



VERSAFLOW VORTEX Handbook

Vortex flowmeter

Honeywell

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While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer to determine the suitability of the product in the application.

Honeywell Field Solutions
512 Virginia Drive
Fort Washington, PA 19034

Abstract

This document provides descriptions and procedures for the Installation, Configuration, Operation, and Troubleshooting of your device.

Contacts

World Wide Web:

The following lists Honeywell’s World Wide Web sites that will be of interest to our customers.

Honeywell Organization

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WWW Address (URL)

<http://www.honeywell.com>
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Contact us by telephone at the numbers listed below.

Organization

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Tech. Support: 1-800-423-9883
Service: 1-800-525-7439

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1.1 Intended use

The vortex flowmeters are made to measure the flow of gases, vapours and liquids.

The devices are particularly suitable for the measurement of:

- Clean liquids with low viscosity (< 10 cP)
- Hydrocarbons with low viscosity (< 10 cP)
- Water
- Chemicals with low corrosiveness
- Saturated steam
- Superheated steam, including CIP and SIP applications in the food industry
- Industrial gases

The devices are rated for the following flow velocities:

- Liquids: 0.3...7 m/s / 1.0...23 ft/s
- Gases and steam: 2.0...80 m/s / 6.6...262 ft/s
DN15: 3.0...45 m/s / 9.8...148 ft/s; DN25: 2.0...70 m/s / 6.6...230 ft/s

If the danger of waterhammers can occur in steam networks appropriate condensate separators have to be installed.

Suitable measures must be taken to avoid water cavitation if it is a possible risk.



CAUTION!

Responsibility for the use of the measurement devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

- The sensors are made from Stainless Steel 316 L (1.4404) or Hastelloy® C22.
- In your project planning, please observe the data given in the corrosion tables.
- The pressure-bearing parts have been designed and rated for stationary operation taking into account the maximum pressure and temperature.
- Observe the data indicated on the nameplate for PS, TS and PT (PED 97/23/EC).
- External forces and moments, caused e.g. by pipe stresses, have not been taken into account.

Primarily, volumetric flow and temperature are measured, with pressure measurement as an option. From these parameters the measuring device calculates the mass flow or standard volumetric flow using pre-programmed density data and then exports the measured values via various communication interfaces.

1.2 Certifications

CE marking



The device fulfils the statutory requirements of the following EC directives:

- Pressure Equipment Directive 97/23/EC
- EMC Directive 2004/108/EC

as well as

- EN 61010
- EMC specification acc. to EN 61326/A1
- NAMUR recommendations NE 21 and NE 43

The manufacturer certifies successful testing of the product by applying the CE marking.

1.3 Safety instructions from the manufacturer

1.3.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

The contents and works in this document are subject to copyright. Contributions from third parties are identified as such. Reproduction, processing, dissemination and any type of use beyond what is permitted under copyright requires written authorisation from the respective author and/or the manufacturer.

The manufacturer tries always to observe the copyrights of others, and to draw on works created in-house or works in the public domain.

The collection of personal data (such as names, street addresses or e-mail addresses) in the manufacturer's documents is always on a voluntary basis whenever possible. Whenever feasible, it is always possible to make use of the offerings and services without providing any personal data.

We draw your attention to the fact that data transmission over the Internet (e.g. when communicating by e-mail) may involve gaps in security. It is not possible to protect such data completely against access by third parties.

We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.3.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect or incidental and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.3.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation and operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.3.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of underneath icons.

1.3.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.



DANGER!

This information refers to the immediate danger when working with electricity.



DANGER!

This warning refers to the immediate danger of burns caused by heat or hot surfaces.



DANGER!

This warning refers to the immediate danger when using this device in a hazardous atmosphere.



DANGER!

These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.



WARNING!

Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.



CAUTION!

Disregarding these instructions can result in damage to the device or to parts of the operator's plant.



INFORMATION!

These instructions contain important information for the handling of the device.



LEGAL NOTICE!

This note contains information on statutory directives and standards.



• **HANDLING**

This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➡ **RESULT**

This symbol refers to all important consequences of the previous actions.

1.4 Safety instructions for the operator



WARNING!

*In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.
This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.*

2.1 Scope of delivery



INFORMATION!

Inspect the cartons carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.



INFORMATION!

Do a check of the packing list to make sure that you have all the elements given in the order.



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

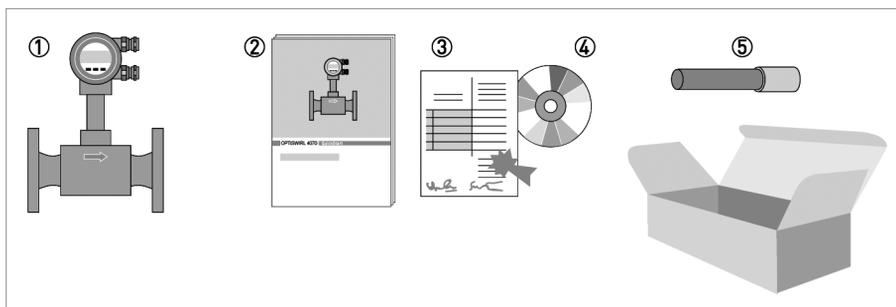


Figure 2-1: Scope of delivery

- ① Measuring device in ordered version
- ② Quick Start
- ③ Certificates, calibration report and parameter datasheet
- ④ CD with complete documentation
- ⑤ Bar magnet

2.2 Device versions

The devices are delivered in the following variants:

- Signal converter with display
- Flange Version, Sensor: F
- Sandwich version, Sensor: S
- Remote version - Sensor with on-site remote converter

The following designs are available as options:

- with pressure sensor
- with shut-off valve for the pressure sensor
- Flange version with single reduction, Sensor: FR
- Flange version with double reduction, Sensor: F2R

2.2.1 Devices with connection flange

The measuring system consists of a measuring sensor and a signal converter. These elements form a permanent mechanical unit.

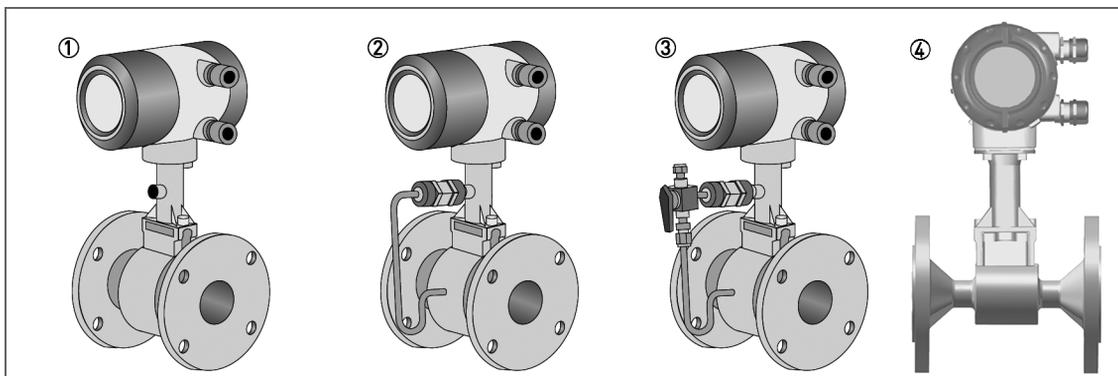


Figure 2-2: Flanged devices with display

- ① Version with temperature sensor
- ② Version with temperature sensor and optional pressure sensor
- ③ Version with temperature sensor, optional pressure sensor and shut-off valve
- ④ Version flange-sensor with inlet reduction

2.2.2 Sandwich version

The sandwich version features 2 centring rings to aid with installation.

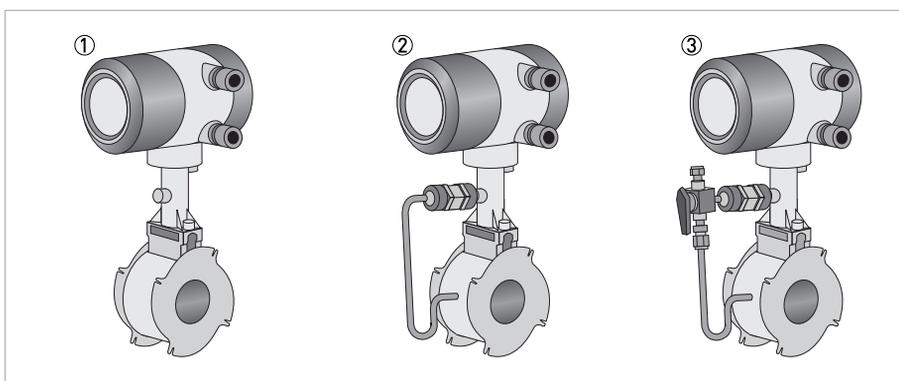
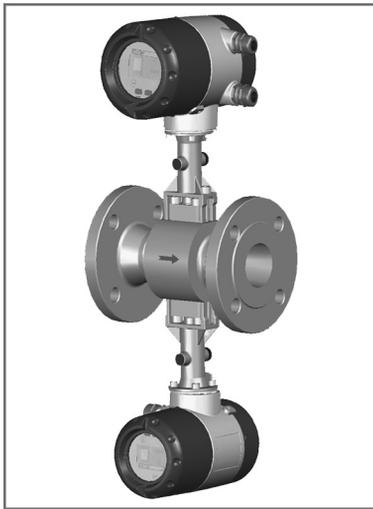


Figure 2-3: Sandwich versions with display

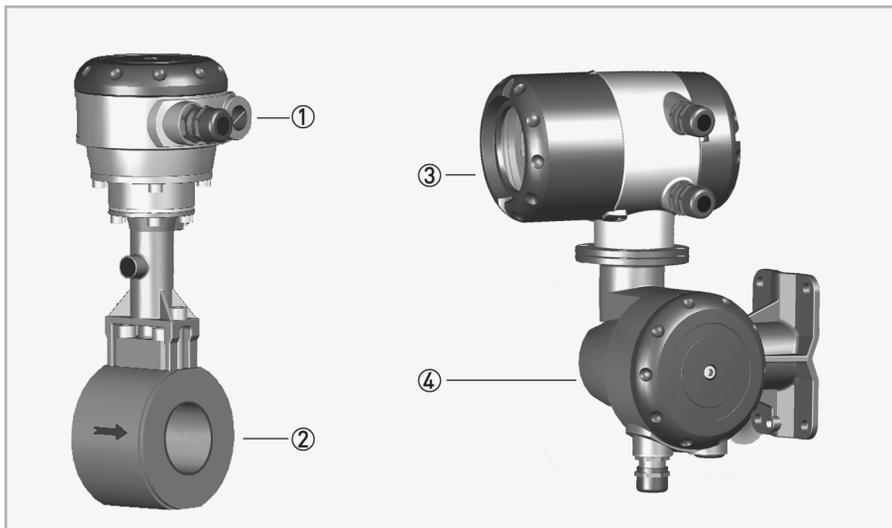
- ① Version with temperature sensor
- ② Version with temperature sensor and optional pressure sensor
- ③ Version with temperature sensor, optional pressure sensor and shut-off valve

2.2.3 Devices for dual measurement and twofold reliability



This is a genuine redundant system with two independent measuring sensors and two signal converters. This provides twofold functional reliability and availability of the measurement. This variant is ideally suited for measurements in multi-product pipelines. In such pipelines, two different products are moved through one after the other. One signal converter can be programmed for one product, and the other signal converter for the other product.

2.2.4 Device version remote



- ① Sensor terminal box
- ② Sensor
- ③ Signal converter
- ④ Wall mount bracket connection box

With the remote variant, sensors and converters are separate. The 10-pin, shielded connection cable may not exceed 15m in length.

2.2.5 Device description

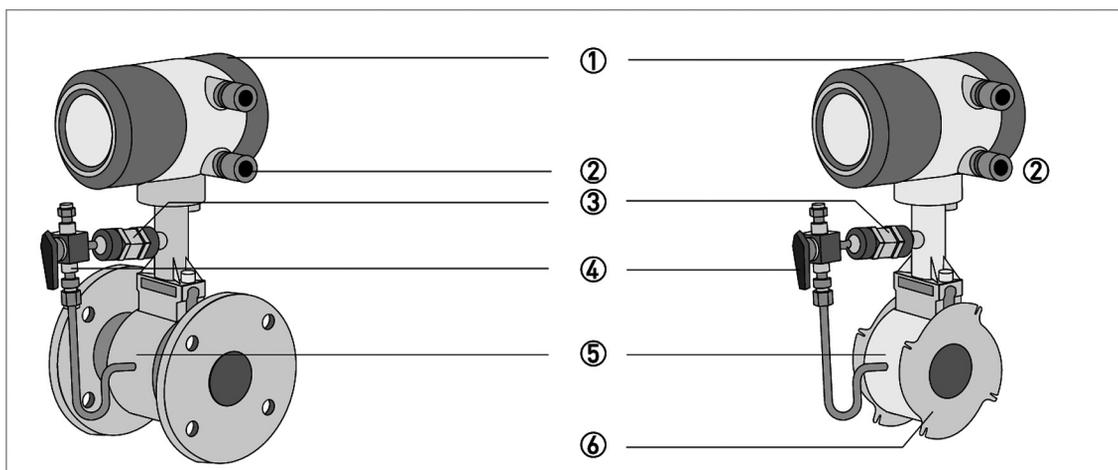


Figure 2-4: Device description

- ① Signal converter
- ② Cable feedthrough grey, standard version
- ③ Pressure sensor, optional
- ④ Shut-off valve, optional
- ⑤ Measuring sensor
- ⑥ Centering ring

2.2.6 Free air delivery measurement - FAD (optional)

A (air) compressor draws air from the ambient atmosphere, compresses it and delivers it at the required pressure. Since the ambient atmosphere also contains water vapour, what the compressor draws in is a mixture of air and water vapour. Free air delivery measurement is to be understood under this condition. Most manufacturers specify free air delivery only at standard intake conditions. What the user ultimately requires as process air must first be determined before measuring can take place with an accuracy of $\pm 1\%$.

The vortex flowmeter with the optional FAD function can measure the free air delivery online, humidity and speed compensated, regardless of its function as standard flowmeter. The integrated software evaluates the free air delivery automatically online.

The menu-driven, user-friendly software prompts the operator to enter the pressure, relative humidity, the required as well as current discharge pressure.

The steam tables and compressibility tables are saved as standard. The measuring device is optionally available with a pressure sensor which measures the discharge pressure online, making manual input of the values unnecessary.

2.2.7 Gross heat meter

In almost all applications with saturated steam, the steam is used for heating. It is much more interesting to know how great the heat flow volume is that is available to the process, than to know how great the flow is in kg/h.

As the enthalpy of steam changes with the temperature, it cannot be assumed as a constant. The vortex flowmeter has a special feature that can calculate the flow of vapour and water as power output. The enthalpy tables are permanently programmed in the memory of the device.

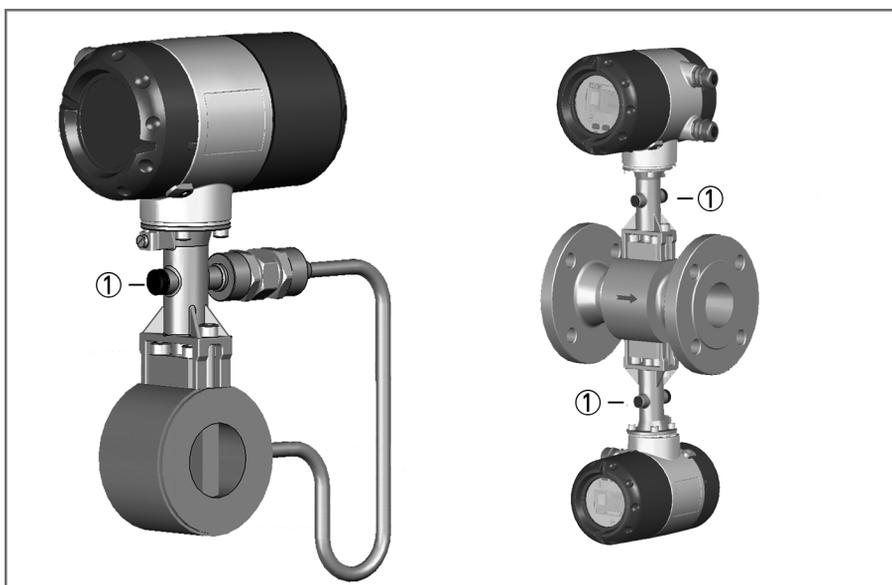
The online density-compensated mass flow is multiplied by the correct enthalpy to obtain the flow as power output.

Power $\{Q_H\}$ = mass flow $[Q_m]$ x enthalpy $[H]$

If the gross heat meter is activated, both the totalizer for the absolute steam consumption as well as that for the energy run internally.

2.2.8 Dual seal

To cover the requirements of ANSI/ISA-12.27.01-2003 “Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluid” Dual seal, a membrane vent is integrated in the neck of the instrument. This vent works in the improbable case of a leakage as an annunciation valve between the primary seal (Process) and secondary seal (electronic compartment).



① Annunciation valve (Membrane vent)

The sealing between the pick-up and the Flow tube is considered as the primary seal. Its construction material is always the same as the Flow tube itself (e.g. Stainless steel 316L or Hastelloy C22). Chemicals used for the process, going through the Flow tube, must be compatible with the designated material.

By using the membrane vent as annunciation valve, all requirements for a dual seal device in accordance to above mentioned standard, are fulfilled.

- It protects the electronic compartment against access by process media, due to possible leakages.
- The leakage of the primary seal is visible.

Regular maintenance should be performed by the customer to ensure this Dual Seal notification system is working properly or that there is no leak.

If a leakage is noticed:

The manufacturer service should be contacted for servicing or replacement of the meter.

3.1 Notes on installation



INFORMATION!

Inspect the cartons carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.



INFORMATION!

Do a check of the packing list to make sure that you have all the elements given in the order.



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2 Storage

- Store the device in a dry and dust-free location.
- Avoid extended direct exposure to the sun.
- Store the device in its original packing.
- The permissible storage temperature for standard devices is -40...+80°C / -40...+176°F.

3.3 Transport

- Use lifting straps wrapped around both process connections for transport.
- Do not lift measuring devices by the signal converter housing for transport.
- Never lift the measuring device by the pressure sensor.
- Do not use lifting chains as they may damage the housing.

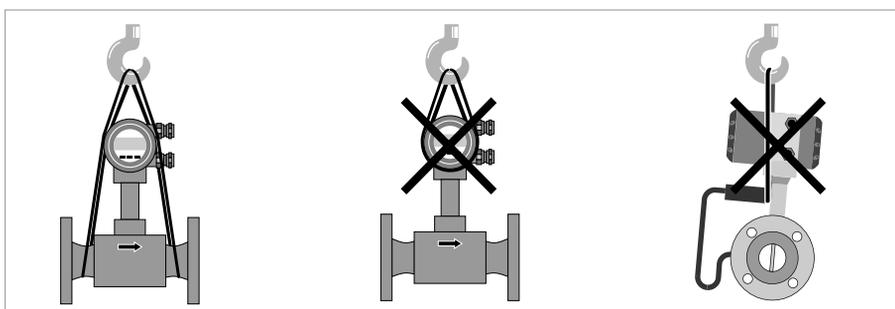


Figure 3-1: Transport instructions



CAUTION!

Non-secured devices can pose risk of injury. The centre of mass of the device is often higher than the point at which the lifting straps are attached. Prevent the measuring device from sliding or rotating accidentally.

3.4 Installation conditions

**INFORMATION!**

For accurate volumetric flow measurement the measuring device needs a completely filled pipe and a fully developed flow profile.

Please observe the instructions regarding inlet and outlet pipe runs as well as the installation position.

In the event of vibrations on the piping, select the installation site so that the vibrations are at their lowest in a transverse direction to the flowmeter.

**CAUTION!**

When installing the device in the piping, the following points must be observed:

- *Nominal diameter of connection pipe flange = nominal flange diameter of pipe!*
- *Use flanges with smooth holes, e.g. welding neck flanges.*
- *Align carefully the holes of the connecting flange and the flowmeter flange.*
- *Check the compatibility of the gasket material with the process product.*
- *Make sure that the gaskets are arranged concentrically. The flange gaskets must not project into the pipe cross-section.*
- *The flanges have to be concentric.*
- *There must not be any pipe bends, valves, flaps or other internals in the immediate inlet run.*
- *Devices in sandwich version may only be installed using a centering ring.*
- *Never install the device directly behind piston compressors or rotary piston meters.*
- *Do not lay signal cables directly next to cables for the power supply.*

**INFORMATION!**

If the danger of waterhammers can occur in steam networks appropriate condensate separators have to be installed.

Suitable measures must be taken to avoid water cavitation if it is a possible risk.

3.4.1 Measurement of liquids

Prohibited installation

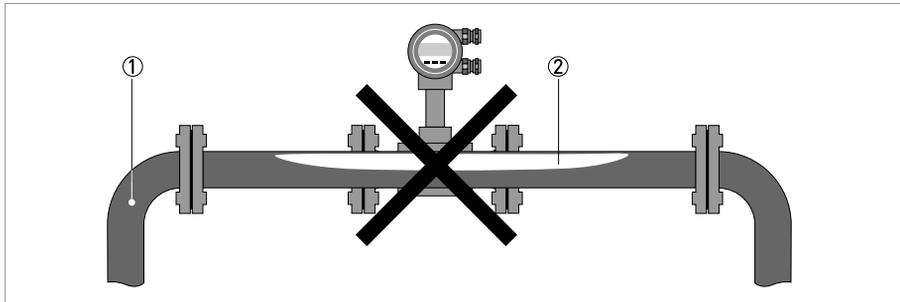


Figure 3-2: Upper pipe bend



CAUTION!

Prohibited: Installing the device in an upper pipe bend ①, because there is a risk of gas bubbles ② forming. Gas bubbles can lead to pressure surges and inaccurate measurement.

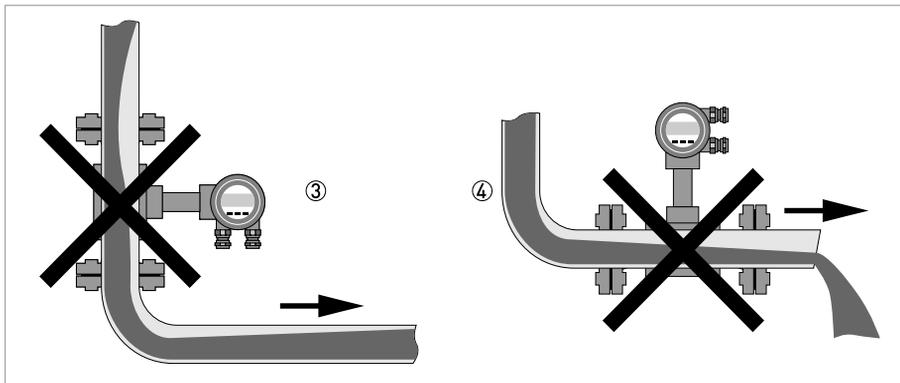


Figure 3-3: Downpipe and outlet



CAUTION!

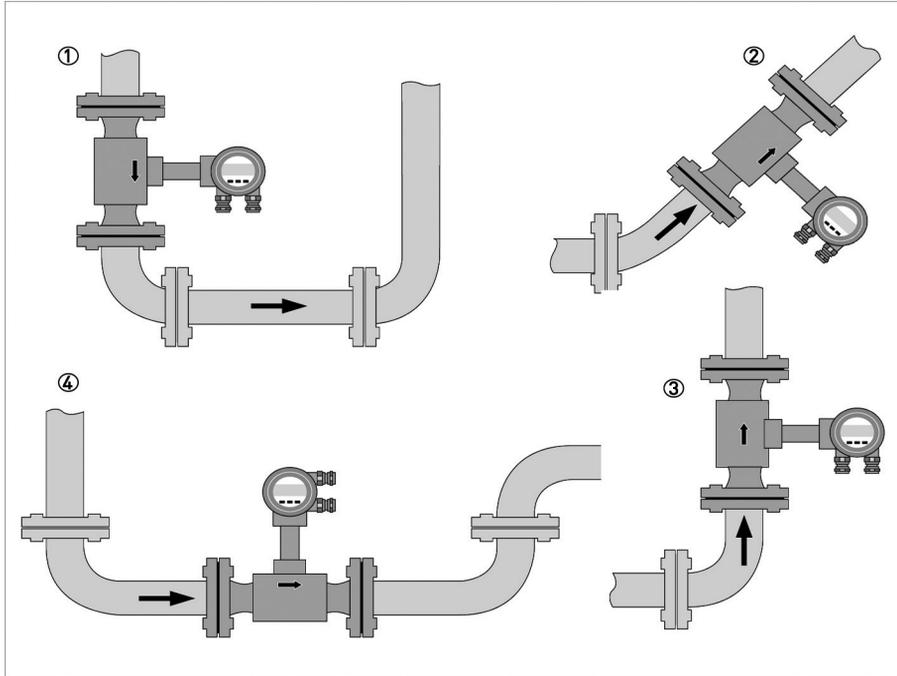
Prohibited: Installing the device in a downstream pipe ③ or upstream pipe of a outlet ④. There is the risk of partially filled pipes.

Recommended installations for measurement of liquids

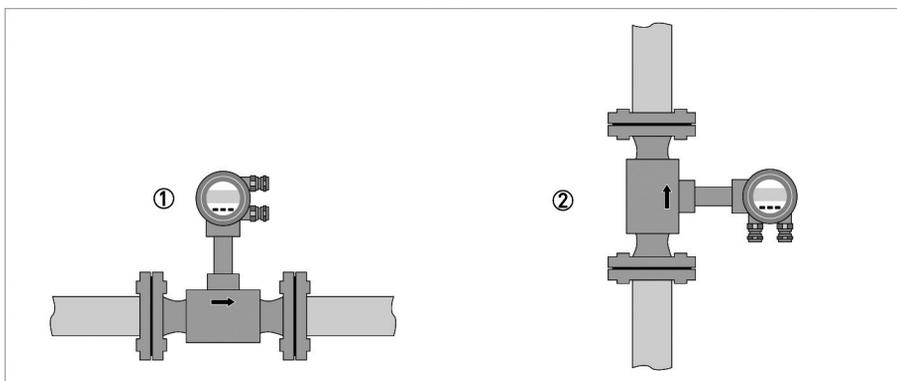


CAUTION!

It is absolutely necessary to comply with the required inlet and outlet runs.



- ① If the device is installed in a downpipe, a standpipe must be installed immediately after it.
- ② Installing the device in an inclined standpipe.
- ③ Installing the device in a vertical standpipe.
- ④ Installing the device in the lower pipe bend.



- ① Above a horizontal pipe
- ② On a vertical pipe

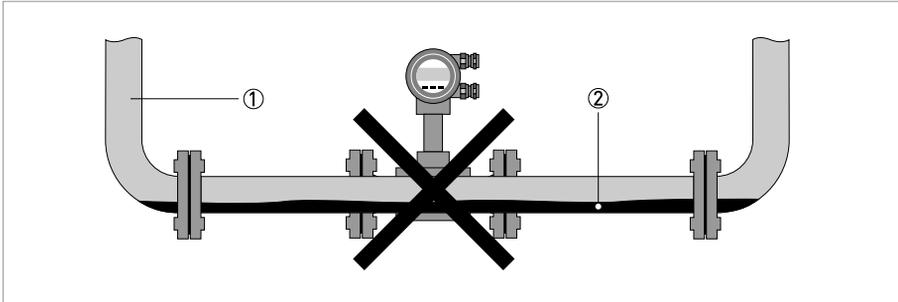


INFORMATION!

Depending on the installation position, you may have to rotate the display and/or the connection housing.

3.4.2 Measurement of vapours and gases

Prohibited installation



- ① Lower pipe bends
- ② Condensate



DANGER!

Prohibited: Installing the device in a lower pipe bend ①, because there is a risk of condensate forming ②.

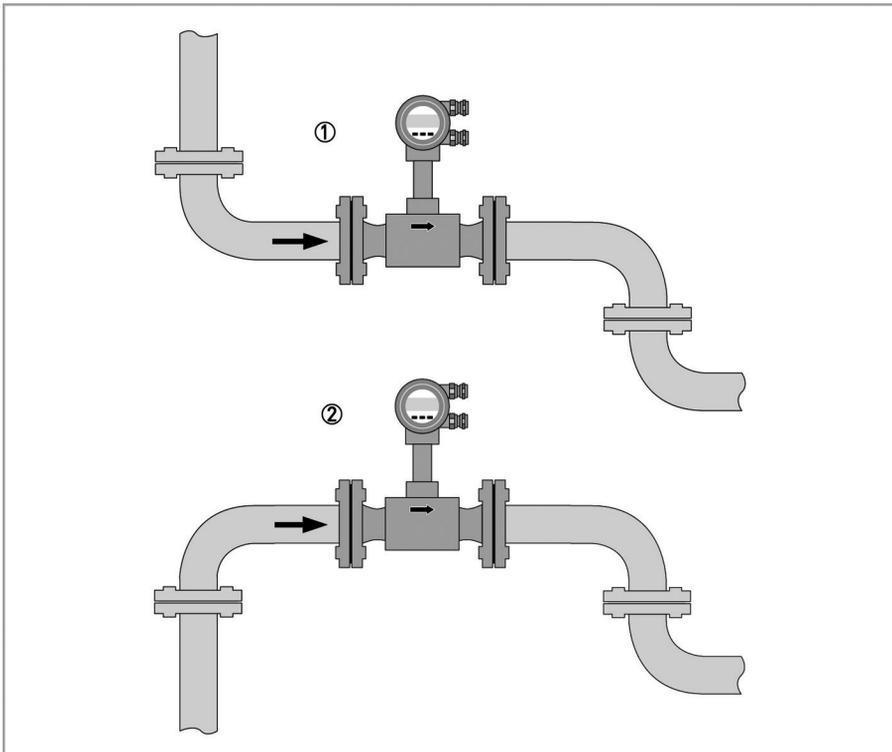
Condensate can lead to cavitation and inaccurate measurement. Under certain circumstances the device can be destroyed and the measured product can leak.

Recommended installations



CAUTION!

It is absolutely necessary to maintain the required inlet and outlet runs.



- ① Inlet and outlet falling
- ② Rising inlet - falling outlet

3.4.3 Pipelines with control valve

**INFORMATION!**

To ensure smooth and correct measurement, the manufacturer recommends not installing the measuring device downstream from a control valve. This would run the risk of vortex formation, which would distort the measuring result.

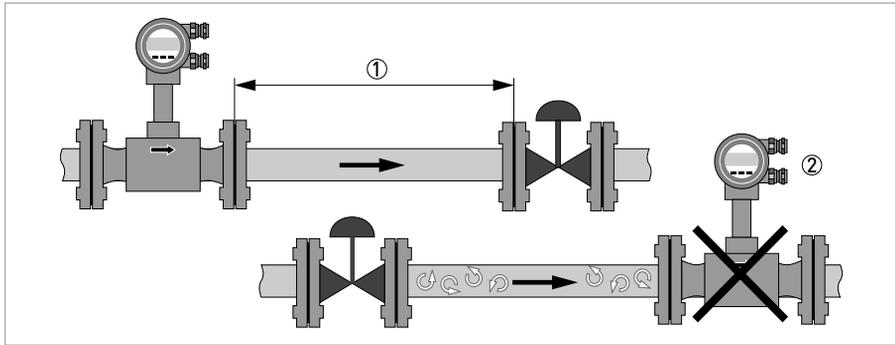
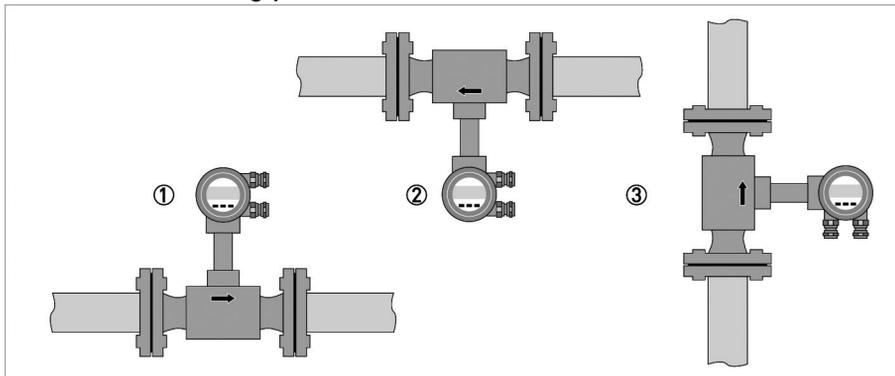


Figure 3-4: Pipeline with control valve

- ① Recommended: installing the device **upstream** from the control valve at a distance of ≥ 5 DN
- ② Not recommended: Installing the flowmeter **directly downstream** of control valves, due to vortex formation.

3.4.4 Preferred mounting position

Preferred mounting position



- ① Above a horizontal pipe
- ② underneath a horizontal pipe (not permitted with lines at risk for condensate)
- ③ On a vertical pipe

**INFORMATION!**

Depending on the installation position, you may have to rotate the display and/or the connection housing. For further information refer to *Turning the display on page 30*.

3.4.5 Turning the connection housing



DANGER!

All work on the device electricians may only be carried out by appropriately trained personnel. The regional occupational health and safety directives must always be observed.



CAUTION!

Do not damage the electrical cable by overtwisting it.
Do not remove the electrical connector.

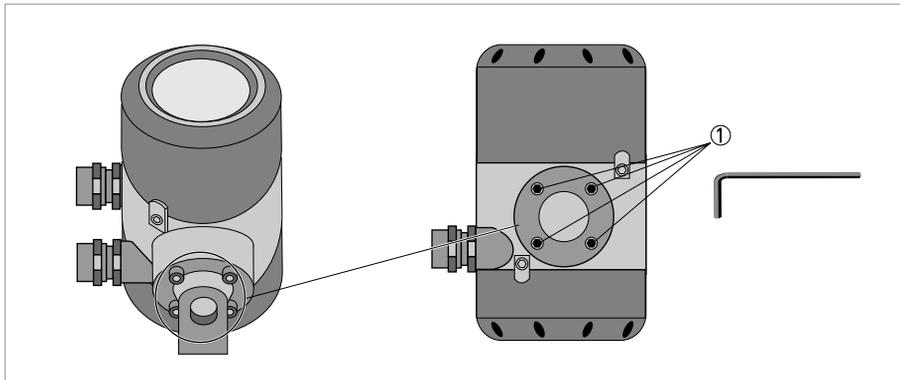


Figure 3-5: Allen screws on connection housing



- Disconnect the power supply from the measuring device.
- Loosen the four screws ① on the rear side of the connection housing.
- Lift the connection housing and turn it to the required position in 90° steps.
- Screw the connection housing back on.

3.4.6 Turning the display

**DANGER!**

All work on the device electrically may only be carried out by appropriately trained personnel. The regional occupational health and safety directives must always be observed.

**INFORMATION!**

If the measuring device is installed in a vertical pipe, you will have to turn the display by 90°; if installed below a pipe, turn 180°.

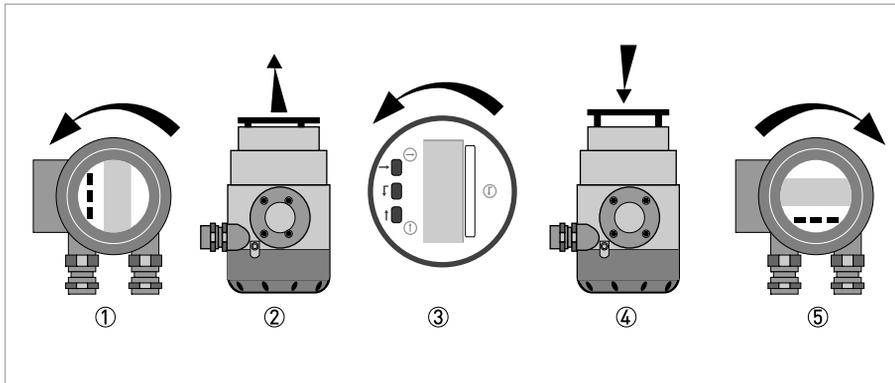


Figure 3-6: Turning the display

**Turn the display as follows:**

- Disconnect the power supply from the measuring device.
- Unscrew the cover in front of the display ① from the connection housing.
- Pull the display ② carefully a few centimetres out of the anchor fitting and turn it to the required position ③.
- Press the display onto the spacer pins ④, until it clicks.
- Turn the cover with gasket ⑤ back onto the housing and tighten it by hand.

3.4.7 Heat insulation



CAUTION!

The area above the converter support must not be heat-insulated.
 The heat insulation ③ may only extend to the maximum height ① shown below up to the connecting screws of the measuring sensor.

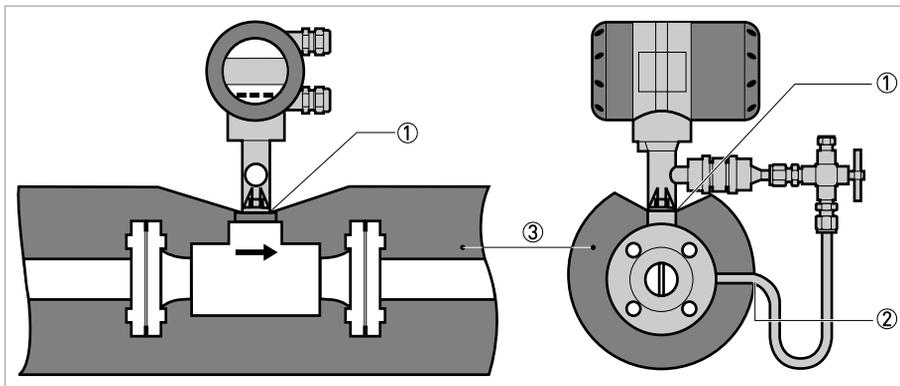


Figure 3-7: Heat insulation on connection piece and signal cable

- ① Max. height of insulation up to intermediate piece between measuring sensor and signal converter
- ② Max. thickness of the insulation up to the bend of the pressure pipe
- ③ Insulation

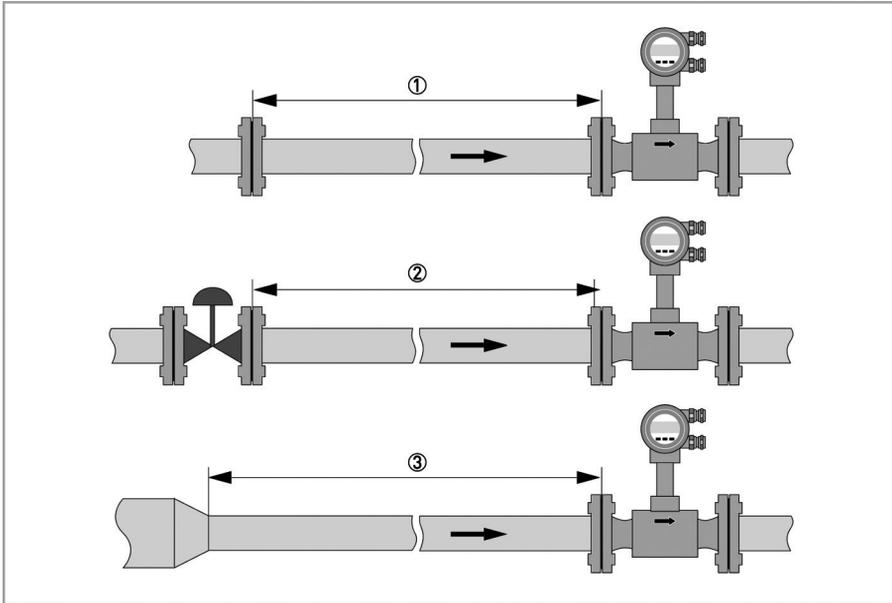


CAUTION!

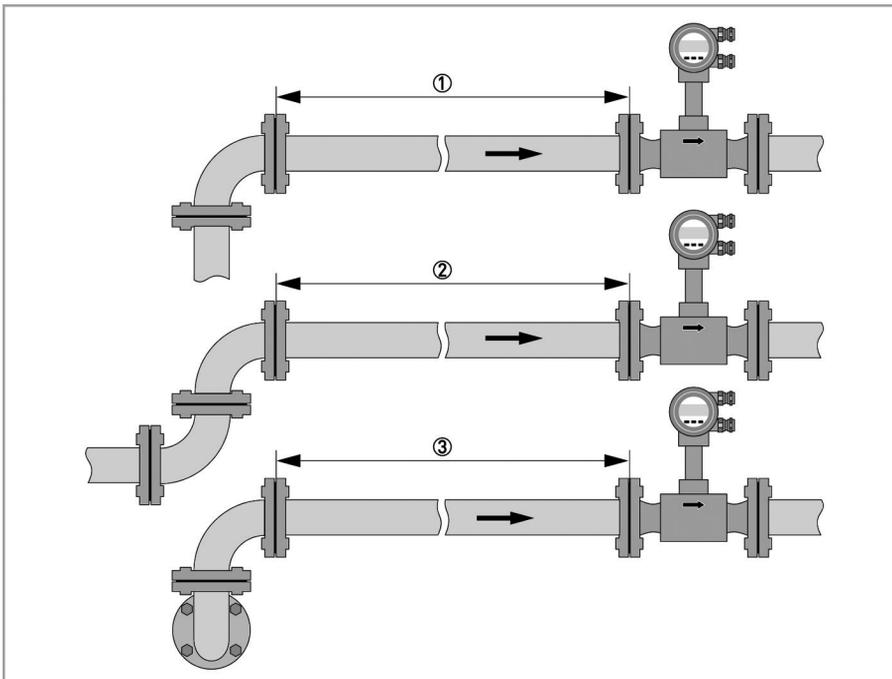
The heat insulation ③ may only extend as far as the bend of the pressure sensing line ②.

3.5 Inlet and outlet runs

3.5.1 Minimum inlet runs



- ① General inlet run without disturbing flow ≥ 20 DN
- ② Behind a control valve ≥ 50 DN
- ③ After a pipe diameter reduction ≥ 20 DN



- ① After a single bend $90^\circ \geq 20$ DN
- ② After a double bend $2 \times 90^\circ \geq 30$ DN
- ③ After a double three-dimensional bend $2 \times 90^\circ \geq 40$ DN

3.5.2 Minimum outlet runs

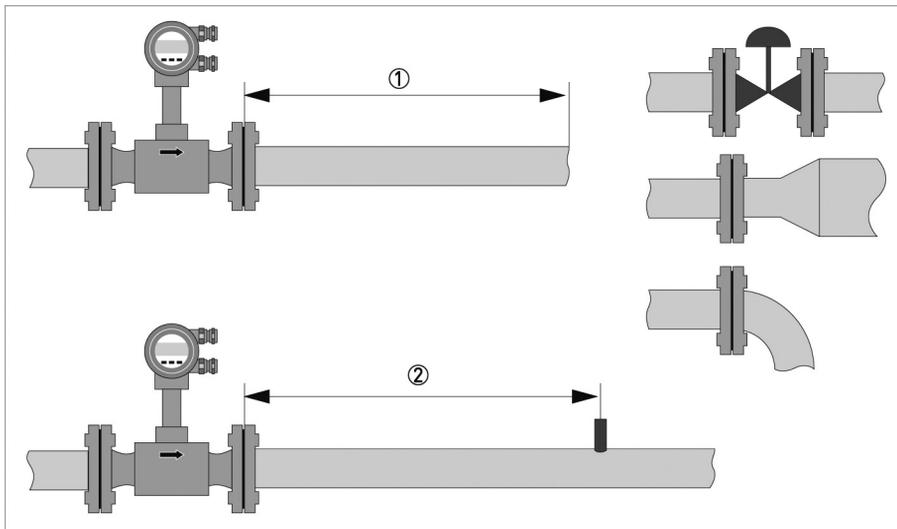


Figure 3-8: Minimum outlet runs

- ① Upstream of pipe expanders, pipe bends, control valves, etc. ≥ 5 DN
- ② Upstream of metering points $\geq 5 \dots 6$ DN



INFORMATION!

The interior of the pipe at the metering points must be free of burrs and other flow impediments. The measuring device has an internal temperature sensor. External temperature sensor must be located ≥ 5 DN behind the flow sensor outlet. Use sensors that are as short as possible to avoid disturbing the flow profile.

3.5.3 Flow straightener

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

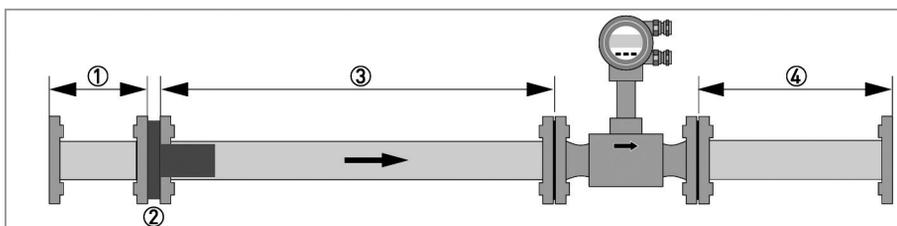


Figure 3-9: Flow straightener

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

3.6 Installation

3.6.1 General installation notes



CAUTION!

Installation, assembly, start-up and maintenance may only be performed by appropriately trained personnel. The regional occupational health and safety directives must always be observed.



The following procedures have to be carried out before installing the device:

- Remove all transportation safety devices and protective coverings from the device.
- Ensure that the gaskets have the same diameter as the pipelines.
- Note the correct flow direction for the device. This is indicated by an arrow on the housing of the measuring sensor.
- On metering points with varying thermal loads, the flowmeters have to be mounted with stress bolts (DIN 2510).
- Stress bolts or bolts and nuts are not included in the scope of delivery.
- Ensure that the measuring flange is concentrically fitted.
- Note the exact installation length of the measuring device when preparing the metering point.

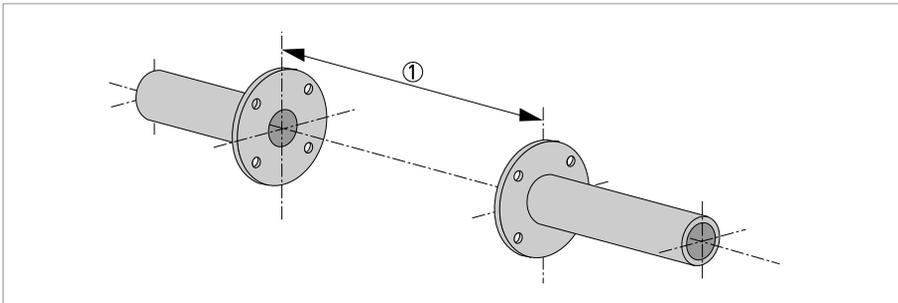


Figure 3-10: Preparing the metering point

- ① Installation length of measuring device + thickness of gaskets.



CAUTION!

The internal diameter of the pipelines, the measuring sensor and the gaskets must match. The gaskets may not protrude into the flow.

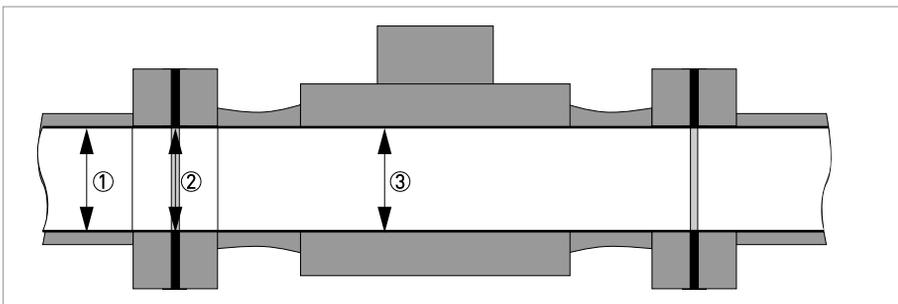


Figure 3-11: Internal diameter

- ① Internal diameter connection pipe
 ② Internal diameter flange and gasket
 ③ Internal diameter measuring sensor

3.6.2 Installing devices in flange design

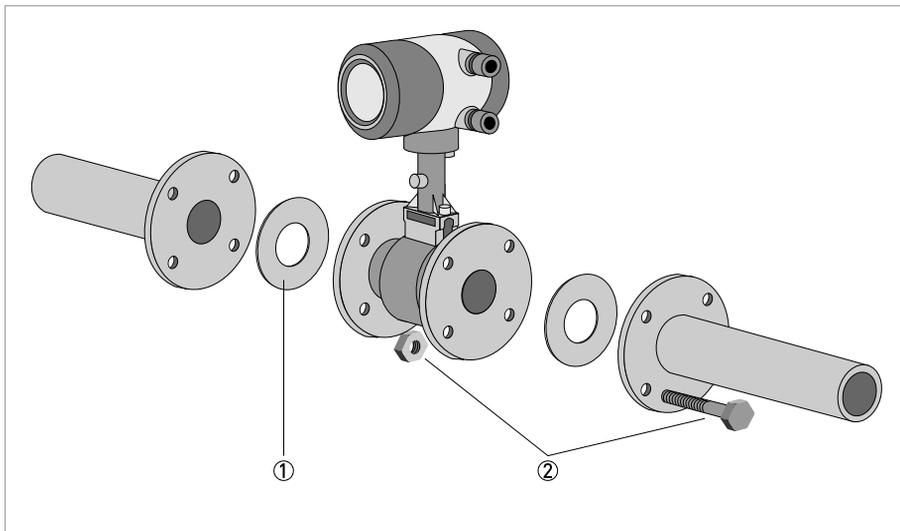


Figure 3-12: Installing devices in flange design

- ① Gasket
- ② Bolts with fixing nuts



- Use bolts and fastening nuts ② to attach the measuring device to one side of the flange.
- While doing so, insert the gaskets ① between measuring sensor and flange and align them.
- Check that the gasket is concentric and that it is not protruding into the pipe cross-section.
- Install the gasket, bolts and fastening nuts on the other side of the flange.
- Align the measuring device and the gaskets so they are concentric.
- Now tighten all nuts bit by bit alternately across the diagonal.

3.6.3 Installing devices in sandwich design

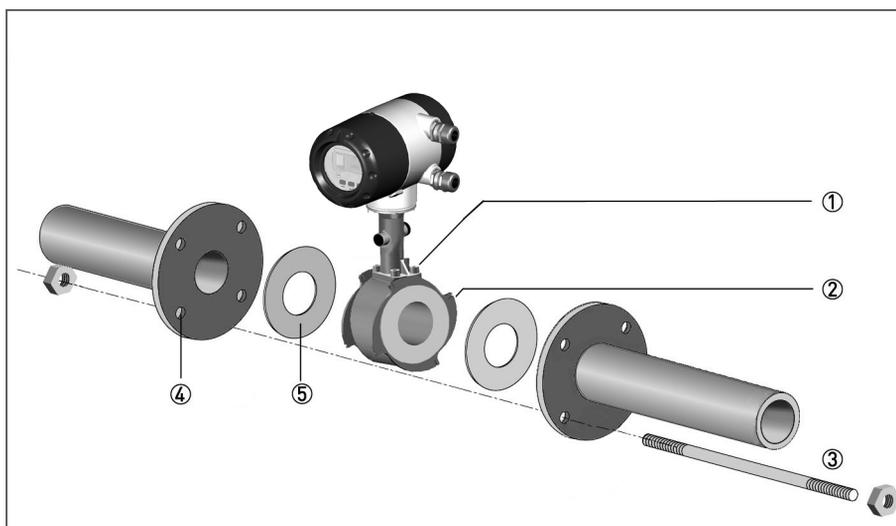


Figure 3-13: Installation using centering ring

- ① Measuring sensor
- ② Centering ring
- ③ Bolts with fixing nuts
- ④ Hole
- ⑤ Gasket



- Push the first bolt ③ through the hole ⑤ of both flanges.
- Screw on the nuts and washers to both ends of the bolt ③ but do not tighten them.
- Install the second bolt through the holes ④.
- Place the measuring sensor ① between the two flanges.
- Insert the gaskets ⑥ between measuring sensor ① and flanges and align them.
- Check that the flange is concentric.
- Install the remaining bolts, washers and nuts. Do not yet tighten the nuts.
- Turn the centering ring ② in a counter-clockwise direction and align the device.
- Check that the gaskets ⑥ are concentric; they must not protrude into the pipe cross-section.
- Now tighten all nuts bit by bit alternately across the diagonal.

4.1 Safety instructions



DANGER!

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!



DANGER!

Observe the national regulations for electrical installations!



DANGER!

For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.



WARNING!

Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.



INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

4.2 Connecting the signal converter

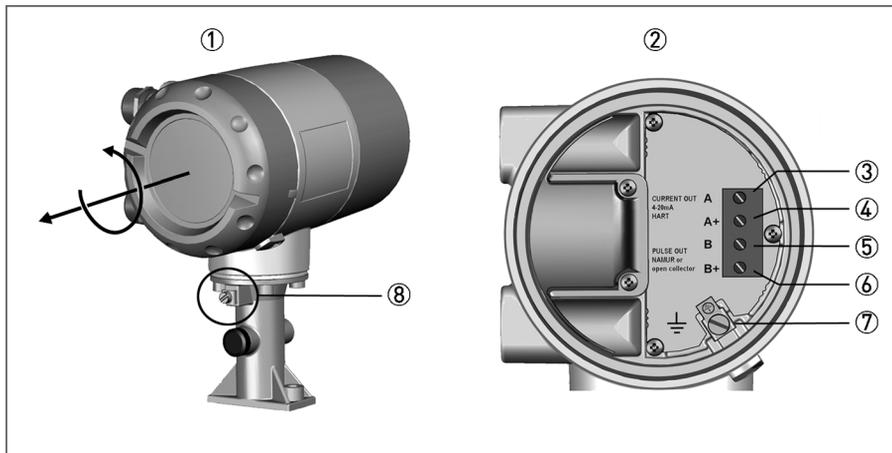


Figure 4-1: Signal converter housing with housing cover

- ① Housing cover of the electrical terminal compartment
- ② Electrical connection terminals with the housing cover open
- ③ Terminal A current output -
- ④ Terminal A+ current output +
- ⑤ Terminal B pulse output -
- ⑥ Terminal B+ Pulse output +
- ⑦ PE terminal in housing
- ⑧ PE terminal on connection piece between measuring sensor and signal converter.

Both grounding terminals ⑦ and ⑧ are equally effective from a technical point of view.



The following procedures are to be performed:

- Unscrew the housing cover ① of the electrical terminal compartment.
- Thread the connection cable through the leadthrough in the housing.
- Connect the cable for the current output and the cable for the optional pulse output as shown in the cable terminal diagrams below. To facilitate installation the connection plug can be removed from the device. The plug is configured in such a way as to prevent reverse polarity.
- Connect the grounding to terminal ⑦ alternatively use the PE terminal on the connection piece between measuring sensor and signal converter ⑧.
- Tighten the cable glands.
- Hand-tight the housing cover with gasket.

4.3 Electrical connection of current and pulse output

- **Current output:**
In some cases, a shielded or twisted cable may be necessary. The cable shield may only be earthed (grounded) at one place (on the power supply unit).
- **Pulse output:**
When using the pulse output, two separate signal circuits are necessary if the pulse output is utilized together with analogue signals. Each signal circuit requires its own power supply. The total resistance must be adapted so that the total current I_{tot} does not exceed 100 mA.
- Connection current output on terminals A, A+
Connection pulse output on terminals B, B+

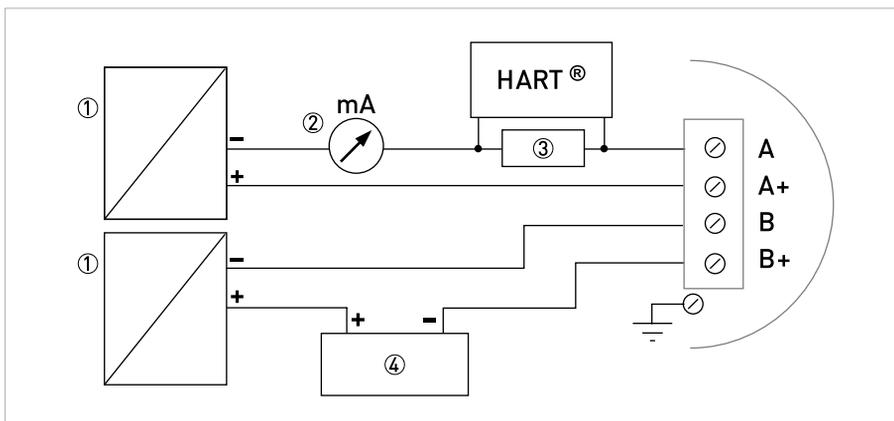


Figure 4-2: Electrical connection of current and pulse output

- ① Power supply per signal circuit
- ② Optional display unit
- ③ Load for HART® ≥ 250 Ω
- ④ e.g. counter

The maximum load resistance is calculated as follows:

$$R_L = \frac{U_{ext.} - 14V}{22 mA}$$

4.3.1 Power supply



INFORMATION!

The supply voltage has to be between 14 VDC and 36 VDC. This is based on the total resistance of the measuring loop. To determine this, add up the resistances of each component in the measuring loop (not including the measuring device).

The required supply voltage can be calculated using the formula below:

$$U_{\text{ext.}} = R_L * 22\text{mA} + 14\text{V}$$

where

$U_{\text{ext.}}$ = the minimum supply voltage and

R_L = the total measuring loop resistance is.



INFORMATION!

The power supply has to be able to supply a minimum of 22 mA.

4.3.2 Totalizer / pulse output

The base units for the totalizer and the pulse output are **m³** for volume, **m³norm.** for standard volume and **kg** for mass.

The unit and the conversion factor can be changed in menu item 3.2.8 "Conf.Tot". User specific units (User Def.) can also be entered but the conversion factor must always be entered based on the base unit. For a sample calculation see chapter 6.2.5 "Change units".

The maximum frequency of the pulse output is 0.5 Hz.

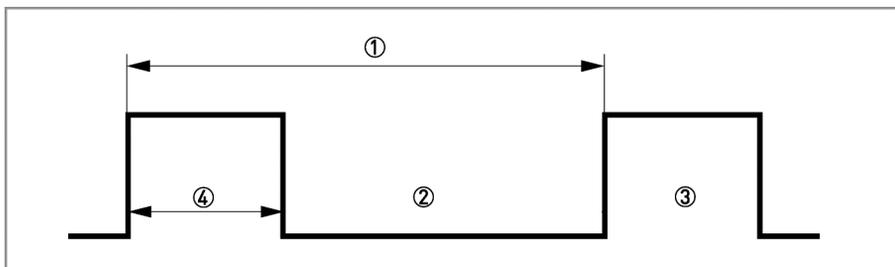


Figure 4-3: pulse output

- ① $f_{\text{max}} \leq 0.5 \text{ Hz}$
- ② closed
- ③ open
- ④ Pulse $\geq 250 \text{ ms}$

The pulse output is a passive "open collector" output which is electrically separated from the current interface and the measuring sensor. It can be configured as a high current output or NAMUR output using a jumper on the amplifier board.

Jumper in NAMUR setting	
$R_i = 900 \Omega$	$U_{max} = 36 \text{ VDC}$

The maximum frequency of the pulse output is $f_{max} = 0.5 \text{ Hz}$

Jumper in high current setting		
Open:	Maximum voltage $U_{max} = 36 \text{ VDC}$	Closed current $I_R < 1 \text{ mA}$
Closed:	Maximum current $I_{max} = 100 \text{ mA}$	Voltage $U < 2 \text{ VDC}$

The maximum frequency of the pulse output is $f_{max} = 0.5 \text{ Hz}$

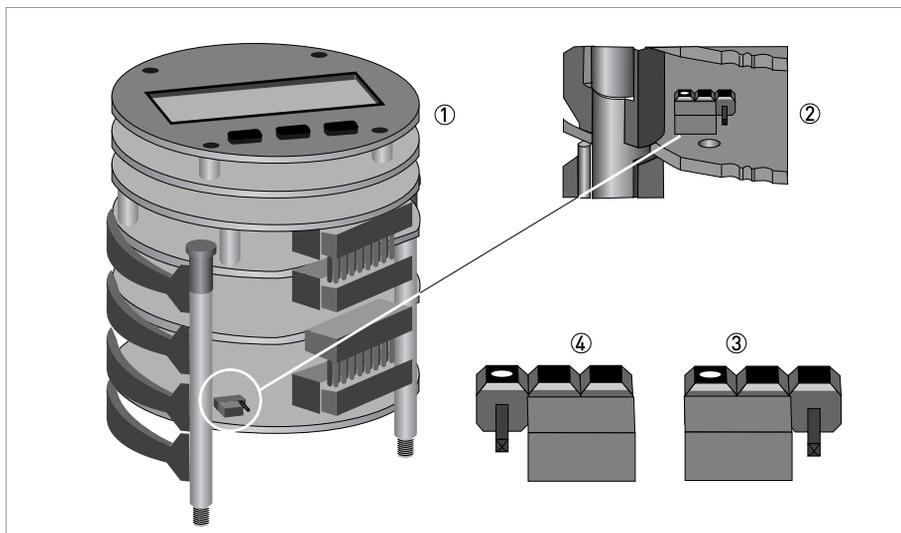
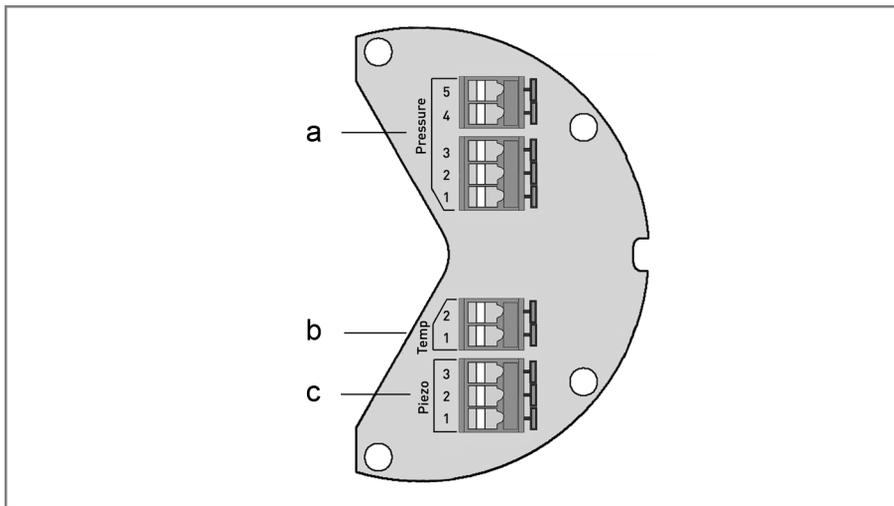


Figure 4-4: Jumper settings pulse output

- ① Electronic insert
- ② Jumper on board
- ③ Jumper in high current setting
- ④ Jumper in NAMUR setting

4.4 Remote version connection

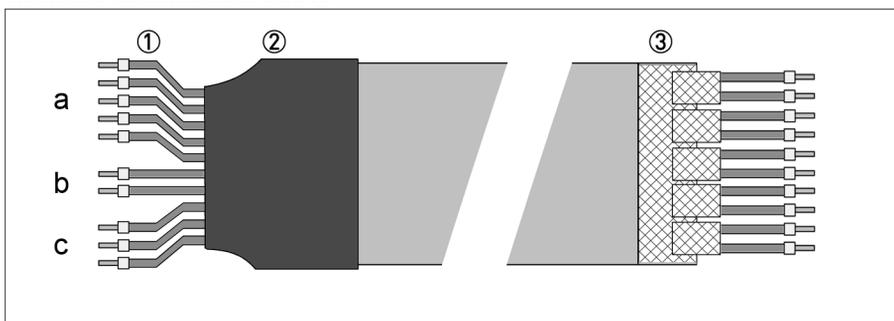


The connections in the sensor and wall mount bracket connection boxes are identical in construction.

Connection cable strand colour

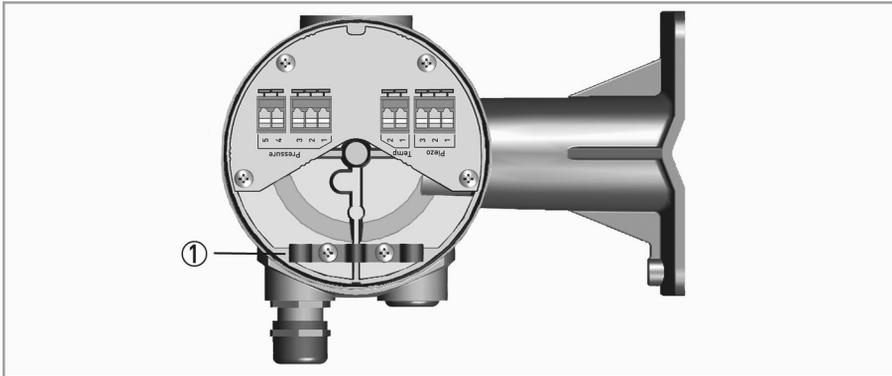
	Connection	Terminal no.:	Strand colour
a	Pressure sensor	5	brown
		4	rose / pink
		3	green
		2	grey
		1	white
b	Temperature sensor	2	black
		1	purple
c	Vortex Sensor	3	red
		2	yellow
		1	blue

Remote connection cable



- ① Sensor connection side - strand length approx. 100mm
- ② Length of shrink hose approx. 30mm
- ③ Wall housing connection side - prefabricated shielding - length approx. 15mm

Connection of shielding connection cable remote version



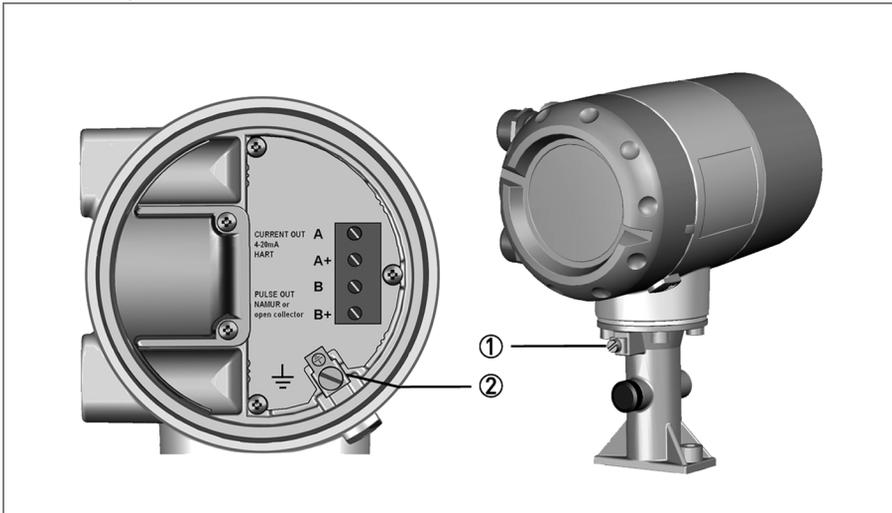
CAUTION!

The cable shielding is connected only on one side under the U-clamp terminal ① in the wall mount bracket connection box.

4.5 Grounding connections

The grounding can be done either by connecting the PE terminal in the housing or the PE terminal on the connection piece between measuring sensor and signal converter. Both of these electrical connections are equally effective from a technical point of view.

Grounding connection compact version



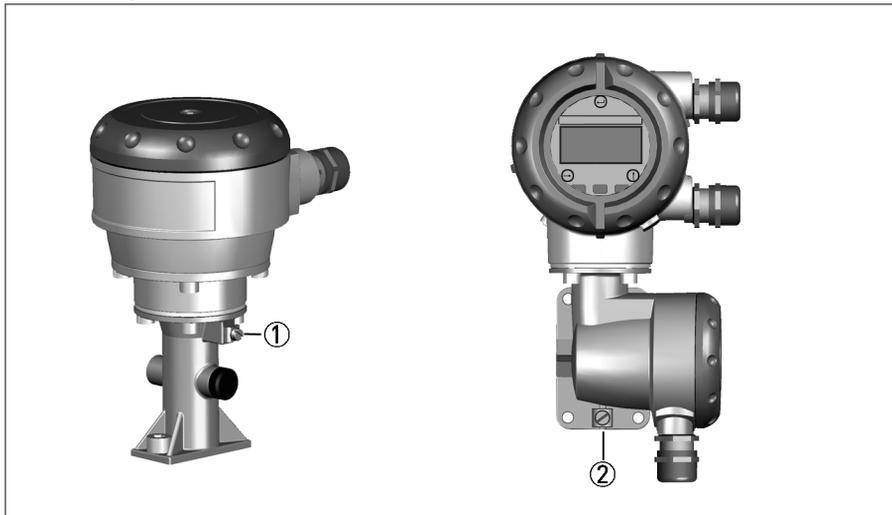
- ① Electrical grounding connection on connection piece between measuring sensor and signal converter.
- ② Electrical grounding connection on housing



CAUTION!

The measuring device has to be grounded properly to achieve accurate measurement. The grounding wire may not transfer any interference voltage. Do not use this grounding wire to ground any other electrical devices.

Grounding connection remote version



- ① Grounding connection on sensor side
- ② Grounding connection on signal converter side

**CAUTION!**

Both parts of the remote versions has to be grounded properly to achieve accurate measurement. The grounding wire may not transfer any interference voltage.

4.6 Protection category

The measuring device meets all requirements of protection category IP66/67.



CAUTION!

After all servicing and maintenance work on the device, the specified protection category has to be ensured again.

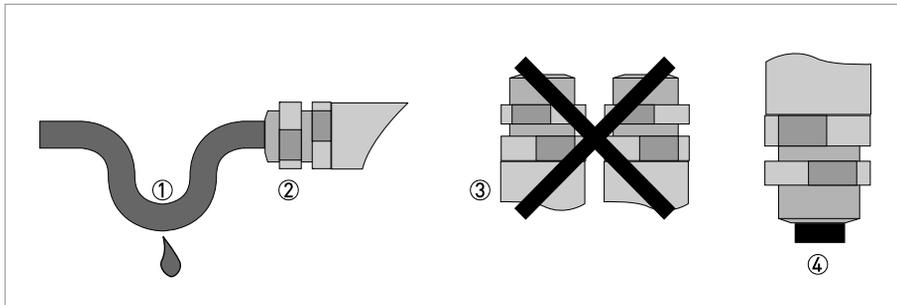


Figure 4-5: Cable feedthrough



Therefore it is essential to observe the following points:

- Use only original gaskets. They must be clean and free of any damage. Defective gaskets must be replaced.
- The electrical cables used must be undamaged and must comply with regulations.
- The cables must be laid with a loop ① upstream of the measuring device to prevent water from getting into the housing.
- The cable feedthroughs ② must be tightened.
- Align the measuring device so that the cable feedthrough is never facing up ③.
- Close the unused cable feedthroughs using blind plugs ④.
- Do not remove the required cable bushing from the cable feedthrough.

5.1 Start

After the device is switched on, the display shows the following in sequence

1. Testing...
2. Device type
Software Version - Revision

The device performs a self-test and switches to measurement mode. Here, all of the parameters preset for the customer are analysed and checked for plausibility, and the current measured value is displayed.

5.2 Start-up and control



INFORMATION!

The flowmeter is largely maintenance-free.

Observe the application limits in respect of temperature and medium. Additional information refer to Technical data on page 78.

6.1 Display and operating elements

With the cover open the device is operated by using the mechanical keys on the front; with the cover closed a bar magnet is used.



CAUTION!

The switching point of the magnetic sensors is directly under the glass panel above the appropriate symbol. Only touch the symbol vertically and from the front using the bar magnet. Touching it from the side may cause a malfunction.

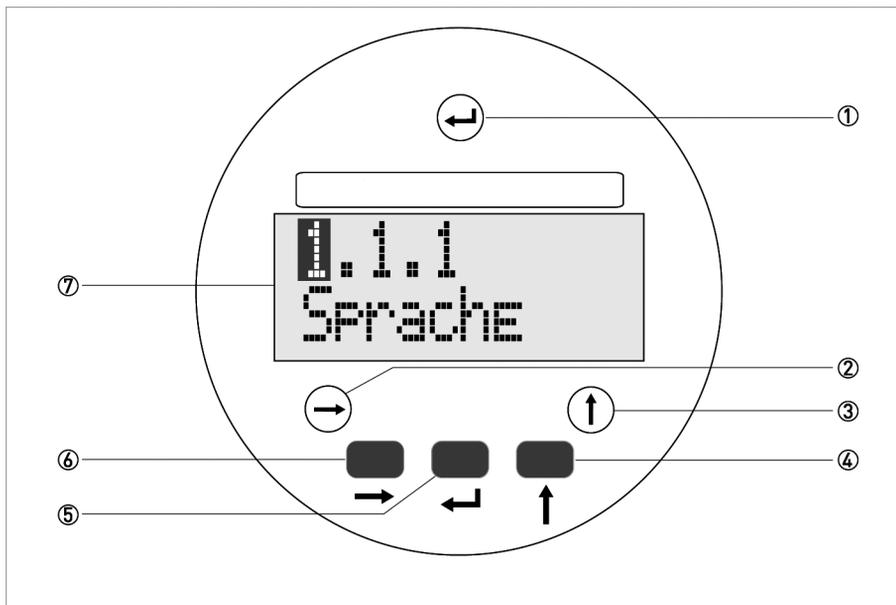


Figure 6-1: Display and operating elements

- ① Enter button (bar magnet)
- ② Right button (bar magnet)
- ③ Up button (bar magnet)
- ④ Up button (mechanical)
- ⑤ Enter button (mechanical)
- ⑥ Right button (mechanical)
- ⑦ Display

The mechanical keys and keys for the bar magnet have the same functionality. In this documentation the keys are represented as symbols to describe the operating functions:

Mechanical	Bar magnet	Symbol
		→
		↑
		←

Table 6-1: Description of keys

6.2 Operating principles

6.2.1 Functional description of the keys

→	Switch from measuring mode to menu mode
	Switch to one menu level lower
	Open menu item and activate change mode
	In change mode: Move the input cursor one position to the right; after the last digit the input cursor jumps back to the beginning.
↑	In measuring mode: Switch between measured values and error messages
	Change between the menu items within a menu level
	In change mode: Changing parameters and settings; running through the available characters; shifting the decimal point to the right.
←	Switch to one menu level higher
	Return to measuring mode with a query whether the data should be accepted

Table 6-2: Description of the operating keys

6.2.2 Switch from measuring mode to menu mode

Measuring mode	Operation	Menu mode
156.3 kg/h	→	1.1.1 Language

6.2.3 Navigation within the menu structure

Navigation within the menu is by means of the → and ← buttons. Pressing → button takes you one menu level lower, ← takes you one menu level higher. If you are already located at the lowest level (function level), you can use the → button to go in the change mode, which can be used to set data and values. If you are located at the first level (main menu), you can use the ← key to exit the menu mode and return to the measuring mode.

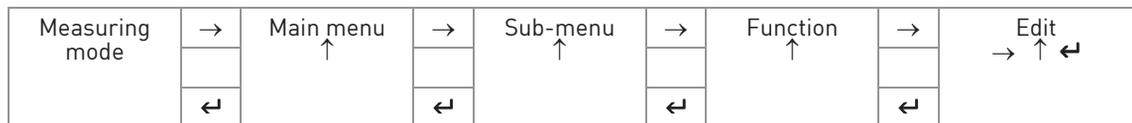


Table 6-3: Navigation menu structure

6.2.4 Changing the settings in the menu



- Use the → and ↑ keys to navigate in the menu in which you want to change a setting or value. Use the → key to activate the change mode in the selected menu.
- ☞ The current values or settings are displayed.
- Use the → and ↑ keys to change the value or setting. Save the new value or setting using the ← key. Some menu items contain several setting options. They are displayed in sequence by pressing the ← key.
- ☞ Takes you back to the main menu.
- Press the ← key to save the settings.
- ☞ The query "Save Yes" appears. Switch between "Yes" and "No" by pressing the ↑ key.

Switch between "YES" and "NO" by pressing the ↑ key.

Save Yes	←	Changes saved. An update is carried out and the display returns to measuring mode.
Save No	←	Changes not saved. The display returns to measuring mode.



CAUTION!

Each time parameters or settings are changed, the measuring device carries out an internal plausibility check. If implausible inputs have been made, the display remains in the current menu, and the changes are not saved.

Example: changing the default parameter from m³/h to l/min

Procedure		Display	Procedure		Display
		107.2 m ³ /h	5	←	0000600.00 L/min
1	3 x →	1.1.1 Language	6	←	Display Unit
2	3 x ↑	1.1.4 Max. Flow	7	←	1.1.4 Max. Flow
3	→	m ³ /h Unit	8	←	Save Yes
4	3 x ↑	L/min Unit	9	←	1787.0000 L/min

6.2.5 Changing units

When entering numbers and values in floating point format, the maximum possible accuracy is 0.003%. The accuracy depends on both the position of the decimal point and the length of the number entered.

Numerical values and factors are displayed in the first line of the 10-digit display. Numerical values are either displayed in floating point format (123.4567890) or are expressed in exponential format (123456E002). The conversion factor of the totalizer and the pulse output is, however, expressed in whole numbers.

Input values exponential format

Display position	1	2	3	4	5	6	7	8	9	10
Decimal point	-	•	•	•	•	-	-	-	-	-
Input values	0 ... 9	E	- or 0	0 ... 3	0 ... 8					

To select the exponential function, the decimal point must be located between the 2nd and 5th decimal position.

Flow units

The base units are m³/h for volume flow measurement, m³/h stand. for standard volumetric flow measurement and kg/h for mass flow measurement.

The flow units can be changed in menu item 1.1.4 "Max.Flow".

User defined units can be entered using "User Def."

The unit (text) as well as the conversion factor (number) can be entered here.

The conversion factor must always be entered based on the base unit.

Conversion

Formula	New unit (User Def.)	=	A1 Coeff.	*	Base unit
Example:	1 litre / h	=	0.001	*	m ³ /h

Menu items

1.1.3	Maes.Inst	Volume / Standard volume / Mass
1.1.4	Max. Flow	Unit (User Def.) / Text / A1 Coeff. / Max. Flow / Flow Displ

Totalizer / pulse output

The base units for the totalizer and the pulse output are **m³** for volume, **m³** norm. for standard volume and **kg** for mass.

The unit and the conversion factor can be changed in menu item 3.2.8 "Tot.Conf.". User defined units (User Def.) can be selected and entered. The conversion factor of the unit must always be entered based on the base unit.

The maximum pulse output frequency is 0.5 Hz. To ensure that the pulse output does not exceed 0.5 Hz, the conversion factor of the totalizer must be selected and set accordingly. The pulse output represents an exact copy of the whole number value of the internal totalizer.

Max. pulses per hour

fmax. ≤ 0.5 Hz	1 pulse-break ≥ 2 seconds	Max. pulses / hour = 1800 pulses
----------------	---------------------------	---

Example

Flow Qmax.	Factor A1 Coef.	Pulses / litre	Pulses / h	Comment
5.6 m ³ /h	0.001	1 pulse / 1 litre	5600	not possible
	0.01	1 pulse / 10 litres	560	560 < 1800 = ok.

Menu items

1.1.3	Maes.Inst	Volume / Standard volume / Mass
1.1.4	Max. Flow	Unit (User Def.) / Text / A1 Coeff. / Max. Flow / Flow Displ
3.2.5	Function P	Yes / No
3.2.7	Totalizer	Tot. on / Tot. off
3.2.8	Tot. Conf.	User def. / Unit Text / A1 Coeff. / Preset Value / Reset / Display

6.2.6 Measures in the event of faulty indications

If the indications on the display or the responses to keypad commands are faulty, you have to do a hardware reset. Switch the power supply OFF and ON again.

6.3 Overview of the most important functions and units



INFORMATION!

A complete list of all functions and short descriptions is provided in the appendix. All default parameters and settings are adapted for the specific customer.

Level	Designation	Explanation
1.1.1	Language	Select the menu language
1.1.4	Max. Flow	Maximum flow rate The value set is represented by a 20 mA analogue current output. If the current value exceeds the preset value, an alarm is indicated.
1.1.5	Min. Flow	Minimum flow rate The set value does not represent the 4 mA value of the current output.
1.1.6	Timeconst.	Time constant, damping value [s]
2.1.1	Test I	Check current output
2.1.2	Test P	Test pulse output
3.1.1	Error Msg.	Error indicator Yes: error messages are displayed No: error messages are suppressed. A flashing cursor at the top left indicates that error messages are present.

Table 6-4: The most important functions

Volume mass units

Volume		Standard volume	Mass
Liquids, steams, gases	Air	Gas	Liquids, steams, gases
m ³ /h	FAD m ³ /h	m ³ /h (norm)	kg/h
m ³ /min	FAD m ³ /min	m ³ /min (norm)	kg/min
m ³ /s	FAD m ³ /s	m ³ /s (norm)	kg/s
L/h	FAD L/h	L/h (norm)	t/h
L/min	FAD L/min	L/min (norm)	t/min
L/s	FAD L/s	L/s (norm)	t/s
ft ³ /h	FAD ft ³ /h	ft ³ /d (std.)	lb/h
ft ³ /min	FAD ft ³ /min	ft ³ /h (std.)	lb/min
ft ³ /s	FAD ft ³ /s	ft ³ /min (std.)	lb/s
gal/h	User Def.	ft ³ /min (std.)	g/min
gal/min		ft ³ /s (std.)	g/s
gal/s		User Def.	User Def.
ImpGal/h			
ImpGal/min			
ImpGal/s			
cm ³ /h			
cm ³ /min			
cm ³ /s			
dm ³ /h			
dm ³ /s			
bbl/h			
bbl/d			
User Def.			

Table 6-5: Flow measurements and units

Unit totalizer

Volume	Standard volume	Mass
Liquids, steams, gases	Gas	Liquids, steams, gases
m ³ L ft ³ /h ft ³ gal ImpGal cm ³ dm ³ bbl User Def.	m ³ norm L norm ft ³ std. User Def.	kg t lb g User Def.

Table 6-6: Totalizer units

Temperature - Pressure - Power - Energy - Density units

Temp.	Absolute pressure (over)	Power	Energy	Density
°C °F K User Def.	Pa(g) kPa(g) MPa(g) kg/ms ² (g) kp/cm ² (g) atm(g) torr(g) bar(g) mbar(g) psi(g) lbf/ft ² (g) kgf/cm ² (g) inHg(g) mmHg(g) mmH ₂ O(g) User Def.	kJ/h MJ/h GJ/h Btu/h th kcal/h User Def.	kW MW TR kJ MJ GJ Btu th kcal kWh MWh User Def.	kg/m ³ kg/L g/L h/mL g/cm ³ g/ft ³ g/ImpGal g/gal kg/gal Lb/gal Lb/ImpGal User Def.

Table 6-7: Additional units

6.4 Error messages

Error message	Cause	Measure
No Signal	No signal from vortex amplifier	Check connector In the event of measuring sensor problems contact service.
Low freq	Sample frequency too low	Contact service.
High Freq	Sample frequency too high	Contact service.
Low Flow	Flow rate less than the set minimum flow rate q_{min}	Signal converter continues to display the current flow rate but the accuracy of the measurement may be affected.
Q too high	Flow rate higher than the set maximum flow rate q_{max}	Corrective measures depend on the application! If the flow rate exceeds the maximum value, the measuring sensor may be physically damaged.
Inv. Config.	Invalid configuration data in FRAM (permanent memory)	Check entire configuration! Contact service if error message persists.
Amp. Fail	Error in the pre-amplifier stage	Contact service.
Chk. Instal.	Quality of the vortex signal too poor	1. Check q_{min} 2. Excessive pipe vibration and faulty flow profile
Low Signal	Amplitude of vortex signal is too low	1. q_{min} ok? 2. If q_{min} OK, contact service
Hi. Signal	Amplitude of vortex signal is too high	Occurs with media of high density 1. Check q_{max} 2. If q_{max} OK, contact service
L.Temp.Phy	Operating temperature lower than specified	Take corrective measures within process, otherwise both the measuring sensor and the signal converter may be damaged.
H.Temp.Phy	Operating temperature higher than specified	
Hi.P.Phy	Pressure higher than specified	
Tsens Shrt.	Temperature sensor short circuit	Shows error at temperature sensor! Contact service.
Tsens Open	Open temperature sensor	
P. Sen. Fail	Faulty pressure sensor	Displays error at pressure sensor! Contact service.

Table 6-8: Error messages

6.5 Menu structure

6.5.1 Overview of firmware versions

There are three firmware versions, each of which is tailored to a different use of the measuring device:

- **Basic:** liquids and gases without compensation, saturated steam with density compensation using the temperature
- **Steam:** saturated and superheated steam with density compensation using pressure and temperature, gross heat meter
- **Gas:** gas, gas mixture and wet gas with density compensation using pressure and temperature, FAD (free air delivery measurement)

The menu structures differ from one another depending on the firmware version. The following table contains an overview of all menu items in the first menu level. For a complete description of the menu, note the firmware version of your measuring device and follow the relevant instructions in the table.

Menu items	Firmware version Basic	Firmware version Steam	Firmware version Gas
1. Quick setup	refer to <i>Menu item Quick Setup</i> on page 59		
2. Tests	refer to <i>Menu item Tests</i> on page 60		
3. Setup	refer to <i>Menu item Setup (firmware version - basic)</i> on page 61	refer to <i>Menu item Setup (firmware version - steam)</i> on page 64	refer to <i>Menu item Setup (firmware version - gas)</i> on page 68
5. Service	The service menu is only accessible to service personnel and is not described.		

Table 6-9: Overview of menu structure



INFORMATION!

The measuring device has been preset at the factory in accordance with the customer order. Therefore, subsequent configuration via the menu is only necessary if the intended use of the measuring device changes.

6.5.2 Entering values in change mode

→

Moves the insertion point one position to the right; after the last position, the insertion point returns to the beginning.

↑

Cycles through available values and characters; moves the decimal point to the right.

←

Accepting the entry.

6.5.3 Character selection in change mode

Depending on the menu function, you can choose from the following characters:

Numbers

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Lowercase letters

a	b	c	d	e	f	g	h	i	j
k	l	m	n	o	p	q	r	s	t
u	v	w	x	y	z				

Uppercase letters

A	B	C	D	E	F	G	H	I	J
K	L	M	N	O	P	Q	R	S	T
U	V	W	X	Y	Z				

Special characters

°	2	3	"	%	&	:	<	=	>
-	.	/	①						

① "blank"

6.5.4 Menu item Quick Setup

Level	Designation	Selection / entry field	Explanation	
1.1.1	Language →		Select menu language	
		German ↑...	German language	
		French ↑...	French language	
		English ↑...←	English language	
1.1.2	Location →	0000000000 Location↑...↑...↑...←	Enter the name of the location (max. 10 characters)	
1.1.3	Maes.Inst →		Select type of flow measurement	
		Volume ↑...	Volume measurement	
		Norm. Vol. ↑... ①	Standard volume flow measurement	
		Mass ↑...←	Mass flow measurement	
1.1.4	Max. Flow →		Set maximum flow rate	
		②	m ³ /h Unit ↑...←	Select unit for volume flow measurement
			8888888888 Upp.Limit	
			00600.0000 or other value m ³ /h ↑...↑...↑...←	Enter value for the maximum volume flow
			Display Unit / Display %Max Flow ↑...←	Display flow rate in units / in % of maximum flow rate
		③	m ³ /h norm Unit ↑...←	Select unit for standard volume flow measurement
			00600.0000 or other value m ³ /h norm ↑...↑...↑...←	Enter value for the maximum standard volume flow rate
			Display Unit / Display %Max Flow ↑...←	Display flow rate in units / in % of maximum flow rate
		④	kg/h Unit	Select unit for mass flow measurement
			00600.0000 or other value kg/h ↑...↑...↑...←	Enter value for the maximum mass flow rate
			Display Unit / Display %Max Flow ↑...←	Display flow rate in units / in % of maximum flow rate
		1.1.5	Min. Flow →	001111111
00300.0000 m ³ /h ←	The minimum flow rate value is factory-set.			
1.1.6	Timeconst. →	00002.0000 s ↑...↑...↑...←	Enter the time constant for the measured value output in seconds (0 – 20 s) 0: disabled	

① only with gas

② available if Maes.Inst = Volume [see menu item 1.1.3]

③ available if Maes.Inst = Norm. Vol. [see menu item 1.1.3]

④ available if Maes.Inst = Mass [see menu item 1.1.3]

6.5.5 Menu item Tests

Level	Designation	Selection / entry	Explanation
2.1.1	Test I →	4 mA ←	Test current output
		8 mA ←	
		12 mA ←	
		16 mA ←	
		20 mA ←	
2.1.2	Test P →	0.5003 Hz ←	Test pulse output

Table 6-10: Menu item Test

Every current value has to be confirmed with ←. Only after this is the current output set to the respective value. The following is then displayed:

- "Contin. Yes": continue with the test of current output function
- "Contin. No": back to menu

The test current is maintained until the menu has been exited.

6.5.6 Menu item Setup (firmware version - basic)

Version Basic			
Level	Designation	Selection / entry	Explanation
3.1			Set display
3.1.1	Error message →		Display error
		Yes ↑...	Shows error messages in measuring mode in plain text alternating with the measured values
		No ↑...←	Flashing cursor in the top left corner of the display indicates errors.
3.1.2	Cycle.Disp. →		Display measured values
		Yes ↑...	Cyclically display measured values in measuring mode (6 s intervals)
		No ↑...←	Do not display measured values cyclically
3.1.3	Code 1 →		Set security query 1 (menu)
		Yes ↑...	Activate access code: →→→↑↑↑←←←←
		No ↑...←	Deactivate access code
3.2			I/O settings
3.2.1	4-20mA off →		Current output 4-20 mA and error current
		4-20mA ↑...	Current output 4-20 mA
		4-20/22E ↑...	Current output 4-20 mA or error current 22 mA
		4-20/3.55E ↑...←	Current output 4-20 mA or error current 3.55 mA
3.2.5	Function P →		pulse output
		Yes ↑...	Activate pulse output
		No ↑...←	Deactivate pulse output
3.2.7	Totalizer →		Totalizer
		Tot. on ↑...	Start Totaliser
		Tot. off ↑...←	Stop totalizer (value is held)
3.2.8	Tot. Conf. →		Configure totalizer
	(available if Maes.Inst = Volume, see menu item 1.1.3)	m ³ Unit ↑...←	Select totalizer unit for volume flow measurement
		0000000000 m ³ ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Reset totalizer / Do not reset totalizer/
		Disp. off / Disp. on ↑...←	Display totalizer / Do not display totalizer
	(available if Maes.Inst = Norm. Vol., see menu item 1.1.3)	m ³ norm Unit ↑...←	Select totalizer unit for standard volume flow measurement
		0000000000 m ³ norm ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Reset totalizer / Do not reset totalizer/
		Disp. off / Disp. on ↑...←	Display totalizer / Do not display totalizer

Version Basic			
Level	Designation	Selection / entry	Explanation
	(available if Maes.Inst = Mass, see menu item 1.1.3)	kg Unit ↑...←	Select totalizer unit for mass flow measurement
		0000000000 kg ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Reset totalizer / Do not reset totalizer/
		Disp. off / Disp. on ↑...←	Display totalizer / Do not display totalizer
3.3			HART settings
3.3.1	Poll. Adr. →	000 0 – 15 ↑...→↑...→↑...←	Enter HART polling address for "Multidrop operation"
3.3.2	HART SV →	Total Flow ←	HART secondary variable
3.3.3	HART TV →	Temp. ←	HART tertiary variable
		Density ←	
3.3.4	HART 4V →	Density ←	HART quaternary variable
		Temp. ←	
3.4			Set fluid and medium
3.4.1	Fluid ① →		Set fluid type
		Gas ↑...	Gas
		Liquid. ↑...	Liquid
		Steam ↑...←	Steam
3.4.2	Medium →		Set medium
		(available if Fluid = Gas or Liquid, see menu item 3.4.1) Custom ↑...	Customer medium
		(available if Fluid = Steam, see menu item 3.4.1) Sat.Steam ↑...← Custom	Saturated steam
① Density check			
3.5			Set pressure, temperature and density
3.5.1	T-sensor →		Internal temperature sensor
		No ↑... Yes ↑...←	No temperature sensor available Temperature sensor available
3.5.3	Sat.P/T → (available if Fluid = Steam, see menu item 3.4.1)		Density calculation for saturated steam
		Sat. T ←	Density calculation for saturated steam with the saturated temperature
3.5.4	Oper. Temp. →		Operating temperature
		°C Unit ↑...←	Set temperature unit
		0000000.0 °C ←	Operating temperature
		Disp. on / Disp. off ↑...←	Display temperature / Do not display temperature

Version Basic			
Level	Designation	Selection / entry	Explanation
3.5.6	Oper. Dens. →		Density at operating pressure and operating temperature
		kg/m ³ Unit ↑...←	Set density unit
		00000.0000 kg/m ³ ← ①	Operating density
3.5.9	Dens. Norm ② →	00000.0000 kg/m ³ ↑...↑... ↑...←	Enter density for reference conditions (pressure and temperature)
3.6			
3.6.1	Remote	0.000 length/m	(max. = 15m)
3.6.2	Cable Coef	14.074 Cable Coef	
① Disp. off Disp. on ② available if Maes.Inst = Norm.Vol.			

6.5.7 Menu item Setup (firmware version - steam)

Version Steam			
Level	Designation	Selection / entry	Explanation
3.1			Set display
3.1.1	Error message →		Display error
		Yes ↑...	Shows error messages in measuring mode in plain text alternating with the measured values
		No ↑...←	Shows a flashing cursor in the top left corner of the display to indicate that there are errors.
3.1.2	Cycle.Disp. →		Display measured values
		Yes ↑...	Cyclically display measured values in measuring mode (6 s intervals)
		No ↑...←	Do not display measured values cyclically
3.1.3	Code 1 →		Set security query 1 (menu)
		Yes ↑...	Activate access code: →→→↑↑↑←←←←
		No ↑...←	Deactivate access code
3.2			I/O settings
3.2.1	4-20mA off →		Current output 4-20 mA and error current
		4-20mA ↑...	Current output 4-20 mA
		4-20/22E ↑...	Current output 4-20 mA or error current 22 mA
		4-20/3.55E ↑...←	Current output 4-20 mA or error current 3.55 mA
3.2.2	Variable I → (available if DEVICE TYPE = GROSS HEAT, see menu item 5.4.1, service menu)		Set display variable for current output
		Maes.Inst ↑...	Flow rate
		Power ↑...←	Power
3.2.3	Power Unit → (available if DEVICE TYPE = GROSS HEAT, see menu item 5.4.1, service menu)		Set unit for heat output
		kJ/h Unit ↑...←	Select unit for measuring heat output
		Disp. on / Disp. off ↑...←	Display measured value/ Do not display measured value
3.2.4	FS power → (available if Variable I = Power, see menu item 3.2.2)		End value for power measuring range
		7000000.00 kJ/h ←	Power value at 20 mA current output
3.2.5	Function P →		Pulse output
		Yes ↑...	Activate pulse output
		No ↑...←	Deactivate pulse output
3.2.6	Variable P → (available if DEVICE TYPE = GROSS HEAT, see menu item 5.4.1, service menu)		Set output variable for the pulse output
		Total Flow ↑...	Total flow
		Energy ↑...←	Energy
3.2.7	Totalizer →		Totalizer
		Tot. on ↑...	Start Totaliser
		Tot. off ↑...←	Stop totalizer (value is held)

Version Steam			
Level	Designation	Selection / entry	Explanation
3.2.8	Tot. Conf. →		Configure totalizer
	(available if Maes.Inst = Volume, see menu item 1.1.3)	m ³ Unit ↑...←	Select totalizer unit for volume flow measurement
		0000000000 m ³ ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Do not reset totalizer/ Reset totalizer
		Disp. off / Disp. on ↑...←	Do not display totalizer Display totalizer /
	(available if Maes.Inst = Norm. Vol., see menu item 1.1.3)	m ³ norm Unit ↑...←	Select totalizer unit for standard volume flow measurement
		0000000000 m ³ norm ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Do not reset totalizer/ Reset totalizer
		Disp. off / Disp. on ↑...←	Do not display totalizer Display totalizer /
	(available if Maes.Inst = Mass, see menu item 1.1.3)	kg Unit ↑...←	Select totalizer unit for mass flow measurement
		0000000000 kg ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Do not reset totalizer/ Reset totalizer
		Disp. off / Disp. on ↑...←	Do not display totalizer Display totalizer /
3.2.9	E.tot. on → (available if DEVICE TYPE = GROSS HEAT, see menu item 5.4.1, service menu)		Energy totalizer
		Tot. on ↑...	Start Totaliser
		Tot. off ↑...←	Stop totalizer (value is held)
3.2.10	Enerг. Unit → (available if DEVICE TYPE = GROSS HEAT, see menu item 5.4.1, service menu)		Set unit for heat energy
		kJ Unit ↑...←	Set unit for heat energy
		0000000000 kJ ↑...↑...↑...←	Enter preset totalizer value
		Reset No / Reset Yes ↑...←	Do not reset heat energy/ Reset heat energy
		Disp. on / Disp. off ↑...←	Display heat energy / Do not display heat energy
3.3			HART settings
3.3.1	Poll. Aдр. →	000 0 – 15 ↑...→↑...→↑...←	Enter HART polling address for "Multidrop operation"

Version Steam			
Level	Designation	Selection / entry	Explanation
3.3.2	HART SV →		HART secondary variable
		Total Flow ↑...	
3.3.3	HART TV →	Energy ↑...↵ #available if Meter Type = Gross Heat (menu item 5.3.1, service menu)	
		Temperature ↑..	
		Pressure ↑...	
		Density ↑...↵	
3.3.4	HART 4V →		HART quaternary variable
		Temperature ↑..	
		Pressure ↑...	
		Density ↑...↵	
3.4			Set fluid and medium
3.4.1	Fluid ① →		Fluid type
		Steam ↵	Steam
3.4.2	Medium →		Process medium
		Sat.Steam ↑...	Saturated steam
		Sup.Steam ↑...↵	Overheated steam
3.4.5	Dry. Fact. → (available if Medium = Sat.Steam, see menu item 3.4.2)		Enter portion of dryness in saturated steam
		0000001.00 0.85 TO 1 ↑...↑... ↑...↵	Factor = 1 - %water mass
① Density check			
3.5			Pressure, temperature and density
3.5.1	T-sensor →		Internal temperature sensor
		No ↑...	No temperature sensor available
		Yes ↑...↵	Temperature sensor available
3.5.2	P-sensor →		Pressure sensor
		Intern ↑...	Internal pressure sensor
		--- ↑...↵	No pressure sensor available
3.5.3	Sat.P/T → (available if Medium = Sat.Steam, see menu item 3.4.2)		Density calculation for saturated steam
		Sat. T ↑...	Density calculation for saturated steam from saturated temperature
		Sat. P ↑...↵	Density calculation for saturated steam from saturated pressure

Version Steam			
Level	Designation	Selection / entry	Explanation
3.5.4	Oper. Temp. → (for saturated steam with Sat. Temp. or Sup.Steam, see menu items 3.4.2 and 3.5.3)		Operating temperature
		°C Unit ↑...←	Set temperature unit
		0000000.0 °C ←	Operating temperature
		Disp. on / Disp. off ↑...←	Display temperature / Do not display temperature
3.5.5	Oper. press. (available for SAT.STEAM with SAT. P or SUP.STEAM, see menu items 3.4.2 and 3.5.3)		Operating pressure
		Pa Unit ↑...←	Set pressure unit
		0000000.0 Pa ←	Operating pressure
		Disp. on / Disp. off ↑...←	Display pressure / Do not display pressure
3.5.6	Oper. dens. →		Density at operating pressure and operating temperature
		kg/m ³ Unit ↑...←	Set density unit
		00000.0000 kg/m ³ ← ①	Operating density
3.5.10	P-Excit. V → (available if P-Sensor = Internal, see menu item 3.5.2)	0005.00000 V ←	Exciting voltage of pressure sensor
3.5.11	P-Sen.P1V1 → (available if P-Sensor = Internal, see menu item 3.5.2)		Pressure sensor: Enter 1st calibration point
		0001.00000 P1 kg/cm ² g ↑...↑... ↑...←	
		0002.00000 V1 mV ↑...↑...↑...←	
3.5.12	P-Sen.P2V2 → (available if P-Sensor = Internal, see menu item 3.5.2)		Pressure sensor: Enter 2nd calibration point
		0005.00000 P2 kg/cm ² g ↑...→↑...→↑...←	
		0048.00048 V2 mV ↑...→↑...→↑...←	
3.6			
3.6.1	Remote	0.000 length/m	(max. = 15m)
3.6.2	Cable Coef	14.074 Cable Coef	

6.5.8 Menu item Setup (firmware version - gas)

Version gas			
Level	Designation	Selection / entry	Explanation
3.1			Set display
3.1.1	Error message →		Display error
		Yes ↑...	Shows error messages in measuring mode in plain text alternating with the measured values
		No ↑...←	Shows a flashing cursor in the top left corner of the display to indicate that there are errors.
3.1.2	Cycle.Disp. →		Display measured values
		Yes ↑...	Cyclically display measured values in measuring mode (6 s intervals)
		No ↑...←	Do not display measured values cyclically
3.1.3	Code 1 →		Set security query 1 (menu)
		Yes ↑...	Activate access code: →→→↑↑↑←←←←
		No ↑...←	Deactivate access code
3.2			I/O settings
3.2.1	4-20mA off →		Current output 4-20 mA and error current
		4-20mA ↑...	Current output 4-20 mA
		4-20/22E ↑...	Current output 4-20 mA or error current 22 mA
		4-20/3.55E ↑...←	Current output 4-20 mA or error current 3.55 mA
3.2.5	Function P →		Pulse output
		Yes ↑...	Activate pulse output
		No ↑...←	Deactivate pulse output
3.2.7	Totalizer →		Totalizer
		Tot. on ↑...	Start Totaliser
		Tot. off ↑...←	Stop totalizer (value is held)
3.2.8	Tot. Conf. →		Configure totalizer
	(available if Maes.Inst = Volume, see menu item 1.1.3)	m ³ Unit ↑...←	Select totalizer unit for volume flow measurement
		0000000000 m ³ ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Reset totalizer Do not reset totalizer/
		Disp. off / Disp. on ↑...←	Do not display totalizer Display totalizer /
	(available if Maes.Inst = Norm. Vol., see menu item 1.1.3)	m ³ norm Unit ↑...←	Select totalizer unit for standard volume flow measurement
		0000000000 m ³ norm ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Reset totalizer Do not reset totalizer/
		Disp. off / Disp. on ↑...←	Do not display totalizer Display totalizer /

Version gas			
Level	Designation	Selection / entry	Explanation
	(available if Maes.Inst = Mass, see menu item 1.1.3)	kg Unit ↑...←	Select totalizer unit for mass flow measurement
		0000000000 kg ↑...↑...↑...←	Enter preset totalizer value
		Reset Yes / Reset No ↑...←	Reset totalizer Do not reset totalizer/
		Disp. off / Disp. on ↑...←	Do not display totalizer Display totalizer /
3.3			HART settings
3.3.1	Poll. Addr.. →	000 0 – 15 ↑...→↑...→↑...←	Enter HART polling address for "Multidrop operation"
3.3.2	HART SV →		HART secondary variable
		Total Flow ↑... FAD ↑...← #available if Meter Type = FAD meter (see menu item 5.3.1, service personnel only)	
3.3.3	HART TV →		HART tertiary variable
		Temp. ↑..	
		Pressure ↑...	
		Density ↑... FAD ↑...← #available if Meter Type = FAD meter (see menu item 5.3.1, service personnel only)	
3.3.4	HART 4V →		HART quaternary variable
		Temperature ↑..	
		Pressure ↑...	
		Density ↑... FAD ↑...← #available if Meter Type = FAD meter (see menu item 5.3.1, service personnel only)	
3.4			Set fluid and medium
3.4.1	Fluid ① →		Set fluid type
		Gas ↑...	Gas
		Gas Mix. ↑...	Gas mixture
		Wet Gas ↑...←	Wet gas
① When changing fluid: check density			

Version gas			
Level	Designation	Selection / entry	Explanation
3.4.2	Medium (available if Fluid = Gas / Wet Gas, see menu item 3.4.1)		Set process medium
		Air ↑...	Air
		Ammonia ↑...	Ammonia
		Argon ↑...	Argon
		etc. ↑...←	other gases not listed here
3.4.3	% Gas (available if Fluid = Gas Mix., see menu item 3.4.1)		Determine composition of gas mixture
		050.000000 Air ↑...↑...↑...←	Select gas and enter percentage
		100.00 Total % ←	Total percentage
3.4.4	%Rel.Hum (available if Fluid = Wet Gas, see menu item 3.4.1)	0000000.00 % Rel.Hum ↑...→↑...→↑...←	Determine relative humidity
3.4.6	FAD unit → (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)		Determine unit for FAD
		FAD m ³ /h Unit ↑...←	Set unit for FAD
		Disp. on / Disp. off ↑...←	Display measured value / Do not display measured value
3.4.7	Suct.Temp. (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)		Enter temperature in suction area of compressor
		°C Unit ↑...←	Select temperature unit
		0000200.00 °C ↑...↑...↑...←	Enter temperature value
3.4.8	Atm. Pressure (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)		Atmospheric pressure
		Pa Unit ↑...←	Select pressure unit
		00001.0000 Pa ↑...↑...↑...←	Enter pressure value
3.4.9	Fil. P. Drop. (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)		Pressure drop via filter at compressor inlet
		Pa Unit ↑...←	Select pressure unit
		00000.0000 Pa ↑...↑...↑...←	Enter pressure value
3.4.10	Inlet RH (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)	0000060.00 % Rel.Hum ↑...→↑...→↑...←	Enter relative humidity in suction area of compressor
3.4.11	Actual Rpm (available if Meter Type = FAD meter, see menu item 5.3.1, service personnel only)	0001500.00 RPM ←	Current speed of compressor motor in revolutions per minute
3.4.12	Rated Rpm. (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)	0001500.00 RPM ←	Rated speed of compressor motor in revolutions per minute

Version gas			
Level	Designation	Selection / entry	Explanation
3.4.13	Outlet RH (available if Meter Type = FAD meter, see menu item 5.4.1, service personnel only)	0000100.00 % Rel.Hum ↑...→↑...→↑...←	Enter relative humidity at measuring device (compressor outlet)
3.5			Pressure, temperature and density
3.5.1	T-sensor →		Internal temperature sensor
		No ↑...	No temperature sensor available
		Yes ↑...←	Temperature sensor available
3.5.2	P-sensor →		Pressure sensor
		Intern ↑...	Internal pressure sensor
		--- ↑...←	No pressure sensor available
3.5.4	Oper. temp. →		Operating temperature
		°C Unit ↑...←	Set temperature unit
		0000000.0 °C ←	Operating temperature
		Disp. on / Disp. off ↑...←	Display temperature / Do not display temperature
3.5.5	Oper. press. →		Operating pressure
		Pa Unit ↑...←	Set pressure unit
		0000000.0 Pa ←	Operating pressure
		Disp. on / Disp. off ↑...←	Display pressure / Do not display pressure
3.5.6	Oper. dens.		Density at operating pressure and operating temperature
		kg/m ³ Unit ↑...←	Set density unit
		00011.0000 kg/m ³ ←	Operating density
3.5.7	Temp.Norm . (available if Maes.Inst = Norm. Vol., see menu item 1.1.3)	00000020.0 °C ↑...↑...↑...←	Enter normal temperature Unit as 3.5.4
3.5.8	Press.Norm (available if Maes.Inst = Norm. Vol., see menu item 1.1.3)	00000000.0 Pa ↑...↑...↑...←	Enter normal pressure Unit as 3.5.5
3.5.9	Dens. norm (for unknown gases using standard volume flow measurement, see menu items 1.1.3, 3.4.1 and 3.4.2)	00001.2900 kg/m ³ ←	Enter density for reference conditions (pressure and temperature)
3.5.10	P-Excit. V (available if P-Sensor = Internal, see menu item 3.5.2)	0005.00000 V ←	Exciting voltage of pressure sensor

Version gas			
Level	Designation	Selection / entry	Explanation
3.5.11	P-Sen.P1V1 (available if P-Sensor = Internal, see menu item 3.5.2)		Pressure sensor: 1st calibration point
		0001.00000 P1 kg/cm ² g ↑...↑... ↑...↵	
		0002.00000 V1 mV ↑...↑...↑...↵	
3.5.12	P-Sen.P2V2 → (available if P-Sensor = Internal, see menu item 3.5.2)		Pressure sensor: 2nd calibration point
		0005.00000 P2 kg/cm ² g ↑...→↑...→↑...↵	
		0048.00048 V2 mV ↑...→↑...→↑...↵	
3.6			
3.6.1	Remote	0.000 length/m	(max. = 15m)
3.6.2	Cable Coef	14.074 Cable Coef	

7.1 Replacing signal converter / LC display

The signal converter has to be replaced by a converter of the same type. The following parameters must be observed:

- The item number must correspond: 2.143670.xxx
- The software version ② must match.
- The basic version has no software identification
- The gas version is marked: "gas"
- The steam version is marked: "steam"

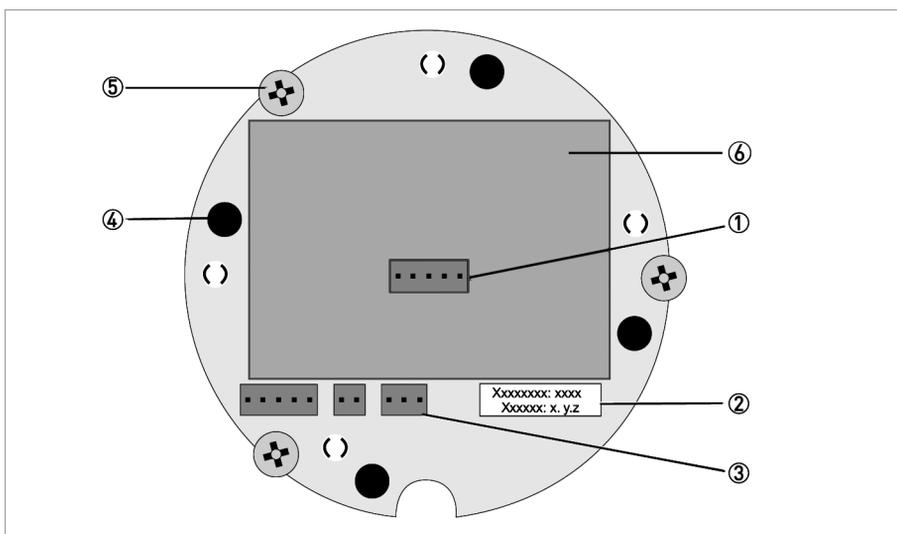


Figure 7-1: Board, example

- ① Connector for display
- ② Version number, software identification
- ③ Connector for measuring sensor
- ④ Spacer pins
- ⑤ Fixing screw (Phillips)



The following steps are to be performed:

- Switch off the power supply.
- Unscrew the front cover.
- Detach the display from the spacer pins.
- Detach the display cable ①.
- Detach the measuring sensor cable ③.
- Loosen the three fixing screws ⑤ (Phillips).
- Pull out signal converter.
- Insert new signal converter.
- Tighten the three screws.
- Attach measuring sensor cable ③ [Caution: ensure that the measuring sensor cables are not on top of the spacer pins ④ May be damaged].
- Attach display cable ①.
- Attach display in desired position, apply even pressure to the entire surface.
- Screw on cover by hand.

7.2 Spare parts availability

The manufacturer adheres to the basic principle that functionally adequate spare parts for each device or each important accessory part will be kept available for a period of 3 years after delivery of the last production run for the device.

This regulation only applies to spare parts which are subject to wear and tear under normal operating conditions.

7.3 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, maintenance, technical support and training.



INFORMATION!

For more precise information, please contact your local sales office.

7.4 Returning the device to the manufacturer

7.4.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.



CAUTION!

Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of our personnel, manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*



CAUTION!

If the device has been operated with toxic, caustic, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralising, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that it is safe to handle and stating the product used.*

7.4.2 Form (for copying) to accompany a returned device

Company:		Address:	
Department:		Name:	
Tel. no.:		Fax no.:	
Manufacturer's order no. or serial no.:			
The device has been operated with the following medium:			
This medium is:	water-hazardous		
	toxic		
	caustic		
	flammable		
	We checked that all cavities in the device are free from such substances.		
	We have flushed out and neutralized all cavities in the device.		
We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.			
Date:		Signature:	
Stamp:			

7.5 Disposal



CAUTION!

Disposal must be carried out in accordance with legislation applicable in your country.

8.1 Functional principle

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

The measuring principle is based on the Karman vortex street. The measuring tube contains a bluff body, behind which vortex shedding occurs. The frequency **f** of the vortex shedding is proportional to the flow rate **v**. The nondimensional Strouhal number **S** describes the relationship between vortex frequency **f**, width **b** of bluff body and the mean flow velocity **v**:

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

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

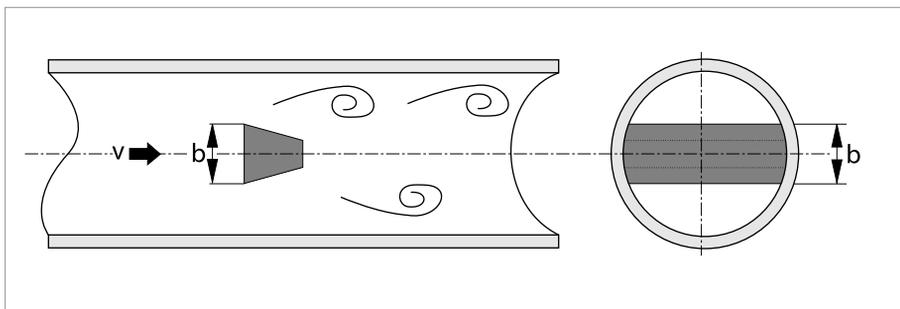


Figure 8-1: Functional principle

8.2 Technical data



INFORMATION!

- The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.
- Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website.

Measuring system

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

Measured value

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

Signal converter

Versions	Compact
	Remote version - cable length \leq 15m (49 ft)
	Option: Ex version

Measuring sensor

Standard	Flange version (with integrated temperature measurement), sensor: F
	Sandwich version (with integrated temperature measurement), sensor: S
Optional	Basic device with additional pressure measurement
	Basic device with additional pressure measurement and shut-off valve for pressure sensor
	Dual measuring device in both flange and sandwich version (redundant measurement)
	Dual measuring device in flange version with additional pressure measurement
	Flange version with simple reduction, sensor: FR
	Flange version with double reduction, sensor: F2R

Display and user interface

Local display	2 lines, 10 characters per line
Operating and display languages	German, English, French

Measuring accuracy

Reference condition	Water at 20°C
	Air at 20°C and 1.013 bar abs.
Accuracy	Based on volume flow
Liquids	±0.75% of measured value (Re ≥ 20000)
	±2.0% of measured value (10000 < Re < 20000)
Gases and steams	±1.0% of measured value (Re ≥ 20000)
	±2.0% of measured value (10000 < Re < 20000)
	Pressure and temperature compensation: ±1.5% of measured value (Re ≥ 20000); ±2.5% of measured value (10000 < Re < 20000)
Repeatability	±0.1% of measured value
Long-term stability	±0.01% of measured value

Operating conditions

Temperature

Product	-40...+240°C / -40...+465°F
Ambient	Non-Ex: -40...+85°C / -40...+185°F
	Ex: -40...+60°C / -40...+140°F
Storage	-50...+85°C / -58...+185°F

Pressure

Product	Max. 100 bar / 1450 psi; Information on higher pressures on request.
Ambient	Atmosphere

Chemical properties

Density	Taken into consideration when sizing.
Viscosity	< 10 cP
Reynold's number	10000...2300000

Recommended flow velocities

Liquids	0.3...7 m/s / 0.98...23 ft/s (optional up to 10 m/s / 32.8 ft/s taking cavitation into account)
Gases and steams	2.0...80 m/s / 6.6...262.5 ft/s
	DN15: 3.0...45 m/s / 9.8...148 ft/s; DN25: 2.0...70 m/s / 6.6...230 ft/s
	For detailed information, see chapter "Flow tables".

Other conditions

Protection category	IP 66/67
---------------------	----------

Installation conditions

Inlet run	≥ 20 x DN (without disturbing flow, after pipe narrowing, after a single 90° bend)
	≥ 30 x DN (after a double bend 2x90°)
	≥ 40 x DN (after a double three-dimensional bend 2x90°)
	≥ 50 x DN (after control valves)
	≥ 2 DN before flow straightener; ≥ 8 DN after flow straightener (specified values apply only to original ≥ 20 DN inlet run)
Outlet run	≥ 5 x DN
Dimensions and weights	For detailed information refer to chapter "Dimensions and weights".

Materials

Measuring sensor and process connections	Standard: 1.4404/316L
	Option: Hastelloy® C-22 on request
Converter housing	Die-cast Aluminium
Pressure sensor gasket	Standard: FPM
	Option: FFKM
Measuring tube gasket	Standard: 1.4435/316L
	Option: Hastelloy® C-276
	Selection depends on measuring sensor material/medium.

Process connections Flange version

DIN EN 1092-1	DN15...300 in PN16...100
ASME B16.5	½...12" in 150...600 lb
JIS B 2220	DN15...300 in JIS 10...20 K
	For detailed information on combination flange/pressure rating, refer to chapter "Dimensions and weights".

Process connections Sandwich version

DIN	DN15...100 in PN100 (higher pressures on request)
ASME	½...4" in 600 lb (higher pressures on request)
JIS	DN15...100 in 10...20 K (higher pressures on request)

Electrical connections

Power supply	Non-Ex: 14...36 VDC
	Ex: 14...30 VDC

Current output

Description of the used abbreviations	U_{ext} = external voltage; R_L = load + resistance
Measuring range	4...20 mA (max. 20.8 mA) + HART® protocol
Load	Minimum 0 Ω; maximum $R_L = ((U_{ext} - 14 \text{ VDC}) / 22 \text{ mA})$
Error signal	Acc. to NAMUR NE43
	Upper value: ≥ 21.0 mA
	Lower value: ≤ 3.6 mA (not with HART® protocol)

Pulse output

Pulse rate	Max. 0.5 pulse/s (corresponds to 1800 pulses/hour)
Power supply	Non-Ex: 24 VDC as NAMUR or open < 1 mA, maximum 36 V, closed 100 mA, U < 2 V
	Ex: 24 VDC as NAMUR or open < 1 mA, maximum 30 V, closed 100 mA, U < 2 V

HART®

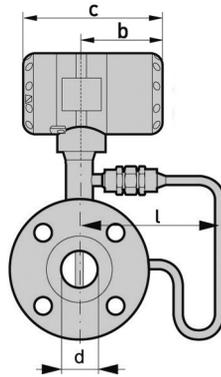
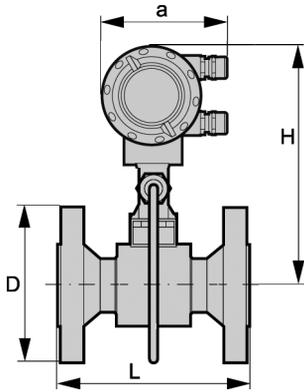
	HART® protocol via current output
Device revision	1
Physical layer	FSK
Device category	Transmitter, galvanically isolated
System requirements	Load min. 250 Ω
Multidrop operation	4 mA

Approvals and certifications

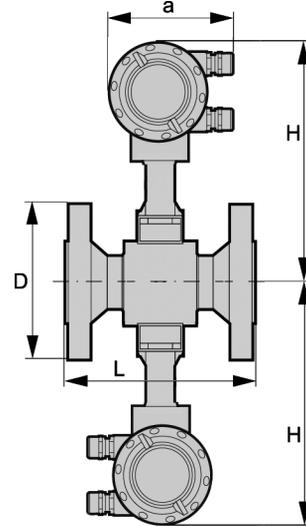
ATEX	ATEX II 2G Ex d ia [ia] IIC T6
FM	Class I, II, III Div 1/2, groups A-G

8.3 Dimensions and weights

8.3.1 Flange versions



Option: version with 2 transmitters



a = 135 mm / 5.32"

b = 108 mm / 4.26"
c = 184 mm / 7.25"

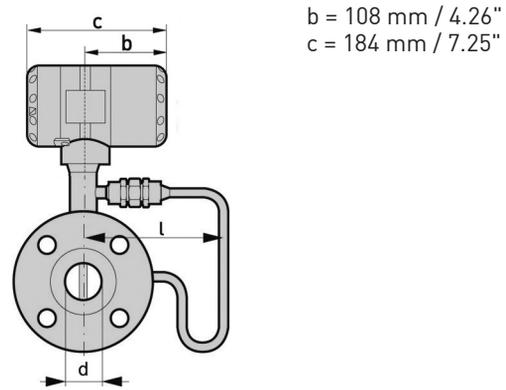
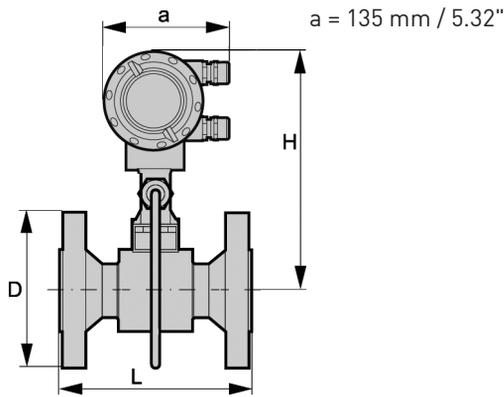
Specified weight + 2.80 kg

Flange version EN 1092-1

Size	Pressure rating	Dimensions [mm]							Weight [kg]	
		d	d FR ①	d F2R ②	D	L	H	l	with pressure sensor	without pressure sensor
DN	PN									
15	40	17.3	-	-	95	200	265	174.3	6.1	5.5
15	100	17.3	-	-	105	200	265	174.3	7.1	6.5
25	40	28.5	17.3	-	115	200	265	174.3	7.9	7.3
25	100	28.5	17.3	-	140	200	265	174.3	9.9	9.3
40	40	43.1	28.5	17.3	150	200	270	174.5	10.8	10.2
40	100	42.5	28.5	17.3	170	200	270	174.5	14.8	14.2
50	16	54.5	42.5	28.5	165	200	275	174.5	12.7	12.1
50	40	54.5	42.5	28.5	165	200	275	174.5	12.9	12.3
50	63	54.5	42.5	28.5	180	200	275	174.5	16.9	16.3
50	100	53.9	42.5	28.5	195	200	275	174.5	18.4	17.8
80	16	82.5	54.5	42.5	200	200	290	174.25	17.4	16.8
80	40	82.5	54.5	42.5	200	200	290	174.25	19.4	18.8
80	63	81.7	54.5	42.5	215	200	290	174.25	23.4	22.8
80	100	80.9	54.5	42.5	230	200	290	174.25	27.4	26.8
100	16	107.1	80.9	54.5	220	250	310	174.5	22,0	21.4
100	40	107.1	80.9	54.5	235	250	310	174.5	25,0	24.4
100	63	106.3	80.9	54.5	250	250	310	174.5	30,0	29.4

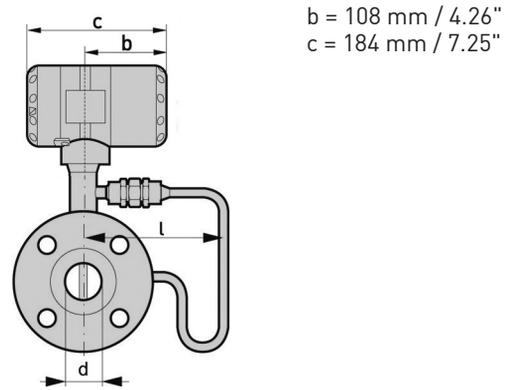
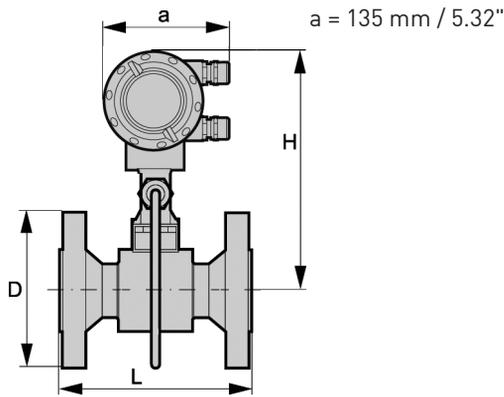
Size	Pressure rating	Dimensions [mm]							Weight [kg]		
		d	d FR ①	d F2R ②	D	L	H	l	with	without	
DN	PN									pressure sensor	
100	100	104.3	80.9	54.5	265	250	310	174.5	36.0	35.4	
150	16	159.3	107.1	80.9	285	300	325	196.5	35.8	35.2	
150	40	159.3	107.1	80.9	300	300	325	196.5	41.8	41.2	
150	63	157.1	107.1	80.9	345	300	325	196.5	59.8	59.2	
150	100	154.1	107.1	80.9	355	300	325	196.5	67.8	67.2	
200	10	206.5	159.3	107.1	340	300	350	208.5	38.4	37.8	
200	16	206.5	159.3	107.1	340	300	350	208.5	38.4	37.8	
200	25	206.5	159.3	107.1	360	300	350	208.5	47.4	46.8	
200	40	206.5	159.3	107.1	375	300	350	208.5	55.4	54.8	
250	10	260.4	206.5	159.3	395	380	370	236.5	58.0	57.4	
250	16	260.4	206.5	159.3	405	380	370	236.5	59.0	58.4	
250	25	258.8	206.5	159.3	425	380	370	236.5	75.0	74.4	
250	40	258.8	206.5	159.3	450	380	370	236.5	93.0	92.4	
300	10	309.7	260.4	206.5	445	450	395	261	76.3	75.7	
300	16	309.7	260.4	206.5	460	450	395	261	82.8	82.2	
300	25	307.9	260.4	206.5	485	450	395	261	99.3	98.7	
300	40	307.9	260.4	206.5	515	450	395	261	128.1	127.5	

- ① FR - single reduction
- ② F2R - double reduction



Flange version ASME B16.5

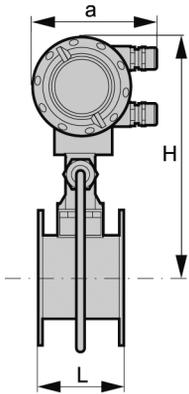
Size	Pressure rating	Dimensions [mm]							Weight [kg / lb]	
		d	d FR ①	d F2R ②	D	L	H	l	with	without
NPS	Class	pressure sensor								
½	150	15.8	-	-	90.0	200	265	174.3	5.1 / 11.2	4.5 / 9.9
½	300	15.8	-	-	95.0	200	265	174.3	5.5 / 12.1	4.9 / 10.8
½	600	13.9	-	-	95.0	200	265	174.3	5.7 / 12.6	5.1 / 11.2
1	150	26.6	15.8	-	110	200	265	174.3	6.8 / 15.0	6.2 / 13.7
1	300	26.6	15.8	-	125	200	265	174.3	7.8 / 17.2	7.2 / 15.9
1	600	24.3	15.8	-	125	200	265	174.3	8.1 / 17.9	7.5 / 16.5
1½	150	40.9	26.6	15.8	125	200	270	174.3	8.9 / 19.9	8.3 / 18.3
1½	300	40.9	26.6	15.8	155	200	270	174.3	11.0 / 24.3	10.4 / 22.9
1½	600	38.1	26.6	15.8	155	200	270	174.3	12.0 / 26.5	11.4 / 25.1
2	150	52.6	40.9	26.6	150	200	275	174.3	11.6 / 25.6	11.0 / 24.3
2	300	52.6	40.9	26.6	165	200	275	174.3	13.0 / 28.7	12.4 / 27.4
2	600	49.3	40.9	26.6	165	200	275	174.3	14.5 / 32.0	13.9 / 30.6
3	150	78.0	52.6	40.9	190	200	290	174.5	20.4 / 45.0	19.8 / 43.7
3	300	78.0	52.6	40.9	210	200	290	174.5	23.4 / 51.6	22.8 / 50.2
3	600	73.7	52.6	40.9	210	200	290	174.5	24.4 / 52.8	23.8 / 52.5
4	150	102.4	78.0	52.6	230	250	310	176.5	24.0 / 52.9	23.4 / 51.6
4	300	102.4	78.0	52.6	255	250	310	176.5	32.0 / 70.6	31.4 / 69.2
4	600	97.2	78.0	52.6	275	250	310	176.5	41.0 / 90.4	40.4 / 89.1
6	150	154.2	102,4	78.0	280	300	325	196.5	36.8 / 81.1	36.2 / 79.8
6	300	154.2	102,4	78.0	320	300	325	196.5	51.8 / 114	51.2 / 113
6	600	146.3	102,4	78.0	355	300	325	196.5	76.8 / 169	46.2 / 102
8	150	202.7	154,2	102.4	345	300	350	208.5	50.6 / 146	50.0 / 146
8	300	202.7	154,2	102.4	380	300	350	208.5	75.4 / 190	74.8 / 190
10	150	254.5	202,7	154.2	405	380	370	236.5	75.0 / 197	74.4 / 196
10	300	254.5	202,7	154,2	455	380	370	236.5	107 / 252	106 / 240
12	150	304.8	254,5	202,7	485	450	395	261.0	107 / 318	106 / 317
12	300	304.8	254,5	202,7	520	450	395	261.0	152 / 415	151 / 414



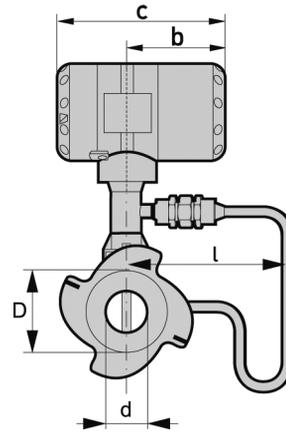
Flange version ASME B16.5

Size	Pressure rating	Dimensions [inches]							Weight [kg / lb]	
		d	d FR ①	d F2R ②	D	L	H	l	with	without
NPS	Class	pressure sensor								
½	150	0.6	-	-	3.5	7.9	10.4	6.9	5.1 / 11.2	4.5 / 9.9
½	300	0.6	-	-	3.7	7.9	10.4	6.9	5.5 / 12.1	4.9 / 10.8
½	600	0.5	-	-	3.7	7.9	10.4	6.9	5.7 / 12.6	5.1 / 11.2
1	150	1.1	0.6	-	4.3	7.9	10.4	6.9	6.8 / 15.0	6.2 / 13.7
1	300	1.1	0.6	-	4.9	7.9	10.4	6.9	7.8 / 17.2	7.2 / 15.9
1	600	1.0	0.6	-	4.9	7.9	10.4	6.9	8.1 / 17.9	7.5 / 16.5
1½	150	1.6	1.1	0.6	4.9	7.9	10.6	6.9	8.9 / 19.9	8.3 / 18.3
1½	300	1.6	1.1	0.6	6.1	7.9	10.6	6.9	11.0 / 24.3	10.4 / 22.9
1½	600	1.5	1.1	0.6	6.1	7.9	10.6	6.9	12.0 / 26.5	11.4 / 25.1
2	150	2.1	1.6	1.1	5.9	7.9	10.8	6.9	11.6 / 25.6	11.0 / 24.3
2	300	2.1	1.6	1.1	6.5	7.9	10.8	6.9	13.0 / 28.7	12.4 / 27.4
2	600	1.9	1.6	1.1	6.5	7.9	10.8	6.9	14.5 / 32.0	13.9 / 30.6
3	150	3.1	2.1	1.6	7.5	7.9	11.4	6.9	20.4 / 45.0	19.8 / 43.7
3	300	3.1	2.1	1.6	8.3	7.9	11.4	6.9	23.4 / 51.6	22.8 / 50.2
3	600	2.9	2.1	1.6	8.3	7.9	11.4	6.9	24.4 / 52.8	23.8 / 52.5
4	150	4.0	3.1	2.1	9.1	9.8	12.2	7.0	24.0 / 52.9	23.4 / 51.6
4	300	4.0	3.1	2.1	10.0	9.8	12.2	7.0	32.0 / 70.6	31.4 / 69.2
4	600	3.8	3.1	2.1	10.8	9.8	12.2	7.0	41.0 / 90.4	40.4 / 89.1
6	150	6.1	4.0	3.1	11.0	11.8	12.8	7.7	36.8 / 81.1	36.2 / 79.8
6	300	6.1	4.0	3.1	12.6	11.8	12.8	7.7	51.8 / 114	51.2 / 113
6	600	5.8	4.0	3.1	14.0	11.8	12.8	7.7	76.8 / 169	46.2 / 102
8	150	8.0	6.1	4.0	13.6	11.8	13.8	8.2	50.6 / 146	50.0 / 146
8	300	8.0	6.1	4.0	15.0	11.8	13.8	8.2	75.4 / 190	74.8 / 190
10	150	10.0	8.0	6.1	15.5	15.0	14.6	9.3	75.0 / 197	74.4 / 196
10	300	10.0	8.0	6.1	17.9	15.0	14.6	9.3	107 / 252	106 / 240
12	150	12.0	10.0	8.0	19.1	17.7	15.6	10.3	107 / 318	106 / 317
12	300	12.0	10.0	8.0	20.5	17.7	15.6	10.3	152 / 415	151 / 414

8.3.2 Sandwich version



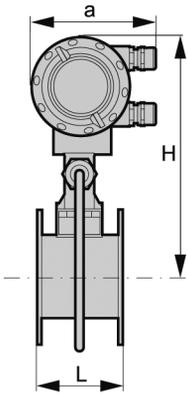
a = 135 mm / 5.32"



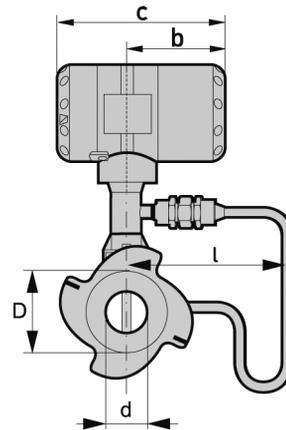
b = 108 mm / 4.26"
c = 184 mm / 7.25"

Sandwich version EN

Size DN	Pressure rating PN	Dimensions [mm]					Weight [kg]	
		d	D	L	H	l	With pressure sensor	Without
15	100	16	45	65	265	174.25	4.1	3.5
25	100	24	65	65	265	174.25	4.9	4.3
40	100	38	82	65	270	174.5	5.5	4.9
50	100	50	102	65	275	174.5	6.6	6
80	100	74	135	65	290	174.25	8.8	8.2
100	100	97	158	65	310	176.5	10.1	9.5



a = 135 mm / 5.32"

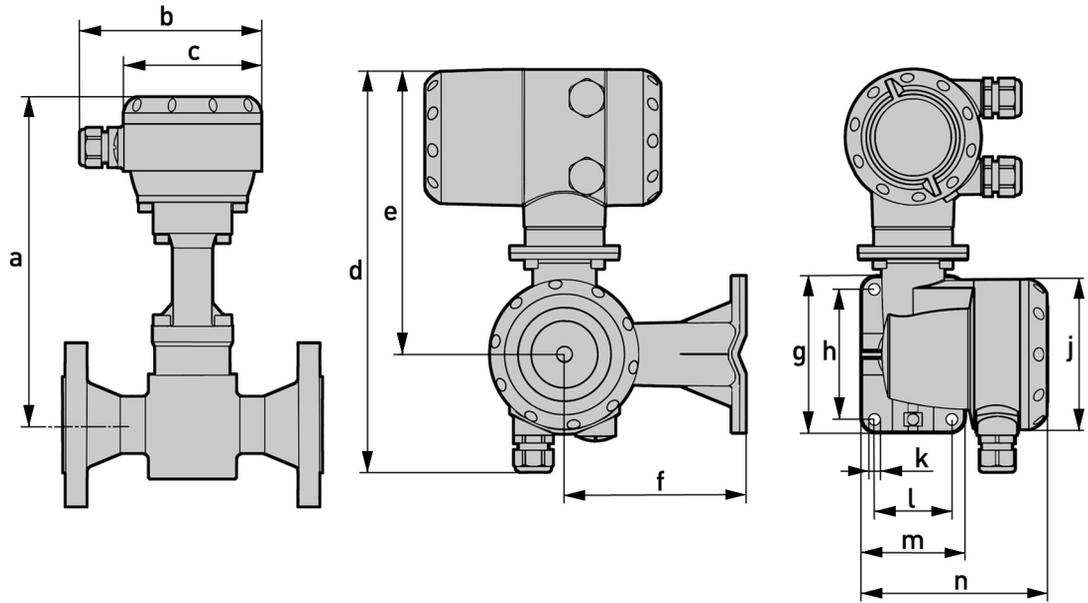


b = 108 mm / 4.26"
c = 184 mm / 7.25"

Sandwich version ASME

Size NPS	Pressure rating Class	Dimensions [inches]					Weight [lb]	
		d	D	L	H	l	With pressure sensor	Without
1/2	150	0.63	1.77	2.56	10.43	6.82	9.04	7.72
1/2	300	0.63	1.77	2.56	10.43	6.82	9.04	7.72
1/2	600	0.55	1.77	2.56	10.43	6.82	9.04	7.72
1	150	0.94	2.56	2.56	10.43	6.82	10.8	9.48
1	300	0.94	2.56	2.56	10.43	6.82	10.8	9.48
1	600	0.94	2.56	2.56	10.43	6.82	10.8	9.48
1 1/2	150	1.5	3.23	2.56	10.63	6.87	12.13	10.8
1 1/2	300	1.5	3.23	2.56	10.63	6.87	12.13	10.8
1 1/2	600	1.5	3.23	2.56	10.63	6.87	12.13	10.8
2	150	1.97	4.02	2.56	10.83	6.87	14.55	13.23
2	300	1.97	4.02	2.56	10.83	6.87	14.55	13.23
2	600	1.97	4.02	2.56	10.83	6.87	14.55	13.23
3	150	2.91	5.31	2.56	11.42	6.82	19.4	18.08
3	300	2.91	5.31	2.56	11.42	6.82	19.4	18.08
3	600	2.91	5.31	2.56	11.42	6.82	19.4	18.08
4	150	3.82	6.22	2.56	12.21	6.95	22.27	20.94
4	300	3.82	6.22	2.56	12.21	6.95	22.27	20.94
4	600	3.82	6.22	2.56	12.21	6.95	22.27	20.94

8.3.3 Dimensions remote version



Dimension a

	Flanged version										
	Sandwich version						-				
DN ▶	15	25	40	50	80	100	150	200	250	300	
NPS ▶	½	1	1½	2	3	4	6	8	10	12	
[mm] ▶	248	248	253	258	273	293	308	333	353	378	
["] ▶	9.77	9.77	9.97	10.2	10.8	11.5	12.1	13.1	13.9	14.9	

	b	c	d	e	f	g	h	j	k	l	m	n
[mm]	140	∅ 106	310	219	140	120	100	∅ 115	∅ 9 (4x)	60	80	144
["]	5.52	∅ 4.18	12.2	8.63	5.52	4.73	3.94	∅ 4.53	∅ 0.36 (4x)	2.36	3.15	5.67

8.4 Flow tables

Measuring ranges

Size		Q _{min}	Q _{max}	Q _{min}	Q _{max}
DN - EN 1092-1	NPS - ASME B16.5	[m ³ /h]		[gph]	

Water

15	½	0.45	5.0	119	1321
25	1	0.81	11.40	214	3012
40	1½	2.04	28.57	539	7547
50	2	3.53	49.47	933	13069
80	3	7.74	108.37	2045	28629
100	4	13.30	186.21	3514	49192
150	6	30.13	421.86	7960	111445
200	8	52.66	792.42	13911	209335
250	10	90.5	1266.8	23908	334653
300	12	113.41	1839.8	29960	486024
Values based on water at 20°C / 68°F					

Air

15	½	6.79	32.56	1794	8602
25	1	10.20	114.0	2695	30116
40	1½	25.35	326.63	6697	86287
50	2	43.89	565.49	11595	149388
80	3	96.14	1238.60	25398	327207
100	4	165.19	2128.27	43639	562236
150	6	374.23	4821.57	98862	1273738
200	8	702.95	9056.8	185700	2392553
250	10	1123.7	14478	29685	3824683
300	12	1632.1	21028	431155	55550104
Values based on air at 20°C / 68°F and 1.013 bar abs / 14.891 psig					

Flow rate limits

Product	Nominal sizes		Minimum flow rates		Maximum flow rates	
	EN	ASME	[m/s]	[ft/s]	[m/s]	[ft/s]
Liquids	DN15...300	½...12"	0.5x(998/ρ) ^{0.5} ①	1.64x(998/ρ) ^{0.5} ②	7x(998/ρ) ^{0.47} ①	23x(998/ρ) ^{0.47} ②
Gas, steam	DN15...300	½...12"	6x(1.29/ρ) ^{0.5} ③	16.4x(1.29/ρ) ^{0.5} ④	7x(998/ρ) ^{0.47} ③	23x(998/ρ) ^{0.47} ④
ρ = operating density [kg/m ³]						

① Minimum flow rate 0.3 m/s - maximum flow rate 7 m/s

② Minimum flow rate 0.984 ft/s - maximum flow rate 23 ft/s

③ Minimum flow rate 2 m/s - maximum flow rate 80 m/s; DN15 up to 45 m/s and DN25 up to 70 m/s

④ Minimum flow rate 6.6 ft/s - maximum flow rate 262 ft/s; DN15 up to 148 ft/s and DN25 up to 230 ft/s

Measuring range saturated steam: 1...7 bar

Overpressure [bar]		1		3.5		5.2		7	
Density [kg/m ³]		1.13498		2.4258		3.27653		4.16732	
Temperature [°C]		120.6		148.2		160.4		170.6	
Flow rate		min.	max.	min.	max.	min.	max.	min.	max.
DN EN 1092-1	NPS ASME B16.5	[kg/h]		[kg/h]		[kg/h]		[kg/h]	
15	½	5.87	36.97	7.68	79.0	8.93	106.68	10.06	135.69
25	1	11.82	129.39	17.28	276.40	20.09	373.53	22.66	474.82
40	1½	29.64	370.71	43.33	792.33	50.63	1070.2	56.8	1361.2
50	2	51.31	641.82	75.02	1371.8	87.19	1852.8	98.33	2356.6
80	3	112.41	1405.8	164.33	3004.7	191	4058.4	215.39	5161.8
100	4	193.14	2415.5	282.36	5162.7	328.16	6973.3	370.09	8869.2
150	6	437.56	5472.4	639.69	11696	743.45	15798	838.44	20093
200	8	821.91	10279	1201.6	21970	1396.5	29675	1574.9	37743
250	10	1313.9	16433	1920.9	35122	2232.5	47439	2517.7	60337
300	12	1908.3	23866	2789.8	51010	3242.4	68899	3656.6	87630

Measuring range saturated steam: 10.5...20 bar

Overpressure [bar]		10.5		14		17.5		20	
Density [kg/m ³]		5.88803		7.60297		9.31702		10.5442	
Temperature [°C]		186.2		198.5		208.5		215	
Flow rate		min.	max.	min.	max.	min.	max.	min.	max.
DN EN 1092-1	NPS ASME B16.5	[kg/h]		[kg/h]		[kg/h]		[kg/h]	[kg/h]
15	½	12.78	191.71	16.51	247.55	20.23	303.36	22.89	343.32
25	1	26.93	670.88	30.6	857.88	33.87	955.48	36.04	1201.41
40	1½	67.51	1878.2	76.72	2150.7	84.93	2395.3	90.35	2557.7
50	2	116.89	3251.7	132.82	3723.4	147.03	4147	156.42	4428.1
80	3	256.03	7122.4	290.93	8155.8	322.06	9083.7	342.62	9699.3
100	4	439.91	12238	499.9	14013	553.38	15608	588.69	16666
150	6	996.62	27725	1132.5	31747	1253.7	35359	1333.7	37756
200	8	1872.1	52079	2127.3	59634	2354.9	66419	2505.2	70921
250	10	2992.7	83254	3400.71	95333	3764.6	106180	4004.9	113380
300	12	4346.5	120920	4939.1	138460	5467.5	154210	5816.5	164660

Measuring range saturated steam: 15...100 psig

Overpressure [psig]		15		50		75		100	
Density [lb/ft ³]		0.0719		0.1497		0.2036		0.2569	
Temperature [°F]		249.98		297.86		320.36		338.184	
Flow rate		min.	max.	min.	max.	min.	max.	min.	max.
DN EN 1092-1	NPS ASME B16.5	[lb/h]		[lb/h]		[lb/h]		[lb/h]	[lb/h]
15	½	12.9	82.70	16.83	1720.12	19.62	234.0	22.04	295.23
25	1	26.25	289.40	37.86	602.09	44.15	818.63	49.59	1032.76
40	1½	65.81	829.61	94.92	1726	110.68	2346.7	124.32	2960.5
50	2	113.94	1436.3	164.34	2988	191.63	4062.9	215.23	5125.6
80	3	249.57	3146.1	360	6545.3	419.74	8899.4	471.45	11227
100	4	428.81	5405.7	618.51	11246	721.21	15291	810.06	19291
150	6	971.47	12246	1401.2	25478	1633.9	34642	1835.2	43703
200	8	1824.8	23004	2632.1	47859	3069.1	65072	3447.2	82092
250	10	2917.2	36774	4207.7	76508	4906.4	104030	5510.8	131230
300	12	4236.8	53410	6111.1	111120	7125.8	151080	8003.6	190600

Measuring range saturated steam: 150...300 psig

Overpressure [psig]		150		200		250		300	
Density [lb/ft ³]		0.3627		0.4681		0.5735		0.6792	
Temperature [°F]		366.08		388.04		406.22		422.06	
Flow rate		min.	max.	min.	max.	min.	max.	min.	max.
DN EN 1092-1	NPS ASME B16.5	[lb/h]		[lb/h]		[lb/h]		[lb/h]	[lb/h]
15	½	27.79	416.68	35.86	573.83	43.94	659.14	52.04	780.29
25	1	58.93	1459.16	66.94	1875.90	74.1	2089.00	80.63	2284.90
40	1½	147.72	4107.2	167.83	4702.8	185.76	5237	202.15	5728
50	2	255.75	7111.9	290.56	8141.9	321.6	9066.8	350	9917
80	3	560.19	15578	636.44	17834	704.43	19860	766.6	21722
100	4	962.54	26766	1093.5	30643	1210.4	34124	1317.2	37324
150	6	2180.6	60639	2477.4	69421	2742.1	77307	2984	84556
200	8	4096.1	113900	4653.6	130400	5150.7	145210	5605.2	158830
250	10	6548.1	182090	7439.3	208460	8234.1	232140	8960.6	253910
300	12	9510.2	264460	10805	302760	11959	337150	13014	368770

**Honeywell Field Solutions
512 Virginia Drive
Fort Washington, PA 19034
www.honeywell.com/ps**

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