Operating Instruction
UM_F631V7-0EN
AN 27761
2026-03-01

Flexim FLUXUS F631

Ultrasonic Flowmeter

FLEXIM

EMERSON

Table of contents

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 and instructions for the accessories used 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. 2.1: Explanation of symbols on the transmitter and accessories:

symbol	meaning
⎓	direct current
⏚	ground conductor terminal
	Electric devices must be disposed of separately. If necessary, additional hazardous substances are indicated for disposal.
⚠	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.

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

Observe the instructions for hazardous substances and the respective safety data sheets. Observe the regulations for the disposal of electrical equipment and batteries.

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 as well as other related properties, such as temperature and pressure, are measured and evaluated.

The transmitter uses these values to calculate the sought quantities, e.g., volumetric flow rate, mass flow rate and thermal energy. 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 this 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.
- 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.

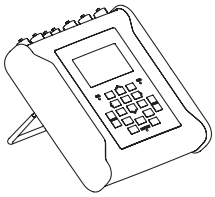
2.5 Safety instructions for the operator

- 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, 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

- Electrical work may only be carried out if there is enough space.
- The degree of protection of the transmitter is only ensured if all unused connections are covered.
- The condition and tight fit of the electrical connections have to be checked at regular intervals.
- The power supply unit for charging the battery may only be connected to networks up to overvoltage category II. Use only the supplied power supply unit.
- The transmitter and the power supply unit must not be disassembled. 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. 2.1: Transmitter



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

In the ultrasonic flow measurement, the flow velocity of the fluid in a pipe is determined. Further physical quantities are derived from the flow velocity and, if necessary, from additional physical quantities.

3.1 Measurement principle

The flow velocity of the fluid is measured in the TransitTime mode using the ultrasonic transit time difference correlation principle. When measuring with a high proportion of gas bubbles or solid particles, the transmitter can toggle into the NoiseTrek mode.

3.1.1 Terms

Flow profile

Distribution of flow velocities over the cross-sectional pipe area. For an optimal measurement, the flow profile has to be fully developed and axisymmetrical. The shape of the flow profile depends on whether the flow is laminar or turbulent and is strongly influenced by the conditions at the inlet of the measuring point.

Reynolds number

Coefficient describing the turbulence behavior of a fluid in the pipe. The Reynolds number Re is calculated from the flow velocity, the kinematic viscosity of the fluid and the inner pipe diameter.

If the Reynolds number exceeds a critical value (usually approx. 2300, if the fluid flows in a pipe), a transition from a laminar flow to a turbulent flow takes place.

Laminar flow

A flow without any turbulence. There is no mixing between the parallel flowing layers of the fluid.

Turbulent flow

A flow with turbulences (swirling of the fluid). In technical applications, the flow in the pipe is mostly turbulent.

Transition range

The flow is partly laminar and partly turbulent.

Sound speed

Speed of the propagating sound. The sound speed depends on the mechanical properties of the fluid or the pipe material. In pipe materials and other solids, a distinction is made between the longitudinal and transversal sound speed.

Flow velocity

Average of all flow velocities of the fluid over the cross-sectional pipe area.

Acoustic calibration factor

$$k_a = \frac{c_\alpha}{\sin\alpha}$$

The acoustic calibration factor k_a is a transducer parameter which results from the sound speed c within the transducer and the angle of incidence. According to Snell's law of refraction, the angle of propagation in the adjoining fluid or pipe material is:

$$k_a = \frac{c_\alpha}{\sin\alpha} = \frac{c_\beta}{\sin\beta} = \frac{c_\gamma}{\sin\gamma}$$

Fluid mechanic calibration factor

With the fluid mechanic calibration factor k_{Re}, the flow velocity measured in the area of the sound beam is converted into the average flow velocity across the whole cross-sectional pipe area. In case of a fully developed turbulent flow profile, the fluid mechanic calibration factor only depends on the Reynolds number and the roughness of the inner pipe wall. The fluid mechanic calibration factor is recalculated by the transmitter for each new measurement.

Volumetric flow rate

$$\dot{V} = v \cdot A$$

The volume of the fluid that passes through the pipe per unit time. The volumetric flow rate is calculated from the product of the flow velocity v and the cross-sectional pipe area A.

Mass flow rate

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

The mass of the fluid that passes through the pipe per unit time. The mass flow rate is calculated from the product of the volumetric flow rate $\dot{V}$ and the density ρ.

Thermal energy rate

The thermal energy that is transported per unit time.

3.1.2 Measurement of the flow velocity in the TransitTime mode

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.

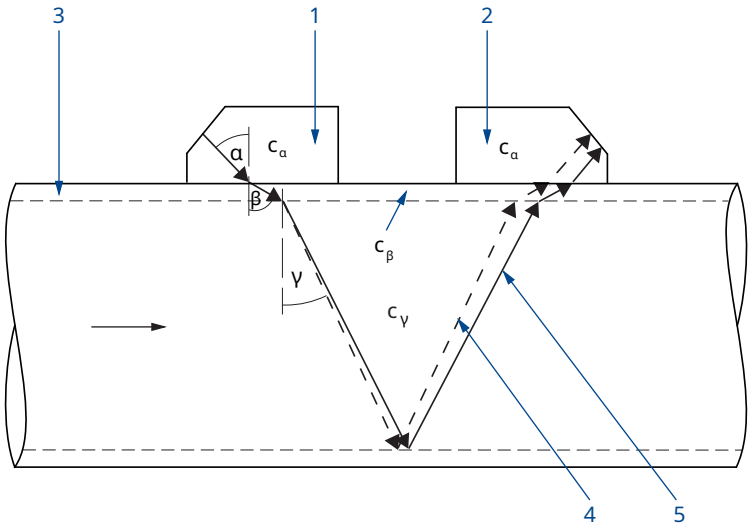
The average flow velocity of the fluid is calculated as follows:

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

where

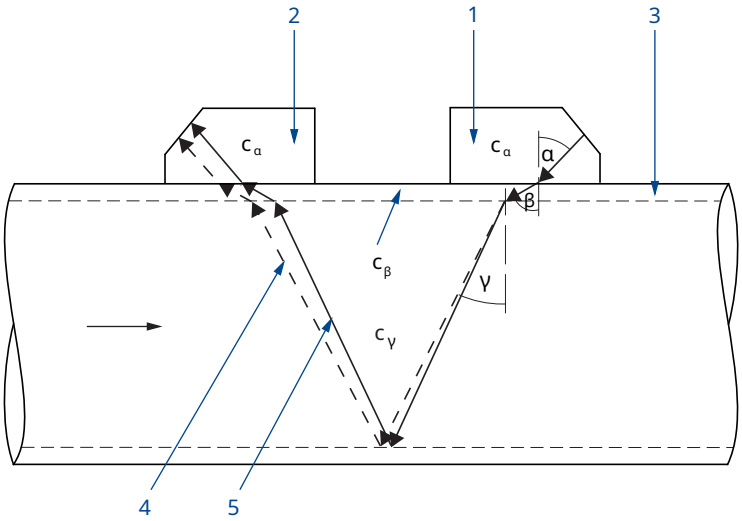
- v – average flow velocity of the fluid
- k_{Re} – fluid mechanic calibration factor
- k_a – acoustic calibration factor
- Δt – transit time difference
- t_γ – transit time in the fluid

Fig. 3.1: Sound path of the signal in the flow direction



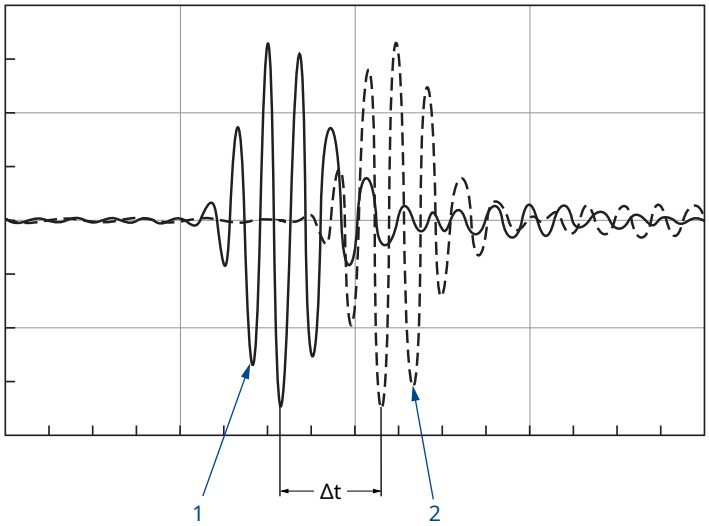
1 transducer (emitter)
2 transducer (receiver)
3 pipe wall
4 sound path without flow
5 sound path with flow
c sound speed

Fig. 3.2: 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
c sound speed

Fig. 3.3: Transit time difference Δt



1 signal in flow direction
2 signal against flow direction

3.1.3 Measurement of the flow velocity in the NoiseTrek mode

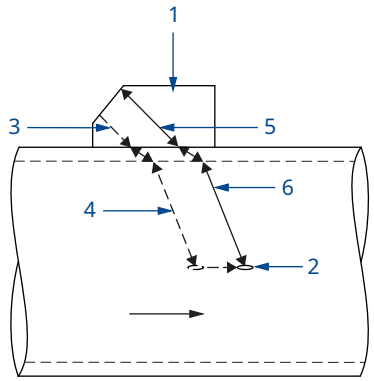
If the proportion of gas bubbles and/or solid particles in the fluid is high, the ultrasonic signal can be attenuated to such an extent that the complete penetration of the fluid and therefore a measurement in TransitTime mode is not possible. In this case, the NoiseTrek mode has to be used. The measurement arrangement does not need to be changed.

The NoiseTrek mode uses the presence of gas bubbles and/or solid particles in the fluid.

Ultrasonic signals are sent by a transducer into the fluid at short intervals, reflected by gas bubbles and/or solid particles and received again by the same transducer.

The transit time difference Δt of 2 consecutive ultrasonic signals is determined. It is proportional to the distance the gas bubbles/solid particles are covering between 2 consecutive pulses and thus to the average flow velocity of the fluid.

Fig. 3.4: Measurement of the flow velocity in the NoiseTrek mode



1 transducer
2 gas bubble or solid particle
3 pulse at time t
4 ultrasonic signal S_1, transit time t_1
5 pulse at time t + Δt_p
6 ultrasonic signal S_2, transit time t_2

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

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

where

- v – average flow velocity of the fluid
- k_{Re} – fluid mechanic calibration factor
- k_a – acoustic calibration factor
- Δt_p – time difference between 2 consecutive pulses
- Δt – transit time difference of ultrasonic signals S_1 and S_2 ($\Delta t = t_2 - t_1$)

Depending on the attenuation of the ultrasonic signal, the measurement error in the NoiseTrek mode can be greater than in the TransitTime mode.

3.1.4 Measurement of the flow velocity in the HybridTrek mode

The HybridTrek mode combines the TransitTime and the NoiseTrek mode. During a measurement in the HybridTrek mode, the transmitter automatically toggles between the TransitTime and the NoiseTrek mode depending on the proportion of gas bubbles and solid particles in the fluid.

The measurement arrangement is identical to the one in the TransitTime mode.

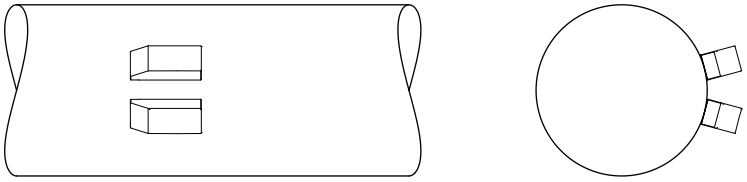
3.1.5 Measurement of the flow velocity in the NoiseTrek parallel beam mode

Pipes with a small diameter or fluids which strongly attenuate the ultrasonic signal can cause a reduction of the transit time in the fluid with the result that the signal quality is no longer sufficient. In this case, the NoiseTrek parallel beam mode has to be used.

The NoiseTrek parallel beam mode works in the same way the NoiseTrek mode does. Ultrasonic signals are sent ans received by different transducers. This leads to a better signal quality. The transducers are mounted in parallel at a small distance from each other on the pipe.

A measurement in TransitTime mode is not possible when using this measurement arrangement.

Fig. 3.5: Measurement arrangement in the NoiseTrek parallel beam mode



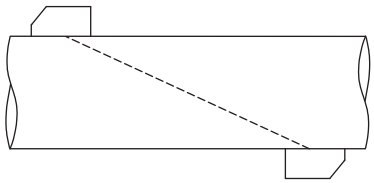
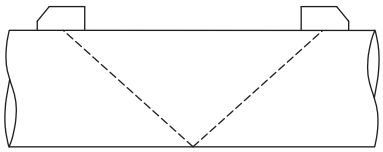
3.1.6 Synchronized channel averaging

Synchronized channel averaging reduces turbulence-related fluctuations of the measured values without the need of long-term averaging. When measuring in reflection arrangement, in x arrangement or displaced X arrangement with synchronized channel averaging, the almost simultaneous measurement on all measuring channels results in optimized compensation of turbulent flow fluctuations.

For the synchronized channel averaging, all transducer pairs must be of the same type and installed at the same measuring point. The measurement arrangement has to be the same for all transducer pairs.

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. 3.6: Diagonal arrangement with 2 sound beams and 6 sound paths

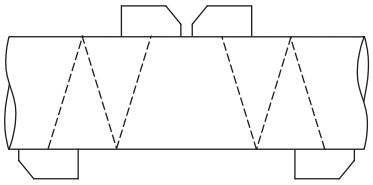
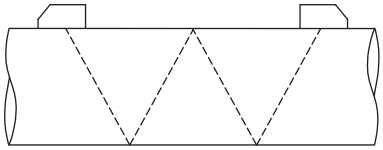


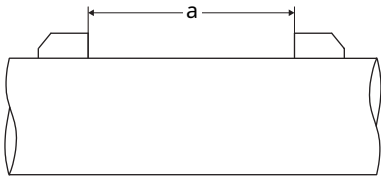
Fig. 3.7: Reflection arrangement with 1 sound beam and 4 sound paths



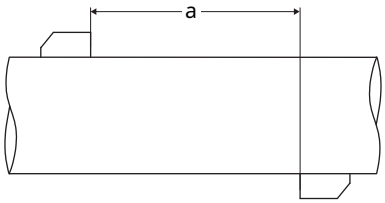
Transducer distance

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

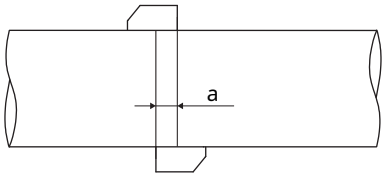
reflection arrangement



diagonal arrangement (positive transducer distance)



diagonal arrangement (negative transducer distance)



a transducer distance

Sound beam plane

Plane the sound beam is located in.

Fig. 3.8: 2 sound beams in 1 plane

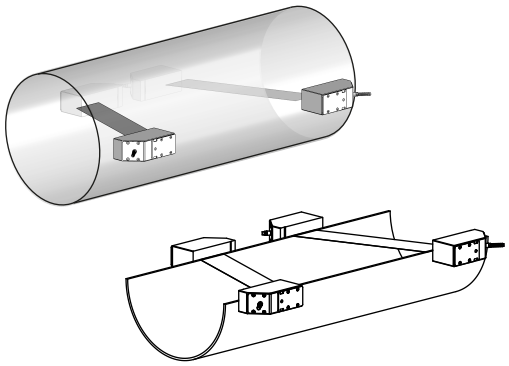
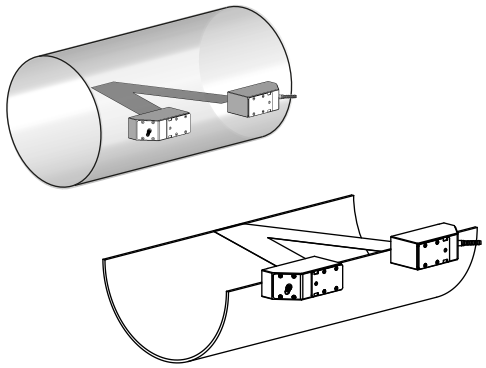
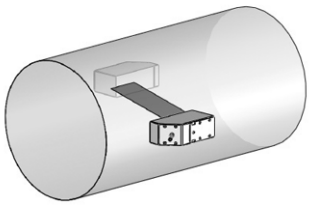
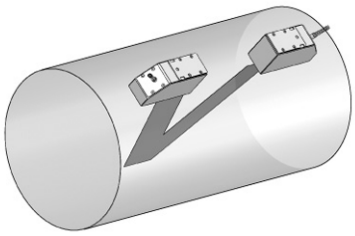
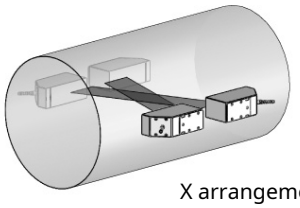
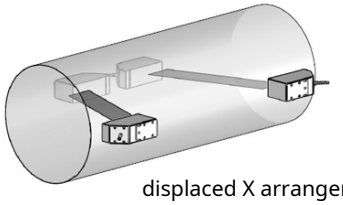
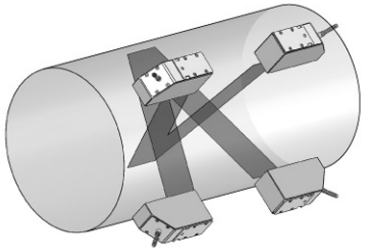


Fig. 3.9: 2 sound paths in 1 plane



3.2.2 Examples

Diagonal arrangement with 1 beam	**Reflection arrangement with 1 beam**
1 transducer pair 1 sound path 1 sound beam 1 plane	1 transducer pair 2 sound paths 1 sound beam 1 plane
	
Diagonal arrangement with 2 beams	**Reflection arrangement with 2 beams and 2 planes**
2 transducer pairs 2 sound paths 2 sound beams 1 plane	2 transducer pairs 4 sound paths 2 sound beams 2 planes
 X arrangement  displaced 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

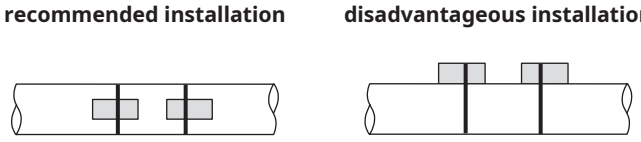
Even bubble-free fluids can form gas bubbles when the fluid expands, e.g., upstream of pumps and downstream of great cross-section enlargements.

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, allowing the sound waves to propagate horizontally in 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.

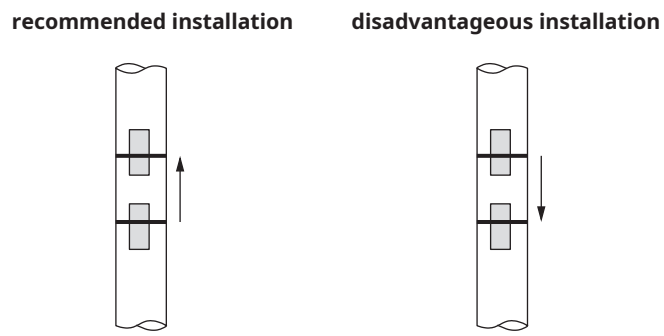
Fig. 3.10: Transducer installation



Vertical pipe

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

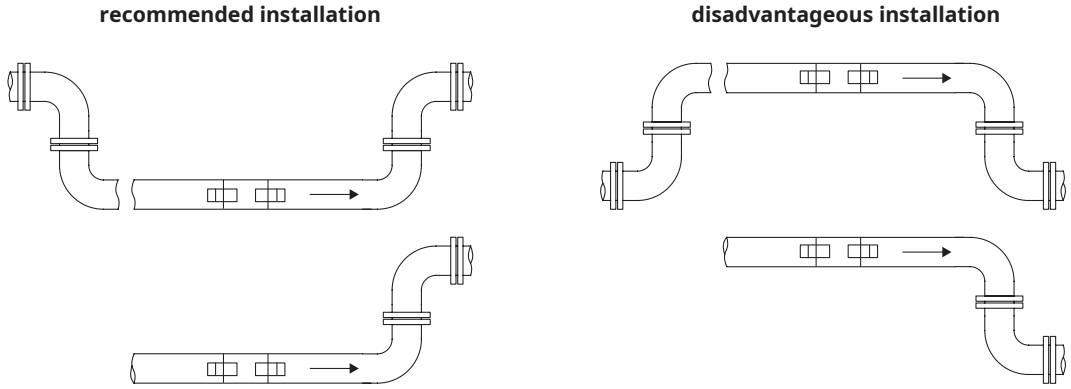
Fig. 3.11: Transducer installation



Free inlet or outlet

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

Fig. 3.12: Transducer installation



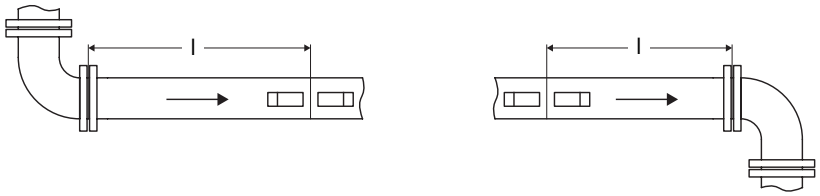
3.4 Undisturbed flow profile

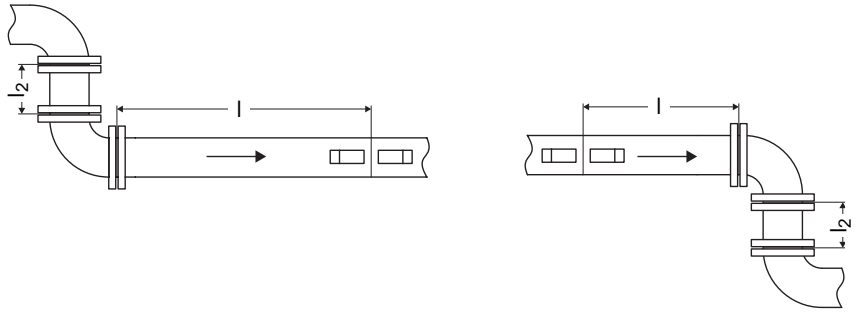
Some flow elements (e.g., elbows, valves, pumps, reducers) distort the flow profile in their vicinity. The axisymmetrical flow profile in the pipe needed for correct measurement is no longer given. A careful selection of the measuring point helps to reduce the impact of disturbances.

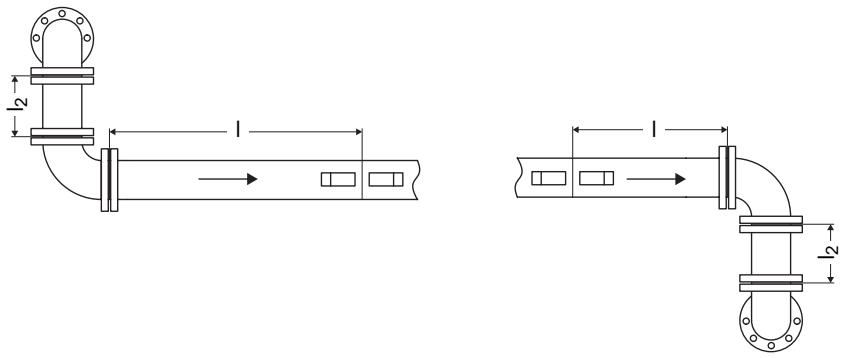
It is most important that the measuring point is located at a sufficient distance from any disturbance. Only then it can be assumed that the flow profile in the pipe is fully developed. However, the disturbance correction (see section *Profile correction [▶ 107]*) allows a measurement even at smaller distances of min. 2 d.

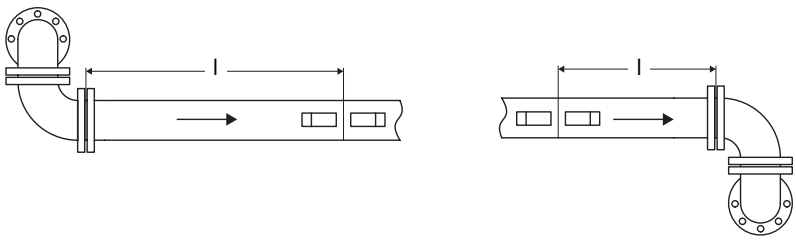
The recommended straight inlet and outlet pipe lengths for different types of flow disturbances are shown in the following table. These are to be measured from the end of the disturbance, which is not always at the position of the nearest flange (see table *Disturbance parameters [▶ 108]*).

Tab. 3.1: Recommended distance from disturbances

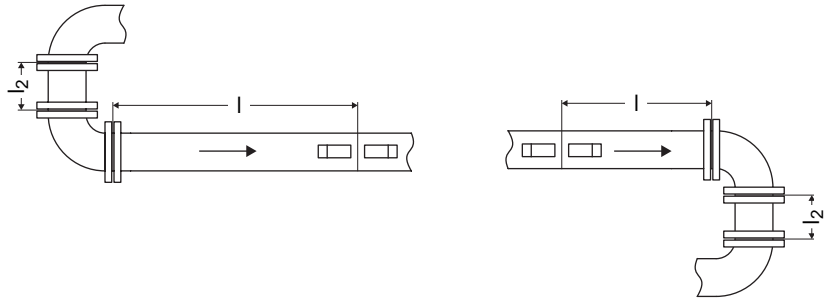
disturbance: 90° elbow	
inlet: l ≥ 10 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

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
	

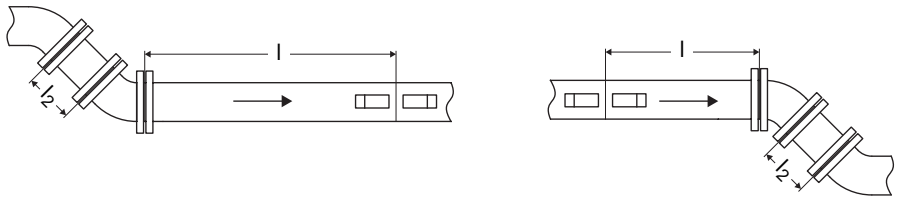
disturbance: double elbow out of plane (directly coupled)	
inlet: l ≥ 40 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d
	

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

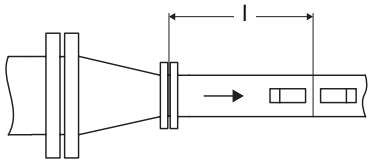
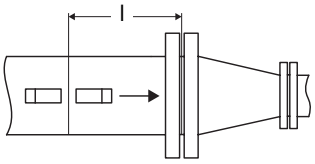


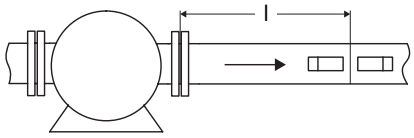
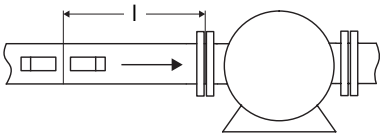
disturbance: 45° elbow	
inlet: l ≥ 15 d (l ≥ 2 d with disturbance correction)	outlet: l ≥ 3 d

disturbance: 45° double elbow (with elbow distance $l_2 \geq 3$ 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
	

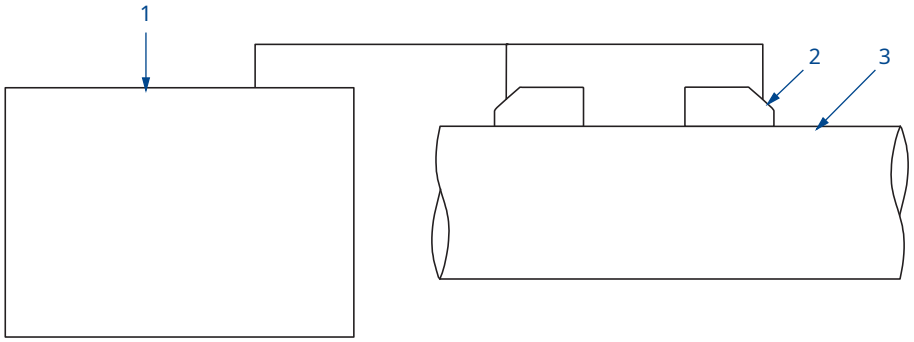
d – inner pipe diameter at the measuring point
l – recommended distance between disturbance and transducer position

4 Product description

4.1 Measuring system

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

Fig. 4.1: Example of a measurement arrangement



1 transmitter **2 transducer**
3 pipe

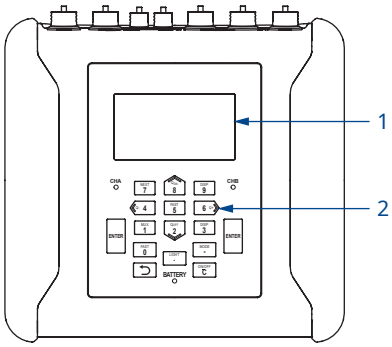
The transducers are mounted on the outside of the pipe. They send and receive ultrasonic signals through the fluid.

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. 4.2: Command panel of the transmitter



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

Tab. 4.1: 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., Modbus RTU)
`Miscellaneous`	modification 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

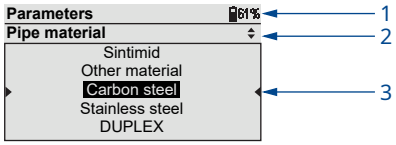
When starting up the transmitter for the first time, settings relating to the language, time, date and system of units have to be made. Afterwards, the menu `Parameters` will be displayed.

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

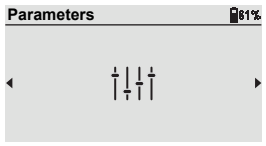
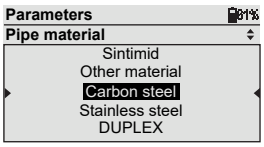
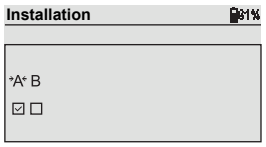
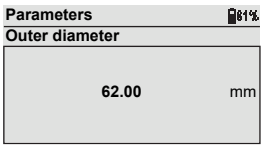
Structure

Fig. 4.3: Menu Parameters (example)



1 menu
2 menu item currently being edited
3 scroll list

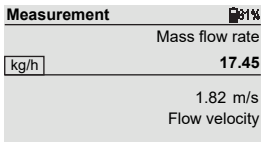
Tab. 4.2: Navigation

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. 4.4: Status indication (line 1)



Status indicators:

- running measurement
- error message
- FastFood mode activated
- data logger full
- connection via USB cable
- USB stick connected
- key lock activated
- charge state of the battery

4.4 Keyboard

The keyboard has 16 keys, including 4 function keys: ENTER, ↩, C and LIGHT.

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. 4.3: General functions

C	switching the transmitter on/off
LIGHT	switching the display backlight on/off
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. 4.4: 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. 4.5: 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. 4.6: 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 or respective transport case.
- Position the transmitter, transducers and accessories in the middle of the cardboard box or respective transport case.
- 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 or respective transport case.
- 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

⚠ 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.

⚠ CAUTION

Pipes can be sharp.

Risk of injury!

→ Debur sharp edges.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

Important

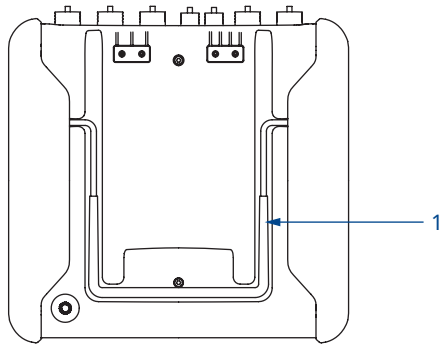
Do not leave the transmitter unattended on the floor.

6.1 Transmitter

6.1.1 Placement

A handle is mounted to the back side of the flowmeter. The handle can also be used as support.

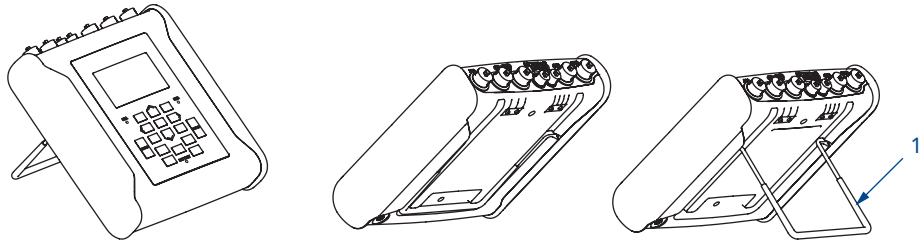
Fig. 6.1: Rear side of the transmitter



1 handle/support

- Pull the handle back as far as possible.

Fig. 6.2: Transmitter placement

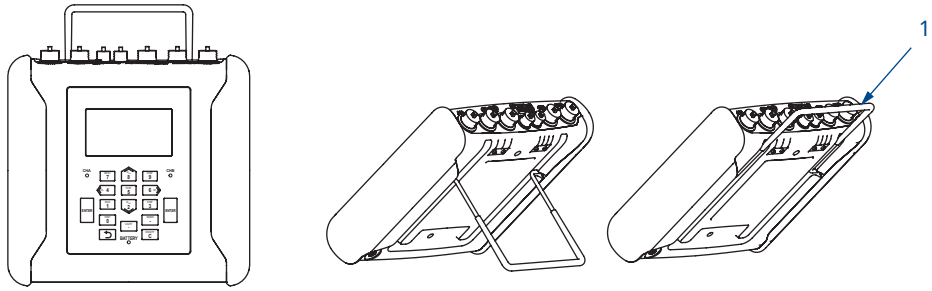


1 handle/support

6.1.2 Hang up

- Press both ends of the handle outward.
- Turn the handle upward.

Fig. 6.3: Hanging up the transmitter



1 handle/support

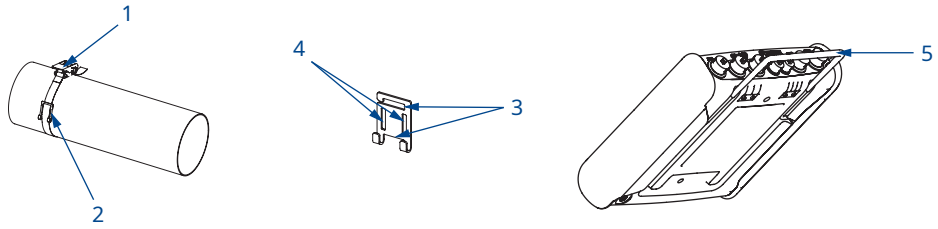
6.1.3 Pipe mounting

Important

The pipe temperature must not exceed the operating temperature of the transmitter.

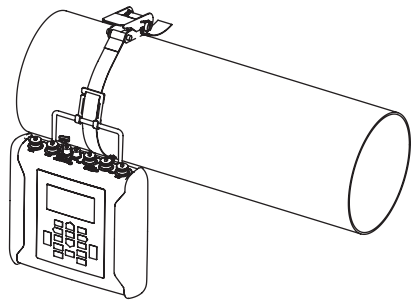
- Fix the tension strap with the hook to the pipe.
- Tighten the strap using the ratchet.
- Hang the transmitter on the hook using the handle.

Fig. 6.4: Pipe mounting



1 ratchet
2 hook on pipe
3 notch for horizonal pipe
4 notch for vertical pipe
5 handle/support

Fig. 6.5: Transmitter on the pipe



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.

⚠ CAUTION

Crushing hazard during transducer mounting.

Risk of injury!

→ Wear the required personal protective equipment.

→ Be careful during mounting.

⚠ CAUTION

Transducers and transducer mounting fixtures can fall down during mounting.

Risk of injury!

→ Secure the parts during mounting.

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).

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

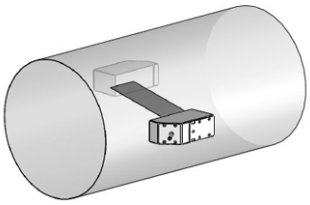
Observe the selection criteria of pipe and measuring point.

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.

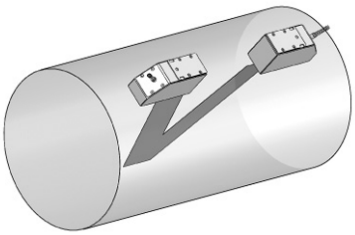
6.2.1.3 Selection of the measurement arrangement

Diagonal arrangement with 1 beam



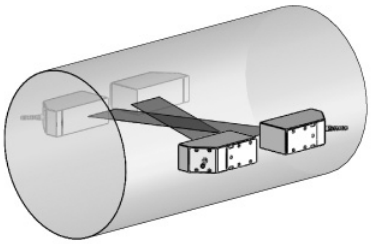
- wider flow velocity and sound speed range compared to the reflection arrangement
- use in the presence of deposits on the inner pipe wall or with strongly attenuating gases or liquids (only 1 sound path)

Reflection arrangement with 1 beam

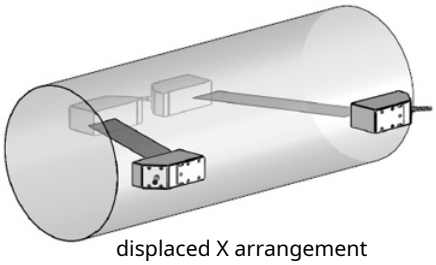


- smaller flow velocity and sound speed range compared to the diagonal arrangement
- cross-flow effects are compensated because the beam crosses the pipe in 2 directions
- higher accuracy of measurement because the accuracy increases with the number of sound paths

Diagonal arrangement with 2 beams



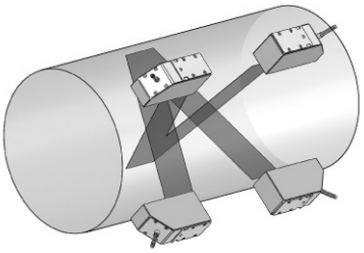
X arrangement



displaced X arrangement

- same characteristics as diagonal arrangement with 1 beam
- additional characteristic: cross-flow effects are compensated because the measurement is conducted with 2 beams

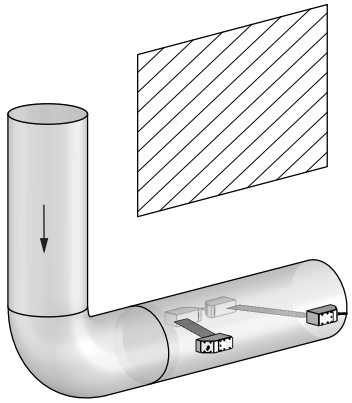
Reflection arrangement with 2 beams and 2 planes



- same characteristics as reflection arrangement with 1 beam
- additional characteristic: influences of the flow profile are compensated because the measurement takes place in 2 planes

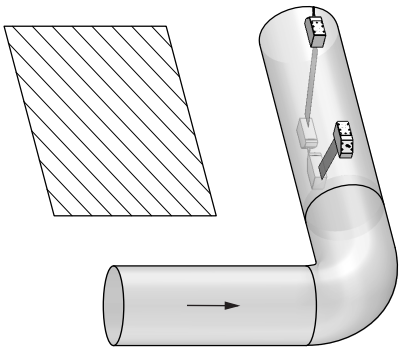
If the measuring point is situated near an elbow, the following measurement arrangements are recommended for the selection of the sound beam plane.

Vertical pipe



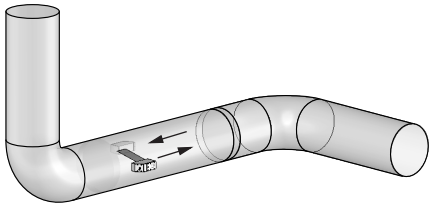
- The sound beam plane is selected at an angle of 90° to the elbow plane (hatched area). The elbow is upstream of the measuring point.

Horizontal pipe



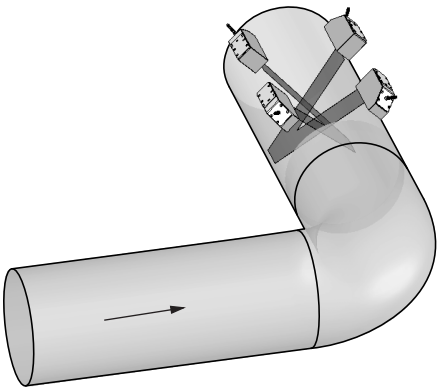
- The sound beam plane is selected at an angle of 90° ± 45° to the elbow plane (hatched area). The elbow is upstream of the measuring point.

Bidirectional measurement



- The sound beam plane is selected according to the nearest elbow (depending on whether the pipe is horizontal or vertical – see above).

Measurement in reflection arrangement with 2 beams and 2 planes



- The 2 sound beam planes are selected at an angle of 45° to the elbow plane. The elbow is upstream of the measuring point.
- On horizontal pipes, the transducers are mounted on the upper half of the pipe.

6.2.2 Installation of the transducers

Important

Handle the transducers with care. Do not let the transducers hang on their cables.

Important

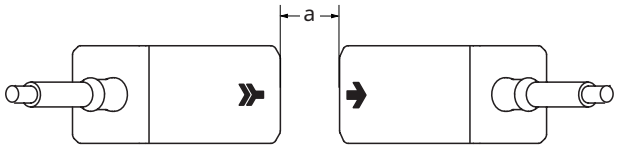
Handle the cables with care. Avoid excessive bending, buckling or crushing, especially at simultaneous strain.

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. 6.6: Orientation and distance of the transducers



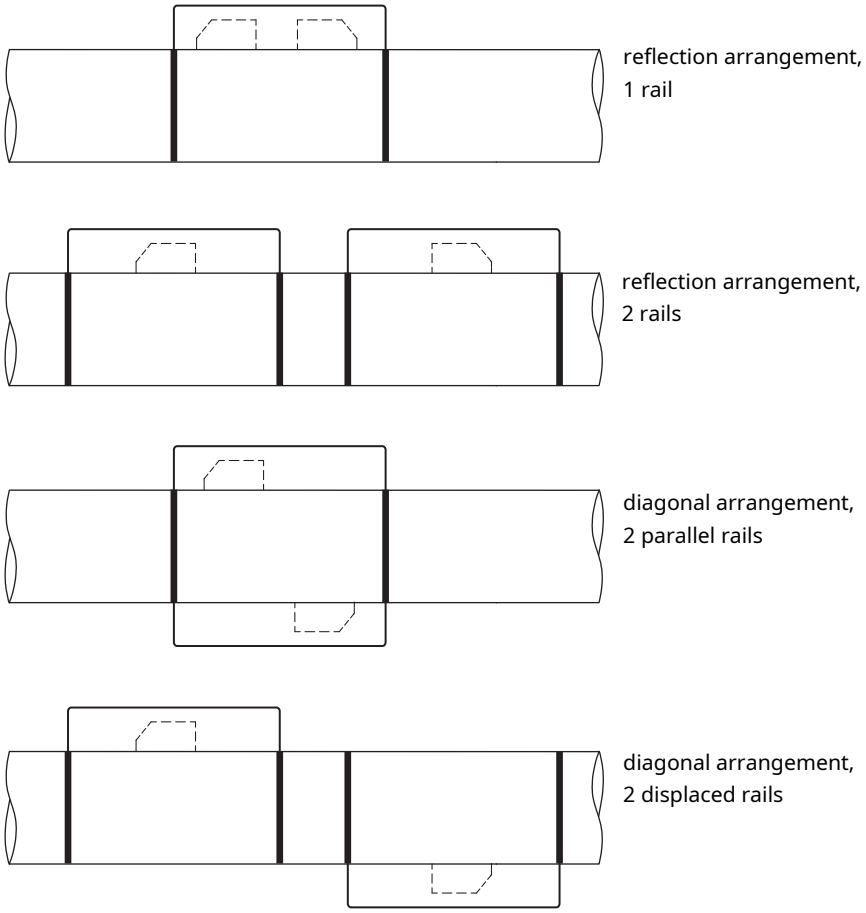
a transducer distance

- 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. 6.7: Transducer arrangement in mounting rails



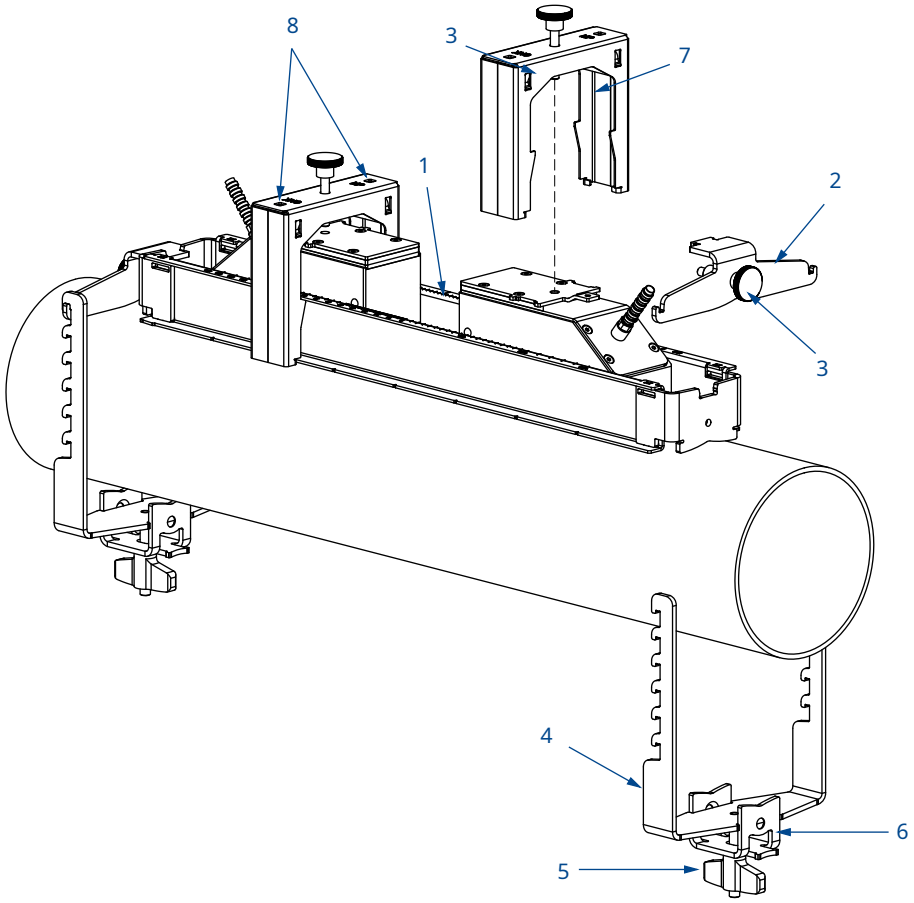
6.2.2.3 Mounting with Variofix M

Normally, each transducer is mounted to its own Variofix M. If the transducer distance is small and both transducers are on the same side of the pipe (reflection arrangement), both transducers can be fixed in one Variofix M.

Variofix M mounting with retention hooks

- Hang the counterparts in the Variofix M.
- Tighten the knurled screws of the counterparts.
- Place the Variofix M with the counterparts on the pipe.
- Hang one retention hook in each counterpart.
- Tighten the butterfly nut of the tensioning bracket of each retention hook to fix them on the pipe.
- Repeat the steps if the second transducer is to be fixed in a separate Variofix M.

Fig. 6.8: Variofix M mounting with retention hooks (reflection arrangement)

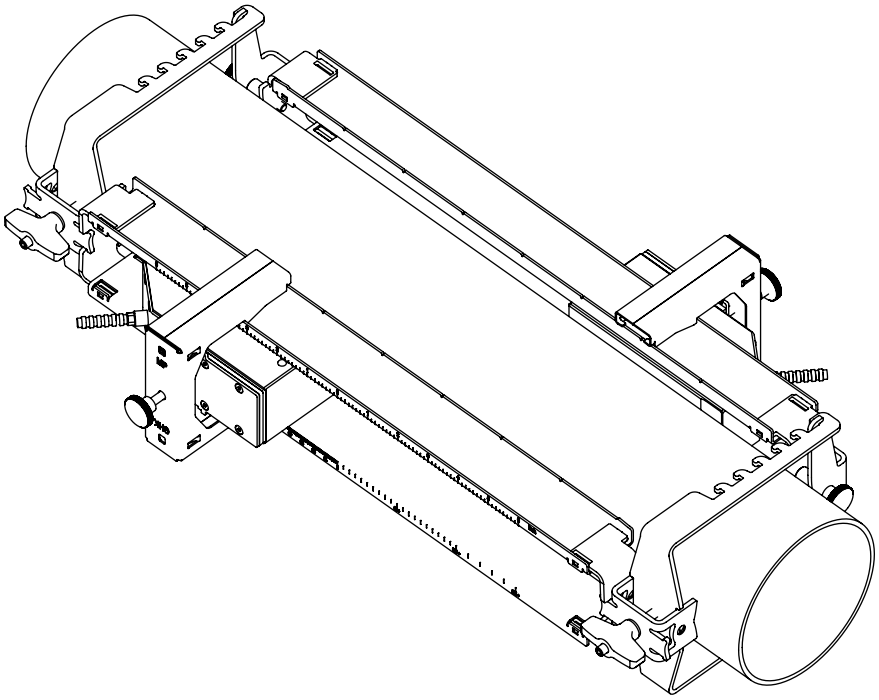


1 Variofix M
2 counterpart
3 knurled screw
4 retention hook
5 butterfly nut
6 tensioning bracket
7 spring clip
8 indicator

If the transducers are to be mounted in a diagonal arrangement, a second Variofix M is hooked into the tensioning brackets.

- Loosen the butterfly nut of one retention hook and and slide it slightly outward.
- Hang a second Variofix M in the tensioning brackets and position it on the pipe.
- Tighten the butterfly nut of the tensioning bracket to fix the retention hook on the pipe.

Fig. 6.9: Variofix M mounting with retention hooks (diagonal arrangement)



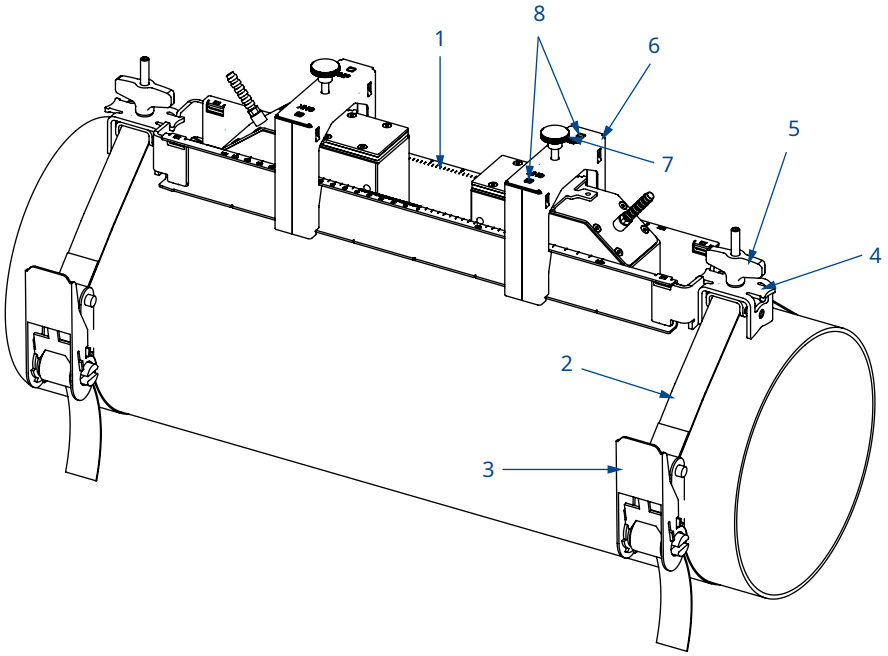
Variofix M mounting with tension straps

NOTICE

The butterfly nut on the tensioning bracket has to be loosen before tightening the strap.

- Push the tension straps through the buckles of the tensioning brackets.
- Place the tension strap around the pipe and insert it into the ratchet and slightly tension it.
- Position the tensioning bracket on the pipe. On a horizontal pipe, mount the tensioning bracket laterally to the pipe, if possible.
- Tighten the strap using the ratchet.
- Place the second tension strap around the pipe and insert it into the ratchet and slightly tension it.
- Hang the Variofix M in the tensioning brackets.
- Tighten the butterfly nut of the first tensioning bracket to fix the Variofix M to the pipe.
- Align the second tensioning bracket so that the rail is parallel to the pipe.
- Tighten the second strap using the ratchet.
- Tighten the butterfly nut of the second tensioning bracket to fix the Variofix M to the pipe.
- Repeat the steps if the second transducer is to be fixed in a separate Variofix M.

Fig. 6.10: Variofix M mounting with tension straps



1 Variofix M
2 tension strap
3 ratchet
4 tensioning bracket with buckle
5 butterfly nut
6 spring clip
7 knurled screw
8 indicator

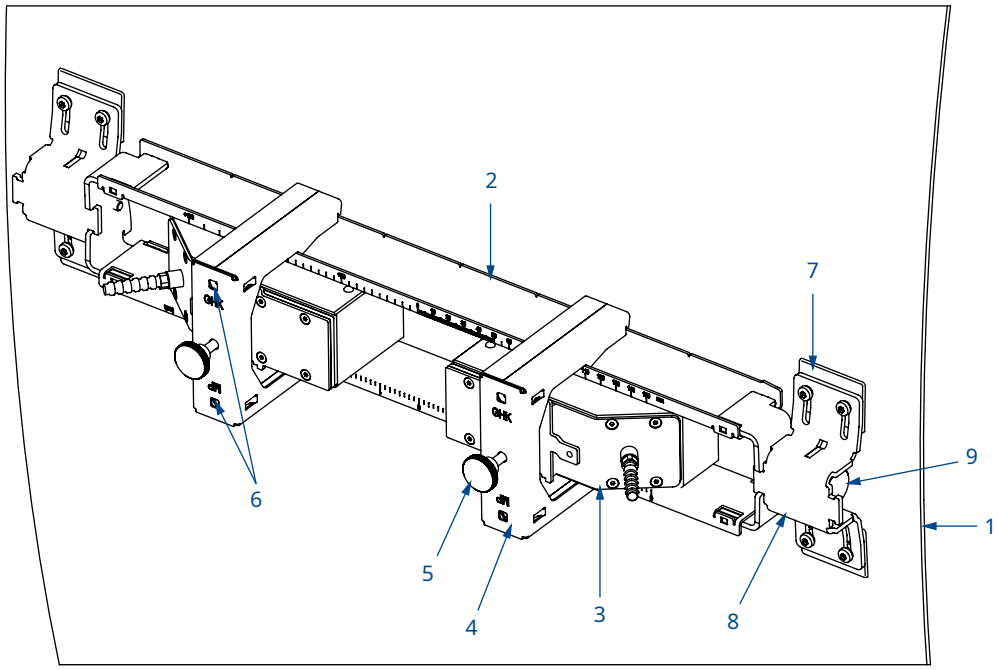
Variofix M mounting with magnets

NOTICE

Magnets can only be used if the pipe material is ferromagnetic.

- Place both magnet brackets on the Variofix M and fix them with the knurled screw.
- Place the Variofix M with the magnet brackets on the pipe.
- Repeat the steps if the second transducer is to be fixed in a separate Variofix M.

Fig. 6.11: Variofix M mounting with magnets



1 pipe
2 Variofix M
3 transducer
4 spring clip
5 knurled screw (spring clip)
6 indicator
7 magnet
8 magnet bracket
9 knurled screw (magnet bracket)

Transducer mounting in Variofix M

NOTICE

Apply some coupling compound to the contact surface of the transducers when mounting the Variofix M with magnets.

- Place the transducer into the Variofix M. Observe the mounting direction.
- Slide the spring clip over the transducer until the knurled screw is positioned exactly above the blind hole of the transducer.
- Fix the transducer by tightening the knurled screw by hand. Make sure not to tilt the transducer.
- Repeat the steps for fixing the second transducer.
- Adjust the transducer distance by loosening the knurled screw of a spring clip and shifting the transducer.
- Tighten the transducer with the knurled screw.

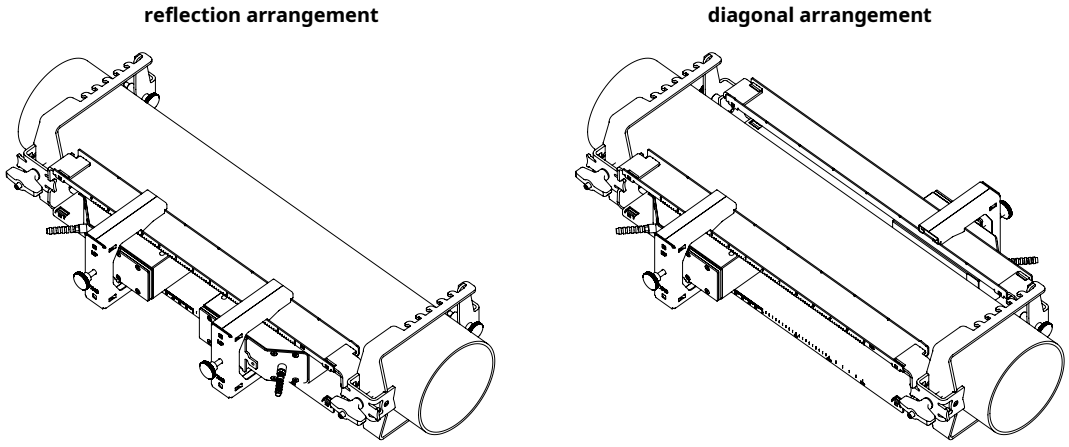
NOTICE

In case the Variofix M lifts when tightening the knurled screw in the spring clip, the straps have to be retightened. The ratchet has to be completely in contact with the pipe to ensure a good fixation.

NOTICE

When the transducers are mounted with coupling foil, the indicator is used to check that the contact pressure is correct. Tighten the knurled screw on the spring clip until the indicator is flush with the spring clip.
Tightening it too much can damage the transducer or distort the measurement results. Insufficient tightening can result in insufficient acoustic contact between the pipe and the transducers.

Fig. 6.12: Variofix M with transducers on the pipe



Transducer adapter

The Variofix M is available in 2 sizes with corresponding spring clip.
The corresponding transducer frequency is written on the spring clip. If the transducer does not fit the Variofix M, a transducer adapter has to be used.

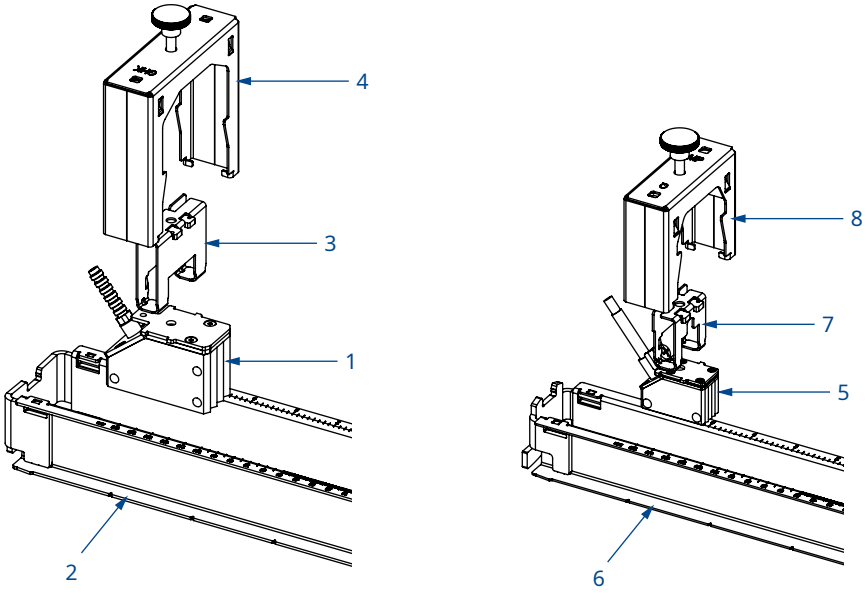
Tab. 6.1: Overview of transducers to be used

transducer frequency	Variofix M size	transducer adapter
G	GHK	-
H	GHK	-
K	GHK	-
M	MPQ	-
	GHK	MP
P	MPQ	-
	GHK	MP
Q	MPQ	Q

The transducer adapters can be slid onto the transducers without tools and click into place in the designated position.

- Place the transducer with adapter into the Variofix M. Observe the mounting direction.
- Slide the spring clip over the transducer and transducer adapter so that the knurled screw is positioned over the hole in the adapter.
- Fix the transducer by tightening the knurled screw by hand.
- Repeat the steps for fixing the second transducer.
- Adjust the transducer distance by loosening the knurled screw of a spring clip and shifting the transducer.
- Tighten the knurled screw on the spring clip until the indicator corresponding to the transducer is flush with the spring clip.

Fig. 6.13: Transducer mounting with transducer adapter

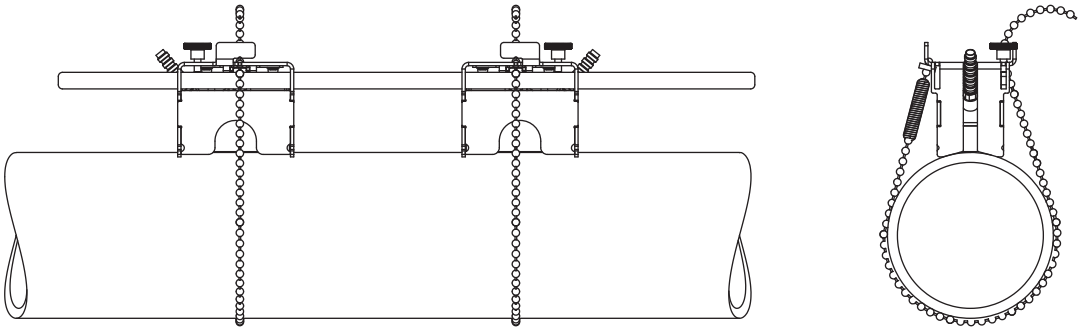


1 transducers (transducer frequencies M, P)
2 rail (size GHK)
3 transducer adapter MP
4 spring clip (size GHK)
5 transducer (transducer frequency Q)
6 rail (size MP)
7 transducer adapter Q
8 spring clip (size MP)

6.2.2.4 Mounting with fastening shoes and chains

- Press the transducers firmly into their clamping fixtures in the fastening shoes until they are tightly fixed.
- Apply some coupling compound to the contact surface of the transducers.
- Insert the ruler into the lateral slot of the fastening shoes.
- Adjust the displayed transducer distance.
- Fix the ruler to the fastening shoes using the knurled screws.
- Take the spring end of the chains and insert the last ball into the slot on the upper side of the fastening shoes.
- Place the fastening shoes/ruler assembly on the pipe at the measuring point.
- Place the chains around the pipe.
- Tighten the chains so that their springs are under tension and insert them into the other slot of the fastening shoes. There must be no air pockets between the pipe wall and the contact surface of the transducers.

Fig. 6.14: Transducer mounting with fastening shoes and chains



Extension of the ball chain

In order to extend the chain, insert the last ball of the extension into the fastening clip of the ball chain. The spare fastening clips supplied with the chain can be used to repair a broken chain.

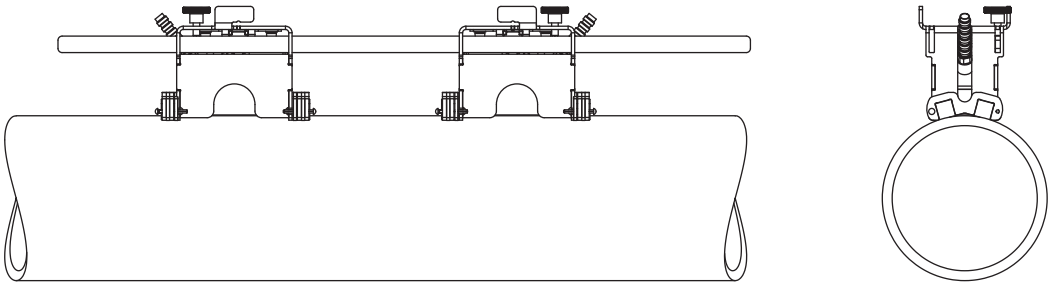
NOTICE

When using fastening shoes, the reflection arrangement is to be preferred. The ruler can be used as mounting aid. In case the mounting has to be carried out in diagonal arrangement (without ruler), contact Flexim for further support.

6.2.2.5 Mounting with magnetic fastening shoes

- Press the transducers firmly into their clamping fixtures in the fastening shoes until they are tightly fixed.
- Apply some coupling compound to the contact surface of the transducers.
- Insert the ruler into the lateral slot of the fastening shoes.
- Adjust the displayed transducer distance.
- Fix the ruler to the fastening shoes using the knurled screws.
- Place the fastening shoes/ruler assembly on the pipe at the measuring point. There must be no air pockets between the pipe wall and the contact surface of the transducers.

Fig. 6.15: Transducer mounting with magnetic fastening shoes



NOTICE

When using fastening shoes, the reflection arrangement is to be preferred. The ruler can be used as mounting aid. In case the mounting has to be carried out in diagonal arrangement (without ruler), contact Flexim for further support.

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.

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

6.3.2.1 Temperature probe (response time 50 s)

⚠ 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.

NOTICE

The temperature probe has to be thermally insulated.

Select the installation instruction of the supplied clasp:

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. 6.16: Clasp

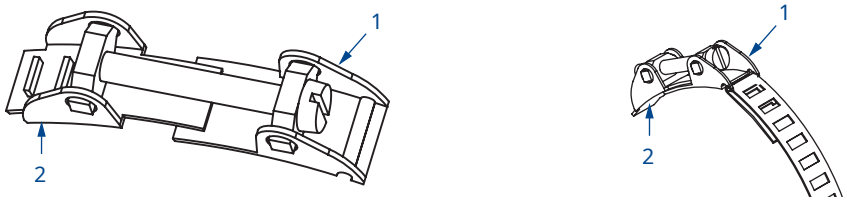
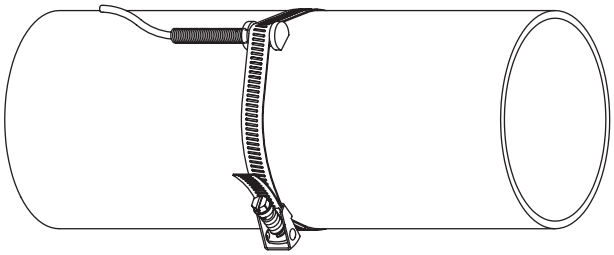


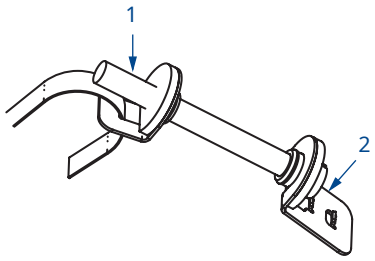
Fig. 6.17: Temperature probe on the pipe



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.

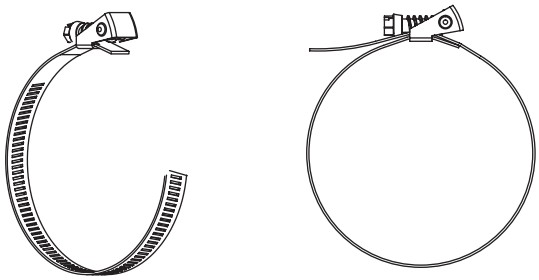
Fig. 6.18: Flexim clasp



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.

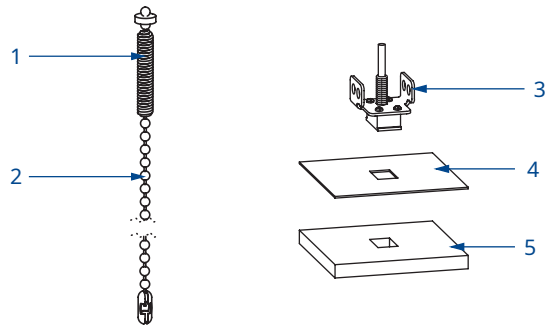
Fig. 6.19: Quick release clasp



6.3.2.2 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. 6.20: Temperature probe

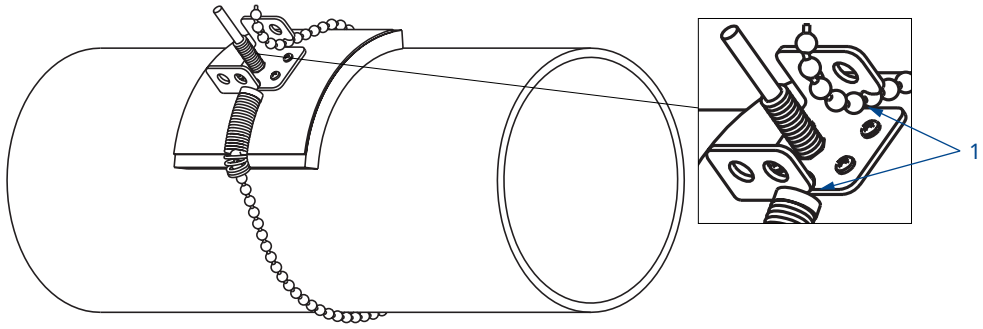


1 spring end
2 chain
3 temperature probe
4 protection plate
5 insulation foam

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. 6.21: Temperature probe on the pipe



1 slots on the upper side of the temperature probe

7 Connection

⚠ WARNING

Tripping hazard due to cables

When laying the cables, make sure that there is no tripping hazard. Mark this area, if necessary.

Important

Handle the cables with care. Avoid subjecting the cables to mechanical stress.

Important

Before making any electrical connections, make sure that all plug connectors are clean and undamaged. Damaged and dirty plug connectors must not be used.

Close unused sockets with covers.

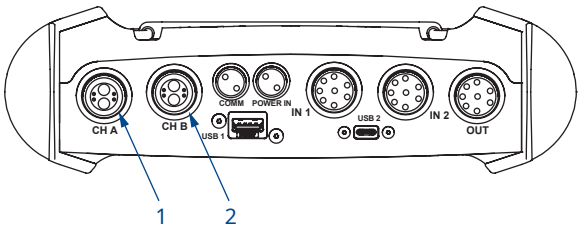
7.1 Transducers

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

The connections are on the upper side of the transmitter:

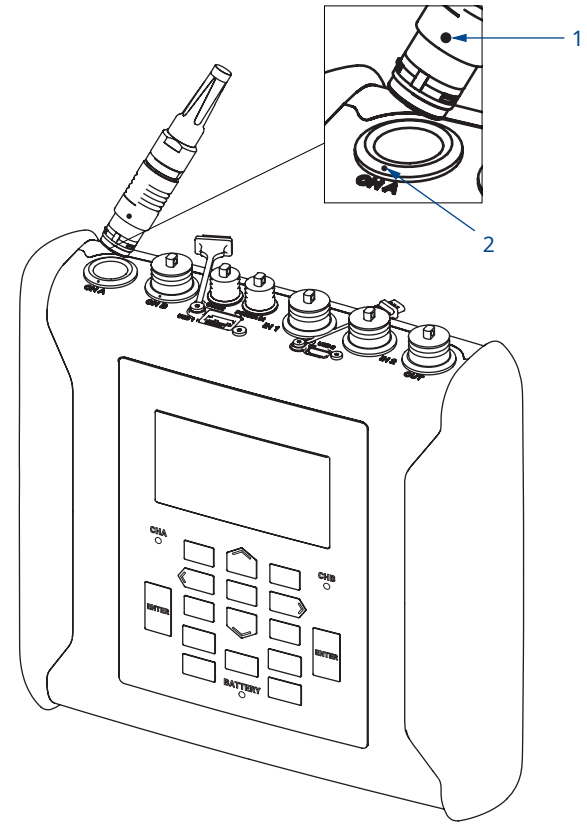
- Pull out the socket cover.
- Insert the connector of the transducer cable into the socket of the transmitter. The red point on the connector has to be aligned with the red one of the socket.

Fig. 7.1: Connections of the transmitter



1 transducers of measuring channel A **2 transducers of measuring channel B**

Fig. 7.2: Transducer connection

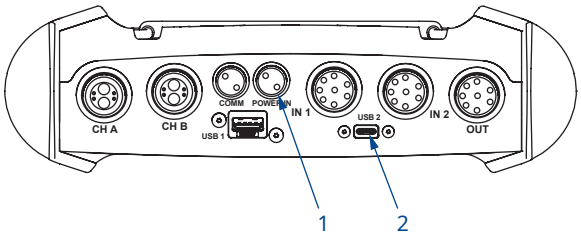


1 red point on the connector **2 red point on the socket**

7.2 Power supply

The transmitter can be operated with the integrated battery, the power supply unit, the USB cable or the power pack PP026NN, see document QSPowerPack_PP026.

Fig. 7.3: Connection of the power supply unit to the transmitter



1 IN 2 socket **2 USB 2 socket**

7.2.1 Battery operation

The transmitter has a Li-ion battery and can therefore be operated independently. When delivered, the battery is charged with approx. 30 %. The battery does not need to be fully charged before it is used for the first time.

Charge state of the battery

The charge state of the battery can be displayed.

- Select the list item `Miscellaneous\System settings\Battery`.
- Press ENTER.
- Press 2 or 8 to scroll through the list.

The symbol  in the status line provides information about the remaining battery capacity.

Potential problems with the battery are shown as follows:

 An question mark is displayed if the battery is not recognized.

 An exclamation mark refers to a battery problem, which can be seen in the event protocol. If the exclamation mark flashes, switch off the transmitter and contact Flexim.

NOTICE

A firmware update is not feasible if the battery is almost empty.

Charging the battery

The transmitter has 2 sockets to charge the battery.

POWER IN

The transmitter is charged by means of the delivered power supply unit via the POWER IN socket.

- Connect the power supply unit to the transmitter.

USB 2

The transmitter is charged by means of a USB PD device via the USB 2 socket.

The transmitter automatically chooses one of the following profiles: 5 V/3 A, 9 V/3 A or 15 V/3 A. If several profiles are available, the one with the highest power is chosen.

- Connect the USB PD device to the transmitter.

When both power supplies are connected, charging is performed via the power supply unit.

The transmitter can be charged while it is switched off. The LED "BATTERY" flashes green while charging. When the transmitter is switched on, the battery symbol indicates that charging is in progress. If a battery cannot be recognized due to an error, a battery symbol with a question mark appears. If a critical error has been detected, e.g., battery overheating, a battery symbol with an exclamation mark appears.

A measurement can be made during charging. Charging will be stopped automatically when the battery is fully charged.

Operational state of the battery

The operational state of the battery is indicated by the LED "BATTERY".

Tab. 7.1: Operational state of the battery

LED "BATTERY"	operation state
off	transmitter switched off or charging due to errors not possible
flashes green	battery charging
lights green	battery charged
lights red	battery almost empty, connect the power supply unit

Automatic power-off

In battery mode, the transmitter has an automatic power-off. The transmitter will be switched off if:

- no measurement is being made and no key is pressed within 10 min
- the battery is empty.

7.2.2 External power supply

Power is supplied either via the power supply unit or a USB cable.

Power supply unit

Important

Use only the supplied power supply unit.

The power supply unit is not protected against moisture. Use it only in dry rooms.
The voltage indicated on the power supply unit must not be exceeded.
Do not connect a defective power supply unit to the transmitter.

- Connect the power supply unit to the POWER IN socket on the upper side of the transmitter.

USB cable

The USB cable must not be longer than 3 m.

- Connect the USB cable to the USB 2 socket on the upper side of the transmitter.

Important

The USB 1 socket is not suitable to supply the transmitter with power.

7.3 Outputs

Important

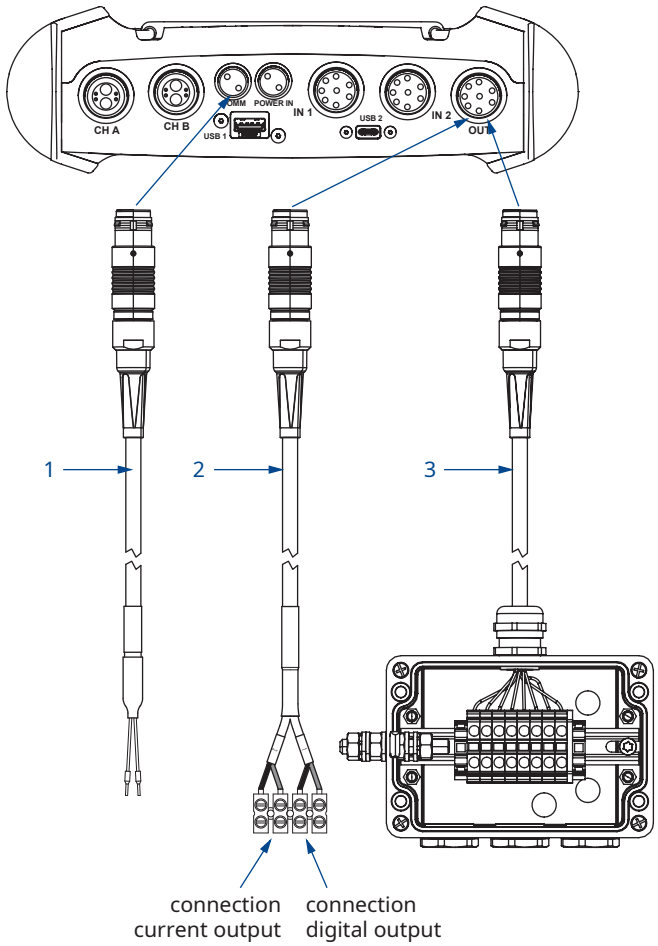
The max. voltage between the outputs and the internal power supply of the transmitter is 42 V DC (permanent).

Connection of output adapters

The following output adapters (optional) are available for connecting outputs:

- output adapter AO61: connection of several outputs
- output adapter AO62: connection of max. 1 current output and 1 digital output
- Modbus adapter AO63: connection of Modbus

Fig. 7.4: Connection of output adapters to the transmitter



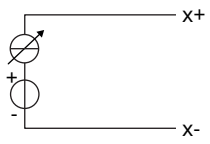
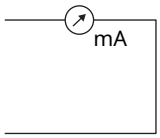
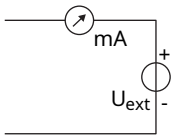
1 Modbus adapter AO63 **2 output adapter AO62 (red (+), black (-))**
3 output adapter AO61

Tab. 7.2: Terminal assignment of output adapter AO61

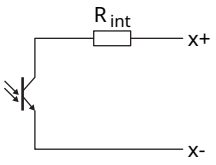
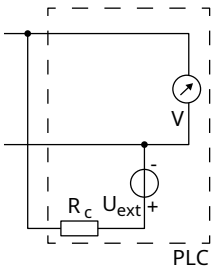
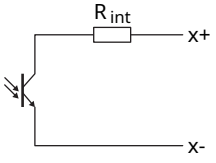
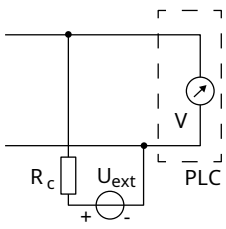
terminal	output connection	terminal	output connection
1	digital output B1 (+)	5	current output I1 (+)
2	digital output B1 (-)	6	current output I1 (-)
3	digital output B2 (+)	7	current output I2 (+)
4	digital output B2 (-)	8	current output I2 (-)

7.3.1 Output circuits

Tab. 7.3: 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. 7.4: Digital output

internal circuit (transmitter)	external circuit	remark
circuit 1		• 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
		
circuit 2		
		

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 terminal assignment is displayed on the transmitter during configuration of the outputs.

7.4 Inputs

Important

The max. voltage between the inputs and the internal power supply of the transmitter is 42 V DC (permanent).

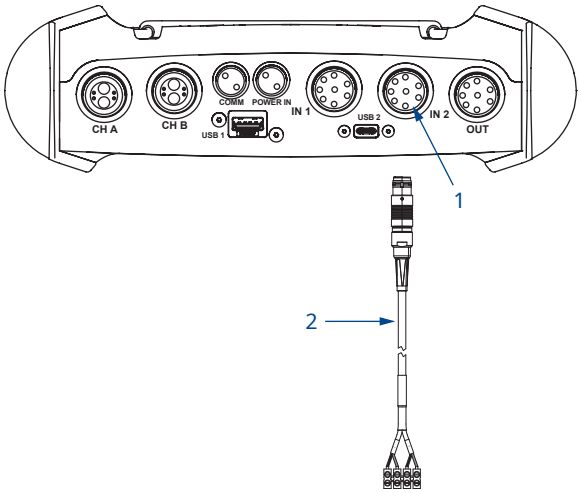
Connection of input adapters

The transmitter is equipped with max. 4 inputs.

The following input adapter (optional) is available for the connection of current inputs:

- input adapter AI62: connection of max. 2 current inputs

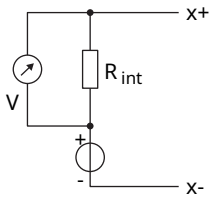
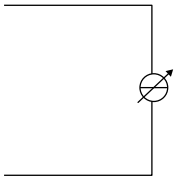
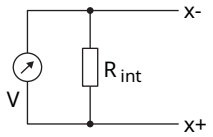
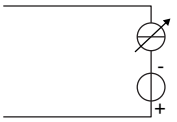
Fig. 7.5: Connection of input adapters to the transmitter



1 socket IN 2 **2 input adapter AI62**

7.4.1 Circuits of the inputs

Tab. 7.5: 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.

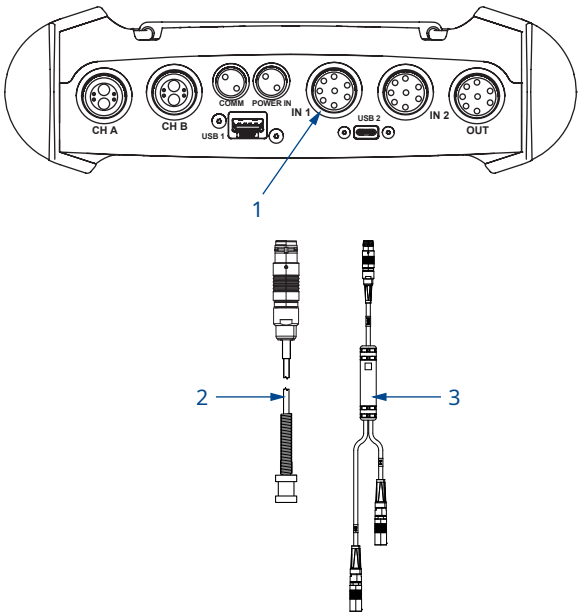
7.5 Temperature probe

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

The following input adapter (optional) is available for the connection of temperature probes:

- input adapter AI61: connection of 2 temperature probe

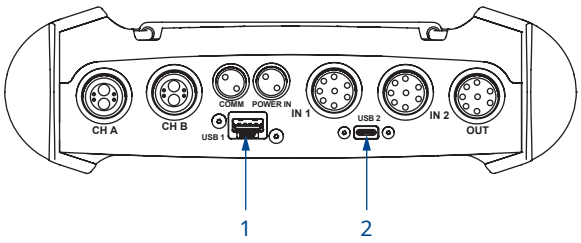
Fig. 7.6: Connection of the temperature probes to the transmitter



1 IN 1 socket
2 temperature probe
3 input adapter AI61

7.6 Service interfaces

Fig. 7.7: Connection of the service interfaces to the transmitter



1 USB interface type A
2 USB interface type C

7.6.1 USB interface type A (USB 1)

The transmitter has a USB interface type A that can be used to connect a USB stick. When a USB stick is connected, the symbol is displayed in the status line.

7.6.2 USB interface type C (USB 2)

The transmitter has a USB interface type C hat can be used to connect it to a PC.

8 Start-up

⚠ 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/off

Switching on the transmitter

- Press and hold key C to switch on the transmitter.

After switching on the transmitter, the main menu is displayed in the default language. The language can be changed.

Switching off the transmitter

- Keep key C pressed. A dialog appears for switching off the transmitter.
- Select `Yes` to switch off the transmitter.

When pressing the key C for approx. 3 s during the measurement, the menu item `Execute command` appears.

- Select the list item `Switch off device`is selected, to stop the measurement and to switch off the transmitter.

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. 8.1: 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
`Verification log`	state of the verification logger

9 Measurement

⚠ 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 Input of parameters

NOTICE

During the parameter input, the transducers have to be connected to the transmitter.

NOTICE

Avoid a simultaneous parameter entry via the keyboard and the service or process interface. The parameter records received via these interfaces will overwrite the current transmitter parametrization.

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.

9.1.1 Measuring point configuration

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

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

The display will not be indicated if the transmitter has only one measuring channel.

Tab. 9.1: Measuring point configuration

1 meas. point (A)	1 meas. point (AB)	2 meas. points (A|B)
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 2 measuring channels at 2 measuring points.

If `2 meas. points (A|B)` is selected for the configuration of the measuring point, the parameters have to be entered for each measuring point.

`Parameters\Measuring point config.\2 meas. points (A|B)\Select meas. point\A:`

- Select the measuring point.
- Press ENTER.

If the synchronized channel averaging is activated in the menu item `Miscellaneous\Measurement\Measurement modes\Synch. chan. averag.`, `1 meas. point (AB)` has to be selected for the configuration of the measuring point.

9.1.2 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.`.

9.1.3 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.

If no transducers are connected to the transmitter, `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.

9.1.4 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

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.

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

- Enter the sound speed of the pipe material.
- 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 chapter Annex: Reference.

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 chapter Annex: Reference.

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

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.

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

- Enter the sound speed of the lining material.
- 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`.

9.1.5 Input of fluid parameters

Fluid

```
Parameters\Fluid
```

- Select the fluid from the scroll list.
- If the fluid is not in the scroll list, select the list item `Other fluid`.
- Press ENTER.

Sound speed of the fluid

```
Parameters\Fluid\Other fluid\c fluid
```

The sound speed of the fluid is used for the calculation of the transducer distance. The exact value of the sound speed is not always known. Therefore, a range of possible values for the sound speed has to be entered.

- Enter the average sound speed of the fluid.
- Press ENTER.

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

Sound speed range of the fluid

`Parameters\Fluid\Other fluid\Range c fluid`

- Select `Automatic` if the range around the average sound speed has to be set to ± 10 % the entered sound speed.
- Select `Customized` if the range around the average sound speed has to be entered.
- Press ENTER.

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

`Parameters\Fluid\Other fluid\Range c fluid\Customized`

- Enter the range around the average sound speed of the fluid.
- Press ENTER.

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

Kinematic viscosity of the fluid

`Parameters\Fluid\Other fluid\Kin. viscosity`

The kinematic viscosity influences the flow profile of the fluid. The value is considered in the profile correction.

- Enter the kinematic viscosity of the fluid.
- Press ENTER.

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

Fluid density

`Parameters\Fluid\Other fluid\Fluid density`

The density is used to calculate the mass flow rate.

If the mass flow rate is not measured, it is not necessary to enter a value. The default value can be used.

- Enter the operating density of the fluid.
- Press ENTER.

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

9.1.6 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.

9.1.7 Further parameters

Fluid temperature

```
Parameters\Fluid temp.
```

The fluid temperature is used:

- at the beginning of the measurement for the interpolation of the sound speed and therefore for the calculation of the recommended transducer distance
- during the measurement for the interpolation of the density and the viscosity of the fluid

This value is only used, if the fluid temperature is not measured. It 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.

NOTICE

If the relation between the sound speed and the temperature is not linear, see the sound speed-temperature curve.

Parametrization of a mixture with changing composition

If a mixture with changing composition has been selected, the variable proportion of the mixture has to be entered (see table *Typical properties of selected fluids at 20 °C* *[▶ 201]*).

- Enter the variable proportion of the mixture.
- 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 only be indicated if the list item `1 meas. point (AB)` or `2 meas. points (A|B)` is selected in the menu item `Parameters\Measuring point config.`.

Tab. 9.2: 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.

9.2 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.

If the list item `2 meas. points (A|B)` is selected in the menu item `Parameters\Measuring point config.`, the measuring point must be selected whose measured values are to be transmitted to the output.

- Select a list 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. 9.3: Configuration of the outputs

source item	list item	output
`Flow quantities`	`Flow velocity`	flow velocity
	`Volumetric flow rate`	volumetric flow rate
	`Mass flow rate`	mass flow rate
	`Thermal energy rate` (1)	thermal energy rate
`Totalizers`	`Volume (+)`	totalizer for the volumetric flow rate in positive flow direction
	`Volume (-)`	totalizer for the volumetric flow rate in negative flow direction
	`Volume (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
	`Thermal energy (+)` (1)	thermal energy totalizer for positive measured values of the thermal energy rate
	`Thermal energy (-)` (1)	thermal energy totalizer for negative measured values of the thermal energy rate
	`Thermal energy (Δ)` (1)	difference of the thermal energy totalizers

source item	list item	output
Fluid properties	Fluid temp.	fluid temperature
	Supply temperature [1]	supply temperature (thermal energy rate measurement)
	Return temperature [1]	return temperature (thermal energy rate measurement)
	Temperature (Δ) [1]	difference between supply and return temperature (thermal energy rate measurement)
	Fluid pressure	fluid pressure
	Supply pressure [1]	supply pressure (thermal energy rate measurement)
	Return pressure [1]	return pressure (thermal energy rate measurement)
	Pressure (Δ) [1]	difference between supply and return pressure (thermal energy rate measurement)
	Fluid density	fluid density
	Kin. viscosity	kinematic viscosity
	Dyn. viscosity	dynamic viscosity
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
Miscellaneous	Custom. Input 1	measured values of input quantities (e.g., temperature, pressure) 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)	difference of the measured sound speed and the sound speed calculated from the fluid data

[1] only if Thermal energy rate is selected as physical quantity in the menu Parameters

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

Tab. 9.4: 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	
	`Sound speed`	x	x	
	`Miscellaneous`	x	x	
	`Diagnostic values`	x		
events	`Event trigger`			x

9.2.1 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`

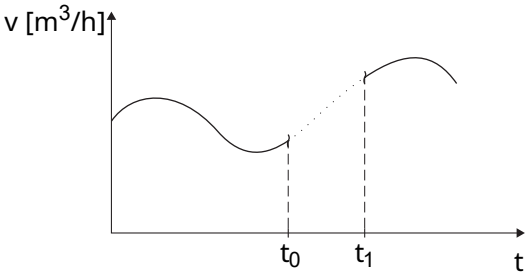
An error value can be defined which is output if the source item cannot be measured.

- 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.

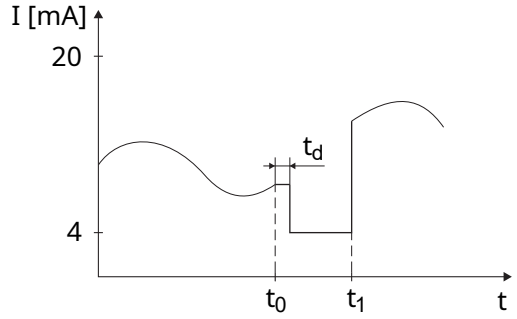
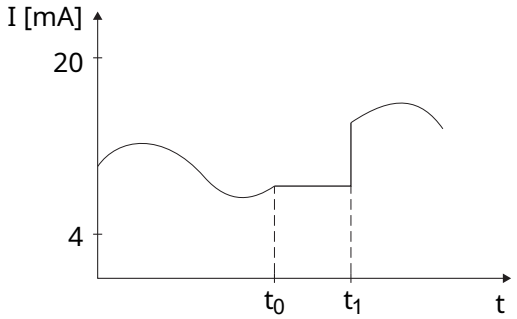
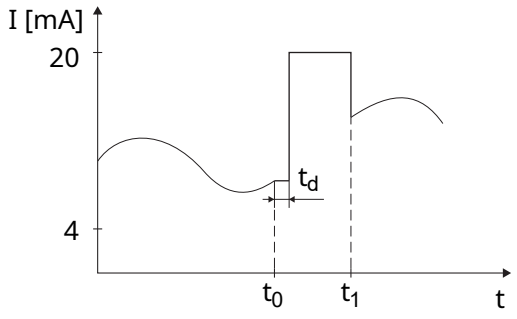
Example

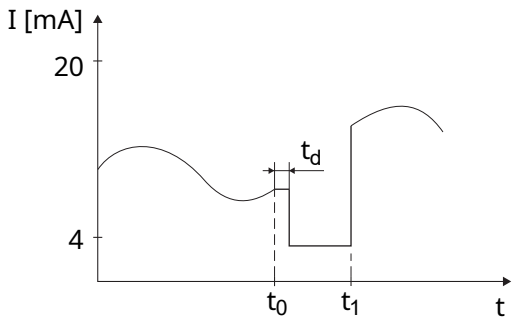
source item:	volumetric flow rate
output:	current output
output range:	4...20 mA
error delay:	$t_d > 0$

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



Tab. 9.5: 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.

9.2.2 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. 9.6:

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. 9.7:

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.

9.2.3 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.

9.3 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.

If `2 meas. points (A|B)` is selected in the menu item `Parameters\Measuring point config.`, the following settings are queried for each measuring point.

Calibration of the temperature calculation from the sound speed

The transmitter is able to calculate the temperature from the sound speed of the fluid during the measurement. The accuracy of the measured sound speed of the fluid depends on the accuracy of the entered parameters and on the mounting of the transducers.

If the temperature has to be calculated from the sound speed of the fluid during the measurement, a calibration based on the actual fluid temperature is carried out when starting the measurement. The actual fluid temperature has to be measured and entered in the transmitter. An offset, being the difference between the entered fluid temperature and the fluid temperature calculated from the sound speed, is determined and stored in the transmitter.

If a measurement with active calculation of the fluid temperature from the sound speed of the fluid is started for the first time on a measuring channel, the transmitter has not stored any offset yet. The fluid temperature has to be entered.

```
Installation\Fluid temp.
```

- Enter the measured fluid temperature.
- Press ENTER.

This display will only be indicated if the calculation of the temperature offset is enabled in the menu item `Miscellaneous\Special settings\Fluid: c -> T`.

NOTICE

The determination of the offset can take up to 2 minutes after starting the measurement (100 sound speed measurements are averaged).

Input of the number of sound paths

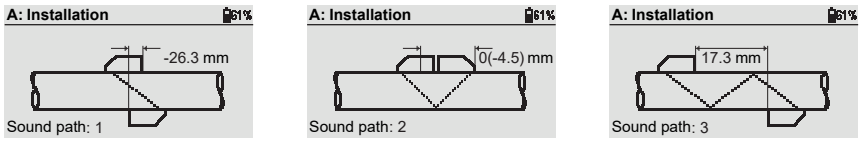
`Installation\Sound path`

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

Adjustment of the transducer distance

`Installation\Transducer distance`

The display visualizes the measurement arrangement with recommended transducer distance. Depending on the number of selected sound paths the transmitter visualizes different images.



If the recommended transducer distance is negative and the transducers cannot be placed in displaced arrangement, a distance of 0 mm is displayed and the recommended distance is visualized in brackets. In this case, increasing the number of sound paths can be considered.

NOTICE

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

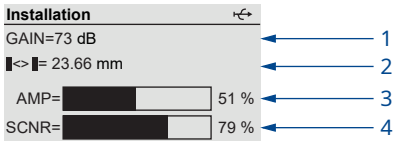
- Mount the transducers on the pipe and adjust the recommended transducer distance.
- Press ENTER.

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. 9.1: 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. 9.8: 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 line is hidden in the other line.

[2] is only displayed when 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. 9.9: 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. 9.10: Max. permitted deviation between the recommended and the entered transducer distance

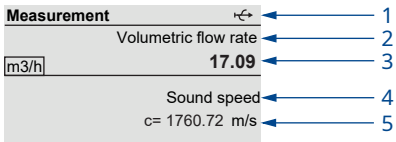
transducer frequency (3rd character of the technical type)	max. difference between recommended and entered transducer distance [mm]	
	shear wave transducer	Lamb wave transducer
F	-	-60...+120
G	20	-45...+90
H	-	-30...+60
K	15	-20...+40
M	10	-10...+20
P	8	-5...+10
Q	6	-3...+5
S	3	-

9.4 Display during the measurement

9.4.1 Measured values

The measured values are displayed during the measurement as follows:

Fig. 9.2: Display of measured values



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

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.

Toggling between the measuring channels

If `2 meas. points (A|B)` is selected for the configuration of the measuring point, the measurement is started on several measuring channels. The display of the measured values can be adapted as follows:

AutoMux mode

In AutoMux mode, the measured values of all activated measuring channels are displayed one after the other. After 3 s, the display toggles to the next measuring channel. The toggle time can be changed in the menu item `Miscellaneous\Dialogs/Menus\Toggle time`.

HumanMux mode

In HumanMux mode, the measured values of one single measuring channel are displayed. The measurement on the other measuring channels continues.

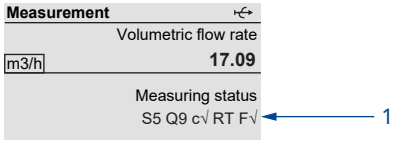
- Press 7 to display the next activated measuring channel. The measured values for the selected measuring channel are displayed.

Each measurement starts in AutoMux mode. Press 1 to toggle between the modes.

9.4.2 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. 9.3: Display of the status line



1 status line

Tab. 9.11: 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

	value	meaning
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
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

9.4.3 Diagnostic values

The diagnostic values can be displayed during the measurement (see table *Diagnostic values [▶ 85]*).

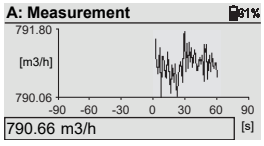
- Press ENTER to go to the diagnostics window.
- If the measurement is started on several measuring channels, press ENTER to go to the diagnostics window for measuring channel B.
- Press ENTER again to return to the display of measured values.

9.4.4 Physical quantity

The physical quantity set in the menu `Parameters` can be visualized over time. The display appears by pressing the key ENTER after the diagnostic values are displayed.

- Press ENTER until the physical quantity is displayed.
- Press key 7 to toggle between the channels. The display is automatically scaled.
- Press ENTER again or key ↩ to return to the display of measured values.

Fig. 9.4: Display of a volumetric flow rate measurement after running approx. 60 s



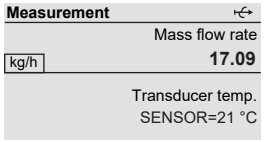
9.4.5 Parameters

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. 9.5: Display of the transducer temperature



NOTICE

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

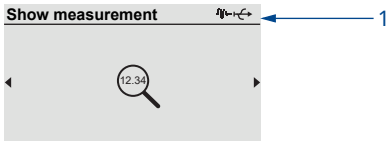
Parameter settings

The parameter settings can be displayed during the measurement.

- Press [↩] during the measurement.

The transmitter returns to the main menu.

Fig. 9.6: 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

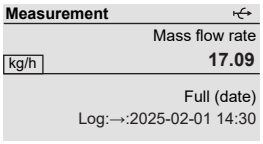
The parameters cannot be changed during the measurement. When trying to do this, the message `Read-only mode` is displayed. The measurement has first to be stopped.

Information regarding the data logger

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

- Press 9 until the following is displayed.

Fig. 9.7: 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.

Display of the current temperature offset

If the calculation of the fluid temperature from the sound speed is activated, the temperature offset can be displayed during the measurement.

```
Miscellaneous\Special settings\Fluid: c -> T
```

- Press ↩ during the measurement.
- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Fluid: c -> T` is displayed.
- Press ENTER.

The temperature offset is displayed.

9.4.6 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.

9.5 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. 9.12: Special functions

key	function
1	toggling between AutoMux and HumanMux mode [1]
8	totalizer display
5	triggering of snaps
6	press and hold to toggle between the standard and alternating display of measured values (only for thermal energy rate measurement)
7	toggling between the displays of the activated measuring channels [1]
0	toggling between TransitTime and FastFood mode
–	toggling between TransitTime and NoiseTrek mode
↩	return to the main menu to stop the measurement or display the parameters
ENTER	display of the diagnostic window

[1] only if `2 meas. points (A|B)` is selected for the configuration of the measuring point

Additional functions can be executed by pressing C. If `2 meas. points (A|B)` is selected for the configuration of the measuring point, the functions of the measuring channel that was last visible on the display are executed.

- 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. 9.13: 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 NoiseTrek or FastFood mode is enabled, it is possible to toggle between them 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.

Channel toggling

If `2 meas. points (A|B)` is selected for the configuration of the measuring point, the display of measured values can be adapted as follows:

`Measurement\Execute command\Channel toggling`

- Select the list item `Channel toggling`.
- Press ENTER.

During the measurement, the measured values of measuring channel A or B can be displayed, or the display automatically toggles between these channels.

- Select a list item for measuring channel toggling.
- 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.

Toggling between standard and alternating display of measured values (only for thermal energy rate measurement)

`Measurement\Execute command\Display toggling on`

- Select the list item `Display toggling on` to activate the automatic toggling of the measured value display.
- Press ENTER.

`Measurement\Execute command\Display toggling off`

- Select the list item `Display toggling off` to deactivate this function.
- Press ENTER.

Switching off the transmitter

```
Measurement\Execute command\Switch off device
```

- Select the list item `Switch off device`.
- Press ENTER.

Measurement is stopped and the transmitter is switched off.

9.6 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

⚠ 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.

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.

Highly viscous fluids strongly attenuate the ultrasonic signal.

- The measurement of fluids with a viscosity of > 1000 mm^2/s is possible to only a limited extent.

Gas bubbles or solids present in high concentration in the fluid scatter and absorb the ultrasonic signal and thus attenuate the measuring signal.

- A measurement is impossible if the value is ≥ 10%. If the proportion is high, but < 10%, a measurement is possible to only a limited extent.

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.

There is gas in the pipe.

- If there is gas in the pipe, the measured flow will be too high.

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.

10.7 Problems during the thermal energy rate measurement

The measured fluid temperatures differ from the actual values.

- The temperature probes are not sufficiently insulated.
- On a pipe with a small diameter, the temperature probe is lifted from the pipe surface by the insulation foam.

The measured absolute value of the thermal energy rate is correct but has the opposite sign.

- Check the assignment of the supply and return temperature to the temperature inputs.

The calculated thermal energy rate differs from the actual one although the measured flow and temperature values are correct.

- Check the thermal energy rate coefficients of the fluid.

11 Maintenance and cleaning

⚠ 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

Tab. 11.1: Recommended maintenance intervals

item	maintenance step	interval	measure
housing • transmitter	visual inspection for corrosion and damages	annually	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
	check of the battery charge state	-	see section --- FEHLENDER LINK ---
transmitter and transducers	recalibration	-	see section --- FEHLENDER LINK ---

11.2 Cleaning

Housing

• Clean the housing with a soft cloth. Do not use detergents.

Transducers

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

11.3 Recalibration

Transmitter and transducers were calibrated by the manufacturer. Recalibration of the transmitter is recommended after 5 years at latest. Transmitter and transducers can be recalibrated independently from each other.

It can be advisable to recalibrate the measuring equipment at shorter intervals, e.g., if the contact surfaces of the transducers show visible traces of wear or if the measuring equipment has been used near the specified temperature limit over a long period of time (e.g., for several months).

For a recalibration at reference conditions the measuring equipment has to be send to Flexim.

11.4 Firmware update

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

- For the connection of the transmitter to a PC see section *Service interfaces [▶ 62]*.

12 Dismounting and disposal

12.1 Dismounting

Dismounting is carried out in reverse order to the installation.

Important

Observe the safety instructions!

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. 13.1: Menu items of the user modes

menu item	Standard User	Expert User	Super User	SuperUser ext.	default
menu item Miscellaneous\Special settings					
Enable NoiseTrek	x	x	x	x	Off
Start in meas. mode	x	x	x	x	
Turbulence mode	x	x	x	x	Off
Max. gain		x	x	x	Off
Pipe signal detection		x	x	x	On
Fluid: c -> T	x	x	x	x	Off
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	

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 NoiseTrek mode

When measuring with a high proportion of gas bubbles or solid particles, the NoiseTrek mode can be used.

NOTICE

Due to its higher measuring accuracy, the TransitTime mode should be preferred to the NoiseTrek mode.
In the NoiseTrek mode it is not possible to determine the sound speed in the fluid.
The following diagnostic values are not available in the NoiseTrek mode: signal quality, amplitude variation and transit time variation.

`Miscellaneous\Special settings\Enable NoiseTrek`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Enable NoiseTrek` is displayed.
- Select `Default` to use the default value. Select `On` to enable the NoiseTrek mode. Select `Off` to disable it.
- Press ENTER.

If `On` has been selected, the following list items are available:

- `Manual`
- `HybridTrek`
- `Parallel beam`

If the synchronized channel averaging is activated in the menu item `Miscellaneous\Measurement\Measurement modes\Synch. chan. averag.`, this function will not be available.

13.1.1.1 Manual mode

In order to manually toggle between the TransitTime and the NoiseTrek mode during the measurement, press [–] when the measured value is displayed.

13.1.1.2 HybridTrek mode

The HybridTrek mode combines the TransitTime and the NoiseTrek mode. During a measurement in the HybridTrek mode, the transmitter automatically toggles between the TransitTime and the NoiseTrek mode depending on the proportion of gas bubbles and solid particles in the fluid in order to receive valid measured values.

If the NoiseTrek mode is enabled, the menu item `HybridTrek` will be displayed.

```
Miscellaneous\Special settings\HybridTrek
```

- Select `On` to activate the automatic toggling between the TransitTime and the NoiseTrek mode. If `On` is selected, the NoiseTrek mode can also be activated and deactivated manually during the measurement.
- Select `Off` to deactivate the automatic toggling between the TransitTime and the NoiseTrek mode. If `Off` is selected, the NoiseTrek mode can only be manually activated and deactivated during the measurement.
- Press ENTER.

```
Miscellaneous\Special settings\HybridTrek\TT -> NT
```

If the automatic toggling between the TransitTime and NoiseTrek mode is activated, further parameters have to be configured.

- Enter the time after which the transmitter has to toggle to the NoiseTrek mode if there are no valid measured values in the TransitTime mode.
- Press ENTER.

```
Miscellaneous\Special settings\HybridTrek\NT -> TT
```

- Enter the time after which the transmitter has to toggle to the TransitTime mode if there are no valid measured values in the NoiseTrek mode.
- Press ENTER.

```
Miscellaneous\Special settings\HybridTrek\NT -> TT possible
```

If there are valid measured values in the NoiseTrek mode, the transmitter can periodically toggle to the TransitTime mode in order to check whether a measurement in the TransitTime mode is possible again. The time interval and the checking duration are set as follows:

- Enter the time after which the transmitter has to toggle to the TransitTime mode. If zero is entered, the transmitter does not toggle to the TransitTime mode.
- Press ENTER.

```
Miscellaneous\Special settings\HybridTrek\Keep TT
```

- Enter the time after which the transmitter has to toggle back to the NoiseTrek mode if there are no valid measured values in the TransitTime mode.
- Press ENTER.

Example

`TT -> NT`: 40 s
`NT -> TT`: 60 s
`NT -> TT possible`: 300 s
`Keep TT`: 5 s

If no measurement is possible in the TransitTime mode within 40 s, the transmitter toggles to the NoiseTrek mode. If no measurement is possible in the NoiseTrek mode within 60 s, the transmitter toggles back to the TransitTime mode.

If valid measured values are obtained during the measurement in the NoiseTrek mode, the transmitter toggles to the TransitTime mode every 300 s. If no measurement is possible in the TransitTime mode within 5 s, the transmitter toggles back to the NoiseTrek mode. If a valid measured value is obtained in the TransitTime mode within 5 s, the transmitter continues the measurement in the TransitTime mode.

13.1.1.3 NoiseTrek parallel beam mode

The NoiseTrek parallel beam mode works with transducers mounted in parallel. It improves the signal quality when measuring on small pipes or with strongly attenuating fluids.

13.1.2 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 or the NoiseTrek mode is enabled.

- Select `TransitTime`, `FastFood` or `NoiseTrek` 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.

The measuring modes `FastFood` and `NoiseTrek` can only be selected if they are available and activated in the transmitter.

If the synchronized channel averaging is activated in the menu item `Miscellaneous\Measurement\Measurement modes\Synch. chan. averag.`, this function will not be available.

13.1.3 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.
- If turbulence mode is activated, the signal gain must be at least 3 dB lower than when turbulence mode is deactivated. 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 `Automatic` if the turbulence mode is to be activated or deactivated automatically depending on the signal strength. Select `Default` to use the default value (`Off`).
- Press ENTER.

13.1.4 Calculation of the fluid temperature from the sound speed of the fluid

`Miscellaneous\Special settings\Fluid: c -> T`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Fluid: c -> T` is displayed.
- Select `On` if the fluid temperature has to be calculated from the sound speed. Select `Off` if not.
- Press ENTER.

13.1.5 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.

13.1.6 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 table *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.

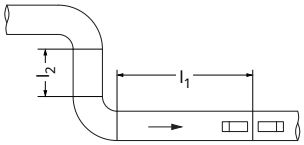
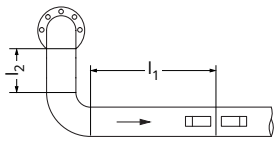
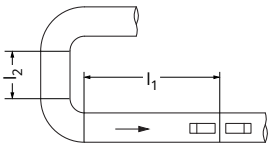
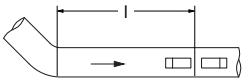
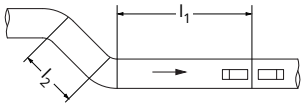
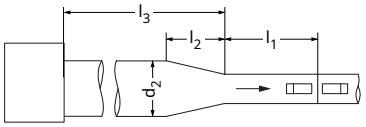
Selection of the disturbance

`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. 13.2: 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)	
90° U double elbow	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`

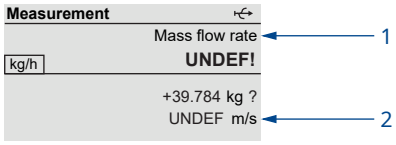
- Enter a flow velocity limit for the measurement against the flow direction.
- Press ENTER.

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. 13.1: 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 Calculation of the fluid temperature from the sound speed of the fluid

`Miscellaneous\Special settings\Fluid: c -> T`

- Select the menu item `Miscellaneous\Special settings`.
- Press ENTER until the menu item `Fluid: c -> T` is displayed.
- Select `On` if the fluid temperature has to be calculated from the sound speed. Select `Off` if not.
- Press ENTER.

If the transmitter is operating in the `SuperUser` or `SuperUser ext.` mode and `On` is selected, options for temperature calculation will be displayed.

`Miscellaneous\Special settings\Fluid: c -> T\Temperature meas.`

- Select `With calibration` if the temperature calculation is to be calibrated.

When starting the measurement, an offset is determined, being the difference between the entered fluid temperature and the fluid temperature calculated from the sound speed. The fluid temperature has to be entered.

- Press ENTER.
- Select `Without calibration` if no measured temperature value is available.
- Press ENTER.

NOTICE

If the fluid temperature is calculated from the sound speed without calibration, large temperature deviations may occur.

- Select `Customized` to enter an offset.
- Press ENTER.
- Enter the offset.
- Press ENTER.

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.

If the list item `2 meas. points (A|B)` is selected in the menu item `Parameters\Measuring point config.`, the pipe wall calibration can be activated for each measuring point.

`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.

If the list item `1 meas. point (AB)`, `2 meas. points (A|B)` or `Channel-based param.` is selected in the menu item `Parameters\Measuring point config.`, the weighting factor can be activated individually for each measuring channel.

`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 the list item for the quantity to be output.
- Press ENTER.

Tab. 13.3: 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 [▶ 67]*.

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. 13.4: Calculation types

calculation type	description	calculation function
`Average (all chan. OK)`	average (AND operation) All measuring channels have to deliver a valid measured value.	`Y = (A + B)/2`
`Average (1 chan. OK)`	average (OR operation) At least one measuring channel has to deliver a valid measured value.	`Y = (A + B)/n`
`Sum`	sum of measuring channels	`Y = A + B`
`Difference (A-B)`	difference of measuring channels	`Y = A - B`
`Difference (B-A)`	difference of measuring channels	`Y = B - A`
`Special`	Each measuring channel selected for calculation can be assigned with a signed value.	

If the synchronized channel averaging is activated in the menu item `Miscellaneous\Measurement\Measurement modes\Synch. chan. averag.`, the average can only be selected as calculation type (AND or OR operation).

```
Parameters\Measuring point config.\Channel-based param.\Channel Y\
Calculation type
```

- Select a calculation type.
- Press ENTER.
- Assign a measuring channel to each source channel.
- Press ENTER after each selection.

Example

calculation type:	`Special`
source channel 1:	`Meas. Channel A`
sign of source channel 1:	`|A|`
source channel 2:	`Meas. Channel B`
sign of source channel 2:	`|B|`
average:	`1/2 (AND)`
linear correction:	`Yes`
factor:	`1.5 Factor`
offset:	`2.0 m/s`
calculation function:	`1.5 * (|A| + |B|)/2 + 2 m/s`

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. 13.5: Source item "Extended diagnostics"

source item	list item	output
`Extended diagnostics`	`Valid channels`	percentage of physical channels with valid measuring status
	`Δ(Sound speed)`	path difference of the sound speed
	`Δ(Flow velocity)`	path difference of the flow velocity
	`Δ(Gain)`	path difference of the signal gain
	`Δ(Amplitude)`	path difference of the signal amplitude
	`Δ(Quality)`	path difference of the signal quality
	`Δ(SNR)`	path difference of SNR
	`Δ(SCNR)`	path difference of SCNR
	`Δ(VariAmp)`	path difference of the amplitude variation
	`Δ(VariTime)`	path difference of the transit time variation

The list item `Valid channels` will not be displayed if a binary output was selected as output.

The status of a path difference is OK if a measured value for calculation is available on 2 measuring channels.

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 [▶ 75]*.

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. 14.1: 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 an output

`Outputs\Digital output B1\B1 Enable\Select meas. point`

- Select the measuring point.
- Press ENTER.

This display will only be indicated if `2 meas. points (A|B)` is selected for the configuration of the measuring point.

Assignment of a source item

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

`Outputs\Source item`

Tab. 14.2: 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. 14.3: 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. 14.4: 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. 14.5: 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. 14.6: 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. 14.7: 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. 14.8: 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. 14.9: 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. 16.1:

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. 16.2: 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. 16.3: 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

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) allow data to be transmitted from the transmitter to the PC using the FluxDiag Reader program.

The following tasks can be carried out with the program FluxDiag Reader:

- read and store measured values, setup settings and snaps
- graphically display measured values
- export data in csv format

NOTICE

To transmit data from the PC to the transmitter, the program FluxDiag has to be used.

17.1.1 USB interface type A

The transmitter has a USB interface 2.0 type A that can be used to connect a USB stick. When a USB stick is connected, the symbol is displayed in the status line. Setups can be imported or exported via the USB stick.

```
Storage\USB mass storage
```

- Select the list item `USB mass storage` in the menu `Storage`.
- Press ENTER.

Export setup

- Select the list item `Export setup`.
- Press ENTER.
- Select `Setup and data logger` to export the current setup and the content of the data logger. Select `Setup only` to export only the current setup.
- Press ENTER.

The exported data are automatically given a name, e.g., `FluxusSetup_2025-03-10_15-41-21.fluxus`.

If the export fails, an error message appears. Check whether the data system of the USB stick is a FAT12, FAT16 or FAT32 system. If necessary, the USB stick has to be formatted.

Import setup

- Select the list item `Import setup`.
- Press ENTER.

All setups are displayed.

- Select with key 2 or 8 one setup for the import.
- Press ENTER.

Important

Make sure that only setups of the same device type are imported.

17.1.2 USB interface type C

The transmitter has a USB interface type C hat can be used to connect it to a PC.

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.

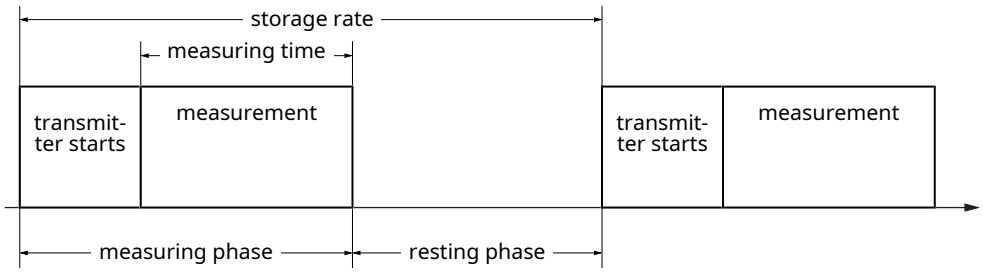
18 Advanced functions

18.1 Low-power mode

The low-power mode serves to prolong the battery life of the transmitter.

If the low-power mode is activated, the transmitter switches off for a certain time (resting phase) after finishing the measuring cycle.

Fig. 18.1: Measurement in the low-power mode



The storage rate and the measuring time can be entered. The starting phase is determined by the system and cannot be adjusted. During measuring time, several measurements are carried out and averaged, depending on the length. In doing so, the adjusted damping factor is taken into account. Exactly 1 measured value per measuring time is stored in the data logger.

NOTICE

While the low-power mode is activated, all outputs, process interfaces and totalizers are deactivated.

18.1.1 Activation of the low-power mode

`Miscellaneous\Measurement\Low power mode`

- Select the list item `Low power mode` in the menu item `Miscellaneous\Measurement`.
- Press ENTER.
- Select `On` to activate the low-power mode. Select `Off` to operate the transmitter in normal measuring mode.
- Press ENTER.

18.1.2 Low-power mode settings

`Miscellaneous\Measurement\Low power mode\Storage rate`

- Select the list item `Low power mode` in the menu item `Miscellaneous\Measurement`.
- Press ENTER until the menu item `Storage rate` is displayed.
- Enter the storage rate.
- Press ENTER.
- The menu item `Measuring time` is displayed.
- Select `Customized` to define the length of the measuring time (default: 5 s).

- Press ENTER.
- Enter the length of the measuring time.
- Press ENTER.

18.1.3 Measurement

Start of measurement

NOTICE

In order to start a measurement, the parameter input has to be completed.

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

The following display appears: `Start low power mode`.

- Select `Yes` to start the transmitter in low-power mode.

This display will only be indicated if the low-power mode is activated in the menu item `Miscellaneous\Measurement\Low power mode`.

The measurement will be started in low-power mode.
The display backlight switches off after the first measurement.

NOTICE

Expect of key C, all other keys are blocked in low-power mode.

Intervention in the measurement

- Keep key C pressed until the display is switched on.

The following display appears: `Stop low power mode`.

- Select `No` to continue in low-power mode.

The current measurement and the battery charge state are displayed.

- Press key C to continue in low-power mode.

The display backlight switches off after the first measurement.

Stop of measurement

- Keep key C pressed (at least 3 s) until the display is switched on.

The following display appears: `Stop low power mode`.

- Select `Yes` to stop the measurement in low-power mode.

18.1.4 Status indicators

The operational state of the transmitter, operating in low-power mode, is indicated by the LED "BATTERY".

Tab. 18.1: Operational state of the transmitter

LED "BATTERY"	operation state
flashes green (every 4 s)	resting phase in low-power mode
flashes green twice (every 4 s)	battery charging
flashes green three times (every 4 s)	battery charged
flashes red (every 4 s)	battery almost empty, connect the power supply unit

18.2 Totalizers

It is possible to determine the thermal energy, total volume or total mass of the fluid at the measuring point.

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 heat, volume or mass unit selected for the physical quantity (default, for global changes see section *Units of measurement* [▶ *164*]).

The totalizer values can be displayed in the status line during the measurement.

Tab. 18.2: 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.

18.2.1 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. 18.3: 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. 18.4: 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.

18.2.2 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.

18.2.3 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 table *Scroll list [▶ 91]*).

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.

18.2.4 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.

18.2.5 Totalizer behavior during thermal energy rate measurement

During the thermal energy rate measurement, it is possible to output and store the values the thermal energy totalizer and of the volume totalizer.

`Storage\Totalizers\Therm.energy+flow tot.`

- Select the menu item `Storage\Totalizers`.
- Press ENTER until the menu item `Therm.energy+flow tot.` is displayed.

- Select `Yes` if the values of the thermal energy totalizer and the volume totalizer are to be stored and output during the thermal energy measurement.
- Press ENTER.

18.2.6 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.
- Press ENTER.

18.2.7 Display of the totalizers

The values of both the totalizers (positive and negative flow direction) can be displayed simultaneously during the measurement.

`Storage\Totalizers\Show +/-Q`

- Select the list item `Totalizers` in the menu item `Storage`.
- Press ENTER until the menu item `Show +/-Q` is displayed.
- Select `Yes` to display simultaneously both totalizer values.
- Press ENTER.

18.2.8 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.

18.3 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.

If `2 meas. points (A|B)` is selected in the menu item `Parameters` for the configuration of the measuring point, the following points have to be observed:

- It is not possible to change the measuring channel. The measurement takes place on one channel only. As long as the FastFood mode is activated, no measurement is carried out on the other measuring channels.

- The outputs of the measuring channel activated in FastFood mode can still be used. They are updated synchronously with the FastFood measuring rate, independently from the storage rate.
- Any outputs of further measuring channels (multi-channel measurement) transmit an error value.

If the synchronized channel averaging is activated in the menu item `Miscellaneous\Measurement\Measurement modes\Synch. chan. averag.`, this function will not be available.

18.3.1 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` if the default value (50 ms) is to be used. Select `Customized` if a value for the FastFood measuring rate is to be entered.
- If `Customized` is selected, enter a value for 20...200 ms.
- Press ENTER.

18.3.2 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. Select `Customized` if the value for the storage rate is to be defined.
- Press ENTER.
- If `Customized` is selected, enter a value.
- Press ENTER.

18.3.3 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.

18.4 Diagnostics using the snap function

A snap is a saved image of a measurement cycle. 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. Snaps are useful to evaluate signal quality and for troubleshooting.

18.4.1 Configuration

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.

```
Storage\Snap\Configuration\Periodic snaps
```

- Select `Yes` if a snap has to be triggered at a specific time interval.
- Press ENTER.
- Select a list item for the time interval.
- Press ENTER.

The selected time interval for periodic snaps is not affected by other types of snap triggers.

18.4.2 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.

18.4.3 View snaps

Snaps are useful to visualize the signal shape, i.e., signal strength over the duration of a snap.

- Select the list item `View snaps` in the menu item `Storage\Snap`.
- Press ENTER.

A list with all snaps stored in the transmitter is displayed. The snaps are marked with a number, a date and time, channel on which the snap was taken and measuring mode, see following table (example: `#1: 2025-03-27 10:42:33 A: TT`).

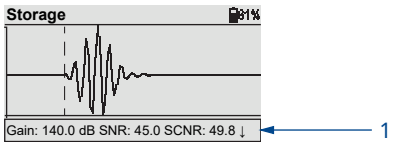
Tab. 18.5: Display of measuring mode

display	description
TT	TransitTime
NT	NoiseTrek
WT	wall thickness measurement

- Scroll with key 2 or 8 through the list and select a snap.
- Press ENTER.

The display visualizes the signal strength over time.

Fig. 18.2: Snap



1 Snap related data

The vertical, dashed line represents the signal beginning. The lower line contains additional information related to the snap. These data can differ depending on the measuring mode. Press key 7 to toggle between the different displays. An arrow describes whether it is the positive or negative flow direction of the signal.
The keys 8 and 2 are useful to scale up or down the snap view. The signal can be horizontally shifted with key 4 and 6. When the keys for zoom and navigation are kept pressed, the process is accelerated.
The zoom is reset with key 9. If the signal beginning is known, pressing key 9 allows to toggle between a zoom on the signal beginning and an unscaled view.

18.4.4 Information on snaps

`Storage\Snap\Snap info`

- Select the list item `Snap info` in the menu item `Storage\Snap`.
- Press ENTER.

Tab. 18.6: 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

18.4.5 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.

18.5 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. Select `Customized` if a min. pipe diameter is to be defined.
- Press ENTER.
- If `Customized` is selected, 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.

18.6 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
- hold last value

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.

18.6.1 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 (-)`
  - `Hold last value (-)`
- 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)` or `2 meas. points (A|B)` are 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.

Hold last value

- Select the list item `Hold last value`.
- Press ENTER.

If the function `Hold last value` activated and no measurement value can be measured during a measurement, the last valid measured value is hold. The letter H is displayed after the last valid measurement value. The process outputs and the process interface output the valid measured value held. The totalizer continues counting with the held value. The information that `Hold last value` is activated is saved in the data logger.

NOTICE

The event trigger used must not have a flow quantity, sound speed, or a totalizer as its source item.

- 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.

If the function `Hold last value` is activated, a max. hold time can be defined.

- Select the list item `Yes` in the menu item `Max. hold time`, to define a max. hold time.
- Press ENTER.
- Enter a value for the max. hold time.
- Press ENTER.

The function `Hold last value` is deactivated after this time has elapsed.

18.7 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 `1 meas. point (AB)` is selected in the menu `Parameters` for the configuration of the measurement point, it is possible to activate up to 4 independent event triggers: R1, R2, R3 and R4 for each measuring channel. These event triggers can only be used for diagnostic values of the measuring channels.

```
Functions\Event trigger
```

- Select the menu item `Functions\Event trigger`.
- Press ENTER.

```
Functions\Event trigger\Channel x
```

- Select a measuring channel.
- Press ENTER.

```
Functions\Event trigger\Channel x\Rx(-)
```

- Select an event trigger.
- Press ENTER.

The following applies to all event triggers:
If the event trigger has already been installed, it is displayed as follows: `Rx(√)`.

`Functions\Event trigger\Rx Enable`

- 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\Rx Enable\Source item`

- Select the source item (physical quantity) to define a condition for.

Tab. 18.7: Source items

source item	list item	output
`Flow quantities`	`Flow velocity`	flow velocity
	`Volumetric flow rate`	volumetric flow rate
	`Mass flow rate`	mass flow rate
	`Thermal energy rate` (1)	thermal energy rate
`Totalizers`	`Volume (+)`	totalizer for the volumetric flow rate in positive flow direction
	`Volume (-)`	totalizer for the volumetric flow rate in negative flow direction
	`Volume (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
	`Thermal energy (+)` (1)	thermal energy totalizer for positive measured values of the thermal energy rate
	`Thermal energy (-)` (1)	thermal energy totalizer for negative measured values of the thermal energy rate
	`Thermal energy (Δ)` (1)	difference of the thermal energy totalizers

source item	list item	output
Fluid properties	Fluid temp.	fluid temperature
	Supply temperature [1]	supply temperature (thermal energy rate measurement)
	Return temperature [1]	return temperature (thermal energy rate measurement)
	Temperature (Δ) [1]	difference between supply and return temperature (thermal energy rate measurement)
	Fluid pressure	fluid pressure
	Supply pressure [1]	supply pressure (thermal energy rate measurement)
	Return pressure [1]	return pressure (thermal energy rate measurement)
	Pressure (Δ) [1]	difference between supply and return pressure (thermal energy rate measurement)
	Fluid density	fluid density
	Kin. viscosity	kinematic viscosity
	Dyn. viscosity	dynamic viscosity
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
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 measured in the fluid
	Sound speed (Δ)	difference of the measured sound speed and the sound speed calculated from the fluid data

[1] only if Thermal energy rate is selected as physical quantity in the menu Parameters

Afterwards, the properties of the event trigger are defined.

Tab. 18.8: 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.
`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.

18.7.1 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.

18.7.2 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.

18.7.3 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`.

18.7.4 Display of the event trigger state

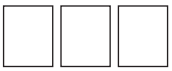
NOTICE

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.

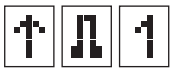
The display of the event trigger state is structured as follows:

Rx =  with x being the number of the event trigger and  a pictogram according to *Pictograms for the display of the event trigger state [▶ 159]*.

Tab. 18.9: 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 = 

18.8 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.
- Enter zero. The menu item `Pipe circumference` is displayed.
- 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 `Installation`, 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.

Toggle time

If `2 meas. points (A|B)` is selected for the configuration of the measuring point in the menu `Parameters`, the time interval can be defined, after which the transmitter toggles between the different measuring channels during the measurement (default: 3 s).

```
Miscellaneous\Dialogs/Menus\Toggle time
```

- Press ENTER until the menu item `Toggle time` is displayed.
- Enter a different toggle time if the default value is not to be used.
- Press ENTER.

This value remains stored until a new toggle time is entered.

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 list item `Measurement modes`.
- Press ENTER.

Synchronized channel averaging

`Miscellaneous\Measurement\Measurement modes\Synch. chan. averag.`

- Press ENTER until the menu item `Synch. chan. averag.` is displayed.
- Select `On` to activate the synchronized channel averaging. Select `Off` to deactivate it.
- Press ENTER.

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.

This display will not be indicated if the synchronized channel averaging is activated.

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.

```
Storage\Param. record memo.
```

- Select the menu item `Storage\Param. record memo.`.
- Press ENTER.
- Select the menu item `Save current record`.
- Press ENTER.

```
Storage\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.

```
Storage\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

```
Storage\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 Display settings

19.8.1 Backlight

The backlight can be switched on and off by pressing key LIGHT.

19.8.2 Brightness

The display brightness can be adjusted.

`Miscellaneous\System settings\Display brightness`

- Select the list item `Display brightness` in the menu item `Miscellaneous\System settings`.
- Press ENTER.

The display brightness can be adjusted with the following keys:

4 reduce brightness gradually

6 increase brightness gradually

2 adjust brightness to 0 %

5 adjust brightness to 50 %

8 adjust brightness to 100 %

NOTICE

At a brightness level of 0 %, the backlight is switched off.

19.9 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. 19.1: HotCodes for certain functions

function	HotCode
set display contrast to medium value	555000
set display brightness to maximum value	555500
language selection	9090xx
initialization	909000

Language selection

The language can be selected in the menu item `Miscellaneous\System settings\Language` or with a HotCode.

Tab. 19.2: 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.

19.10 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.

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. 19.3:

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 • toggling to NoiseTrek mode • stop of totalizers • reset of totalizers • stop of measurement

20 Wall thickness measurement (optional)

⚠ 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.

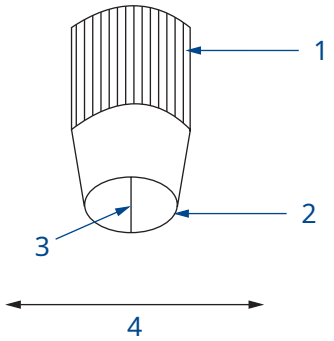
→ Wear the required personal protective equipment.

→ Observe the applicable rules.

20.1 Orientation of the wall thickness probe

When measuring on pipes or cylindrical vessels, the probe has to be pressed centrally against the object. The applied pressure has to be constant. The acoustic partition boundary of the wall thickness probe has to be perpendicular to the longitudinal axis of the pipe.

Fig. 20.1: Orientation of the wall thickness probe



1 wall thickness probe
2 contact surface
3 acoustic partition boundary
4 pipe axis

20.2 Wall thickness measurement

When the wall thickness probe is connected to an arbitrary measuring channel, the following main menu appears:

- `Wall thickness meas.`
- `Storage`
  - `Snap`
  - `Event log`
- `Communication`

- `Miscellaneous`
  - `System settings`
  - `Units of measurement`
    (here only unit of measurement settings for length, temperature and sound speed)

- Connect the wall thickness probe to the measuring channel A or B.

The main menu of the wall thickness measurement is displayed.

NOTICE

As soon as the wall thickness probe is connected to the measuring channel, the wall thickness measurement is activated.

20.2.1 Pipe wall thickness measurement

`Wall thickness meas.\Physical quantity\Pipe wall thickness`

- Select the list item `Pipe wall thickness` in the menu item `Wall thickness meas.\Physical quantity`.
- Press ENTER.

`Wall thickness meas.\Physical quantity\...\Pipe material`

- 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

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.

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

- Enter the sound speed of the pipe material.
- 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 chapter Annex: Reference.

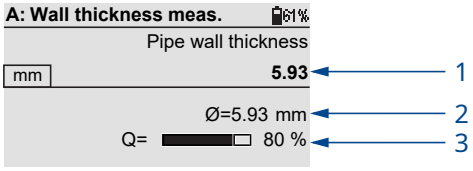
If the sound speed of the material stored in the material database depends on temperature, the material temperature has to be entered.

`Wall thickness meas.\Physical quantity\...\Material temperature`

- Enter the temperature of the pipe material.
- Press ENTER.

The wall thickness measurement is started.

Fig. 20.2: Wall thickness measurement



1 current measured value **2 average of the last 10 measurements**
3 measurement quality

- Press key ENTER or .

The following display appears `Apply result`.

- Select a list item.
- Press key to return to the display of measured values.
- Press ENTER to stop the measurement.

When the measured value is accepted, the thickness and material of the pipe wall are transferred to the setup of the transmitter.

20.2.2 Sound speed measurement

`Wall thickness meas.\Physical quantity\c longitudinal`

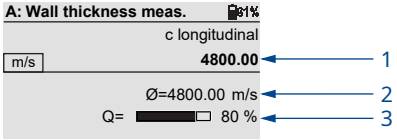
- Select the list item `c longitudinal` in the menu item `Wall thickness meas.\Physical quantity`.
- Press ENTER.

`Wall thickness meas.\Physical quantity\...\Material thickness`

- Enter the pipe wall thickness.
- Press ENTER.

The sound speed measurement is started.

Fig. 20.3: Display of sound speed measurement



1 current measured value **2 average of the last 10 measurements**
3 measurement quality

- Press key ENTER or .

The following display appears `Apply result`.

- Select a list item.
- Press key to return to the display of measured values.
- Press ENTER to stop the measurement.

When the measured value is accepted, the material is set to `Other material` for the following wall thickness measurement and the measured longitudinal sound speed is stored in the transmitter.

20.2.3 Errors during the measurement

If no valid wall thickness can be measured:

- remove the wall thickness probe from the pipe wall
- clean the wall thickness probe and the place where the measurement takes place
- apply a thin film of the coupling compound to the pipe wall
- press the wall thickness probe against the pipe wall in this position
- try to measure again

NOTICE

Use a small amount of coupling compound. Press the wall thickness probe evenly against the pipe wall.

⚠ CAUTION

Contact with chemical substances

Contact with chemical substances can lead to allergic reactions.

→ Wear the required personal protective equipment.

20.2.4 Possible reasons for incorrect measuring results

- temperature fluctuations:
  The sound speed is temperature dependent.
- doubling effect:
  When measuring the wall thickness using ultrasonic signals, a phenomenon called doubling effect can occur if the wall thickness is smaller than the min. value of the measuring range of the probe. The measured value is then twice (or sometimes 3 times) as high as the actual wall thickness because of repeated reflections of the ultrasonic signal.
- the measured value is too low:
  The ultrasonic signal was reflected by a defect and not by the boundary layer, resulting in a shorter transit time and therefore a lower wall thickness.
- curved surfaces:
  The probe has to be pressed centrally against the pipe or cylindrical vessel. The applied pressure has to be constant. The acoustic partition boundary of the wall thickness probe has to be perpendicular to the longitudinal axis of the pipe.
- surface conditions:
  Regular unevenness (e.g., small grooves) on the surface of the pipe can result in wrong measured values. Normally, this problem can be avoided by turning the wall thickness probe in such a way that its acoustic partition boundary is perpendicular to the orientation of the grooves.

20.2.5 Stop of the wall thickness measurement

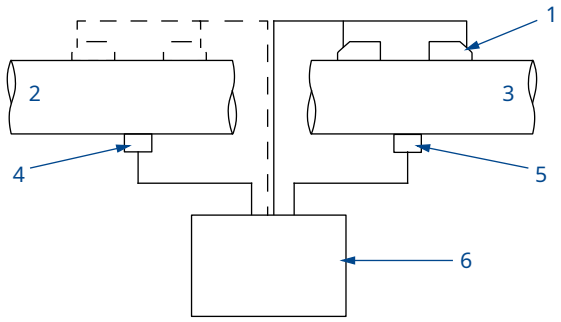
- In order to quit the wall thickness measurement, disconnect the wall thickness probe from the transmitter.

21 Thermal energy rate measurement (optional)

If the transmitter has the optional thermal energy measurement and 2 temperature inputs, the thermal energy rate can be measured. For this purpose, one temperature probe is mounted on the supply line and one on the return line.

The transducers should preferably be mounted on the return line. If this is not possible, they can also be mounted on the supply line.

Fig. 21.1: Thermal energy rate measurement with flow measurement



1 transducers
2 supply line
3 return line
4 temperature probe on supply line (temperature input T_V)
5 temperature probe on return line (temperature input T_R)
6 transmitter

Tab. 21.1: Possible measurement arrangements

heating application	$T_V > T_R$	transducers on supply line
		transducers on return line
cooling application	$T_V < T_R$	transducers on supply line
		transducers on return line

A temperature correction value (offset) can be set for each temperature input.

The thermal energy is the totalizer of the thermal energy rate.

21.1 Calculation of the thermal energy rate

The thermal energy rate is calculated with the following formula:

$$\Phi = k_i \cdot \dot{V} \cdot (T_V - T_R)$$

where

- Φ – thermal energy rate
- k_i – heat transfer coefficient
- $\dot{V}$ – volumetric flow rate
- T_V – supply temperature
- T_R – return temperature

The heat transfer coefficient k_i is calculated from several thermal energy rate coefficients for the specific enthalpy and the density of the fluid. The thermal energy rate coefficients of some fluids are stored in the internal database of the transmitter.

If no thermal energy rate coefficients are available for the selected fluid, an error message will be displayed.

21.2 Definition of the physical quantity and the unit of measurement

`Parameters\...\Physical quantity`

- Select the menu `Parameters`.
- Press ENTER until the menu item `Physical quantity` is displayed.
- Select the list item `Thermal energy rate`.
- Press ENTER.
- Select the unit of measurement to be used for the thermal energy rate.
- Press ENTER.

21.3 Application and transducer positioning

`Parameters\...\Thermal energy rate\Application`

- Select `Heating` if the system is to be operated as heating application. Select `Cooling` if the system is to be operated as cooling application.
- Press ENTER.

`Parameters\...\Thermal energy rate\Transducer location`

- Select `Return line` if the measurement arrangement was configured for a thermal energy rate measurement on the return line. Select `Supply line` if the measurement arrangement was configured for a thermal energy rate measurement on the supply line.
- Press ENTER.

`Parameters\...\Thermal energy rate\Thermal energy rate`

- Select `Sign` if the sign of the thermal energy rate is to be considered. Select `Absolute value` if the absolute value of the thermal energy rate is to be displayed.
- Press ENTER.

`Parameters\...\Thermal energy rate\Limit ΔT`

- Select `Customized` to define a lower limit for the thermal energy rate measurement. Select `Default` if the default value is to be used. Select `Off` if no lower limit for the thermal energy rate measurement is to be defined.
- Press ENTER.

`Parameters\...\Thermal energy rate\Phase transition`

- Select `Yes` if the state of aggregation of the fluid changes between the return and supply line. Select `No` if it does not change.
- Press ENTER.

This function is only available in SuperUser mode, if water, ammonia or a coolant is selected as fluid. It is possible to enter a lower limit of the temperature difference.

21.4 Assignment of the temperature inputs

The supply and return temperatures are assigned to `Supply temperature` and `Return temperature`, respectively, in the transmitter. The temperatures can be measured or entered as constant values.

The temperature inputs have to be enabled in the menu `Inputs`.

`Inputs\Assign inputs`

- Select the menu item `Inputs\Assign inputs`.
- Press ENTER.
- Select the menu item `Supply temperature`.
- Press ENTER.
- Select an input for the supply temperature. Select `Fixed value` if the supply temperature is known and constant during the whole measurement. The value has to be entered in the menu `Parameters`.
- Press ENTER.
- Select the menu item `Return temperature`.
- Press ENTER.
- Select an input for the return temperature. Select `Fixed value` if the return temperature is known and constant during the whole measurement. The value has to be entered in the menu `Parameters`.
- Press ENTER.

21.5 Two independent thermal energy rate measurements

If the transmitter has 2 measuring channels and 4 temperature inputs for each measuring channel, it is possible to conduct 2 independent thermal energy rate measurements at the same time.

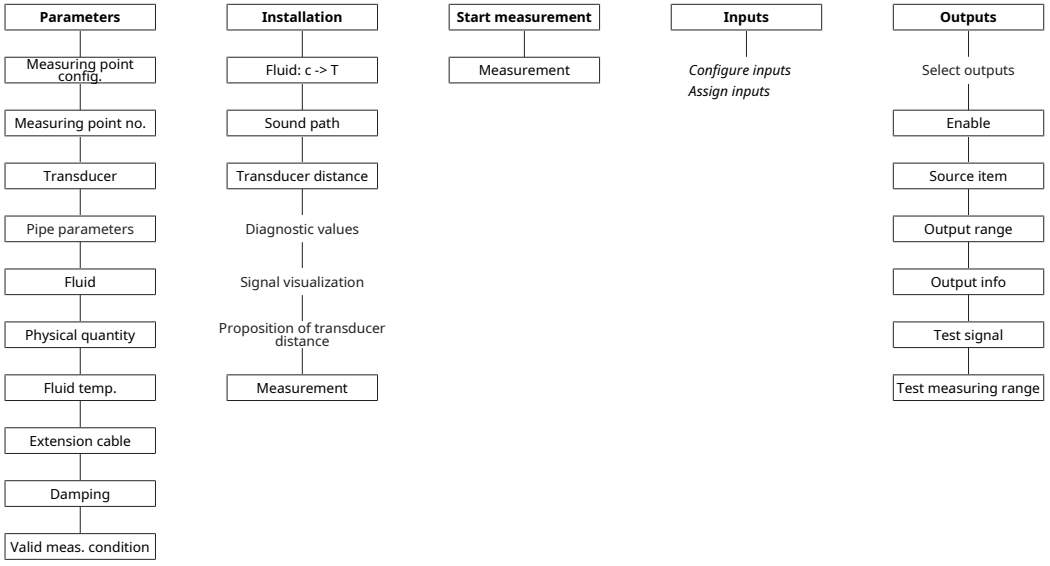
Select `2 meas. points (A|B)` in the menu `Parameters` to configure the measuring point.

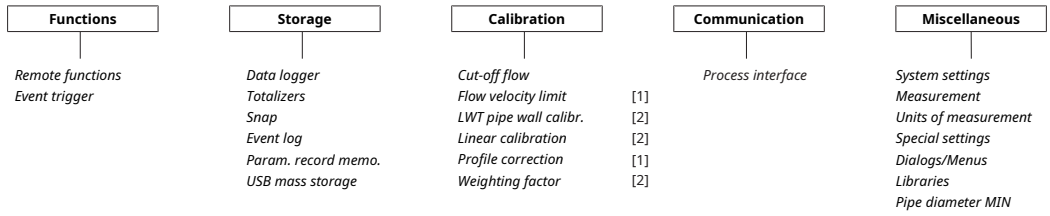
Tab. 21.2: Configuration of the temperature inputs in case of 2 independent thermal energy rate measurements

		temperature input
measuring channel A	supply temperature	T1 or constant value
	return temperature	T2 or constant value
	measurement of thermal energy	possible
measuring channel B	supply temperature	T3 or constant value
	return temperature	T4 or constant value
	measurement of thermal energy	possible

A Annex: Menu structure

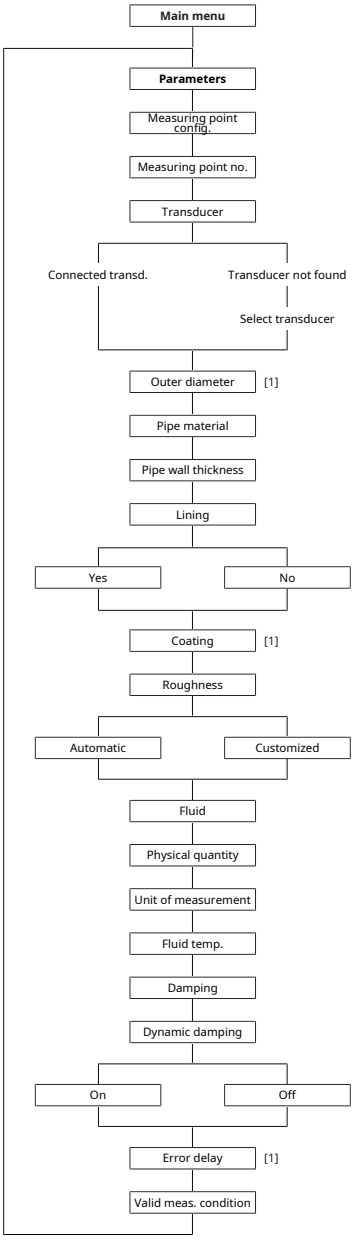
Main menu





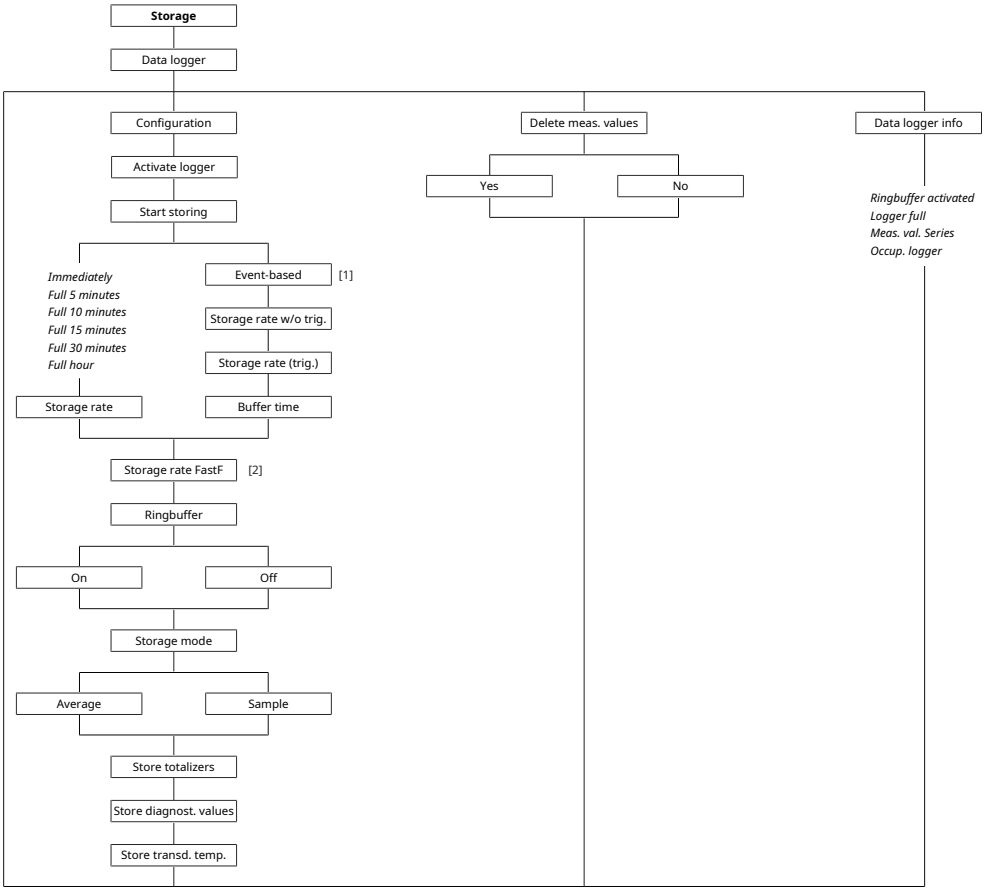
Legend
[1] from ExpertUser mode
[2] from SuperUser mode

Input of parameters



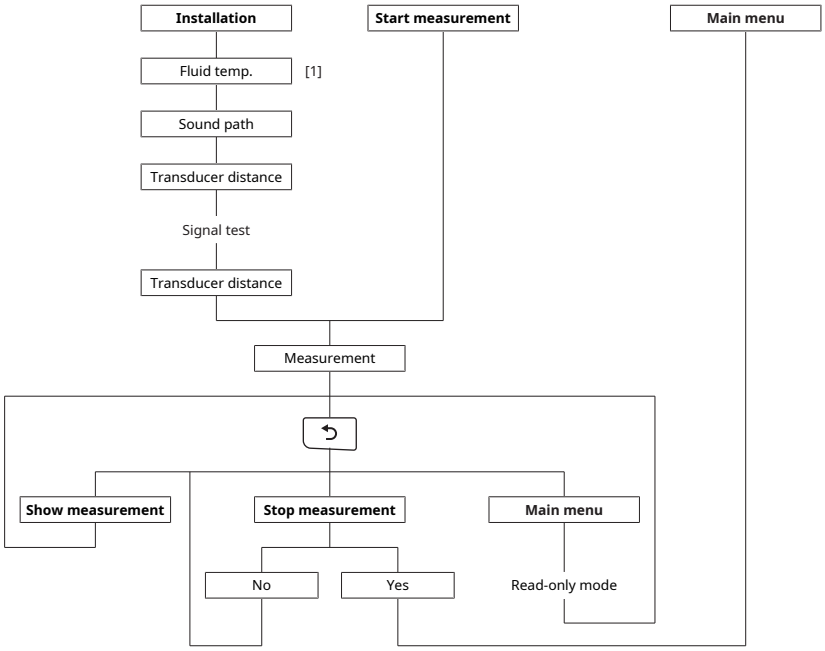
Legend
[1] only if enabled

Data logger



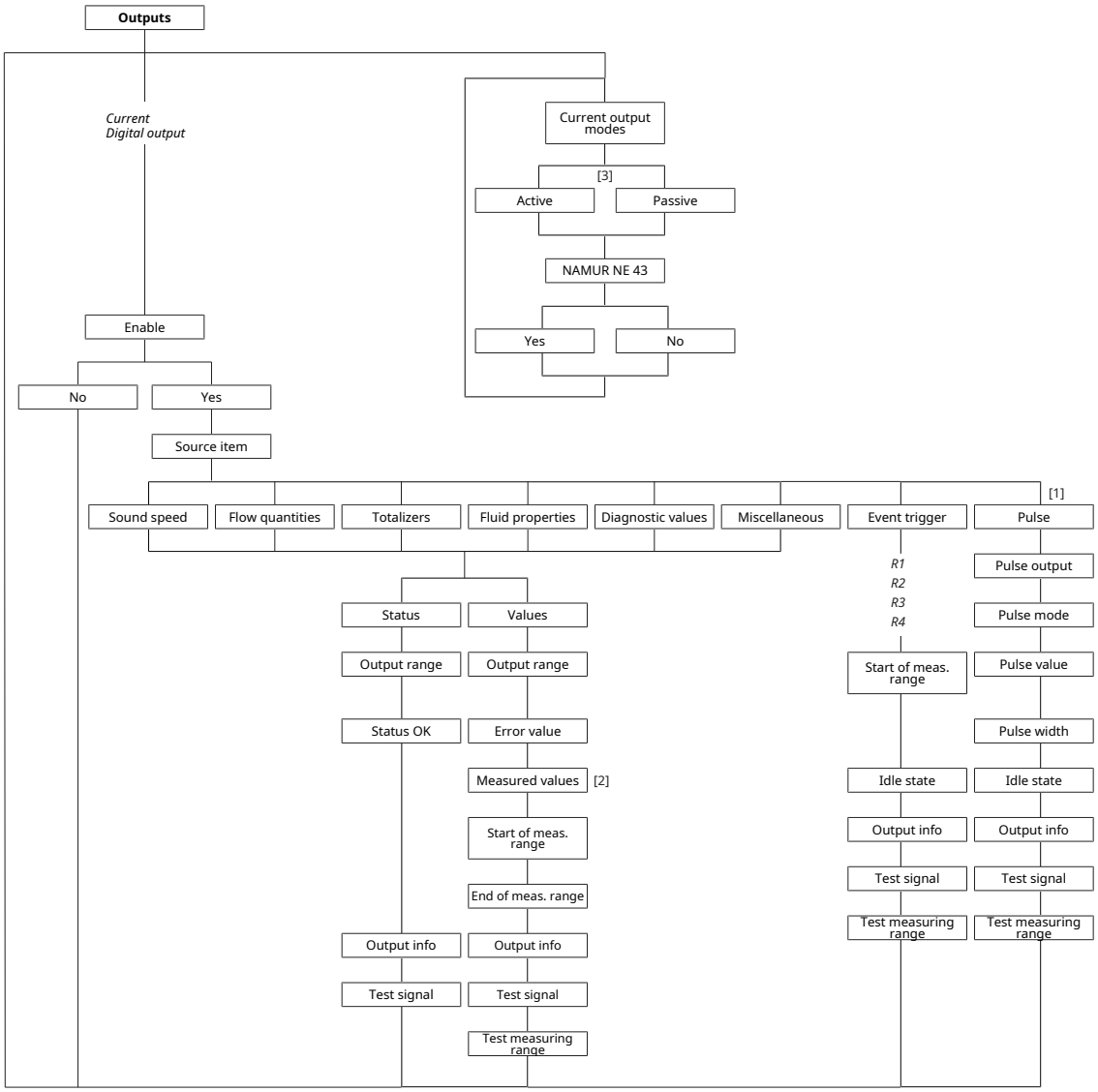
Legend
[1] list of parameterized triggerable inputs and event triggers
[2] only if enabled

Measurement start



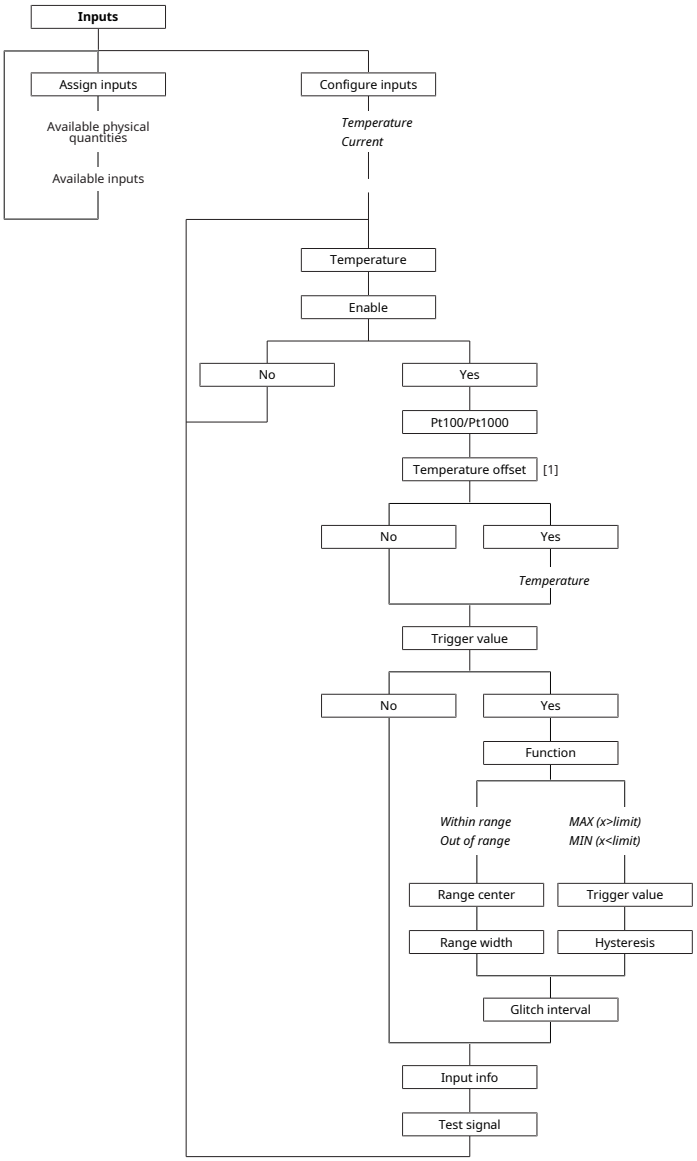
Legend
[1] only if enabled

Configuration of outputs



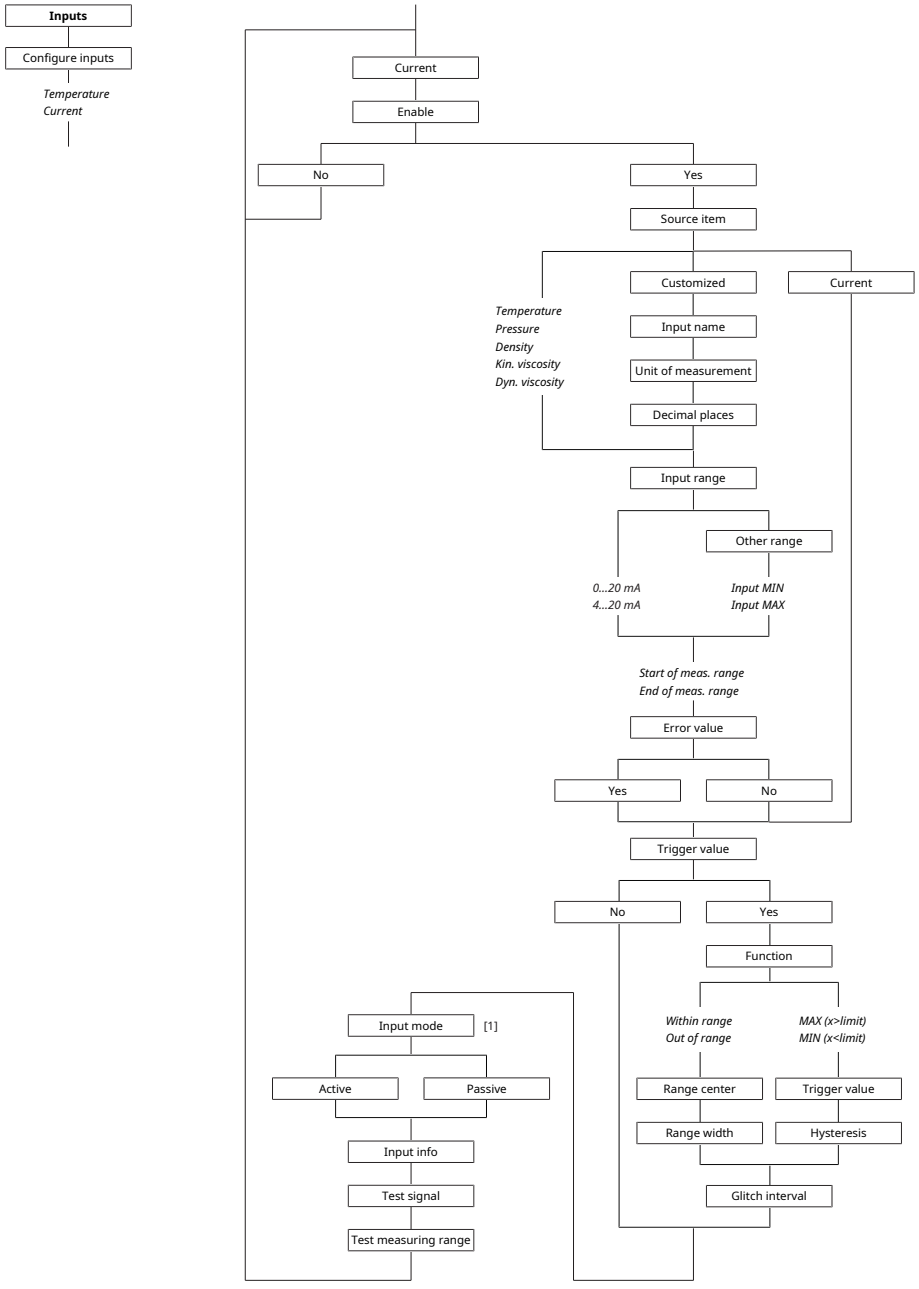
Legend
[1] only available for digital outputs supporting pulse output
[2] requested only if the physical quantity can adopt a negative value
[3] only if switchable current outputs are available

Temperature inputs



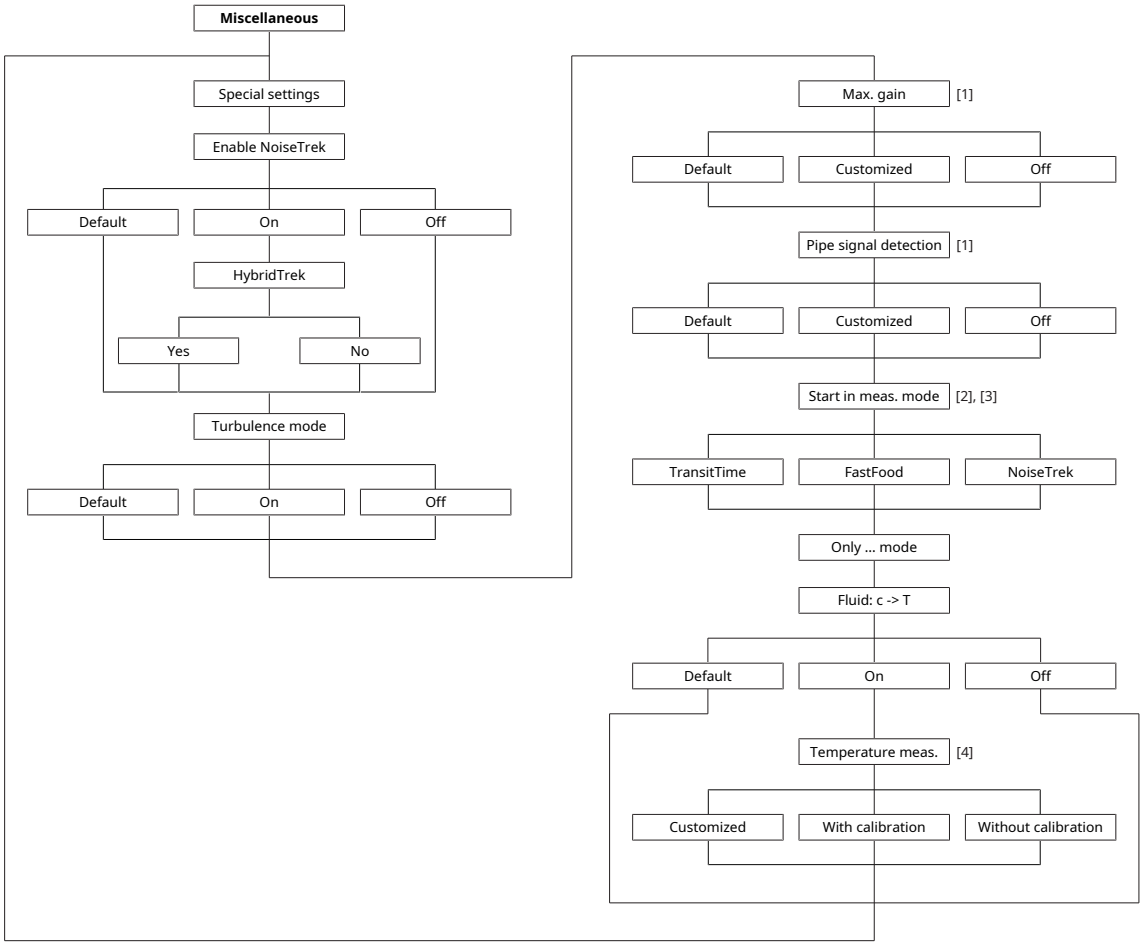
Legend
[1] only if enabled

Current inputs



Legend
[1] only if supported by the hardware

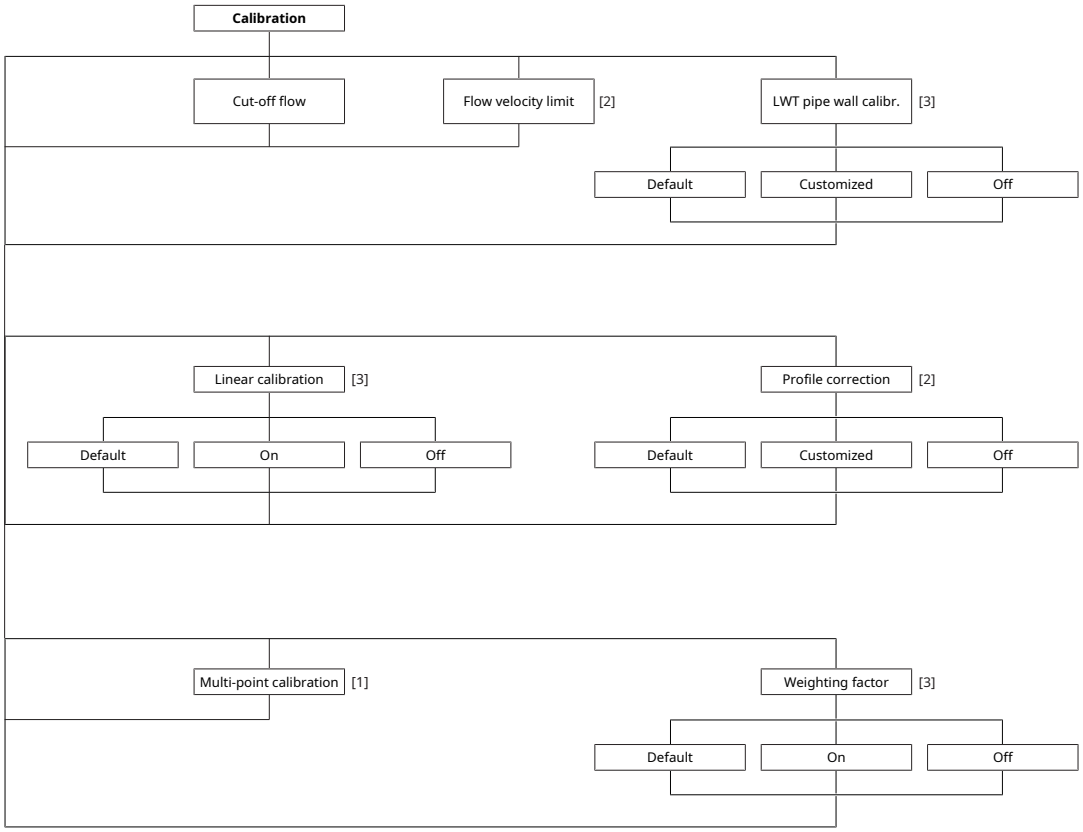
Special settings



Legend
[1] only in ExpertUser, SuperUser and SuperUser ext. mode
[2] only if FastFood mode is enabled or NoiseTrek mode is supported
[3] only if synchronized channel averaging is deactivated
[4] only in SuperUser mode

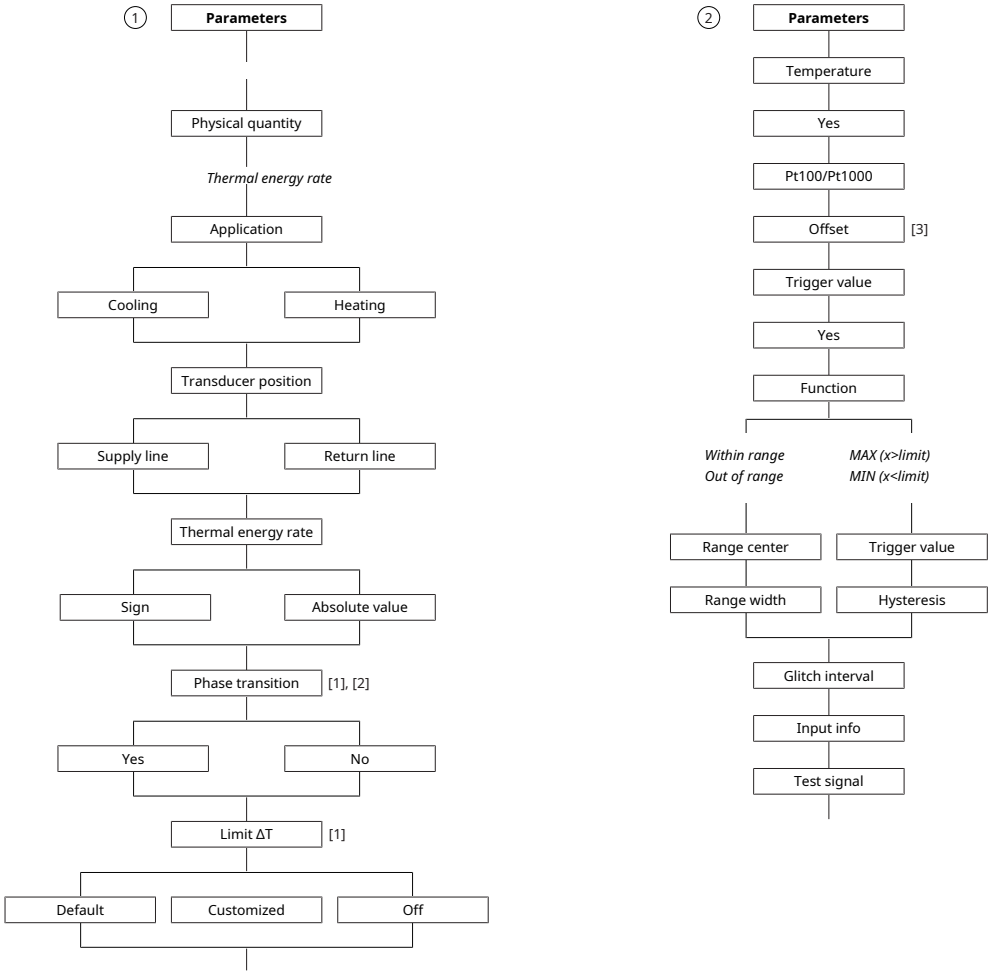
Calibration

If `Channel-based param.` is selected for the configuration of the measuring point, the settings can be made individually for each measuring channel.



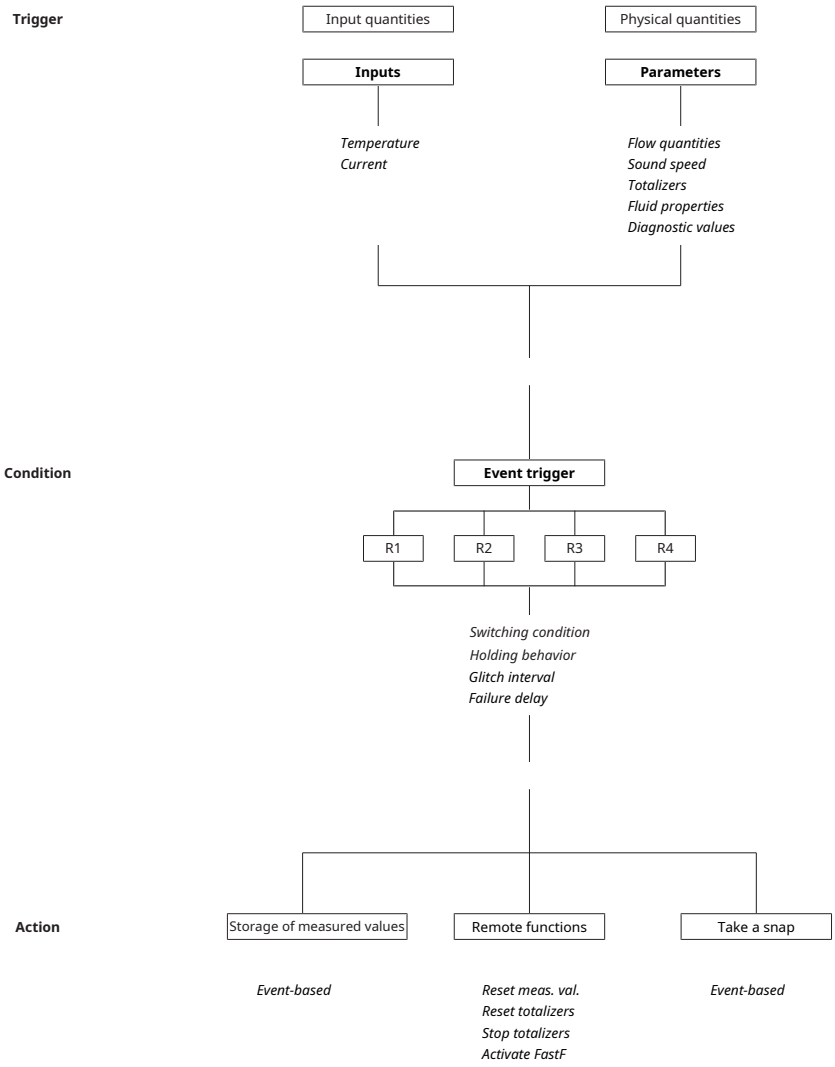
Legend
[1] only if enabled
[2] only in ExpertUser, SuperUser and SuperUser ext. mode
[3] only in SuperUser and SuperUser ext. mode

Thermal energy rate measurement

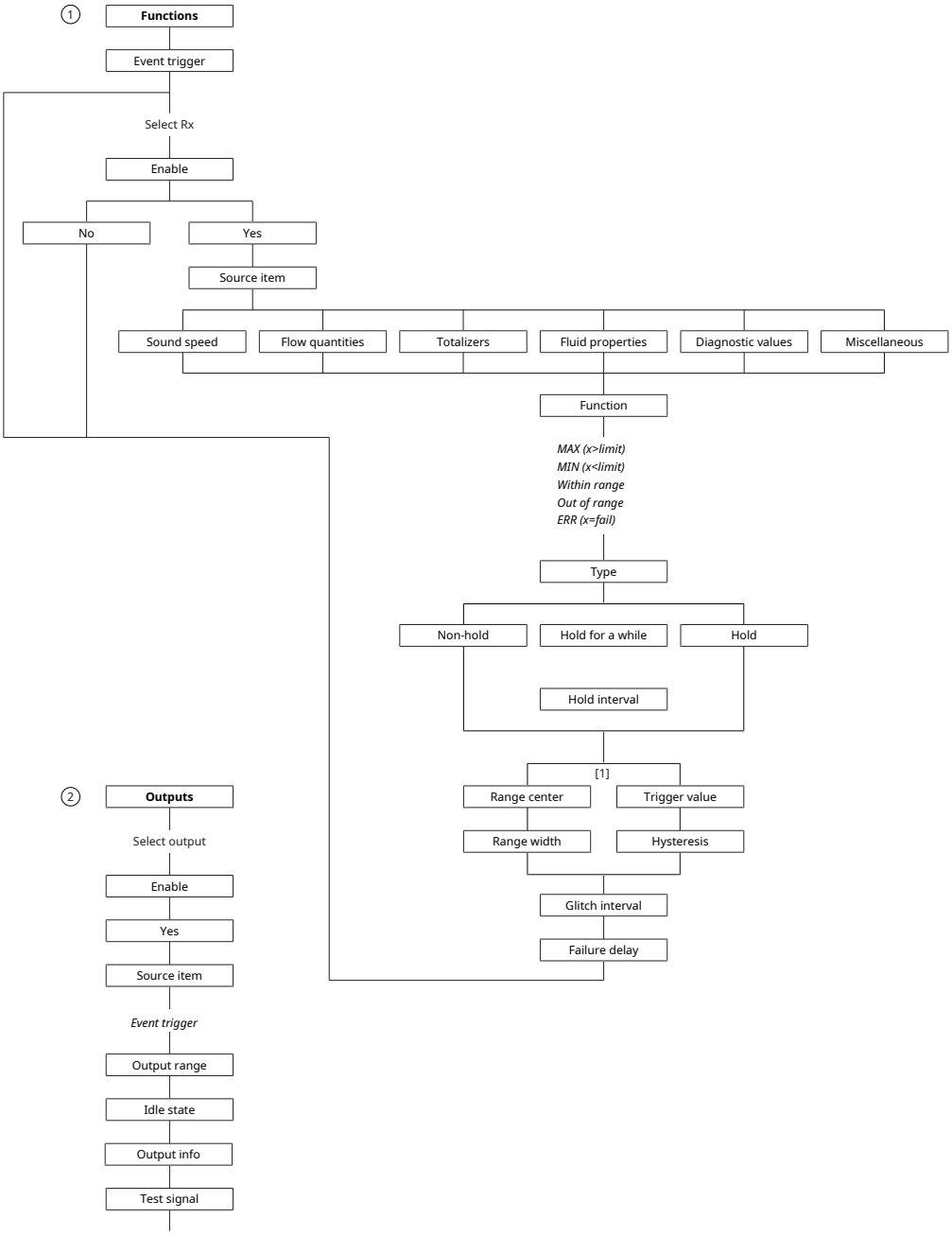


Legend
[1] only in SuperUser mode
[2] only if the corresponding data is stored for the selected fluid
[3] only if enabled

Events – overview

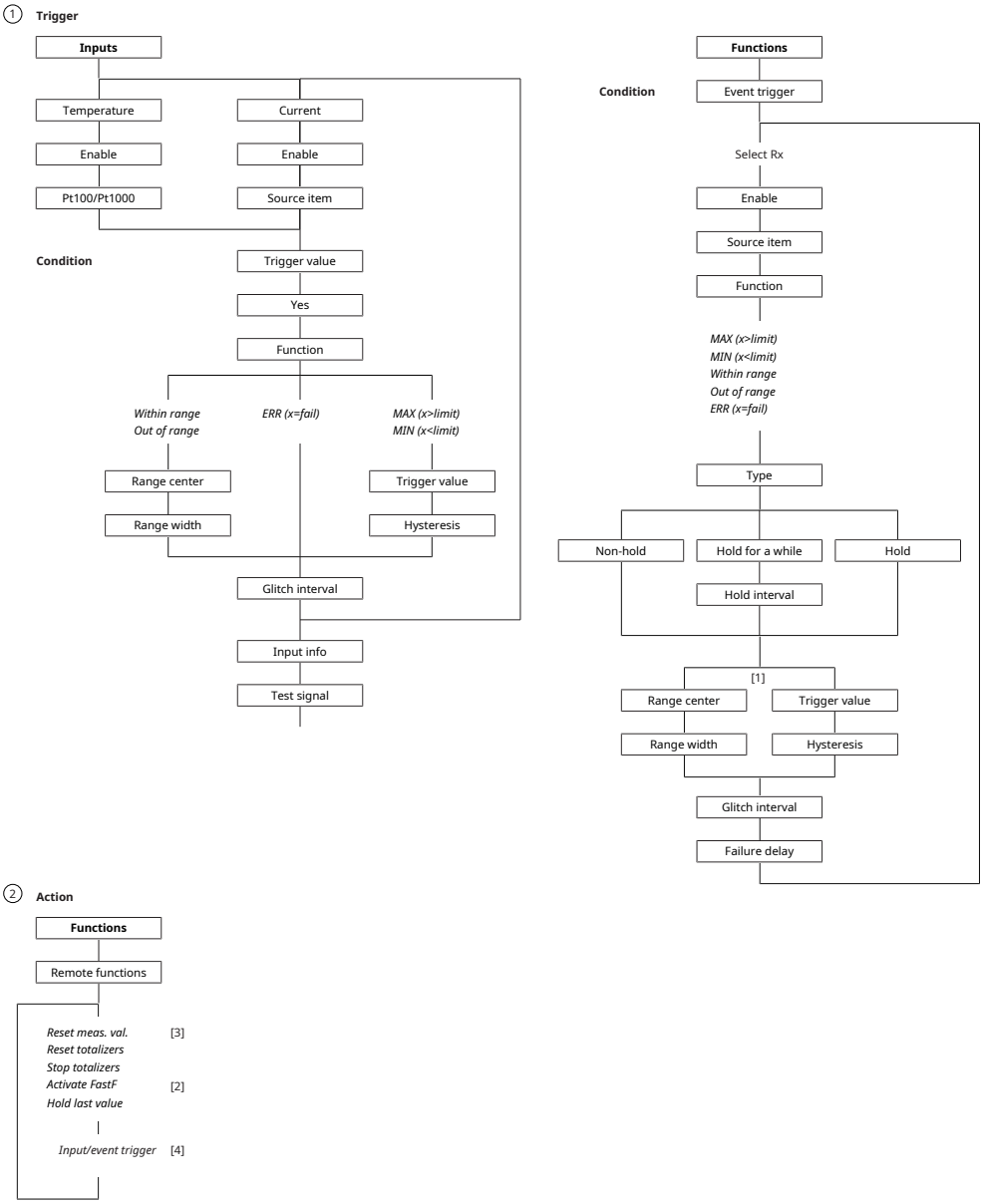


Definition of event triggers



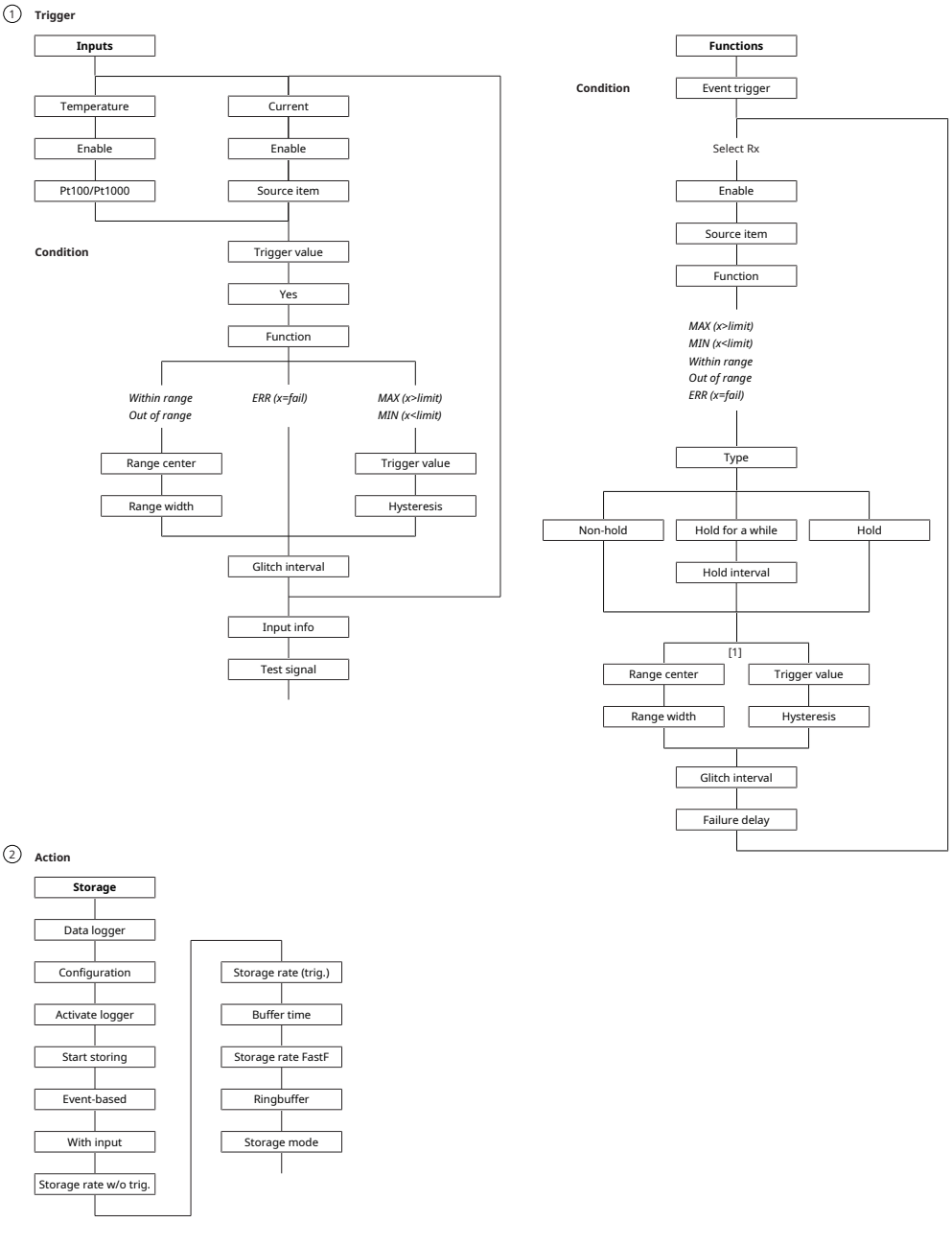
Legend
[1] depending on the selected function

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

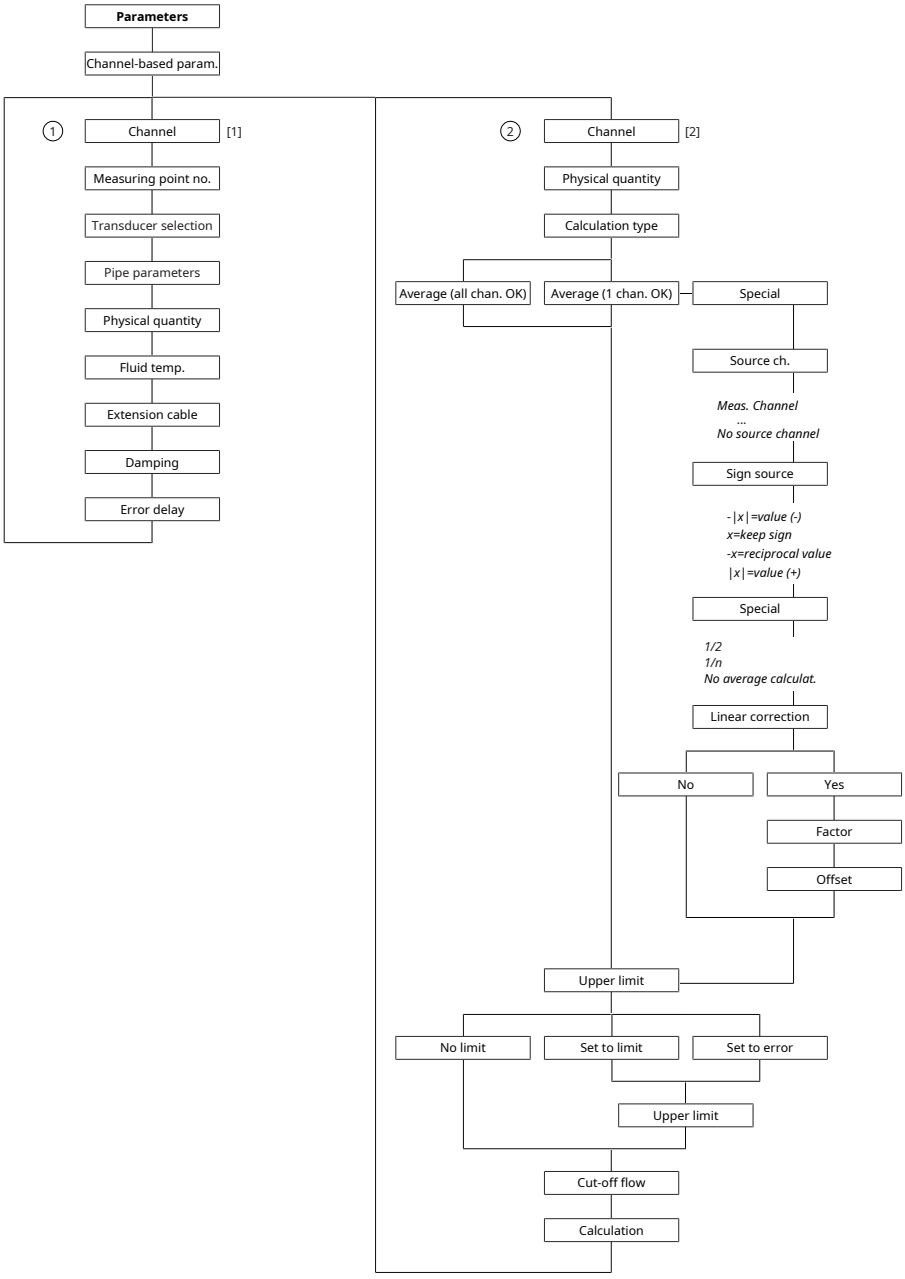
Event-based storing of measured values



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)

Density

unit of measurement	description
g/cm3	gram per cubic centimeter
kg/cm3	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 range

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

Volumetric flow rate

unit of measurement	description	default 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
USgps (US-gal/s)	gallon per second	gal
KGPM (US-Kgal/m)	kilogallon per minute	kgal

unit of measurement	description	default volume (totalized) [1]
MGD (US-Mgal/d)	million gallons per day	Mgal
CFD	cubic foot per day	cft [2]
CFH	cubic foot per hour	cft [2]
CFM	cubic foot per minute	cft [2]
CFS	cubic foot per second	aft [3]
MCFD	thousand cubic feet per day	MCF
MCFH	thousand cubic feet per hour	MCF
MMCFD	million cubic feet per day	MMCF
MMCFH	million cubic feet per hour	MMCF
Igpd (Imp-gal/d)	imperial gallon per day	Igal
Igph (Imp-gal/h)	imperial gallon per hour	Igal
Igpm (Imp-gal/m)	imperial gallon per minute	Igal
Igps (Imp-gal/s)	imperial 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 volumetric flow rate and the totalized 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 oil barrel = 42.0 US-gal ≈ 159 l

US wine barrel = 31.5 US-gal ≈ 119 l

US beer barrel = 31.0 US-gal ≈ 117 l

imperial (UK) barrel = 36.0 UK-gal ≈ 164 l

Thermal energy rate

unit of measurement	description	thermal energy (totalized) [1]
W	watt	Wh
kW	kilowatt	kWh
MW	megawatt	MWh
GW	gigawatt	GWh
kcal/second	kilocalorie per second	kcal
kcal/minute	kilocalorie per minute	kcal
kcal/hour	kilocalorie per hour	kcal
BTU/minute	BTU per minute	BTU
kBTU/minute	thousand BTU per minute	kBTU
kBTU/hour	thousand BTU per hour	kBTU
kBTU/day	thousand BTU per day	kBTU
MBTU/hour	million BTU per hour	MBTU
MBTU/day	million BTU per day	MBTU
TON (TH)	TON, totals in TONhours	TH
TON (TD)	TON, totals in TONdays	TD
kTON (kTH)	kTON, totals in kTONhours	kTH
kTON (kTD)	kTON, totals in kTONdays	kTD

BTU: British Thermal Unit

1 W = 1 J/s = (1/1055.05585262) BTU/s

TON: ton of refrigeration

1 W = 1 J/s = (1/3516.852842) TON

1 TON = 200 BTU/min

[1] selection via `Parameters\Units of measurement`

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
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.

material (display)	explanation	c_{trans} [m/s]	c_{long} [m/s]
Carbon steel	carbon steel	3230	5930
Stainless steel	stainless steel	3100	5790
DUPLEX	duplex stainless steel	3272	5720
Ductile iron	ductile iron	2650	-
Asbestos cement	asbestos cement	2200	-
Titanium	titanium	3067	5955
Copper	copper	2260	4700
Aluminum	aluminum	3100	6300
Brass	brass	2100	4300
Plastic	plastic	1120	2000
GRP	glass reinforced plastic	-	2650
PVC	polyvinyl chloride	-	2395
PE	polyethylene	540	1950
PP	polypropylene	2600	2550
Bitumen	bitumen	2500	-
Acrylic glass	acrylic glass	1250	2730
Lead	lead	700	2200
Cu-Ni-Fe	copper-nickel-iron alloy	2510	4900
Cast iron	cast iron	2200	4600
Rubber	rubber	1900	2400
Glass	glass	3400	5600
PFA	perfluoralcoxy	500	1185
PVDF	polyvinylidene fluorid	760	2050
Sintimid	Sintimid	-	2472
Teka PEEK	Teka PEEK	-	2534
Tekason	Tekason	-	2230

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

Mixtures with non-changing composition

fluid	explanation	sound speed [m/s]	density [kg/m^3]	kinematic viscosity [mm^2/s]	valid range of fluid data [°C]	thermal energy measurement [(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	-10...+450	
Diesel	hydrocarbon with 38 °API	1380	831	2.2	-10...+450	

(1) thermal energy rate coefficient included in the fluid data set

Mixtures with changing composition

fluid	explanation	parame-trization [1]	sound speed [m/s]	density [kg/m³]	kinematic viscosity [mm²/s]	valid range of fluid data	thermal energy measure ment [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 %	
Hydro-chloric acid	mixture of hydrochloric acid and water	proportion of hydrochlori c 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 %	
Hydro-fluoric 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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https://github.com/weston-embedded/uC-TCP-IP/tree/v3.06.01

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uC-TCPIP/IP/IPv4/net_ipv4.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

uC-TCPIP/Source/net_sock.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

uC-TCPIP/Source/net_tcp.h FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

2. uC-Common

https://github.com/weston-embedded/uC-Common/tree/v1.02.01

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uC-DHCPc/OS/uCOS-II/dhcp-c_os.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

4. uC-LIB

https://github.com/weston-embedded/uC-LIB/tree/v1.39.01

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5. uC-OS2

https://github.com/weston-embedded/uC-OS2/tree/v2.93.01

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uC-OS2/Source/os_tmr.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

uC-OS2/Source/ucos_ii.h FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

6. uC-FS

https://github.com/weston-embedded/uC-FS/tree/v4.08.01

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uC-FS/FAT/fs_fat_journal.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

7. uC-USBH

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uC-USBH/HCD/EHCI/usbh_hcd_ehci.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

uC-USBH/HCD/EHCI/usbh_hcd_ehci.h FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

uC-USBH/Source/usbh_class.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

uC-USBH/Source/usbh_core.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

8. uC-OS3

https://github.com/weston-embedded/uC-OS3/tree/v3.08.02

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9. uC-CPU

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uC-CPU/cpu_core.c FILE HAS BEEN MODIFIED FROM ITS ORIGINAL VERSION

10. STM32CubeL4 CMSIS Device MCU Component

https://github.com/STMicroelectronics/cmsis-device-l4/tree/v1.7.4

https://github.com/STMicroelectronics/cmsis-device-l4/blob/v1.7.4/LICENSE.md

11. STM32CubeL0 CMSIS Device MCU Component

https://github.com/STMicroelectronics/cmsis-device-l0/tree/v1.9.3

https://github.com/STMicroelectronics/cmsis-device-l0/blob/v1.9.3/LICENSE.md

12. CMSIS Version 5

https://github.com/STMicroelectronics/STM32CubeL4/tree/v1.18.1/Drivers/CMSIS

https://github.com/STMicroelectronics/STM32CubeL4/blob/v1.18.1/Drivers/CMSIS/LICENSE.txt

13. STM32CubeL4 HAL Driver MCU Component

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E Annex: Declarations of conformity

EU Declaration of Conformity

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Boxberger Straße 4
12681 Berlin
Germany

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a = F, G, H
b = any
c = any

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

FLEXIM Flexible Industriemesstechnik GmbH
Boxberger Straße 4
12681 Berlin
Germany

declares as manufacturer under its sole responsibility that the following products comply with the relevant statutory instruments of the United Kingdom valid at the time this declaration was signed, including the latest amendments:

Ultrasonic Flowmeters FLUXUS a631bc-NNN, PIOX S631bc-NNN and Adapters AO61, AT61

a = F, G, H
b = any
c = any

Jens Hilpert
Vice President, Ultrasonic

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:

EN IEC 63000:2018

Operating Instruction
UM_F631V7-0EN
AN 27761
2026-03-01

Emerson
Flexim GmbH
Boxberger Str. 4
12681 Berlin
Germany
T +49 (30) 93 66 76 60
F +49 (30) 93 66 76 80
www.Emerson.com

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