



## OPTISWIRL 4070 Handbook

Vortex flowmeter

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## 1.1 Intended use

**CAUTION!**

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

**INFORMATION!**

*This device is a Group 1, Class A device as specified within CISPR11:2009. It is intended for use in industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.*

**INFORMATION!**

*The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.*

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

**CAUTION!**

*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.*

- 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



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

- Pressure equipment directive
- EMC directive
- Devices for use in hazardous areas: ATEX directive

as well as

- EN 61010
- NAMUR recommendations NE 21 and NE 43

The manufacturer certifies successful testing of the product by applying the CE marking. A CE declaration of conformity regarding the directives in question and the associated harmonised standards can be downloaded from our internet site.



***DANGER!***

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

## **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 or 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 icons as shown below.

### 1.3.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.



**DANGER!**

*This warning 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 packaging 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.*

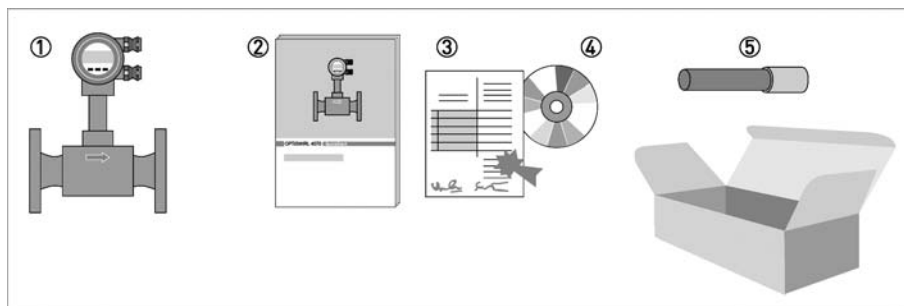


Figure 2-1: Scope of delivery

- 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
- Measuring sensor in flanged design, Sensor F
- Measuring sensor in sandwich design, Sensor S
- Remote version - Measuring sensor with separated remote signal converter

**The following designs are available as options:**

- with pressure sensor
- with shut-off valve for the pressure sensor
- Flange version, measuring sensor with single reduction F1R
- Flange version, measuring sensor with double reduction 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.

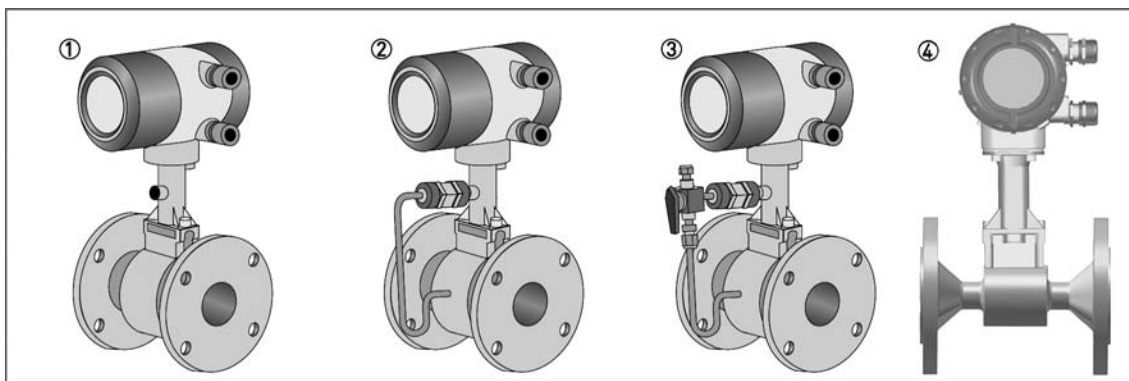


Figure 2-2: Flanged devices with display

- 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 Flange sensor version with inlet reduction

### 2.2.2 Sandwich version

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

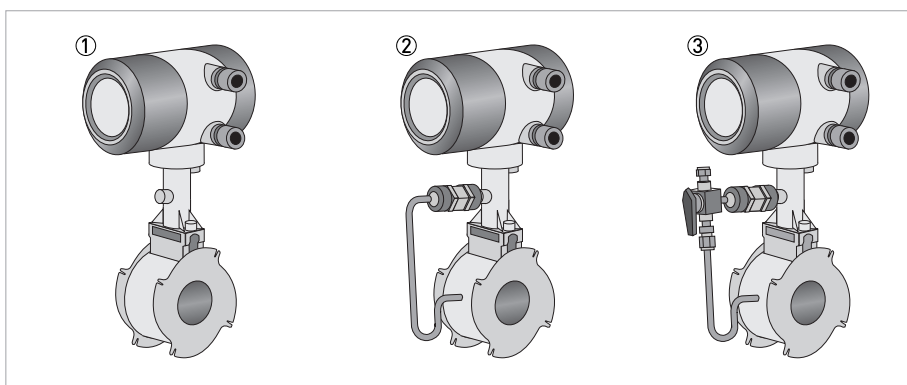
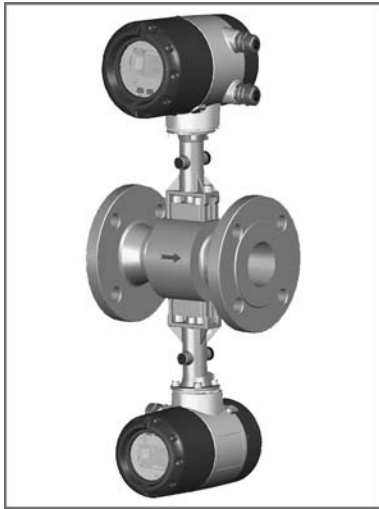


Figure 2-3: Sandwich versions with display

- 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



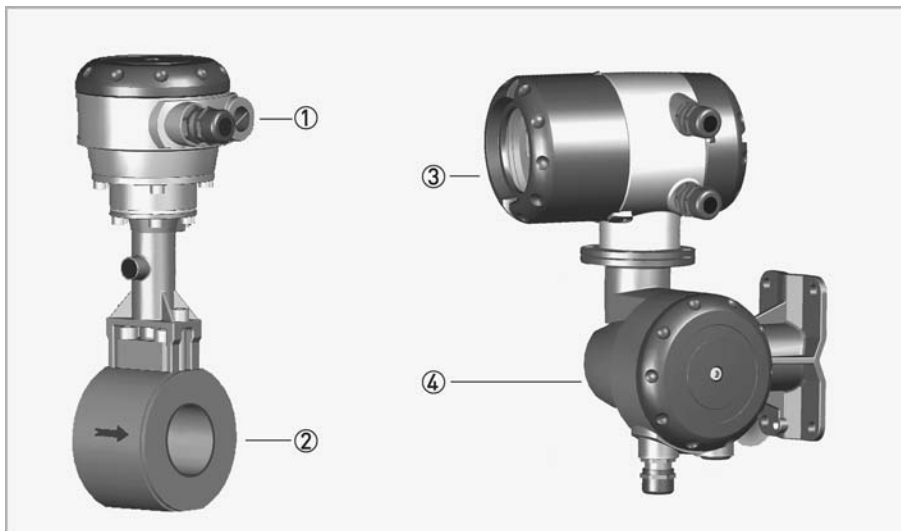
This is a genuine redundant system with two independent measuring sensors and two signal converters.

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, the measuring sensor and signal converters are located separately. The 10-pin, shielded connection cable may not exceed 15m in length.

The marking of the devices is shown on the nameplates below (see also description code). On both the compact devices and the remote versions, the main plate is located on the converter housing. On the remote versions there is an additional marking on the measuring sensor.

### 2.2.5 Device description

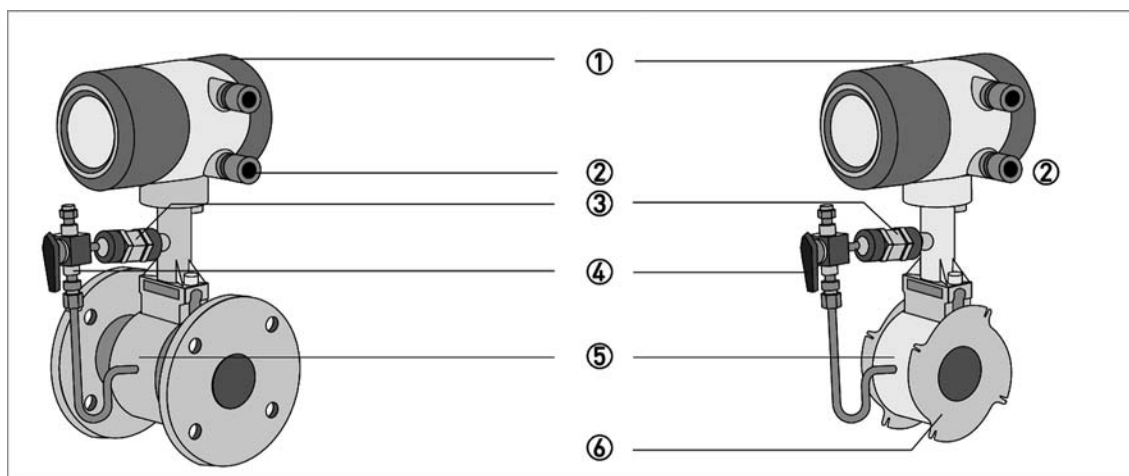


Figure 2-4: Device description

- 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 as power output. The enthalpy tables are permanently programmed in the memory of the device.

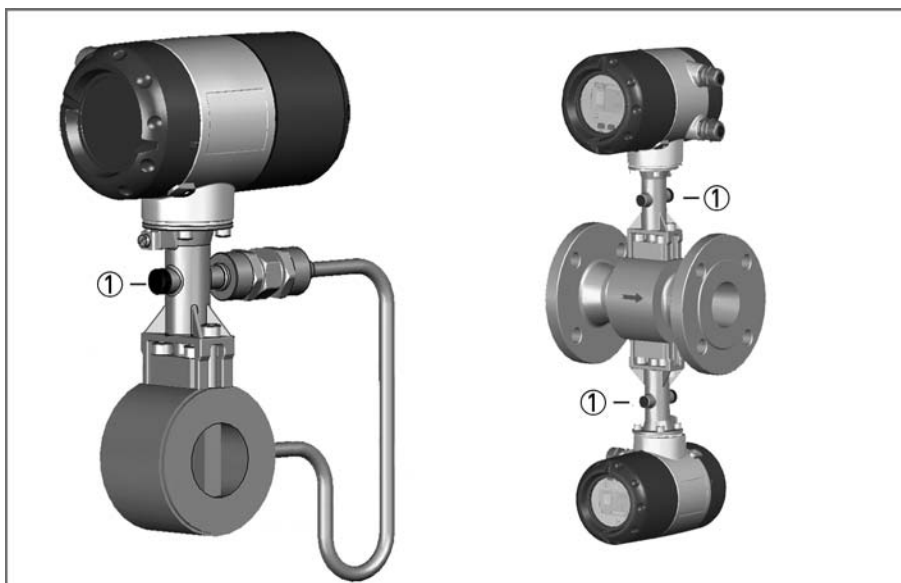
The online density-compensated mass flow is multiplied by the correct enthalpy to obtain the flow as power output.

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

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 comply with the requirements of ANSI/ISA 12.27.01-2003 "Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluid", a membrane vent is integrated in the neck of the device. This vent is located between the primary seal (process) and the secondary seal (electronics compartment) and works to prevent pressure build-up in the device neck, thus preventing product from penetrating the electronics compartment in the unlikely event of a leak in the primary seal.



① Membrane vent

The seal between the pick-up and the measuring tube is considered as the primary seal. The material used for it is always the same as that used for the measuring tube itself (e.g. stainless steel 1.4404 / 316L or Hastelloy® C22). When selecting a material, corrosion resistance in relation to process parameters (media, temperature) must be taken into account. By using the membrane vent, all requirements for a "DUAL SEAL" version in terms of the above mentioned standards are met.

- It protects the electronics from the process media.
- Any leak in the primary seal can be detected.

Even though there is no reason to expect the seal to fail, regular visual checks should still be carried out to detect any possible leak as early as possible.

In the event of a leak, contact the manufacturer's service department to service or replace the device.



## 2.3 Nameplate



### INFORMATION!

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

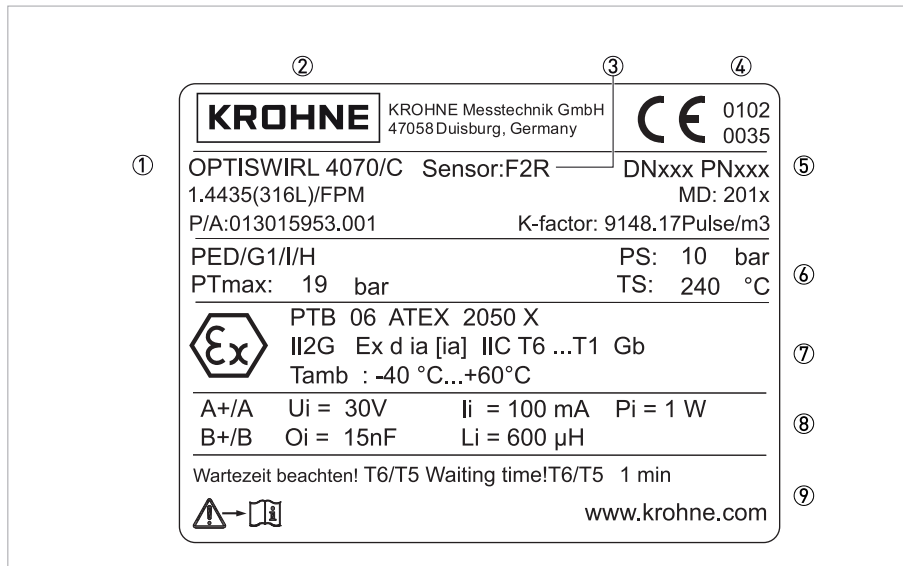


Figure 2-5: Example of nameplate

- ① Device type
- ② Manufacturer
- ③ Sensor:  
S - Sandwich  
F - Flange  
F1R - Flange single reduction  
F2R - Flange double reduction
- ④ Notified bodies for ATEX & PED (only available if this option was ordered)
- ⑤ Connection data: nominal diameter and pressure rating
- ⑥ PED data
- ⑦ Ex data (only available if this option was ordered)
- ⑧ Electrical connection data
- ⑨ Manufacturer's website

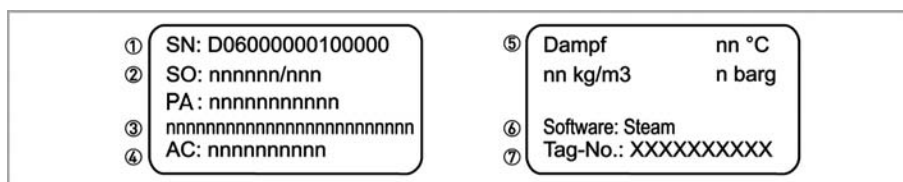


Figure 2-6: Example of nameplate

- ① Serial number
- ② Order number
- ③ Type code
- ④ Item number
- ⑤ Fluid data
- ⑥ Software variant
- ⑦ Tag number

## 2.4 Description code

The description code\* consists of the following elements:

### Compact device

OPTISWIRL 4070 C / ...			
①	②	③	④

- ① Product designation
- ② Type series
- ③ Compact measuring device
- ④ Marking without influence on the explosion safety protection

### Signal converter remote version

VFC	070	F	...
①	②	③	④

- ① Product designation
- ② Type series
- ③ Remote version
- ④ Marking without influence on the explosion safety protection

### Sensor remote version

OPTISWIRL 4000 ...			
①	②	③	

- ① Product designation
- ② Type series sensor
- ③ Marking without influence on the explosion safety protection

\* positions which are not needed are omitted (no blank positions)

The remote version consisting of the OPTISWIRL 4000 flow sensor and the VFC 070 F signal converter is called the OPTISWIRL 4070 F.

### 3.1 General notes on installation



**INFORMATION!**

*Inspect the packaging 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, dust-free location.
- Avoid extended direct exposure to the sun.
- Store the device in the original packaging.
- The permissible storage temperature for standard devices is -40...+85°C / -40...+185°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.

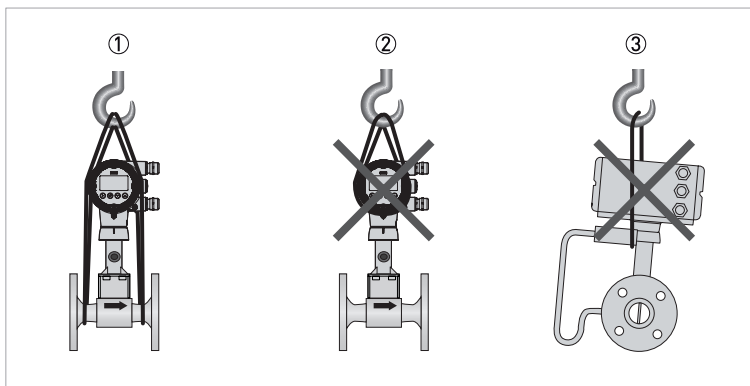


Figure 3-1: Transport instructions



**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.*

**CAUTION!**

*Eliminate vibrations in the pipeline by properly installing the measuring device. Any vibration will distort the measuring result.*

**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 there is a risk of water hammers in steam networks, appropriate condensate separators must be installed.*

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

### 3.4.1 Prohibited installation when measuring liquids

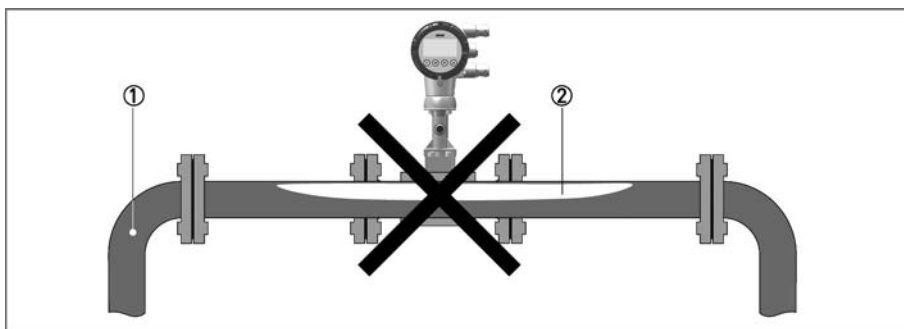


Figure 3-2: Upper pipe bend



**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.*

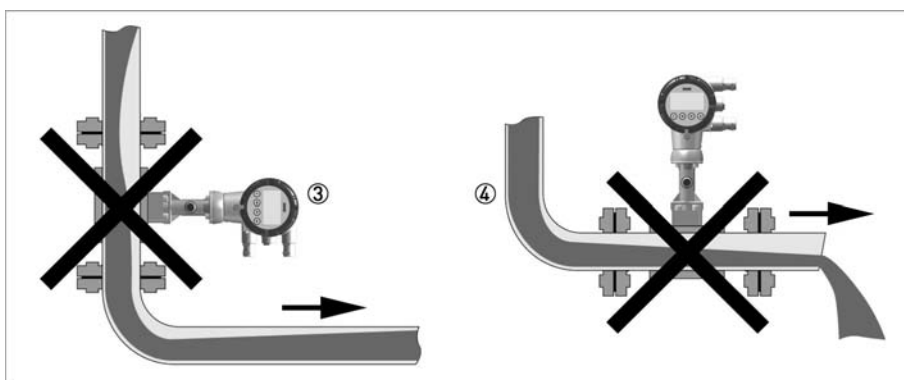


Figure 3-3: Downstream pipe and outlet



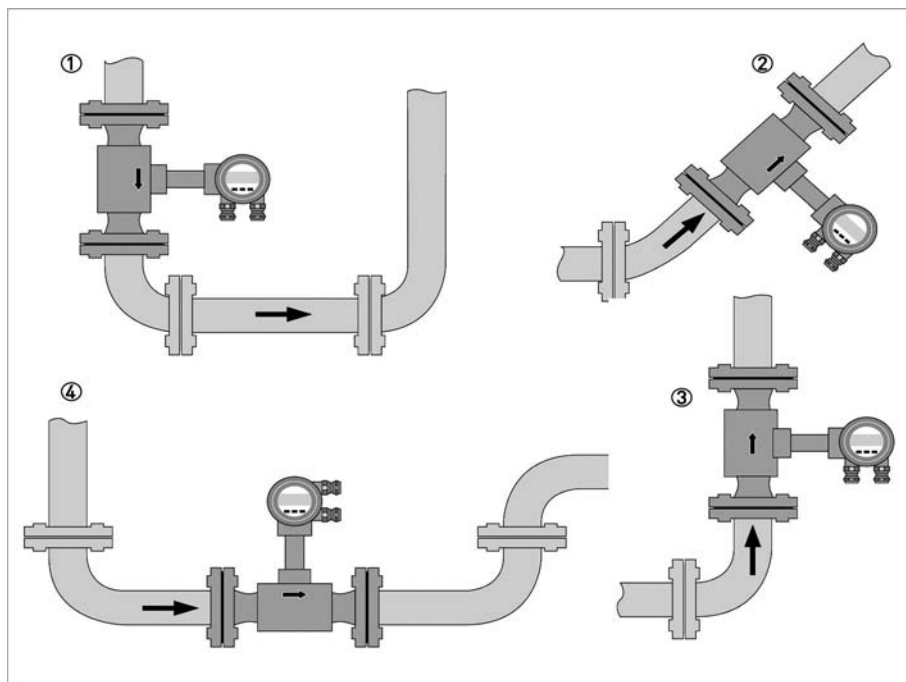
**CAUTION!**

*Installing the device in a downstream pipe ③ or upstream pipe of an outlet ④. There is the risk of partially filled pipes leading to inaccurate measurements.*

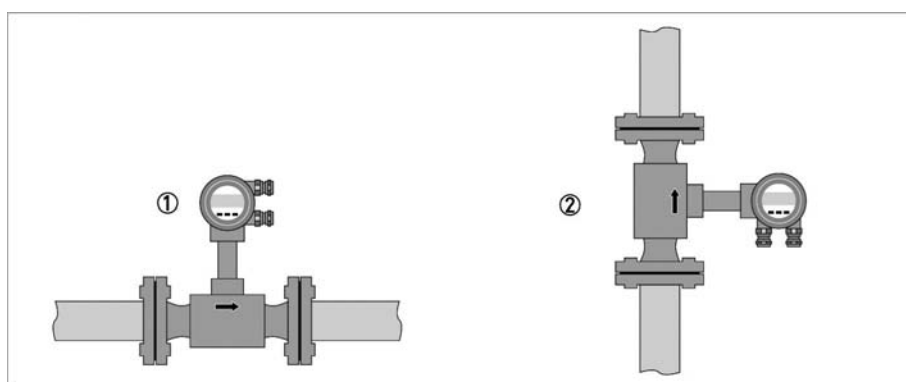
## 3.4.2 Recommended installations for measurement of liquids

**CAUTION!**

*The required inlet and outlet sections must be observed.*



- 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.

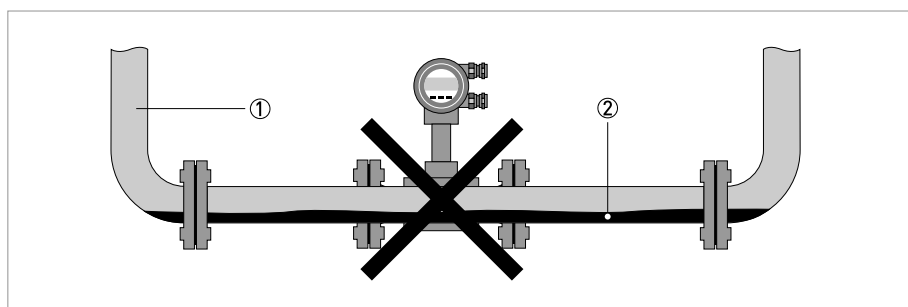


- ① Above a horizontal pipe
- ② On a vertical pipe

**INFORMATION!**

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

### 3.4.3 Prohibited installation when measuring vapours and gases



- 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.*

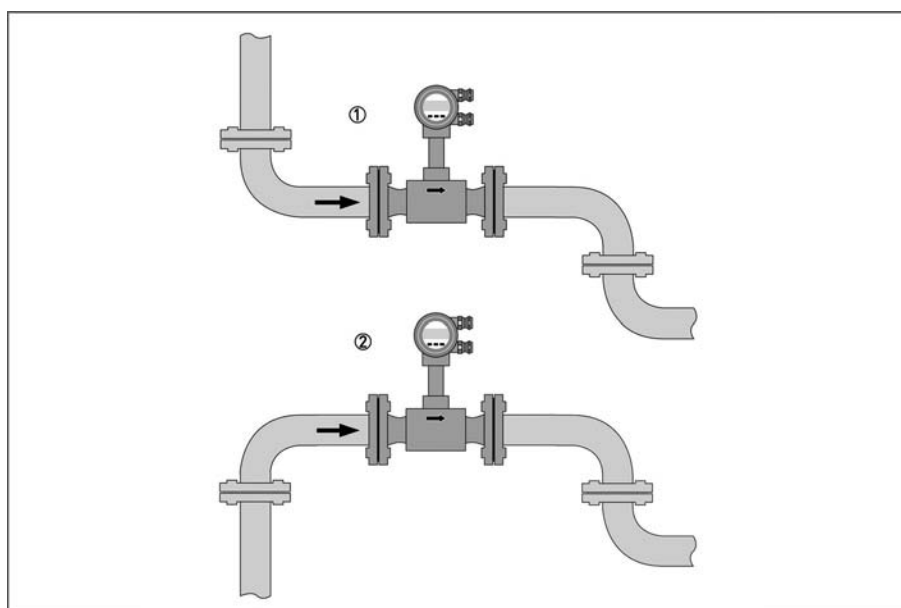
*Condensate can lead to cavitation and inaccurate measurement. Under certain circumstances the device can be destroyed and the measured product can leak.*

### 3.4.4 Recommended installations for measurement of steam and gases



**CAUTION!**

*The required inlet and outlet sections must be observed.*



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

## 3.4.5 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.

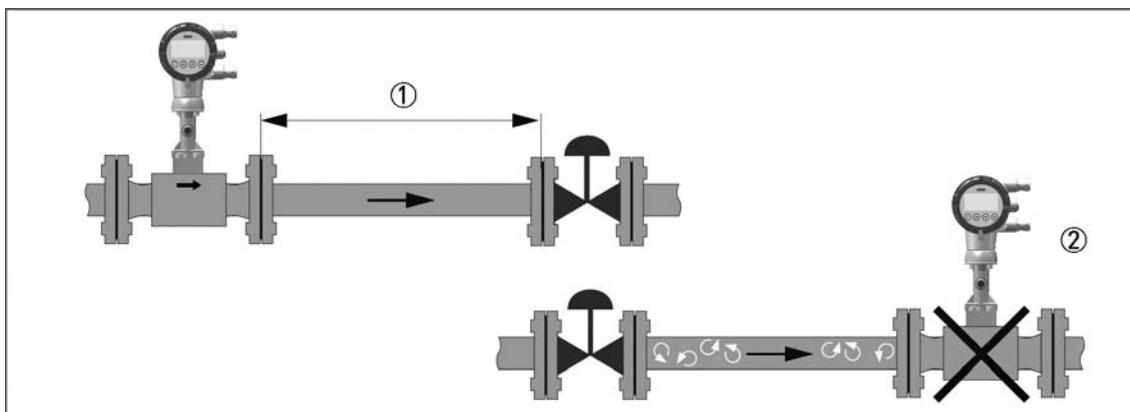
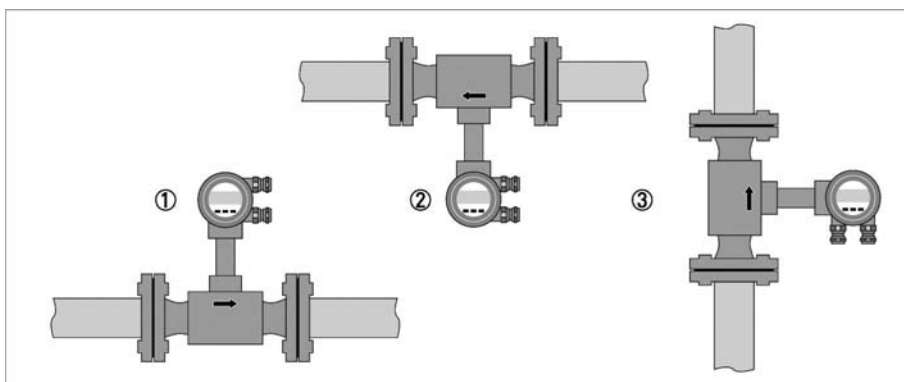


Figure 3-4: Pipeline with control valve

- ① Recommended: installing the device before the control valve at a distance of  $\geq 5$  DN
- ② Not recommended: Installing the flowmeter directly downstream of control valves, due to vortex formation.

## 3.4.6 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.



### 3.4.7 Turning the connection housing

**DANGER!**

*All work on the device electrics 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.*

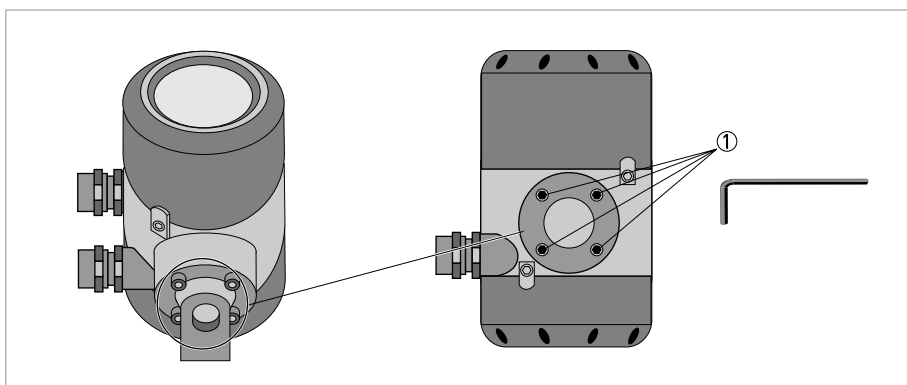


Figure 3-5: Allen screws on connection housing



- 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.

## 3.4.8 Turning the display

**DANGER!**

All work on the device electrics 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°.

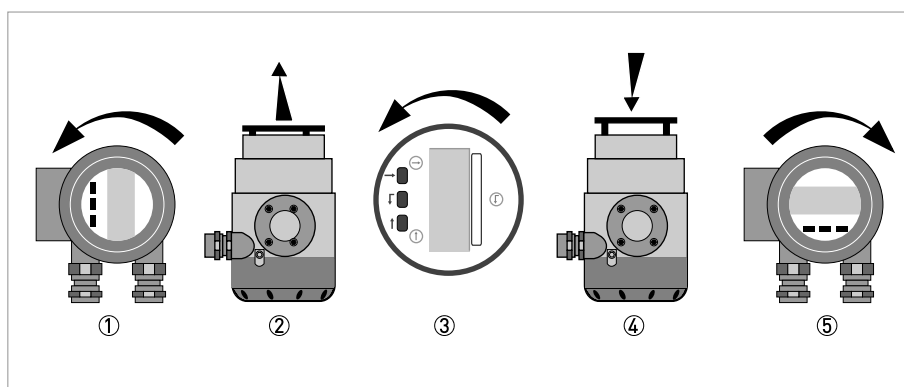


Figure 3-6: Turning the display

**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.

### 3.4.9 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.

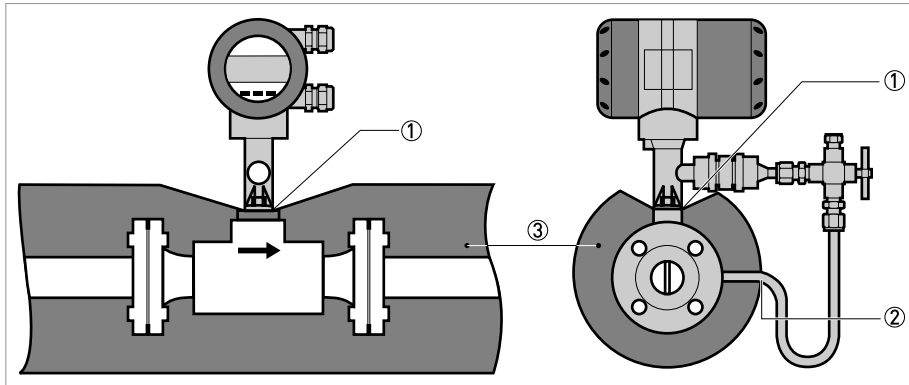


Figure 3-7: Heat insulation on connection piece and signal cable

- 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

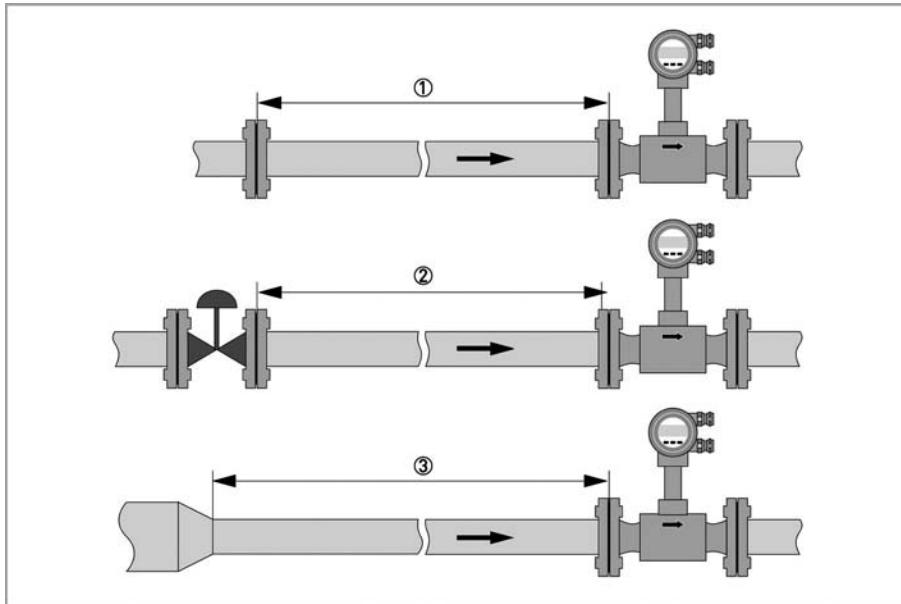


**CAUTION!**

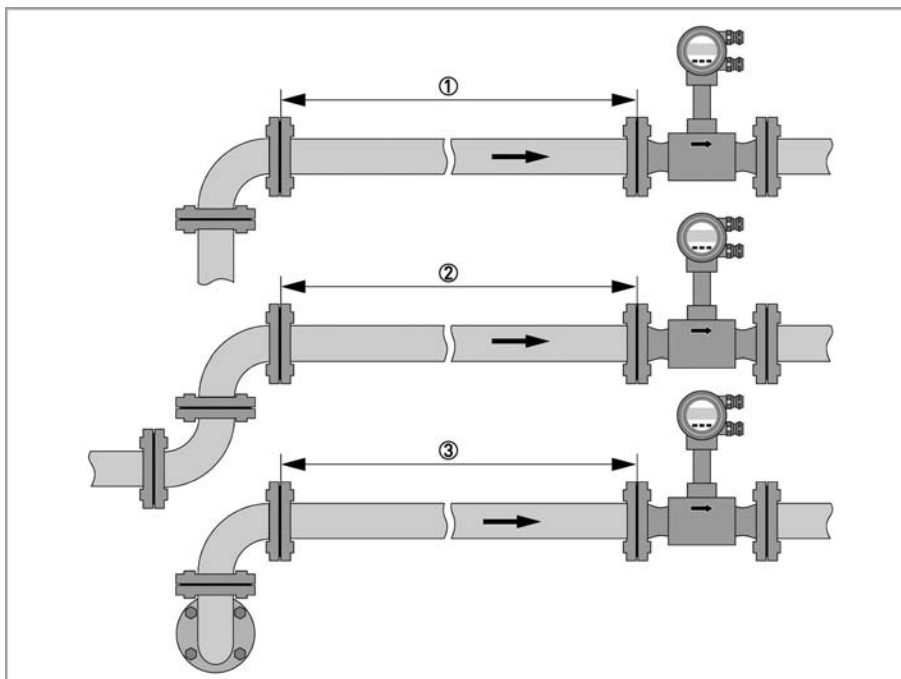
The heat insulation ③ may only extend as far as the bend of the pressure sensing line ②.

### 3.5 Inlet and outlet runs

#### 3.5.1 Minimum inlet runs



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

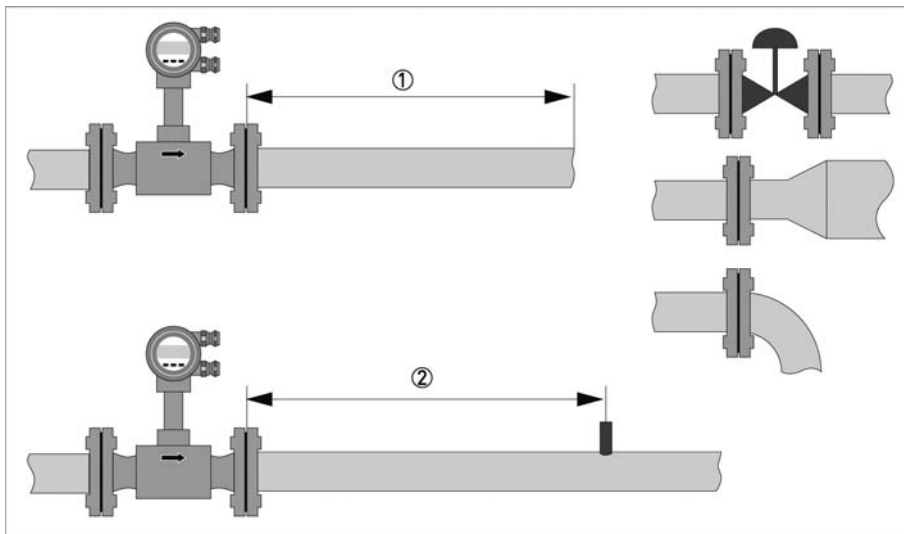


Figure 3-8: Minimum outlet sections

- ① Upstream of pipe expanders, pipe bends, control valves, etc.  $\geq 5$  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. The distance from external temperature measuring points must be  $\geq 5$  DN. Use measuring sensors that are as short as possible to avoid disturbances of 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.

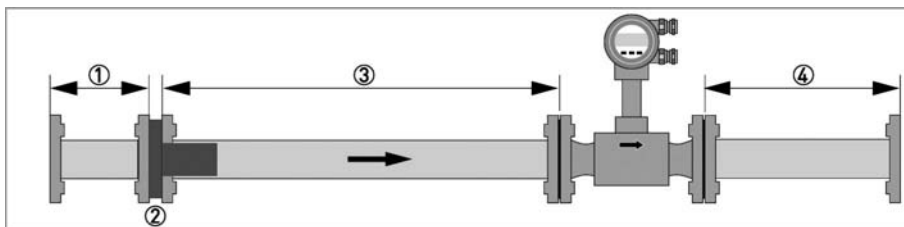


Figure 3-9: Flow straightener

- ① Straight inlet run upstream of straightener  $\geq 2$  DN
- ② Flow straightener
- ③ Straight pipe run between flow straightener and device  $\geq 8$  DN
- ④ Minimum straight outlet run  $\geq 5$  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:**

- 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 neck of the flow sensor.
- On measuring points with varying thermal loads, the devices 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 measuring point.

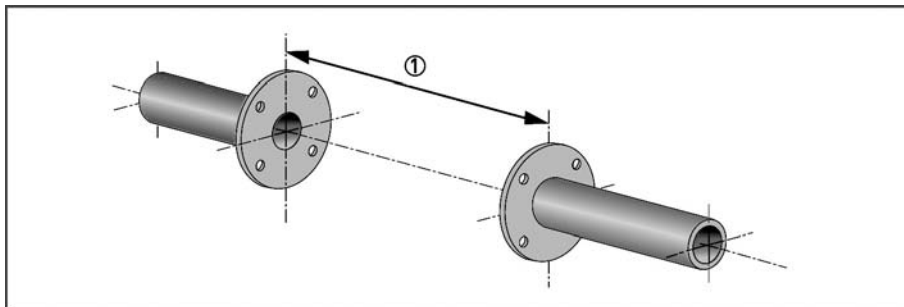


Figure 3-10: Preparing the metering point

① Installation length of measuring device + thickness of gaskets.



**CAUTION!**

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

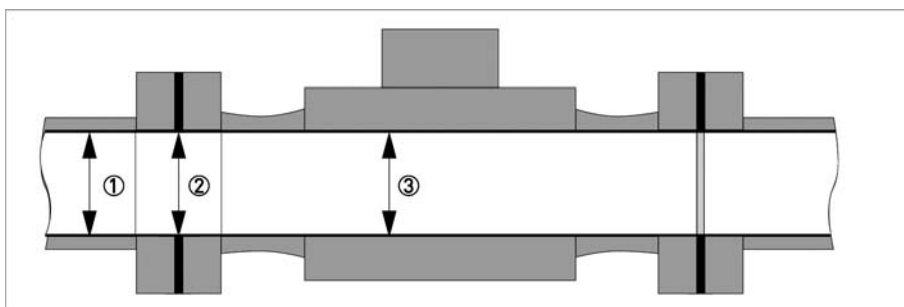


Figure 3-11: Inner diameter

- ① Inner diameter of connection pipe
- ② Inner diameter of flange and gasket
- ③ Inner diameter of flow sensor

### 3.6.2 Installing devices in flange design

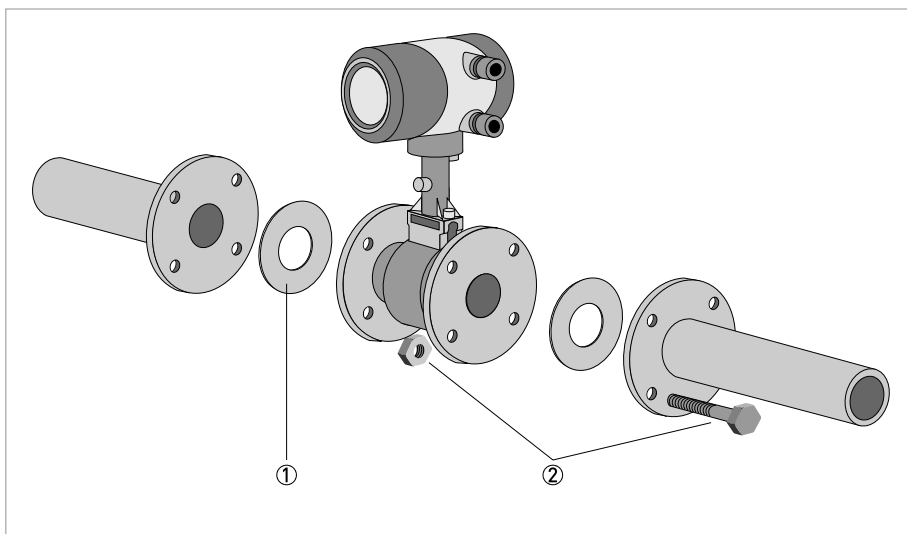


Figure 3-12: Installing devices in flange design

- 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

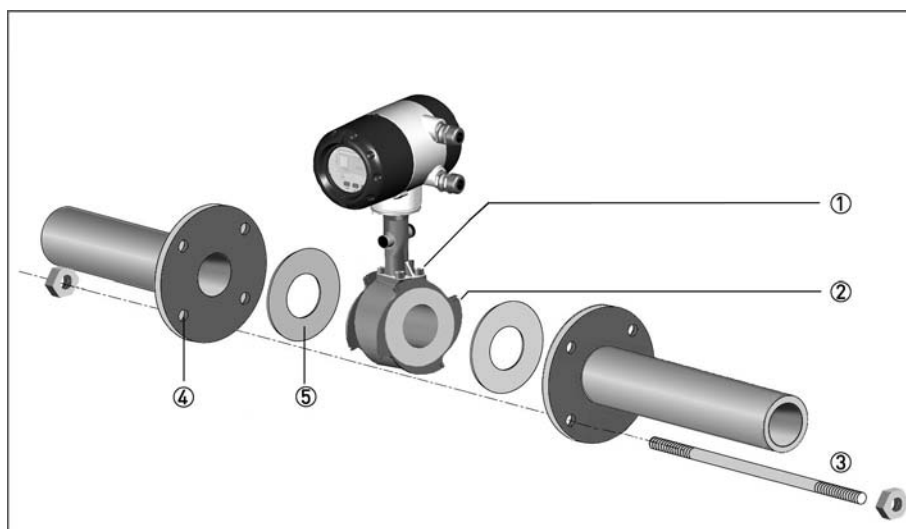


Figure 3-13: Installation using centering ring

- ① Flow sensor
- ② Centering ring
- ③ Bolts with fixing nuts
- ④ Drill hole
- ⑤ Sealing



- 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 centring 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.*

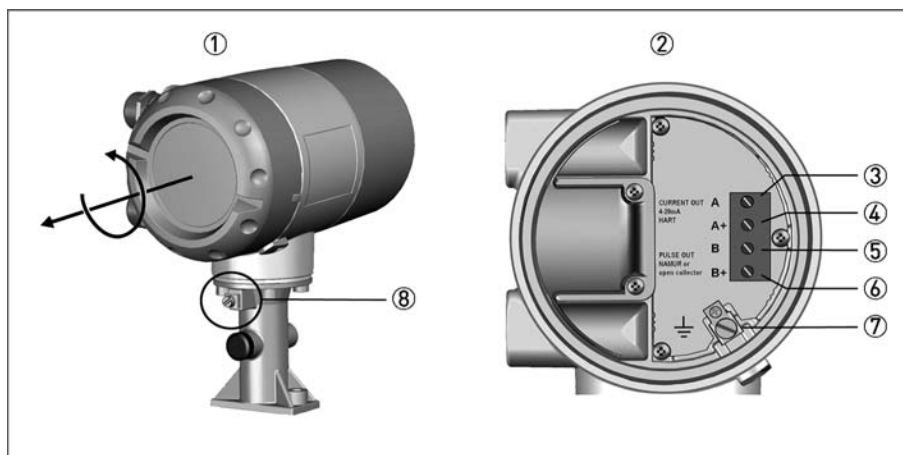
**WARNING!**

*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



- 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 Ground terminal in housing
- ⑧ Ground 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.
- Feed the connection cable through the cable entry 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 the terminal ⑦, alternatively use the PE terminal on the connection piece between the measuring sensor and the 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  $I_{\text{tot}}$  does not exceed 100 mA.
- Connection current output on terminals A, A+  
Connection pulse output on terminals B, B+

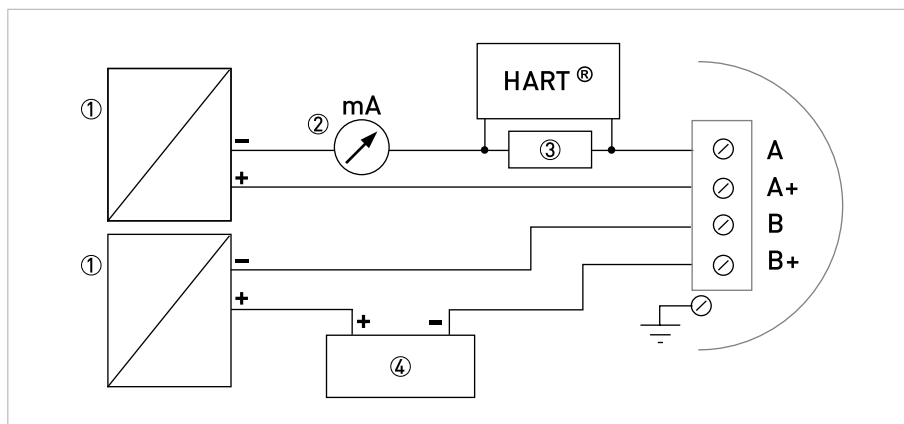


Figure 4-1: Electrical connection of current and pulse output

- 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:

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

### 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:

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

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 **m<sup>3</sup>** for volume, **m<sup>3</sup>norm.** 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.

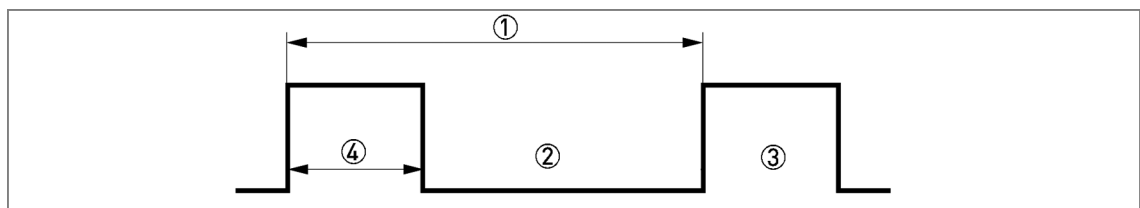


Figure 4-2: pulse output

- 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  $f_{\max} = 0.5 \, \text{Hz}$

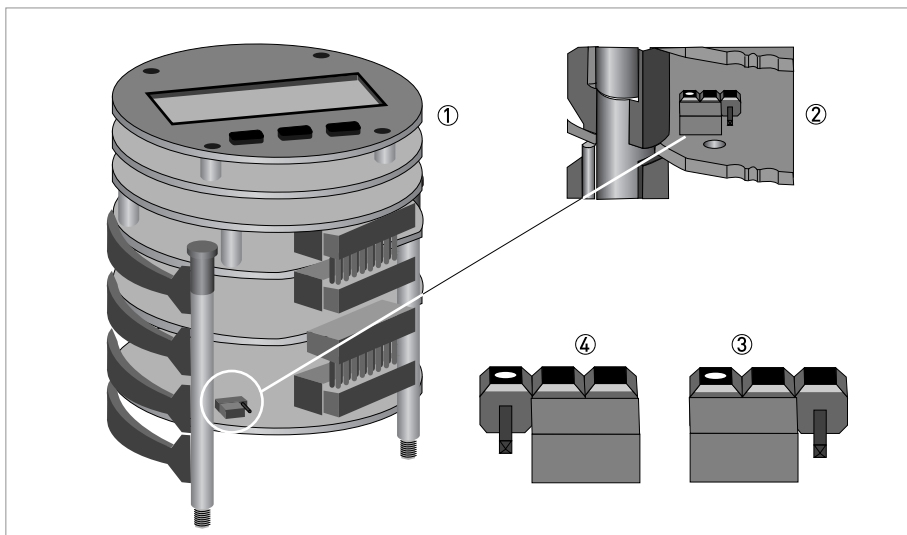
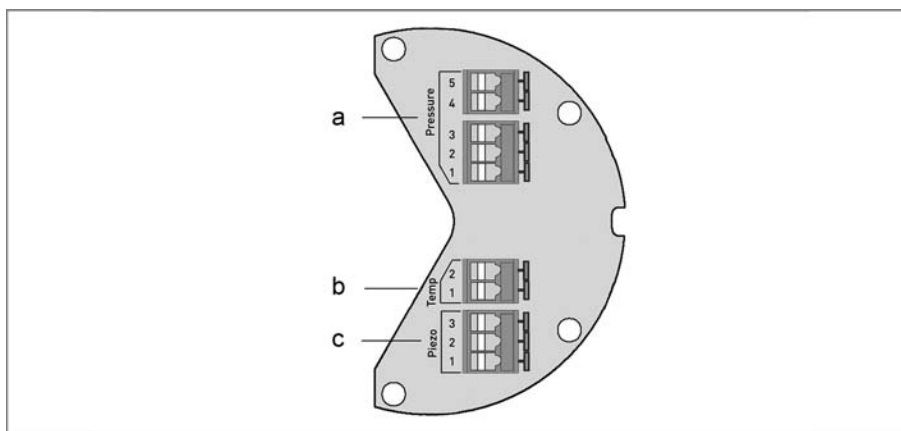


Figure 4-3: Jumper settings pulse output

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

## 4.4 Remote version connection

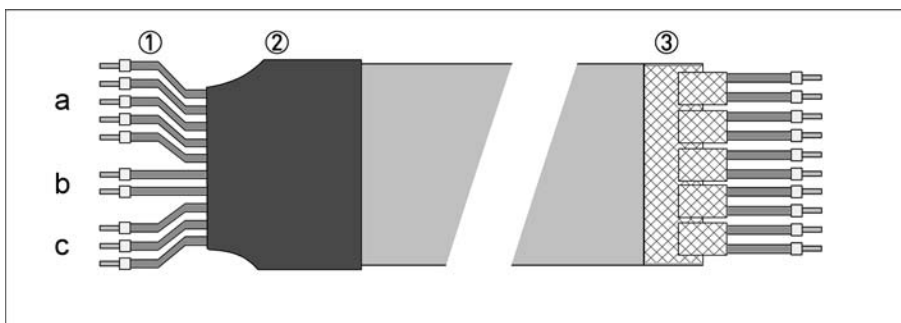


The connections in the sensor and wall mount bracket connection boxes are identical in construction.

### Connection cable strand colour

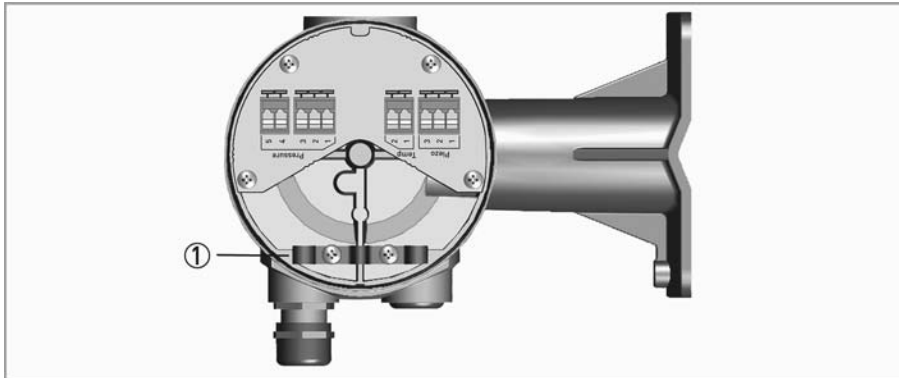
	Connection	Terminal no.:	Strand colour
a	Pressure sensor	5	brown
		4	rose / pink
		3	green
		2	grey
		1	white
b	Temperature sensor	2	black
		1	purple
c	Vortex Sensor	3	red
		2	yellow
		1	blue

### 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



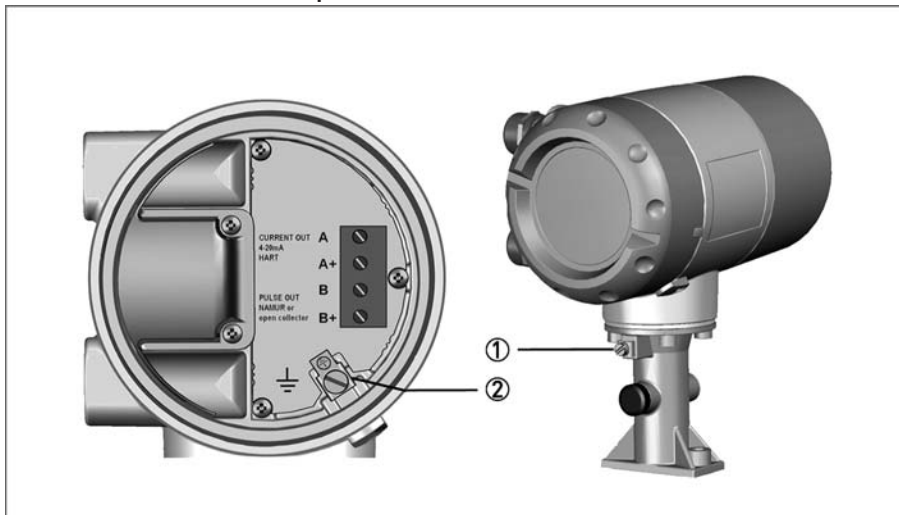
**CAUTION!**

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.

### Ground connection compact version



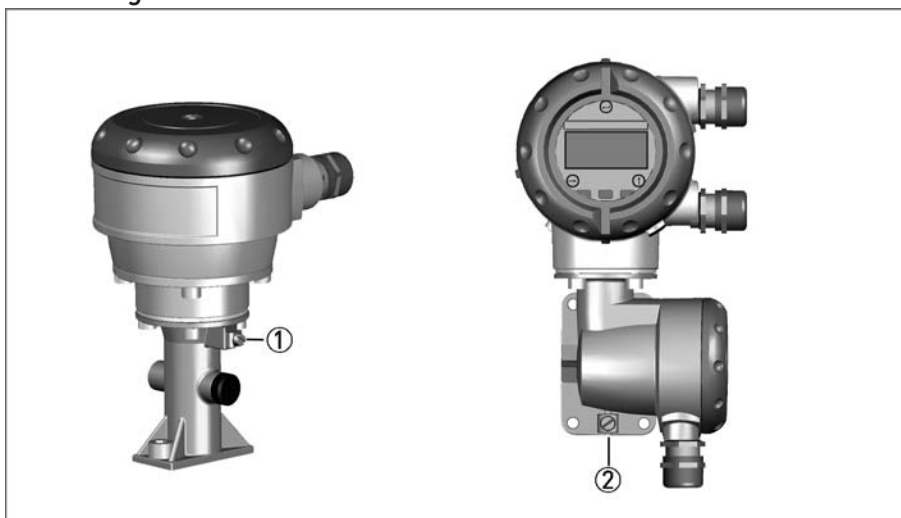
- ① Electrical grounding connection on connection piece between measuring sensor and signal converter.
- ② Electrical grounding connection on housing



**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 cable 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 device parts have to be grounded properly to achieve accurate measurement. The grounding wire may not transfer any interference voltage.*



## 4.6 Ingress protection

The converter electronics housing meets the requirements for IP66/67 in accordance with EN60529 both for the compact and for the remote version. For the remote version, the sensor electronics housing meets the requirements for IP66/68.



### CAUTION!

*After all servicing and maintenance work on the measuring device, the specified protection category must be ensured again.*

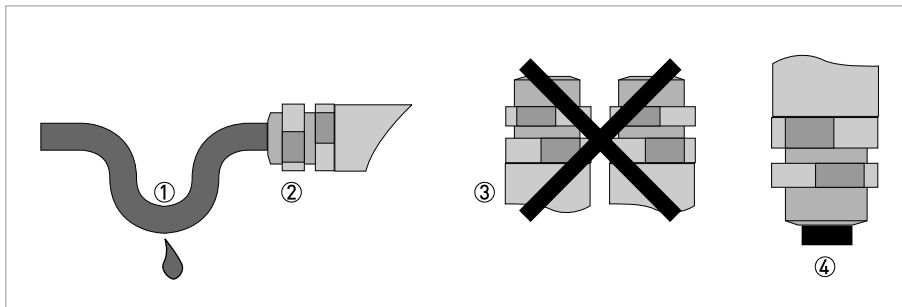


Figure 4-4: Cable feedthrough



### 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. Note that the clamping range of the cable feedthrough corresponds to the outer diameter of the cable.
- Align the measuring device so that the cable feedthrough is never facing up ③.
- Close any unused cable feedthroughs using blind plugs ④ suitable for the protection category.
- 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 71.*

## 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*

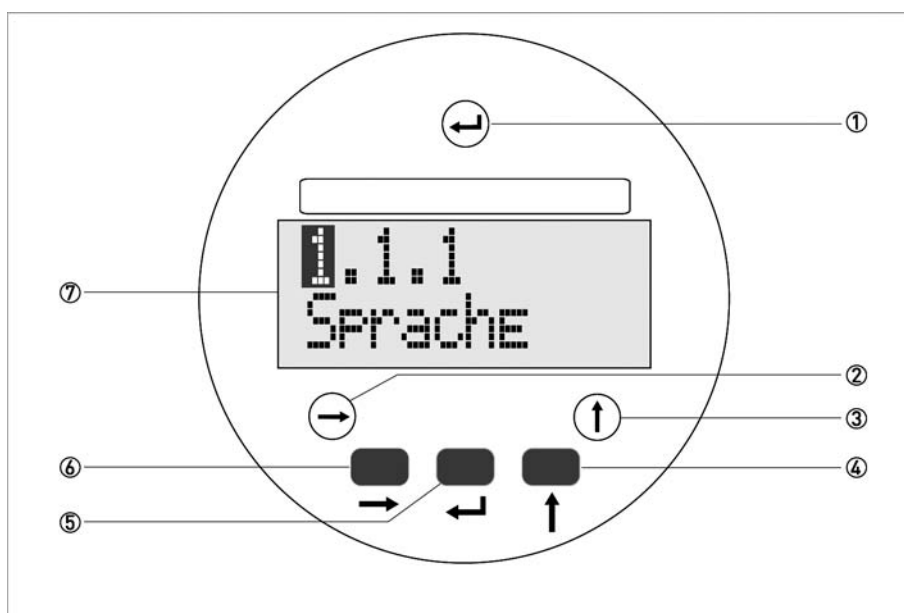


Figure 6-1: Display and operating elements

- 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
	<b>In change mode:</b> Move the input cursor one position to the right; after the last digit the input cursor jumps back to the beginning.
↑	<b>In measuring mode:</b> Switch between measured values and error messages
	Change between the menu items within a menu level
	<b>In change mode:</b> 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.

Measuring mode	→	Main menu	→	Sub-menu	→	Function	→	Edit
		↑		↑		↑		→ ↑ ←
	←		←	←	←	←		

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 m<sup>3</sup>/h to l/min

Procedure		Display	Procedure		Display
		107.2 m <sup>3</sup> /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 <sup>3</sup> /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	0 ... 9	0 ... 9	0 ... 9	0 ... 9	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 m<sup>3</sup>/h for volume flow measurement, m<sup>3</sup>/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 <sup>3</sup> /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 **m<sup>3</sup>** for volume, **m<sup>3</sup> 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 = <b>1800</b> pulses
----------------	---------------------------	---

### Example

Flow Qmax.	Factor A1 Coef.	Pulses / litre	Pulses / h	Comment
5.6 m <sup>3</sup> /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. / <b>Max. Flow</b> / Flow Displ
3.2.5	Function P	<b>Yes</b> / No
3.2.7	Totalizer	<b>Tot. on</b> / Tot. off
3.2.8	Tot. Conf.	<b>User def.</b> / <b>Unit Text</b> / <b>A1 Coeff.</b> / 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 <b>not</b> 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 <sup>3</sup> /h	FAD m <sup>3</sup> /h	m <sup>3</sup> /h (norm)	kg/h
m <sup>3</sup> /min	FAD m <sup>3</sup> /min	m <sup>3</sup> /min (norm)	kg/min
m <sup>3</sup> /s	FAD m <sup>3</sup> /s	m <sup>3</sup> /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 <sup>3</sup> /h	FAD ft <sup>3</sup> /h	ft <sup>3</sup> /d (std.)	lb/h
ft <sup>3</sup> /min	FAD ft <sup>3</sup> /min	ft <sup>3</sup> /h (std.)	lb/min
ft <sup>3</sup> /s	FAD ft <sup>3</sup> /s	ft <sup>3</sup> /min (std.)	lb/s
gal/h	User Def.	ft <sup>3</sup> /min (std.)	g/min
gal/min		ft <sup>3</sup> /s (std.)	g/s
gal/s		User Def.	User Def.
ImpGal/h			
ImpGal/min			
ImpGal/s			
cm <sup>3</sup> /h			
cm <sup>3</sup> /min			
cm <sup>3</sup> /s			
dm <sup>3</sup> /h			
dm <sup>3</sup> /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 <sup>3</sup> L ft <sup>3</sup> /h ft <sup>3</sup> gal ImpGal cm <sup>3</sup> dm <sup>3</sup> bbl User Def.	m <sup>3</sup> norm L norm ft <sup>3</sup> 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 <sup>2</sup> (g) kp/cm <sup>2</sup> (g) atm(g) torr(g) bar(g) mbar(g) psi(g) lbf/ft <sup>2</sup> (g) kgf/cm <sup>2</sup> (g) inHg(g) mmHg(g) mmH <sub>2</sub> 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 <sup>3</sup> kg/L g/L h/mL g/cm <sup>3</sup> g/ft <sup>3</sup> 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	Shows error at temperature sensor! Contact service.
Tsens Shrt.	Temperature sensor short circuit	
Tsens Open	Open temperature sensor	Displays error at pressure sensor! Contact service.
P. Sen. Fail	Faulty pressure sensor	

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 53		
2. Tests	refer to <i>Menu item Tests</i> on page 54		
3. Setup	refer to <i>Menu item Setup (firmware version - basic)</i> on page 55	refer to <i>Menu item Setup (firmware version - steam)</i> on page 58	refer to <i>Menu item Setup (firmware version - gas)</i> on page 62
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 <sup>3</sup> /h Unit ↑...↵	Select unit for volume flow measurement
		8888888888 Upp.Limit	
		00600.0000 or other value m <sup>3</sup> /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 <sup>3</sup> /h norm Unit ↑...↵	Select unit for standard volume flow measurement
		00600.0000 or other value m <sup>3</sup> /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 <sup>3</sup> /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)

Basic version:			
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 Totalizer
		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 <sup>3</sup> Unit ↑...↵	Select totalizer unit for volume flow measurement
		0000000000 m <sup>3</sup> ↑...↑...↑...↵	Enter preset totalizer value
		Reset Yes / Reset No ↑...↵	Reset counter / 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 <sup>3</sup> norm Unit ↑...↵	Select totalizer unit for standard volume flow measurement
		0000000000 m <sup>3</sup> norm ↑...↑...↑...↵	Enter preset totalizer value
		Reset Yes / Reset No ↑...↵	Reset counter / Do not reset totalizer/
		Disp. off / Disp. on ↑...↵	Display totalizer / Do not display totalizer

Basic version:			
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 counter / 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. ↵ Density ↵	HART tertiary variable
3.3.4	HART 4V →	Density ↵ Temp. ↵	HART quaternary variable
3.4			Set fluid and medium
3.4.1	Fluid ① →	Gas ↑... Liquid. ↑... Steam ↑...↵	Set fluid type Gas Liquid 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 →	No ↑... Yes ↑...↵	Internal temperature sensor No temperature sensor available Temperature sensor available
3.5.3	Sat. P/T → [available if Fluid = Steam, see menu item 3.4.1]	Sat. T ↵	Density calculation for saturated steam Density calculation for saturated steam with the saturated temperature
3.5.4	Oper. temp. →	°C Unit ↑...↵ 0000000.0 °C ↵ Disp. on / Disp. off ↑...↵	Operating temperature Set temperature unit Operating temperature Display temperature / Do not display temperature



Basic version:			
Level	Designation	Selection / entry	Explanation
3.5.6	Dens. Opr. →		Density at operating pressure and operating temperature
		kg/m <sup>3</sup> Unit ↑...←	Set density unit
		00000.0000 kg/m <sup>3</sup> ← ①	Operating density
3.5.9	Dens. Norm. ② →	00000.0000 kg/m <sup>3</sup> ↑...↑...↑...←	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 ↑...←	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
3.2.2	Variable I → [available if Meter 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 Meter 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 Meter 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 Totalizer
		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 <sup>3</sup> Unit ↑...←	Select totalizer unit for volume flow measurement
		0000000000 m <sup>3</sup> ↑...↑...↑...←	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 <sup>3</sup> norm Unit ↑...←	Select totalizer unit for standard volume flow measurement
		0000000000 m <sup>3</sup> 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 Meter Type = Gross Heat, see menu item 5.4.1, service menu]		Energy totalizer
		Tot. on ↑...	Start Totalizer
		Tot. off ↑...←	Stop totalizer (value is held)
3.2.10	Energ.Unit → [available if Meter 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. Adr. →	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 ↑...	
		Energy    ↑...↵ #available if Meter Type = Gross Heat (menu item 5.3.1, service menu)	
3.3.3	HART TV →		HART tertiary variable
		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    ↑...↵	superheated 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	Dens. Opr. →		Density at operating pressure and operating temperature
		kg/m <sup>3</sup> Unit ↑...←	Set density unit
		00000.0000 kg/m <sup>3</sup> ← 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 <sup>2</sup> 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 <sup>2</sup> 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 ↑...←	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 Totalizer
		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 <sup>3</sup> Unit ↑...←	Select totalizer unit for volume flow measurement
		000000000 m <sup>3</sup> ↑...↑...↑...←	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 <sup>3</sup> norm Unit ↑...←	Select totalizer unit for standard volume flow measurement
		000000000 m <sup>3</sup> 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
		Temperature ↑..	
		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 <sup>3</sup> /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	Dens. Opr.		Density at operating pressure and operating temperature
		kg/m <sup>3</sup> Unit ↑...←	Set density unit
		00011.0000 kg/m <sup>3</sup> ←	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 <sup>3</sup> ←	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 <sup>2</sup> 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 <sup>2</sup> 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 Exchanging 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 match: 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"

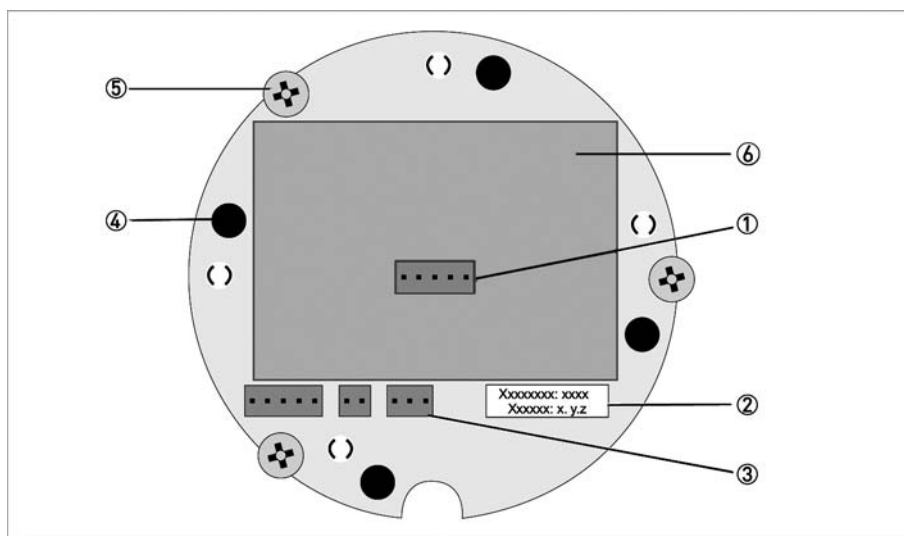


Figure 7-1: Board, example

- 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 the personnel, the 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 is safe to handle and stating the product used.*

### 7.4.2 Form (for copying) to accompany a returned device



**CAUTION!**

*To avoid any risk for our service personnel, this form has to be accessible from outside of the packaging with the returned device.*

Company:		Address:	
Department:		Name:	
Tel. no.:		Fax no. and/or Email address:	
Manufacturer's order no. or serial no.:			
The device has been operated with the following medium:			
This medium is:	<input type="checkbox"/>	radioactive	
	<input type="checkbox"/>	water-hazardous	
	<input type="checkbox"/>	toxic	
	<input type="checkbox"/>	caustic	
	<input type="checkbox"/>	flammable	
	<input type="checkbox"/>	We checked that all cavities in the device are free from such substances.	
		<input type="checkbox"/>	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.*

**Separate collection of WEEE (Waste Electrical and Electronic Equipment) in the European Union:**



According to the directive 2012/19/EU, the monitoring and control instruments marked with the WEEE symbol and reaching their end-of-life **must not be disposed of with other waste**.

The user must dispose of the WEEE to a designated collection point for the recycling of WEEE or send them back to our local organisation or authorised representative.

## 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 velocity  $v$ . The non-dimensional Stouhal number  $S$  describes the relationship between vortex frequency  $f$ , width  $b$  of the 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.

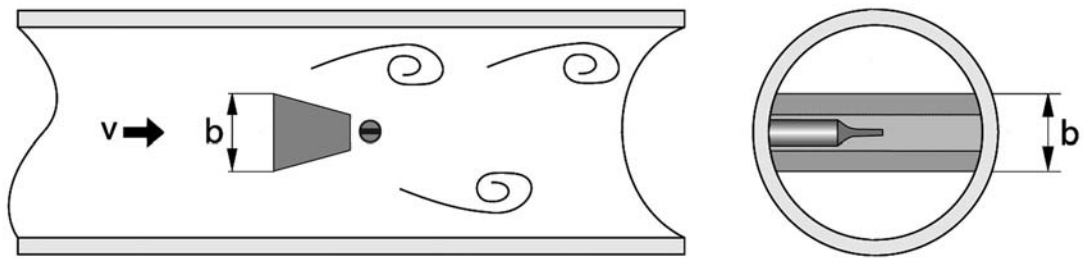


Figure 8-1: Functional principle

## 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 (Downloadcenter).

### Measuring system

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

### Measured value

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

### Transmitter

Versions	Compact
	Remote version - cable length ≤ 15 m / 49 ft

### Flow sensor

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

### Display and user interface

Local display	2 rows, 10 characters
Interface and display languages	German, English, French

**Measuring accuracy**

Reference condition	Water at +20°C / +68°F
	Air at +20°C / +68°F and 1.013 bara/ 14.7 psia
Accuracy	Based on volume flow
Liquids	±0.75% of measured value ( $Re \geq 20000$ )
	±2.0% of measured value ( $10000 < Re < 20000$ )
Gases and vapours	±1.0% of measured value ( $Re \geq 20000$ )
	±2.0% of measured value ( $10000 < Re < 20000$ )
	Pressure and temperature compensation: ±1.5% of measured value ( $Re \geq 20000$ ); ±2.5% of measured value ( $10000 < Re < 20000$ ) ①
	① The maximum error of measurement refers to measurement at an operating pressure >65% of the full scale value of the applied pressure sensor.
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

**Media 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 vapours	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, refer to chapter "Flow tables".

**Other conditions**

Ingress protection	IP 66/67
--------------------	----------



### Installation conditions

Inlet section	$\geq 20 \times \text{DN}$ (without disturbing flow, after pipe narrowing, after a single 90° bend)
	$\geq 30 \times \text{DN}$ (after a double bend 2x90°)
	$\geq 40 \times \text{DN}$ (after a double three-dimensional bend 2x90°)
	$\geq 50 \times \text{DN}$ (after control valves)
	$\geq 2 \text{ DN}$ before flow straightener; $\geq 8 \text{ DN}$ after flow straightener (specified values apply only to original $\geq 20 \text{ DN}$ inlet run)
Outlet section	$\geq 5 \times \text{DN}$
Dimensions and weights	See chapter "Dimensions and weights"

### Materials

Flow sensor and process connections	Standard: 1.4404/316L
	Option: Hastelloy® C-22 on request
Electronics 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 flow sensor material/medium.

### Process connections of 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 section "Dimensions and weights".

### Process connections of 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 abbreviations	$U_{\text{ext}}$ = external voltage; $R_L$ = load + resistance
Measuring range	4...20 mA (max. 20.8 mA) + HART® protocol
Load	Minimum 0 Ω; maximum $R_L = [(U_{\text{ext}} - 14 \text{ VDC}) / 22 \text{ mA}]$
Error signal	Acc. to NAMUR NE43
	Upper value: $\geq 21.0 \text{ mA}$
	Lower value: $\leq 3.6 \text{ mA}$ (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®**

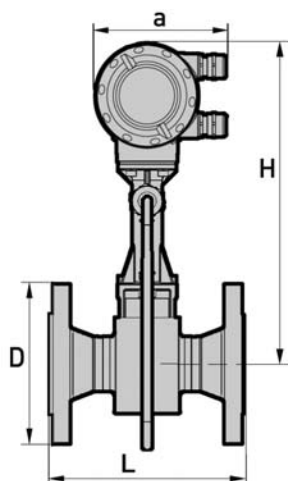
	HART® protocol via current output
Device revision	1
Physical layer	FSK
Device category	Transmitter, galvanically isolated
System requirements	Load min. 250 Ω
Multidrop operation	4 mA

**Approvals and certificates**

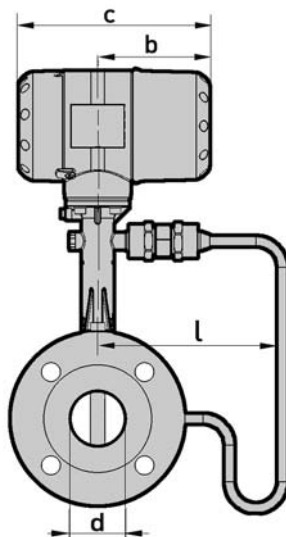
ATEX	ATEX II 2G Ex d ia [ia] IIC T6
FM	Class I, II, III Div 1/2, groups A-G

## 8.3 Dimensions and weights

### 8.3.1 Flange versions

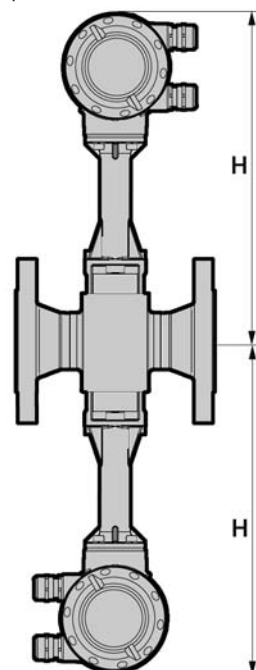


a = 135 mm / 5.32"



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

Option: version with 2 transmitters



Specified weight + 2.8 kg / 6.2 lb

### Flange version EN 1092-1

Nominal size	Pressure rating	Dimensions [mm]						
		d	D	L	H	H F1R ①	H F2R ②	l
DN	PN							
15	40	17.3	95	200	315	-	-	174.3
15	100	17.3	105	200	315	-	-	174.3
25	40	28.5	115	200	315	315	-	174.3
25	100	28.5	140	200	315	315	-	174.3
40	40	43.1	150	200	320	315	315	174.5
40	100	42.5	170	200	320	315	315	174.5
50	16	54.5	165	200	325	320	315	174.5
50	40	54.5	165	200	325	320	315	174.5
50	63	54.5	180	200	325	325	320	174.5
50	100	53.9	195	200	325	325	320	174.5
80	16	82.5	200	200	340	325	325	174.25
80	40	82.5	200	200	340	325	325	174.25
80	63	81.7	215	200	340	340	325	174.25
80	100	80.9	230	200	340	340	325	174.25
100	16	107.1	220	250	360	340	340	174.5

Nominal size	Pressure rating	Dimensions [mm]						
		d	D	L	H	H F1R ①	H F2R ②	l
DN	PN							
100	40	107.1	235	250	360	340	340	174.5
100	63	106.3	250	250	360	360	340	174.5
100	100	104.3	265	250	360	360	340	174.5
150	16	159.3	285	300	375	360	360	196.5
150	40	159.3	300	300	375	360	360	196.5
150	63	157.1	345	300	375	375	360	196.5
150	100	154.1	355	300	375	375	360	196.5
200	10	206.5	340	300	400	375	375	208.5
200	16	206.5	340	300	400	375	375	208.5
200	25	206.5	360	300	400	400	375	208.5
200	40	206.5	375	300	400	400	375	208.5
250	10	260.4	395	380	420	400	400	236.5
250	16	260.4	405	380	420	400	400	236.5
250	25	258.8	425	380	420	420	400	236.5
250	40	258.8	450	380	420	420	400	236.5
300	10	309.7	445	450	445	420	420	261
300	16	309.7	460	450	445	420	420	261
300	25	307.9	485	450	445	445	420	261
300	40	307.9	515	450	445	445	420	261

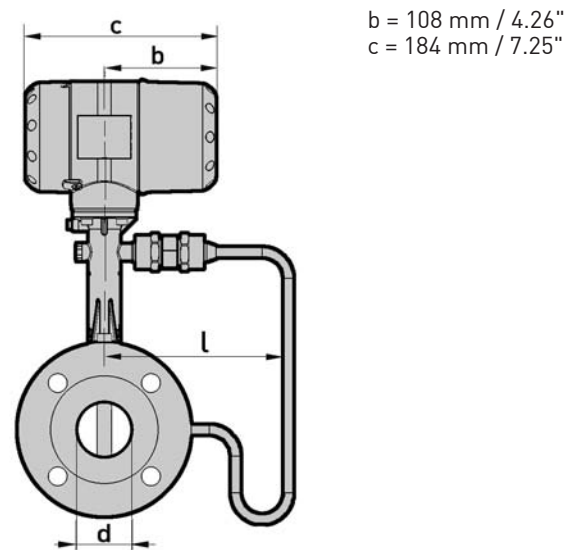
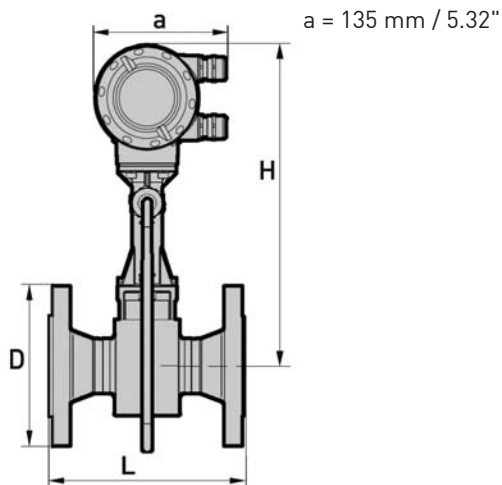
① F1R - single reduction

② F2R - double reduction

## Weight for flange version EN 1092-1 [kg]

Nominal size DN	Pressure rating PN	with	without	F1R ① with	F1R ① without	F2R ② with	F2R ② without
		Pressure sensor		Pressure sensor		Pressure sensor	
15	40	6.1	5.5	-	-	-	-
15	100	7.1	6.5	-	-	-	-
25	40	7.9	7.3	6.8	6.2	-	-
25	100	9.9	9.3	9.3	8.7	-	-
40	40	10.8	10.2	9.3	8.7	8.5	7.9
40	100	14.8	14.2	12.9	12.3	12.1	11.5
50	16	12.7	12.1	11.0	10.4	10.2	9.6
50	40	12.9	12.3	11.5	10.9	10.8	10.2
50	63	16.9	16.3	14.6	14.0	13.9	13.3
50	100	18.4	17.8	16.8	16.2	16.2	15.6
80	16	17.4	16.8	15.2	14.6	13.8	13.2
80	40	19.4	18.8	16.7	16.1	15.4	14.8
80	63	23.4	22.8	19.9	19.3	18.6	18.0
80	100	27.4	26.8	23.6	23.0	22.4	21.8

Nominal size DN	Pressure rating PN	with	without	F1R ① with	F1R ① without	F2R ② with	F2R ② without
		Pressure sensor		Pressure sensor		Pressure sensor	
100	16	22.0	21.4	21.1	20.5	18.3	17.7
100	40	25.0	24.4	24.5	23.9	21.7	21.1
100	63	30.0	29.4	29.7	29.1	27.0	26.4
100	100	36.0	35.4	36.3	35.7	33.6	33.0
150	16	35.8	35.2	33.5	32.9	31.9	31.3
150	40	41.8	41.2	41.0	40.4	39.8	39.2
150	63	59.8	59.2	57.9	57.3	58.6	58.0
150	100	67.8	67.2	68.8	68.2	70.4	69.8
200	10	38.4	37.8	40.3	39.7	42.7	42.1
200	16	38.4	37.8	39.9	39.3	43.9	43.3
200	25	47.4	46.8	49.1	48.5	50.4	49.8
200	40	55.4	54.8	57.6	57.0	58.1	57.5
250	10	58.0	57.4	62.7	62.1	59.4	58.8
250	16	59.0	58.4	64.3	63.7	61.1	60.5
250	25	75.0	74.4	78.1	77.5	76.4	75.8
250	40	93.0	92.4	95.9	95.3	95.7	95.1
300	10	76.3	75.7	80.7	80.1	85.4	84.8
300	16	82.8	82.2	87.2	86.6	92.5	91.9
300	25	99.3	98.7	104.7	104.1	112.6	112.0
300	40	128.1	127.5	131.6	131.0	142.8	142.2
Weight specifications for version with two signal converters + 3.2 kg / 7.05 lb							



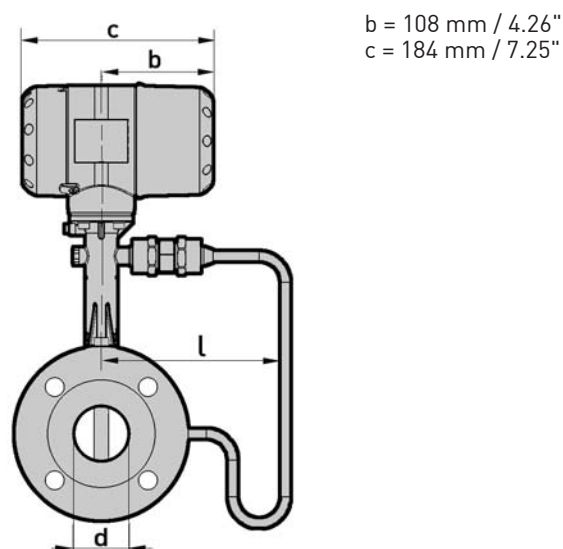
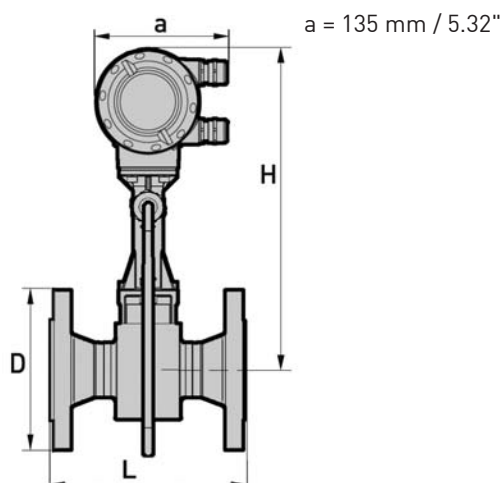
## Flange version ASME B16.5

Nominal size	Pressure rating	Dimensions [mm]						
		d	D	L	H	H F1R ①	H F2R ②	l
NPS	Class							
½	150	15.8	90.0	200	315	-	-	174.3
½	300	15.8	95.0	200	315	-	-	174.3
½	600	13.9	95.0	200	315	-	-	174.3
1	150	26.6	110	200	315	315	-	174.3
1	300	26.6	125	200	315	315	-	174.3
1	600	24.3	125	200	315	315	-	174.3
1½	150	40.9	125	200	320	315	315	174.3
1½	300	40.9	155	200	320	315	315	174.3
1½	600	38.1	155	200	320	315	315	174.3
2	150	52.6	150	200	325	320	315	174.3
2	300	52.6	165	200	325	320	315	174.3
2	600	49.3	165	200	325	320	315	174.3
3	150	78.0	190	200	340	325	320	174.5
3	300	78.0	210	200	340	325	320	174.5
3	600	73.7	210	200	340	325	320	174.5
4	150	102.4	230	250	360	340	325	176.5
4	300	102.4	255	250	360	340	325	176.5
4	600	97.2	275	250	360	340	325	176.5
6	150	154.2	280	300	375	360	340	196.5
6	300	154.2	320	300	375	360	340	196.5
6	600	146.3	355	300	375	360	340	196.5
8	150	202.7	345	300	400	375	360	208.5
8	300	202.7	380	300	400	375	360	208.5

Nominal size NPS	Pressure rating Class	Dimensions [mm]						
		d	D	L	H	H F1R ①	H F2R ②	l
10	150	254.5	405	380	420	400	375	236.5
10	300	254.5	455	380	420	400	375	236.5
12	150	304.8	485	450	445	420	400	261.0
12	300	304.8	520	450	445	420	400	261.0

### Weight - flange version ASME B16.5 [kg]

Nominal size NPS	Pressure rating Class	with	without	F1R with	F1R without	F2R with	F2R without
		Pressure sensor		Pressure sensor		Pressure sensor	
½	150	5.1	4.5	-	-	-	-
½	300	5.5	4.9	-	-	-	-
½	600	5.7	5.1	-	-	-	-
1	150	6.8	6.2	6.4	5.6	-	-
1	300	7.8	7.2	7.2	6.6	-	-
1	600	8.1	7.5	7.5	6.9	-	-
1½	150	8.9	8.3	8.2	7.6	7.3	6.7
1½	300	11.0	10.4	10.5	9.9	9.6	9.0
1½	600	12.0	11.4	11.4	10.8	10.6	10.0
2	150	11.6	11.0	10.6	10.0	9.9	9.3
2	300	13.0	12.4	12.2	11.6	11.5	10.9
2	600	14.5	13.9	13.6	13.0	13.0	12.4
3	150	20.4	19.8	16.5	15.9	15.2	14.6
3	300	23.4	22.8	20.0	19.4	18.8	18.2
3	600	24.4	23.8	22.5	21.9	21.4	20.8
4	150	24.0	23.4	24.9	24.3	22.3	21.7
4	300	32.0	31.4	33.5	32.9	30.8	30.2
4	600	41.0	40.4	43.7	43.1	40.8	40.2
6	150	36.8	36.2	37.4	36.8	36.5	35.9
6	300	51.8	51.2	55.7	55.1	55.4	54.8
6	600	76.8	76.2	79.4	78.8	82.2	81.6
8	150	50.6	50.0	48.4	47.8	52.1	51.5
8	300	75.4	74.8	71.8	71.2	77.7	77.1
10	150	75.0	74.4	74.8	74.2	73.5	72.9
10	300	107.0	106.4	112.0	111.4	113.1	112.5
12	150	107.0	106.4	109.4	108.8	120.0	119.4
12	300	152.0	151.4	165.0	155.4	171.3	170.7



## Flange version ASME B16.5

Nominal size	Pressure rating	Dimensions [inch]						
		d	D	L	H	H F1R ①	H F2R ②	l
NPS	Class							
½	150	0.6	3.5	7.9	12.4	-	-	6.9
½	300	0.6	3.7	7.9	12.4	-	-	6.9
½	600	0.5	3.7	7.9	12.4	-	-	6.9
1	150	1.1	4.3	7.9	12.4	12.4	-	6.9
1	300	1.1	4.9	7.9	12.4	12.4	-	6.9
1	600	1.0	4.9	7.9	12.4	12.4	-	6.9
1½	150	1.6	4.9	7.9	12.6	12.4	12.4	6.9
1½	300	1.6	6.1	7.9	12.6	12.4	12.4	6.9
1½	600	1.5	6.1	7.9	12.6	12.4	12.4	6.9
2	150	2.1	5.9	7.9	12.8	12.6	12.4	6.9
2	300	2.1	6.5	7.9	12.8	12.6	12.4	6.9
2	600	1.9	6.5	7.9	12.8	12.6	12.4	6.9
3	150	3.1	7.5	7.9	13.4	12.8	12.6	6.9
3	300	3.1	8.3	7.9	13.4	12.8	12.6	6.9
3	600	2.9	8.3	7.9	13.4	12.9	12.6	6.9
4	150	4.0	9.1	9.8	14.2	13.4	12.8	7.0
4	300	4.0	10.0	9.8	14.2	13.4	12.8	7.0
4	600	3.8	10.8	9.8	14.2	13.4	12.8	7.0
6	150	6.1	11.0	11.8	14.8	14.2	13.4	7.7
6	300	6.1	12.6	11.8	14.8	14.2	13.4	7.7
6	600	5.8	14.0	11.8	14.8	14.2	13.4	7.7
8	150	8.0	13.6	11.8	15.8	14.8	14.2	8.2
8	300	8.0	15.0	11.8	15.8	14.8	14.2	8.2

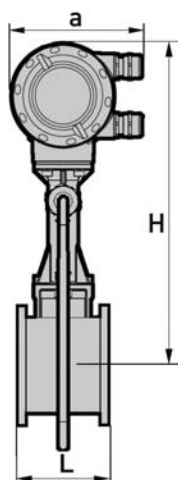


Nominal size NPS	Pressure rating Class	Dimensions [inch]						
		d	D	L	H	H F1R ①	H F2R ②	l
10	150	10.0	15.5	15.0	16.6	15.8	14.8	9.3
10	300	10.0	17.9	15.0	16.6	15.8	14.8	9.3
12	150	12.0	19.1	17.7	17.6	16.6	15.8	10.3
12	300	12.0	20.5	17.7	17.6	16.6	15.8	10.3

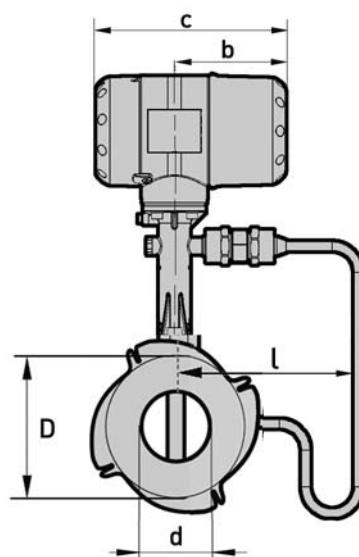
### Weight - flange version ASME B16.5 [lb]

Nominal size NPS	Pressure rating Class	with	without	F1R with	F1R without	F2R with	F2R without
		Pressure sensor		Pressure sensor		Pressure sensor	
½	150	11.2	9.9	-	-	-	-
½	300	12.1	10.8	-	-	-	-
½	600	12.6	11.2	-	-	-	-
1	150	15.0	13.7	13.7	12.3	-	-
1	300	17.2	15.9	15.9	14.5	-	-
1	600	17.9	16.5	16.5	15.2	-	-
1½	150	19.9	18.3	18.1	16.7	16.1	14.8
1½	300	24.3	22.9	23.1	21.8	21.2	19.7
1½	600	26.5	25.1	25.1	23.8	23.2	22.0
2	150	25.6	24.3	23.4	22.0	21.8	20.5
2	300	28.7	27.3	26.9	25.6	25.3	24.0
2	600	32.0	30.7	30.0	28.7	28.8	27.3
3	150	45.0	43.7	36.4	35.1	33.5	32.2
3	300	51.6	50.3	44.1	42.8	41.4	40.1
3	600	53.8	52.5	49.6	48.3	47.2	45.9
4	150	52.9	51.6	54.9	53.6	49.2	47.8
4	300	70.6	69.3	73.9	72.5	67.9	66.6
4	600	90.4	89.1	98.4	95.0	90.1	88.6
6	150	81.2	79.8	82.5	81.1	80.5	79.1
6	300	114.2	112.9	122.8	121.5	122.2	120.8
6	600	169.4	168.1	175.1	173.8	181.3	180.1
8	150	111.6	110.3	106.7	105.4	114.9	113.6
8	300	166.3	165.0	158.3	157.0	171.3	170.1
10	150	165.4	164.1	165.0	163.6	162.1	160.8
10	300	236.0	234.7	247.0	245.7	249.4	248.1
12	150	236.0	234.7	241.3	239.9	264.6	263.3
12	300	335.2	333.9	363.9	342.7	377.8	376.5

## 8.3.2 Sandwich version



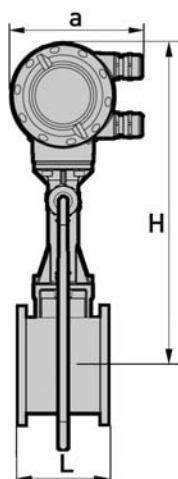
a = 133 mm / 5.24"



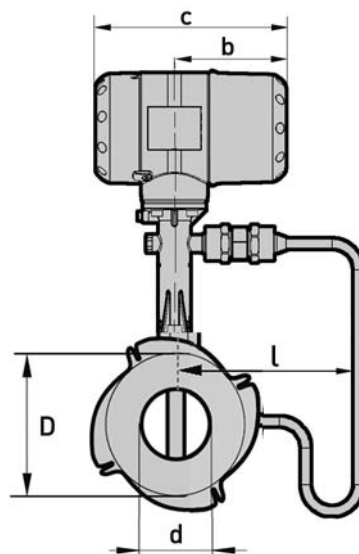
b = 105 mm / 4.13"  
c = 179 mm / 7.05"

## Sandwich version EN

Nominal size	Pressure rating	Dimensions [mm]					Weight [kg]	
DN	PN	d	D	L	H	l	with	without
							Pressure sensor	
15	100	16	45	65	315	174.25	4.1	3.5
25	100	24	65	65	315	174.25	4.9	4.3
40	100	38	82	65	320	174.5	5.5	4.9
50	100	50	102	65	325	174.5	6.6	6
80	100	74	135	65	340	174.25	8.8	8.2
100	100	97	158	65	360	176.5	10.1	9.5



a = 135 mm / 5.32"

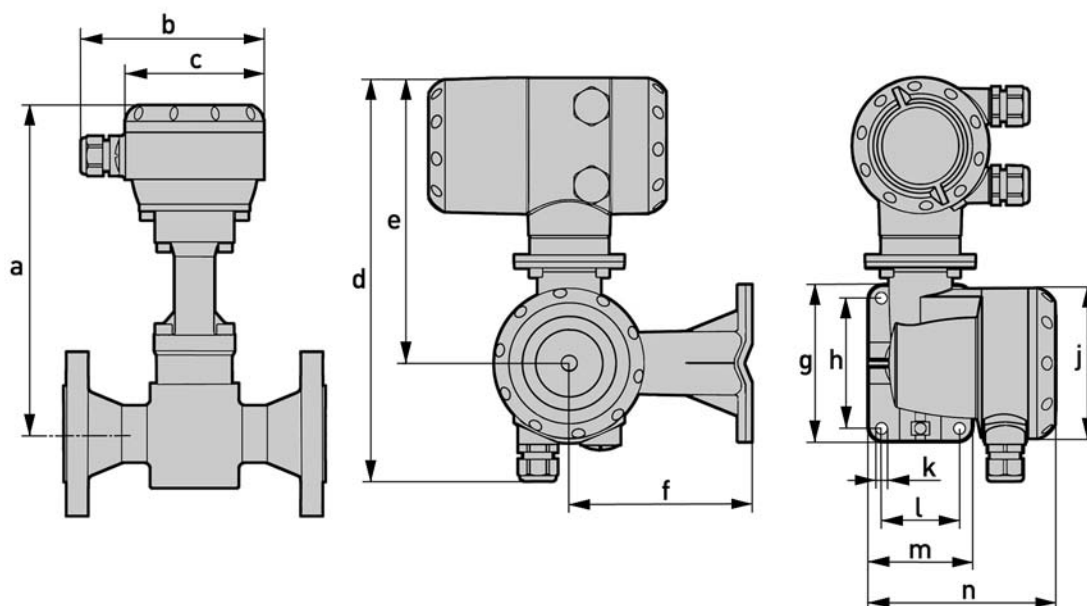


b = 108 mm / 4.26"  
c = 184 mm / 7.25"

#### Sandwich version ASME

Nominal size	Pressure rating	Dimensions [inch]					Weight [lb]	
		d	D	L	H	l	with	without
							Pressure sensor	
½	150	0.63	1.77	2.56	12.43	6.82	9.04	7.72
½	300	0.63	1.77	2.56	12.43	6.82	9.04	7.72
½	600	0.55	1.77	2.56	12.43	6.82	9.04	7.72
1	150	0.94	2.56	2.56	12.43	6.82	10.8	9.48
1	300	0.94	2.56	2.56	12.43	6.82	10.8	9.48
1	600	0.94	2.56	2.56	12.43	6.82	10.8	9.48
1½	150	1.5	3.23	2.56	12.63	6.87	12.13	10.8
1½	300	1.5	3.23	2.56	12.63	6.87	12.13	10.8
1½	600	1.5	3.23	2.56	12.63	6.87	12.13	10.8
2	150	1.97	4.02	2.56	12.83	6.87	14.55	13.23
2	300	1.97	4.02	2.56	12.83	6.87	14.55	13.23
2	600	1.97	4.02	2.56	12.83	6.87	14.55	13.23
3	150	2.91	5.31	2.56	13.42	6.82	19.4	18.08
3	300	2.91	5.31	2.56	13.42	6.82	19.4	18.08
3	600	2.91	5.31	2.56	13.42	6.82	19.4	18.08
4	150	3.82	6.22	2.56	14.21	6.95	22.27	20.94
4	300	3.82	6.22	2.56	14.21	6.95	22.27	20.94
4	600	3.82	6.22	2.56	14.21	6.95	22.27	20.94

## 8.3.3 Dimensions remote version



Dimension a

	Flange 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] ▶	298	298	303	308	323	343	358	383	403	428
["] ▶	11.77	11.77	11.97	12.2	12.8	13.5	14.1	15.1	15.9	16.9

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

## 8.4 Flow tables

### Measuring ranges

Nominal size		$Q_{\min}$	$Q_{\max}$	$Q_{\min}$	$Q_{\max}$
DN - EN 1092-1	NPS - ASME B16.5	[m <sup>3</sup> /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"	$0.5 \times (998/\rho)^{0.5}$ ①	$1.64 \times (998/\rho)^{0.5}$ ②	$7 \times (998/\rho)^{0.47}$ ①	$23 \times (998/\rho)^{0.47}$ ②
Gas, steam	DN15...300	½...12"	$6 \times (1.29/\rho)^{0.5}$ ③	$16.4 \times (1.29/\rho)^{0.5}$ ④	$7 \times (998/\rho)^{0.47}$ ③	$23 \times (998/\rho)^{0.47}$ ④
$\rho$ = operating density [kg/m <sup>3</sup> ]						

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/m³]		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/m³]		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

Gauge pressure [psig]		15		50		75		100	
Density [lb/ft³]		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

Gauge pressure [psig]		150		200		250		300	
Density [lb/ft³]		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



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