Ultrasonic Flowmeter for Liquids

FLUXUS F704**-NN  
FLUXUS F704**-A2  
FLUXUS F704**-F2

FLUXUS F705**-NN  
FLUXUS F705**-A2  
FLUXUS F705**-F2

FLUXUS F706**-NN  
FLUXUS F706**-A2  
FLUXUS F706**-F2

FLUXUS F709**-NN
The transmitter can be operated in the language of your choice (see section 8.5).
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1 Introduction

1.1 Regarding this User Manual

This user manual has been written for the personnel operating the ultrasonic flowmeter FLUXUS. It contains important information about the measuring instrument, how to handle it correctly, and how to avoid damages.

**Attention!** Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS).

Read the safety instructions carefully. Make sure you have read and understood this user manual before using the measuring instrument.

| Note! | For technical data, see Technical Specifications. |

All reasonable effort has been made to ensure the correctness of the content of this user manual. However, if you find any erroneous information, please inform us. We will be grateful for any suggestions and comments regarding the concept and your experience working with the measuring instrument.

This will ensure that we can further develop our products for the benefit of our customers and in the interest of technological progress. If you have any suggestions about improving the documentation and particularly this user manual, please let us know so that we can consider your comments for future reprints.

The contents of this user manual are subject to changes without prior notice. All rights reserved. No part of this user manual may be reproduced in any form without FLEXIM's written permission.

1.2 Safety Instructions

The user manual contains instructions that are marked as follows:

| Note! | This text contains important information about the use of the measuring instrument. |
| **Attention!** | This text contains important instructions which should be observed to avoid damage or destruction of the measuring instrument. Proceed with special caution! |

**Attention!** This text contains Safety Instructions for the Use in Explosive Atmosphere.

Observe these safety instructions!

1.3 Warranty

The FLUXUS measuring instrument is guaranteed for the term and to the conditions specified in the sales contract provided the equipment has been used for the purpose for which it has been designed and operated according to the instructions given in this User Manual. Misuse of the FLUXUS will immediately revoke any warranty given or implied.

This includes:
- replacement of a component of FLUXUS with a component that was not approved by FLEXIM
- unsuitable or insufficient maintenance
- repair of FLUXUS by unauthorized personnel

FLEXIM assumes no responsibility for injury to the customer or third persons proximately caused by the material owing to defects in the product which were not predictable or for any indirect damages.

FLUXUS is a very reliable instrument. It is manufactured under strict quality control using modern production techniques. If installed as recommended in an appropriate location, used cautiously and taken care of conscientiously, no troubles should appear.

In case of a problem which cannot be solved with the help of this user manual (see chapter 19), contact our sales office giving a precise description of the problem. Specify the type, serial number and firmware version of the measuring instrument.
2 Handling

2.1 First Inspection
The measuring instrument has already been tested thoroughly at the factory. At delivery, proceed to a visual control to make sure that no damage has occurred during transportation.

Check that the specifications of the measuring instrument delivered correspond to the specifications given on the purchase order.

The type and the serial number of the transmitter are shown on the nameplate. The transducer type is printed on the transducers.

2.2 General Precautions

| Attention! | Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS). |

FLUXUS is a precision measuring instrument and has to be handled with care. To obtain good measurement results and not damage the measuring instrument, it is important that great attention is paid to the instructions given in this user manual, particularly to the following points:

- Protect the transmitter from shocks.
- The housing may only be opened by authorized personnel. The degree of protection of the transmitter FLUXUS F704, F705, F706 will only be ensured if the front plate is tightly screwed to the housing.
- Keep the transducers clean. Manipulate the transducer cables with caution. Avoid excessive cable bend.
- Make sure to work under correct ambient and operating temperatures. The ambient temperature has to be within the operating temperature range of the transmitter and the transducers (see Technical Specifications).
- Observe the degree of protection (see Technical Specifications).

2.3 Cleaning
- Clean the transmitter with a soft cloth. Do not use detergents.
- Remove traces of the coupling compound from the transducers with a soft paper towel.
3 General Principles

For the ultrasonic measurement of the flow rate, the flow velocity of the medium flowing in a pipe is determined. Further physical quantities (e.g., volumetric flow rate, mass flow rate, heat flow rate) are derived from the flow velocity and from additional physical quantities, if necessary.

3.1 Measurement System

The measurement system consists of a transmitter, the ultrasonic transducers with the transducer cables and the pipe on which the measurement is conducted.

The ultrasonic transducers are mounted on the outside of the pipe. Ultrasonic signals are sent through the medium and received by the transducers. The transmitter controls the measuring cycle, eliminates the disturbance signals and analyzes the useful signals. The measured values can be displayed, used for calculations and transmitted.

3.2 Measurement Principle

In the TransitTime mode, the flow velocity of the medium is measured using the transit time difference correlation principle (see section 3.2.2). If the proportion of gas or solid particles is too high, the transmitter can toggle to the NoiseTrek mode (see section 3.2.3).

3.2.1 Terms

Flow profile
Distribution of the 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 in the supply line of the measuring point (see chapter 5).

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

If the Reynolds number exceeds a critical value (usually approx. 2 300, if the medium 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 disruption between the parallel flowing layers of the medium.

Turbulent flow
A flow in which turbulence (swirling of the medium) occurs. In technical applications, the flow in the pipe is mostly turbulent.

Transition range
The flow is partly laminar and partly turbulent.

Transit time difference Δt
Difference of the transit times of the signals. In the TransitTime method, the transit time difference of the signals in and against the flow direction is measured, in the NoiseTrek mode - the time difference of the signal from the transducer to the particle and from the particle to the transducer. The flow velocity of the medium in the pipe is determined from the transit time difference (see Fig. 3.2, Fig. 3.3 and Fig. 3.4).
Sound speed $c$

Speed of the propagating sound. The sound speed depends on the mechanical properties of the medium or the pipe material. In pipe materials and other solid materials, a distinction is made between the longitudinal and transversal sound speed. For the sound speed of some media and materials see annex C.1.

Flow velocity $v$

average value of the flow velocities over the cross-sectional pipe area.

Acoustic calibration factor $k_a$

\[ k_a = \frac{c_\alpha}{\sin \alpha} \]

The acoustic calibration factor $k_a$ is a parameter of the transducer which results from the sound speed $c$ within the transducer and the angle of incidence (see Fig. 3.2). According to Snell's law of refraction, the angle of propagation in the adjoining medium or pipe material is:

\[ k_a = \frac{c_\alpha}{\sin \alpha} = \frac{c_\beta}{\sin \beta} = \frac{c_\gamma}{\sin \gamma} \]

Fluid mechanics correction factor $k_{Re}$

With the fluid mechanics correction 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 correction factor only depends on the Reynolds number and the roughness of the inner pipe wall. The fluid mechanics correction factor is recalculated by the transmitter for each new measurement.

Volumetric Flow Rate $V$

\[ V = v \cdot A \]

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

Mass flow rate $m$

\[ m = V \cdot \rho \]

The mass of the medium that passes through the pipe per unit time. The mass flow rate is calculated from the product of the volumetric flow rate $v$ and the density $\rho$.

Heat flow rate $\Phi$

The heat quantity that is transferred per unit time. For the calculation of the heat flow, see chapter 16.

3.2.2 Measurement of the Flow Velocity in the TransitTime Mode

The signals are emitted and received by two transducers alternatively in and against the flow direction. If the medium moves, the signals propagating in the medium are displaced with the flow. This displacement causes a reduction in distance for the signal in the flow direction and an increase in distance for the signal against the flow direction in the wedge of the receiving transducer (see Fig. 3.2 and Fig. 3.3). This causes a change in the transit times. The transit time of the signal in the flow direction is shorter than the transit time against the flow direction. This transit time difference is proportional to the average flow velocity.

The flow velocity of the medium is calculated as follows:

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

with

$v$ – flow velocity of the medium

$k_{Re}$ – fluid mechanics correction factor

$k_a$ – acoustic calibration factor

$\Delta t$ – transit time difference

$t_{fl}$ – transit time in the medium
Fig. 3.2: Sound path of the signal in the flow direction

Fig. 3.3: Sound path of the signal against the flow direction

Fig. 3.4: Transit time difference $\Delta t$
3.2.3 Measurement of the Flow Velocity in the NoiseTrek Mode

When media with a high proportion of gas bubbles or solid particles are measured, the attenuation of the ultrasonic signal increases and can inhibit the propagation of the signal in the medium. A measurement in the TransitTime mode is no longer possible.

The NoiseTrek mode uses the presence of gas bubbles and solid particles in the medium. The measurement setup used in the TransitTime mode does not need to be changed. Ultrasonic signals are sent into the medium at short intervals, reflected by the gas bubbles or the solids particles and again received by the transducer. The transit time difference between two consecutive measuring signals that are reflected by the same particle is determined. The transit time difference is proportional to the distance covered by the particle in the time between the two measuring signals and therefore to the velocity at which the particle moves through the pipe (see Fig. 3.5).

The average value of all measured velocities of gas bubbles and/or particles corresponds to the flow velocity of the medium:

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

with

- \(v\) — flow velocity of the medium
- \(k_{Re}\) — fluid mechanics correction factor
- \(k_a\) — acoustic calibration factor
- \(\Delta t\) — transit time difference of the measuring signals
- \(t_s\) — time interval between the measuring signals

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

3.2.4 HybridTrek Mode

The HybridTrek mode combines the TransitTime mode and the NoiseTrek mode. During a measurement in the HybridTrek mode, the transmitter automatically toggles between the TransitTime mode and the NoiseTrek mode depending on the gaseous or solid content.
3.3 Measurement Arrangements

3.3.1 Terms and Definitions

Diagonal arrangement
The transducers are mounted on the opposite sides of the pipe (see Fig. 3.6).

Reflection arrangement
The transducers are mounted on the same side of the pipe (see Fig. 3.7).

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 conducted in the diagonal arrangement (see Fig. 3.6)
• even if the measurement is conducted in the reflection arrangement (see Fig. 3.7).

Beam
The path covered by the ultrasonic signal between the transducers: the transducer emitting the ultrasonic signal and the transducer receiving it. A beam consists of 1 or several sound paths (see Fig. 3.8 or Fig. 3.9).

Transducer distance
Distance between the transducers. It is measured between the inner edges of the transducers.

reflection arrangement

Diagonal arrangement (positive transducer distance)

Diagonal arrangement (negative transducer distance)
### Sound beam plane
The plane containing one, two or more sound paths or beams (see Fig. 3.10).

![Sound beam plane examples](image)

#### Fig. 3.10: Sound paths and beams in one plane

#### 3.3.2 Examples

<table>
<thead>
<tr>
<th>Diagonal arrangement with 1 beam</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>
<tr>
<td>1 beam</td>
<td>1 beam</td>
</tr>
<tr>
<td>1 plane</td>
<td>1 plane</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagonal arrangement with 2 beams</th>
<th>Reflection arrangement with 2 beams and 2 planes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 transducer pairs</td>
<td>2 transducer pairs</td>
</tr>
<tr>
<td>2 sound path</td>
<td>4 sound paths</td>
</tr>
<tr>
<td>2 beams</td>
<td>2 beams</td>
</tr>
<tr>
<td>1 plane</td>
<td>2 planes</td>
</tr>
</tbody>
</table>

- X arrangement
- Displaced X arrangement
<table>
<thead>
<tr>
<th>Diagonal arrangement with 4 beams and 2 planes</th>
<th>Reflection arrangement with 4 beams and 4 planes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 transducer pairs</td>
<td>4 transducer pairs</td>
</tr>
<tr>
<td>4 sound path</td>
<td>8 sound paths</td>
</tr>
<tr>
<td>4 beams</td>
<td>4 beams</td>
</tr>
<tr>
<td>2 planes</td>
<td>4 planes</td>
</tr>
</tbody>
</table>

*Diagonal arrangement with 4 beams and 2 planes* [Diagram](#)

*Reflection arrangement with 4 beams and 4 planes* [Diagram](#)
4 Description of the Transmitter

Attention! The degree of protection of the transmitter will only be ensured if the cable glands are firmly tightened and the housing is tightly screwed.

4.1 Design of FLUXUS F704

The front plate has to be removed to access the command panel.

4.2 Design of FLUXUS F705

The front plate has to be removed to access the command panel.
4.3 Design of FLUXUS F706

The front plate has to be removed to access the command panel.

4.4 Design of FLUXUS F709

The transmitter is designed as a 19" module (42 HP, 3 U).
4.5 Keyboard

The keyboard consists of three function keys ENTER, BRK and C and ten numerical keys. Several keys have double functions. They can be used for entering data and for navigating through scroll lists. The arrow-shaped keys , , , and  are used as cursor keys in the selection mode and for entering digits and letters in the input mode.

Tab. 4.1: General functions

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTER</td>
<td>confirmation of selection or of entered value</td>
</tr>
<tr>
<td>BRK + C + ENTER</td>
<td>RESET: Press these three keys simultaneously to correct a malfunction. The reset has the same effect as restarting the transmitter. Stored data are not affected.</td>
</tr>
<tr>
<td>BRK</td>
<td>interruption of the measurement and selection of the main menu</td>
</tr>
<tr>
<td></td>
<td>Be careful not to stop a current measurement by inadvertently pressing key BRK!</td>
</tr>
</tbody>
</table>

Tab. 4.2: Navigation

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRK</td>
<td>selection of the main menu</td>
</tr>
<tr>
<td>4 6</td>
<td>scroll to the left/right through a scroll list</td>
</tr>
<tr>
<td>8 2</td>
<td>scroll upwards/downwards through a scroll list</td>
</tr>
<tr>
<td>ENTER</td>
<td>confirmation of the selected menu item</td>
</tr>
</tbody>
</table>

Tab. 4.3: Input of digits

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ... 9</td>
<td>input of the digit shown on the key</td>
</tr>
<tr>
<td>-</td>
<td>sign for the input of negative values</td>
</tr>
<tr>
<td>*</td>
<td>decimal marker</td>
</tr>
<tr>
<td>C</td>
<td>Delete values. After the value has been deleted, the previous value will be displayed.</td>
</tr>
<tr>
<td>ENTER</td>
<td>confirmation of input</td>
</tr>
</tbody>
</table>

Tab. 4.4: Input of text

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 6</td>
<td>positioning of the cursor</td>
</tr>
<tr>
<td>9</td>
<td>changing the currently selected character to an &quot;A&quot;</td>
</tr>
<tr>
<td>3</td>
<td>changing the currently selected character to a &quot;Z&quot;</td>
</tr>
<tr>
<td>5</td>
<td>changing between small and capital letters</td>
</tr>
<tr>
<td>1 2</td>
<td>selection of the previous/next ASCII character</td>
</tr>
<tr>
<td>0</td>
<td>deleting the character and inserting a blank</td>
</tr>
<tr>
<td>7 ... 1</td>
<td>Automatic scrolling up or down through the limited ASCII character set. The character changes every second. The scrolling is stopped by pressing any other key.</td>
</tr>
<tr>
<td>ENTER</td>
<td>finishing editing</td>
</tr>
</tbody>
</table>
5 Selection of the Measuring Point

Attention! Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SiFLUXUS).

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 (see section 5.1)
- the flow profile is fully developed (see section 5.2)

The correct selection of the measuring point and thus, the correct transducer positioning guarantees that the sound signal will be received under optimum conditions and evaluated correctly.

Due to the variety of applications and the different factors that influence the measurement, there is no standard solution for the transducer positioning. The correct position of the transducers is influenced by the following factors:
- diameter, material, lining, wall thickness and shape of the pipe
- medium
- gas bubbles in the medium

Avoid measuring points in the vicinity of deformations and defects of the pipe and in the vicinity of welds.
Avoid locations with deposit formation in the pipe.

The ambient temperature at the measuring point has to be within the operating temperature range of the transducers (see Technical Specifications).
Select the location of the transmitter within cable reach of the measuring point.
The ambient temperature at the location has to be within the operating temperature range of the transmitter (see Technical Specifications).

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

5.1 Acoustic Penetration

The pipe has to be acoustically penetrable at the measuring point. The acoustic penetration is reached when pipe and medium do not attenuate the sound signal so strongly that it is completely absorbed before reaching the second transducer.

The attenuation in the pipe and in the medium depends on:
- kinematic viscosity of the medium
- proportion of gas bubbles and solids in the medium
- deposits on the inner pipe wall
- pipe material

The following requirements have to be met at the measuring point:
- the pipe is always filled completely
- no material deposits in the pipe
- no bubbles accumulate

Note! Even bubble-free media can form gas bubbles when the medium expands, e.g., before pumps and after great cross-section extensions.

Observe the notes in the following table.
### Horizontal pipe
Select a measuring point where the transducers can be mounted on the side of the pipe, allowing the sound waves to propagate in the pipe horizontally. Thus, solid at the bottom or gas bubbles at the top of the pipe will not influence the propagation of the signal.

<table>
<thead>
<tr>
<th>Correct</th>
<th>Disadvantageous</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

### Vertical pipe
Select the measuring point at a pipe location where the medium flows upward. The pipe has to be completely filled.

<table>
<thead>
<tr>
<th>Correct</th>
<th>Disadvantageous</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

### Free inlet or outlet pipe section:
Select the measuring point at a pipe location where the pipe cannot run empty.

<table>
<thead>
<tr>
<th>Correct</th>
<th>Disadvantageous</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
5.2 Undisturbed Flow Profile

Some flow elements (elbows, slide valves, valves, control valves, pumps, reducers, diffusers, etc.) distort the flow profile in their vicinity. The axisymmetrical flow profile needed for correct measurement is no longer given. A careful selection of the measuring point helps to reduce the impact of disturbance sources.

It is most important that the measuring point is chosen at a sufficient distance from any disturbance sources. Only then it can be assumed that the flow profile in the pipe is fully developed. However, measuring results can be obtained even if the recommended distance to disturbance sources cannot be observed for practical reasons.

Recommended straight inlet and outlet pipe lengths for different types of flow disturbance sources are shown in the examples in Tab. 5.2.

Tab. 5.2: Recommended distance from disturbance sources;
- D – nominal pipe diameter at the measuring point,
- I – recommended distance between disturbance source and transducer position

<table>
<thead>
<tr>
<th>Disturbance Source</th>
<th>Inlet: $I \geq 40 , \text{D}$</th>
<th>Outlet: $I \geq 5 , \text{D}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>90° elbow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 x 90° elbow on different levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Tab. 5.2: Recommended distance from disturbance sources;

- **D** – nominal pipe diameter at the measuring point,
- **l** – recommended distance between disturbance source and transducer position

<table>
<thead>
<tr>
<th>Disturbance Source</th>
<th>Inlet Requirement</th>
<th>Outlet Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducer</td>
<td>( l \geq 10 , D )</td>
<td>( l \geq 5 , D )</td>
</tr>
<tr>
<td>Pump</td>
<td>( l \geq 20 , D )</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of reducer disturbance source and transducer position](image)

![Diagram of pump disturbance source and transducer position](image)
5.3 Selection of the Measurement Arrangement Taking onto Account the Measuring Range and the Measuring Conditions

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 media (only 1 sound path)

Reflection arrangement with 1 beam

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

Diagonal arrangement with 2 beams

Reflection arrangement with 2 beams and 2 planes

- the same properties like reflection arrangement with 2 beams
- additional property: influences of the flow profile are compensated for because the measurement takes place in 2 planes

- the same properties like diagonal arrangement with 1 beam
- additional property: transverse flow effects are compensated for because the measurement is conducted with 2 beams
Diagonal arrangement with 4 beams and 2 planes

- same features as diagonal arrangement with 2 beams
- influences of the flow profile are compensated for because the measurement takes place in 2 planes

Reflection arrangement with 4 beams and 4 planes

- same features as reflection arrangement with 2 beams and 2 planes
- influences of the flow profile are compensated for effectively because the measurement takes place in 4 planes
5.4 Selection of the Sound Beam Plane Near an Elbow

On vertical pipes

- The sound beam plane (see section 3.3.1) has an angle of 90° to the elbow plane. The elbow is upstream of the measuring point.

With measurements in both directions

- The sound beam plane (see section 3.3.1) is selected according to the nearest elbow (horizontal or vertical, depending on the pipe orientation - see above).

On horizontal pipes

- The sound beam plane (see section 3.3.1) has an angle of 90° ±45° to the elbow plane. The elbow is upstream of the measuring point.

With measurements in the reflection arrangement with 2 beams and 2 planes

- The 2 sound beam planes (see section 3.3.1) have an angle of 45° to the elbow plane. The elbow is upstream of the measuring point.
- With horizontal pipes, the transducers are mounted on the upper half of the pipe.
6 Installation

6.1 Location

- Select the measuring point according to the recommendations in chapter 3 and 5.
- Select the location of the transmitter within cable reach of the measuring point.

The ambient temperature at the location has to be within the operating temperature range of the transmitter and the transducers (see Technical Specifications).

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

6.2 Transmitter FLUXUS F704, F705, F706

6.2.1 Opening and Closing the Housing

**Attention!** Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS).

**Opening**
- Loosen the 4 screws of the housing of the transmitter.
- Open the front plate of the transmitter.

**Closing**
- Close the front plate.
- Tighten the 4 screws of the housing of the transmitter (max. torque of 1 Nm).

**Attention!** The degree of protection of the transmitter is ensured only if the cable glands are firmly tightened and the housing is tightly screwed.

6.2.2 Wall Installation

**FLUXUS F704**
- Loosen the 4 screws of the housing of the transmitter.
- Open the cover of the transmitter.
- Fix the transmitter to the wall (see Fig. 6.1).

![Fig. 6.1: FLUXUS F704 (dimensions in mm)](image-url)
**FLUXUS F705, F706**

- Fix the transmitter to the wall (see Fig. 6.2 and Fig. 6.3).

### 6.2.3 Pipe Installation

**Installation on a 2” pipe**

The mounting kit is fixed to the pipe using a shackle.
- Fix the pipe mounting plate (2) and the instrument mounting plate (3) to the pipe using the nuts (4) and the shackle (1) (see Tab. 6.1 and Fig. 6.4).
- Use the screws to fix the transmitter to the instrument mounting plate (see Fig. 6.5 or Fig. 6.6).

**Installation on a pipe > 2”**

The mounting kit is fixed to the pipe using tension straps.
- Insert the tension straps into the holes of the pipe mounting plate (2) and the instrument mounting plate (3) (see Tab. 6.1 and Fig. 6.7).
- Fix the pipe mounting plate and the instrument mounting plate to the pipe using the tension strap.
- Use the screws to fix the transmitter to the instrument mounting plate (see Fig. 6.5 or Fig. 6.6).

**Tab. 6.1: Parts of the mounting kit**

<table>
<thead>
<tr>
<th>number</th>
<th>designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>shackle</td>
</tr>
<tr>
<td>2</td>
<td>pipe mounting plate</td>
</tr>
<tr>
<td>3</td>
<td>instrument mounting plate</td>
</tr>
<tr>
<td>4</td>
<td>nut</td>
</tr>
<tr>
<td>5</td>
<td>tension strap</td>
</tr>
</tbody>
</table>

**Fig. 6.2: FLUXUS F705 (dimensions in mm)**

**Fig. 6.3: FLUXUS F706 (dimensions in mm)**

**Fig. 6.4: Installation of the instrument mounting plate**
6.3 Transmitter FLUXUS F709

The transmitter is designed as a 19" module (42 HP, 3 U).
6.4 Transducers

| Attention! | Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS). |

6.4.1 Preparation of the Pipe
- The pipe has to be stable. It has to be able to withstand the pressure exerted by the transducer mounting fixture.
- Rust, paint or other deposits on the pipe absorb the sound signal. A good acoustic contact between the pipe and the transducers is obtained as follows:
  - Clean the pipe at the selected measuring point:
    - If present, the paint layer has to be smoothed by sanding. The paint does not need to be removed completely.
    - Remove any rust or loose paint.
  - Use coupling foil or apply a bead of acoustic coupling compound along the center line of the contact surface of the transducers.
- Observe that there must be no air pockets between the transducer contact surface and the pipe wall.

6.4.2 Orientation of the Transducers
Mount the transducers onto the pipe in such way that the engravings on the transducers form an arrow (see Fig. 6.9). The transducer cables show in opposite directions.
For the determination of the flow direction see section 9.8.

Select the installation instructions that correspond to the supplied transducer mounting fixture.
- Variofix L: see section 6.4.3
- Variofix C: see section 6.4.4
- mounting shoe and clasp: see section 6.4.5

6.4.3 Transducer Mounting Fixture Variofix L
When measuring in reflection arrangement, the transducer mounting fixtures are mounted on the same side of the pipe (see Fig. 6.10).
When measuring in diagonal arrangement, the transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 6.11).
In the following, the mounting of two transducer mounting fixtures in reflection arrangement is described (one transducer mounting fixture for each transducer).
Overview of the mounting steps

• **step 1**
  disassemble the transducer mounting fixture Variofix L

• **step 2**
  fix the clasps to the tension straps

• **step 3**
  fix one tension strap to the pipe

• **step 4**
  use screws to fix the rail to the tension strap and fix it with the second tension strap

• **step 5**
  insert the transducer in the cover, use screws to fix the cover with the transducer to the rail

If the transducer distance is small and when measuring in reflection arrangement, only one transducer mounting fixture has to be mounted (see Tab. 6.2).

**Tab. 6.2: Approximate values for the mounting of a Variofix L**

<table>
<thead>
<tr>
<th>Transducer Frequency</th>
<th>Length of the Rail [mm]</th>
<th>Length of the Rail [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q 176 &lt; 69</td>
<td>M, P 234 &lt; 84 (Lamb wave transducers)</td>
<td>G, H, K (all but ***<em>LI</em>) 348 &lt; 89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G, H, K (only ***<em>LI</em>) 368 &lt; 94</td>
</tr>
</tbody>
</table>

Fig. 6.12: Scope of delivery
6.4.3.1 Disassembly of Variofix L

- Disassemble the transducer mounting fixture Variofix L (see Fig. 6.13).

6.4.3.2 Fixing the Clasps to the Tension Straps

Select the installation instructions that correspond to the supplied clasp:

**Band clamp clasp**

The clasp is fixed to the tension strap (see Fig. 6.14).

**Quick release clasp**

The clasp is fixed to the tension strap (see Fig. 6.15).

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

**Ratchet clasp**

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

**Attention!** The edge of the tension strap is very sharp, leading to risk of injury. Remove the burr of the sharp edge.

- Insert approx. 100 mm of the tension strap into parts 1 and 2 of the clasp (see Fig. 6.16 a).
- Bend the tension strap.
- Insert the tension strap into part (1) of the ratchet clasp (see Fig. 6.16 b).
- Tighten the tension strap.
- Repeat the steps for the second tension strap.
6.4.3.3 Fixing the Tension Strap to the Pipe

One tension strap is fixed to the pipe (see Fig. 6.17). The second tension strap is mounted later.

Select the installation instructions that correspond to the supplied clasp:

**Band clamp clasp**
- Insert the tension strap into the tension strap clamp (see Fig. 6.18).
- Position the clasp and the tension strap clamp on the pipe (see Fig. 6.17). On a horizontal pipe, mount the tension strap clamp on the side of the pipe, if possible.
- Place the tension strap around the pipe and insert it into the clasp (see Fig. 6.20).
- Tighten the tension strap.
- Tighten the screw of the clasp.

**Quick release clasp**
- Insert the tension strap into the tension strap clamp and the metal spring (see Fig. 6.18 and Fig. 6.19).
- Position the clasp, the metal spring and the tension strap clamp on the pipe (see Fig. 6.17):
  - On a horizontal pipe, mount the tension strap clamp on the side of the pipe, if possible.
  - Mount the metal spring on the opposite side of the tension strap clamp.
- Place the tension strap around the pipe and insert it into the clasp (see Fig. 6.21).
- Tighten the tension strap.
- Tighten the screw of the clasp.
Ratchet clasp

- Insert the tension strap into the tension strap clamp and the metal spring (see Fig. 6.22). It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer pipe diameter < 80 mm or
  - on pipes that are not subjected to significant temperature fluctuations
- Position the clasp, the metal spring (if necessary) and the tension strap clamp on the pipe (see Fig. 6.17).
  - On a horizontal pipe, mount the tension strap clamp on the side of the pipe, if possible.
  - Mount the metal spring on the opposite side of the tension strap clamp (if necessary).
- Place the tension strap around the pipe and insert it into part 3 of the clasp (see Fig. 6.23).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 6.24).

| Attention! | The edge of the tension strap is very sharp, leading to risk of injury. Remove the burr of the sharp edge. |

- Tighten the screw of the clasp.

![Fig. 6.22: Tension strap with the metal spring and the tension strap clamp](image1)

![Fig. 6.23: Ratchet clasp with tension strap](image2)

![Fig. 6.24: Ratchet clasp with tension strap](image3)

| Attention! | To release the screw and the tension strap press the lever down (see Fig. 6.24). |
6.4.3.4 Fixing the Rail to the Pipe

- Place one tension strap clamp in the rail (see tension strap clamp 1 in Fig. 6.25). Observe the orientation of the tension strap clamp.
- Tighten the nut of tension strap clamp 1 slightly.
- Screw the rail to tension strap clamp 2 (see Fig. 6.26).
- Tighten the nut of tension strap clamp 2, but not too firmly in order not to damage the tension strap.

![Fig. 6.25: Rail with tension strap clamp](image)

![Fig. 6.26: Rail, mounted on one side of the pipe](image)

- Select the installation instructions that correspond to the supplied clasp:

**Band Clamp Clasp**

- Insert the tension strap into tension strap clamp 1 (see Fig. 6.27).
- Place the tension strap around the pipe and insert it into the clasp (see Fig. 6.28).
- Tighten the tension strap.
- Tighten the screw of the clasp.
- Tighten the nut of tension strap clamp 1, but not too firmly in order not to damage the tension strap (see Fig. 6.27).

![Fig. 6.27: Rail on the pipe](image)
**Quick release clasp**
- Insert the tension strap into tension strap clamp 1 and the metal spring (see Fig. 6.29 and Fig. 6.27).
- Place the tension strap around the pipe and insert it into the clasp.
- Place the metal spring on the opposite side of tension strap clamp 1.
- Tighten the tension strap.
- Tighten the screw of the clasp.
- Tighten the nut of tension strap clamp 1, but not too firmly in order not to damage the tension strap (see Fig. 6.27).

**Ratchet clasp**
- Insert the tension strap into tension strap clamp 1 and the metal spring (see Fig. 6.27 and Fig. 6.30). It is not necessary to mount the metal spring:
  – on steel pipes
  – on pipes with an outer pipe diameter < 80 mm or
  – on pipes that are not subjected to significant temperature fluctuations
- Position the clasp, the metal spring (if necessary) and tension strap clamp 1 on the pipe. Mount the metal spring on the opposite side of the tension strap clamp.
- Place the tension strap around the pipe and insert it into part 3 of the clasp (see Fig. 6.31).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 6.32).

**Attention!**
The edge of the tension strap is very sharp, leading to risk of injury. Remove the burr of the sharp edge.

- Tighten the screw of the clasp.
- Tighten the nut of tension strap clamp 1, but not too firmly in order not to damage the tension strap (see Fig. 6.27).
• Repeat the steps for fixing the second rail (see Fig. 6.33).

![Ratchet clasp with tension strap](image)

**Note!** To release the screw and the tension strap, press the lever down (see Fig. 6.32).

**Installation of the transducers in Variofix L**

• Press the transducers firmly on the transducer clamping fixture in the covers until the transducers are firmly fixed (one transducer in each cover). The transducer cables show in opposite directions (see Fig. 6.34).

**Note!** The arrows on the transducers and the cover have to point in the same direction.

![Transducers in the cover](image)

• Adjust the transducer distance displayed by the transmitter (see section 9.5 and Fig. 6.35).
• Fix the cables of the transducers with the strain relief clamp to protect them from mechanical strain (see Fig. 6.35).
• Put coupling foil (or 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 of the transducer with a small amount of the coupling compound.
• Put the covers with the transducers on the rail.
• Correct the transducer distance, if necessary (see section 9.6.1 and 9.6.2).

**Note!** Make sure that the coupling foil remains on the contact surface of the transducers.

• Tighten the screws of the cover (see Fig. 6.36).

### 6.4.4 Mounting with Variofix C

When measuring in reflection arrangement, one transducer mounting fixture is mounted on the side of the pipe (see Fig. 6.37).

When measuring in diagonal arrangement, two transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 6.38).

In the following, the mounting of one transducer mounting fixture is described (transducers in reflection arrangement).
Overview of the mounting steps

- **step 1**
  disassemble the transducer mounting fixture Variofix C

- **step 2**
  mount the tension straps (with or without clasp) and fix the rail to the tension straps with screws

- **step 3**
  insert the transducers into the rail and fix them

- **step 4**
  screw the cover onto the rail

### 6.4.4.1 Disassembly of Variofix C

- Disassemble the transducer mounting fixture Variofix C.

  In order to remove the cover from the rail, bend the outer sides of the cover outwards (see Fig. 6.40).

  In order to remove the spring clip from the rail, slide it over the indentation on the rail and lift it off (see Fig. 6.41).
6.4.4.2 Installation of the Rail

Select the installation instructions that correspond to the supplied clasp:
- see section Installation of the rail without a clasp
- see section Installation of the rail with the ratchet clasp

Installation of the rail without a clasp

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

**Note!** The edge of the tension strap is very sharp, leading to risk of injury. Remove the burr of the sharp edge.

- Insert approx. 100 mm of the tension strap into one of the slots of the tension strap clamp and bend it (see Fig. 6.42).
- If necessary, insert the long end of the tension strap into the metal spring (see Fig. 6.43). It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer pipe diameter < 80 mm or
  - on pipes that are not subjected to significant temperature fluctuations
- Place the tension strap around the pipe (see Fig. 6.44).

**Fig. 6.41:** Disassembly of Variofix C

**Fig. 6.42:** Tension strap with tension strap clamp

**Fig. 6.43:** Tension strap with the metal spring and the tension strap clamp

- Position the metal spring (if mounted) and the tension strap clamp (see Fig. 6.44):
  - On a horizontal pipe, mount the tension strap clamp on the side of the pipe, if possible.
  - Mount the metal spring (if necessary) on the opposite side of the tension strap clamp.
Installation of the rail with the ratchet clasp

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

**Note!** The edge of the tension strap is very sharp, leading to risk of injury. Remove the burr of the sharp edge.

- Insert approx. 100 mm of the tension strap into parts 1 and 2 of the ratchet clasp (see Fig. 6.46 a).
• Bend the tension strap.
• Insert the tension strap into part (1) of the ratchet clasp (see Fig. 6.46 b).
• Tighten the tension strap.
• Insert the long end of the tension strap into the tension strap clamp and the metal spring (see Fig. 6.47). It is not necessary to mount the metal spring:
  – on steel pipes
  – on pipes with an outer pipe diameter < 80 mm or
  – on pipes that are not subjected to significant temperature fluctuations
• Place the tension strap around the pipe (see Fig. 6.48).

Fig. 6.47: Tension strap with the metal spring and the tension strap clamp

• Position the metal spring (if mounted), the ratchet clasp and the tension strap clamp:
  – On a horizontal pipe, mount the tension strap clamp on the side of the pipe, if possible.
  – Mount the metal spring (if necessary) on the opposite side of the tension strap clamp.
• Insert the long end of the tension strap into part (3) of the ratchet clasp (see Fig. 6.49).
• Tighten the tension strap.
• Cut off the protruding tension strap (see Fig. 6.50).
• Tighten the screw of the ratchet clasp.
• Repeat the steps for the second tension strap.

Fig. 6.48: Tension strap with the metal spring, the ratchet clasp and the tension strap clamp on the pipe

Fig. 6.49: Ratchet clasp with tension strap
6.4.4.3 Installation of the transducers in Variofix C

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

**Note!** If coupling foil is used: If the signal is not sufficient for the measurement, use the coupling compound instead of the coupling foil.

- Position the transducers on the rail in such way that the engravings on the transducers form an arrow. The transducer cables show in opposite directions (see Fig. 6.52).
- Adjust the transducer distance displayed by the transmitter (see section 9.5 and Fig. 6.52).
- Slide the spring clips on the transducers (see Fig. 6.53).
- Fix the transducers by tightening the tensioning screws slightly. The end of the screw has to be placed above the hole in the transducer (see Fig. 6.52).
- Correct the transducer distance, if necessary (see section 9.6.1 and section 9.6.2).
- Tighten the tensioning screw.
- Fix the spacing element on the rail to mark the transducer position (see Fig. 6.52).
- Use a cable tie to fix the transducer cables in order to protect them from mechanical strain (see Fig. 6.53).
- Put the cover on the rail (see Fig. 6.54).
- Tighten the screws on both sides of the cover.
The cover can be removed from the mounted transducer mounting fixture as follows:

- Use a lever tool to remove the cover.
- Insert the lever tool in one of the four openings of the cover (see Fig. 6.55).
- Press the lever tool against the fixture.
- Bend the cover outwards and release it from the anchoring.
- Repeat the steps for the other three openings.
- Remove the cover from the rail.
6.4.5 Mounting with Mounting Shoe and Band Clamp Clasp

- Insert the tension strap into the groove on the upper side of the mounting shoe (see Fig. 6.56).
- Position the mounting shoe and the clasp on the pipe. On horizontal pipes, mount the mounting shoe on the side of the pipe, if possible.
- Place the tension strap around the pipe and insert it into the clasp.
- Tighten the tension strap.
- Tighten the screw of the clasp.

**Note!** The clasp has to be completely in contact with the pipe to ensure a good fixation.

- Repeat the steps for fixing the second mounting shoe. Adjust the displayed transducer distance between the inner edges of the mounting shoes by means of the measuring tape.
- Tighten the screws of the clasps.
- Insert the transducers into the mounting shoes. Press the transducer firmly on the pipe. There should be no air pockets between transducer surface and pipe wall. Tighten the screw of the mounting shoe.

![Fig. 6.56: Transducer in the mounting shoe, installed with tension strap and clasp](image)

**Note!** If the transducers are mounted on a vertical pipe and the transmitter is placed lower than the transducers, the transducer cables should be fixed to the tension strap by a cable tie to protect them from mechanical strain.

6.5 Temperature Probe

**Attention!** Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS).

6.5.1 Preparation of the Pipe

The pipe has to be stable. It has to be able to withstand the pressure exerted by the mounting fixture of the temperature probe.

A good thermal contact between pipe and 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 sanding. The paint does not need to be removed completely.
- Use thermal conductivity foil or apply a layer of thermal conductivity paste or coupling compound to the contact surface of the temperature probe. Observe the corresponding operating temperature range.
- Observe that there must be no air pockets between the contact surface of the temperature probe and the pipe wall.

For the installation of the temperature probe (response time 50 s), see section 6.5.2.
For the installation of the temperature probe (response time 8 s), see section 6.5.3.
6.5.2 Installation of the Temperature Probe (Response Time 50 s)

Note! In case of great temperature differences, it is recommended to thermally insulate the temperature probe from the environment.

Select the installation instructions of the supplied clasp:
• for the installation with a clasp see section 6.5.2.1
• for the installation with a FLEXIM clasp see section 6.5.2.2
• for the installation with a quick release clasp see section 6.5.2.3

6.5.2.1 Installation with a Clasp
• Cut the tension strap to length (pipe circumference + at least 120 mm).
• Make sure that part (2) of the clasp is on top of part (1) (see Fig. 6.57 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. 6.57 b).
• Bend the end of the tension strap.
• Position the temperature probe on the pipe (see Fig. 6.58).
• Place the tension strap around the temperature probe and the pipe.
• Insert the tension strap through the parts (2) and (1) of the clasp.
• Pull the tension strap firmly and engage it in the inner hooks of the clasp.
• Tighten the screws of the clasps.

6.5.2.2 Installation with a FLEXIM Clasp
• 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 (see Fig. 6.59).
• Bend the end of the tension strap.
• Position the temperature probe on the pipe (see Fig. 6.58).
• Place the tension strap around the temperature probe and the pipe.
• Insert the tension strap through the parts (2) and (1) of the clasp.
• Pull the tension strap firmly and engage it in the inner hooks of the clasp.
• Tighten the screws of the clasp.
6.5.2.3 Installation with a Quick Release Clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Position the temperature probe on the pipe (see Fig. 6.58).
- Place the tension strap around the temperature probe and the pipe.
- Insert the tension strap into the clasp (see Fig. 6.60).
- Tighten the tension strap.
- Tighten the screw of the clasp.

![Fig. 6.60: Quick release clasp](image)

6.5.3 Installation of the Temperature Probe (Response Time 8 s)

- Fix the protection plate and the insulation foam to the temperature probe (see Fig. 6.61).
- Take the spring end of the ball chain and insert the last ball into one of the slots on the upper side of the temperature probe (see Fig. 6.62).
- Place the chain around the pipe. Tighten the chain and insert it into the other slot of the temperature probe.

![Fig. 6.61: Temperature probe](image)

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

![Fig. 6.62: Temperature probe on the pipe](image)
7 Connection

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

For the connections of the transmitter FLUXUS F704 see section 4.1, F705 see section 4.2, F706 see section 4.3 and F709 see section 4.4.

Terminal designation

Fig. 7.1: Transmitter FLUXUS F704
Fig. 7.2: Transmitter FLUXUS F705
Fig. 7.3: Transmitter FLUXUS F706
Fig. 7.4: Transmitter FLUXUS F709
7.1 Transducers

**Note!** If transducers are replaced or added, the sensor module also has to be replaced or added (see section 7.7).

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

For the connection of the transducer cable to the transmitter see section 7.1.1 (FLUXUS F704, FLUXUS F705, FLUXUS F706).

For the connection of the extension cable to the transmitter see section 7.1.2.

For the connection of the transducer cable to the junction box see section 7.1.3.

For the connection of the extension cable to the junction box see section 7.1.4.

### 7.1.1 Connection of the Transducer Cable to the Transmitter (FLUXUS F704, F705, F706)

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

**Attention!** The degree of protection of the transmitter is ensured only if the cable glands are firmly tightened and the housing is tightly screwed.

For the connection of the transducer cable with SMB connectors (connection system TS, direct connection) see section 7.1.1.1.

For the connection of the transducer cable with a plastic cable jacket and stripped cable ends (connection system TS, direct connection) see section 7.1.1.2.

For the connection of the transducer cable with a stainless steel conduit and stripped cable ends (connection system TS, direct connection) see section 7.1.1.3.

#### 7.1.1.1 Transducer Cable with SMB Connectors

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

- Remove the left blind plug for the connection of the transducer cable (see Fig. 7.5 or Fig. 7.6).
FLUXUS F704
• Insert the transducer cable with the SMB connectors into the housing.
• Fix the transducer cable by tightening the cable gland.
• Connect the SMB connectors to the sockets of the transmitter (see Fig. 7.1, Fig. 7.5 and Tab. 7.1).

FLUXUS F705, F706
• Push the transducer cable through the sealing ring (only for cable gland M20, not for cable gland 1/2 NPS).
• Insert the transducer cable with the SMB connectors into the housing.
• Fix the transducer cable by tightening the cable gland with the counter nut.
• Connect the SMB connectors to the sockets of the transmitter (see Fig. 7.2, Fig. 7.6 and Tab. 7.1).

Tab. 7.1: Terminal assignment (transducer cable)

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>X_AV</td>
<td>SMB connector (brown cable, marked white)</td>
</tr>
<tr>
<td>X_AR</td>
<td>SMB connector (brown cable, marked black)</td>
</tr>
</tbody>
</table>
7.1.1.2 Transducer Cable with Plastic Cable Jacket and Stripped Cable Ends

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

- Remove the left blind plug for the connection of the transducer cable (see Fig. 7.7 or Fig. 7.8).
- Open the cable gland of the transducer cable. The compression part remains in the cap nut.

**FLUXUS F704**
- Push the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Cut the external shield and brush it back over the compression part.
- Screw the gasket ring side of the basic part into the housing of the transmitter.
- Insert the transducer cable into the housing.

**Attention!** For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and the housing).

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the transmitter (see Fig. 7.1, Fig. 7.7 and Tab. 7.2).

**FLUXUS F705, FLUXUS F706**
- Push the transducer cable through the cap nut, the compression part, the basic part and the sealing ring (sealing ring: only for cable gland M20, not for cable gland 1/2 NPS).
- Prepare the transducer cable.
- Cut the external shield and brush it back over the compression part.
- Insert the transducer cable into the housing.

**Attention!** For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and the housing).

- Fix the cable gland by screwing the cap nut onto the basic part.
- Fix the transducer cable by tightening the cable gland with the counter nut.
- Connect the transducer cable to the terminals of the transmitter (see Fig. 7.2, Fig. 7.8 and Tab. 7.2).

**Tab. 7.2: Terminal assignment**

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV</td>
<td>transducer [1] (core)</td>
</tr>
<tr>
<td>AVS</td>
<td>transducer [2] (internal shield)</td>
</tr>
<tr>
<td>ARS</td>
<td>transducer [3] (inner shield)</td>
</tr>
<tr>
<td>AR</td>
<td>transducer [5] (core)</td>
</tr>
</tbody>
</table>
Fig. 7.7: Connection of the transducer cable with plastic cable jacket and stripped cable ends to the transmitter FLUXUS F704

Fig. 7.8: Connection of the transducer cable with plastic cable jacket and stripped cable ends to the transmitter FLUXUS F705, F706 (example with FLUXUS F705)
7.1.1.3 Transducer Cable with Stainless Steel Conduit and Stripped Cable Ends

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

• Remove the left blind plug for the connection of the transducer cable (see Fig. 7.9 or Fig. 7.10).

**FLUXUS F704**
• 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 (see Fig. 7.1, Fig. 7.9 and Tab. 7.3).

**FLUXUS F705, F706**
• Push the transducer cable through the sealing ring (only for cable gland M20, not for cable gland 1/2 NPS).
• Insert the transducer cable into the housing.
• Fix the transducer cable by tightening the cable gland with the counter nut.
• Connect the transducer cable to the terminals of the transmitter (see Fig. 7.2, Fig. 7.10 and Tab. 7.3).

Tab. 7.3: Terminal assignment (transducer cable)

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV</td>
<td>transducer (white 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 (white cable)</td>
</tr>
</tbody>
</table>

![Fig. 7.9: Connection of the transducer cable with stainless steel conduit and stripped cable ends to the transmitter FLUXUS F704](image-url)
7.1.2 Connection of the Extension Cable to the Transmitter

Attention! Observe the “Safety Instructions for the Use in Explosive Atmosphere” (see document SIFLUXUS).

For the connection of the extension cable with AMP-Quick and SMB connectors (connection system AS) see section 7.1.2.1.

For the connection of the extension cable with a plastic cable jacket and stripped cable ends (connection system TS) see section 7.1.2.2.

7.1.2.1 Extension Cable with AMP-Quick and SMB Connectors

FLUXUS F704

• Remove the left blind plug for the connection of extension cable (see Fig. 7.11).
• Insert the extension cable with the AMP-Quick and SMB connectors into the housing.
• Fix the extension cable by tightening the cable gland.
• Connect the AMP-Quick and SMB connectors to the sockets of the transmitter (see Fig. 7.1, Fig. 7.11 and Tab. 7.4).
• Connect the connectors of the transducer cable and the extension cable.

Tab. 7.4: Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>X_AV</td>
<td>SMB connector (white or marked cable)</td>
</tr>
<tr>
<td>X_AR</td>
<td>SMB connector (brown cable)</td>
</tr>
<tr>
<td>X1</td>
<td>AMP-Quick connector (connection of the sensor module)</td>
</tr>
</tbody>
</table>
Fig. 7.11: Connection of the extension cable with AMP-Quick and SMB connectors to the transmitter FLUXUS F704

Fig. 7.12: Connection of the extension cable with AMP-Quick and SMB connectors to the transmitter FLUXUS F705
FLUXUS F705

- Remove the left blind plug for the connection of extension cable (see Fig. 7.12).
- Push the extension cable through the sealing ring (only for cable gland M20, not for cable gland 1/2 NPS).
- Insert the extension cable with the AMP-Quick and SMB connectors into the housing.
- Fix the extension cable by tightening the cable gland with the counter nut.
- Connect the AMP-Quick and SMB connectors to the sockets of the transmitter (see Fig. 7.2, Fig. 7.12 and Tab. 7.4).
- Connect the connectors of the transducer cable and the extension cable.

FLUXUS F709

- Open the cable gland of the extension cable (see Fig. 7.13).

![Connection Diagram]

Fig. 7.13: Connection of the extension cable with AMP-Quick and SMB connectors to the transmitter FLUXUS F709

- Push the basic part of the cable gland towards the AMP-Quick and SMB connectors, the cap nut and the compression part in the other direction.

**Note!** Cap nut, compression part and basic part of the cable gland remain on the cable.

- Push the extension cable through the shield terminal to terminal strip KL6 for measuring channel A and to terminal strip KL8 for measuring channel B.
- Pull the extension cable back until the brushed back outer shield is below the shield terminal.
- Fix the extension cable and the external shield to the shield terminal.
- Insert the extension cable with the AMP-Quick and SMB connectors into the housing.
- Connect the AMP-Quick and SMB connectors to the sockets of the transmitter (see Fig. 7.4, Fig. 7.13 and Tab. 7.5).
- Connect the connectors of the transducer cable and the extension cable.
7.1.2.2 Extension Cable with Plastic Cable Jacket and Stripped Cable Ends

**Attention!** Observe the “Safety Instructions for the Use in Explosive Atmosphere” (see document SIFLUXUS).

**FLUXUS F704**
- Remove the left blind plug for the connection of extension cable (see Fig. 7.14).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut and the compression part.
- Prepare the extension cable.
- Cut the external shield and brush it back over the compression part.
- Screw the gasket ring side of the basic part into the housing of the transmitter.
- Insert the extension cable into the housing.

**Attention!** For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and 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 (see Fig. 7.1, Fig. 7.14 and Tab. 7.6).

**FLUXUS F705, F706**
- Remove the left blind plug for the connection of extension cable (see Fig. 7.15).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut, the compression part, the basic part and the gasket ring. (Sealing ring: only for cable gland M20, not for cable gland 1/2 NPS.)
- Prepare the extension cable.
- Cut the external shield and brush it back over the compression part.
- Insert the extension cable into the housing.

**Attention!** For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and the housing).

- Fix the cable gland by screwing the cap nut onto the basic part.
- Fix the extension cable by tightening the cable gland with the counter nut.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.2, Fig. 7.15 and Tab. 7.6).

**Tab. 7.5: Terminal assignment**

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>measuring</td>
<td>measuring</td>
</tr>
<tr>
<td>channel A</td>
<td>channel B</td>
</tr>
<tr>
<td>X6AV</td>
<td>X8BV</td>
</tr>
<tr>
<td>X6AR</td>
<td>X8BR</td>
</tr>
<tr>
<td>X5</td>
<td>X7</td>
</tr>
</tbody>
</table>

**Tab. 7.6: 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 (shield)</td>
</tr>
<tr>
<td>ARS</td>
<td>brown cable (shield)</td>
</tr>
<tr>
<td>AR</td>
<td>brown cable (core)</td>
</tr>
</tbody>
</table>
Fig. 7.14: Connection of the extension cable with plastic cable jacket and stripped cable ends to the transmitter FLUXUS F704

Fig. 7.15: Connection of the extension cable with plastic cable jacket and stripped cable ends to the transmitter FLUXUS F705, F706 (example with FLUXUS F705)
FLUXUS F709
• Prepare the extension cable. Cut the external shield and brush it back (see Fig. 7.16).
• Push the extension cable through the shield terminal to terminal strip KL6 for measuring channel A and to terminal strip KL8 for measuring channel B.
• Pull the extension cable back until the brushed back outer shield is below the shield terminal.
• Fix the extension cable and the external shield to the shield terminal.
• Connect the extension cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.16 and Tab. 7.7).

Tab. 7.7: 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 (shield)</td>
</tr>
<tr>
<td>ARS</td>
<td>brown cable (shield)</td>
</tr>
<tr>
<td>AR</td>
<td>brown cable (core)</td>
</tr>
</tbody>
</table>

Fig. 7.16: Connection of the extension cable with plastic cable jacket and stripped cable ends to the transmitter FLUXUS F709
7.1.3 Connection of the Transducer Cable to the Junction Box

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

For the connection of the transducer cable with SMB connectors (connection system TS) see section 7.1.3.1.
For the connection of the transducer cable with a plastic cable jacket and stripped cable ends (connection system TS) see section 7.1.3.2.
For the connection of the transducer cable with a stainless steel conduit and stripped cable ends (connection system TS) see section 7.1.3.3.

7.1.3.1 Transducer Cable with SMB Connectors

- Remove the right blind plug for the connection of the transducer cable (see Fig. 7.17).
- Insert the transducer cable with the SMB connectors into the junction box.
- Fix the transducer cable by tightening the cable gland.
- Connect the SMB connectors to the sockets of the junction box (see Fig. 7.17 and Tab. 7.8).

Tab. 7.8: Terminal assignment

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>XV</td>
<td>SMB connector (brown cable, marked white)</td>
</tr>
<tr>
<td>XR</td>
<td>SMB connector (brown cable, marked black)</td>
</tr>
</tbody>
</table>

**Attention!**

For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and the junction box).

7.1.3.2 Transducer Cable with Plastic Cable Jacket and Stripped Cable Ends

- Remove the right blind plug for the connection of the transducer cable (see Fig. 7.19).
- Open the cable gland of the transducer cable. The compression part remains in the cap nut (see Fig. 7.18).
- Push the transducer cable through the cap nut and the compression part. Prepare the transducer cable.
- Cut 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 transducer cable into the junction box.

**Attention!**

Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).
• Fix the cable gland by screwing the cap nut onto the basic part.
• Connect the transducer cable to the terminals of the junction box (see Fig. 7.20 or Fig. 7.21 and Tab. 7.9).

Tab. 7.9: Terminal assignment (KL1)

<table>
<thead>
<tr>
<th>terminal (JBP2, JBP3)</th>
<th>terminal (JBO1)</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>V</td>
<td>transducer (core)</td>
</tr>
<tr>
<td>TVS</td>
<td>VS</td>
<td>transducer (shield)</td>
</tr>
<tr>
<td>TRS</td>
<td>RS</td>
<td>transducer (shield)</td>
</tr>
<tr>
<td>TR</td>
<td>R</td>
<td>transducer (core)</td>
</tr>
</tbody>
</table>

Fig. 7.18: Cable gland

Fig. 7.19: Connection of the transducer cable with plastic cable jacket and stripped cable ends

Fig. 7.20: Terminal designation (junction box JBP2, JBP3)

Fig. 7.21: Terminal designation (junction box JBO1)
7.1.3.3 Transducer Cable with Stainless Steel Conduit and Stripped Cable Ends

Attention! Observe the “Safety Instructions for the Use in Explosive Atmosphere” (see document SIFLUXUS).

- Remove the right blind plug for the connection of the transducer cable (see Fig. 7.22).
- 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 (see Fig. 7.21, Fig. 7.22 and Tab. 7.10).

Tab. 7.10: Terminal assignment (KL1)

<table>
<thead>
<tr>
<th>terminal (JB01)</th>
<th>connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>transducer (white 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 (white cable)</td>
</tr>
</tbody>
</table>

![Fig. 7.22: Connection of the transducer cable with stainless steel conduit and stripped cable ends]
7.1.4 Connection of the Extension Cable to the Junction Box

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

- Remove the left blind plug for the connection of extension cable (see Fig. 7.23).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut and the compression part.

- Prepare the extension cable.
- Cut the external shield 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.

Attention! For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and 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 transmitter (see Fig. 7.24 and Tab. 7.11).
7.2 Temperature Probe

**Attention!** Observe the “Safety Instructions for the Use in Explosive Atmosphere” (see document SIFLUXUS).

Temperature probes Pt100/Pt1000 (4-wire) can be connected to the inputs of the transmitter (optional).

For the direct connection of the temperature probe, see section 7.2.1 and Tab. 7.12.

For the connection with an extension cable, see section 7.2.2 and Tab. 7.12.

For the connection with a junction box, see section 7.2.3 and Tab. 7.12.

---

**Tab. 7.11: Terminal assignment (extension cable, KL2)**

<table>
<thead>
<tr>
<th>terminal</th>
<th>connection</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>
</tbody>
</table>

---

**Fig. 7.24: Connection of the extension cable and the transducer cable to the junction box JBxx (example with JB01)**
Tab. 7.12: Connection systems

<table>
<thead>
<tr>
<th>direct connection</th>
<th>connection with extension cable</th>
<th>connection with junction box</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Diagram of direct connection]</td>
<td>![Diagram of connection with extension cable]</td>
<td>![Diagram of connection with junction box]</td>
</tr>
</tbody>
</table>

1 FLUXUS F709: Connection to the transmitter without cable gland

For the assignment and the activation of the temperature inputs see chapter 17.

### 7.2.1 Direct Connection of the Temperature Probe

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

**FLUXUS F704**

- Remove the second blind plug on the right for the connection of the temperature probe (see Fig. 7.25).
- Open the cable gland of the temperature probe. The compression part remains in the cap nut (see Fig. 7.26 and Tab. 7.12).
- 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 gasket ring side of the reducer tightly into the housing of the transmitter.
- Tightly 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 (see Fig. 7.1, Fig. 7.25 and Tab. 7.13).
FLUXUS F705, F706

• Remove the second blind plug on the right for the connection of the temperature probe (see Fig. 7.27).
• Open the cable gland of the temperature probe. The compression part remains in the cap nut (see Fig. 7.28 and Tab. 7.12).
• Push the cable of the temperature probe through the cap nut, the compression part, the basic part, the reducer and the sealing ring. (Sealing ring: only for cable gland M20, not for cable gland 1/2 NPS.)
• Prepare the cable.
• Insert the cable into the housing.
• Tightly screw the basic part into the reducer.
• Fix the cable gland by screwing the cap nut onto the basic part.
• Fix the transducer cable by tightening the cable gland with the ferrite nut.
• Connect the temperature probe to the terminals of the transmitter (see Fig. 7.2, Fig. 7.27 and Tab. 7.13).

Tab. 7.13: Terminal assignment of the transmitter

<table>
<thead>
<tr>
<th>terminal</th>
<th>temperature probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a...T4a</td>
<td>red</td>
</tr>
<tr>
<td>T1A...T4A</td>
<td>red/blue</td>
</tr>
<tr>
<td>T1b...T4b</td>
<td>white/blue</td>
</tr>
<tr>
<td>T1B...T4B</td>
<td>white</td>
</tr>
<tr>
<td>S1...S4</td>
<td>shield</td>
</tr>
</tbody>
</table>

Fig. 7.25: Transmitter FLUXUS F704

Fig. 7.26: Cable gland and preparation

Fig. 7.27: Transmitter FLUXUS F705, F706 (example with FLUXUS F705)

Fig. 7.28: Cable gland and preparation

Fig. 7.29: Temperature probe
FLUXUS F709

- Prepare the cable of the temperature probe (see Fig. 7.31).
- Connect the temperature probe to the terminals of the transmitter (see Fig. 7.4, Fig. 7.30 and Tab. 7.14).

![Temperature Probe](image1)

![Preparation of the Cable](image2)

Tab. 7.14: Terminal assignment of the transmitter

<table>
<thead>
<tr>
<th>terminal</th>
<th>temperature probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a...T4a</td>
<td>red</td>
</tr>
<tr>
<td>T1A...T4A</td>
<td>red/blue</td>
</tr>
<tr>
<td>T1b...T4b</td>
<td>white/blue</td>
</tr>
<tr>
<td>T1B...T4B</td>
<td>white</td>
</tr>
<tr>
<td>S1...S4</td>
<td>shield</td>
</tr>
</tbody>
</table>

7.2.2 Connection with an Extension Cable

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

FLUXUS F704

- Remove the second blind plug on the right for the connection of the extension cable (see Fig. 7.25).
- Open the cable gland of the extension cable. The compression part remains in the cap nut (see Fig. 7.26 and Tab. 7.12).
- Push the extension cable through the cap nut, the compression part, the basic part, and the reducer.
- Prepare the extension cable.
- Insert the extension cable into the housing.
- Screw the gasket ring side of the reducer tightly into the housing of the transmitter.
- Tightly screw the basic part into the reducer.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the connectors of the extension cable and the temperature probe.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.1, Fig. 7.25 and Tab. 7.15).
**FLUXUS F705, F706**

- Remove the second blind plug on the right for the connection of the extension cable (see Fig. 7.27).
- Open the cable gland of the extension cable. The compression part remains in the cap nut (see Fig. 7.28 and Tab. 7.12).
- Push the extension cable through the cap nut, the compression part, the basic part, the reducer and the gasket ring.
  (Sealing ring: only for cable gland M20, not for cable gland 1/2 NPS.)
- Prepare the extension cable.
- Insert the extension cable into the housing.
- Tightly screw the basic part into the reducer.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Fix the extension cable by tightening the cable gland with the counter nut with the ferrite nut.
- Connect the connectors of the extension cable and the temperature probe.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.2, Fig. 7.27 and Tab. 7.15)

<table>
<thead>
<tr>
<th>terminal</th>
<th>extension cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a...T4a</td>
<td>red</td>
</tr>
<tr>
<td>T1A...T4A</td>
<td>gray</td>
</tr>
<tr>
<td>T1b...T4b</td>
<td>blue</td>
</tr>
<tr>
<td>T1B...T4B</td>
<td>white</td>
</tr>
<tr>
<td>S1...S4</td>
<td>shield</td>
</tr>
</tbody>
</table>

**FLUXUS F709**

- Prepare the extension cable (see Fig. 7.31).
- Connect the connectors of the extension cable and the temperature probe.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.30 and Tab. 7.15).

### 7.2.3 Connection with Junction Box

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

For the connection of the extension cable to the transmitter see section 7.2.3.1.

For the connection of the extension cable and the temperature probe to the junction box see section 7.2.3.2.

#### 7.2.3.1 Connection to the Transmitter

**FLUXUS F704**

- Remove the second blind plug on the right for the connection of the extension cable (see Fig. 7.25).
- Open the cable gland of the extension cable. The compression part remains in the cap nut (see Fig. 7.26 and Tab. 7.12).
- Push the extension cable through the cap nut, the compression part, the basic part, and the reducer.
- Prepare the extension cable.
- Insert the extension cable into the housing.
- Screw the gasket ring side of the reducer tightly into the housing of the transmitter.
- Tightly screw the basic part into the reducer.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.1, Fig. 7.25 and Tab. 7.15).
FLUXUS F705, F706

• Remove the second blind plug on the right for the connection of the extension cable (see Fig. 7.27).
• Open the cable gland of the extension cable. The compression part remains in the cap nut (see Fig. 7.28 and Tab. 7.12).
• Push the extension cable through the cap nut, the compression part, the basic part, the reducer and the gasket ring. (Sealing ring: only for cable gland M20, not for cable gland 1/2 NPS.)
• Prepare the extension cable.
• Insert the extension cable into the housing.
• Tightly screw the basic part into the reducer.
• Fix the cable gland by screwing the cap nut onto the basic part.
• Connect the extension cable to the terminals of the transmitter (see Fig. 7.2, Fig. 7.27 and Tab. 7.15).

FLUXUS F709

• Prepare the extension cable (see Fig. 7.31).
• Connect the extension cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.30 and Tab. 7.15).

7.2.3.2 Connection to the Junction Box

Extension cable

• Remove the blind plug in the middle for the connection of extension cable (see Fig. 7.34).
• Open the cable gland of the extension cable (see Fig. 7.33 and Tab. 7.12). The compression part remains in the cap nut.
• Push the extension cable through the cap nut and the compression part.
• Prepare the extension cable.
• Cut the external shield and brush it back over the compression part.
• Screw the gasket ring side of the reducer into the junction box (see Fig. 7.33).
• Tightly screw the basic part into the reducer.
• Insert the extension cable into the junction box.
• Fix the cable gland by screwing the cap nut onto the basic part.
• Connect the extension cable to the terminals of the transmitter (see Fig. 7.34 and Tab. 7.16).
Temperature probe

• Remove the blind plug for the connection of the temperature probe (see Fig. 7.34).
• Open the cable gland of the temperature probe (see Fig. 7.35 and Tab. 7.12). The compression part remains in the cap nut.
• Push the cable of the temperature probe through the cap nut and the compression part.
• Prepare the cable.
• Cut the external shield and brush it back over the compression part.
• Screw the gasket ring side of the reducer into the junction box.
• Tightly screw the basic part into the reducer.
• Insert the cable into the junction box.
• Fix the cable gland by screwing the cap nut onto the basic part.
• Connect the temperature probe to the terminals of the junction box (see Fig. 7.34 and Tab. 7.16).

Tab. 7.16: Terminal assignment of the junction box

<table>
<thead>
<tr>
<th>terminal</th>
<th>extension cable (KL2)</th>
<th>temperature probe (KL1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>2</td>
<td>gray</td>
<td>red/blue</td>
</tr>
<tr>
<td>3</td>
<td>white</td>
<td>white</td>
</tr>
<tr>
<td>4</td>
<td>blue</td>
<td>white/blue</td>
</tr>
</tbody>
</table>

Fig. 7.34: Junction box JBT2, JBT3

Tab. 7.16: Terminal assignment of the junction box

<table>
<thead>
<tr>
<th>terminal</th>
<th>extension cable (KL2)</th>
<th>temperature probe (KL1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>2</td>
<td>gray</td>
<td>red/blue</td>
</tr>
<tr>
<td>3</td>
<td>white</td>
<td>white</td>
</tr>
<tr>
<td>4</td>
<td>blue</td>
<td>white/blue</td>
</tr>
</tbody>
</table>

Fig. 7.35: Preparation
7.3 Power Supply

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

The external protective earth is connected to the equipotential bonding terminal on the housing of the transmitter FLUXUS F704**-A2, F705**-A2, F705**-NN (see Fig. 7.36 or Fig. 7.37). It always has to be connected.

Attention! According to IEC 61010-1:2010, a switch has to be provided near the measuring instrument in the building installation, easily accessible for the user and marked as a disconnection device for the measuring instrument.

If the transmitter FLUXUS F704**-A2, F705**-A2 is used in an explosive atmosphere, the switch should be installed outside the explosive atmosphere. If this is not possible, the switch should be installed in the least hazardous area.

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

FLUXUS F704, F705, F706

For the connection of the power cable to the transmitter, see box Cable connection, Fig. 7.1 or Fig. 7.2, Fig. 7.36 or Fig. 7.37 and Tab. 7.17.

Cable connection

- Remove the blind plug from the transmitter for the connection of the cable (if present).
- Prepare the cable with an M20 cable gland.
- Push the cable through the cap nut, the compression part and the basic part of the cable gland.
- Insert the cable into the housing of the transmitter.
- Screw the gasket ring side of the basic part into the housing of the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the cable to the terminals of the transmitter.

FLUXUS F704:

- Prepare the cable with an M20 cable gland.
- Push the cable through the cap nut, the compression part and the basic part of the cable gland.
- Insert the cable into the housing of the transmitter.
- Screw the gasket ring side of the basic part into the housing of the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the cable to the terminals of the transmitter.

FLUXUS F705, F706:

- Prepare the cable with a cable gland.
- Push the extension cable through the cap nut, the compression part, the basic part and the gasket ring.
  (Sealing ring: only for cable gland M20, not for cable gland 1/2 NPS.)
- Insert the cable into the housing of the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Fix the transducer cable by tightening the cable gland with the ferrite nut.
- Connect the cable to the terminals of the transmitter.

Fig. 7.36: Transmitter FLUXUS F704
For the voltage, see Technical Specifications.

**FLUXUS F709**

- Prepare the power cable.
- Connect the power cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.38 and Tab. 7.18).

### Tab. 7.17: Terminal assignment

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Connection AC</th>
<th>Connection DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>earth/ground</td>
<td>earth/ground</td>
</tr>
<tr>
<td>N(-)</td>
<td>neutral</td>
<td>+ DC</td>
</tr>
<tr>
<td>L(+)</td>
<td>phase 100...230 V AC, 50...60 Hz</td>
<td>+ DC</td>
</tr>
<tr>
<td>Fuse</td>
<td>1 A, time-lag</td>
<td>1.6 A, time-lag</td>
</tr>
</tbody>
</table>

For the voltage, see Technical Specifications.

### Fig. 7.37: Transmitter FLUXUS F705, F706

(example with FLUXUS F705)

### Tab. 7.18: Terminal assignment (power supply)

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Connection AC</th>
<th>Connection DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>earth/ground</td>
<td>earth/ground</td>
</tr>
<tr>
<td>L1</td>
<td>phase 100...230 V AC, 50...60 Hz</td>
<td>+ DC</td>
</tr>
<tr>
<td>Fuse</td>
<td>1 A, time-lag</td>
<td>1.6 A, time-lag</td>
</tr>
</tbody>
</table>

For the voltage, see Technical Specifications.
7.4 Outputs

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

Attention! The outputs can only be connected to a low voltage circuit (max. 30 V AC or 42 V DC against earth).

FLUXUS F704, F705, F706

For the connection of the output cable to the transmitter, see box Cable connection S. 75, Fig. 7.1 or Fig. 7.2, Fig. 7.39 or Fig. 7.40 and Tab. 7.19.

FLUXUS F709

• Prepare the output cable.
• Connect the output cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.41 and Tab. 7.19).
<table>
<thead>
<tr>
<th>output</th>
<th>transmitter circuit</th>
<th>connection</th>
<th>external circuit</th>
<th>remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>active current loop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>passive current loop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>switchable current loop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HART (active)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HART (passive)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voltage output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>frequency output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The number, type and connections of the outputs are customized.

$R_{\text{ext}}$ is the sum of all ohmic resistances in the circuit (e.g. resistance of the conductors, resistance of the ammeter/voltmeter).
For the display and the setting of the switchable current loop see section 18.1.

<table>
<thead>
<tr>
<th>output</th>
<th>transmitter</th>
<th>internal circuit</th>
<th>connection</th>
<th>external circuit</th>
<th>remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>binary output (opto-relay) F704 F705 F706</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pxa</td>
<td></td>
<td></td>
<td></td>
<td>U_{\text{ext}} \leq 28 V</td>
<td>I_{\text{c}} \leq 100 mA</td>
</tr>
<tr>
<td>Pxb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>binary output (open collector)</td>
<td></td>
<td></td>
<td></td>
<td>U_{\text{ext}} = 5...24 V</td>
<td>R_c [k\Omega] = U_{\text{ext}}/I_{\text{c}} [mA]</td>
</tr>
<tr>
<td>P_{x+/Pxa}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{x-/Pxb}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>binary output (Reed relay)</td>
<td></td>
<td></td>
<td></td>
<td>U_{\text{max}} = 48 V</td>
<td>I_{\text{max}} = 100 mA</td>
</tr>
<tr>
<td>P_{x+/Pxa}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{x-/Pxb}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS485 F704 F705 F706</td>
<td></td>
<td></td>
<td></td>
<td>120 \Omega</td>
<td>termination resistor</td>
</tr>
<tr>
<td>A+</td>
<td></td>
<td></td>
<td></td>
<td>shied 101</td>
<td></td>
</tr>
<tr>
<td>B-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS485 F709</td>
<td></td>
<td></td>
<td></td>
<td>120 \Omega</td>
<td>termination resistor</td>
</tr>
<tr>
<td>4A+</td>
<td></td>
<td></td>
<td></td>
<td>shield 43</td>
<td></td>
</tr>
<tr>
<td>4B-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The number, type and connections of the outputs are customized.

\( R_{\text{ext}} \) is the sum of all ohmic resistances in the circuit (e.g. resistance of the conductors, resistance of the ammeter/voltmeter).

\(^1\) For the display and the setting of the switchable current loop see section 18.1.
7.5 Inputs

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

Attention! The inputs can only be connected to a low voltage circuit (max. 30 V AC or 42 V DC against earth).

Fig. 7.42: Transmitter FLUXUS F704

Fig. 7.43: Transmitter FLUXUS F705, F706) (example with FLUXUS F705)

Fig. 7.44: Transmitter FLUXUS F709
7.5.1 Temperature Input

The temperature probes Pt100/Pt1000 (4-wire) can be connected to the inputs of the transmitter (optional) (see section 7.2). For the assignment and the activation of the temperature inputs see chapter 17.

7.5.2 Current Input

An active or a passive current source can be connected to the current inputs of the transmitter (active current source: with own power supply, passive current source: with external power supply).

For the connection of an active current source see section 7.5.2.1.
For the connection of a passive current source see section 7.5.2.2.

7.5.2.1 Connection of an Active Current Source

**Attention!** The terminals Tx and Tb must not be connected.

**FLUXUS F704, FLUXUS F705, F706**

For the connection of the input cable to the transmitter see box **Cable connection S. 75, Fig. 7.1 or Fig. 7.2, Fig. 7.42 or Fig. 7.43 and Tab. 7.20.**

**FLUXUS F709**

- Prepare the input cable.
- Connect the input cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.44 and Tab. 7.20).

Tab. 7.20: Connection of an active current source

<table>
<thead>
<tr>
<th>input</th>
<th>transmitter internal circuit</th>
<th>connection</th>
<th>external circuit</th>
<th>comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>current input</td>
<td></td>
<td>TxA</td>
<td>+</td>
<td>max. permanent overcurrent: 100 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TxB</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Txb (not connected)</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

If the polarity of the current source is inversed, only the sign of the measured current will change. For the assignment and the activation of the current input, see chapter 17.

7.5.2.2 Connection of a Passive Current Source

**Attention!** The terminals Tx and Tbx must not be connected.

**Attention!** Observe the correct polarity in order to avoid damaging the current source. A permanent short circuit can lead to the destruction of the current input.

**FLUXUS F704, FLUXUS F705, FLUXUS F706**

For the connection of the input cable to the transmitter see box **Cable connection S. 75, Fig. 7.1 or Fig. 7.2, Fig. 7.42 or Fig. 7.43 and Tab. 7.21.**
FLUXUS F709
• Prepare the input cable.
• Connect the input cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.44 and Tab. 7.21).

Tab. 7.21: Connection of a passive current source

<table>
<thead>
<tr>
<th>input</th>
<th>transmitter internal circuit</th>
<th>connection</th>
<th>external circuit</th>
<th>comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>current input</td>
<td></td>
<td>TxA</td>
<td></td>
<td>max. permanent overcurrent: 100 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TxB (not connected)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Txb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At full load (20 mA), a voltage of 22.9 V DC (FLUXUS F704, F705, F706) or 13.9 V DC (FLUXUS F709) is available for the supply of the passive current source.

For the assignment and the activation of the current input see chapter 17.

7.5.3 Binary Input
The transmitter can be equipped with 1 or 2 binary inputs. Via the binary outputs, it is possible to remotely trigger some functions of the transmitter (see section 11.10).

FLUXUS F704, FLUXUS F705, FLUXUS F706
For the connection of the input cable to the transmitter see box Cable connection S. 75, Fig. 7.1 or Fig. 7.2, Fig. 7.42 or Fig. 7.43 and Tab. 7.22).

FLUXUS F709
• Prepare the input cable.
• Connect the input cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.44 and Tab. 7.22).

Tab. 7.22: Connection of the binary inputs

<table>
<thead>
<tr>
<th>binary input</th>
<th>terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>P1+, P1-</td>
</tr>
<tr>
<td>S2</td>
<td>P2+, P2-</td>
</tr>
</tbody>
</table>
7.6 Serial Interface

Attention! Observe the “Safety Instructions for the Use in Explosive Atmosphere” (see document SIFLUXUS).

7.6.1 RS232 Interface

The RS232 interface is located on the front plate of the transmitter (see Fig. 7.45, Fig. 7.46 or Fig. 7.47).

- Connect the RS232 cable to the transmitter and to the serial interface of the PC. If the RS232 cable cannot be connected to the PC, use the RS232/USB adapter.

The RS232 cable and the RS232/USB adapter are part of the serial data kit (optional).

Note! If a problem occurs when the RS232/USB adapter is used for the connection, contact your system administrator.

7.6.2 RS485 Interface

The transmitter can also be equipped with an RS485 interface (optional).

**FLUXUS F704, F705, F706**

For the connection of the RS485 cable to the transmitter, see box Cable connection S. 75, Fig. 7.1 or Fig. 7.2, Fig. 7.45 or Fig. 7.46 and Tab. 7.19).
FLUXUS F709

• Prepare the RS485 cable.

• Connect the RS485 cable to the terminals of the transmitter (see Fig. 7.4, Fig. 7.48 and Tab. 7.19).

For further information on the data transmission see chapter 12.

7.7 Sensor Module (SENSPROM)

Attention! Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

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

With the transducers of the connection system AS, the sensor module is integrated in the transducer. They are connected via AMP-Quick connectors (see Fig. 7.49).

With the transducers of the connection system TS, the sensor module is supplied separately. The sensor module is already connected to the terminals of the transmitter (see Fig. 7.50).

Attention! The AMP-Quick connector and the separate sensor module must never be connected to the transmitter at the same time.
If transducers are replaced or added, the sensor module has to be replaced or added.

**Note!** The serial number of sensor module and transducer have to be identical. A wrong or incorrectly connected sensor module will lead to incorrect measured values or to a measurement failure.

**FLUXUS F704, FLUXUS F705**

- Disconnect the power supply from the transmitter.
- For the connection of the AMP-Quick connector (connection system AS), see section 7.1.2.1.
- For the connection of the separate sensor module (connection system TS):
  – Insert the sensor module into the lower row of terminal strip (see Fig. 7.1 or Fig. 7.2 and Fig. 7.51 or Fig. 7.52). The slots SA1...SA4 are assigned to the transducers of measuring channel A, the slots SB1...SB4 are assigned to the transducers of measuring channel B.
- Connect the transmitter to the power supply.
- Enter all parameters of the program branch Stop Charging.
- Press ENTER until the main menu is displayed again.

![Fig. 7.51: Transmitter FLUXUS F704](image1)

![Fig. 7.52: Transmitter FLUXUS F705](image2)

**FLUXUS F706**

- Disconnect the power supply from the transmitter.
- For the connection of the AMP-Quick connector (connection system AS), see section 7.1.2.1.
- For the connection of the separate sensor module (connection system TS):
  – Insert the sensor module into the lower row of terminal strip (see Fig. 7.1 or Fig. 7.2 and Fig. 7.51 or Fig. 7.52). The slots ROA A are assigned to the transducers of measuring channel A, the slots ROB B are assigned to the transducers of measuring channel B, the slots ROC C are assigned to the transducers of measuring channel C, the slots ROD D are assigned to the transducers of measuring channel D.
- Connect the transmitter to the power supply.
- Enter all parameters of the program branch Stop Charging.
- Press ENTER until the main menu is displayed again.

![Abb. 7.53: Messumformer FLUXUS F706](image3)
FLUXUS F709

- Disconnect the power supply from the transmitter.
- For the connection of the AMP-Quick connector (connection system AS), see section 7.1.2.1.
- For the connection of the separate sensor module (connection system TS):
  - Insert the sensor module into the terminal strip KL5 or KL7 (see Fig. 7.4 and Fig. 7.54). The slots SA1...SA4 are assigned to the transducers of measuring channel A, the slots SB1...SB4 are assigned to the transducers of measuring channel B.
- Connect the transmitter to the power supply.
- Enter all parameters of the program branch Stop Charging.
- Press ENTER until the main menu is displayed again.

7.8 SD Card (Optional)

**Attention!** Observe the "Safety Instructions for the Use in Explosive Atmosphere" (see document SIFLUXUS).

Additionally, the transmitter FLUXUS F704, F705, F706 can be equipped with an SD card (see Fig. 7.55). Measured values can be stored on the SD card for a longer period of time.

At first, the serial data transmission has to be parametrized. For the parametrization and activation of the serial data transmission see section 12.2.

When the housing is opened, the SD card can be extracted and the measured values can be read out by a PC.

![Fig. 7.54: Transmitter FLUXUS F709](image)

*Fig. 7.54: Transmitter FLUXUS F709*

![Fig. 7.55: Transmitter FLUXUS F70x (example with F704)](image)

*Fig. 7.55: Transmitter FLUXUS F70x (example with F704)*
8 Start-up of the Transmitter

8.1 Switching on

As soon as the transmitter is connected to the power supply, the display indicates which transducer has been detected at which channel.

Afterwards, the serial number of the transmitter is displayed for a short time.

Data cannot be entered while the serial number is displayed.

After the transmitter is switched on, the main menu is displayed in the default language. The language of the display can be set (see section 8.5).

8.2 Initialization

During an initialization (INIT) of the transmitter, the settings in the program branches Parameter and Output Options and some of the settings in the program branch Special Funct. are reset to the default settings of the manufacturer. For INIT-resistant settings, see annex A.

Proceed as follows to execute an initialization:

- While switching on the transmitter: keep keys BRK and C pressed.
- During the operation of the transmitter: press keys BRK, C and ENTER at the same time. A RESET is executed. Release key ENTER only. Keep keys BRK and C pressed.

After the initialization has been executed, the message INITIALISATION DONE is displayed.

After the initialization, the remaining settings of the transmitter can be reset to the default settings and/or the stored measured values can be deleted.

Select yes to reset the remaining settings to the default settings or no to keep them at the current settings.

Press ENTER.

If yes is selected, the message FACTORY DEFAULT DONE will be displayed.

Select yes to delete the stored measured values or no to keep them stored.

Press ENTER.

This display will only be indicated if measured values are stored in the data logger.

8.3 Display

8.3.1 Main Menu

The main menu contains the following program branches:

- par (Parameter)
- mea (Measuring)
- opt (Output Options)
- sf (Special Function)

The selected program branch is displayed in capital letters and in angle brackets. The complete designation of the selected program branch is displayed in the lower line.

Select a program branch by pressing key 4 and 6. Press ENTER.

Note! By pressing key BRK, the measurement will be stopped and the main menu is selected.

Note! In this user manual, all program entries and keys are indicated with typewriter characters (Parameter). The menu items are separated from the main menu by a backslash ".".
8.3.2 Program Branches

- **Program branch Parameter**
  input of the pipe and medium parameters

- **Program branch Measuring**
  processing of the steps for the measurement

- **Program branch Output Options**
  setting of the physical quantity, the unit of measurement and the parameters for the measured value transmission

- **Program branch Special Funct.**
  contains all functions that are not directly related to the measurement

For an overview of the program branches see figure below. For a detailed overview of the menu structure see annex A.

```
Parameter >PAR<
  ↓
  selection of the measuring channel
  ↓
  pipe parameters
  ↓
  medium parameters
  ↓
  transducer type
  ↓
  extension cable
  ↓
  measurement
  ↓
  consistency check

Measuring >MEA<
  ↓
  selection of the measuring channel
  ↓
  measuring point number
  ↓
  sound path
  ↓
  transducer positioning
  ↓
  measurement
  ↓
  consistency check

Output Options >OPT<
  ↓
  selection of the measuring channel
  ↓
  physical quantity
  ↓
  unit of measurement
  ↓
  damping
  ↓
  measured value transmission

Special Funct. >SF<
  ↓
  system settings¹
  ↓
  instrument information
  ↓
  print measured values
  ↓
  delete measured values
  ↓
  program code
  ↓
  install material
  ↓
  install medium
```

¹ **SYSTEM settings** contains the following menu items:
- dialogs and menus
- inputs
- measuring
- outputs
- storing
- serial transmission
- miscellaneous
- set clock
- libraries
8.3.3 Navigation

A vertical arrow \( \updownarrow \) will be displayed if the menu item contains a scroll list. The current list item will be displayed in the lower line.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>for Channel A:</th>
</tr>
</thead>
</table>

Use key 4 and 6 to select a list item in the lower line. Press ENTER.

Some menu items contain a horizontal scroll list in the lower line. The selected list item is displayed in capital letters and in angle brackets.

| Lining | no >YES< |

Press key 4 and 6 to scroll through the lower line and select a list item. Press ENTER.

Some menu items contain a horizontal scroll list in the upper line. The selected list item is displayed in capital letters and in angle brackets. The current value of the list item is displayed in the lower line.

| R1=FUNC<typ mode | Function: MAX |

Press key 4 and 6 to scroll through the upper line and select a list item. Press key 1 and 2 to scroll through the lower line and select a value for the selected list item. Press ENTER.

8.4 HotCodes

A HotCode is a key sequence that activates certain functions and settings:

<table>
<thead>
<tr>
<th>function</th>
<th>HotCode</th>
<th>see section</th>
<th>deactivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>language selection</td>
<td>9090xx</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>enabling of the FastFood mode</td>
<td>007022</td>
<td>11.7.1</td>
<td>HotCode 007022</td>
</tr>
<tr>
<td>manual input of the lower limit for the inner pipe diameter</td>
<td>071001</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td>activation of the SuperUser mode</td>
<td>071049</td>
<td>15.1</td>
<td>HotCode 071049</td>
</tr>
<tr>
<td>change of the transmission parameters of the RS232 interface</td>
<td>232-0-</td>
<td>12.2.4</td>
<td></td>
</tr>
<tr>
<td>activation of the BTU mode</td>
<td>007025</td>
<td>16.3.1</td>
<td>HotCode 007025</td>
</tr>
<tr>
<td>resetting the contrast of the display to medium</td>
<td>555000</td>
<td>14.4</td>
<td></td>
</tr>
</tbody>
</table>

A HotCode can be entered in the main menu after pressing key C. The HotCode is not displayed during the input.
8.5  Language Selection

The transmitter can be operated in the languages listed below. The language can be selected with the following Hot-Codes:

Tab. 8.1: HotCodes for language selection

<table>
<thead>
<tr>
<th>HotCode</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>909031</td>
<td>Dutch</td>
</tr>
<tr>
<td>909033</td>
<td>French</td>
</tr>
<tr>
<td>909034</td>
<td>Spanish</td>
</tr>
<tr>
<td>909044</td>
<td>English</td>
</tr>
<tr>
<td>909049</td>
<td>German</td>
</tr>
</tbody>
</table>

Depending on the technical data of the transmitter, some of the languages might not be implemented. When the last digit has been entered, the main menu will be displayed in the selected language. The selected language remains activated when the transmitter is switched off and on again. After an initialization, the default language set by the manufacturer is activated.

8.6  Operation State Indication (FLUXUS F709)

The operation state is indicated by 2 LEDs

Tab. 8.2: Operation State Indication (LED SIGNAL)

<table>
<thead>
<tr>
<th>LED State</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED off</td>
<td>transmitter offline</td>
</tr>
<tr>
<td>LED lights green</td>
<td>signal quality of the measuring channel sufficient for a measurement</td>
</tr>
<tr>
<td>LED lights red</td>
<td>signal quality of the measuring channel not sufficient for a measurement</td>
</tr>
</tbody>
</table>

Tab. 8.3: Operation state indication (LED READY)

<table>
<thead>
<tr>
<th>LED State</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED off</td>
<td>no measurement</td>
</tr>
<tr>
<td>LED lights yellow</td>
<td>measurement</td>
</tr>
<tr>
<td>LED flashes yellow</td>
<td>before a HotCode can be entered, key C has to be pressed</td>
</tr>
</tbody>
</table>

8.7  Interruption of the Power Supply

As soon as the measurement begins, all current measuring parameters will be stored in a non-volatile INIT-resistant EPROM. The measurement will be interrupted if the power supply fails. All input data will remain stored.

After the return of the power supply, the serial number is displayed for a few seconds.

FLEXIM FLUXUS F70x -XXXXXXXX

The interrupted measurement is continued. All selected output options are still active. The measurement will not be continued after the return of the power supply if an initialization has been performed.
9 Basic Measurement

The pipe and medium parameters are entered for the selected measuring point (see chapter 5). The parameter ranges are limited by the technical characteristics of the transducers and of the transmitter.

| Attention! | Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS). |

| Note!      | During the parameter input, the transducers have to be connected to the transmitter. |
| Note!      | The parameters will only be stored when the program branch Parameter has been edited in its entirety. |

9.1 Input of the Pipe Parameters

Select the program branch Parameter. Press ENTER.

Select the channel for which the parameters are to be entered. Press ENTER.
This display will not be indicated if the transmitter has only one measuring channel.

9.1.1 Outer Pipe Diameter/ Pipe Circumference

Enter the outer pipe diameter. Press ENTER.

An error message will be displayed if the entered parameter is outside of the range. The limit will be displayed.
Example: upper limit 1100 mm for the connected transducers and for a pipe wall thickness of 50 mm.

It is possible to enter the pipe circumference instead of the outer pipe diameter (see section 14.2.1).
If the input of the pipe circumference has been activated and 0 (zero) is entered for the Outer Diameter, the menu item Pipe Circumfer. will be displayed. If the pipe circumference is not to be entered, press key BRK to return to the main menu and start the parameter input again.

9.1.2 Pipe Wall Thickness

Enter the pipe wall thickness. Press ENTER.

Note! The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness) is calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed.
It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 11.9).
9.1.3 Pipe Material

The pipe material has to be selected to be able to determine the sound speed. The sound speed for the materials in the scroll list are stored in the transmitter.

<table>
<thead>
<tr>
<th>Pipe Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel</td>
</tr>
</tbody>
</table>

Select the pipe material. If the medium is not in the scroll list, select Other Material. Press ENTER.

It can be specified which materials will be displayed in the scroll list (see section 13.5). When the pipe material has been selected, the corresponding sound speed is set automatically. If Other Material has been selected, the sound speed has to be entered.

Enter the sound speed of the pipe material. Press ENTER.

Note! Enter the sound speed of the material (i.e. longitudinal or transversal speed) which is nearer to 2500 m/s.

For the sound speed of some materials see annex C.1.

9.1.4 Pipe Lining

If the pipe has an inner lining, select yes. Press ENTER. If no is selected, the next parameter will be displayed (see section 9.1.5).

Select the lining material. If the material is not in the scroll list, select Other Material. Press ENTER.

Enter the sound speed of the lining material. Press ENTER.

For the sound speed of some materials see annex C.1.

Enter the thickness of the liner. Press ENTER.

Note! The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness - 2x liner thickness) is calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed. It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 11.9).

9.1.5 Pipe Roughness

The flow profile of the medium is influenced by the roughness of the inner pipe wall. The roughness is used for the calculation of the profile correction factor. As, in most cases, the pipe roughness cannot be determined exactly, it has to be estimated.

For the roughness of some materials see annex C.2.

Enter the roughness of the selected pipe or liner material. Change the value according to the condition of the inner pipe wall. Press ENTER.
## 9.2 Input of the Medium Parameters

Select the medium from the scroll list. If the medium is not in the scroll list, select Other Medium. Press ENTER.

It is possible to specify which media will be displayed in the scroll list (see section 13.5). For the programmed parameters of common media see annex C.3. If a medium is selected from the scroll list, the menu item for the input of the medium temperature is displayed directly (see section 9.2.4).

If Other Medium is selected, the medium parameters have to be entered first:
- average sound speed of the medium
- range around the average sound speed of the medium
- kinematic viscosity
- density

### 9.2.1 Sound Speed

The sound speed of the medium is used for the calculation of the transducer distance at the beginning of the measurement. However, the sound speed does affect the measuring result directly. Often, the exact value of the sound speed for a medium is unknown. Therefore, a range of possible values for the sound speed has to be entered.

Enter the average sound speed of the medium. Press ENTER.

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

Select auto or user. Press ENTER.

auto: The area around the average sound speed is defined by the transmitter.

user: The area around the average sound speed has to be entered.

Enter the area around the average sound speed of the medium. Press ENTER.

This display will only be indicated if user is selected.

### 9.2.2 Kinematic Viscosity

The kinematic viscosity has an effect on the flow profile of the medium. The entered value and other parameters are used for the profile correction.

Enter the kinematic viscosity of the medium. Press ENTER.

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

### 9.2.3 Density

The density is used to calculate the mass flow (product of the volumetric flow rate and the density).

**Note!** If the mass flow is not measured, press ENTER. The other measuring results will not be affected.

Enter the operating density of the medium. Press ENTER.

This display will only be indicated if Other Medium is selected.
9.2.4 Medium Temperature
At the beginning of the measurement, the medium temperature is used for the interpolation of the sound speed and thus, for the calculation of the recommended transducer distance.
During the measurement, the medium temperature is used for the interpolation of the density and the viscosity of the medium.
The value entered here will be used for the calculations if the medium temperature is not measured and fed into the transmitter via an input.

Enter the medium temperature. The value has to be within the operating temperature range of the transducers. Press ENTER.

9.2.5 Medium Pressure
The medium pressure is used for the interpolation of the sound speed.

Enter the medium pressure. Press ENTER.
This display will only be indicated if Special Funct.\SYSTEM settings\Dialogs/Menus\Fluid pressure is activated.

9.3 Other Parameters

9.3.1 Transducer Parameters
If transducers are detected on a measuring channel, the parameter input is finished. Press ENTER. The main menu is displayed.
If no or special transducers are connected, the transducer parameters have to be entered.
Select Standard to use the standard transducer parameters stored in the transmitter.
Select Special Version to enter the transducer parameters. The transducer parameters have to be provided by the transducer manufacturer.
Press ENTER.

Note! If standard transducer parameters are used, FLEXIM cannot guarantee for the precision of the measured values. A measurement might even be impossible.

If Special Version has been selected, enter the 6 transducer parameters specified by the manufacturer. Press ENTER after each input.

9.3.2 Extension Cable
If the transducer cable has to be extended, enter the additional cable length (e.g., between the junction box and the transmitter). Press ENTER.
9.4 Selection of the Channels

The channels on which a measurement is being made can be activated individually.

- Press key 4 and 6 to select a channel.
- Press key 8 to activate or deactivate the selected channel. Press ENTER.

A deactivated channel will be ignored during the measurement. Its parameters will remain unchanged.

If the data logger or the serial interface is activated, the measuring point number has to be entered:

- Enter the measuring point number. Press ENTER.
- If arrows are displayed in the lower line on the right, ASCII text can be entered. If no arrows are displayed, only digits, point and hyphen can be entered.

9.5 Defining the Number of Sound Paths

A number of sound paths is recommended according to the connected transducers and the entered parameters. Change the value, if necessary.

Press ENTER.

For defining the number of sound paths, see section 3.3.

9.6 Transducer Distance

A value for the transducer distance is recommended. Fix the transducers (see section 6.4).

Adjust the transducer distance.

Press ENTER.

The transducer distance is the distance between the inner edges of the transducers (see section 3.3 and Fig. 6.9)

In case of a measurement in diagonal arrangement on very small pipes, a negative transducer distance is possible.

- Enter the measuring point number. Press ENTER.
- If arrows are displayed in the lower line on the right, ASCII text can be entered. If no arrows are displayed, only digits, point and hyphen can be entered.

Note! A channel cannot be activated if the parameters are not valid, e.g., if the parameters in the program branch Parameter of the channel are not complete.
9.6.1 Fine Adjustment of the Transducer Distance

If the displayed transducer distance is adjusted, press ENTER.
The measuring for the positioning of the transducers is started.

The amplitude of the received signal is displayed by the bar graph $S=\cdot$
If the LED of the measuring channel lights green, the signal is sufficient for a measurement (FLUXUS F704).
If the LED of the measuring channel lights red, the signal is not sufficient for a measurement (FLUXUS F709).
Shift a transducer slightly within the range of the recommended transducer distance
• FLUXUS F704, F705: until the bar graph reaches its max. length (max. 6 squares)
• FLUXUS F709: until the LED of the measuring channel lights green.

The following quantities can be displayed in the upper line by pressing key 0 and in the lower line by pressing key 3:
• $A=\cdot$: transducer distance
• $S=\cdot$: signal amplitude
• $Q=\cdot$: signal quality, bar graph has to have max. length
If the signal is not sufficient for measurement, $Q=\cdot$ UNDEF will be displayed.

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

After the precise positioning of the transducers, the recommended transducer distance is displayed again.
Enter the actual (precise) transducer distance. Press ENTER.
Repeat the steps for all channels on which a measurement is being made. The measurement will be started automatically afterwards.

9.6.2 Consistency Check

If a wide range for the sound speed has been entered in the program branch Parameter or the exact parameters of the medium are not known, a consistency check is recommended.

The optimum transducer distance (here: 50.0 mm) is displayed in the upper line in parentheses, followed by the entered transducer distance (here: 54.0 mm). The latter value has to correspond to the adjusted transducer distance. Press ENTER to optimize the transducer distance.

The optimum 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 Parameter.
If the difference between the optimum and the entered transducer distance is less than specified in Tab. 9.1, the measurement is consistent and the measured values are valid. The measurement can be continued.
If the difference is greater, adjust the transducer distance to the displayed optimum value. Afterwards, check the signal quality and the signal amplitude bar graph (see section 9.6.1). Press ENTER.
9.6.3 Value of the Sound Speed

The sound speed of the medium can be displayed during the measurement by pressing key . If an approximate range for the sound speed has been entered in the program branch Parameter and the transducer distance has been optimized afterwards as described in section 9.6.2, it is recommended to write down the sound speed for the next measurement. By doing this, it will not be necessary to repeat the fine adjustment. Also write down the medium temperature because the sound speed depends on the temperature. The value can be entered in the program branch Parameter or a user-defined medium can be created for this sound speed (see section 13.2 and 13.3).

9.7 Start of the Measurement

If more than one measuring channel is available/activated, the transmitter works with an integrated measuring point multiplexer providing simultaneous measurement on the different measuring channels. The flow is measured on one measuring channel for approx. 1 s, then the multiplexer switches to the next activated channel. The time necessary for the measurement depends on the measuring conditions. E.g., if the measuring signal cannot be detected immediately, the measurement time might be > 1 s. The outputs and the serial interface continuously receive the measured values of the corresponding channel. The results are displayed according to the currently selected output options. The default unit of measurement of the volumetric flow rate is m³/h. For the selection of the values to be displayed and for the setting of the output options see chapter 10. For further measuring functions see chapter 11.

9.8 Detection of the Flow Direction

The flow direction in the pipe can be detected with the help of the displayed volumetric flow rate in conjunction with the arrow on the transducers:

- The medium flows in the direction of the arrow if the displayed volumetric flow rate is positive (e.g., 54.5 m³/h).
- The medium flows against the direction of the arrow if the displayed volumetric flow rate is negative (e.g., -54.5 m³/h).

9.9 Interruption of the Measurement

The measurement is interrupted by pressing key BRK if it is not protected by a program code (see section 11.11).

<table>
<thead>
<tr>
<th>tab. 9.1: Standard values for signal optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>transducer frequency ( (\text{third character of the technical type}) )</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>K</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>P</td>
</tr>
<tr>
<td>Q</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>

Enter the new adjusted transducer distance. Press ENTER.

Press key \( \text{ } \) again to scroll until the transducer distance is displayed and check the difference between the optimum and the entered transducer distance. Repeat the steps if necessary.

Note! If the transducer distance is changed during the measurement, the consistency check will have to be repeated.

Repeat the steps for all channels on which a measurement is being made.
10 Displaying the Measured Values

The physical quantity is set in the program branch Output Options (see section 10.1).

During the measurement, the designation of the physical quantity is displayed in the upper line, the measured value in the lower line. The display can be adapted (see section 10.3).

10.1 Selection of the Physical Quantity and of the Unit of Measurement

The following physical quantities can be measured:

- **sound speed**
- **flow velocity**: calculated on the basis of the measured transit time difference
- **volumetric flow rate**: calculated by multiplying the flow velocity by the cross-section of the pipe
- **mass flow rate**: calculated by multiplying the volumetric flow rate by the operating density of the medium
- **heat flow (optional)**: calculated on the basis of the volumetric flow rate, the measured temperatures of the supply and return lines, and the heat flow coefficients of the medium

The physical quantity is selected as follows:

```
par mea >OPT< sf
Output Options
```

Select the program branch Output Options. Press ENTER.

```
Output Options : for Channel A:
Physic. Quant. : Volume flow
Volume in: : m3/h
```

Select the channel for which the physical quantity is to be entered. Press ENTER.

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

Select the physical quantity in the scroll list. Press ENTER.

For the selected physical quantity (except for the sound speed), a scroll list with the available units of measurement is displayed. The unit of measurement which was selected previously is displayed first.

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

Press BRK to return to the main menu. The further menu items of the program branch Output Options are for the activation of the measured value transmission.

**Note!** If the physical quantity or the unit of measurement is changed, the settings of the outputs will have to be checked (see chapter 18).

10.2 Toggling Between the Channels

If more than one channel is available/activated, the display for the measured values can be adapted as follows:

- **AutoMux mode**
  - all channels
  - only calculation channels
- **HumanMux mode**

Key toggles between the modes.

10.2.1 AutoMux Mode

In the AutoMux mode, the display and the measuring process are synchronized. The channel on which a measurement is being made is displayed in the upper line on the left.

The measured values are displayed as configured in the program branch Output Options (see section 10.1). When the multiplexer switches to the next channel, the display is updated.

```
A:Volume flow
  54.5 m3/h
```

```
B:Flow Velocity
  1.25 m/s
```

The AutoMux mode is the default display mode. It is activated after an initialization.
All channels
The measured values of all channels (measuring and calculation channels) are displayed. The next active channel is displayed after min. 1.5 s.

Only calculation channels
Only the measured values of the calculation channels are displayed. The next active calculation channel is displayed after min. 1.5 s.

This mode can only be activated if at least 2 calculation channels are active.

10.2.2 HumanMux Mode
In the HumanMux mode, the measured values of one channel are displayed. The measurement on the other channels is continued, but not displayed.

Press key \[ \rightarrow \] to display the next activated channel. The measured values of the selected channel will be displayed as configured in the program branch Output Options (see section 10.1).

10.3 Adjustment of the Display
During the measurement, the display can be adapted as to display two measured values simultaneously (one in each line of the display). This does not affect totalizing, storing of measured values, transmission of the measured values, etc.

The following information can be displayed in the upper line:

<table>
<thead>
<tr>
<th>display</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass Flow</td>
<td>designation of the physical quantity</td>
</tr>
<tr>
<td>A: +8.879 m³</td>
<td>values of the totalizers, if activated</td>
</tr>
<tr>
<td>T×</td>
<td>temperatures assigned to the channel and their difference if the temperature is measured</td>
</tr>
<tr>
<td>full</td>
<td>date and time at which the data logger will be full, if activated</td>
</tr>
<tr>
<td>Mode</td>
<td>measuring mode</td>
</tr>
<tr>
<td>L</td>
<td>transducer distance</td>
</tr>
<tr>
<td>R×</td>
<td>alarm state indication if it is activated (see section 18.7.5) and if alarm outputs are activated (see section 18.6).</td>
</tr>
<tr>
<td>δc</td>
<td>difference between the measured sound speed and the sound speed of a selected reference medium, if activated (see section 14.3)</td>
</tr>
<tr>
<td></td>
<td>status line (see section 10.4)</td>
</tr>
</tbody>
</table>

The measured values of the physical quantity selected in the program branch Output Options can be displayed in the lower line:

<table>
<thead>
<tr>
<th>display</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.3 m/s</td>
<td>flow velocity</td>
</tr>
<tr>
<td>1423 m/s</td>
<td>sound speed</td>
</tr>
<tr>
<td>124 kg/h</td>
<td>mass flow rate</td>
</tr>
<tr>
<td>15 m³/h</td>
<td>volumetric flow rate</td>
</tr>
<tr>
<td>12 kW</td>
<td>heat flow rate</td>
</tr>
</tbody>
</table>

Press key \[ \rightarrow \] during the measurement to change the display in the upper line, press key \[ \rightarrow \] to change the display in the lower line.

The character * indicates that the displayed value (here: flow velocity) is not the selected physical quantity.
10.4 Status Line

Important data on the ongoing measurement are displayed in the status line. The quality and precision of the ongoing measurement can be estimated.

Press key [9] during the measurement to scroll through the upper line to 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>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>
<tr>
<td>c</td>
<td>sound speed</td>
</tr>
<tr>
<td>√</td>
<td>ok, is equal to the expected value</td>
</tr>
<tr>
<td>↑</td>
<td>&gt; 20 % of the expected value</td>
</tr>
<tr>
<td>↓</td>
<td>&lt; 20 % of the expected value</td>
</tr>
<tr>
<td>?</td>
<td>unknown, cannot be measured</td>
</tr>
<tr>
<td>R</td>
<td>flow profile</td>
</tr>
<tr>
<td>T</td>
<td>fully turbulent flow profile</td>
</tr>
<tr>
<td>L</td>
<td>fully laminar flow profile</td>
</tr>
<tr>
<td>▲</td>
<td>the flow is in the transition range between laminar and turbulent flow</td>
</tr>
<tr>
<td>?</td>
<td>unknown, cannot be calculated</td>
</tr>
<tr>
<td>F</td>
<td>flow velocity</td>
</tr>
<tr>
<td>√</td>
<td>ok, the flow velocity is not in the critical range</td>
</tr>
<tr>
<td>↑</td>
<td>the flow velocity is higher than the current limit</td>
</tr>
<tr>
<td>↓</td>
<td>the flow velocity is lower than the current cut-off flow (even if it is not set to zero)</td>
</tr>
<tr>
<td>0</td>
<td>the flow velocity is in the offset range of the measuring method</td>
</tr>
<tr>
<td>?</td>
<td>unknown, cannot be measured</td>
</tr>
</tbody>
</table>

10.5 Transducer Distance

By pressing key [6] during the measurement, it is possible to scroll to the display of the transducer distance.

The optimum transducer distance (here: 51.2 mm) is displayed in parentheses in the upper line, followed by the entered transducer distance (here: 50.8 mm).

The optimum transducer distance might change during the measurement (e.g., due to temperature fluctuations).

A deviation from the optimum transducer distance (here: -0.4 mm) is compensated internally.

Note! Never change the transducer distance during the measurement!
11 Advanced Measuring Functions

11.1 Damping Factor

Each displayed measured value is a floating average of all measured values of the last x seconds, with x being the damping factor. A damping factor of 1 s means that the measured values are not averaged because the measuring rate is approx 1/s. The default value of 10 s is appropriate for normal flow conditions. Strongly fluctuating values caused by high flow dynamics require a higher damping factor.

Select the program branch Output Options. Press ENTER until the menu item Damping is displayed.

Enter the damping factor. Press ENTER.

Press BRK to return to the main menu.

11.2 Totalizers

Heat quantity, total volume or total mass of the medium at the measuring point can be determined.

There are two totalizers, one for the positive flow direction, one for the negative flow direction.

The unit of measurement used for totalizing corresponds to the heat, volume or mass unit selected for the physical quantity.

The values of the totalizers can be displayed with up to 11 decimal places, e.g., 74890046.03. For the definition of the number of decimal places see (max 4) see section 15.7.

To activate the totalizers, press key 1 during the measurement (see Tab. 11.1).

The value of the totalizer will be displayed in the upper line (here: the volume which has passed through the pipe at the measuring point in the positive flow direction after the activation of the totalizers).

Tab. 11.1: Keys for display of the totalizers

<table>
<thead>
<tr>
<th>action</th>
<th>key combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>activation</td>
<td>press key 1 once during the measurement</td>
</tr>
<tr>
<td>deactivation</td>
<td>press key 2 three times during the measurement</td>
</tr>
<tr>
<td>display of the totalizer for the positive flow direction</td>
<td>press key 3 during the measurement</td>
</tr>
<tr>
<td>display of the totalizer for the negative flow direction</td>
<td>press key 4 during the measurement</td>
</tr>
<tr>
<td>reset of the totalizers to zero</td>
<td>press key 5 three times during measurement</td>
</tr>
</tbody>
</table>

This error message will be displayed if the totalizers of a measuring channel used for measuring the flow velocity are to be activated. The flow velocity cannot be totalized.

Note! The totalizers can only be activated for the measuring channel whose measured values are displayed at the moment.

Note! The pressing of a key will only influence the totalizers if the totalizer is displayed in the upper line.

Selection of the totalizers for storing

It is possible to store only the value of the totalizer that is currently displayed or one value for each flow direction. Select Special Funct.\SYSTEM settings\Storing\Quantity Storage.

If one is selected, only the value of the totalizer that is currently displayed will be stored.

If both is selected, the values of the totalizers totalizer for both flow directions will be stored.

Press ENTER.
When the measurement is stopped
The behavior of the totalizers when the measurement is stopped or after a RESET of the transmitter is set in Special Funct.\SYSTEM settings\Measuring\Quantity recall.

- **Quantity recall**
  - On: if on is selected, the values of the totalizers will be stored and used for the next measurement.
  - Off: if off is selected, the totalizers will be reset to zero.

During the heat flow measurement
During the heat flow measurement, it is possible to transmit and store the values of the heat quantity totalizer and of the volume totalizer. Select Special Funct.\SYSTEM settings\Measuring\heat+flow quant.

- **heat+flow quant.**
  - On: Select on to store and transmit the values of the heat quantity totalizer and the volume totalizer during the heat flow measurement.
  - Off: Select off to work without overflow.

Select on to store and transmit the values of the heat quantity totalizer and the volume totalizer during the heat flow measurement.
Press ENTER.

### 11.2.1 Overflow of the Totalizers
The overflow behavior of the totalizers can be set:

**Without overflow:**
- The value of the totalizer increases to the internal limit of $10^{38}$.
- If necessary, the values will be displayed as exponential numbers ($\pm 1.00000E10$). The totalizer can only be reset to zero manually.

**With overflow:**
- The totalizer will be reset to zero automatically when $\pm 9999999999$ is reached.

Select Special Funct.\SYSTEM settings\Measuring\Quant. wrapping.

- **Quant. wrapping**
  - On: Select on to work with overflow.
  - Off: Select off to work without overflow.

Select on to work with overflow. Select off to work without overflow. Press ENTER.

Independently of the setting, the totalizers can be reset to zero manually.

**Note!**
- The overflow of a totalizer influences all output channels, e.g., data logger, online transmission of data.
- The transmission of the sum of both totalizers (the throughput $\Sigma Q$) via an output will not be valid after the first overflow (wrapping) of one of the corresponding totalizers.
- To signalize the overflow of a totalizer, an alarm output with the switching condition QUANT. and the type HOLD have to be activated.

### 11.3 Settings of the HybridTrek Mode
The HybridTrek mode combines the TransitTime mode and the NoiseTrek mode. During a measurement in the HybridTrek mode, the transmitter automatically toggles between the TransitTime mode and the NoiseTrek mode in order to receive an optimal measuring result when the gaseous or solid content increases temporarily.

Select Special Funct.\SYSTEM settings\Measuring. Press ENTER until the list item Enable NoiseTrek is displayed. NoiseTrek mode on to enable the NoiseTrek mode, off to disable it. Press ENTER.

Select **no** to deactivate the automatic toggling between the TransitTime and the NoiseTrek mode. If **no** is selected, the NoiseTrek mode can only be activated and deactivated manually during the measurement.

Select **yes** to activate the automatic toggling between the TransitTime and the NoiseTrek mode. If **yes** the NoiseTrek mode can also be activated and deactivated manually during the measurement.
Press ENTER.
This display will only be indicated if the NoiseTrek mode is enabled.
If the automatic toggling between the TransitTime and the NoiseTrek mode is activated, the toggling parameters have to be configured.

Enter the time after which the transmitter has to toggle to the NoiseTrek mode if there are no valid measured values in the TransitTime mode. If 0 (zero) is entered, the transmitter does not toggle to the NoiseTrek mode.

Enter the time after which the transmitter has to toggle to the TransitTime mode if there are no valid measured values in the NoiseTrek mode. If 0 (zero) is entered, the transmitter does not toggle to the TransitTime mode.

The measurement in the NoiseTrek mode can lead to a greater measurement error than in the TransitTime mode. Therefore, even if there are valid measured values in the NoiseTrek mode, the transmitter can periodically toggle to the TransitTime mode in order to check if a measurement in the TransitTime mode is possible again. The time interval and the duration of the checking are set as follows:

Enter the time after which the transmitter has to toggle to the TransitTime mode. If 0 (zero) is entered, the transmitter does not toggle to the TransitTime mode.

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

Example: TT-Failed -NoiseTrek: After 40s  
NT-Failed -TransTime: After 60s  
NT-Ok,but check TT: Each 300s  
Keep TT checking: For 5s

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

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

In order to toggle between the TransitTime mode and the NoiseTrek mode manually during the measurement, press key

11.4 Upper Limit of the Flow Velocity

Single outliers caused by heavily disturbed surroundings can appear among the measured values of the flow velocity. If the outliers are not ignored, they will affect all derived physical quantities, which will then be unsuitable for the integration (e.g., pulse outputs).

It is possible to ignore all measured flow velocities higher than a upper limit. These measured values will be marked as outliers.

The upper limit of the flow velocity is set in Special Funct.\SYSTEM settings\Measuring\Velocity limit.

Enter 0 (zero) to switch off the checking for outliers.

Enter a limit > 0 to switch on the checking for outliers. The measured flow velocity will then be compared to the entered upper limit.

Press ENTER.

If the flow velocity is higher than the upper limit,
• the flow velocity will be marked as invalid. The physical quantity cannot be determined.
• the LED of the measuring channel will light red (FLUXUS F709)
• "!" will be displayed after the unit of measurement (in case of a normal error, "?" is displayed)

Note! If the upper limit is too low, a measurement might be impossible because most of the measured values will be marked as "invalid".
11.5 Cut-off Flow

The cut-off flow is a lower limit for the flow velocity. All measured flow velocities that are lower than the limit and their derived values are set to zero.

The cut-off flow can depend on the flow direction or not. The cut-off flow is set in Special Funct.\SYSTEM settings\Measuring\Cut-off Flow.

Select **sign** to define a cut-off flow in dependence on the flow direction. Two independent limits are set for the positive and negative flow directions.

Select **absolut** to define a cut-off flow independently of the flow direction. A limit is set for the absolute value of the flow velocity.

Press ENTER.

Select **factory** to use the default limit of 2.5 cm/s (0.025 m/s) for the cut-off flow.

Select **user** to enter the cut-off flow.

Press ENTER.

If **Cut-off Flow\sign** and **user** are selected, two values will have to be entered:

- **+Cut-off Flow**
  - 2.5 cm/s

- **-Cut-off Flow**
  - -2.5 cm/s

If **Cut-off Flow\absolut** and **user** is selected, only one value will have to be entered:

- **Cut-off Flow**
  - 2.5 cm/s

11.6 Uncorrected Flow Velocity

For special applications, the uncorrected flow velocity might be of interest.

The profile correction for the flow velocity is activated in Special Funct.\SYSTEM settings\Measuring\Flow Velocity.

Select **normal** to display and transmit the flow velocity with profile correction.

Select **uncorr.** to display the flow velocity without profile correction. Press ENTER.

If **uncorr.** is selected, it has to be confirmed each time the program branch Measuring is selected if the profile correction is to be used.

If **no** is selected, the profile correction will be switched off. All physical quantities will be calculated with the uncorrected flow velocity.

During the measurement, the designation of the physical quantity will be displayed in capital letters to indicate that the value is uncorrected.

Press ENTER.

If **yes** is selected, the uncorrected flow velocity will only be used if the flow velocity is selected as the physical quantity in the program branch Output Options.

All other physical quantities (volumetric flow rate, mass flow, rate etc.) will be determined with the corrected flow velocity.

During the measurement, the designation of the physical quantity will be displayed in capital letters to indicate that the value is uncorrected.

Press ENTER.

In both cases, the corrected flow velocity can also be displayed.

Press key **3** to scroll until the flow velocity is displayed. The uncorrected flow velocity is marked with **U**.

Uncorrected flow velocities transmitted to a PC are marked with **uncorr.**
11.7 Measurement of Highly Dynamic Flows (FastFood Mode)

The FastFood mode enables the measurement of flows with high dynamics. A continuous adaptation to changing measuring conditions which takes place in the normal measuring mode is only partially realized in the FastFood mode.

- The sound speed of the medium is not measured. Instead, the sound speed stored in the internal database is used, taking into account the medium temperature entered in the program branch Parameter (or the measured temperature if the medium temperature is measured).
- A change of measuring channel is not possible.
- The inputs and outputs can still be used.
- The measured values are stored as usual.
- The FastFood mode has to be enabled and activated.

11.7.1 Enabling/Disabling the FastFood Mode

Press key C. Enter HotCode 007022.

Select yes to enable the FastFood Mode, no to disable it.

11.7.2 Storage Rate of the FastFood Mode

If the FastFood mode is enabled, a Storage Rate in ms will have to be entered in the program branch Output Options. Press ENTER.

11.7.3 Activation/Deactivation of the FastFood Mode

If the FastFood mode is enabled and a measurement is started, the normal measuring mode will still be running (i.e. multi-channel measurement with permanent adaptation to the measuring conditions). If the data logger is activated, the measured values will not be stored.

If the data logger is activated, a new series of measured values will be created and storing of measured values will be started. If the FastFood mode is deactivated or if the measurement is interrupted, the storing will be stopped.

Note!
The values of the current series of measured values will be deleted if the FastFood mode is deactivated and activated again without interrupting the measurement.
The values of the current series of measured values will be kept if the measurement is interrupted before the FastFood mode is activated again. A new series of measured values is created when the next measurement is started.

11.8 Calculation Channels

Note! Calculation channels are only available if the transmitter has more than one measuring channel.

In addition to the ultrasonic measuring channels, the transmitter has two virtual calculation channels Y and Z. The measured values of the measuring all channels can be used for calculations by the calculation channels.

The result of the calculation is the measured value of the selected calculation channel. This measured value is equivalent to the measured values of a measuring channel. All operations with the measured values of a measuring channel (totalizing, online transmission of data, storing, outputs, etc.) can also be done with the values of a calculation channel.
11.8.1 Characteristics of the Calculation Channels

In the program branch Parameter, the measuring channels to be used for the calculation and the calculation function have to be entered.

A calculation channel cannot be attenuated. The damping factor has to be set separately for each measuring channel. Two cut-off flow values for each calculation channel can be defined. The cut-off flow is not based on the flow velocity as for measuring channels. Instead, it is defined in the unit of measurement of the physical quantity selected for the calculation channel. During the measurement, the calculated values are compared to the cut-off flow values and set to zero if necessary.

A calculation channel provides valid measured values if at least one measuring channel provides valid measured values.

11.8.2 Parametrization of a Calculation Channel

Select a calculation channel (Y or Z) in the program branch Parameter. Press ENTER.

The current calculation function is displayed. Press ENTER to edit the function.

Three scroll lists are displayed in the upper line:

- selection of the first measuring channel (ch1)
- selection of the calculation function (funct)
- selection of the second measuring channel (ch2)

Select a scroll list with key ↑ or ↓.

The list items are displayed in the lower line. Scroll with key ↑ and ↓ through the scroll list. All measuring channels and their absolute values can be used as input channels for the calculation.

The following calculation functions are available:

- -: Y = ch1 - ch2
- +: Y = ch1 + ch2
- (+)/2: Y = (ch1 + ch2)/2
- (+)/n: Y = (ch1 + ch2)/n
- |-|: Y = |ch1 - ch2|

Press ENTER.

This message will be displayed after the parametrization of the calculation channel if the calculation function (+)/2 is selected. The measured values of the calculation channel (here: Y) will be valid if the measured values of both measuring channels (here: A and B) are valid. If only one measuring channel provides valid measured values, the measured values of the calculation channel will be invalid.

This message will be displayed after the parametrization of the calculation channel if the calculation function (+)/n is selected. The measured values of the calculation channel (here: Y) will be valid if the measured values of at least one measuring channel (here A or B) are valid. If only one measuring channel provides valid measured values, these measured values will be used for the calculation channel.
11.8.3 Output Options for a Calculation Channel

Select a calculation channel in the program branch Output Options. Press ENTER.

Select the physical quantity to be calculated. Press ENTER.

Make sure that the physical quantity selected for the calculation channel can be calculated from the physical quantities of the selected measuring channels. Possible combinations are shown in Tab. 11.2.

Tab. 11.2: Physical quantity of the calculation channel

<table>
<thead>
<tr>
<th>physical quantity of the calculation channel</th>
<th>possible physical quantity of the first measuring channel (ch1)</th>
<th>possible physical quantity of the second measuring channel (ch2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>flow velocity</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>volumetric flow rate</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>mass flow rate</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>heat flow rate</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>flow velocity</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>volumetric flow rate</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>mass flow rate</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>heat flow rate</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Example 1: The difference of the volume flow rates of the channels A and B is to be calculated. The physical quantity of channel A and B can be the volumetric flow rate or the mass flow rate, but not the flow velocity. The physical quantities of the two measuring channels do not need to be identical (channel A = mass flow rate, channel B = volumetric flow rate).

Example 2: To determine the heat flow difference, the physical quantity of the two input channels has to be the heat flow.

Select the unit of measurement. Press ENTER.

Two cut-off flow values for each calculation channel can be defined. They are defined in the unit of measurement of the physical quantity selected for the calculation channel.

All positive calculated values that are lower than the limit will be set to 0.

All negative calculated values that are greater than the limit will be set to 0.

The data logger can be activated/deactivated. Press ENTER.
11.8.4 Measurement with Calculation Channels

Select program branch Measuring. Press ENTER.

Activate the necessary channels. Calculation channels are activated or deactivated in the same way as the measuring channels. Press ENTER.

If a measuring channel that is needed for an activated calculation channel has not been activated, a warning will be displayed. Press ENTER.

Position the transducers for all activated measuring channels. The measurement will be started automatically.

If a calculation channel is activated, the HumanMux mode (see section 10.2.2) will be selected at the beginning of the measurement and the values of the calculation channel will be displayed.

If the AutoMux mode is selected, the measured values of the measuring channels, but not the measured values of the calculation channels, will be displayed alternately.

Press key \[6\] to display the calculation function.

Press key \[7\] to display the measured values of the different channels.

11.9 Change of the Limit for the Inner Pipe Diameter

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

• Press key C. Enter HotCode 071001.

Enter the lower limit of the inner pipe diameter of the displayed transducer type. Press ENTER to select the next transducer type.

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

11.10 Remote Functions

The remote function will be triggered if a voltage in the active range is applied at the binary input:

• FLUXUS F70x**-A2, F70x**-NN: 5...30 V
• FLUXUS F70x**-F2: 5...26 V

The remote function will be reset if the voltage at the binary input is switched back to the passive range (< 5 V).

One single binary input can be used to trigger one or several remote functions of multiple channels.

Following remote functions are available:

• resetting the measured value to 0
• resetting the totalizers to 0
• stopping the totalizers
• activating the FastFood mode
11.10.1 Configuration of the Remote Function
The remote function can be configured for each individual channel.

Select Special Funct.\SYSTEM settings\Remote inputs. Press ENTER.

Select the channel for which a remote function is to be activated. Press ENTER.

In the following scroll list, it can be determined how the remote function of the selected channel is to be configured or deactivated. Following list items are available:
- **Edit**: editing of the remote function of the selected channel (see section 11.10.1.1)
- **Copy from**: copying the previously configured remote function from a different channel (see section 11.10.1.2)
- **Clear all**: resetting the previously configured remote functions (see section 11.10.2)
- **go back**: quitting the configuration of the remote function and return to the main menu

11.10.1.1 Editing the Remote Function
If the list item **Edit** is selected in the scroll list of the menu item **Remote inputs**, the remote function of the selected channel can be edited.

**Resetting the all measured values derived from the flow velocity to 0**

Select the list item **Signal Lock**. Press ENTER.

The actual measured flow velocity is ignored and the measured value is reset to 0. Therefore, all values of the physical quantities derived from the flow velocity also yield 0. When the voltage of the binary input is switched to the passive range, the current measured values of the flow velocity are again output and used for further calculations.

**Resetting the totalizers**

Select the list item **clear totals**. Press ENTER. The totalizers are reset to 0. The totalizers are deactivated for the duration of the switching signal.

Totalizing restarts at 0 when the voltage at the binary input is switched back to the passive range.

If the totalizers are reset to 0 with using the remote function, a downward arrow will be displayed next to the value of the totalizer during the measurement.

**Stopping the totalizers**

Select the list item **No totalizing**. Press ENTER.

The totalizers are stopped for the duration of the switching signal.

Totalizing is continued at the last recorded totalizer value when the voltage at the binary input is switched back to the passive range.
Activating the FastFood mode

Select the list item FastFoodMode. Press ENTER.
The FastFood mode is activated for the duration of the switching signal.
The FastFood mode is deactivated when the voltage at the binary input is switched back to the passive range.
This list item is only available for measuring channels.
For more information regarding the FastFood mode see section 11.7.

Quitting the configuration

Select the list item go back. Press ENTER.
Editing of the remote function is stopped. The menu item Remote inputs is displayed.

Assigning the binary input

After the editing of the remote function, it is determined which binary input is to be used to trigger this function.
Select the binary input (Binary Input S1 or Binary Input S2) which is to be used to trigger the previously selected remote function (here: clear totals). To deactivate the remote function, select NO INPUT. Press ENTER.
This display will only be indicated if the transmitter is equipped with 2 binary inputs.
After assigning the binary input, the menu item Remote-Func. is displayed again.

After assigning the binary input, it is possible to activate additional remote functions for the channel selected previously. If the configuration of the remote functions is complete, the menu item can be left by pressing BRK. All new settings will be accepted.

11.10.1.2 Copying the Remote Function
If a remote function has already been configured for a channel, its configuration can be copied to the currently selected channel.
Select the channel (here: B) from which the remote function configuration is to be copied to the currently selected channel. Press ENTER.

11.10.2 Resetting the Remote Function
Select Special Funct.\SYSTEM settings\Remote inputs. Press ENTER.
Select the channel for which the remote function is to be reset. Press ENTER.
Select the list item Clear all.
A request is displayed if the remote function is to be reset. Select yes. Press ENTER.
11.11 Program Code
An ongoing measurement can be protected from an inadvertent intervention by means of a program code. If a program code has been defined, it will be requested when there is an intervention in the measurement (key BRK).

11.11.1 Defining a Program Code
A program code will remain valid as long as:
• no other valid program code is entered or
• the program code is not deactivated.

Note! Do not forget the program code!

11.11.2 Intervention in the Measurement
If a program code is active, the message PROGRAM CODE ACTIVE will be displayed for a few seconds when a key is pressed.

To stop a measurement when it is protected by a program code, press key C and enter the program code. The display does not change during the input of the program code. If the entered program code is correct, the measurement will be interrupted and the main menu will be displayed.

The input of a program code is interrupted by pressing key C.

11.11.3 Deactivation of the Program Code
Select Special Funct.\Program code.
The program code is deleted by entering "-------". Press ENTER.
If the character "-" is entered less than six times, this character sequence will be used as the new program code.
12 Data Logger and Transmission of Data

The transmitter has a data logger in which the measured values are stored during the measurement (see section 12.1). In addition, the measurement data can be transmitted to a PC via the serial interface or stored on an SD card (see section 12.2). For the connection of the serial interface see section 7.6.

12.1 Data Logger

The following data will be stored:

- date
- time
- measuring point number
- pipe parameters
- medium parameters
- transducer data
- sound path (reflection or diagonal arrangement)
- transducer distance
- damping factor
- storage rate
- physical quantity
- unit of measurement
- measured values (physical quantity and input quantities)
- totalizer values (if the totalizers are activated)
- diagnostic values (if storing of diagnostic values is activated)

In order to store the measured data, the data logger has to be activated (see section 12.1.1). The available data logger memory can be displayed (see section 12.1.6).

The storing of each measured value will be signaled acoustically. This signal can be deactivated (see section 12.1.3 in Acoustic Signal).

12.1.1 Activation/Deactivation of the Data Logger

Select in the program branch Output Options the channel for which the data logger is to be activated. Press ENTER.

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

Press ENTER until the menu item Store Meas. Data is displayed. Select yes to activate the data logger. Press ENTER.

If EXTRA has been selected, enter the storage rate. Press ENTER.

12.1.2 Setting the Storage Rate

The storage rate is the frequency at which the measured values are transmitted or stored. The storage rate is set separately for each measuring channel.

If the storage rate is not set, the storage rate which was selected previously will be used.

The storage interval should be at least equal to the number of activated measuring channels, e.g., the storage interval of a channel should be min. 2 s if 2 measuring channels are activated, min. 4 s are recommended.

Select a storage rate or EXTRA. Press ENTER.

This display will only be indicated if Store Meas. Data and/or Serial Output are activated.

If EXTRA has been selected, enter the storage rate. Press ENTER.
12.1.3 Settings of the Data Logger

Select program branch Special Funct.\SYSTEM settings\Storing. It contains the following menu items:

• ringbuffer
• storage mode
• storing of the totalizers
• storing of the signal amplitude
• storing of the sound speed
• start of the storing
• acoustic signal during the storing

Ringbuffer

The setting of ringbuffer affects the storing of measured values as soon as the data memory is full:

• If the ringbuffer is activated, the available data logger will be halved. The oldest measured values will be overwritten.

Only the data logger memory that was free during the activation will be used by the ringbuffer. If more data logger memory is necessary, measured values in the data logger should previously be deleted.

• If the ringbuffer is deactivated, the storing of measured values will be stopped.

Select the behavior of the ringbuffer. Press ENTER.

Storage mode

Select the storage mode. Press ENTER.

If sample is selected, the displayed measured value will be used for storing and online transmission of data.

If average is selected, the average of all values measured during a storage interval will be used for storing and online transmission of data.

Note! The storage mode does not affect the outputs.

Note! Storage mode ≠ average

The average of the physical quantity and other physical quantities assigned to the measuring channel, e.g., the measured temperature, will be calculated.

If the storage rate < 5 s (see section 12.1.2) is selected, sample will be used.

If no average could be calculated over the complete storage interval, the value will be marked as invalid. The ASCII file will contain "??" instead of invalid average values of the physical quantity and "?UNDEF" instead of invalid temperatures.

Storing of the totalizers

see section 11.2

Storing of the signal amplitude

If on is selected and the data logger is activated, the amplitude of the measured signal will be stored together with the measured values. Press ENTER.

Storing of the sound speed

If on is selected and the data logger is activated, the sound speed of the medium will be stored together with the measured values. Press ENTER.

Storing of the diagnostic values

If on is selected and the data logger is activated, the diagnostic values will be stored together with the measured values. Press ENTER.
Start of the storing
If it is necessary to synchronize the storing of measured values on several transmitters, the starting time of the storing can be set.

Select the starting time of the storing of measured values.

- **Promptly:** Storing will be started immediately.
- **On full 5 min.:** Storing will be started on the next full 5 minutes.
- **On full 10 min.:** Storing will be started on the next full 10 minutes.
- **On quarter hour:** Storing will be started on the next full 15 minutes.
- **On half hour:** Storing will be started on the next half hour.
- **On full hour:** Storing will be started on the next full hour.

**Example:**
- Current time: 9:06
- Setting: On full 10 min.
- Storing will be started at 9:10.

Acoustic signal during the storing
Per default, an acoustic signal will be emitted every time a measured value is stored or transmitted to a PC or printer. The signal can be deactivated in Special Funct.\SYSTEM settings\Storing\Beep on storage.

Select off to deactivate the acoustic signal, on to activate it. Press ENTER.

**12.1.4 Measurement with Activated Data Logger**

- Start the measurement.

  - Enter the measuring point number. Press ENTER.
    - If arrows are displayed in the lower line on the right, ASCII text can be entered. If digits are displayed, only digits, point and hyphen can be entered.
    - For the setting of the input mode see section 14.2.3.
    - Press ENTER.
    - The error message will be displayed periodically.

  The storing will be stopped.

**12.1.5 Deleting the Measured Values**

Select Special Funct.\Delete Meas.Val. Press ENTER.

Select yes or no. Press ENTER.

**12.1.6 Available Data Logger Memory**

If the data logger is empty and a measurement is started with one physical quantity on one measuring channel without storing the totalizer, approx. 100 000 measured values can be stored. The available data logger memory can be displayed:

Select Special Funct.\Instrum. Inform. Press ENTER.

The type and the serial number of the transmitter will be displayed in the upper line.

The available data logger memory will be displayed in the lower line (here: 18 327 additional measured values can be stored). Press key BRK twice to return to the main menu.
Max. 100 series of measured values can be stored. The number of series of measured values depends on the total number of measured values stored in the previous series of measured values.

The time at which the data logger memory will be full can be displayed during the measurement. All activated channels, totalizers and other values will be considered.

Press key s during the measurement to scroll through the displays of the upper line.

If the ringbuffer is activated and has overflown at least once, this display will be indicated.

### 12.2 Transmission of Data

The measurement data can be transmitted to a PC via the serial interface RS232 or RS485 (optional) or stored on an SD card (optional).

#### 12.2.1 Online Transmission of Data

The measurement data are transmitted during the measurement.

It is possible to:

- transmit the measurement data to a terminal program
- store the measurement data on an SD card

Tab. 12.1: Overview online transmission of data

<table>
<thead>
<tr>
<th>serial interface</th>
<th>transmission of data</th>
<th>see</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS232</td>
<td>terminal program</td>
<td>section 12.2.5</td>
</tr>
<tr>
<td>RS485 (sender)</td>
<td>terminal program / SD card</td>
<td>section 12.2.5</td>
</tr>
</tbody>
</table>

The data logger works independently of the online transmission of data.

**Note!** It is recommended to use the RS485 interface for the online transmission of data. The RS232 interface should only be used if the transmitter does not have an RS485 interface.

#### 12.2.2 Offline Transmission of Data

The measurement data of the data logger are transmitted.

Tab. 12.2: Overview offline transmission of data

<table>
<thead>
<tr>
<th>serial interface</th>
<th>transmission of data</th>
<th>see</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS232</td>
<td>terminal program</td>
<td>section 12.2.6</td>
</tr>
<tr>
<td>RS232</td>
<td>FluxData</td>
<td>section 12.2.7</td>
</tr>
<tr>
<td>RS485 (sender)</td>
<td>terminal program</td>
<td>section 12.2.6</td>
</tr>
</tbody>
</table>

**Selection of the serial interface for the offline transmission of data**

Select Special Funct.>SYSTEM settings>serial transmit..< Press ENTER until Send Offline via is displayed.

Select the serial interface for the offline transmission of data.

This display will only be indicated if the transmitter has an RS485 interface.
12.2.3 Format of the Measurement Data

Select **Special Funct.\SYSTEM settings\serial transmis.**

- **SER:kill spaces**
  - **off** > **ON**<
  - Select on if the space characters are not to be transmitted. Press ENTER.
  - The file size will be considerably smaller (shorter transmission time).

- **SER:decimalpoint**
  - `,` > `,`<
  - Select the decimal marker to be used for floating-point numbers (point or comma). Press ENTER.
  - This setting depends on the setting of the operating system of the PC.

- **SER:col-separat.**
  - `;` > `TAB`<
  - Select the character to be used to separate columns (semicolon or tabulator). Press ENTER.

12.2.4 Transmission Parameters

- The transmitter sends CRLF-terminated ASCII
- max. line length: 255 digits

**RS232**
- default: 9600 bits/s, 8 data bits, even parity, 2 stop bits, protocol RTS/CTS (hardware, handshake)

The transmission parameters of the RS232 interface can be changed:

Press key C. Enter HotCode **232-0-**.

- **baud<**
  - **data par st**
  - 9600 8bit EVEN 2
  - Set the transmission parameters in the 4 scroll lists. Press ENTER.
  - **baud:** baud rate
  - **data:** number of data bits
  - **par:** parity
  - **st:** number of stop bits

**RS485**
- default: 9600 bits/s, 8 data bits, even parity, 1 stop bit

The transmission parameters of the RS485 interface can be changed in the program branch **Special Funct.\SYSTEM settings\Network**. This display will only be indicated if the transmitter has an RS485 interface.

- **SYSTEM settings\Network**
  - **Device address:** 0 ADR
  - Select **Special Funct.\SYSTEM settings\Network** to change the settings of the transmission parameters.

- **RS485 protocol default > SETUP**
  - Press ENTER to confirm the address of the measuring instrument in the network.

Select **default** to display the default transmission parameters.

Select **setup** to change the transmission parameters. Press ENTER.

- **>baud<**
  - **parity st**
  - 9600 EVEN 1
  - Set the transmission parameters in the 3 scroll lists. Press ENTER.
  - **baud:** baud rate
  - **parity:** parity
  - **st:** number of stop bits

The default transmission parameters will be set if **default** is selected and the transmission parameters have not been changed.
12.2.5 Online Transmission of Data to a Terminal Program or an SD Card

If data are transmitted online to a terminal program:

- Start the terminal program.
- Enter the transmission parameters into the terminal program (see section 12.2.4). The transmission parameters of the terminal program and of the transmitter have to be identical.

Settings in the transmitter

- Select the program branch Output Options. Press ENTER.
- Select the channel for which the online transmission of data is to be activated. Press ENTER until the menu item Serial Output is displayed.

Select yes to activate the online transmission of data. Press ENTER.

- Set the storage rate (see section 12.1.2).
- Start the measurement. The measuring point number will be requested (see section 12.1.4).

The measured values are transmitted during the measurement.

If the transmitter is equipped with an SD card (optional), the measurement data will be stored as an ASCII file every day at 0:00 a.m. (file name: yymmdd01.txt).

12.2.6 Offline Transmission of Data to a Terminal Program

- Start the terminal program.
- Enter the transmission parameters into the terminal program (see section 12.2.4). The transmission parameters of the terminal program and of the transmitter have to be identical.

Select Special Funct.\Print Meas.Val.. Press ENTER.

This error message will be displayed if no measured values are stored. Press ENTER.

This message will be displayed if the measuring signal is sufficient.

The progress of the transmission of data is displayed by a bar graph.

This error message will be displayed if an error has occurred during the serial transmission. Press ENTER. Check the connections and make sure that the PC is ready to receive data.
12.2.7 Offline Transmission of Data with the Program FluxData

The measurement data in the data logger are transmitted to a PC via the serial interface RS232 with the FLEXIM program FluxData.

Settings in the program
Start the program FluxData V3.0 or higher on the PC.

Select the menu:
Options > Serial interface.

Select the serial interface used by the PC (e.g., COM1). Click on Protocol. Click on OK.

Enter the transmission parameters (see section 12.2.4). If the default settings of the transmission parameters are be used, click on Default protocol.
The transmission parameters of the program FluxData and of the transmitter have to be identical.
Click on OK.

Transmission of Data
Select the menu: DUT > Receive measuring values.
Wait until the data are transmitted.
12 Data Logger and Transmission of Data

**Stop of the transmission of data**

Select the menu: File > Save.

Select the series of measurement to be stored. Click on OK.
Select the path on which the data should be stored. Enter the file name. Click on Save.
The file will be stored with the file extension .flx.

**12.2.8 Structure of the Data**

The header is transmitted at the beginning of the measurement. The first 4 lines contain general information about the transmitter and the measurement. The following lines contain the parameters of each channel.

**Example:**

```
DEVICE : F70X -XXXXXXXX
MODE : ONLINE
DATE : 2011-01-09
TIME : 19:56:52
Par.Record Meas.Point No. : A:F5050
Pipe
  Outer Diameter : 60.3 mm
  Wall Thickness : 5.5 mm
  Roughness : 0.1 mm
  Pipe Material : Carbon Steel
  Lining : WITHOUT LINING
Medium : Water
Medium Temperat. : 38 C
Fluid pressure : 1.00 bar
Transducer Type : xxx
Sound Path : 3 NUM
Transd. Distance : -15.6 mm
Damping : 20 s
Full-Scale Val. : 4.50 m3/h
Physic. Quant. : Volume flow
Unit Of Measure : [m3/h]/[m3]
Numb.Of Meas.Val : 100
```
The line \DATA will be transmitted next. Afterwards the column titles will be transmitted for the respective channel (see Tab. 12.3) The measured values are transmitted afterwards.

Example:

```
A: \*MEASURE; Q_POS; Q_NEG;
B: \*MEASURE; Q_POS; Q_NEG;
```

In every storage interval, one data line per activated measuring channel is transmitted. The line "???" will be transmitted if there are no measured values available for the storage interval.

Example:

```
With a storage interval of 1 s, 10 lines with "???" will be transmitted if the measurement has been re-started after a 10 s interruption for the positioning of the transducers.
```

The following data columns can be transmitted:

Tab. 12.3: Columns of data

<table>
<thead>
<tr>
<th>column title</th>
<th>column format</th>
<th>contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>*MEASURE</td>
<td>###000000.00</td>
<td>physical quantity selected in Output Options</td>
</tr>
<tr>
<td>Q_POS</td>
<td>+00000000.00</td>
<td>totalizer value for the positive flow direction</td>
</tr>
<tr>
<td>Q_NEG</td>
<td>-00000000.00</td>
<td>totalizer value for the negative flow direction</td>
</tr>
<tr>
<td>FQ_POS</td>
<td></td>
<td>value of the totalizer for the positive flow direction (if the heat flow has been selected as the physical quantity)</td>
</tr>
<tr>
<td>FQ_NEG</td>
<td></td>
<td>the value of the totalizer for the negative flow direction (if the heat flow has been selected as the physical quantity)</td>
</tr>
<tr>
<td>T1</td>
<td>###000.0</td>
<td>temperature T1 (= supply temperature if the heat flow has been selected as the physical quantity)</td>
</tr>
<tr>
<td>T2</td>
<td>###000.0</td>
<td>temperature T2 (= return temperature if the heat flow has been selected as the physical quantity)</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td>designation for other inputs</td>
</tr>
<tr>
<td>SSPEED</td>
<td></td>
<td>sound speed of the medium</td>
</tr>
<tr>
<td>AMP</td>
<td></td>
<td>signal amplitude</td>
</tr>
</tbody>
</table>

Online transmission of data

Columns will be created for all quantities that appear during the measurement. The columns Q_POS and Q_NEG will remain empty if the totalizers are deactivated.

As the totalizers cannot be activated for the physical quantity flow velocity, these columns will not be created.

Offline transmission of data

During the offline output, columns will only be created if at least one measured value is stored in the series of measured values. The columns Q_POS and Q_NEG will not be created if the totalizers are deactivated.
13 Libraries

The internal material database of the transmitter contains parameters for pipe and lining materials as well as for media. It can be extended with user-defined materials or media. User-defined materials and media will always be displayed in the scroll lists of the program branch Parameter.

User-defined materials and media can be stored in an integrated coefficient memory (user area). The coefficient memory has to be partitioned first (see section 13.1).

The parameters of user-defined materials or media can be entered as follows:

- as constants without the extended library (see section 13.2)
- as constants or temperature and pressure dependent functions by means of the extended library (see section 13.3)

The material and media scroll lists displayed in the program branch Parameter can be arranged (see section 13.5). Shorter scroll lists make working more efficient.

13.1 Partitioning of the Coefficient Memory

The coefficient memory can be divided into parts for the following material data:

- material parameters:
  - transversal and longitudinal sound speed
  - typical roughness
- medium parameters:
  - min. and max. sound speed
  - kinematic viscosity
  - density
- heat flow coefficients (additional medium parameter)
- steam coefficients (additional medium parameter)

For the max. number of data sets for each category of these material data see Tab. 13.1.

Tab. 13.1: Capacity of the coefficient memory

<table>
<thead>
<tr>
<th></th>
<th>max. number of data sets</th>
<th>occupancy of the coefficient memory in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>materials</td>
<td>13</td>
<td>97</td>
</tr>
<tr>
<td>media</td>
<td>13</td>
<td>97</td>
</tr>
<tr>
<td>heat flow coefficients</td>
<td>29</td>
<td>98</td>
</tr>
<tr>
<td>steam coefficients</td>
<td>19</td>
<td>95</td>
</tr>
</tbody>
</table>

Select Special Funct.\SYSTEM\settings\Libraries\Format USER-AREA. Press ENTER.

This error message will be displayed if the entered number of data sets for a category of material data exceeds the capacity of the coefficient memory.

Enter the number of the user-defined materials. Press ENTER.

Enter the number of the user-defined media. Press ENTER.

Enter the number of user-defined data sets for the heat flow coefficients. Press ENTER. Heat flow coefficients can only be entered if the transmitter has temperature inputs.

Enter the number of user-defined data sets for the steam coefficients. Press ENTER. Steam coefficients can only be entered if the transmitter has temperature inputs.
13.1.1 Data Retention During the Partitioning of the Coefficient Memory

When the coefficient memory is repartitioned, max. 8 data sets of each type can be retained.

Example 1: The number of user-defined materials is reduced from 5 to 3. The data sets #01 to #03 are retained. The data sets #04 and #05 are deleted.

Example 2: The number of user-defined materials is increased from 5 to 6. All 5 data sets are kept.

13.2 Input of Material/Medium Parameters Without the Extended Library

To enter the material/medium parameters as constants, the extended library has to be deactivated.

Select **off** to deactivate the extended library. Press ENTER.

The parameters of a user-defined material/medium can be entered now. The input of a material or a medium is almost identical. Therefore, displays for a medium will only be shown and described in case of differences.

Select **edit**. Press ENTER.

Select a user-defined material/medium. Press ENTER.

Change the designation of the material/medium.

The default name for a user-defined material/medium is USER MATERIAL N or USER MEDIUM N with N being an integer.

**Note!** 95 ASCII characters (letters, capital letters, numbers, special characters [!? * + - ( ) > < % * etc.]) are available for the designation of materials/media.

A designation can have max. 16 characters. The input of text is described in section 4.5.
Material parameters

Enter the sound speed of the material. Press ENTER.
For the sound speed of some materials annex C.1.

Enter the roughness of the material. Press ENTER.
For the typical roughness of some materials see annex C.2.

Medium parameters

Enter the average sound speed of the medium. Press ENTER.

Select auto or user. Press ENTER.

auto: The area around the average sound speed is defined by the transmitter.
user: The area around the average sound speed has to be entered.

Enter the area around the average sound speed of the medium. Press ENTER.
This display will only be indicated if user has been selected.

Enter the kinematic viscosity of the medium. Press ENTER.

Enter the density of the medium. Press ENTER.

13.3 Extended Library

13.3.1 Introduction

If the extended library is activated, it is possible to enter material and medium parameters as a function of the temperature or of the pressure and additional medium parameters (heat flow coefficients, steam coefficients and concentration coefficients). These data can be entered into the transmitter directly or by means of the program FluxKoef.

Tab. 13.2: Material and medium parameters that can be stored

<table>
<thead>
<tr>
<th>parameter</th>
<th>parameter is necessary for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>material parameter</td>
<td></td>
</tr>
<tr>
<td>transversal sound speed</td>
<td>flow measurement</td>
</tr>
<tr>
<td>longitudinal sound speed</td>
<td>flow measurement</td>
</tr>
<tr>
<td>type of sound wave</td>
<td>flow measurement</td>
</tr>
<tr>
<td>typical roughness</td>
<td>profile correction of the flow velocity</td>
</tr>
<tr>
<td>medium parameter</td>
<td></td>
</tr>
<tr>
<td>sound speed</td>
<td>start of measurement</td>
</tr>
<tr>
<td>viscosity</td>
<td>profile correction of the flow velocity</td>
</tr>
<tr>
<td>density</td>
<td>calculation of mass flow rate</td>
</tr>
<tr>
<td>additional parameters of a medium</td>
<td></td>
</tr>
<tr>
<td>heat flow coefficients</td>
<td>heat flow measurement</td>
</tr>
<tr>
<td>steam coefficients</td>
<td>heat flow measurement with steam in supply line</td>
</tr>
</tbody>
</table>
Enter only the parameters needed for the measuring task.

**Example:**

The density of a medium is unknown. If the mass flow rate is not measured, any constant value can be entered as the density.

The measurement of the flow velocity and of the volumetric flow rate will not be affected. However, the value of the mass flow rate will be wrong.

The dependence of the material/medium parameters on the temperature and pressure can be described

- as constants
- as linear function
- with polynomials of grade 1 to 4
- with customized interpolation functions

In most cases, constants or a linear function are sufficient.

If, e.g., the temperature fluctuations at the measuring point are low compared to the temperature dependence of the material parameters, the linearization or the complete neglect of the temperature dependence will not result in a considerable additional measuring error.

If, however, the process conditions fluctuate strongly and the medium parameters depend strongly on the temperature (e.g., viscosity of a hydraulic oil), polynomials or customized interpolation functions should be used. Contact FLEXIM to find the best solution for the measuring task.

**Customized interpolation functions**

Some dependencies are only approximated insufficiently by polynomials. A number of customized interpolation functions are available to interpolate multidimensional dependencies $y = f(T, p)$. Contact FLEXIM for more information.

### 13.3.2 Activation of the Extended Library

Select **Special Funct.\SYSTEM settings\Libraries\Extended Library**. Press ENTER. Select **on** to activate the extended library. Press ENTER.

### 13.3.3 Input of Material/Medium Parameters

The parameters of a user-defined material/medium can be entered now.

The input of a material or a medium is almost identical. Therefore, the displays for a medium will only be shown and described in case of differences.

Select **Special Funct.\Install Material** or **Install Medium**. Press ENTER.

An error message will be displayed if the coefficient memory does not contain an area for user-defined materials/media.

Partition the coefficient memory accordingly (see section 13.1).

Select the function for the temperature or pressure dependence of the material/medium parameters:

- **Y=const.**: constants
- **Y=M*X+N**: linear function of the temperature
- **Y=Polynom**: $y = k_0 + k_1 \cdot x + k_2 \cdot x^2 + k_3 \cdot x^3 + k_4 \cdot x^4$
- **Y=F(X,Z)**: customized interpolation function (only for experienced users or after consultation with FLEXIM)

**go back**: return to the previous menu item

Select a user-defined material/medium.
Material parameters
Enter the material's:
• transversal sound speed
• longitudinal sound speed
1...5 values depending on the selected function have to be entered. Press ENTER after each input.
If an already defined material is edited, for each parameter there will be a request whether it is to be edited. Select yes or no. Press ENTER. Change the values, if necessary.

<table>
<thead>
<tr>
<th>Material parameters</th>
<th>User-defined Material 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default soundsp. long.</td>
<td>&gt;TRANS.&lt;</td>
</tr>
<tr>
<td>Roughness</td>
<td>0.4 mm</td>
</tr>
<tr>
<td>Save changes</td>
<td>no &gt;YES&lt;</td>
</tr>
</tbody>
</table>

Select edit to edit the material/medium parameters or delete to delete the material/medium and to return to the scroll list Edit Material or Edit Medium.
This display will only be indicated if an already existing material/medium has been selected.

Enter the designation of the material/medium. Press ENTER.
The default name for a user-defined material/medium is USER MATERIAL N or USER MEDIUM N with N being an integer.

Medium parameters
Enter the medium's:
• longitudinal sound speed
• kinematic viscosity
• density
Depending on the selected function, 1...5 values have to be entered. Press ENTER after each input.
If an already defined medium is edited, for each parameter of some of the functions there will be a request whether it is to be edited. Select yes or no. Press ENTER. Change the values, if necessary.

<table>
<thead>
<tr>
<th>Medium parameters</th>
<th>User-defined Material 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughness</td>
<td>0.4 mm</td>
</tr>
<tr>
<td>Save changes</td>
<td>no &gt;YES&lt;</td>
</tr>
</tbody>
</table>

Select yes to store the entered parameters or no to quit the menu item without storing. Press ENTER.
13.3.4 Input of Heat Flow Coefficients

Note! The heat flow coefficients can also be edited with the programs FluxData and FluxKoef.

Note! The entered coefficients will not be checked. Absurd values can result in wrong measured values or in permanent system errors.

Select Special Funct.
Install Medium. Press ENTER.

Select Heat-flow coeffs. Press ENTER.

This error message will be displayed if the coefficient memory does not contain an area for the heat flow coefficients.
Partition the coefficient memory accordingly (see section 13.1).

Select the medium for which the heat flow coefficients have to be entered.
User-defined media will be displayed first, followed by the media of the internal database.

Select an index for storing the heat flow coefficients of the selected medium. Press ENTER.
If the coefficient memory is partitioned in such way that heat flow coefficients for two media can be entered, indices 01 and 02 are available.

Enter the 10 heat flow coefficients: a0...a4, r0...r4. Press ENTER after each input.

Select yes to store the heat flow coefficients. Press ENTER.

Note! The entered coefficients will not be checked. Absurd values can result in wrong measured values or in permanent system errors.

Select delete. Press ENTER.

Select the material/medium to be deleted. Press ENTER.
Select yes or no. Press ENTER.

13.3.5 Input of the Steam Coefficients

Use the program FluxKoef (optional).

Note! The entered coefficients will not be checked. Absurd values can result in wrong measured values or in permanent system errors.

13.4 Deleting a User-Defined Material/Medium

To delete a user-defined material/medium, proceed as follows:
Select Special Funct.
Install Material or Install Medium. Press ENTER.
If the extended library is activated, press ENTER until the request for deleting is displayed.

Select delete. Press ENTER.

Select the material/medium to be deleted. Press ENTER.
Select yes or no. Press ENTER.
13.5 Arrangement of the Material/Medium Scroll List

The materials and media to be displayed in the program branch Parameter are arranged in the material scroll list and in the medium scroll list.

**Note!** User-defined materials/media will always be displayed in the scroll lists of the program branch Parameter.

Select Special Funct.\SYSTEM settings\Libraries. Press ENTER.

Select Material list to edit the material scroll list or Medium list to edit the medium scroll list.

Select go back to return to SYSTEM settings. Press ENTER.

Select factory if all materials/media of the internal database are to be displayed in the scroll list. An already existing scroll list will not be deleted but only deactivated.

Select user to activate the user-defined scroll list. Press ENTER.

If user has been selected, the material or medium scroll list can be edited (see section 13.5.1...13.5.3).

Select End of Edit to stop editing. Press ENTER.

Select yes to store all changes of the scroll list or no to quit the menu item without storing. Press ENTER.

**Note!** If the material/medium scroll list is quit by pressing key BRK before storing, all changes will be lost.

### 13.5.1 Displaying a Scroll List

Select Show list. Press ENTER to display the scroll list as in the program branch Parameter.

The current scroll list is displayed in the lower line. Press ENTER to return to the scroll list Material list or Medium list.

### 13.5.2 Adding a Material/Medium to the Scroll List

Select Add Material or Add Medium to add a material/medium to the scroll list. Press ENTER.

All materials/media that are not contained in the current scroll list will be displayed in the lower line.

Select the material/medium. Press ENTER. The material/medium will be added to the scroll list.

**Note!** The materials/media are displayed in the order in which they have been added.
13.5.3 Adding all Materials/Media to the Scroll List

Select **Add all** to add all materials/media of the database to the current scroll list. Press ENTER.

13.5.4 Removing a Material/Medium from the Scroll List

Select **Remove Material** or **Remove Medium** to remove a material/medium from the scroll list. Press ENTER.

All materials/media of the current scroll list will be displayed in the lower line. Select the material/medium. Press ENTER. The material/medium will be removed from the scroll list.

Note! User-defined materials/media will always be displayed in the scroll lists of the program branch Parameter. They cannot be removed.

13.5.5 Removing all Materials/Media from the Scroll List

Select **Remove all** to remove all materials/media from the scroll list. Press ENTER. User-defined materials/media will not be removed.
14 Settings

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

14.1.1 Time

Select Special Funct.\SYSTEM settings\Set Clock. Press ENTER.

The current time is displayed. Select ok to confirm the time or new to set the time. Press ENTER.

Press key and to select the digit to be edited.
Press key and to edit the selected digit. Press ENTER.

The new time is displayed. Select ok to confirm the time or new to set the time again. Press ENTER.

14.1.2 Date
After the time has been set, DATE is displayed.

Select ok to confirm the date or new to set the date. Press ENTER.

Press key and to select the digit to be edited.
Press key and to edit the selected digit. Press ENTER.

The new date is displayed. Select ok to confirm the date or new to set the date again. Press ENTER.

14.2 Dialogs and Menus

Select Special Funct.\SYSTEM settings\Dialogs/Menus. Press ENTER.

Note! The settings of the menu item Dialogs/Menus will be stored at the end of the dialog. If the menu item is quit before the end of the dialog, the settings will not be effective.

14.2.1 Pipe Circumference

Select on if the pipe circumference is to be entered instead of the pipe diameter in the program branch Parameter. Press ENTER.

If on has been selected for Pipe Circumfer., the outer pipe diameter will nevertheless be requested in the program branch Parameter.

To select the menu item Pipe Circumfer., enter 0 (zero). Press ENTER.

The value displayed in Pipe Circumfer. is calculated on the basis of the last displayed value of the 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.
During the next scroll through the program branch Parameter, the outer pipe diameter that corresponds to the entered pipe circumference will be displayed.

**Example:**
- entered pipe circumference: 100 mm
- displayed outer pipe diameter: 31.8 mm

When the transmitter switches back to the display of the pipe circumference, 99.9 mm will be displayed.

### 14.2.2 Medium Pressure

The dependence of the properties of a medium on the pressure can be taken into account.

**Fluid pressure**
- If on has been selected, the medium pressure will be requested in the program branch Parameter.
- If off has been selected, 1 bar will be used for all calculations.

**Note!** For documentation purposes, it is useful to enter the medium pressure, even if the transmitter contains no pressure-dependent characteristic curves.

### 14.2.3 Measuring Point Number

Select (1234) if the measuring point is to be identified only by numbers, point and dash. Select (↑↓←→) if the measuring point is to be designated with ASCII characters.

### 14.2.4 Transducer Distance

**recommended setting: user**
- user will be selected if the measuring point is always the same.
- auto can be selected if the measuring point changes often.

In the program branch Measuring, the recommended transducer distance will be displayed in parentheses, followed by the entered transducer distance if the recommended and the entered transducer distances are not identical.

During transducer positioning in the program branch Measuring
- only the entered transducer distance will be displayed if Transd. Distance = user has been selected and the recommended and the entered transducer distances are identical
- only the recommended transducer distance will be displayed if Transd. Distance = auto has been selected.

### 14.2.5 Steam in the Supply Line

Select on if the medium in the supply line can be vaporous during the heat flow measurement (see section 16.6). In this case, the supply pressure will have to be entered in the program branch Parameter.

### 14.2.6 Temperature Correction

Select on to enable the input of a temperature correction for each temperature input (see section 17.2.5).
### 14.2.7 Error Value Delay

The error value delay is the time after which an error value will be sent to an output if no valid measured values are available.

![Error-val. delay damping >EDIT<]

Select **edit** to enter an error value delay. Select **damping** if the damping factor is to be used as the error value delay.

For further information on the behavior of missing measured values see section 18.1.2 and 18.2.

### 14.2.8 Alarm State Indication

![SHOW RELAIS STAT off >ON<]

Select **on** to display the alarm state during the measurement.

For further information on the alarm outputs see section 18.6.

### 14.2.9 Units of Measurement

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

- **Length unit**
  - Select **mm** or **inch** as the unit of measurement for the length. Press ENTER.

- **Temperature**
  - Select °C or °F as the unit of measurement for the temperature. Press ENTER.

- **Pressure**
  - Select bar or psi as the unit of measurement for the pressure. Press ENTER.

- **Density**
  - Select yes if lb/ft³ is to be used as the unit of measurement for the density. Press ENTER.

- **Density unit**
  - Select g/cm³ or kg/m³ as the unit of measurement for the density. Press ENTER.

- **Viscosity unit**
  - Select mm²/s or cSt as the unit of measurement for the kinematic viscosity. Press ENTER.

- **Sound speed unit**
  - Select m/s or fps as the unit of measurement for the sound speed. Press ENTER.

### 14.2.10 Setting for the Medium Pressure

It is possible to set whether the absolute or the relative pressure will be used:

- **Pressure absolut**
  - Select **on** or **off**. Press ENTER.

- **Fluid pressure**
  - The pressure and its unit of measurement will, e.g., be displayed in the program branch **Parameter**. It will be followed by the selected pressure, indicated in parentheses.

  - a - absolute pressure
  - g - relative pressure

**Note!** All changes will be stored at the end of the dialog.
### 14.3 Measurement Settings

Select `Special Funct.\SYSTEM settings\Measuring`. Press ENTER.

**Note!** The settings of the menu item `Measuring` will be stored at the end of the dialog. If the menu item is quit before the end of the dialog, the settings will not be effective.

**Wave Injector**
- `off` > `ON<`  

**Compare c-fluid**
- `no` > `YES<`

**Flow Velocity**
- `>NORMAL<` `uncorr.`

**Cut-off Flow**
- `absolut` > `SIGN<`
- `factory` > `USER<`

**Velocity limit**
- `24.0 m/s`

**Heat Quantity**
- `>[J]<` `[Wh]`

**heat+flow quant.**
- `off` > `ON<`

**Quant. wrapping**
- `off` > `ON<`

**Quantity recall**
- `off` > `ON<`

**Turbulence mode**
- `off` > `ON<`

**This menu item will only be displayed if a Wave Injector is in the scope of supply (see user manual of the Wave Injector).**

Select `yes` if the measured sound speed is to be compared to the theoretical or expected value. The difference

\[ \delta c = c_{\text{mea}} - c_{\text{stored}} \]

between the two sound speeds will be displayed during the measurement. \( c_{\text{stored}} \) is the sound speed stored in the database.

Press key \[ \text{3} \] during the measurement to scroll to the display of \( \delta c \).

Select `normal` to display and transmit the profile corrected flow values, `uncorr.` to display and transmit the flow values without flow profile correction. Press ENTER. For further information see section 11.6.

A lower limit for the flow velocity can be entered (see section 11.5).

An upper limit for the flow velocity can be entered (see section 11.4).

Enter 0 (zero) to deactivate the flow velocity check.

The heat quantity is the totalizer of the heat flow. Select the unit of measurement for the heat flow (`J` or `Wh`).

Select `on` to store and transmit the values of the heat quantity totalizer and the volume totalizer during the heat flow measurement.

Select the overflow behavior of the totalizers (see section 11.2.1).

Select `on` to keep the previous totalizer values after a restart of the measurement.

Select `off` to reset the totalizers to zero after a restart of the measurement.

The activation of the turbulence mode can improve the signal quality if the flow is highly turbulent (e.g., in the vicinity of an elbow or valve). An SNR value of min. 6 dB is required during the measurement.

**Note!** All changes will be stored at the end of the dialog.
14.4 Setting the Contrast

Select Special Funct.\SYSTEM settings\Miscellaneous to set the contrast of the display of the transmitter. Press ENTER.

The contrast of the display is adjusted with the following keys:
- increases the contrast
- reduces the contrast
- = min. contrast
- = medium contrast
- = max. contrast

It is possible to reset the display to medium contrast. Press key C. Enter HotCode 555000.

Note! After an initialization of the transmitter, the display is displayed to medium contrast.

14.5 Instrument Information

Select Special Funct.\Instrum. Inform. to display information about the transmitter. Press ENTER.

The type and the serial number of the transmitter will be displayed in the upper line.

The max. available data logger memory will be displayed in the lower line (here: 18 327 additional measured values can be stored). For further information on the data logger see section 12.1.6.

Press ENTER.

The type and the serial number of the transmitter will be displayed in the upper line.

The firmware version of the transmitter with date is displayed in the lower line.

Press ENTER.
15  SuperUser Mode

The SuperUser mode offers the possibility of an advanced analysis of the signal and the measured values as well as the definition of additional parameters adapted to the measuring point, in order to achieve better measuring values or during experimental work. Features of the SuperUser mode are:

• Defaults will not be observed.
• There are no plausibility checks when parameters are being entered.
• There is no check whether the entered parameters are within the limits determined by the laws of physics and technical data.
• The cut-off flow is not active.
• A value for the number of sound paths has to be entered.
• Some menu items that are not visible in the normal mode are displayed.

Attention! The SuperUser mode is intended for experienced users with advanced application knowledge. The parameters can affect the normal measuring mode and lead to wrong measuring values or to a failure of the measurement when a new measuring point is set up.

15.1 Activation/Deactivation

Press key C. Enter HotCode 071049. It is displayed that the SuperUser mode is activated. Press ENTER. The main menu will be displayed.

Press key C. Enter HotCode 071049 again to deactivate the SuperUser mode. It is displayed that the SuperUser mode is deactivated. Press ENTER. The main menu will be displayed.

Attention! Some of the defined parameters are still active after the deactivation of the SuperUser mode.

15.2 Transducer Parameters

In the SuperUser mode, the menu item Transducer Type will be displayed at the end of the input in the program branch Parameter, even if the transducers are detected by the transmitter.

Press ENTER. or Select Special Version to enter the transducer parameters. Press ENTER.

If Special Version has been selected, the transducer parameters have to be entered. The transducer parameters have to be provided by the transducer manufacturer. Press ENTER after each input.

15.3 Defining the Flow Parameters

In the SuperUser mode, it is possible to define some flow parameters (profile bounds, correction of the flow velocity) for the specific application or measuring point.

Select Special Funct.\SYSTEM settings\Measuring\Calibration. Press ENTER. Select the measuring channel for which the flow parameters are to be defined. Press ENTER.
15.3.1 Profile Bounds

Select user if the profile bounds are to be defined. If factory is selected, the default profile bounds will be used and the menu item Calibration will be displayed (see section 15.3.2).

Press ENTER.

Enter the max. Reynolds number at which the flow is laminar. The entered number will be rounded to the hundreds. Enter 0 (zero) to use the default value 1 000.

Press ENTER.

Enter the min. Reynolds number at which the flow is turbulent. The entered number will be rounded to the hundreds. Enter 0 (zero) to use the default value 3 000.

Press ENTER.

A request is displayed if an additional correction of the flow velocity is to be defined. Select on to define the correction data, off to work without correction of the flow velocity and return to the menu item SYSTEM settings.

For the definition of the correction of the flow velocity see section 15.3.2.

Example:
profile bound for the laminar flow: 1 500
profile bound for the turbulent flow: 2 500
At Reynolds numbers < 1 500, the flow during the measurement is regarded as laminar for the calculation of the physical quantity. At Reynolds numbers > 2 500, the flow is regarded as turbulent. The range 1 500...2 500 is the transition range between laminar and turbulent flow.

Attention! The defined profile bounds are still active after the deactivation of the SuperUser mode.

15.3.2 Correction of the Flow Velocity

After the profile bounds have been defined (see section 15.3.1), it is possible to define a correction of the flow velocity.

\[ v_{\text{cor}} = m \cdot v + n \]

with

- \( v \) – measured flow velocity
- \( m \) – slope, range: -2.000...+2.000
- \( n \) – offset, range: -12.7...+12.7 cm/s
- \( v_{\text{cor}} \) – corrected flow velocity

All quantities derived from the flow velocity will be calculated with the corrected flow velocity. The correction data will be transmitted to the PC or printer during the online or offline transmission of data.

Note! During the measurement, it will not be displayed that the correction of the flow velocity is active.

Select on to define the correction data, off to work without correction of the flow velocity and return to the menu item SYSTEM settings.

If on has been selected, enter the slope. If 0.0 is entered, the correction will be deactivated.

Press ENTER.

Enter the offset. Enter 0 (zero) to work without an offset.

Press ENTER.
15.4 Limit of the 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 flow velocity will be marked as invalid. The physical quantity cannot be determined.
• the LED of the measuring channel will light red (FLUXUS F709)
• a hash symbol "#" will be displayed after the unit of measurement (in case of a normal error, "?" is displayed).

Select Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item Gain threshold is displayed.

Example 1:
Slope: 1.1
Offset: -10.0 cm/s = -0.1 m/s
If a flow velocity \( v = 5 \text{ m/s} \) is measured, before the calculation of the derived quantities, it will be corrected as follows:
\[ v_{\text{corr}} = 1.1 \cdot 5 \text{ m/s} - 0.1 \text{ m/s} = 5.4 \text{ m/s} \]

Example 2:
Slope: -1.0
Offset: 0.0
Only the sign of the measured values is changed.

Note! The correction data will only be stored when a measurement is started. If the transmitter is switched off without starting a measurement, the entered correction data will be lost.

Attention! The correction of the flow velocity is still active after the deactivation of the SuperUser mode.

15.5 Upper Limit of the Sound Speed

When the plausibility of the signal is evaluated, it will be checked if the sound speed is within a defined range. The upper limit used for the evaluation is the greater of the following values:

• fixed upper value, default: 1 848 m/s
• value of the sound speed curve of the medium at the operating point plus offset, default offset: 300 m/s

In the SuperUser mode, the values can be defined for media that are not contained in the data set of the transmitter. Select Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item Bad soundspeed is displayed.

Enter for each measuring channel the fixed upper limit of the sound speed. Enter 0 (zero) to use the default value of 1 848 m/s.

Enter for each measuring channel the offset. Enter 0 (zero) to use the default value of 300 m/s.
15.6 Detection of Long Measurement Failures

If there are no valid measured value during a long time interval, new increments of the totalizers will be ignored. The values of the totalizers remain unchanged.

In the SuperUser mode, it is possible to set the time interval. Select Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item Do not total. if no meas. is displayed.

Enter the time. If 0 (zero) is entered, the default value 30 s will be used.

15.7 Number of Decimal Places of the Totalizers

The values of the totalizers can be displayed with up to 11 places, e.g., 74890046.03. In the SuperUser mode, it is possible to define the number of decimal places.

Select Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item Total digits is displayed.

Select one of the following list items:
- Automatic: dynamic adjustment
- Fixed to x digit: x decimal places (range: 0...4)

Press ENTER.

The number of decimal places will be adjusted dynamically. Low values will first be displayed with 3 decimal places. With greater values, 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>±0.00</td>
</tr>
<tr>
<td>&lt; 10^7</td>
<td>±1000000.00</td>
</tr>
<tr>
<td>&lt; 10^8</td>
<td>±10000000.0</td>
</tr>
<tr>
<td>&lt; 10^10</td>
<td>±1000000000</td>
</tr>
</tbody>
</table>

Example: fixed upper value of the sound speed thresh.: 2 007 m/s
offset: 600 m/s
value of the sound speed curve at the operating point: 1 546 m/s
As 1 546 m/s + 600 m/s = 2 146 m/s is greater than the fixed upper value 2 007, this value will be used as the upper limit of the sound speed when the plausibility of the signal is evaluated.

It is possible to display the valid range for the sound speed (SS—) in the lower line during the measurement. The second value (here: 2 146 m/s) is the upper limit at the operating point.

Attention! The defined upper limit of the sound speed is still active after the deactivation of the SuperUser mode.

SS=1038/2146 m/s

Attention! The defined upper limit of the sound speed is still active after the deactivation of the SuperUser mode.
**Total digits = Fixed to x digit**

The number of decimal points is constant. The max value of the totalizer is reduced with each additional decimal place.

<table>
<thead>
<tr>
<th>decimal places</th>
<th>max. value</th>
<th>max. display</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt; $10^{16}$</td>
<td>±99999999999</td>
</tr>
<tr>
<td>1</td>
<td>&lt; $10^8$</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>±9999.9999</td>
</tr>
</tbody>
</table>

**Note!** The number of decimal places and the max. value defined here only affect the display of the totalizers.

For setting the behavior of the totalizers when the max. value is reached see section 11.2.1.

### 15.8 Temperature-Based Heat Flow Cut-Off

With the temperature-based heat flow cut-off, all measured temperature differences between the supply and return line that are lower than a defined value are set to zero. The heat flow is also set to zero. The value of the heat quantity totalizer remains unchanged.

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item Thermal low cut is displayed.`

Select **on** to activate the temperature-based heat flow cut-off, **off** to deactivate it. Press ENTER.

If **on** has been selected, enter the limit of the temperature difference. All temperature differences between the supply and return line that are lower than this value will be set to zero. Enter 0 (zero) to work without the temperature-based heat flow cut-off. Press ENTER.

### 15.9 Manual Reset of the Totalizers

If the manual reset of the totalizers is activated, the totalizers can be reset to zero during the measurement by pressing key C three times, even if a program code is activated.

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item 3xC clear totals is displayed.`

Select **on** to activate the manual reset of the totalizers, **off** to deactivate it. Press ENTER.

**Note!** The manual reset of the totalizers is still active after the deactivation of the SuperUser mode.

### 15.10 Display of the Sum of the Totalizers

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

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous. Press ENTER until the menu item Show ΣQ is displayed.`

Select **on** to activate the display of the sum of the totalizers, **off** to deactivate it. Press ENTER.

If the display of the sum of the totalizers is activated, the sum ΣQ can be displayed in the upper line during the measurement.
15.11 Display of the Last Valid Measured Value

If the signal is not sufficient for a measurement, usually \texttt{UNDEF} will be displayed. Instead of \texttt{UNDEF}, it is also possible to display the last valid measured value.

Select \texttt{Special Funct.\textbackslash SYSTEM settings\textbackslash Measuring\textbackslash Miscellaneous}. Press ENTER until the menu item \texttt{Keep display val} is displayed.

Select \texttt{on} to activate the display of the last valid measured value, \texttt{off} to deactivate it. Press ENTER.

15.12 Display During the Measurement

In the SuperUser mode, the following information can be displayed during the measurement besides the normal information (see section 10.3):

<table>
<thead>
<tr>
<th>display</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t=$</td>
<td>transit time of the measuring signal</td>
</tr>
<tr>
<td>$c=$</td>
<td>sound speed</td>
</tr>
<tr>
<td>REYNOLD-</td>
<td>Reynolds number</td>
</tr>
<tr>
<td>VARI A=</td>
<td>standard deviation of the signal amplitude</td>
</tr>
<tr>
<td>VARI V=</td>
<td>standard deviation of the transit time of the measuring signal</td>
</tr>
<tr>
<td>dt-norm=</td>
<td>transit time difference standardized to the transducer frequency</td>
</tr>
<tr>
<td></td>
<td>density of the medium</td>
</tr>
</tbody>
</table>
16 Heat Flow Measurement

If the transmitter has the optional heat quantity measurement and two temperature inputs, the heat flow can be measured. A temperature probe is fixed on the supply and the return line. For the mounting of the temperature probes see section 6.5.

The transducers are mounted on the return line (see Fig. 16.1). If this is not possible, they can also be mounted on the supply line (see Fig. 16.2).

For the heat flow measurement, two different measuring modes can be used:

- The normal measuring mode (see section 16.2) can be used if in a heating application the transducers are mounted on the return line.
- The BTU mode (see section 16.3) facilitates the measurement with other configurations (e.g., if the transducers are mounted on the supply line or in a cooling application) and offers additional units of measurement for the heat flow.

A temperature correction value (offset) can be defined for each temperature input (see section 17.2.5).

If the supply or return temperature is known and constant during the whole measurement, this temperature can be entered in the transmitter. In this case, the corresponding temperature probe does not need to be connected (see section 16.2.3 or 16.3.3).

If the supply pressure is constant or can be measured with an additional input, the heat flow can be determined for a medium that is vaporous in the supply line (see section 16.6).

In the SuperUser mode, it is possible to define a temperature-based cut-off flow of the heat flow (see section 15.8).

The heat quantity is the totalizer of the heat flow (see section 11.2).
16.1 Calculation of the Heat Flow Rate

The heat flow rate is calculated by the following formula:

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

with

- $\Phi$ – heat flow rate
- $k_i$ – heat coefficient
- $V$ – volumetric flow rate
- $T_V$ – supply temperature
- $T_R$ – return temperature

The heat coefficient $k_i$ is calculated from 10 heat flow coefficients for the specific enthalpy and the density of the medium. The heat flow coefficients of some media are stored in the internal database of the transmitter. The heat flow coefficients of other media have to be entered before the start of the measurement (see section 13.3.4).

16.2 Normal Measuring Mode

The supply and return temperature are assigned to the measuring channels as T-Inlet and T-Fluid/Outlet. The temperatures can be measured or entered as constant values.

16.2.1 Flow Measurement on the Return Line

The temperature inputs (see Fig. 16.1) are configured as follows:

- Select Special Funct.\SYSTEM settings\Proc. inputs\Link temperature. Press ENTER.
- Select the list item Input T1 to assign the temperature probe on the supply line to the temperature input T1. Press ENTER.
- Select the list item Input T2 to assign the temperature probe on the return line to the temperature input T2. Press ENTER.

The measuring values of the heat flow will be displayed with the opposite sign during the measurement.

16.2.2 Flow Measurement on the Supply Line

The temperature inputs (see Fig. 16.2) are configured as follows:

- Select Special Funct.\SYSTEM settings\Proc. inputs\Link temperature. Press ENTER.
- Select the list item Input T2 to assign the temperature probe on the supply line to the temperature input T2 (even though it is connected to the temperature input T1!). Press ENTER.
- Select the list item Input T1 to assign the temperature probe on the return line to the temperature input T1 (even though it is connected to the temperature input T2!). Press ENTER.

The sign of the measured values is changed by
- switching the transducers
- switching the temperature probes (leads to an additional measuring error)
- entering the slope -1.0 in the correction formula of the flow velocity (see section 15.3.2).
16.2.3  Input of a Constant Temperature
If the supply or return temperature is known and constant during the whole measurement, this temperature can be entered in the transmitter.

Note! A constant temperature should be entered if, e.g., the supply temperature can only be measured with difficulty but is known and constant.

The temperature inputs are configured as follows:

- Select Special Funct.\SYSTEM settings\Proc. inputs\Link temperature. Press ENTER.
- Select the list item Fixed input val. if the supply temperature is known and constant. Press ENTER.
- Select the list item Fixed input val. if the return temperature is known and constant. Press ENTER.

Repeat the steps for all measuring channels on which a measurement is being conducted.

The constant value of the temperature is entered before the start of the measurement in the program branch Measuring (see section 16.4).

16.2.4  Defining the Physical Quantity and of the Unit of Measurement
- Select the program branch Output Options.
- Select the measuring channel on which the heat flow is to be measured (the channel to which the temperature inputs have been assigned). Press ENTER.
- This display will not be indicated if the transmitter has only one measuring channel.
- Select Heatflow as the physical quantity. Press ENTER.
- Select the unit of measurement to be used for the heat flow.

Note! The physical quantity Heatflow will only be displayed in the program branch Output Options of a measuring channel if the supply and return temperature have been assigned to this channel.

If the heat quantity is also to be measured, select Special Funct.\SYSTEM settings\Measuring. Press ENTER until the list item Heat Quantity is displayed.

Select the unit of measurement (J or Wh). Press

16.3  BTU Mode
The BTU mode is a measuring mode that is designed specifically for the heat flow measurement. In the BTU mode, the position of the transducers and the application can be assigned to avoid receiving the opposite sign of the measured values.

16.3.1  Activation/Deactivation of the BTU Mode
Press key C. Enter HotCode 007025.
- Select on to activate the BTU mode, off to deactivate it. Press ENTER.

Note! The BTU mode remains active after a restart of the transmitter.
16.3.2 Assignment of the Transducers and the Temperature Inputs

The position of the transducers and the temperature inputs can be assigned in accordance with the application.

Select Special Funct.\SYSTEM settings\Proc. inputs\Link temperature.

In case of a heating application, select heat, in case of a cooling application, select chill. Press ENTER.

Select return if the transducers are mounted on the return line or supply if the transducers are mounted on the supply line. Press ENTER.

Select sign if the sign of the heat flow is to be considered, absolute if only the absolute value of the heat flow is to be displayed. Press ENTER.

Select the temperature input to be assigned to the supply temperature. Press ENTER.

Select the temperature input to be assigned to the return temperature. Press ENTER.

16.3.3 Input of a Constant Temperature

If the supply or return temperature is known and constant during the whole measurement, this temperature can be entered in the transmitter.

Note! A constant temperature should be entered if, e.g., the supply temperature can only be measured with difficulty but is known and constant.

The temperature inputs are configured as follows:

Select Special Funct.\SYSTEM settings\Proc. inputs\Link temperature. Press ENTER.

Select the list item Fixed input val. if the supply temperature is known and constant. Press ENTER.

Select the list item Fixed input val. if the return temperature is known and constant. Press ENTER.

Repeat the steps for all measuring channels on which a measurement is being conducted.

The constant value of the temperature is entered before the start of the measurement in the program branch Measuring (see section 16.4).

16.3.4 Defining the Physical Quantity and of the Unit of Measurement

Select program branch Output Options.

Select the measuring channel on which the heat flow is to be measured (the channel to which the temperature inputs have been assigned). Press ENTER.

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

Select Thermal energy as the physical quantity. Press ENTER.

Select the unit of measurement to be used for the heat flow.
In the BTU mode, additional units of measurement are available for the physical quantity and the heat quantity (see section 11.2). The unit of measurement displayed during the measurement will be adjusted automatically:

<table>
<thead>
<tr>
<th>unit of measurement of the heat flow</th>
<th>unit of measurement of the heat quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>kBTU/min</td>
<td>kBTU</td>
</tr>
<tr>
<td>kBTU/h</td>
<td>kBTU</td>
</tr>
<tr>
<td>MBTU/h</td>
<td>MBTU</td>
</tr>
<tr>
<td>kBTU/day</td>
<td>kBTU</td>
</tr>
<tr>
<td>TON (TH)</td>
<td>TH</td>
</tr>
<tr>
<td>TON (TD)</td>
<td>TD</td>
</tr>
<tr>
<td>kTON (kTH)</td>
<td>kTH</td>
</tr>
<tr>
<td>kTON (kTD)</td>
<td>kTD</td>
</tr>
</tbody>
</table>

16.3.5 Automatic Toggling of the Display in the Lower Line
In the BTU mode, it is possible to activate automatic toggling of the display in the lower line. Press key three times during the measurement. The following physical quantities will be displayed at an interval of 3 s:
• physical quantity selected in the program branch Output Options
• medium temperature in the supply line
• medium temperature in the return line
• difference between the medium temperatures in the supply line and the return line
Press key three times to deactivate the automatic toggling.

16.4 Measurement
Start the measurement as usual.

If no heat flow coefficients are available for the selected medium, an error message will be displayed. For the input of the heat flow coefficients, see section 13.3.4.

The two temperature inputs are checked and the measured temperatures are displayed. Press ENTER.

If a temperature cannot be measured (the temperature probe is not connected or is defective), the error message ?UNDEF will be displayed.

If Fixed input val. has been selected during the configuration of the temperature input, the temperature input (Ts) or the return temperature (Tr) has to be entered now.

For simulations, it is possible to enter both the supply and return temperatures as constants. In this case, do not connect the temperature probes to the transmitter.

Enter the medium temperature. Press ENTER.

The measured heat flow (in the BTU mode Thermal energy) is displayed.

For the activation of the heat quantity totalizer see section 11.2.
16.5 Two Independent Heat Flow Rate Measurements

If the transmitter has 2 measuring channels and 2 temperature inputs for each measuring channel, it is possible to conduct 2 independent heat flow measurements at the same time. Tab. 16.1 shows a typical configuration of the temperature inputs.

Tab. 16.1: Configuration of the temperature inputs in case of two independent heat flow measurements

<table>
<thead>
<tr>
<th>temperature input</th>
<th>measuring channel A</th>
<th>measuring channel B</th>
</tr>
</thead>
<tbody>
<tr>
<td>supply temperature</td>
<td>T1 or constant value</td>
<td>T3 or constant value</td>
</tr>
<tr>
<td>return temperature</td>
<td>T2 or constant value</td>
<td>T4 or constant value</td>
</tr>
<tr>
<td>heat quantity measurement</td>
<td>possible</td>
<td>possible</td>
</tr>
</tbody>
</table>

Note! The measurement of the volumetric flow rate and the heat flow is only possible when the medium is liquid in the return line.

16.6 Steam in the Supply Line

If the supply pressure is constant or can be measured with an additional input, the heat flow can be determined for a medium that is vaporous in the supply line.

The state of aggregation of the medium is determined by means of the supply pressure and the supply temperature.

Note! The steam coefficients of water and ammonia are stored in the internal database of the transmitter. The steam coefficients of other media have to be entered with the program FluxKoef.

16.6.1 Activation/Deactivation

Select Special Funct.\SYSTEM settings\Dialogs/Menus\Steam in inlet.

Select on to activate Steam in inlet. The state of aggregation of the medium is determined by means of the supply pressure and the supply temperature.

Select off to activate Steam in inlet. The medium is always assumed to be liquid in the supply line.

If Steam in inlet is activated, the supply pressure has to be entered in the program branch Parameter.

Enter the supply pressure. Press ENTER.

Note! The menu item Steam in inlet will always be displayed independently of the selected physical quantity. However, the supply pressure will only be used for the heat flow measurement.
16.6.2 Display of the State of Aggregation

During the heat flow measurement, the state of aggregation of the medium can be displayed in the upper line by pressing key 3.

<table>
<thead>
<tr>
<th>display</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>S=</td>
<td>state of aggregation in the supply line</td>
</tr>
<tr>
<td>R=</td>
<td>state of aggregation in the return line</td>
</tr>
<tr>
<td>GAS</td>
<td>The medium is completely gaseous.</td>
</tr>
<tr>
<td>LIQU</td>
<td>The medium is completely liquid.</td>
</tr>
<tr>
<td>BOIL</td>
<td>The medium is in the phase transition.</td>
</tr>
</tbody>
</table>

In this case, an exact measurement of the heat flow is not possible because the proportion of the medium in liquid phase in the supply line has to be known in order to calculate the enthalpy of the supply. The critical range of water is defined as the range ±3 °C around the boiling temperature. In the critical range, the steam saturation enthalpy is used to calculate the heat flow.

Example:

A:S= GAS  R= LIQU
426.23 kW

The medium in the supply line is completely gaseous. The medium in the return line is completely liquid. A heat flow measurement is not possible.
17 Inputs

17.1 Binary Inputs

The transmitter can be equipped with 1 or 2 binary inputs. Using the binary outputs, it is possible to remotely trigger some functions of the transmitter (see section 11.10).

17.2 Analog Inputs

External sensors can be connected to the inputs (optional) to measure the following physical quantities:
- temperature
- density
- pressure
- kinematic viscosity
- dynamic viscosity

The values of the current, voltage, and temperature inputs can be used by all measuring channels.

An input has to be assigned to a measuring channel (see section 17.2.1 and 17.2.3) and activated (see section 17.2.4) before it can be used for the measurement and for the storing of measured values.

**Note!** The configuration of a measuring channel will be stored when the next channel is selected. The configuration dialog for a channel has to be completed in order to store the changes.
17.2.2 Selection of the Temperature Probe

Select **Special Funct.\SYSTEM settings\Proc. inputs**. Press ENTER.

**SYSTEM settings:**

**Proc. inputs**

Select the list item **PT100/PT1000**.

**Proc. inputs :**

**PT100 / PT1000**

Select the temperature probe.

If necessary, select the temperature probe for **Input T2...T4** accordingly.

17.2.3 Assignment of Other Inputs to the Measuring Channels

Select **Special Funct.\SYSTEM settings\Proc. inputs**. Press ENTER.

**SYSTEM settings:**

**Proc. inputs :**

**Link other inp.**

Select the first input to be assigned to measuring channel A. Only the installed inputs are displayed in the scroll list.

Select the list item **No measuring** if no input is to be assigned to measuring channel A.

Press ENTER.

Select the list items for **ext.Input(2)...(4)** of measuring channel A and the other activated channels accordingly.

**Note!** The configuration of a measuring channel will be stored when the next channel is selected. The configuration dialog of a channel has to be finished to store the changes.

17.2.4 Activation of the Inputs

The activation of the inputs in program branch **Output Options** will only be displayed if the transmitter has inputs of the corresponding type and they have been assigned to a measuring channel.

17.2.4.1 Activation of the Temperature Inputs

**Note!** If **Heatflow** has been selected as the physical quantity, the corresponding temperature inputs will be activated automatically. The steps described below are only necessary if the measured temperatures are to be used for the interpolation of the viscosity and the density of the medium.

Temperature inputs have to be activated if the measured temperatures are to be displayed, stored and/or transmitted or if the measured temperature is to be used for the interpolation of the viscosity and the density of the medium.

Select in the program branch **Output Options** the channel for which a temperature input has to be activated.

The temperature inputs assigned to the channel will be displayed one after another. Select **yes** for the temperature inputs that are to be activated.

**Note!** The total number of measured values that can be stored will be reduced if a temperature input is activated.
17.2.4.2 Activation of Other Inputs

Attention! Observe the correct polarity to avoid damaging the current source. A permanent short circuit can lead to the destruction of the current input.

Inputs have to be activated if the measured values are to be displayed, stored and/or transmitted together with the other measured values.

| Input | I1 | no >YES< |

In the program branch Output Options, select the channel for which an input is to be activated.

The inputs assigned to the channel will be displayed one after another. Select yes for the inputs that are to be activated.

Note! The total number of measured values that can be stored will be reduced if an input is activated.

17.2.5 Temperature Correction

A temperature correction value (offset) can be set for each temperature input. If a correction value has been defined, it will be added automatically to the measured temperature. This function is useful if, e.g.:
- the characteristic curves of the two temperature probes differ considerably from each other.
- a known and constant temperature gradient exists between the measured temperature and the actual temperature.

17.2.5.1 Activation/Deactivation the Temperature Correction

The temperature correction can be activated/deactivated in program branch Special Funct.\SYSTEM settings\Dialogs/Menus.

| Tx Corr.Offset | off >ON< |

Select on to activate the temperature correction, off to deactivate it.

Note! If off is selected, the temperature correction will be deactivated for all inputs. However, the entered correction values for each temperature input will be stored and displayed again when the temperature correction is activated again.

17.2.5.2 Input of the Temperature Correction

During the flow transducer positioning, the correction values will be requested for each input which has been activated and where the temperature can be measured.

Enter the offset for the temperature input.

Press ENTER.

Note! Only measured temperatures can be corrected.

In order to adjust the zero point, the same reference temperature is measured with the two temperature probes. The difference between the two measured temperatures is entered as the offset for one of the temperature inputs. The difference can also be distributed between the offsets of the two channels.

The display of the temperature difference T1-T2 does not indicate if one or both temperatures are constant or if the values have been corrected.

| T1 Corr.Offset | 0.3 C |

During the measurement, a corrected temperature value is marked by cor.
18 Outputs

If the transmitter is equipped with outputs, they have to be installed and activated before they can be used:
• assign a measuring channel (source channel) to the output (if the transmitter has more than one measuring channel)
• assign the physical quantity (source item) to be transmitted to the output by the source channel, and the properties of the signal
• define the behavior of the output in case no valid measured values are available
• activation of the installed output in the program branch Output Options

18.1 Installation of an Output

All outputs are installed in Special Funct.\SYSTEM settings\Proc. outputs.

Note! The configuration of an output will be stored at the end of the dialog. If the dialog is quit by pressing key BRK, the changes will not be stored.

Select Special Funct.\SYSTEM settings\Proc. outputs. Press ENTER.

Select the output to be installed. Press ENTER.

The scroll list contains all available outputs. A tick ✓ after a list item indicates that this output has already been installed.

Select active if all current outputs to be installed are to be operated as active current outputs.
Select passive if all current outputs to be installed are to be operated as passive current outputs.

This display will only be indicated if the transmitter is equipped with switchable current outputs.

This display will be indicated if the output has not been installed yet. Select yes. Press ENTER.

If the output has already been installed, select no to reconfigure it or yes to uninstall the output and to return to the previous menu item to select another output. Press ENTER.

Select in the scroll list the measuring channel to be assigned to the output as the source channel. Press ENTER.

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

Select the physical quantity (source item) to be transmitted from the source channel to the output.
If a binary output is configured, only the list items Limit and Impuls will be displayed.

The source items and their scroll lists are shown in Tab. 18.1.
**Tab. 18.1: Configuration of the outputs**

<table>
<thead>
<tr>
<th>source item</th>
<th>list item</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring value</td>
<td>actual measure</td>
<td>physical quantity selected in the program branch Output Options flow, independently of the physical quantity selected in the program branch Output Options</td>
</tr>
<tr>
<td></td>
<td>Flow</td>
<td>heat flow, independently of the physical quantity selected in the program branch Output Options</td>
</tr>
<tr>
<td></td>
<td>Heatflow</td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>Q+</td>
<td>totalizer for the positive flow direction</td>
</tr>
<tr>
<td></td>
<td>* actual measure</td>
<td>totalizer for the physical quantity selected in the program branch Output Options</td>
</tr>
<tr>
<td></td>
<td>* Flow</td>
<td>flow totalizer</td>
</tr>
<tr>
<td></td>
<td>* Heatflow</td>
<td>totalizer for the heat flow</td>
</tr>
<tr>
<td></td>
<td>Q-</td>
<td>totalizer for the negative flow direction</td>
</tr>
<tr>
<td></td>
<td>* actual measure</td>
<td>totalizer for the physical quantity selected in the program branch Output Options</td>
</tr>
<tr>
<td></td>
<td>* Flow</td>
<td>flow totalizer</td>
</tr>
<tr>
<td></td>
<td>* Heatflow</td>
<td>totalizer for the heat flow</td>
</tr>
<tr>
<td></td>
<td>ΣQ</td>
<td>sum of the totalizers (positive and negative flow direction)</td>
</tr>
<tr>
<td></td>
<td>* actual measure</td>
<td>totalizer for the physical quantity selected in the program branch Output Options</td>
</tr>
<tr>
<td></td>
<td>* Flow</td>
<td>flow totalizer</td>
</tr>
<tr>
<td></td>
<td>* Heatflow</td>
<td>totalizer for the heat flow</td>
</tr>
<tr>
<td>Limit</td>
<td>R1</td>
<td>limit message (alarm output R1)</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>limit message (alarm output R2)</td>
</tr>
<tr>
<td></td>
<td>R3</td>
<td>limit message (alarm output R3)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Is only available if a temperature input has been assigned to the channel.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tfluid ← (Ti)</td>
<td>medium temperature of the temperature probe at the point where the flow is measured</td>
</tr>
<tr>
<td></td>
<td>Taux S/R ← (Ti)</td>
<td>medium temperature of the other temperature probe</td>
</tr>
<tr>
<td></td>
<td>Tsupply ← (Ti)</td>
<td>supply temperature</td>
</tr>
<tr>
<td></td>
<td>Treturn ← (Ti)</td>
<td>return temperature</td>
</tr>
<tr>
<td></td>
<td>Ts-Tr (Ti-Tj)</td>
<td>difference supply temperature-return temperature</td>
</tr>
<tr>
<td></td>
<td>Tr-Ts (Ti-Tj)</td>
<td>difference return temperature-supply temperature</td>
</tr>
<tr>
<td></td>
<td>T(3) ← (Ti)</td>
<td>third temperature input of the measuring channel</td>
</tr>
<tr>
<td></td>
<td>T(4) ← (Ti)</td>
<td>fourth temperature input of the measuring channel</td>
</tr>
<tr>
<td></td>
<td>* i, j: number of the assigned temperature input</td>
<td></td>
</tr>
<tr>
<td>Impuls</td>
<td>from abs(x)</td>
<td>pulse without sign consideration</td>
</tr>
<tr>
<td></td>
<td>from x &gt; 0</td>
<td>pulse for positive measured values</td>
</tr>
<tr>
<td></td>
<td>from x &lt; 0</td>
<td>pulse for negative measured values</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>c-Medium</td>
<td>sound speed of the medium</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td>signal amplitude of a measuring channel</td>
</tr>
<tr>
<td></td>
<td>SCNR</td>
<td>ratio useful signal to correlated disturbance signal</td>
</tr>
<tr>
<td></td>
<td>VariAmp</td>
<td>standard deviation of the signal amplitude</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>density of the medium</td>
</tr>
</tbody>
</table>
18.1.1 Output Range

During the configuration of an analog output, the output range is defined. Select a list item or other range... to enter the output range manually.

If other range... has been selected, enter the values Output MIN and Output MAX. Press ENTER after each input.

This error message will be displayed if the output range is not min. 10 % of the max. output range. The next possible value will be displayed. Repeat the input.

Example: \( I_{\text{MAX}} - I_{\text{MIN}} \geq 2 \text{ mA} \) for a 4…20 mA current output

18.1.2 Error Output

In the following dialog, an error value can be defined which is to be output if the source item cannot be measured, e.g., if there are gas bubbles in the medium:

<table>
<thead>
<tr>
<th>error value</th>
<th>result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>output of the lower limit of the output range</td>
</tr>
<tr>
<td>Hold last value</td>
<td>output of the last measured value</td>
</tr>
<tr>
<td>Maximum</td>
<td>output of the upper limit of the output range</td>
</tr>
<tr>
<td>Other value...</td>
<td>The value has to be entered manually. It has to be within the limits of the output.</td>
</tr>
</tbody>
</table>

Example: source item: volumetric flow rate
output: current output
output range: 4…20 mA
error value delay \( t_{\text{d}} \) (see section 18.2): > 0

The volumetric flow rate cannot be measured during the time interval \( t_0...t_1 \) (see Fig. 18.1). The error value will be output.

Fig. 18.1: Error output
Tab. 18.3: Examples for the error output

<table>
<thead>
<tr>
<th>list item for the error output</th>
<th>output signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error-value; Minimum (4.0mA)</td>
<td><img src="image1" alt="Graph 1" /></td>
</tr>
<tr>
<td>Error-value; Hold last value</td>
<td><img src="image2" alt="Graph 2" /></td>
</tr>
<tr>
<td>Error-value; Maximum (20.0mA)</td>
<td><img src="image3" alt="Graph 3" /></td>
</tr>
<tr>
<td>Error-value; Other value...</td>
<td><img src="image4" alt="Graph 4" /></td>
</tr>
</tbody>
</table>

| Error-value; Minimum (4.0mA)  | ![Graph 1](image1) |
| Error-value; Other value...   | ![Graph 4](image4) |

Select a list item for the error output. Press ENTER.

If Other value has been selected, enter an error value. It has to be within the limits of the output. Press ENTER.

Note! The settings will be stored at the end of the dialog.

I1 active loop
Terminal: P1+, P1-

The terminals for the connection of the output are displayed (here: P1+ and P1- for the active current loop). Press ENTER.
18.1.3 Function Test

The function of the installed output can now be tested. Connect a multimeter with the installed output.

Test of the Analog Outputs

The current output is tested in the display. Enter a test value. It has to be within the output range. Press ENTER.

If the multimeter displays the entered value, the output functions correctly.
Select "yes" to repeat the test, "no" to return to SYSTEM settings. Press ENTER.

Test of the binary outputs

Select "Reed-Relay OFF" or "Open collect OFF" in the scroll list Output Test to test the de-energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be high ohmic.

Select "yes". Press ENTER.

Select "Reed-Relay ON" or "Open collect ON" in the scroll list Output Test to test the energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be low ohmic.

Select "yes" to repeat the test, "no" to return to SYSTEM settings. Press ENTER.

18.2 Error Value Delay

The error value delay is the time interval after which the error value will be transmitted to the output in case no valid measured values are available. The error value delay can be entered in the program branch Output Options if this menu item has previously been activated in the program branch Special Funct.. If the error value delay is not entered, the damping factor will be used.

Select "Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay.".
Select "Damping" if the damping factor is to be used as the error value delay. Select "Edit" to activate the menu item Error-val. delay in the program branch Output Options.

From now on, the error value delay can be entered in the program branch Output Options.

18.3 Activation of an Analog Output

Note! An output can only be activated in the program branch Output Options if it has previously been installed.

In the program branch Output Options, select the channel for which an output is to be activated. Press ENTER.
This display will not be indicated, if the transmitter has only one measuring channel.

Press ENTER until Current Loop is displayed. Select "yes" to activate the output. Press ENTER.
18 Outputs

18.3.1 Measuring Range of the Analog Outputs
After an analog output has been activated in the program branch Output Options, the measuring range of the source item has to be entered.

- **Meas. Values**
  - >ABSOLUT< sign

  - **Zero-Scale Val.**
    - 0.00 m³/h

  - **Full-Scale Val.**
    - 300.00 m³/h

Select *sign* if the sign of the measured values is to be considered for the output.
Select *absolut* if the sign is not to be considered.

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

Zero-Scale Val. is the measured value that corresponds to the lower limit of the output range as defined in section 18.1.1.

Enter the highest expected measured value.

Full-Scale Val. is the measured value that corresponds to the upper limit of the output range as defined in section 18.1.1.

**Example:**
- output: current output
- output range: 4...20 mA
- Zero-Scale Val.: 0 m³/h
- Full-Scale Val.: 300 m³/h
- Volumetric flow rate = 0 m³/h, corresponds to 4 mA
- Volumetric flow rate = 300 m³/h, corresponds to 20 mA

18.3.2 Function Test
The function of the installed output can now be tested. Connect a multimeter to the installed output.

- **I1: Test output ?**
  - no >YES<

- **I1: Test value =**
  - 150.00 m³/h

Select *yes* to activate the output. Press ENTER.
Enter a test value for the selected physical quantity. If the multimeter displays the corresponding current value, the output functions correctly. Press ENTER.

Select *yes* to repeat the test. Press ENTER.

**Example:**
- output: current output
- output range: 4...20 mA
- Zero-Scale Val.: 0 m³/h
- Full-Scale Val.: 300 m³/h
- Test value = 150 m³/h (center of the measuring range, corresponds to 12 mA)
- If the multimeter displays 12 mA, the current output functions correctly.

18.4 Configuration of a Frequency Output as a Pulse Output
A frequency output sends a signal with a frequency that depends on the volume flow rate. The frequency output can be configured in such way that the source item can be totalized by using each period of the output signal as the increment.

18.4.1 Installation of a Frequency Output (Optional)

- **Install Output :**
  - Frequency F1

  - **F1 enable**
    - no >YES<

  - **F1 disable**
    - >NO< yes

Select *Frequency F1* in Special Funct.\SYSTEM settings\Proc. outputs. Press ENTER.
Select *yes* if the output has not been installed. Press ENTER.
or
Select *no* if the output has already been installed. Press ENTER.
18.4.2 Activation of the Output

In the program branch Output Options, select the channel for which the input is to be activated. Press ENTER.

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

Select yes to activate the output. Press ENTER.

Enter the number of pulses that is to be assigned to the unit of measurement of the totalizer. Press ENTER.

Example: 1000 pulses correspond to 1 m³ of the totalized medium.

The max. flow depending on the upper limit of the frequency and pulse value is indicated. Press ENTER.

18.5 Activation of a Binary Output as a Pulse Output

A pulse output is an integrating output which emits a pulse when the volume or the mass of the medium which has passed the measuring point reaches a given value (Pulse Value). The integrated quantity is the selected physical quantity. Integration is restarted as soon as a pulse is emitted.

Note! The menu item Pulse Output will only be indicated in the program branch Output Options if a pulse output has been installed.

Select in the program branch Output Options the channel for which a pulse output is to be activated. Press ENTER.

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

Select yes to activate the output. Press ENTER.

This error message will be displayed if the flow velocity has been selected as the physical quantity.

The use of the pulse output is not possible in this case because integrating the flow velocity does not result in a reasonable value.

Enter the pulse value. The unit of measurement will be displayed according to the current physical quantity.

When the totalized physical quantity reaches the pulse value, a pulse will be emitted.

Enter the pulse width.

The range of possible pulse widths depends on the specification of the measuring instrument (e.g., counter, PLC) that is to be connected to the output.

The max. flow that the pulse output can work with will be displayed now. This value is calculated on the basis of the entered pulse value and pulse width.

If the flow exceeds this value, the pulse output will not function properly. In this case, the pulse value and the pulse width have to be adapted to the flow conditions. Press ENTER.
18.6 Activation of a Binary Output as an Alarm Output

**Note!** The menu item Alarm Output will only be displayed in the program branch Output Options if an alarm output has been installed.

Select in the program branch Output Options the channel for which an alarm output is to be activated. Press ENTER until the menu item Alarm Output is displayed. This display will not be indicated if the transmitter has only one measuring channel. Select yes to activate the alarm output. Press ENTER.

Max. 3 alarm outputs R1, R2, R3 per channel operating independently of each other can be configured. The alarm outputs can be used to output information on the current measurement or to start and stop pumps, motors, etc.

### 18.6.1 Alarm Properties

The switching condition, the holding behavior and the switching function of an alarm output can be defined.

Three scroll lists will be displayed:

- **func**: switching condition
- **typ**: holding behavior
- **mode**: switching function

Press key (4) and (6) to select a scroll list in the upper line. Press key (5) and (7) to select a list item in the lower line. Press ENTER to store the settings.

<table>
<thead>
<tr>
<th>alarm property</th>
<th>setting</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>func</strong> (switching condition)</td>
<td>MAX</td>
<td>The alarm will switch if the measured value exceeds the upper limit.</td>
</tr>
<tr>
<td></td>
<td>MIN</td>
<td>The alarm will switch if the measured value falls below the lower limit.</td>
</tr>
<tr>
<td></td>
<td>+→-</td>
<td>The alarm will switch if the flow direction changes (sign change of measured value).</td>
</tr>
<tr>
<td></td>
<td>QUANT.</td>
<td>The alarm will switch if totalizing is activated and the totalizer reaches the limit.</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
<td>The alarm will switch if a measurement is not possible.</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>The alarm is switched off.</td>
</tr>
<tr>
<td><strong>typ</strong> (holding behavior)</td>
<td>NON-HOLD</td>
<td>If the switching condition is not true anymore, the alarm will return to the idle state after approx. 1 s.</td>
</tr>
<tr>
<td></td>
<td>HOLD</td>
<td>The alarm remains activated even if the switching condition is not true anymore.</td>
</tr>
<tr>
<td><strong>mode</strong> (switching function)</td>
<td>NO Cont.</td>
<td>The alarm is energized if the switching condition is true and de-energized if idle.</td>
</tr>
<tr>
<td></td>
<td>NC Cont.</td>
<td>The alarm is de-energized if the switching condition is true and energized if idle.</td>
</tr>
</tbody>
</table>

**Note!** If no measurement is made, all alarms will be de-energized, independently of the programmed switching function.
18.6.2 Setting the Limits

If the switching condition MAX or MIN is selected in the scroll list func, the limit of the output will have to be defined:

Select in the scroll list Input the physical quantity to be used for the comparison. The following list items are available for the alarm output R1:

- selected physical quantity
- signal amplitude
- sound speed of the medium
Press ENTER.

For the alarm outputs R2 and R3, the current physical quantity is selected automatically.

Switching condition: MAX
Enter the upper limit. Press ENTER.
The alarm will switch if the measured value exceeds the limit.

Switching condition: MIN
Enter the lower limit. Press ENTER.
The alarm will switch if the measured value falls below the limit.

Example 1:
High Limit: -10 m³/h
volumetric flow rate = -9.9 m³/h
the limit is exceeded, the alarm switches
volumetric flow rate = -11 m³/h
the limit is not exceeded, the alarm does not switch

Example 2:
Low Limit: -10 m³/h
volumetric flow rate = -11 m³/h
the measured value is below the limit, the alarm switches
volumetric flow rate = -9.9 m³/h
the measured value is not below the limit, the alarm does not switch

If the switching condition QUANT. is selected in the scroll list func, the limit of the output will have to be defined:

Enter the limit of the totalizer. Press ENTER.
The alarm will switch if the measured value reaches the limit.

Example 1:
physical quantity: volumetric flow rate in m³/h
Quantity Limit: 1 m³

Example 2:
physical quantity: volumetric flow rate in m³/h
Low Limit: 60 m³/h
The unit of measurement of the physical quantity is changed to m³/min. The new limit to be entered is 1 m³/min.
18.6.3 Defining the Hysteresis

A hysteresis can be defined for the alarm output R1 to prevent a constant triggering of the alarm due to small fluctuations of the measured values around the limit.

The hysteresis is a symmetrical range around the limit. The alarm will be activated if the measured values exceed the upper limit and deactivated if the measured values fall below the lower limit.

Example:  
High Limit: 30 m³/h  
Hysteresis: 1 m³/h  
The alarm will be triggered at values > 30.5 m³/h and deactivated at values < 29.5 m³/h.

18.7 Behavior of the Alarm Outputs

18.7.1 Apparent Switching Delay

Measured values and totalizer values will be displayed rounded to two 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 two decimal places). In this case, the switching accuracy of the output is greater than the accuracy of the display.

18.7.2 Reset and Initialization of the Alarms

After an initialization, all alarm outputs will be initialized as follows:

Press key C three times during the measurement to set all alarm outputs to the idle state. Alarm outputs whose switching condition is still met will be activated again after 1 s. This function is used to reset alarm outputs of the type HOLD if the switching condition is no longer met.

By pressing key BRK, the measurement will be stopped and the main menu selected. All alarm outputs will be de-energized, independently of the programmed idle state.

18.7.3 Alarm Outputs During Transducer Positioning

At the beginning of the transducer positioning (bar graph display), all alarm outputs switch back to the programmed idle state.

If the bar graph is selected during the measurement, all alarm outputs will switch back to the programmed idle state.

An alarm output of the type HOLD that has been activated during the previous measurement will remain in the idle state after the transducer positioning if the switching condition is no longer met.

Switching of the alarms into the idle state will not be displayed.

---

**Example:**

| R1 Hysteresis: | 1.00 m³/h |

Switching condition: MIN or MAX  
Enter the value for Hysteresis.  
or  
Enter 0 (zero) to work without a hysteresis.  
Press ENTER.
18.7.4 Alarm Outputs During the Measurement

An alarm output with switching condition **MAX** or **MIN** will be updated max. once per second to avoid humming (i.e. fluctuation of the measured values around the value of the switching condition).

An alarm output of the type **NON-HOLD** will be activated if the switching condition is met. It will be deactivated if the switching condition is no longer met. The alarm will remain activated min. 1 s even if the switching condition is met for a shorter period of time.

Alarm outputs with the switching condition **QUANT.** will be activated if the limit is reached. Alarm outputs with the switching condition **ERROR** will only be activated after several unsuccessful measuring attempts. Therefore, typical short-term disturbances of the measurement (e.g., switching on of a pump) will not activate the alarm. Alarm outputs with the switching condition **+→−→+** and of the type **NON-HOLD** will be activated with each change of the flow direction for approx. 1 s (see Fig. 18.2).

Alarm outputs with the switching condition **+→−→−** and of the type **HOLD** will be active after the first change of the flow direction. They can be switched back by pressing key C three times (see Fig. 18.2).

If there is an internal adaptation to changing measuring conditions, e.g., to a considerable rise of the medium temperature, the alarm will not switch. Alarm outputs with the switching condition **OFF** will be set automatically to the switching function **NO Cont.**.

18.7.5 Indication of the Alarm State

**Note!** There is no visual or acoustic indication of alarm output switching.

After the configuration of the alarm outputs and during the measurement, the state of the alarms can be indicated. This function is activated in the program branch **Special Funct.\SYSTEM settings\Dialogs/Menus.** It is recommended to activate this function if the alarm outputs often have to be reconfigured.

Select the menu item **SHOW RELAIS STAT**. Select **on** to activate the indication of the alarm state.

If the indication of the alarm state is activated, the state of the alarm outputs will be indicated after the configuration of the alarm outputs:

The indication of the alarm state is structured as follows:

![Diagram](image-url)

where **X** is the number of the alarm output and ** is a pictogram according to Tab. 18.6.

It is possible to repeat the configuration of the alarm outputs by pressing key C. If the configuration of the alarm outputs is complete, press **ENTER**. The main menu will be displayed.

If the indication of the alarm state is activated, it is possible to show the alarm state during the measurement. Press key **9** to scroll through the upper line and **3** to scroll through the lower line until the alarm state is indicated.
18 Outputs

18.8 Deactivation of the Outputs

If the programmed outputs are no longer required, they can be deactivated. The configuration of a deactivated output is stored and will be available if the output is activated again.

Example: R1 = 

Select no in Output Options\Alarm Output to deactivate an output. Press ENTER.

<table>
<thead>
<tr>
<th>Nr.</th>
<th>func (switching condition)</th>
<th>typ (holding behavior)</th>
<th>mode (switching function)</th>
<th>current state</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OFF</td>
<td>NON-HOLD</td>
<td>NO Cont.</td>
<td>closed</td>
</tr>
<tr>
<td>2</td>
<td>MAX</td>
<td>HOLD</td>
<td>NC Cont.</td>
<td>open</td>
</tr>
<tr>
<td>3</td>
<td>MIN</td>
<td></td>
<td>QUANT.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ERROR</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 18.6: Pictograms for the alarm state indication
19 Troubleshooting

If any problem appears which cannot be solved with the help of this user manual, 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.

Calibration

FLUXUS is a very reliable instrument. It is manufactured under strict quality control, using modern production techniques. If installed as recommended in an appropriate location, used cautiously and taken care of conscientiously, no troubles should appear. The transmitter has been calibrated at the factory and, usually, a re-calibration of the transmitter will not be necessary. A re-calibration is recommended if

- the contact surface of the transducers shows visible wear or
- the transducers were used for a prolonged period of time at a high temperature (several months >130 °C for normal transducers or > 200 °C for high-temperature transducers).

The transmitter has to be sent to FLEXIM for recalibration under reference conditions.

The display does not work at all or fails regularly

Check the contrast setting of the transmitter (see section 14.4). Make sure that the correct voltage is available at the terminals. The voltage is indicated on the metal plate below the outer right terminal. 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.

The message SYSTEM ERROR is displayed

Press key BRK to return to the main menu. If this message is displayed repeatedly, write down the number in the lower line. Track down the situations when the error is displayed. Contact FLEXIM.

The transmitter does not react when key BRK is pressed during the measurement

A program code has been defined. Press key C and enter the program code.

The backlight of the display does not work, but all other functions are available.

The backlight is defective. This problem does not affect the other functions of the display. Send the transmitter to FLEXIM for repair.

The display in the lower line constantly toggles between different physical quantities

Automatic toggling of the display in the BTU mode is activated. For the deactivation of the automatic toggling see section 16.3.5.

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

The data backup battery has to be replaced. Send the transmitter to FLEXIM.

An output does not work

Make sure that the outputs are configured correctly. Check the function of the output as described in section 18.1.3. If the output is defective, contact FLEXIM.

A measurement is impossible or the measured values substantially differ from the expected values

see section 19.1.

The values of the totalizer are wrong

see section 19.6.
19 Troubleshooting FLUXUS F70x

19.1 Problems with the Measurement

A measurement is impossible because no signal is received. A question mark is displayed in the lower line on the right

- Check if the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound speed of the medium. (Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.)
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point has been selected (see section 19.2).
- Try to establish better acoustic contact between the pipe and the transducers (see section 19.3).
- Enter a lower value for the number of sound paths. The signal attenuation might be too high due to a high medium viscosity or deposits on the inner pipe wall (see section 19.4).

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

- An exclamation mark "!" in the lower line on the right indicates that the defined upper limit of the flow velocity is exceeded and, therefore, the measured values are marked as invalid. The limit has to be adapted to the measuring conditions or checking has to be deactivated (see section 11.4).
- If no exclamation mark "!" is displayed, a measurement at the selected measuring point is not possible.

Loss of signal during the measurement

- If the pipe had run empty: Was there no measuring signal afterwards? Contact FLEXIM.
- Wait briefly until acoustic contact is reestablished. The measurement can be interrupted by a temporarily higher proportion of gas bubbles and solids in the medium.

The measured values substantially differ from the expected values

- Wrong measured values are often caused by wrong parameters. Make sure that the entered parameters are correct for the measuring point.
- If the parameters are correct, see section 19.5 for the description of typical situations in which wrong measured values are obtained.

19.2 Selection of the Measuring Point

- Make sure that the recommended min. distance to any disturbance source is observed (see chapter 5, Tab. 5.2).
- Avoid measuring points with deposit formation in the pipe.
- Avoid measuring points in the vicinity of deformations and defects on the pipe and in the vicinity of welds.
- 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 on the side of the pipes.
- A vertical pipe always has to be filled at the measuring point and the medium should flow upward.
- No gas bubbles should form (even bubble-free media can form gas bubbles when the medium expands, e.g., upstream of pumps and downstream of great cross-section enlargements).
19.3 Maximum Acoustic Contact
Observe the instructions in chapter 6.

19.4 Application Specific Problems

The entered sound speed of the medium is wrong
The entered 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 orientation.

The entered pipe roughness is not appropriate
Check the entered value. The state of the pipe should be taken into account.

Measurements on porous pipe materials (e.g., concrete or cast iron) are only possible under certain conditions
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 measuring on a liner free section of the pipe.

Highly viscous media strongly attenuate the ultrasonic signal
Measurements on media with a viscosity > 1000 mm²/s are only possible under certain conditions.

A higher proportion of gas bubbles or solids in the medium scatter and absorb the ultrasonic signal and therefore attenuate the measuring signal
A measurement is impossible if the value is ≥ 10 %. If the proportion is high, but < 10 %, a measurement is only possible under certain conditions.

The flow is in the transition range between laminar and turbulent flow where flow measurement is difficult
Calculate the Reynolds number of the flow at the measuring point with the program FluxFlow (free download: www.flexim.com). Contact FLEXIM.

19.5 Large Deviations of the Measured Values

The entered sound speed of the medium is wrong
A wrong sound speed can result in the ultrasonic signal that is reflected directly on the pipe wall being mistaken for the measuring signal that has passed through the medium. The flow calculated on the basis of the wrong signal by the transmitter is very small or fluctuates around zero.

There is gas in the pipe
If there is gas in the pipe, the measured flow will always be too high because both the gas volume and the liquid volume are measured.

The entered 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 derived from the flow velocity will also be marked 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 (default: 2.5 cm/s) has to be set to a low value in order to be able to measure at low flow velocities.

The entered pipe roughness is not appropriate

The flow velocity of the medium is outside the measuring range of the transmitter

The measuring point is not appropriate
Select another measuring point to check whether the results are better. Because pipes are never rotationally symmetric, the flow profile is affected. Change the transducer position according to the pipe deformation.
19.6 Problems with the Totalizers

The values of the totalizer are too high
See Special Function\SYSTEM settings\Measuring\Quantity recall. If this menu item is activated, the values of the totalizer will be stored. The totalizer will continue with this value at the start of the next measurement.

The values of the totalizer are too low
One of the totalizers has reached the upper limit and has to be reset to zero manually.

The sum of the totalizers is not correct
See Special Function\SYSTEM settings\Measuring\Quant. wrapping. The sum of both totalizers (throughput) transmitted via an output is not valid after the overflow (wrapping) of one of the totalizers.

19.7 Problems During the Heat Flow Measurement

The measured temperature values differ from the actual values.
The temperature probes are not sufficiently insulated.

On a pipe with a small diameter, the temperature probe is lifted from the pipe surface by the insulation foam.
The measured absolute value of the heat flow is correct but has the opposite sign.
Check the assignment of the supply and return temperature to the temperature inputs (see section 16.2 or 16.3).

The calculated heat flow differs from the actual heat flow although the measured flow and temperature values are correct
Check the heat flow coefficients of the medium (see section 13.3.4).

19.8 Data Transmission

The file with the transmitted measuring data contains meaningless strings
The transmission parameters of the transmitter and the transmission program are not identical. Adjust the transmission parameters of the transmitter (see section 12.2.4) and of the program FluxData (see section 12.2.7) or of the terminal program.
## A  Menu Structure

**Program Branch Parameter**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;PAR&lt; mea opt sf</td>
<td>main menu: selection of the program branch Parameter</td>
</tr>
<tr>
<td>Parameter ! for Channel A:</td>
<td>selection of a measuring channel (A, B) or of a calculation channel (Y, Z)</td>
</tr>
<tr>
<td></td>
<td>This display will not be indicated if the transmitter has only one measuring channel.</td>
</tr>
</tbody>
</table>

**When a Measuring Channel is Selected (A, B)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Diameter</td>
<td>input of the outer pipe diameter</td>
</tr>
<tr>
<td>100.0 mm</td>
<td></td>
</tr>
<tr>
<td>Pipe Circumfer.</td>
<td>input of the pipe circumference</td>
</tr>
<tr>
<td>314.2 mm</td>
<td>This display will only be indicated if Special Punct. \ SYSTEM settings\Dialogs/Menus\Pipe Circumfer. is activated and Outer Diameter = 0 has been entered.</td>
</tr>
<tr>
<td>Wall Thickness</td>
<td>input of the pipe wall thickness</td>
</tr>
<tr>
<td>3.0 mm</td>
<td>range: depends on the connected transducers</td>
</tr>
<tr>
<td></td>
<td>default: 3 mm</td>
</tr>
<tr>
<td>Pipe Material</td>
<td>selection of the pipe material</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td></td>
</tr>
<tr>
<td>c-Material</td>
<td>input of the sound speed of the pipe material</td>
</tr>
<tr>
<td>3230.0 m/s</td>
<td>range: 600...6553.5 m/s</td>
</tr>
<tr>
<td>Lining no &gt;YES&lt;</td>
<td>This display will only be indicated if Other Material has been selected.</td>
</tr>
<tr>
<td>Lining Bitumen</td>
<td>selection whether the pipe is lined</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>c-Material</td>
<td>input of the sound speed of the lining material</td>
</tr>
<tr>
<td>3200.0 m/s</td>
<td>range: 600...6553.5 m/s</td>
</tr>
<tr>
<td>Lining Bitumen</td>
<td>This display will only be indicated if Other Material has been selected.</td>
</tr>
<tr>
<td>Liner Thickness</td>
<td>input of the liner thickness</td>
</tr>
<tr>
<td>3.0 mm</td>
<td>default: 3 mm</td>
</tr>
<tr>
<td>Roughness</td>
<td>input of the roughness of the inner pipe wall</td>
</tr>
<tr>
<td>0.4 mm</td>
<td>range: 0...5 mm</td>
</tr>
<tr>
<td></td>
<td>default: 0.1 mm (for steel as pipe material)</td>
</tr>
<tr>
<td>Medium Water</td>
<td>selection of the medium</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>c-Medium</td>
<td>input of the average sound speed of the medium</td>
</tr>
<tr>
<td>1500.0 m/s</td>
<td>range: 500...3500 m/s</td>
</tr>
<tr>
<td></td>
<td>This display will only be indicated if Other Medium has been selected.</td>
</tr>
</tbody>
</table>
selection of the range of the sound speed
auto: The area around the average sound speed is defined by the transmitter.
user: The area around the average sound speed has to be entered.

input of the range around the average sound speed of the medium
This display will only be indicated if Other Medium has been selected.

input of the kinematic viscosity of the medium
range: 0.01...30 000 mm²/s
This display will only be indicated if Other Medium has been selected or no data set for the selected medium is stored in the transmitter.

input of the operating density of the medium
range: 0.01...20 g/cm³
This display will only be indicated if Other Medium has been selected.

input of the medium temperature
default: 20 °C

input of the medium pressure
range: 1...600 bar
This display will only be indicated if Special Funct.
SYSTEM settings\Dialogs/Menus\ Fluid pressure is activated.

selection of the transducer type
This display will only be indicated if no or special transducers are connected.

input of the length of an extension cable

When a Calculation Channel is Selected (Y, Z)
Calculation channels will only be available if the transmitter has more than one measuring channel.

display of the current calculation function

selection of the calculation function

Program Branch Measuring
main menu: selection of the program branch Measuring

activation of the channels
This display will not be indicated if the transmitter has only one measuring channel.

input of the measuring point number
This display will only be indicated if Output Options\Store Meas.Data and/or Serial Output are activated.

activation/deactivation of the flow profile correction
This display will only be indicated if Special Funct.
SYSTEM settings\Measuring\Flow Velocity = uncorr. has been selected.
input of the number of sound paths

display of the transducer distance to be adjusted between the inner edges of the transducers

Program Branch Output Options

main menu: selection of the program branch Output Options

selection of the channel whose output options are to be defined

selection of the physical quantity

selection of the unit of measurement for the physical quantity

activation of a temperature input
This display will only be indicated if the temperature input T1 has been assigned to the channel in Special Funct.\SYSTEM settings\Proc. inputs\Link temperature.

activation of a current input for an external temperature measurement
This display will only be indicated if the input I1 has been assigned to the channel in Special Funct.\SYSTEM settings\Proc. inputs\Link other inp..

input of the duration over which a floating average of the measured values has to be determined
range: 1...600 s

activation of the data logger

activation of the measured value transmission to a PC or a printer via the serial interface

selection of the storage rate for storing measured values in the data logger
This display will only be indicated if Output Options\Store Meas.Data and/or Serial Output are activated.

Input of the storage rate if Storage Rate = EXTRA has been selected
range: 1...43 200 s (= 12 h)

Current Loop

activation of a current output
This display will only be indicated if the current output has been installed in Special Funct.\SYSTEM settings\Proc. outputs.

selection whether the sign of the measured values is to be considered for the output
This display will only be indicated if Current Loop is activated.
input of the lowest/highest measured value to be expected for the current output
The values are assigned to the lower/upper limit of the output range.
These displays will only be indicated if Current Loop is activated.

input of the error value delay, i.e. of the time interval after which the value entered for the error output will be transmitted to the output if no valid measured values are available
This display will only be indicated if Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay = EDIT has been selected.

**Pulse Output**

Activation of a Pulse Output
This display will only be indicated if a pulse output has been installed in Special Funct.\SYSTEM settings\Dialogs/Menus\Proc. outputs.

input of the pulse value (value of the totalizer at which a pulse will be emitted)
This display will only be indicated if Pulse Output is activated.

input of the pulse width
range: 1 or 80...1000 ms
This display will only be indicated if Pulse Output is activated.

**Alarm Output**

Activation of an alarm output
This display will only be indicated if an alarm output has been installed in Special Funct.\SYSTEM settings\Proc. outputs.

Selection of the switching condition (func), the holding behavior (typ) and the switching function (mode) of the alarm output.
This display will only be indicated if Alarm Output is activated.

selection of the physical quantity to be monitored
This display will only be indicated for R1 if Alarm Output is activated.

input of the upper limit of the physical quantity to be monitored
This display will only be indicated if Alarm Output has been activated and MAX has been selected as the switching condition.

input of the lower limit of the physical quantity to be monitored
This display will only be indicated if Alarm Output has been activated and MIN has been selected as the switching condition.

input of the limit for the totalizer of the physical quantity to be monitored
This display will only be indicated if Alarm Output has been activated and QUANT. has been selected as the switching condition.

input of the hysteresis for the lower or upper limit
This display will only be indicated if Alarm Output has been activated and MIN or MAX has been selected as the switching condition.

**Program Branch Special Funct.**

main menu: selection of the program branch Special Funct.
<table>
<thead>
<tr>
<th>SYSTEM settings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Funct.</td>
<td>selection of Special Funct.</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td></td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td>Set Clock</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td>Libraries</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td>Libraries \ Material list</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td>Libraries \ Medium list</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td>Libraries \ Format USER-AREA</td>
</tr>
<tr>
<td>Libraries \ Format USER-AREA</td>
<td></td>
</tr>
<tr>
<td>Materials:</td>
<td>03</td>
</tr>
<tr>
<td>Media:</td>
<td>03</td>
</tr>
<tr>
<td>Heat-Coeffs:</td>
<td>00</td>
</tr>
<tr>
<td>Steam-Coeffs:</td>
<td>00</td>
</tr>
<tr>
<td>USER AREA:</td>
<td>52% used</td>
</tr>
<tr>
<td>Format NOW?</td>
<td>yes &gt;YES&lt;</td>
</tr>
<tr>
<td>FORMATTING ...</td>
<td></td>
</tr>
</tbody>
</table>
### SYSTEM settings\Libraries\Extended Library

- **Libraries**
  - 1
- **Extended Library**
  - off >ON<

**selection of the displays for the activation of the extended library**

**activation of the extended library**

### SYSTEM settings\Dialogs/Menus

- **SYSTEM settings\Dialogs/Menus**
- **Pipe Circumfer.**
  - off >ON<
- **Fluid pressure**
  - off >ON<
- **Meas. Point No.:**
  - (1234) >{↑↓←→}<
- **Transd. Distance**
  - auto >USER<
- **Steam in inlet**
  - off >ON<
- **Tx Corr. Offset**
  - off >ON<
- **Error=val. delay damping**
  - >EDIT<
- **SHOW RELAIS STAT**
  - off >ON<
- **Length unit**
  - >[mm]< [inch]
- **Temperature**
  - >[°C]< [°F]
- **Pressure absolut**
  - off >ON<

**selection of the displays for the activation/deactivation or setting of the menu items in the other program branches**

**activation of the menu item for the input of the pipe circumference in the program branch**

**activation of the menu item for the input of the medium pressure in the program branch**

**selection of the input mode for the measuring point number in the program branch Measuring:**
- user: only the entered transducer distance will be displayed if the recommended and the entered transducer distances are identical
- auto: only the recommended transducer distance will be displayed

**recommended setting: user**

**setting for the display for the input of the transducer distance in the program branch Measuring:**
- damping: The damping factor will be used.
- edit: The menu item for the input of the error value delay in the program branch Output Options will be activated.

**activation of the menu item for the input of the supply pressure in the program branch**

**activation of the menu item for the input of a correction value (offset) for each temperature input in the program branch Measuring**

**selection of the error value delay**
- damping: The damping factor will be used.
- edit: The menu item for the input of the error value delay in the program branch Output Options will be activated.

**activation of the display of the alarm state during the measurement**

**selection of the unit of measurement for the length**

**selection of the unit of measurement for the temperature**

**selection if the absolute pressure \( p_a \) or the relative pressure \( p_g \) is to be used**
### Selections for Units of Measurement

<table>
<thead>
<tr>
<th>Selection</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure</strong></td>
<td>![Pressure Symbol] &lt; [psi]</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>![Density Symbol] &lt; [lb/ft³]</td>
</tr>
<tr>
<td><strong>Density Unit</strong></td>
<td>![Density Unit Symbol] &lt; [g/cm³] &lt; [kg/m³]</td>
</tr>
<tr>
<td><strong>Viscosity Unit</strong></td>
<td>![Viscosity Unit Symbol] &lt; [mm²/s] &lt; [cSt]</td>
</tr>
<tr>
<td><strong>Sound Speed Unit</strong></td>
<td>![Sound Speed Unit Symbol] &lt; [m/s] &lt; [fps]</td>
</tr>
</tbody>
</table>

### System Settings \ Proc. Inputs

- Selection of the displays for the setting of the inputs of the transmitter
- Assignment of temperature inputs and other inputs to the measuring channels

### System Settings \ Measuring

- Selection of the displays for the settings of the measurement
- Activation of the WaveInjector (optional)
<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable NoiseTrek</td>
<td>enabling of the NoiseTrek mode</td>
</tr>
<tr>
<td>Auto NoiseTrek?</td>
<td>Selection if the toggling between the TransitTime and the NoiseTrek mode has to be carried out manually or automatically. This display will only be indicated if the NoiseTrek mode is enabled.</td>
</tr>
<tr>
<td>TT-Failed</td>
<td>Input of the time after which the transmitter has to toggle to the NoiseTrek mode if there are no valid measured values in the TransitTime mode. range: 0...9999 s 0: no toggling to the NoiseTrek mode This display will only be indicated if the automatic toggling between the Transit-Time and the NoiseTrek mode is activated.</td>
</tr>
<tr>
<td>NT-Failed</td>
<td>Input of the time after which the transmitter has to toggle to the TransitTime mode if there are no valid measured values in the NoiseTrek mode. range: 0...9999 s 0: no toggling to the TransitTime mode This display will only be indicated if the automatic toggling between the Transit-Time and the NoiseTrek mode is activated.</td>
</tr>
<tr>
<td>NT-Ok, but Each</td>
<td>Input of the time after which the transmitter has to toggle to the TransitTime mode. range: 0...9999 s 0: no toggling to the TransitTime mode This display will only be indicated if the automatic toggling between the Transit-Time and the NoiseTrek mode is activated.</td>
</tr>
<tr>
<td>Keep TT</td>
<td>Input of the cut-off flow for positive measured values range: 0...12.7 cm/s (0.127 m/s) default: 2.5 cm/s (0.025 m/s) This display will only be indicated if Cut-off Flow = sign and Cut-off Flow = user has been selected.</td>
</tr>
<tr>
<td>Compare c-fluid</td>
<td>selection whether the flow velocity is displayed and transmitted with or without profile correction</td>
</tr>
<tr>
<td>Flow Velocity</td>
<td>input of an upper limit of the flow velocity range: 0.1...25.5 m/s 0 m/s: no detection for outliers All measured values that are greater than the limit will be marked as outliers.</td>
</tr>
<tr>
<td>Velocity limit</td>
<td>selection of the input of a lower limit for the flow velocity: • absolut: independent of the flow direction • sign: dependent on the flow direction activation of the input of a lower limit of the flow velocity: • factory: the default limit of 2.5 cm/s will be used • user: input of a limit</td>
</tr>
<tr>
<td>Cut-off Flow</td>
<td>input of the cut-off flow for positive measured values range: 0...12.7 cm/s (0.127 m/s) default: 2.5 cm/s (0.025 m/s) This display will only be indicated if Cut-off Flow = sign and Cut-off Flow = user has been selected.</td>
</tr>
</tbody>
</table>
### Input of the cut-off flow for negative measured values

- **Range:** -12.7...0 cm/s
- **Default:** -2.5 cm/s

This display will only be indicated if `Cut-off Flow = sign` and `Cut-off Flow = user` has been selected.

### Input of the cut-off flow for the absolute value of the measured values

- **Range:** 0...12.7 cm/s
- **Default:** 2.5 cm/s

This display will only be indicated if `Cut-off Flow = absolut` and `Cut-off Flow = user` has been selected.

### Input of the max. signal amplification.

- **Range:** 0...255
- **Default:** 0: no limit of the signal amplification

This display will only be indicated if the SuperUser mode is activated.

### Input of the fixed upper limit of the sound speed.

- **Range:** 0...3000 m/s
- **Default:** 0: the default value 1848 m/s is used

This display will only be indicated if the SuperUser mode is activated.

### Input of the offset.

- **Range:** 0...900 m/s
- **Default:** 0: the default value 300 m/s is used

This display will only be indicated if the SuperUser mode is activated.

### Selection of the unit of measurement for the heat quantity

- **Activation of the transmission and storing of the heat quantity totalizer values during the heat flow measurement**

- **Activation of the overflow of the totalizers**

- **Activation of the taking-over of the totalizer values after a restart of the measurement**

- **Input of the time interval without any valid measured values after which the transmitter recognizes a long measurement failure**
  - **Default:** 0: the default value 30 s is used

This display will only be indicated if the SuperUser mode is activated.

### Input of the number of decimal places for the totalizers:

- **Automatic:** dynamic adjustment
- **Fixed to x digit:** 0...4 decimal places

This display will only be indicated if the SuperUser mode is activated.

### Activation of the temperature-based heat flow cut-off

This display will only be indicated if the SuperUser mode is activated.
<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal flow -&gt;0</td>
<td>Input of the limit for the temperature difference. All temperature differences between the supply and return line that are lower than this value will be set to zero.</td>
</tr>
<tr>
<td>if</td>
<td>(dT</td>
</tr>
<tr>
<td>3xC clear totals</td>
<td>Activation of the manual reset of the totalizers. This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>off &gt;ON&lt;</td>
<td></td>
</tr>
<tr>
<td>Show ΣQ</td>
<td>Activation of the display of the sum of the totalizers. This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>off &gt;ON&lt;</td>
<td></td>
</tr>
<tr>
<td>Keep display val</td>
<td>Activation of the display of the last valid measured value. This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>off &gt;ON&lt;</td>
<td></td>
</tr>
<tr>
<td>Turbulence mode off</td>
<td>Activation of the turbulence mode. This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>&gt;ON&lt;</td>
<td></td>
</tr>
</tbody>
</table>

### Special Functions 

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibrat. data : for Channel A:</td>
<td>selection of the measuring channel for which the flow parameters are to be defined  This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>A:Profile bounds</td>
<td>definition of the profile bounds  factory: the default profile bounds is used  user: the profile bounds can be defined  This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>factory &gt;USER&lt;</td>
<td></td>
</tr>
<tr>
<td>Laminar flow</td>
<td>Input of the max. Reynolds number at which the flow is laminar.  range: 0...25 500 (rounded to hundreds)  0: the default value 1 000 is used  This display will only be indicated if the SuperUser mode is activated and Profile bounds = user is selected.</td>
</tr>
<tr>
<td>if R*&lt; 0</td>
<td></td>
</tr>
<tr>
<td>Turbulent flow</td>
<td>input of the min. Reynolds number at which the flow is turbulent.  range: 0...25 500 (rounded to hundreds)  0: the default value 3 000 is used  This display will only be indicated if the SuperUser mode is activated and Profile bounds = user is selected.</td>
</tr>
<tr>
<td>if R*&gt; 0</td>
<td></td>
</tr>
<tr>
<td>A:Calibration ?</td>
<td>request if an additional correction of the flow velocity is to be defined  on: the correction data can be defined  off: no correction of the flow velocity will be used  This display will only be indicated if the SuperUser mode is activated.</td>
</tr>
<tr>
<td>&gt;OFF&lt; on</td>
<td></td>
</tr>
<tr>
<td>A:Slope= 1.00</td>
<td>input of the slope for the correction formula.  range: -2.000...+2.000  0: no correction  This display will only be indicated if the SuperUser mode is activated and Calibration = on is selected.</td>
</tr>
</tbody>
</table>
input of the offset.
range: -12.7...+12.7 cm/s
0: no offset
This display will only be indicated if the SuperUser mode is activated and Calibration = on is selected.

**SYSTEM settings\Proc. outputs**

- selection of the displays for the setting of the outputs of the transmitter
- selection of the output to be installed

**SYSTEM settings\Storing**

- selection of the displays for the storing of measured values in the data logger
- setting of the overflow behavior of the data logger
- selection of the sample mode
  - sample: storing and online transmission of the displayed measured value
  - average: storing and online transmission of the average of all measured values of a storage interval
- setting of the storing behavior of the totalizers
  - one: the value of the totalizer that is currently displayed will be stored
  - both: one value for each flow direction will be stored
- activation of the storing of the signal amplitude
  - The value will only be stored if the data logger is activated.
- activation of the storing of the sound speed of the medium
  - The value will only be stored if the data logger is activated.
- activation of the storing of diagnostic values
- activation of an acoustic signal every time a measured value is stored or transmitted

**SYSTEM settings\serial transmis.**

- selection of the displays for the formatting of the serial transmission of measured values
- activation of the serial transmission of data with/without blanks
- selection of the decimal marker for floating point numbers
<table>
<thead>
<tr>
<th>Menu Structure</th>
<th>INIT-resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>SER: col-separat.</td>
<td>x</td>
</tr>
<tr>
<td>',' &gt; 'TAB' &lt;</td>
<td></td>
</tr>
<tr>
<td>Send Offline via</td>
<td>x</td>
</tr>
<tr>
<td>RS232 &gt; RS485&lt;</td>
<td></td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td></td>
</tr>
<tr>
<td>NETWORK</td>
<td></td>
</tr>
<tr>
<td>change of the settings of the transmission parameters of the RS485 interface</td>
<td></td>
</tr>
<tr>
<td>input of the address of the measuring instrument</td>
<td>x</td>
</tr>
<tr>
<td>confirmation or change of the transmission parameters</td>
<td>x</td>
</tr>
<tr>
<td>change of the baud rate, parity or number of stop bits</td>
<td>x</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td></td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td></td>
</tr>
<tr>
<td>selection of the display for the setting of the contrast</td>
<td></td>
</tr>
<tr>
<td>setting of the contrast of the display</td>
<td></td>
</tr>
<tr>
<td>Instrum. Inform.</td>
<td></td>
</tr>
<tr>
<td>selection of the displays for information about the transmitter</td>
<td>x</td>
</tr>
<tr>
<td>display of the type, serial number and max. available data logger memory</td>
<td>x</td>
</tr>
<tr>
<td>display of the type, serial number and firmware version with the date (dd - day, mm - month, yy - year)</td>
<td>x</td>
</tr>
<tr>
<td>Print Meas. Val.</td>
<td></td>
</tr>
<tr>
<td>selection of the displays for the transmission of stored measured values to a PC</td>
<td></td>
</tr>
<tr>
<td>start of the transmission of measured values</td>
<td></td>
</tr>
<tr>
<td>This display will only be indicated if the data logger contains measured values and the transmitter is connected to a PC via a serial cable.</td>
<td></td>
</tr>
<tr>
<td>display of the data transmission progress</td>
<td></td>
</tr>
</tbody>
</table>
**Delete Meas. Val.**

- **Special Funct. ↓**
  - **Delete Meas. Val.**

  Selection of the displays for the deleting of stored measured values.

- **Really Delete?**
  - **no >YES<**

  Confirmation for the deleting of measured values. This display will only be indicated if measured values are stored in the data logger.

**Install Material**

- **Special Funct. ↓**
  - **Install Material**

  Selection of the displays for the input of the pipe and lining materials.

**Install Material With Special Funct.**

- **SYSTEM settings\Libraries\Extended Library = off**

  Selection whether a user-defined material is to be edited or deleted.

  - **Install Material >EDIT< delete**

  Selection of a user-defined material.

  - **USER Material ↓**
    - **#01:--not used--**

    Input of a designation for the selected material.

  - **EDIT TEXT (↑↓←) USER MATERIAL 1**

    Input of the sound speed of the material.

    - **c-Material**
      - **1590.0 m/s**

    Input of the roughness of the material.

    - **Roughness**
      - **0.4 mm**

**Install Material With Special Funct.**

- **SYSTEM settings\Libraries\Extended Library = on**

  Selection of the function for the temperature and pressure dependence of the material properties.

  - **Edit Material ↓**
    - **Basics: Y=m*X +n**

  Selection of a user-defined material.

  - **USER Material ↓**
    - **#01:--not used--**

  Selection whether the user-defined material is to be edited or deleted.

  This display will only be indicated if the selected material already exists.

  - **USER Material 2 >EDIT< delete**

  Input of a designation for the selected material.

  - **#2: Input Name:**
    - **USER MATERIAL 2**

  Input of the constants for the transversal sound speed of the material.

  - **T-SOUNDSP.**
    - **1500.0 m/s**

  Input of the constants for the longitudinal sound speed of the material.

  - **L-SOUNDSP.**
    - **1500.0 m/s**

  Selection of the sound wave type for the flow measurement.

  - **Default soundsp. long. >TRANS.<**
input of the roughness of the material

confirmation that the changes are to be stored
This display will only be indicated if a new material has been entered or the properties of an existing material have been changed.

<table>
<thead>
<tr>
<th>Install Medium</th>
<th>selection of the displays for the input of media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install Medium</td>
<td>selection whether a user-defined medium is to be edited or deleted</td>
</tr>
<tr>
<td>USER Medium</td>
<td>selection of a user-defined medium</td>
</tr>
<tr>
<td>EDIT TEXT</td>
<td>input of a designation for the selected medium</td>
</tr>
<tr>
<td>c-Medium</td>
<td>input of the sound speed of the medium range: 500.0...3500.0 m/s</td>
</tr>
<tr>
<td>c-Medium=1500m/s</td>
<td>input of the range around the average sound speed of the medium range: 50...999 m/s</td>
</tr>
<tr>
<td>Kinem.Viscosity</td>
<td>input of the kinematic viscosity of the medium range: 0.01...30 000.00 mm²/s</td>
</tr>
<tr>
<td>Density</td>
<td>input of the operating density of the medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Install Medium with Special Funct. \SYSTEM settings\Libraries\Extended Library = off</th>
<th>selection of the function for the temperature and pressure dependence of the medium properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edit Medium</td>
<td>selection of a user-defined medium</td>
</tr>
<tr>
<td>USER Medium</td>
<td>selection whether the user-defined medium is to be edited or deleted This display will only be indicated if the selected medium already exists.</td>
</tr>
<tr>
<td>#2: Input Name:</td>
<td>input of a designation for the selected medium</td>
</tr>
<tr>
<td>SOUNDSPEED</td>
<td>input of the constants for the longitudinal sound speed of the medium The number of constants depends on the function selected above.</td>
</tr>
<tr>
<td>Feature</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>VISCOSITY</td>
<td>input of the kinematic viscosity of the medium</td>
</tr>
<tr>
<td>DENSITY</td>
<td>input of the operating density of the medium</td>
</tr>
<tr>
<td>Save changes</td>
<td>confirmation that the changes are to be stored</td>
</tr>
<tr>
<td>Special Funct.</td>
<td>This display will only be indicated if a new medium has been entered or the properties of an existing medium have been changed.</td>
</tr>
<tr>
<td>SYSTEM settings</td>
<td>selection of the menu item for the remote functions</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>selection of the channel for which the remote function is to be configured</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>selection of the method for the configuration or deactivation of the remote function of the selected channel</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>The actual measured flow velocity will be ignored and the measured value will be set to 0.</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>The totalizers are reset to 0. The totalizers are deactivated for the duration of the switching signal.</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>If the totalizers are reset to 0 with using the remote function, a downward arrow will be displayed next to the value of the totalizer during the measurement.</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>The totalizers are stopped for the duration of the switching signal.</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>The FastFood mode is activated for the duration of the switching signal.</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>stop of the editing of the remote function</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>selection of the binary input which is to be used to trigger the previously selected remote function (here: clear totals)</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>selection of the channel from which the remote function configuration is to be copied to the currently selected channel</td>
</tr>
<tr>
<td>Remote inputs</td>
<td>selection for the reset of the remote function</td>
</tr>
<tr>
<td>After the Input of HotCode 071001</td>
<td>input of the lower limit of the inner pipe diameter for the displayed transducer type</td>
</tr>
<tr>
<td>DNmin Q-Sensor</td>
<td>range: 3...63 mm</td>
</tr>
</tbody>
</table>
# 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>
</tr>
<tr>
<td>inch</td>
<td>inch</td>
</tr>
</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>
</tr>
</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>
</tbody>
</table>

## Kinematic viscosity

<table>
<thead>
<tr>
<th>Unit of measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm²/s</td>
<td>square millimeter per second</td>
</tr>
</tbody>
</table>

1 mm²/s = 1 cSt

## Flow velocity

<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>cm/s</td>
<td>centimeter per second</td>
</tr>
<tr>
<td>in/s</td>
<td>inch per second</td>
</tr>
<tr>
<td>fps (ft/s)</td>
<td>foot per second</td>
</tr>
<tr>
<td>Volumetric flow rate</td>
<td>description</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>unit of measurement</td>
<td></td>
</tr>
<tr>
<td>m³/d</td>
<td>cubic meter per day</td>
</tr>
<tr>
<td>m³/h</td>
<td>cubic meter per hour</td>
</tr>
<tr>
<td>m³/min</td>
<td>cubic meter per minute</td>
</tr>
<tr>
<td>m³/s</td>
<td>cubic meter per second</td>
</tr>
<tr>
<td>km³/h</td>
<td>1000 cubic meters per hour</td>
</tr>
<tr>
<td>ml/min</td>
<td>milliliter per minute</td>
</tr>
<tr>
<td>l/h</td>
<td>liter per hour</td>
</tr>
<tr>
<td>l/min</td>
<td>liter per minute</td>
</tr>
<tr>
<td>l/s</td>
<td>liter per second</td>
</tr>
<tr>
<td>hl/h</td>
<td>hectoliter per hour</td>
</tr>
<tr>
<td>hl/min</td>
<td>hectoliter per minute</td>
</tr>
<tr>
<td>hl/s</td>
<td>hectoliter per second</td>
</tr>
<tr>
<td>Ml/d (Megalit/d)</td>
<td>megaliter per day</td>
</tr>
<tr>
<td>bbl/d</td>
<td>barrel per day</td>
</tr>
<tr>
<td>bbl/h</td>
<td>barrel per hour</td>
</tr>
<tr>
<td>bbl/m</td>
<td>barrel per minute</td>
</tr>
<tr>
<td>USgpd (US-gal/d)</td>
<td>gallon per day</td>
</tr>
<tr>
<td>USgph (US-gal/h)</td>
<td>gallon per hour</td>
</tr>
<tr>
<td>USgpm (US-gal/m)</td>
<td>gallon per minute</td>
</tr>
<tr>
<td>USgps (US-gal/s)</td>
<td>gallon per second</td>
</tr>
<tr>
<td>KGPM (US-Kgal/m)</td>
<td>kilogallon per minute</td>
</tr>
<tr>
<td>MGD (US-Mgal/d)</td>
<td>million gallons per day</td>
</tr>
<tr>
<td>CFD</td>
<td>cubic foot per day</td>
</tr>
<tr>
<td>CFH</td>
<td>cubic foot per hour</td>
</tr>
<tr>
<td>CFM</td>
<td>cubic foot per minute</td>
</tr>
<tr>
<td>CFS</td>
<td>cubic foot per second</td>
</tr>
<tr>
<td>MMCFD</td>
<td>million cubic feet per day</td>
</tr>
<tr>
<td>MMCFH</td>
<td>million cubic feet per hour</td>
</tr>
</tbody>
</table>

* Selection with HotCode 007027, firmware version V5.91 or higher
** cft: cubic foot
*** aft: acre foot
1 US-gal = 3.78541 l
1 bbl = 42 US-gal = 158.9873 l
### Mass flow rate

<table>
<thead>
<tr>
<th>Unit of Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>t/h</td>
<td>metric ton per hour</td>
</tr>
<tr>
<td>t/d</td>
<td>metric 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

### Heat flow rate

<table>
<thead>
<tr>
<th>Unit of Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Watt</td>
</tr>
<tr>
<td>kW</td>
<td>kilowatt</td>
</tr>
<tr>
<td>MW</td>
<td>megawatt</td>
</tr>
<tr>
<td>GW</td>
<td>gigawatt</td>
</tr>
<tr>
<td>kBTU/minute</td>
<td>kBTU per minute</td>
</tr>
<tr>
<td>kBTU/hour</td>
<td>kBTU per hour</td>
</tr>
<tr>
<td>MBTU/hour</td>
<td>MBTU per hour</td>
</tr>
<tr>
<td>MBTU/day</td>
<td>MBTU per day</td>
</tr>
<tr>
<td>TON (TH)</td>
<td>TON, totals in TONhours</td>
</tr>
<tr>
<td>TON (TD)</td>
<td>TON, totals in TONdays</td>
</tr>
<tr>
<td>kTON (kTH)</td>
<td>kTON, totals in TONhours</td>
</tr>
<tr>
<td>kTON (kTD)</td>
<td>kTON, totals in TONdays</td>
</tr>
</tbody>
</table>

BTU: British Thermal Unit
1 W = 1 J/s = (1/1055.05555262) BTU/s
TON: ton of refrigeration
1 W = 1 J/s = (1/3516.852842) TON
1 TON = 200 BTU/min

*Selection in Special Func. SYSTEM settings Measuring
Flow Nomogram (Metrical)

- Flow velocity [m/s]
- Volumetric flow rate

The diagram shows the relationship between flow velocity and volumetric flow rate using logarithmic scales.
Flow Nomogram (Imperial)
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 sound speed (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>carbon steel</td>
<td>3 230</td>
<td>5 930</td>
<td>trans</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>stainless steel</td>
<td>3 100</td>
<td>5 790</td>
<td>trans</td>
</tr>
<tr>
<td>DUPLEX</td>
<td>duplex stainless steel</td>
<td>3 272</td>
<td>5 720</td>
<td>trans</td>
</tr>
<tr>
<td>Ductile Iron</td>
<td>ductile cast iron</td>
<td>2 650</td>
<td>-</td>
<td>trans</td>
</tr>
<tr>
<td>Asbestos Cement</td>
<td>asbestos cement</td>
<td>2 200</td>
<td>-</td>
<td>trans</td>
</tr>
<tr>
<td>Titanium</td>
<td>titanium</td>
<td>3 067</td>
<td>5 955</td>
<td>trans</td>
</tr>
<tr>
<td>Copper</td>
<td>copper</td>
<td>2 260</td>
<td>4 700</td>
<td>trans</td>
</tr>
<tr>
<td>Aluminium</td>
<td>aluminum</td>
<td>3 100</td>
<td>6 300</td>
<td>trans</td>
</tr>
<tr>
<td>Brass</td>
<td>brass</td>
<td>2 100</td>
<td>4 300</td>
<td>trans</td>
</tr>
<tr>
<td>Plastic</td>
<td>plastic</td>
<td>1 120</td>
<td>2 000</td>
<td>long</td>
</tr>
<tr>
<td>GRP</td>
<td>glass-reinforced plastic</td>
<td>-</td>
<td>2 650</td>
<td>long</td>
</tr>
<tr>
<td>PVC</td>
<td>polyvinyl chloride</td>
<td>-</td>
<td>2 395</td>
<td>long</td>
</tr>
<tr>
<td>PE</td>
<td>polyethylene</td>
<td>540</td>
<td>1 950</td>
<td>long</td>
</tr>
<tr>
<td>PP</td>
<td>polypropylene</td>
<td>2 600</td>
<td>2 550</td>
<td>trans</td>
</tr>
<tr>
<td>Bitumen</td>
<td>bitumen</td>
<td>2 500</td>
<td>-</td>
<td>trans</td>
</tr>
<tr>
<td>Acrylic</td>
<td>acrylic glass</td>
<td>1 250</td>
<td>2 730</td>
<td>long</td>
</tr>
<tr>
<td>Lead</td>
<td>lead</td>
<td>700</td>
<td>2 200</td>
<td>long</td>
</tr>
<tr>
<td>Cu-Ni-Fe</td>
<td>alloy of copper, nickel, and iron</td>
<td>2 510</td>
<td>4 900</td>
<td>trans</td>
</tr>
<tr>
<td>Grey Cast Iron</td>
<td>gray cast iron</td>
<td>2 200</td>
<td>4 600</td>
<td>trans</td>
</tr>
<tr>
<td>Rubber</td>
<td>rubber</td>
<td>1 900</td>
<td>2 400</td>
<td>trans</td>
</tr>
<tr>
<td>Glass</td>
<td>glass</td>
<td>3 400</td>
<td>5 600</td>
<td>trans</td>
</tr>
<tr>
<td>PFA</td>
<td>perfluoroalkoxy</td>
<td>500</td>
<td>1 185</td>
<td>long</td>
</tr>
<tr>
<td>PVDF</td>
<td>polyvinylidene fluoride</td>
<td>760</td>
<td>2 050</td>
<td>long</td>
</tr>
<tr>
<td>Sintimid</td>
<td>Sintimid</td>
<td>-</td>
<td>2 472</td>
<td>long</td>
</tr>
<tr>
<td>Teka PEEK</td>
<td>Teka PEEK</td>
<td>-</td>
<td>2 534</td>
<td>long</td>
</tr>
<tr>
<td>Tekason</td>
<td>Tekason</td>
<td>-</td>
<td>2 230</td>
<td>long</td>
</tr>
</tbody>
</table>

The sound speed depends on the composition and the manufacturing process of the material. The sound speed of alloys and cast materials fluctuates strongly. The values only serve as an orientation.
C.2 Typical Roughnesses 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 Media at 20 °C and 1 bar

<table>
<thead>
<tr>
<th>medium (display)</th>
<th>explanation</th>
<th>sound speed [m/s]</th>
<th>kinematic viscosity [mm²/s]</th>
<th>density [g/cm³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>acetone</td>
<td>1 190</td>
<td>0.4</td>
<td>0.73</td>
</tr>
<tr>
<td>Ammonia (NH₃)</td>
<td>ammonia (NH₃)</td>
<td>1 386</td>
<td>0.2</td>
<td>0.6130</td>
</tr>
<tr>
<td>Gasoline</td>
<td>gasoline</td>
<td>1 295</td>
<td>0.7</td>
<td>0.8800</td>
</tr>
<tr>
<td>Beer</td>
<td>beer</td>
<td>1 482</td>
<td>1.0</td>
<td>0.9980</td>
</tr>
<tr>
<td>BP Transcal LT</td>
<td>BP Transcal LT</td>
<td>1 365</td>
<td>20.1</td>
<td>0.8760</td>
</tr>
<tr>
<td>BP Transcal N</td>
<td>BP Transcal N</td>
<td>1 365</td>
<td>94.3</td>
<td>0.8760</td>
</tr>
<tr>
<td>Diesel</td>
<td>diesel fuel</td>
<td>1 210</td>
<td>7.1</td>
<td>0.8260</td>
</tr>
<tr>
<td>Ethanol</td>
<td>ethanol</td>
<td>1 402</td>
<td>1.5</td>
<td>0.7950</td>
</tr>
<tr>
<td>HF acid 50%</td>
<td>hydrofluoric acid, 50 %</td>
<td>1 221</td>
<td>1.0</td>
<td>0.9980</td>
</tr>
<tr>
<td>HF acid 80%</td>
<td>hydrofluoric acid, 80 %</td>
<td>777</td>
<td>1.0</td>
<td>0.9980</td>
</tr>
<tr>
<td>Glycol</td>
<td>glycol</td>
<td>1 665</td>
<td>18.6</td>
<td>1.1100</td>
</tr>
<tr>
<td>20% Glycol / H₂O</td>
<td>glycol/H₂O, 20 %</td>
<td>1 655</td>
<td>1.7</td>
<td>1.0280</td>
</tr>
<tr>
<td>30% Glycol / H₂O</td>
<td>glycol/H₂O, 30 %</td>
<td>1 672</td>
<td>2.2</td>
<td>1.0440</td>
</tr>
<tr>
<td>40% Glycol / H₂O</td>
<td>glycol/H₂O, 40 %</td>
<td>1 688</td>
<td>3.3</td>
<td>1.0600</td>
</tr>
<tr>
<td>50% Glycol / H₂O</td>
<td>glycol/H₂O, 50 %</td>
<td>1 705</td>
<td>4.1</td>
<td>1.0750</td>
</tr>
<tr>
<td>ISO VG 100</td>
<td>ISO VG 100</td>
<td>1 487</td>
<td>314.2</td>
<td>0.8690</td>
</tr>
<tr>
<td>ISO VG 150</td>
<td>ISO VG 150</td>
<td>1 487</td>
<td>539.0</td>
<td>0.8690</td>
</tr>
<tr>
<td>ISO VG 22</td>
<td>ISO VG 22</td>
<td>1 487</td>
<td>50.2</td>
<td>0.8690</td>
</tr>
<tr>
<td>ISO VG 220</td>
<td>ISO VG 220</td>
<td>1 487</td>
<td>811.1</td>
<td>0.8690</td>
</tr>
<tr>
<td>medium (display)</td>
<td>explanation</td>
<td>sound speed [m/s]</td>
<td>kinematic viscosity [mm²/s]</td>
<td>density [g/cm³]</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>------------------</td>
<td>-----------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>ISO VG 32</td>
<td>ISO VG 32</td>
<td>1.487</td>
<td>78.0</td>
<td>0.8690</td>
</tr>
<tr>
<td>ISO VG 46</td>
<td>ISO VG 46</td>
<td>1.487</td>
<td>126.7</td>
<td>0.8730</td>
</tr>
<tr>
<td>ISO VG 68</td>
<td>ISO VG 68</td>
<td>1.487</td>
<td>201.8</td>
<td>0.8750</td>
</tr>
<tr>
<td>Methanol</td>
<td>methanol</td>
<td>1.119</td>
<td>0.7</td>
<td>0.7930</td>
</tr>
<tr>
<td>Milk</td>
<td>milk</td>
<td>1.482</td>
<td>5.0</td>
<td>1.0000</td>
</tr>
<tr>
<td>Mobiltherm 594</td>
<td>Mobiltherm 594</td>
<td>1.365</td>
<td>7.5</td>
<td>0.8730</td>
</tr>
<tr>
<td>Mobiltherm 603</td>
<td>Mobiltherm 603</td>
<td>1.365</td>
<td>55.2</td>
<td>0.8590</td>
</tr>
<tr>
<td>caustic soda 10%</td>
<td>caustic soda, 10%</td>
<td>1.762</td>
<td>2.5</td>
<td>1.1140</td>
</tr>
<tr>
<td>caustic soda 20%</td>
<td>caustic soda, 20%</td>
<td>2.061</td>
<td>4.5</td>
<td>1.2230</td>
</tr>
<tr>
<td>Paraffin 248</td>
<td>paraffin 248</td>
<td>1.468</td>
<td>195.1</td>
<td>0.8450</td>
</tr>
<tr>
<td>R134 Freon</td>
<td>R134 Freon</td>
<td>0.522</td>
<td>0.2</td>
<td>1.2400</td>
</tr>
<tr>
<td>R22 Freon</td>
<td>R22 Freon</td>
<td>0.558</td>
<td>0.1</td>
<td>1.2130</td>
</tr>
<tr>
<td>Crudeoil hi-API</td>
<td>crude oil, light</td>
<td>1.163</td>
<td>14.0</td>
<td>0.8130</td>
</tr>
<tr>
<td>Crudeoil low API</td>
<td>crude oil, heavy</td>
<td>1.370</td>
<td>639.5</td>
<td>0.9220</td>
</tr>
<tr>
<td>30% H2SO4</td>
<td>sulphuric acid, 30 %</td>
<td>1.526</td>
<td>1.4</td>
<td>1.1770</td>
</tr>
<tr>
<td>80% H2SO4</td>
<td>sulphuric acid, 80 %</td>
<td>1.538</td>
<td>13.0</td>
<td>1.7950</td>
</tr>
<tr>
<td>96% H2SO4</td>
<td>sulphuric acid, 96 %</td>
<td>1.366</td>
<td>11.5</td>
<td>1.8350</td>
</tr>
<tr>
<td>Juice</td>
<td>juice</td>
<td>1.482</td>
<td>1.0</td>
<td>0.9980</td>
</tr>
<tr>
<td>HCl 25%</td>
<td>hydrochloric acid, 25 %</td>
<td>1.504</td>
<td>1.0</td>
<td>1.1180</td>
</tr>
<tr>
<td>HCl 37%</td>
<td>hydrochloric acid, 37 %</td>
<td>1.511</td>
<td>1.0</td>
<td>1.1880</td>
</tr>
<tr>
<td>Seawater</td>
<td>sea water</td>
<td>1.522</td>
<td>1.0</td>
<td>1.0240</td>
</tr>
<tr>
<td>Shell Thermina B</td>
<td>Shell Thermina B</td>
<td>1.365</td>
<td>89.3</td>
<td>0.8630</td>
</tr>
<tr>
<td>Silicon oil</td>
<td>silicone oil</td>
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### C.4 Properties of Water at 1 bar and at Saturation Pressure

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* at constant pressure
D Declarations of Conformity
We,

FLEXIM Flexible Industriemesstechnik GmbH
Boxberger Straße 4
12681 Berlin
Germany,

declare under our sole responsibility that the transmitters

FLUXUS "704**-NN, "705**-NN, "706**-NN, "709**-NN

to which this declaration relates are in conformity with the following EU directives:

- EMC Directive 2014/30/EU for Electromagnetic Compatibility
- Low Voltage Directive 2014/35/EU for Electrical Safety

The transmitters are in conformity with the following European standards when used with the FLEXIM transducers and accessories:

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<thead>
<tr>
<th>EU directive</th>
<th>Class</th>
<th>Standard</th>
<th>Description</th>
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<td>EMC Requirement</td>
<td>EN 61326-1:2013</td>
<td>Electrical equipment for measurement, control and laboratory use – EMC requirements – General requirements</td>
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<td>- Immunity</td>
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<td>Electrical equipment for continuous, unattended operation intended to be used in an industrial electromagnetic environment</td>
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The installation, operating and safety instructions have to be observed!

Berlin, 2017-10-19

Dipl.-Ing. Jens Hilpert
Managing Director