ISO 9001
ISO 14001

Manufacturer
TLV CO., LTD.
Kakogawa, Japan
is approved by LRQA Ltd. to ISO 9001/14001

Technical Information

Vortex flowmeter

EF200R-C

Table of contents

About this document

Symbols

Electrical symbols

Symbol	Meaning
⎓	Direct current
∼	Alternating current
≂	Direct current and alternating current
⏚	Ground connection A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
	Protective Earth (PE) A terminal which must be connected to ground prior to establishing any other connections. The ground terminals are situated inside and outside the device: • Inner ground terminal: Connects the protectiv earth to the mains supply. • Outer ground terminal: Connects the device to the plant grounding system.

Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation.
	Reference to page.
	Reference to graphic.
	Visual inspection.

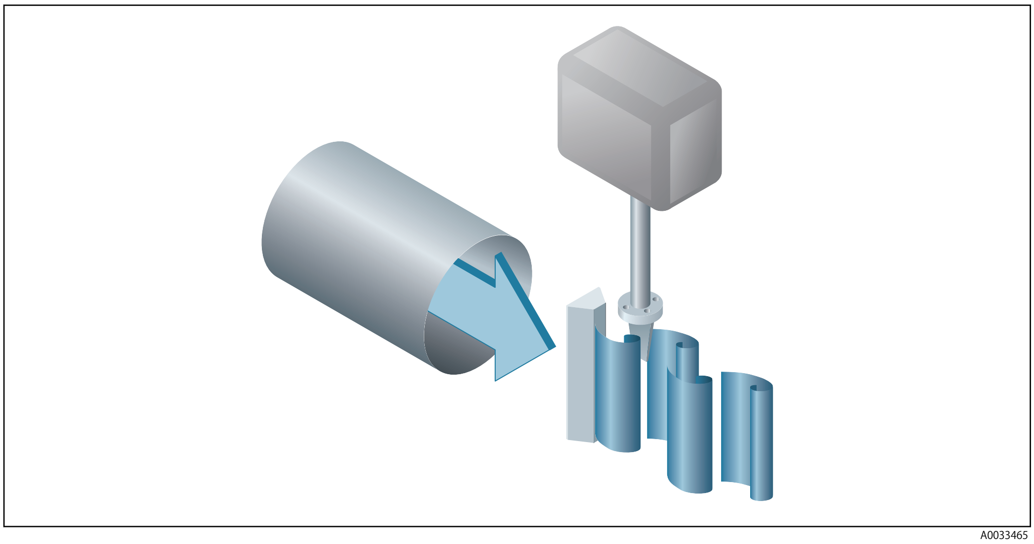
Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections
≈➡	Flow direction

Function and system design

Measuring principle

Vortex meters work on the principle of the Karman vortex street When fluid flows past a bluff body, vortices are alternately formed on both sides with opposite directions of rotation. These vortices each generate a local low pressure. The pressure fluctuations are recorded by the sensor and converted to electrical pulses. The vortices develop very regularly within the permitted application limits of the device. Therefore, the frequency of vortex shedding is proportional to the volume flow.



Sample graphic

The calibration factor (K-factor) is used as the proportional constant:

$$\text{K-Factor} = \frac{\text{Pulses}}{\text{Unit Volume [m}^3\text{]}}$$

Within the application limits of the device, the K-factor only depends on the geometry of the device. It is for Re > 10000:
- Independent of the flow velocity and the fluid properties viscosity and density
- Independent of the type of substance under measurement: steam, gas or liquid

The primary measuring signal is linear to the flow. After production, the K-factor is determined in the factory by means of calibration. It is not subject to long-time drift or zero-point drift.

The device does not contain any moving parts and does not require any maintenance.

The capacitance sensor

The sensor of a vortex flowmeter has a major influence on the performance, robustness and reliability of the entire measuring system.

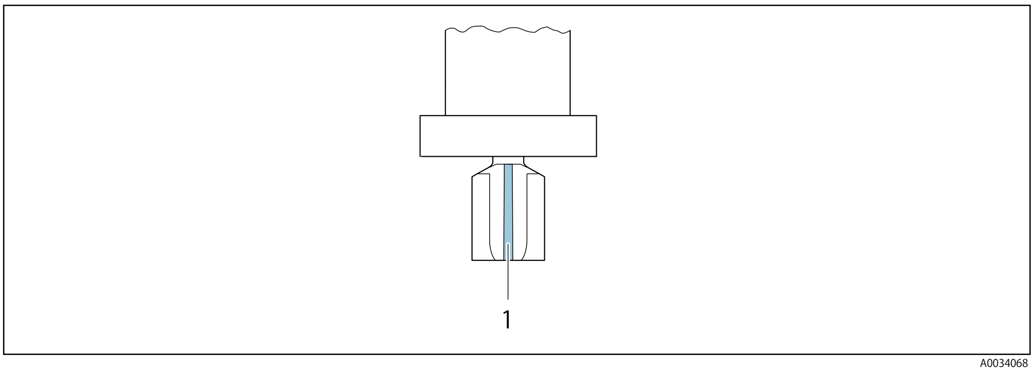
The robust DSC sensor is:
- burst-tested
- tested against vibrations
- tested against thermal shock (thermal shocks of 150 K/s)

The measuring device uses the tried-and-tested, capacitance measuring technology, which is already in use in over 450 000 measuring points worldwide. Thanks to its design, the capacitance sensor is also particularly mechanically resistant to temperature shocks and pressure shocks in steam pipelines.

Temperature measurement

The measuring device can also measure the temperature of the medium.

The temperature is measured via Pt 1000 temperature sensors. These are located in the paddle of the DSC sensor and are therefore in the direct vicinity of the fluid.



1 DSC sensor

Pressure and temperature measurement

The measuring device can also measure the pressure and temperature of the fluid.

The temperature is measured via Pt 1000 temperature sensors. These are located in the paddle of the DSC sensor and are therefore in the direct vicinity of the fluid. Pressure measurement is located directly on the meter body at the level of the bluff body. The position of the pressure tapping was chosen so that pressure and temperature could be measured at the same point. This enables accurate density and/or energy compensation of the fluid using pressure and temperature. The measured pressure tends to be somewhat lower than the line pressure. For this reason, TLV offers a correction to the line pressure (integrated in the device).

Order code for "Sensor version; DSC sensor; measuring tube":
- Option "Mass steam; 316L; 316L (integrated pressure/temperature measurement)"

Lifelong calibration

Experience has shown that recalibrated measuring devices demonstrate a very high degree of stability compared to their original calibration: The recalibration values were all within the original measuring accuracy specifications of the devices. This applies to the measured volume flow, the device's primary measured variable.

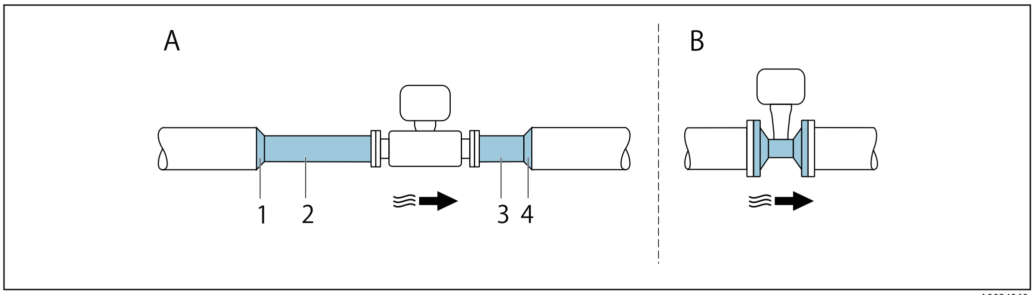
Various tests and simulation have shown that once the radii of the edges on the bluff body are less than 1 mm (0.04 in), the resulting effect does not have a negative impact on accuracy.

If the radii of the edges on the bluff body do not exceed 1 mm (0.04 in), the following general statements apply (in the case of non-abrasive and non-corrosive media, such as in most water and steam applications):
- The measuring device does not display an offset in the calibration and the accuracy is still guaranteed.
- All the edges on the bluff body have a radius that is typically smaller in size. As the measuring devices are naturally also calibrated with these radii, the measuring device remains within the specified accuracy rating provided that the additional radius that is produced as a result of wear and tear does not exceed 1 mm (0.04 in).

Consequently, it can be said that the product line offers lifelong calibration if the measuring device is used in non-abrasive and non-corrosive media.

Sensors with integrated nominal diameter reduction

In many applications the nominal diameter of the customer's pipe does not match the nominal diameter that is optimum for a vortex meter. As a result, the flow velocity is too low for vortex formation after the bluff body. This is expressed in signal loss in the lower flow range. The flow velocity can be increased by reducing the nominal diameter by one sizes. This enables the installation of the following adapters:



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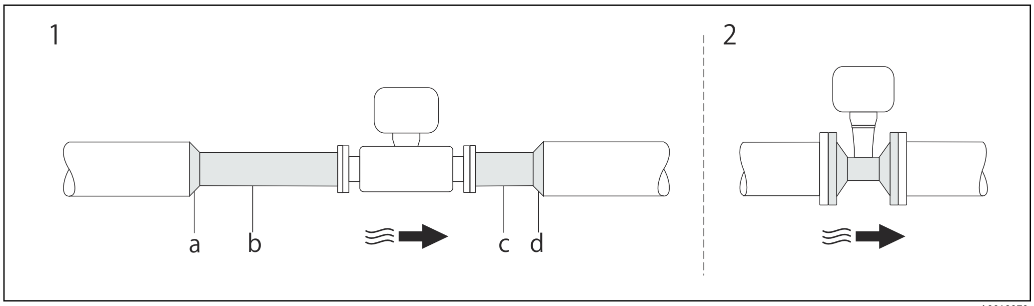


A0019070

A Nominal diameter reduction by installing various adapters and pipe segments in the pipe
B Nominal diameter reduction by using the Prowirl with integrated line size reduction
1 Reducer element
2 Straight pipe segment as the inlet run (min. 15 × DN) upstream from the vortex meter
3 Straight pipe segment as the outlet run (min. 5 × DN) downstream from the vortex meter
4 Expansion element

- EF200R-C ": with single inner diameter line size reduction, e.g. from DN 80 (3") to DN 50 (2")

These models offer the following benefits:
Savings in terms of cost and time: the additional adapters are replaced entirely by one single device

- Measuring range extended for lower flow rates
- Lower risk in the planning phase as same lengths are used compared to standard flanged devices
- All device types can be used alternatively without the need for complicated changes to the layout
- Accuracy specifications identical to those for standard devices

Inlet and outlet runs to be considered → See page 31.

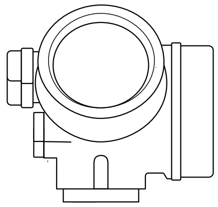
1) o.r. = of reading

Measuring system

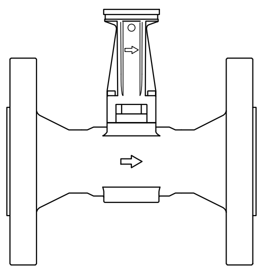
The device consists of a transmitter and a sensor.

Two device versions are available:
- Compact version – transmitter and sensor form a mechanical unit.
- Remote version - transmitter and sensor are mounted in separate locations.

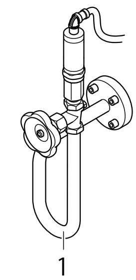
Transmitter

EF200-C  A0013471	Device versions and materials: • Compact or remote version, aluminum coated: Aluminum, AlSi10Mg, coated Configuration: • Via four-line local display with key operation or via four-line, • Via operating tools

Sensor

EF200R-C

A0034075
	Flanged version with integrated nominal diameter reduction:
	• Two versions with a different nominal diameter range are available:
	  • "R-type" with single inner diameter line size reduction: DN 25R to 200R (1R to 8R")
	• Materials:
	  • Measuring tubes DN 15 to 150 (½ to 6"): stainless cast steel, CF3M/ 1.4408

Pressure measuring cell


A0034080
1 Pressure measuring cell
	Versions:
	Pressure components
	• Pressure measuring cell 40 bar_a
	
	Material
	• Wetted parts:
	  • Process connection
	  Stainless steel, 1.4404/316L
	  • Membrane
	  Stainless steel, 1.4435/316L
	• Non-wetted parts:
	Housing
	Stainless steel ,1.4404

Input

Measured variable

Direct measured variables

Description	Measured variable
Mass; 316L; 316L (integrated temperature measurement)	• Volume flow • Temperature

Calculated measured variables

Version with pressure measuring cell	
Description	Measured variable
Mass; 316L; 316L (integrated temperature measurement)	• Corrected volume flow • Mass flow • Calculated saturated steam pressure • Energy flow • Heat flow difference • Specific volume

Measuring range

The measuring range is dependent on the nominal diameter, the fluid and environmental influences.

The following specified values are the largest possible flow measuring ranges (Q_{min} to Q_{max}) for each nominal diameter. Depending on the fluid properties and environmental influences, the measuring range may be subject to additional restrictions. Additional restrictions apply to both the lower range value and the upper range value.

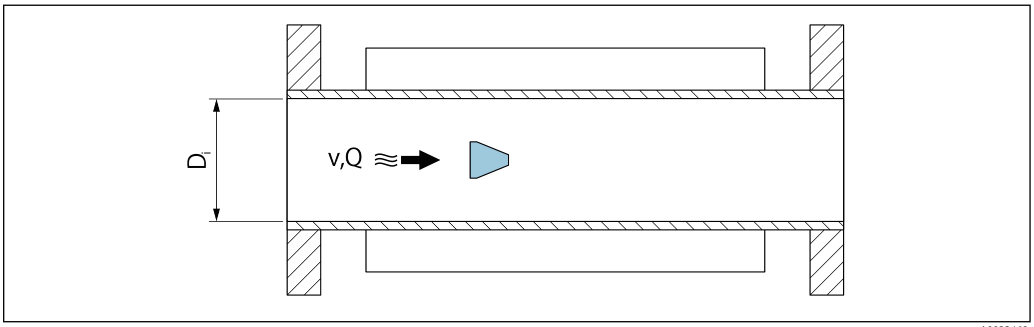
Flow measuring ranges in SI units

DN [mm]	Liquids [m^3/h]	Gas/steam [m^3/h]
25R	0.1 to 4.9	0.52 to 25
40R	0.32 to 15	1.6 to 130
50R	0.78 to 37	3.9 to 310
80R	1.3 to 62	6.5 to 820
100R	2.9 to 140	15 to 1800
150R	5.1 to 240	25 to 3200
200R	11 to 540	57 to 7300

Flow measuring ranges in US units

DN	Liquids	Gas/steam
[in]	[ft³/min]	[ft³/min]
1R	0.061 to 2.9	0.31 to 15
1½R	0.19 to 8.8	0.93 to 74
2R	0.46 to 22	2.3 to 180
3R	0.77 to 36	3.8 to 480
4R	1.7 to 81	8.6 to 1 100
6R	3 to 140	15 to 1 900
8R	6.8 to 320	34 to 4 300

Flow velocity



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D_i Internal diameter of measuring tube (corresponds to dimension K→ See page 41)
v Velocity in measuring tube
Q Flow

The internal diameter of measuring tube D_i is denoted in the dimensions as dimension K.→ See page 25.

Calculation of flow velocity:

$$v\,[m/s] = \frac{4 \cdot Q\,[m^3/h]}{\pi \cdot D_i\,[m]^2} \cdot \frac{1}{3600\,[s/h]}$$

$$v\,[ft/s] = \frac{4 \cdot Q\,[ft^3/min]}{\pi \cdot D_i\,[ft]^2} \cdot \frac{1}{60\,[s/min]}$$

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Lower range value

A restriction applies to the lower range value due to the turbulent flow profile, which only occurs with Reynolds numbers greater than 5000. The Reynolds number is dimensionless and indicates the ratio of the inertia force of a fluid to its viscous force when flowing and is used as a characteristic variable for pipe flows. In the case of pipe flows with Reynolds numbers less than 5000, periodic vortices are no longer generated and flow rate measurement is no longer possible.

The Reynolds number is calculated as follows:

$$Re = \frac{4 \cdot Q\,[m^3/s] \cdot \rho[kg/m^3]}{\pi \cdot D_i\,[m] \cdot \mu\,[Pa \cdot s]}$$

$$Re = \frac{4 \cdot Q\,[ft^3/s] \cdot \rho[lbm/ft^3]}{\pi \cdot D_i\,[ft] \cdot \mu\,[lbf \cdot s/ft^2]}$$

A0034291

Re	Reynolds number
Q	Flow
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See 41)
μ	Dynamic viscosity
ρ	Density

The Reynolds number, 5000 together with the density and viscosity of the fluid and the nominal diameter, is used to calculate the corresponding flow rate.

$$Q_{Re = 5000}\,[m^3/h] = \frac{5000 \cdot \pi \cdot D_i\,[m] \cdot \mu[Pa \cdot s]}{4 \cdot \rho[kg/m^3]} \cdot 3600\,[s/h]$$

$$Q_{Re = 5000}\,[ft^3/h] = \frac{5000 \cdot \pi \cdot D_i\,[ft] \cdot \mu[lbf \cdot s/ft^2]}{4 \cdot \rho[lbm/ft^3]} \cdot 60\,[s/min]$$

A0034302

$Q_{Re = 5000}$	Flow rate is dependent on the Reynolds number
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See page 41)
μ	Dynamic viscosity
ρ	Density

The measuring signal must have a certain minimum signal amplitude so that the signals can be evaluated without any errors. Using the nominal diameter, the corresponding flow can also be derived from this amplitude. The minimum signal amplitude depends on the setting for the sensitivity of the DSC sensor (s), the steam quality (x) and the force of the vibrations present (a). The value mf corresponds to the lowest measurable flow velocity without vibration (no wet steam) at a density of 1 kg/m^3 (0.0624 lbm/ft^3). The value mf can be set in the range from 6 to 20 m/s (1.8 to 6 ft/s) (factory setting 12 m/s (3.7 ft/s)) with the Sensitivity parameter (value range 1 to 9, factory setting 5).

The lowest flow velocity that can be measured on account of the signal amplitude v_{AmpMin} is derived from the Sensitivity parameter and the steam quality (x) or from the force of vibrations present (a).

$$v_{AmpMin}\,[m/s] = \max\left\{\frac{mf\,[m/s]}{x^2} \cdot \sqrt{\frac{1\,[kg/m^3]}{\rho[kg/m^3]}}\right.$$

$$v_{AmpMin}\,[ft/s] = \max\left\{\frac{mf\,[ft/s]}{x^2} \cdot \sqrt{\frac{0.062\,[lb/ft^3]}{\rho[lb/ft^3]}}\right.$$

A0034303

v_{AmpMin}	Minimum measurable flow velocity based on signal amplitude
mf	Sensitivity
x	Steam quality
ρ	Density

$$Q_{AmpMin}\,[m^3/h] = \frac{v_{AmpMin}\,[m/s] \cdot \pi \cdot D_i\,[m]^2}{4 \cdot \sqrt{\frac{\rho[kg/m^3]}{1\,[kg/m^3]}}} \cdot 3600\,[s/h]$$

$$Q_{AmpMin}\,[ft^3/min] = \frac{v_{AmpMin}\,[ft/s] \cdot \pi \cdot D_i\,[ft]^2}{4 \cdot \sqrt{\frac{\rho\,[lbm/ft^3]}{0.0624\,[lbm/ft^3]}}} \cdot 60\,[s/min]$$

A0034304

Q_{AmpMin}	Minimum measurable flow rate based on signal amplitude
v_{AmpMin}	Minimum measurable flow velocity based on signal amplitude
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See page 41)
ρ	Density

The effective lower range value Q_{Low} is determined using the largest of the three values Q_{min}, $Q_{Re=5000}$ and Q_{AmpMin}.

$$Q_{Low}[m^3/h] = \max\begin{cases} Q_{min}[m^3/h] \\ Q_{Re=5000}[m^3/h] \\ Q_{AmpMin}[m^3/h] \end{cases}$$

$$Q_{Low}\,[ft^3/min] = \max\begin{cases} Q_{min}\,[ft^3/min] \\ Q_{Re=5000}\,[ft^3/min] \\ Q_{AmpMin}\,[ft^3/min] \end{cases}$$

A0034313

Q_{Low}	Effective lower range value
Q_{min}	Minimum measurable flow rate
$Q_{Re=5000}$	Flow rate is dependent on the Reynolds number
Q_{AmpMin}	Minimum measurable flow rate based on signal amplitude

Upper range value

The measuring signal amplitude must be below a certain limit value to ensure that the signals can be evaluated without error. This results in a maximum permitted flow rate Q_{AmpMax}:

$$Q_{AmpMax}\,[m^3/h] = \frac{350\,[m/s] \cdot \pi \cdot D_i\,[m]^2}{4 \cdot \sqrt{\frac{\rho[kg/m^3]}{1\,[kg/m^3]}}} \cdot 3600\,[s/h]$$

$$Q_{AmpMax}\,[ft^3/min] = \frac{1148\,[ft/s] \cdot \pi\, D_i\,[ft]^2}{4 \cdot \sqrt{\frac{\rho\,[lbm/ft^3]}{0.0624\,[lbm/ft^3]}}} \cdot 60\,[s/min]$$

A0034316

Q_{AmpMax}	Maximum measurable flow rate based on signal amplitude
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See page 41)
ρ	Density

For gas applications, an additional restriction applies to the upper range value with regard to the Mach number in the measuring device, which must be less than 0.3. The Mach number Ma describes the ratio of the flow velocity v to the sound velocity c in the fluid.

$$Ma = \frac{v\,[m/s]}{c\,[m/s]}$$

$$Ma = \frac{v\,[ft/s]}{c\,[ft/s]}$$

A0034321

Ma	Mach number
v	Flow velocity
c	Sound velocity

The corresponding flow rate can be derived using the nominal diameter.

$$Q_{Ma=0.3}\,[m^3/h] = \frac{0.3 \cdot c\,[m/s] \cdot \pi\, D_i\,[m]^2}{4} \cdot 3600\,[s/h]$$

$$Q_{Ma=0.3}\,[ft^3/min] = \frac{0.3 \cdot c\,[ft/s] \cdot \pi\, D_i\,[ft]^2}{4} \cdot 60\,[s/min]$$

A0034337

$Q_{Ma=0.3}$	Restricted upper range value is dependent on Mach number
c	Sound velocity
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See page 41)
ρ	Density

The effective upper range value Q_{High} is determined using the smallest of the three values Q_{max}, Q_{AmpMax} and $Q_{Ma=0.3}$.

$$Q_{High}\ [m^3/h] = \min \begin{cases} Q_{max}\ [m^3/h] \\ Q_{AmpMax}\ [m^3/h] \\ Q_{Ma=0.3}\ [m^3/h] \end{cases}$$

$$Q_{High}\ [ft^3/min] = \min \begin{cases} Q_{max}\ [ft^3/min] \\ Q_{AmpMax}\ [ft^3/min] \\ Q_{Ma=0.3}\ [ft^3/min] \end{cases}$$

A0034338

Q_{High}	Effective upper range value
Q_{max}	Maximum measurable flow rate
Q_{AmpMax}	Maximum measurable flow rate based on signal amplitude
$Q_{Ma=0.3}$	Restricted upper range value is dependent on Mach number

For liquids, the occurrence of cavitation may also restrict the upper range value.

Operable flow range

The value, which is typically up to 49: 1, may vary depending on the operating conditions (ratio between upper range value and lower range value)

Input signal

Integrated pressure and temperature measurement

The measuring device can also directly record external variables for density and energy compensation.

This product version offers the following benefits:
- Measurement of pressure, temperature and flow in a true 2-wire version
- Recording of pressure and temperature at the same point, thus ensuring maximum accuracy of density and energy compensation
- Easy testing of pressure measurement accuracy:
  - Application of pressure by pressure calibration unit, followed by input into measuring device
  - Automatic error correction performed by device in the event of a deviation
- Availability of calculated line pressure.

Output

Output signal

Current output

Current output 1	4-20 mA (passive)
Resolution	< 1 µA
Damping	Adjustable: 0.0 to 999.9 s
Assignable measured variables	• Volume flow • Corrected volume flow • Mass flow • Flow velocity • Temperature • Pressure • Calculated saturated steam pressure • Total mass flow • Energy flow • Heat flow difference

Pulse/frequency/switch output

Function	Can be set to pulse, frequency or switch output
Version	Passive, open collector
Maximum input values	• DC 35 V • 50 mA
Voltage drop	• For ≤ 2 mA: 2 V • For 10 mA: 8 V
Residual current	≤ 0.05 mA
Pulse output	
Pulse width	Adjustable: 5 to 2000 ms
Maximum pulse rate	100 Impulse/s
Pulse value	Adjustable
Assignable measured variables	• Mass flow • Volume flow • Corrected volume flow • Total mass flow • Energy flow • Heat flow difference
Frequency output	
Output frequency	Adjustable: 0 to 1000 Hz
Damping	Adjustable: 0 to 999 s
Pulse/pause ratio	1:1
Assignable measured variables	• Volume flow • Corrected volume flow • Mass flow • Flow velocity • Temperature • Calculated saturated steam pressure • Total mass flow • Energy flow • Heat flow difference • Pressure
Switch output	
Switching behavior	Binary, conductive or non-conductive
Switching delay	Adjustable: 0 to 100 s
Number of switching cycles	Unlimited

Assignable functions	• Off
	• On
	• Diagnostic behavior
	• Limit value
	  • Volume flow
	  • Corrected volume flow
	  • Mass flow
	  • Flow velocity
	  • Temperature
	  • Calculated saturated steam pressure
	  • Total mass flow
	  • Energy flow
	  • Heat flow difference
	  • Pressure
	  • Reynolds number
	  • Totalizer 1-3
	• Status
	• Status of low flow cut off

Signal on alarm

Depending on the interface, failure information is displayed as follows:

Current output 4 to 20 mA

4 to 20 mA

Failure mode	Choose from: • 4 to 20 mA in accordance with NAMUR recommendation NE 43 • 4 to 20 mA in accordance with US • Min. value: 3.59 mA • Max. value: 22.5 mA • Freely definable value between: 3.59 to 22.5 mA • Actual value • Last valid value

Pulse/frequency/switch output

Pulse output	
Failure mode	No pulses
Frequency output	
Failure mode	Choose from: • Actual value • 0 Hz • Defined value: 0 to 1250 Hz
Switch output	
Failure mode	Choose from: • Current status • Open • Closed

Local display

Plain text display	With information on cause and remedial measures

Status signal as per NAMUR recommendation NE 107

Interface/protocol

- Via digital communication:
  - HART protocol
- Via service interface
  CDI service interface

Plain text display	With information on cause and remedial measures

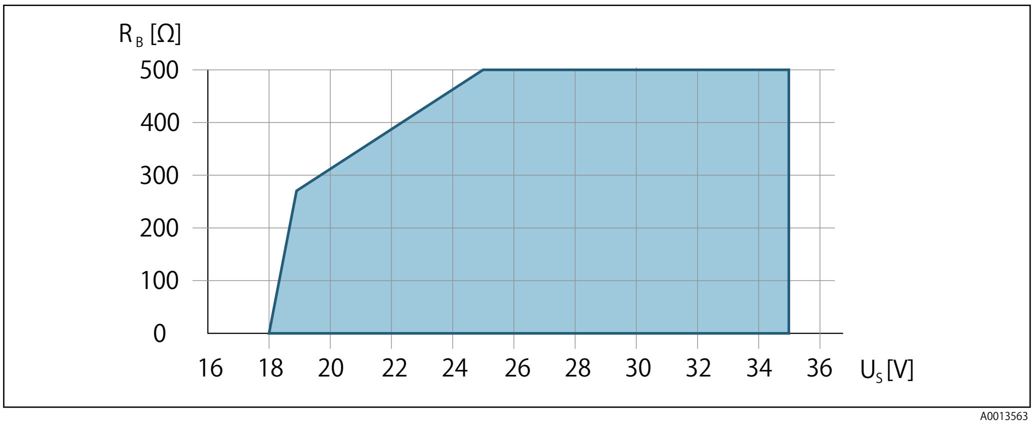
Load

Load for current output: 0 to 500 Ω, depending on the external supply voltage of the power supply unit

Calculation of the maximum load

Depending on the supply voltage of the power supply unit (U_S), the maximum load (R_B) including line resistance must be observed to ensure adequate terminal voltage at the device. In doing so, observe the minimum terminal voltage

- For U_S = 17.9 to 18.9 V: $R_B \leq (U_S$ - 17.9 V): 0.0036 A
- For U_S = 18.9 to 24 V: $R_B \leq (U_S$ - 13 V): 0.022 A
- For U_S = ≥ 24 V: $R_B \leq$ 500 Ω



Operating range

Sample calculation
Supply voltage of power supply unit: U_S=19 V
Maximum load: $R_B \leq$ (19 V - 13 V): 0.022 A = 273 Ω

Low flow cut off

The switch points for low flow cut off are preset and can be configured.

Galvanic isolation

All inputs and outputs are galvanically isolated from one another.

Protocol-specific data

HART

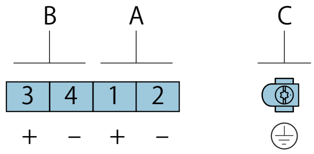
Manufacturer ID	0x11
Device type ID	0x0038
HART protocol revision	7
Device description files (DTM, DD)	Consult TLV for more information.
HART load	• Min. 250 Ω • Max. 500 Ω

Power supply

Terminal assignment

Transmitter

Connection versions



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Maximum number of terminals
Terminals 1 to 4:
Without integrated overvoltage protection

A	Output 1 (passive): supply voltage and signal transmission
B	Output 2 (passive): supply voltage and signal transmission
C	Ground terminal for cable shield

Terminal numbers			
Output 1		Output 2	
1 (+)	2 (-)	3 (+)	4 (-)
4-20 mA (passive)		Pulse/frequency/switch output (passive)	

1) Output 1 must always be used; output 2 is optional.

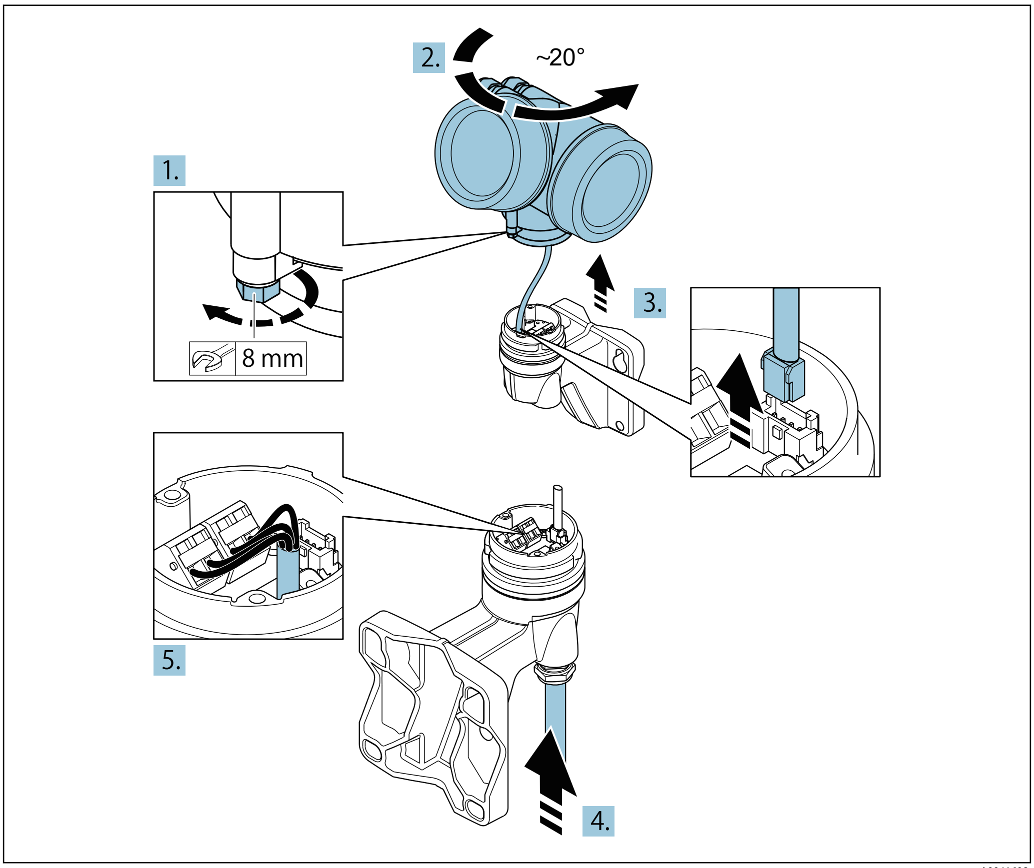
Connecting cable for remote version

Transmitter and sensor connection housing

In the case of the remote version, the sensor and transmitter are mounted separately from on another and connected by a connecting cable. Connection is performed via the sensor connection housing and the transmitter housing.

Terminals are always used to connect the connecting cable in the sensor connection housing (tightening torques for screws for cable strain relief: 1.2 to 1.7 Nm).

Connection via terminals



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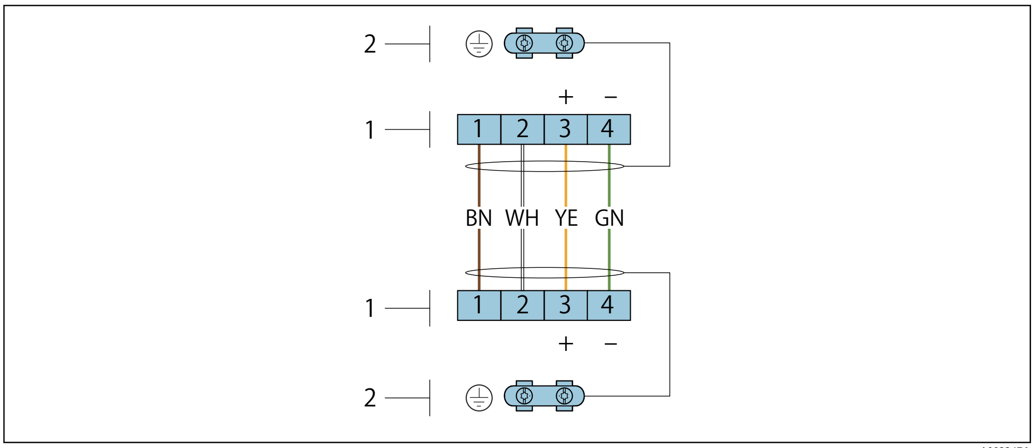
1. Loosen the securing clamp of the transmitter housing.
2. Turn the transmitter housing clockwise by approx. 20°.
3. **NOTICE**

   The connection board of the wall housing is connected to the electronics board of the transmitter via a signal cable!

   ▶ Pay attention to the signal cable when lifting the transmitter housing!

   Lift the transmitter housing, plug the signal cable out of the connection board of the wall holder and remove the transmitter housing.
4. Release the cable gland and insert the connecting cable (use the shorter stripped end of the connecting cable).
5. Wire the connecting cable → Fig. 2, See 19 → Fig. 3, See 19.
6. Reverse the removal procedure to reassemble the transmitter housing.
7. Firmly tighten the cable gland.

Connecting cable



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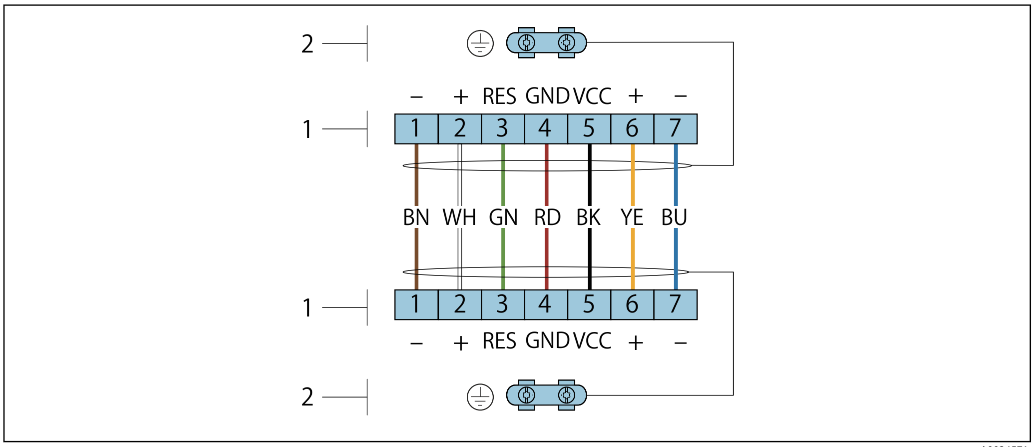
Terminals for connection compartment in the transmitter wall holder and the sensor connection housing

1 Terminals for connecting cable
2 Grounding via the cable strain relief

Terminal number	Assignment	Cable color Connecting cable
1	Supply voltage	Brown
2	Grounding	White
3	RS485 (+)	Yellow
4	RS485 (–)	Green

Connecting cable (option "mass pressure-/temperature-compensated")

Order code for "Sensor version; DSC sensor; measuring tube", option



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Terminals for connection compartment in the transmitter wall holder and the sensor connection housing

1 Terminals for connecting cable
2 Grounding via the cable strain relief

Terminal number	Assignment	Cable color Connecting cable
1	RS485 (-) DPC	Brown
2	RS485 (+) DPC	White
3	Reset	Green
4	Supply voltage	red
5	Grounding	Black
6	RS485 (+)	Yellow
7	RS485 (–)	Blue

Supply voltage

Transmitter

An external power supply is required for each output.

Supply voltage for a compact version without a local display

Order code for "Output; input"	Minimum terminal voltage [1]	Maximum terminal voltage
4-20 mA, pulse/frequency/switch output	≥ DC 12 V	DC 35 V

1) The minimum terminal voltage increases if local operation is used: see the following table

Increase in minimum terminal voltage

“Display”	Increase in minimum terminal voltage
LCD display Local operation	+ DC 1 V

"Sensor version; DSC sensor; measuring tube"	Increase in minimum terminal voltage
Mass steam; 316L; 316L (integrated pressure/temperature measurement)	+ DC 1 V

For information about the load → See p.17

Power consumption

Transmitter

Order code for "Output; input"	Maximum power consumption
4-20 mA, pulse/frequency switch output	• Operation with output 1: 770 mW • Operation with output 1 and 2: 2770 mW
Option C: 4-20 mA HART + 4-20 mA	

Current consumption

Current output

For every 4-20 mA or 4-20 mA current output: 3.6 to 22.5 mA

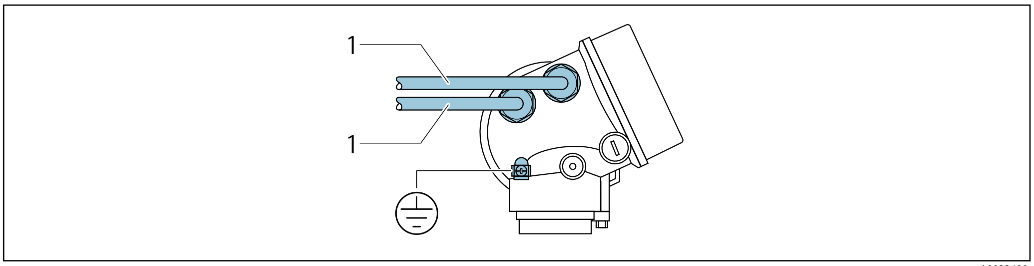
If the option Defined value is selected in the Failure mode parameter : 3.59 to 22.5 mA

Power supply failure

- Totalizers stop at the last value measured.
- Depending on the device version, the configuration is retained in the device memoryor in the pluggable data memory (HistoROM DAT).
- Error messages (incl. total operated hours) are stored.

Electrical connection

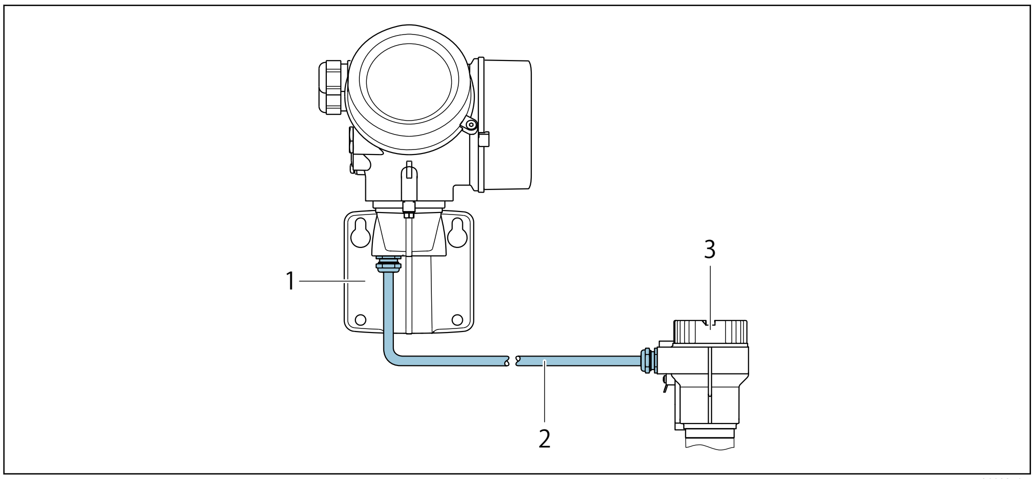
Connecting the transmitter



1 Cable entries for inputs/outputs

Remote version connection

Connecting cable



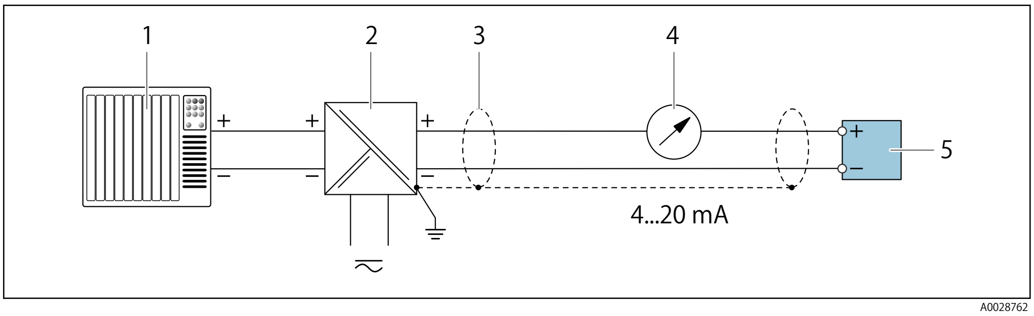
Connecting cable connection

1 Wall holder with connection compartment (transmitter)
2 Connecting cable
3 Sensor connection housing

Terminals are always used to connect the connecting cable in the sensor connection housing (tightening torques for screws for cable strain relief: 1.2 to 1.7 Nm).

Connection examples

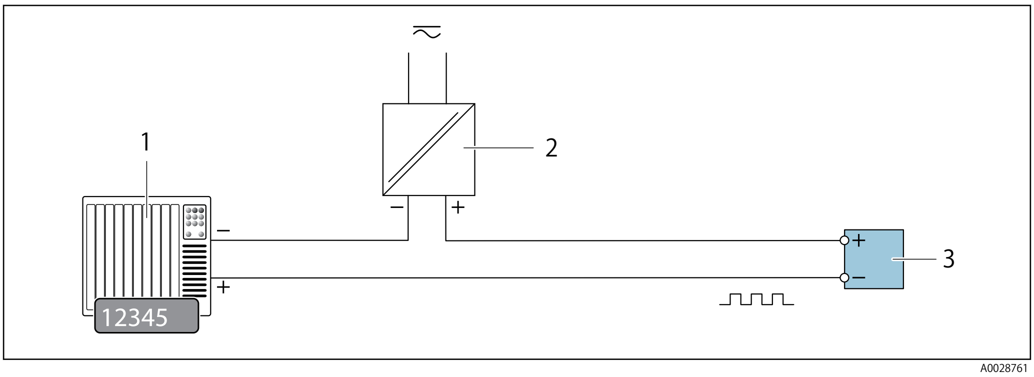
Current output 4-20 mA HART



Connection example for 4 to 20 mA HART current output (passive)

1 Automation system with current input (e.g. PLC)
2 Power supply
3 Cable shield provided at one end. The cable shield must be grounded at both ends to comply with EMC requirements; observe cable specifications
4 Analog display unit: observe maximum load
5 Transmitter

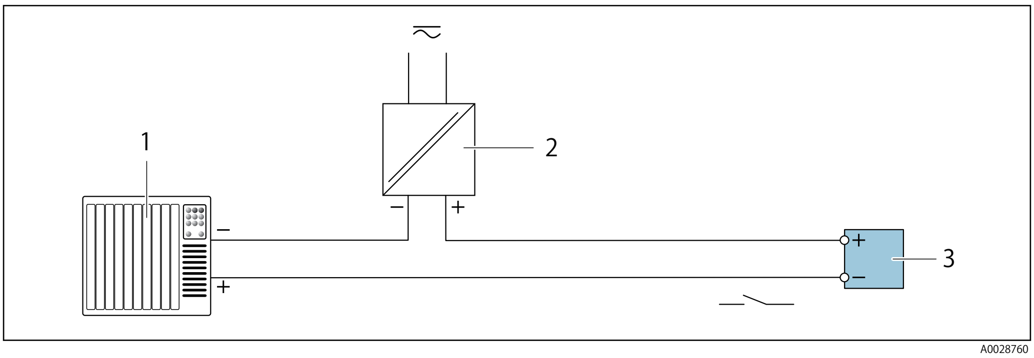
Pulse/frequency output



Connection example for pulse/frequency output (passive)

1 Automation system with pulse/frequency input (e.g. PLC)
2 Power supply
3 Transmitter: Observe input values

Switch output



Connection example for switch output (passive)

1 Automation system with switch input (e.g. PLC)
2 Power supply
3 Transmitter: Observe input values

Potential equalization

Requirements

Please consider the following to ensure correct measurement:
- Same electrical potential for the fluid and sensor
- Remote version: same electrical potential for the sensor and transmitter
- Company-internal grounding concepts
- Pipe material and grounding

Terminals

- For device version without integrated overvoltage protection: plug-in spring terminals for wire cross-sections 0.5 to 2.5 mm^2 (20 to 14 AWG)
- For device version with integrated overvoltage protection: screw terminals for wire cross-sections 0.2 to 2.5 mm^2 (24 to 14 AWG)

Cable entries

- Thread for cable entry:
  - For non-hazardous and hazardous areas (not for XP): G ½"

Cable specification

Permitted temperature range

- The installation guidelines that apply in the country of installation must be observed.
- The cables must be suitable for the minimum and maximum temperatures to be expected.

Signal cable

Current output 4 to 20 mA

A shielded cable is recommended. Observe grounding concept of the plant.

Pulse/frequency/switch output

Standard installation cable is sufficient.

Connecting cable for remote version

Connecting cable (standard)

Standard cable	2 × 2 × 0.5 mm^2 (22 AWG) PVC cable with common shield (2 pairs, pair-stranded)[1)]
Flame resistance	According to DIN EN 60332-1-2
Oil-resistance	According to DIN EN 60811-2-1
Shielding	Galvanized copper-braid, opt. density approx. 85%
Cable length	5 m (16 ft), 10 m (32 ft), 20 m (65 ft), 30 m (98 ft)
Operating temperature	When mounted in a fixed position: –50 to +105 °C (–58 to +221 °F); when cable can move freely: –25 to +105 °C (–13 to +221 °F)

1) UV radiation may cause damage to the outer jacket of the cable. Protect the cable from exposure to sun as much as possible.

Connecting cable (option "mass pressure-/temperature-compensated")

Order code for "Sensor version; DSC sensor; measuring tube", option

Standard cable	[(3 × 2) + 1] × 0.34 mm^2 (22 AWG)PVC cable with common shield (3 pairs, pair-stranded)[1)]
Flame resistance	According to DIN EN 60332-1-2
Oil-resistance	According to DIN EN 60811-2-1
Shielding	Galvanized copper-braid, opt. density approx. 85%
Cable length	30 m (98 ft)
Operating temperature	When mounted in a fixed position: –50 to +105 ° C (–58 to +221 ° F); when cable can move freely: –25 to +105 ° C (–13 to +221 ° F)

1) UV radiation may cause damage to the outer jacket of the cable. Protect the cable from exposure to sun as much as possible.

Overvoltage protection

The device can be ordered with integrated overvoltage protection for diverse approvals:
Order code for "Accessory mounted", option NA "Overvoltage protection"

Input voltage range	Values correspond to supply voltage specifications → See 20 [1)]
Resistance per channel	2 · 0.5 Ω max.
DC sparkover voltage	400 to 700 V
Trip surge voltage	< 800 V
Capacitance at 1 MHz	< 1.5 pF
Nominal discharge current (8/20 μ s)	10 kA
Temperature range	–40 to +85 °C (–40 to +185 °F)

1) The voltage is reduced by the amount of the internal resistance $I_{min} \cdot R_i$

Depending on the temperature class, restrictions apply to the ambient temperature for device versions with overvoltage protection .

Performance characteristics

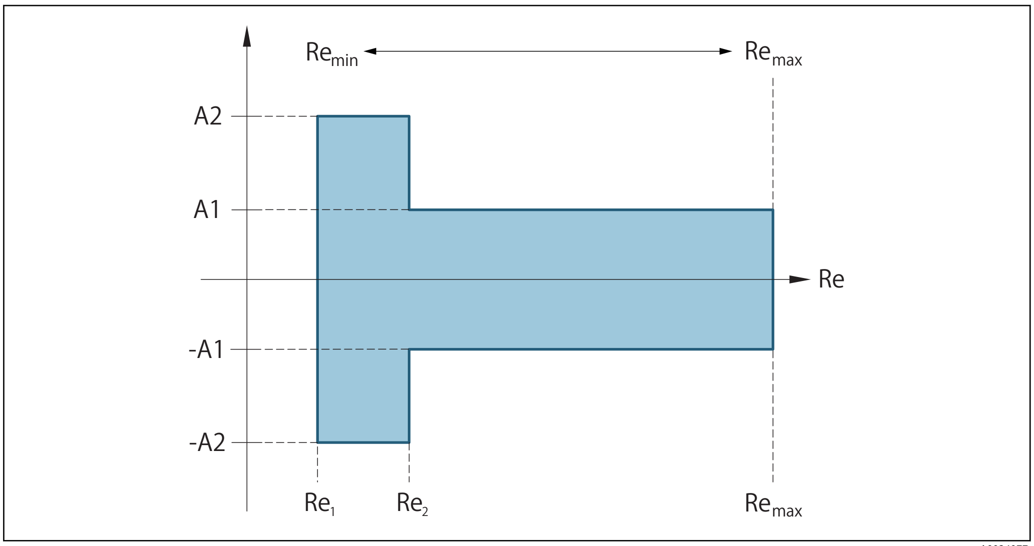
Reference operating conditions

- Error limits following ISO/DIN 11631
- +20 to +30 °C (+68 to +86 °F)
- 2 to 4 bar (29 to 58 psi)
- Calibration system traceable to national standards
- Calibration with the process connection corresponding to the particular standard

Maximum measured error

Base accuracy

o.r. = of reading



A0034077

Reynolds number	
Re_1	5 000
Re_2	10 000
Re_{min}	Reynolds number for minimum permitted volume flow in measuring tube
	• Standard • Option N "0.65% volume PremiumCal 5-point
	$Q_{AmpMin}\,[m^3/h] = \dfrac{v_{AmpMin}\,[m/s] \cdot \pi \cdot D_i\,[m]^2}{4 \cdot \sqrt{\dfrac{\rho[kg/m^3]}{1\,[kg/m^3]}}} \cdot 3600\,[s/h]$ $Q_{AmpMin}\,[ft^3/min] = \dfrac{v_{AmpMin}\,[ft/s] \cdot \pi \cdot D_i\,[ft]^2}{4 \cdot \sqrt{\dfrac{\rho\,[lbm/ft^3]}{0.0624\,[lbm/ft^3]}}} \cdot 60\,[s/min]$ A0034304
Re_{max}	Defined by internal diameter of measuring tube, Mach number and maximum permitted velocity in measuring tube $Re_{max} = \dfrac{\rho \cdot 4 \cdot Q_{Heigh}}{\mu \cdot \cdot K}$ A0034339 Further information on effective upper range value Q_{High} → See 13

Volume flow

Medium type		Incompressible	Compressible
Reynolds number range	Measured value deviation	Standard	Standard
Re_2 to Re_{max}	A1	< 0.75 %	< 1.0 %
Re_1 to Re_2	A2	< 5.0 %	< 5.0 %

Temperature

- Saturated steam and liquids at room temperature, if T > 100 °C (212 °F): < 1 °C (1.8 °F)
- Gas: < 1% o.r. [K]
- Volume flow: 70 m/s (230 ft/s): 2 % o.r.
- Rise time 50% (stirred under water, following IEC 60751): 8 s

Pressure

Order code for "Pressure component"[1]	Nominal value [bar abs.]	Pressure ranges and measured errors [2]	
		Pressure range [bar abs.]	Maximum measured error
Pressure measuring cell 40 bar_a	40	$0.01 \le p \le 8$ $8 \le p \le 40$	0.5 % of 8 bar abs. 0.5 % o.r.

1) The "mass" sensor version (integrated pressure/temperature measurement) is available only for measuring devices in HART communication mode.
2) The specific measured errors refer to the position of the measurement in the measuring tube and do not correspond to the pressure in the pipe connection line upstream or downstream from the measuring device. No measured error is specified for the measured error for the "pressure" measured variable that can be assigned to the outputs.

Mass flow saturated steam

Sensor version				Mass (integrated temperature measurement)	Mass (integrated pressure/ temperature measurement) [1]
Process pressure [bar abs.]	Flow velocity [m/s (ft/s)]	Reynolds number range	Measured value deviation	Standard	Standard
> 4.76	20 to 50 (66 to 164)	Re_2 to Re_{max}	A1	< 1.7 %	< 1.5 %
> 3.62	10 to 70 (33 to 230)	Re_2 to Re_{max}	A1	< 2.0 %	< 1.8 %
In all cases not specified here, the following applies: < 5.7 %					

1) Sensor version available only for measuring devices in HART communication mode.

Mass flow of superheated steam/gases

Sensor version				Mass (integrated pressure/ temperature measurement) [1]	Mass (integrated temperature measurement) + external pressure compensation[2]
Process pressure [bar abs.]	Flow velocity [m/s (ft/s)]	Reynolds number range	Measured value deviation	Standard	Standard
< 40	All velocities	Re_2 to Re_{max}	A1	< 1.5 %	< 1.7 %
< 120		Re_2 to Re_{max}	A1	< 2.4 %	< 2.6 %
In all cases not specified here, the following applies: < 6.6 %					

1) Sensor version available only for measuring devices in HART communication mode.
2) The use of a Cerabar S is required for the measured errors listed in the following section. The measured error used to calculate the error in the measured pressure is 0.15 %.

Water mass flow

Sensor version				Mass (integrated temperature measurement)
Process pressure [bar abs.]	Flow velocity [m/s (ft/s)]	Reynolds number range	Measured value deviation	Standard
All pressures	All velocities	Re_2 to Re_{max}	A1	< 0.85 %
		Re_1 to Re_2	A2	< 2.7 %

1) Order code for "Calibration flow", option N "0.65% volume PremiumCal 5-point"

Mass flow (user-specific liquids)

Example
- Acetone is to be measured at fluid temperatures from +70 to +90 °C (+158 to +194 °F).
- For this purpose, the Reference temperature parameter (7703) (here 80 °C (176 °F)), Reference density parameter (7700) (here 720.00 kg/m^3) and Linear expansion coefficient parameter (7621) (here 18.0298 × 10^{-4} 1/VC) must be entered in the transmitter.
- The overall system uncertainty, which is less than 0.9% for the example above, is comprised of the following measurement uncertainties: uncertainty of volume flow measurement, uncertainty of temperature measurement, uncertainty of the density-temperature correlation used (including the resulting uncertainty of density).

Mass flow (other media)

Depends on the selected fluid and the pressure value, which is specified in the parameters. Individual error analysis must be performed.

Diameter mismatch correction

The measuring device is calibrated according to the ordered process connection. This calibration takes account of the edge at the transition from the mating pipe to the process connection. If the mating pipe used deviates from the ordered process connection, a diameter mismatch correction can compensate for the effects. The difference between the internal diameter of the ordered process connection and the internal diameter of the mating pipe used must be taken into consideration.

The measuring device can correct shifts in the calibration factor which are caused, for example, by a diameter mismatch between the device flange (e.g. ASME B16.5/Sch. 80, DN 50 (2")) and the mating pipe (e.g. ASME B16.5/Sch. 40, DN 50 (2")). Only apply diameter mismatch correction within the following limit values (listed below) for which test measurements have also been performed.

Flange connection:
- DN 15 (½"): ±20% of the internal diameter
- DN 25 (1"): ±15% of the internal diameter
- DN 40 (1½"): ±12% of the internal diameter
- DN ≥ 50 (2"): ±10% of the internal diameter

If the standard internal diameter of the ordered process connection differs from the internal diameter of the mating pipe, an additional measuring uncertainty of approx. 2% o.r. must be expected.

Example
Influence of the diameter mismatch without using the correction function:
- Mating pipe DN 100 (4"), Schedule 80
- Device flange DN 100 (4"), Schedule 40
- This installation position results in a diameter mismatch of 5 mm (0.2 in). If the correction function is not used, an additional measuring uncertainty of approx. 2% o.r. must be expected.
- If the basic conditions are met and the feature is enabled, the additional measuring uncertainty is 1 % o.r.

For detailed information on the parameters for diameter mismatch correction, see the Operating Instructions

3) single gas, gas mixture, air: NEL40; natural gas: ISO 12213-2 contains AGA8-DC92, AGA NX-19, ISO 12213-3 contains SGERG-88 and AGA8 Gross Method 1

Accuracy of outputs

The outputs have the following base accuracy specifications.

Current output

Accuracy	±10 µA

Pulse/frequency output

o.r. = of reading

Accuracy	Max. ±100 ppm o.r.

Repeatability

o.r. = of reading

$$r = \left\{ \frac{100 \cdot D_i^3}{V} \right\}^{1/2} \% \text{ o.r.}$$

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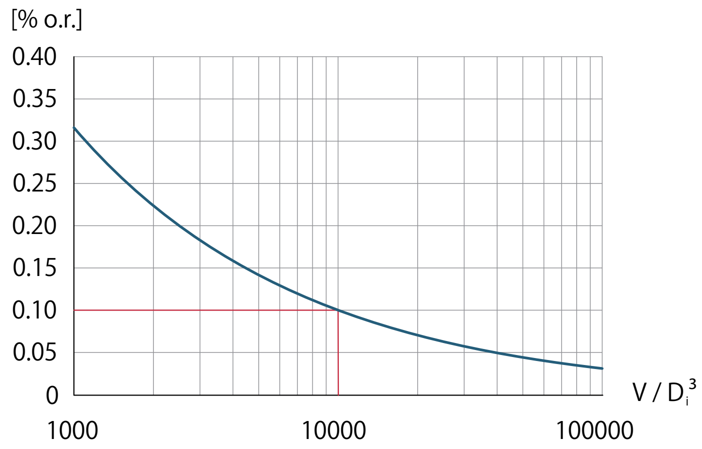


A0042123-EN

Repeatability = 0.1% o.r. with a measured volume [m 3]

The repeatability can be improved if the measured volume is increased. Repeatability is not a device characteristic but a statistical variable that is dependent on the boundary conditions indicated.

Response time

If all the configurable functions for filter times (flow damping, display damping, current output time constant, frequency output time constant, status output time constant) are set to 0, in the event of vortex frequencies of 10 Hz and higher a response time of max(T_v,100 ms) can be expected.

In the event of measuring frequencies < 10 Hz, the response time is > 100 ms and can be up to 10 s. T_v is the average vortex period duration of the flowing fluid.

Influence of ambient temperature

Current output

o.r. = of reading

Additional error, in relation to the span of 16 mA:

Temperature coefficient at zero point (4 mA)	0.02%/10 K
Temperature coefficient with span (20 mA)	0.05%/10 K

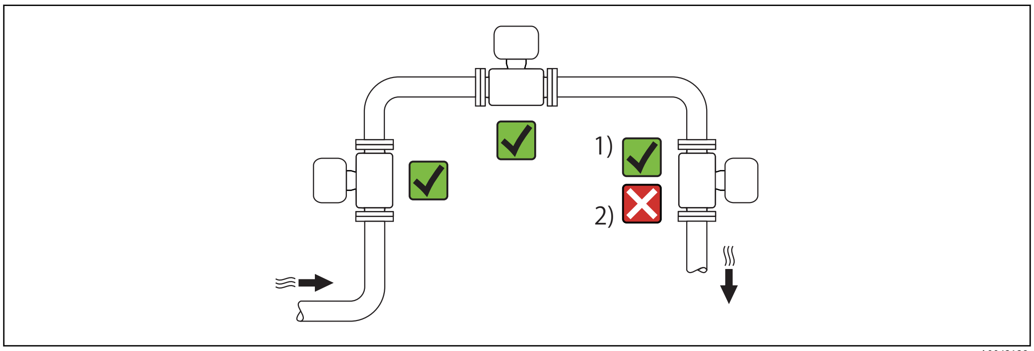
Pulse/frequency output

o.r. = of reading

Temperature coefficient	Max. ±100 ppm o.r.

Installation

Mounting location



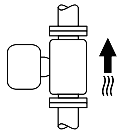
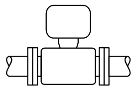
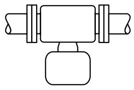
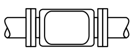
A0042128

1 Installation suitable for gases and steam
2 Installation not suitable for liquids

Orientation

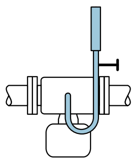
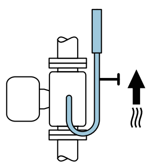
The direction of the arrow on the sensor nameplate helps you to install the sensor according to the flow direction (direction of medium flow through the piping).

Vortex meters require a fully developed flow profile as a prerequisite for correct volume flow measurement. Therefore, please note the following:

Orientation			Recommendation	
			Compact version	Remote version
A	Vertical orientation (liquids)	 A0015591	✓ ✓ [1]	✓ ✓
B	Horizontal orientation, transmitter head up	 A0015589	✓ ✓ [2] [3]	✓ ✓
C	Horizontal orientation, transmitter head down	 A0015590	✓ ✓ [4] [5]	✓ ✓
D	Horizontal orientation, transmitter head at side	 A0015592	✓ ✓ [4]	✓ ✓

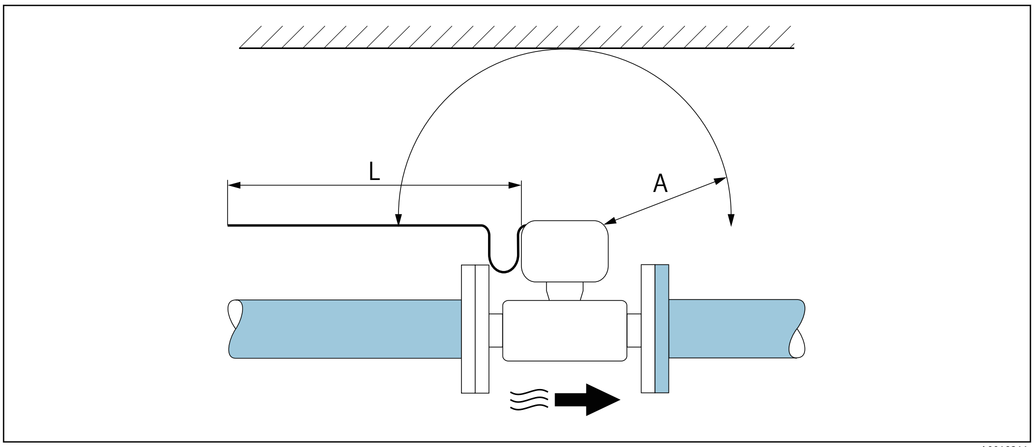
1) In the case of liquids, there should be upward flow in vertical pipes to avoid partial pipe filling (Fig. A). Disruption in flow measurement!
2) Danger of electronics overheating! If the fluid temperature is ≥ 200 °C (392 °F), orientation B is not permitted for the wafer version (Prowirl D) with nominal diameters of DN 100 (4") and DN 150 (6").
3) In the case of hot media (e.g. steam or fluid temperature (TM) ≥ 200 °C (392 °F): orientation C or D
4) In the case of very cold media (e.g. liquid nitrogen): orientation B or D
5) For "Wet steam detection/measurement" option: orientation C

Pressure measuring cell

Steam pressure measurement			Option
E	• With the transmitter installed at the bottom or at the side • Protection against rising heat • Reduction in temperature to almost ambient temperature due to siphon[1]	 A0034057	✓ ✓
F		 A0034058	✓ ✓

1) Note max. permitted ambient temperature of transmitter→ See page 35.

Minimum spacing and cable length

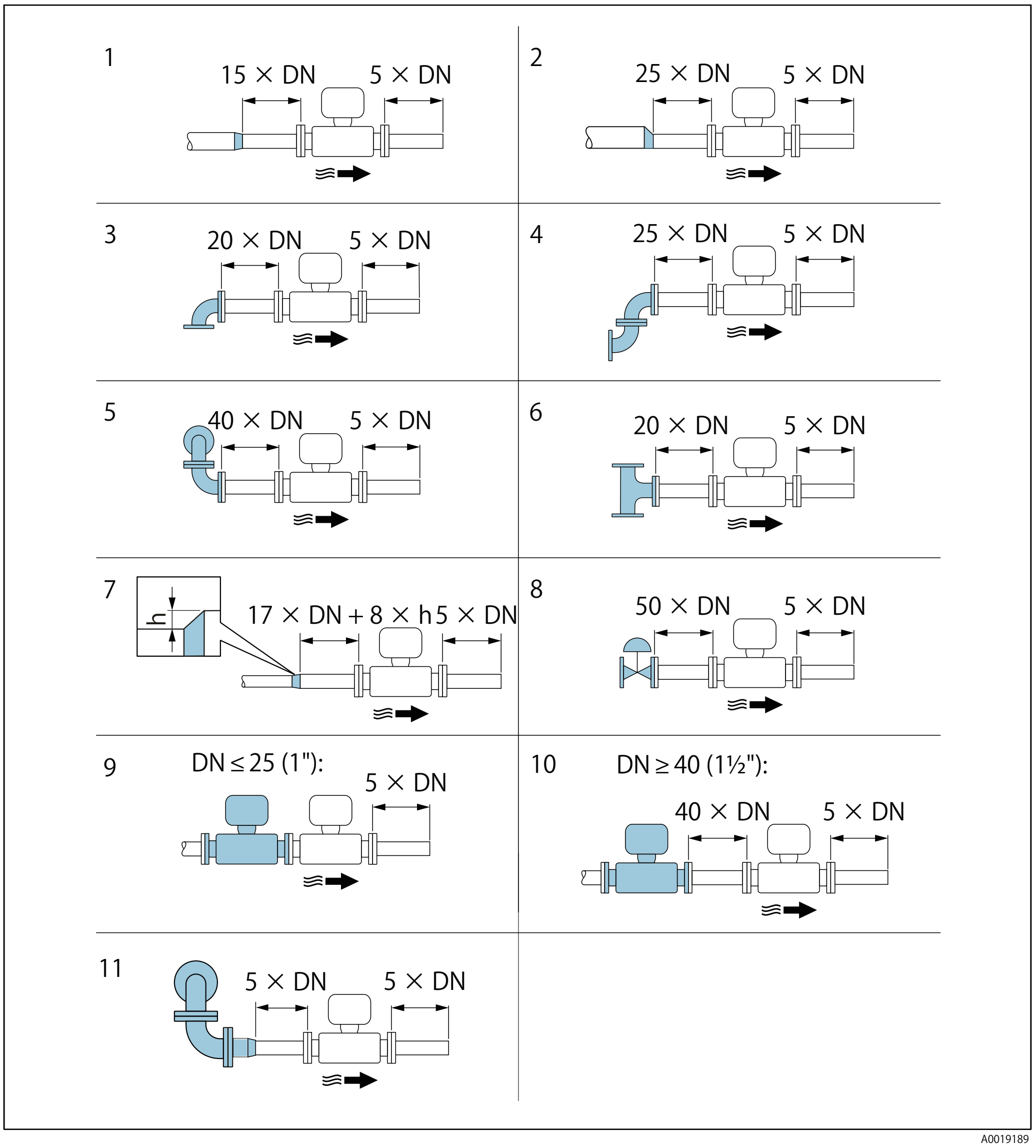


A Minimum spacing in all directions
L Required cable length

The following dimensions must be observed to guarantee problem-free access to the device for service purposes:
- A =100 mm (3.94 in)
- L = L + 150 mm (5.91 in)

Inlet and outlet runs

To attain the specified level of accuracy of the measuring device, the inlet and outlet runs mentioned below must be maintained at the very minimum.



Minimum inlet and outlet runs with various flow obstructions (DN: Pipe diameter)

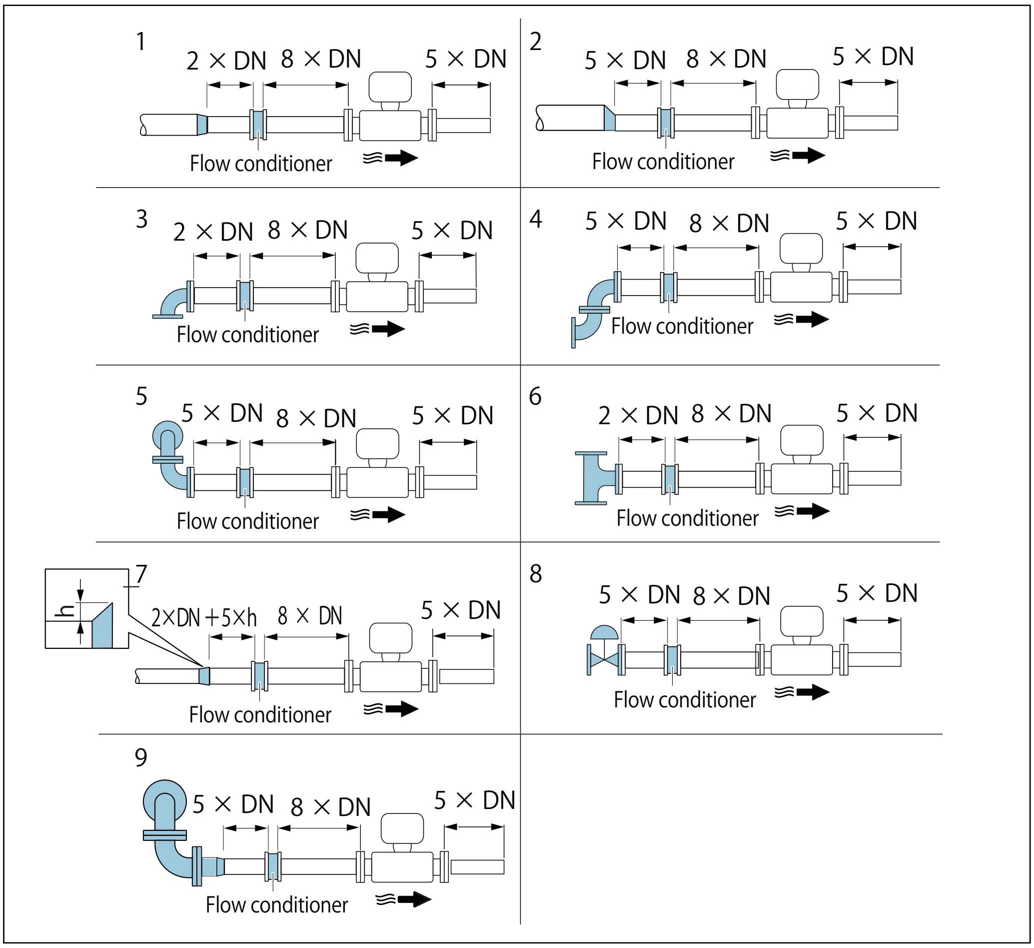
h Difference in expansion
1 Concentric reducer
2 Eccentric reducer
3 Single elbow (90° elbow)
4 Double elbow (2 × 90° elbows, opposite, on one plane)
5 Double elbow 3D (2 × 90° elbows, opposite, not on one plane)
6 T-piece
7 Expansion
8 Control valve
9 Two measuring devices in a row where DN ≤ 25 (1"): directly flange on flange
10 Two measuring devices in a row where DN ≥ 40 (1½"): for spacing, see graphic
11 Combination pipe (Double elbow 3D (2 × 90° elbows, opposite, not on one lane) + reducer, etc.)

- If there are several flow disturbances present, the longest specified inlet run must be maintained.
- If the required inlet runs cannot be observed, it is possible to install a specially designed flow conditioner.

Flow conditioner

If the inlet runs cannot be observed, the use of a flow conditioner is recommended.

The flow conditioner is fitted between two pipe flanges and centered by the mounting bolts. Generally this reduces the inlet run needed to 10 × DN or 13× DN with full accuracy.



Minimum inlet and outlet runs with various flow obstructions (DN: Pipe diameter)

1 Concentric reducer
2 Eccentric reducer
3 Single elbow (90° elbow)
4 Double elbow (2 × 90° elbows, on one plane)
5 Double elbow 3D (2 × 90° elbows, not on one plane)
6 T-piece
7 Expansion
8 Control valve
9 Combination pipe (Double elbow 3D (2 × 90° elbows, opposite, not on one lane) + reducer, etc.)

The pressure loss for flow conditioners is calculated as follows: Δp [mbar] = 0.0085 · ρ [kg/m³] · v^2 [m/s]

Example for steam

p = 10 bar abs.

t = 240 °C → ρ = 4.39 kg/m³

v = 40 m/s

Δ p = 0.0085 · 4.394.39 · 40^2 = 59.7 mbar

Example for H_2O condensate (80 °C)

ρ = 965 kg/m³

v = 2.5 m/s

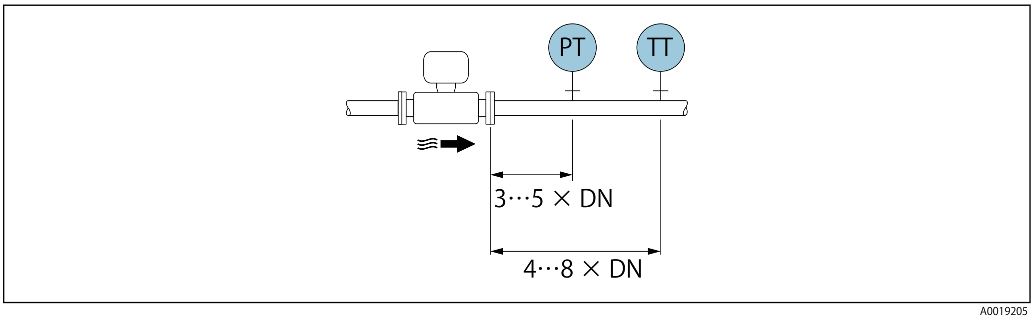
Δ p = 0.0085 · 965 · 2.5^2 = 51.3 mbar

ρ: density of the process medium
v: average flow velocity
abs. = absolute

Refer to the Mechanical construction setion for dimensions of the flow conditioner.

Outlet runs when installing external devices

If installing an external device, observe the specified distance.



PT Pressure
TT Temperature device

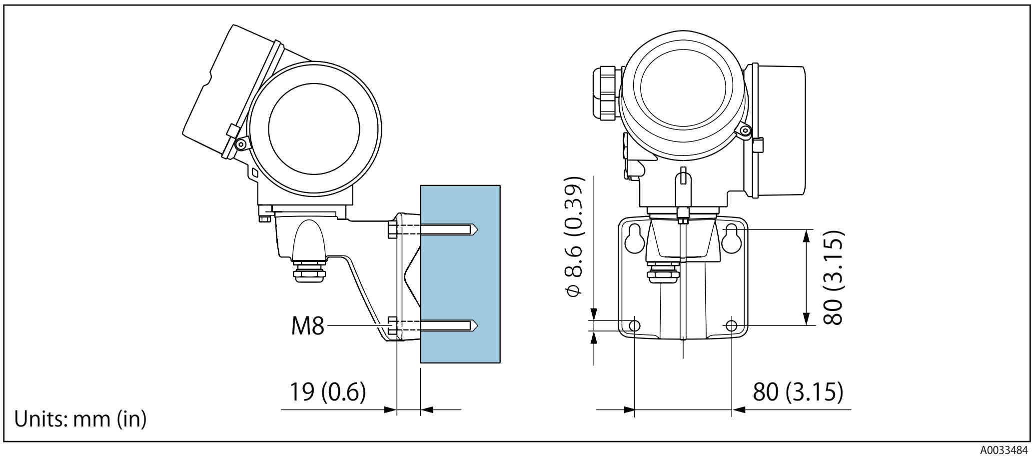
Length of connecting cable

To ensure correct measuring results when using the remote version,
- observe the maximum permitted cable length: L_{max} = 30 m (90 ft).
- The value for the cable length must be calculated if the cable cross-section differs from the specification.

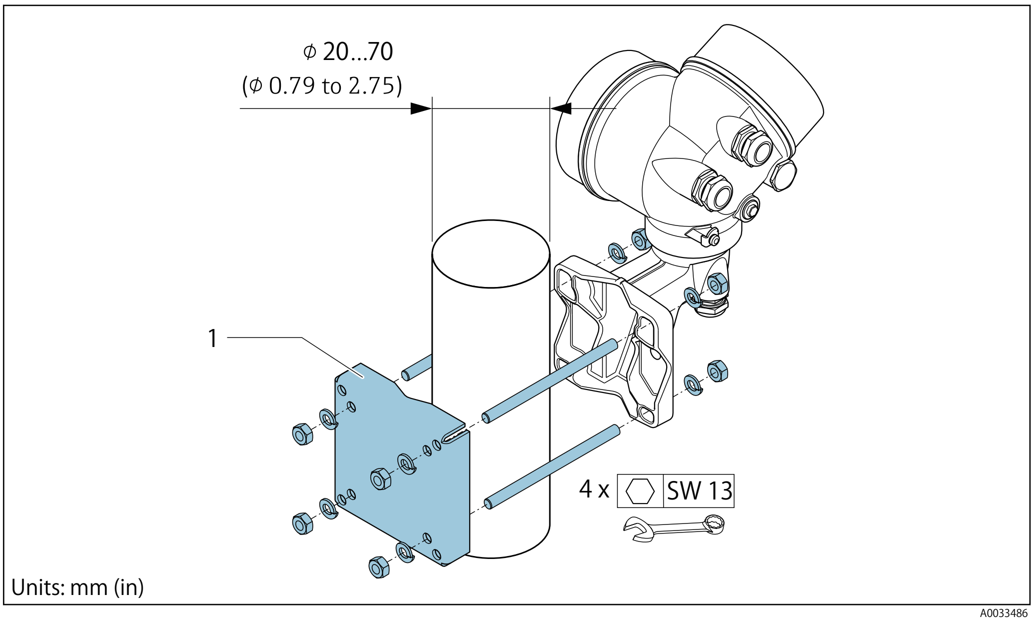
For detailed information about calculating the length of the connecting cable, refer to the Operating Instructions for the device.

Mounting the transmitter housing

Wall mounting



Post mounting



Environment

Ambient temperature range

Compact version

Measuring device	–40 to +80 °C (–40 to +176 °F)
Local display	–40 to +70 °C (–40 to +158 °F) [1)]

1) At temperatures < –20 °C (–4 °F), depending on the physical characteristics involved, it may no longer be possible to read the liquid crystal display.

Remote version

Transmitter	–40 to +80 °C (–40 to +176 °F)
Sensor	–40 to +85 °C (–40 to +185 °F)
Local display	–40 to +70 °C (–40 to +158 °F) [1)]

1) At temperatures < –20 °C (–4 °F), depending on the physical characteristics involved, it may no longer be possible to read the liquid crystal display.

▶ If operating outdoors:
Avoid direct sunlight, particularly in warm climatic regions.

You can order a weather protection cover from TLV.

Storage temperature

All components apart from the display modules:
-50 to +80 °C (-58 to +176 °F)

Climate class

DIN EN 60068-2-38 (test Z/AD)

Degree of protection

Transmitter
- As standard: IP66/67, type 4X enclosure
- When housing is open: IP20, type 1 enclosure
- Display module: IP20, type 1 enclosure

Sensor
IP66/67, type 4X enclosure

Connector
IP67, only in screwed situation

Vibration- and shock-resistance

Vibration sinusoidal, according to IEC 60068-2-6
- 2 to 8.4 Hz, 7.5 mm peak
- 8.4 to 500 Hz, 2 g peak

Vibration broad-band random, according to IEC 60068-2-64
- 10 to 200 Hz, 0.01 g^2/Hz
- 200 to 500 Hz, 0.003 g^2/Hz
- Total: 1.67 g rms

Shock half-sine, according to IEC 60068-2-27

6 ms 50 g

Rough handling shocks according to IEC 60068-2-31

Electromagnetic compatibility (EMC)

As per IEC/EN 61326 and NAMUR Recommendation 21 (NE 21)

Details are provided in the Declaration of Conformity.

Process

Medium temperature range

DSC sensor[1)]

Description	Medium temperature ranges
Mass; 316L; 316L	-200 to +400 °C (-328 to +752 °F), stainless steel
Mass steam; 316L; 316L	-200 to +400 °C (-328 to +752 °F), stainless steel [2) 3)]

1) Capacitance sensor
2) Siphon enables use for extended temperature range (up to +400 °C (+752 °F)).
3) In steam applications, in conjunction with the siphon, the steam temperature may be higher (up to +400 °C (+752 °F)) than the permitted temperature of the pressure measuring cell. Without a siphon, the gas temperature is restricted due to the maximum permitted temperature of the pressure measuring cell. This applies regardless of whether or not a stop cock is present.

Pressure measuring cell

Description	Medium temperature range
Pressure measuring cell 40 bar/580 psi abs	-40 to +100 °C (-40 to +212 °F)

Seals

Description	Medium temperature range
Graphite (standard)	-200 to +400 °C (–328 to +752 °F)

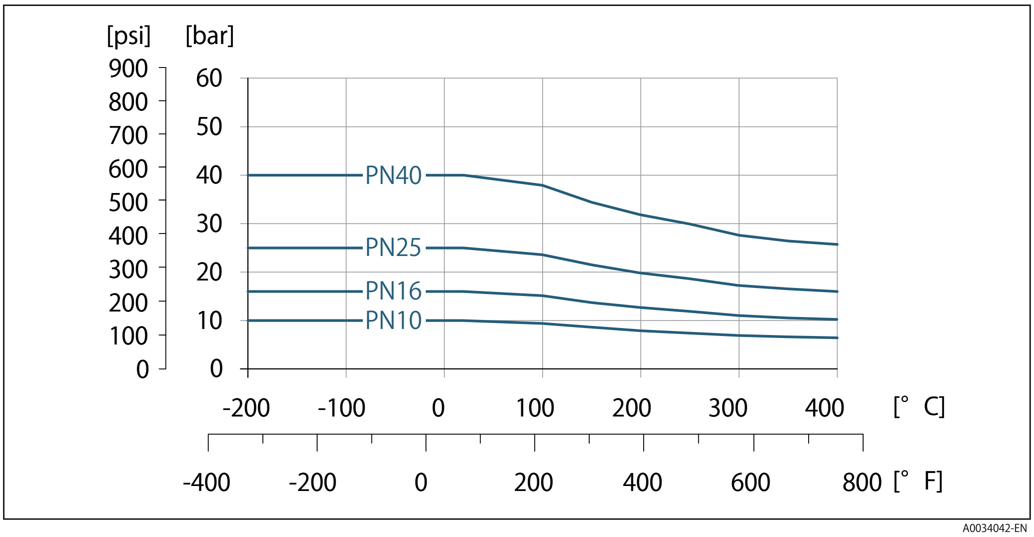
Pressure-temperature ratings

The following pressure/temperature diagrams apply to all pressure-bearing parts of the device and not just the process connection. The diagrams show the maximum permissible medium pressure depending on the specific medium temperature.

The pressure-temperature rating for the specific measuring device is programmed into the software. If values exceed the curve range a warning is displayed. Depending on the system configuration and sensor version, the pressure and temperature are determined by entering, reading in or calculating values.

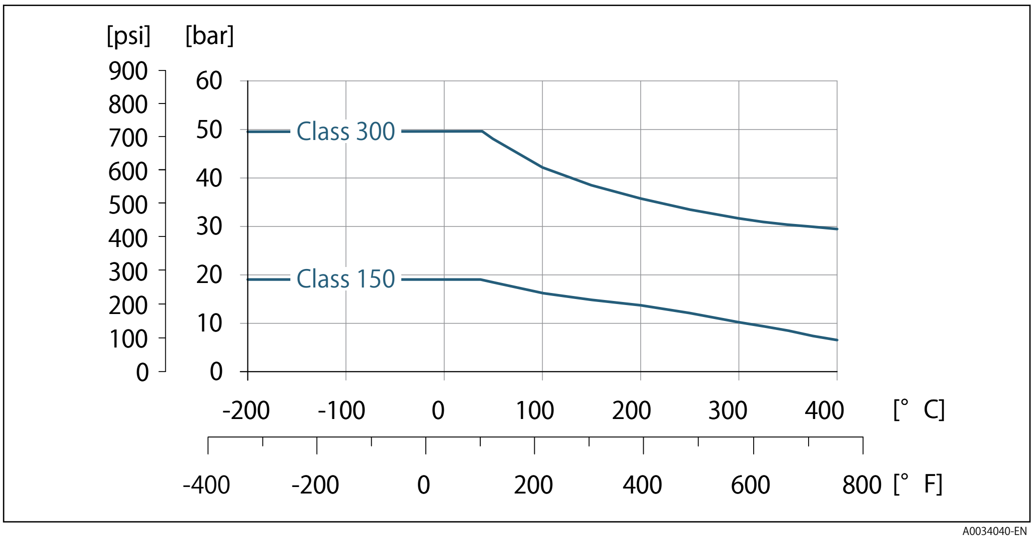
Integral mass vortex: The permitted pressure for the measuring device can be less than indicated in this section, depending on the selected pressure measuring cell. → See page 39

Flange connection: flange according to EN 1092-1 (DIN 2501)



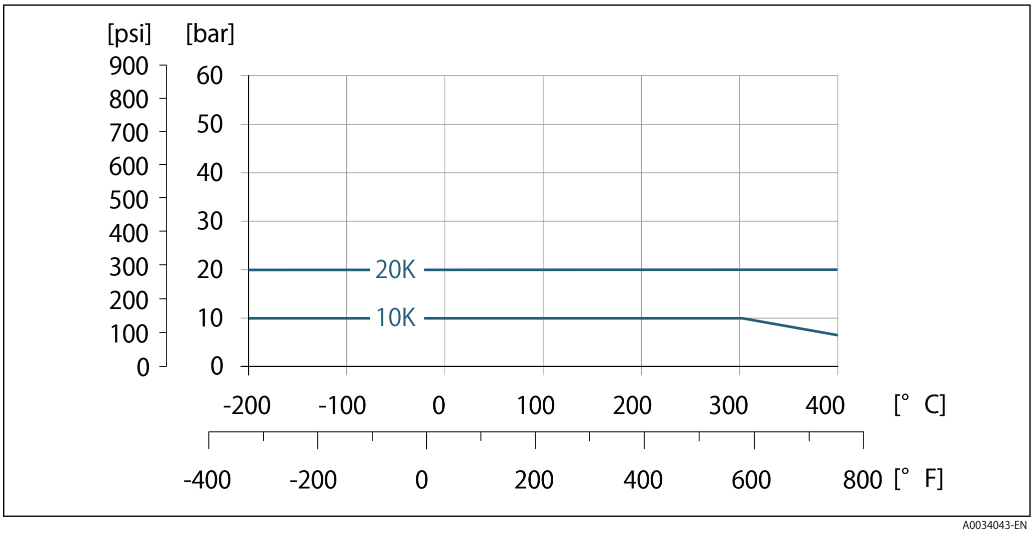
Flange connection material: stainless steel, multiple certifications, 1.4404/F316/F316L

Flange connection: flange according to ASME B16.5



Flange connection material: stainless steel, multiple certifications, 1.4404/F316/F316L

Flange connection: flange according to JIS B2220



Flange connection material: stainless steel, multiple certifications, 1.4404/F316/F316L

Nominal pressure of sensor

The following overpressure resistance values apply to the sensor shaft in the event of a membrane rupture:

Sensor version; DSC sensor; measuring tube	Overpressure, sensor shaft in [bar a]
Mass (integrated temperature measurement)	200
Mass steam (integrated pressure/temperature measurement)	200

Pressure specifications

The OPL (over pressure limit = sensor overload limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. For the appropriate standards and further information → See page 26. The OPL may only be applied for a limited period of time.

The MWP (maximum working pressure) for the sensors depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. For the appropriate standards and further information → See page 26. The MWP may be applied at the devicefor an unlimited period. The MWP can also be found on the nameplate.

WARNING

The maximum pressure for the measuring device depends on the lowest-rated element with regard to pressure.

- ▶ Note specifications regarding pressure range→ See 41.
- ▶ The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP of the device.
- ▶ MWP: The MWP is indicated on the nameplate. This value refers to a reference temperature of +20 °C (+68 °F) and may be applied to the device for an unlimited time. Note temperature dependence of MWP.
- ▶ OPL: The test pressure corresponds to the over pressure limit of the sensor and may be applied only temporarily to ensure that the measurement is within the specifications and no permanent damage occurs. In the case of sensor range and process connection combinations where the OPL of the process connection is less than the nominal value of the sensor, the device is set at the factory, at the very maximum, to the OPL value of the process connection. If using the entire sensor range, select a process connection with a higher OPL value.

Sensor	Maximum sensor measuring range		MWP	OPL
	Lower (LRL)	Upper (URL)		
	[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]
40 bar (600 psi)	0 (0)	+40 (+600)	100 (1500)	160 (2400)

Pressure loss

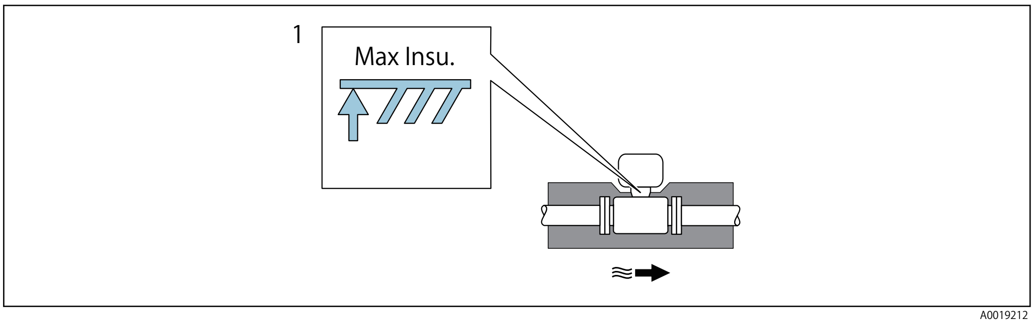
Consult TLV for a precise calculation.

Thermal insulation

For optimum temperature measurement and mass calculation, heat transfer at the sensor must be avoided for some fluids. This can be ensured by installing thermal insulation. A wide range of materials can be used for the required insulation.

This applies for:
- Compact version
- Remote sensor version

The maximum insulation height permitted is illustrated in the diagram:



1 Maximum insulation height

▶ When insulating, ensure that a sufficiently large area of the housing support remains exposed.

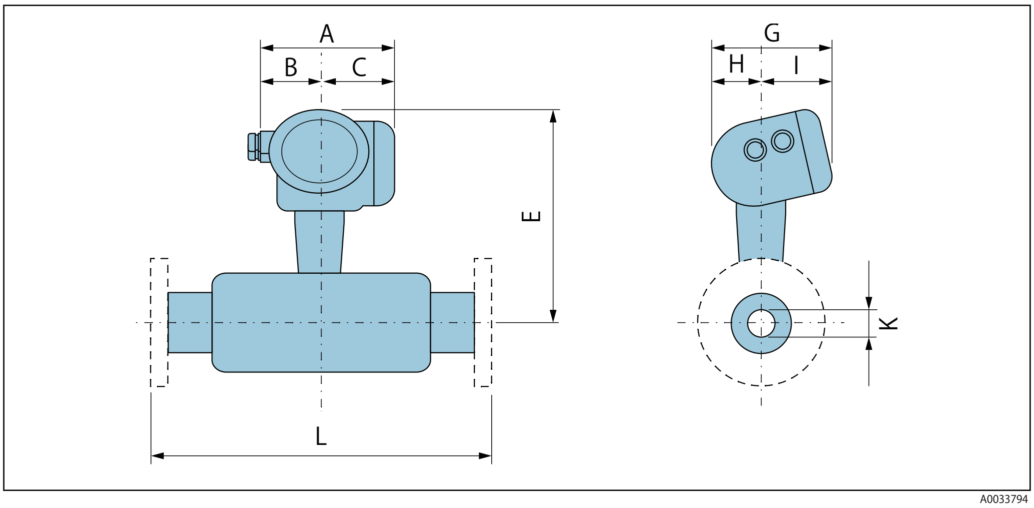
The uncovered part serves as a radiator and protects the electronics from overheating and excessive cooling.

Mechanical construction

Dimensions in SI units

Pay attention to the information on diameter mismatch correction→ See 27.

Compact version

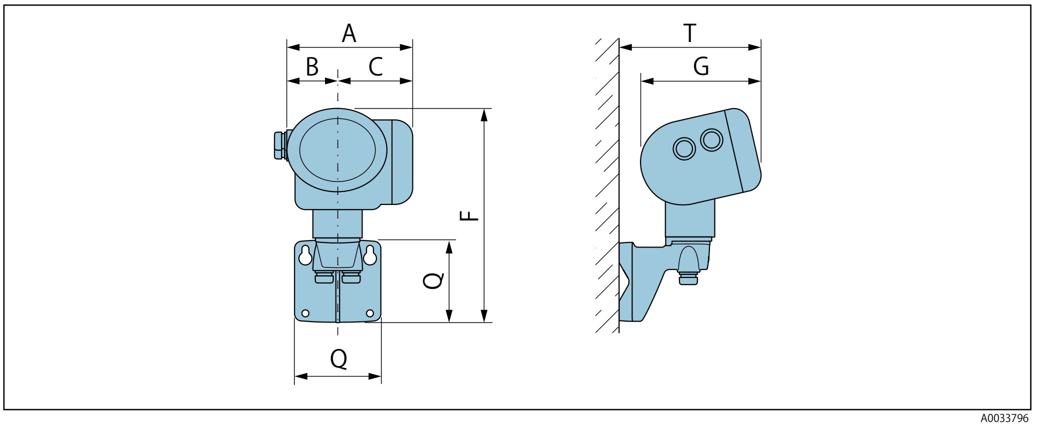


Grayed out: Dualsens version

DN [mm]	Reduction to DN [mm]	A 1) [mm]	B [mm]	C 1) [mm]	E [mm]	G [mm]	H [mm]	I [mm]	K (D_i) [mm]	L [mm]
25R	15	140.2	51.7	88.5	252	159.9	58.2	101.7	13.9	2)
40R	25	140.2	51.7	88.5	258	159.9	58.2	101.7	24.3	2)
50R	40	140.2	51.7	88.5	266	159.9	58.2	101.7	38.1	2)
80R	50	140.2	51.7	88.5	272	159.9	58.2	101.7	49.2	2)
100R	80	140.2	51.7	88.5	286	159.9	58.2	101.7	73.7	2)
150R	100	140.2	51.7	88.5	300	159.9	58.2	101.7	97	2)
200R	150	140.2	51.7	88.5	325	159.9	58.2	101.7	146.3	2)

1) For version with overvoltage protection: values + 8 mm
2) Dependent on respective flange connection

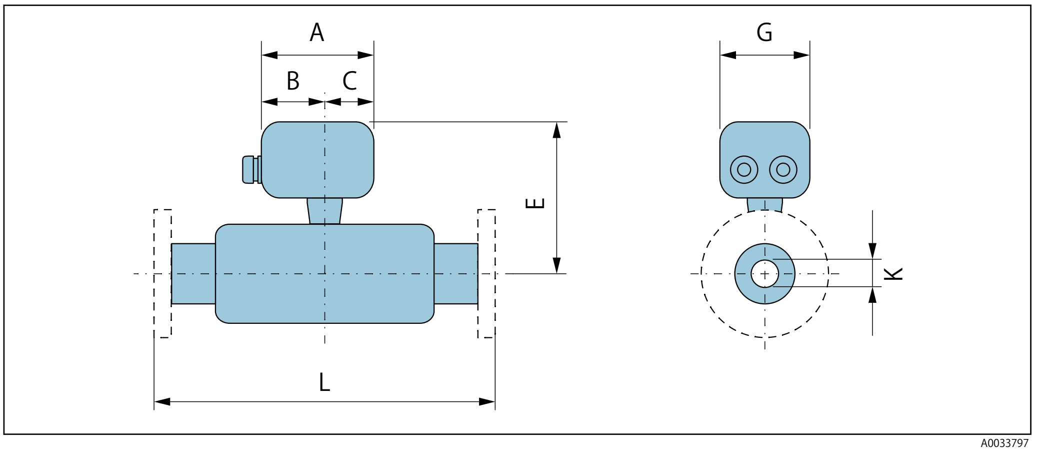
Transmitter remote version



A [1] [mm]	B [mm]	C [1] [mm]	F [mm]	G [mm]	Q [mm]	T [mm]
140.2	51.7	88.5	254	159.9	107	191

1) For version with overvoltage protection: value + 8 mm

Sensor remote version



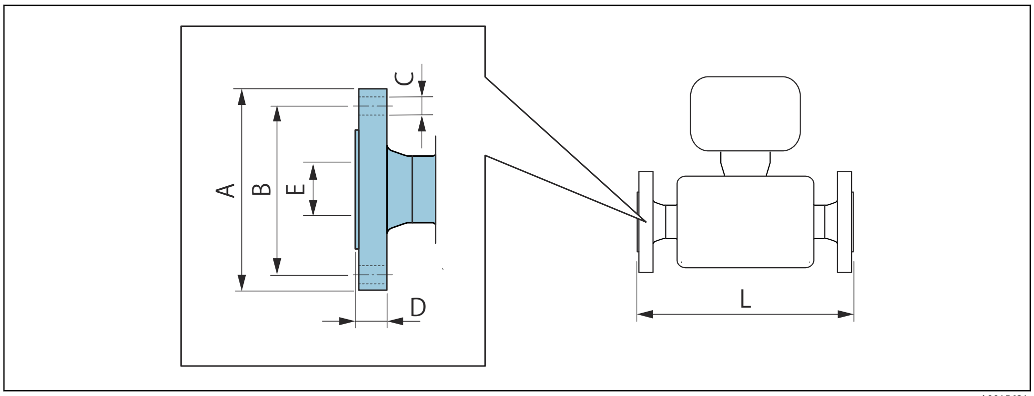
Grayed out: Dualsens version

DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	C [mm]	E [mm]	G [mm]	K (D_i) [mm]	L [mm]
25R	15	107.3	60.0	47.3	225	94.5	13.9	[1]
40R	25	107.3	60.0	47.3	231	94.5	24.3	[1]
50R	40	107.3	60.0	47.3	239	94.5	38.1	[1]
80R	50	107.3	60.0	47.3	245	94.5	49.2	[1]
100R	80	107.3	60.0	47.3	259	94.5	73.7	[1]
150R	100	107.3	60.0	47.3	273	94.5	97	[1]
200R	150	107.3	60.0	47.3	298	94.5	146.3	[1]

1) For high-temperature/low-temperature version: values +29 mm
2) Dependent on respective flange connection

Flange connections

Flange



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Length tolerance for dimension L in mm:
DN ≤ 100: +1.5 to -2.0 mm
DN ≥ 150: ±3.5 mm

Flange connection dimensions according to DIN EN 1092-1: PN 10 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
200R	150	340	295	8 × 22	24	146.3	300
Raised face according to DIN EN 1092-1 Form B1: Ra 6.3 to 12.5 µm							

1) In compliance with ISO 13359 for DN 150.

Flange connection dimensions according to DIN EN 1092-1: PN 16 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
100R	80	220	180	8 × 18	22	87.0	250
150R	100	285	240	8 × 22	25	112.0	300
200R	150	340	295	12 × 22	24	146.3	300
Raised face according to DIN EN 1092-1 Form B1: Ra 6.3 to 12.5 µm							

1) In compliance with ISO 13359 for DN 100 to 150.

Flange connection dimensions according to DIN EN 1092-1: PN 16 with groove Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
100R	80	220	180	8 × 18	22	87.0	250
150R	100	285	240	8 × 22	25	112.0	300
Raised face according to DIN EN 1092-1 Form B1: Ra 6.3 to 12.5 µm							

1) In compliance with ISO 13359 for DN 100 to 150.

Flange connection dimensions according to DIN EN 1092-1: PN 25 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
200R	150	360	310	12 × 26	30	146.3	300
Raised face according to DIN EN 1092-1 Form B1: Ra 6.3 to 12.5 µm							

1) In compliance with ISO 13359 for DN 150.

Flange connection dimensions according to DIN EN 1092-1: PN 40 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
25R	15	115	85	4 × 14	18.0	22.0	200
40R	25	150	110	4 × 18	21.0	30.0	200
50R	40	165	125	4 × 18	22.0	45.0	200
80R	50	200	160	8 × 18	25.0	56.5	200
100R	80	235	190	8 × 22	26.5	87.0	250
150R	100	300	250	8 × 26	31.0	112.0	300
200R	150	375	320	12 × 30	36.5	146.3	300
Raised face according to DIN EN 1092-1 Form B1: Ra 6.3 to 12.5 µm							

1) In compliance with ISO 13359 for DN 15 to 150.

Flange connection dimensions according to DIN EN 1092-1: PN 40 with groove Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
25R	15	115	85	4 × 14	18.0	22.0	200
40R	25	150	110	4 × 18	21.0	30.0	200

Flange connection dimensions according to DIN EN 1092-1: PN 40 with groove Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [1)] [mm]
50R	40	165	125	4 × 18	22.0	45.0	200
80R	50	200	160	8 × 18	25.0	56.5	200
100R	80	235	190	8 × 22	26.5	87.0	250
150R	100	300	250	8 × 26	31.0	112.0	300
Raised face according to DIN EN 1092-1 Form B1: Ra 6.3 to 12.5 µm							

1) In compliance with ISO 13359 for DN 15 to 100.

Flange connection dimensions according to ASME B16.5: Class 150, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
25R	15	108.0	79.2	4 × 15.7	18.0	22.0	200
40R	25	127.0	98.6	4 × 15.7	18.0	30.0	200
50R	40	152.4	120.7	4 × 19.1	20.0	45.0	200
80R	50	190.5	152.4	4 × 19.1	23.9	56.5	200
100R	80	228.6	190.5	8 × 19.1	24.5	87.0	250
150R	100	279.4	241.3	8 × 22.4	25.5	112.0	300
200R	150	342.9	298.5	8 × 22.4	28.4	146.3	300
Raised face according to ASME 16.5: Ra 3.2 to 6.3 µm							

Flange connection dimensions according to ASME B16.5: Class 150, Schedule 80 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
25R	15	108.0	79.2	4 × 15.7	18.5	22.0	200
40R	25	127.0	98.6	4 × 15.7	18.0	30.0	200
50R	40	152.4	120.7	4 × 19.1	20.0	45.0	200
80R	50	190.5	152.4	4 × 19.1	23.9	56.5	200
100R	80	228.6	190.5	8 × 19.1	24.5	87.0	250
150R	100	279.4	241.3	8 × 22.4	26.0	112.0	300
Raised face according to ASME 16.5: Ra 3.2 to 6.3 µm							

Flange connection dimensions according to ASME B16.5: Class 300, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
25R	15	124.0	88.9	4 × 19.1	22.0	22.0	200
40R	25	155.4	114.3	4 × 22.4	25.0	30.0	200
50R	40	165.1	127.0	8 × 19.1	25.0	45.0	200
80R	50	209.6	168.1	8 × 22.4	28.9	56.5	200
100R	80	254.0	200.2	8 × 22.4	31.8	87.0	200
150R	100	317.5	269.7	12 × 22.4	38.5	112.0	300
200R	150	381.0	330.2	12 × 25.4	41.1	146.3	300
Raised face according to ASME 16.5: Ra 3.2 to 6.3 µm							

Flange connection dimensions according to ASME B16.5: Class 300, Schedule 80 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
25R	15	124.0	88.9	4 × 19.1	22.0	22.0	200
40R	25	155.4	114.3	4 × 22.4	25.0	30.0	200
50R	40	165.1	127.0	8 × 19.1	25.0	45.0	200
80R	50	209.6	168.1	8 × 22.4	28.9	56.5	200
100R	80	254.0	200.2	8 × 22.4	31.8	87.0	250
150R	100	317.5	269.7	12 × 22.4	39.0	112.0	300
Raised face according to ASME 16.5: Ra 3.2 to 6.3 µm							

Flange connection dimensions according to JIS B2220: 10K, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
50R	40	155	120	4 × 19	20.0	45.0	200
80R	50	185	150	8 × 19	22.0	56.5	200
100R	80	210	175	8 × 19	22.0	87.0	250
150R	100	280	240	8 × 23	31.0	112.0	300
Raised face according to: Ra 3.2 to 6.3 µm							

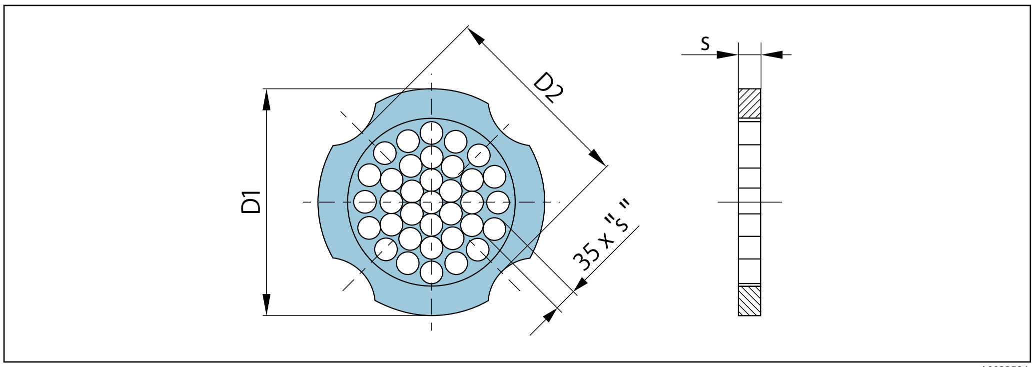
Flange connection dimensions according to JIS B2220: 10K, Schedule 80 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
50R	40	155	120	4 × 19	20.0	45.0	200
80R	50	185	150	8 × 19	22.0	56.5	200
100R	80	210	175	8 × 19	22.0	87.0	250
150R	100	280	240	8 × 23	31.5	112.0	300
Raised face according to JIS 2220: Ra 3.2 to 6.3 µm							

Flange connection dimensions according to JIS B2220: 20K, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
25R	15	125	90	4 × 19	18.5	22.0	200
40R	25	140	105	4 × 19	18.5	30.0	200
50R	40	155	120	8 × 19	20.0	45.0	200
80R	50	200	160	8 × 23	26.5	56.5	200
100R	80	225	185	8 × 23	25.5	87.0	250
150R	100	305	260	12 × 25	37.5	112.0	300
200R	150	350	305	12 × 25	31.0	146.3	300
Raised face according to JIS 2220: Ra 3.2 to 6.3 µm							

Flange connection dimensions according to JIS B2220: 20K, Schedule 80 Triple-certified material, 1.4404/F316/F316L							
DN [mm]	Reduction to DN [mm]	A [mm]	B [mm]	Ø C [mm]	D [mm]	E [mm]	L [mm]
25R	15	125	90	4 × 19	18.5	22.0	200
40R	25	140	105	4 × 19	19.0	30.0	200
50R	40	155	120	8 × 19	22.0	45.0	200
80R	50	200	160	8 × 23	27.0	56.5	200
100R	80	225	185	8 × 23	26.0	87.0	250
150R	100	305	260	12 × 25	37.5	112.0	300
Raised face according to JIS 2220: Ra 3.2 to 6.3 µm							

Accessories

Flow conditioner



Used in combination with flanges according to DIN EN 1092-1: PN 10 1.4404 (316, 316L) Order code for "Accessory enclosed", option PF			
DN [mm]	Centering diameter [mm]	D1 1) / D2 2)	s [mm]
15	54.3	D2	2.0
25	74.3	D1	3.5
40	95.3	D1	5.3
50	110.0	D2	6.8
80	145.3	D2	10.1
100	165.3	D2	13.3
150	221.0	D2	20.0
200	274.0	D1	26.3
250	330.0	D2	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to DIN EN 1092-1: PN 16 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 1) / D2 2)	s [mm]
15	54.3	D2	2.0
25	74.3	D1	3.5
40	95.3	D1	5.3
50	110.0	D2	6.8
80	145.3	D2	10.1
100	165.3	D2	13.3
150	221.0	D2	20.0
200	274.0	D2	26.3

Used in combination with flanges according to DIN EN 1092-1: PN 16 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	54.3	D2	2.0
25	74.3	D1	3.5
40	95.3	D1	5.3
50	110.0	D2	6.8
80	145.3	D2	10.1
100	165.3	D2	13.3
150	221.0	D2	20.0
200	274.0	D2	26.3
250	330.0	D2	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to DIN EN 1092-1: PN 25 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	54.3	D2	2.0
25	74.3	D1	3.5
40	95.3	D1	5.3
50	110.0	D2	6.8
80	145.3	D2	10.1
100	171.3	D1	13.3
150	227.0	D2	20.0
200	280.0	D1	26.3
250	340.0	D1	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to DIN EN 1092-1: PN 40 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	54.3	D2	2.0
25	74.3	D1	3.5
40	95.3	D1	5.3
50	110.0	D2	6.8
80	145.3	D2	10.1
100	171.3	D1	13.3
150	227.0	D2	20.0

Used in combination with flanges according to DIN EN 1092-1: PN 40 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
200	294.0	D2	26.3
250	355.0	D2	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to ASME B16.5: Class 150 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	50.1	D1	2.0
25	69.2	D2	3.5
40	88.2	D2	5.3
50	106.6	D2	6.8
80	138.4	D1	10.1
100	176.5	D2	13.3
150	223.5	D1	20.0
200	274.0	D2	26.3
250	340.0	D1	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to ASME B16.5: Class 300 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	56.5	D1	2.0
25	74.3	D1	3.5
40	97.7	D2	5.3
50	113.0	D1	6.8
80	151.3	D1	10.1
100	182.6	D1	13.3
150	252.0	D1	20.0
200	309.0	D1	26.3
250	363.0	D1	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to JIS B2220: 10K 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	60.3	D2	2.0
25	76.3	D2	3.5
40	91.3	D2	5.3
50	106.6	D2	6.8
80	136.3	D2	10.1
100	161.3	D2	13.3
150	221.0	D2	20.0
200	271.0	D2	26.3
250	330.0	D2	33.0

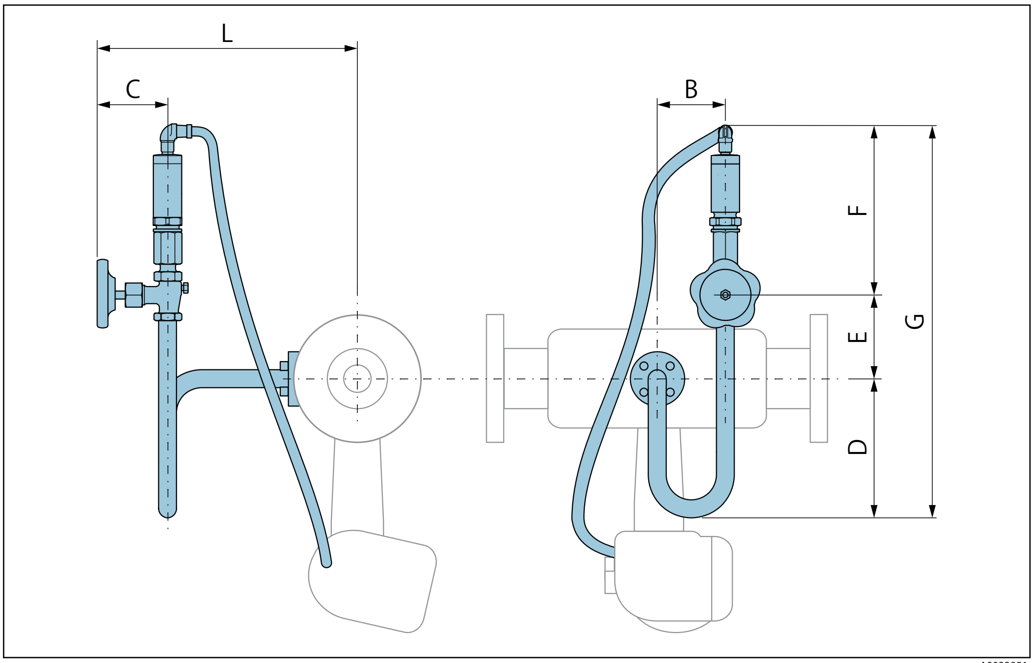
1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to JIS B2220: 20K 1.4404 (316, 316L)			
DN [mm]	Centering diameter [mm]	D1 [1)] / D2 [2)]	s [mm]
15	60.3	D2	2.0
25	76.3	D2	3.5
40	91.3	D2	5.3
50	106.6	D2	6.8
80	142.3	D1	10.1
100	167.3	D1	13.3
150	240.0	D1	20.0
200	284.0	D1	26.3
250	355.0	D2	33.0

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Pressure measuring cell

For order code for "Sensor version; DSC sensor; measuring tube" and option "Mass steam", the following applies:
- Only available for measuring devices with the HART communication protocol
- Oil-free or grease-free cleaning is not possible



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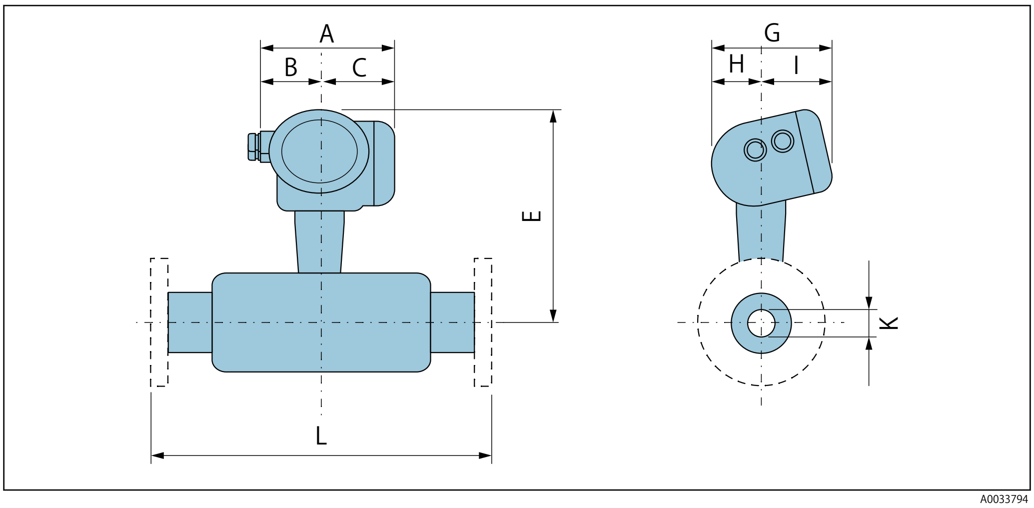
Order code for "Sensor version; DSC sensor; measuring tube": Option "Mass steam; 316L; 316L (integrated pressure/temperature measurement)"							
DN [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	G [mm]	L [mm]
40R	76	78.8	155	60.8	190.5	407	307
50R	76	78.8	155	60.8	190.5	407	314
80R	76	78.8	155	60.8	190.5	407	320
100R	76	78.8	155	60.8	190.5	407	331
150R	76	78.8	155	60.8	190.5	407	346
200R	76	78.8	155	60.8	190.5	407	372

Dimensions in US units

Compact version



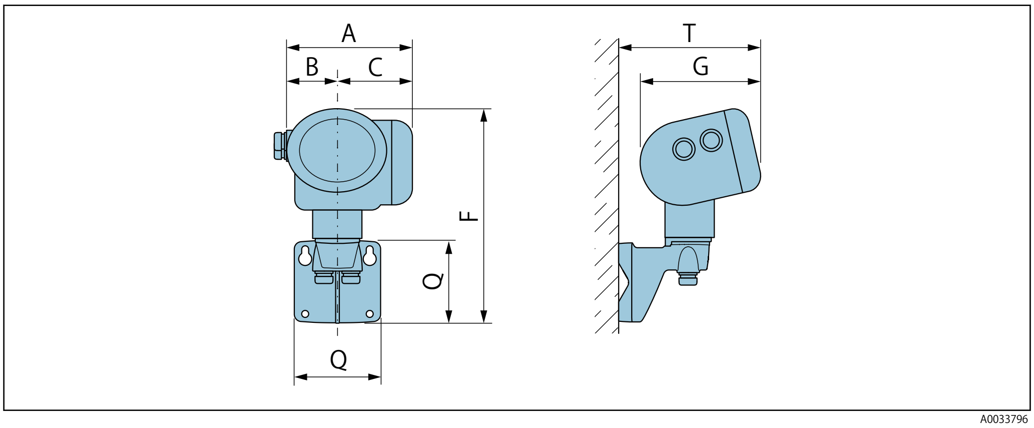
Grayed out: Dualsens version

Single inner diameter line size reduction

DN [in]	Reduction to DN [in]	A [1)] [in]	B [in]	C [1)] [in]	E [in]	G [in]	H [in]	I [in]	K (D_i) [in]	L [in]
1R	½	5.52	2.04	3.48	9.92	6.3	2.29	4	0.55	[2)]
1½R	1	5.52	2.04	3.48	10.2	6.3	2.29	4	0.96	[2)]
2R	1½	5.52	2.04	3.48	10.5	6.3	2.29	4	1.5	[2)]
3R	2	5.52	2.04	3.48	10.7	6.3	2.29	4	1.94	[2)]
4R	3	5.52	2.04	3.48	11.3	6.3	2.29	4	2.9	[2)]
6R	4	5.52	2.04	3.48	11.8	6.3	2.29	4	3.82	[2)]
8R	6	5.52	2.04	3.48	12.8	6.3	2.29	4	5.76	[2)]

1) For version with overvoltage protection: values + 0.31 in
2) Dependent on respective flange connection

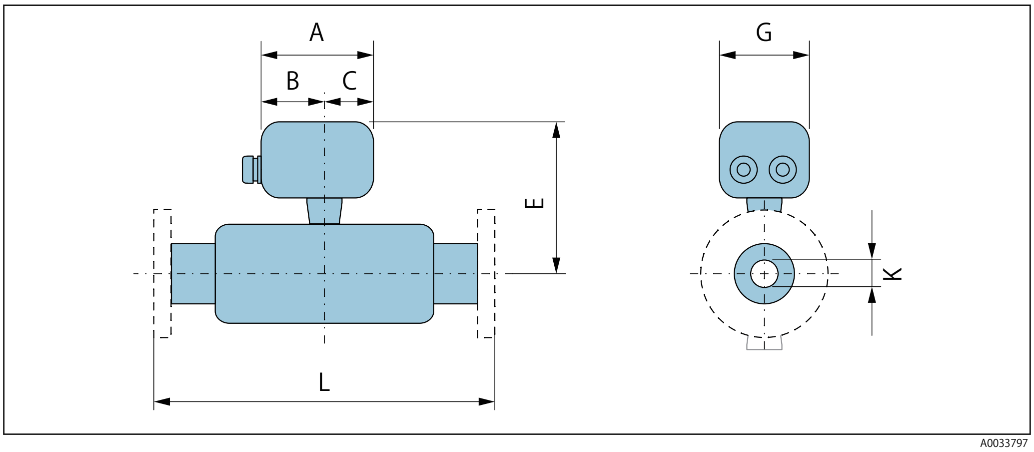
Transmitter remote version



A [1] [in]	B [in]	C [1] [in]	F [in]	G [in]	Q [in]	T [in]
5.52	2.04	3.48	10	6.3	4.21	7.52

1) For version with overvoltage protection: value + 0.31 in

Sensor remote version



Grayed out: Dualsens version

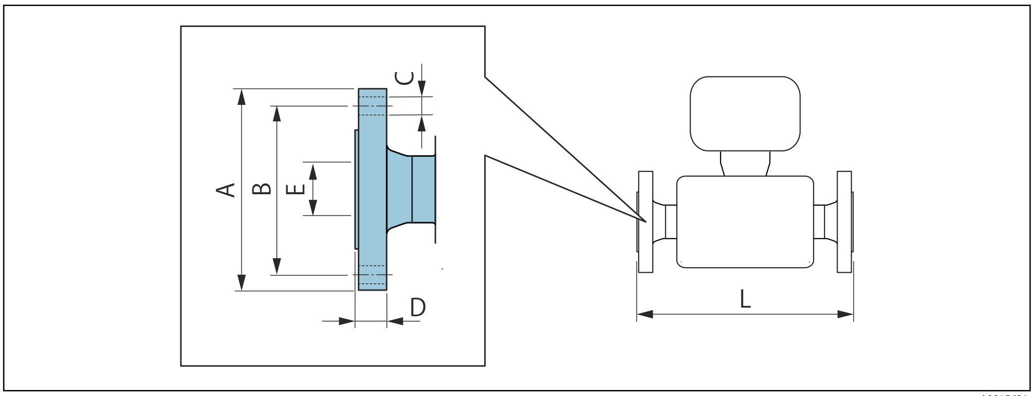
Single inner diameter line size reduction

Flange according to ASME B16.5: Class 150/300, Schedule 40/80 Stainless steel ,1.4404								
DN [in]	Reduction to DN [in]	A [in]	B [in]	C [in]	E 1) [in]	G [in]	K (D_i) [in]	L [in]
1R	½	4.22	2.36	1.86	8.86	3.72	0.55	2)
1½R	1	4.22	2.36	1.86	9.09	3.72	0.96	2)
2R	1½	4.22	2.36	1.86	9.41	3.72	1.5	2)
3R	2	4.22	2.36	1.86	9.65	3.72	1.94	2)
4R	3	4.22	2.36	1.86	10.2	3.72	2.9	2)
6R	4	4.22	2.36	1.86	10.7	3.72	3.82	2)
8R	6	4.22	2.36	1.86	11.7	3.72	5.76	2)

1) For high-temperature/low-temperature version: values +1.14 in
2) Dependent on respective flange connection

Flange connections

Flange



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Length tolerance for dimension L in inch:
DN ≤ 4": +0.06 to –0.08 in
DN ≥ 6": ±0.14 in

Flange connection dimensions according to ASME B16.5: Class 150, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [in]	Reduction to DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	L [in]
1R	½	4.26	3.12	4 × Ø 0.62	0.71	0.87	7.87
1½R	1	5	3.88	4 × Ø 0.62	0.71	1.18	7.87
2R	1½	6	4.75	4 × Ø 0.75	0.79	1.77	7.87
3R	2	7.5	6	4 × Ø 0.75	0.94	2.22	7.87
4R	3	9	7.5	8 × Ø 0.75	0.96	3.43	9.84
6R	4	11	9.5	8 × Ø 0.88	1	4.41	11.8
8R	6	13.5	11.8	8 × Ø 0.88	1.12	5.76	11.8
Raised face according to ASME B16.5: Ra 125 to 250µin							

Flange connection dimensions according to ASME B16.5: Class 150, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [in]	Reduction to DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	L [in]
8R	6	13.5	11.8	8 × Ø 0.88	1.12	5.76	11.8
Raised face according to ASME B16.5: Ra 125 to 250µin							

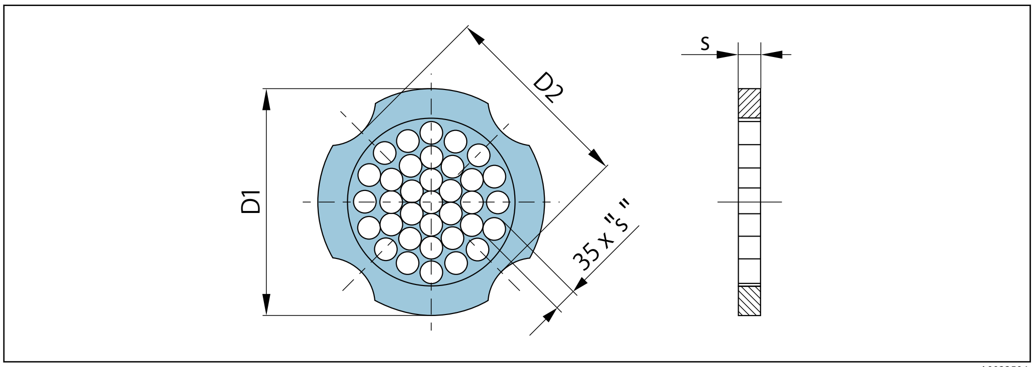
Flange connection dimensions according to ASME B16.5: Class 150, Schedule 80 Triple-certified material, 1.4404/F316/F316L							
DN [in]	Reduction to DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	L [in]
1R	½	4.26	3.12	4 × Ø 0.62	0.73	0.87	7.87
1½R	1	5	3.88	4 × Ø 0.62	0.71	1.18	7.87
2R	1½	6	4.75	4 × Ø 0.75	0.79	1.77	7.87
3R	2	7.5	6	4 × Ø 0.75	0.94	2.22	7.87
4R	3	9	7.5	8 × Ø 0.75	0.96	3.43	9.84
6R	4	11	9.5	8 × Ø 0.88	1.02	4.41	11.8
Raised face according to ASME B16.5: Ra 125 to 250µin							

Flange connection dimensions according to ASME B16.5: Class 300, Schedule 40 Triple-certified material, 1.4404/F316/F316L							
DN [in]	Reduction to DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	L [in]
1R	½	4.89	3.5	4 × Ø 0.75	0.87	0.87	7.87
1½R	1	6.12	4.5	4 × Ø 0.88	0.99	1.18	7.87
2R	1½	6.5	5	8 × Ø0.75	0.99	1.77	7.87
3R	2	8.25	6.62	8 × Ø0.88	1.14	2.22	7.87
4R	3	10	7.88	8 × Ø 0.88	1.25	3.43	7.87
6R	4	11.8	10.6	12 × Ø 0.88	1.52	4.41	11.80
8R	6	15	13	12 × Ø 1	1.62	5.76	11.80
Raised face according to ASME B16.5: Ra 125 to 250µin							

Flange connection dimensions according to ASME B16.5: Class 300, Schedule 80 Triple-certified material, 1.4404/F316/F316L							
DN [in]	Reduction to DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	L [in]
1R	½	4.89	3.5	4 × Ø 0.75	0.87	0.87	7.87
1½R	1	6.12	4.5	4 × Ø 0.88	0.99	1.18	7.87
2R	1½	6.5	5	8 × Ø 0.75	0.99	1.77	7.87
3R	2	8.25	6.62	8 × Ø 0.88	1.14	2.22	7.87
4R	3	10	7.88	8 × Ø 0.88	1.25	3.43	9.84
6R	4	11.8	10.6	12 × Ø 0.88	1.54	4.41	11.8
Raised face according to ASME B16.5: Ra 125 to 250µin							

Accessories

Flow conditioner



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Used in combination with flanges according to ASME B16.5: Class 150 1.4404 (316, 316L)			
DN [in]	Centering diameter [in]	D1 [1)] / D2 [2)]	s [in]
½	1.97	D1	0.08
1	2.72	D2	0.14
1½	3.47	D2	0.21
2	4.09	D2	0.27
3	5.45	D1	0.40
4	6.95	D2	0.52
6	8.81	D1	0.79
8	10.80	D2	1.04
10	13.40	D1	1.30

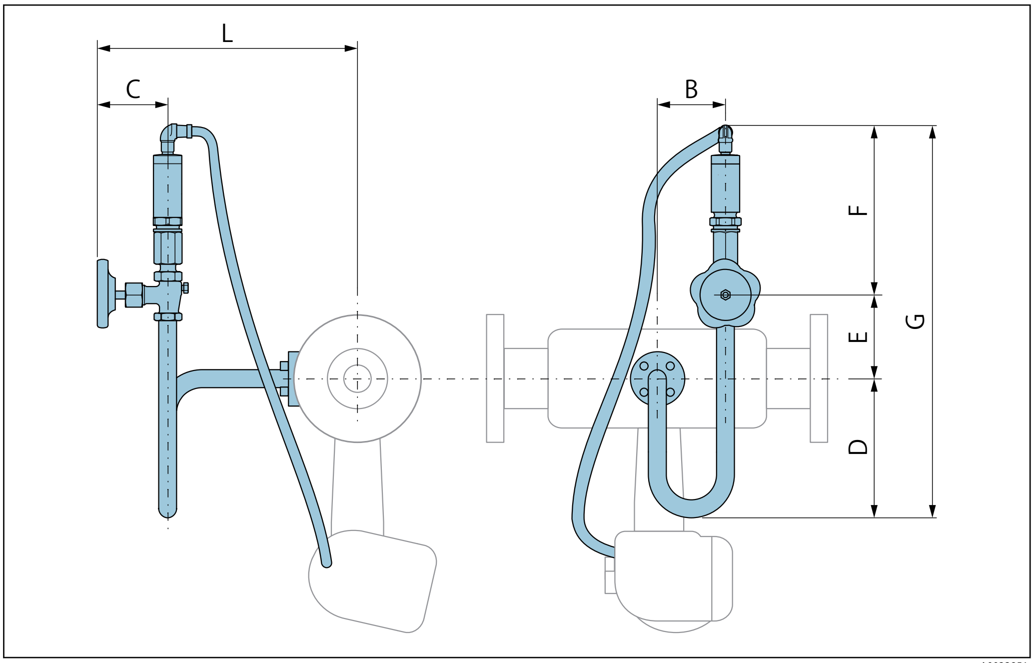
1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Used in combination with flanges according to ASME B16.5: Class 300 1.4404 (316, 316L)			
DN [in]	Centering diameter [in]	D1 [1)] / D2 [2)]	s [in]
½	2.22	D1	0.08
1	2.93	D1	0.14
1½	3.85	D2	0.21
2	4.45	D1	0.27
3	5.96	D1	0.40
4	7.19	D1	0.52
6	9.92	D1	0.79
8	12.20	D1	1.04
10	14.30	D1	1.30

1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

Pressure measuring cell

For order code for "Sensor version; DSC sensor; measuring tube" and option "Mass steam", the following applies:
- Only available for measuring devices with the HART communication protocol
- Oil-free or grease-free cleaning is not possible



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Order code for "Sensor version; DSC sensor; measuring tube": Option DA "Mass steam; 316L; 316L (integrated pressure/temperature measurement)"							
DN [in]	B [in]	C [in]	D [in]	E [in]	F [in]	G [in]	L [in]
1½R	2.99	3.1	6.1	2.39	7.5	16.02	12.09
2R	2.99	3.1	6.1	2.39	7.5	16.02	12.36
3R	2.99	3.1	6.1	2.39	7.5	16.02	12.6
4R	2.99	3.1	6.1	2.39	7.5	16.02	13.03
6R	2.99	3.1	6.1	2.39	7.5	16.02	13.62
8R	2.99	3.1	6.1	2.39	7.5	16.02	14.65

Weight

Compact version

Weight data:
- Including the transmitter:
  - Aluminum, coated, compact" 1.8 kg (4.0 lb):

- Excluding packaging material

Weight in SI units

All values (weight) refer to devices with EN (DIN), PN 40 flanges. Weight information in [kg].

DN [mm]	Internal diameter [mm]	Weight [kg] Aluminum, coated, compact" 1)
25R	15	6.1
40R	25	10.1
50R	40	12.1
80R	50	16.1
100R	80	23.1
150R	100	42.1
200R	150	63.1

1) For high-temperature/low-temperature version: values + 0.2 kg

Weight in US units

All values (weight) refer to devices with ASME B16.5, Class 300/Sch. 40 flanges. Weight information in [lbs].

DN [in]	Internal diameter [in]	Weight [lbs] Aluminum, coated, compact" 1)
1R	½	18.0
1½R	1	22.4
2R	1½	26.8
3R	2	48.8
4R	3	68.7
6R	4	121.6
8R	6	165.7

1) For high-temperature/low-temperature version: values + 0.4 lbs

Transmitter remote version

Wall-mount housing

Dependent on the material of wall-mount housing:

Sensor remote version

Weight data:
- Including sensor connection housing:
- Excluding the connecting cable
- Excluding packaging material

Weight in SI units

All values (weight) refer to devices with EN (DIN), PN 40 flanges. Weight information in [kg].

DN [mm]	Internal diameter [mm]	Weight [kg] Aluminum, coated, compact" 1)
25R	15	5.1
40R	25	9.1
50R	40	11.1
80R	50	15.1
100R	80	22.1
150R	100	41.1
200R	150	62.1

1) For high-temperature/low-temperature version: values + 0.2 kg

Weight in US units

All values (weight) refer to devices with ASME B16.5, Class 300/Sch. 40 flanges. Weight information in [lbs].

DN [in]	Internal diameter [in]	Weight [lbs] Aluminum, coated, compact" 1)
1R	½	15.6
1½R	1	20.0
2R	1½	24.4
3R	2	46.4
4R	3	66.3
6R	4	119.2
8R	6	163.3

1) For high-temperature/low-temperature version: values + 0.4 lbs

Accessories

Flow conditioner

Weight in SI units

DN [1)] [mm]	Pressure rating	Weight [kg]
15	PN 10 to 40	0.04
25	PN 10 to 40	0.1
40	PN 10 to 40	0.3
50	PN 10 to 40	0.5
80	PN 10 to 40	1.4
100	PN10 to 40	2.4
150	PN 10/16 PN 25/40	6.3 7.8
200	PN 10 PN 16/25 PN 40	11.5 12.3 15.9
250	PN 10 to 25 PN 40	25.7 27.5

1) EN (DIN)

DN [1)] [mm]	Pressure rating	Weight [kg]
15	Class 150 Class 300	0.03 0.04
25	Class 150 Class 300	0.1
40	Class 150 Class 300	0.3
50	Class 150 Class 300	0.5
80	Class 150 Class 300	1.2 1.4
100	Class 150 Class 300	2.7
150	Class 150 Class 300	6.3 7.8
200	Class 150 Class 300	12.3 15.8
250	Class 150 Class 300	25.7 27.5

1) ASME

DN [1] [mm]	Pressure rating	Weight [kg]
15	20K	0.06
25	20K	0.1
40	20K	0.3
50	10K 20K	0.5
80	10K 20K	1.1
100	10K 20K	1.80
150	10K 20K	4.5 5.5
200	10K 20K	9.2
250	10K 20K	15.8 19.1

1) JIS

Weight in US units

DN [1] [in]	Pressure rating	Weight [lbs]
½	Class 150 Class 300	0.07 0.09
1	Class 150 Class 300	0.3
1½	Class 150 Class 300	0.7
2	Class 150 Class 300	1.1
3	Class 150 Class 300	2.6 3.1
4	Class 150 Class 300	6.0
6	Class 150 Class 300	14.0 16.0
8	Class 150 Class 300	27.0 35.0
10	Class 150 Class 300	57.0 61.0

1) ASME

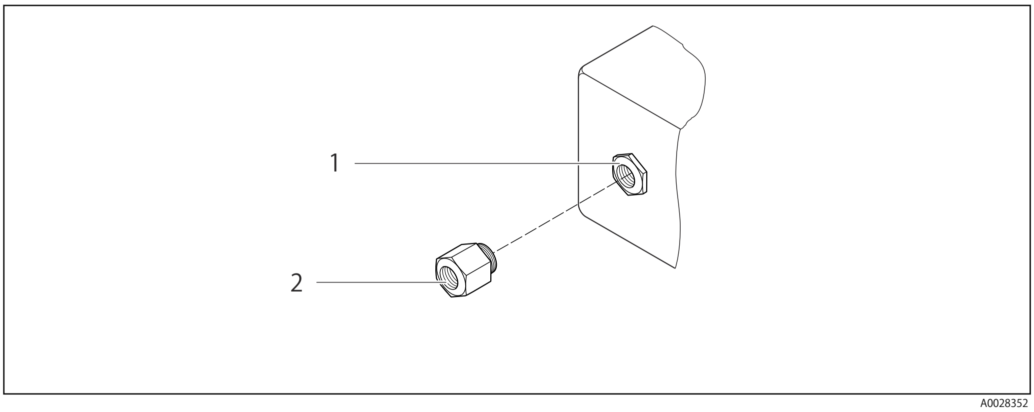
Materials

Transmitter housing

Compact version
- Aluminum, coated, compact": Aluminum, AlSi10Mg, coated
- Window material: glass

Remote version
- Aluminum, coated, remote": Aluminum, AlSi10Mg, coated
- Window material: glass

Cable entries/cable glands



Possible cable entries/cable glands

1 Female thread M20 × 1.5
2 Adapter for cable entry with female thread G ½" or NPT ½"

Cable entry/cable gland	Type of protection	Material
Cable gland M20 × 1.5	Adapter for cable entry with female thread G ½"	Nickel-plated brass

Connecting cable for remote version
- Standard cable: PVC cable with copper shield

Connecting cable, pressure measuring cell

Standard cable: PVC cable with copper shield

Sensor connection housing
- Aluminum, coated, remote": Coated aluminum AlSi10Mg

Measuring tubes

DN 15 to 300 (½ to 12"), pressure ratings PN 10/16/25/40 /63/100, Class 150/300 /600 , as well as JIS 10K/20K:
Stainless cast steel, CF3M/1.4408
Compliant with:
- NACE MR0175
- NACE MR0103
- DN15 to 150 (½ to 6"): AD2000, permitted temperature range –10 to +400 ° C (+14 to +752 ° F) restricted)

DSC sensor

- Stainless steel 1.4404 and 316 and 316L
- Compliant with:
  - NACE MR0175/ISO 15156-2015
  - NACE MR0103/ISO 17945-2015

Parts not in contact with medium:
Stainless steel 1.4301 (304)

Pressure measuring cell

- Wetted parts:
  - Process connection
    Stainless steel, 1.4404/316L
  - Membrane
    Stainless steel, 1.4435/316L
- Non-wetted parts:
  Housing
  Stainless steel ,1.4404
- Siphon [4]
  Stainless steel ,1.4571
- Adjusting nut
  Stainless steel ,1.4571
- Pressure gauge valve
  Stainless steel ,1.4571
- Welded connection on meter body
  Stainless steel, multiple certifications 1.4404/316/316L
- Seals
  Copper

Process connections

DN 15 to 300 (½ to 12"), pressure ratings PN 10/16/25/40/63/100, Class 150/300/600, as well as JIS 10K/20K:

Welding neck flanges DN 15 to 300 (½ to 12")
Compliant with:
NACE MR0175-2003
NACE MR0103-2003

The following materials are available depending on the pressure rating:
- Stainless steel, multiple certifications, 1.4404/F316/F316L)

Available process connections→ See page 70

4) Only with order code for "Sensor version; DSC sensor; measuring tube", option available.

Seals

- Graphite (standard)
  Sigraflex foil™ (BAM-tested for oxygen applications, "high-grade in the context of TA-Luft Clean Air Guidelines")
- FPM (Viton ™)
- Kalrez 6375 ™
- Gylon 3504 ™ (BAM-tested for oxygen applications, "high-grade in the context of TA-Luft clean air guidelines")

Order code for "Sensor version; DSC sensor; measuring tube", option, Copper

Housing support

Stainless steel, 1.4408 (CF3M)

Screws for DSC sensor

- Stainless steel, A2-80 according to ISO 3506-1 (304)

Accessories

Protective cover

Stainless steel, 1.4404 (316L)

Flow conditioner

- Stainless steel, multiple certifications, 1.4404 (316, 316L)
- Compliant with:
  - NACE MR0175-2003
  - NACE MR0103-2003

Flange connections

Flange connection dimensions and raised face in accordance with:
- DIN EN 1092-1
- ASME B16.5
- JIS B2220

For information on the different materials used in the flange connections → See page 69

Operability

Operating concept

Operator-oriented menu structure for user-specific tasks
- Commissioning
- Operation
- Diagnostics
- Expert level

Quick and safe commissioning
- Guided menus ("Make-it-run" wizards) for applications
- Menu guidance with brief explanations of the individual parameter functions

Reliable operation
- Operation in the following languages:
  - Via local display:
    English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Swedish, Turkish, Chinese, Japanese, Korean, Bahasa (Indonesian), Vietnamese, Czech
- Uniform operating philosophy applied to device and operating tools
- If replacing the electronic module, transfer the device configuration via the integrated memory (integrated HistoROM) which contains the process and measuring device data and the event logbook. No need to reconfigure.

Efficient diagnostics increase measurement availability
- Troubleshooting measures can be called up via the device and in the operating tools
- Diverse simulation options, logbook for events that occur and optional line recorder functions

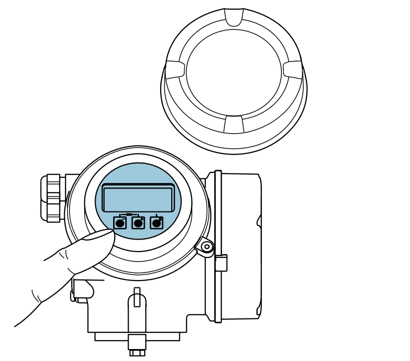
Languages

Can be operated in the following languages:
- Via local display:
  English, German, French, Spanish, Italian, Dutch, Portuguese, Polish, Russian, Swedish, Turkish, Chinese, Japanese, Korean, Bahasa (Indonesian), Vietnamese, Czech

Local operation

Via display module

Two display modules are available:



1 Operation with pushbuttons

Display elements

- 4-line, illuminated, graphic display
- Format for displaying measured variables and status variables can be individually configured
- Permitted ambient temperature for the display: –20 to +60 °C (–4 to +140 °F)
  The readability of the display may be impaired at temperatures outside the temperature range.

Operating elements

- Operation with 3 push buttons with open housing: ⊕ ⊖ Ⓔ

Remote operation

Via HART protocol

This communication interface is available in device versions with a HART output.

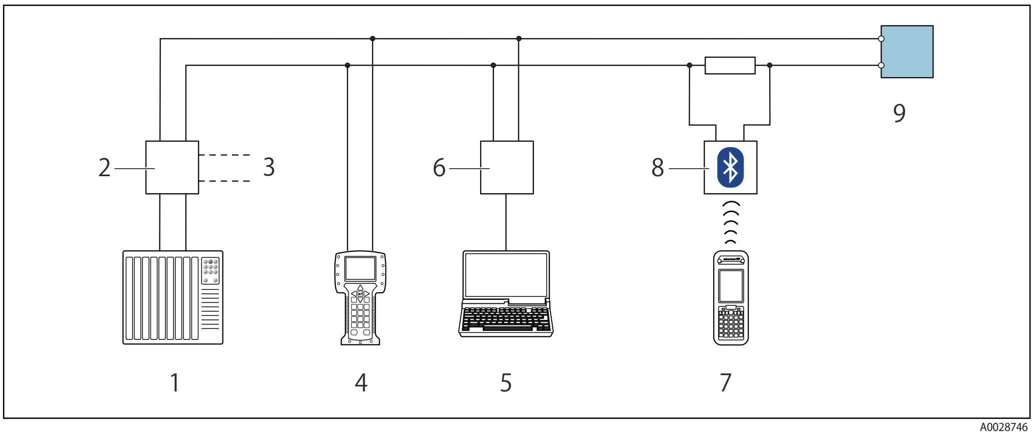


Fig. 29 Options for remote operation via HART protocol (passive)

1 Control system (e.g. PLC)
2 Transmitter power supply unit, e.g. RN221N (with communication resistor)
3 Connection for Commubox FXA195 and Field Communicator 475
4 Field Communicator 475
5 Computer with web browser (e.g. Internet Explorer) for accessing computers with operating tool (e.g. FieldCare, DeviceCare, AMS Device Manager, SIMATIC PDM) with COM DTM "CDI Communication TCP/IP"
6 Commubox FXA195 (USB)
7 Field Xpert SFX350 or SFX370
8 VIATOR Bluetooth modem with connecting cable
9 Transmitter

Certificates and approvals

CE mark

The device meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

TLV confirms successful testing of the device by affixing to it the CE mark.

RCM-tick symbol

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

HART certification

HART interface

The measuring device is certified and registered by the FieldComm Group. The measuring system meets all the requirements of the following specifications:
- Certified according to HART
- The device can also be operated with certified devices of other manufacturers (interoperability)

Pressure Equipment Directive

The devices can be ordered with or without a PED approval. If a device with a PED approval is required, this must be explicitly stated in the order.

- With the identification PED/G1/x (x = category) on the sensor nameplate, Endress+Hauser confirms conformity with the "Essential Safety Requirements" specified in Appendix I of the Pressure Equipment Directive 2014/68/EU.
- Devices bearing this marking (PED) are suitable for the following types of medium: Media in Group 1 and 2 with a vapor pressure greater than, or smaller and equal to0.5 bar (7.3 psi)
- Devices not bearing this marking (PED) are designed and manufactured according to good engineering practice. They meet the requirements of Article 4 paragraph 3 of the Pressure Equipment Directive 2014/68/EU. The range of application is indicated in tables 6 to 9 in Annex II of the Pressure Equipment Directive 2014/68/EU.

Experience	The EF200-C measuring system is the official successor to EF200 and EF73.
Other standards and guidelines	• EN 60529 Degrees of protection provided by enclosures (IP code) • DIN ISO 13359 Measurement of conductive liquid flow in closed conduits - Flanged-type electromagnetic flowmeters - Overall length • EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use - general requirements • IEC/EN 61326 Emission in accordance with Class A requirements. Electromagnetic compatibility (EMC requirements). • NAMUR NE 21 Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment • NAMUR NE 32 Data retention in the event of a power failure in field and control instruments with microprocessors • NAMUR NE 43 Standardization of the signal level for the breakdown information of digital transmitters with analog output signal. • NAMUR NE 53 Software of field devices and signal-processing devices with digital electronics • NAMUR NE 105 Specifications for integrating fieldbus devices in engineering tools for field devices • NAMUR NE 107 Self-monitoring and diagnosis of field devices • NAMUR NE 131 Requirements for field devices for standard applications

Supplementary documentation

Standard documentation

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
EF200-C	172-65765M

Operating Instructions

Measuring device	Documentation code
EF200R-C	172-65757M

Description of Device Parameters

Measuring device	Documentation code
EF200-C	172-65764M

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3. improper disassembly and reassembly, or inadequate inspection and maintenance by persons other than TLV or TLV group company personnel, or service representatives authorized by TLV; or
4. disasters or forces of nature or Acts of God; or
5. abuse, abnormal use, accidents or any other cause beyond the control of TLV, TII or TLV group companies; or
6. improper storage, maintenance or repair; or
7. operation of the Products not in accordance with instructions issued with the Products or with accepted industry practices; or
8. use for a purpose or in a manner for which the Products were not intended; or
9. use of the Products in a manner inconsistent with the Specifications; or
10. use of the Products with Hazardous Fluids (fluids other than steam, air, water, nitrogen, carbon dioxide and inert gases (helium, neon, argon, krypton, xenon and radon)); or
11. failure to follow the instructions contained in the TLV Instruction Manual for the Product.

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