Operating instruction

FLUXUS G532ST-LT
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1 Introduction
This operating instruction has been written for users operating the ultrasonic flowmeter FLUXUS. It contains important information about the measuring equipment, how to handle it correctly, and how to avoid damages. Read the safety instructions carefully. Make sure you have read and understood this operating instruction before using the measuring equipment.

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

Presentation of warnings
This operating instruction contains warnings marked as follows:

<table>
<thead>
<tr>
<th>Danger!</th>
<th>Type and source of danger</th>
<th>danger with high level of risk, which, if not avoided, can lead to death or serious injuries</th>
<th>→ measures of prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning!</td>
<td>Type and source of danger</td>
<td>danger with medium level of risk, which, if not avoided, can lead to serious or moderate injuries</td>
<td>→ measures of prevention</td>
</tr>
<tr>
<td>Caution!</td>
<td>Type and source of danger</td>
<td>danger with low level of risk, which, if not avoided, can lead to moderate or minor injuries</td>
<td>→ measures of prevention</td>
</tr>
<tr>
<td>Important!</td>
<td>This text contains important information which should be observed in order to avoid material damage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notice!</td>
<td>This text contains important information about the handling of the measuring equipment.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Storage of the operating instruction
The operating instruction must permanently be available at the place where the measuring equipment is used. It must be available to the user at all times.

User comments
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.

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2 Safety instructions

2.1 General safety instructions

Prior to any work, read the operating instruction carefully and in full. Failure to comply with the instructions, in particular with the safety instructions, poses a risk to health and can lead to material damages. For further information, contact FLEXIM.

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

Explanation of symbols on the transmitter and accessories:

<table>
<thead>
<tr>
<th>symbol</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sim\sim\sim$</td>
<td>direct current</td>
</tr>
<tr>
<td>$\downarrow$</td>
<td>connection for equipotential bonding/grounding</td>
</tr>
<tr>
<td>$|$</td>
<td>protective ground terminal</td>
</tr>
<tr>
<td>$\times$</td>
<td>Electric devices must be disposed of separately. If necessary, additional hazardous substances are indicated for disposal.</td>
</tr>
<tr>
<td>$\triangle$</td>
<td>Warning! Electric shock possible.</td>
</tr>
<tr>
<td>$\square$</td>
<td>Observe the operating instruction.</td>
</tr>
<tr>
<td>$\square\triangle$</td>
<td>Warning! Observe the safety instructions in the manufacturer's documentation.</td>
</tr>
</tbody>
</table>

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.

The personnel has to be suitably trained and experienced for the work.

2.2 Intended use

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

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

• All instructions of 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.
• If an extension cable is required to connect the transducers to the transmitter, a junction box can be used (optional). Observe the safety instructions in the operating instruction. For the technical data of the junction box, see technical specification.
• Observe the operating conditions, e.g., environment, voltage ranges. For the technical data of the 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 in this 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 11, the measuring equipment is maintenance-free. Any components and spare parts may only be replaced by FLEXIM. The operator shall carry out periodic checks for changes or damages that can present a danger. For further information, contact FLEXIM.
• Observe the specifications for the installation and connection of the transmitter, transducers and accessories.

2.6 Safety instructions for electrical work

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

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.
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 from additional physical quantities, if necessary.

3.1 Measurement principle
The flow velocity of the fluid is measured using the transit time difference correlation principle.

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 influenced by the conditions at the inlet of the measuring point.

Reynolds number Re
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 c
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 solid materials, a distinction is made between the longitudinal and transversal sound speed.

Flow velocity v
Average value of all flow velocities of the fluid over the cross-sectional pipe area.

Acoustic calibration factor $k_a$

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

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:

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

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

Operating volumetric flow rate $\dot{V}$

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

The volume of the fluid that passes through the pipe per unit time. The operating volumetric flow rate is calculated from the product of the flow velocity $v$ and the cross-sectional pipe area $A$. 
3 General principles
3.1 Measurement principle

Standard volumetric flow rate \( V_N \)

Volumetric flow rate of a gas under specified standards conditions. During the measurement of a gas, the temperature and the pressure have a strong influence on the measured operating volumetric flow rate. The measured operating volumetric flow rate can be converted into the standard volumetric flow rate \( V_N \) by the transmitter:

\[
V_N = \dot{V} \cdot \frac{P}{P_N} \cdot \frac{T}{T_N} \cdot \frac{1}{K}
\]

where

\[
\begin{align*}
\dot{V}_N & \quad \text{standard volumetric flow rate} \\
\dot{V} & \quad \text{operating volumetric flow rate} \\
P_N & \quad \text{standard pressure (absolute value)} \\
P & \quad \text{operating pressure (absolute value)} \\
T_N & \quad \text{standard temperature in K} \\
T & \quad \text{operating temperature in K} \\
K & \quad \text{compressibility coefficient of the gas: ratio of the compressibility factors of the gas at operating conditions and at standard conditions (Z/Z_N)}
\end{align*}
\]

The values for standard pressure \( P_N \) (default: 1.013 bar(a)) and standard temperature \( T_N \) (default: 0 °C) can be entered. The compressibility coefficient of the gas \( K \) is stored in the data set of the fluid or can be entered by the user. The operating temperature \( T \) and the operating pressure \( P \) can be fed into the transmitter via the inputs or entered as constant values.

Mass flow rate \( m \)

\[
m = \dot{V} \cdot \rho
\]

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 \( \rho \).

3.1.2 Measurement of the flow velocity

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. Caused by this displacement, the sound path of the signal is reduced in flow direction and increased in the opposite direction.

This causes a change in the transit times. The transit time of the signal in flow direction is shorter than the transit time 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:

\[
v = k_{Re} \cdot k_a \cdot \frac{\Delta t}{2 \cdot t_y}
\]

where

\[
\begin{align*}
v & \quad \text{average flow velocity of the fluid} \\
k_{Re} & \quad \text{fluid mechanic calibration factor} \\
k_a & \quad \text{acoustic calibration factor} \\
\Delta t & \quad \text{transit time difference} \\
t_y & \quad \text{transit time in the fluid}
\end{align*}
\]
3 General principles

3.1 Measurement principle

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

- $c$ – sound speed
- 1 – transducer (emitter)
- 2 – transducer (receiver)
- 3 – pipe wall

**Fig. 3.2:** Sound path of the signal against the flow direction

- $c$ – sound speed
- 1 – transducer (emitter)
- 2 – transducer (receiver)
- 3 – pipe wall

**Fig. 3.3:** Transit time difference $\Delta t$

- 1 – signal in the flow direction
- 2 – signal against the flow direction
3.2 Measurement arrangements

3.2.1 Terms

<table>
<thead>
<tr>
<th>diagonal arrangement</th>
<th>reflection arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>The transducers are mounted on opposite sides of the pipe.</td>
<td>The transducers are mounted on the same side of the pipe.</td>
</tr>
</tbody>
</table>

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

Beam

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

Transducer distance

The transducer distance is measured between the inner edges of the transducers.
### Sound beam plane
Plane, containing sound paths or beams.

Fig. 3.6: 2 sound paths in 1 plane

#### 3.2.2 Examples

<table>
<thead>
<tr>
<th>diagonal arrangement with 1 beams</th>
<th>reflection arrangement with 1 beam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 transducer pair</td>
<td>1 transducer pair</td>
</tr>
<tr>
<td>1 sound path</td>
<td>2 sound paths</td>
</tr>
</tbody>
</table>

#### 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 so strongly 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 liquids and solids in the fluid
- deposits on the inner pipe wall
- pipe material

The following requirements have to be met at the measuring point:
- no solid deposits in the pipe
- no accumulation of liquid (condensate), e.g., before orifice plates or at pipe sections located lower

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, solids or liquid on the bottom of the pipe are prevented from influencing the propagation of the signal.

Fig. 3.7: Recommended transducer mounting position (laterally)

Fig. 3.8: Disadvantageous transducer mounting position (on top)
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 chosen at a sufficient distance from any disturbances. Only then it can be assumed that the flow profile in the pipe is fully developed. The use of the disturbance correction (see section 13.2.4) 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.

Tab. 3.1: Recommended distance from disturbances

<table>
<thead>
<tr>
<th>Disturbance</th>
<th>Inlet: l ≥ 10·d</th>
<th>Outlet: l ≥ 2·d</th>
</tr>
</thead>
<tbody>
<tr>
<td>90° elbow</td>
<td>(l ≥ 2·d with disturbance correction)</td>
<td></td>
</tr>
<tr>
<td>Double elbow</td>
<td>l ≥ 10·d</td>
<td>l ≥ 3·d</td>
</tr>
<tr>
<td>Double elbow out of plane</td>
<td>l ≥ 10·d</td>
<td>l ≥ 3·d</td>
</tr>
</tbody>
</table>
Tab. 3.1: Recommended distance from disturbances

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

<table>
<thead>
<tr>
<th>Disturbance</th>
<th>Inlet: ( l \geq 40 , d ) (with disturbance correction)</th>
<th>Outlet: ( l \geq 3 , d )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double elbow out of plane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table shows recommended distances from various disturbances in a pipeline system, ensuring an undisturbed flow profile.


3.5 Influence of noise

Ultrasonic waves do not only propagate in the fluid but also in the pipe wall. They are reflected at flanges.

**Fig. 3.9: Propagation of ultrasonic waves**

1 – ultrasonic waves in the fluid (measuring signal)
2 – ultrasonic waves in the pipe wall (pipe wall signal)

The reflected pipe wall signals can disturb the measurement, especially if:

- the measuring point is close to the reflection point
- the pipe wall signals and measuring signals are received by the transducer at the same time

**Measuring points to be avoided**

- measuring point directly at the reflection point \((l < 3\,D)\)
- measuring point at a distance of \((l_s - 2)\,D\) and \((l_s + 2)\,D\) from the reflection point

\[ l_s = \frac{n}{2} \cdot \frac{c_\beta}{c_\gamma} \cdot D \]

\(l, l_s\) – distance to reflection point
\(D\) – outer pipe diameter
\(c_\gamma\) – sound speed of the fluid
\(c_\beta\) – sound speed of the pipe
\(n\) – number of sound paths

**Fig. 3.10: Measuring points to be avoided**

\(l < 3\,D\) \(l_s\) \((l_s - 2)\,D\) \((l_s + 2)\,D\)  disadvantageous measuring
3.6 Selection of the measuring point taking into account the flow profile and the influence of noise

- Select an area on the pipe where the flow profile is fully developed.
- Select the measuring point within this area so that the influence of noise can be neglected.

**Example**

- fluid: natural gas, \( c_\gamma = 400 \text{ m/s} \)
- pipe material: stainless steel, \( c_\beta = 3000 \text{ m/s} \)
- length of pipe segment 1: 20 D
- length of pipe segment 2: 20 D
- number of sound paths: 2
- \( l_5 = 7.5 \text{ D} \)
  - area with developed flow profile:
    - disturbance: 90° elbow
    - recommended area for the measuring point: \( l \geq 10 \text{ D} \) (complete pipe segment 2)
  - area with low influence of noise:
    - reflection point: flange
    - recommended area for the measuring point: \( l \geq 3 \text{ D} \) and outside of \( l_5 = (7.5 \pm 2) \text{ D} \) on pipe segment 2

Fig. 3.11: Area for the measuring point with a favorable flow profile and low influence of noise

Considering flow profile and influence of noise, the measuring point can be selected in the area \( 3...(7.5 - 2) \text{ D} \) on the right side of pipe segment 2 (with max. distance from the elbow).

In the example, a distance of 36 D from the elbow was selected.

Sometimes, both demands cannot be reconciled at the same time. In these cases, the measuring point has to be selected in such way that the influence of noise is min. and the measuring point is as far from the disturbances of the flow profile as possible.
3 General principles
3.6 Selection of the measuring point taking into account the flow profile and the influence of noise

Example

fluid: natural gas, \(c_γ = 400\) m/s
pipe material: stainless steel, \(c_β = 3000\) m/s
length of pipe segment 1: 20 D
length of pipe segment 2: 5 D
number of sound paths: 2

\(l_s = 7.5\) D

• area with developed flow profile:
disturbance: 90° elbow
recommended area for the measuring point: \(l \geq 10\) D (complete pipe segment 2)

• area with low influence of noise:
reflection point: flange
recommended area for the measuring point: \(l \geq 3\) D and outside of \(l_s = (7.5 \pm 2)\) D on pipe segment 1

Fig. 3.12: Area for the measuring point with low influence of noise and not fully developed flow profile

In the example, there is no area where both demands are met at the same time. The measuring point has to be selected as far as possible from the elbow, at a point where the influence of noise can be neglected: \(3\ldots(7.5 - 2)\) D on the right side of pipe segment 1. In the example, a distance of 16 D from the elbow was selected.
4  Product description

4.1  Measuring system

The measuring system consists of the transmitter, the temperature probe, pressure sensor, the ultrasonic transducers and the pipe on which the measurement is taken.

Fig. 4.1:  Example of a measurement arrangement

1 – transmitter
2 – transducers
3 – damping coat
4 – external pressure sensor
5 – temperature probe
6 – pipe
7 – insulation

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, eliminates 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 ➤ the following program branches are displayed consecutively:

• Parameters
• Measurement
• Options
• Special functions

The program branch is displayed between 2 arrows (➡️).
When starting up the transmitter for the first time, settings relating to the language, time, date and system of units have to be made. Then the program branch Parameters will be displayed.

At later start-ups the measured values will be displayed in case the measurement had not been stopped before the transmitter was disconnected from the power supply. If the measurement had been stopped, the program branch 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. A change of the parameter settings is not possible during the measurement. The measurement has to be stopped in order to change the parameter settings or configuration of the transmitter outputs.

<table>
<thead>
<tr>
<th>program branch</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>Before starting a measurement, the transducer, pipe and fluid parameters have to be entered in the program branch Parameters.</td>
</tr>
<tr>
<td>Measurement</td>
<td>Having entered the parameters for the measuring point, the measurement can be started in the program branch Measurement.</td>
</tr>
<tr>
<td>Options</td>
<td>Settings are carried out in the program branch Options, e.g., selection of the physical quantity and unit of measurement, input of the damping factor, configuration of the outputs, assignation of the inputs.</td>
</tr>
<tr>
<td>Special functions</td>
<td>Global settings relating to the transmitter are carried out in the program branch Special functions, e.g., system settings (language, key lock), measurement settings, communication, data logger, snaps, configuration of inputs.</td>
</tr>
</tbody>
</table>
4.3 Display

Structure

Fig. 4.3: Menu item of the program branch Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connected transd.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select transducer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 – program branch
2 – currently edited menu item
3 – area for scroll lists, selection fields or input fields

Tab. 4.2: Navigation

<table>
<thead>
<tr>
<th>horizontal scroll list</th>
<th>vertical scroll list</th>
<th>input fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>Parameters</td>
<td>Parameter</td>
</tr>
<tr>
<td></td>
<td>Transducer</td>
<td>Cursor diameter</td>
</tr>
<tr>
<td></td>
<td>Connected transd.</td>
<td>62.00</td>
</tr>
<tr>
<td></td>
<td>Select transducer</td>
<td>mm</td>
</tr>
</tbody>
</table>

• scroll horizontally with or CLR

• scroll vertically with or

• input numbers or text with or delete with C

Status indicators

Several symbols are used as status indicators.

Fig. 4.4: Status indicators (line 1)

- running measurement
- error message
- activated FastFood mode
- data logger full
- connection via USB cable
- key lock activated
4.4 **Keyboard**
The keyboard consists of the following keys: ENTER, BRK, CLR, ← and ↓. The keys are operated using a magnetic pen with the housing being closed.

### Tab. 4.3: General functions

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTER</td>
<td>confirmation of selection or input</td>
</tr>
<tr>
<td>BRK</td>
<td>during the parameter input:</td>
</tr>
<tr>
<td></td>
<td>short press: return to the previous menu item</td>
</tr>
<tr>
<td></td>
<td>long press (several seconds): return to the beginning of the program branch</td>
</tr>
<tr>
<td></td>
<td>during the measurement:</td>
</tr>
<tr>
<td></td>
<td>display of scroll list: Stop measurement, Show parameters, Show measurement</td>
</tr>
<tr>
<td>BRK + C + ENTER</td>
<td>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.</td>
</tr>
<tr>
<td>BRK + C</td>
<td>INIT: when initializing the transmitter, all settings are reset to the factory settings.</td>
</tr>
</tbody>
</table>

### Tab. 4.4: Navigation

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>←</td>
<td>scroll to the right or up through a scroll list</td>
</tr>
<tr>
<td>↓</td>
<td>scroll down through a scroll list</td>
</tr>
<tr>
<td>CLR</td>
<td>scroll to the left through a scroll list</td>
</tr>
</tbody>
</table>

### Tab. 4.5: Input of numbers

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>←</td>
<td>move the cursor to the right</td>
</tr>
<tr>
<td>↓</td>
<td>scroll through the numbers above the cursor</td>
</tr>
<tr>
<td>CLR</td>
<td>short press: move the cursor to the left</td>
</tr>
<tr>
<td></td>
<td>long press (several seconds): reset the value to the previously stored one</td>
</tr>
</tbody>
</table>

### Tab. 4.6: Input of text

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>←</td>
<td>move the cursor to the right</td>
</tr>
<tr>
<td>↓</td>
<td>scroll through the characters above the cursor</td>
</tr>
<tr>
<td>CLR</td>
<td>short press: move the cursor to the left</td>
</tr>
<tr>
<td></td>
<td>long press (several seconds): reset the text to the previously stored one</td>
</tr>
</tbody>
</table>
5 Transport and storage

Caution!

When packaging, the transmitter can fall down.
There is a danger of crushing body parts or damaging the measuring equipment.
→ Secure the transmitter against falling during packaging.
→ Wear the required personal protective equipment.
→ Observe the applicable rules.

Caution!

When lifting, the center of gravity of the transmitter can be displaced within the cardboard box. The transmitter can fall down.
There is a danger of crushing body parts or damaging the measuring equipment.
→ Secure the transmitter against falling during transport.
→ Wear the required personal protective equipment.
→ Observe the applicable rules.

5.1 Transport

The measuring equipment must be packaged properly for transport. For weight indications, see technical specification.
• Use, if possible, the original packaging by FLEXIM or an equivalent cardboard box.
• Position the transmitter, transducers and accessories in the middle of the cardboard box.
• Fill any voids with appropriate packaging material (e.g., paper, foam, bubble wrap).
• Protect the cardboard box against humidity.

5.2 Storage

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

6.1  Transmitter

6.1.1  Opening and closing the housings

Opening

**Important!**

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

- Loosen the screws of the transmitter housing.
- Open the housing cover of the transmitter.
- Remove the protection foils on the window of the housing cover (inside and outside) as well as on the transmitter display.

**Warning!**

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

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

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

**Warning!**

**Touching live parts**

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

→ Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply. It is not sufficient to remove the internal fuse of the instrument.

**Caution!**

**Safety and accident prevention regulations for electrical systems and equipment**

Failure to observe these regulations may lead to severe injuries.

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

**Caution!**

**Touching hot or 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.

**Notice!**

Protective foils on measuring equipment and transducer mounting fixture can be removed.
Closing

• Close the housing cover.
• Tighten the screws on the transmitter housing evenly.

6.1.2 Installation of the transmitter

6.1.2.1 Wall mounting

• Loosen the screws of the transmitter housing.
• Open the housing cover of the transmitter.
• Fix the transmitter to the wall using 4 screws.

1 – fixing holes for wall mounting
6.1.2.2 Pipe mounting

**Important!**

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

**Mounting on a 2" pipe**

The pipe mounting kit is fixed to the pipe using a shackle.

- Fix the pipe mounting plate (2) to the instrument mounting plate (3) using the supplied screws. Make sure the pipe mounting plate is aligned corresponding to the pipe orientation.
- Fix the pipe mounting plate and the instrument mounting plate to the pipe using the nuts (4) and the shackle (1).
- Use the screws to fix the transmitter to the instrument mounting plate.

![Pipe mounting kit diagram](image)

1 – shackle  
2 – pipe mounting plate  
3 – instrument mounting plate  
4 – nut

**Mounting on a pipe > 2"**

The pipe mounting kit is fixed to the pipe by using tension straps.

**Caution!**

The edge of the tension strap is very sharp.

Risk of injury.

→ Deburr sharp edges.

→ Wear the required personal protective equipment.

→ Observe the applicable rules.

- Fix the pipe mounting plate (1) to the instrument mounting plate (2) using the supplied screws. Make sure the pipe mounting plate is aligned corresponding to the pipe orientation.
- Insert the tension straps (3) into the holes of the pipe mounting plate and the instrument mounting plate.
- Fix the pipe mounting plate and the instrument mounting plate to the pipe using the tension straps.
- Use the screws to fix the transmitter to the instrument mounting plate.
Fig. 6.4: Pipe mounting with tension straps

1 – pipe mounting plate
2 – instrument mounting plate
3 – tension strap
6.2  Transducers

Caution!

Warning of severe injuries from hot or cold components
Touching hot or 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.

6.2.1  Preparation

6.2.1.1  Measuring point selection
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 influence of noise is sufficiently low

The correct selection of the measuring point and the correct transducer positioning guarantee that the sound 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
– 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 specific 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.

The pipe must be free of splash water, dirt, salt, grease or oils.
• Remove rust with sandpaper, if present.
The damping coat can be applied on a thin rust layer if it is not loose.
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

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. 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. The elbow is upstream of the measuring point.
6.2.2 Applying the damping coat

<table>
<thead>
<tr>
<th>Danger!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage to health caused by noncompliance with the notes of the supplied manufacturer's document of the damping coat</td>
</tr>
<tr>
<td>Maloperation caused by noncompliance with the notes of the supplied manufacturer's document can lead to dangerous situations and damage to health.</td>
</tr>
<tr>
<td>→ Before using the damping coat, read the supplied manufacturer's document and in particular the safety data sheet.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warning!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any work with the damping coat by unauthorized and unqualified personnel.</td>
</tr>
<tr>
<td>This may result in personal or material damage or dangerous situations.</td>
</tr>
<tr>
<td>→ Any work with the damping coat has to be carried out by authorized and qualified personnel.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Danger!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touching hot or cold surfaces</td>
</tr>
<tr>
<td>This may result in injuries (e.g., thermal damages).</td>
</tr>
<tr>
<td>→ Observe the ambient conditions at the measuring point when applying the damping coat onto the pipe.</td>
</tr>
<tr>
<td>Wear the required personal protective equipment. Observe the applicable rules.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage to health by contact with the liquid damping coat</td>
</tr>
<tr>
<td>This may result in injuries (e.g., breathing difficulties, skin reactions, eye irritations).</td>
</tr>
<tr>
<td>→ Wear the required personal protective equipment. Observe the applicable rules.</td>
</tr>
</tbody>
</table>

Ultrasonic waves do not only propagate in the fluid but also in the pipe wall. They are reflected at reflection points (e.g., flanges). Damping materials are used to counteract the propagation of ultrasonic waves in the pipe wall and to reduce the amplitudes of the reflecting ultrasonic waves.

The damping coat is used at high temperatures (T ≥ 80 °C). It is applied onto the pipe by means of a roller. Depending on the transducer type, it is necessary to apply several layers of the damping coat.

The following things are needed for the coating:

- roller
- packing drum with damping coat
- lockable mixing container
- cordless drill with stirring staff
- putty knife
- sandpaper
- covering sheet
6.2.2.1 Product properties

Roller
- material: foam material
- shape: concave
- texture: extra fine (fine-pored)

Damping coat

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>fluid temperature when applying</td>
<td>10...200 °C</td>
</tr>
<tr>
<td>drying time (example)</td>
<td>approx. 3 h at 20 °C</td>
</tr>
<tr>
<td></td>
<td>approx. 15 min at 150 °C</td>
</tr>
<tr>
<td>temperature resistance in dry state</td>
<td>max. 650 °C</td>
</tr>
<tr>
<td>durability of the packing drum (unopened)</td>
<td>2 years</td>
</tr>
</tbody>
</table>

6.2.2.2 Mixing of the damping coat

**Notice!**

It is recommended to carry out the mixing process 1 or 2 days before the application. For storage of the prepared damping coat see the manufacturer's safety data sheet.

- Wear the required personal protective equipment.
- Use the covering sheet to protect the environment.
- Open the packing drum with the damping coat.
- First, give the liquid layer of the damping coat into the mixing container, see Fig. 6.6.
- Afterwards, the semi-solid layer. Use the putty knife.
- Mix both layers until obtaining a homogeneous mixture. For this purpose, use a cordless drill with stirring staff.
- Scrape the solid layer out of the packing drum by using the putty knife and add it to the mixture.
- Mix it another 15 minutes until obtaining a homogeneous mixture.
6.2.2.3 Applying the damping coat

- Wear the required personal protective equipment.
- Use the covering sheet to protect the environment.
- Use the roller to apply the damping coat.
- Apply the first layer and let it dry.

**Notice!**

The first layer must be completely dried before the next layer is applied.

One layer has a thickness of aprox. 0.4 mm. The first layer is usually thinner.

The damping coat is applied on the entire pipe circumference. The length (l) of the damping coat has to have the same length as the transducer mounting fixture, but at least 500 mm, see Fig. 6.7.

- Apply progressively the needed layers, see Tab. 6.1.
- Check the layer. It has to be uniform and bubble-free in order to achieve an optimal damping.
  
  If the surface of the layer is not uniform, the mixture is not homogeneous or sufficiently mixed.
  
  In case of bubbling, the first layer has not dried yet or thinner was used.

**Notice!**

A non-uniform surface and bubbling reduce the damping.

---

**Fig. 6.6:** Decanting of the damping coat from the packing drum to the mixing container

1 – liquid phase
2 – semisolid phase
3 – solid phase
4 – packing drum with damping coat
5 – mixing container

**Fig. 6.7:** Length of the damping coat

\[ l \geq 500 \text{ mm} \]
6.2 Transducers

6.2.3 Installation of the transducers

After applying the damping coat, wait at least 24 h before mounting the transducers. The damping coat must be completely dried to obtain an optimal damping and to avoid that parts of the transducer mounting fixture can damage the damping coat.

<table>
<thead>
<tr>
<th>transducer frequency</th>
<th>necessary layer thickness</th>
<th>number of single layers</th>
<th>increase of pipe circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.7 mm</td>
<td>2</td>
<td>4 mm</td>
</tr>
<tr>
<td>M, P</td>
<td>0.3 mm</td>
<td>1</td>
<td>2 mm</td>
</tr>
</tbody>
</table>

- Schedule long drying periods between the application of the single layers.
- When the damping coat is dried on the pipe, it has a pitted and dull finish.
- In order to prevent the roller from being dried, put it into an airtight container during the drying periods.
- Seal the mixing container airtight during the drying periods.
- Size the pipe circumference when the layers are dried in order to check if the required layer thickness is reached. A thickly applied layer is uncritical. If the layer thickness is too thin, another layer has to be applied.

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.

The transducers must not be mounted directly on the damping coat.

- Remove a part of the damping coat for the mounting of the transducers, see Fig. 6.8 or Fig. 6.9. For this purpose, use sandpaper.

Fig. 6.8: Removed area beneath the transducers (here: diagonal arrangement)

1 – removed area
b – transducer width

Fig. 6.9: Removed area beneath the transducers (here: reflection arrangement)

1 – removed area = base area of the transducers
a – transducer distance
6.2.3.1 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. 6.10: Orientation and distance of the transducers

a — transducer distance

• Select the installation instructions of the supplied transducer mounting fixture.

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

Fig. 6.11: Transducer arrangement in mounting rails

reflection arrangement, 1 rail

reflection arrangement, 2 rails

diagonal arrangement, 2 parallel rails

diagonal arrangement, 2 displaced rails
6.2.3.3 Mounting with Variofix L (PermaRail)

Scope of delivery (example)

Variofix L

transducer pair

quick release clasp with tension strap

or

band clamp clasp with tension strap

or

ratchet clasp and tension strap coil

Mounting

When measuring in diagonal arrangement, the transducer mounting fixtures are mounted on opposite sides of the pipe. When measuring in reflection arrangement, the transducer mounting fixtures are mounted on the same side of the pipe. When measuring in diagonal arrangement with 2 beams in displaced X arrangement, 4 transducer mounting fixtures have to be mounted. When measuring in reflection arrangement with a small transducer distance, only 1 transducer mounting fixture has to be mounted.

Tab. 6.2: Approximate values for the mounting of both transducers in a Variofix L

<table>
<thead>
<tr>
<th>transducer frequency (3rd character of the technical type)</th>
<th>rail length [mm]</th>
<th>transducer distance [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>348</td>
<td>&lt; 89</td>
</tr>
<tr>
<td>M, P</td>
<td>234</td>
<td>&lt; 84</td>
</tr>
</tbody>
</table>
In the following, the mounting of 2 transducer mounting fixtures in reflection arrangement is described (1 transducer mounting fixture for each transducer).

Overview of installation steps

• **step 1**
  disassembly of the transducer mounting fixture Variofix L

• **step 2**
  fixation of the clasps to the tension straps

• **step 3**
  fixation of the tension strap to the pipe

• **step 4**
  fixation of the rail to the pipe

• **step 5**
  installation of the transducers in the mounting fixture Variofix L

**Step 1: Disassembly of the transducer mounting fixture Variofix L**

• Disassemble the transducer mounting fixture Variofix L.

**Step 2: Fixation of the clasps to the tension straps**

• Select the installation instruction of the supplied clasp:
  
  **Band clamp clasp**
  The clasp is fixed to the tension strap (see Fig. 6.15).

  **Quick release clasp**
  The clasp is fixed to the tension strap (see Fig. 6.16).

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

39UMFLUXUS_G532ST-LTV1-0EN, 2022-09-01

6.2 Transducers

A Ratchet clasp

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

**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.

- Insert approx. 100 mm of the tension strap into part (1) and (2) of the ratchet clasp (see Fig. 6.17 a).
- Bend the tension strap.
- Insert the tension strap into part (1) of the ratchet clasp (see Fig. 6.17 b).
- Tighten the tension strap.
- Repeat the steps for the second tension strap.

**Fig. 6.15:** Band clamp clasp with tension strap

**Fig. 6.16:** Quick release clasp with tension strap

**Fig. 6.17:** Ratchet clasp with tension strap

**Step 3: Fixation of the tension strap to the pipe**

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

**Fig. 6.18:** Tension strap with clamp and metal spring on the pipe

1 – tension strap clamp
2 – clasp
3 – metal spring
Select the installation instruction of the supplied clasp:

**Band clamp clasp**
- Insert the tension strap into its clamp (see Fig. 6.19).
- Position the clasp and the tension strap clamp on the pipe (see Fig. 6.18). On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
- Place the tension strap around the pipe and insert it into the clasp (see Fig. 6.21).
- Tighten the tension strap.
- Tighten the clasp screw.

**Quick release clasp**
- Insert the tension strap into its clamp and the metal spring (see Fig. 6.19 and Fig. 6.20).
- Position the clasp, the tension strap clamp and the metal spring on the pipe (see Fig. 6.18):
  - On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
  - Mount the metal spring opposite the tension strap clamp.

**Ratchet clasp**
- Insert the tension strap into its clamp and the metal spring (see Fig. 6.22). The metal spring does not have to be mounted on:
  - steel pipes
  - pipes with an outer diameter < 80 mm
  - pipes that are not subjected to significant temperature fluctuations
- Position the ratchet clasp, tension strap clamp and metal spring (if necessary) on the pipe (see Fig. 6.18):
  - On a horizontal pipe, mount the tension strap clamp laterally to the pipe, if possible.
  - Mount the metal spring (if necessary) opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the slot of the clasp screw (see Fig. 6.23).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 6.23).
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.

• Tighten the clasp screw.

Notice!

In order to release the screw and the tension strap, press the lever down (see Fig. 6.23).

Fig. 6.22: Tension strap with metal spring and clamp

1 – metal spring
2 – tension strap clamp

Fig. 6.23: Ratchet clasp with tension strap

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

Step 4: Fixation of the rail to the pipe

• Place the tension strap clamp (2) in the rail (see Fig. 6.24). Observe the orientation of the tension strap clamp.
• Slightly tighten the nut of the tension strap clamp (2).
• Screw the rail to tension strap clamp (1) (see Fig. 6.25).
• Tighten the nut of tension strap clamp (1), but not too firmly in order not to damage the tension strap.

Fig. 6.24: Rail with tension strap clamp

1 – nut
2 – tension strap clamp
• Select the installation instruction of the supplied clasp:

**Band clamp clasp**

• Insert the tension strap into the tension strap clamp (2).
• Place the tension strap around the pipe and insert it into the clasp (see Fig. 6.26 and Fig. 6.27).
• Tighten the tension strap.
• Tighten the clasp screw.
• Tighten the nut of tension strap clamp (2), but not too firmly in order not to damage the tension strap.

**Quick release clasp**

• Insert the tension strap into its clamp (2) and the metal spring.
• Place the tension strap around the pipe and insert it into the clasp (see Fig. 6.26 and Fig. 6.28).
• Position the metal spring opposite the tension strap clamp (2).
• Tighten the tension strap.
• Tighten the clasp screw.
• Tighten the nut of tension strap clamp (2), but not too firmly in order not to damage the tension strap.
Ratchet clasp

- Insert the tension strap into its clamp (2) and the metal spring (see Fig. 6.26 and Fig. 6.29). The metal spring does not have to be mounted on:
  - steel pipes
  - pipes with an outer diameter < 80 mm
  - pipes that are not subjected to significant temperature fluctuations
- Position the ratchet clasp, tension strap clamp (2) and metal spring (if necessary) on the pipe.
- Mount the metal spring opposite the tension strap clamp.
- Place the tension strap around the pipe and pass it through the slot of the clasp screw (see Fig. 6.30).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 6.30).

**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.

- Tighten the clasp screw.
- Tighten the nut of the tension strap clamp (2), but not too firmly in order not to damage the tension strap (see Fig. 6.26).

**Notice!**

In order to release the screw and the tension strap, press the lever down (see Fig. 6.23).
Repeat the steps to fix the second rail, see Fig. 6.31.

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

- Press the transducers firmly into their clamping fixtures in the covers until they are tightly fixed. The transducer cables show in opposite directions (see Fig. 6.32).

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

- Adjust the transducer distance displayed by the transmitter (see Fig. 6.33).
- Fix the transducer cables with the strain relief clamp to protect them from mechanical strain, see Fig. 6.33.
- Put coupling foil (or apply some coupling compound for a short-term installation) on the contact surface of the transducers. The coupling foil can be fixed to the contact surface with some coupling compound.
- Put the covers with the transducers on the rails.
- Correct the transducer distance, if necessary.
Fig. 6.33: Adjustment of the transducer distance

1 – cover
2 – strain relief clamp
3 – equipotential bonding terminal
a – transducer distance

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

• Tighten the cover screws, see Fig. 6.34.

Fig. 6.34: Variofix L with transducers on the pipe

1 – equipotential bonding terminal
2 – cover screws
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 specific ambient temperature.
• Observe that there must be no air pockets between the contact surface of the temperature probe and the pipe wall.

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

**Notice!**
The temperature probe has to be thermally insulated.

Select the installation instruction of the supplied clasp:

6.3.2.1 Installation with clasp

**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.

• 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) (see Fig. 6.35 a). The hooks of part (2) have to be on the outer side of the clasp.
• Pull approx. 20 mm of the tension strap through the slot of the clasp to fix the clasp to the tension strap (see Fig. 6.35 b).
• Bend the end of the tension strap.
• Position the temperature probe on the pipe (see Fig. 6.36).
• Place the tension strap around the temperature probe and the pipe.
• Push 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.
6.3.2.2 Installation with FLEXIM clasp

**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.

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Insert approx. 20 mm of the tension strap into the slot of the clasp.
- Bend the end of the tension strap.
- Position the temperature probe on the pipe (see Fig. 6.36).
- Place the tension strap around the temperature probe and the pipe.
- Push 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. 6.37: FLEXIM clasp
6.3.2.3 Installation with quick release clasp

**Caution!**

The edge of the tension strap is very sharp.
Risk of injury!
→ Deburr sharp edges.
→ Wear the required personal protective equipment.
→ Observe the applicable rules.

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Position the temperature probe on the pipe (see Fig. 6.36).
- Place the tension strap around the temperature probe and the pipe.
- Insert the tension strap into the clasp.
- Tighten the tension strap.
- Tighten the screw of the clasp.

Fig. 6.38: Quick release clasp
6.4 Pressure transmitter

Scope of delivery
The scope of delivery includes the following parts for the installation and connection of the pressure transmitter:

Fig. 6.39: Scope of delivery

1 – 1 x pressure transmitter with connector
2 – 1 x cable
3 – 1 x cable gland and reducer

Installation
Before mounting the pressure transmitter onto the pipe, the connector has to be removed.
• Loosen the connector screw.
• Remove the connector from the pressure transmitter. The flat gasket remains on the pins of the pressure transmitter.
• Install the pressure transmitter (see the documentation provided by the manufacturer).

Fig. 6.40: Removal of the connector

1 – pressure transmitter
2 – pins
3 – connector
4 – screw
5 – flat gasket
Fig. 6.41: Installed pressure transmitter

1 – flat gasket
2 – pressure transmitter
3 – pipe
7 Connection

### Warning!

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

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

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

### Warning!

**Touching live parts**

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

→ Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply. It is not sufficient to remove the internal fuse of the instrument.

### Caution!

**Safety and accident prevention regulations for electrical systems and equipment**

Failure to observe these regulations may lead to severe injuries.

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

### 7.1 Transducers

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

### Notice!

If transducers are replaced, the SENSROM has to be replaced as well.

---

Fig. 7.1: Connection of the transducers to the transmitter

![Connection diagram](image)
7.1.1  Connection of the transducer cable to the transmitter

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

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

Tab. 7.1: Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV</td>
<td>transducer [ ] (brown cable, marked white)</td>
</tr>
<tr>
<td>AVS</td>
<td>transducer [ ] (red cable)</td>
</tr>
<tr>
<td>ARS</td>
<td>transducer [ ] (red cable)</td>
</tr>
<tr>
<td>AR</td>
<td>transducer [ ] (brown cable)</td>
</tr>
</tbody>
</table>

![Fig. 7.2: Connection of the transducer cable with stainless steel conduit and stripped ends to the transmitter](image)

1 – cable gland
7.1.2 Connection of the extension cable to the transmitter

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

- Remove the blind plug for the connection of the transducer cable.
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut and the compression part.
- Prepare the extension cable.
- Shorten the external shield and brush it back over the compression part.
- Screw the sealing ring side of the basic part into the transmitter housing.
- Insert the extension cable into the housing.

Notice!

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

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the transmitter.

Tab. 7.2: Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV</td>
<td>white or marked cable (core)</td>
</tr>
<tr>
<td>AVS</td>
<td>white or marked cable (internal shield)</td>
</tr>
<tr>
<td>ARS</td>
<td>brown cable (internal shield)</td>
</tr>
<tr>
<td>AR</td>
<td>brown cable (core)</td>
</tr>
</tbody>
</table>

7.1.3 Connection of the transducer cable to the junction box

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

Tab. 7.3: Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>transducer (brown cable, marked white)</td>
</tr>
<tr>
<td>VS</td>
<td>transducer (red cable)</td>
</tr>
<tr>
<td>RS</td>
<td>transducer (red cable)</td>
</tr>
<tr>
<td>R</td>
<td>transducer (brown cable)</td>
</tr>
</tbody>
</table>
7.1.4 Connection of the extension cable to the junction box

7.1.4.1 Connection without potential separation (standard)

The connection of the extension cable to the junction box without potential separation ensures that the transducer, junction box and transmitter are on the same potential. The extension cable should always be connected in this manner, especially if power current cables are nearby. If earthing on the same potential cannot be ensured, see section 7.1.4.2.

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

Notice!

For good electromagnetic compatibility (EMC), it is important to ensure good electrical contact between the external shield and the cap nut (and thus the housing).
Tab. 7.4: Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection (extension cable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>white or marked cable (core)</td>
</tr>
<tr>
<td>TVS</td>
<td>white or marked cable (internal shield)</td>
</tr>
<tr>
<td>TRS</td>
<td>brown cable (internal shield)</td>
</tr>
<tr>
<td>TR</td>
<td>brown cable (core)</td>
</tr>
<tr>
<td>cable gland</td>
<td>external shield</td>
</tr>
</tbody>
</table>

Fig. 7.4: Connection of the extension and transducer cable to the junction box

1 – extension cable
2 – external shield, brushed back
3 – cap nut
4 – compression part
5 – basic part
6 – connection of the extension cable
7 – connection of the transducer cable
7.1.4.2 Connection with potential separation

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

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

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

**Important!**

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

**Important!**

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

- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the junction box.

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection (extension cable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>white or marked cable (core)</td>
</tr>
<tr>
<td>TVS</td>
<td>white or marked cable (internal shield)</td>
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<td>TRS</td>
<td>brown cable (internal shield)</td>
</tr>
<tr>
<td>TR</td>
<td>brown cable (core)</td>
</tr>
<tr>
<td>shield terminal</td>
<td>external shield</td>
</tr>
</tbody>
</table>
Fig. 7.5: Connection of the extension and transducer cable to the junction box

1 – extension cable
2 – external shield
3 – shield terminal
4 – cap nut
5 – compression part
6 – basic part
7 – connection of the extension cable
8 – connection of the transducer cable
7.1.5 SENSPROM

The SENSPROM contains important transducer data for the operation of the transmitter with the transducers. If transducers are replaced, the SENSPROM has to be replaced as well.

Notice!

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

- Disconnect the transmitter from the power supply.
- Insert the SENSPROM into its socket.
- Connect the transmitter to the power supply.
- Enter all parameters of the program branch Parameters.
- Start the measurement.

Fig. 7.6: Connection of the SENSPROM

1 – SENSPROM
7.2 Power supply

The installation of the power supply is carried out by the operator. The operator has to provide an overcurrent protector (fuse or similar device) disconnecting all energizing wires in case of an inadmissible high current consumption. The impedance of the protective ground has to be low ohmic in order not to allow touch voltage pass the permissible limit.

**Important!**

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

• Connect the power cable to the transmitter, see section 7.2.1, Fig. 7.7 and Tab. 7.6.

![Connection of the power supply to the transmitter](image)

**Fig. 7.7:** Connection of the power supply to the transmitter

1 – fuse
2 – connection of the power supply

**Tab. 7.6:** Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection AC</th>
<th>terminal</th>
<th>connection DC</th>
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<tbody>
<tr>
<td>L</td>
<td>phase 100...230 V</td>
<td>(+)</td>
<td>+</td>
</tr>
<tr>
<td>N</td>
<td>neutral</td>
<td>(-)</td>
<td>-</td>
</tr>
<tr>
<td>PE</td>
<td>protective ground</td>
<td>PE</td>
<td>protective ground</td>
</tr>
</tbody>
</table>
7.2.1 Cable connection
• Remove the blind plug to connect the cable to the transmitter.
• Prepare the cable with an M20 cable gland.
The used cable has to have a wire cross-section of 0.25…2.5 mm².
• Push the cable through the cap nut, compression part and basic part of the cable gland.
• Insert the cable into the housing of the transmitter.
• Screw the sealing ring side of the basic part into the transmitter housing.
• Fix the cable gland by screwing the cap nut onto the basic part.
When the transmitter is connected to a AC power supply, the power cable has to be prepared as shown in Fig. 7.9.
• Connect the cable to the terminals of the transmitter.

Fig. 7.8: Cable gland
Fig. 7.9: Preparation of the power cable

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

7.3 Outputs

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

• Connect the output cable to the transmitter, see section 7.2.1, Fig. 7.10 and section 7.3.1.

Fig. 7.10: Connection of the outputs to the transmitter
7.3.1 Output circuits

Tab. 7.7: Switchable current output Ix

<table>
<thead>
<tr>
<th>transmitter</th>
<th>internal circuit</th>
<th>external circuit</th>
<th>explanation</th>
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<td></td>
<td></td>
<td></td>
<td>R_{ext} &lt; 530 \Omega</td>
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<td></td>
<td>U_{\text{max}} = 28 V DC</td>
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<td></td>
<td>adjustable fault current (no valid measured value, no measurement):</td>
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<td>I_{\text{fault}} = 3.2…24 mA</td>
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<td></td>
<td></td>
<td>hardware fault current: I_{\text{fault}} = 3.2 mA</td>
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<td>U_{\text{ext}} ≤ 30 V DC</td>
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<td>U_{\text{ext}} &gt; 0.024 A \cdot R_{\text{ext}} [\Omega] + 9 V</td>
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<td>R_{\text{ext}} &lt; 875 \Omega</td>
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<td>U_{\text{ext}} = 20 V</td>
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<td>R_{\text{ext}} &lt; 458 \Omega</td>
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<td>adjustable fault current (no valid measured value, no measurement):</td>
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<td></td>
<td>I_{\text{fault}} = 3.2…24 mA</td>
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<td></td>
<td></td>
<td>hardware fault current: I_{\text{fault}} = 3.2 mA</td>
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</table>

Tab. 7.8: Switchable current output Ix/HART

<table>
<thead>
<tr>
<th>transmitter</th>
<th>internal circuit</th>
<th>external circuit</th>
<th>explanation</th>
</tr>
</thead>
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<td><img src="image" alt="Diagram" /></td>
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<td>250 \Omega &lt; R_{\text{ext}} &lt; 530 \Omega</td>
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<td></td>
<td></td>
<td></td>
<td>U_{\text{max}} = 28 V DC</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>adjustable fault current (no valid measured value, no measurement):</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>I_{\text{fault}} = 3.5…22 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hardware fault current: I_{\text{fault}} = 3.2 mA</td>
</tr>
<tr>
<td>passive</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>U_{\text{ext}}: 9…30 V DC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>U_{\text{ext}} &gt; 0.024 A \cdot R_{\text{ext}} [\Omega] + 9 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R_{\text{ext}}: 250…875 \Omega</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>example:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>U_{\text{ext}} = 20 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>250 \Omega &lt; R_{\text{ext}} &lt; 458 \Omega</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>adjustable fault current (no valid measured value, no measurement):</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{\text{fault}} = 3.2…22 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hardware fault current: I_{\text{fault}} = 3.2 mA</td>
</tr>
</tbody>
</table>
Tab. 7.9: Digital output (according to IEC 60947-5-6 (NAMUR))

<table>
<thead>
<tr>
<th>transmitter internal circuit</th>
<th>connection</th>
<th>external circuit</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>circuit 1</td>
<td>x⁺</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x⁻</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For all circuits apply:

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

Fig. 7.11: Connection of the inputs to the transmitter

7.4.1 Circuits of the inputs

Important!

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

For the connection of the input cable to the transmitter, see section 7.2.1 and Fig. 7.11.

Tab. 7.10: Switchable current input IX

<table>
<thead>
<tr>
<th>Transmitter</th>
<th>Internal Circuit</th>
<th>External Circuit</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{int} = 75 , \Omega$</td>
<td>$I_{\text{max}} \leq 30 , \text{mA}$</td>
<td>$U_{\text{max}} = 28 , \text{V (unloaded)}$</td>
</tr>
<tr>
<td></td>
<td>$I = 0 \ldots 20 , \text{mA (measuring range)}$</td>
<td>$U_{\text{min}} = 22.9 , \text{V} - (R_{int} \cdot I)$</td>
<td>$U_{\text{min}} = 21.4 , \text{V}$</td>
</tr>
<tr>
<td></td>
<td>The current input is galvanically isolated from the transmitter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{int} = 35 , \Omega$</td>
<td>$U_{\text{max}} = 26 , \text{V}$</td>
<td>$I_{\text{max}} \leq 24 , \text{mA}$</td>
</tr>
<tr>
<td></td>
<td>$I = 0 \ldots 20 , \text{mA (measuring range)}$</td>
<td>$U_{\text{min}} = 23.4 , \text{V} - (R_{int} \cdot I)$</td>
<td>$U_{\text{min}} = 22.7 , \text{V}$</td>
</tr>
<tr>
<td></td>
<td>The current input is galvanically isolated from the transmitter.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For all circuits apply:

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

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

Fig. 7.12: Connection of the temperature probes to the transmitter

7.5.1 Circuit of the temperature inputs

Tab. 7.11: Temperature input – not intrinsically safe

<table>
<thead>
<tr>
<th>transmitter</th>
<th>connection</th>
<th>external circuit</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>internal circuit</td>
<td>2 4</td>
<td></td>
<td>Pt100/Pt1000 (4-wire) The input is galvanically isolated from the transmitter.</td>
</tr>
</tbody>
</table>

7.5.2 Direct connection of the temperature probe

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

Fig. 7.13: Preparation of the temperature probe

1 – cap nut
2 – compression part
3 – basic part
4 – reducer
5 – sealing ring side
### 7.6 Pressure transmitter

#### 7.6.1 Disassembly of the connector

Before connecting the cable, the connector has to be disassembled.

- Remove the screw, if necessary.
- Turn the tensioning screw out of the connector housing.
- Remove the sealing ring and washer.
- Use a lever tool to remove the terminal block.
- Insert the lever tool into the slot of the terminal block.
- Press the lever tool against the connector housing.
- Remove the terminal block from the connector housing.

![Fig. 7.14: Disassembled connector](image)

1 – connector housing  
2 – screw  
3 – sealing ring  
4 – washer  
5 – tensioning screw  
6 – terminal block  
7 – slot of the terminal block

#### 7.6.2 Connection to the connector

- Push the cable through the tensioning screw, washer, sealing ring and connector housing.

![Fig. 7.15: Mounting of the cable](image)

1 – cable  
2 – connector housing  
3 – sealing ring  
4 – washer  
5 – tensioning screw
• Prepare the cable, if necessary.
• Cut off the external shield so that it is flush with the cable jacket.

Fig. 7.16: Preparation of the cable

![Diagram of cable preparation]

• Connect the cable to the terminals of the terminal block.
• Use wire end ferrules, if possible.

Fig. 7.17: Terminal assignment (connector)

![Diagram of terminal assignment]

1 – terminal block

Tab. 7.12: Terminal assignment (connector)

<table>
<thead>
<tr>
<th>terminal</th>
<th>cable labeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>not connected</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>not connected</td>
</tr>
</tbody>
</table>

• Press the terminal block, sealing ring and washer into the connector housing.
• Turn the tensioning screw firmly into the connector housing.

Fig. 7.18: Mounting of the connector and cable

![Diagram of connector and cable mounting]

1 – terminal block
2 – connector housing
3 – sealing ring
4 – washer
5 – tensioning screw
- Put the connector onto the pressure transmitter. The flat gasket has to be between the connector and the pressure transmitter. Observe the orientation of the pins.
- Tighten the screw of the connector housing.

**Fig. 7.19: Fixation of the connector**

1 – screw
2 – connector
3 – flat gasket
4 – pressure transmitter

**Fig. 7.20: Pins of the pressure transmitter**

7.6.3 **Connection to the transmitter**

- Remove the blind plug to connect the cable.
- Open the cable gland. The compression part remains in the cap nut.
- Push the cable through the cap nut and the compression part.
- Prepare the cable, if necessary.
- Shorten the external shield and brush it back over the compression part.
- Screw the sealing ring side of the reducer into the transmitter housing.
- Screw the basic part into the reducer.
- Insert the cable into the housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
**Notice!**

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

- Connect the cable to the terminals of the transmitter.
- Use wire end ferrules, if possible.

Fig. 7.21: Connection of the inputs to the transmitter

Fig. 7.22: Cable gland

Fig. 7.23: Prepared cable

1 – cap nut
2 – compression part
3 – basic part
4 – reducer

Tab. 7.13: Terminal assignment (transmitter)

<table>
<thead>
<tr>
<th>terminal</th>
<th>cable labeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
7.7 Service interfaces

7.7.1 USB interface
The transmitter can be connected directly to the PC via the USB interface.
• Connect the USB cable to the USB interface of the transmitter and to the PC.

7.7.2 LAN interface
The transmitter can be connected to the PC or LAN via a LAN cable.

• Remove the blind plug to connect the cable to the transmitter.
• Slide the flat gasket ring onto the LAN cable.
• Insert the cable into the transmitter housing.
• Insert the connector into the LAN interface.
• Mount the split cable gland on the LAN cable.
• Slide the flat gasket ring onto the cable gland and screw it into the transmitter housing.
Fig. 7.26: Split cable gland

1 – split sealing ring insert
2 – split fitting
3 – flat gasket ring
4 – annular spring
8  Start-up

### Warning!

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

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

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

### Caution!

**Safety and accident prevention regulations for electrical systems and equipment**

Failure to observe these regulations may lead to severe injuries.

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

### Caution!

**Warning of severe injuries from hot or cold components**

Touching hot or 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 transducers have to be checked to ensure proper condition and operational safety before each use. The transmitter housing 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
- time/date
- unit of measurement

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.
8.2 Switching on

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

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

By pressing BRK in the program branch Measurement it is possible either to stop the measurement or to display the current parameter settings.
8.3 Program branches
The following schema shows the program branches. For a detailed overview of the menu structure see annex A.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Measurement</th>
<th>Options</th>
<th>Special functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer parameters</td>
<td>Measuring point number</td>
<td>Physical quantity</td>
<td>Inputs</td>
</tr>
<tr>
<td>Pipe parameters</td>
<td>Number of sound paths</td>
<td>Units of measurement</td>
<td>Current output</td>
</tr>
<tr>
<td>Fluid parameters</td>
<td>Transducers</td>
<td>Outputs</td>
<td>Measurement</td>
</tr>
<tr>
<td>Length of extension cable</td>
<td>Diagnostic values</td>
<td>Input assignment</td>
<td>Data logger</td>
</tr>
<tr>
<td></td>
<td>Transducer positioning</td>
<td>Remote functions</td>
<td>Snaps</td>
</tr>
<tr>
<td></td>
<td>Measurement</td>
<td>Event triggers</td>
<td>Communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Special settings</td>
<td></td>
</tr>
</tbody>
</table>

8.4 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. The selected language remains activated when the transmitter is switched off and on again.
The language can also be changed by entering a HotCode.
8.5 Initialization

During an initialization (INIT) of the transmitter, all settings are reset to factory default. The initialization is started with the HotCode 909000.

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. For the input of numbers see section 4.4.
• Press ENTER.

If a measurement is running, it will be stopped.

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

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

• Language
• Date/time
• Units of measurement
• Delete meas. values
• Delete snaps
• Delete user subst. (all customized materials and fluids which were stored after delivery will be deleted)
• Reset totalizers

8.6 Date and time

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

• Select the menu item Date/time.

The adjusted time is displayed.

• Enter the current time. For the input of numbers, see section 4.4.
• Press ENTER.

The adjusted date is displayed.

• Enter the current date. For the input of numbers, see section 4.4.
• Press ENTER.

8.7 Information regarding the transmitter

The following information relating to the transmitter is displayed:

<table>
<thead>
<tr>
<th>display</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial number</td>
<td>serial number of the transmitter</td>
</tr>
<tr>
<td>Firmware version</td>
<td>version number of the installed firmware</td>
</tr>
<tr>
<td>Firmware date</td>
<td>creation date of the installed firmware</td>
</tr>
<tr>
<td>Verification log</td>
<td>state of the verification logger</td>
</tr>
</tbody>
</table>
9 Measurement

Caution!

Warning of severe injuries from hot or cold components

Touching hot or 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 Parameter input

Notice!

Avoid a simultaneous parameter entry via the keyboard and the USB, LAN or process interface. The parameter records received via these interfaces will overwrite the current transmitter parameterization.

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 program branch Parameters.
• Press ENTER.

see annex A
9.1.1 Transducer selection

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

**Parameters\Clamp-on transducer CDP2E52**

- The transducer (here: CDP2E52) connected to the transmitter is displayed.
- Press ENTER.
The display will only be indicated if a SENSPROM is connected to the transmitter.

**Parameters\Connected transd.**
The parameters can also be entered without connected transducers or SENSPROM.
- Select the list item Connected transd.
- Press ENTER.
The display Transducer not found will be indicated if neither transducers nor SENSPROM are connected.
- Press ENTER.

**Parameters\Select transducer**

- Select the list item Select transducer to use standard transducers stored in the transmitter.
- Select the transducer.
- Press ENTER.
This display will not be indicated if the transducers and the SENSPROM are connected to the transmitter.

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

9.1.2 Input of pipe parameters

**Outer pipe diameter**

**Parameters\Outer diameter**

- Enter the outer pipe diameter.
- Press ENTER.
It is possible to enter the pipe circumference instead of the outer pipe diameter.

**Pipe circumference**

**Parameters\Pipe circumference**

- Activate the input of the pipe circumference in the menu item Special functions\Dialogs/Menus\Pipe circumference.
- Enter zero in the menu item Outer diameter. The menu item Pipe circumference will be displayed.
- Enter the pipe circumference.
- Press ENTER.
If the outer pipe diameter is to be entered, enter zero. The menu item Outer diameter is displayed.
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 in the scroll list, select the list item Other material.
- Press ENTER.

Sound speed of the pipe material

- Enter the sound speed of the pipe material.

Notice!

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

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

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

For the sound speed of some materials see annex C.

Roughness of the pipe material

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 into the calculation.
- Enter the roughness of the pipe material in case the pipe has no lining. Press ENTER.

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

For the roughness of some materials see annex C.

Wall thickness

- Enter the pipe wall thickness.
- Press ENTER.

Lining

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

- Enter the sound speed of the lining material.

Notice!

For pipe materials there are 2 sound speeds, the longitudinal and the transversal one. Enter the sound speed which is nearer to 2500 m/s.

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

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

Roughness of the lining material

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

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

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

Roughness

- Enter the roughness of the lining material.
- Press ENTER.
  
This display will not be indicated if Other material is selected in the menu item Pipe material or Lining material.
9.1.3  Input of 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

- 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

- 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.

Kinematic viscosity of the fluid

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

This display will only be indicated if Customized is selected.

Compressibility coefficient

- Enter the compressibility coefficient of the gas.
- 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. If the mass flow is not measured, an input is unnecessary. 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.

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. The value has to be within the ambient temperature of the transducers.
- In case of a temperature range, enter the average fluid temperature.

Notice!

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

- Press ENTER.

Fluid pressure

Parameters\Fluid pressure

The fluid pressure is used for the interpolation of the sound speed and the gas compressibility coefficient.
- Enter the fluid pressure.
- Press ENTER.
This display will only be indicated if the option Gas measurement has been activated in the menu item Special functions\Measurement\Measurement modes.

9.1.4 Other parameters

Extension cable

Parameters\Extension cable

In case the transducer cable is extended (e.g., between junction box and transmitter), enter the length of the extension cable.
- Select the menu item Extension cable in the program branch Parameters.
- Enter the length of the extension cable.
- Press ENTER.
9.2 Measurement settings

- Select the program branch Options.
- Press ENTER.

Options \ Measurement

- Select the menu item Measurement.
- Press ENTER.

9.2.1 Selection of the physical quantity

Options \ Measurement \ Physical quantity

The available physical quantities are displayed in a list.
- Select the physical quantity.
- Press ENTER.

9.2.2 Selection of the unit of measurement

Options \ ... \ Volumetric flow rate

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

Notice!

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

9.2.3 Input of the damping factor

Options \ ... \ 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, caused by a higher dynamic flow, a higher damping factor can be very useful.
- Enter the damping factor.
- Press ENTER.
9.2.4 Dynamic damping

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

**Important!**

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

Options\...
Dynamic damping

• Select On to activate the dynamic damping and
• Press ENTER.

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

Options\...
Dynamic damping\Dynamic threshold

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

Options\...
Dynamic damping\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.

9.2.5 Input of the error delay

Options\...
Error delay

The error delay is the time interval after 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 Special functions\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.
• Press BRK for several seconds to return to the main menu.
9.2.6 Configuration of an output

If a current output has to be operated according to NAMUR NE43, this function has to be enabled.

**Special functions\Current output\NAMUR NE43**

- Select the list item **Current output** in the menu item **Special functions**.
- Press ENTER until the menu item **NAMUR NE43** is displayed.
- Select **Yes** to enable NAMUR NE43.
- Press ENTER.

**Assignment of an output**

- Select the menu item **Outputs**.
- Press ENTER.

**Options\Outputs\Current I1(--)**

- Select the output (here: **Current I1(--)**).
- Press ENTER.

The scroll list contains all available outputs of the transmitter.

**Tab. 9.1: Configuration of the outputs**

<table>
<thead>
<tr>
<th>source item</th>
<th>list item</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow quantities</td>
<td>Flow velocity</td>
<td>flow velocity</td>
</tr>
<tr>
<td></td>
<td>Norm vol. flow rate</td>
<td>standard volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Operation vol. flow</td>
<td>operating volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Mass flow rate</td>
<td>mass flow rate</td>
</tr>
<tr>
<td>Totalizers</td>
<td>Volume (+)</td>
<td>totalizer for the volumetric flow rate in positive flow direction</td>
</tr>
<tr>
<td></td>
<td>Volume (-)</td>
<td>totalizer for the volumetric flow rate in negative flow direction</td>
</tr>
<tr>
<td></td>
<td>Volume (Δ)</td>
<td>difference of the totalizers for the positive and negative flow direction</td>
</tr>
<tr>
<td></td>
<td>Standard volume (+)</td>
<td>totalizer for the standard volumetric flow rate in positive flow direction</td>
</tr>
<tr>
<td></td>
<td>Standard volume (-)</td>
<td>totalizer for the standard volumetric flow rate in negative flow direction</td>
</tr>
<tr>
<td></td>
<td>Standard vol. (Δ)</td>
<td>difference of the totalizers for the positive and negative flow direction</td>
</tr>
<tr>
<td></td>
<td>Mass (+)</td>
<td>totalizer for the mass flow rate in positive flow direction</td>
</tr>
<tr>
<td></td>
<td>Mass (-)</td>
<td>totalizer for the mass flow rate in negative flow direction</td>
</tr>
<tr>
<td></td>
<td>Mass (Δ)</td>
<td>difference of the totalizers for the positive and negative flow direction</td>
</tr>
</tbody>
</table>
### Tab. 9.1: Configuration of the outputs

<table>
<thead>
<tr>
<th>source item</th>
<th>list item</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse</td>
<td>Pulse (</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Pulse +V</td>
<td>pulse for positive measured values of the volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Pulse -V</td>
<td>pulse for negative measured values of the volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Pulse (</td>
<td>V(n)</td>
</tr>
<tr>
<td></td>
<td>Pulse +V(n)</td>
<td>pulse for positive measured values of the standard volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Pulse -V(n)</td>
<td>pulse for negative measured values of the standard volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Pulse (</td>
<td>m</td>
</tr>
<tr>
<td></td>
<td>Pulse +m</td>
<td>pulse for the positive measured values of the mass flow rate</td>
</tr>
<tr>
<td></td>
<td>Pulse -m</td>
<td>pulse for the negative measured values of the mass flow rate</td>
</tr>
<tr>
<td>Fluid properties</td>
<td>Fluid temp.</td>
<td>fluid temperature</td>
</tr>
<tr>
<td></td>
<td>Fluid pressure</td>
<td>fluid pressure</td>
</tr>
<tr>
<td></td>
<td>Fluid density</td>
<td>fluid density</td>
</tr>
<tr>
<td></td>
<td>Kin. viscosity</td>
<td>kinematic viscosity</td>
</tr>
<tr>
<td></td>
<td>Dyn. viscosity</td>
<td>dynamic viscosity</td>
</tr>
<tr>
<td></td>
<td>Norm. density</td>
<td>density at reference temperature</td>
</tr>
<tr>
<td></td>
<td>Compress. coeff.</td>
<td>gas compressibility coefficient</td>
</tr>
<tr>
<td>Event trigger</td>
<td>R1</td>
<td>limit message (Event trigger R1)</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>limit message (Event trigger R2)</td>
</tr>
<tr>
<td></td>
<td>R3</td>
<td>limit message (Event trigger R3)</td>
</tr>
<tr>
<td></td>
<td>R4</td>
<td>limit message (Event trigger R4)</td>
</tr>
<tr>
<td>Diagnostic values</td>
<td>Amplitude</td>
<td>signal amplitude</td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>signal quality</td>
</tr>
<tr>
<td></td>
<td>SNR</td>
<td>signal-to-noise ratio</td>
</tr>
<tr>
<td></td>
<td>SCNR</td>
<td>signal-to-correlated noise ratio</td>
</tr>
<tr>
<td></td>
<td>VariAmp</td>
<td>amplitude variation</td>
</tr>
<tr>
<td></td>
<td>VariTime</td>
<td>transit time variation</td>
</tr>
<tr>
<td></td>
<td>Amplification</td>
<td>amplification required to receive a useful signal</td>
</tr>
<tr>
<td></td>
<td>Pig detection</td>
<td>signalizes whether a pig is detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This display will only be indicated if Pig detection is activated.</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Custom. Input 1</td>
<td>measured values of input quantities (e.g., temperature, density) which are not used for calculation</td>
</tr>
<tr>
<td></td>
<td>Custom. Input 2</td>
<td>In the menu item Options Assign inputs it is possible to assign configured inputs to customized inputs.</td>
</tr>
<tr>
<td></td>
<td>Custom. Input 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Custom. Input 4</td>
<td></td>
</tr>
<tr>
<td>Sound speed</td>
<td>Sound speed</td>
<td>sound speed</td>
</tr>
<tr>
<td></td>
<td>Sound speed (Δ)</td>
<td>difference of the measured sound speed and the sound speed calculated from the fluid data</td>
</tr>
</tbody>
</table>
Depending on the selected source item, it is possible to output measured values, status values or event values.

### 9.2.6.1 Output of a measured value

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

#### 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**.

#### Error output

- **Select** a list item.
- **Other value**
- **Select** the list item `Options\Outputs\...\Error value`.
- **Press** ENTER.

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 NE43 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. 9.3: Examples for the error output (output range: 4...20 mA)

<table>
<thead>
<tr>
<th>list item</th>
<th>output signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 mA</td>
<td>![Graph]</td>
</tr>
<tr>
<td>Last value</td>
<td>![Graph]</td>
</tr>
<tr>
<td>20.0 mA</td>
<td>![Graph]</td>
</tr>
<tr>
<td>Other value</td>
<td>![Graph]</td>
</tr>
<tr>
<td>error value = 3.5 mA</td>
<td>![Graph]</td>
</tr>
</tbody>
</table>
**Measuring range**

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

- **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.

**Options\Outputs\...\Measured values\Absolute value**

**Options\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.

**Options\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**

**Options\Outputs\...\Output info**

The terminals for the connection of the output are displayed. 
By pressing < or > 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.

**Options\Outputs\...\Test signal**

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

**Options\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 or *Finish* to display the next menu item.  
  *Press ENTER.*

**Options\Outputs\...\Test mea. 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.*
Options\Outputs\.\.\Enter test value

- Enter a test value for the selected physical quantity. It has to be within the measuring 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.

### 9.2.6.2 Output of a status/event value

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

**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 max. output value (Output MAX). If the output range is smaller, an error message will be displayed. The next possible value will be displayed.

<table>
<thead>
<tr>
<th>status value – status OK</th>
<th>event value – idle state</th>
</tr>
</thead>
<tbody>
<tr>
<td>The status of the output signal is defined which is to be output when measuring a measured value.</td>
<td>The status of the output signal is defined which is to be output if no event occurs.</td>
</tr>
<tr>
<td>• Select the value for status OK from the scroll list.</td>
<td>• Select the value for the idle state.</td>
</tr>
<tr>
<td>• Press ENTER.</td>
<td>• Press ENTER.</td>
</tr>
</tbody>
</table>

**Terminal assignment**

Options\Outputs\.\.\Output info

The terminals for the connection of the output are displayed.

By pressing ➡ or ▼ 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.

Options\Outputs\.\.\Test signal

- Select Yes to test the output. Select No to display the next menu item.
- Press ENTER.
9.2 Measurement settings

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• 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 or Finish to display the next menu item.
• Press ENTER.

Options\Outputs\...\Enter test value

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

Options\Outputs\...\Test mea. range

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

<table>
<thead>
<tr>
<th>status value</th>
<th>event value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status OK or Status error. If the external measuring instrument displays the value (min. output value for Status error, max. output for Status OK), the output functions correctly.</td>
<td>Active or Passive. If the external measuring instrument displays the value (min. output value for Passive, max. output for Active), the output functions correctly.</td>
</tr>
</tbody>
</table>

• Select Repeat to repeat the test or Finish to display the next menu item.
• Press ENTER.
• Press BRK for several seconds to return to the main menu.

9.2.6.3 Switchable current outputs

If the transmitter has switchable current outputs, it has to be defined how to switch them.
• Select the menu item Current output in the program branch Special functions.
• Press ENTER.

Special functions\Current output

• Select Active if the current outputs are to be switched to active.
• Press ENTER.
All switchable current outputs are switched to active.
• Select Passive if the current outputs are to be switched to passive.
• Press ENTER.
All switchable current outputs are switched to passive.
9.3 Start of the measurement

- Select the program branch Measurement.
- Press ENTER.

Input of the measuring point number

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

For the activation of text input see Special functions\Dialogs/Menus\Measuring point no.

Input of the sound path number

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

Adjustment of the transducer distance

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

Notice!

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

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

The diagnostics window is displayed.

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

The bar graph SCNR shows the ratio of the useful signal an the correlated noise signal.
9.3 Start of the measurement

In case of large diagnostic value deviations of the recommended limits, check if the entered parameters are correct or repeat the measurement at a different point on the pipe.

Press ENTER.

Tab. 9.5: Recommended diagnostic limits

<table>
<thead>
<tr>
<th>good measurement</th>
<th>measurement at limit</th>
<th>measurement not possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCNR &gt; 30 dB (&gt; 50 %)</td>
<td>20 dB ≤ SCNR ≤ 30 dB (0 % &lt; SCNR ≤ 50 %)</td>
<td>SCNR &lt; 20 dB (= 0 %)</td>
</tr>
<tr>
<td>SNR &gt; 15 dB</td>
<td>0 dB ≤ SNR ≤ 15 dB</td>
<td>SNR &lt; 0 dB</td>
</tr>
<tr>
<td>GAIN &lt; 98 dB</td>
<td>98 dB ≤ GAIN ≤ 113 dB</td>
<td>GAIN &gt; 113 dB</td>
</tr>
</tbody>
</table>

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 sound speed range entered in the program branch 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.
9.4 Display of measured values

The measured values are displayed during the measurement as follows:

### Fig. 9.2: Display of measured values

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT-3302</td>
<td>Volumetric flow rate</td>
<td>389.15</td>
<td>2.37 m/s</td>
<td>Flow velocity</td>
</tr>
</tbody>
</table>

1 – program branch, status indicators
2 – display toggling between physical quantity and fluid
3 – measured value
4 – further physical quantity
5 – further physical quantity

By pressing → or ↓, additional physical quantities can be displayed during the measurement.

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

### Status line

Important information of the running measurement is summarized in the status line. The quality and precision of the measurement can be evaluated. Press → during the measurement to scroll to the status line.

### Fig. 9.3: Display of the status line

<table>
<thead>
<tr>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Measurement</td>
</tr>
<tr>
<td>Norm vol. flow rate</td>
</tr>
<tr>
<td>111.72</td>
</tr>
<tr>
<td>S3 39 © RTF / WGR</td>
</tr>
<tr>
<td>Measuring status</td>
</tr>
</tbody>
</table>

1 – status line

### Tab. 9.7: Description of the status line

<table>
<thead>
<tr>
<th>value</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>signal amplitude</td>
</tr>
<tr>
<td>0</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>9</td>
<td>≥ 90 %</td>
</tr>
<tr>
<td></td>
<td>values ≥ 3 are sufficient for the measurement</td>
</tr>
<tr>
<td>Q</td>
<td>signal quality</td>
</tr>
<tr>
<td>0</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>9</td>
<td>≥ 90 %</td>
</tr>
</tbody>
</table>
Transducer distance

By pressing ➕ during the measurement, it is possible to scroll to the display of the transducer distance.

Fig. 9.4: Display of the transducer distance

The recommended transducer distance will be displayed in brackets, the measured transducer distance will be displayed afterwards. The recommended transducer distance might change during the measurement (e.g., due to temperature fluctuations). A deviation from the recommended transducer distance will be compensated internally.

Notice!

Never change the transducer distance during the measurement.
Transducer temperature

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

By pressing \( \equiv \) during the measurement, it is possible to scroll to the transducer temperature display.

Fig. 9.5: Display of the transducer temperature

<table>
<thead>
<tr>
<th>FT-2332</th>
<th>Volume flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>m3/h</td>
<td>393.25</td>
</tr>
<tr>
<td>SENSOR 21 °C</td>
<td>Transducer temp.</td>
</tr>
</tbody>
</table>

Notice!

If the compliance of the specified transducer temperature has to be monitored, an event trigger can be set on the temperature value.

9.5 Display of parameters

The parameters can be displayed during the measurement.

\• Press BRK during the measurement.

The following display appears:

• Select Show parameters in the scroll list.
• Press ENTER.

The program branch Measurement is displayed.

• Select another program branch to display the parameters.

Notice!

The parameters cannot be changed during the measurement. When attempting to change the parameters, the message Read-only mode will be displayed.

The measurement has to be stopped in order to change the parameters.
Information regarding the data logger

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

- Press ➔ until the following is displayed:

Fig. 9.7: Information regarding the data logger

If the ringbuffer is deactivated, line 4 indicates when the data logger will be full in case all settings are kept.

If the ringbuffer is activated, line 4 indicates how long measurement data can still be stored without losing older measurement data.

The information regarding the data logger can also be displayed using the function Show parameters.

### Special functions \ Data logger

- Select the list item Data logger info in the menu item Data logger.
- Press ENTER.

The information regarding the data logger will be displayed.

### 9.6 Repeated display of measured values

- Select the program branch Measurement to return to the measured value display.
- Press ENTER.

The following display appears:

Fig. 9.8: Scroll list in the program branch Measurement

### 9.7 Execution of special functions

During a measurement, the keyboard can be used to carry out special functions.

Tab. 9.8: Special functions

<table>
<thead>
<tr>
<th>key</th>
<th>function</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRK</td>
<td>display of the scroll list in the program branch Measurement</td>
</tr>
<tr>
<td>ENTER</td>
<td>display of the diagnostic window</td>
</tr>
<tr>
<td>CLR</td>
<td>display of the menu item Execute command</td>
</tr>
</tbody>
</table>

- Press and hold CLR until the menu item Execute command is displayed.
Totalizers

- Select the list item Totalizers.
- Press ENTER.

The following scroll list appears:

<table>
<thead>
<tr>
<th>display</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset totalizers</td>
<td>reset the totalizer to zero</td>
</tr>
<tr>
<td>Freeze display</td>
<td>display the measured value of the totalizer for several seconds</td>
</tr>
<tr>
<td>Fehler zurücksetzen</td>
<td>reset the totalizer error</td>
</tr>
<tr>
<td>Stop/clear totalizers</td>
<td>stop totalizer and reset it to zero</td>
</tr>
<tr>
<td>Start totalizers</td>
<td>start totalizer</td>
</tr>
</tbody>
</table>

Measuring mode

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

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

Taking a snap

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

A snap will be taken.

This display will only be indicated if snap function is enabled in the menu item Special functions\Snap\Configuration\Snap.

Reset the event trigger to idle state

- 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 also been triggered.
9.8 Stop of the measurement

- Press BRK during the measurement.
The following display appears:

Fig. 9.9: Scroll list in the program branch Measurement

- Select Stop measurement.
- Press ENTER.
The measurement is stopped. The program branch Parameters is displayed.
After disconnecting and reconnecting the power supply, the program branch Parameters appears.
10 Troubleshooting

Warning!

Service works by unauthorized and unqualified personnel
This may result in personal or material damage or dangerous situations.
→ Any work on the transmitter has to be carried out by authorized and qualified personnel.

Caution!

Safety and accident prevention regulations for electrical systems and equipment
Failure to observe these regulations may lead to severe injuries.
→ Observe the safety and accident prevention regulations for electrical systems and equipment.

Warning!

Touching live parts
Electric shock or arc faults can lead to severe injuries. The measuring equipment can be damaged.
→ Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply. It is not sufficient to remove the internal fuse of the instrument.

Caution!

Touching hot or 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 at all or fails regularly.

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

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

• Press BRK to return to the main menu.
• Select the menu item Special functions\System settings\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

A measurement is not possible because no signal is received. An interrogation point is displayed after the physical quantity. The LED lights 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.
- Check the number of sound paths.
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point is selected and the number of sound paths was entered correctly.
- Try to establish a better acoustic contact between the pipe and the transducers.
- Enter a lower value for 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 lower limit is below, UNDEF and after the physical quantity an exclamation point will be displayed. 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 the pipe was without any pressure and afterwards no measuring signal has been received, contact FLEXIM.
- Wait a moment until the acoustic contact is reestablished. The measurement can be interrupted by a temporarily high portion of liquid 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 Measuring point selection

- Make sure that the recommended min. distance to any disturbance is observed.
- Avoid measuring points with deposit formation in the pipe.
- Avoid measuring points in the vicinity of deformations and defects on the pipe as well as 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 have to be mounted laterally on the pipe.

10.3 Maximum acoustic contact

- see section 6.2
10 Troubleshooting

10.4 Application-specific problems

A fluid with a wrong sound speed was selected.

- If the selected sound speed in the fluid does not match the actual one, the 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 transducer positioning. 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 only conditionally possible.

- 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.

Droplets or solid particles 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 only conditionally possible.

10.5 Significant deviations of the measured values

A fluid with a wrong sound speed was selected.

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

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

- All measured flow velocities that are greater than 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. The cut-off flow has to be set to a low value to be able to measure at low flow velocities (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.

The measuring point is not appropriate.

- Check whether a different measuring point provides better results. Because pipes are never rotationally symmetric and the flow profile is affected.

The operating volumetric flow rate meets the expectations, but the standard volumetric flow rate deviates strongly

- The parameters (standard and operating temperature, standard and operating pressure) for the measurement of the standard volumetric flow rate have not been entered correctly.

10.6 Problems with the totalizers

The values of the totalizers are too small.

- 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 $\sum Q$) transmitted via an output is not 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 can be wrong.
11 Maintenance and cleaning

11.1 Maintenance

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Maintenance Step</th>
<th>Interval</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel housing</td>
<td>Visual inspection for corrosion and damages</td>
<td>Annually</td>
<td>Cleaning</td>
</tr>
<tr>
<td>• Junction box</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Transducer mounting fixture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum housing</td>
<td>Visual inspection for contamination</td>
<td>Annually or more frequently, depending on the ambient conditions</td>
<td></td>
</tr>
<tr>
<td>• Transmitter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transducers</td>
<td>Check of the transducer coupling on the pipe</td>
<td>Annually</td>
<td>Replacement of coupling foil, if necessary</td>
</tr>
<tr>
<td>Transmitter</td>
<td>Check for firmware updates</td>
<td>Annually</td>
<td>Update, if necessary</td>
</tr>
<tr>
<td>Functional test</td>
<td></td>
<td>Annually</td>
<td>Reading of measured and diagnostic values</td>
</tr>
<tr>
<td>Transmitter and transducers</td>
<td>Calibration</td>
<td>-</td>
<td>See section 11.3</td>
</tr>
</tbody>
</table>
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 Calibration
If installed as recommended in an appropriate location, used cautiously and serviced conscientiously, no troubles should appear.
The transmitter has been calibrated at factory and, usually, a recalibration is not necessary.

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

In order to realize a recalibration under reference conditions, either the transmitter, the transducers or both have to be sent to FLEXIM.
12 Dismounting and disposal

### Warning!

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

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

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

### Warning!

**Touching live parts**

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

→ Prior to any work on the transmitter (e.g., installation, dismounting, connection, start-up), the transmitter has to be disconnected from the power supply. It is not sufficient to remove the internal fuse of the instrument.

### Caution!

**Safety and accident prevention regulations for electrical systems and equipment**

Failure to observe these regulations may lead to severe injuries.

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

12.1 Dismounting

Dismounting is carried out in reverse order to the installation.

12.2 Disposal

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

### Important!

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

Depending on the material, the corresponding parts 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, further options are displayed in the menu item Options\Special settings.

Tab. 13.1: Menu items of the user modes

<table>
<thead>
<tr>
<th>Options/Special settings</th>
<th>StandardUser</th>
<th>ExpertUser</th>
<th>SuperUser</th>
<th>SuperUser ext.</th>
<th>default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-off flow</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>On</td>
</tr>
<tr>
<td>Flow velocity limit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Off</td>
</tr>
<tr>
<td>Turbulence mode</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Off</td>
</tr>
<tr>
<td>Max. amplification</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Off</td>
</tr>
<tr>
<td>Pipe signal detection</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>On</td>
</tr>
<tr>
<td>LWT pipe wall calibr.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Off</td>
</tr>
<tr>
<td>Linear calibration</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Off</td>
</tr>
<tr>
<td>Profile correction</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>On</td>
</tr>
<tr>
<td>Multi-point calibration</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(if enabled in the menu item Special functions\Measurement\Measurement settings)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use satur. steam curve</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Start in meas. mode</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transducer temp. and Transd. temp. violat. (as source item Diagnostic values)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

User mode selection

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

Options\Special settings

- Select the menu item Options\Special settings.
- Press ENTER.

The menu items of the user mode are consecutively displayed.

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 Cut-off flow

The cut-off flow is a lower limit for the flow velocity. All measured flow velocities that are below the limit are set to zero. The cut-off flow can depend on the flow direction.

Options\Special settings\Cut-off flow

- Select the menu item Options\Special settings.
- Press ENTER until the menu item Cut-off flow is displayed.
- Select Off if no value is to be entered for the cut-off flow.
- Select Default if no customized inputs are to be made (default: ± 25 mm/s).
- Select Customized to define the values of the cut-off flow for the positive and negative flow direction.
- Press ENTER.

Options\Special settings\+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.

Options\Special settings\-Cut-off flow

All values of the flow velocity for the negative flow direction (as absolute value) below this absolute limit are set to zero.
- Enter the cut-off flow as absolute value.
- Press ENTER.

13.1.2 Turbulence mode

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

Requirement for a measurement with activated turbulence mode

- The SNR has to be > 15 dB with deactivated turbulence mode.
- The signal amplification with activated turbulence mode is min. 3 dB smaller than with deactivated turbulence mode. For this purpose, the signal amplification 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.
Options\Special settings\Turbulence mode

- Select the menu item Special settings in the program branch Options.
- Press ENTER until the menu item Turbulence mode is displayed.
- Select On to activate the turbulence mode. Select Off to deactivate it. Select Default if no customized inputs are to be made.
- Press ENTER.

13.1.3 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 of values has to be identical with the eventual operating range.
- Note or store the measured values.

Input of a series of measured values:
- Select the menu item Special settings in the program branch Options.
- Press ENTER until the menu item Multi-point calibration is displayed.

Options\Special settings\Multi-point calibration

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

Options\Special settings\Multi-point calibration\Calibration points

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

Options\Special settings\Multi-point calibration\Point x=act. value

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

Options\Special settings\Multi-point calibration\Point x=set value

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

Options\Special settings\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.
### 13.1.4 Start in measuring mode

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

- Select the menu item **Special settings** in the program branch **Options**.
- Press ENTER until the menu item **Start in meas. mode** is displayed.
- Select **TransitTime** or **FastFood** to start the measurement in the corresponding mode.
- Press ENTER.

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

- Select **Yes** to keep always the same the measuring mode. Select **No** to be able to select another measuring mode during the measurement.

### 13.1.5 Settings for steam measurement

In the menu item **Use satur. steam curve** it is possible to select whether the saturation pressure is to be calculated from the temperature or the saturation temperature from the pressure during the steam measurement.

- Select the menu item **Special settings** in the program branch **Options**.
- Press ENTER until the menu item **Use satur. steam curve** is displayed.
- Select **Tf -> Pf**, if the fluid pressure has to be calculated from the fluid temperature. Select **Pf -> Tf**, if the fluid temperature has to be calculated from the fluid pressure. Select **No** if the pressure and temperature are independently available.
- Press ENTER.

If **Tf -> Pf** or **Pf -> Tf** is selected, the information concerning the calculated quantity will be displayed in the program branch **Parameters** after the fluid temperature or fluid pressure has been entered.

### 13.2 ExpertUser mode

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

<table>
<thead>
<tr>
<th>Notice!</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notice!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some of the defined parameters remain activated when switching to the StandardUser mode. These parameters are displayed but cannot be changed.</td>
</tr>
</tbody>
</table>

### 13.2.1 Limit of the flow velocity

Single outliers caused by heavily disturbed surroundings can appear among the measured values of the flow velocity. If these outliers are not ignored, they will affect all derived physical quantities, which will be unsuitable for the 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 higher or lower than the preset limit. In this case an error will be output.
13 User modes
13.2 ExpertUser mode

Options\Special settings\Flow velocity limit

• Select the menu item **Special settings in the program branch** Options.
• Press ENTER until the menu item **Flow velocity limit** is displayed.
• Select **Off** if no limit for the flow velocity is to be used.
• Select **Default** if no customized inputs are to be made.
• Select **Customized** to define a limit for the flow velocity.
• Press ENTER.

Options\Special settings\+Flow velocity limit

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

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

Options\Special settings\-Flow velocity limit

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

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

![Fig. 13.1: Flow velocity outside the valid range](image)

1 – physical quantity
2 – flow velocity

**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.
13.2.2 Max. signal amplification

In order to prevent disturbing 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 amplification.

If the signal amplification is greater than the max. signal amplification:

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

Options\Special settings\Max. amplification

- Select the menu item Special settings in the program branch Options.
- Press ENTER until the menu item Max. amplification is displayed.
- Select Off if no limit of the signal amplification is to be used.
- Select Default if no customized inputs are to be made.
- Select Customized to define a limit for the max. amplification.
- Press ENTER.
- Enter a value for the max. signal amplification.
- 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 is calculated from the greatest of the following values:

- absolute threshold, default value: 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

Options\Special settings\Pipe signal detection

- Select the menu item Special settings in the program branch Options.
- Press ENTER until the menu item Pipe signal detection is displayed.
- Select Off to measure without pipe signal detection.
- Select Default if no customized inputs are to be made and the default values are to be used.
- Select Customized to define the values of the pipe signal detection.
- Press ENTER.

Options\Special settings\Absolute threshold

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

Options\Special settings\Relative threshold

- Enter the value for 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 greater than the absolute value 2007 m/s, this value will be used as the absolute limit of the sound speed when the plausibility of the signal is evaluated.
13.2.4 Profile correction

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

- $k_{Re} \, 1.0$: profile correction (previous version)
- $k_{Re} \, 2.0$: improved profile correction (current version, default)
- $k_{Re} \, 2.0 \, \text{disturb. corr.}$: improved profile correction at non ideal inflow conditions for the positive flow direction (negative flow direction without disturbance correction)
- $k_{Re} \, 2.0 \, \text{dist.corr.bidir.}$: 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 for all measuring channels in the program branch Special functions.
- selection of the disturbance type in the program branch Parameters.
- input of the disturbance distance in the program branch Parameters if $k_{Re} \, 2.0 \, \text{disturb. corr.}$ or $k_{Re} \, 2.0 \, \text{dist.corr.bidir.}$ has been selected.

Notice!

If $k_{Re} \, 2.0 \, \text{disturb. corr.}$ or $k_{Re} \, 2.0 \, \text{dist.corr.bidir.}$ has been selected, the transducers have to be mounted in reflection arrangement to compensate cross-flow effects.

Selection of the version

Special functions\Measurement\Measurement settings\Profile correction

- Select the menu item Measurement settings in the program branch Special functions.
- Press ENTER until the menu item Profile correction is displayed.
- Select a list item (default: $k_{Re} \, 2.0$).
- Press ENTER.

Selection of the disturbance

Parameters\Disturbance type

- Select a list item.
- Press ENTER.

If $k_{Re} \, 2.0 \, \text{disturb. corr.}$ or $k_{Re} \, 2.0 \, \text{dist.corr.bidir.}$ is selected, the disturbance parameters have to be entered.
13.3 SuperUser mode 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 it is not possible to carry out any plausibility test of the entered parameters.

Notice!
The SuperUser and SuperUser ext. 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 failure of the measurement 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 Pipe wall calibration for Lamb wave transducers

The parameter record of a measuring channel for Lamb wave transducers has 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 for the pipe material is defined and selected from the program branch Parameters

The factor can be activated in the transmitter.

Options\Special settings\LWT pipe wall calibr.

- Select the menu item Special settings in the program branch Options.
- Press ENTER until the menu item LWT pipe wall calibr. is displayed.
- Select Off to measure without pipe wall calibration.
- Select Default if no customized inputs are to be made.
- Select On to define the values for the pipe wall calibration.
- Press ENTER.

<table>
<thead>
<tr>
<th>disturbance type</th>
<th>further inputs</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>90° elbow</td>
<td>Disturbance distance (l)</td>
<td></td>
</tr>
<tr>
<td>Double elbow</td>
<td>Disturbance distance (l₁)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dist. between elbows (l₂)</td>
<td></td>
</tr>
<tr>
<td>Double elb. out of plane</td>
<td>Disturbance distance (l₁)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dist. between elbows (l₂)</td>
<td></td>
</tr>
</tbody>
</table>
13.3.2  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 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.

**Options\Special settings\Linear calibration**

- Select the menu item **Special settings in the program branch** **Options**.
- Press ENTER until the menu item **Linear calibration** is displayed.
- Select **Off** to measure without linear calibration.
- Select **Default** if no customized inputs are to be made.
- Select **On** to define the values for the calibration.
- Press ENTER.

**Options\...\Factor**

- Enter the factor for the linear calibration.
- Press ENTER.

**Options\...\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, before the calculation of the derived quantities it will be corrected as follows:

$$v_{cor} = 1.1 \cdot 5$ m/s - 0.1 m/s = 5.4 m/s$$

**Example**

- factor: -1
- offset: 0

Only the sign of the measured values changes.

**Notice!**

The correction data will not be stored until a measurement is started.
If the transmitter is switched off without starting a measurement, the entered correction data will be lost.
13.3.3 Transducer temperature and transducer temperature violation as diagnostic value

When configuring outputs, the list items Diagnostic values and Transducer temp. are available in the menu item Transd. temp. violat. The diagnostic values can either be transmitted via the output of the transmitter or defined as source of the event trigger.

Options\Outputs...\Source item

- Select Diagnostic values as source item.
- Press ENTER.
- Select a list item for the quantity to be output.
- Press ENTER.

Tab. 13.3: Source item Diagnostic values

<table>
<thead>
<tr>
<th>source item</th>
<th>list item</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic values</td>
<td>Transducer temp.</td>
<td>average temperature of both transducers</td>
</tr>
<tr>
<td></td>
<td>Transd. temp. violat.</td>
<td>status information: yes/no</td>
</tr>
</tbody>
</table>
14 Outputs

If the transmitter is equipped with outputs, they have to be configured. For the configuration of the analog output, see section 9.2.6.

The transmitter can also be equipped with digital outputs. A digital output combines the functions of the following outputs:

- binary output (output of binary switching conditions)
- pulse output (integrating output of quantities)
- frequency output (scaled output of flow quantities)

These functions depend on the selected physical quantity.

14.1 Configuration of a digital output as binary output

A digital 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

Assignment of an output

**Options > Outputs**

- Select the list item Outputs.
- Press ENTER.

**Options > Outputs > Digital output B1 (0)**

- Select the output (here: Digital output B1).
- Press ENTER.

If the output has already been activated, it is displayed as follows: Digital output B1 (✓).
14.1 Configuration of a digital output as binary output

**Options\Outputs\Digital output B1\Enable B1**

- 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.

**Assignment of a source item**

**Options\Outputs\...\Source item**

Depending on the selected source item, status or event values can be output.

**Tab. 14.2: Output of status values or event values**

<table>
<thead>
<tr>
<th>source item</th>
<th>status value</th>
<th>event value</th>
</tr>
</thead>
<tbody>
<tr>
<td>physical quantities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow quantities</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fluid properties</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>(Custom. Input 1...4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totalizers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>events</td>
<td>Event trigger</td>
<td>x</td>
</tr>
</tbody>
</table>

- 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**

<table>
<thead>
<tr>
<th>property</th>
<th>switching function</th>
<th>description</th>
</tr>
</thead>
</table>
| Status OK      | NC                 | • valid measured value: binary output is closed  
                  |                    | • invalid measured value: binary output is open |
| (status value) | NO                 | • valid measured value: binary output is open  
                  |                    | • invalid measured value: binary output is closed |
| Idle state     | NO                 | • event occurs: binary output is closed  
                  | (event value)      | • 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 carried out, all binary outputs are open (de-energized), independent of the set switching condition.
Terminal assignment

Options\Outputs\...\Output info

The terminals for the connection of the output are displayed. By pressing \[
\begin{align*}
\text{[} & \text{]} \\
\text{[} & \text{]} \\
\end{align*}
\] further information is displayed.
• Press ENTER.

Output function test

The function of the output can now be tested.
• Connect a multimeter to the output.

Options\Outputs\...\B1 Test signal

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

Options\Outputs\...\B1 Enter test value

• Select a test value.
• Press ENTER.

Tab. 14.4: Output function test – signal

<table>
<thead>
<tr>
<th>test value</th>
<th>description</th>
</tr>
</thead>
</table>
| 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 or Finish to display the next menu item.
• Press ENTER.

Options\Outputs\...\B1 Test signal

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

Options\Outputs\...\B1 Enter test value

• Select a test value.
• Press ENTER.
14 Outputs

FLUXUS G532ST-LT 14.2 Configuration of a digital output as pulse output

Before the activation, the digital output has to be configured.

• Select Digital output.
• Press ENTER.

Assignment of a source item

Options\Outputs\Digital output B1\Source item\Pulse

• Select Pulse as source item.
• Press ENTER.

Options\Outputs\Digital output B1\Source item\Pulse\Pulse +V

• Select a list item (here: Pulse +V).
• Press ENTER.

Tab. 14.5: Output function test – measuring range

<table>
<thead>
<tr>
<th>property</th>
<th>switching function</th>
<th>test value</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status OK (status value)</td>
<td>NC</td>
<td>Status OK</td>
<td>• binary output is energized</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Status error</td>
<td>• binary output is de-energized</td>
</tr>
<tr>
<td>NO</td>
<td>Status OK</td>
<td></td>
<td>• binary output is de-energized</td>
</tr>
<tr>
<td></td>
<td>Status error</td>
<td></td>
<td>• binary output is energized</td>
</tr>
<tr>
<td>Idle state (event value)</td>
<td>NC</td>
<td>Passive</td>
<td>• binary output is energized</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>• binary output is energized</td>
</tr>
<tr>
<td>NO</td>
<td>Passive</td>
<td></td>
<td>• binary output is de-energized</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td></td>
<td>• binary output is energized</td>
</tr>
</tbody>
</table>

Options\Outputs\Digital output

• Select Repeat to repeat the test or 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 is restarted as soon as the pulse is emitted. Before the activation, the digital output has to be configured.
14 Outputs
14.2 Configuration of a digital output as pulse output

14.2.1 Pulse output by defining the pulse value

*Select the list item Pulse value.*

*Press ENTER.*

*Select a mode.*

*Press ENTER.*

<table>
<thead>
<tr>
<th>mode</th>
<th>description</th>
</tr>
</thead>
</table>
| Continuous pulses | • output of a continuous pulse sequence, reproducing the temporal behavior of the corresponding flow quantity (volumetric flow rate, mass flow rate), at simultaneous totalizing  
|                | • smallest pulse break = 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 arise intermittently with equidistant pulse distances (pulse break = pulse width)  
|                | • serves exclusively for totalizing  
|                | • max. pulse rate (depends on the pulse width that is constant)  |

*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.*

*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.*

---

Tab. 14.6: Selection of the physical quantity

<table>
<thead>
<tr>
<th>source item</th>
<th>list item</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse</td>
<td>Pulse</td>
<td>pulse without considering the sign of the volumetric flow rate</td>
</tr>
<tr>
<td>Pulse +V</td>
<td>Pulse +V</td>
<td>pulse for positive measured values of the volumetric flow rate</td>
</tr>
<tr>
<td>Pulse -V</td>
<td>Pulse -V</td>
<td>pulse for negative measured values of the volumetric flow rate</td>
</tr>
<tr>
<td>Pulse</td>
<td>Pulse</td>
<td>pulse without considering the sign of the mass flow rate</td>
</tr>
<tr>
<td>Pulse +m</td>
<td>Pulse +m</td>
<td>pulse for the positive measured values of the mass flow rate</td>
</tr>
<tr>
<td>Pulse -m</td>
<td>Pulse -m</td>
<td>pulse for the negative measured values of the mass flow rate</td>
</tr>
</tbody>
</table>
14.2.2 Pulse output by defining pulses per unit

- Select the list item Pulses per unit.
- Press ENTER.

- 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.

- 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

- Select the setting of the idle state:

<table>
<thead>
<tr>
<th>setting</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>The pulse output is energized if a pulse is emitted and de-energized if no pulse is emitted (idle state).</td>
</tr>
<tr>
<td>NC</td>
<td>The pulse output is de-energized if a pulse is emitted and energized if no pulse is emitted (idle state).</td>
</tr>
</tbody>
</table>

Terminal assignment

The terminals for the connection of the output are displayed.

By pressing or further information is displayed.
- Press ENTER.

Output function test

- Select Yes to test the status of the output signal. Select No to display the next menu item.
- Press ENTER.
14 Outputs
14.3 Configuration of a digital output as frequency output

Tab. 14.7: Output function test – signal

<table>
<thead>
<tr>
<th>output mode</th>
<th>test value</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulses per unit</td>
<td>The entered test value has to be within the output range.</td>
<td>If the external measuring instrument displays the entered value, the output functions correctly.</td>
</tr>
<tr>
<td>Pulse value</td>
<td>NO</td>
<td>• pulse output is de-energized</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• measured value has to be high ohmic</td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>• pulse output is energized</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• measured value has to be low ohmic</td>
</tr>
</tbody>
</table>

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 source item sent to the output.

Assignment of a source item

Options\Outputs\Digital output B1\Source item

• Select a list item.
• Press ENTER.

Options\Outputs\Digital output B1\Source item\...\Volumetric flow rate

• Select a list item (here: Volumetric flow rate).
• Press ENTER.
• Select the list item Values.
• Press ENTER.
• Pass the menu item Options\...\Outputs with following menu items in its entirety:
  – output range
  – error value
  – measuring range
  – output info
  – function test
For the description of the individual steps, see section 9.2.6.
15 Inputs
The inputs are configured in the program branch Special functions and assigned in the program branch Options.

15.1 Configuration of an input

If the transmitter is equipped with inputs, they have to be configured.

• Select the program branch Special functions.
• Press ENTER.

The scroll list contains all available inputs.

• Select a list item:
  - 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)

• Select Yes to enable an input or change the settings for an already enabled input.
• Select No to uninstall 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 now be selected and the input and measuring range is defined.

Selection of the source item

• Select the source item.

Input range
Now the input range is defined.

• 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

• Enter the lowest expected measured value. The unit of measurement of the source item will be displayed. 
  Start of meas. range is the physical quantity assigned to the lower limit of the input range (Input MIN).
• Enter the highest expected measured value. The unit of measurement of the source item will be displayed. 
  End of meas. range is the physical quantity assigned to the higher limit of the input range (Input MAX).

Input of an 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.

15.1.2 Temperature inputs

When configuring the temperature input, the temperature probe can now be selected.

Selection of the temperature probe

• 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 Special version\Dialogs/Menus.

• 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

• Enter the offset for the temperature input.
• Press ENTER.
15.1.3 Definition of a switching condition

If a transmitter function is to be performed by remote control, a switching condition has to be defined.

Select Yes if a switching condition is to be defined. Select No to display the next menu item.

Press ENTER.

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.

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.

Enter the 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.

Enter the center of the switching range.
Press ENTER.

This display will only be indicated if Within range or Out of range is selected.

Enter the width of the switching range.
Press ENTER.

This display will only be indicated if Within range or Out of range is selected.

Enter a time interval at the end of which the event trigger has to switch.
Press ENTER.
15 Inputs
15.2 Assignment of an input

15.1.4 Terminal assignment

The terminals for the connection of the input are displayed.
By pressing further information is displayed.
• Press ENTER.

15.1.5 Function test of the input

The function of the installed input can now be tested.

Analog input
• Connect the signal source to the input.

15.2 Assignment of an input

• Select the menu item Assign inputs.
• Press ENTER.
• Select a list item. Only the installed inputs are displayed in the scroll list.
• Select the list item No linkage if no input is to be assigned.
• Press ENTER.
The transmitter has a data logger which stores the measured values 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 the 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

#### Starting time

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 **Configuration**.
- Press ENTER until the menu item **Start storing** is displayed.
- Select the moment at which to start the storing.

<table>
<thead>
<tr>
<th>display</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately</td>
<td>The storing starts immediately.</td>
</tr>
<tr>
<td>Full 5 minutes</td>
<td>The storing starts in the next full 5 minutes.</td>
</tr>
<tr>
<td>Full 10 minutes</td>
<td>The storing starts in the next full 10 minutes.</td>
</tr>
<tr>
<td>Full 15 minutes</td>
<td>The storing starts in the next full 15 minutes.</td>
</tr>
<tr>
<td>Full 30 minutes</td>
<td>The storing starts in the next full 30 minutes.</td>
</tr>
<tr>
<td>Full hour</td>
<td>The storing starts in the next full 60 minutes.</td>
</tr>
<tr>
<td>Event-based</td>
<td>The storing starts when a defined event occurs.</td>
</tr>
</tbody>
</table>
16  Data logger
16.1  Configuration of the data logger FLUXUS G532ST-LT

Event-based starting time

If it is necessary to start the storing of measured values at a particular event, select 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 through which the event is to be signalized.
• Press ENTER.

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.

• Select in the scroll list a storage rate for storing the measured values in case the event occurs.
• Press ENTER.

The storage rate is the frequency to transmit or store measured values.

• Enter the time interval for the measured values to be stored before the event occurs.
• Press ENTER.

• Enter the time interval for the measured values to be stored if the event is no longer activated.
• Press ENTER.

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.
Storage rate

The storage rate is the frequency to transmit or store measured values. If a start time for storing the measured values is defined, a storage rate has to be entered.

- Select the menu item 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 at which the measured values are stored in the FastFood mode.

This display will only be indicated if the FastFood mode has been activated in the menu item Special functions\Measurement\Measurement modes.

- Select the menu item Configuration.
- Press ENTER until the menu item Storage rate FastF is displayed.
- Select Automatic if the storage rate has to correspond to the value of 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

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. 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 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

• Select the menu item 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 temperature) will be calculated.
If a storage rate < 5 s is selected, Sample will be used.
If no average could be calculated over the complete storage interval, the value will be 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. 16.1: Parameters for storing

<table>
<thead>
<tr>
<th>display</th>
<th>description of the parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store totalizers</td>
<td>values of the totalizers</td>
</tr>
<tr>
<td>Store diagnost. values</td>
<td>diagnostic values</td>
</tr>
<tr>
<td>Store transd. temp.</td>
<td>transducer temperature</td>
</tr>
</tbody>
</table>

• Select Yes to store the value. Select No in order not to store the value.

16.2 Deletion of the data logger

• Select the menu item Delete meas. values.
• Press ENTER.
• Select Yes or No.
• Press ENTER.
16.3 Information regarding the data logger

• Select the menu item Data logger info.
• Press ENTER.
The following information regarding the data logger is displayed:

<table>
<thead>
<tr>
<th>display</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activated:</td>
<td>data logger is activated/deactivated</td>
</tr>
<tr>
<td></td>
<td>This display will only be indicated if the measurement has started and the data logger is activated.</td>
</tr>
<tr>
<td>Full (date)</td>
<td>date on which the data logger will be full</td>
</tr>
<tr>
<td></td>
<td>This display will only be indicated if the measurement has started and the ringbuffer is deactivated.</td>
</tr>
<tr>
<td>Full (time)</td>
<td>time at which the data logger will be full</td>
</tr>
<tr>
<td></td>
<td>This display will only be indicated if the measurement has started, the ringbuffer is deactivated and the data logger is not full yet.</td>
</tr>
<tr>
<td>Overflow (date)</td>
<td>date from which the oldest measured values will be overwritten</td>
</tr>
<tr>
<td></td>
<td>This display will only be indicated if the measurement has started, the ringbuffer is activated and the data logger is not full yet.</td>
</tr>
<tr>
<td>Capacity (time)</td>
<td>remaining data logger capacity</td>
</tr>
<tr>
<td></td>
<td>This display will only be indicated if the measurement has started and the ringbuffer is activated.</td>
</tr>
<tr>
<td>Ringbuffer:</td>
<td>ringbuffer is activated/deactivated</td>
</tr>
<tr>
<td>Meas. val. series:</td>
<td>number of stored series of measured values</td>
</tr>
<tr>
<td>Occup. logger:</td>
<td>percentage of memory actually used</td>
</tr>
</tbody>
</table>

16.4 Print of measured values

• Start the terminal program.
• Enter the transmission parameters into the terminal program. The transmission parameters of the terminal program and the transmitter have to be identical.

• Select the menu item Print meas. values.
This display will only be indicated if the transmitter has an interface RS485.
• Press ENTER.
16.5 Transmission settings

- Select the menu item Transmission settings.
  This display will only be indicated if the transmitter has an interface RS485.
- Press ENTER.

- Select On if the space characters are not to be transmitted.
- Press ENTER.
  The file size will be considerably reduced (shorter transmission time).

- Select the decimal marker to be used for floating-point numbers (point or comma).
- Press ENTER.
  This setting depends on the setting of the PC operating system.

- Select the character to be used to separate columns (semicolon or tabulator).
- Press ENTER.

- Select Yes to transmit time and date.
- Press ENTER.
17 Data transmission
The data is transmitted via the service interface (USB) or the process interface (option) of the transmitter.

17.1 Service interfaces
By means of the program FluxDiagReader it is possible to transmit via service interfaces (USB, LAN) data to the PC.
The following tasks can be carried out:
• read and store measured values, setup settings and snaps
• graphically display measured values
• export of data in csv format
For the operation of FluxDiagReader see the help function of this program.

17.1.1 LAN interface
In order to use the LAN interface it is important to enter the network parameters.
• Select the program branch Special functions.
• Press ENTER.

Manual input
• Select Manual to enter the network parameter (IP address, subnet mask and standard gateway).

Notice!
The entered network parameters have to accord with the network parameters of the LAN.

Default values in the transmitter:
– IP address: 192.168.0.70
– subnet mask: 255.255.255.0
– standard gateway: 192.168.0.1

Automatic addressing with DHCP
• Select Automatic to automatically identify the network parameters (IP address, subnet mask and gateway address) via a DHCP server.

Notice!
The network parameters can only be automatically identified if the LAN supports DCHP.

• Select the menu item Special functions\Communication\Network\Show auto config. to display the identified network parameters.
• Press ENTER.

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

RS485 interface

- Select the menu item RS485 to change the settings of the transmission parameters.
- Press ENTER.

This display will only be indicated if the transmitter has an interface RS485.

Default: 9600 bit/s, 8 data bits, no parity, 1 stop bit
- Set the transmission parameters in the scroll lists.
  - Baud (baud rate)
  - Data bits
  - Stop bits
  - Parity
  - Data flow control
- Press ENTER.

The terminals for the connection of the RS485 interface are displayed.
- Press ENTER.
18 Advanced functions

18.1 Totalizers

The total volume or total mass of the fluid at the measuring point can be determined. There are 2 totalizers, one for the positive and the other for the negative flow direction. The unit of measurement used for totalizing corresponds to the volume or mass unit selected for the physical quantity. The totalizer values can be displayed in the status line during the measurement.

• Press and hold CLR until the menu item **Execute command** is displayed:

<table>
<thead>
<tr>
<th>Measurement \ Execute command \ Totalizers</th>
</tr>
</thead>
</table>

• Select the list item **Totalizers**.
• Press ENTER.

The following scroll list appears:

<table>
<thead>
<tr>
<th>display</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start totalizers</td>
<td>start and stop totalizer</td>
</tr>
<tr>
<td>Reset totalizers</td>
<td>reset the totalizer to zero</td>
</tr>
<tr>
<td>Freeze display</td>
<td>display the measured value of the totalizer for several seconds</td>
</tr>
<tr>
<td>Reset error</td>
<td>reset the totalizer error</td>
</tr>
<tr>
<td>Stop/clear totalizers</td>
<td>stop totalizer and reset it to zero</td>
</tr>
</tbody>
</table>

By pressing → or ↓, the totalizers for the positive and the negative flow direction can be displayed during the measurement.

18.1.1 Number of decimal places

The values of the totalizers can be displayed with up to 11 places, e.g., 74890046.03. The number of decimal places (max. 4) can be defined.

<table>
<thead>
<tr>
<th>Special functions \ Totalizers</th>
</tr>
</thead>
</table>

• Select the menu item **Totalizers** in the **program branch** **Special functions**.
• 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.

<table>
<thead>
<tr>
<th>max. value</th>
<th>display</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10^6</td>
<td>±0.000</td>
</tr>
<tr>
<td>&lt; 10^7</td>
<td>±100000.00</td>
</tr>
<tr>
<td>&lt; 10^8</td>
<td>±1000000.0</td>
</tr>
<tr>
<td>&lt; 10^10</td>
<td>±100000000</td>
</tr>
<tr>
<td></td>
<td>±999999.99</td>
</tr>
<tr>
<td></td>
<td>±99999999.9</td>
</tr>
<tr>
<td></td>
<td>±999999999.9</td>
</tr>
</tbody>
</table>

• 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.
18 Advanced functions
18.1 Totalizers

18.1.2 Detection of long measurement failures
If there are no valid measured values during a long time interval, the totalizers remain unchanged. Behind this value an interrogation point will be displayed.

The time interval can be defined.

• Select the menu item Totalizers in the program branch Special functions.
• Press ENTER until the menu item Totalizer timeout is displayed.
• Select Default if no customized inputs are to be carried out and the default value of 30 s is to be used.
• Press ENTER.
• Select Customized if the time interval is to be defined.
• Press ENTER.
• Enter the time interval.
• Press ENTER.

18.1.3 Totalizer overflow
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 ($\pm 1.00000E10$), if necessary. The totalizer can only be reset to zero manually.

With overflow
The totalizer will be automatically reset to zero when reaching $\pm 9999999999$.

<table>
<thead>
<tr>
<th>decimal places</th>
<th>max. value</th>
<th>max. display</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$&lt; 10^0$</td>
<td>±9999999999</td>
</tr>
<tr>
<td>1</td>
<td>$&lt; 10^1$</td>
<td>±99999999.9</td>
</tr>
<tr>
<td>2</td>
<td>$&lt; 10^7$</td>
<td>±999999.99</td>
</tr>
<tr>
<td>3</td>
<td>$&lt; 10^6$</td>
<td>±99999.999</td>
</tr>
<tr>
<td>4</td>
<td>$&lt; 10^5$</td>
<td>±99999.9999</td>
</tr>
</tbody>
</table>

Notice!
The number of decimal places and the max. value of the totalizers only affect the display.

18.1.2 Detection of long measurement failures
If there are no valid measured values during a long time interval, the totalizers remain unchanged. Behind this value an interrogation point will be displayed.

The time interval can be defined.

• Select the menu item Totalizers in the program branch Special functions.
• Press ENTER until the menu item Totalizer timeout is displayed.
• Select Default if no customized inputs are to be carried out and the default value of 30 s is to be used.
• Press ENTER.
• Select Customized if the time interval is to be defined.
• Press ENTER.
• Enter the time interval.
• Press ENTER.

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With overflow
The totalizer will be automatically reset to zero when reaching $\pm 9999999999$.

<table>
<thead>
<tr>
<th>decimal places</th>
<th>max. value</th>
<th>max. display</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$&lt; 10^0$</td>
<td>±9999999999</td>
</tr>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>$&lt; 10^7$</td>
<td>±999999.99</td>
</tr>
<tr>
<td>3</td>
<td>$&lt; 10^6$</td>
<td>±99999.999</td>
</tr>
<tr>
<td>4</td>
<td>$&lt; 10^5$</td>
<td>±99999.9999</td>
</tr>
</tbody>
</table>

Notice!
The number of decimal places and the max. value of the totalizers only affect the display.
18.1.4 Totalizer behavior after the measurement is stopped

It is possible to define the totalizer behavior after the measurement is stopped or after a reset of the transmitter.

- Select the menu item Totalizers in the program branch Special functions.
- Press ENTER until the menu item Keep totalizers is displayed.
- Select Yes if the values of the totalizers are to be stored and used for the next measurement. Select No if the totalizers are to be set to zero.
- Press ENTER.

18.1.5 Totalizer sum

The sum of the totalizers for both flow directions can be displayed in the status line during the measurement.

- Select the menu item Totalizers in the program branch Special functions.
- Press ENTER until the menu item Show ΣQ is displayed.
- Select Yes to display the totalizer sum. Select No if it is not to be displayed.
- Press ENTER.

18.1.6 Totalizer storing

The totalizer values can be stored now.

- Select the menu item Special functions\Data logger\Configuration.
- Press ENTER until the menu item Store totalizers is displayed.
- Select Yes.
- Press ENTER.

18.2 FastFood mode

The FastFood mode allows to measure highly dynamic flows. A continuous adaptation to changing measuring conditions is only partially realized in the FastFood mode.

- The sound speed of the fluid is not updated. The last measured value of the sound speed before toggling to the FastFood mode is used.
- The outputs can still be used. They are updated synchronously with the FastFood measuring rate, independently from the storage rate.
- The measured values are stored with the storage rate of the FastFood mode.
- The FastFood mode has to be enabled and activated.

18.2.1 Enabling/disabling the FastFood mode

- Select the menu item 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 in which interval measured values are transmitted to the process outputs.

- Select Default if no customized inputs are to be made (default: 50 ms).
- Select Customized if a value for the FastFood measuring rate is to be entered.
- Enter a value within the range 20...200 ms.
- Press ENTER.
18.2.2 Storage rate of the FastFood mode
The storage rate for the FastFood mode is entered during the configuration of the data logger in the menu item Storage rate FastF.

- Select the menu item Configuration.
- Press ENTER until the menu item Storage rate FastF is displayed.
- Select Automatic if the storage rate has to correspond to the value of the FastFood measuring rate.
- Press ENTER.
- Select Customized if the value for the storage rate is to be defined.
- Press ENTER.
- Enter a value.
- Press ENTER.

18.2.3 Activation/deactivation of the FastFood mode
If the FastFood mode is enabled and a measurement has been started, the normal measuring mode runs at first.

- Press and hold CLR until the menu item Execute command is displayed:

- Select the list item Measuring mode.
- Press ENTER.
- Select the list item FastFood to activate/deactivate the FastFood mode. The symbol for the FastFood mode appears in the upper line.
- Press ENTER.

The FastFood mode can also be activated/deactivated via a remote function.

18.3 Diagnosis with the help of the snap function

18.3.1 Configuration
By means of the snap function it is possible to store measuring parameters which are useful for the evaluation of measuring results or for diagnostic purposes. In order to use of the snap function it has to be configured.

- Select the menu item Configuration.
- Press ENTER.

- Select On to activate the snap function.
- Press ENTER.

- Select Yes to activate the snap ringbuffer.

If the snap ringbuffer is activated, after taking the 51th, snap the oldest snaps are overwritten. If the ringbuffer is deactivated, up to 50 snaps can be stored.
- Press ENTER.
• Select Yes if the auto snap has to be activated.
If the auto snap is activated, snaps are automatically stored during a measurement failure.
• Press ENTER.

• Select Yes if an event that releases a snap has been parameterized for the event trigger R1.
• Press ENTER.

### 18.3.2 Taking 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 will be taken.

### 18.3.3 Information concerning snaps

• Select the menu item **Snap info**.
• Press ENTER.

The following information is displayed:

<table>
<thead>
<tr>
<th>display</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stored snaps</td>
<td>number of stored snaps</td>
</tr>
<tr>
<td>Snaps left</td>
<td>number of snaps that can still be stored</td>
</tr>
<tr>
<td>Ringbuffer</td>
<td>snap ringbuffer activated</td>
</tr>
</tbody>
</table>

### 18.3.4 Deletion of snaps

• Select the menu item **Delete snaps**.
• Press ENTER.
• Select Yes or No.
• Press ENTER.
18.4 Modification of the limit for the inner pipe diameter

It is possible to modify the lower limit of the inner pipe diameter for a given transducer type.

- Select the program branch Special functions.
- Press ENTER.

Special functions\Pipe diameter MIN

- Select Pipe diameter MIN.
- Press ENTER.

It is possible to define a min. pipe diameter for all relevant transducer frequencies.

- Select Default if no customized inputs are to be made and the default values are to be used.
- Press ENTER.
- Select Customized if a min. pipe diameter is to be defined.
- Press ENTER.
- Enter the pipe diameter in mm.
- Press ENTER.

Notice!

If a transducer is used below its recommended inner pipe diameter, a measurement might be impossible.

18.5 Remote functions

Remote functions can be triggered by triggerable analog inputs or event triggers.

In order to define an input for a remote function, it has to be enabled in the menu item Special functions\Inputs.

In order to define an event trigger for a remote function, it has to be enabled in the menu item Options\Event trigger.

It is possible to trigger one or more of the following remote functions:

- reset of measured values
- reset of totalizers
- stop of totalizers
- activation of the FastFood mode

**Triggerable inputs and event triggers**

The remote function is triggered if the switching condition is met. The remote function is reset as soon as the switching condition is not longer met.
18.5.1 Configuration of the remote function

Options\Remote functions

- Select the menu item Options\Remote functions.
- Press ENTER.

In the scroll list of the functions it is displayed whether, and if so, which input or event trigger is assigned to a function.
- Select a list item:
  - Reset meas. val. (-)
  - Reset totalizers (-)
  - Stop totalizers (-)
  - Activate FastF(-)

If an input or event trigger has already been assigned to this function, this is displayed as follows: Reset meas. val. (R1).
- Press BRK to return to the previous menu.

Reset of measured values
- Select the list item Reset meas. val.
- Press ENTER.

The measured value output 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 quantity derived from the flow velocity also yield zero.

The transmitter continues the measurement if the condition of the remote function is no longer met.
- Select the input which is to be used to trigger the selected remote function.
- Press ENTER.
- Select No linkage in order to deactivate the remote function.
- Press ENTER.

Reset of totalizers
- Select the list item Reset totalizers.
- Press ENTER.

The totalizers are set to zero. The totalizers are 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.
When the totalizers are reset to zero with the remote function, the character H is displayed next to the measured value during the measurement.
- Select the input which is to be used to trigger the selected remote function.
- Press ENTER.
- Select No linkage in order 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 be continued with the last registered totalizer value if the condition of the remote function is no longer met.
- Select the input which is to be used to trigger the selected remote function.
- Press ENTER.
- Select No linkage in order 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 was activated in menu item **Special functions\Measurement\Measurement modes\FastFood**.

• Select the input which is to be used to trigger the selected remote function.
• Press ENTER.
• Select **No linkage** in order to deactivate the remote function.
• Press ENTER.

### 18.6 Event triggers

It is possible to configure max. 4 independent event trigger R1, R2, R3, R4.

The event triggers can be used, e.g., to:
- output information about the running measurement
- trigger special remote functions
- switch on/off pumps and motors

• Select the program branch **Options**.
• Press ENTER.

• Select the event trigger.
If an event trigger has already been installed, it is displayed as follows: **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.

• Select the source item (physical quantity) for which a condition has to be defined.

### Tab. 18.1: Source items

<table>
<thead>
<tr>
<th>source item</th>
<th>list item</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow quantities</td>
<td>Flow velocity</td>
<td>flow velocity</td>
</tr>
<tr>
<td></td>
<td>Operation vol. flow</td>
<td>operating volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Norm vol. flow rate</td>
<td>standard volumetric flow rate</td>
</tr>
<tr>
<td></td>
<td>Mass flow rate</td>
<td>mass flow rate</td>
</tr>
</tbody>
</table>
Afterwards the properties of the event trigger are defined.

<table>
<thead>
<tr>
<th>Tab. 18.1: Source items</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>source item</strong></td>
</tr>
<tr>
<td>Totalizers</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fluid properties</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Diagnostic values</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>This display will only be indicated if Pig detection is activated.</td>
</tr>
<tr>
<td>Miscellaneous</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sound speed</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Tab. 18.2: Properties of the event trigger

<table>
<thead>
<tr>
<th>property</th>
<th>setting</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function (switching condition)</td>
<td>MAX (x&gt;limit)</td>
<td>The event trigger switches when the measured value exceeds the upper limit.</td>
</tr>
<tr>
<td></td>
<td>MIN (x&lt;limit)</td>
<td>The event trigger switches when the measured value falls below the lower limit.</td>
</tr>
<tr>
<td></td>
<td>ERR (x=fail)</td>
<td>The event trigger switches when a measurement is not possible.</td>
</tr>
<tr>
<td></td>
<td>Within range</td>
<td>The event trigger switches when the measured value is within the defined range.</td>
</tr>
<tr>
<td></td>
<td>Out of range</td>
<td>The event trigger switches when the measured value is outside the defined range.</td>
</tr>
<tr>
<td>Type (holding behavior)</td>
<td>Non-hold</td>
<td>When the switching condition is no longer met, the event trigger returns to the idle state after approx. 1 s.</td>
</tr>
<tr>
<td></td>
<td>Hold</td>
<td>The event trigger remains activated even when the switching condition is no longer met.</td>
</tr>
<tr>
<td></td>
<td>Hold for a while</td>
<td>The event trigger remains activated during a defined time even when the switching condition is no longer met.</td>
</tr>
</tbody>
</table>

Definition of the switching condition

Options\Event trigger\Rx Enable\Source item\...

- Select the switching condition.
- Press ENTER.

Definition of the holding behavior

Options\Event trigger\Rx Enable\Source item\...

- Select the type of the holding behavior.
- Press ENTER.

Definition of trigger limits

Options\Event trigger\Rx Enable\Source item\...

The limits are to be entered at which the event trigger has to switch.
- Enter the upper limit MAX (x>limit).
- Press ENTER.
- Enter the lower limit MIN (x<limit).
- Press ENTER.

Options\Event trigger\Rx Enable\Source item\...

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 the value for the hysteresis.
If zero is entered, no hysteresis is used.
- Press ENTER.
18.6.1 Apparent switching delay
The measured values and totalizer values will be displayed rounded according to the set number of decimal places. The limits, however, will be compared to the non-rounded measured values. This might cause an apparent switching delay when the measured value changes marginally (less than the visualized decimal places). In this case, the switching accuracy of the event trigger is higher than the accuracy of the display.

18.6.2 Reset and initialization of the event triggers
After an initialization of the transmitter all event triggers are deactivated. Event triggers whose switching condition is still met will be activated again after 1 s. This function is used to reset event triggers of the type HOLD if the switching condition is no longer met. If a measurement is stopped, all event triggers will be deactivated and the corresponding process outputs will be de-energized, independently of the programmed idle state.
18.6.3 Event trigger during the measurement

An event trigger with the switching condition \( \text{MAX}\ (x>\text{limit}), \text{MIN}\ (x<\text{limit}), \text{Within range} \) or \( \text{Out of range} \) is updated max. once per second to avoid a 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 \( \text{ERR}\ (x=\text{fail}) \) is activated during a measurement failure.

An event trigger of the type \emph{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 the type \emph{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 the type \emph{Hold for a while} is activated when the switching condition is met. The time after which the deactivation takes place is defined in the menu item \emph{Hold interval}.

18.6.4 Status display of the event triggers

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
\textbf{no.} & \textbf{Function (switching condition)} & \textbf{Type (holding behavior)} & \textbf{current state} \\
\hline
R & = & & \\
1 & \uparrow \quad \text{MAX}\ (x>\text{limit}) & \downarrow \quad \text{Non-hold} & \quad \text{deactivated (false state)} \\
2 & \downarrow \quad \text{MIN}\ (x<\text{limit}) & \uparrow \quad \text{Hold} & \quad \text{activated (true state)} \\
3 & \quad \text{Within range} & \quad \text{Hold for a while} & \\
4 & \quad \text{Out of range} & \quad \text{ERR}\ (x=\text{fail}) & \\
\hline
\end{tabular}
\end{table}

\textbf{Example}

\( R_1 = \uparrow \quad \downarrow \quad 1 \)
18.7 Event protocol

If an error occurs, an error message will be displayed in the first line indicating the symbol △. The error message can be displayed via the menu item Event log.

- Select the menu item Event log.
- Press ENTER.

A list is displayed containing all error messages since the last time the transmitter was switched on.
- Press ▼ to select an error message.
- Press ENTER.

The display indicates the cause of the error.

Notice!

After reading out the event protocol the error message symbol will be deleted on the display, even if the error has not been eliminated yet.

The event protocol will be deleted after a restart of the transmitter.
19 Settings

19.1 Dialogs and menus

Special functions\Dialogs/Menus

• Select the menu item Dialogs/Menus in the program branch Special functions.
• Press ENTER.

Pipe circumference

Special functions\Dialogs/Menus\Pipe circumference

• Select the menu item Pipe circumference.
• Select Yes if the pipe circumference is to be entered instead of the pipe diameter in the program branch Parameters.
• Press ENTER.
If Yes is selected for Pipe circumference, the outer pipe diameter will still be requested in the program branch Parameters.
• Enter zero. The menu item Pipe circumference will be displayed.
• Press ENTER.
The value displayed in the menu item Pipe circumference is calculated from the last displayed outer pipe diameter.
Example: 100 mm \( \pi = 314.2 \) 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 program branch Parameters, the outer pipe diameter that corresponds to the entered pipe circumference will be displayed.
Example: 180 mm \( \pi = 57.3 \) mm

Coating

If the pipe has a coating, the material parameters of the coating have to be entered in the program branch Parameters.

Special functions\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 coating have to be entered in the program branch Parameters.

Special functions\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

Special functions\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.

- 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

- 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

- 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 program branch Measurement, the recommended transducer distance will be displayed in parenthesis, below the entered transducer distance.

Sound speed of the reference fluid

- Press ENTER until the menu item Compare c fluid is displayed.
Select Yes if the difference $\Delta c = c_{\text{mea}} - c_{\text{stored}}$ between the two sound speeds has to be displayed. $c_{\text{ref}}$ is the calculated sound speed of the reference fluid at same process conditions (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 $\downarrow$ during the measurement to scroll to the display of $\Delta c$.

Display of the 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. Behind this value an interrogation point will be displayed.

Primary display value

- Press ENTER until the menu item Primary display value is displayed.
- Select Flow quantity to display the selected physical quantity value 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

• Press ENTER until the menu item Light autom. off is displayed.
• Select Yes to activate the automatic switch-off.
• 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 Measuring modes

• Select the menu item Measurement in the program branch Special functions.
• Press ENTER.
• Select the menu item Measurement modes.
• Press ENTER.

Gas measurement

• Select On to activate the gas measurement or Off to deactivate it.
• Press ENTER.

• Enter the temperature according to the local and valid reference conditions (default: 0 °C).
• Press ENTER.

• Enter the pressure according to the local reference conditions (default: 1.01325 bar(a)).
• Press ENTER.

FastFood mode

• Select On to enable the FastFood mode. Select Off to disable it.
• Press ENTER.
19.3 Measurement settings

• Select the menu item Measurement in the program branch Special functions.
• Press ENTER.
• Select the menu item Measurement settings.
• Press ENTER.

Multi-point calibration
A multi-point calibration allows a very precise output of measuring results. It is based on calibration curves of series of measured values

• Select the menu item Multi-point calibration.
• Select On to activate the multi-point calibration. Select Off to deactivate it (default: Off).
• Press ENTER.

If On is selected, a series of measured values has to be entered in the program branch Options.

Swift damping
If Swift damping is activated, each displayed measured value is a floating average of the last x seconds, with x being the damping factor. The display thus takes 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 form of an exponential time course in the measuring result.

• Select the menu item Swift damping.
• Select Off to deactivate the swift damping. Select On to activate 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 through the transmitter without any time lag.

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

• Select the menu item Dynamic damping.
• Select On to activate the dynamic damping and Off to deactivate it (default: Off).
• Press ENTER.

If On is selected, the dynamic damping has to be parameterized in the menu item Options\Measurement\Dynamic damping.
19.4 Units of measurement

It is possible to set the global units of measurement for length, temperature, pressure, sound speed, density and kinematic viscosity.

**Special functions\Units of measurement**

- Select the menu item Units of measurement.
- Press ENTER.
- Select a unit of measurement for all quantities.
- Press ENTER.

**Special functions\Units of measurement\Unit prefix**

For better differentiation between the operating volumetric flow rate and the standard volumetric flow rate, the units of measurement can be displayed with a prefix. The unit of measurement of the operating volumetric flow rate is displayed with an A, the unit of measurement of the standard volumetric flow rate with an N or S.

- Select a list item for the setting of the prefix.
- Press ENTER.

**Special functions\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 operating volumetric flow rate.

- Select a barrel type.
- Press ENTER.

19.5 Material and fluid scroll list

At delivery, all stored materials and fluids are displayed in the corresponding lists in the menu item Parameters\Pipe material or Parameters\Fluid.

For the sake of clarity, materials and fluids can be removed from the scroll list. Removed materials and fluids can be added at any time.

**Adding or removing materials/fluids**

- Select the menu item Special functions\Libraries\Use material list.
- Press ENTER.

**Special functions\Libraries\Use material list**

- Select Yes if a material is to be added or removed from the material scroll list.
- Press ENTER.
- Press ↓ to scroll through the list.
- Press + to add (+) or remove (-) a material.
- Press ENTER.

Similarly, the fluid scroll list can be adapted (Special functions\Libraries\Use fluid list).

**Adding all materials/fluids**

- Select the menu item Special functions\Libraries\Use material list.
- Press ENTER.

**Special functions\Libraries\Use material list**

- Select No if all materials are to be displayed in the material scroll list.
- Press ENTER.

Similarly, the fluid scroll list can be adapted (Special functions\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 max. 20 parameter records.

### Notice!

No parameter records are stored in the delivery state. Parameter records have to be entered manually.

The parameters have first to be entered in the program branches Parameters, Options and Special functions. Afterwards, they can be stored as parameter record.

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

### 19.6.2 Load of a parameter record

Stored parameter records can be loaded and used for measurement.

- 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

- Select the menu item Delete param. record.
- Press ENTER.
- Select the parameter record to be deleted.
- Press ENTER.
19.7 Contrast settings

Special functions\System settings\Display contrast

• Select the menu item System settings in the program branch Special functions.
• Press ENTER.
• Select the menu item Display contrast.
• Press ENTER.
The display contrast can be adjusted with the following keys:

increase contrast
CLR reduce contrast

• Press ENTER.

Notice!

After an initialization of the transmitter, the display is reset to medium contrast.

19.8 HotCodes

Special functions\System settings\HotCode

• Select the menu item System settings in the program branch Special functions.
• Press ENTER.
• Select the menu item HotCode.
• Press ENTER.
• Enter the HotCode via the keyboard. For the input of numbers see section 4.4.
• Press ENTER.

<table>
<thead>
<tr>
<th>function</th>
<th>HotCode</th>
</tr>
</thead>
<tbody>
<tr>
<td>display setting to medium contrast</td>
<td>555000</td>
</tr>
<tr>
<td>language selection</td>
<td>9090xx</td>
</tr>
<tr>
<td>initialization</td>
<td>909000</td>
</tr>
<tr>
<td>activation/deactivation of the flow direction detection</td>
<td>007026</td>
</tr>
<tr>
<td>activation/deactivation of the pig detection</td>
<td>007028</td>
</tr>
<tr>
<td>select customized natural gas</td>
<td>007029</td>
</tr>
<tr>
<td>display of totalizers in the lower line as well</td>
<td>007032</td>
</tr>
</tbody>
</table>
Language selection

The language selection can either be carried out in the program branch Special functions or by entering a HotCode:

<table>
<thead>
<tr>
<th>language</th>
<th>HotCode</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>909044</td>
</tr>
<tr>
<td>German</td>
<td>909049</td>
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<tr>
<td>French</td>
<td>909033</td>
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<td>Spanish</td>
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<td>Russian</td>
<td>909007</td>
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<td>Polish</td>
<td>909048</td>
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<td>Turkish</td>
<td>909090</td>
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<tr>
<td>Italian</td>
<td>909039</td>
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</tbody>
</table>

After the last digit has been entered, the main menu is displayed in the selected language. The selected language remains activated when the transmitter is switched off and on again.

19.9 Key lock

An ongoing measurement can be protected from an inadvertent intervention by means of a key lock.

Definition of a key lock code

- Select the menu item System settings in the program branch Special functions.
- Press ENTER.
- Select Key lock.
- Press ENTER.
- Enter a 6-digit key lock code. For the input of numbers see section 4.4.
- Press ENTER.

Notice!

Do not forget the key lock code!

Intervention in the measurement

If the key lock is activated, the message Key lock activated will be displayed for a few seconds when pressing a key. In order to interrupt a measurement, the key lock has to be deactivated.

- Press BRK.
- Select Show parameters.
- Press ENTER.
- Deactivate the key lock.
Deactivation of the key lock

- Select the menu item **System settings in the program branch** **Special functions**.
- Press ENTER.

| Special functions | System settings | Key lock |

- Select **Key lock**.
- Press ENTER.
- Enter a 6-digit key lock code. For the input of numbers see section 4.4.
- Press ENTER.

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.

<table>
<thead>
<tr>
<th>measurement not started</th>
<th>measurement started</th>
</tr>
</thead>
<tbody>
<tr>
<td>• parameter input</td>
<td>• settings that can be changed during the measurement (e.g., language selection)</td>
</tr>
<tr>
<td>• modification of settings (e.g., measuring modes)</td>
<td>• triggering of snaps</td>
</tr>
<tr>
<td>• deletion of the data logger</td>
<td>• toggling to FastFood mode</td>
</tr>
<tr>
<td>• date/time settings</td>
<td>• totalizer stop</td>
</tr>
<tr>
<td>• measurement start (start-up)</td>
<td>• totalizer reset</td>
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<td>• measurement stop</td>
</tr>
</tbody>
</table>
## Annex

### A Menu structure

#### Program branches

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Measurement</th>
<th>Options</th>
<th>Special functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer</td>
<td>Measuring point no.</td>
<td>Measurement</td>
<td>System settings</td>
</tr>
<tr>
<td>Outer diameter</td>
<td>Expected max. flow</td>
<td>Units of measurement</td>
<td>Inputs</td>
</tr>
<tr>
<td>Pipe material</td>
<td>Transducer distance A</td>
<td>Outputs</td>
<td>Outputs</td>
</tr>
<tr>
<td>Pipe wall thickness</td>
<td>Barrier distance</td>
<td>Assign inputs</td>
<td>Measurement</td>
</tr>
<tr>
<td>Lining</td>
<td>Transducer distance B</td>
<td>Remote functions</td>
<td>Data logger</td>
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<tr>
<td>Roughness</td>
<td>Parameter search</td>
<td>Event trigger</td>
<td>Snap</td>
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<tr>
<td>Fluid temp.</td>
<td>Measurement</td>
<td>Special settings</td>
<td>Communication</td>
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<td>Fluid pressure</td>
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<td>Extension cable</td>
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</tbody>
</table>
Parameter input

Parameters

Connected trans.

Select transducer

Outer diameter

Pipe material

Pipe wall thickness

Lining

Yes

No

Lining 2

Coating

Roughness

Automatic

Customized

Fluid

Fluid temp.

Fluid pressure

Extension cable

Legend

[1] only if enabled in Special functions\Dialogs/Menus

[2] not always available
Measurement settings

Options

- Measurement
  - Physical quantity
    - Operation vol. flow
    - Mass flow rate
    - Flow velocity
  - Unit of measurement
  - Damping
    - Dynamic damping [1]
    - Error delay [2]
- Units of measurement
  - Flow velocity
  - Volumetric flow rate
  - Volume total
  - Mass flow rate
  - Mass total

Legend
[1] only if enabled in the menu item Measurement\Measurement settings\Dynamic damping
[2] only if enabled in the menu item Special Functions\Dialogs\Menus
Configuration of outputs

Options
- Outputs
  - Current
  - Voltage
  - Digital output
  - Enable

Special functions
- Current output
  - Active
  - Passive
  - NAMUR NE43

Source item
- Yes

Flow quantities
- Totalizers
- Fluid properties
- Diagnostic values
- Miscellaneous
- Event trigger

Status
- Values
  - Output range
  - Output range

Status OK
- Error value
- Measured values

Absolute value
- Sign

Start of meas. range
- Idle state
- Output info
- Test signal
- Test mea. range

Legend
[1] requested only if the physical quantity can adopt a negative value
[2] only if switchable current outputs are available
Configuration of inputs

Special functions

Inputs

→ Temperature

→ Current

Temperature

Enable Tx

No

Yes

Pt100/Pt1000

Temperature offset [1]

No

Yes

Trigger value

Function

→ Within range

→ Out of range

→ MAX (+limit)

→ MIN (+limit)

→ ERR (+fail)

Range center

Trigger value

Range width

Hysteresis

Glitch interval

Input info

Test signal

Inputs

Legend

[1] only if enabled in the menu item Special functions/Dialogs/Menus
### Configuration of inputs

#### Special functions
- Inputs
  - → Temperature
  - → Current

#### Current
- Enable Ix
  - Yes
  - No

#### Inputs
- Source item
  - Customized
  - Current
  - Input name
  - Unit of measurement
  - Decimal places

#### Input range
- → 0…20 mA
- → 4…20 mA

#### Other range
- → Input MIN I
- → Input MAX I

#### Error value
- Yes
- No

#### Trigger value
- No
- Yes

#### Function
- Within range
- Out of range
- MAX (x>limit)
- MIN (x<limit)
- ERR (x=fail)

#### Inputs
- Input mode
  - [1] Active
  - Passive

#### Input info
- Test signal
- Test meas. range

#### Legend
- [1] only if supported by the hardware
Results – overview

**Trigger**

- Input quantities
  - Temperature
  - Current

- Physical quantities
  - Flow quantities
  - Sound speed
  - Totalizers
  - Fluid properties
  - Diagnostic values

- Special functions

- Options

**Condition**

- Event trigger
  - R1
  - R2
  - R3
  - R4

- Switching condition
- Holding behavior
- Glitch interval
- Failure delay

**Action**

- Storage of measured values
  - Event-based

- Remote functions
  - Reset meas. val.
  - Reset totalizers
  - Stop totalizers
  - Activate FastF

- Take a snap
  - Event-based
Definition of event triggers

1. Options
   - Event trigger
      - Select Rx
      - Enable Rx

2. Options
   - Outputs
     - Select output
       - Enable ...
       - Yes
       - Source item
     - Event trigger
     - Output range
     - Idle state
     - Output info
     - Test signal

Legend
[1] depending on the selected function
Remote functions

1. Trigger

- Special functions
- Inputs
  - Temperature
  - Enable
  - Pt100/Pt1000

- Condition
  - Trigger value
  - Range center
  - Range width
  - Hysteresis
  - Glitch interval
  - Input info
  - Test signal

- Action
  - Options
    - Restart meas. val [3]
    - Restart totalizers
    - Stop totalizers
    - Activate FastF [2]
  - Input/event trigger [4]

Legend

- [1] depending on the selected function
- [2] only if FastFood mode is enabled in the menu item Special functions → Measurement → Measurement modes
- [3] only controllable via inputs
- [4] list of parameterized triggerable inputs and event triggers
Event-based storing of measured values

1. Trigger

   Special functions
   Inputs
   Temperature → Current
   Enable → Enable
   Pt100/Pt1000 → Source item

   Condition
   Trigger value
   → Out of range → ERR (x=fail)
   → MAX (x>limit)
   → MIN (x<limit)
   → Within range
   → Out of range
   → ERR (x=fail)

   Range center
   Trigger value
   Range width
   Hysteresis
   Glitch interval

   Input info
   Test signal

2. Action

   Special functions
   Data logger
   Configuration
   Buffer time → Pi
   Start storing
   Buffer time Pi →
   Event-based
   Storage rate FastF
   With input
   Ringbuffer
   Storage rate w/o trig.
   Storage mode
   Storage rate (trig.)

Legend
[1] depending on the selected function
Example 1

The diagnostic values are to be checked.
If the SCNR is < 20 dB, a snap has to be triggered.

Trigger: \(\text{SCNR} < 20 \text{ dB}\)
Condition: \(R1 \text{ with SCNR} < 20 \text{ dB}\)
Action: trigger a snap

1. Options
   - Event trigger
     - Select R1
     - Enable R1
     - Yes
   - Source item
     - Diagnostic values
   - Diagnostic values
     - SCNR
   - Function
     - MIN (unlimited)
   - Type
     - Non-hold
   - Trigger value
     - 20.0 dB
   - Hysteresis
     - 1.0 dB
   - Glitch interval
     - 1.0 s
   - Failure delay
     - 1.0 s

2. Special functions
   - Snap
     - Configuration
     - On
     - Snap ringbuffer
     - Yes
     - Auto snap
     - No
     - Snap on R1
     - Yes
The storage rate of all measured and diagnostic values of a certain temperature range is to be changed.
The normal storage rate of all measured and diagnostic values is 1 h. If the temperature is outside the defined range of 20…40 °C, the storage rate should be 1 min. At the same time a record has to be carried out 10 s before and 60 s after the event.
The temperature range of 0…100 °C has to be determined via a current input of 4…20 mA.

Trigger: 20 °C > fluid temperature > 40 °C on current input I1
Condition: I1 as trigger value outside the range 20…40 °C
Action: store measured values within the temperature range 20…40 °C with a storage rate of 1 h
Example 3

The flow velocity is measured. If the flow velocity is ≤ 5 m/s, the transmitter measures in the TransitTime mode. As long as the flow velocity is > 5 m/s, the transmitter has to measure in the FastFood mode.

**Trigger:** flow velocity > 5 m/s

**Condition:** R1 with flow velocity > 5 m/s

**Action:** measurement in the FastFood mode
### B Units of measurement

#### Length/roughness

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>millimeter</td>
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<tr>
<td>in</td>
<td>inch</td>
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</tbody>
</table>

#### Temperature

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>degree Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>degree Fahrenheit</td>
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</tbody>
</table>

#### Pressure

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bar(a)</td>
<td>bar (absolute)</td>
</tr>
<tr>
<td>bar(g)</td>
<td>bar (relative)</td>
</tr>
<tr>
<td>psi(a)</td>
<td>pound per square inch (absolute)</td>
</tr>
<tr>
<td>psi(g)</td>
<td>pound per square inch (relative)</td>
</tr>
</tbody>
</table>

#### Density

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>g/cm³</td>
<td>gram per cubic centimeter</td>
</tr>
<tr>
<td>kg/cm³</td>
<td>kilogram per cubic centimeter</td>
</tr>
</tbody>
</table>

#### Sound speed

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>m/s</td>
<td>meter per second</td>
</tr>
<tr>
<td>fps (ft/s)</td>
<td>foot per second</td>
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</tbody>
</table>

#### Kinematic viscosity

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
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</thead>
<tbody>
<tr>
<td>mm²/s</td>
<td>square millimeter per second</td>
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1 mm²/s = 1 cSt

#### Flow velocity

<table>
<thead>
<tr>
<th>unit of measurement</th>
<th>description</th>
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</thead>
<tbody>
<tr>
<td>m/s</td>
<td>meter per second</td>
</tr>
<tr>
<td>cm/s</td>
<td>centimeter per second</td>
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<tr>
<td>in/s</td>
<td>inch per second</td>
</tr>
<tr>
<td>fps (ft/s)</td>
<td>foot per second</td>
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</table>
Annex

B Units of measurement

Standard/operating volumetric flow rate

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<tr>
<th>unit of measurement</th>
<th>description</th>
<th>standard/operating volume (totalized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>m³/d</td>
<td>cubic meter per day</td>
<td>m³</td>
</tr>
<tr>
<td>m³/h</td>
<td>cubic meter per hour</td>
<td>m³</td>
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<tr>
<td>m³/ min</td>
<td>cubic meter per minute</td>
<td>m³</td>
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<tr>
<td>m³/ s</td>
<td>cubic meter per second</td>
<td>m³</td>
</tr>
<tr>
<td>km³/ h</td>
<td>cubic kilometer per hour</td>
<td>km³</td>
</tr>
<tr>
<td>ml/ min</td>
<td>milliliter per minute</td>
<td>ml</td>
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<tr>
<td>1/ h</td>
<td>liter per hour</td>
<td>1</td>
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<tr>
<td>1/ min</td>
<td>liter per minute</td>
<td>1</td>
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<tr>
<td>1/ s</td>
<td>liter per second</td>
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<td>hl/ min</td>
<td>hectoliter per minute</td>
<td>hl</td>
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<tr>
<td>hl/ s</td>
<td>hectoliter per second</td>
<td>hl</td>
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<tr>
<td>Ml/ d (Megalit/d)</td>
<td>megaliter per day</td>
<td>Ml</td>
</tr>
<tr>
<td>bbl/ d (4)</td>
<td>barrel per day</td>
<td>bbl</td>
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<tr>
<td>bbl/ h (4)</td>
<td>barrel per hour</td>
<td>bbl</td>
</tr>
<tr>
<td>bbl/ m (4)</td>
<td>barrel per minute</td>
<td>bbl</td>
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<tr>
<td>Mgal/ d (Megalit/d)</td>
<td>megaliter per day</td>
<td>Mgal</td>
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<tr>
<td>gal/ d (US-gal/d)</td>
<td>gallon per day</td>
<td>gal</td>
</tr>
<tr>
<td>gal/ h (US-gal/h)</td>
<td>gallon per hour</td>
<td>gal</td>
</tr>
<tr>
<td>gal/ m (US-gal/m)</td>
<td>gallon per minute</td>
<td>gal</td>
</tr>
<tr>
<td>gal/ s (US-gal/s)</td>
<td>gallon per second</td>
<td>gal</td>
</tr>
<tr>
<td>kgal/ m (US-Kgal/m)</td>
<td>kilogallon per minute</td>
<td>kgal</td>
</tr>
<tr>
<td>Mgal (US-Mgal/d)</td>
<td>million gallons per day</td>
<td>Mgal</td>
</tr>
<tr>
<td>CFD</td>
<td>cubic foot per day</td>
<td>cft (2)</td>
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<tr>
<td>CFH</td>
<td>cubic foot per hour</td>
<td>cft</td>
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<tr>
<td>CFM</td>
<td>cubic foot per minute</td>
<td>cft</td>
</tr>
<tr>
<td>CFS</td>
<td>cubic foot per second</td>
<td>aft (3)</td>
</tr>
<tr>
<td>MMCFD</td>
<td>million cubic feet per day</td>
<td>MMCF</td>
</tr>
</tbody>
</table>

(1) selection in the menu item Options\Units of measurement
(2) cft: cubic foot
(3) aft: acre foot
(4) In the menu item Special functions\Units of measurement\Barrel type the barrel type to be displayed when setting the units of measurement for standard/operating volumetric flow rate and totalized standard/operating volume can be defined. 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
### Unit of Measurement

<table>
<thead>
<tr>
<th>Mass flow rate unit</th>
<th>Description</th>
<th>Mass (Totalized)</th>
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</thead>
<tbody>
<tr>
<td>MMCFH</td>
<td>Million cubic feet per hour</td>
<td>MMCF</td>
</tr>
<tr>
<td>lgpd (Imp-gal/d)</td>
<td>Gallon per day</td>
<td>Igal</td>
</tr>
<tr>
<td>lgpH (Imp-gal/h)</td>
<td>Gallon per hour</td>
<td>Igal</td>
</tr>
<tr>
<td>lgpM (Imp-gal/m)</td>
<td>Gallon per minute</td>
<td>Igal</td>
</tr>
<tr>
<td>lgpS (Imp-gal/s)</td>
<td>Gallon per second</td>
<td>Igal</td>
</tr>
<tr>
<td>IKGM (Imp-Kgal/m)</td>
<td>Imperial kilogallon per minute</td>
<td>IKG</td>
</tr>
<tr>
<td>IMGD (Imp-Mgal/d)</td>
<td>Million imperial gallons per day</td>
<td>IMG</td>
</tr>
</tbody>
</table>

(1) Selection in the menu item Options \ Units of measurement
(2) cft: cubic foot
(3) aft: acre foot
(4) In the menu item Special functions \ Units of measurement \ Barrel type the barrel type to be displayed when setting the units of measurement for standard/operating volumetric flow rate and totalized standard/operating volume can be defined. 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

### Mass Flow Rate

<table>
<thead>
<tr>
<th>Mass flow rate unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>t/h</td>
<td>Ton per hour</td>
</tr>
<tr>
<td>t/d</td>
<td>Ton per day</td>
</tr>
<tr>
<td>kg/h</td>
<td>Kilogram per hour</td>
</tr>
<tr>
<td>kg/min</td>
<td>Kilogram per minute</td>
</tr>
<tr>
<td>kg/s</td>
<td>Kilogram per second</td>
</tr>
<tr>
<td>g/s</td>
<td>Gram per second</td>
</tr>
<tr>
<td>lb/d</td>
<td>Pound per day</td>
</tr>
<tr>
<td>lb/h</td>
<td>Pound per hour</td>
</tr>
<tr>
<td>lb/m</td>
<td>Pound per minute</td>
</tr>
<tr>
<td>lb/s</td>
<td>Pound per second</td>
</tr>
<tr>
<td>klb/h</td>
<td>Kilopound per hour</td>
</tr>
<tr>
<td>klb/m</td>
<td>Kilopound per minute</td>
</tr>
</tbody>
</table>

1 lb = 453.59237 g
1 t = 1000 kg
## Reference

The following tables provide assistance for the user. The accuracy of the data depends on the composition, temperature and processing of the material. FLEXIM does not assume liability for any inaccuracies.

### C.1 Sound speed of selected pipe and lining materials at 20 °C

The values of some of these materials are stored in the internal database of the transmitter. Column $c_{\text{flow}}$ shows the type of sound wave (longitudinal or transversal) used for the flow measurement.

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

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 roughness values of pipes
The values are based on experience and measurements.

<table>
<thead>
<tr>
<th>material</th>
<th>absolute roughness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>drawn pipes of non-ferrous metal, glass, plastics and light metal</td>
<td>0…0.0015</td>
</tr>
<tr>
<td>drawn steel pipes</td>
<td>0.01…0.05</td>
</tr>
<tr>
<td>fine-planed, polished surface</td>
<td>max. 0.01</td>
</tr>
<tr>
<td>planed surface</td>
<td>0.01…0.04</td>
</tr>
<tr>
<td>rough-planed surface</td>
<td>0.05…0.1</td>
</tr>
<tr>
<td>welded steel pipes, new</td>
<td>0.05…0.1</td>
</tr>
<tr>
<td>after long use, cleaned</td>
<td>0.15…0.2</td>
</tr>
<tr>
<td>moderately rusted, slightly encrusted</td>
<td>max. 0.4</td>
</tr>
<tr>
<td>heavily encrusted</td>
<td>max. 3</td>
</tr>
<tr>
<td>cast iron pipes:</td>
<td></td>
</tr>
<tr>
<td>bitumen lining</td>
<td>&gt; 0.12</td>
</tr>
<tr>
<td>new, without lining</td>
<td>0.25…1</td>
</tr>
<tr>
<td>rusted</td>
<td>1…1.5</td>
</tr>
<tr>
<td>encrusted</td>
<td>1.5…3</td>
</tr>
</tbody>
</table>

C.3 Typical properties of selected fluids at 20 °C and 1 bar

<table>
<thead>
<tr>
<th>fluid</th>
<th>explanation</th>
<th>sound speed [m/s]</th>
<th>density [g/cm³]</th>
<th>kinematic viscosity [mm²/s]</th>
<th>field of application</th>
<th>WMM (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low pressure steam</td>
<td>steam (150 °C, saturated steam pressure), steam measurement</td>
<td>493</td>
<td>0.957</td>
<td>5.5</td>
<td>100…200 °C 1…15.5 bar</td>
<td>x</td>
</tr>
</tbody>
</table>

(1) thermal energy rate coefficient included in the fluid data set
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FLEXIM Flexible Industriemesstechnik GmbH
Boxberger Straße 4
12681 Berlin
Germany

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FLUXUS a532
a = F, G

complies/comply with the relevant EU regulations and directives, including any amendments valid at the time this declaration was signed. This declaration of conformity is based on the following harmonized EU standards:

EU directive 2014/35/EU (low voltage directive) relating to the making available on the market of electrical equipment designed for use within certain voltage limits
EN IEC 61010-2-030:2021 + A11:2021
Safety requirements for electrical equipment for measurement, control, and laboratory use
Part 1: General requirements
Safety requirements for electrical equipment for measurement, control, and laboratory use
Part 2-030: Particular requirements for testing and measuring circuits

EU directive 2014/30/EU (EMC directive) relating to electromagnetic compatibility
EN 61326-1:2013
Electrical equipment for measurement, control, and laboratory use – EMC requirements
Part 1: General requirements

EU directive 2011/65/EU (RoHS directive) on the restriction of the use of certain hazardous substances in electrical and electronic equipment
EN IEC 63000:2018
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

FLEXIM GmbH
Signed for and on behalf of

Berlin, 2022-12-01
Place and date

Jens Hilpert
Managing Director
UK declaration of conformity according to UK statutory instruments

FLEXIM Flexible Industriemesstechnik GmbH
Boxberger Straße 4
12681 Berlin
Germany

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UK statutory instruments 2016 No.1101 (electrical equipment (safety) regulations) relating to the safety of electrical equipment designed for use within certain voltage limits
Part 1: General requirements
EN 61010-2-030:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use
Part 2-030: Particular requirements for testing and measuring circuits

UK statutory instruments 2016 No.1091 (EMC regulations) relating to electromagnetic compatibility
EN 61326-1:2013 Electrical equipment for measurement, control, and laboratory use – EMC requirements
Part 1: General requirements

UK statutory instruments 2012 No.3032 (RoHS regulations) on the restriction of the use of certain hazardous substances in electrical and electronic equipment
EN IEC 63000:2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

FLEXIM GmbH
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Jens Hilpert
Managing Director