ISO 9001
ISO 14001

CERTIFIED ISO 9001 · ISO 14001

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

TLV®

Technical Information

Vortex flowmeter

EF200W-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.

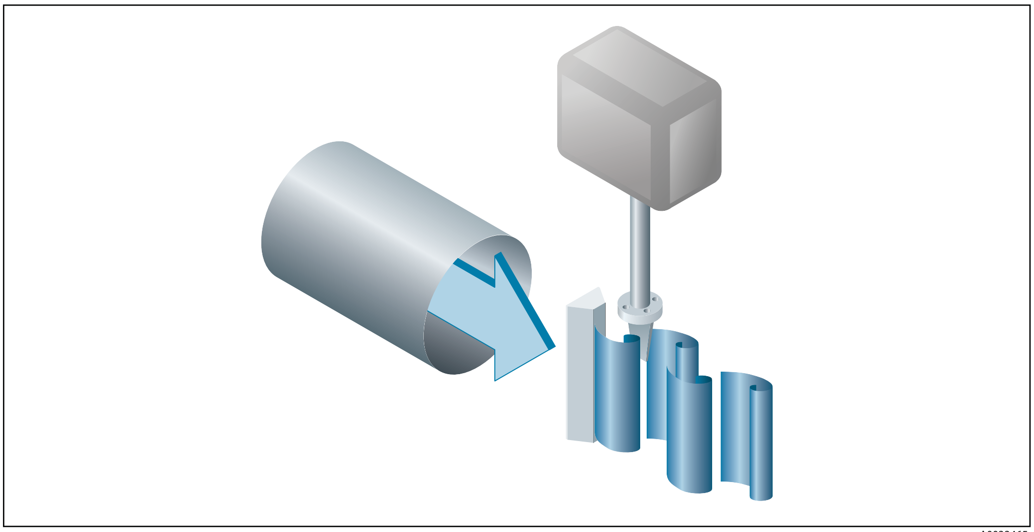
Symbols in graphics

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

Function and system design

Measuring principle

Vortex meters work on the principle of the Karman vortex streetWhen 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 > 20000:
- 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.

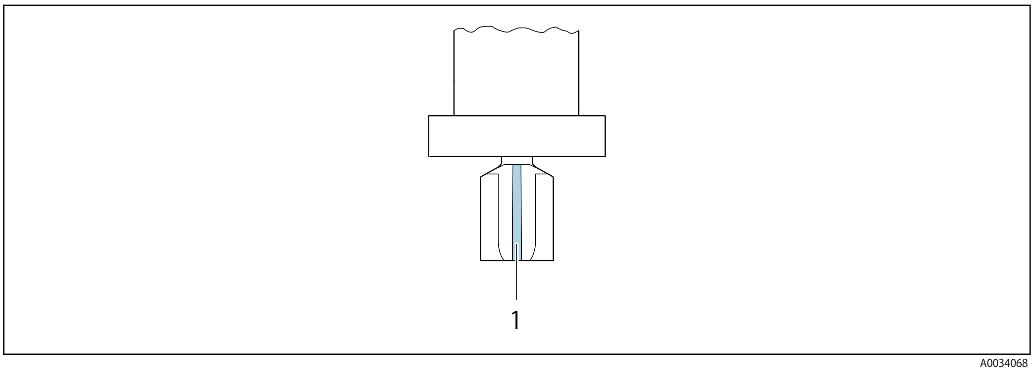
The robust DSC sensor is:
- burst-tested
- tested against vibrations
- tested against thermal shock (thermal shocks of 150 K/s)

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

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.

Air and industrial gases

The measuring device enables users to calculate the density and energy of air and industrial gases. The calculations are based on time-tested standard calculation methods. It is possible to automatically compensate for the effect of pressure and temperature via an external or constant value.

This makes it possible to output the energy flow, standard volume flow and mass flow of the following gases:
- Single gas
- Gas mixture
- Air
- User-specific gas

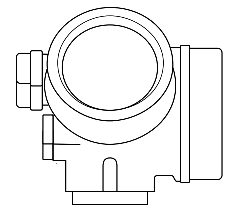
For detailed information on the parameters, see the Operating Instructions.→ See page 52

Measuring system

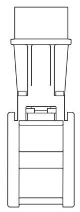
The device consists of a transmitter and a sensor.

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

EF200W-C  A0009922	Disc (wafer version): • Nominal diameter range: DN 15 to 150 (½ to 6") • Materials: Measuring tubes: stainless steel, CF3M/1.4408

Input

Measured variable

Direct measured variables

Order code for "Sensor version; DSC sensor; measuring tube"	
Description	Measured variable
Mass; 316L; 316L (integrated temperature measurement)	• Volume flow • Temperature

Calculated measured valuables

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 • Degrees of superheat

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 (Qmin to Qmax) 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.

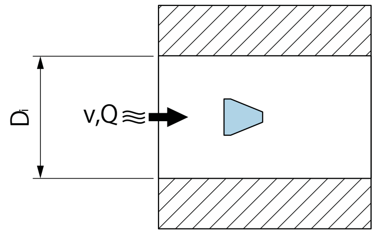
Flow measuring ranges in SI units

DN [mm]	Liquids [m^3/h]	Gas/steam [m^3/h]
15	0.06 to 4.9	0.3 to 25
25	0.18 to 15	0.9 to 130
40	0.45 to 37	2.3 to 310
50	0.75 to 62	3.8 to 820
80	1.7 to 140	8.5 to 1 800
100	2.9 to 240	15 to 3 200
150	6.7 to 540	33 to 7 300

Flow measuring ranges in US units

DN [in]	Liquids [ft^3/min]	Gas/steam [ft^3/min]
½	0.035 to 2.9	0.18 to 15
1	0.11 to 8.8	0.54 to 74
1½	0.27 to 22	1.3 to 180
2	0.44 to 36	2.2 to 480
3	1 to 81	5 to 1 100
4	1.7 to 140	8.7 to 1 900
6	3.9 to 320	20 to 4 300

Flow velocity



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D_i Internal diameter of measuring tube (corresponds to dimension K→ See page 34)
v Velocity in mating pipe
Q Flow

The internal diameter of measuring tube D_i is denoted in the dimensions as dimension K.→ See page 34.

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 page 34)
μ	Dynamic viscosity
ρ	Density

The Reynolds number, 5 000 together with the density and viscosity of the fluid and the nominal diameter, is used to calculate the corresponding flow rate.

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

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

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$Q_{Re=5000}$	Flow rate is dependent on the Reynolds number
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See page 34)
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/m³ (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).

$$v_{AmpMin}\,[m/s] = \max \begin{cases} \dfrac{mf\,[m/s]}{x^2} \\ \sqrt{\dfrac{1\,[kg/m^3]}{\rho\,[kg/m^3]}} \end{cases}$$

$$v_{AmpMin}\,[ft/s] = \max \begin{cases} \dfrac{mf\,[ft/s]}{x^2} \\ \sqrt{\dfrac{0.062\,[lb/ft^3]}{\rho\,[lb/ft^3]}} \end{cases}$$

A0034303

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

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

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

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 34)
ρ	Density

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

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

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

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Q_{Low}	Effective lower range value
Q_{min}	Minimum measurable flow rate
$Q_{=5000}$	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}:

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

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

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Q_{AmpMax}	Maximum measurable flow rate based on signal amplitude
D_i	Internal diameter of measuring tube (corresponds to dimension K→ See page 34)
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.

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

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

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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 34)
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)

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 2 000 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 1 000 Hzv
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

Additional information on remote operation → See page 50

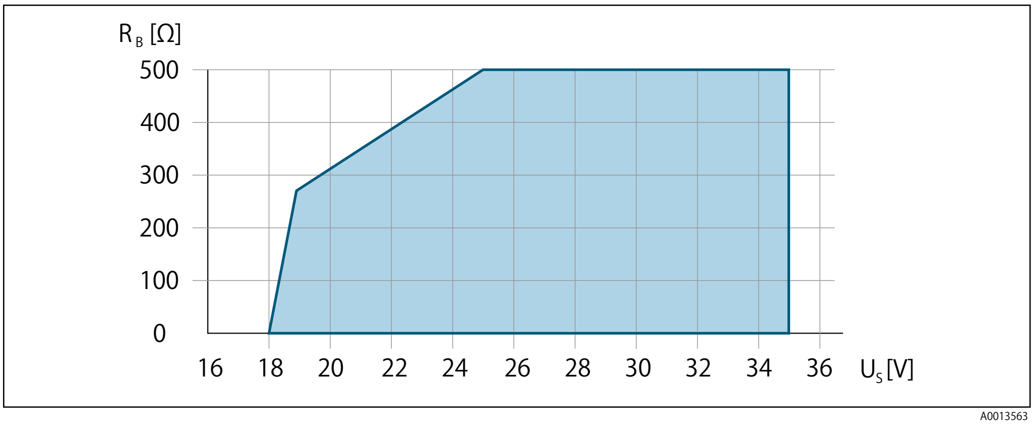
Load

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 $U_S = \geq$ 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

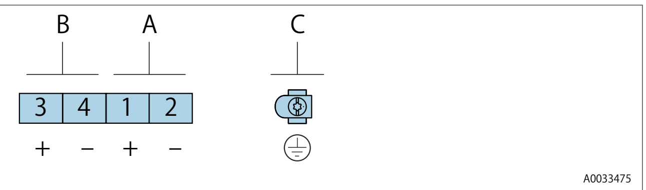
Manufacturer ID	0x11
Device type ID	0x0038
HART protocol revision	7
Device description files (DTM, DD)	Consult TLV for more information.
HART load	• Min. 250 Ω • Max. 500 Ω

Power supply

Terminal assignment

Transmitter

Connection versions



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 HART (passive)		Pulse/frequency/switch output (passive)	

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

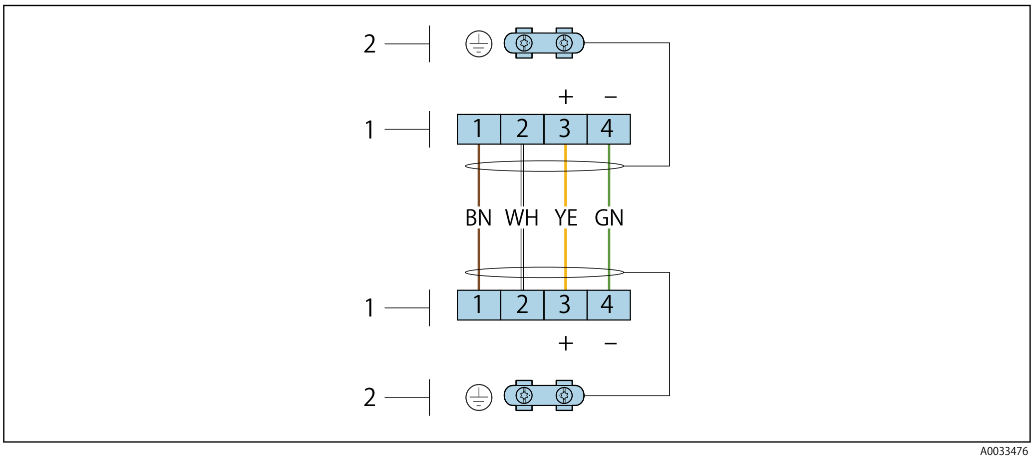
Connecting cable for remote version

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).

Connecting cable



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

Supply voltage

Transmitter

An external power supply is required for each output.

Supply voltage for a compact version without a local display [1]

Output	Minimum terminal voltage [2]	Maximum terminal voltage
4-20 mA HART, pulse/frequency/switch output	≥ DC 12 V	DC 35 V

1) In event of external supply voltage of the power supply unit with load
2) The minimum terminal voltage increases if local operation is used: see the following table
3) Voltage drop 2.2 to 3 V for 3.59 to 22 mA

Increase in minimum terminal voltage

Display; operation	Increase in minimum terminal voltage
Local operation	+ DC 1 V

Power consumption

Transmitter

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

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

Current output

3.59 to 22.5 mA

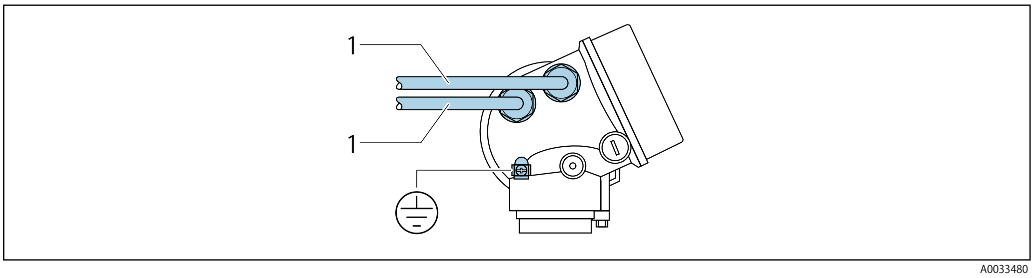
IInternal current limiting: max 26 mA

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

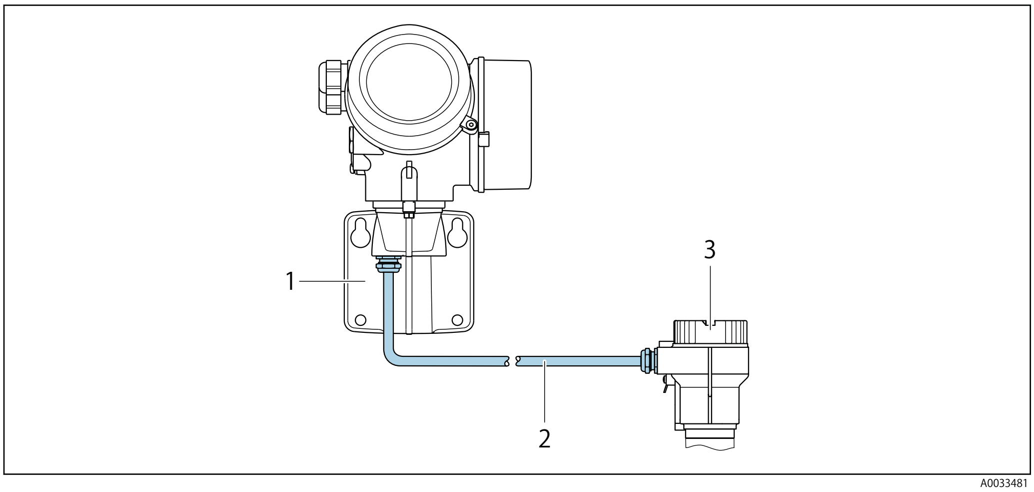
Connecting the transmitter



1 Cable entries for inputs/outputs

Remote version connection

Connecting cable



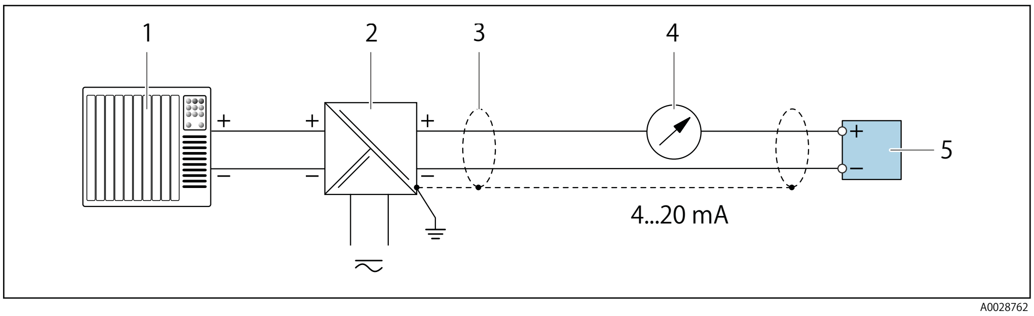
Connecting cable connection

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

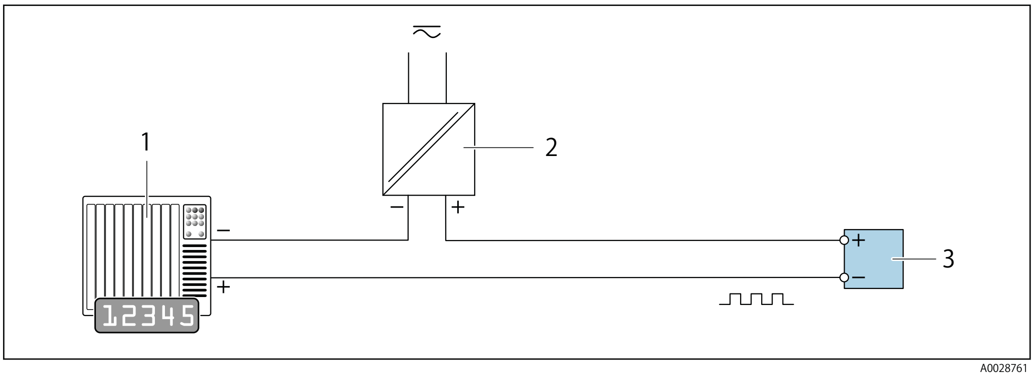
Current output 4-20 mA



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

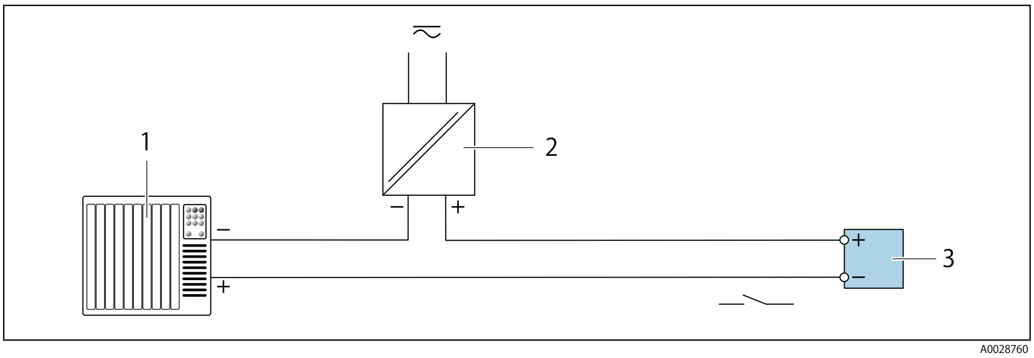
Pulse/frequency output



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:
  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 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	30 m (98 ft)
Operating temperature	When mounted in a fixed position: –50 to +105 ° C (–58 to +221 ° F); when

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 page 17[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 μs)	10 kA
Temperature range	–40 to +85 °C (–40 to +185 °F)

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

Performance characteristics

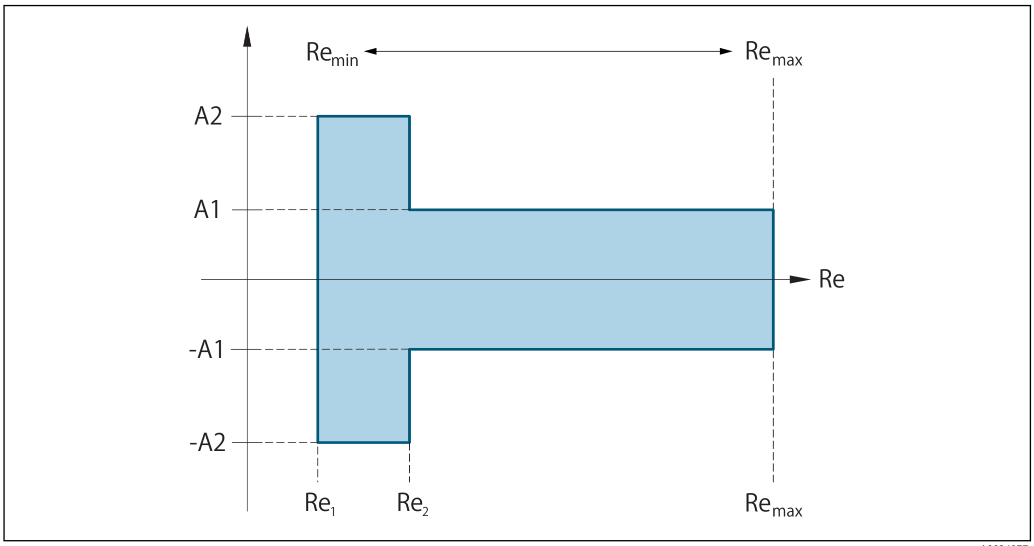
Reference operating conditions

- 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 numbers	Incompressible	Compressible
	Standard	Standard
Re_1	5 000	
Re_2	20 000	

Volume flow

Medium type		Incompressible	Compressible[1]
Reynolds number range	Measured value deviation	Standard	Standard
Re_1 to Re_2	A2	< 10 %	< 10 %
Re_2 to Re_{max}	A1	< 0.75 %	< 1.0 %

1) Accuracy specifications valid up to 75 m/s (246 ft/s)

Temperature

- Saturated steam and liquids at room temperature, if T > 100 ° C (212 ° F) applies:
  < 1 ° C (1.8 ° F)
- Gas:
  < 1 % o.r. [K]
- Volume flow if > 70 m/s (230 ft/s):
  2 % o.r.

Rise time 50 % (stirred under water, following IEC 60751): 8 s

Mass flow saturated steam

Flow velocity [m/s (ft/s)]	Temperature [° C (° F)]	Reynolds number range	Maximum measured error	Standard
20 to 50 (66 to 164)	150 (302) or (423 K)	Re_2 to Re_{max}	A1	< 1.7 %
		Re_1 to Re_2	A2	< 10 %
10 to 70 (33 to 210)	> 140 (284) or (413 K)	Re_2 to Re_{max}	A1	< 2 %
		Re_1 to Re_2	A2	< 10 %
< 10 (33)	–	$Re > Re_1$	A2, A1	5%

Mass flow of superheated steam/gases[1]

Process pressure [bar abs. (psi abs.)]	Reynolds number range	Measured value deviation	Standard[1]
< 40 (580)	Re_2 to Re_{max}	A1	1.7 %
	Re_1 to Re_2	A2	10 %
< 120 (1 740)	Re_2 to Re_{max}	A1	2.6 %
	Re_1 to Re_2	A2	10 %

1) 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

Reynolds number range	Measured value deviation	Standard
$Re = Re_2$	A1	< 0.85 %
Re_1 to Re_2	A2	< 10 %

1) Air: NEL40

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/° C) 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 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.

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

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

±0.2 % o.r.

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

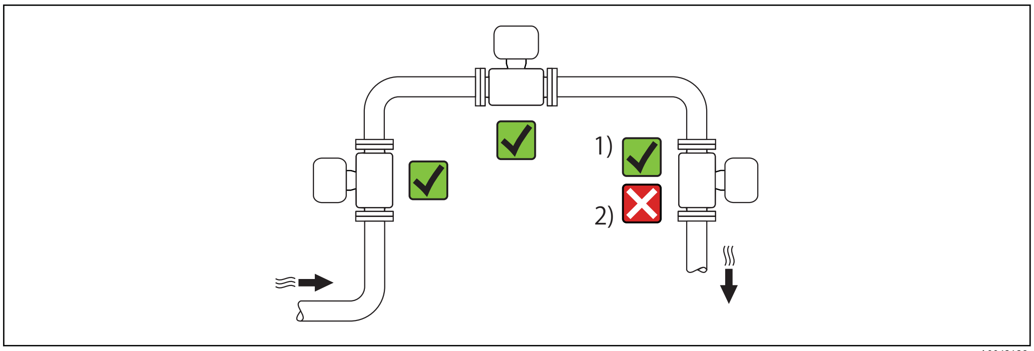
Pulse/frequency output

o.r. = of reading

Temperature coefficient	Max. ±100 ppm o.r.

Installation

Mounting location

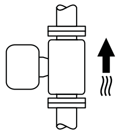
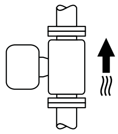
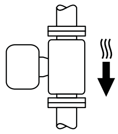
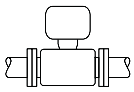
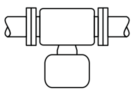
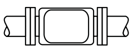


1 Installation suitable for gases and steam
2 Installation not suitable for liquids

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).

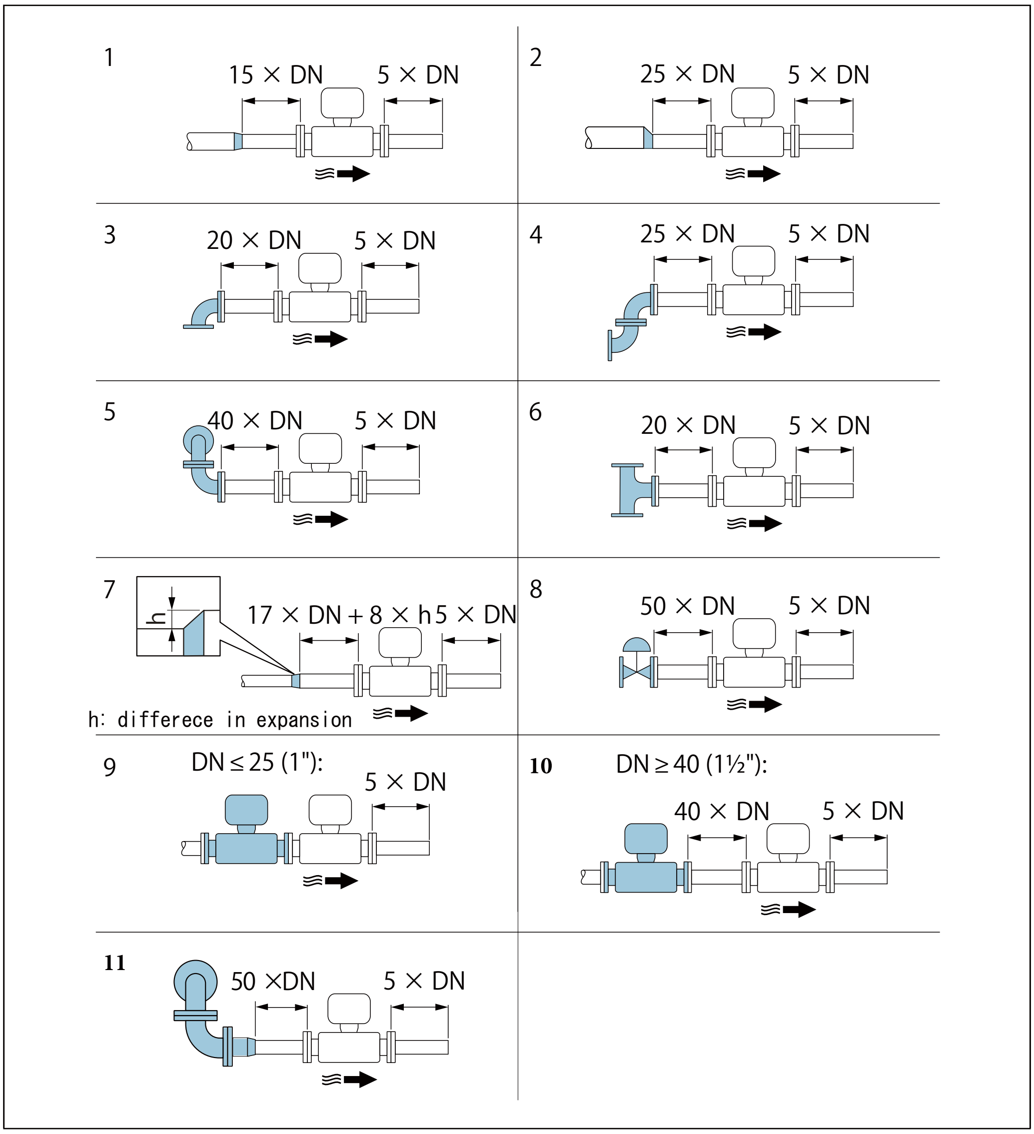
Vortex meters require a fully developed flow profile as a prerequisite for correct volume flow measurement. Therefore, please note the following:

Orientation			Recommendation	
			Compact version	Remote version
A	Vertical orientation (liquids)	 A0015591	✓✓ 1)	✓✓
A	Vertical orientation (dry gases)	 A0015591  A0041785	✓✓	✓✓
B	Horizontal orientation, transmitter head up	 A0015589	✓✓ 2) 3)	✓✓
C	Horizontal orientation, transmitter head down	 A0015590	✓✓ 4)	✓✓
D	Horizontal orientation, transmitter head at side	 A0015592	✓✓	✓✓

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 (EF200W-C) 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

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)

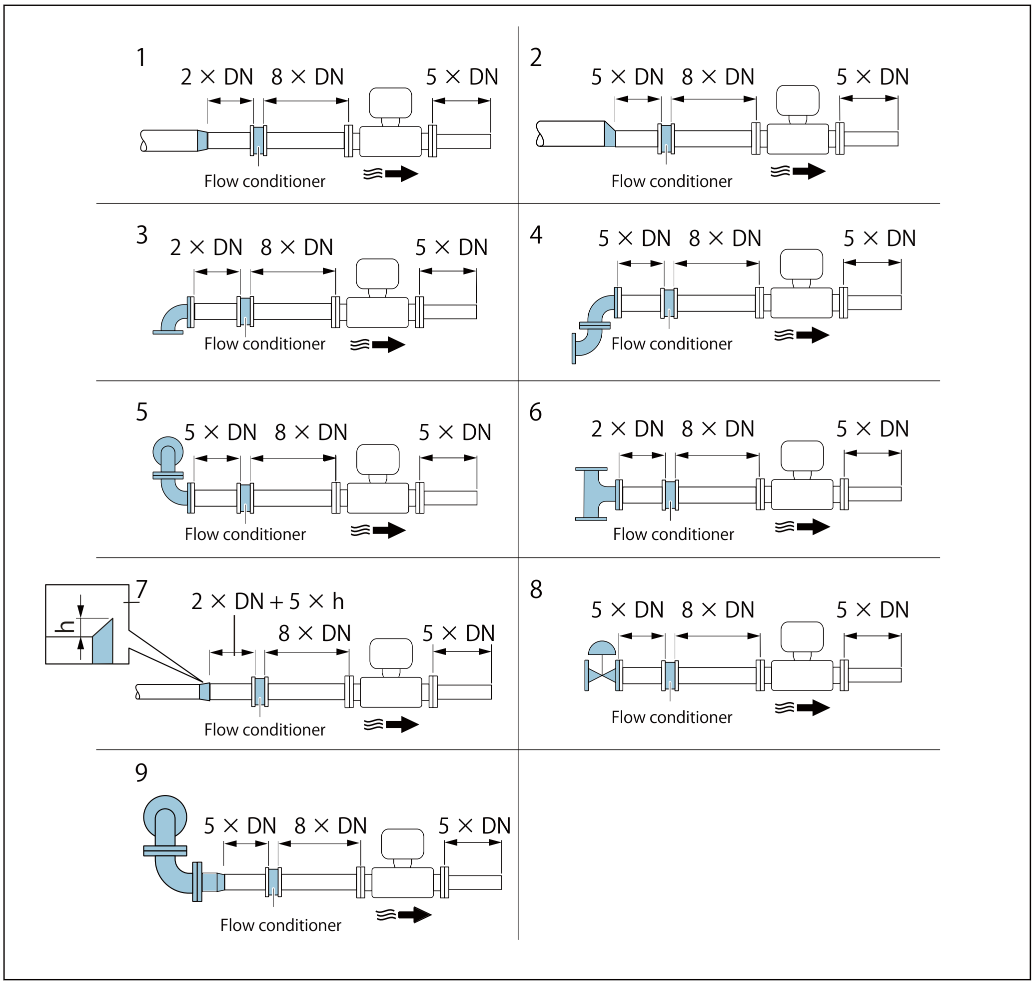
1 Concentric reducer
2 Eccentric reducer
3 Single elbow (90° elbow)
4 Double elbow (2 × 90° elbows, opposite, on one plane)
5 Double elbow 3D (2 × 90° elbows, opposite, not on one plane)
6 T-piece
7 Expansion
8 Control valve
9 Two measuring devices in a row where DN ≤ 25 (1"): directly flange on flange
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

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] = $0.0085 \cdot \rho$ [kg/m³] $\cdot v^2$ [m/s]

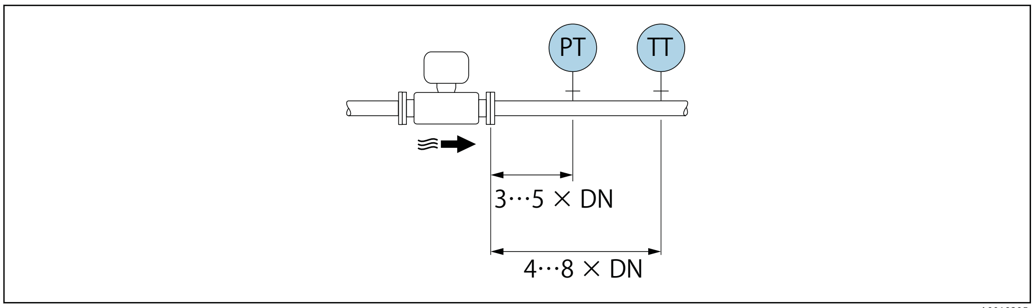
Example for steam	Example for2 H_2O condensate (80 ° C)
p = 10 bar abs.	$\rho = 965$ kg/m³
t = 240 ° C → $\rho = 4.39$ kg/m³	v = 2.5 m/s
v = 40 m/s	$\Delta p = 0.0085 \cdot 965 \cdot 2.5^2 = 51.3$ mbar
$\Delta p = 0.0085 \cdot 4.394.39 \cdot 40^2 = 59.7$ mbar	

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

A specially designed flow conditioner is available from TLV. → See page 37

Outlet runs when installing external devices

If installing an external device, observe the specified distance.



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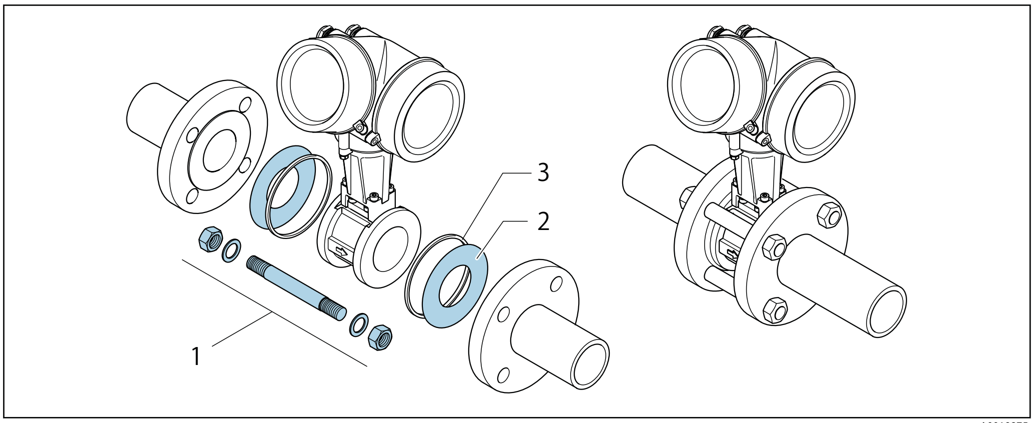
PT Pressure
TT Temperature device

Mounting kit for disc (wafer version)

The centering rings supplied are used to mount and center the wafer-style devices.

A mounting kit comprises:
- Tie rods
- Seals
- Nuts
- Washers



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Mounting kit for wafer version

1 Nut, washer, tie rod
2 Seal
3 Centering ring (is supplied with the measuring device)

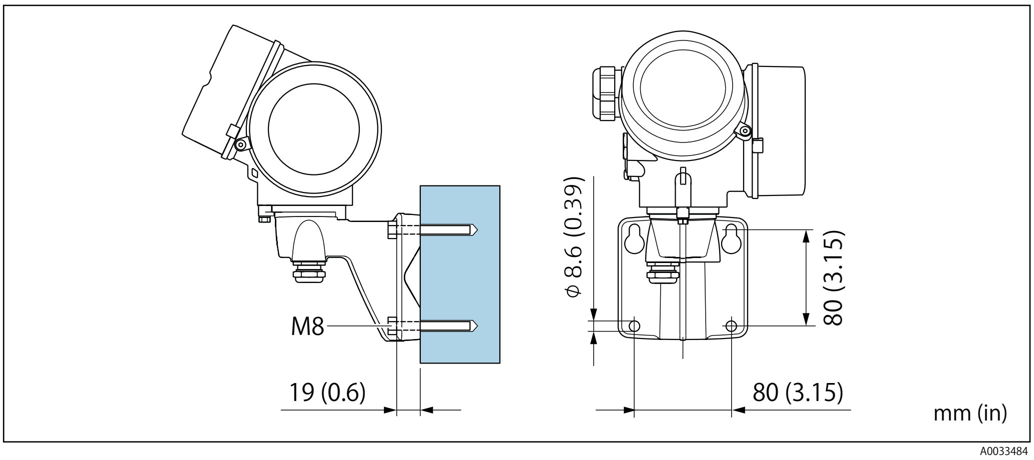
Length of connecting cable

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.

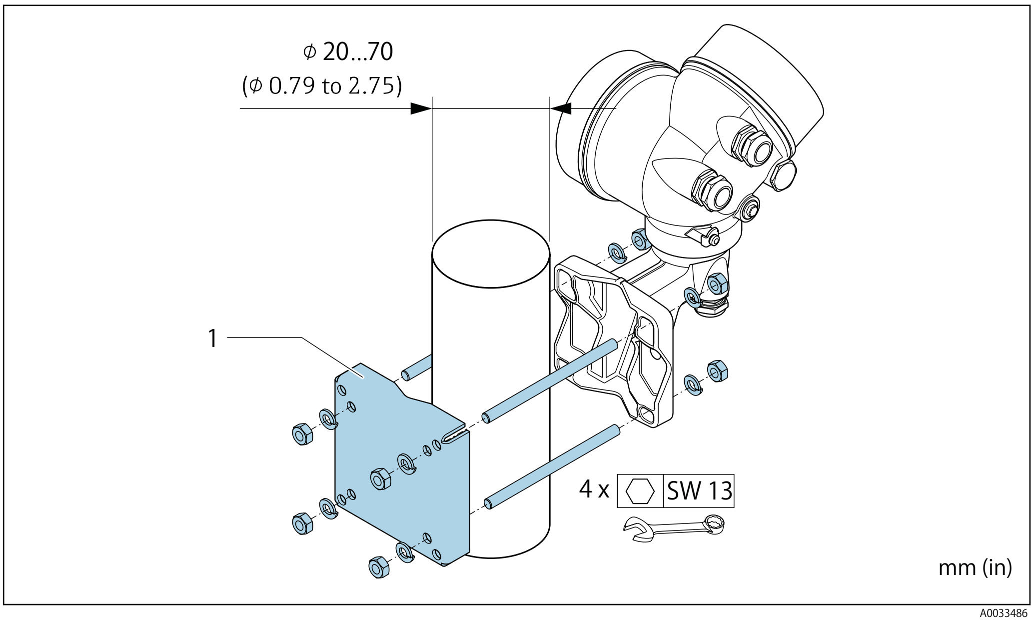
For detailed information about calculating the length of the connecting cable, refer to the Operating Instructions

Mounting the transmitter housing

Wall mounting



Post mounting



1 Mounting kit for 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)

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)

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

–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 range
Mass; 316L; 316L	–200 to +400 °C (–328 to +750 ° F), stainless steel

1) Capacitance sensor

Seals

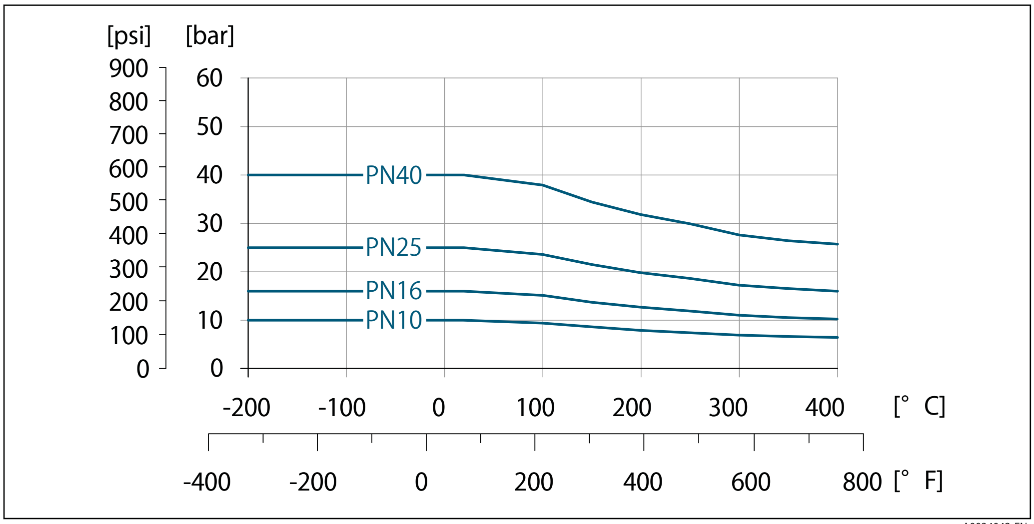
Description	Medium temperature range
Graphite (standard)	–200 to +400 ° C (–328 to +752 ° F)

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.

Wafer flange for pressure ratings according to EN 1092-1, material group 13E0



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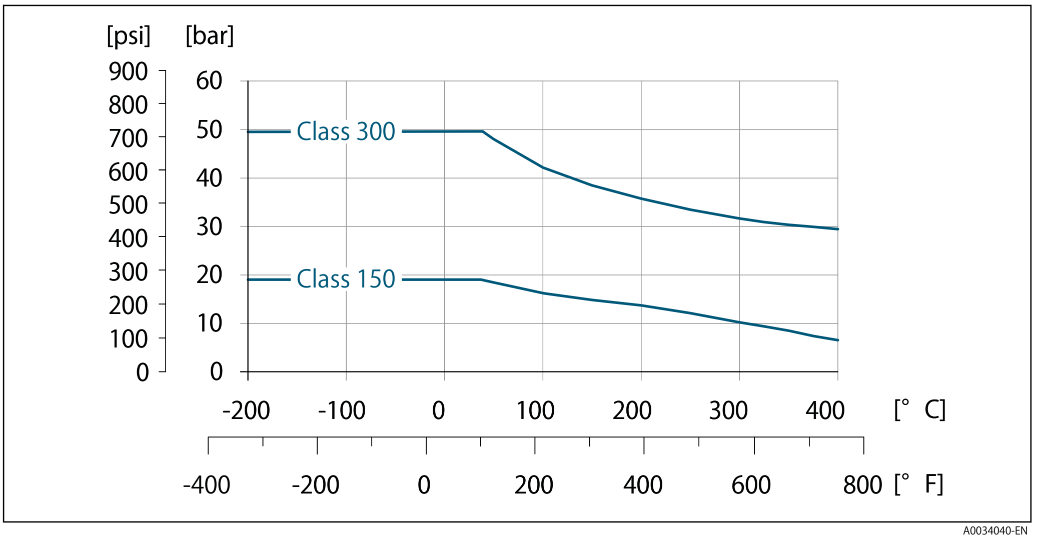
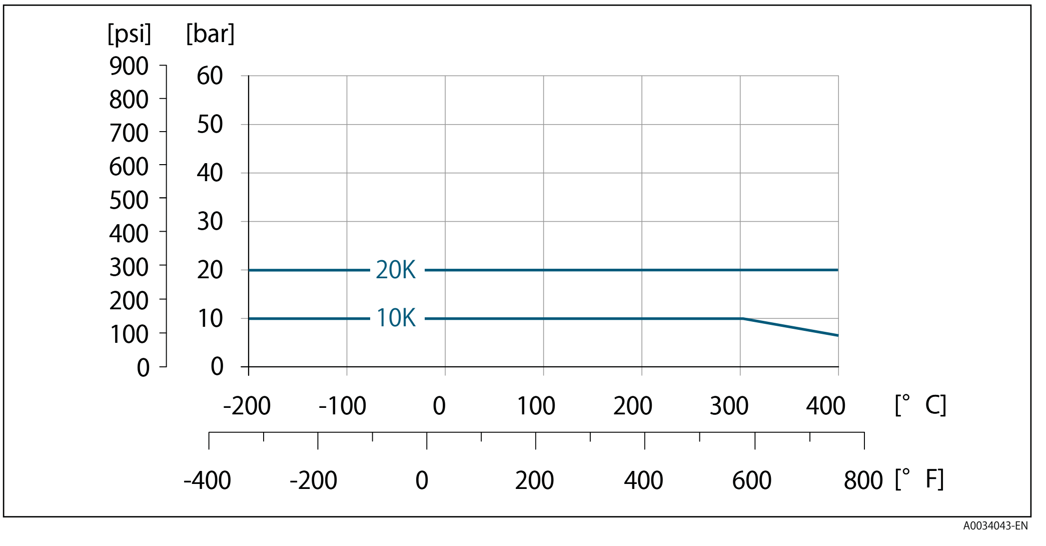
Material: stainless steel, CF3M/1.4408

Wafer flange for pressure ratings according to ASME B16.5, material group 2.2



Material: stainless steel, CF3M/1.4408

Wafer flange for connection to flanges according to JIS B2220



Material: stainless steel, CF3M/1.4408

Nominal pressure of sensor

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

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

Pressure loss

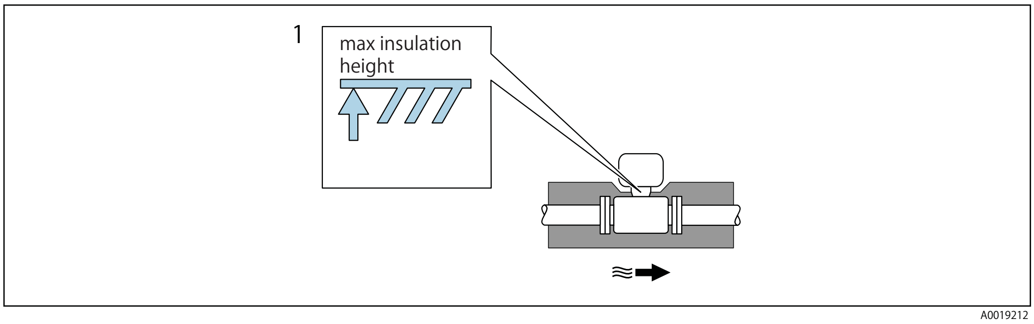
Consult TLV for a precise calculation.

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

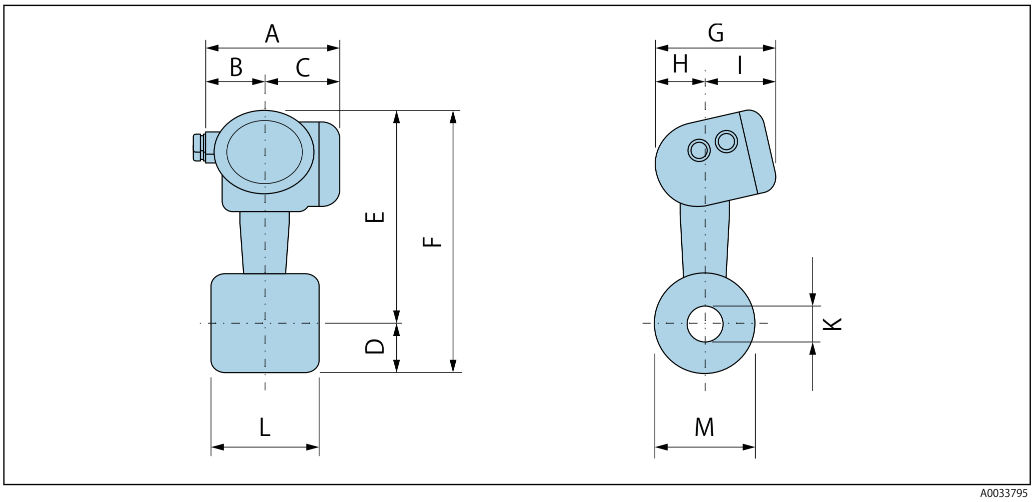
► When insulating, ensure that a sufficiently large area of the housing support remains exposed.

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

Mechanical construction

Dimensions in SI units

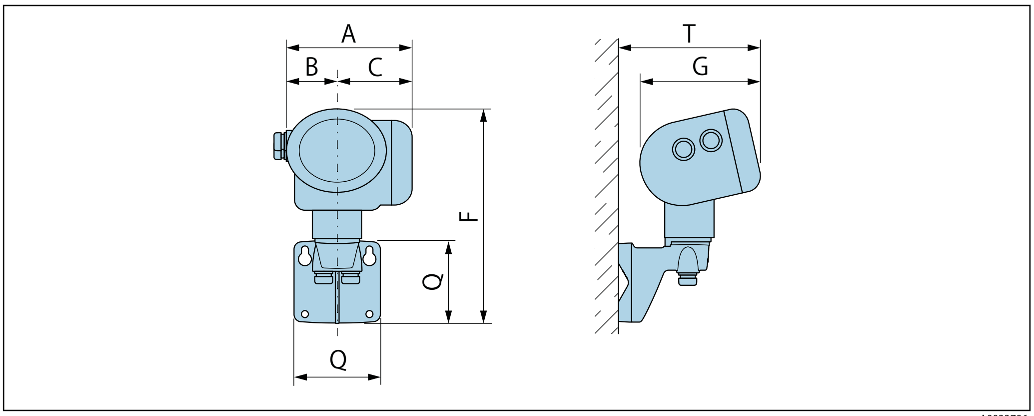
Compact version



Wafer flange according to: • EN 1092-1-B1 (DIN 2501): PN 10/16/25/40 • ASME B16.5: Class 150/300, Schedule 40 • JIS B2220: 10/20K, Schedule 40 1.4404/F316/F316L												
DN [mm]	A [1)] [mm]	B [mm]	C [1)] [mm]	D [mm]	E [2)] [mm]	F [2)] [mm]	G [mm]	H [mm]	I [mm]	K (D_i) [mm]	L [3)] [mm]	M [mm]
15 [4)]	140.2	51.7	88.5	23.4	252.5	275.9	159.9	58.2	101.7	16.5	65	45
25 [4)]	140.2	51.7	88.5	32.4	262.0	294.4	159.9	58.2	101.7	27.6	65	64
40 [4)]	140.2	51.7	88.5	41.5	270.5	312.0	159.9	58.2	101.7	42	65	82
50	140.2	51.7	88.5	46.5	277.5	324.0	159.9	58.2	101.7	53.5	65	92
80	140.2	51.7	88.5	64.0	291.5	355.5	159.9	58.2	101.7	80.3	65	127
100 [5)]	140.2	51.7	88.5	79.1	304.0	383.1	159.9	58.2	101.7	104.8	65	157.2
100 [6)]	140.2	51.7	88.5	79.1	303.2	382.3	159.9	58.2	101.7	102.3	65	157.2
150	140.2	51.7	88.5	108.5	330.0	438.5	159.9	58.2	101.7	156.8	65	215.9

1) For version with overvoltage protection: values + 8 mm
2) For version without local display: values - 10 mm
3) ±0.5 mm
4) Not available for JIS B2220, 10K
5) EN (DIN), ASME
6) JIS

Transmitter remote version



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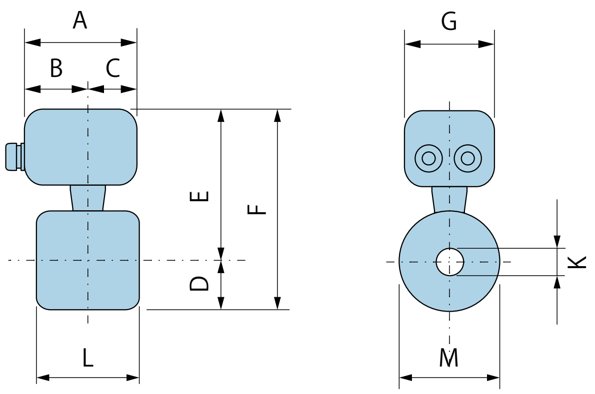
A [1] [mm]	B [mm]	C [1] [mm]	F [2] [mm]	G [3] [mm]	Q [mm]	T [3] [mm]
140.2	51.7	88.5	254	159.9	107	191

1) For version with overvoltage protection: value + 8 mm
2) For version without local display: value - 10 mm
3) For version without local display: value - 7 mm

Sensor remote version



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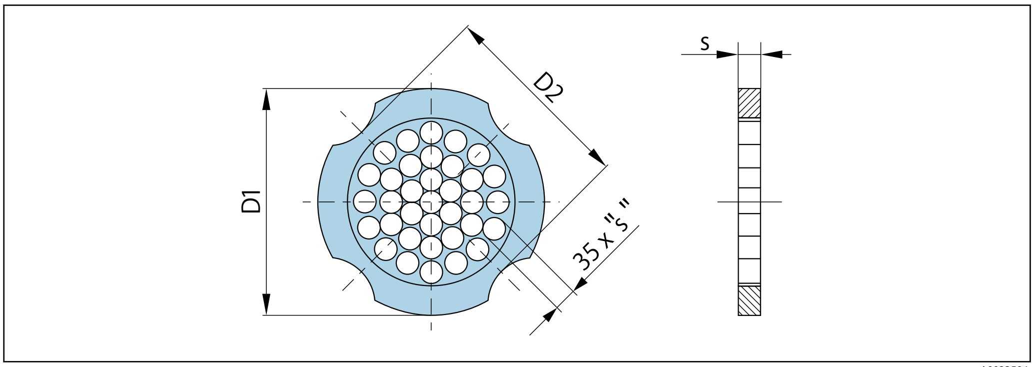
Wafer flange according to: • EN 1092-1-B1 (DIN 2501): PN 10/16/25/40 • ASME B16.5: Class 150/300, Schedule 40 • JIS B2220: 10/20K, Schedule 40 1.4404/F316/F316L										
DN [mm]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	G [mm]	K (D_i) [mm]	L [1] [mm]	M [mm]
15 [2]	107.3	60	47.3	23.4	222.8	246.2	94.5	16.5	65	45
25 [2]	107.3	60	47.3	32.4	232.3	264.7	94.5	27.6	65	64
40 [2]	107.3	60	47.3	41.5	240.8	282.3	94.5	42	65	82
50	107.3	60	47.3	46.5	247.8	294.3	94.5	53.5	65	92
80	107.3	60	47.3	64.0	261.8	325.8	94.5	80.3	65	127
100 [3]	107.3	60	47.3	79.1	274.3	353.4	94.5	104.8	65	157.2
100 [4]	107.3	60	47.3	79.1	273.5	352.6	94.5	102.3	65	157.2
150	107.3	60	47.3	108.5	300.3	408.8	94.5	156.8	65	215.9

1) ±0.5 mm
2) Not available for JIS B2220, 10K
3) EN (DIN), ASME
4) JIS

Accessories

Flow conditioner



Used in combination with flanges according to DIN EN 1092-1: PN 10 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

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

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

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

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

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

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

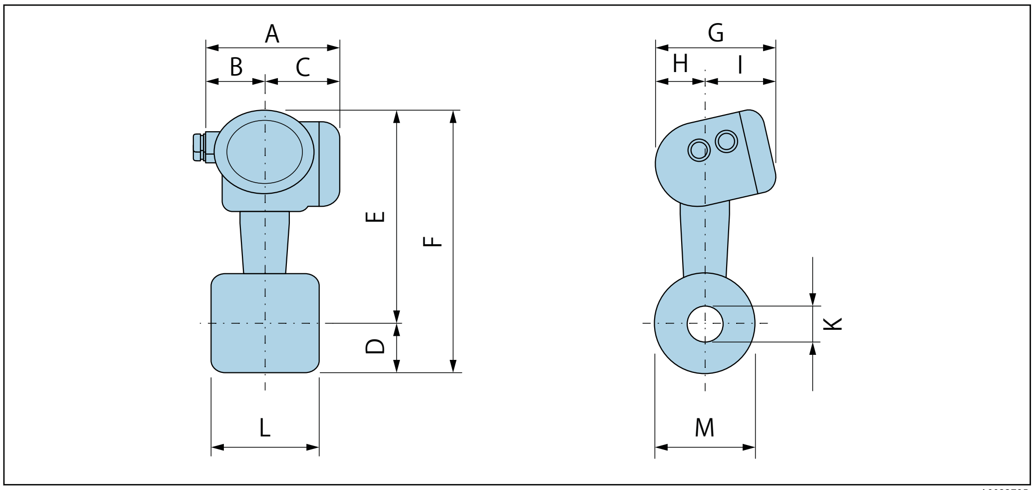
1) The flow conditioner is fitted at the outer diameter between the bolts.
2) The flow conditioner is fitted at the indentations between the bolts.

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

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.

Dimensions in US units

Compact version

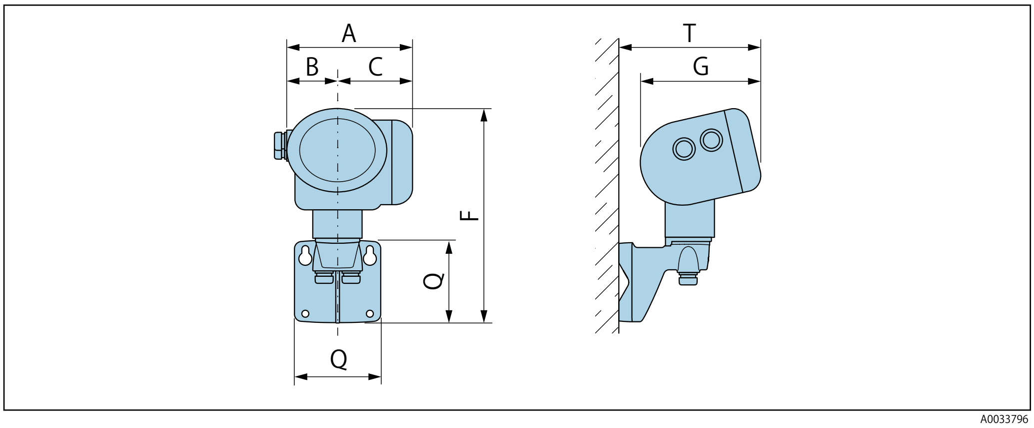


A0033795

Wafer flange according to: • EN 1092-1-B1 (DIN 2501): PN 10/16/25/40 • ASME B16.5: Class 150/300, Schedule 40 • JIS B2220: 10/20K, Schedule 40 1.4404/F316/F316L												
DN	A 1)	B	C 1)	D	E 2)	F 2)	G	H		K (D_i)	L 3)	M
[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]
½	5.52	2.04	3.48	0.92	9.94	10.9	6.3	2.29	4	0.65	2.56	1.77
1	5.52	2.04	3.48	1.28	10.3	11.6	6.3	2.29	4	1.09	2.56	2.52
1 ½	5.52	2.04	3.48	1.63	10.6	12.3	6.3	2.29	4	1.65	2.56	3.23
2	5.52	2.04	3.48	1.83	10.9	12.8	6.3	2.29	4	2.11	2.56	3.62
3	5.52	2.04	3.48	2.52	11.5	14	6.3	2.29	4	3.16	2.56	5
4	5.52	2.04	3.48	3.11	12	15.1	6.3	2.29	4	4.13	2.56	6.19
6	5.52	2.04	3.48	4.27	13	17.3	6.3	2.29	4	6.17	2.56	8.5

1) For version with overvoltage protection: values + 0.31 in
2) For version without local display: values - 0.39 in
3) ±0.02 in

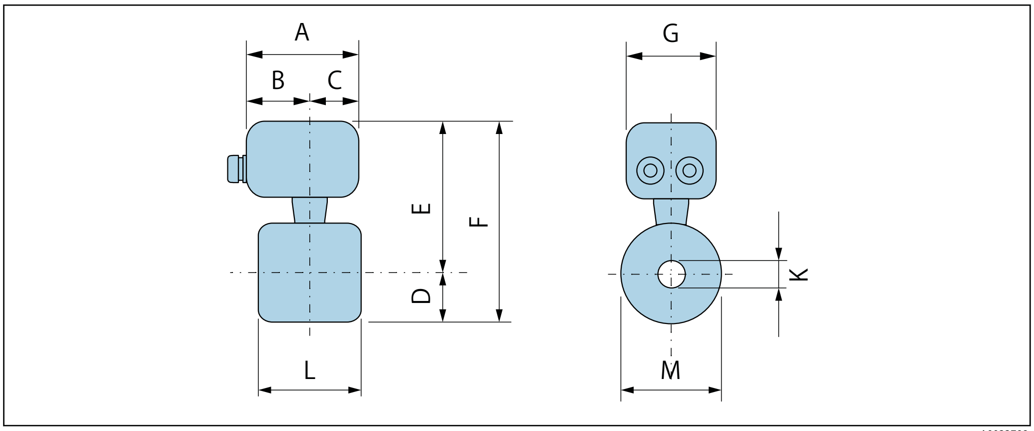
Transmitter remote version



A 1) [in]	B [in]	C 1) [in]	F 2) [in]	G 3) [in]	Q [in]	T 3) [in]
5.52	2.04	3.48	10	6.3	4.21	7.52

1) For version with overvoltage protection: value + 0.31 in
2) For version without local display: value - 0.39 in
3) For version without local display: value - 0.28 in

Sensor remote version



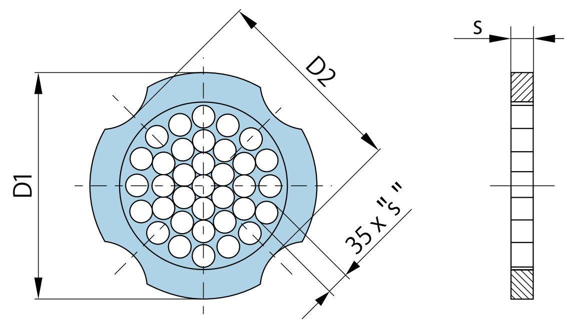
A0033798

Wafer flange according to: • EN 1092-1-B1 (DIN 2501): PN 10/16/25/40 • ASME B16.5: Class 150/300, Schedule 40 • JIS B2220: 10/20K, Schedule 40 1.4404/F316/F316L										
DN [in]	A [in]	B [in]	C [in]	D [in]	E [in]	F [in]	G [in]	K (D_i) [in]	L [1)] [in]	M [in]
½	4.22	2.36	1.86	0.92	8.77	9.69	3.72	0.65	2.56	1.77
1	4.22	2.36	1.86	1.28	9.15	10.4	3.72	1.09	2.56	2.52
1 ½	4.22	2.36	1.86	1.63	9.48	11.1	3.72	1.65	2.56	3.23
2	4.22	2.36	1.86	1.83	9.76	11.6	3.72	2.11	2.56	3.62
3	4.22	2.36	1.86	2.52	10.3	12.8	3.72	3.16	2.56	5
4	4.22	2.36	1.86	3.11	10.8	13.9	3.72	4.13	2.56	6.19
6	4.22	2.36	1.86	4.27	11.8	16.1	3.72	6.17	2.56	8.5

1) ±0.02 in

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

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

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.

Weight

Compact version

Weight data:
- Including the transmitter:

  1.8 kg (4.0 lb):

- Excluding packaging material

Weight in SI units

DN [mm]	Weight [kg]
	Aluminum, coated, compact"
15	3.1
25	3.3
40	3.9
50	4.2
80	5.6
100	6.6
150	9.1

Weight in US units

DN [in]	Weight [lbs]
	Auminum, coated, compact"
½	6.9
1	7.4
1½	8.7
2	9.4
3	12.4
4	14.6
6	20.2

Transmitter remote version

Wall-mount housing

- 2.4 kg (5.2 lb)

Sensor remote version

Weight data:
- Including sensor connection housing:
  - 0.8 kg (1.8 lb)
- Excluding the connecting cable
- Excluding packaging material

Weight in SI units

DN [mm]	Weight [kg]
	Aluminum, coated, remote
15	2.1
25	2.3
40	2.9
50	3.2
80	4.6
100	5.6
150	8.1

Weight in US units

DN [in]	Weight [lbs]
	Aluminum, coated, remote
½	4.5
1	5.0
1½	6.3
2	7.0
3	10.0
4	12.3
6	17.3

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

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

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

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

1) ASME

Materials

Transmitter housing

Compact version

- Aluminum, AlSi10Mg, coated
- Window material: glass

Remote version

- Aluminum, AlSi10Mg, coated
- Window material: glass

Cable entries/cable glands

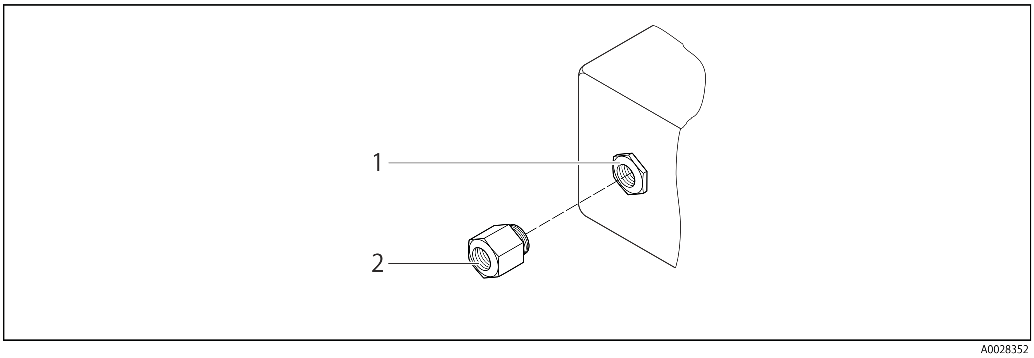


Fig. 19 Possible cable entries/cable glands

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

Sensor connection housing

Aluminum, AlSi10Mg

Measuring tubes

DN 15 to 150 (½ to 6"), pressure ratings PN 10/16/25/40, Class 150/300 , as well as JIS 10K/20K:
Stainless cast steel, CF3M/1.4408
Compliant with:
- NACE MR0175
- NACE MR0103

DSC sensor

Pressure ratings PN 10/16/25/40, Class 150/300, as well as JIS 10K/20K:
Parts in contact with medium (marked as "wet" on the DSC sensor flange):
- 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)

Seals

- Graphite (standard)
  Sigraflex foil™ (BAM-tested for oxygen applications, "high-grade in the context of TA-Luft Clean Air Guidelines")

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

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.

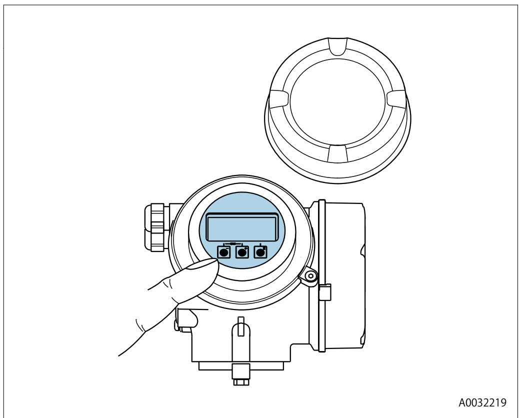
Efficient diagnostics increase measurement availability
- Troubleshooting measures can be called up via the device and in the operating tools
- Diverse simulation options, logbook for events that occur and optional line recorder functions

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



1 Operation with pushbuttons

Display elements

- 4-line, illuminated, graphic display
- White background lighting; switches to red in event of device errors
- 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: ⊕, ⊖, Ⓔ

Additional functionality

- Data backup function
  The device configuration can be saved in the display module.
- Data comparison function
  The device configuration saved in the display module can be compared to the current device configuration.
- Data transfer function
  The transmitter configuration can be transmitted to another device using the display module.

Remote operation

Via HART protocol

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

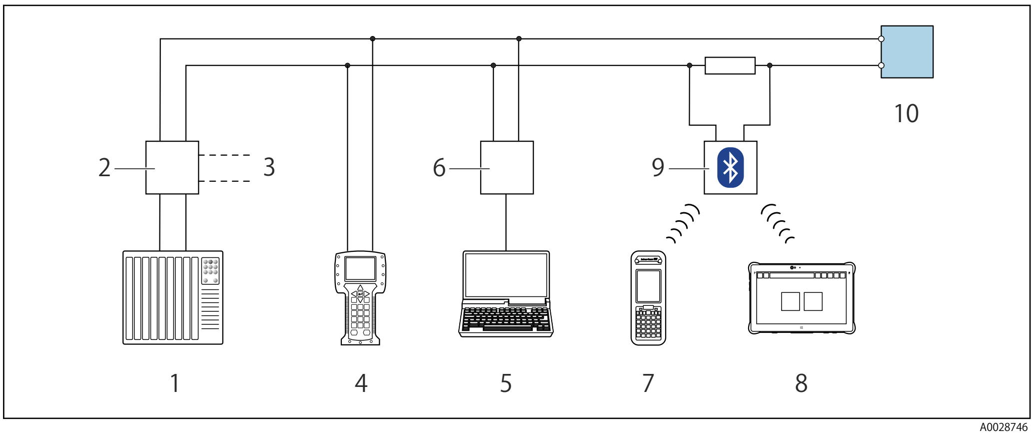


Fig. 21 Options for remote operation via HART protocol (passive)

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. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
C-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

Standard documentation

Brief Operating Instructions

Brief Operating Instructions for the sensor

Measuring device	Documentation code
EF200-C	172-65765

Operating Instructions

Measuring device	Documentation code
EF200W-C	172-65761

Description of Device Parameters

Measuring device	Documentation code
EF200-C	172-65764

Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, Texas, USA

Product Warranty

1. Warranty Period
   One year following product delivery.
2. Warranty Coverage
   TLV CO., LTD. warrants this product to the original purchaser to be free from defective materials and workmanship. Under this warranty, the product will be repaired or replaced at our option, without charge for parts or labor.
3. This product warranty will not apply to cosmetic defects, nor to any product whose exterior has been damaged or defaced; nor does it apply in the following cases:
   1) Malfunctions due to improper installation, use, handling, etc., by other than TLV CO., LTD. authorized service representatives.
   2) Malfunctions due to dirt, scale, rust, etc.
   3) Malfunctions due to improper disassembly and reassembly, or inadequate inspection and maintenance by other than TLV CO., LTD. authorized service representatives.
   4) Malfunctions due to disasters or forces of nature.
   5) Accidents or malfunctions due to any other cause (such as water hammer) beyond the control of TLV CO., LTD.
4. Under no circumstances will TLV CO., LTD. be liable for consequential economic loss damage or consequential damage to property.

Service

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