) For the supply circuit (terminals 31 / 32) and the switching outputs 41 and 42, cables suitable for temperatures up to T = 110 °C (230 °F) may be used without restriction. Cables which are only suitable for temperatures up to T = 80 °C (176 °F) restrict the temperature ranges. These restrictions also apply to the VR version (remote design) and the PROFIBUS PA design with plug connector.



Important

The legibility of the display can be impaired at temperatures < 0 °C (< 32 °F) and > 55 °C (> 131 °F). The functionality of the meter and the outputs remains unaffected by this. Please refer to the order information for ambient temperatures < -20 °C (< -4 °F).

Please note the information in the section titled 5 „Transmitter specifications“.

3.13 Installation Requirements

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 inflow/outflow sections
- The flow direction must correspond to that indicated by the arrow on the flowmeter sensor.
- Compliance with the required minimum interval for removing the transmitter and replacing the sensor
- Avoidance of mechanical vibrations of the pipeline (by fitting supports if necessary)
- The internal diameter of the flowmeter sensor and the pipe must be identical.
- Avoidance of pressure vibrations at zero flow by fitting gates at intervals in long pipeline systems
- 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 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 pipeline 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 media and must not run dry.
- When fluids are measured and during damping there must be no evidence of cavitation.
- The relationship between the temperature of the media and the ambient temperature has to be taken into account (see "Ambient conditions" in the section titled "Technical data").
- At high media temperatures > 150 °C (302 °F), the flowmeter sensor must be installed so that the electronics are pointing to the side or downward.

3.14 Recommended inflow and outflow sections

3.14.1 Vortex flowmeter

In order to maximize operational reliability, the flow profile at the inflow end must not be distorted if at all possible. Provision should be made for an inflow section measuring approx. 15 times the nominal diameter. At elbows, the inflow section should measure at least 25 times the nominal diameter, at round elbows 40 times the nominal diameter and where shutoff valves appear in the inflow section, 50 times the nominal diameter. A value 5 times the size of the nominal diameter is required at the outflow end.

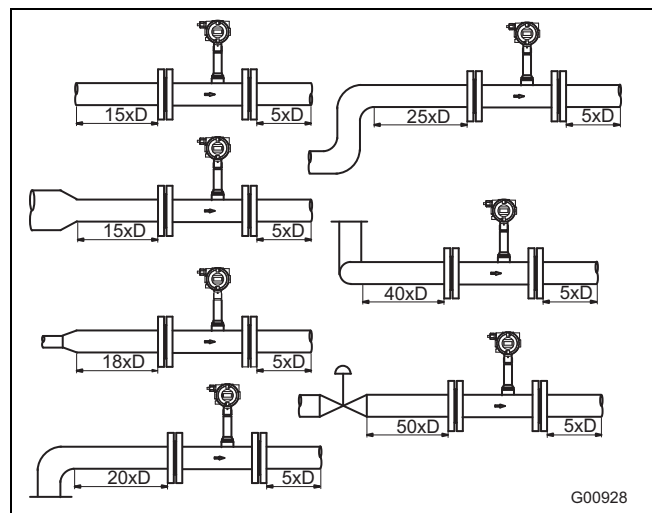


Fig. 8: Recommended inflow and outflow sections

3.14.2 Swirl flowmeter

On account of its operating principle, the Swirl flowmeter functions virtually without inflow and outflow sections. The figure below shows the recommended inflow and outflow sections for various installations. Inflow and outflow sections are not required if the elbow radius of single or double pipe elbows upstream and downstream of the meter is greater than $1.8 \times D$. Similarly, additional inflow and outflow sections are not required downstream of reductions with flange transition pieces conforming to DIN 28545 ($\alpha/2 = 8$).

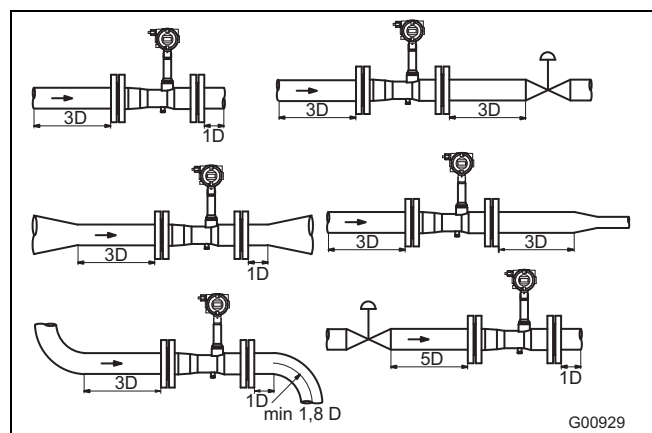


Fig. 9: Recommended inflow and outflow sections

3.15 Installation at high media temperatures > 150°C (302°F)

At high media temperatures > 150°C (302 F) the flowmeter sensor must be installed so that the transmitter is pointing to the side or downward (see the figure below).

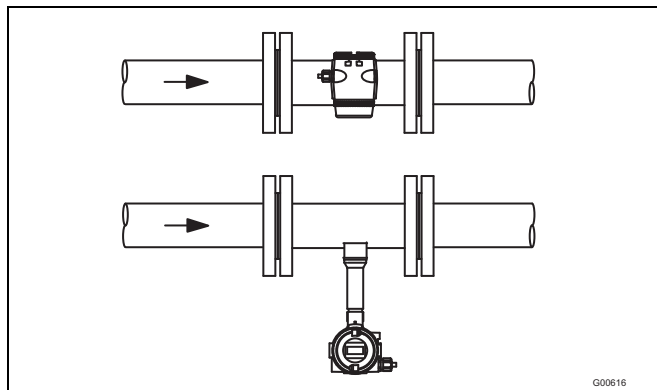


Fig. 10

3.16 Installation for pressure and temperature measurement

As an option, the flowmeter can be fitted with a Pt100 for direct temperature measurement. This temperature measurement supports, for example, the monitoring of the media 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 "Sensycal"), the measuring points must be installed as illustrated in the figure below.

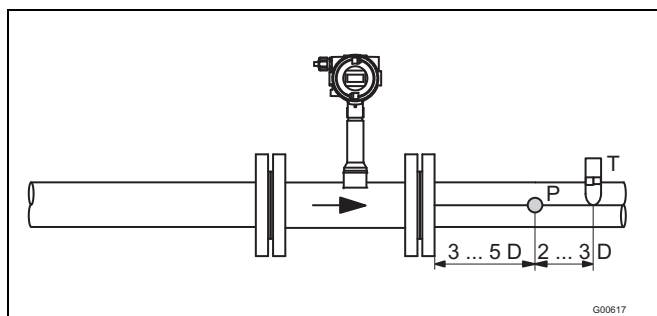


Fig. 11: Arrangement of temperature and pressure measuring points

3.17 Installation of final controlling equipment

Final controlling equipment must be arranged at the outflow end spaced at a minimum 5 x DN.

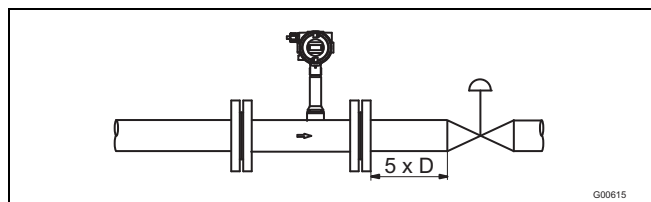


Fig. 12: Installation of final controlling equipment

If the 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 pipeline when the valve is closed. If this does occur, the valve absolutely has to be installed in the flow direction upstream of the flowmeter. The FS4000 Swirl flowmeter is particularly suited to such scenarios. Suitable dampers (e.g. air vessels in the case of pumping using a compressor) might need to be used.

3.18 Process connections

	Flange design		Wafer flange design	
	Process connection	Operating pressure	Process connection	Operating pressure
FV4000-VT4/VR4	DN15 ... DN300	O-ring gasket: DIN PN 10 ... PN 40, option up to PN 160 ASME Class 150 / 300, option up to 900 lb Flat gasket (graphite): Maximum PN 64 / ASME Class 300 lb	DN25 ... DN150	O-ring gasket: DIN PN 64, option up to PN 100 ASME Class 150 / 300, option up to 600 lb Flat gasket (graphite): Maximum PN 64 / ASME Class 300 lb
FS4000-ST4/SR4	DN 15 ... DN 200 ¹⁾	DIN PN 10 ... PN 40 ASME Class 150/300	-	-
	DN 300 ... DN 400 ¹⁾	DIN PN 10 ... PN 16 ASME Class 150		

1) Other designs on request.

3.19 Materials

Component	Material	Temperature range	
		FV4000-VT4/VR4	FS4000-ST4/SR4
Meter housing	Stainless steel 1.4571 (316Ti) / 316L / CF8 / CF8C, Option: Hastelloy C	-55 ... 400 °C (-67 ... 752 °F)	-55 ... 280 °C (-67 ... 536 °F)
Swirl body / Inlet/outlet pipes	Stainless steel 1.4571 (316Ti) / 316L / CF8 / CF8C, Option: Hastelloy C	(CF8: -55 ... 300 °C (-67 ... 572 °F))	
Sensor	Stainless steel 1.4571, Option: Hastelloy C		
Sensor gasket ¹⁾	Kalrez (3018) o-ring	0 ... 280 °C (32 ... 536 °F)	0 ... 280 °C (32 ... 536 °F)
	Kalrez (6375) o-ring	-20 ... 275 °C (-4 ... 527 °F)	20 ... 275 °C (68 ... 527 °F)
	Viton o-ring	-55 ... 230 °C (-67 ... 446 °F)	-55 ... 230 °C (-67 ... 446 °F)
	PTFE o-ring	-55 ... 200 °C (-67 ... 392 °F)	-55 ... 200 °C (-67 ... 392 °F)
	Graphite	-55 ... 280 °C (-67 ... 536 °F)	-55 ... 280 °C (-67 ... 536 °F)
	Graphite special	-55 ... 400 °C (-67 ... 752 °F) (High temperature)	-
Housing, electronics	Cast aluminum, varnished		

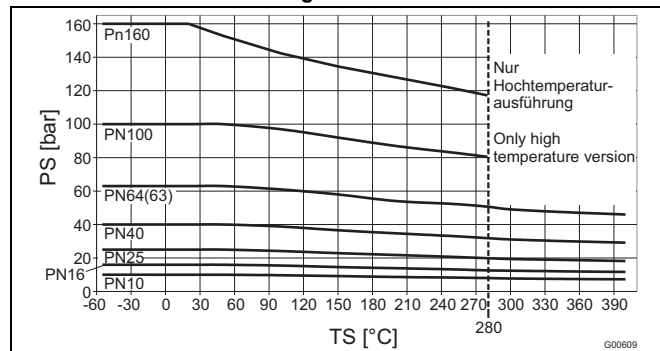
1) Other designs on request.

3.20 Weights

The dimension tables contain weight details.

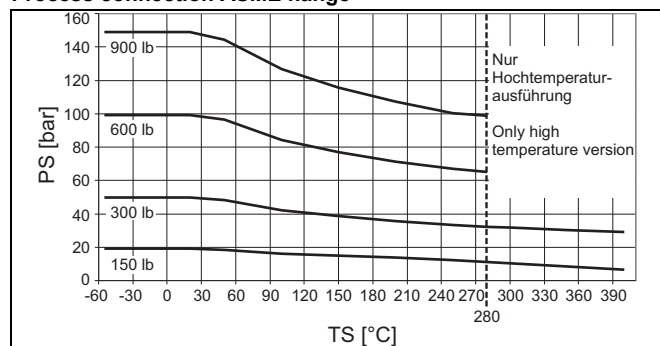
3.20.1 Permissible operating pressures FV4000

Process connection DIN flange



PS Pressure (bar) TS Temperature (°C)

Process connection ASME flange

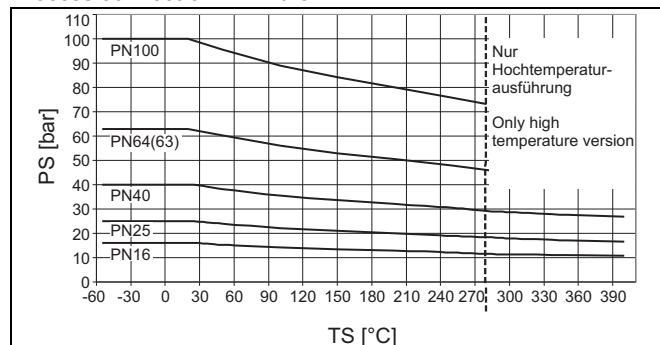


PS Pressure (bar) TS Temperature (°C)

Aseptic flange to DIN 11864-2

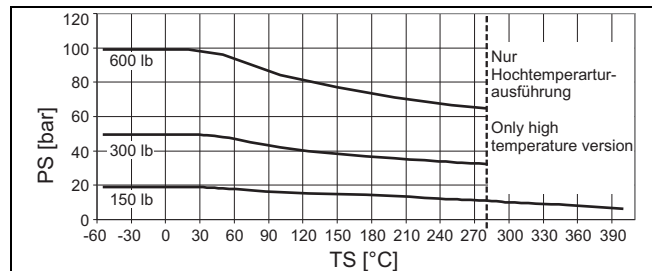
- DN 25 to DN 40:
PS = 25 bar to TS = 140 °C if suitable gasket materials are selected
- DN 50 and DN 80:
PS = 16 bar to TS = 140 °C if suitable gasket materials are selected

Process connection DIN wafer



PS Pressure (bar) TS Temperature (°C)

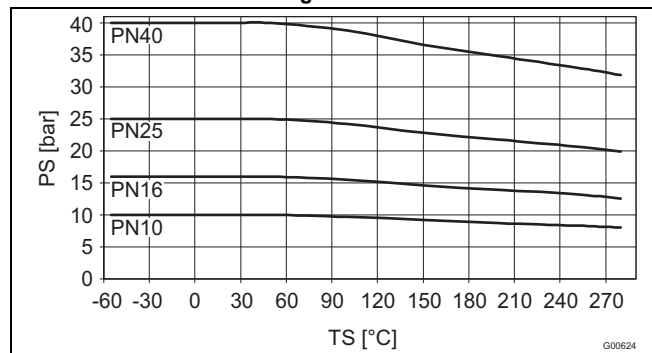
Process connection ASME wafer



PS Pressure (bar) TS Temperature (°C)

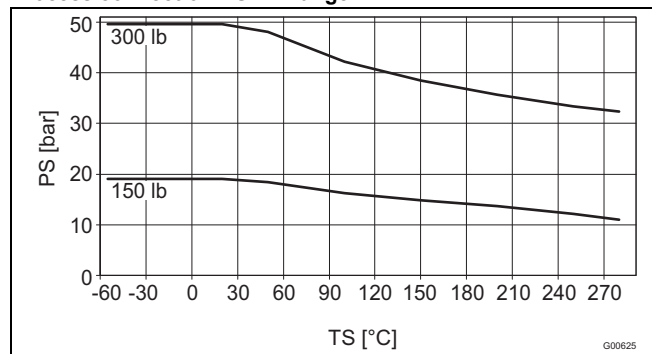
3.20.2 Permissible operating pressures FS4000

Process connection DIN flange



PS Pressure (bar) TS Temperature (°C)

Process connection ASME flange



PS Pressure (bar) TS Temperature (°C)

4 Dimensions

4.1 FV4000-VT4/VR4 (TRIO-WIRL V), wafer design

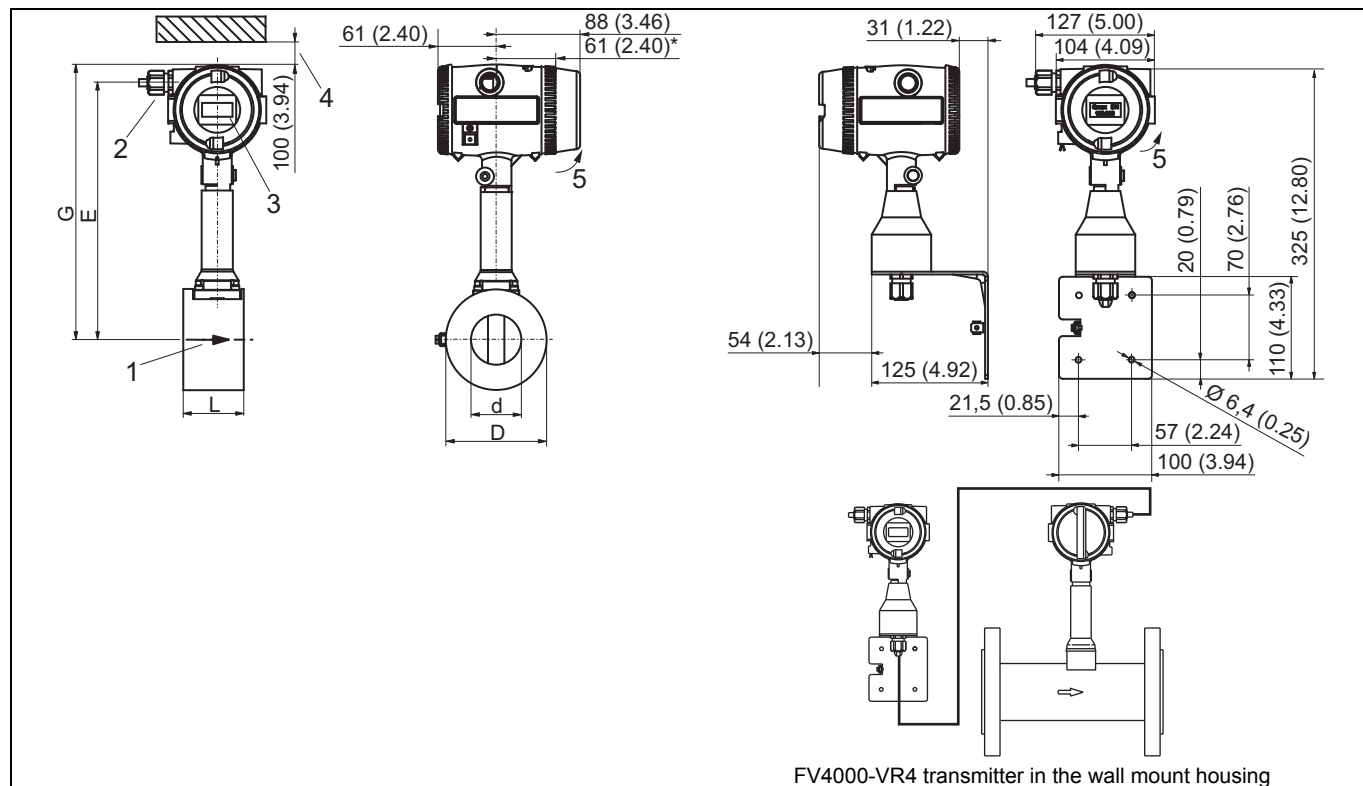


Fig. 19: Dimensions in mm (inch), projection in accordance with ISO method E

- 1 Flow direction
- 2 Power supply
- 3 Display with VT4 design only

- 4 Required minimum distance for removing the transmitter and disassembling the sensor unit
- 5 Can be rotated 330°

*) Reduced dimension for VR4 design with remote transmitters

Nominal diameter DN	Nominal pressure PN	Dimensions in mm (inch)					Weight in kg (lb)
		L	E	D	G	d	
		T _{max} 280 °C (536 °F)					
25	64	65 (2,56)	274 (10,79)	73 (2,87)	293 (11,54)	28,5 (1,12)	4,1 (9,0)
40	64	65 (2,56)	290 (11,42)	94 (3,70)	309 (12,17)	43 (1,69)	4,8 (10,6)
50	64	65 (2,56)	298 (11,73)	109 (4,29)	317 (12,48)	54,4 (2,14)	5,6 (12,4)
80	64	65 (2,56)	312 (12,28)	144 (5,67)	331 (13,03)	82,4 (3,24)	7,6 (16,8)
100	64	65 (2,56)	320 (12,6)	164 (6,46)	339 (13,35)	106,8 (4,20)	8,5 (18,7)
150	64	65 (2,56)	352 (13,86)	220 (8,66)	371 (14,61)	159,3 (6,27)	13 (28,7)

Nominal diameter DN	Pressure PN		Dimensions in mm (inch)					Weight in kg (lb)
			L	E	D	G	d	
	Lb	Schedule	T _{max} 280 °C					
1"	300	80	112,5 (4,43)	284 (11,18)	70,5 (2,78)	303 (11,93)	24,3 (0,96)	5,1 (11,2)
1 1/2"	300	80	113 (4,45)	290 (11,42)	89,5 (3,52)	309 (12,17)	38,1 (1,50)	6,1 (13,5)
2"	150 / 300	80	112,5 (4,43)	296 (11,65)	106,5 (4,19)	315 (12,40)	49,2 (1,94)	8,4 (18,5)
3"	300	80	111 (4,37)	312 (12,28)	138,5 (5,45)	331 (13,03)	73,7 (2,90)	11,2 (24,7)
4"	300	80	116 (4,57)	325 (12,80)	176,5 (6,95)	344 (13,54)	97,2 (3,83)	17,2 (37,9)
6"	300	80	137 (5,39)	352 (13,86)	222,2 (8,75)	371 (14,61)	146,4 (5,76)	25,7 (56,7)

4.2 FV4000-VT4/VR4 (TRIO-WIRL V), flange design, DIN

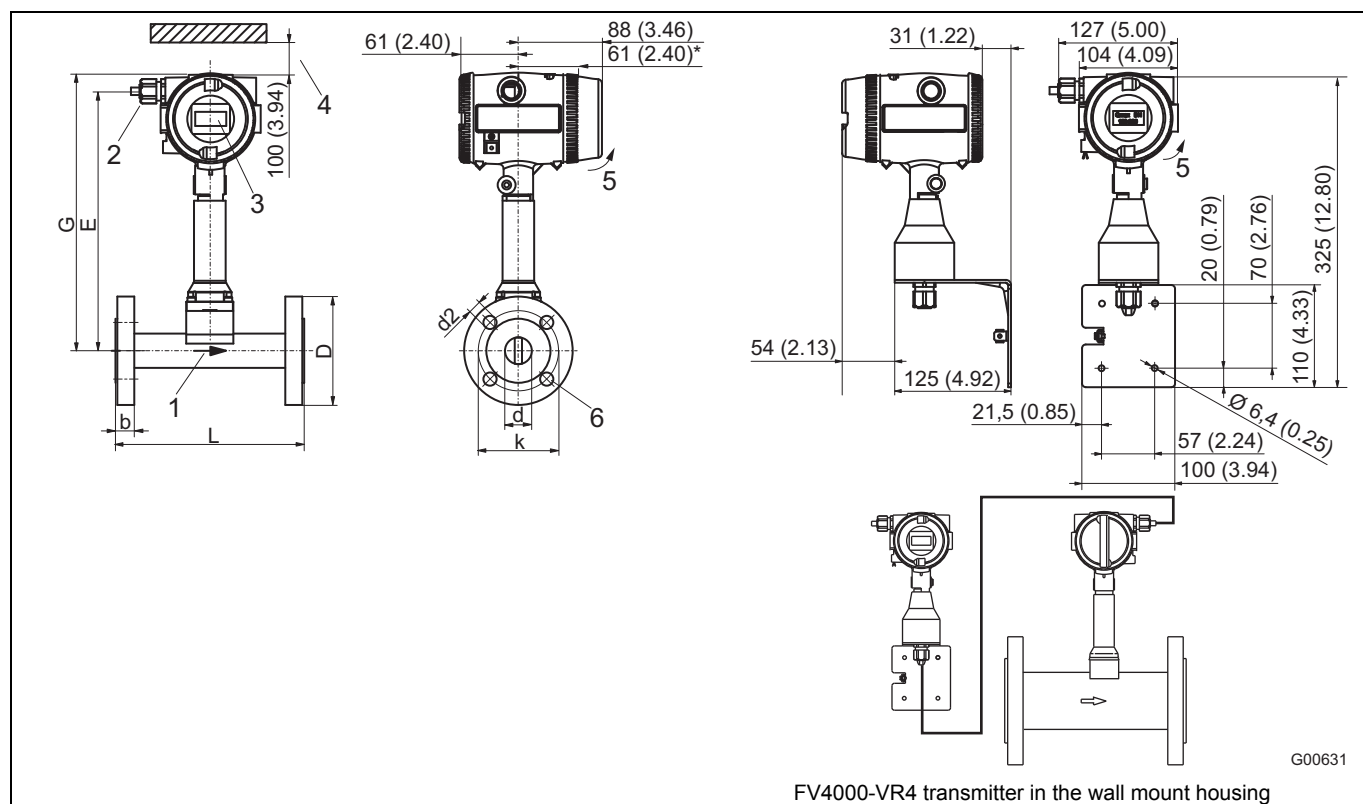


Fig. 20: Dimensions in mm (inch), projection in accordance with ISO method E

- 1 Flow direction
- 2 Power supply
- 3 Display with VT4 design only
- 4 Required minimum distance for removing the transmitter and disassembling the sensor unit
- 5 Can be rotated 330°
- 6 Number of holes N

*) Reduced dimension for VR4 design with remote transmitters

Nominal diameter DN	Nominal pressure DN	Dimensions in mm (inch)				Weight in kg (lb)
		L ¹⁾	E	D	G	
		T _{max} 280 °C / 536 °F				
15	10 ... 40	200 (7,87)	296 (11,65)	95 (3,74)	315 (12.40)	4,5 (9,9)
	64 / 100	200 (7,87)		105 (4,13)		5,4 (11,9)
	160	200 (7,87)		105 (4,13)		5,4 (11,9)
25	10 ... 40	200 (7,87)	313 (12,32)	115 (4,53)	332 (13.07)	5,1 (11,2)
	64	210 (8,27)		140 (5,51)		7,8 (17,2)
	100					
	160					
40	10 ... 40	200 (7,87)	291 (11,46)	150 (5,91)	310 (12.20)	6,6 (14,6)
	64	220 (8,66)		170 (6,69)		10,1 (22,3)
	100	220 (8,66)		170 (6,69)		10,5 (23,2)
	160	225 (8,86)		170 (6,69)		10,5 (23,2)
50	10 ... 40	200 (7,87)	298 (11,73)	165 (6,50)	317 (12.48)	8,7 (19,2)
	64	220 (8,66)		180 (7,09)		12,2 (26,9)
	100	230 (9,06)		195 (7,68)		15,1 (33,3)
	160	245 (9,65)		195 (7,68)		15,6 (34,4)
80	10 ... 40	200 (7,87)	316 (12,44)	200 (7,87)	335 (13.19)	13,1 (28,9)
	64	250 (9,84)		215 (8,46)		17 (37,5)
	100	260 (10,24)		230 (9,06)		21,4 (47,2)
	160	280 (11,02)		230 (9,06)		22,9 (50,5)
100	10 ... 16	250 (9,84)	325 (12,80)	220 (8,66)	344 (13.54)	14 (30,9)
	25 ... 40	250 (9,84)		235 (9,25)		17,8 (39,2)
	64	270 (10,63)		250 (9,84)		24,1 (53,1)
	100	300 (11,81)		265 (10,43)		32,2 (71,0)
	160	320 (12,60)		265 (10,43)		34,4 (75,9)
150	10 ... 16	300 (11,81)	352 (13,86)	285 (11,22)	371 (14.61)	25,4 (56,0)
	25 ... 40	300 (11,81)		300 (11,81)		33,6 (74,1)
	64	330 (12,99)		345 (13,58)		53,8 (118,6)
	100	370 (14,57)		355 (13,98)		70,4 (155,2)
	160	390 (15,35)		355 (13,98)		75 (165,4)
200	10	350 (13,78)	414 (16,30)	340 (13,39)	433 (17.05)	45,3 (99,9)
	16	350 (13,78)		340 (13,39)		45,3 (99,9)
	25	350 (13,78)		360 (14,17)		66,3 (146,2)
	40	350 (13,78)		375 (14,76)		66,3 (146,2)
	64	370 (14,57)		415 (16,34)		93,1 (205,3)
250	10 / 16	450 (17,72)	439 (17,28)	395 / 405 (15,55 / 15,94)	458 (18.03)	67,4 (148,6)
	25 / 40	450 (17,72)		425 / 450 (16,73 / 17,72)		106,4 (234,6)
	64	450 (17,72)		470 (18,50)		135,6 (299,0)
300	10 / 16	500 (19,69)	464 (18,27)	445 / 460 (17,52 / 18,11)	483 (19.02)	77,2 (170,2)
	25 / 40	500 (19,69)		485 / 515 (19,09 / 20,28)		123,2 (271,6)
	64	500 (19,69)		530 (20,87)		170,6 (376,1)

1) Dimension tolerance: DN 15 ... DN 200 +0 / -3 mm; DN 300 ... DN 400: +0 / -5 mm

4.3 FV4000-VT4/VR4 (TRIO-WIRL V), flange design, ASME

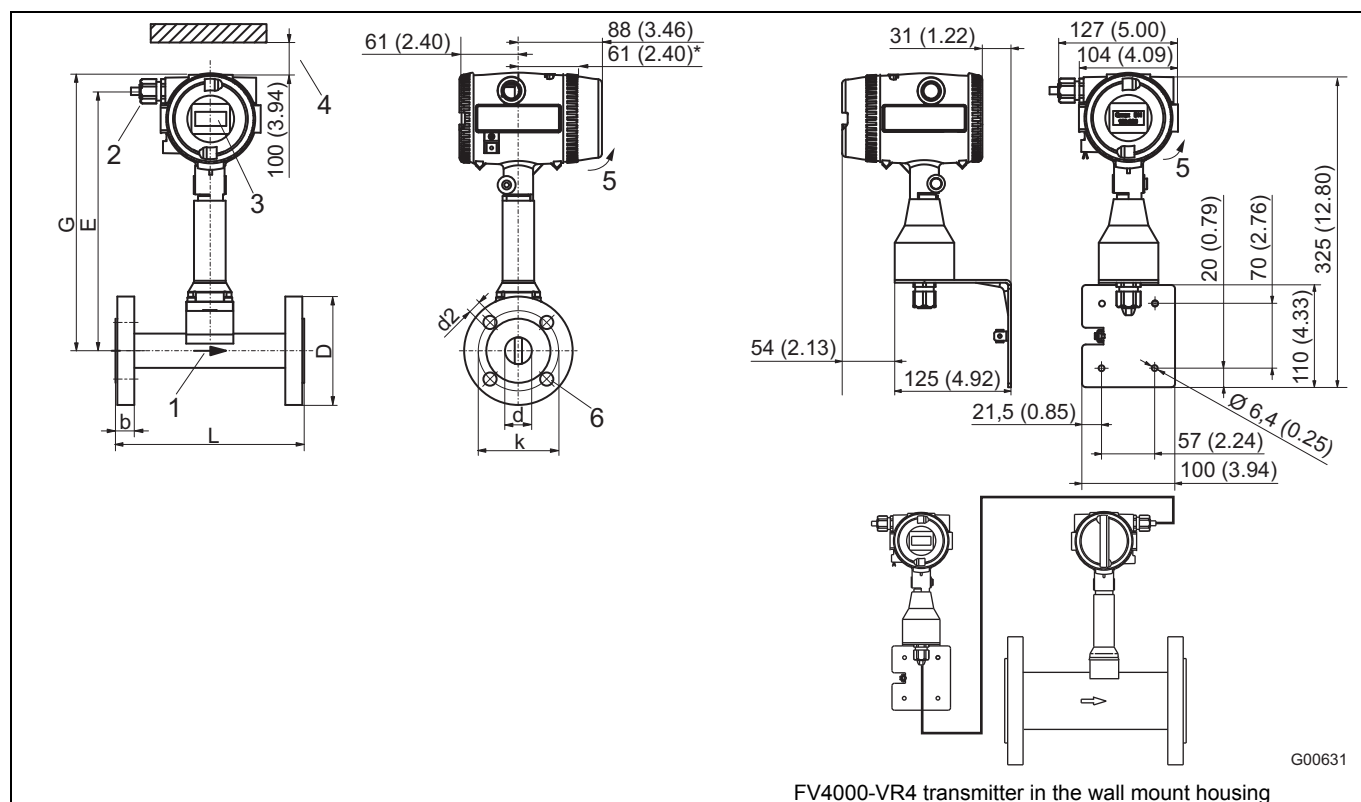


Fig. 21: Dimensions in mm (inch), projection in accordance with ISO method E

- | | | | |
|---|------------------------------|---|--|
| 1 | Flow direction | 4 | Required minimum distance for removing the transmitter and disassembling the sensor unit |
| 2 | Power supply | 5 | Can be rotated 330° |
| 3 | Display with VT4 design only | 6 | Number of holes N |

*) Reduced dimension for VR4 design with remote transmitters

Nominal diameter DN	Pressure PN		Dimensions in mm (inch)				Weight in kg (lb)
			L	E	D	G	
	lb	Schedule	T _{max} 280 C / 536 °F				
1/2"	150	40	200 (7,87)	296 (11,65)	88,9 (3,5)	315 (12,4)	5,0 (11)
	300	40	200 (7,87)		95,2 (3,75)		5,1 (11,2)
	600	40	200 (7,87)		95,3 (3,75)		5,2 (11,5)
	900	40	200 (7,87)		120,6 (4,75)		7,9 (17,4)
1"	150	80	200 (7,87)	313 (12,32)	108 (4,25)	332 (13,07)	5,7 (12,6)
	300	80	200 (7,87)		124 (4,88)		6,7 (14,8)
	600	80	200 (7,87)		124 (4,88)		7,3 (16,1)
	900	80	240 (9,45)		149,3 (5,88)		11,2 (24,7)
1 1/2"	150	80	200 (7,87)	291 (11,46)	127 (5,0)	310 (12,2)	8,5 (18,7)
	300	80	200 (7,87)		155,6 (6,13)		10,9 (24)
	600	80	235 (9,25)		155,6 (6,13)		12,1 (26,7)
	900	80	260 (10,24)		177,8 (7,0)		17,0 (37,5)
2"	150	80	200 (7,87)	298 (11,73)	152,4 (6,0)	317 (12,8)	10,1 (22,3)
	300	80	200 (7,87)		165 (6,5)		11,7 (25,8)
	600	80	240 (9,45)		165 (6,5)		13,6 (30)
	900	80	300 (11,81)		215,9 (8,5)		26,5 (58,4)
3"	150	80	200 (7,87)	316 (12,44)	190,5 (7,5)	335 (13,19)	17,6 (38,8)
	300	80	200 (7,87)		209,5 (8,25)		21,7 (47,8)
	600	80	265 (10,43)		209,5 (8,25)		25,8 (56,9)
	900	80	305 (12,01)		241,3 (9,5)		35,0 (77,2)
4"	150	80	250 (9,84)	325 (12,8)	228,6 (9,0)	344 (13,54)	20,1 (44,3)
	300	80	250 (9,84)		254 (10,0)		28,8 (63,5)
	600	80	315 (12,40)		273,1 (10,75)		41,4 (91,3)
	900	80	340 (13,39)		292,1 (11,5)		51,4 (113,3)
6"	150	80	300 (11,81)	352 (13,86)	279,4 (11,0)	371 (14,61)	32,8 (72,3)
	300	80	300 (11,81)		317,5 (12,5)		49,8 (109,8)
	600	80	365 (14,37)		355,6 (14)		81,6 (179,9)
	900	80	410 (16,14)		381 (15)		106,8 (235,5)
8"	150	80	350 (13,78)	414 (16,30)	343 (13,5)	433 (17,05)	
	300	80	350 (13,78)		381 (15)		
	600	80	415 (16,34)		419,1 (16,5)		
	900	80	470 (18,5)		469,9 (18,5)		
10"	150	40	450 (17,72)	439 (17,28)	406,4 (16)	458 (18,03)	
	300	40	450 (17,72)		444,5 (17,5)		
	600	80	470 (18,50)		508 (20)		
12"	150	40	500 (19,69)	464 (18,27)	482,6 (19)	483 (19,02)	
	300	40	500 (19,69)		520,7 (20,5)		
	600	80	500 (19,69)		558,8 (22)		

4.4 FS4000-ST4/SR4 (TRIO-WIRL S)

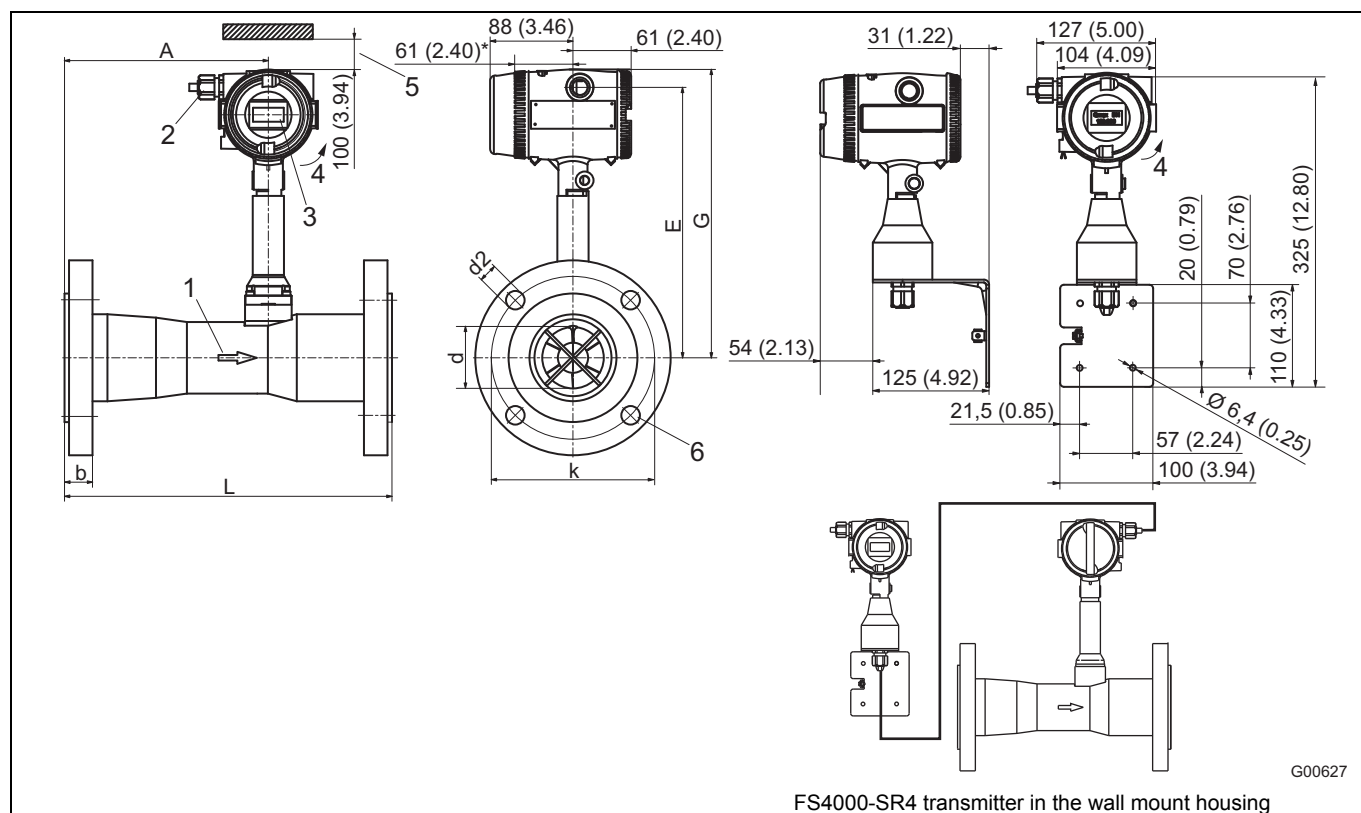


Fig. 22: All dimensions in mm (inch), projection in accordance with ISO method E

- | | |
|--------------------------------|--|
| 1 Flow direction | 4 Can be rotated 330° |
| 2 Power supply | 5 Required minimum distance for removing the transmitter and disassembling the sensor unit |
| 3 Display with ST4 design only | 6 Number of holes N |

*) Reduced dimension for SR4 design with remote transmitters

Nominal diameter DN	Nominal pressure PN	Dimensions in mm (inch)						Weight in kg (lb)
		L ¹⁾	G	E	A	D	d	
15	10 ... 40	200 (7,87)	319 (12,56)	300 (11,81)	83 (3,27)	95 (3,74)	17,3 (0,68)	5,8 (12,8)
20	10 ... 40	200 (7,87)	322 (12,68)	303 (11,93)	68 (2,68)	105 (4,13)	22,6 (0,89)	2,4 (5,3)
25	10 ... 40	150 (5,91)	321 (12,64)	302 (11,89)	67 (2,64)	115 (4,53)	28,1 (1,11)	3,5 (7,7)
32	10 ... 40	150 (5,91)	319 (12,56)	300 (11,81)	68 (2,68)	140 (5,51)	37,1 (1,46)	4,7 (10,4)
40	10 ... 40	200 (7,87)	323 (12,72)	304 (11,97)	79 (3,11)	150 (5,91)	42,1 (1,66)	8 (17,6)
50	10 ... 40	200 (7,87)	326 (12,83)	307 (12,09)	106 (4,17)	165 (6,50)	51,1 (2,01)	7,2 (15,9)
80	10 ... 40	300 (11,81)	329 (12,95)	310 (12,20)	159 (6,26)	200 (7,87)	82,6 (3,25)	12,2 (26,9)
100	10 ... 16	350 (13,78)	333 (13,11)	314 (12,36)	189 (7,44)	220 (8,66)	101,1 (3,98)	14,2 (31,3)
	25 ... 40	350 (13,78)			189 (7,44)	235 (9,25)	101 (3,98)	18 (39,7)
150	10 ... 16	480 (18,90)	357 (14,06)	338 (13,31)	328 (12,91)	285 (11,22)	150,1 (5,91)	28,5 (62,8)
	25 ... 40	480 (18,90)			328 (12,91)	300 (11,81)	150,1 (5,91)	34,5 (76,1)
200	10 / 16	600 (23,62)	377 (14,84)	358 (14,09)	436 (17,17)	340 (13,39)	203,1 (8,00)	50 (110,2)
	25 / 40	600 (23,62)			436 (17,17)	360 / 375 (14,17 / 14,76)	203,1 (8,00)	59 / 66 (130,1 / 145,5)
300	10 / 16	1000 (39,37)	423 (16,65)	404 (15,91)	662 (26,06)	445 / 460 (17,52 / 18,11)	309,7 (12,19)	171 / 186 (377,0 / 410,1)
400	10 / 16	1274 (50,16)	459 (18,07)	440 (17,32)	841 (33,11)	565 / 580 (22,24 / 22,83)	390,4 (15,37)	245 / 266 (540,1 / 586,4)

1) Dimension tolerance: DN 15 ... DN 200 +0 / -3 mm; DN 300 ... DN 400: +0 / -5 mm

Nominal diameter DN	Nominal pressure lb	Dimensions in mm (inch)						Weight in kg (lb)
		L ¹⁾	G	E	A	D	d	
1/2"	150	200 (7,87)	319 (12,56)	300 (11,81)	83 (3,27)	88,9 (3,5)	15,8 (0,62)	5,3 (11,7)
	300	200 (7,87)			83 (3,27)	95,2 (3,75)		5,8 (12,8)
3/4"	150	220 (8,66)	322 (12,68)	303 (11,93)	68 (2,68)	98,4 (3,87)	22,6 (0,89)	2,1 (4,6)
	300	230 (9,06)			68 (2,68)	117,5 (4,63)	22,6 (0,89)	3,0 (6,6)
1"	150	150 (5,91)	321 (12,64)	302 (11,89)	67 (2,64)	108 (4,25)	28,1 (1,1)	3,4 (7,5)
	300	150 (5,91)			67 (2,64)	124 (4,88)	28,1 (1,1)	3,6 (7,9)
1 1/4"	150	150 (5,91)	319 (12,56)	300 (11,81)	68 (2,68)	118 (4,65)	37,1 (1,46)	3,7 (8,2)
	300	150 (5,91)			68 (2,68)	133 (5,24)		5,4 (11,9)
1 1/2"	150	200 (7,87)	323 (12,72)	304 (11,97)	79 (3,11)	127 (5)	42,1 (1,66)	6,8 (15)
	300	200 (7,87)			79 (3,11)	155,6 (6,13)	42,1 (1,66)	8,9 (19,6)
2"	150	200 (7,87)	326 (12,83)	307 (12,09)	106 (4,17)	152,4 (6)	51,1 (2,01)	7,1 (15,7)
	300	200 (7,87)			106 (4,17)	165 (6,5)	51,1 (2,01)	9,8 (21,61)
3"	150	300 (11,81)	329 (12,95)	310 (12,2)	159 (6,26)	190,5 (7,5)	82,6 (3,25)	11,7 (25,8)
	300	300 (11,81)			159 (6,26)	209,5 (8,25)	82,6 (3,25)	16,2 (35,7)
4"	150	350 (13,78)	333 (13,11)	314 (12,2)	189 (7,44)	228,6 (9)	101,1 (3,98)	18,0 (39,7)
	300	350 (13,78)			189 (7,44)	254 (10)	101,1 (3,98)	27,5 (60,6)
6"	150	480 (18,9)	357 (14,06)	338 (13,31)	328 (12,9)	279,4 (11)	150,1 (5,91)	30,0 (66,1)
	300	480 (18,9)			328 (12,9)	317,5 (12,5)	150,1 (5,91)	46,0 (101,4)
8"	150	600 (23,62)	377 (14,84)	358 (14,09)	436 (17,17)	343 (13,5)	203,1 (8)	45,0 (99,2)
	300	600 (23,62)			436 (17,17)	381 (15)	203,1 (8)	75 (165,4)
12"	150	1000 (39,37)	423 (16,65)	404 (15,91)	662 (26,1)	482,6 (19)	309,7 (12,19)	182 (401,2)
16"	150	1274 (50,16)	459 (18,07)	440 (17,32)	841 (33,1)	596,9 (23,5)	390,4 (15,37)	260 (573,2)

1) Dimension tolerance: DN 15 ... DN 200 +0 / -3 mm; DN 300 ... DN 400: +0 / -5 mm

5 Transmitter specifications

5.1.1 General specifications

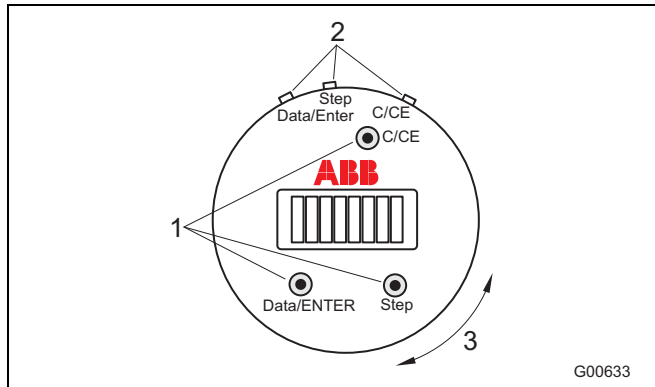


Fig. 23: Transmitter keypad and LCD display

- | | |
|------------------------------------|---------------------------|
| 1 Magnet sensors | 3 Can be rotated +/- 90 ° |
| 2 Control buttons for direct entry | |

Measuring ranges

The full-scale value can be set at any point between the maximum possible upper range value $1.15 \times Q_{\max DN}$ and $0.15 \times Q_{\max DN}$.

Parameter setting

Data can be entered using 3 control buttons (not with the Ex "d" hazardous area design) or, if the housing is sealed, directly from an external location using a magnetic pen.

Data is entered in plain text with the display or using digital communication via the HART protocol or PROFIBUS PA/FOUNDATION fieldbus.

Flow operating modes

The following operating modes can be selected dependent upon the design purchased (with or without Pt100):

Fluid medium:

- Operating flow
- Mass flow with constant or temperature-dependent density

Gas/steam medium:

- Operating flow
- Mass flow with constant or temperature-dependent density (at constant pressure)
- Standard flow with constant or temperature-dependent standard factor (at constant pressure)
- Mass flow with saturated steam and temperature-driven density

Data backup

Counter readings and parameters for specific measuring points backed up in FRAM (more than 10 years without supply power) in the case of shutdown or should the supply voltage fail.

Damping

Configurable from 1 ... 100 s, corresponds to 5 τ .

$Q_{v \min}$ (low flow)

Configurable between 2 ... 25 % of $Q_{\max DN}$ (max. operating flow per nominal size). The actual low flow is determined by application and installation.

Function tests

Software-internal function tests can be used to test individual internal modules. For the purpose of commissioning and testing, the current output (4 ... 20 mA design) or the digital output signal (fieldbus designs) can be simulated in line with flowrates selected by the user (manual process control). The switching output can also be controlled directly for the purpose of function testing.

Electrical connection

Screw-type terminals, plug-in connection on PROFIBUS PA (option) cable gland: -standard., Ex "ib" / Ex "ia": M20 x 1.5; NPT 1/2" -Ex "d": NPT 1/2"

Ingress protection

IP 67 to EN 60529

Display

High-contrast LCD display, 2 x 8-digit (4 ... 20 mA design) or 4 x 16-digit (PROFIBUS PA / FOUNDATION fieldbus design). Shows the instantaneous flowrate along with the totalized flow or temperature of the medium (option).

On the 4 ... 20 mA design, the multiplex function enables 2 values (e.g., flowrate and totalized flow) to be displayed virtually in parallel. Up to 4 values can be displayed on the fieldbus design.

Switching output terminals 41 / 42

(standard on all designs)

The function can be selected via the software:

- Max./min. alarm for flow or temperature
- System alarm
- Pulse output: $f_{\max}$: 100 Hz; t_{on} : 1 ... 256 ms

Contact type:

- Standard and Ex "d": Optocoupler $U_H = 16 \dots 30 \text{ V}$
 $I_L = 2 \dots 15 \text{ mA}$
- Ex "ib" / Ex "ia": Configured as NAMUR contact

EMC protection

The flowmeter corresponds to NAMUR recommendations NE21. Electromagnetic compatibility of equipment for process and lab control technology 5/93 and EMC Directive 2004/108/EC (EN 61326-1). Note: EMC protection and protection against accidental contact are limited when the housing cover is open.

6 Communication

6.1 2-wire technology design

The design of the Vortex or Swirl flowmeter transmitter features 2-wire technology, i.e., the power supply and digital communication for the fieldbus interface both use the same wires. An additional switching output is also available for use at the same time.

All stored data is preserved in the event of a power failure. The SMART VISION program can be used for operation and configuration purposes. SMART VISION is a piece of universal communication software for intelligent field devices based on FDT / DTM technology.

Data can be exchanged with a comprehensive range of field devices using various means of communication. The main applications include parameter display, configuration, diagnostics, recording, and data management for all intelligent field devices that specifically meet the communication requirements involved.

6.2 4 ... 20 mA / HART

6.2.1 Electrical connection for 4 ... 20 mA / HART

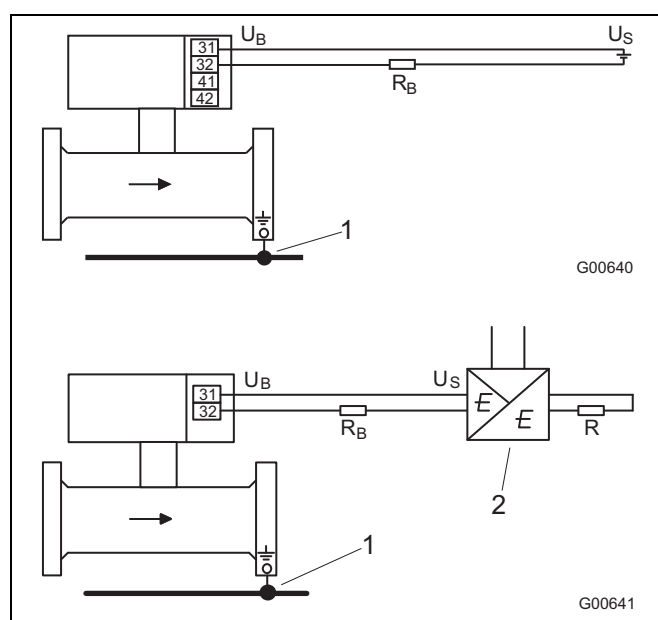


Fig. 24: Supply power from central power supply, supply power (DC or AC) from power supply unit

1 Functional ground 2 Power supply unit

UB = Supply voltage = min. 14 V DC

US = Supply voltage = 14 ... 46 V DC

RB = Maximum permissible load for the power supply unit (e.g. display, load)

R = Maximum permissible load for the output circuit (determined by the power supply unit)

Supply power (terminals 31 / 32)

Standard	14 ... 46 V DC
Hazardous area design	See Chapter 7, "Ex relevant specifications for transmitter".
Residual ripple	Maximum 5 % or. ± 1.5 Vpp
Power consumption	< 1 W

Electrical connection for FV4000-VR4, FS4000-SR4

With these designs, the sensor and transmitter are separated by a signal cable of up to 10 m in length. The signal cable is permanently connected to the transmitter and can be made shorter if required. Fig. 24 shows how the supply power connection is arranged for the transmitter.

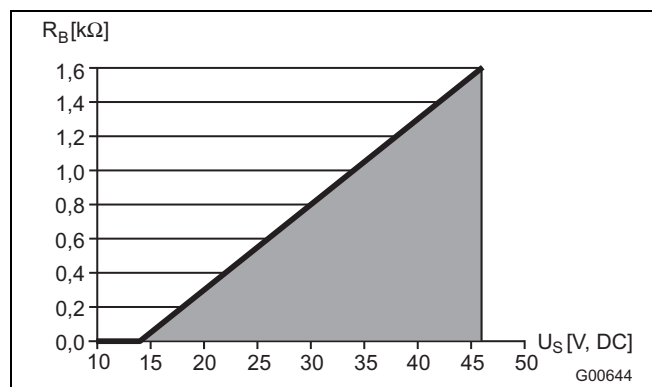


Fig. 25: Load diagram for current output, load via supply power

In HART communication, the smallest load is 250 Ω. The load RE is calculated on the basis of the available supply voltage US and the selected signal current as follows:

$$R_E = \frac{U_S}{I_B}$$

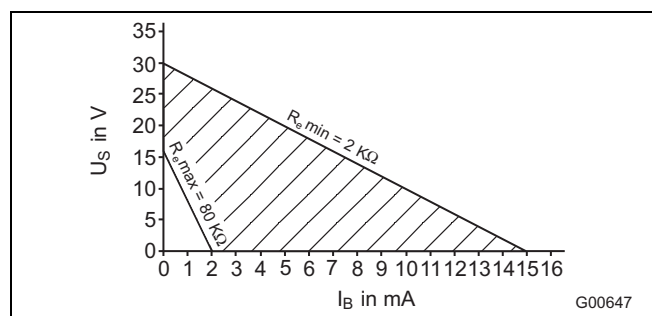


Fig. 26: Load resistance of the switching output as a function of current and voltage

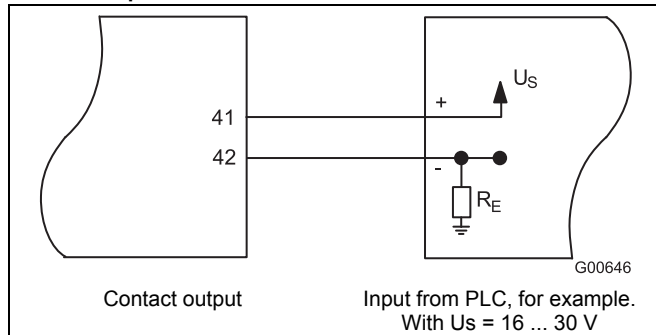
Contact output

Fig. 27: Electrical connection

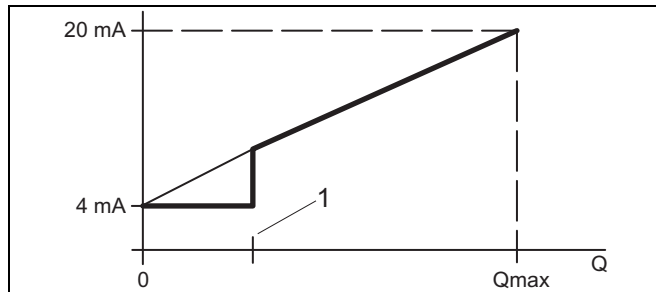


Fig. 28: Current output

1 Low flow

The measurement value output at the current output is as shown in the figure: Above the low flow, the current is a straight line that would have 4 mA in $Q = 0$ and 20 mA in $Q = Q_{\max}$ operating mode. Due to low flow cutoff, the flow is set to 0 below $x\%$ $Q_{\max}$ or the low flow (in other words, the current is 4 mA).

6.2.2 Current output for alarm

21 ... 23 mA in accordance with NAMUR NE43

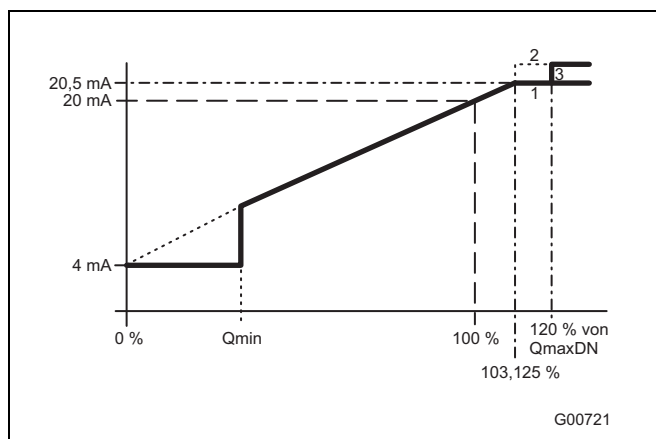


Fig. 29

- 1 Current output without errors "3" and "9", output: 20.5 mA (NAMUR NE43)
- 2 Current output with errors "3" and "9", the output switches to alarm status (21 ... 23 mA, configurable)
- 3 Current output with error "9", the output switches to alarm status at 120 % of $Q_{\max DN}$ (21 ... 23 mA, configurable)

 $Q_{\min}$ = Low flow**6.2.3 HART protocol communication**

The HART protocol is used for digital communication between a process control system / PC, a handheld terminal, and the Vortex or Swirl flowmeter.

It can be used to send all device and measuring point parameters from the transmitter to the process control system or PC. Conversely, it also provides a means of reconfiguring the transmitter. Digital communication utilizes an alternating current superimposed on the analog output (4 ... 20 mA) that does not affect any meters connected to the output.

Transmission method

FSK modulation at current output of 4 ... 20 mA based on the Bell 202 standard. Max. signal amplitude: 1.2 mA ss.

Current output loadMin. > 250 Ω , max. 750 Ω

Max. cable length: 1,500 m; AWG 24 twisted and shielded

Baud rate

1,200 baud

Display

Logic 1: 1,200 Hz, Logic 0: 2,200 Hz

Current output for alarm

High = 21 ... 23 mA, adjustable (NE43)

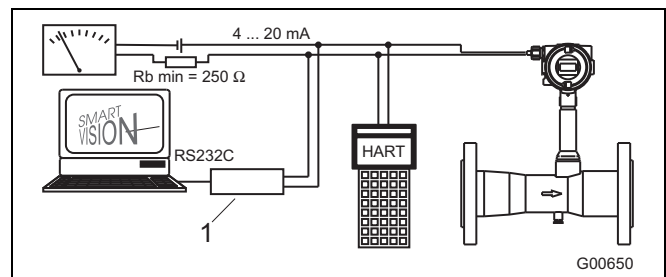


Fig. 30: HART communication

1 FSK modem

6.3 PROFIBUS PA

6.3.1 PROFIBUS PA electrical connection

1) Terminals 31, 32

Function PA+, PA-

Connection for PROFIBUS PA to IEC 1158-2

U = 9 ... 24 V, I = 10 mA (normal operation)
13 mA (in the event of an error / FDE)

2) Terminals 41, 42

Function C9, E9

Switching output: Function can be selected via software as a pulse output (fmax: 100 Hz, 1 ... 256 ms), min. / max. alarm or system alarm.

Configured as NAMUR contact to DIN 19234.

Closed: 1 K Ω
Open: > 10 K Ω

M12 plug-in connector

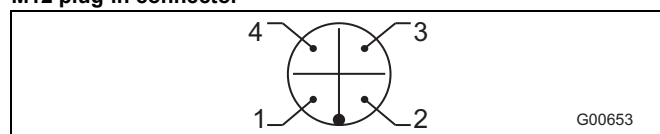


Fig. 31: Assignment for connection using optional M12 plug-in connector

Pin	Assignment
1	PA+ (31)
2	NC
3	PA- (32)
4	Shield

6.3.2 PROFIBUS PA communication

The transmitter is suitable for connection to DP/PA segment couplers and the ABB MB204 multibarrier.

PROFIBUS PA protocol

Output signal: in accordance with EN 50170 Volume 2,

PROFIBUS transmission method: IEC 1158-2/EN 61158-2

Transmission speed: 31.25 KByte/s

PROFIBUS profile: Version 3.0

Ident Number

05DC hex

Function blocks

2 x AI,

1 x TOT

GSD files

- PA139700 (1 x AI)
- PA139740 (1 x AI, 1 x TOT)
- ABB_05DC (2 x AI, 1 x TOT + manufacturer-specific data)

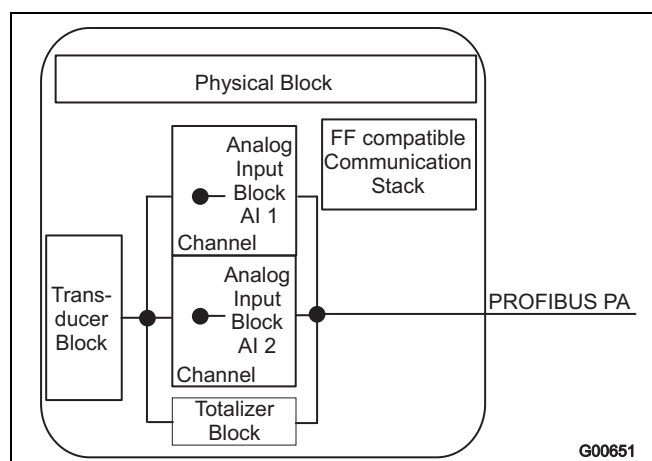


Fig. 32: Block structure for PROFIBUS PA

6.3.3 Example: PROFIBUS PA communication

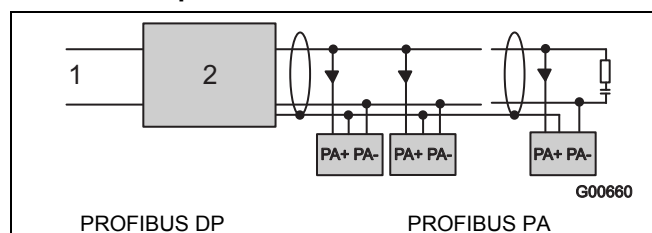


Fig. 33: Example for PROFIBUS PA interface connection

1 H2 bus

2 Segment coupler (incl. bus supply and termination)

6.4 FOUNDATION fieldbus

6.4.1 FOUNDATION fieldbus electrical connection

1) Terminals 31, 32

Function FF+, FF-

Connection for FOUNDATION fieldbus (H1) to IEC 1158-2

U = 9 ... 24 V, I = 10 mA (normal operation)
13 mA (in the event of an error / FDE)

2) Terminals 41, 42

Function C9, E9

Switching output: Function can be selected via software as a pulse output (fmax: 100 Hz, 1 ... 256 ms), min. / max. alarm or system alarm.

Configured as NAMUR contact to DIN 19234.

Closed: 1 K Ω
Open: > 10 K Ω

6.4.2 FOUNDATION fieldbus communication

The transmitter is suitable for connection to special power supply units, a linking device, and the ABB MB204 multibarrier.

FOUNDATION fieldbus protocol

Output signal: in accordance with the FOUNDATION fieldbus protocol

Specification: 1.4 / ITK 4.01 for the H1 bus

Transmission method: IEC 1158-2 / EN 61158-2

Transmission speed: 31.25 KByte/s

Manufacturer ID: 0x000320 Device ID: 0x0015

Reg. number: IT013600

Function blocks

2 x analog inputs

Stack

With LAS functionality

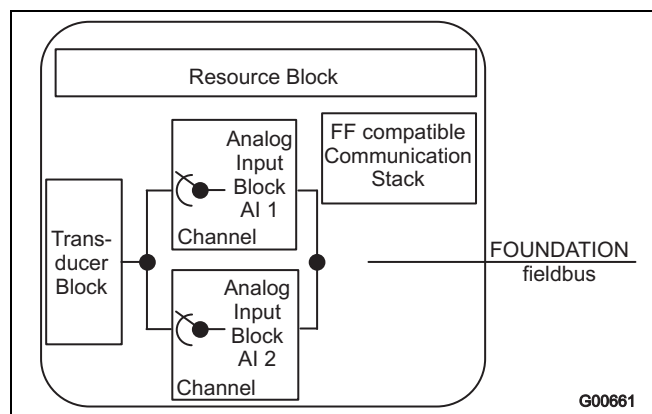


Fig. 34: Block structure for FOUNDATION fieldbus

The channel selector can be used to select the initial variable (volume / mass / standard flow, counter or temperature).

6.4.3 Example: FOUNDATION fieldbus communication

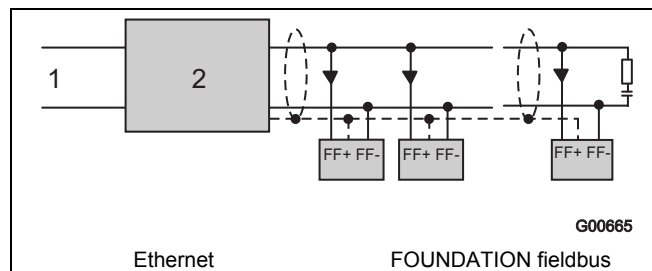


Fig. 35: Example for FOUNDATION fieldbus interface connection

- 1 HSE bus
- 2 Linking device (incl. bus supply and termination)

7 Ex relevant specifications for transmitter

7.1 Ex "ib" / Ex "n" design for VT41/ST41 and VR41/SR41 (4 ... 20 mA / HART)



Important

The devices may only be operated in explosive areas if the housing covers have been fully closed.

EC type-examination certificate TÜV 08 ATEX 554808 X / TÜV 10 ATEX 387786 X ¹⁾

Designation:

II 2G Ex ib IIC T4
II 2D Ex tD A21 T85°C...T_{medium} IP 67

Declaration of conformity TÜV 08 ATEX 554833 X / TÜV 10 ATEX 556214 X ¹⁾

Designation:

II 3G Ex nA [nL] IIC T4
II 3D Ex tD A22 T85°C...T_{medium} IP 67

Certificate of conformity IECEx TUN 07.0014 X / TUN 10.0024 X

Designation:

Ex ib IIC T4...T1
Ex nA [nL] IIC T4...T1
Ex tD A21 IP6X TX°C

1) Not for Shanghai production site

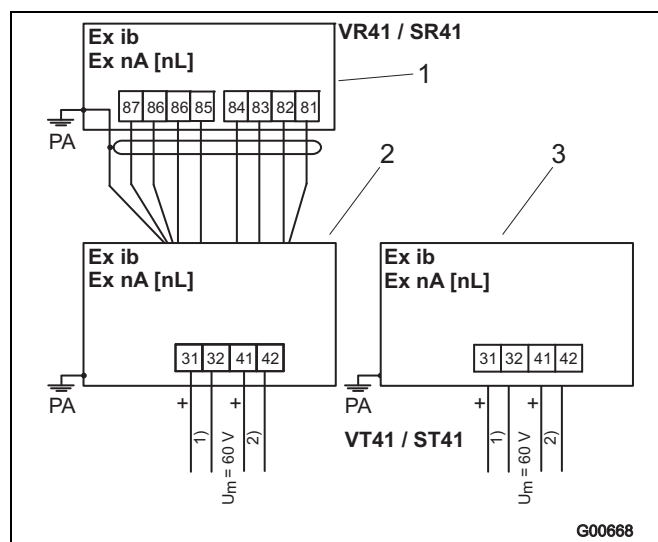


Fig. 36: Electrical connection for VT41 / ST41 and VR41 / SR41

- 1 Flowmeter sensor 3 Flowmeter
2 Transmitter

Flowmeter sensor wire colors

Terminal	Wire color
81	Red
82	Blue
83	Pink
84	Gray
85	Yellow
86	Green
86	Brown
87	White

- Supply power terminals 31 / 32
 - Ex ib: $U_i = 28 \text{ V DC}$
 - Ex nA [nL] $U_B = 14 \dots 46 \text{ V DC}$
- Switching output, terminals 41/ 42

The switching output (passive) optocoupler is designed as a NAMUR contact (to DIN 19234).

When the contact is closed, the internal resistance is approx. 1,000 Ω . When the contact is open, it is > 10 K Ω . The switching output can be changed over to "optocoupler" if required.

- NAMUR with switching amplifier
- Switching output (optocoupler)

- Ex ib: $U_i = 15 \text{ V}$
- Ex nA [nL]: $U_B = 16 \dots 30 \text{ V}$
 $I_B = 2 \dots 15 \text{ mA}$



Important

The installation instructions in accordance with EN 60079-14 must be complied with.

When commissioning the flowmeter, refer to IEC 61241-1-2 regarding use in areas with combustible dust. The transmitter housing cover must be secured by means of the safety locking device. After switching off the supply power, wait $t > 2$ minutes before opening the transmitter housing.

7.1.1 Supply power or supply current

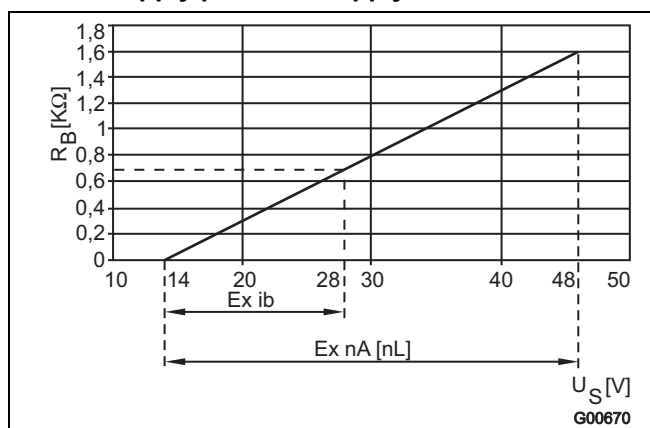


Fig. 37

The minimum voltage U_S of 14 V is based on a load of 0 Ω .

U_S = supply voltage

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

7.1.2 Approval data for hazardous areas

Power supply circuit	Terminals 31, 32
Type of protection $U_m = 60 \text{ V}$	Zone 1: Ex ib IIC $T_{amb} = (-40 \text{ °C}) -20 \dots 70 \text{ °C}$ $U_i = 28 \text{ V}$ $I_i = 110 \text{ mA}$ $P_i = 770 \text{ mW}$ Effective internal capacitance: 14.6 nF Effective internal capacitance to ground: 24.4 nF Effective internal inductance: 0.27 mH
	Zone 2: Ex nA [nL] IIC $T_{amb} = (-40 \text{ °C}) -20 \dots 70 \text{ °C}$ $U_B = 14 \dots 46 \text{ V}$
	Zone 21 / 22: Ex tD A21 / Ex tD A22 $T_{amb} = -20 \text{ °C} \dots 60 \text{ °C}$
Power supply circuit	Terminals 41, 42
Type of protection $U_m = 60 \text{ V}$	Zone 1: Ex ib IIC $U_i = 15 \text{ V}$ $I_i = 30 \text{ mA}$ $P_i = 115 \text{ mW}$ Effective internal capacitance: 11,6 nF Effective internal capacitance to ground: 19.6 nF Effective internal inductance: 0.14 mH
	Zone 2: Ex nA [nL] IIC $U_B = 16 \dots 30 \text{ V}$ $I_B = 2 \dots 15 \text{ mA}$
	Zone 21 / 22: Ex tD A21 / Ex tD A22 $T_{amb} = -20 \text{ °C} \dots 60 \text{ °C}$

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 conform to degree of protection IP 65 / IP 67. If the device is installed as intended, this requirement is met by the housing as standard.

When connected to the line supply / not connected to the line supply, the electrical circuits must not exceed overvoltage category III / II.

7.1.3 Medium temperatures / Temperature classes

For the supply circuit "Terminals 31, 32" and the switching outputs "Terminals 41, 42", cables suitable for temperatures up to $T = 110 \text{ °C}$ ($T = 230 \text{ °F}$) can be used without restriction.

Category 2/3G

For cables suitable only for temperatures up to $T = 80 \text{ °C}$ ($T = 176 \text{ °F}$), the interconnection of both circuits needs to be taken into account in the event of a fault. Otherwise, the restricted temperature ranges listed in the following table shall apply.

Category 2D

For cables suitable only for temperatures up to $T = 80 \text{ °C}$ ($T = 176 \text{ °F}$), the restricted temperature ranges listed in the following table shall apply.

Ambient temperature ²⁾	Max. temperature at used connecting cable, "Terminals 31, 32", "Terminals 41, 42"	Max. permissible medium temperature
$(-40) -20 \dots 70 \text{ °C}$ ³⁾ $((-40) -4 \dots 158 \text{ °F})$ ³⁾	110 °C (230 °F)	280 °C / 400 °C ¹⁾ (536 °F / 752 °F) ¹⁾
$(-40) -20 \dots 70 \text{ °C}$ ³⁾ $((-40) -4 \dots 158 \text{ °F})$ ³⁾	80 °C (176 °F)	160 °C (320 °F)
$(-40) -20 \dots 60 \text{ °C}$ $((-40) -4 \dots 140 \text{ °F})$		240 °C (464 °F)
$(-40) -20 \dots 55 \text{ °C}$ $((-40) -4 \dots 131 \text{ °F})$		280 °C (536 °F)
$(-40) -20 \dots 50 \text{ °C}$ $((-40) -4 \dots 122 \text{ °F})$		320 °C (608 °F) ¹⁾
$(-40) -20 \dots 40 \text{ °C}$ $((-40) -4 \dots 104 \text{ °F})$		400 °C (752 °F) ¹⁾

1) Medium temperatures > 280 °C (> 536 °F) with FV4000 Vortex flowmeter only

2) The permissible limits for the ambient temperature are approval- and order-specific (standard: -20 °C (-4 °F)).

3) Category 2D (dust-ignition proof) maximum 60 °C (140 °F)

Maximum medium temperature	Temperature class
130 °C (266 °F)	T4
195 °C (383 °F)	T3
290 °C (554 °F)	T2
400 °C (752 °F)	T1

7.2 Ex "d" / Ex "ib" / Ex "n" design for VT42/ST42 and VR42/SR42 (4 ... 20 mA / HART)



Important

The devices may only be operated in explosive areas if the housing covers have been fully closed.

EC type-examination certificate TÜV 08 ATEX 554955 X / TÜV 10 ATEX 387788 X ¹⁾

Designation

- Transmitter / flowmeter
II 2G Ex d [ib] IIC T6
II 2G Ex ib IIC T4
II 2D Ex tD A21 T 85 °C ... T_{medium} IP 67
- Flowmeter sensor
II 2G Ex ib IIC T4
II 2D Ex tD A21 T 85 °C ... T_{medium} IP 67

Declaration of conformity TÜV 08 ATEX 554956 X / TÜV 10 ATEX 556215 X ¹⁾

Designation on sensor / transmitter / flowmeter:

- II 3G Ex nA [nL] IIC T4
- II 3D Ex tD A22 T85°C...T_{medium} IP 67

Certificate of conformity IECEx TUN 08.0010 X / TUN 10.0025 X

Designation:

- Ex d [ib] IIC T6 to T1
- Ex ib IIC T4 to T1
- Ex tD A21 IP6X T85°C...T_{medium}
- Ex nA [nL] IIC T4 to T1

- Not for Shanghai production site

Flowmeter sensor wire colors

Terminal	Wire color
81	Red
82	Blue
83	Pink
84	Gray
85	Yellow
86	Green
86	Brown
87	White

- Supply power terminals 31 / 32
 - Ex ib: $U_i = 28 \text{ V DC}$
 - Ex d [ib] / Ex nA [nL] $U_B = 14 \dots 46 \text{ V DC}$
- Switching output, terminals 41 / 42
The switching output (passive) is designed as an optocoupler. If required, the switching output (passive) can be designed as a NAMUR contact (to DIN 19234).
 - NAMUR with switching amplifier
 - Switching output (optocoupler)
 - Ex ib: $U_i = 15 \text{ V}$
 - Ex d [ib] / Ex nA [nL]: $U_B = 16 \dots 30 \text{ V}$
 $I_B = 2 \dots 15 \text{ mA}$



Important

Supply current (supply power) and switching output must be either only intrinsically safe or only non-intrinsically safe. A combination of the two is not permitted. On intrinsically safe circuits, equipotential bonding must be in place along the entire length of the cable used.

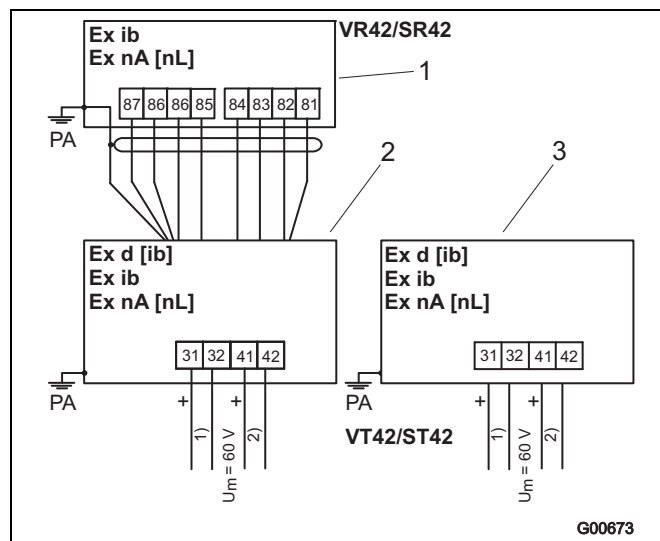


Fig. 38: Electrical connection for VT42 / ST42 and VR42 / SR42

- Flowmeter sensor
- Transmitter
- Flowmeter

7.2.1 Supply power or supply current

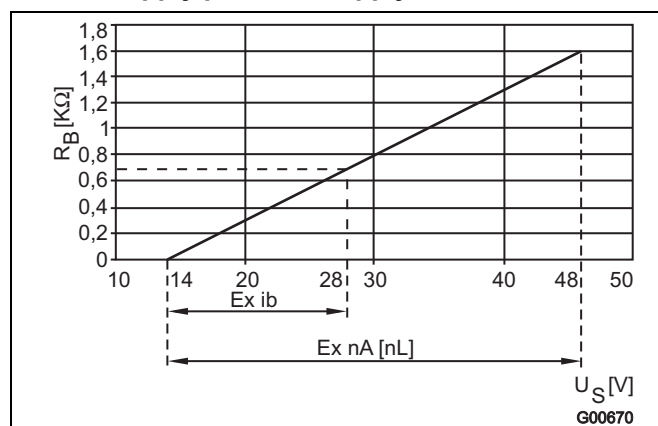


Fig. 39

The minimum voltage U_S of 14 V is based on a load of 0 Ω .

U_S = supply voltage

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

i

Important

The installation instructions in accordance with EN 60079-14 must be complied with.

When commissioning the flowmeter, refer to IEC 61241-1-2 regarding use in areas with combustible dust. The transmitter housing cover must be secured by means of the safety locking device. After switching off the supply power, wait $t > 2$ minutes before opening the transmitter housing.

7.2.2 Approval data for hazardous areas

Power supply circuit	Terminals 31, 32
Type of protection $U_m = 60$ V	Zone 1: Ex d [ib] IIC $T_{amb} = (-40\text{ °C}) -20 \dots 60\text{ °C}$ Zone 2: Ex nA [nL] IIC $T_{amb} = (-40\text{ °C}) -20 \dots 70\text{ °C}$ $U_B = 14 \dots 46$ V
	Zone 1: Ex ib IIC $T_{amb} = (-40\text{ °C}) -20 \dots 70\text{ °C}$ $U_i = 28$ V $I_i = 110$ mA $P_i = 770$ mW Effective internal capacitance: 14.6 nF Effective internal capacitance to ground: 24.4 nF Effective internal inductance: 0.27 mH
	Zone 21 / 22: Ex td A21 / Ex tD A22 $T_{amb} = -20 \dots 60\text{ °C}$

Power supply circuit	Terminals 41, 42
Type of protection $U_m = 60$ V	Zone 1: Ex d [ib] IIC Zone 2: Ex nA [nL] IIC $U_B = 16 \dots 30$ V $I_B = 2 \dots 15$ mA
	Zone 1: Ex ib IIC $U_i = 15$ V $I_i = 30$ mA $P_i = 115$ mW Effective internal capacitance: 11.6 nF Effective internal capacitance to ground: 19.6 nF Effective internal inductance: 0.14 mH
	Zone 21 / 22: Ex td A21 / Ex td A22 $T_{amb} = -20 \dots 60\text{ °C}$

When connected to the line supply / not connected to the line supply, the electrical circuits must not exceed overvoltage category III / II.

7.2.3 Medium temperatures / Temperature classes

For the supply circuit "Terminals 31, 32" and the switching outputs "Terminals 41, 42", cables suitable for temperatures up to $T = 110\text{ °C}$ ($T = 230\text{ °F}$) can be used without restriction.

Category 2/3G (Ex ib IIC)

For cables suitable only for temperatures up to $T = 80\text{ °C}$ ($T = 176\text{ °F}$), the interconnection of both circuits needs to be taken into account in the event of a fault. Otherwise, the restricted temperature ranges listed in the following table shall apply.

Category 2D

For cables suitable only for temperatures up to $T = 80\text{ °C}$ ($T = 176\text{ °F}$), the restricted temperature ranges listed in the following table shall apply.

Ambient temperature ²⁾	Max. temperature at used connecting cable, "Terminals 31, 32", "Terminals 41, 42"	Max. permissible medium temperature
(-40) -20 ... 60 °C (-40) -4 ... 140 °F)	110 °C (230 °F)	280 °C / 400 °C ¹⁾ (536 °F / 752 °F) ¹⁾
(-40) -20 ... 60 °C (-40) -4 ... 140 °F)	80 °C (176 °F)	240 °C (464 °F)
(-40) -20 ... 55 °C (-40) -4 ... 131 °F)		280 °C (536 °F)
(-40) -20 ... 50 °C (-40) -4 ... 122 °F)		320 °C (608 °F) ¹⁾
(-40) -20 ... 40 °C (-40) -4 ... 104 °F)		400 °C (752 °F) ¹⁾

- 1) Medium temperatures > 280 °C (> 536 °F) with FV4000 Vortex flowmeter only
 2) The permissible lower limits for the ambient temperature are approval- and order-specific (standard: -20 °C (-4 °F)).

Hazardous area design	Maximum medium temperature	Temperature class
Ex d [ib] IIC	80 °C (176 °F)	T6 ³⁾
	95 °C (203 °F)	T5 ³⁾
Ex ib IIC bzw. Ex nA [nL]	130 °C (266 °F)	T4
	195 °C (383 °F)	T3
	290 °C (554 °F)	T2
	400 °C (752 °F)	T1

- 3) Not possible for flowmeter sensor version VR42 / SR42

7.3 FM approval design for the USA and Canada for VT43/ST43 and VR43/SR43 (4 ... 20 mA / HART)



Important

The devices may only be operated in explosive areas if the housing covers have been fully closed.

Designation

Explosion-proof	XP/Class I/Div 1/BCD/T4 Ta = 70 °C Type 4X
Dust-ignition-proof	DIP/Class II,III/Div 1/EFG/T4 Ta = 70 °C Type 4X
Intrinsic safety	IS/Class I, II,III/Div 1/ABCEFG/T4 Ta = 70 °C Entity Type 4X
Non-incendive	NI/Class I/Div 2/ABCD/T4 Ta = 70 °C Type 4X
Suitable	S/Class II,III/Div 2/FG/T4 Ta = 70 °C Type 4X

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 conform to degree of protection IP65 / IP67. If the device is installed as intended, this requirement is met by the housing as standard.

When connected to the line supply / not connected to the line supply, the electrical circuits must not exceed overvoltage category III / II.

IS Entity see: SD-50-2681 (Fig. 35)

Parameters: V_{max} , I_{max} , P_i , L_i , C_i

Enclosure: Type 4X

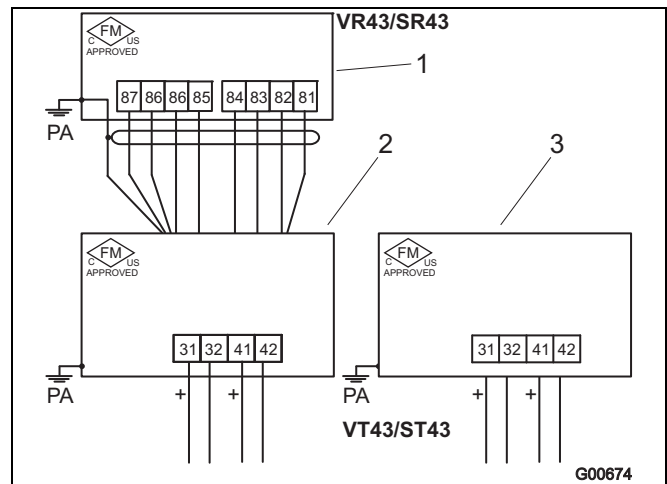


Fig. 40: Electrical connection for VT43 / ST43 and VR43 / SR43

- 1 Flowmeter sensor 3 Flowmeter
2 Transmitter

Flowmeter sensor wire colors

Terminal	Wire color
81	Red
82	Blue
83	Pink
84	Gray
85	Yellow
86	Green
86	Brown
87	White

7.3.1 Supply power or supply current

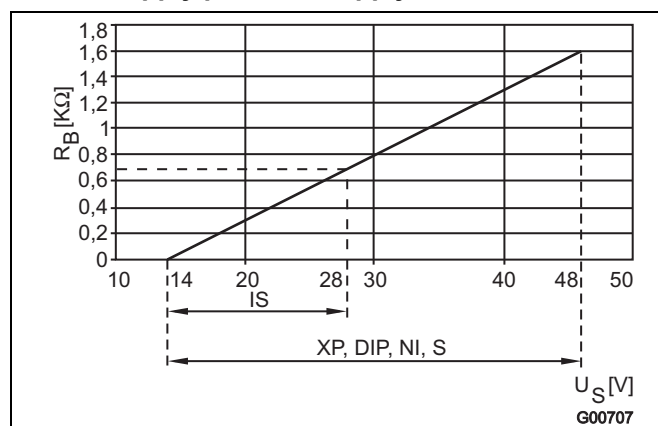


Fig. 41

The minimum voltage U_S of 14 V is based on a load of 0 Ω .

U_S = supply voltage

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

7.3.2 Medium temperatures / Temperature classes

For the supply circuit "Terminals 31, 32" and the switching outputs "Terminals 41, 42", cables suitable for temperatures up to $T = 110^\circ\text{C}$ ($T = 230^\circ\text{F}$) can be used without restriction.

For cables suitable only for temperatures up to $T = 80^\circ\text{C}$ ($T = 176^\circ\text{F}$), the restricted temperature ranges listed in the following table shall apply.

Ambient temperature	Max. temperature at used connecting cable, "Terminals 31, 32", "Terminals 41, 42"	Max. permissible medium temperature
(-45) -20 ... 70 °C (-49) -4 ... 158 °F)	110 °C (230 °F)	280 °C / 400 °C ¹⁾ (536 °C / 752 °F) ¹⁾
(-45) -20 ... 60 °C (-49) -4 ... 140 °F)	80 °C (176 °F)	240 °C (464 °F)
(-45) -20 ... 55 °C (-49) -4 ... 131 °F)		280 °C (536 °F)
(-45) -20 ... 50 °C (-49) -4 ... 122 °F)		320 °C (608 °F) ¹⁾
(-45) -20 ... 40 °C (-49) -4 ... 104 °F)		400 °C (752 °F) ¹⁾

¹⁾ Medium temperatures > 280 °C (> 536 °F) with VT43 / VR43 Vortex flowmeter only

7.3.3 Approval data for hazardous areas

Supply circuit terminals 31, 32

Explosion-proof	XP/Class I/Div 1/BCD/T4 Ta = 70 °C Type 4X	$U_B = 14 \dots 46 \text{ V}$
Dust-ignition-proof	DIP/Class II,III/Div 1/EFG/T4 Ta = 70 °C Type 4X DIP/Class II,III /Div 2 /EFG /T4 Ta=70°C Type 4X	
Intrinsic safety	IS/Class I, II,III/Div 1 ABCDEFG/T4 Ta = 70 °C Entity Type 4X	$V_{\max} = 28 \text{ V}$ $I_{\max} = 110 \text{ mA}$ $P_i = 770 \text{ mW}$ Effective internal capacitance: 14.6 nF Effective internal inductance: 0.27 mH
Non-incendive	NI/Class I/Div 2/ABCD/T4 Ta = 70 °C Type 4X	$U_B = 14 \dots 46 \text{ V}$

Supply circuit terminals 41, 42

Explosion-proof	XP/Class I/Div 1/BCD/T4 Ta = 70 °C Type 4X	$U_B = 16 \dots 30 \text{ V}$ $I_B = 2 \dots 15 \text{ mA}$
Dust-ignition-proof	DIP/Class II,III/Div 1/EFG/T4 Ta = 70 °C Type 4X DIP/Class II,III /Div 2 /EFG /T4 Ta=70°C Type 4X	
Intrinsic safety	IS/Class I, II,III/Div 1 ABCDEFG/T4 Ta = 70 °C Entity Type 4X	$V_{\max} = 15 \text{ V}$ $I_{\max} = 30 \text{ mA}$ $P_i = 115 \text{ mW}$ Effective internal capacitance: 11 nF Effective internal inductance: 0.14 mH
Non-incendive	NI/Class I/Div 2/ABCD/T4 Ta = 70 °C Type 4X	$U_B = 16 \dots 30 \text{ V}$ $I_B = 2 \dots 15 \text{ mA}$

Fig. 42: Electrical connection and connection data, VT43 / VR43 and ST43 / SR43

7.4 Ex "ia" design for VT4A/ST4A and VR4A/SR4A (fieldbus)



Important

The devices may only be operated in explosive areas if the housing covers have been fully closed.

EC type-examination test certificate TÜV 10 ATEX 556309 X / TÜV 10 ATEX 387782 X ¹⁾

Designation

II 2G Ex ia IIC T4 Gb
 II 2 D Ex ta IIIC T85°C ... T_{medium} Db IP67 (type VT4A. / ST4A.)
 II 2 D Ex ta IIIC T85°C Db IP67 (type VR4A. / SR4A.)

Certificate of conformity IECEx CoC TUN 10.0028 X / CoC TUN 10.0029 X

Designation

Ex ia IIC T4 Gb
 Ex ia IIIC T85°C ... T_{medium} Db IP67 (type VT4A. / ST4A. / VR4A. / SR4A.)
 Ex ia IIIC T85°C Db IP67 (type VR4A. / SR4A.)

The hazardous area design is based on the PTB's FISCO model (FISCO = fieldbus intrinsically safe concept).

1) Not for Shanghai production site

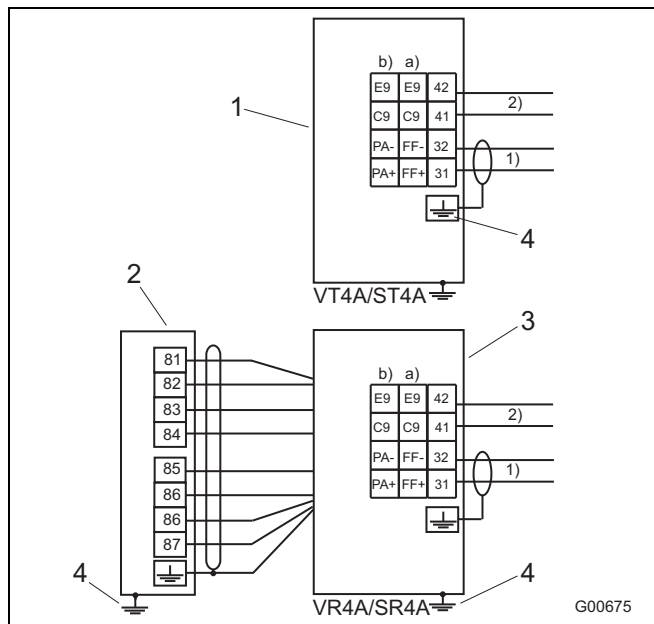


Fig. 43: Electrical connection for PROFIBUS PA interface connection

- | | |
|--------------------|---------------------|
| 1 Flowmeter | 3 Transmitter |
| 2 Flowmeter sensor | 4 Functional ground |

Flowmeter sensor wire colors

Terminal	Wire color
81	Red
82	Blue
83	Pink
84	Gray
85	Yellow
86	Green
86	Brown
87	White

7.4.1 PROFIBUS PA electrical connection

1) Terminals 31, 32

Function PA+, PA-

Connection for PROFIBUS PA to IEC 1158-2

U = 9 ... 24 V, I = 10 mA (normal operation)
 13 mA (in the event of an error / FDE)

2) Terminals 41, 42

Function C9, E9

Switching output: Function can be selected via software as a pulse output (fmax: 100 Hz, 1 ... 256 ms), min. / max. alarm or system alarm.

Configured as NAMUR contact to DIN 19234.

Closed: 1 KΩ

Open: > 10 KΩ

M12 plug-in connector

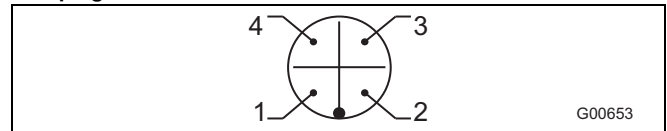


Fig. 44: Assignment for connection using optional M12 plug-in connector

Pin	Assignment
1	PA+ (31)
2	NC
3	PA- (32)
4	Shield

7.4.2 FOUNDATION fieldbus electrical connection

1) Terminals 31, 32

Function FF+, FF-

Connection for FOUNDATION fieldbus (H1) to IEC 1158-2

U = 9 ... 24 V, I = 10 mA (normal operation)
 13 mA (in the event of an error / FDE)

2) Terminals 41, 42

Function C9, E9

Switching output: Function can be selected via software as a pulse output (fmax: 100 Hz, 1 ... 256 ms), min. / max. alarm or system alarm.

Configured as NAMUR contact to DIN 19234.

Closed: 1 KΩ

Open: > 10 KΩ



Important

The installation instructions in accordance with EN 60079-14 must be complied with.

When commissioning the flowmeter, refer to IEC 61241-1-2 regarding use in areas with combustible dust. The transmitter housing cover must be secured by means of the safety locking device. After switching off the supply power, wait t > 2 minutes before opening the transmitter housing.

7.4.3 Approval data for hazardous areas

II 2D T 85 °C ... T_{medium} IP 67 /

T_{amb} = -20 °C ... 60 °C

Power supply circuit	Terminals 31/32
Type of protection	II 2G Ex ia IIC T4 / T _{amb} = (-40 °C) -20 ... 70 °C U _i = 24 V I _i = 380 mA P _i = 9.12 W The effective internal capacitance and inductance are negligibly low.

Power supply circuit	Terminals 41/42
Type of protection	II 2G Ex ia IIC T4 U _i = 15 V I _i = 30 mA P _i = 115 mW Effective internal capacitance: 3.6 nF Effective internal capacitance to ground: 3.6 nF Effective internal inductance: 0.14 mH

VR4A / SR4A only

Type of protection	II 2G Ex ia IIC T4
Piezo sensor	U ₀ = 8.5 V
Terminals 85, 86, 86, 87	I ₀ = 1,073 mA
Pt100 circuit, terminals 81, 82, 83, 84	P ₀ = 2,280 mW

i Important (Note)

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 conform to protection type IP 65 / IP 67. If the device is installed as intended, this requirement is met by the housing as standard. When connected to the line supply / not connected to the line supply, the electrical circuits must not exceed overvoltage category III / II.

7.4.4 Medium temperatures / Temperature classes

For the supply circuit "Terminals 31, 32" and the switching outputs "Terminals 41, 42", cables suitable for temperatures up to T = 110 °C (T = 230 °F) can be used without restriction.

Category 2/3G

For cables suitable only for temperatures up to T = 80 °C (T = 176 °F), the interconnection of both circuits needs to be taken into account in the event of a fault. Otherwise, the restricted temperature ranges listed in the following table shall apply.

Category 2D

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

Ambient temperature ²⁾	Max. temperature at used connecting cable, "Terminals 31, 32", "Terminals 41, 42"	Max. permissible medium temperature
(-30) -20 ... 70 °C ((-22) -4 ... 158 °F)	110 °C (230 °F)	280 °C / 400 °C ¹⁾ (536 °C / 752 °F) ¹⁾
(-30) -20 ... 70 °C ((-22) -4 ... 158 °F)	80 °C (176 °F)	160 °C (320 °F)
(-30) -20 ... 60 °C ((-22) -4 ... 140 °F)		240 °C (464 °F)
(-30) -20 ... 55 °C ((-22) -4 ... 131 °F)		280 °C (536 °F)
(-30) -20 ... 50 °C ((-22) -4 ... 122 °F)		320 °C (608 °F) ¹⁾
(-30) -20 ... 40 °C ((-22) -4 ... 104 °F)		400 °C (752 °F) ¹⁾

1) Medium temperatures > 280 °C (> 536 °F) with FV4000 Vortex flowmeter only

2) The permissible limits for the ambient temperature are approval- and order-specific (standard: -20 °C (-4 °F)).

Maximum medium temperature	Temperature class
130 °C (266 °F)	T4
195 °C (383 °F)	T3
290 °C (554 °F)	T2
400 °C (752 °F)	T1

8.1 FV4000-VT4/VR4 Vortex flowmeter

Continued on next page

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Continued

		Main order number																						Add. order no.
Version number		1 - 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22			
Vortex flowmeter	Remote mount design	VR4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FV4000-VT4/VR4	Integral mount design	VT4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Sensor Design																								
Standard single sensor (Tmax = 280 °C [536 °F])											1													
Standard single sensor with integrated temperature sensor (Tmax = 280 °C [536 °F])											2													
Standard double sensor (Tmax = 280 °C [536 °F]) (min. DN 50 (2 in.))											3													
Standard double sensor with integral temperature sensor (Tmax = 280 °C [536 °F]) (min. DN 50 (2 in.))											4													
High temperature single sensor (< 400 °C [< 752 °F])											A													
Others											Z													
Sensor Seals / Fluid Temperature Range																								
Graphite / -55 ... 280 °C (-67 ... 536 °F) (Max. PN 64 / ASME CL 300)											1													
Graphite special / -55 ... 400 °C (-67 ... 752 °F) (Max. PN 64 / ASME CL 300) (only for high temperature sensor)											2													
Kalrez (3018) O-Ring / 0 ... 280 °C (32 ... 536 °F)											3													
Viton O-Ring / -55 ... 230 °C (-67 ... 446 °F) (not for steam)											4													
PTFE O-Ring / -55 ... 200 °C (-67 ... 392 °F)											5													
Kalrez (6375) O-Ring / -20 ... 275 °C (-4 ... 527 °F)											8													
Certificates																								
Standard												A												
Inspection certificate 3.1 acc. EN 10204												B												
Material certificate 3.1 acc. EN 10204 with pressure test acc. AD2000												C												
Pressure test acc. AD2000												D												
Communication																								
With display with HART													2											
With display with PROFIBUS PA													4											
With display with FOUNDATION fieldbus													6											
Others													9											
Name Plate																								
German															G									
English															E									
French															F									
Chinese															7) C									
Design Level / Software Level																								
(Specified by ABB)																	x							
Accessories																								
Without																		0						
2-inch pipe mounting																		1						
Climate-proof version																		2						
Climate-proof version + 2-inch pipe mounting																		3						
Operating Mode																								
Continuous flowrate metering																		A						
Cable Gland																								
M20 x 1.5 (not for Ex approval Code 2 or 3)																			A					
1/2-inch NPT																			B					
Plug connection M12 (Only for communication 4 and Ex approval 0 or A)																		8) C						
Others																			Z					
Calibration																								
Test certificate																			9) A					
Calibration certificate																			10) B					
Others																				Z				
Ambient temperature range																								
-20 ... 70 °C (standard for Ex approval Code 0, 1, or A)																					1			
-55 ... 70 °C (extended temperature range for Ex approval Code 0 or 1)																					2			
-20 ... 60 °C (standard for Ex approval Code 2)																					3			
-40 ... 60 °C (extended temperature range for Ex approval Code 2 or A)																					4			
-40 ... 70 °C (extended temperature range for Ex approval Code 1)																					5			
-45 ... 70 °C (extended temperature range for Ex approval Code 3)																					6			
-30 ... 70 °C (extended temperature range for Ex approval Code A)																					7			

7) For Chinese production only.

8) Socket NPE300-NE is not included in the scope of delivery. Please order separately, if needed (Part No. 9890116).

9) Test certificate with k-factors.

10) Test certificate with k-factors and error curve.

Continued

Main order number																						Add. order no.
Version number	1 - 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	xx	
	VR4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX	
	VT4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Certificates: PED																						CP1
Meter tube with PED certificate (Pressure Equipment Directive 97 / 23 / EC)																						
Other Explosion Protection Certification and Approvals																						7) ES1
China: NEPSI certificate																						

7) For Chinese production only.

8.2 FS4000-ST4/SR4 Swirl flowmeter

Main order number																						Add. order no.
Version number		1 - 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	xx
Swirl flowmeter	Remote mount design	SR4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX
FS4000-ST4/SR4	Integral mount design	ST4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Ex Approval																						
Without			0																			
IECEX / ATEX Cat. 2 (Zone 1 / 21), Ex ib / Ex td (for HART)			1)																			
IECEX / ATEX Cat. 2 (Zone 1 / 21), Ex d + Ex ib / Ex td (for HART)			2)																			
FM approval (Class 1 / Div. 1) (for HART)			3																			
IECEX / ATEX Cat. 2 (Zone 1 / 21, FISCO model), Ex ia / Ex td (for PA / FF)			3) A																			
FM Approval Electric Safety Standard (Class 3810/NEMA 250) PA / FF			4) F																			
Others			9																			
Process Connection																						
Flange			1																			
Flange with groove (DIN 2512)			2																			
Other			9																			
Fluid																						
Liquid			1																			
Gas			2																			
Steam			3																			
Oxygen			5) 6																			
Other			9																			
Material Housing // Inlet / Outlet Guide // Sensor																						
AISI 316Ti SST (1.4571) / AISI 316Ti SST (1.4571) / AISI 316Ti SST (1.4571)			1																			
AISI 316Ti SST (1.4571) / Hastelloy C / AISI 316Ti SST (1.4571)			2																			
Hastelloy C / Hastelloy C /Hastelloy C			3																			
AISI 316Ti SST (1.4571) / Hastelloy C / Hastelloy C			4																			
Others			9																			
Meter Size																						
DN 15 (1/2 inch)			1 5																			
DN 20 (3/4 inch)			2 0																			
DN 25 (1 inch)			2 5																			
DN 32 (1-1/4 inch)			3 2																			
DN 40 (1-1/2 inch)			4 0																			
DN 50 (2 inch)			5 0																			
DN 80 (3 inch)			8 0																			
DN 100 (4 inch)			1 H																			
DN 150 (6 inch)			1 F																			
DN 200 (8 inch)			2 H																			
DN 300 (12 inch)			3 H																			
DN 400 (16 inch)			4 H																			
Pressure Rating																						
PN 10			A																			
PN 16			B																			
PN 25			C																			
PN 40			D																			
ASME CL 150			Q																			
ASME CL 300			R																			
Others			Z																			
Gasket Surface Roughness																						
Standard			A																			
Others			Z																			

Continued on next page

- 1) Design is also certified for use in Zone 2 (II 3G Ex n [L] IIC T4).
- 2) Design is also certified for use in Zone 2 (II 3G Ex n [L] IIC T4) and Zone 1 (II 2G Ex ib IIC T4).
- 3) China production IECEx only.
- 4) For US production only.
- 5) Flowmeter sensor for oxygen use, cleaned and labeled.

Add.
order no.

- 6) For Chinese production only.
- 7) Socket NPE300-NE is not included in the scope of delivery. Please order separately, if needed (Part No. 9890116).
- 8) Test certificate with k-factors.
- 9) Test certificate with k-factors and error curve.

Continued

		Main order number																						Add. order no.	
Version number	1 - 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	xx				
	SR4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX				
	ST4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
Other Explosion Protection Certification and Approvals China: NEPSI Certificate																						6)	ES1		

6) For Chinese production only.

9 Accessories

If P/T compensation is required, see the "Sensycal measurement computer" data sheet.

i Important

The flowmeter must be connected to the Sensyflow via a power input card. This will then also be responsible for the supply function.

Connection via the pulse output is not possible, as the pulse output delivers pulse packets rather than a steady frequency.

Wafer accessories (optional)

Depending on the nominal diameter / nominal pressure, some centering elements are also included in the standard accessories (bolts, nuts, spring washers) available as an option.

Important

Seals are not included in the accessories.

Nominal diameter	Nominal pressure rating	Order number	No centering aids required	With centering sleeves	With centering	With centering segments
DN 25	PN 64 ... PN 100	D614L384U11			x	
DN 25	ASME 150	D614L414U01	x			
DN 25	ASME 300 ... 600	D614L414U02			x	
DN 40	PN 10 ... PN 40	D614L384U02	x			
DN 40	PN 64	D614L384U14			x	
DN 40	ASME 150	D614L414U03	x			
DN 40	ASME 300 ... 600	D614L414U04			x	
DN 50	PN 10 ... PN 40	D614L384U03	x			
DN 50	PN 64	D614L384U13		x		
DN 50	ASME 150	D614L414U05	x			
DN 50	ASME 300	D614L414U06		x		
DN 50	ASME 600	D614L414U14		x		
DN 80	PN 10 ... PN 40	D614L384U04	x			
DN 80	PN 64	D614L384U12				x
DN 80	ASME 150	D614L414U07	x			
DN 80	ASME 300 ... 600	D614L414U08				x
DN 100	PN 10 ... PN 16	D614L384U05	x			
DN 100	PN 25 ... PN 40	D614L384U06		x		
DN 100	PN 64	D614L384U16				x
DN 100	ASME 150	D614L414U09	x			
DN 100	ASME 300	D614L414U10				x
DN 100	ASME 600	D614L414U13				x
DN 150	PN 10 ... PN 16	D614L384U07	x			
DN 150	PN 25 ... PN 40	D614L384U08		x		
DN 150	PN 64	D614L384U17				x
DN 150	ASME 150	D614L414U11	x			
DN 150	ASME 300	D614L414U12				x
DN 150	ASME 600	D614L414U15				x

Customer:	Date:
Ms./Mr.:	Department:
Phone:	Fax:

Measuring system: ☐ FV4000 Vortex flowmeter ☐ FS4000 Swirl flowmeter ☐ Integrated Pt100 (for measuring media temperature recording or saturated steam mass calculation)	
---	--

Fluid: Aggregate state	☐ Oxygen ☐ Steam / gas	☐ Fluid
Flowrate: (min., max., operating point)	_____	☐ m ³ /h ☐ US gal/min ☐ ft ³ /min ☐ kg/h ☐ lb/h ☐ Standard condition ☐ Mass ☐ Operating mode
Density: (min., max., operating point)	_____	☐ kg/m ³ ☐ lb/ft ³ ☐ Standard condition ☐ Operating mode
Viscosity: (min., max., operating point)	_____	☐ mPas (cp) ☐ cst (Please specify for fluids)
Fluid temperature: (min., max., operating point)	_____	☐ °C ☐ °F
Ambient temperature: (min., max., operating point)	_____	☐ °C ☐ °F
Pressure: (min., max., operating point)	_____	☐ bar ☐ psi
Nominal diameter/nominal pressure rating of the pipeline:	_____ _____	DN PN
Eff. inside diameter of the pipeline:	_____	☐ mm ☐ inch

Transmitter design / communication:	☐ 4 ... 20 mA (2-wire) HART (standard)	☐ 2-wire PROFIBUS PA	☐ 2-wire FOUNDATION fieldbus
	Explosion protection ☐ Without ☐ 2G Ex "ib" ☐ 2G Ex "d" ☐ 3G Ex "nA [L]"	Explosion protection ☐ Without ☐ 2G Ex "ia"	Explosion protection ☐ Without ☐ 2G Ex "ia"

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