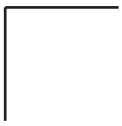
Operating Instruction
UM_H736V7-0EN
AN 27628
2025-06-01

Flexim FLUXUS H736

Ultrasonic Flowmeter

FLEXIM

EMERSON



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1 Introduction

This operating instruction has been written for users operating the ultrasonic flowmeter FLUXUS. It contains important information about the measuring equipment, how to handle it correctly, and how to avoid damages. Read the safety instructions carefully. Make sure you have read and understood the operating instruction before using the measuring equipment.

Any work on the measuring equipment has to be carried out by authorized and qualified personnel only, able to detect and avoid possible risks and dangers.

Presentation of warnings

This operating instruction contains warnings marked as follows:

⚠ DANGER

Type and source of danger

danger with high level of risk, which, if not avoided, can lead to death or serious injuries

→measures of prevention

⚠ WARNING

Type and source of danger

danger with medium level of risk, which, if not avoided, can lead to serious or moderate injuries

→measures of prevention

⚠ CAUTION

Type and source of danger

danger with low level of risk, which, if not avoided, can lead to moderate or minor injuries

→measures of prevention

Important

This text contains important information which should be observed to avoid material damage.

NOTICE

This text contains important information about the use of the measuring equipment.

Storage of the operating instruction

The operating instruction must permanently be available at the place where the measuring equipment is used. It must always be available to the user.

User feedback

All reasonable effort has been made to ensure the correctness of the content of this operating instruction. If you, however, find some erroneous information or miss information, please inform us.

We will be grateful for any suggestions and comments regarding the concept and your experience when working with the measuring equipment. If you have any suggestions about improving the documentation and particularly this operating instruction, please let us know so that we can consider your comments for future reprints.

Copyright

2 Safety instructions

2.1 General safety instructions

Prior to any work, read the operating instruction carefully and in full.

Failure to comply with the instructions, in particular with the safety instructions, poses a risk to health and can lead to material damages. For further information, contact Flexim.

During installation and operation of the measuring equipment, observe the ambient and installation conditions specified in the documentation.

Tab. 1: Explanation of symbols on the transmitter and accessories:

symbol	meaning
⎓	direct current
⏚	connection for equipotential bonding/grounding
⏚	protective ground terminal
	Electric devices and batteries must be disposed of separately. If necessary, additional hazardous substances are indicated for disposal.
	Warning! Electric shock possible.
	Observe the operating instruction.
	Warning! Observe the safety instructions in the manufacturer's documentation.

The measuring equipment has to be checked for proper condition and operational safety before each use. If troubles or damages have occurred during installation or operation of the measuring equipment, please inform Flexim.

It is not allowed to make unauthorized modifications or alterations to the measuring equipment.

If the measuring point is within an explosive atmosphere, the danger zone and present explosive atmosphere have to be determined. The transmitter, transducers and accessories have to be appropriate and approved for the conditions within the corresponding zone.

Personnel has to be suitably trained and experienced for the work.

Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS). Observe the instructions for hazardous substances and the respective safety data sheets. Observe the regulations for the disposal of electrical equipment.

2.2 Intended use

The measuring equipment is intended for the measurement of fluid properties in closed pipes. By means of connected transducers, the transit times of the ultrasonic signals in the fluid and the pipe are measured and evaluated.

The transmitter uses these values to calculate the sought quantities, e.g., volumetric flow rate and mass flow rate. Through comparison with the values stored in the transmitter, further physical quantities can be determined. The physical quantities are provided via configurable outputs and the display.

- All instructions of the operating instruction have to be observed to ensure intended use.
- Any use beyond or other than the intended use is not covered by warranty and can present a danger. Any damage arising from not intended use shall be solely the liability of the operator or user.
- The measurement is carried out without direct contact to the fluid in the pipe. The flow profile is not influenced.
- The transducers are fixed to the pipe using the supplied transducer mounting fixture.
- If an extension cable is required to connect the transducers to the transmitter, a junction box can be used (optional). Observe the safety instructions in the operating instruction. For the technical data of the junction box see technical specification.
- Observe the operating conditions, e.g., environment, voltage ranges. For the technical data of transmitter, transducers and accessories see technical specification.

2.3 Not intended use

Not intended use in terms of a misuse means:

- any work on the measuring equipment without observing all instructions of the operating instruction
- use of transmitter, transducer and accessory combinations not intended by Flexim
- installation of the transmitter, transducers and accessories in explosive atmospheres they are not approved for
- any work on the measuring equipment (e.g., installation, dismounting, connection, start-up, operation, service and maintenance) carried out by unauthorized and untrained personnel
- storage, installation and operation of the measuring equipment outside the specified ambient conditions (see technical specification)

2.4 Safety instructions for the user

Any work on the transmitter has to be carried out by authorized and qualified personnel only. Observe the safety instructions in the operating instruction. For the technical data of transmitter, transducers and accessories see technical specification.

- Observe the safety and accident prevention regulations applicable on the site of operation.
- Only use the supplied mounting fixtures and transducers as well as the intended accessories.
- Always wear the required personal protective equipment.

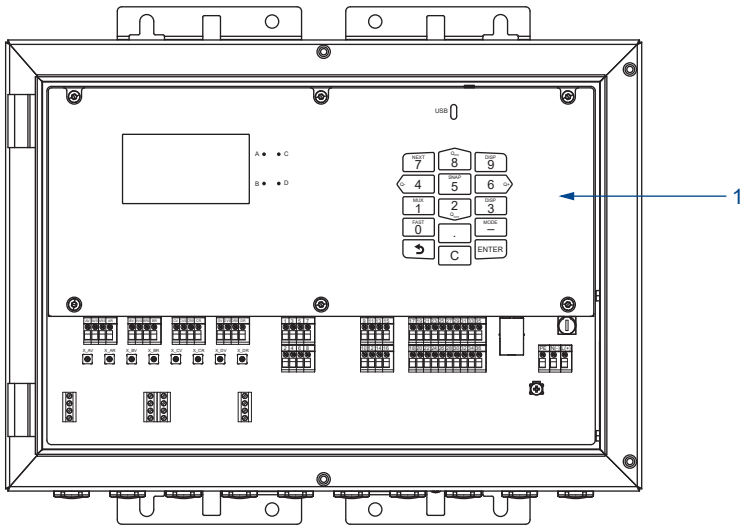
2.5 Safety instructions for the operator

- The operator shall qualify the personnel to perform their assigned tasks. The operator shall provide the required personal protective equipment and oblige the personnel to wear it. It is recommended to risk assess the workplace.
- Besides the safety instructions in this operating instruction, the health, safety and environment regulations applicable for the range of application of the transmitter, transducers and accessories have to be observed.
- With the exceptions stated in chapter Maintenance and cleaning [▶ 143], the measuring equipment is maintenance-free. Any components and spare parts may only be replaced by Flexim. The operator shall carry out periodic checks for changes or damages that can present a danger. For further information, contact Flexim.
- Observe the specifications for the installation and connection of the transmitter, transducers and accessories.

2.6 Safety instructions for electrical work

- Prior to any work on the transmitter (e.g., installation, dismounting, connection, service and maintenance), the transmitter has to be disconnected from the power supply. It is not sufficient to remove the internal fuse of the instrument.
- Electrical work may only be carried out if there is enough space.
- Open the transmitter in safe ambient conditions only (e.g., air humidity < 90 %, no conductive pollution, no explosive atmosphere). Otherwise, additional protective measures have to be taken.
- The degree of protection of the transmitter is only ensured if all cables are tightly fitted using cable glands and the housing is firmly screwed.
- The condition and tight fit of the electrical connections have to be checked at regular intervals.
- When connecting the transmitter to the power supply, an appropriate equipment switch according to IEC 60947-1 and IEC 60947-3 has to be installed as disconnecting device. The equipment switch has to disconnect all live wires ≤ 16 A. The protective conductor connection must not be interrupted. The equipment switch has to be easily accessible and clearly marked as a disconnecting device for the transmitter. It should be located near the transmitter. If the transmitter is used in an explosive atmosphere, the equipment switch has to be installed outside the explosive atmosphere. If this is not possible, it must meet the requirements for the use in explosive atmospheres.
- The connection may only be made to networks up to overvoltage category II. When connecting the inputs and outputs as well as the power supply, observe the installation instructions, in particular the terminal assignment.
- The front plate must not be removed. The transmitter does not contain any components to be maintained by the user. For repair and service work, please contact Flexim.
- Observe the safety and accident prevention regulations for electrical systems and equipment.

Fig. 1: Transmitter



1 front plate

2.7 Safety instructions for transport

⚠ CAUTION

Warning of injuries due to falling objects

Unsecured and falling objects can lead to severe injuries.

→Secure all components against falling during transport.

→Wear the required personal protective equipment.

→Observe the applicable rules.

- If you detect a transport damage when unpacking the delivery, please contact the supplier or Flexim immediately.
- The transmitter is a sensitive electronic measuring instrument. Avoid shocks or impacts.
- Handle the transducer cable with care. Avoid excessive bending or buckling. Observe the ambient conditions.
- Select a solid surface to put the transmitter, transducers and accessories on.

2.8 Recommended procedure in hazardous situations

Fire fighting measures

- If possible, disconnect the transmitter from the power supply.
- Prior to extinguishing, protect any electrical parts that are not affected by the fire (e.g., using a cover).
- Select a suitable extinguishing agent. Avoid, if possible, conductive extinguishing agents.
- Observe the applicable minimum distances. The minimum distances differ depending on the used extinguishing agent.

2.9 Secure operation guidelines

Product operation

Best practices of product operation:

- Operate the device within a controlled and secured physical environment.
- Operate the device within a controlled and secured network environment.
- Manage all the accounts on the device according to the security policy of your company.

Reporting security vulnerabilities

Use "Report a Vulnerability" on https://www.emerson.com/en-us for reporting vulnerabilities back to Emerson.

3 General principles

The FLUXUS H*3* is used in the oil and gas industry on single and multiproduct pipelines of liquid hydrocarbons. Its purpose is the measurement of the volumetric flow rate and the standard volumetric flow rate by means of the transit time difference principle. Furthermore, the mass flow rate and other fluid parameters (e.g., API gravity, density, standardized density, kinematic viscosity) can be determined from the sound speed (transit time measurement) and the temperature. The FLUXUS H*3* can also be used for leakage detection, fluid detection (using the fluid table) and interface detection (slope).

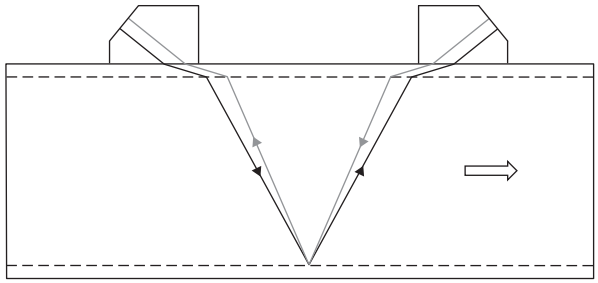
Terms and abbreviations

term/abbreviation	explanation
HPI	hydrocarbon processing industry
ASTM	ASTM International (formerly known as American Society for Testing and Materials; an international standardization organization)
standardized density	density at reference conditions
fluid decision (table)	HPI measuring mode with editable table
slope	change of an HPI physical quantity over time

3.1 Measurement principle

The ultrasonic transducers are mounted on the pipe which is completely filled with the fluid. The ultrasonic signals are alternatively emitted and received by the transducers. The physical quantities are determined from the transit times of the ultrasonic signals.

Fig. 2: Path of the ultrasonic signal in the flowing fluid



Transit time difference principle

The signals are emitted and received by two transducers alternatively in and against the flow direction. If the fluid is flowing, the signals propagating in the fluid are displaced with the flow.

This displacement changes the length of the signal sound paths in and against the flow direction and thus the transit times. The transit time of the signal in the flow direction is shorter than that against the flow direction. The transit time difference is proportional to the average flow velocity.

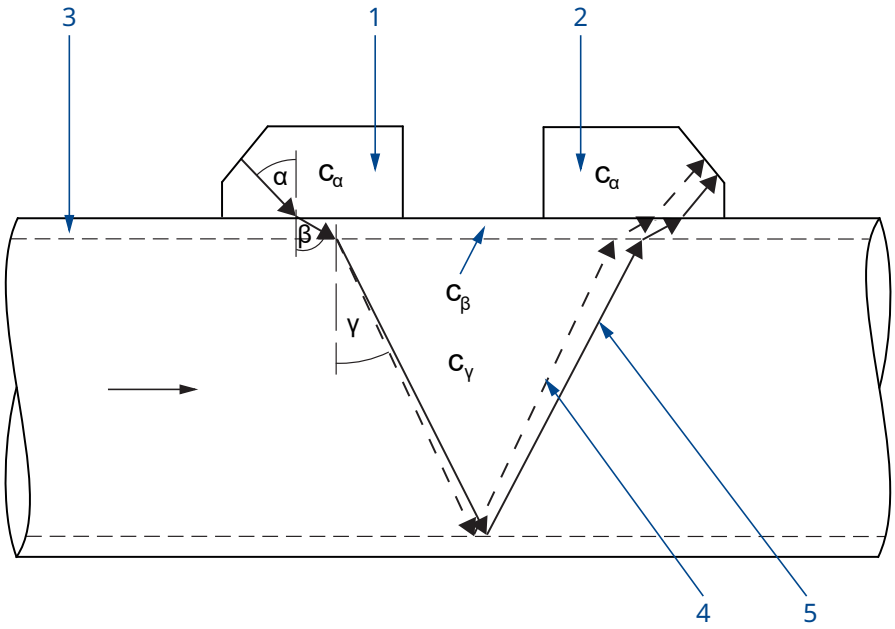
The average flow velocity of the fluid is calculated as follows:

$$v = k_{Re} \cdot k_a \cdot \frac{\Delta t}{2 \cdot t_\gamma}$$

where

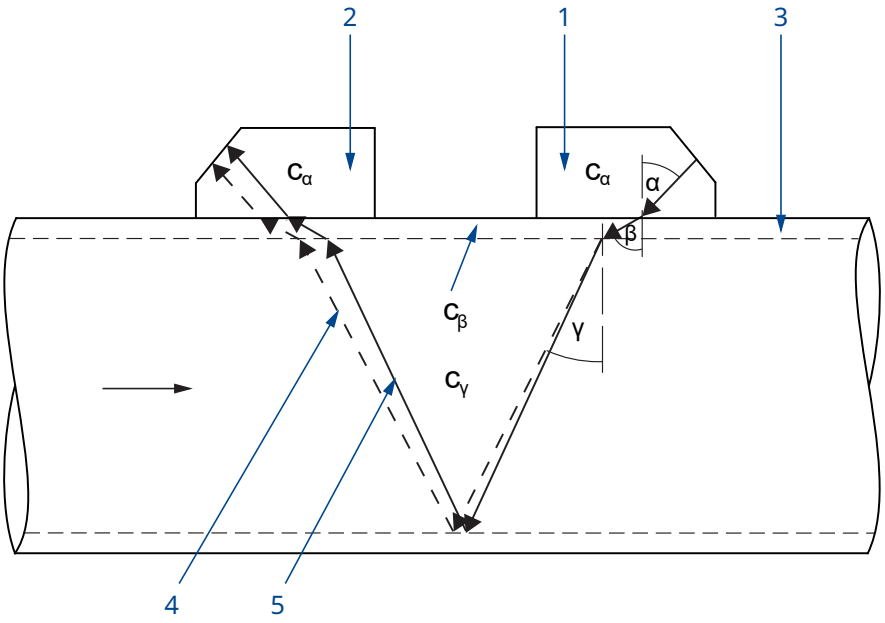
v – average flow velocity of the fluid
k_{Re} – fluid mechanic calibration factor
k_a – acoustic calibration factor
Δt – transit time difference
t_γ – transit time in the fluid

Fig. 3: Sound path of the signal in the flow direction



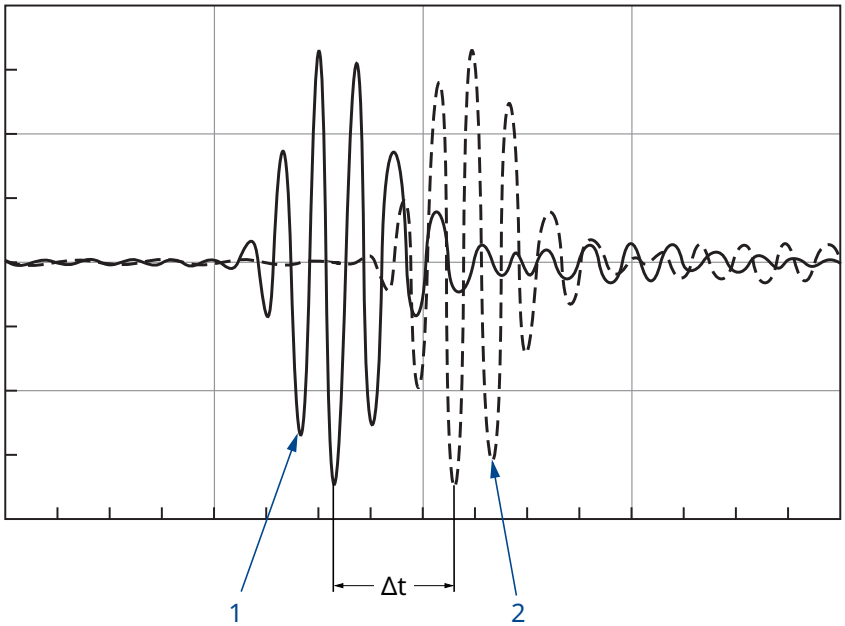
1 transducer (emitter)
2 transducer (receiver)
3 pipe wall
4 sound path without flow
5 sound path with flow

Fig. 4: Sound path of the signal against the flow direction



1 transducer (emitter)
2 transducer (receiver)
3 pipe wall
4 sound path without flow
5 sound path with flow

Fig. 5: Transit time difference Δt

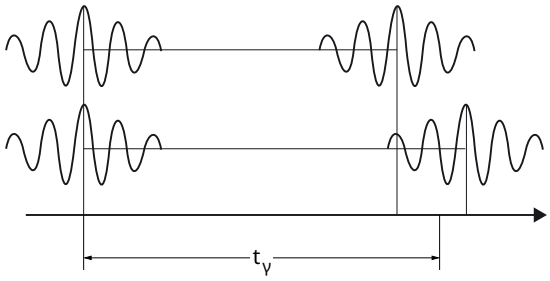


1 signal in flow direction
2 signal against flow direction

Transit time measurement

The average of the transit times of the ultrasonic signals in the fluid and the length of the sound paths in the fluid are used to calculate the sound speed. By using the average, the sound speed is independent of the flow velocity of the fluid.

Fig. 6: Average of the transit times in the flowing fluid



Calculation of the sound speed

$$c_\gamma = \frac{l_\gamma}{t_\gamma}$$

where

- c_γ – sound speed in the fluid
- l_γ – sound path in the fluid
- t_γ – average of the transit times in the fluid

Calculation of the volumetric flow rate

$$\dot{V} = k_{Re} \cdot A \cdot k_a \cdot \frac{\Delta t}{2 \cdot t_\gamma}$$

where

- $\dot{V}$ – volumetric flow rate
- k_{Re} – fluid mechanic calibration factor
- A – cross-sectional pipe area
- k_a – acoustic calibration factor
- Δt – transit time difference
- t_γ – average of the transit times in the fluid

The Reynolds number that depends on the kinematic viscosity is used for the calculation of the fluid mechanic calibration factor. Since the kinematic viscosity of hydrocarbons, unlike that of other fluids, depends not only on the temperature but also on the density and type of hydrocarbon, it is determined from the sound speed and the temperature.

Calculation of the standard volumetric flow rate

$$\dot{V}_N = \dot{V} \cdot VCF$$

$$VCF = CTL \cdot CPL = \frac{\rho}{\rho_N}$$

where

$\dot{V}_N$ – standard volumetric flow rate

$\dot{V}$ – volumetric flow rate

ρ_N – standardized density, calculated from the measured sound speed and temperature

ρ – density, selected from ASTM 1250 as a function of ρ_N

CPL – correction for the effect of pressure on liquid, selected from ASTM 1250 as a function of ρ_N

CTL – correction for the effect of temperature on liquid, calculated from ρ and ρ_N

VCF – volume correction factor

Calculation of mass flow rate

The operating density of the fluid is calculated as a function of the API gravity and temperature of the fluid:

$\rho = f(API, T)$

The mass flow rate is calculated from the operating density and the volumetric flow rate:

$$\dot{m} = \dot{V} \cdot \rho$$

where

ρ – operating density

API – API gravity

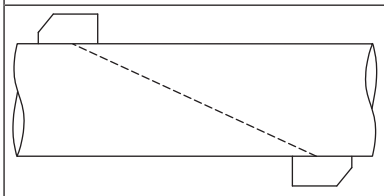
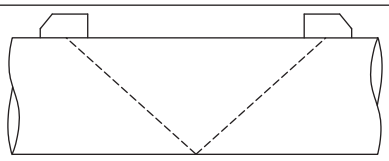
T – temperature

$\dot{m}$ – mass flow rate

$\dot{V}$ – volumetric flow rate

3.2 Measurement arrangements

3.2.1 Terms

diagonal arrangement	reflection arrangement
The transducers are mounted on opposite sides of the pipe.	The transducers are mounted on the same side of the pipe.
	

Sound path

The distance covered by the ultrasonic signal after crossing the pipe once. The number of the sound paths is:

- odd if the measurement is carried out in diagonal arrangement
- even if the measurement is carried out in reflection arrangement

Sound beam

The path covered by the ultrasonic signal between the transducers, i.e., the transducer emitting the ultrasonic signal and the transducer receiving it. A sound beam consists of 1 or several sound paths.

Fig. 7: Diagonal arrangement with 2 sound beams and 6 sound paths

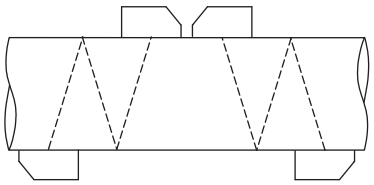
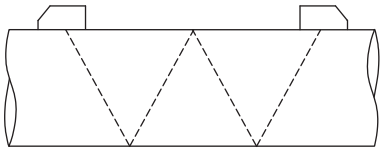


Fig. 8: Reflection arrangement with 1 sound beam and 4 sound paths



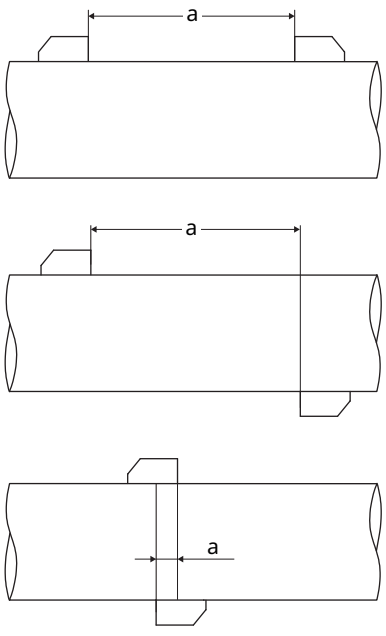
Transducer distance

The transducer distance is measured between the inner edges of the transducers.

reflection arrangement

diagonal arrangement
(positive transducer distance)

diagonal arrangement
(negative transducer distance)



a transducer distance

Sound beam plane

Plane the sound beam is located in.

Fig. 9: 2 sound beams in 1 plane

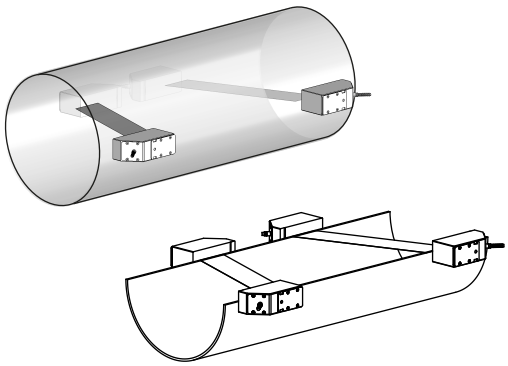
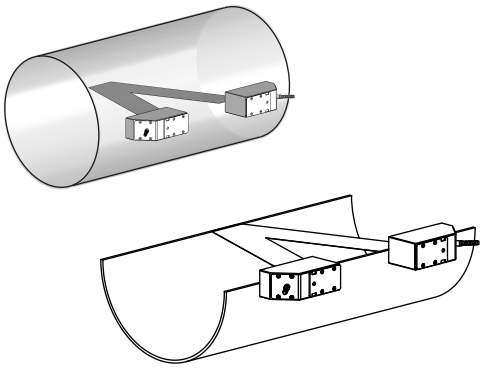
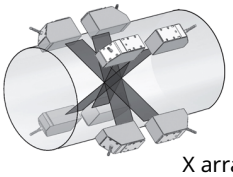
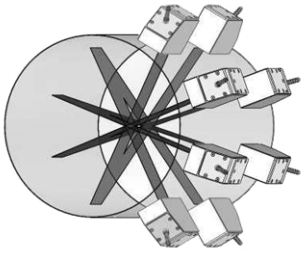


Fig. 10: 2 sound paths in 1 plane



3.2.2 Examples

diagonal arrangement with 4 beams and 2 planes	**reflection arrangement with 4 beams and 4 planes**
4 transducer pairs 4 sound paths 4 sound beams 2 planes	4 transducer pairs 8 sound paths 4 sound beams 4 planes
 X arrangement	

3.3 Acoustic penetration

The pipe has to be acoustically penetrable at the measuring point. The acoustic penetration is given when pipe and fluid do not attenuate the sound signal to such an extent that it is completely absorbed before reaching the second transducer.

The attenuation caused by the pipe and the fluid depends on:

- kinematic viscosity of the fluid
- proportion of gas bubbles and solid particles in the fluid
- deposits on the inner pipe wall
- pipe material

The following requirements have to be met at the measuring point:

- pipe always completely filled
- no deposits of solid particles in the pipe
- no formation of gas bubbles

NOTICE

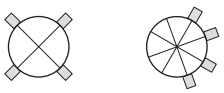
Even bubble-free fluids can form gas bubbles when the fluid expands, e.g., upstream of pumps and downstream of great cross-section enlargements.

Observe the following notes on the selection of the measuring point:

Horizontal pipe

Select a measuring point where the transducers can be mounted laterally on the pipe. Thus, solid particles on the bottom of the pipe or gas bubbles in the upper part are prevented from influencing the propagation of the signal.

Fig. 11: Recommended transducer mounting position



Vertical pipe

Select the measuring point at a pipe section where the fluid flows upward. The pipe has to be completely filled.

Fig. 12: Recommended transducer mounting position

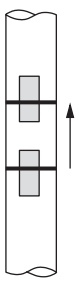
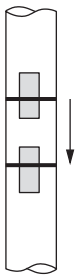


Fig. 13: Disadvantageous transducer mounting position



Free inlet or outlet

Select the measuring point at a pipe section where the pipe cannot run empty.

Fig. 14: Recommended transducer mounting position

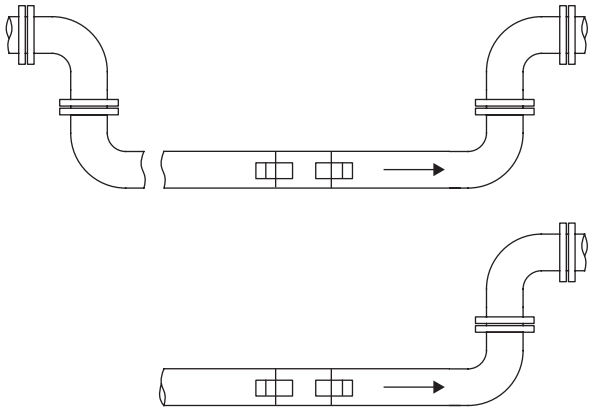
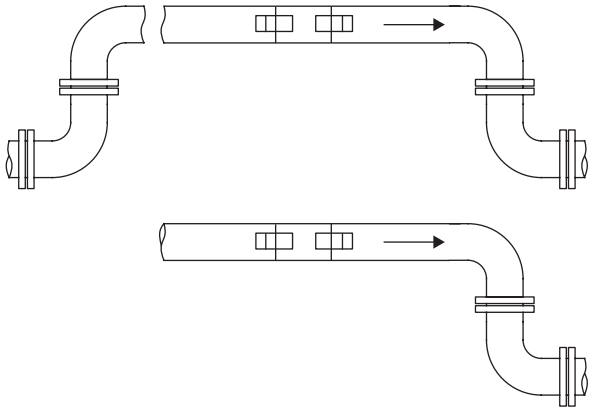


Fig. 15: Disadvantageous transducer mounting position



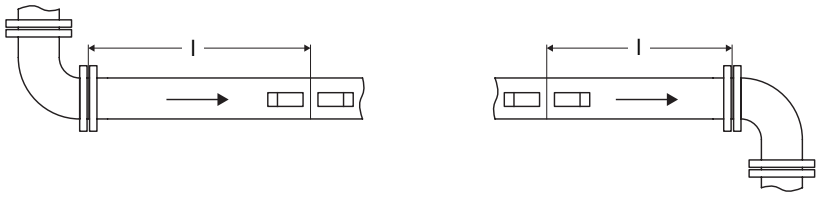
3.4 Undisturbed flow profile

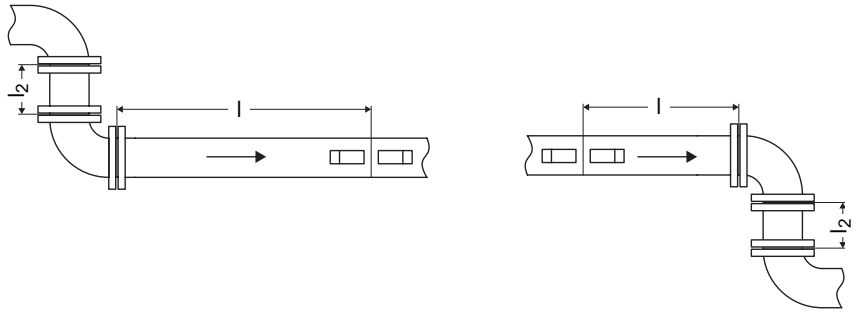
Some flow elements (e.g., elbows, valves, pumps, reducers) distort the flow profile in their vicinity. The axisymmetrical flow profile in the pipe needed for correct measurement is no longer given. A careful selection of the measuring point helps to reduce the impact of disturbances.

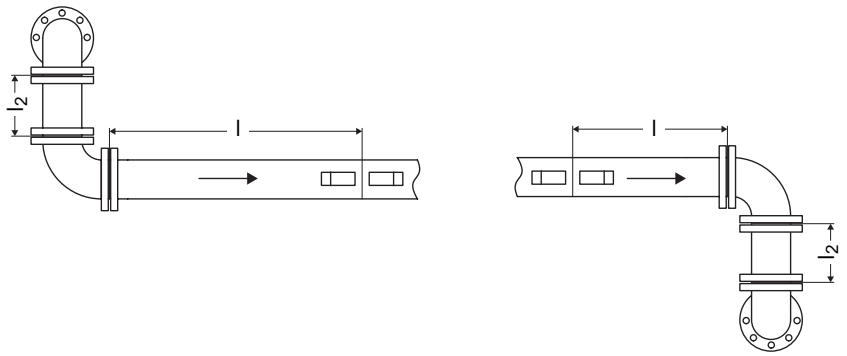
It is most important that the measuring point is located at a sufficient distance from any disturbance. Only then it can be assumed that the flow profile in the pipe is fully developed. However, the disturbance correction (see section Profile correction [▶ 150]) allows a measurement even at smaller distances of min. 2 d.

The recommended straight inlet and outlet pipe lengths for different types of flow disturbances are shown in the following table. These are to be measured from the end of the disturbance, which is not always at the position of the nearest flange (see Tab. 49: Disturbance parameters [▶ 151]).

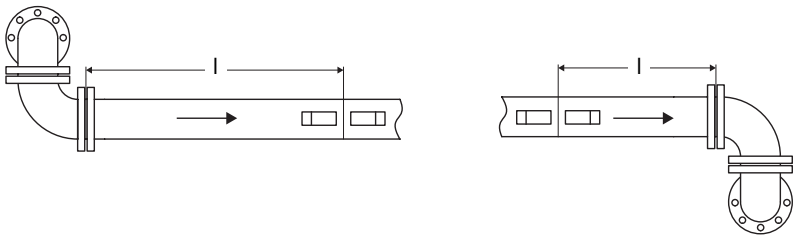
Tab. 2: Recommended distance from disturbances

disturbance: 90° elbow	
inlet: l ≥ 10 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

disturbance: 90° double elbow (with elbow distance l_2 ≥ 3 d)	
inlet: l ≥ 10 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

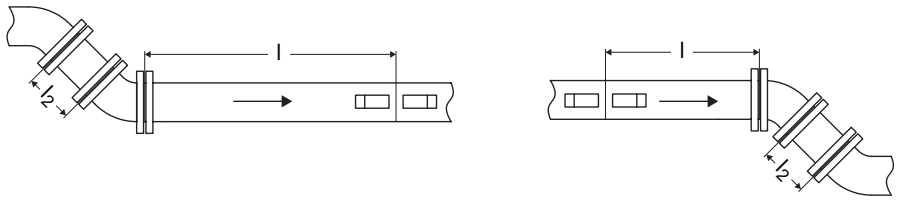
disturbance: double elbow out of plane (with elbow distance l_2 ≥ 3 d)	
inlet: l ≥ 10 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

disturbance: double elbow out of plane (directly coupled)	
inlet: l ≥ 40 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d

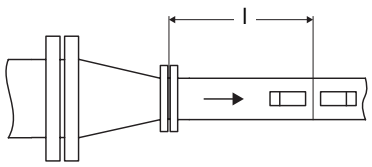
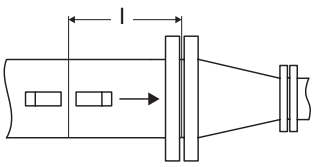


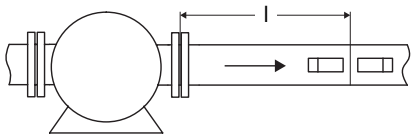
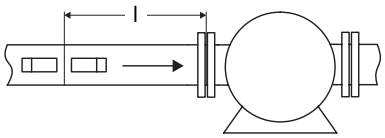
disturbance: 45° elbow	
inlet: l ≥ 15 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d

disturbance: 45° double elbow (with elbow distance l_2 ≥ 3 d)	
inlet: l ≥ 15 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d



disturbance: valve	
inlet: l ≥ 40 d	outlet: l ≥ 3 d

disturbance: reducer	
inlet: l ≥ 10 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

disturbance: pump	
inlet: l ≥ 20 d	outlet: l ≥ 3 d
	

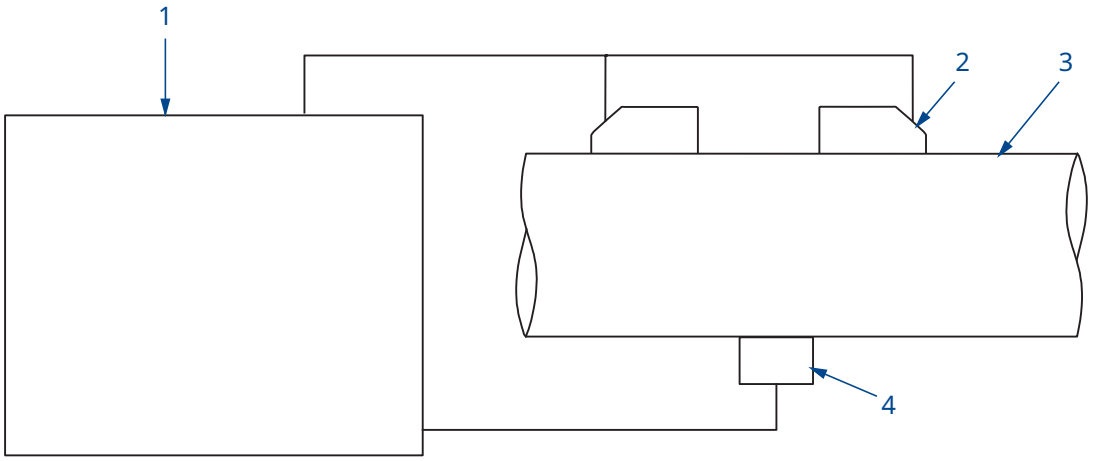
d – inner pipe diameter at the measuring point
l – recommended distance between disturbance and transducer position

4 Product description

4.1 Measuring system

The measurement system consists of the transmitter, the temperature probe, the ultrasonic transducers and the pipe on which the measurement is carried out.

Fig. 16: Example of a measurement arrangement



1 transmitter
2 transducer
3 pipe
4 temperature probe

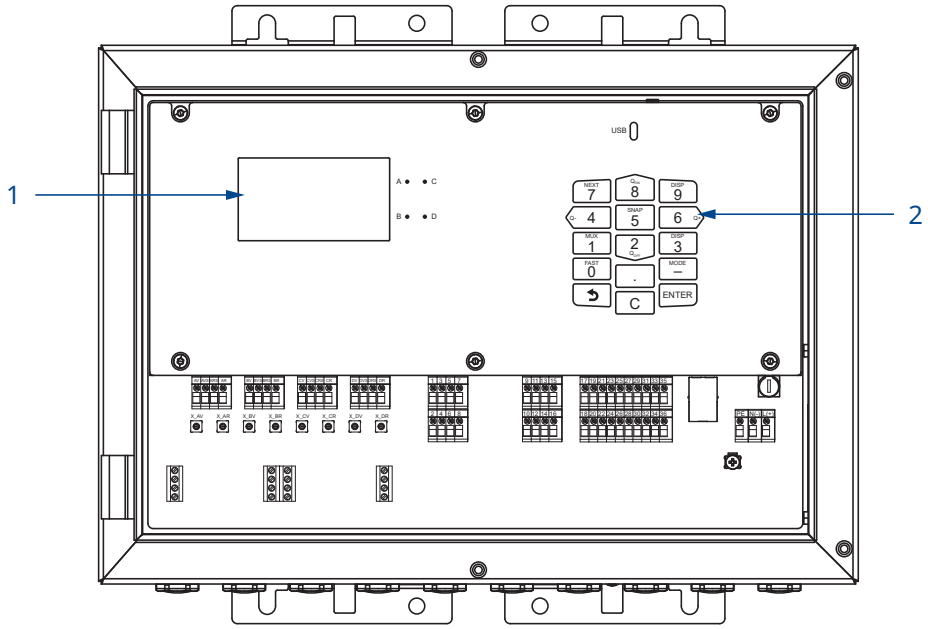
The transducers are mounted on the outside of the pipe. They send and receive ultrasonic signals through the fluid.

The transmitter controls the measuring cycle, reduces noise signals and analyzes useful signals. The measured values can be displayed, used for calculations and transmitted.

4.2 Handling concept

The transmitter is operated via the keyboard. By pressing 4 or 6 the menus are displayed consecutively.

Fig. 17: Command panel of the transmitter



1 LCD display (backlit) **2 keyboard**

Tab. 3: Description of the menus

menu	description
`Parameters`	input of sensor, pipe and fluid parameters
`Installation`	input of measuring point specific parameters [1]
`Start measurement`	measurement start [1]
`Show measurement`	display of measured values [2]
`Stop measurement`	measurement stop [2]
`Inputs`	configuration and assignment of inputs
`Outputs`	configuration of outputs
`Functions`	configuration of event triggers and remote functions
`Storage`	configuration of data logger and snaps
`Calibration`	definition of correction values to compensate unfavorable measuring conditions
`Communication`	configuration of communication interfaces (e.g., fieldbuses (optional))
`Miscellaneous`	change of system, measurement and dialog/menu settings

[1] will only be displayed if no measurement is running
[2] will only be displayed if a measurement is running

When starting up the transmitter for the first time, settings relating to the language, time, date and system of units have to be made. Afterwards, the menu `Parameters` will be displayed.

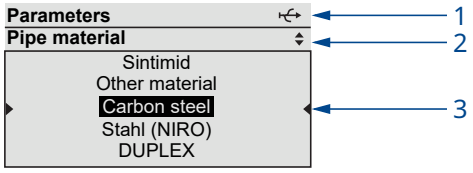
At later start-ups the measured values will be displayed in case the measurement had not been stopped before the transmitter was disconnected from the power supply. If the measurement had been stopped, the menu `Parameters` will be displayed.

After starting the measurement, the parameter settings or the configuration of the transmitter outputs can be displayed at any time without interrupting the measurement. However, it is not possible to change them during the measurement.

4.3 Display

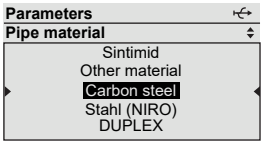
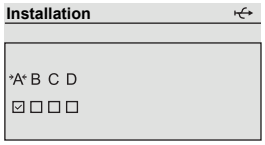
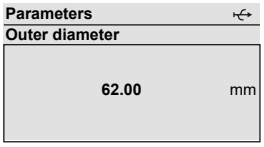
Structure

Fig. 18: Menu Parameters (example)



1 menu
2 menu item currently being edited
3 scroll list

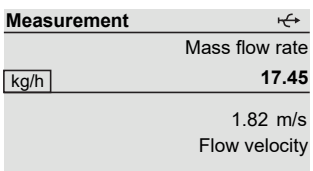
Tab. 4: Navigation

horizontal scroll list	vertical scroll list	selection fields	input fields
			
• scroll horizontally with 4 or 6	• scroll vertically with 8 or 2	• scroll horizontally with 4 or 6 • activate/deactivate with 2 or 8	• input via the 10 numerical keys of the keyboard • delete with C

Status indicators

Several symbols are used as status indicators.

Fig. 19: Status indication (line 1)



Status indicators:

- running measurement
- error message
- FastFood mode activated
- data logger full
- connection via USB cable
- key lock activated

4.4 Keyboard

The keyboard has 15 keys, including 3 function keys: ENTER, ⮌ and C.

Some keys have multiple functions. They can be used to enter data, to navigate through scroll lists as well as to execute special functions (e.g., reset of totalizers).

Tab. 5: General functions

ENTER	confirmation of selection or input
⮌ + C + ENTER	RESET: press these 3 keys simultaneously to correct a malfunction. The reset has the same effect as a restart of the transmitter. Stored data are not affected.
⮌ + C	INIT: when initializing the transmitter, all settings are reset to the factory settings.

Tab. 6: Navigation

⮌	During the input of parameters: short press: return to the previous menu item long press (several seconds): return to the beginning of the menu during the measurement: return to the main menu
4 6	scroll to the left/right through a scroll list
8 2	scroll upwards/downwards through a scroll list
ENTER	confirmation of a menu item

Tab. 7: Input of numbers

0 ... 9	input of the number shown on the key
−	sign for the input of negative values
·	decimal marker
C	deletion of values After a value has been deleted, the previous value will be displayed.
ENTER	confirmation of the input

Tab. 8: Input of text

4 6	cursor positioning
9	"A" is displayed and upper case is activated
3	"Z" is displayed and upper case is activated
5	toggling between upper and lower case
8 2	selection of the previous/next character
0	deletion of a character and insertion of a blank
ENTER	confirmation of the input

5 Transport and storage

⚠ CAUTION

When packaging, the transmitter can fall down.

There is a danger of crushing body parts or damaging the measuring equipment.

→Secure the transmitter against falling during packaging.

→Wear the required personal protective equipment.

→Observe the applicable rules.

⚠ CAUTION

When lifting, the center of gravity of the transmitter can be displaced within the cardboard box. The transmitter can fall down.

There is a danger of crushing body parts or damaging the measuring equipment.

→Secure the transmitter against falling during transport.

→Wear the required personal protective equipment.

→Observe the applicable rules.

5.1 Transport

The measuring equipment must be packaged properly for transport. For weight indications see technical specification.

- Use, if possible, the original packaging by Flexim or an equivalent cardboard box.
- Position the transmitter, transducers and accessories in the middle of the cardboard box.
- Fill any voids with appropriate packaging material (e.g., paper, foam, bubble wrap).
- Protect the measuring equipment against humidity and sunlight.
- Transport the measuring equipment in compliance with the valid temperature range (see technical specification, storage).

5.2 Storage

- Store the measuring equipment within the original package.
- Do not store the measuring equipment outdoors.
- Seal all openings with blind plugs.
- Protect the measuring equipment against sunlight.
- Store the measuring equipment in a dry place without dust and within the valid temperature range (see technical specification).

6 Mounting

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ WARNING

Installation, connection and start-up by unauthorized and unqualified personnel

This may result in personal or material damage or dangerous situations.

→Any work on the transmitter has to be carried out by authorized and qualified personnel only.

⚠ WARNING

Touching live parts

Electric shock or arc faults can lead to severe injuries. The measuring equipment can be damaged.

→Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply.

⚠ CAUTION

Safety and accident prevention regulations for electrical systems and equipment

Failure to observe these regulations may lead to severe injuries.

→Observe the safety and accident prevention regulations for electrical systems and equipment.

⚠ CAUTION

Touching hot or very cold surfaces

This may result in injuries (e.g., thermal damages).

→Observe the ambient conditions at the measuring point during installation.

→Wear the required personal protective equipment.

→Observe the applicable rules.

6.1 Transmitter

6.1.1 Opening and closing the housing

6.1.1.1 Opening

⚠ CAUTION

Possible danger by opening the equipment at improper ambient conditions

Open the transmitter in safe ambient conditions only (e.g., air humidity < 90 %, no conductive pollution, no explosive atmosphere). Otherwise, additional protective measures have to be taken.

Important

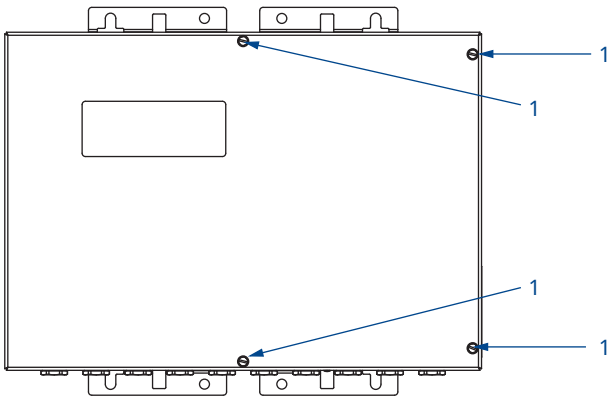
Do not open the housing cover using objects which may damage the housing gasket.

- Loosen the screws of the transmitter housing.
- Open the housing cover of the transmitter.

6.1.1.2 Closing

- Close the housing cover.
- Tighten the screws of the transmitter housing with a max. torque of 1 Nm.

Fig. 20: Transmitter



1 screw

6.1.2 Installation of the transmitter

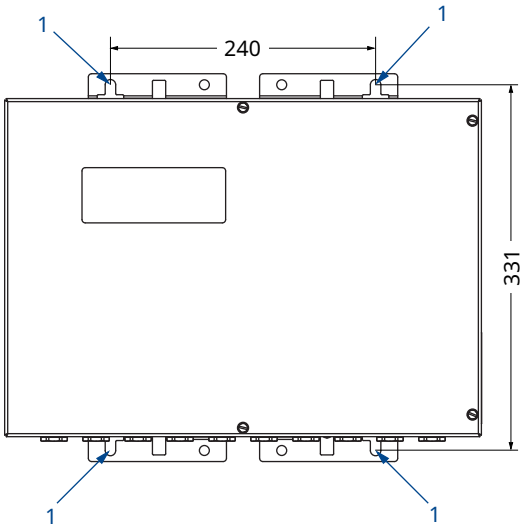
NOTICE

Install the device in a shady place, the cable glands facing downward. Observe the temperature and weight indications according to the technical specification when choosing the fixation elements and the place of installation.

6.1.2.1 Wall mounting

- Fix the transmitter to the wall using 4 screws.

Fig. 21: Transmitter (dimensions in mm)



1 fixing hole for wall mounting Ø 9

6.1.2.2 Pipe mounting

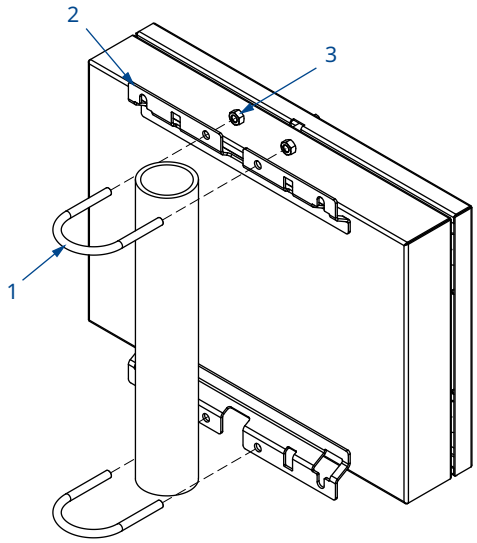
Important

The pipe has to be sufficiently stable to withstand the pressure exerted by the transmitter and the shackles.

Mounting on a 2'' pipe

- Push the shackles through the holes in the instrument mounting plate.
- Fix the transmitter by screwing the nuts onto the shackles and tightening them firmly.

Fig. 22: Installation of the transmitter



1 shackle **2 instrument mounting plate**
3 nut

6.2 Transducers

⚠ CAUTION

Warning of severe injuries from hot or very cold components

Touching hot or very cold components can lead to severe injuries (e.g., thermal damage).

→Any mounting, installation or connection work has to be concluded.

→Any work on the measuring point during the measurement is prohibited.

→Observe the ambient conditions at the measuring point during installation.

→Wear the required personal protective equipment.

→Observe the applicable rules.

NOTICE

If the transducers are insulated on the pipe, make sure that the transducer cables are routed directly out of the insulation (not along the pipe).

6.2.1 Preparation

6.2.1.1 Selection of the measuring point

The correct selection of the measuring point is crucial for achieving reliable measurement results and a high measurement accuracy.

A measurement on a pipe is possible if:

- the ultrasound propagates with a sufficiently high amplitude
- the flow profile is fully developed

The correct selection of the measuring point and the correct transducer positioning guarantee that the ultrasonic signal will be received under optimum conditions and evaluated correctly.

Because of the variety of applications and the different factors that influence the measurement, there is no standard solution for the transducer positioning.

The measurement is influenced by the following factors:

- diameter, material, lining, wall thickness and shape of the pipe
- fluid
- gas bubbles in the fluid

Notes:

- Avoid measuring points in the vicinity of distorted or defective areas of the pipe or in the vicinity of welds.
- Avoid measuring points with deposit formation in the pipe.
- Make sure the pipe surface at the selected measuring point is even.
- Select the location of the transmitter within the transducer cable range.
- The temperature at the measuring point has to be within the specified ambient temperature range of the transmitter and the transducers (see technical specification).

If the measuring point is within an explosive atmosphere, the danger zone and present gases have to be determined. The transducers and the transmitter have to be appropriate for these conditions.

6.2.1.2 Pipe preparation

⚠ CAUTION

Contact with grinding dust

This may result in injuries (e.g., breathing difficulties, skin reactions, eye irritations).

→Wear the required personal protective equipment.

→Observe the applicable rules.

Important

The pipe has to be sufficiently stable to withstand the pressure exerted by the transducers and the fasteners.

NOTICE

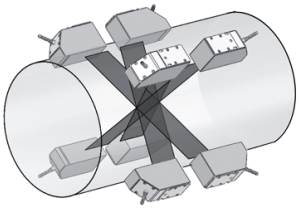
Observe the selection criteria of pipe and measuring point.

Rust, paint or deposits on the pipe absorb the ultrasonic signal. A good acoustic contact between the pipe and the transducers is obtained as follows:

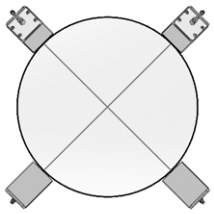
- Clean the pipe at the selected measuring point.
  - If present, the paint layer has to be smoothed by grinding. The paint does not need to be removed completely.
  - Remove any rust or loose paint.

6.2.1.3 Selection of the measurement arrangement

Diagonal arrangement with 4 beams and 2 planes

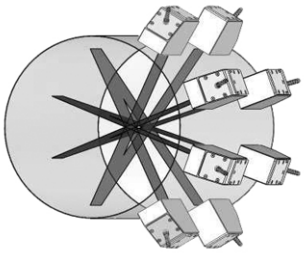


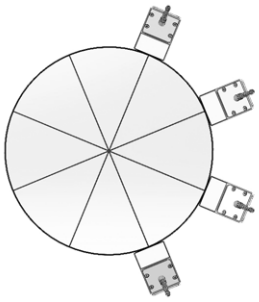
X arrangement



- wider flow velocity and sound speed range compared to the reflection arrangement
- influences of the flow profile are compensated for because the measurement takes place in 2 planes

Reflection arrangement with 4 beams and 4 planes

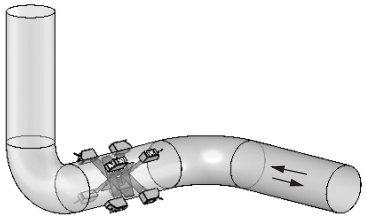




- smaller flow velocity and sound speed range compared to the diagonal arrangement
- influences of the flow profile are better compensated for because the measurement takes place in 4 planes

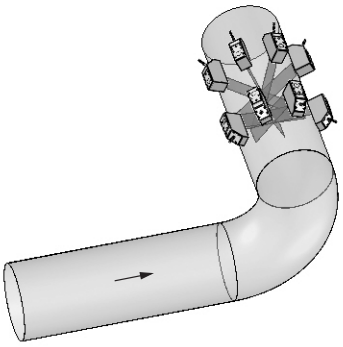
If the measuring point is situated near an elbow, the following measurement arrangements are recommended for the selection of the sound beam plane.

Bidirectional measurement



- The sound beam plane is selected according to the nearest elbow.

Measurement in reflection arrangement with 2 beams and 4 planes



- The 4 sound beam planes are selected at an angle of 30...60° to the elbow plane. The elbow is upstream of the measuring point.

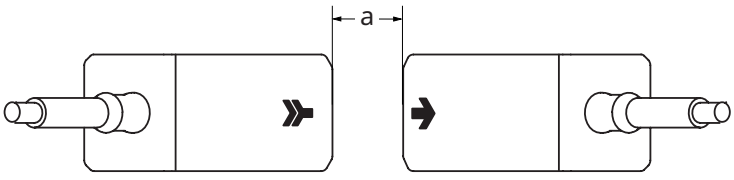
6.2.2 Installation of the transducers

6.2.2.1 Orientation of the transducers and determination of the transducer distance

Observe the orientation of the transducers. If the transducers have been mounted properly, the engravings on them form an arrow. The transducer cables show in opposite directions.

The transducer distance is measured between the inner edges of the transducers.

Fig. 23: Orientation and distance of the transducers



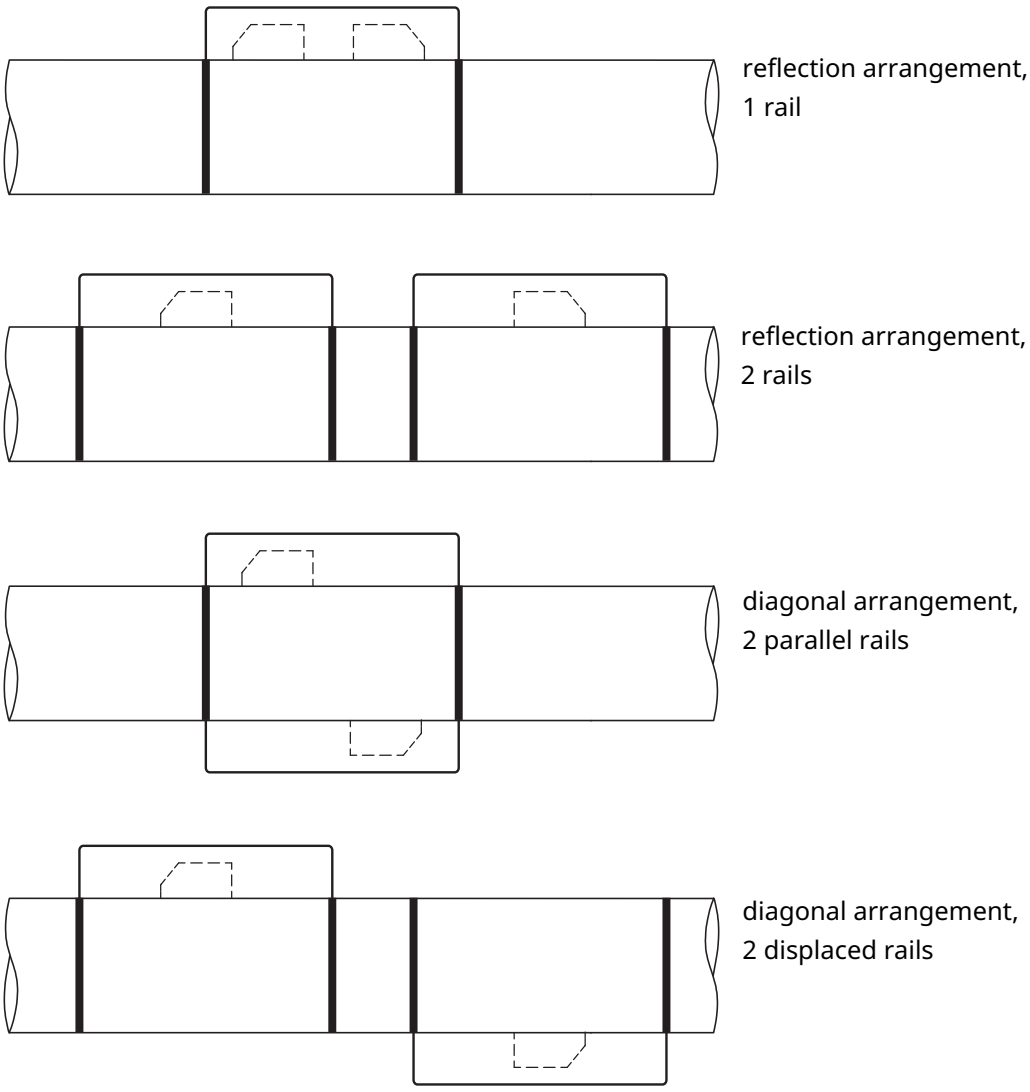
a transducer distance

- Select the installation instruction of the supplied transducer mounting fixture.

6.2.2.2 Transducer arrangement

The transducers can be arranged in the mounting rails in different ways:

Fig. 24: Transducer arrangement in mounting rails

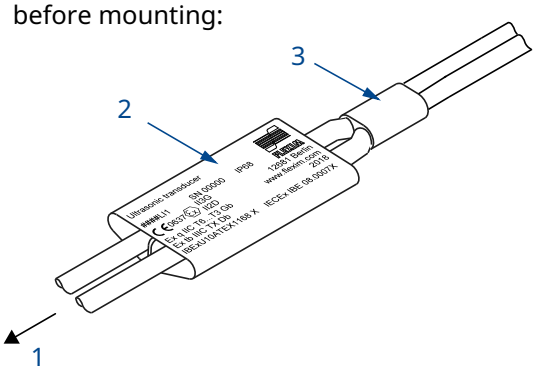


6.2.2.3 Mounting of ****LI* transducers

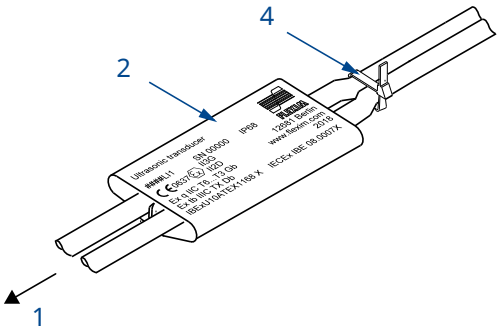
If the nameplate of the transducers ****LI* is removed from the transducer cable during installation, it has afterwards to be remounted and fixed to the transducer cable using the provided cable tie. The heat shrink tubing must not be reused.

Fig. 25: Nameplate on the transducer cable

before mounting:



after mounting:

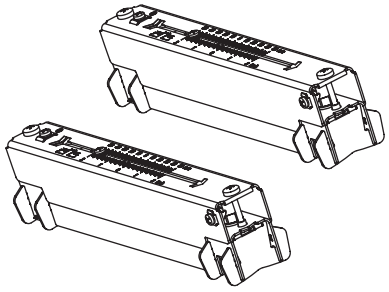


1 transducers
2 nameplate
3 heat shrink tubing
4 cable tie

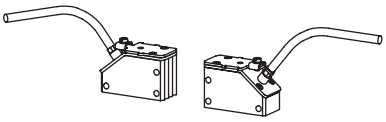
6.2.2.4 Mounting with Variofix C

Scope of delivery (example)

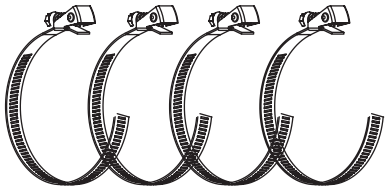
Variofix L



transducer pair

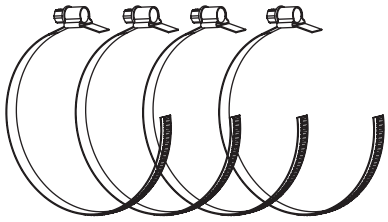


quick release clasp with tension strap



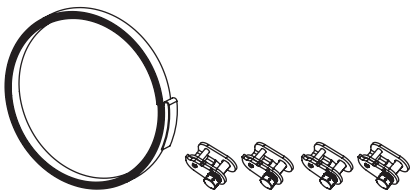
or

band clamp clasp with tension strap



or

ratchet clasp and tension strap coil



Mounting

⚠ CAUTION

The edge of the tension strap is very sharp.

Risk of injury!

→Debur sharp edges.

→Wear the required personal protective equipment.

→Observe the applicable rules.

When measuring in diagonal arrangement, the transducer mounting fixtures are mounted on opposite sides of the pipe. When measuring in reflection arrangement, the transducer mounting fixtures are mounted on the same side of the pipe.

Tab. 9: Approximate values for the mounting of 2 transducers in a Variofix L

transducer frequency (3rd character of the technical type)	rail length [mm]	transducer distance [mm]
F	368	< 94
G, H, K (****LI*)	368	< 94
G, H, K (except ****LI*)	348	< 89
M, P (Lamb wave transducers) M, P (shear wave transducers)	234	< 84 < 100
Q	176	< 69

In the following, the mounting of 2 transducer mounting fixtures in reflection arrangement is described (1 mounting fixture for each transducer).

Fig. 26: Transducer mounting fixture Variofix L (diagonal arrangement)

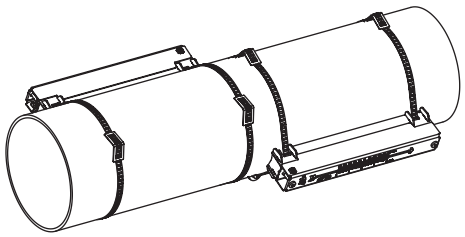
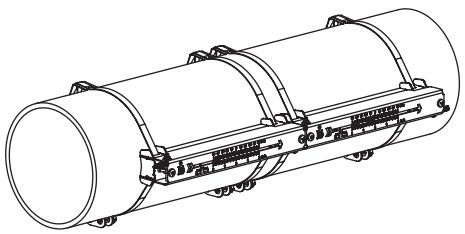


Fig. 27: Transducer mounting fixture Variofix L (reflection arrangement)



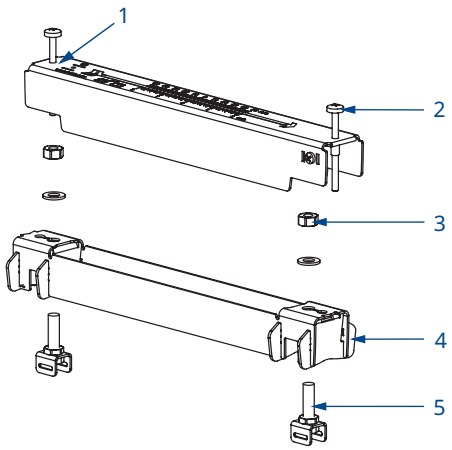
Overview of mounting steps

- **step 1**
  disassembly of the transducer mounting fixture Variofix L
- **step 2**
  fixation of the clasps to the tension straps
- **step 3**
  fixation of the tension strap to the pipe
- **step 4**
  fixation of the rail to the pipe
- **step 5**
  installation of the transducers in the mounting fixture Variofix L

Step 1: Disassembly of the transducer mounting fixture Variofix L

- Disassemble the transducer mounting fixture Variofix L.

Fig. 28: Disassembly of the transducer mounting fixture Variofix L



1 cover
2 bolt
3 nut
4 rail
5 tension strap clamp

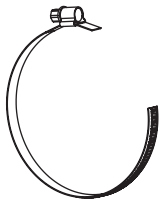
Step 2: Fixation of the clasps to the tension straps

- Select the installation instruction of the supplied clasp:

Band clamp clasp

The clasp is fixed to the tension strap.

Fig. 29: Band clamp clasp with tension strap

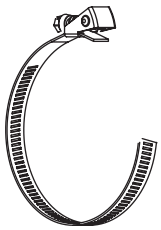


Quick release clasp

The clasp is fixed to the tension strap.

- Cut the tension strap to length (pipe circumference + at least 120 mm).

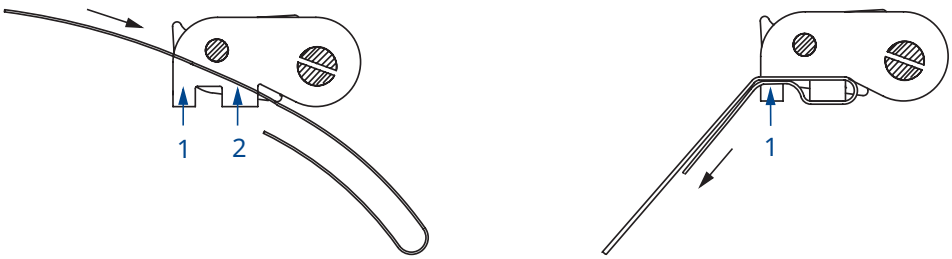
Fig. 30: Quick release clasp with tension strap



Ratchet clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Pass approx. 100 mm of the tension strap through part (1) and (2) of the ratchet clasp.
- Bend the tension strap.
- Pass the tension strap through part (1) of the ratchet clasp.
- Tighten the tension strap.
- Repeat the steps for the second tension strap.

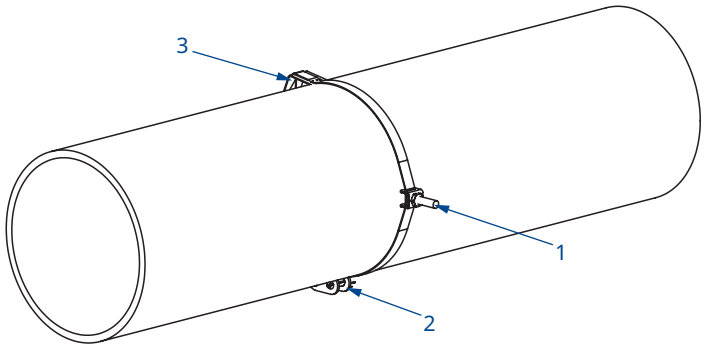
Fig. 31: Ratchet clasp with tension strap



Step 3: Fixation of the tension strap to the pipe

One tension strap is fixed to the pipe. The second tension strap will be mounted later.

Fig. 32: Tension strap with clamp and metal spring on the pipe



1 tension strap clamp **2 clasp**
3 metal spring

- Pass the tension strap through the clamp and the metal spring. It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer diameter < 80 mm
  - on pipes that are not subjected to significant temperature fluctuations
- Select the installation instruction of the supplied clasp:

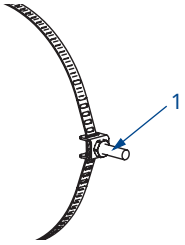
Band clamp clasp

- Position the clasp and the tension strap clamp on the pipe. On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
- Place the tension strap around the pipe and pass it through the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.

Quick release clasp

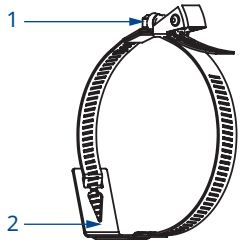
- Position the clasp, the tension strap clamp and the metal spring on the pipe:
  - On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
  - Mount the metal spring opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.

Fig. 33: Tension strap with clamp



1 tension strap clamp

Fig. 34: Tension strap with quick release clasp and metal spring



1 clasp screw **2 metal spring**

Fig. 35: Tension strap with band clamp clasp

1 clasp screw

Ratchet clasp

- Position the ratchet clasp, tension strap clamp and metal spring (if necessary) on the pipe:
  - On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
  - Mount the metal spring (if necessary) opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the slot of the clasp screw.
- Tighten the tension strap.
- Cut off the protruding tension strap.
- Tighten the clasp screw.

NOTICE

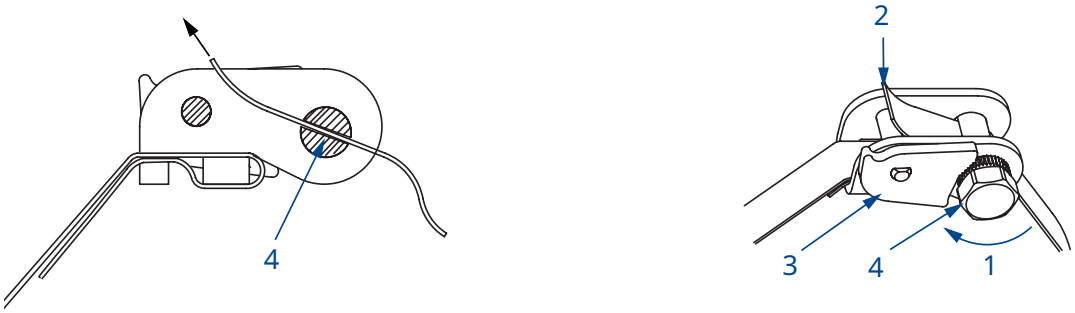
In order to release the screw and the tension strap, press the lever down.

Fig. 36: Tension strap with metal spring and clamp

1 metal spring

2 tension strap clamp

Fig. 37: Ratchet clasp with tension strap



1 sense of rotation

2 edge

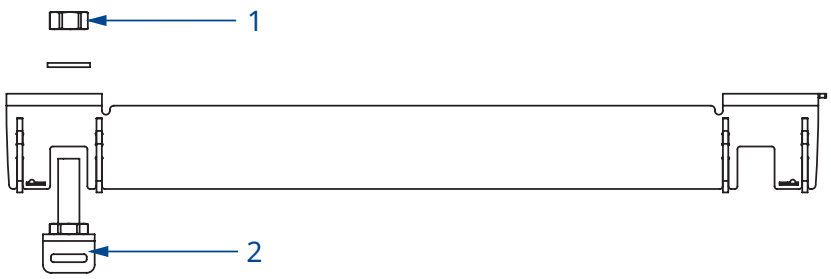
3 lever

4 clasp screw with slot

Step 4: Fixation of the rail to the pipe

- Place the second tension strap clamp in the rail, observing the orientation of the clamp.
- Slightly tighten the nut of the second tension strap clamp.
- Screw the rail to the first tension strap clamp.
- Tighten the nut of the first tension strap clamp, but not too firmly in order not to damage the tension strap.

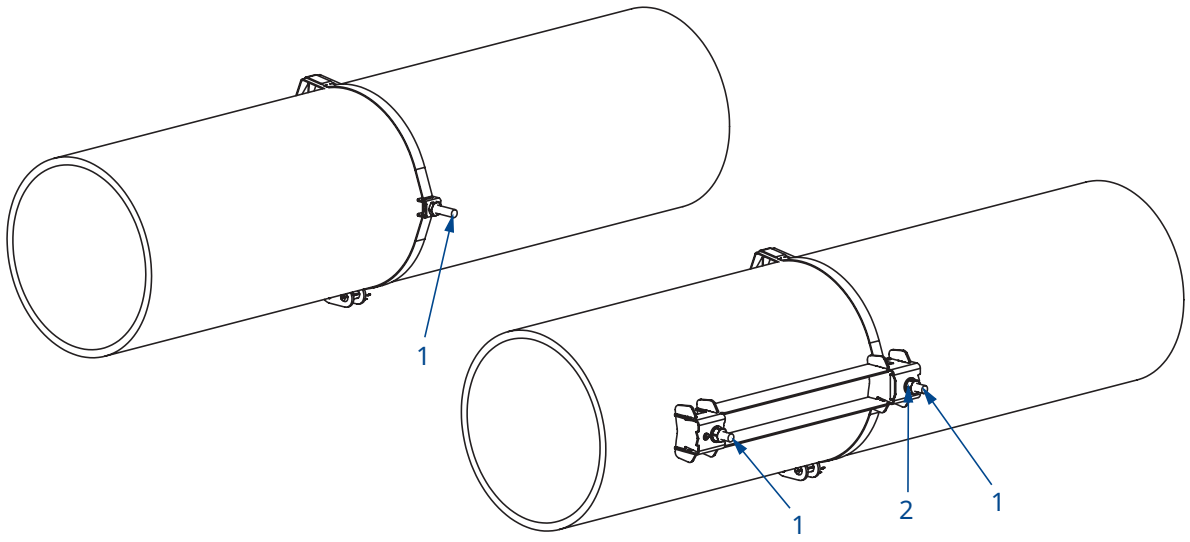
Fig. 38: Rail with tension strap clamp



1 nut

2 tension strap clamp

Fig. 39: Rail, fixed on one side to the pipe



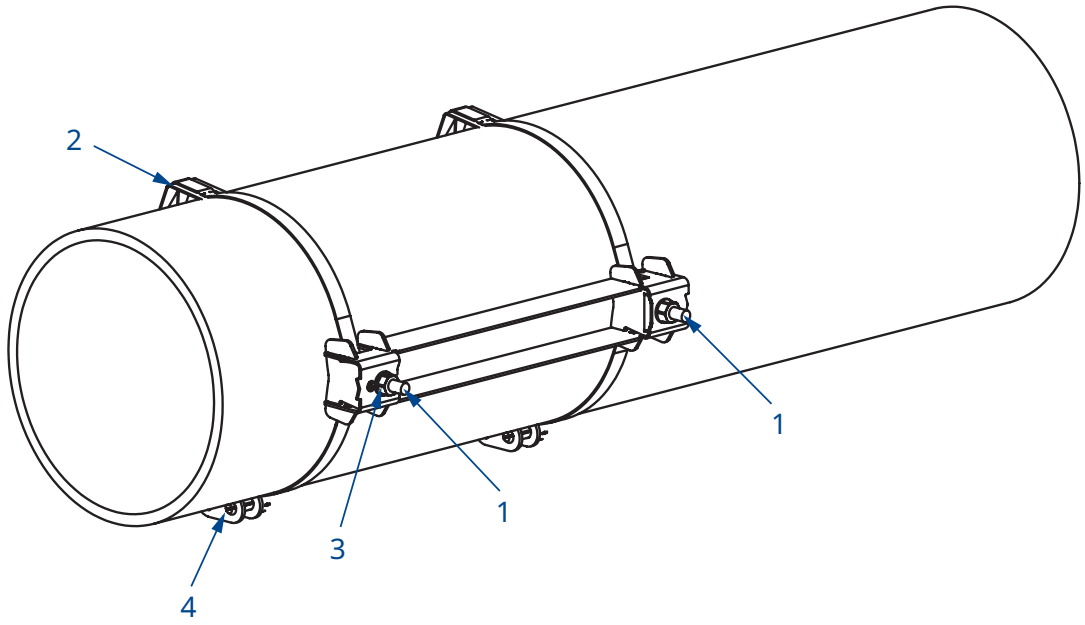
1 tension strap clamp **2 nut**

- Select the installation instruction of the supplied clasp:

Band clamp clasp

- Pass the tension strap through the second tension strap clamp.
- Place the tension strap around the pipe and pass it through the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.
- Tighten the nut of the second tension strap clamp, but not too firmly in order not to damage the tension strap.

Fig. 40: Rail on the pipe



1 tension strap clamp
2 metal spring
3 nut
4 clasp

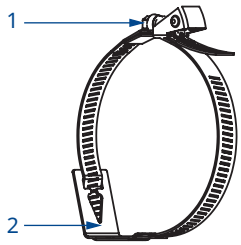
Quick release clasp

- Pass the tension strap through the clamp and the metal spring.
- Place the tension strap around the pipe and pass it through the clasp.
- Position the metal spring opposite the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.
- Tighten the nut of tension strap clamp, but not too firmly in order not to damage the tension strap.

Fig. 41: Tension strap with band clamp clasp

1 clasp screw

Fig. 42: Tension strap with quick release clasp and metal spring



1 clasp screw **2 metal spring**

Ratchet clasp

- Pass the tension strap through the clamp and the metal spring. It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer diameter < 80 mm
  - on pipes that are not subjected to significant temperature fluctuations
- Position the ratchet clasp, tension strap clamp and metal spring (if necessary) on the pipe:
- Mount the metal spring opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the slot of the clasp screw.
- Tighten the tension strap.
- Cut off the protruding tension strap.
- Tighten the clasp screw.
- Tighten the nut of tension strap clamp, but not too firmly in order not to damage the tension strap.

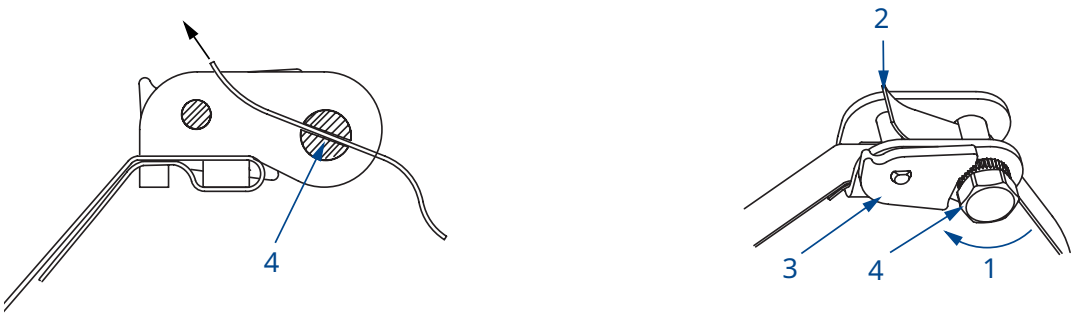
NOTICE

In order to release the screw and the tension strap, press the lever down.

Fig. 43: Tension strap with metal spring and clamp

1 metal spring **2 tension strap clamp**

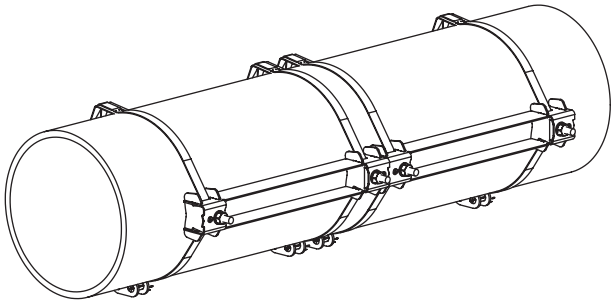
Fig. 44: Ratchet clasp with tension strap



1 sense of rotation
2 edge
3 lever
4 clasp screw with slot

- Repeat the steps to fix the second rail.

Fig. 45: Pipe with 2 rails



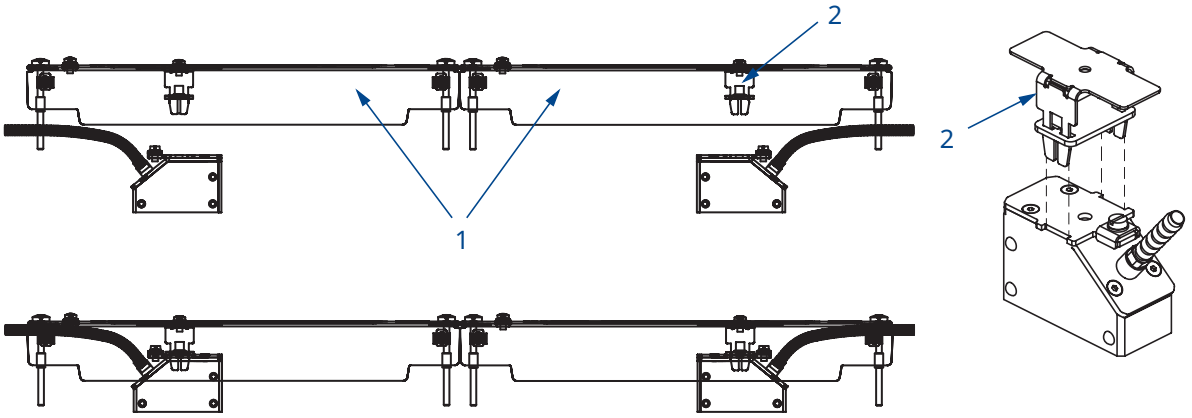
Step 5: Installation of the transducers in the mounting fixture Variofix L

- Press the transducers firmly into their clamping fixtures in the covers until they are tightly fixed. The transducer cables show in opposite directions.

NOTICE

The arrows on the transducers and the covers have to point in the same direction.

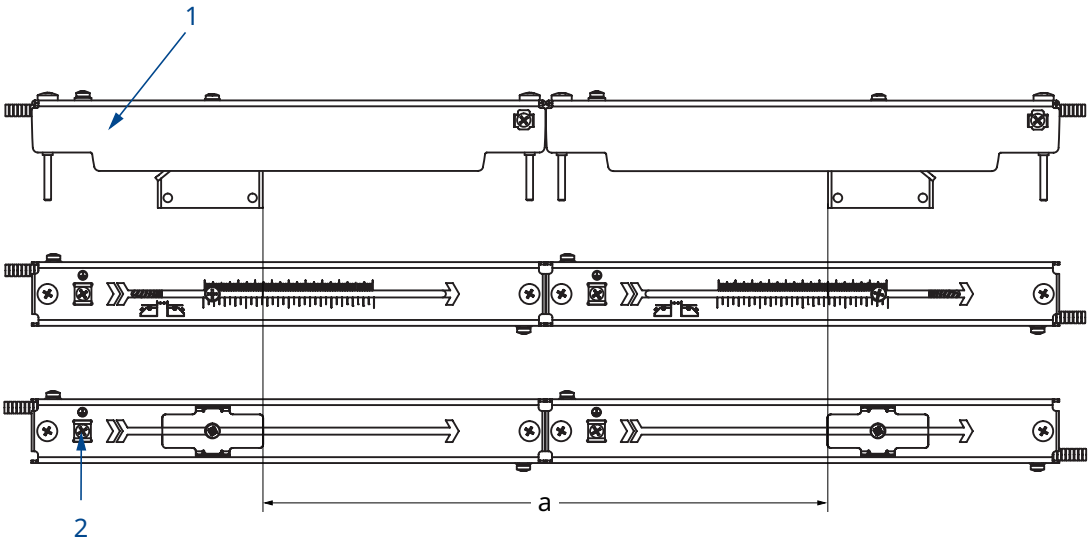
Fig. 46: Installation of the transducers in the covers



1 cover **2 transducer clamping fixture**

- Adjust the transducer distance displayed by the transmitter.

Fig. 47: Adjustment of the transducer distance

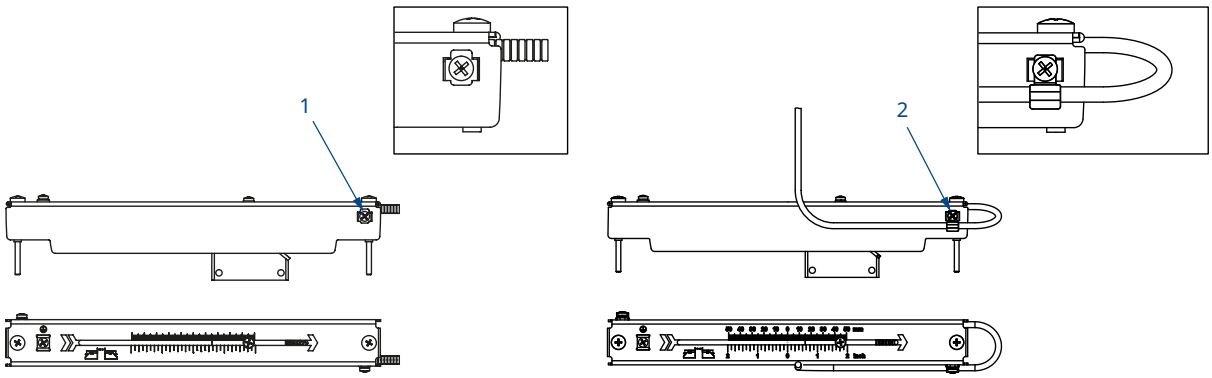


1 cover

2 equipotential bonding terminal

- Fix the transducer cables with the strain relief clamp to protect them from mechanical strain. Transducer cables with stainless steel conduit are fixed inside the housing, transducer cables with plastic conduit are fixed to the outside of the housing.
- Put coupling foil (or apply some coupling compound for a short-term installation) on the contact surface of the transducers. The coupling foil can be fixed to the contact surface with some coupling compound.
- Put the covers with the transducers on the rails.
- Correct the transducer distance, if necessary.

Fig. 48: Fixing the transducer cables



1 strain relief clamp for transducer cable with stainless steel conduit

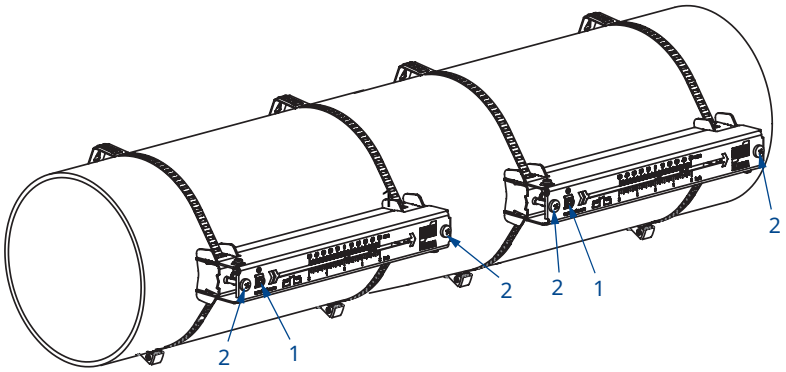
2 strain relief clamp for transducer cable with plastic conduit

NOTICE

Make sure that the coupling foil remains on the contact surface of the transducers. For information concerning the coupling foil see the safety data sheet.

- Tighten the cover screws.

Fig. 49: Variofix L with transducers on the pipe

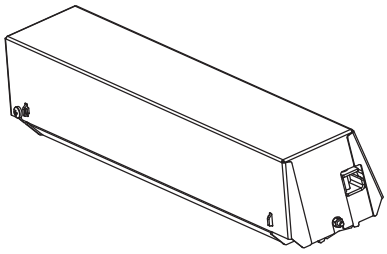


1 equipotential bonding terminal **2 screw**

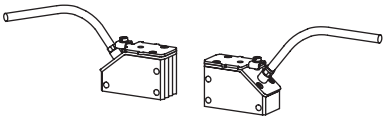
6.2.2.5 Mounting with Variofix C

Scope of delivery (example)

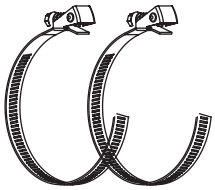
Variofix C



transducer pair

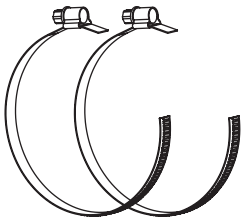


quick release clasp
with tension strap



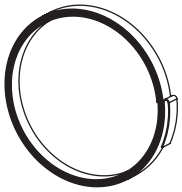
or

band clamp clasp
with tension strap



or

tension strap coil



ratchet clasp

Mounting

⚠ CAUTION

The edge of the tension strap is very sharp.

Risk of injury!

→Debur sharp edges.

→Wear the required personal protective equipment.

→Observe the applicable rules.

When measuring in reflection arrangement, 1 transducer mounting fixture is mounted laterally on the pipe.

When measuring in diagonal arrangement, 2 transducer mounting fixtures are mounted on opposite sides of the pipe.

In the following, the mounting of 1 transducer mounting fixture in reflection arrangement is described.

Fig. 50: Transducer mounting fixture Variofix C (reflection arrangement)

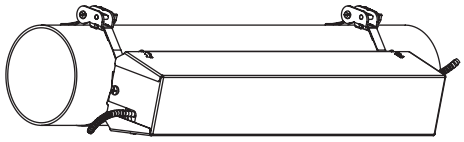
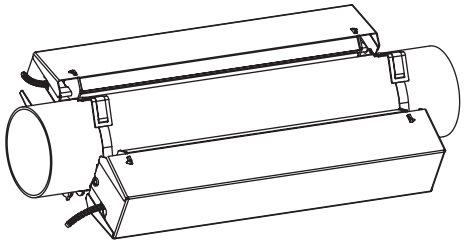


Fig. 51: Transducer mounting fixture Variofix L (diagonal arrangement)



Overview of the mounting steps

- **step 1**
  disassembly of the transducer mounting fixture Variofix C
- **step 2**
  fixation of the clasps to the tension straps
- **step 3**
  fixation of the tension strap to the pipe
- **step 4**
  fixation of the rail to the pipe
- **step 5**
  installation of the transducers in the mounting fixture Variofix C

Step 1: Disassembly of the transducer mounting fixture Variofix C

- Disassemble the transducer mounting fixture Variofix C.

In order to remove the cover from the rail, bend the outer sides of the cover outwards.

In order to remove the spring clip from the rail, slide it over the indentations on the rail and lift it off.

Fig. 52: Removal of the cover

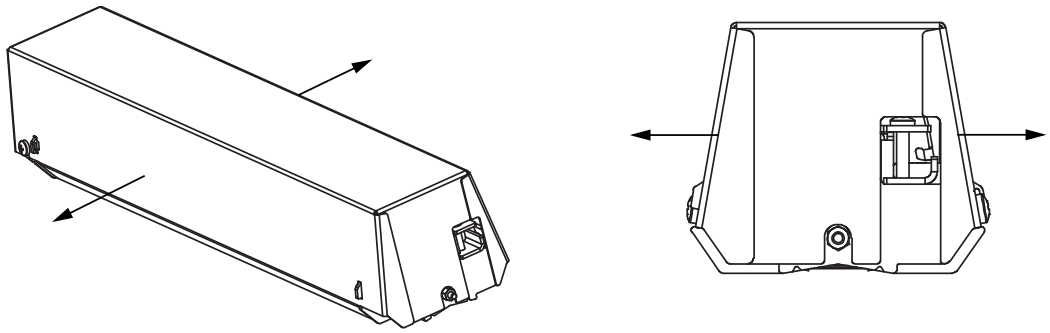
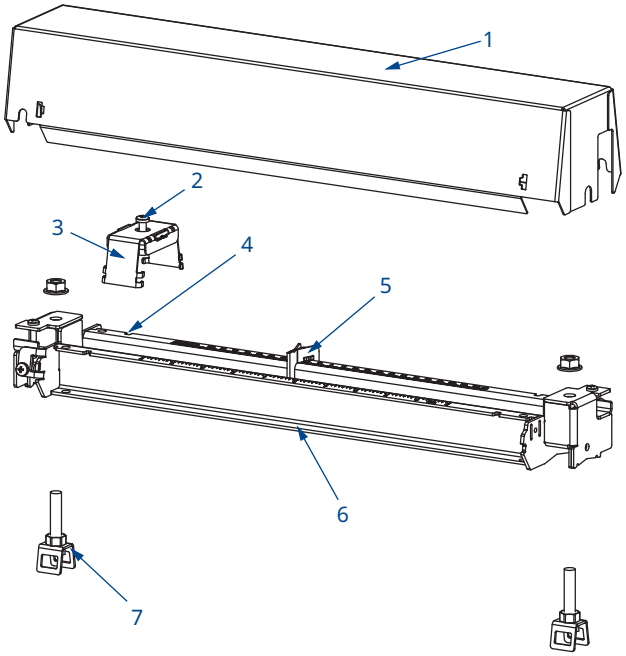


Fig. 53: Disassembly of the transducer mounting fixture Variofix C



1 cover
2 tensioning screw
3 spring clip
4 indentation
5 spacing element
6 rail
7 tension strap clamp

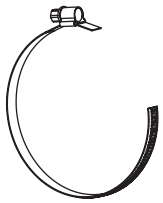
Step 2: Fixation of the clasps to the tension straps

- Select the installation instruction of the supplied clasp:

Band clamp clasp

The clasp is fixed to the tension strap.

Fig. 54: Band clamp clasp with tension strap

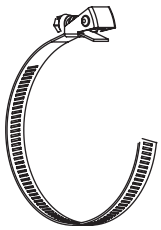


Quick release clasp

The clasp is fixed to the tension strap.

- Cut the tension strap to length (pipe circumference + at least 120 mm).

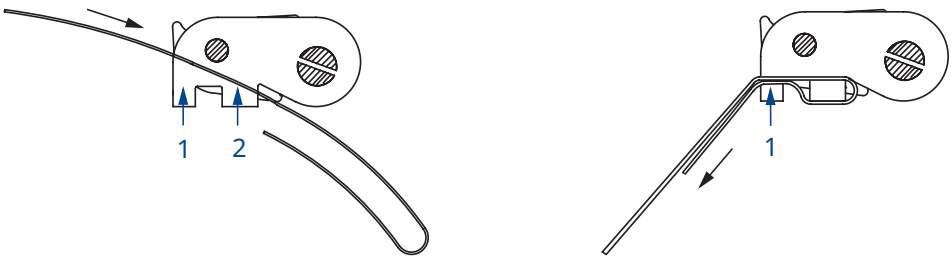
Fig. 55: Quick release clasp with tension strap



Ratchet clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Pass approx. 100 mm of the tension strap through part (1) and (2) of the ratchet clasp.
- Bend the tension strap.
- Pass the tension strap through part (1) of the ratchet clasp.
- Tighten the tension strap.
- Repeat the steps for the second tension strap.

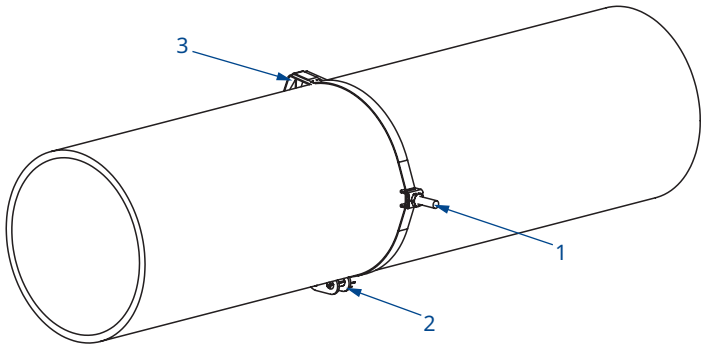
Fig. 56: Ratchet clasp with tension strap



Step 3: Fixation of the tension strap to the pipe

One tension strap is fixed to the pipe. The second tension strap will be mounted later.

Fig. 57: Tension strap with clamp and metal spring on the pipe



1 tension strap clamp **2 clasp**
3 metal spring

- Pass the tension strap through the clamp and the metal spring. It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer diameter < 80 mm
  - on pipes that are not subjected to significant temperature fluctuations
- Select the installation instruction of the supplied clasp:

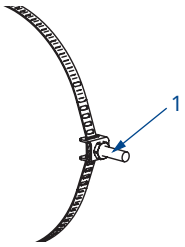
Band clamp clasp

- Position the clasp and the tension strap clamp on the pipe. On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
- Place the tension strap around the pipe and pass it through the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.

Quick release clasp

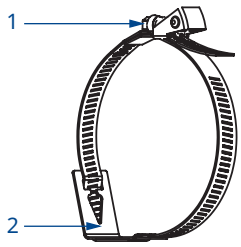
- Position the clasp, the tension strap clamp and the metal spring on the pipe:
  - On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
  - Mount the metal spring opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.

Fig. 58: Tension strap with clamp



1 tension strap clamp

Fig. 59: Tension strap with quick release clasp and metal spring



1 clasp screw **2 metal spring**

Fig. 60: Tension strap with band clamp clasp

1 clasp screw

Ratchet clasp

- Position the ratchet clasp, tension strap clamp and metal spring (if necessary) on the pipe:
  - On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
  - Mount the metal spring (if necessary) opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the slot of the clasp screw.
- Tighten the tension strap.
- Cut off the protruding tension strap.
- Tighten the clasp screw.

NOTICE

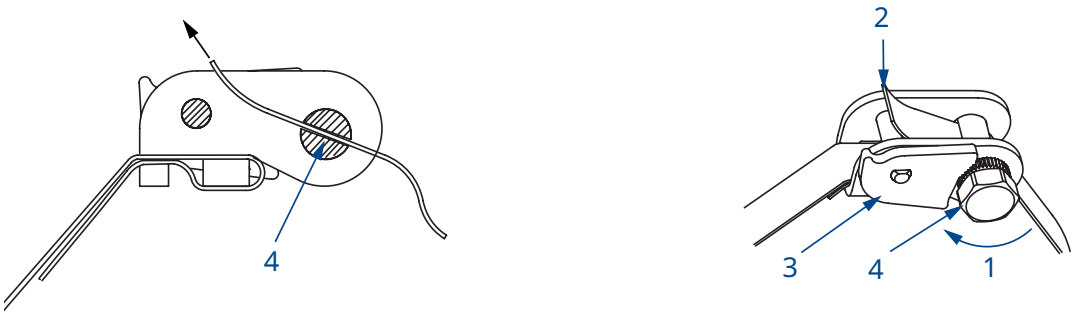
In order to release the screw and the tension strap, press the lever down.

Fig. 61: Tension strap with metal spring and clamp

1 metal spring

2 tension strap clamp

Fig. 62: Ratchet clasp with tension strap



1 sense of rotation

2 edge

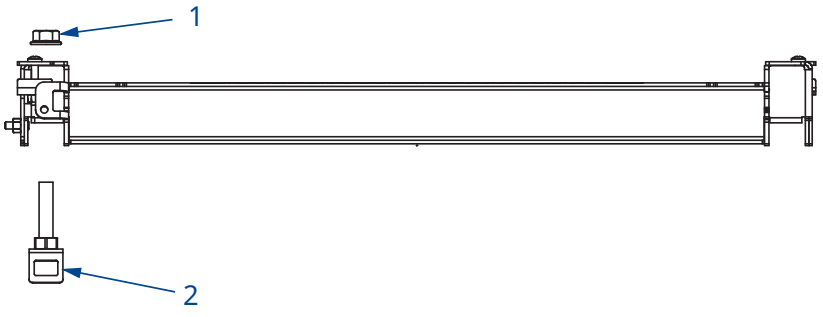
3 lever

4 clasp screw with slot

Step 4: Fixation of the rail to the pipe

- Place the tension strap clamp in the rail. Observe the orientation of the tension strap clamp.
- Slightly tighten the nut of the tension strap clamp.
- Screw the rail to the tension strap clamp on the pipe.
- Tighten the nut of tension strap clamp, but not too firmly in order not to damage the tension strap.

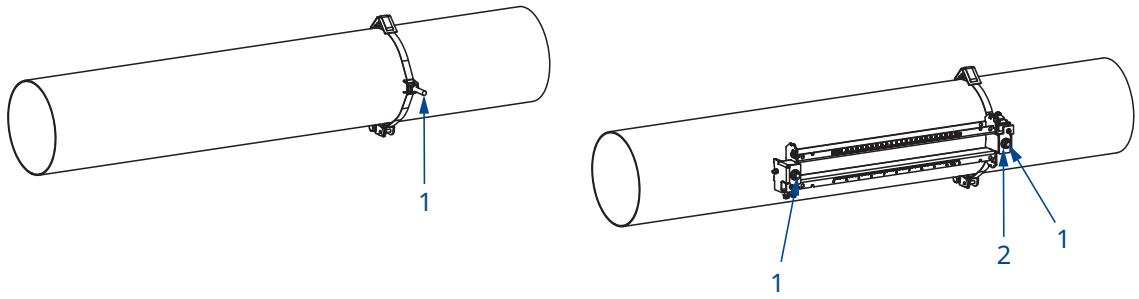
Fig. 63: Rail with tension strap clamp



1 nut

2 tension strap clamp

Fig. 64: Rail, fixed on one side to the pipe



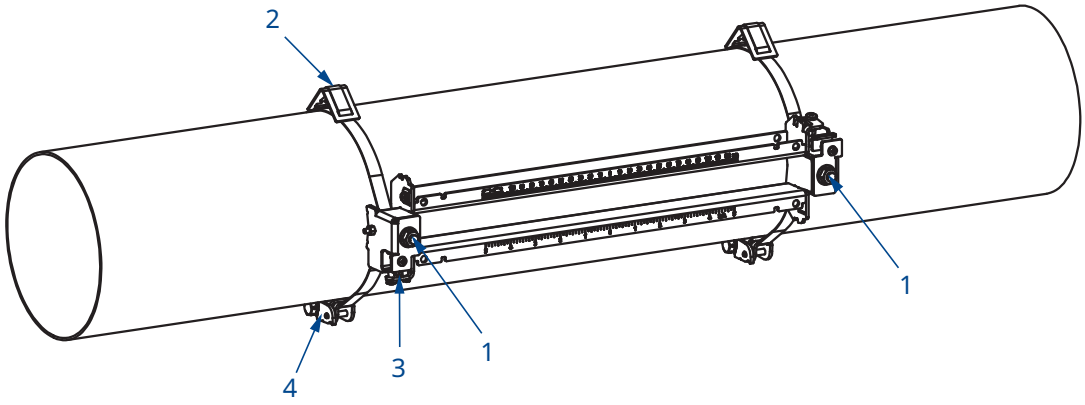
1 tension strap clamp **2 nut**

- Select the installation instruction of the supplied clasp:

Band clamp clasp

- Pass the tension strap through the tension strap clamp.
- Place the tension strap around the pipe and pass it through the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.
- Tighten the nut of tension strap clamp, but not too firmly in order not to damage the tension strap. The rail has to be firmly fixed to the pipe.

Fig. 65: Rail on the pipe



1 tension strap clamp **2 metal spring**
3 nut **4 clasp**

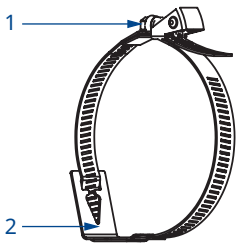
Quick release clasp

- Pass the tension strap through the clamp and the metal spring.
- Place the tension strap around the pipe and pass it through the clasp.
- Position the metal spring opposite the clasp.
- Tighten the tension strap.
- Tighten the clasp screw.
- Tighten the nut of tension strap clamp, but not too firmly in order not to damage the tension strap.

Fig. 66: Tension strap with band clamp clasp

1 clasp screw

Fig. 67: Tension strap with quick release clasp and metal spring



1 clasp screw **2 metal spring**

Ratchet clasp

- Pass the tension strap through the clamp and the metal spring. It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer diameter < 80 mm
  - on pipes that are not subjected to significant temperature fluctuations
- Position the ratchet clasp, tension strap clamp and metal spring (if necessary) on the pipe:
- Mount the metal spring opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the slot of the clasp screw.
- Tighten the tension strap.
- Cut off the protruding tension strap.
- Tighten the clasp screw.
- Tighten the nut of tension strap clamp, but not too firmly in order not to damage the tension strap.

NOTICE

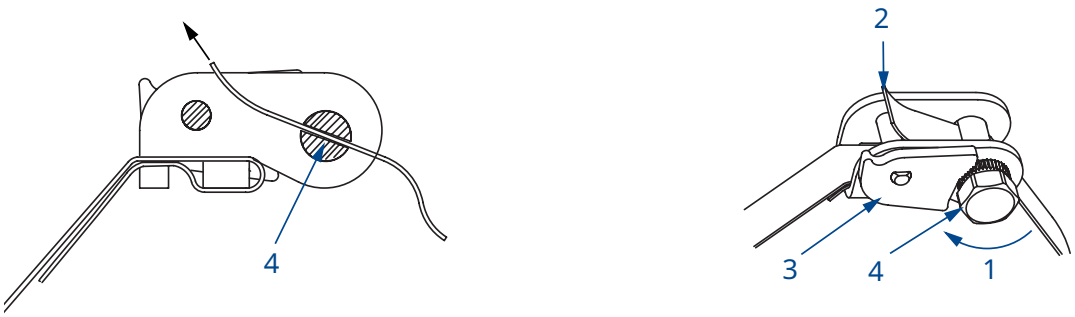
In order to release the screw and the tension strap, press the lever down.

Fig. 68: Tension strap with metal spring and clamp

1 metal spring

2 tension strap clamp

Fig. 69: Ratchet clasp with tension strap



1 sense of rotation

2 edge

3 lever

4 clasp screw with slot

Step 5: Installation of the transducers in the mounting fixture Variofix C

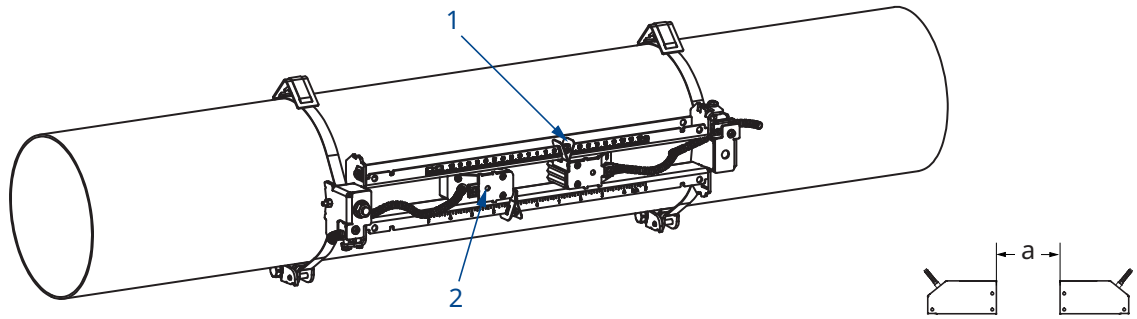
- Put coupling foil (or apply some coupling compound for a short-term installation) on the contact surface of the transducers. The coupling foil can be fixed to the contact surface with a small amount of coupling compound.

NOTICE

If the signal is not sufficient for the measurement, use coupling compound instead of coupling foil. For information concerning the coupling foil or coupling compound see the safety data sheet.

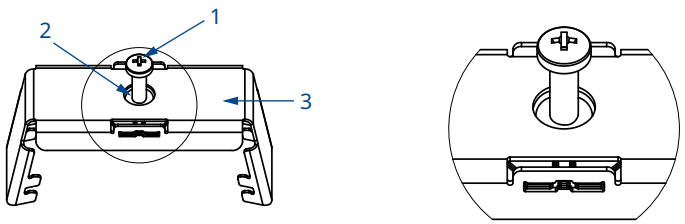
- Position the transducers in the rail in such a way that the engravings on them form an arrow. The transducer cables show in opposite directions.
- Adjust the transducer distance displayed by the transmitter.
- Slide the spring clips on the transducers.
- Fix the transducers by slightly tightening the tensioning screws. The end of each tensioning screw has to be placed above the hole in the respective transducer.
- Correct the transducer distance, if necessary.
- Tighten the tensioning screws until the collar of the rivet nut is flush with the clip.
- Fix the spacing elements on the rail to mark the transducer position.
- Fix the transducer cables with the cable fixture to protect them from mechanical strain.
- Put the cover on the rail.
- Tighten the screws on both sides of the cover.

Fig. 70: Transducers in the rail (spring clip not shown)



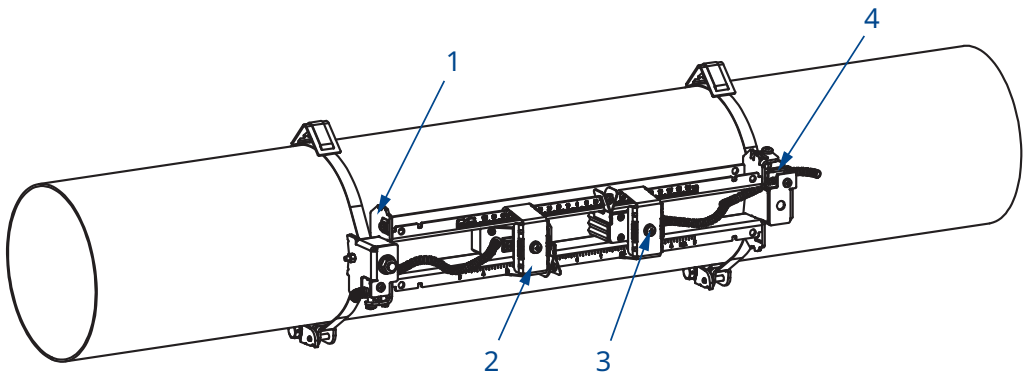
1 spacing element
2 hole
a transducer distance

Fig. 71: Spring clip



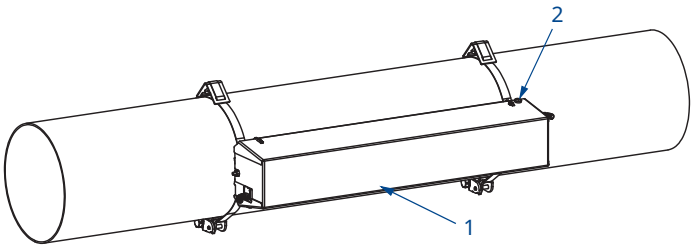
1 tensioning screw
2 collar of the rivet nut
3 clip

Fig. 72: Transducers in the rail



1 equipotential bonding terminal
2 spring clip
3 tensioning screw
4 cable fixture

Fig. 73: Variofix C with transducers on the pipe

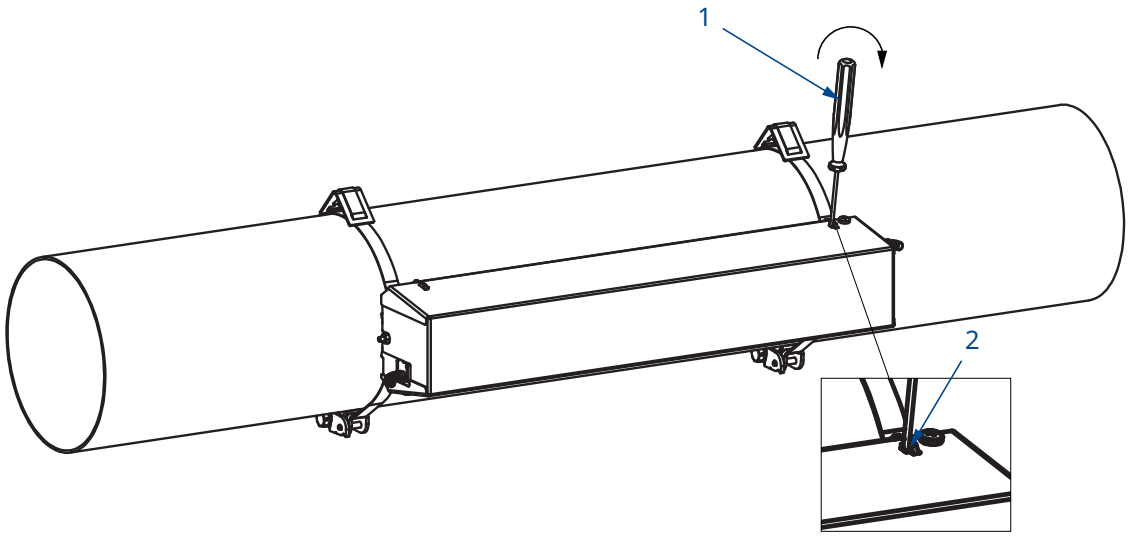


1 cover
2 screw

Remove the cover from the mounted transducer mounting fixture Variofix C as follows:

- Loosen the screws.
- Use a lever tool to remove the cover.
- Insert the lever tool max. 3 mm in one of the 4 openings of the cover.
- Press the lever tool against the fixture.
- Bend the cover outwards and release it from the anchoring.
- Repeat the steps for the other 3 openings.
- Remove the cover from the rail.

Fig. 74: Removal of the cover



1 lever tool **2 fixture**

6.3 Temperature probe

6.3.1 Pipe preparation

⚠ CAUTION

Contact with grinding dust

This may result in injuries (e.g., breathing difficulties, skin reactions, eye irritations).

→Wear the required personal protective equipment.

→Observe the applicable rules.

⚠ CAUTION

The edge of the tension strap is very sharp.

Risk of injury!

→Debur sharp edges.

→Wear the required personal protective equipment.

→Observe the applicable rules.

Important

The pipe has to be sufficiently stable to withstand the pressure exerted by the temperature probe.

Rust, paint or deposits on the pipe thermally insulate the measuring point. A good thermal contact between the pipe and the temperature probe is obtained as follows:

- Clean the pipe at the selected measuring point.
  - Remove any insulation material, rust or loose paint.
  - If present, the paint layer has to be smoothed by grinding. The paint does not need to be removed completely.
- Use coupling foil or apply a layer of thermal conductivity paste or coupling compound on the contact surface of the temperature probe. Observe the specified ambient temperature.
- Observe that there must be no air pockets between the contact surface of the temperature probe and the pipe wall.

6.3.2 Installation of the temperature probe (response time 50 s)

NOTICE

The temperature probe has to be thermally insulated.

Select the installation instruction of the supplied clasp:

6.3.2.1 Installation with clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Make sure that part (2) of the clasp is on top of part (1). The hooks of part (2) have to be on the outer side of the clasp.
- Pass approx. 20 mm of the tension strap through the slot of the clasp to fix the clasp to the tension strap.
- Bend the end of the tension strap.
- Position the temperature probe on the pipe.
- Place the tension strap around the temperature probe and the pipe.
- Pass the tension strap through part (2) and (1) of the clasp.
- Tighten the tension strap and engage it in the inner hook of the clasp.
- Tighten the screw of the clasp.

Fig. 75: Clasp

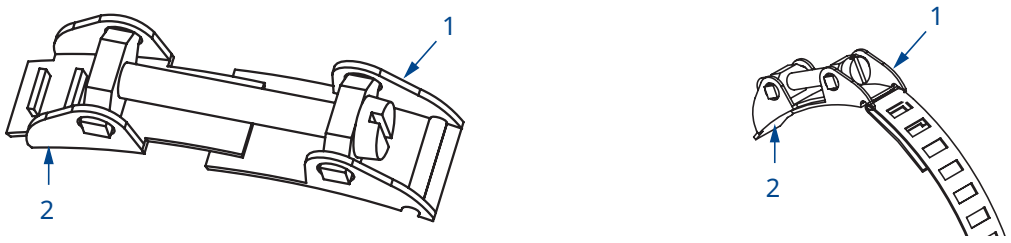
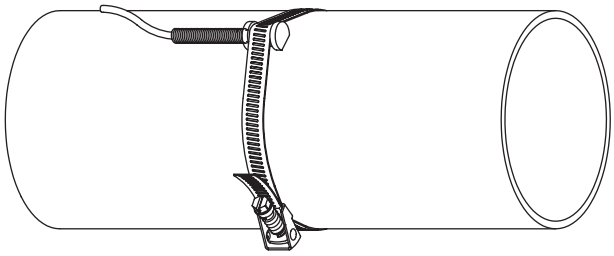


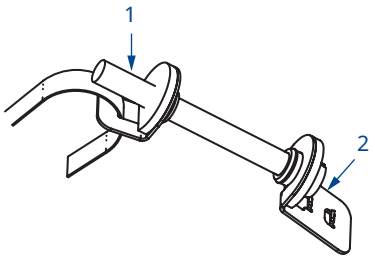
Fig. 76: Temperature probe on the pipe



6.3.2.2 Installation with Flexim clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Pass approx. 20 mm of the tension strap through the slot of the clasp.
- Bend the end of the tension strap.
- Position the temperature probe on the pipe.
- Place the tension strap around the temperature probe and the pipe.
- Pass the tension strap through part (2) and (1) of the clasp.
- Tighten the tension strap and engage it in the inner hook of the clasp.
- Tighten the screw of the clasp.

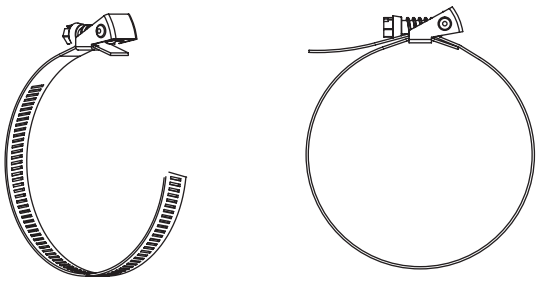
Fig. 77: Flexim clasp



6.3.2.3 Installation with quick release clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Position the temperature probe on the pipe.
- Place the tension strap around the temperature probe and the pipe.
- Pass the tension strap through the clasp.
- Tighten the tension strap.
- Tighten the screw of the clasp.

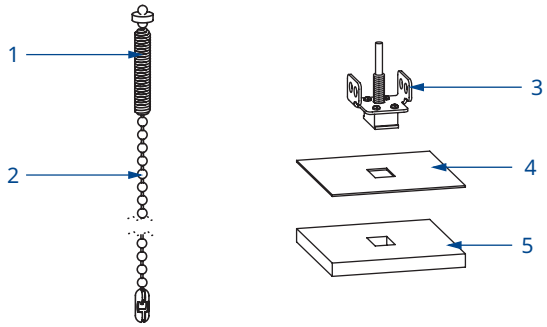
Fig. 78: Quick release clasp



6.3.3 Installation of the temperature probe (response time 8 s)

- Fix the protection plate and the insulation foam to the temperature probe.
- Take the spring end of the chain and insert the first ball into one of the slots on the upper side of the temperature probe.
- Place the chain around the pipe.
- Tighten the chain and insert it into the other slot of the temperature probe.

Fig. 79: Temperature probe

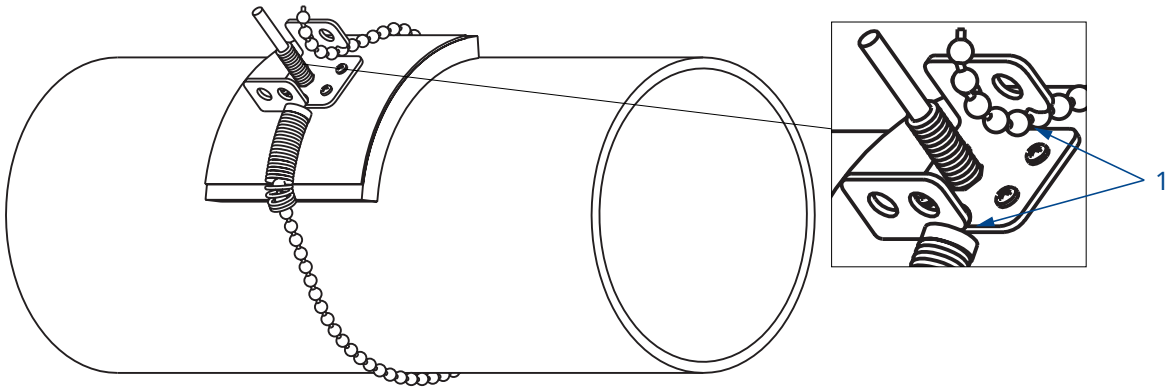


1 spring end
2 chain
3 temperature probe
4 protection plate
5 insulation foam

NOTICE

The entire contact surface of the temperature probe always has to rest on the pipe. In case of very small pipes, the protection plate and the insulation foam have to be cut to size, if necessary.

Fig. 80: Temperature probe on the pipe



1 slots on the upper side of the temperature probe

7 Connection

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ WARNING

Installation, connection and start-up by unauthorized and unqualified personnel

This may result in personal or material damage or dangerous situations.

→Any work on the transmitter has to be carried out by authorized and qualified personnel only.

⚠ WARNING

Touching live parts

Electric shock or arc faults can lead to severe injuries. The measuring equipment can be damaged.

→Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply.

⚠ CAUTION

Safety and accident prevention regulations for electrical systems and equipment

Failure to observe these regulations may lead to severe injuries.

→Observe the safety and accident prevention regulations for electrical systems and equipment.

NOTICE

Observe the safety instructions given by the manufacturers of the cable glands, blind plugs and adapters used with the transmitter.
The installation instruction with the safety instructions and the declarations of conformity of the components supplied by Flexim with the transmitter are on the provided USB stick ("Flexim"; drive:\Ex_documentation).

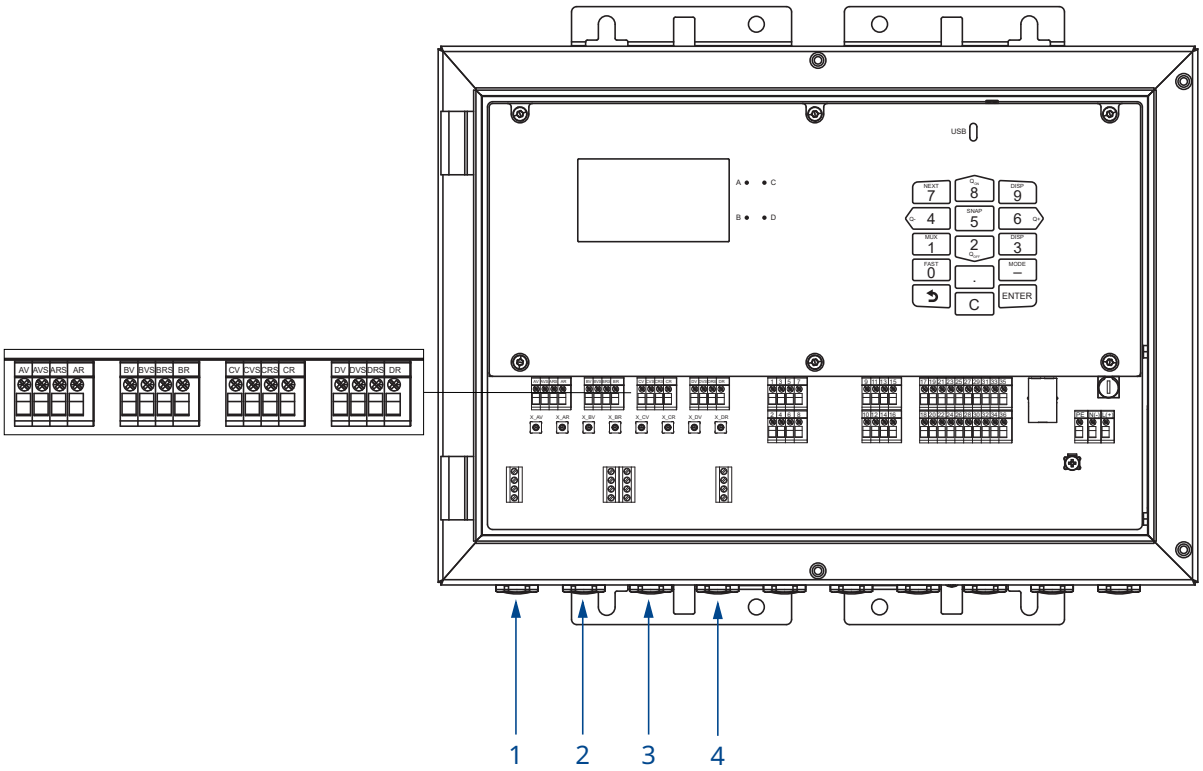
7.1 Transducers

It is recommended to run the cables from the measuring point to the transmitter before connecting the transducers to avoid load on the connectors.

NOTICE

If transducers are replaced or added, the SENSPROM has to be replaced or added as well.

Fig. 81: Connection of the transducers to the transmitter



1 transducers of measuring channel A
2 transducers of measuring channel B
3 transducers of measuring channel C
4 transducers of measuring channel D

7.1.1 Connection of the transducer cable to the transmitter

Important

The degree of protection of the transmitter is only ensured if all cables are tightly fitted using cable glands and the housing is firmly screwed.

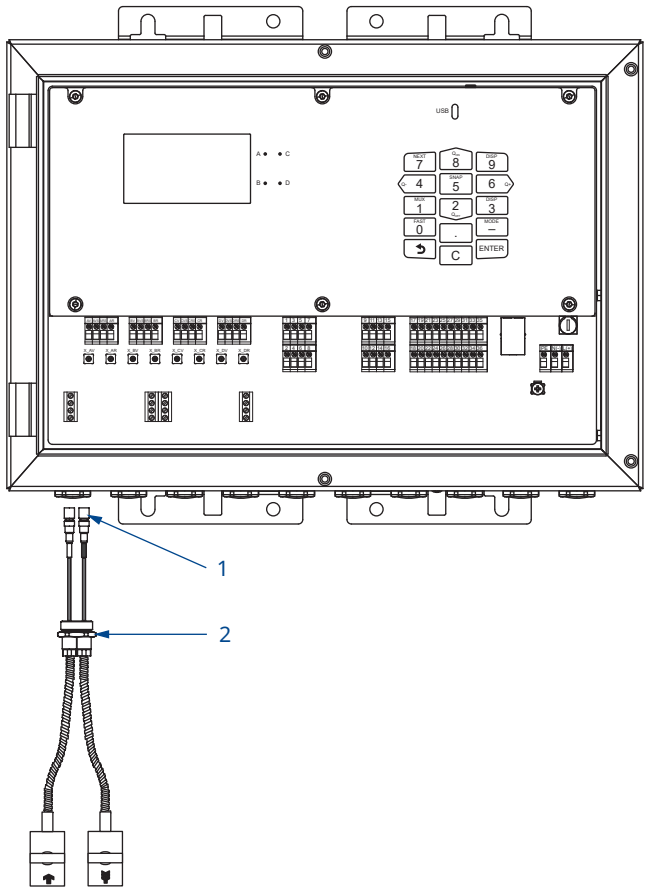
7.1.1.1 Transducer cable with SMB connectors

- Remove the blind plug for the connection of the transducer cable.
- Insert the transducer cable with the SMB connectors into the housing.
- Fix the transducer cable by tightening the cable gland.
- Connect the SMB connectors to the sockets of the transmitter.

Tab. 10: Terminal assignment

terminal	connection
X_*V	SMB connector (marked white)
X_*R	SMB connector (marked black)

Fig. 82: Connection of the transducer cable with SMB connectors to the transmitter



1 SMB connector **2 cable gland**

7.1.1.2 Transducer cable with plastic jacket and stripped ends

- Remove the blind plug for the connection of the transducer cable.
- Open the cable gland of the transducer cable. The compression part remains in the cap nut.
- Pass the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Cut the external shield to length and brush it back over the compression part.
- Screw the sealing ring side of the basic part into the transmitter housing.
- Insert the transducer cable into the housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the transmitter.

NOTICE

For good electromagnetic compatibility (EMC), it is important to ensure good electrical contact between the external shield and the cap nut (and thus the housing).

Tab. 11: Terminal assignment

terminal	connection
*V	transducer ↑ (core)
*VS	transducer ↑ (internal shield)
*RS	transducer ↓ (internal shield)
*R	transducer ↓ (core)

Fig. 83: Connection of the transducer cable with plastic jacket and stripped ends to the transmitter

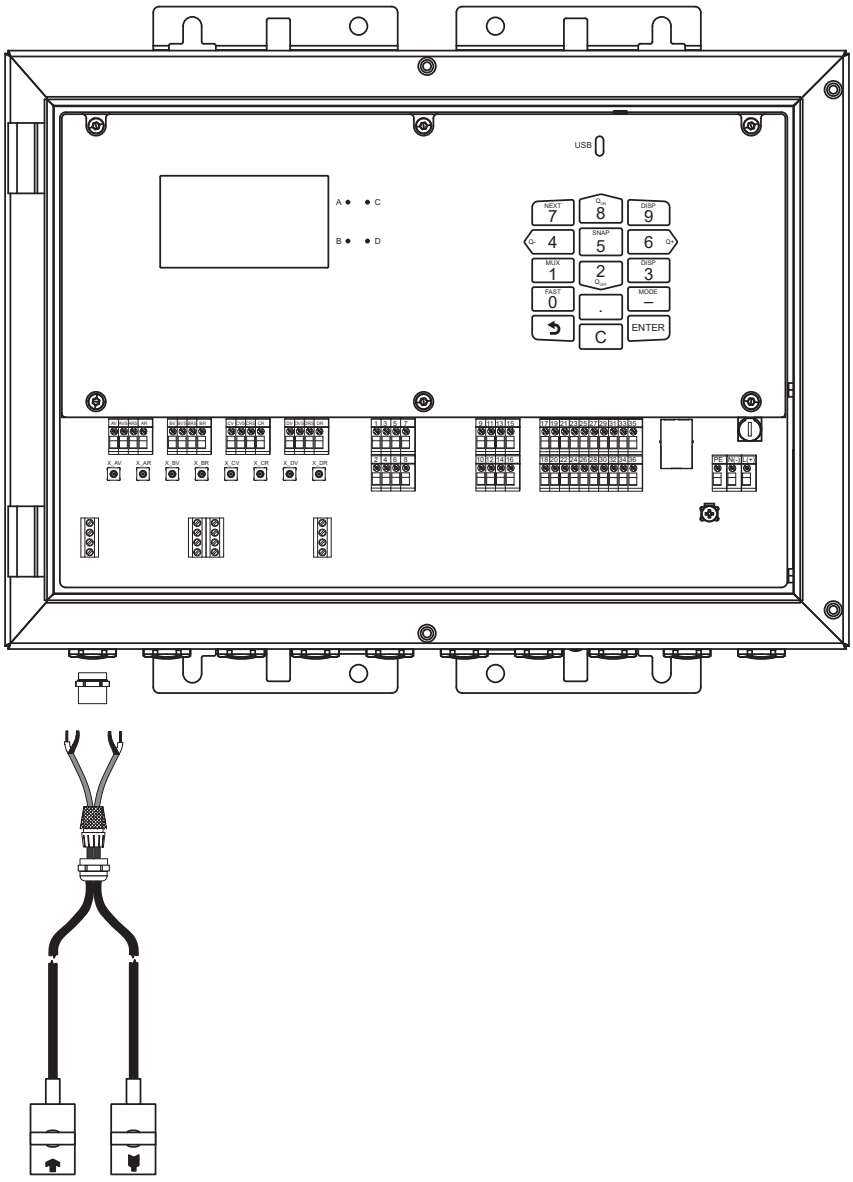
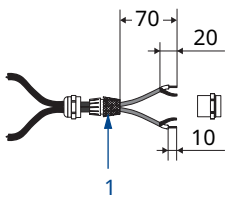
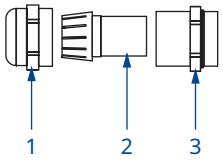


Fig. 84: Preparation of the transducer cable (dimensions in mm)



1 external shield, brushed back

Fig. 85: Cable gland



1 cap nut
2 compression part
3 basic part

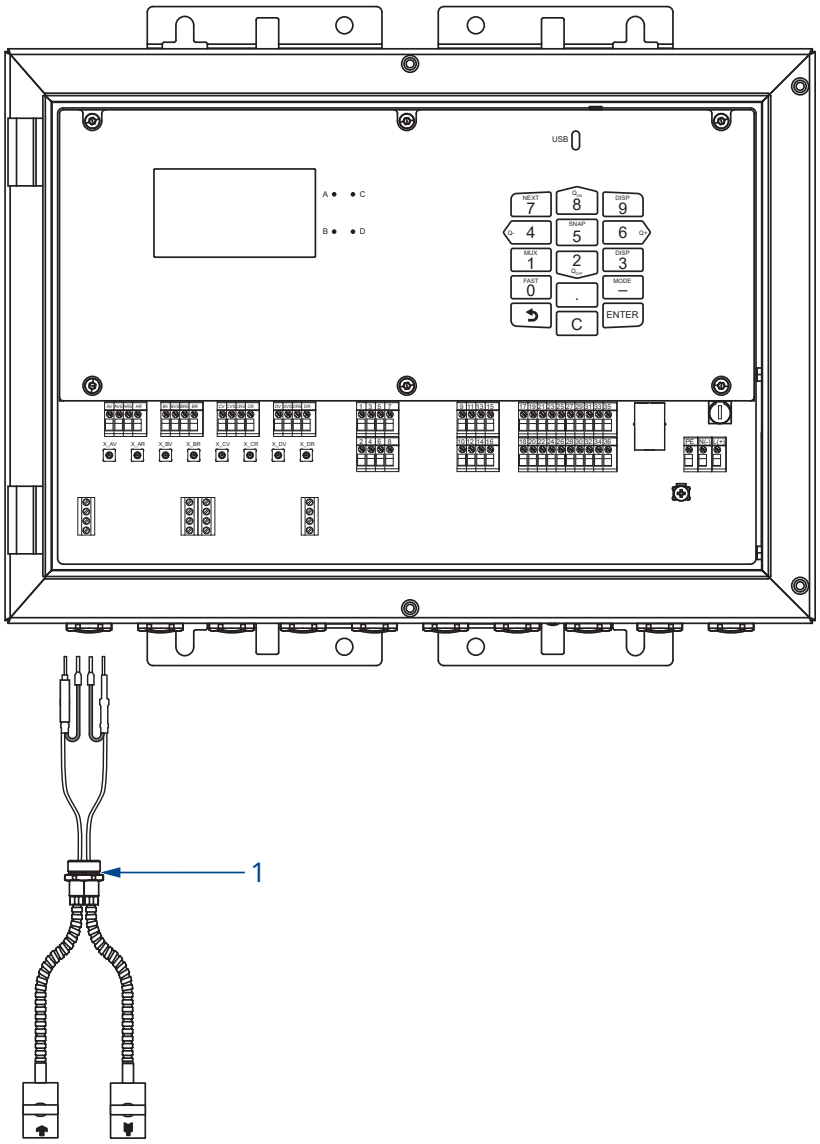
7.1.1.3 Transducer cable with stainless steel conduit and stripped ends

- Remove the blind plug for the connection of the transducer cable.
- Insert the transducer cable into the housing.
- Fix the transducer cable by tightening the cable gland.
- Connect the transducer cable to the terminals of the transmitter.

Tab. 12: Terminal assignment

terminal	connection
*V	transducer ↑ (brown cable, marked white)
*VS	transducer ↑ (red cable)
*RS	transducer ↓ (red cable)
*R	transducer ↓ (brown cable)

Fig. 86: Connection of the transducer cable with stainless steel conduit and stripped ends to the transmitter



1 cable gland

7.1.2 Connection of the extension cable to the transmitter

The extension cable is connected to the transmitter via the transducer connection.

- Remove the blind plug for the connection of the transducer cable.
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Pass the extension cable through the cap nut and the compression part.
- Prepare the extension cable.
- Cut the external shield to length and brush it back over the compression part.
- Screw the sealing ring side of the basic part into the transmitter housing.
- Insert the extension cable into the housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the transmitter.

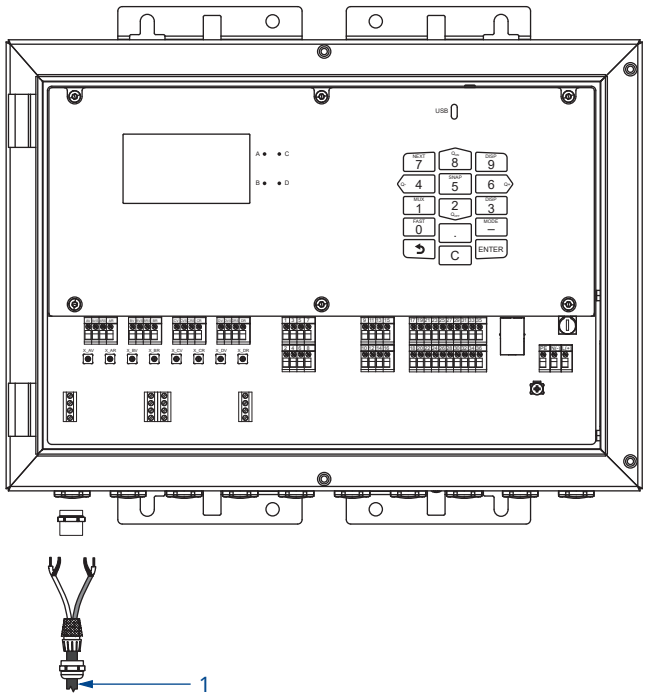
NOTICE

For good electromagnetic compatibility (EMC), it is important to ensure good electrical contact between the external shield and the cap nut (and thus the housing).

Tab. 13: Terminal assignment

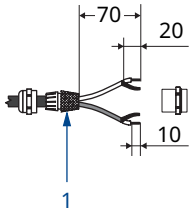
terminal	connection
*V	white or marked cable (core)
*VS	white or marked cable (internal shield)
*RS	brown cable (internal shield)
*R	brown cable (core)

Fig. 87: Connection of the extension cable to the transmitter



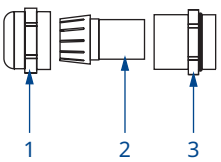
1 extension cable

Fig. 88: Preparation of the extension cable (dimensions in mm)



1 external shield, brushed back

Fig. 89: Cable gland



1 cap nut
2 compression part
3 basic part

7.1.3 Connection of the transducer cable to the junction box

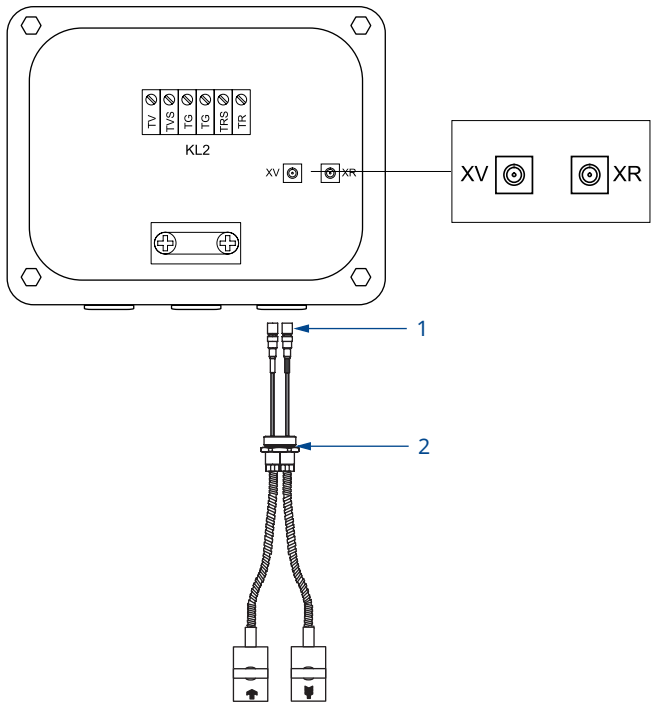
7.1.3.1 Transducer cable with SMB connectors

- Remove the blind plug for the connection of the transducer cable.
- Insert the transducer cable with the SMB connectors into the junction box.
- Fix the transducer cable by tightening the cable gland.
- Connect the SMB connectors to the sockets of the junction box.

Tab. 14: Terminal assignment

terminal	connection
XV	SMB connector (marked white)
XR	SMB connector (marked black)

Fig. 90: Connection of the transducer cable with SMB connectors



1 SMB connector **2 cable gland**

7.1.3.2 Transducer cable with plastic jacket and stripped ends

- Remove the blind plug for the connection of the transducer cable.
- Open the cable gland of the transducer cable. The compression part remains in the cap nut.
- Pass the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Cut the external shield to length and brush it back over the compression part.
- Screw the gasket ring side of the basic part into the junction box.
- Insert the transducer cable into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the junction box.

NOTICE

For good electromagnetic compatibility (EMC), it is important to ensure good electrical contact between the external shield and the cap nut (and thus the housing).

Tab. 15: Terminal assignment

terminal	connection
V	transducer ↑ (core)
VS	transducer ↑ (internal shield)
RS	transducer ↓ (internal shield)
R	transducer ↓ (core)

Fig. 91: Connection of the transducer cable with plastic jacket and stripped ends

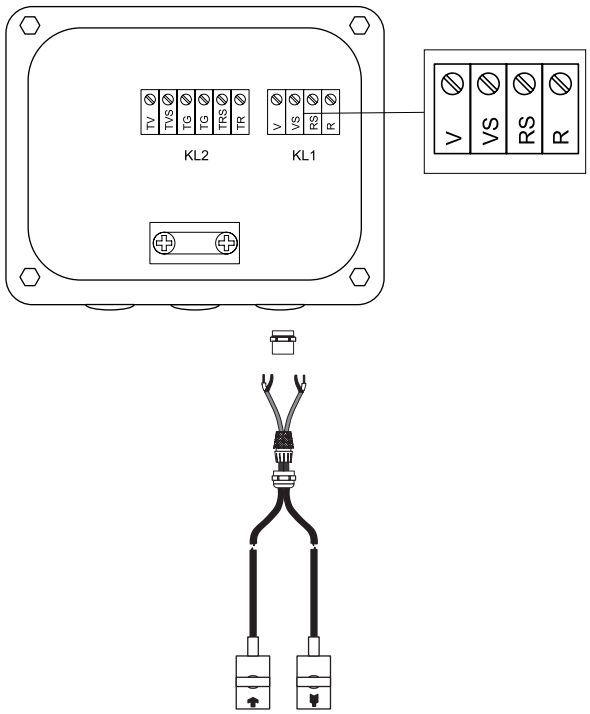
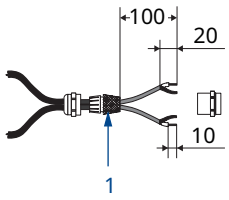
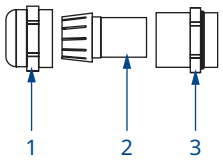


Fig. 92: Preparation of the transducer cable (dimensions in mm)



1 external shield, brushed back

Fig. 93: Cable gland



1 cap nut
2 compression part
3 basic part

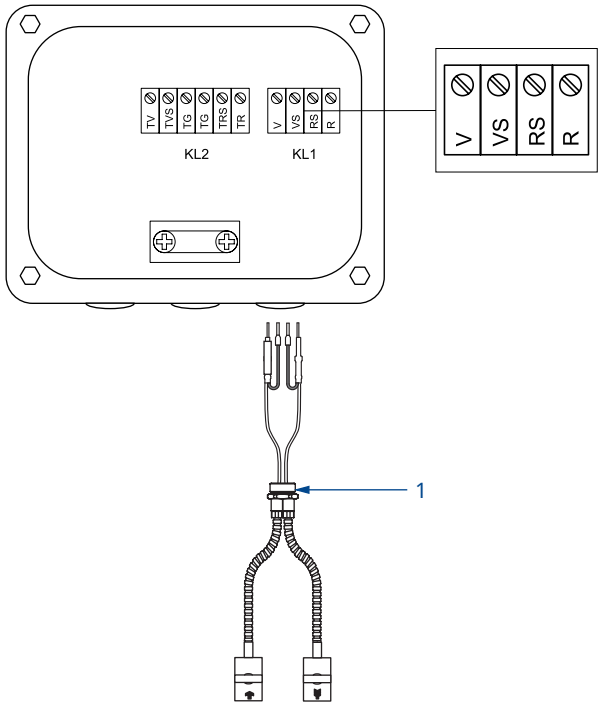
7.1.3.3 Transducer cable with stainless steel conduit and stripped ends

- Remove the blind plug for the connection of the transducer cable.
- Insert the transducer cable into the junction box.
- Fix the transducer cable by tightening the cable gland.
- Connect the transducer cable to the terminals of the junction box.

Tab. 16: Terminal assignment

terminal	connection
V	transducer ↑ (brown cable, marked white)
VS	transducer ↑ (red cable)
RS	transducer ↓ (red cable)
R	transducer ↓ (brown cable)

Fig. 94: Connection of the transducer cable with stainless steel conduit and stripped ends



1 cable gland

7.1.4 Connection of the extension cable to the junction box

7.1.4.1 Connection without potential separation (standard)

The connection of the extension cable to the junction box without potential separation ensures that the transducer, junction box and transmitter are on the same potential. The extension cable should always be connected in this manner, especially if power cables are nearby. If grounding on the same potential cannot be ensured, see section Connection with potential separation [▶ 88].

- Remove the blind plug for the connection of the extension cable.
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Pass the extension cable through the cap nut and the compression part.
- Prepare the extension cable.
- Cut the external shield to length and brush it back over the compression part.
- Screw the gasket ring side of the basic part into the junction box.
- Insert the extension cable into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the junction box.

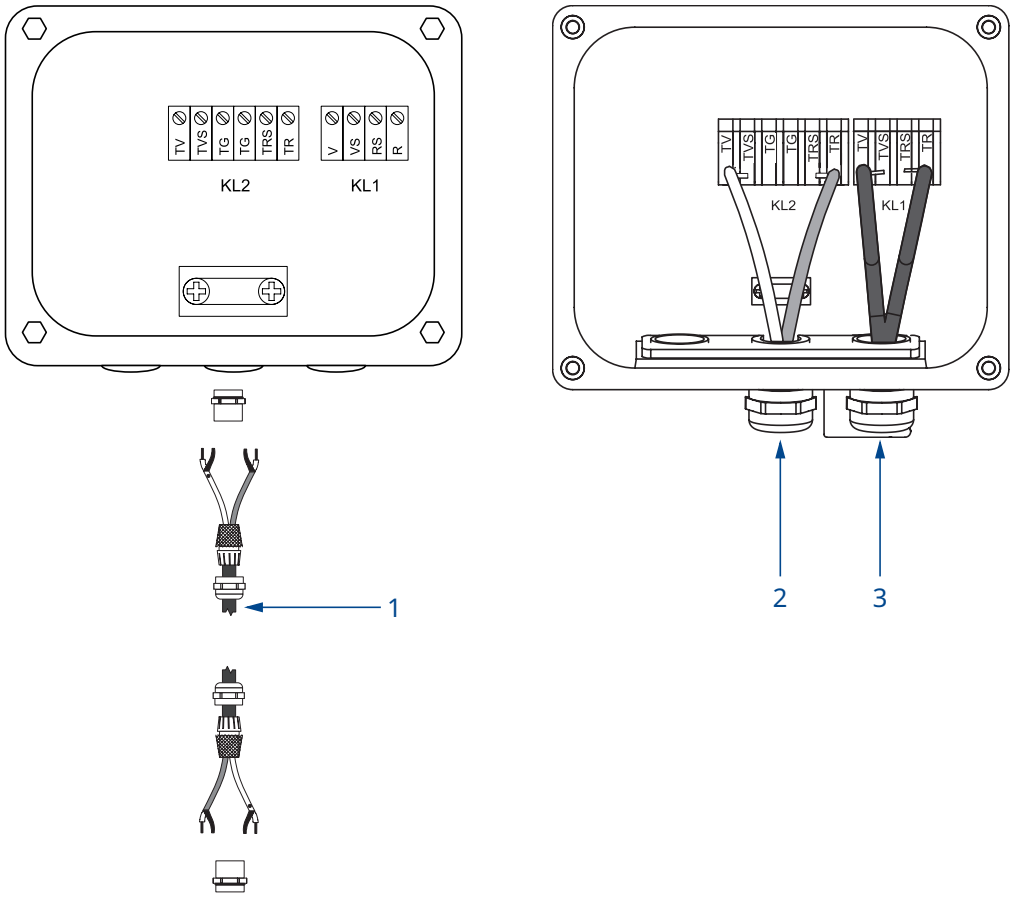
NOTICE

For good electromagnetic compatibility (EMC), it is important to ensure good electrical contact between the external shield and the cap nut (and thus the housing).

Tab. 17: Terminal assignment

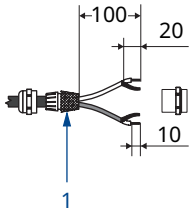
terminal	connection (extension cable)
TV	white or marked cable (core)
TVS	white or marked cable (internal shield)
TRS	brown cable (internal shield)
TR	brown cable (core)
cable gland	external shield

Fig. 95: Connection of the extension cable to the junction box (without potential separation)



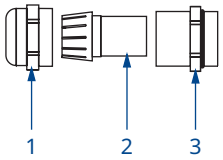
1 extension cable
2 connection of the extension cable
3 connection of the transducer cable

Fig. 96: Preparation of the extension cable (dimensions in mm)



1 external shield, brushed back

Fig. 97: Cable gland



1 cap nut
2 compression part
3 basic part

7.1.4.2 Connection with potential separation

If grounding on the same potential cannot be ensured, e.g., in measurement arrangements with long extension cables, the extension cable and the junction box have to be electrically insulated from each other. The junction box and the transducers have to be on the same potential. Thus, no compensation currents can flow to the transmitter via the extension cable.

For measurement arrangements where the junction box and the transducers have to be electrically insulated from each other see the document TIFLUXUS_GalvSep.

- Remove the blind plug for the connection of the extension cable.
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Pass the extension cable through the cap nut, the compression part and the basic part.
- Insert the extension cable into the junction box.
- Prepare the extension cable.
- Cut the external shield to length and brush it back.
- Pull the extension cable back until the brushed-back external shield is below the shield terminal. The extension cable has to remain completely insulated up to the shield terminal.
- Screw the gasket ring side of the basic part into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the junction box.

Important

Observe the max. permissible voltage of 60 V DC between the ground potentials.

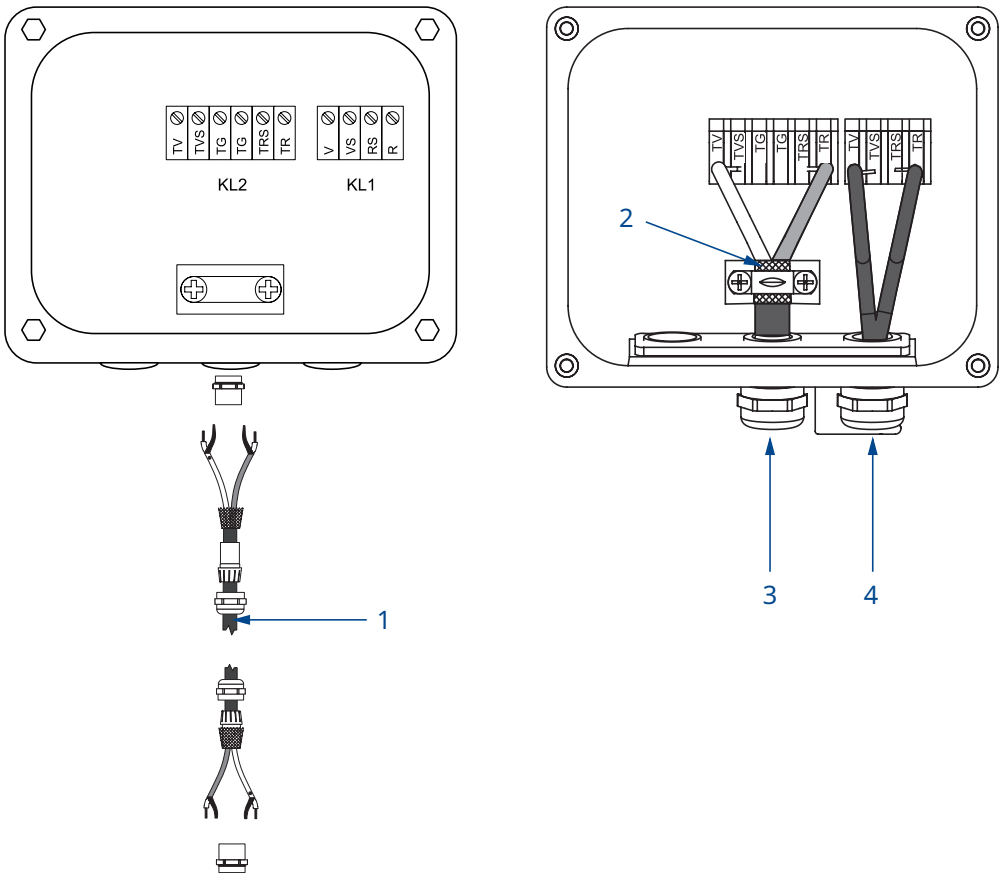
Important

The external shield of the extension cable must not have electrical contact to the junction box. Therefore, the extension cable has to remain completely insulated up to the shield terminal.

Tab. 18: Terminal assignment

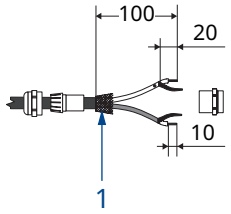
terminal	connection (extension cable)
TV	white or marked cable (core)
TVS	white or marked cable (internal shield)
TRS	brown cable (internal shield)
TR	brown cable (core)
shield terminal	external shield

Fig. 98: Connection of the extension cable to the junction box (with potential separation)



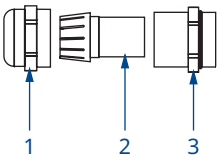
1 extension cable
2 shield terminal
3 connection of the extension cable
4 connection of the transducer cable

Fig. 99: Preparation of the extension cable (dimensions in mm)



1 external shield

Fig. 100: Cable gland



1 cap nut **2 compression part**
3 basic part

7.1.5 SENSPROM

The SENSPROM contains important transducer data for the operation of the transmitter with the transducers.

If transducers are replaced or added, the SENSPROM has to be replaced or added as well.

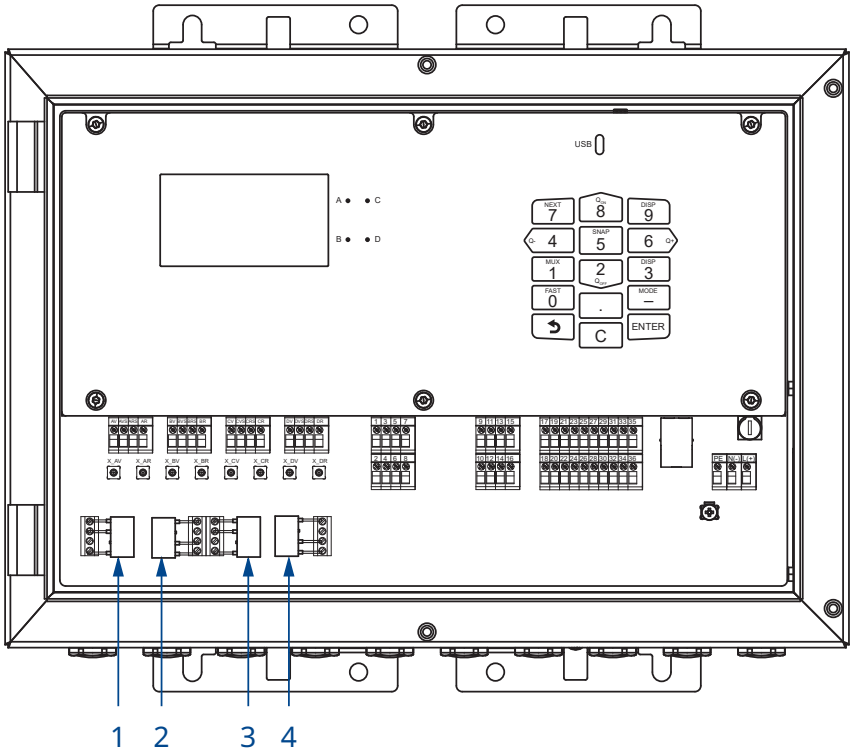
NOTICE

The serial numbers of the SENSPROM and the transducer have to be identical. A wrong or wrongly connected SENSPROM will lead to incorrect measured values or to a measurement failure.

The SENSPROM is connected to the terminals of the transmitter.

- Disconnect the transmitter from the power supply.
- Connect each SENSPROM to the corresponding terminal of the transmitter.
- Connect the transmitter to the power supply.
- Enter all parameters of the menu `Parameters`.
- Start the measurement.

Fig. 101: Connection of the SENSPROM to the transmitter



1 SENSPROM of measuring channel A
2 SENSPROM of measuring channel B
3 SENSPROM of measuring channel C
4 SENSPROM of measuring channel D

7.2 Power supply

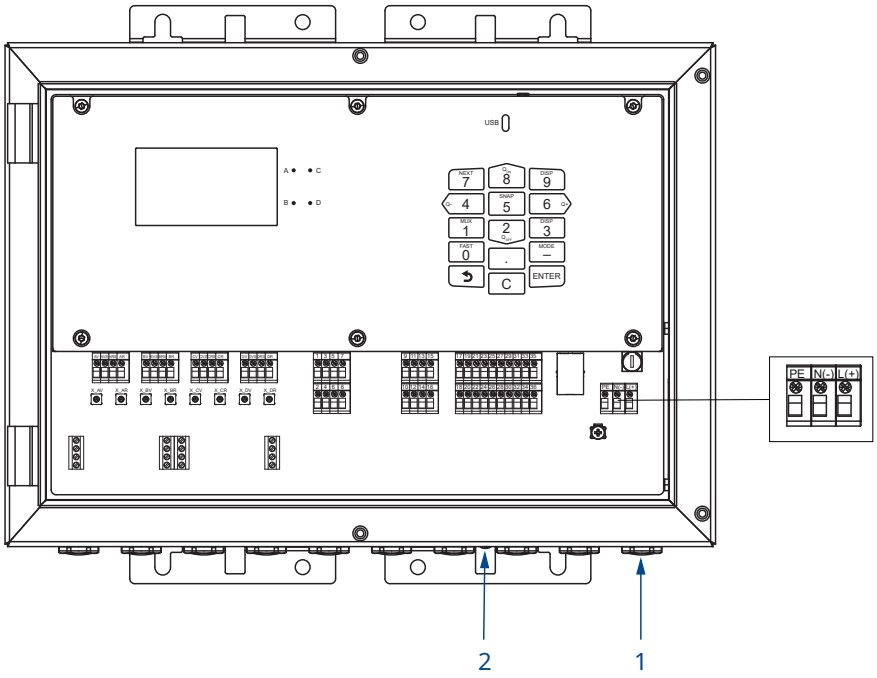
The installation of the power supply is carried out by the operator. The operator has to provide an overcurrent protector of max. 16 A (fuse or similar device) disconnecting all energized wires in case of an inadmissible high current consumption. The impedance of the protective ground has to be low ohmic in order not to allow touch voltage pass the permissible limit. The equipotential bonding terminal serves as functional ground of the transmitter.

Important

The degree of protection of the transmitter will only be guaranteed if the power cable fits firmly and tightly in the cable gland.

- Connect the power cable to the transmitter (see section Cable connection [▶ 92]).

Fig. 102: Connection of the power supply to the transmitter



1 connection of the power supply **2 equipotential bonding terminal**

Tab. 19: Terminal assignment

terminal	AC connection	connection DC
L(+)	line conductor	DC
N(-)	neutral conductor	GND
PE	protective conductor	protective conductor

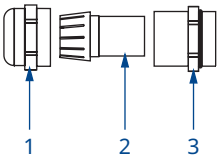
7.2.1 Cable connection

- Remove the blind plug to connect the cable to the transmitter.
- Prepare the cable with a cable gland.

The used cable has to have a wire cross-section of 0.25...2.5 mm^2.

- Push the cable through the cap nut, compression part and basic part of the cable gland.
- Insert the cable into the transmitter housing.
- Screw the sealing ring side of the basic part into the transmitter housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the cable to the terminals of the transmitter.

Fig. 103: Cable gland



1 cap nut
2 compression part
3 basic part

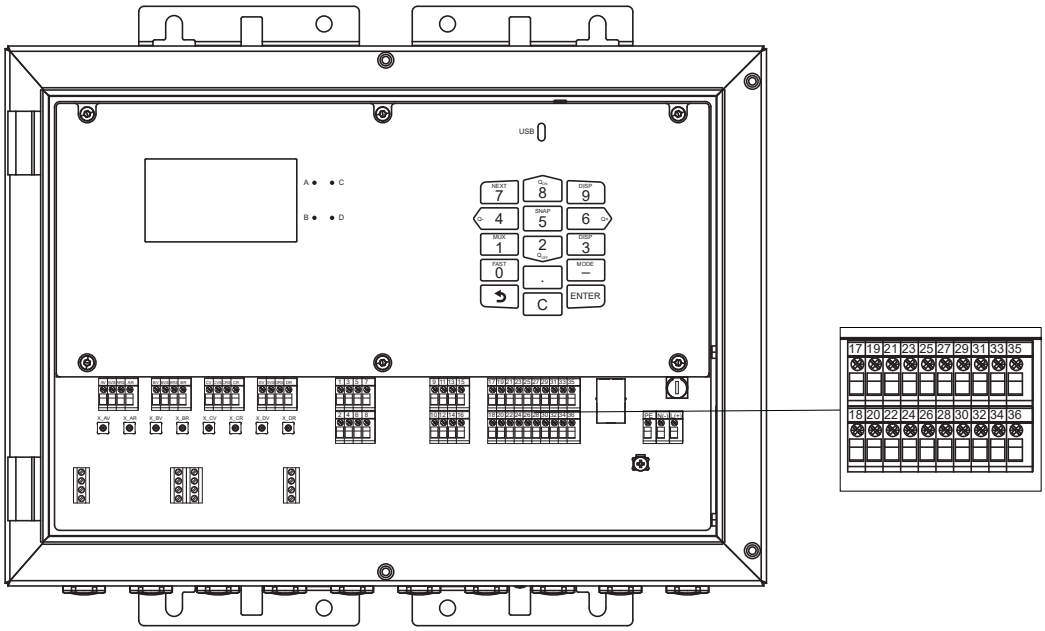
7.3 Outputs

Important

The max. permissible voltage between the outputs and against PE is 60 V DC (permanent).

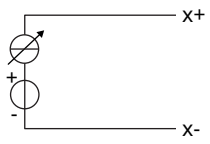
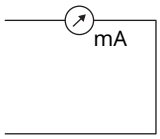
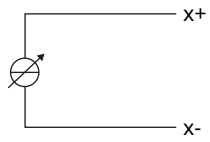
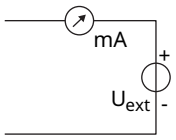
- Connect the output cable to the transmitter (see section Cable connection [▶ 92] andOutput circuits [▶ 94]).

Fig. 104: Connection of the outputs to the transmitter

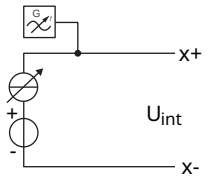
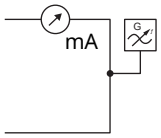
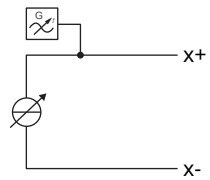
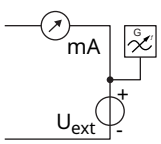


7.3.1 Output circuits

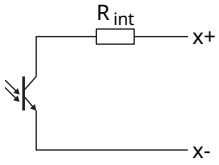
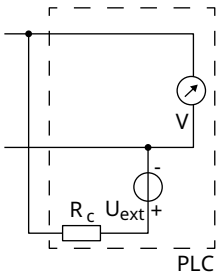
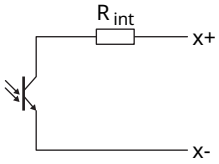
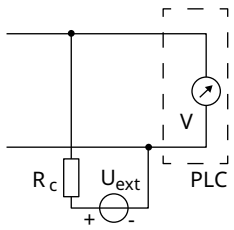
Tab. 20: Switchable current output Ix

internal circuit (transmitter)	external circuit	remark
active		
		R_{ext} = 250...530 Ω $U_{opencircuit}$ = 28 V DC adjustable fault current (no valid measured value, no measurement): 3.2...3.99 mA, 20.01...24 mA hardware fault current: 3.2 mA
passive		
		U_{ext} = 9...30 V DC, dependent on R_{ext} (R_{ext} = 458 Ω with 20 V) adjustable fault current (no valid measured value, no measurement): 3.2...3.99 mA, 20.01...24 mA hardware fault current: 3.2 mA

Tab. 21: Switchable current output Ix/HART

internal circuit (transmitter)	external circuit	remark
active		
		R_{ext} = 250...530 Ω $U_{opencircuit}$ = 28 V DC adjustable fault current (no valid measured value, no measurement): 3.5...3.99 mA, 20.01...22 mA hardware fault current: 3.2 mA
passive		
		U_{ext} = 9...30 V DC, dependent on R_{ext} (R_{ext} = 250...458 Ω with 20 V) adjustable fault current (no valid measured value, no measurement): 3.5...3.99 mA, 20.01...22 mA hardware fault current: 3.2 mA

Tab. 22: Digital output

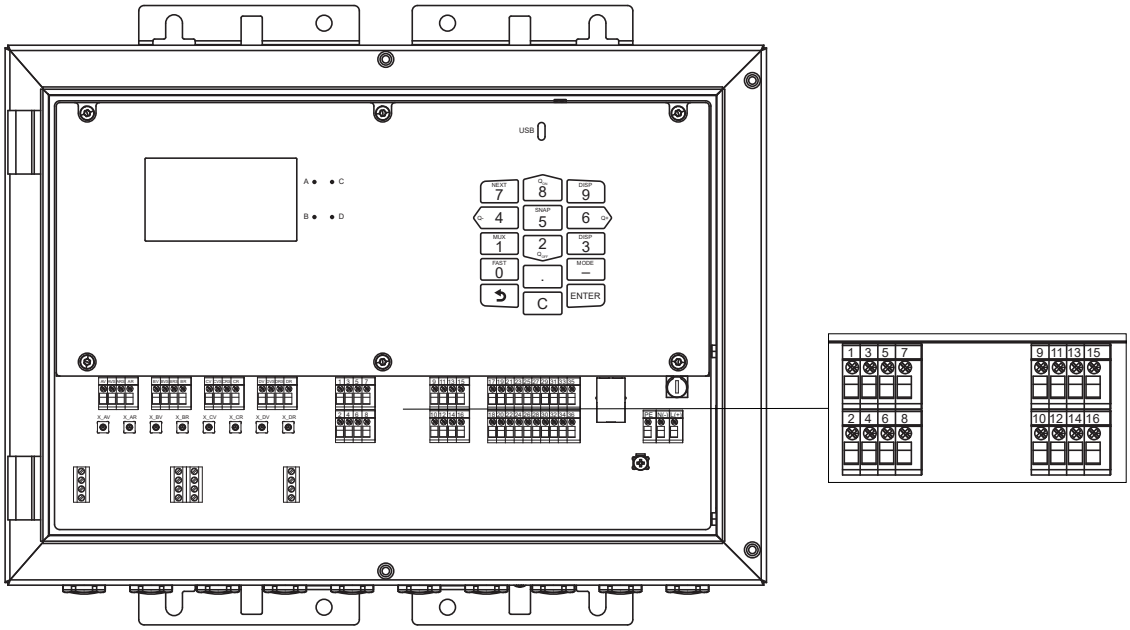
<table>
<tr><th>internal circuit (transmitter)</th><th>external circuit</th><th>remark</th></tr>
<tr><td colspan="2">circuit 1</td><td rowspan="3">OC30V according to IEC 60947-5-6 (NAMUR)
• 5...30 V
• I_{max} = 20 mA
R_{int} = 1020 Ω
$R_{ext} = U_{ext}/I - R_{int}$ with $I \leq I_{max}$
• open circuit: I_{OL} = 400...800 µA
• wire break: I_{LBD} < 400 µA
• closed circuit: $I_{CL} = U_{ext}/(R_{int} + R_{ext})$
• short circuit: $I_{LSD} > I_{CL}$ + 5% of I_{CL}
• f = 0.002...10 kHz
• T_p = 0.05...1000 ms</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">circuit 2</td></tr>
<tr><td> 
</td><td> 
</td><td>OC30V/100mA
• 5...30 V
• I_{max} = 100 mA
R_{int} = 20 Ω
$R_{ext} = U_{ext}/I - R_{int}$ with $I \leq I_{max}$
• open circuit: I_{OL} = 400...800 µA
• wire break: I_{LBD} < 400 µA
• closed circuit: $I_{CL} = U_{ext}/(R_{int} + R_{ext})$
• short circuit: $I_{LSD} > I_{CL}$ + 5% of I_{CL}
• f = 0.002...10 kHz
• T_p = 0.05...1000 ms</td></tr>
</table>

The following applies for all circuits:

- R_{ext} is the sum of all ohmic resistances in the circuit (e.g., resistance of the conductors, resistance of the ammeter/voltmeter).
- The number, type and connections of the outputs depend on the order.
- The terminal assignment is displayed on the transmitter during configuration of the outputs.

7.4 Inputs

Fig. 105: Connection of the inputs to the transmitter



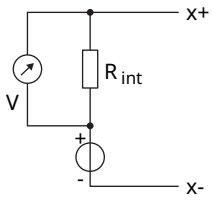
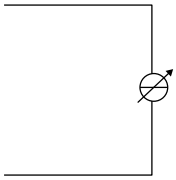
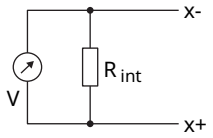
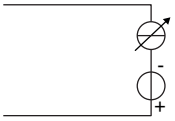
7.4.1 Circuits of the inputs

Important

Observe the correct polarity in order to avoid damaging the current source. A permanent short circuit can destroy the current input.

For the connection of the input cable to the transmitter see section Cable connection [▶ 92].

Tab. 23: Switchable current input Ix

internal circuit (transmitter)	external circuit	remark
active		
		R_{int} = 75 Ω I_{max} ≤ 30 mA I = 0...20 mA (measuring range) $U_{opencircuit}$ = 28 V U_{min} = 21.4 V with 20 mA The current input is galvanically isolated from the transmitter.
passive		
		R_{int} = 35 Ω U_{max} = 24 V I_{max} ≤ 24 mA I = 0...20 mA (measuring range) The current input is galvanically isolated from the transmitter.

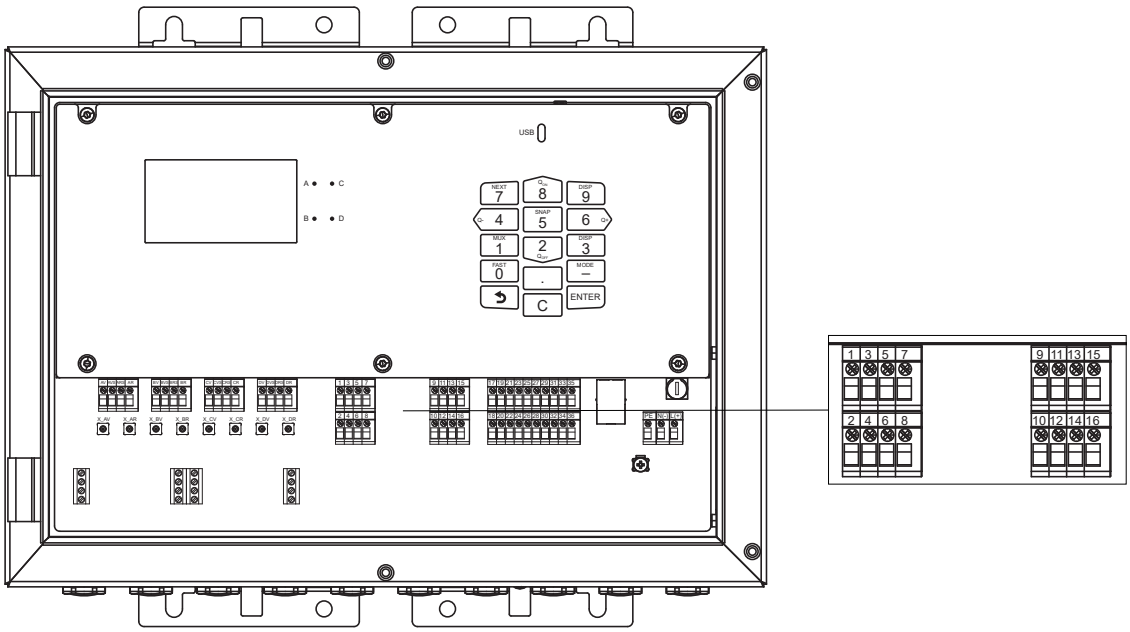
The following applies for all circuits:

- The number, type and connections of the inputs depend on the order.
- The terminal assignment is displayed on the transmitter during the configuration of the inputs.

7.5 Temperature probe

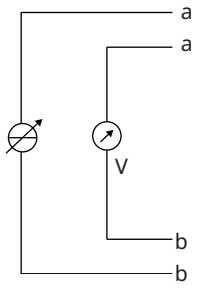
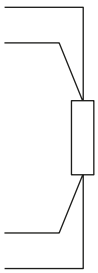
It is possible to connect the temperature probes Pt100/Pt1000 (4-wire) to the inputs of the transmitter (optional).

Fig. 106: Connection of the temperature probes to the transmitter



7.5.1 Circuit of the temperature inputs

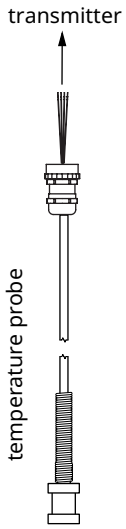
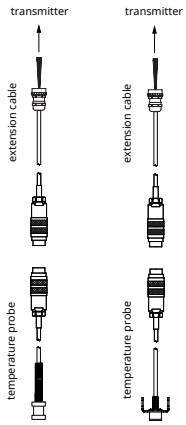
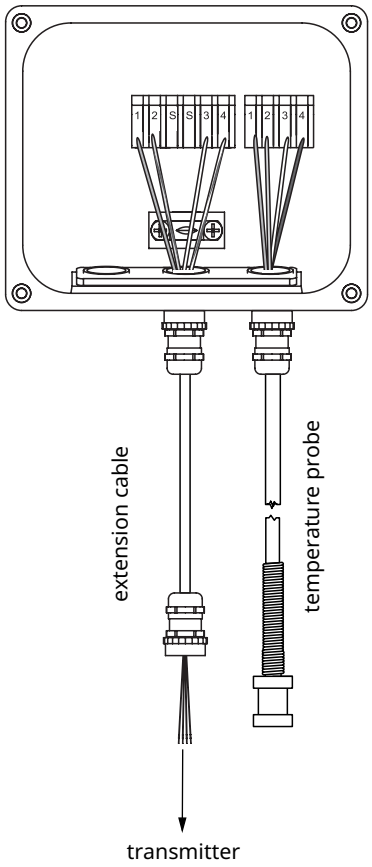
Tab. 24: Temperature input – not intrinsically safe

internal circuit (transmitter)	external circuit	remark
		Pt100/Pt1000 (4-wire) The input is galvanically isolated from the transmitter.

- The number, type and connections of the inputs depend on the order.
- The terminal assignment is displayed on the transmitter during the configuration of the inputs.

7.5.2 Connection systems

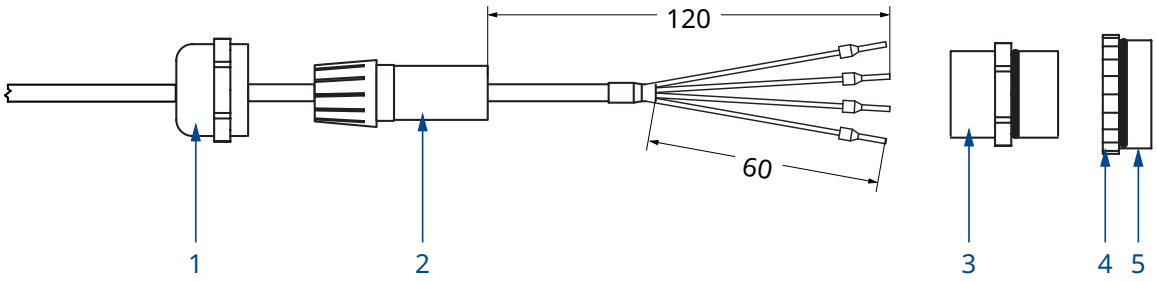
Tab. 25: Connection systems

direct connection	connection with extension cable	connection with junction box
		

7.5.3 Direct connection of the temperature probe

- Remove the blind plug for the connection of the temperature probe.
- Open the cable gland of the temperature probe. The compression part remains in the cap nut.
- Push the cable of the temperature probe through the cap nut, the compression part, the basic part and the reducer.
- Prepare the cable.
- Insert the cable into the housing.
- Screw the sealing ring side of the reducer into the transmitter housing.
- Screw the basic part into the reducer.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the temperature probe to the terminals of the transmitter.

Fig. 107: Preparation of the temperature probe (dimensions in mm)



1 cap nut
2 compression part
3 basic part
4 reducer
5 sealing ring side

7.5.4 Connection with extension cable

Connection of the extension cable to the transmitter

- Remove the blind plug for the connection of the temperature probe.
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut, the compression part, the basic part and the reducer.
- Prepare the extension cable.
- Cut the external shield to length and brush it back over the compression part.
- Insert the extension cable into the housing.
- Screw the sealing ring side of the reducer into the transmitter housing.
- Screw the basic part into the reducer.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the transmitter.

Tab. 26: Terminal assignment (transmitter)

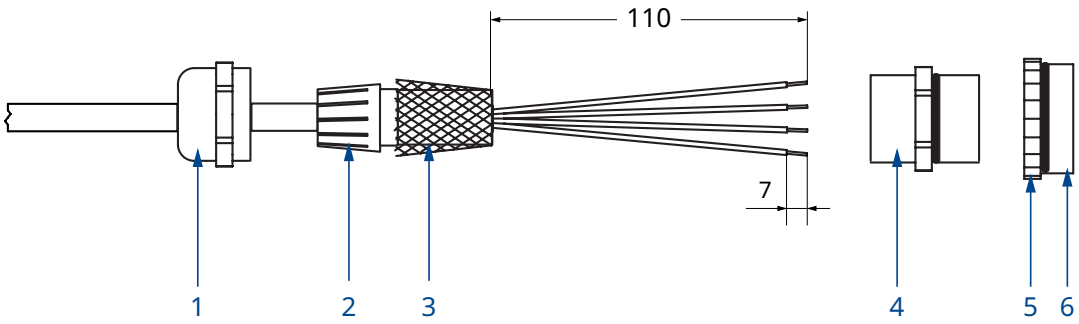
terminal	extension cable
a	red
a	gray
b	blue
b	white

The terminal assignment is displayed on the transmitter during the configuration of the inputs.

Connection of the extension cable to the junction box

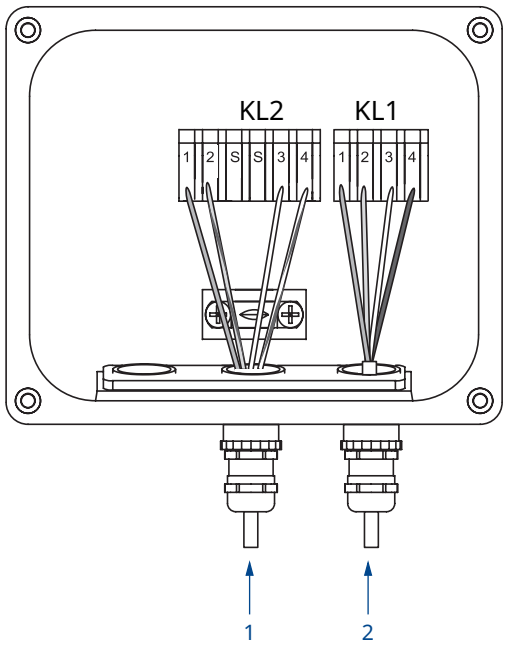
- Remove the blind plug for the connection of the extension cable.
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut and the compression part.
- Prepare the extension cable.
- Cut the external shield to length and brush it back over the compression part.
- Screw the sealing ring side of the reducer into the junction box.
- Screw the basic part into the reducer.
- Insert the extension cable into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the junction box.

Fig. 108: Preparation of the extension cable (dimensions in mm)



1 cap nut
2 compression part
3 external shield, brushed back
4 basic part
5 reducer
6 sealing ring side

Fig. 109: Junction box

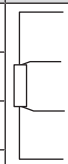


1 connection of the extension cable **2 connection of the temperature probe**

Connection of the temperature probe to the junction box

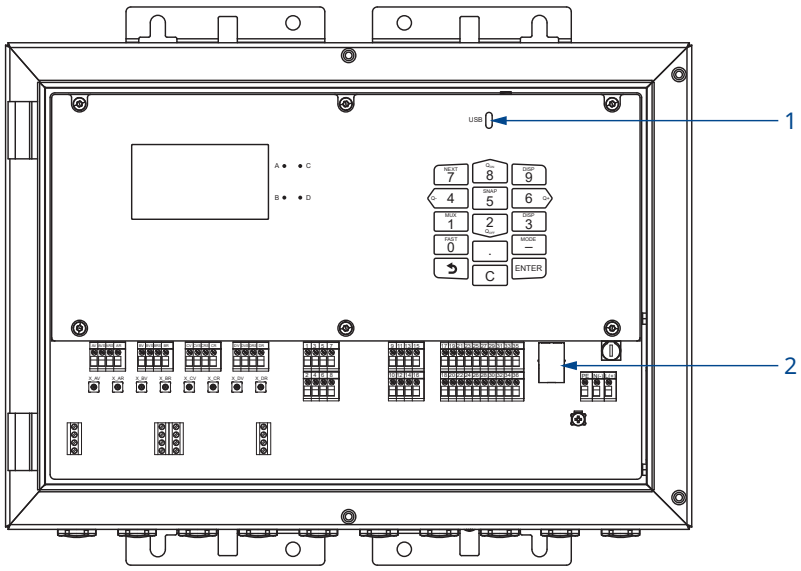
- Remove the blind plug for the connection of the temperature probe.
- Open the cable gland of the temperature probe. The compression part remains in the cap nut.
- Push the cable of the temperature probe through the cap nut and the compression part.
- Prepare the cable.
- Cut the external shield to length and brush it back over the compression part.
- Screw the sealing ring side of the reducer into the junction box.
- Screw the basic part into the reducer.
- Insert the cable into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the temperature probe to the terminals of the junction box.

Tab. 27: Terminal assignment (junction box)

terminal	extension cable (KL2)	temperature probe (KL1)
1	red	
3	gray	
4	blue	
2	white	

7.6 Service interfaces

Fig. 110: Connection of the service interfaces to the transmitter



1 USB interface **2 LAN interface**

7.6.1 USB interface

The transmitter can be connected directly to the PC via the USB interface.

- Connect the USB cable to the USB interface of the transmitter and to the PC.

NOTICE

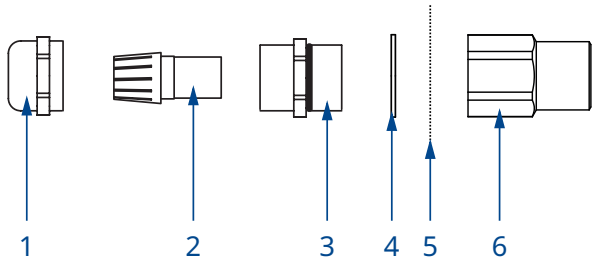
If the transmitter is powered via the USB interface, it is neither possible to start a measurement nor to test process inputs or outputs.

7.6.2 LAN interface

The transmitter can be connected to a PC or the local area network via the LAN cable.

- Remove the blind plug to connect the cable to the transmitter.
- Open the cable gland of the LAN cable. The compression part remains in the cap nut.

Fig. 111: Cable gland



1 cap nut
2 compression part
3 basic part
4 sealing ring (only for cable gland M20, not for cable gland 1/2 NPS)
5 housing wall
6 ferrite nut

- Push the cable through the cap nut, compression part, basic part and the sealing ring (sealing ring: only for cable gland M20, not for cable gland 1/2 NPS).
- Insert the cable into the transmitter housing.
- Push the cable through the ferrite nut.
- Prepare the cable (see the documentation provided by the manufacturer).
- Install the connector (see the documentation provided by the manufacturer).
- Insert the connector into the LAN interface port.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Fix the cable by tightening the cable gland with the ferrite nut.

8 Start-up

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ WARNING

Installation, connection and start-up by unauthorized and unqualified personnel

This may result in personal or material damage or dangerous situations.

→Any work on the transmitter has to be carried out by authorized and qualified personnel only.

⚠ CAUTION

Safety and accident prevention regulations for electrical systems and equipment

Failure to observe these regulations may lead to severe injuries.

→Observe the safety and accident prevention regulations for electrical systems and equipment.

⚠ CAUTION

Warning of severe injuries from hot or very cold components

Touching hot or very cold components can lead to severe injuries (e.g., thermal damage).

→Any mounting, installation or connection work has to be concluded.

→Any work on the measuring point during the measurement is prohibited.

→Observe the ambient conditions at the measuring point during installation.

→Wear the required personal protective equipment.

→Observe the applicable rules.

NOTICE

The transmitter and the transducers have to be checked for proper condition and operational safety before each use. The housing of the transmitter must always be closed during operation. Observe that maintenance work must be concluded.

8.1 Start-up settings

When starting up the transmitter for the first time, the following settings are required:

- language
- date/time
- system of units

These displays will only be indicated when the transmitter is switched on for the first time or after an initialization.

`Language`

The available transmitter languages are displayed.

- Select a language.
- Press ENTER.

The menus are displayed in the selected language.

`Set time`

The current time is displayed.

- Press ENTER to confirm the time or set the current time via the numeric field.
- Press ENTER.

`Set date`

The current date is displayed.

- Press ENTER to confirm the date or set the current date via the numeric field.
- Press ENTER.

`System of units`

- Select `Metric` or `Imperial`.
- Press ENTER.

`Region of Canada`

- Select `Yes` if the transmitter is to be used in the region of Canada.
- Press ENTER.

This display will only be indicated if `Imperial` is selected.

8.2 Switching on

As soon as the transmitter is connected to the power supply, the menu is displayed in the selected language. The language can be changed.

NOTICE

The parameters cannot be changed during the measurement.

If the transmitter was switched off during the measurement, the message `Measurement started` will be displayed after connecting the transmitter to the power supply. The measurement continues with the parameters set last.

After pressing ⮌ it is possible to stop the measurement or to display the current parameter settings.

Operational state indication

The operational state is indicated by LEDs next to the display.

Tab. 28: Operational state of the transmitter

LED off	transmitter in idle state
LED lights green	signal quality of the measuring channel sufficient for a measurement
LED lights red	signal quality of the measuring channel not sufficient for a measurement

8.3 Language selection

`Miscellaneous\System settings\Language`

The language of the transmitter can be selected:

- Select the menu item `Language`.
- Press ENTER.
- Select the desired language from the scroll list.
- Press ENTER.

Afterwards the menu will be displayed in the selected language. This language remains activated when the transmitter is switched off and on again.

The language can also be changed by entering a HotCode.

8.4 Initialization

During an initialization (INIT) of the transmitter, all settings are reset to factory default.

Proceed as follows to execute an initialization:

- When switching on the transmitter: keep ↩ and C pressed.
- During the operation of the transmitter: press ↩, C and ENTER simultaneously. Release only ENTER. Keep ↩ and C pressed.

During an initialization it is tested whether the key lock is activated. If so, it has to be deactivated.

- Enter the 6-digit key lock code.
- Press ENTER.

If a measurement is running, it will be stopped.

It will be asked whether the initial settings are to be carried out.

`Initial settings`

If `Yes` is selected, the following setting dialogs will be displayed:

- `Language`
- `Date/time`
- `System of units`
- `Delete meas. values`
- `Delete snaps`
- `Delete user subst.` (all customized materials and fluids stored after delivery will be deleted)
- `Reset totalizers`

The initialization can also be started with the HotCode **909000**.

8.5 Date and time

`Miscellaneous\System settings\Date/time`

The transmitter has a battery-powered clock. Measured values are automatically stored with date and time.

- Select the menu item `Date/time`.

The set time is displayed.

- Enter the current time.
- Press ENTER.

The set date is displayed.

- Enter the current date.
- Press ENTER.

8.6 Information regarding the transmitter

`Miscellaneous\System settings\Transmitter info`

- Select the menu item `Transmitter info`.
- Press ENTER.
- Press 2 or 8 to scroll through the list.
- Press ↩ to return to the menu item `System settings`.

Tab. 29: Information regarding the transmitter

display	description
`Serial number`	serial number of the transmitter
`Firmware version`	version number of the installed firmware
`Firmware date`	creation date of the installed firmware
`Production date`	manufacturing date of the transmitter
`MAC address`	MAC address of the transmitter
`Service TCP port`	TCP port of the transmitter
`Verification log`	state of the verification logger

9 Measurement

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ CAUTION

Warning of severe injuries from hot or very cold components

Touching hot or very cold components can lead to severe injuries (e.g., thermal damage).

→Any mounting, installation or connection work has to be concluded.

→Any work on the measuring point during the measurement is prohibited.

→Observe the ambient conditions at the measuring point during installation.

→Wear the required personal protective equipment.

→Observe the applicable rules.

9.1 Enabling the HPI measuring mode

NOTICE

If the HPI measuring mode is not enabled, the transmitter operates as an ultrasonic flowmeter (see operating instruction UMFLUXUS_F736 provided on the USB stick).

`Miscellaneous\Measurement\Measurement modes`

- Select the menu item `Miscellaneous\Measurement`.
- Press ENTER.
- Select the menu item `Measurement modes`.
- Press ENTER.

`Miscellaneous\Measurement\Measurement modes\HPI measurement`

- Select `On` to enable the HPI measuring mode. Select `Off` to disable it.
- Press ENTER.

NOTICE

When operating a transmitter with several measuring channels, the fluid detection can only be run with a common fluid table. The fluid data set and the HPI physical quantity have to be identical on all measuring channels.

Example

global inputs:

- reference temperature: 20 °C
- reference pressure: 1 bar
- source item: API gravity (recommended: = physical quantity)
- method for volume correction (see Tab. 31: CTL calculation [▶ 111] and Tab. 32: CPL calculation [▶ 112]):
  - CTL calculation: `Density` ρ/ρ_N
  - CPL calculation: `Without` (pressure is selected automatically according to the density)
- number of fluids: 4
- min. range distance: 0.01

global inputs from SuperUser mode:

- fluid change time base: 1 min
- fluid change damping: 10 s

Tab. 30: Inputs for each fluid in the fluid table

no.	name	API gravity	volume correction
1	Fuel oils	17...22 °API	CTL: density; CPL: automatically
2	Crude oil	30...45 °API	CTL: density; CPL: automatically
3	Gasolines	47...65 °API	CTL: density; CPL: automatically
4	Naphta	70...85 °API	CTL: density; CPL: automatically

from SuperUser mode:

- selection of the volume correction method (if necessary, overwrites the global selection): not selected here
- fluid-specific calibration factor: not selected here

If `On` is selected, the following menu items are displayed:

```
Miscellaneous\Measurement\Measurement modes\...\Reference temp.
```

- Enter the temperature according to the local reference conditions (default: 20 °C).
- Press ENTER.

```
Miscellaneous\Measurement\Measurement modes\...\Reference pressure
```

- Enter the pressure according to the local reference conditions (default: 1 bar).
- Press ENTER.

Assignment of a source item

```
Miscellaneous\Measurement\Measurement modes\...\Source item
```

- Select the source item (recommended: = physical quantity) whose measured value, status value or event value is to be displayed.
- Press ENTER.

Selection of the CTL calculation

Correction of the temperature influence on the fluid. The following table provides an overview of the selectable calculation types.

Tab. 31: CTL calculation

CTL calculation	basis	explanation
Density	Analysis Basic curve	The CTL factor is determined from the relation of the calculated density and the standardized density. The default setting is Analysis. In case the density cannot be determined from the measured sound speed and temperature, select Basic curve. The fluid temperature entered in the menu Parameters will be used.
ASTM1250	Crude oil Fuel oils Jet fuels Transition zone Gasolines Lubricating oil Special application	calculation according to section 11.1 of the MPMS (Manual of Petroleum Measurement Standards)
ASTM4311	15 °C - group A 15 °C - group B 60 °F - group A 60 °F - group B	calculation for heavy hydrocarbons, e.g., bitumen
TP25	1 EE (68/32)(1) 2 Ethane 3 EP (65/35)(2) 4 EP (35/65)(3) 5 Propane 6 i-Butane 7 n-Butane 8 i-Pentane 9 n-Pentane 10 i-Hexane 11 n-Hexane 12 n-Heptane	calculation according to section 11.2.4 of the MPMS (Manual of Petroleum Measurement Standards)

`Miscellaneous\Measurement\Measurement modes\...\CTL method`

- Select the CTL calculation to be used.
- Press ENTER.
- Select a list item to be used as the basis for calculation.
- Press ENTER.

Selection of the CPL calculation

Correction of the pressure influence on the fluid. The following table provides an overview of the selectable calculation types.

Tab. 32: CPL calculation

CPL calculation	explanation
ASTM1121	calculation according to section 11.2.1 of the MPMS (Manual of Petroleum Measurement Standards)
ASTM1122	calculation according to section 11.2.2 of the MPMS (Manual of Petroleum Measurement Standards)
Automatic	Calculation automatically adapts to the measured density. For light and medium hydrocarbons, the calculation is corrected according to MPMS sections 11.2.2 and 11.2.1, respectively. For heavy hydrocarbons, the CPL factor is always 1.

```
Miscellaneous\Measurement\Measurement modes\...\CPL method
```

- Select the CPL calculation to be used.
- Press ENTER.

Fluid change time base

```
Miscellaneous\Measurement\Measurement modes\...\Fluid change time base
```

- Select the time needed to complete a fluid change.
- Press ENTER.

This display will be indicated from the SuperUser mode.

Damping factor for fluid change

```
Miscellaneous\Measurement\Measurement modes\...\Fluid change damping
```

- Enter the damping factor for the duration of the fluid change.
- Press ENTER.

This display will be indicated from the SuperUser mode.

Definition of fluid parameters

```
Miscellaneous\Measurement\Measurement modes\...\Number of fluids
```

- Enter the number of fluids.
- Press ENTER.

```
Miscellaneous\Measurement\Measurement modes\...\Number of fluids\Min.
range distance
```

A min. range distance is required. The ranges of the source items of the individual fluids have to be clearly delimited from each other (default: 0.01 wt%, optimized for API gravity).

- Enter the min. range distance.
- Press ENTER.

The following data have to be entered for each fluid:

`Miscellaneous\Measurement\Measurement modes\...\Fluid name`

- Enter the fluid name.
- Press ENTER.

`Miscellaneous\Measurement\Measurement modes\...\min.`

The range of the source item for each fluid has to be entered. The ranges must not overlap.

- Enter the min. value of the selected source item.
- Press ENTER.

`Miscellaneous\Measurement\Measurement modes\...\max.`

- Enter the max. value of the selected source item.
- Press ENTER.

From the SuperUser mode, the following menu items are displayed additionally:

`Miscellaneous\Measurement\Measurement modes\...\Spec. CTL method`

Deviating from the global device settings in the menu item `CTL method`, a separate CTL calculation can be selected for the respective fluid.

- Select `Yes` if a separate CTL calculation has to be selected for the fluid.
- Press ENTER.
- Select the CTL calculation to be used.
- Press ENTER.
- Select a list item to be used as the basis for calculation.
- Press ENTER.

`Miscellaneous\Measurement\Measurement modes\...\Spec. CPL method`

Deviating from the global device settings in the menu item `CPL method`, a separate CPL calculation can be selected for the respective fluid.

- Select `Yes` if a separate CPL calculation has to be selected for the fluid.
- Press ENTER.
- Select the CPL calculation to be used.
- Press ENTER.

`Miscellaneous\Measurement\Measurement modes\...\Flow calib. factor`

If the fluid-specific calibration factor for a detected fluid from the fluid table is known, it can be entered.

- Select `Yes` to enter a fluid-specific calibration factor.
- Press ENTER.
- Enter the calibration factor.
- Press ENTER.

9.2 Input of parameters

The pipe and fluid parameters are entered for the selected measuring point. The parameter ranges are limited by the technical characteristics of the transducers and the transmitter.

- Select the menu `Parameters`.
- Press ENTER.

9.2.1 Measuring point configuration

`Parameters\Measuring point config.\1 meas. point (ABCD)`

- Select the configuration of the measuring point (here: `1 meas. point (ABCD)`).
- Press ENTER.

Tab. 33: Measuring point configuration

`1 meas. point (A)`	`1 meas. point (AB)`	`1 meas. point (ABC)`	`1 meas. point (ABCD)`
The measurement is carried out using 1 measuring channel at 1 measuring point.	The measurement is carried out using 2 measuring channels at 1 measuring point.	The measurement is carried out using 3 measuring channels at 1 measuring point.	The measurement is carried out using 4 measuring channels at 1 measuring point.

9.2.2 Input of the measuring point number

`Parameters\Measuring point no.`

- Enter the number of the measuring point.
- Press ENTER.

For the activation of text input see `Miscellaneous\Dialogs/Menus\Measuring point no.`.

9.2.3 Transducer selection

NOTICE

The transducers have to be selected depending on the application parameters (see technical specification).

`Parameters\Connected transd.`

- The transducer connected to the transmitter is displayed.
- Press ENTER.

The display will only be indicated if a SENSPROM is connected to the transmitter.

If neither transducers nor SENSPROM are connected, `Transducer not found` will be displayed.

- Press ENTER.

`Parameters\Select transducer`

The display `Select transducer` appears to select one of the standard transducers stored in the transmitter.

- Select the transducer.
- Press ENTER.

NOTICE

If a standard transducer is selected, no transducer-specific calibration values are considered. A higher uncertainty has to be expected.

9.2.4 Input of pipe parameters

Outer pipe diameter

`Parameters\Outer diameter`

- Enter the outer pipe diameter. If the pipe has a coating, enter the outer diameter including the coating.
- Press ENTER.

It is possible to enter the pipe circumference instead of the outer pipe diameter.

Pipe circumference

`Parameters\Pipe circumference`

- The input of the pipe circumference can be activated in the menu item `Miscellaneous\Dialogs/Menus\Pipe circumference`.
- Press [–] in the menu item `Outer diameter`. The menu item `Pipe circumference` is displayed.
- Enter the pipe circumference. If the pipe has a coating, enter the circumference including the coating.
- Press ENTER.

If the outer pipe diameter is to be entered, press [–]. The menu item `Outer diameter` is displayed.

Pipe material

`Parameters\Pipe material`

The pipe material has to be selected to be able to determine the corresponding sound speed.

The sound speeds for the materials in the scroll list are stored in the transmitter.

- Select the pipe material.
- If the material is not included in the scroll list, select the list item `Other material`.
- Press ENTER.

Sound speed of the pipe material

`Parameters\Pipe material\Other material\c material`

- Enter the sound speed of the pipe material.

NOTICE

There are 2 sound speeds for pipe materials: the longitudinal and the transversal one. Enter the sound speed which is closer to 2500 m/s.

- Press ENTER.
- Select `Transverse wave` or `Longitudinal wave`.
- Press ENTER.

These displays will only be indicated if `Other material` is selected.

For the sound speed of some materials see Annex: Reference [▶ 226].

Roughness of the pipe material

`Parameters\Pipe material\Other material\Roughness`

The flow profile of the fluid is influenced by the roughness of the inner pipe wall.

The roughness is used for the calculation of the profile correction factor.

In most cases, the pipe roughness cannot be exactly determined and must therefore be estimated.

- Press ENTER if the pipe has a lining. The roughness of the lining is included in the calculation.
- Enter the roughness of the pipe material in case the pipe has no lining.
- Press ENTER.

This display will only be indicated if `Other material` is selected.

For the roughness of some materials see Annex: Reference [▶ 226].

Pipe wall thickness

`Parameters\Pipe wall thickness`

- Enter the pipe wall thickness.
- Press ENTER.

Lining

`Parameters\Lining`

- Select `Yes` if the pipe has a lining. Select `No` if it has no lining.
- Press ENTER.

Lining material

`Parameters\Lining material`

- Select the lining material.
- Press ENTER.
- If the lining material is not included in the scroll list, select the list item `Other material`.
- Press ENTER.

This display will only be indicated if `Yes` is selected in the menu item `Lining`.

Sound speed of the lining material

`Parameters\Lining material\Other material\c material`

- Enter the sound speed of the lining material.

NOTICE

There are 2 sound speeds for lining materials: the longitudinal and the transversal one. Enter the sound speed which is closer to 2500 m/s.

- Press ENTER.
- Select `Transverse wave` or `Longitudinal wave`.
- Press ENTER.

These displays will only be indicated if `Other material` is selected.

Roughness of the lining material

`Parameters\Lining material\Other material\Roughness`

The flow profile of the fluid is influenced by the roughness of the inner pipe wall.

The roughness is used for the calculation of the profile correction factor.

In most cases, the pipe roughness cannot be exactly determined and must therefore be estimated.

- Enter the roughness of the lining material.
- Press ENTER.

This display will only be indicated if `Other material` is selected.

Lining thickness

`Parameters\Lining thickness`

- Enter the thickness of the lining.
- Press ENTER.

This display will only be indicated if `Yes` is selected in the menu item `Lining`.

Roughness

`Parameters\Roughness`

The flow profile of the fluid is influenced by the roughness of the inner pipe wall.

The roughness is used for the calculation of the profile correction factor.

In most cases, the pipe roughness cannot be exactly determined and must therefore be estimated.

- If `Automatic` is selected, the roughness values stored in the transmitter are used.
- If `Customized` is selected, a roughness value has to be entered.
- Press ENTER.

This display will not be indicated if `Other material` is selected in the menu item `Pipe material` or `Lining material`.

9.2.5 Measurement settings

Selection of the physical quantity

`Parameters\Physical quantity`

The available physical quantities are displayed in a list.

- Select the physical quantity.
- Press ENTER.

Selection of the unit of measurement

`Parameters\Physical quantity\Flow velocity`

For the selected physical quantity (except sound speed), a scroll list with the available units of measurement is displayed.

- Select the unit of measurement of the physical quantity.
- Press ENTER.

NOTICE

If the physical quantity or the unit of measurement is changed, the settings of the outputs have to be checked.

9.2.6 Definition of the HPI physical quantity

`Parameters\Select analysis quant.`

- Select one of the following HPI physical quantities:
  - `API gravity`
  - `Density`
  - `Norm. density`
- Press ENTER.

`Parameters\API gravity`

- Enter the value of the HPI physical quantity (here: `API gravity`) at the operating point.
- Press ENTER.

If the entered value of the HPI physical quantity at the operating point is outside the valid range, it has to be checked whether the selected data set is adequate. The value has to be within the valid range.

`Parameters\Show range info`

The valid range of the selected HPI physical quantity and of the temperature, density and sound speed can be displayed.

- Select `Yes` to display the valid range. Select `No` to return to the beginning of the menu `Parameters`.

9.2.7 Further parameters

Fluid temperature

`Parameters\Fluid temp.`

At the beginning of the measurement, the fluid temperature is used for the interpolation of the sound speed and therefore for the calculation of the recommended transducer distance. The value has to be within the ambient temperature of the transducers.

- Enter the fluid temperature. In case of a temperature range, enter the average fluid temperature.
- Press ENTER.

Fluid pressure

`Parameters\Fluid pressure`

At the beginning of the measurement, the fluid pressure is used for the calculation of the CPL correction factor.

- Enter the fluid pressure.
- Press ENTER.

Extension cable

`Parameters\Extension cable`

In case the transducer cable is extended (e.g., between junction box and transmitter), enter the length of the extension cable.

- Enter the length of the extension cable.
- Press ENTER.

Input of the damping factor

`Parameters\Damping`

Each displayed measured value is a floating average of the last x seconds, with x being the damping factor. If 0 s is entered as damping factor, no average is calculated.

The value of 10 s is appropriate for normal flow conditions. If the values fluctuate strongly due to a higher flow dynamic, a higher damping factor can be useful.

- Enter the damping factor.
- Press ENTER.

Dynamic damping

If dynamic damping is activated, volatile changes in the measured values of the selected physical quantity are transmitted by the transmitter without any time lag.

Important

The dynamic damping will only have an impact on the selected physical quantity. All other physical quantities are not dynamically damped.

`Parameters\Dynamic damping`

- Select `On` to activate the dynamic damping.
- Press ENTER.

This display will only be indicated if dynamic damping has been activated in the menu item `Miscellaneous\Measurement\Measurement settings\Dynamic damping`.

`Parameters\...\Dynamic threshold`

- Enter the value for the dynamic threshold. If zero is entered, dynamic damping will be deactivated.
- Press ENTER.

`Parameters\...\Transient damping`

- Enter the damping factor for the temporary damping.
- Press ENTER.

NOTICE

If another physical quantity is selected, the dynamic damping has to be entered again.

Input of the error delay

```
Parameters\Error delay
```

The error delay is the time interval at the end of which the error value is transmitted to the output.

This display will only be indicated if the list item `Edit` is selected in the menu item `Miscellaneous\Dialogs/Menus\Error delay`.

If no error delay is entered, the damping factor will be used.

- Enter a value for the error delay.
- Press ENTER.

Definition of conditions for a valid measurement

```
Parameters\Valid meas. condition
```

- Select a condition.
- Press ENTER.

This display will not be indicated if the list item `1 meas. point (A)` is selected in the menu item `Parameters\Measuring point config.`.

Tab. 34: Condition for a valid measurement

all channels OK	1 channel OK
average with "AND" All measuring channels have to deliver a valid measured value.	average with "OR" At least one measuring channel has to deliver a valid measured value.

9.3 Configuration of an output

If a current output has to be operated according to `NAMUR NE 43`, this function has to be enabled.

```
Outputs\Current output modes\NAMUR NE 43
```

- Select the list item `Current output modes` in the menu item `Outputs`.
- Press ENTER until the menu item `NAMUR NE 43` is displayed.
- Select `Yes` to enable `NAMUR NE 43`.
- Press ENTER.

If the transmitter is equipped with outputs, they have to be configured. The measured value, the status value or an event value can be transmitted via the different outputs.

In the following, the configuration of a current output is described.

- Select the menu `Outputs`.
- Press ENTER.

The scroll list contains all available outputs of the transmitter.

```
Outputs\Current I1(-)
```

- Select an output (here: `Current I1(-)`).
- Press ENTER.

If the output has already been enabled, it is displayed as follows: `Current I1 (V)`.

`Outputs\Current I1\Enable I1`

- Select `Yes` to change the settings for an already enabled output.
- Select `No` to cancel the assignment and to return to the previous menu item.
- Press ENTER.

Assignment of a source item

A source item has to be assigned to each selected output.

`Outputs\...\Source item`

- Select a source item whose measured value, status value or event value is to be transmitted to the output.
- Press ENTER.

Tab. 35: Configuration of the outputs

source item	list item	output
`Flow quantities`	`Flow velocity`	flow velocity
	`Norm vol. flow rate`	standard volumetric flow rate
	`Operation vol. flow`	operating volumetric flow rate
	`Mass flow rate`	mass flow rate
`Totalizers`	`Operating volume (+)`	totalizer for the volumetric flow rate in positive flow direction
	`Operating volume (-)`	totalizer for the volumetric flow rate in negative flow direction
	`Operating volume (Δ)`	difference of the totalizers for the positive and negative flow direction
	`Standard volume (+)`	totalizer for the standard volumetric flow rate in positive flow direction
	`Standard volume (-)`	totalizer for the standard volumetric flow rate in negative flow direction
	`Standard vol. (Δ)`	difference of the totalizers for the positive and negative flow direction
	`Mass (+)`	totalizer for the mass flow rate in positive flow direction
	`Mass (-)`	totalizer for the mass flow rate in negative flow direction
	`Mass (Δ)`	difference of the totalizers for the positive and negative flow direction

source item	list item	output
Fluid properties	Fluid temp.	fluid temperature
	Fluid pressure	fluid pressure
	Fluid density	fluid density
	Kin. viscosity	kinematic viscosity
	Dyn. viscosity	dynamic viscosity
	Norm. density	density at reference temperature
Event trigger	R1	limit message (Event trigger R1)
	R2	limit message (Event trigger R2)
	R3	limit message (Event trigger R3)
	R4	limit message (Event trigger R4)
Diagnostic values	Amplitude	signal amplitude
	Quality	signal quality
	SNR	signal-to-noise ratio
	SCNR	signal-to-correlated-noise ratio
	VariAmp	amplitude variation
	VariTime	transit time variation
	Gain	gain required to receive a useful signal
HPI measurement	API gravity	scale value that derives from the density at standard conditions
	Δ API gravity	absolute change of the HPI property per time base set for the fluid change
	Current fluid	number of the detected fluid
Miscellaneous	Custom. Input 1	measured values of input quantities (e.g., temperature, pressure) which are not used for calculation In the menu item Inputs\Assign inputs it is possible to assign configured inputs to customized inputs.
	Custom. Input 2	
	Custom. Input 3	
	Custom. Input 4	
Sound speed	Sound speed	sound speed
	Sound speed (Δ)	absolute change of the measured sound speed per time base set for the fluid change

Depending on the selected source item, it is possible to output measured values, status values or event values.

Tab. 36: Output of measured values, status values or event values

	source item	measured value		event value
		value	status	
physical quantities	`Flow quantities`	x	x	
	`Totalizers`	x	x	
	`Fluid properties`	x	x	
	`Miscellaneous`	x	x	
	`Sound speed`	x	x	
	`HPI measurement`	x	x	
	`Diagnostic values` (except `Pig detection`)	x		
events	`Diagnostic values\Pig detection`			x
	`Event trigger`			x

9.3.1 Output of a measured value

- Select the list item `Outputs\...\Values`.
- Press ENTER.

Output range

`Outputs\...\Output range`

- Select a list item.
  - `4...20 mA`
  - `Other range`
- Press ENTER.

  If `Other range` is selected, enter the values `Output MIN` and `Output MAX`.

The output range has to be > 10% of the value entered for `Output MAX`. If the output range is smaller, an error message will be displayed.

If the function `NAMUR NE 43` is activated in the menu item `Outputs\Current output modes`, only the output range 4...20 mA applies.

Error output

`Outputs\...\Error value`

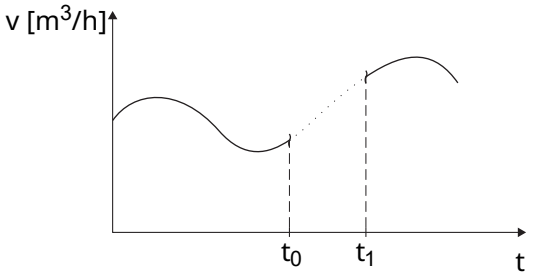
An error value can be defined which is output if the source item cannot be measured.

- Select a list item for the error output.
- Press ENTER.
- If `Other value` is selected or the function `NAMUR NE 43` is activated, enter an error value. The value has to be outside the output range. If the entered value is not valid, an error message and the permissible range will be displayed.
- Press ENTER.

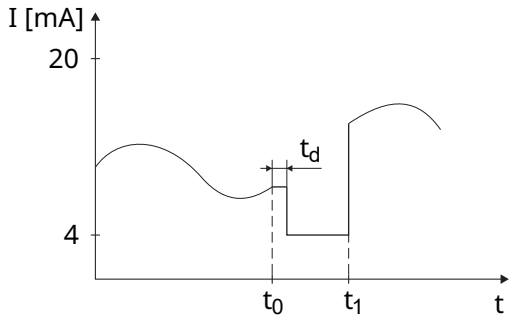
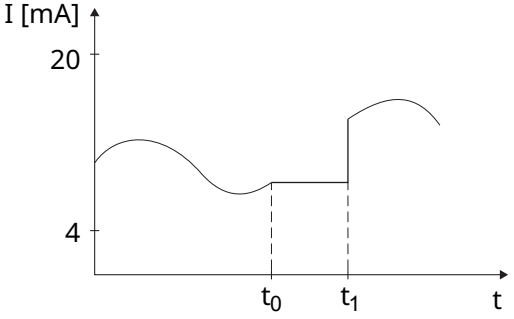
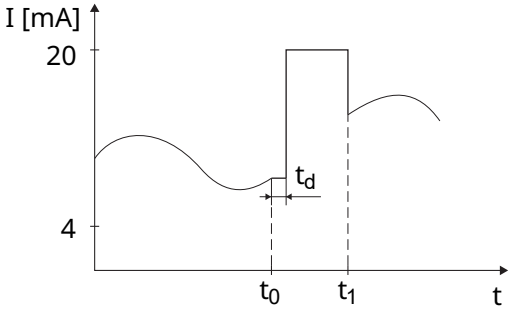
Example

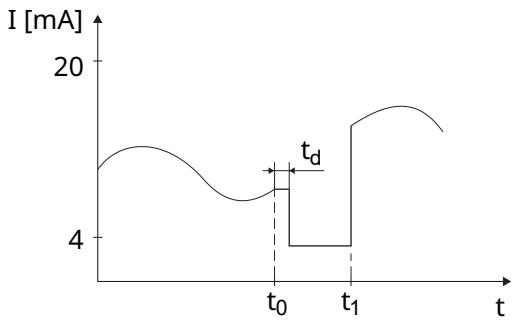
source item:	volumetric flow rate
output:	current output
output range:	4...20 mA
error delay:	$t_d > 0$

The volumetric flow rate cannot be measured during the time interval t_0...t_1. The error value will be output.



Tab. 37: Examples for the error output (output range: 4...20 mA)

list item	output signal
4.0 mA	
Last value	
20.0 mA	

list item	output signal
`Other value` error value = 3.5 mA	

Measuring range

The sign of the measured value and the measuring range are determined.

`Outputs\...\Measured values\Absolute value`

- Select `Sign` if the sign of the measured values is to be considered for the output.
- Select `Absolute value` if the sign of the measured values is not to be considered for the output.

`Outputs\...\Start of meas. range`

- Enter the lowest expected measured value. The unit of measurement of the source item will be displayed.

`Start of meas. range` is the value assigned to the value `Output MIN` of the output range.

`Outputs\...\End of meas. range`

- Enter the highest expected measured value. The unit of measurement of the source item will be displayed.

`End of meas. range` is the value assigned to the value `Output MAX` of the output range.

Terminal assignment

`Outputs\...\Output info`

The terminals for the connection of the output are displayed.

By pressing 2 or 8 further information is displayed.

- Press ENTER.

Output function test

The function of the output can now be tested.

- Connect an external measuring instrument to the terminals of the installed output.

`Outputs\...\Test signal`

- Select `Yes` to test the output. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\Enter test value`

- Enter a test value. It has to be within the output range.
- Press ENTER.

If the external measuring instrument displays the entered value, the output functions correctly.

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

`Outputs\...\Test measuring range`

- Select `Yes` to test the assignment of the measured value to the output signal. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\Enter test value`

- Enter a test value. It has to be within the expected measuring range.
- Press ENTER.

If the external measuring instrument displays the corresponding current value, the output functions correctly.

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

9.3.2 Output of a status/event value

- Select the list item `Outputs\...\Status`.
- Press ENTER.

Output range

`Outputs\...\Output range`

- Select a list item.
  - `4...20 mA`
  - `Other range`
- Press ENTER.

  If `Other range` is selected, enter the values `Output MIN` and `Output MAX`.

The output range has to be > 10 % of the value entered for `Output MAX`. If the output range is smaller, an error message will be displayed. The next possible value will be displayed.

Tab. 38:

status value – status OK	event value – idle state
The status of the output signal is defined which is to be output when measuring a measured value.	The status of the output signal is defined which is to be output if no event occurs.
• Select the value for status OK from the scroll list. • Press ENTER.	• Select the value for the idle state. • Press ENTER.

Terminal assignment

`Outputs\...\Output info`

The terminals for the connection of the output are displayed.

By pressing 2 or 8 further information is displayed.

- Press ENTER.

Output function test

The function of the output can now be tested.

- Connect an external measuring instrument to the terminals of the installed output.

`Outputs\...\Test signal`

- Select `Yes` to test the output. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\Enter test value`

- Enter a test value. It has to be within the output range.
- Press ENTER.

If the external measuring instrument displays the entered value, the output functions correctly.

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

`Outputs\...\Test measuring range`

- Select `Yes` to test the status of the output signal. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\Enter test value`

- Select a list item as test value.
- Press ENTER.

Tab. 39:

status value	event value
`Status OK` or `Status error` If the external measuring instrument displays the value (min. output value for `Status error`, max. output value for `Status OK`), the output functions correctly.	`Active` or `Passive` If the external measuring instrument displays the value (min. output value for `Passive`, max. output value for `Active`), the output functions correctly.

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

9.3.3 Operating mode for current outputs

If the transmitter has current outputs that can be operated actively or passively, the operating mode of the current outputs has to be defined.

- Select the list item `Current output modes` in the menu `Outputs`.
- Press ENTER.

`Outputs\Current output modes`

- Select `Active` or `Passive` to operate the current outputs in the corresponding mode.
- Press ENTER.

The selected setting always applies to all available current outputs.

If the transmitter can be configured according to NAMUR NE 43, the operating mode of the current output has to be defined.

- Select the list item `Current output modes` in the menu `Outputs`.
- Press ENTER until the menu item `NAMUR NE 43` is displayed.

`Outputs\NAMUR NE 43`

- Select `Yes` if the current output is to be configured according to NAMUR NE 43.
- Press ENTER.

9.4 Start of measurement

Before starting the measurement, the measuring point has to be parameterized. If another measurement has already been performed using the same measuring point parameters, the measurement can be started immediately.

- Select the menu `Start measurement`.
- Press ENTER.

The measurement is started. The measured values are displayed.

In case parameters or the measurement arrangement have changed, the measurement has to be started via the menu `Installation`.

- Select the menu `Installation`.
- Press ENTER.

Input of the number of sound paths

`Installation\Sound path`

- Enter the number of sound paths.
- Press ENTER.

Adjustment of the transducer distance

`Installation\Transducer distance`

The recommended transducer distance will be displayed. The transducer distance is measured between the inner edges of the transducers. In case of a measurement in diagonal arrangement on very small pipes, a negative transducer distance is possible.

NOTICE

The accuracy of the recommended transducer distance depends on the accuracy of the entered pipe and fluid parameters.

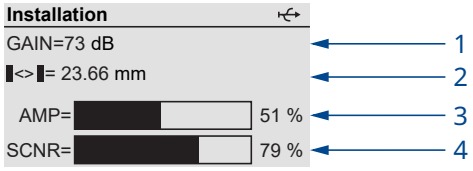
- Mount the transducers on the pipe and adjust the recommended transducer distance.
- Press ENTER.

The diagnostics window is displayed.

The amplitude of the received signal is displayed by bar graph AMP.

The bar graph SCNR shows the ratio of the useful signal and the correlated noise signal.

Fig. 112: Diagnostics window



1 diagnostic value, selection with key [9]
2 diagnostic value, selection with key [3]
3 amplitude (bar graph)
4 SCNR value (bar graph)

Tab. 40: Diagnostic values

	display [1]	explanation
line 1 of the display, scroll with [9]	c, G [2]	measured sound speed of the fluid and signal gain
	SCNR	signal-to-correlated-noise ratio
	SNR	signal-to-noise ratio
	Q	signal quality By pressing [8] it is possible to display the numerical value instead of the bar graph.
	GAIN	signal gain If the current signal gain exceeds the max. gain, the value is followed by →FAIL!.
line 2 of the display, scroll with [3]	■ <>■	recommended transducer distance, followed in brackets by the currently set transducer distance
	SCNR	signal-to-correlated-noise ratio
	SNR	signal-to-noise ratio
	Q	signal quality By pressing [2] it is possible to display the numerical value instead of the bar graph.

[1] In order to avoid doubling, a value already displayed in one of the lines will be ignored in the other.
[2] will only be displayed if the measurement has started

- In case the diagnostic values deviate significantly from the recommended limits, check whether the parameters have been entered correctly or repeat the measurement at a different point on the pipe.
- Press ENTER.

Tab. 41: Recommended diagnostic limits

good measurement	measurement at limit	measurement not possible
SCNR > 30 dB (> 50 %)	20 dB ≤ SCNR ≤ 30 dB (0 % < SCNR ≤ 50 %)	SCNR < 20 dB (= 0 %)
SNR > 15 dB	0 dB ≤ SNR ≤ 15 dB	SNR < 0 dB
GAIN < 98 dB	98 dB ≤ GAIN ≤ 113 dB	GAIN > 113 dB

Input of the transducer distance

`Installation\Transducer distance`

The recommended transducer distance is calculated on the basis of the measured sound speed. It is therefore a better approximation than the first recommended value which had been calculated on the basis of the parameters entered in the menu `Parameters`.

- Measure the adjusted transducer distance.
- Enter the measured transducer distance. The max. permissible difference to the recommended transducer distance must not be exceeded.
- Press ENTER.

The measurement is started. The measured values are displayed.

Tab. 42: Max. permitted deviation between the recommended and the entered transducer distance

transducer frequency (3rd character of the technical type)	max. difference between recommended and entered transducer distance [mm]	
	shear wave transducer	Lamb wave transducer
F	-	-60...+120
G	20	-45...+90
H	-	-30...+60
K	15	-20...+40
M	10	-10...+20
P	8	-5...+10
Q	6	-3...+5
S	3	-

9.5 Field calibration

The field calibration function allows a comparison between the actual and the set value of the HPI physical quantity for each measuring channel.

The field calibration can be carried out for each HPI physical quantity selectable in the transmitter. Any tolerances in the pipe geometry and measurement arrangement have to be compensated for by applying a sound speed offset. When sampling, the temperature and the sound speed are stored for each series of measured values. Up to 64 pairs of measured values are possible per series.

After the samples have been analyzed in the laboratory, the set values are entered into the transmitter.

The transmitter calculates the correction of the average sound speed and stores it for all HPI applications.

Start of measurement

- Select the menu `Measurement`.
- Press ENTER.

Storing of calibration values

The sound speed and temperature measured during sampling have to be stored.

- Press [·].

The sample number and the time of sampling are displayed.

Several calibration values can be stored per series of measured values. They remain stored in the transmitter until an auto calibration is carried out or the samples are deleted.

When a new measurement is started and new calibration values are stored, the calibration values of the previous series of measured values are overwritten.

Stop of measurement

- Press and hold ⮌ to return to the main menu.
- Select the menu `Stop measurement`.
- Press ENTER.
- Select `Yes` to stop the measurement.
- Press ENTER.

The measurement is stopped. The main menu is displayed.

Input of the reference value

- Select the menu `Calibration`.
- Press ENTER.

```
Calibration\Field calibration c
```

- Select the list item `Field calibration c`.
- Press ENTER.
- Select the channel for which the field calibration is to be carried out.
- Press ENTER.
- Select the list item `Edit samples`.
- The sample number and the time of sampling are displayed.
- Press ENTER.
- Enter the reference value of the sampling.
- Press ENTER.

NOTICE

The reference quantity has to correspond to the physical quantity of the fluid selected in the menu `Parameters`.

Auto calibration

- Select the list item `Auto calibration`.
- Press ENTER.

The calibration is carried out.

NOTICE

If several reference values have been stored, e.g., during various samplings with different concentrations, an average valid for the entire operating range is calculated during auto calibration.

Auto activation

- Select the list item `Auto activation`.
- Select `On` if the offset of the sound speed obtained during the field calibration is to be used for the calculation of the HPI physical quantity.
- Press ENTER.

In case of service, the auto activation can be switched off to check the offset. In extreme cases, an error of the HPI physical quantity is displayed.

- Select `Off` in case the offset of the sound speed is not to be used. The transmitter works with the measured sound speed without any correction.
- Press ENTER.
- Select `Default` (`Auto activation` = `Off`) if no customized inputs are to be made.
- Press ENTER.

Deletion of samples

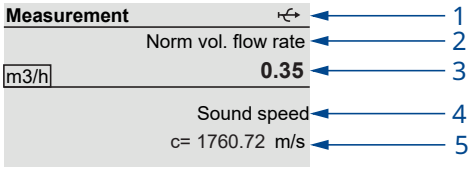
- Select the list item `Clear samples`.
- Select `Yes` to delete the samples.
- Press ENTER.

9.6 Display during the measurement

9.6.1 Measured values

The measured values are displayed during the measurement as follows:

Fig. 113: Display of measured values



1 menu, status indicators
2 physical quantity
3 unit of measurement and measured value
4 further physical quantity
5 further physical quantity

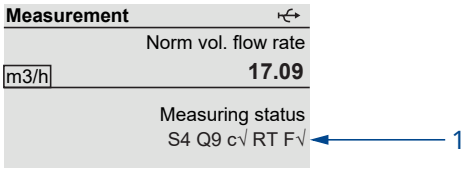
By pressing 3 or 9, additional physical quantities can be displayed during the measurement.

- Press 3 to display the measured values in line 5. The designation of the physical quantity is displayed in line 4 by pressing 9 for several seconds.
- Press 9 to display the measured values in line 4. The designation of the physical quantity is displayed in line 5 by pressing 3 for several seconds.

9.6.2 Status line

Important information of the running measurement is summarized in the status line. This allows to evaluate the quality and precision of the measurement. Press 3 or 9 during the measurement to scroll to the status line.

Fig. 114: Display of the status line



1 Status line

Tab. 43: Description of the status line

	value	meaning
S		signal amplitude
	0	< 5 %
	...	...
	9	≥ 90 %
		values ≥ 3 are sufficient for the measurement
Q		signal quality
	0	< 5 %
	...	...
	9	≥ 90 %
c		sound speed comparison of the measured and the expected sound speed of the fluid The expected sound speed is calculated from the fluid parameters.
	√	OK, is equal to the expected value
	↑	> 20 % of the expected value
	↓	< 20 % of the expected value
	?	unknown, cannot be measured
R		flow profile information about the flow profile based on the Reynolds number
	T	fully turbulent flow profile
	L	fully laminar flow profile
	↕	transition range between laminar and turbulent flow
	?	unknown, cannot be calculated

	value	meaning
F		flow velocity comparison of the measured flow velocity with the flow limits of the system
	√	OK, the flow velocity is not within the critical range
	↑	the flow velocity is above the current limit
	↓	the flow velocity is below the current cut-off flow
	0	the flow velocity is within the limit range of the measuring method
	?	unknown, cannot be measured

9.6.3 Diagnostic values

The diagnostic values can be displayed during the measurement (see Tab. 40: Diagnostic values [▶ 129]).

- Press ENTER to go to the diagnostics window.
- If the measurement is started on several measuring channels, press ENTER to go to the diagnostics window for measuring channel B.
- Press ENTER again to return to the display of measured values.

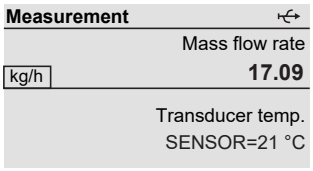
9.6.4 Parameters

Transducer temperature

In the `SuperUser` and `SuperUser ext.` modes it is possible to display the transducer temperature during the measurement.

By pressing 3 or 9 during the measurement, it is possible to scroll to the transducer temperature display.

Fig. 115: Display of the transducer temperature



NOTICE

If compliance with the specified transducer temperature is to be monitored, an event trigger can be set.

HPI physical quantities

In the HPI measuring mode, the following physical quantities can also be displayed.

Tab. 44: HPI physical quantities

display	description
Df	fluid density
Tf	fluid temperature
Dfn	standardized density
Fl	fluid number
VCF	volume correction factor
SLP	slope
K	API gravity

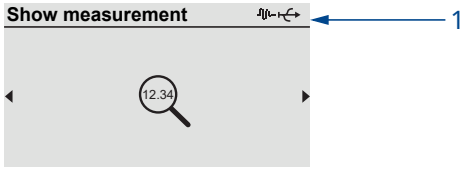
Parameter settings

The parameter settings can be displayed during the measurement.

- Press ⮌ during the measurement.

The transmitter returns to the main menu.

Fig. 116: Display of the main menu during the measurement



1 status indication

The measurement continues running in the background. The symbol is displayed in the status indication.

- Press 4 or 6 to select the corresponding menu to display the parameters.

NOTICE

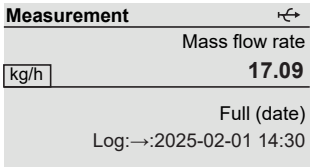
The parameters cannot be changed during the measurement. When trying to do this, the message `Read-only mode` is displayed. The measurement has first to be stopped.

Information regarding the data logger

Information regarding the data logger can be displayed during the measurement.

- Press 9 until the following is displayed.

Fig. 117: Information regarding the data logger



If the ringbuffer is deactivated, line 5 indicates when the data logger will be full in case all settings are kept.

If the ringbuffer is activated, line 5 indicates how long measurement data can still be stored without losing older measurement data.

The information regarding the data logger can also be displayed via the menu `Storage`.

```
Storage\Data logger\Data logger info
```

- Press ⮌ during the measurement.
- Select the list item `Data logger\Data logger info` in the menu `Storage`.
- Press ENTER.

The information regarding the data logger is displayed.

9.6.5 Switching to the display of measured values

- Press and hold ⮌ to return to the main menu.
- Select the menu `Show measurement`.
- Press ENTER.

The measured values are displayed.

9.7 Execution of special functions

Some keys have special functions. They can be used to enter data, to navigate through scroll lists and to execute special functions.

Tab. 45: Special functions

key	function
8	totalizer display
5	triggering of snaps
0	toggling between TransitTime and FastFood mode
.	storing of the measured sound speed and temperature for field calibration
⮌	return to the main menu to stop the measurement or display the parameters
ENTER	display of the diagnostic window

Additional functions can be executed by pressing C.

- Press and hold C until the menu item `Execute command` is displayed.
- Select a list item.
- Press ENTER.

Totalizers

```
Measurement\Execute command\Totalizers
```

- Select the list item `Totalizers`.
- Press ENTER.

Tab. 46: Scroll list

display	description
`Reset totalizers`	reset the totalizers to zero
`Show +Q`/ `Show -Q`	toggle between the totalizer displays for the positive and negative flow direction
`Freeze display`	display the measured value of the totalizer for several seconds
`Reset error`	reset the totalizer error
`Stop/clear totalizers`	stop and reset the totalizers to zero
`Start totalizers`	start the totalizers

Measuring mode

If the FastFood mode is enabled, it is possible to toggle between it and the TransitTime mode.

`Measurement\Execute command\Measuring mode`

- Select the list item `Measuring mode`.
- Press ENTER.
- Select a list item for the measuring mode.
- Press ENTER.

Taking a snap

`Measurement\Execute command\Take a snap`

- Select the list item `Take a snap`.
- Press ENTER.

A snap is taken.

Reset of the event trigger to idle state

`Measurement\Execute command\Clear alarms`

- Select the list item `Clear alarms`.
- Press ENTER.

This display will only be indicated if an event trigger has been parameterized and at least one event trigger has been triggered.

Sampling

`Measurement\Execute command\Sampling`

- Select the list item `Sampling`.
- Press ENTER.

The sample number and the time of sampling are displayed.

9.8 Stop of measurement

- Press and hold ⮌ to return to the main menu.
- Select the menu `Stop measurement`.
- Press ENTER.
- Select `Yes` to stop the measurement.
- Press ENTER.

The measurement is stopped. The main menu is displayed.

10 Troubleshooting

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ WARNING

Service works by unauthorized and unqualified personnel

This may result in personal or material damage or dangerous situations.

→Any work on the transmitter has to be carried out by authorized and qualified personnel only.

⚠ CAUTION

Safety and accident prevention regulations for electrical systems and equipment

Failure to observe these regulations may lead to severe injuries.

→Observe the safety and accident prevention regulations for electrical systems and equipment.

⚠ WARNING

Touching live parts

Electric shock or arc faults can lead to severe injuries. The measuring equipment can be damaged.

→Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply.

⚠ CAUTION

Touching hot or very cold surfaces

This may result in injuries (e.g., thermal damages).

→Observe the ambient conditions at the measuring point during installation.

→Wear the required personal protective equipment.

→Observe the applicable rules.

If any problem appears which cannot be solved with the help of this operating instruction, contact our sales office and give a precise description of the problem. Specify the type, the serial number and the firmware version of the transmitter.

The display does not work or fails regularly.

- Check the contrast setting of the transmitter or enter the HotCode **555000** to set the display to medium contrast.
- Make sure that the correct voltage is available at the terminals. The destined transmitter voltage is indicated on the nameplate below the outer right terminal strip.
- If the power supply is OK, the transducers or an internal component of the transmitter are defective. The transducers and the transmitter have to be sent to Flexim for repair.
- If the transmitter is only connected via the USB interface, the backlight will be switched off.

An error is displayed in the status indication (symbol ⚠).

- Press and hold ⮌ to return to the main menu.
- Select the menu item `Storage\Event log`.
- Press ENTER.

The error message list will be displayed.

Date and time are wrong, the measured values are deleted when the transmitter is switched off.

- If the date and the time are reset or wrong or the measured values are deleted after the transmitter has been switched off and on again, the data backup battery has to be replaced.

An output does not work.

- Make sure that the outputs are configured correctly. Check the function of the output. If the output is defective, contact Flexim.

10.1 Problems with the measurement

The measurement is impossible because no signal is received. An interrogation point is displayed after the physical quantity. The LED lights up red after starting the measurement.

- Check whether the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound speed of the fluid. Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.
- Make sure that an appropriate measuring point is selected and the number of sound paths was entered correctly.
- Make sure that the recommended transducer distance was set when mounting the transducers.
- Try to establish a better acoustic contact between the pipe and the transducers.
- Reduce the number of sound paths. The signal attenuation might be too high due to a high fluid viscosity or deposits on the inner pipe wall.

The measuring signal is received but no measured values can be obtained.

- If the defined upper limit of the flow velocity is exceeded or the value falls below the lower limit, UNDEF is displayed as well as an exclamation point after the physical quantity. The measured values are marked as invalid. The limit has to be adapted to the measuring conditions.
- If no exclamation point is displayed, a measurement at the selected measuring point is impossible.

The signal is lost during the measurement.

- If there is no measuring signal after the pipe had been run empty and refilled, contact Flexim.
- Wait a moment until the acoustic penetration is reestablished. The measurement can be interrupted due to a temporarily higher proportion of gas bubbles and solids in the fluid.

The measured values substantially differ from the expected values.

- Wrong measured values are often caused by wrong parameters. Make sure that the parameters entered for the measuring point are correct.

10.2 Selection of the measuring point

- Make sure that the recommended minimum distance to any disturbance is observed.
- Avoid measuring points with deposit formation in the pipe.
- Avoid measuring points near deformations and defects on the pipe as well as in the vicinity of welds.
- Make sure the pipe surface at the selected measuring point is even.
- Measure the temperature at the measuring point and make sure that the transducers are suitable for this temperature.
- Make sure that the outer pipe diameter is within the measuring range of the transducers.
- When measuring on a horizontal pipe, the transducers should be mounted laterally to the pipe.
- A vertical pipe always has to be filled at the measuring point.
- The measuring point is not appropriate if gas bubbles can form (even bubble-free fluids can form gas bubbles when the fluid expands, e.g., upstream of pumps and downstream of great cross-section enlargements).

10.3 Maximum acoustic contact

- see section Installation of the transducers [▶ 39]

10.4 Application-specific problems

A fluid with a wrong sound speed was selected.

- If the sound speed of the selected fluid stored in the transmitter does not match the actual one, the recommended transducer distance may not be determined correctly.
- The fluid sound speed is used to calculate the transducer distance and is therefore very important for the positioning of the transducers. The sound speeds stored in the transmitter only serve as an orientation.

The entered pipe roughness is not appropriate.

- Check the entered value considering the pipe condition.

Measurements on pipes made of porous materials (e.g., concrete or cast iron) are possible to only a limited extent.

- Contact Flexim.

The pipe lining may cause problems during the measurement if it is not firmly attached to the inner pipe wall or consists of an acoustically absorbing material.

- Try to measure on a section of the pipe free from lining.

10.5 Significant deviations of the measured values

A fluid with a wrong sound speed was selected.

- If a fluid is selected whose sound speed does not match the actual one, a pipe wall signal can be mistaken for the measuring signal. The flow calculated by the transmitter on the basis of the wrong signal is very small or fluctuates around zero.

The defined upper limit of the flow velocity is too low.

- All measured flow velocities above the upper limit will be ignored and marked as invalid. All quantities deviated from the flow velocity will also be indicated as invalid. If several correct measured values are ignored, the totalizer values will be too low.

The entered cut-off flow is too high.

- All flow velocities below the cut-off flow are set to zero. All derived quantities are also set to zero. To be able to measure at low flow velocities, the cut-off flow has to be set to a low value (default: 2.5 cm/s).

The entered pipe roughness is not appropriate.

The flow velocity of the fluid is outside the measuring range of the transmitter or the transducers.

The measuring point is not appropriate.

- Check whether another measuring point provides better results. Since pipes are never perfectly rotationally symmetric, the flow profile is affected.

10.6 Problems with the totalizers

The values of the totalizers are too low.

- One of the totalizers has reached the upper limit and has to be reset to zero manually.

The sum of the totalizers is not correct.

- The sum of both totalizers (throughput ΣQ) transmitted via an output is no longer valid after one of the totalizers has overflowed for the first time.

An interrogation point is displayed after the value of the totalizer.

- The measurement was temporarily impossible. Therefore, the totalizer value may be incorrect.

11 Maintenance and cleaning

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ WARNING

Service works by unauthorized and unqualified personnel

This may result in personal or material damage or dangerous situations.

→Any work on the transmitter has to be carried out by authorized and qualified personnel only.

⚠ WARNING

Touching live parts

Electric shock or arc faults can lead to severe injuries. The measuring equipment can be damaged.

→Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply.

⚠ CAUTION

Safety and accident prevention regulations for electrical systems and equipment

Failure to observe these regulations may lead to severe injuries.

→Observe the safety and accident prevention regulations for electrical systems and equipment.

⚠ CAUTION

Touching hot or very cold surfaces

This may result in injuries (e.g., thermal damages).

→Observe the ambient conditions at the measuring point during installation.

→Wear the required personal protective equipment.

→Observe the applicable rules.

11.1 Maintenance

The transmitter and the transducers are practically maintenance-free. In order to ensure security, the following maintenance intervals are recommended:

Tab. 47: Recommended maintenance intervals

item	maintenance step	interval	measure
stainless steel housing • transmitter • junction box • transducer mounting fixture	visual inspection for corrosion and damages	annually or more frequently, depending on the ambient conditions	cleaning
	visual inspection for contamination	annually or more frequently, depending on the ambient conditions	
transducers	check of the transducer coupling on the pipe	annually	replacement of coupling foil, if necessary
transmitter	check for firmware updates	annually	update, if necessary
	functional test	annually	reading of measured and diagnostic values
transmitter and transducers	calibration	-	see section Calibration [▶ 144]

11.2 Cleaning

Housing

- Clean the housing with a soft cloth and care and cleaning spray for stainless steel.

Transducers

- Remove traces of coupling compound from the transducers with a soft paper towel.

11.3 Calibration

If the measuring equipment is installed correctly in an appropriate location in accordance with this operating instruction, used conscientiously and maintained carefully, no troubles are to be expected.

The transmitter has been calibrated at factory and, usually, a recalibration is not necessary.

A recalibration is recommended if:

- the contact surfaces of the transducers show visible wear
- the transducers were used for a prolonged period at high temperatures (several months > 130 °C for normal transducers or > 200 °C for high temperature transducers)

For recalibration under reference conditions, either the transmitter, the transducers or both have to be sent to Flexim.

11.4 Firmware update

A firmware update is carried out with FluxDiag or FluxDiag Reader (optional).

- For the connection of the transmitter to a PC see section Service interfaces [▶ 103].

12 Dismounting and disposal

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

⚠ WARNING

Installation, connection and start-up by unauthorized and unqualified personnel

This may result in personal or material damage or dangerous situations.

→Any work on the transmitter has to be carried out by authorized and qualified personnel only.

⚠ WARNING

Touching live parts

Electric shock or arc faults can lead to severe injuries. The measuring equipment can be damaged.

→Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply.

⚠ CAUTION

Safety and accident prevention regulations for electrical systems and equipment

Failure to observe these regulations may lead to severe injuries.

→Observe the safety and accident prevention regulations for electrical systems and equipment.

12.1 Dismounting

Dismounting is carried out in reverse order to the installation.

12.2 Disposal

The measuring equipment has to be disposed of in accordance with the applicable regulations.

Important

Proper disposal of components of the transmitter and accessories that are no longer required avoids environmental damage and conserves resources.

Depending on the material, the components have to be disposed of in residual or special waste or recycled in accordance with the applicable regulations.
Batteries must be disposed of separately from electrical or electronic equipment. For this purpose, remove the batteries from the device and take them to the designated disposal system.
The components are taken back free of charge by Flexim in accordance with national regulations. Contact Flexim.

13 User modes

The user modes allow extended diagnostics of signals and measured values as well as the definition of additional parameters adapted to the application.

The following user modes can be selected:

- StandardUser
- ExpertUser
- SuperUser
- SuperUser ext.

Depending on the selected user mode, different menu items are displayed within the menu Calibration and the menu item Miscellaneous\Special settings:

Tab. 48: Menu items of the user modes

menu item	Standard-User	Expert-User	Super-User	SuperUser ext.	default
menu item Miscellaneous\Special settings					
Start in meas. mode	x	x	x	x	
Pig detection			x	x	Off
Turbulence mode	x	x	x	x	Off
Max. gain		x	x	x	Off
Pipe signal detection		x	x	x	On
menu Calibration					
Cut-off flow	x	x	x	x	On
Flow velocity limit		x	x	x	Off
LWT pipe wall calibr.			x	x	Off
Linear calibration			x	x	Off
Profile correction		x	x	x	On
Weighting factor			x	x	Off
Multi-point calibration (if enabled in Miscellaneous\Measurement\Measurement settings)	x	x	x	x	
list item in the menu item Outputs\...\Source item\Diagnostic values					
Transducer temp.			x	x	
Transd. temp. violat.			x	x	
source item during channel-based parametrization in the menu Outputs					
Extended diagnostics			x	x	
further options in the menu item Miscellaneous\Measurement\Measurement modes\HPI measurement					
Fluid change time base			x	x	

menu item	Standard-User	Expert-User	Super-User	SuperUser ext.	default
Fluid change damping			x	x	
Spec. CTL method			x	x	
Spec. CPL method			x	x	
Flow calib. factor			x	x	

User mode selection

`Miscellaneous\System settings\User mode`

- Select the menu item `User mode`.
- Press ENTER.
- Select a list item.
- Press ENTER.

13.1 StandardUser mode

In the StandardUser mode, all measurements can be carried out for the corresponding application. At the first start-up the transmitter operates in the StandardUser mode.

13.1.1 Start in measuring mode

For some applications it is necessary to start the measurement in a particular measuring mode.

`Miscellaneous\Special settings\Start in meas. mode`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Start in meas. mode` is displayed.

The menu item `Start in meas. mode` will only be displayed if the FastFood mode is enabled.

- Select `TransitTime` or `FastFood` to start the measurement in the corresponding mode.
- Press ENTER.

`Miscellaneous\Special settings\Start in meas. mode\Only ... mode`

- Select `Yes` to keep always the same the measuring mode. Select `No` to be able to select another measuring mode by pressing [0] during the measurement.

13.1.2 Turbulence mode

In the presence of high turbulence, i.e., high Reynolds numbers or disturbed flow profiles due to short inlet and outlet lengths, there are large fluctuations in the transit time of the ultrasonic signals, resulting in poor signal quality (e.g., reduction in signal amplitude, increase in gain). An unstable measurement with frequent signal losses and VariAmp > 5% indicate strong turbulence. It can be helpful here to activate the turbulence mode.

Requirements for a measurement with activated turbulence mode

- The SNR has to be > 15 dB with deactivated turbulence mode.
- The signal gain with activated turbulence mode is min. 3 dB below that with deactivated turbulence mode. For this purpose, the signal gain must be measured in each case at flow velocities at the operating point where strong turbulence is suspected.

If these criteria are fulfilled, the specified measurement uncertainty can also be met with activated turbulence mode.

If they are not fulfilled, the measurement with deactivated turbulence mode is to be preferred.

`Miscellaneous\Special settings\Turbulence mode`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Turbulence mode` is displayed.
- Select `On` to activate the turbulence mode. Select `Off` to deactivate it. Select `Default` to use the default value.
- Press ENTER.

13.1.3 Cut-off flow

The cut-off flow is a lower limit for the flow velocity. All measured flow velocities below this limit are set to zero.

The cut-off flow can depend on the flow direction.

`Calibration\Cut-off flow`

- Select the menu item `Calibration\Cut-off flow`.
- Press ENTER.
- Select `Off` if no value is to be entered for the cut-off flow. Select `Default` if the default values of ± 25 mm/s are to be used. Select `Customized` to define the values of the cut-off flow for the positive and negative flow direction.
- Press ENTER.

`Calibration\Cut-off flow\Customized\+Cut-off flow`

All values of the flow velocity for the positive flow direction below this limit are set to zero.

- Enter the cut-off flow.
- Press ENTER.

`Calibration\Cut-off flow\Customized\-Cut-off flow`

All (absolute) values of the flow velocity for the negative flow direction below this limit are set to zero.

- Enter the cut-off flow as absolute value.
- Press ENTER.

13.1.4 Multi-point calibration

It is possible to enter a series of measured values in order to define a calibration curve for the flow velocity.

Record of a series of measured values:

- Start a measurement with the transmitter and a reference flowmeter.
- Gradually increase the value of the flow velocity. The measuring range has to be identical with the eventual operating range.
- Note or store the measured values.

Input of a series of measured values:

- Activate the multi-point calibration in the menu item `Miscellaneous\Measurement\Measurement settings`.
- Select the menu item `Calibration\Multi-point calibration`.
- Press ENTER.

```
Calibration\Multi-point calibration
```

- Select `Yes` to define the calibration curve. Select `No` to measure without calibration.
- Press ENTER.

```
Calibration\Multi-point calibration\Calibration points
```

- Enter the number of pairs of measured values.
- Press ENTER.

```
Calibration\Multi-point calibration\Point x=act. value
```

- Enter the value measured by the transmitter.
- Press ENTER.

```
Calibration\Multi-point calibration\Point x=set value
```

- Enter the value measured by the reference flowmeter.
- Press ENTER.
- Repeat the input for all pairs of measured values.
- Press ENTER after each input.

```
Calibration\Multi-point calibration\Bidirectional use
```

- Select `Yes` to apply the calibration curve for negative flow velocities as well. Select `No` if it is not to be used for negative flow velocities.

13.2 ExpertUser mode

Some menu items that are not visible in the StandardUser mode are displayed.

NOTICE

The ExpertUser mode is intended for experienced users with advanced application knowledge. Changed parameters can affect the StandardUser mode and lead to wrong measured values or to a measurement failure when setting up a new measuring point.

NOTICE

Some of the defined parameters remain activated when switching to the StandardUser mode. These parameters are displayed but cannot be changed.

13.2.1 Profile correction

It is possible to select the following versions for the calculation of the fluid mechanic calibration factor k_{Re}:

- `kRe 1.0`: profile correction (previous version)
- `kRe 2.0`: improved profile correction (current version)
- `kRe 2.0 disturb. corr.`: improved profile correction at non ideal inflow conditions for the positive flow direction (negative flow direction without disturbance correction, default)
- `kRe 2.0 dist.corr.bidir.`: improved profile correction at non ideal inflow conditions for the positive and negative flow direction (automatic toggling of the profile correction depending on the flow direction)

The following steps are necessary to set the profile correction:

- selection of the profile correction version in the menu `Miscellaneous`

If `kRe 2.0 disturb. corr.` or `kRe 2.0 dist.corr.bidir.` is selected:

- selection of the disturbance in the menu `Parameters`
- input of the disturbance distance in the menu `Parameters`

The disturbance distance has to be measured from the end of the respective disturbance (see Tab. 2: Recommended distance from disturbances [▶ 24]).

NOTICE

If `kRe 2.0 disturb. corr.` or `kRe 2.0 dist.corr.bidir.` has been selected, the transducers have to be mounted in reflection arrangement, X arrangement or displaced X arrangement to compensate cross-flow effects.

Selection of the version

`Miscellaneous\Measurement\Measurement settings\Profile correction`

- Select the menu item `Miscellaneous\Measurement\Measurement settings`.
- Press ENTER until the menu item `Profile correction` is displayed.
- Select a list item (default: `kRe 2.0 disturb. corr.`).
- Press ENTER.

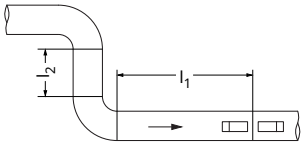
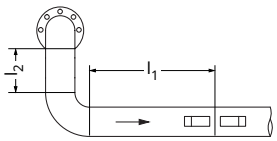
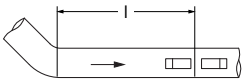
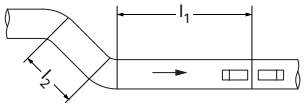
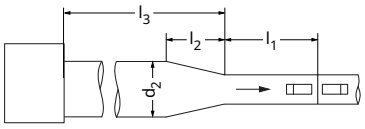
Selection of the disturbance

`Parameters\Disturbance type`

- Select a list item.
- Press ENTER.

If `kRe 2.0 disturb. corr.` or `kRe 2.0 dist.corr.bidir.` is selected, the disturbance parameters have to be entered.

Tab. 49: Disturbance parameters

disturbance	parameter	description
90° elbow	Disturbance distance (l)	
90° double elbow	Disturbance distance (l_1) Dist. between elbows (l_2)	
90° doub.elb. out of plane	Disturbance distance (l_1) Dist. between elbows (l_2)	
45° elbow	Disturbance distance (l)	
45° double elbow	Disturbance distance (l_1) Dist. between elbows (l_2)	
Reducer	Disturbance distance (l_1) Reducer length (l_2) Inlet outer diameter (d_2) in case of a reducer with additional upstream disturbance also the following: Add. disturb. distance (l_3) Add. upstream disturb. (e.g., 90° elbow) parameters of the additional upstream disturbance	

13.2.2 Maximum signal gain

In order to prevent noise and/or pipe wall signals (e.g., if the pipe has run empty) from being interpreted as useful signals, it is possible to define a max. signal gain.

If the signal gain is above the max. signal gain:

- the physical quantity cannot be determined and the measured value is marked as invalid
- a hash sign is displayed after the unit of measurement (in case of a normal error, an interrogation point is displayed)

`Miscellaneous\Special settings\Max. gain`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Max. gain` is displayed.
- Select `Off` to measure without signal gain limit. Select `Default` if the default value is to be used. Select `Customized` to define a value for the max. signal gain.
- Press ENTER.
- Enter a value for the max. signal gain.
- Press ENTER.

13.2.3 Pipe signal detection

When evaluating the plausibility of the signal, it is checked whether the sound speed is within a defined range. The absolute threshold of the fluid sound speed used for this purpose is the greater of the following values:

- absolute threshold, default: 1848 m/s
- value of the sound speed curve of the fluid at the operating point plus relative threshold, default relative threshold: 200 m/s

`Miscellaneous\Special settings\Pipe signal detection`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Pipe signal detection` is displayed.
- Select `Off` to measure without pipe signal detection. Select `Default` if the default values are to be used. Select `Customized` to define the values of the pipe signal detection.
- Press ENTER.

`Miscellaneous\Absolute threshold`

- Enter the value of the absolute threshold.
- Press ENTER.

`Miscellaneous\Relative threshold`

- Enter the value of the relative threshold.
- Press ENTER.

Example

absolute threshold: 2007 m/s

relative threshold: 600 m/s

value of the sound speed curve at the measuring point: 1546 m/s

As 1546 m/s + 600 m/s = 2146 m/s is above the absolute value of 2007 m/s, this value will be used as the absolute threshold of the sound speed when evaluating the plausibility of the signal.

13.2.4 Limit of the flow velocity

In heavily disturbed environments, the measured values of the flow velocity may have individual outliers. If these outliers are not ignored, they will affect all derived physical quantities, which will then be unsuitable for integration (e.g., pulse outputs).

In the ExpertUser mode it is possible to enter a limit for the flow velocity.

It is possible to ignore all measured flow velocities above or below the preset limit. In this case an error will be output.

`Calibration\Flow velocity limit`

- Select the menu item `Calibration\Flow velocity limit`.
- Press ENTER.
- Select `Off` if no limit is to be entered for the flow velocity. Select `Default` if the default value is to be used. Select `Customized` to define a limit for the flow velocity.
- Press ENTER.

`Calibration\+Flow velocity limit`

- Enter a flow velocity limit for the measurement in flow direction.
- Press ENTER.

If the flow velocity is above this limit, it will be marked as invalid. The physical quantity cannot be determined. UNDEF will be displayed.

`Calibration\-Flow velocity limit`

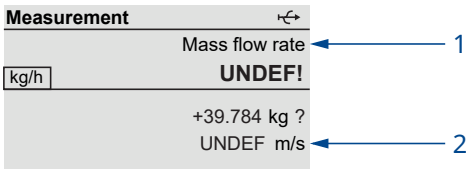
- Enter a flow velocity limit for the measurement against the flow direction.
- Press ENTER.

If the flow velocity is below this limit, it will be marked as invalid. The physical quantity cannot be determined. UNDEF will be displayed.

NOTICE

If the limit of the flow velocity `+Flow velocity limit` is too low or `-Flow velocity limit` is too high, a measurement might be impossible because most of the measured values will be marked as invalid.

Fig. 118: Flow velocity outside the valid range



1 physical quantity **2 flow velocity**

13.2.5 Measuring point specific profile correction

In special cases a measuring point specific profile correction can be used.

`Calibration\Profile correction`

- Select the menu item `Calibration\Profile correction`.
- Press ENTER.
- Select `Off` to deactivate the profile correction. Select `Default` to use the global setting from the menu item `Miscellaneous\Measurement settings\Profile correction` for the profile correction. Select `Customized` to use a measuring point specific profile correction.
- Press ENTER.

In case the list item `Customized` has been selected, the parameters of the measuring point specific profile correction will now be displayed. The parameters of the profile correction are preferably to be sent to the transmitter via the service interface, but can also be entered here.

13.3 SuperUser and SuperUser ext. mode

Some menu items that are not visible in the StandardUser or ExpertUser mode are now displayed.

In the SuperUser ext. mode the plausibility of the entered parameters is not checked.

NOTICE

The SuperUser and the SuperUser ext. mode are intended for experienced users with advanced application knowledge.
Changed parameters can affect the StandardUser mode and lead to wrong measured values or to a measurement failure when setting up a new measuring point.

NOTICE

Some of the defined parameters remain activated when switching to the StandardUser mode. These parameters are displayed but cannot be changed.

13.3.1 Pig detection

This function detects pigs inside the pipe. The pig detection can be activated/deactivated via the HotCode **007028** (default: deactivated).

13.3.2 Pipe wall calibration for Lamb wave transducers

For Lamb wave transducers, the parameter record of a measuring channel contains a calibration factor for the uncorrected flow velocity. This calibration factor depends on the pipe material.

The pipe wall calibration for Lamb wave transducers becomes effective if the following criteria are met when starting a measurement:

- Lamb wave transducers are used
- pipe wall calibration is activated
- a factor is defined for the pipe material selected in the menu `Parameters`

The factor can be activated in the transmitter.

`Calibration\LWT pipe wall calibr.`

- Select the menu item `Calibration\LWT pipe wall calibr.`.
- Press ENTER.
- Select `Off` to measure without pipe wall calibration. Select `Default` if the default values are to be used. Select `On` to define the values for the pipe wall calibration.
- Press ENTER.

13.3.3 Linear calibration

It is possible to define a correction of the flow velocity:

$v_{cor} = m \cdot v + n$

where

v	–	measured flow velocity
m	–	factor, range: -2...+2
n	–	offset, range: -12...+12 cm/s
v_{cor}	–	corrected flow velocity

All quantities derived from the flow velocity will then be calculated with the corrected flow velocity.

NOTICE

It will not be displayed during the measurement that the correction of the flow velocity is activated.

`Calibration\Linear calibration`

- Select the menu item `Calibration\Linear calibration`.
- Press ENTER.
- Select `Off` to measure without linear calibration. Select `Default` if the default values are to be used. Select `On` to define the values for the calibration.
- Press ENTER.

`Calibration\Factor`

- Enter the factor for the linear calibration.
- Press ENTER.

`Calibration\Offset`

- Enter the offset for the linear calibration.
- Press ENTER.

Example

factor: 1.1

offset: -10 cm/s = -0.1 m/s

If a flow velocity v = 5 m/s is measured, it will be corrected as follows before the calculation of derived quantities:

$v_{cor} = 1.1 \cdot 5 \text{ m/s} - 0.1 \text{ m/s} = 5.4 \text{ m/s}$

Example

factor: -1

offset: 0

Only the sign of the measured values changes.

13.3.4 Weighting factor

The weighting factor is used for transducers installed on the same pipe in order to compensate differences between the flow velocity values measured on different measuring channels.

The differences can be caused by profile deformations or cross-flows. These influences are reduced by averaging the measured values of several channels. However, if a measuring channel temporarily fails, the average will change abruptly. In order to avoid these changes, all measuring channels have to be adjusted with the weighting factor.

The weighting factor for the measuring channel x results from the flow velocity v_x measured on measuring channel x and the average flow velocity of all measuring channels v_m:

$$w_x = \frac{v_m}{v_x}$$

The weighting factor can be activated in the transmitter.

This display will not be indicated if the list item `1 meas. point (A)` is selected in the menu item `Parameters\Measuring point config.`.

```
Calibration\Weighting factor
```

- Select the menu item `Calibration\Weighting factor`.
- Press ENTER.
- Select `Off` to measure without weighting factor. Select `Default` if the default value is to be used. Select `On` to define the weighting factor.
- Press ENTER.

13.3.5 Transducer temperature and transducer temperature violation as diagnostic values

When configuring outputs, the list items `Transducer temp.` and `Transd. temp. violat.` are available in the menu item `Diagnostic values`. The diagnostic values can either be transmitted via the outputs of the transmitter or defined as source of the event triggers.

```
Outputs\...\Source item
```

- Select `Diagnostic values` as source item.
- Press ENTER.
- Select a list item for the quantity to be output.
- Press ENTER.

Tab. 50: Source item "Diagnostic values"

source item	list item	output
`Diagnostic values`	`Transducer temp.`	average temperature of both transducers
	`Transd. temp. violat.`	status information: yes/no

13.3.6 Activation of measuring channels

`Installation\Select channels`

The measuring channels can be activated and deactivated.

☑ measuring channel activated

☐ measuring channel deactivated

This display will not be indicated if the transmitter has only 1 measuring channel or if the list item `1 meas. point (A)` is selected in the menu item `Parameters\Measuring point config.`.

- Select a measuring channel with 4 or 6.
- Press 2 or 8 to activate or deactivate the measuring channel.

13.3.7 Channel-based parametrization

`Parameters\Measuring point config.\Channel-based param.`

- Select the list item `Channel-based param.` in the menu item `Parameters\Measuring point config.`.
- Press ENTER.
- Select the measuring channel the parameters are to be entered for.
- Press ENTER.

For the description of further inputs see section Input of parameters [▶ 113].

The parameters have to be entered separately for each measuring channel.

13.3.8 Calculation channels

In addition to the ultrasonic measuring channels, the transmitter has 2 virtual calculation channels Y and Z which calculate the measured values of all measuring channels.

The result of the defined calculation function is the measured value of the selected calculation channel. This measured value is equivalent to the measured values of a measuring channel. All operations which are possible with the measured values of a measuring channel (totalizing, storing, output, etc.) can also be done with the measured values of a calculation channel.

13.3.8.1 Characteristics of the calculation channels

The measuring channels to be used for calculation and the calculation function have to be entered in the menu `Parameters`.

It is possible to define 2 cut-off flows for each calculation channel. The cut-off flow is not based on the flow velocity as is the case with the measuring channels. Instead, it is defined in the unit of measurement of the physical quantity selected for the calculation channel. During the measurement, the calculation values are compared with the cut-off values and set to zero, if necessary.

13.3.8.2 Parametrization of a calculation channel

`Parameters\Measuring point config.\Channel-based param.\Channel Y`

- Select the list item `Channel-based param.` in the menu item `Parameters\Measuring point config.`.
- Press ENTER.
- Select a calculation channel (here: `Channel Y`).
- Press ENTER.

The current calculation function is displayed.

- Press ENTER.

Selection of the calculation type

Tab. 51: Calculation types

`Average (all chan. OK)`	`Average (1 chan. OK)`
average with "AND" All measuring channels have to deliver a valid measured value.	average with "OR" At least one measuring channel has to deliver a valid measured value.
calculation function: `Y = (A + B + C + D)/4`	calculation function: `Y = (A + B + C + D)/n`

`Parameters\Measuring point config.\Channel-based param.`
`\Channel Y\Calculation type`

- Select a calculation type.
- Press ENTER.

Input of limits

It is possible to define limits for the physical quantity of each calculation channel. They are entered in the unit of measurement of the physical quantity selected for the calculation channel.

`Parameters\...\Calculation type\+Upper limit`

- Select `No limit` if the calculation channel has to output all positive values without upper limit. Select `Set to limit` if the calculation channel has to output the limit when exceeding the upper limit. Select `Set to error` if the calculation channel has to output an error (`UNDEF`) when exceeding the upper limit.
- Press ENTER.

`Parameters\...\Calculation type\-Upper limit`

- Select `No limit` if the calculation channel has to output all negative values without upper limit. Select `Set to limit` if the calculation channel has to output the limit when falling below the upper limit. Select `Set to error` if the calculation channel has to output an error (`UNDEF`) when falling below the upper limit.
- Press ENTER.

It is possible to define 2 cut-off flows for each calculation channel. They are entered in the unit of measurement of the physical quantity selected for the calculation channel.

`Parameters\...\Calculation type\+Cut-off flow`

- Enter a value for the positive cut-off flow.
- Press ENTER.

All positive calculated values below the limit are set to zero.

`Parameters\...\Calculation type\-Cut-off flow`

- Enter a value for the negative cut-off flow as absolute value.
- Press ENTER.

All negative calculated values with absolute values below the limit are set to zero.

13.3.8.3 Measurement with calculation channels

- Select the menu `Installation`.
- Press ENTER.

`Installation\Select channels`

- Activate the necessary channels. Calculation channels are activated or deactivated in the same way as measuring channels.
- Press ENTER.

NOTICE

If a measuring channel that is needed for an activated calculation channel is deactivated, this measuring channel will not be considered for calculation.

13.3.8.4 Extended diagnostics

The extended diagnostics serves to detect errors on the individual measuring channels. The values of the extended diagnostics can either be transmitted via the outputs of the transmitter or defined as source of the event triggers.

Assignment of an output

- Select the menu `Outputs`.
- Press ENTER.

`Outputs\Current I1(-)`

- Select the output to be assigned to the calculation channel (here: `Current I1(-)`).
- Press ENTER.

The scroll list contains all available outputs of the transmitter.

If the output has already been assigned to a channel, it is displayed as follows: `Current I1 (Y)`.

`Outputs\Current I1\Enable I1`

- Select `Yes` to change the settings for an already assigned output or to assign a new one. Select `No` to cancel the assignment and to return to the previous menu item.
- Press ENTER.

Selection of the calculation channel

`Outputs\Channel Y`

- Select the calculation channel (here: `Channel Y`).
- Press ENTER.

Assignment of a source item

A source item has to be assigned to each selected output.

`Outputs\Channel Y\...\Source item`

- Select `Extended diagnostics` as source item.
- Press ENTER.
- Select the list item for the quantity to be output.
- Press ENTER.

Tab. 52: Source item "Extended diagnostics"

source item	list item	output
`Extended diagnostics`	`Valid channels`	percentage of physical channels with valid measuring status
	`σ(Sound speed)`	standard deviation of sound speed
	`σ(Flow velocity)`	standard deviation of flow velocity
	`σ(Gain)`	standard deviation of signal gain
	`σ(Amplitude)`	standard deviation of signal amplitude
	`σ(Quality)`	standard deviation of signal quality
	`σ(SNR)`	standard deviation of SNR
	`σ(SCNR)`	standard deviation of SCNR
	`σ(VariAmp)`	standard deviation of amplitude variation
	`σ(VariTime)`	standard deviation of transit time variation

The list item `Valid channels` will not be displayed if a binary output was selected as output.

The status of a standard deviation is OK if a measured value for calculation is available on at least 2 measuring channels.

If the measurement is running with 2 measuring channels at the measuring point, the path difference and not the standard deviation is calculated.

Definition of an event trigger

`Functions\Channel Y`

- In the menu `Functions`, select a calculation channel (here: `Channel Y`) to enable an event trigger for.
- Press ENTER.
- Select the menu item `Event trigger`.
- Press ENTER.

`Functions\Channel Y\Event trigger\Rx(-)`

- Select the event trigger.

If the event trigger has already been enabled, it is displayed as follows: `R1(+)`.

`Functions\Channel Y\Event trigger\Enable Rx`

- Select `Yes` to change the settings for an already assigned event trigger or to assign a new one.
- Select `No` to cancel the assignment and to return to the previous menu item.
- Press ENTER.

`Functions\Channel Y\Event trigger\Enable Rx\Source item`

- Select the source item `Extended diagnostics`.
- Press ENTER.
- Select the list item to define a condition for.
- Press ENTER.

14 Outputs

If the transmitter is equipped with outputs, they have to be configured. For the configuration of an analog output see section Configuration of an output [▶ 120].

The transmitter can also be equipped with digital outputs:

- binary output (output of binary switching states)
- pulse output (integrating output of quantities)
- frequency output (scaled output of flow quantities)

The function of a digital output is determined by the selected physical quantity.

Tab. 53: Output via digital outputs

	source item	binary output		pulse output	frequency output
		status value	event value		
physical quantities	Sound speed	x			x
	Flow quantities	x			x
	Totalizers	x			x
	Pulse			x	
	Fluid properties	x			x
	Diagnostic values	x			x
	Miscellaneous	x			x
events	Event trigger		x		

14.1 Configuration of a digital output as binary output

A binary output switches if one of the following switching conditions is met:

- the measured value exceeds or falls below a limit
- the measured value lays within or outside a defined range
- a measurement is not possible
- an event occurs

Enabling the output

The output has to be enabled before use.

```
Outputs\Digital output B1(-)
```

- Select the menu item Outputs\Digital output B1(-).
- Press ENTER.

If the output has already been enabled, it is displayed as follows: Digital output B1 (√).

```
Outputs\Digital output B1\Enable B1
```

- Select Yes to enable the output or to change the settings.
- Select No to cancel the enabling and to return to the previous menu item.
- Press ENTER.

Assignment of a source item

A source item has to be assigned to each selected output.

`Outputs\Source item`

Tab. 54: Output of status values or event values

	source item	status value	event value
physical quantities	`Flow quantities`	x	
	`Fluid properties`	x	
	`Miscellaneous`	x	
	`Sound speed`	x	
	`Totalizers`	x	
events	`Event trigger`		x

- Select the source item.
- Press ENTER.
- Select the list item `Status`.
- Press ENTER.

If `Event trigger` is selected as source item, `Idle state` will be displayed as property of the binary output.

14.1.1 Definition of the switching function for the status/ event value

- Select the switching function for the output of the status/event value.
- Press ENTER.

Tab. 55: Selection of the switching condition

property	switching function	description
`Status OK` (status value)	`NC`	• valid measured value: binary output is closed • invalid measured value: binary output is open
	`NO`	• valid measured value: binary output is open • invalid measured value: binary output is closed
`Idle state` (event value)	`NO`	• event occurs: binary output is closed • event has not occurred yet: binary output is open
	`NC`	• event occurs: binary output is open • event has not occurred yet: binary output is closed

If no measurement is running, all binary outputs are open (de-energized), regardless of the set switching condition.

Terminal assignment

`Outputs\Digital output B1\...\Output info`

The terminals for the connection of the output are displayed.

By pressing 2 or 8 further information is displayed.

- Press ENTER.

Output function test

The function of the output can now be tested.

- Connect a multimeter to the output.

`Outputs\...\B1 Test signal`

- Select `Yes` to test the output. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\B1 Enter test value`

- Select a list item as test value.
- Press ENTER.

Tab. 56: Output function test – signal

list item	description
`NC`	• binary output is energized • measured value has to be low ohmic
`NO`	• binary output is de-energized • measured value has to be high ohmic

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

`Outputs\...\B1 Test measuring range`

- Select `Yes` to test the status of the output signal. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\B1 Enter test value`

- Select a list item as test value.
- Press ENTER.

Tab. 57: Output function test – measuring range

list item	switching function	test value	description
`Status OK` (status value)	`NC`	`Status OK`	• binary output is energized • measured value has to be low ohmic
		`Status error`	• binary output is de-energized • measured value has to be high ohmic
	`NO`	`Status OK`	• binary output is de-energized • measured value has to be high ohmic
		`Status error`	• binary output is energized • measured value has to be low ohmic
`Idle state` (event value)	`NC`	`Passive`	• binary output is energized • measured value has to be low ohmic
		`Active`	• binary output is de-energized • measured value has to be high ohmic
	`NO`	`Passive`	• binary output is de-energized • measured value has to be high ohmic
		`Active`	• binary output is energized • measured value has to be low ohmic

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

14.2 Configuration of a digital output as pulse output

A pulse output is an integrating output which emits a pulse when the volume or the mass of the fluid which has passed the measuring point reaches a certain value (pulse value).

The integrated quantity is the selected physical quantity. The integration restarts as soon as the pulse is emitted. The digital output has to be configured before activation.

`Outputs\Digital output B1\Source item`

- Select the menu item `Outputs\Digital output B1\Source item`.
- Press ENTER.

Assignment of a source item

`Outputs\Source item\Pulse`

- Select `Pulse` as source item.
- Press ENTER.

`Outputs\Pulse\Pulse +V`

- Select a list item (here: `Pulse +V`).
- Press ENTER.

Tab. 58: Selection of the physical quantity

source item	list item	output
`Pulse`	`Pulse |V|`	pulse without considering the sign of the volumetric flow rate
	`Pulse +V`	pulse for positive measured values of the volumetric flow rate
	`Pulse -V`	pulse for negative measured values of the volumetric flow rate
	`Pulse |m|`	pulse without considering the sign of the mass flow rate
	`Pulse +m`	pulse for the positive measured values of the mass flow rate
	`Pulse -m`	pulse for the negative measured values of the mas flow rate

14.2.1 Pulse output by defining the pulse value

`Outputs\Pulse output`

- Select the list item `Pulse value`.
- Press ENTER.

Tab. 59: Pulse output modes

mode	description
`Continuous pulses`	• output of a continuous pulse sequence, reproducing the temporal behavior of the corresponding flow quantity (volumetric flow rate, mass flow rate), with simultaneous totalizing • smallest interpulse period = pulse width at max. pulse rate (pulse width is constant)
`Burst pulses`	• output of a discontinuous pulse sequence, reproducing the behavior of the totalizer • several pulses can occur intermittently with equidistant pulse intervals (interpulse period = pulse width) • serves exclusively for totalizing • max. pulse rate (depends on the pulse width that is constant)

- Select a list item.
- Press ENTER.

`Outputs\Pulse value`

- Enter the pulse value.

The unit of measurement will be displayed according to the actual physical quantity.

When the counted physical quantity reaches the entered pulse value, a pulse will be transmitted.

- Press ENTER.

`Outputs\Pulse width`

- Enter the pulse width.

The range of possible pulse widths depends on the specification of the instrument (e.g., counter, PLC) that is to be connected to the output.

- Press ENTER.

14.2.2 Pulse output by defining pulses per unit

`Outputs\Pulse output`

- Select the list item `Pulses per unit`.
- Press ENTER.

`Outputs\Output range`

- Select a list item:
  - `0...1 kHz`
  - `0...5 kHz`
  - `Other range`
- Press ENTER.

If `Other range` is selected, enter a value for `Output MAX`.

`Outputs\Pulses per unit`

- Enter the number of pulses per unit.
- Press ENTER.

The unit of measurement will be displayed according to the actual physical quantity.

14.2.3 Output options

`Outputs\Idle state`

- Select the setting of the idle state:

Tab. 60: Idle state settings

setting	description
`NO`	The pulse output is energized if a pulse is emitted and de-energized if no pulse is emitted (idle state).
`NC`	The pulse output is de-energized if a pulse is emitted and energized if no pulse is emitted (idle state).

If no measurement is running, all pulse outputs are open (de-energized), regardless of the set switching condition.

Terminal assignment

`Outputs\...\Output info`

The terminals for the connection of the output are displayed.

By pressing 2 or 8 further information is displayed.

- Press ENTER.

Output function test

`Outputs\...\B1 Test signal`

- Select `Yes` to test the status of the output signal. Select `No` to display the next menu item.
- Press ENTER.

`Outputs\...\B1 Enter test value`

- Select a list item as test value.
- Press ENTER.

Tab. 61: Output function test – signal

output mode	test value	description
`Pulses per unit`	The entered test value has to be within the output range.	If the external measuring instrument displays the entered value, the output functions correctly.
`Pulse value`	`NO`	• pulse output is de-energized • measured value has to be high ohmic
	`NC`	• pulse output is energized • measured value has to be low ohmic

14.3 Configuration of a digital output as frequency output

The frequency output emits a square wave signal with a frequency which is proportional to the measured value of the source item sent to the output.

`Outputs\Digital output B1\Source item`

- Select the menu item `Outputs\Digital output B1\Source item`.
- Press ENTER.

Assignment of a source item

- Select one of the following source items:
  - `Flow quantities`
  - `Totalizers`
  - `Fluid properties`
  - `Diagnostic values`
  - `Miscellaneous`
  - `Sound speed`

`Outputs\Flow quantities`

- Select a list item (here: `Flow quantities`).
- Press ENTER.

`Outputs\Volumetric flow rate`

- Select a list item (here: `Volumetric flow rate`).
- Press ENTER.
- Select the list item `Values`.
- Press ENTER.

Output range

`Outputs\...\Output range`

- Select a list item.
  - `0...1 kHz`
  - `0...10 kHz`
  - `Other range`
- Press ENTER.

If `Other range` is selected, enter the values `Output MIN` and `Output MAX`.

Error output

`Outputs\...\Error value`

An error value can be defined which is output if the source item cannot be measured.

- Select a list item for the error output.
- Press ENTER.

Measuring range

The sign of the measured value and the measuring range are determined.

`Outputs\...\Measured values\Absolute value`

- Select `Sign` if the sign of the measured values is to be considered for the output.
- Select `Absolute value` if the sign of the measured values is not to be considered for the output.

`Outputs\...\Start of meas. range`

- Enter the lowest expected measured value. The unit of measurement of the source item will be displayed.

`Start of meas. range` is the value assigned to the value `Output MIN` of the output range.

`Outputs\...\End of meas. range`

- Enter the highest expected measured value. The unit of measurement of the source item will be displayed.

`End of meas. range` is the value assigned to the value `Output MAX` of the output range.

Idle state

The idle state is the status of the output signal to be output when no measured value is measured.

- Select a list item for the idle state.
- Press ENTER.

Terminal assignment

```
Outputs\...\Output info
```

The terminals for the connection of the output are displayed.

By pressing 2 or 8 further information is displayed.

- Press ENTER.

Output function test

The function of the output can now be tested.

- Connect an external measuring instrument to the terminals of the installed output.

```
Outputs\...\Test signal
```

- Select `Yes` to test the output. Select `No` to display the next menu item.
- Press ENTER.

```
Outputs\...\Enter test value
```

- Enter a test value. It has to be within the output range.
- Press ENTER.

If the external measuring instrument displays the entered value, the output functions correctly.

- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

```
Outputs\...\Test measuring range
```

- Select `Yes` to test the assignment of the measured value to the output signal. Select `No` to display the next menu item.
- Press ENTER.

```
Outputs\...\Enter test value
```

- Enter a test value. It has to be within the output range.
- Press ENTER.

If the external measuring instrument displays the entered value, the output functions correctly.

- Select `Repeat` to repeat the test. Select `Finish` to finish it.
- Press ENTER.

15 Inputs

15.1 Configuration of an input

If the transmitter is equipped with inputs, they have to be configured.

- Select the menu item `Inputs\Configure inputs`.
- Press ENTER.

```
Inputs\Configure inputs
```

- Select the input to be configured.
- Press ENTER.

The scroll list contains all available inputs.

- `Current Ix (-)`
- `Temperature Tx (-)`

If the input has already been configured, it is displayed as follows: `Current I1 (√)`.

Enabling the input

To use the input, it has to be enabled (here: `Current I1`).

```
Inputs\Configure inputs\Current I1\Enable I1
```

- Select `Yes` to enable an input or change the settings for an already enabled input.
- Select `No` to block an already configured input and to return to the previous menu item.
- Press ENTER.

15.1.1 Current inputs

When configuring the current inputs, the source item can be selected and the input and measuring range is defined.

Selection of the source item

```
Inputs\...\Source item
```

- Select the source item.

Input range

```
Inputs\...\Input range
```

- Select a list item:
  - `0...20 mA`
  - `4...20 mA`
  - `Other range`
- Press ENTER.

If `Other range` is selected, enter the values `Input MIN` and `Input MAX`.

Measuring range

```
Inputs\...\Start of meas. range
```

- Enter the lowest expected measured value. The unit of measurement of the source item will be displayed.

`Start of meas. range` is the measured value assigned to the lower limit of the input range (`Input MIN`).

`Inputs\...\End of meas. range`

- Enter the highest expected measured value. The unit of measurement of the source item will be displayed.

`End of meas. range` is the measured value assigned to the upper limit of the input range (`Input MAX`).

Input of an error value

`Inputs\...\Error value`

It is possible to define an error value which is output if the source item is not available.

- Select `Yes` if an error value is to be defined.
- Press ENTER.
- Enter the error value.
- Press ENTER.

Input mode

`Inputs\...\Input mode`

It is determined whether the current inputs are switched to active or passive.

- Select a list item.
- Press ENTER.

15.1.2 Temperature inputs

When configuring a temperature input, the temperature probe can now be selected.

Selection of the temperature probe

`Inputs\Configure inputs\Temperature Tx\Pt100/Pt1000`

- Select the temperature probe:
  - Pt100
  - Pt1000

Activation of the temperature correction

A temperature correction (offset) can be set for each temperature input. This function is activated in the menu item `Miscellaneous\Dialogs/Menus\Tx temperature offset`.

`Miscellaneous\Dialogs/Menus\Tx temperature offset`

- Select the menu item `Miscellaneous\Dialogs/Menus`.
- Press ENTER until the menu item `Tx temperature offset` is displayed.
- Select `Yes` to activate the temperature correction. Select `No` to deactivate it.
- Press ENTER.

NOTICE

The entered correction value for each temperature input will be stored and displayed when the temperature correction is activated again.

The correction value is automatically added to the measured temperature. It is used e.g., if the characteristic curves of the two temperature probes differ considerably from each other or a known and constant temperature gradient exists between the measured temperature and the actual temperature.

Input of the temperature correction

`Inputs\Temperature offset`

- Select `Yes` to enter an offset for the temperature input.
- Press ENTER.
- Enter the offset for the temperature input.
- Press ENTER.

15.1.3 Definition of a switching condition

If a transmitter function is to be remote-controlled, a switching condition has to be defined.

`Inputs\...\Trigger value`

- Select `Yes` to define a switching condition. Select `No` to display the next menu item.
- Press ENTER.

`Inputs\...\Function`

- Select a list item:
  - `MAX (x>limit)`: the switching condition is met when the measured value exceeds the limit
  - `MIN (x<limit)`: the switching condition is met when the measured value falls below the limit
  - `ERR (x=fail)`: the switching condition is met when a measurement is not possible
  - `Within range`: the switching condition is met when the measured value is within the defined range
  - `Out of range`: the switching condition is met when the measured value is outside the defined range
- Press ENTER.

`Inputs\...\Trigger value`

- Enter the limit for the switching condition.
- Press ENTER.

This display will only be indicated if `MAX (x>limit)` or `MIN (x<limit)` is selected.

`Inputs\...\Hysteresis`

It is possible to define a hysteresis to avoid constant switching of the event trigger.

The event trigger is activated when the measured value exceeds the upper limit and deactivated when it falls below the lower limit.

- Enter a value for the hysteresis.

If zero is entered, no hysteresis is used.

- Press ENTER.

This display will only be indicated if `MAX (x>limit)` or `MIN (x<limit)` is selected.

`Inputs\...\Range center`

- Enter the center of the switching range.
- Press ENTER.

This display will only be indicated if `Within range` or `Out of range` is selected.

`Inputs\...\Range width`

- Enter the width of the switching range.
- Press ENTER.

This display will only be indicated if `Within range` or `Out of range` is selected.

`Inputs\...\Glitch interval`

- Enter a time interval at the end of which the event trigger has to switch.
- Press ENTER.

15.1.4 Terminal assignment

`Inputs\...\Input info`

The terminals for the connection of the input are displayed.

By pressing 2 or 8 further information is displayed.

- Press ENTER.

15.1.5 Function test of the input

The function of the input can now be tested.

Analog input

- Connect the signal source to the input.

`Inputs\...\I1 Test signal`

- Select `Yes` to test the input signal. Select `No` to display the next menu item.
- Press ENTER.

`Inputs\...\I1 Test signal\Current`

- If the transmitter displays a value (here: `Current`), the input functions correctly.
- Press ENTER.
- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.

`Inputs\...\I1 Test measuring range`

- Select `Yes` to test the assignment of the measured value to the input signal. Select `No` to display the next menu item.
- Press ENTER.

```
Inputs\...\I1 Test measuring range\Current
```

- If the transmitter displays a value (here: `Current`), the input functions correctly.
- Press ENTER.
- Select `Repeat` to repeat the test. Select `Finish` to display the next menu item.
- Press ENTER.
- Press ⮌ to return to the main menu.

15.2 Assignment of an input

- Select the menu item `Inputs\Assign inputs`.
- Press ENTER.

```
Inputs\Assign inputs
```

- Select a physical quantity in the scroll list.
- Press ENTER.
- Select the input via which the physical quantity is to be entered. Only configured inputs are displayed in the scroll list.
- Select the list item `No linkage` if no input is to be assigned to the physical quantity.
- Press ENTER.

16 Data logger

The transmitter has a data logger which stores the measurement data during the measurement.

NOTICE

In order to store measured data, the data logger has to be configured.

The following data can be stored:

- date
- time
- measuring point number
- pipe parameters
- fluid parameters
- transducer data
- physical quantity
- unit of measurement
- measured values

Measured values transmitted via the outputs are also stored in the data logger.

If pulse values are transmitted via an output, the corresponding flow quantity and the totalizer value are stored in the data logger. In case of absolute pulse values, the values of both totalizers are stored.

16.1 Configuration of the data logger

Activation of the data logger

`Storage\Data logger\Configuration\Activate logger`

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER.
- Select `Yes` to activate the data logger.
- Press ENTER.

Starting time

`Storage\Data logger\Configuration\Start storing`

It is possible to set a starting time if it is necessary to synchronize the storing of measured values for several transmitters.

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Start storing` is displayed.
- Select the moment at which to start the storing.
- Press ENTER.

Tab. 62:

display	description
`Immediately`	The storing starts immediately.
`Full 5 minutes`	The storing starts on the next full 5 minutes.
`Full 10 minutes`	The storing starts on the next full 10 minutes.
`Full 15 minutes`	The storing starts on the next full 15 minutes.
`Full 30 minutes`	The storing starts on the next full 30 minutes.
`Full hour`	The storing starts on the next full hour.
`Event-based`	The storing starts when a defined event occurs.

Example

actual time: 09:06 am
setting: `Full 10 minutes`
The storing starts at 09:10 am.

NOTICE

Make sure that the time of all transmitters is synchronized.

Event-based starting time

```
Storage\Data logger\Configuration\Start storing\Event-based
```

If you want to start the storing of measured values at a particular event, select the list item `Event-based` as starting time.

The event is signalized via an input or event trigger. All configured inputs and event triggers are displayed in the scroll list.

- Select the input or the event trigger to be used to signalize the event.
- Press ENTER.

```
Storage\Data logger\Configuration\Start storing\Event-based\Storage rate
w/o trig.
```

The storage rate is the frequency to transmit or store measured values.

- Select in the scroll list a storage rate for storing the measured values in case the event does not occur.
- Press ENTER.
- Select `Off` if no measured values are to be stored as long as the event does not occur.
- Press ENTER.

```
Storage\Data logger\Configuration\Start storing\Event-based\Storage rate
(trig.)
```

- Select in the scroll list a storage rate for storing the measured values in case the event occurs.
- Press ENTER.

```
Storage\Data logger\Configuration\Start storing\Event-based\Buffer time -
>Π
```

- Enter the time interval for the measured values to be stored before the event occurs.
- Press ENTER.

```
Storage\Data logger\Configuration\Start storing\Event-based\Buffer time Π->
```

- Enter the time interval for the measured values to be stored if the event is no longer activated.
- Press ENTER.

Storage rate

```
Storage\Data logger\Configuration\Storage rate
```

The storage rate is the frequency to store the measured values. If a start time for storing the measured values is defined, a storage rate has to be entered.

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Storage rate` is displayed.
- Select a storage rate from the scroll list.
- Press ENTER.
- If `Customized` is selected, enter the storage rate.
- Press ENTER.

Storage rate of the FastFood mode

The storage rate of the FastFood mode is the frequency to store the measured values in the FastFood mode.

```
Storage\Data logger\Configuration\Storage rate FastF
```

This display will only be indicated if the FastFood mode has been activated in the menu item `Miscellaneous\Measurement\Measurement modes`.

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Storage rate FastF` is displayed.
- Select `Automatic` if the storage rate has to correspond to the FastFood measuring rate.
- Press ENTER.
- Select `Customized` if the value for the storage rate is to be defined.
- Press ENTER.
- Enter a value.
- Press ENTER.

Ringbuffer

```
Storage\Data logger\Configuration\Ringbuffer
```

The data logger can be configured as linear logger or ringbuffer. If the ringbuffer is deactivated and the data logger is full, the storing of measured values will be terminated. It can be continued after clearing the data logger. If the ringbuffer is activated and the data logger is full, the oldest measured values will be overwritten. In ringbuffer mode, the remaining capacity of the data logger is displayed during the measurement, e.g.:

`Log⟷ : 1d 6h 57m` is displayed, if no measured values have been overwritten.

`Log|⟷| : 1d 6h 57m` is displayed, if the old measured values have been overwritten.

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Ringbuffer` is displayed.
- Select `On` to activate the ringbuffer.
- Press ENTER.

If the ringbuffer is deactivated and the data logger is full, the storing of measured values will be terminated.

- Select `Off` to deactivate the ringbuffer.
- Press ENTER.

Storage mode

`Storage\Data logger\Configuration\Storage mode`

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Storage mode` is displayed.
- Press ENTER.
- Select `Sample` to store the current measured value.
- Select `Average` if the average of all undamped measured values of a storage interval is to be stored.

NOTICE

The storage mode does not affect the outputs.

NOTICE

`Storage mode` = `Average`
The average of the physical quantity and of other quantities (e.g., the measured temperatures) will be calculated.
If a storage rate < 5 s is selected, `Sample` is used.
If no average could be calculated over the complete storage interval, the value is marked as invalid.

Further parameters for storing

It can be defined whether the following parameters are to be stored together with the measured values.

Tab. 63: Parameters for storing

display	description
`Store totalizers`	totalizer values
`Store diagnost. values`	diagnostic values
`Store transd. temp.`	transducer temperature

- Select `Yes` to store the value. Select `No` if it is not to be stored.

16.2 Clearing of the data logger

`Storage\Data logger\Delete meas. values`

- Select the menu item `Storage\Data logger\Delete meas. values`.
- Press ENTER.
- Select `Yes` to delete the measured values.
- Press ENTER.

16.3 Information regarding the data logger

`Storage\Data logger\Data logger info`

- Select the menu item `Storage\Data logger\Data logger info`.
- Press ENTER.

Tab. 64: Information regarding the data logger

display	description
`Activated`	data logger is activated/deactivated This display will only be indicated if the measurement has started and the data logger is activated.
`Full (date)`	date on which the data logger will be full This display will only be indicated if the measurement has started and the ringbuffer is deactivated.
`Full (time)`	time at which the data logger will be full This display will only be indicated if the measurement has started, the ringbuffer is deactivated and the data logger is not full yet.
`Overflow (date)`	date from which the oldest measured values will be overwritten This display will only be indicated if the measurement has started, the ringbuffer is activated and the data logger is not full yet.
`Capacity (time)`	remaining data logger capacity This display will only be indicated if the measurement has started and the ringbuffer is activated.
`Ringbuffer`	ringbuffer is activated/deactivated
`Meas. val. Series`	number of stored series of measured values

17 Data transmission

⚠ DANGER

Risk of explosion when using the measuring equipment in explosive atmospheres

This may result in personal or material damage or dangerous situations.

→Observe the "Safety instructions for the use in explosive atmospheres".

The data is transmitted via the service interface (USB, LAN) or the process interface (optional) of the transmitter.

17.1 Service interfaces

The service interfaces (USB, LAN) allow data to be transmitted from the transmitter to the PC using the FluxDiag Reader program.

The following tasks can be carried out:

- read and store measured values, setup settings and snaps
- graphically display measured values
- export data in csv format
- generate verification report for installation
- update transmitter firmware

NOTICE

To transmit data from the PC to the transmitter, the program FluxDiag has to be used.

17.1.1 LAN interface

In order to use the LAN interface it is important to adapt the network parameters. The transmitter supports the internet protocol versions 4 and 6.

`Communication\Network`

- Select the list item `Network` in the menu item `Communication`.
- Press ENTER.

17.1.1.1 Internet protocol version 4

- If the network parameters for IPv4 are to be adjusted, select the list item `IPv4`.
- Press ENTER.

Manual input

- Select `Manual` to enter the network parameters (IP address, subnet mask and standard gateway).

NOTICE

The entered network parameters have to accord with the LAN parameters.

Default values in the transmitter:

- IP address: 192.168.0.70
- subnet mask: 255.255.255.0
- standard gateway: 192.168.0.1

Automatic addressing with DHCP

- Select `Automatic` to automatically identify the network parameters (IP address, subnet mask and standard gateway) via a DHCP server.

NOTICE

The network parameters can only be automatically identified if the LAN supports DCHP.

- Select the menu item `Communication\Network\IPv4\Show auto config.` to display the automatically identified network parameters.
- Press ENTER.

17.1.1.2 Internet protocol version 6

If the network parameters for IPv6 are to be displayed, select the list item `IPv6`.

- Press ENTER.

If the LAN supports DHCP and an IP address is assigned, the global address is displayed. With this address, the transmitter can be reached worldwide.

17.2 Process interface

The transmitter can be equipped with a process interface (e.g., Profibus, Modbus). For the connection of the process interface to the transmitter see supplement to operating instruction.

18 Advanced functions

18.1 Totalizers

The total volume or total mass of the fluid at the measuring point can be determined.

There are 2 totalizers, one for the positive and the other for the negative flow direction. The unit of measurement used for totalizing corresponds to the volume or mass unit selected for the physical quantity (default, for global changes see section Units of measurement [▶ 201]).

The totalizer values can be displayed in the status line during the measurement.

Tab. 65: Key functions

totalizer display	press 8 during the measurement
freezing of the displayed totalizer value	press 8 for at least 2 s during the measurement
display of the totalizer for the positive flow direction	press 6 during the measurement
display of the totalizer for the negative flow direction	press 4 during the measurement
reset of the totalizers to zero	press 2 3 times during the measurement totalizing will be restarted after pressing 8
	press 8 3 times during the measurement totalizing will be restarted and displayed immediately

NOTICE

If `Channel-based param.` is selected in the menu `Parameters` for the configuration of the measuring point, a keystroke will only influence the totalizers of the measuring channel whose measured values are currently displayed.

18.1.1 Number of decimal places

The values of the totalizers can be displayed with up to 11 places, e.g., 74890046.03. The number of decimal places (max. 4) can be defined.

`Storage\Totalizers`

- Select the menu item `Storage\Totalizers`.
- Press ENTER.
- Select `Automatic` if the number of decimal places has to be adjusted automatically.
- Press ENTER.

Low totalizer values will initially be displayed with 3 decimal places. If the values of the totalizers are higher, the number of decimal places will be reduced.

Tab. 66: Display of values with dynamic adjustment of decimal places

max. value	display
$< 10^6$	±0.000...±999999.999
$< 10^7$	±1000000.00...±9999999.99
$< 10^8$	±10000000.0...±99999999.9
$< 10^{10}$	±1000000000...±9999999999

- Select the number of decimal places.
- Press ENTER.

The number of decimal places is constant. The max. value of the totalizers decreases with an increasing number of decimal places.

Tab. 67: Display of values depending on the number of decimal places

number of decimal places	max. value	max. display
0	$< 10^{10}$	±9999999999
1	$< 10^8$	±99999999.9
2	$< 10^7$	±9999999.99
3	$< 10^6$	±999999.999
4	$< 10^5$	±99999.9999

NOTICE

The number of decimal places and the max. value of the totalizers only affect the display.

18.1.2 Detection of long measurement failures

If there are no valid measured values during a long time interval, the totalizers remain unchanged and will be followed by an interrogation point.

The time interval can be defined (default: 30 s).

`Storage\Totalizers\Totalizer timeout`

- Select the menu item `Storage\Totalizers`.
- Press ENTER until the menu item `Totalizer timeout` is displayed.
- Select `Default` if the default value is to be used.
- Press ENTER.
- Select `Customized` to define a time interval.
- Press ENTER.
- Enter the time interval.
- Press ENTER.

18.1.3 Overflow of the totalizers

The overflow behavior of the totalizers can be set:

Without overflow

The totalizer value increases up to the internal limit of 10^{38}.
The values will be displayed as exponential numbers (±1.00000E10), if necessary. The totalizer can only be reset to zero manually.

With overflow

The totalizer will be automatically reset to zero when reaching ±9999999999.

`Storage\Totalizers\Overflow behavior`

- Select the menu item `Storage\Totalizers`.
- Press ENTER until the menu item `Overflow behavior` is displayed.
- Select `Yes` to work with overflow. Select `No` to work without overflow.
- Press ENTER.

Independent of the setting, the totalizers can be reset to zero manually (see Tab. 46: Scroll list [▶ 137]).

NOTICE

The overflow of a totalizer influences all output channels, e.g., the data logger and the online transmission of data.
The sum of both totalizers (throughput ΣQ) transmitted via an output is no longer valid after one of the totalizers has overflowed for the first time.

18.1.4 Totalizer behavior after stop of measurement

The totalizer behavior when the measurement is stopped or after a reset of the transmitter can be defined.

`Storage\Totalizers\Keep totalizers`

- Select the menu item `Storage\Totalizers`.
- Press ENTER until the menu item `Keep totalizers` is displayed.
- Select `Yes` if the values of the totalizers are to be stored and used for the next measurement. Select `No` if the totalizers are to be set to zero.
- Press ENTER.

18.1.5 Totalizer sum

The sum of the totalizers for both flow directions can be displayed in the status line during the measurement.

`Storage\Totalizers\Show ΣQ`

- Select the menu item `Storage\Totalizers`.
- Press ENTER until the menu item `Show ΣQ` is displayed.
- Select `Yes` to display the totalizer sum. Select `No` if it is not to be displayed.
- Press ENTER.

18.1.6 Totalizer storing

The totalizer values can be stored in the data logger.

`Storage\Data logger\Configuration`

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Store totalizers` is displayed.
- Select `Yes`.
- Press ENTER.

18.2 FastFood mode

The FastFood mode allows to measure highly dynamic flows. A continuous adaptation to changing measuring conditions is only partially realized in this mode.

- The measured values are stored with the storage rate of the FastFood mode.
- The FastFood mode has to be enabled and activated.
- The outputs can still be used. They are updated synchronously with the FastFood measuring rate, independently from the storage rate.

18.2.1 Enabling/disabling the FastFood mode

`Miscellaneous\Measurement\Measurement modes\Enable FastFood`

- Select the menu item `Miscellaneous\Measurement\Measurement modes`.
- Press ENTER until the menu item `Enable FastFood` is displayed.
- Select `On` to enable the FastFood mode. Select `Off` to disable it.
- Press ENTER.

If `On` is selected, the menu item `Measuring rate FastF` is displayed. The FastFood measuring rate indicates the interval at which the measured values are transmitted to the process outputs.

- Select `Default` to use the default value of 50 ms.
- Select `Customized` if a value for the FastFood measuring rate is to be entered.
- Enter a value within the range of 20...200 ms.
- Press ENTER.

18.2.2 Storage rate of the FastFood mode

The storage rate of the FastFood mode is entered during the configuration of the data logger in the menu item `Storage rate FastF`.

`Storage\Data logger\Configuration\Storage rate FastF`

- Select the menu item `Storage\Data logger\Configuration`.
- Press ENTER until the menu item `Storage rate FastF` is displayed.
- Select `Automatic` if the storage rate has to correspond to the FastFood measuring rate.
- Press ENTER.
- Select `Customized` if the value for the storage rate is to be defined.
- Press ENTER.
- Enter a value.
- Press ENTER.

18.2.3 Activation/deactivation of the FastFood mode

If the FastFood mode is enabled and a measurement has been started, the normal measuring mode runs at first.

- Press 0 to activate the FastFood mode. The symbol for the FastFood mode  appears in the upper line.
- Press 0 to deactivate the FastFood mode.

The FastFood mode can also be activated/deactivated via a remote function.

18.3 Diagnostics using the snap function

18.3.1 Configuration

By means of the snap function it is possible to store measuring parameters which are useful for the evaluation of measuring results or for diagnostic purposes. The snap function can be configured.

```
Storage\Snap\Configuration
```

- Select the menu item `Storage\Snap\Configuration`.
- Press ENTER.

```
Storage\Snap\Configuration\Snap ringbuffer
```

- Select `Yes` to activate the snap ringbuffer.

If the snap ringbuffer is activated, the oldest snaps will be overwritten after taking the 101st snap. If the snap ringbuffer is deactivated, up to 100 snaps can be stored.

- Press ENTER.

```
Storage\Snap\Configuration\Auto snap
```

- Select `Yes` to activate the auto snap function.

If this function is activated, a snap is automatically stored during a measurement failure.

- Press ENTER.

```
Storage\Snap\Configuration\Snap on R1
```

- Select `Yes` if an event that triggers a snap has been parameterized for the event trigger R1.
- Press ENTER.

18.3.2 Taking a snap

- Press 5 during the measurement.

A snap is taken.

or

```
Measurement\Execute command\Take a snap
```

- Press and hold C during the measurement until the menu item `Execute command` is displayed.
- Select the list item `Take a snap`.
- Press ENTER.

A snap is taken.

If the measurement is running on several measuring channels, snaps will be taken from all of them.

18.3.3 Information on snaps

`Storage\Snap\Snap info`

- Select the list item `Snap info` in the menu item `Storage\Snap`.
- Press ENTER.

Tab. 68: Information on snaps

display	description
`Stored snaps`	number of stored snaps
`Snaps left`	number of snaps that can still be stored
`Ringbuffer`	snap ringbuffer activated

18.3.4 Deletion of snaps

`Storage\Snap\Delete snaps`

- Select the list item `Delete snaps` in the menu item `Storage\Snap`.
- Press ENTER.
- Select `Yes` or `No`.
- Press ENTER.

18.4 Modification of the limit for the inner pipe diameter

It is possible to modify the lower limit of the inner pipe diameter for a given transducer type.

`Miscellaneous\Pipe diameter MIN`

- Select the menu item `Miscellaneous\Pipe diameter MIN`.
- Press ENTER.

It is possible to define a min. pipe diameter for all relevant transducer frequencies.

- Select `Default` if the default values are to be used.
- Press ENTER.
- Select `Customized` if a min. pipe diameter is to be defined.
- Press ENTER.
- Enter the pipe diameter in mm.
- Press ENTER.

NOTICE

If a transducer is used below its recommended inner pipe diameter, a measurement might be impossible.

18.5 Remote functions

Remote functions can be triggered by triggerable analog inputs or event triggers.

In order to define an input for a remote function, it has to be enabled in the menu `Inputs`.

In order to define an event trigger for a remote function, it has to be enabled in the menu item `Functions\Event trigger`.

It is possible to trigger one or more of the following remote functions:

- reset measured values
- reset totalizers
- stop totalizers
- activate FastFood mode

Triggerable inputs and event triggers

The remote function is triggered when the switching condition is met. The remote function is reset as soon as the switching condition is no longer met.

18.5.1 Configuration of the remote function

`Functions\Remote functions`

- Select the menu item `Functions\Remote functions`.
- Press ENTER.

The scroll list of functions shows whether an input or event trigger, and if so, which one, is assigned to a function.

- Select a list item:
  - `Reset meas. val. (-)`
  - `Reset totalizers (-)`
  - `Stop totalizers (-)`
  - `Activate FastF (-)`
- Press ⮌ to return to the previous menu item.

Reset of measured values

- Select the list item `Reset meas. val.`.
- Press ENTER.

The measured value transmission simulates a reposing application for the duration of the signal. The actual measured flow velocity is ignored and the measured value is set to zero. All values of the physical quantities derived from the flow velocity therefore also yield zero.

The transmitter continues the measurement as soon as the condition of the remote function is no longer met.

- Select the input or the event trigger to be used to trigger the selected remote function.
- Press ENTER.
- Select `No linkage` to deactivate the remote function.
- Press ENTER.

Reset of totalizers

- Select the list item `Reset totalizers`.
- Press ENTER.

The totalizers are set to zero and deactivated for the duration of the signal.

Totalizing starts at zero again as soon as the condition for the remote function is no longer met.

If the totalizers are set to zero using the remote function, an H is displayed next to the measured value during the measurement.

- Select the input or the event trigger to be used to trigger the selected remote function.
- Press ENTER.
- Select `No linkage` to deactivate the remote function.
- Press ENTER.

Stop of totalizers

- Select the list item `Stop totalizers`.
- Press ENTER.

The totalizers are stopped for the duration of the signal.

Totalizing will continue from the last registered totalizer value as soon as the condition of the remote function is no longer met.

- Select the input or the event trigger to be used to trigger the selected remote function.
- Press ENTER.
- Select `No linkage` to deactivate the remote function.
- Press ENTER.

Activation of the FastFood mode

- Select the list item `Activate FastF`.
- Press ENTER.

The FastFood mode is activated for the duration of the signal. It is deactivated as soon as the condition for the remote function is no longer met.

This list item only appears if the FastFood mode is enabled in the menu item `Miscellaneous\Measurement\Measurement modes\FastFood` and `1 meas. point (A)` is selected for the configuration of the measuring point.

- Select the input or the event trigger to be used to trigger the selected remote function.
- Press ENTER.
- Select `No linkage` to deactivate the remote function.
- Press ENTER.

18.6 Event triggers

It is possible to activate up to 4 independent event triggers: R1, R2, R3 and R4.

They can be used, e.g., to:

- output information about the running measurement
- trigger special remote functions
- switch on/off pumps and motors

```
Functions\Event trigger
```

- Select the menu item `Functions\Event trigger`.
- Press ENTER.

```
Functions\Event trigger\Rx(-)
```

- Select an event trigger.
- Press ENTER.

If the event trigger has already been installed, it is displayed as follows: `Rx(√)`.

`Functions\Event trigger\Enable Rx`

- Select `Yes` to change the settings for an already assigned event trigger or to assign a new one. Select `No` to cancel the assignment and to return to the previous menu item.
- Press ENTER.

`Functions\Event trigger\Enable Rx\Source item`

- Select the source item (physical quantity) to define a condition for.

Tab. 69: Source items

source item	list item	output
`Flow quanti-ties`	`Flow velocity`	flow velocity
	`Norm vol. flow rate`	standard volumetric flow rate
	`Operation vol. flow`	operating volumetric flow rate
	`Mass flow rate`	mass flow rate
`Totalizers`	`Operating volume (+)`	totalizer for the volumetric flow rate in positive flow direction
	`Operating volume (-)`	totalizer for the volumetric flow rate in negative flow direction
	`Operating volume (Δ)`	difference of the totalizers for the positive and negative flow direction
	`Standard volume (+)`	totalizer for the standard volumetric flow rate in positive flow direction
	`Standard volume (-)`	totalizer for the standard volumetric flow rate in negative flow direction
	`Standard vol. (Δ)`	difference of the totalizers for the positive and negative flow direction
	`Mass (+)`	totalizer for the mass flow rate in positive flow direction
	`Mass (-)`	totalizer for the mass flow rate in negative flow direction
	`Mass (Δ)`	difference of the totalizers for the positive and negative flow direction
`Fluid proper-ties`	`Fluid temp.`	fluid temperature
	`Fluid pressure`	fluid pressure
	`Fluid density`	fluid density
	`Kin. viscosity`	kinematic viscosity
	`Dyn. viscosity`	dynamic viscosity
	`Norm. density`	density at reference temperature

source item	list item	output
Diagnostic values	Amplitude	signal amplitude
	Quality	signal quality
	SNR	signal-to-noise ratio
	SCNR	signal-to-correlated-noise ratio
	VariAmp	amplitude variation
	VariTime	transit time variation
	Gain	gain required to receive a useful signal
	Pig detection	signalizes whether a pig is detected This display will only be indicated if Pig detection is activated.
HPI measure-ment	API gravity	scale value that derives from the density at standard conditions
	Volume corr. factor	volume correction factor
	Current fluid	number of the detected fluid
	Δ API gravity	absolute change of the HPI property per time base set for the fluid change
Miscellaneous	Custom. Input 1	measured values of input quantities (e.g., temperature, pressure) which are not used for calculation In the menu item Inputs\Assign inputs it is possible to assign configured inputs to customized inputs.
	Custom. Input 2	
	Custom. Input 3	
	Custom. Input 4	
Sound speed	Sound speed	sound speed
	Sound speed (Δ)	absolute change of the measured sound speed per time base set for the fluid change

Afterwards, the properties of the event trigger are defined.

Tab. 70: Properties of the event trigger

property	setting	description
Function (switching condition)	MAX (x>limit)	The event trigger switches when the measured value exceeds the upper limit.
	MIN (x<limit)	The event trigger switches when the measured value falls below the lower limit.
	ERR (x=fail)	The event trigger switches when a measurement is not possible.
	Within range	The event trigger switches when the measured value is within the defined range.
	Out of range	The event trigger switches when the measured value is outside the defined range.

property	setting	description
Type (holding behavior)	Non-hold	When the switching condition is no longer met, the event trigger returns to the idle state after approx. 1 s.
	Hold	The event trigger remains activated even when the switching condition is no longer met.
	Hold for a while	The event trigger remains activated for a defined time even when the switching condition is no longer met.

Definition of the switching condition

```
Functions\Event trigger\Enable Rx\Source item\...\Function
```

- Select the switching condition.
- Press ENTER.

Definition of the holding behavior

```
Functions\Event trigger\Enable Rx\Source item\...\Type
```

- Select the type of the holding behavior.
- Press ENTER.

Definition of trigger limits

```
Functions\Event trigger\Enable Rx\Source item\...\Trigger value
```

The limits at which the event trigger has to switch are to be entered.

- Enter the upper limit `MAX (x>limit).`
- Press ENTER.
- Enter the lower limit `MIN (x<limit).`
- Press ENTER.

```
Functions\Event trigger\Enable Rx\Source item\...\Hysteresis
```

It is possible to define a hysteresis to avoid constant switching of the event trigger.

The event trigger is activated when the measured values exceed the upper limit. It is deactivated when the measured values fall below the lower limit.

- Enter a value for the hysteresis.

If zero is entered, no hysteresis is used.

- Press ENTER.

Example

`MAX (x>limit)`: 30 m^3/h

`Hysteresis`: 1 m^3/h

The event trigger is activated for measured values > 30.5 m^3/h and deactivated for measured values < 29.5 m^3/h.

`Functions\Event trigger\Enable Rx\Source item\...\Range center`

- Enter the center of the range in which the event trigger has to switch.
- Press ENTER.

`Functions\Event trigger\Enable Rx\Source item\...\Range width`

- Enter the width of the range in which the event trigger has to switch.
- Press ENTER.

Example

`Function`: `Out of range`

`Range center`: 100 m^3/h

`Range width`: 40 m^3/h

The event trigger switches when the measured value is below 80 m^3/h or above 120 m^3/h.

Definition of the switching delay

`Functions\Event trigger\Enable Rx\Source item\...\Glitch interval`

- Enter a time interval at the end of which the event trigger has to switch in case the event occurred.
- Press ENTER.

`Functions\Event trigger\Enable Rx\Source item\...\Failure delay`

- Enter a time interval at the end of which the event trigger has to be deactivated in case of a measurement failure.
- Press ENTER.

18.6.1 Apparent switching delay

The measured values and totalizer values will be displayed rounded according to the set number of decimal places. However, the limits will be compared to the non-rounded measured values. This might cause an apparent switching delay when the measured value changes marginally (less than the visualized decimal places). In this case, the switching accuracy of the event trigger is higher than the accuracy of the display.

18.6.2 Reset and initialization of the event triggers

After an initialization of the transmitter all event triggers are deactivated.

- Press 3 times C during the measurement to set all event triggers to the idle state.

Event triggers whose switching condition is still met will be activated again after 1 s. This function is used to reset event triggers of type `Hold` when the switching condition is no longer met.

If a measurement is stopped, all event triggers will be deactivated and the corresponding process outputs will be de-energized, independently of the programmed idle state.

18.6.3 Event triggers during the measurement

An event trigger with the switching condition `MAX (x>limit)`, `MIN (x<limit)`, `Within range` or `Out of range` is updated max. once per second to avoid constant switching of the event trigger (in case the measured values fluctuate around the value of the switching condition).

An event trigger with switching condition `ERR (x=fail)` is activated when the measurement fails.

An event trigger of type `Non-hold` is activated when the switching condition is met. It is deactivated when the switching condition is no longer met. But it remains activated for at least 1 s even when the switching condition is met for a shorter period of time.

An event trigger of type `Hold` is activated when the switching condition is met. It remains activated even when the switching condition is no longer met.

An event trigger of type `Hold for a while` is activated when the switching condition is met. The time at the end of which it is deactivated again is defined in the menu item `Hold interval`.

18.6.4 Display of the event trigger state

NOTICE

There is no visual or acoustic indication of event trigger switching.

The state of the event triggers is displayed during the measurement.

- Press 9 to scroll through the second line from below until the event trigger state is displayed.

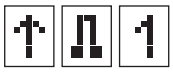
The display of the event trigger state is structured as follows:

Rx = □□□ with x being the number of the event trigger and □ a pictogram according to Tab. 71: Pictograms for the display of the event trigger state [▶ 196].

Tab. 71: Pictograms for the display of the event trigger state

	no.		Function (switching condition)		Type (holding behavior)		current state	
R		=						
	1			MAX (x>limit)		Non-hold		deactivated (false state)
	2			MIN (x<limit)		Hold		activated (true state)
	3			Within range		Hold for a while		
	4			Out of range				
				ERR (x=fail)				

Example

R1 = 

18.7 Event log

In case of an error, the symbol ⚠ in the first line indicates an error message. This message can be displayed.

`Storage\Event log`

- Select the menu item `Storage\Event log`.
- Press ENTER.

A list is displayed containing all error messages since the last time the transmitter was switched on.

- Press 8 and 2 to scroll through the list and select an error message.
- Press ENTER.

The cause of the error is displayed.

NOTICE

After reading out the event log, the error message symbol on the display will be deleted, even if the error has not been eliminated yet. The event log will be deleted after a restart of the transmitter.

19 Settings

19.1 Dialogs and menus

`Miscellaneous\Dialogs/Menus`

- Select the menu item `Miscellaneous\Dialogs/Menus`.
- Press ENTER.

Pipe circumference

`Miscellaneous\Dialogs/Menus\Pipe circumference`

- Press ENTER until the menu item `Pipe circumference` is displayed.
- Select `Yes` if the pipe circumference is to be entered instead of the pipe diameter in the menu `Parameters`.
- Press ENTER.

If `Yes` is selected for `Pipe circumference`, the outer pipe diameter will still be requested in the menu `Parameters`.

- Press `Pipe circumference` to select the menu item [-].
- Press ENTER.

The value displayed in the menu item `Pipe circumference` is calculated from the last displayed outer pipe diameter.

Example: 100 mm · π = 314.2 mm

- Enter the pipe circumference. The limits for the pipe circumference are calculated on the basis of the limits for the outer pipe diameter.
- Press ENTER.

During the next scroll through the menu `Parameters`, the outer pipe diameter that corresponds to the entered pipe circumference will be displayed.

Example: 180 mm : π = 57.3 mm

Coating

If the pipe has a coating, the material parameters of the coating have to be entered in the menu `Parameters`.

`Miscellaneous\Dialogs/Menus\Edit coating`

- Press ENTER until the menu item `Edit coating` is displayed.
- Select `Yes` if the pipe has a coating.
- Press ENTER.

Lining 2

If the pipe has a second lining, the material parameters of the second lining have to be entered in the menu `Parameters`.

`Miscellaneous\Dialogs/Menus\Edit Lining 2`

- Press ENTER until the menu item `Edit Lining 2` is displayed.
- Select `Yes` if the pipe has 2 linings.
- Press ENTER.

Measuring point number

`Miscellaneous\Dialogs/Menus\Measuring point no.`

- Press ENTER until the menu item `Measuring point no.` is displayed.
- Select `Number` if the measuring point number should only consist of numeric characters. Select `Text` if the measuring point number should only consist of alphabetic characters.
- Press ENTER.

Error delay

The error delay is the time after which an error value will be sent to an output if no valid measured values are available.

`Miscellaneous\Dialogs/Menus\Error delay`

- Press ENTER until the menu item `Error delay` is displayed.
- Select `Edit` to enter an error delay. Select `Damping` if the damping factor is to be used as the error delay.
- Press ENTER.

Temperature correction

`Miscellaneous\Dialogs/Menus\Tx temperature offset`

- Press ENTER until the menu item `Tx temperature offset` is displayed.
- Select `Yes` to enable the input of a temperature correction for each temperature input.
- Press ENTER.

Transducer distance

`Miscellaneous\Dialogs/Menus\Transducer distance`

- Press ENTER until the menu item `Transducer distance` is displayed.
- Select `Customized` if the measuring point is always the same. Select `Automatic` if the measuring point often changes.
- Press ENTER.

In the menu `Measurement`, the recommended transducer distance will be displayed in brackets, followed by the entered transducer distance.

Sound speed of the reference fluid

`Miscellaneous\Dialogs/Menus\Compare c fluid`

- Press ENTER until the menu item `Compare c fluid` is displayed.

Select `Yes` if the difference $\Delta c = c_{mea} - c_{ref}$ between the two sound speeds has to be displayed during the measurement. c_{ref} is the calculated sound speed of the fluid at the same process conditions (e.g., temperature, pressure).

- Press ENTER.

`Compare c fluid` can also be activated or deactivated during the measurement and has an immediate effect on the display of the measured values.

- Press 3 during the measurement to scroll to the display of Δc.

Display of the last value

```
Miscellaneous\Dialogs/Menus\Display last value
```

- Press ENTER until the menu item `Display last value` is displayed.
- Select `Yes` to display the last valid value.
- Press ENTER.

If `Yes` is selected and no valid measured value can be displayed during the measurement, the last valid value will be displayed, followed by an interrogation point.

Primary display value

```
Miscellaneous\Dialogs/Menus\Primary display value
```

- Press ENTER until the menu item `Primary display value` is displayed.
- Select `Flow quantity` to display the value of the selected physical quantity as primary value during the measurement. Select `Totalizer` to display the totalizer value as primary value during the measurement.
- Press ENTER.

Switching off the display backlight

```
Miscellaneous\Dialogs/Menus\Light autom. off
```

- Press ENTER until the menu item `Light autom. off` is displayed.
- Select `Yes` to activate the automatic switch-off of the display backlight.
- Press ENTER.

If the automatic switch-off of the display backlight is activated, the backlight is switched off after about 30 s. When pressing a key or connecting a USB cable, the backlight is switched on again.

19.2 Measurement modes

```
Miscellaneous\Measurement\Measurement modes
```

- Select the menu item `Miscellaneous\Measurement`.
- Press ENTER.
- Select the menu item `Measurement modes`.
- Press ENTER.

Enabling the HPI measurement

```
Miscellaneous\Measurement\Measurement modes\HPI measurement
```

- Select `On` to enable the HPI measurement. Select `Off` to disable it.
- Press ENTER.

```
Miscellaneous\Measurement\Measurement modes\Reference temp.
```

- Enter the temperature according to the local reference conditions (default value: 20 °C).
- Press ENTER.

```
Miscellaneous\Measurement\Measurement modes\Reference pressure
```

- Enter the pressure according to the local reference conditions (default value: 1 bar).
- Press ENTER.

For further settings see section Enabling the HPI measuring mode [▶ 109].

FastFood mode

`Miscellaneous\Measurement\Measurement modes\Enable FastFood`

- Press ENTER until the menu item `Enable FastFood` is displayed.
- Select `On` to enable the FastFood mode. Select `Off` to disable it.
- Press ENTER.

19.3 Measurement settings

`Miscellaneous\Measurement\Measurement settings`

- Select the menu item `Miscellaneous\Measurement`.
- Press ENTER.
- Select the menu item `Measurement settings`.
- Press ENTER.

Multi-point calibration

Multi-point calibration allows a very precise output of measuring results. It is based on calibration curves of series of measured values.

`Miscellaneous\Measurement\Measurement settings\Multi-point calibration`

- Press ENTER until the menu item `Multi-point calibration` is displayed.
- Select `On` to activate the multi-point calibration. Select `Off` do deactivate it (default: `Off`).
- Press ENTER.

If `On` is selected, a series of measured values has to be entered in the menu item `Calibration\Multi-point calibration`.

Swift damping

If `Swift damping` is activated, each displayed measured value is an average of the last x seconds, with x being the damping factor. The display thus requires x seconds to fully respond to flow rate changes.

If `Swift damping` is deactivated, the damping is calculated as first order low-pass filter, i.e., changes of measured values become effective in the measuring result in the form of an exponential time course.

`Miscellaneous\Measurement\Measurement settings\Swift damping`

- Press ENTER until the menu item `Swift damping` is displayed.
- Select `On` to activate the swift damping. Select `Off` to deactivate it (default: `On`).
- Press ENTER.

Dynamic damping

If dynamic damping is activated, volatile changes in the measured values of the selected physical quantity are transmitted by the transmitter without any time lag.

Important

The dynamic damping will only have an impact on the selected physical quantity. All other physical quantities are not dynamically damped.

`Miscellaneous\Measurement\Measurement settings\Dynamic damping`

- Press ENTER until the menu item `Dynamic damping` is displayed.
- Select `On` to activate the dynamic damping. Select `Off` to deactivate it (default: `Off`).
- Press ENTER.

If `On` is selected, the dynamic damping has to be parameterized in the menu item `Parameters\Dynamic damping`.

19.4 Units of measurement

It is possible to set the global units of measurement for the length, temperature, pressure, sound speed, density and kinematic viscosity.

`Miscellaneous\Units of measurement`

- Select the menu item `Miscellaneous\Units of measurement`.
- Press ENTER.
- Select a unit of measurement for all quantities.
- Press ENTER.

`Miscellaneous\Units of measurement\Barrel type`

In this menu item it is possible to define which barrel type is to be displayed as unit of measurement for the volumetric flow rate.

- Press ENTER until the menu item `Barrel type` is displayed.
- Select a barrel type.
- Press ENTER.

The unit of measurement used for totalizing corresponds to the heat, volume or mass unit selected for the physical quantity. The preset unit of measurement can be changed.

`Miscellaneous\Units of measurement`

- Select the menu item `Miscellaneous\Units of measurement`.
- Press ENTER until the units for the thermal energy rate, volumetric flow rate and mass flow rate are displayed.
- Select a unit of measurement for the physical quantity.
- Press ENTER.
- Select a unit of measurement for totalizing.
- Press ENTER.

19.5 Material and fluid scroll list

At delivery, all materials and fluids stored in the transmitter are displayed in the corresponding lists in the menu item `Parameters\Pipe material` and `Parameters\Fluid`, respectively.

For the sake of clarity, materials and fluids that are not needed can be removed from the scroll lists. Removed materials and fluids can be added again at any time.

Adding or removing materials/fluids

`Miscellaneous\Libraries\Use material list`

- Select the menu item `Miscellaneous\Libraries\Use material list`.
- Press ENTER.
- Select `Yes` if a material is to be added to or removed from the material scroll list.
- Press ENTER.
- Press 8 or 2 to scroll through the scroll list.
- Press 6 or 4 to add (+) or remove (-) a material, respectively.
- Press ENTER.

The fluid scroll list can be adapted in the same way (`Miscellaneous\Libraries\Use fluid list`).

Adding all materials/fluids

`Miscellaneous\Libraries\Use material list`

- Select the menu item `Miscellaneous\Libraries\Use material list`.
- Press ENTER.
- Select `No` if all materials are to be displayed in the material scroll list.
- Press ENTER.

The fluid scroll list can be adapted in the same way (`Miscellaneous\Libraries\Use fluid list`).

19.6 Working with parameter records

19.6.1 Introduction

Parameter records are data sets that contain all information necessary to perform a certain measurement task:

- pipe parameters
- transducer parameters
- fluid parameters
- output options

Working with parameter records will make repeated measurement tasks easier and faster. The transmitter can store up to 20 parameter records.

NOTICE

On delivery, no parameter records are stored. They have to be entered manually.

The parameters have first to be entered in the menus `Parameters` and `Miscellaneous`. Afterwards, they can be stored as parameter record.

`Miscellaneous\Param. record memo.`

- Select the menu item `Miscellaneous\Param. record memo.`.
- Press ENTER.
- Select the menu item `Save current record`.
- Press ENTER.

`Miscellaneous\Param. record name`

- Enter the name the parameter record has to be stored with.
- Press ENTER.

19.6.2 Loading a parameter record

Stored parameter records can be loaded and used for measurement.

`Miscellaneous\Param. record memo.\Load param. record`

- Select the menu item `Load param. record`.
- Press ENTER.
- Select the parameter record to be loaded.
- Press ENTER.

19.6.3 Deletion of parameter records

`Miscellaneous\Param. record memo.\Delete param. record`

- Select the menu item `Delete param. record`.
- Press ENTER.
- Select the parameter record to be deleted.
- Press ENTER.

19.7 Contrast settings

`Miscellaneous\System settings\Display contrast`

- Select the menu item `Miscellaneous\System settings`.
- Press ENTER.
- Select the menu item `Display contrast`.
- Press ENTER.

The display contrast can be adjusted with the following keys:

6 increases the contrast

4 reduces the contrast

- Press ENTER.

NOTICE

After an initialization of the transmitter, the display is reset to medium contrast.

19.8 HotCodes

A HotCode is a digit sequence that activates certain functions and settings.

- Press and hold ⮌ for several seconds to return to the beginning of the menu.
- Press C.
- Enter the HotCode via the keyboard. It is not displayed during the input.

Tab. 72: HotCodes for certain functions

function	HotCode
setting to medium display contrast	555000
language selection	9090xx
initialization	909000
activation/deactivation of flow direction detection	007026
activation/deactivation of pig detection	007028
display of totalizers in the lower line as well	007032

Language selection

The language can be selected in the menu item `Miscellaneous\System settings\Language` or with a HotCode.

Tab. 73: Language HotCodes

language	HotCode
English	909044
German	909049
French	909033
Spanish	909034
Dutch	909031
Russian	909007
Polish	909048
Turkish	909090
Italian	909039
Chinese	909086

After the last digit has been entered, the main menu is displayed in the selected language. This language remains activated when the transmitter is switched off and on again.

19.9 Key lock

A running measurement can be protected against inadvertent intervention by means of a key lock

Definition of a key lock code

- Select the menu item `Miscellaneous\System settings`.
- Press ENTER.

`Miscellaneous\System settings\Key lock`

- Select the menu item `Key lock`.
- Press ENTER.
- Enter a 6-digit key lock code.
- Press ENTER.

NOTICE

Do not forget the key lock code!

Deactivation of the key lock

`Miscellaneous\System settings\Key lock`

- Select the menu item `Miscellaneous\System settings`.
- Press ENTER.
- Select the list item `Key lock`.
- Press ENTER.
- Enter a 6-digit key lock code.
- Press ENTER.

Intervention in the measurement

If the key lock is activated, the message `Key lock activated` will be displayed for a few seconds when pressing a key.

In order to interrupt a measurement, the key lock has to be deactivated.

- Press ⮌.
- Select the menu item `Miscellaneous\System settings\Key lock`.
- Press ENTER.
- Deactivate the key lock.

Disabled functions with activated key lock

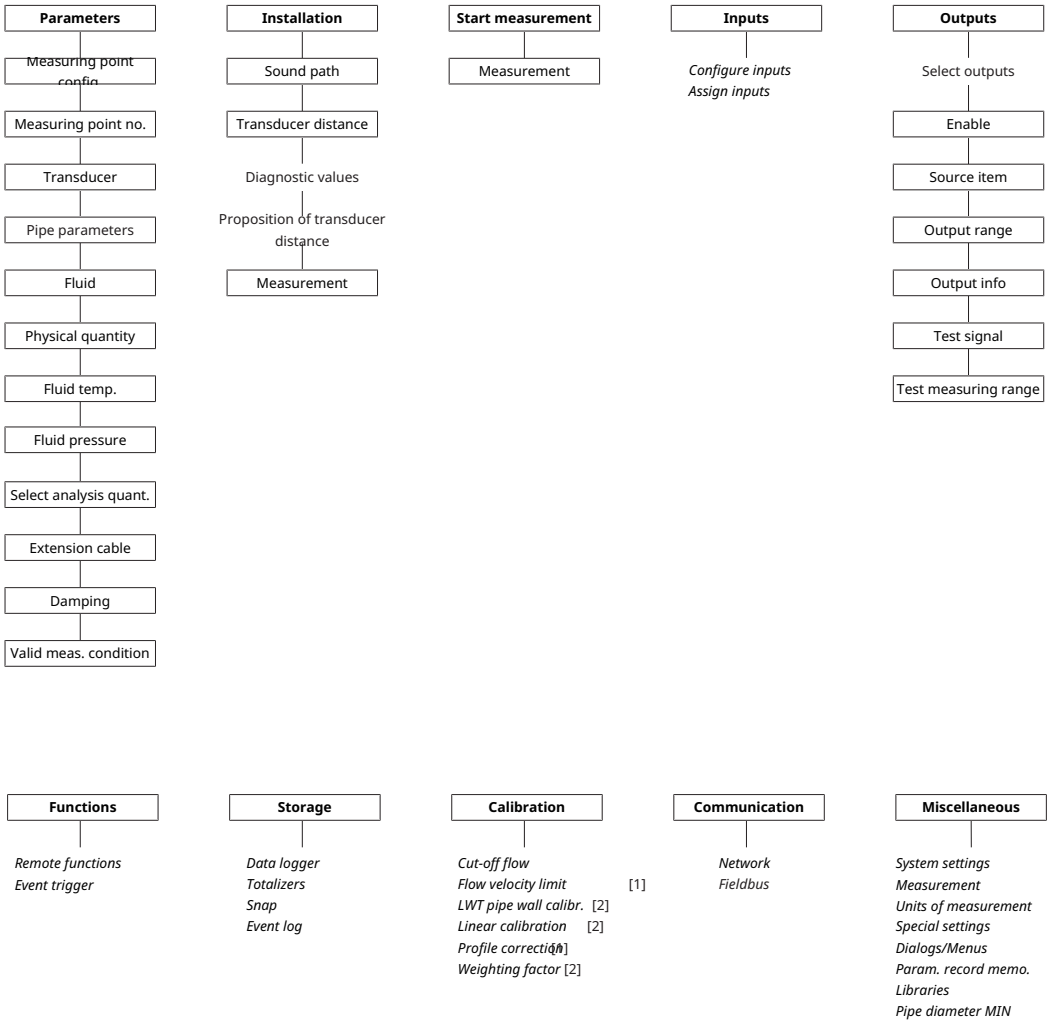
The following table gives an overview of the transmitter functions that are not available when the key lock is activated.

Tab. 74:

measurement not started	measurement started
• input of parameters • modification of settings (e.g., measuring modes) • clearing of data logger • setting of date/time • start of measurement (start-up)	• modification of settings that can be made during the measurement (e.g., language selection) • triggering of snaps • toggling to FastFood mode • stop of totalizers • reset of totalizers • stop of measurement

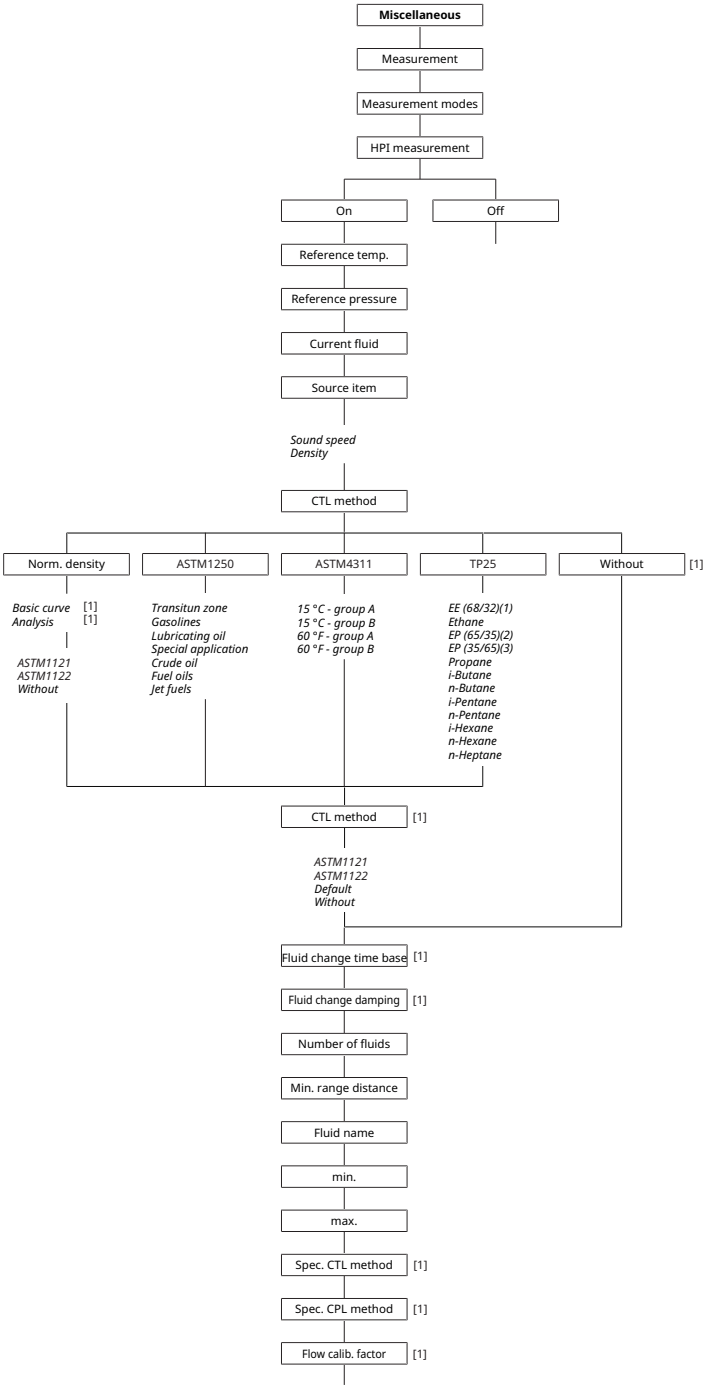
A Annex: Menu structure

Main menu



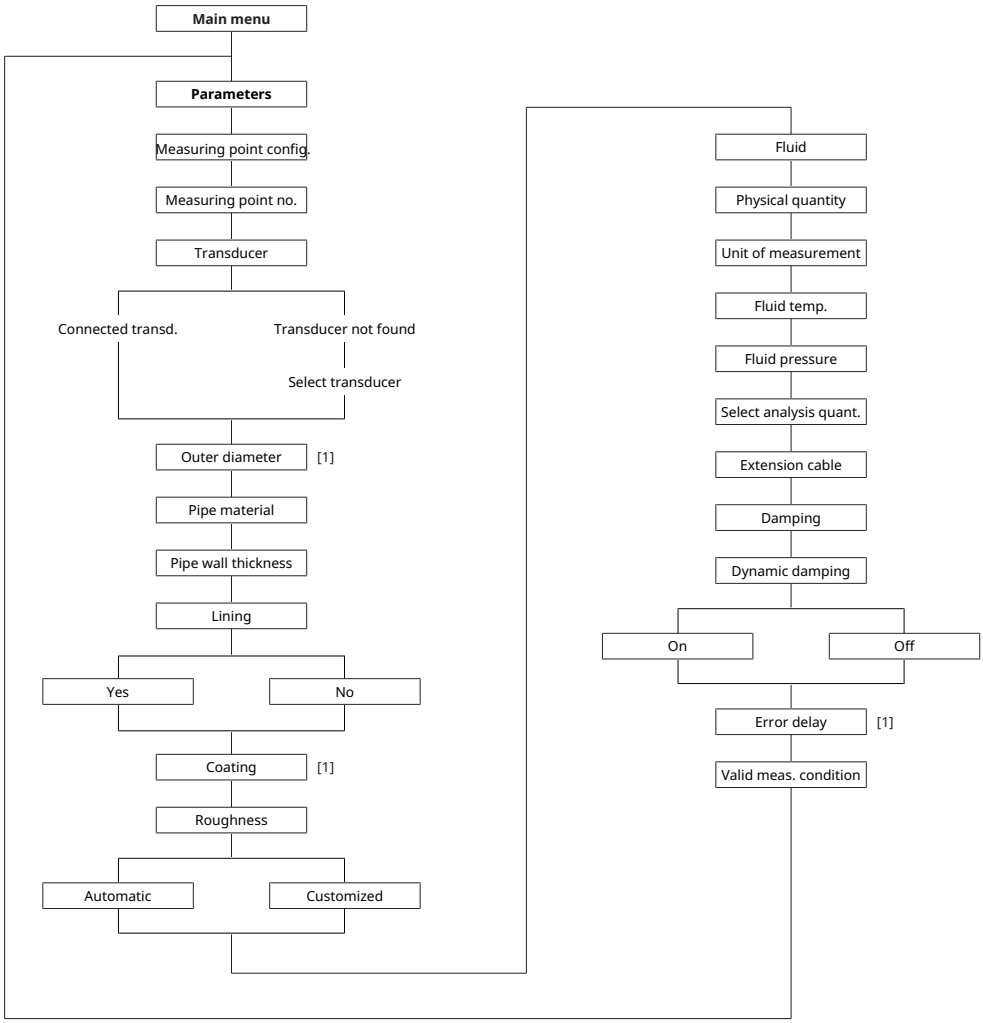
Legend
[1] from ExpertUser mode
[2] from SuperUser mode

HPI measuring mode



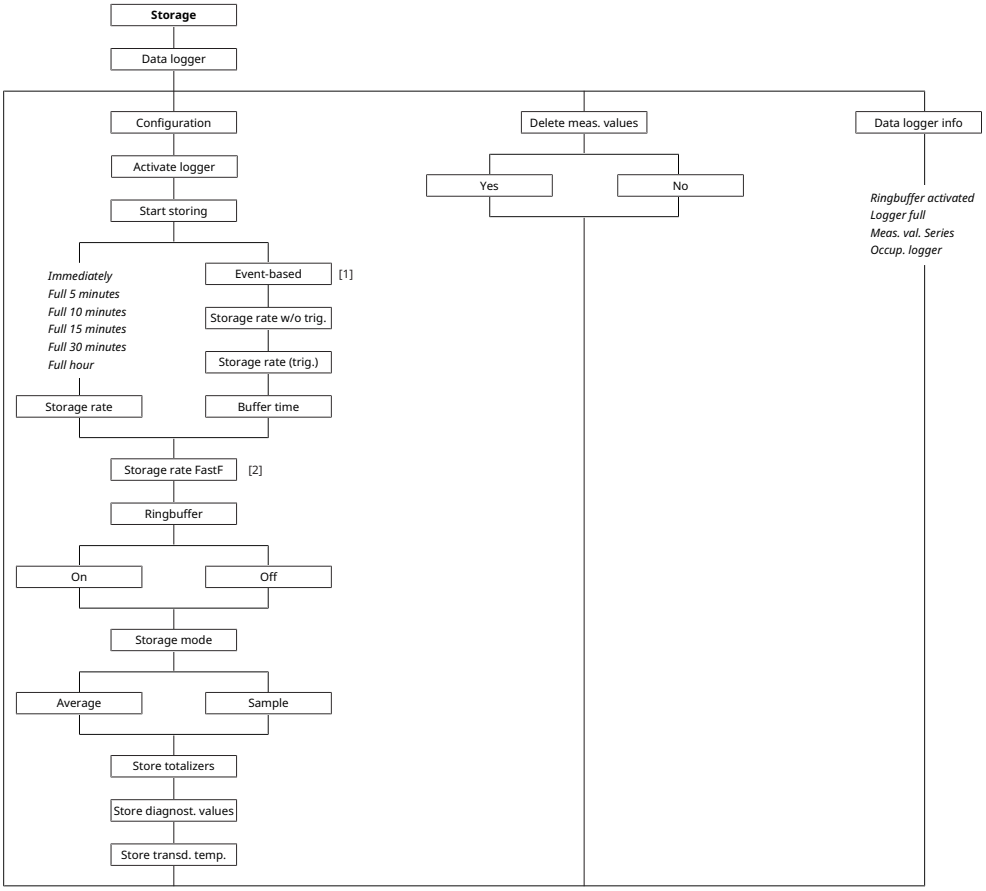
Legend
[1] from SuperUser mode

Input of parameters



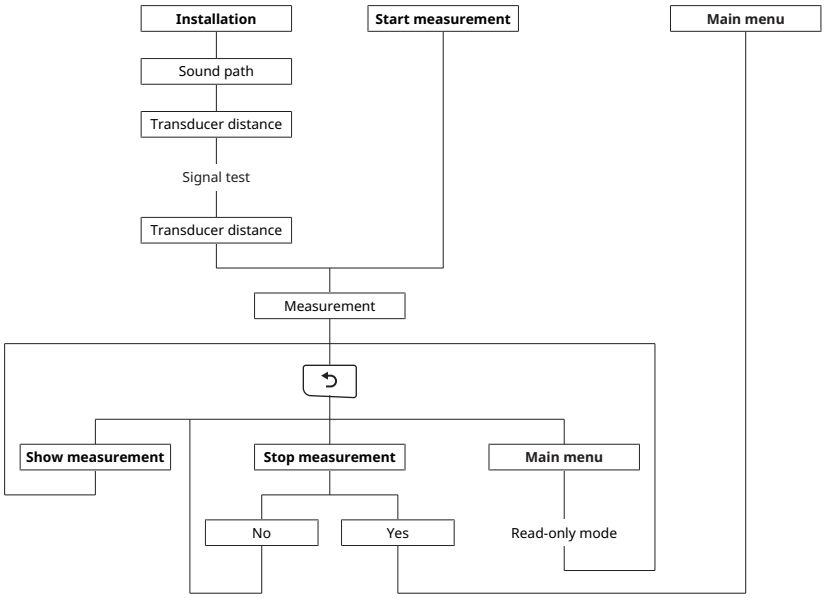
Legend
[1] only if enabled

Data logger

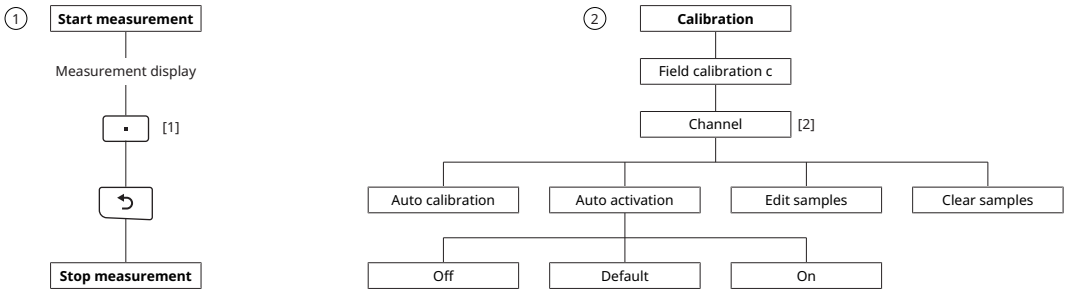


Legend
[1] list of parameterized triggerable inputs and event triggers
[2] only if enabled

Measurement start

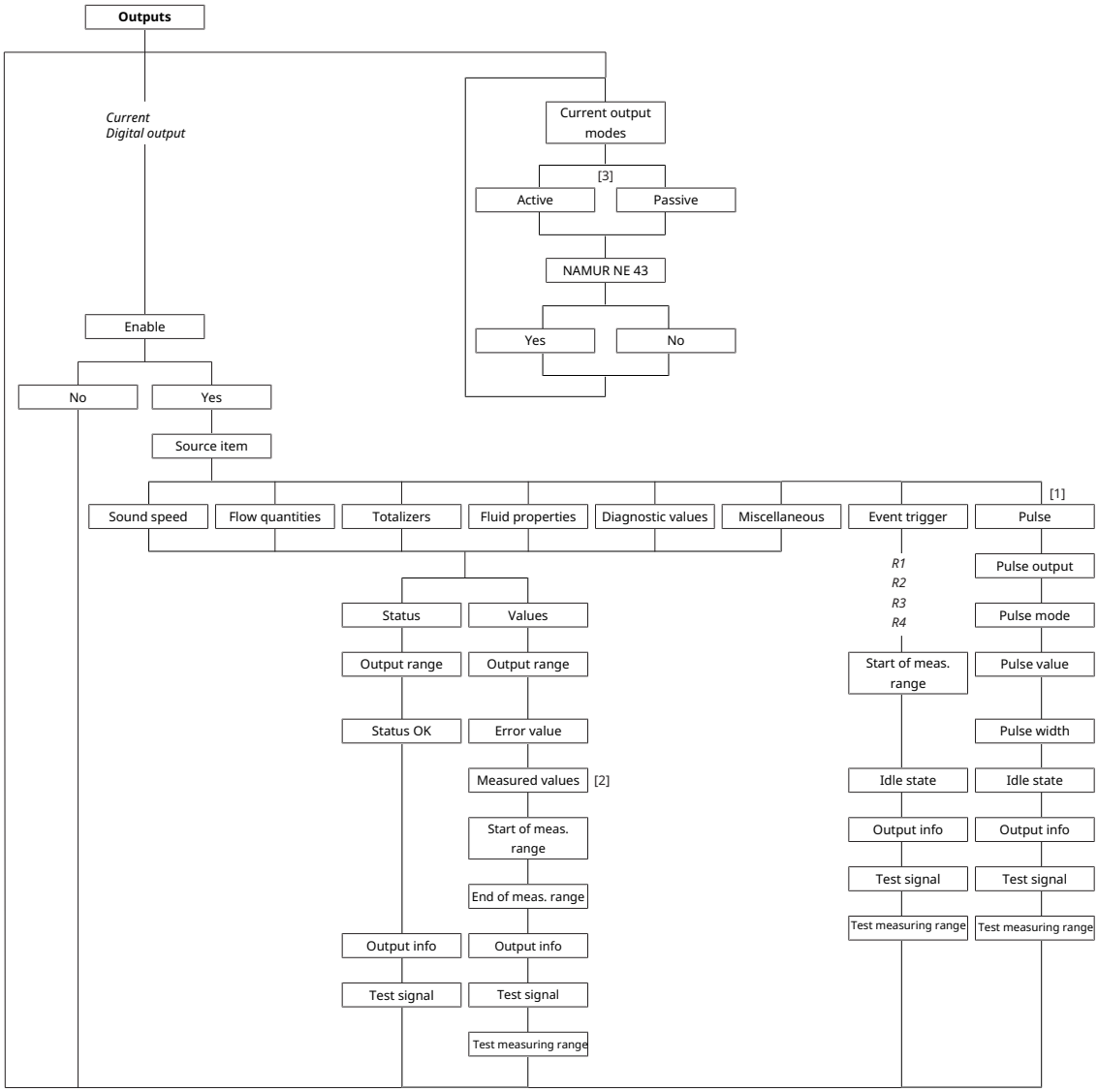


Field calibration



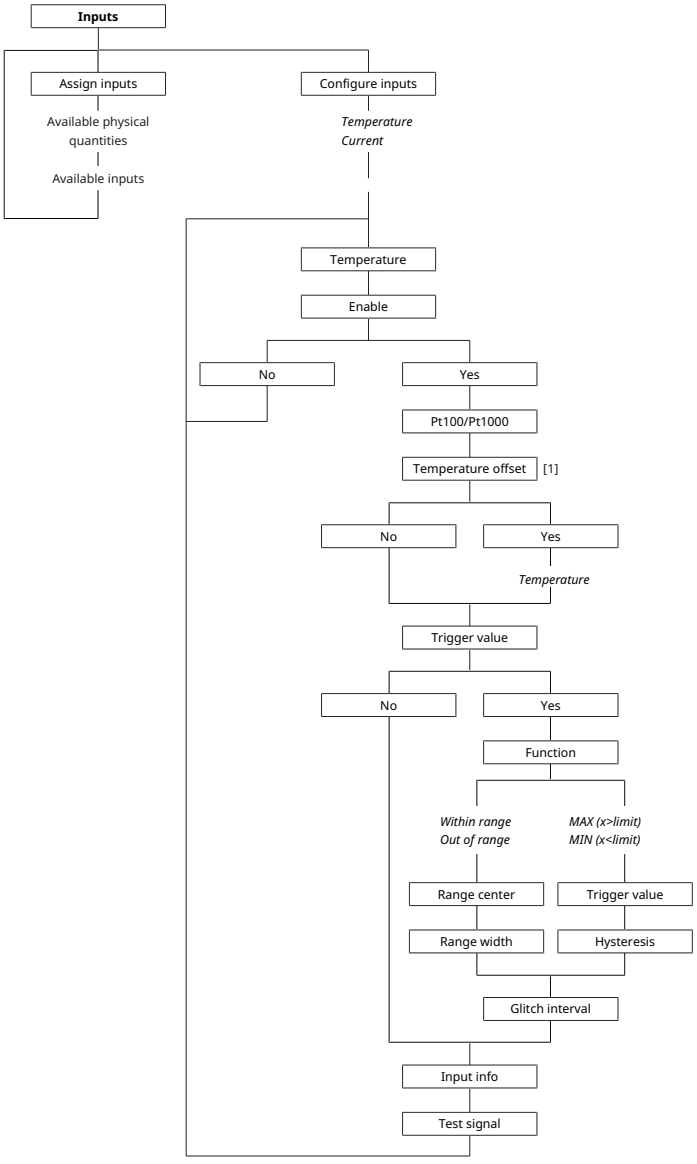
Legend
[1] sampling to store calibration values
[2] only if 1 meas. point (AB) is selected for the configuration of the measuring point

Configuration of outputs



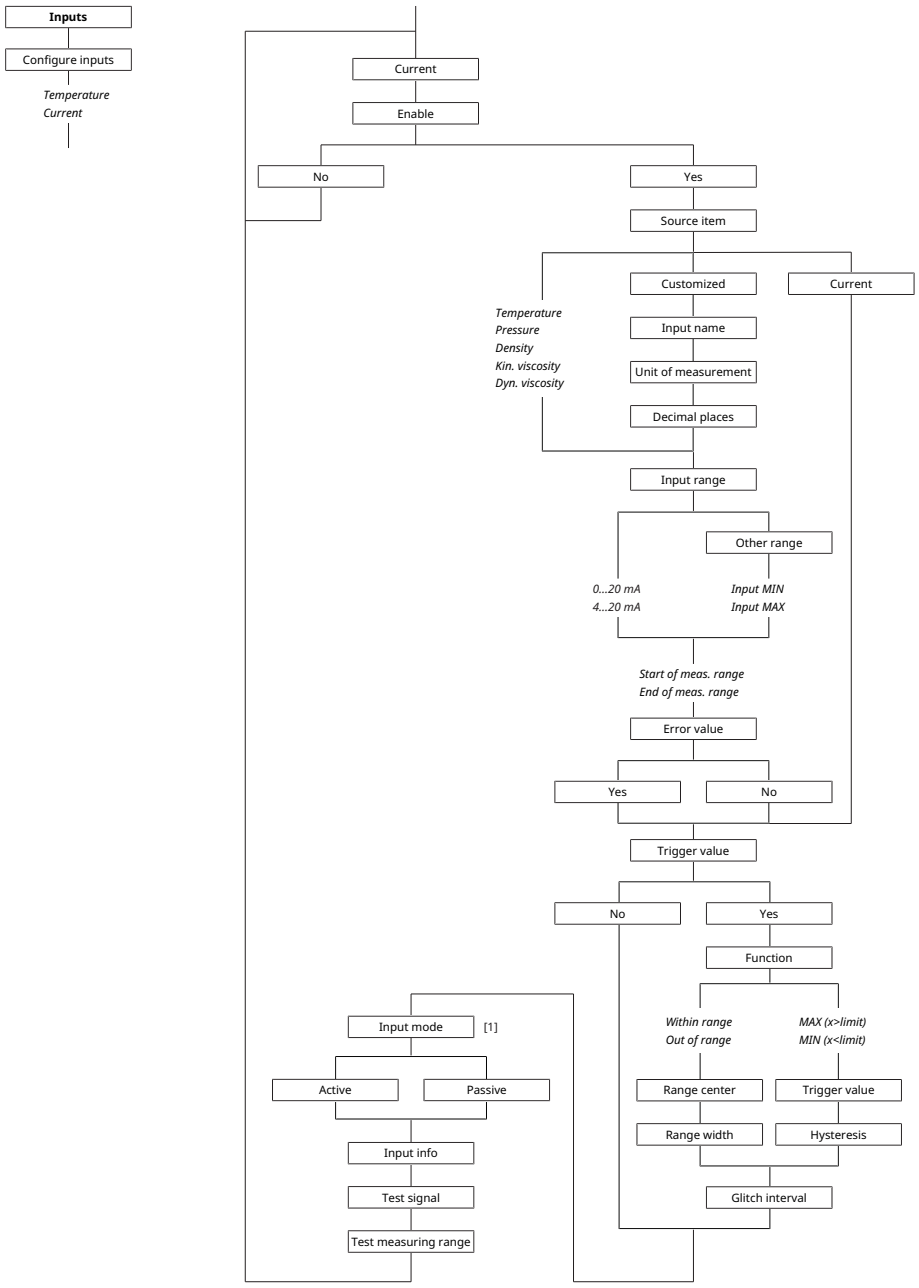
Legend
[1] only available for digital outputs supporting pulse output
[2] requested only if the physical quantity can adopt a negative value
[3] only if switchable current outputs are available

Temperature inputs



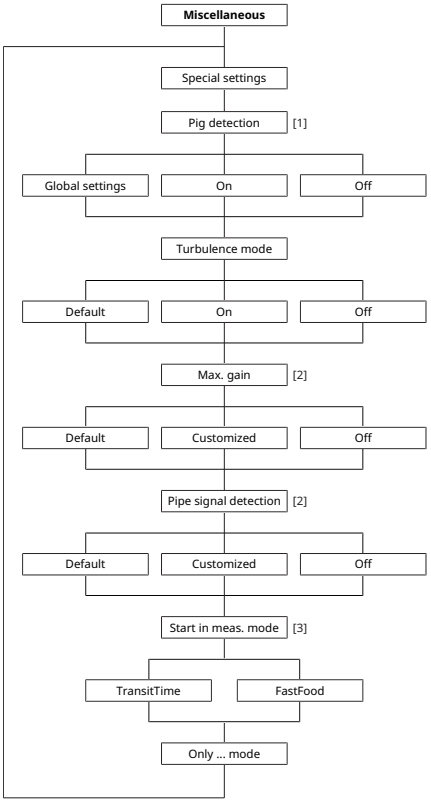
Legend
[1] only if enabled

Current inputs



Legend
[1] only if supported by the hardware

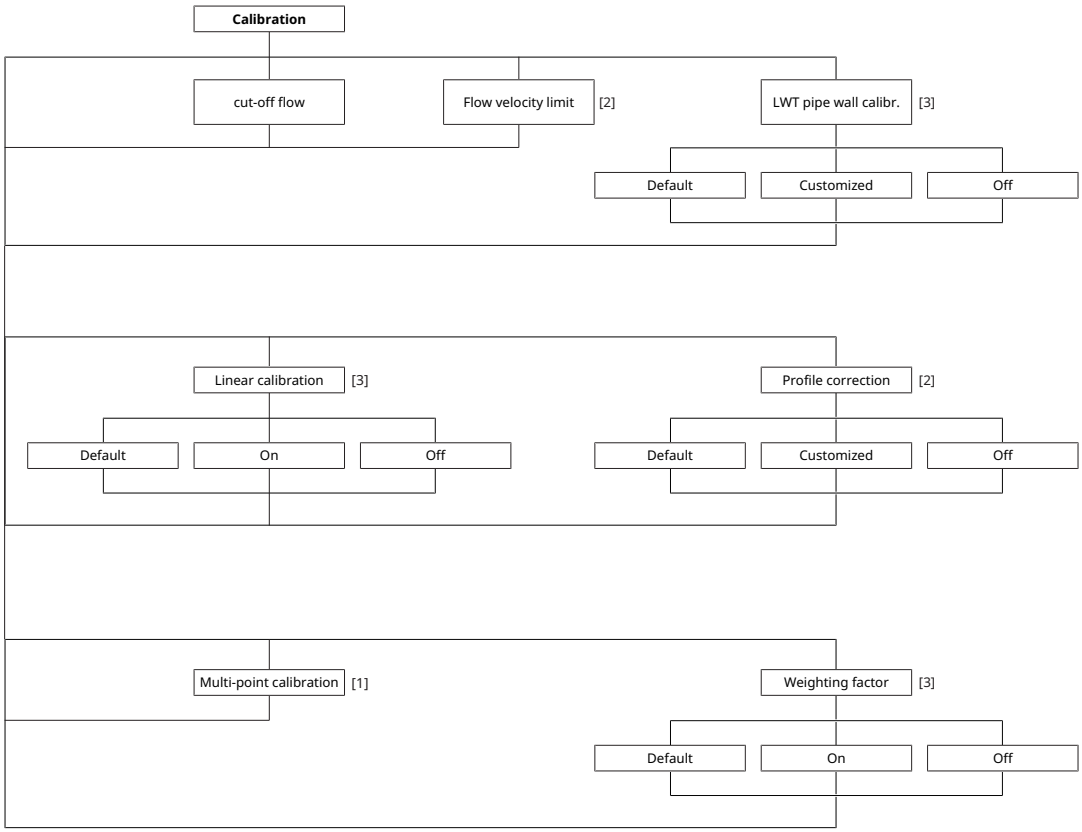
Special settings



Legend
[1] only in SuperUser mode and if activated via HotCode
[2] only in ExpertUser, SuperUser and SuperUser ext. mode
[3] only if FastFood mode is enabled

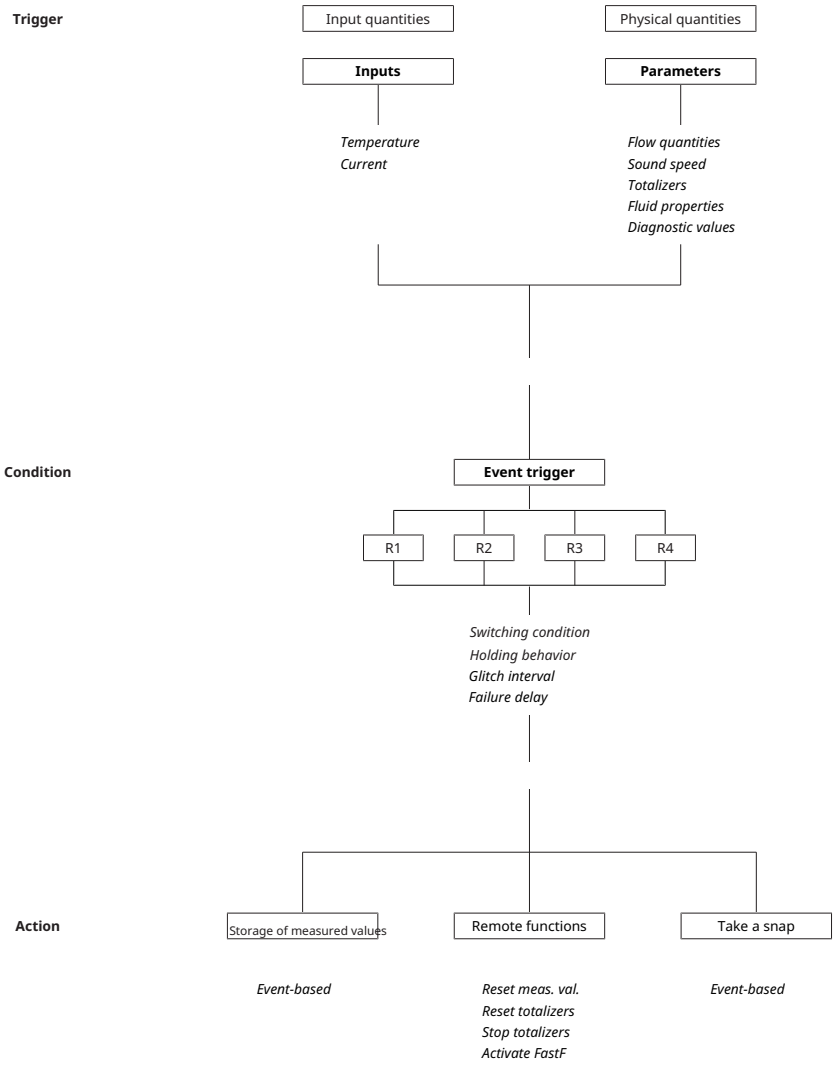
Calibration

If `Channel-based param.` is selected for the configuration of the measuring point, the settings can be made individually for each measuring channel.

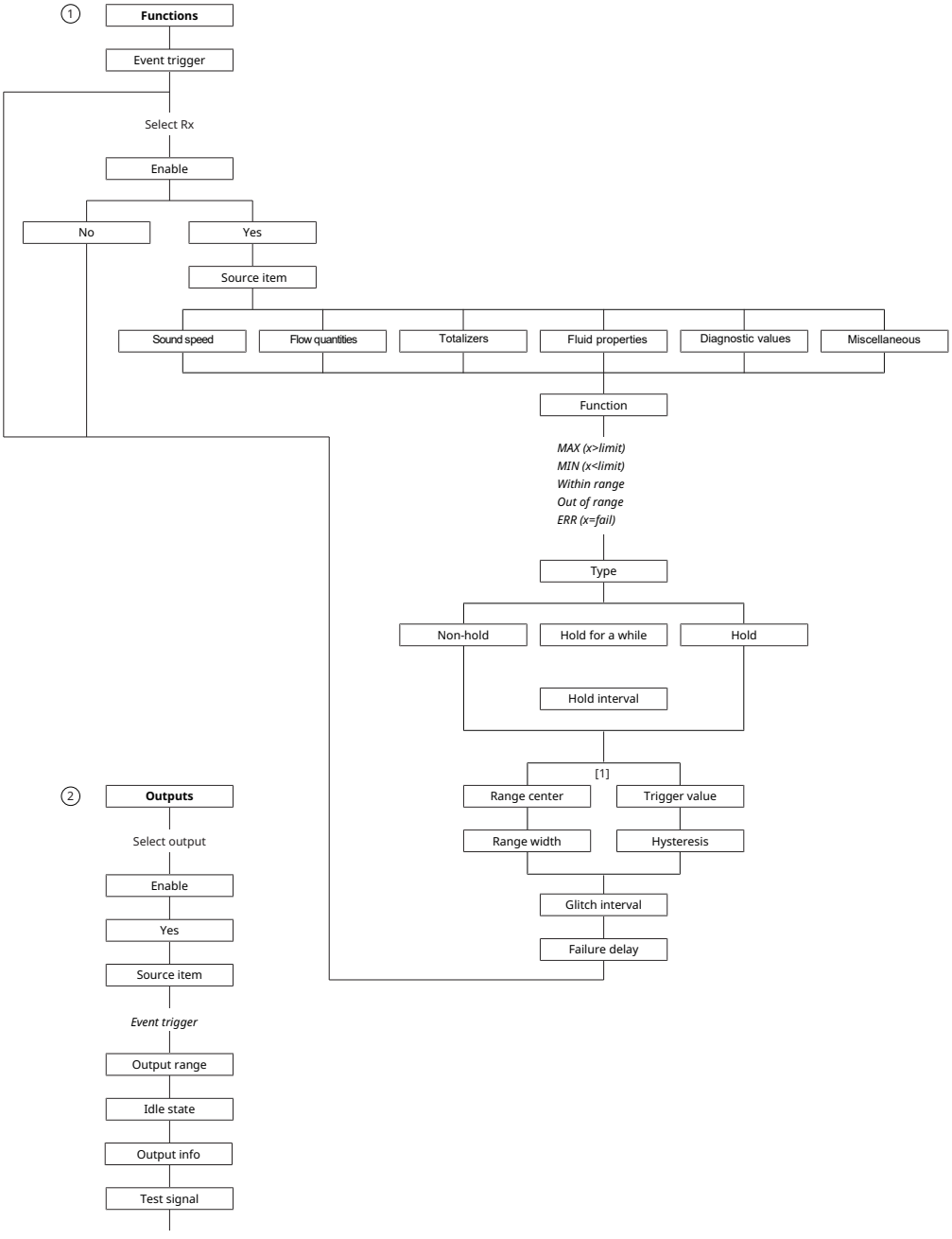


Legend
[1] only if enabled
[2] only in ExpertUser, SuperUser and SuperUser ext. mode
[3] only in SuperUser and SuperUser ext. mode

Events – overview

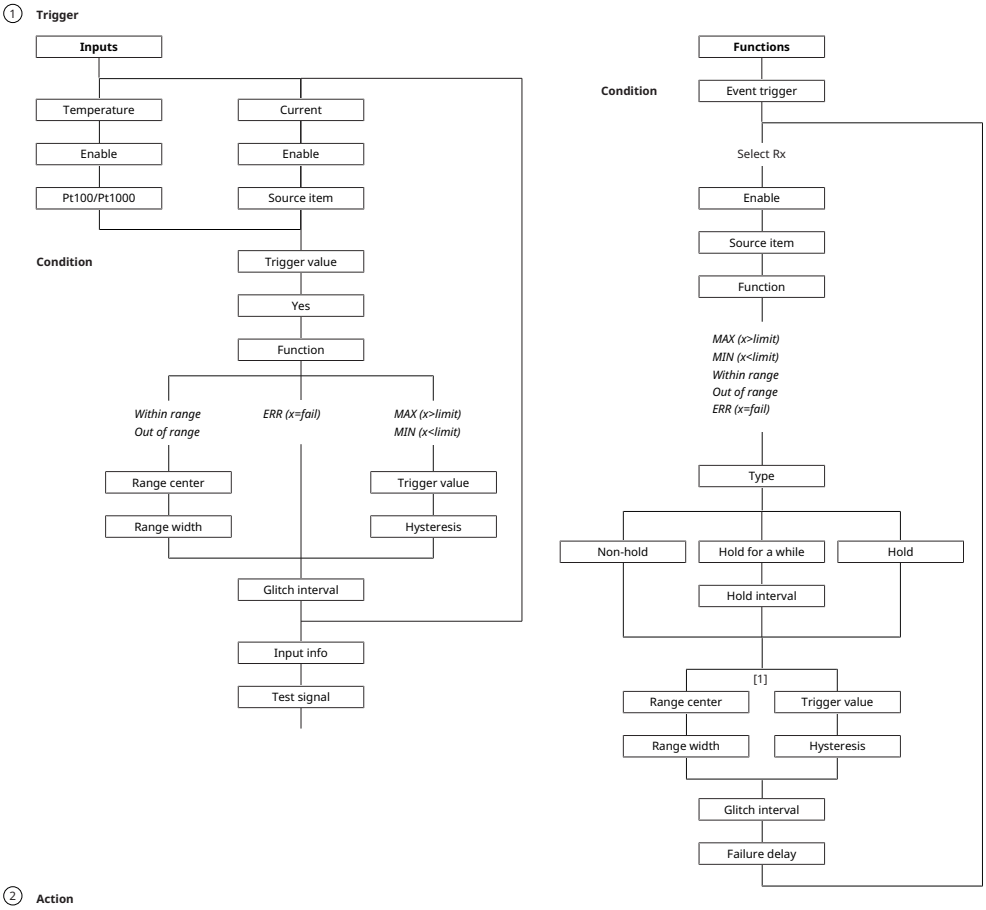


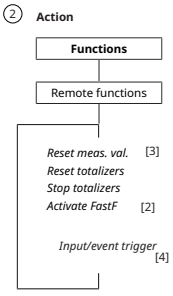
Definition of event triggers



Legend
[1] depending on the selected function

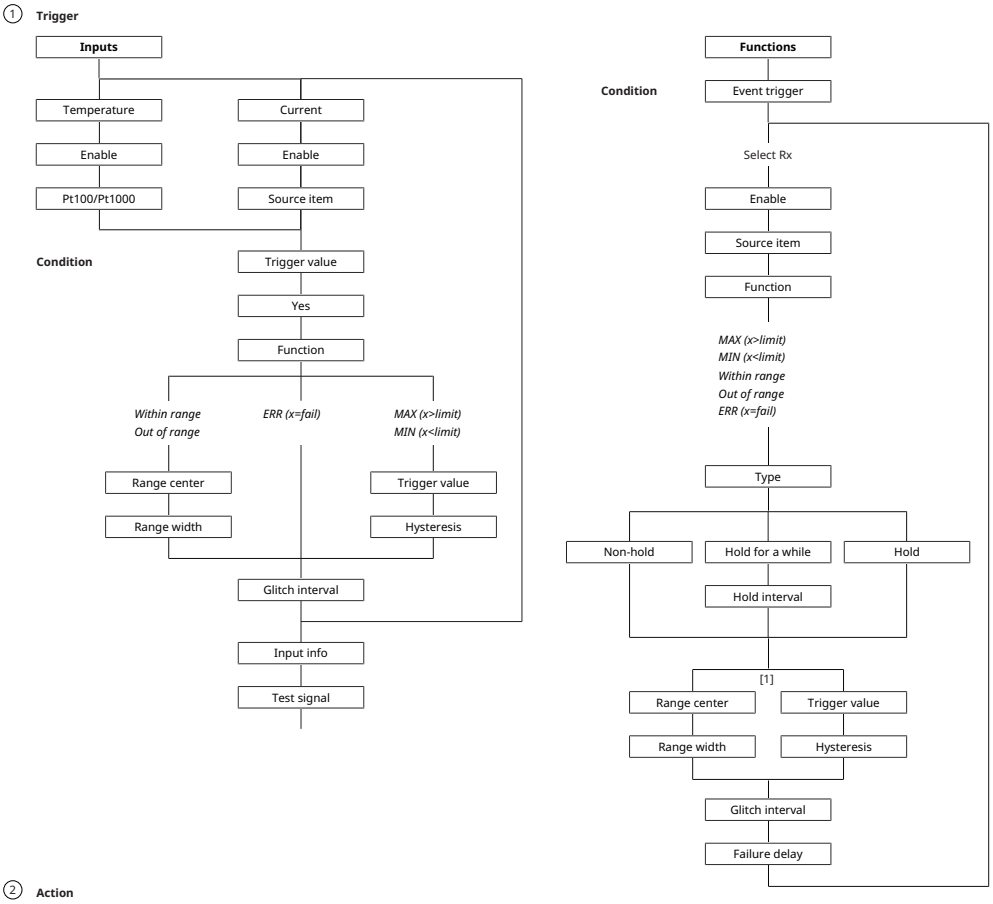
Remote functions





Legend
[1] depending on the selected function
[2] only if FastFood mode is enabled
[3] only controllable via inputs
[4] list of parameterized triggerable inputs and event triggers

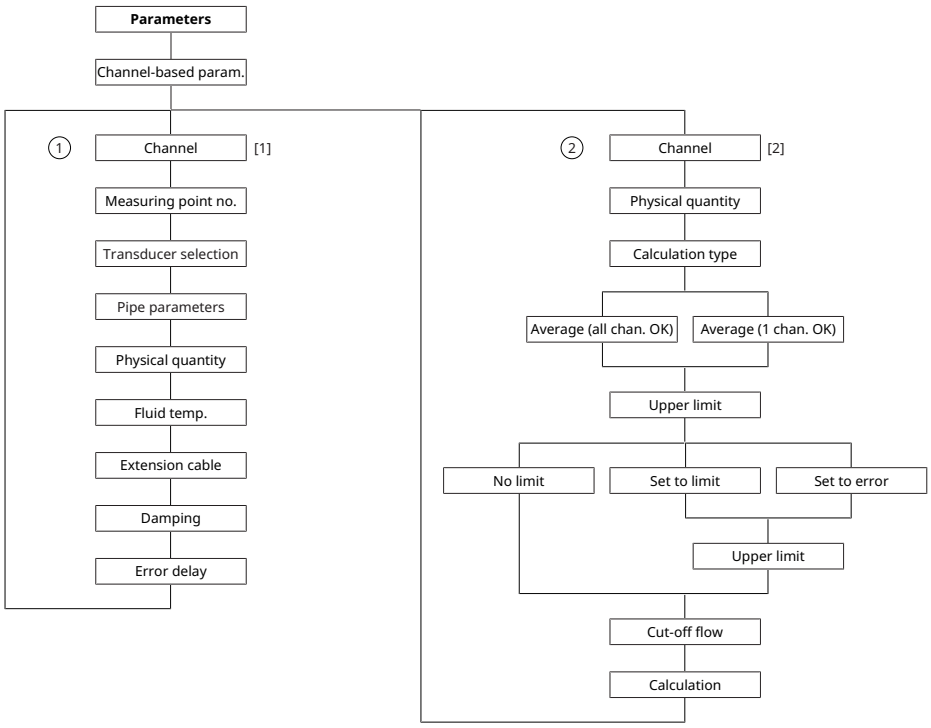
Event-based storing of measured values



Legend
[1] depending on the selected function

Calculation channels

This function is only available in `SuperUser` or `SuperUser ext.` mode.



Legend
[1] available measuring channels
[2] calculation channels

B Annex: Units of measurement

Length/roughness

unit of measurement	description
mm	millimeter
in	inch

Temperature

unit of measurement	description
°C	degree Celsius
°F	degree Fahrenheit

Pressure

unit of measurement	description
bar(a)	bar (absolute)
bar(g)	bar (relative)
mbar(a)	millibar (absolute)
mbar(g)	millibar (relative)
MPa	megapascal
mmHg	millimeter of mercury
mH2O	meter head of water
psi(a)	pound per square inch (absolute)
psi(g)	pound per square inch (relative)
mH2O	meter head of water

Density

unit of measurement	description
g/m3	gram per cubic centimeter
kg/m3	kilogram per cubic centimeter
lb/ft3	pound per cubic foot

Sound speed

unit of measurement	description
m/s	meter per second
fps (ft/s)	foot per second

Kinematic viscosity

unit of measurement	description
mm2/s	square millimeter per second
cSt	centistokes

1 mm^2/s = 1 cSt

Flow velocity

unit of measurement	description
m/s	meter per second
cm/s	centimeter per second
in/s	inch per second
fps (ft/s)	foot per second

Standard/operating volumetric flow rate

unit of measurement	description	standard/operating volume (totalized) [1]
m3/d	cubic meter per day	m3
m3/h	cubic meter per hour	m3
m3/min	cubic meter per minute	m3
m3/s	cubic meter per second	m3
km3/h	cubic kilometer per hour	km3
ml/min	milliliter per minute	l
l/h	liter per hour	l
l/min	liter per minute	l
l/s	liter per second	l
hl/h	hectoliter per hour	hl
hl/min	hectoliter per minute	hl
hl/s	hectoliter per second	hl
Ml/d (Megalit/d)	megaliter per day	Ml
bbl/d [4]	barrel per day	bbl
bbl/h [4]	barrel per hour	bbl
bbl/m [4]	barrel per minute	bbl
bbl/s [4]	barrel per second	bbl
USgpd (US-gal/d)	gallon per day	gal
USgph (US-gal/h)	gallon per hour	gal
USgpm (US-gal/m)	gallon per minute	gal

unit of measurement	description	standard/operating volume (totalized) [1]
USgps (US-gal/s)	gallon per second	gal
KGPM (US-Kgal/m)	kilogallon per minute	kgal
MGD (US-Mgal/d)	million gallons per day	Mgal
CFD	cubic foot per day	cft [2]
CFH	cubic foot per hour	cft
CFM	cubic foot per minute	cft
CFS	cubic foot per second	aft [3]
MCFD	thousand cubic feet per day	CCF
MCFH	thousand cubic feet per hour	CCF
MMCFD	million cubic feet per day	MMCF
MMCFH	million cubic feet per hour	MMCF
Igpd (Imp-gal/d)	gallon per day	Igal
Igph (Imp-gal/h)	gallon per hour	Igal
Igpm (Imp-gal/m)	gallon per minute	Igal
Igps (Imp-gal/s)	gallon per second	Igal
IKGM (Imp-Kgal/m)	imperial kilogallon per minute	IKG
IMGD (Imp-Mgal/d)	million imperial gallons per day	IMG

[1] selection in the menu item Parameters\Units of measurement

[2] cft: cubic foot

[3] aft: acre foot

[4] In the menu item Miscellaneous\Units of measurement\Barrel type it is possible to define the barrel type to be displayed when setting the units of measurement for the standard/operating volumetric flow rate and the totalized standard/operating volume. If the barrel type Imperial (UK) is selected, imperial (UK) gallons instead of US gallons are used.

1 US-gal = 3.78541 l

1 UK-gal = 4.54609 l

US Barrel Oil = 42.0 US-gal ≈ 159 l

US Barrel Wine = 31.5 US-gal ≈ 119 l

US Barrel Beer = 31.0 US-gal ≈ 117 l

Imperial (UK) Barrel = 36.0 UK-gal ≈ 164 l

Mass flow rate

unit of measurement	description	mass (totalized)
t/h	ton per hour	t
t/d	ton per day	t
kg/h	kilogram per hour	kg
kg/min	kilogram per minute	kg

unit of measurement	description	mass (totalized)
`kg/s`	kilogram per second	`kg`
`g/s`	gram per second	`g`
`lb/d`	pound per day	`lb`
`lb/h`	pound per hour	`lb`
`lb/m`	pound per minute	`lb`
`lb/s`	pound per second	`lb`
`klb/h`	kilopound per hour	`klb`
`klb/m`	kilopound per minute	`klb`

1 lb = 453.59237 g

1 t = 1000 kg

C Annex: Reference

The following tables provide assistance for the user. The accuracy of the data depends on the composition, temperature and processing of the material. Flexim does not assume liability for any inaccuracies.

C.1 Sound speed of selected pipe and lining materials at 20 °C

The values of some of these materials are stored in the internal database of the transmitter. Column c_{flow} shows the type of sound waves (longitudinal or transversal) used for the flow measurement.

material (display)	explanation	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
Carbon steel	carbon steel	3230	5930	trans
Stainless steel	stainless steel	3100	5790	trans
DUPLEX	duplex stainless steel	3272	5720	trans
Ductile iron	ductile iron	2650	-	trans
Asbestos cement	asbestos cement	2200	-	trans
Titanium	titanium	3067	5955	trans
Copper	copper	2260	4700	trans
Aluminum	aluminum	3100	6300	trans
Brass	brass	2100	4300	trans
Plastic	plastic	1120	2000	long
GRP	glass reinforced plastic	-	2650	long
PVC	polyvinyl chloride	-	2395	long
PE	polyethylene	540	1950	long
PP	polypropylene	2600	2550	trans
Bitumen	bitumen	2500	-	trans
Acrylic glass	acrylic glass	1250	2730	long
Lead	lead	700	2200	long
Cu-Ni-Fe	copper-nickel-iron alloy	2510	4900	trans
Cast iron	cast iron	2200	4600	trans
Rubber	rubber	1900	2400	trans
Glass	glass	3400	5600	trans
PFA	perfluoralcoxy	500	1185	long

material (display)	explanation	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
PVDF	polyvinylidene fluorid	760	2050	long
Sintimid	Sintimid	-	2472	long
Teka PEEK	Teka PEEK	-	2534	long
Tekason	Tekason	-	2230	long

The sound speed depends on the composition and processing of the material. The sound speed of alloys and cast materials fluctuates strongly. The values only serve as an orientation.

C.2 Typical pipe roughness values

The values are based on experience and measurements.

material	absolute roughness [mm]
drawn pipes of non-ferrous metal, glass, plastics and light metal	0...0.0015
drawn steel pipes	0.01...0.05
fine-planed, polished surface	max. 0.01
planed surface	0.01...0.04
rough-planed surface	0.05...0.1
welded steel pipes, new	0.05...0.1
after long use, cleaned	0.15...0.2
moderately rusted, slightly encrusted	max. 0.4
heavily encrusted	max. 3
cast iron pipes:	
bitumen lining	> 0.12
new, without lining	0.25...1
rusted	1...1.5
encrusted	1.5...3

C.3 Typical properties of selected fluids at 20 °C

C.3.1 Mixtures with non-changing composition

fluid	explanation	sound speed [m/s]	density [kg/m³]	kine-matic viscosity [mm²/s]	valid range of fluid data [°C]	thermal energy measure-ment (1)
Water	liquid water	1482	999	1	0...350	x
Propane	liquefied under pressure	755	500	0.2	-180...+97	
Butane	liquefied under pressure, coolant R-600	929	577	0.3	-135...+152	x
Ammonia	liquefied under pressure, coolant R-717	1373	610	0.2	-78...+132	x
Methanol		1119	792	0.7	-95...+240	
Ethanol		1158	789	1.5	-110...+241	
Acetone		1187	791	0.4	-90...+235	
R134a HFC	coolant HFC	521	1240	0.2	-100...+100	x
R407C HFC	coolant HFC	494	1158	0.1	-20...+81	x
R410A HFC	coolant HFC	457	1085	0.1	-130...+71	x
R22 CFC	coolant HFC	557	1213	0.1	-150...+90	x
BP Transcal LT	thermal oil	1365	876	20	-20...+260	x
BP Transcal N	thermal oil	1365	876	94	0...320	x
Shell Thermia B	thermal oil	1365	863	89	0...310	x
Mobiltherm 594	thermal oil	1365	873	7.5	-44...+260	x
Mobiltherm 603	thermal oil	1365	859	55	0...320	x
Gasoline	hydrocarbon with 58 °API	1252	741	1.1	-50...+450	
Diesel	hydrocarbon with 38 °API	1380	831	2.2	-50...+450	
Jet A1	hydrocarbon with 44 °API	1358	821	1.7	-50...+450	

(1) thermal energy rate coefficient included in the fluid data set

C.3.2 Mixtures with changing composition

fluid	explanation	parametrization [1]	sound speed [m/s]	density [kg/m³]	kinematic viscosity [mm²/s]	valid range of fluid data	thermal energy measurement [2]
Glycol/H2O	ethylene glycol	proportion of glycol	1482...1710	999...1132	1...23	-30...+150 °C 0...100 %	x
Petroleum	hydrocarbon	API gravity	530...1800	440...1130	1...> 400	-50...+450 °C -10...+200 °API	
Lubricant	hydrocarbon-based lubricant, kinematic viscosity at 40 °C	viscosity grade (VG)	1433...1485	871...923	1...> 400	-40...+300 °C 1...1500 VG	
Sea water		salinity (S in g/kg)	1482...1840	999...1230	1...1.3	-30...+150 °C 0...300 g/kg	x
Sulfuric acid	mixture of sulfuric acid and water	proportion of sulfuric acid	1280...1560	999...1907	1...12	-20...+250 °C 0...100 %	
Hydrochloric acid	mixture of hydrochloric acid and water	proportion of hydrochloric acid	1482...1527	999...1256	1...1.5	-20...+150 °C 0...50 %	
Nitric acid	mixture of nitric acid and water	proportion of nitric acid	1286...1590	999...1554	1...2.4	-20...+150 °C 0...100 %	
Hydrofluoric acid	mixture of hydrofluoric acid and water	proportion of hydrofluoric acid	804...1482	999...1195	0.5...1	-20...+105 °C 0...100 %	
Soda lye	mixture of soda lye and water	proportion of soda lye	1482...2563	999...1666	1...265	-10...+200 °C 0...65 %	

[1] menu Parameters

[2] thermal energy rate coefficient included in the fluid data set

C.4 Properties of water at 1 bar and at saturation pressure

fluid temperature [°C]	fluid pressure [bar]	sound speed [m/s]	density [kg/m^3]	specific heat [1] [kJ/kg/K^{-1}]
0.1	1.013	1402.9	999.8	4.219
10	1.013	1447.3	999.7	4.195
20	1.013	1482.3	998.2	4.184
30	1.013	1509.2	995.6	4.180
40	1.013	1528.9	992.2	4.179
50	1.013	1542.6	988.0	4.181
60	1.013	1551.0	983.2	4.185
70	1.013	1554.7	977.8	4.190
80	1.013	1554.4	971.8	4.197
90	1.013	1550.5	965.3	4.205
100	1.013	1543.2	958.3	4.216
120	1.985	1519.9	943.1	4.244
140	3.615	1486.2	926.1	4.283
160	6.182	1443.2	907.4	4.335
180	10.03	1391.7	887.0	4.405
200	15.55	1332.1	864.7	4.496
220	23.20	1264.5	840.2	4.615
240	33.47	1189.0	813.4	4.772
260	46.92	1105.3	783.6	4.986
280	64.17	1012.6	750.3	5.289
300	85.88	909.40	712.1	5.750
320	112.8	793.16	667.1	6.537
340	146.0	658.27	610.7	8.208
360	186.7	479.74	527.6	15.00
373.946	220.640	72.356	322.0	∞

[1] at constant pressure

D Annex: Legal information – open source licenses

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E Annex: Declarations of conformity

For the EU declaration of conformity according to ATEX directive see document SIFLUXUS.

EU Declaration of Conformity

CE

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Boxberger Straße 4
12681 Berlin
Germany

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Ultrasonic Flow Meters FLUXUS a736-NN**

a = F, G, H

Jens Hilpert
Vice President, Ultrasonic

Low Voltage Directive (2014/35/EU)

Harmonized Standards:

EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019

EMC Directive (2014/30/EU)

Harmonized Standards:

EN IEC 61326-1:2021

RoHS Directive (2011/65/EU)

Harmonized Standards:

EN IEC 63000:2018

UK Declaration of Conformity

UK CA

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Boxberger Straße 4
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Electrical Equipment Safety Regulations (UK Statutory Instruments 2016 No. 1101)

Designated Standards:

EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019

EMC Regulations (UK Statutory Instruments 2016 No. 1091)

Designated Standards:

EN IEC 61326-1:2021

RoHS Regulations (UK Statutory Instruments 2012 No. 3032)

Designated Standards:

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Operating Instruction
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Flexim GmbH
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