KROHNE

measure the facts

OPTISWIRL 4200

Vortex flowmeter

- Integrated pressure and temperature compensation for steam and gases
- Gross and net heat measurement for hot water and steam
- Stable measurements even under demanding process conditions with advanced technology for signal filtering (AVFD)

HART COMMUNICATION PROTOCOL

Functional principle

Vortex flowmeters are used to measure the flow of gases, vapours and liquids at completely filled pipes.

The measuring principle is based on the Karman vortex street. The measuring tube contains a bluff body at which vortex shedding occurs and which is detected by a sensor unit located behind. The frequency f of the vortex shedding is proportional to the flow velocity v. The non-dimensional Stouhal number S describes the relationship between vortex frequency f, width b of the bluff body and the average flow velocity v:

$$f = \frac{S \cdot v}{b}$$

The vortex frequency is recorded at the flow sensor and evaluated at the signal converter.

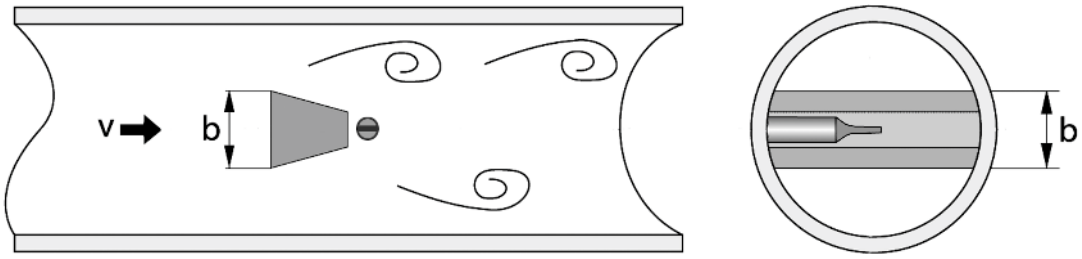
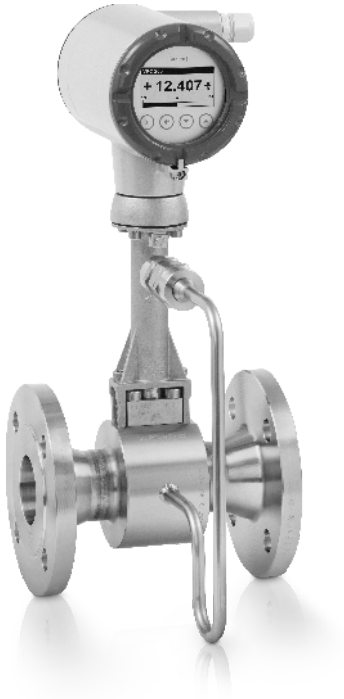


Figure 1: Functional principle

The all-in-one solution

Vortex flowmeters are suitable for a wide range of media. This is particularly true for the OPTISWIRL 4200. It's capability to master even fluctuating pressures and temperatures turns it into an ideal all-rounder for the measurement of energy carriers in auxiliary and supply processes.



Already the basic version of the OPTISWIRL 4200 is equipped with a temperature compensation for saturated steam applications. With the optional pressure sensor the flowmeter has an integrated density compensation available, which even allows an exact measurement of gases and superheated steam with varying process conditions. The additional integrated gross and net heat measurement makes this flowmeter to be a reliable partner for advanced energy management systems.

With the innovative AVFD (Advanced Vortex Frequency Detection) the OPTISWIRL 4200 is fitted with an up-to-date signal filter. It analyses the measured signal and eliminates interferences and perturbations. Thereby, stable measurements can even be realised under demanding process conditions.

This vortex flowmeter was designed for the safety-related applications from the very beginning. It was developed according to the standard IEC 61508 edition 2. The certification is effected within the scope of a full assessment by TUEV Sued. Thereby the flowmeter can be used for continuous volume flow measurement in safety-related applications with classification SIL 2 available optionally.

Highlights

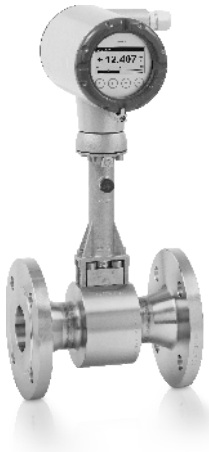
- Development according to IEC 61508, edition 2
- Advanced technology for signal filtering - AVFD (Advanced Vortex Frequency Detection)
- Integrated pressure and temperature compensation
- Temperature compensation for saturated steam included as standard
- Integrated gross and net heat calculation for steam and hot water
- Comprehensive communication options
- Remote version with field housing converter with cable length up to 50 m / 164 ft
- Integrated reduction of nominal size
- Measurement of conductive and non-conductive liquids, gases and steam

Applications

- Measurement of saturated steam and superheated steam
- Steam boiler monitoring
- Heat metering of steam and hot water
- Measurement of consumption of industrial gases
- Measurement of consumption in compressed air systems
- Monitoring of compressor output
- Evaluation of free air delivery (FAD)
- SIP and CIP processes in the food, beverage and pharmaceutical industries
- Safety-related measurement in SIL applications (SIL 2)

Options and variants

1. The universal device with temperature compensation for saturated steam integrated as standard



The OPTISWIRL 4200 C as compact flowmeter in a flange version is suitable for universal use in measuring liquids, gases and vapours.

The temperature compensation for saturated steam is integrated as standard, thus enabling direct compensation of the density; the mass and energy can also be measured.

The advanced signal filter technology AVFD (Advanced Vortex Frequency Detection) complements the high accurate measurement.

2. The easy to install sandwich version with optimised centering rings

The OPTISWIRL 4200 C as a compact flowmeter in a sandwich version is suitable for universal use in the measurement of liquids, gases and vapours.

The temperature compensation for saturated steam is integrated as standard.

The flowmeter is provided with additional optimised centering rings. The vortex flowmeter can be aligned centrically by turning the centering rings, eliminating any offset between the flowmeter and the pipeline.

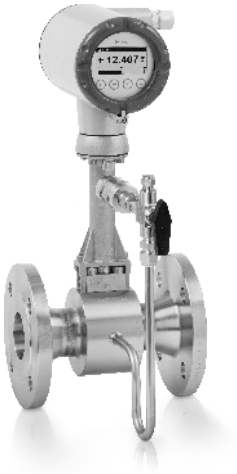
3. The one-of-a-kind 2-wire device with integrated pressure and temperature compensation

The OPTISWIRL 4200 as a flange or sandwich flowmeter is optionally available with integrated pressure and temperature compensation for gases, wet gases, gas mixtures or steam.

The advantages of this unique design couldn't be clearer:

- No additional cost-intensive installation of pressure and temperature sensors
- No additional cabling work
- No faulty measurement results, because pressure, temperature and volume flow can be read at a single point
- Direct measurement of mass and/or energy

4. Vortex flowmeter with shut-off valve for the pressure measurement



As an option, the OPTISWIRL 4200 can be supplied with a shut-off valve to allow the pressure sensor to be exchanged without interrupting the process.

What is more, the pressure sensor can be shut off for the purpose of pressure or leak testing of the pipeline.

Using the built-in two-way valve, the pressure sensor can also be calibrated and tested at a later time.

5. Dual measurement for twofold reliability

The OPTISWIRL 4200 is optionally available as a dual version.

This is a genuine redundant system with two independent flow sensors and two signal converters. This provides twofold functional reliability and availability of the measurement.

This variant is ideally suited for measurements in multi-product pipelines. In such pipelines, two different products are moved through one after the other.

One signal converter can be programmed for one product, and the other signal converter for the other product.

6. The OPTISWIRL 4200 F as remote version

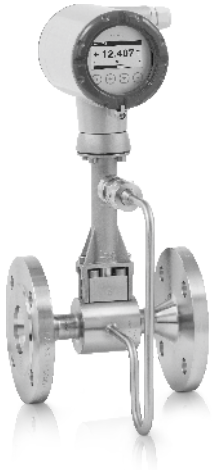
The OPTISWIRL 4200 is also available as a remote version with field housing converter.

This feature allows separating the signal converter from the flow sensor up to a distance of 50 m / 164 ft, in case the flow sensor is mounted in inaccessible areas.

The remote mounted signal converter allows easy operation and reading of values at eye level.

Additionally to the flow rates, measurements of the integrated pressure and temperature sensors can be displayed.

7. OPTISWIRL 4200 F1R / F2R with integrated nominal diameter reduction



The OPTISWIRL 4200 F1R / F2R with integrated nominal diameter reduction up to two nominal diameter sizes assures best results in accuracy and optimal measuring ranges even in pipelines with large diameters, which have been designed for a low pressure loss.

By forgoing complex pipeline reduction installations, space and cost saving installations can be realized. At the same time the number of potential leakages is reduced to a minimum.

Devices with integrated nominal diameter reduction

The device versions F1R and F2R offer an integrated nominal diameter reduction up to two nominal diameter sizes to assure best results in accuracy and optimum measuring ranges; even in pipelines with large diameters, which have been designed for a low pressure loss.

Nominal diameter of flow sensor	Nominal size of process connections									
	DN15	DN25	DN40	DN50	DN80	DN100	DN150	DN200	DN250	DN300
DN15	StV	F1R	F2R	-	-	-	-	-	-	-
DN25		StV	F1R	F2R	-	-	-	-	-	-
DN40	-	-	StV	F1R	F2R	-	-	-	-	-
DN50	-	-	-	StV	F1R	F2R	-	-	-	-
DN80	-	-	-	-	StV	F1R	F2R	-	-	-
DN100	-	-	-	-	-	StV	F1R	F2R	-	-
DN150	-	-	-	-	-	-	StV	F1R	F2R	-
DN200	-	-	-	-	-	-	-	StV	F1R	F2R
DN250	-	-	-	-	-	-	-	-	StV	F1R
DN300	-	-	-	-	-	-	-	-	-	StV

StV - Standard Vortex

Measuring system

Application range	Flow measurement of liquids, gases and vapours
Function / Measuring principle	Karman vortex street

Measurement

Primary measured value	Number of separated vortices
Secondary measured value	Operating and standard volume flow and mass flow

Signal converter

Versions	Compact
	Remote version Cable length: ≤ 50 m / 164 ft

Flow sensor

Standard	Flange version (with integrated temperature measurement), flow sensor: F
	Sandwich version (with integrated temperature measurement), flow sensor: S
Option	Basic device with additional pressure measurement
	Basic device with additional pressure measurement and shut-off valve for pressure sensor
	Dual measuring device in both flange and sandwich version (redundant measurement)
	Dual measuring device with additional pressure measurement
	Flange version with single reduction of nominal diameter, flow sensor: F1R
	Flange version with double reduction of nominal diameter, flow sensor: F2R

Display and user interface

Local display	Graphic display
Interface and display language	German, English, French, Italian, Spanish, Russian, Chinese, Swedish, Danish, Czech, Polish; 15 further languages (under preparation)

Measuring accuracy

Reference condition

Reference conditions	Water at +20°C / +68°F
	Air at +20°C / +68°F and 1.013 bara / 14.7 psia

Maximum measuring error

Volume flow (liquid)	±0.75% of measured value (Re ≥ 20000)
Volume flow	±1.0% of measured value (Re ≥ 20000)
Mass flow (gases and steam)	±1.5% of measured value (Re ≥ 20000)
Mass flow (liquid / water)	±1.5% of measured value (Re ≥ 20000)
Normalised volume flow (gas)	±1.5% of measured value (Re ≥ 20000)
Repeatability (volume flow)	±0.1% of measured value

Operating conditions

Medium temperature	-40...+240°C / -40...+465°F
Ambient temperature	Non-Ex: -40...+85°C / -40...+185°F Ex: -40...+65°C / -40...+140°F
Storage temperature	-40...+85°C / -40...+185°F

Pressure

Medium pressure	Max. 100 bar / 1450 psi (higher pressures on request)
Ambient pressure	Atmosphere

Media properties

Density	Taken into consideration when sizing.
Viscosity	< 10 cP
Reynold's number	> 1000

Other conditions

Ingress protection	Compact version: IP66/67
	Remote version: signal converter housing: IP66/67; flow sensor housing: IP66/67

Installation conditions

Inlet section	≥ 15 x DN without disturbing flow, after pipe narrowing, after a single 90° bend
	≥ 30 x DN after a double bend 2x90°
	≥ 40 x DN after a double three-dimensional bend 2x90°
	≥ 50 x DN after control valves
	≥ 2 DN before flow straightener; ≥ 8 DN after flow straightener
Outlet section	≥ 5 x DN

Materials

Flow sensor and process connections	Standard: 1.4404/316L
	Option: Hastelloy® C-22 on request
Electronics housing	Aluminium die-cast, two-layer coating (epoxy/polyester)
	Option: die-cast aluminium with finish for advanced requirements
	Option : Stainless Steel
Pressure sensor gasket	FPM
Measuring tube gasket (Pickup)	Standard: 1.4435/316L
	Option: Hastelloy® C-276
	Selection depends on flow sensor material / medium.

Process connections of flange version

DIN EN 1092-1	DN15...300 - PN16...100 (higher pressures on request)
ASME B16.5	½ ...12" - 150...600 lb (higher pressures on request)

Process connections of sandwich version

DIN	DN15...100 - PN100 (higher pressures on request)
ASME	½ ...4" - 600 lb (higher pressures on request)

Electrical connections

Power supply	Non-Ex: 12...36 VDC
	Ex i: 12...30 VDC
	Ex d: 12...36 VDC

Inputs and outputs

General	All inputs and outputs are electrically isolated from one another.
Time constant	The time constant corresponds to 63% of the elapsed time of a processor procedure. 0...100 seconds (rounded up to 0.1 seconds)

Current output

Type	4...20 mA HART® (passive)
Output data	Volume flow, mass flow, norm. volume flow, gross/net power, free air delivery, density, temperature (internal sensor), pressure, vortex frequency, flow velocity
Resolution	5 µA
Linearity / accuracy	0.1% (of read value)
Error signal	According to NE 43
Description of abbreviations	Uext = external voltage;
	RL = load + resistance
Load	Minimum RL = 0 Ω; maximum RL = (Uext - 12 VDC) / 22 mA)

HART®

	HART® protocol via passive current output
HART® Revision	HART® 7
	Burst mode
	Catch device
System requirements	Load min. 250 Ω
Multidrop operation	4 mA

Other communication protocols

FOUNDATION Fieldbus (Optional)
PROFIBUS PA (Optional)

Binary output

Function	Pulse, frequency, status, limit switch
Type	Passive
	Proximity sensor acc. to DIN EN 60947-5-6 (NAMUR sensor) or pulse output signal acc. to VDI/VDE 2188 (category 2)
Pulse	width 0.5...2000 ms

Current input

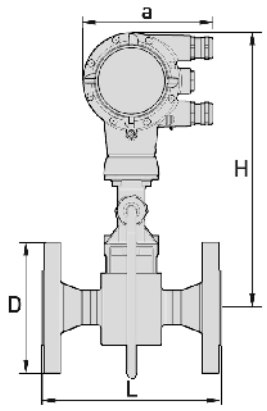
Type	4...20 mA (passive)
Resolution	6 µA
Linearity / accuracy	0.1% (of read value)
Voltage drop	10 V

Approvals and certificates

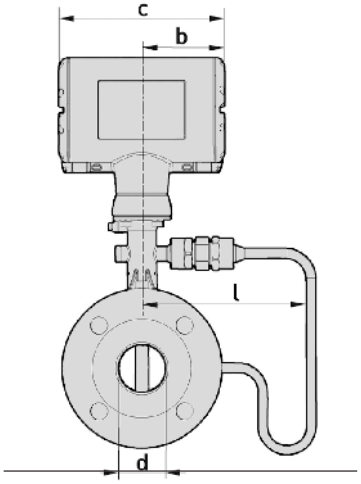
IECEx	IECEx - Ex ia IIC T6...T2 Gb
	IECEx - Ex d ia IIC T6...T2 Gb
	IECEx - Ex nA IIC T6...T2 Gc
	IECEx - Ex tb IIIC T70°C Db
CCOE / PESO	Petroleum and Explosives Safety Organisation
IBR	Indian Boiler Regulation – For steam applications

Dimensions and weights

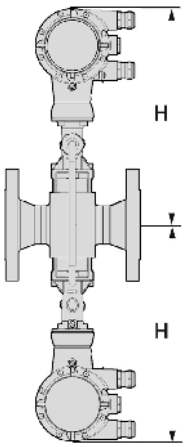
Flange versions



a = 148.5 mm / 5.85"



b = 85.8 mm / 3.38"
c = 171.5 mm / 6.76"



Option:
Version with two signal converter

Dimensions of flange version ASME B16.5 [mm]

Nominal size DN	Pressure Rating Class	d	D	L	H	H F1R ①	H F2R ②	l	l F1R ①	l F2R ②
½	150	16	90	200	358.8	-	-	169.3	-	-
½	300	16	95	200	358.8	-	-	169.3	-	-
½	600	16	95	200	358.8	-	-	169.3	-	-
1	150	26.6	110	200	358.3	358.8	-	169.3	169.3	-
1	300	26.6	125	200	358.3	358.8	-	169.3	169.3	-
1	600	24	125	200	358.3	358.8	-	169.3	169.3	-
1 ½	150	41	125	200	362.3	358.3	358.8	169.5	169.3	169.3
1 ½	300	41	155	200	362.3	358.3	358.8	169.5	169.3	169.3
1 ½	600	41	155	200	362.3	358.3	358.8	169.5	169.3	169.3
2	150	52.5	150	200	368.3	362.3	358.3	169.5	169.5	169.3
2	300	52.5	165	200	368.3	362.3	358.3	169.5	169.5	169.3
2	600	49.2	165	200	368.3	362.3	358.3	169.5	169.5	169.3
3	150	77.9	190	200	380.3	368.3	362.3	169.3	169.5	169.5
3	300	77.9	210	200	380.3	368.3	362.3	169.3	169.5	169.5
3	600	74.0	210	200	380.3	368.3	362.3	169.3	169.5	169.5
4	150	102.3	230	250	396.8	380.3	368.3	171.5	169.3	169.5
4	300	102.3	255	250	396.8	380.3	368.3	171.5	169.3	169.5
4	600	97.0	275	250	396.8	380.3	368.3	171.5	169.3	169.5
6	150	154.1	280	300	416.3	396.8	380.3	191.5	171.5	169.3
6	300	154.1	320	300	416.3	396.8	380.3	191.5	171.5	169.3
6	600	146.0	355	300	416.3	396.8	380.3	191.5	171.5	169.3

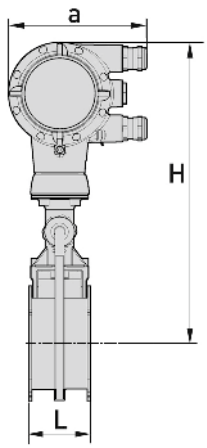
Nominal size DN	Pressure Rating Class	d	D	L	H	H F1R ①	H F2R ②	l	l F1R ①	l F2R ②
8	150	202.7	345	300	442.1	416.3	396.8	202.8	191.5	171.5
8	300	202.7	380	300	442.1	416.3	396.8	202.8	191.5	171.5
10	150	254.6	405	380	468.8	442.1	416.3	229.5	202.8	191.5
10	300	254.6	455	380	468.8	442.1	416.3	229.5	202.8	191.5
12	150	300.0	485	450	442.8	468.8	442.1	255.0	229.5	202.8
12	300	300.0	520	450	442.8	468.8	442.1	255.0	229.5	202.8

① F1R - single reduction
② F2R - double reduction

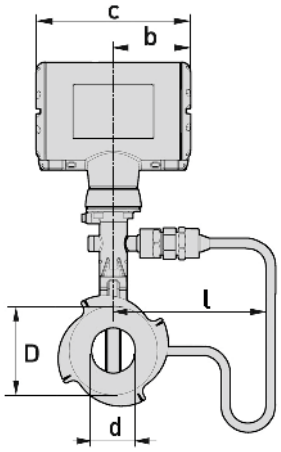
Weight of flange version ASME B16.5 [kg]

Nominal size DN	Pressure Rating Class	with	without	F1R with	F1R without	F2R with	F2R without
		Pressure sensor		Pressure sensor		Pressure sensor	
1/2	150	5.1	4.5	-	-	-	-
1/2	300	5.5	4.9	-	-	-	-
1/2	600	5.7	5.1	-	-	-	-
1	150	6.8	6.2	6.6	6.0	-	-
1	300	7.8	7.2	7.6	7.0	-	-
1	600	8.1	7.5	7.9	7.3	-	-
1 1/2	150	8.9	8.3	8.6	8.0	7.7	7.1
1 1/2	300	11.0	10.4	10.9	10.3	10.0	9.4
1 1/2	600	12.0	11.4	11.8	11.2	11.0	10.4
2	150	11.6	11.0	11.0	10.4	10.3	9.7
2	300	13.0	12.4	12.6	12.0	11.9	11.3
2	600	14.5	13.9	14.0	13.4	13.4	12.8
3	150	20.4	19.8	16.9	16.3	15.6	15.0
3	300	23.4	22.8	20.4	19.8	19.2	18.6
3	600	24.4	23.8	22.9	22.3	21.8	21.2
4	150	24.0	23.4	25.3	24.7	22.7	22.1
4	300	32.0	31.4	33.9	33.3	31.2	30.6
4	600	41.0	40.4	44.1	43.5	41.2	40.6
6	150	36.8	36.2	37.8	37.2	36.9	36.3
6	300	51.8	51.2	56.1	55.5	55.8	55.2
6	600	76.8	76.2	79.8	79.2	82.6	82.0
8	150	50.6	50.0	48.8	48.2	52.5	51.9
8	300	75.4	74.8	72.2	71.6	78.1	77.5
10	150	75.0	74.4	75.2	74.6	73.9	73.3
10	300	107.0	106.4	112.4	111.8	113.5	112.9
12	150	107.0	106.4	109.8	109.2	120.4	119.8
12	300	152.0	151.4	165.4	155.8	171.7	171.1

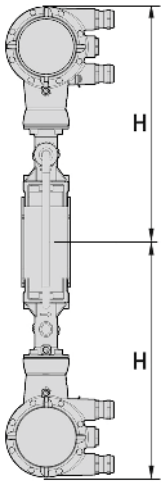
Sandwich version



a = 133 mm / 5.24"



b = 105 mm / 4.13"
c = 179 mm / 7.05"

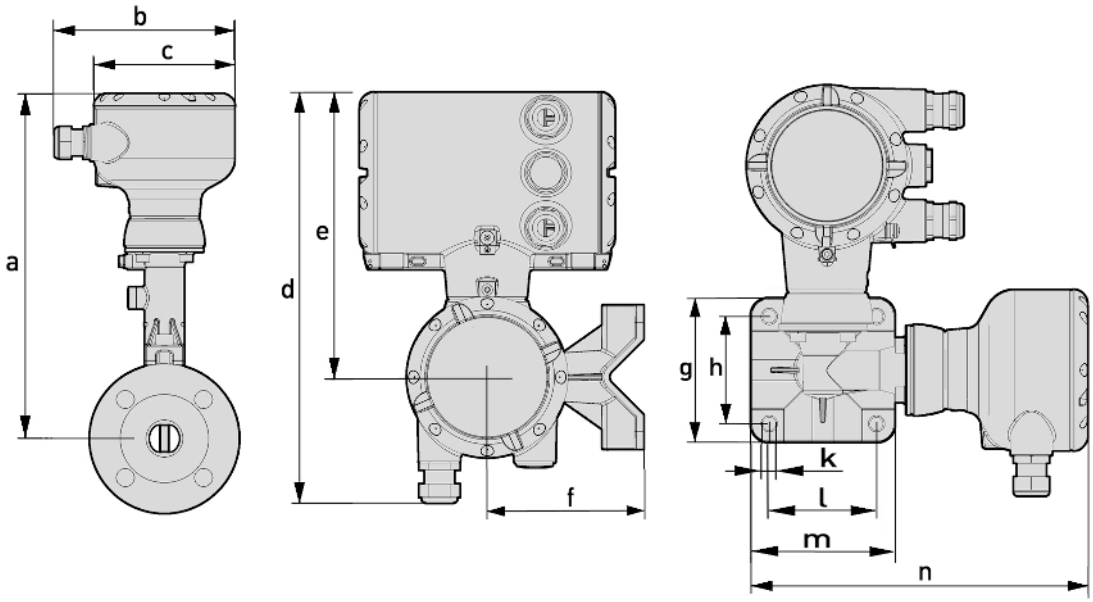


Dimension H x 2
Specified weight: + 2.8 kg / 6.2 lb

Sandwich version ASME

Nominal size	Pressure rating	Dimensions [inch]					Weight [lb]	
NPS	Class	d	D	L	H	l	with	without
							Pressure sensor	
½	150	0.63	1.77	2.56	14.13	6.67	9.04	7.72
½	300	0.63	1.77	2.56	14.13	6.67	9.04	7.72
½	600	0.55	1.77	2.56	14.13	6.67	9.04	7.72
1	150	0.94	2.56	2.56	14.13	6.67	10.8	9.48
1	300	0.94	2.56	2.56	14.13	6.67	10.8	9.48
1	600	0.94	2.56	2.56	14.13	6.67	10.8	9.48
1 ½	150	1.5	3.23	2.56	14.27	6.67	12.13	10.8
1 ½	300	1.5	3.23	2.56	14.27	6.67	12.13	10.8
1 ½	600	1.5	3.23	2.56	14.27	6.67	12.13	10.8
2	150	1.97	4.02	2.56	14.50	6.67	14.55	13.23
2	300	1.97	4.02	2.56	14.50	6.67	14.55	13.23
2	600	1.97	4.02	2.56	14.50	6.67	14.55	13.23
3	150	2.91	5.31	2.56	14.98	6.67	19.4	18.08
3	300	2.91	5.31	2.56	14.98	6.67	19.4	18.08
3	600	2.91	5.31	2.56	14.98	6.67	19.4	18.08
4	150	3.82	6.22	2.56	15.63	6.75	22.27	20.94
4	300	3.82	6.22	2.56	15.63	6.75	22.27	20.94
4	600	3.82	6.22	2.56	15.63	6.75	22.27	20.94

Dimensions of remote version



Dimension a

	Flange & sandwich version						Flange version			
DN ▸	15	25	40	50	80	100	150	200	250	300
NPS ▸	½	1	1½	2	3	4	6	8	10	12
[mm] ▸	265.7	265.2	269.2	275.2	287.2	303.7	323.2	348.9	375.7	399.7
[inch] ▸	10.5	10.4	10.6	10.8	11.3	12.0	12.7	13.7	14.8	15.7

Dimension a F1/2R

	Flange version									
DN ▸	15	25	40	50	80	100	150	200	250	300
NPS ▸	½	1	1½	2	3	4	6	8	10	12
F1R ① [mm] ▸	-	315.7	315.2	319.2	325.2	337.2	353.7	373.2	398.9	425.7
F1R ① [inch] ▸	-	12.4	12.4	12.6	12.8	13.3	13.9	14.7	15.7	16.8
F2R ② [mm] ▸	-	-	315.7	315.2	319.2	325.2	337.2	353.7	373.2	398.9
F2R ② [inch] ▸	-	-	12.4	12.4	12.6	12.8	13.3	13.9	14.7	15.7

① F1R - single reduction -② F2R - double reduction

Dimensions b...n

	b	c	d	e	f	g	h	j	k	l	m	n
[mm]	138.5	108.0	275.6	191.2	105.0	97.0	72.0	108.0	9.0	72.0	97.0	226.0
[inch]	5.46	4.25	10.9	7.53	4.14	3.82	2.84	4.25	0.35	2.84	3.82	8.90

Minimum inlet sections

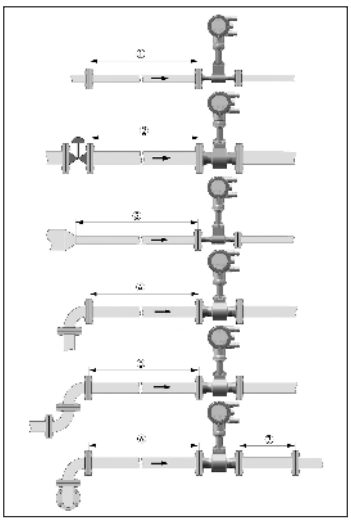


Figure 2: Minimum inlet sections

1 General inlet section without disturbing flow ≥ 15 DN
2 After a control valve ≥ 50 DN
3 After a pipe diameter reduction ≥ 20 DN
4 After a single bend 90° ≥ 20 DN
5 After a double bend 2x90° ≥ 30 DN
6 After a double three-dimensional bend 2x90° ≥ 40 DN
7 Outlet section: >5 DN

The nominal diameter of the flange is significant for the determination of the minimum inlet and outlet sections for the nominal diameter reduced versions of vortex flowmeter versions F1R and F2R.

Minimum outlet sections

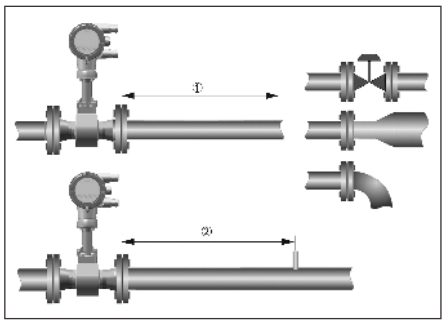


Figure 3: Minimum outlet sections

1 Upstream of pipe expanders, pipe bends, control valves, etc. ≥ 5 DN
2 Upstream of measuring points ≥ 5 DN

The interior of the pipe at the metering points must be free of burrs and other flow impediments.

The measuring device has an internal temperature sensor. The distance from external temperature measuring points must be ≥ 5 DN. Use flow sensors that are as short as possible to avoid disturbances of the flow profile.

Flow straightener

If, due to the type of installation, the required inlet sections are not available, the manufacturer recommends using flow straighteners. Flow straighteners are installed between two flanges upstream of the device and shorten the required inlet section.

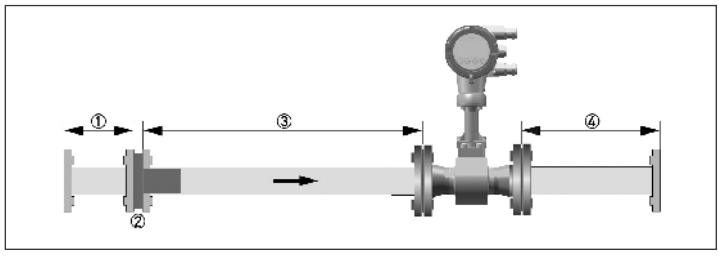


Figure 4: Flow straightener

1 Straight inlet section upstream of straightener ≥ 2 DN
2 Flow straightener
3 Straight pipe run between flow straightener and device ≥ 8 DN
4 Minimum straight outlet section ≥ 5 DN

FORBES MARSHALL

KROHNE Marshall Pvt. Ltd.
A36/B14, MIDC,
Industrial Estate,
'H' Block, Pimpri,
Pune - 411 018. India.

Tel.: +91-20-27442020
Fax: +91-20-27442040
E-mail: ksales@krohnemarshall.com
www.krohne.in
www.forbesmarshall.com

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